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FEASIBILITY STUDY ADDENDUM FOR INSTALLATION RESTORATION PROGRAM SITE 16

NCBC DAVISVILLE RI

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TETRA TECH

Feasibility Study Addendum
for
Installation Restoration Program Site 16

Former Naval Construction Battalion Center Davisville
North Kingstown, Rhode Island

Naval Facilities Engineering Command Mid-Atlantic

Contract Number N62470-08-D-1001

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FEASIBILITY STUDY ADDENDUM

FOR

INSTALLATION RESTORATION PROGRAM SITE 16

FORMER NAVAL CONSTRUCTION BATTALION CENTER DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criterion
BaPEq	Benzo(a)pyrene equivalent
bgs	Below ground surface
BRAC	Base Realignment and Closure
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CO_2e	Carbon dioxide equivalents
COC	Chemical of Concern
CSF	Cancer Slope Factor
CTO	Contract Task Order
CVOC	Chlorinated volatile organic compound
CWA	Clean Water Act
cy	Cubic yard
DCE	Dichloroethene
DEC	Direct Exposure Criterion
DO	Dissolved oxygen
DoD	Department of Defense
DPT	Direct push technology
EOS	Emulsified oil substrate
FEMA	Federal Emergency Management Agency
FS	Feasibility Study
FSA	Feasibility Study Addendum
ft^2	Square foot
GAC	Granular activated carbon
GHG	Greenhouse gas
IDW	Investigation derived waste
IR	Installation Restoration
LDR	Land Disposal Restriction
LUC	Land use control
LUC RD	Land use control remedial design
LUCIP	Land Use Control Implementation Plan
MCL	Maximum Contaminant Level

MCLG	Maximum Contaminant Level Goal
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MMBTU	Million British thermal units
MNA	Monitored natural attenuation
NAVFAC	Naval Facilities Engineering Command
NCA	North Central Area
NCBC	Naval Construction Battalion Center
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NERP	Navy Environmental Restoration Program
NESHAP	National Emissions Standards for Hazardous Air Pollutant
NO_x	Nitrogen oxides
NORAD	North American Distribution, Inc.
NPDES	National Pollutant Discharge Elimination System
NPW	Net Present Worth
NRWQC	National Recommended Water Quality Criteria
O&M	Operation and Maintenance
ORP	Oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PCE	Tetrachloroethene (also known as perchloroethene)
PM_{10}	Particulate matter with a diameter of 10 micrometers or less
PMO	Project Management Office
PPE	Personal protective equipment
ppb	Parts per billion
PRG	Preliminary Remediation Goal
PVC	Polyvinyl chloride
QDC	Quonset Development Corporation
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RfD	Reference Dose
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management
RIGL	Rhode Island General Laws
ROD	Record of Decision

SDWA	Safe Drinking Water Act
SO_x	Sulfur oxides
TBC	To Be Considered
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
TSD	Treatment, storage, and disposal
Tetra Tech	Tetra Tech, Inc.
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
USC	United States Code
USEPA	United States Environmental Protection Agency
VC	Vinyl chloride
VOC	Volatile organic compound
WMA	Waste management area

1.0 INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF REPORT

1.1.1 Purpose

This Feasibility Study (FS) Addendum (FSA) for Installation Restoration (IR) Program Site 16, Operable Unit (OU) 9, at the Former Naval Construction Battalion Center (NCBC) at Davisville, North Kingstown, Rhode Island, was prepared for Navy Facilities Engineering Command (NAVFAC) Mid-Atlantic by Tetra Tech, Inc. (Tetra Tech) under Contract Task Order (CTO) WE51 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62470-08-D-1001. The document was prepared to fulfill the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and is consistent with United States Environmental Protection Agency (USEPA) Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (1988) and the Navy Environmental Restoration Program (NERP) Manual, Chapter 8, Remedial Investigation/Feasibility Study (Navy, 2006). This FSA modifies and supplements the FS of May 2012 (Tetra Tech, 2012) and describes the evaluation of additional remedial alternatives for contaminated soil and groundwater at Site 16.

1.1.2 Document Organization

This FSA has been organized with the intent of meeting the general requirements for an FS specified in the Remedial Investigation/Feasibility Study (RI/FS) Guidance Document (USEPA, 1988). This report contains the following five sections:

- Section 1.0, Introduction, summarizes the purpose of the FSA, provides general site background information, and provides the report outline.

- Section 2.0, Additional Remedial Action Objectives, provides additional remedial action objectives (RAOs) that were developed after the FS was completed.

- Section 3.0, Detailed Analysis of the New Remedial Alternatives, describes the new alternatives, and performs a detailed analysis of these alternatives in accordance with seven of the nine CERCLA criteria.

- Section 4.0, Detailed Analyses of Common Revised Components, describes revised components that will be added to the existing alternatives. The detailed analysis of each component is developed.

- Section 5.0, Comparative Analysis of Remedial Alternatives, compares the new and previously developed soil and groundwater remedial alternatives on a criterion-by-criterion basis, for each of the seven CERCLA analysis criteria used in Section 3

Appendix A contains conceptual design calculations for the new remedial alternatives. Appendix B contains the cost estimates for the new alternatives. Appendix C contains a sustainability evaluation. Appendix D includes the revised groundwater modeling for the new groundwater alternative. Appendix E contains the calculations for the human health and ecological trigger concentrations for the protection of receptors in Allen Harbor.

1.2 SITE BACKGROUND

A very brief description of the site is provided below. Additional details can be found in the FS Report (Tetra Tech, 2012).

1.2.1 Site Description

The former NCBC Davisville facility is located in the Town of North Kingstown, Rhode Island, and is approximately 18 miles south of Providence. The NCBC Davisville mission was to provide mobilization support to the active Naval Construction force; to act as a mobilization base for the rapid assembly, outfitting, and readying of Reserve Construction Battalions; to store, preserve, and ship advance base and mobilization stocks; and to procure, receive, pack, and ship equipment for Atlantic, European, and Caribbean military construction projects. NCBC was composed primarily of warehouse space and freight yards, most of which have been demolished or redeveloped. The base was decommissioned in March 1994, and closed on April 1, 1994 under the Base Realignment and Closure (BRAC) program.

Site 16 is an irregularly shaped area bounded on the west by Thompson Road, to the north by Davisville Road, to the south by rail tracks; and extending to Allen Harbor and east to Narragansett Bay. Most of the site consists of parking area and buildings. The North Central Area (NCA) of Site 16 was the location of the former creosote dip tanks and fire training area. The NCA is bounded by Allen Harbor to the north, Westcott Road to the west, Davisville Road to the south, and Allen Harbor Road to the east.

The site includes the area between former Building 41 and Narragansett Bay because the volatile organic compound (VOC) plume extends eastward to Narragansett Bay. Some of the property was transferred prior to the BRAC program under the Shore Establishment Realignment announcement in 1973.

The NCA is currently vacant land. The rest of Site 16 includes mostly paved areas that are now primarily used for the temporary storage of cars delivered by ships and trains, pending delivery to automotive

dealers. The anticipated future land use for all of Site 16 is commercial/industrial uses related to port facilities.

The portion of Site 16 immediately north of the NCA is within the area currently leased to the Quonset Davisville Navy Yacht Club. It is anticipated that this area will continue to be used for marina (recreational) purposes.

The principal contaminants associated with the Site 16 groundwater are VOCs such as trichloroethene (TCE), tetrachloroethene (PCE), cis-1,2-dichloroethene (cis-1,2-DCE), vinyl chloride, and benzene. TCE is the primary VOC found in the groundwater. The maximum concentration detected in the groundwater exceeds 5,000 parts per billion (ppb).

Based on investigations conducted during the RI and evaluations during the risk assessment, it was determined that sediment was not a media of concern because sediment contamination was not found to be site-related and does not exceed local anthropogenic background levels. Therefore, there are no sediment COCs. Similarly, the risk assessment for surface water showed that there were no unacceptable risks, so there are no surface water COCs.

1.2.2 Geology and Hydrogeology

The results of field investigations show that the subsurface geology at the site is characterized by Quaternary glacial deposits mantling quartzitic and phyllitic bedrock (weathered and competent zones). The unconsolidated sedimentary (fill, intertidal, and glacial) deposits consist of the following units, in descending order:

- Reworked soil and fill material and recent harbor and adjacent deposits.
- Glacio-fluvial, glacio-lacustrine, and lower sand deposits.
- Sandy silty gravel to gravelly sand to sandy gravelly silt (possibly till).

Weathered bedrock separates the underlying competent bedrock from the overlying unconsolidated glacial deposits. The thickness of the weathered bedrock varies from less than 2 feet to 20 feet, although the thickness is typically 5 feet or less.

The bedrock underlying the investigation area consists of alternating layers of quartzite and phyllite that can vary considerably between these rock types over short horizontal and vertical distances. The quartzite bedrock typically includes significant amounts of quartz veins and nearly vertical and horizontal fractures. Bedrock groundwater can flow along interconnected fractures in the bedrock, such as along bedding planes, fractures, and joints.

The previously described geological units underlying the site have been divided into four hydrogeological zones. The overburden is divided into three zones, primarily distinguished by the characteristics of the deposits. There are no confining layers separating these zones. Beneath the overburden, the competent bedrock is divided into a shallow and deep zone.

Groundwater flow at Site 16 is generally northeast from former Building 41 towards Allen Harbor for each of the monitored groundwater zones, with flow also occurring to the east toward Narragansett Bay from the southeastern portion of former Building 41.

1.3 FS DEVELOPMENT

The FS was developed in stages. A Draft was submitted in February 2009. After addressing comments by the USEPA and Rhode Island Department of Environmental Management (RIDEM), an FS Field Investigation Sampling and Analysis Plan was prepared in April 2010, and the Data Package for the 2010 Feasibility Study Support Field Investigation was submitted in November 2010, followed by the submission of a Revised FS in February 2011. After addressing additional comments from USEPA and RIDEM, a Draft Final FS was submitted in May 2012. The document was not disputed by the USEPA or RIDEM, so pursuant to the Federal Facilities Agreement the May 2012 Draft Final FS became the Final FS.

Over the course of the development of the FS, there have been many discussions between Navy, EPA, and RIDEM to refine the alternatives, but there was no consensus about alternative selection at the time of the submission of the Draft Final FS.

Following the submission of the May 2012 FS, there were additional discussions between the Navy, USEPA, and RIDEM which also considered the short-term and long-term impacts that many of the groundwater alternatives would have on QDC and tenant [North American Distribution, Inc. (NORAD)] operations. The alternatives described in this FSA were developed to be acceptable to the Navy and agencies such that a Proposed Plan can be prepared and presented to the community. In addition to the revisions to the alternatives, two RAOs were added and are included in Section 2.0.

1.4 FSA CHANGES FROM THE FS

The new alternatives (one soil alternative and one groundwater alternative) are described and evaluated in Sections 3 and 5 of this FSA. The alternatives developed in the FS are still being considered and are listed below for reference. Details and analysis of these alternatives are provided in the FS (Tetra Tech, 2012). Section 4 describes components or elements that will be added to many of the alternatives and

provides the detailed analyses for these common changes. In addition, changes in the NCP criteria analysis concerning the pairing of soil alternatives that have or do not have a waste management area with the groundwater alternatives are also included in the discussions in Sections 3.0, 4.0, and 5.0

The following six soil remedial alternatives were developed in the FS:

- Alternative S-1: No Action.
- Alternative S-2: Soil Cover and/or Cap, Monitoring, and Land Use Controls (LUCs).
- Alternative S-3: Excavation, Off-Site Disposal, and LUCs.
- Alternative S-4: Soil Cover, Selected Excavation and Disposal, and LUCs.
- Alternative S-5: Excavation and Off-Site Disposal – Unrestricted Use.
- Alternative S-6: Full Soil Cover, Monitoring, and LUCs.

The following seven groundwater remedial alternatives were developed in the FS:

- Alternative G-1: No Action.
- Alternative G-2: Monitored Natural Attenuation (MNA) and LUCs.
- Alternative G-3: In-Situ Chemical Oxidation (High-Concentration Areas), MNA, and LUCs.
- Alternative G-3A: In-Situ Chemical Oxidation (Source Areas), MNA, and LUCs.
- Alternative G-4: Enhanced Bioremediation (High-Concentration Areas), MNA, and LUCs.
- Alternative G-5: Groundwater Extraction and Treatment (High-Concentration Areas), MNA, and LUCs.
- Alternative G-6: Enhanced Bioremediation, MNA, and LUCs (Reduced Remediation Time).

2.0 ADDITIONAL REMEDIAL ACTION OBJECTIVES

2.1 INTRODUCTION

After the Draft Final FS (Tetra Tech, 2012) was submitted, EPA/RIDEM proposed an additional soil RAO and an additional groundwater RAO. The Navy, USEPA, and RIDEM discussed the proposed changes and determined that the additional RAOs would not change the previous FS evaluations.

2.2 ADDITIONAL REMEDIAL ACTION OBJECTIVES

2.2.1 Soil RAO

The following soil RAO will be added as part of the FSA:

Soil RAO No. 7: Prevent recreational user exposure to soil in the vicinity of the Marina Building containing concentrations of COCs (e.g., PAHs) that cause unacceptable risk.

The RIDEM residential exposure criteria will be considered in determining cleanup requirements to meet this RAO. The specific COC in the vicinity of the Marina Building is benzo(a)pyrene equivalents (BaPEqs), and the criterion is 400 µg/kg.

2.2.2 Groundwater RAO

The following groundwater RAO will be added as part of the FSA:

Groundwater RAO No. 4: Restore groundwater quality to its beneficial use.

Although the groundwater is not used, it is a potential source of drinking water. Therefore, the beneficial use of the groundwater is as a drinking water source. By meeting the preliminary remediation goals (PRGs) which are based on Maximum Contaminant Levels (MCLs), or risk-based criteria assuming potable water use where an MCL is not available, the groundwater alternatives that were developed for the FS and in this FSA will meet this RAO.

2.3 REVISED REMEDIAL ACTION OBJECTIVES

Some of the RAOs presented in the FS have been revised as listed below. These revisions did not substantially affect the alternatives or the analysis of the alternatives.

Soil RAO No. 2: Ensure and verify that surface and subsurface soil contaminants (naphthalene) in the NWNCA (excluding the BTEX Hot Spot Area) do not result in unacceptable risks from groundwater, sediment, and surface water outside a waste management area.

Soil RAO No. 5: Ensure and verify that surface and subsurface soil contaminants (benzene and naphthalene) in the BTEX Hot Spot Area do not result in unacceptable risks from groundwater, sediment, and surface water outside a waste management area.

Groundwater RAO No. 1 (which addresses groundwater exposure and meeting PRGs) is not being changed, but note that this RAO is temporary outside of a waste management area (until groundwater cleanup standards are achieved), and permanent inside of the compliance boundary of a waste management area.

3.0 DETAILED ANALYSIS OF NEW REMEDIAL ALTERNATIVES

3.1 SOIL ALTERNATIVE S-3A: SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCS

3.1.1 Description

Alternative S-3A would consist of six major components: (1) excavation, (2) off-site disposal, (3) cover, (4) Monitoring, (5) LUCs, and (6) Five-Year Reviews.

Component 1: Excavation

In the NCA, soil with chemical of concern (COC) concentrations greater than industrial PRGs and RIDEM industrial direct exposure criteria (DECs) would be excavated to a depth of 2 feet below ground surface (bgs). Conventional excavation equipment would be used. Pre-excavation sampling would be conducted to verify the exact extent of the contamination and to characterize the soil for disposal. The area of contaminated soil is estimated to be approximately 42,000 square feet (ft^2) as shown on Figure 3-1. The total volume of soil to be excavated (including soil excavated in the vicinity of the marina building, described below) would be approximately 3,200 cubic yards. Following excavation, the excavated areas would be backfilled with clean fill and regraded to achieve desired surface elevations. Because of the shallow excavation depths and absence of adjacent structures, sloping would be used in most areas to maintain the stability of the side walls.

Near the marina building (constructed in 1954), contaminated soil with COC concentrations greater than RIDEM residential DECs would be excavated to a depth of 2 feet bgs to meet recreational use requirements, per discussions with RIDEM. The limits of the soil excavation in the marina area are based on existing sampling locations where PRGs have been met such that pre-excavation sampling in the marina area is not warranted. There is uncertainty as to whether the building could be occupied during excavation and whether the building would remain structurally sound; therefore, shoring may be required due to the close proximity of the excavation to the building. If sampling indicates that contamination extends beneath the marina building, then the soil beneath the building would be included in the LUCs. Only soil in the unsaturated zone would be excavated, so no dewatering of the excavation would be required. Following excavation, the excavated area would be backfilled with clean fill and regraded to achieve original surface elevations.

Section 8.10 of the RIDEM Remediation Regulations would be considered during the preparation of the sampling requirements in the remediation work plan and long-term monitoring plan.

An estimated 10 pounds of BaPEqs, 1 pound of naphthalene, and 101 pounds of arsenic would be removed during the excavations in the NCA and near the marina building by this alternative. Approximately 100 pounds of total petroleum hydrocarbons (TPH) that is co-located with the BaPEqs and naphthalene would also be removed.

Component 2: Off-Site Disposal

Based on data from the RI, most of the soil is expected to be non-hazardous. However, some lead concentrations are greater than 100 milligrams per kilogram (mg/kg), and therefore could exceed the Toxicity Characteristic Leaching Procedure (TCLP) criterion of 5 milligrams per liter (mg/L). For the purposes of the FSA, 10 percent of the excavated soil (approximately 490 tons) is assumed to be hazardous. The hazardous soil would have to be treated prior to disposal to meet land disposal restrictions (LDRs). Treatment would be performed off-site at a Resource Conservation and Recovery Act (RCRA) treatment facility, and this would be included as part of the overall disposal process.

Based on the results of the characterization, soil would either be disposed at an off-site non-hazardous waste disposal facility (approximately 4,400 tons), or a permitted hazardous waste disposal facility (approximately 490 tons).

Component 3: Cover

The two foot thick layer of clean backfill placed after the excavation of portions of the NCA and Marina areas will be maintained as cover to prevent direct contact with contaminated subsurface soils. Existing uncontaminated surface soil will also be maintained to prevent contact with contaminated subsurface soil. Because subsurface contamination and buried debris would remain at the site, clean backfill for the excavations along with the existing shallow soil will be managed as a cover. Therefore, the NCA would be designated as a waste management area (WMA). Figure 3-2 shows the extent of the soil cover and compliance boundary of the WMA. Per the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) preamble, concentrations of COCs in the groundwater beneath the WMA footprint do not need to meet the PRGs but inside the WMA, the PRGs would be used as performance standards for monitoring at the compliance boundary of the WMA. In addition, Rhode Island soil leachability standards are also performance standards for monitoring at the WMA compliance boundary, but are not required to be achieved within the compliance boundary.

Component 4: Monitoring

Monitoring will be established at the WMA compliance boundary to ensure contaminated groundwater exceeding performance standards is not migrating beyond the compliance boundary either into areas of

adjacent groundwater or into marine sediments and surface water in Allen Harbor or Narragansett Bay. Compliance monitoring will be conducted at least yearly to ensure the LUCs, described below, remain in effect and are enforced.

Component 5: LUCs

LUCs would be implemented to control excavation and disturbance of the soil cover in the NCA and Marina areas and prevent exposure of the contaminated soil below the cover. In the event work is required below any cover areas, any work within the contaminated subsurface soil would need to be performed according to a health and safety plan and an approved soil management plan. LUCs would be established to prevent residential development within areas of the NCA exceeding unrestricted use risk standards. Within the Marina area, LUCs would be implemented to permit the continued use of the area as a marina or other recreational use as long as the two foot thick clean cover is maintained, per RIDEM approval. The LUCs would also establish a requirement that any work beneath marina building would need to be performed according to a health and safety plan and an approved soil management plan. Long-term monitoring would be required that includes annual inspections to determine whether that LUCs were being complied with and that components of the remedy, particularly the cover, were not disturbed. The mechanism for implementing LUCs on property that the Navy has already transferred will be determined during the RD. For property that has already been transferred, the Navy will establish legally enforceable environmental restrictions and retain the responsibility for enforcing the environmental restrictions. Drawings showing specific boundaries for each LUC will be prepared as part of the LUC RD.

Component 6: Five-Year Reviews

Because this remedy would result in hazardous substances, pollutants, or contaminants remaining on site in excess of levels that allow for unlimited use and unrestricted exposure, in accordance with Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(c), a statutory review will be conducted within 5 years of initiation of remedial action, and every 5 years thereafter to ensure that the remedy continues to be protective of human health and the environment. Each five-year review would consist of a review of relevant documents, interviews, a site inspection, and preparation of a summary report.

3.1.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative S-3A would be protective of human health and the environment. Soil with contaminant concentrations greater than industrial PRGs and RIDEM DECs would be removed from the surface of the site in the NCA. Soil in the vicinity of the Marina Building with contaminant concentrations greater than

RIDEM residential DECs would be removed to a depth of 2 feet bgs. Off-site treatment (if required) and disposal of the excavated soil would further protect human health and the environment.

Maintenance of the cover, monitoring, and LUCs regulating the protection of the cover and the disturbance of soil below a depth of 2 feet would be protective by preventing unacceptable risks from exposure to contaminated soil under the current industrial use of the site. In addition, LUCs restricting the NCA to industrial use would be protective by preventing unacceptable risks to hypothetical future residents from direct exposure to contaminated soil. LUCs implemented in the vicinity of the Marina Building would be protective by preventing unacceptable risks to recreational users from exposure to contaminated soil. Maintenance of the two foot thick clean cover, monitoring, and LUCs in the marina area will permit the continued use of the area as a marina or other recreational use by preventing exposure to contaminated subsurface soil. Soil Alternative S-3A will achieve all Soil RAOs.

Compliance with ARARs and TBCs

Alternative S-3A would comply with all chemical-, location-, and action-specific applicable or relevant and appropriate requirements (ARARs) and to be considered (TBCs) criteria. Alternative S-3A has a WMA, so leachability criteria exceedances do not need to be addressed except for monitoring at the WMA compliance boundary. The chemical-, location-, and action-specific ARARs and TBCs for Alternative S-3A are listed in Tables 3-1, 3-2, and 3-3, respectively.

Long-Term Effectiveness and Permanence

Alternative S-3A would provide long-term effectiveness and permanence.

Excavation of contaminated soil at the surface would effectively and permanently prevent unacceptable risk from exposure to contaminated soil under the industrial exposure scenario in the NCA and recreational use in the vicinity of the Marina Building. LUCs that control disturbance of contaminated soil and prevent hypothetical future residential development would effectively and permanently prevent unacceptable risk from direct exposure to contaminated soil.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative S-3A would not reduce the toxicity, mobility, or volume of the soil contaminants through treatment.

Short-Term Effectiveness

Implementation of the excavation and off-site disposal components of Alternative S-3A could expose construction workers to contaminated soil. This potential for exposure would be minimized by the implementation of engineering controls such as dust suppression and air quality monitoring. The potential for worker exposure would be further reduced by the wearing of appropriate personal protective equipment (PPE), and compliance with applicable Occupational Safety and Health Administration (OSHA) regulations and proper site-specific health and safety procedures.

Implementation of the excavation components is not expected to adversely impact either the surrounding community or the environment. However, measures such as spill prevention and containment, erosion and sedimentation control, and perimeter air monitoring would be taken to ensure that the impact remains acceptable. Trucks associated with disposal of contaminated soil and bringing clean soil to the site (approximately 470 truckloads) would increase traffic on surrounding roads.

Alternative S-3A could be completed in approximately 5 months, and would achieve the soil RAOs and attain the soil cleanup levels at completion.

Overall, the sustainability impact of Alternative S-3A would be moderate based on a sustainability analysis using SiteWise^{TM} (see Appendix C). Emissions of CO_2, CH_4, and N_2O were normalized to carbon dioxide equivalents (CO_2e), which is a cumulative method of weighing greenhouse gas (GHG) emissions relative to global warming potential. Alternative S-3A contained low CO_2e emissions (256 tons). Criteria pollutant emissions associated with Alternative S-3A for nitrogen oxides (NO_x), sulfur oxides (SO_x), and particulate matter with a diameter of 10 micrometers or less (PM_{10}) emissions would be 0.47, 0.13, and 0.12 tons, respectively. Energy demand for Alternative S-3A would be low [12,000 million British Thermal Units (MMBTU)], and would be largely attributed to material production. Water usage associated with decontamination activities and the manufacture of steel used in sheet piles for shoring would be moderate.

Implementability

Alternative S-3A would be technically implementable. Contractors qualified to excavate and dispose the contaminated soil are readily available, and this work could be performed with normal construction equipment. Because there are few structures near the excavations, the need for shoring would be limited, although the marina building would be protected by shoring, if needed. No dewatering would be required. Off-site borrow locations for clean soil backfill, and disposal facilities for excavated soil would be readily available. Performance of regular site inspections and 5-year reviews could readily be

accomplished. The resources, equipment, and materials required for these activities are readily available.

The administrative aspects of Alternative S-3A for property under the control of the Navy would be relatively simple to implement. The LUCs would be incorporated into the Land Use Control Implementation Plan (LUCIP). The administrative aspects of Alternative S-3A for the application of LUCs to the portion of the site that is already under an existing leasing agreement or has already been transferred would require coordination with the current property user and/or local or state officials. For property that has already been transferred, the Navy will establish legally enforceable environmental restrictions and retain the responsibility for enforcing the environmental restrictions.

Cost

The estimated costs for Alternative S-3A are as follows:

Capital Cost:	$ 1,943,000
30-Year Net Present Worth (NPW) of Annual Costs:	$ 176,000
30-Year NPW:	$ 2,119,000

The capital cost associated with the excavation and disposal of soil that is contaminated only with TPH is approximately $150,000. This cost can be subtracted from the above costs to obtain the costs associated with the CERCLA COCs. A detailed breakdown of estimated costs for this alternative is provided in Appendix B.

3.2 GROUNDWATER ALTERNATIVE G-3B: IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUCS

3.2.1 Description

Alternative G-3B would consist of four major components: (1) in-situ chemical oxidation, (2) MNA, (3) LUCs, and (4) Five-Year Reviews.

Component 1: In-Situ Chemical Oxidation

For soil alternatives that manage waste in place such that the NCA would be designated as a WMA (see Figure 3-2), and concentrations of COCs in the groundwater beneath the WMA footprint do not need to meet the PRGs, and therefore do not need to be treated. Only a small area (compared to the area treated in Alternative G-3A) at the eastern end of former Building 41 would be proposed for treatment in this alternative because the WMA covers most of the high concentration areas that are treated in the

other alternatives. The treatment of VOCs in this area will reduce the mass of contaminants available for transport downgradient and will reduce the time for MNA to meet PRGs. A sodium permanganate solution, or similar oxidant would be injected into the subsurface using the twelve injection wells in the vicinity of the eastern end of former Building 41 (shown on Figure 3-3) which were installed for a pilot test in 2004, but were not used. Approximately 4,300 gallons of sodium permanganate solution (5.3 percent) would be injected at each injection point for a total volume of approximately 52,000 gallons and a total mass of approximately 23,000 pounds of sodium permanganate. A bench test could be performed, if necessary to refine chemical feed requirements and select the appropriate oxidant.

For the purposes of this FSA, two injection events as described above are assumed, with the second event 12 months after the first. Monitoring (baseline and quarterly for 1 year) would be performed to evaluate the effectiveness of the chemical oxidation and monitor for rebound. After the chemical oxidation step is completed, monitoring for MNA (described below) would begin.

Note that if Alternative S-5 were implemented, all of the contaminated soil and waste would be removed, so no waste would be managed in place and there would be no WMA. Thus, the portion of the high contamination areas that are not treated would need to meet the PRGs as cleanup goals.

Component 2: Monitored Natural Attenuation and Monitoring

This component would be nearly identical to Component 1 of Alternative G-2 and is described below for completeness.

Natural attenuation would rely on naturally occurring processes within the aquifer to reduce the concentrations of TCE, cis-1,2-DCE, and vinyl chloride (VC). Chlorinated VOC (CVOC) concentrations would be reduced through biological activity, dispersion, and dilution through aquifer movement and adsorption onto soil particles. Benzene concentrations in the vicinity of the BTEX Hot Spot Area would be reduced through biological activity, dispersion, dilution, and adsorption. Arsenic concentrations would be reduced as the groundwater flows into zones with oxidizing conditions and by dispersion and dilution through aquifer movement. Note that groundwater PRGs would not need to be met within the compliance boundary of the WMA (Alternatives S-2, S-3, S-3A, S-4, and S-6), and it is estimated that PRGs would be met in approximately 100 years. If this alternative is paired with Alternative S-5, then PRGs must be met throughout the plume because there is no WMA, and the estimated time to meet the PRGs is approximately 100 to 150 years.

Monitoring would be conducted to assess the effectiveness of natural attenuation. Groundwater samples would be collected and analyzed for CVOCs and natural attenuation parameters such as oxidation-reduction potential (ORP) and metabolic gases (methane, ethane, ethene, and carbon dioxide). Wells

would be selected upgradient of the source and high-concentration areas, within the source and high-concentration areas, within the plume, and near the downgradient edge of the plume. Wells would be selected from the shallow, intermediate, and deep portions of the overburden aquifer and from the bedrock aquifer. A long-term monitoring plan would be prepared to identify the wells to be sampled and the analyses.

Several other COCs, such as naphthalene and arsenic were observed at low frequencies and low concentrations (see Table 2-4 in the FS). Natural attenuation processes, such as dispersion, dilution, and sorption are anticipated to reduce the concentrations of these COCs. Because of the low frequencies of detection and the low concentrations, these COCs would not be included in the monitoring program. Iron and manganese were detected at concentrations greater than PRGs at several locations. However, because of the low toxicity of these metals and the low probability of using the groundwater as a drinking water source (Component 3: LUCs), a passive approach using monitoring and natural attenuation will also be used in lieu of active remediation.

Because natural attenuation processes are expected to be slow, sampling would be conducted annually until trends could be identified to refine the time frame to reach PRGs. All monitoring events would use low-flow groundwater sampling techniques.

However, because the part of the source area is being treated, it is assumed that fewer monitoring wells would be needed for the MNA program compared to Alternative G-2. For Alternative G-3B, the number of wells in the MNA program would be approximately 28.

Groundwater samples will be collected from monitoring wells along the saline shoreline to meet the groundwater RAO to prevent migration of groundwater contamination into sediments/surface water in Allen Harbor and Narragansett Bay. The results of the sampling will be compared to trigger levels (see Table 3-4 and Appendix E) to determine if additional actions need to be taken to address surface water, pore water, or sediment quality. When paired with Soil Alternatives that manage waste in place with a WMA (Alternatives S-2, S-3, S-3A, S-4, and S-6), the performance standards would be based both risk-based standards and soil leachability standards. When this groundwater alternative is paired with Alternative S-5, the performance standards would only be based on risk-based standards (since all soil exceeding leachability standards would be removed under Soil Alternative S-5).

Note that PRGs are not applicable to the groundwater beneath the WMA or along the coast and along Allen Harbor where groundwater is saline (see Figure 3-2). Where the groundwater is saline, remedial goals protective of ecological receptors in surface water, pore water, and sediment apply as shown on Table 3-4 (see also Appendix E). Section 8.10 of the RIDEM Remediation Regulations would be

considered during the preparation of the sampling requirements in the remediation work plan and long-term monitoring plan.

Component 3: LUCs

This component would be identical to Component 2 of Alternative G-2 and is repeated below for completeness.

The existing deed and lease restrictions would be maintained and incorporated in the LUCs. South of Davisville Road, the property (previously conveyed) would be used and maintained in perpetuity for the development or operation of a port facility. Additionally, a condition of the deed requires that the Navy be notified if a well, for any purpose, is installed.

North of Davisville Road, these restrictions include use of the property for the development or operation of a port facility and prohibition of the use of groundwater as a drinking water source.

Annual inspections would be conducted to verify compliance with the LUCs.

For Navy-owned property, Environmental LUCs that meet State recording standards would be included in the deed and recorded as part of the eventual property transfer. In addition, per the LIFOC between the Navy and RIEDC, Navy approval is required prior to any alteration or addition, and 60 days notice must be given to USEPA and RIDEM prior to any alteration or addition. These terms will also be incorporated into the LUC RD. For property already transferred, implementation of the environmental LUCs will be coordinated with QDC. For property that has already been transferred, the Navy will establish legally enforceable environmental restrictions and retain the responsibility for enforcing the environmental restrictions.

In addition to the existing restrictions, LUCs would be prepared to prohibit the use of groundwater. Similarly, LUCs would be added to prevent residential use of the site. Figure 4-8 of the FS shows the groundwater LUC boundary. If this alternative is paired with a soil alternative that manages waste in place, the boundaries of a WMA would be defined in a LUC. A groundwater compliance boundary would be established around the WMA. Groundwater cleanup levels (PRGs) would have to be achieved outside of the compliance boundary. Inside the compliance boundary groundwater performance standards would be established as monitoring standards to ensure that soil/groundwater contamination within the WMA is not migrating beyond the compliance boundary. The LUCs would be permanent within the compliance boundary and temporary outside of the compliance boundary until groundwater cleanup standards are achieved. If the alternative is paired with soil Alternative S-5, the LUCs are temporary until federal drinking water standards are achieved.

An additional LUC would be added to restrict construction methods for new buildings that may be constructed on the site. Because of the presence of TCE and other VOCs in shallow groundwater, vapor intrusion is a potential exposure pathway. Thus, the additional LUC would be applied to areas where VOC-contaminated shallow groundwater is present, and wherever vapor intrusion could be a potential pathway. This is assumed to be coincidental with the area where groundwater use is prohibited. The LUC would require special construction methods such as foundation venting to prevent unacceptable exposure to VOCs through vapor intrusion. This additional LUC could be readily incorporated into the LUCIP and would require coordination with the current owner of the transferred parcel.

The LUCs, in accordance with Navy LUC Principles, would be implemented through a LUC Remedial Design (LUC RD) that would be prepared as a component of the overall RD. Details for the LUCs would be developed in the LUC RD. The LUC RD would also describe how LUCs would be applied to parcels that the Navy no longer controls. The mechanism for implementation of LUCs on property that the Navy has already transferred will be determined during the LUC RD. Figure 4-8 in the FS shows the proposed extent of groundwater LUC boundaries. Drawings showing specific boundaries for each LUC will be prepared as part of the LUC RD.

Component 6: Five-Year Reviews

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site in excess of levels that allow for unlimited use and unrestricted exposure, in accordance with Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(c), a statutory review will be conducted within 5 years of initiation of remedial action, and every 5 years thereafter to ensure that the remedy continues to be protective of human health and the environment. Each five-year review would consist of a review of relevant documents, interviews, a site inspection, and preparation of a summary report.

Contingency Remedy

A remedial action to intercept the plume is recommended as a “contingency component” only at this time because TCE and its degradation products (e.g., cis-1,2-DCE, vinyl chloride) have not been detected in the surface waters and sediments of Allen Harbor at concentrations that would result in unacceptable risks to either human or ecological receptors. More significantly, the TCE concentrations detected in the groundwater samples collected from piezometers advanced in Allen Harbor or from the deep groundwater monitoring wells abutting Allen Harbor do not exceed the ecological screening level that Navy, USEPA, and RIDEM have discussed for TCE, [approximately 1,920 micrograms per liter [µg/L)]. For the most part, only the TCE concentrations in the Building 41 source area wells exceed this ecological screening level (a few exceedances are noted in the NCA wells, but, not those abutting Allen Harbor).

If monitoring results of the deep groundwater abutting Allen Harbor exceed the ecological screening level, the monitoring program could be increased to include pore water beneath Allen Harbor, based on BCT discussion. Results of this monitoring would be compared to ecological and human health risk-based trigger levels (see Appendix E). If the trigger levels are exceeded in the surface water or pore water, then the need for a contingency remedial action to intercept the plume would be evaluated.

In aggregate, the CVOC data for the Site 16 monitoring wells, the piezometers in Allen Harbor, and the surface water/sediments of Allen Harbor indicate a significant attenuation in TCE concentrations from the Building 41 source area to the Allen Harbor surface waters and sediments (most likely the result of biodegradation and dilution). (See figures and tables from Phase III RI and 2010 Data Package Report in Appendix E.)

A contingency remedy would be further evaluated for possible implementation if and when CVOC concentrations detected for sentinel wells along Allen Harbor exceeded a trigger concentration calculated as detailed in Appendix E. The trigger concentration considers both human and ecological receptors of concern and a dilution factor established based on both chemical and hydrogeological data available for Site 16. The decision to design and install a contingency remedy would be made in consultation with USEPA and RIDEM, and would consider chemical concentrations actually detected in the surface waters and sediments and groundwater piezometers of Allen Harbor at the time the exceedances of screening levels in the sentinel wells were noted.

One approach for a contingency remedial action would be to create a bio-barrier at the leading edge of the plume along the shore of Allen Harbor. Emulsified vegetable oil would be injected via wells into the subsurface to create a barrier perpendicular to the groundwater flow direction along Allen Harbor. The spacing between the injection wells in the overburden is assumed to be 10 feet, and the spacing between individual wells in the bedrock is assumed to be 7.5 feet because of uncertainty about the lateral interconnection of fractures. The effectiveness of the process in bedrock is uncertain because of uncertainties of distribution of the solution in the bedrock formation. The estimated number of injection wells in the barrier and the quantity of emulsified oil injected would be determined after evaluating the monitoring results. Because of the low alkalinity of the groundwater, a buffered emulsified oil product is expected to be required. A pilot study would be performed to confirm well spacing and emulsified oil application rate.

Additional injections of emulsified oil would be applied approximately every 5 years as needed until it is determined that trigger levels are no longer exceeded. Monitoring wells on both sides of each barrier would be used to monitor the progress and effectiveness of the emulsified oil. For estimating purposes,

in the first year, samples would be collected quarterly and analyzed for VOCs, ORP, and iron. After the first year, samples would be collected and analyzed annually. After treatment is successfully completed, the injection wells would be abandoned.

3.2.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative G-3B would be protective of human health and the environment.

By actively treating part of the source of contamination, in-situ chemical oxidation would significantly reduce the mass of contaminants in the plume. This would reduce risk from exposure to contaminated groundwater. Similarly, downgradient VOC concentrations would be reduced by natural attenuation. Arsenic concentrations would also be reduced by natural attenuation.

Monitoring would be protective by confirming the effectiveness of in-situ chemical oxidation and evaluating the progress of natural attenuation processes.

LUCs would be protective of human health and the environment during the remedial period until PRGs are met. When paired with a soil alternative with a WMA (Alternatives S-2, S-3, S-3A, S-4, and S-6), maintenance of the WMA and restricting the use of groundwater would be protective of human health and the environment by avoiding unacceptable risks from exposure to contaminated groundwater. Exposure to VOCs through vapor intrusion would be controlled by building construction methods. Overall protectiveness of this alternative is contingent on adequate enforcement of the LUCs preventing use of the groundwater for an extended period until PRGs are achieved.

When paired with Alternative S-5, restricting the use of groundwater would be protective of human health and the environment by avoiding unacceptable risks from exposure to contaminated groundwater. Exposure to VOCs through vapor intrusion would be controlled by building construction methods. Overall protectiveness of this alternative is contingent on adequate enforcement of the LUCs preventing use of the groundwater for an extended period until PRGs are achieved.

Compliance with ARARs and TBCs

When paired with a soil alternative with a WMA (Alternatives S-2, S-3, S-3A, S-4, and S-6), Alternative G-3B would eventually comply with chemical-specific ARARs and TBCs through a combination of in-situ chemical oxidation and natural attenuation. Alternative G-3B would also comply with location- and action-specific ARARs and TBCs. The chemical-, location-, and action-specific ARARs

and TBCs for Alternative G-3B are listed in Tables 3-5, 3-6, and 3-7, respectively. Note that PRGs would not need to be met within the compliance boundary of the WMA.

When paired with Alternatives S-5 which does not have a WMA, Alternative G-3B would eventually comply with chemical-specific ARARs and TBCs through a combination of in-situ chemical oxidation and natural attenuation, but the time period would be in excess of 100 to 150 years. Alternative G-3B would also comply with location- and action-specific ARARs and TBCs. The chemical-, location-, and action-specific ARARs and TBCs for Alternative G-3B are listed in Tables 3-5, 3-6, and 3-7, respectively.

Long-Term Effectiveness and Permanence

Alternative G-3B would provide long-term effectiveness and permanence.

In-situ chemical oxidation would effectively and permanently remove part of the source of groundwater contamination. This would accelerate the remediation process and reduce the size of the plume. In-situ chemical oxidation is a relatively well-established technology.

Monitoring the progress of natural attenuation would be an effective means to evaluate the progress of remediation and to verify that reduction of COCs is occurring.

Groundwater use restrictions would effectively prevent the use of groundwater until PRGs are met. Requirements for building construction methods would effectively prevent exposure to VOCs through vapor intrusion.

The controls proposed in this alternative are considered reliable.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G-3B would reduce the toxicity, mobility, and volume of groundwater COCs through treatment. In-situ chemical oxidation would permanently and irreversibly destroy an estimated 48 pounds of COCs (46 pounds of TCE, and 2 pounds of cis-1,2-DCE) from groundwater. The remaining mass of TCE and other VOCs that would be degraded through biological and abiotic processes, and the mass of arsenic that would be precipitated through abiotic processes is uncertain. No treatment residues would be generated by this alternative.

Short-Term Effectiveness

Alternative G-3B would reduce human health risks in the short term because groundwater use restrictions would be implemented. Exposure of workers to contamination during installation of monitoring wells, sodium permanganate injection, and groundwater sampling would be minimized by compliance with OSHA requirements including wearing of appropriate PPE and adherence to site-specific health and safety procedures. There would be a slight potential for impact on the local community during the transport of the oxidizer to the site. The introduction of the oxidizer may temporarily mobilize some metals in the groundwater.

Groundwater RAO Nos. 1 and 3 would be achieved immediately upon implementation of LUCs and monitoring. Following the completion of a bench test, if necessary, the in-situ chemical oxidation applications and associated post-injection monitoring would be completed in approximately 1 year. When paired with a soil alternative with a WMA (Alternatives S-2, S-3, S-3A, S-4, and S-6), it is estimated that Alternative G-3B would require approximately 100 years to meet groundwater RAO Nos. 2 and 4 and attain the groundwater PRGs through natural attenuation (see Appendix D). When paired with Alternatives S-5 which does not have a WMA, the RAOs would be met in excess of 100 to 150 years.

Overall, the sustainability impact of Alternative G-3B would be low based on a sustainability analysis using SiteWise^{TM} (see Appendix C). Emissions of CO_2, CH_4, and N_2O were normalized to CO_2e, which is a cumulative method of weighing GHG emissions relative to global warming potential. Alternative G-3B would produce low CO_2e emissions (253 tons), and the majority of these emissions would be attributed to the production of chemicals for the sodium permanganate. Criteria pollutant emissions associated with Alternative G-3B for NO_x, SO_x, and PM_{10} emissions would be 0.55, 0.37, and 0.01 tons, respectively. The main contributor to NO_X, SO_x, and PM_{10} emissions would be the laboratory analytical services. Energy demand for Alternative G-3B would be low (2,800 MMBTU) and would be largely attributed to the production of sodium permanganate to be used for treatment. Water usage would be low, and the consumption would be 140,000 gallons of water for use as injection water.

Implementability

The existing wells injection system could be readily applied for in-situ chemical oxidation treatment. There are a number of qualified contractors to provide chemical injection. Sampling and maintenance of existing monitoring wells and performance of 5-year reviews could readily be accomplished. The resources, equipment, and materials required for these activities are readily available. Implementation of the drilling and injection on property that has already been transferred would require coordination with the current property owner. However, current site activities would be disrupted for approximately 1 to 2 weeks by the injection equipment during the initial and follow-up injections. The area around each

injection well would have to be temporarily cleared of vehicles to make way for injection equipment and personnel. This activity would be coordinated with QDC and tenants to minimize the short term disruption.

The administrative aspects of Alternative G-3B for the property under the control of the Navy would be relatively simple to implement. The LUCs would be incorporated into the LUCIP. The implementation of LUCs on the property that has already been transferred would require coordination with the current property owner and/or local or state officials. For property that has already been transferred, the Navy will establish legally enforceable environmental restrictions and retain the responsibility for enforcing the environmental restrictions. Site access would need to be coordinated with the current owner to allow for the treatment to be performed.

Cost

The estimated costs for Alternative G-3B are as follows:

Capital Cost:	$ 612,000
30-Year NPW of Annual Costs:	$1,176,000
30-Year NPW:	$1,788,000

A detailed breakdown of the estimated costs for this alternative is provided in Appendix B.

TABLE 3-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE S-3A – SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
Cancer Slope Factors (CSFs)	-	TBC	Guidance values used to evaluate the potential carcinogenic hazards caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media (Industrial exposure in the NCA and recreational exposure near the marina building). Risks due to carcinogens as assessed with slope factors will be addressed through excavation, maintenance of cover, LUCs, and long-term monitoring by preventing exposure to contaminants.
Reference Doses (RfDs)	-	TBC	Guidance values used to evaluate the potential non-carcinogenic hazards caused by exposure to contaminants.	Used to calculate potential non-carcinogenic hazards caused by exposure to contaminants (Industrial exposure in the NCA and recreational exposure near the marina building). Hazards due to noncarcinogens with EPA RfDs will be addressed through excavation, maintenance of cover, LUCs, and long-term monitoring by preventing exposure to contaminants.
Guidelines for Carcinogen Risk Assessment	EPA/630/P-03/001F (March 2005)	To Be Considered	Guidance for assessing cancer risk.	Used to calculate potential carcinogenic risks caused by exposure to contaminants (Industrial exposure in the NCA and recreational exposure near the marina building). Hazards due to carcinogens assessed through excavation, maintenance of cover, LUCs, and long-term monitoring by preventing exposure to contaminants.

TABLE 3-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE S-3A – SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (continued)				
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F (March 2005)	To Be Considered	Guidance of assessing cancer risks to children.	Used to calculate potential carcinogenic risks to children caused by exposure to contaminants (Industrial exposure in the NCA and recreational exposure near the marina building). Carcinogenic risks to children assessed through this guidance will be addressed through excavation, maintenance of cover, LUCs, and long-term monitoring by preventing exposure to contaminants.
Draft Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds	-	To Be Considered	The draft report includes significant new analyses on potential cancer and non-cancer human health effects that may result from exposures to dioxins and includes an oral reference dose for what is considered to be the most toxic of the dioxin-like compounds.	Risks from dioxins (Industrial exposure in the NCA) assessed under this guidance will be addressed through excavation, maintenance of cover, LUCs, and long-term monitoring by preventing exposure to contaminants.

TABLE 3-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE S-3A – SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (continued)				
Recommenda-tions of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposure to Lead in Soil	-	To Be Considered	EPA guidance for evaluating the risks posed by lead in soil.	Risks from lead (Industrial exposure in the NCA and recreational exposure near the marina building) assessed under this guidance will be addressed through excavation, maintenance of cover, LUCs, and long-term monitoring by preventing exposure to contaminants.

TABLE 3-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE S-3A – SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State				
State of Rhode Island Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Short Title: Remediation Regulations)	DEM-DSR-01-93, Section 8.02(A) and Table 1	Applicable	These regulations set remediation standards to prevent direct contact with contaminated soil resulting from the unpermitted release of hazardous material in Rhode Island.	In the NCA area excavation of the top two feet of contaminated soil exceeding industrial direct exposure criteria, maintenance of a clean 2 foot cover, LUCs to protect the cover and prevent exposure to subsurface soils, and monitoring will meet Industrial exposure standards. LUCs to prevent residential use in the NCA area will address remaining areas that exceed unrestricted use criteria for direct contact. In the Marina area excavation of the top two feet of contaminated soil exceeding criteria for recreational use, maintenance of a clean 2 foot cover, LUCs to protect the cover and prevent exposure to subsurface soils under the cover and marina buildings, and monitoring will achieve standards to permit continued recreational use of the Marina area.

TABLE 3-2

FEDERAL AND STATE LOCATION-SPECIFIC ARARs – ALTERNATIVE S-3A – SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
Floodplain Management and Protection of Wetlands	44 Code of Federal Regulations (CFR) 9	Relevant and appropriate	FEMA regulations that set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11988, Floodplain Management, and Executive Order 11990, Protection of Wetlands.	Remedial alternatives conducted within the 100-year floodplain of Allen Harbor/Narragansett Bay or within federal jurisdictional wetlands will be implemented in compliance with these standards. The Navy will solicit public comment as part of the proposed plan on the measures taken through the remedial action to protect floodplain and wetland resources.
Coastal Zone Management Act	16 United States Code (USC) 1451 et. seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state-approved management programs.	Part of the site is located in a coastal zone management area; therefore, applicable coastal zone management requirements need to be addressed.
Endangered Species Act	16 USC 1531 et seq.	Applicable	Requires consultation with appropriate agencies if a threatened or listed species or their habitat may be affected by a federal action.	The Navy will coordinate with appropriate agencies to consider mitigation measures if any remedial actions adjacent to Allen Harbor may affect the habitat of the federally-listed loggerhead turtle (*Carette caretta*), Kemp's ridley turtle (*Lepidochelys kempii*), and Atlantic sturgeon (*Acipenser oxyrinchus*).

TABLE 3-2

FEDERAL AND STATE LOCATION-SPECIFIC ARARs – ALTERNATIVE S-3A – SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State				
Coastal Resources Management	Rhode Island General Laws (RIGL) 46-23-1 et seq. and Coastal Resources Management Program	Applicable	Sets standards for management and protection of coastal resources.	Part of the site is located in a coastal resource management area; therefore, applicable coastal resource management requirements need to be addressed**.**
State of Rhode Island Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Short Title: Remediation Regulations)	DEM-DSR-01-93, Section 8.09 (Institutional Controls)	Applicable	Describes the provisions required for environmental land usage restrictions where levels of hazardous substances remain on site at concentrations greater than those protective of residential use.	The substantive portions of this section will be used in the preparation of the LUCs and deed restrictions which would be provided to RIDEM for review. These provisions are listed in subsections A through E.

TABLE 3-3

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE S-3A – SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
Resource Conservation and Recovery Act (RCRA) Regulations	42 United States Code (USC) 6901 et seq.	Applicable	Rhode Island has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the State.	Refer to State ARARs for hazardous waste requirements.
CWA, Phase II Storm Water Standards	40 Code of Federal Regulations (CFR) 122.26 and 123	Applicable if over one acre is disturbed	Storm water control standards for construction projects.	Any remedial action that disturbs more than 1 acre of soil will meet these standards to control storm water runoff and prevent erosion.
Clean Water Act, National Recommended Water Quality Criteria (NRWQC)	33 USC 1251 et seq.; 40 CFR 122.44	Relevant and Appropriate	Used to establish water quality standards for the protection of aquatic life.	Water quality monitoring will be conducted to ensure that these criteria are not exceeded during excavation and other remedial activities or during long-term water quality/sediment monitoring of any waste that is left to be managed on site in a waste management area.
Management of Undesirable Plants on Federal Lands	7 USC 2814	Relevant and Appropriate	Requires federal agencies to establish integrated management systems to control or contain undesirable plant species on federal lands under the agency's jurisdiction.	Measures will be taken to control the establishment of *Phragmites*, or other invasive plants within all remediated areas, particularly along the harbor shoreline. An invasive species control plan will be developed as part of the long-term O&M for this site.

TABLE 3-3

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE S-3A – SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (continued)				
Clean Water Act - National Pollutant Discharge Elimination System (NPDES)	40 CFR 122	Applicable	Establishes the specifications for discharging pollutants from any point source into the waters of the U.S.	Any water discharged to surface water bodies during remedial activities (including excavation of the marina area and installation of the cover) will comply with this regulation.
State				
State of Rhode Island Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Short Title: Remediation Regulations)	DEM-DSR-01-93, Section 8.02(A)(ii), 8.02(B), and Table 2	Applicable	These regulations set remediation standards to prevent leaching of soil contaminants into groundwater and sediment/surface water resulting from the unpermitted release of hazardous material in Rhode Island.	These leachability criteria will be used to develop monitoring standards for groundwater and sediment /pore water/surface water at the waste management area compliance boundary.
Rules and Regulations for Hazardous Waste Management, Definition of Hazardous Waste	DEM OWM-HW01-07, Rule 3	Applicable	Under State regulation hazardous wastes are defined as any hazardous waste as defined in 40 CFR 261.3. The standards also apply to “Rhode Island Wastes” which are defined as any waste meeting the definition of R001 through R005 and R010 under the Rule and which do not meet any of the federal definitions of a hazardous waste.	These regulations would apply when determining whether or not a solid waste is hazardous, either by being listed exhibiting a hazardous characteristic or meeting the definition of a Rhode Island Waste.

TABLE 3-3

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE S-3A – SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State (continued)				
Standards for Generators of Hazardous Waste	Rules and Regulations for Hazardous Waste Management, Section 5.00	Applicable	Establishes manifesting, pre-transport, and recordkeeping requirements for hazardous waste.	These regulations would apply to the contaminated soil, if hazardous.
Clean Air Act - Fugitive Dust Control	Air Pollution Control Regulation No. 5 – Fugitive Dust	Applicable	Requires that reasonable precaution be taken to prevent particulate matter from becoming airborne.	Control of dust during excavation and handling of soil would be implemented to prevent material from becoming airborne.
Clean Air Act - Emissions Detrimental to Persons or Property	Air Pollution Control Regulation No. 7	Applicable	Prohibits emissions of contaminants which may be injurious to humans, plant or animal life or cause damage to property or which reasonably interferes with the enjoyment of life and property.	Methods would be implemented to prevent material from becoming airborne during handling of contaminated material. Monitoring of air emissions during removal will be used to assess compliance with these standards if threshold levels are reached.
Clean Air Act – Volatile Organic Compounds (VOCs)	Air Pollution Control Regulation No. 22 – Air Toxics	Applicable	Prohibits emissions of contaminants that may be injurious to humans, plant or animal life or cause damage to property or that reasonably interferes with the enjoyment of life and property.	Control of emissions during excavation and handling of soil.

TABLE 3-3

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE S-3A – SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State (continued)				
Well Standards	State of Rhode Island Rules and Regulations for Groundwater Quality – Appendix 1	Applicable	Identifies the standards and specification that must be followed for the installation or abandonment of monitoring wells.	Applies to wells installed for monitoring and replacement of abandoned wells.
Standards for Storm Water Management and Sediment Reduction	Regulations of Rhode Island Pollutant Discharge Elimination System, Rules 15 and 31	Applicable	Identifies storm water management and sediment control requirements for remedial actions or corrective measures involving land-disturbance activities.	Soil excavation activities would need to meet these regulations.
Storm Drainage System Maintenance	Rhode Island General Law (RIGL) 45-61.1(2)(b)	Relevant and Appropriate	Storm drainage systems prone to flooding or contributing significantly to storm water management problems shall be inspected at least once per year and maintained and cleaned as necessary in order to reduce the risks of flooding and ensure proper functioning of storm drain systems.	Storm drain systems created as part of the remedial alternatives will be maintained in compliance with these standards.

TABLE 3-3

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE S-3A – SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State (continued)				
Drilling of Drinking Water Wells; Rules and Regulations Governing the Enforcement of Chapter 46-13.2 Relating to the Drilling of Drinking Water Wells	RIGL 46-13..2 *et seq.*	Applicable	Prohibits installing drinking water wells in contaminated aquifers.	Under these standards drinking water wells are prohibited within areas of contamination.
Water Pollution Control - Pollutant Discharge Elimination Systems	Regulations of Rhode Island Pollutant Discharge Elimination System	Applicable	Contains effluent monitoring requirements, and standards and special conditions for discharges.	The substantive provisions of these standards will be satisfied through on-site treatment of water from excavations prior to being discharged to surface waters.
Water Pollution Control - Water Quality	RIGL 42-16 et seq.; CRIR 12-190-001	Applicable	Establishes water use classification and water quality criteria for waters of the state.	Water quality standards used to develop monitoring standards both during the active remedial period such as dewatering excavations and for long-term monitoring.
Solid Waste Landfill Regulations - Monitoring	DEM OWM SW04- 01, 2.1.08(c)(1)(i) (B), (C), and (D).	Relevant and Appropriate	Describes horizontal and vertical placement of monitoring wells relative to location of landfill waste.	Monitoring wells installed as part of the LTM program will be located according to these regulations.

TABLE 3-4

REMEDIAL GOALS/CONTINGENT REMEDIAL GOALS FOR MARINE SURFACE WATER/PORE WATER
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Parameter	NRWQC Chronic Criteria Ecological (ug/L) (For Pore Water) (Contingency Only, See Note 1)	NRWQC Human Health Consumption of Biota (ug/L) (For Surface Water)	Appendix E Screening Level Ecological (ug/L) (For Pore Water) (Contingency Only, See Note 2)	Appendix E Screening Level Recreational Human Exposure (ug/L) (For Surface Water)
Trichloroethene	NA	30	1,940	35
Cis-1,2-Dichloroethene	NA	NA	680	1,160
Trans-1,2-Dichloroethene	NA	10,000	680	11,600
Vinyl chloride	NA	2.4	930	2
1,1-Dichloroethene	NA	7,100	2,240	27,600
1,2-Dichloroethane	NA	37	1,130	59.7
Benzene	NA	51	110	38.5
Tetrachloroethene	NA	3.3	45	391
Naphthalene	NA	NA	1.4	3,250

1 -There are no ecological NRWQC for these volatile organic compounds/naphthalene for marine life.
2 - The Appendix E Ecological Screening Levels are best described as "Contingency Remedial Goals" only at this time. Per the methodology presented in Appendix E, exceedances of the Appendix E screening levels would trigger a series of sampling/risk analyses events (including possibly a Baseline Ecological Risk Assessment) that might result in the conclusion that unacceptable ecological risks exist. Then, remedial goals for pore water would be determined. This approach is the standard ecological risk assessment protocol under CERCLA.

NA - Not available.
NRWQC - National Recommended Water Quality Criteria.

TABLE 3-5

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-3B - IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUC
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
Cancer Slope Factors (CSFs)	-	To Be Considered	Guidance values used to evaluate the potential carcinogenic hazards caused by exposure to contaminants.	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media. Risks due to carcinogens as assessed with slope factors will be addressed through chemical oxidation, MNA, LUCs, and long-term monitoring.
Reference Doses (RfDs)	-	To Be Considered	Guidance values used to evaluate the potential non-carcinogenic hazards caused by exposure to contaminants.	Used to calculate potential non-carcinogenic hazards caused by exposure to contaminants. Hazards due to noncarcinogens with EPA RfDs will be addressed through chemical oxidation, MNA, LUCs, and long-term monitoring.
Guidelines for Carcinogen Risk Assessment	EPA/630/P-03/001F (March 2005)	To Be Considered	Guidance for assessing cancer risk.	Used to calculate potential carcinogenic risks caused by exposure to contaminants. Hazards due to carcinogens assessed through chemical oxidation, MNA, LUCs, and long-term monitoring.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F (March 2005)	To Be Considered	Guidance of assessing cancer risks to children.	Used to calculate potential carcinogenic risks to children caused by exposure to contaminants. Carcinogenic risks to children assessed through this guidance will be addressed through chemical oxidation, MNA, LUCs, and long-term monitoring.

TABLE 3-5

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-3B - IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUC
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (continued)				
Safe Drinking Water Act, National Primary Drinking Water Regulations - Maximum Contaminant Levels (MCLs)	40 Code of Federal Regulations (CFR) 141, Subpart G	Relevant and Appropriate	Establishes maximum contaminant levels (MCLs) for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	MCLs were considered in development of PRGs and will be addressed through chemical oxidation, MNA, LUCs, and long-term monitoring. If this alternative is paired with a soil alternative that manages waste in place, then these standards will be used to establish PRGs for groundwater outside of the WMA compliance boundary (and used as Action-specific Performance Standards for inside of the compliance boundary). If this alternative is paired with Soil Alternative S-5, these standards will be used to develop PRGs for the entire Site, except where the groundwater is saline.
Safe Drinking Water Act; National Primary Drinking Water Regulations - Maximum Contaminant Level Goals (MCLGs)	40 CFR 141, Subpart F	Relevant and Appropriate for non-zero MCLGs only	Establishes maximum contaminant level goals (MCLGs) for public water supplies. MCLGs are health goals for drinking water sources. These unenforceable health goals are available for a number of organic and inorganic compounds.	Non-zero MCLGs were considered in development of PRGs and will be addressed through chemical oxidation, MNA, LUCs, and long-term monitoring. If this alternative is paired with a soil alternative that manages waste in place, then these standards will be used to establish PRGs for groundwater outside of the WMA compliance boundary (and used as Action-specific Performance Standards for inside of the compliance boundary). If this alternative is paired with Soil Alternative S-5, these standards will be used to develop PRGs for the entire Site, except where the groundwater is saline.

TABLE 3-5

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-3B - IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUC
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (continued)				
OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils	EPA/530-D-02-004	To Be Considered	Used to evaluate potential risks associated with indoor air at buildings near the Site.	Potential risks associated with indoor air at buildings on or near the Site will be evaluated, monitored and corrected, consistent with this guidance. LUCs will be used to address vapor intrusion risks by controlling building design and construction methods.
State				
State of Rhode Island Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Short Title: Remediation Regulations)	DEM-DSR-01-93, Section 8.03	Applicable	These regulations set remediation standards for contaminated media resulting from the unpermitted release of hazardous material in Rhode Island.	Groundwater will achieve numerical groundwater cleanup standards when the standard for a contaminant is more stringent than federal standards. Remediation standards were considered in development of PRGs and will be met through will be addressed through chemical oxidation, MNA, LUCs, and long-term monitoring. If this alternative is paired a soil alternative that manages waste in place, then these standards will be used to establish PRGs for groundwater outside of the WMA compliance boundary (and used as Action-specific Performance Standards for inside of the compliance boundary). If this alternative is paired with Soil Alternative S-5, these standards will be used to develop PRGs for the entire Site, except where the groundwater is saline.

TABLE 3-6

FEDERAL AND STATE LOCATION-SPECIFIC ARARs – ALTERNATIVE G-3B - IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUC
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
Endangered Species Act	16 United States Code (USC) 1531 et seq.	Applicable	Requires consultation with appropriate agencies if a threatened or listed species or their habitat may be affected by a federal action.	The Navy will coordinate with appropriate agencies to consider mitigation measures if any remedial actions adjacent to Allen Harbor may affect the habitat of the federally-listed loggerhead turtle (*Carette caretta*), Kemp's ridley turtle (*Lepidochelys kempii*), and Atlantic sturgeon (*Acipenser oxyrinchus*).
Coastal Zone Management Act	16 USC 1451 et. seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state approved management programs.	Part of the site is located in a coastal zone management area; therefore, applicable coastal zone management requirements need to be addressed.
Floodplain Management and Protection of Wetlands	44 Code of Federal Regulations (CFR) 9	Relevant and appropriate	FEMA regulations that set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11988, Floodplain Management, and Executive Order 11990, Protection of Wetlands.	Remedial alternatives (such as installation/operation of monitoring/treatment wells) conducted within the 100-year floodplain of Allen Harbor/Narragansett Bay or within federal jurisdictional wetlands will be implemented in compliance with these standards. The Navy will solicit public comment as part of the proposed plan on the measures taken through the remedial action to protect floodplain and wetland resources.

TABLE 3-6

FEDERAL AND STATE LOCATION-SPECIFIC ARARs – ALTERNATIVE G-3B - IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUC
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State				
Coastal Resources Management	Rhode Island General Laws (RIGL) 46-23-1 et seq. and Coastal Resources Management Program	Applicable	Sets standards for management and protection of coastal resources.	Part of the site is located in a coastal resource management area; therefore, applicable coastal resource management requirements need to be addressed**.**
State of Rhode Island Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Short Title: Remediation Regulations)	DEM-DSR-01-93, Section 8.09 (Institutional Controls)	Applicable	Describes the provisions required for environmental land usage restrictions where levels of hazardous substances remain on site at concentrations greater than those protective of residential use.	The substantive portions of this section will be used in the preparation of the LUCs and deed restrictions which would be provided to RIDEM for review. These provisions are listed in subsections A through E.

TABLE 3-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-3B - IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
Resource Conservation and Recovery Act (RCRA) Regulations,	42 United States Code (USC) 6901 et seq.	Applicable	Rhode Island has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the State.	Refer to State ARARs for hazardous waste requirements.
CWA, Underground Injection Control	40 Code of Federal Regulations (CFR) 144, 146,147	Applicable	Standards for discharge of treated groundwater back into the ground.	These regulations would apply to remedial actions involving underground injection of an oxidizer.
Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites.	OSWER Directive 9200.4-17P, April 21, 1999.	To Be Considered	Used to evaluate the monitored natural attenuation component of the remedy.	Any proposed monitored natural attenuation remedy will evaluated and monitored consistent with this guidance.

TABLE 3-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-3B - IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (continued)				
Safe Drinking Water Act; National Primary Drinking Water Regulations - Maximum Contaminant Levels (MCLs)	42 USC Section 300f et seq.; 40 CFR 141, Subpart G	Relevant and Appropriate	Establishes MCLs for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate standards for aquifers and surface water bodies that are potential drinking water sources.	Groundwater within the compliance boundary for any waste management area established for the soil component of the remedy will be monitored using the standards to evaluate migration beyond the compliance boundary. If this alternative is paired with a soil alternative that manages waste in place, then these standards will be used as Performance Standards for monitoring inside the compliance boundary for the waste management area. If this alternative is paired with Soil Alternative S-5, these standards will be used to monitor groundwater until treatment and MNA have achieved groundwater cleanup standards throughout the Site, except where the groundwater is saline.

TABLE 3-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-3B - IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (continued)				
Safe Drinking Water Act; National Primary Drinking Water Regulations - Maximum Contaminant Level Goals (MCLGs)	42 USC Section 300f et seq.; 40 CFR 141, Subpart F	Relevant and Appropriate for non-zero MCLGs only	Establishes maximum contaminant level goals (MCLGs) for public water supplies. MCLGs are health goals for drinking water sources. These unenforceable health goals are available for a number of organic and inorganic compounds.	Groundwater within the compliance boundary for any waste management area established for the soil component of the remedy will be monitored using the standards to evaluate migration beyond the compliance boundary. If this alternative is paired with a soil alternative that manages waste in place, then these standards will be used as Performance Standards for monitoring inside the compliance boundary for the waste management area. If this alternative is paired with Soil Alternative S-5, these standards will be used to monitor groundwater until treatment and MNA have achieved groundwater cleanup standards throughout the Site, except where the groundwater is saline.

TABLE 3-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-3B - IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (continued)				
EPA Groundwater Protection Strategy; Guidelines for Ground-Water Classification (November 1986)	August 1984; NCP Preamble, Vol. 55, No. 46, March 8, 1990, 40 CFR Part 300, p. 8733	To Be Considered	The Groundwater Protection Strategy provides a common reference for preserving clean groundwater and protecting the public health against the effects of past contamination. Guidelines for consistency in groundwater protection programs focus on the highest beneficial use of a groundwater aquifer and define three classes of groundwater. These documents defined Class I, II and III groundwaters.	If this groundwater alternative is paired with a soil alternative that manages waste in place, groundwater outside of the compliance boundary for the waste management area established at the Site needs to attain federal drinking water and risk-based standards. Groundwater monitoring using these standards will be used to evaluate migration beyond the compliance boundary. Exceedances of these standards within the compliance boundary are a basis for establishing prohibitions on the use of groundwater within the compliance boundary. An additional buffer zone beyond the compliance boundary to prevent groundwater wells from being installed that would draw contaminated groundwater beyond the compliance boundary may also be established, if required. If this alternative is paired with Soil Alternative S-5, then this groundwater alternative will achieve groundwater cleanup standards throughout the entire Site, except where the groundwater is saline.

TABLE 3-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-3B - IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (continued)				
Clean Water Act, National Recommended Water Quality Criteria (NRWQC)	33 USC 1251 et seq.; 40 CFR 122.44	Relevant and Appropriate	Used to establish water quality standards for the protection of aquatic life.	Water quality monitoring will be conducted to ensure that these criteria are not exceeded during remedial activities or during long-term water quality monitoring.
Marine Screening Benchmarks	USEPA Region 3 Biological Technical Assistance Group Marine Screening Benchmarks, July 2006	To Be Considered	Media-specific sets of ecotoxicological benchmarks that should be used in developing a screening level risk assessment. These guidelines are to be used to screen exposure through routes other than food chain exposure.	The benchmarks will be used as a basis for the development of trigger levels to evaluate the results of groundwater samples in the vicinity of Allen Harbor. If the groundwater results are greater than the trigger values, then further action will be evaluated.
State				
Rules and Regulations for Hazardous Waste Management, Definition of Hazardous Waste	DEM OWM-HW01-07, Rule 3	Applicable	Under State regulation hazardous wastes are defined as any hazardous waste as defined in 40 CFR 261.3. The standards also apply to “Rhode Island Wastes” which are defined as any waste meeting the definition of R001 through R005 and R010 under the Rule and which do not meet any of the federal definitions of a hazardous waste.	These regulations would apply when determining whether or not a solid waste, such as drill cuttings from injection wells is hazardous, either by being listed exhibiting a hazardous characteristic or meeting the definition of a Rhode Island Waste.

TABLE 3-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-3B - IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Standards for Generators of Hazardous Waste	Rules and Regulations for Hazardous Waste Management, Section 5.00	Applicable	Establishes manifesting, pre-transport, and recordkeeping requirements for hazardous waste.	These regulations would apply to well installation and sampling IDW, if hazardous.
State (continued)				
Underground Injection Control Program Rules and Regulations	Regulations pursuant to the authority of Chapter 42-17.1 and Chapter 46-12 of the Rhode Island General Laws	Applicable	Establishes a State Underground Injection Control Program consistent with federal requirements to preserve the quality of the groundwater of the state.	These regulations apply underground injection of oxidizing chemical.
Rules and Regulations Governing Drilling of Drinking Water Wells	Rules and Regulations Governing the Enforcement of Chapter 46-13.2	Applicable	Establish prohibitions against installing drinking water wells in contaminated aquifers.	Remedial alternatives that leave contaminants in place will include prohibitions on installing drinking water wells.

TABLE 3-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-3B - IN-SITU CHEMICAL OXIDATION (EAST END OF FORMER BUILDING 41), MNA, AND LUCs
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Well Standards	State of Rhode Island Rules and Regulations for Groundwater Quality – Appendix 1	Applicable	Identifies the standards and specifications that must be followed for the installation or abandonment of monitoring wells.	Applies to wells installed for monitoring.

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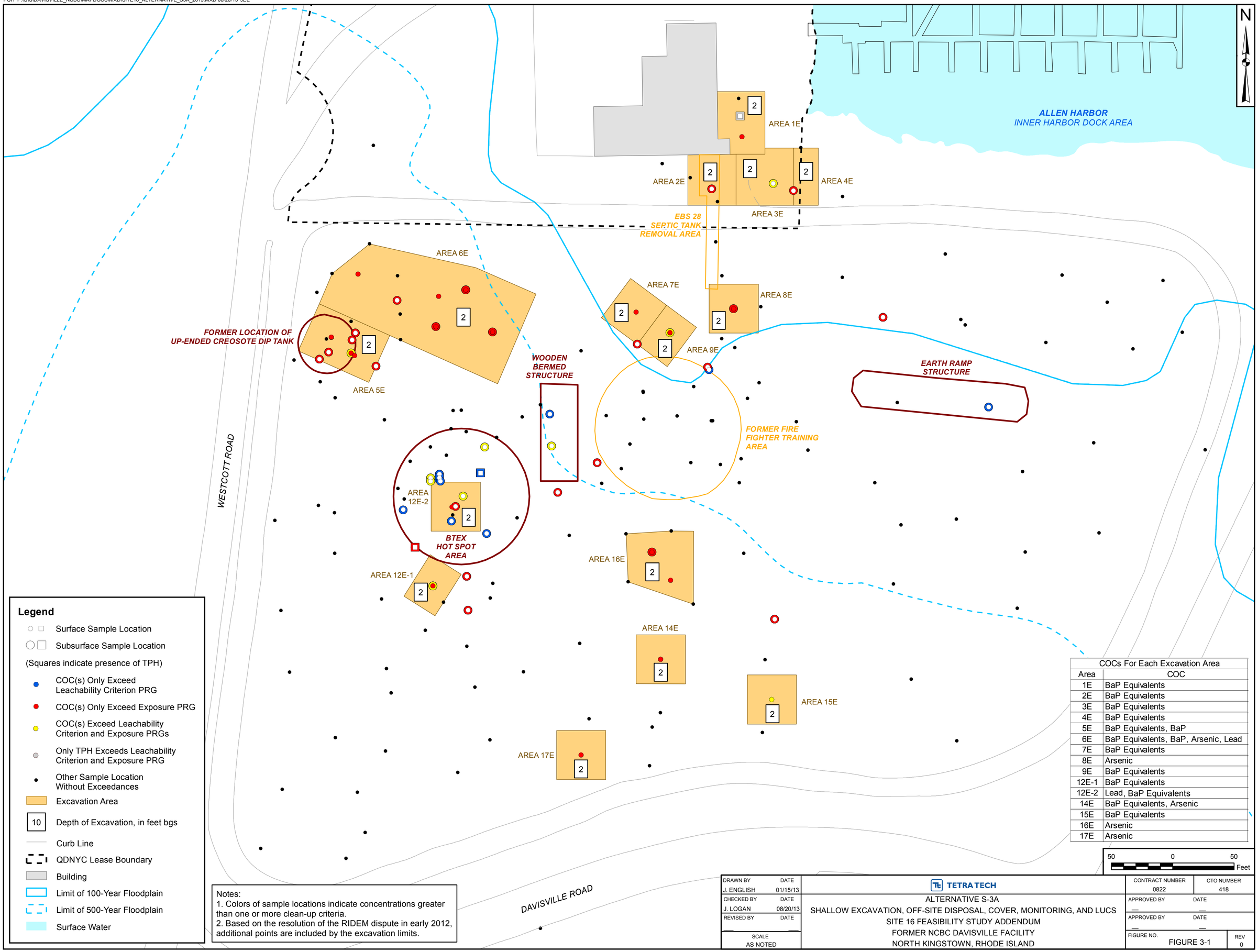

COCs For Each Excavation Area	
Area	COC
1E	BaP Equivalents
2E	BaP Equivalents
3E	BaP Equivalents
4E	BaP Equivalents
5E	BaP Equivalents, BaP
6E	BaP Equivalents, BaP, Arsenic, Lead
7E	BaP Equivalents
8E	Arsenic
9E	BaP Equivalents
12E-1	BaP Equivalents
12E-2	Lead, BaP Equivalents
14E	BaP Equivalents, Arsenic
15E	BaP Equivalents
16E	Arsenic
17E	Arsenic

Notes:
1. Colors of sample locations indicate concentrations greater than one or more clean-up criteria.
2. Based on the resolution of the RIDEM dispute in early 2012, additional points are included by the excavation limits.

DRAWN BY	DATE
J. ENGLISH	01/15/13
CHECKED BY	DATE
J. LOGAN	08/20/13
REVISED BY	DATE
—	—
SCALE	
AS NOTED	

TETRA TECH

ALTERNATIVE S-3A
SHALLOW EXCAVATION, OFF-SITE DISPOSAL, COVER, MONITORING, AND LUCS
SITE 16 FEASIBILITY STUDY ADDENDUM
FORMER NCBC DAVISVILLE FACILITY
NORTH KINGSTOWN, RHODE ISLAND

CONTRACT NUMBER	CTO NUMBER
0822	418
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE 3-1	0

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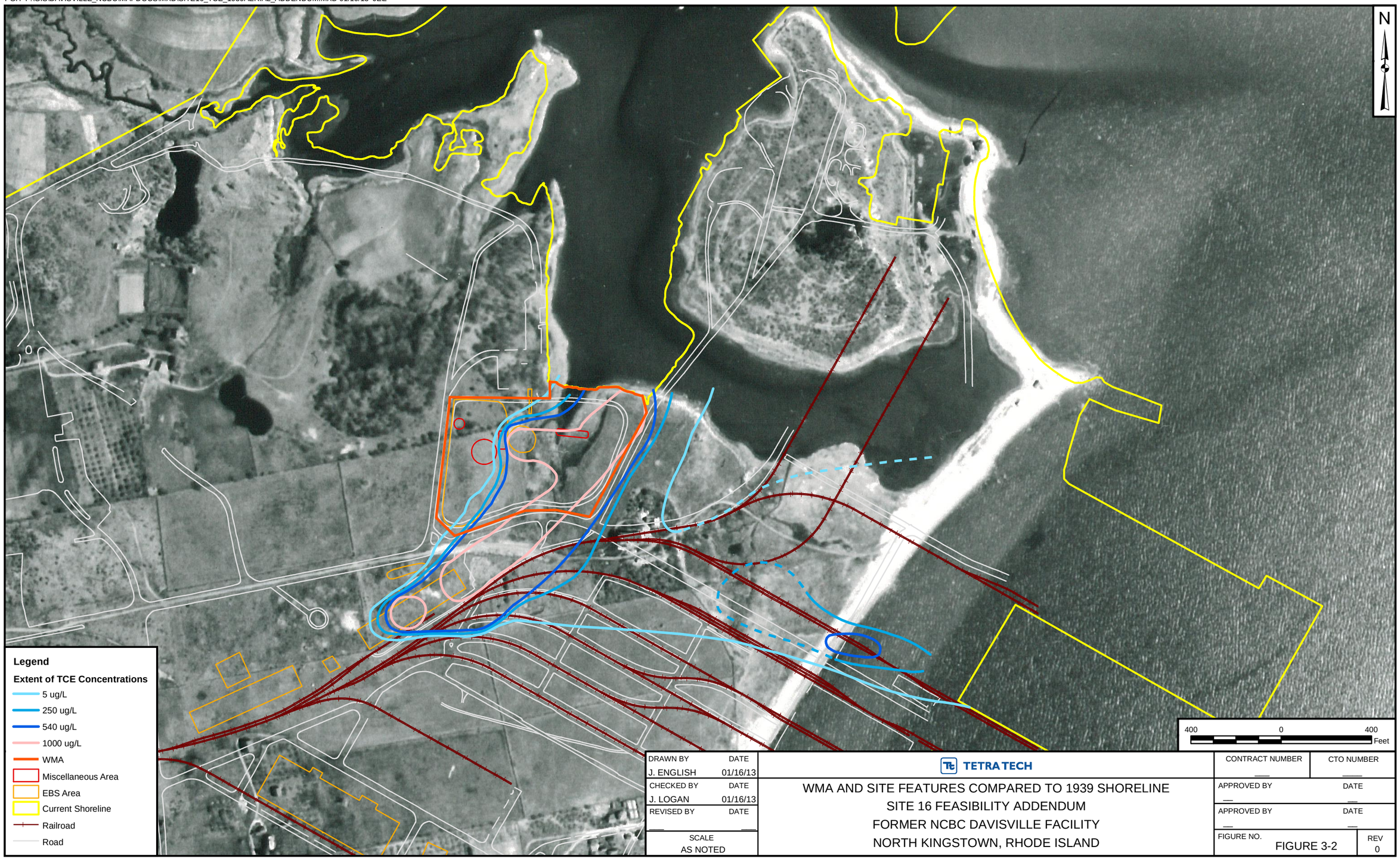

DRAWN BY	DATE
J. ENGLISH	01/16/13
CHECKED BY	DATE
J. LOGAN	01/16/13
REVISED BY	DATE
SCALE	
AS NOTED	

TETRA TECH

WMA AND SITE FEATURES COMPARED TO 1939 SHORELINE
SITE 16 FEASIBILITY ADDENDUM
FORMER NCBC DAVISVILLE FACILITY
NORTH KINGSTOWN, RHODE ISLAND

CONTRACT NUMBER	CTO NUMBER
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO. FIGURE 3-2	REV 0

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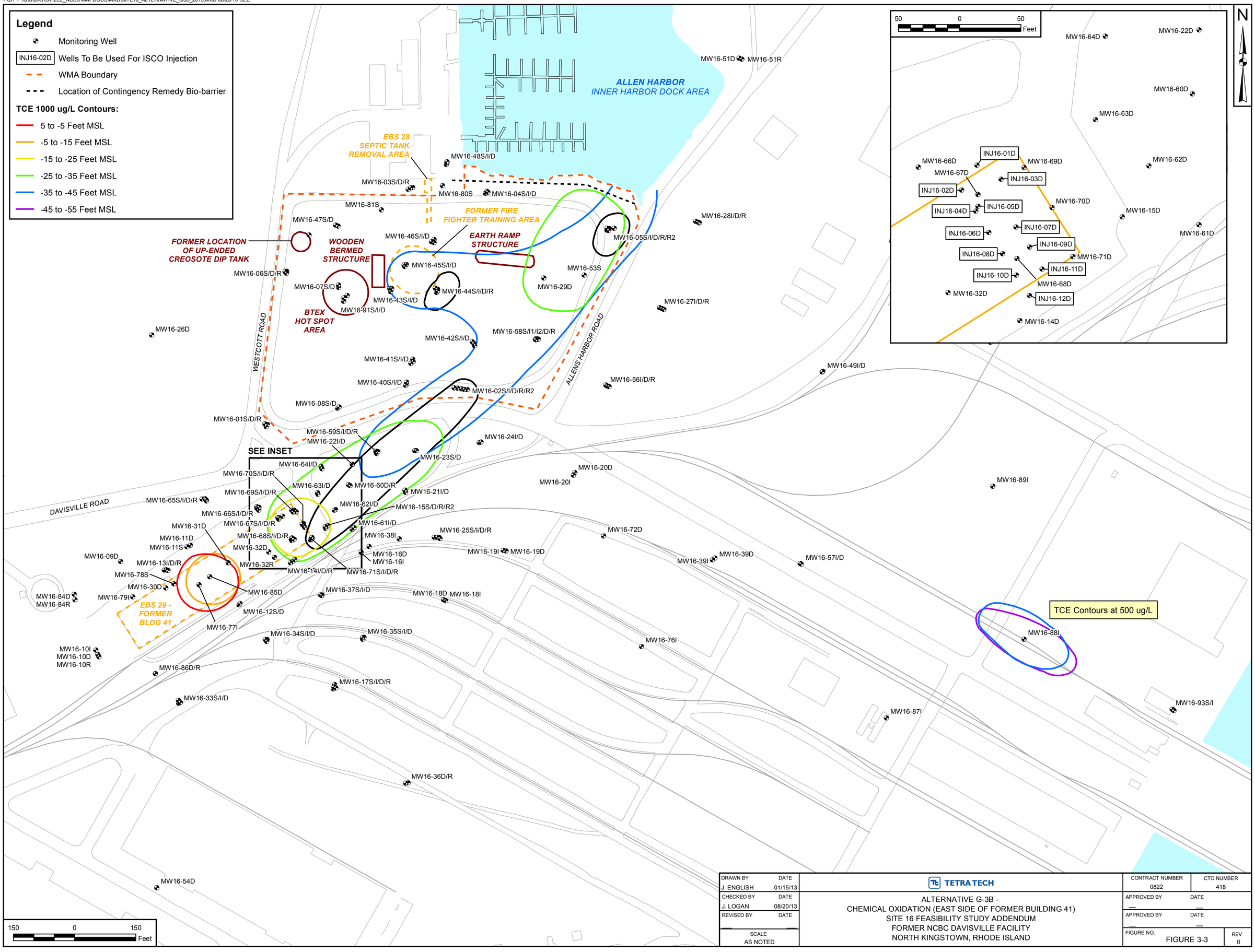

DRAWN BY	DATE	TETRA TECH	CONTRACT NUMBER	CTO NUMBER
J. ENGLISH	01/15/13		0822	418
CHECKED BY	DATE	ALTERNATIVE G-3B -	APPROVED BY	DATE
J. LOGAN	08/20/13	CHEMICAL OXIDATION (EAST SIDE OF FORMER BUILDING 41)	—	—
REVISED BY	DATE	SITE 16 FEASIBILITY STUDY ADDENDUM	APPROVED BY	DATE
—	—	FORMER NCBC DAVISVILLE FACILITY	—	—
SCALE		NORTH KINGSTOWN, RHODE ISLAND	FIGURE NO.	REV
AS NOTED			FIGURE 3-3	0

4.0 DETAILED ANALYSIS OF COMMON REVISED ELEMENTS

This section describes common elements, either a feature or component, that are being added to several alternatives, and presents an evaluation of each element with respect to the criteria of the NCP. The comparative analysis of the common elements is considered as necessary in Section 5.0.

4.1 WASTE MANAGEMENT AREA

A WMA is a feature of soil alternatives that leave waste in place: Alternatives S-2, S-3, S-3A, S-4, and S-6. The effects of the presence or absence of a WMA on the groundwater alternatives are discussed in this section. The covers that are typically part of an alternative with a WMA have been described previously in the analyses of the soil alternatives.

4.1.1 Description

A WMA is part of Alternatives S-2, S-3, S-3A, S-4, and S-6. The effects of designating a WMA extending over the entire NCA was not fully incorporated into the evaluation in the FS of several groundwater alternatives, specifically Alternatives G-2, G-3, G-4, G-5, and G-6. The WMA is also included in Alternative G-3B in this FSA. The WMA was included in the evaluation of Alternative G-3A.

The WMA would be defined by the extent of the NCA generally bound by Allen Harbor, Allen Harbor Road, Davisville Road, and Wescott Road (See Figure 3-2). The area is approximately 425,000 square feet.

The boundaries of the WMA would be defined in a LUC. A groundwater compliance boundary would be established around the WMA. Groundwater cleanup levels (PRGs) would have to be achieved outside of the compliance boundary. Inside the compliance boundary groundwater performance standards would be established as monitoring standards to ensure that soil/groundwater contamination within the WMA is not migrating beyond the compliance boundary. Within the NCA, the WMA extends over the 1,000 µg/L TCE contours and most of the 500 µg/L TCE contours. Groundwater with concentrations of TCE greater than 500 µg/L and less than 1,000 µg/L will be outside of the footprint of the WMA along the eastern side of the NCA. When a groundwater alternative is paired with a soil alternative that manages waste in place, the LUCs would be permanent within the compliance boundary and temporary until groundwater cleanup standards are achieved outside of the compliance boundary. If the alternative is paired with soil Alternative S-5, the LUCs are temporary until PRGs are achieved.

As described for Alternative S-3A (see Section 3.1.1), a groundwater monitoring program would be developed and implemented to evaluate the long-term potential migration of contaminants and to monitor contaminant concentrations within the compliance boundary of the WMA. Monitoring would be required around a groundwater compliance zone established around areas where waste is managed in place. The number of wells that may be required and monitoring frequency would be determined during the remedial design. Monitoring would be coordinated with any additional monitoring required to address site groundwater contaminated beyond the compliance zone.

A line of six shallow monitoring wells would be installed along the downgradient edge of the WMA, near Allen Harbor. The results from samples collected from these wells would be compared to standards to be determined based on water quality criteria. Approximately six other wells within the footprint of the WMA would be monitored to evaluate changes in the groundwater quality. The PRG values would be used as performance standards for monitoring wells within the WMA boundary.

4.1.2 Detailed Analysis

4.1.2.1 Overall Protection of Human Health and the Environment

The WMA would add to the protectiveness of the groundwater alternatives by providing an additional restriction on groundwater use within the NCA, although groundwater use restrictions would already be implemented through the LUCs. The LUCs would include the boundaries of the WMA and describe maintenance of the WMA, and the limitations on the groundwater quality within the boundaries.

Note that the absence of a WMA does not affect the overall protectiveness of the groundwater alternatives. LUCs would still be required which would put restrictions on groundwater use.

4.1.2.2 Compliance with ARARs

There are no additional ARAR requirements associated with the WMA. Note that within a WMA, groundwater PRGs would not need to be met within the compliance boundary, and PRGs would be used as performance standards. For Alternative G-2, the estimated time would be 300 Years. For Alternatives G-3, G-3A, G-4, and G-5, the estimated time would be approximately 100 years. There would be no change in the estimated time (50 years) for Alternative G-6.

If a groundwater alternative is paired with Alternative S-5, the estimated time for Alternative G-2 to meet PRGs would be greater than 300 years. For Alternatives G-3, G-3A, G-4, and G-5, the estimated time to meet PRGs would be 100 to 150 years. There would be no change in the estimated time (50 years) for Alternative G-6.

Alternatives S-2, S-3, S-3A, S-4, and S-6 have a WMA, so leachability criteria exceedances do not need to be addressed except for monitoring at the WMA compliance boundary. In the case of Alternative S-5, because all contaminated soil would be removed, soil leachability criteria would be met.

4.1.2.3 Long-Term Effectiveness and Permanence

There would be no changes in the long-term effectiveness and permanence of the groundwater alternatives by the designation of the WMA. LUCs associated with the WMA and maintenance of the WMA would effectively prevent the use of groundwater until PRGs are met.

4.1.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

There would be no reduction of toxicity, mobility, or volume of groundwater COCs through treatment associated with the designation of the WMA. Similarly, there would be no treatment residues associated with the designation of the WMA.

4.1.2.5 Short-Term Effectiveness

Exposure of workers to contamination during groundwater sampling would be minimized by compliance with OSHA requirements including wearing of appropriate PPE and adherence to site-specific health and safety procedures. This potential exposure would be in addition to potential exposure during monitoring that is part of all of the groundwater alternatives. Implementation of the WMA and associated monitoring would not adversely impact the surrounding community or the environment.

Because PRGs do not need to be met within the WMA footprint, the estimated time to meet RAO No. 2 was re-evaluated for each alternative. For Alternative G-2, the estimated time would be 300 Years. For Alternatives G-3, G-3A, G-4, and G-5, the estimated time would be approximately 100 years. There would be no change in the estimated time for Alternative G-6.

Because of the additional monitoring, there would be slight increases in sustainability impacts for each alternative. These were not quantitatively evaluated for this FSA.

If paired with Alternative S-5, the estimated time for Alternative G-2 to meet RAO No. 2 would be greater than 300 years. For Alternatives G-3, G-3A, G-4, and G-5, the estimated time to meet RAO No. 2 would be 100 to 150 years. There would be no change in the estimated time (50 years) for Alternative G-6.

4.1.2.6 Implementability

Implementation of the WMA would be relatively simple and would be part of the overall LUCs plan and LUC RD.

4.1.2.7 Cost

The increase in costs for the installation of additional monitoring wells and the sampling and analysis of these wells is low compared to the overall costs of the alternatives. The incremental cost is well within the uncertainty range of the cost estimates. Therefore, no changes in the cost estimates are included in this analysis.

4.2 MARINA SOIL REMEDIATION

4.2.1 Description of Component

The approach to soil remediation in the vicinity of the marina building varied for each alternative. Based on recent discussions with RIDEM and the USEPA, the soil remediation in this area can be addressed as described in Alternative S-3A in this FSA. Thus, a separate component for the remediation of the soil in the vicinity of the marina building is described and analyzed below for inclusion with soil Alternatives S-2, S-3, S-4, and S-6. This component is not needed for Alternative S-5 because the extensive soil excavation in that alternative includes the marina building area.

Near the marina building, contaminated soil with COC concentrations greater than RIDEM residential DECs would be excavated to a depth of 2 feet bgs to meet recreational use requirements, per discussions with RIDEM, as shown on Figure 3-1. Approximately 460 cubic yards of soil would be excavated and replaced with clean backfill which would be managed as cover. Based on contaminant concentrations, this component would require excavation in close proximity to the building. Because of the age of the building, there is uncertainty as to whether the building could be occupied during excavation and whether the building would remain structurally sound; therefore, shoring may be required. If sampling indicates that contamination extends beneath the marina building, then the soil beneath the building would be included in the LUCs. Only soil in the unsaturated zone would be excavated, so no dewatering of the excavated material would be required. After backfilling is complete, the surface would be restored to match the pre-excavation condition (paved or seeded with grass). LUCs will be implemented to require annual inspection and maintenance of the cover and prevent disturbance of the cover and underlying contaminated soil.

4.2.2 Detailed Analysis

4.2.2.1 Overall Protection of Human Health and the Environment

This component would be protective of human health and the environment by removal of contaminated soil that is near the surface. Soil with contaminant concentrations greater than RIDEM residential DECs would be removed to a depth of 2 feet bgs. Clean fill cover prevents exposure to contaminants at greater depths. Off-site treatment (if required) and disposal of the excavated soil would further protect human health and the environment. LUCs would require maintenance of the soil cover.

4.2.2.2 Compliance with ARARs

This component would comply with all chemical-, location-, and action-specific ARARs and TBCs. There are no additional ARAR requirements associated with the activities.

4.2.2.3 Long-Term Effectiveness and Permanence

This component would provide long-term effectiveness and permanence.

Excavation of contaminated soil at the surface would effectively and permanently prevent unacceptable risk from exposure to contaminated soil under the recreational use exposure scenario. LUCs that control recreational exposure, require inspection and maintenance of the cover, control disturbance of contaminated soil, and prevent hypothetical future residential development would effectively and permanently prevent unacceptable risk from direct exposure to contaminated soil.

4.2.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This component would not reduce the toxicity, mobility, or volume of the soil contaminants through treatment.

4.2.2.5 Short-Term Effectiveness

Implementation of the excavation and off-site disposal components of this component could expose construction workers to contaminated soil, but these exposure risks are already present in the soil alternatives. This potential for exposure would be minimized by the implementation of engineering controls such as dust suppression and air quality monitoring. The potential for worker exposure would be further reduced by the wearing of appropriate PPE, and compliance with applicable OSHA regulations and proper site-specific health and safety procedures.

Implementation of the excavation components is not expected to adversely impact either the surrounding community or the environment. However, measures such as spill prevention and containment, erosion and sedimentation control, and perimeter air monitoring would be taken to ensure that the impact remains acceptable. Trucks associated with disposal of contaminated soil and bringing clean soil to the site may increase traffic on surrounding roads, but this is already considered in the analysis of the soil alternatives.

Because of the differences in excavation in this component compared to the similar component in the other soil alternatives, there would be slight increases or decreases in sustainability impacts for each alternative. These were not quantitatively evaluated for this FSA.

4.2.2.6 Implementability

Excavation would be technically implementable. Contractors qualified to excavate and dispose the contaminated soil are readily available, and this work could be performed with normal construction equipment. The marina building would be protected by shoring, if needed. No dewatering would be required. Off-site borrow locations for clean soil backfill and disposal facilities for excavated soil would be readily available. The resources, equipment, and materials required for these activities are readily available. LUCs can be readily implemented.

4.2.2.7 Cost

The cost for the excavation described in this component is similar in scope to the remedial component for this area described in the other soil alternatives. The incremental cost difference is well within the uncertainty range of the cost estimates. Therefore, no changes in the cost estimates are included in this analysis.

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section compares the analyses for each of the soil and groundwater remedial alternatives including the new alternatives presented in Section 3.0, and the common revised components presented in Section 4.0. The criteria for comparison are identical to those used for the detailed analysis of individual alternatives. This section uses Section 5.0 of the FS (Tetra Tech, 2012) as the base text.

5.1 COMPARISON OF SOIL REMEDIAL ALTERNATIVES BY CRITERIA

The following remedial alternatives for Site 16 soil are compared in this section:

- Alternative S-1: No Action.
- Alternative S-2: Soil Cover and/or Cap, Monitoring, and LUCs.
- Alternative S-3: Excavation, Off-site Disposal, and LUCs.
- Alternative S-3A: Shallow Excavation, Off-site Disposal, Cover, Monitoring, and LUCs.
- Alternative S-4: Soil Cover, Selected Excavation and Disposal, and LUCs.
- Alternative S-5: Excavation and Off-site Disposal – Unrestricted Use.
- Alternative S-6: Full Soil Cover, Monitoring, and LUCs.

Note that the existing alternatives S-2, S-3, S-4, and S-6 include the WMA that coincides with Alternative S-3A and is discussed in Section 4.0.

5.1.1 Overall Protection of Human Health and the Environment

Alternative S-5 would be the most protective because contaminants with concentrations greater than residential PRGs would be removed and there would be no site use restrictions. Alternative S-3 would be the next most protective alternative because contaminants with concentrations greater than industrial PRGs in the surface soil and all soil with contaminant concentrations greater than leachability PRGs would be removed in the NCA. Alternative S-3A would be comparable to Alternative S-3 because contaminants with concentrations greater than PRGs and RIDEM industrial DECs would be removed in the NCA and cover would prevent exposure to subsurface contaminants. Alternative S-4 would be protective but slightly less protective than Alternatives S-3 and S-3A because some contaminants with concentrations greater than industrial PRGs would remain in the NCA, although covered. Alternative S-2 would be protective but slightly less than Alternative S-4 because no contaminants would be removed, and contaminants would remain in the NCA at concentrations greater than industrial and leachability PRGs, although capped or covered. Alternative S-6 would be as protective as Alternative S-2 because no contaminants would be removed and contaminants would remain in the NCA at concentrations greater

than industrial and leachability PRGs, although covered. For Alternatives S-2, S-3, S-3A, S-4, and S-6, LUCs would prevent residential uses of the site. Alternatives S-2, S-3, S-3A, S-4, and S-6 are protective of recreational users near the Marina Building by removing contaminated soil to a depth of 2 feet bgs and replacing it with clean fill, and by providing LUCs to prevent exposure to subsurface soil.

Alternative S-1 could provide some protection of human health and the environment. Under the current LUCs, the portion of the site north of Davisville Road cannot be used for residential purposes. However, contaminants could still leach into groundwater. Because the existing LUCs are not environmental LUCs, they could be readily lifted. Therefore, Alternative S-1 would not be fully protective.

5.1.2 Compliance with ARARs and TBCs

Alternatives S-2, S-3, S-3A, S-4, S-5, and S-6 would comply with all chemical-, location-, and action-specific ARARs and TBCs. Alternatives S-3, S-3A, and S-5 would meet the chemical-specific ARARs by removing the contaminants and using LUCs. Alternatives S-2 and S-6 would meet chemical-specific ARARs by covering or capping the site and eliminating the exposure routes. Alternative S-4 would meet the chemical-specific ARARs through a combination of excavation and cover. Alternatives S-2, S-3, S-3A, S-4, and S-6 have a WMA, so leachability criteria exceedances do not need to be addressed except for monitoring at the WMA compliance boundary.

Alternative S-1 would not comply with chemical-specific ARARs, and compliance with location-specific ARARs would be incidental. Location-specific and action-specific ARARs or TBCs would not apply.

5.1.3 Long-Term Effectiveness and Permanence

Alternatives S-2, S-3, S-3A, S-4, S-5, and S-6 would provide long-term effectiveness and permanence. Alternative S-5 would be the most effective and permanent because all contaminants at concentrations greater than residential and leachability PRGs would be removed from the site. Alternative S-3 would be the next most effective and permanent because contaminants with concentrations greater than industrial PRGs in the surface soil and all soil with contaminant concentrations greater than leachability PRGs would be removed from the NCA. Similarly, Alternative S-3A is comparable to Alternative S-3 because contaminants with concentrations greater than PRGs and RIDEM industrial DECs in the surface soil would be removed from the NCA, but some contaminants would remain at the site under cover. Alternative S-4 would be slightly less permanent than Alternatives S-3 and S-3A, because although some contaminants would be removed from the NCA, some contaminants would remain at the site, although under a cover. Alternatives S-2 and S-6 would each be slightly less permanent than Alternative S-4 because contaminants would remain at the NCA, although under caps and cover. For Alternatives S-2, S-3, S-3A, S-4, and S-6, the LUCs would be effective in maintaining designated site uses and maintaining

the cover and caps in good condition. Alternatives S-2, S-3, S-3A, S-4, and S-6 would provide long-term effectiveness in the vicinity of the Marina Building by removal of contaminated soil to a depth of 2 feet bgs and by providing LUCs to prevent exposure to subsurface soil and maintaining the condition of the backfill cover.

Alternative S-1 would have limited long-term effectiveness and permanence because contaminated soil would remain on site. The existing LUCs for the area north of Davisville Road will limit exposure under residential uses, but these are not environmental LUCs that are enforceable under relevant environmental regulations. Because there would be no groundwater monitoring, potential migration of soil COCs to the groundwater and potential off-site migration of soil COCs would not be detected. Although COC concentrations might eventually decrease to PRGs through natural attenuation, no monitoring would verify this.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

None of the soil alternatives provide reductions in toxicity, mobility, or volume through treatment. No treatment residues would be generated by any of the alternatives.

5.1.5 Short-Term Effectiveness

Implementation of Alternative S-1 would not result in risks to site workers or adversely impact the surrounding community or environment because no remedial activities would be performed.

Implementation of Alternatives S-2, S-3, S-3A, S-4, S-5, and S-6 could expose construction workers to contaminated soil. This potential for exposure would be minimized by the implementation of engineering controls, such as dust suppression, and air quality monitoring. The potential for worker exposure would be further reduced by the wearing of appropriate PPE and compliance with applicable OSHA regulations and proper site-specific health and safety procedures. Alternative S-5 would have the greatest amount of exposure to contaminated soil because the alternative has the largest amount of excavation. Alternative S-4 would have slightly less exposure than Alternatives S-3 and S-3A, because less soil would be excavated. Alternatives S-2 and S-6 have the least amount of excavated soil and the least exposure.

Implementation of Alternative S-2 would have very little adverse impact on either the surrounding community or the environment because of the small amount of excavated soil transported through the community, although the transport of soil to the site for the cover would require approximately 600 truckloads. Alternatives S-3, S-3A, S-4, S-5, and S-6 have a greater potential for impacts because of the handling and transport of the contaminated soil disposal and clean soil for backfill and/or cover. Alternatives S-3, S-3A, S-4, and S-6 would require approximately 1,000, 470, 1,200, and 1,200

truckloads, respectively. The potential impact from Alternative S-5 would be the greatest because the quantity of excavated soil for disposal and clean soil for backfill would require approximately 7,100 truckloads. However, measures such as spill prevention and containment, erosion and sedimentation control, and perimeter air monitoring would be taken to ensure that the impact remains acceptable.

Alternative S-2 would be expected to be completed in approximately 4 months, Alternatives S-3, S-3A, and S-4 would be expected to be completed within 6 months. Alternative S-6 would be expected to be completed in 9 months. Alternative S-5 would be expected to be completed in approximately 12 months.

Alternatives S-2, S-3, S-3A, S-4, S-5, and S-6 would meet the soil RAOs. Alternative S-5 would meet all residential soil PRGs. Alternative S-3 would meet the soil industrial PRGs in surface soil and leachability PRGs in all soil in the NCA, and would eliminate the exposure pathways to deeper contamination. Alternative S-3A would meet the soil industrial PRGs and RIDEM DECs in surface soil in the NCA, and exposure to remaining contaminants that may leach from the soil into the groundwater would be addressed by the WMA. In Alternatives S-2, S-4, and S-6, COCs would be present in soil at concentrations greater than the PRGs in the NCA, but a cover and caps would eliminate the exposure pathways. Alternatives S-2, S-3, S-3A, S-4, S-5, and S-6 would meet recreational use requirements in the vicinity of the Marina Building.

Because no actions would be implemented in Alternative S-1, there would be no impacts on sustainability factors.

Alternative S-2 would generally produce the lowest CO_2e, NO_x, SO_x, and PM_{10} emissions, followed by Alternatives S-3A, S-6, S-3, and S-4, although these alternatives would have similar levels of emissions. Alternative S-5 would produce the highest emissions, primarily because of the operation of equipment associated with the excavation of the large volume soil, as compared to the other alternatives.

Because energy demand and emissions are related, the relative ranking of the alternatives based on energy demand is similar to the ranking based on emissions. Alternative S-2 would have the lowest energy demand, followed by Alternatives S-3A, S-6, S-3, and S-4, although these alternatives would have similar demands. Alternative S-5 would have the highest energy demand.

Alternative S-2 would have the lowest water usage, followed by Alternatives S-4, S-3, S-3A, and S-6, although these alternatives would have similar water usages. Alternative S-5 would have the highest water usage.

5.1.6 Implementability

Alternative S-1 would be easiest to implement because there would be no activities to implement.

Alternative S-2 would be slightly easier to implement than Alternatives S-3, S-3A, and S-4 because installation of the cover and caps requires little handling of contaminated soil. Alternative S-6 would be slightly more difficult to implement than alternative S-3, S-3A, and S-4 because of the larger area to cover. Alternative S-4 would be slightly more difficult to implement than Alternative S-2 because of the excavation. Alternative S-3 would be more difficult to implement compared to the other alternatives because of the larger extent of excavation. Alternative S-3A would be less difficult to implement compared to Alternative S-3 because of the lower volume of excavated soil. Alternative S-5 would be the most difficult to implement because it has the largest volume of excavated soil. Alternative S-6 would also be somewhat difficult to implement because a local source of fill material may be difficult to identify. The monitoring aspects of Alternatives S-2 and S-6 would be easy to implement. The technologies used by all of these alternatives are available from many contractors.

LUCs can be applied to property owned by the Navy through an established LUCIP. However, Alternatives S-2, S-3, S-3A, S-4, and S-6 would all require LUCs to be applied to property that is already under an existing leasing agreement and would require coordination with the current property user. No LUCs would be required for Alternative S-5.

5.1.7 Cost

The capital and operation and maintenance (O&M) costs and NPW of the alternatives are as follows.

Alternative	Capital	NPW of Annual Costs	NPW
S-1	$7,000	$113,000(30-year)	$120,000
S-2	$2,051,000	$451,000(30-year)	$2,502,000 (30 years)
S-3	$5,136,000	$176,000(30-year)	$5,312,000 (30 years)
S-3A	$1,943,000	$176,000(30-year)	$2,119,000 (30 years)
S-4	$5,222,000	$176,000(30-year)	$5,398,000 (30 years)
S-5	$29,115,000	$0	$29,115,000
S-6	$3,009,000	$176,000(30-year)	$3,185,000 (30 years)

5.2 SUMMARY OF COMPARATIVE ANALYSIS OF SOIL REMEDIAL ALTERNATIVES

Table 5-1 summarizes the comparative analysis of the soil remedial alternatives.

5.3 COMPARISON OF GROUNDWATER REMEDIAL ALTERNATIVES BY CRITERIA

The following remedial alternatives for Site 16 groundwater are compared in this section:

- Alternative G-1: No Action.
- Alternative G-2: MNA and LUCs.
- Alternative G-3: In-Situ Chemical Oxidation (High-Concentration Areas), MNA, and LUCs.
- Alternative G-3A: In-Situ Chemical Oxidation (Source Areas), MNA, and LUCs.
- Alternative G-3B: In-Situ Chemical Oxidation (East End of Former Building 41), MNA, and LUCs.
- Alternative G-4: Enhanced Bioremediation (High-Concentration Areas), MNA, and LUCs.
- Alternative G-5: Groundwater Extraction and Treatment (High-Concentration Areas), MNA, and LUCs.
- Alternative G-6: Enhanced Bioremediation, MNA, and LUCs (Reduced Remediation Time).

Note that in the following comparative analysis for the groundwater alternatives it is assumed that a soil alternative with a WMA as discussed in Section 4.0 has been selected. For each criterion, the effects of selecting soil Alternative S-5 is also included separately.

5.3.1 Overall Protection of Human Health and the Environment

Assuming that a soil alternative that includes a WMA would be selected, Alternatives G-2, G-3, G-3A, G-3B, G-4, G-5, and G-6 would all provide protection to human health and the environment. Alternative G-6 provides the best protection because the largest volume is actively treated. Alternatives G-3 and G-5 would provide the next best protection because they treat the high-TCE concentration areas in the shortest amount of time. Alternative G-4 provides the next best protection because of the relatively long time that the high-concentrations areas would persist as they pass through the treatment barriers. Alternative G-3A provides the next best protection because a smaller area is treated compared to Alternative G-3. Alternative G-3B provides less protection than Alternative G-3A because a smaller area is treated. In Alternative G-2, high concentrations would persist for the longest time because of the slow rate of natural attenuation.

The natural attenuation components of Alternatives G-3, G-3A, G-3B, G-4, G-5, and G-6 would further reduce contaminant concentrations. This would significantly reduce risk from exposure to contaminated groundwater. The duration of natural attenuation for Alternative G-6 would be less than that of the other alternatives. Monitoring would be effective in detecting the potential migration of the plume and in monitoring the progress of the remediation. LUCs would provide protection of human health by restricting the use of groundwater until PRGs are met.

Alternative G-1 would provide some protection of human health and the environment. Under the existing LUCs, the portion of the site north of Davisville Road cannot be used for residential purposes and groundwater supply wells cannot be installed. However, groundwater contamination might migrate off site, and the potential for vapor intrusion into buildings to be constructed in the future would not be considered. Because no monitoring would be performed, potential migration of COCs would not be detected.

If the groundwater alternatives would be paired with Alternative S-5 which does not have a WMA, the conclusions of the comparative analysis for this criterion would be the same. LUCs would still be required to restrict groundwater use.

5.3.2 Compliance with ARARs and TBCs

Assuming that a soil alternative that includes a WMA would be selected, Alternatives G-2, G-3, G-3A, G-3B, G-4, G-5, and G-6 would comply with location- and action-specific ARARs and TBCs.

Alternatives G-2, G-3, G-3A, G-3B, G-4, G-5, and G-6 would not immediately comply with chemical-specific ARARs and TBCs. Alternatives G-3, G-3A, G-3B, G-4, G-5, and G-6 would eventually achieve compliance as they attain PRGs through a combination of active treatment and natural attenuation. Alternative G-2 would eventually achieve compliance as it attains PRGs through natural attenuation. Note that PRGs would not need to be met beneath the compliance boundary of the WMA.

Alternative G-1 would not comply with chemical-specific ARARs, and compliance with location-specific ARARs would be incidental. Although it may eventually meet chemical-specific ARARs though natural attenuation, there would be no monitoring to confirm this. Location-specific and action-specific ARARs or TBCs would not apply.

If a groundwater alternative is paired with Alternative S-5, the estimated time to meet PRGs would increase for most of the alternatives. The estimated time for Alternative G-2 to meet PRGs would be greater than 300 years. For Alternatives G-3, G-3A, G-4, and G-5, the estimated time to meet PRGs would be 100 to 150 years. There would be no change in the estimated time for Alternative G-6.

5.3.3 Long-Term Effectiveness and Permanence

Alternatives G-2, G-3, G-3A, G-3B, G-4, G-5, and G-6 would provide long-term effectiveness and permanence. Alternatives G-3, G-3A, G-4, G-5, and G-6 provide essentially equal levels of long-term effectiveness and permanence through a combination of treatment, MNA, and LUCs. Alternative G-3B would be slightly less effective than Alternative G-3A because a smaller area is treated. Alternative G-2

is somewhat less permanent because there is no active treatment to remove high concentrations of contaminants, thus extending the time to meet PRGs. For all alternatives, LUCs could be maintained until PRGs are met.

Alternative G-1 would have little long-term effectiveness and permanence because contaminated groundwater would remain on site. Existing LUCs provide some protection by limiting the use of groundwater, but these are not environmental LUCs that are enforceable under relevant environmental regulations and, therefore, would not be fully protective. Because there would be no LUCs to restrict building construction methods, the potential would also exist for unacceptable risk to develop for human receptors through vapor intrusion. Because there would be no groundwater monitoring, potential off-site migration of COCs would not be detected. Although COC concentrations might eventually decrease to PRGs through natural attenuation, no monitoring would verify this.

If the groundwater alternatives would be paired with Alternative S-5 which does not have a WMA, the conclusions of the comparative analysis for this criterion would be the same.

5.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives G-3, G-3A, G-3B, G-4, and G-6 would achieve reductions in COC toxicity and volume through treatment. Alternative G-5 would achieve reductions in COC volume through treatment assuming that the spent granular activated carbon (GAC) is regenerated or destroyed by a thermal process off site.

Alternative G-6 would permanently and irreversibly remove an estimated 670 pounds of COCs (640 pounds of TCE and 30 pounds of cis-1,2-DCE) through bioremediation. Alternative G-3 would permanently and irreversibly remove an estimated 324 pounds of COCs (310 pounds of TCE and 14 pounds of cis-1,2-DCE) through chemical oxidation. Alternative G-4 would permanently and irreversibly remove the same amount of COCs as Alternative G-3 through bioremediation. Alternative G-5 would permanently and irreversibly remove the same amount of COCs through groundwater extraction as Alternatives G-3 and G-4. However, the contaminants would be captured by GAC (vapor-phase and liquid-phase), which might then be landfilled, regenerated, or thermally treated. Alternative G-3A would permanently and irreversibly remove an estimated 117 pounds of COCs (110 pounds of TCE and 7 pounds of cis-1,2-DCE) through chemical oxidation. Alternative G-3B would permanently and irreversibly remove an estimated 48 pounds of COCs (46 pounds of TCE and 2 pounds of cis-1,2-DCE) through chemical oxidation.

Alternatives G-3, G-3A, G-3B, G-4, G-5, and G-6 would not generate treatment residues. Alternative G-5 would generate used GAC that would require off-site disposal.

Alternatives G-1 and G-2 would not achieve any reduction of toxicity, mobility, or volume of COCs through active treatment.

If the groundwater alternatives would be paired with Alternative S-5 which does not have a WMA, the conclusions of the comparative analysis for this criterion would be the same.

5.3.5 Short-Term Effectiveness

Assuming that a soil alternative that includes a WMA would be selected, implementation of Alternatives G-2, G-3, G-3A, G-3B, G-4, G-5, and G-6 would result in a slight possibility of exposing site workers to contaminated groundwater during the installation, maintenance, and sampling of new and existing monitoring wells, and during active remediation. Alternative G-2 would result in the lowest short-term risk with the potential for exposure only during groundwater sampling. Alternative G-3A would result in approximately the same level of short-term exposure, with additional potential exposure during installation of injection points. During implementation of Alternative G-3A, workers also would be required handle a strong oxidizer. During implementation of Alternative G-3B, workers would also be required to handle a strong oxidizer, but would not be potentially exposed to contaminants because existing wells would be used for injection. Alternatives G-3 and G-4 would result in approximately the same level of short-term exposure, with additional potential exposure during installation of injection points. During implementation of Alternative G-3, workers also would be required handle a strong oxidizer.

Alternative G-6 would result in a greater level of short-term exposure because of additional potential exposure during installation of a large number of injection points. Alternative G-5 would present the highest potential for additional exposure to contaminated groundwater during the long-term operation of the groundwater treatment plant. However, these risks of exposure would be effectively controlled by wearing appropriate PPE, and compliance with proper site-specific health and safety procedures. Implementation of Alternatives G-2, G-4, G-5, and G-6 would not adversely impact the surrounding community or environment. Alternatives G-3, G-3A, and G-3B would have a slight risk to the community due to the transport of oxidizer to the site. Implementation of Alternative G-5 has a slight risk to the surrounding community during the transport of spent GAC from the site.

Alternatives G-2, G-3, G-3A, G-3B, G-4, G-5, and G-6 would achieve groundwater RAO Nos. 1 and 3 immediately upon implementation of LUCs and monitoring. Construction activities associated with Alternative G-4 would be completed in 3 months, construction activities associated with Alternatives G-3 and G-3A would be completed in 4 months, construction activities associated with Alternative G-3B would be completed in 12 months and construction activities associated with Alternatives G-5 and G-6 would be completed in 6 months. Groundwater RAO No. 2 would be attained in approximately 50 years for Alternative G-6. Groundwater RAO No. 2 would be attained in excess of approximately 300 years for

Alternative G-2, and in approximately 100 years for Alternatives G-3, G-3A, G-3B, G-4, and G-5. Because natural attenuation for a large portion of the plume is a component for Alternatives G-3, G-3A, G-3B, G-4, and G-5, the time to meet PRGs would be approximately the same for these five alternatives.

Implementation of Alternative G-1 would not result in risks to site workers or adversely impact the surrounding community or environment because no remedial activities would be performed. Alternative G-1 would not achieve the RAOs, and although the cleanup goals might eventually be attained through natural processes, this would not be verified.

Because no actions would be implemented in Alternative G-1, there would be no impacts on sustainability factors.

Alternative G-2 would produce the lowest CO_2e, NO_x, SO_x, and PM_{10} emissions, followed by Alternatives G-4, G-3A, G-3B, G-6, and G-3, although the emission rates of the last five alternatives would be similar. Alternative G-5 would produce the highest emissions primarily because operation of equipment associated with the groundwater treatment system.

Because energy demand and emissions are related, the relative ranking of the alternatives based on energy demand is similar to the ranking based on emissions. Alternative G-2 would have the lowest energy demand, followed by Alternatives G-3A, G-3B, G-4, G-3, and G-6, although the energy demands of each of the last five alternatives would be similar. Alternative G-5 would have the highest energy demand.

Alternative G-2 would have the lowest water usage followed by Alternatives G-3A, G-3B, G-3, G-4, and G-6, although the water usage of each of the last five alternatives would be similar. Alternative G-5 would have the highest water usage, with much of the water associated with the production of steel for the treatment building and treatment equipment.

If the groundwater alternatives would be paired with Alternative S-5 which does not have a WMA, the conclusions of the comparative analysis for this criterion would be the same. However, the estimated time to meet RAO No. 2 would increase for most of the alternatives. The estimated time for Alternative G-2 to meet RAO No. 2 would be greater than 300 years. For Alternatives G-3, G-3A, G-4, and G-5, the estimated time to meet RAO No. 2 would be 100 to 150 years. There would be no change in the estimated time (50 years) for Alternative G-6.

5.3.6 Implementability

Alternative G-1 would be easiest to implement because there would be no activities to implement.

Technical implementation of the various components of Alternative G-2 would be the easiest to implement. Alternatives G-3, G-3A, G-3B, G-4, and G-6 would be the next easiest to implement, although handling of the oxidizing agent in Alternatives G-3, G-3A, and G-3B, would be slightly more difficult. For all six of these alternatives, contractors and equipment are readily available.

Alternative G-5 would be more complicated to implement and would require long-term O&M. However, equipment and operators are readily available.

Because some of the property has already been transferred, implementation of LUCs would be coordinated with the current property owner. Additional LUCs could be applied to the land that the Navy still controls.

NORAD and QDC have stated that their use of the property would be affected by the implementation of the alternatives. Specifically, the area around the injection area would have to be cleared of vehicles to make way for drilling equipment, injection equipment, and personnel. Similarly, the area around each monitoring well would have to be cleared of vehicles to make way for sampling equipment and personnel. Alternative G-2 would have the least impact because only monitoring well sampling would be involved, and most wells are readily accessible. Alternative G-3B would have the second-least impact on property use because the alternative uses 12 existing wells for injection and the activity would be completed in 1 to 2 weeks. Alternatives G-3 and G-3A would temporarily impact site use for 1 to 2 months during installation of the injection wells and during injection of the oxidizer, and Alternative G-4 would temporarily impact site use for 1 to 2 months during installation of the injection wells and injection of emulsified vegetable oil. Alternative G-6 would also impact site use for other 2 months during installation of the injection wells, but to the greatest extent because of the large number of injection wells. Alternative G-5 would impact site use for 1 to 2 months during well and extraction piping installation. The buried piping and treatment plant building might also limit site uses. The area around each extraction well would have to be kept clear at all times to allow for access for routine inspection and maintenance of the well and extraction pump.

If the groundwater alternatives would be paired with Alternative S-5 which does not have a WMA, the conclusions of the comparative analysis for this criterion would be the same.

5.3.7 Cost

The capital and O&M costs and NPW of the alternatives are as follows.

Alternative	Capital	NPW of Annual Costs	NPW
G-1	$7,000	$113,000	$120,000
G-2	$44,000	$1,080,000 (30 Years)	$1,124,000 (30 Years)
G-3	$7,922,000	$1,428,000 (30 Years)	$9,350,000 (30 Years)
G-3A	$4,283,000	$1,304,000 (30 Years)	$5,587,000 (30 Years)
G-3B	$612,000	$1,176,000 (30 Years)	$1,788,000 (30 Years)
G-4	$6,160,000	$3,496,000 (30 Years)	$9,656,000 (30 Years)
G-5	$4,862,000	$5,070,000 (30 Years)	$9,932,000 (30 Years)
G-6	$17,614,000	$6,891,000 (30 Years)	$24,505,000 (30 Years)

5.4 SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES

Table 5-2 summarizes the comparative analysis of the groundwater remedial alternatives.

TABLE 5-1

SUMMARY OF COMPARATIVE ANALYSIS OF SOIL REMEDIAL ALTERNATIVES
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Evaluation Criterion	Alternative S-1: No Action	Alternative S-2: Soil Cover and/or Cap, Monitoring, and LUCs	Alternative S-3: Excavation, Off-site Disposal, and LUCs	Alternative S-3A: Shallow Excavation, Off-site Disposal, Cover, Monitoring, and LUCs	Alternative S-4: Soil Cover, Selected Excavation and Disposal, and LUCs	Alternative S-5: Excavation and Off-site Disposal – Unrestricted Use	Alternative S-6: Full Soil Cover, Monitoring, and LUCs
Overall Protection of Human Health and Environment	Limited protectiveness under existing LUCs. Because the existing LUCs are not environmental LUCs, they could be readily lifted. Therefore, Alternative S-1 would not be fully protective.	Would be protective but less protective than Alternatives S-3, S-3A, S-4, and S-5, and as protective as Alternative S-6.	Would be protective and would be more protective than Alternatives S-2, S-4, and S-6, and less protective than Alternative S-5.	Would be protective and would be more protective than Alternatives S-2, S-4, and S-6, and less protective than Alternative S-5. Comparable to Alternative S-3.	Would be protective. Would be slightly more protective than Alternatives S-2 and S-6 and slightly less protective than Alternative S-3, S-3A, and less protective than Alternative S-5.	Would be most protective.	Would be protective but less protective than Alternatives S-3, S-3A, S-4, and S-5, and as protective as Alternative S-2.
Compliance with ARARs and TBCs							
Chemical-Specific	Would not comply	Would comply by eliminating exposure routes and using LUCs	Would comply removing contaminated soil and using LUCs	Would comply removing contaminated soil and using LUCs	Would comply by eliminating exposure routes and using LUCs	Would comply	Would comply by eliminating exposure routes and using LUCs
Location-Specific	Not applicable	Would comply	Would comply	Would comply	Would comply	Would comply	Would comply
Action-Specific	Not applicable	Would comply	Would comply	Would comply	Would comply	Would comply	Would comply
Long-Term Effectiveness and Permanence	Not effective, although existing LUCs would limit residential use and exposure. Existing LUCs are not enforceable under environmental regulations.	Would be effective in the long-term and permanent. Cover would require long-term maintenance and monitoring. Would be less effective and permanent than Alternatives S-3, S-3A, S-4, and S-5, and about the same as Alternative S-6.	Would be effective in the long-term and permanent. Cover would require long-term maintenance and monitoring. Would be more effective and permanent than Alternatives S-2, S-4, and S-6 but less effective and permanent than Alternative S-5.	Would be effective in the long-term and permanent. Cover would require long-term maintenance and monitoring. Would be more effective and permanent than Alternatives S-2, S-4, and S-6 but less effective and permanent than Alternative S-5. Comparable to Alternative S-3.	Would be effective in the long-term and permanent. Cover would require long-term maintenance and monitoring. Would be slightly more effective and permanent than Alternatives S-2 and S-6, but slightly less effective and permanent than Alternatives S-3 and S-3A and less effective and permanent than Alternative S-5.	Would be most effective in the long-term and permanent.	Would be effective in the long-term and permanent. Cover would require long-term maintenance and monitoring. Would be less effective and permanent than Alternatives S-3, S-3A, S-4, and S-5, and about the same as Alternative S-2.
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	None	No treatment.	No treatment.	No treatment.	No treatment.	No treatment.	No treatment.

TABLE 5-1

SUMMARY OF COMPARATIVE ANALYSIS OF SOIL REMEDIAL ALTERNATIVES
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Evaluation Criterion	Alternative S-1: No Action	Alternative S-2: Soil Cover and/or Cap, Monitoring, and LUCs	Alternative S-3: Excavation, Off-site Disposal, and LUCs	Alternative S-3A: Shallow Excavation, Off-site Disposal, Cover, Monitoring, and LUCs	Alternative S-4: Soil Cover, Selected Excavation and Disposal, and LUCs	Alternative S-5: Excavation and Off-site Disposal – Unrestricted Use	Alternative S-6: Full Soil Cover, Monitoring, and LUCs
Short-Term Effectiveness	No short-term risks because no action would occur. RAOs would not be met. Cleanup goals might be met through natural attenuation, but there would be no monitoring to verify this.	Exposure of remedial workers would be controlled by PPE and safety procedures. Action would be completed in 4 months. RAOs would be met. Contaminant concentrations would exceed cleanup goals, but LUCs would eliminate exposure pathway. Least amount of short-term impacts.	Exposure of remedial workers would be controlled by PPE and safety procedures. Action would be completed in 6 months. RAOs would be met. Potential for worker exposure would be greater than Alternatives S-2 and S-4 and less than Alternatives S-5 and S-6.	Exposure of remedial workers would be controlled by PPE and safety procedures. Action would be completed in 5 months. RAOs would be met. Potential for worker exposure would be greater than Alternatives S-2 and S-4, and less than Alternatives S-5 and S-6. Comparable to Alternative S-3.	Exposure of remedial workers would be controlled by PPE and safety procedures. Action would be completed in 6 months. RAOs would be met. Contaminant concentrations would exceed cleanup goals, but LUCs would eliminate exposure pathways. Potential for worker exposure would be greater than Alternative S-2, and less than Alternatives S-3, S-3A, S-5, and S-6.	Exposure of remedial workers would be controlled by PPE and safety procedures. Action would be completed in 12 months. RAOs would be met. Potential for worker exposure would be greatest compared to the other alternatives. Greatest amount of potential short-term impacts due to potential exposure to and transport of contaminated soil.	Exposure of remedial workers would be controlled by PPE and safety procedures. Action would be completed in 9 months. RAOs would be met. Contaminant concentrations would exceed cleanup goals, but LUCs would eliminate exposure pathway. Second highest amount of potential short-term impacts due to truck traffic.
Implementability	Nothing to implement.	Easy to implement cover, capping, and monitoring. May be difficult to apply LUCs to property that has already been transferred. Use of property may be affected by cover and caps. Easiest to implement.	Easy to implement excavation and monitoring. May be difficult to apply LUCs to property that has already been transferred. Use of property generally not affected after completion of work, other than LUC restrictions. Alternatives S-3, S-3A, and S-4 are comparable and second easiest to implement.	Easy to implement excavation and monitoring. May be difficult to apply LUCs to property that has already been transferred. Use of property generally not affected after completion of work, other than LUC restrictions. Alternatives S-3, S-3A, and S-4 are comparable and second easiest to implement.	Easy to implement cover, excavation, and monitoring. May be difficult to apply LUCs to property that has already been transferred. Use of property may be affected by cover. Alternatives S-3, S-3A, and S-4 are comparable and second easiest to implement.	Easy to implement excavation, but local borrow and disposal capacity may not be readily available. Use of property not affected after completion of work. Most difficult to implement due to large volume of contaminated soil.	Easy to implement cover, capping, and monitoring. May be difficult to apply LUCs to property that has already been transferred. Use of property may be affected by cover. Second most difficult to implement due to large amount of fill material to handle for cover.
Costs:							
Capital	$7,000	$2,051,000	$5,136,000	$1,943,000	$5,222,000	$29,115,000	$3,009,000
NPW of Annual Costs	$113,000	$451,000 (30-Year)	$176,000 (30-Year)	$176,000 (30-Year)	$176,000 (30-Year)	$0	$176,000 (30-Year)
NPW	$120,000	$2,502,000 (30-Year)	$5,312,000 (30-Year)	$2,119,000 (30-Year)	$5,398,000 (30-Year)	$29,115,000	$3,185,000 (30-Year)

ARARs - Applicable or Relevant and Appropriate Requirements.
LUCs - Land use controls.
NPW - Net present worth.
O&M - Operation and maintenance.
PPE - Personal protective equipment.
RAO - Remedial Action Objective.
TBC - To Be Considered.

TABLE 5-2

SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Evaluation Criterion	Alternative G-1: No Action[1]	Alternative G-2: MNA and LUCs[1]	Alternative G-3: In-Situ Chemical Oxidation (High-Concentration Areas), MNA, and LUCs[1]	Alternative G-3A: In-Situ Chemical Oxidation (Source Areas), MNA, and LUCs[1]	Alternative G-3B: In-Situ Chemical Oxidation (East End of Building 41), MNA, and LUCs[1]	Alternative G-4: Enhanced Bioremediation (High-Concentration Areas), MNA, and LUCs[1]	Alternative G-5: Groundwater Extraction and Treatment (High-Concentration Areas), MNA, and LUCs[1]	Alternative G-6: Enhanced Bioremediation, MNA, and LUCs (Reduced Remediation Time)[1]
Overall Protection of Human Health and Environment	Would offer limited protectiveness of human health because of existing LUCs. Would not be protective of the environment because no action would occur. Migration of COCs would continue and remain undetected. Because the existing LUCs are not environmental LUCs, they could be readily lifted. Therefore, Alternative G-1 would not be fully protective.	Would be protective of human health and the environment. Would be less protective than Alternatives G-3 through G-6 because there would be no active reduction of the high-TCE concentration areas. LUCs would prevent exposure to the rest of the plume.	Would be protective of human health and the environment. Would be more protective than Alternatives G-3A, G-3B, G-4, and G-5 because high-TCE concentration areas would be treated in a short time. LUCs would prevent exposure to the rest of the plume.	Would be protective of human health and the environment. Would be more protective than Alternatives G-4 and G-5 because source areas would be treated in a short time. Would be slightly less protective than Alternative G-3 because smaller area is treated, but more protective than Alternative G-3B. LUCs would prevent exposure to the rest of the plume.	Would be protective of human health and the environment. Would be more protective than Alternatives G-4 and G-5 because source area would be treated in a short time. Would be slightly less protective than Alternatives G-3 and G-3A because smaller area is treated. LUCs would prevent exposure to the rest of the plume.	Would be protective of human health and the environment. Would be slightly less protective than Alternative G-5. High TCE concentrations would persist until plume moves through the barriers. LUCs would prevent exposure to the rest of the plume.	Would be protective of human health and the environment. Would be slightly less protective than Alternatives G-3, G-3B, G-3A, and G-4 because high-TCE concentration areas would be treated for a longer time. LUCs would prevent exposure to the rest of the plume.	Would be protective of human health and the environment. Would be most protective because the largest volume is actively treated. High TCE concentrations would persist until plume moves through the barriers. LUCs would prevent exposure to the rest of the plume.
Compliance with ARARs and TBCs:								
Chemical-Specific	Would not comply	Would eventually comply	Would eventually comply	Would eventually comply	Would eventually comply	Would eventually comply	Would eventually comply	Would eventually comply
Location-Specific	Not applicable	Would comply	Would comply	Would comply	Would comply	Would comply	Would comply	Would comply
Action-Specific	Not applicable	Would comply	Would comply	Would comply	Would comply	Would comply	Would comply	Would comply
Long-Term Effectiveness and Permanence	Existing LUCs would provide limited long-term effectiveness and permanence but otherwise no action would occur. Contaminant reduction or migration would remain undetected because no monitoring would occur. Existing LUCs are not enforceable under environmental regulations.	Would be as permanent and effective as the other alternatives, although the remediation time will be longer because there is no high-concentration area treatment. Natural attenuation would reduce COCs, and LUCs would prevent exposure.	Would be as permanent and effective as the Alternatives G-3A, G-3B, and G-4 through G-6. Chemical oxidation and natural attenuation would reduce COCs, and LUCs would prevent exposure.	Would be as permanent and effective as the Alternatives G-3 through G-6. Chemical oxidation and natural attenuation would reduce COCs, and LUCs would prevent exposure.	Would be as permanent and effective as the Alternatives G-3 through G-6. Chemical oxidation and natural attenuation would reduce COCs, and LUCs would prevent exposure. Contingency component (biobarrier along Allen Harbor) would be implemented, if needed.	Would be as permanent and effective as the Alternatives G-3, G-3A, G-3B, and G-6. Enhanced bioremediation and natural attenuation would reduce COCs, and LUCs would prevent exposure.	Would be as permanent and effective as the Alternatives G-3, G-3A, G-3B, G-4, and G-6. Extraction and treatment along with natural attenuation would reduce COCs, and LUCs would prevent exposure.	Would be as permanent and effective as the Alternatives G-3 through G-5, but would be met in a shorter period of time. Enhanced bioremediation and natural attenuation would reduce COCs, and LUCs would prevent exposure.

TABLE 5-2

SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Evaluation Criterion	Alternative G-1: No Action[1]	Alternative G-2: MNA and LUCs[1]	Alternative G-3: In-Situ Chemical Oxidation (High-Concentration Areas), MNA, and LUCs[1]	Alternative G-3A: In-Situ Chemical Oxidation (Source Areas), MNA, and LUCs[1]	Alternative G-3B: In-Situ Chemical Oxidation (East End of Building 41), MNA, and LUCs[1]	Alternative G-4: Enhanced Bioremediation (High-Concentration Areas), MNA, and LUCs[1]	Alternative G-5: Groundwater Extraction and Treatment (High-Concentration Areas), MNA, and LUCs[1]	Alternative G-6: Enhanced Bioremediation, MNA, and LUCs (Reduced Remediation Time)[1]
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not reduce contaminant toxicity, mobility or volume through treatment because no treatment would occur.	Would not reduce contaminant toxicity and volume of an uncertain quantity through treatment.	Would irreversibly and permanently reduce contaminant toxicity and volume by removing an estimated 324 pounds of organic COCs through in-situ chemical oxidation.	Would irreversibly and permanently reduce contaminant toxicity and volume by removing an estimated 117 pounds of organic COCs through in-situ chemical oxidation.	Would irreversibly and permanently reduce contaminant toxicity and volume by removing an estimated 48 pounds of organic COCs through in-situ chemical oxidation.	Would irreversibly and permanently reduce contaminant toxicity and volume by removing an estimated 324 pounds of organic COCs through in-situ enhanced bioremediation.	Would irreversibly and permanently reduce contaminant toxicity and volume by removing an estimated 324 pounds of organic COCs through extraction. The amount of COCs reduced through treatment would depend on whether GAC is landfilled, regenerated, or thermally treated.	Would irreversibly and permanently reduce contaminant toxicity and volume by removing an estimated 670 pounds of organic COCs through in-situ enhanced bioremediation.

TABLE 5-2

SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Evaluation Criterion	Alternative G-1: No Action[1]	Alternative G-2: MNA and LUCs[1]	Alternative G-3: In-Situ Chemical Oxidation (High-Concentration Areas), MNA, and LUCs[1]	Alternative G-3A: In-Situ Chemical Oxidation (Source Areas), MNA, and LUCs[1]	Alternative G-3B: In-Situ Chemical Oxidation (East End of Building 41), MNA, and LUCs[1]	Alternative G-4: Enhanced Bioremediation (High-Concentration Areas), MNA, and LUCs[1]	Alternative G-5: Groundwater Extraction and Treatment (High-Concentration Areas), MNA, and LUCs[1]	Alternative G-6: Enhanced Bioremediation, MNA, and LUCs (Reduced Remediation Time)[1]
Short-Term Effectiveness	Would not result in any short-term risk to site workers or adversely impact the surrounding community or environment because no action would occur. The RAOs would never be achieved with the implementation of this alternative.	Would result in a possibility of exposing site workers to contaminated groundwater as a result of monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. Least amount of potential for short term risks. There would be no risk to the surrounding community or the environment. Groundwater RAO Nos. 1 and 3 would be achieved immediately upon implementation of LUCs and monitoring. Approximately 300 years would be required to meet groundwater RAO Nos. 2 and 4 and cleanup goals. If paired with Alternative S-5, approximately 300 years would be required to meet RAO Nos. 2 and 4 and cleanup goals.	Would result in a possibility of exposing site workers to contaminated groundwater as a result of the injection of the oxidizer and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. There would be a slight risk to the surrounding community from oxidizer transport. Groundwater RAO Nos. 1 and 3 would be achieved immediately upon implementation of LUCs and monitoring. Approximately 100 years would be required to meet groundwater RAO Nos. 2 and 4 and cleanup goals. Treatment activities would be completed in 4 months. If paired with Alternative S-5, approximately 100 to 150 years would be required to meet RAO Nos. 2 and 4 and cleanup goals.	Would result in a possibility of exposing site workers to contaminated groundwater as a result of the injection of the oxidizer and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. There would be a slight risk to the surrounding community from oxidizer transport. Groundwater RAO Nos. 1 and 3 would be achieved immediately upon implementation of LUCs and monitoring. Approximately 100 years would be required to meet groundwater RAO Nos. 2 and 4 and cleanup goals. Treatment activities would be completed in 4 months. If paired with Alternative S-5, approximately 100 to 150 years would be required to meet RAO Nos. 2 and 4 and cleanup goals.	Would result in a possibility of exposing site workers to contaminated groundwater as a result of the injection of the oxidizer and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. There would be a slight risk to the surrounding community from oxidizer transport. Groundwater RAO Nos. 1 and 3 would be achieved immediately upon implementation of LUCs and monitoring. Approximately 100 years would be required to meet groundwater RAO Nos. 2 and 4 and cleanup goals. Treatment activities would be completed in 12 months. If paired with Alternative S-5, approximately 100 to 150 years would be required to meet RAO Nos. 2 and 4 and cleanup goals.	Would result in a possibility of exposing site workers to contaminated groundwater as a result of the injection of the electron donor and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. There would be no risk to the surrounding community or the environment. Groundwater RAO Nos. 1 and 3 would be achieved immediately upon implementation of LUCs and monitoring. Approximately 100 years would be required to meet groundwater RAO Nos. 2 and 4 and cleanup goals. Treatment activities would be completed in 3 months. If paired with Alternative S-5, approximately 100 to 150 years would be required to meet RAO Nos. 2 and 4 and cleanup goals.	Would result in a possibility of exposing site workers to contaminated groundwater as a result of groundwater extraction, treatment, and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. Because of the long period of active treatment, this alternative has the highest potential for short-term exposure. There would be a slight risk to the surrounding community from Spent GAC transport. Groundwater RAO Nos. 1 and 3 would be achieved immediately upon implementation of LUCs and monitoring. Approximately 100 years would be required to meet groundwater RAO Nos. 2 and 4 and cleanup goals. Treatment activities would be completed in 6 months. If paired with Alternative S-5, approximately 100 to 150 years would be required to meet RAO Nos. 2 and 4 and PRGs.	Would result in a possibility of exposing site workers to contaminated groundwater as a result of the injection of the electron donor and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. There would be no risk to the surrounding community or the environment. Groundwater RAO Nos. 1 and 3 would be achieved immediately upon implementation of LUCs and monitoring. Approximately 50 years would be required to meet groundwater RAO Nos. 2 and 4 and cleanup goals. Treatment activities would be completed in 6 months. If paired with Alternative S-5, approximately 50 years would be required to meet RAO Nos. 2 and 4 and cleanup goals.

TABLE 5-2

SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES
SITE 16 FEASIBILITY STUDY ADDENDUM
NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Evaluation Criterion	Alternative G-1: No Action[1]	Alternative G-2: MNA and LUCs[1]	Alternative G-3: In-Situ Chemical Oxidation (High-Concentration Areas), MNA, and LUCs[1]	Alternative G-3A: In-Situ Chemical Oxidation (Source Areas), MNA, and LUCs[1]	Alternative G-3B: In-Situ Chemical Oxidation (East End of Building 41), MNA, and LUCs[1]	Alternative G-4: Enhanced Bioremediation (High-Concentration Areas), MNA, and LUCs[1]	Alternative G-5: Groundwater Extraction and Treatment (High-Concentration Areas), MNA, and LUCs[1]	Alternative G-6: Enhanced Bioremediation, MNA, and LUCs (Reduced Remediation Time)[1]
Implementability	Technical and administrative implementation would be extremely simple because there would be no action to implement.	Easy to implement monitoring. Would be the easiest active alternative to implement. May be difficult to apply LUCs to property that has already been transferred.	Easy to implement in-situ chemical oxidation and monitoring. More difficult to implement than Alternatives G-2, G-3B, and G-4; about the same as Alternative G-3A; less difficult than Alternatives G-5 and G-6. Bench- and pilot-scale treatability testing would be required. May be difficult to apply LUCs to property that has already been transferred. Use of property will be temporarily affected by injection points.	Easy to implement in-situ chemical oxidation and monitoring. More difficult to implement than Alternatives G-2, G-3B, and G-4; about the same as Alternative G-3; less difficult than Alternatives G-5 and G-6. Bench- and pilot-scale treatability testing would be required. May be difficult to apply LUCs to property that has already been transferred. Use of property will be temporarily affected by injection points.	Easy to implement in-situ chemical oxidation and monitoring. More difficult to implement than Alternative G-2; less difficult than Alternatives G-3, G-3A, G-4, G-5 and G-6. May be difficult to apply LUCs to property that has already been transferred. Use of property will be temporarily affected by injection points.	Easy to implement enhanced bioremediation and monitoring. More difficult to implement than Alternatives G-2 and G-3B; less difficult than Alternatives G-3, G-3A, G-5, and G-6. Pilot-scale treatability testing would be required. May be difficult to apply LUCs to property that has already been transferred. Use of property will be affected by injection wells.	Easy to implement extraction, treatment, and monitoring. More difficult to implement than Alternatives G-2, G-3, G-3A, G-3B, G-4 and G-6. May be difficult to apply LUCs to property that has already been transferred. Use of property will be affected by extraction wells, extraction piping, and treatment plant.	Easy to implement enhanced bioremediation and monitoring. More difficult to implement than Alternatives G-2, G-3, G-3A, G-3B, G-4, and G-5. Pilot-scale treatability testing would be required. May be difficult to apply LUCs to property that has already been transferred. Use of property will be affected by injection wells.
Costs: Capital NPW of Annual Costs NPW	 $7,000 $113,000 $120,000	 $44,000 $1,080,000 (30-Year) $1,124,000 (30-Year)	 $7,922,000 $1,428,000 (30-Year) $9,350,000 (30-Year)	 $4,283,000 $1,304,000 (30-Year) $5,587,000 (30-Year)	 $612,000 $1,176,000 (30-Year) $1,788,000 (30-Year)	 $6,160,000 $3,496,000 (30-Year) $9,656,000 (30-Year)	 $4,862,000 $5,070,000 (30-Year) $9,932,000 (30-Year)	 $17,614,000 $6,891,000 (30-Year) $24,505,000 (30-Year)

1 – Evaluations apply to cases where the groundwater alternative is paired with a soil alternative that includes a WMA (Alternatives S-2, S-3, S-3A, S-4, and S-6) unless noted. If there are any effects for the case where the groundwater alternative is paired with Alternative S-5, then they are noted separately.
ARARs - Applicable or Relevant and Appropriate Requirements.
BRAC PMO - Base Realignment and Closure Project Management Office.
COC - Chemicals of concern.
LUCs - Land use controls.
MNA - Monitored natural attenuation.
NPW - Net present worth.
RAO - Remedial Action Objective.
TBC - To be considered

REFERENCES

DoD (Department of Defense), 2003. Principles and Procedures for Specifying, Monitoring and Enforcement of Land Use Controls and Other Post-ROD Actions. October.

Navy, 2006. Environmental Restoration Program Manual. August.

Navy et al. (United States Navy, United States Army Corps of Engineers, and Battelle), 2010. SiteWise™. May.

Tetra Tech (Tetra Tech, Inc.), 2012. Draft Final Feasibility Study Report for Installation Restoration Program Site 16. Former Naval Construction Battalion Center Davisville, North Kingstown, Rhode Island. May.

USEPA (United States Environmental Protection Agency), 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. October.

APPENDIX A

PROCESS CALCULATIONS AND VENDOR INFORMATION

Alternative S-3A

Tetra Tech NUS			*STANDARD CALCULATION SHEET*
CLIENT: NAVFAC, NCBC Davisville, Site 16 FS	FILE No:	BY: JWL	PAGE: 1 of 2
SUBJECT: Alternative S-3A – Cost item and quantity estimates		CHECKED BY: CAH 01/31/13	DATE: 01/16/13

Purpose: Estimate quantities for various cost items to be used in the cost estimate for Alternative S-3A.

Additional delineation: Assume that the areas require additional delineation. (Note that this applies to all of the soil alternatives.)

Same as Alternative S-2

Labor (sampling for delineation and characterization sampling)

Same as Alternative S-2

Characterization sampling:

Same as Alternative S-3

Survey site (for sample locations)

Same as Alternative S-3

Clear and grub:

Same as Alternative S-3

Top soil (6 “) for final backfill:

(From Soil Remediation Areas spreadsheet)

Total Area = 46,000 ft2

46,000 ft2 x 0.5 ft = 23,000 ft3 = 850 cy

Total Backfill volume (from Soil Remediation Areas Spreadsheet):

3,249 cy

Less top soil:

3,249 – 850 = 2,399 cy

Disposal:

Assume 10% is hazardous.

Assume bulk density of soil as 1.5 Ton/cy

3,249 x 0.1 = 325 cy Hazardous = 488 tons
3,249 x 0.9 = 2,924 cy non-hazardous = 4,386 tons

Five Year review

Same as Alternative S-3

DAVISVILLE - SITE 16 SOIL REMEDIATION AREAS - S-3A
Estimated areas and perimeters of each soil remediation area.
"Perimeter" refers to the edge along clean soil.
1/14/2013

Designation		Dimensions, feet	Area, ft2	Perimeter (along clean soil), feet	Notes
1E		38.5 x 46	1,771	84.5	
2E		40 x 42	1,680	80	
3E		46 x 42	1,932	85	
4E		20 x 42	840	80	
5E		42 x 62	2,604	140	
6E		planimeter	17,800	350	
7E		35 x 42 + 35 x 42	2,940	224	Incls part of 9E
8E	*	40 x 40	1,600	160	
12E-1		30 x 40	1,200	140	
12E-2	*	40 x 40	1,600	160	
14E	*	40 x 40	1,600	160	
15E	*	40 x 40	1,600	160	
16E		58 x 50	2,900	210	
17E	*	40 x 40	1,600	160	
			41,667		

* - denotes area based on default 40' x 40' square.
scale is 1.3 inch = 100 feet; inches x 100/1.3 = feet; inches x 76.92 = feet

NCBC DAVISVILLE
SITE 16
SOIL REMEDIATION AREAS - S-3A

1/14/2013
CONTAMINATED SOIL VOLUME

Area Designation	Area, Ft2	Full Depth, ft	Volume, ft3
1E	1,771	2	3,542
2E	1,680	2	3,360
3E	1,932	2	3,864
4E	840	2	1,680
5E	2,604	2	5,208
6E	17,800	2	35,600
7E	2,940	2	5,880
8E	1,600	2	3,200
12E-1	1,200	2	2,400
12E-2	1,600	2	3,200
14E	1,600	2	3,200
15E	1,600	2	3,200
16E	2,900	2	5,800
17E	1,600	2	3,200

Total (S-3A)		83,334
Total, cy (S-3A)		3,086

NCBC DAVISVILLE
SITE 16
SOIL REMEDIATION AREAS

1/14/2013

				Alternative S-3A						
Area Designation	Area, Ft2	Perimeter (sloped), Ft	Full Depth, ft	Exc vol, ft3	Exc side slope vol, ft3	Total Exc, ft3	Backfill, Ft3	Exc Area, Ft2	Extra side slope area, ft2	Total area, ft2
1E	1,771	84.5	2	3,542	169	3,711	3,711	1,771	169	1,940
2E	1,680	80	2	3,360	160	3,520	3,520	1,680	160	1,840
3E	1,932	85	2	3,864	170	4,034	4,034	1,932	170	2,102
4E	840	80	2	1,680	160	1,840	1,840	840	160	1,000
5E	2,604	140	2	5,208	280	5,488	5,488	2,604	280	2,884
6E	17,800	350	2	35,600	700	36,300	36,300	17,800	700	18,500
7E	2,940	224	2	5,880	448	6,328	6,328	2,940	448	3,388
8E	1,600	160	2	3,200	320	3,520	3,520	1,600	320	1,920
12E-1	1,200	140	2	2,400	280	2,680	2,680	1,200	280	1,480
12E-2	1,600	160	2	3,200	320	3,520	3,520	1,600	320	1,920
14E	1,600	160	2	3,200	320	3,520	3,520	1,600	320	1,920
15E	1,600	160	2	3,200	320	3,520	3,520	1,600	320	1,920
16E	2,900	210	2	5,800	420	6,220	6,220	2,900	420	3,320
17E	1,600	160	2	3,200	320	3,520	3,520	1,600	320	1,920

Total				83,334		87,721	87,721			46,054
Total, cy				3,086		3,249	3,249			

Notes
Perimeter is perimeter along the outer wall.
Full Depth is maximum depth of contamination.

DAVISVILLE SITE 16 FS - MASS OF CONTAMINANTS GREATER THAN INDUSTRIAL CRITERIA IN SOIL REMOVED IN S-3A
12/20/2010
REV 01/16/13 - This sheet only for mass calculation. Links to other sheets are removed.

			Lead, mg/kg				Arsenic, mg/kg				BaP Eqs, ug/kg				Naphthalene, ug/kg				TPH, mg/kg				Benzene, ug/kg			
Area Designation	Area, Ft2	Excavation depth of contam soil, ft	Maximum	Goal	geomean	mass, lb	Maximum	Goal	geomean	mass, lb	Maximum	Goal	geomean	mass, lb	Maximum	Goal	geomean	mass, lb	Maximum	Detection limit	geomean	mass, lb	Maximum	Detection limit	geomean	mass, lb
1E	1,771	2		80	80	0		13	13	0	1,103	800	939	0.4		500	0	0	2,600	26	260	101		0.3	0	0
2E	1,680	2		80	80	0		13	13	0	17,995	800	3,794	1		500	0	0		26	26	0		0.3	0	0
3E	1,932	2		80	80	0		13	13	0	3,014	800	1,553	1	1,900	500	975	0.4		26	26	0		0.3	0	0
4E	840	2		80	80	0		13	13	0	909	800	853	0.2		500	0	0		26	26	0		0.3	0	0
5E	2,604	2		80	80	0		13	13	0	14,995	800	3,464	2	550	500	524	0.3		26	26	0		0.3	0	0
6E	17,800	2	3,950	80	212	830	32.3	13	20	80	1,222	800	989	4		500	0	0		26	26	0		0.3	0	0
7E	2,940	2		80	80	0		13	13	0	1,226	800	990	1		500	0	0		26	26	0		0.3	0	0
14E	1,600	2		80	80	0	23.5	13	17	6	1,511	800	1,099	0.4		500	0	0		26	26	0		0.3	0	0
15E	1,600	2		80	80	0		13	13	0	1,023	800	905	0.3	830	500	644	0.2		26	26	0		0.3	0	0
8E	1,600	2		80	80	0	7.7	13	10	4		800	0	0		500	0	0		26	26	0		0.3	0	0
12E1	1,200	2		80	80	0		13	13	0	1,043	800	913	0.2		500	0	0		26	26	0		0.3	0	0
12E2	1,600	2	134	80	91	32		13	13	0		800	800	0		500	0	0		26	26	0		0.3	0	0
16E	2,900	2		80	80	0	11.6	13	12	8		800	0	0		500	0	0		26	26	0		0.3	0	0
17E	1,600	2		80	80	0	7.7	13	10	4		800	0	0		500	0	0		26	26	0		0.3	0	0
Total						862				101				10				1				101				0

Bulk density, lb/ft3	110

Notes
TPH is skewed by single high result. Two additional DL points were used in calculation.
Lead is skewed by single high results. Two additional DL points were used in the calculation.
In addition, the Goal for lead was reduced to reflect the generally low concentrations in other areas of the site.
For each area, RI samples were identified. The data for each area was reviewed to determine the maximum.

Alternative G-3B

Logan, Joe

From: Will Moody <wmoody@geocleanse.com>
Sent: Thursday, August 09, 2012 2:42 PM
To: Logan, Joe
Subject: NCBC Davisville Project - Estimated Costs

Hi Joe,

Based on the site information and our correspondence, I have developed two scenarios to address an approximate 150 ft x 90 ft area with a 10-ft vertical treatment interval. The treatment area surrounds the injection wells and is bounded by MW16-14I, MW16-66D and approximately 10 to 15 ft past the MW16-69, -70 and -71 well clusters. The fittings on the injection wells should not pose a problem for our injection heads. A 20-ft radius of influence (ROI) should be expected, but due to permanganates long lifetime we may see a greater ROI. I recommend conducting a permanganate natural oxidant demand (PNOD) test to determine the amount of permanganate that will be necessary to overcome the naturally occurring oxidizable materials in the subsurface. In order to complete the PNOD testing, soil must be collected from the treatment area and vertical interval that will be targeted during the field application. Carus Corporation can conduct PNOD tests (approximately $300 per test) that measure the loss of permanganate in the presence of site-specific soil over a period of 48 hrs. The PNOD values obtained can then be used to determine appropriate permanganate dosing for field-scale applications. I would recommend that at least two soil samples from the treatment interval are obtained. We have conducted treatment programs in the past without conducting the PNOD test and for this estimate, I have assumed reasonable PNOD values that are based on our experience at similar sites. Below are costs to implement the treatment programs:

Option 1 (PNOD of 2 grams of permanganate per kilogram of soil)
Project Design: $3,400 Includes site-specific Health & Safety Plan and Work Plan, conference calls, etc.
Injection Program: $23,050 Includes four days of site setup and injection, equipment, crew, etc.
Reagents: $44,568 Includes 15,228 pounds of sodium permanganate, transportation and tax.
Mobilization: $7,560 Includes crew and equipment mobilization/demobilization costs, per diem, etc..
Project Documentation: $2,650 Includes post-treatment injection report and tabulated field data.

Total Cost: $81,228

Option 2 (PNOD of 3 grams of permanganate per kilogram of soil)
Project Design: $3,400 Includes site-specific Health & Safety Plan and Work Plan, conference calls, etc.
Injection Program: $27,300 Includes five days of site setup and injection, equipment, crew, etc.
Reagents: $65,438 Includes 22,821 pounds of sodium permanganate, transportation and tax.
Mobilization: $8,050 Includes crew and equipment mobilization/demobilization costs, per diem, etc.
Project Documentation: $2,650 Includes post-treatment injection report and tabulated field data.

Total Cost: $106,838

Our costs do not include water (H&S and dilution of the permanganate to a 5.3% concentration), performance monitoring or permitting (if necessary, we will assist with the permitting process). Please contact me if you have questions or need any additional information. Thanks again for the opportunity.

Regards,

Will

Will Moody
Project Manager
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DAVISVILLE SITE 16 FS
INJECTION WELL ABANDOMENT COSTS
1/14/2013

Assumptions:
Grouting cost at 6 $/ft (from 2009 Cecil Project)
Upper 4 feet must be removed (Per RIDEM Rules, Appendix 1)
Assume that remaining casing can be left in place.

Assume that weight of upper 4 feet is primarily the concrete pad.
8 inch x 8 inch x 2 feet at 140 lb/ft3 = 124 lb per casing.
Because of large number of casings, assume bulk disposal in a dumpster at 50 $/ton.

Assume mobilization of $1,000.

Unit costs	
Grout, $/ft	$6
Casing disp, $/ton	$50
Mob	$1,000

Alternative	Number of wells	Total feet	Weight of casing, ton	Cost, grouting, $	Cost, casing disp, $	Cost, Mob, $	**Cost, Total, $**	Year
G-3B	12	720	1	$4,320	$37	$1,000	$5,357	5

For ISCO, abandonment will be at year 5.

NCBC DAVISVILLE
SITE 16 FS
TCE PLUME CALCULATIONS
3/8/2012 - REV 01/16/13 for G-3B

								Aqueous						TCE, sorbed					cis-1,2-DCE, sorbed					VC, sorbed				
Top el, ft	Bottom el, ft	Location	Area, in2	Area, ft2	Vol, in place, ft3	n	Vol, water, gal	TCE, ug/L	TCE, lb	cis-1,2-DCE, ug/L	cis-1,2-DCE, lb	VC, ug/L	VC, lb	Koc, L/kg	Kd, L/kg	Cs, ug/kg	Soil mass, lb	lb sorbed	Koc, L/kg	Kd, L/kg	Cs, ug/kg	Soil mass, lb	lb sorbed	Koc, L/kg	Kd, L/kg	Cs, ug/kg	Soil mass, lb	lb sorbed
5	-5	W. end of Bldg (1,000)	0.124	11,200	112,000	0.25	209,000	2,775	4.8	190	0.3	10	0.02	160	0.8	2,220	12,320,000	27.3	35	0.175	33.25	12,320,000	0.4	3	0.015	0.15	12,320,000	0.00
-5	-15	C. Bldg (1,000)	0.124	11,200	112,000	0.3	251,000	2,775	5.8	190	0.4	10	0.02	160	0.8	2,220	12,320,000	27.3	35	0.175	33.25	12,320,000	0.4	3	0.015	0.15	12,320,000	0.00
-5	-15	E. end of Bldg (500)	0.177	15,900	159,000	0.3	357,000	524	1.6	40	0.1	2	0.01	160	0.8	420	17,490,000	7.3	35	0.175	7	17,490,000	0.1	3	0.015	0.03	17,490,000	0.001
-5	-15	SE of bldg (500)	0.403	36,300	363,000	0.3	815,000	640	4.4	40	0.3	2	0.01	160	0.8	512	39,930,000	20.5	35	0.175	7	39,930,000	0.3	3	0.015	0.03	39,930,000	0.001
-5	-15	E. of bldg (500)	0.062	5,600	56,000	0.3	126,000	628	0.7	40	0.0	2	0.00	160	0.8	503	6,160,000	3.1	35	0.175	7	6,160,000	0.0	3	0.015	0.03	6,160,000	0.000
-5	-15	Harbor (500)	0.124	11,200	112,000	0.3	251,000	596	1.2	40	0.1	2	0.00	160	0.8	477	12,320,000	5.9	35	0.175	7	12,320,000	0.1	3	0.015	0.03	12,320,000	0.000
-15	-25	Bldg (1,000)	0.263	23,700	237,000	0.3	532,000	1,095	4.9	80	0.4	3	0.01	160	0.8	876	26,070,000	22.8	35	0.175	14.0	26,070,000	0.4	3	0.015	0.05	26,070,000	0.001
-15	-25	E. of bldg (500)	0.186	16,700	167,000	0.3	375,000	628	2.0	40	0.1	2	0.01	160	0.8	503	18,370,000	9.2	35	0.175	7	18,370,000	0.1	3	0.015	0.03	18,370,000	0.001
-15	-25	NE Cent area (500)	0.0707	6,400	64,000	0.3	144,000	636	0.8	40	0.0	2	0.00	160	0.8	509	7,040,000	3.6	35	0.175	7	7,040,000	0.0	3	0.015	0.03	7,040,000	0.000
-25	-35	Bldg (1,000)	1.162	105,000	1,050,000	0.25	1,964,000	1,517	24.8	110	1.8	5	0.08	160	0.8	1,213	115,500,000	140.1	35	0.175	19.3	115,500,000	2.2	3	0.015	0.08	115,500,000	0.009
-25	-35	Harbor (1,000)	0.155	14,000	140,000	0.25	262,000	1,095	2.4	80	0.2	3	0.01	160	0.8	876	15,400,000	13.5	35	0.175	14.0	15,400,000	0.2	3	0.015	0.05	15,400,000	0.001
-25	-35	Eastern (500)	0.186	16,700	167,000	0.25	312,000	596	1.5	40	0.1	2	0.01	160	0.8	477	18,370,000	8.8	35	0.175	7.0	18,370,000	0.1	3	0.015	0.03	18,370,000	0.001
-35	-45	Bldg corner (1,000)	0.0314	2,800	28,000	0.01	2,000	1,091	0.02	80	0.0	3	0.00	160	0.8	873	30,800	0.03	35	0.175	14.0	30,800	0.000	3	0.015	0.05	30,800	0.00000
-35	-45	NE of bldg (1,000)	0.925	83,300	833,000	0.01	62,000	1,342	0.7	90	0.0	4	0.00	160	0.8	1,073	916,300	1.0	35	0.175	15.8	916,300	0.01	3	0.015	0.06	916,300	0.0001
-35	-45	Harbor (1,000)	0.51	45,900	459,000	0.01	34,000	1,095	0.3	80	0.0	3	0.00	160	0.8	876	504,900	0.4	35	0.175	14.0	504,900	0.01	3	0.015	0.05	504,900	0.0000
15	5	Building 41 - west end	0.093	8,400	84,000	0.25	157,000	30	0.04	2	0.0	0.1	0.0001	160	0.8	24	9,240,000	0.2	35	0.175	0.4	9,240,000	0.00	3	0.015	0.001	9,240,000	0.00001
15	5	Building 41 - east end	0.23	21,000	210,000	0.25	393,000	10	0.03	1	0.0	0.0	0.0001	160	0.8	8	23,100,000	0.2	35	0.175	0.2	23,100,000	0.00	3	0.015	0.000	23,100,000	0.00001
15	5	East of Building 41	0.2	18,000	180,000	0.25	337,000	12	0.03	1	0.0	0.0	0.0001	160	0.8	10	19,800,000	0.2	35	0.175	0.2	19,800,000	0.003	3	0.015	0.0006	19,800,000	0.00001
15	5	South of Buildng 41	0.11	9,900	99,000	0.25	185,000	22	0.03	2	0.0	0.1	0.0001	160	0.8	17	10,890,000	0.2	35	0.175	0.4	10,890,000	0.004	3	0.015	0.0010	10,890,000	0.00001
5	-5	*5 ug/L plume outline*	3.55	319,500	3,195,000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5	-5	5 ug/L plume*	3.55	319,500	3,083,000	0.25	5,766,000	21	1.0	1	0.0	0.1	0.00	160	0.8	17	339,130,000	5.7	35	0.175	0.2	339,130,000	0.1	3	0.015	0.0009	339,130,000	0.000
-5	-15	*5 ug/L plume outline*	4.7	423,000	4,230,000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
-5	-15	5 ug/L plume*	4.7	423,000	3,540,000	0.3	7,945,000	24	1.6	2	0.1	0.1	0.00	160	0.8	20	389,400,000	7.6	35	0.175	0.4	389,400,000	0.1	3	0.015	0.0011	389,400,000	0.000
-15	-25	*5 ug/L plume outline*	5.1	459,000	4,590,000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
-15	-25	5 ug/L plume*	5.1	459,000	4,186,000	0.3	9,395,000	33	2.6	2	0.2	0.1	0.01	160	0.8	27	460,460,000	12.2	35	0.175	0.4	460,460,000	0.2	3	0.015	0.0015	460,460,000	0.001
-25	-35	*5 ug/L plume outline*	11.5	1,035,000	10,350,000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
-25	-35	5 ug/L plume*	11.5	1,035,000	8,153,000	0.25	15,248,000	45	5.8	3	0.4	0.1	0.02	160	0.8	36	896,830,000	32.5	35	0.175	0.5	896,830,000	0.5	3	0.015	0.0020	896,830,000	0.00
-25	-35	*500 ug/L plume*	2.1	189,000	1,890,000	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x
-25	-35	500-1000 ug/L annulus		84,000	840,000	0.25	1,571,000	704	9.2	50	0.7	2	0.03	160	0.8	563	92,400,000	52.0	35	0.175	8.8	92,400,000	0.8	3	0.015	0.03166	92,400,000	0.00
-35	-45	*500 ug/L plume*	1.9	171,000	1,710,000	0.01	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x
-35	-45	500-1000 ug/L annulus		87,700	877,000	0.01	66,000	600	0.3	40	0.02	2	0.00	160	0.8	480	964,700	0.5	35	0.175	7.0	964,700	0.01	3	0.015	0.027	964,700	0.0000
-35	-45	*5 ug/L plume outline*	10.4	936,000	9,360,000	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
-35	-45	5 ug/L plume*	10.4	936,000	7,163,000	0.01	536,000	42	0.2	3	0.01	0.1	0.001	160	0.8	33	7,879,300	0.3	35	0.175	0.5	7,879,300	0.00	3	0.015	0.0019	7,879,300	0.0000
Total									76.7		5.3		0.2					402.5					6.1					0.0
Sub total - 1,000 ug/L									43.7		3.1		0.1					232.6					3.6					0.01
Sub total - 500 ug/L									21.6		1.5		0.1					110.8					1.7					0.01
Sub total - 5 ug/L									11.3		0.7		0.0					59.1					0.8					0.00
Total									76.7		5.3		0.2					402.5					6.1					0.0

The plumes treated by INJ are highlighted. 100% of the -15 to -25 contour area is treated by the INJ wells. 20% of the -25 to -35 contour area is treated by the INJ wells.
Assume 100% removal.

Mass in these rows removed.

			Aqueous					Sorbed					
			TCE, lb		cis-1,2-DCE, lb		VC, lb		lb TCE sorbed		lb cis-1,2-DCE sorbed		lb VC sorbed
-15	-25	Bldg (1,000)	4.9		0.4		0.0		22.8		0.4		0.0
-25	-35	Bldg (1,000) AT 20%	5.0		0.4		0.0		28.0		0.4		0.0
		Total	9.8		0.7		0.0		50.9		0.8		0.0
		Total aqueous + sorbed	**60.7**		**1.5**		**0.0**						

APPENDIX B

COST ESTIMATES

Cost Estimate - Alternative S-3A

NCBC DAVISVILLE
Davisville, Rhode Island
Site 16
Alternative S-3A: Selected Excavation and Disposal and LUCs
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Work Plans	400	hr			$37.00		$0	$0	$14,800	$0	$14,800
1.2 Prepare LUCs	100	hr			$37.00		$0	$0	$3,700	$0	$3,700
1.3 Construction Completion Report	100	hr			$37.00		$0	$0	$3,700	$0	$3,700
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	8	ea			$177.00	$610.00	$0	$0	$1,416	$4,880	$6,296
3 FIELD SUPPORT											
3.1 Site Support Facilities (trailers, phone, electric, etc.)	4	mo		$470.00		$452.00	$0	$1,880	$0	$1,808	$3,688
3.2 Survey Support	4	day	$1,075.00				$4,300	$0	$0	$0	$4,300
3.3 Site Superintendent	13	week		$700.00	$1,923.20		$0	$9,100	$25,002	$0	$34,102
3.4 Site Health & Safety and QA/QC	13	week		$700.00	$1,538.40		$0	$9,100	$19,999	$0	$29,099
4 DECONTAMINATION											
4.1 Decontamination Services	3	mo		$1,220.00	$2,244.00	$1,550.00	$0	$3,660	$6,732	$4,650	$15,042
4.2 Temporary Equipment Decon Pad	1	ls		$1,800.00	$2,200.00	$450.00	$0	$1,800	$2,200	$450	$4,450
4.3 Decon Water	3,000	gal		$0.20			$0	$600	$0	$0	$600
4.4 Decon Water Storage Tank, 6,000 gallon	3	mo				$771.00	$0	$0	$0	$2,313	$2,313
4.5 Clean Water Storage Tank, 4,000 gallon	3	mo				$693.00	$0	$0	$0	$2,079	$2,079
4.6 Disposal of Decon Waste (liquid & solid)	3	mo	$985.00				$2,955	$0	$0	$0	$2,955
5 SITE PREPARATION											
5.1 Underground Utility Clearance	1	ls	$10,000.00				$10,000	$0	$0	$0	$10,000
5.2 Soil Sampling: PAHs	26	ea	$120.00				$3,120	$0	$0	$0	$3,120
5.3 Soil Sampling: Lead/Arsenic	16	ea	$20.00				$320	$0	$0	$0	$320
5.4 Soil Sampling: TCLP (disposal)	30	ea	$750.00				$22,500	$0	$0	$0	$22,500
5.5 Soil Sampling: Labor	80	hr			$32.00		$0	$0	$2,560	$0	$2,560
5.6 Monitoring Well Abandonment, 15 wells	445	lf	$6.00				$2,670	$0	$0	$0	$2,670
5.7 Monitoring Well Head Abandonment, 15 wells	15	ea	$100.00				$1,500	$0	$0	$0	$1,500
5.8 Clear & Grub North Central Area (NCA)	1.5	ac			$2,400.00	$2,025.00	$0	$0	$3,600	$3,038	$6,638
6 EXCAVATION AND DISPOSAL											
6.1 Non-Hazardous Soil Transportation & Disposal	4,386	ton	$95.00				$416,670	$0	$0	$0	$416,670
6.2 Hazardous Soil Transportation & Disposal	488	ton	$235.00				$114,680	$0	$0	$0	$114,680
6.3 Building Shoring Support	200	sf	$3.65				$730	$0	$0	$0	$730
6.4 Backfill	2,399	cy		$17.96			$0	$43,086	$0	$0	$43,086
6.5 Topsoil	850	cy		$27.67			$0	$23,520	$0	$0	$23,520
6.6 Excavator, 2.5 cy	25	day			$355.20	$1,784.00	$0	$0	$8,880	$44,600	$53,480
6.7 Dozer, 300 hp	25	day			$342.60	$1,592.00	$0	$0	$8,565	$39,800	$48,365
6.8 Compactor	25	day			$342.60	$1,243.00	$0	$0	$8,565	$31,075	$39,640
6.9 Site Labor, (3 laborers)	75	day			$264.80		$0	$0	$19,860	$0	$19,860
7 SITE RESTORATION											
7.1 Revegetation, seed	7,000	sy		$0.50	$1.67	$0.34	$0	$3,500	$11,690	$2,380	$17,570
7.2 Pavement Replacement	1,500	sf	$3.03				$4,545	$0	$0	$0	$4,545
7.3 Replace Monitoring Wells, 7 wells	250	lf	$65.00				$16,250	$0	$0	$0	$16,250
7.4 Monitoring Well Head	7	ea	$500.00				$3,500	$0	$0	$0	$3,500
7.5 IDW Disposal	25	drum	$175.00				$4,375	$0	$0	$0	$4,375
Subtotal							$608,115	$97,246	$141,269	$140,573	$987,202

NCBC DAVISVILLE
Davisville, Rhode Island
Site 16
Alternative S-3A: Selected Excavation and Disposal and LUCs
Capital Cost

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Overhead on Labor Cost @	30%								$42,381		$42,381
G & A on Labor Cost @	10%								$14,127		$14,127
G & A on Material Cost @	10%							$9,725			$9,725
G & A on Equipment Cost @	10%									$14,057	$14,057
G & A on Subcontract Cost @	10%						$60,812				$60,812
Tax on Materials and Equipment Cost @	7%							$6,807		$9,840	$16,647
Total Direct Cost							$668,927	$113,777	$197,776	$164,470	$1,144,950
Indirects on Total Direct Cost @	25%	(excluding transportation and disposal cost)									$151,567
Profit on Total Direct Cost @	10%										$114,495
Subtotal											$1,411,012
Health & Safety Monitoring @	2%										$28,220
Total Field Cost											$1,439,233
Contingency on Total Field Costs @	25%										$359,808
Engineering on Total Field Cost @	10%										$143,923
TOTAL CAPITAL COST											**$1,942,964**

NCBC DAVISVILLE
Davisville, Rhode Island
Site 16
Alternative S-3A: Selected Excavation and Disposal and LUCs
Annual Cost

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Item	Item Cost years 1 - 30	Item Cost every 5 years	Notes
Site Inspection and Report	$2,650		LUC Inspection and Reporting
Five Year Site Review		$25,000	Five Year Site Reviews
SUBTOTAL	$2,650	$25,000	
Contingency @ 10%	$265	$2,500	
TOTAL	**$2,915**	**$27,500**	

NCBC DAVISVILLE
Davisville, Rhode Island
Site 16
Alternative S-3A: Selected Excavation and Disposal and LUCs
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.3%	Present Worth
0	$1,942,964		$1,942,964	1.000	$1,942,964
1		$2,915	$2,915	0.978	$2,849
2		$2,915	$2,915	0.956	$2,785
3		$2,915	$2,915	0.934	$2,723
4		$2,915	$2,915	0.913	$2,662
5		$30,415	$30,415	0.893	$27,146
6		$2,915	$2,915	0.872	$2,543
7		$2,915	$2,915	0.853	$2,486
8		$2,915	$2,915	0.834	$2,430
9		$2,915	$2,915	0.815	$2,376
10		$30,415	$30,415	0.797	$24,229
11		$2,915	$2,915	0.779	$2,270
12		$2,915	$2,915	0.761	$2,219
13		$2,915	$2,915	0.744	$2,169
14		$2,915	$2,915	0.727	$2,120
15		$30,415	$30,415	0.711	$21,625
16		$2,915	$2,915	0.695	$2,026
17		$2,915	$2,915	0.679	$1,980
18		$2,915	$2,915	0.664	$1,936
19		$2,915	$2,915	0.649	$1,892
20		$30,415	$30,415	0.635	$19,301
21		$2,915	$2,915	0.620	$1,808
22		$2,915	$2,915	0.606	$1,768
23		$2,915	$2,915	0.593	$1,728
24		$2,915	$2,915	0.579	$1,689
25		$30,415	$30,415	0.566	$17,226
26		$2,915	$2,915	0.554	$1,614
27		$2,915	$2,915	0.541	$1,578
28		$2,915	$2,915	0.529	$1,542
29		$2,915	$2,915	0.517	$1,507
30		$30,415	$30,415	0.506	$15,375
AVERAGE ANNUAL COST		**$8,415**		**TOTAL PRESENT WORTH**	**$2,118,567**

Cost Estimate - Alternative G-3B

NCBC DAVISVILLE
Davisville, Rhode Island
Site 16
Alternative G-3B - In-Situ Chemical Oxidation using Existing INJ Wells
Capital Cost

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans	80	hr			$37.00		$0	$0	$2,960	$0	$2,960
1.2 Prepare MNA Plans	0	hr			$37.00		$0	$0	$0	$0	$0
1.3 Prepare LUCs	0	hr			$37.00		$0	$0	$0	$0	$0
1.4 Subcontractor Design	1	ls	$3,400.00				$3,400	$0	$0	$0	$3,400
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	0	ls		$1,000.00		$3,500.00	$0	$0	$0	$0	$0
2.2 Equipment Mobilization/Demobilization	0	ea			$177.00	$610.00	$0	$0	$0	$0	$0
3 FIELD SUPPORT (two injections)											
3.1 Site Support Facilities (trailers, phone, electric, etc.)	1	mo		$470.00		$452.00	$0	$470	$0	$452	$922
3.2 Survey Support	0	day	$1,075.00				$0	$0	$0	$0	$0
3.3 Site Superintendent	4	week		$700.00	$1,923.20		$0	$2,800	$7,693	$0	$10,493
3.4 Site Health & Safety and QA/QC	2	week		$700.00	$1,538.40		$0	$1,400	$3,077	$0	$4,477
4 DECONTAMINATION (Two injections)											
4.1 Decontamination Services	0	mo		$1,220.00	$2,244.00	$1,550.00	$0	$0	$0	$0	$0
4.2 Temporary Equipment Decon Pad	0	ls		$1,800.00	$2,200.00	$450.00	$0	$0	$0	$0	$0
4.3 Decon Water	2,000	gal		$0.20			$0	$400	$0	$0	$400
4.4 Decon Water Storage Tank, 6,000 gallon	2	mo				$771.00	$0	$0	$0	$1,542	$1,542
4.5 Clean Water Storage Tank, 4,000 gallon	2	mo				$693.00	$0	$0	$0	$1,386	$1,386
4.6 Disposal of Decon Waste (liquid & solid)	2	mo	$985.00				$1,970	$0	$0	$0	$1,970
5 SITE PREPARATION AND BENCH SCALE TESTING											
5.1 Underground Utility Clearance	0	ls	$7,750.00				$0	$0	$0	$0	$0
5.2 Bench Scale Planning/Sampling	0	hr			$37.00		$0	$0	$0	$0	$0
5.3 Bench Scale Analyses	0	ea	$200.00				$0	$0	$0	$0	$0
5.4 Bench Scale ODCs	0	ls		$500.00			$0	$0	$0	$0	$0
5.5 Bench Scale Test	0	ls	$65,000.00				$0	$0	$0	$0	$0
6 CHEMICAL INJECTION No. 1								$0	$0	$0	
6.1 Subcontractor Mob/Demob	1	ls	$8,100.00				$8,100	$0	$0	$0	$8,100
6.2 Install injection wells	0	ls	$896,000.00				$0	$0	$0	$0	$0
6.3 Injection (1 week)	1	ls	$28,000.00				$28,000	$0	$0	$0	$28,000
6.4 Sodium Permanganate	1	ls		$66,000.00			$0	$66,000	$0	$0	$66,000
6.5 Subcontractor's Report	1	ls	$2,700.00				$2,700	$0	$0	$0	$2,700
6.6 Water Tank Truck	5	day				$470.00	$0	$0	$0	$2,350	$2,350
6.7 Injection Water	52,000	gal		$0.20			$0	$10,400	$0	$0	$10,400
6.8 IDW	0	drum	$175.00				$0	$0	$0	$0	$0
7 CHEMICAL INJECTION No. 2								$0	$0	$0	
7.1 Subcontractor Mob/Demob	1	ls	$8,100.00				$8,100	$0	$0	$0	$8,100
7.2 Install injection wells	0	ls	$896,000.00				$0	$0	$0	$0	$0
7.3 Injection (1 week)	1	ls	$28,000.00				$28,000	$0	$0	$0	$28,000
7.4 Sodium Permanganate	1	ls		$66,000.00			$0	$66,000	$0	$0	$66,000
7.5 Subcontractor's Report	1	ls	$2,700.00				$2,700	$0	$0	$0	$2,700
7.6 Water Tank Truck	5	day				$470.00	$0	$0	$0	$2,350	$2,350
7.7 Injection Water	52,000	gal		$0.20			$0	$10,400	$0	$0	$10,400
7.8 IDW	0	drum	$175.00				$0	$0	$0	$0	$0

NCBC DAVISVILLE
Davisville, Rhode Island
Site 16
Alternative G-3B - In-Situ Chemical Oxidation using Existing INJ Wells
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
8 POST-INJECTION SAMPLING (Two phases of Five events)											
8.1 Sampling Labor	300	hr		$37.00			$0	$11,100	$0	$0	$11,100
8.2 Sampling ODCs	10	ea	$500.00				$5,000	$0	$0	$0	$5,000
8.3 Sampling Analysis	10	ea	$400.00				$4,000	$0	$0	$0	$4,000
8.4 Sampling Report	400	hr		$37.00			$0	$14,800	$0	$0	$14,800
Subtotal							$91,970	$183,770	$13,730	$8,080	$297,550
Overhead on Labor Cost @	30%								$4,119		$4,119
G & A on Labor Cost @	10%								$1,373		$1,373
G & A on Material Cost @	10%							$18,377			$18,377
G & A on Equipment Cost @	10%									$808	$808
G & A on Subcontract Cost @	10%						$9,197				$9,197
Tax on Materials and Equipment Cost @	7%							$12,864		$566	$13,430
Total Direct Cost							$101,167	$215,011	$19,221	$9,454	$344,853
Indirects on Total Direct Cost @	25%										$86,213
Profit on Total Direct Cost @	10%										$34,485
Subtotal											$465,551
Health & Safety Monitoring @	1%										$4,656
Total Field Cost											$470,207
Contingency on Total Field Costs @	25%										$117,552
Engineering on Total Field Cost @	5%										$23,510
TOTAL CAPITAL COST											**$611,269**

NCBC DAVISVILLE
Davisville, Rhode Island
Site 16
Alternative G-3B - In-Situ Chemical Oxidation using Existing INJ Wells
Annual Cost

Item	Item Cost yearly	Item Cost every 5 years	Notes
Site Inspection and Report	$2,650		LUC Inspection and Reporting
MNA Sampling	$18,000		Labor and supplies to collect samples from 28 wells using a crew of two annually.
MNA Sampling Analysis/Water	$6,500		Analyze groundwater samples for MNA
MNA Sampling Report	$6,000		
WMA Sampling	$3,200		Labor and supplies to collect samples from 6 wells using a crew of two annually.
WMA Sampling Analysis/Water	$800		Analyze groundwater samples for VOCs
WMA Sampling Report	$6,000		
Surface Water/Seep Sampling		$4,000	Labor and supplies to collect samples from 10 locations using a crew of two annually.
Surface Water/Seep Analysis		$4,500	Analyze surface water/seep samples for VOCs and SVOCs.
Five Year Site Review		$25,000	Five Year Site Reviews
SUBTOTAL	$43,150	$33,500	
Contingency @ 10%	$4,315	$3,350	
TOTAL	**$47,465**	**$36,850**	
Well Abandonment		$5,000	

NCBC DAVISVILLE
Davisville, Rhode Island
Site 16
Alternative G-3B - In-Situ Chemical Oxidation using Existing INJ Wells
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.3%	Present Worth
0	$611,269		$611,269	1.000	$611,269
1		$47,465	$47,465	0.978	$46,398
2		$47,465	$47,465	0.956	$45,355
3		$47,465	$47,465	0.934	$44,335
4		$47,465	$47,465	0.913	$43,338
5		$89,315	$89,315	0.893	$79,716
6		$47,465	$47,465	0.872	$41,411
7		$47,465	$47,465	0.853	$40,480
8		$47,465	$47,465	0.834	$39,570
9		$47,465	$47,465	0.815	$38,681
10		$84,315	$84,315	0.797	$67,166
11		$47,465	$47,465	0.779	$36,961
12		$47,465	$47,465	0.761	$36,130
13		$47,465	$47,465	0.744	$35,318
14		$47,465	$47,465	0.727	$34,523
15		$84,315	$84,315	0.711	$59,947
16		$47,465	$47,465	0.695	$32,989
17		$47,465	$47,465	0.679	$32,247
18		$47,465	$47,465	0.664	$31,522
19		$47,465	$47,465	0.649	$30,813
20		$84,315	$84,315	0.635	$53,505
21		$47,465	$47,465	0.620	$29,443
22		$47,465	$47,465	0.606	$28,781
23		$47,465	$47,465	0.593	$28,134
24		$47,465	$47,465	0.579	$27,502
25		$84,315	$84,315	0.566	$47,754
26		$47,465	$47,465	0.554	$26,279
27		$47,465	$47,465	0.541	$25,688
28		$47,465	$47,465	0.529	$25,111
29		$47,465	$47,465	0.517	$24,546
30		$84,315	$84,315	0.506	$42,622

AVERAGE ANNUAL COST **$55,002** **TOTAL PRESENT WORTH** **$1,787,534**

APPENDIX C

SUSTAINABILITY EVALUATION

APPENDIX C-1: SUSTAINABLE EVALUATION NARRATIVE

APPENDIX C

Environmental Footprint Evaluation
Feasibility Study
Site 16
NCBC Davisville
Davisville, Rhode Island
January 2012

OBJECTIVE

This Environmental Footprint Evaluation of remedial alternatives is provided as an Appendix to the Feasibility Study (FS) for Site 16 at the NCBC Davisville located in Davisvile, RI. The purpose of the footprint evaluation is to assess the environmental impacts of the remedial alternatives using the metrics of greenhouse gas (GHG) and criteria pollutant emissions, energy use, water consumption, and worker safety. The results of this footprint evaluation are intended to provide additional information for consideration during remedy selection, design, and to enhance the understanding of the environmental impacts throughout the remedy life-cycle for each of the proposed alternatives.

POLICY BACKGROUND

Department of Defense (DOD) and Navy policies require continual optimization of remedies in every phase from remedy selection through site closeout (NAVFAC, 2010a).

In January 2007, Executive Order 13423 set targets for sustainable practices for (i) energy efficiency, greenhouse gas emissions avoidance or reduction, and petroleum products use reduction, (ii) renewable energy, including bioenergy, (iii) water conservation, (iv) acquisition, (v) pollution and waste prevention and recycling, etc. In October 2009, Executive Order 13514 was issued, which reinforced these sustainability requirements and established specific goals for federal agencies to meet by 2020.

In August 2009 DOD issued a policy for “Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program.” The DOD policy and related Navy guidance state that opportunities to increase sustainability should be considered throughout all phases of remediation (i.e., site investigation, remedy selection, remedy design and construction, operation, monitoring, and site closeout). In response to this policy, the Department of the Navy (DON) issued an updated Navy Guidance for “Optimizing Remedy Evaluation, Selection, and Design” (NAVFAC, 2010), which includes environmental footprint evaluations as part of the traditional DON optimization review process for remedy

selection, design, and remedial action operation. In August 2010, the Naval Facilities Engineering Command (NAVFAC) issued policy requiring use of the SiteWise™ tool to perform environmental impact reviews as part of all Feasibility Studies. As such, this environmental footprint evaluation of remedial alternatives is being performed to estimate the environmental footprint associated with each alternative in the interest of reducing the environmental impact of remedial action at Site 16, NCBC Davisville.

Applying the DON optimization concepts with an environmental footprint evaluation within the remedy selection and design phases allows for the following benefits:

- Determining factors in each remedial alternative with the greatest environmental impacts and gathering insight into how to reduce these impacts;
- Evaluating remedial alternatives with optimized or reduced environmental footprints in conjunction with other selection criteria;
- Designing and implementing a more robust remedy while balancing the impact to the environment; and
- Ensuring efficient, cost-effective and sustainable site closeout.

EVALUATION TOOLS

This evaluation was performed using a hybrid model of the Navy's SiteWise™ tool supplemented with Tetra Tech developed model as appropriate for some site-specific items.

SiteWise™ is a life-cycle footprint assessment tool developed jointly by the U.S. Navy, U.S. Army Corps of Engineers (USACE), and Battelle. SiteWise™ assesses the environmental footprint of a remedial alternative/technology using a consistent set of metrics. The assessment is conducted using a building block approach, where each remedial alternative is first broken down into modules that follow the phases for most remedial actions, including remedial investigation (RI), remedial action construction (RA-C), remedial action operation (RA-O), and long-term monitoring (LTM). Once broken down by remedial phase, the footprint of each phase is calculated. The phase-specific footprints are then combined to estimate the overall footprint of the remedial alternative. This building block approach reduces redundancy in the footprint assessment and facilitates the identification of specific impact drivers that contribute to the environmental footprint. The inputs that need to be considered include (1) production of material required by the activity; (2) transportation of the required materials to the site, transportation of personnel; (3) all site activities to be performed; and (4) management of the waste produced by the activity.

GSRx builds off of SiteWise™ and allows for a flexible, detailed analysis, particularly for materials and equipment use. GSRx was used to account for materials and activities not readily input into SiteWise™

and where equipment usage assumptions built into SiteWise™ were not consistent with site-specific requirements.

ENVIRONMENTAL FOOTPRINT EVALUATION FRAMEWORK AND LIMITATIONS

The environmental footprint evaluation performed for the FS of Site 16 at NCBC Davisville considered life-cycle quantitative metrics for global warming potential (through greenhouse gas emissions), criteria air pollutant emissions (through NO_X, SO_X and PM_{10} emissions), energy consumption, water usage, and worker safety.

Life cycle impacts were calculated for energy consumption, emissions of GHG (carbon dioxide [CO_2], methane [CH_4], and nitrous oxide [N_2O]) and criteria pollutants (nitrogen oxides [NO_x], sulfur oxides [SO_x] and particulate matter [PM_{10}]), water usage, and energy consumption, and worker safety.

Life cycle inventory inputs in SiteWise™ were divided into four categories – 1) materials production; 2) transportation of personnel, materials and equipment; 3) equipment use and miscellaneous; and 4) residual handling and disposal. Cost estimates from the RI/FS and design calculations were used as a basis for inventory quantities and related assumptions. Emission factors, energy consumption, and water usage data were correlated to material quantities, equipment, transportation distances, and installation time frames in order to calculate life-cycle emissions, energy consumption, water usage, and worker safety. Default SiteWise™ emission, energy usage, water consumption, and worker fatality and accident risk factors were utilized.

Although GSRx was used to minimize limitations resulting within SiteWise™, elimination of all limitations was not possible while using a hybrid model of SiteWise™ and GSRx. For example, several materials and construction equipment inventoried were input into GSRx and these impacts were incorporated into SiteWise™ within the “Equipment Use and Miscellaneous” sector. This sector in SiteWise™ does not differentiate into the specific equipment usage or material consumption items that are input in GSRx, but rather are considered miscellaneous items. However, impact drivers for items input in GSRx can be identified and evaluated directly within the respective GSRx evaluation and output summary sheets. In addition, worker safety results in general do not include worker safety related to equipment usage that was input within GSRx because GSRx was not developed to evaluate worker safety.

EVALUATION RESULTS: GROUNDWATER

The following are the alternatives that were analyzed with SiteWise™ and GSRx for Site 16 NCBC Daviscille FS:

- Alternative G2: MNA and LUCs
- Alternative G3: In-Situ Chemical Oxidation, MNA and LUCs
- Alternative G3A: In-Situ Chemical Oxidation, MNA and LUCs
- Alternative G3B: In-Situ Chemical Oxidation Using Existing Injection Wells, MNA and LUCs
- Alternative G4: Enhanced Bioremediation, MNA and LUCs
- Alternative G5: Pump and Treat
- Alternative G6: Enhanced Bioremediation, MNA, LUCs (short treatment period)

The following sections summarize the relative environmental impacts and primary impact drivers for the proposed alternatives and their respective metrics. In addition, the attachment includes the inventory and output sheets that were used for the SiteWise™/GSRx hybrid model. An evaluation of SiteWise™ and GSRx output summary sheets and related figures included in the footprint evaluation attachments (Appendix C-2 and C-3), provides detailed information on the contribution to each metric from each phase of the remedial process (RI, RAC, RAO, and LTM) and for each respective input category (materials production, transportation, equipment usage, etc). Further inspection of related inventory sheets provide information on the specific contribution to a metric from each item of material, transportation, equipment, etc. This level of detail also helps clarify results that could be misinterpreted based on SiteWise™ data entry limitations mentioned previously. The environmental impacts of the alternatives analyzed are summarized quantitatively in Table C1.

Greenhouse Gas Emissions

Emissions of CO_2, CH_4, and N_2O were normalized to CO_2 equivalents (CO_2e), which is a cumulative method of weighing GHG emissions relative to global warming potential. Figure C1 shows the overall GHG emissions of each of the alternatives analyzed; the x-axis represents the seven alternatives evaluated and the y-axis represents the GHG emissions in metric tons of CO_2e.

The total amount of GHG emissions from Alternative G-2 is 150.32 metric tons of CO_2e. The main contributor the GHG emissions is the laboratory analytical services; the amount of emissions resulting from this activity is 145.06 metric tons of CO_2e, corresponding to approximately 97 percent of the total GHG emissions. Transportation of personnel is the activity with the second highest contribution to GHG emissions, 5.26 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to approximately 3 percent of the total GHG emissions.

The total amount of GHG emissions from Alternative G-3 is 1,176.71 metric tons of CO_2e. The main contributor the GHG emissions is the production of sodium permanganate, the amount of emissions resulting from this activity is 719.93 metric tons of CO_2e, corresponding to approximately 78.8 percent of

the total GHG emissions. The production of PVC is the activity with the second highest contribution to GHG emissions, where 65.01 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to 7.12 percent of the total GHG emissions. Laboratory analytical services is the activity with the third highest contribution to the CO_2e emissions, with 61.32 metric tons, corresponding to approximately 6.7 percent of the total emissions.

The total amount of GHG emissions from Alternative G-3A is 354.93 metric tons of CO_2e. The main contributor the GHG emissions is the laboratory analytical services, the amount of emissions resulting from this activity is 156.85 metric tons of CO_2e, corresponding to approximately 49 percent of the total GHG emissions. The production of potassium permanganate is the activity with the second highest contribution to GHG emissions, where 124.16 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to approximately 39 percent of the total GHG emissions. Transportation of personnel is the activity with the third highest contribution to the CO_2e emissions, with 11.22 metric tons, corresponding to approximately 3.5 percent of the total emissions.

The total amount of GHG emissions from Alternative G-3B is 253.64 metric tons of CO_2e. The main contributor the GHG emissions is the laboratory analytical services, the amount of emissions resulting from this activity is 156.85 metric tons of CO_2e, corresponding to approximately 62 percent of the total GHG emissions. The production of potassium permanganate is the activity with the second highest contribution to GHG emissions, where 85.24 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to approximately 34 percent of the total GHG emissions. Transportation of personnel is the activity with the third highest contribution to the CO_2e emissions, with 9.38 metric tons, corresponding to approximately four percent of the total emissions.

The total amount of GHG emissions from Alternative G-4 is 353.62 metric tons of CO_2e. The main contributor the GHG emissions is the laboratory analytical services; the amount of emissions resulting from this activity is 158.26 metric tons of CO_2e, corresponding to 45 percent of the total GHG emissions. The production of vegetable oil is the activity with the second highest contribution to GHG emissions, 100.36 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to 28 percent of the total GHG emissions. Production of PVC is the activity with the third highest contribution to the CO_2e emissions, with 35.65 metric tons, corresponding to approximately 10 percent of the total emissions.

The total amount of GHG emissions from Alternative G-5 is 198,232 metric tons of CO_2e. The main contributor the GHG emissions is the generation of electricity to run the treatment system during 30 years; the amount of emissions resulting from this activity is 195,045 metric tons of CO_2e, corresponding to 98 percent of the total GHG emissions. The production of granulated activated carbon is the activity with the second highest contribution to GHG emissions, 2,960 metric tons of CO_2e are released to the atmosphere

through the lifetime of the project, corresponding to 1.5 percent of the total GHG emissions. Transportation of personnel is the activity with the third highest contribution to the CO_2e emissions, with 87.58 metric tons, corresponding to less than one percent of the total emissions.

The total amount of GHG emissions from Alternative G-6 is 580.83 metric tons of CO_2e. The main contributor the GHG emissions is the production of vegetable oil; the amount of emissions resulting from this activity is 261.95 metric tons of CO_2e, corresponding to 51 percent of the total GHG emissions. Laboratory analytical services is the activity with the second highest contribution to GHG emissions, 101.54 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to 20 percent of the total GHG emissions. Production of PVC is the activity with the third highest contribution to the CO_2e emissions, with 85.5 metric tons, corresponding to approximately 17 percent of the total emissions.

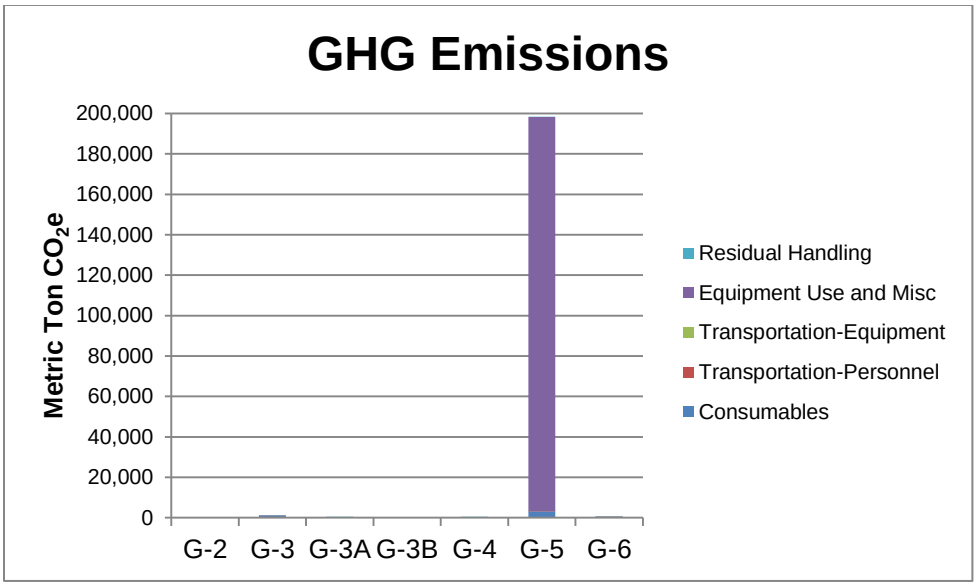


Figure C1: GHG Emissions for Groundwater Alternatives at Site 16, NCBC Davisville

Criteria Pollutant Emissions

NO_X

Figure C2 shows the breakdown of the NO_X emissions for the seven alternatives evaluated. The x–axis of this figure represents the proposed Alternatives; the y-axis represents the NO_X emissions in metric tons.

The total amount of NO_X emissions from Alternative G-2 is $5.04x10^{-1}$ metric tons. The activity with the highest contribution to NO_X emissions is the use of laboratory analytical services, emitting $5.02x10^{-1}$ metric tons of NO_X, corresponding to approximately 99 percent of the total NO_X emissions. Transportation of personnel emits $1.95x10^{-3}$ metric tons of NO_X, corresponding to less than one percent of the total emissions.

The total amount of NO_X emissions from Alternative G-3 is $5.49x10^{-1}$ metric tons. The activity with the highest contribution to NO_X emissions is the use of the DPT drill rig, emitting $3.23x10^{-1}$ metric tons of NO_X, corresponding to approximately 58.8 percent of the total NO_X emissions. The activity with the second highest contribution to these emissions is the laboratory analytical services which emits $2.12x10^{-1}$ metric tons of NO_X, corresponding to approximately 38.6 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the transportation of equipment and materials, emitting $5.66x10^{-3}$ metric tons of NO_X corresponding to approximately one percent of the total NO_X emissions.

The total amount of NO_X emissions from Alternative G-3A is $6.36x10^{-1}$ metric tons. The activity with the highest contribution to NO_X emissions is the laboratory analytical services, emitting $5.43x10^{-1}$ metric tons of NO_X, corresponding to approximately 85 percent of the total NO_X emissions. The activity with the second highest contribution to these emissions is the use of the DPT drill rig which emits $8.4x10^{-2}$ metric tons of NO_X, corresponding to approximately 13 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the transportation of personnel, emitting $4.15x10^{-3}$ metric tons of NO_X corresponding to less than one percent of the total NO_X emissions.

The total amount of NO_X emissions from Alternative G-3B is $5.47x10^{-1}$ metric tons. The activity with the highest contribution to NO_X emissions is the laboratory analytical services, emitting $5.43x10^{-1}$ metric tons of NO_X, corresponding to approximately 99 percent of the total NO_X emissions. The activity with the second highest contribution to these emissions is the transportation of personnel which emits $3.47x10^{-3}$ metric tons of NO_X, corresponding to approximately one percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the transportation of injection water, emitting $5.44x10^{-4}$ metric tons of NO_X corresponding to less than one percent of the total NO_X emissions.

The total amount of NO_X emissions from Alternative G-4 is $6.46x10^{-1}$ metric tons. The activity with the highest contribution to NO_X emissions is the use of laboratory analytical services, emitting $5.48x10^{-1}$ metric tons of NO_X, corresponding to approximately 85 percent of the total NO_X emissions. The use of the DPT drilling rig emits $8.02x10^{-2}$ metric tons of NO_X, corresponding to approximately 12 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the transportation of personnel, emitting $7.80x10^{-3}$ metric tons of NO_X corresponding to 1.2 percent of the total NO_X emissions.

The total amount of NO_X emissions from Alternative G-5 is $1.74x10^2$ metric tons. The activity with the highest contribution to NO_X emissions is the generation of electricity during the 30 years of operations, emitting $.60x10^2$ metric tons of NO_X, corresponding to approximately 92 percent of the total NO_X emissions. The production of granular activated carbon emits $1.4x10^1$ metric tons of NO_X, corresponding to approximately 8 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the laboratory analytical services, emitting $2018x10^{-1}$ metric tons of NO_X corresponding to less than one percent of the total NO_X emissions.

The total amount of NO_X emissions from Alternative G-6 is $5.38x10^{-1}$ metric tons. The activity with the highest contribution to NO_X emissions is the use of laboratory analytical services, emitting $3.51x10^{-1}$ metric tons of NO_X, corresponding to approximately 65 percent of the total NO_X emissions. The use of the DPT drilling rig emits $1.42x10^{-1}$ metric tons of NO_X, corresponding to approximately 26 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the generation of electricity for the treatment stage, emitting $1.35x10^{-2}$ metric tons of NO_X corresponding to 2.4 percent of the total NO_X emissions.

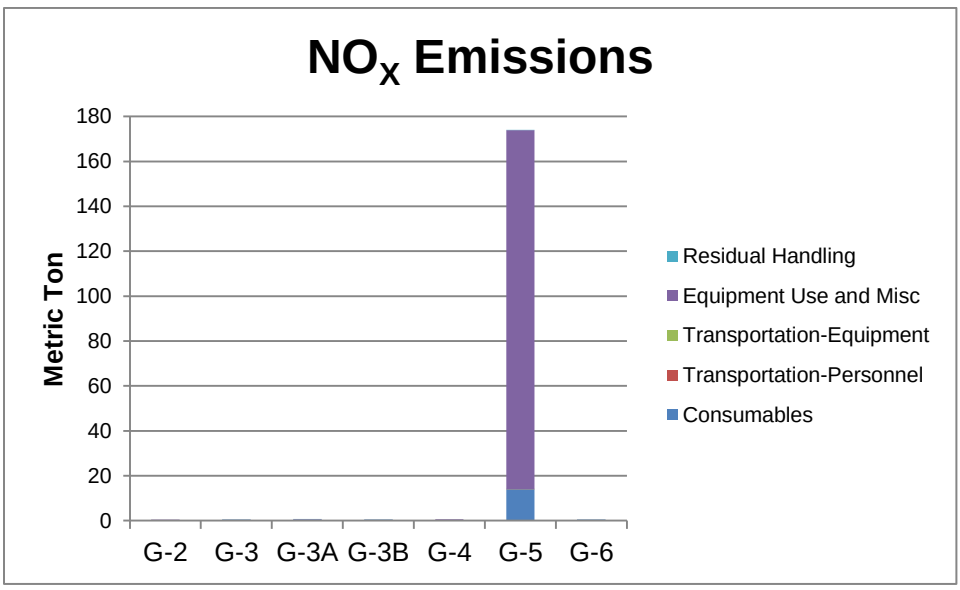


Figure C2 NO_X Emissions for Groundwater Alternatives at Site 16, NCBC Davisville

SO_X

Figure C3 contains the distribution of the SO_X emissions resulting from the activities related to the proposed Alternatives. The x-axis of this graph represents the alternatives evaluated; the y-axis represents the SO_X emissions in metric tons.

The total amount of SO_X emissions from Alternative G-2 is 3.35×10^{-1} metric tons. The activity with the highest contribution to SO_X emissions is the laboratory analytical services, emitting 3.35×10^{-1} metric tons of SO_X, corresponding to approximately 99.98 percent of the total SO_X emissions. Transportation of personnel emits 6.85×10^{-5} metric tons of SO_X, corresponding to approximately to less than 1 percent of the total emissions.

The total amount of SO_X emissions from Alternative G-3 is 8.47×10^{-1} metric tons. The activity with the highest contribution to SO_X emissions is the laboratory analytical services, emitting 1.42×10^{-1} metric tons of SO_X, corresponding to approximately 39 percent of the total SO_X emissions. Manufacture of PVC emits 1.27×10^{-1} metric tons of SO_X, corresponding to approximately 35 percent of the total emissions. The activity with the third highest contribution to SO_X emissions is the production of sodium permanganate, emitting 7.02×10^{-2} metric tons of SO_X corresponding to approximately 19 percent of the total SO_X emissions.

The total amount of SO_X emissions from Alternative G-3A is 4.72×10^{-1} metric tons. The activity with the highest contribution to SO_X emissions is the laboratory analytical services, emitting 3.62×10^{-1} metric tons of SO_X, corresponding to approximately 89 percent of the total SO_X emissions. Manufacture of PVC emits 1.93×10^{-2} metric tons of SO_X, corresponding to approximately 5 percent of the total emissions. The activity with the third highest contribution to SO_X emissions is the production of sodium permanganate, emitting 1.22×10^{-2} metric tons of SO_X corresponding to approximately 3 percent of the total SO_X emissions.

The total amount of SO_X emissions from Alternative G-3B is 3.71×10^{-1} metric tons. The activity with the highest contribution to SO_X emissions is the laboratory analytical services, emitting 3.62×10^{-1} metric tons of SO_X, corresponding to approximately 98 percent of the total SO_X emissions. The activity with the second highest contribution to SO_X emissions is the production of sodium permanganate, emitting 8.34×10^{-3} metric tons of SO_X corresponding to approximately two percent of the total SO_X emissions. Transportation of personnel emits 1.22×10^{-4} metric tons of SO_X, corresponding to less than one percent of the total emissions.

The total amount of SO_X emissions from Alternative G-4 is $5.52x10^{-1}$ metric tons. The activity with the highest contribution to SO_X emissions is the laboratory analytical services, emitting $3.65x10^{-1}$ metric tons of SO_X, corresponding to approximately 66 percent of the total SO_X emissions. Manufacture of vegetable oil used during the treatment stage emits $9.98x10^{-2}$ metric tons of SO_X, corresponding to approximately 18 percent of the total emissions. The activity with the third highest contribution to SOX emissions is the production of PVC, emitting $6.96x10^{-2}$ metric tons of SO_X corresponding to approximately 12 percent of the total SO_X emissions.

The total amount of SO_X emissions from Alternative G-5 is $4.38x10^{2}$ metric tons. The activity with the highest contribution to SO_X emissions is the generation of electricity used during the operation of the treatment system, emitting $4.36x10^{2}$ metric tons of SO_X, corresponding to approximately 99 percent of the total SO_X emissions. Manufacture of granular activated carbon used during the treatment stage emits $1.36x10^{0}$ metric tons of SO_X, corresponding to less than one percent of the total emissions. The activity with the third highest contribution to SOX emissions is the laboratory analytical services, emitting $1.39x10^{-1}$ metric tons of SO_X corresponding to less than once percent of the total SO_X emissions.

The total amount of SO_X emissions from Alternative G-6 is $7.1x10^{-1}$ metric tons. The activity with the highest contribution to SO_X emissions is the production of vegetable oil, emitting $2.60x10^{-1}$ metric tons of SO_X, corresponding to approximately 37 percent of the total SO_X emissions. Laboratory analytical services emits $2.34x10^{-1}$ metric tons of SO_X, corresponding to approximately 33 percent of the total emissions. The activity with the third highest contribution to SOX emissions is the production of PVC, emitting $1.67x10^{-1}$ metric tons of SO_X corresponding to approximately 23 percent of the total SO_X emissions.

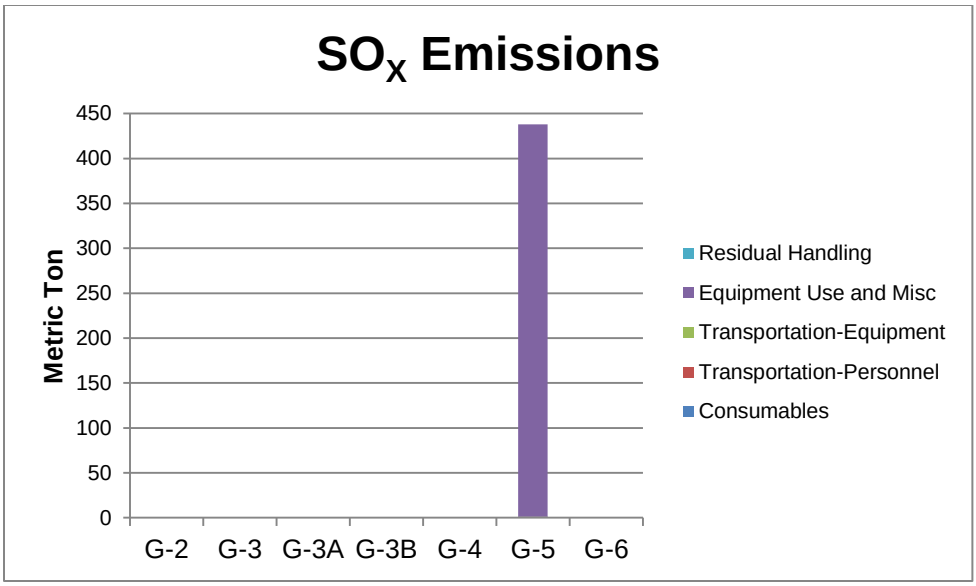


Figure C3: SO_X Emissions for Groundwater Alternatives at Site 16, NCBC Davisville

PM_{10}

The breakdown of the distribution of the PM_{10} emissions resulting from the activities involved in the groundwater Alternatives are shown in Figure C4. The x-axis of this figure represents the seven alternatives evaluated, while the y-axis represents the PM_{10} emissions in metric tons.

The total PM_{10}emissions resulting from Alternative G-2 is 1.31×10^{-2} metric tons. The activity with the highest contribution to these emissions is the analytical laboratory services emitting 1.27×10^{-2} metric ton of PM_{10}, approximately 97 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the transportation of personnel; this activity contributes with approximately 3 percent of the total PM_{10} emissions, approximately 3.95×10^{-4} metric tons of PM_{10}.

The total PM_{10}emissions resulting from Alternative G-3 is 1.32×10^{-1} metric tons. The activity with the highest contribution to these emissions is the use of the DPT drill rig, emitting 3.22×10^{-2} metric ton of PM_{10}, approximately 55 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the production of PVC; this activity contributes with approximately 32 percent of the total PM_{10} emissions, approximately 1.83×10^{-2} metric tons of PM_{10}. Laboratory analytical services is the activity with the third highest contribution, approximately 9 percent of the total PM_{10} emissions (5.83×10^{-3} metric tons of PM_{10}).

The total PM_{10}emissions resulting from Alternative G-3A is $3.60x10^{-2}$ metric tons. The activity with the highest contribution to these emissions is the laboratory analytical services, emitting $1.38x10^{-2}$ metric ton of PM_{10}, approximately 52 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the use of the DPT drill rig; this activity contributes with approximately 32 percent of the total PM_{10} emissions, approximately $8.37x10^{-3}$ metric tons of PM_{10}. Production of PVC is the activity with the third highest contribution, approximately 11 percent of the total PM_{10} emissions ($2.79x10^{-3}$ metric tons of PM_{10}).

The total PM_{10}emissions resulting from Alternative G-3B is $1.45x10^{-2}$ metric tons. The activity with the highest contribution to these emissions is the laboratory analytical services, emitting $1.38x10^{-2}$ metric ton of PM_{10}, approximately 95 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the use of the transportation of personnel; this activity contributes with approximately five percent of the total PM_{10} emissions, $7.04x10^{-4}$ metric tons of PM_{10}. Transportation of injection water is the activity with the third highest contribution, less than one percent of the total PM_{10} emissions ($4.84x10^{-5}$ metric tons of PM_{10}).

The total PM_{10}emissions resulting from Alternative G-4 is $3.52x10^{-2}$ metric tons. The activity with the highest contribution to these emissions is laboratory analytical services, emitting $1.39x10^{-2}$ metric ton of PM_{10}, approximately 39 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the production of PVC; this activity contributes with 28 percent of the total PM_{10} emissions, approximately $1x10^{-2}$ metric tons of PM_{10}. The use of the DPT drill rig is the activity with the third highest contribution, approximately 23 percent of the total PM_{10} emissions ($7.98x10^{-3}$ metric tons of PM_{10}).

The total PM_{10}emissions resulting from Alternative G-5 is $3.72x10^{-2}$ metric tons. The activity with the highest contribution to these emissions is the production of PVC, emitting $1.63x10^{-2}$ metric ton of PM_{10}, approximately 44 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the transportation of personnel; this activity contributes with 18 percent of the total PM_{10} emissions, approximately $6.57x10^{-3}$ metric tons of PM_{10}. Laboratory analytical services is the activity with the third highest contribution, approximately 14 percent of the total PM_{10} emissions ($5.27x10^{-3}$ metric tons of PM_{10}).

The total PM_{10}emissions resulting from Alternative G-6 is $3.72x10^{-2}$ metric tons. The activity with the highest contribution to these emissions is the production of PVC, emitting $2.41x10^{-2}$ metric ton of PM_{10}, approximately 45 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the use of the DPT drill rig; this activity contributes with approximately 27 percent of the total PM_{10} emissions, $1.41x10^{-2}$ metric tons of PM_{10}. Laboratory analytical services is the activity with the third highest contribution, approximately 16 percent of the total PM_{10} emissions ($8.90x10^{-3}$ metric tons of PM_{10}).

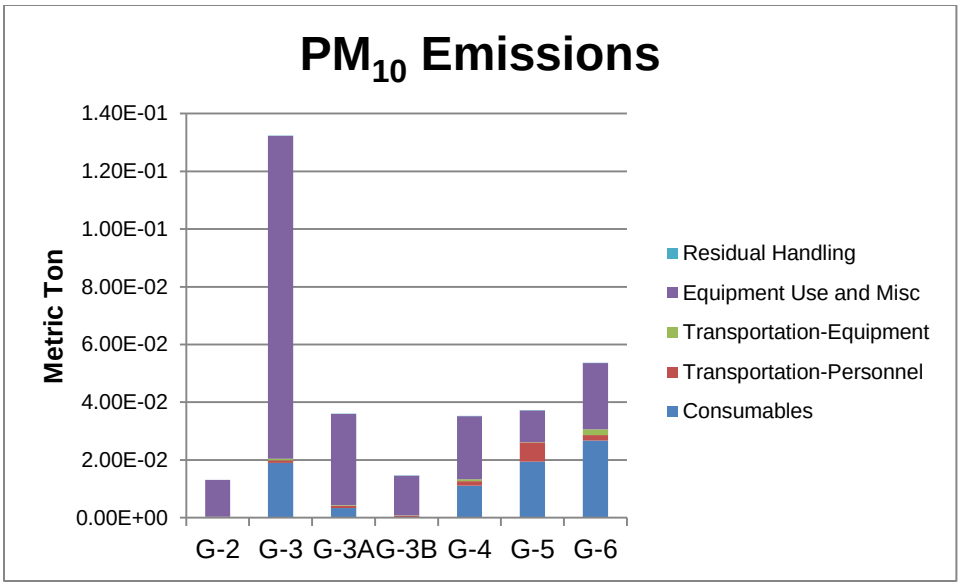


Figure C4: PM_{10} Emissions for Groundwater Alternatives at Site 16, NCBC Davisville

Energy Consumption

The energy consumption for each of the alternatives evaluated is shown in Figure C5. The x-axis shows the proposed alternatives evaluated, and the y-axis shows the amount of energy consumed in million British Thermal Units (MMBTU).

The total amount of energy consumed by Alternative G-2 is 2,164.80 MMBTU. The activity with the highest energy consumption is the laboratory analytical services, utilizing 2,164.8 MMBTU, corresponding to approximately 97 percent of the total energy consumption. The activity with the second highest energy use is the transportation of personnel, consuming 66.15 MMBTU, approximately 3 percent of the total energy consumption of this alternative.

The total amount of energy consumed by Alternative G-3 is 25,313 MMBTU. The activity with the highest energy consumption is the production of PVC, utilizing 4,070 MMBTU, corresponding to approximately 46 percent of the total energy consumption. The activity with the second highest energy use is the production of sodium permanganate, consuming 2,506 MMBTU, approximately 28 percent of the total energy consumption of this alternative. The third highest energy consumption corresponds to laboratory analytical services, where 915 MMBTUs are consumed, approximately 10 percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative G-3A is 6,043 MMBTU. The activity with the highest energy consumption is the laboratory analytical services, utilizing 2,340 MMBTU, corresponding to approximately 60 percent of the total energy consumption. The activity with the second highest energy use is the production of PVC, consuming 620 MMBTU, approximately 16 percent of the total energy consumption of this alternative. The third highest energy consumption corresponds to production of sodium permanganate, where 423 MMBTUs are consumed, approximately 11 percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative G-3B is 2,784 MMBTU. The activity with the highest energy consumption is the laboratory analytical services, utilizing 2,340 MMBTU, corresponding to approximately 84 percent of the total energy consumption. The activity with the second highest energy use is the production of potassium permanganate, consuming 297 MMBTU, approximately 11 percent of the total energy consumption of this alternative. The third highest energy consumption corresponds to transportation of personnel, where 118 MMBTUs are consumed, approximately four percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative G-4 is 17,423 MMBTU. The activity with the highest energy consumption is the production of vegetable oil, utilizing 11,912 MMBTU, corresponding to approximately 68 percent of the total energy consumption. The activity with the second highest energy use is laboratory analytical services, consuming 2,361 MMBTU, approximately 14 percent of the total energy consumption of this alternative. The third highest energy consumption corresponds to the production of PVC, where 2,231 MMBTUs are consumed, approximately 13 percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative G-5 is 4,247,670 MMBTU. The activity with the highest energy consumption is the generation of electricity that is used during the treatment, utilizing 4,214,915 MMBTU, corresponding to approximately 99 percent of the total energy consumption. The activity with the second highest energy use is production of granular activated carbon, consuming 26,772 MMBTU, less than one percent of the total energy consumption of this alternative. The third highest energy consumption corresponds to the production of PVC, where 3,623 MMBTUs are consumed, less than one percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative G-6 is 40,055 MMBTU. The activity with the highest energy consumption is the production of vegetable oil, utilizing 31,094 MMBTU, corresponding to approximately 78 percent of the total energy consumption. The activity with the second highest energy use is production of PVC, consuming 5,352 MMBTU, approximately 13 percent of the total energy consumption of this alternative. The third highest energy consumption corresponds to the laboratory

analytical services, where 1,516 MMBTUs are consumed, approximately 4 percent of the total energy used during this alternative.

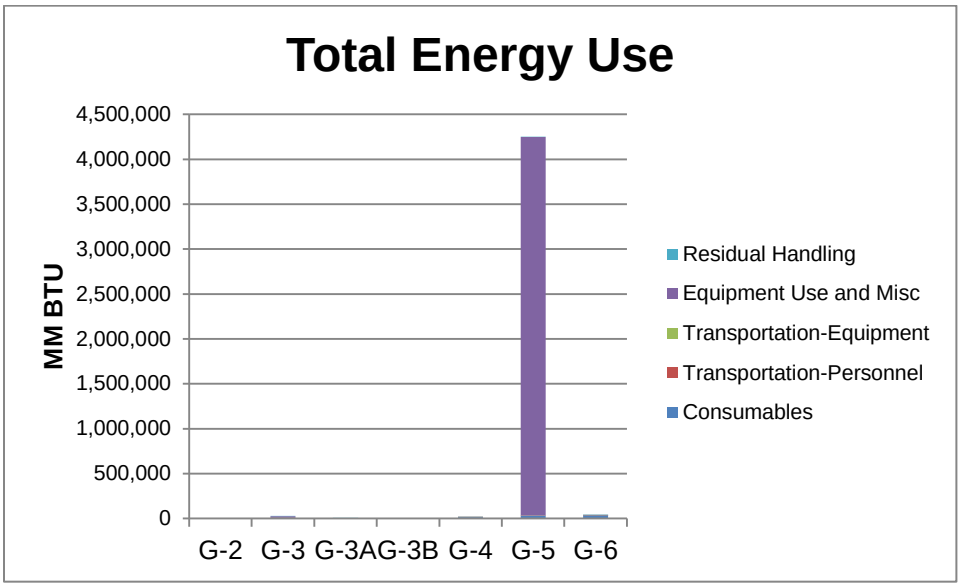


Figure C5: Energy Consumption for Groundwater Alternatives at Site 16, NCBC Davisville

Water Usage

The water consumption of the evaluated alternatives is shown in Figure C6. The x-axis shows the evaluated alternatives, and the y-axis show the amount of water consumed in thousands of gallons.

There is no direct water consumption for Alternative G-2 through the activities evaluated.

The total water consumption for Alternative G-3 is 449.433 thousand gallons of water. The amount of water used for injection during the treatment is approximately 69 percent of the total amount of water consumed. The water consumed during the production of sodium permanganate represents 19 percent of the total water used. The water consumed during the production of PVC corresponds to 11 percent of the total amount of water consumed during this alternative.

The total water consumption for Alternative G-3A is 426.312 thousand gallons of water. The amount of water used for injection during the treatment is approximately 82 percent of the total amount of water consumed. The water consumed during the production of sodium permanganate represents 12 percent

of the total water used. The water consumed during the production of PVC corresponds to 5 percent of the total amount of water consumed during this alternative.

The total water consumption for Alternative G-3B is 140.2 thousand gallons of water. The amount of water used for injection (104 thousand gallons of water) during the treatment is approximately 74 percent of the total amount of water consumed. The water consumed during the production of sodium permanganate (34.2 thousand gallons of water) represents 24 percent of the total water used. The water consumed during the decontamination activities (2 thousand gallons of water) corresponds to approximately one percent of the total amount of water consumed during this alternative.

The total water consumption for Alternative G-4 is 1.684 million gallons of water. Injection water corresponds to the highest consumption of water, with 78 percent of the total amount of water used during this alternative. Water consumption during the production of vegetable oil has the second highest water consumption, approximately 17 percent of the total amount of water. The production of PVC is the activity with the third highest water consumption with approximately 3 percent of the total amount of water utilized.

The total water consumption for Alternative G-5 is 208.429 million gallons of water. Generation of electricity consumes the highest amount of water for this alternative, 99 percent of the total amount of water used during this alternative. Water used during the operation of the treatment system has the second highest water consumption, approximately 0.1 percent of the total amount of water. The production of granular activated carbon is the activity with the third highest water consumption with approximately 0.1 percent of the total amount of water utilized.

The total water consumption for Alternative G-6 is 4.94 million gallons of water. Injection water corresponds to the highest consumption of water, with 80 percent of the total amount of water used during this alternative. Water consumption during the production of vegetable oil has the second highest water consumption, approximately 16 percent of the total amount of water. The production of PVC is the activity with the third highest water consumption with approximately 3 percent of the total amount of water utilized.

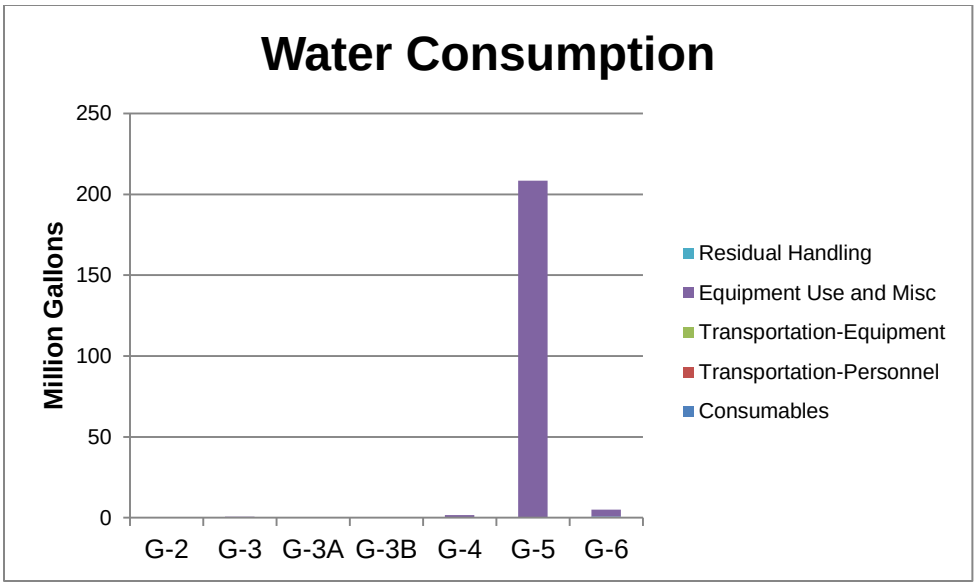


Figure C6: Water Consumption for Groundwater Alternatives at Site 16, NCBC Davisville

Accident Risk

Accident risk is calculated for activities such as driving and operation of heavy equipment. The risk for driving is calculated with the number of miles driven, and the risk for operation of heavy equipment is calculated with the number of hours that a worker was operating a piece of heavy equipment. The risk presented below is not intended to be compared to exposure risk or cancer risk.

Accident Risk Fatality

Figure C7 shows the risk of fatality between the evaluated alternatives. The x-axis represents the seven alternatives evaluated, and the y-axis represents the risk of fatality.

For all Alternatives, the activity with the highest risk of fatality is the transportation of personnel.

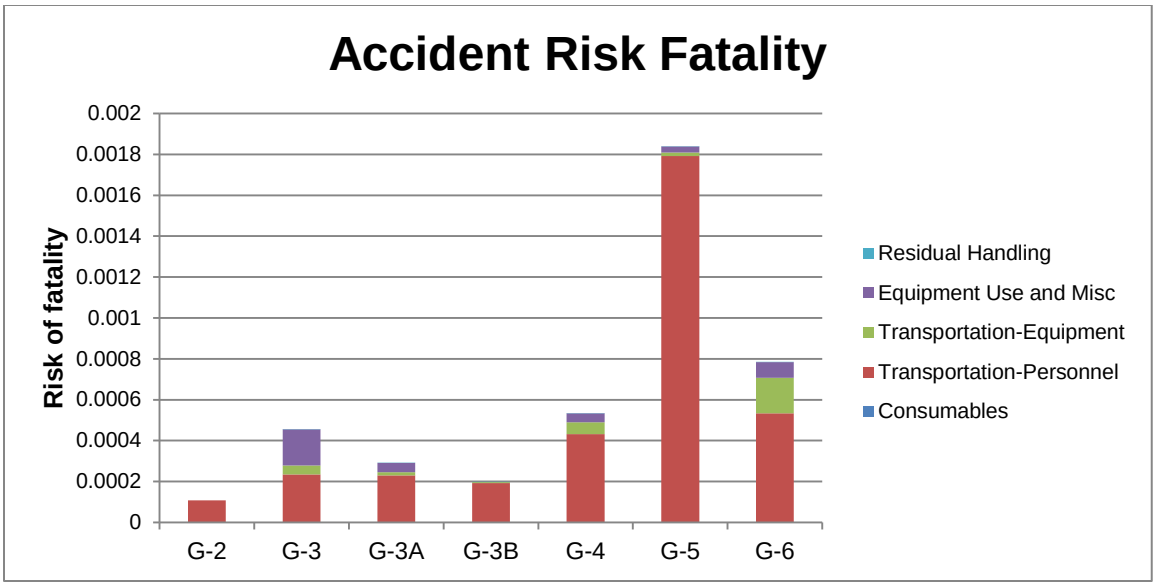


Figure C7 Risk of Fatality for Groundwater Alternatives at Site 16, NCBC Davisville

Accident Risk Injury

Figure C8 shows the risk of injury between the evaluated alternatives. The x-axis represents the seven alternatives evaluated, and the y-axis represents the risk of injury.

For all Alternatives except Alternative G-3, the activity with the highest risk of injury is the transportation of personnel. For Alternative G-3 the activity with the highest risk of injury is the equipment use.

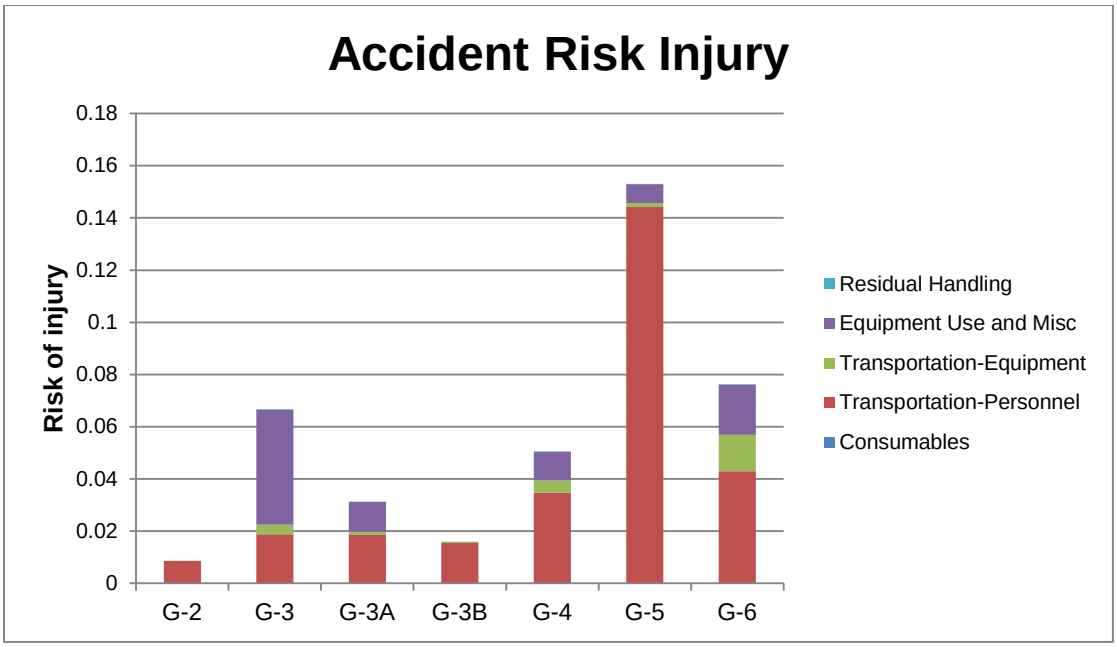


Figure C8 Risk of Injury for Groundwater Alternatives at Site 16, NCBC Davisville

CONCLUSIONS AND RECOMMENDATIONS

During selection and design of the remedy, a sensitivity analysis considering elements of the remedy that have the greatest impact on remedy effectiveness, life-cycle cost, and environmental footprint metrics may provide additional insight into appropriate optimization. To aid in the sensitivity analysis, an impact analysis summary was created to qualitatively highlight the relative impact of respective metrics for the two alternatives and to identify the primary drivers of emissions, energy consumption, and water usage for each alternative (see Table C2 for details).

Measures identified in the evaluation that may reduce the environmental footprint of the alternatives are listed below for consideration.

- All Alternatives: Some reduction of the environmental footprint, particularly GHG emissions and energy consumption, could be realized for all alternatives through the possible use of emission control measures such as alternate fuel sources (e.g. biodiesel), equipment exhaust controls (e.g. diesel), and equipment idle reduction.
- All Alternatives: Consider optimizing of the use of equipment, particularly the use of the DPT drill rig, and even the type of equipment used during operations.

- All Alternatives: Consider the optimization of the use of EOS during the treatment stage. The environmental impact of this chemical has an influence in most of the impact categories evaluated.
- All Alternatives: Design an optimized sampling schedule that minimizes the number of samples that need to be analyzed and maximizes the results, for this alternative laboratory analytical services are the main driver for most of the impact categories evaluated.
- All Alternatives: Optimize the number of samples analyzed during the operation and monitoring stages given that the laboratory analytical services is one of the major drivers in some of the impact categories.
- All Alternatives: Consider ways to reduce vehicle mileage to reduce worker risk as well as energy use and emissions. Encourage site workers to carpool daily to the site to reduce total vehicle mileage.
- All Alternatives: Consider the optimization of the use of injection water. The amount of water used during the treatment stage is high.
- Alternative G-5: Consider optimization on the amount of energy used during the 30 year lifetime of the Alternative. Consider alternative sources of energy (such as solar if possible) to reduce the load of generating electricity through the grid.
- Alternative G-5: Consider the use of using a certain amount of regenerated GAC instead of virgin GAC during the replacement of the fill of the chambers during the treatment.

EVALUATION RESULTS: SOIL

The following are the alternatives that were analyzed with SiteWise™ and GSRx for Site 16 NCBC Daviscille FS:

- Alternative S2: Soil Cover and/or Cap, Selected Excavation and Disposal, Monitoring, and LUCs
- Alternative S3: Excavation and Disposal and LUCs
- Alternative S3A: Selected Excavation and Disposal and LUCs
- Alternative S4: Soil, Cover, Selected Excavation and Disposal and LUCs
- Alternative S5: Excavation and Disposal – Unrestricted Site Use
- Alternative S6: Soil Cover, Selected Excavation and Disposal, Monitoring and LUCs

The following sections summarize the relative environmental impacts and primary impact drivers for the proposed alternatives and their respective metrics. In addition, the attachment includes the inventory and output sheets that were used for the SiteWise™/GSRx hybrid model. An evaluation of SiteWise™ and GSRx output summary sheets and related figures included in the footprint evaluation attachments (Appendix C-2 and C-3), provides detailed information on the contribution to each metric from each phase of the remedial process (RI, RAC, RAO, and LTM) and for each respective input category (materials

production, transportation, equipment usage, etc). Further inspection of related inventory sheets provide information on the specific contribution to a metric from each item of material, transportation, equipment, etc. This level of detail also helps clarify results that could be misinterpreted based on SiteWise™ data entry limitations mentioned previously. The environmental impacts of the alternatives analyzed are summarized quantitatively in Table C3.

Greenhouse Gas Emissions

Emissions of CO_2, CH_4, and N_2O were normalized to CO_2 equivalents (CO_2e), which is a cumulative method of weighing GHG emissions relative to global warming potential. Figure C9 shows the overall GHG emissions of each of the alternatives analyzed; the x-axis represents the six alternatives evaluated and the y-axis represents the GHG emissions in metric tons of CO_2e.

The total amount of GHG emissions from Alternative S-2 is 325.43 metric ton of CO_2e. The main contributor the GHG emissions is the production of borrow soil; the amount of emissions resulting from this activity is 152.71 metric tons of CO_2e, corresponding to approximately 47 percent of the total GHG emissions. The use of the dozer is the activity with the second highest contribution to GHG emissions, 46.29 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to approximately 14 percent of the total GHG emissions. Transportation of materials is the activity with the third highest contribution to GHG emissions, where 28.87 metric ton of CO_2e are released to the atmosphere, corresponding to approximately nine percent of the total GHG emissions for Alternative S-2.

The total amount of GHG emissions from Alternative S-3 is 772.81 metric tons of CO_2e. The main contributor the GHG emissions is the production of borrow soil, the amount of emissions resulting from this activity is 369.25 metric tons of CO_2e, corresponding to approximately 48 percent of the total GHG emissions. The disposal of non-hazardous materials is the activity with the second highest contribution to GHG emissions, where 128.23 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to 17 percent of the total GHG emissions. Transportation of materials is the activity with the third highest contribution to the CO_2e emissions, with 70 metric tons, corresponding to approximately nine percent of the total emissions.

The total amount of GHG emissions from Alternative S-3A is 255.73 metric tons of CO_2e. The main contributor the GHG emissions is the production of borrow soil, the amount of emissions resulting from this activity is 101.67 metric tons of CO_2e, corresponding to approximately 40 percent of the total GHG emissions. The disposal of non-hazardous materials is the activity with the second highest contribution to GHG emissions, where 34.84 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to 14 percent of the total GHG emissions. The use of the dozer is the activity

with the third highest contribution to the CO_2e emissions, with 29 metric tons, corresponding to 11 percent of the total emissions.

The total amount of GHG emissions from Alternative S-4 is 999.59 metric tons of CO_2e. The main contributor the GHG emissions is the production of borrow soil, the amount of emissions resulting from this activity is 561.39 metric tons of CO_2e, corresponding to 56 percent of the total GHG emissions. The transportation of non-hazardous wastes is the activity with the second highest contribution to GHG emissions, 108.06 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to 11 percent of the total GHG emissions. Transportation of materials is the activity with the third highest contribution to the CO_2e emissions, with 106.21 metric tons, corresponding to 11 percent of the total emissions.

The total amount of GHG emissions from Alternative S-5 is 4,546.72 metric tons of CO_2e. The main contributor the GHG emissions is the production of borrow soil, the amount of emissions resulting from this activity is 2,579.76 metric tons of CO_2e, corresponding to 57 percent of the total GHG emissions. The transportation of non-hazardous wastes is the activity with the second highest contribution to GHG emissions, 960.96 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to 21 percent of the total GHG emissions. Transportation of materials is the activity with the third highest contribution to the CO_2e emissions, with 487.22 metric tons, corresponding to 11 percent of the total emissions.

The total amount of GHG emissions from Alternative S-6 is 803.04 metric tons of CO_2e. The main contributor the GHG emissions is the production of borrow soil, the amount of emissions resulting from this activity is 548.87 metric tons of CO_2e, corresponding to 68 percent of the total GHG emissions. The transportation of materials is the activity with the second highest contribution to GHG emissions, 103.92 metric tons of CO_2e are released to the atmosphere through the lifetime of the project, corresponding to 13 percent of the total GHG emissions. The use of the dozer is the activity with the third highest contribution to the CO_2e emissions, with 46.29 metric tons, corresponding to approximately six percent of the total emissions.

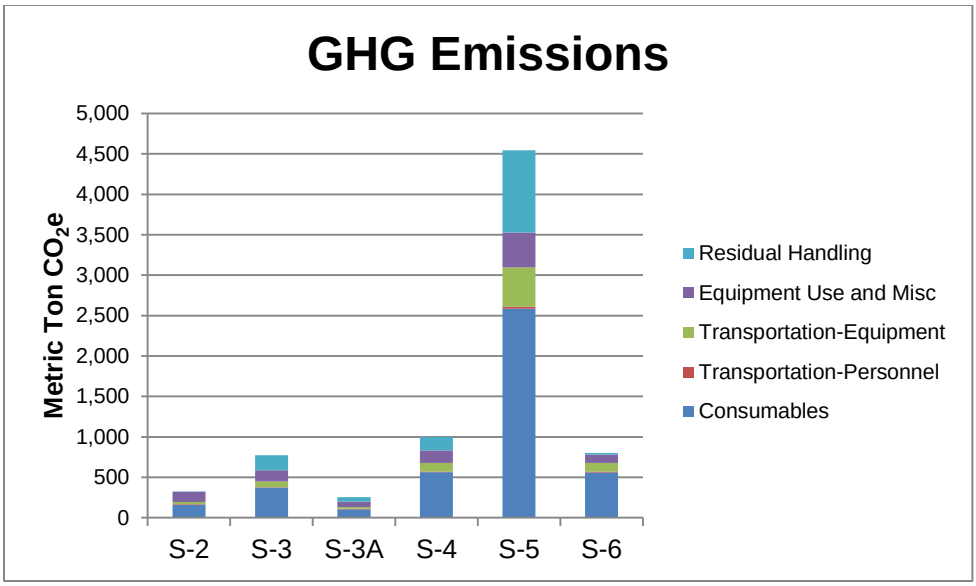


Figure C9: GHG Emissions for Soil Alternatives at Site 16, NCBC Davisville

Criteria Pollutant Emissions

NO_X

Figure C10 shows the breakdown of the NO_X emissions for the six alternatives evaluated. The x–axis of this figure represents the proposed Alternatives; the y-axis represents the NO_X emissions in metric tons.

The total amount of NO_X emissions from Alternative S-2 is 8.06×10^{-1} metric tons. The activity with the highest contribution to NO_X emissions is the use of the dozer, emitting 3.37×10^{-1} metric tons of NO_X, corresponding to approximately 42 percent of the total NO_X emissions. The use of the excavator emits 1.76×10^{-1} metric tons of NO_X, corresponding to 22 percent of the total emissions. The activity with the third highest contribution to NO_X is the use of the compactor, where 1.64×10^{-1} metric ton of NO_X are emitted, corresponding to 20 percent of the total NO_X emissions for this Alternative.

The total amount of NO_X emissions from Alternative S-3 is 1.00 metric ton. The activity with the highest contribution to NO_X emissions is the use of the dozer, emitting 4.63×10^{-1} metric tons of NO_X, corresponding to 46 percent of the total NO_X emissions. The activity with the second highest contribution to these emissions is the use of the excavator, which emits 2.15×10^{-1} metric tons of NO_X, corresponding to 21 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the use of the compactor, emitting 2.00×10^{-1} metric tons of NO_X corresponding to 20 percent of the total NO_X emissions.

The total amount of NO_X emissions from Alternative S-3A is 4.69×10^{-1} metric ton. The activity with the highest contribution to NO_X emissions is the use of the dozer, emitting 2.01×10^{-1} metric tons of NO_X, corresponding to 45 percent of the total NO_X emissions. The activity with the second highest contribution to these emissions is the use of the excavator, which emits 9.75×10^{-2} metric tons of NO_X, corresponding to 21 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the use of the compactor, emitting 9.09×10^{-2} metric tons of NO_X corresponding to 19 percent of the total NO_X emissions.

The total amount of NO_X emissions from Alternative S-4 is 1.15 metric ton. The activity with the highest contribution to NO_X emissions is the use of the dozer, emitting 5.47×10^{-1} metric tons of NO_X, corresponding to 47 percent of the total NO_X emissions. The activity with the second highest contribution to these emissions is the use of the excavator, which emits 2.54×10^{-1} metric tons of NO_X, corresponding to 22 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the use of the compactor, emitting 2.36×10^{-1} metric tons of NO_X corresponding to 20 percent of the total NO_X emissions.

The total amount of NO_X emissions from Alternative S-5 is 3.05 metric ton. The activity with the highest contribution to NO_X emissions is the use of the dozer, emitting 1.46 metric tons of NO_X, corresponding to 54 percent of the total NO_X emissions. The activity with the second highest contribution to these emissions is the use of the excavator, which emits 7.61×10^{-1} metric tons of NO_X, corresponding to 25 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the transportation of non-hazardous waste, emitting 3.02×10^{-1} metric tons of NO_X corresponding approximately to ten percent of the total NO_X emissions.

The total amount of NO_X emissions from Alternative S-6 is 6.59×10^{-1} metric tons. The activity with the highest contribution to NO_X emissions is the use of the dozer, emitting 3.37×10^{-1} metric tons of NO_X, corresponding to approximately 51 percent of the total NO_X emissions. The use of the excavator emits 2.15×10^{-1} metric tons of NO_X, corresponding to approximately 33 percent of the total emissions. The activity with the third highest contribution to NO_X emissions is the transportation of materials, emitting 3.27×10^{-2} metric tons of NO_X corresponding to approximately five percent of the total NO_X emissions.

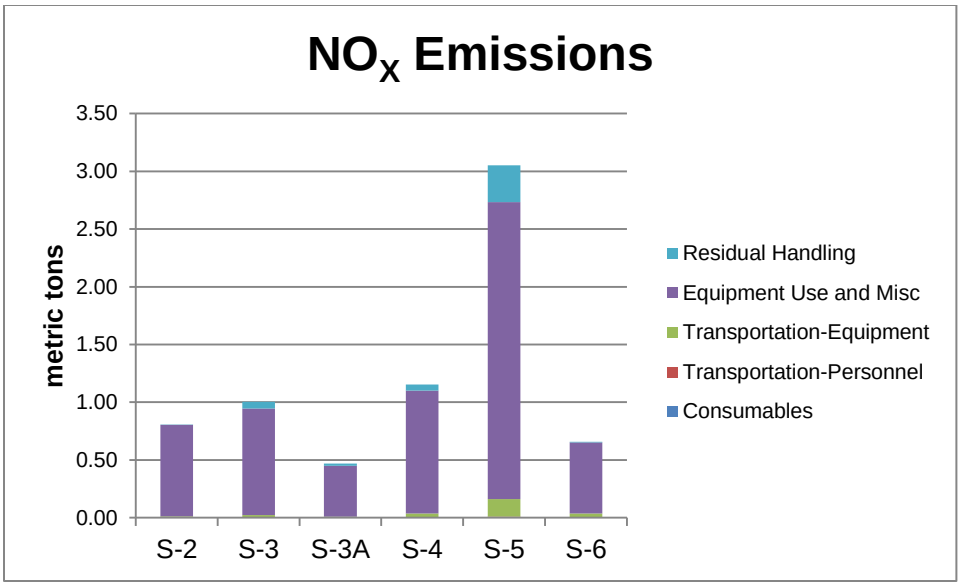


Figure C10 NO_X Emissions for Soil Alternatives at Site 16, NCBC Davisville

SO_X

Figure C11 contains the distribution of the SO_X emissions resulting from the activities related to the proposed Alternatives. The x-axis of this graph represents the alternatives evaluated; the y-axis represents the SO_X emissions in metric tons.

The total amount of SO_X emissions from Alternative S-2 is 2.51×10^{-1} metric tons. The activity with the highest contribution to SO_X emissions is the use of the dozer, emitting 8.54×10^{-2} metric tons of SO_X, corresponding to 34 percent of the total SO_X emissions. Laboratory analytical services is the activity with the second highest contribution to SO_X emissions, were 5.69×10^{-2} metric ton are emitted, corresponding to 23 percent of the total SO_X emissions. The use of the excavator, emitting 5.18×10^{-2} metric tons of SO_X corresponding to approximately to 21 percent of the total emissions is the activity with the third highest contribution to SO_X emissions.

The total amount of SO_X emissions from Alternative S-3 is 2.58×10^{-1} metric tons. The activity with the highest contribution to SO_X emissions is the use of the dozer, emitting 1.17×10^{-1} metric tons of SO_X, corresponding to 46 percent of the total SO_X emissions. The use of the excavator is the activity with the second highest contribution to these emissions, where it emits 6.33×10^{-2} metric tons of SO_X, corresponding to approximately 25 percent of the total emissions. The activity with the third highest contribution to SO_X emissions is the use of the compactor, emitting 4.89×10^{-2} metric tons of SO_X corresponding to 25 percent of the total SO_X emissions.

The total amount of SO_X emissions from Alternative S-3A is $1.32x10^{-1}$ metric tons. The activity with the highest contribution to SO_X emissions is the use of the dozer, emitting $5.34x10^{-2}$ metric tons of SO_X, corresponding to 40 percent of the total SO_X emissions. The use of the excavator is the activity with the second highest contribution to these emissions, where it emits $2.88x10^{-2}$ metric tons of SO_X, corresponding to 22 percent of the total emissions. The activity with the third highest contribution to SO_X emissions is the use of the compactor, emitting $2.22x10^{-2}$ metric tons of SO_X corresponding to 17 percent of the total SO_X emissions.

The total amount of SO_X emissions from Alternative S-4 is $2.83x10^{-1}$ metric tons. The activity with the highest contribution to SO_X emissions is the use of the dozer, emitting $1.39x10^{-1}$ metric tons of SO_X, corresponding to 49 percent of the total SO_X emissions. The use of the excavator is the activity with the second highest contribution to these emissions, where it emits $7.48x10^{-2}$ metric tons of SO_X, corresponding to 26 percent of the total emissions. The activity with the third highest contribution to SO_X emissions is the use of the compactor, emitting $5.78x10^{-2}$ metric tons of SO_X corresponding to 20 percent of the total SO_X emissions.

The total amount of SO_X emissions from Alternative S-5 is $7.36x10^{-1}$ metric tons. The activity with the highest contribution to SO_X emissions is the use of the dozer, emitting $4.16x10^{-1}$ metric tons of SO_X, corresponding to 57 percent of the total SO_X emissions. The use of the excavator is the activity with the second highest contribution to these emissions, where it emits $2.24x10^{-1}$ metric tons of SO_X, corresponding to 30 percent of the total emissions. The activity with the third highest contribution to SO_X emissions is the laboratory and analytical services, emitting $7.24x10^{-2}$ metric tons of SO_X corresponding to approximately ten percent of the total SO_X emissions.

The total amount of SO_X emissions from Alternative S-6 is $1.88x10^{-1}$ metric tons. The activity with the highest contribution to SO_X emissions is the use of the dozer, emitting $8.54x10^{-2}$ metric tons of SO_X, corresponding to 46 percent of the total SO_X emissions. The use of the excavator is the activity with the second highest contribution to these emissions, where it emits $6.33x10^{-2}$ metric tons of SO_X, corresponding to 34 percent of the total emissions. The activity with the third highest contribution to SO_X emissions is the production of HDPE, emitting $1.66x10^{-2}$ metric tons of SO_X corresponding to approximately nine percent of the total SO_X emissions.

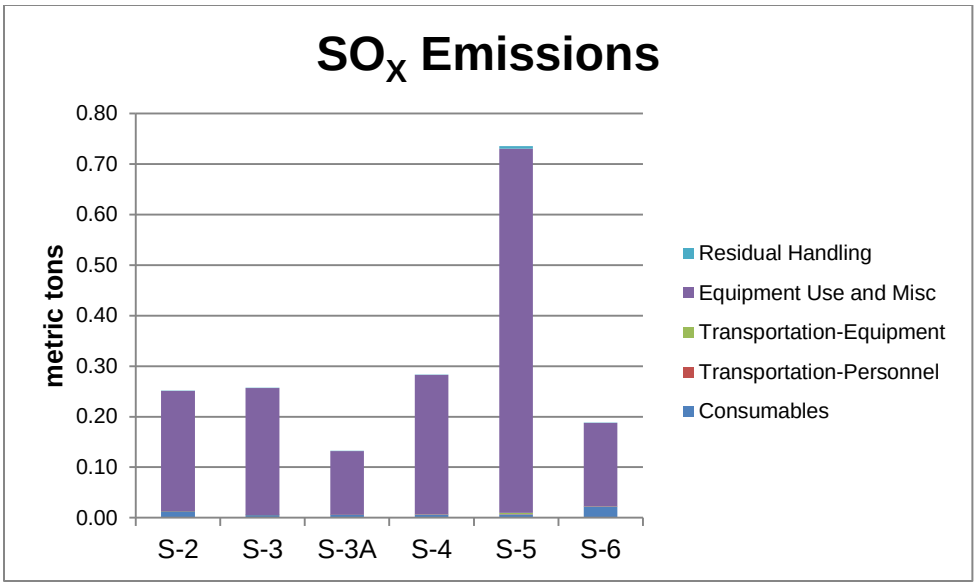


Figure C11: SO_X Emissions for Soil Alternatives at Site 16, NCBC Davisville

PM_{10}

The breakdown of the distribution of the PM_{10} emissions resulting from the activities involved in the proposed Alternatives are shown in Figure C12. The x-axis of this figure represents the six alternatives evaluated, while the y-axis represents the PM_{10} emissions in metric tons.

The total PM_{10} emissions resulting from Alternative S-2 is 6.84×10^{-2} metric tons. The activity with the highest contribution to these emissions is the use of the dozer, emitting 2.79×10^{-2} metric ton of PM_{10}, approximately 41 percent of the total PM_{10} emissions. The use of the excavator emits 1.67×10^{-2} metric tons of PM_{10}, corresponding to 24 percent of the total emissions. The activity with the third highest contribution to PM_{10} is the use of the compactor, where 1.32×10^{-2} metric ton of PM_{10} are emitted, corresponding to 19 percent of the total PM_{10} emissions for this Alternative.

The total PM_{10} emissions resulting from Alternative S-3 is 1.68×10^{-1} metric tons. The activity with the highest contribution to these emissions is the production of asphalt, emitting 8.17×10^{-2} metric ton of PM_{10}, 49 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the use of the dozer; this activity contributes with 23 percent of the total PM_{10} emissions, approximately 3.83×10^{-2} metric tons of PM_{10}. The use of the excavator is the activity with the third highest contribution, contributing with 12 percent of the total PM_{10} emissions (2.04×10^{-2} metric tons of PM_{10}).

The total PM_{10} emissions resulting from Alternative S-3A is $1.22x10^{-1}$ metric tons. The activity with the highest contribution to these emissions is the production of asphalt, emitting $8.17x10^{-2}$ metric ton of PM_{10}, 67 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the use of the dozer; this activity contributes with 14 percent of the total PM_{10} emissions, approximately $1.74x10^{-2}$ metric tons of PM_{10}. The use of the excavator is the activity with the third highest contribution, contributing with approximately eight percent of the total PM_{10} emissions ($9.27x10^{-3}$ metric tons of PM_{10}).

The total PM_{10} emissions resulting from Alternative S-4 is $1.83x10^{-1}$ metric tons. The activity with the highest contribution to these emissions is the production of asphalt, emitting $8.17x10^{-2}$ metric ton of PM_{10}, 44 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the use of the dozer; this activity contributes with 25 percent of the total PM_{10} emissions, approximately $4.53x10^{-2}$ metric tons of PM_{10}. The use of the excavator is the activity with the third highest contribution, contributing with 13 percent of the total PM_{10} emissions ($2.41x10^{-2}$ metric tons of PM_{10}).

The total PM_{10} emissions resulting from Alternative S-5 is $3.94x10^{-1}$ metric tons. The activity with the highest contribution to these emissions is the use of the dozer, emitting $1.36x10^{-1}$ metric ton of PM_{10}, 35 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the production of asphalt; this activity contributes with 21 percent of the total PM_{10} emissions, approximately $8.17x10^{-2}$ metric tons of PM_{10}. The use of the excavator is the activity with the third highest contribution, contributing with 18 percent of the total PM_{10} emissions ($7.23x10^{-2}$ metric tons of PM_{10}).

The total PM_{10} emissions resulting from Alternative S-6 is $1.60x10^{-1}$ metric tons. The activity with the highest contribution to these emissions is the production of asphalt, emitting $8.17x10^{-2}$ metric ton of PM_{10}, 51 percent of the total PM_{10} emissions. The activity with the second highest PM_{10} release is the use of the dozer; this activity contributes with 17 percent of the total PM_{10} emissions, approximately $2.79x10^{-2}$ metric tons of PM_{10}. The use of the excavator is the activity with the third highest contribution, contributing with 13 percent of the total PM_{10} emissions ($2.04x10^{-2}$ metric tons of PM_{10}).

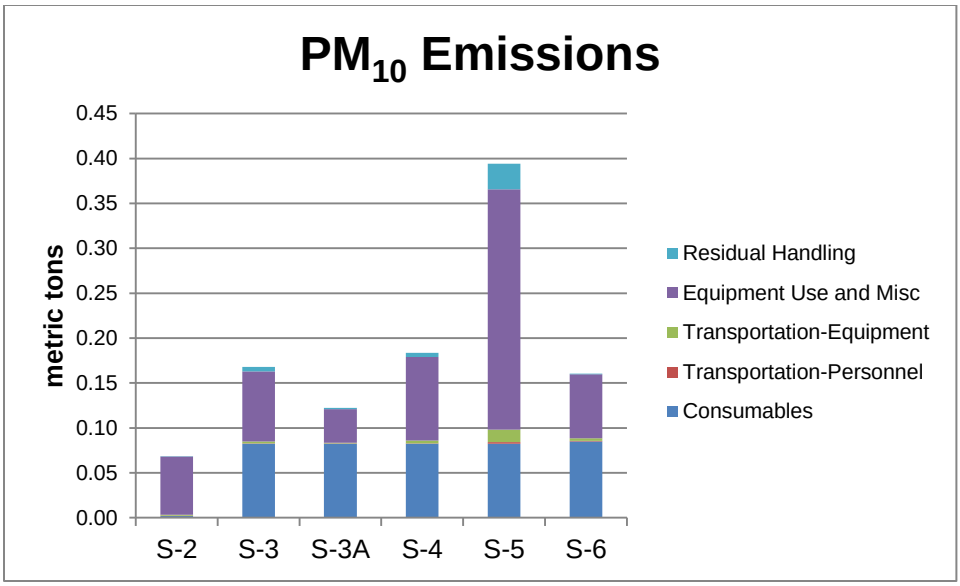


Figure C12: PM_{10} Emissions for Soil Alternatives at Site 16, NCBC Davisville

Energy Consumption

The energy consumption for each of the alternatives evaluated is shown in Figure C13. The x-axis shows the proposed alternatives evaluated, and the y-axis shows the amount of energy consumed in million British Thermal Units (MMBTU).

The total amount of energy consumed by Alternative S-2 is 16,426 MMBTU. The activity with the highest energy consumption is the production of borrow soil, utilizing 13,769 MMBTU, corresponding to 84 percent of the total energy consumption. The activity with the second highest energy use is the use of the dozer, consuming 768 MMBTU, approximately five percent of the total energy consumption of this alternative. The use of the excavator consumes 432 MMBTU, is the activity with the third highest energy consumption, corresponding to approximately three percent of the total energy consumption for this Alternative.

The total amount of energy consumed by Alternative S-3 is 38,953 MMBTU. The activity with the highest energy consumption is the production of borrow soil, utilizing 33,294 MMBTU, corresponding to 85 percent of the total energy consumption. The activity with the second highest energy use is the transportation of non-hazardous waste, consuming 1,674 MMBTU, approximately four percent of the total energy consumption of this alternative. The third highest energy consumption activity corresponds to the use of the dozer, where 1,057 MMBTUs are consumed, approximately three percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative S-3A is 11,446 MMBTU. The activity with the highest energy consumption is the production of borrow soil, utilizing 9,167 MMBTU, corresponding to 80 percent of the total energy consumption. The second highest energy consumption activity corresponds to the use of the dozer, where 480. MMBTUs are consumed, approximately four percent of the total energy used during this alternative. The activity with the third highest energy use is the transportation of non-hazardous waste, consuming 455 MMBTU, approximately four percent of the total energy consumption of this alternative.

The total amount of energy consumed by Alternative S-4 is 56,793 MMBTU. The activity with the highest energy consumption is the production of borrow soil, utilizing 50,618 MMBTU, corresponding to approximately 89 percent of the total energy consumption. The activity with the second highest energy use is the transportation of non-hazardous waste, consuming 1,410 MMBTU, approximately two percent of the total energy consumption of this alternative. The third highest energy consumption corresponds to the use of the dozer, where 1,386 MMBTUs are consumed, approximately two percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative S-5 is 259,037 MMBTU. The activity with the highest energy consumption is the production of borrow soil, utilizing 232,606 MMBTU, corresponding to 90 percent of the total energy consumption. The activity with the second highest energy use is the transportation of non-hazardous waste, consuming 12,542 MMBTU, approximately five percent of the total energy consumption of this alternative. The third highest energy consumption corresponds to the transportation of materials, where 6,359 MMBTUs are consumed, approximately two percent of the total energy used during this alternative.

The total amount of energy consumed by Alternative S-6 is 53,199 MMBTU. The activity with the highest energy consumption is the production of borrow soil, utilizing 49,490 MMBTU, corresponding to 93 percent of the total energy consumption. The activity with the second highest energy use is transportation of materials, consuming 1,356 MMBTU, approximately three percent of the total energy consumption of this alternative. The third highest energy consumption corresponds to the use of the dozer, where 769 MMBTUs are consumed, approximately one percent of the total energy used during this alternative.

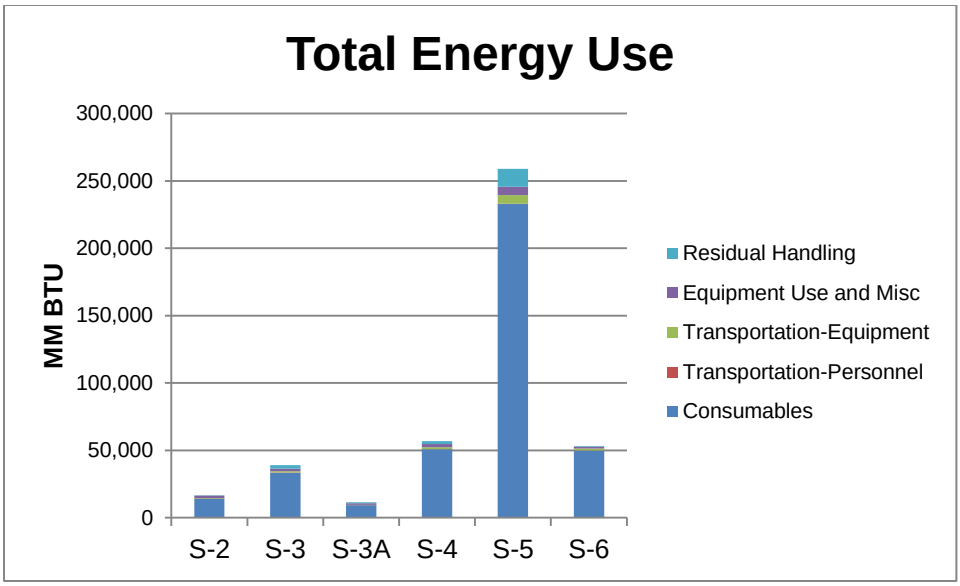


Figure C13: Energy Consumption for Soil Alternatives at Site 16, NCBC Davisville

Water Usage

The water consumption of the evaluated alternatives is shown in Figure C14. The x-axis shows the evaluated alternatives, and the y-axis show the amount of water consumed in thousands of gallons.

The total amount of water consumed by Alterative S-2 is 5.6 thousand gallons of water. Decontamination water (three thousand gallons) is the activity with the highest water consumption, corresponding to 53 percent of the total water usage for this Alternative. The production of PVC consumes 1.7 thousand gallons of water, corresponding to 31 percent of the total water usage. The production of HDPE is the activity with the third highest water consumption, 651 gallons of water, corresponding to 12 percent of the total water use for Alternative S-2.

The total water consumption for Alternative S-3 is 5.01 thousand gallons of water. The amount of water used for decontamination activities is 80 percent of the total amount of water consumed (four thousand gallons were used for these activities). The water consumed during the production of PVC represents 14 percent of the total water used. The water consumed during the production of HDPE corresponds to approximately five percent of the total amount of water consumed during this alternative.

The total water consumption for Alternative S-3A is 4.36 thousand gallons of water. The amount of water used for decontamination activities is 69 percent of the total amount of water consumed (three thousand gallons were used for these activities). The water consumed during the production of PVC represents 24

percent of the total water used. The water consumed during the production of HDPE corresponds to approximately six percent of the total amount of water consumed during this alternative.

The total water consumption for Alternative S-4 is 4.43 thousand gallons of water. The amount of water used for decontamination activities is 68 percent of the total amount of water consumed (three thousand gallons were used for these activities). The water consumed during the production of PVC represents 24 percent of the total water used. The water consumed during the production of HDPE corresponds to approximately six percent of the total amount of water consumed during this alternative.

The total water consumption for Alternative S-5 is 11.1 thousand gallons of water. The amount of water used for decontamination activities is 81 percent of the total amount of water consumed (nine thousand gallons were used for these activities). The water consumed during the production of PVC represents 14 percent of the total water used. The water consumed during the production of fertilizer corresponds to approximately three percent of the total amount of water consumed during this alternative.

The total water consumption for Alternative S-6 is 8.01 thousand gallons of water. The amount of water used for decontamination activities is 50 percent of the total amount of water consumed (four thousand gallons were used for these activities). The water consumed during the production of PVC represents 30 percent of the total water used. The water consumed during the production of HDPE corresponds to 15 percent of the total amount of water consumed during this alternative.

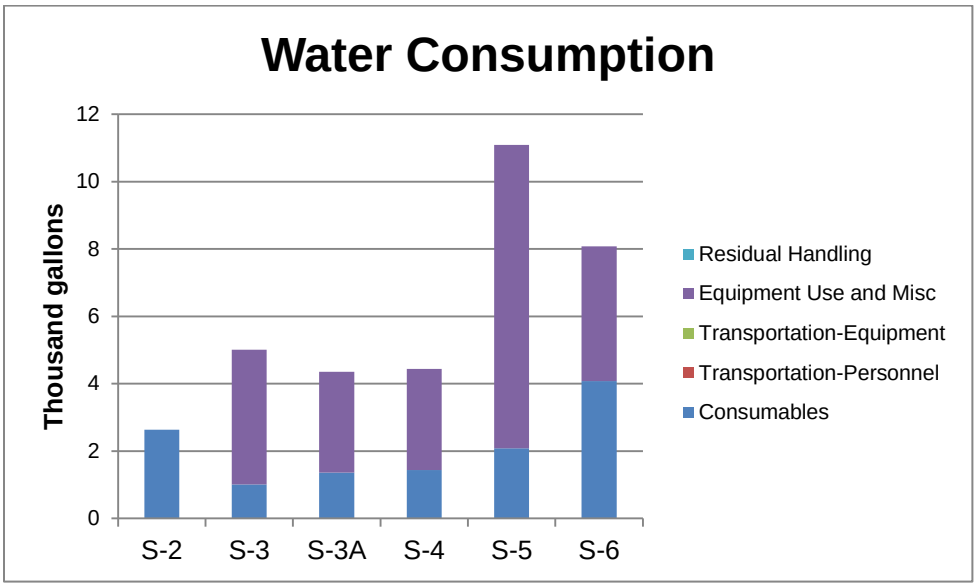


Figure C14: Water Consumption for Soil Alternatives at Site 16, NCBC Davisville

Accident Risk

Accident risk is calculated for activities such as driving and operation of heavy equipment. The risk for driving is calculated with the number of miles driven, and the risk for operation of heavy equipment is calculated with the number of hours that a worker was operating a piece of heavy equipment. The risk presented below is not intended to be compared to exposure risk or cancer risk.

Accident Risk Fatality

Figure C15 shows the risk of fatality between the evaluated alternatives. The x-axis represents the six alternatives evaluated, and the y-axis represents the risk of fatality.

For Alternatives S-3, S-3A, S-4 and S-5, the activity with the highest risk to result in a fatality is the residual handling operations. For Alternative S-2, the activity with the highest risk of fatality is transportation of personnel. For Alternative S-6, the activity with the highest risk of fatality is transportation of equipment and materials.

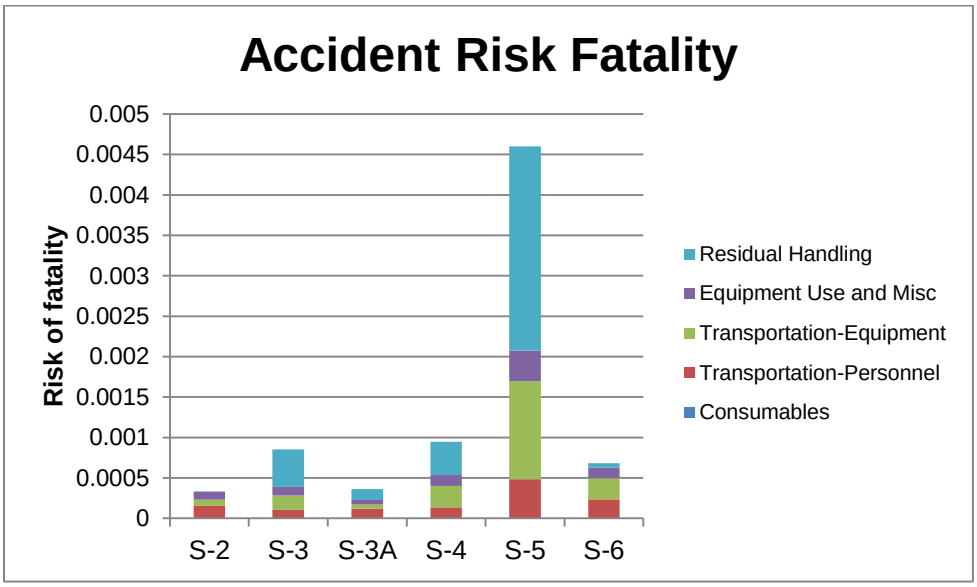


Figure C15 Risk of Fatality for Soil Alternatives at Site 16, NCBC Davisville

Accident Risk Injury

Figure C16 shows the risk of injury between the evaluated alternatives. The x-axis represents the six alternatives evaluated, and the y-axis represents the risk of injury.

For Alternatives S-3, S-4 and S-5, the activity with the highest risk of injury is the residual handling operations. For Alternatives S-2, S-3A and S-6, the activity with the highest risk of injury is the equipment use.

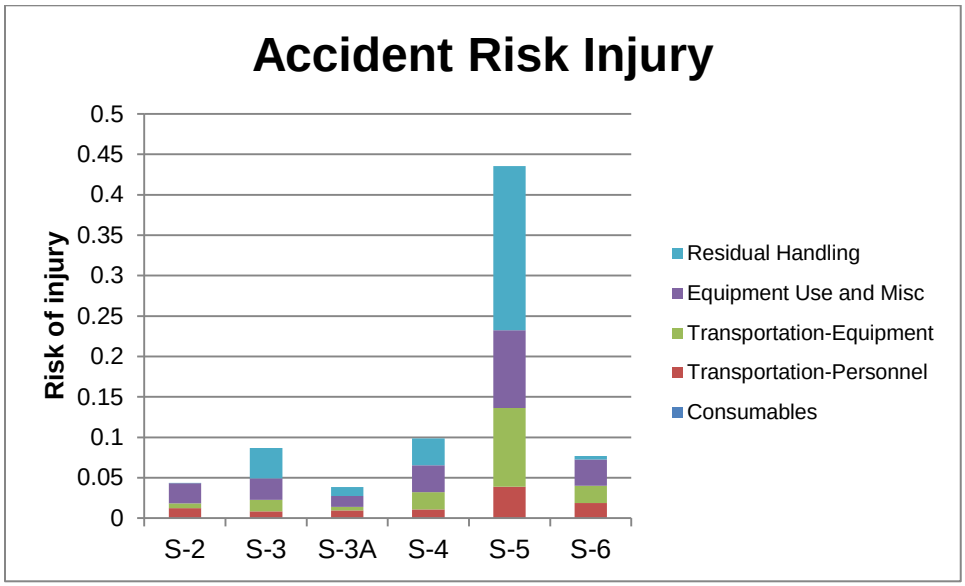


Figure C16 Risk of Injury for Soil Alternatives at Site 16, NCBC Davisville

CONCLUSIONS AND RECOMMENDATIONS

During selection and design of the remedy, a sensitivity analysis considering elements of the remedy that have the greatest impact on remedy effectiveness, life-cycle cost, and environmental footprint metrics may provide additional insight into appropriate optimization. To aid in the sensitivity analysis, an impact analysis summary was created to qualitatively highlight the relative impact of respective metrics for the two alternatives and to identify the primary drivers of emissions, energy consumption, and water usage for each alternative (see Table C4 for details).

Measures identified in the evaluation that may reduce the environmental footprint of the alternatives are listed below for consideration.

- All Alternatives: Some reduction of the environmental footprint, particularly GHG emissions and energy consumption, could be realized for all alternatives through the possible use of emission control measures such as alternate fuel sources (e.g. biodiesel), equipment exhaust controls (e.g. diesel), and equipment idle reduction.

- All Alternatives: Consider optimizing of the use of equipment, particularly the use of the dozer, compactor and excavator, and even the type of equipment used during operations.
- All Alternatives: Consider the optimization of the amount of borrow soil needed.
- All Alternatives: Design an optimized sampling schedule that minimizes the number of samples that need to be analyzed and maximizes the results, for this alternative laboratory analytical services are the main driver for most of the impact categories evaluated.
- All Alternatives: Optimize the number of samples analyzed during the operation and monitoring stages given that the laboratory analytical services is one of the major drivers in some of the impact categories.
- All Alternatives: Consider ways to reduce vehicle mileage to reduce worker risk as well as energy use and emissions. Encourage site workers to carpool daily to the site to reduce total vehicle mileage.

REFERENCES

(a) NAVFAC, DON Guidance for Optimizing Remedy Evaluation, Selection, and Design, March 2010
(b) NAVFAC, DON Policy on SiteWise™ Optimization/GSR Tool Usage, email received from Brian Harrison/NAVFAC HQ dated 10 AUG 2010

Table C1
Environmental Impact Results
Site 16, NCBC Davisville
Davisville, Rhode Island

Alternative	Activities	GHG Emissions	Total Energy Used	Water Impacts	NOx Emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		Metric Ton CO_2e	MMBTU	Gallons	Metric Ton	Metric Ton	Metric Ton		
G-2	Materials Production	0.00	0.00	0.00	0.00E+00	0.00E+00	0.00E+00	NA	NA
	Transportation-Personnel	5.26	66.15	NA	1.95E-03	6.85E-05	3.95E-04	1.08E-04	8.66E-03
	Transportation-Equipment	0.00	0.00	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Equipment Use and Misc	145.06	2,164.80	0.00	5.02E-01	3.35E-01	1.27E-02	0.00E+00	0.00E+00
	Residual Handling	0.00	0.00	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Total	150.32	2,230.95	0.00	5.04E-01	3.35E-01	1.31E-02	1.08E-04	8.66E-03
G-3	Materials Production	786.51	6,608.19	444,468.62	1.76E-04	2.01E-01	1.90E-02	NA	NA
	Transportation-Personnel	11.43	143.81	NA	4.23E-03	1.49E-04	8.58E-04	2.34E-04	1.88E-02
	Transportation-Equipment	18.17	237.09	NA	5.71E-03	1.01E-04	5.08E-04	4.50E-05	3.62E-03
	Equipment Use and Misc	360.42	18,322.38	4,965.29	5.39E-01	6.73E-01	1.12E-01	1.76E-04	4.42E-02
	Residual Handling	0.18	2.38	NA	5.74E-05	1.02E-06	5.11E-06	7.80E-07	6.28E-05
	Total	1,176.71	25,313.86	449,433.90	5.49E-01	8.74E-01	1.32E-01	4.55E-04	6.67E-02
G-3A	Materials Production	135.63	1,083.80	71,004.32	3.04E-05	3.50E-02	3.34E-03	NA	NA
	Transportation-Personnel	11.22	141.17	NA	4.15E-03	1.46E-04	8.42E-04	2.30E-04	1.85E-02
	Transportation-Equipment	6.00	82.05	NA	1.93E-03	7.67E-05	1.57E-04	1.53E-05	1.23E-03
	Equipment Use and Misc	201.76	4,732.10	355,308.67	6.30E-01	4.37E-01	3.16E-02	4.58E-05	1.15E-02
	Residual Handling	0.31	4.10	NA	9.86E-05	1.74E-06	8.77E-06	1.56E-06	1.26E-04
	Total	354.93	6,043.22	426,312.99	6.36E-01	4.72E-01	3.60E-02	2.92E-04	3.13E-02
G-3B	Materials Production	85.24	296.82	34,172.37	2.09E-05	8.34E-03	2.50E-05	NA	NA
	Transportation-Personnel	9.38	117.92	NA	3.47E-03	1.22E-04	7.04E-04	1.92E-04	1.54E-02
	Transportation-Equipment	1.98	25.83	NA	6.22E-04	1.10E-05	5.53E-05	5.46E-06	4.39E-04
	Equipment Use and Misc	156.88	2,341.42	106,030.42	5.43E-01	3.62E-01	1.38E-02	0.00E+00	0.00E+00
	Residual Handling	0.16	2.07	NA	5.00E-05	8.84E-07	4.44E-06	7.80E-07	6.28E-05
	Total	253.64	2,784.07	140,202.79	5.47E-01	3.71E-01	1.45E-02	1.98E-04	1.59E-02
G-4	Materials Production	139.15	14,207.53	349,760.82	0.00E+00	1.76E-01	1.11E-02	NA	NA
	Transportation-Personnel	21.08	265.09	NA	7.80E-03	2.75E-04	1.58E-03	4.31E-04	3.47E-02
	Transportation-Equipment	23.64	308.57	NA	7.43E-03	1.31E-04	6.61E-04	5.85E-05	4.71E-03
	Equipment Use and Misc	169.55	2,639.43	1,334,894.34	6.31E-01	3.75E-01	2.19E-02	4.36E-05	1.10E-02
	Residual Handling	0.20	2.58	NA	6.21E-05	1.10E-06	5.52E-06	7.80E-07	6.28E-05
	Total	353.62	17,423.19	1,684,655.16	6.46E-01	5.52E-01	3.52E-02	5.34E-04	5.05E-02
G-5	Materials Production	3,027.92	30,592.48	229,653.12	1.40E+01	1.49E+00	1.95E-02	NA	NA
	Transportation-Personnel	87.58	1,101.58	NA	3.24E-02	1.14E-03	6.57E-03	1.79E-03	1.44E-01
	Transportation-Equipment	6.94	90.56	NA	2.18E-03	3.86E-05	1.94E-04	1.74E-05	1.40E-03
	Equipment Use and Misc	195,109.94	4,215,883.65	208,199,949.05	1.60E+02	4.36E+02	1.10E-02	2.87E-05	7.22E-03
	Residual Handling	0.18	2.38	NA	5.74E-05	1.02E-06	5.11E-06	7.80E-07	6.28E-05
	Total	198,232.56	4,247,670.64	208,429,602.17	1.74E+02	4.38E+02	3.72E-02	1.84E-03	1.53E-01
G-6	Materials Production	353.65	36,601.27	920,532.92	2.56E-07	4.36E-01	2.67E-02	NA	NA
	Transportation-Personnel	26.11	328.36	NA	9.66E-03	3.40E-04	1.96E-03	5.34E-04	4.30E-02
	Transportation-Equipment	69.64	908.93	NA	2.19E-02	3.87E-04	1.95E-03	1.72E-04	1.39E-02
	Equipment Use and Misc	131.00	2,211.45	4,029,037.75	5.06E-01	2.73E-01	2.30E-02	7.70E-05	1.93E-02
	Residual Handling	0.43	5.61	NA	1.35E-04	2.39E-06	1.20E-05	1.56E-06	1.26E-04
	Total	580.83	40,055.62	4,949,570.67	5.38E-01	7.10E-01	5.36E-02	7.85E-04	7.64E-02

Table C2
Environmental Impact Analysis
Site 16, NCBC Davisville
Davisville, Rhode Island

	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
G-2	Low	Low	Low	Low	Low	Low	Low	Low
	Laboratory analytical services	Laboratory analytical services	Laboratory analytical services	Laboratory analytical services	Laboratory analytical services	Laboratory analytical services	Transportation of personnel	Transportation of personnel
G-3	Low	Low	Low	Low	Low	High	Low to moderate	Moderarte
	Production of sodium permanganate	Production of PVC	Injection water	DPT Drill Rig	Laboratory analytical services	DPT Drill Rig	Transportation of personnel	Equipment use
G-3A	Low	Low	Low	Low	Low	Low to moderate	Low	Low
	Laboratory analytical services	Laboratory analytical services	Injection water	Laboratory analytical services	Laboratory analytical services	Laboratory analytical services	Transportation of personnel	Transportation of personnel
G-3B	Low	Low	Low	Low	Low	Low	Low	Low
	Laboratory analytical services	Laboratory analytical services	Injection water	Laboratory analytical services	Laboratory analytical services	Laboratory analytical services	Transportation of personnel	Transportation of personnel
G-4	Low	Low	Low	Low	Low	Low to moderate	Low to moderate	Low to moderate
	Laboratory analytical services	Production of Vegetable oil	Injection water	Laboratory analytical services	Laboratory analytical services	Laboratory analytical services	Transportation of personnel	Transportation of personnel
G-5	High	High	High	High	High	Low to moderate	High	High
	Electricity to run the treatment	Electricity to run the treatment	Electricity to run the treatment	Electricity to run the treatment	Electricity to run the treatment	Production of PVC	Transportation of personnel	Transportation of personnel
G-6	Low	Low	Low	Low	Low	Moderarte	Moderarte	Moderarte
	Production of vegetable oil	Production of vegetable oil	Injection water	Laboratory analytical services	Laboratory analytical services	Production of PVC	Transportation of personnel	Transportation of personnel

Table C-3
Environemtal Impacts Results
Site 16, NCBC Davisville
Davisville, Rhode Island

Alternative	Activities	GHG Emissions	Total Energy Used	Water Impacts	NOx Emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		Metric Ton CO_2e	MMBTU	Gallons	Metric Ton	Metric Ton	Metric Ton		
S-2	Materials Production	159.21	14,004.44	2,633.09	0.00E+00	1.28E-02	1.83E-03	NA	NA
	Transportation-Personnel	7.56	95.15	NA	2.80E-03	9.86E-05	5.68E-04	1.55E-04	1.25E-02
	Transportation-Equipment	30.45	397.43	NA	9.57E-03	1.69E-04	8.51E-04	7.54E-05	6.07E-03
	Equipment Use and Misc	126.19	1,902.58	0.00	7.93E-01	2.38E-01	6.51E-02	9.85E-05	2.48E-02
	Residual Handling	2.02	26.32	NA	6.34E-04	1.12E-05	5.63E-05	7.02E-06	5.65E-04
	Total	325.43	16,425.92	2,633.09	8.06E-01	2.51E-01	6.84E-02	3.36E-04	4.39E-02
S-3	Materials Production	372.65	33,449.18	1,013.73	0.00E+00	5.03E-03	8.24E-02	NA	NA
	Transportation-Personnel	5.14	64.71	NA	1.90E-03	6.71E-05	3.86E-04	1.05E-04	8.48E-03
	Transportation-Equipment	71.49	933.06	NA	2.25E-02	3.97E-04	2.00E-03	1.77E-04	1.42E-02
	Equipment Use and Misc	137.02	2,071.61	4,000.00	9.21E-01	2.51E-01	7.81E-02	1.06E-04	2.67E-02
	Residual Handling	186.51	2,434.29	NA	5.86E-02	1.04E-03	5.21E-03	4.63E-04	3.72E-02
	Total	772.82	38,952.85	5,013.73	1.00E+00	2.58E-01	1.68E-01	8.51E-04	8.67E-02
S-3A	Materials Production	105.52	9,350.55	1,357.61	0.00E+00	5.91E-03	8.25E-02	NA	NA
	Transportation-Personnel	5.91	74.30	NA	2.19E-03	7.70E-05	4.43E-04	1.21E-04	9.73E-03
	Transportation-Equipment	21.00	274.04	NA	6.60E-03	1.17E-04	5.87E-04	5.20E-05	4.18E-03
	Equipment Use and Misc	67.99	1,025.48	3,000.00	4.42E-01	1.26E-01	3.73E-02	5.35E-05	1.35E-02
	Residual Handling	55.31	721.93	NA	1.74E-02	3.08E-04	1.55E-03	1.37E-04	1.10E-02
	Total	255.73	11,446.30	4,357.61	4.69E-01	1.32E-01	1.22E-01	3.64E-04	3.84E-02
S-4	Materials Production	565.31	50,805.99	1,435.78	0.00E+00	5.76E-03	8.25E-02	NA	NA
	Transportation-Personnel	6.63	83.41	NA	2.45E-03	8.64E-05	4.98E-04	1.36E-04	1.09E-02
	Transportation-Equipment	107.77	1,406.53	NA	3.39E-02	5.99E-04	3.01E-03	2.67E-04	2.15E-02
	Equipment Use and Misc	153.54	2,325.72	3,000.00	1.06E+00	2.76E-01	9.29E-02	1.32E-04	3.31E-02
	Residual Handling	166.34	2,171.04	NA	5.23E-02	9.25E-04	4.65E-03	4.13E-04	3.32E-02
	Total	999.59	56,792.69	4,435.78	1.15E+00	2.83E-01	1.83E-01	9.47E-04	9.87E-02
S-5	Materials Production	2,584.67	232,857.23	2,088.05	0.00E+00	6.80E-03	8.26E-02	NA	NA
	Transportation-Personnel	23.67	297.68	NA	8.76E-03	3.08E-04	1.78E-03	4.84E-04	3.90E-02
	Transportation-Equipment	488.78	6,379.41	NA	1.54E-01	2.72E-03	1.37E-02	1.21E-03	9.74E-02
	Equipment Use and Misc	430.37	6,200.13	9,000.00	2.57E+00	7.20E-01	2.68E-01	3.82E-04	9.61E-02
	Residual Handling	1,019.23	13,302.77	NA	3.20E-01	5.67E-03	2.85E-02	2.52E-03	2.03E-01
	Total	4,546.72	259,037.22	11,088.05	3.05E+00	7.36E-01	3.94E-01	4.60E-03	4.36E-01
S-6	Materials Production	560.97	49,940.14	4,077.70	0.00E+00	2.18E-02	8.47E-02	NA	NA
	Transportation-Personnel	11.47	144.29	NA	4.24E-03	1.50E-04	8.61E-04	2.35E-04	1.89E-02
	Transportation-Equipment	105.80	1,380.85	NA	3.32E-02	5.88E-04	2.96E-03	2.62E-04	2.11E-02
	Equipment Use and Misc	103.01	1,449.13	4,000.00	6.14E-01	1.65E-01	7.12E-02	1.30E-04	3.26E-02
	Residual Handling	21.79	284.35	NA	6.85E-03	1.21E-04	6.09E-04	5.46E-05	4.39E-03
	Total	803.04	53,198.77	8,077.70	6.59E-01	1.88E-01	1.60E-01	6.81E-04	7.69E-02

Table C-4
Environemtal Impacts Drivers
Site 16, NCBC Davisville
Davisville, Rhode Island

Alternatives	GHG Emsissions	Energy Use	Water Consumption	NO_X Emissions	SO_X Emissions	PM_{10} Emissions	Risk of injury	Risk of fatality
S-2	Low	Low	Low to moderate	Low to moderate	Low to moderate	Low	Low	Low
	Production of borrow soil	Production of borrow soil	Decontamination water	Use of dozer	Use of dozer	Use of dozer	Transportation personnel	Equipment use
S-3	Low	Low	Moderate	Low to moderate	Low to moderate	Moderate	Low	Low
	Production of borrow soil	Production of borrow soil	Decontamination water	Use of dozer	Use of dozer	Production of asphalt	Residual handling operations	Residual handling operations
S-3A	Low	Low	Low to moderate	Low	Low	Low to moderate	Low	Low
	Production of borrow soil	Production of borrow soil	Decontamination water	Use of dozer	Use of dozer	Production of asphalt	Residual handling operations	Equipment use
S-4	Low to moderate	Low to moderate	Low to moderate	Low to moderate	Low to moderate	Moderate	Low to moderate	Low to moderate
	Production of borrow soil	Production of borrow soil	Decontamination water	Use of dozer	Use of dozer	Production of asphalt	Residual handling operations	Residual handling operations
S-5	High	High	High	High	High	High	High	High
	Production of borrow soil	Production of borrow soil	Decontamination water	Use of dozer	Use of dozer	Use of dozer	Residual handling operations	Residual handling operations
S-6	Low	Low to moderate	Moderate to high	Low to moderate	Low to moderate	moderate	Low	Low
	Production of borrow soil	Production of borrow soil	Decontamination water	Use of dozer	Use of dozer	Moderate	Transportation of equipment and materials	Equipment use

APPENDIX C-2: INPUT INVENTORIES

APPENDIX C-2-1: GROUNDWATER INPUT INVENTORY

Alternative G-2: Monitored Natural Attenuation and Land Use Controls

LTM

Transportation-Personnel

Item	Quantity	Units	Comments
Site Inspection	1,500	miles	1 visit per year, 50 miles per visit, 1 people, every year for 30 years
MNA Sampling	12,000	miles	1 visit per year, 4 days per visit, 50 miles per day, 2 people, every year for 30 years
5 Year Review Site visit	300	miles	1 visit every 5 years, 50 miles per visit, 1 person, for 30 years

Laboratory Analytical Services

Item	Quantity	Units	Comments
MNA Sampling	246,000	Dollars	41 samples per year, $200 per sample

Alternative G-3: In-Situ Chemical Oxidation, Monitored Natural Attenuation and Land Use Controls

RAC

Materials

Item	Quantity	Units	Comments
decon water	4,000.00	gallons	
Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Pipe, 1" PVC Sched 40	28,350.00	lb	1500 wells, 60 ft each, 1" dia, .315 lb/ft
Injection Well Head	500.00	lb	1500 wells 50 lbs each, 10 units, assume PVC
Sodium Permanganate	388,500.00	lb	Sodium Permanganate, 259000 lbs + 50% second injection
Injection Water	1,050,000.00	gallons	

Transportation-Personnel

Item	Quantity	Units	Comments
Site Superintendent	3,750	miles	15 weeks, 5 days a week, 50 miles per day, 1 person
Site Health &Safety	3,750	miles	15 weeks, 5 days a week, 50 miles per day, 1 person
Chemical Injection site labor	10,200	miles	68 days, 50 miles per trip, 3 people
post injection sampling	1,500	miles	10 days, 50 miles per trip, 3 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	30	ton	3 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip
Injection System	10	ton	Assume 10 ton
DPT Drill Rig	3	ton	3 ton, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Pipe, 1" PVC Sched 40	14.18	ton	1500 wells, 60 ft each, 1" dia, .315 lb/ft
Injection Well Head	0.25	ton	1500 wells 50 lbs each, 10 units, assume PVC
Sodium Permanganate	194.25	ton	Sodium Permanganate, 259000 lbs + 50% second injection
Injection Water	4,368.00	ton	

Equipment Use

Item	Quantity	Units	Comments
DPT Drill Rig	1,920.00	hours	5 wells per day, 8 hours per day, 80% utilization
Pumps	1,305.60	hrs	68 days, 24 horus a day, 80% utilization, 1-10 hp

Residual Handling

Item	Quantity	Units	Comments
Disposal decon water	16.64	ton	4000 gallons, 8.32 ppg, 2000 lb per ton

Transportation-residual handling

Item	Quantity	Units	Comments

Disposal decon water	100	miles	4000 gallons, 8.32 ppg, 2000 lb per ton

Transportation-residual handling			
Item	Quantity	Units	Comments
Bench Scale Analysis	1,000	dollars	5 samples, $200 per sample
Post Injection Sampling	1,000	dollars	5 samples, $200 per sample

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
Site Inspection	1,500	miles	1 day per visit, 50 miles per day, 1 person per visit, for 30 years
MNA sampling	9,000	miles	3 days per year, 50 miles per day, 2 people per visti, for 30 years
5 Year Review Site visit	300	miles	1 visit every 5 years, 50 miles per visit, 1 person, for 30 years

Laboratory Analytical Services			
Item	Quantity	Units	Comments
MNA Sampling	102,000	Dollars	34 samples per year, $100 per sample

Alternative G-3a: In-situ Chemical Oxidation, Monitored Natural Attenuation, LUCs

RAC

Materials

Item	Quantity	Units	Comments
Decon water	2000	gallons	
Equipment Decon Pad	700.4712112	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.1574636	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Injection water	350000	gallons	
Injection wells	3896.1	lb	390 wells, Assume PVC, 1 inch Schedule 40, 30 ft deep, 0.333 lb/ft
Injection well heads	500	lb	10 well heads, 50 lb PVC,
Sodium Permanganate	67000	lb	Assume Pottasium permanganate, 67000 lb

Transportation-Personnel

Item	Quantity	Units	Comments
Site Superintendent	2500	miles	10 weeks, 5 days per week, 50 miles per day, 1 person
Site Health and Safety	2500	miles	10 weeks, 5 days per week, 50 miles per day, 1 person
Chemical Injection labor	3750	miles	25 days, 50 miles per day, 3 people,
Post Injection Sampling	900	miles	9 days, 50 miles per day, 2 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	30	ton	3 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip
DPT drill	3.05		1 drill rig, 6100 lb, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Injection water	1456	ton	
Injection wells	1.95	ton	390 wells, Assume PVC, 1 inch Schedule 40, 30 ft deep, 0.333 lb/ft
Injection well heads	0.25	ton	10 well heads, 50 lb PVC,
Sodium Permanganate	33.5	ton	Assume Pottasium permanganate, 67000 lb

Equipment Use

Item	Quantity	Units	Comments
DPT drill	499.2	hours	390 wells, 5 wells per day, 8 hours per day, 80% utilization
Injection (electricity)	870	hours	Pumps, 1 hp

Residual Handling

Item	Quantity	Units	Comments
Decon water	8.32	tons	2000 gallons, 8.32 ppg, 2000 lb per ton
IDW	6.62	tons	40 drum, 55 gallons per drum, 721 kg/m3 density

Transportation-residual handling

Item	Quantity	Units	Comments
Decon water	100	miles	2000 gallons, 8.32 ppg, 2000 lb per ton
IDW	100	miles	30 drum, 55 gallons per drum, 721 kg/m3 density

Laboratory Analytical Services			
Item	Quantity	Units	Comments
Bench Scale ODCs	1000		5 samples, $200 per sample,
ODC Sampling	1000	dollars	5 samples, $200 per sample,

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
Site Inspection	1500	miles	1 day per visit, 50 miles per day, 1 person per visit, for 30 years
MNA sampling	9000	miles	3 days per year, 50 miles per day, 2 people, for 30 years
WMA	3000	miles	1 day per year, 50 miles per day, 2 people, for 30 years
Surface water sampling	6000	miles	2 days per visit, 50 miles per day, 2 people, for 30 years
5 year review	300	miles	1 day per visit, 50 miles per day, 1 person per visit, every 5 years for 30 years

Laboratory Analytical Services			
Item	Quantity	Units	Comments
MNA Sampling	168,000	Dollars	28 samples per year, $200 per sample
WMA Sampling	36,000	Dollars	6 samples per year, $200 per sample
Surface water sampling	60,000	Dollars	10 samples per year, $200 per sample

Alternative G-3b: In-situ Chemical Oxidation using Existing INJ Wells

Mobilization
decontamination
site preparation and bench scale testing
chemical injection 1
chemical injection 2
post injection sampling
site inspection
mna sampling
five year site review

RAC

Materials

Item	Quantity	Units	Comments
Decon water	2,000.00	gallons	
Injection water	52,000.00	gallons	
Sodium Permanganate	23,000.00	lb	Assume Pottasium permanganate, 23000 lb
Injection water	52,000.00	gallons	
Sodium Permanganate	23,000.00	lb	Assume Pottasium permanganate, 23000 lb

Transportation-Personnel

Item	Quantity	Units	Comments
Site Superintendent	1,000.00	miles	4 weeks, 5 days per week, 50 miles per day, 1 person
Site Health and Safety	500.00	miles	2 weeks, 5 days per week, 50 miles per day, 1 person
Chemical Injection labor	750.00	miles	5 days, 50 miles per day, 3 people,
Chemical Injection labor	750.00	miles	5 days, 50 miles per day, 3 people,
Post Injection Sampling	1,800.00	miles	18 days, 50 miles per day, 2 people

Transportation-equipment

Item	Quantity	Units	Comments
Decon Water Storage Tank	0.90	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.60	ton	4000 gallons capacity HPDE, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
Injection water	216.32	ton	
Sodium Permanganate	11.50	ton	Assume Pottasium permanganate, 67000 lb
Injection water	216.32	ton	
Sodium Permanganate	11.50	ton	Assume Pottasium permanganate, 67000 lb

Equipment Use

Item	Quantity	Units	Comments
Injection (electricity)	40.00	hours	5 days, 8 hours per day, Pumps, 1 hp
Injection (electricity)	40.00	hours	5 days, 8 hours per day, Pumps, 1 hp

Residual Handling

Item	Quantity	Units	Comments
Decon water	8.32	tons	2000 gallons, 8.32 ppg, 2000 lb per ton

Transportation-residual handling

Item	Quantity	Units	Comments
Decon water	100.00	miles	2000 gallons, 8.32 ppg, 2000 lb per ton

Laboratory Analytical Services

Item	Quantity	Units	Comments

ODC Sampling	2,000.00	dollars	10 samples, $200 per sample,

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
Site Inspection	1,500.00	miles	1 day per visit, 50 miles per day, 1 person per visit, for 30 years
MNA sampling	9,000.00	miles	3 days per year, 50 miles per day, 2 people, for 30 years
WMA	3,000.00	miles	1 day per year, 50 miles per day, 2 people, for 30 years
Surface water sampling	6,000.00	miles	2 days per visit, 50 miles per day, 2 people, for 30 years
5 year review	300.00	miles	1 day per visit, 50 miles per day, 1 person per visit, every 5 years for 30 years

Laboratory Analytical Services			
Item	Quantity	Units	Comments
MNA Sampling	168,000.00	Dollars	28 samples per year, $200 per sample
WMA Sampling	36,000.00	Dollars	6 samples per year, $200 per sample
Surface water sampling	60,000.00	Dollars	10 samples per year, $200 per sample

Alternative G-4: Enhanced Bioremediation, Monitored Natural Attenuation, Land Use Controls

RAC

Materials

Item	Quantity	Units	Comments
Decon water	3000	gallons	
Equipment Decon Pad	700.4712112	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.1574636	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Injection wells, 1 inch diam	3861	lb	Assume PVC, 1 inch diameter, Schedule 40, 230 wells, 11700 ft, 0.33 lb/ft
Injection wells, 2 inch diam	10080	lb	Assume PVC, 2 inch diameter, Schedule 40, 130 wells, 14000 ft, 0.72 lb.ft
Injection well heads	500	lb	Assume PVC, 10 well heads, 50 lb each
New monitoring wells, 2 inch	540	lb	Assume PVC, 2 inch diameter, Schedule 40, 12 wells, 750 ft, 0.72 lb/ft
Injection water	663000	gallons	
EOS	335290.6626	lb	Assume Vegetable oil, 30650 gallons, assume 1310.8216 kg/m3 density

Transportation-Personnel

Item	Quantity	Units	Comments
Site Superintendent	3000	miles	12 weeks, 5 days per week, 50 miles per day, 1 person
Site Health and Safety	3000	miles	12 weeks, 5 days per week, 50 miles per day, 1 person
Bioremediation labor	9000	miles	90 days, 50 miles per day, 2 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	30	ton	3 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip
DPT Injection wells, 1 inch	3.05	ton	1 drill rig, 6100 lb, 100 miles round trip
DPT Injection wells, 2 inch	3.05	ton	1 drill rig, 6100 lb, 100 miles round trip
DPT New Injection wells, 2 inch	3.05	ton	1 drill rig, 6100 lb, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Injection wells, 1 inch diam	1.93	ton	Assume PVC, 1 inch diameter, Schedule 40, 230 wells, 11700 ft, 0.33 lb/ft
Injection wells, 2 inch diam	5.04	ton	Assume PVC, 2 inch diameter, Schedule 40, 130 wells, 14000 ft, 0.72 lb.ft
Injection well heads	0.25	ton	Assume PVC, 10 well heads, 50 lb each
New monitoring wells, 2 inch	0.27	ton	Assume PVC, 2 inch diameter, Schedule 40, 12 wells, 750 ft, 0.72 lb/ft
Injection water	2,758.08	ton	
EOS	167.65	ton	Assume Vegetable oil, 30650 gallons, assume 1310.8216 kg/m3 density

Equipment Use

Item	Quantity	Units	Comments
DPT Injection wells, 1 inch	294.4	hours	230 wells, 5 wells per day, 8 hours per day, 80% utilization

DPT Injection wells, 2 inch	166.4	hours	130 wells, 5 wells per day, 8 hours per day, 80% utilization
DPT New Injection wells, 2 inch	15.36	hours	12 wells, 5 wells per day, 8 hours per day, 80% utilization
Injection pumps (electricity)	512	hours	80 days, 8 hours per day, 80% utilization

Residual Handling			
Item	Quantity	Units	Comments
Decon water	12.48	tons	3000 gallons, 8.32 ppg, 2000 lb per ton

Transportation-residual handling			
Item	Quantity	Units	Comments
Decon water	100	miles	3000 gallons, 8.32 ppg, 2000 lb per ton

RAC, year 5

Materials			
Item	Quantity	Units	Comments
Decon water	2000	gallons	
Equipment Decon Pad	700.4712112	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.1574636	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Injection water	663000	gallons	
EOS	335290.6626	lb	Assume Vegetable oil, 30650 gallons, assume 1310.8216 kg/m3 density

Transportation-Personnel			
Item	Quantity	Units	Comments
Siet Superintendent	2250	miles	9 weeks. 5 days a week, 50 miles per day, 1 person
Site Health and Safety	2250	miles	9 weeks. 5 days a week, 50 miles per day, 1 person
Bioremediation labor	9000	miles	90 days, 50 miles per day, 2 people

Transportation-equipment			
Item	Quantity	Units	Comments
Trailers	30	ton	3 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip

Transportation-materials			
Item	Quantity	Units	Comments
Equipment Decon Pad	0.350235606	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.220578732	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Injection water	2758.08	ton	
EOS	167.6453313	ton	Assume Vegetable oil, 30650 gallons, assume 1310.8216 kg/m3 density

Equipment Use			
Item	Quantity	Units	Comments
Injection pumps (electricity)	512	hours	80 days, 8 hours per day, 80% utilization

Residual Handling			
Item	Quantity	Units	Comments
Decon water	8.32	tons	2000 gallons, 8.32 ppg, 2000 lb per ton

Transportation-residual handling			
Item	Quantity	Units	Comments
Decon water	100	miles	2000 gallons, 8.32 ppg, 2000 lb per ton

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
site inspection	1,500.00	miles	1 day a visit, 50 miles per visit, 1 person, 30 years
mna sampling	9,000.00	miles	3 days a visit, 50 miles per day, 2 people, years 1 through 30
eos sampling	16,000.00	miles	5 days per visit, 50 miles per day, 2 people, 2 times per year for year 1 and 2, once a year for years 3 through 30
5 year review	300.00	miles	1 day per visit, 50 miles per day, 1 person per visit, every 5 years for 30 years

Laboratory Analytical Services			
Item	Quantity	Units	Comments
MNA Sampling	102,000	Dollars	34 samples per year, $100 per sample
EOS Sampling	166,400	Dollars	52 samples per year. Year 1 and 2, sampling twice, years 3 through 30, sampling once a year

Alternative G-5: Pump and Treat

RAC

Materials

Item	Quantity	Units	Comments
Decon water	4,000.00	gallons	
Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Extraction wells	14,586.00	lb	Assume PVC, 45 wells, 6 in, Schedule 80, 2600 lft, 5.61 lb.ft
Extraction well wellheads	500.00	lb	Assume PVC, 10 wellheads, 50 lb per unit
Transfer piping 1 inch diameter	98.79	lb	Assume PVC, Schedule 80, 1 inch diameter, 2300 lf, 0.424 lb/ft
Transfer piping fittings, 1 inch	125.00	lb	Assume PVC, assume 1 inch fittings, Schedule 80, 250 fittings, 0.5 lb per unit
Transfer Piping valves, 1 inch	200.00	lb	Ball valve, 200 units, 1 inch diameter, PVC, 1 lb per unit
Transfer Piping, 2 inch	6,002.40	lb	Assume PVC, SChedule 80, 2 inch diameter, 6100 lf, 0.984 lb/ft
Transfer piping fittings, 2 inch, double wall	250.00		Assume PVC, assume 2 inch fittings, Schedule 80, 250 fittings, 1 lb per unit
Transfer Piping valves, 2 inch	12.00		Ball valve, 12 units, 2 inch diameter, PVC, 1 lb per unit
manholes	1,108.07	lb	Assume concrete, 2'x2'x2 3 inch deep, assue contrete with concrete cover, 7 manholes, 2371 kg/m3
Piping, 2 inch diameter, PVC, Sch 80	1,476.00	lb	Assume PVC, Schedule 80, 2 in diameter, 1500 lf, 0.984 lb/ft
Transfer piping fittings, 2 inch	100.00	lb	Assume PVC, assume 2 inch fittings, Schedule 80, 200 fittings, 0.5 lb per unit
Transfer Piping valves, 2 inch	40.00	lb	Ball valve, 40 units, 2 inch diameter, PVC, 1 lb per unit
Piping, 6 inch diameter, PVC, Sch 80	1,402.50	lb	Assume PVC, Schedule 80, 6 in diameter, 250 lf, 5.61 lb/ft
Transfer piping fittings, 6 inch	12.50	lb	Assume PVC, assume 6 inch fittings, Schedule 80, 25 fittings, 0.5 lb per unit
Transfer Piping valves,6 inch	4.00	lb	Ball valve, 4 units, 6 inch diameter, PVC, 1 lb per unit
Bag filters	2.33	lb	2 bag filters, 2 sf, Assume HDPE, 3 mm thick, 0.95 g/cm3

Transportation-Personnel

Item	Quantity	Units	Comments
Site Superintendent	6,500	miles	26 weeks, 5 days per week, 50 miles per day, 1 person
Site Health and Safety'	6,500	miles	26 weeks, 5 days per week, 50 miles per day, 1 person
Transfer piping crew	5,000	miles	50 days, 50 miles per day, 2 people
Site Labor for extraction system	6,000	miles	40 days, 50 miles per day, 3 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	50.00	ton	5 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.90	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.60	ton	4000 gallons capacity HPDE, 100 miles round trip
Feed Tank, 200 gallons	0.30	ton	2000 gallons capacity HPDE, 100 miles round trip
Drill Rig	3.05	ton	1 drill rig, 6100 lb, 100 miles round trip

Backhoe-loader,1 CY	11.23	ton	1 backhoe loader, 1 CY, 22466 lb per unit, 100 miles per trip
Treatment System	50.00	ton	Assume 50 ton for all treatment system equipment

Transportation-materials

Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Extraction wells	7.29	ton	Assume PVC, 45 wells, 6 in, Schedule 80, 2600 lft, 5.61 lb.ft
Extraction well wellheads	0.25	ton	Assume PVC, 10 wellheads, 50 lb per unit
Transfer piping 1 inch diameter	0.05	ton	Assume PVC, Schedule 80, 1 inch diameter, 2300 lf, 0.424 lb/ft
Transfer piping fittings, 1 inch	0.06	ton	Assume PVC, assume 1 inch fittings, Schedule 80, 250 fittings, 0.5 lb per unit
Transfer Piping valves, 1 inch	0.10	ton	Ball valve, 200 units, 1 inch diameter, PVC, 1 lb per unit
Transfer Piping, 2 inch	3.00	ton	Assume PVC, SChedule 80, 2 inch diameter, 6100 lf, 0.984 lb/ft
Transfer piping fittings, 2 inch, double wall	0.13	ton	Assume PVC, assume 2 inch fittings, Schedule 80, 250 fittings, 1 lb per unit
Transfer Piping valves, 2 inch	0.01	ton	Ball valve, 12 units, 2 inch diameter, PVC, 1 lb per unit
manholes	0.55	ton	Assume concrete, 2'x2'x2 3 inch deep, assue contrete with concrete cover, 7 manholes, 2371 kg/m3
Piping, 2 inch diameter, PVC, Sch 80	0.74	ton	Assume PVC, Schedule 80, 2 in diameter, 1500 lf, 0.984 lb/ft
Transfer piping fittings, 2 inch	0.05	ton	Assume PVC, assume 2 inch fittings, Schedule 80, 200 fittings, 0.5 lb per unit
Transfer Piping valves, 2 inch	0.02	ton	Ball valve, 40 units, 2 inch diameter, PVC, 1 lb per unit
Piping, 6 inch diameter, PVC, Sch 80	0.70	ton	Assume PVC, Schedule 80, 6 in diameter, 250 lf, 5.61 lb/ft
Transfer piping fittings, 6 inch	0.01	ton	Assume PVC, assume 6 inch fittings, Schedule 80, 25 fittings, 0.5 lb per unit
Transfer Piping valves,6 inch	0.002	ton	Ball valve, 4 units, 6 inch diameter, PVC, 1 lb per unit
Bag filters	0.001	ton	2 bag filters, 2 sf, Assume HDPE, 3 mm thick, 0.95 g/cm3

Equipment Use

Item	Quantity	Units	Comments
Drill Rig, DPT	57.6	hours	45 wells, 5 wells per day, 8 hours per day, 80% utilization
submersible pumps	11,826,000	hours	45 submersible pumps, 1 hp, running 24 hours per day, 365 days, for 30 years
Backhoe, loader, 80 HP, 1 4/4 cy	256	hours	40 days, 8 hours per day, 80% utilization

Residual Handling

Item	Quantity	Units	Comments
Decon water	16.64	tons	4000 gallons, 8.32 ppg, 2000 lb per ton

Transportation-residual handling

Item	Quantity	Units	Comments
Decon water	100	miles	4000 gallons, 8.32 ppg, 2000 lb per ton

RAO			
Materials			
Item	Quantity	Units	Comments
GAC forLiquid phase	300,000	lb	5000 lb per vessel, 2 vessels, replace once per year every year for 30 years
GAC for Vapor phase	216,000	lb	3000 lb per vessel, 2 vessels, replace 4 times during first year, replace 2 times a year for years 2,3, and 4, replace once a year for years 5 through 30
bag filters	3,642.42	lb	104 bag filters per year, for 30 years, 2 sf, Assume HDPE, 3 mm thick, 0.95 g/cm3
Potable water	300,000	gallons	10,000 gallons per year, for 30 years
Transportation-Personnel			
Item	Quantity	Units	Comments
Treatment plant operator	195,000	miles	130 days, 50 miles per day, 1 person, for 30 years
Transportation-materials			
Item	Quantity	Units	Comments
GAC forLiquid phase	150	ton	5000 lb per vessel, 2 vessels, replace once per year every year for 30 years
GAC for Vapor phase	108	ton	3000 lb per vessel, 2 vessels, replace 4 times during first year, replace 2 times a year for years 2,3, and 4, replace once a year for years 5 through 30
bag filters	1.82	ton	104 bag filters per year, for 30 years, 2 sf, Assume HDPE, 3 mm thick, 0.95 g/cm3
Potable water	1,248	ton	10,000 gallons per year, for 30 years
Equipment Use			
Item	Quantity	Units	Comments
Electricity	10,800,000		360,000 kWh per year, for 30 years
Laboratory Analytical Services			
Item	Quantity	Units	Comments
MNA Sampling	288,000	Dollars	12 samples per quarter, 4 quarters per year, $200 per sample

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
site inspection	1500	miles	1 day a visit, 50 miles per visit, 1 person, 30 years
mna sampling	9000	miles	3 days a visit, 50 miles per day, 2 people, years 1 through 30
5 Year Review	300	miles	1 day a visit, 50 miles per visit, 1 person, every 5 years for 30 years
Laboratory Analytical Services			
Item	Quantity	Units	Comments
MNA Sampling	102,000	Dollars	34 samples per year, $100 per sample

Alternative G-6: Enhanced Bioremediation, Monitored Natural Attenuation, Land Use Controns, Short Treament Period

RAC

Materials

Item	Quantity	Units	Comments
Decon water	6,000.00	gallons	
Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Injection wells, 1 inch diam	13,860.00	lb	Assume PVC, 1 inch diameter, Schedule 40, 230 wells, 42000 ft, 0.33 lb/ft
Injection wells, 2 inch diam	23,040.00		Assume PVC, 2 inch diameter, Schedule 40, 130 wells, 32000 ft, 0.72 lb.ft
Injection well heads	500.00	lb	Assume PVC, 10 well heads, 50 lb each
injection water	2,000,000.00	gallons	
New monitoring wells, 2 inch	540.00	lb	Assume PVC, 2 inch diameter, Schedule 40, 12 wells, 750 ft, 0.72 lb/ft
EOSAquabupH	875,146.92	lb	Assume vegetable oil, 80,000 gallons, 1310.82 kg/m3
ORC	7,000.00	lb	70,000 pounds, assume lime

Transportation-Personnel

Item	Quantity	Units	Comments
Site Superintendent	7,500	miles	30 weeks, 5 days per week, 50 miles per day, 1 person
Site Health and Safety'	7,500	miles	30 weeks, 5 days per week, 50 miles per day, 1 person
Labor for EOS	11,200	miles	140 days, 50 miles per day, 2 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	40	ton	4 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.22	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Injection wells, 1 inch diam	6.93	lb	Assume PVC, 1 inch diameter, Schedule 40, 230 wells, 42000 ft, 0.33 lb/ft
Injection wells, 2 inch diam	11.52		Assume PVC, 2 inch diameter, Schedule 40, 130 wells, 32000 ft, 0.72 lb.ft
Injection well heads	0.25	lb	Assume PVC, 10 well heads, 50 lb each
injection water	8,320.00	gallons	
New monitoring wells, 2 inch	0.27	lb	Assume PVC, 2 inch diameter, Schedule 40, 12 wells, 750 ft, 0.72 lb/ft
EOSAquabupH	437.57	lb	Assume vegetable oil, 80,000 gallons, 1310.82 kg/m3
ORC	3.50	lb	70,000 pounds, assume lime

Equipment Use

Item	Quantity	Units	Comments
DPT Injection wells 1 inch	294.4	hours	5 wells per day, 230 wells, 8 hours per day, 80% utilization

DPT Injection wells 2 inch	166.4	hours	5 wells per day, 130 wells, 8 hours per day, 80% utilization
DPT Monitoring wells	15.36	hours	5 wells per day, 12 wells, 8 hours per day, 80% utilization
Injection pumps for EOS	2240	hours	280 days, 10 hours per day
DPT Rig	364.8	hours	57 days, 8 hours per day, 80% utilization

Residual Handling			
Item	Quantity	Units	Comments
Decon water	24.96	tons	6000 gallons, 8.32 ppg, 2000 lb per ton

Transportation-residual handling			
Item	Quantity	Units	Comments
Decon water	100	miles	6000 gallons, 8.32 ppg, 2000 lb per ton

RAC 5 year

Materials			
Item	Quantity	Units	Comments
Decon water	6,000.00	gallons	
Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
EOSAquabupH	875,146.92	lb	Assume vegetable oil, 80,000 gallons, 1310.82 kg/m3
injection water	2,000,000.00	gallons	

Transportation-Personnel			
Item	Quantity	Units	Comments
Site Superintendent	7,500	miles	30 weeks, 5 days per week, 50 miles per day, 1 person
Site Health & Safety	7,500	miles	30 weeks, 5 days per week, 50 miles per day, 1 person
Laborfor EOS	14,500	miles	290 days, 50 miles per day, 1 person

Transportation-equipment			
Item	Quantity	Units	Comments
Trailers	30	ton	3 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip

Transportation-materials			
Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
EOSAquabupH	437.57	ton	Assume vegetable oil, 80,000 gallons, 1310.82 kg/m3
injection water	8,320.00	ton	

Equipment Use			
Item	Quantity	Units	Comments
Injection pumps for EOS	2240	hours	280 days, 10 hours per day, 80% utilization

Residual Handling			
Item	Quantity	Units	Comments
Decon water	24.96	tons	6000 gallons, 8.32 ppg, 2000 lb per ton

Transportation-residual handling			
Item	Quantity	Units	Comments
Decon water	100	miles	6000 gallons, 8.32 ppg, 2000 lb per ton

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
site visit	1,500	miles	1 day, 50 miles per day, 1 person, for 30 years
MNA sampling	3,000	miles	1 day, 50 miles per day, 2 people, for 30 years
EOS Sampling	8,000	miles	10 days, 50 miles per day, 2 people, twice a year for year 1 and 2, once a year for years 3 through 10
5 year review	300	miles	1 day, 50 miles per day, 1 person, every 5 years for 30 years

Laboratory Analytical Services			
Item	Quantity	Units	Comments
MNA Sampling	45,000	Dollars	15 samples per year, $100 per sample
EOS Sampling	127,200	Dollars	106 samples per year. Year 1 and 2, sampling twice, years 3 through 10, sampling once a year

APPENDIX C-2-2: SOIL INPUT INVENTORY

Alternative S-2: Soil Cover and/or Cap, Selected Excavation and Disposal, Monitoring, and Land Use Controls

RAC

Materials

Item	Quantity	Units	Comments
Decon water	3,000.00	gallons	
Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Monitoring well abandonmnet wells	17,001.63	lb	28 wells, 1020 ft, 2 inch diameter, assume sand dry, 1602 kg/m3,
Cover fill	3,150,000.00	lb	10,050 CY, Assume common soil,
Select Fill	420,000.00	lb	140 CY, Assume common soil
Cover Liner	1,111.11	lb	Assume HDPE, 20,000 sf, 8oz/sy
Top soil	10,650,000.00	lb	Assume Top soil, 3550 CY
Backfill	420,000.00	lb	Assume top soil, 140 CY
Revegetation, seed	479.25	lb	Assume fertilizer, 21300 sy, 3 lb of seed per 1.2 msf
Replacement monitoring wells	525.60	lb	730 lf, Assume PVC, 2 inch, SCH 40, 18 wells, 0.72 lb/ft
New LUC Monitoring wells	32.40	lb	45 lf, Assume PVC,2 inch SCH 40, 3 wells, 0.72 lb/ft
monitoring and LUC well heads	250.00	lb	5 units, Assume PVC, 50 lb per unit

Transportation-Personnel

Item	Quantity	Units	Comments
Soil Sampling labor	500	miles	10 days, 50 miles per day, 1 person
Clear and grub crew	1,200	miles	4 days, 50 miles per day, 6 people
Site Labor for area cover	6,000	miles	40 days, 50 miles per day, 3 people
Site labor for Selected Excavation	750	miles	5 days, 50 miles per day, 3 people
Labor for Revegetation	6,600	miles	22 days, 50 miles per day, 6 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	80	ton	8 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip
brush chipper, 130 HP	2.85	ton	1 wood chipper, 2.85 tons per woodchipper, 100 miles round trip
1 loader, 3CY	12.0705	ton	24141 lb per loader, 1 loader, 100 miles round trip
2 chain saws, 36in long (gas)	0.0165	ton	16.5 lb per chain saw, 2 chain sawys, 100 miles round trip
Excavator, 2.5 CY	20	ton	1 excavator, 20 ton per excavator, 100 miles round trip
Dozer, 300 hp	28	ton	1 dozer, 28 tons per dozer
Compactor (roller 240 hp)	11.176	ton	1 compactor roller, 115 hp, 22,352 lbs, 100 miles round trip
Excavator, 2.5 CY	20	ton	1 excavator, 20 ton per excavator, 100 miles round trip
Compactor (roller 240 hp)	11.176	ton	1 compactor roller, 115 hp, 22,352 lbs, 100 miles round trip
Backhoe loader, 48 hp 5/8 CY	11.233	ton	1 backhoe loader, 1 CY, 22466 lb per unit, 100 miles round trip
DPT drill rig	3.05	ton	1 drill rig, 6100 lb, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments

Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Monitoring well abandonmnet wells	8.50	ton	28 wells, 1020 ft, 2 inch diameter, assume sand dry, 1602 kg/m3,
Cover fill	1,575.00	ton	10,050 CY, Assume common soil,
Select Fill	210.00	ton	140 CY, Assume common soil
Cover Liner	0.56	ton	Assume HDPE, 20,000 sf, 8oz/sy
Top soil	5,325.00	ton	Assume Top soil, 3550 CY
Backfill	210.00	ton	Assume top soil, 140 CY
Revegetation, seed	0.24	ton	Assume fertilizer, 21300 sy, 3 lb of seed per 1.2 msf
Replacement monitoring wells	0.26	ton	730 lf, Assume PVC, 2 inch, SCH 40, 18 wells, 0.72 lb/ft
New LUC Monitoring wells	0.02	ton	45 lf, Assume PVC,2 inch SCH 40, 3 wells, 0.72 lb/ft
monitoring and LUC well heads	0.13	ton	5 units, Assume PVC, 50 lb per unit

Equipment Use			
Item	Quantity	Units	Comments
brush chipper, 130 HP	25.6	hours	4 days, 8 hours per day, 80% utilization
1 loader, 3CY	25.6	hours	4 days, 8 hours per day, 80% utilization
2 chain saws, 36in long (gas)	25.6	hours	4 days, 8 hours per day, 80% utilization
Excavator, 2.5 CY	256	hours	40 days, 8 hours per day, 80% utilization
Dozer, 300 hp	256	hours	40 days, 8 hours per day, 80% utilization
Compactor (roller 240 hp)	256	hours	40 days, 8 hours per day, 80% utilization
Excavator, 2.5 CY	32	hours	5 days, 8 hours per day, 80% utilization
Compactor (roller 240 hp)	32	hours	5 days, 8 hours per day, 80% utilization
Backhoe loader, 48 hp 5/8 CY	140.8	hours	22 days, 8 hours per day, 80% utilization
DPT drill rig	26.88	hours	21 wells, 5 wells per day, 8 hours per day, 80% utilziation

Residual Handling			
Item	Quantity	Units	Comments
Disposal decon water	12.48	ton	3000 gallons, 8.32 ppg, 2000 lb per ton
Non hazardous soil transportation and disposal	210.00	ton	210 ton
IDW disposal	9.93	ton	60 drum, 55 gallons per drum, 721 kg/m3 density

Transportation-residual handling			
Item	Quantity	Units	Comments
Disposal decon water	100	miles	3000 gallons, 8.32 ppg, 2000 lb per ton
Non hazardous soil transportation and disposal	100	miles	210 ton
IDW disposal	100	miles	60 drum, 55 gallons per drum, 721 kg/m3 density

Laboratory Analytical Services			
Item	Quantity	Units	Comments
Site Preparation Samples	5,600	Dollars	28 samples, $200 per sample
Soil Sampling TCLP	200	Dollars	1 sample, $200 per sample

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
Site Inspection	1500	miles	1 visti per year, 50 miles per visit, 1 person, for 30 years
Field Sampling	3000	miles	1 visit per year, 50 miles per year, 2 people, for 30 years

5 year review	300 miles	1 visit every 5 years, 50 miles per visit, 1 person, during 30 yeasr

Laboratory Analytical Services

Alternative S3: Excavation and Disposal and Land Use Controls

RAC

Materials

Item	Quantity	Units	Comments
Decon water	4,000.00	gallons	
Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Monitoring Well Abandonment Wells	7,417.38	lb	445 lf, 15 wells, assume sand dry, 1602 kg/m3,
Backfill	31,890,000.00	lb	10630 CY, assume top soil
Topsoil	3,510,000.00	lb	1170 CY, asume top soil
Revegetation, seed	157.50	lb	Assume fertilizer, 7000 sy, 3 lb of seed per 1.2 msf
Pavement Replacement, stone base	75,007.19	lb	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3
Pavement Replacement, bounder course	23,753.84	lb	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3
Pavement Replacement, topping	11,252.64	lb	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3
Replace monitoring wells	180.00	lb	7 wells, 250 lf, assume 2 in diameter, 0.72 lb/ft
Replace monitoring well head	150.00	lb	3 well heads, 50 lb per unit, assume PVC

Transportation-Personnel

Item	Quantity	Units	Comments
Soil Sampling Labor	500	miles	10 days, 50 miles per trip, 1 person
Clear & Grub Labor	600	miles	2 days, 50 miles per day, 6 people
Excavation and disposal site labor	8,250	miles	55 days, 50 miles per day, 3 people
Labor for Revegetation	2,100	miles	7 days, 50 miles per day, 6 people
Labor for pavement replacement	250	miles	1 day, 50 miles per day 5 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	80	ton	8 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip
Brush Chipper, 130 HP	2.85	ton	1 wood chipper, 2.85 tons per woodchipper, 100 miles round trip
1 crawler loader, 3CY	12.0705	ton	24141 lb per loader, 1 loader, 100 miles round trip
2 chain saws	0.0165	ton	16.5 lb per chain saw, 2 chain sawys, 100 miles round trip
Excavator, 2.5 CY	20	ton	1 excavator, 20 ton per excavator, 100 miles round trip
Dozer 300 hp	28	ton	1 dozer, 28 tons per dozer
Compactor (roller, 240 hp)	11.176	ton	1 compactor roller, 115 hp, 22,352 lbs, 100 miles round trip
Backhoe loader, 48 hp 5/8 CY	11.233	ton	1 backhoe loader, 1 CY, 22466 lb per unit, 100 miles round trip
Asphalt Paver, 130 hp	17.645	ton	1 Asphalt paver, 130 hp, 35290 pounds per unit, 100 miles round trip
1 Tandem Roller, 10 ton	10	ton	
DPT Drill Rig	3.05		1 drill rig, 6100 lb, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Monitoring Well Abandonment Wells	3.71	ton	445 lf, 15 wells, assume sand dry, 1602 kg/m3,

Backfill	15,945.00	ton	10630 CY, assume top soil
Topsoil	1,755.00	ton	1170 CY, asume top soil
Revegetation, seed	0.08	ton	Assume fertilizer, 7000 sy, 3 lb of seed per 1.2 msf
Pavement Replacement, stone base	37.50	ton	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3
Pavement Replacement, bounder course	11.88	ton	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3
Pavement Replacement, topping	5.63	ton	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3
Replace monitoring wells	0.09	ton	7 wells, 250 lf, assume 2 in diameter, 0.72 lb/ft
Replace monitoring well head	0.08	ton	3 well heads, 50 lb per unit, assume PVC

Equipment Use			
Item	Quantity	Units	Comments
Brush Chipper, 130 HP	12.8	hours	2 days, 8 hours per day, 80% utilization
1 crawler loader, 3CY	12.8	hours	2 days, 8 hours per day, 80% utilization
2 chain saws	12.8	hours	2 days, 8 hours per day, 80% utilization
Excavator, 2.5 CY	352	hours	55 days, 8 hours per day, 80% utilization
Dozer 300 hp	352	hours	55 days, 8 hours per day, 80% utilization
Compactor (roller, 240 hp)	352	hours	55 days, 8 hours per day, 80% utilization
Backhoe loader, 48 hp 5/8 CY	44.8	hours	7 days, 8 hours per day, 80% utilization
Asphalt Paver, 130 hp	6.4	hours	1 day, 8 hours per day, 80% utilization
1 Tandem Roller, 10 ton	6.4	hours	1 day, 8 hours per day, 80% utilization
DPT Drill Rig	8.96	hours	7 wells, 5 wells per day, 8 hours per day, 80% utilization

Residual Handling			
Item	Quantity	Units	Comments
Disposal decon water	16.64	ton	4000 gallons, 8.32 ppg, 2000 lb per ton
Non-hazardous soil transportation and disposal	16230	ton	
hazardous soil transportation and disposal	1470	ton	
IDW disposal	4.14	ton	25 drums, 55 gallons per drum, 721 kg/m3 density

Transportation-residual handling			
Item	Quantity	Units	Comments
Disposal decon water	100	miles	4000 gallons, 8.32 ppg, 2000 lb per ton
Non-hazardous soil transportation and disposal	100	miles	
hazardous soil transportation and disposal	500	miles	
IDW disposal	100	miles	25 drums, 55 gallons per drum

Laboratory Analytical Services			
Item	Quantity	Units	Comments
Soil Sampling	14400		72 samples, $200 per sample

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
Site Inspection	1500		1 visti per year, 50 miles per visit, 1 person, for 30 years
5 year review	300	miles	1 visit every 5 years, 50 miles per visit, 1 person, during 30 yeasr

Alternative SA3: Selected Excavation and Disposal and Land Use Controls

mobilization/dembolization
decontamination
site preparation
Excavation and disposal
site restoration
site inspection

RAC

Materials

Item	Quantity	Units	Comments
Decon water	3,000.00	gallons	
Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Monitoring Well Abandonment Wells	7,417.38	lb	445 lf, 15 wells, assume sand dry, 1602 kg/m3,
Backfill	7,197,000.00	lb	2399 CY, assume top soil
Topsoil	2,550,000.00	lb	850 CY, asume top soil
Revegetation, seed	157.50	lb	Assume fertilizer, 7000 sy, 3 lb of seed per 1.2 msf
Pavement Replacement, stone base	75,007.19	lb	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3
Pavement Replacement, bounder course	23,753.84	lb	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3
Pavement Replacement, topping	11,252.64	lb	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3
Replace monitoring wells	180.00	lb	7 wells, 250 lf, assume 2 in diameter, 0.72 lb/ft
Replace monitoring well head	350.00	lb	7 well heads, 50 lb per unit, assume PVC

Transportation-Personnel

Item	Quantity	Units	Comments
Site superintendent	3250	miles	13 weeks, 5 days per week, 50 miles per trip, 1 person
Site Health and Safety and QAQC	3250	miles	13 weeks, 5 days per week, 50 miles per trip, 1 person
Soil Sampling Labor	500	miles	10 days, 50 miles per trip, 1 person
Clear & Grub Labor	600	miles	2 days, 50 miles per day, 6 people
Excavation and disposal site labor	3,750	miles	25 days, 50 miles per day, 3 people
Labor for Revegetation	2,100	miles	7 days, 50 miles per day, 6 people
Labor for pavement replacement	250	miles	1 day, 50 miles per day 5 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	80	ton	8 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip
Brush Chipper, 130 HP	2.85	ton	1 wood chipper, 2.85 tons per woodchipper, 100 miles round trip
1 crawler loader, 3CY	12.0705	ton	24141 lb per loader, 1 loader, 100 miles round trip
2 chain saws	0.0165	ton	16.5 lb per chain saw, 2 chain sawys, 100 miles round trip
Excavator, 2.5 CY	20	ton	1 excavator, 20 ton per excavator, 100 miles round trip
Dozer 300 hp	28	ton	1 dozer, 28 tons per dozer
Compactor (roller, 240 hp)	11.176	ton	1 compactor roller, 115 hp, 22,352 lbs, 100 miles round trip
Backhoe loader, 48 hp 5/8 CY	11.233	ton	1 backhoe loader, 1 CY, 22466 lb per unit, 100 miles round trip
Asphalt Paver, 130 hp	17.645	ton	1 Asphalt paver, 130 hp, 35290 pounds per unit, 100 miles round trip

1 Tandem Roller, 10 ton	10	ton	
DPT Drill Rig	3.05	ton	1 drill rig, 6100 lb, 100 miles round trip

Transportation-materials			
Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Monitoring Well Abandonment Wells	3.71	ton	445 lf, 15 wells, assume sand dry, 1602 kg/m3,
Backfill	3,598.50	lb	2399 CY, assume top soil
Topsoil	1,275.00	lb	850 CY, asume top soil
Revegetation, seed	0.08	ton	Assume fertilizer, 7000 sy, 3 lb of seed per 1.2 msf
Pavement Replacement, stone base	37.50	ton	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3
Pavement Replacement, bounder course	11.88	ton	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3
Pavement Replacement, topping	5.63	ton	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3
Replace monitoring wells	0.09	ton	7 wells, 250 lf, assume 2 in diameter, 0.72 lb/ft
Replace monitoring well head	0.08	ton	3 well heads, 50 lb per unit, assume PVC

Equipment Use			
Item	Quantity	Units	Comments
Brush Chipper, 130 HP	12.8	hours	2 days, 8 hours per day, 80% utilization
1 crawler loader, 3CY	12.8	hours	2 days, 8 hours per day, 80% utilization
2 chain saws	12.8	hours	2 days, 8 hours per day, 80% utilization
Excavator, 2.5 CY	160	hours	25 days, 8 hours per day, 80% utilization
Dozer 300 hp	160	hours	25 days, 8 hours per day, 80% utilization
Compactor (roller, 240 hp)	160	hours	25 days, 8 hours per day, 80% utilization
Backhoe loader, 48 hp 5/8 CY	44.8	hours	7 days, 8 hours per day, 80% utilization
Asphalt Paver, 130 hp	6.4	hours	1 day, 8 hours per day, 80% utilization
1 Tandem Roller, 10 ton	6.4	hours	1 day, 8 hours per day, 80% utilization
DPT Drill Rig	8.96	hours	7 wells, 5 wells per day, 8 hours per day, 80% utilization

Residual Handling			
Item	Quantity	Units	Comments
Disposal decon water	12.48	ton	3000 gallons, 8.32 ppg, 2000 lb per ton
Non-hazardous soil transportation and disposal	4386	ton	
hazardous soil transportation and disposal	488	ton	
IDW disposal	4.14	ton	25 drums, 55 gallons per drum, 721 kg/m3 density

Transportation-residual handling			
Item	Quantity	Units	Comments
Disposal decon water	100	miles	4000 gallons, 8.32 ppg, 2000 lb per ton
Non-hazardous soil transportation and disposal	100	miles	
hazardous soil transportation and disposal	500	miles	
IDW disposal	100	miles	25 drums, 55 gallons per drum

Laboratory Analytical Services			
Item	Quantity	Units	Comments
Soil Sampling	14400		72 samples, $200 per sample

LTM			
Transportation-Personnel			

Item	Quantity	Units	Comments
Site Inspection	1500		1 visti per year, 50 miles per visit, 1 person, for 30 years
5 year review	300	miles	1 visit every 5 years, 50 miles per visit, 1 person, during 30 yeasr

Alternative S4: Soil Cover, Selected Excavation and Disposal, and Land Use Controls

RAC

Materials

Item	Quantity	Units	Comments
Decon water	3000	gallons	
Equipment Decon Pad	700.471211	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.157464	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Monitoring Well Abandonment Wells	11751.13	lb	705 lf, 21wells, assume 2 in diameter, assume sand dry, 1602 kg/m3,
Backfill (cover & excavation)	46800000	lb	Assume top soil, 15600 CY
Select fill (building)	420000	lb	Assume top soil, 140 CY
Top soil	6600000	lb	Assume top soil, 2200 CY
Revegetation, seed	292.5	lb	Assume fertilizer, 13,000 sy` (thousand square feet), 3 lb of seed per 1.2 msf
Pavement Replacement, stone base	75,007.19	lb	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3
Pavement Replacement, bounder course	23,753.84	lb	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3
Pavement Replacement, topping	11,252.64	lb	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3
Replace monitoring wells	331.2	lb	13 wells, 460 lf, assume 2 in diameter
Replace monitoring well head	150	lb	3 well heads, 50 lb per unit, assume PVC

Transportation-Personnel

Item	Quantity	Units	Comments
Soil Sampling Labor	500	miles	10 days, 50 miles per trip, 1 person
Clear & Grub Labor	1200	miles	4 days, 50 miles per day, 6 people
excavation and disposal labor	9750	miles	65 days, 50 miles per day, 3 people
Labor for Revegetation	3900	miles	13 days, 50 miles per day, 6 people
Labor for pavement replacement	250	miles	1 day, 50 miles per day 5 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	80	ton	8 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip
Brush Chipper, 130 HP	2.85	ton	1 wood chipper, 2.85 tons per woodchipper, 100 miles round trip
1 crawler loader, 3CY	12.0705	ton	24141 lb per loader, 1 loader, 100 miles round trip
2 chain saws	0.0165	ton	16.5 lb per chain saw, 2 chain sawys, 100 miles round trip
Excavator, 2.5 CY	20	ton	1 excavator, 20 ton per excavator, 100 miles round trip
Dozer 300 hp	28	ton	1 dozer, 28 tons per dozer
Compactor (roller, 240 hp)	11.176	ton	1 compactor roller, 115 hp, 22,352 lbs, 100 miles round trip
Backhoe loader, 48 hp 5/8 CY	11.233	ton	1 backhoe loader, 1 CY, 22466 lb per unit, 100 miles round trip
Asphalt Paver, 130 hp	17.645	ton	1 Asphalt paver, 130 hp, 35290 pounds per unit, 100 miles round trip
1 Tandem Roller, 10 ton	10	ton	
DPT Drill Rig	3.05	ton	1 drill rig, 6100 lb, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3

Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Monitoring Well Abandonment Wells	5.88	ton	705 lf, 21wells, assume 2 in diameter, assume sand dry, 1602 kg/m3,
Backfill (cover & excavation)	23,400.00	ton	Assume top soil, 15600 CY
Select fill (building)	210.00	ton	Assume top soil, 140 CY
Top soil	3,300.00	ton	Assume top soil, 2200 CY
Revegetation, seed	0.15	ton	Assume fertilizer, 13,000 sy` (thousand square feet), 3 lb of seed per 1.2 msf
Pavement Replacement, stone base	37.50	ton	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3
Pavement Replacement, bounder course	11.88	ton	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3
Pavement Replacement, topping	5.63	ton	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3
Replace monitoring wells	0.17	ton	13 wells, 460 lf, assume 2 in diameter
Replace monitoring well head	0.08	ton	3 well heads, 50 lb per unit, assume PVC

Equipment Use			
Item	Quantity	Units	Comments
Brush Chipper, 130 HP	25.6	hours	4 days, 8 hours per day, 80% utilization
1 crawler loader, 3CY	25.6	hours	4 days, 8 hours per day, 80% utilization
2 chain saws	25.6	hours	4 days, 8 hours per day, 80% utilization
Excavator, 2.5 CY	416	hours	65 days, 8 hours per day, 80% utilization
Dozer 300 hp	416	hours	65 days, 8 hours per day, 80% utilization
Compactor (roller, 240 hp)	416	hours	65 days, 8 hours per day, 80% utilization
Backhoe loader, 48 hp 5/8 CY	83.2	hours	13 days, 8 hours per day, 80% utilization
Asphalt Paver, 130 hp	6.4	hours	1 day, 8 hours per day, 80% utilization
1 Tandem Roller, 10 ton	6.4	hours	1 day, 8 hours per day, 80% utilization
DPT Drill Rig	16.64	hours	13 wells, 5 wells per day, 8 hours per day, 80% utilization

Residual Handling			
Item	Quantity	Units	Comments
Disposal decon water	12.48	ton	3000 gallons, 8.32 ppg, 2000 lb per ton
Non-hazardous soil transportation and disposal	13650	ton	
hazardous soil transportation and disposal	1470	ton	
IDW disposal	6.62	ton	40 drums, 55 gallons per drum, 721 kg/m3 density

Transportation-residual handling			
Item	Quantity	Units	Comments
Disposal decon water	100	miles	3000 gallons, 8.32 ppg, 2000 lb per ton
Non-hazardous soil transportation and disposal	100	miles	
hazardous soil transportation and disposal	500	miles	
IDW disposal	100	miles	40 drums, 55 gallons per drum, 721 kg/m3 density

Laboratory Analytical Services			
Item	Quantity	Units	Comments
Soil Sampling	12000		60 samples, $200 per sample

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
Site Inspection	1500		1 visti per year, 50 miles per visit, 1 person, for 30 years

5 year review	300 miles	1 visit every 5 years, 50 miles per visit, 1 person, during 30 yeasr

Alternative S5: Excavation and Disposal - Unrestricted Site Use

RAC

Materials

Item	Quantity	Units	Comments
Decon water	9000	gallons	
Equipment Decon Pad	700.471211	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.157464	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Monitoring Well Abandonment Wells	28336.05		1700 lf, 42wells, assume 2 in diameter, assume sand dry, 1602 kg/m3,
Backfill (cover & excavation)	231000000		Assume top soil, 77000 CY
Select fill (building)	420000		Assume top soil, 140 CY
Top soil	15900000		Assume top soil, 5300 CY
Revegetation, seed	708.75	lb	Assume fertilizer, 31500 sy, 3 lb of seed per 1.2 msf
Pavement Replacement, stone base	75,007.19	lb	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3
Pavement Replacement, bounder course	23,753.84	lb	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3
Pavement Replacement, topping	11,252.64	lb	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3
Replace monitoring wells	525.6	lb	18 wells, 730 lf, assume 2 in diameter
Replace monitoring well head	150	lb	3 well heads, 50 lb per unit, assume PVC

Transportation-Personnel

Item	Quantity	Units	Comments
Sampling labor	500	miles	10 days, 50 miles per day, 1 person
Clear & Grub Labor	3,000	miles	10 days, 50 miles per day, 6 people
excavation and disposal labor	48,750	miles	195 days, 50 miles per day, 5 people
Labor for Revegetation	9,600	miles	32 days, 50 miles per day, 6 people
Labor for pavement replacement	250	miles	1 day, 50 miles per day 5 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	80	ton	8 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip
Brush Chipper, 130 HP	2.85	ton	1 wood chipper, 2.85 tons per woodchipper, 100 miles round trip
1 crawler loader, 3CY	12.0705	ton	24141 lb per loader, 1 loader, 100 miles round trip
2 chain saws	0.0165	ton	16.5 lb per chain saw, 2 chain sawys, 100 miles round trip
Excavator, 2.5 CY, 2 units	20	ton	1 excavator, 20 ton per excavator, 100 miles round trip
Dozer 300 hp, 2 units	28	ton	1 dozer, 28 tons per dozer
Compactor (roller, 240 hp), 2 units	11.176	ton	1 compactor roller, 115 hp, 22,352 lbs, 100 miles round trip
Backhoe loader, 48 hp 5/8 CY	11.233	ton	1 backhoe loader, 1 CY, 22466 lb per unit, 100 miles round trip
Asphalt Paver, 130 hp	17.645	ton	1 Asphalt paver, 130 hp, 35290 pounds per unit, 100 miles round trip
1 Tandem Roller, 10 ton	10	ton	
DPT Drill Rig	3.05	ton	1 drill rig, 6100 lb, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3

Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Monitoring Well Abandonment Wells	14.17	ton	1700 lf, 42wells, assume 2 in diameter, assume sand dry, 1602 kg/m3,
Backfill (cover & excavation)	115,500.00	ton	Assume top soil, 77000 CY
Select fill (building)	210.00	ton	Assume top soil, 140 CY
Top soil	7,950.00	ton	Assume top soil, 5300 CY
Revegetation, seed	0.35	ton	Assume fertilizer, 31500 sy, 3 lb of seed per 1.2 msf
Pavement Replacement, stone base	37.50	ton	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3
Pavement Replacement, bounder course	11.88	ton	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3
Pavement Replacement, topping	5.63	ton	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3
Replace monitoring wells	0.26	ton	18 wells, 730 lf, assume 2 in diameter
Replace monitoring well head	0.08	ton	3 well heads, 50 lb per unit, assume PVC

Equipment Use

Item	Quantity	Units	Comments
Brush Chipper, 130 HP	64	hours	10 days, 8 hours per day, 80% utilization
1 crawler loader, 3CY	64	hours	10 days, 8 hours per day, 80% utilization
2 chain saws	64	hours	10 days, 8 hours per day, 80% utilization
Excavator, 2.5 CY, 2 units	1248	hours	195 days, 8 hours per day, 80% utilization
Dozer 300 hp, 2 units	1248	hours	195 days, 8 hours per day, 80% utilization
Compactor (roller, 240 hp), 2 units	1248	hours	195 days, 8 hours per day, 80% utilization
Backhoe loader, 48 hp 5/8 CY	204.8	hours	32 days, 8 hours per day, 80% utilization
Asphalt Paver, 130 hp	6.4	hours	1 day, 8 hours per day, 80% utilization
1 Tandem Roller, 10 ton	6.4	hours	1 day, 8 hours per day, 80% utilization
DPT Drill Rig	23.04	hours	18 wells, 5 wells per day, 8 hours per day, 80% utilization

Residual Handling

Item	Quantity	Units	Comments
Disposal decon water	37.44	ton	9000 gallons, 8.32 ppg, 2000 lb per ton
Non-hazardous soil transportation and disposal	121950	ton	
hazardous soil transportation and disposal	1470	ton	
IDW disposal	8.94		54 drums, 55 gallons per drum, 721 kg/m3 density

Transportation-residual handling

Item	Quantity	Units	Comments
Disposal decon water	100	miles	9000 gallons, 8.32 ppg, 2000 lb per ton
Non-hazardous soil transportation and disposal	100	miles	
hazardous soil transportation and disposal	500	miles	
IDW disposal	100	miles	54 drums, 55 gallons per drum, 721 kg/m3 density

Laboratory Analytical Services

Item	Quantity	Units	Comments
Soil Sampling	53200	dollars	266 samples, $200 per sample

Alternative S6: Soil Cover, Selected Excavation and Disposal, Monitoring and Land Use Controls

RAC

Materials

Item	Quantity	Units	Comments
Decon water	4000	gallons	
Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Monitoring well abandonmnet wells	23002.21	lb	38 wells, 1380 ft, 2 inch diameter, assume sand dry, 1602 kg/m3,
Cover fill	23610000	lb	7870 CY, Assume common soil, 1.5 ton/cy, 2000 lb per ton
Cover Liner	2625	lb	Assume HDPE, 47250 sf, 8oz/sy
Top soil	23610000	lb	Assume Top soil, 7870 CY, 1.5 ton/cy, 2000 lb pre ton
Select Fill	5400000	lb	Assume top soil, 1800 CY, 1.5 ton/CY, 2000 lb per ton
Revegetation, seed	1064.25	lb	Assume fertilizer, 47300 sy, 3 lb of seed per 1.2 msf
Replacement monitoring wells	799.2	lb	1100 lf, Assume PVC, 2 inch, SCH 40, 28 wells, 0.72 lb/ft
New LUC Monitoring wells	32.4	lb	45 lf, Assume PVC,2 inch SCH 40, 3 wells, 0.72 lb/ft
monitoring and LUC well heads	250	lb	5 units, Assume PVC, 50 lb per unit
Pavement Replacement, stone base	75,007.19	lb	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3
Pavement Replacement, bounder course	23,753.84	lb	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3
Pavement Replacement, topping	11,252.64	lb	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3

Transportation-Personnel

Item	Quantity	Units	Comments
Soil Sampling labor	500	miles	10 days, 50 miles per day, 1 person
Clear and grub crew	4200	miles	14 days, 50 miles per day, 6 people
Site Labor for area cover	6000	miles	40 days, 50 miles per day, 3 people
Site labor for Selected Excavation	2250	miles	15 days, 50 miles per day, 3 people
Labor for Revegetation	14400	miles	48 days, 50 miles per day, 6 people
Labor for pavement replacement	250	miles	1 day, 50 miles per day 5 people
Drillers	700	miles	7 days, 50 miles per day, 2 people

Transportation-equipment

Item	Quantity	Units	Comments
Trailers	90	ton	9 trailers, 10 ton per trailer, 100 miles round trip
Decon Water Storage Tank	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 ln per 500 gal capacity tank
Clean Water Storage Tank	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip
brush chipper, 130 HP	2.85	ton	1 wood chipper, 2.85 tons per woodchipper, 100 miles round trip
1 loader, 3CY	12.0705	ton	24141 lb per loader, 1 loader, 100 miles round trip
2 chain saws, 36in long (gas)	0.0165	ton	16.5 lb per chain saw, 2 chain sawys, 100 miles round trip
Excavator, 2.5 CY	20	ton	1 excavator, 20 ton per excavator, 100 miles round trip
Dozer, 300 hp	28	ton	1 dozer, 28 tons per dozer
Compactor (roller 240 hp)	11.176	ton	1 compactor roller, 115 hp, 22,352 lbs, 100 miles round trip
Excavator, 2.5 CY	20	ton	1 excavator, 20 ton per excavator, 100 miles round trip

Compactor (roller 240 hp)	11.176	ton	1 compactor roller, 115 hp, 22,352 lbs, 100 miles round trip
Backhoe loader, 48 hp 5/8 CY	11.233	ton	1 backhoe loader, 1 CY, 22466 lb per unit, 100 miles round trip
Asphalt Paver, 130 hp	17.645	ton	1 Asphalt paver, 130 hp, 35290 pounds per unit, 100 miles round trip
1 Tandem Roller, 10 ton	10	ton	
DPT Drill Rig	3.05		1 drill rig, 6100 lb, 100 miles round trip

Transportation-materials			
Item	Quantity	Units	Comments
Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Monitoring well abandonmnet wells	11.50	ton	38 wells, 1380 ft, 2 inch diameter, assume sand dry, 1602 kg/m3,
Cover fill	11805	ton	7870 CY, Assume common soil, 1.5 ton/cy, 2000 lb per ton
Cover Liner	11.8125	ton	Assume HDPE, 47250 sf, 8oz/sy
Top soil	11805	ton	Assume Top soil, 7870 CY, 1.5 ton/cy, 2000 lb pre ton
Select Fill	2700	ton	Assume top soil, 1800 CY, 1.5 ton/CY, 2000 lb per ton
Revegetation, seed	0.532125	lb	Assume fertilizer, 47300 sy, 3 lb of seed per 1.2 msf
Replacement monitoring wells	0.3996	lb	1100 lf, Assume PVC, 2 inch, SCH 40, 28 wells, 0.72 lb/ft
New LUC Monitoring wells	0.0162	lb	45 lf, Assume PVC,2 inch SCH 40, 3 wells, 0.72 lb/ft
monitoring and LUC well heads	0.125	lb	5 units, Assume PVC, 50 lb per unit
Pavement Replacement, stone base	37.50	lb	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3
Pavement Replacement, bounder course	11.88	lb	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3
Pavement Replacement, topping	5.63	lb	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3

Equipment Use			
Item	Quantity	Units	Comments
brush chipper, 130 HP	25.6	hours	14 days, 8 hours per day, 80% utilization
1 loader, 3CY	25.6	hours	14 days, 8 hours per day, 80% utilization
2 chain saws, 36in long (gas)	51.2	hours	14 days, 8 hours per day, 80% utilization
Excavator, 2.5 CY	256	hours	40 days, 8 hours per day, 80% utilization
Dozer, 300 hp	256	hours	40 days, 8 hours per day, 80% utilization
Compactor (roller 240 hp)	256	hours	40 days, 8 hours per day, 80% utilization
Excavator, 2.5 CY	96	hours	15 days, 8 hours per day, 80% utilization
Compactor (roller 240 hp)	96	hours	15 days, 8 hours per day, 80% utilization
DPT drill	39.68	hours	31 wells, 5 wells per day, 8 hours per day, 80% utilization
Backhoe loader, 48 hp 5/8 CY	300.8	hours	47 days, 8 hours per day, 80% utilization
Asphalt Paver, 130 hp	6.4	hours	1 day, 8 hours per day, 80% utilization
1 Tandem Roller, 10 ton	6.4	hours	1 day, 8 hours per day, 80% utilization

Residual Handling			
Item	Quantity	Units	Comments
Disposal decon water	16.64	ton	4000 gallons, 8.32 ppg, 2000 lb per ton
Non hazardous soil transportation and disposal	2700	ton	2700 ton
IDW disposal	16.55	ton	100 drum, 55 gallons per drum, 721 kg/m3

Transportation-residual handling			
Item	Quantity	Units	Comments
Disposal decon water	100	miles	4000 gallons, 8.32 ppg, 2000 lb per ton
Non hazardous soil transportation and disposal	100	miles	2700 ton
IDW disposal	100	miles	100 drum, 55 gallons per drum,

Laboratory Analytical Services			
Item	Quantity	Units	Comments
Site Preparation Samples	5,600	Dollars	28 samples, $200 per sample
Soil Sampling TCLP	400	Dollars	2 sample, $200 per sample

LTM			
Transportation-Personnel			
Item	Quantity	Units	Comments
Site Inspection	1500		1 visti per year, 50 miles per visit, 1 person, for 30 years
5 year review	300	miles	1 visit every 5 years, 50 miles per visit, 1 person, during 30 yeasr

APPENDIX C-3: RESULTS

APPENDIX C-3-1: GROUNDWATER RESULTS

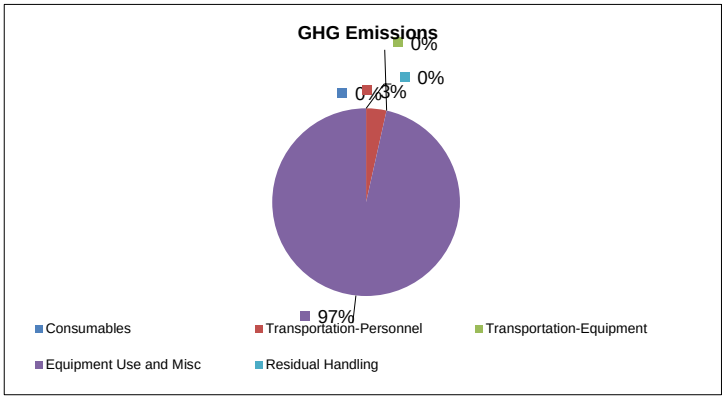
Sustainable Remediation - Environmental Footprint Summary
G-2

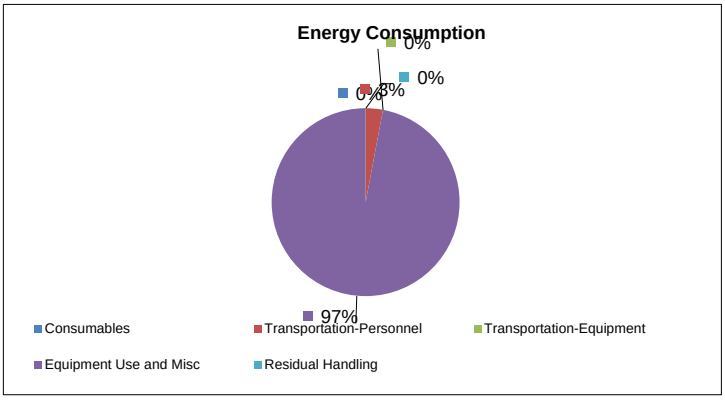
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	5.26	6.6E+01	NA	1.9E-03	6.9E-05	3.9E-04	1.1E-04	8.7E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	145.06	2.2E+03	0.0E+00	5.0E-01	3.3E-01	1.3E-02	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	150.32	2.23E+03	0.00E+00	5.04E-01	3.35E-01	1.31E-02	1.08E-04	8.66E-03
Total		**1.5E+02**	**2.2E+03**	**0.0E+00**	**5.0E-01**	**3.3E-01**	**1.3E-02**	**1.1E-04**	**8.7E-03**

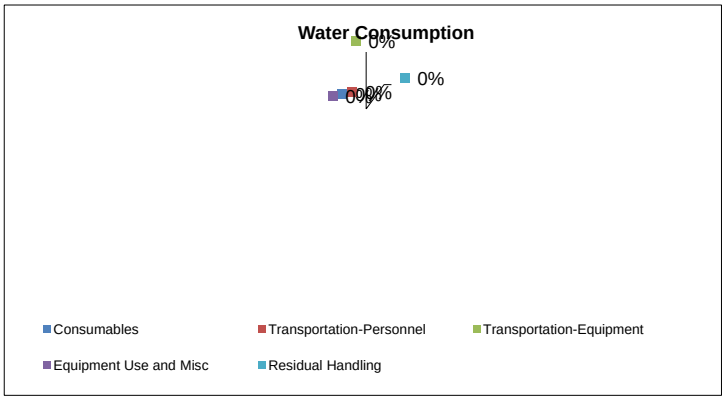
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	6.9E-02
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**6.9E-02**

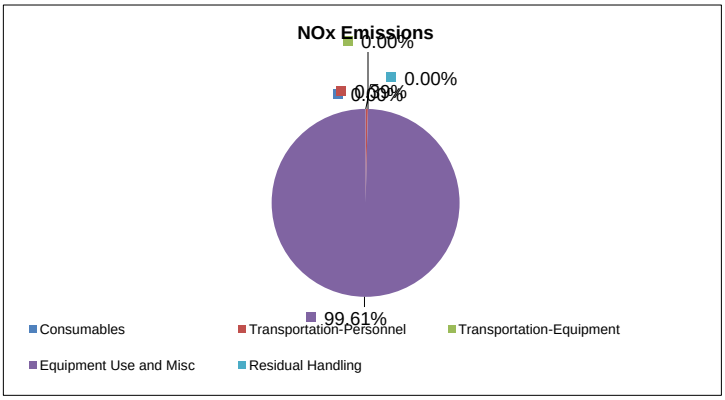
Total Cost with Footprint Reduction
$0

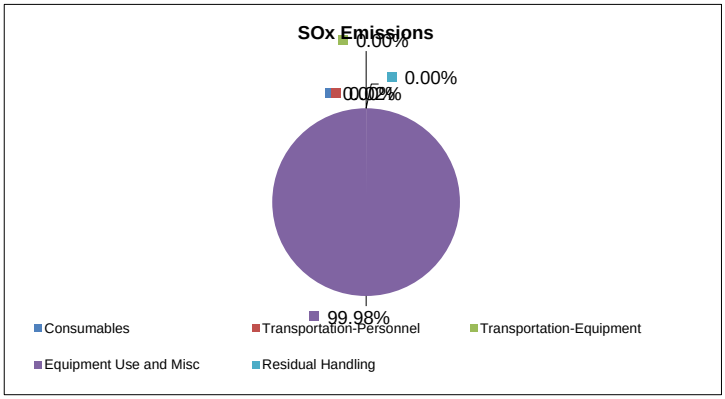
SiteWise™ Results Alternative G-2
Remedial Action Construction Stage
Site 16, NCBC Davisville
Davisville, Rhode Island

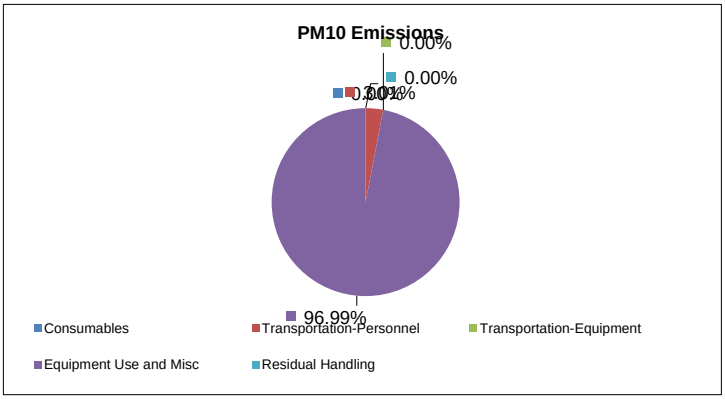


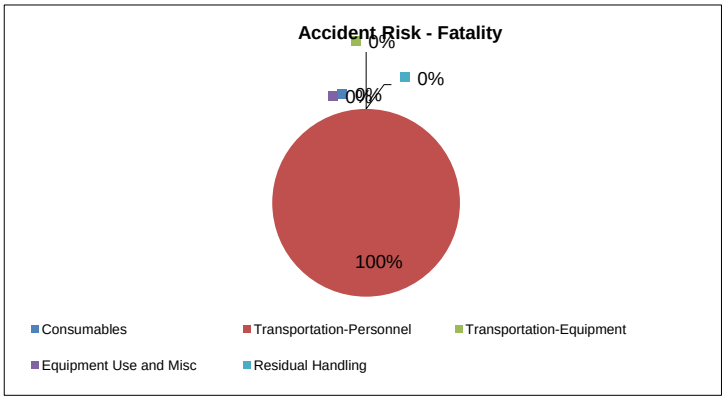


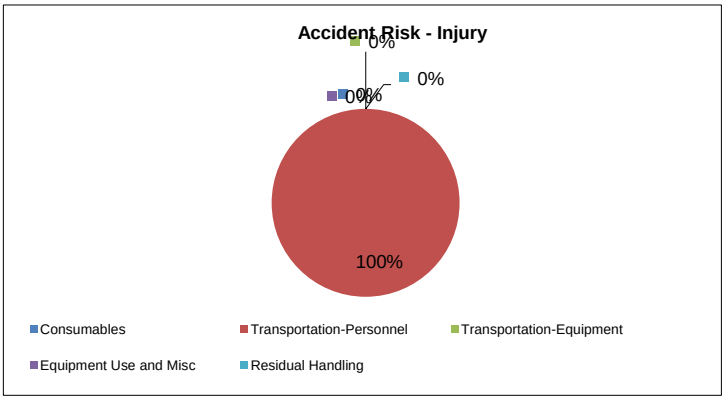


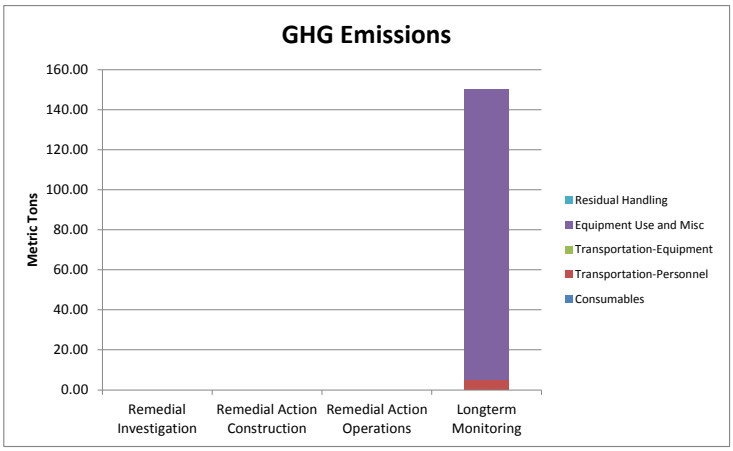


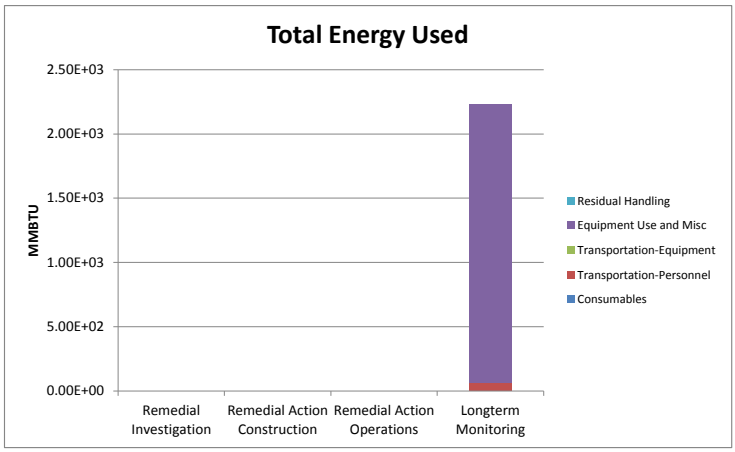


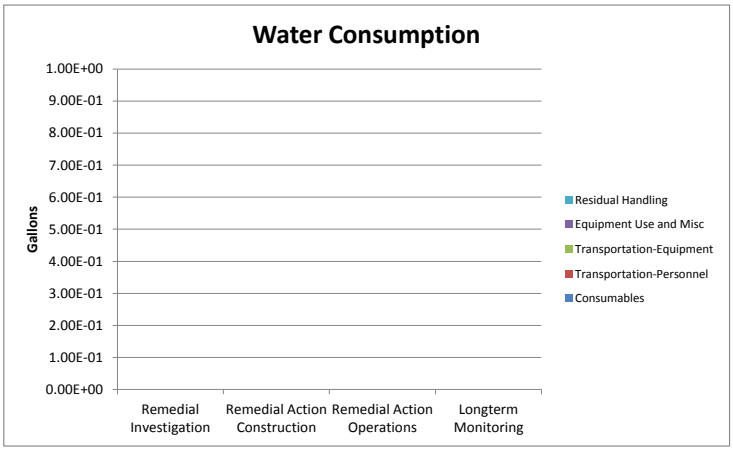


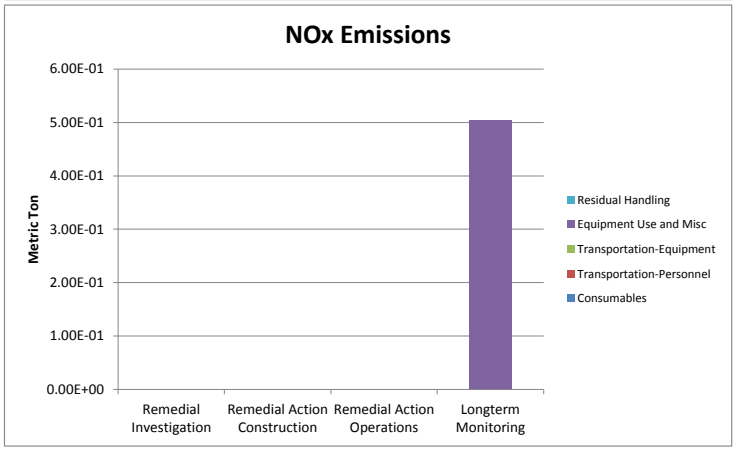


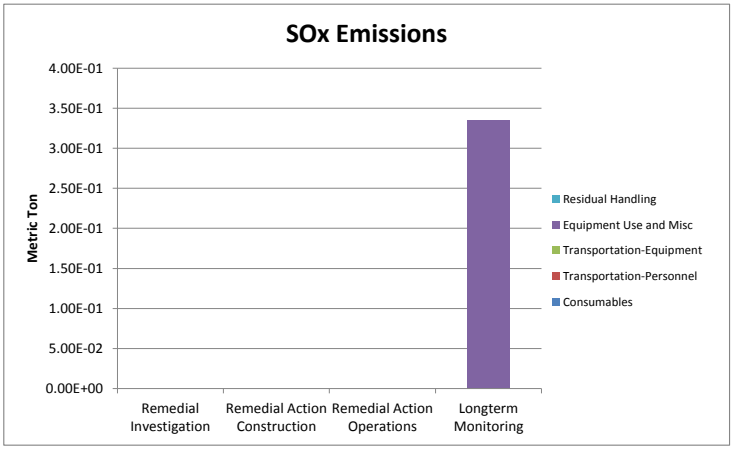


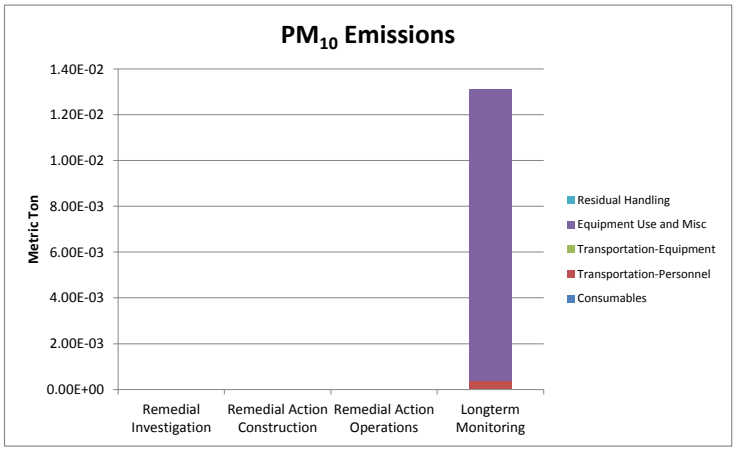

GHG Emissions
Metric Tons
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

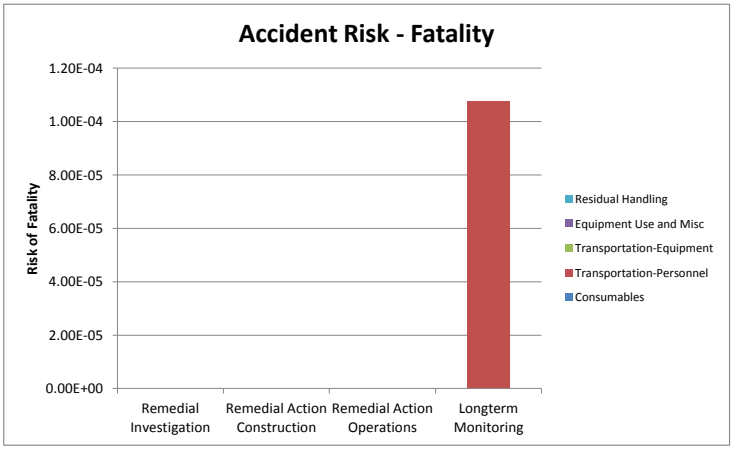

Total Energy Used
MMBTU
2.50E+03
2.00E+03
1.50E+03
1.00E+03
5.00E+02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

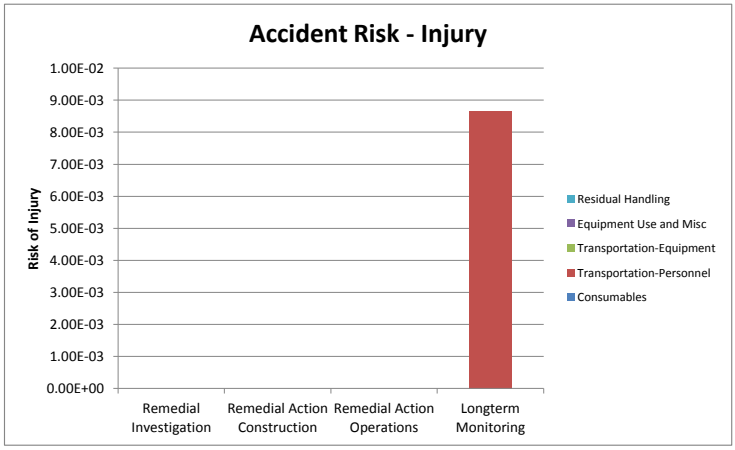

Water Consumption
Gallons
1.00E+00
9.00E-01
8.00E-01
7.00E-01
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
1.40E-02
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
1.20E-04
1.00E-04
8.00E-05
6.00E-05
4.00E-05
2.00E-05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

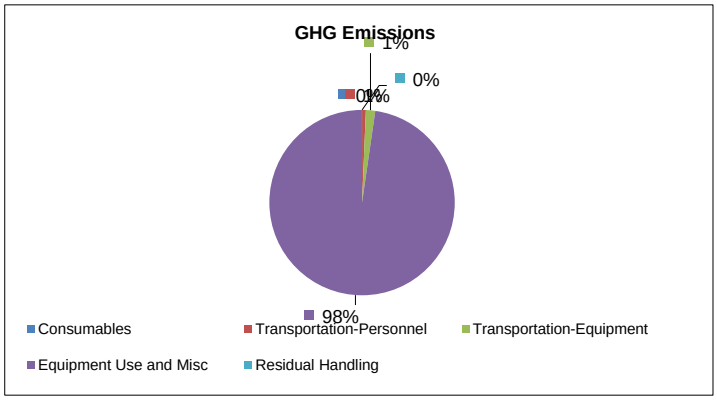

Accident Risk - Injury
Risk of Injury
1.00E-02
9.00E-03
8.00E-03
7.00E-03
6.00E-03
5.00E-03
4.00E-03
3.00E-03
2.00E-03
1.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

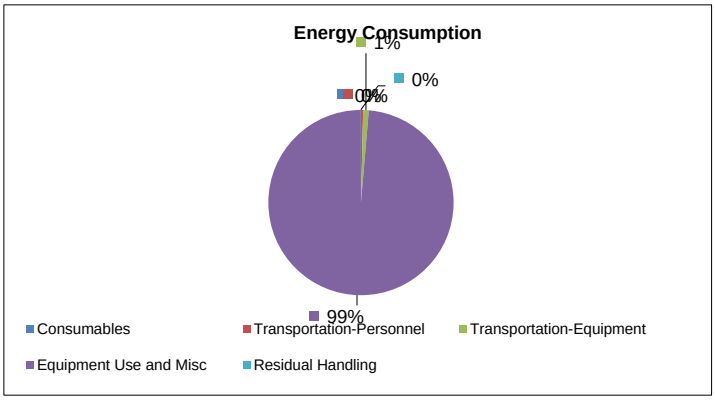
Sustainable Remediation - Environmental Footprint Summary
G-3

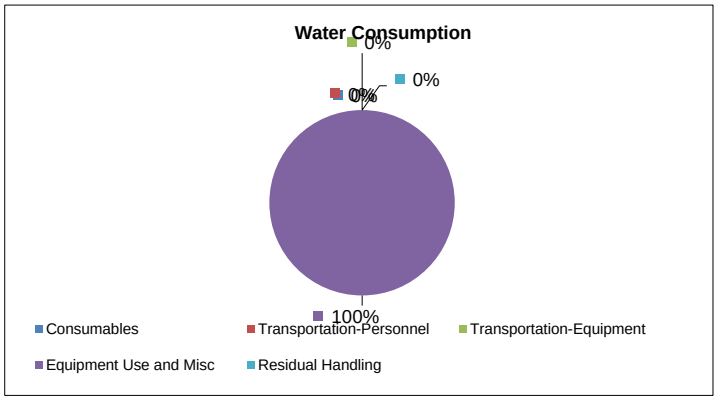
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	7.32	9.2E+01	NA	2.7E-03	9.5E-05	5.5E-04	1.5E-04	1.2E-02
	Transportation-Equipment	18.17	2.4E+02	NA	5.7E-03	1.0E-04	5.1E-04	4.5E-05	3.6E-03
	Equipment Use and Misc	1,086.78	2.4E+04	4.5E+05	3.3E-01	7.4E-01	1.3E-01	1.8E-04	4.4E-02
	Residual Handling	0.18	2.4E+00	NA	5.7E-05	1.0E-06	5.1E-06	7.8E-07	6.3E-05
	Sub-Total	1,112.45	2.44E+04	4.49E+05	3.40E-01	7.35E-01	1.27E-01	3.71E-04	5.99E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	4.12	5.2E+01	NA	1.5E-03	5.4E-05	3.1E-04	8.4E-05	6.8E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	60.15	9.0E+02	0.0E+00	2.1E-01	1.4E-01	5.3E-03	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	64.26	9.49E+02	0.00E+00	2.10E-01	1.39E-01	5.58E-03	8.42E-05	6.78E-03
Total		**1.2E+03**	**2.5E+04**	**4.5E+05**	**5.5E-01**	**8.7E-01**	**1.3E-01**	**4.6E-04**	**6.7E-02**

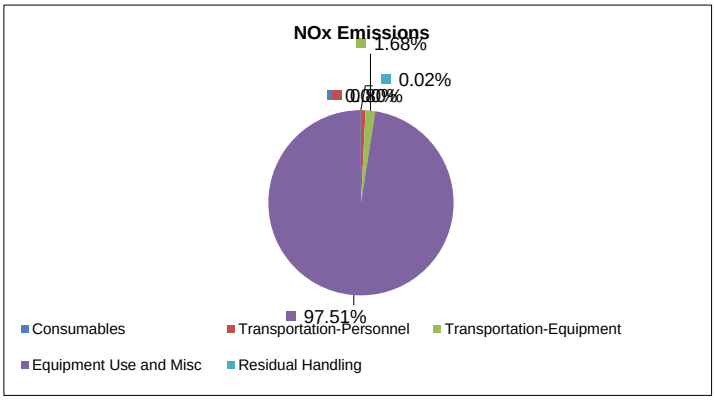
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	1.1E+06	0	4.8E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	5.4E-02
Total	**0.0E+00**	**0.0E+00**	**1.1E+06**	**$0**	**5.3E-01**

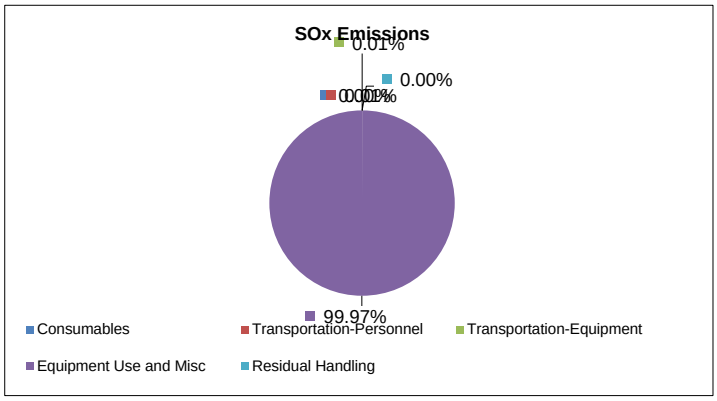
Total Cost with Footprint Reduction
$0

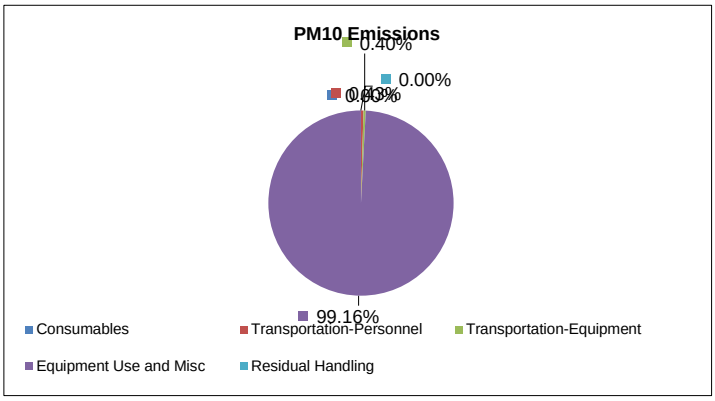

GHG Emissions
1%
0%
98%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

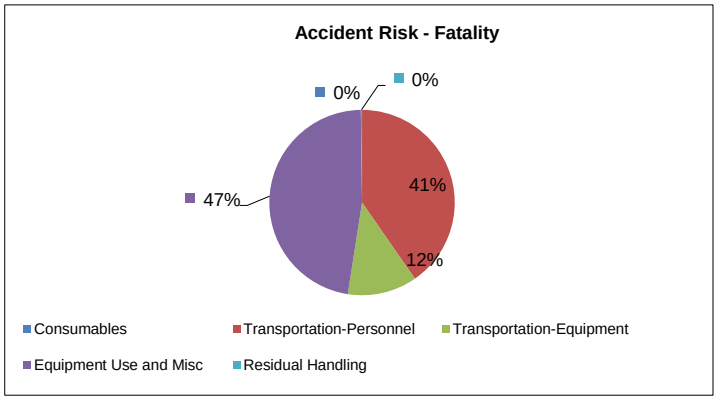

Energy Consumption
1%
0%
99%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

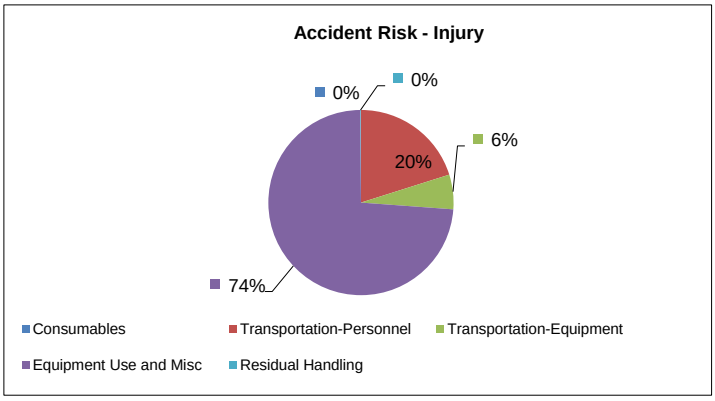

Water Consumption
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

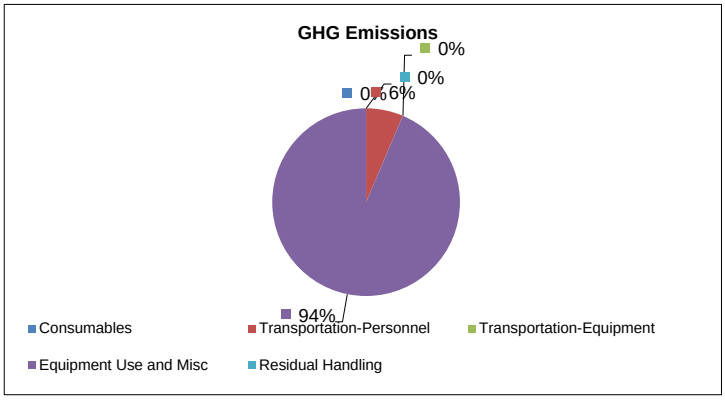

NOx Emissions
1.68%
0.02%
97.51%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

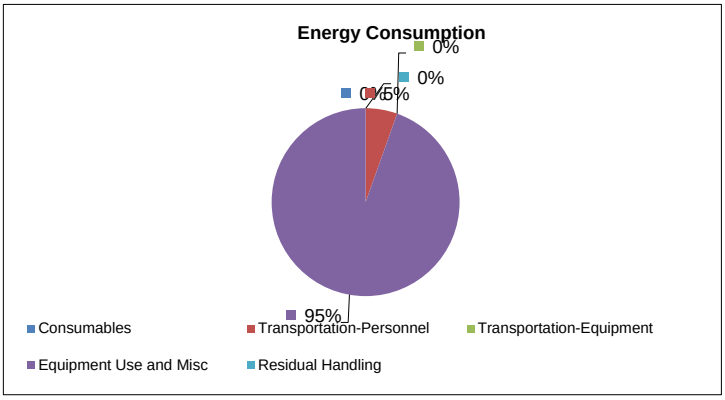

SOx Emissions
0.01%
0.00%
99.97%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

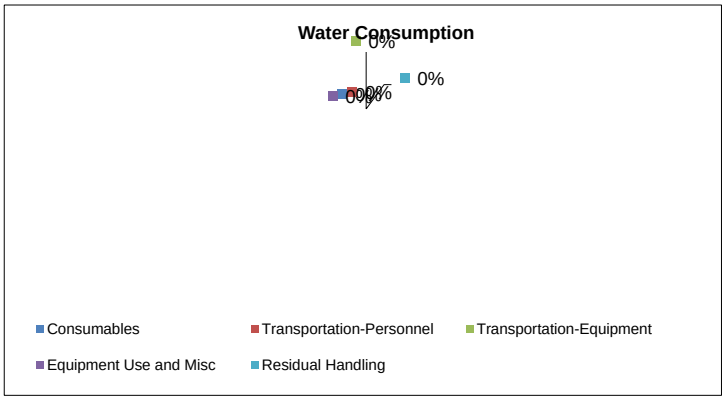

PM10 Emissions
0.40%
0.00%
99.16%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

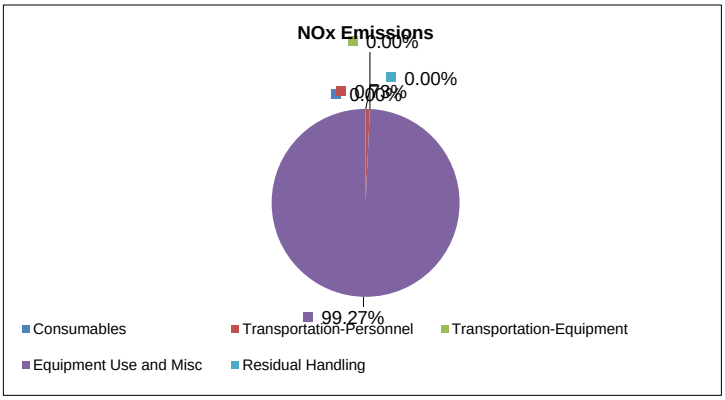

Accident Risk - Fatality
0%
0%
41%
47%
12%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

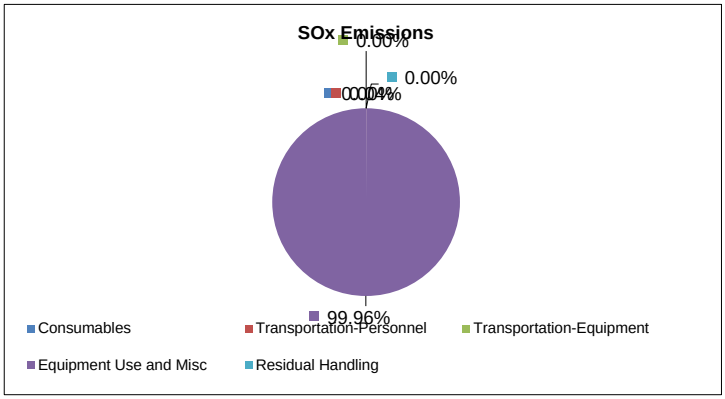

Accident Risk - Injury
0%
0%
6%
20%
74%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

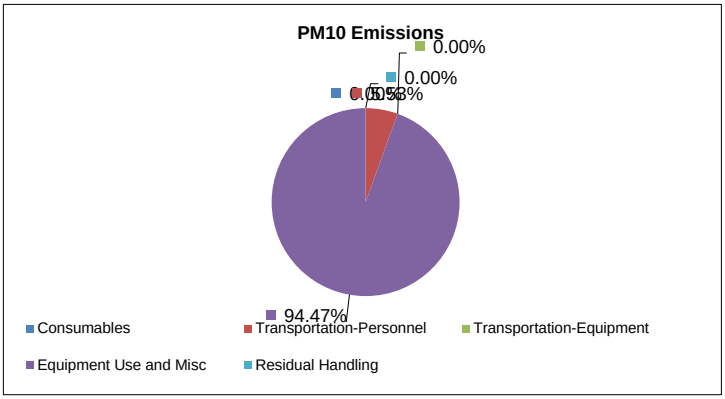

GHG Emissions
0%
0%
0%
6%
94%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

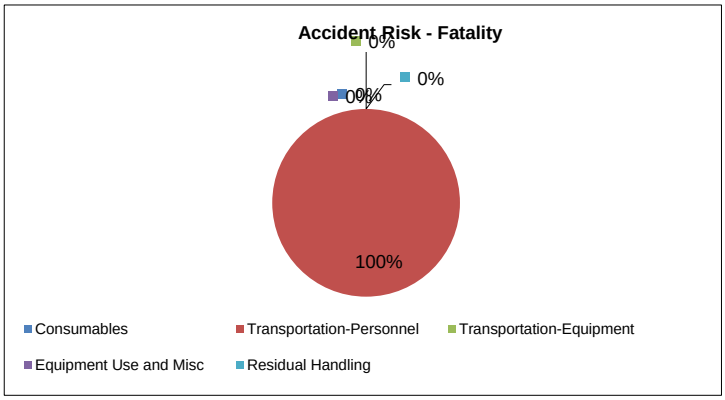

Energy Consumption
0%
0%
0%
5%
95%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

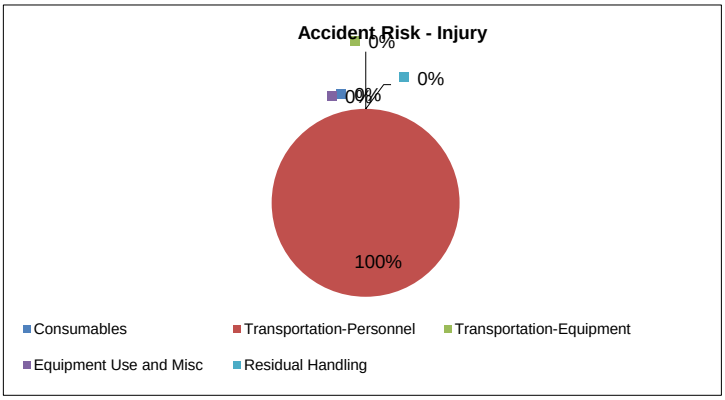

Water Consumption
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

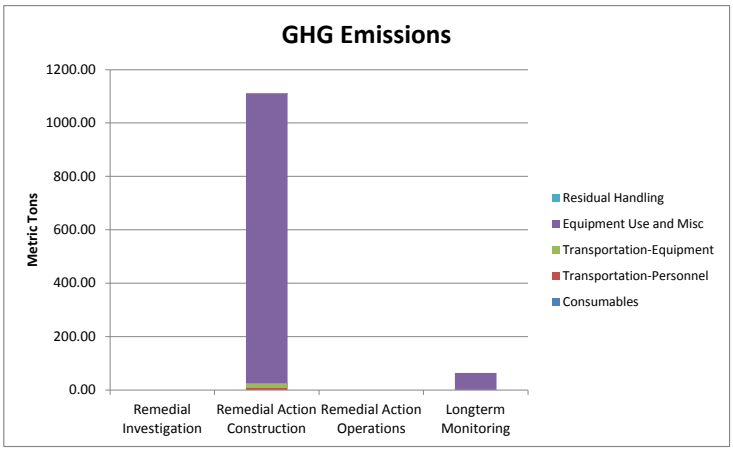

NOx Emissions
0.00%
0.00%
99.27%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

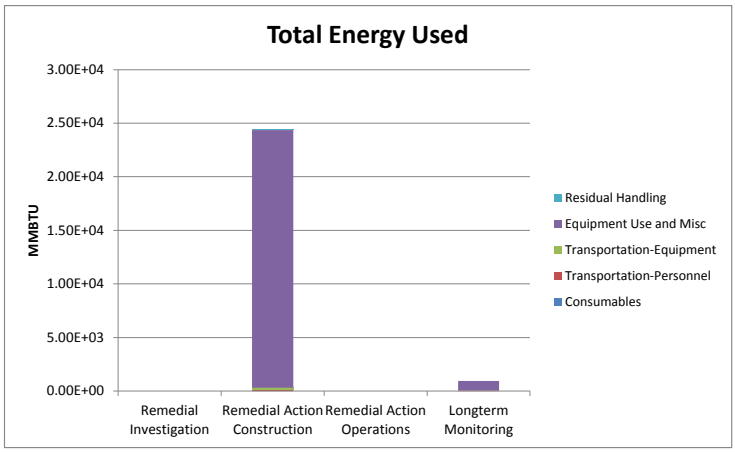

SOx Emissions
0.00%
0.00%
99.96%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

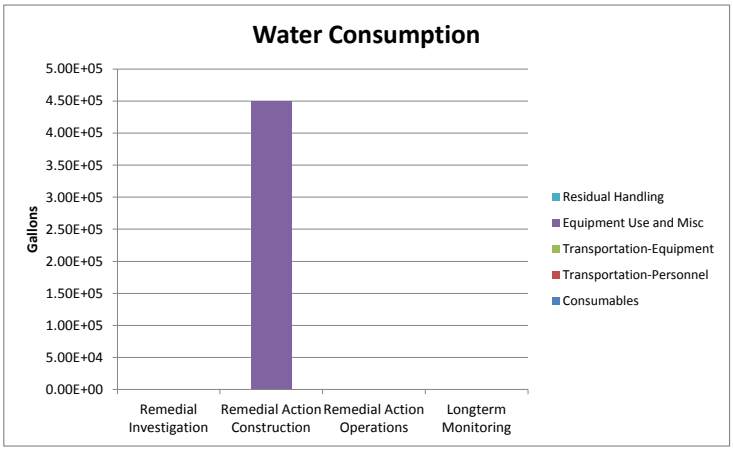

PM10 Emissions
0.00%
0.00%
94.47%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

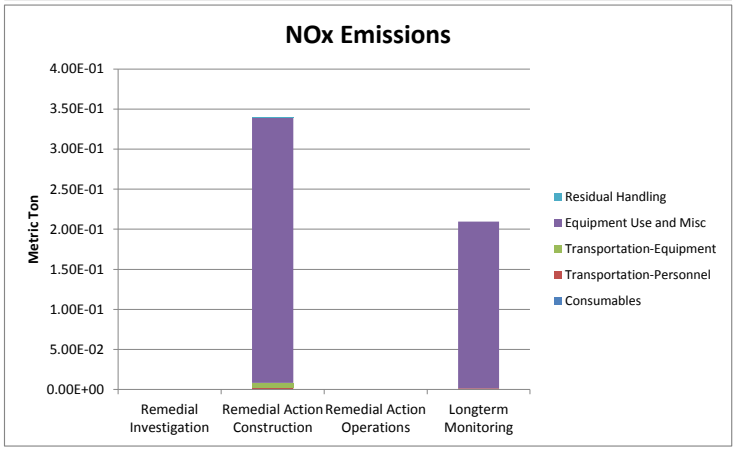

Accident Risk - Fatality
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

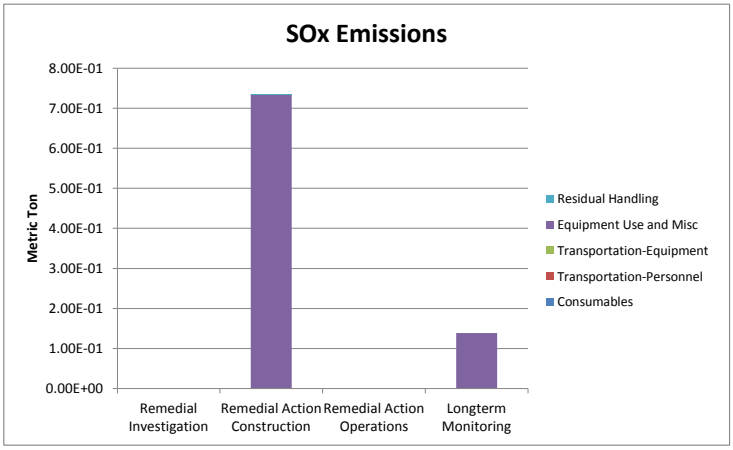

Accident Risk - Injury
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

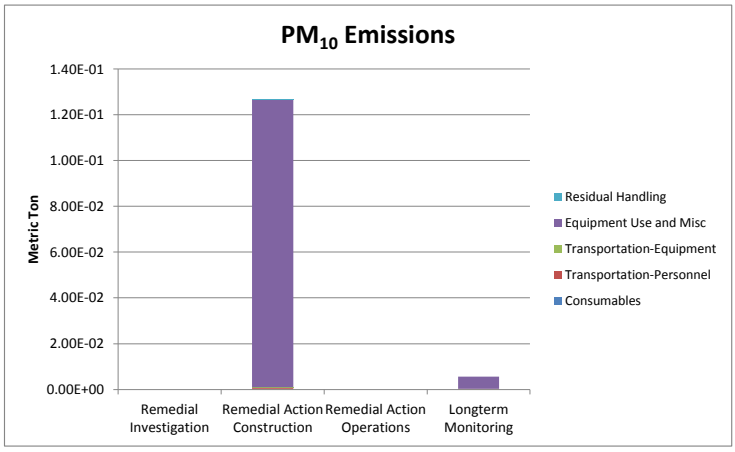

GHG Emissions
Metric Tons
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

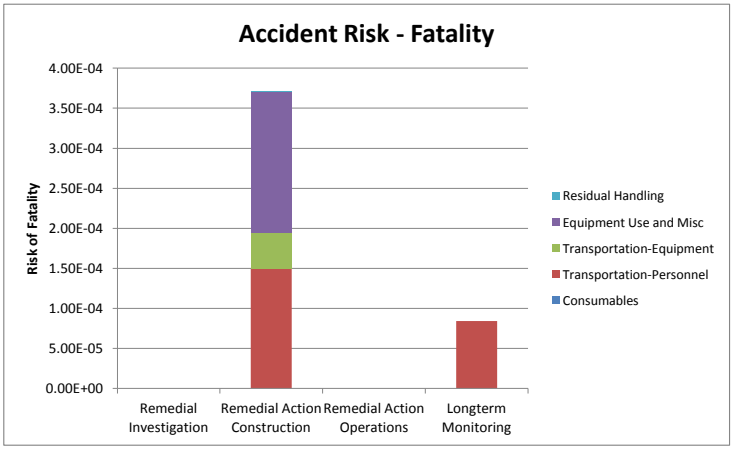

Total Energy Used
MMBTU
3.00E+04
2.50E+04
2.00E+04
1.50E+04
1.00E+04
5.00E+03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

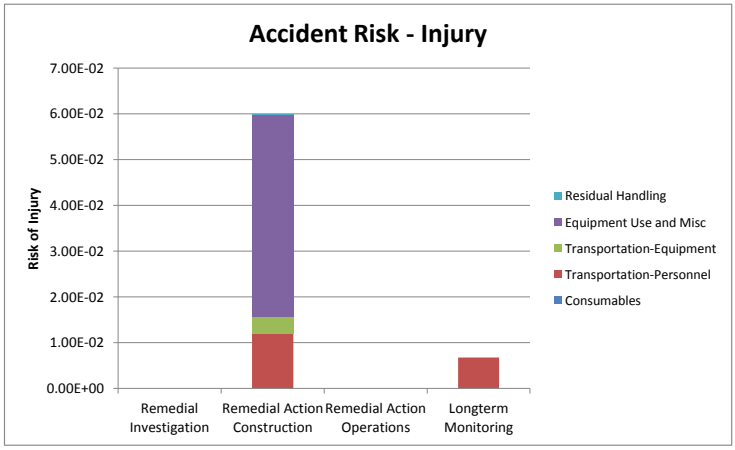

Water Consumption
Gallons
5.00E+05
4.50E+05
4.00E+05
3.50E+05
3.00E+05
2.50E+05
2.00E+05
1.50E+05
1.00E+05
5.00E+04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
8.00E-01
7.00E-01
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
1.40E-01
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
4.00E-04
3.50E-04
3.00E-04
2.50E-04
2.00E-04
1.50E-04
1.00E-04
5.00E-05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
7.00E-02
6.00E-02
5.00E-02
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Pipe, 1" PVC Sched 40	PVC	1500 wells, 60 ft each, 1" dia, .315 lb/ft	90,000.00	lft	63.89	32.14	0.08	0.37	0.00	0.12	0.02	1172.19	154.75
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Injection Well Head	PVC	1500 wells 50 lbs each, 10 units, assume PVC	500.00	lbs	1.13	0.57	0.00	0.01	0.00	0.00	0.00	20.67	0.86
RAC	Sodium Permanganate	Potassium Permanganate	Sodium Permanganate, 259000 lbs + 50% second injection	388,500.00	lbs	719.93	704.76	0.04	0.18	0.00	0.07	0.00	734.71	288.61
	Subtotal					**786.51**	**738.30**	**0.12**	**0.56**	**0.00**	**0.20**	**0.02**	**1936.75**	**444.47**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	DPT Drill Rig	Drill Rig, DPT (diesel)	5 wells per day, 8 hours per day, 80% utilization	1920	hrs	30.77	30.03	0.00	0.04	0.32	0.01	0.03	234.64	
	Subtotal					**30.77**	**30.03**	**0.00**	**0.04**	**0.32**	**0.01**	**0.03**	**234.64**	**0**
				Total		**817**	**768**	**0.12**	**0.60**	**0.32**	**0.21**	**0.05**	**2,171**	**444**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
				Tonnes				**MMBTU**	**gal**
RI	-	-	-	-	-	-	-	-	-
RAC	817.29	768.34	36.42	12.53	0.32	0.21	0.05	7,408.79	444,468.62
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

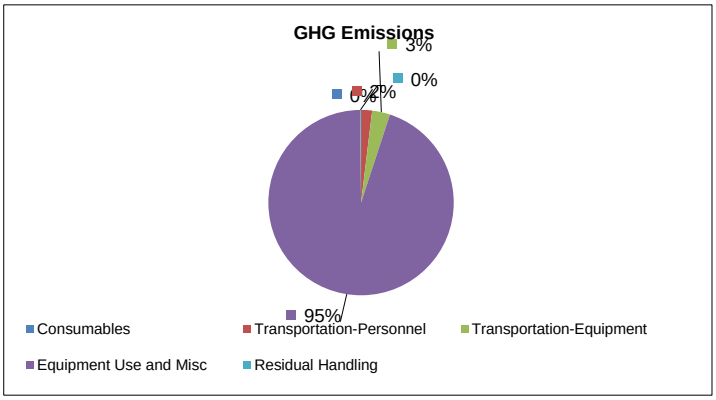
Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

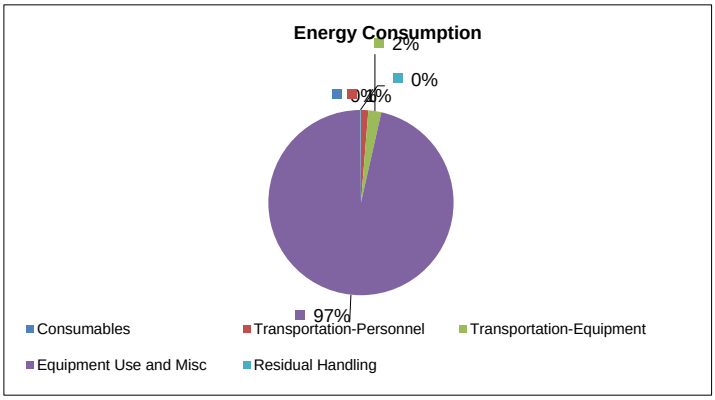
Sustainable Remediation - Environmental Footprint Summary
G-3A

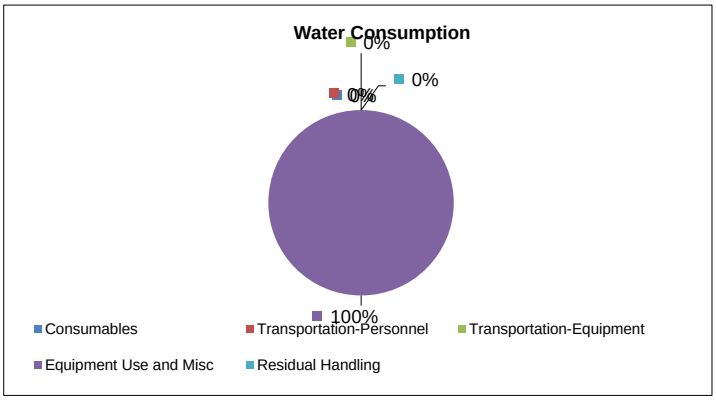
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	3.68	4.6E+01	NA	1.4E-03	4.8E-05	2.8E-04	7.5E-05	6.1E-03
	Transportation-Equipment	6.00	8.2E+01	NA	1.9E-03	7.7E-05	1.6E-04	1.5E-05	1.2E-03
	Equipment Use and Misc	181.72	3.5E+03	4.3E+05	9.1E-02	1.1E-01	2.1E-02	4.6E-05	1.2E-02
	Residual Handling	0.31	4.1E+00	NA	9.9E-05	1.7E-06	8.8E-06	1.6E-06	1.3E-04
	Sub-Total	191.71	3.63E+03	4.26E+05	9.41E-02	1.12E-01	2.18E-02	1.38E-04	1.89E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	7.55	9.5E+01	NA	2.8E-03	9.8E-05	5.7E-04	1.5E-04	1.2E-02
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	155.67	2.3E+03	0.0E+00	5.4E-01	3.6E-01	1.4E-02	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	163.22	2.42E+03	0.00E+00	5.42E-01	3.59E-01	1.42E-02	1.54E-04	1.24E-02
Total		**3.5E+02**	**6.0E+03**	**4.3E+05**	**6.4E-01**	**4.7E-01**	**3.6E-02**	**2.9E-04**	**3.1E-02**

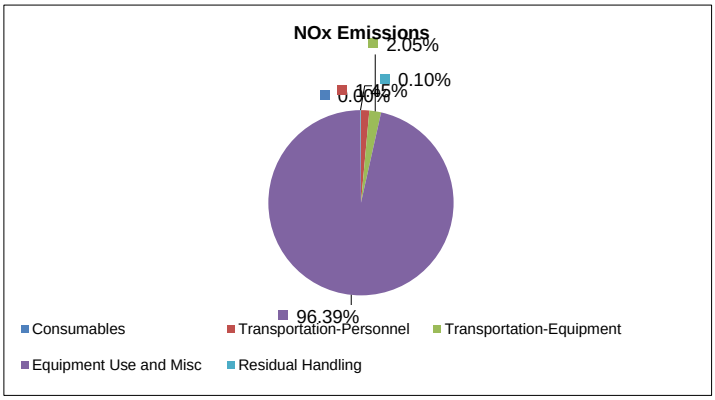
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	1.5E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	9.9E-02
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**2.5E-01**

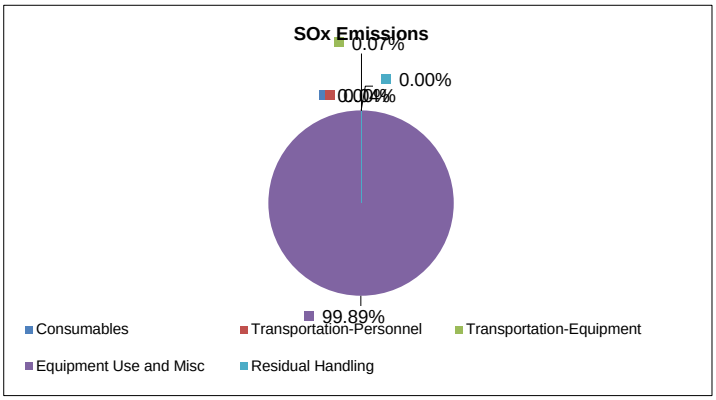
Total Cost with Footprint Reduction
$0

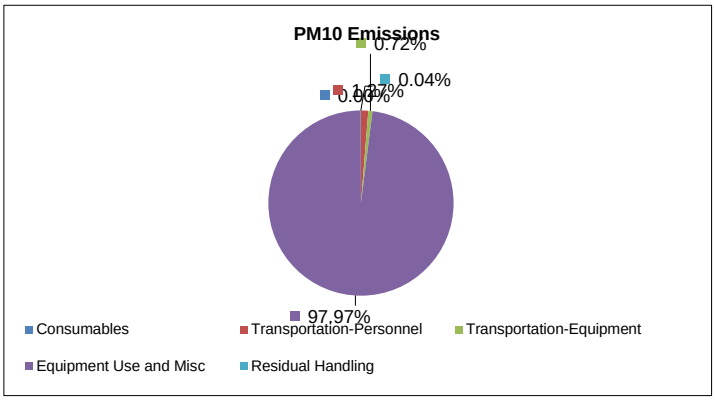

GHG Emissions
3%
0%
0%
2%
95%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

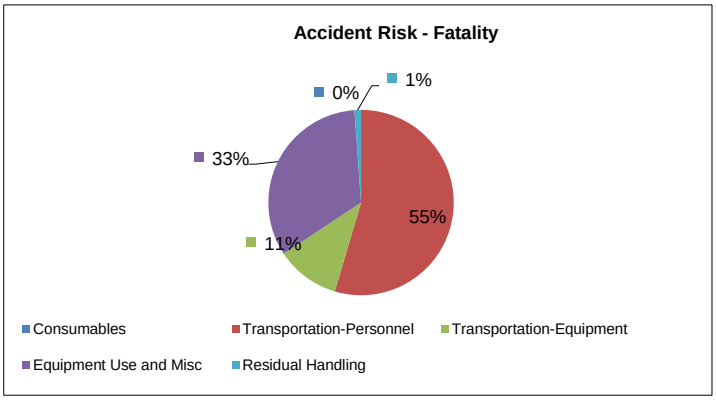

Energy Consumption
2%
0%
0%
1%
97%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

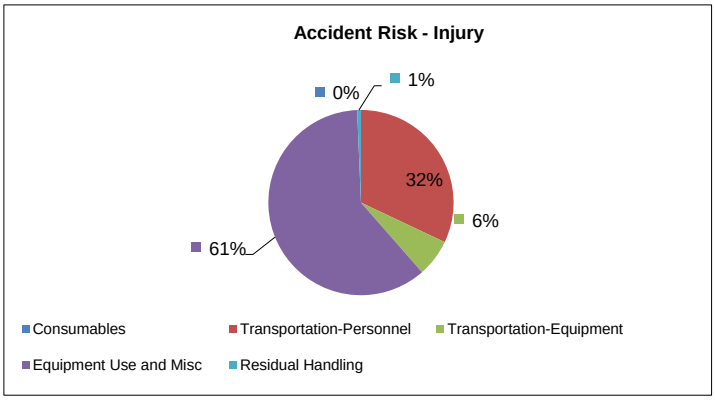

Water Consumption
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

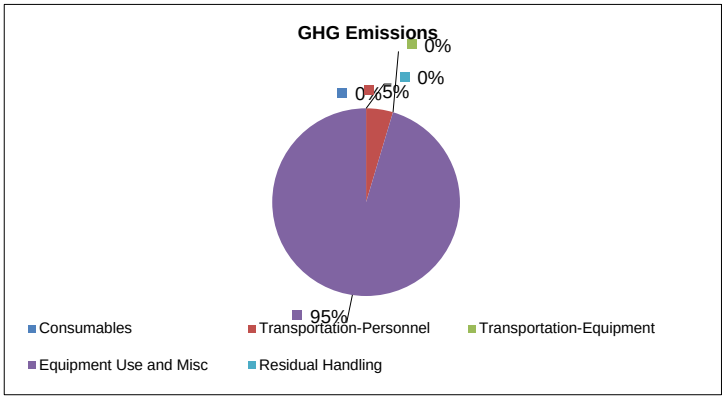

NOx Emissions
2.05%
0.10%
0.00%
1.45%
96.39%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

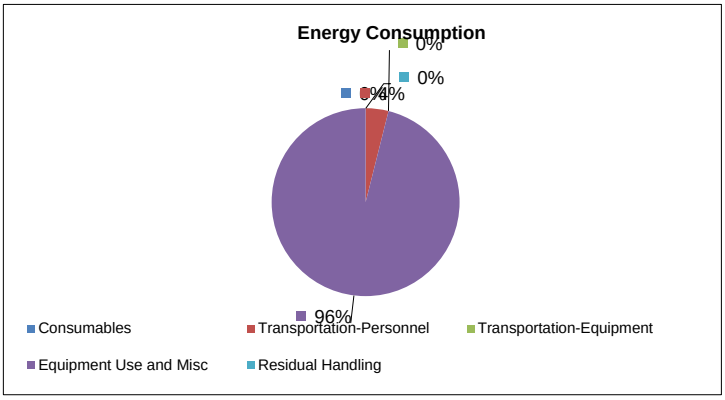

SOx Emissions
0.07%
0.00%
0.00%
0.04%
99.89%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

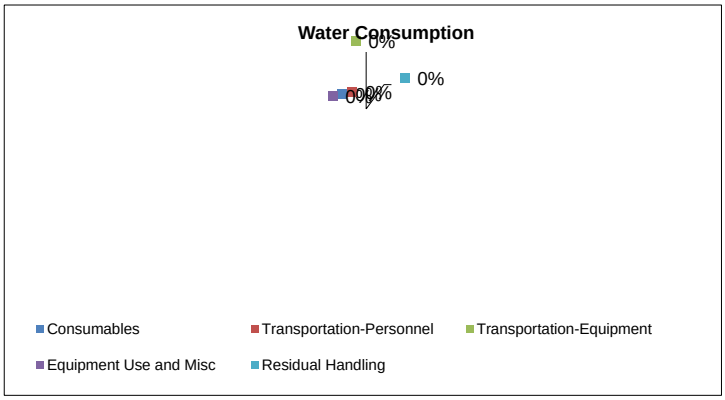

PM10 Emissions
0.72%
0.04%
0.00%
1.27%
97.97%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

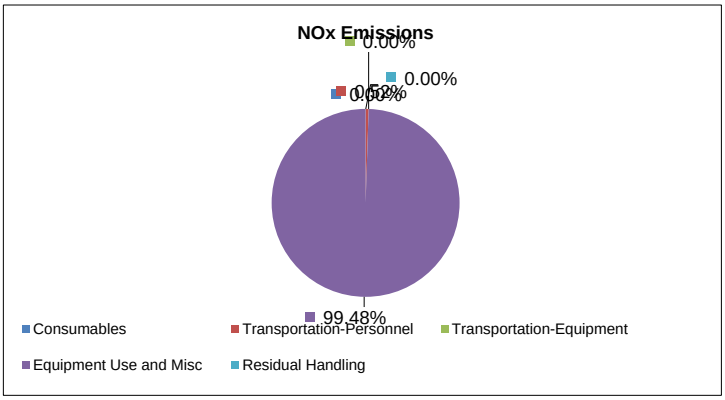

Accident Risk - Fatality
0%
1%
33%
55%
11%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

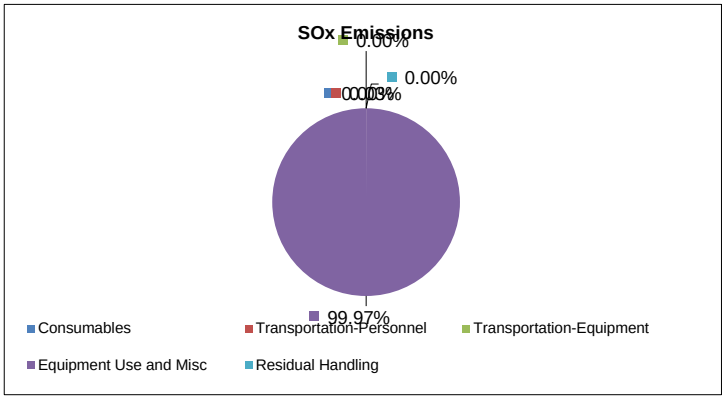

Accident Risk - Injury
0%
1%
32%
6%
61%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

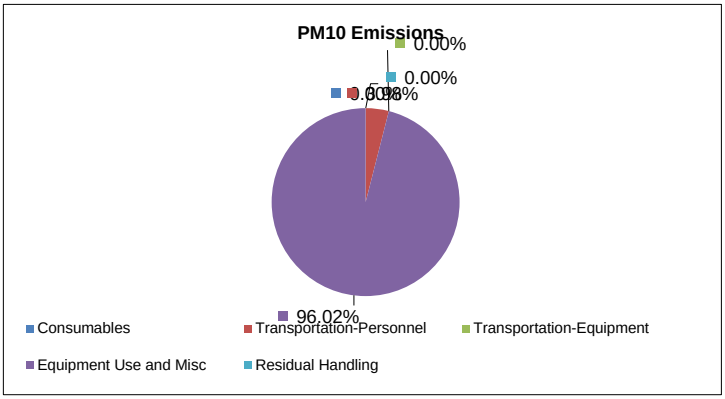

GHG Emissions
0%
0%
0%
5%
95%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

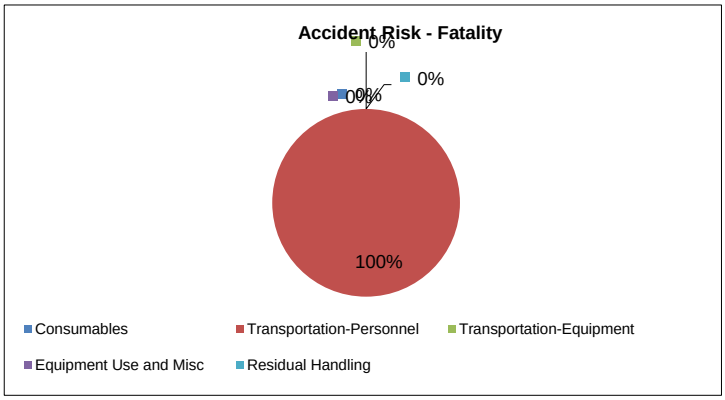

Energy Consumption
0%
0%
0%
4%
96%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

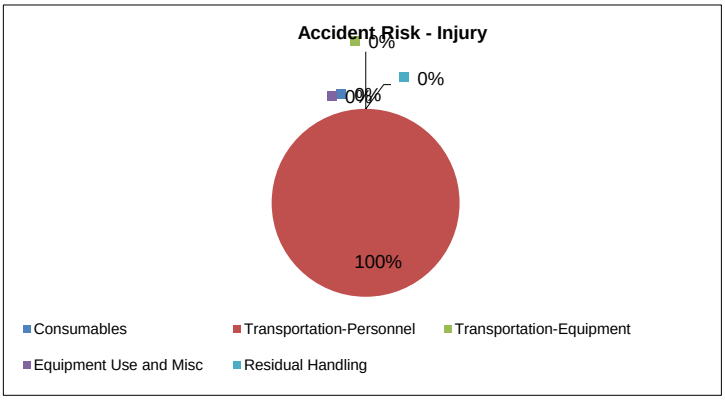

Water Consumption
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

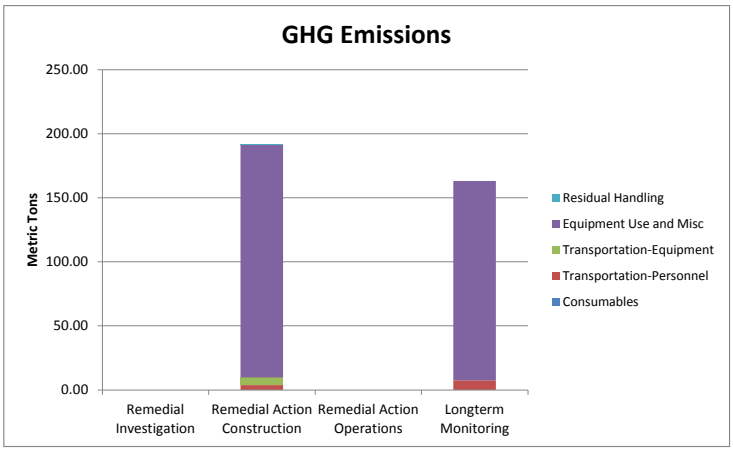

NOx Emissions
0.00%
0.00%
0.52%
99.48%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

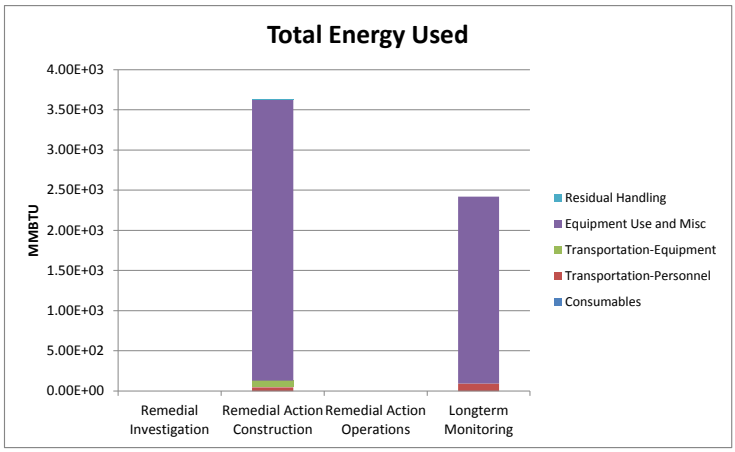

SOx Emissions
0.00%
0.00%
99.97%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

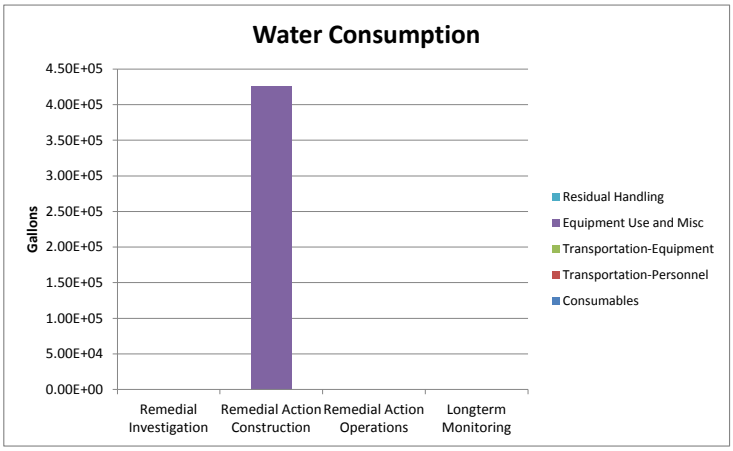

PM10 Emissions
0.00%
0.00%
96.02%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

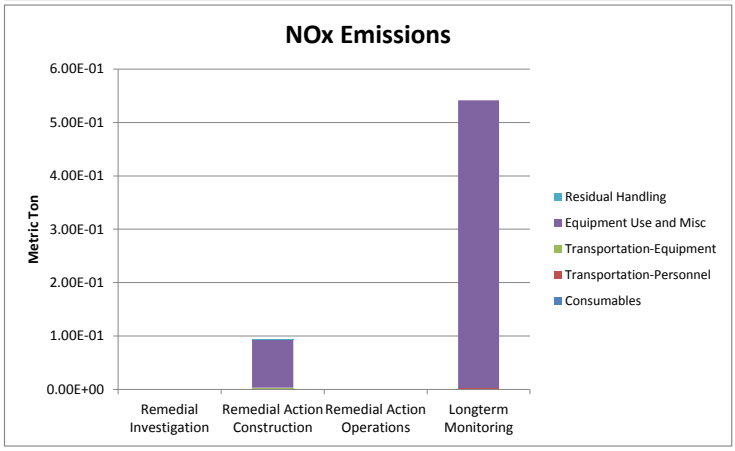

Accident Risk - Fatality
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

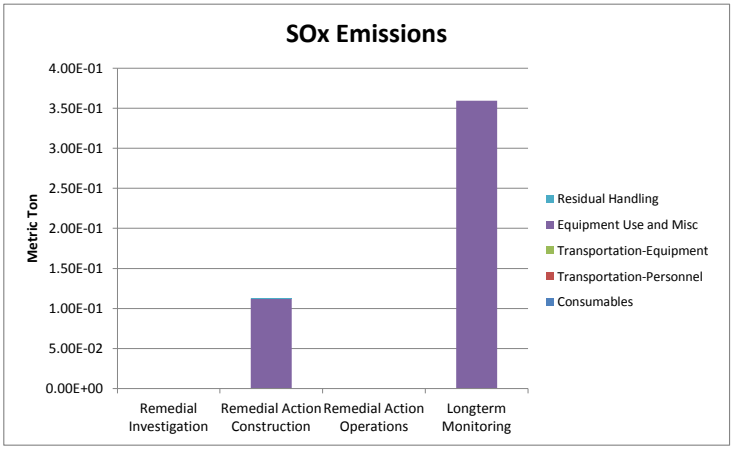

Accident Risk - Injury
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

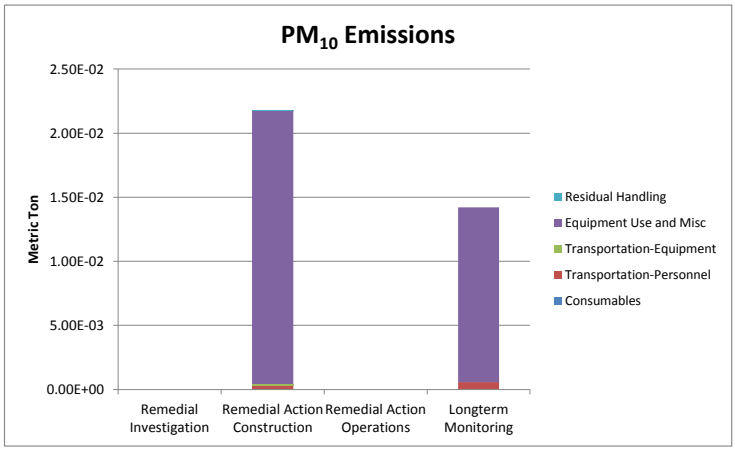

GHG Emissions
Metric Tons
250.00
200.00
150.00
100.00
50.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

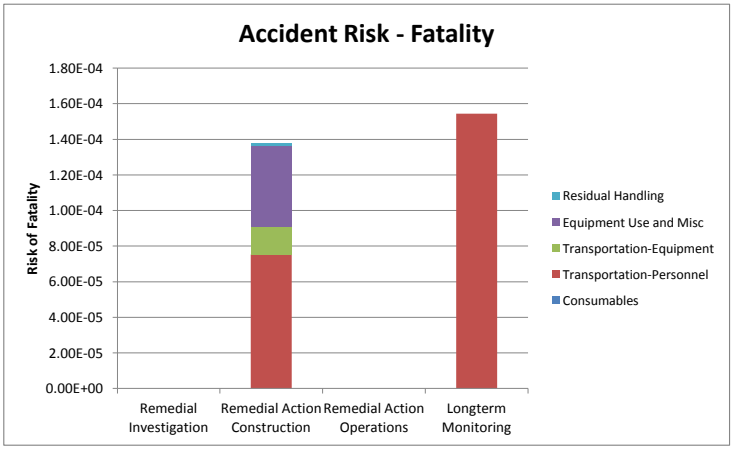

Total Energy Used
MMBTU
4.00E+03
3.50E+03
3.00E+03
2.50E+03
2.00E+03
1.50E+03
1.00E+03
5.00E+02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

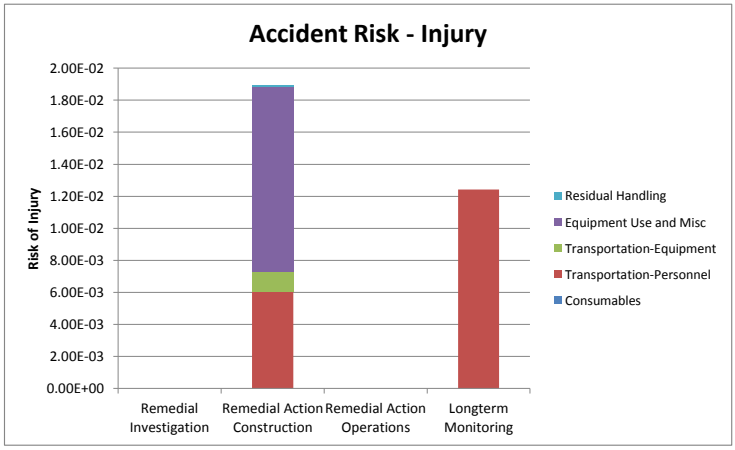

Water Consumption
Gallons
4.50E+05
4.00E+05
3.50E+05
3.00E+05
2.50E+05
2.00E+05
1.50E+05
1.00E+05
5.00E+04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
1.80E-04
1.60E-04
1.40E-04
1.20E-04
1.00E-04
8.00E-05
6.00E-05
4.00E-05
2.00E-05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
2.00E-02
1.80E-02
1.60E-02
1.40E-02
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Injection wells	PVC	390 wells, Assume PVC, 1 inch Schedule 40, 30 ft deep, 0.333 lb/ft	11,700.00	lft	8.78	4.42	0.01	0.05	0.00	0.02	0.00	161.09	20.12
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Injection well heads	PVC	10 well heads, 50 lb PVC,	500.00	lbs	1.13	0.57	0.00	0.01	0.00	0.00	0.00	20.67	0.86
RAC	Sodium Permanganate	Potassium Permanganate	Assume Pottasium permanganate, 67000 lb	67,000.00	lbs	124.16	121.54	0.01	0.03	0.00	0.01	0.00	126.71	49.77
	Subtotal					**135.63**	**127.36**	**0.02**	**0.09**	**0.00**	**0.03**	**0.00**	**317.65**	**71.00**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	DPT drill	Drill Rig, DPT (diesel)	390 wells, 5 wells per day, 8 hours per day, 80% utilization	499.20	hrs	8.00	7.81	0.00	0.01	0.08	0.00	0.01	61.01	
	Subtotal					**8.00**	**7.81**	**0.00**	**0.01**	**0.08**	**0.00**	**0.01**	**61.01**	**0**
				Total		**144**	**135**	**0.02**	**0.10**	**0.08**	**0.04**	**0.01**	**379**	**71**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
				Tonnes				**MMBTU**	**gal**
RI	-	-	-	-	-	-	-	-	-
RAC	143.63	135.17	6.30	2.17	0.08	0.04	0.01	1,291.96	71,004.32
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

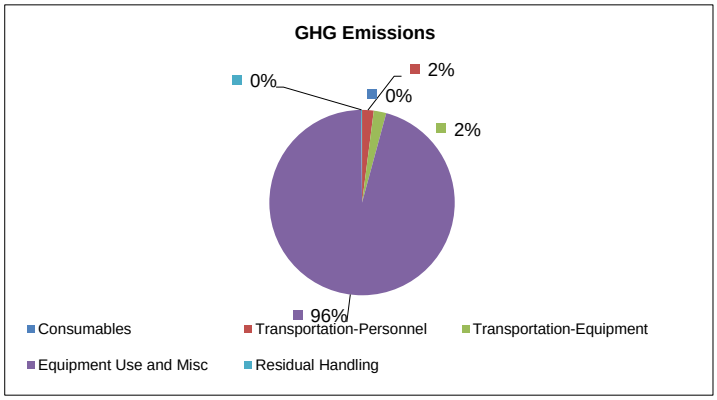
Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

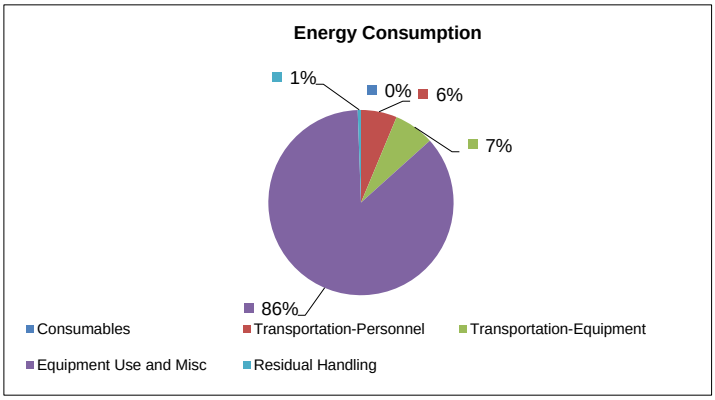
Sustainable Remediation - Environmental Footprint Summary
G-3B

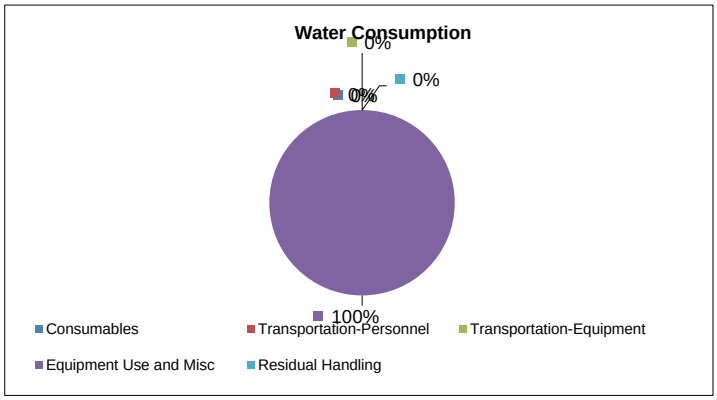
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	1.83	2.3E+01	NA	6.8E-04	2.4E-05	1.4E-04	3.7E-05	3.0E-03
	Transportation-Equipment	1.98	2.6E+01	NA	6.2E-04	1.1E-05	5.5E-05	5.5E-06	4.4E-04
	Equipment Use and Misc	86.45	3.2E+02	1.4E+05	4.1E-03	1.1E-02	1.3E-04	0.0E+00	0.0E+00
	Residual Handling	0.16	2.1E+00	NA	5.0E-05	8.8E-07	4.4E-06	7.8E-07	6.3E-05
	Sub-Total	90.42	3.66E+02	1.40E+05	5.48E-03	1.12E-02	3.25E-04	4.37E-05	3.52E-03
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	7.55	9.5E+01	NA	2.8E-03	9.8E-05	5.7E-04	1.5E-04	1.2E-02
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	155.67	2.3E+03	0.0E+00	5.4E-01	3.6E-01	1.4E-02	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	163.22	2.42E+03	0.00E+00	5.42E-01	3.59E-01	1.42E-02	1.54E-04	1.24E-02
Total		**2.5E+02**	**2.8E+03**	**1.4E+05**	**5.5E-01**	**3.7E-01**	**1.5E-02**	**2.0E-04**	**1.6E-02**

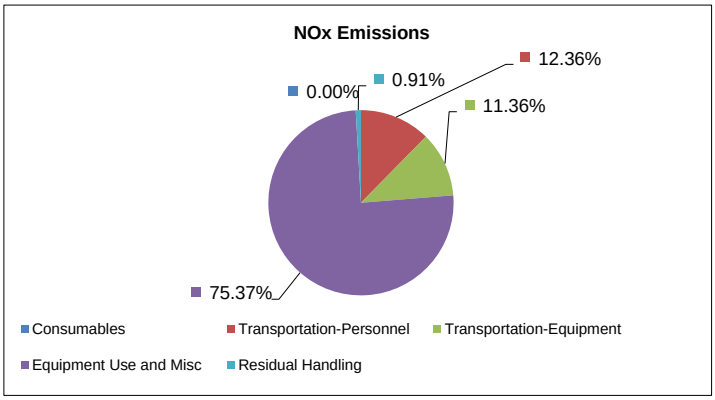
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	2.8E-02
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	9.9E-02
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**1.3E-01**

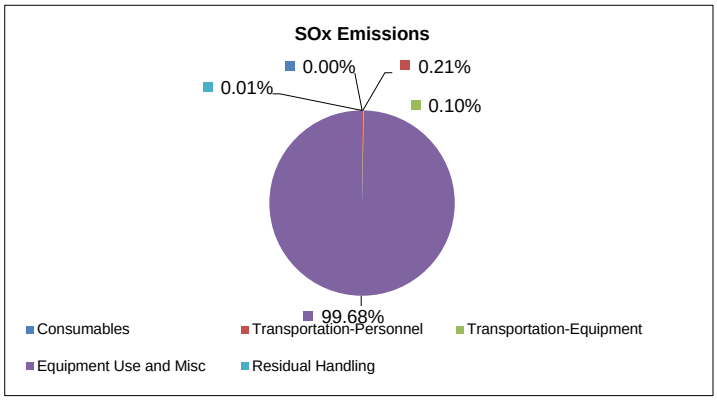
Total Cost with Footprint Reduction
$0

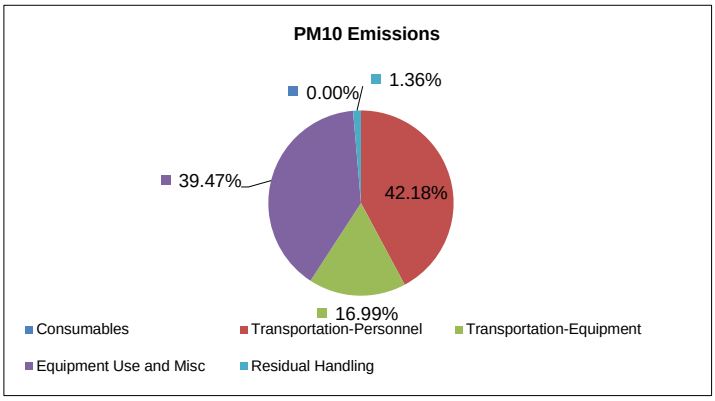

GHG Emissions
0%
2%
0%
2%
96%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

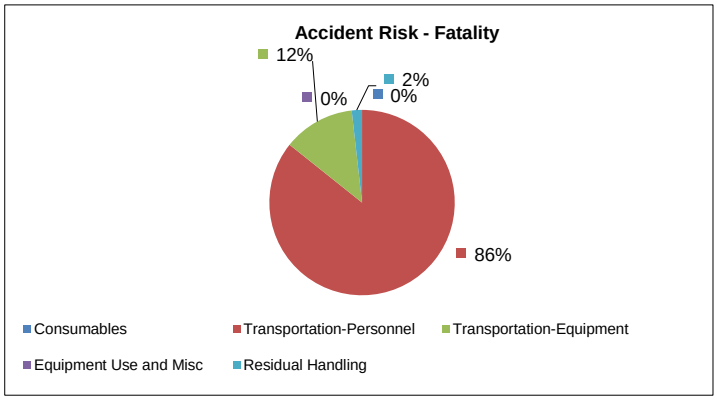

Energy Consumption
1%
0%
6%
7%
86%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

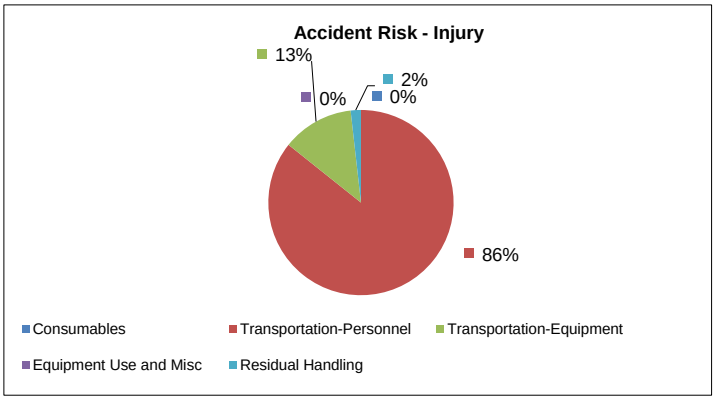

Water Consumption
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

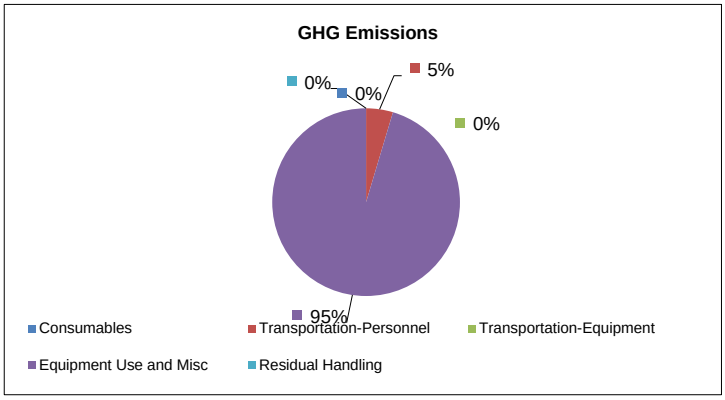

NOx Emissions
12.36%
0.00%
0.91%
11.36%
75.37%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

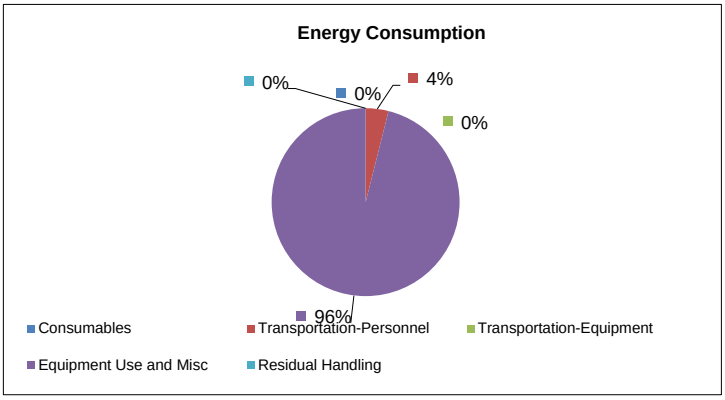

SOx Emissions
0.00%
0.21%
0.01%
0.10%
99.68%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

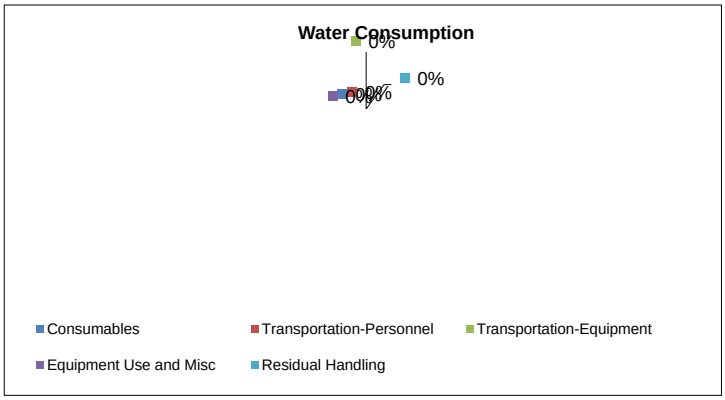

PM10 Emissions
1.36%
0.00%
39.47%
42.18%
16.99%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

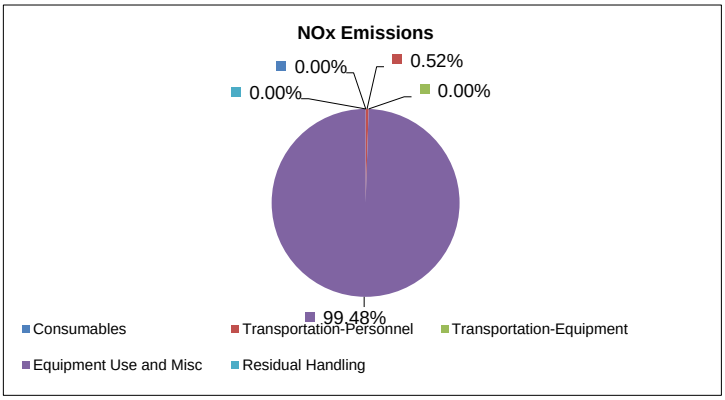

Accident Risk - Fatality
12%
2%
0%
0%
86%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

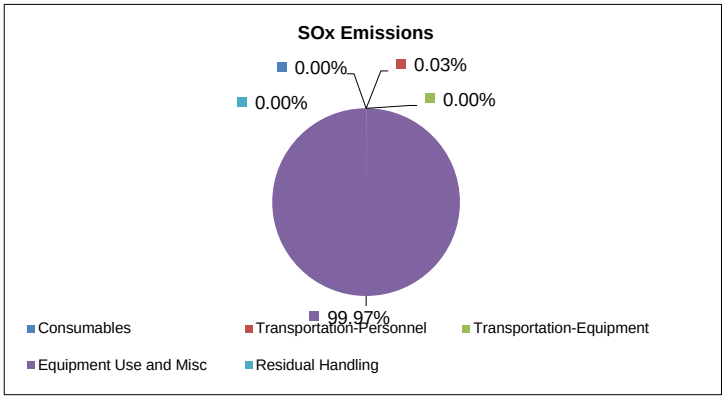

Accident Risk - Injury
13%
2%
0%
0%
86%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

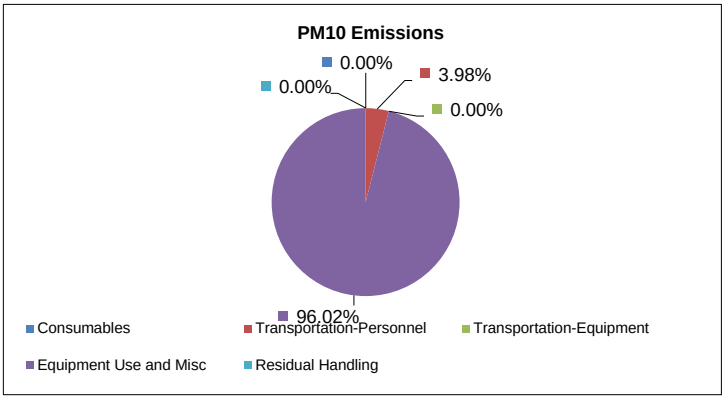

GHG Emissions
0%
0%
5%
0%
95%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

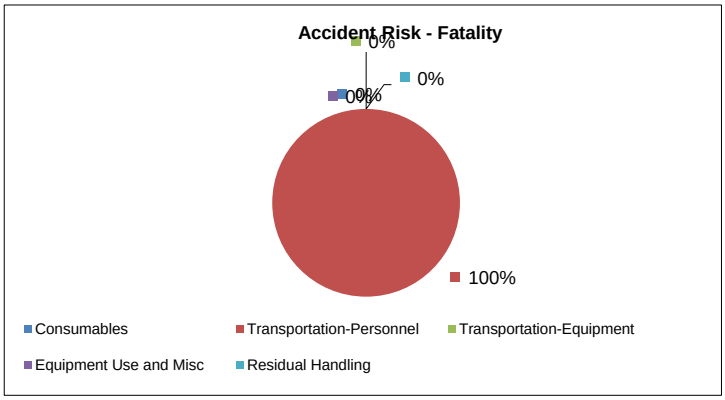

Energy Consumption
0%
0%
4%
0%
96%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

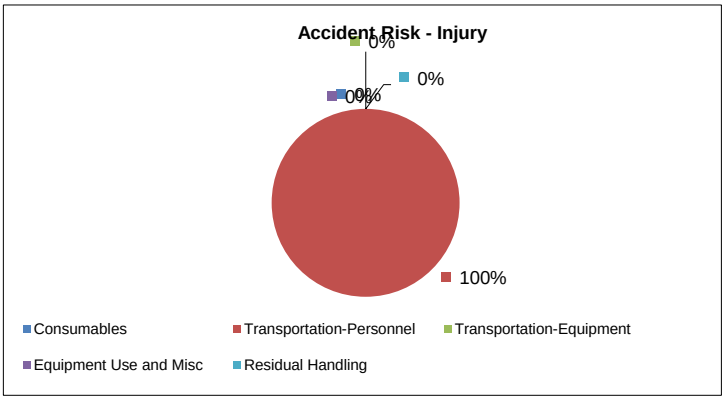

Water Consumption
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

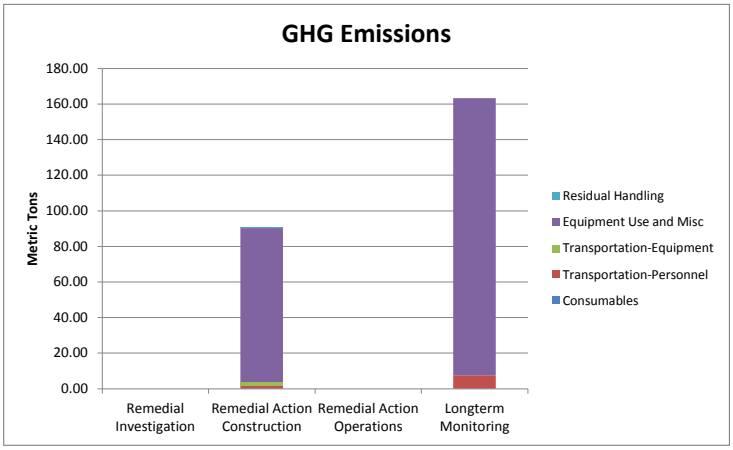

NOx Emissions
0.00%
0.52%
0.00%
0.00%
99.48%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

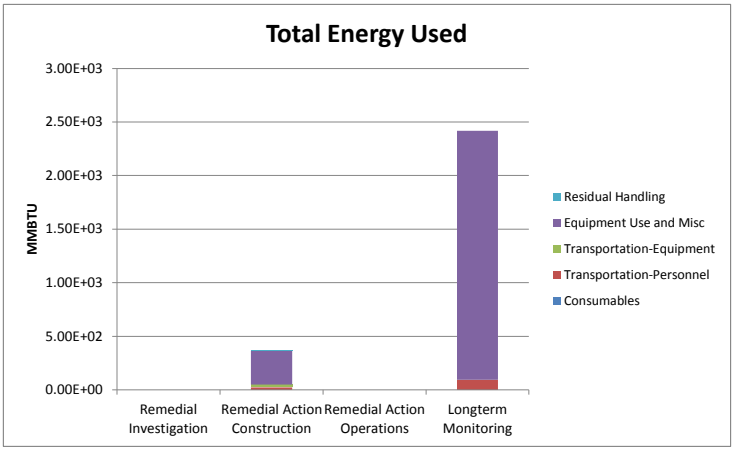

SOx Emissions
0.00%
0.03%
0.00%
0.00%
99.97%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

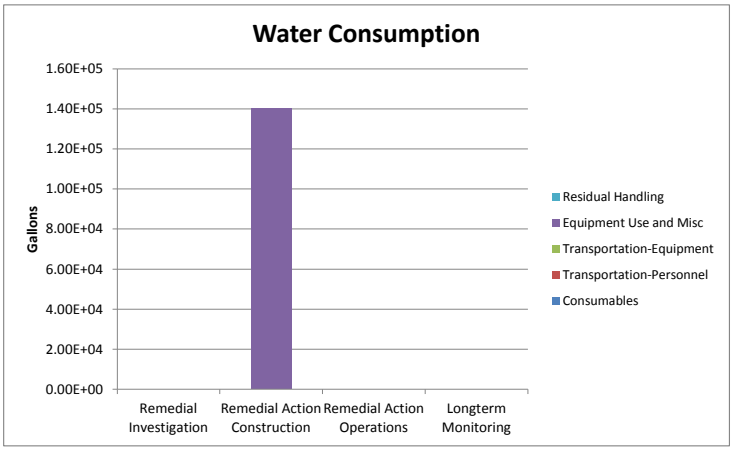

PM10 Emissions
0.00%
3.98%
0.00%
0.00%
96.02%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

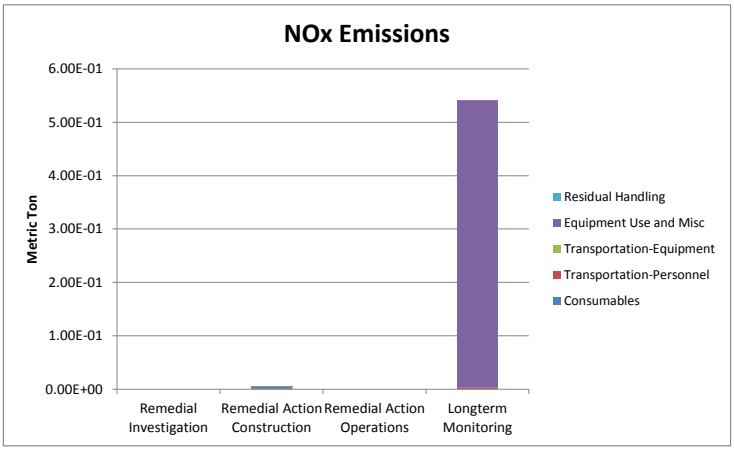

Accident Risk - Fatality
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

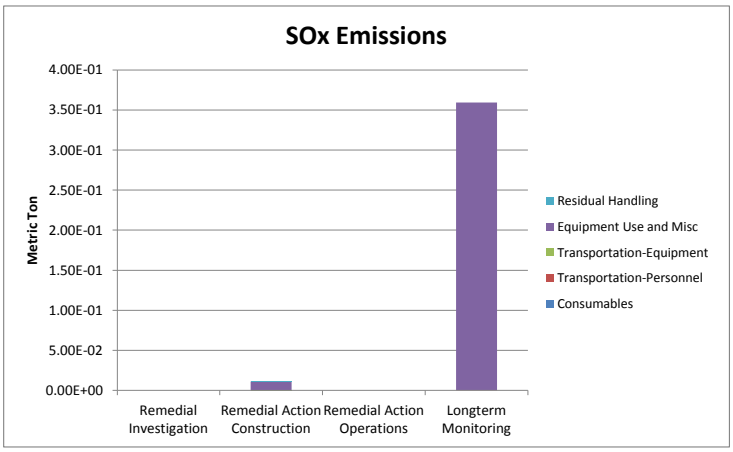

Accident Risk - Injury
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

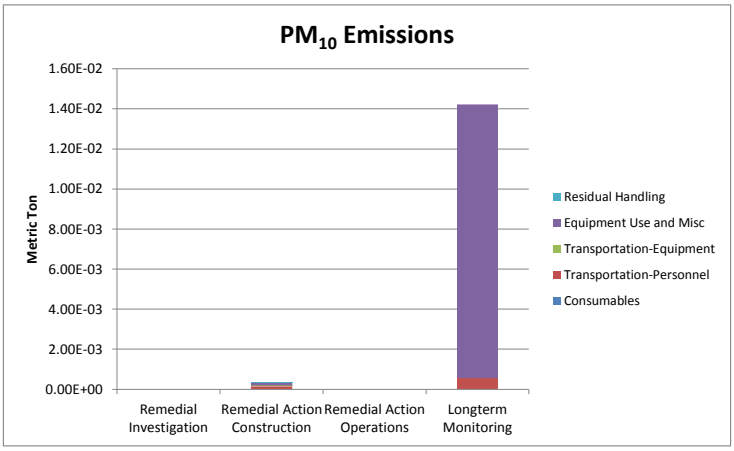

GHG Emissions
Metric Tons
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

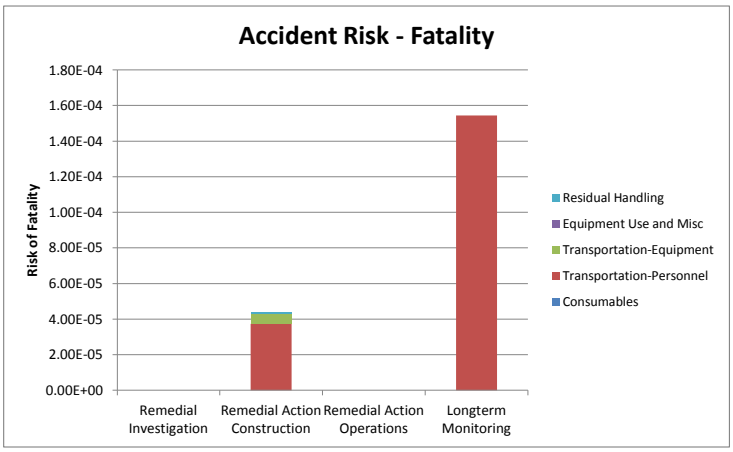

Total Energy Used
MMBTU
3.00E+03
2.50E+03
2.00E+03
1.50E+03
1.00E+03
5.00E+02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

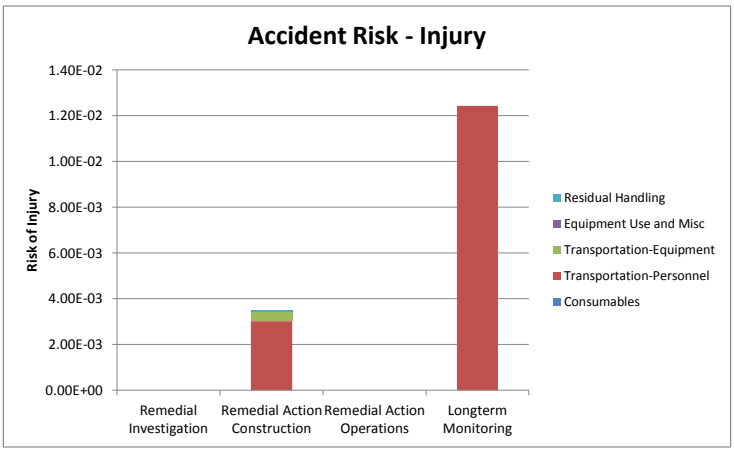

Water Consumption
Gallons
1.60E+05
1.40E+05
1.20E+05
1.00E+05
8.00E+04
6.00E+04
4.00E+04
2.00E+04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
1.60E-02
1.40E-02
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
1.80E-04
1.60E-04
1.40E-04
1.20E-04
1.00E-04
8.00E-05
6.00E-05
4.00E-05
2.00E-05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
1.40E-02
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Sodium Permanganate	Potassium Permanganate	Assume Pottasium permanganate, 23000 lb	23,000.00	lbs	42.62	41.72	0.00	0.01	0.00	0.00	0.00	43.50	17.09
RAC	Sodium Permanganate	Potassium Permanganate	Assume Pottasium permanganate, 23000 lb	23,000.00	lbs	42.62	41.72	0.00	0.01	0.00	0.00	0.00	43.50	17.09
	Subtotal					**85.24**	**83.45**	**0.00**	**0.02**	**0.00**	**0.01**	**0.00**	**86.99**	**34.17**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
	Subtotal					**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0**
				Total		**85**	**83**	**0.00**	**0.02**	**0.00**	**0.01**	**0.00**	**87**	**34**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO_2e)	CH_4 (CO_2e)	NO_x	SO_x	PM_{10}		
				Tonnes				**MMBTU**	**gal**
RI	-	-	-	-	-	-	-	-	-
RAC	85.24	83.45	1.36	0.44	0.00	0.01	0.00	296.82	34,172.37
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

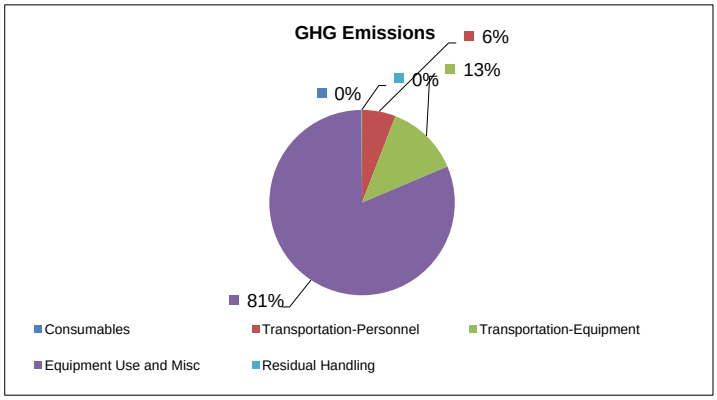
Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

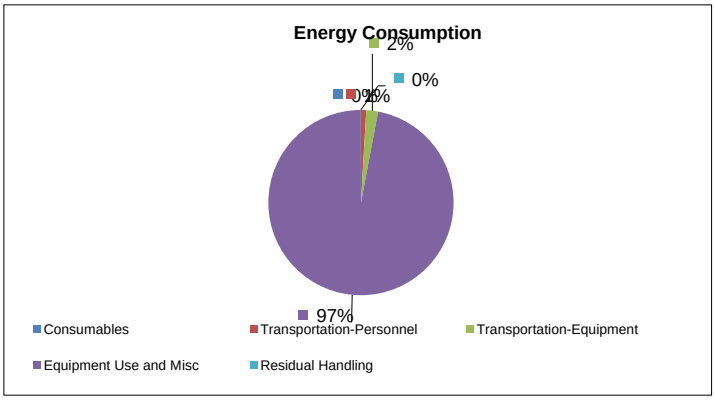
Sustainable Remediation - Environmental Footprint Summary
G-4

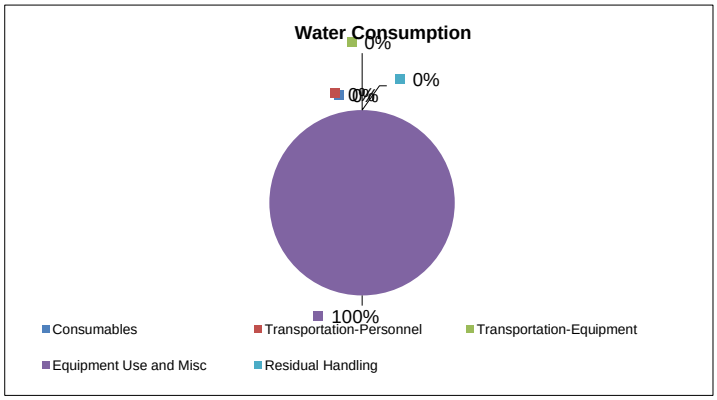
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	10.86	1.4E+02	NA	4.0E-03	1.4E-04	8.2E-04	2.2E-04	1.8E-02
	Transportation-Equipment	23.64	3.1E+02	NA	7.4E-03	1.3E-04	6.6E-04	5.9E-05	4.7E-03
	Equipment Use and Misc	150.44	1.4E+04	1.7E+06	8.3E-02	1.9E-01	1.9E-02	4.4E-05	1.1E-02
	Residual Handling	0.20	2.6E+00	NA	6.2E-05	1.1E-06	5.5E-06	7.8E-07	6.3E-05
	Sub-Total	185.14	1.49E+04	1.68E+06	9.47E-02	1.86E-01	2.06E-02	3.25E-04	3.36E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	10.21	1.3E+02	NA	3.8E-03	1.3E-04	7.7E-04	2.1E-04	1.7E-02
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	158.27	2.4E+03	0.0E+00	5.5E-01	3.7E-01	1.4E-02	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	168.48	2.49E+03	0.00E+00	5.52E-01	3.65E-01	1.46E-02	2.09E-04	1.68E-02
Total		**3.5E+02**	**1.7E+04**	**1.7E+06**	**6.5E-01**	**5.5E-01**	**3.5E-02**	**5.3E-04**	**5.0E-02**

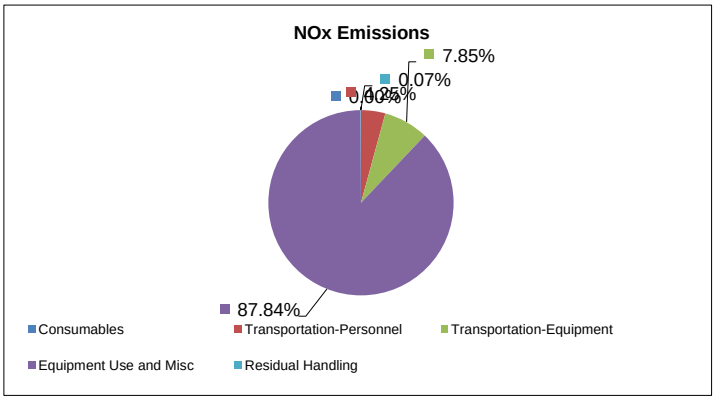
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	2.7E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	1.3E-01
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**4.0E-01**

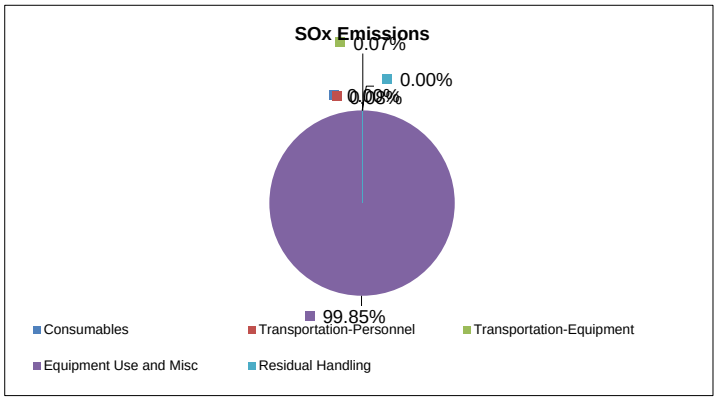
Total Cost with Footprint Reduction
$0

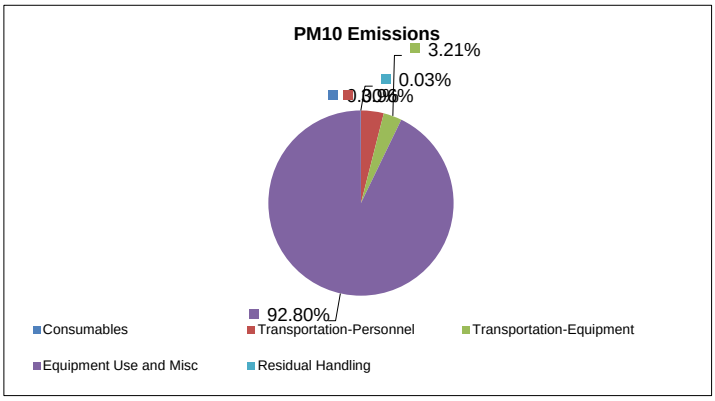

GHG Emissions
6%
13%
0%
0%
81%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

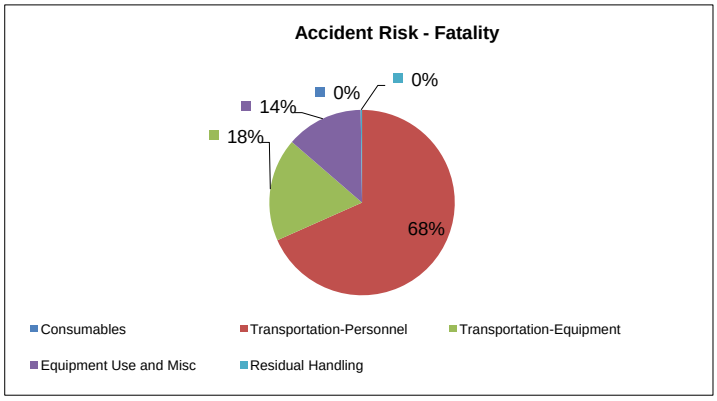

Energy Consumption
2%
0%
97%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

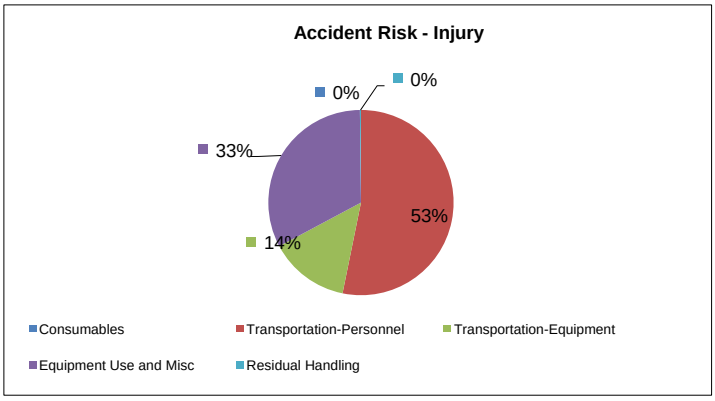

Water Consumption
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

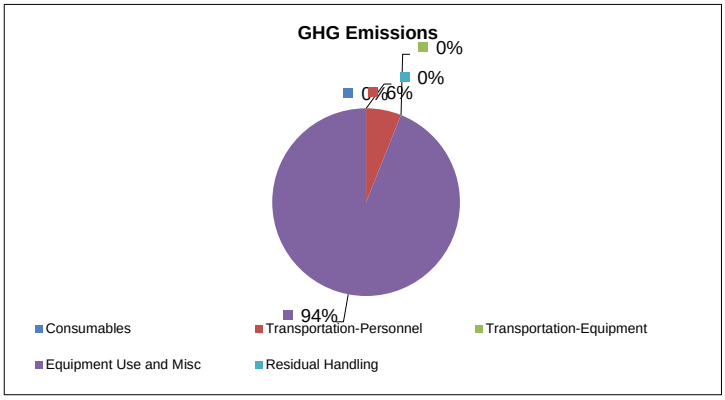

NOx Emissions
7.85%
0.07%
87.84%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

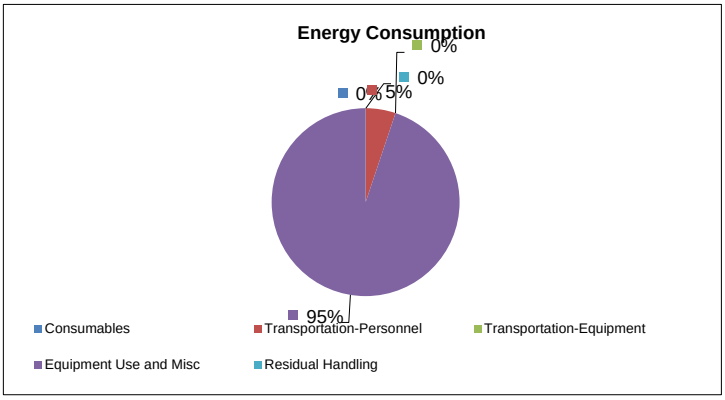

SOx Emissions
0.07%
0.00%
99.85%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

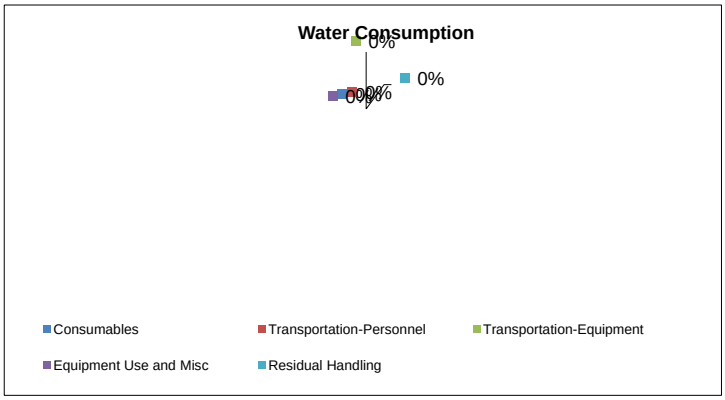

PM10 Emissions
3.21%
0.03%
92.80%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

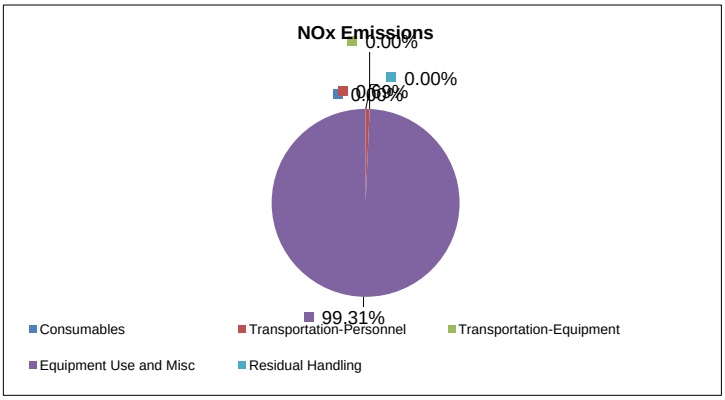

Accident Risk - Fatality
0%
0%
14%
18%
68%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

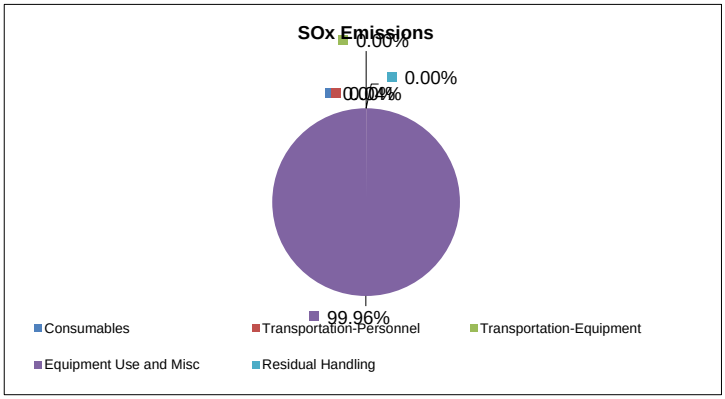

Accident Risk - Injury
0%
0%
33%
53%
14%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

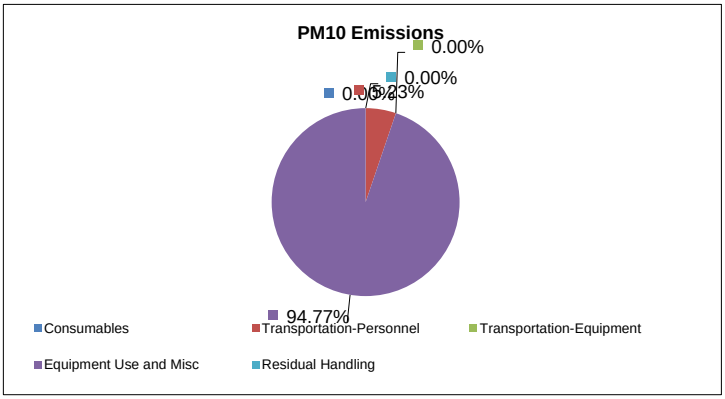

GHG Emissions
0%
0%
0%
6%
94%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

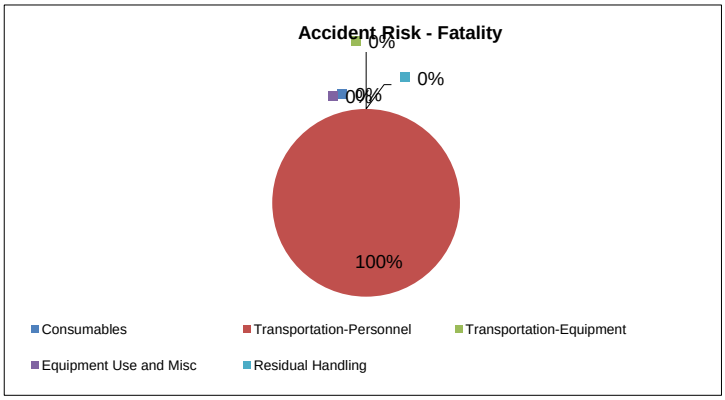

Energy Consumption
0%
0%
0%
5%
95%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

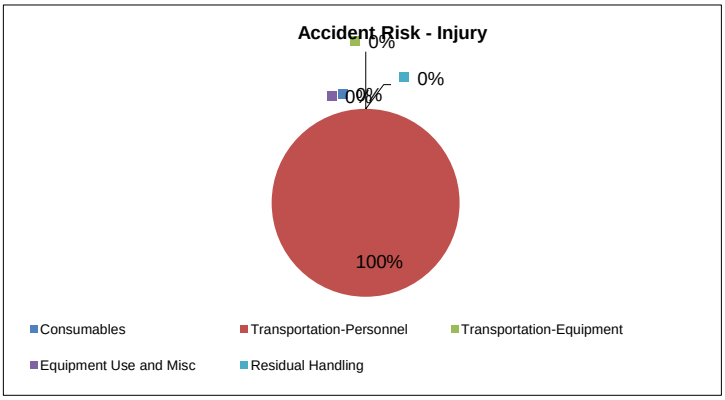

Water Consumption
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

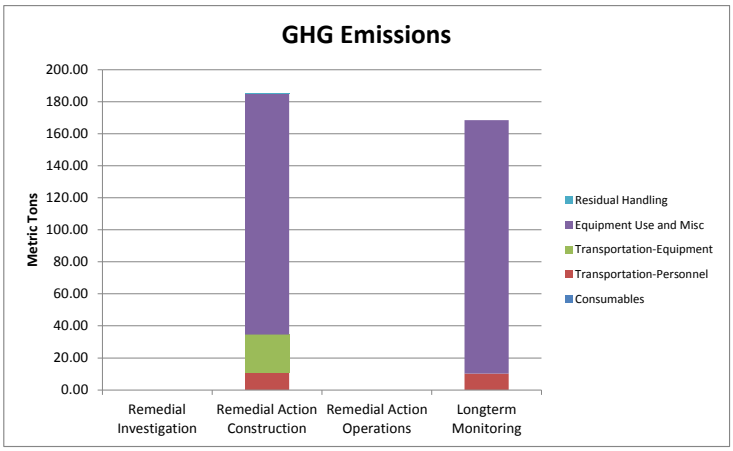

NOx Emissions
0.00%
0.00%
99.31%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

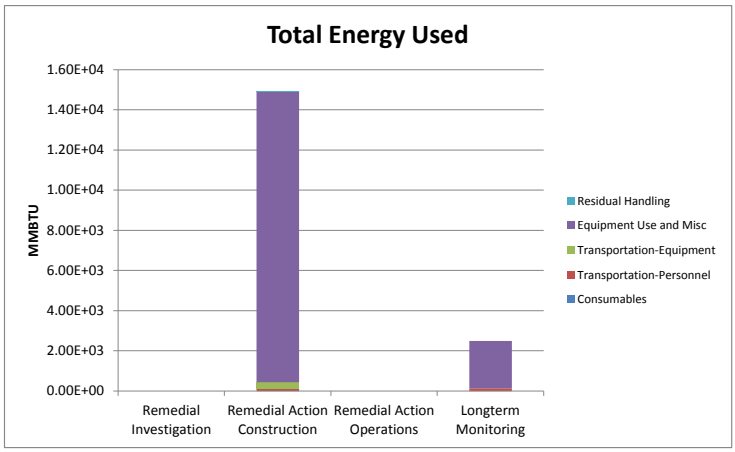

SOx Emissions
0.00%
0.00%
99.96%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

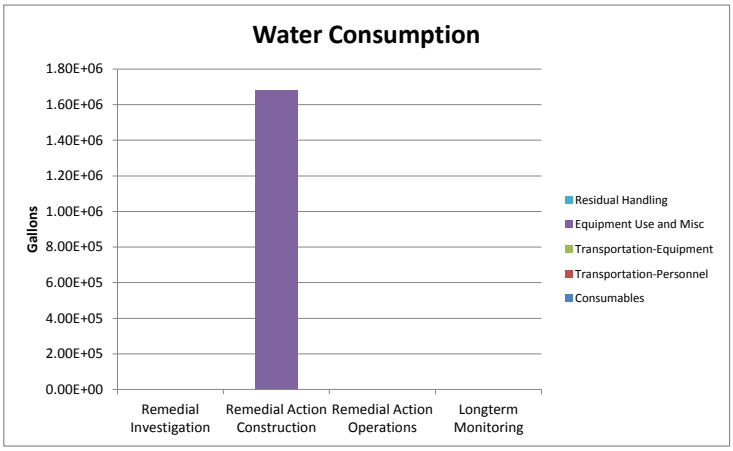

PM10 Emissions
0.00%
0.00%
5.23%
94.77%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

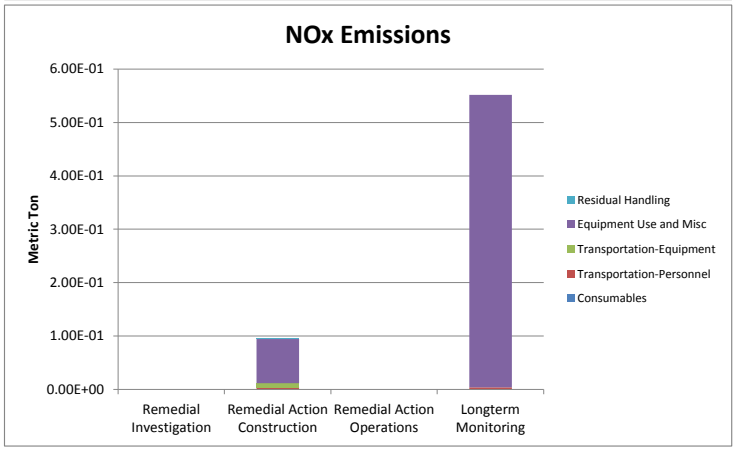

Accident Risk - Fatality
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

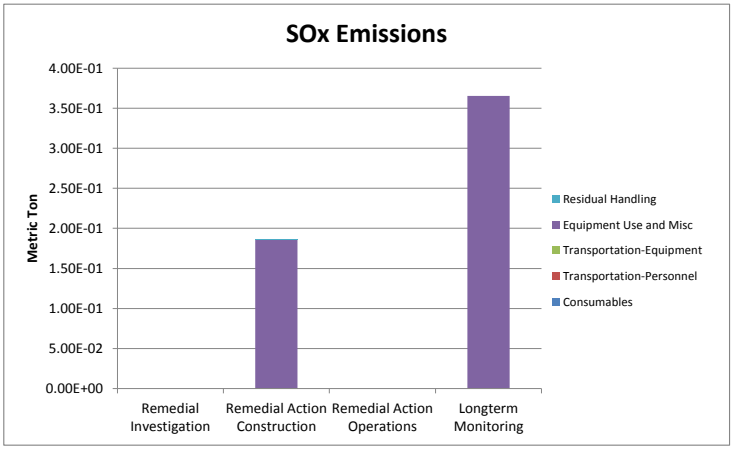

Accident Risk - Injury
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

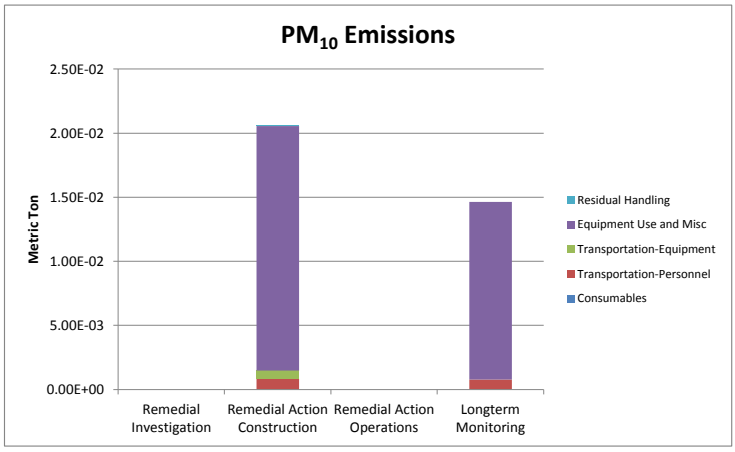

GHG Emissions
Metric Tons
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

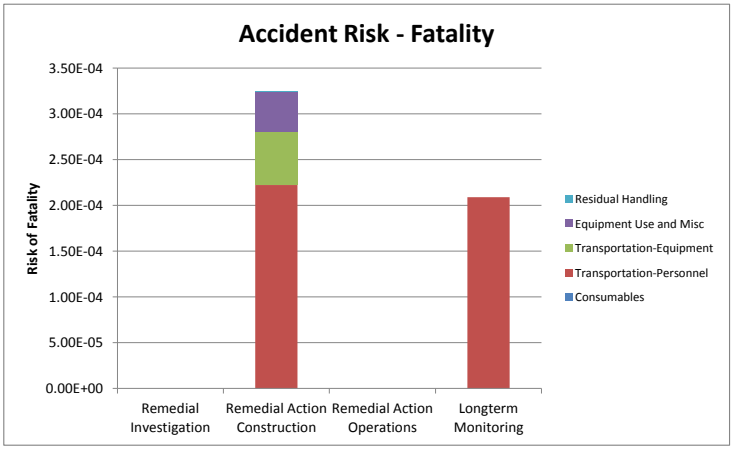

Total Energy Used
MMBTU
1.60E+04
1.40E+04
1.20E+04
1.00E+04
8.00E+03
6.00E+03
4.00E+03
2.00E+03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

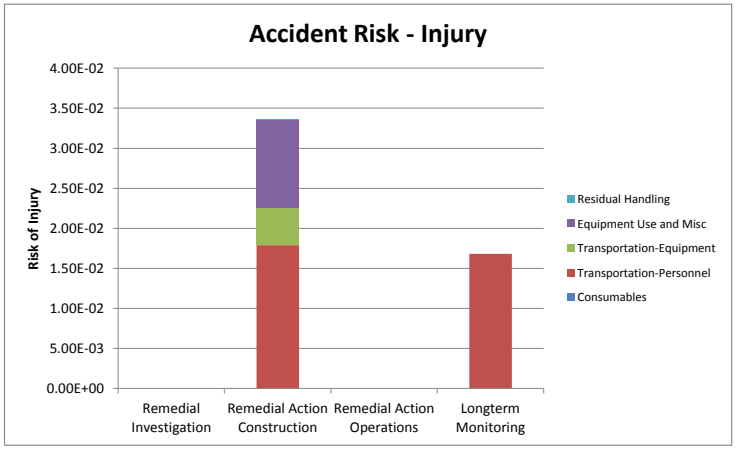

Water Consumption
Gallons
1.80E+06
1.60E+06
1.40E+06
1.20E+06
1.00E+06
8.00E+05
6.00E+05
4.00E+05
2.00E+05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
3.50E-04
3.00E-04
2.50E-04
2.00E-04
1.50E-04
1.00E-04
5.00E-05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
4.00E-02
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Injection wells, 1 inch diam	PVC	Assume PVC, 1 inch diameter, Schedule 40, 230 wells, 11700 ft, 0.33 lb/ft	11,700.00	lft	8.70	4.38	0.01	0.05	0.00	0.02	0.00	159.64	20.12
RAC	Injection wells, 2 inch diam	PVC	Assume PVC, 2 inch diameter, Schedule 40, 130 wells, 14000 ft, 0.72 lb.ft	14,000.00	lft	24.61	12.38	0.03	0.14	0.00	0.05	0.01	451.51	24.07
RAC	New monitoring wells, 2 inch	PVC	Assume PVC, 2 inch diameter, Schedule 40, 12 wells, 750 ft, 0.72 lb/ft	750.00	lft	1.22	0.61	0.00	0.01	0.00	0.00	0.00	22.33	1.29
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Injection well heads	PVC	Assume PVC, 10 well heads, 50 lb each	500.00	lbs	1.13	0.57	0.00	0.01	0.00	0.00	0.00	20.67	0.86
RAC	EOS	Vegetable Oil	Assume Vegetable oil, 30650 gallons, assume 1310.8216 kg/m3 density	335,290.66	lbs	50.18	50.18	0.00	0.00	0.00	0.05	0.00	1745.75	151.46
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	EOS	Vegetable Oil	Assume Vegetable oil, 30650 gallons, assume 1310.8216 kg/m3 density	335,290.66	lbs	50.18	50.18	0.00	0.00	0.00	0.05	0.00	1745.75	151.46
	Subtotal					**139.15**	**119.96**	**0.05**	**0.22**	**0.00**	**0.18**	**0.01**	**4163.99**	**349.76**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	DPT Injection wells, 1 inch	Drill Rig, DPT (diesel)	230 wells, 5 wells per day, 8 hours per day, 80% utilization	294.40	hrs	4.72	4.61	0.00	0.01	0.05	0.00	0.00	35.98	
RAC	DPT Injection wells, 2 inch	Drill Rig, DPT (diesel)	130 wells, 5 wells per day, 8 hours per day, 80% utilization	166.40	hrs	2.67	2.60	0.00	0.00	0.03	0.00	0.00	20.34	
RAC	DPT New Injection wells, 2 inch	Drill Rig, DPT (diesel)	12 wells, 5 wells per day, 8 hours per day, 80% utilization	15.36	hrs	0.25	0.24	0.00	0.00	0.00	0.00	0.00	1.88	
	Subtotal					**7.63**	**7.45**	**0.00**	**0.01**	**0.08**	**0.00**	**0.01**	**58.19**	**0**
				Total		**147**	**127**	**0.05**	**0.23**	**0.08**	**0.18**	**0.02**	**4,222**	**350**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
				Tonnes				**MMBTU**	**gal**
RI	-	-	-	-	-	-	-	-	-
RAC	146.78	127.41	14.57	4.81	0.08	0.18	0.02	14,406.08	349,760.82
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

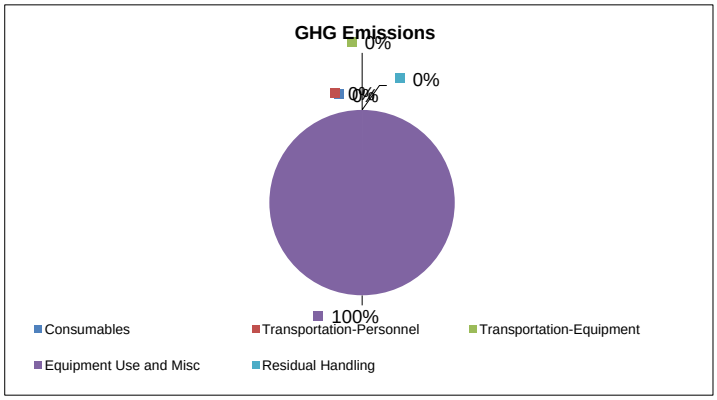
Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

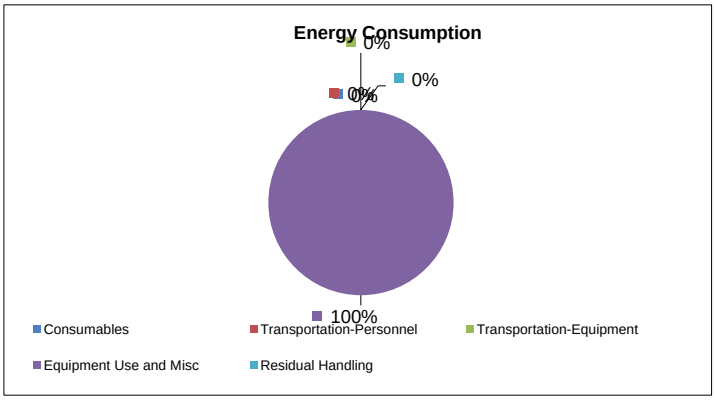
Sustainable Remediation - Environmental Footprint Summary
G-5

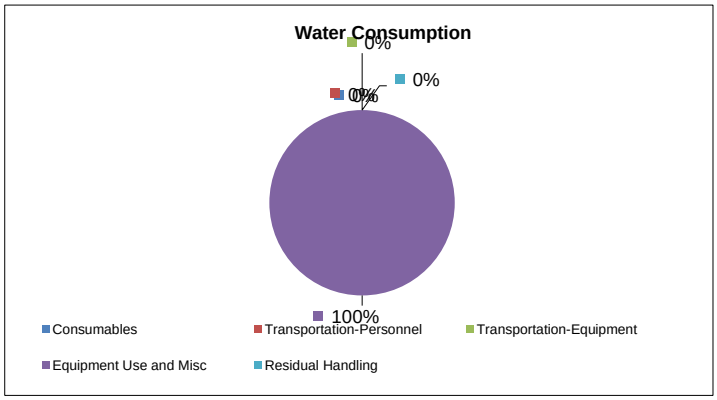
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	9.15	1.2E+02	NA	3.4E-03	1.2E-04	6.9E-04	1.9E-04	1.5E-02
	Transportation-Equipment	1.00	1.3E+01	NA	3.1E-04	5.6E-06	2.8E-05	2.7E-06	2.1E-04
	Equipment Use and Misc	189,941.76	4.1E+06	2.0E+08	1.6E+02	4.2E+02	2.3E-02	2.9E-05	7.2E-03
	Residual Handling	0.18	2.4E+00	NA	5.7E-05	1.0E-06	5.1E-06	7.8E-07	6.3E-05
	Sub-Total	189,952.09	4.11E+06	2.02E+08	1.55E+02	4.25E+02	2.33E-02	2.19E-04	2.26E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	74.32	9.3E+02	NA	2.7E-02	9.7E-04	5.6E-03	1.5E-03	1.2E-01
	Transportation-Equipment	5.94	7.8E+01	NA	1.9E-03	3.3E-05	1.7E-04	1.5E-05	1.2E-03
	Equipment Use and Misc	8,135.95	1.4E+05	6.0E+06	1.8E+01	1.3E+01	2.6E-03	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	8,216.20	1.40E+05	6.01E+06	1.83E+01	1.29E+01	8.39E-03	1.54E-03	1.24E-01
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	4.12	5.2E+01	NA	1.5E-03	5.4E-05	3.1E-04	8.4E-05	6.8E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	60.15	9.0E+02	0.0E+00	2.1E-01	1.4E-01	5.3E-03	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	64.26	9.49E+02	0.00E+00	2.10E-01	1.39E-01	5.58E-03	8.42E-05	6.78E-03
Total		**2.0E+05**	**4.2E+06**	**2.1E+08**	**1.7E+02**	**4.4E+02**	**3.7E-02**	**1.8E-03**	**1.5E-01**

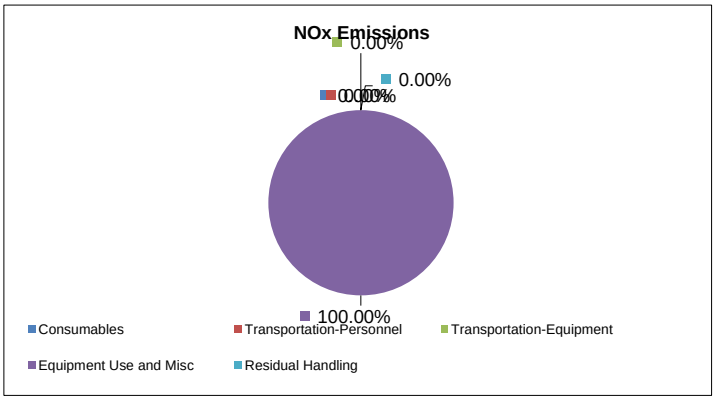
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	1.8E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	9.9E-01
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	5.4E-02
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**1.2E+00**

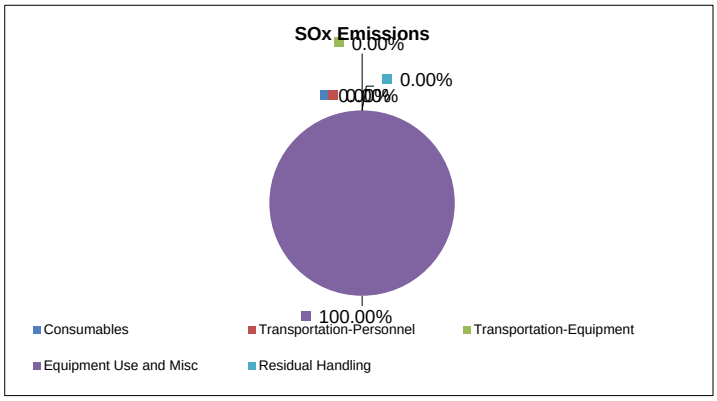
Total Cost with Footprint Reduction
$0

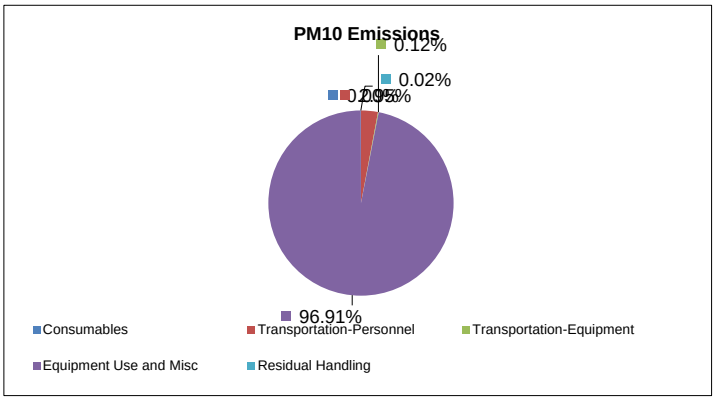

GHG Emissions
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

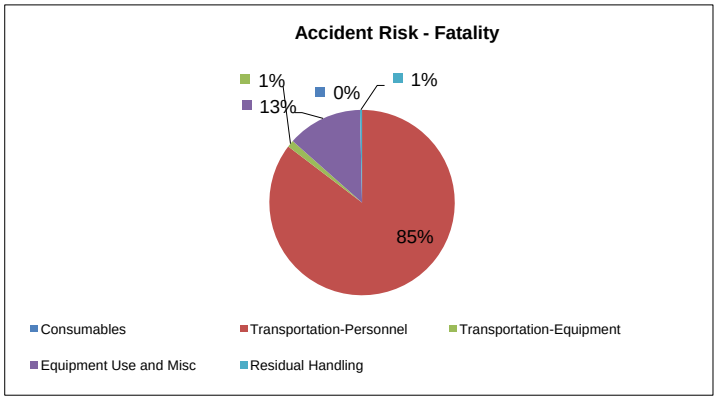

Energy Consumption
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

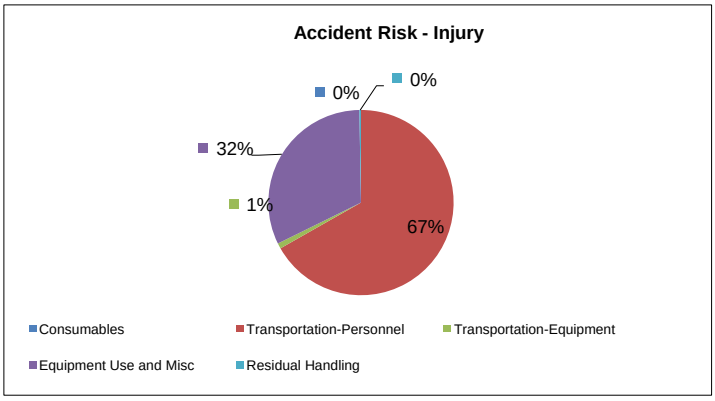

Water Consumption
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling


NOx Emissions
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

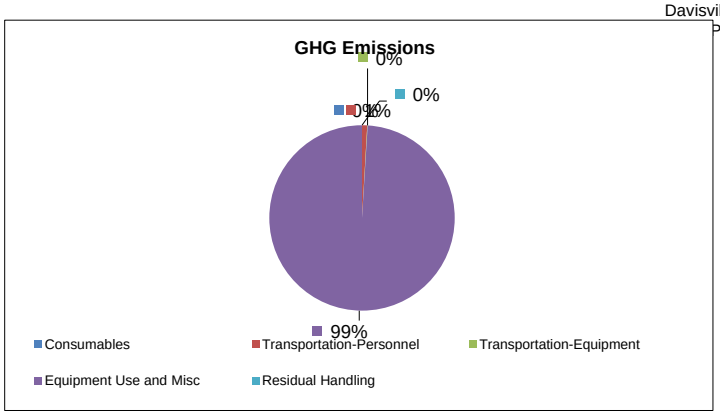

SOx Emissions
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

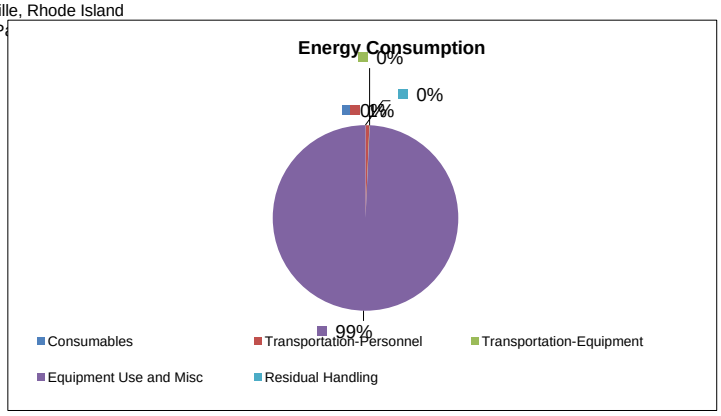

PM10 Emissions
0.12%
0.02%
96.91%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

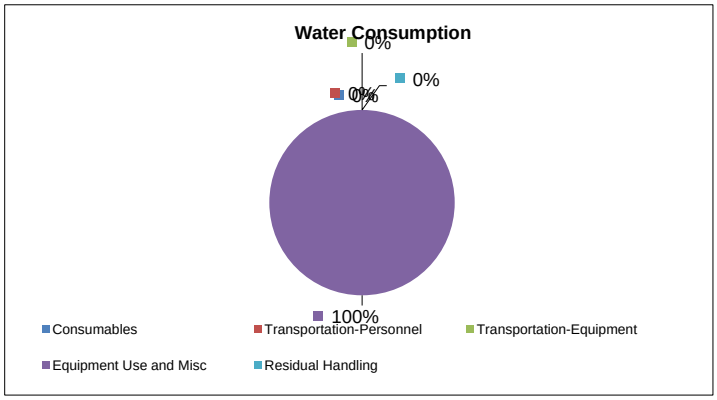

Accident Risk - Fatality
1%
0%
1%
13%
85%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

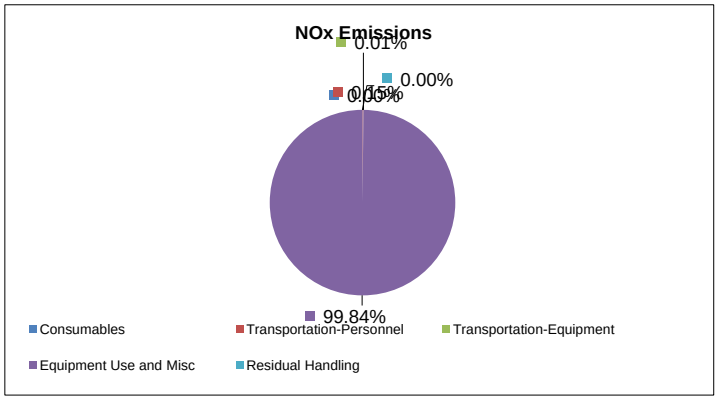

Accident Risk - Injury
0%
0%
32%
1%
67%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

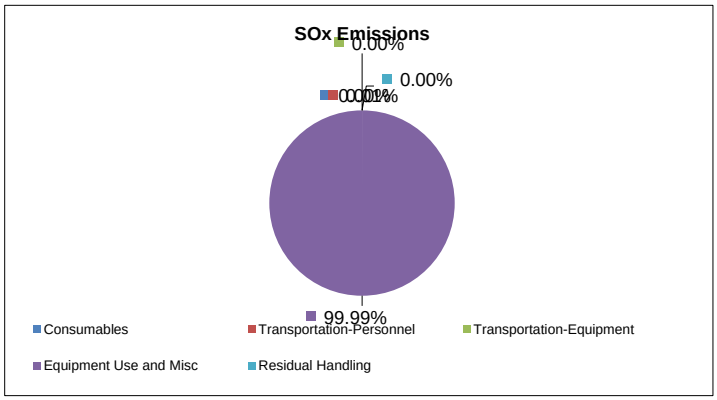
SiteWise™ Results Alternative G-5
Remedial Action Operation Stage
Site 16, NCBC Davisville
Davisville, Rhode Island

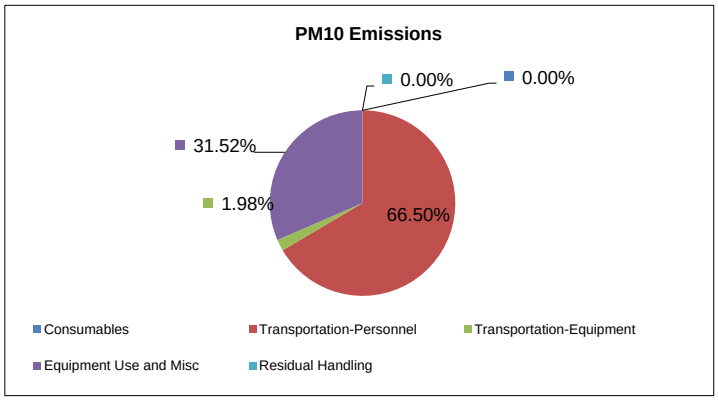


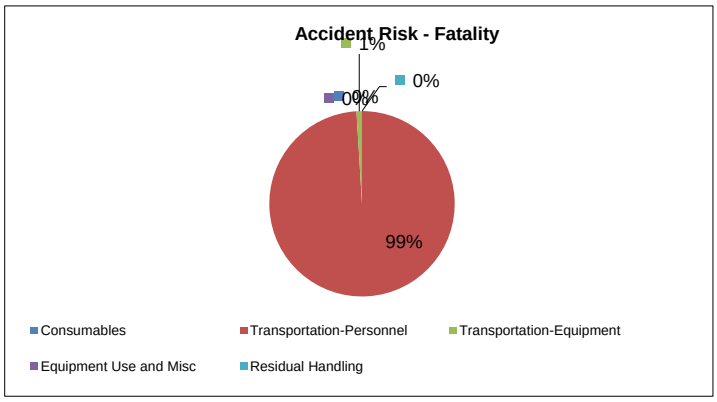


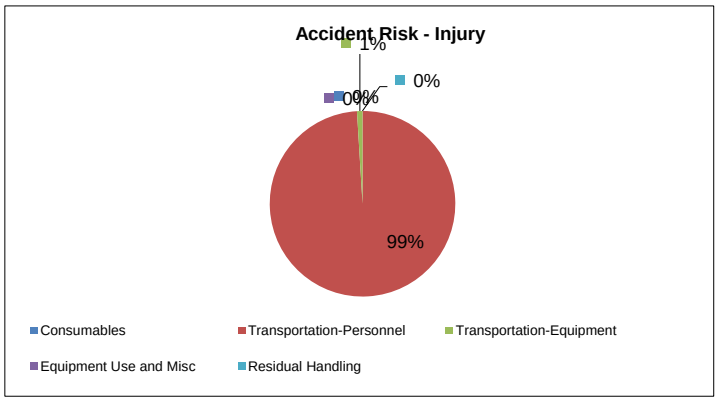


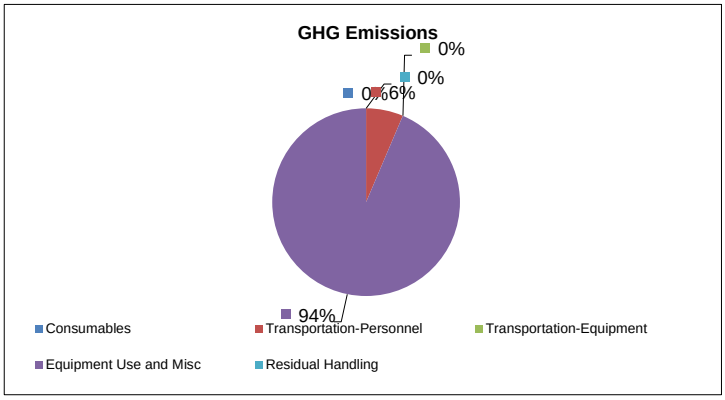


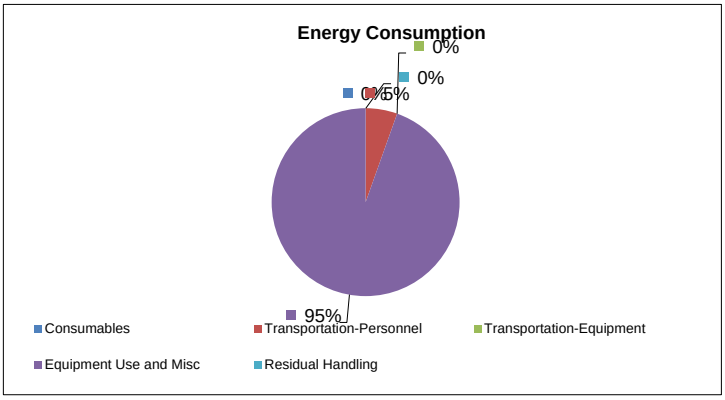


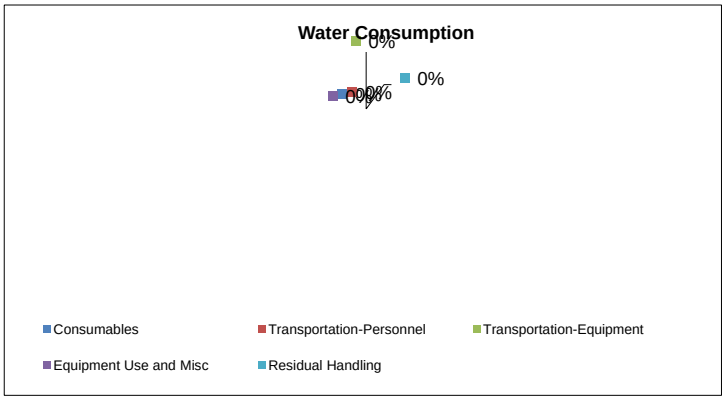


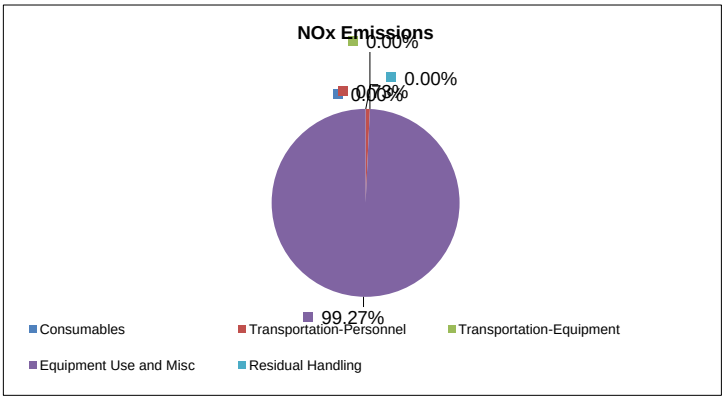


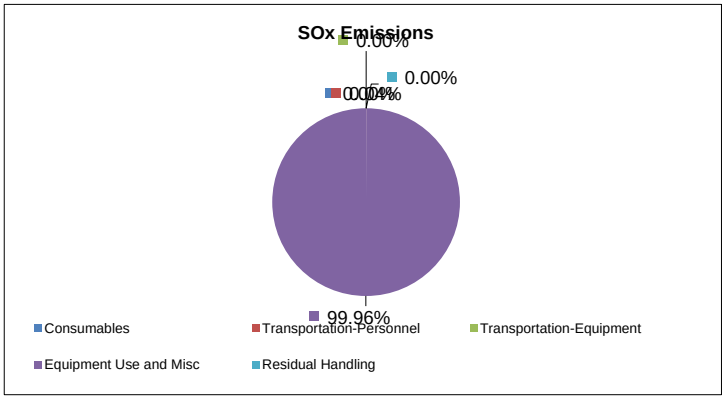


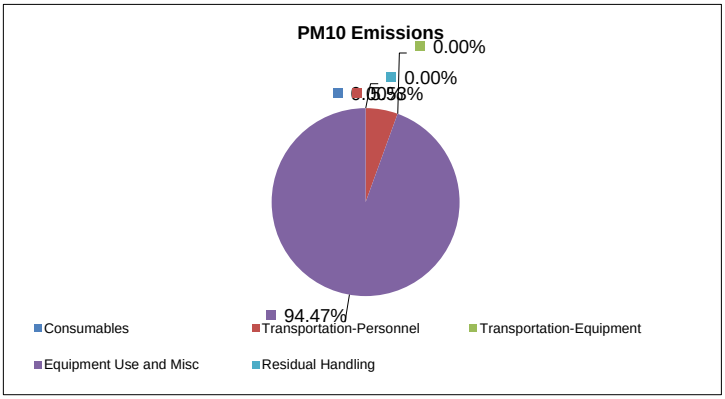

GHG Emissions
0%
0%
0%
6%
94%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

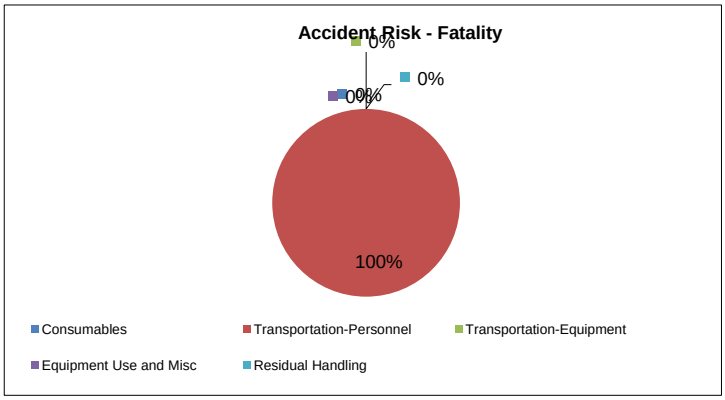

Energy Consumption
0%
0%
0%
5%
95%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

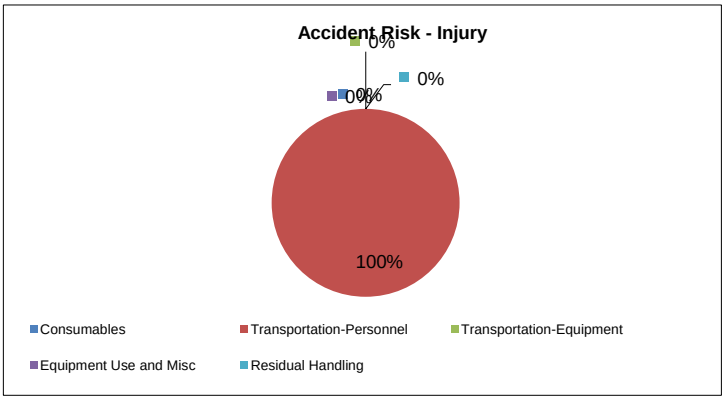

Water Consumption
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

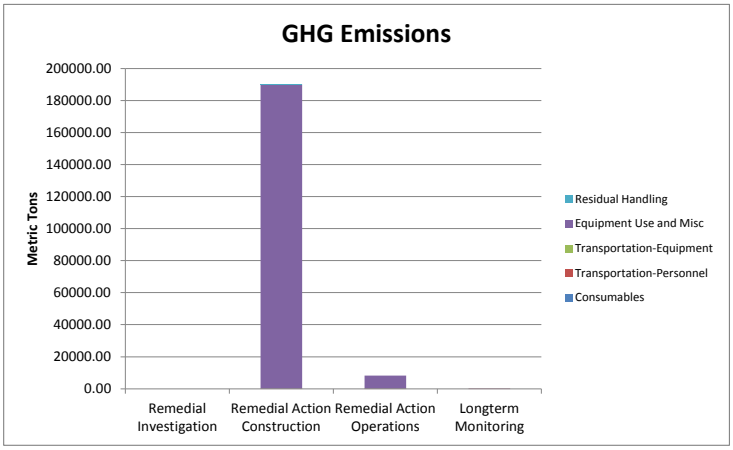

NOx Emissions
0.00%
0.00%
0.73%
99.27%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

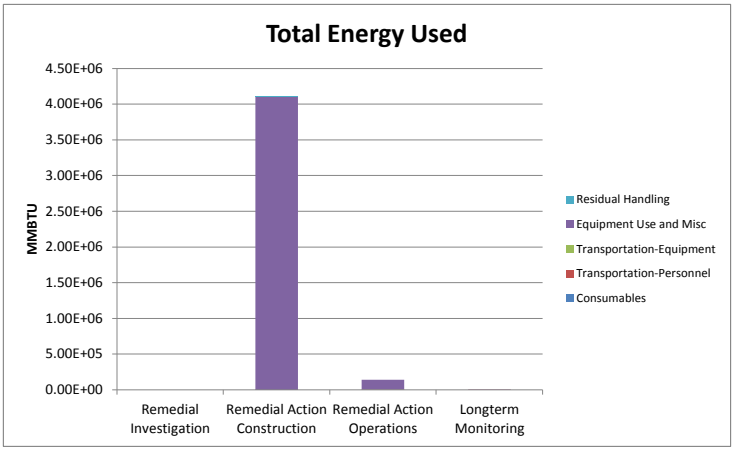

SOx Emissions
0.00%
0.00%
99.96%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

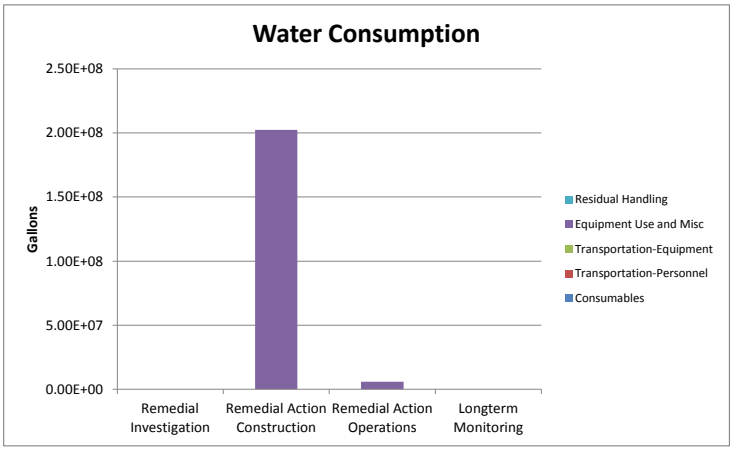

PM10 Emissions
0.00%
0.00%
5.53%
94.47%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

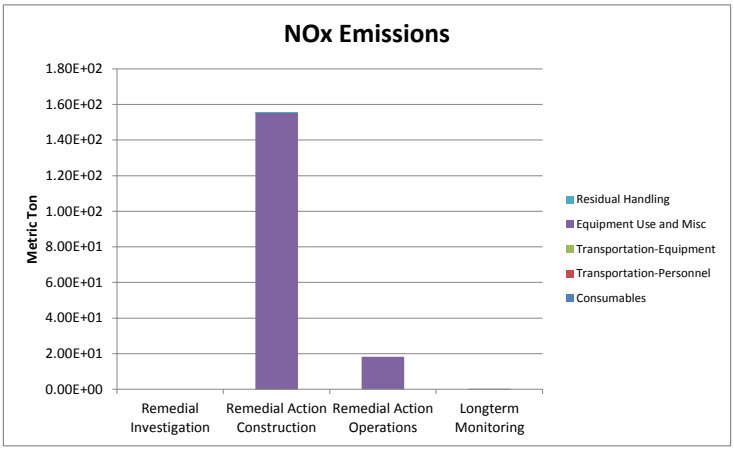

Accident Risk - Fatality
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

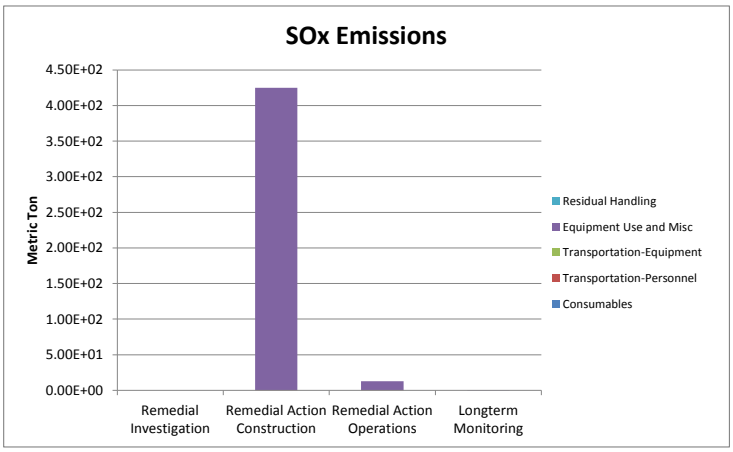

Accident Risk - Injury
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

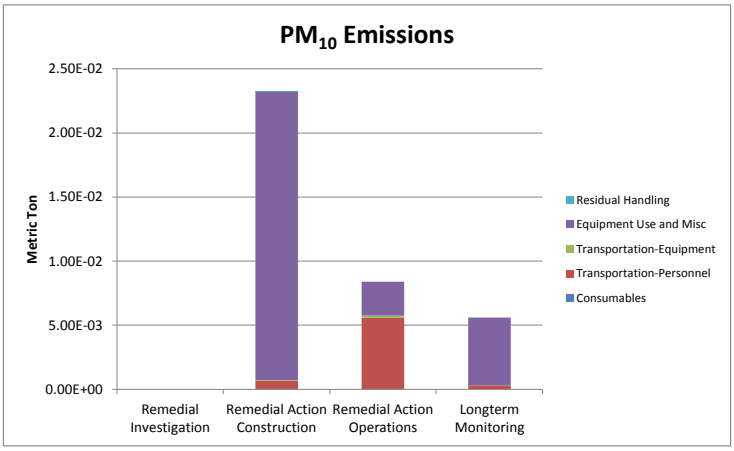

GHG Emissions
Metric Tons
200000.00
180000.00
160000.00
140000.00
120000.00
100000.00
80000.00
60000.00
40000.00
20000.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

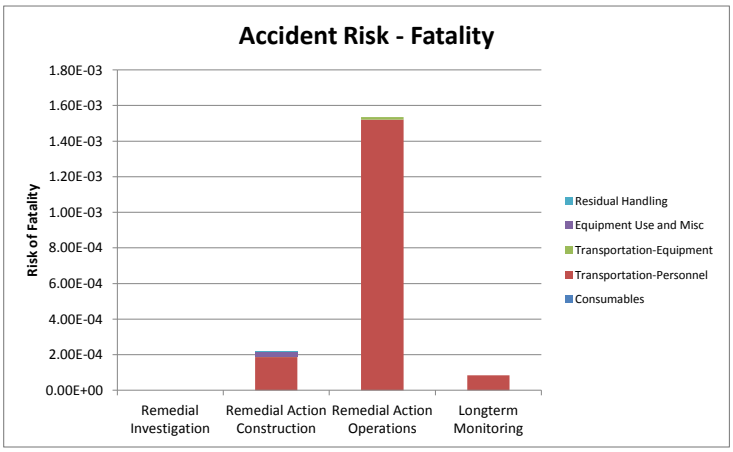

Total Energy Used
MMBTU
4.50E+06
4.00E+06
3.50E+06
3.00E+06
2.50E+06
2.00E+06
1.50E+06
1.00E+06
5.00E+05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

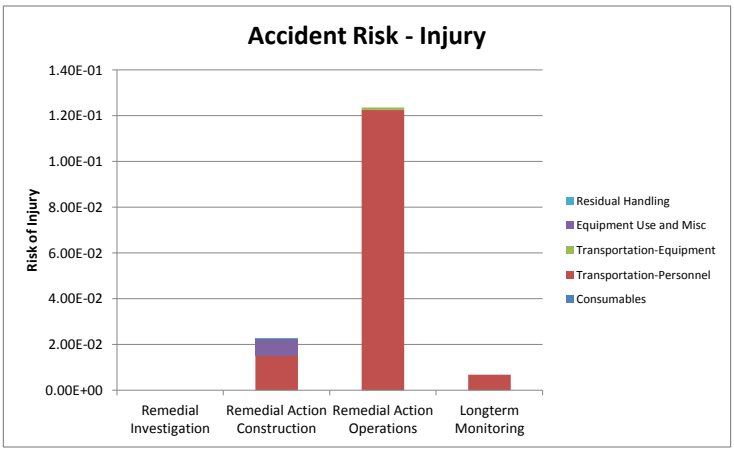

Water Consumption
Gallons
2.50E+08
2.00E+08
1.50E+08
1.00E+08
5.00E+07
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
1.80E+02
1.60E+02
1.40E+02
1.20E+02
1.00E+02
8.00E+01
6.00E+01
4.00E+01
2.00E+01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
4.50E+02
4.00E+02
3.50E+02
3.00E+02
2.50E+02
2.00E+02
1.50E+02
1.00E+02
5.00E+01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
1.80E-03
1.60E-03
1.40E-03
1.20E-03
1.00E-03
8.00E-04
6.00E-04
4.00E-04
2.00E-04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
1.40E-01
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

GSRx Results Alternative G-5
Site 16, NCBC Davisville
Davisville, Rhode Island

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Extraction wells	PVC	Assume PVC, 45 wells, 6 in, Schedule 80, 2600 lft, 5.61 lb.ft	2,600.00	lft	32.87	16.54	0.04	0.19	0.00	0.06	0.01	603.09	4.47
RAC	Transfer piping 1 inch diameter	PVC	Assume PVC, Schedule 80, 1 inch diameter, 2300 lf, 0.424 lb/ft	2,300.00	lft	2.20	1.11	0.00	0.01	0.00	0.00	0.00	40.32	3.95
RAC	Transfer Piping, 2 inch	PVC	Assume PVC, SChedule 80, 2 inch diameter, 6100 lf, 0.984 lb/ft	6,100.00	lft	13.53	6.81	0.02	0.08	0.00	0.03	0.00	248.18	10.49
RAC	Piping, 2 inch diameter, PVC, Sch 80	PVC	Assume PVC, Schedule 80, 2 in diameter, 1500 lf, 0.984 lb/ft	1,500.00	lft	3.33	1.67	0.00	0.02	0.00	0.01	0.00	61.03	2.58
RAC	Piping, 6 inch diameter, PVC, Sch 80	PVC	Assume PVC, Schedule 80, 6 in diameter, 250 lf, 5.61 lb/ft	250.00	lft	3.16	1.59	0.00	0.02	0.00	0.01	0.00	57.99	0.43
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Extraction well wellheads	PVC	Assume PVC, 10 wellheads, 50 lb per unit	500.00	lbs	1.13	0.57	0.00	0.01	0.00	0.00	0.00	20.67	0.86
RAC	Transfer piping fittings, 1 inch	PVC	Assume PVC, assume 1 inch fittings, Schedule 80, 250 fittings, 0.5 lb per unit	125.00	lbs	0.28	0.14	0.00	0.00	0.00	0.00	0.00	5.17	0.21
RAC	Transfer Piping valves, 1 inch	PVC	Ball valve, 200 units, 1 inch diameter, PVC, 1 lb per unit	200.00	lbs	0.45	0.23	0.00	0.00	0.00	0.00	0.00	8.27	0.34
RAC	Transfer piping fittings, 2 inch, double wall	PVC	Assume PVC, assume 2 inch fittings, Schedule 80, 250 fittings, 1 lb per unit	250.00	lbs	0.56	0.28	0.00	0.00	0.00	0.00	0.00	10.34	0.43
RAC	Transfer Piping valves, 2 inch	PVC	Ball valve, 12 units, 2 inch diameter, PVC, 1 lb per unit	12.00	lbs	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.50	0.02
RAC	manholes	General Concrete	Assume concrete, 2'x2'x2 3 inch deep, assue contrete with concrete cover, 7 manholes, 2371 kg/m3	1,108.07	lbs	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.64	0.00
RAC	Transfer piping fittings, 2 inch	PVC	Assume PVC, assume 2 inch fittings, Schedule 80, 200 fittings, 0.5 lb per unit	100.00	lbs	0.23	0.11	0.00	0.00	0.00	0.00	0.00	4.13	0.17
RAC	Transfer Piping valves, 2 inch	PVC	Ball valve, 40 units, 2 inch diameter, PVC, 1 lb per unit	40.00	lbs	0.09	0.05	0.00	0.00	0.00	0.00	0.00	1.65	0.07
RAC	Transfer piping fittings, 6 inch	PVC	Assume PVC, assume 6 inch fittings, Schedule 80, 25 fittings, 0.5 lb per unit	12.50	lbs	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.52	0.02
RAC	Transfer Piping valves,6 inch	PVC	Ball valve, 4 units, 6 inch diameter, PVC, 1 lb per unit	4.00	lbs	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.01
RAC	Bag filters	HDPE	2 bag filters, 2 sf, Assume HDPE, 3 mm thick, 0.95 g/cm3	2.33	lbs	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
RAO	GAC forLiquid phase	GAC	5000 lb per vessel, 2 vessels, replace once per year every year for 30 years	300,000.00	lbs	1721.09	877.55	2.72	0.00	8.16	0.79	0.00	4561.98	118.62
RAO	GAC for Vapor phase	GAC	3000 lb per vessel, 2 vessels, replace 4 times during first year, replace 2 times a year for years 2,3, and 4, replace once a year for years 5 through 30	216,000.00	lbs	1239.18	631.84	1.96	0.00	5.88	0.57	0.00	3284.63	85.41
RAO	bag filters	HDPE	104 bag filters per year, for 30 years, 2 sf, Assume HDPE, 3 mm thick, 0.95 g/cm3	3,642.42	lbs	8.13	4.29	0.01	0.03	0.00	0.02	0.00	47.67	1.31
	Subtotal					**3027.92**	**1543.70**	**4.76**	**0.38**	**14.04**	**1.49**	**0.02**	**8966.14**	**229.65**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Drill Rig, DPT	Drill Rig, DPT (diesel)	45 wells, 5 wells per day, 8 hours per day, 80% utilization	57.60	hrs	0.92	0.90	0.00	0.00	0.01	0.00	0.00	7.04	
RAC	Backhoe, loader, 80 HP, 1 4/4 cy	Loader, 65 HP, 1 CY (diesel)	40 days, 8 hours per day, 80% utilization	256.00	hrs	3.03	3.03	0.00	0.00	0.02	0.01	0.00	13.56	
	Subtotal					**3.96**	**3.93**	**0.00**	**0.00**	**0.03**	**0.01**	**0.01**	**20.60**	**0**
				Total		**3,032**	**1,548**	**4.76**	**0.38**	**14.07**	**1.50**	**0.03**	**8,987**	**230**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
	Tonnes							MMBTU	gal
RI	-	-	-	-	-	-	-	-	-
RAC	63.48	33.96	22.28	7.24	0.03	0.12	0.02	3,727.50	24,316.11
RAO	2,968.40	1,513.68	1,454.06	0.66	14.04	1.38	0.00	26,935.26	205,337.01
LTM	-	-	-	-	-	-	-	-	-

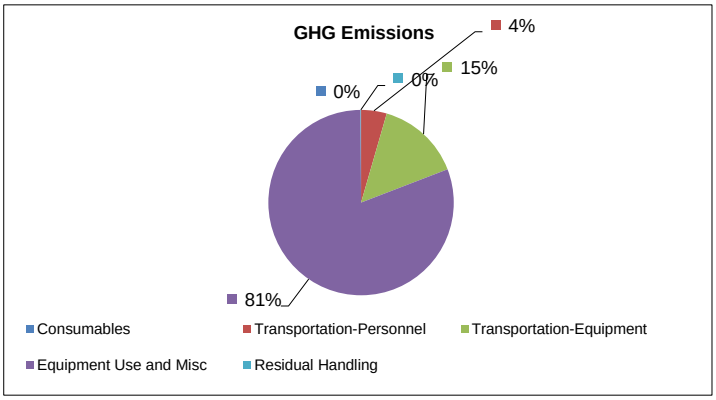
Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

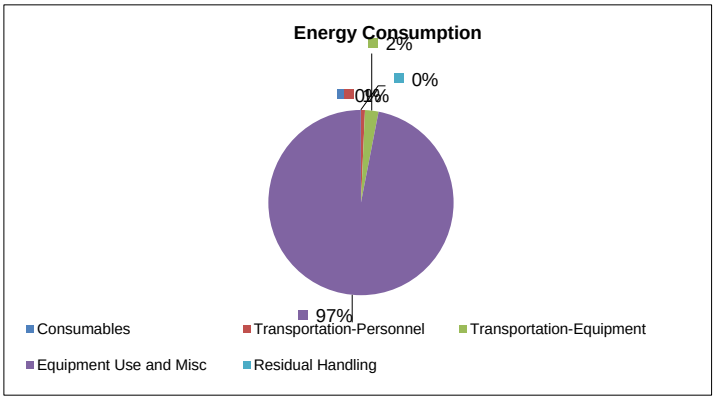
Sustainable Remediation - Environmental Footprint Summary
G-6

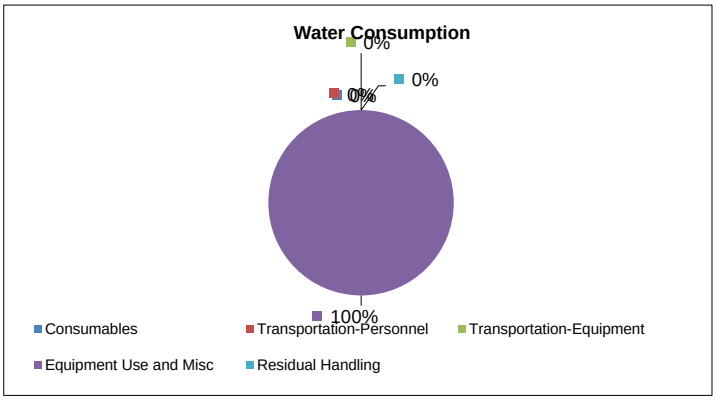
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	21.23	2.7E+02	NA	7.9E-03	2.8E-04	1.6E-03	4.3E-04	3.5E-02
	Transportation-Equipment	69.64	9.1E+02	NA	2.2E-02	3.9E-04	1.9E-03	1.7E-04	1.4E-02
	Equipment Use and Misc	383.11	3.7E+04	4.9E+06	1.5E-01	4.8E-01	4.1E-02	7.7E-05	1.9E-02
	Residual Handling	0.43	5.6E+00	NA	1.4E-04	2.4E-06	1.2E-05	1.6E-06	1.3E-04
	Sub-Total	474.41	3.85E+04	4.95E+06	1.85E-01	4.76E-01	4.44E-02	6.85E-04	6.83E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	4.88	6.1E+01	NA	1.8E-03	6.4E-05	3.7E-04	1.0E-04	8.0E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	101.54	1.5E+03	0.0E+00	3.5E-01	2.3E-01	8.9E-03	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	106.42	1.58E+03	0.00E+00	3.53E-01	2.34E-01	9.27E-03	9.98E-05	8.04E-03
Total		**5.8E+02**	**4.0E+04**	**4.9E+06**	**5.4E-01**	**7.1E-01**	**5.4E-02**	**7.9E-04**	**7.6E-02**

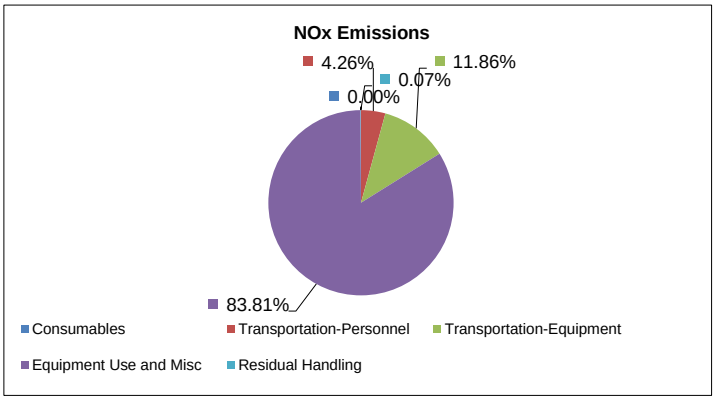
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	5.5E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	6.4E-02
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**6.1E-01**

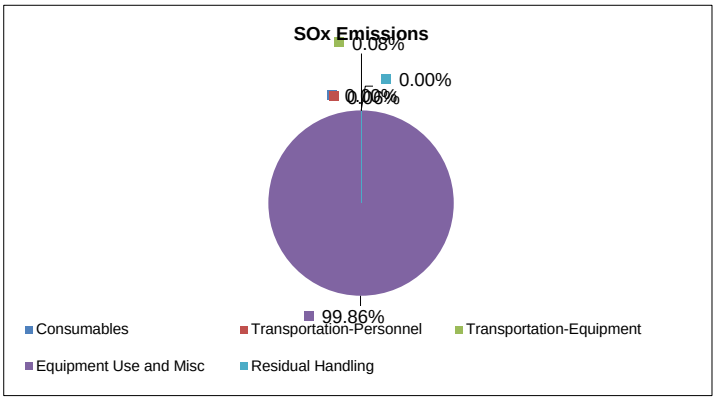
Total Cost with Footprint Reduction
$0

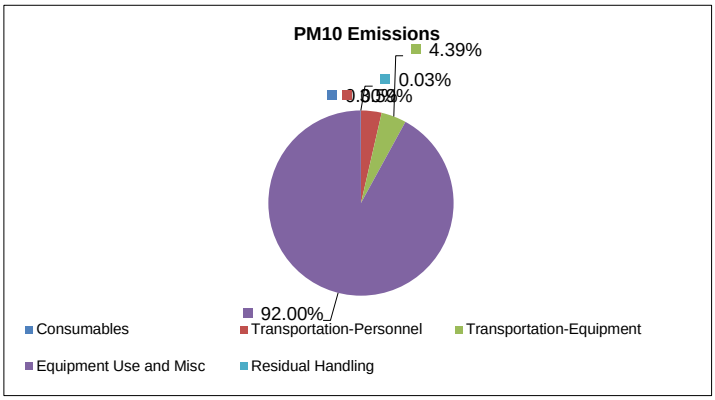

GHG Emissions
4%
15%
0%
0%
81%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

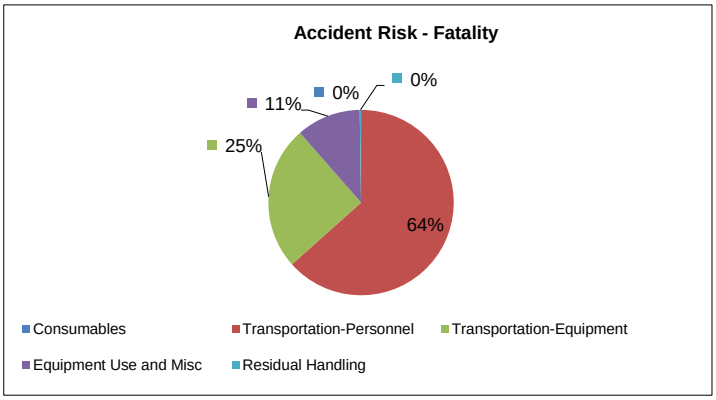

Energy Consumption
2%
0%
97%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

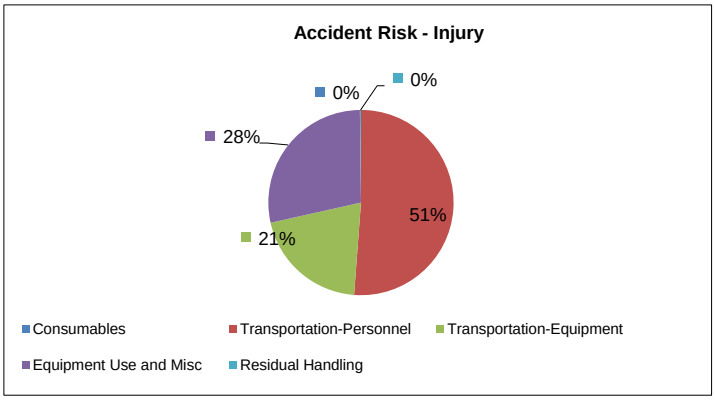

Water Consumption
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

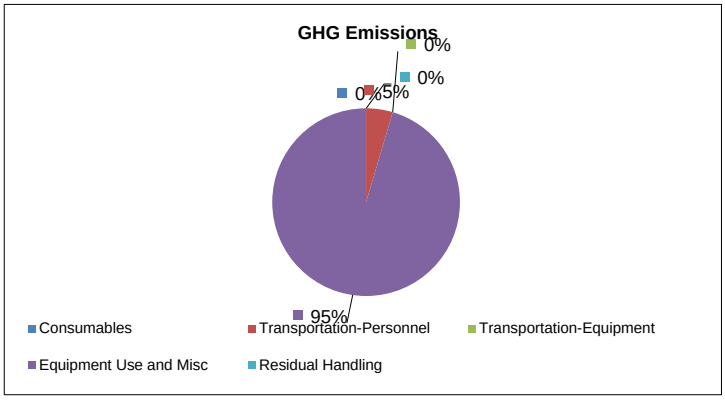

NOx Emissions
4.26%
11.86%
0.07%
0.00%
83.81%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

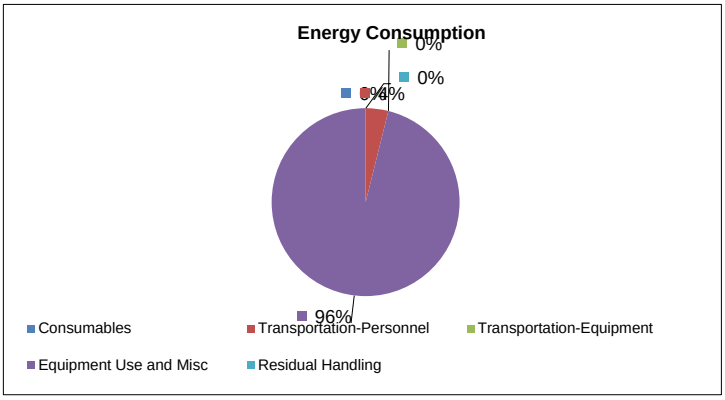

SOx Emissions
0.08%
0.00%
99.86%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

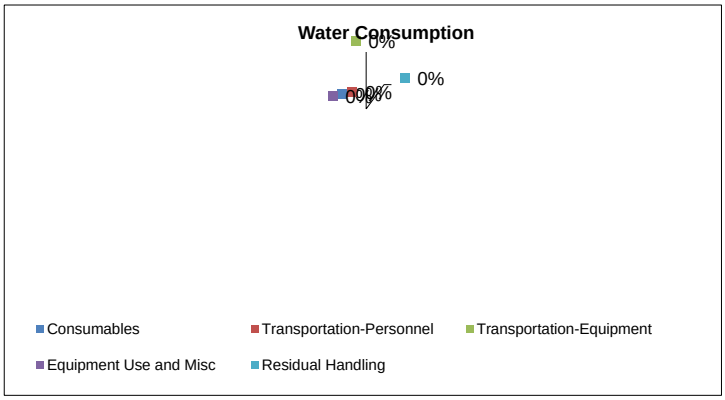

PM10 Emissions
4.39%
0.03%
92.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

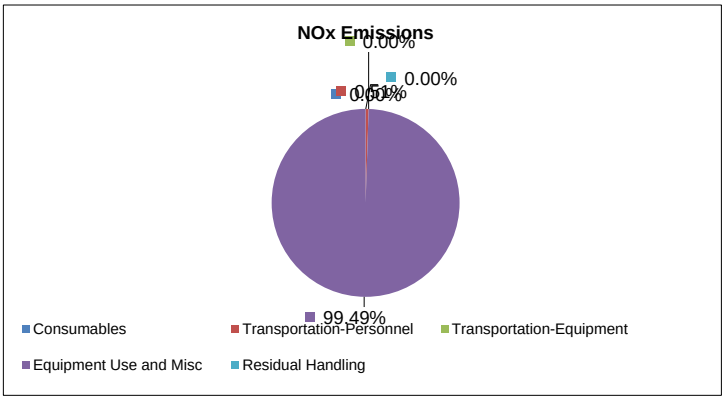

Accident Risk - Fatality
0%
0%
11%
25%
64%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

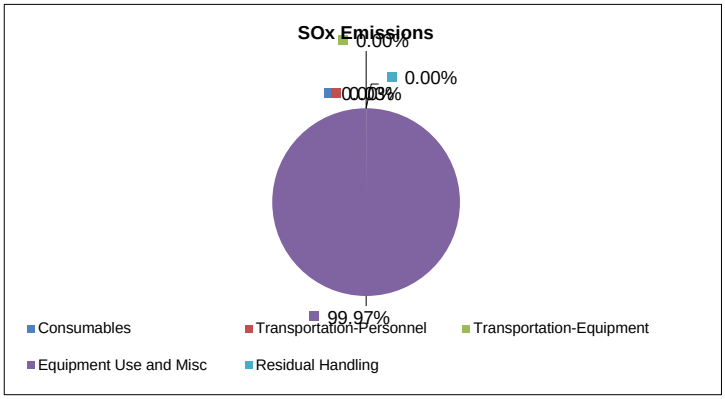

Accident Risk - Injury
0%
0%
28%
51%
21%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

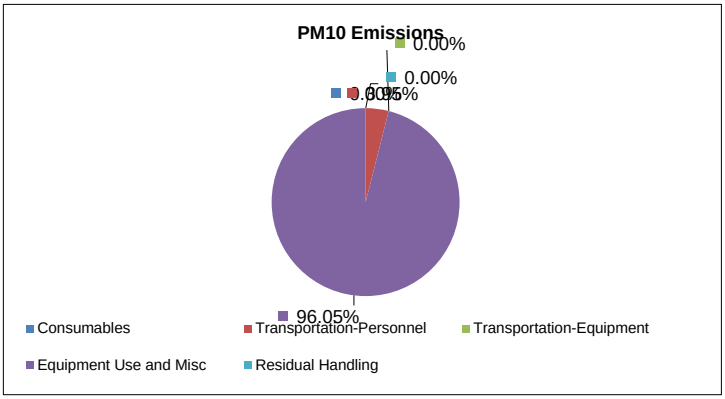

GHG Emissions
0%
0%
0%
5%
95%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

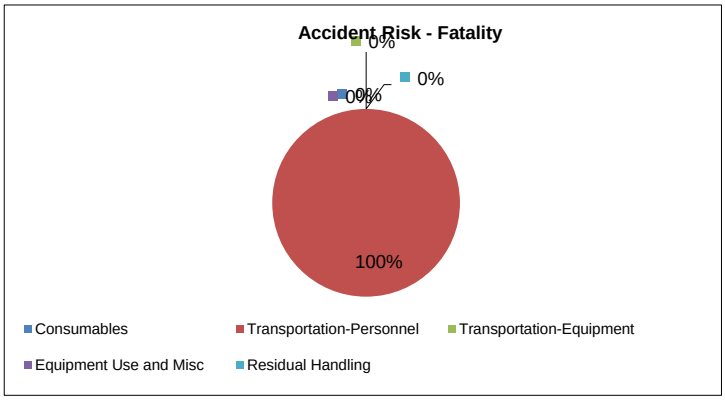

Energy Consumption
0%
0%
0%
4%
96%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

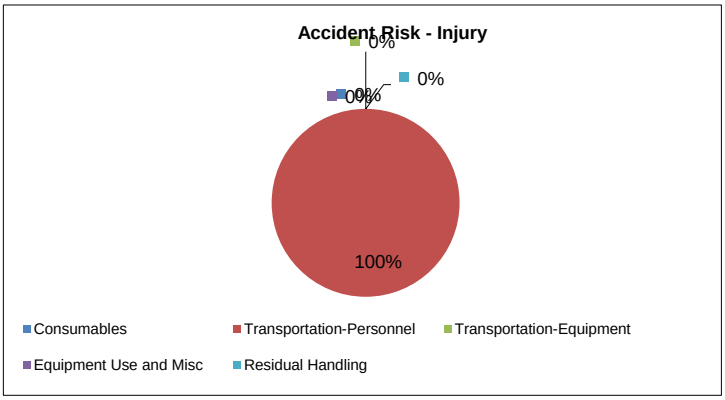

Water Consumption
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

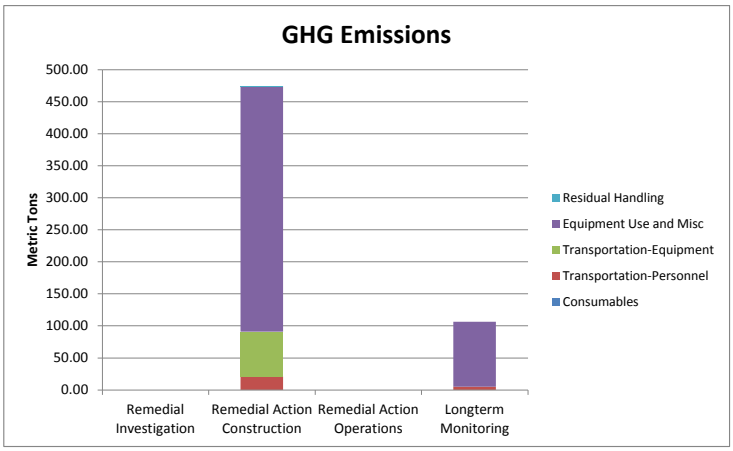

NOx Emissions
0.00%
0.00%
0.51%
99.49%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

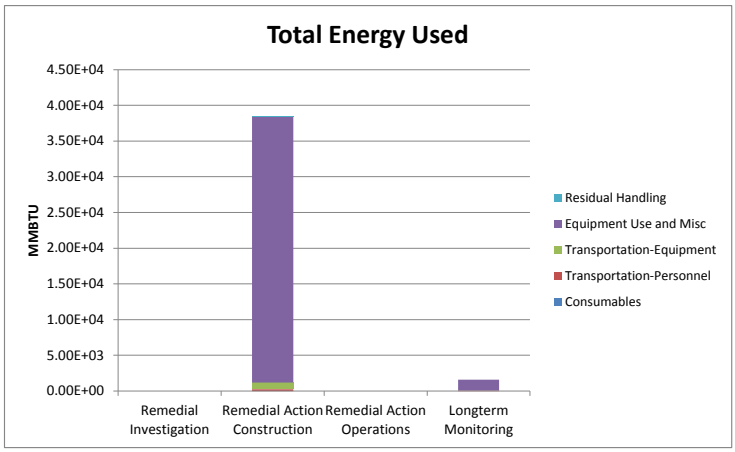

SOx Emissions
0.00%
0.00%
99.97%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

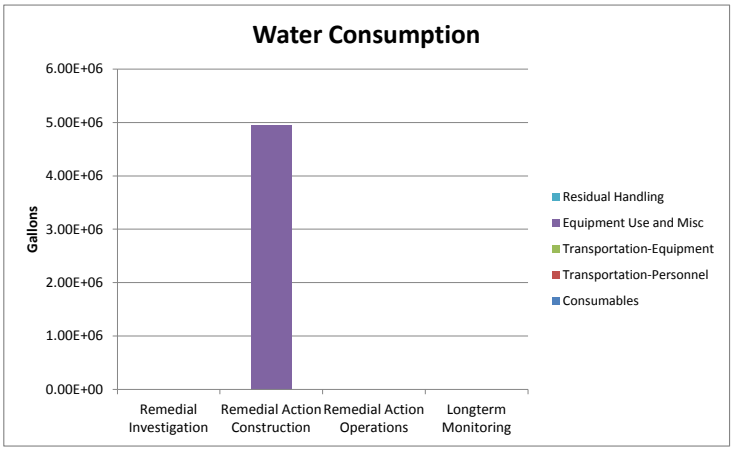

PM10 Emissions
0.00%
0.00%
96.05%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

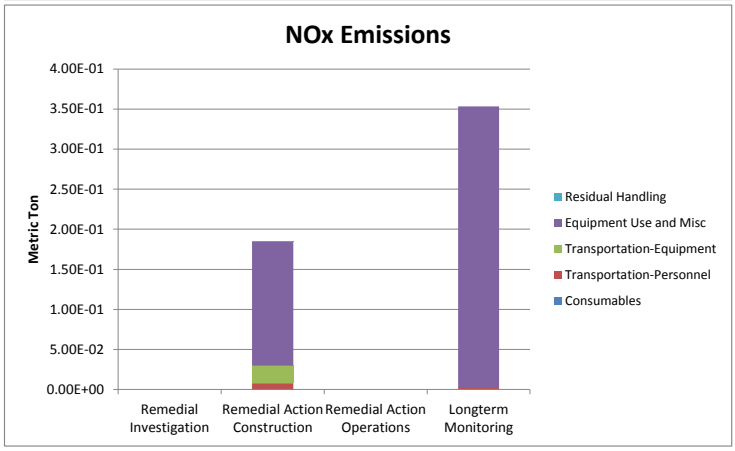

Accident Risk - Fatality
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

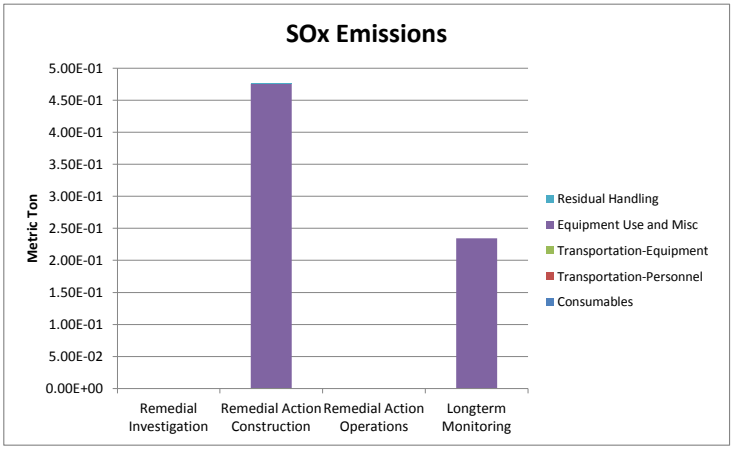

Accident Risk - Injury
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

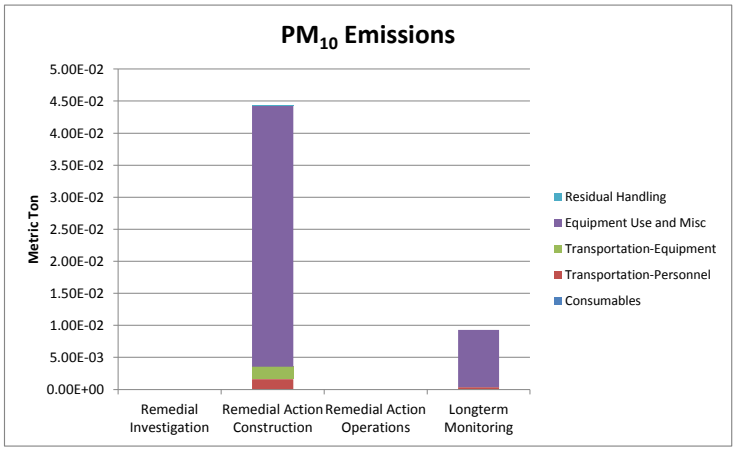

GHG Emissions
Metric Tons
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

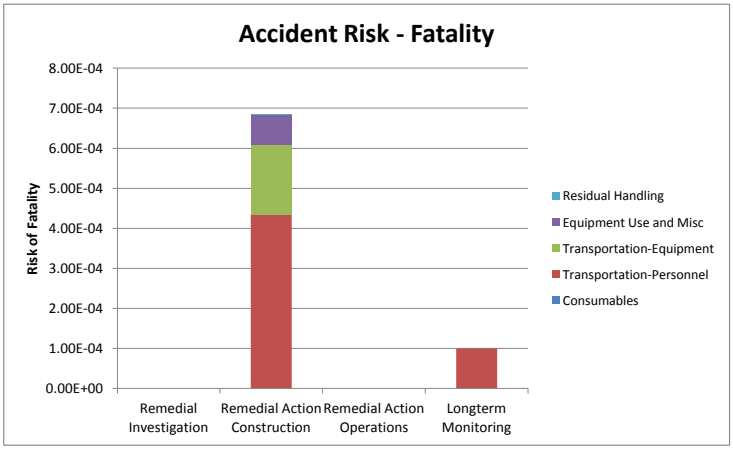

Total Energy Used
MMBTU
4.50E+04
4.00E+04
3.50E+04
3.00E+04
2.50E+04
2.00E+04
1.50E+04
1.00E+04
5.00E+03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

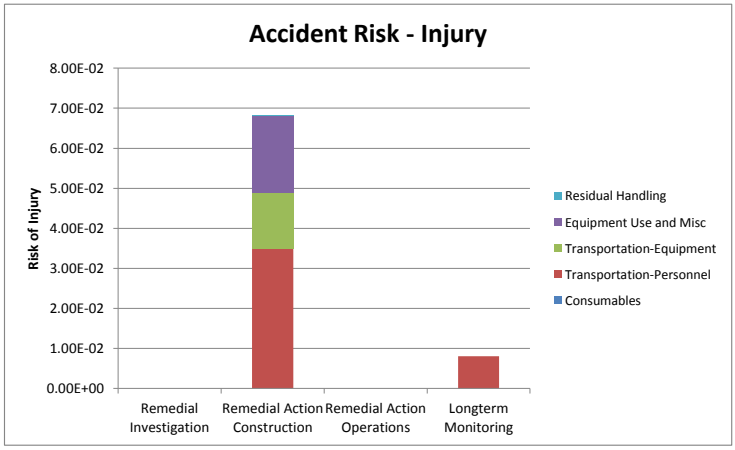

Water Consumption
Gallons
6.00E+06
5.00E+06
4.00E+06
3.00E+06
2.00E+06
1.00E+06
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
5.00E-01
4.50E-01
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
5.00E-02
4.50E-02
4.00E-02
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
8.00E-04
7.00E-04
6.00E-04
5.00E-04
4.00E-04
3.00E-04
2.00E-04
1.00E-04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
8.00E-02
7.00E-02
6.00E-02
5.00E-02
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

GSRx Results Alternative G-6
Site 16, NCBC Davisville
Davisville, Rhode Island

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Injection wells, 1 inch diam	PVC	Assume PVC, 1 inch diameter, Schedule 40, 230 wells, 42000 ft, 0.33 lb/ft	42,000.00	lft	31.23	15.71	0.04	0.18	0.00	0.06	0.01	573.07	72.21
RAC	Injection wells, 2 inch diam	PVC	Assume PVC, 2 inch diameter, Schedule 40, 130 wells, 32000 ft, 0.72 lb.ft	32,000.00	lft	51.92	26.12	0.06	0.30	0.00	0.10	0.01	952.64	55.02
RAC	New monitoring wells, 2 inch	PVC	Assume PVC, 2 inch diameter, Schedule 40, 12 wells, 750 ft, 0.72 lb/ft	750.00	lft	1.22	0.61	0.00	0.01	0.00	0.00	0.00	22.33	1.29
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Injection well heads	PVC	Assume PVC, 10 well heads, 50 lb each	500.00	lbs	1.13	0.57	0.00	0.01	0.00	0.00	0.00	20.67	0.86
RAC	EOSAquabupH	Vegetable Oil	Assume vegetable oil, 80,000 gallons, 1310.82 kg/m3	875,146.92	lbs	130.98	130.97	0.00	0.00	0.00	0.13	0.00	4556.60	395.32
RAC	ORC	Lime	70,000 pounds, assume lime	7,000.00	lbs	3.06	2.62	0.00	0.00	0.00	0.00	0.00	26.97	0.00
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	EOSAquabupH	Vegetable Oil	Assume vegetable oil, 80,000 gallons, 1310.82 kg/m3	875,146.92	lbs	130.98	130.97	0.00	0.00	0.00	0.13	0.00	4556.60	395.32
	Subtotal					**353.65**	**309.25**	**0.11**	**0.51**	**0.00**	**0.44**	**0.03**	**10727.22**	**920.53**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	DPT Injection wells 1 inch	Drill Rig, DPT (diesel)	5 wells per day, 230 wells, 8 hours per day, 80% utilization	294.4	hrs	4.72	4.61	0.00	0.01	0.05	0.00	0.00	35.98	
RAC	DPT Injection wells 2 inch	Drill Rig, DPT (diesel)	5 wells per day, 130 wells, 8 hours per day, 80% utilization	166.4	hrs	2.67	2.60	0.00	0.00	0.03	0.00	0.00	20.34	
RAC	DPT Monitoring wells	Drill Rig, DPT (diesel)	5 wells per day, 12 wells, 8 hours per day, 80% utilization	15.36	hrs	0.25	0.24	0.00	0.00	0.00	0.00	0.00	1.88	
RAC	DPT Rig	Drill Rig, DPT (diesel)	57 days, 8 hours per day, 80% utilization	364.8	hrs	5.85	5.71	0.00	0.01	0.06	0.00	0.01	44.58	
	Subtotal					**13.48**	**13.15**	**0.00**	**0.02**	**0.14**	**0.00**	**0.01**	**102.77**	**0**
				Total		**367**	**322**	**0.11**	**0.53**	**0.14**	**0.44**	**0.04**	**10,830**	**921**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
				Tonnes				**MMBTU**	**gal**
RI	-	-	-	-	-	-	-	-	-
RAC	367.13	322.40	33.60	11.12	0.14	0.44	0.04	36,951.93	920,532.92
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

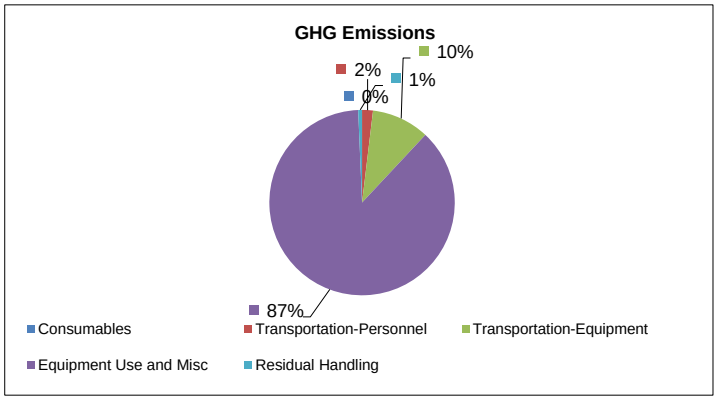
APPENDIX C-3-2: SOI LRESULTS

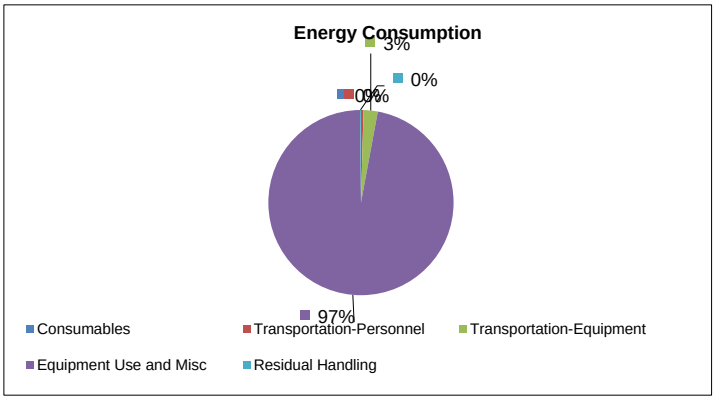
Sustainable Remediation - Environmental Footprint Summary
S-2

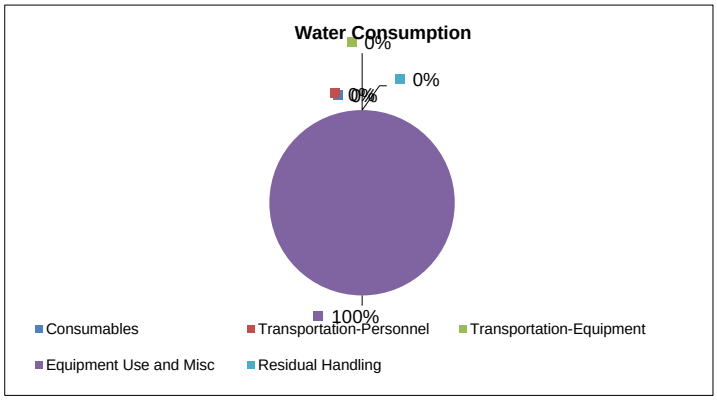
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	5.74	7.2E+01	NA	2.1E-03	7.5E-05	4.3E-04	1.2E-04	9.4E-03
	Transportation-Equipment	30.45	4.0E+02	NA	9.6E-03	1.7E-04	8.5E-04	7.5E-05	6.1E-03
	Equipment Use and Misc	264.17	1.6E+04	2.6E+03	7.2E-01	2.0E-01	6.5E-02	9.9E-05	2.5E-02
	Residual Handling	2.02	2.6E+01	NA	6.3E-04	1.1E-05	5.6E-05	7.0E-06	5.7E-04
	Sub-Total	302.37	1.61E+04	2.63E+03	7.32E-01	2.02E-01	6.64E-02	2.98E-04	4.09E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	1.83	2.3E+01	NA	6.8E-04	2.4E-05	1.4E-04	3.7E-05	3.0E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	21.23	3.2E+02	0.0E+00	7.3E-02	4.9E-02	1.9E-03	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	23.06	3.40E+02	0.00E+00	7.42E-02	4.90E-02	2.00E-03	3.74E-05	3.01E-03
Total		**3.3E+02**	**1.6E+04**	**2.6E+03**	**8.1E-01**	**2.5E-01**	**6.8E-02**	**3.4E-04**	**4.4E-02**

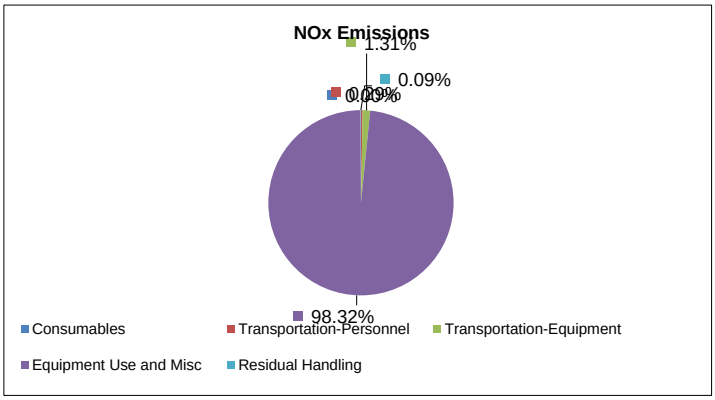
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	3.3E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	2.4E-02
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**3.5E-01**

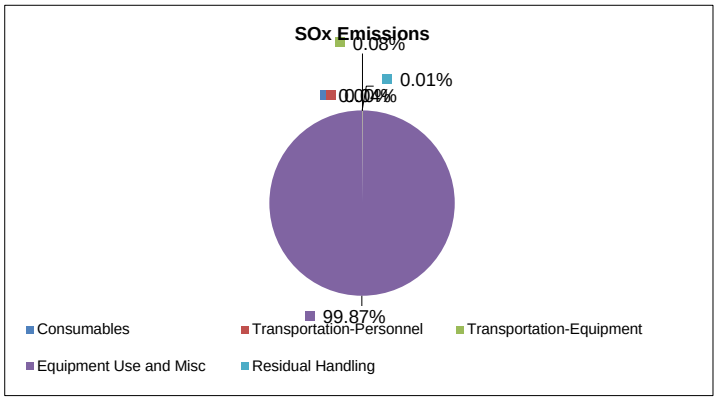
Total Cost with Footprint Reduction
$0

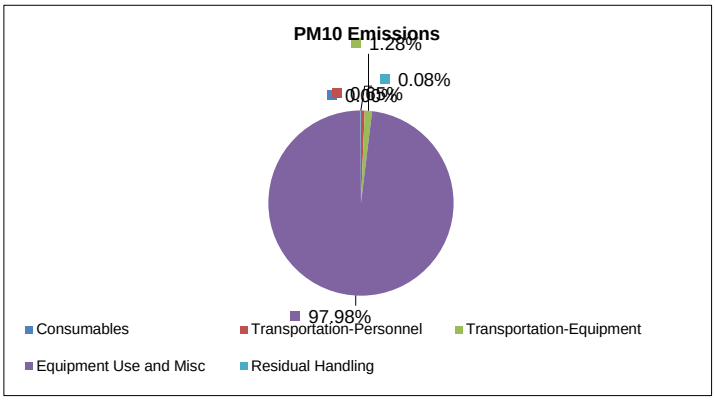

GHG Emissions
10%
2%
1%
0%
87%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

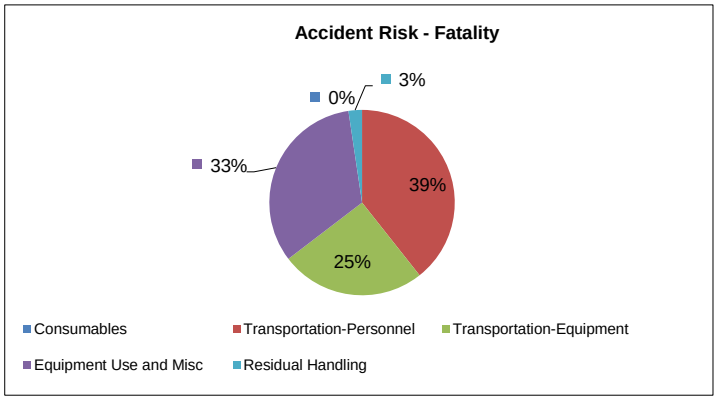

Energy Consumption
3%
0%
97%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

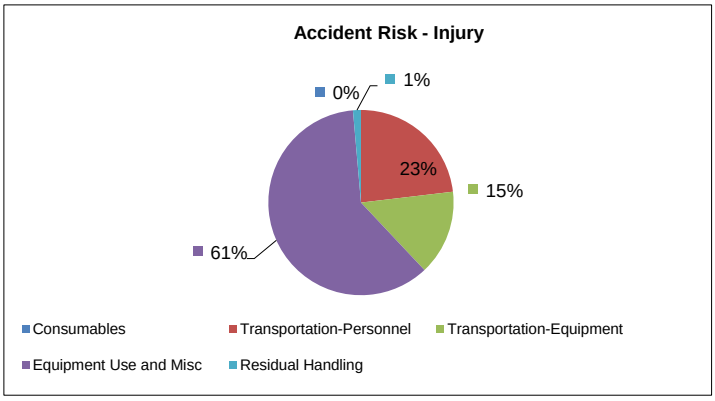

Water Consumption
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

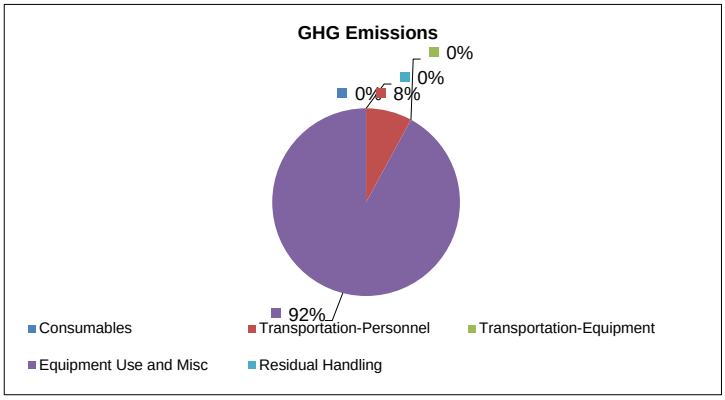

NOx Emissions
1.31%
0.09%
98.32%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

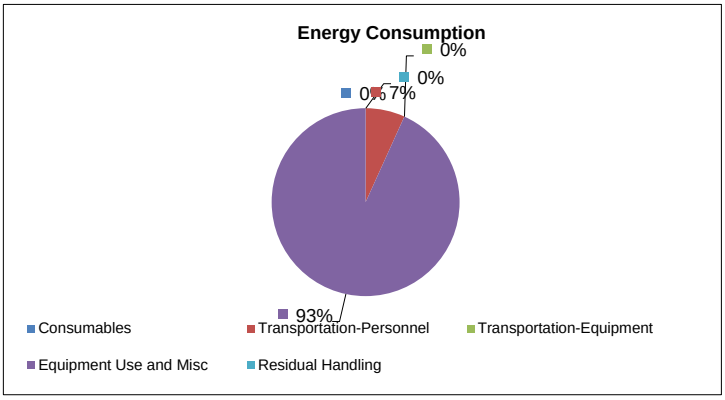

SOx Emissions
0.08%
0.01%
99.87%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

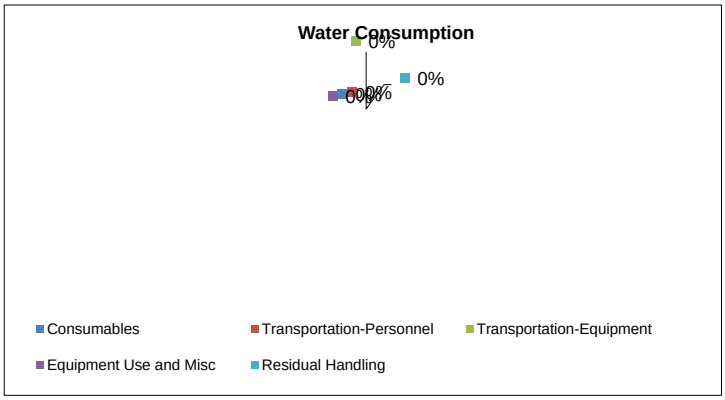

PM10 Emissions
1.28%
0.08%
97.98%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

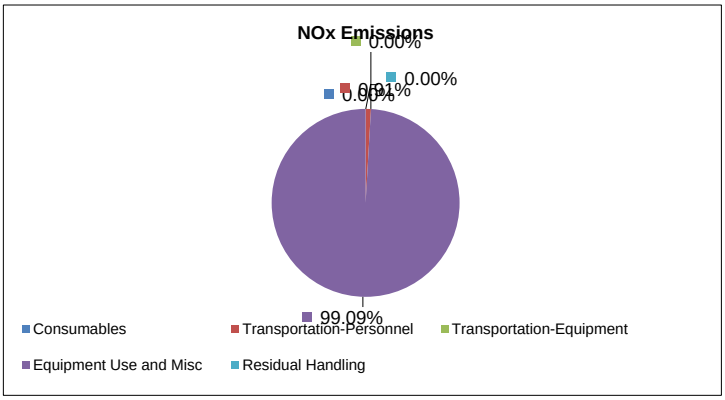

Accident Risk - Fatality
3%
0%
33%
39%
25%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

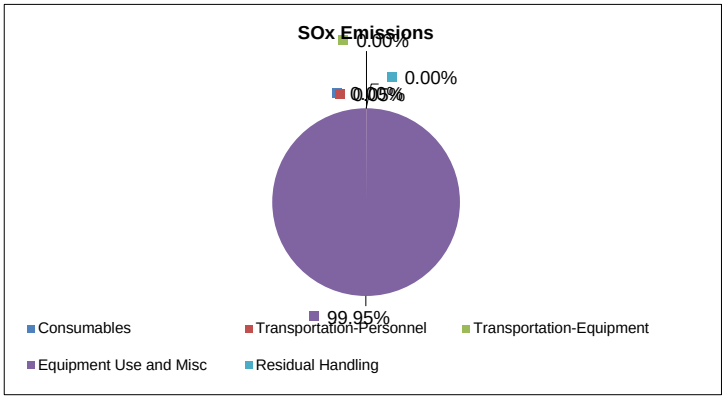

Accident Risk - Injury
1%
0%
23%
15%
61%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

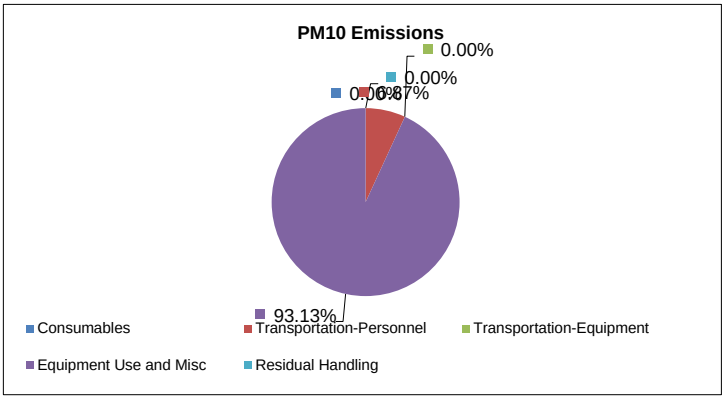

GHG Emissions
0%
0%
0%
8%
92%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

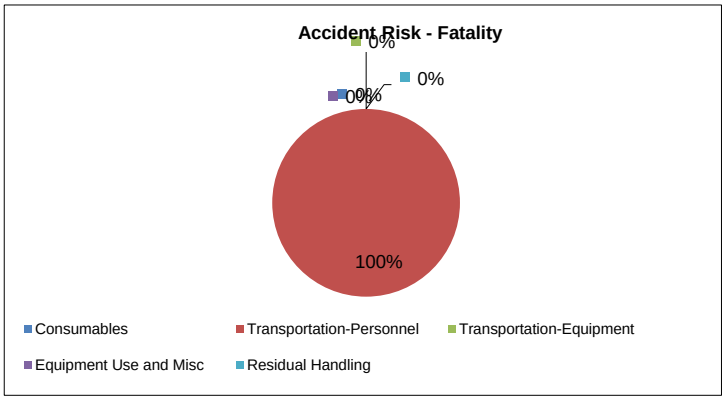

Energy Consumption
0%
0%
0%
7%
93%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

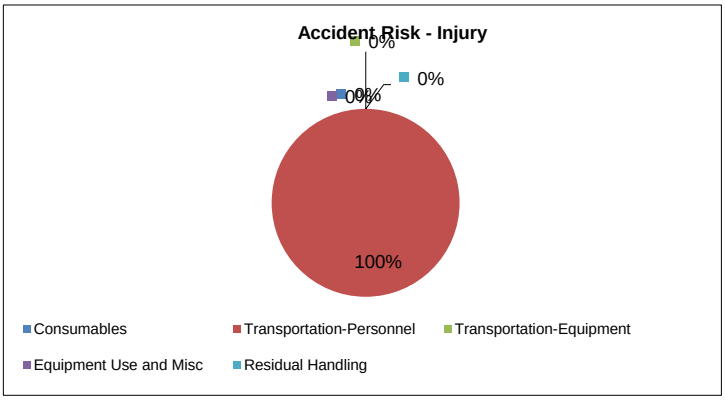

Water Consumption
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

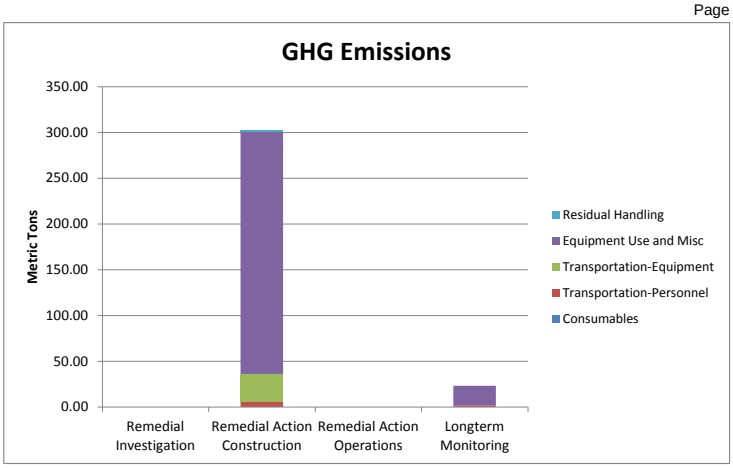

NOx Emissions
0.00%
0.00%
99.09%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

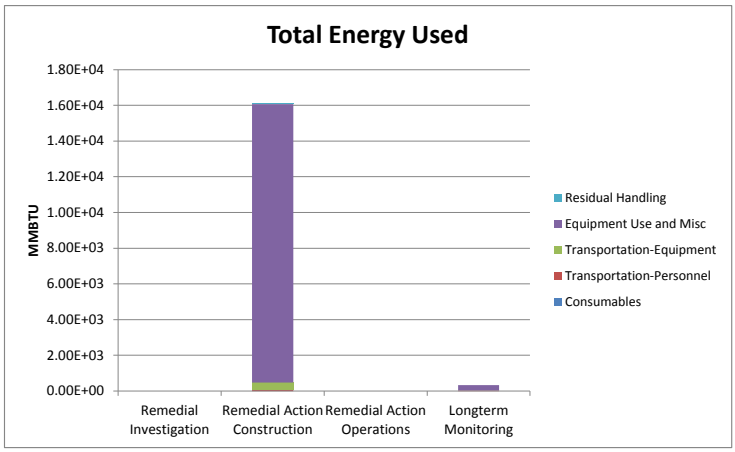

SOx Emissions
0.00%
0.00%
99.95%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

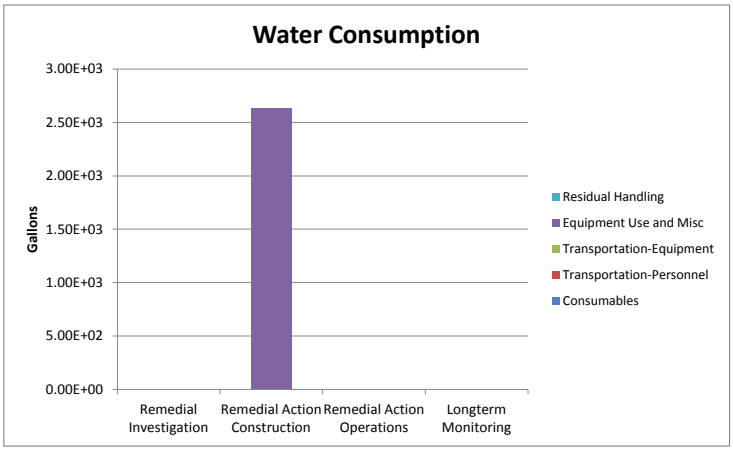

PM10 Emissions
0.00%
0.00%
93.13%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

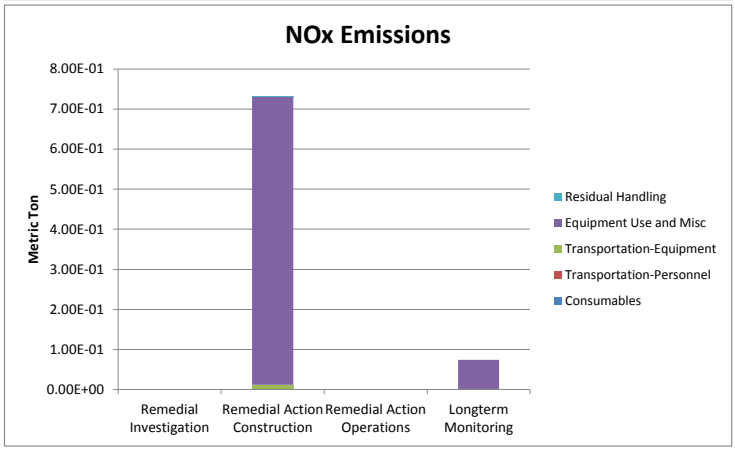

Accident Risk - Fatality
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

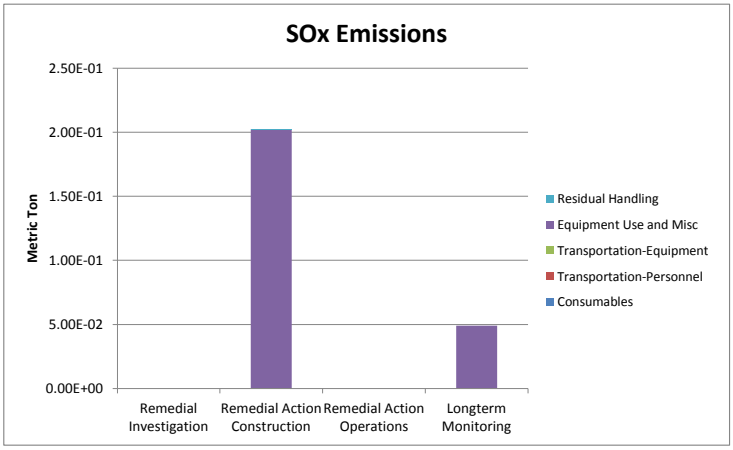

Accident Risk - Injury
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

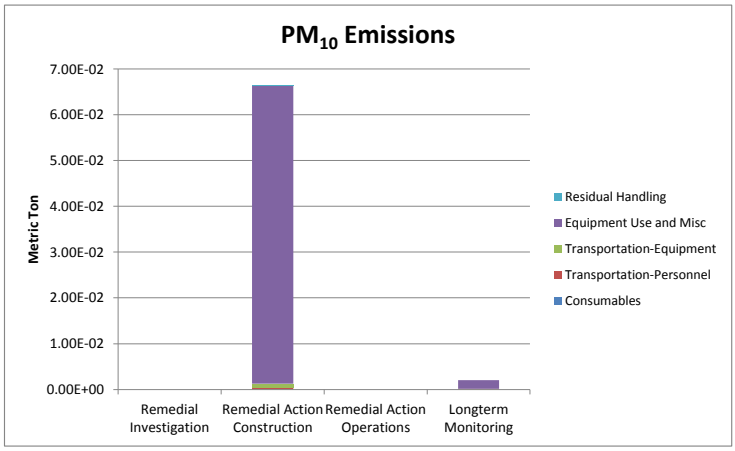

GHG Emissions
Metric Tons
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

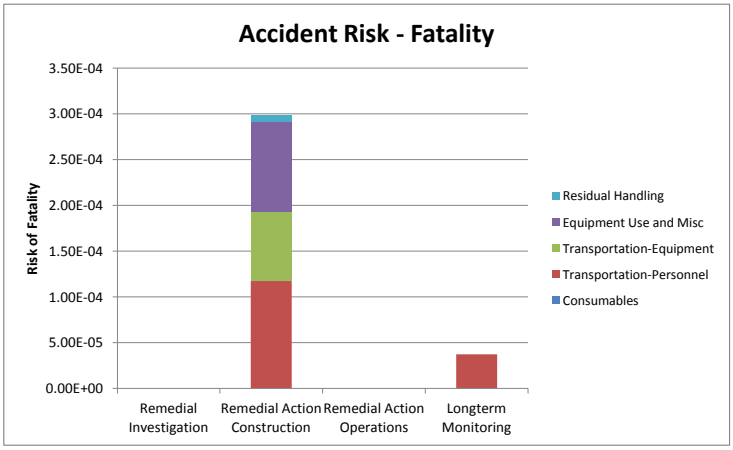

Total Energy Used
MMBTU
1.80E+04
1.60E+04
1.40E+04
1.20E+04
1.00E+04
8.00E+03
6.00E+03
4.00E+03
2.00E+03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

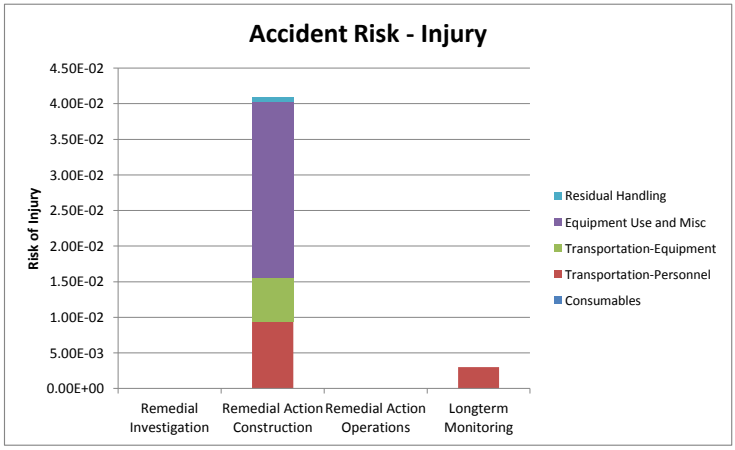

Water Consumption
Gallons
3.00E+03
2.50E+03
2.00E+03
1.50E+03
1.00E+03
5.00E+02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
8.00E-01
7.00E-01
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
7.00E-02
6.00E-02
5.00E-02
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
3.50E-04
3.00E-04
2.50E-04
2.00E-04
1.50E-04
1.00E-04
5.00E-05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
4.50E-02
4.00E-02
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

GSRx Results Alternative S-2
Site 16, NCBC Davisville
Davisville, Rhode Island

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Replacement monitoring wells	PVC	730 lf, Assume PVC, 2 inch, SCH 40, 18 wells, 0.72 lb/ft	730.00	lft	1.18	0.60	0.00	0.01	0.00	0.00	0.00	21.73	1.26
RAC	New LUC Monitoring wells	PVC	45 lf, Assume PVC,2 inch SCH 40, 3 wells, 0.72 lb/ft	45.00	lft	0.07	0.04	0.00	0.00	0.00	0.00	0.00	1.34	0.08
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Monitoring well abandonmnet wells	Sand	28 wells, 1020 ft, 2 inch diameter, assume sand dry, 1602 kg/m3,	17,001.63	lbs	0.04	0.04	0.00	0.00	0.00	0.00	0.00	1.04	0.00
RAC	Cover fill	Soil	10,050 CY, Assume common soil,	3,150,000.00	lbs	32.86	32.86	0.00	0.00	0.00	0.00	0.00	868.29	0.00
RAC	Select Fill	Soil	140 CY, Assume common soil	420,000.00	lbs	4.38	4.38	0.00	0.00	0.00	0.00	0.00	115.77	0.00
RAC	Cover Liner	HDPE	Assume HDPE, 20,000 sf, 8oz/sy	1,111.11	lbs	2.48	1.31	0.00	0.01	0.00	0.01	0.00	14.54	0.40
RAC	Top soil	Soil	Assume Top soil, 3550 CY	10,650,000.00	lbs	111.09	111.09	0.00	0.00	0.00	0.00	0.00	2935.64	0.00
RAC	Backfill	Soil	Assume top soil, 140 CY	420,000.00	lbs	4.38	4.38	0.00	0.00	0.00	0.00	0.00	115.77	0.00
RAC	Revegetation, seed	Fertilizer	Assume fertilizer, 21300 sy, 3 lb of seed per 1.2 msf	479.25	lbs	0.60	0.60	0.00	0.00	0.00	0.00	0.00	10.83	0.22
RAC	monitoring and LUC well heads	PVC	5 units, Assume PVC, 50 lb per unit	250.00	lbs	0.56	0.28	0.00	0.00	0.00	0.00	0.00	10.34	0.43
	Subtotal					**159.21**	**156.40**	**0.01**	**0.03**	**0.00**	**0.01**	**0.00**	**4104.47**	**2.63**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	brush chipper, 130 HP	WOOD CHIPPER	4 days, 8 hours per day, 80% utilization	25.60	hrs	1.11	1.11	0.00	0.00	0.01	0.00	0.00	4.89	
RAC	1 loader, 3CY	Loader, 155 HP, 3 CY (diesel)	4 days, 8 hours per day, 80% utilization	25.60	hrs	0.52	0.52	0.00	0.00	0.00	0.00	0.00	2.19	
RAC	2 chain saws, 36in long (gas)	Chainsaw, gasoline, 3<hp<=6, 2 stroke	4 days, 8 hours per day, 80% utilization	25.60	hrs	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.24	
RAC	Excavator, 2.5 CY	Excavator, Hydraulic, 2 CY (diesel)	40 days, 8 hours per day, 80% utilization	256.00	hrs	24.81	24.81	0.00	0.00	0.16	0.05	0.01	112.63	
RAC	Dozer, 300 hp	Dozer, 335 HP (D8) w/U Blade (diesel)	40 days, 8 hours per day, 80% utilization	256.00	hrs	46.29	46.29	0.00	0.00	0.34	0.09	0.03	225.26	
RAC	Compactor (roller 240 hp)	Roller, 300 HP (diesel)	40 days, 8 hours per day, 80% utilization	256.00	hrs	20.94	20.80	0.00	0.00	0.15	0.04	0.01	70.92	
RAC	Excavator, 2.5 CY	Excavator, Hydraulic, 2 CY (diesel)	5 days, 8 hours per day, 80% utilization	32.00	hrs	3.10	3.10	0.00	0.00	0.02	0.01	0.00	14.08	
RAC	Compactor (roller 240 hp)	Roller, 300 HP (diesel)	5 days, 8 hours per day, 80% utilization	32.00	hrs	2.62	2.60	0.00	0.00	0.02	0.00	0.00	8.86	
RAC	Backhoe loader, 48 hp 5/8 CY	Loader, 65 HP, 1 CY (diesel)	22 days, 8 hours per day, 80% utilization	140.80	hrs	1.67	1.67	0.00	0.00	0.01	0.00	0.00	7.46	
RAC	DPT drill rig	Drill Rig, DPT (diesel)	21 wells, 5 wells per day, 8 hours per day, 80% utilziation	26.88	hrs	0.43	0.42	0.00	0.00	0.00	0.00	0.00	3.29	
	Subtotal					**101.54**	**101.37**	**0.00**	**0.00**	**0.71**	**0.18**	**0.06**	**449.81**	**0**
				Total		**261**	**258**	**0.01**	**0.03**	**0.71**	**0.19**	**0.06**	**4,554**	**3**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
	Tonnes							**MMBTU**	**gal**
RI	-	-	-	-	-	-	-	-	-
RAC	260.75	257.77	2.39	0.58	0.71	0.19	0.06	15,539.18	2,633.09
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

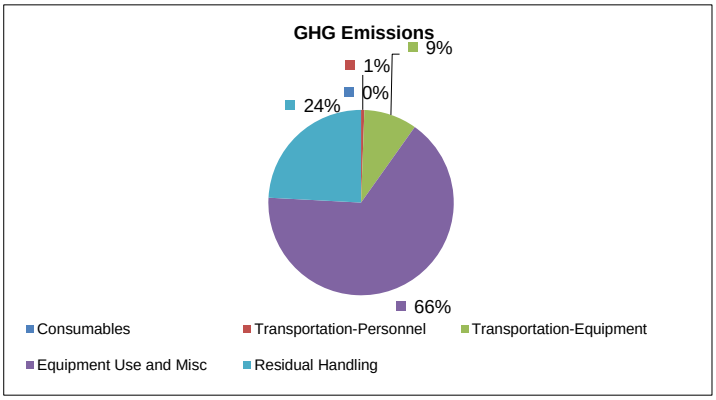
Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

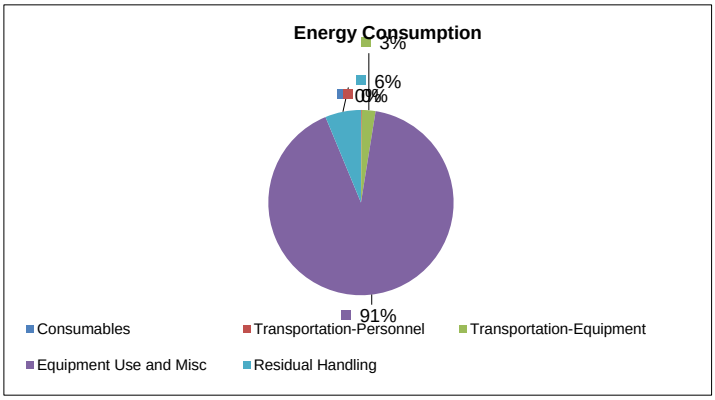
Sustainable Remediation - Environmental Footprint Summary
S-3

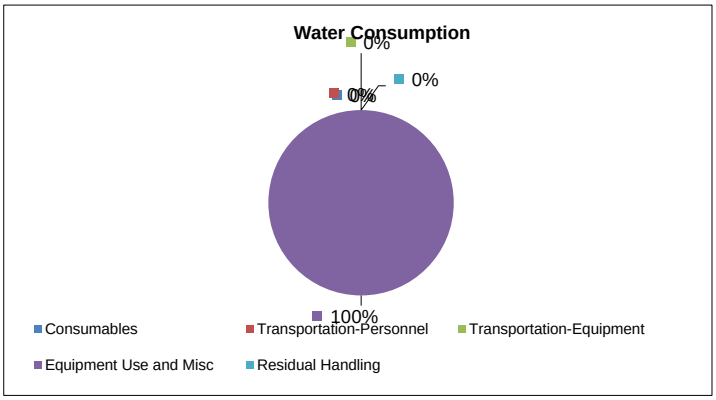
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	4.46	5.6E+01	NA	1.6E-03	5.8E-05	3.3E-04	9.1E-05	7.3E-03
	Transportation-Equipment	71.49	9.3E+02	NA	2.2E-02	4.0E-04	2.0E-03	1.8E-04	1.4E-02
	Equipment Use and Misc	509.67	3.6E+04	5.0E+03	9.2E-01	2.6E-01	1.6E-01	1.1E-04	2.7E-02
	Residual Handling	186.51	2.4E+03	NA	5.9E-02	1.0E-03	5.2E-03	4.6E-04	3.7E-02
	Sub-Total	772.13	3.89E+04	5.01E+03	1.00E+00	2.58E-01	1.68E-01	8.37E-04	8.55E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.69	8.6E+00	NA	2.5E-04	8.9E-06	5.1E-05	1.4E-05	1.1E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.69	8.63E+00	0.00E+00	2.54E-04	8.94E-06	5.15E-05	1.40E-05	1.13E-03
Total		**7.7E+02**	**3.9E+04**	**5.0E+03**	**1.0E+00**	**2.6E-01**	**1.7E-01**	**8.5E-04**	**8.7E-02**

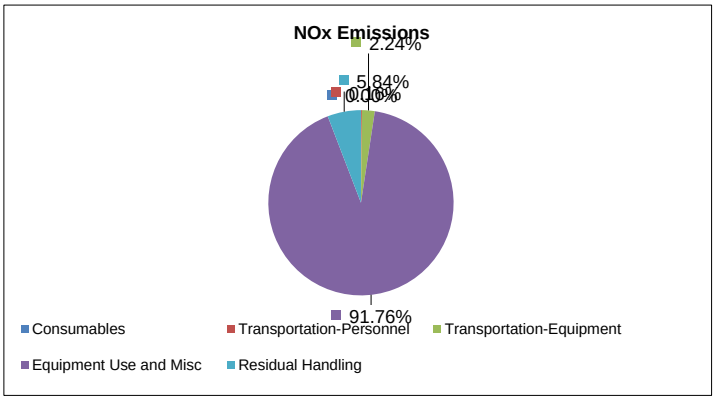
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	1.2E+04	0	6.8E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	9.0E-03
Total	**0.0E+00**	**0.0E+00**	**1.2E+04**	**$0**	**6.9E-01**

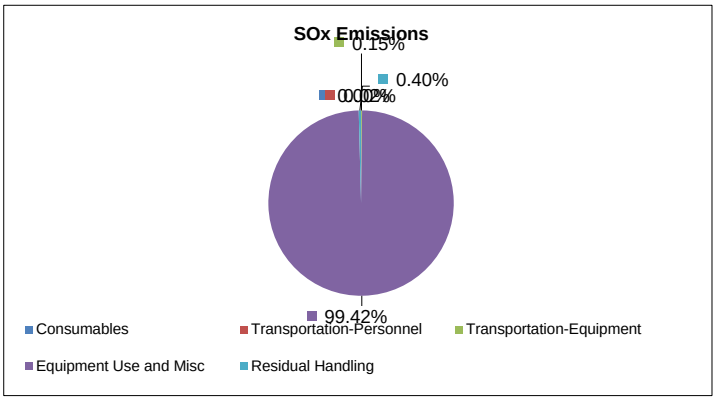
Total Cost with Footprint Reduction
$0

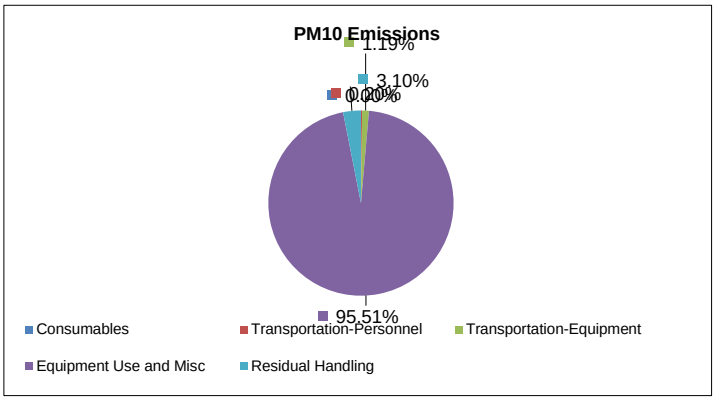

GHG Emissions
9%
1%
0%
24%
66%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

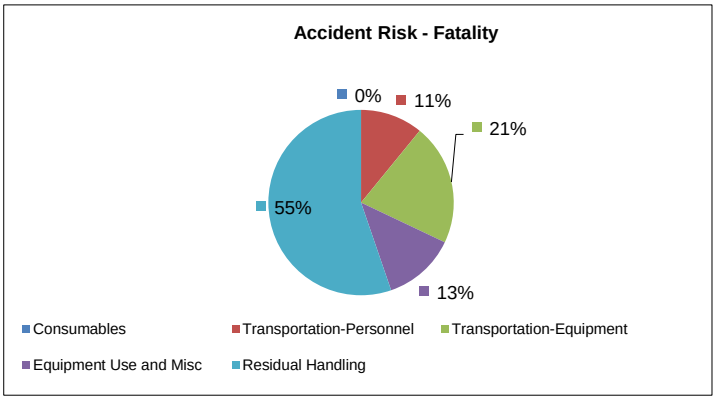

Energy Consumption
3%
6%
91%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

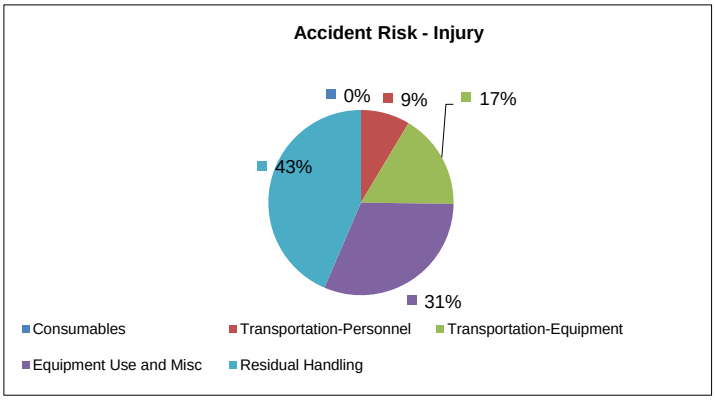

Water Consumption
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

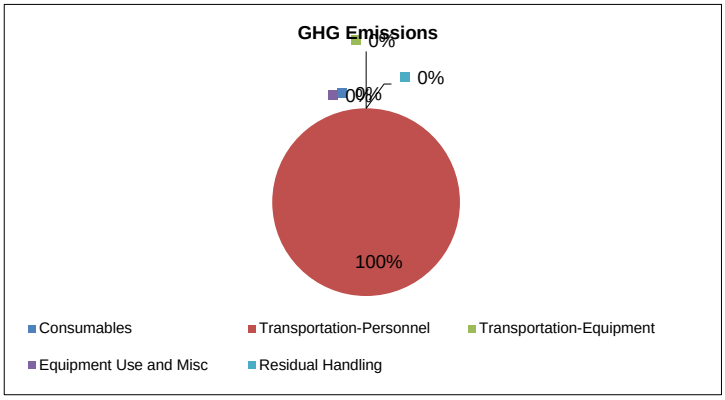

NOx Emissions
2.24%
5.84%
91.76%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

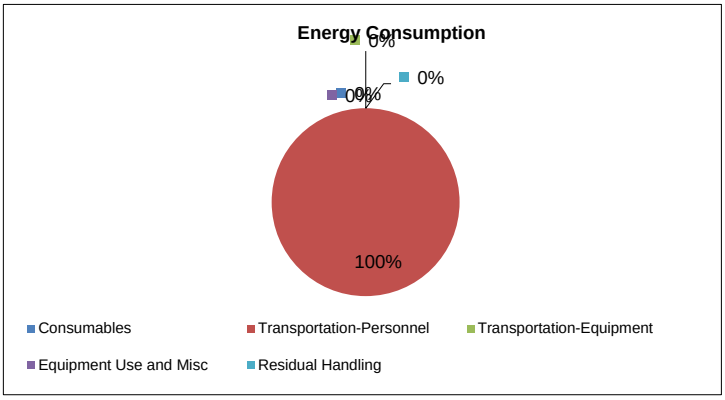

SOx Emissions
0.15%
0.40%
99.42%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

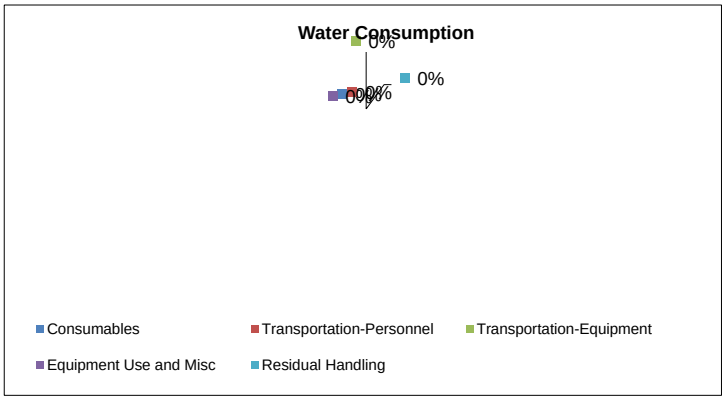

PM10 Emissions
1.19%
3.10%
95.51%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

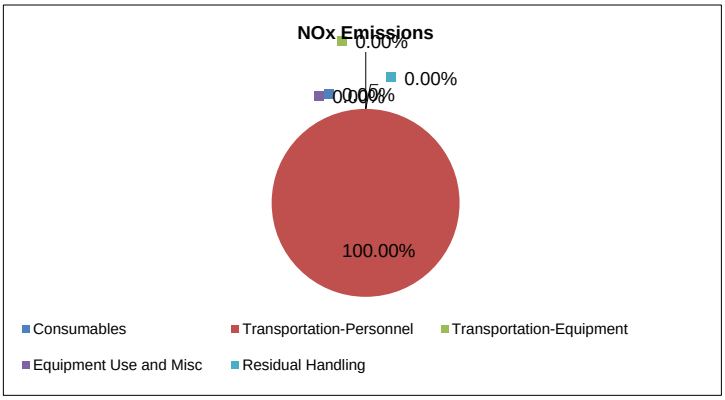

Accident Risk - Fatality
0%
11%
21%
55%
13%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

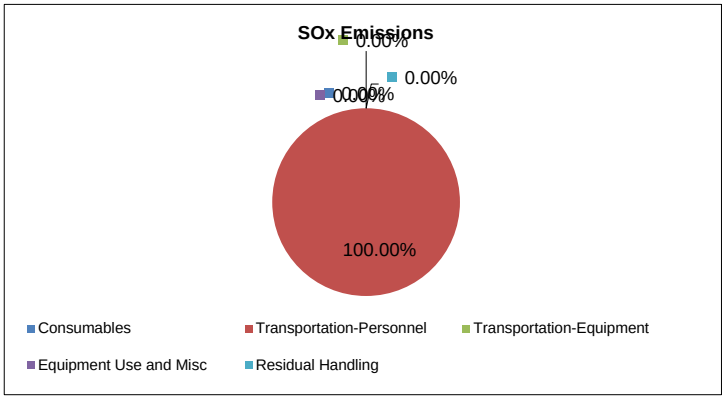

Accident Risk - Injury
0%
9%
17%
43%
31%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

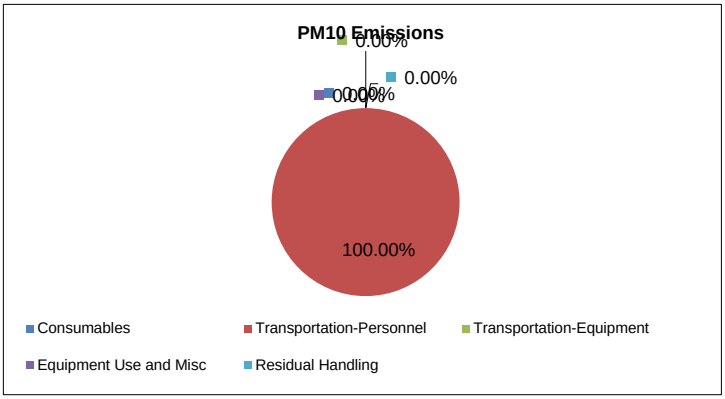

GHG Emissions
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

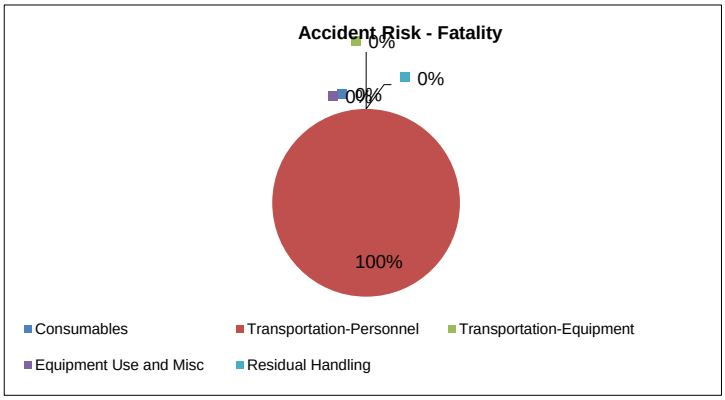

Energy Consumption
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

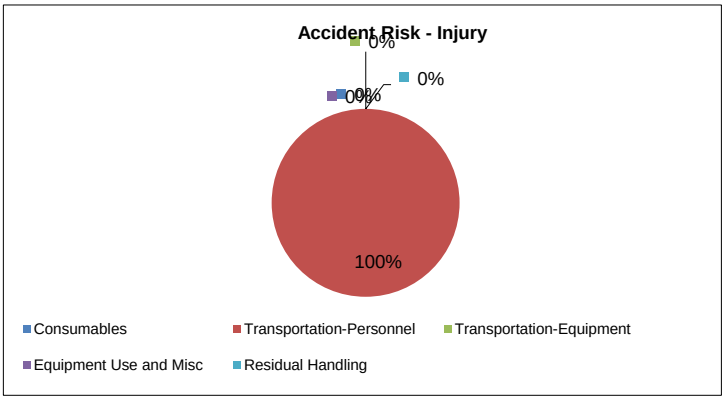

Water Consumption
0%
0%
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

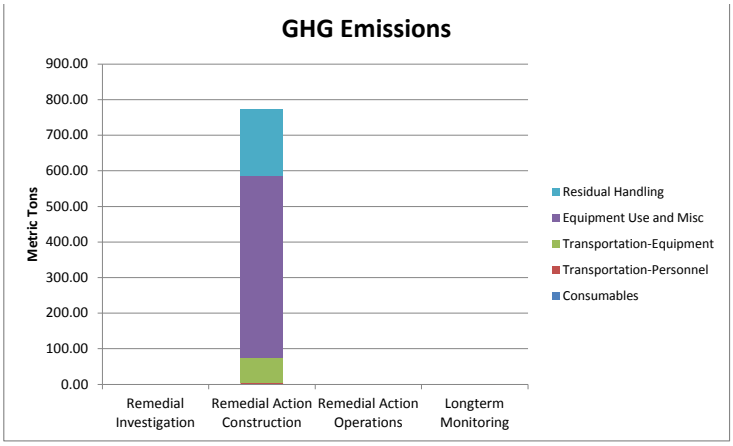

NOx Emissions
0.00%
0.00%
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

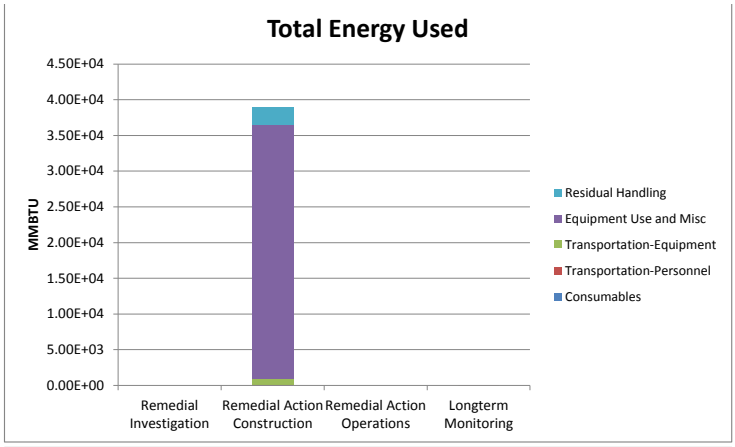

SOx Emissions
0.00%
0.00%
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

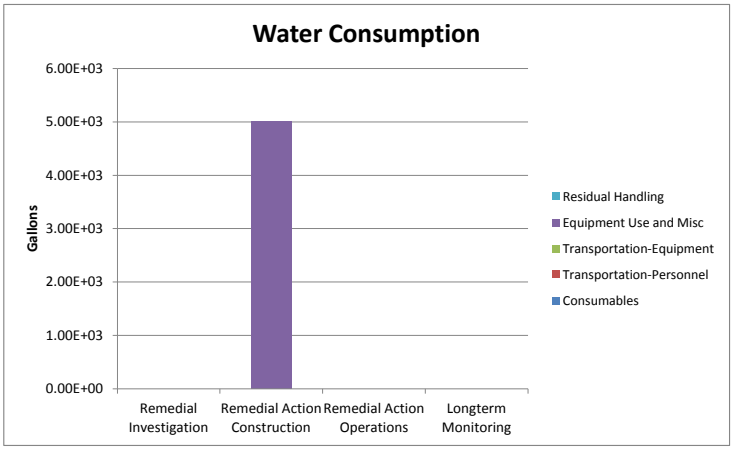

PM10 Emissions
0.00%
0.00%
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

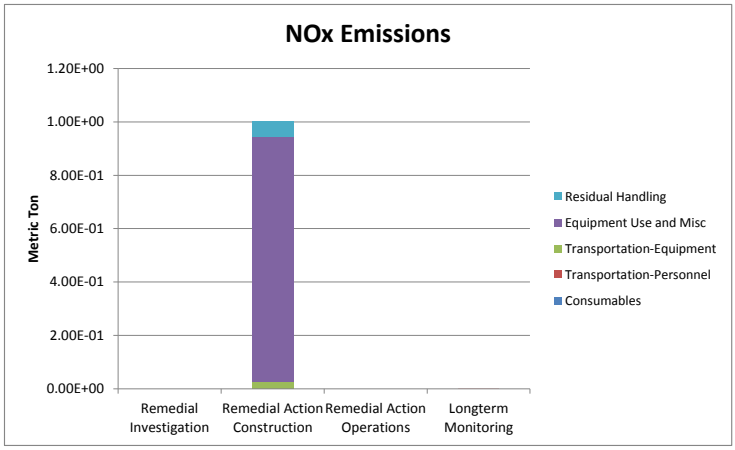

Accident Risk - Fatality
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

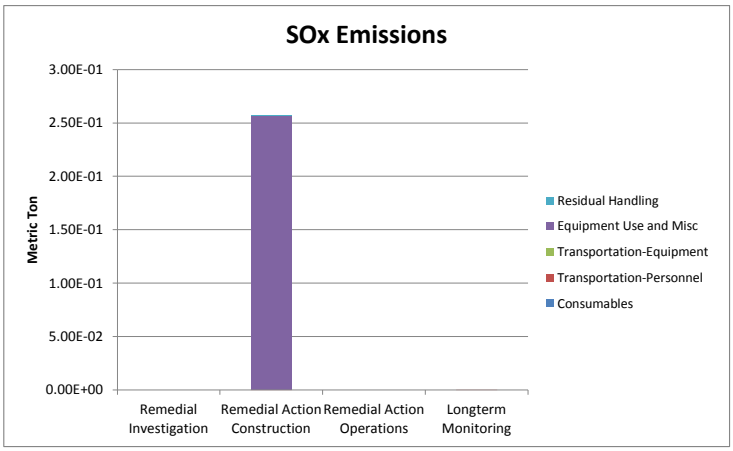

Accident Risk - Injury
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

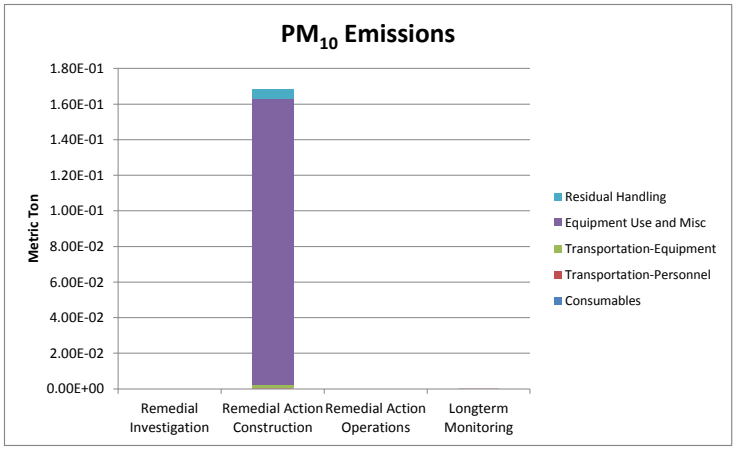

GHG Emissions
Metric Tons
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

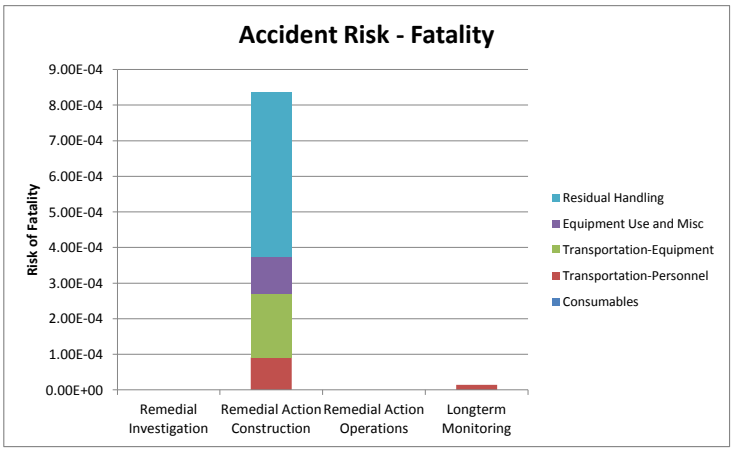

Total Energy Used
MMBTU
4.50E+04
4.00E+04
3.50E+04
3.00E+04
2.50E+04
2.00E+04
1.50E+04
1.00E+04
5.00E+03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

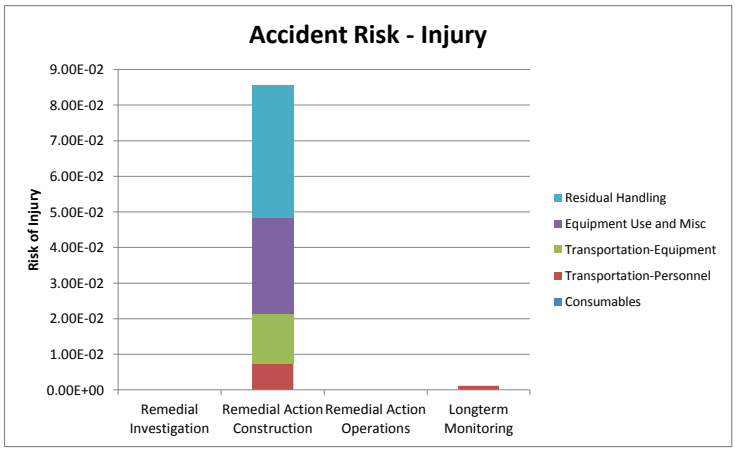

Water Consumption
Gallons
6.00E+03
5.00E+03
4.00E+03
3.00E+03
2.00E+03
1.00E+03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
1.20E+00
1.00E+00
8.00E-01
6.00E-01
4.00E-01
2.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
1.80E-01
1.60E-01
1.40E-01
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
9.00E-04
8.00E-04
7.00E-04
6.00E-04
5.00E-04
4.00E-04
3.00E-04
2.00E-04
1.00E-04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
9.00E-02
8.00E-02
7.00E-02
6.00E-02
5.00E-02
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

GSRx Results Alternative S-3
Site 16, NCBC Davisville
Davisville, Rhode Island

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Replace monitoring wells	PVC	7 wells, 250 lf, assume 2 in diameter, 0.72 lb/ft	250.00	lft	0.41	0.20	0.00	0.00	0.00	0.00	0.00	7.44	0.43
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Monitoring Well Abandonment Wells	Sand	445 lf, 15 wells, assume sand dry, 1602 kg/m3,	7,417.38	lbs	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.45	0.00
RAC	Backfill	Soil	10630 CY, assume top soil	31,890,000.00	lbs	332.64	332.64	0.00	0.00	0.00	0.00	0.00	8790.38	0.00
RAC	Topsoil	Soil	1170 CY, asume top soil	3,510,000.00	lbs	36.61	36.61	0.00	0.00	0.00	0.00	0.00	967.52	0.00
RAC	Revegetation, seed	Fertilizer	Assume fertilizer, 7000 sy, 3 lb of seed per 1.2 msf	157.50	lbs	0.20	0.20	0.00	0.00	0.00	0.00	0.00	3.56	0.07
RAC	Pavement Replacement, stone base	Gravel	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3	75,007.19	lbs	0.58	0.58	0.00	0.00	0.00	0.00	0.00	13.78	0.00
RAC	Pavement Replacement, bounder course	Gravel	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3	23,753.84	lbs	0.18	0.18	0.00	0.00	0.00	0.00	0.00	4.37	0.00
RAC	Pavement Replacement, topping	Asphalt	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3	11,252.64	lbs	0.11	0.09	0.00	0.00	0.00	0.00	0.08	0.51	0.00
RAC	Replace monitoring well head	PVC	3 well heads, 50 lb per unit, assume PVC	150.00	lbs	0.34	0.17	0.00	0.00	0.00	0.00	0.00	6.20	0.26
	Subtotal					**372.65**	**371.53**	**0.00**	**0.01**	**0.00**	**0.01**	**0.08**	**9803.40**	**1.01**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Brush Chipper, 130 HP	WOOD CHIPPER	2 days, 8 hours per day, 80% utilization	12.80	hrs	0.56	0.56	0.00	0.00	0.00	0.00	0.00	2.45	
RAC	1 crawler loader, 3CY	Loader, 155 HP, 3 CY (diesel)	2 days, 8 hours per day, 80% utilization	12.80	hrs	0.26	0.26	0.00	0.00	0.00	0.00	0.00	1.10	
RAC	2 chain saws	Chainsaw, gasoline, 3<hp<=6, 2 stroke	2 days, 8 hours per day, 80% utilization	12.80	hrs	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.12	
RAC	Excavator, 2.5 CY	Excavator, Hydraulic, 2 CY (diesel)	55 days, 8 hours per day, 80% utilization	352.00	hrs	34.11	34.11	0.00	0.00	0.21	0.06	0.02	154.87	
RAC	Dozer 300 hp	Dozer, 335 HP (D8) w/U Blade (diesel)	55 days, 8 hours per day, 80% utilization	352.00	hrs	63.65	63.65	0.00	0.00	0.46	0.12	0.04	309.73	
RAC	Compactor (roller, 240 hp)	Roller, 300 HP (diesel)	55 days, 8 hours per day, 80% utilization	352.00	hrs	28.79	28.60	0.00	0.00	0.20	0.05	0.02	97.51	
RAC	Backhoe loader, 48 hp 5/8 CY	Loader, 65 HP, 1 CY (diesel)	7 days, 8 hours per day, 80% utilization	44.80	hrs	0.53	0.53	0.00	0.00	0.00	0.00	0.00	2.37	
RAC	Asphalt Paver, 130 hp	Paver, 100 HP (diesel)	1 day, 8 hours per day, 80% utilization	6.40	hrs	0.23	0.23	0.00	0.00	0.00	0.00	0.00	0.78	
RAC	1 Tandem Roller, 10 ton	Roller, 100 HP (diesel)	1 day, 8 hours per day, 80% utilization	6.40	hrs	0.23	0.23	0.00	0.00	0.00	0.00	0.00		
RAC	DPT Drill Rig	Drill Rig, DPT (diesel)	7 wells, 5 wells per day, 8 hours per day, 80% utilization	8.96	hrs	0.14	0.14	0.00	0.00	0.00	0.00	0.00	1.10	
	Subtotal					**128.53**	**128.34**	**0.00**	**0.00**	**0.89**	**0.23**	**0.08**	**570.01**	**0**
				Total		**501**	**500**	**0.00**	**0.01**	**0.89**	**0.24**	**0.16**	**10,373**	**1**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
	Tonnes							**MMBTU**	**gal**
RI	-	-	-	-	-	-	-	-	-
RAC	501.18	499.86	1.07	0.25	0.89	0.24	0.16	35,394.07	1,013.73
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

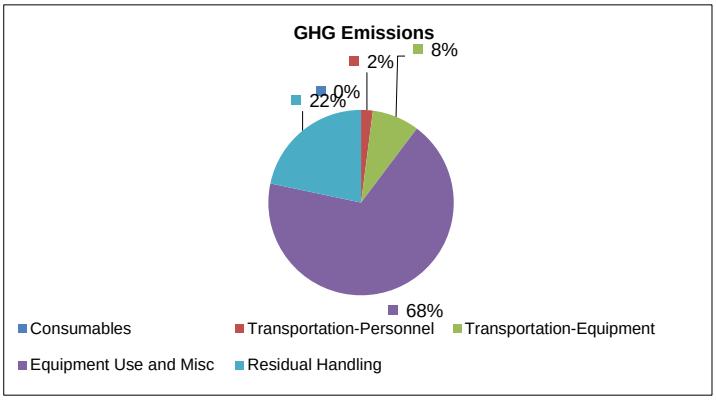
Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

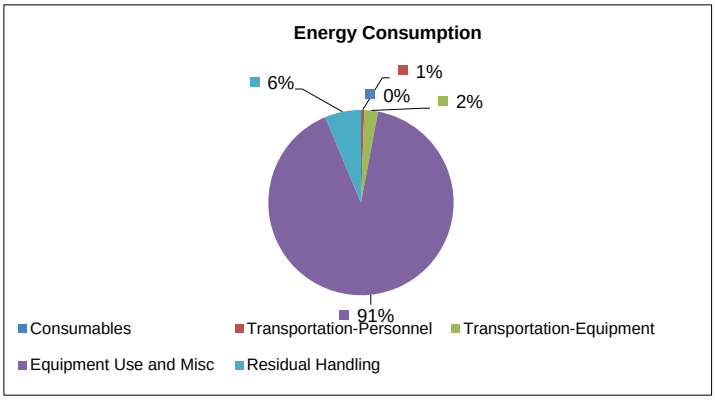
Sustainable Remediation - Environmental Footprint Summary
S-3A

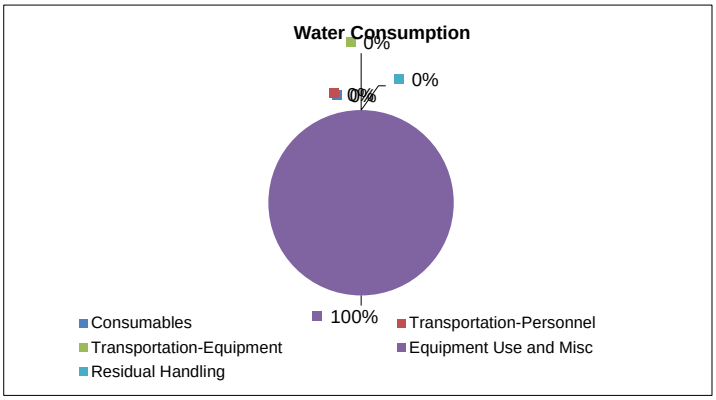
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	5.22	6.6E+01	NA	1.9E-03	6.8E-05	3.9E-04	1.1E-04	8.6E-03
	Transportation-Equipment	21.00	2.7E+02	NA	6.6E-03	1.2E-04	5.9E-04	5.2E-05	4.2E-03
	Equipment Use and Misc	173.51	1.0E+04	4.4E+03	4.4E-01	1.3E-01	1.2E-01	5.4E-05	1.3E-02
	Residual Handling	55.31	7.2E+02	NA	1.7E-02	3.1E-04	1.5E-03	1.4E-04	1.1E-02
	Sub-Total	255.04	1.14E+04	4.36E+03	4.68E-01	1.32E-01	1.22E-01	3.50E-04	3.73E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.69	8.6E+00	NA	2.5E-04	8.9E-06	5.1E-05	1.4E-05	1.1E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.69	8.63E+00	0.00E+00	2.54E-04	8.94E-06	5.15E-05	1.40E-05	1.13E-03
Total		**2.6E+02**	**1.1E+04**	**4.4E+03**	**4.7E-01**	**1.3E-01**	**1.2E-01**	**3.6E-04**	**3.8E-02**

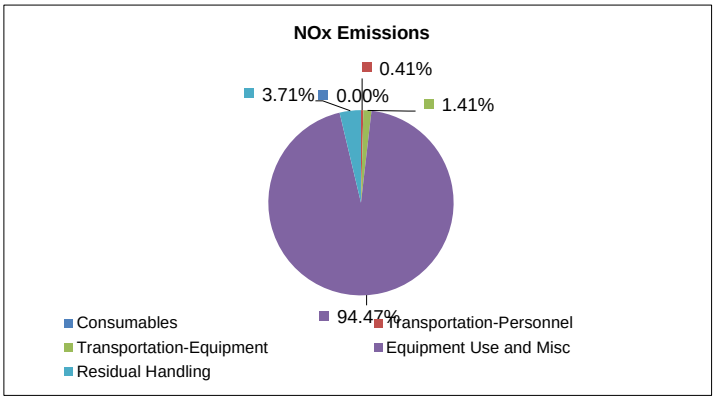
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	3.0E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	9.0E-03
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**3.1E-01**

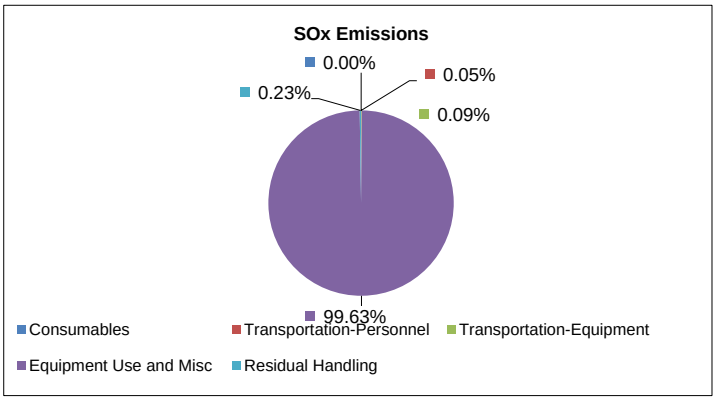
Total Cost with Footprint Reduction
$0

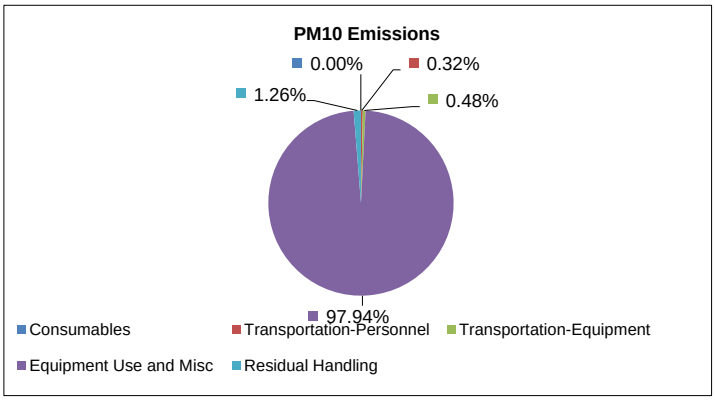

GHG Emissions
2%
8%
0%
22%
68%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

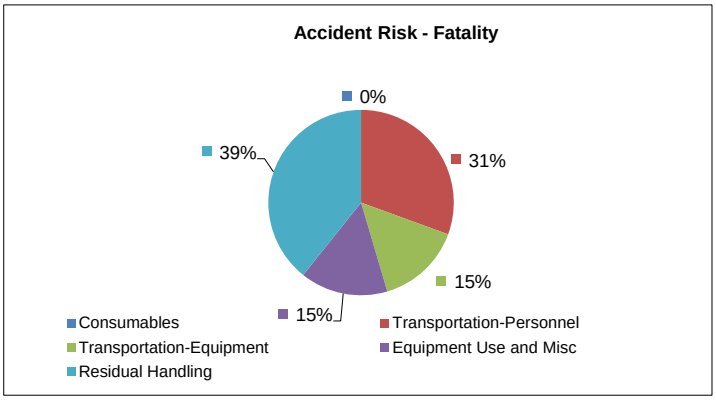

Energy Consumption
6%
1%
0%
2%
91%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

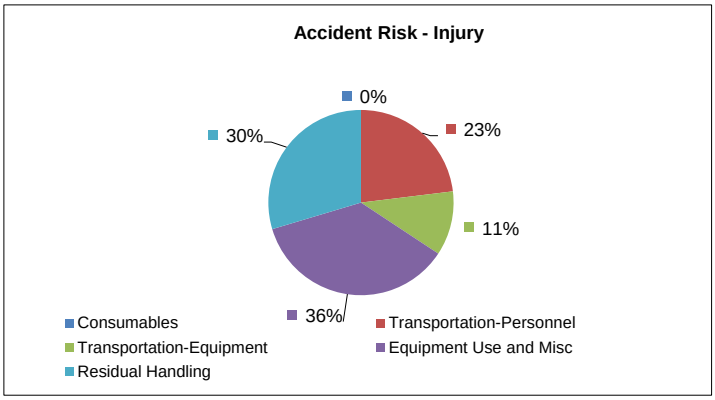

Water Consumption
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

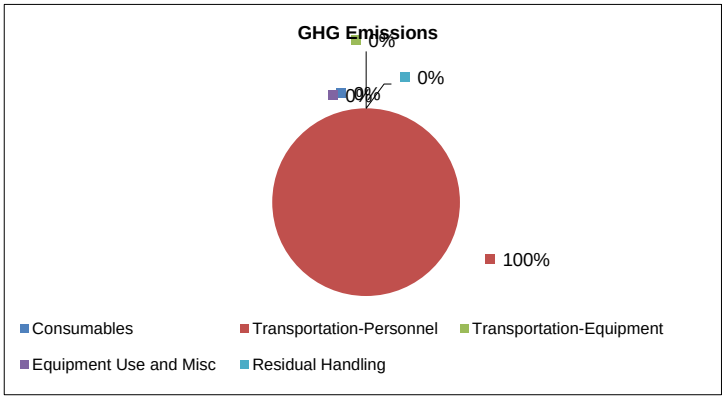

NOx Emissions
0.41%
3.71%
0.00%
1.41%
94.47%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

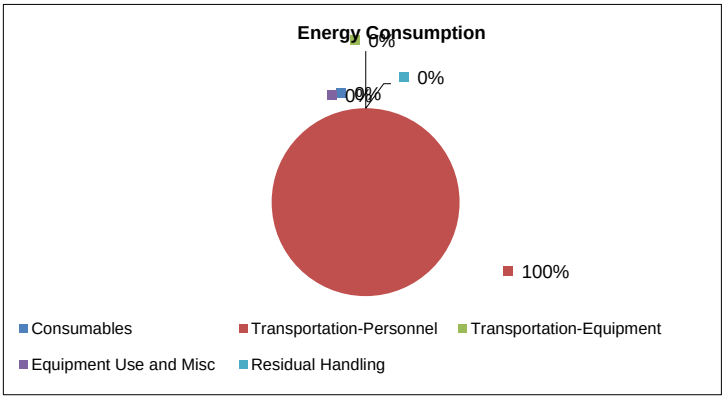

SOx Emissions
0.00%
0.05%
0.23%
0.09%
99.63%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

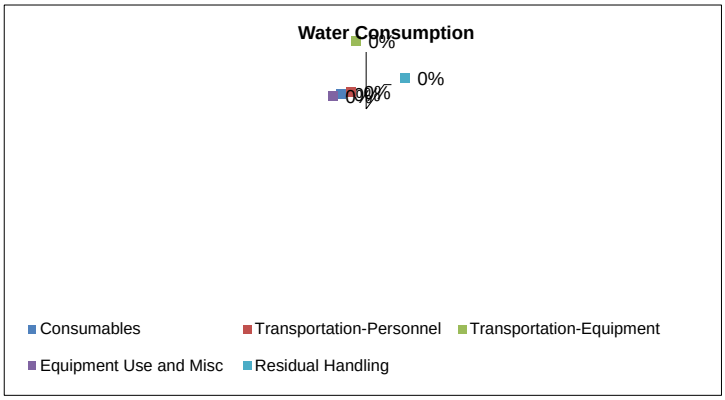

PM10 Emissions
0.00%
0.32%
1.26%
0.48%
97.94%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

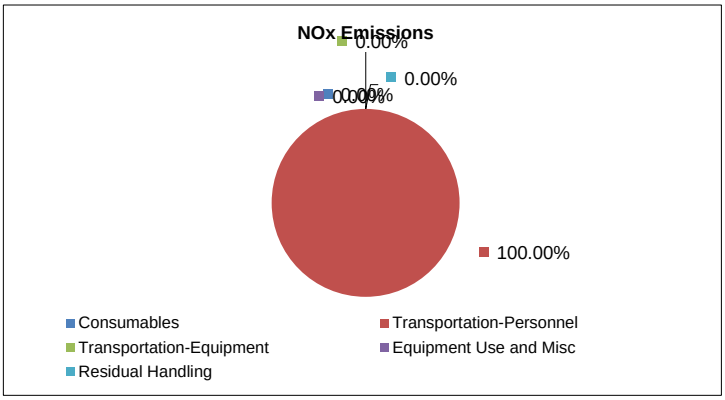

Accident Risk - Fatality
0%
39%
31%
15%
15%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

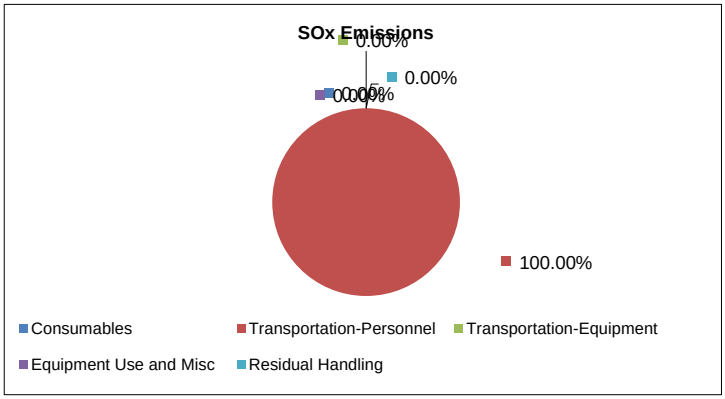

Accident Risk - Injury
0%
30%
23%
11%
36%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

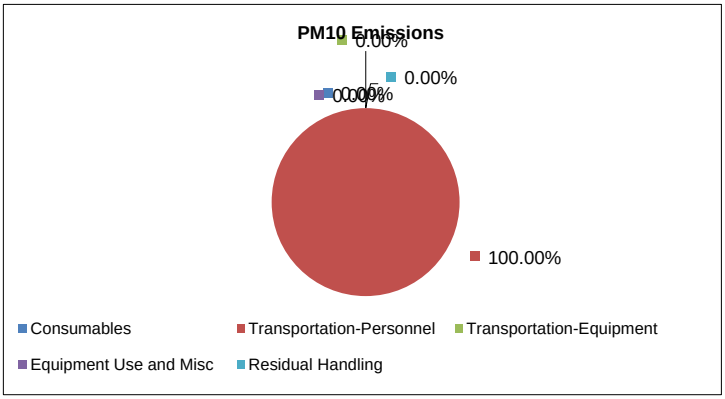

GHG Emissions
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

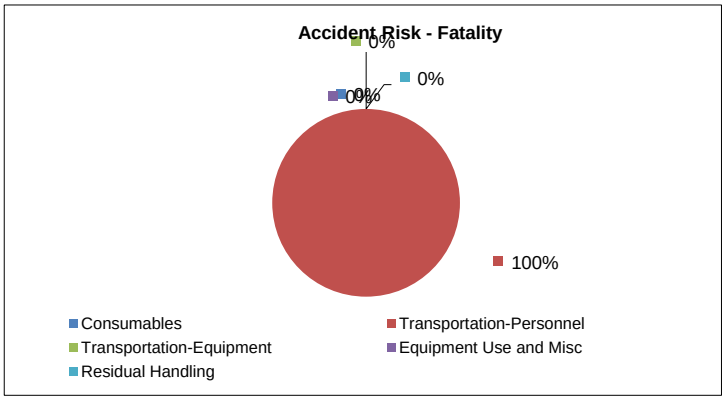

Energy Consumption
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

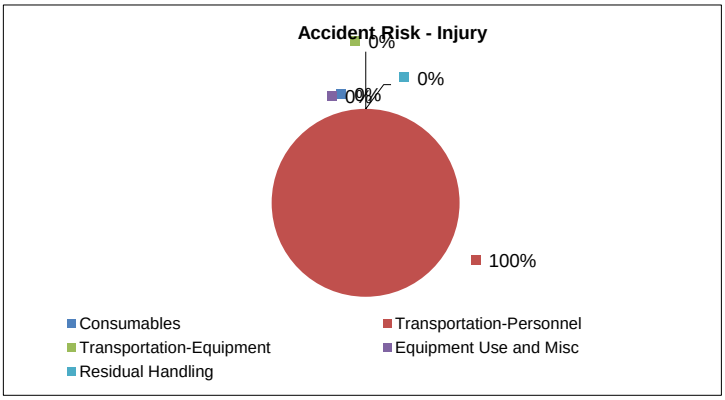

Water Consumption
0%
0%
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

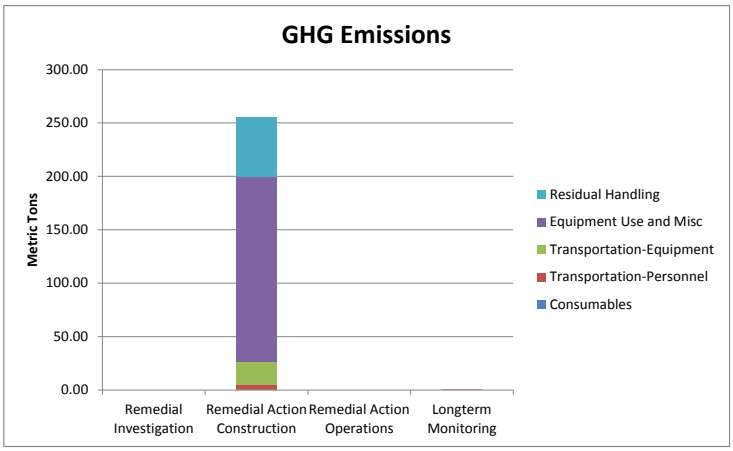

NOx Emissions
0.00%
0.00%
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

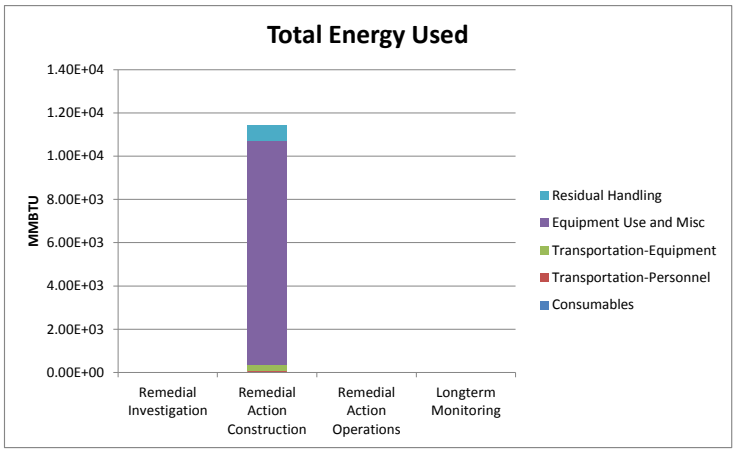

SOx Emissions
0.00%
0.00%
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

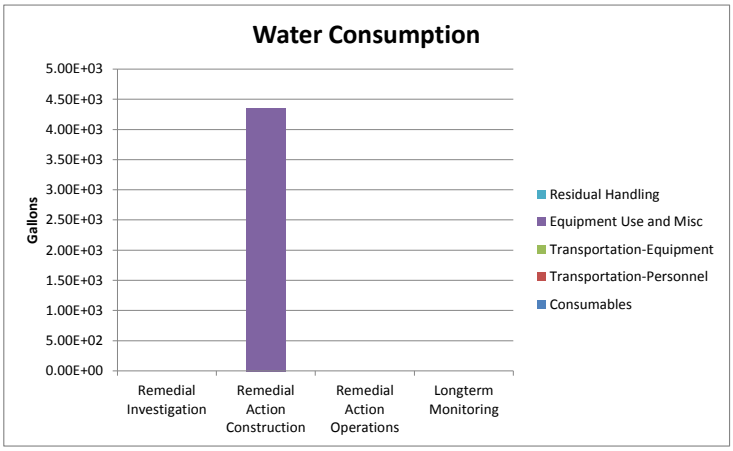

PM10 Emissions
0.00%
0.00%
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

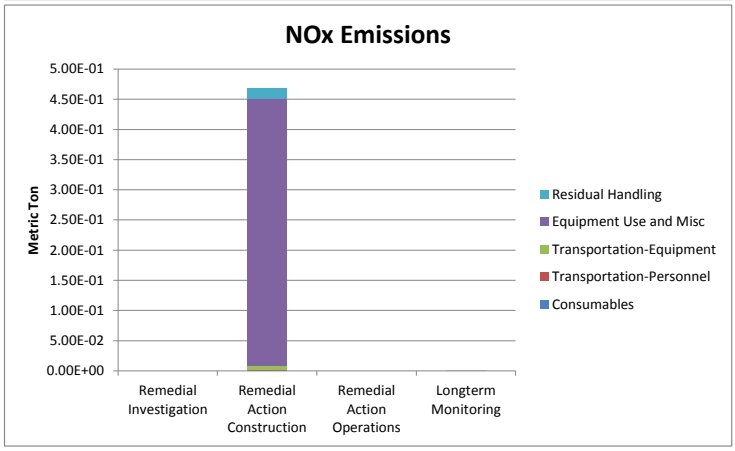

Accident Risk - Fatality
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

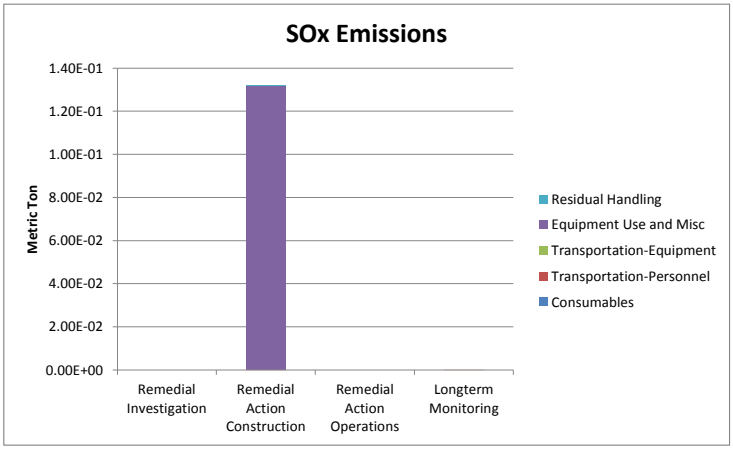

Accident Risk - Injury
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

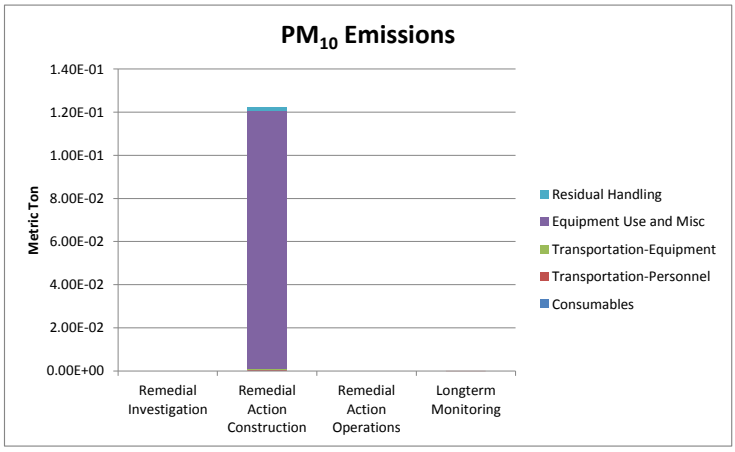

GHG Emissions
Metric Tons
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

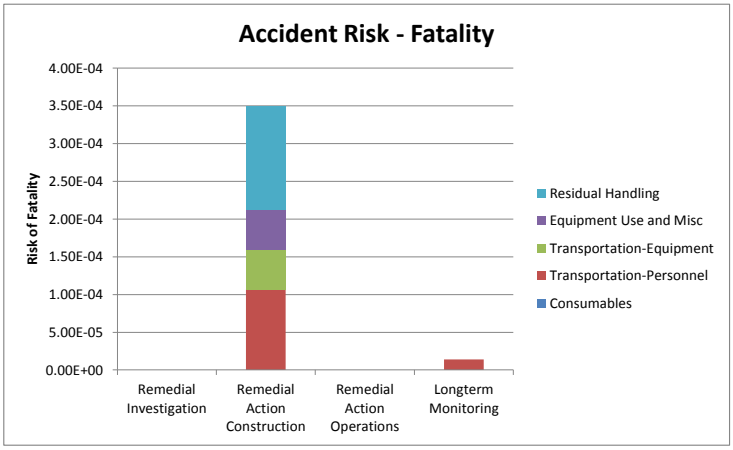

Total Energy Used
MMBTU
1.40E+04
1.20E+04
1.00E+04
8.00E+03
6.00E+03
4.00E+03
2.00E+03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

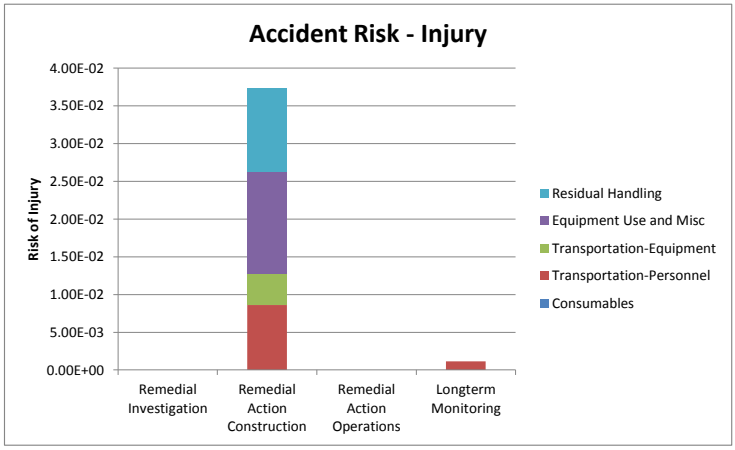

Water Consumption
Gallons
5.00E+03
4.50E+03
4.00E+03
3.50E+03
3.00E+03
2.50E+03
2.00E+03
1.50E+03
1.00E+03
5.00E+02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
5.00E-01
4.50E-01
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
1.40E-01
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
1.40E-01
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
4.00E-04
3.50E-04
3.00E-04
2.50E-04
2.00E-04
1.50E-04
1.00E-04
5.00E-05
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
4.00E-02
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

GSRx Results Alternative S-3A
Site 16, NCBC Davisville
Davisville, Rhode Island

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Replace monitoring wells	PVC	7 wells, 250 lf, assume 2 in diameter, 0.72 lb/ft	250.00	lft	0.41	0.20	0.00	0.00	0.00	0.00	0.00	7.44	0.43
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Monitoring Well Abandonment Wells	Sand	445 lf, 15 wells, assume sand dry, 1602 kg/m3,	7,417.38	lbs	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.45	0.00
RAC	Backfill	Soil	2399 CY, assume top soil	7,197,000.00	lbs	75.07	75.07	0.00	0.00	0.00	0.00	0.00	1983.83	0.00
RAC	Topsoil	Soil	850 CY, asume top soil	2,550,000.00	lbs	26.60	26.60	0.00	0.00	0.00	0.00	0.00	702.90	0.00
RAC	Revegetation, seed	Fertilizer	Assume fertilizer, 7000 sy, 3 lb of seed per 1.2 msf	157.50	lbs	0.20	0.20	0.00	0.00	0.00	0.00	0.00	3.56	0.07
RAC	Pavement Replacement, stone base	Gravel	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3	75,007.19	lbs	0.58	0.58	0.00	0.00	0.00	0.00	0.00	13.78	0.00
RAC	Pavement Replacement, bounder course	Gravel	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3	23,753.84	lbs	0.18	0.18	0.00	0.00	0.00	0.00	0.00	4.37	0.00
RAC	Pavement Replacement, topping	Asphalt	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3	11,252.64	lbs	0.11	0.09	0.00	0.00	0.00	0.00	0.08	0.51	0.00
RAC	Replace monitoring well head	PVC	7 well heads, 50 lb per unit, assume PVC	350.00	lbs	0.79	0.40	0.00	0.00	0.00	0.00	0.00	14.47	0.60
	Subtotal					**105.52**	**104.17**	**0.00**	**0.01**	**0.00**	**0.01**	**0.08**	**2740.49**	**1.36**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Brush Chipper, 130 HP	WOOD CHIPPER	2 days, 8 hours per day, 80% utilization	12.80	hrs	0.56	0.56	0.00	0.00	0.00	0.00	0.00	2.45	
RAC	1 crawler loader, 3CY	Loader, 155 HP, 3 CY (diesel)	2 days, 8 hours per day, 80% utilization	12.80	hrs	0.26	0.26	0.00	0.00	0.00	0.00	0.00	1.10	
RAC	2 chain saws	Chainsaw, gasoline, 3<hp<=6, 2 stroke	2 days, 8 hours per day, 80% utilization	12.80	hrs	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.12	
RAC	Excavator, 2.5 CY	Excavator, Hydraulic, 2 CY (diesel)	25 days, 8 hours per day, 80% utilization	160.00	hrs	15.51	15.51	0.00	0.00	0.10	0.03	0.01	70.39	
RAC	Dozer 300 hp	Dozer, 335 HP (D8) w/U Blade (diesel)	25 days, 8 hours per day, 80% utilization	160.00	hrs	28.93	28.93	0.00	0.00	0.21	0.05	0.02	140.79	
RAC	Compactor (roller, 240 hp)	Roller, 300 HP (diesel)	25 days, 8 hours per day, 80% utilization	160.00	hrs	13.09	13.00	0.00	0.00	0.09	0.02	0.01	44.32	
RAC	Backhoe loader, 48 hp 5/8 CY	Loader, 65 HP, 1 CY (diesel)	7 days, 8 hours per day, 80% utilization	44.80	hrs	0.53	0.53	0.00	0.00	0.00	0.00	0.00	2.37	
RAC	Asphalt Paver, 130 hp	Paver, 100 HP (diesel)	1 day, 8 hours per day, 80% utilization	6.40	hrs	0.23	0.23	0.00	0.00	0.00	0.00	0.00	0.78	
RAC	1 Tandem Roller, 10 ton	Roller, 100 HP (diesel)	1 day, 8 hours per day, 80% utilization	6.40	hrs	0.23	0.23	0.00	0.00	0.00	0.00	0.00		
RAC	DPT Drill Rig	Drill Rig, DPT (diesel)	7 wells, 5 wells per day, 8 hours per day, 80% utilization	8.96	hrs	0.14	0.14	0.00	0.00	0.00	0.00	0.00	1.10	
	Subtotal					**59.50**	**59.41**	**0.00**	**0.00**	**0.41**	**0.11**	**0.04**	**263.41**	**0**
				Total		**165**	**164**	**0.00**	**0.01**	**0.41**	**0.11**	**0.12**	**3,004**	**1**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
	Tonnes							**MMBTU**	**gal**
RI	-	-	-	-	-	-	-	-	-
RAC	165.02	163.58	1.15	0.29	0.41	0.11	0.12	10,249.31	1,357.61
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

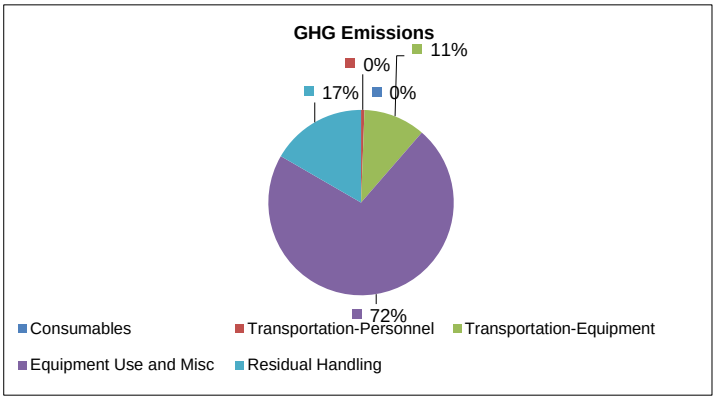
Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

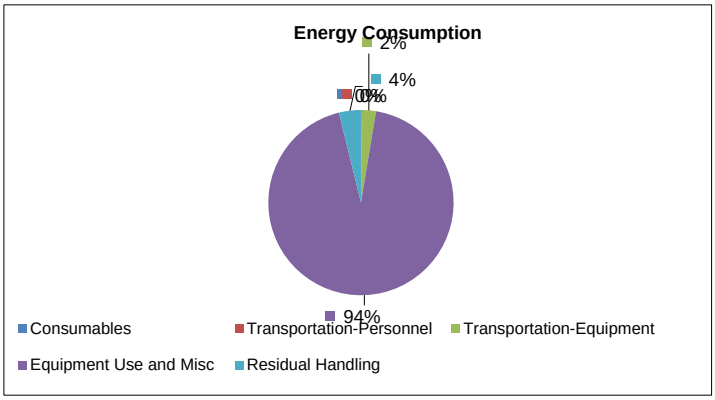
Sustainable Remediation - Environmental Footprint Summary
S-4

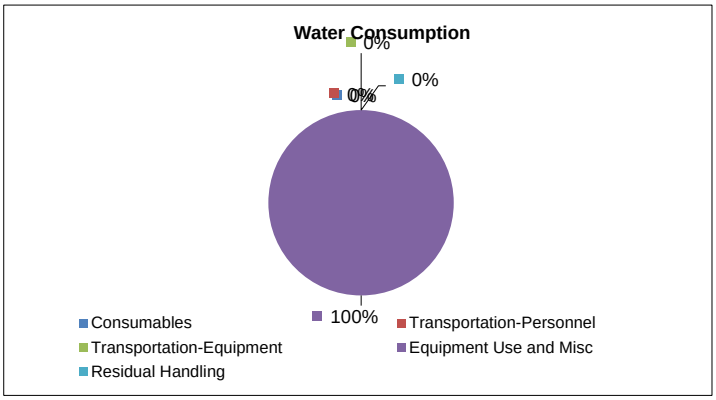
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	5.95	7.5E+01	NA	2.2E-03	7.7E-05	4.5E-04	1.2E-04	9.8E-03
	Transportation-Equipment	107.77	1.4E+03	NA	3.4E-02	6.0E-04	3.0E-03	2.7E-04	2.1E-02
	Equipment Use and Misc	718.85	5.3E+04	4.4E+03	1.1E+00	2.8E-01	1.8E-01	1.3E-04	3.3E-02
	Residual Handling	166.34	2.2E+03	NA	5.2E-02	9.2E-04	4.6E-03	4.1E-04	3.3E-02
	Sub-Total	998.90	5.68E+04	4.44E+03	1.15E+00	2.83E-01	1.83E-01	9.33E-04	9.76E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.69	8.6E+00	NA	2.5E-04	8.9E-06	5.1E-05	1.4E-05	1.1E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.69	8.63E+00	0.00E+00	2.54E-04	8.94E-06	5.15E-05	1.40E-05	1.13E-03
Total		**1.0E+03**	**5.7E+04**	**4.4E+03**	**1.2E+00**	**2.8E-01**	**1.8E-01**	**9.5E-04**	**9.9E-02**

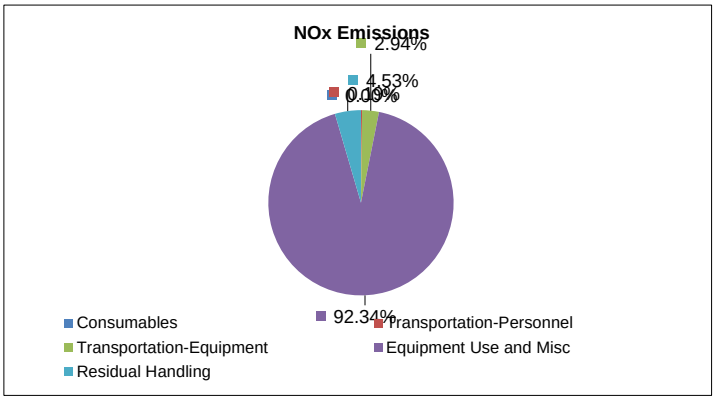
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	1.8E+04	0	7.8E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	9.0E-03
Total	**0.0E+00**	**0.0E+00**	**1.8E+04**	**$0**	**7.9E-01**

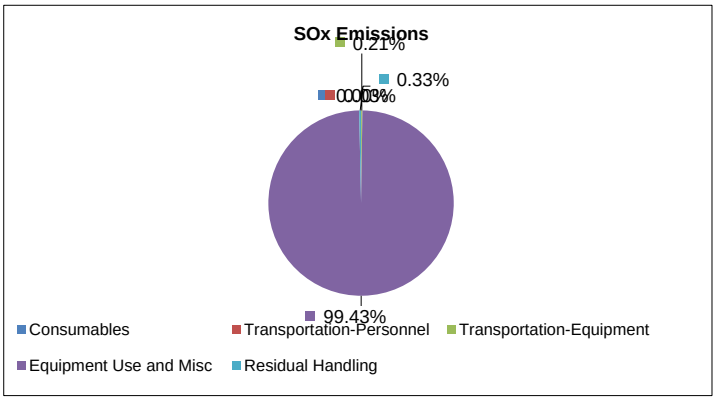
Total Cost with Footprint Reduction
$0

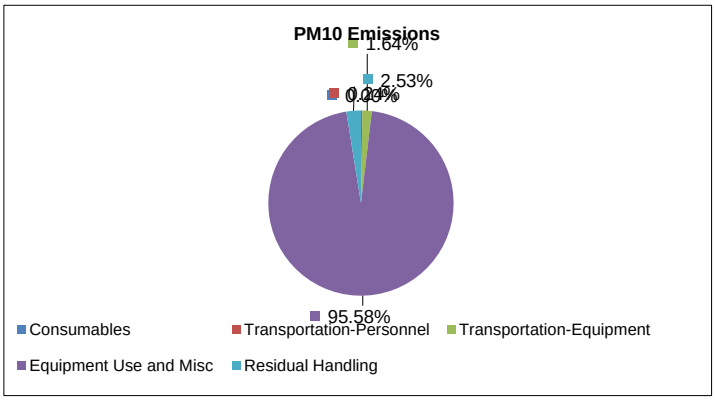

GHG Emissions
0%
11%
17%
0%
72%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

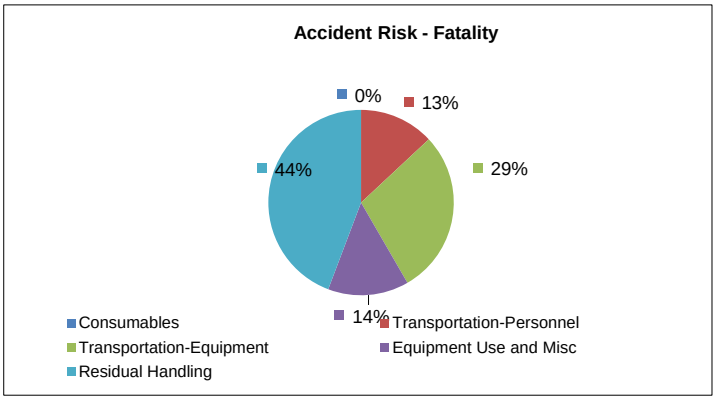

Energy Consumption
2%
4%
94%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

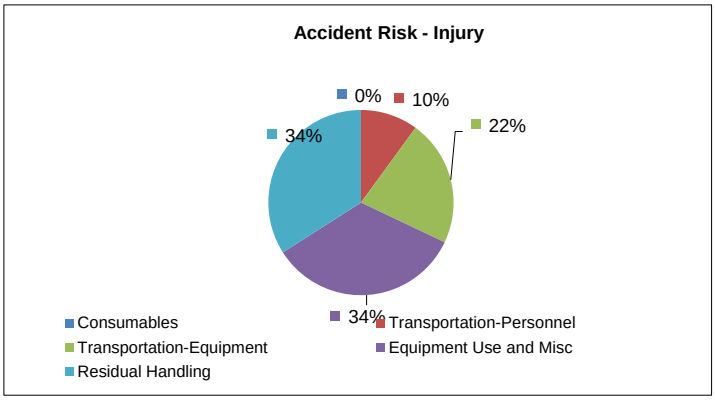

Water Consumption
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

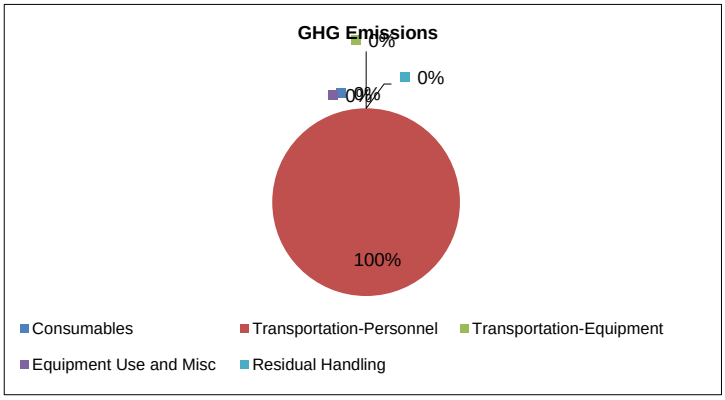

NOx Emissions
2.94%
4.53%
92.34%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

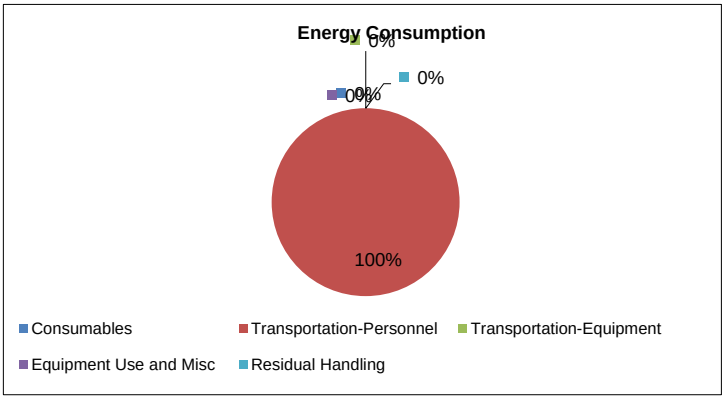

SOx Emissions
0.21%
0.33%
99.43%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

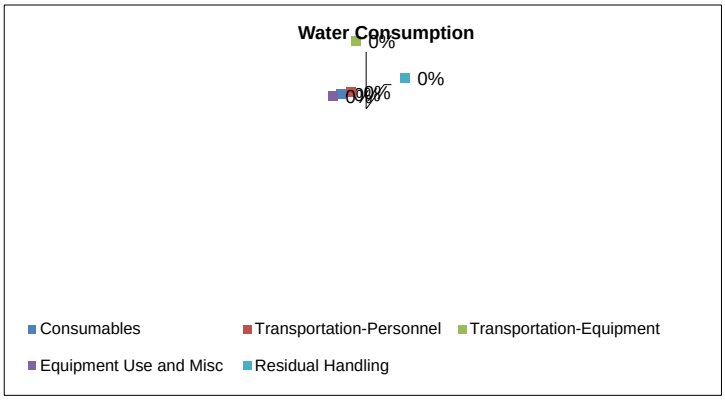

PM10 Emissions
1.64%
2.53%
95.58%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

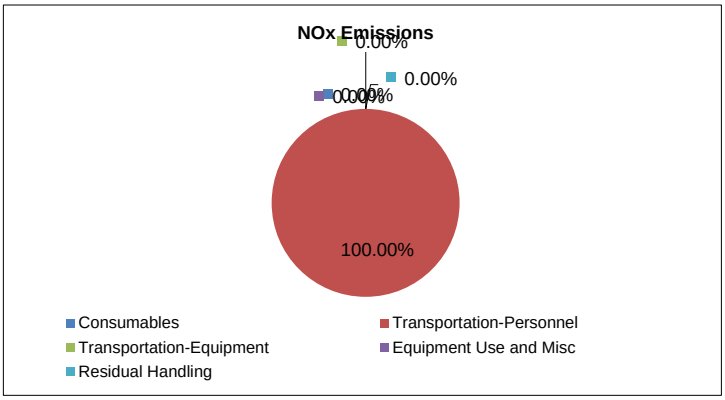

Accident Risk - Fatality
0%
13%
29%
44%
14%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

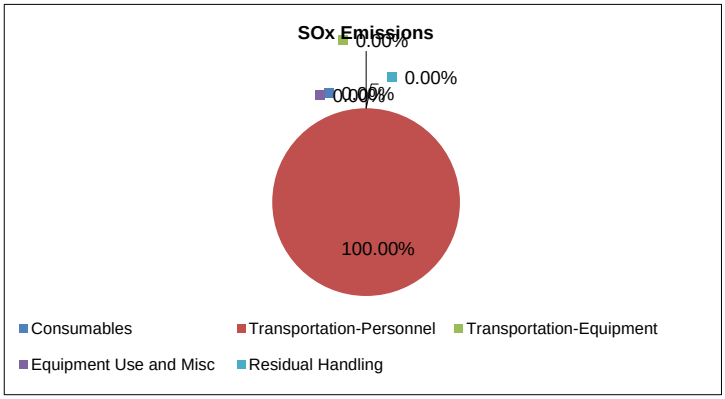

Accident Risk - Injury
0%
10%
22%
34%
34%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

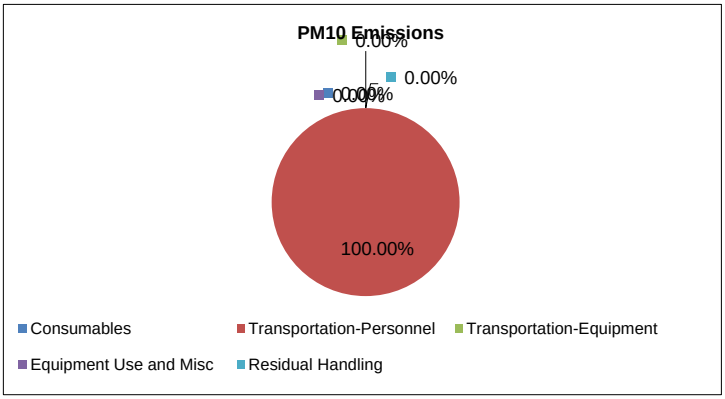

GHG Emissions
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

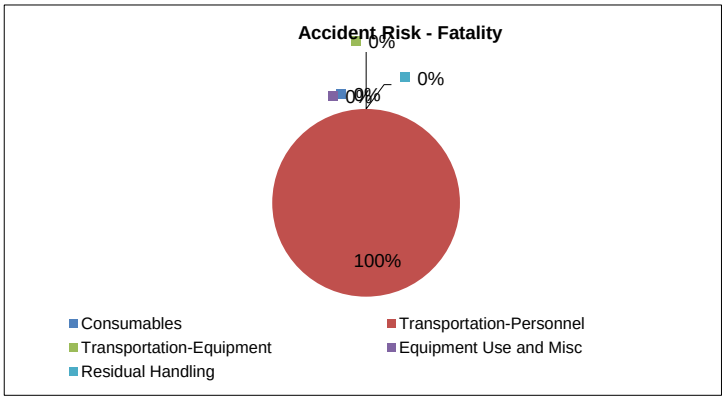

Energy Consumption
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

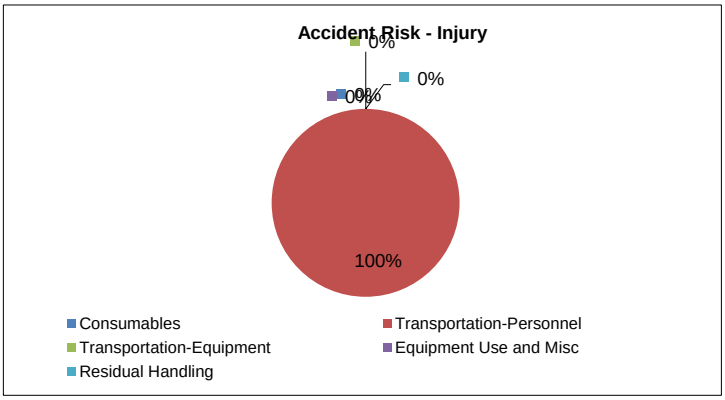

Water Consumption
0%
0%
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

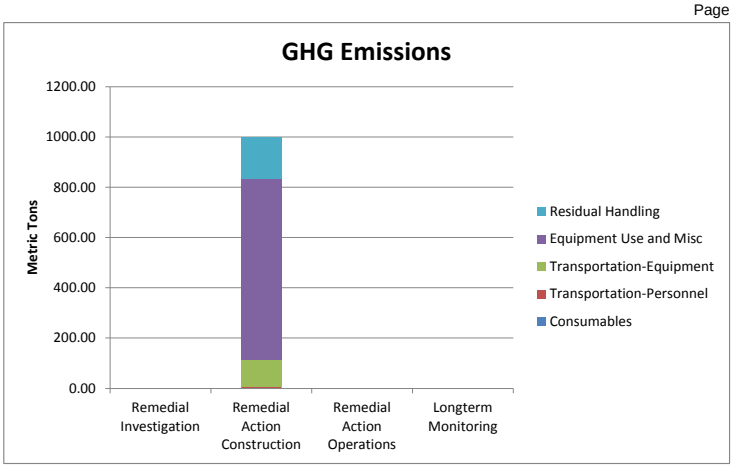

NOx Emissions
0.00%
0.00%
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

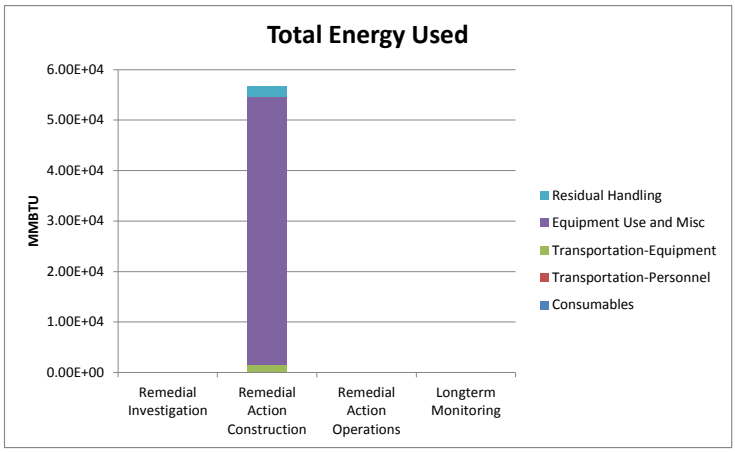

SOx Emissions
0.00%
0.00%
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

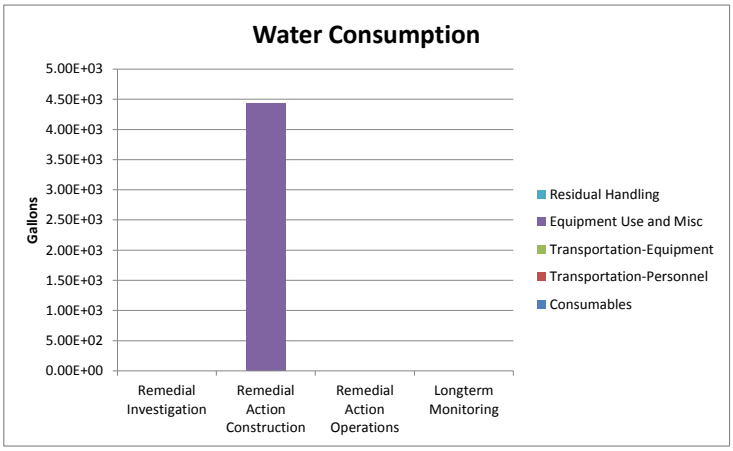

PM10 Emissions
0.00%
0.00%
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

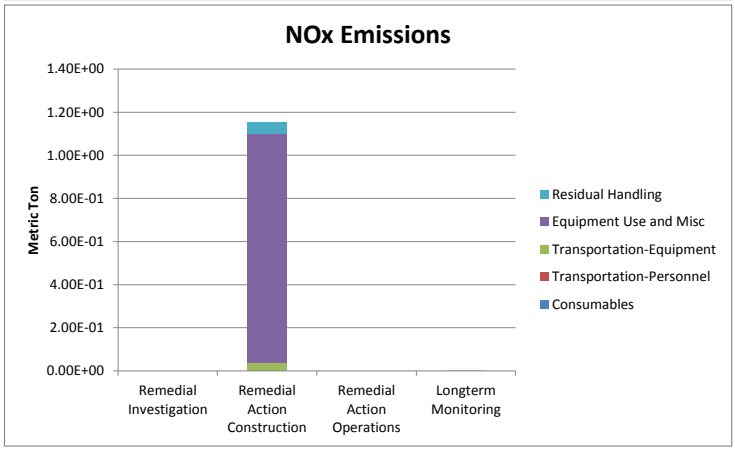

Accident Risk - Fatality
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

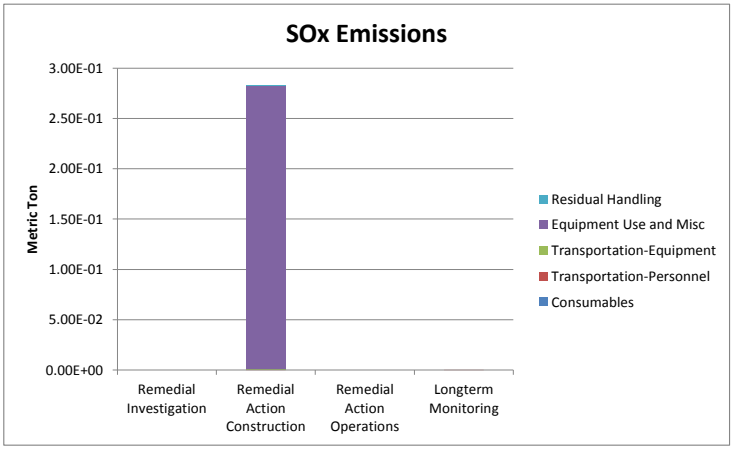

Accident Risk - Injury
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

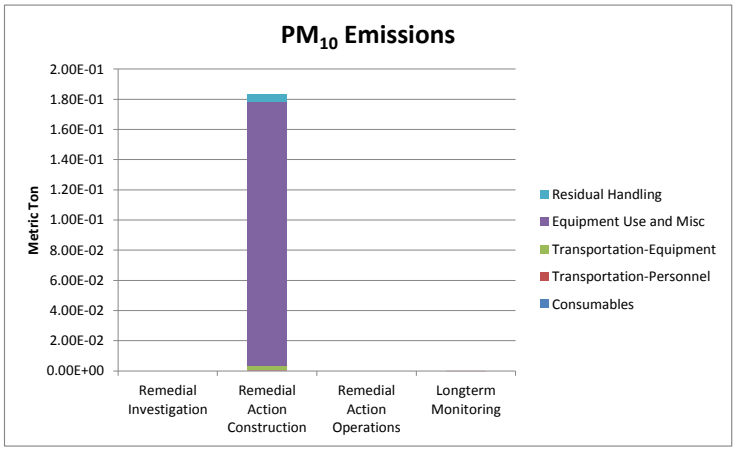

GHG Emissions
Metric Tons
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

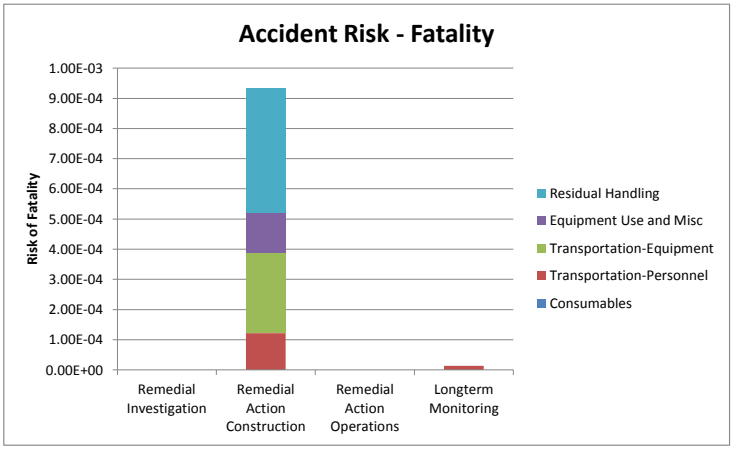

Total Energy Used
MMBTU
6.00E+04
5.00E+04
4.00E+04
3.00E+04
2.00E+04
1.00E+04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

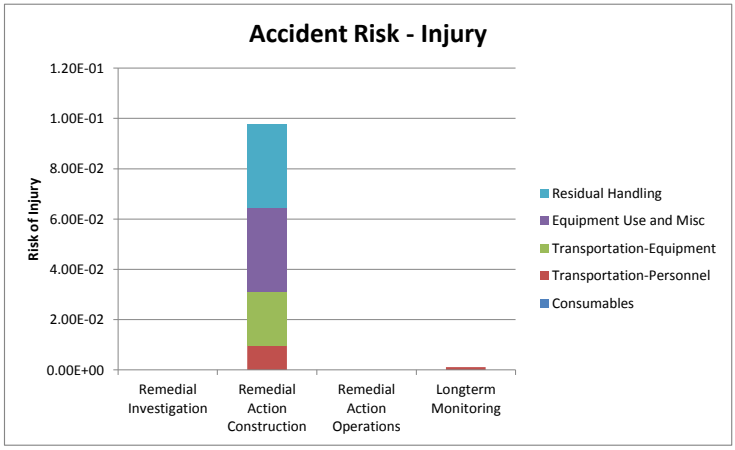

Water Consumption
Gallons
5.00E+03
4.50E+03
4.00E+03
3.50E+03
3.00E+03
2.50E+03
2.00E+03
1.50E+03
1.00E+03
5.00E+02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
1.40E+00
1.20E+00
1.00E+00
8.00E-01
6.00E-01
4.00E-01
2.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
2.00E-01
1.80E-01
1.60E-01
1.40E-01
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
1.00E-03
9.00E-04
8.00E-04
7.00E-04
6.00E-04
5.00E-04
4.00E-04
3.00E-04
2.00E-04
1.00E-04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Replace monitoring wells	PVC	13 wells, 460 lf, assume 2 in diameter	460.00	lft	0.75	0.38	0.00	0.00	0.00	0.00	0.00	13.69	0.79
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Monitoring Well Abandonment Wells	Sand	705 lf, 21wells, assume 2 in diameter, assume sand dry, 1602 kg/m3,	11,751.13	lbs	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.72	0.00
RAC	Backfill (cover & excavation)	Soil	Assume top soil, 15600 CY	46,800,000.00	lbs	488.16	488.16	0.00	0.00	0.00	0.00	0.00	12900.28	0.00
RAC	Select fill (building)	Soil	Assume top soil, 140 CY	420,000.00	lbs	4.38	4.38	0.00	0.00	0.00	0.00	0.00	115.77	0.00
RAC	Top soil	Soil	Assume top soil, 2200 CY	6,600,000.00	lbs	68.84	68.84	0.00	0.00	0.00	0.00	0.00	1819.27	0.00
RAC	Revegetation, seed	Fertilizer	Assume fertilizer, 13,000 sy` (thousand square feet), 3 lb of seed per 1.2 msf	292.50	lbs	0.36	0.36	0.00	0.00	0.00	0.00	0.00	6.61	0.13
RAC	Pavement Replacement, stone base	Gravel	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3	75,007.19	lbs	0.58	0.58	0.00	0.00	0.00	0.00	0.00	13.78	0.00
RAC	Pavement Replacement, bounder course	Gravel	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3	23,753.84	lbs	0.18	0.18	0.00	0.00	0.00	0.00	0.00	4.37	0.00
RAC	Pavement Replacement, topping	Asphalt	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3	11,252.64	lbs	0.11	0.09	0.00	0.00	0.00	0.00	0.08	0.51	0.00
RAC	Replace monitoring well head	PVC	3 well heads, 50 lb per unit, assume PVC	150.00	lbs	0.34	0.17	0.00	0.00	0.00	0.00	0.00	6.20	0.26
	Subtotal					**565.31**	**564.01**	**0.00**	**0.01**	**0.00**	**0.01**	**0.08**	**14890.38**	**1.44**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Brush Chipper, 130 HP	WOOD CHIPPER	4 days, 8 hours per day, 80% utilization	25.60	hrs	1.11	1.11	0.00	0.00	0.01	0.00	0.00	4.89	
RAC	1 crawler loader, 3CY	Loader, 155 HP, 3 CY (diesel)	4 days, 8 hours per day, 80% utilization	25.60	hrs	0.52	0.52	0.00	0.00	0.00	0.00	0.00	2.19	
RAC	2 chain saws	Chainsaw, gasoline, 3<hp<=6, 2 stroke	4 days, 8 hours per day, 80% utilization	25.60	hrs	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.24	
RAC	Excavator, 2.5 CY	Excavator, Hydraulic, 2 CY (diesel)	65 days, 8 hours per day, 80% utilization	416.00	hrs	40.32	40.32	0.00	0.00	0.25	0.07	0.02	183.02	
RAC	Dozer 300 hp	Dozer, 335 HP (D8) w/U Blade (diesel)	65 days, 8 hours per day, 80% utilization	416.00	hrs	75.22	75.22	0.00	0.00	0.55	0.14	0.05	366.05	
RAC	Compactor (roller, 240 hp)	Roller, 300 HP (diesel)	65 days, 8 hours per day, 80% utilization	416.00	hrs	34.02	33.80	0.00	0.00	0.24	0.06	0.02	115.24	
RAC	Backhoe loader, 48 hp 5/8 CY	Loader, 65 HP, 1 CY (diesel)	13 days, 8 hours per day, 80% utilization	83.20	hrs	0.99	0.99	0.00	0.00	0.01	0.00	0.00	4.41	
RAC	Asphalt Paver, 130 hp	Loader, 100 HP, 2 CY (diesel)	1 day, 8 hours per day, 80% utilization	6.40	hrs	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.47	
RAC	1 Tandem Roller, 10 ton	Roller, 100 HP (diesel)	1 day, 8 hours per day, 80% utilization	6.40	hrs	0.23	0.23	0.00	0.00	0.00	0.00	0.00		
RAC	DPT Drill Rig	Drill Rig, DPT (diesel)	13 wells, 5 wells per day, 8 hours per day, 80% utilization	16.64	hrs	0.27	0.26	0.00	0.00	0.00	0.00	0.00	2.03	
	Subtotal					**152.83**	**152.60**	**0.00**	**0.00**	**1.06**	**0.27**	**0.09**	**678.53**	**0**
				Total		**718**	**717**	**0.00**	**0.01**	**1.06**	**0.28**	**0.18**	**15,569**	**1**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
	Tonnes							MMBTU	gal
RI	-	-	-	-	-	-	-	-	-
RAC	718.14	716.61	1.23	0.30	1.06	0.28	0.18	53,121.14	1,435.78
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

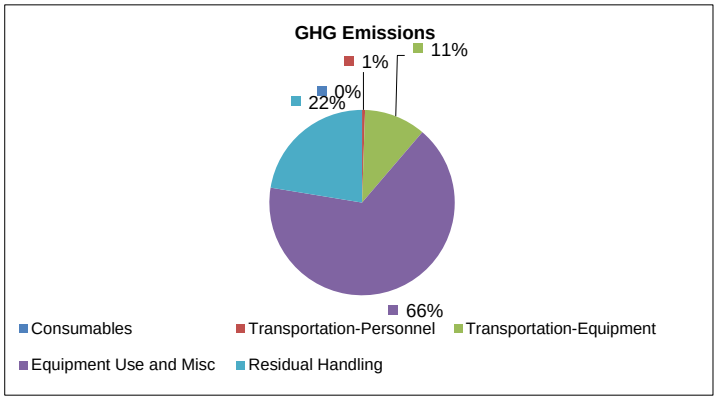
Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

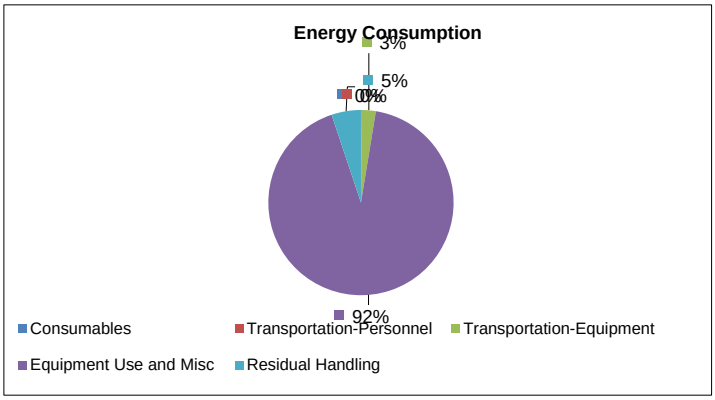
Sustainable Remediation - Environmental Footprint Summary
S-5

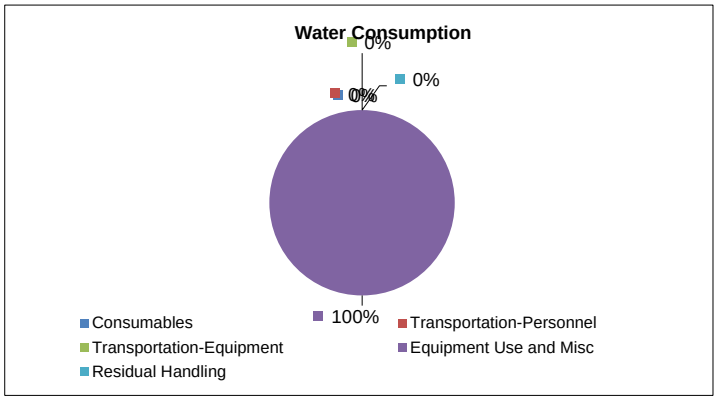
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	23.67	3.0E+02	NA	8.8E-03	3.1E-04	1.8E-03	4.8E-04	3.9E-02
	Transportation-Equipment	488.78	6.4E+03	NA	1.5E-01	2.7E-03	1.4E-02	1.2E-03	9.7E-02
	Equipment Use and Misc	3,015.04	2.4E+05	1.1E+04	2.6E+00	7.3E-01	3.5E-01	3.8E-04	9.6E-02
	Residual Handling	1,019.23	1.3E+04	NA	3.2E-01	5.7E-03	2.8E-02	2.5E-03	2.0E-01
	Sub-Total	4,546.72	2.59E+05	1.11E+04	3.05E+00	7.36E-01	3.94E-01	4.60E-03	4.36E-01
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total		**4.5E+03**	**2.6E+05**	**1.1E+04**	**3.1E+00**	**7.4E-01**	**3.9E-01**	**4.6E-03**	**4.4E-01**

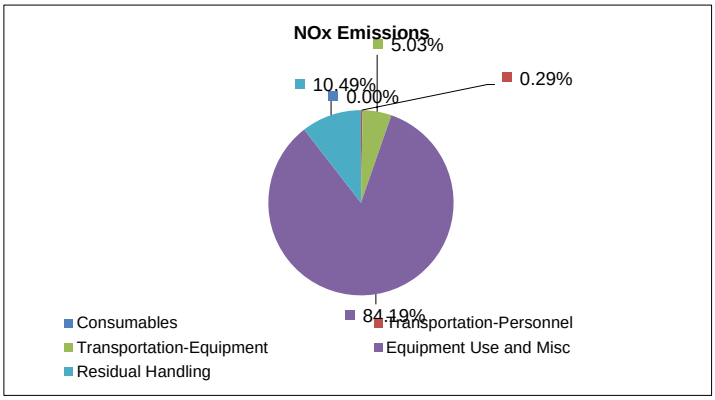
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	8.2E+04	0	3.5E+00
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Total	**0.0E+00**	**0.0E+00**	**8.2E+04**	**$0**	**3.5E+00**

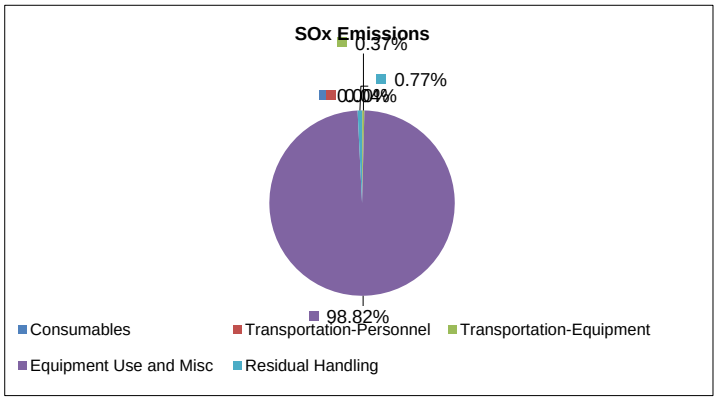
Total Cost with Footprint Reduction
$0

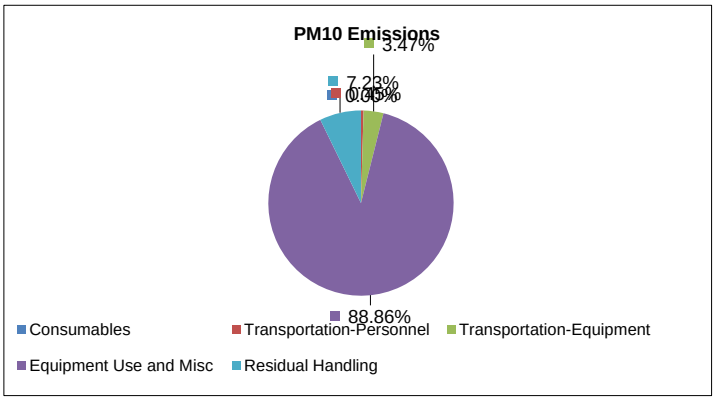

GHG Emissions
1%
11%
0%
22%
66%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

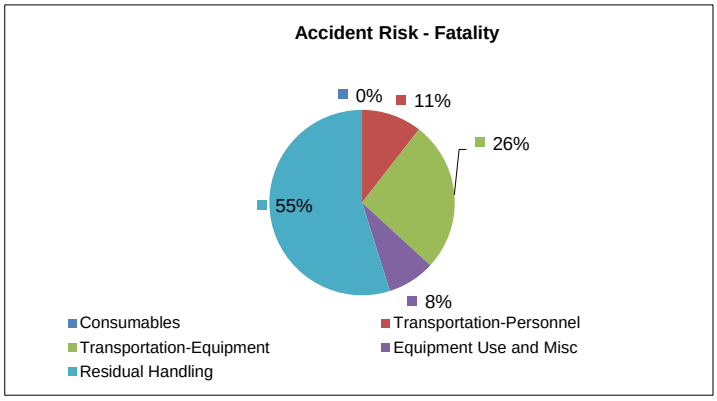

Energy Consumption
3%
5%
92%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

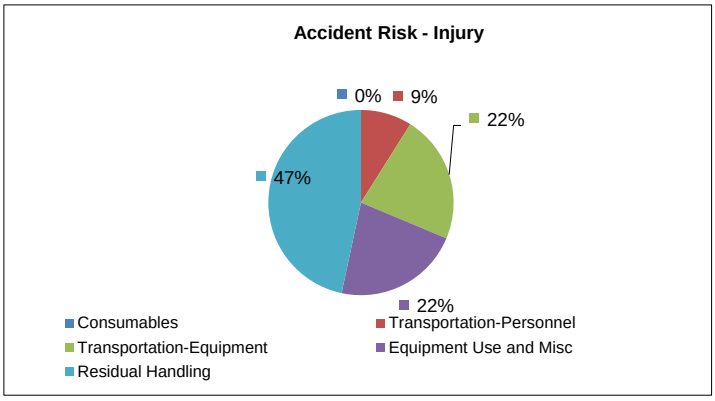

Water Consumption
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

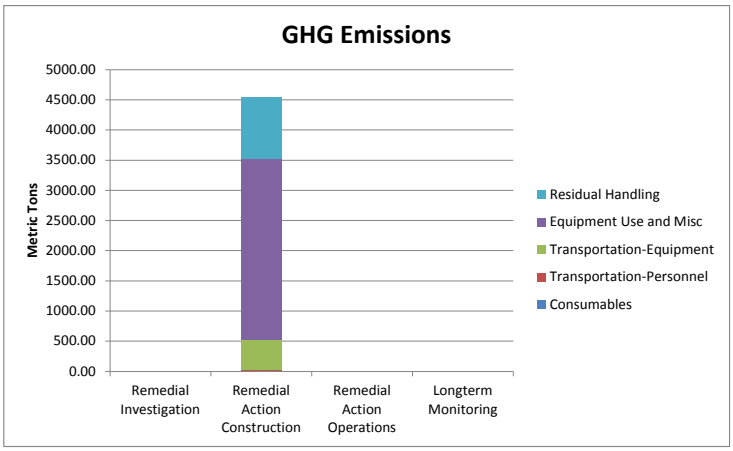

NOx Emissions
5.03%
0.29%
10.49%
0.00%
84.19%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

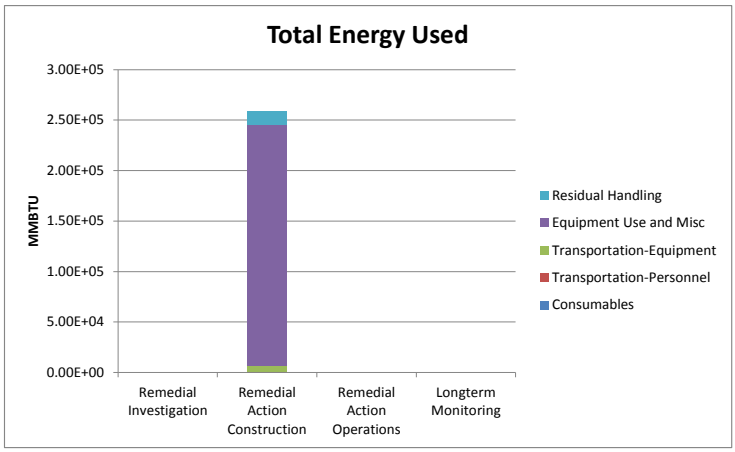

SOx Emissions
0.37%
0.77%
98.82%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

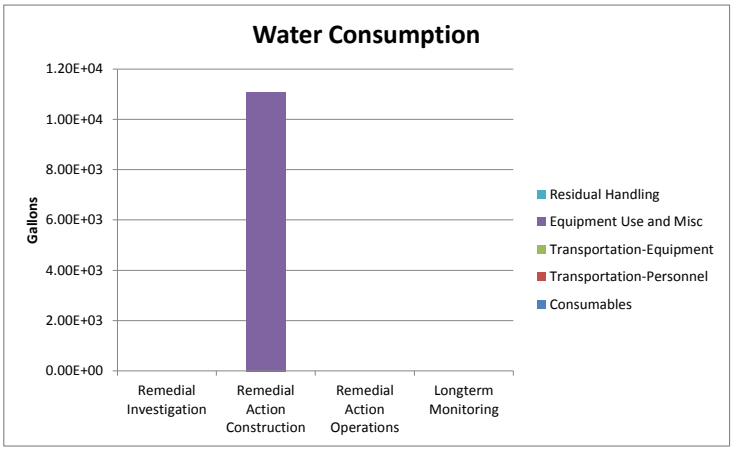

PM10 Emissions
3.47%
7.23%
88.86%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

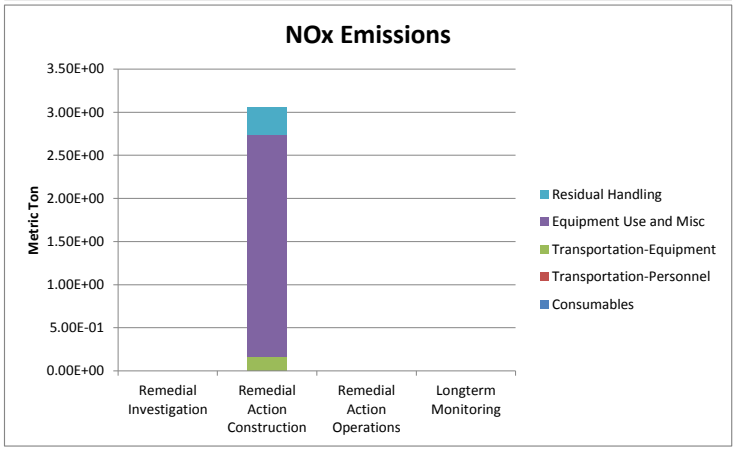

Accident Risk - Fatality
0%
11%
26%
55%
8%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

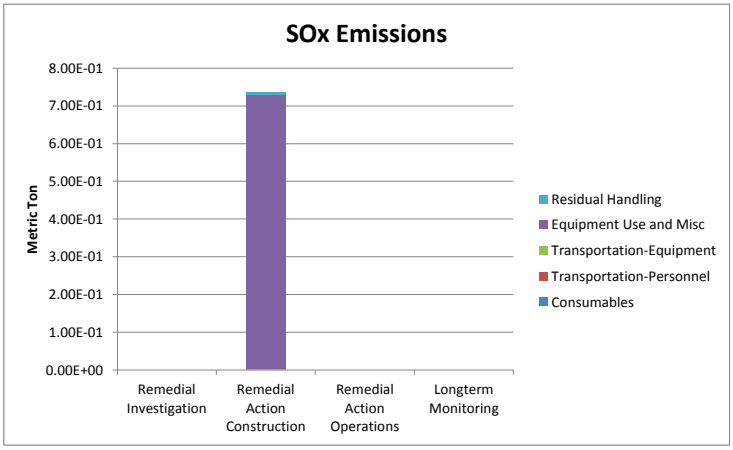

Accident Risk - Injury
0%
9%
22%
47%
22%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

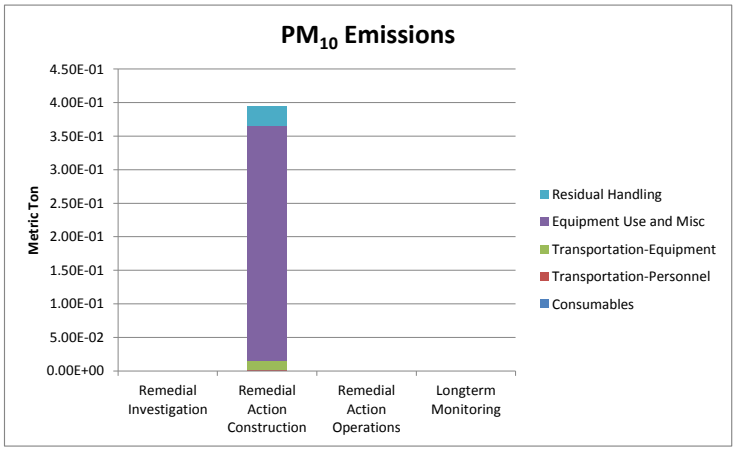

GHG Emissions
Metric Tons
5000.00
4500.00
4000.00
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

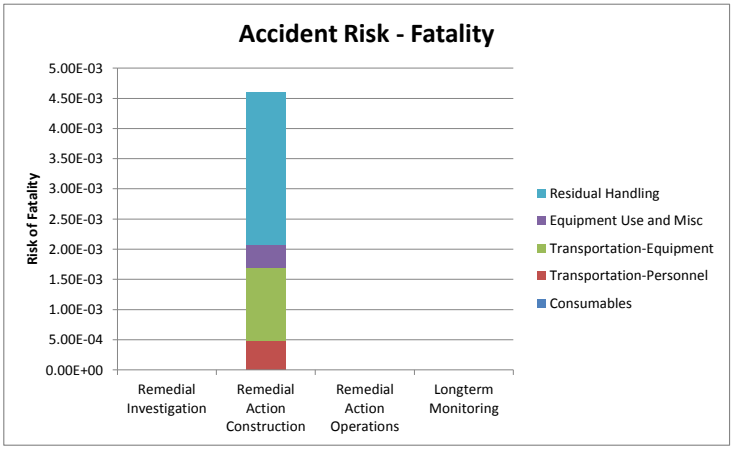

Total Energy Used
MMBTU
3.00E+05
2.50E+05
2.00E+05
1.50E+05
1.00E+05
5.00E+04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

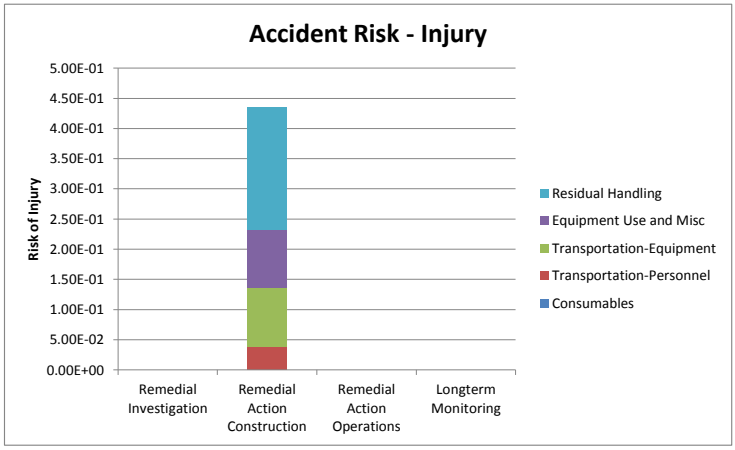

Water Consumption
Gallons
1.20E+04
1.00E+04
8.00E+03
6.00E+03
4.00E+03
2.00E+03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
3.50E+00
3.00E+00
2.50E+00
2.00E+00
1.50E+00
1.00E+00
5.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
8.00E-01
7.00E-01
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
4.50E-01
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
5.00E-03
4.50E-03
4.00E-03
3.50E-03
3.00E-03
2.50E-03
2.00E-03
1.50E-03
1.00E-03
5.00E-04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
5.00E-01
4.50E-01
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Replace monitoring wells	PVC	18 wells, 730 lf, assume 2 in diameter	730.00	lft	1.18	0.60	0.00	0.01	0.00	0.00	0.00	21.73	1.26
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Monitoring Well Abandonment Wells	Sand	1700 lf, 42wells, assume 2 in diameter, assume sand dry, 1602 kg/m3,	28,336.05	lbs	0.06	0.06	0.00	0.00	0.00	0.00	0.00	1.74	0.00
RAC	Backfill (cover & excavation)	Soil	Assume top soil, 77000 CY	231,000,000	lbs	2409.52	2409.52	0.00	0.00	0.00	0.00	0.00	63674.47	0.00
RAC	Select fill (building)	Soil	Assume top soil, 140 CY	420,000	lbs	4.38	4.38	0.00	0.00	0.00	0.00	0.00	115.77	0.00
RAC	Top soil	Soil	Assume top soil, 5300 CY	15,900,000	lbs	165.85	165.85	0.00	0.00	0.00	0.00	0.00	4382.79	0.00
RAC	Revegetation, seed	Fertilizer	Assume fertilizer, 31500 sy, 3 lb of seed per 1.2 msf	708.75	lbs	0.88	0.88	0.00	0.00	0.00	0.00	0.00	16.02	0.32
RAC	Pavement Replacement, stone base	Gravel	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3	75,007.19	lbs	0.58	0.58	0.00	0.00	0.00	0.00	0.00	13.78	0.00
RAC	Pavement Replacement, bounder course	Gravel	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3	23,753.84	lbs	0.18	0.18	0.00	0.00	0.00	0.00	0.00	4.37	0.00
RAC	Pavement Replacement, topping	Asphalt	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3	11,252.64	lbs	0.11	0.09	0.00	0.00	0.00	0.00	0.08	0.51	0.00
RAC	Replace monitoring well head	PVC	3 well heads, 50 lb per unit, assume PVC	150.00	lbs	0.34	0.17	0.00	0.00	0.00	0.00	0.00	6.20	0.26
	Subtotal					**2584.67**	**2583.16**	**0.00**	**0.01**	**0.00**	**0.01**	**0.08**	**68246.55**	**2.09**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Brush Chipper, 130 HP	WOOD CHIPPER	10 days, 8 hours per day, 80% utilization	64.00	hrs	2.79	2.79	0.00	0.00	0.02	0.00	0.00	12.23	
RAC	1 crawler loader, 3CY	Loader, 155 HP, 3 CY (diesel)	10 days, 8 hours per day, 80% utilization	64.00	hrs	1.30	1.30	0.00	0.00	0.01	0.00	0.00	5.48	
RAC	2 chain saws	Chainsaw, gasoline, 3<hp<=6, 2 stroke	10 days, 8 hours per day, 80% utilization	64.00	hrs	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.59	
RAC	Excavator, 2.5 CY, 2 units	Excavator, Hydraulic, 2 CY (diesel)	195 days, 8 hours per day, 80% utilization	1,248.00	hrs	120.95	120.95	0.00	0.00	0.76	0.22	0.07	549.07	
RAC	Dozer 300 hp, 2 units	Dozer, 335 HP (D8) w/U Blade (diesel)	195 days, 8 hours per day, 80% utilization	1,248.00	hrs	225.66	225.66	0.00	0.00	1.64	0.42	0.14	1098.14	
RAC	Compactor (roller, 240 hp), 2 units	Roller, 100 HP (diesel)	195 days, 8 hours per day, 80% utilization	1,248.00	hrs	44.93	44.93	0.00	0.00	0.00	0.00	0.05		
RAC	Backhoe loader, 48 hp 5/8 CY	Loader, 65 HP, 1 CY (diesel)	32 days, 8 hours per day, 80% utilization	204.80	hrs	2.43	2.43	0.00	0.00	0.02	0.00	0.00	10.85	
RAC	Asphalt Paver, 130 hp	Paver, 100 HP (diesel)	1 day, 8 hours per day, 80% utilization	6.40	hrs	0.23	0.23	0.00	0.00	0.00	0.00	0.00	0.78	
RAC	1 Tandem Roller, 10 ton	Roller, 100 HP (diesel)	1 day, 8 hours per day, 80% utilization	6.40	hrs	0.23	0.23	0.00	0.00	0.00	0.00	0.00		
RAC	DPT Drill Rig	Drill Rig, DPT (diesel)	18 wells, 5 wells per day, 8 hours per day, 80% utilization	23.04	hrs	0.37	0.36	0.00	0.00	0.00	0.00	0.00	2.82	
	Subtotal					**399.00**	**398.99**	**0.00**	**0.00**	**2.46**	**0.65**	**0.26**	**1679.94**	**0**
				Total		**2,984**	**2,982**	**0.00**	**0.02**	**2.46**	**0.65**	**0.35**	**69,926**	**2**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
	Tonnes							MMBTU	gal
RI	-	-	-	-	-	-	-	-	-
RAC	2,983.67	######	1.20	0.32	2.46	0.65	0.35	238,589.20	2,088.05
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

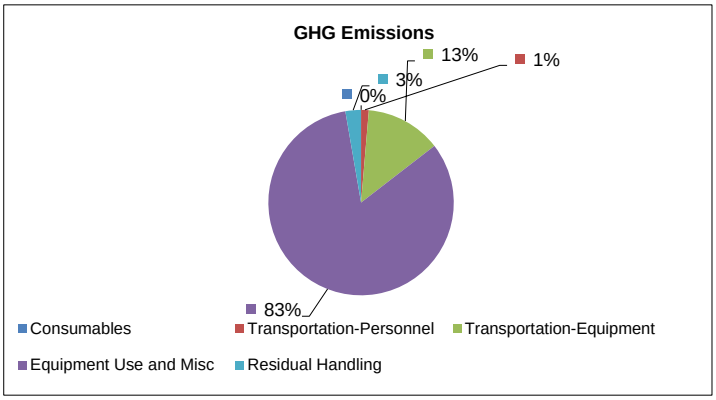
Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

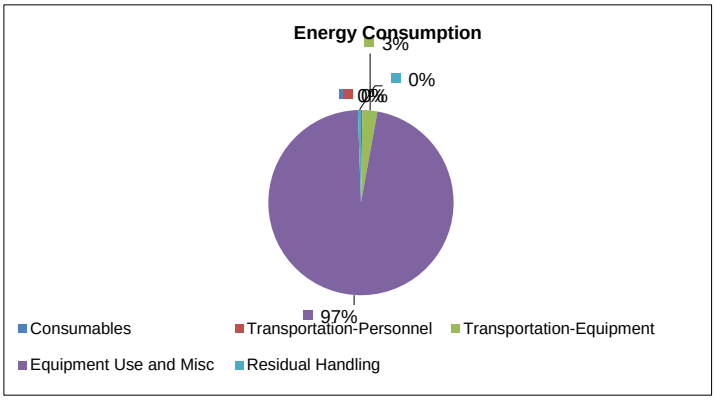
Sustainable Remediation - Environmental Footprint Summary
S-6

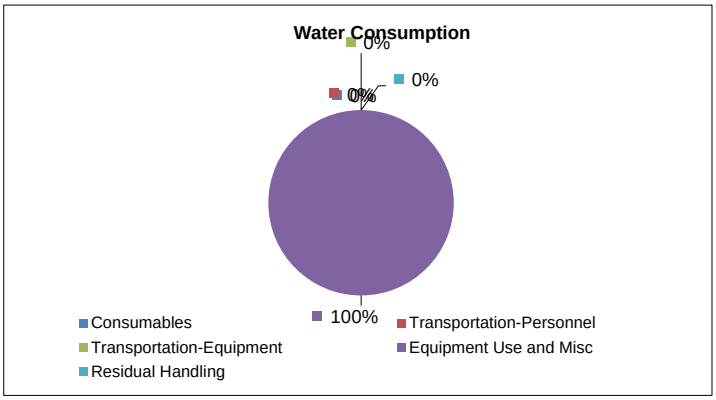
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	10.79	1.4E+02	NA	4.0E-03	1.4E-04	8.1E-04	2.2E-04	1.8E-02
	Transportation-Equipment	105.80	1.4E+03	NA	3.3E-02	5.9E-04	3.0E-03	2.6E-04	2.1E-02
	Equipment Use and Misc	663.98	5.1E+04	8.1E+03	6.1E-01	1.9E-01	1.6E-01	1.3E-04	3.3E-02
	Residual Handling	21.79	2.8E+02	NA	6.8E-03	1.2E-04	6.1E-04	5.5E-05	4.4E-03
	Sub-Total	802.35	5.32E+04	8.08E+03	6.58E-01	1.88E-01	1.60E-01	6.67E-04	7.58E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.69	8.6E+00	NA	2.5E-04	8.9E-06	5.1E-05	1.4E-05	1.1E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.69	8.63E+00	0.00E+00	2.54E-04	8.94E-06	5.15E-05	1.40E-05	1.13E-03
Total		**8.0E+02**	**5.3E+04**	**8.1E+03**	**6.6E-01**	**1.9E-01**	**1.6E-01**	**6.8E-04**	**7.7E-02**

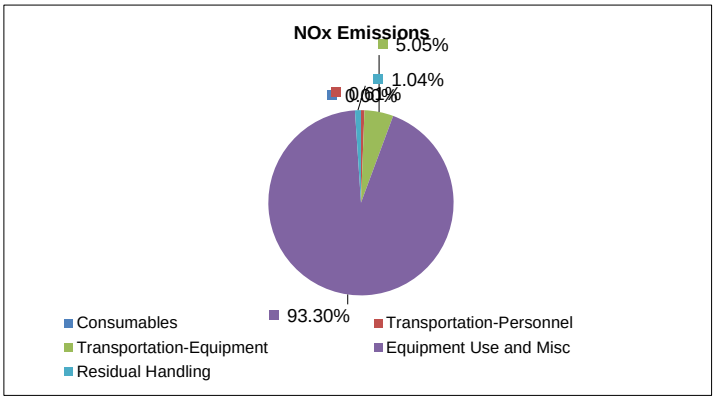
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	1.8E+04	0	6.1E-01
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	9.0E-03
Total	**0.0E+00**	**0.0E+00**	**1.8E+04**	**$0**	**6.2E-01**

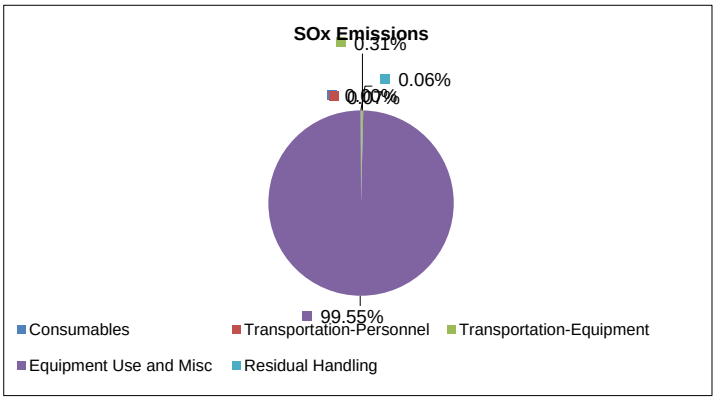
Total Cost with Footprint Reduction
$0

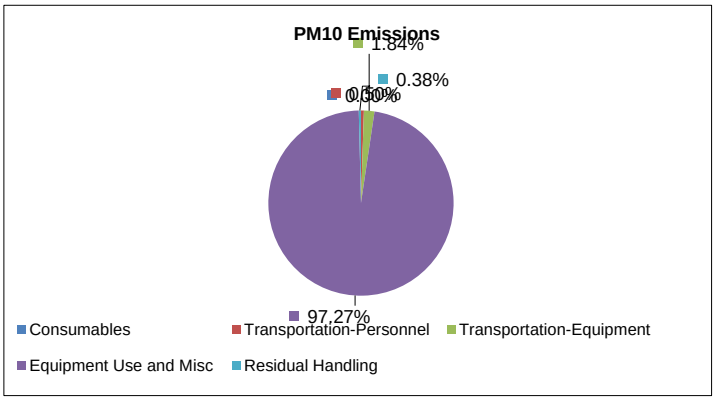

GHG Emissions
13%
1%
3%
0%
83%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

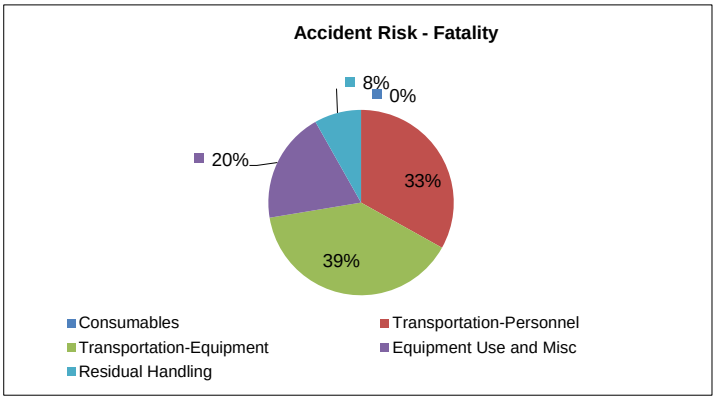

Energy Consumption
3%
0%
97%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

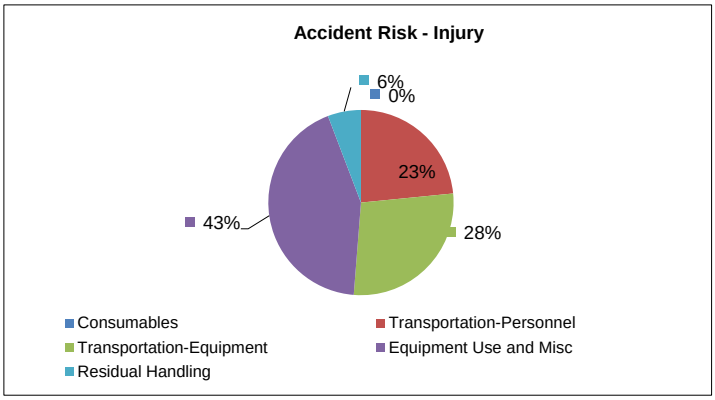

Water Consumption
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

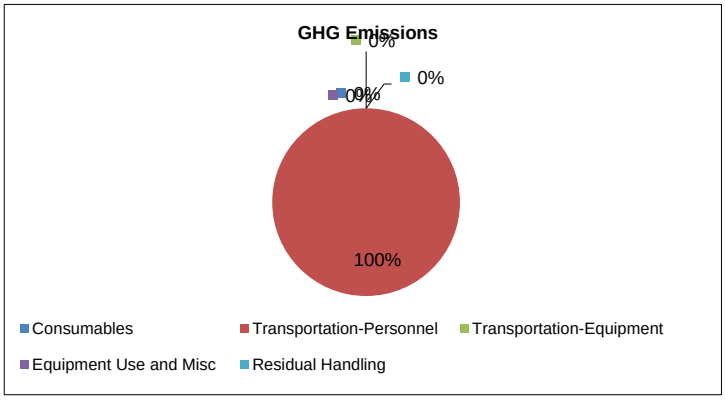

NOx Emissions
5.05%
1.04%
93.30%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

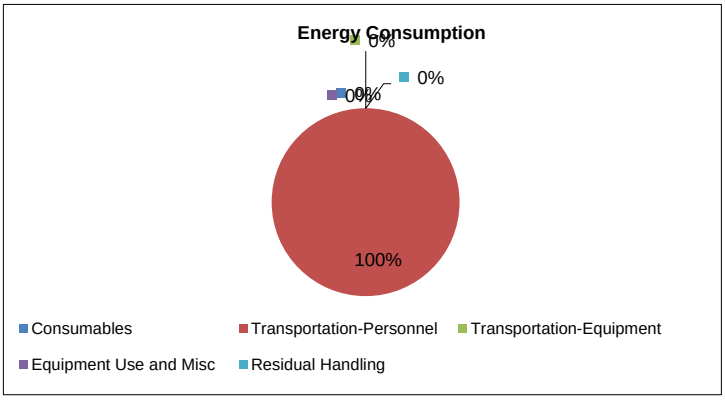

SOx Emissions
0.31%
0.06%
99.55%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

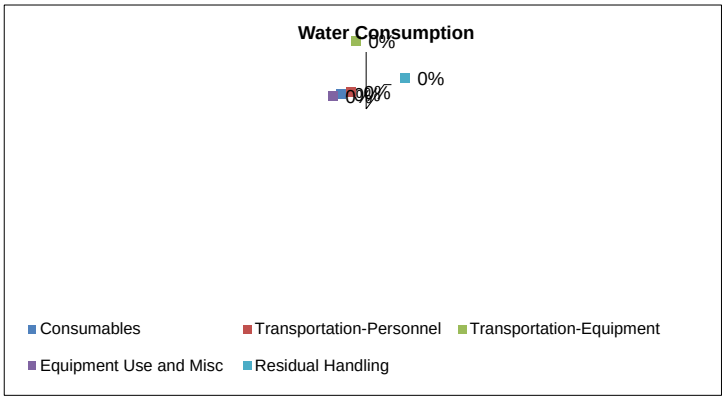

PM10 Emissions
1.84%
0.38%
97.27%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

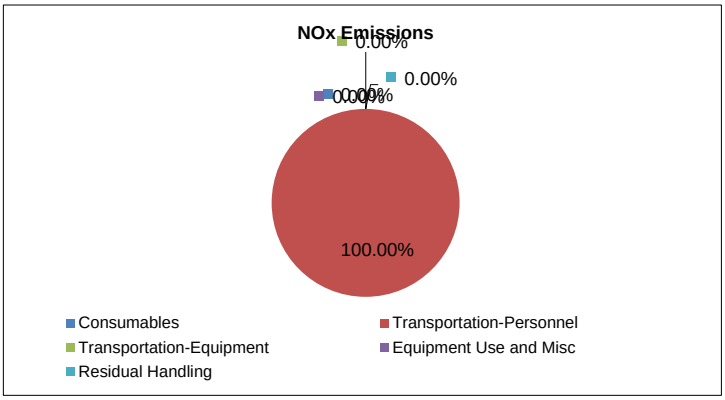

Accident Risk - Fatality
8%
0%
20%
33%
39%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

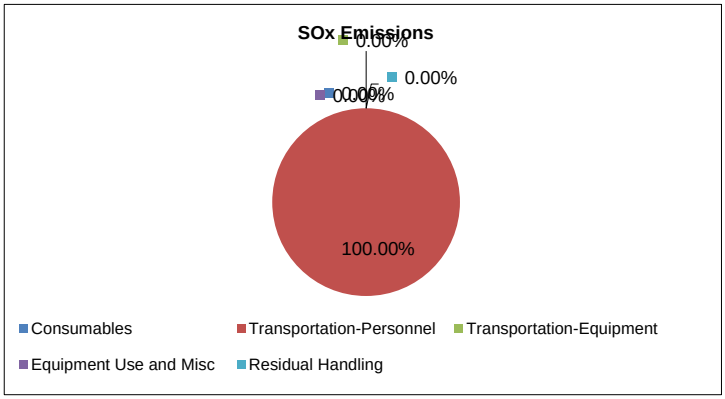

Accident Risk - Injury
6%
0%
23%
43%
28%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

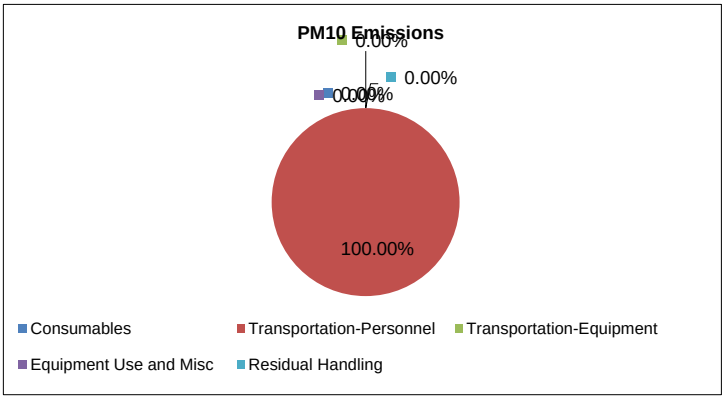

GHG Emissions
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

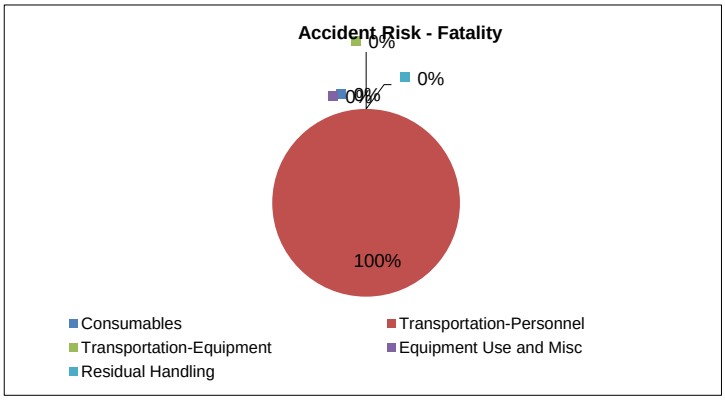

Energy Consumption
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

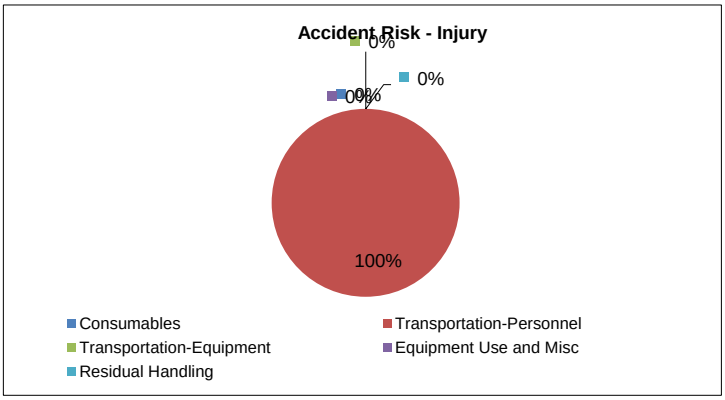

Water Consumption
0%
0%
0%
0%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

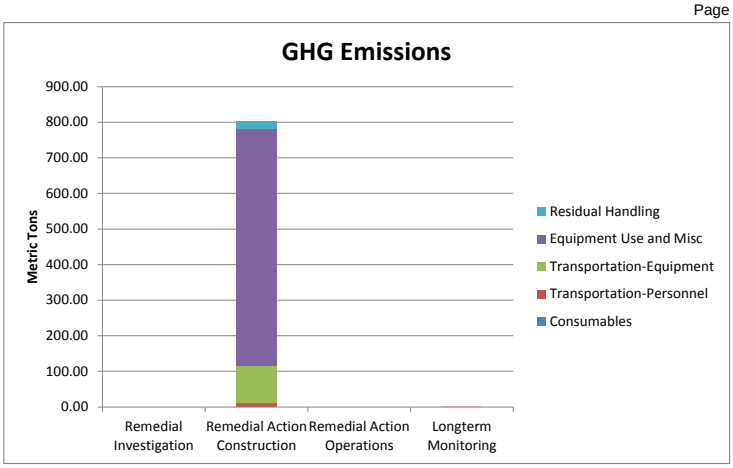

NOx Emissions
0.00%
0.00%
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

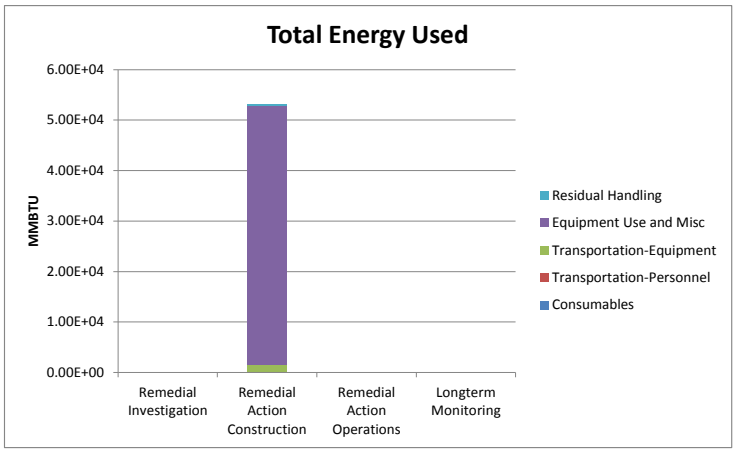

SOx Emissions
0.00%
0.00%
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

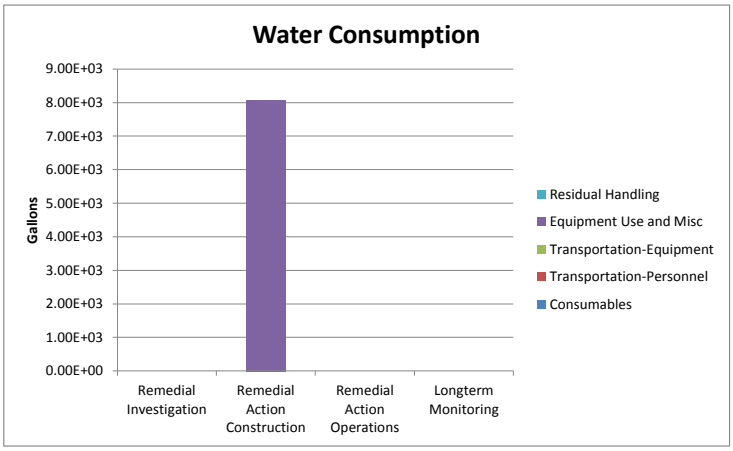

PM10 Emissions
0.00%
0.00%
0.00%
0.00%
100.00%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

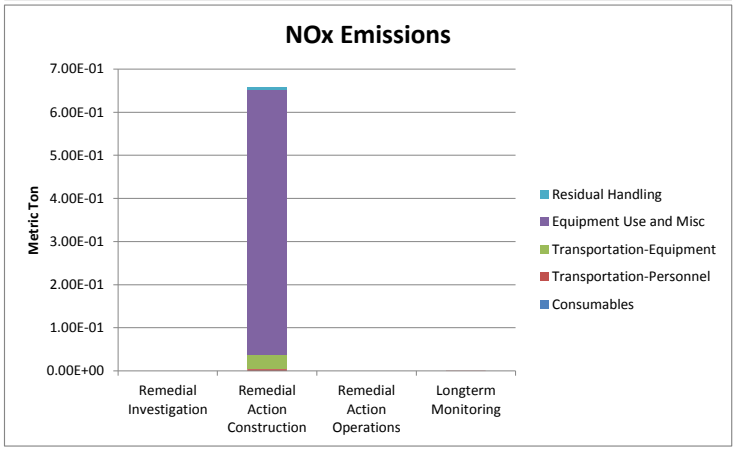

Accident Risk - Fatality
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

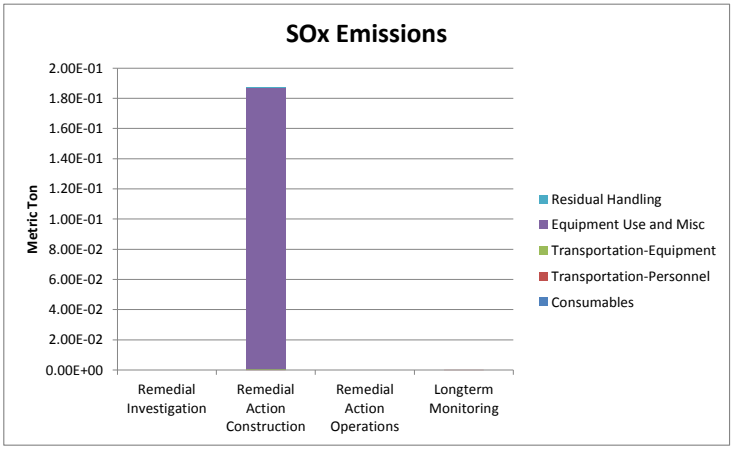

Accident Risk - Injury
0%
0%
0%
0%
100%
Consumables
Transportation-Personnel
Transportation-Equipment
Equipment Use and Misc
Residual Handling

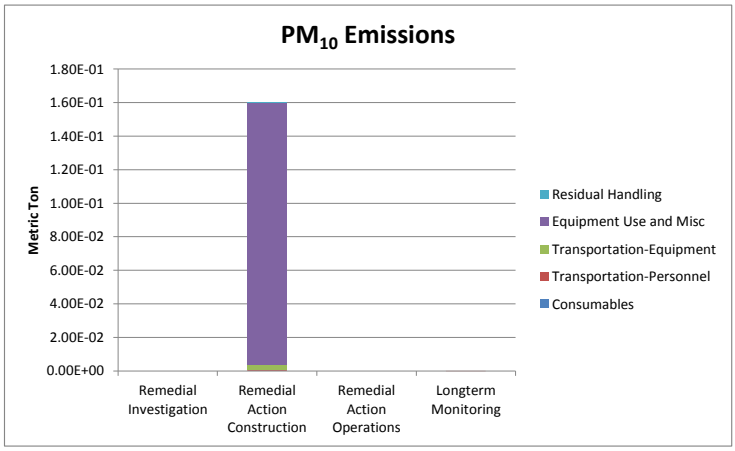

GHG Emissions
Metric Tons
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

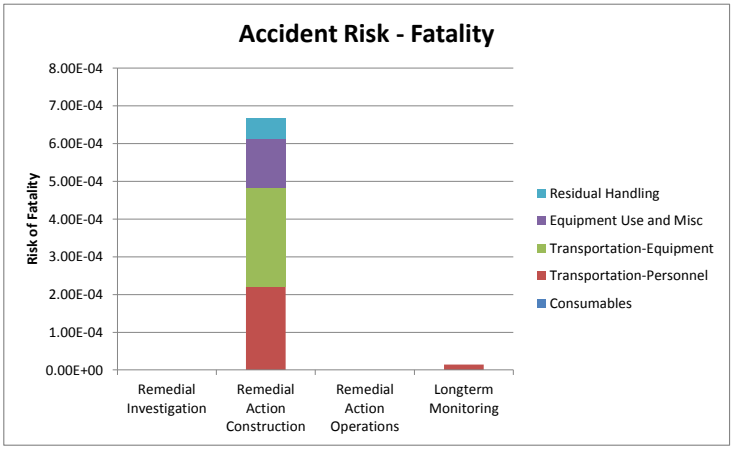

Total Energy Used
MMBTU
6.00E+04
5.00E+04
4.00E+04
3.00E+04
2.00E+04
1.00E+04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

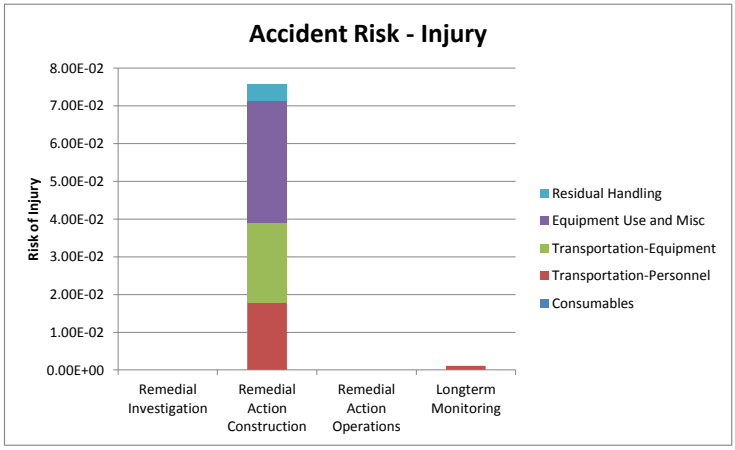

Water Consumption
Gallons
9.00E+03
8.00E+03
7.00E+03
6.00E+03
5.00E+03
4.00E+03
3.00E+03
2.00E+03
1.00E+03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


NOx Emissions
Metric Ton
7.00E-01
6.00E-01
5.00E-01
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


SOx Emissions
Metric Ton
2.00E-01
1.80E-01
1.60E-01
1.40E-01
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


PM10 Emissions
Metric Ton
1.80E-01
1.60E-01
1.40E-01
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Fatality
Risk of Fatality
8.00E-04
7.00E-04
6.00E-04
5.00E-04
4.00E-04
3.00E-04
2.00E-04
1.00E-04
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Accident Risk - Injury
Risk of Injury
8.00E-02
7.00E-02
6.00E-02
5.00E-02
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Replacement monitoring wells	PVC	1100 lf, Assume PVC, 2 inch, SCH 40, 28 wells, 0.72 lb/ft	1,100.00	lft	1.78	0.90	0.00	0.01	0.00	0.00	0.00	32.75	1.89
RAC	New LUC Monitoring wells	PVC	45 lf, Assume PVC,2 inch SCH 40, 3 wells, 0.72 lb/ft	45.00	lft	0.07	0.04	0.00	0.00	0.00	0.00	0.00	1.34	0.08
RAC	Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Monitoring well abandonmnet wells	Sand	38 wells, 1380 ft, 2 inch diameter, assume sand dry, 1602 kg/m3,	23,002.21	lbs	0.05	0.05	0.00	0.00	0.00	0.00	0.00	1.41	0.00
RAC	Cover fill	Soil	7870 CY, Assume common soil, 1.5 ton/cy, 2000 lb per ton	23,610,000.00	lbs	246.27	246.27	0.00	0.00	0.00	0.00	0.00	6508.03	0.00
RAC	Cover Liner	HDPE	Assume HDPE, 47250 sf, 8oz/sy	2,625.00	lbs	5.86	3.10	0.01	0.02	0.00	0.01	0.00	34.35	0.94
RAC	Top soil	Soil	Assume Top soil, 7870 CY, 1.5 ton/cy, 2000 lb pre ton	23,610,000.00	lbs	246.27	246.27	0.00	0.00	0.00	0.00	0.00	6508.03	0.00
RAC	Select Fill	Soil	Assume top soil, 1800 CY, 1.5 ton/CY, 2000 lb per ton	5,400,000.00	lbs	56.33	56.33	0.00	0.00	0.00	0.00	0.00	1488.49	0.00
RAC	Revegetation, seed	Fertilizer	Assume fertilizer, 47300 sy, 3 lb of seed per 1.2 msf	1,064.25	lbs	1.33	1.33	0.00	0.00	0.00	0.00	0.00	24.06	0.48
RAC	monitoring and LUC well heads	PVC	5 units, Assume PVC, 50 lb per unit	250.00	lbs	0.56	0.28	0.00	0.00	0.00	0.00	0.00	10.34	0.43
RAC	Pavement Replacement, stone base	Gravel	Assume 6 in, 1500 SF, assume stone, 1602 kg/m3	75,007.19	lbs	0.58	0.58	0.00	0.00	0.00	0.00	0.00	13.78	0.00
RAC	Pavement Replacement, bounder course	Gravel	Assume 2 in, 1500 SF, assume gravel/sand, 1522 kg/m3	23,753.84	lbs	0.18	0.18	0.00	0.00	0.00	0.00	0.00	4.37	0.00
RAC	Pavement Replacement, topping	Asphalt	Assume 2 in, 1500 SF, assume asphalt, 721 kg/m3	11,252.64	lbs	0.11	0.09	0.00	0.00	0.00	0.00	0.08	0.51	0.00
	Subtotal					**560.97**	**556.25**	**0.01**	**0.04**	**0.00**	**0.02**	**0.08**	**14636.62**	**4.08**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	brush chipper, 130 HP	WOOD CHIPPER	14 days, 8 hours per day, 80% utilization	25.60	hrs	1.11	1.11	0.00	0.00	0.01	0.00	0.00	4.89	
RAC	1 loader, 3CY	Loader, 155 HP, 3 CY (diesel)	14 days, 8 hours per day, 80% utilization	25.60	hrs	0.52	0.52	0.00	0.00	0.00	0.00	0.00	2.19	
RAC	2 chain saws, 36in long (gas)	Chainsaw, gasoline, 3<hp<=6, 2 stroke	14 days, 8 hours per day, 80% utilization	51.20	hrs	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.48	
RAC	Excavator, 2.5 CY	Excavator, Hydraulic, 2 CY (diesel)	40 days, 8 hours per day, 80% utilization	256.00	hrs	24.81	24.81	0.00	0.00	0.16	0.05	0.01	112.63	
RAC	Dozer, 300 hp	Dozer, 335 HP (D8) w/U Blade (diesel)	40 days, 8 hours per day, 80% utilization	256.00	hrs	46.29	46.29	0.00	0.00	0.34	0.09	0.03	225.26	
RAC	Compactor (roller 240 hp)	Roller, 100 HP (diesel)	40 days, 8 hours per day, 80% utilization	256.00	hrs	9.22	9.22	0.00	0.00	0.00	0.00	0.01		
RAC	Excavator, 2.5 CY	Excavator, Hydraulic, 2 CY (diesel)	15 days, 8 hours per day, 80% utilization	96.00	hrs	9.30	9.30	0.00	0.00	0.06	0.02	0.01	42.24	
RAC	Compactor (roller 240 hp)	Roller, 100 HP (diesel)	15 days, 8 hours per day, 80% utilization	96.00	hrs	3.46	3.46	0.00	0.00	0.00	0.00	0.00		
RAC	DPT drill	Drill Rig, DPT (diesel)	31 wells, 5 wells per day, 8 hours per day, 80% utilization	39.68	hrs	0.64	0.62	0.00	0.00	0.01	0.00	0.00	4.85	
RAC	Backhoe loader, 48 hp 5/8 CY	Loader, 65 HP, 1 CY (diesel)	47 days, 8 hours per day, 80% utilization	300.80	hrs	3.56	3.56	0.00	0.00	0.03	0.01	0.01	15.93	
RAC	Asphalt Paver, 130 hp	Paver, 100 HP (diesel)	1 day, 8 hours per day, 80% utilization	6.40	hrs	0.23	0.23	0.00	0.00	0.00	0.00	0.00	0.78	
RAC	1 Tandem Roller, 10 ton	Roller, 100 HP (diesel)	1 day, 8 hours per day, 80% utilization	6.40	hrs	0.23	0.23	0.00	0.00	0.00	0.00	0.00		
	Subtotal					**99.47**	**99.45**	**0.00**	**0.00**	**0.60**	**0.16**	**0.07**	**409.24**	**0**
				Total		**660**	**656**	**0.01**	**0.04**	**0.60**	**0.18**	**0.16**	**15,046**	**4**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
	Tonnes							MMBTU	gal
RI	-	-	-	-	-	-	-	-	-
RAC	660.44	655.70	3.83	0.91	0.60	0.18	0.16	51,336.47	4,077.70
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

APPENDIX D

BIOCHLOR CALCULATIONS

NATURAL ATTENUATION MODELING
INSTALLATION RESTORATION PROGRAM SITE 16 – FEASIBILITY STUDY
NCBC DAVISVILLE
NORTH KINGSTON, RHODE ISLAND

INTRODUCTION AND OBJECTIVE

The BIOCHLOR analytical solute transport model was used to perform screening level modeling at Site 16 NCBC Davisville in North Kingston, Rhode Island. The natural attenuation modeling was done to support the Site 16 Feasibility Study (FS) by evaluating natural attenuation based remedial alternatives, and alternatives with a combination of active treatment and natural attenuation. Scenarios for no active remediation (Alternatives G-1 and G-2) and source treatment (Alternatives G-3, G-4, G-5 and G-6) were evaluated in order to estimate the time frames to achieve remedial goals (MCLs) under the same remedial alternatives evaluated in the FS. For all source treatment alternatives evaluated, the scenarios do not include the time to reach the source treatment concentrations (scenarios assume immediate reductions to the stated concentrations).

MODEL DESCRIPTION, BACKGROUND AND APPROACH

BIOCHLOR, a Microsoft Excel-based spreadsheet model based on the Domenico analytical solute transport model, was developed by the Air Force Center for Environmental Excellence [AFCEE, 2002 (version 2.2)] Technology Transfer Division at Brooks Air Force Base. BIOCHLOR is a screening-level tool that has the ability to simulate 1-D advection, 3-D dispersion, linear adsorption, and biotransformation via reductive dechlorination. Reductive dechlorination is assumed to occur under anaerobic conditions and dissolved solvent degradation is assumed to follow a sequential first-order decay process. The analytical model predicts contaminant concentrations at various distances downgradient from the source area at user-selected time frames based on site-specific input parameters. Concentration trends with distance along the centerline of the plume for the selected time are developed for first order decay and instantaneous reaction models of contaminant degradation (reductive dechlorination), along with a no-degradation simulation for comparison purposes. The model also has the ability to estimate the lateral distribution of contamination and the remaining source mass and plume mass at user-selected times.

BIOCHLOR is utilized in order to investigate how far a dissolved chlorinated solvent plume will extend if no engineered controls or source area reduction measures are implemented. In other words, the model will predict the distance that the dissolved-phase chlorinated solvent plume will migrate under a given groundwater regime and specified natural attenuation parameters. Concentrations of both parent and daughter products are provided from the source area to plume edge. BIOCHLOR can also be utilized to determine how long it will take for dissolved-phase chlorinated solvents to reach concentrations below risk-based or other regulatory standards.

The results of these BIOCHLOR simulations are used to determine if MNA alone, or in conjunction with active remediation is a feasible remedial alternative based on the time period to reach remedial goals for each alternative.

SITE BACKGROUND AND MODEL APPLICATION

Details of the site background pertinent to a successful BIOCHLOR evaluation are provided in the Phase III Draft Final RI for Site 16, particularly Sections 3 and 4. This data will be outlined during the Model Setup section below.

Field work performed in 2010 to support the Site 16 Feasibility Study included collection of MNA data at key locations along several transport pathways identified at Site 16. This data was

summarized and "scored" through the Natural Attenuation Screening Protocol system (see Appendix B) and is spatially presented in Appendix E-1. In general, data across the various pathways shows that there is limited evidence of reductive dechlorination occurring. In a few areas, mostly in the North Central Area, there is adequate evidence of reductive dechlorination occurring. While using the "scoring" system is beneficial to semi-quantify the potential or occurrence of natural attenuation at a site, analysis of contaminant concentrations are also important. Most importantly is the presence or absence of daughter by-products and the relative ratios between the parent and daughter by-products. The "scoring" system showed that there is limited evidence of reductive dechlorination occurring based on the score of individual wells. The presence of low-level (generally less than 100 ug/L) and low ratio (generally less than 10% total combined mass) parent and daughter by-products (e.g. Trichloroethene and total-1,2-Dichloroethene) confirms that reductive dechlorination is occurring on an limited basis throughout the site.

Due to the complex nature of the coalesced CVOC plume present at Site 16 and the intent that this effort is a screening-evaluation, only the area surrounding former Building 41 was analyzed in this evaluation. Since the BTEX Hot Spot Area, North Central Area and Eastern Arm area are all located downgradient of the primary source areas, and additional sources exist at those areas (not at the Eastern Arm), calibration to site data would be very difficult if not impossible due to the these factors. Additionally, from a groundwater perspective, the most limited reductive dechlorination appears to be occurring at the former Building 41 area thereby making the screening-level results very conservative as compared to other areas where greater evidence of reductive dechlorination indicators such as daughter by-products occur.

As seen in the Phase III RI for Site 16, while over 10 years of groundwater data is available at the site, for most locations, only a few analytical results are available. Therefore, it is difficult to determine if trends observed in just a few samples are accurate and/or indicative of long term trends. To determine if short term trends (over a few years) are representative of long term trends (over a few decades), concentration versus time was evaluated for wells MW16-14D, -15D, -22D, -23D, -29D and -59D since all are along the primary groundwater transport pathway and downgradient from the presumed sources at the former Building 41. Data for these wells analyzed are provided in Appendix E-2. While downward trends appear at MW16-14D and -15D, no apparent trends occur at the remaining wells. Rather, it appears that groundwater concentrations for CVOC (Trichloroethene dominantly detected) fluctuate, likely with a seasonal effect. Therefore, calibration of the BIOCHLOR models will focus on long term trends.

The dates of releases are thought to be over a short period from 1951 to 1953 and they were certainly after NCBC was commissioned in 1940, as stated in the Phase III RI. However, the initial source concentrations to groundwater of each release are not known, nor are the exact dates or even number of releases. The highest CVOC concentrations are observed at MW16-77I and are 7,700 ug/L. Therefore, the initial release had to be greater than this concentration since it is located approximately 61.5 feet downgradient of the inferred release area (the former solvent recovery still) and is measured approximately 60 years later. To evaluate the natural attenuation occurring in the former Building 41 area, three assumed source concentrations were considered, 10 mg/L, 50 mg/L and 100 mg/L. It should not be concluded that these are the only possible source concentrations plausible; however, based on the lack of vertical contamination and general flow with the groundwater flow field (see Phase III RI for Site 16), it is likely that the release was no more than 10 to 20 percent (100 to 200 mg/L) as a higher concentration (DNAPL) source release should have migrated vertically downward with less impacts from groundwater flow.

For each of the three assumed source concentrations (10 mg/L, 50 mg/L and 100 mg/L), site-specific models were calibrated to 2004 and 2007 field data. These two time frames were selected as they represent the most comprehensive spatial coverage of the modeled area. Once calibration was complete, several scenarios were evaluated and include – no active remediation (Alternative G-1 and G-2), reduction of source area to 1 mg/L (Alternatives G-3, G-4 and G-5) and

reduction of source area to 0.5 mg/L (Alternative G-6).

MODEL SETUP

BIOCHLOR requires that the user input a number of site-specific and chemical-specific parameters. Some of the parameters are fixed inputs that do not vary and are specific to each base scenario (such as porosity and fraction of organic carbon), while other parameters are initially set up based on either site-specific data or validated reference values and are free to vary within a range (variance for each parameter is confined by reference values for similar sites) during the calibration process (such as hydraulic conductivity, hydraulic gradient, etc.). Definitions of all model input parameters, as well as representative reference values, are provided in the BIOCHLOR User's Manual. Appendix E-3 provides site- and chemical-specific input for Site 16.

The following are the input parameters used for each of the modeling runs and their source:

Hydrogeologic Data

- Hydraulic conductivity = Data from RI was used. Specifically, the geometric means of the hydraulic conductivity calculated in monitoring wells along the primary flowpath were used (see *field data for comparison* below), which is 4.48 feet/day (0.00158 cm/sec).

- Hydraulic gradient = 0.005391 ft/ft. Geometric mean of the November 2004, March 2007 and November 2007 gradients for the deep overburden zone (Table 3-6 of Phase III Draft RI).

- Porosity = 0.25. Source: Value is consistent with ranges based on lithology in published literature (Freeze and Cherry, 1973) and in BIOCHLOR and same as used in RI.

Based on these inputs, the seepage velocity was calculated by BIOCHLOR.

Dispersion Data

Dispersion is the process whereby a dissolved constituent will be spatially distributed longitudinally (along the direction of groundwater flow), transversely (perpendicular to groundwater flow) and vertically (generally downward) because of physical mixing and chemical diffusion. It is these processes that give a contaminant plume its size and shape. Vertical Dispersivity should not be confused with vertical migration due to advective flow.

Dispersivity values can range over 2-3 orders of magnitude for a given plume. A commonly accepted option to estimate values of dispersivity in each direction is to assume that longitudinal dispersivity is 10% of the current plume length as determined from site-specific plume maps. Transverse and vertical dispersivities are further assumed to be 10% of the horizontal dispersivity and nearly zero, respectively. BIOCHLOR also allows the user to estimate the longitudinal dispersivity based on a correlation equation by Xu and Exkstein, 1995 and Al-Suwaiyan, 1996 (see BIOCHLOR manual for complete reference).

- Longitudinal Dispersivity = 49.2 feet. Estimated from plume length of 1000 feet (from release area to Davisville Road) and estimated from *Gelhar et. al* of Figure A.3 of BIOCHLOR Appendix.

- Transverse Dispersivity was assumed to be 10% of the longitudinal dispersivity.

- Vertical Dispersivity was assumed to be nearly zero. A value of 1E-99 was used as a non-zero value is required in BIOCHLOR.

During the calibration process, the values for transverse dispersivity and vertical dispersivity remained fixed while longitudinal dispersivity was varied within the prescribed ranges until site-specific data was matched appropriately.

Adsorption Data

- Soil Bulk Density = 1.5908 grams/cubic centimeter. Based on geometric mean of geotechnical data collected at Site 16.

- Fraction Organic Carbon = 0.1209 %. Based on the geometric mean of foc data collected at Site 16 in the saturated zone south of Davisville Road.

- Retardation factor = 2.0 was assumed, based on RI data of partition coefficient values from the RI data set and calculated by BIOCHLOR based on soil bulk density and foc.

Biotransformation Data – First Order Decay Coefficient

- TCE to 1,2-DCE 0.05 to 0.9 $years^{-1}$. Based on ranges in various literature sources (primarily BIOCHLOR manual).

Only biotransformation from TCE to 1,2-DCE was included as there is only limited evidence of this occurring within the modeled area.

General Data – General Model Parameters

- Simulation time assumed to be 53 years for 2004 data and 56 years for 2007 data (source release assumed to be 1951).

- Model area width and Model area length was set to be slightly larger than the plumes width and length, consistent with RI data. It is approximately 1000 feet from the inferred release area to Davisville road (north of Davisville Road, gradient changes and much greater concentrations and ratios of parent and daughter by-products).

- Biotransformation zone was set to 1 zone. Site-specific data did not support the use of two zones since the environmental conditions (DO, ORP, etc.) did not change appreciably over the extent of the observed contaminant plume. BIOCHLOR automatically selects the zone length to be equal to the model area length.

For each model run, these general data input parameters were fixed.

Source Data

- Source Thickness in the Saturated Zone = 15 feet, consistent with the RI (see Section 4 of Phase III RI).

- Source area width was set to 50 feet, consistent with the RI (see Section 4 of Phase III RI).

- Source area concentration was based on three assumed values – 10, 50 and 100 mg/L.

- Source decay constant is a representative first order source decay constant for all chemical constituents and includes physical and chemical destruction mechanisms. It is not a biotransformation rate coefficient. The source decay constant rate is determined from site-specific data when available or during the calibration process.

Field Data for Comparison

The field data for comparison consists of observed concentrations along the centerline of the contaminant plume for the specific model run, at the endpoint of time for that model run. Data from 2004 and 2007 was used. A total of 11 groundwater monitoring wells were selected that occur along the primary flowpath of the modeled area (most have data in both data sets analyzed). The following summarizes the observation wells used in both base files, with distances form inferred source release: MW16-77I – 61.5 feet, MW16-85D – 92.3 feet, MW16-14D – 287.2 feet, INJ-12D – 311.4 feet, MW16-71D – 359.8 feet, MW16-15D – 413 feet, MW16-62D – 464.6 feet, MW16-60D – 534 feet, MW16-22D – 590.4 feet, MW16-59D – 635.9 feet, and MW16-23D – 889.0 feet.

Model Calibration

Natural attenuation modeling was performed where calibration was done with three assumed source concentrations (10, 50 and 100 mg/L) and two sets of field observations (2004 and 2007) to match to the various input parameters. The following summarizes the model calibration results. Calibration input and output are provided in Appendix E-4.

2004 Calibration Results

Fairly strong calibration results were obtained to all three assumed source concentrations with minimal deviations to various input parameters. A very solid calibration to field data was attained for the assumed source of 10 mg/L. However, to match the field data, the source decay term was essentially close to zero and no biotransformation within published ranges could be used. In effect, to calibrate to a 10 mg/L assumed source release requires a nearly constant source. For both the 50 and 100 mg/L assumed source releases, two sets of model calibration runs were produced – one that matches no degradation and one that matches with first order decay. In both sets of calibrations for each assumed source concentrations, the match to site data is reasonably strong. In order to get a no degradation scenario to fit site data, the seepage velocity was increased to 75 feet/year and 90 feet/year for the 50 and 100 mg/L inferred source concentrations, respectively. All other input parameters remained unchanged. While these rates are still within observed ranges, generally the fit of the data at downgradient locations was less precise, being over-estimated in the modeling results. On the contrary, the fit to site data was better when low-end levels of biotransformation were considered. Additionally, as the source increased (from 50 to 100 mg/L), the first order decay coefficient also increased to slightly above low-end literature values. And, increased seepage velocities were not needed, relying on all assumed geometric means for data input. Since low-level 1,2-DCE is observed in the site data and the calibration with inclusion of the low-end biotransformation term produces a stronger fit to observed site data, the calibration runs that contain this parameter is more accurate to site conditions.

Overall, it was found that using geometric means of site-specific data produce strong calibrations to both the 50 and 100 mg/L inferred source concentrations that contain low-end biotransformation rates. This is consistent with site data and observations. Since the calibration to 10 mg/L inferred source required essentially a constant source and since this is not occurring at the site, the 10 mg/L should be considered a worst case, ultra conservative scenario.

2007 Calibration Results

In general, the calibration results for the 2007 data set are very similar to the results from the 2004 data set. Most notably, calibration to the 10 mg/L inferred source also only fit 2007 site data when the source decay term is essentially zero and no biotransformation is occurring. Again as in the 2004 calibration, this is not likely to be representative and should only be considered as a worst case scenario. Also as observed in the 2004 calibration, the best fit to site data for 2007

occur when the inferred source area is either 50 or 100 mg/L and a low-end biotransformation term is used. In fact, the use of only the calibrated models with the low-end biotransformation term is better supported from this data set (2007) as even with higher seepage velocities, the match to site data in the no degradation scenarios are not well calibrated. In order to match the higher concentrations observed closer to the source area (MW16-77I and MW16-85D), this causes the remainder downgradient portions of the model predicted concentrations to be well above measured concentrations. On the contrary, when low-end biotransformation values (0.07 to 0.10 $year^{-1}$) are considered, the overall fit of the modeled concentrations to the measured data is quite strong. Compared to the 2004 calibration, the fit is less strong to the overall data (e.g. see 100 mg/L source with BIO for 2004 versus 2007), generally over-predicting some locations but fitting higher observed plume concentrations quite well.

Overall Calibration Results

Overall, it was found that using site-specific data input and three assumed source concentrations, site data could be very accurately reproduced by the BIOCHLOR model. When a source concentration of 10 mg/L is assumed, a nearly constant source with essentially no biotransformation is required to fit site data. Though likely not the best representative scenario for the site, it does provide a significantly conservative evaluation. The best match to site data occurs in both 2004 and 2007 data sets when a low-end biotransformation value is used with either a 50 or 100 mg/L inferred source concentration. While there are minor variations to the fit of the modeled to observed data, both source concentrations provide reasonable modeled scenarios for further consideration and evaluation.

Predictive Model Scenarios

Three predictive model scenarios were completed:

- one with no active remediation (Alternatives G-1 and G-2);
- one with a reduction of source concentration of TCE to 1,000 ug/L (Alternatives G-3, G-4 and G-5); and
- One with a reduction of source concentration of TCE to 500 ug/L (Alternative G-6).

Predictive model input and output are provided in Appendix E-4.

The remedial goal was to attain the MCL of 5 ug/L for TCE. Data input and output of BIOCHLOR results are attached for each of the three scenarios for both the 2004 and 2007 calibrated models. Only the final time-step is provided and only for parameters where field data observes the parameter to be present. The following table summarizes the predictive model scenario results:

Predictive Model Scenario	2004 Data 10 mg/L Source	2004 Data 50 mg/L Source	2004 Data 100 mg/L Source	2007 Data 10 mg/L Source	2007 Data 50 mg/L Source	2007 Data 100 mg/L Source
No Active Remediation Alternatives G-1 and G-2	443	118	93	1446	221	161
Reduction to 1 mg/L Alternatives G-3, G-4, G-5	350	100	80	1050	161	120
Reduction to 0.5 mg/L Alternative G-6	305	85	67	925	140	101

Note: All results are in years, adjusted as appropriate for the no active remediation scenarios (Model Time = Total time to reach MCL *minus* Start time of 1951 *plus* difference between calibration time and 2011). No adjustments to time were made for scenarios with Reduction though no it is assumed that reduction to respective concentrations is immediate (no time considered to reach these end-points from current conditions).

The summary table shows, while there is a broad range in years to reach the remedial goal of 5 ug/L for TCE for any particular remedial strategy, there is limited advantage gained by active remediation.

However, the predictive BIOCHLOR scenarios most likely over-estimate the time to reach the remedial goal when the TCE plume is reduced to either 1 or 0.5 mg/L. This over-estimation occurs due to the assumptions within the model. BIOCHLOR assumes the source to be a relatively small area (50 feet wide by 15 feet thick) and further assumes that the reductions in concentrations then migrates downgradient under the data input (site-specific geometric means). In reality, if these scenarios were to be enacted, the area effected by the source reduction would be much larger and it is also likely that biotransformation decay rates may increase for alternatives G-3 and G-4, even if only temporarily (no enhancement of biotransformation rates would be assumed for G-5 since it is just groundwater extraction and treatment above grade). Therefore, these numbers should be considered to be conservative for alternatives G-3, G-4 and G-6 and representative for alternative G-5.

Sensitivity Analysis – Source Area

A formal sensitivity analysis was not performed whereby various input parameters were modified in order to evaluate how impacts of ranges of data input effect model output. Rather, since the concentration of the source release(s) is not precisely known, additional assumed source concentrations were evaluated so as not to under-estimate remedial scenario time-frames. Potential large changes in the assumed source area would have greater implications to remedial scenario evaluations rather than simply varying input data over ranges (which would change remedial times, but not significantly).

For both the 2004 and 2007 field data, two additional source area concentrations were assumed, 200 mg/L and 500 mg/L. All other input parameters consistent with the calibration process for 2004 and 2007 remained unchanged. The input and output for the sensitivity analyses are included in Appendix E-4.

During calibration for both of the field data used and for both the 200 and 500 mg/L assumed sources, an important observation was made. This observation is that additional increases in assumed source concentration do not generally change the calibration and/or predictive scenarios timeframes. For example, changing the inferred source area concentration to 200 or 500 mg/L resulted in negligible calibration results to either the 2004 or 2007 field data. In effect, the higher assumed concentrations required a higher source decay term and slightly higher biotransformation term resulting in a balanced decay through distance that still produced a tight fit to observed data. However, ultimately, this resulted in higher concentrations of 1,2-DCE being produced from the model that are not measured at the site. Therefore, it is more likely that a source concentration was less than 200 mg/L in order to better match to observed site conditions.

The result (that source concentration does not affect the predictive scenarios) is consistent with the Phase III RI data, which supported a conclusion that source material (DNAPL) was not present. If DNAPL was present, the predictive calculations in BIOCHLOR would not be applicable until the source material was exhausted. This conclusion is also supported by the distribution of soil and groundwater contamination as presented in the Phase III RI (including the observation that soil contamination does not migrate vertically downward at the inferred release area as would be expected of DNAPL).

Discussion of BIOCHLOR Modeling Results

As can be seen from the modeling results, calibration was strong to site data using geometric means of site inputs. Even though a range of time periods to reach the remedial goals are produced, and values likely conservatively high, there is not much difference in predicted

remedial time frames when comparing no active remediation to active or aggressive source reduction strategies.

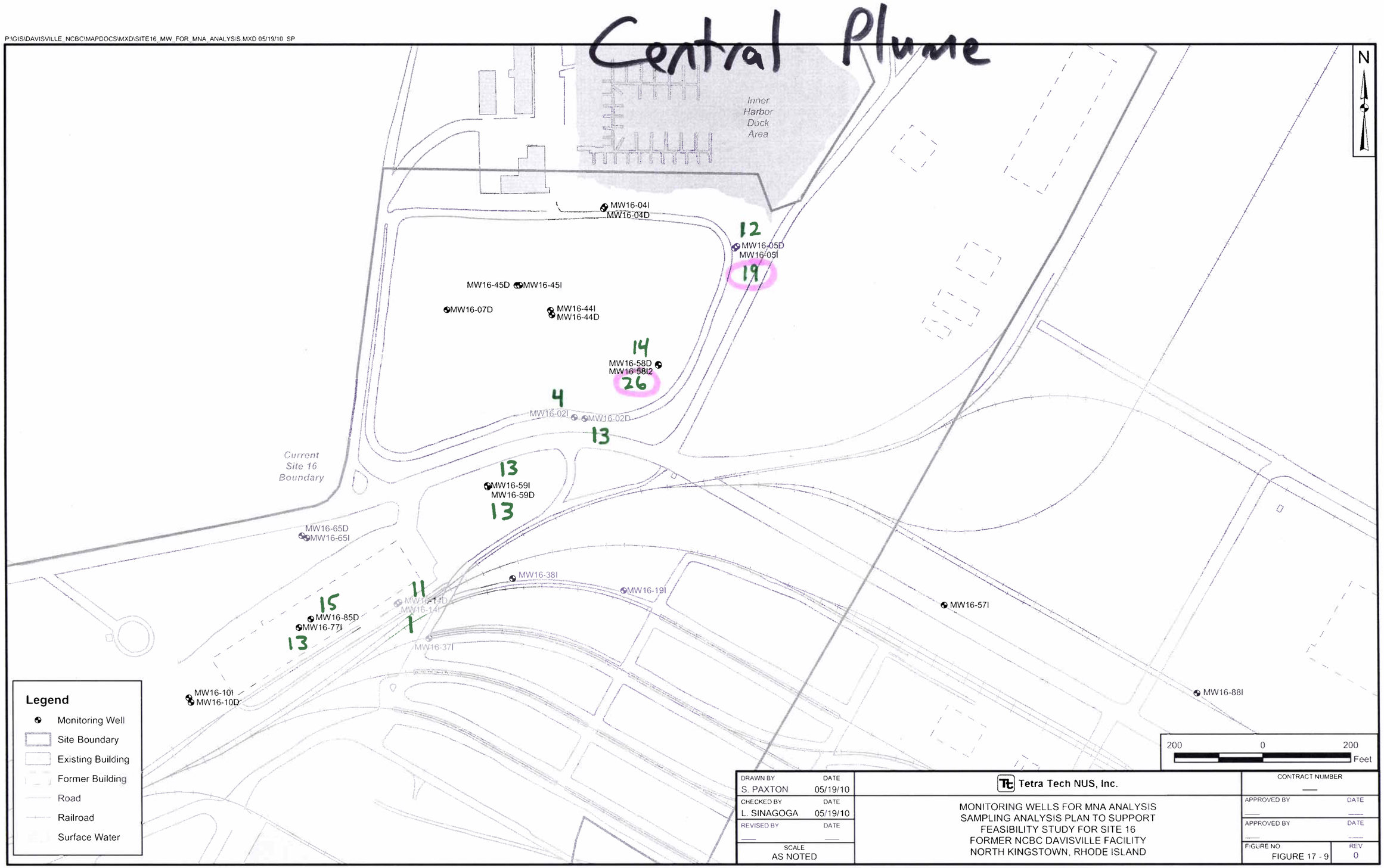
It should be emphasized that BIOCHLOR is a screening-level model and as such, the modeling results are estimates. The most significant data limitation for BIOCHLOR at this site is that the release concentrations are unknown. Additionally, while it was assumed that 1951 was the release date, there is no information to confirm this assumption, although the release date is certainly after 1940. These parameters affect both the model calculations and the actual rate of attenuation, and could either decrease or increase the time frames to reach remedial goals. This makes both source definition and distance-concentration trend determinations problematic. Because of these limitations, the modeling results are suitable for use as relative indicators of remedial timeframes more so than indicators of actual timeframes.

As outlined in the Phase III RI for Site 16, the subsurface geology is quite complex and plume is represented by multiple coalescing sources from an unknown number of discreet releases (both spatially and temporally). Local variations in TCE concentrations can be expected due to aquifer and vadose zone heterogeneities, historic contaminant release mechanisms/timing, co-contaminants that contribute organic carbon, and other factors.

Appendix E-1

MNA Spatial Analysis

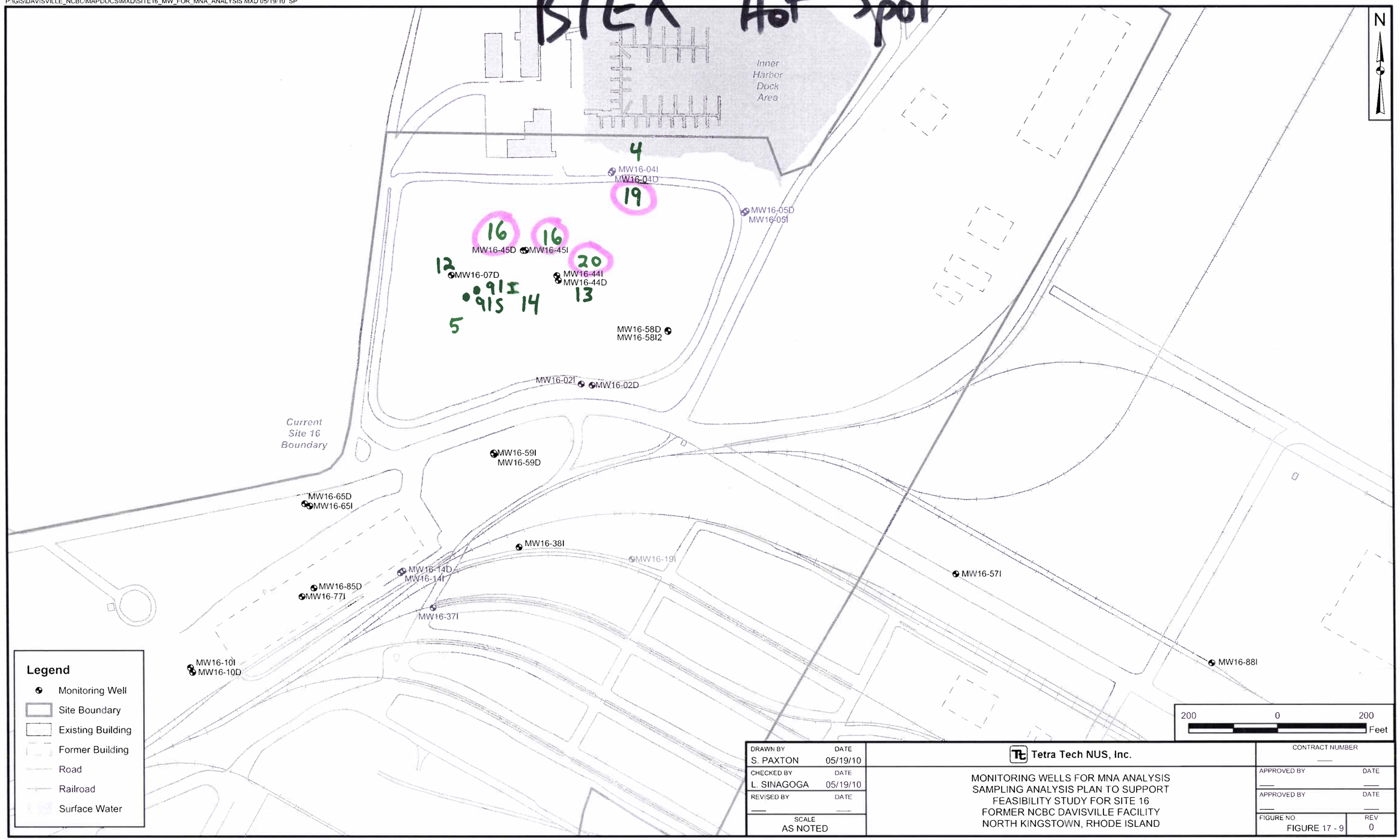
P:\GIS\DAVISVILLE_NCBC\MAPDOCS\MXD\SITE16_MW_FOR_MNA_ANALYS\S.MXD 05/19/10 SP



DRAWN BY S. PAXTON	DATE 05/19/10	Tetra Tech NUS, Inc.	CONTRACT NUMBER —
CHECKED BY L. SINAGOGA	DATE 05/19/10	MONITORING WELLS FOR MNA ANALYSIS SAMPLING ANALYSIS PLAN TO SUPPORT FEASIBILITY STUDY FOR SITE 16 FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	APPROVED BY — DATE —
REVISED BY —	DATE —		APPROVED BY — DATE —
SCALE AS NOTED			FIGURE NO FIGURE 17 - 9 / REV 0

P:\GIS\DAVISVILLE_NCBC\MAPDOCS\MXD\SITE16_MW_FOR_MNA_ANALYSIS.MXD 05/19/10 SP

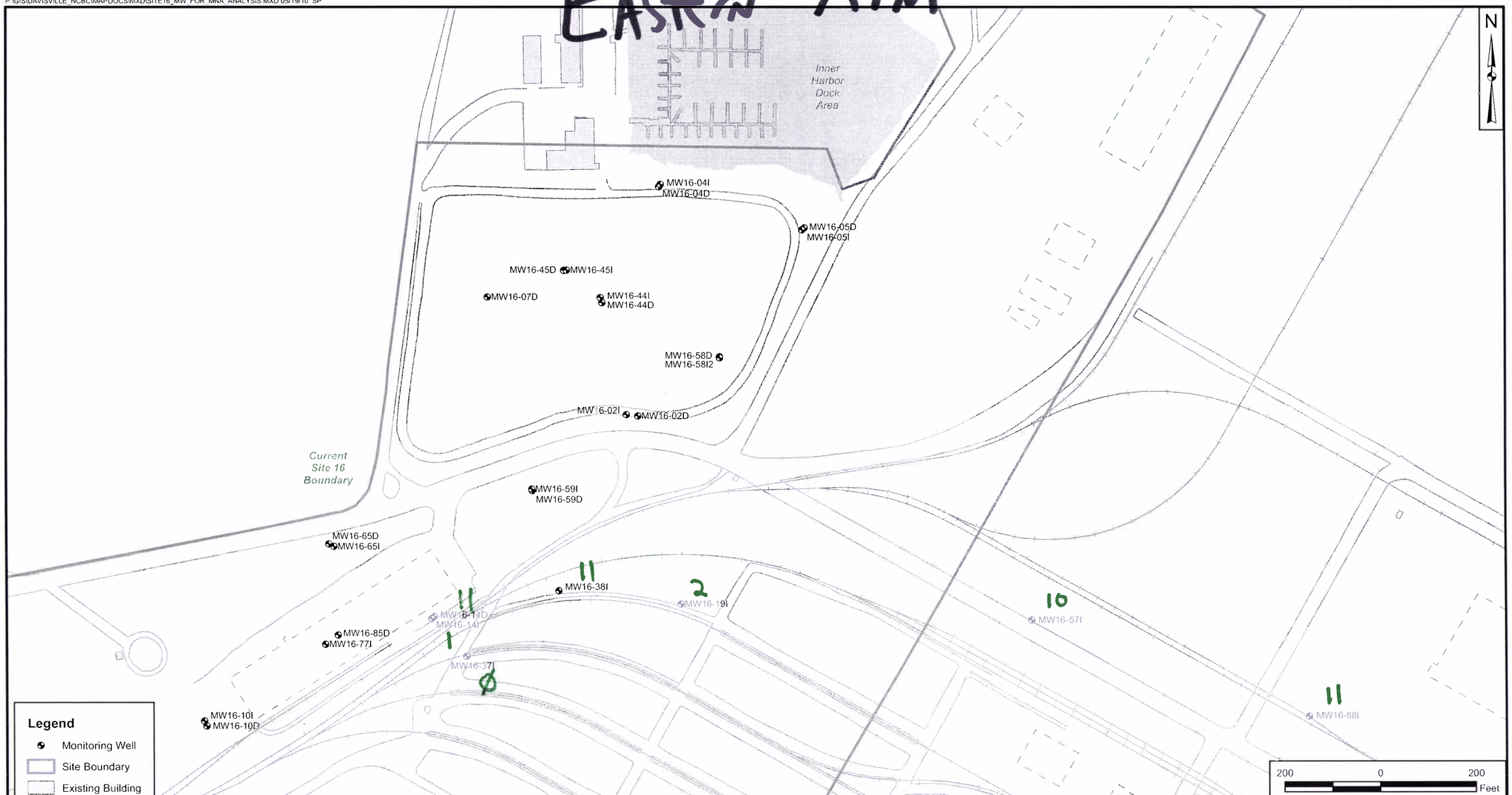
BTEX Hot Spot



DRAWN BY S. PAXTON	DATE 05/19/10	Tetra Tech NUS, Inc.	CONTRACT NUMBER —
CHECKED BY L. SINAGOGA	DATE 05/19/10	MONITORING WELLS FOR MNA ANALYSIS SAMPLING ANALYSIS PLAN TO SUPPORT FEASIBILITY STUDY FOR SITE 16 FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	APPROVED BY — DATE —
REVISED BY —	DATE —		APPROVED BY — DATE —
SCALE AS NOTED			FIGURE NO. FIGURE 17 - 9 / REV 0

P:\GIS\DAVISVILLE_NCBC\MAPDOCS\MXD\SITE16_MW_FOR_MNA_ANALYSIS.MXD 05/19/10 SP

Eastern Arm



DRAWN BY S. PAXTON	DATE 05/19/10	Tetra Tech NUS, Inc.	CONTRACT NUMBER —
CHECKED BY L. SINAGOGA	DATE 05/19/10	MONITORING WELLS FOR MNA ANALYSIS SAMPLING ANALYSIS PLAN TO SUPPORT FEASIBILITY STUDY FOR SITE 16 FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	APPROVED BY — DATE —
REVISED BY —	DATE —		APPROVED BY — DATE —
SCALE AS NOTED			FIGURE NO FIGURE 17 - 9 / REV 0

Appendix E-2

Select Site 16

Trend Analysis

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-13				MW16-14				MW16-15			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NORMAL	NORMAL
Shallow Overburden												
Tetrachloroethene											1 U	0.1 U
Trichloroethene											6.15	6.6
1,1-Dichloroethane											1 U	0.1 U
1,1-Dichloroethane, LV												
1,1-Dichloroethene												0.1 U
1,1-Dichloroethene, LV											0.1 U	
cis-1,2-Dichloroethene											1 U	0.53 U
trans-1,2-Dichloroethene											1 U	0.5 U
Total 1,2-Dichloroethene											1 U	
1,2-Dichloroethane												0.1 U
1,2-Dichloroethane, LV											0.1 U	
Vinyl Chloride												0.1 U
Vinyl Chloride, LV											0.1 U	
Chloroethane											1 U	0.9 U
Ethane											6.2 U	
Ethene											5.8 U	
Methane											3.3 U	

Well Node	MW16-13				MW16-14				MW16-15			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL	NS	NS	NS	NS	NS
Intermediate Overburden												
Tetrachloroethene		1.64	0.473 J	0.1 U		0.17 J	1 U					
Trichloroethene		5.28	9.15	13		26	10					
		1 U	1 U	0.1 U		1 U	1 U					
1,1-Dichloroethane, LV		0.1 U				0.1 U						
1,1-Dichloroethene				0.1 U								
1,1-Dichloroethene, LV		0.1 U	0.1 U			0.1 U	0.1 U					
cis-1,2-Dichloroethene		1 U	1 U	0.53 U		0.34 J	1 U					
trans-1,2-Dichloroethene		1 U	1 U	0.5 U		1 U	1 U					
Total 1,2-Dichloroethene		1 U	1 U			0.34	1 U					
1,2-Dichloroethane		1 U		0.1 U		1 U						
1,2-Dichloroethane, LV			0.1 U				0.1 U					
Vinyl Chloride				0.1 U								
Vinyl Chloride, LV		0.1 U	0.1 U			0.1 U	0.1 U					
Chloroethane		1 U	1 U	0.9 U		1 U	1 U					
Ethane		2 UJ	6.2 U			2 UJ	6.2 U					
Ethene		3 UJ	5.8 U			3 UJ	5.8 U					
Methane		1 UJ	3.3 U			1 UJ	1.6 J					

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Well Node	MW16-13				MW16-14				MW16-15			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL	NORMAL	NORMAL	AVG	NORMAL	NORMAL	NS
Deep Overburden												
Tetrachloroethene	1 U	1 U	1 U		1 U	0.3 J	50 U	0.52 U	0.7	0.67 J	1 U	
Trichloroethene	1 U	0.32 J	0.326 J		4900	3000 J	2000	2300	6300	2700 J	1400	
1,1-Dichloroethane	1 U	1 U	1 U		1 U	1 U	50 U	0.5 U	1 U	1 U	1 U	
1,1-Dichloroethane, LV		0.1 U				0.1 U				0.1 U		
1,1-Dichloroethene	1 U				1 U			1.5	0.85 J			
1,1-Dichloroethene, LV		0.1 U	0.1 UJ			0.5	0.137			0.1 U	0.442	
cis-1,2-Dichloroethene	2 U	0.23 J	1 U		5	1.87	50 U	1.6	3	2.18	2.19	
trans-1,2-Dichloroethene	2 U	1 U	1 U		2 U	0.27 J	50 U	0.5 U	0.7	0.25 J	0.275 J	
Total 1,2-Dichloroethene	2 U	0.23	1 U		5	2.14	50 U		3.35	2.43	2.47	
1,2-Dichloroethane	0.3	1 U			1 U	1 U		0.45 U	1 UJ	1 U		
1,2-Dichloroethane, LV			0.1 UJ				0.1 U				0.1 U	
Vinyl Chloride	2 U				2 U			0.51 U	2 UJ			
Vinyl Chloride, LV		0.1 U	0.1 UJ			0.1 U	0.1 U			0.1 U	0.0193 J	
Chloroethane	2 U	1 U	1 U		0.6	1 U	50 U	0.9 U	2 U	1 U	1 U	
Ethane		2 UJ	6.2 U			2 UJ	6.2 U			2 U	6.2 U	
Ethene		3 UJ	5.8 U			3 UJ	5.8 U			3 U	5.8 U	
Methane		92 J	210			1 UJ	3.3 U			1 U	3.3 U	

Well Node	MW16-13				MW16-14				MW16-15			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NORMAL	NS	NS	NORMAL	NORMAL	NORMAL	NORMAL	AVG	NS
Shallow Bedrock												
Tetrachloroethene				0.1 U			1 U	0.1 U	50 U	1 U	1 U	
Trichloroethene				0.1 U			0.85 J	4.4	4600	1300 J	705 J	
1,1-Dichloroethane				0.1 U			1 U	0.1 U	50 U	1 U	1 U	
1,1-Dichloroethane, LV										0.1		
1,1-Dichloroethene				0.1 U				0.1 U	50 U			
1,1-Dichloroethene, LV							0.1 U			1	0.8185 J	
cis-1,2-Dichloroethene				0.14 U			1 U	0.53 U	110	52 J	54.5	
trans-1,2-Dichloroethene				0.13 U			1 U	0.5 U	100 U	0.3 J	0.213 J	
Total 1,2-Dichloroethene							1 U		110	52.3	54.7	
1,2-Dichloroethane				0.1 U				0.1 U	50 U	1 U		
1,2-Dichloroethane, LV							0.1 U				0.0263 J	
Vinyl Chloride				0.1 U				0.1 U	100 U			
Vinyl Chloride, LV							0.1 U			0.4	0.2705	
Chloroethane				0.85 U			1 U	0.9 U	100 U	1 U	1 U	
Ethane							6.2 U			9.1	5.05 J	
Ethene							5.8 U			6.8	3.9 J	
Methane							3.3 U			1 U	835 J	

Well Node	MW16-13				MW16-14				MW16-15			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NORMAL	NORMAL	NS
Deep Bedrock												
Tetrachloroethene										1 U	1 U	
Trichloroethene										160 J	210	
1,1-Dichloroethane										1 U	1 U	
1,1-Dichloroethane, LV										0.06 J		
1,1-Dichloroethene												
1,1-Dichloroethene, LV										0.8	1.31	
cis-1,2-Dichloroethene										21	27	
trans-1,2-Dichloroethene										0.35 J	0.306 J	
Total 1,2-Dichloroethene										21.4	27.3	
1,2-Dichloroethane										1 U		
1,2-Dichloroethane, LV											0.1 U	
Vinyl Chloride												
Vinyl Chloride, LV										0.1 U	0.19	
Chloroethane										1 U	1 U	
Ethane										2 U	6.2 U	
Ethene										3 U	5.8 U	
Methane										1 U	3.3 U	

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-22			MW16-23				MW16-24		MW16-25			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NORMAL	NORMAL	NS	NS	NS	NS	NORMAL	NORMAL
Shallow Overburden													
Tetrachloroethene						1 U	0.4					1 U	0.1 UJ
Trichloroethene						31	30					2.9	1.5 J
1,1-Dichloroethane						1 U	0.1 U					1 U	0.1 UJ
1,1-Dichloroethane, LV													
1,1-Dichloroethene							0.1 U						0.1 UJ
1,1-Dichloroethene, LV						0.1 U						0.1 U	
cis-1,2-Dichloroethene						0.61 J	0.53 U					0.233 J	0.53 U
trans-1,2-Dichloroethene						1 U	0.5 U					1 U	0.5 U
Total 1,2-Dichloroethene						0.61 J						0.233 J	
1,2-Dichloroethane							0.1 U						0.1 UJ
1,2-Dichloroethane, LV						0.1 U						0.1 U	
Vinyl Chloride							0.1 U						0.1 UJ
Vinyl Chloride, LV						0.1 U						0.1 U	
Chloroethane						1 U	0.9 U					1 U	0.9 U
Ethane						6.2 U						6.2 U	
Ethene						5.8 U						5.8 U	
Methane						5.3 U						3.3 U	

Well Node	MW16-22			MW16-23				MW16-24		MW16-25			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8		Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NORMAL	NORMAL	NS	NS	NS		NORMAL	AVG	NS	NORMAL	NORMAL	NORMAL
Intermediate Overburden													
Tetrachloroethene		1.28	0.905 J					0.11 J	1 U		1 UJ	5 U	0.4 UJ
Trichloroethene		190	110					41	35		220 J	120	85
		1 U	1 U					1 U	1 U		1 UJ	5 U	0.4 UJ
1,1-Dichloroethane, LV		0.1 U						0.1 U			0.1 U		
1,1-Dichloroethene		1 U											0.4 UJ
1,1-Dichloroethene, LV		0.1 U	0.0168 J					0.1 U	0.1425		0.07 J	0.0326 J	
cis-1,2-Dichloroethene			0.681 J					0.63 J	1.54		1.11 J	5 U	0.53 U
trans-1,2-Dichloroethene			1 U					1 U	1 U		1 UJ	5 U	0.5 U
Total 1,2-Dichloroethene		2 U	0.681 J					0.63	1.54		1.11	5 U	
1,2-Dichloroethane		1 U						1 U			1 U		0.4 UJ
1,2-Dichloroethane, LV			0.1 U						0.1 U			0.1 U	
Vinyl Chloride													0.4 UJ
Vinyl Chloride, LV		0.1 U	0.1 U					0.1 U	0.1 U		0.1 U	0.1 U	
Chloroethane		1 U	1 U					1 U	1 U		1 UJ	5 U	0.9 U
Ethane		2 UJ	6.2 U					2 U	6.2 U		2 U	6.2 U	
Ethene		3 UJ	5.8 U					3 U	5.8 U		3 U	5.8 U	
Methane		1 UJ	1.2 J					1 U	1.2 J		1 U	3.3 U	

Well Node	MW16-22			MW16-23				MW16-24		MW16-25			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL	NORMAL	NORMAL	AVG	NORMAL
Deep Overburden													
Tetrachloroethene	1 U	0.29 J	1 U	1 U	20 U	1 U		1 U	1 U	0.5	1 UJ	0.3825 J	2.2 U
Trichloroethene	2600	920	1500	3500	500	1900		520	690	890	470 J	415	530
1,1-Dichloroethane	1 U	1 U	1 U	1 U	20 U	1 U		1 U	1 U	0.4 J	1 UJ	0.136 J	2 UJ
1,1-Dichloroethane, LV		0.1			0.1 U			0.2			0.2		
1,1-Dichloroethene	1	1 U		0.5	20 U					0.7			2 UJ
1,1-Dichloroethene, LV		1	0.422		0.4	0.844		14	0.624		0.3	0.0257 J	
cis-1,2-Dichloroethene	10		2.39	4		25		48	11	2	1 UJ	0.2285 J	2.7 U
trans-1,2-Dichloroethene	0.6		0.38 J	2 U		0.48 J		0.66 J	0.367 J	2 UJ	1 UJ	1 U	2.5 U
Total 1,2-Dichloroethene	10.6	2 U	2.77	4	40 U	25.5		48.7	11.4	2	1 U	0.229 J	
1,2-Dichloroethane	1 UJ	1 U		1 U	20 U			1 U		0.4	1 U		2 UJ
1,2-Dichloroethane, LV			0.1 U			0.1 U			0.0933 J			0.1 U	
Vinyl Chloride	2 U			2 U						2 UJ			2 UJ
Vinyl Chloride, LV		0.05 J	0.0273 J		0.05 J	0.0918 J		22	7.87		0.1 U	0.1 U	
Chloroethane	2 U	1 U	1 U	2 U	20 U	1 U		1 U	1 U	2 U	1 UJ	1 U	4.5 U
Ethane		2 UJ	6.2 U		2 UJ	6.2 U		2 U	6.2 U		2 U	6.2 U	
Ethene		3 UJ	5.8 U		3 UJ	5.8 U		3 U	5.8 U		3 U	5.8 U	
Methane		1 UJ	1 J		24 J	6.6 J		1 U	6.9		1 U	1.1 J	

Well Node	MW16-22			MW16-23				MW16-24		MW16-25			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	AVG	NORMAL	NORMAL	NORMAL
Shallow Bedrock													
Tetrachloroethene										1 U	1 UJ	1 U	0.1 U
Trichloroethene										1 U	1.08 J	0.445 J	0.12
1,1-Dichloroethane										1 U	1 UJ	0.285 J	0.29
1,1-Dichloroethane, LV											0.4		
1,1-Dichloroethene										1 U			0.1 U
1,1-Dichloroethene, LV											0.1 U	0.1 U	
cis-1,2-Dichloroethene										2 U	1 UJ	1 U	0.53 U
trans-1,2-Dichloroethene										2 U	1 UJ	1 U	0.5 U
Total 1,2-Dichloroethene										2 U	1 U	1 U	
1,2-Dichloroethane										1 UJ	1 U		0.1 U
1,2-Dichloroethane, LV												0.1 U	
Vinyl Chloride										2 U			0.1 U
Vinyl Chloride, LV											0.1 U	0.1 U	
Chloroethane										2 U	1 UJ	1 U	0.9 U
Ethane											2 U	6.2 U	
Ethene											3 U	5.8 U	
Methane											1 U	26	

Well Node	MW16-22			MW16-23				MW16-24		MW16-25			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock													
Tetrachloroethene													
Trichloroethene													
1,1-Dichloroethane													
1,1-Dichloroethane, LV													
1,1-Dichloroethene													
1,1-Dichloroethene, LV													
cis-1,2-Dichloroethene													
trans-1,2-Dichloroethene													
Total 1,2-Dichloroethene													
1,2-Dichloroethane													
1,2-Dichloroethane, LV													
Vinyl Chloride													
Vinyl Chloride, LV													
Chloroethane													
Ethane													
Ethene													
Methane													

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-29			MW16-30			MW16-31			MW16-32		
Investigation	Round 5	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Shallow Overburden												
Tetrachloroethene												
Trichloroethene												
1,1-Dichloroethane												
1,1-Dichloroethane, LV												
1,1-Dichloroethene												
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene												
trans-1,2-Dichloroethene												
Total 1,2-Dichloroethene												
1,2-Dichloroethane												
1,2-Dichloroethane, LV												
Vinyl Chloride												
Vinyl Chloride, LV												
Chloroethane												
Ethane												
Ethene												
Methane												

Well Node	MW16-29			MW16-30			MW16-31			MW16-32		
Investigation	Round 5	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Intermediate Overburden												
Tetrachloroethene												
Trichloroethene												
1,1-Dichloroethane, LV												
1,1-Dichloroethene												
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene												
trans-1,2-Dichloroethene												
Total 1,2-Dichloroethene												
1,2-Dichloroethane												
1,2-Dichloroethane, LV												
Vinyl Chloride												
Vinyl Chloride, LV												
Chloroethane												
Ethane												
Ethene												
Methane												

Well Node	MW16-29			MW16-30			MW16-31			MW16-32		
Investigation	Round 5	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Deep Overburden												
Tetrachloroethene	1 UJ	1 U	1 U	1 U	1 U	0.1 U	0.14 J	1 U	0.4 UJ	0.61 J	10 U	0.52 U
Trichloroethene	2700	1200	2900	0.38 J	1 U	0.1 U	210	150	100	2700	290	260
1,1-Dichloroethane	1 UJ	1 U	1 U	1 U	1 U	0.1 U	1 U	1 U	0.4 UJ	1 U	10 U	0.5 U
1,1-Dichloroethane, LV		0.1 U		0.1 U			0.1 U			0.09 J		
1,1-Dichloroethene	3 UJ			1 U		0.1 U			0.4 UJ			0.76 U
1,1-Dichloroethene, LV		4	1.17	0.1 U	0.1 U		0.1	0.197		2	0.479	
cis-1,2-Dichloroethene	52 J	61	35		1 U	0.53 U	0.82 J	1 U	0.53 U	7.03	10 U	0.53 U
trans-1,2-Dichloroethene	3 J	2.03	2.02		1 U	0.5 U	0.13 J	0.143 J	0.5 U	1.81	10 U	0.5 U
Total 1,2-Dichloroethene	55	63	37	2 U	1 U		0.95	0.143 J		8.84	10 U	
1,2-Dichloroethane	1 UJ	1 U		1 U		0.1 U	1 U		0.4 UJ	1 U		0.45 U
1,2-Dichloroethane, LV			0.1 U		0.1 U			0.1 U			0.1 U	
Vinyl Chloride	2 J					0.1 U			0.4 UJ			0.51 U
Vinyl Chloride, LV		1	0.515	0.1 U	0.0717 J		0.1 U	0.111		0.1 U	0.023 J	
Chloroethane	2 UJ	1 U	1 U	1 U	1 U	0.9 U	1 U	1 U	0.9 U	1 U	10 U	0.9 U
Ethane		2 U	6.2 U	2 UJ	6.2 U		2 UJ	6.2 U		2 UJ	1.3 J	
Ethene		3 U	5.8 U	3 UJ	5.8 U		3 UJ	5.8 U		3 UJ	5.8 U	
Methane		410 J	3000	1.5 J	110		1 UJ	3.3 U		1 UJ	1.7 U	

Well Node	MW16-29			MW16-30			MW16-31			MW16-32		
Investigation	Round 5	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NORMAL	NORMAL
Shallow Bedrock												
Tetrachloroethene											5 U	0.52 U
Trichloroethene											110	52 J
1,1-Dichloroethane											5 U	0.5 U
1,1-Dichloroethane, LV												
1,1-Dichloroethene												0.76 U
1,1-Dichloroethene, LV											0.12	
cis-1,2-Dichloroethene											5 U	0.53 U
trans-1,2-Dichloroethene											5 U	0.5 U
Total 1,2-Dichloroethene											5 U	
1,2-Dichloroethane												0.45 U
1,2-Dichloroethane, LV											0.1 U	
Vinyl Chloride												0.51 U
Vinyl Chloride, LV											0.1 U	
Chloroethane											5 U	0.9 U
Ethane											1 J	
Ethene											5.8 U	
Methane											3.3 U	

Well Node	MW16-29			MW16-30			MW16-31			MW16-32		
Investigation	Round 5	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock												
Tetrachloroethene												
Trichloroethene												
1,1-Dichloroethane												
1,1-Dichloroethane, LV												
1,1-Dichloroethene												
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene												
trans-1,2-Dichloroethene												
Total 1,2-Dichloroethene												
1,2-Dichloroethane												
1,2-Dichloroethane, LV												
Vinyl Chloride												
Vinyl Chloride, LV												
Chloroethane												
Ethane												
Ethene												
Methane												

Appendix E-3

Summary of BIOCHLOR Model Input parameters

A former fire fighting training area (FFTA) was reportedly located in an asphalt-paved area east of the former Creosote Dip Tank Area (Figure 1-2). Reportedly, structures were constructed, doused with flammable materials, set on fire, and extinguished as part of fire fighting training exercises during the late 1960s. Based on the results of related EBS investigations, study of the former FFTA continued into the Phase I and II RI and during environmental investigations conducted in 2004. Based on the groundwater data collected to date, one or more groundwater contaminant source areas may exist in the area east of the "expanded" Creosote Dip Tank Area, which includes the location of the suspected former FFTA. A portion of this area is also downgradient of suspected source areas in the general vicinity of Building 41 located to the southwest. As detailed in Section 2, this area was also extensively investigated during the Phase III RI.

During the EBS investigations, the reported underground storage tank (UST) located near the southeastern corner of Building E-107 was identified as two septic tanks (buried and interconnected pontoon tanks). They were excavated and removed along with the related total petroleum hydrocarbon (TPH)-impacted soil. NFA was recommended in the closure report prepared by Foster Wheeler Environmental Corporation (FWENC) for the septic tanks (May 1998). However, as detailed in Section 4, two test pits excavated in this area during the Phase III RI revealed subsurface debris (e.g., charred wood) and the analytical results for soil samples collected from this area suggest that residual polynuclear aromatic hydrocarbon (PAH) contamination remains in this area.

1.4.2 EBS Review Item 29 - Former Building 41

As stated in the Phase II EBS (EA, February 1998), Building 41 was a preservation and packing shop and a construction equipment and automotive parts storage building (Figure 1-5). Preservation and degreasing operations occurred within the building. Because Building 41 was demolished and the area paved by RIEDC during October 2002, the following descriptions are based on available information and observations prior to the demolition activity. Based on past activities, it is likely that petroleum products and solvents were used and stored within Building 41.

The preservation tanks used within Building 41 were remediated under the Navy's UST program. Stained asphalt floors observed during the Phase II EBS were not considered to be of concern during the EBS based on the limited extent of the staining, sorptive ability of asphalt, and lack of a direct pathway for exposure of humans or ecological receptors to associated contaminants (e.g., spill runoff from the concrete to a foundation wall or soil). No floor drains were located in Building 41. The floor staining was considered to be consistent with the previous use of the building as an equipment preservation and packing shop and for parts storage. Consequently, the Davisville BRAC Cleanup Team (BCT) recommended NFA following a review of available Phase II EBS information and site visits conducted by the BCT, Town of North Kingstown personnel, and RIEDC representatives in September and October

1995. No field activities were conducted and no samples were collected during the EBS and EBS follow-on activities for this Review Item based on the BCT recommendation for NFA. Parcel 8 was transferred to QDC in 1998 without any CERCLA remedies.

Subsequent to the EBS, however, discussions occurred with a Seabee veteran (November 2000), who worked in Building 41 from 1951 to 1953, to improve the Navy's understanding of the historical use of the building. Additionally, Navy representatives accompanied the Seabee veteran on a visit to the building in February 2001. According to this veteran, rust removal (using heated manganesed phosphoric acid or Phospholene), metal preservation (using Cosmolene, particularly for Quonset Huts), and degreasing (using chlorinated solvent, including a solvent recovery still) operations in Building 41 may have begun and ended between 1951 and 1953. Waste solvent and sludge from the solvent recovery still were reportedly transported in drums to the Allen Harbor Landfill for disposal. After 1953, the preservation and degreasing operations were reportedly moved south to Building E-319.

By all accounts, Building 41 was divided into three sections as shown on Figure 1-5, which illustrates the Navy's current understanding of the historical use of the building from 1951 to 1953. Figure 1-5 is based on the Phase I RI discussions referenced in the preceding paragraph and on historical floor plan drawings obtained from RIEDC. The following summarizes activities that reportedly occurred in the three sections of the building:

- The northeastern one-third (bay) of the building was reportedly used for packing and storage of parts for shipment. The area was observed on February 15, 2001, to be a large room with a high ceiling and was generally empty, except for piles of salted sand stored by RIEDC in part of the southwestern portion. This area would not typically be expected to be a significant chemical contaminant release area.

- The middle one-third of the building was used for at least two different processes. Quonset Huts were dipped into a large, partially in-ground tank(s) of Cosmolene (a grease used to prevent rusting of metallic surfaces) for preservation. The Cosmolene dipping appears to have involved a group of four tanks (Tanks 41-1 through 41-4) located in the northeastern section of the middle one-third of the building. This northeastern area was observed in February 2001 to be a large room with a high ceiling and was generally empty. Historically, rust was stripped from metal parts in an aboveground tank of Phospholene (manganesed phosphoric acid) located in the southwestern portion of the middle one-third of the building. This tank (Tank 41-5) was reportedly above floor grade. Based on a related Tank Closure Assessment Report by HRP Associates, Inc. (March 1995), Tank 41-5 was a rectangular, open-top, steel tank located along the eastern wall of the former restrooms area. An area of etching on the concrete floor surface, observed on February 15, 2001, may be evidence of its

SUMMARY OF SLUG TEST RESULTS
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Location	Falling Head K Value (ft/day)	Rising Head K Value (ft/day)
MW16-77I	1.80	1.69
MW16-77I	1.42	1.42
MW16-14D	1.99	1.39
MW16-15D	8.52	6.70
MW16-22D	31.73	38.38
MW16-23D	2.39	1.92
MW16-59D	2.40	2.75
MW16-60D	14.30	17.49
MW16-62D	9.95	12.16
MW16-71D	6.88	6.93
MW16-85D	1.41	1.57
INJ16-12D	7.08	5.19
Minimum		**1.39**
Maximum		**38.38**
Average		**7.81**
Geometric Mean		**4.48**

Gradients	0.004916	
	0.006192	
	0.005146	
	0.005418	Average
	0.005391	Geometric Mean

$$\frac{4.48\ ft}{day} \times \frac{1\ day}{86400\ sec} \times \frac{30.48\ cm}{1\ ft} = \frac{136.5504}{86400}\ cm/sec$$

$$= 0.00158\ cm/sec$$

$$1.58 \times 10^{-3}\ cm/sec$$

TABLE 3-6

SUMMARY OF HORIZONTAL HYDRAULIC GRADIENTS
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Pathway	Zone	November 2004	May 2007	November 2007
West of former Building 224 to Vicinity of Davisville Road	Shallow Overburden		0.004211	0.002584
	Intermediate Overburden			
	Deep Overburden	0.003086	0.004932	0.002481
	Shallow Bedrock		0.004566	0.002066
Vicinity of Davisville Road to area between/near Building 39 and/or former Building 41	Shallow Overburden		0.001932	0.001570
	Intermediate Overburden			
	Deep Overburden	0.001182	0.001109	0.001571
	Shallow Bedrock		0.001157	0.001527
Area between/near Building 39 and/or former Building 41 to Davisville Road area south of North Central Area	Shallow Overburden	0.006173	0.006667	0.005656
	Intermediate Overburden	0.006633	0.005882	0.005345
	Deep Overburden	0.004916	0.006192	0.005146
	Shallow Bedrock	0.004566	0.005952	0.005066
Davisville Road south of NC Area to Allen Harbor	Shallow Overburden	0.01905	0.02273	0.01031
	Intermediate Overburden	0.01389	0.01923	0.01111
	Deep Overburden	0.01073	0.02160	0.00808
	Shallow Bedrock	0.01220	0.01543	0.00769
South of former Building 41 to Narragansett Bay/West of Sea Freeze Building (eastern most portion of Site 16)	Shallow Overburden			
	Intermediate Overburden	0.006944	0.008264	0.005121
	Deep Overburden	0.007669	0.008499	0.004968
	Shallow Bedrock			0.005886

Notes:

All values expressed in feet/feet.
Hydraulic gradient not calculated in null fields due to insignificant data coverage.

TABLE 3-8

SUMMARY OF SLUG TEST RESULTS
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 1 OF 6

Well Location	Falling Head K Value (ft/day)	Rising Head K Value (ft/day)
Shallow (S) Overburden Zone		
MW16-03S	15.16	13.61
MW16-04S	22.50	9.72
MW16-05S	9.90	29.75
MW16-06S	20.11	
MW16-08S	29.07	46.32
MW16-11S		26.41
MW16-12S	55.04	98.49
MW16-15S		17.22
MW16-17S	1.53	4.05
MW16-23S	10.73	13.29
MW16-25S		122.20
MW16-35S		3.99
MW16-40S		22.53
MW16-41S		16.94
MW16-42S		21.61
MW16-43S	4.99	7.78
MW16-44S	1.23	5.50
MW16-45S	0.99	1.98
MW16-53S		8.45
MW16-58S	16.26	25.42
MW16-59S	29.05	48.57
MW16-65S	2.79	1.96
MW16-66S	6.81	7.53
MW16-67S		45.13
MW16-68S	24.13	40.06
MW16-69S		10.15
MW16-70S		31.33
MW16-71S		14.80
MW16-78S	7.84	6.05
MW16-78S	7.04	10.04
Minimum		**0.99**
Maximum		**122.20**
Average		**20.77**
Geometric Mean		**12.28**
Intermediate (I) Overburden Zone		
MW16-02I	1.20	1.35
MW16-04I	1.24	1.54
MW16-05I	21.78	28.30
MW16-10I	3.31	3.74
MW16-13I	3.69	3.82
MW16-14I	1.48	1.60
MW16-16I	0.79	1.02
MW16-17I	1.27	0.90
MW16-18I	6.01	7.32

TABLE 3-8

SUMMARY OF SLUG TEST RESULTS
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 2 OF 6

Well Location	Falling Head K Value (ft/day)	Rising Head K Value (ft/day)
MW16-19I	4.61	4.50
MW16-21I	1.46	2.20
MW16-22I	0.85	0.78
MW16-24I	1.44	1.10
MW16-24I	2.32	
MW16-24I	1.20	
MW16-25I	1.38	1.57
MW16-27I	4.01	4.13
MW16-28I	7.80	9.90
MW16-33I	1.77	1.81
MW16-34I	3.68	4.15
MW16-35I	3.30	2.37
MW16-37I	1.88	1.97
MW16-38I	1.74	1.66
MW16-39I	4.60	4.44
MW16-40I	2.37	2.42
MW16-41I	2.71	2.22
MW16-42I	1.04	1.28
MW16-43I	4.08	3.98
MW16-43I	2.96	
MW16-43I	4.07	
MW16-44I	2.23	2.21
MW16-45I	4.61	4.42
MW16-46I	4.09	7.80
MW16-49I	4.07	4.25
MW16-50I	1.48	1.50
MW16-55I	3.07	1.73
MW16-56I	3.34	2.79
MW16-57I	2.58	3.05
MW16-58I1	1.45	1.76
MW16-58I2	3.38	3.37
MW16-59I	0.63	0.68
MW16-61I	3.88	3.56
MW16-62I	3.37	3.64
MW16-63I	8.81	8.52
MW16-64I	0.66	0.62
MW16-65I	1.37	1.28
MW16-66I	0.84	0.86
MW16-67I	0.13	0.67
MW16-68I	3.74	2.72
MW16-69I	5.79	6.18
MW16-70I	2.38	2.14
MW16-71I	1.30	1.31
MW16-76I	3.18	3.91
MW16-76I	3.98	4.21
MW16-77I	1.80	1.69
MW16-77I	1.42	1.42
MW16-79I	1.79	1.10

TABLE 3-8

SUMMARY OF SLUG TEST RESULTS
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 3 OF 6

Well Location	Falling Head K Value (ft/day)	Rising Head K Value (ft/day)
MW16-79I	0.69	0.72
MW16-87I	2.38	3.58
MW16-87I	4.89	7.22
MW16-88I	0.79	1.32
MW16-88I	1.41	2.23
MW16-89I	3.06	5.22
Minimum		**0.13**
Maximum		**28.30**
Average		**3.17**
Geometric Mean		**2.31**

Deep (D) Overburden Zone		
MW16-01D	2.76	2.78
MW16-01D	2.58	1.87
MW16-01D	2.18	
MW16-02D	32.27	28.91
MW16-02D	32.42	
MW16-04D	15.19	12.59
MW16-05D	22.11	15.99
MW16-06D	44.74	22.13
MW16-07D	4.31	7.73
MW16-07D	4.63	4.38
MW16-08D	48.69	45.33
MW16-09D	1.34	1.16
MW16-09D	1.09	1.18
MW16-10D	1.16	0.71
MW16-11D	2.77	2.19
MW16-12D	10.68	6.89
MW16-13D	2.73	2.56
MW16-14D	1.99	1.39
MW16-15D	8.52	6.70
MW16-16D	12.84	8.01
MW16-16D	7.19	
MW16-17D	1.80	1.15
MW16-18D	1.08	0.52
MW16-19D	84.54	156.40
MW16-20D	0.33	0.37
MW16-21D	4.48	1.98
MW16-22D	31.73	38.38
MW16-23D	2.39	1.92
MW16-24D	3.20	2.54
MW16-25D	2.14	1.84
MW16-26D	0.91	0.60
MW16-27D	23.50	19.71
MW16-28D	4.16	3.94
MW16-29D	2.99	3.09
MW16-31D	1.46	1.41

TABLE 3-8

SUMMARY OF SLUG TEST RESULTS
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 4 OF 6

Well Location	Falling Head K Value (ft/day)	Rising Head K Value (ft/day)
MW16-32D	0.01	
MW16-32D	0.02	0.07
MW16-33D	2.52	2.55
MW16-34D	30.62	56.35
MW16-35D	1.59	1.44
MW16-36D	38.92	34.30
MW16-37D	16.45	24.16
MW16-40D	5.38	5.34
MW16-41D	3.35	2.84
MW16-42D	1.12	1.61
MW16-43D	2.65	2.99
MW16-43D	2.40	2.26
MW16-44D	1.04	1.08
MW16-45D	0.71	0.57
MW16-45D	1.61	
MW16-45D	0.69	
MW16-46D	1.22	0.87
MW16-46D	0.87	
MW16-47D	2.01	1.44
MW16-49D	0.97	1.09
MW16-50D	1.53	
MW16-51D	5.01	4.40
MW16-52D	30.57	78.26
MW16-54D	3.55	2.28
MW16-54D		1.30
MW16-55D	1.26	1.13
MW16-56D	2.44	2.48
MW16-57D	6.26	6.84
MW16-58D	12.76	12.69
MW16-59D	2.40	2.75
MW16-60D	14.30	17.49
MW16-61D	2.56	2.40
MW16-62D	9.95	12.16
MW16-63D	17.62	13.73
MW16-64D	12.59	13.42
MW16-65D	9.20	8.44
MW16-66D	4.47	9.53
MW16-67D	11.67	10.31
MW16-68D	14.96	12.73
MW16-69D	1.15	0.94
MW16-70D	9.12	9.82
MW16-71D	6.88	6.93
MW16-72D	1.84	0.70
MW16-73D	0.34	0.22
MW16-74D	2.80	3.67
MW16-74D	2.80	4.75
MW16-82D	0.57	0.58
MW16-83D	0.58	0.68

TABLE 3-8

SUMMARY OF SLUG TEST RESULTS
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 5 OF 6

Well Location	Falling Head K Value (ft/day)	Rising Head K Value (ft/day)
MW16-84D	3.91	4.74
MW16-84D	2.79	4.12
MW16-85D	1.41	1.57
MW16-86D	1.50	1.73
MW16-90D	10.09	30.68
MW16-90D	25.13	36.84
INJ16-01D	17.91	20.48
INJ16-02D	7.19	7.68
INJ16-03D	3.25	3.02
INJ16-04D	6.97	7.09
INJ16-05D	4.67	8.38
INJ16-06D	5.47	5.04
INJ16-07D	20.86	21.14
INJ16-08D	12.20	11.35
INJ16-09D	6.75	4.81
INJ16-10D	3.98	3.60
INJ16-11D	9.37	9.43
INJ16-12D	7.08	5.19
MW-Z4-02D	3.52	3.25
PGU-Z3-10D	54.21	53.40
Minimum		**0.01**
Maximum		**156.40**
Average		**9.99**
Geometric Mean		**4.08**

Shallow Bedrock (R) Zone		
MW16-01R	58.43	67.57
MW16-01R		64.38
MW16-03R	3.76	0.97
MW16-06R	2.28	1.60
MW16-10R		0.05
MW16-13R	8.79	2.04
MW16-13R	9.26	1.97
MW16-15R	1.04	
MW16-15R	1.44	
MW16-15R	1.42	0.20
MW16-15R	0.80	
MW16-15R	0.73	
MW16-17R	6.23	3.99
MW16-25R	17.77	14.34
MW16-25R	18.45	17.95
MW16-28R	9.12	6.05
MW16-36R	1.16	0.57
MW16-44R	7.55	5.34
MW16-52R	0.59	0.42
MW16-55R	2.03	1.29
MW16-56R	13.97	19.76

TABLE 3-8

SUMMARY OF SLUG TEST RESULTS
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 6 OF 6

Well Location	Falling Head K Value (ft/day)	Rising Head K Value (ft/day)
MW16-58R	13.53	11.52
MW16-60R	16.54	11.85
MW16-65R	0.08	0.02
MW16-66R	22.70	24.64
MW16-67R	4.69	3.50
MW16-68R Upper	327.40	386.60
MW16-68R Lower	5.99	0.88
MW16-69R	3.94	6.21
MW16-70R Upper	0.05	0.44
MW16-70R Lower	4.11	0.41
MW16-71R	0.98	0.62
MW16-82R	1.02	0.54
MW16-83R	1.15	0.64
MW16-84R	7.91	7.37
MW16-84R	7.94	7.42
MW16-86R	11.49	12.37
MW16-86R	11.61	12.55
Minimum		**0.02**
Maximum		**386.60**
Average		**18.60**
Geometric Mean		**3.43**

Deep Bedrock (R2) Zone		
MW16-02R2	45.43	91.75
MW16-05R2	11.28	13.54
MW16-15R2	33.84	36.27
MW16-55R2	4.02	3.14
Minimum		**3.14**
Maximum		**91.75**
Average		**29.91**
Geometric Mean		**17.75**

Notes:
Null cells not applicable (no test performed).

TABLE 3-9

SUMMARY OF GROUNDWATER VELOCITIES AND TRAVEL TIMES
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

		Horizontal Hydraulic Gradients			Geometric Mean of Hydrualic Conductivity		Velocities (ft/year)			Travel Times (years)		
Pathway	Zone	November 2004	May 2007	November 2007	Site Wide K	Pathway Specific K	November 2004	May 2007	November 2007	November 2004	May 2007	November 2007
West of former Building 224 to Vicinity of Davisville Road - Approximately 600 feet	Shallow Overburden		0.004211	0.002584	12.28	12.28		75.5	46.4		7.9	12.9
	Intermediate Overburden				2.31	2.31						
	Deep Overburden	0.003086	0.004932	0.002481	4.08	6.32	28.5	45.5	22.9	21.1	13.2	26.2
	Shallow Bedrock		0.004566	0.002066	3.43	6.32		42.2	19.1		14.2	31.5
Vicinity of Davisville Road to area between/near Building 39 and/or former Building 41 - Approximately 1900 feet	Shallow Overburden		0.001932	0.001570	12.28	12.28		34.7	28.2		54.8	67.5
	Intermediate Overburden				2.31	2.31						
	Deep Overburden	0.001182	0.001109	0.001571	4.08	2.49	4.3	4.0	5.7	441.9	470.9	332.5
	Shallow Bedrock		0.001157	0.001527	3.43	3.29		5.6	7.3		341.6	258.9
Area between/near Building 39 and/or former Building 41 to Davisville Road area south of North Central Area - Approximately 930 feet	Shallow Overburden	0.006173	0.006667	0.005656	12.28	20.86	188.1	203.2	172.4	4.9	4.6	5.4
	Intermediate Overburden	0.006633	0.005882	0.005345	2.31	1.79	14.5	12.8	11.6	64.3	72.5	79.8
	Deep Overburden	0.004916	0.006192	0.005146	4.08	4.77	34.3	43.2	35.9	27.1	21.6	25.9
	Shallow Bedrock	0.004566	0.005952	0.005066	3.43	3.74	24.9	32.5	27.7	37.3	28.6	33.6
Davisville Road south of NC Area to Allen Harbor - Approximately 560 feet	Shallow Overburden	0.01905	0.02273	0.01031	12.28	10.74	298.9	356.7	161.8	1.9	1.6	3.5
	Intermediate Overburden	0.01389	0.01923	0.01111	2.31	2.95	49.9	69.1	39.9	11.2	8.1	14.0
	Deep Overburden	0.01073	0.02160	0.00808	4.08	3.93	61.6	124.0	46.4	9.1	4.5	12.1
	Shallow Bedrock	0.01220	0.01543	0.00769	3.43	11.83	210.9	266.7	132.9	2.7	2.1	4.2
South of former Building 41 to Narragansett Bay/West of Sea Freeze Building (eastern most portion of Site 16) - Approximately 1570 feet	Shallow Overburden				12.28	12.28						
	Intermediate Overburden	0.006944	0.008264	0.005121	2.31	2.75	23.2	27.7	17.1	67.5	56.7	91.6
	Deep Overburden	0.007669	0.008499	0.004968	4.08	4.72	52.9	58.6	34.3	29.7	26.8	45.8
	Shallow Bedrock			0.005886	3.43	12.45			107.1			14.7

Notes:

Horizontanl hydraulic gradient is feet/feet. Hydraulic conductivity is feet/day.
Velocity and travel times not calculated in null cells because gradient infromation is not available.
Travel times do not consider various degradation processes (physical, chemical or biological). Travel times based on only advective results.
Pathway specific hydraulic conductivity include only hydraulic conductivities from wells along specified pathway.
Distance along each pathway estimated. Actual distance in a particular flow field may vary from estimated length.
Porosity in Shallow Bedrock assumed to be the same/similar as Deep Overburden (assumed to be fractured with soil infilled fractures).

Sample ID	Depth	Date	Dry Density, pcf
A3-34	4 to 5	2007	98
A3-34	15 to 16	2007	120
A3-35	2 to 3	2007	103
A3-35	12 to 13	2007	94
SG16-003-005	3 to 4	2007	91
SG16-003-005	12 to 13	2007	109
65-0010	1 to 2	2007	110
65-0010	5 to 6	2007	88
SB16-101-SO-0510	5 to 10	2010	102
SB16-102-SO-0005	0 to 5	2010	111
SB16-103-SO-0005	0 to 5	2010	114
SB16-104-SO-0510	5 to 10	2010	100
SB16-105-SO-0510	5 to 10	2010	101
SB16-106-SO-0005	0 to 5	2010	86
SB16-107-SO-0005	0 to 5	2010	112
SB16-108-SO-0510	5 to 10	2010	90
SB16-109-SO-0510	5 to 10	2010	77
SB16-110-SO-0005	0 to 5	2010	106
SB16-132-SO-0510	5 to 10	2010	87
		AVE	99.95 pcf
		GEOMEAN	99.31 pcf
		AVE	1.6010 gcm3
		GEOMEAN	1.5908 gcm3

Geomean foc = 1209 mg/kg

0.1209 %

Appendix A.4

Dispersivity Estimates

Dispersion refers to the process whereby a dissolved solvent will be spatially distributed longitudinally (along the direction of ground-water flow), transversely (perpendicular to ground-water flow), and vertically (downward) because of mechanical mixing and chemical diffusion in the aquifer. These processes develop the "plume" shape that is the spatial distribution of the dissolved solvent mass in the aquifer.

Selection of dispersivity values is a difficult process, given the impracticability of measuring dispersion in the field. However, dispersivity data from over 50 sites has been compiled by Gelhar *et al.* (1992) (see Figures A.3 and A.4). The empirical data indicates that longitudinal dispersivity, in units of length, is related to scale (distance between source and measurement point). Gelhar *et al.* (1992) indicate 1) there is a considerable range of dispersivity values at any given scale (on the order of 2 - 3 orders of magnitude), 2) suggest using values at the low end of the range of possible dispersivity values, and 3) caution against using a single relation between scale and dispersivity to estimate dispersivity. However, most modeling studies do start with such simple relations, and BIOCHLOR is programmed with some commonly used relations representative of typical and low-end dispersivities.

Note: Based on Gelhar's work, use of variable dispersivity values should yield a better estimate of concentration at each distance downgradient of the source. However, when using field data to calibrate the model and estimate rate coefficients, be aware that the Domenico model assumes constant dispersivity values. The user must choose between using a variable dispersivity that is likely to be more physically accurate at each point or a fixed dispersivity value that makes each point mathematically consistent with each other. In general, if the user would like the best estimate of concentration at each point in a BIOCHLOR simulation, use a variable dispersivity. If the user would like accurate mass balances between each point, use a fixed dispersivity. Fixed dispersivity values should be used for two-zone simulations.

BIOCHLOR is programmed with some commonly used relations based on x (distance from the source in ft) that are representative of typical and low-end dispersivities. The user also has the option to enter fixed diffusivity values.

- Longitudinal Dispersivity

The user is given three options:

> ***Option 1*** *(the default option)* allows the user to specify a fixed value for alpha x. One commonly used relation is to assume that alpha x is 10% of the estimated plume length.
>
> ***Option 2*** assumes that alpha x = 0.1* x
>
> ***Option 3*** calculates the longitudinal dispersivity using the following correlation:

$$\text{Alpha x} = 3.28 \cdot 0.82 \cdot \left[\log_{10}\left(\frac{x}{3.28}\right)\right]^{2.446}$$ (Xu and Eckstein, 1995; Al-Suwaiyan, 1996)

- **Transverse Dispersivity**

The user may choose a ratio of alpha y : alpha x. One commonly used ratio is:

Alpha y: alpha x = 0.10 *(Based on high reliability points from* Gelhar et al., 1992)

- **Vertical Dispersivity**

The user may choose a ratio of alpha z : alpha x. One commonly used ratio is:

Alpha z: alpha x = 0.05 *(ASTM, 1995)*

Alternatively, alpha z :alpha x can be set to a very low number (e.g., E-99) to yield a conservative estimate of vertical dispersion. This is the default value used in BIOCHLOR.

Other commonly used relations include:

Alpha x = 0.1 Lp *(Pickens and Grisak, 1981)*

Alpha y = 0.33 alpha x	*(ASTM, 1995) (EPA, 1986)*
Alpha z = 0.05 alpha x	*(ASTM, 1995)*
Alpha z = 0.025 alpha x to 0.1 alpha x	*(U.S. EPA, 1986)*

The BIOCHLOR input screen includes Excel formulas to estimate dispersivities from scale. BIOCHLOR uses the modified Xu and Eckstein (1995) algorithm for estimating longitudinal dispersivities because 1) it provides lower range estimates of dispersivity, especially for large values of x and 2) it was developed after weighing the reliability of the various field data compiled by Gelhar *et al.* (1992) (see Figure A.3). BIOCHLOR also employs low-end estimates for transverse and vertical dispersivity estimates (0.10 * alpha x and 0, respectively) because these relations better fit high reliability field data reported by Gelhar *et al.* (see Figure A.4), and Gelhar *et al.* recommend use of values in the lower range of the observed data. The user can also enter a fixed longitudinal dispersivity value in the "Change Alpha x Calc." dialog box on the input screen.

Note that the Domenico model and BIOCHLOR are not formulated to simulate the effects of chemical diffusion. Therefore, contaminant transport through very slow hydrogeologic regimes (e.g., clays and slurry walls) should probably not be modeled using BIOCHLOR unless the effects of chemical diffusion are proven to be insignificant.

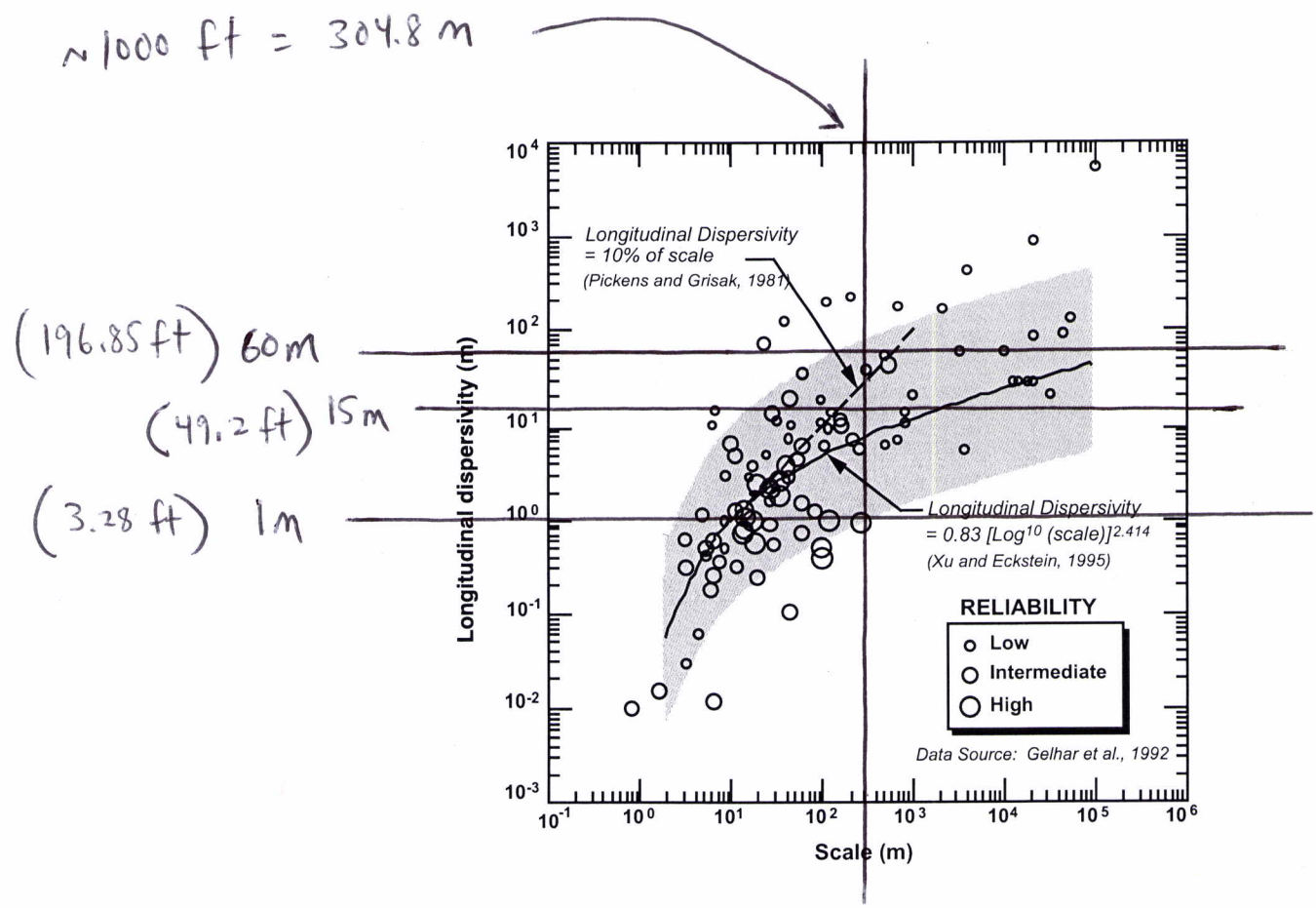

Figure A.3. Longitudinal dispersivity vs. scale data reported by Gelhar et al. (1992). Data includes Gelhar's reanalysis of several dispersivity studies. Size of circle represents general reliability of dispersivity estimates. Location of 10% of scale linear relation plotted as dashed line (Pickens and Grisak, 1981). Xu and Eckstein's regression shown as solid line. Shaded area defines ±1 order of magnitude from the Xu and Eckstein regression line and represents general range of acceptable values for dispersivity estimates.

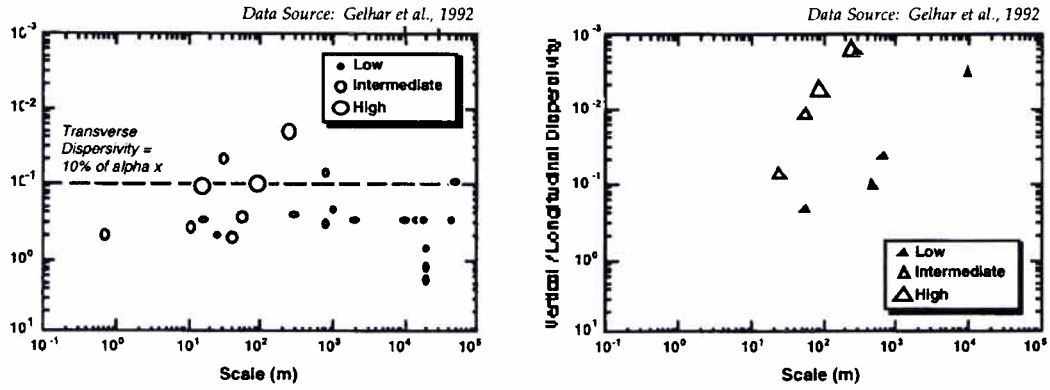

Figure A.4. Ratio of transverse dispersivity and vertical dispersivity to longitudinal dispersivity data vs. scale reported by Gelhar et al. (1992). Data includes Gelhar's reanalysis of several dispersivity studies. Size of symbol represents general reliability of dispersivity estimates. Location of transverse dispersivity relation used in BIOCHLOR is plotted as dashed line.

Appendix A.5

Pump and Treat Comparison

A useful way to estimate the clean-up time for a contaminated aquifer is to consider the number of pore volumes that must be pumped from the contaminated zone to achieve clean-up goals. A pump and treat module was added to the BIOCHLOR array output page to permit users to test the feasibility of pump and treat systems and to compare pump and treat clean-up times with natural attenuation predictions.

The user is provided with the volume of ground water in the plume (i.e., a pore volume). One pore volume is only a small fraction of the volume of ground water requiring treatment because dense non-aqueous phase liquids (DNAPLs), such as solvents, and sorbed constituents act as continuing sources of ground-water contamination. The number of pore volumes required for clean-up (i.e., the number of times the contaminated region must be flushed) is a function of many different factors including: the clean-up standard, the initial chemical concentration, the degree of mixing of clean and contaminated ground water, geologic heterogeneities, the presence and quantity of DNAPL, and sorbed constituents (NRC, 1994).

In the pump and treat module, the user enters the system pumping rate, and the number of pore volumes treated/ removed in one year is calculated by the program. This value provides the user with an indication of the feasibility of the pump and treat system. If the extraction rate is less than one pore volume per year, the attainment of clean-up criteria will likely take decades, even under the most favorable conditions (NRC, 1994).

Another cell asks the user to input the number of pore volumes that must be removed in order to clean up the aquifer. Using this value and the pumping rate, the time to clean up the contaminated aquifer can be estimated. The number of pore volumes required to remediate the aquifer is a site-specific and technology-specific value. The document, "Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites"(U.S. EPA, 1988), describes two methods for estimating ground-water clean-up times based on the number of pore volumes: the batch flushing model and the continuous flushing model. Neither of these methods account for DNAPL and, therefore, underestimate clean-up times. A third method accounting for DNAPL is reported in Newell *et al.* (1994) and Wiedemeier *et al.* (1999).

TETRA TECH NUS, INC. **CALCULATION WORKSHEET** PAGE 1 OF

CLIENT		JOB NUMBER	
SUBJECT			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE

$\frac{39u}{200'} = \frac{x}{y}$ 40 scale

$y = \frac{(200')(\text{measured})}{39u}$

50 scale $\frac{31u'}{50'} = \frac{x}{y}$

$y = \frac{(50')(\text{measured})}{31u}$

1. Source → 77I : $y = \frac{(200)(12)}{39} = 61.5'$

2. Source → 85D : $y = \frac{(200)(18)}{39} = 92.3'$

3. Source → 14D : $y = \frac{(200)(56)}{39} = 287.2'$

4. Source → 59D : $y = \frac{(200)(124)}{39} = 635.9'$

More Locations –

1. 14D → INJ16-12D : $y = \frac{(50)(15)}{31} = 24.2'$

2. 14D → MW16-71D : $y = \frac{(50)(45)}{31} = 72.6'$

3. 14D → MW16-15D : $y = \frac{(50)(78)}{31} = 125.8'$

4. 14D → MW16-62D : $y = \frac{(50)(110)}{31} = 177.4'$

5. 14D → MW16-60D : $y = \frac{(50)(153)}{31} = 246.8'$

6. 14D → MW16-22D : $y = \frac{50(188)}{31} = 303.2'$

TETRA TECH NUS, INC. **CALCULATION WORKSHEET** PAGE 2 OF

CLIENT		JOB NUMBER	
SUBJECT			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE

(7) 59D → 23D : $y = \frac{(175)(45)}{31} = 254.0'$

Centerline distances from "Source Area"

Source	–	0	ft
77I	–	61.5	ft
85D	–	92.3	ft
14D	–	287.2	ft
INJ-12D	–	311.4	ft
71D	–	359.8	ft
15D	–	413.0	ft
62D	–	464.6	ft
60D	–	534	ft
22D	–	590.4	ft
59D	–	635.9	ft
23D	–	889.9	ft

→ Assume Release Origin Date of 1951

- from 1951 to 1953

2001	–	1951	=	50	years
2002	–	1951	=	51	years
2004	–	1951	=	53	years
2007	–	1951	=	56	years
2010	–	1951	=	59	years

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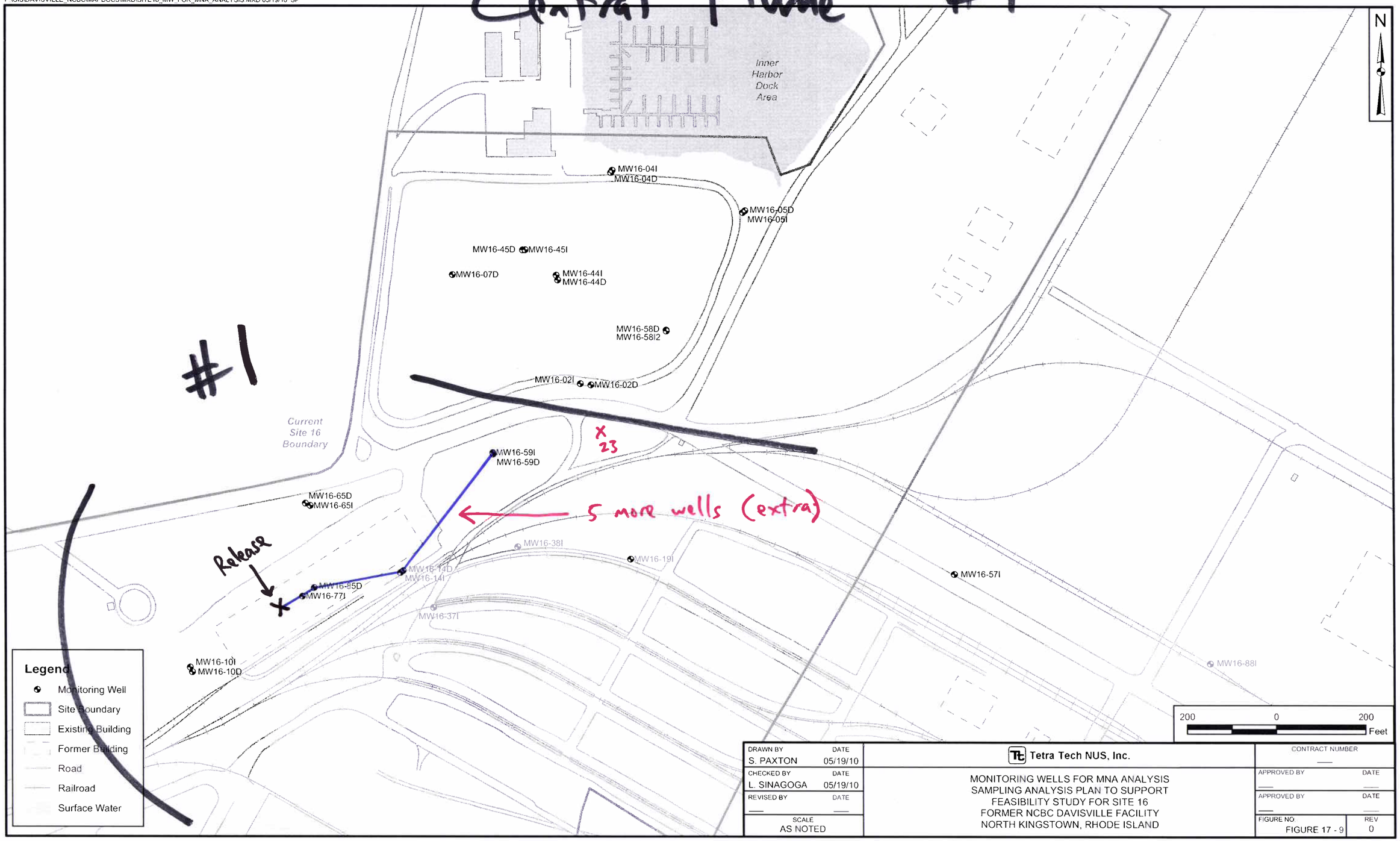
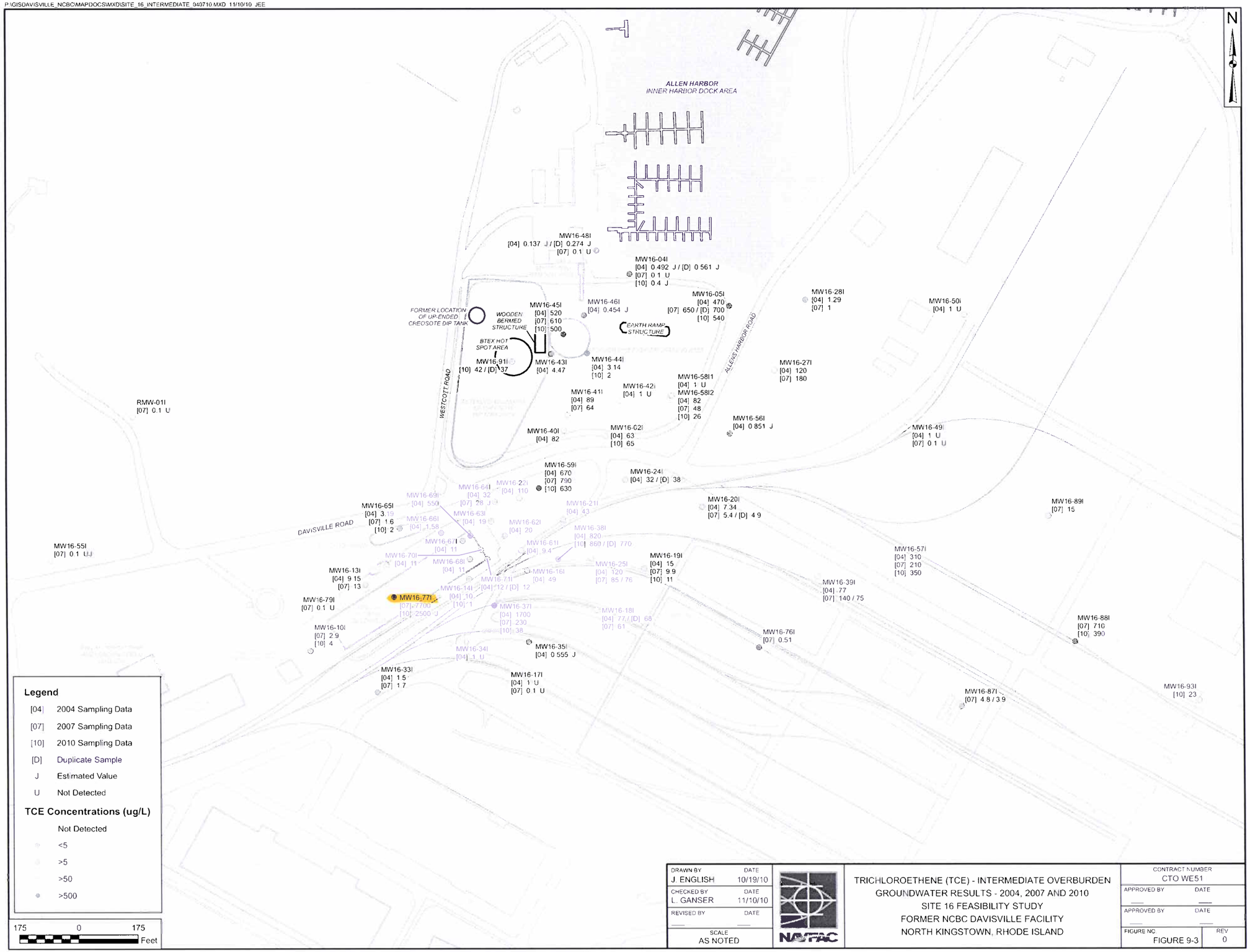
Central Plume #1



DRAWN BY S. PAXTON	DATE 05/19/10	Tetra Tech NUS, Inc.	CONTRACT NUMBER —
CHECKED BY L. SINAGOGA	DATE 05/19/10	MONITORING WELLS FOR MNA ANALYSIS SAMPLING ANALYSIS PLAN TO SUPPORT FEASIBILITY STUDY FOR SITE 16 FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	APPROVED BY — DATE —
REVISED BY —	DATE —		APPROVED BY — DATE —
SCALE AS NOTED			FIGURE NO. FIGURE 17 - 9 / REV 0

P:\GIS\DAVISVILLE_NCBC\MAPDOCS\MXD\SITE_16_INTERMEDIATE_040710.MXD 11/10/10 JEE



DRAWN BY J. ENGLISH	DATE 10/19/10	TRICHLOROETHENE (TCE) - INTERMEDIATE OVERBURDEN GROUNDWATER RESULTS - 2004, 2007 AND 2010 SITE 16 FEASIBILITY STUDY FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	CONTRACT NUMBER CTO WE51
CHECKED BY L. GANSER	DATE 11/10/10		APPROVED BY / DATE
REVISED BY	DATE		APPROVED BY / DATE
SCALE AS NOTED			FIGURE NO FIGURE 9-3 / REV 0

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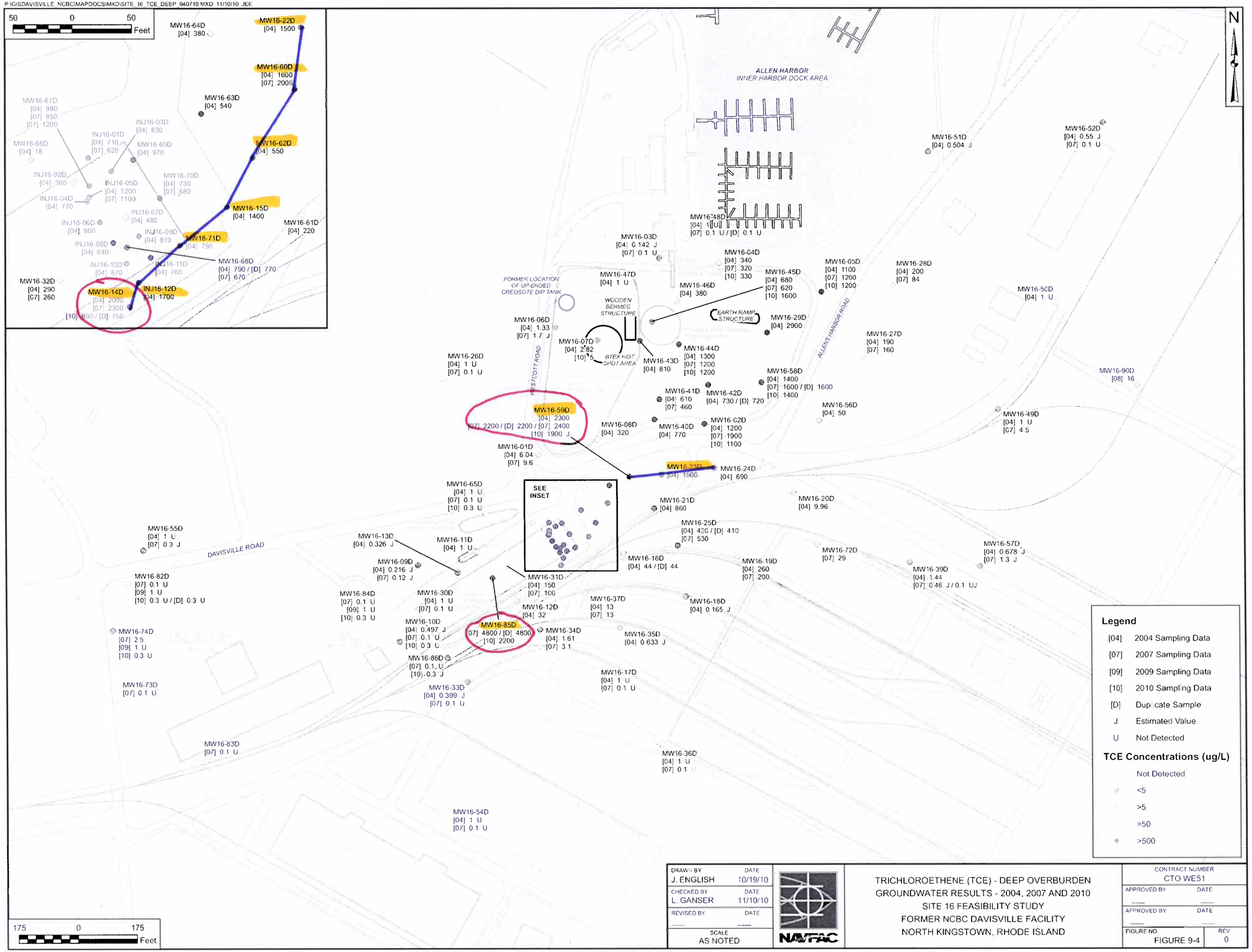

DRAWN BY	DATE
J. ENGLISH	10/19/10
CHECKED BY	DATE
L. GANSER	11/10/10
REVISED BY	DATE
SCALE	
AS NOTED	

NAVFAC

TRICHLOROETHENE (TCE) - DEEP OVERBURDEN
GROUNDWATER RESULTS - 2004, 2007 AND 2010
SITE 16 FEASIBILITY STUDY
FORMER NCBC DAVISVILLE FACILITY
NORTH KINGSTOWN, RHODE ISLAND

CONTRACT NUMBER	
CTO WE51	
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO.	REV
FIGURE 9-4	0

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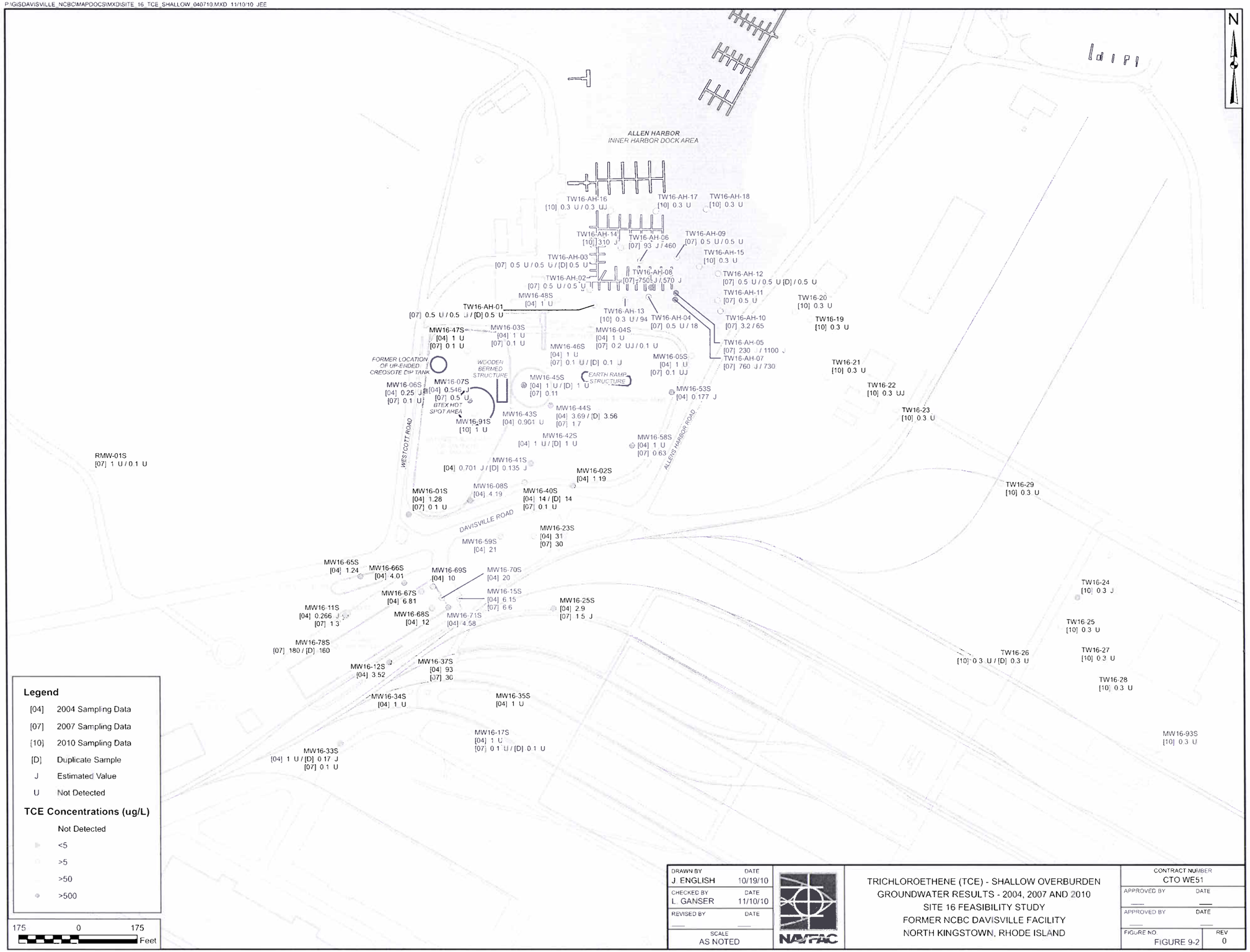

DRAWN BY J. ENGLISH	DATE 10/19/10	TRICHLOROETHENE (TCE) - SHALLOW OVERBURDEN GROUNDWATER RESULTS - 2004, 2007 AND 2010 SITE 16 FEASIBILITY STUDY FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	CONTRACT NUMBER CTO WE51
CHECKED BY L. GANSER	DATE 11/10/10		APPROVED BY / DATE
REVISED BY	DATE		APPROVED BY / DATE
SCALE AS NOTED		NAVFAC	FIGURE NO. FIGURE 9-2 / REV 0

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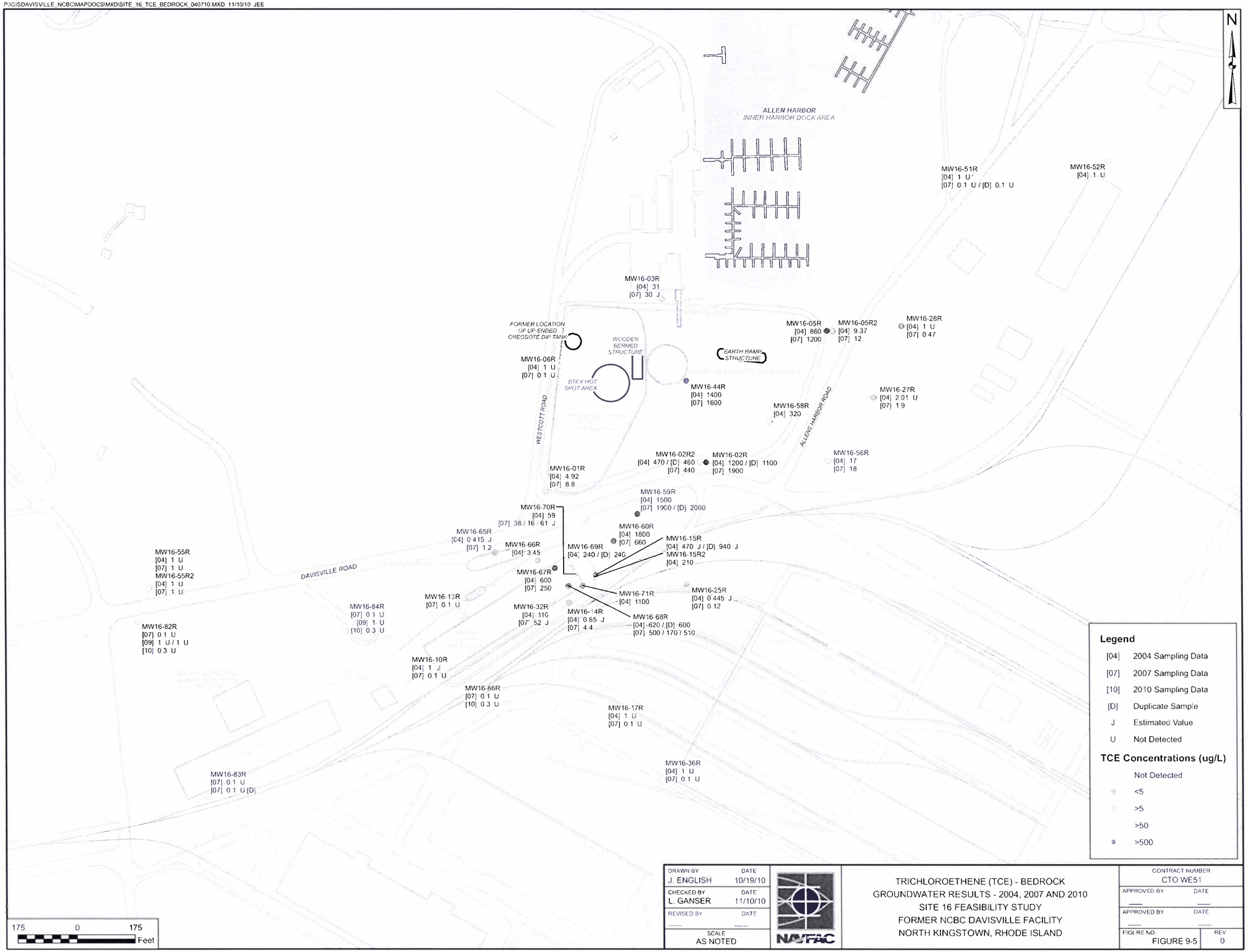

DRAWN BY	DATE
J. ENGLISH	10/19/10
CHECKED BY	DATE
L. GANSER	11/10/10
REVISED BY	DATE
—	—
SCALE	
AS NOTED	

NAVFAC

TRICHLOROETHENE (TCE) - BEDROCK
GROUNDWATER RESULTS - 2004, 2007 AND 2010
SITE 16 FEASIBILITY STUDY
FORMER NCBC DAVISVILLE FACILITY
NORTH KINGSTOWN, RHODE ISLAND

CONTRACT NUMBER	
CTO WE51	
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
FIGURE NO	REV
FIGURE 9-5	0

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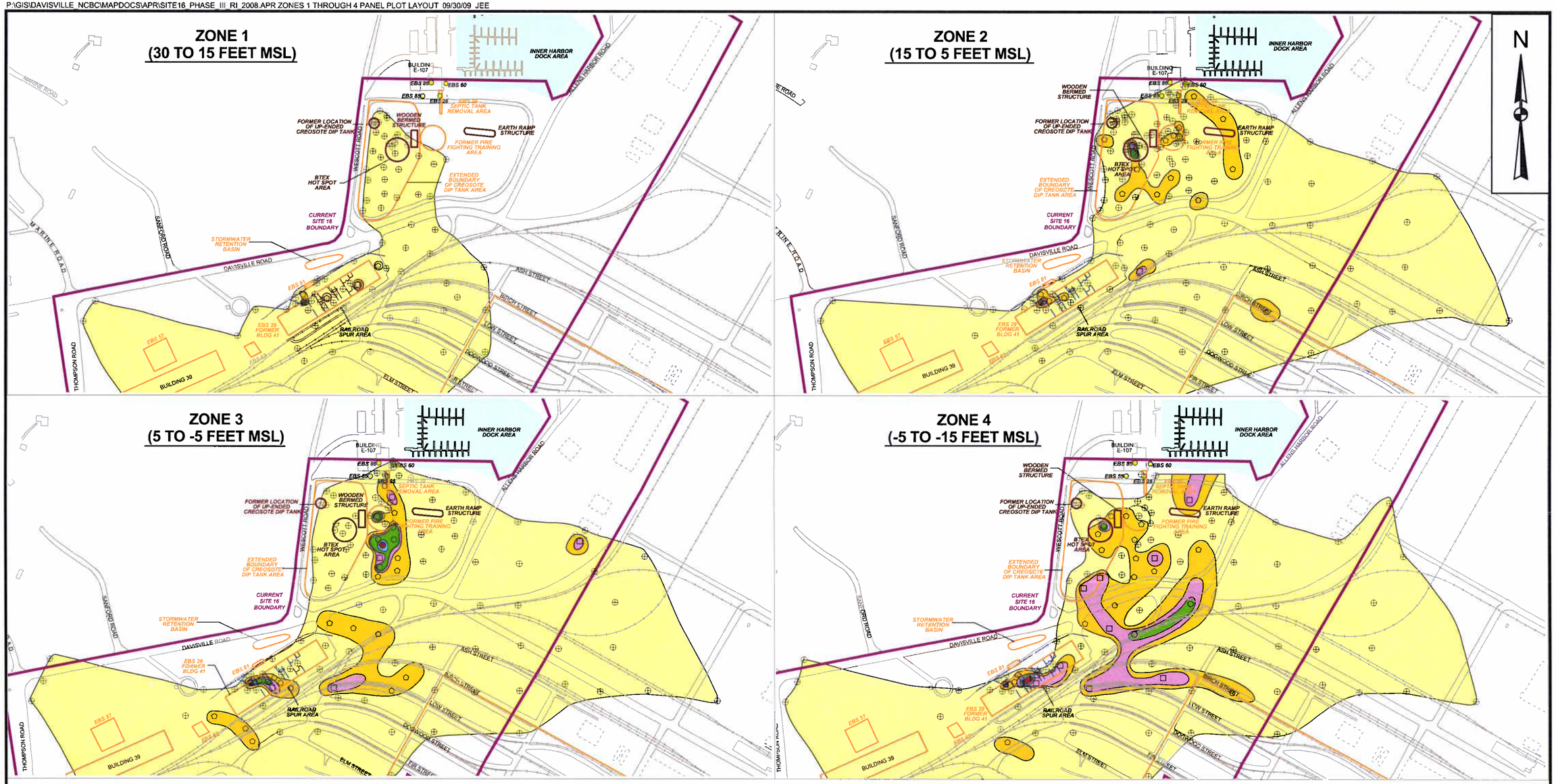


Legend

Soil Sample Location, Total CVOC Concentration (µg/kg)

- ◑ 6000 - 20000
- △ 3000 - 6000
- ○ 300 - 3000
- □ 30 - 300
- ⬡ >0 - 30
- ⊕ Non Detect

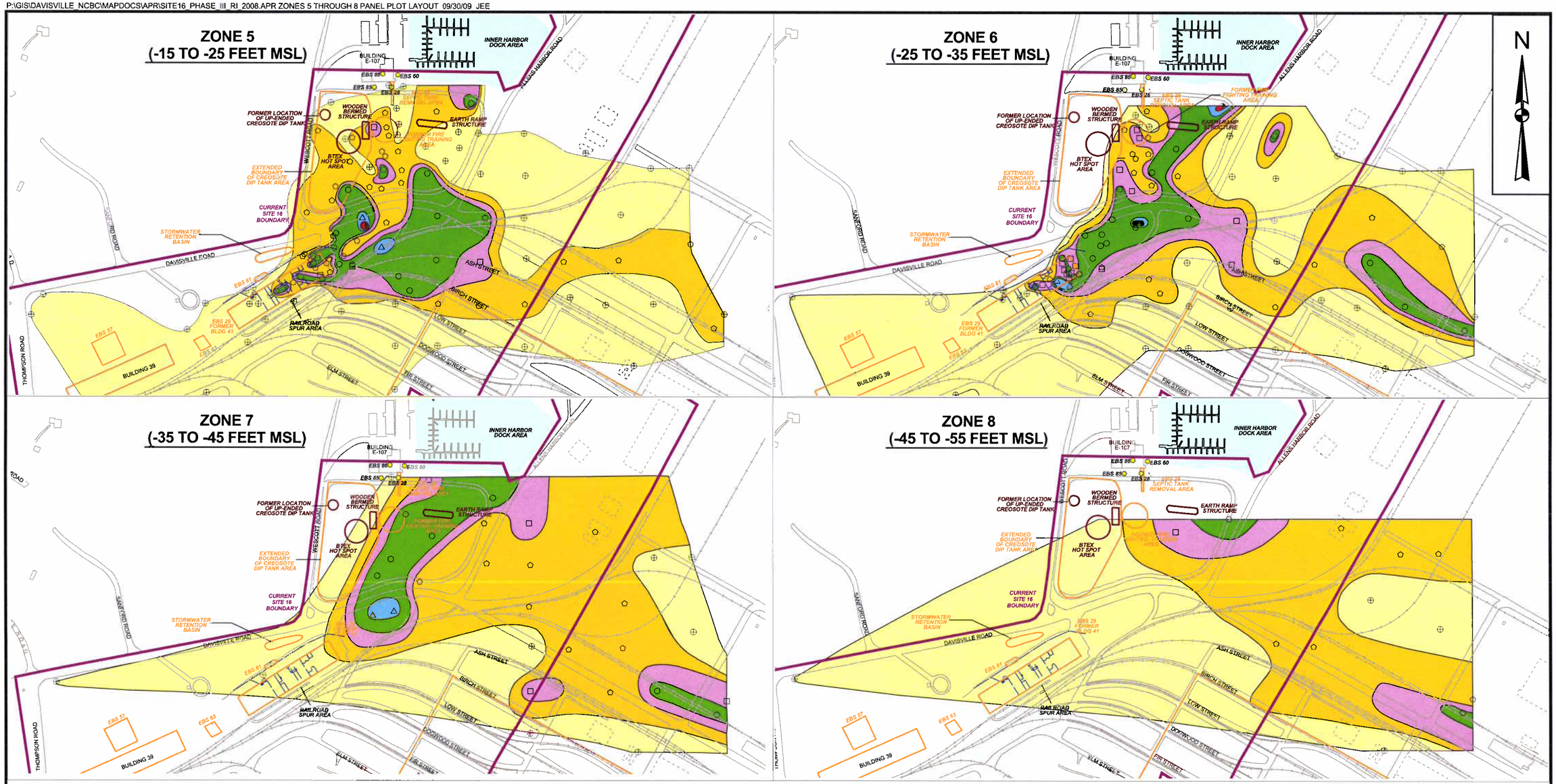
Total CVOC Isoconcentration in Soil (µg/kg)

- 6000 - 20000
- 3000 - 6000
- 300 - 3000
- 30 - 300
- >0 - 30
- Non Detect

200 0 200 Feet

DRAWN BY S. STROZ	DATE 8/20/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO 0418	OWNER NUMBER 0822
CHECKED BY L. SINAGOGA	DATE 09/30/09	TOTAL CHLORINATED VOLATILE ORGANIC COMPOUND CONCEPTUALIZED ISOCONCENTRATION RANGES FOR SOIL SAMPLING AND ANALYSIS PLAN TO SUPPORT FEASIBILITY STUDY FOR SITE 16 FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	APPROVED BY —	DATE —
COST/SCHEDULE-AREA			APPROVED BY —	DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 10-8A	REV 0

P:\GIS\DAVISVILLE_NCBC\MAPDOCS\APR\SITE16_PHASE_III_RI_2008.APR ZONES 5 THROUGH 8 PANEL PLOT LAYOUT 09/30/09 JEE



Legend

Soil Sample Location, Total CVOC Concentration (µg/kg)

- ◑ 6000 - 20000
- △ 3000 - 6000
- ○ 300 - 3000
- □ 30 - 300
- ⬠ >0 - 30
- ⊕ No Detect

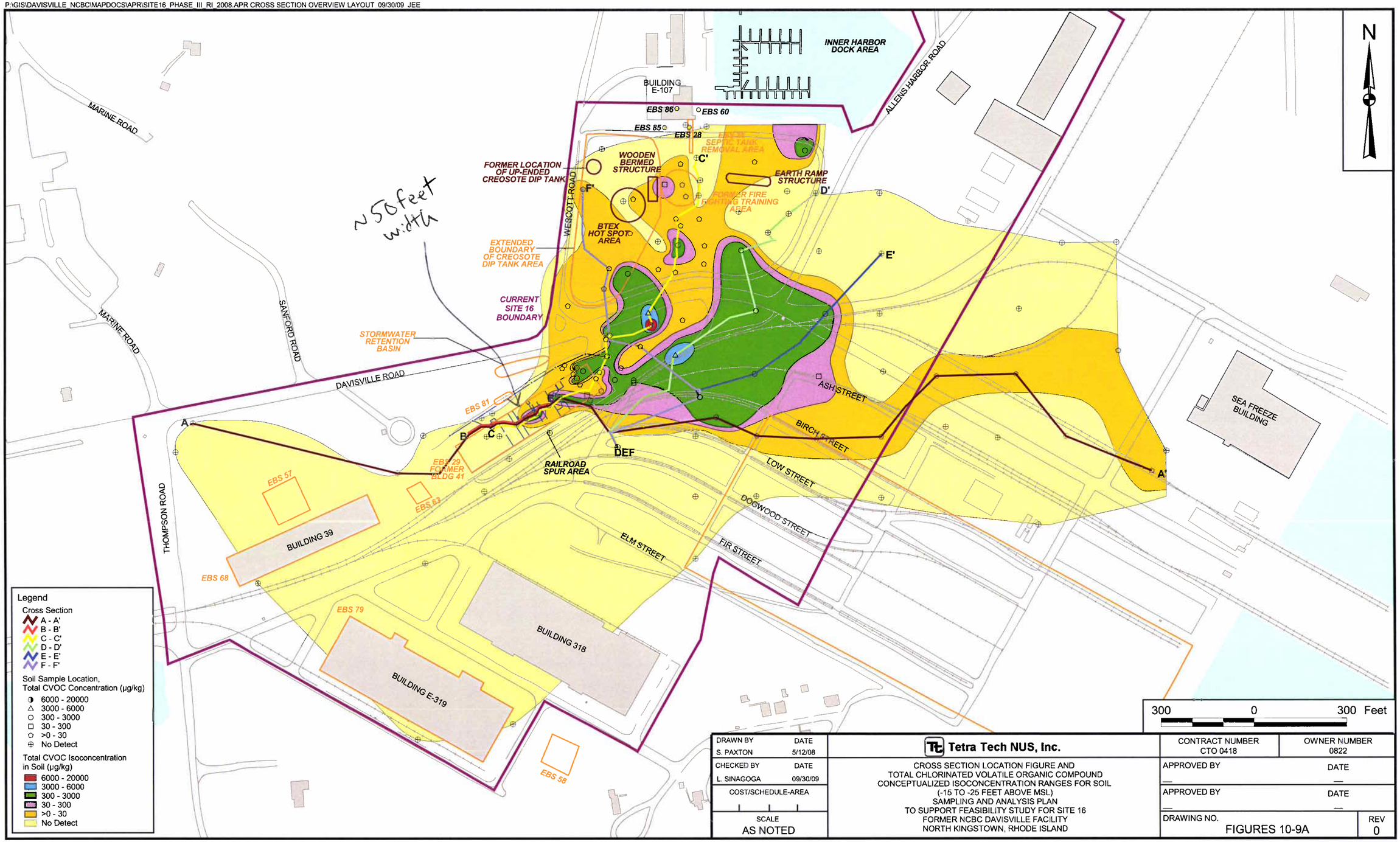
Total CVOC Isoconcentration in Soil (µg/kg)

- 6000 - 20000
- 3000 - 6000
- 300 - 3000
- 30 - 300
- >0 - 30
- No Detect

200 0 200 Feet

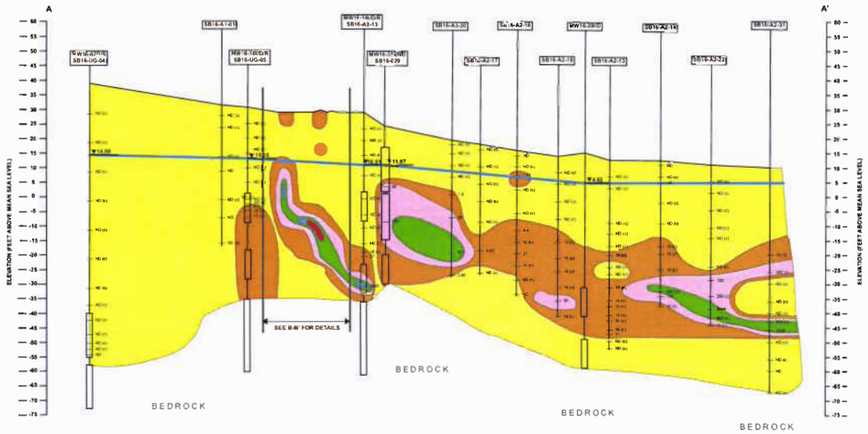
DRAWN BY S. STROZ	DATE 8/20/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO 0418 / OWNER NUMBER 0822
CHECKED BY L. SINAGOGA	DATE 09/30/09	TOTAL CHLORINATED VOLATILE ORGANIC COMPOUND CONCEPTUALIZED ISOCONCENTRATION RANGES FOR SOIL SAMPLING AND ANALYSIS PLAN TO SUPPORT FEASIBILITY STUDY FOR SITE 16 FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 10-8B / REV 0

P:\GIS\DAVISVILLE_NCBC\MAPDOCS\APR\SITE16_PHASE_III_RI_2008.APR CROSS SECTION OVERVIEW LAYOUT 09/30/09 JEE



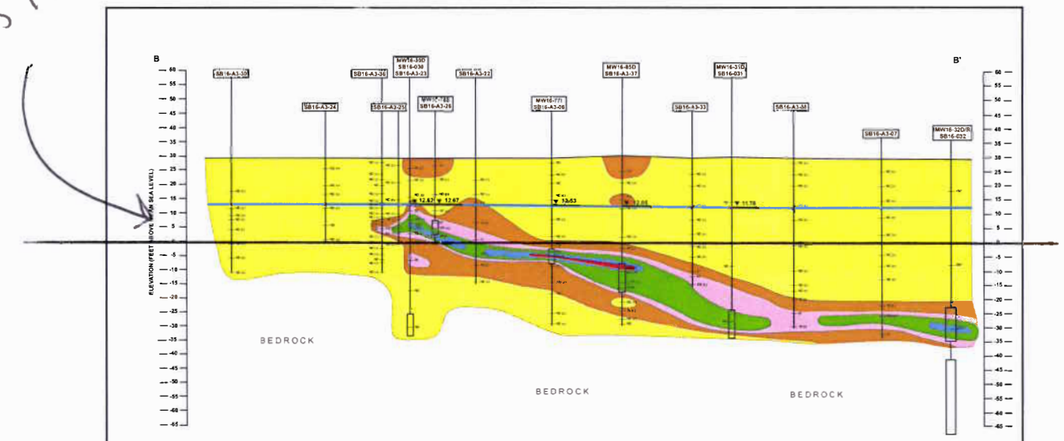
DRAWN BY S. PAXTON	DATE 5/12/08	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO 0418 / OWNER NUMBER 0822
CHECKED BY L. SINAGOGA	DATE 09/30/09	CROSS SECTION LOCATION FIGURE AND TOTAL CHLORINATED VOLATILE ORGANIC COMPOUND CONCEPTUALIZED ISOCONCENTRATION RANGES FOR SOIL (-15 TO -25 FEET ABOVE MSL) SAMPLING AND ANALYSIS PLAN TO SUPPORT FEASIBILITY STUDY FOR SITE 16 FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURES 10-9A / REV 0

P:\GIS\DAVISVILLE_NCBC\MAPDOCS\MXD\CROSS_SECTION_ABC_PANELS.MXD 09/30/09

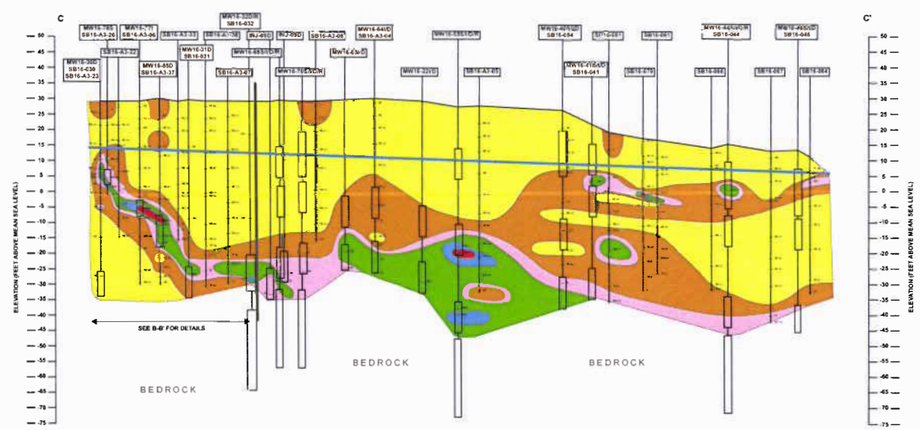


CROSS SECTION A-A'

~15 feet source



CROSS SECTION B-B'



CROSS SECTION C-C'

Legend
Total CVOC Isoconcentration in Soil (µg/kg)

- Non Detect
- >0-30
- 30-300
- 300-3000
- 3000-6000
- 6000-20000
- 16 (c) Color-Tec Result
- 38 Fixed-Base Laboratory Result

Key

- Groundwater Elevation, Deep Overburden Zone, November 2007
- Potentiometric Surface of Deep Overburden
- Sample Location
- Well Screen

DRAWN BY S. STROZ	DATE 8/21/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO 0418 / OWNER NUMBER 0822
CHECKED BY L. SINAGOGA	DATE 09/30/09	CROSS SECTIONS (A - A', B - B', AND C - C') AND TOTAL CHLORINATED VOLATILE ORGANIC COMPOUND ISOCONCENTRATION RANGES FOR SOIL SAMPLING AND ANALYSIS PLAN TO SUPPORT FEASIBILITY STUDY FOR SITE 16 FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTON, RHODE ISLAND	APPROVED BY / DATE
COST/SCHEDULE-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 10-9B / REV 0

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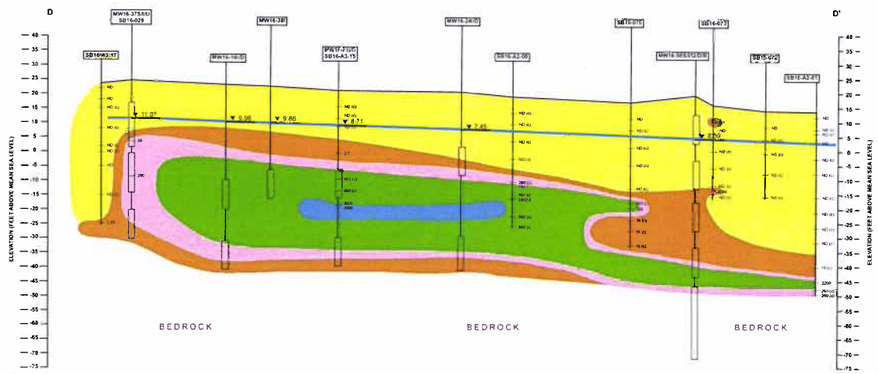
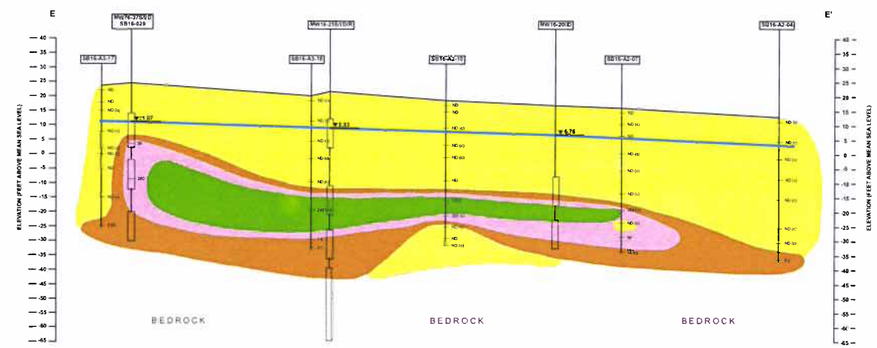
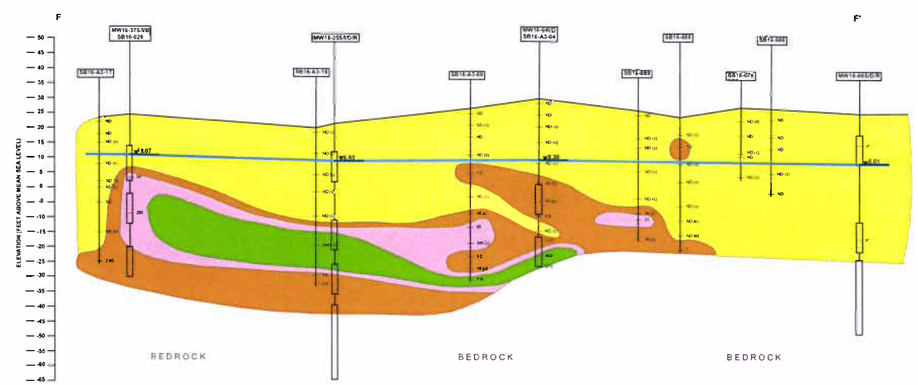


CROSS SECTION D-D'



CROSS SECTION E-E'



CROSS SECTION F-F'

Legend
Total CVOC Isoconcentration in Soil (µg/kg)

- Non Detect
- >0-30
- 30-300
- 300-3000
- 3000-6000
- 6000-20000
- 16 (c) Color-Tec Result
- 38 Fixed-Base Laboratory Result

Key

- Groundwater Elevation, Deep Overburden Zone, November 2007
- Potentiometric Surface of Deep Overburden
- Sample Location
- Well Screen

DRAWN BY S. STROZ	DATE 8/21/09	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO 0418	OWNER NUMBER 0822
CHECKED BY L. SINAGOGA	DATE 09/30/09	CROSS SECTIONS (D - D', E - E', AND F - F') AND TOTAL CHLORINATED VOLATILE ORGANIC COMPOUND ISOCONCENTRATION RANGES FOR SOIL SAMPLING AND ANALYSIS PLAN TO SUPPORT FEASIBILITY STUDY FOR SITE 16 FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTON, RHODE ISLAND	APPROVED BY	DATE
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 10-9C	REV 0

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node Investigation Sample Code	28-GW-01 Round 3 NORMAL	28-GW-02 Round 3 NORMAL	28-GW-03 Round 3 NORMAL	28-GW-04 Round 3 NORMAL	28-GW-05 Round 3 NORMAL	28-GW-06 Round 3 NORMAL	28-GW-07 Round 3 NORMAL	28-GW-08 Round 3 AVG	28-GW-01A Round 2 AVG	EBS81-01 Round 3 NORMAL	EBS81-02 Round 3 NORMAL
					Shallow Overburden						
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U
Trichloroethene	1 U	**0.8**	**4**	**1**	1 U	1 U	1 U	1 U	2 U	2 U	2 U
1,1-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U
1,1-Dichloroethane, LV											
1,1-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	3 U	3 U
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene	1 U	1 U	**7 J**	**31 J**	1 U	**0.4**	1 U	1 U	2 U	5 U	5 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U
1,2-Dichloroethane, LV											
Vinyl Chloride	1 U	1 U	**2 J**	**10**	**3**	**8**	1 U	**4**	2 U	3 U	3 U
Vinyl Chloride, LV											
Chloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	2 U	2 U
Ethane											
Ethene											
Methane											

Well Node Investigation Sample Code	28-GW-01 Round 3 NORMAL	28-GW-02 Round 3 NORMAL	28-GW-03 Round 3 NORMAL	28-GW-04 Round 3 NORMAL	28-GW-05 Round 3 NORMAL	28-GW-06 Round 3 NORMAL	28-GW-07 Round 3 NORMAL	28-GW-08 Round 3 NORMAL	28-GW-01A Round 2 NS	EBS81-01 Round 3 NS	EBS81-02 Round 3 NS
					Intermediate Overburden						
Tetrachloroethene	1 U	1 U		1 U	1 U	1 U	1 U	1 U			
Trichloroethene	1 U	0.8 U		**570 J**	**210 J**	**2**	1 U	**49 J**			
	1 U	1 U		1 U	1 U	1 U	1 U	1 U			
1,1-Dichloroethane, LV											
1,1-Dichloroethene	1 U	1 U		**0.4**	**1**	1 U	1 U	1 U			
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene	1 U	1 U		**13 J**	**4**	1 U	1 U	**2**			
1,2-Dichloroethane	1 U	1 U		1 U	1 U	1 U	1 U	1 U			
1,2-Dichloroethane, LV											
Vinyl Chloride	1 U	1 U		1 U	1 U	1 U	1 U	**3**			
Vinyl Chloride, LV											
Chloroethane	1 U	1 U		1 U	1 U	1 U	1 U	1 U			
Ethane											
Ethene											
Methane											

Well Node Investigation Sample Code	28-GW-01 Round 3 NS	28-GW-02 Round 3 NS	28-GW-03 Round 3 NORMAL	28-GW-04 Round 3 NS	28-GW-05 Round 3 NS	28-GW-06 Round 3 NS	28-GW-07 Round 3 NS	28-GW-08 Round 3 NS	28-GW-01A Round 2 NS	EBS81-01 Round 3 NS	EBS81-02 Round 3 NS
					Deep Overburden						
Tetrachloroethene			1 UJ								
Trichloroethene			**160 J**								
1,1-Dichloroethane			1 UJ								
1,1-Dichloroethane, LV											
1,1-Dichloroethene			**0.3 J**								
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene			**2 J**								
1,2-Dichloroethane			1 UJ								
1,2-Dichloroethane, LV											
Vinyl Chloride			1 UJ								
Vinyl Chloride, LV											
Chloroethane			1 UJ								
Ethane											
Ethene											
Methane											

Well Node Investigation Sample Code	28-GW-01 Round 3 NS	28-GW-02 Round 3 NS	28-GW-03 Round 3 NS	28-GW-04 Round 3 NS	28-GW-05 Round 3 NS	28-GW-06 Round 3 NS	28-GW-07 Round 3 NS	28-GW-08 Round 3 NS	28-GW-01A Round 2 NS	EBS81-01 Round 3 NS	EBS81-02 Round 3 NS
					Shallow Bedrock						
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

Well Node Investigation Sample Code	28-GW-01 Round 3 NS	28-GW-02 Round 3 NS	28-GW-03 Round 3 NS	28-GW-04 Round 3 NS	28-GW-05 Round 3 NS	28-GW-06 Round 3 NS	28-GW-07 Round 3 NS	28-GW-08 Round 3 NS	28-GW-01A Round 2 NS	EBS81-01 Round 3 NS	EBS81-02 Round 3 NS
					Deep Bedrock						
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-01				MW16-02				MW16-03			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NS	NORMAL	AVG	NORMAL	NORMAL
Shallow Overburden												
Tetrachloroethene	1 U	1 U	1 U	0.1 U	1 U	1 U	1 U		1 U	1 U	1 U	0.1 U
Trichloroethene	**1**	**1.65**	**1.28**	0.1 U	1 U	1 U	**1.19**		1 U	1.62 U	1 U	0.1 U
1,1-Dichloroethane	1 U	1 U	1 U	0.1 U	1 U	1 U	1 U		1 U	1 U	1 U	0.1 U
1,1-Dichloroethane, LV		0.1 U				0.1 U				0.1 U		
1,1-Dichloroethene	1 U			0.1 U	1 U				1 U			0.1 U
1,1-Dichloroethene, LV		0.1 U	0.1 UJ			0.1 U	**0.029 J**			0.1 U	**0.0202 J**	
cis-1,2-Dichloroethene	2 U	1 U	1 U	0.53 U	2 U	1 U	**0.166 J**		2 U	1 U	1 U	0.53 U
trans-1,2-Dichloroethene	2 U	1 U	1 U	0.5 U	2 U	1 U	1 U		2 U	1 U	1 U	0.5 U
Total 1,2-Dichloroethene	2 U	1 U	1 U		2 U	1 U	**0.166 J**		2 U	1 U	1 U	
1,2-Dichloroethane	1 U	1 U		0.1 U	1 U	1 U			1 U	1 U		0.1 U
1,2-Dichloroethane, LV			0.1 U				0.1 U				0.1 U	
Vinyl Chloride	2 U			0.1 U	2 U				2 U			0.1 U
Vinyl Chloride, LV		0.1 U	0.1 U			0.1 U	0.1 U			0.1 U	0.1 U	
Chloroethane	2 U	1 U	1 U	0.9 U	2 U	1 UJ	1 U		2 U	1 U	1 U	0.9 U
Ethane		2 U	6.2 U			2 UJ	6.2 U			2 UJ	6.2 U	
Ethene		3 U	5.8 U			3 UJ	5.8 U			3 UJ	5.8 U	
Methane		1 U	3.3 U			**7.3 J**	**1.8 J**			**55.5**	**140**	

Well Node	MW16-01				MW16-02				MW16-03			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NORMAL	NORMAL	NS	NS	NS	NS	NS
Intermediate Overburden												
Tetrachloroethene						1 U	2 U					
Trichloroethene						**61**	**63**					
						1 U	2 U					
1,1-Dichloroethane, LV						0.1 U						
1,1-Dichloroethene												
1,1-Dichloroethene, LV						0.1 U	**0.641**					
cis-1,2-Dichloroethene						**0.53 J**	**0.603 J**					
trans-1,2-Dichloroethene						1 U	**0.515 J**					
Total 1,2-Dichloroethene						**0.53**	**1.12 J**					
1,2-Dichloroethane						1 U						
1,2-Dichloroethane, LV							0.1 U					
Vinyl Chloride												
Vinyl Chloride, LV						0.1 U	0.1 U					
Chloroethane						1 UJ	2 U					
Ethane						2 UJ	6.2 U					
Ethene						3 UJ	5.8 U					
Methane						1 UJ	3.3 U					

Well Node	MW16-01				MW16-02				MW16-03			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	AVG	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Deep Overburden												
Tetrachloroethene	1 U	1 U	1 U	0.1 U	1 U	**0.14 J**	50 U	5 UJ	1 U	1 U	1 U	0.1 U
Trichloroethene	**3**	**3.78**	**6.04**	**9.6**	**2100**	**1500 J**	**1200**	**1900**	1 U	1 U	**0.142 J**	0.1 U
1,1-Dichloroethane	1 U	1 U	1 U	0.1 U	1 U	1 U	50 U	5 UJ	1 U	1 U	1 U	0.1 U
1,1-Dichloroethane, LV		0.1 U				**0.07 J**				0.1 U		
1,1-Dichloroethene	1 U			0.1 U	**1**			5 UJ	1 U			0.1 U
1,1-Dichloroethene, LV		0.1 U	0.1 U			**1.5 J**	**0.598**			0.1 U	**0.021 J**	
cis-1,2-Dichloroethene	2 U	1 U	1 U	0.53 U	**5**	**6.295**	50 U	5.3 U	2 U	1 U	1 U	0.53 U
trans-1,2-Dichloroethene	2 U	1 U	1 U	0.5 U	**0.8**	**0.95 J**	50 U	5 U	2 U	1 U	1 U	0.5 U
Total 1,2-Dichloroethene	2 U	1 U	1 U		**5.8**	**7.25**	50 U		2 U	1 U	1 U	
1,2-Dichloroethane	1 U	1 U		0.1 U	1 U	1 U		5 UJ	1 U	1 U		0.1 U
1,2-Dichloroethane, LV			0.1 U				0.023 U				0.1 U	
Vinyl Chloride	2 U			0.1 U	2 U			5 UJ	2 U			0.1 U
Vinyl Chloride, LV		0.1 U	0.1 U			**0.085 J**	**0.04 J**			0.1 U	0.1 U	
Chloroethane	2 U	1 U	1 U	0.9 U	2 U	1 UJ	50 U	9 U	2 U	1 U	1 U	0.9 U
Ethane		2 U	6.2 U			2 UJ	6.2 U			2 UJ	6.2 U	
Ethene		3 U	5.8 U			3 UJ	5.8 U			3 UJ	5.8 U	
Methane		1 U	3.3 U			1 UJ	3.3 U			1 U	3.3 U	

Well Node	MW16-01				MW16-02				MW16-03			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NORMAL	NORMAL	NORMAL	NORMAL	AVG	NORMAL	NS	NS	NORMAL	NORMAL
Shallow Bedrock												
Tetrachloroethene			1 U	0.1 U	1 U	1 U	37.5 U	5 UJ			1 U	0.1 U
Trichloroethene			**4.92**	**8.8**	**3100**	**840**	**1150**	**1900**			**31**	**30 J**
1,1-Dichloroethane			1 U	0.1 U	1 U	**0.12 J**	37.5 U	5 UJ			1 U	0.1 U
1,1-Dichloroethane, LV						**0.2**						
1,1-Dichloroethene				0.1 U	**2**			5 UJ				0.1 U
1,1-Dichloroethene, LV			0.1 U			**5**	**1.46**				**0.0433 J**	
cis-1,2-Dichloroethene			1 U	0.53 U	**7**	**19**	**19.5 J**	8.5 U			3.32 U	**3 J**
trans-1,2-Dichloroethene			1 U	0.5 U	**0.9**	**0.95 J**	37.5 U	8 U			1 U	0.5 U
Total 1,2-Dichloroethene			1 U		**7.9**	**20**	**19.5 J**				1 U	
1,2-Dichloroethane				0.1 U	1 U	1 U		5 UJ				0.1 U
1,2-Dichloroethane, LV			0.1 U				0.1 U				0.1 U	
Vinyl Chloride				0.1 U	2 U			5 UJ				0.1 U
Vinyl Chloride, LV			0.1 U			**0.4**	**0.371**				**0.0373 J**	
Chloroethane			1 U	0.9 U	2 U	1 U	37.5 U	14 U			1 U	0.9 U
Ethane			6.2 U			2 U	**4.75 J**				6.2 U	
Ethene			5.8 U			3 U	**2.05 J**				5.8 U	
Methane			3.3 U			1 U	**8.4**				3.3 U	

Well Node	MW16-01				MW16-02				MW16-03			
Investigation	Round 5	Round 6	Round 8		Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS		NS	NORMAL	AVG	NORMAL	NS	NS	NS	NS
Deep Bedrock												
Tetrachloroethene						1 U	5.5 U	0.52 U				
Trichloroethene						**120**	**465**	**440**				
1,1-Dichloroethane						**0.13 J**	**0.184 J**	0.5 U				
1,1-Dichloroethane, LV						**0.2**						
1,1-Dichloroethene								**3.9**				
1,1-Dichloroethene, LV						**2**	**0.589**					
cis-1,2-Dichloroethene						**3.24**	**5.74 J**	**7.2**				
trans-1,2-Dichloroethene						**0.18 J**	**0.448 J**	0.5 U				
Total 1,2-Dichloroethene						**3.42**	**5.96 J**					
1,2-Dichloroethane						1 U		0.45 U				
1,2-Dichloroethane, LV							0.1 U					
Vinyl Chloride								0.51 U				
Vinyl Chloride, LV						**0.2**	**0.345**					
Chloroethane						1 U	5.5 U	0.9 U				
Ethane						2 U	6.2 U					
Ethene						3 U	5.8 U					
Methane						1 U	**1.05 J**					

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-04				MW16-05				MW16-06			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Shallow Overburden												
Tetrachloroethene	1 U	1 U	1 U	0.1 U	1 U	1 U	1 U	0.1 UJ	1 U	1 UJ	1 U	0.1 U
Trichloroethene	**0.5**	1 U	1 U	0.1 U	1 U	1 UJ	1 U	0.1 UJ	**1**	**0.73 J**	**0.25 J**	0.1 U
1,1-Dichloroethane	1 U	1 U	1 U	0.1 U	1 U	1 U	1 U	0.1 UJ	1 U	1 UJ	1 U	0.1 U
1,1-Dichloroethane, LV		0.1 U				0.1 U				0.1 U		
1,1-Dichloroethene	1 U			0.1 U	1 U			0.1 UJ	1 U			0.1 U
1,1-Dichloroethene, LV		0.1 U	**0.027 J**			0.1 U	0.1 U			0.1 U	0.1 U	
cis-1,2-Dichloroethene	2 U	1 U	1 U	0.53 U	2 U	1 U	1 U	0.53 U	2 U	1 UJ	1 U	0.53 U
trans-1,2-Dichloroethene	2 U	1 U	1 U	0.5 U	2 U	1 U	1 U	0.5 U	2 U	1 UJ	1 U	0.5 U
Total 1,2-Dichloroethene	2 U	1 U	1 U		2 U	1 U	1 U		2 U	1 U	1 U	
1,2-Dichloroethane	1 U	1 U		0.1 U	1 U	1 U		0.1 UJ	1 U	1 UJ		0.1 U
1,2-Dichloroethane, LV			0.1 U				0.1 U				0.1 U	
Vinyl Chloride	**0.9**			0.1 U	2 U			0.1 UJ	2 U			0.1 UJ
Vinyl Chloride, LV		**0.3**	**0.521**			0.1 U	0.1 U			0.1 U	0.1 U	
Chloroethane	2 U	1 U	1 U	0.9 U	2 U	1 U	1 U	0.9 U	2 U	1 UJ	1 U	0.9 U
Ethane		20 U	6.2 U			2 U	6.2 U			2 U	6.2 U	
Ethene		30 U	**5.3 J**			3 U	5.8 U			3 U	5.8 U	
Methane		**700**	**12000**			**18**	**65**			1 U	**1.3 J**	

Well Node	MW16-04				MW16-05				MW16-06			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NORMAL	AVG	NORMAL	NS	NORMAL	NORMAL	AVG	NS	NS	NS	NS
Intermediate Overburden												
Tetrachloroethene		1 U	1 U	0.1 U		1 U	1 U	2 UJ				
Trichloroethene		**0.63 J**	**0.527 J**	0.1 U		**750**	**470**	**675**				
`		1 U	1 U	0.1 U		1 U	1 U	2 UJ				
1,1-Dichloroethane, LV		0.1 U				**0.05 J**						
1,1-Dichloroethene				0.1 U				2 UJ				
1,1-Dichloroethene, LV		0.1 U	0.1 U			**0.6**	**1.52**					
cis-1,2-Dichloroethene		1 U	1 U	0.53 U		**19**	**23**	**21.5**				
trans-1,2-Dichloroethene		1 U	1 U	0.5 U		**0.73 J**	**1.1**	1.5 U				
Total 1,2-Dichloroethene		1 U	1 U			**19.7**	**24.1**					
1,2-Dichloroethane		1 U		0.1 U		1 U		2 UJ				
1,2-Dichloroethane, LV			0.1 U				0.1 U					
Vinyl Chloride				0.1 U				2 UJ				
Vinyl Chloride, LV		0.1 U	**0.011 J**			**0.3**	**0.413**					
Chloroethane		1 U	1 U	0.9 U		1 U	1 U	2.7 U				
Ethane		2 U	6.2 U			2 U	6.2 U					
Ethene		3 U	5.8 U			3 U	5.8 U					
Methane		1 U	**6.5 J**			**270**	**1600**					

Well Node	MW16-04				MW16-05				MW16-06			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	AVG	AVG	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Deep Overburden												
Tetrachloroethene	1 U	1 U	1 U	0.8 UJ	1 U	**0.11 J**	1 U	4.4 U	1 U	1 U	1 U	0.1 U
Trichloroethene	**560**	**260**	**340**	**320**	**2250**	**1450 J**	**1100**	**1200**	1 U	**1.72 J**	**1.33**	**1.7 J**
1,1-Dichloroethane	1 U	1 U	1 U	0.8 UJ	1 U	**0.195 J**	**0.164 J**	4 UJ	1 U	1 U	1 U	0.1 U
1,1-Dichloroethane, LV		0.1 U				**0.125 J**				0.1 U		
1,1-Dichloroethene	2 U			0.8 UJ	2 U			4 UJ	1 U			0.1 U
1,1-Dichloroethene, LV		**0.9 J**	**0.382**			**1.1 J**	**0.948**			0.1 U	0.1 U	
cis-1,2-Dichloroethene	**6**	**4.21**	**4.79**	**4.4**	**6.5**	**5.075 J**	**4.83**	**4.8**	2 U	1 U	1 U	0.53 U
trans-1,2-Dichloroethene	2 U	**0.22 J**	**0.26 J**	1 U	**0.85**	**0.445 J**	**0.527 J**	0.5 U	2 U	1 U	1 U	0.5 U
Total 1,2-Dichloroethene	**6**	**4.43**	**5.05**		**7.35**	**5.52**	**5.36**		2 U	1 U	1 U	
1,2-Dichloroethane	1 U	1 U		0.8 UJ	1 U	1 U		4 UJ	1 U	1 U		0.1 U
1,2-Dichloroethane, LV			0.1 U				0.1 U				0.1 U	
Vinyl Chloride	2 U			0.8 UJ	2 U			4 UJ	2 U			0.1 U
Vinyl Chloride, LV		**0.09 J**	**0.134**			**0.075 J**	**0.049 J**			0.1 U	0.1 U	
Chloroethane	2 U	1 U	1 U	1.8 U	2 U	1 U	1 U	0.9 U	2 U	1 U	1 U	0.9 U
Ethane		2 U	6.2 U			2 U	6.2 U			2 U	6.2 U	
Ethene		3 U	5.8 U			3 U	5.8 U			3 U	5.8 U	
Methane		1 U	**2.7 J**			**2.1 J**	**23**			1 U	3.3 U	

Well Node	MW16-04				MW16-05				MW16-06			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL	NORMAL
Shallow Bedrock												
Tetrachloroethene						1 U	1 U	2.6 U		1 U	1 U	0.1 U
Trichloroethene						**750 J**	**860**	**1200**		**1.09 J**	1 U	0.1 U
1,1-Dichloroethane						**0.1 J**	1 U	2.5 U		1 U	1 U	0.1 U
1,1-Dichloroethane, LV						**0.2 J**				0.1 U		
1,1-Dichloroethene								3.8 U				0.1 U
1,1-Dichloroethene, LV						**2 J**	**0.549**			0.1 U	0.1 U	
cis-1,2-Dichloroethene						**8.2 J**	**8.08**	**11**		1 U	1 U	0.53 U
trans-1,2-Dichloroethene						**0.29 J**	**0.376 J**	2.5 U		1 U	1 U	0.5 U
Total 1,2-Dichloroethene						**8.49**	**8.46**			1 U	1 U	
1,2-Dichloroethane						1 U		2.3 U		1 U		0.1 U
1,2-Dichloroethane, LV							0.1 U				0.1 U	
Vinyl Chloride								2.6 U				0.1 U
Vinyl Chloride, LV						**0.2 J**	**0.141**			0.1 U	0.1 U	
Chloroethane						1 U	1 U	4.5 U		1 U	1 U	0.9 U
Ethane						2 U	6.2 U			2 U	6.2 U	
Ethene						3 U	5.8 U			3 U	5.8 U	
Methane						1 UJ	5.3 U			1 U	**78**	

Well Node	MW16-04				MW16-05				MW16-06			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NORMAL	NORMAL	NS	NS	NS	NS
Deep Bedrock												
Tetrachloroethene							1 U	0.1 U				
Trichloroethene							**9.37**	**12**				
1,1-Dichloroethane							1 U	0.1 U				
1,1-Dichloroethane, LV												
1,1-Dichloroethene								0.1 U				
1,1-Dichloroethene, LV							**0.093 J**					
cis-1,2-Dichloroethene							**0.597 J**	0.53 U				
trans-1,2-Dichloroethene							1 U	0.5 U				
Total 1,2-Dichloroethene							**0.597 J**					
1,2-Dichloroethane								0.1 U				
1,2-Dichloroethane, LV							0.1 U					
Vinyl Chloride								0.1 UJ				
Vinyl Chloride, LV							0.1 U					
Chloroethane							1 U	0.9 U				
Ethane							6.2 U					
Ethene							5.8 U					
Methane							4.3 U					

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-07				MW16-08			MW16-09			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	AVG	NORMAL	NORMAL	NORMAL	NS	NS	NORMAL	NS	NS	NS	NS
Shallow Overburden											
Tetrachloroethene	1 U	1 U	1 U	0.52 U			1 U				
Trichloroethene	**0.8**	1 U	**0.546 J**	0.5 U			**4.19**				
1,1-Dichloroethane	1 U	1 U	1 U	0.5 U			1 U				
1,1-Dichloroethane, LV		0.1 U									
1,1-Dichloroethene	1 U			0.76 U							
1,1-Dichloroethene, LV		0.1 U	0.1 U				0.1 U				
cis-1,2-Dichloroethene	2 U	1 U	1 U	0.53 U			1 U				
trans-1,2-Dichloroethene	2 U	1 U	1 U	0.5 U			1 U				
Total 1,2-Dichloroethene	2 U	1 U	1 U				1 U				
1,2-Dichloroethane	1 U	1 U		0.45 U							
1,2-Dichloroethane, LV			0.1 U				0.1 U				
Vinyl Chloride	2 U			0.51 U							
Vinyl Chloride, LV		0.1 U	0.1 U				0.1 U				
Chloroethane	2 U	1 U	1 U	0.9 U			1 U				
Ethane		2 UJ	6.2 U				6.2 U				
Ethene		3 UJ	5.8 U				5.8 U				
Methane		**5.6 J**	**200**				3.3 U				

Well Node	MW16-07				MW16-08			MW16-09			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Intermediate Overburden											
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

Well Node	MW16-07				MW16-08			MW16-09			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Deep Overburden											
Tetrachloroethene	1 U	1 U	1 U		1 U	**0.2 J**	1 U	1 U	1 UJ	1 U	0.1 UJ
Trichloroethene	**1**	1 U	**2.82**		**190**	**140**	**320**	1 U	**7.66 J**	**0.216 J**	**0.12 J**
1,1-Dichloroethane	1 U	1 U	1 U		1 U	1 U	1 U	1 U	1 UJ	1 U	0.1 UJ
1,1-Dichloroethane, LV		0.1 U				0.1 U			0.1 U		
1,1-Dichloroethene	1 U				1 U			1 U			0.1 UJ
1,1-Dichloroethene, LV		0.1 U	0.1 U			**0.2**	**0.188**		0.1 U	**0.0197 J**	
cis-1,2-Dichloroethene	2 U	1 U	1 U		**2**	**2.44**	**3.76**	2 U	1 UJ	1 U	0.53 U
trans-1,2-Dichloroethene	2 U	1 U	1 U		2 U	1 U	**0.158 J**	2 U	1 UJ	1 U	0.5 U
Total 1,2-Dichloroethene	2 U	1 U	1 U		**2**	**2.44**	**3.92**	2 U	1 U	1 U	
1,2-Dichloroethane	1 U	1 U			1 UJ	1 U		**0.4**	1 UJ		0.1 UJ
1,2-Dichloroethane, LV			0.1 U				0.1 U			0.1 U	
Vinyl Chloride	2 U				2 U			2 U			0.1 UJ
Vinyl Chloride, LV		0.1 U	**0.013 J**			**0.3**	**0.386**		0.1 U	0.1 U	
Chloroethane	2 U	1 U	1 U		2 U	1 U	1 U	2 U	1 UJ	1 U	0.9 U
Ethane		2 U	6.2 U			2 U	6.2 U		2 U	6.2 U	
Ethene		3 U	5.8 U			3 U	5.8 U		3 U	5.8 U	
Methane		**5.7**	3.3 U			1 U	3.3 U		1 U	3.3 U	

Well Node	MW16-07				MW16-08			MW16-09			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Shallow Bedrock											
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

Well Node	MW16-07				MW16-08			MW16-09			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock											
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-10				MW16-11				MW16-12		
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	NORMAL	NORMAL	NORMAL	NS	NS	NORMAL
Shallow Overburden											
Tetrachloroethene						1 U	1 U	0.1 U			1 U
Trichloroethene						**0.9 J**	**0.266 J**	**1.3**			**3.52**
1,1-Dichloroethane						1 U	1 U	0.1 U			1 U
1,1-Dichloroethane, LV						0.1 U					
1,1-Dichloroethene								0.1 U			
1,1-Dichloroethene, LV						0.1 U	0.1 U				0.1 U
cis-1,2-Dichloroethene						1 U	1 U	0.53 U			**0.972 J**
trans-1,2-Dichloroethene						1 U	1 U	0.5 U			1 U
Total 1,2-Dichloroethene						1 U	1 U				**0.972 J**
1,2-Dichloroethane						1 U		0.1 U			
1,2-Dichloroethane, LV							0.1 U				0.1 U
Vinyl Chloride								0.1 U			
Vinyl Chloride, LV						0.1 U	0.1 U				0.1 U
Chloroethane						1 U	1 U	0.9 U			1 U
Ethane						2 UJ	6.2 U				6.2 U
Ethene						3 UJ	5.8 U				5.8 U
Methane						1 UJ	3.3 U				3.3 U

Well Node	MW16-10				MW16-11				MW16-12		
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8
Sample Code	NS	NS	NS	NORMAL	NS	NS	NS	NS	NS	NS	NS
Intermediate Overburden											
Tetrachloroethene				**1.7**							
Trichloroethene				**2.9**							
				0.1 U							
1,1-Dichloroethane, LV											
1,1-Dichloroethene				0.1 U							
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene				0.14 U							
trans-1,2-Dichloroethene				0.13 U							
Total 1,2-Dichloroethene											
1,2-Dichloroethane				0.1 U							
1,2-Dichloroethane, LV											
Vinyl Chloride				0.1 U							
Vinyl Chloride, LV											
Chloroethane				0.85 U							
Ethane											
Ethene											
Methane											

Well Node	MW16-10				MW16-11				MW16-12		
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8
Sample Code	AVG	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL	NORMAL
Deep Overburden											
Tetrachloroethene	**0.55**	1 UJ	1 U	0.1 U	1 U	1 U	1 U		1 U	1 U	1 U
Trichloroethene	1 U	1 UJ	**0.497 J**	0.1 U	1 U	**4.94**	1 U		**21**	**23**	**32**
1,1-Dichloroethane	1 U	1 UJ	1 U	0.1 U	1 U	1 U	1 U		1 U	1 U	1 U
1,1-Dichloroethane, LV		**0.1**				0.1 U				**0.1**	
1,1-Dichloroethene	1 U			0.1 U	1 U				1 U		
1,1-Dichloroethene, LV		**0.6**	0.1 U			0.1 U	0.1 U			**0.08 J**	**0.021 J**
cis-1,2-Dichloroethene	2 U	1 UJ	1 U	0.53 U	2 U	1 U	1 U		2 U	1 U	1 U
trans-1,2-Dichloroethene	2 U	1 UJ	1 U	0.5 U	2 U	1 U	1 U		2 U	1 U	1 U
Total 1,2-Dichloroethene	2 U	1 U	1 U		2 U	1 U	1 U		2 U	1 U	1 U
1,2-Dichloroethane	**0.3**	1 UJ		0.1 U	**0.4**	1 U			1 U	1 U	
1,2-Dichloroethane, LV			0.1 U				0.1 U				0.1 U
Vinyl Chloride	2 U			0.1 U	2 U				2 U		
Vinyl Chloride, LV		0.1 U	0.1 U			0.1 U	0.1 U			0.1 U	0.1 U
Chloroethane	2 U	1 UJ	1 U	0.9 U	2 U	1 U	1 U		2 U	1 U	1 U
Ethane		2 U	6.2 U			2 UJ	6.2 U			2 U	6.2 U
Ethene		3 U	5.8 U			3 UJ	5.8 U			3 U	5.8 U
Methane		1 U	3.3 U			1 UJ	3.3 U			1 U	3.3 U

Well Node	MW16-10				MW16-11				MW16-12		
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NS	NS	NS	NS	NS	NS	NS
Shallow Bedrock											
Tetrachloroethene	1 U	1 U	1 U	0.1 U							
Trichloroethene	1 U	1 U	1 U	0.1 U							
1,1-Dichloroethane	1 U	1 U	1 U	0.1 U							
1,1-Dichloroethane, LV		0.1 U									
1,1-Dichloroethene	1 U			0.1 U							
1,1-Dichloroethene, LV		0.1 U	**0.027 J**								
cis-1,2-Dichloroethene	2 U	1 U	1 U	0.53 U							
trans-1,2-Dichloroethene	2 U	1 U	1 U	0.5 U							
Total 1,2-Dichloroethene	2 U	1 U	1 U								
1,2-Dichloroethane	1 U	1 U		0.1 U							
1,2-Dichloroethane, LV			0.1 U								
Vinyl Chloride	2 U			0.1 U							
Vinyl Chloride, LV		0.1 U	**0.065 J**								
Chloroethane	2 U	1 U	1 U	0.9 U							
Ethane		2 U	6.2 U								
Ethene		3 U	5.8 U								
Methane		**40**	**540**								

Well Node	MW16-10				MW16-11				MW16-12		
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock											
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-13				MW16-14				MW16-15			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NORMAL	NORMAL
Shallow Overburden												
Tetrachloroethene											1 U	0.1 U
Trichloroethene											6.15	6.6
1,1-Dichloroethane											1 U	0.1 U
1,1-Dichloroethane, LV												
1,1-Dichloroethene												0.1 U
1,1-Dichloroethene, LV											0.1 U	
cis-1,2-Dichloroethene											1 U	0.53 U
trans-1,2-Dichloroethene											1 U	0.5 U
Total 1,2-Dichloroethene											1 U	
1,2-Dichloroethane												0.1 U
1,2-Dichloroethane, LV											0.1 U	
Vinyl Chloride												0.1 U
Vinyl Chloride, LV											0.1 U	
Chloroethane											1 U	0.9 U
Ethane											6.2 U	
Ethene											5.8 U	
Methane											3.3 U	

Well Node	MW16-13				MW16-14				MW16-15			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL	NS	NS	NS	NS	NS
Intermediate Overburden												
Tetrachloroethene		1.64	0.473 J	0.1 U		0.17 J	1 U					
Trichloroethene		5.28	9.15	13		26	10					
		1 U	1 U	0.1 U		1 U	1 U					
1,1-Dichloroethane, LV		0.1 U				0.1 U						
1,1-Dichloroethene				0.1 U								
1,1-Dichloroethene, LV		0.1 U	0.1 U			0.1 U	0.1 U					
cis-1,2-Dichloroethene		1 U	1 U	0.53 U		0.34 J	1 U					
trans-1,2-Dichloroethene		1 U	1 U	0.5 U		1 U	1 U					
Total 1,2-Dichloroethene		1 U	1 U			0.34	1 U					
1,2-Dichloroethane		1 U		0.1 U		1 U						
1,2-Dichloroethane, LV			0.1 U				0.1 U					
Vinyl Chloride				0.1 U								
Vinyl Chloride, LV		0.1 U	0.1 U			0.1 U	0.1 U					
Chloroethane		1 U	1 U	0.9 U		1 U	1 U					
Ethane		2 UJ	6.2 U			2 UJ	6.2 U					
Ethene		3 UJ	5.8 U			3 UJ	5.8 U					
Methane		1 UJ	3.3 U			1 UJ	1.6 J					

Well Node	MW16-13				MW16-14				MW16-15			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL	NORMAL	NORMAL	AVG	NORMAL	NORMAL	NS
Deep Overburden												
Tetrachloroethene	1 U	1 U	1 U		1 U	0.3 J	50 U	0.52 U	0.7	0.67 J	1 U	
Trichloroethene	1 U	0.32 J	0.326 J		4900	3000 J	2000	2300	6300	2700 J	1400	
1,1-Dichloroethane	1 U	1 U	1 U		1 U	1 U	50 U	0.5 U	1 U	1 U	1 U	
1,1-Dichloroethane, LV		0.1 U				0.1 U				0.1 U		
1,1-Dichloroethene	1 U				1 U			1.5	0.85 J			
1,1-Dichloroethene, LV		0.1 U	0.1 UJ			0.5	0.137			0.1 U	0.442	
cis-1,2-Dichloroethene	2 U	0.23 J	1 U		5	1.87	50 U	1.6	3	2.18	2.19	
trans-1,2-Dichloroethene	2 U	1 U	1 U		2 U	0.27 J	50 U	0.5 U	0.7	0.25 J	0.275 J	
Total 1,2-Dichloroethene	2 U	0.23	1 U		5	2.14	50 U		3.35	2.43	2.47	
1,2-Dichloroethane	0.3	1 U			1 U	1 U		0.45 U	1 UJ	1 U		
1,2-Dichloroethane, LV			0.1 UJ				0.1 U				0.1 U	
Vinyl Chloride	2 U				2 U			0.51 U	2 UJ			
Vinyl Chloride, LV		0.1 U	0.1 UJ			0.1 U	0.1 U			0.1 U	0.0193 J	
Chloroethane	2 U	1 U	1 U		0.6	1 U	50 U	0.9 U	2 U	1 U	1 U	
Ethane		2 UJ	6.2 U			2 UJ	6.2 U			2 U	6.2 U	
Ethene		3 UJ	5.8 U			3 UJ	5.8 U			3 U	5.8 U	
Methane		92 J	210			1 UJ	3.3 U			1 U	3.3 U	

Well Node	MW16-13				MW16-14				MW16-15			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NORMAL	NS	NS	NORMAL	NORMAL	NORMAL	NORMAL	AVG	NS
Shallow Bedrock												
Tetrachloroethene				0.1 U			1 U	0.1 U	50 U	1 U	1 U	
Trichloroethene				0.1 U			0.85 J	4.4	4600	1300 J	705 J	
1,1-Dichloroethane				0.1 U			1 U	0.1 U	50 U	1 U	1 U	
1,1-Dichloroethane, LV										0.1		
1,1-Dichloroethene				0.1 U				0.1 U	50 U			
1,1-Dichloroethene, LV							0.1 U			1	0.8185 J	
cis-1,2-Dichloroethene				0.14 U			1 U	0.53 U	110	52 J	54.5	
trans-1,2-Dichloroethene				0.13 U			1 U	0.5 U	100 U	0.3 J	0.213 J	
Total 1,2-Dichloroethene							1 U		110	52.3	54.7	
1,2-Dichloroethane				0.1 U				0.1 U	50 U	1 U		
1,2-Dichloroethane, LV							0.1 U				0.0263 J	
Vinyl Chloride				0.1 U				0.1 U	100 U			
Vinyl Chloride, LV							0.1 U			0.4	0.2705	
Chloroethane				0.85 U			1 U	0.9 U	100 U	1 U	1 U	
Ethane							6.2 U			9.1	5.05 J	
Ethene							5.8 U			6.8	3.9 J	
Methane							3.3 U			1 U	835 J	

Well Node	MW16-13				MW16-14				MW16-15			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NORMAL	NORMAL	NS
Deep Bedrock												
Tetrachloroethene										1 U	1 U	
Trichloroethene										160 J	210	
1,1-Dichloroethane										1 U	1 U	
1,1-Dichloroethane, LV										0.06 J		
1,1-Dichloroethene												
1,1-Dichloroethene, LV										0.8	1.31	
cis-1,2-Dichloroethene										21	27	
trans-1,2-Dichloroethene										0.35 J	0.306 J	
Total 1,2-Dichloroethene										21.4	27.3	
1,2-Dichloroethane										1 U		
1,2-Dichloroethane, LV											0.1 U	
Vinyl Chloride												
Vinyl Chloride, LV										0.1 U	0.19	
Chloroethane										1 U	1 U	
Ethane										2 U	6.2 U	
Ethene										3 U	5.8 U	
Methane										1 U	3.3 U	

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-16			MW16-17				MW16-18			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NORMAL	NORMAL	AVG	NS	NS	NS	NS
Shallow Overburden											
Tetrachloroethene					1 U	1 U	0.1 U				
Trichloroethene					1 U	1 U	0.1 U				
1,1-Dichloroethane					1 U	1 U	0.1 U				
1,1-Dichloroethane, LV					0.1 U						
1,1-Dichloroethene							0.1 U				
1,1-Dichloroethene, LV					0.1 U	0.1 U					
cis-1,2-Dichloroethene					1 U	1 U	0.53 U				
trans-1,2-Dichloroethene					1 U	1 U	0.5 U				
Total 1,2-Dichloroethene					1 U	1 U					
1,2-Dichloroethane					1 U		0.1 U				
1,2-Dichloroethane, LV						0.1 U					
Vinyl Chloride							0.1 U				
Vinyl Chloride, LV					0.1 U	0.1 U					
Chloroethane					1 UJ	1 U	0.9 U				
Ethane					2 UJ	6.2 U					
Ethene					3 UJ	5.8 U					
Methane					1 UJ	1 J					

Well Node	MW16-16			MW16-17				MW16-18			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NORMAL	NORMAL	NS	AVG	NORMAL	NORMAL	NS	NORMAL	AVG	NORMAL
Intermediate Overburden											
Tetrachloroethene		1 U	1 U		**0.835 J**	**0.766 J**	0.1 U		**1.08**	**1.975**	**1.4**
Trichloroethene		**200 J**	**49**		**0.43 J**	1 U	0.1 U		**23**	**72.5**	**61**
		1 U	1 U		1 U	1 U	0.1 U		1 U	1 U	0.4 U
1,1-Dichloroethane, LV		0.1 U			0.1 U				0.1 U		
1,1-Dichloroethene							0.1 U				0.4 U
1,1-Dichloroethene, LV		**0.07 J**	**0.0235 J**		0.1 U	0.1 U			0.1 U	0.1 U	
cis-1,2-Dichloroethene		**0.47 J**	**0.441 J**		1 U	1 U	0.53 U		1 U	1 U	0.53 U
trans-1,2-Dichloroethene		1 U	1 U		1 U	1 U	0.5 U		1 U	1 U	0.5 U
Total 1,2-Dichloroethene		**0.47**	**0.441 J**		1 U	1 U			1 U	1 U	
1,2-Dichloroethane		1 U			1 U		0.1 U		1 U		0.4 U
1,2-Dichloroethane, LV			0.1 U			0.1 U				0.1 U	
Vinyl Chloride							0.1 U				0.4 U
Vinyl Chloride, LV		0.1 U	0.1 U		0.1 U	0.1 U			0.1 U	0.1 U	
Chloroethane		1 U	1 U		1 U	1 U	0.9 U		1 UJ	1 U	0.9 U
Ethane		2 UJ	6.2 U		2 U	6.2 U			2 UJ	6.2 U	
Ethene		3 UJ	5.8 U		3 U	5.8 U			3 UJ	5.8 U	
Methane		1 UJ	3.3 U		1 U	**1 J**			1 UJ	**1.1 J**	

Well Node	MW16-16			MW16-17				MW16-18			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	AVG	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Deep Overburden											
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U	1 U	0.1 U	1 U	1 U	1 U	
Trichloroethene	**89**	**51 J**	**44**	1 U	1 U	1 U	0.1 U	**0.7**	1 U	**0.165 J**	
1,1-Dichloroethane	**0.6**	**0.35 J**	**0.2505 J**	1 U	1 U	1 U	0.1 U	1 U	1 U	1 U	
1,1-Dichloroethane, LV		**0.5**			0.1 U				**0.2**		
1,1-Dichloroethene	**0.7**			1 U			0.1 U	1 U			
1,1-Dichloroethene, LV		**0.5**	0.1 U		0.1 U	0.1 U			0.1 U	0.1 U	
cis-1,2-Dichloroethene	2 U	1 U	1 U	2 U	1 U	1 U	0.53 U	2 U	1 U	1 U	
trans-1,2-Dichloroethene	2 U	1 U	1 U	2 U	1 U	1 U	0.5 U	2 U	1 U	1 U	
Total 1,2-Dichloroethene	2 U	1 U	1 U	2 U	1 U	1 U		2 U	1 U	1 U	
1,2-Dichloroethane	1 U	1 U		1 UJ	1 U		0.1 U	1 U	1 U		
1,2-Dichloroethane, LV			0.1 U			0.1 U				0.1 U	
Vinyl Chloride	2 U			2 U			0.1 U	2 U			
Vinyl Chloride, LV		0.1 U	0.1 U		0.1 U	0.1 U			0.1 U	0.1 U	
Chloroethane	2 U	1 U	1 U	2 U	1 UJ	1 U	0.9 U	2 U	1 UJ	1 U	
Ethane		2 U	6.2 U		2 UJ	6.2 U			2 UJ	6.2 U	
Ethene		3 U	5.8 U		3 UJ	5.8 U			3 UJ	5.8 U	
Methane		1 U	**1.1 J**		1 UJ	**1.1 J**			1 UJ	**1.1 J**	

Well Node	MW16-16			MW16-17				MW16-18			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NORMAL	NORMAL	NORMAL	NS	NS	NS	NS
Shallow Bedrock											
Tetrachloroethene					1 U	1 U	0.1 U				
Trichloroethene					**0.34 J**	1 U	0.1 U				
1,1-Dichloroethane					1 U	1 U	0.1 U				
1,1-Dichloroethane, LV					0.1 U						
1,1-Dichloroethene							0.1 U				
1,1-Dichloroethene, LV					0.1 U	0.1 U					
cis-1,2-Dichloroethene					1 U	1 U	0.53 U				
trans-1,2-Dichloroethene					1 U	1 U	0.5 U				
Total 1,2-Dichloroethene					1 U	1 U					
1,2-Dichloroethane					1 U		0.1 U				
1,2-Dichloroethane, LV						0.1 U					
Vinyl Chloride							0.1 U				
Vinyl Chloride, LV					0.1 U	0.1 U					
Chloroethane					1 U	1 U	0.9 U				
Ethane					2 U	6.2 U					
Ethene					3 U	5.8 U					
Methane					1 U	**44**					

Well Node	MW16-16			MW16-17				MW16-18			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock											
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-19				MW16-20				MW16-21		
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Shallow Overburden											
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

Well Node	MW16-19				MW16-20				MW16-21		
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8
Sample Code	NS	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL
Intermediate Overburden											
Tetrachloroethene		1 UJ	1 U	**0.11**		1 U	1 U	0.1 U		1 UJ	1 U
Trichloroethene		**32 J**	**15**	**9.9**		**12**	**7.34**	**5.15**		**14 J**	**43**
		1 UJ	1 U	0.1 U		1 U	1 U	0.1 U		1 UJ	1 U
1,1-Dichloroethane, LV		0.1 U				0.1 U				0.1 U	
1,1-Dichloroethene				0.1 U				0.1 U			
1,1-Dichloroethene, LV		0.1 U	0.1 U			0.1 U	0.1 U			0.1 U	0.1 U
cis-1,2-Dichloroethene		1 UJ	1 U	0.53 U		**0.28 J**	**0.158 J**	0.53 U		**0.18 J**	**0.304 J**
trans-1,2-Dichloroethene		1 UJ	1 U	0.5 U		1 U	1 U	0.5 U		1 UJ	1 U
Total 1,2-Dichloroethene		1 U	1 U			**0.28**	**0.158 J**			**0.18**	**0.304 J**
1,2-Dichloroethane		1 U		0.1 U		1 U		0.1 U		1 UJ	
1,2-Dichloroethane, LV			0.1 U				0.1 U				0.1 U
Vinyl Chloride				0.1 U				0.1 U			
Vinyl Chloride, LV		0.1 U	0.1 U			0.1 U	0.1 U			0.1 U	0.1 U
Chloroethane		1 UJ	1 U	0.9 U		1 U	1 U	0.9 U		1 UJ	1 U
Ethane		2 U	6.2 U			2 U	6.2 U			2 UJ	6.2 U
Ethene		3 U	5.8 U			3 U	5.8 U			3 UJ	5.8 U
Methane		1 U	**1 J**			1 U	3.3 U			1 UJ	**2.3 J**

Well Node	MW16-19				MW16-20				MW16-21		
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL	NORMAL
Deep Overburden											
Tetrachloroethene	1 U	1 U	1 U	0.52 U	1 U	1 U	1 U		**0.4**	**0.24 J**	**0.371 J**
Trichloroethene	**390**	**320**	**260**	**200**	**1**	**11**	**9.96**		**1900**	**650 J**	**860**
1,1-Dichloroethane	1 U	**0.17 J**	1 U	0.5 U	1 U	1 U	1 U		1 U	**0.17 J**	**0.176 J**
1,1-Dichloroethane, LV		**0.2**				0.1 U				**0.8**	
1,1-Dichloroethene	1 U			0.76 U	1 U				**0.7**		
1,1-Dichloroethene, LV		**0.3**	**0.0274 J**			0.1 U	**0.0483 J**			**2**	**0.386**
cis-1,2-Dichloroethene	2 U	**0.62 J**	**0.492 J**	0.53 U	2 U	1 U	1 U		**1**	**0.78 J**	**1.31**
trans-1,2-Dichloroethene	2 U	1 U	1 U	0.5 U	2 U	1 U	1 U		2 U	**0.12 J**	**0.255 J**
Total 1,2-Dichloroethene	2 U	**0.62**	**0.492 J**		2 U	1 U	1 U		**1**	**0.9**	**1.57**
1,2-Dichloroethane	1 U	1 U		0.45 U	1 U	1 U			1 U	1 U	
1,2-Dichloroethane, LV			0.1 U				**0.0529 J**				0.1 U
Vinyl Chloride	2 U			0.51 U	2 U				2 U		
Vinyl Chloride, LV		0.1 U	**0.125**			0.1 U	**0.0592 J**			0.1 U	**0.0322 J**
Chloroethane	2 U	1 U	1 U	0.9 U	2 U	1 U	1 U		2 U	1 U	1 U
Ethane		2 U	6.2 U			2 U	6.2 U			2 U	6.2 U
Ethene		3 U	5.8 U			3 U	5.8 U			3 U	5.8 U
Methane		1 U	**1.3 J**			1 U	3.3 U			1 U	**1.6 J**

Well Node	MW16-19				MW16-20				MW16-21		
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Shallow Bedrock											
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

Well Node	MW16-19				MW16-20				MW16-21		
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock											
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-22			MW16-23				MW16-24		MW16-25			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NORMAL	NORMAL	NS	NS	NS	NS	NORMAL	NORMAL
Shallow Overburden													
Tetrachloroethene						1 U	0.4					1 U	0.1 UJ
Trichloroethene						31	30					2.9	1.5 J
1,1-Dichloroethane						1 U	0.1 U					1 U	0.1 UJ
1,1-Dichloroethane, LV													
1,1-Dichloroethene							0.1 U						0.1 UJ
1,1-Dichloroethene, LV						0.1 U						0.1 U	
cis-1,2-Dichloroethene						0.61 J	0.53 U					0.233 J	0.53 U
trans-1,2-Dichloroethene						1 U	0.5 U					1 U	0.5 U
Total 1,2-Dichloroethene						0.61 J						0.233 J	
1,2-Dichloroethane							0.1 U						0.1 UJ
1,2-Dichloroethane, LV						0.1 U						0.1 U	
Vinyl Chloride							0.1 U						0.1 UJ
Vinyl Chloride, LV						0.1 U						0.1 U	
Chloroethane						1 U	0.9 U					1 U	0.9 U
Ethane						6.2 U						6.2 U	
Ethene						5.8 U						5.8 U	
Methane						5.3 U						3.3 U	

Well Node	MW16-22			MW16-23				MW16-24		MW16-25			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8		Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NORMAL	NORMAL	NS	NS	NS		NORMAL	AVG	NS	NORMAL	NORMAL	NORMAL
Intermediate Overburden													
Tetrachloroethene		1.28	0.905 J					0.11 J	1 U		1 UJ	5 U	0.4 UJ
Trichloroethene		190	110					41	35		220 J	120	85
		1 U	1 U					1 U	1 U		1 UJ	5 U	0.4 UJ
1,1-Dichloroethane, LV		0.1 U						0.1 U			0.1 U		
1,1-Dichloroethene		1 U											0.4 UJ
1,1-Dichloroethene, LV		0.1 U	0.0168 J					0.1 U	0.1425		0.07 J	0.0326 J	
cis-1,2-Dichloroethene			0.681 J					0.63 J	1.54		1.11 J	5 U	0.53 U
trans-1,2-Dichloroethene			1 U					1 U	1 U		1 UJ	5 U	0.5 U
Total 1,2-Dichloroethene		2 U	0.681 J					0.63	1.54		1.11	5 U	
1,2-Dichloroethane		1 U						1 U			1 U		0.4 UJ
1,2-Dichloroethane, LV			0.1 U						0.1 U			0.1 U	
Vinyl Chloride													0.4 UJ
Vinyl Chloride, LV		0.1 U	0.1 U					0.1 U	0.1 U		0.1 U	0.1 U	
Chloroethane		1 U	1 U					1 U	1 U		1 UJ	5 U	0.9 U
Ethane		2 UJ	6.2 U					2 U	6.2 U		2 U	6.2 U	
Ethene		3 UJ	5.8 U					3 U	5.8 U		3 U	5.8 U	
Methane		1 UJ	1.2 J					1 U	1.2 J		1 U	3.3 U	

Well Node	MW16-22			MW16-23				MW16-24		MW16-25			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL	NORMAL	NORMAL	AVG	NORMAL
Deep Overburden													
Tetrachloroethene	1 U	0.29 J	1 U	1 U	20 U	1 U		1 U	1 U	0.5	1 UJ	0.3825 J	2.2 U
Trichloroethene	2600	920	1500	3500	500	1900		520	690	890	470 J	415	530
1,1-Dichloroethane	1 U	1 U	1 U	1 U	20 U	1 U		1 U	1 U	0.4 J	1 UJ	0.136 J	2 UJ
1,1-Dichloroethane, LV		0.1			0.1 U			0.2			0.2		
1,1-Dichloroethene	1	1 U		0.5	20 U					0.7			2 UJ
1,1-Dichloroethene, LV		1	0.422		0.4	0.844		14	0.624		0.3	0.0257 J	
cis-1,2-Dichloroethene	10		2.39	4		25		48	11	2	1 UJ	0.2285 J	2.7 U
trans-1,2-Dichloroethene	0.6		0.38 J	2 U		0.48 J		0.66 J	0.367 J	2 UJ	1 UJ	1 U	2.5 U
Total 1,2-Dichloroethene	10.6	2 U	2.77	4	40 U	25.5		48.7	11.4	2	1 U	0.229 J	
1,2-Dichloroethane	1 UJ	1 U		1 U	20 U			1 U		0.4	1 U		2 UJ
1,2-Dichloroethane, LV			0.1 U			0.1 U			0.0933 J			0.1 U	
Vinyl Chloride	2 U			2 U						2 UJ			2 UJ
Vinyl Chloride, LV		0.05 J	0.0273 J		0.05 J	0.0918 J		22	7.87		0.1 U	0.1 U	
Chloroethane	2 U	1 U	1 U	2 U	20 U	1 U		1 U	1 U	2 U	1 UJ	1 U	4.5 U
Ethane		2 UJ	6.2 U		2 UJ	6.2 U		2 U	6.2 U		2 U	6.2 U	
Ethene		3 UJ	5.8 U		3 UJ	5.8 U		3 U	5.8 U		3 U	5.8 U	
Methane		1 UJ	1 J		24 J	6.6 J		1 U	6.9		1 U	1.1 J	

Well Node	MW16-22			MW16-23				MW16-24		MW16-25			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	AVG	NORMAL	NORMAL	NORMAL
Shallow Bedrock													
Tetrachloroethene										1 U	1 UJ	1 U	0.1 U
Trichloroethene										1 U	1.08 J	0.445 J	0.12
1,1-Dichloroethane										1 U	1 UJ	0.285 J	0.29
1,1-Dichloroethane, LV											0.4		
1,1-Dichloroethene										1 U			0.1 U
1,1-Dichloroethene, LV											0.1 U	0.1 U	
cis-1,2-Dichloroethene										2 U	1 UJ	1 U	0.53 U
trans-1,2-Dichloroethene										2 U	1 UJ	1 U	0.5 U
Total 1,2-Dichloroethene										2 U	1 U	1 U	
1,2-Dichloroethane										1 UJ	1 U		0.1 U
1,2-Dichloroethane, LV												0.1 U	
Vinyl Chloride										2 U			0.1 U
Vinyl Chloride, LV											0.1 U	0.1 U	
Chloroethane										2 U	1 UJ	1 U	0.9 U
Ethane											2 U	6.2 U	
Ethene											3 U	5.8 U	
Methane											1 U	26	

Well Node	MW16-22			MW16-23				MW16-24		MW16-25			
Investigation	Round 5	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10	Round 6	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock													
Tetrachloroethene													
Trichloroethene													
1,1-Dichloroethane													
1,1-Dichloroethane, LV													
1,1-Dichloroethene													
1,1-Dichloroethene, LV													
cis-1,2-Dichloroethene													
trans-1,2-Dichloroethene													
Total 1,2-Dichloroethene													
1,2-Dichloroethane													
1,2-Dichloroethane, LV													
Vinyl Chloride													
Vinyl Chloride, LV													
Chloroethane													
Ethane													
Ethene													
Methane													

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-26				MW16-27				MW16-28			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Shallow Overburden												
Tetrachloroethene												
Trichloroethene												
1,1-Dichloroethane												
1,1-Dichloroethane, LV												
1,1-Dichloroethene												
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene												
trans-1,2-Dichloroethene												
Total 1,2-Dichloroethene												
1,2-Dichloroethane												
1,2-Dichloroethane, LV												
Vinyl Chloride												
Vinyl Chloride, LV												
Chloroethane												
Ethane												
Ethene												
Methane												

Well Node	MW16-26				MW16-27				MW16-28			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NORMAL	NORMAL	NS	NS	NORMAL	NORMAL
Intermediate Overburden												
Tetrachloroethene							1 U	1 U			1 U	0.1 U
Trichloroethene							**120**	**180**			**1.29**	**1**
							1 U	1 U			1 U	0.1 U
1,1-Dichloroethane, LV												
1,1-Dichloroethene								**2.4**				0.1 U
1,1-Dichloroethene, LV							**0.314**				0.1 U	
cis-1,2-Dichloroethene							**6.93**	**4.2**			1 U	0.53 U
trans-1,2-Dichloroethene							**0.238 J**	0.5 U			1 U	0.5 U
Total 1,2-Dichloroethene							**7.17**				1 U	
1,2-Dichloroethane								1 U				0.1 U
1,2-Dichloroethane, LV							0.1 U				0.1 U	
Vinyl Chloride								1 UJ				0.1 U
Vinyl Chloride, LV							0.1 U				0.1 U	
Chloroethane							1 U	0.9 U			1 U	0.9 U
Ethane							6.2 U				6.2 U	
Ethene							5.8 U				5.8 U	
Methane							3.3 U				**6.7 J**	

Well Node	MW16-26				MW16-27				MW16-28			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Deep Overburden												
Tetrachloroethene	1 U	1 U	1 U	0.1 U	1 U	1 U	1 U	0.52 U	1 U	1 U	1 U	0.4 U
Trichloroethene	**0.7**	1 UJ	1 U	0.1 U	**310**	**240**	**190**	**160**	**120**	**59 J**	**200**	**84**
1,1-Dichloroethane	1 U	1 U	1 U	0.1 U	1 U	1 U	1 U	0.5 U	1 U	1 U	1 U	0.4 U
1,1-Dichloroethane, LV		0.1 U				0.1 U				0.1 U		
1,1-Dichloroethene	1 U			0.1 U	**1**			0.76 U	1 U			0.4 U
1,1-Dichloroethene, LV		0.1 U	0.1 U			**1**	**0.811**			**0.5**	**0.18**	
cis-1,2-Dichloroethene	2 U	1 U	1 U	0.14 U	**9**	**10**	**8.95**	**7.3**	**0.8**	**0.94 J**	**1.15**	**1.4**
trans-1,2-Dichloroethene	2 U	1 U	1 U	0.13 U	**0.7**	**0.75 J**	**0.686 J**	0.5 U	2 U	1 U	1 U	0.5 U
Total 1,2-Dichloroethene	2 U	1 U	1 U		**9.7**	**10.8**	**9.64**		**0.8**	**0.94**	**1.15**	
1,2-Dichloroethane	1 U	1 U		0.1 U	1 UJ	1 U		0.45 U	1 U	1 U		0.4 U
1,2-Dichloroethane, LV			0.1 U				**0.0753 J**				0.1 U	
Vinyl Chloride	2 U			0.1 U	2 U			0.51 U	2 U			0.4 U
Vinyl Chloride, LV		0.1 U	**0.0786 J**			**0.06 J**	**0.0506 J**			0.1 U	0.1 U	
Chloroethane	2 U	1 U	1 U	0.85 U	2 U	1 U	1 U	0.9 U	2 U	1 U	1 U	0.9 U
Ethane		2 U	6.2 U			2 UJ	6.2 U			2 U	6.2 U	
Ethene		3 U	5.8 U			3 UJ	5.8 U			3 U	5.8 U	
Methane		**35**	**14**			**3.4 J**	**11**			1 U	3.3 U	

Well Node	MW16-26				MW16-27				MW16-28			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 8	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NORMAL	AVG	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Shallow Bedrock												
Tetrachloroethene					1 U	1 U	1 U	0.1 U	1 U	1 U	1 U	0.1 U
Trichloroethene					**1**	1.895 U	2.01 U	**1.9**	**0.9**	1 UJ	1 U	**0.47**
1,1-Dichloroethane					1 U	1 U	1 U	0.1 U	1 U	1 U	1 U	0.1 U
1,1-Dichloroethane, LV						0.1 U				0.1 U		
1,1-Dichloroethene					1 U			0.1 U	1 U			0.1 U
1,1-Dichloroethene, LV						0.1 U	0.1 U			0.1 U	0.1 U	
cis-1,2-Dichloroethene					**1**	**1.35**	1.64 U	**1.5**	2 U	1 U	1 U	0.53 U
trans-1,2-Dichloroethene					2 U	1 U	1 U	0.5 U	2 U	1 U	1 U	0.5 U
Total 1,2-Dichloroethene					**1**	**1.35**	1 U		2 U	1 U	1 U	
1,2-Dichloroethane					1 UJ	1 U		0.1 U	1 UJ	1 U		0.1 U
1,2-Dichloroethane, LV							0.1 U				**0.016 J**	
Vinyl Chloride					2 U			0.1 U	2 U			0.1 U
Vinyl Chloride, LV						0.1 U	**0.66 J**			0.1 U	0.1 U	
Chloroethane					2 U	1 U	1 U	0.9 U	2 U	1 U	1 U	0.9 U
Ethane						2 UJ	6.2 U			2 U	6.2 U	
Ethene						3 UJ	5.8 U			3 U	5.8 U	
Methane						1 UJ	3.3 U			1 U	**28**	

Well Node	MW16-26				MW16-27				MW16-28			
Investigation	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10	Round 5	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock												
Tetrachloroethene												
Trichloroethene												
1,1-Dichloroethane												
1,1-Dichloroethane, LV												
1,1-Dichloroethene												
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene												
trans-1,2-Dichloroethene												
Total 1,2-Dichloroethene												
1,2-Dichloroethane												
1,2-Dichloroethane, LV												
Vinyl Chloride												
Vinyl Chloride, LV												
Chloroethane												
Ethane												
Ethene												
Methane												

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-29			MW16-30			MW16-31			MW16-32		
Investigation	Round 5	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Shallow Overburden												
Tetrachloroethene												
Trichloroethene												
1,1-Dichloroethane												
1,1-Dichloroethane, LV												
1,1-Dichloroethene												
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene												
trans-1,2-Dichloroethene												
Total 1,2-Dichloroethene												
1,2-Dichloroethane												
1,2-Dichloroethane, LV												
Vinyl Chloride												
Vinyl Chloride, LV												
Chloroethane												
Ethane												
Ethene												
Methane												

Well Node	MW16-29			MW16-30			MW16-31			MW16-32		
Investigation	Round 5	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Intermediate Overburden												
Tetrachloroethene												
Trichloroethene												
1,1-Dichloroethane, LV												
1,1-Dichloroethene												
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene												
trans-1,2-Dichloroethene												
Total 1,2-Dichloroethene												
1,2-Dichloroethane												
1,2-Dichloroethane, LV												
Vinyl Chloride												
Vinyl Chloride, LV												
Chloroethane												
Ethane												
Ethene												
Methane												

Well Node	MW16-29			MW16-30			MW16-31			MW16-32		
Investigation	Round 5	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Deep Overburden												
Tetrachloroethene	1 UJ	1 U	1 U	1 U	1 U	0.1 U	**0.14 J**	1 U	0.4 UJ	**0.61 J**	10 U	0.52 U
Trichloroethene	**2700**	**1200**	**2900**	**0.38 J**	1 U	0.1 U	**210**	**150**	**100**	**2700**	**290**	**260**
1,1-Dichloroethane	1 UJ	1 U	1 U	1 U	1 U	0.1 U	1 U	1 U	0.4 UJ	1 U	10 U	0.5 U
1,1-Dichloroethane, LV		0.1 U		0.1 U			0.1 U			**0.09 J**		
1,1-Dichloroethene	3 UJ			1 U		0.1 U			0.4 UJ			0.76 U
1,1-Dichloroethene, LV		**4**	**1.17**	0.1 U	0.1 U		**0.1**	**0.197**		**2**	**0.479**	
cis-1,2-Dichloroethene	**52 J**	**61**	**35**		1 U	0.53 U	**0.82 J**	1 U	0.53 U	**7.03**	10 U	0.53 U
trans-1,2-Dichloroethene	**3 J**	**2.03**	**2.02**		1 U	0.5 U	**0.13 J**	**0.143 J**	0.5 U	**1.81**	10 U	0.5 U
Total 1,2-Dichloroethene	**55**	**63**	**37**	2 U	1 U		**0.95**	**0.143 J**		**8.84**	10 U	
1,2-Dichloroethane	1 UJ	1 U		1 U		0.1 U	1 U		0.4 UJ	1 U		0.45 U
1,2-Dichloroethane, LV			0.1 U		0.1 U			0.1 U			0.1 U	
Vinyl Chloride	**2 J**					0.1 U			0.4 UJ			0.51 U
Vinyl Chloride, LV		**1**	**0.515**	0.1 U	**0.0717 J**		0.1 U	**0.111**		0.1 U	**0.023 J**	
Chloroethane	2 UJ	1 U	1 U	1 U	1 U	0.9 U	1 U	1 U	0.9 U	1 U	10 U	0.9 U
Ethane		2 U	6.2 U	2 UJ	6.2 U		2 UJ	6.2 U		2 UJ	**1.3 J**	
Ethene		3 U	5.8 U	3 UJ	5.8 U		3 UJ	5.8 U		3 UJ	5.8 U	
Methane		**410 J**	**3000**	**1.5 J**	**110**		1 UJ	3.3 U		1 UJ	1.7 U	

Well Node	MW16-29			MW16-30			MW16-31			MW16-32		
Investigation	Round 5	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NORMAL	NORMAL
Shallow Bedrock												
Tetrachloroethene											5 U	0.52 U
Trichloroethene											**110**	**52 J**
1,1-Dichloroethane											5 U	0.5 U
1,1-Dichloroethane, LV												
1,1-Dichloroethene												0.76 U
1,1-Dichloroethene, LV											**0.12**	
cis-1,2-Dichloroethene											5 U	0.53 U
trans-1,2-Dichloroethene											5 U	0.5 U
Total 1,2-Dichloroethene											5 U	
1,2-Dichloroethane												0.45 U
1,2-Dichloroethane, LV											0.1 U	
Vinyl Chloride												0.51 U
Vinyl Chloride, LV											0.1 U	
Chloroethane											5 U	0.9 U
Ethane											**1 J**	
Ethene											5.8 U	
Methane											3.3 U	

Well Node	MW16-29			MW16-30			MW16-31			MW16-32		
Investigation	Round 5	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock												
Tetrachloroethene												
Trichloroethene												
1,1-Dichloroethane												
1,1-Dichloroethane, LV												
1,1-Dichloroethene												
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene												
trans-1,2-Dichloroethene												
Total 1,2-Dichloroethene												
1,2-Dichloroethane												
1,2-Dichloroethane, LV												
Vinyl Chloride												
Vinyl Chloride, LV												
Chloroethane												
Ethane												
Ethene												
Methane												

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-33			MW16-34			MW16-35		MW16-36			MW16-37		
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	AVG	AVG	NORMAL	NORMAL	NORMAL	NS	NORMAL	NORMAL	NS	NS	NS	NORMAL	NORMAL	NORMAL
Shallow Overburden														
Tetrachloroethene	1.375	0.322 J	0.21	0.69 J	1 U		0.34 J	1 U				0.58 J	1 U	0.1 U
Trichloroethene	0.75 J	0.17 J	0.1 U	1 U	1 U		1 U	1 U				840	93	30
1,1-Dichloroethane	1 U	1 U	0.1 U	1 U	1 U		1 U	1 U				1 U	1 U	0.1 U
1,1-Dichloroethane, LV	0.1 U			0.1			0.1 U					0.1 U		
1,1-Dichloroethene			0.1 U											0.1 U
1,1-Dichloroethene, LV	0.1 U	0.1 U		0.09 J	0.1 U		0.1 U	0.1 U				0.1 U	0.1 U	
cis-1,2-Dichloroethene	1 U	1 U	0.53 U	1 U	1 U		1 U	1 U				1 U	1 U	0.53 U
trans-1,2-Dichloroethene	1 U	1 U	0.5 U	1 U	1 U		1 U	1 U				1 U	1 U	0.5 U
Total 1,2-Dichloroethene	1 U	1 U		1 U	1 U		1 U	1 U				1 U	1 U	
1,2-Dichloroethane	1 U		0.1 U	1 U			1 U					1 U		0.1 U
1,2-Dichloroethane, LV		0.1 U			0.1 U			0.1 U					0.1 U	
Vinyl Chloride			0.1 U											0.1 U
Vinyl Chloride, LV	0.1 U	0.1 U		0.1 U	0.1 U		0.1 U	0.1 U				0.1 U	0.1 U	
Chloroethane	1 U	1 U	0.9 U	1 U	1 U		1 UJ	1 U				1 U	1 U	0.9 U
Ethane	2 UJ	6.2 U		2 U	6.2 U		2 UJ	6.2 U				2 UJ	6.2 U	
Ethene	3 U	5.8 U		3 U	5.8 U		3 UJ	5.8 U				3 UJ	5.8 U	
Methane	1 U	1.1 J		1 U	3.3 U		1 UJ	3.3 U				1 UJ	1.1 J	

Well Node	MW16-33			MW16-34			MW16-35		MW16-36			MW16-37		
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	AVG	NORMAL	NORMAL	AVG	NORMAL	NS	NORMAL	NORMAL	NS	NS	NS	NORMAL	NORMAL	NORMAL
Intermediate Overburden														
Tetrachloroethene	24	18	15 J	4.77 J	3.9		3.76	3.81				0.94 J	50 U	1.6
Trichloroethene	2.015 U	1.5	1.7	2.74 J	1 U		0.6 J	0.555 J				1100	1700	230
	1 U	1 U	0.1 U	1 UJ	1 U		1 U	1 U				1 U	50 U	0.5 U
1,1-Dichloroethane, LV	0.1 U			0.1 U			0.1 U					0.1 U		
1,1-Dichloroethene			0.1 U											0.76 U
1,1-Dichloroethene, LV	0.1 U	0.1 U		0.1 U	0.1 U		0.1 U	0.1 U				0.1 U	0.044 J	
cis-1,2-Dichloroethene	1 U	1 U	0.53 U	1 UJ	1 U		1 U	1 U				1 U	50 U	0.53 U
trans-1,2-Dichloroethene	1 U	1 U	0.5 U	1 UJ	1 U		1 U	1 U				1 U	50 U	0.5 U
Total 1,2-Dichloroethene	1 U	1 U		1 U	1 U		1 U	1 U				1 U	50 U	
1,2-Dichloroethane	1 U		0.1 U	1 UJ			1 U					1 U		0.45 U
1,2-Dichloroethane, LV		0.1 U			0.1 U			0.1 U					0.1 U	
Vinyl Chloride			0.1 U											0.51 U
Vinyl Chloride, LV	0.1 U	0.1 U		0.1 U	0.1 U		0.1 U	0.1 U				0.1 U	0.1 U	
Chloroethane	1 U	1 U	0.9 U	1 UJ	1 U		1 U	1 U				1 U	50 U	0.9 U
Ethane	2 UJ	6.2 U		2 U	6.2 U		2 UJ	6.2 U				2 UJ	6.2 U	
Ethene	3 U	5.8 U		3 U	5.8 U		3 UJ	5.8 U				3 UJ	5.8 U	
Methane	1 UJ	1.1 J		1 U	3.3 U		1 UJ	3.3 U				1 UJ	1.3 J	

Well Node	MW16-33			MW16-34			MW16-35		MW16-36			MW16-37		
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Deep Overburden														
Tetrachloroethene	1 U	1 U	0.1 U	23	7.91	10 J	1 U	1 U	1 UJ	1 U	0.1 U	1.35	1.58	1.2
Trichloroethene	1 U	0.399 J	0.1 U	5.03	1.61	3.1	1 U	0.633 J	1 UJ	1 U	0.1 U	21	13	13
1,1-Dichloroethane	1 U	1 U	0.1 U	1 U	1 U	0.1 U	1 U	1 U	1 UJ	1 U	0.1 U	0.16 J	1 U	0.11
1,1-Dichloroethane, LV	0.06 J			0.1			0.1		0.1 U			0.1		
1,1-Dichloroethene			0.1 U			0.1 U					0.1 U			0.23
1,1-Dichloroethene, LV	0.1 U	0.1 U		0.09 J	0.1 U		0.07 J	0.1 U	0.1 U	0.1 U		0.2	0.1 U	
cis-1,2-Dichloroethene	1 U	1 U	0.53 U	1 U	1 U	0.53 U	1 U	1 U	1 UJ	1 U	0.53 U	1 U	1 U	0.53 U
trans-1,2-Dichloroethene	1 U	1 U	0.5 U	1 U	1 U	0.5 U	1 U	1 U	1 UJ	1 U	0.5 U	1 U	1 U	0.5 U
Total 1,2-Dichloroethene	1 U	1 U		1 U	1 U		1 U	1 U	1 U	1 U		1 U	1 U	
1,2-Dichloroethane	1 U		0.1 U	1 U		0.1 U	1 U		1 UJ		0.1 U	1 U		0.1 U
1,2-Dichloroethane, LV		0.1 U			0.1 U			0.032 J		0.1 U			0.1 U	
Vinyl Chloride			0.1 U			0.1 U					0.1 U			0.1 U
Vinyl Chloride, LV	0.1 U	0.1 U		0.1 U	0.1 U		0.1 U	0.1 U	0.1 U	0.1 U		0.1 U	0.1 U	
Chloroethane	1 U	1 U	0.9 U	1 U	1 U	0.9 U	1 UJ	1 U	1 UJ	1 U	0.9 U	1 U	1 U	0.9 U
Ethane	2 UJ	6.2 U		2 U	6.2 U		2 UJ	6.2 U	2 UJ	6.2 U		2 UJ	6.2 U	
Ethene	3 U	5.8 U		3 U	5.8 U		3 UJ	5.8 U	3 UJ	5.8 U		3 UJ	5.8 U	
Methane	1 U	1.6 J		1 U	3.3 U		1 UJ	3.3 U	1 UJ	1.1 J		1 UJ	3.3 U	

Well Node	MW16-33			MW16-34			MW16-35		MW16-36			MW16-37		
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NORMAL	NORMAL	NORMAL	NS	NS	NS
Shallow Bedrock														
Tetrachloroethene									1 U	1 U	0.1 U			
Trichloroethene									1 U	1 U	0.1 U			
1,1-Dichloroethane									1 U	1 U	0.1 U			
1,1-Dichloroethane, LV									0.1 U					
1,1-Dichloroethene											0.1 U			
1,1-Dichloroethene, LV									0.1 U	0.1 U				
cis-1,2-Dichloroethene									1 U	1 U	0.53 U			
trans-1,2-Dichloroethene									1 U	1 U	0.5 U			
Total 1,2-Dichloroethene									1 U	1 U				
1,2-Dichloroethane									1 U		0.1 U			
1,2-Dichloroethane, LV										0.1 U				
Vinyl Chloride											0.1 U			
Vinyl Chloride, LV									0.1 U	0.1 U				
Chloroethane									1 U	1 U	0.9 U			
Ethane									2 UJ	6.2 U				
Ethene									3 UJ	5.8 U				
Methane									1 UJ	1.6 J				

Well Node	MW16-33			MW16-34			MW16-35		MW16-36			MW16-37		
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock														
Tetrachloroethene														
Trichloroethene														
1,1-Dichloroethane														
1,1-Dichloroethane, LV														
1,1-Dichloroethene														
1,1-Dichloroethene, LV														
cis-1,2-Dichloroethene														
trans-1,2-Dichloroethene														
Total 1,2-Dichloroethene														
1,2-Dichloroethane														
1,2-Dichloroethane, LV														
Vinyl Chloride														
Vinyl Chloride, LV														
Chloroethane														
Ethane														
Ethene														
Methane														

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-38		MW16-39			MW16-40			MW16-41			MW16-42	
Investigation	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	AVG	AVG	NORMAL	NORMAL	AVG	NS	NORMAL	AVG
Shallow Overburden													
Tetrachloroethene						1 U	1 U	0.1 U	1 U	1 U		1 U	1 U
Trichloroethene						14.5	14	0.1 U	1 U	0.418 J		1 U	1 U
1,1-Dichloroethane						1 U	1 U	0.1 U	1 U	1 U		1 U	1 U
1,1-Dichloroethane, LV						0.1 U			2 U			0.1 U	
1,1-Dichloroethene								0.1 U					
1,1-Dichloroethene, LV						0.1	6.68		2 U	1.24		0.1 U	0.7455
cis-1,2-Dichloroethene						93.5	87	4.1	7.06	3.86		2.5	5.195
trans-1,2-Dichloroethene						5.37	5.175	0.5 U	1.44	1.1		0.27 J	0.575 J
Total 1,2-Dichloroethene						98.9	92.2		8.5	4.96		2.77	5.77
1,2-Dichloroethane						1 U		0.1 U	1 U			1 U	
1,2-Dichloroethane, LV							0.1 U			0.1 U			0.1 U
Vinyl Chloride								26					
Vinyl Chloride, LV						10	55		36	24		5	9.28
Chloroethane						1 U	1 U	0.9 U	1 U	1 U		1 U	1 U
Ethane						2 U	9.55		3.9 J	10.5		2 UJ	2.85 J
Ethene						3 U	5.8 U		3 UJ	5.8 U		3 UJ	5.8 U
Methane						340 J	2600		300 J	1650		200	1750

Well Node	MW16-38		MW16-39			MW16-40			MW16-41			MW16-42	
Investigation	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NS	NORMAL	NS	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Intermediate Overburden													
Tetrachloroethene	0.64 J	20 U	0.26 J	2 U	0.5 UJ		1 U		0.45 J	5 U	0.1 U	1 U	1 U
Trichloroethene	1200	820	86 J	77	140		82		96	89	64	1 U	1 U
`	0.1 J	20 U	1 U	2 U	0.5 UJ		1 U		1 U	5 U	0.1 U	1 U	1 U
1,1-Dichloroethane, LV	0.2		0.1 U						0.1 U			0.1 U	
1,1-Dichloroethene					0.5 UJ						0.1 U		
1,1-Dichloroethene, LV	0.4	0.299	0.1	0.095 J			0.0138 J		0.1 U	0.0144 J		0.1 U	2.99 J
cis-1,2-Dichloroethene	0.49 J	20 U	0.29 J	2 U	0.53 U		1 U		0.5 J	5 U	0.53 U	51	38
trans-1,2-Dichloroethene	1 U	20 U	1 U	2 U	0.5 U		1 U		1 U	5 U	0.5 U	3.75	3.03
Total 1,2-Dichloroethene	0.49	20 U	0.29	2 U			1 U		0.5	5 U		54.8	41
1,2-Dichloroethane	1 U		1 U		0.5 UJ				1 U		0.1 U	1 U	
1,2-Dichloroethane, LV		0.048 J		0.1 U			0.1 U			0.1 U			0.1 U
Vinyl Chloride					0.5 UJ						7.4 J		
Vinyl Chloride, LV	0.1 U	0.1 U	0.1 U	0.1 U			0.0155 J		0.1 U	0.1 U		25	33
Chloroethane	1 U	20 U	1 U	2 U	0.9 U		1 U		1 U	5 U	0.9 U	1 U	1 U
Ethane	2 U	6.2 U	2 U	6.2 U			6.2 U		2 UJ	6.2 U		20 UJ	12
Ethene	3 U	5.8 U	3 U	5.8 U			5.8 U		3 UJ	5.8 U		30 U	5.8 U
Methane	1 U	3.3 U	1 U	3.3 U			3.3 U		1 UJ	1.1 J		3800	16000

Well Node	MW16-38		MW16-39			MW16-40			MW16-41			MW16-42	
Investigation	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NS	NS	NORMAL	NORMAL	NORMAL	NS	NORMAL	NS	NORMAL	NORMAL	NORMAL	NORMAL	AVG
Deep Overburden													
Tetrachloroethene			1 U	1 U	0.1 UJ		0.426 J		0.34 J	20 U	0.52 U	0.66 J	20 U
Trichloroethene			1 U	1.44	0.46 J		770		410	610	460	990	725
1,1-Dichloroethane			1 U	1 U	0.1 UJ		1 U		1 U	20 U	0.5 U	1 U	20 U
1,1-Dichloroethane, LV			0.2						0.1 U			0.1 U	
1,1-Dichloroethene					0.1 UJ						0.76 U		
1,1-Dichloroethene, LV			0.1 U	0.1 U			0.441		0.9	0.429		1	0.374
cis-1,2-Dichloroethene			1 U	1 U	0.53 U		4.84		4.11	4.4 J	3.1	6.87	4.82 J
trans-1,2-Dichloroethene			1 U	1 U	0.5 U		0.329 J		0.24 J	20 U	0.5 U	0.32 J	20 U
Total 1,2-Dichloroethene			1 U	1 U			5.17		4.35	4.4 J		7.19	4.82 J
1,2-Dichloroethane			1 U		0.1 UJ				1 U		0.45 U	1 U	
1,2-Dichloroethane, LV				0.1 U			0.1 U			0.1 U			0.1 U
Vinyl Chloride					0.1 UJ						0.51 U		
Vinyl Chloride, LV			0.1 U	0.056 J			0.189		0.1	0.106		0.2	0.135
Chloroethane			1 U	1 U	0.9 U		1 U		1 U	20 U	0.9 U	1 U	20 U
Ethane			2 U	6.2 U			6.2 U		2 UJ	6.2 U		2 UJ	6.2 U
Ethene			3 U	5.8 U			5.8 U		3 UJ	5.8 U		3 UJ	5.8 U
Methane			1 U	1.6 J			3.3 U		1 UJ	1.6 J		1 U	3.3 U

Well Node	MW16-38		MW16-39			MW16-40			MW16-41			MW16-42	
Investigation	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Shallow Bedrock													
Tetrachloroethene													
Trichloroethene													
1,1-Dichloroethane													
1,1-Dichloroethane, LV													
1,1-Dichloroethene													
1,1-Dichloroethene, LV													
cis-1,2-Dichloroethene													
trans-1,2-Dichloroethene													
Total 1,2-Dichloroethene													
1,2-Dichloroethane													
1,2-Dichloroethane, LV													
Vinyl Chloride													
Vinyl Chloride, LV													
Chloroethane													
Ethane													
Ethene													
Methane													

Well Node	MW16-38		MW16-39			MW16-40			MW16-41			MW16-42	
Investigation	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock													
Tetrachloroethene													
Trichloroethene													
1,1-Dichloroethane													
1,1-Dichloroethane, LV													
1,1-Dichloroethene													
1,1-Dichloroethene, LV													
cis-1,2-Dichloroethene													
trans-1,2-Dichloroethene													
Total 1,2-Dichloroethene													
1,2-Dichloroethane													
1,2-Dichloroethane, LV													
Vinyl Chloride													
Vinyl Chloride, LV													
Chloroethane													
Ethane													
Ethene													
Methane													

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-43		MW16-44			MW16-45			MW16-46		
Investigation	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	AVG	AVG	NORMAL	NORMAL	AVG	NORMAL	NORMAL	NORMAL	AVG
Shallow Overburden											
Tetrachloroethene	1 U	1 U	1 U	1 U	0.1 U	1 U	1 U	0.1 U	1 U	1 U	0.1 U
Trichloroethene	0.37 J	0.901 U	2.475	3.625	1.7	1 U	1 U	0.11	0.18 J	1 U	0.1 U
1,1-Dichloroethane	1 U	1 U	1 U	1 U	0.1 U	1 U	1 U	0.1 U	1 U	1 U	0.1 U
1,1-Dichloroethane, LV	0.1 U		0.1 U			0.1 U			0.1 U		
1,1-Dichloroethene					0.1 U			0.1 U			0.1 U
1,1-Dichloroethene, LV	0.1 U	0.357	0.25 J	2.23		0.1 U	0.7605		0.1 U	0.244	
cis-1,2-Dichloroethene	7.17	4.1	15	19.5	9	3.9	3.405	3.2	0.5 J	0.731 J	0.53 U
trans-1,2-Dichloroethene	0.38 J	0.213 J	1.215	1.76	1.5	1.06	0.729 J	0.5 U	0.32 J	0.245 J	0.5 U
Total 1,2-Dichloroethene	7.55	4.31	16.2	21.3		4.96	4.13		0.82	0.976 J	
1,2-Dichloroethane	1 U		1 U		0.1 U	1 U		0.1 U	1 U		0.1 U
1,2-Dichloroethane, LV		0.1 U		0.1 U			0.0173 J			0.1 U	
Vinyl Chloride					5.3			0.26			0.52
Vinyl Chloride, LV	2	0.415	44	12		0.1	0.1805		2	1.86	
Chloroethane	1 U	1 U	1 U	1 U	0.9 U	1 UJ	1 U	0.9 U	1 U	1 U	0.9 U
Ethane	2 U	6.2 U	2 U	6.2 U		2 UJ	6.2 U		20 U	6.2 U	
Ethene	3 U	5.8 U	3 U	5.8 U		3 UJ	5.8 U		30 U	5.8 U	
Methane	580	1500	525 J	2700		720	1385 J		460	4100	

Well Node	MW16-43		MW16-44			MW16-45			MW16-46		
Investigation	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	AVG	NORMAL	NS	NORMAL	NORMAL	NORMAL	AVG	NORMAL	NS
Intermediate Overburden											
Tetrachloroethene	1 U	1 U	1 U	1 U		1 U	1 U	0.52 U	1 U	1 U	
Trichloroethene	3.09	4.47	2.7525 J	3.14		820	520	610	0.445 J	0.454 J	
	1 U	1 U	1 U	1 U		1 U	1 U	0.5 U	1 U	1 U	
1,1-Dichloroethane, LV	0.1 U		0.1 U			0.06 J			0.1 U		
1,1-Dichloroethene								0.76 U			
1,1-Dichloroethene, LV	0.1 U	0.187	0.1 U	0.386		2	0.484		0.1 U	0.497	
cis-1,2-Dichloroethene	0.87 J	0.333 J	3.28	4.14		7.19	6.15	5.6	0.425 J	0.349 J	
trans-1,2-Dichloroethene	0.65 J	0.153 J	0.28 J	0.316 J		0.54 J	0.552 J	2.4	0.435 J	0.494 J	
Total 1,2-Dichloroethene	1.52	0.486 J	3.56	4.46		7.73	6.7		0.86	0.843 J	
1,2-Dichloroethane	1 U		1 U			1 U		0.45 U	1 U		
1,2-Dichloroethane, LV		0.1 U		0.1 U			0.0366 J			0.1 U	
Vinyl Chloride								0.51 U			
Vinyl Chloride, LV	0.1 U	0.1 U	0.55 J	0.926		0.3	0.117		0.1 U	0.1 U	
Chloroethane	1 U	1 U	1 U	1 U		1 U	1 U	0.9 U	1 U	1 U	
Ethane	2 U	6.2 U	2 U	6.2 U		2 UJ	6.2 U		2 U	6.2 U	
Ethene	3 U	5.8 U	3 U	5.8 U		3 UJ	5.8 U		3 U	5.8 U	
Methane	16	13	3.75	37		2.6	6.9 U		54.5	110	

Well Node	MW16-43		MW16-44			MW16-45			MW16-46		
Investigation	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NS
Deep Overburden											
Tetrachloroethene	1 U	1 U	1 U	1 U	0.52 U	1 U	20 U	0.52 U	1 U	10 U	
Trichloroethene	770	810	660 J	1300	1200	780	680	620	360	380	
1,1-Dichloroethane	1 U	1 U	1 U	1 U	0.5 U	1 U	20 U	0.5 U	1 U	10 U	
1,1-Dichloroethane, LV	0.1 U		0.1 U			0.1 U			0.1 U		
1,1-Dichloroethene					0.76 U			0.76 U			
1,1-Dichloroethene, LV	2	0.83	2	0.764		1	0.196		2	0.576	
cis-1,2-Dichloroethene	8.79	6.91	16	13	9.5	9.21	6.94 J	5.6	5.38	5.36 J	
trans-1,2-Dichloroethene	0.42 J	0.618 J	0.28 J	0.618 J	0.5 U	0.37 J	20 U	0.5 U	0.54 J	10 U	
Total 1,2-Dichloroethene	9.21	7.53	16.3	13.6		9.58	6.94 J		5.92	5.36 J	
1,2-Dichloroethane	1 U		1 U		0.45 U	1 U		0.45 U	1 U		
1,2-Dichloroethane, LV		0.1 U		0.1 U			0.1 U			0.0296 J	
Vinyl Chloride					0.51 U			0.51 U			
Vinyl Chloride, LV	0.1 U	0.139	0.3	0.322		0.2	0.0212 J		0.2	0.113	
Chloroethane	1 U	1 U	1 U	1 U	0.9 U	1 U	20 U	0.9 U	1 U	10 U	
Ethane	2 U	6.2 U	2 U	6.2 U		2 UJ	6.2 U		2 U	6.2 U	
Ethene	3 U	5.8 U	3 U	5.8 U		3 UJ	5.8 U		3 U	5.8 U	
Methane	1 U	3.3 U	1 U	1.6 J		1 U	3.3 U		1 U	3.6 U	

Well Node	MW16-43		MW16-44			MW16-45			MW16-46		
Investigation	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NS	NS	NORMAL	NORMAL	NORMAL	NS	NS	NS	NS	NS	NS
Shallow Bedrock											
Tetrachloroethene			1 U	1 U	0.52 U						
Trichloroethene			940 J	1400	1600						
1,1-Dichloroethane			1 U	1 U	0.5 U						
1,1-Dichloroethane, LV			0.1 U								
1,1-Dichloroethene					2.4						
1,1-Dichloroethene, LV			0.9	0.51							
cis-1,2-Dichloroethene			15	22	13						
trans-1,2-Dichloroethene			0.13 J	0.405 J	0.5 U						
Total 1,2-Dichloroethene			15.1	22.4							
1,2-Dichloroethane			1 U		0.45 U						
1,2-Dichloroethane, LV				0.1 U							
Vinyl Chloride					0.51 U						
Vinyl Chloride, LV			0.3 J	0.461							
Chloroethane			1 U	1 U	0.9 U						
Ethane			2 U	6.6							
Ethene			3 U	7.8							
Methane			2	11							

Well Node	MW16-43		MW16-44			MW16-45			MW16-46		
Investigation	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock											
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-47			MW16-48			MW16-49			MW16-50	
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NS	NS	NS	NS	NS	NS
Shallow Overburden											
Tetrachloroethene	1 U	1 U	0.1 U	1 U	1 U						
Trichloroethene	1 U	1 U	0.1 U	1 U	1 U						
1,1-Dichloroethane	1 U	1 U	0.1 U	1 U	1 U						
1,1-Dichloroethane, LV	0.1 U			0.1 U							
1,1-Dichloroethene			0.1 U								
1,1-Dichloroethene, LV	0.1 U	0.1 U		0.1 U	0.1 U						
cis-1,2-Dichloroethene	1 U	1 U	0.14 U	1 U	1 U						
trans-1,2-Dichloroethene	1 U	1 U	0.13 U	1 U	1 U						
Total 1,2-Dichloroethene	1 U	1 U		1 U	1 U						
1,2-Dichloroethane	1 U		0.1 U	1 U							
1,2-Dichloroethane, LV		0.1 U			0.1 U						
Vinyl Chloride			0.1 U								
Vinyl Chloride, LV	0.1 U	0.1 U		0.1 U	0.1 U						
Chloroethane	1 U	1 U	0.85 U	1 U	1 U						
Ethane	2 UJ	6.2 U		2 U	6.2 U						
Ethene	3 U	5.8 U		3 U	5.8 U						
Methane	1 U	3.3 U		**580 J**	**2900**						

Well Node	MW16-47			MW16-48			MW16-49			MW16-50	
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NS	NS	NS	AVG	AVG	NORMAL	NS	NORMAL	NORMAL	NS	NORMAL
Intermediate Overburden											
Tetrachloroethene				1 U	1 U	0.1 U		1 U	0.1 U		1 U
Trichloroethene				1 U	**0.2055 J**	0.1 U		1 U	0.1 U		1 U
				1 U	1 U	0.1 U		1 U	0.1 U		1 U
1,1-Dichloroethane, LV				0.1 U							
1,1-Dichloroethene						0.1 U			0.1 U		
1,1-Dichloroethene, LV				0.1 U	0.1 U			**0.096 J**			0.1 U
cis-1,2-Dichloroethene				1 U	1 U	0.53 U		1.31 U	0.53 U		1 U
trans-1,2-Dichloroethene				1 U	1 U	0.5 U		1 U	0.5 U		1 U
Total 1,2-Dichloroethene				1 U	1 U			1 U			1 U
1,2-Dichloroethane				1 U		0.1 U			0.1 U		
1,2-Dichloroethane, LV					0.1 U			0.1 U			0.1 U
Vinyl Chloride						0.1 UJ			0.1 U		
Vinyl Chloride, LV				0.1 U	0.1 U			0.1 U			0.1 U
Chloroethane				1 U	1 U	0.9 U		1 U	0.9 U		1 U
Ethane				2 U	6.2 U			6.2 U			6.2 U
Ethene				3 U	5.8 U			5.8 U			5.8 U
Methane				1 U	**1.5 J**			**16**			**12000**

Well Node	MW16-47			MW16-48			MW16-49			MW16-50	
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NORMAL	NORMAL	NS	NORMAL	NORMAL	AVG	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Deep Overburden											
Tetrachloroethene	1 U	1 U		1 U	1 U	0.1 U	1 U	1 U	0.1 U	1 U	1 U
Trichloroethene	1 U	1 U		**0.12 J**	1 U	0.1 U	**1.99**	1 U	**4.5**	**2.05**	1 U
1,1-Dichloroethane	1 U	1 U		1 U	1 U	0.1 U	1 U	1 U	0.1 U	1 U	1 U
1,1-Dichloroethane, LV	0.1 U			0.1 U			0.1 U			0.1 U	
1,1-Dichloroethene						0.1 U			0.1 U		
1,1-Dichloroethene, LV	0.1 U	0.1 U		0.1 U	0.1 U		**0.1**	0.1 U		**0.07 J**	0.1 U
cis-1,2-Dichloroethene	1 U	1 U		**0.35 J**	1 U	0.53 U	1 U	1 U	0.53 U	1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U		1 U	1 U	0.5 U	1 U	1 U	0.5 U	1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U		**0.35**	1 U		1 U	1 U		1 U	1 U
1,2-Dichloroethane	1 U			1 U		0.1 U	1 U		0.1 U	1 U	
1,2-Dichloroethane, LV		0.1 U			0.1 U			0.1 U			0.1 U
Vinyl Chloride						0.1 U			0.1 U		
Vinyl Chloride, LV	0.1 U	0.1 U		0.1 U	0.1 U		0.1 UJ	**0.498**		0.1 U	**0.031 J**
Chloroethane	1 U	1 U		1 U	1 U	0.9 U	1 U	1 U	0.9 U	1 U	1 U
Ethane	2 UJ	6.2 U		2 U	6.2 U		2 UJ	6.2 U		2 UJ	6.2 U
Ethene	3 UJ	5.8 U		3 U	5.8 U		3 UJ	5.8 U		3 UJ	5.8 U
Methane	1 U	3.3 U		1 U	**1.9 J**		**7.1 J**	3.3 U		**10 J**	**54 J**

Well Node	MW16-47			MW16-48			MW16-49			MW16-50	
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Shallow Bedrock											
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

Well Node	MW16-47			MW16-48			MW16-49			MW16-50	
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock											
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-51			MW16-52			MW16-53		MW16-54			MW16-55	
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	NS	NORMAL	NORMAL	NS	NS	NS	NS	NS
Shallow Overburden													
Tetrachloroethene							1 U	1 U					
Trichloroethene							**1.32**	**0.177 J**					
1,1-Dichloroethane							1 U	1 U					
1,1-Dichloroethane, LV							0.1 U						
1,1-Dichloroethene													
1,1-Dichloroethene, LV							0.1 U	0.1 U					
cis-1,2-Dichloroethene							1 U	1 U					
trans-1,2-Dichloroethene							1 U	1 U					
Total 1,2-Dichloroethene							1 U	1 U					
1,2-Dichloroethane							1 U						
1,2-Dichloroethane, LV								0.1 U					
Vinyl Chloride													
Vinyl Chloride, LV							0.1 U	0.1 U					
Chloroethane							1 U	1 U					
Ethane							2 UJ	6.2 U					
Ethene							3 UJ	5.8 U					
Methane							**75 J**	**1200**					

Well Node	MW16-51			MW16-52			MW16-53		MW16-54			MW16-55	
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Intermediate Overburden													
Tetrachloroethene													
Trichloroethene													
`													
1,1-Dichloroethane, LV													
1,1-Dichloroethene													
1,1-Dichloroethene, LV													
cis-1,2-Dichloroethene													
trans-1,2-Dichloroethene													
Total 1,2-Dichloroethene													
1,2-Dichloroethane													
1,2-Dichloroethane, LV													
Vinyl Chloride													
Vinyl Chloride, LV													
Chloroethane													
Ethane													
Ethene													
Methane													

Well Node	MW16-51			MW16-52			MW16-53		MW16-54			MW16-55	
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NORMAL	NORMAL	NS	NORMAL	NORMAL	NORMAL	NS	NS	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Deep Overburden													
Tetrachloroethene	1 U	1 U		1 U	1 U	0.1 U			1 U	1 U	0.1 U	1 U	1 U
Trichloroethene	**0.44 J**	**0.504 J**		1 U	**0.55 J**	0.1 U			1 U	1 U	0.1 U	1 UJ	1 U
1,1-Dichloroethane	1 U	1 U		1 U	1 U	0.1 U			1 U	1 U	0.1 U	1 U	1 U
1,1-Dichloroethane, LV	0.1 U			0.1 U					**0.06 J**			0.1 U	
1,1-Dichloroethene						0.1 U					0.1 U		
1,1-Dichloroethene, LV	**0.08 J**	**0.0237 J**		0.1 U	0.1 U				**0.1**	0.1 U		0.1 U	0.1 U
cis-1,2-Dichloroethene	**0.26 J**	**0.336 J**		1 U	1 U	0.53 U			1 U	1 U	0.53 U	1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U		1 U	1 U	0.5 U			1 U	1 U	0.5 U	1 U	1 U
Total 1,2-Dichloroethene	**0.26**	**0.336 J**		1 U	1 U				1 U	1 U		1 U	1 U
1,2-Dichloroethane	1 U			1 U		0.1 U			1 U		0.1 U	1 U	
1,2-Dichloroethane, LV		0.1 U			0.1 U					0.1 U			0.1 U
Vinyl Chloride						0.1 U					0.1 U		
Vinyl Chloride, LV	0.1 U	**0.0198 J**		0.1 U	**0.0641 J**				0.1 U	0.1 U		0.1 U	0.1 U
Chloroethane	1 U	1 U		1 U	1 U	0.9 U			1 U	1 U	0.9 U	1 U	1 U
Ethane	2 U	**1.3 J**		2 U	6.2 U				2 UJ	6.2 U		2 UJ	6.2 U
Ethene	3 U	5.8 U		3 U	5.8 U				3 UJ	5.8 U		3 UJ	5.8 U
Methane	**23**	**51**		**14**	**61**				1 UJ	3.3 U		1 UJ	3.3 U

Well Node	MW16-51			MW16-52			MW16-53		MW16-54			MW16-55	
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NORMAL	NORMAL	AVG	NORMAL	NORMAL	NS	NS	NS	NS	NS	NS	NORMAL	NORMAL
Shallow Bedrock													
Tetrachloroethene	1 U	1 U	0.1 U	1 U	1 U							1 U	1 U
Trichloroethene	**0.1 J**	1 U	0.1 U	1 U	1 U							1 U	1 U
1,1-Dichloroethane	1 U	1 U	0.1 U	1 U	1 U							1 U	1 U
1,1-Dichloroethane, LV	0.1 U			0.1 U								0.1 U	
1,1-Dichloroethene			0.1 U										
1,1-Dichloroethene, LV	0.1 U	0.1 U		0.1 U	0.1 U							0.1 U	0.1 U
cis-1,2-Dichloroethene	1 U	1 U	0.53 U	1 U	1 U							1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U	0.5 U	1 U	1 U							1 U	1 U
Total 1,2-Dichloroethene	1 U	1 U		1 U	1 U							1 U	1 U
1,2-Dichloroethane	1 U		0.1 U	1 U								1 U	
1,2-Dichloroethane, LV		0.1 U			0.1 U								0.1 U
Vinyl Chloride			0.1 U										
Vinyl Chloride, LV	0.1 U	0.1 U		0.1 U	0.1 U							0.1 U	0.1 U
Chloroethane	1 U	1 U	0.9 U	1 U	1 U							1 U	1 U
Ethane	2 U	6.2 U		2 U	6.2 U							2 UJ	6.2 U
Ethene	3 U	5.8 U		3 U	5.8 U							3 UJ	5.8 U
Methane	**3.8**	**11**		**3.8**	**160**							1 UJ	3.3 U

Well Node	MW16-51			MW16-52			MW16-53		MW16-54			MW16-55	
Investigation	Round 6	Round 8	Round 10	Round 6	Round 8	Round 10	Round 6	Round 8	Round 6	Round 8	Round 10	Round 6	Round 8
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NORMAL	NORMAL
Deep Bedrock													
Tetrachloroethene												1 U	1 U
Trichloroethene												1 UJ	1 U
1,1-Dichloroethane												1 U	1 U
1,1-Dichloroethane, LV												0.1 U	
1,1-Dichloroethene													
1,1-Dichloroethene, LV												0.1 U	0.1 U
cis-1,2-Dichloroethene												1 U	1 U
trans-1,2-Dichloroethene												1 U	1 U
Total 1,2-Dichloroethene												1 U	1 U
1,2-Dichloroethane												1 U	
1,2-Dichloroethane, LV													0.1 U
Vinyl Chloride													
Vinyl Chloride, LV												0.1 U	0.1 U
Chloroethane												1 U	1 U
Ethane												2 UJ	6.2 U
Ethene												3 UJ	5.8 U
Methane												1 UJ	3.3 U

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-56		MW16-57		MW16-58		MW16-59		MW16-60		MW16-61	MW16-62
Investigation	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 8
Sample Code	NS	NS	NS	NS	NORMAL	NORMAL	NORMAL	NS	NS	NS	NS	NS
Shallow Overburden												
Tetrachloroethene					1 U	0.1 U	1 U					
Trichloroethene					1 U	**0.63**	**21**					
1,1-Dichloroethane					1 U	0.1 U	1 U					
1,1-Dichloroethane, LV												
1,1-Dichloroethene						0.1 U						
1,1-Dichloroethene, LV					0.1 U		0.1 U					
cis-1,2-Dichloroethene					1 U	0.53 U	1 U					
trans-1,2-Dichloroethene					1 U	0.5 U	1 U					
Total 1,2-Dichloroethene					1 U		1 U					
1,2-Dichloroethane						0.1 U						
1,2-Dichloroethane, LV					0.1 U		0.1 U					
Vinyl Chloride						0.1 U						
Vinyl Chloride, LV					**0.0266 J**		0.1 U					
Chloroethane					1 U	0.9 U	1 U					
Ethane					6.2 U		6.2 U					
Ethene					5.8 U		5.8 U					
Methane					**22**		3.3 U					

Well Node	MW16-56		MW16-57		MW16-58		MW16-59		MW16-60		MW16-61	MW16-62
Investigation	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 8	Round 8	Round 8
Sample Code	NORMAL	NS	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NS	NS	NORMAL	NORMAL
Intermediate Overburden												
Tetrachloroethene	1 U		1 U	0.52 U	1 U	0.2 U	1 U	0.52 U			1 U	**0.322 J**
Trichloroethene	**0.851 J**		**310**	**210**	1 U	**48**	**670**	**790**			**9.4**	**20**
	1 U		1 U	0.5 U	1 U	0.2 U	1 U	0.5 U			1 U	1 U
1,1-Dichloroethane, LV												
1,1-Dichloroethene				0.76 U		0.2 U		0.76 U				
1,1-Dichloroethene, LV	0.1 U		**0.443**		0.1 U		**0.131**				0.1 U	0.1 U
cis-1,2-Dichloroethene	1 U		**1.2**	0.53 U	1.67 U	**25**	**3.3**	**3.3**			**0.529 J**	**0.815 J**
trans-1,2-Dichloroethene	1 U		**0.307 J**	0.5 U	1 U	**1.2**	1 U	0.5 U			1 U	1 U
Total 1,2-Dichloroethene	1 U		**1.5**		1 U		**3.3**				**0.529 J**	**0.815 J**
1,2-Dichloroethane				0.45 U		0.2 U		0.45 U				
1,2-Dichloroethane, LV	0.1 U		**0.0283 J**		0.1 U		0.1 U				0.1 U	0.1 U
Vinyl Chloride				0.51 U		**16 J**		0.51 U				
Vinyl Chloride, LV	0.1 U		**0.022 J**		**0.0304 J**		**0.158**				0.1 U	0.1 U
Chloroethane	1 U		1 U	0.9 U	1 U	0.9 U	1 U	0.9 U			1 U	1 U
Ethane	6.2 U		6.2 U		6.2 U		6.2 U				6.2 U	6.2 U
Ethene	5.8 U		5.8 U		5.8 U		5.8 U				5.8 U	5.8 U
Methane	3.3 U		3.3 U		**1300**		3.3 U				3.3 U	3.3 U

Well Node	MW16-56		MW16-57		MW16-58		MW16-59		MW16-60		MW16-61	MW16-62
Investigation	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 8
Sample Code	NORMAL	NS	NORMAL	NORMAL	NORMAL	AVG	NORMAL	AVG	NORMAL	NORMAL	NORMAL	NORMAL
Deep Overburden												
Tetrachloroethene	1 U		1 U	0.1 UJ	1 U	0.52 U	1 U	5.4 UJ	1 U	0.52 U	10 U	20 U
Trichloroethene	**50**		**0.678 J**	**1.3 J**	**1400**	**1600**	**2300**	**2150**	**1600**	**2000**	**220**	**550**
1,1-Dichloroethane	1 U		1 U	0.1 UJ	**0.196 J**	0.5 U	**0.135 J**	5.4 UJ	1 U	0.5 U	10 U	20 U
1,1-Dichloroethane, LV												
1,1-Dichloroethene				0.1 UJ		**2.25**		**2.5 J**		0.76 U		
1,1-Dichloroethene, LV	**0.0809 J**		0.1 U		**1.85**		**2.82**		**0.527**		**0.0465 J**	**0.336**
cis-1,2-Dichloroethene	**0.33 J**		1 U	0.53 U	**6.24**	**4.4**	**14**	9.75 U	**1.67**	**1.8**	10 U	20 U
trans-1,2-Dichloroethene	1 U		1 U	0.5 U	**0.845 J**	0.5 U	**0.392 J**	9 U	**0.255 J**	0.5 U	10 U	20 U
Total 1,2-Dichloroethene	**0.33 J**		1 U		**7.09**		**14.4**		**1.93**		10 U	20 U
1,2-Dichloroethane				0.1 UJ		0.45 U		5.4 UJ		0.45 U		
1,2-Dichloroethane, LV	**0.0746 J**		0.1 U		**0.0484 J**		**0.119**		**0.0229 J**		0.1 U	0.1 U
Vinyl Chloride				0.1 UJ		0.51 U		5.4 UJ		0.51 U		
Vinyl Chloride, LV	**0.0301 J**		**0.028 J**		**0.116**		**0.947**		**0.0236 J**		0.1 U	**0.0306 J**
Chloroethane	1 U		1 U	0.9 U	1 U	0.9 U	1 U	16 U	1 U	0.9 U	10 U	20 U
Ethane	6.2 U		6.2 U		6.2 U		**0.85 J**		**0.68 J**		6.2 U	**1.6 J**
Ethene	5.8 U		5.8 U		5.8 U		5.8 U		**0.88 J**		5.8 U	5.8 U
Methane	3.3 U		3.3 U		3.3 U		3.3 U		3.3 U		3.3 U	3.3 U

Well Node	MW16-56		MW16-57		MW16-58		MW16-59		MW16-60		MW16-61	MW16-62
Investigation	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 8
Sample Code	NORMAL	NORMAL	NS	NS	NORMAL	NS	NORMAL	NS	NORMAL	NS	NS	NS
Shallow Bedrock												
Tetrachloroethene	1 U	0.1 U			1 U		1 U	0.52 U	1 U	2 UJ		
Trichloroethene	**17**	**18**			**320**		**1500**	**1950**	**1800**	**660**		
1,1-Dichloroethane	1 U	0.1 U			1 U		**0.233 J**	0.5 U	1 U	2 UJ		
1,1-Dichloroethane, LV												
1,1-Dichloroethene		**0.24**						**4.65**		2 UJ		
1,1-Dichloroethene, LV	**0.279**				**0.715**		**4.2**		**5.05**			
cis-1,2-Dichloroethene	**1.5**	**1.2**			**6.65**		**23**	**29**	**16**	2.1 U		
trans-1,2-Dichloroethene	1 U	0.5 U			**0.663 J**		**0.559 J**	0.5 U	**0.668 J**	2 U		
Total 1,2-Dichloroethene	**1.5**				**7.31**		**23.6**		**16.7**			
1,2-Dichloroethane		0.1 U						0.45 U		2 UJ		
1,2-Dichloroethane, LV	**0.0124 J**				0.1 U		**0.0801 J**		**0.0652 J**			
Vinyl Chloride		0.1 UJ						**1.3 J**		2 UJ		
Vinyl Chloride, LV	**0.0498 J**				**0.112**		**0.916**		**0.413**			
Chloroethane	1 U	0.9 U			1 U		1 U	0.9 U	1 U	3.6 U		
Ethane	6.2 U				6.2 U		**3.2 J**		**3.1 J**			
Ethene	5.8 U				5.8 U		5.8 U		**1.7 J**			
Methane	3.3 U				**5**		3.3 U		3.3 U			

Well Node	MW16-56		MW16-57		MW16-58		MW16-59		MW16-60		MW16-61	MW16-62
Investigation	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 10	Round 8	Round 8
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock												
Tetrachloroethene												
Trichloroethene												
1,1-Dichloroethane												
1,1-Dichloroethane, LV												
1,1-Dichloroethene												
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene												
trans-1,2-Dichloroethene												
Total 1,2-Dichloroethene												
1,2-Dichloroethane												
1,2-Dichloroethane, LV												
Vinyl Chloride												
Vinyl Chloride, LV												
Chloroethane												
Ethane												
Ethene												
Methane												

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-63	MW16-64		MW16-65		MW16-66	MW16-67		MW16-68		MW16-69
Investigation	Round 8	Round 8	Round 10	Round 8	Round 10	Round 9	Round 9	Round 10	Round 9	Round 10	Round 9
Sample Code	NS	NS	NS	NORMAL	NORMAL	NORMAL	NORMAL	NS	NORMAL	NS	NORMAL
Shallow Overburden											
Tetrachloroethene				1 U							
Trichloroethene				**1.24**		**4.01**	**6.81**		**12**		**10**
1,1-Dichloroethane				1 U		1 U	1 U		1 U		1 U
1,1-Dichloroethane, LV											
1,1-Dichloroethene						1 U	1 U		1 U		1 U
1,1-Dichloroethene, LV				0.1 U							
cis-1,2-Dichloroethene				1 U		1 U	1 U		1 U		1 U
trans-1,2-Dichloroethene				1 U		1 U	1 U		1 U		1 U
Total 1,2-Dichloroethene				1 U		2 U	2 U		2 U		2 U
1,2-Dichloroethane						1 U	1 U		1 U		1 U
1,2-Dichloroethane, LV				0.1 U							
Vinyl Chloride						1 U	1 U		1 U		1 U
Vinyl Chloride, LV				0.1 U							
Chloroethane				1 U		1 U	1 U		1 U		1 U
Ethane				6.2 U		6.2 U	6.2 U		6.2 U		6.2 U
Ethene				5.8 U		5.8 U	5.8 U		5.8 U		5.8 U
Methane				5.3 U		5 U	4.4 U		14 U		3.3 U

Well Node	MW16-63	MW16-64		MW16-65		MW16-66	MW16-67		MW16-68		MW16-69
Investigation	Round 8	Round 8	Round 10	Round 8	Round 10	Round 9	Round 9	Round 10	Round 9	Round 10	Round 9
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NS	NORMAL	NS	NORMAL
Intermediate Overburden											
Tetrachloroethene	**0.311 J**	**0.431 J**	**0.4 J**	1 U	0.1 U						
Trichloroethene	**19**	**32**	**28 J**	**3.19**	**1.6**	**1.58**	**11**		**11**		**550**
	1 U	1 U	0.1 U	1 U	0.1 U	1 U	1 U		1 U		1 U
1,1-Dichloroethane, LV											
1,1-Dichloroethene			0.1 U		0.1 U	1 U	1 U		1 U		**0.302 J**
1,1-Dichloroethene, LV	0.1 U	0.1 U		0.1 U							
cis-1,2-Dichloroethene	**0.303 J**	**0.238 J**	0.53 U	1 U	0.53 U	1 U	1 U		1 U		**1.36**
trans-1,2-Dichloroethene	1 U	1 U	0.5 U	1 U	0.5 U	1 U	1 U		1 U		**0.201 J**
Total 1,2-Dichloroethene	**0.303 J**	**0.238 J**		1 U		2 U	2 U		2 U		**1 J**
1,2-Dichloroethane			0.1 U		0.1 U	1 U	1 U		1 U		1 U
1,2-Dichloroethane, LV	0.1 U	0.1 U		0.1 U							
Vinyl Chloride			0.1 U		0.1 U	1 U	1 U		1 U		1 U
Vinyl Chloride, LV	0.1 U	0.1 U		0.1 U							
Chloroethane	1 U	1 U	0.9 U	1 U	0.9 U	1 U	1 U		1 U		1 U
Ethane	6.2 U	6.2 U		6.2 U		6.2 U	6.2 U		6.2 U		6.2 U
Ethene	5.8 U	5.8 U		5.8 U		5.8 U	5.8 U		5.8 U		5.8 U
Methane	3.3 U	10 U		7.2 U		4.7 U	3.9 U		3.3 U		**15 J**

Well Node	MW16-63	MW16-64		MW16-65		MW16-66	MW16-67		MW16-68		MW16-69
Investigation	Round 8	Round 8	Round 10	Round 8	Round 10	Round 9	Round 9	Round 10	Round 9	Round 10	Round 9
Sample Code	NORMAL	NORMAL	NS	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	AVG	NORMAL	NORMAL
Deep Overburden											
Tetrachloroethene	20 U	1 U		1 U	0.1 U			0.52 U		2 UJ	
Trichloroethene	**540**	**380**		1 U	0.1 U	**18**	**980**	**1200**	**780**	**670**	**970**
1,1-Dichloroethane	20 U	1 U		1 U	0.1 U	1 U	1 U	0.5 U	1 U	2 UJ	1 U
1,1-Dichloroethane, LV											
1,1-Dichloroethene					0.1 U	1 U	**0.487 J**	0.76 U	**0.3355 J**	2 UJ	**0.74 J**
1,1-Dichloroethene, LV	**0.356**	**0.289**		0.1 U							
cis-1,2-Dichloroethene	20 U	**1.28**		1 U	0.53 U	**1.33**	**2.53**	**2.1**	**1.76**	2.1 U	**7.67**
trans-1,2-Dichloroethene	20 U	**0.145 J**		1 U	0.5 U	1 U	**0.245 J**	0.5 U	**0.133 J**	2 U	**0.164 J**
Total 1,2-Dichloroethene	20 U	**1.43**		1 U		**1.33 J**	**2.53**		**1.87 J**		**8.2**
1,2-Dichloroethane					0.1 U	1 U	1 U	0.45 U	1 U	2 UJ	1 U
1,2-Dichloroethane, LV	0.1 U	0.1 U		0.1 U							
Vinyl Chloride					0.1 U	1 U	1 U	0.51 U	1 U	2 UJ	1 U
Vinyl Chloride, LV	0.1 U	0.1 U		0.1 U							
Chloroethane	20 U	1 U		1 U	0.9 U	1 U	1 U	0.9 U	1 U	3.6 U	1 U
Ethane	6.2 U	6.2 U		6.2 U		6.2 U	6.2 U		6.2 U		**3.5 J**
Ethene	5.8 U	5.8 U		5.8 U		5.8 U	5.8 U		5.8 U		5.8 U
Methane	3.3 U	3.5 U		3.3 U		4.5 U	3.3 U		5.4 U		6.2 U

Well Node	MW16-63	MW16-64		MW16-65		MW16-66	MW16-67		MW16-68		MW16-69
Investigation	Round 8	Round 8	Round 10	Round 8	Round 10	Round 9	Round 9	Round 10	Round 9	Round 10	Round 9
Sample Code	NS	NS	NS	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	AVG	NORMAL	AVG
Shallow Bedrock											
Tetrachloroethene				**0.824 J**	**0.15**			0.52 U		0.52 U	
Trichloroethene				**0.415 J**	**1.2**	**3.45**	**600**	**250**	**610**	**510**	**240**
1,1-Dichloroethane				1 U	0.1 U	1 U	1 U	0.5 U	1 U	0.5 U	10 U
1,1-Dichloroethane, LV											
1,1-Dichloroethene					0.1 U	1 U	**0.533 J**	0.76 U	**0.327 J**	0.76 U	10 U
1,1-Dichloroethene, LV				0.1 U							
cis-1,2-Dichloroethene				1 U	0.53 U	**0.292 J**	**2.95**	**1.9**	**1.335**	**1.2**	**8.155 J**
trans-1,2-Dichloroethene				1 U	0.5 U	1 U	**0.212 J**	0.5 U	**0.13 J**	0.5 U	10 U
Total 1,2-Dichloroethene				1 U		**0.292 J**	**3.16**		**1.5 J**		**8.16 J**
1,2-Dichloroethane					0.1 U	1 U	1 U	0.45 U	1 U	0.45 U	10 U
1,2-Dichloroethane, LV				0.1 U							
Vinyl Chloride					0.1 U	1 U	1 U	0.51 U	1 U	0.51 U	10 U
Vinyl Chloride, LV				0.1 U							
Chloroethane				1 U	0.9 U	1 U	1 U	0.9 U	1 U	0.9 U	10 U
Ethane				**1 J**		6.2 U	**0.8 J**		6.2 U		6.2 U
Ethene				**0.9 J**		5.8 U	5.8 U		5.8 U		5.8 U
Methane				5.4 U		4.4 U	3.9 U		5.2 U		3.3 U

Well Node	MW16-63	MW16-64		MW16-65		MW16-66	MW16-67		MW16-68		MW16-69
Investigation	Round 8	Round 8	Round 10	Round 8	Round 10	Round 9	Round 9	Round 10	Round 9	Round 10	Round 9
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock											
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node	MW16-70		MW16-71	INJ16-01D		INJ16-02D	INJ16-03D	INJ16-04D	INJ16-05D		INJ16-06D	INJ16-07D
Investigation	Round 9	Round 10	Round 9	Round 9	Round 10	Round 9	Round 9	Round 9	Round 9	Round 10	Round 9	Round 9
Sample Code	NORMAL	NS	NORMAL	NS	NS	NS	NS	NS	NS	NS	NS	NS
Shallow Overburden												
Tetrachloroethene												
Trichloroethene	**20**		**4.58**									
1,1-Dichloroethane	1 U		1 U									
1,1-Dichloroethane, LV												
1,1-Dichloroethene	1 U		1 U									
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene	1 U		1 U									
trans-1,2-Dichloroethene	1 U		1 U									
Total 1,2-Dichloroethene	2 U		2 U									
1,2-Dichloroethane	1 U		1 U									
1,2-Dichloroethane, LV												
Vinyl Chloride	1 U		1 U									
Vinyl Chloride, LV												
Chloroethane	1 U		1 U									
Ethane	6.2 U		6.2 U									
Ethene	5.8 U		5.8 U									
Methane	4.6 U		4.2 U									

Well Node	MW16-70		MW16-71	INJ16-01D		INJ16-02D	INJ16-03D	INJ16-04D	INJ16-05D		INJ16-06D	INJ16-07D
Investigation	Round 9	Round 10	Round 9	Round 9	Round 10	Round 9	Round 9	Round 9	Round 9	Round 10	Round 9	Round 9
Sample Code	NORMAL	NS	AVG	NS	NS	NS	NS	NS	NS	NS	NS	NS
Intermediate Overburden												
Tetrachloroethene												
Trichloroethene	**11**		**12**									
	1 U		1 U									
1,1-Dichloroethane, LV												
1,1-Dichloroethene	1 U		1 U									
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene	1 U		**0.174 J**									
trans-1,2-Dichloroethene	1 U		1 U									
Total 1,2-Dichloroethene	2 U		**0.174 J**									
1,2-Dichloroethane	1 U		1 U									
1,2-Dichloroethane, LV												
Vinyl Chloride	1 U		1 U									
Vinyl Chloride, LV												
Chloroethane	1 U		1 U									
Ethane	6.2 U		6.2 U									
Ethene	5.8 U		5.8 U									
Methane	5.2 U		3.55 U									

Well Node	MW16-70		MW16-71	INJ16-01D		INJ16-02D	INJ16-03D	INJ16-04D	INJ16-05D		INJ16-06D	INJ16-07D
Investigation	Round 9	Round 10	Round 9	Round 9	Round 10	Round 9	Round 9	Round 9	Round 9	Round 10	Round 9	Round 9
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Deep Overburden												
Tetrachloroethene		4.2 U			0.5 U					0.52 U		
Trichloroethene	**730**	**680**	**790**	**710**	**620**	**360**	**830**	**770**	**1200**	**1100**	**860**	**480**
1,1-Dichloroethane	25 U	4 U	1 U	25 U	0.5 U	1 U	25 U	25 U	50 U	0.5 U	25 U	1 U
1,1-Dichloroethane, LV												
1,1-Dichloroethene	25 U	6.1 U	**0.295 J**	25 U	0.5 U	1 U	25 U	25 U	50 U	0.76 U	25 U	**0.303 J**
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene	25 U	4.2 U	**1.57**	25 U	**2.3**	**6.25**	25 U	25 U	50 U	**1.3**	25 U	**1.52**
trans-1,2-Dichloroethene	25 U	4 U	1 U	25 U	0.5 U	1 U	25 U	25 U	50 U	0.5 U	25 U	**0.111 J**
Total 1,2-Dichloroethene	50 U		**1.57 J**	50 U		**6.25**	50 U	50 U	100 U		50 U	**1.63 J**
1,2-Dichloroethane	25 U	3.6 U	1 U	25 U	0.5 U	1 U	25 U	25 U	50 U	0.45 U	25 U	1 U
1,2-Dichloroethane, LV												
Vinyl Chloride	25 U	4.1 U	1 U	25 U	0.5 U	**0.366 J**	25 U	25 U	50 U	0.51 U	25 U	1 U
Vinyl Chloride, LV												
Chloroethane	25 U	13 U	1 U	25 UJ	0.9 U	1 U	25 UJ	25 UJ	50 UJ	0.9 U	25 U	1 U
Ethane	6.2 U		6.2 U	6.2 U		6.2 U	6.2 U	6.2 U	6.2 U		6.2 U	6.2 U
Ethene	5.8 U		5.8 U	5.8 U		5.8 U	5.8 U	5.8 U	5.8 U		5.8 U	5.8 U
Methane	5.6 U		3.3 U	4.5 U		**15 J**	4.4 U	4 U	4.2 U		4.2 U	6.3 U

Well Node	MW16-70		MW16-71	INJ16-01D		INJ16-02D	INJ16-03D	INJ16-04D	INJ16-05D		INJ16-06D	INJ16-07D
Investigation	Round 9	Round 10	Round 9	Round 9	Round 10	Round 9	Round 9	Round 9	Round 9	Round 10	Round 9	Round 9
Sample Code	NORMAL	NORMAL	NORMAL	NS	NS	NS	NS	NS	NS	NS	NS	NS
Shallow Bedrock												
Tetrachloroethene		0.52 U										
Trichloroethene	**59**	**61 J**	**1100**									
1,1-Dichloroethane	1 U	0.5 U	**0.172 J**									
1,1-Dichloroethane, LV												
1,1-Dichloroethene	**0.403 J**	0.76 U	**2.56**									
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene	**3.93**	**2.4 J**	**23**									
trans-1,2-Dichloroethene	1 U	0.5 U	**1.04**									
Total 1,2-Dichloroethene	**4.12**		**24**									
1,2-Dichloroethane	1 U	0.45 U	1 U									
1,2-Dichloroethane, LV												
Vinyl Chloride	1 U	0.51 U	1 U									
Vinyl Chloride, LV												
Chloroethane	1 U	0.9 U	1 U									
Ethane	6.2 U		**1.3 J**									
Ethene	5.8 U		5.8 U									
Methane	3.7 U		3.3 U									

Well Node	MW16-70		MW16-71	INJ16-01D		INJ16-02D	INJ16-03D	INJ16-04D	INJ16-05D		INJ16-06D	INJ16-07D
Investigation	Round 9	Round 10	Round 9	Round 9	Round 10	Round 9	Round 9	Round 9	Round 9	Round 10	Round 9	Round 9
Sample Code	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Deep Bedrock												
Tetrachloroethene												
Trichloroethene												
1,1-Dichloroethane												
1,1-Dichloroethane, LV												
1,1-Dichloroethene												
1,1-Dichloroethene, LV												
cis-1,2-Dichloroethene												
trans-1,2-Dichloroethene												
Total 1,2-Dichloroethene												
1,2-Dichloroethane												
1,2-Dichloroethane, LV												
Vinyl Chloride												
Vinyl Chloride, LV												
Chloroethane												
Ethane												
Ethene												
Methane												

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node Investigation Sample Code	INJ16-08D Round 9 NS	INJ16-09D Round 9 NS	INJ16-10D Round 9 NS	INJ16-11D Round 9 NS	INJ16-12D Round 9 NS	RMW-01 Round 10 NORMAL	RMW-02 Round 10 NS	TW16-108 Round 10 AVG	MW16-82 Round 10 NS	MW16-83 Round 10 NS	MW16-84 Round 10 NS	MW16-85 Round 10 NS	MW16-86 Round 10 NS
						Shallow Overburden							
Tetrachloroethene						0.1 U		**0.55**					
Trichloroethene						0.1 U		**170**					
1,1-Dichloroethane						0.1 U		0.5 U					
1,1-Dichloroethane, LV													
1,1-Dichloroethene						0.1 U		0.5 U					
1,1-Dichloroethene, LV													
cis-1,2-Dichloroethene						0.14 U		0.53 U					
trans-1,2-Dichloroethene						0.13 U		0.5 U					
Total 1,2-Dichloroethene													
1,2-Dichloroethane						0.1 U		0.5 U					
1,2-Dichloroethane, LV													
Vinyl Chloride						0.1 U		0.5 U					
Vinyl Chloride, LV													
Chloroethane						0.85 U		0.9 U					
Ethane													
Ethene													
Methane													

Well Node Investigation Sample Code	INJ16-08D Round 9 NS	INJ16-09D Round 9 NS	INJ16-10D Round 9 NS	INJ16-11D Round 9 NS	INJ16-12D Round 9 NS	RMW-01 Round 10 NS	RMW-02 Round 10 NS	TW16-108 Round 10 NS	MW16-82 Round 10 NS	MW16-83 Round 10 NS	MW16-84 Round 10 NS	MW16-85 Round 10 NS	MW16-86 Round 10 NS
						Intermediate Overburden							
Tetrachloroethene													
Trichloroethene													
1,1-Dichloroethane, LV													
1,1-Dichloroethene													
1,1-Dichloroethene, LV													
cis-1,2-Dichloroethene													
trans-1,2-Dichloroethene													
Total 1,2-Dichloroethene													
1,2-Dichloroethane													
1,2-Dichloroethane, LV													
Vinyl Chloride													
Vinyl Chloride, LV													
Chloroethane													
Ethane													
Ethene													
Methane													

Well Node Investigation Sample Code	INJ16-08D Round 9 NORMAL	INJ16-09D Round 9 NORMAL	INJ16-10D Round 9 NORMAL	INJ16-11D Round 9 NORMAL	INJ16-12D Round 9 NORMAL	RMW-01 Round 10 NS	RMW-02 Round 10 AVG	TW16-108 Round 10	MW16-82 Round 10 NORMAL	MW16-83 Round 10 NORMAL	MW16-84 Round 10 NORMAL	MW16-85 Round 10 AVG	MW16-86 Round 10 NORMAL
						Deep Overburden							
Tetrachloroethene							0.1 U		0.1 U	0.1 U	0.1 U	0.59 U	**0.1**
Trichloroethene	**640**	**810**	**870**	**760**	**1700**		0.1 U		0.1 U	0.1 U	0.1 U	**4800**	0.1 U
1,1-Dichloroethane	25 U	25 U	25 U	25 U	50 U		0.1 U		0.1 U	0.1 U	**0.15**	0.082 U	0.1 U
1,1-Dichloroethane, LV													
1,1-Dichloroethene	25 U	25 U	25 U	25 U	50 U		0.1 U		0.1 U	0.1 U	0.1 U	1 U	0.1 U
1,1-Dichloroethene, LV													
cis-1,2-Dichloroethene	25 U	25 U	25 U	25 U	50 U		0.14 U		0.14 U	0.14 U	0.14 U	**6.5**	0.14 U
trans-1,2-Dichloroethene	25 U	25 U	25 U	25 U	50 U		0.13 U		0.13 U	0.13 U	0.13 U	**1.1**	0.13 U
Total 1,2-Dichloroethene	50 U	50 U	50 U	50 U	100 U								
1,2-Dichloroethane	25 U	25 U	25 U	25 U	50 U		0.1 U		0.1 U	0.1 U	0.1 U	0.12 U	0.1 U
1,2-Dichloroethane, LV													
Vinyl Chloride	25 U	25 U	25 U	25 U	50 U		0.1 U		0.1 U	0.1 U	0.1 U	0.54 U	0.1 U
Vinyl Chloride, LV													
Chloroethane	25 UJ	25 U	25 U	25 UJ	50 UJ		0.85 U		0.85 U	0.85 U	0.85 U	0.85 U	0.85 U
Ethane	6.2 U	6.2 U	6.2 U	6.2 U	6.2 U								
Ethene	5.8 U	5.8 U	5.8 U	5.8 U	5.8 U								
Methane	4.1 U	4.7 U	4.8 U	3.8 U	4 U								

Well Node Investigation Sample Code	INJ16-08D Round 9 NS	INJ16-09D Round 9 NS	INJ16-10D Round 9 NS	INJ16-11D Round 9 NS	INJ16-12D Round 9 NS	RMW-01 Round 10	RMW-02	TW16-108 Round 10	MW16-82 Round 10 NORMAL	MW16-83 Round 10 AVG	MW16-84 Round 10 NORMAL	MW16-85 Round 10	MW16-86 Round 10 NORMAL
						Shallow Bedrock							
Tetrachloroethene									0.1 U	0.1 U	0.1 U		0.1 U
Trichloroethene									0.1 U	0.1 U	0.1 U		0.1 U
1,1-Dichloroethane									0.1 U	0.1 U	0.1 U		0.1 U
1,1-Dichloroethane, LV													
1,1-Dichloroethene									0.1 U	0.1 U	0.1 U		0.1 U
1,1-Dichloroethene, LV													
cis-1,2-Dichloroethene									0.14 U	0.14 U	0.14 U		0.14 U
trans-1,2-Dichloroethene									0.13 U	0.13 U	0.13 U		0.13 U
Total 1,2-Dichloroethene													
1,2-Dichloroethane									0.1 U	0.1 U	0.1 U		0.1 U
1,2-Dichloroethane, LV													
Vinyl Chloride									0.1 U	0.1 U	0.1 U		0.1 U
Vinyl Chloride, LV													
Chloroethane									0.85 U	0.85 U	0.85 U		0.85 U
Ethane													
Ethene													
Methane													

Well Node Investigation Sample Code	INJ16-08D Round 9 NS	INJ16-09D Round 9 NS	INJ16-10D Round 9 NS	INJ16-11D Round 9 NS	INJ16-12D Round 9 NS	RMW-01 Round 10	RMW-02	TW16-108 Round 10	MW16-82 Round 10	MW16-83 Round 10	MW16-84 Round 10	MW16-85 Round 10	MW16-86 Round 10
						Deep Bedrock							
Tetrachloroethene													
Trichloroethene													
1,1-Dichloroethane													
1,1-Dichloroethane, LV													
1,1-Dichloroethene													
1,1-Dichloroethene, LV													
cis-1,2-Dichloroethene													
trans-1,2-Dichloroethene													
Total 1,2-Dichloroethene													
1,2-Dichloroethane													
1,2-Dichloroethane, LV													
Vinyl Chloride													
Vinyl Chloride, LV													
Chloroethane													
Ethane													
Ethene													
Methane													

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Well Node Investigation Sample Code	MW16-87 Round 10 NS	MW16-88 Round 10 NS	MW16-89 Round 10 NS	MW16-90 Round 10 NS	TW16-101 Round 10 NS	TW16-102 Round 10 NS	TW16-103 Round 10 NS	TW16-104 Round 10 NS	TW16-106 Round 10 NS	TW16-107 Round 10 NS	TW16-109 Round 10 NS
						Shallow Overburden					
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

Well Node Investigation Sample Code	MW16-87 Round 10 NORMAL	MW16-88 Round 10 NORMAL	MW16-89 Round 10 NORMAL	MW16-90 Round 10 NS	TW16-101 Round 10 NS	TW16-102 Round 10 NORMAL	TW16-103 Round 10 NS	TW16-104 Round 10 NS	TW16-106 Round 10 NORMAL	TW16-107 Round 10 NORMAL	TW16-109 Round 10 NORMAL
						Intermediate Overburden					
Tetrachloroethene	**0.58**	0.59 U	0.1 U			0.1 UJ			**0.28**	10 U	0.1 U
Trichloroethene	**4.8**	**710**	**15**			0.1 UJ			**0.51**	**7700**	0.1 U
	0.1 U	0.082 U	0.1 U			0.1 UJ			0.1 U	10 U	0.1 U
1,1-Dichloroethane, LV											
1,1-Dichloroethene	0.1 U	1 U	**0.48**			0.1 UJ			0.1 U	15 U	0.1 U
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene	0.14 U	**2.3**	**1**			0.53 U			0.53 U	11 U	0.53 U
trans-1,2-Dichloroethene	0.13 U	0.13 U	0.13 U			0.5 U			0.5 U	10 U	0.5 U
Total 1,2-Dichloroethene											
1,2-Dichloroethane	0.1 U	0.12 U	0.1 U			0.1 UJ			0.1 U	9 U	0.1 U
1,2-Dichloroethane, LV											
Vinyl Chloride	0.1 U	0.54 U	0.1 U			0.1 UJ			0.1 U	10 U	0.1 U
Vinyl Chloride, LV											
Chloroethane	0.85 U	0.85 U	0.85 U			0.9 U			0.9 U	18 U	0.9 U
Ethane											
Ethene											
Methane											

Well Node Investigation Sample Code	MW16-87 Round 10 NS	MW16-88 Round 10 NS	MW16-89 Round 10 NS	MW16-90 Round 10 NORMAL	TW16-101 Round 10 NORMAL	TW16-102 Round 10 NS	TW16-103 Round 10 NORMAL	TW16-104 Round 10 NORMAL	TW16-106 Round 10 NS	TW16-107 Round 10 NS	TW16-109 Round 10 NS
						Deep Overburden					
Tetrachloroethene				0.1 U	0.1 UJ		0.1 U	0.1 U			
Trichloroethene				**16**	**29**		0.1 U	**2.5**			
1,1-Dichloroethane				0.1 U	**0.18 J**		0.1 U	0.1 U			
1,1-Dichloroethane, LV											
1,1-Dichloroethene				0.1 U	**0.31 J**		0.1 U	0.1 U			
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene				**2.4**	0.53 U		1 U	0.53 U			
trans-1,2-Dichloroethene				0.44 U	0.5 U		1 U	0.5 U			
Total 1,2-Dichloroethene											
1,2-Dichloroethane				0.1 U	0.1 UJ		0.1 U	0.1 U			
1,2-Dichloroethane, LV											
Vinyl Chloride				0.1 U	**0.14 J**		0.1 U	0.1 U			
Vinyl Chloride, LV											
Chloroethane				0.75 U	0.9 U		1 U	0.9 U			
Ethane											
Ethene											
Methane											

Well Node Investigation Sample Code	MW16-87 Round 10	MW16-88 Round 10	MW16-89 Round 10	MW16-90 Round 10	TW16-101 Round 10	TW16-102 Round 10	TW16-103 Round 10	TW16-104 Round 10	TW16-106 Round 10	TW16-107 Round 10	TW16-109 Round 10
						Shallow Bedrock					
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

Well Node Investigation Sample Code	MW16-87 Round 10	MW16-88 Round 10	MW16-89 Round 10	MW16-90 Round 10	TW16-101 Round 10	TW16-102 Round 10	TW16-103 Round 10	TW16-104 Round 10	TW16-106 Round 10	TW16-107 Round 10	TW16-109 Round 10
						Deep Bedrock					
Tetrachloroethene											
Trichloroethene											
1,1-Dichloroethane											
1,1-Dichloroethane, LV											
1,1-Dichloroethene											
1,1-Dichloroethene, LV											
cis-1,2-Dichloroethene											
trans-1,2-Dichloroethene											
Total 1,2-Dichloroethene											
1,2-Dichloroethane											
1,2-Dichloroethane, LV											
Vinyl Chloride											
Vinyl Chloride, LV											
Chloroethane											
Ethane											
Ethene											
Methane											

TABLE 4-56

SUMMARY OF PRIMARY CHLORINATED VOCs AND DEGRADATION PRODUCTS
BY GROUNDWATER ZONE
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
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Investigation Description:
02 - EBS Phase II Follow-On Sampling
03 - EBS Phase II Follow-On Addendum Sampling
05 - Stage II Phase I RI Sampling Event
06 - Phase II RI Sampling Event
08 - CTO 97 Supplemental Phase II Investigation
09 - CTO 107 HRC Injection Study
10 - Phase III Sampling Event

Qualifiers:
J - Estimated value.
U - Nondetected result.
UJ - Nondetected result is estimated.

Sample Code Description:
NORMAL - One sample was collected at this location.
NS - No sample collected during this sampling event.
AVG - Average concentration for duplicate samples.

Acronyms:
LV = Low level
RI = Remedial Investigation
VOC = Volatile organic compound

A blank cell indicates that the chemical was not a target analyte for the sampling event.

LOCATION	MW16-02D	MW16-02I	MW16-04D	MW16-04I	MW16-05D	MW16-05I
SAMPLE ID	MW16-02D-072810	MW16-02I-072810	MW16-04D-072710	MW16-04I-072710	MW16-05D-072910	MW16-05I-072810
SAMPLE DATE	20100728	20100728	20100727	20100727	20100729	20100728
PROBLEM CODE	9	9	9	9	9	9
AREA	NCENTRAL EASTERN	NCENTRAL EASTERN	NCENTRAL EASTERN/E-107	NCENTRAL EASTERN/E-107	NCENTRAL EASTERN	NCENTRAL EASTERN
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW	GW	GW
SAMPLE TYPE	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
SUBMATRIX	NA	NA	NA	NA	NA	NA
TOP DEPTH	-9999	-9999	-9999	-9999	-9999	-9999
BOTTOM DEPTH	-9999	-9999	-9999	-9999	-9999	-9999
DISSOLVED METALS (UG/L)						
IRON	3690	2780	2170	6.27 U	1520	1170
MANGANESE	374	146	405	0.8 U	395	1150
FIELD (%)						
SALINITY	0.12	0.01	0.22	0.16	0.16	0.37
FIELD (C)						
TEMPERATURE	17.6	19.8	14.4	12.7	16.6	17.4
FIELD (MG/L)						
CARBON DIOXIDE	30	28	26	75	20	65
DISSOLVED OXYGEN	NA	4	NA	1.8	2.2	1.5 J
DISSOLVED OXYGEN - METER	0.85	3.02	0.21	1.64	2.72	2.47
FERROUS IRON	3	0.2	2.2	0	1.8	1.6
SULFIDE	0	0	0	0	0	0
FIELD (MS/CM)						
CONDUCTIVITY	0.213	0.028	0.355	0.25	0.335	0.75
FIELD (MV)						
OXIDATION REDUCTION POTENTIAL	38.7	151.3	-17.2	140.1	58.5	-5.8
FIELD (NTU)						
TURBIDITY	0	41.7	0	0	0.95	0
FIELD (S.U.)						
PH	6.11	5.7	6.63	6.24	6.16	6.82
MISCELLANEOUS PARAMETERS (MG/L)						
ALKALINITY	5 U	9.5	36	55	11	97
CHLORIDE	49	150	98	61	77	170
DISSOLVED ORGANIC CARBON	3.8	0.45 J	0.39 J	0.71 J	0.77 J	0.98 J
NITRATE-N	0.05 U	2.8	0.0174 U	1	0.05 U	0.05 U
NITRITE-N	0.05 U	0.05 U	0.00922 U	0.00922 U	0.05 U	0.05 U
SULFATE	38	7.6	14 J	12 J	16	4.3
SULFIDE	1 U	1.2	2.4	3.9	2.9	3.2
TOTAL DISSOLVED SOLIDS	190	380	230	190	250	560
TOTAL ORGANIC CARBON	0.29 J	0.55 J	0.31 J	0.69 J	0.3 J	0.74 J
VOLATILE GASES (UG/L)						
METHANE	2.3 J	1.2 J	2.2 J	59	68	2900
VOLATILES (UG/L)						
1,1,1-TRICHLOROETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,1-DICHLOROETHENE	1	0.4 U	0.8 J	0.4 U	1	0.9 J
1,2-DICHLOROETHANE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
2-BUTANONE	1 U	1 U	1 U	1 U	1 U	1 U
ACETONE	2 J	2 U	2 U	2 U	2 U	2 U
CARBON DISULFIDE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CHLOROBENZENE	0.4 J	0.4 J	0.2 U	0.2 U	0.2 U	0.2 U
CHLOROMETHANE	0.4 U	0.4 U	0.4 U	0.4 U	0.6 J	0.5 J
CIS-1,2-DICHLOROETHENE	5	0.6 J	5	0.2 U	5	22
CYCLOHEXANE	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
METHYL CYCLOHEXANE	0.3 U	0.3 U	0.3 UJ	0.3 U	0.3 UJ	0.3 U
METHYLENE CHLORIDE	1 U	1 U	1 U	1 U	1 U	1 U
TETRACHLOROETHENE	0.4 UJ	0.4 UJ	0.4 U	0.4 UJ	0.4 U	0.4 UJ
TOTAL CHLORINATED VOCS	1107	65.6	336	0.4	1208	568
TRANS-1,2-DICHLOROETHENE	1	0.2 U	0.3 J	0.2 U	0.5 J	1
TRICHLOROETHENE	1100	65	330	0.4 J	1200	540
VINYL CHLORIDE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4

MW16-07D MW16-07D-073010 20100730 9 NCENTRAL CREOSOTE DIP TANK NORMAL GW NORMAL NA -9999 -9999	MW16-10D MW16-10D-072210 20100722 9 UPGRADIENT NORMAL GW NORMAL NA -9999 -9999	MW16-10I MW16-10I-072310 20100723 9 UPGRADIENT NORMAL GW NORMAL NA -9999 -9999	MW16-14D MW16-14D-072210 20100722 9 BUILDING 41 ORIG GW NORMAL NA -9999 -9999	MW16-14D MW16-14D-072210-AVG 20100722 9 BUILDING 41 AVG GW NORMAL NA -9999 -9999	MW16-14D MW16-14D-072210-D 20100722 9 BUILDING 41 DUP GW NORMAL NA -9999 -9999	MW16-14I MW16-14I-072610 20100726 9 BUILDING 41 NORMAL GW NORMAL NA -9999 -9999
10800	55.8 J	510	112	113.5	115	16.8 U
662	251	40.8	161	161.5	162	33
0.21	0.01	0.1	0.03	NA	NA	0.03
13.8	18.4	18.4	19.3	NA	NA	17.9
27	35	17	25	NA	NA	14.5
NA	NA	1	NA	NA	NA	3.3
0.24	0.75	1.4	0.47	NA	NA	3.11
6	0	0.8	0	NA	NA	0
0	0	0	0	NA	NA	0
0.346	0.026	0.183	0.065	NA	NA	0.048
-87	175.9	158	88.3	NA	NA	154.2
8.9	6.88	3.72	1.94	NA	NA	4.92
6.77	5.53	6.02	5.6	NA	NA	5.72
15	5.4	9	5.6	5.8	6	4.6 J
99	4.1	40	9	9.05	9.1	9.3
0.88 J	0.79 J	0.71 J	1.6	1.5	1.4	2.3
0.075	0.12	0.17	0.062	0.0485 J	0.035 J	0.34
0.05 U	0.00922 U	0.00922 U	0.00922 U	0.00922 U	0.00922 U	0.00922 U
20	4.6	12	12	12	12	2.6 J
1 U	0.69 U	2.2	1.2	0.7725	0.69 U	0.9 J
220	26	130	55	50.5	46	38
0.33 J	1.1 U	0.58 U	1.5 U	1.45 U	1.4 U	2.3
0.91 J	2.3 J	1.3 J	4.2 J	4.25 J	4.3 J	1.3 J
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1 U	1 U	1 U	1 U	1 U	1 U	1 U
2 U	2 U	2 UJ	2 UJ	2.5 UJ	3 U	3 J
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1 J	0.4 U	0.4 J	0.4 U	0.4 U	0.4 U	0.4 U
0.2 U	0.2 U	0.2 U	1 J	0.95 J	0.9 J	0.2 U
0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
0.3 UJ	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 UJ
1 U	1 U	1 U	1 U	1 U	1 U	1 U
0.4 U	0.4 U	2	0.4 U	0.4 U	0.4 U	0.4 U
6	0 U	6.4	691	721	751	1
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
5	0.3 U	4	690	720	750	1
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U

MW16-19I MW16-19I-072610 20100726 9 EASTERN AREA NORMAL GW NORMAL NA -9999 -9999	MW16-37I MW16-37I-072510 20100725 9 EASTERN AREA NORMAL GW NORMAL NA -9999 -9999	MW16-38I MW16-38I-072510 20100725 9 EASTERN AREA ORIG GW NORMAL NA -9999 -9999	MW16-38I MW16-38I-072510-AVG 20100725 9 EASTERN AREA AVG GW NORMAL NA -9999 -9999	MW16-38I MW16-38I-072510-D 20100725 9 EASTERN AREA DUP GW NORMAL NA -9999 -9999	MW16-44D MW16-44D-072610 20100726 9 NCENTRAL FFTA NORMAL GW NORMAL NA -9999 -9999	MW16-44I MW16-44I-072610 20100726 9 NCENTRAL FFTA NORMAL GW NORMAL NA -9999 -9999
6.27 U	6.27 U	18.8 U	19.8 U	20.8 U	2030	7640
1.8 U	7.8	24.9	25.2	25.5	714	545
0.04	0.07	0.06	NA	NA	0.15	0.13
19.9	23.4	21.1	NA	NA	16.2	15.4
23	22	20	NA	NA	18	85
5.7	5	NA	NA	NA	2.8 J	NA
5.52	4.92	0.36	NA	NA	2.82	0.62
0	0	0	NA	NA	2	4.3
0	0	0	NA	NA	0	0
0.088	0.156	0.115	NA	NA	0.264	0.226
153.1	193.8	143.4	NA	NA	34	-5.1
2.85	0	1.34	NA	NA	4.93	18.4
5.74	5.57	6.01	NA	NA	6.15	6.15
7.8	4.9 J	13 J	12.5 J	12	16	61
12	36	16	16	16	68	29
0.39 J	0.58 J	0.36 J	0.415 J	0.47 J	0.69 J	1.2
1.5	1.5	0.24	0.245	0.25	0.04 J	0.2
0.00922 U	0.00922 U	0.00922 U	0.00922 U	0.00922 U	0.00922 U	0.00922 U
5.9	5.5	17	17	17	16	8.4 J
1.1	0.69 U	0.8 J	1.7 J	2.6	1.1	1.5
48	120	85	79.5	74	220	120
0.37 J	0.29 J	0.55 J	0.495 J	0.44 J	0.3 J	1.2
1.1 J	1.1 J	1.3 J	1.125 J	0.95 J	1 J	71
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	1	0.4 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1 U	1 U	1 U	1 U	1 U	1 U	1 U
2 U	3 J	3 J	3 J	3 J	2 U	2 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
0.2 U	0.2 J	0.5 J	0.45 J	0.4 J	10	5
0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 UJ
1 U	1 U	1 U	1.25 J	2 J	1 U	1 U
0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
11	38.2	861	817	772	1211	9.4
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.4 J	0.4 J
11	38	860	815	770	1200	2
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	2 J

MW16-45D MW16-45D-072610 20100726 9 NCENTRAL FFTA NORMAL GW NORMAL NA -9999 -9999	MW16-45I MW16-45I-072610 20100726 9 NCENTRAL FFTA NORMAL GW NORMAL NA -9999 -9999	MW16-57I MW16-57I-072910 20100729 9 EASTERN AREA NORMAL GW NORMAL NA -9999 -9999	MW16-58D MW16-58D-073010 20100730 9 NCENTRAL EASTERN NORMAL GW NORMAL NA -9999 -9999	MW16-58I2 MW16-58I2-072910 20100729 9 NCENTRAL EASTERN NORMAL GW NORMAL NA -9999 -9999	MW16-59D MW16-59D-072910 20100729 9 EASTERN AREA NORMAL GW NORMAL NA -9999 -9999	MW16-59I MW16-59I-072310 20100723 9 EASTERN AREA NORMAL GW NORMAL NA -9999 -9999
9160	8820	22.8 U	3160	15300	1490	8840
706	1450	15.7	392	1070	506	320
0.2	0.22	0.05	0.14	0.36	0.09	0.1
18.1	15.8	18	14.8	18.3	19.3	16.6
27	40	25	20	93	27	22
NA	NA	NA	NA	NA	NA	NA
0.23	0.22	0.39	0.35	0.21	0.45	0.2
4.8	4.6	0	2.5	7.3	1.6	8.2
0	0	0	0	0	0	0
0.357	0.376	0.09	0.289	0.64	0.165	0.22
-51.1	58.2	48.1	50.3	-114.6	-13.4	-33.5
9.85	18.4	619	9.46	3.66	49.5	119
6.64	6.66	6.38	6.21	6.93	6.35	6.66
20	33	17	7.5	130	22	12
88	96	7.3	62	120	23	30
2.6	0.52 J	0.4 J	1.3	1.4	0.43 J	0.45 J
0.0174 U	0.0174 U	0.046 J	0.041 J	0.024 J	0.034 J	0.026 J
0.00922 U	0.00922 U	0.05 U	0.05 U	0.05 U	0.05 U	0.00922 U
17	16 J	16	17	0.38 J	18	15
0.69 U	0.69 U	1 U	1 U	1.4	1 U	0.69 U
260	230	70	230	320	92	180
0.28 J	0.78 J	0.39 U	0.27 J	0.86 J	0.48 J	0.59 U
1.6 J	8.1 J	1.4 J	1.4 J	8800	5.7 J	1.2 J
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.8 J	1	0.4 U	2	0.4 U	3	0.4 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1 U	1 U	1 U	1 U	1 U	1 U	1 U
2 U	2 J	2 U	2 U	2 J	2 U	2 UJ
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.4 U	0.4 U	0.4 U	0.7 J	0.6 J	0.4 U	0.4 U
6	6	1	6	25	19	4
0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
0.3 U	0.3 UJ	0.3 UJ	0.3 UJ	0.3 UJ	0.3 UJ	0.3 U
1 U	1 U	1 U	1 U	1 U	1 U	1 U
0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1607	511	351	1410	78.6	1924	634
0.3 J	4	0.3 J	0.8 J	2	0.6 J	0.2 U
1600	500	350	1400	26	1900 J	630
0.2 U	0.2 U	0.2 U	0.2 U	25	0.6 J	0.2 U

MW16-65D MW16-65D-072710 20100727 9 UPGRADIENT NORMAL GW NORMAL NA -9999 -9999	MW16-65I MW16-65I-072310 20100723 9 UPGRADIENT NORMAL GW NORMAL NA -9999 -9999	MW16-74D MW16-74D-072410 20100724 8 UPGRADIENT NORMAL GW NORMAL NA -9999 -9999	MW16-77I MW16-77I-072910 20100729 9 BUILDING 41 NORMAL GW NORMAL NA -9999 -9999	MW16-82D MW16-82D-072410 20100724 8 UPGRADIENT ORIG GW NORMAL NA -9999 -9999	MW16-82D MW16-82D-072410-AVG 20100724 8 UPGRADIENT AVG GW NORMAL NA -9999 -9999	MW16-82D MW16-82D-072410-D 20100724 8 UPGRADIENT DUP GW NORMAL NA -9999 -9999
14000	6.27 U	NA	4820	NA	NA	NA
929	3.7 J	NA	237	NA	NA	NA
0.16	0.02	0.07	0.19	0.06	NA	NA
17.4	15.3	19.8	19.3	17.2	NA	NA
40	14	NA	31	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA
0.29	6.2	0.39	0.5	0.12	NA	NA
4.6	0	NA	4.2	NA	NA	NA
0	0	NA	0	NA	NA	NA
0.328	0.035	0.148	0.389	0.112	NA	NA
-82.2	238.8	-43.4	7.9	-150.4	NA	NA
2.37	21.7	3.27	4.04	2000	NA	NA
6.75	6.07	6.59	6.34	7.2	NA	NA
16	8.8	NA	17	NA	NA	NA
65	50	NA	88	NA	NA	NA
0.67 J	0.33 J	NA	0.6 J	NA	NA	NA
0.0174 U	1.2	NA	0.05 U	NA	NA	NA
0.00922 U	0.00922 U	NA	0.05 U	NA	NA	NA
20 J	9.2	NA	14	NA	NA	NA
0.75 J	0.69 U	NA	1 U	NA	NA	NA
270	150	89	250	13 J	54 J	95 J
0.31 J	0.44 U	NA	0.36 J	NA	NA	NA
1.2 J	0.68 U	NA	1.1 J	NA	NA	NA
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1 U	1 U	1 U	1 U	1 U	1 U	1 U
2 U	2 UJ	2 UJ	2 U	3 J	3 J	4 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
0.2 U	0.2 U	0.2 U	2	0.2 U	0.2 U	0.2 U
0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
0.3 UJ	0.3 U	0.3 U	0.3 UJ	0.3 U	0.3 U	0.3 U
1 U	1 U	1 U	1 U	1 U	1 U	1 U
0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
0 U	2	0 U	2503	0 U	0 U	0 U
0.2 U	0.2 U	0.2 U	0.6 J	0.2 U	0.2 U	0.2 U
0.3 U	2	0.3 U	2500 J	0.3 U	0.3 U	0.3 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U

MW16-82R MW16-82R-072410 20100724 8 UPGRADIENT NORMAL GW NORMAL NA -9999 -9999	MW16-84D MW16-84D-072510 20100725 8 UPGRADIENT NORMAL GW NORMAL NA -9999 -9999	MW16-84R MW16-84R-072510 20100725 8 UPGRADIENT NORMAL GW NORMAL NA -9999 -9999	MW16-85D MW16-85D-072210 20100722 9 BUILDING 41 NORMAL GW NORMAL NA -9999 -9999	MW16-86D MW16-86D-072510 20100725 8 EASTERN AREA NORMAL GW NORMAL NA -9999 -9999	MW16-86R MW16-86R-072510 20100725 8 EASTERN AREA NORMAL GW NORMAL NA -9999 -9999	MW16-88I MW16-88I-072310 20100723 9 EASTERN AREA NORMAL GW NORMAL NA -9999 -9999
NA	NA	NA	5310	NA	NA	266
NA	NA	NA	293	NA	NA	98.6
0.09	0.08	0.11	0.01	0.07	0.04	0.1
20.9	21.1	23.2	16.1	20.6	22.1	18.9
NA	NA	NA	32	NA	NA	28
NA	NA	NA	NA	NA	NA	NA
0.3	0.29	0.32	0.23	0.22	0.51	0.41
NA	NA	NA	4.2	NA	NA	0
NA	NA	NA	0	NA	NA	0
0.181	0.166	0.234	0.038	0.135	0.091	0.172
-157.6	-51.9	-117.8	60.3	-88.3	48.8	-39.5
4.73	44.6	4.86	110.7	4.74	4.61	61.4
7.94	6.49	6.77	6.21	6.77	6.15	7.32
NA	NA	NA	17	NA	NA	38
NA	NA	NA	50	NA	NA	25
NA	NA	NA	0.39 J	NA	NA	1.8
NA	NA	NA	0.0174 U	NA	NA	0.11
NA	NA	NA	0.00922 U	NA	NA	0.00922 U
NA	NA	NA	16	NA	NA	13
NA	NA	NA	0.69 U	NA	NA	0.69 U
120	98	140	220	80	63	96
NA	NA	NA	0.45 U	NA	NA	1.5 U
NA	NA	NA	1.3 J	NA	NA	3.6 J
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.4 U	0.4 U	0.4 U	0.5 J	0.4 U	0.4 U	0.6 J
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1 U	1 U	1 U	1 U	3 J	11	1 U
2 U	3 J	3 J	3 U	2 J	8	3 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3 U	0.2 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.6 J	0.4 U	0.6 J	0.4 U	0.4 U	0.4 U	0.4 U
0.2 U	0.2 U	0.2 U	4	0.2 U	0.2 U	2
0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
0.3 UJ	0.3 UJ	0.3 UJ	0.3 U	0.3 U	0.3 U	0.3 U
1 U	1 U	1 U	1 U	1 U	1 U	1 U
0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
0.6	0 U	0.6	2205	0.3	0 U	393
0.2 U	0.2 U	0.2 U	0.6 J	0.2 U	0.2 U	0.2 U
0.3 U	0.3 U	0.3 U	2200	0.3 J	0.3 U	390
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U

MW16-91I MW16-91I-072910 20100729 2 BTEX HOTSPOT ORIG GW NORMAL NA -9999 -9999	MW16-91I MW16-91I-072910-AVG 20100729 2 BTEX HOTSPOT AVG GW NORMAL NA -9999 -9999	MW16-91I-072910-D 20100729 2 BTEX HOTSPOT DUP GW NORMAL NA -9999 -9999	MW16-91S MW16-91S-073010 20100730 2 BTEX HOTSPOT NORMAL GW NORMAL NA -9999 -9999	MW16-93I MW16-93I-072310 20100723 5 SEAFREEZE BLDG NORMAL GW NORMAL NA -9999 -9999	MW16-93S MW16-93S-072410 20100724 5 SEAFREEZE BLDG NORMAL GW NORMAL NA -9999 -9999
12200	11850	11500	122	78.2 J	NA
1020	1001	982	84.6	47.1	NA
0.31	NA	NA	0.21	0.58	0.14
17.3	NA	NA	13.5	16.6	19.5
25	NA	NA	24	65	NA
NA	NA	NA	6.5	NA	NA
0.29	NA	NA	5.72	0.22	1.73
8.6	NA	NA	0.2	0	NA
0	NA	NA	0	0	NA
0.53	NA	NA	0.337	1.16	0.289
-80	NA	NA	151	-126.1	90.9
4.25	NA	NA	1.27	22.3	2.93
6.71	NA	NA	5.82	7.89	7.84
20	23	26	20	91	NA
140	140	140	93	140	NA
0.95 J	1.025 J	1.1	0.45 J	2.1	NA
0.05 U	0.05 U	0.05 U	1.1	0.0174 U	NA
0.05 U	0.05 U	0.05 U	0.05 U	0.00922 U	NA
19	19	19	19	47	NA
1 U	0.78 J	0.78 J	1.5	0.69 U	NA
370	355	340	180	380	200
0.4 J	0.42 J	0.44 J	0.54 J	1.6 U	NA
0.99 J	1.695 J	2.4 J	2.2 J	7.1 J	NA
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
0.2 U	0.2 U	0.2 U	0.2 U	0.8 J	0.2 U
1 U	1 U	1 U	1 U	1 U	1 U
2 U	3 J	5 J	3 U	2 UJ	3 J
0.2 U	0.2 U	0.2 U	0.2 U	0.3 J	0.2 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
0.4 U	0.45 J	0.7 J	0.8 J	0.4 J	0.5 J
0.8 J	0.8 J	0.8 J	0.2 U	0.2 U	0.2 U
0.7 J	0.7 J	0.7 J	0.4 J	0.3 U	0.3 U
3 J	1.575 J	0.3 UJ	0.5 J	0.3 U	0.3 U
1 U	1 U	1 U	1 U	1 U	1 U
0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
42.8	40.7	38.5	0.8	24.2	0.5
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
42	39.5	37	1 U	23	0.3 U
0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U

Appendix E-4

BIOCHLOR MODELING INPUT/OUTPUT

BioChlor

Calibration

Output

Calibration to 2004 Field Data

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 10 mg/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)	Calc. Alpha x
(Alpha y) / (Alpha x)*	0.1	(-)	
(Alpha z) / (Alpha x)*	1.E-99	(-)	

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION **-1st Order Decay Coefficient***

Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	53	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.015
TCE	10.0	0.015
DCE		0.015
VC		0.015
ETH		0.015

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

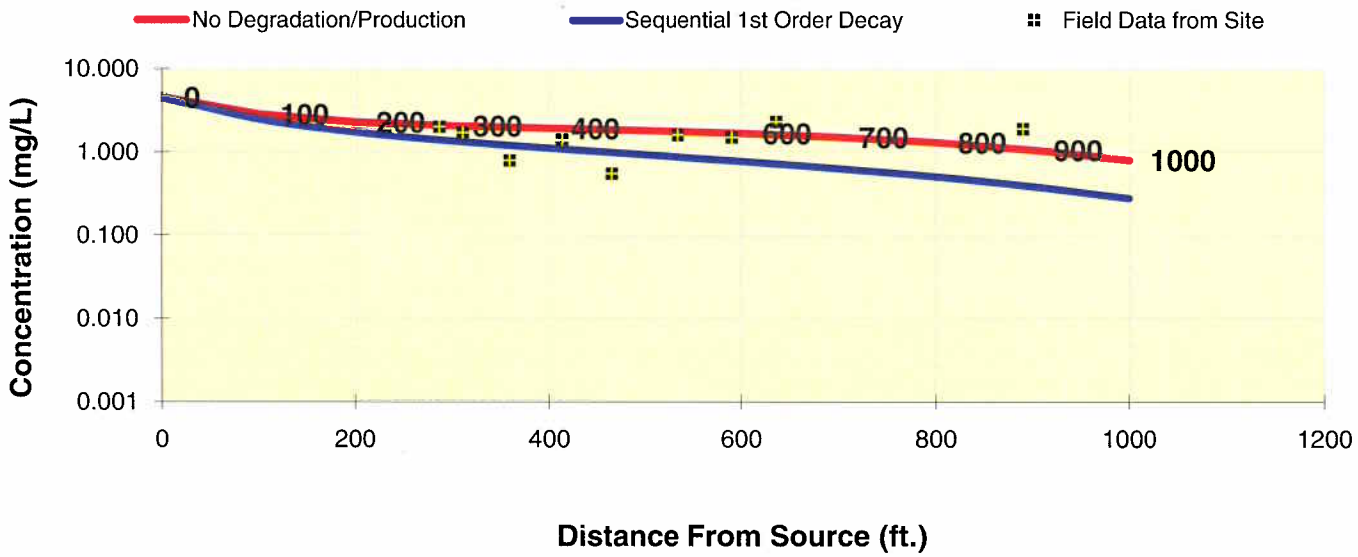
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	4.516	2.833	2.292	2.059	1.921	1.807	1.678	1.512	1.304	1.062	0.809
Biotransformation	4.5158	2.454	1.724	1.350	1.106	0.923	0.770	0.633	0.505	0.386	0.279
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

53.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 50 mg/L - BIO
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2

	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	53	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

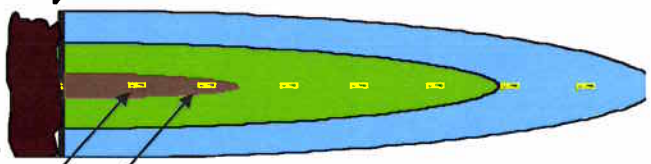
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1: 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.054
TCE	50.0	0.054
DCE		0.054
VC		0.054
ETH		0.054

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

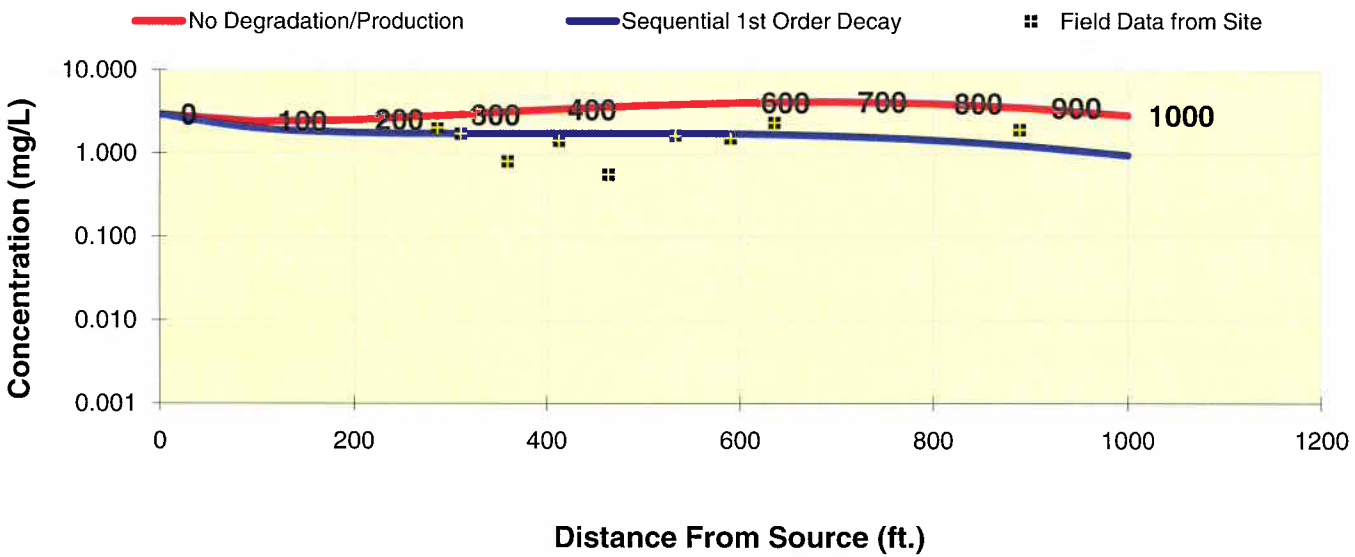
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	2.934	2.416	2.531	2.886	3.331	3.763	4.075	4.166	3.977	3.516	2.859
Biotransformation	2.9345	2.008	1.767	1.720	1.727	1.734	1.703	1.608	1.441	1.210	0.945
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

53.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 50 mg/L - No BIO
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then (C)
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	75.0	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	53	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

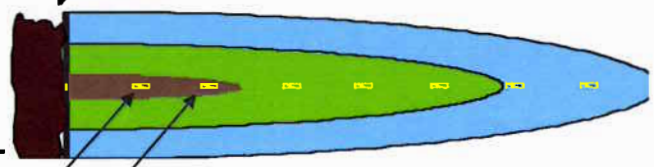
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.054
TCE	50.0	0.054
DCE		0.054
VC		0.054
ETH		0.054

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

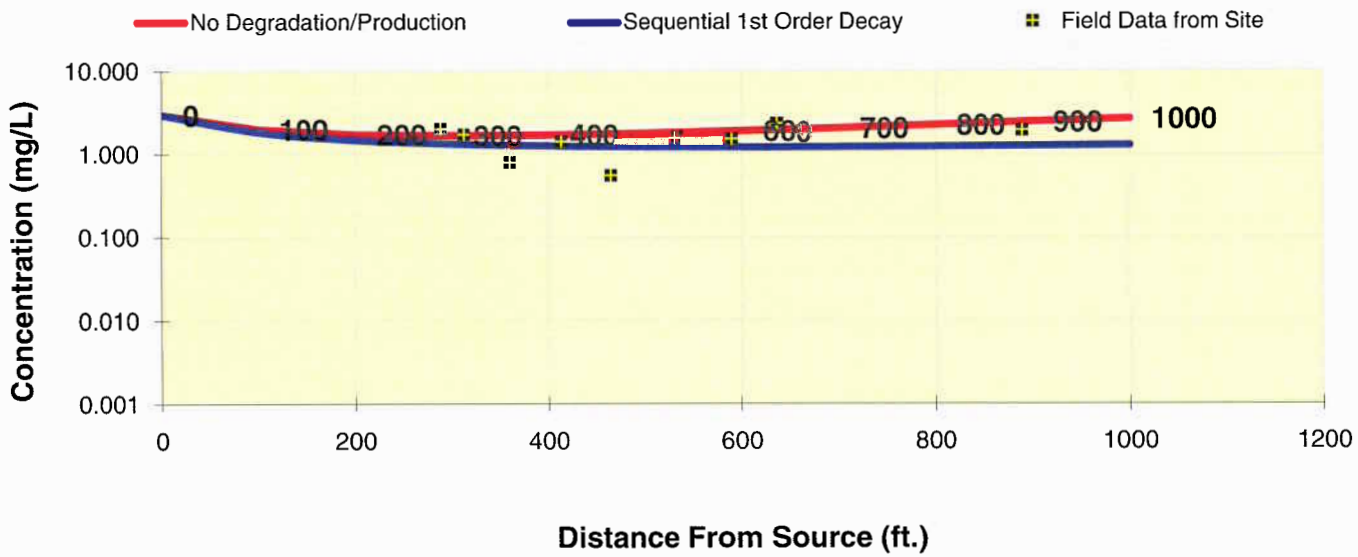
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	2.934	1.967	1.706	1.653	1.684	1.766	1.884	2.033	2.209	2.408	2.622
Biotransformation	2.9345	1.825	1.467	1.319	1.247	1.213	1.202	1.205	1.219	1.239	1.263
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:
53.0 Years
Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 100 mg/L - BIO
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray cells. Press Enter, then C
0.02
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

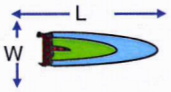
-1st Order Decay Coefficient*

		λ (1/yr)	half-life (yrs)	Yield
Zone 1				
PCE →	TCE	0.000		0.79
TCE →	DCE	0.070		0.74
DCE →	VC	0.000		0.64
VC →	ETH	0.000		0.45
Zone 2		λ (1/yr)	half-life (yrs)	
PCE →	TCE	0.000		
TCE →	DCE	0.000		
DCE →	VC	0.000		
VC →	ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	53	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

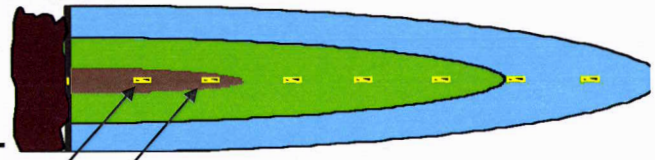
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.068
TCE	100.0	0.068
DCE		0.068
VC		0.068
ETH		0.068

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

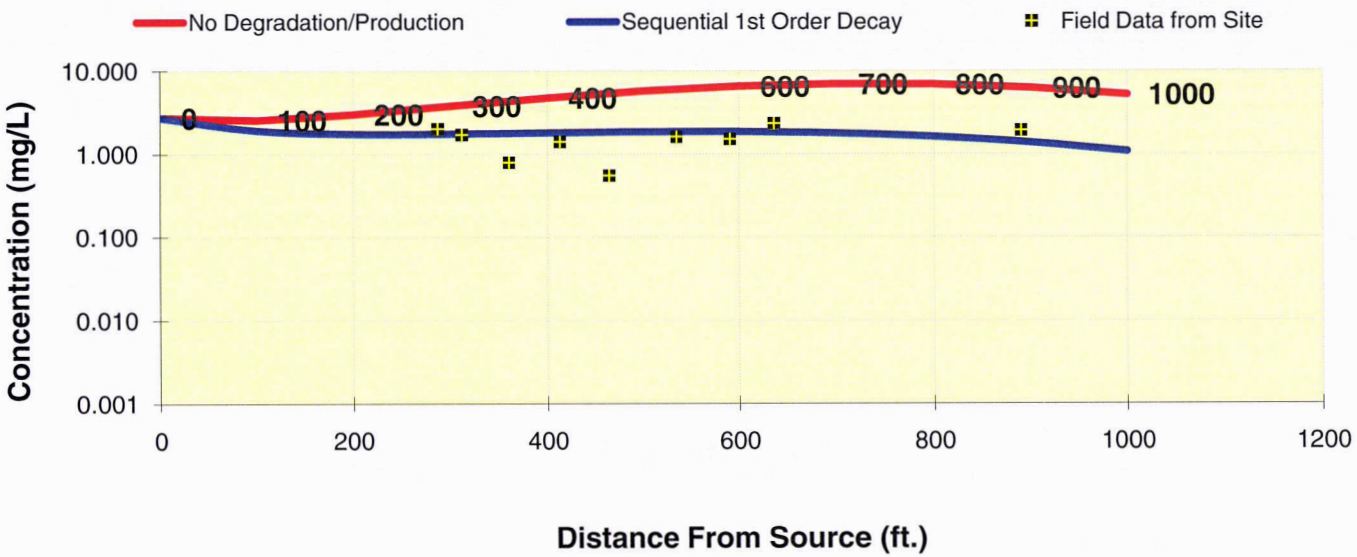
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	2.721	2.546	2.986	3.751	4.689	5.652	6.444	6.864	6.768	6.139	5.097
Biotransformation	2.7215	1.920	1.741	1.741	1.793	1.839	1.840	1.764	1.599	1.357	1.068
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

53.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 100 mg/L - No BIO
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	90.0	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2

	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	53	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

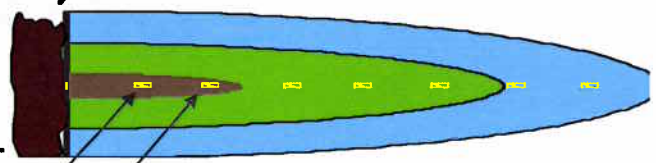
TYPE: Decaying Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations

	Y1	k_s* (1/yr)
Width* (ft)	50	
Conc. (mg/L)*	C1	
PCE		0.068
TCE	100.0	0.068
DCE		0.068
VC		0.068
ETH		0.068



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

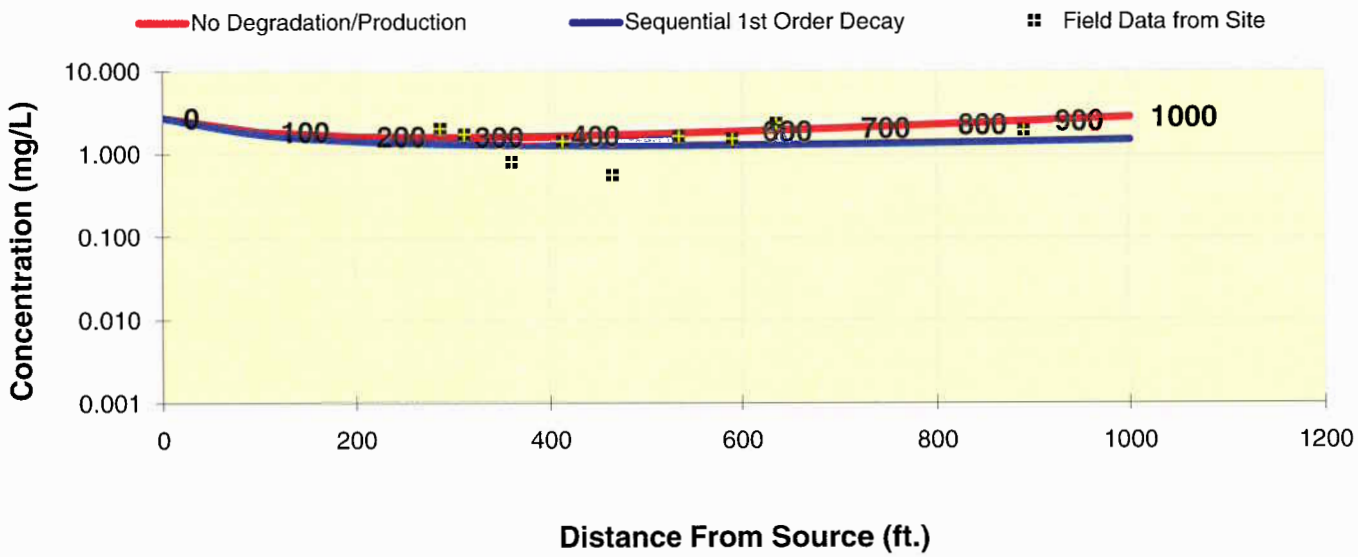
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	2.721	1.843	1.614	1.580	1.627	1.724	1.860	2.033	2.242	2.487	2.769
Biotransformation	2.7215	1.729	1.421	1.305	1.260	1.253	1.269	1.302	1.348	1.405	1.472
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

53.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

Calibration to 2007 Field Data

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 10 mg/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

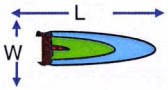
-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	56	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

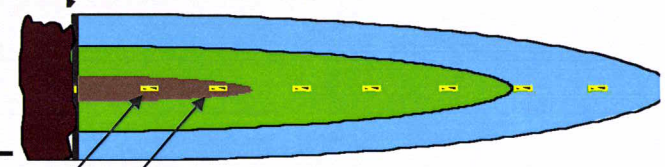
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations

	Y1
Width* (ft)	50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.005
TCE	10.0	0.005
DCE		0.005
VC		0.005
ETH		0.005



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

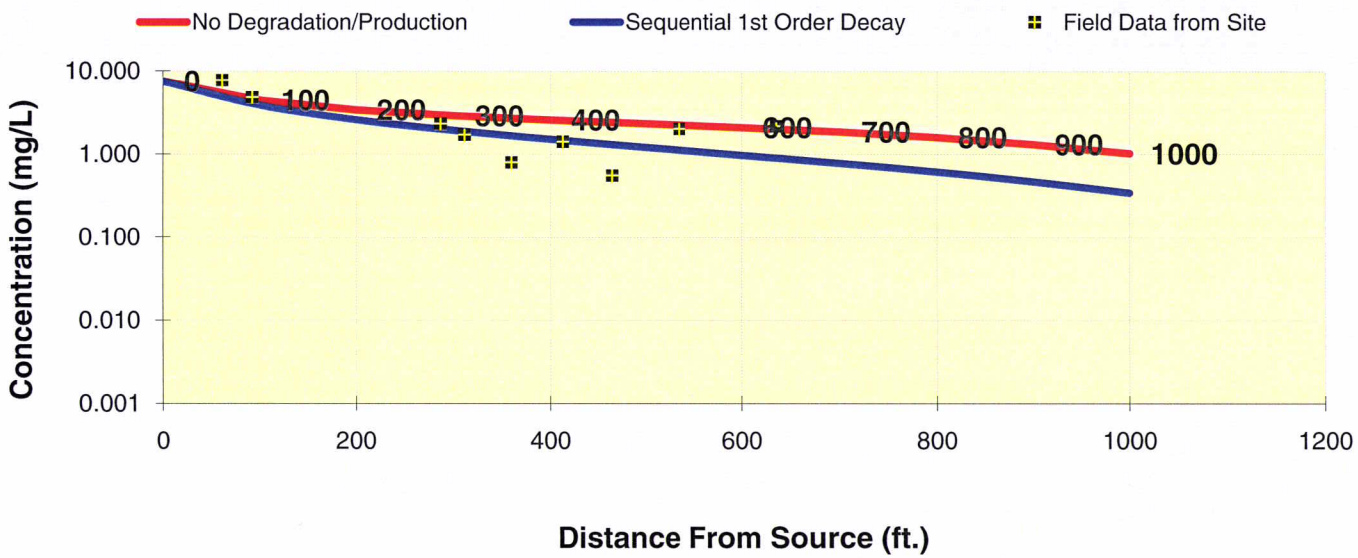
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	7.558	4.467	3.410	2.900	2.577	2.326	2.096	1.857	1.595	1.311	1.021
Biotransformation	7.5578	3.898	2.600	1.935	1.511	1.208	0.973	0.780	0.614	0.469	0.344
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

56.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 50 mg/L - BIO
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then (C)
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.070		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2

	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	56	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

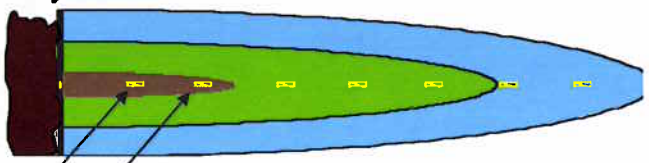
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.033
TCE	50.0	0.033
DCE		0.033
VC		0.033
ETH		0.033

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

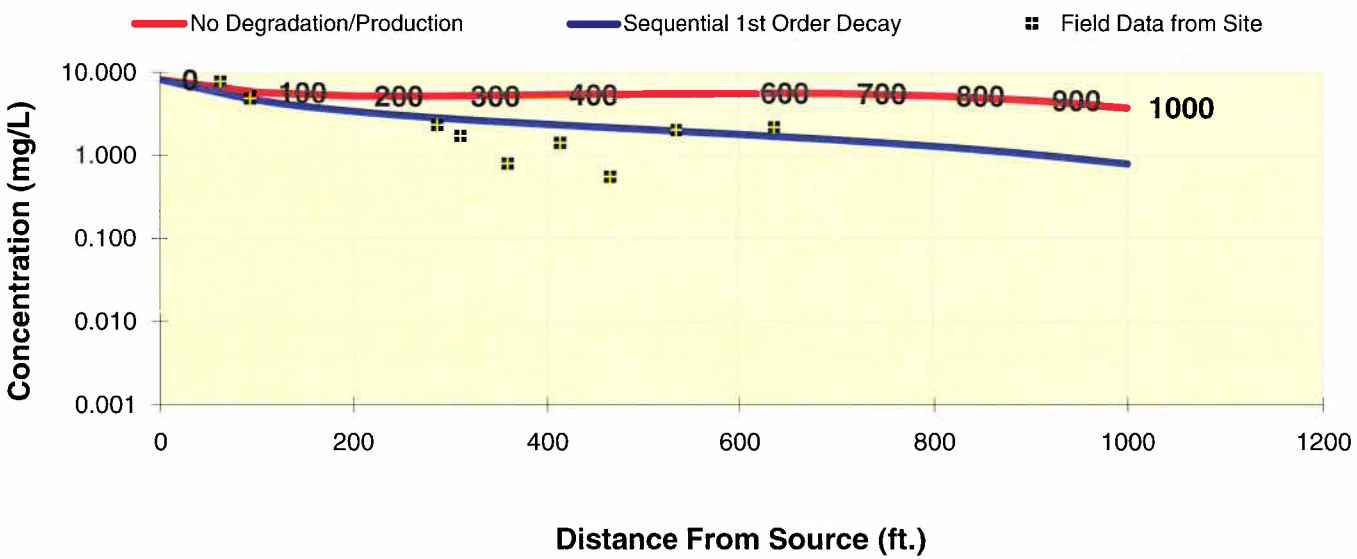
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	8.101	5.699	5.160	5.169	5.350	5.548	5.645	5.546	5.193	4.583	3.780
Biotransformation	8.1013	4.588	3.358	2.740	2.339	2.035	1.773	1.525	1.276	1.028	0.786
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

56.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 50 mg/L - No BIO
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then (C)
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	75.0	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	56	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.033
TCE	50.0	0.033
DCE		0.033
VC		0.033
ETH		0.033

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

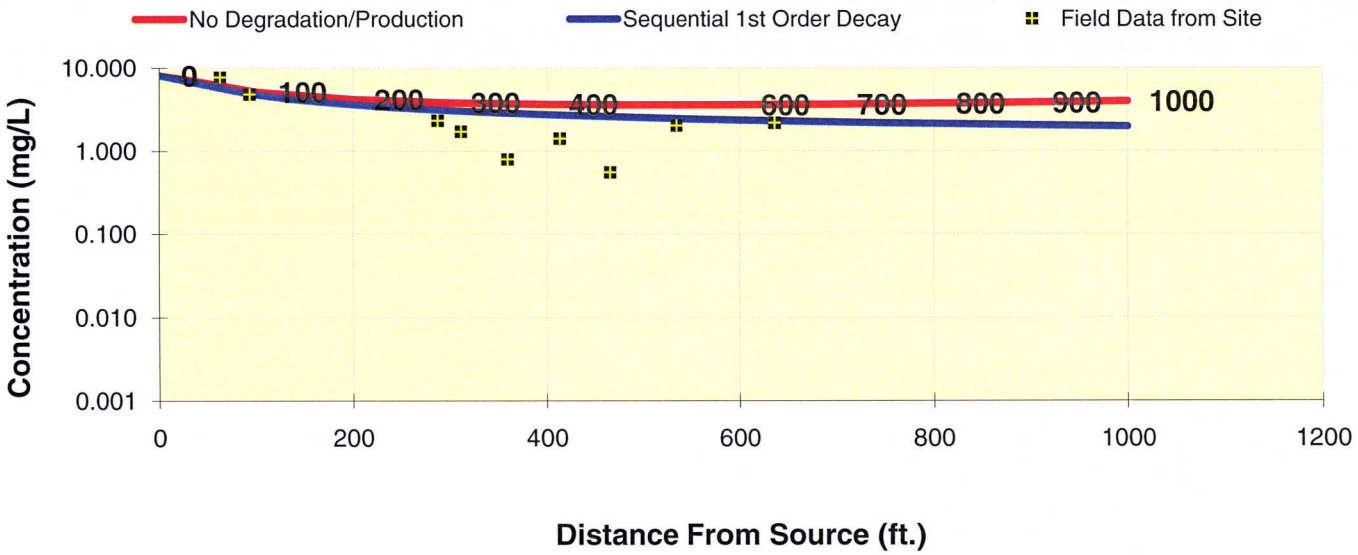
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	8.101	5.096	4.147	3.771	3.606	3.549	3.558	3.613	3.699	3.810	3.936
Biotransformation	8.1013	4.749	3.601	3.052	2.720	2.495	2.332	2.208	2.110	2.029	1.961
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

56.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 100 mg/L - BIO
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.100		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

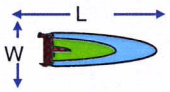
Zone 2

	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	56	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

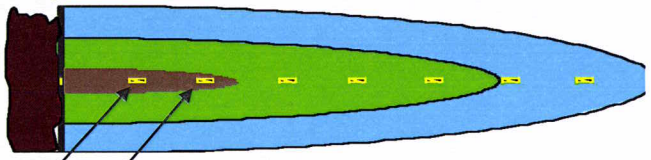
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.045
TCE	100.0	0.045
DCE		0.045
VC		0.045
ETH		0.045

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

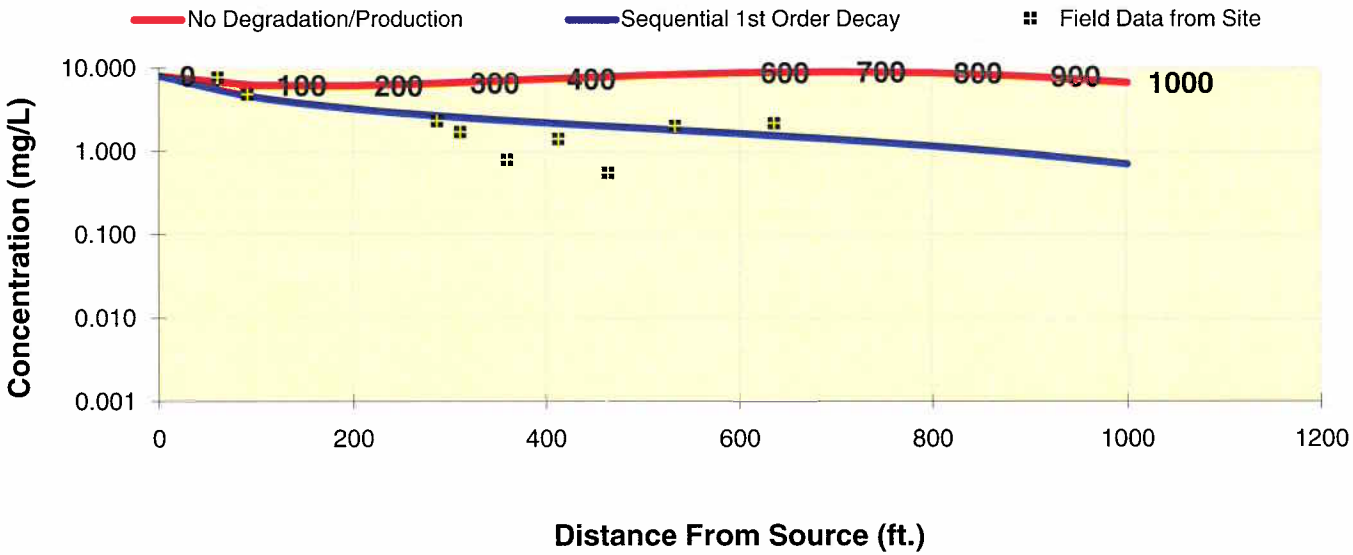
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	8.046	6.202	6.126	6.651	7.400	8.169	8.762	8.991	8.719	7.917	6.682
Biotransformation	8.0460	4.494	3.244	2.612	2.201	1.891	1.629	1.387	1.151	0.920	0.700
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

56.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 100 mg/L - No BIO
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	90.0	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

		λ (1/yr)	half-life (yrs)	Yield
Zone 1				
PCE →	TCE	0.000		0.79
TCE →	DCE	0.100		0.74
DCE →	VC	0.000		0.64
VC →	ETH	0.000		0.45
Zone 2		λ (1/yr)	half-life (yrs)	
PCE →	TCE	0.000		
TCE →	DCE	0.000		
DCE →	VC	0.000		
VC →	ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	56	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

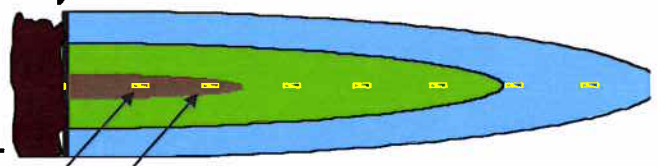
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.045
TCE	100.0	0.045
DCE		0.045
VC		0.045
ETH		0.045

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

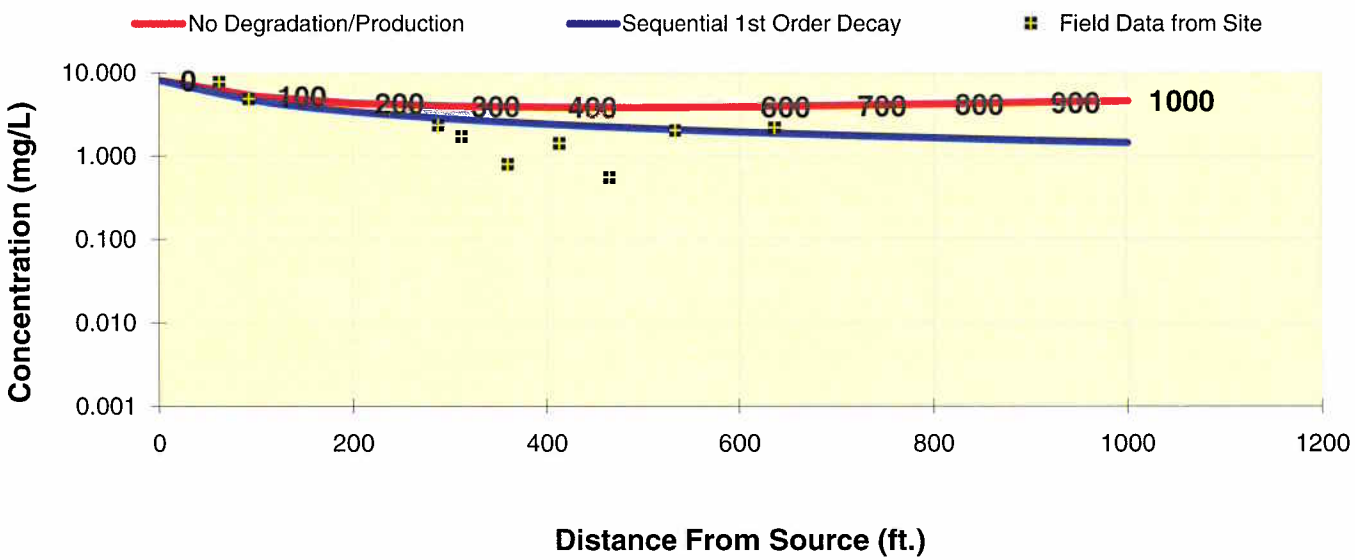
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	8.046	5.137	4.242	3.915	3.800	3.796	3.864	3.985	4.148	4.348	4.582
Biotransformation	8.0460	4.572	3.360	2.760	2.384	2.120	1.921	1.763	1.634	1.526	1.433
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

56.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

Predictive Modeling Scenarios

No
Active
Remediation

No Active Remediation

2004 Field Data

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
10 mg/L - No Active Remed.
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then (C)
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)

Common R (used in model)* = 2.00

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	503	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

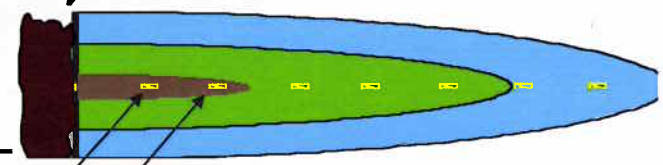
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.015
TCE	10.0	0.015
DCE		0.015
VC		0.015
ETH		0.015

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

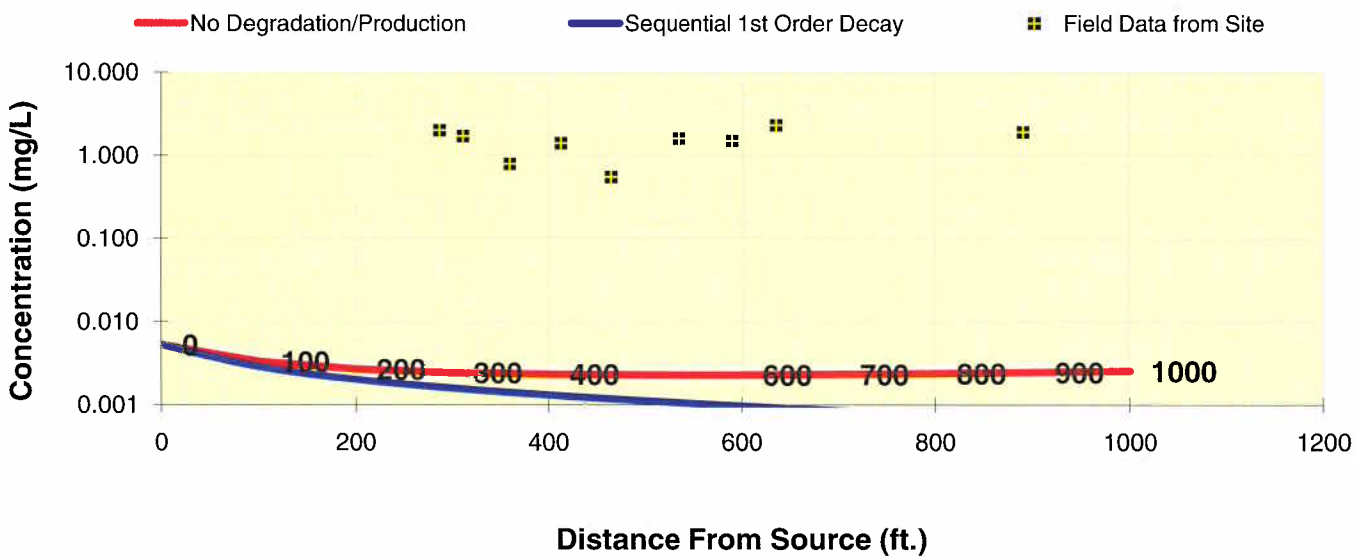
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003
Biotransformation	0.0053	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

503.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
50 mg/L - No Active Remed.
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)

Common R (used in model)* = 2.00

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2

	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	178	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.054
TCE	50.0	0.054
DCE		0.054
VC		0.054
ETH		0.054

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

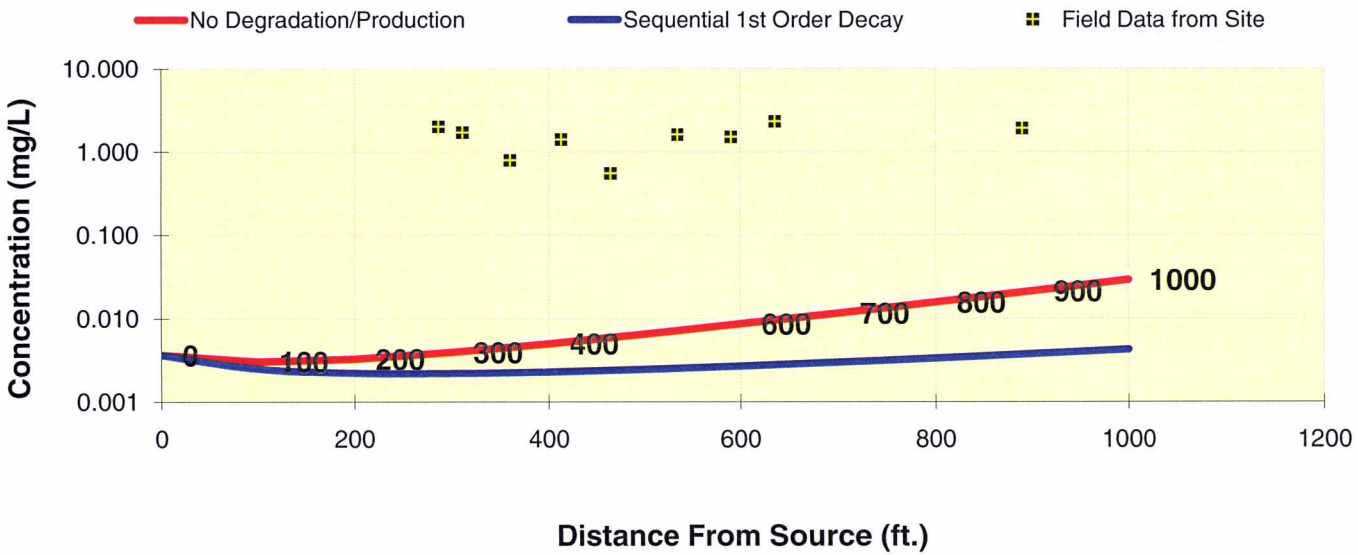
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.004	0.003	0.003	0.004	0.005	0.007	0.009	0.012	0.016	0.021	0.029
Biotransformation	0.0037	0.003	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.004	0.004
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

178.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
100 mg/L - No Active Remed.
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

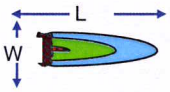
-1st Order Decay Coefficient*

		λ (1/yr)	half-life (yrs)	Yield
Zone 1				
PCE →	TCE	0.000		0.79
TCE →	DCE	0.070		0.74
DCE →	VC	0.000		0.64
VC →	ETH	0.000		0.45
Zone 2		λ (1/yr)	half-life (yrs)	
PCE →	TCE	0.000		
TCE →	DCE	0.000		
DCE →	VC	0.000		
VC →	ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	153	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

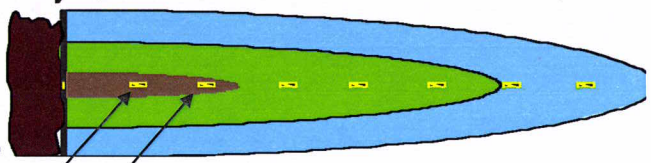
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.068
TCE	100.0	0.068
DCE		0.068
VC		0.068
ETH		0.068

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

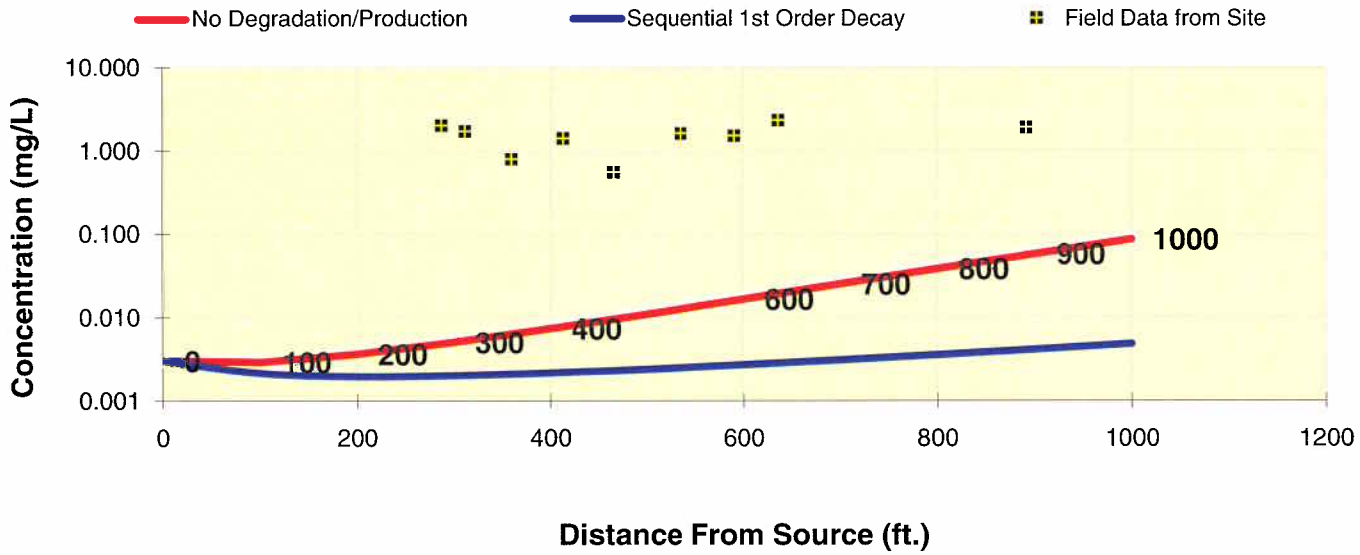
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.003	0.003	0.004	0.005	0.007	0.011	0.017	0.025	0.038	0.057	0.086
Biotransformation	0.0030	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.004	0.004	0.005
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

153.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

No Active Remediation

2007 Field Data

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
10 mg/L - No Active Remed.
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	1506	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

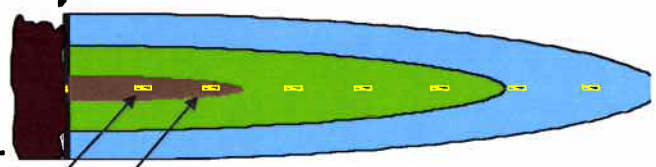
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.005
TCE	10.0	0.005
DCE		0.005
VC		0.005
ETH		0.005

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

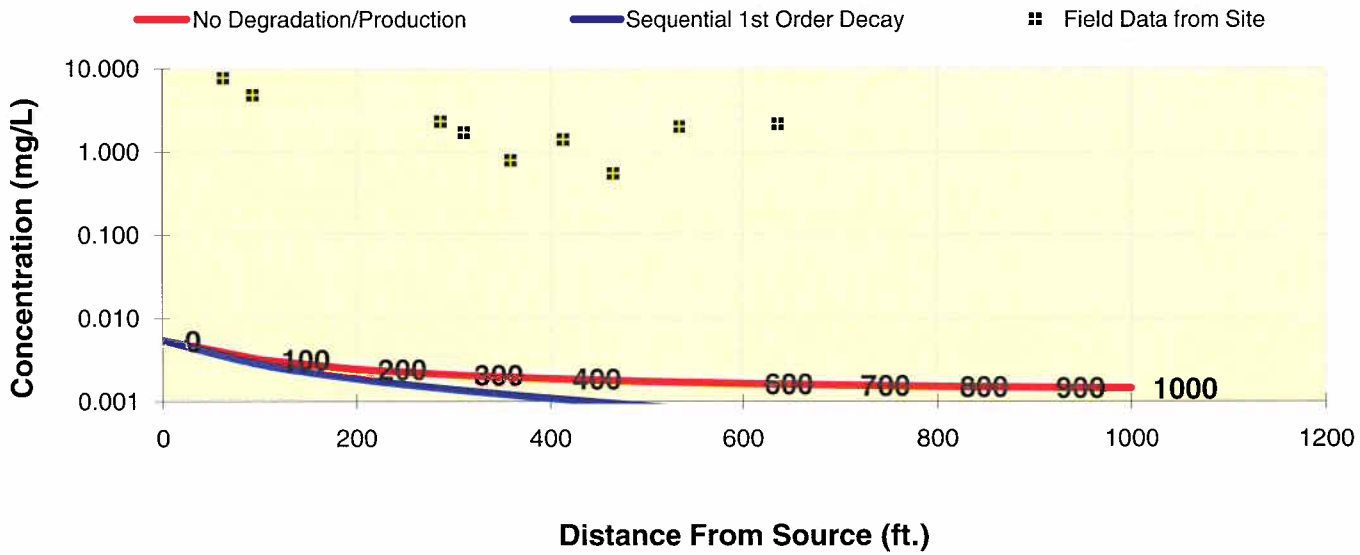
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001
Biotransformation	0.0054	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

1,506.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
50 mg/L - No Active Remed.
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then (C)
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ● Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION **-1st Order Decay Coefficient***

Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.070		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	281	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

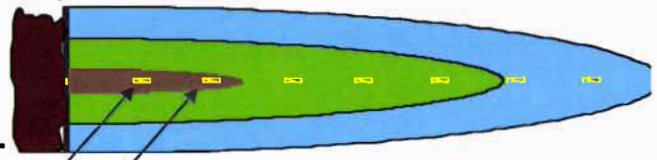
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.033
TCE	50.0	0.033
DCE		0.033
VC		0.033
ETH		0.033

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

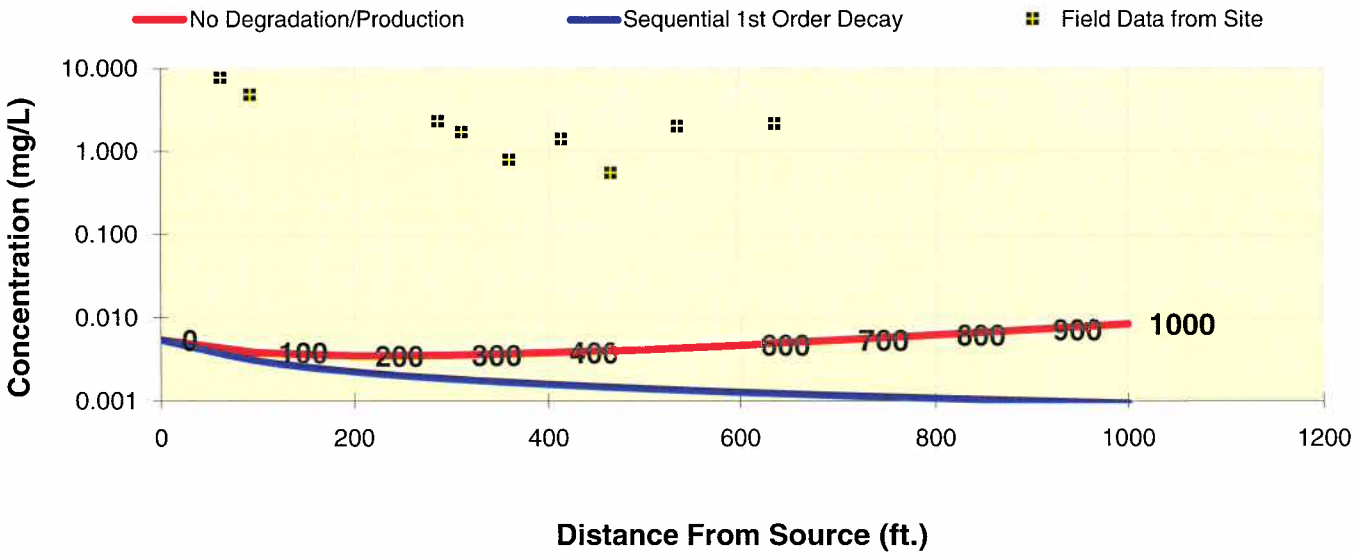
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.004	0.003	0.004	0.004	0.004	0.005	0.005	0.006	0.007	0.008
Biotransformation	0.0054	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

281.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
100 mg/L - No Active Remed.
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ● Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)

Common R (used in model)* = 2.00

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.100		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	221	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

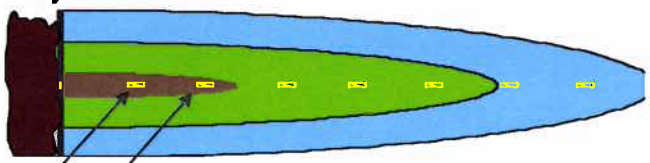
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.045
TCE	100.0	0.045
DCE		0.045
VC		0.045
ETH		0.045

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

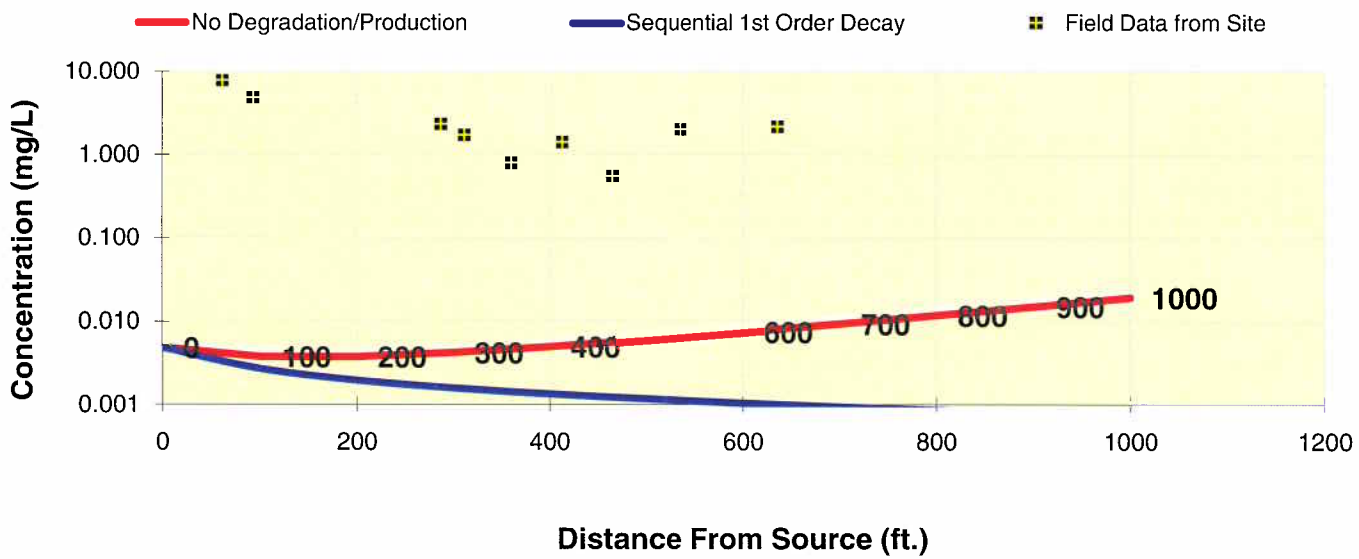
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.004	0.004	0.004	0.005	0.006	0.007	0.009	0.012	0.015	0.019
Biotransformation	0.0048	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

221.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

Active Remediation Scenario's

Reduction of Source Area to 1 mg/L

2004 Field Data

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
10 mg/L - Reduced to 1 mg/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then (C)
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	350	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

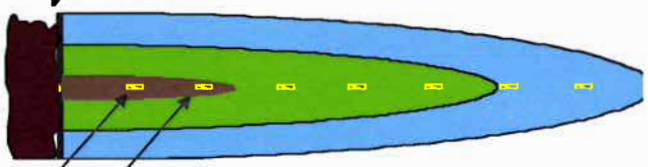
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.015
TCE	1.0	0.015
DCE		0.015
VC		0.015
ETH		0.015

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

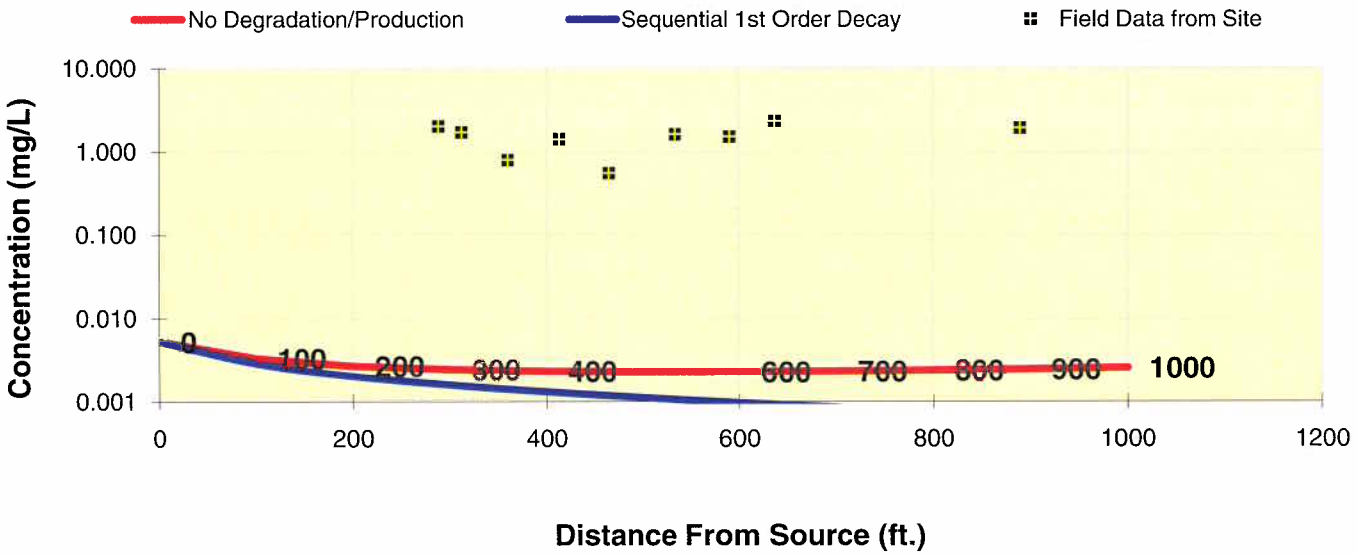
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003
Biotransformation	0.0052	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

350.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
50 mg/L - Reduced to 1 mg/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION **-1st Order Decay Coefficient***

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

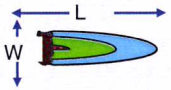
Zone 2

	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	100	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

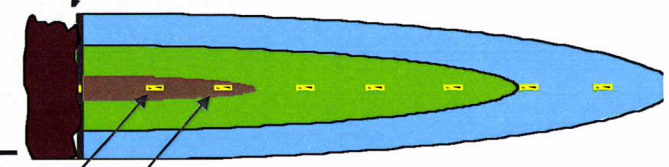
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.054
TCE	1.0	0.054
DCE		0.054
VC		0.054
ETH		0.054

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

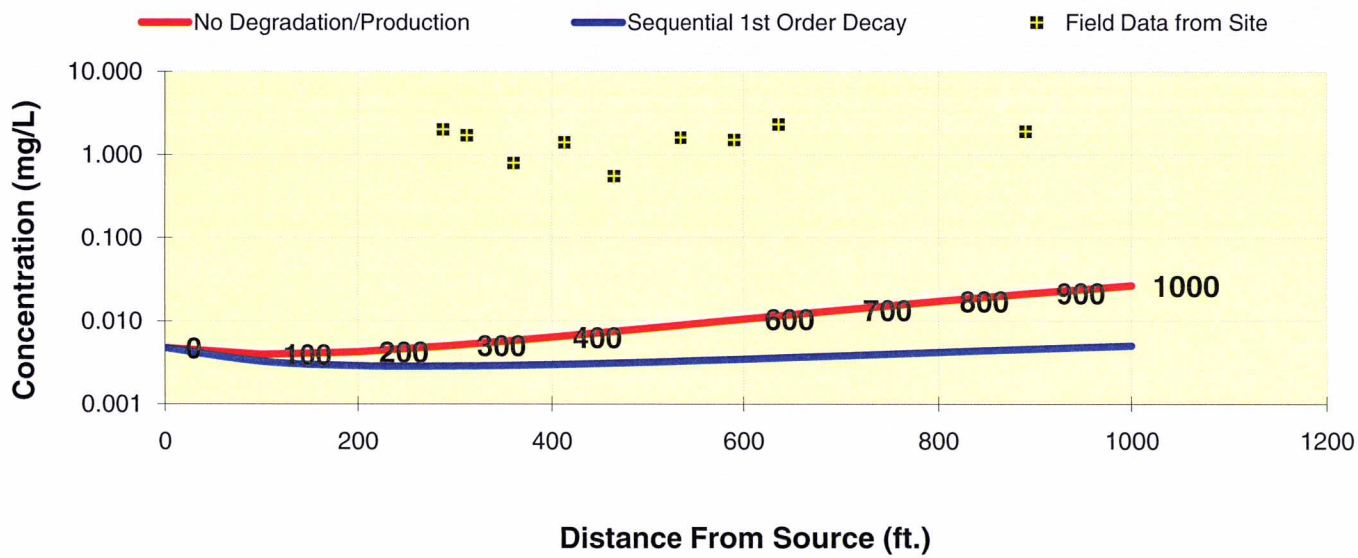
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.004	0.004	0.005	0.006	0.008	0.011	0.014	0.017	0.022	0.027
Biotransformation	0.0047	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.005	0.005
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

100.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
100 mg/L - Reduced to 1 mg/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.070		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	80	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

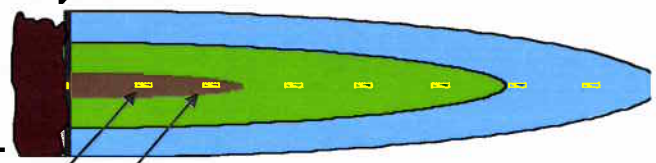
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.068
TCE	1.0	0.068
DCE		0.068
VC		0.068
ETH		0.068

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

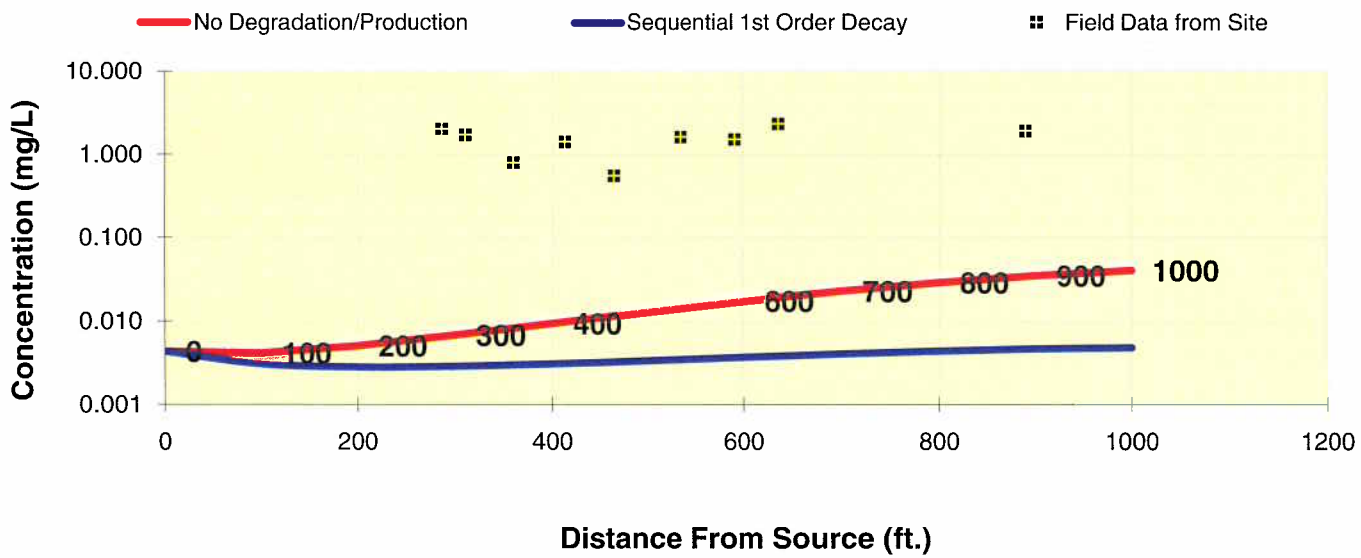
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.004	0.004	0.005	0.007	0.009	0.013	0.017	0.023	0.029	0.035	0.040
Biotransformation	0.0043	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.005
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

80.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

Reduction of Source Area to 1 mg/L

2007 Field Data

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
10 mg/L - Reduced to 1 mg/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	1050	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

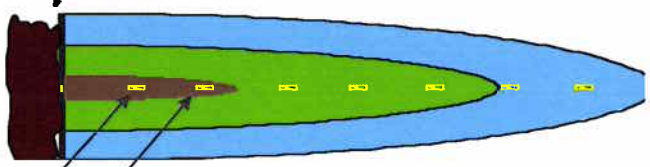
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.005
TCE	1.0	0.005
DCE		0.005
VC		0.005
ETH		0.005

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

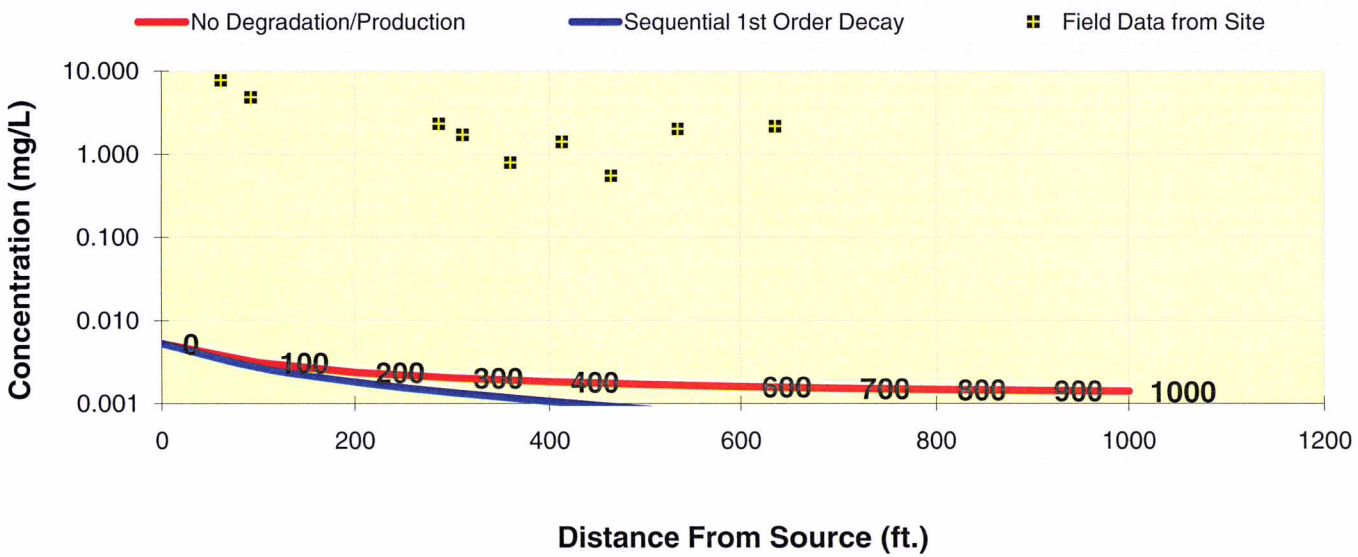
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001
Biotransformation	0.0052	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

1,050.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
50 mg/L - Reduced to 1 mg/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray cells. Press Enter, then C
0.02
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

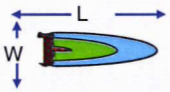
-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.070		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	161	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

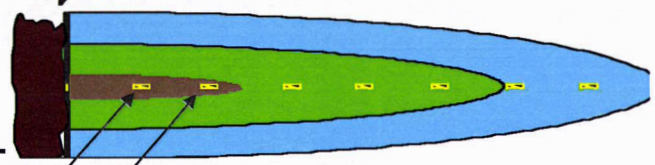
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.033
TCE	1.0	0.033
DCE		0.033
VC		0.033
ETH		0.033

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

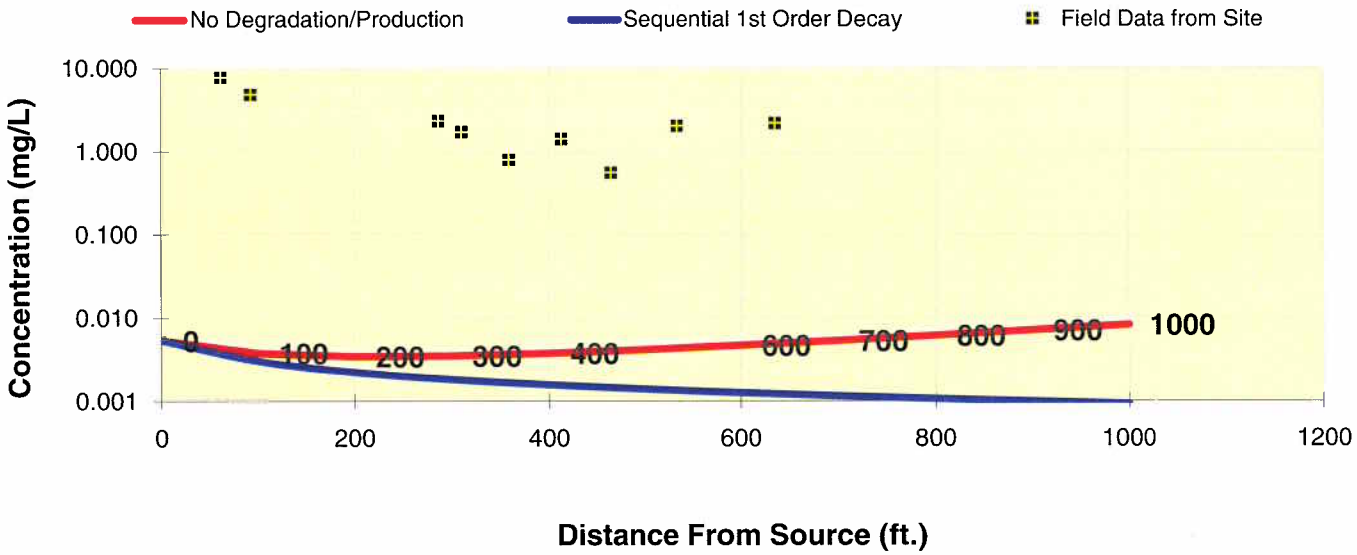
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.004	0.003	0.004	0.004	0.004	0.005	0.005	0.006	0.007	0.008
Biotransformation	0.0053	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

161.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
100 mg/L - Reduced to 1 mg/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then (C)
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ● Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

			R	
Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.100		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2

	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	120	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

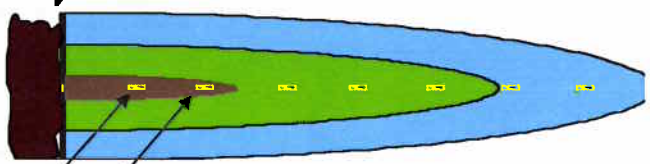
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.045
TCE	1.0	0.045
DCE		0.045
VC		0.045
ETH		0.045

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

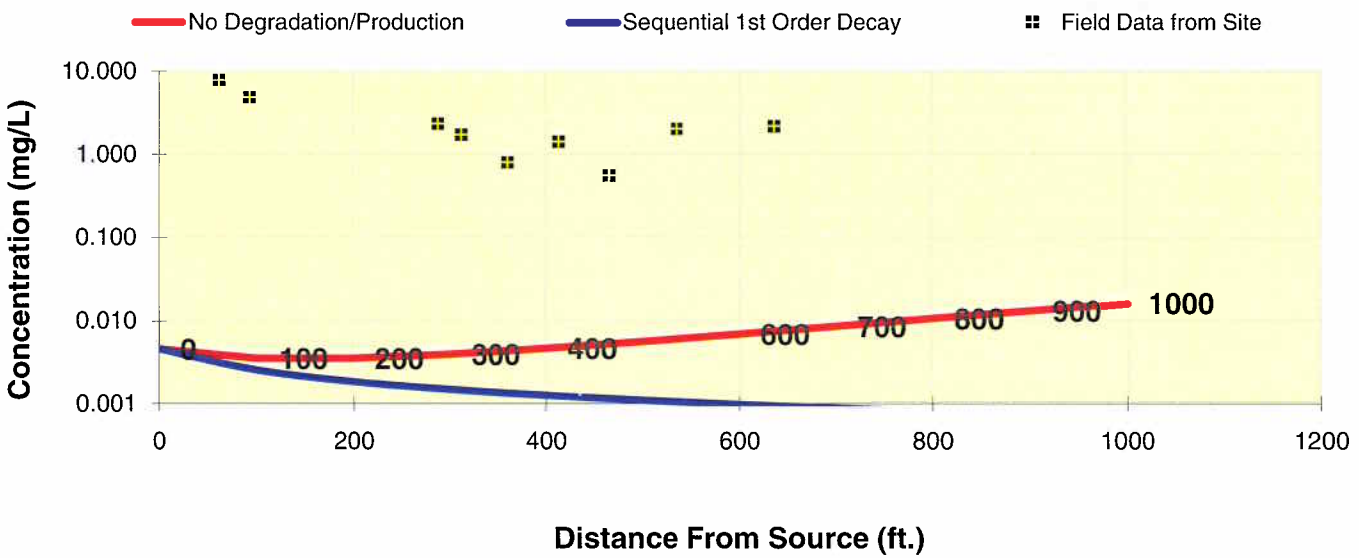
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.004	0.004	0.004	0.005	0.006	0.007	0.008	0.011	0.013	0.016
Biotransformation	0.0045	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

120.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

Reduction of Source Area to 0.5 mg/L

2004 Field Data

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
10 mg/L - Reduced to 500 ug/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then (C)
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2

	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	305	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

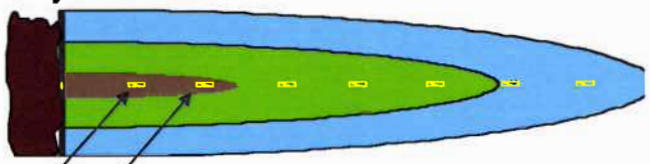
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.015
TCE	.5	0.015
DCE		0.015
VC		0.015
ETH		0.015

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

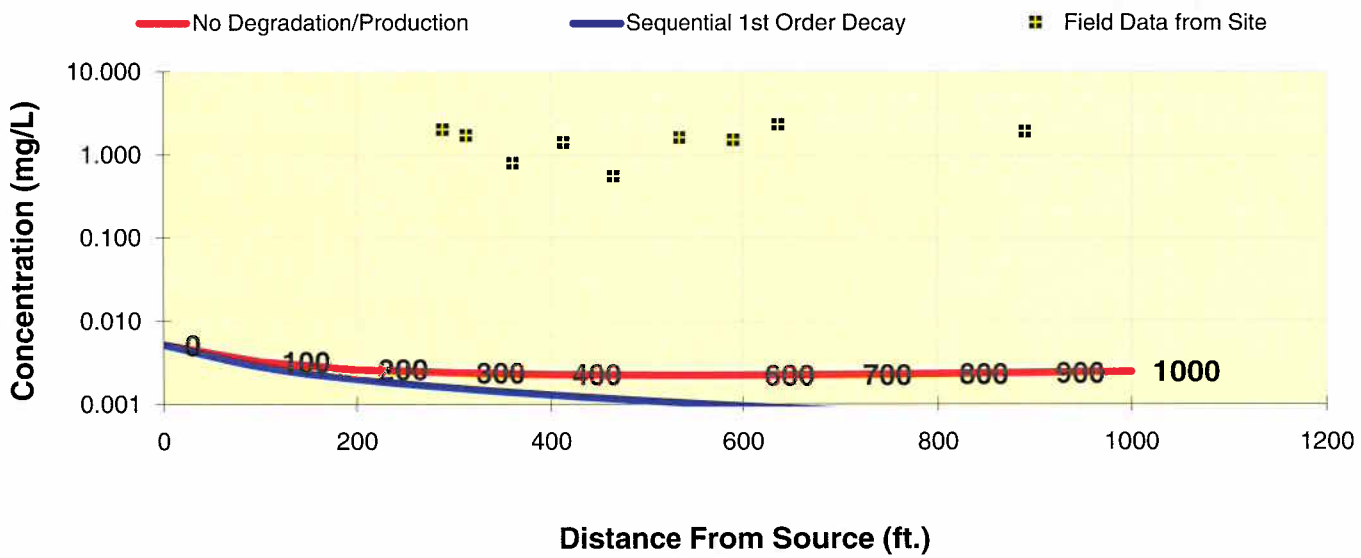
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Biotransformation	0.0052	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

305.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
50 mg/L - Reduced to 500 ug/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	85	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

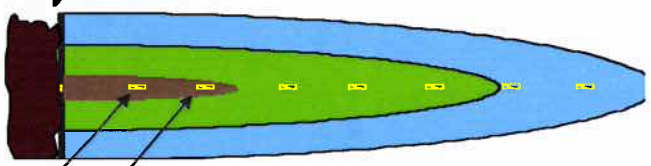
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.054
TCE	.5	0.054
DCE		0.054
VC		0.054
ETH		0.054

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

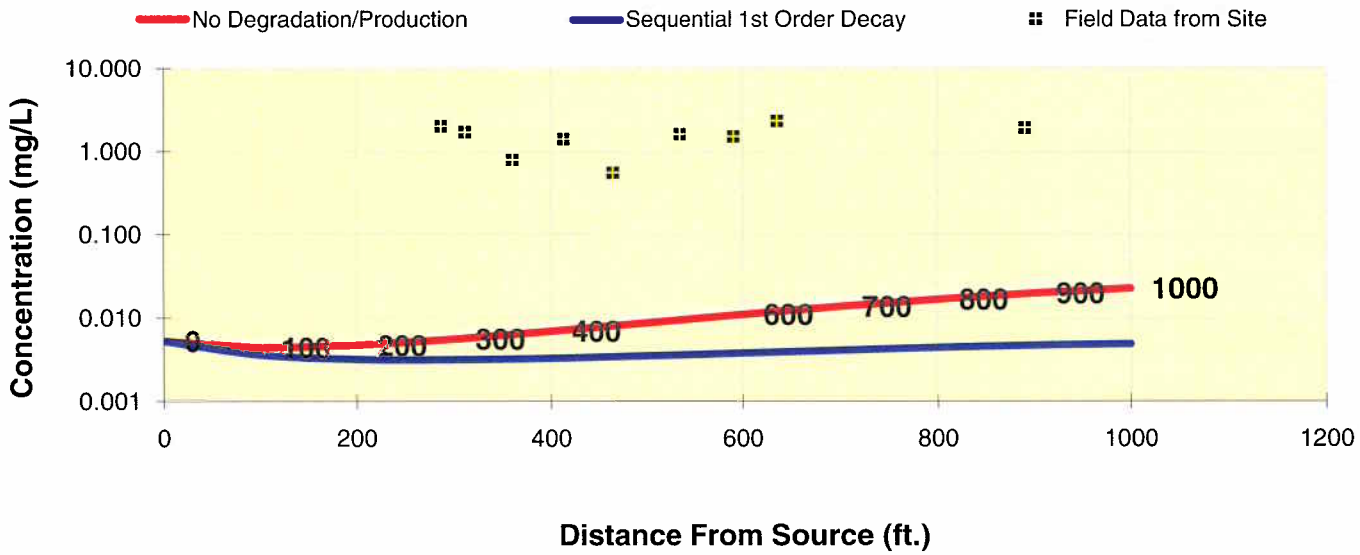
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.004	0.005	0.006	0.007	0.009	0.011	0.014	0.017	0.020	0.023
Biotransformation	0.0053	0.004	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.005	0.005
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

85.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
100 mg/L - Reduced to 500 ug/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray cells. Press Enter, then C
0.02
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)

Common R (used in model)* = 2.00

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

		λ (1/yr)	half-life (yrs)	Yield
Zone 1				
PCE →	TCE	0.000		0.79
TCE →	DCE	0.070		0.74
DCE →	VC	0.000		0.64
VC →	ETH	0.000		0.45
Zone 2		λ (1/yr)	half-life (yrs)	
PCE →	TCE	0.000		
TCE →	DCE	0.000		
DCE →	VC	0.000		
VC →	ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	67	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

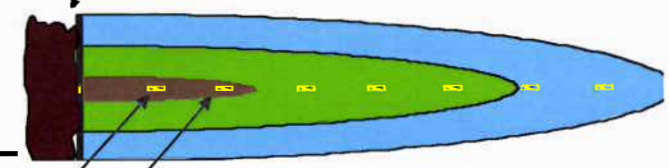
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.068
TCE	.5	0.068
DCE		0.068
VC		0.068
ETH		0.068

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

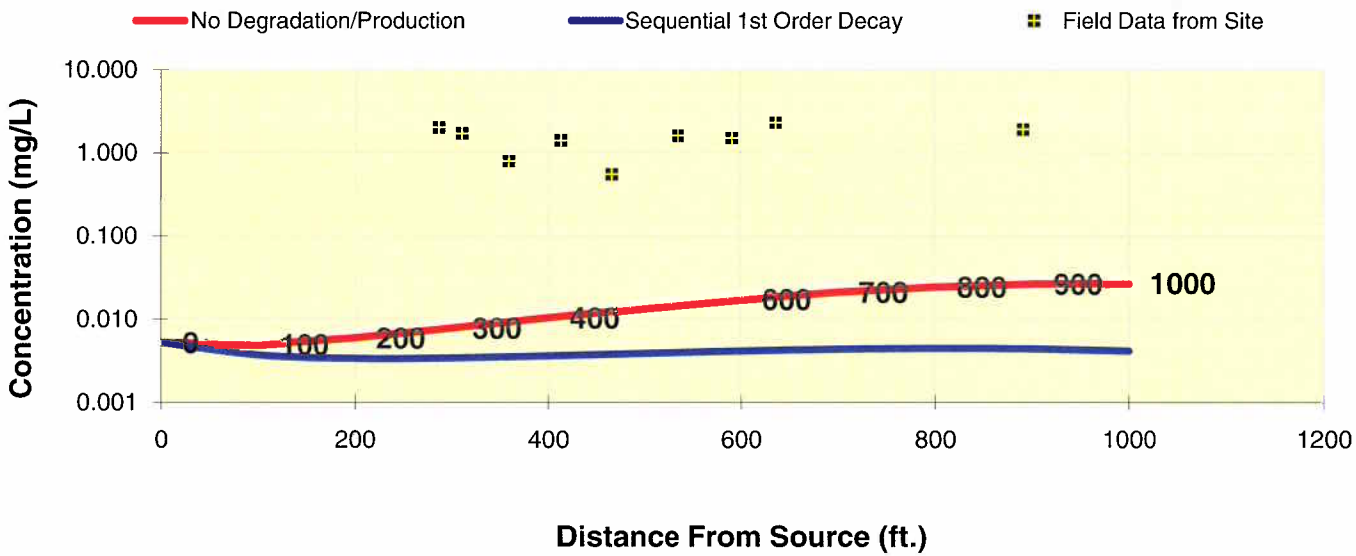
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.005	0.006	0.008	0.010	0.014	0.017	0.021	0.025	0.027	0.027
Biotransformation	0.0053	0.004	0.003	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

67.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

Reduction of Source Area to 0.5 mg/L

2007 Field Data

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
10 mg/L - Reduced to 500 ug/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 ↗ cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.050		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

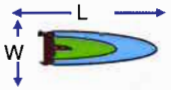
Zone 2

	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	925	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

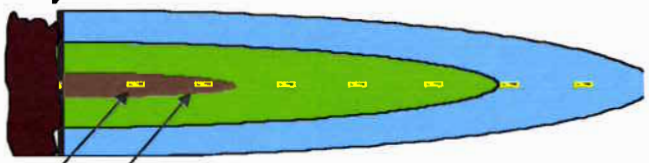
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.005
TCE	.5	0.005
DCE		0.005
VC		0.005
ETH		0.005

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

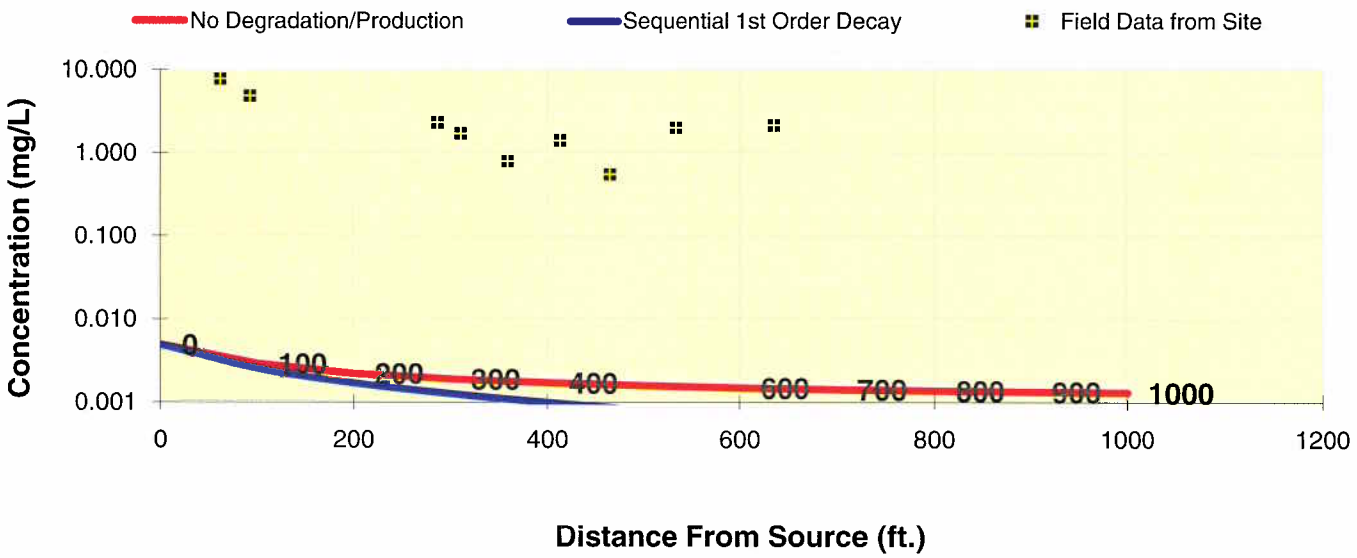
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.003	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001
Biotransformation	0.0049	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

925.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
50 mg/L - Reduced to 500 ug/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray cells. Press Enter, then C
0.02
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION **-1st Order Decay Coefficient***

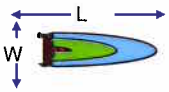
Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.070		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	140	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

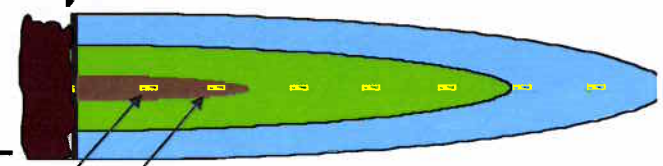
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.033
TCE	.5	0.033
DCE		0.033
VC		0.033
ETH		0.033

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

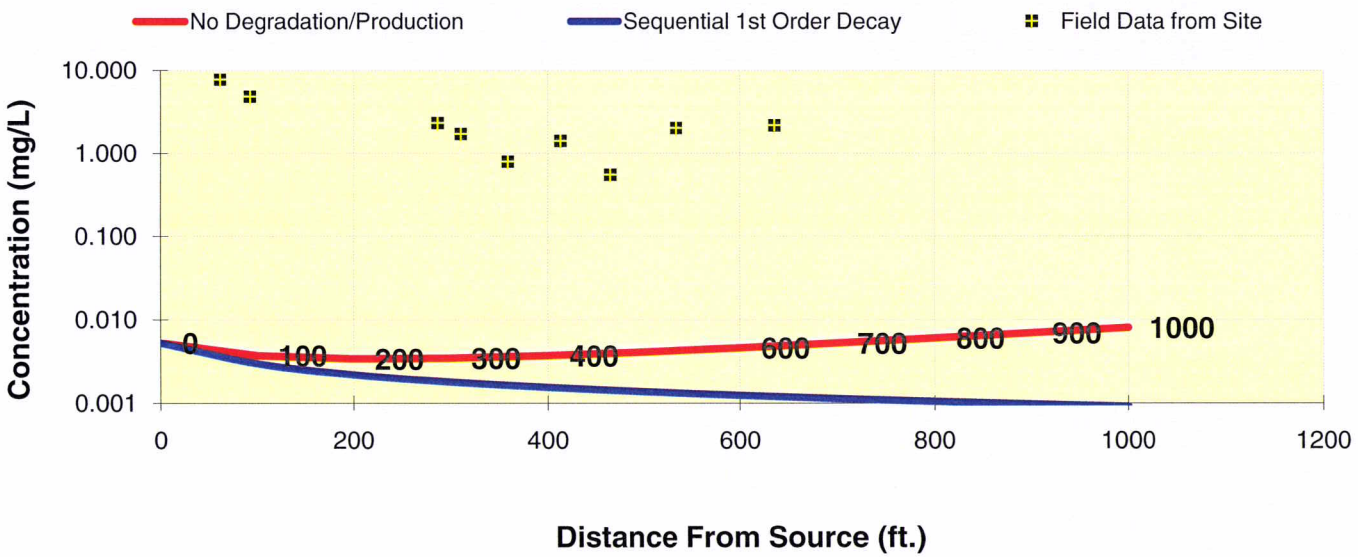
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.004	0.003	0.003	0.004	0.004	0.005	0.005	0.006	0.007	0.008
Biotransformation	0.0053	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

140.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
100 mg/L - Reduced to 500 ug/L
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray cells. Press Enter, then C
0.02
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

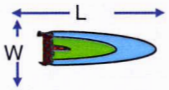
-1st Order Decay Coefficient*

		λ (1/yr)	half-life (yrs)	Yield
Zone 1				
PCE →	TCE	0.000		0.79
TCE →	DCE	0.100		0.74
DCE →	VC	0.000		0.64
VC →	ETH	0.000		0.45
Zone 2		λ (1/yr)	half-life (yrs)	
PCE →	TCE	0.000		
TCE →	DCE	0.000		
DCE →	VC	0.000		
VC →	ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	101	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

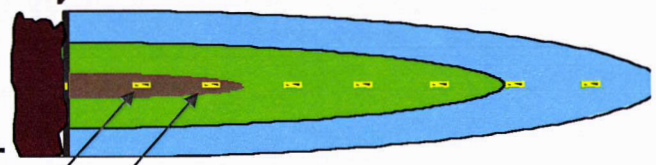
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.045
TCE	.5	0.045
DCE		0.045
VC		0.045
ETH		0.045

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

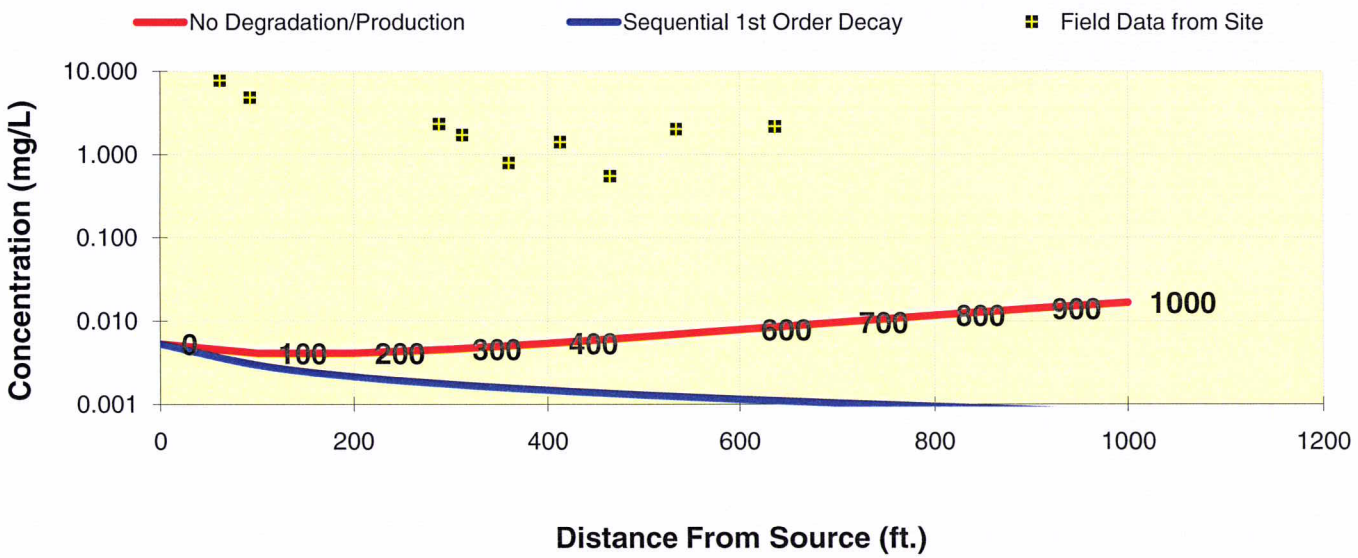
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.005	0.004	0.004	0.005	0.005	0.006	0.008	0.010	0.012	0.014	0.017
Biotransformation	0.0053	0.003	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

101.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

Sensitivity Analysis

Assumed Source Concentrations

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 200 mg/L - BIO
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.115		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2

	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	53	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

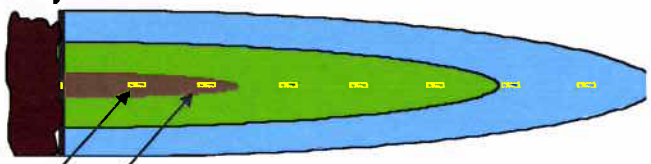
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.068
TCE	200.0	0.068
DCE		0.068
VC		0.068
ETH		0.068

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

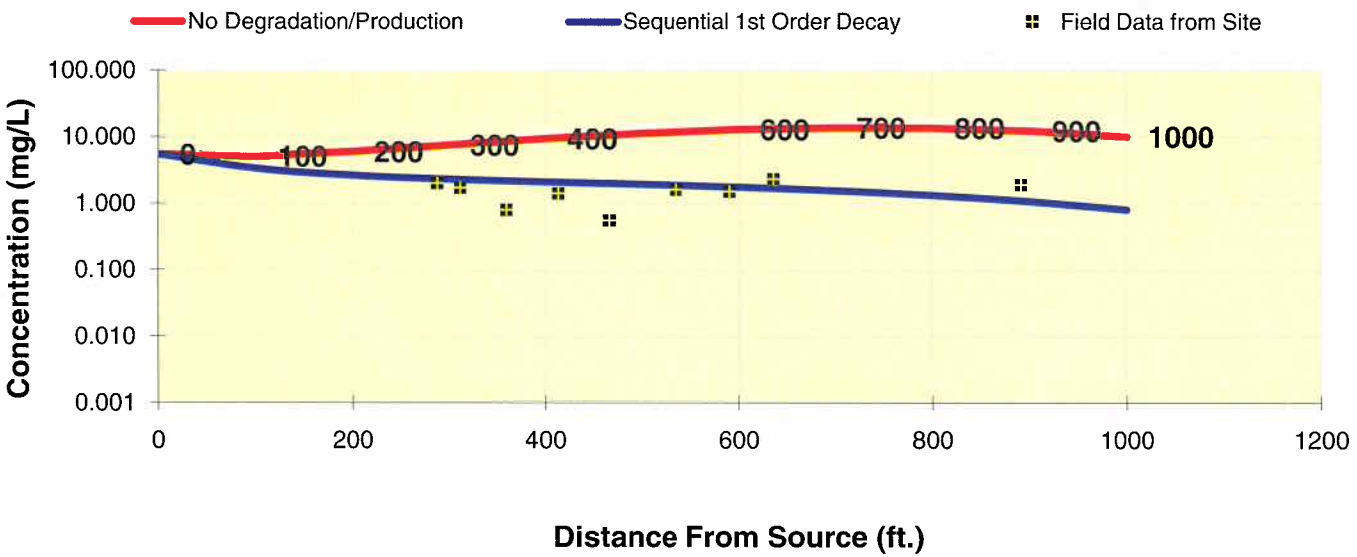
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	5.443	5.091	5.973	7.501	9.378	11.303	12.888	13.727	13.536	12.277	10.193
Biotransformation	5.4429	3.322	2.617	2.291	2.088	1.921	1.750	1.552	1.320	1.064	0.803
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

53.0 Years

Log ⟺ Linear

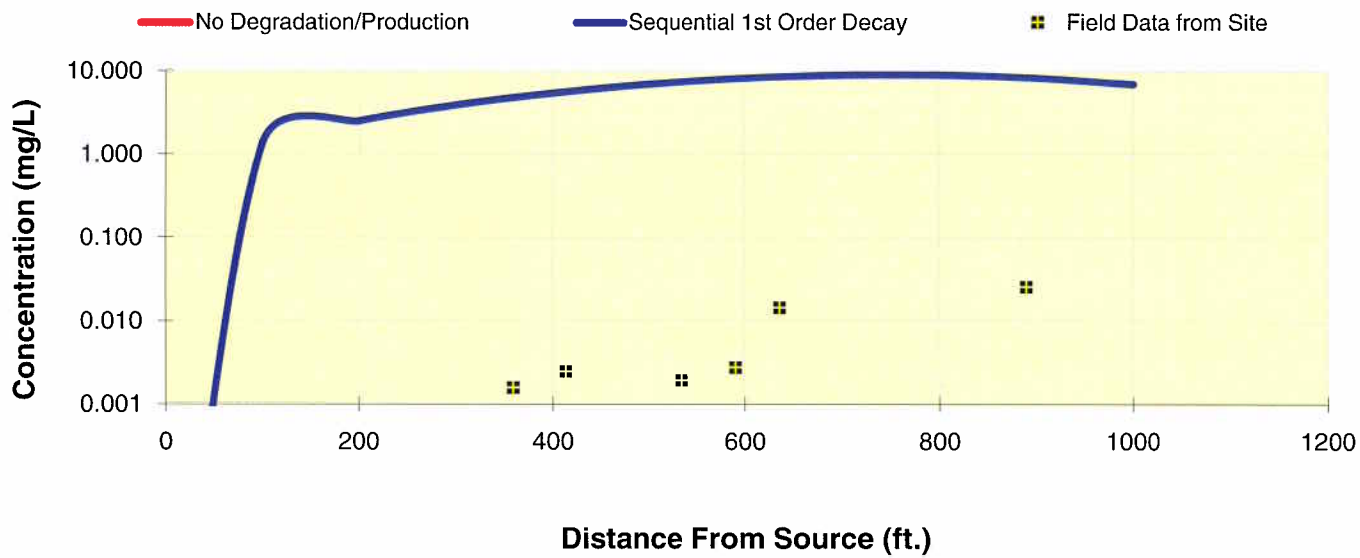
Return to Input

To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

DCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0000	1.305	2.475	3.842	5.376	6.919	8.214	8.978	9.008	8.269	6.925
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site					0.002	0.002		0.002	0.003	0.014	0.026



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

53.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 500 mg/L - BIO
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.160		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2

	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	53	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

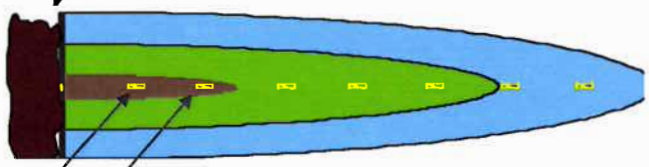
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.075
TCE	500.0	0.075
DCE		0.075
VC		0.075
ETH		0.075

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

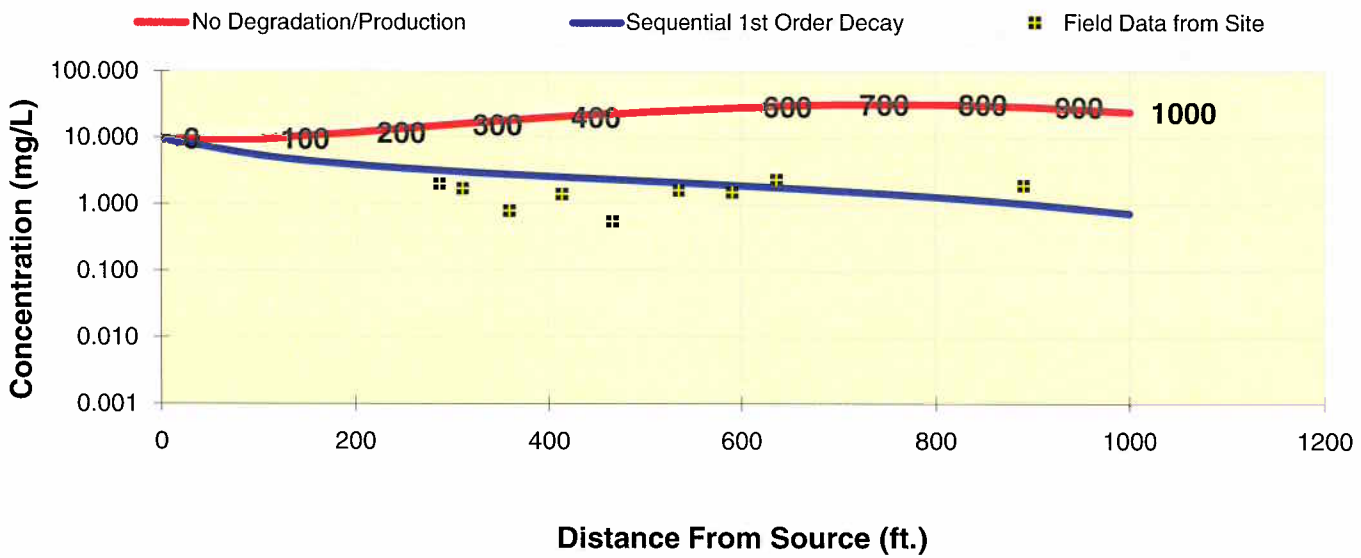
PCE Conc. (mg/L)											
TCE Conc. (mg/L)			2.0	1.7	.79	1.4	.55	1.6	1.5	2.3	1.9
DCE Conc. (mg/L)					.002	.002		.002	.003	.014	.026
VC Conc. (mg/L)						.0	.0				
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2004										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	9.642	9.611	11.896	15.610	20.213	25.046	29.186	31.621	31.603	28.972	24.260
Biotransformation	9.6418	5.370	3.864	3.099	2.597	2.213	1.883	1.574	1.274	0.986	0.720
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site			2.000	1.700	0.790	1.400	0.550	1.600	1.500	2.300	1.900



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

53.0 Years

Log ⟺ Linear

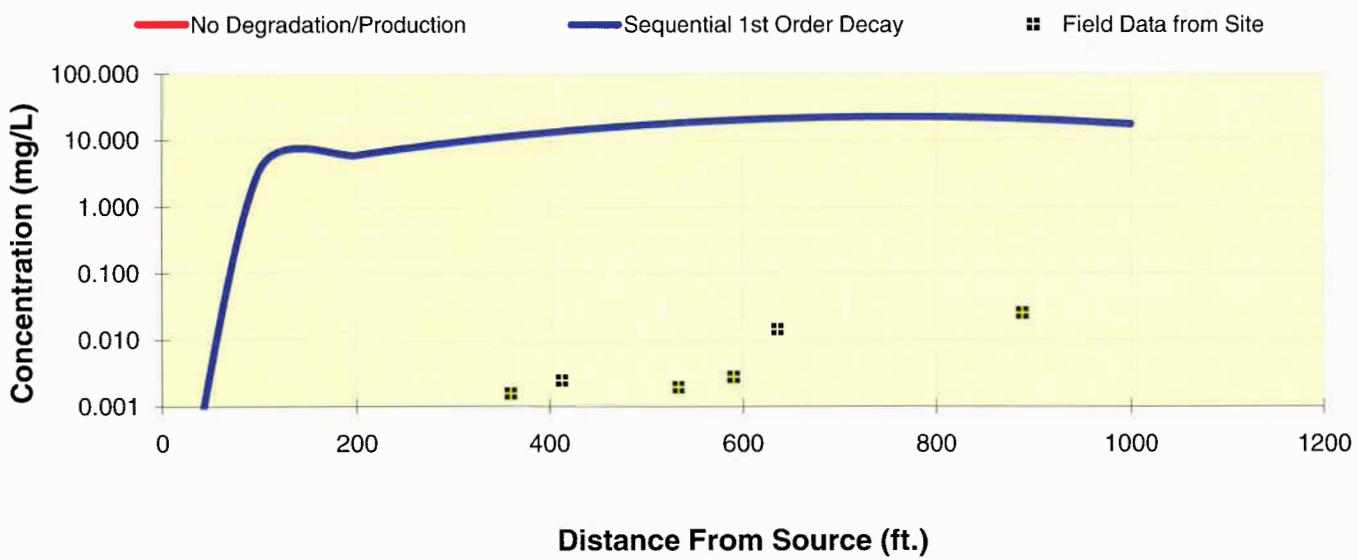
Return to Input

To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

DCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0000	3.127	5.923	9.226	12.990	16.838	20.134	22.157	22.366	20.638	17.360
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site					0.002	0.002		0.002	0.003	0.014	0.026



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

53.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 200 mg/L - BIO
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.130		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

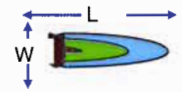
Zone 2

	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	56	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

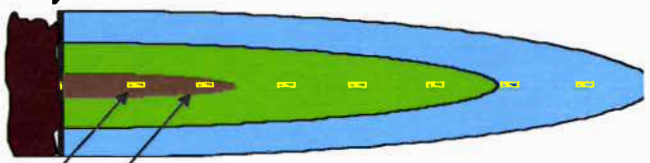
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.054
TCE	200.0	0.054
DCE		0.054
VC		0.054
ETH		0.054

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

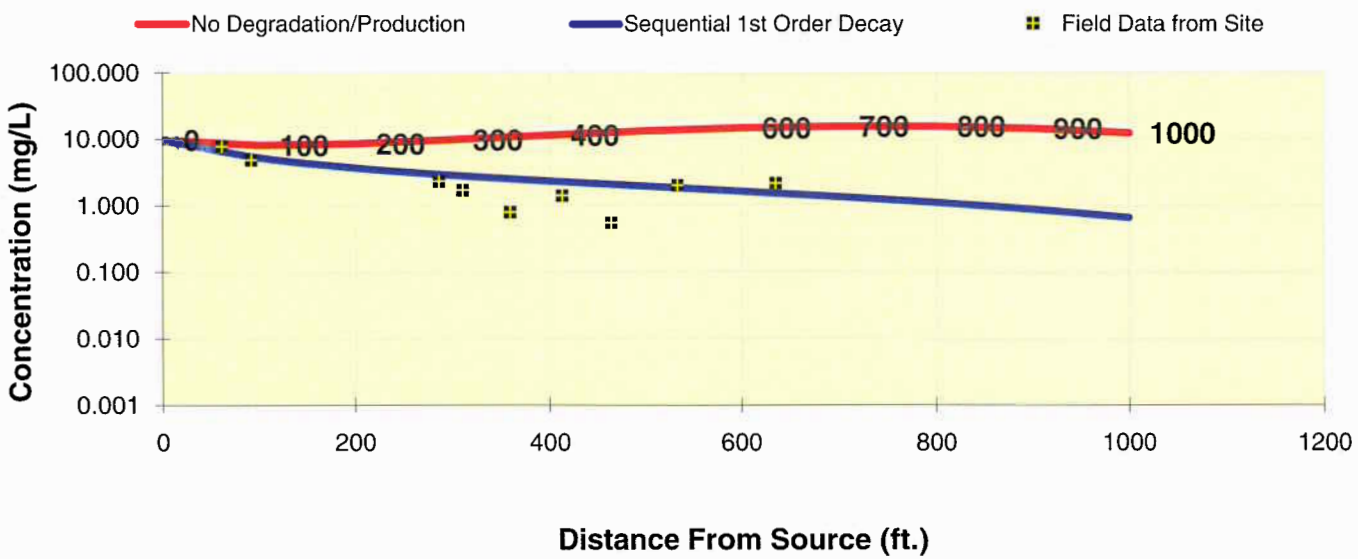
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	9.721	8.052	8.505	9.809	11.500	13.269	14.760	15.598	15.490	14.336	12.285
Biotransformation	9.7213	5.256	3.673	2.865	2.341	1.953	1.638	1.361	1.107	0.869	0.651
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

56.0 Years

Log ⟺ Linear

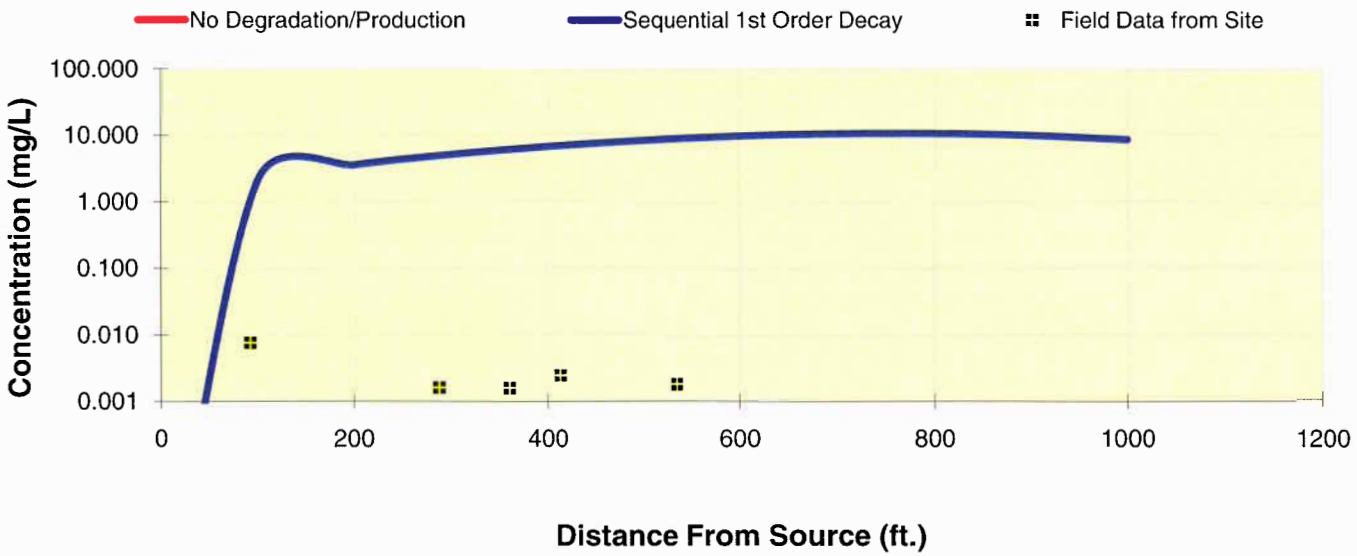
Return to Input

To All

To Array

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

DCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0000	2.062	3.563	5.121	6.755	8.345	9.677	10.499	10.607	9.931	8.579
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site		0.008	0.002		0.002	0.002		0.002			



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

56.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Davisville Site 16
Calib. 500 mg/L - BIO
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or* 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	35.3	(ft/yr)
or			
Hydraulic Conductivity	K	1.6E-03	(cm/sec)
Hydraulic Gradient	i	0.005391	(ft/ft)
Effective Porosity	n	0.25	(-)

2. DISPERSION

Alpha x*	49.2	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.5908	(kg/L)		
FractionOrganicCarbon, foc	1.2E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)		(-)
TCE	130	(L/kg)	2.00	(-)
DCE	125	(L/kg)		(-)
VC	30	(L/kg)		(-)
ETH	302	(L/kg)		(-)
Common R (used in model)* =			**2.00**	

4. BIOTRANSFORMATION

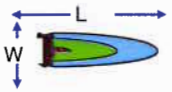
-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.170		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	56	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)



Zone 2= L - Zone 1

6. SOURCE DATA

TYPE: Decaying Single Planar

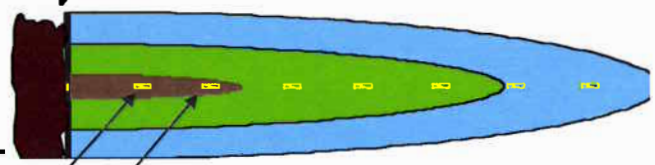
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 50

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.068
TCE	500.0	0.068
DCE		0.068
VC		0.068
ETH		0.068

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

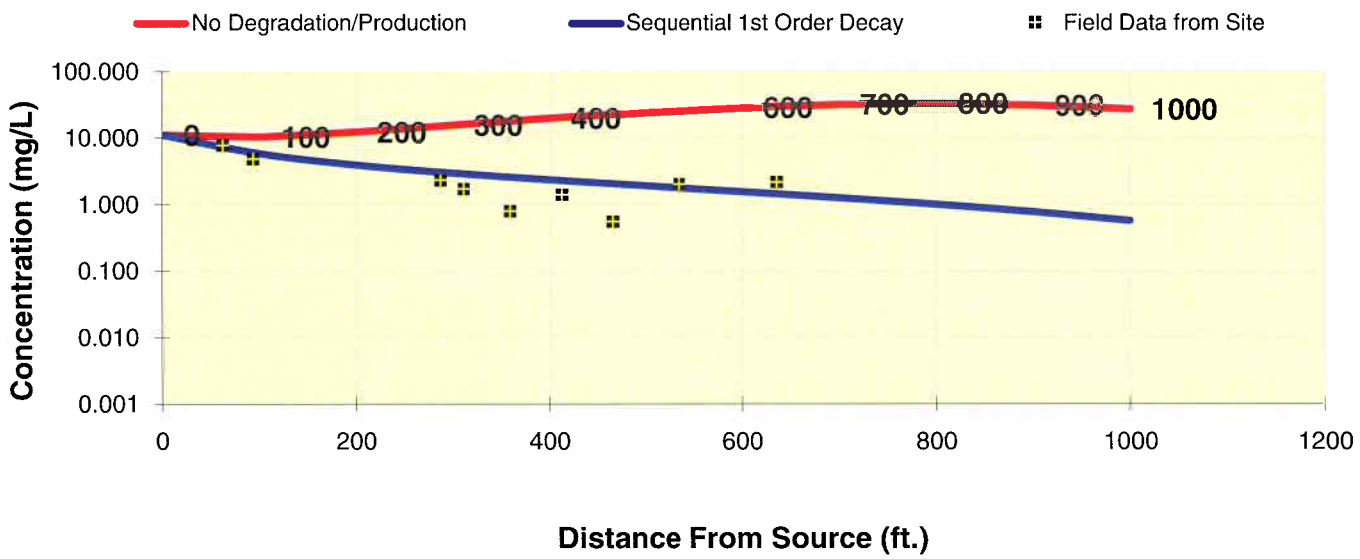
PCE Conc. (mg/L)											
TCE Conc. (mg/L)	7.7	4.8	2.3	1.7	.79	1.4	.55	2.0		2.15	
DCE Conc. (mg/L)		.008	.002		.002	.002		.002			
VC Conc. (mg/L)						.0					
ETH Conc. (mg/L)											
Distance from Source (ft)	62	92	287	311	360	413	465	534	590	636	890
Date Data Collected	2007										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	11.096	10.416	12.306	15.634	19.877	24.506	28.756	31.716	32.588	30.990	27.144
Biotransformation	11.0963	5.813	3.937	2.976	2.359	1.912	1.561	1.266	1.008	0.777	0.574
	Monitoring Well Locations (ft)										
	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site	7.700	4.800	2.300	1.700	0.790	1.400	0.550	2.000		2.150	



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

56.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

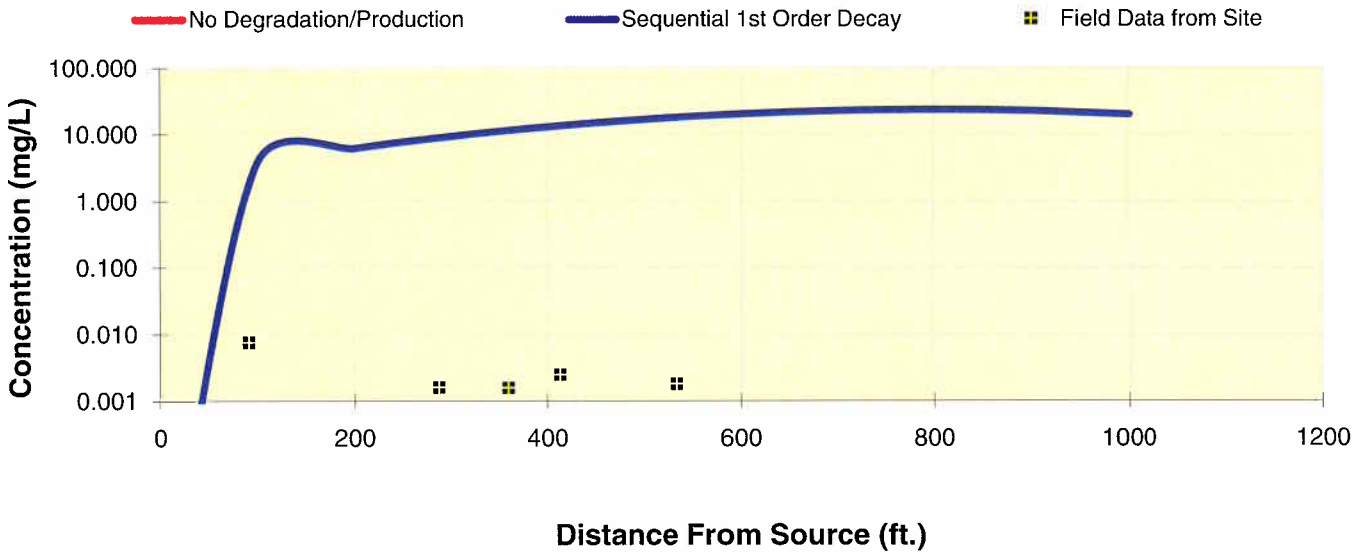
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

DCE	0	100	200	300	400	500	600	700	800	900	1000
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.0000	3.395	6.172	9.334	12.919	16.661	20.054	22.455	23.288	22.280	19.594

Monitoring Well Locations (ft)

	61.5	92.3	287.2	311.4	359.8	413	464.6	534	590.4	635.9	889.9
Field Data from Site		0.008	0.002		0.002	0.002		0.002			



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

56.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

Site 16 Eastern Arm of the CVOC Plume Evaluation

Groundwater modeling was performed at Site 16 in the former Building 41 area in order to estimate times to reach remedial goals under several potential remedial designs (Appendix E of the Feasibility Study Report For Installation Restoration Program Site 16 submitted May 2012 by Tetra Tech, Inc.). The modeling evaluated groundwater in the former Building 41 area and downgradient until approximately Davisville Road. A limited area of residual elevated CVOC concentrations occurs along the eastern plume arm – notably at MW16-88I. Additionally, low level (less than 500 ug/L) CVOC occur throughout the eastern plume arm.

Since no remedial scenarios evaluated the removal or reduction of elevated concentrations or any treatment of any other portion of the eastern arm, the following evaluation estimates the time to reach MCLs where MCLs would apply. This area has been defined as the area outside the waste management area, and within the 1939 shoreline. TCE was the most frequently detected CVOC and also was detected at the highest concentrations. Therefore, this evaluation focused on TCE and the time it would take for groundwater to reach the MCL of 5 ug/L.

Data tables and figures are included to facilitate the evaluation.

Data Evaluation

Trends for TCE were analyzed for all wells in the Eastern Arm of the CVOC plume within and adjacent to the area where MCLs would apply.

Wells within where the MCLs would apply are: MW16-28, MW16-27, MW16-39, MW16-57, MW16-49, MW16-90, MW16-89 and MW16-88I. Generally, for most wells, up to 4 data points occur, though many have only 2 or 3. From the limited data sets, some trends can still be estimated. Most wells have no trends or increasing trends. There are a few locations with decreasing trends for all data at those wells - MW16-27D, MW16-28I, MW16-39D and MW16-88I. At MW16-39D the trends are decreasing, but the values are already less than 5 ppb.

Wells adjacent to the area where MCLs apply are MW16-76I, MW16-87I and MW16-93I. There are not enough TCE detections at these locations to determine trends.

The attached figure shows the estimated trends for each well within and adjacent to the area where MCLs would apply.

Estimation of First Order Decay Rates

In the attached table, the first order decay rates were estimated at groundwater monitoring wells where downward trends have been observed over time. The rates were estimated from TCE concentrations at 8 groundwater monitoring well locations

where concentrations decreased through time. Subsequent samples were used and when possible, consecutive decreasing concentrations over time. While this is a simple approach to estimating the first order decay rate (neglects longer-term trends), it does provide an accurate estimation based on site-specific information.

One weakness with this approach occurs at MW16-28D. At this location, concentrations decrease from 2001 to 2002 from 120 to 59 ug/L, increase from 2002 to 2004 from 59 to 200 ug/L, then decrease from 2004 to 2007, 200 to 84 ug/L. Over the long-term, there is likely no trend at this well; however, decreases that do occur can still be used to estimate the first order decay rate.

Well MW16-39I has four data points with TCE varying from 86-77-140-75 (ug/L) so four different (positive) decay rates can be calculated. These have the most variability of the data set.

Overall, the average half-life is 9.24 years and the geometric mean is 3.44 years. Average time to reach 5 ppb is approximately 50 years while the geomean is 24 years. The longest time to reach MCLs is 274.4 years.

The location with the highest TCE concentration, well MW-16-88I, (where MCLs apply) is predicted to reach MCLs in approximately 19 years.

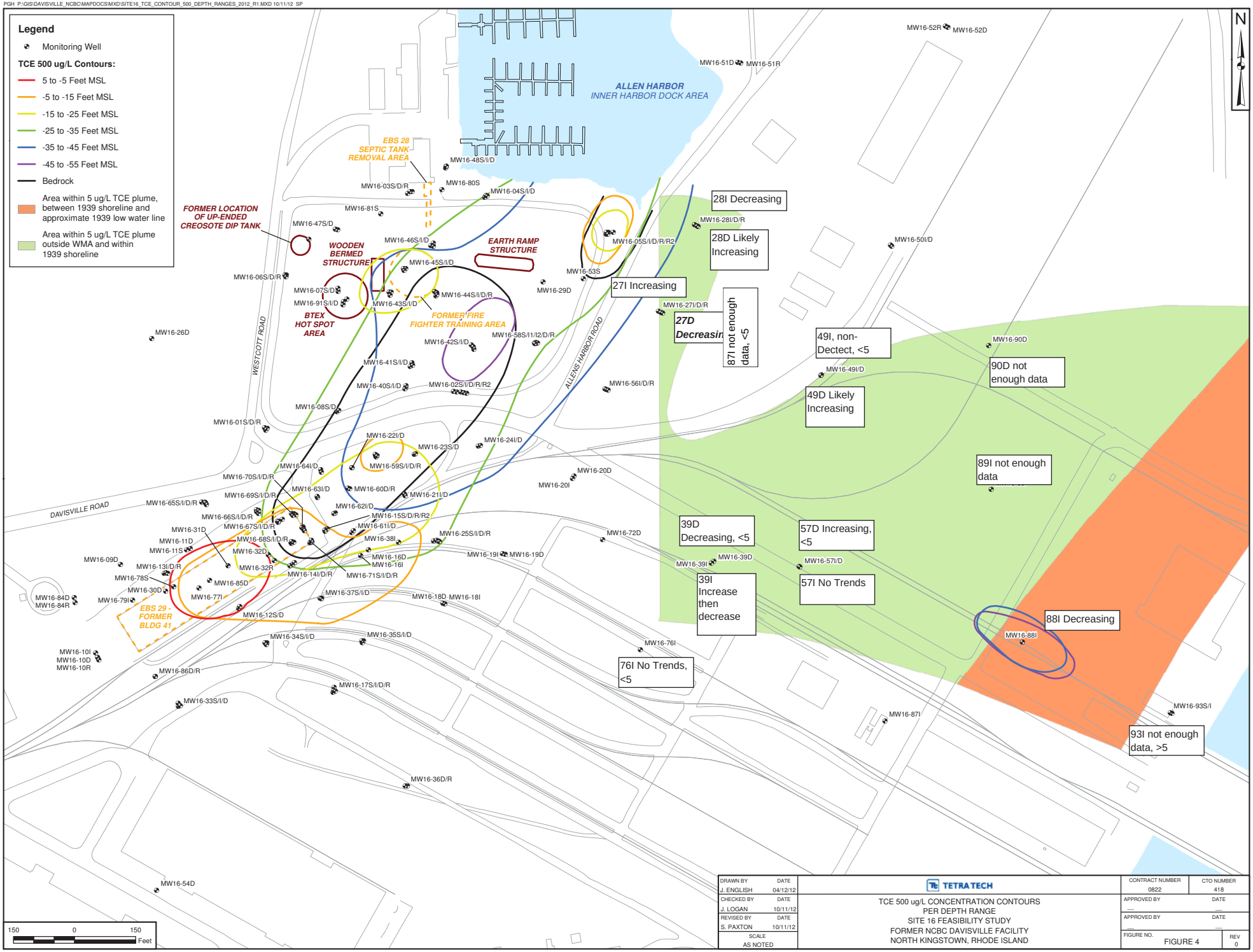
Impacts of ISCO performed in the Upgradient Area

The first order decay rates are based on monitored natural attenuation only. They do not account for the concept that some groundwater at the source area that will be remediated by ISCO is predicted to enter the area where MCLs apply.

Table 3-9 of the Final Site RI Report shows the velocities and travels times for groundwater through this area of the Eastern Plume arm. From this table, velocities in the Intermediate zone are 17.1 to 27.7 ft/year with overall travel times of 56 to 92 years. For the deep zone, velocities are 34 to 59 ft/year for travel times of 27 to 46 years. Using an intermediate velocity of 17-28 feet per year, and a ~600 foot distance from the ISCO area to the edge of the area where MCLs apply gives a travel time of 21-35 years.

Therefore, groundwater at the source area that will be remediated by ISCO is predicted to enter the area where MCLs apply in 21-35 years. This treated groundwater will increase the decay/flushing rate of contaminants in the area where MCLs apply, thereby reducing the overall time to reach MCLs.

PGH P:\GIS\DAVISVILLE_NCBC\MAPDOCS\MXD\SITE16_TCE_CONTOUR_500_DEPTH_RANGES_2012_R1.MXD 10/11/12 SP



DRAWN BY	DATE	TETRA TECH	CONTRACT NUMBER	CTO NUMBER
J. ENGLISH	04/12/12		0822	418
CHECKED BY	DATE	TCE 500 ug/L CONCENTRATION CONTOURS PER DEPTH RANGE	APPROVED BY	DATE
J. LOGAN	10/11/12	SITE 16 FEASIBILITY STUDY	—	—
REVISED BY	DATE	FORMER NCBC DAVISVILLE FACILITY	APPROVED BY	DATE
S. PAXTON	10/11/12	NORTH KINGSTOWN, RHODE ISLAND	—	—
SCALE AS NOTED			FIGURE NO. FIGURE 4	REV 0

Table 1

First-Order Rate Calculation of time for TCE to reach MCL
NCBC Davisville

Calculation of time for groundwater to meet MCLs for the using trend data from 2001-2010, outside the waste management area, within 1939 shoreline.
See figure of this area

Well	Contaminant	C_0, ug/L	C_t, ug/L	t, years	k	Half-life, yrs	C_x, ug/L	t_x, years	t_x, years (no negatives)
MW16-27D	TCE	310	240	1.75	0.14626	4.74	5	26.47	26.47
MW16-27D	TCE	310	190	3.58	0.13676	5.07	5	26.60	26.60
MW16-27D	TCE	310	160	6.5	0.10176	6.81	5	34.06	34.06
MW16-27D	TCE	240	190	1.92	0.12169	5.69	5	29.90	29.90
MW16-27D	TCE	190	160	2.83	0.06073	11.41	5	57.07	57.07
MW16-28D	TCE	120	59	1.67	0.42517	1.63	5	5.81	5.81
MW16-28D	TCE	120	84	6.5	0.05488	12.63	5	51.42	51.42
MW16-28D	TCE	200	84	2.83	0.30657	2.26	5	9.20	9.20
MW16-28I	TCE	1.29	1	2.83	0.08999	7.70	5	Below MCL	NA
MW16-39D	TCE	1.44	0.46	2.5	0.45652	1.52	5	Below MCL	NA
MW16-39D	TCE	1.44	0.1	2.75	0.97000	0.71	5	Below MCL	NA
MW16-39D	TCE	0.46	0.1	0.167	9.13901	0.08	5	Below MCL	NA
MW16-39I	TCE	86	77	1.92	0.05758	12.04	5	47.49	47.49
MW16-39I	TCE	86	75	4.58	0.02989	23.19	5	90.63	90.63
MW16-39I	TCE	77	75	2.67	0.00986	70.30	5	274.74	274.74
MW16-39I	TCE	140	75	0.083	7.52071	0.09	5	0.36	0.36
MW16-49D	TCE	1.99	1	1.92	0.35844	1.93	5	Below MCL	NA
MW16-57I	TCE	310	210	2.67	0.14588	4.75	5	25.62	25.62
MW16-88I	TCE	710	390	2.58	0.23224	2.98	5	18.76	18.76

C_0 = TCE Concentration at time 0 C_t = TCE Concentration at time C_x = Target TCE concentration = MCL

t = Elapsed time t_x = Time required to reach target concentration, from current time t

$C_t = C_0 \times e^{-kt}$ $C_x = C_0 \times e^{-ktx}$

half-life = .693/k k = 1st order coefficient = $-(\ln (C_t/C_0))/t$ $t_x = -(\ln(C_x/C_0))/k$

Summary of TCE Half-lifes		
	Minimum	***0.08***
	Maximum	***70.30***
	Average	***9.24***
	Geomean	***3.44***

Time to Reach MCLs		
	Minimum	***0.36***
	Maximum	***274.74***
	Average	***49.87***
	Geomean	***24.15***

Site 16 TCE Data for Groundwater Monitoring Wells in the Eastern Arm

location_id	sample_id	sample_date	sample_time	qc_type	sacode	matrix	top_depth	bottom_depth	depth_unit	submatrix	sample_method	composite	parameter	cas	fraction	val_res	val_qual	detect	ourresult	units	sdg	anal_method	dil_factor
MW16-27D	MW16-27D-NWG-032701	20010327	00:00:00	NM	NORMAL	GW	54	64	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	310		Y	310	UG/L	DAVISVLE_2	8260	1
MW16-27D	MW16-27D-NWG-082607	20070826	11:15:00	NM	NORMAL	GW	54	64	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	160		Y	160	UG/L	MF1196	8260B	2
MW16-27D	MW16-27D-NWG-101204	20041012	10:40:00	NM	NORMAL	GW	54	64	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	190		Y	190	UG/L	41100	8260	10
MW16-27D	MW16-27D-NWG-121902	20021219	00:00:00	NM	NORMAL	GW	54	64	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	240		Y	240	UG/L	DAVISVLE_2	8260	1
MW16-27I	MW16-27I-NWG-082607	20070826	13:35:00	NM	NORMAL	GW	34	44	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	180		Y	180	UG/L	MF1196	8260B-SIM	10
MW16-27I	MW16-27I-NWG-101404	20041014	09:50:00	NM	NORMAL	GW	34	44	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	120		Y	120	UG/L	041112	8260	5
MW16-27R	MW16-27R-NWG-032701	20010327	00:00:00	NM	NORMAL	GW	66.5	92	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1		Y	1	UG/L	DAVISVLE_2	8260	1
MW16-27R	MW16-27R-NWG-082607	20070826	17:20:00	NM	NORMAL	GW	66.5	92	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.9		Y	1.9	UG/L	MF1196	8260B	1
MW16-27R	MW16-27R-NWG-101204	20041012	11:00:00	NM	NORMAL	GW	66.5	92	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	2.01	U	N	2.01 U	UG/L	41100	8260	1
MW16-27R	MW16-27R-NWG-121902	20021219	00:00:00	NM	ORIG	GW	66.5	92	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.89	U	N	1.89 U	UG/L	DAVISVLE_2	8260	1
MW16-27R	MW16-27R-NWG-121902-AVG	20021219	00:00:00	NM	AVG	GW	66.5	92	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.895	U	N	1.895 U	UG/L	DAVISVLE_2	8260	1
MW16-27R	MW16-27R-NWG-121902-D	20021219	00:00:00	FD	DUP	GW	66.5	92	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.9	U	N	1.9 U	UG/L	DAVISVLE_2	8260	1
MW16-28D	MW16-28D-NWG-032701	20010327	00:00:00	NM	NORMAL	GW	54.5	64.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	120		Y	120	UG/L	DAVISVLE_2	8260	1
MW16-28D	MW16-28D-NWG-081107	20070811	11:50:00	NM	NORMAL	GW	54.5	64.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	84		Y	84	UG/L	MF1137	8260B	1
MW16-28D	MW16-28D-NWG-101104	20041011	11:00:00	NM	NORMAL	GW	54.5	64.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	200		Y	200	UG/L	41080	8260	5
MW16-28D	MW16-28D-NWG-121202	20021212	00:00:00	NM	NORMAL	GW	54.5	64.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	59	J	Y	59 J	UG/L	DAVISVLE_2	8260	1
MW16-28I	MW16-28I-NWG-081107	20070811	10:10:00	NM	NORMAL	GW	22.5	32.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1		Y	1	UG/L	MF1137	8260B-SIM	1
MW16-28I	MW16-28I-NWG-101404	20041014	10:15:00	NM	NORMAL	GW	22.5	32.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.29		Y	1.29	UG/L	041112	8260	1
MW16-28R	MW16-28R-NWG-032701	20010327	00:00:00	NM	NORMAL	GW	68	93	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.9		Y	0.90	UG/L	DAVISVLE_2	8260	1
MW16-28R	MW16-28R-NWG-081107	20070811	15:35:00	NM	NORMAL	GW	68	93	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.47		Y	0.47	UG/L	MF1137	8260B-SIM	1
MW16-28R	MW16-28R-NWG-101104	20041011	10:50:00	NM	NORMAL	GW	68	93	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	41100	8260	1
MW16-28R	MW16-28R-NWG-121202	20021212	00:00:00	NM	NORMAL	GW	68	93	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	UJ	N	1 UJ	UG/L	DAVISVLE_2	8260	1
MW16-39D	MW16-39D-NWG-052207	20070522	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.46	J	Y	0.46 J	UG/L	F0688	8260B-SIM	1
MW16-39D	MW16-39D-NWG-070107	20070701	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.1	UJ	N	0.1 UJ	UG/L	F0918	8260B-SIM	1
MW16-39D	MW16-39D-NWG-100604	20041006	09:55:00	NM	NORMAL	GW	64	74	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.44		Y	1.44	UG/L	41072	8260	1
MW16-39D	MW16-39D-NWG-121102	20021211	00:00:00	NM	NORMAL	GW	64	74	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	DAVISVLE_2	8260	1
MW16-39I	MW16-39I-NWG-052207	20070522	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	140		Y	140	UG/L	F0688	8260B	1
MW16-39I	MW16-39I-NWG-063007	20070630	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	75		Y	75	UG/L	F0918	8260B	1
MW16-39I	MW16-39I-NWG-100604	20041006	09:45:00	NM	NORMAL	GW	45	55	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	77		Y	77	UG/L	41072	8260	2
MW16-39I	MW16-39I-NWG-121102	20021211	00:00:00	NM	NORMAL	GW	45	55	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	86	J	Y	86 J	UG/L	DAVISVLE_2	8260	1
MW16-49D	MW16-49D-NWG-072907	20070729	18:30:00	NM	NORMAL	GW	62	76	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	4.5		Y	4.5	UG/L	F1047	8260B	1
MW16-49D	MW16-49D-NWG-101104	20041011	11:25:00	NM	NORMAL	GW	62	76	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	41100	8260	1
MW16-49D	MW16-49D-NWG-121902	20021219	00:00:00	NM	NORMAL	GW	62	76	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.99		Y	1.99	UG/L	DAVISVLE_2	8260	1
MW16-49I	MW16-49I-NSO-080404-10	20040804	00:00:00	NM	ORIG	SO	10	12	FT	SB	G	N	TRICHLOROETHENE	79-01-6	OV	4	U	N	4 U	UG/KG	040792	8260	1
MW16-49I	MW16-49I-NSO-080404-10-AVG	20040804	00:00:00	NM	AVG	SO	10	12	FT	SB	G	N	TRICHLOROETHENE	79-01-6	OV	4	U	N	4 U	UG/KG	040792	8260	1
MW16-49I	MW16-49I-NSO-080404-10-D	20040804	00:00:00	FD	DUP	SO	10	12	FT	SB	G	N	TRICHLOROETHENE	79-01-6	OV	4	U	N	4 U	UG/KG	040792	8260	1
MW16-49I	MW16-49I-NWG-072907	20070729	15:55:00	NM	NORMAL	GW	37	47	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.1	U	N	0.1 U	UG/L	F1047	8260B-SIM	1
MW16-49I	MW16-49I-NWG-101104	20041011	11:40:00	NM	NORMAL	GW	37	47	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	41100	8260	1
MW16-57D	MW16-57D-NWG-063007	20070630	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.3	J	Y	1.3 J	UG/L	F0918	8260B-SIM	1
MW16-57D	MW16-57D-NWG-102604	20041026	14:05:00	NM	NORMAL	GW	66.5	76.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.678	J	Y	0.678 J	UG/L	41178	8260	1
MW16-57I	MW16-57I-072910	20100729	10:30:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	350		Y	350	UG/L	WE51-21	8260B	4
MW16-57I	MW16-57I-NWG-063007	20070630	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	210		Y	210	UG/L	F0918	8260B	2
MW16-57I	MW16-57I-NWG-102604	20041026	14:15:00	NM	NORMAL	GW	43	53	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	310		Y	310	UG/L	41178	8260	10
MW16-88I	MW16-88I-072310	20100723	18:25:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	390		Y	390	UG/L	WE51-18	8260B	4
MW16-88I	MW16-88I-NWG-121707	20071217	12:50:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	710		Y	710	UG/L	F1903	8260	5
MW16-89I	MW16-89I-NWG-121807	20071218	17:40:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	15		Y	15	UG/L	F1903	8260	1
MW16-90D	MW16-90D-020608	20080206	11:08:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	16		Y	16	UG/L	G0164	8260	1

Site 16 TCE Data for Groundwater Monitoring Wells adjacent to the Eastern Arm

location_id	sample_id	sample_date	sample_time	qc_type	sacode	matrix	top_depth	bottom_depth	depth_unit	submatrix	sample_method	composite	parameter	cas	fraction	val_res	val_qual	detect	ourresult	units	sdg	anal_method	dil_factor
MW16-18D	MW16-18D-NWG-032801	20010328	00:00:00	NM	NORMAL	GW	42.5	52.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.7		Y	0.70	UG/L	DAVISVLE_2	8260	1
MW16-18D	MW16-18D-NWG-100504	20041005	09:45:00	NM	NORMAL	GW	42.5	52.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.165	J	Y	0.165 J	UG/L	41069	8260	1
MW16-18D	MW16-18D-NWG-120502	20021205	00:00:00	NM	NORMAL	GW	42.5	52.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	DAVISVLE_2	8260	1
MW16-18I	MW16-18I-NWG-061507	20070615	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	61		Y	61	UG/L	F0827	8260B	1
MW16-18I	MW16-18I-NWG-100504	20041005	09:30:00	NM	ORIG	GW	22	34	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	77		Y	77	UG/L	41069	8260	2
MW16-18I	MW16-18I-NWG-100504-AVG	20041005	09:30:00	NM	AVG	GW	22	34	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	72.5		Y	72.5	UG/L	41069	8260	2
MW16-18I	MW16-18I-NWG-100504-D	20041005	09:30:00	FD	DUP	GW	22	34	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	68		Y	68	UG/L	41069	8260	2
MW16-18I	MW16-18I-NWG-120502	20021205	00:00:00	NM	NORMAL	GW	22	34	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	23		Y	23	UG/L	DAVISVLE_2	8260	1
MW16-19D	MW16-19D-NWG-032801	20010328	00:00:00	NM	NORMAL	GW	45.5	54.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	390		Y	390	UG/L	DAVISVLE_2	8260	1
MW16-19D	MW16-19D-NWG-061907	20070618	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	200		Y	200	UG/L	F0847	8260B	2.5
MW16-19D	MW16-19D-NWG-100504	20041005	09:45:00	NM	NORMAL	GW	45.5	54.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	260		Y	260	UG/L	41069	8260	10
MW16-19D	MW16-19D-NWG-112702	20021127	00:00:00	NM	NORMAL	GW	45.5	54.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	320		Y	320	UG/L	DAVISVLE_2	8260	1
MW16-19I	MW16-19I-072610	20100726	11:40:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	11		Y	11	UG/L	WE51-19	8260B	1
MW16-19I	MW16-19I-NWG-061507	20070615	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	9.9		Y	9.9	UG/L	F0827	8260B	1
MW16-19I	MW16-19I-NWG-100504	20041005	09:30:00	NM	NORMAL	GW	30	40	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	15		Y	15	UG/L	41069	8260	1
MW16-19I	MW16-19I-NWG-112202	20021122	00:00:00	NM	NORMAL	GW	30	40	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	32	J	Y	32 J	UG/L	DAVISVLE_2	8260	1
MW16-20D	MW16-20D-NWG-032801	20010328	00:00:00	NM	NORMAL	GW	39.5	49.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1		Y	1	UG/L	DAVISVLE_2	8260	1
MW16-20D	MW16-20D-NWG-102804	20041028	10:15:00	NM	NORMAL	GW	39.5	49.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	9.96		Y	9.96	UG/L	41190	8260	1
MW16-20D	MW16-20D-NWG-121102	20021211	00:00:00	NM	NORMAL	GW	39.5	49.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	11		Y	11	UG/L	DAVISVLE_2	8260	1
MW16-20I	MW16-20I-NWG-061707	20070617	00:00:00	NM	ORIG	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	5.4		Y	5.4	UG/L	F0827	8260B	1
MW16-20I	MW16-20I-NWG-061707-AVG	20070617	00:00:00	NM	AVG	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	5.15		Y	5.15	UG/L	F0827	8260B	1
MW16-20I	MW16-20I-NWG-061707-D	20070617	00:00:00	FD	DUP	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	4.9		Y	4.9	UG/L	F0827	8260B	1
MW16-20I	MW16-20I-NWG-102804	20041028	10:20:00	NM	NORMAL	GW	24	34	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	7.34		Y	7.34	UG/L	41190	8260	1
MW16-20I	MW16-20I-NWG-121102	20021211	00:00:00	NM	NORMAL	GW	24	34	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	12		Y	12	UG/L	DAVISVLE_2	8260	1
MW16-24D	MW16-24D-NWG-100104	20041001	09:55:00	NM	NORMAL	GW	50	62	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	690		Y	690	UG/L	41064	8260	20
MW16-24D	MW16-24D-NWG-121002	20021210	00:00:00	NM	NORMAL	GW	50	62	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	520		Y	520	UG/L	DAVISVLE_2	8260	1
MW16-24I	MW16-24I-NWG-100104	20041001	09:30:00	NM	ORIG	GW	18	28	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	32		Y	32	UG/L	41064	8260	1
MW16-24I	MW16-24I-NWG-100104-AVG	20041001	09:30:00	NM	AVG	GW	18	28	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	35		Y	35	UG/L	41064	8260	1
MW16-24I	MW16-24I-NWG-100104-D	20041001	09:30:00	FD	DUP	GW	18	28	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	38		Y	38	UG/L	41064	8260	1
MW16-24I	MW16-24I-NWG-121002	20021210	00:00:00	NM	NORMAL	GW	18	28	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	41		Y	41	UG/L	DAVISVLE_2	8260	1
MW16-25D	MW16-25D-NWG-032701	20010327	00:00:00	NM	NORMAL	GW	46	58	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	890		Y	890	UG/L	DAVISVLE_2	8260	1
MW16-25D	MW16-25D-NWG-052107	20070521	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	530		Y	530	UG/L	F0688	8260B	5
MW16-25D	MW16-25D-NWG-100504	20041005	10:40:00	NM	ORIG	GW	46	58	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	420		Y	420	UG/L	41069	8260	10
MW16-25D	MW16-25D-NWG-100504-AVG	20041005	10:40:00	NM	AVG	GW	46	58	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	415		Y	415	UG/L	41069	8260	10
MW16-25D	MW16-25D-NWG-100504-D	20041005	10:40:00	FD	DUP	GW	46	58	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	410		Y	410	UG/L	41069	8260	10
MW16-25D	MW16-25D-NWG-112202	20021122	00:00:00	NM	NORMAL	GW	46	58	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	470	J	Y	470 J	UG/L	DAVISVLE_2	8260	1
MW16-25I	MW16-25I-NWG-052107	20070521	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	85		Y	85	UG/L	F0688	8260B	1
MW16-25I	MW16-25I-NWG-061707	20070617	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	76		Y	76	UG/L	F0827	8260B	1
MW16-25I	MW16-25I-NWG-100804	20041008	10:00:00	NM	NORMAL	GW	32	42	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	120		Y	120	UG/L	41080	8260	5
MW16-25I	MW16-25I-NWG-112202	20021122	00:00:00	NM	NORMAL	GW	32	42	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	220	J	Y	220 J	UG/L	DAVISVLE_2	8260	1
MW16-25R	MW16-25R-NWG-032701	20010327	00:00:00	NM	ORIG	GW	61	86	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	DAVISVLE_2	8260	1
MW16-25R	MW16-25R-NWG-032701-AVG	20010327	00:00:00	NM	AVG	GW	61	86	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	DAVISVLE_2	8260	1
MW16-25R	MW16-25R-NWG-032701-D	20010327	00:00:00	FD	DUP	GW	61	86	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	DAVISVLE_2	8260	1
MW16-25R	MW16-25R-NWG-061707	20070617	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.12		Y	0.12	UG/L	F0827	8260B-SIM	1
MW16-25R	MW16-25R-NWG-100504	20041005	09:50:00	NM	NORMAL	GW	61	86	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.445	J	Y	0.445 J	UG/L	41069	8260	1
MW16-25R	MW16-25R-NWG-112202	20021122	00:00:00	NM	NORMAL	GW	61	86	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.08	J	Y	1.08 J	UG/L	DAVISVLE_2	8260	1
MW16-25S	MW16-25S-NWG-052107	20070521	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.5	J	Y	1.5 J	UG/L	F0688	8260B-SIM	1
MW16-25S	MW16-25S-NWG-110104	20041101	13:50:00	NM	NORMAL	GW	9	19	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	2.9		Y	2.9	UG/L	41190	8260	1
MW16-27D	MW16-27D-NWG-032701	20010327	00:00:00	NM	NORMAL	GW	54	64	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	310		Y	310	UG/L	DAVISVLE_2	8260	1
MW16-27D	MW16-27D-NWG-082607	20070826	11:15:00	NM	NORMAL	GW	54	64	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	160		Y	160	UG/L	MF1196	8260B	2
MW16-27D	MW16-27D-NWG-101204	20041012	10:40:00	NM	NORMAL	GW	54	64	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	190		Y	190	UG/L	41100	8260	10
MW16-27D	MW16-27D-NWG-121902	20021219	00:00:00	NM	NORMAL	GW	54	64	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	240		Y	240	UG/L	DAVISVLE_2	8260	1
MW16-27I	MW16-27I-NWG-082607	20070826	13:35:00	NM	NORMAL	GW	34	44	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	180		Y	180	UG/L	MF1196	8260B-SIM	10
MW16-27I	MW16-27I-NWG-101404	20041014	09:50:00	NM	NORMAL	GW	34	44	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	120		Y	120	UG/L	041112	8260	5
MW16-27R	MW16-27R-NWG-032701	20010327	00:00:00	NM	NORMAL	GW	66.5	92	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1		Y	1	UG/L	DAVISVLE_2	8260	1
MW16-27R	MW16-27R-NWG-082607	20070826	17:20:00	NM	NORMAL	GW	66.5	92	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.9		Y	1.9	UG/L	MF1196	8260B	1
MW16-27R	MW16-27R-NWG-101204	20041012	11:00:00	NM	NORMAL	GW	66.5	92	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	2.01	U	N	2.01 U	UG/L	41100	8260	1
MW16-27R	MW16-27R-NWG-121902	20021219	00:00:00	NM	ORIG	GW	66.5	92	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.89	U	N	1.89 U	UG/L	DAVISVLE_2	8260	1
MW16-27R	MW16-27R-NWG-121902-AVG	20021219	00:00:00	NM	AVG	GW	66.5	92	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.895	U	N	1.895 U	UG/L	DAVISVLE_2	8260	1
MW16-27R	MW16-27R-NWG-121902-D	20021219	00:00:00	FD	DUP	GW	66.5	92	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.9	U	N	1.9 U	UG/L	DAVISVLE_2	8260	1
MW16-28D	MW16-28D-NWG-032701	20010327	00:00:00	NM	NORMAL	GW	54.5	64.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	120		Y	120	UG/L	DAVISVLE_2	8260	1
MW16-28D	MW16-28D-NWG-081107	20070811	11:50:00	NM	NORMAL	GW	54.5	64.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	84		Y	84	UG/L	MF1137	8260B	1
MW16-28D	MW16-28D-NWG-101104	20041011	11:00:00	NM	NORMAL	GW	54.5	64.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	200		Y	200	UG/L	41080	8260	5
MW16-28D	MW16-28D-NWG-121202	20021212	00:00:00	NM	NORMAL	GW	54.5	64.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	59	J	Y	59 J	UG/L	DAVISVLE_2	8260	1
MW16-28I	MW16-28I-NWG-081107	20070811	10:10:00	NM	NORMAL	GW	22.5	32.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1		Y	1	UG/L	MF1137	8260B-SIM	1
MW16-28I	MW16-28I-NWG-101404	20041014	10:15:00	NM	NORMAL	GW	22.5	32.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.29		Y	1.29	UG/L	041112	8260	1
MW16-28R	MW16-28R-NWG-032701	20010327	00:00:00	NM	NORMAL	GW	68	93	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.9		Y	0.90	UG/L	DAVISVLE_2	8260	1
MW16-28R	MW16-28R-NWG-081107	20070811	15:35:00	NM	NORMAL	GW	68	93	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.47		Y	0.47	UG/L	MF1137	8260B-SIM	1

Site 16 TCE Data for Groundwater Monitoring Wells adjacent to the Eastern Arm

MW16-28R	MW16-28R-NWG-101104	20041011	10:50:00	NM	NORMAL	GW	68	93	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	41100	8260	1
MW16-28R	MW16-28R-NWG-121202	20021212	00:00:00	NM	NORMAL	GW	68	93	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	UJ	N	1 UJ	UG/L	DAVISVLE_2	8260	1
MW16-39D	MW16-39D-NWG-052207	20070522	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.46	J	Y	0.46 J	UG/L	F0688	8260B-SIM	1
MW16-39D	MW16-39D-NWG-070107	20070701	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.1	UJ	N	0.1 UJ	UG/L	F0918	8260B-SIM	1
MW16-39D	MW16-39D-NWG-100604	20041006	09:55:00	NM	NORMAL	GW	64	74	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.44		Y	1.44	UG/L	41072	8260	1
MW16-39D	MW16-39D-NWG-121102	20021211	00:00:00	NM	NORMAL	GW	64	74	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	DAVISVLE_2	8260	1
MW16-39I	MW16-39I-NWG-052207	20070522	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	140		Y	140	UG/L	F0688	8260B	1
MW16-39I	MW16-39I-NWG-063007	20070630	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	75		Y	75	UG/L	F0918	8260B	1
MW16-39I	MW16-39I-NWG-100604	20041006	09:45:00	NM	NORMAL	GW	45	55	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	77		Y	77	UG/L	41072	8260	2
MW16-39I	MW16-39I-NWG-121102	20021211	00:00:00	NM	NORMAL	GW	45	55	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	86	J	Y	86 J	UG/L	DAVISVLE_2	8260	1
MW16-49D	MW16-49D-NWG-072907	20070729	18:30:00	NM	NORMAL	GW	62	76	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	4.5		Y	4.5	UG/L	F1047	8260B	1
MW16-49D	MW16-49D-NWG-101104	20041011	11:25:00	NM	NORMAL	GW	62	76	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	41100	8260	1
MW16-49D	MW16-49D-NWG-121902	20021219	00:00:00	NM	NORMAL	GW	62	76	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.99		Y	1.99	UG/L	DAVISVLE_2	8260	1
MW16-49I	MW16-49I-NSO-080404-10	20040804	00:00:00	NM	ORIG	SO	10	12	FT	SB	G	N	TRICHLOROETHENE	79-01-6	OV	4	U	N	4 U	UG/KG	040792	8260	1
MW16-49I	MW16-49I-NSO-080404-10-AVG	20040804	00:00:00	NM	AVG	SO	10	12	FT	SB	G	N	TRICHLOROETHENE	79-01-6	OV	4	U	N	4 U	UG/KG	040792	8260	1
MW16-49I	MW16-49I-NSO-080404-10-D	20040804	00:00:00	FD	DUP	SO	10	12	FT	SB	G	N	TRICHLOROETHENE	79-01-6	OV	4	U	N	4 U	UG/KG	040792	8260	1
MW16-49I	MW16-49I-NWG-072907	20070729	15:55:00	NM	NORMAL	GW	37	47	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.1	U	N	0.1 U	UG/L	F1047	8260B-SIM	1
MW16-49I	MW16-49I-NWG-101104	20041011	11:40:00	NM	NORMAL	GW	37	47	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	41100	8260	1
MW16-50D	MW16-50D-NWG-101304	20041013	14:50:00	NM	NORMAL	GW	78	88	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	041112	8260	1
MW16-50D	MW16-50D-NWG-121902	20021219	00:00:00	NM	NORMAL	GW	78	88	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	2.05		Y	2.05	UG/L	DAVISVLE_2	8260	1
MW16-50I	MW16-50I-NSO-080504-22	20040805	00:00:00	NM	NORMAL	SO	22	24	FT	SB	G	N	TRICHLOROETHENE	79-01-6	OV	8	UJ	N	8 UJ	UG/KG	040792	8260	1
MW16-50I	MW16-50I-NWG-102604	20041026	14:15:00	NM	NORMAL	GW	24	34	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1	U	N	1 U	UG/L	41178	8260	1
MW16-56D	MW16-56D-NWG-101404	20041014	10:00:00	NM	NORMAL	GW	59	66	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	50		Y	50	UG/L	041112	8260	2
MW16-56I	MW16-56I-NWG-101404	20041014	10:40:00	NM	NORMAL	GW	33	43	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.851	J	Y	0.851 J	UG/L	041112	8260	1
MW16-56R	MW16-56R-NWG-082807	20070828	11:15:00	NM	NORMAL	GW	69	94	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	18		Y	18.0	UG/L	MF1196	8260B	1
MW16-56R	MW16-56R-NWG-101404	20041014	10:31:00	NM	NORMAL	GW	69	94	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	17		Y	17	UG/L	041112	8260	1
MW16-57D	MW16-57D-NWG-063007	20070630	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	1.3	J	Y	1.3 J	UG/L	F0918	8260B-SIM	1
MW16-57D	MW16-57D-NWG-102604	20041026	14:05:00	NM	NORMAL	GW	66.5	76.5	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.678	J	Y	0.678 J	UG/L	41178	8260	1
MW16-57I	MW16-57I-072910	20100729	10:30:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	350		Y	350	UG/L	WE51-21	8260B	4
MW16-57I	MW16-57I-NWG-063007	20070630	00:00:00	NM	NORMAL	GW	-9999	-9999	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	210		Y	210	UG/L	F0918	8260B	2
MW16-57I	MW16-57I-NWG-102604	20041026	14:15:00	NM	NORMAL	GW	43	53	FT	NA	G	N	TRICHLOROETHENE	79-01-6	OV	310		Y	310	UG/L	41178	8260	10
MW16-87I	MW16-87I-NWG-121807	20071218	17:03:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	4.8		Y	4.8	UG/L	F1903	8260	1
MW16-87I	MW16-87I-NWG-121807	20071218	17:03:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OVSIM	3.9		Y	3.9	UG/L	F1903	LGCYOV	1
MW16-88I	MW16-88I-072310	20100723	18:25:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	390		Y	390	UG/L	WE51-18	8260B	4
MW16-88I	MW16-88I-NWG-121707	20071217	12:50:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	710		Y	710	UG/L	F1903	8260	5
MW16-89I	MW16-89I-NWG-121807	20071218	17:40:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	15		Y	15	UG/L	F1903	8260	1
MW16-90D	MW16-90D-020608	20080206	11:08:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	16		Y	16	UG/L	G0164	8260	1
MW16-93I	MW16-93I-072310	20100723	20:20:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	23		Y	23	UG/L	WE51-18	8260B	1
MW16-93S	MW16-93S-060911	20110609	15:10:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.5	U	N	0.5 U	UG/L	WE51-25	8260B	1
MW16-93S	MW16-93S-072410	20100724	20:10:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.3	U	N	0.30 U	UG/L	WE51-19	8260B	1
MW16-72D	TW16-101D-NWG-070107	20070701	16:45:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	29		Y	29	UG/L	F0917	8260B	1
MW16-76I	TW16-106I-NWG-072907	20070729	12:15:00	NM	NORMAL	GW	-9999	-9999	NA	NA	G	N	TRICHLOROETHENE	79-01-6	OV	0.51		Y	0.51	UG/L	F1049	8260B-SIM	1

APPENDIX E

ECOLOGICAL TRIGGER CONCENTRATION CALCULATIONS

APPENDIX E

TRIGGER CONCENTRATIONS FOR POTENTIAL INSTALLATION OF BIO-BARRIER AT ALLEN HARBOR SHORELINE

The groundwater alternative presented in this Feasibility Study Addendum (FSA) includes a bio-barrier component which would be installed (if necessary) to protect human or ecological receptors in Allen Harbor. The bio-barrier was included in the FSA because the volatile organic chemical (VOC) plume underlying Site 16 has migrated north-northeast and has been detected in the groundwater underlying Allen Harbor (See **Attachment A** Figures 9-2 and 4-25). Trichloroethene (TCE) and its degradation products (e.g., cis-1,2 dichloroethene, and vinyl chloride) are the predominant VOCs currently detected in the groundwater plume. However, in aggregate, the chlorinated VOC data for the Site 16 monitoring wells, the piezometers in Allen Harbor, and the surface water/sediments of Allen Harbor indicate a significant attenuation of the TCE concentrations from the Site 16 source areas to the actual surface waters and sediments in Allen Harbor. (Please see attached figures/tables from Phase III Remedial Investigation [RI] Report [March 2009] and Data Package Report for the 2010 Feasibility Study Support Field Investigation at Installation Restoration Program Site 16 [November, 2010].) (**See Attachment A).** VOCs in these media have not been detected at concentrations that would result in unacceptable risks to either human (i.e., recreators) or ecological receptors in Allen Harbor. More significantly, the TCE concentrations detected in the groundwater samples collected from piezometers advanced in Allen Harbor or from the groundwater monitoring wells abutting Allen Harbor do not exceed the relevant EPA screening levels for the protection of ecological receptors in Allen Harbor (epifauna, infauna, or pelagic receptors) (**see Attachment B**). The Navy, USEPA, and RIDEM have discussed these screening levels in the past.

Allen Harbor is a currently used for marina purposes by the Allen Harbor Boating Association. However, the primary receptors of concern are actually the infauna within shallow sediments potentially exposed to VOCs upwelling from the groundwater plume to the sediment porewater (e.g., meiofauna, shellfish, and worms). This is because exposure to pelagic organisms (plankton, invertebrates, and fish) or epifauna (at the surface of the sediments) or to human recreators in the open water of the harbor would be mitigated by the near instantaneous dilution of the groundwater actually discharging to the surface water of Allen Harbor. However, TCE has have been detected at several hundred parts-per-billion in groundwater samples collected from the piezometers advanced in Allen Harbor and may present in the pore water at concentrations greater than those detected in the actual surface water of the Harbor. Thus, while screening levels for human and ecological receptors are not currently exceeded, monitoring of the VOC discharges to Allen Harbor will be an important component of long-term monitoring plan for Site 16. The bio-barrier is planned as a contingency component should the VOC concentrations increase over the course of time and present an unacceptable risk to human or ecological receptors in surface waters, sediments, or sediment pore water. The screening levels presented herein will be used in the decision making process to determine if and when the contingency remedy is necessary. They are referred to as "trigger" levels in the following narrative because, if exceeded, they will trigger a series of sampling/risk analysis events that might result in the conclusion that unacceptable risks exist and that the contingency remedy is necessary.

The human health and ecological trigger levels for the predominant Site 16 VOCs (and degradation products) are shown below in **Table 1**. The supporting documentation is provided in **Attachment B.**

Table 1

Screening Levels/Trigger Levels for Site 16 VOCs (µg/L)

Contaminant	**Human Health Screening Level (For Surface Water)[1]**	**Ecological Screening Level (For Sentinel Wells/Pore Water)[1]**
Trichloroethene	35	1,940
Cis-1,2-Dichloroethene	1,160	680
Trans-1,2-Dichloroethene	11,600	680
Vinyl Chloride [2]	2	930
1,1-Dichloroethene	27,600	2240
1,2-Dichloroethane	59.7	1130
Benzene	38.5	110
Tetrachloroethene	1,140	45

1) Support documentation for these trigger levels is presented in Attachment B.

2) The Safe Drinking Water Act (SDWA) maximum contaminant level (MCL) is recommended as the basis of the screening level because the risk based concentration for the lifelong receptor is less than the SDWA MCL (Please see Attachment B).

The bio-barrier would be further evaluated for possible installation if the Site 16 CVOC concentrations detected for sentinel wells along Allen Harbor exceed these "trigger" concentrations for ecological receptors or if surface water concentrations exceed trigger concentrations for human receptors. (As noted above, there is near instantaneous dilution of the groundwater actually discharging to the surface water of Allen Harbor. Thus, human health screening levels are presented above for purposes of completeness. The need for the contingency barrier will be driven by the evaluation of risks to ecological receptors) Per discussions with EPA/RIDEM, the ecological trigger levels presented above may be adjusted by the Navy in the future if a defensible dilution factor is developed demonstrating VOC attenuation between the groundwater in the shoreline sentinel wells and the sediment pore water in Allen Harbor. Such a dilution factor would be developed in consultation with EPA/RIDEM.

The decision to ultimately install the bio-barrier would be made in consultation with EPA and RIDEM, and would evaluate chemical concentrations detected in the actual surface waters, sediments, and sediment pore water of the Harbor. Analytical data collected during the long-term monitoring (LTM) plan for Site 16 will be evaluated as follows (also see attached Figure 1):

- **Step 1:** Are VOCs detected in shoreline groundwater sentinel wells/piezometers at concentrations greater than trigger levels that are protective for ecological receptors?
    - **No (Continue LTM program).**
    - **Yes (Go to Step 2)**

- **Step 2:** Sample Allen Harbor surface water/sediment/pore water. Do VOC concentrations in surface water/sediment/pore water samples exceed human health/ecological screening levels?

    - **No (Continue LTM, but, add surface water/sediment/pore water sampling to LTM for Site 16. Review issue with EPA/RIDEM.)**
    - **Yes (Go to Step 3).**

- **Step 3**: Conduct human health and screening level ecological risk assessments (SLERA). Are unacceptable risks predicted?

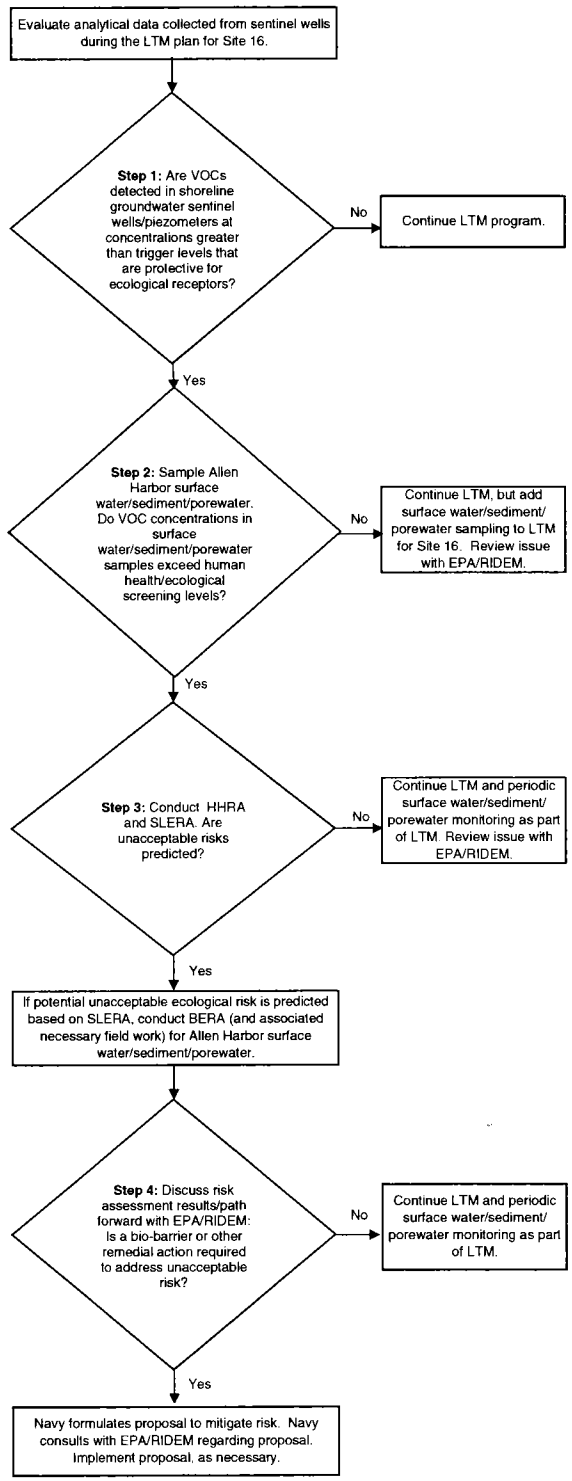
    - **No (Continue LTM and periodic surface water/sediment/pore water monitoring as part of LTM. Review issue with EPA/RIDEM.)**
    - **Yes (If potential unacceptable ecological risk is predicted based on SLERA, conduct Baseline Ecological Risk Assessment [BERA] [and associated necessary field work] for Allen Harbor surface water/sediment/pore water.) (Go to Step 4).**

- **Step 4:** Discuss risk assessment results/path forward with EPA/RIDEM: Is a bio-barrier or other remedial action required to address unacceptable risk?

    - **No (Continue LTM and periodic surface water/sediment/pore water monitoring as part of LTM).**
    - **Yes (Navy formulates proposal to mitigate risk. Navy consults with EPA/RIDEM regarding proposal. Implement proposal, as necessary.)**

FIGURE 1

DECISION DIAGRAM



KEY

BERA = Baseline Ecological Risk Assessment
EPA = United States Environmental Protection Agency
HHRA = Human Health Risk Assessment
LTM = Long-Term Monitoring
RIDEM = Rhode Island Department of Environmental Management
SLERA = Screening Level Ecological Risk Assessment
VOC = Volatile Organic Compound

ATTACHMENT A

SELECT VOC DATA FOR NCBC DAVISVILLE SITE 16

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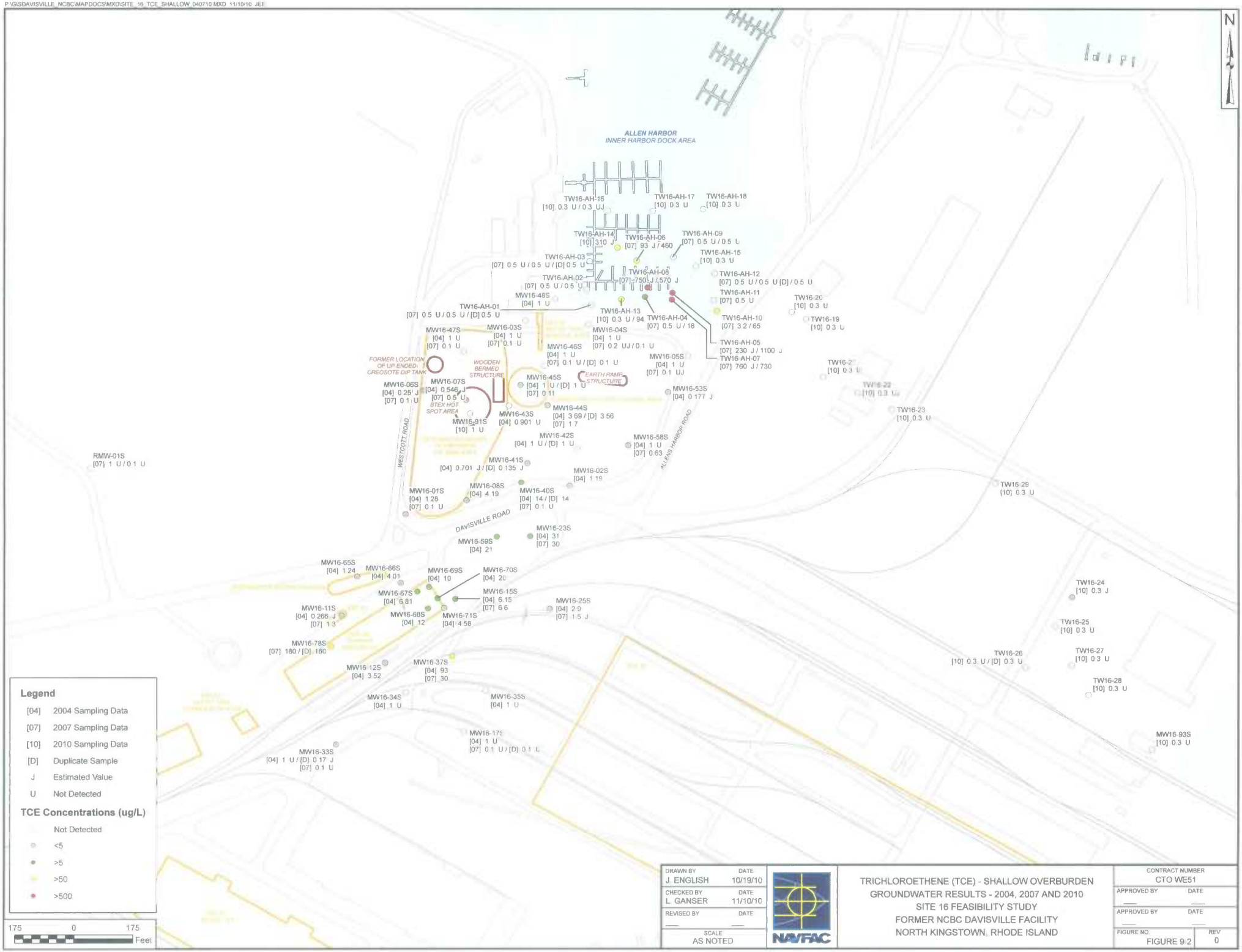

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J. ENGLISH	10/19/10
CHECKED BY	DATE
L. GANSER	11/10/10
REVISED BY	DATE
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SCALE	
AS NOTED	

NAVFAC

TRICHLOROETHENE (TCE) - SHALLOW OVERBURDEN
GROUNDWATER RESULTS - 2004, 2007 AND 2010
SITE 16 FEASIBILITY STUDY
FORMER NCBC DAVISVILLE FACILITY
NORTH KINGSTOWN, RHODE ISLAND

CONTRACT NUMBER	
CTO WE51	
APPROVED BY	DATE
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FIGURE NO.	REV
FIGURE 9-2	0

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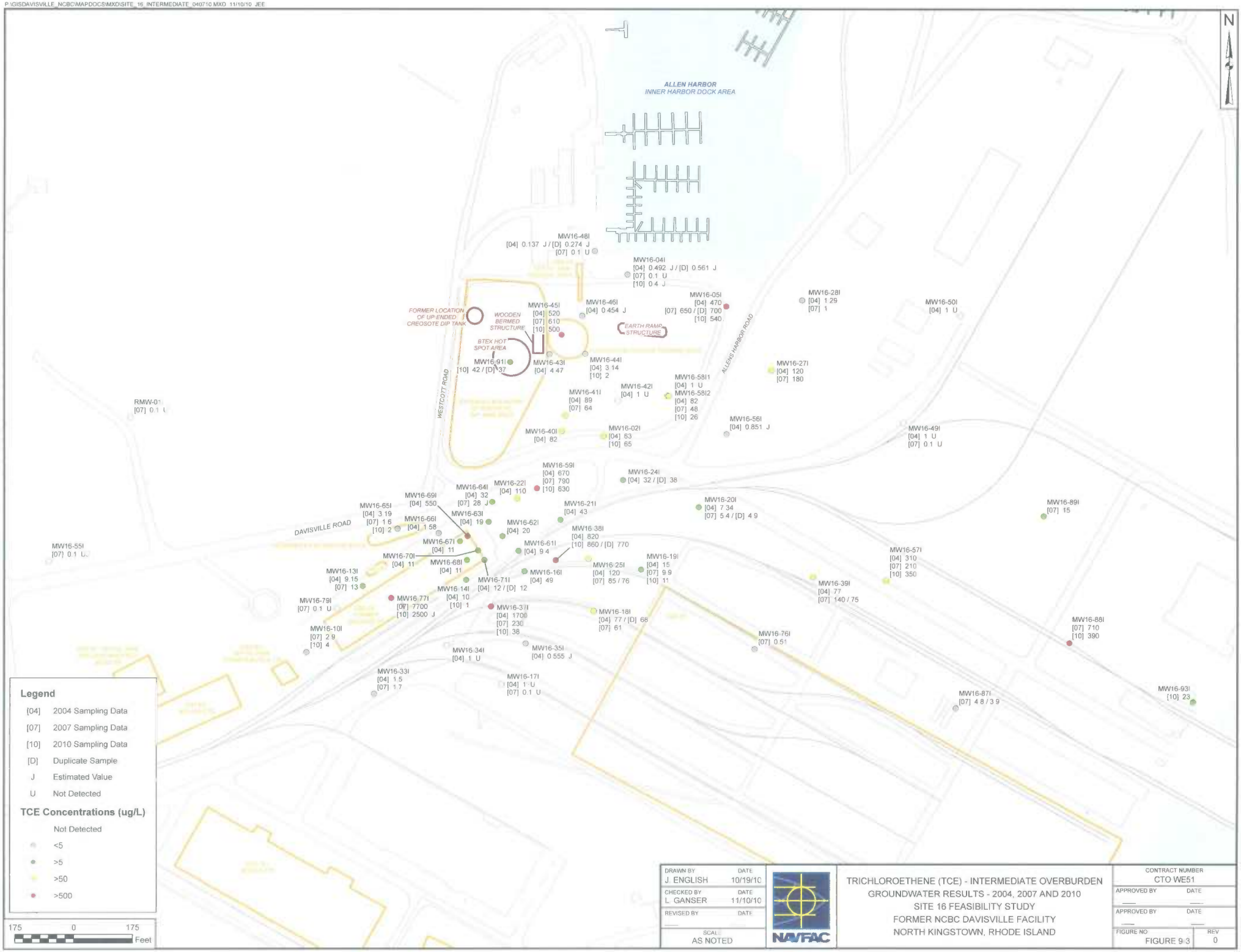

DRAWN BY J. ENGLISH	DATE 10/19/10	TRICHLOROETHENE (TCE) - INTERMEDIATE OVERBURDEN GROUNDWATER RESULTS - 2004, 2007 AND 2010 SITE 16 FEASIBILITY STUDY FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	CONTRACT NUMBER CTO WE51
CHECKED BY L. GANSER	DATE 11/10/10		APPROVED BY — DATE —
REVISED BY —	DATE —		APPROVED BY — DATE —
SCALE AS NOTED			FIGURE NO. FIGURE 9-3 / REV 0

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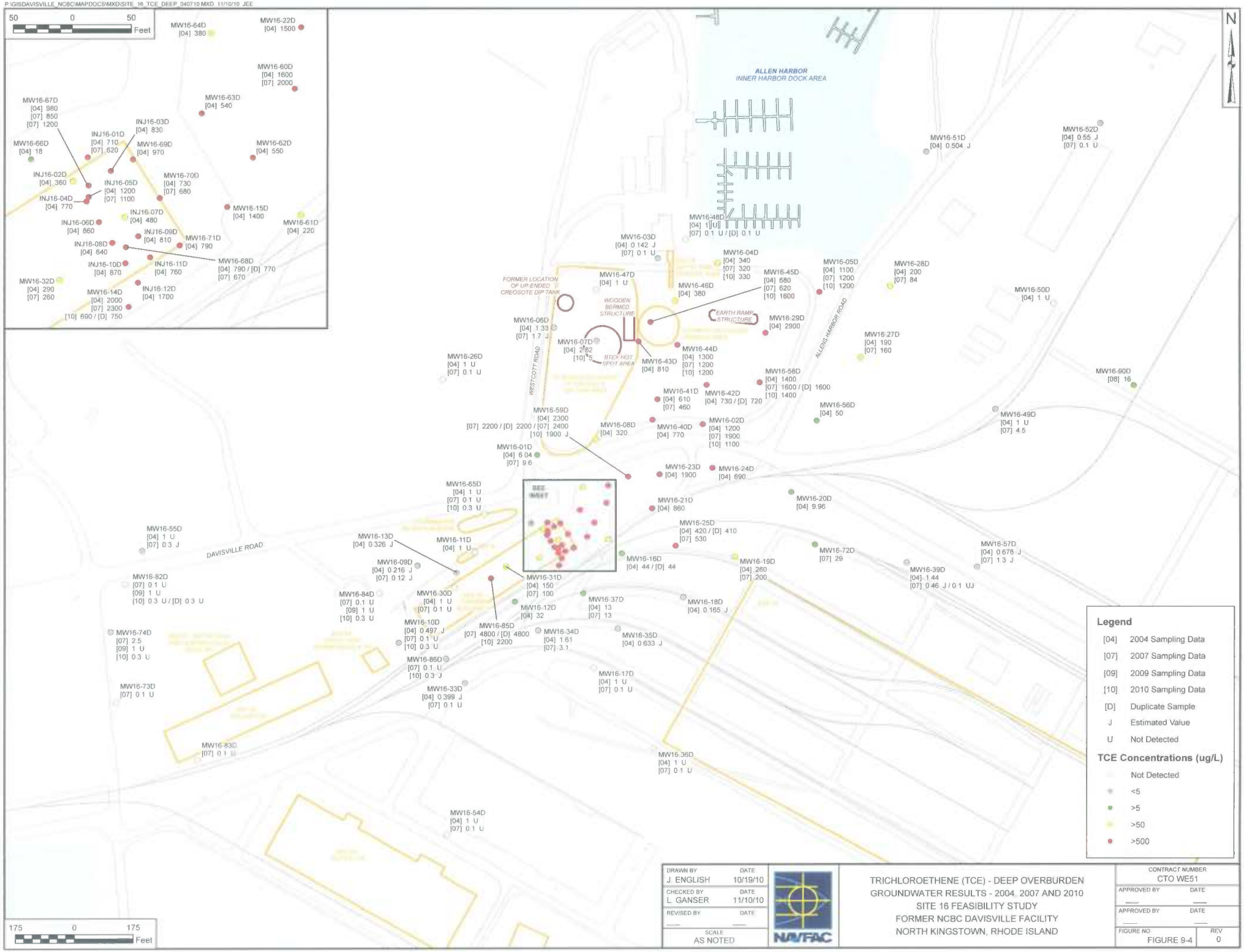

DRAWN BY J. ENGLISH	DATE 10/19/10	TRICHLOROETHENE (TCE) - DEEP OVERBURDEN GROUNDWATER RESULTS - 2004, 2007 AND 2010 SITE 16 FEASIBILITY STUDY FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	CONTRACT NUMBER CTO WE51
CHECKED BY L. GANSER	DATE 11/10/10		APPROVED BY ___ DATE ___
REVISED BY ___	DATE ___		APPROVED BY ___ DATE ___
SCALE AS NOTED		NAVFAC	FIGURE NO FIGURE 9-4 / REV 0

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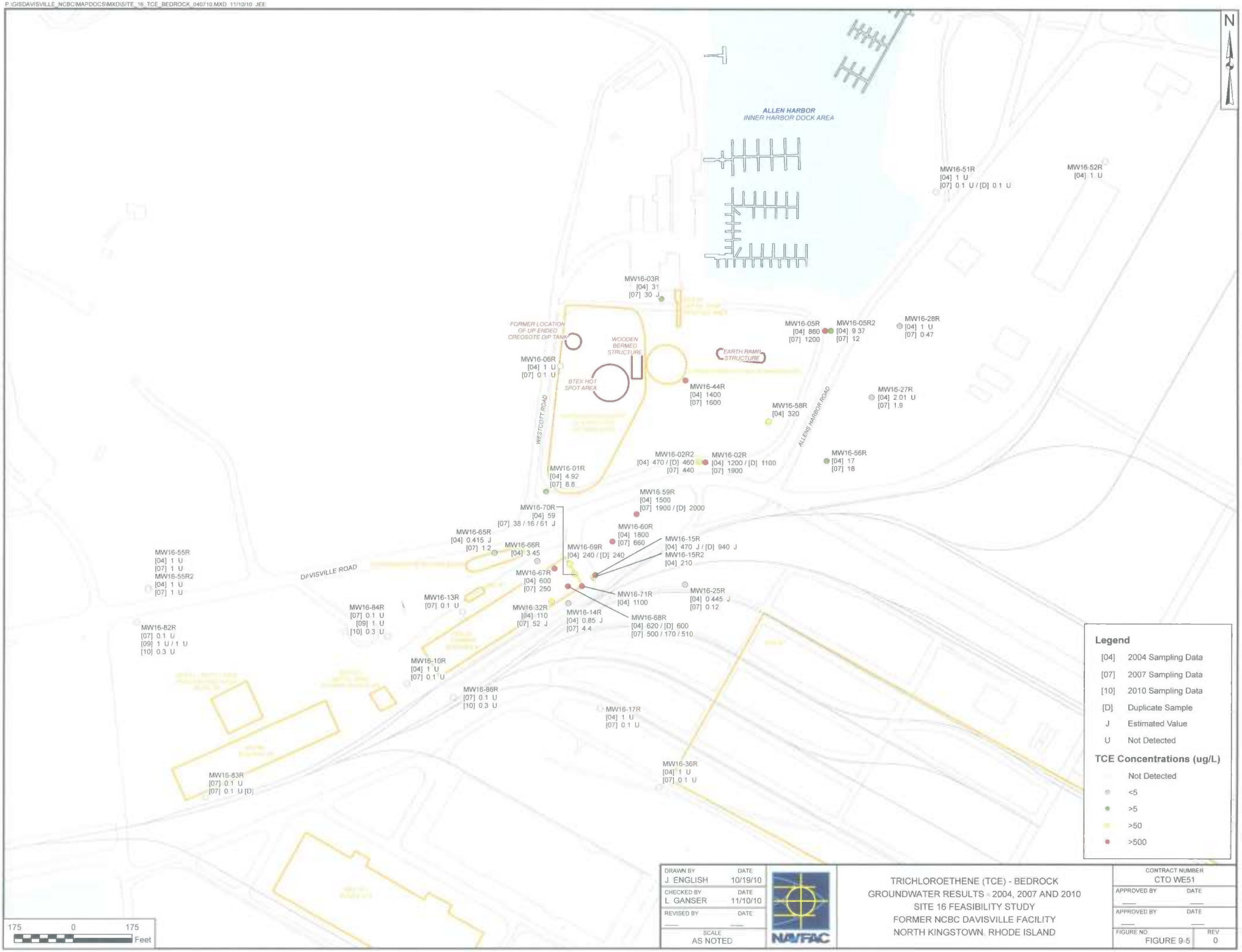


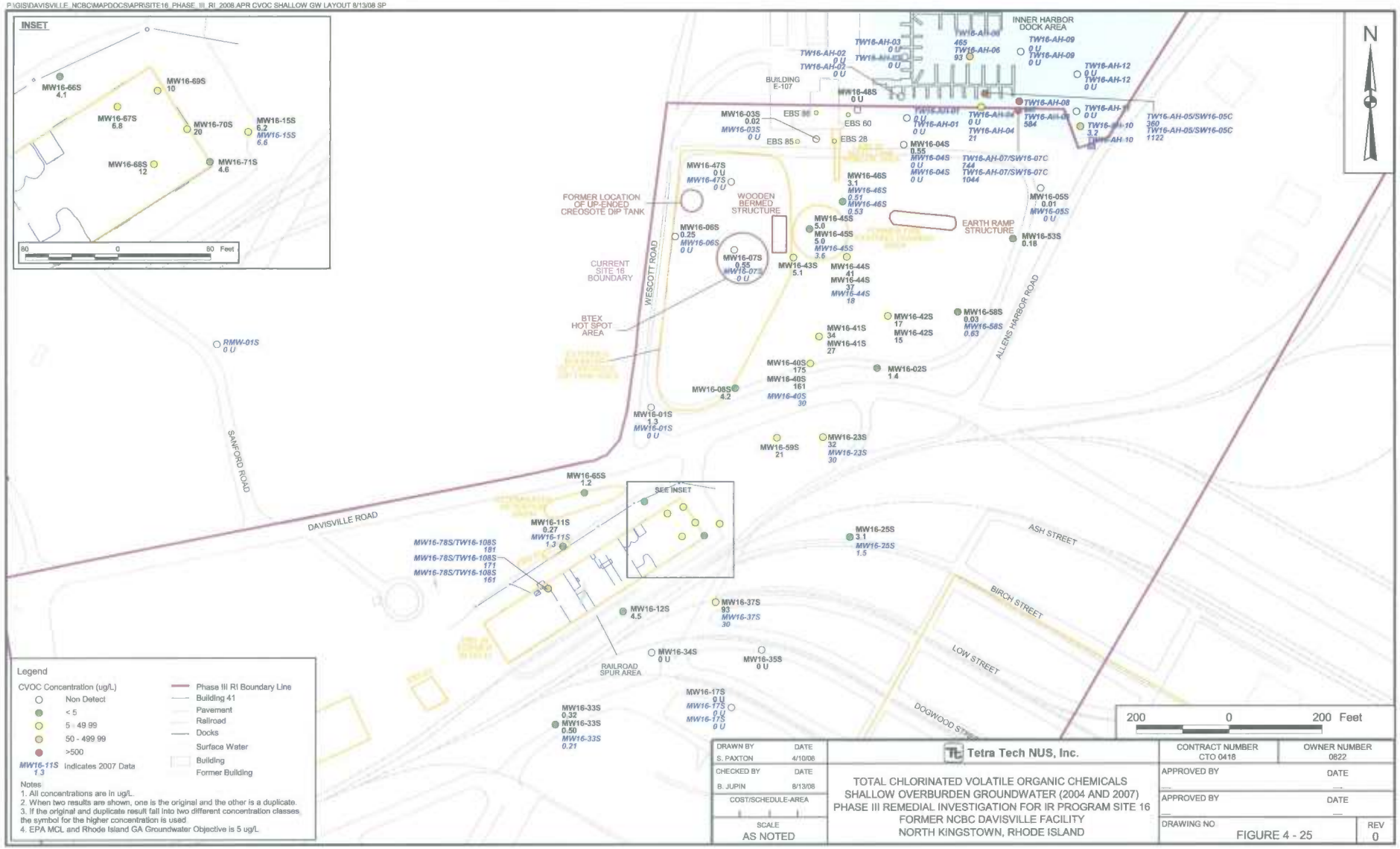
DRAWN BY	DATE
J. ENGLISH	10/19/10
CHECKED BY	DATE
L. GANSER	11/10/10
REVISED BY	DATE
—	—
SCALE	
AS NOTED	

NAVFAC

TRICHLOROETHENE (TCE) - BEDROCK
GROUNDWATER RESULTS - 2004, 2007 AND 2010
SITE 16 FEASIBILITY STUDY
FORMER NCBC DAVISVILLE FACILITY
NORTH KINGSTOWN, RHODE ISLAND

CONTRACT NUMBER	
CTO WE51	
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
FIGURE NO	REV
FIGURE 9-5	0

P:\GIS\DAVISVILLE_NCBC\MAPDOCS\APR\SITE16_PHASE_III_RI_2008.APR CVOC SHALLOW GW LAYOUT 8/13/08 SP



DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NUMBER
S. PAXTON	4/10/08		CTO 0418	0822
CHECKED BY	DATE	TOTAL CHLORINATED VOLATILE ORGANIC CHEMICALS SHALLOW OVERBURDEN GROUNDWATER (2004 AND 2007) PHASE III REMEDIAL INVESTIGATION FOR IR PROGRAM SITE 16 FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	APPROVED BY	DATE
B. JUPIN	8/13/08			
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE			DRAWING NO	REV
AS NOTED			FIGURE 4 - 25	0

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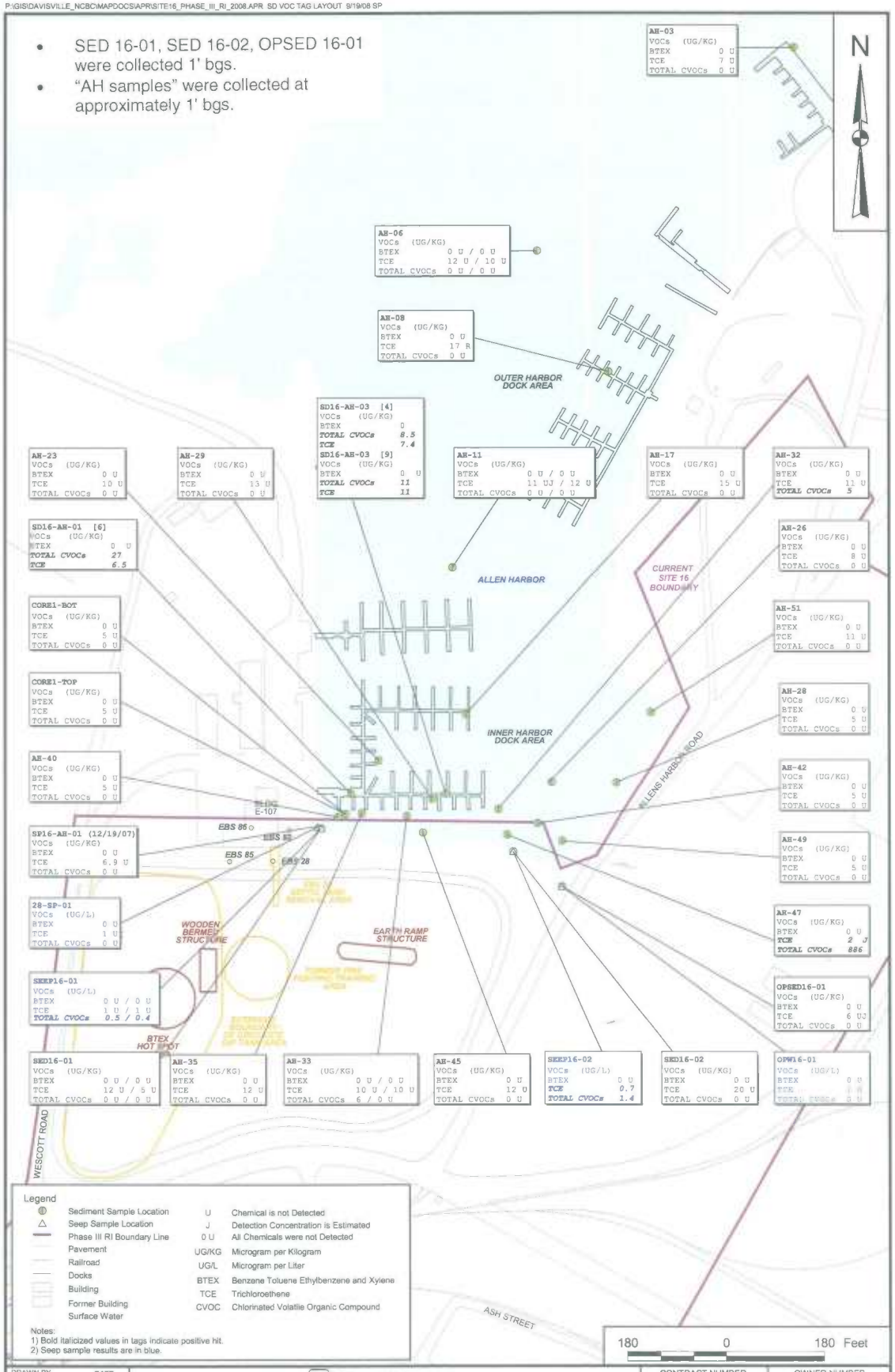

DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NUMBER
S. PAXTON	4/03/08		CTO 0416	0822
CHECKED BY	DATE	TOTAL CHLORINATED VOLATILE ORGANIC RESULTS FOR SEDIMENT AND SEEP SAMPLES PHASE III REMEDIAL INVESTIGATION FOR IR PROGRAM SITE 16 FORMER NCBC DAVISVILLE FACILITY NORTH KINGSTOWN, RHODE ISLAND	APPROVED BY	DATE
B. JUPIN	9/19/08		APPROVED BY	DATE
COST/SCHEDULE-AREA			DRAWING NO.	REV
SCALE			FIGURE 4 - 31	0
AS NOTED				

2010
GW from piezometers

TABLE 1

2010 GROUNDWATER SAMPLES FROM ALLEN HARBOR POSITIVE RESULTS
SITE 16 FEASIBILITY STUDY
FORMER NCBC DAVISVILLE FACILITY
NORTH KINGSTOWN, RHODE ISLAND
PAGE 1 OF 2

LOCATION	TW16-AH-13		TW16-AH-14	TW16-AH-15
SAMPLE ID	TW16-AH-13-0001	TW16-AH-13-0910	TW16-AH-14-0001	TW16-AH-15-0001
SAMPLE DATE	20100624	20100625	20100624	20100625
PROBLEM CODE	3	3	3	3
AREA	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW
TOP DEPTH (FT)	0	9	0	0
BOTTOM DEPTH (FT)	1	10	1	1
VOLATILES (UG/L)				
1,1-DICHLOROETHENE	0.4 U	0.4 U	0.7 J	0.4 U
2-BUTANONE	1 U	1 U	1 U	8
ACETONE	7	2 J	2 J	42
BTEX	0 U	0 U	0.8	1
CARBON DISULFIDE	0.3 J	0.2 U	0.3 J	0.5 J
CIS-1,2-DICHLOROETHENE	0.4 J	2	4	0.2 U
TOLUENE	0.3 U	0.3 U	0.8 J	1
TOTAL CHLORINATED VOCS	0.4	96	315	0 U
TRANS-1,2-DICHLOROETHENE	0.2 U	0.2 U	0.2 U	0.2 U
TRICHLOROETHENE	0.3 U	94	310 J	0.3 U
VINYL CHLORIDE	0.2 U	0.2 U	0.2 U	0.2 U
FIELD SCREENING (UNITLESS)				
COLOR-TEC[1]	0.1-LL-200	2.5-M-200	7.5-L-100	ND

TABLE 1

2010 GROUNDWATER SAMPLES FROM ALLEN HARBOR POSITIVE RESULTS
SITE 16 FEASIBILITY STUDY
FORMER NCBC DAVISVILLE FACILITY
NORTH KINGSTOWN, RHODE ISLAND

LOCATION	TW16-AH-16		TW16-AH-17	TW16-AH-18
SAMPLE ID	TW16-AH-16-0001	TW16-AH-16-0405	TW16-AH-17-0001	TW16-AH-18-0001
SAMPLE DATE	20100623	20100623	20100623	20100622
PROBLEM CODE	3	3	3	3
AREA	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	GW	GW	GW	GW
TOP DEPTH (FT)	0	4	0	0
BOTTOM DEPTH (FT)	1	5	1	1
VOLATILES (UG/L)				
1,1-DICHLOROETHENE	0.4 U	0.4 UJ	0.4 U	0.4 UJ
2-BUTANONE	1 U	1 UJ	1 U	1 U
ACETONE	**9**	6 UJ	**4 J**	2 U
BTEX	0 U	**2**	0 U	0 U
CARBON DISULFIDE	0.2 U	0.2 UJ	0.2 U	0.2 U
CIS-1,2-DICHLOROETHENE	0.2 U	**18 J**	0.2 U	0.2 U
TOLUENE	0.3 U	**2 J**	0.3 U	0.3 U
TOTAL CHLORINATED VOCS	0 U	**19.2**	0 U	0 U
TRANS-1,2-DICHLOROETHENE	0.2 U	**0.8 J**	0.2 U	0.2 U
TRICHLOROETHENE	0.3 U	0.3 UJ	0.3 U	0.3 U
VINYL CHLORIDE	0.2 U	**0.4 J**	0.2 U	0.2 U
FIELD SCREENING (UNITLESS)				
COLOR-TEC[1]	**0.05-LL-200**	**0.3-LL-100**	ND	ND

GW and SW from Allen Harbor 2007

TABLE 2

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN ALLEN HARBOR WATER SAMPLES
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 1 OF 4

Investigation	10	10	10	10	10	10	10	10
Location	TW16-AH-01	TW16-AH-01	TW16-AH-01	TW16-AH-02	TW16-AH-02	TW16-AH-03	TW16-AH-03	TW16-AH-03
Sample Number	TW16-AH-01-0305	TW16-AH-01-0810	TW16-AH-01-0810-D	TW16-AH-02-0305	TW16-AH-02-0810	TW16-AH-03-0305	TW16-AH-03-0810	TW16-AH-03-0810-D
Sample Date	20070807	20070807	20070807	20070807	20070807	20070809	20070809	20070809
Samle Code	NORMAL	ORIG	DUP	NORMAL	NORMAL	NORMAL	ORIG	DUP
Depth Range (feet)	3 - 5	8 - 10	8 - 10	3 - 5	8 - 10	3 - 5	8 - 10	8 - 10
Matrix	GW	GW	GW	GW	GW	GW	GW	GW
Duplicate			TW16-AH-01-0810					TW16-AH-03-0810
Area	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR
Volatile Organic Compounds (ug/L)								
1,1-Dichloroethene	0.76 U	0.76 U	0.76 U	0.76 U	0.76 U	0.76 U	0.76 U	0.76 U
Benzene	0.5 U	0.5 U	0.5 U	0.5 U	**1.4**	**3.2**	0.5 U	0.5 U
BTEX	0 U	0 U	0 U	0 U	**1.4**	**4.7**	0 U	0 U
cis-1,2-Dichloroethene	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U	0.53 U
Methyl Tert-Butyl Ether	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	**1.4**
Toluene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	**1.5**	0.33 U	0.33 UJ
Total Chlorinated VOCs	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U
trans-1,2-Dichloroethene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl Chloride	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U
Miscellaneous Parameters								
Turbidity	**4.45**	**6.8**		**9.43**	**90.4**	**3.77**	**4.55**	

TABLE 2

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN ALLEN HARBOR WATER SAMPLES
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 2 OF 4

Investigation	10	10	10	10	10	10	10	10
Location	TW16-AH-04	TW16-AH-04	SW16-AH-05S	TW16-AH-05/SW16-05C	TW16-AH-05/SW16-05C	TW16-AH-05/SW16-05C	TW16-AH-06	TW16-AH-06
Sample Number	TW16-AH-04-0305	TW16-AH-04-0810	SW16-AH-05S-081107	TW16-AH-05-0305	TW16-AH-05-0810	SW16-AH-05C-081107	TW16-AH-06-0305	TW16-AH-06-0810
Sample Date	20070807	20070807	20070811	20070808	20070808	20070811	20070810	20070810
Samle Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Depth Range (feet)	3 - 5	8 - 10	Above Sediments	3 - 5	8 - 10	Above Sediments	3 - 5	8 - 10
Matrix	GW	GW	SW	GW	GW	SW	GW	GW
Duplicate								
Area	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR
Volatile Organic Compounds (ug/L)								
1,1-Dichloroethene	0.76 U	0.76 U	0.1 U	0.76 U	0.76 U	0.1 U	0.76 U	0.76 U
Benzene	0.5 U	0.5 U	0.1 U	0.5 U	0.5 U	0.1 U	0.5 U	0.5 U
BTEX	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U
cis-1,2-Dichloroethene	0.53 U	**3**	0.53 U	**130**	**20**	0.53 U	0.53 U	**5**
Methyl Tert-Butyl Ether	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U
Toluene	0.33 U	0.33 UJ	0.33 UJ	0.33 U	0.33 U	0.33 UJ	0.33 UJ	0.33 UJ
Total Chlorinated VOCs	0 U	**21**	0 U	**360**	**1122**	0 U	**93**	**465**
trans-1,2-Dichloroethene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	0.5 U	**18**	0.1 U	**230 J**	**1100 J**	0.1 U	**93 J**	**460**
Vinyl Chloride	0.51 U	0.51 U	0.1 U	0.51 U	**2**	0.1 U	0.51 U	0.51 U
Miscellaneous Parameters								
Turbidity	**7.2**	**115**		**20.3**	**151**		**147**	**212**

TABLE 2

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN ALLEN HARBOR WATER SAMPLES
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 3 OF 4

Investigation	10	10	10	10	10	10	10	10
Location	SW16-AH-07S	TW16-AH-07/SW16-07C	TW16-AH-07/SW16-07C	TW16-AH-08	TW16-AH-08	TW16-AH-09	TW16-AH-09	TW16-AH-10
Sample Number	SW16-AH-07S-081107	TW16-AH-07-0305	TW16-AH-07-0810	TW16-AH-08-0305	TW16-AH-08-0810	TW16-AH-09-0305	TW16-AH-09-0810	TW16-AH-10-0305
Sample Date	20070811	20070809	20070809	20070809	20070809	20070811	20070811	20070809
Samle Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Depth Range (feet)	Above Sediments	3 - 5	8 - 10	3 - 5	8 - 10	3 - 5	8 - 10	3 - 5
Matrix	SW	GW	GW	GW	GW	GW	GW	GW
Duplicate								
Area	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR
Volatile Organic Compounds (ug/L)								
1,1-Dichloroethene	0.1 U	**2.5**	**1**	**1.7**	0.76 U	0.76 U	0.76 U	0.76 U
Benzene	0.1 U	**1.3**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
BTEX	0 U	**1.3**	0 U	0 U	0 U	0 U	0 U	0 U
cis-1,2-Dichloroethene	0.53 U	**280 J**	**13**	**190**	**14**	0.53 U	0.53 U	0.53 U
Methyl Tert-Butyl Ether	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U
Toluene	0.33 UJ	0.33 U	0.33 UJ	0.33 U	0.33 U	0.33 UJ	0.33 UJ	0.33 UJ
Total Chlorinated VOCs	0 U	**1044.4**	**744**	**946.8**	**584**	0 U	0 U	**3.2**
trans-1,2-Dichloroethene	0.5 U	**1.9**	0.5 U	**1.3**	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	0.1 U	**760 J**	**730**	**750 J**	**570 J**	0.5 U	0.5 U	**3.2**
Vinyl Chloride	0.1 U	0.51 U	0.51 U	**3.8**	0.51 U	0.51 U	0.51 U	0.51 U
Miscellaneous Parameters								
Turbidity	**4.1**		**4.89**	**43.8**	**9.3**	**23.8**	**30.4**	**71.2**

TABLE 2

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN ALLEN HARBOR WATER SAMPLES
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 4 OF 4

Investigation	10	10	10	10	10
Location	TW16-AH-10	TW16-AH-11	TW16-AH-12	TW16-AH-12	TW16-AH-12
Sample Number	TW16-AH-10-0810	TW16-AH-11-0810	TW16-AH-12-0305	TW16-AH-12-0305-D	TW16-AH-12-0810
Sample Date	20070809	20070807	20070810	20070810	20070810
Samle Code	NORMAL	NORMAL	ORIG	DUP	NORMAL
Depth Range (feet)	8 - 10	8 - 10	3 - 5	3 - 5	8 - 10
Matrix	GW	GW	GW	GW	GW
Duplicate				TW16-AH-12-0305	
Area	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR
Volatile Organic Compounds (ug/L)					
1,1-Dichloroethene	0.76 U	0.76 U	0.76 U	0.76 U	0.76 U
Benzene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
BTEX	0 U	0 U	0 U	0 U	0 U
cis-1,2-Dichloroethene	**1.1**	0.53 U	0.53 U	0.53 U	0.53 U
Methyl Tert-Butyl Ether	0.71 U	0.71 U	0.71 U	0.71 U	0.71 U
Toluene	0.33 UJ	0.33 U	0.33 UJ	0.33 UJ	0.33 UJ
Total Chlorinated VOCs	**66.1**	0 U	0 U	0 U	0 U
trans-1,2-Dichloroethene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	**65**	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl Chloride	0.51 U	0.51 U	0.51 U	0.51 U	0.51 U
Miscellaneous Parameters					
Turbidity	**3.8**	**57.8**	**46.7**		**9.54**

Older seep samples.
1998 and 2001

TABLE 3

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN SEEP SAMPLES
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Investigation	**03**	**05**	**05**	**05**	**05**
Location	**28-SP-01**	**OPW16-01**	**SEEP16-01**	**SEEP16-01**	**SEEP16-02**
Sample Number	**28-SP01-NGW-101598**	**OPW16-01-NWG-032201**	**SEEP16-01-NWG-032101**	**SEEP16-01-NWG-032101-D**	**SEEP16-02-NWG-032601**
Sample Code	**NORMAL**	**NORMAL**	**ORIG**	**DUP**	**NORMAL**
Sample Date	**10/15/1998**	**3/22/2001**	**3/21/2001**	**3/21/2001**	**3/26/2001**
Volatile Organic Compounds (ug/L)					
Acetone	5 U	**0.9 J**	5 UJ	5 UJ	5 UJ
cis-1,2-Dichloroethene		2 U	2 U	2 U	**0.7**
Total 1,2-Dichloroethene	1 U	2 U	2 U	2 U	**0.7**
Total Chlorinated VOCs[1]	0 U	0 U	**0.5**	**0.4**	**1.4**
Trichloroethene	1 U	1 U	1 U	1 U	**0.7**
Vinyl Chloride	1 U	2 U	**0.5 J**	**0.4**	2 U

Investigation Description:
03 - EBS Phase II Follow-On Addendum Sampling
05 - Stage II Phase I RI Sampling Event

Qualifiers:
J - Estimated value.
U - Non-detected result.
UJ - Non-detected result is estimated.

Sample Code Description:
NORMAL - One sample was collected at this location.
ORIG - First of two samples collected at this location.
DUP - Second of two samples collected at this location.

Footnotes:
1 - The calculation of the Total PAHs is defined in Section 4. "0U" indicates that this chemical group was not detected in the sample analyzed.
2 - A concentration that is shaded exceeds the criteria presented in the table.
3 - A blank cell indicates that the sample was not analyzed for the target analyte.

2010 SW from Allen Harbor

TABLE 4

POSITIVE RESULTS FOR SURFACE WATER FROM ALLEN HARBOR
SITE 16 FEASIBILITY STUDY
FORMER NCBC DAVISVILLE FACILITY
NORTH KINGSTOWN, RHODE ISLAND

LOCATION	SW16-AH-08	SW16-AH-09			SW16-AH-10	SW16-AH-11	SW16-AH-12	SW16-AH-13
SAMPLE ID	SW16-AH-08-062610	SW16-AH-09-062610	SW16-AH-09-062610-AVG	SW16-AH-09-062610-D	SW16-AH-10-062610	SW16-AH-11-062610	SW16-AH-12-062610	SW16-AH-13-062610
SAMPLE DATE	20100626	20100626	20100626	20100626	20100626	20100626	20100626	20100626
PROBLEM CODE	3	3	3	3	3	3	3	3
AREA	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR
SAMPLE CODE	NORMAL	ORIG	AVG	DUP	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	SW	SW	SW	SW	SW	SW	SW	SW
DEPTH (FT)	9.81	11.5	11.5	11.5	9.83	24.1	12.8	7.32
TEMPORARY WELL CO-LOCATED	TW16-AH-13	TW16-AH-14	TW16-AH-14	TW16-AH-14	TW16-AH-15	TW16-AH-16	TW16-AH-17	TW16-AH-18
SEDIMENT SAMPLE CO-LOCATED	SD16-AH-20	SD16-AH-21	SD16-AH-21	SD16-AH-21	SD16-AH-22	SD16-AH-23	SD16-AH-24	SD16-AH-25
VOLATILES (UG/L)								
ACETONE	3 J	2 U	2.5 J	4 J	2 U	3 J	2 J	3 J
CARBON DISULFIDE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.4 J	0.3 J	0.3 J
CIS-1,2-DICHLOROETHENE	0.3 J	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
TOTAL CHLORINATED VOCS	0.3	0 U	0 U	0 U	0 U	0 U	0 U	0 U
FIELD SCREENING (UNITLESS)								
COLOR-TEC[1]	ND	ND	NA	NA	ND	ND	ND	ND

1 Presents direct tube reading, tube-type, and purge volume, respectively. Direct tube reading needs to be correlated against laboratory results in order to estimate field screening concentration.

Abbreviations:
NA - Not analyzed
NC - No Criterion
ND - Not detected
J - Estimated value
U - Nondetected result

2004 Sediments from Allen Harbor

TABLE 5

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN 2004 SEDIMENT SAMPLES
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 1 OF 4

Investigation	07	07	07	07	07	07	07	07
Location	AH-03	AH-06	AH-06	AH-08	AH-11	AH-11	AH-17	AH-23
Sample Number	AH-03-NSD-032304	AH-06-NSD-032304	AH-06-NSD-032304-D	AH-08-NSD-032204	AH-11-NSD-032204	AH-11-NSD-032204-D	AH-17-NSD-032304	AH-23-NSD-032404
Sample Code	NORMAL	ORIG	DUP	NORMAL	ORIG	DUP	NORMAL	NORMAL
Sample Date	3/23/2004	3/23/2004	3/23/2004	3/22/2004	3/22/2004	3/22/2004	3/23/2004	3/24/2004
Volatile Organic Compounds (ug/kg)								
1,1-Dichloroethene	7 U	12 U	10 U	17 R	11 UJ	12 U	15 U	10 U
2-Butanone	**7 J**	**10 J**	**14 J**	33 R	21 U	23 U	**20 J**	21 U
Acetone	**220**	**390 J**	**83 J**	210 R	110 U	150 U	**200**	210 U
Carbon Disulfide	11 U	12 U	11 U	24 R	11 U	12 U	24 U	10 U
cis-1,2-Dichloroethene	7 U	12 U	10 U	17 R	11 UJ	12 U	15 U	10 U
Total 1,2-Dichloroethene	7 U	12 U	10 U	17 U	11 U	12 U	15 U	10 U
Total Chlorinated VOCs	0 U	0 U	0 U	0 U	0 U	0 U	0 U	0 U
trans-1,2-Dichloroethene	7 U	12 U	10 U	17 R	11 UJ	12 U	15 U	10 U
Trichloroethene	7 U	12 U	10 U	17 R	11 UJ	12 U	15 U	10 U

TABLE 5

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN 2004 SEDIMENT SAMPLES
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 2 OF 4

Investigation	07	07	07	07	07	07	07	07
Location	AH-26	AH-28	AH-29	AH-32	AH-33	AH-33	AH-35	AH-40
Sample Number	AH-26-NSD-032704	AH-28-NSD-032504	AH-29-NSD-032604	AH-32-NSD-032604	AH-33-NSD-032604	AH-33-NSD-032604-D	AH-35-NSD-032604	AH-40-NSD-032704
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	ORIG	DUP	NORMAL	NORMAL
Sample Date	3/27/2004	3/25/2004	3/26/2004	3/26/2004	3/26/2004	3/26/2004	3/26/2004	3/27/2004
Volatile Organic Compounds (ug/kg)								
1,1-Dichloroethene	8 U	5 U	13 U	11 U	10 U	10 U	12 U	5 U
2-Butanone	17 U	10 U	27 U	**17 J**	**17 J**	**23**	**20 J**	**8**
Acetone	67 UJ	84 UJ	93 UJ	130 U	120 U	85 U	91 U	45 U
Carbon Disulfide	9 U	5 U	13 U	11 U	10 U	10 U	12 U	10 U
cis-1,2-Dichloroethene	8 U	5 U	13 U	**5 J**	**6 J**	10 U	12 U	5 U
Total 1,2-Dichloroethene	8 U	5 U	13 U	**5**	**6**	10 U	12 U	5 U
Total Chlorinated VOCs	0 U	0 U	0 U	**5**	**6**	0 U	0 U	0 U
trans-1,2-Dichloroethene	8 U	5 U	13 U	11 U	10 U	10 U	12 U	5 U
Trichloroethene	8 U	5 U	13 U	11 U	10 U	10 U	12 U	5 U

TABLE 5

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN 2004 SEDIMENT SAMPLES
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 3 OF 4

Investigation	07	07	07	07	07	07	07	05
Location	AH-42	AH-45	AH-47	AH-49	AH-51	CORE1-BOT	CORE1-TOP	OPSED16-01
Sample Number	AH-42-NSD-032704	AH-45-NSD-032604	AH-47-NSD-032604	AH-49-NSD-032504	AH-51-NSD-032704	CORE1-BOTNSD-032704	CORE1-TOPNSD-032704	OPSED16-01-NSD-03220
Sample Code	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
Sample Date	3/27/2004	3/26/2004	3/26/2004	3/25/2004	3/27/2004	3/27/2004	3/27/2004	3/22/2001
Volatile Organic Compounds (ug/kg)								
1,1-Dichloroethene	5 U	12 U	**0.9 J**	5 U	11 U	5 U	5 U	6 UJ
2-Butanone	**8 J**	**15 J**	**8 J**	10 U	**16 J**	**5 J**	**5 J**	13 UJ
Acetone	52 UJ	190 U	72 UJ	79 U	210 UJ	65 UJ	20 U	**89 J**
Carbon Disulfide	5 U	12 U	5 U	5 U	11 U	5 U	5 U	6 UJ
cis-1,2-Dichloroethene	5 U	12 U	**880**	5 U	11 U	5 U	5 U	6 UJ
Total 1,2-Dichloroethene	5 U	12 U	**883**	5 U	11 U	5 U	5 U	6 U
Total Chlorinated VOCs	0 U	0 U	**886**	0 U	0 U	0 U	0 U	0 U
trans-1,2-Dichloroethene	5 U	12 U	**3 J**	5 U	11 U	5 U	5 U	6 UJ
Trichloroethene	5 U	12 U	**2 J**	5 U	11 U	5 U	5 U	6 UJ

TABLE 5

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN 2004 SEDIMENT SAMPLES
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND
PAGE 4 OF 4

Investigation	**05**	**05**	**05**
Location	**SED16-01**	**SED16-01**	**SED16-02**
Sample Number	**SED16-01-NSD-032101**	**SED16-01-NSD-032101-D**	**SED16-02-NSD-032601**
Sample Code	**ORIG**	**DUP**	**NORMAL**
Sample Date	**3/21/2001**	**3/21/2001**	**3/26/2001**
Volatile Organic Compounds (ug/kg)			
1,1-Dichloroethene	12 U	5 U	20 U
2-Butanone	24 UJ	10 UJ	41 UJ
Acetone	**84 J**	**30 J**	**120 J**
Carbon Disulfide	**5 J**	**50 J**	**12**
cis-1,2-Dichloroethene	12 U	5 U	20 U
Total 1,2-Dichloroethene	12 U	5 U	20 U
Total Chlorinated VOCs	0 U	0 U	0 U
trans-1,2-Dichloroethene	12 U	5 U	20 U
Trichloroethene	12 U	5 U	20 U

2007 Sediments

TABLE 6

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN 2007SHALLOW SEDIMENT SAMPLES
PHASE III RI FOR IR PROGRAM SITE 16
FORMER NCBC DAVISVILLE
NORTH KINGSTOWN, RHODE ISLAND

Investigation	10	10	10	10
Location	SD16-AH-01	SD16-AH-03	SD16-AH-03	SP16-AH-01
Sample Number	SD16-AH-01-SD-0506	SD16-AH-03-SD-0304	SD16-AH-03-SD-0809	AH-1-SHEEN-121907
Sample code	NORMAL	NORMAL	NORMAL	NORMAL
Sample Date	8/6/2007	8/6/2007	8/6/2007	12/19/2007
Depth Range (feet)	5 - 6	3 - 4	8 - 9	0 - 0.5
Matrix	SD	SD	SD	SD
Area	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR	ALLEN HARBOR
Volatile Organic Compounds (ug/kg)				
1,2,4-Trichlorobenzene	0.52 U	0.49 U	0.56 U	**2.1 J**
2-Hexanone	0.38 UJ	0.35 UJ	0.4 UJ	**3.1 J**
Acetone	1.3 U	1.2 U	1.3 U	**95 J**
cis-1,2-Dichloroethene	**20**	0.32 U	0.37 U	6.9 U
Methyl Acetate	1.7 U	1.6 U	1.8 U	**12 J**
Methyl Tert-Butyl Ether	0.32 U	0.29 U	0.34 U	**1.7 J**
Methylene Chloride	0.6 U	**1.1 J**	0.64 U	6.9 U
Total Chlorinated VOCs	**26.5**	**8.5**	**11**	
Trichloroethene	**6.5**	**7.4**	**11**	6.9 U

Notes:
Bolding indicates that the chemical was detected in the sample.

Qualifiers:
J - Estimated value.
U - Non-detected result.
UJ - Non-detected result is estimated.
UR - Non-detected result is rejected.

Sample Code Description:
NORMAL - One sample was collected at this location.
ORIG - First of two samples collected at this location.
DUP - Second of two samples collected at this location.

2010 Sediments

TABLE 7

SEDIMENT FROM ALLEN HARBOR POSITIVE RESULTS
SITE 16 FEASIBILITY STUDY
FORMER NCBC DAVISVILLE FACILITY
NORTH KINGSTOWN, RHODE ISLAND
PAGE 1 OF 2

LOCATION	SOUTHWEST POINT	SOUTHWEST POINT	MIDDLE LINE - WESTERN POINT	MIDDLE LINE - EASTERN POINT	MIDDLE LINE - EASTERN POINT	MIDDLE LINE - EASTERN POINT	MIDDLE LINE - EASTERN POINT
SAMPLE ID	SD16-AH-20-0000	SD16-AH-20-0102	SD16-AH-21-0000	SD16-AH-22-0000	SD16-AH-22-0001	SD16-AH-22-0001-AVG	SD16-AH-22-0001-D
SAMPLE DATE	20100621	20100621	20100621	20100622	20100622	20100622	20100622
PROBLEM CODE	3	3	3	3	3	3	3
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL	ORIG	AVG	DUP
MATRIX	SD	SD	SD	SD	SD	SD	SD
TOP DEPTH (FT)	0	1	0	0	0.25	0.25	0.25
BOTTOM DEPTH (FT)	0.25	2	0.25	0.25	1	1	1
TEMPORARY WELL CO-LOCATED	TW16-AH-13	TW16-AH-13	TW16-AH-14	TW16-AH-15	TW16-AH-15	TW16-AH-15	TW16-AH-15
SURFACE WATER SAMPLE CO-	SW16-AH-08	SW16-AH-08	SW16-AH-09	SW16-AH-10	SW16-AH-10	SW16-AH-10	SW16-AH-10
MISCELLANEOUS PARAMETERS (%)							
TOTAL SOLIDS	**50**	**68**	**64**	**38**	**48**	**48.5**	**49**
VOLATILES (UG/KG)							
2-BUTANONE	**50**	NA	**14 J**	18 U	16 U	**15 J**	**15 J**
ACETONE	**180**	NA	**66**	**59 J**	**54 J**	**57 J**	**60 J**
CARBON DISULFIDE	**8 J**	NA	**7**	**14 J**	**14**	**18**	**22**
METHYL TERT-BUTYL ETHER	2 U	NA	**2 J**	3 U	3 U	3 U	3 U
TOTAL CHLORINATED VOCS	0 U	NA	**1**	0 U	0 U	0 U	0 U
TRICHLOROETHENE	0.9 U	NA	**1 J**	2 U	2 U	1.5 U	1 U
FIELD SCREENING							
JAR HEADSPACE (PPM)	0.0	1.4	0.0	0.0	0.0	NA	NA
COLOR-TEC (UNITLESS)[1]	ND	ND	ND	ND	ND	NA	NA

Notes:
Bolded values indicate positive results.

Footnotes:
1 Presents direct tube reading, tube-typ
against laboratory results in order to es

Calculations:
Total chlorinated VOCs - sum of 1,1,1-
cis-1,2-DCE, cis-1,3-dichloropropene

Qualifers:
J - Estimated value
U - Nondetected result
UJ - Estimated, nondetected result
UR - Rejected, nondetected result

Abbreviations:
DCA - Dichloroethane
DCE - Dichloroethene
NA - Not applicable; analysis not perfo
NC - No criteria available
PCE - Tetrachloroethene
TCA - Trichloroethane
TCE - Tetrachloroethene
VOC - Volatile organic compound

TABLE 7

SEDIMENT FROM ALLEN HARBOR POSITIVE RESULTS
SITE 16 FEASIBILITY STUDY
FORMER NCBC DAVISVILLE FACILITY
NORTH KINGSTOWN, RHODE ISLAND
PAGE 2 OF 2

LOCATION	NORTHERN LINE - WESTERN POINT	NORTHERN LINE - CENTER POINT	NORTHERN LINE - EASTERN POINT	NORTHERN LINE - EASTERN POINT
SAMPLE ID	SD16-AH-23-0000	SD16-AH-24-0000	SD16-AH-25-0000	SD16-AH-25-0001
SAMPLE DATE	20100621	20100621	20100622	20100622
PROBLEM CODE	3	3	3	3
SAMPLE CODE	NORMAL	NORMAL	NORMAL	NORMAL
MATRIX	SD	SD	SD	SD
TOP DEPTH (FT)	0	0	0	0.25
BOTTOM DEPTH (FT)	0.25	0.25	0.25	1
TEMPORARY WELL CO-LOCATED	TW16-AH-16	TW16-AH-17	TW16-AH-18	TW16-AH-18
SURFACE WATER SAMPLE CO-	SW16-AH-11	SW16-AH-12	SW16-AH-13	SW16-AH-13
MISCELLANEOUS PARAMETERS (%)				
TOTAL SOLIDS	25	46	45	53
VOLATILES (UG/KG)				
2-BUTANONE	47 J	17 U	15 U	7 U
ACETONE	190 J	80	48 J	22 J
CARBON DISULFIDE	40 J	21	16	11
METHYL TERT-BUTYL ETHER	5 UR	3 U	3 U	1 U
TOTAL CHLORINATED VOCS	0 U	0 U	0 U	0 U
TRICHLOROETHENE	2 UR	2 U	2 U	0.7 U
FIELD SCREENING				
JAR HEADSPACE (PPM)	0.0	0.0	0.0	0.0
COLOR-TEC (UNITLESS)[1]	ND	ND	ND	ND

ɔe, and purge volume, respectively. Direct tube reading needs to be correlated
ɪtimate field screening concentration.

TCA, 1,1,2,2-PCE, 1,1,2-TCA, 1,1,-DCA, 1,1-DCE, 1,2-DCA, 1,2-dichloropropane, carbon tetrachloride, chloroethane, chloromethane,
ı, methylene chloride, PCE, total 1,2-DCE, trans 1,2-DCE, trans-1,3-dichloropropene, TCE, and vinyl chloride

Sample Code:
NORMAL - One sample was collected at this location.
ORIG - First of two samples collected at this location.
DUP - Second of two samples collected at this location.
AVG - Average of two samples collected at this location.

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ATTACHMENT B

SUPPORT DOCUMENTATION FOR SCREENING LEVELS

SUPPORT DOCUMENTATION FOR HUMAN HEALTH SCREENING LEVELS

Table B-1
Surface Water Screening Levels for Recreational Users
NCBC Davisville Site 16
(Calculations Provided on Attached Spreadsheets)

CAS No.	Parameter	Human Health (ug/L)
Volatile Organic Compounds		
79-00-5	1,1,2-Trichloroethane	79.1
75-34-3	1,1-Dichloroethane	681
75-35-4	1,1-Dichloroethene	27,600
120-82-1	1,2,4-Trichlorobenzene	13.1
107-06-2	1,2-Dichloroethane	59.7
106-46-7	1,4-Dichlorobenzene	126
78-93-3	2-Butanone	1,210,000
591-78-6	2-Hexanone	6,060
108-10-1	4-Methyl-2-Pentanone	102,000
67-64-1	Acetone	2,040,000
71-43-2	Benzene	38.5
75-27-4	Bromodichloromethane	79.2
75-15-0	Carbon Disulfide	58,000
108-90-7	Chlorobenzene	5,240
124-48-1	Chlorodibromomethane	63.2
75-00-3	Chloroethane	NA
67-66-3	Chloroform	120
74-87-3	Chloromethane	NA
156-59-2	cis-1,2-Dichloroethene	1,160
110-82-7	Cyclohexane	NA
100-41-4	Ethylbenzene	65.1
98-82-8	Isopropylbenzene	9,530
79-20-9	Methyl Acetate	2,100,000
108-87-2	Methyl Cyclohexane	NA
1634-04-4	Methyl Tert-Butyl Ether	4,570
75-09-2	Methylene Chloride	7,390
100-42-5	Styrene	42,200
127-18-4	Tetrachloroethene	1,140
108-88-3	Toluene	20,100
540-59-0	Total 1,2-Dichloroethene	5,210
1330-20-7	Total Xylenes	32,600
156-60-5	trans-1,2-Dichloroethene	11,600
79-01-6	Trichloroethene (Adult Only)	72
79-01-6	Trichloroethene (Lifelong)	35
79-01-6	Trichloroethene (Child 2-6 & Adult)	47
79-01-6	Trichloroethene (Noncarcinogenic)	260
75-01-4	Vinyl Chloride (Lifelong) (1)	0.142
75-01-4	Vinyl Chloride (Adult Only) (1)	6.4
75-01-4	Vinyl Chloride (Child 2-6 & Adult) (1)	0.142

1) The lifelong screening level is an order of magnitude less than the current Safe Drinking Wate Act maximum contaminant level.

Site-specific
Recreator Equation Inputs for Surface Water

Variable	Value
TR (target cancer risk) unitless	0.000001
THQ (target hazard quotient) unitless	1
EF_{recwc} (child exposure frequency) day/year	52
EF_{recwa} (adult exposure frequency) day/year	52
EF_{0-2} (mutagenic exposure frequency) day/year	52
EF_{2-6} (mutagenic exposure frequency) day/year	52
EF_{6-16} (mutagenic exposure frequency) day/year	52
EF_{16-30} (mutagenic exposure frequency) day/year	52
ED_{recwc} (exposure duration - child) year	6
ED_{recwa} (exposure duration - adult) year	24
ED_{0-2} (mutagenic exposure duration) year	2
ED_{2-6} (mutagenic exposure duration) year	4
ED_{6-16} (mutagenic exposure duration) year	10
ED_{16-30} (mutagenic exposure duration) year	14
LT (lifetime - recreator) year	70
EV_{recwa} (adult) events/day	1
EV_{recwc} (child) events/day	1
EV_{0-2} (mutagenic) events/day	1
EV_{2-6} (mutagenic) events/day	1
EV_{6-16} (mutagenic) events/day	1
EV_{16-30} (mutagenic) events/day	1
ET_{recwa} (adult exposure time) hour/event	4
ET_{recwc} (child exposure time) hour/event	4
$ET_{recw0-2}$ (mutagenic exposure time) hour/event	4
$ET_{recw2-6}$ (mutagenic exposure time) hour/event	4
$ET_{recw6-16}$ (mutagenic exposure time) hour/event	4
$ET_{recw16-30}$ (mutagenic exposure time) hour/event	4
$ET_{recw-adj}$ (age-adjusted exposure time) hour/event	4
$ET_{recw-madj}$ (mutagenic age-adjusted exposure time) hour/event	4
BW_{recwa} (body weight - adult) kg	70
BW_{recwc} (body weight - child) kg	15
BW_{0-2} (mutagenic body weight) kg	15
BW_{2-6} (mutagenic body weight) kg	15
BW_{6-16} (mutagenic body weight) kg	70
BW_{16-30} (mutagenic body weight) kg	70
IRW_{recwa} (water intake rate - adult) L/hr	0.01
IRW_{recwc} (water intake rate - child) L/hr	0.01
IRW_{0-2} (mutagenic water intake rate) L/hr	0.01
IRW_{2-6} (mutagenic water intake rate) L/hr	0.01
IRW_{6-16} (mutagenic water intake rate) L/hr	0.01
IRW_{16-30} (mutagenic water intake rate) L/hr	0.01
SA_{recwa} (skin surface area - adult) cm^2	5700
SA_{recwc} (skin surface area - child) cm^2	2800
SA_{0-2} (mutagenic skin surface area) cm^2	2800
SA_{2-6} (mutagenic skin surface area) cm^2	2800
SA_{6-16} (mutagenic skin surface area) cm^2	5700
SA_{16-30} (mutagenic skin surface area) cm^2	5700
l_{sc} (apparent thickness of stratum corneum) cm	0.001
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	1.545
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	5.745
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	159862.857
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	496921.905

Output generated 04FEB2013:14:23:38

Site-specific
Recreator Risk-Based Screening Levels (RSL) for Surface Water
ca=Cancer, nc=Noncancer, ca* (Where nc SL < 100 x ca SL),
ca** (Where nc SL < 10 x ca SL),
max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat

Chemical	CAS Number	Chemical Type	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Chronic RfD (mg/kg-day)	RfD Ref	RAGSe GIABS (unitless)	KP	MW	pi	logds	dsclc	dsc	c	littleb	B	tstar	tau_event	FA	In EPD?	DAeventc
Acetone	67-64-1	Organics	-		9.00E-01	I	1	5.12E-04	58.08	3.141593	-3.125248	7.50E-04	7.49E-07	3.34E-01	3.04E-01	1.50E-03	5.34E-01	2.22E-01	1	Yes	-
Benzene	71-43-2	Organics	5.50E-02	I	4.00E-03	I	1	1.49E-02	78.11	3.141593	-3.237416	5.79E-04	5.79E-07	3.68E-01	3.35E-01	5.06E-02	6.91E-01	2.88E-01	1	Yes	0.002906
Bromodichloromethane	75-27-4	Organics	6.20E-02	I	2.00E-02	I	1	4.02E-03	163.8	3.141593	-3.717448	1.92E-04	1.92E-07	3.47E-01	3.15E-01	1.98E-02	2.09E+00	8.70E-01	1	Yes	0.002578
Carbon Disulfide	75-15-0	Organics	-		1.00E-01	I	1	1.14E-02	76.13	3.141593	-3.226328	5.94E-04	5.94E-07	3.59E-01	3.27E-01	3.83E-02	6.74E-01	2.81E-01	1	Yes	-
Chlorobenzene	108-90-7	Organics	-		2.00E-02	I	1	2.82E-02	112.6	3.141593	-3.430336	3.71E-04	3.71E-07	4.14E-01	3.78E-01	1.15E-01	1.08E+00	4.49E-01	1	Yes	-
Chlorodibromoethane	73506-94-2	Organics	-		-		1	-	-	3.141593	-	-	-	-	-	-	-	-	-	No	-
Chloroform	67-66-3	Organics	3.10E-02	C	1.00E-02	I	1	6.83E-03	119.4	3.141593	-3.468528	3.40E-04	3.40E-07	3.53E-01	3.21E-01	2.87E-02	1.18E+00	4.90E-01	1	Yes	0.005156
Chloromethane	74-87-3	Organics	-		-		1	3.28E-03	50.49	3.141593	-3.082744	8.27E-04	8.27E-07	3.39E-01	3.09E-01	8.96E-03	4.84E-01	2.02E-01	1	Yes	-
Cumene	98-82-8	Organics	-		1.00E-01	I	1	8.97E-02	120.2	3.141593	-3.47312	3.36E-04	3.36E-07	6.20E-01	5.89E-01	3.78E-01	1.19E+00	4.95E-01	1	Yes	-
Cyclohexene	110-83-8	Organics	-		5.00E-03	P	1	4.31E-02	82.15	3.141593	-3.26004	5.50E-04	5.49E-07	4.40E-01	4.02E-01	1.50E-01	7.28E-01	3.03E-01	1	Yes	-
Dibromochloromethane	124-48-1	Organics	8.40E-02	I	2.00E-02	I	1	2.89E-03	208.3	3.141593	-3.966368	1.08E-04	1.08E-07	3.44E-01	3.13E-01	1.60E-02	3.70E+00	1.54E+00	1	Yes	0.001903
Dichlorobenzene, 1,4-	106-46-7	Organics	5.40E-03	C	7.00E-02	A	1	4.53E-02	147	3.141593	-3.6232	2.38E-04	2.38E-07	4.86E-01	4.48E-01	2.11E-01	1.68E+00	7.00E-01	1	Yes	0.029597
Dichloroethane, 1,1-	75-34-3	Organics	5.70E-03	C	2.00E-01	P	1	6.75E-03	98.96	3.141593	-3.354176	4.42E-04	4.42E-07	3.51E-01	3.19E-01	2.58E-02	9.04E-01	3.77E-01	1	Yes	0.028039
Dichloroethane, 1,2-	107-06-2	Organics	9.10E-02	I	6.00E-03	X	1	4.20E-03	98.96	3.141593	-3.354176	4.42E-04	4.42E-07	3.44E-01	3.13E-01	1.61E-02	9.04E-01	3.77E-01	1	Yes	0.001756
Dichloroethylene, 1,1-	75-35-4	Organics	-		5.00E-02	I	1	1.17E-02	96.94	3.141593	-3.342864	4.54E-04	4.54E-07	3.63E-01	3.31E-01	4.43E-02	8.81E-01	3.67E-01	1	Yes	-
Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	Organics	-		9.00E-03	H	1	1.10E-02	96.94	3.141593	-3.342864	4.54E-04	4.54E-07	3.62E-01	3.29E-01	4.17E-02	8.81E-01	3.67E-01	1	Yes	-
Dichloroethylene, 1,2-cis-	156-59-2	Organics	-		2.00E-03	I	1	1.10E-02	96.94	3.141593	-3.342864	4.54E-04	4.54E-07	3.62E-01	3.29E-01	4.17E-02	8.81E-01	3.67E-01	1	Yes	-
Dichloroethylene, 1,2-trans-	156-60-5	Organics	-		2.00E-02	I	1	1.10E-02	96.94	3.141593	-3.342864	4.54E-04	4.54E-07	3.62E-01	3.29E-01	4.17E-02	8.81E-01	3.67E-01	1	Yes	-
Ethyl Chloride	75-00-3	Organics	-		-		1	6.07E-03	64.52	3.141593	-3.161312	6.90E-04	6.90E-07	3.46E-01	3.15E-01	1.88E-02	5.80E-01	2.42E-01	1	Yes	-
Ethylbenzene	100-41-4	Organics	1.10E-02	C	1.00E-01	I	1	4.93E-02	106.2	3.141593	-3.394552	4.03E-04	4.03E-07	4.74E-01	4.35E-01	1.95E-01	9.92E-01	4.13E-01	1	Yes	0.01453
Hexanone, 2-	591-78-6	Organics	-		5.00E-03	I	1	3.55E-03	100.2	3.141593	-3.360896	4.36E-04	4.36E-07	3.43E-01	3.12E-01	1.37E-02	9.18E-01	3.83E-01	1	Yes	-
Methyl Acetate	79-20-9	Organics	-		1.00E+00	X	1	7.92E-04	74.08	3.141593	-3.214848	6.10E-04	6.10E-07	3.35E-01	3.05E-01	2.62E-03	6.56E-01	2.73E-01	1	Yes	-
Methyl Ethyl Ketone (2-Butanone)	78-93-3	Organics	-		6.00E-01	I	1	9.62E-04	72.11	3.141593	-3.203816	6.25E-04	6.25E-07	3.35E-01	3.05E-01	3.14E-03	6.40E-01	2.66E-01	1	Yes	-
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1	Organics	-		8.00E-02	H	1	3.19E-03	100.2	3.141593	-3.360896	4.36E-04	4.36E-07	3.42E-01	3.11E-01	1.23E-02	9.18E-01	3.83E-01	1	Yes	-
Methyl tert-Butyl Ether (MTBE)	1634-04-4	Organics	1.80E-03	C	-		1	2.11E-03	88.15	3.141593	-3.29364	5.09E-04	5.09E-07	3.38E-01	3.08E-01	7.62E-03	7.87E-01	3.28E-01	1	Yes	0.088791
Methylcyclohexane	108-87-2	Organics	-		-		1	1.10E-01	98.19	3.141593	-3.349864	4.47E-04	4.47E-07	6.54E-01	6.28E-01	4.19E-01	8.95E-01	3.73E-01	1	Yes	-
Methylene Chloride	75-09-2	Organics	2.00E-03	I	6.00E-03	I	1	3.54E-03	84.93	3.141593	-3.275608	5.30E-04	5.30E-07	3.42E-01	3.11E-01	1.25E-02	7.55E-01	3.14E-01	1	Yes	0.025708
Styrene	100-42-5	Organics	-		2.00E-01	I	1	3.72E-02	104.2	3.141593	-3.38324	4.14E-04	4.14E-07	4.37E-01	3.99E-01	1.46E-01	9.67E-01	4.03E-01	1	Yes	-
Tetrachloroethylene	127-18-4	Organics	2.10E-03	I	6.00E-03	I	1	3.34E-02	165.8	3.141593	-3.728648	1.87E-04	1.87E-07	4.51E-01	4.13E-01	1.65E-01	2.14E+00	8.92E-01	1	Yes	0.076107
Toluene	108-88-3	Organics	-		8.00E-02	I	1	3.11E-02	92.14	3.141593	-3.315984	4.83E-04	4.83E-07	4.14E-01	3.77E-01	1.15E-01	8.28E-01	3.45E-01	1	Yes	-
Trichlorobenzene, 1,2,4-	120-82-1	Organics	2.90E-02	P	1.00E-02	I	1	7.05E-02	181.5	3.141593	-3.81612	1.53E-04	1.53E-07	6.09E-01	5.77E-01	3.65E-01	2.62E+00	1.09E+00	1	Yes	0.005511
Trichloroethane, 1,1,2-	79-00-5	Organics	5.70E-02	I	4.00E-03	I	1	5.04E-03	133.4	3.141593	-3.547096	2.84E-04	2.84E-07	3.48E-01	3.17E-01	2.24E-02	1.41E+00	5.87E-01	1	Yes	0.002804
Trichloroethylene	79-01-6	Organics	4.60E-02	I	5.00E-04	I	1	1.16E-02	131.4	3.141593	-3.535784	2.91E-04	2.91E-07	3.68E-01	3.35E-01	5.11E-02	1.37E+00	5.72E-01	1	Yes	0.001118
Vinyl Chloride	75-01-4	Organics	7.20E-01	I	3.00E-03	I	1	8.38E-03	62.5	3.141593	-3.15	7.08E-04	7.08E-07	3.51E-01	3.19E-01	2.55E-02	5.65E-01	2.35E-01	1	Yes	7.20E-06
Xylenes	1330-20-7	Organics	-		2.00E-01	I	1	5.00E-02	106.2	3.141593	-3.394552	4.03E-04	4.03E-07	4.76E-01	4.38E-01	1.98E-01	9.92E-01	4.13E-01	1	Yes	-

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Site-specific
Recreator Risk-Based Screening Levels (RSL) for Surface Wate
ca=Cancer, nc=Noncancer, ca* (Where nc SL < 100 x ca SL),
ca** (Where nc SL < 10 x ca SL),
max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat

Chemical	CAS Number	DAeventnc	DAeventna	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (µg/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL (Child) HQ=1 (ug/L)	Dermal SL (Child) HQ=1 (µg/L)	Noncarcinogenic SL (Child) HQ=1 (ug/L)	Ingestion SL (Adult) HQ=1 (ug/L)	Dermal SL (Adult) HQ=1 (µg/L)	Noncarcinogenic SL (Adult) HQ=1 (ug/L)	Screening Level (ug/L)
Acetone	67-64-1	33.84272	77.580972	-	-	-	2.37E+06	1.49E+07	2.04E+06	1.11E+07	3.41E+07	8.35E+06	
Benzene	71-43-2	0.1504121	0.3448043	3.01E+02	4.42E+01	3.85E+01	1.05E+04	2.29E+03	1.88E+03	4.91E+04	5.24E+03	4.74E+03	3.85E+01 ca**
Bromodichloromethane	75-27-4	0.7520604	1.7240216	2.67E+02	1.13E+02	7.92E+01	5.26E+04	3.28E+04	2.02E+04	2.46E+05	7.53E+04	5.76E+04	7.92E+01 ca**
Carbon Disulfide	75-15-0	3.7603022	8.620108	-	-	-	2.63E+05	7.44E+04	5.80E+04	1.23E+06	1.70E+05	1.50E+05	
Chlorobenzene	108-90-7	0.7520604	1.7240216	-	-	-	5.26E+04	5.81E+03	5.24E+03	2.46E+05	1.33E+04	1.26E+04	
Chlorodibromoethane	73506-94-2	-	-	-	-	-	-	-	-	-	-	-	
Chloroform	67-66-3	0.3760302	0.8620108	5.33E+02	1.54E+02	1.20E+02	2.63E+04	1.12E+04	7.88E+03	1.23E+05	2.58E+04	2.13E+04	1.20E+02 ca**
Chloromethane	74-87-3	-	-	-	-	-	-	-	-	-	-	-	
Cumene	98-82-8	3.7603022	8.620108	-	-	-	2.63E+05	9.89E+03	9.53E+03	1.23E+06	2.27E+04	2.23E+04	
Cyclohexene	110-83-8	0.1880151	0.4310054	-	-	-	1.32E+04	1.05E+03	9.68E+02	6.14E+04	2.40E+03	2.31E+03	
Dibromochloromethane	124-48-1	0.7520604	1.7240216	1.97E+02	9.31E+01	6.32E+01	5.26E+04	3.68E+04	2.17E+04	2.46E+05	8.44E+04	6.28E+04	6.32E+01 ca**
Dichlorobenzene, 1,4-	106-46-7	2.6322115	6.0340756	3.06E+03	1.31E+02	1.26E+02	1.84E+05	1.16E+04	1.10E+04	8.60E+05	2.67E+04	2.59E+04	1.26E+02 ca**
Dichloroethane, 1,1-	75-34-3	7.5206044	17.240216	2.90E+03	8.89E+02	6.81E+02	5.26E+05	2.38E+05	1.64E+05	2.46E+06	5.47E+05	4.47E+05	6.81E+02 ca**
Dichloroethane, 1,2-	107-06-2	0.2256181	0.5172065	1.82E+02	8.89E+01	5.97E+01	1.58E+04	1.14E+04	6.63E+03	7.37E+04	2.62E+04	1.93E+04	5.97E+01 ca**
Dichloroethylene, 1,1-	75-35-4	1.8801511	4.310054	-	-	-	1.32E+05	3.50E+04	2.76E+04	6.14E+05	8.01E+04	7.09E+04	
Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	0.3384272	0.7758097	-	-	-	2.37E+04	6.68E+03	5.21E+03	1.11E+05	1.53E+04	1.35E+04	
Dichloroethylene, 1,2-cis-	156-59-2	0.075206	0.1724022	-	-	-	5.26E+03	1.48E+03	1.16E+03	2.46E+04	3.40E+03	2.99E+03	
Dichloroethylene, 1,2-trans-	156-60-5	0.7520604	1.7240216	-	-	-	5.26E+04	1.48E+04	1.16E+04	2.46E+05	3.40E+04	2.99E+04	
Ethyl Chloride	75-00-3	-	-	-	-	-	-	-	-	-	-	-	
Ethylbenzene	100-41-4	3.7603022	8.620108	1.50E+03	6.81E+01	6.51E+01	2.63E+05	1.76E+04	1.65E+04	1.23E+06	4.04E+04	3.91E+04	6.51E+01 ca**
Hexanone, 2-	591-78-6	0.1880151	0.4310054	-	-	-	1.32E+04	1.12E+04	6.06E+03	6.14E+04	2.57E+04	1.81E+04	
Methyl Acetate	79-20-9	37.603022	86.20108	-	-	-	2.63E+06	1.05E+07	2.10E+06	1.23E+07	2.40E+07	8.12E+06	
Methyl Ethyl Ketone (2-Butanone)	78-93-3	22.561813	51.720648	-	-	-	1.58E+06	5.19E+06	1.21E+06	7.37E+06	1.19E+07	4.55E+06	
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1	3.0082418	6.8960864	-	-	-	2.11E+05	2.00E+05	1.02E+05	9.83E+05	4.57E+05	3.12E+05	
Methyl tert-Butyl Ether (MTBE)	1634-04-4	-	-	9.19E+03	9.09E+03	4.57E+03	-	-	-	-	-		- 4.57E+03 ca**
Methylcyclohexane	108-87-2	-	-	-	-	-	-	-	-	-	-	-	
Methylene Chloride	75-09-2	0.2256181	0.5172065	2.22E+03	1.58E+03	9.25E+02	1.58E+04	1.39E+04	7.39E+03	7.37E+04	3.19E+04	2.22E+04	9.25E+02 ca**
Styrene	100-42-5	7.5206044	17.240216	-	-	-	5.26E+05	4.58E+04	4.22E+04	2.46E+06	1.05E+05	1.01E+05	
Tetrachloroethylene	127-18-4	0.2256181	0.5172065	7.87E+03	4.14E+02	3.93E+02	1.58E+04	1.23E+03	1.14E+03	7.37E+04	2.81E+03	2.71E+03	3.93E+02 ca**
Toluene	108-88-3	3.0082418	6.8960864	-	-	-	2.11E+05	2.22E+04	2.01E+04	9.83E+05	5.09E+04	4.84E+04	
Trichlorobenzene, 1,2,4-	120-82-1	0.3760302	0.8620108	5.70E+02	1.34E+01	1.31E+01	2.63E+04	9.11E+02	8.81E+02	1.23E+05	2.09E+03	2.05E+03	1.31E+01 ca**
Trichloroethane, 1,1,2-	79-00-5	0.1504121	0.3448043	2.90E+02	1.09E+02	7.91E+01	1.05E+04	5.84E+03	3.75E+03	4.91E+04	1.34E+04	1.05E+04	7.91E+01 ca**
Trichloroethylene	79-01-6	0.0188015	0.0431005	9.67E+01	1.92E+01	1.60E+01	1.32E+03	3.24E+02	2.60E+02	6.14E+03	7.42E+02	6.62E+02	1.60E+01 ca**
Vinyl Chloride	75-01-4	0.1128091	0.2586032	5.09E-01	1.96E-01	1.42E-01	7.90E+03	3.07E+03	2.21E+03	3.69E+04	7.04E+03	5.91E+03	1.42E-01 ca**
Xylenes	1330-20-7	7.5206044	17.240216	-	-	-	5.26E+05	3.48E+04	3.26E+04	2.46E+06	7.97E+04	7.72E+04	

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CALCULATION OF RISK-BASED PRELIMINARY CLEANUP LEVELS **Trichloroethene**

SITE NAME: FORMER NCBC DAVISVILLE, NORTH KINGSTOWN, RHODE ISLAND
EXPOSURE POINT: SITE 16
EXPOSURE SCENARIO: *ADULT RECREATIONAL USERS*
MEDIA: SURFACE WATER
DATE: FEBRUARY 6, 2013

THIS SPREADSHEET CALCULATES RISK-BASED CLEANUP GOALS FOR EXPOSURES TO SURFACE WATER
THE INCIDENTAL INGESTION AND DERMAL CONTACT ROUTES OF EXPOSURE ARE CONSIDERED.

RELEVANT EQUATIONS:

$$PRG_{child} = \frac{TCR}{[IntakeFac_{oral(0\text{-}2)} \times CSF_{oral} + IntakeFac_{derm(0\text{-}2)} \times DA_{event} \times CSF_{derm}] \times ADAF_{(0\text{-}2)} + [IntakeFac_{oral(2\text{-}6)} \times CSF_{oral} + IntakeFac_{derm(2\text{-}6)} \times DAevent \times CSF_{derm}] \times ADAF_{(2\text{-}6)}}$$

$$PRG_{adult} = \frac{TCR}{[IntakeFac_{oral(6\text{-}16)} \times CSF_{oral} + IntakeFac_{derm(6\text{-}16)} \times DAevent \times CSF_{derm}] \times ADAF_{(6\text{-}16)} + [IntakeFac_{oral(16\text{-}30)} \times CSF_{oral} + IntakeFac_{derm(16\text{-}30)} \times DAevent \times CSF_{derm}] \times ADAF_{(16\text{-}30)}}$$

$$PRG_{Lifetime} = \frac{TCR}{Intake_{child(0\text{-}2)} \times CSF \times ADAF_{(0\text{-}2)} + Intake_{child(2\text{-}6)} \times CSF \times ADAF_{(2\text{-}6)} + Intake_{adult(6\text{-}16)} \times CSF \times ADAF_{(6\text{-}16)} + Intake_{adult(16\text{-}30)} \times CSF \times ADAF_{(16\text{-}30)}}$$

$$IntakeFac_{oral} = \frac{CR \times ET \times EF \times ED}{BW \times AT}$$

$$IntakeFac_{derm} = \frac{DA_{Event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

WHERE:

Parameter	Child Ages 0 - 2	Child Ages 2 - 6	Adult Ages 6 - 16	Adult Ages 16 - 30	Definition
TCR = :	1E-06				Target Cancer Risk
CR = :	0	0	0.01	0.01	Contact Rate (L/hour)
CF = :	1.0E-03	1.0E-03	1.0E-03	1.0E-03	Conversion Factor (L/m3)
ET = :	4	4	4	4	Exposure time (hours/day)
SA = :	0	0	5700	5700	Skin surface available for contact (cm^2)
DA_{event} = :	Chemical Specific				Chemical specific absorbed dose per event (mg/cm2-event)
EV = :	1	1	1	1	Event frequency (events/day)
EF = :	52	52	52	52	Exposure Frequency (days/year)
ED = :	2	4	10	14	Exposure Duration (years)
BW = :	15	15	70	70	Body Weight (kg)
ATc = :	25,550	25,550	25,550	25,550	Averaging time for carcinogenic exposures (days)
$IntakeFac_{oral}$ = :	0.00E+00	0.00E+00	1.16E-05	1.63E-05	Intake factor - Ingestion (kg/kg-day)
$IntakeFac_{derm}$ = :	0.00E+00	0.00E+00	1.66E+00	2.32E+00	Intake factor - Dermal (kg/kg-day)

CHEMICAL	Organic or Inorganic	Estimated Kp (cm/hr)	FA	tau-event (hr)	B	t* (hr)	DA_{event} - Child (L/cm^2 - event)	DA_{event} - Adult (L/cm^2 - event)
Trichloroethene (Mutagenic)	Organic	1.16E-02	1	5.72E-01	5.11E-02	1.37E+00	5.83E-05	5.83E-05
Trichloroethene (Nonmutagenic)	Organic	1.16E-02	1	5.72E-01	5.11E-02	1.37E+00	5.83E-05	5.83E-05

CHEMICAL	Cancer Slope Factor		Age Dependent Adjustment Factor			
	Oral $(mg/kg/day)^{-1}$	Dermal $(mg/kg/day)^{-1}$	Ages 0 - 2	Ages 2 - 6	Ages 6 - 16	Ages >16
Trichloroethene (Mutagenic)	9.3E-03	9.3E-03	10	3	3	1
Trichloroethene (Nonmutagenic)	3.7E-02	3.7E-02	1	1	1	1

CHEMICAL	Surface Water Concentration (ug/L)		
	Child	Adult	Lifelong
Trichloroethene (Mutagenic)	NA	2.3E+02	2.3E+02
Trichloroethene (Nonmutagenic)	NA	1.0E+02	1.0E+02
Trichloroethene	NA	7.2E+01	7.2E+01

CALCULATION OF RISK-BASED PRELIMINARY CLEANUP LEVELS **Trichloroethene**

SITE NAME: FORMER NCBC DAVISVILLE, NORTH KINGSTOWN, RHODE ISLAND
EXPOSURE POINT: SITE 16
EXPOSURE SCENARIO: *LIFELONG (CHILD AGES 2-6 AND ADULT) RECREATIONAL USERS*
MEDIA: SURFACE WATER
DATE: FEBRUARY 6, 2013

THIS SPREADSHEET CALCULATES RISK-BASED CLEANUP GOALS FOR EXPOSURES TO SURFACE WATER
THE INCIDENTAL INGESTION AND DERMAL CONTACT ROUTES OF EXPOSURE ARE CONSIDERED.

RELEVANT EQUATIONS:

$$PRG_{child} = \frac{TCR}{[IntakeFac_{oral(0\text{-}2)} \times CSF_{oral} + IntakeFac_{derm(0\text{-}2)} \times DA_{event} \times CSF_{derm}] \times ADAF_{(0\text{-}2)} + [IntakeFac_{oral(2\text{-}6)} \times CSF_{oral} + IntakeFac_{derm(2\text{-}6)} \times DAevent \times CSF_{derm}] \times ADAF_{(2\text{-}6)}}$$

$$PRG_{adult} = \frac{TCR}{[IntakeFac_{oral(6\text{-}16)} \times CSF_{oral} + IntakeFac_{derm(6\text{-}16)} \times DAevent \times CSF_{derm}] \times ADAF_{(6\text{-}16)} + [IntakeFac_{oral(16\text{-}30)} \times CSF_{oral} + IntakeFac_{derm(16\text{-}30)} \times DAevent \times CSF_{derm}] \times ADAF_{(16\text{-}30)}}$$

$$PRG_{Lifetime} = \frac{TCR}{Intake_{child(0\text{-}2)} \times CSF \times ADAF_{(0\text{-}2)} + Intake_{child(2\text{-}6)} \times CSF \times ADAF_{(2\text{-}6)} + Intake_{adult(6\text{-}16)} \times CSF \times ADAF_{(6\text{-}16)} + Intake_{adult(16\text{-}30)} \times CSF \times ADAF_{(16\text{-}30)}}$$

$$IntakeFac_{oral} = \frac{CR \times ET \times EF \times ED}{BW \times AT}$$

$$IntakeFac_{derm} = \frac{DA_{Event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

WHERE:

Parameter	Child Ages 0 - 2	Child Ages 2 - 6	Adult Ages 6 - 16	Adult Ages 16 - 30	Definition
TCR = :	1E-06				Target Cancer Risk
CR = :	0	0.01	0.01	0.01	Contact Rate (L/hour)
CF = :	1.0E-03	1.0E-03	1.0E-03	1.0E-03	Conversion Factor (L/m3)
ET = :	4	4	4	4	Exposure time (hours/day)
SA = :	0	2800	5700	5700	Skin surface available for contact (cm^2)
DA_{event} = :	Chemical Specific				Chemical specific absorbed dose per event (mg/cm2-event)
EV = :	1	1	1	1	Event frequency (events/day)
EF = :	52	52	52	52	Exposure Frequency (days/year)
ED = :	2	4	10	14	Exposure Duration (years)
BW = :	15	15	70	70	Body Weight (kg)
ATc = :	25,550	25,550	25,550	25,550	Averaging time for carcinogenic exposures (days)
$IntakeFac_{oral}$ = :	0.00E+00	2.17E-05	1.16E-05	1.63E-05	Intake factor - Ingestion (kg/kg-day)
$IntakeFac_{derm}$ = :	0.00E+00	1.52E+00	1.66E+00	2.32E+00	Intake factor - Dermal (kg/kg-day)

CHEMICAL	Organic or Inorganic	Estimated Kp (cm/hr)	FA	tau-event (hr)	B	t* (hr)	DA_{event} - Child (L/cm^2 - event)	DA_{event} - Adult (L/cm^2 - event)
Trichloroethene (Mutagenic)	Organic	1.16E-02	1	5.72E-01	5.11E-02	1.37E+00	5.83E-05	5.83E-05
Trichloroethene (Nonmutagenic)	Organic	1.16E-02	1	5.72E-01	5.11E-02	1.37E+00	5.83E-05	5.83E-05

CHEMICAL	Cancer Slope Factor		Age Dependent Adjustment Factor			
	Oral $(mg/kg/day)^{-1}$	Dermal $(mg/kg/day)^{-1}$	Ages 0 - 2	Ages 2 - 6	Ages 6 - 16	Ages >16
Trichloroethene (Mutagenic)	9.3E-03	9.3E-03	10	3	3	1
Trichloroethene (Nonmutagenic)	3.7E-02	3.7E-02	1	1	1	1

CHEMICAL	Surface Water Concentration (ug/L)		
	Child	Adult	Lifelong
Trichloroethene (Mutagenic)	3.3E+02	2.3E+02	1.3E+02
Trichloroethene (Nonmutagenic)	2.5E+02	1.0E+02	7.4E+01

Trichloroethene	1.4E+02	7.2E+01	4.7E+01

CALCULATION OF RISK-BASED PRELIMINARY CLEANUP LEVELS **Trichloroethene**

SITE NAME: FORMER NCBC DAVISVILLE, NORTH KINGSTOWN, RHODE ISLAND
EXPOSURE POINT: SITE 16
EXPOSURE SCENARIO: *LIFELONG (CHILD AND ADULT) RECREATIONAL USERS*
MEDIA: SURFACE WATER
DATE: FEBRUARY 6, 2013

THIS SPREADSHEET CALCULATES RISK-BASED CLEANUP GOALS FOR EXPOSURES TO SURFACE WATER
THE INCIDENTAL INGESTION AND DERMAL CONTACT ROUTES OF EXPOSURE ARE CONSIDERED.

RELEVANT EQUATIONS:

$$PRG_{child} = \frac{TCR}{[IntakeFac_{oral(0\text{-}2)} \times CSF_{oral} + IntakeFac_{derm(0\text{-}2)} \times DA_{event} \times CSF_{derm}] \times ADAF_{(0\text{-}2)} + [IntakeFac_{oral(2\text{-}6)} \times CSF_{oral} + IntakeFac_{derm(2\text{-}6)} \times DAevent \times CSF_{derm}] \times ADAF_{(2\text{-}6)}}$$

$$PRG_{adult} = \frac{TCR}{[IntakeFac_{oral(6\text{-}16)} \times CSF_{oral} + IntakeFac_{derm(6\text{-}16)} \times DAevent \times CSF_{derm}] \times ADAF_{(6\text{-}16)} + [IntakeFac_{oral(16\text{-}30)} \times CSF_{oral} + IntakeFac_{derm(16\text{-}30)} \times DAevent \times CSF_{derm}] \times ADAF_{(16\text{-}30)}}$$

$$PRG_{Lifetime} = \frac{TCR}{Intake_{child(0\text{-}2)} \times CSF \times ADAF_{(0\text{-}2)} + Intake_{child(2\text{-}6)} \times CSF \times ADAF_{(2\text{-}6)} + Intake_{adult(6\text{-}16)} \times CSF \times ADAF_{(6\text{-}16)} + Intake_{adult(16\text{-}30)} \times CSF \times ADAF_{(16\text{-}30)}}$$

$$IntakeFac_{oral} = \frac{CR \times ET \times EF \times ED}{BW \times AT}$$

$$IntakeFac_{derm} = \frac{DA_{Event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

WHERE:

Parameter	Child Ages 0 - 2	Child Ages 2 - 6	Adult Ages 6 - 16	Adult Ages 16 - 30	Definition
TCR = :	1E-06				Target Cancer Risk
CR = :	0.01	0.01	0.01	0.01	Contact Rate (L/hour)
CF = :	1.0E-03	1.0E-03	1.0E-03	1.0E-03	Conversion Factor (L/m3)
ET = :	4	4	4	4	Exposure time (hours/day)
SA = :	2800	2800	5700	5700	Skin surface available for contact (cm^2)
DA_{event} = :	Chemical Specific				Chemical specific absorbed dose per event (mg/cm2-event)
EV = :	1	1	1	1	Event frequency (events/day)
EF = :	52	52	52	52	Exposure Frequency (days/year)
ED = :	2	4	10	14	Exposure Duration (years)
BW = :	15	15	70	70	Body Weight (kg)
ATc = :	25,550	25,550	25,550	25,550	Averaging time for carcinogenic exposures (days)
$IntakeFac_{oral}$ = :	1.09E-05	2.17E-05	1.16E-05	1.63E-05	Intake factor - Ingestion (kg/kg-day)
$IntakeFac_{derm}$ = :	7.60E-01	1.52E+00	1.66E+00	2.32E+00	Intake factor - Dermal (kg/kg-day)

CHEMICAL	Organic or Inorganic	Estimated Kp (cm/hr)	FA	tau-event (hr)	B	t* (hr)	DA_{event} - Child (L/cm^2 - event)	DA_{event} - Adult (L/cm^2 - event)
Trichloroethene (Mutagenic)	Organic	1.16E-02	1	5.72E-01	5.11E-02	1.37E+00	5.83E-05	5.83E-05
Trichloroethene (Nonmutagenic)	Organic	1.16E-02	1	5.72E-01	5.11E-02	1.37E+00	5.83E-05	5.83E-05

CHEMICAL	Cancer Slope Factor		Age Dependent Adjustment Factor			
	Oral $(mg/kg/day)^{-1}$	Dermal $(mg/kg/day)^{-1}$	Ages 0 - 2	Ages 2 - 6	Ages 6 - 16	Ages >16
Trichloroethene (Mutagenic)	9.3E-03	9.3E-03	10	3	3	1
Trichloroethene (Nonmutagenic)	3.7E-02	3.7E-02	1	1	1	1

CHEMICAL	Surface Water Concentration (ug/L)		
	Child	Adult	Lifelong
Trichloroethene (Mutagenic)	1.2E+02	2.3E+02	7.9E+01
Trichloroethene (Nonmutagenic)	1.6E+02	1.0E+02	6.4E+01

Trichloroethene	7.0E+01	7.2E+01	3.5E+01

RISK ASSESSMENT SPREADSHEET - CLEANUP LEVELS **Vinyl Chloride**

SITE NAME: FORMER NCBC DAVISVILLE, NORTH KINGSTOWN, RHODE ISLAND
LOCATION: SITE 16
EXPOSURE SCENARIO: *ADULT RECREATIONAL USERS*
MEDIA: SURFACE WATER
DATE: FEBRUARY 6, 2013

THIS SPREADSHEET CALCULATES CLEANUP LEVELS FOR EXPOSURES TO SURFACE WATER
VIA INCIDENTAL INGESTION AND DERMAL CONTACT

RELEVANT EQUATIONS:

$$PRG_{GW} = \frac{TCR}{Intake_{ing} \cdot CSF_{oral} + Intake_{derm} \cdot CSF_{derm}}$$

$$PRG_{GW} = \frac{THI}{\left(\frac{Intake_{ing}}{RfD_{oral}}\right) + \left(\frac{Intake_{derm}}{RfD_{derm}}\right)}$$

$$Intake_{ing} = \frac{CR \times ET \times EF \times ED}{BW \times AT}$$

$$Intake_{derm} = \frac{DA_{Event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

For Inorganics DAevent = Kp x CF x tevent

For Organics

$$\text{If } tevent \le t^*, \text{ then : } DAevent = 2 \times Kp \times FA \times CF \times \sqrt{\frac{6 \times tau \times tevent}{\pi}}$$

$$\text{If } tevent > t^*, \text{ then : } DAevent = Kp \times FA \times CF \times \left[\frac{tevent}{1+B} + 2 \times tau \times \left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]$$

Where:	TCR = :	1.0E-06	Target Cancer Risk
	THI = :	1	Target Hazard Index
	CR = :	0.01	Contact Rate (L/hour)
	ET = :	4	Exposure time (hours/day)
	SA = :	5,700	Skin surface available for contact (cm^2)
	DAevent = :		Chemical specific absorbed dose per event (mg/cm^2-event)
	EV = :	1	Event frequency (events/days)
	EF = :	52	Exposure frequency (days/year)
	ED = :	30	Exposure duration (years)
	BW = :	70	Body weight (kg)
	ATc = :	25,550	Averaging time for carcinogenic exposures (days)
	ATn = :	10,950	Averaging time for noncarcinogenic exposures (days)
	CF = :	0.001	Conversion Factor (L/m^3)
	Kp =:		Chemical specific permeability coefficient (cm/hr)
	Cw = :		Concentration of chemical in water (mg/L)
	tevent = :	4	duration of event (hr/event)
	tau = :		Chemical specific lag time (hr)
	t* = :		Chemical specific time it takes to reach steady state (hr)
	B = :		Chemical specific dimensionless constant
	FA = :		Fraction absorbed (dimensionless)

RISK ASSESSMENT SPREADSHEET - DIRECT DERMAL CONTACT WITH GROUNDWATER (PAGE TWO)

SITE NAME: FORMER NCBC DAVISVILLE, NORTH KINGSTOWN, RHODE ISLAND
LOCATION: SITE 16
EXPOSURE SCENARIO: ADULT RECREATIONAL USERS
MEDIA: SURFACE WATER
DATE: FEBRUARY 6, 2013

CHEMICAL	Organic or Inorganic	Estimated Kp (cm/hr)	FA	tau-event (hr)	B	t* (hr)	DAevent (L/cm^2 - event)
Vinyl Chloride	Organic	8.38E-03	1	2.35E-01	2.55E-02	5.65E-01	3.67E-05

CHEMICAL	Cancer Slope Factor		Reference Dose	
	Oral $(mg/kg/day)^{-1}$	Dermal $(mg/kg/day)^{-1}$	Oral (mg/kg/day)	Dermal (mg/kg/day)
Vinyl Chloride	7.20E-01	7.20E-01	3.00E-03	3.00E-03

CHEMICAL	Carcinogenic Intakes		Noncarcinogenic Intakes	
	Ingestion (L/kg/day)	Dermal (L/kg/day)	Ingestion (L/kg/day)	Dermal (L/kg/day)
Vinyl Chloride	3.49E-05	1.83E-04	8.14E-05	4.26E-04

CHEMICAL	Groundwater Concentration		Risk-Based(1)
	Carcinogenic (ug/L)	Noncarcinogenic (ug/L)	Cleanup Level (ug/L)
Vinyl Chloride	6.4	5912	6.4

Site-specific
Recreator Equation Inputs for Surface Water

Variable	Value
TR (target cancer risk) unitless	0.000001
THQ (target hazard quotient) unitless	1
EF_{recwc} (child exposure frequency) day/year	52
EF_{recwa} (adult exposure frequency) day/year	52
EF_{0-2} (mutagenic exposure frequency) day/year	0
EF_{2-6} (mutagenic exposure frequency) day/year	52
EF_{6-16} (mutagenic exposure frequency) day/year	52
EF_{16-30} (mutagenic exposure frequency) day/year	52
ED_{recwc} (exposure duration - child) year	4
ED_{recwa} (exposure duration - adult) year	24
ED_{0-2} (mutagenic exposure duration) year	0
ED_{2-6} (mutagenic exposure duration) year	4
ED_{6-16} (mutagenic exposure duration) year	10
ED_{16-30} (mutagenic exposure duration) year	14
LT (lifetime - recreator) year	70
EV_{recwa} (adult) events/day	1
EV_{recwc} (child) events/day	1
EV_{0-2} (mutagenic) events/day	1
EV_{2-6} (mutagenic) events/day	1
EV_{6-16} (mutagenic) events/day	1
EV_{16-30} (mutagenic) events/day	1
ET_{recwa} (adult exposure time) hour/event	4
ET_{recwc} (child exposure time) hour/event	4
$ET_{recw0-2}$ (mutagenic exposure time) hour/event	4
$ET_{recw2-6}$ (mutagenic exposure time) hour/event	4
$ET_{recw6-16}$ (mutagenic exposure time) hour/event	4
$ET_{recw16-30}$ (mutagenic exposure time) hour/event	4
$ET_{recw-adj}$ (age-adjusted exposure time) hour/event	4
$ET_{recw-madj}$ (mutagenic age-adjusted exposure time) hour/event	4
BW_{recwa} (body weight - adult) kg	70
BW_{recwc} (body weight - child) kg	15
BW_{0-2} (mutagenic body weight) kg	15
BW_{2-6} (mutagenic body weight) kg	15
BW_{6-16} (mutagenic body weight) kg	70
BW_{16-30} (mutagenic body weight) kg	70
IRW_{recwa} (water intake rate - adult) L/hr	0.01
IRW_{recwc} (water intake rate - child) L/hr	0.01
IRW_{0-2} (mutagenic water intake rate) L/hr	0
IRW_{2-6} (mutagenic water intake rate) L/hr	0.01
IRW_{6-16} (mutagenic water intake rate) L/hr	0.01
IRW_{16-30} (mutagenic water intake rate) L/hr	0.01
SA_{recwa} (skin surface area - adult) cm^2	5700
SA_{recwc} (skin surface area - child) cm^2	2800
SA_{0-2} (mutagenic skin surface area) cm^2	2800
SA_{2-6} (mutagenic skin surface area) cm^2	2800
SA_{6-16} (mutagenic skin surface area) cm^2	5700
SA_{16-30} (mutagenic skin surface area) cm^2	5700
l_{sc} (apparent thickness of stratum corneum) cm	0.001
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	1.268
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	2.971
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	140449.524
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	302788.571

Output generated 06FEB2013:09:15:19

Site-specific
Recreator Risk-Based Screening Levels (RSL) for Surface Water
ca=Cancer, nc=Noncancer, ca* (Where nc SL < 100 x ca SL),
ca** (Where nc SL < 10 x ca SL),
max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat

Chemical	CAS Number	Chemical Type	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Chronic RfD (mg/kg-day)	RfD Ref	RAGSe GIABS (unitless)	KP	MW	pi	logds	dsclc	dsc	c	littleb	B	tstar	tau_event	FA	In EPD?	DAeventc	DAeventnc	DAeventna
Vinyl Chloride	75-01-4	Organics	7.20E-01	I	3.00E-03	I	1	0.00838	62.5	3.1415927	-3.15	0.0007079	7.0795E-7	0.3505315	0.3189446	0.0254807	0.565015	0.2354229	1	Yes	7.2276E-6	0.1128091	0.2586032

Output generated 06FEB2013:09:15:19

Site-specific
Recreator Risk-Based Screening Levels (RSL) for Surface Water
ca=Cancer, nc=Noncancer, ca* (Where nc SL < 100 x ca SL),
ca** (Where nc SL < 10 x ca SL),
max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat

Chemical	CAS Number	Ingestion SL TR=1.0E-6 (ug/L)	Dermal SL TR=1.0E-6 (µg/L)	Carcinogenic SL TR=1.0E-6 (ug/L)	Ingestion SL (Child) HQ=1 (ug/L)	Dermal SL (Child) HQ=1 (µg/L)	Noncarcinogenic SL (Child) HQ=1 (ug/L)	Ingestion SL (Adult) HQ=1 (ug/L)	Dermal SL (Adult) HQ=1 (µg/L)	Noncarcinogenic SL (Adult) HQ=1 (ug/L)	Screening Level (ug/L)
Vinyl Chloride	75-01-4	5.11E-01	1.97E-01	1.42E-01	7.90E+03	3.07E+03	2.21E+03	3.69E+04	7.04E+03	5.91E+03	1.42E-01 ca**

Output generated 06FEB2013:09:15:19

SUPPORT DOCUMENTATION FOR ECOLOGICAL SCREENING LEVELS

May 2010

RECOMMENDED MARINE SURFACE WATER ECOLOGICAL SCREENING VALUES (ESVs) FORMER NCBC DAVISVILLE SITES 07, 09, AND 16

Prepared for:
Naval Facilities Engineering Command
Mid-Atlantic Division

Tetra Tech NUS

Recommended Marine Surface Water Ecological Screening Values (ESVs)
NCBC Davisville

The purpose of this memorandum is to present the results of a literature search that was performed to determine/evaluate if USEPA Region 3 BTAG marine salt water ESVs (2006) are appropriate screening criteria, or if recent research has resulted in more appropriate screening criteria. The goal is to reach agreement on an appropriate set of marine water screening criteria for use at NCBC Davisville.

Based on the results of the literature review and a comparison of the basis/derivation of each ESV, the Navy recommends use of USEPA Region 3 BTAG ESVs. The following narrative provides the rationale for this recommendation.

In 2006, USEPA Region 3 BTAG updated their marine (salt water) ESVs (USEPA, 2006) that were derived/compiled from numerous sources (Table 1). The Region 3 ESVs are also known as marine screening benchmarks. These are designed to be protective of sensitive species, and in choosing values for use as marine ESVs, preference was given to toxicity data based on chronic exposure, non-lethal endpoint studies (USEPA, 2006). Of the nine Region 3 ESVs in Table 1, four were USEPA Region 4 ESVs (USEPA, 2001), three were from the State of Texas (TNRCC, 2001), one was Canadian (CCME, 2003) and one was from the state of Michigan (2002).

Nine VOCs have been detected in groundwater in close proximity to marine surface water at NCBC Davisville Sites 7, 9, and 16 (Table 1). Other VOCs have been detected in groundwater at these sites, but the nine VOCs in Table 1 represent the primary VOCs in groundwater at these sites.

Table 1 shows potential (alternate) ESVs for these nine VOCs and notes regarding the literature source from which the alternate ESVs were obtained. Several alternate ESVs in Table 1 are marine chronic surface water ESVs derived by Buchman (2008) for the National Oceanic and Atmospheric Administration (NOAA). The NOAA values are intended to be used as preliminary screening values for environmental concentrations of contaminants and were taken from numerous federal and state, and international regulatory agencies (Buchman, 2008). Table 1 also summarizes a search of USEPA's ECOTOX (formerly known as AQUIRE) database. ECOTOX is a source for locating single chemical toxicity data for aquatic life, terrestrial plants, and wildlife; the ECOTOX database includes more than 400,000 test records covering 5,900 aquatic and terrestrial species and 8,400 chemicals, and is available at http:/www.epa.gov/ecotox. The objective of summarizing the ECOTOX data in Table 1 was to compare the Region 3 ESVs to the ECOTOX data. The ECOTOX data are summarized in Attachment A. ECOTOX did not have saltwater toxicity data for vinyl chloride or 1,2-DCE.

Ideally, an ESV is based on chronic exposure, non-lethal endpoint studies in which a toxicity threshold (such as a no-observed-effect concentration [NOEC] or a lowest-observed-effect concentration [LOEC]) was derived. Often, however, NOEC and LOEC data are not generated or are absent, chronic data are lacking, and lethality rather than non-lethal endpoints are the test-endpoints. In such cases, USEPA regions and state agencies apply various safety factors to derive an ESV. For example, some toxicity tests are designed to determine the concentration that is lethal to 50 percent of the test organisms; this value is known as the LC_{50}, and a safety factor of 100 is often used to estimate a chronic toxicity threshold from an LC_{50} value. Table 1 explains where safety factors were used by various agencies to derive ESVs for the chemicals in the table.

The EPA Region 3 ESVs for the nine VOCs in Table 1 tended to be at the low end of the range of LC_{50} and E_{50} values, when such values are divided by 100, as is typically done when using LC_{50} values and EC_{50} values to derive ESVs. The Region 3 ESVs in Table 1 are reasonably conservative and are within the range of values presented in the literature search. For this reason, the Navy proposes that the Region 3 ESVs are appropriate for use as screening values at NCBC Davisville.

Table 1. Marine Water Ecological Screening Values, Sources, and Derivation

Chemical	USEPA Region 3 BTAG Screening Benchmark[a]		Other Ecological Screening Benchmark		Source & Notes
	Value (µg/L)	Reference[b]	Value (µg/L)	Reference	
Benzene CAS # 71432	110	CCME, 2003	-	-	1100 µg/L benzene reduced the survival of larval Dungeness crabs *(Cancer magister)* in 40 day exposures (Caldwell et al., 1976). CCME (2003) divided the 40-day marine LOEL (1100 µg/L) by a safety factor of 10 to derive the 110 µg/L guideline.
	-	-	700	USEPA, 1980a)	The Water Quality Criteria document for benzene (USEPA, 1980a) reported that female Pacific herring (*Clupea harengus pallasi*) exposed to 700 µg/L benzene for 48 hours prior to spawning resulted in reduced survival of embryos and larvae upon continued exposure to 700 µg/L. The USEPA (1980a) document pointed out, however, that the adult herring were captured in San Francisco Bay, so accumulated contaminants from the bay might have impacted the toxicity test results. Acute LC_{50} and EC_{50} values in a variety of saltwater species (shrimp, copepods, oysters, crabs, and fish) ranged from 5,100 µg/L to 924,000 µg/L (USEPA, 1980a).
					From ECOTOX database[c]: Range of EC_{50} and LC_{50} values divided by 100 = 10 µg/L to 9,244 µg/L
1,1-Dichloroethene (1,1-Dichloroethylene) CAS # 75354	2240	EPA Region 4[d]	-	-	The EPA Region 4 value was obtained from the Water Quality Criteria document for dichloroethylenes (USEPA, 1980b); the value is based on the lowest 96-hour LC_{50} value for three saltwater species tested under static conditions: 224,000 µg/L for the mysid shrimp (*Mysidopsis bahia*), 249,000 µg/L for the sheepshead minnow (*Cyprinodon variegatus*), and 250,000 µg/L for the tidewater silversides (*Menidia beryllina*). No flow-through data were available to USEPA (1980b) and the only chronic data reported by USEPA (1980b) was an embryo-larval test using the fathead minnow (*Pimephales promelas*) in which no adverse effects were observed at the highest concentration tested (2,800 µg/L). EPA Region 4 divided the lowest acute value (224,000 µg/L) by a safety factor of 10 to derive a chronic value from the reported acute value, and divided by 10 a second time "to protect for a more sensitive species" because there was insufficient information available to derive a criterion.
					From ECOTOX database[c]: Range of LC_{50} values divided by 100 = 2500 µg/L Single available NOEC value = 80,000 µg/L

Table 1. Marine Water Ecological Screening Values, Sources, and Derivation (Continued)					
Chemical	**USEPA Region 3 BTAG Screening Benchmark[a]**		**Other Ecological Screening Benchmark**		**Source & Notes**
	Value (µg/L)	**Reference[b]**	**Value (µg/L)**	**Reference**	
1,2-Dichloroethene (mixed *cis* & *trans*) isomers CAS # 540590	680	TNRCC, 2001	-	-	The TNRCC website cited by Region 3 BTAG is no longer current, and the agency formerly known as Texas Natural Resource Conservation Commission (TNRCC) is now known as the Texas Council on Environmental Quality (TCEQ). According to TCEQ's Water Quality Standards Group, the value is derived from a toxicity test using brine shrimp (*Artemia salina*) in which the 24-hour LC_{50} was 6800 µg/L; TCEQ multiplied the LC_{50} by 0.1 in accordance with their policy for deriving chronic criteria for non-persistent chemicals.
Cis-1,2-Dichloroethene	-	-	-	-	No toxicity data were located for this isomer of 1,2-dichloroethene.
Trans-1,2-Dichloroethene	-	-	-	-	No toxicity data were located for this isomer of 1,2-dichloroethene.
1,2-Dichloroethane CAS # 107062	1130	EPA Region 4[d]	-	-	The EPA Region 4 value was obtained from the Water Quality Criteria document for chlorinated ethanes (USEPA, 1980c), which stated that the 96-hour LC_{50} value for 1,2-Dichloroethane in a static test using mysid shrimp (a saltwater species) was 113,000 µg/L. No data for other saltwater species were available for this chemical in the document, and no flow-through test data were available (USEPA, 1980c). EPA Region 4 divided the LC_{50} value by a safety factor of 10 to derive a chronic value from the reported acute value, and by 10 a second time "to protect for a more sensitive species" because there was insufficient information available to derive a criterion.
			11,300	Buchman, 2008	The National Oceanic and Atmospheric Administration (NOAA) chronic screening value (11,300 µg/L) for this chemical in marine surface water (Buchman, 2008) was derived using the same data as EPA Region 4 (see above), but NOAA applied a safety factor of 10 (for acute-to-chronic derivation) without the additional safety factor of 10.
					From ECOTOX database[c]: Range of LC_{50} and EC_{50} values divided by 100 = 364 µg/L to 9,000 µg/L Single available NOEC value =130,000 µg/L

Table 1. Marine Water Ecological Screening Values, Sources, and Derivation (Continued)					
Chemical	**USEPA Region 3 BTAG Screening Benchmark[a]**		**Other Ecological Screening Benchmark**		**Source & Notes**
	Value (µg/L)	**Reference[b]**	**Value (µg/L)**	**Reference**	
Tetrachloroethane (1,1,2,2-Tetrachloroethane) CAS # 79345	90.2	EPA Region 4[d]	-	-	The EPA Region 4 value was obtained from the Water Quality Criteria document for chlorinated ethanes (USEPA, 1980c), which reported tetrachloroethane 96-hour static test LC_{50} values for two saltwater species: 9,020 µg/L for mysid shrimp and 12,300 µg/L for sheepshead minnows. No flow-through test data were available (USEPA, 1980c). EPA Region 4 divided the lowest LC_{50} value (9,020 µg/L by a safety factor of 10 to derive a chronic value from the reported acute value, and by 10 a second time "to protect for a more sensitive species" because there was insufficient information available to derive a criterion.
	-	-	902	Buchman, 2008	The NOAA chronic screening value (902 µg/L) for this chemical in marine surface water (Buchman, 2008) was derived using the same data as EPA Region 4 (see above), but NOAA applied a safety factor of 10 (for acute-to-chronic derivation) without the additional safety factor of 10.
					From ECOTOX database[c]: Range of LC_{50} values divided by 100 = 120 µg/L to 190 µg/L Single available NOEC value = 8,800 µg/L
1,1,2-Trichloroethane CAS # 79005	550	TNRCC, 2001	275	TCEQ, 2006-	See notes for 1,2-dichloroethene mixed isomers (above) regarding TNRCC citation and current agency name. The current TCEQ ecological benchmark for this compound in marine surface water is 275 µg/L (TCEQ, 2006). According to TCEQ's Water Quality Standards Group, the value is derived from a toxicity test using plaice (*Pleuronectes platessa*) in which the LC_{50} was 5,500 µg/L. TCEQ multiplied the LC_{50} by 0.05 in accordance with their policy for deriving chronic criteria for persistent chemicals that do not bioaccumulate. TCEQ defines a persistent chemical as one with a half life of $\geq$ 4 days in water or sediment. The previous TNRCC/TCEQ benchmark of 550 µg/L was derived from the same LC_{50} value but was multiplied by 0.1 rather than 0.05.
	-	-	1,900	Buchman, 2008	The NOAA chronic screening value (1,900 µg/L) for this chemical in marine surface water (Buchman, 2008) is the ANZECC (2000) "trigger value" for marine water. ANZECC (2000) did not provide data regarding specific toxicity test conditions and species used to derive the value for this chemical, but stated that it was a "moderate reliability" value that was derived from acute toxicity data by applying acute-to-chronic conversion factors, and is intended to protect 95% of aquatic species.
					From ECOTOX database[c]: Range of LC50 values divided by 100 = 1,600 µg/L to 5,000 µg/L

Table 1. Marine Water Ecological Screening Values, Sources, and Derivation (Continued)					
Chemical	USEPA Region 3 BTAG Screening Benchmark[a]		Other Ecological Screening Benchmark		Source & Notes
	Value (µg/L)	Reference[b]	Value (µg/L)	Reference	
Tetrachloroethene (Tetrachloroethylene, 1,1,2,2-Tetrachloroethene, Perchloroethylene) CAS # 127184	45	EPA Region 4[d]	-	-	The EPA Region 4 value was obtained from the Water Quality Criteria document for tetrachloroethylene (USEPA, 1980d), which stated that the chronic LOEL for mysid shrimp (a saltwater species) was 450 µg/L. The length of the study was not provided by USEPA (1980d), but the document stated that it was a "life cycle or partial life cycle" test. The USEPA (1980d) document did not state whether the study was static or flow-through. EPA Region 4 divided the 450 µg/L value by a safety factor of 10 "to protect for a more sensitive species" because there was insufficient information available to derive a criterion.
	-	-	450	Buchman, 2008	The NOAA chronic screening value (450 µg/L) for this chemical in marine surface water (Buchman, 2008) was derived using the same data as EPA Region 4 (see above), but without the safety factor of 10.
					From ECOTOX database[c]: Range of LC_{50} values divided by 100 = 2 µg/L to 520 µg/L Single available NOEC value : 29,000 µg/L
Trichloroethene (TCE, Trichloroethylene, 1,1,2-Trichloroethylene) CAS # 79016	1940	TNRCC, 2001	970	TCEQ, 2006-	See notes for 1,2-dichloroethene (above) regarding TNRCC citation and current agency name. The current TCEQ ecological benchmark for this compound in marine surface water is 970 µg/L (TCEQ, 2006). According to TCEQ's Water Quality Standards Group, the value is based on the geometric mean of several LC_{50} values in toxicity tests using mysid shrimp (*Mysidopsis bahia*). The geometric mean (19,400 µg/L) was multiplied by 0.05 in accordance with their policy for deriving chronic criteria for persistent chemicals that do not bioaccumulate. TCEQ defines a persistent chemical as one with a half life of $\geq$ 4 days in water or sediment. The previous TNRCC/TCEQ benchmark of 1940 µg/L was derived from the same data and geometric mean value, but was multiplied by 0.1 rather than 0.05.
	-	-	200	Buchman, 2008	The Water Quality Criteria document for Trichloroethylene (USEPA, 1980e) had no chronic toxicity data for marine species. Acute toxicity data for two saltwater species were reported in the USEPA (1980e) document; grass shrimp (*Palaemonetes pugio*) were adversely impacted after several minutes of exposure at 2,000 µg/L, and sheepshead minnows were adversely impacted at 20,000 µg/L. The NOAA chronic screening value (200 µg/L) for trichloroethene in marine surface water was derived using the USEPA (1980e) lowest acute value (the 2,000 µg/L) divided by a safety factor of 10 (Buchman, 2008).
					From ECOTOX database[c]: Range of EC50 and LC50 values divided by 100 = 140 µg/L to 1500 µg/L

Table 1. Marine Water Ecological Screening Values, Sources, and Derivation (Continued)					
Chemical	Chemical		Chemical		Chemical
	Value (µg/L)	Reference[b]	Value (µg/L)	Reference	
Vinyl chloride CAS # 75014	930	MDEQ, 2002	-	-	USEPA Region 3 BTAG has no marine surface water benchmark for this compound, so it uses the freshwater value (930 µg/L) as a surrogate. The MDEQ (2002) value is a Final Chronic Value, which is defined by MDEQ as the level "that does not allow injurious or debilitating effects in an aquatic organism resulting from repeated long-term exposure to a substance relative to the organism's lifespan". Specific data regarding the test species, endpoints, etc used to derive the value were not available on the MDEQ website. No saltwater aquatic toxicity data were available for this chemical in the ECOTOX database.

Footnotes:

a USEPA (U.S. Environmental Protection Agency). 2006. EPA Region III BTAG Marine Screening Benchmarks, 7/2006. Mid-Atlantic Risk Assessment, Screening Values. Available at http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/marine/screenbench.htm

b Reference cited by Region 3 BTAG (USEPA 2006); see "Source and Notes" column for further explanation.

c USEPA. 2007. ECOTOX User Guide: ECOTOXicology Database System. Version 4.0. Available at http:/www.epa.gov/ecotox. Data retrievals for this table were performed using Advanced Database Query function; saltwater test conditions; taxonomic groups were animals (amphibians, crustaceans, fish, mollusks, worms, and other invertebrates) and plants (algae, moss, and fungi).

d USEPA Region 4 ecological screening value for marine surface water (USEPA, 2001).

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TCEQ (Texas Council on Environmental Quality) 2006. Update to Guidance for Conducting Ecological Risk Assessments at Remediation Sites In Texas RG-263 (Revised). Remediation Division. January. http://www.tceq.state.tx.us/assets/public/remediation/eco/0106eraqupdate.pdf.

TNRCC (Texas Natural Resource Conservation Commission), Toxicology and Risk Assessment Section. December 2001. Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas, http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/rg/rg-263_189521.pdf, cited in USEPA (2006).

USEPA (United States Environmental Protection Agency). 1980a. Ambient Water Quality Criteria for Benzene. EPA 440/5-80-018, Office of Water Regulations and Standards, Criteria and Standards Division, Washington, DC. October.

USEPA. 1980b. Ambient Water Quality Criteria for Dichloroethylenes. EPA 440/5-80-041, Office of Water Regulations and Standards, Criteria and Standards Division, Washington, DC. October.

USEPA. 1980c. Ambient Water Quality Criteria for Chloronated Ethanes. EPA 440/5-80-029, Office of Water Regulations and Standards, Criteria and Standards Division, Washington, DC. October.

USEPA. 1980d. Ambient Water Quality Criteria for Tetrachloroethylene. EPA 440/5-80-073, Office of Water Regulations and Standards, Criteria and Standards Division, Washington, DC. October.

USEPA. 1980e. Ambient Water Quality Criteria for Trichloroethylene. EPA 440/5-80-077, Office of Water Regulations and Standards, Criteria and Standards Division, Washington, DC. October.

USEPA. 2001. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment. Originally published November 1995. Website version last updated November 30, 2001: http://www.epa.gov/region4/waste/ots/ecolbul.htm. Note: The Region 3 BTAG Marine Screening Benchmark table (USEPA, 2006) provides a date of February 11, 2002 for the Region 4 website. However, the actual Region 4 website provides a date of November 30, 2001.

USEPA. 2006. EPA Region III BTAG Marine Screening Benchmarks, 7/2006. Mid-Atlantic Risk Assessment, Screening Values. Available at http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/marine/screenbench.htm.

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ATTACHMENT A

SUMMARY OF ECOTOX RESULTS

Benzene										
Species Scientific Name	Species Common Name	Species Group	Endpoint	Exposure Duration (Days)	Exposure Type	Calculated EC50 or LC50 (ug/L)	Min Conc. tested (ug/L)	Max Conc. Tested (ug/L)	Source	Publication Year
Dunaliella tertiolecta	Green algae	Algae, Moss, Fungi	EC50	0.04 (1 hour)	S	12,500,000	NR	NR	Water Res. 17(12):1757-1762	1983
Dunaliella tertiolecta	Green algae	Algae, Moss, Fungi	EC50	1	S	27,000,000	NR	NR	Water Res. 17(12):1757-1762	1983
Artemia salina	Brine shrimp	Crustaceans	LC50*	1	S	66,000	NR	NR	J.Water Pollut.Control Fed. 46(1):63-77	1974
Artemia salina	Brine shrimp	Crustaceans	LC50*	2	S	21,000	NR	NR	J.Water Pollut.Control Fed. 46(1):63-77	1974
Cancer magister	Dungeness or edible crab	Crustaceans	LC50	2	S	347,000	NR	NR	In: D.A.Wolfe (Ed.) Fate and Effects of Petroleum Hydrocarbons in Marine Ecosystems and Organisms, Pergamon Press, NY :210-220	1977
Cancer magister	Dungeness or edible crab	Crustaceans	LC50	4	S	108,000	NR	NR	In: D.A.Wolfe (Ed.) Fate and Effects of Petroleum Hydrocarbons in Marine Ecosystems and Organisms, Pergamon Press, NY :210-220	1977
Crangon franciscorum	Bay shrimp	Crustaceans	LC50	1	S	22,000	20000	24000	Calif.Fish Game 63(4):204-209	1977
Crangon franciscorum	Bay shrimp	Crustaceans	LC50	4	S	20,000	19000	22000	Calif.Fish Game 63(4):204-209	1977
Nitocra spinipes	Harpacticoid copepod	Crustaceans	LC50	1	S	111,500	61000	156600	Ph.D.Thesis, Lehigh University, Bethlehem, PA :108 p.	1975
Nitocra spinipes	Harpacticoid copepod	Crustaceans	LC50	1	S	82,000	73000	91000	Ph.D.Thesis, Lehigh University, Bethlehem, PA :108 p.	1975
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	1	S	33,500	31000	36000	Ph.D.Thesis, Lehigh University, Bethlehem, PA :108 p.	1975
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	1	S	38,000	36600	40200	Ph.D.Thesis, Lehigh University, Bethlehem, PA :108 p.	1975
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	1	S	40,200	33500	48200	Ph.D.Thesis, Lehigh University, Bethlehem, PA :108 p.	1975
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	1	S	40,800	38600	43500	Ph.D.Thesis, Lehigh University, Bethlehem, PA :108 p.	1975
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	1	S	43,500	36300	52500	Ph.D.Thesis, Texas A&M University, College Station, TX :133 p.	1975
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	1	S	74,400	66800	81800	Ph.D.Thesis, Lehigh University, Bethlehem, PA :108 p.	1975
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	1	S	90,800	61100	113500	Ph.D.Thesis, Lehigh University, Bethlehem, PA :108 p.	1975
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	1	S	43,500	NR	NR	Estuar.Coast.Mar.Sci. 6(4):365-373	1978
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	2	S	35,000	28000	43800	Ph.D.Thesis, Texas A&M University, College Station, TX :133 p.	1975
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	2	S	35,000	NR	NR	Estuar.Coast.Mar.Sci. 6(4):365-373	1978
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	4	S	27,000	19900	43800	Ph.D.Thesis, Texas A&M University, College Station, TX :133 p.	1975
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	4	S	27,000	NR	NR	Estuar.Coast.Mar.Sci. 6(4):365-373	1978
Scylla serrata	Crab	Crustaceans	LC50	1	S	10,360	NR	NR	Environ.Ecol. 6(1):220-221	1988
Scylla serrata	Crab	Crustaceans	LC50	1	S	12,840	NR	NR	Environ.Ecol. 6(1):220-221	1988
Scylla serrata	Crab	Crustaceans	LC50	1	S	6,380	NR	NR	Environ.Ecol. 6(2):335-339	1988
Scylla serrata	Crab	Crustaceans	LC50	1	S	8,120	NR	NR	Environ.Ecol. 6(2):335-339	1988
Scylla serrata	Crab	Crustaceans	LC50	1	S	8,120	NR	NR	Environ.Ecol. 6(1):220-221	1988
Scylla serrata	Crab	Crustaceans	LC50	2	S	11,380	NR	NR	Environ.Ecol. 6(1):220-221	1988
Scylla serrata	Crab	Crustaceans	LC50	2	S	5,020	NR	NR	Environ.Ecol. 6(2):335-339	1988
Scylla serrata	Crab	Crustaceans	LC50	2	S	6,590	NR	NR	Environ.Ecol. 6(2):335-339	1988
Scylla serrata	Crab	Crustaceans	LC50	2	S	6,590	NR	NR	Environ.Ecol. 6(1):220-221	1988

Benzene										
Species Scientific Name	Species Common Name	Species Group	Endpoint	Exposure Duration (Days)	Exposure Type	Calculated EC50 or LC50 (ug/L)	Min Conc. tested (ug/L)	Max Conc. Tested (ug/L)	Source	Publication Year
Scylla serrata	Crab	Crustaceans	LC50	2	S	9,150	NR	NR	Environ.Ecol. 6(1):220-221	1988
Scylla serrata	Crab	Crustaceans	LC50	3	S	10,160	NR	NR	Environ.Ecol. 6(1):220-221	1988
Scylla serrata	Crab	Crustaceans	LC50	3	S	3,740	NR	NR	Environ.Ecol. 6(2):335-339	1988
Scylla serrata	Crab	Crustaceans	LC50	3	S	5,260	NR	NR	Environ.Ecol. 6(2):335-339	1988
Scylla serrata	Crab	Crustaceans	LC50	3	S	5,260	NR	NR	Environ.Ecol. 6(1):220-221	1988
Scylla serrata	Crab	Crustaceans	LC50	3	S	8,340	NR	NR	Environ.Ecol. 6(1):220-221	1988
Scylla serrata	Crab	Crustaceans	LC50	4	S	4,180	NR	NR	Environ.Ecol. 6(1):220-221	1988
Scylla serrata	Crab	Crustaceans	LC50	4	S	6,920	NR	NR	Environ.Ecol. 6(1):220-221	1988
Scylla serrata	Crab	Crustaceans	LC50	4	S	8,730	NR	NR	Environ.Ecol. 6(1):220-221	1988
Homarus americanus	American lobster	Crustaceans	NR-LETH	NR	S	111,800	NR	NR	In: S.W.Nielsen, G.Migaki, and D.G.Scarpelli (Eds.), Symp.Animals Monitors Environ.Pollut.1977, Storrs, CT 12:383-384	1979
Homarus americanus	American lobster	Crustaceans	NR-LETH	NR	S	111,800	NR	NR	In: S.W.Nielsen, G.Migaki, and D.G.Scarpelli (Eds.), Symp.Animals Monitors Environ.Pollut.1977, Storrs, CT 12:383-384	1979
Oncorhynchus kisutch	Coho salmon,silver salmon	Fish	LC100	1	S	100,000	NR	NR	Copeia 2:326-331	1975
Clupea pallasii	Pacific herring	Fish	LC50	2	R	NR	20000	25000	In: F.J.Vernberg and W.B.Vernberg (Eds.), Pollution and Physiology of Mar.Organisms, Acad.Press, NY :253-284	1974
Clupea pallasii	Pacific herring	Fish	LC50	4	R	NR	40000	45000	In: F.J.Vernberg and W.B.Vernberg (Eds.), Pollution and Physiology of Mar.Organisms, Acad.Press, NY :253-284	1974
Engraulis mordax	Northern anchovy	Fish	LC50	2	R	NR	20000	25000	In: F.J.Vernberg and W.B.Vernberg (Eds.), Pollution and Physiology of Mar.Organisms, Acad.Press, NY :253-284	1974
Morone saxatilis	Striped bass	Fish	LC50	1	S	6,900	NR	NR	Calif.Fish Game 63(4):204-209	1977
Morone saxatilis	Striped bass	Fish	LC50	3	F	10,900	NR	NR	J.Fish.Res.Board Can. 32(10):1864-1866	1975
Morone saxatilis	Striped bass	Fish	LC50	4	F	10,900	NR	NR	J.Fish.Res.Board Can. 32(10):1864-1866	1975
Morone saxatilis	Striped bass	Fish	LC50	4	S	5,800	NR	NR	Calif.Fish Game 63(4):204-209	1977
Mugil curema	White mullet	Fish	LC50	2	R	22,000	NR	NR	Bull.Environ.Contam.Toxicol. 44(2):428-434	1990
Oncorhynchus gorbuscha	Pink salmon	Fish	LC50	4	S	8,470	7890	9090	Trans.Am.Fish.Soc. 108(4):408-414	1979
Oncorhynchus nerka	Sockeye salmon	Fish	LC50	4	S	5,550	2890	8210	Trans.Am.Fish.Soc. 108(4):408-414	1979
Salvelinus malma	Dolly varden	Fish	LC50	4	S	6,300	4600	8000	Trans.Am.Fish.Soc. 108(4):408-414	1979
Terapon jarbua	Tigerfish	Fish	LC50	1	S	96,000	NR	NR	Proc.Symp.Coastal Aquacult. 3:828-832	1984
Terapon jarbua	Tigerfish	Fish	LC50	2	S	94,000	NR	NR	Proc.Symp.Coastal Aquacult. 3:828-832	1984
Terapon jarbua	Tigerfish	Fish	LC50	3	S	88,000	NR	NR	Proc.Symp.Coastal Aquacult. 3:828-832	1984
Terapon jarbua	Tigerfish	Fish	LC50	4	S	84,000	NR	NR	Proc.Symp.Coastal Aquacult. 3:828-832	1984
Morone saxatilis	Striped bass	Fish	LOEC	28	F	NR	1500	5400	U.S.Natl.Mar.Fish Serv.Fish.Bull. 74(3):694-698	1976
Morone saxatilis	Striped bass	Fish	LOEC	14	F	NR	1500	5400	U.S.Natl.Mar.Fish Serv.Fish.Bull. 74(3):694-698	1976

Benzene										
Species Scientific Name	Species Common Name	Species Group	Endpoint	Exposure Duration (Days)	Exposure Type	Calculated EC50 or LC50 (ug/L)	Min Conc. tested (ug/L)	Max Conc. Tested (ug/L)	Source	Publication Year
Morone saxatilis	Striped bass	Fish	LOEC	21	F	NR	3600	8100	U.S.Natl.Mar.Fish Serv.Fish.Bull. 74(3):694-698	1976
Morone saxatilis	Striped bass	Fish	LOEC	28	F	NR	3600	8100	U.S.Natl.Mar.Fish Serv.Fish.Bull. 74(3):694-698	1976
Morone saxatilis	Striped bass	Fish	LOEC	7	F	NR	3600	8100	U.S.Natl.Mar.Fish Serv.Fish.Bull. 74(3):694-698	1976
Morone saxatilis	Striped bass	Fish	LOEC	28	F	NR	3600	8100	U.S.Natl.Mar.Fish Serv.Fish.Bull. 74(3):694-698	1976
Morone saxatilis	Striped bass	Fish	NOEC	21	F	NR	1500	5400	U.S.Natl.Mar.Fish Serv.Fish.Bull. 74(3):694-698	1976
Morone saxatilis	Striped bass	Fish	NOEC	28	F	NR	1500	5400	U.S.Natl.Mar.Fish Serv.Fish.Bull. 74(3):694-698	1976
Morone saxatilis	Striped bass	Fish	NOEC	7	F	NR	1500	5400	U.S.Natl.Mar.Fish Serv.Fish.Bull. 74(3):694-698	1976
Morone saxatilis	Striped bass	Fish	NOEC	28	F	NR	3600	8100	U.S.Natl.Mar.Fish Serv.Fish.Bull. 74(3):694-698	1976
Morone saxatilis	Striped bass	Fish	NOEC	28	F	NR	1500	5400	U.S.Natl.Mar.Fish Serv Fish.Bull. 74(3):694-698	1976
Brachionus plicatilis	Rotifer	Invertebrates	LC50	1	S	1,000	NR	NR	Bull.Environ.Contam.Toxicol. 49(2):266-271	1992
Pocillopora damicornis	Ciliate protozoa	Invertebrates	NR-ZERO	10	S	100,000	NR	NR	Pac.Sci. 45(3):290-298	1991
Crassostrea gigas	Pacific oyster	Molluscs	EC50*	2	S	924,400	NR	NR	Ph.D.Thesis, Univ.of Washington, Seattle, WA :189 p.	1974
Crassostrea gigas	Pacific oyster	Molluscs	LC50*	2	S	377000*	NR	NR	Ph.D.Thesis, Univ.of Washington, Seattle, WA :189 p.	1974
Katelysia opima	Marine bivalve	Molluscs	LC50	1	S	225,000	NR	NR	Proc.Symp.Coastal Aquacult. 3:828-832	1984
Katelysia opima	Marine bivalve	Molluscs	LC50	2	S	205,000	NR	NR	Proc.Symp.Coastal Aquacult. 3:828-832	1984
Katelysia opima	Marine bivalve	Molluscs	LC50	3	S	195,000	NR	NR	Proc.Symp.Coastal Aquacult. 3:828-832	1984
Katelysia opima	Marine bivalve	Molluscs	LC50	4	S	190,000	NR	NR	Proc.Symp.Coastal Aquacult. 3:828-832	1984

Exposure Type: S = static, F = flow through, R = Renewal

Range of EC50 and LC50 values = 1,000 ug/L to 924,400 ug/L (excluding green algae LC50 values of 12,500,00 and 27,000,000 ug/L)
Range of EC50 and LC50 values divided by 100 = 10 ug/L to 9,244 ug/L

1,1-Dichloroethene										
Species Scientific Name	Species Common Name	Species Group	Endpoint	Exposure Duration (Days)	Exposure Type	LC50 or NOEC (ug/L)	Min Conc. tested (ug/L)	Max Conc. Tested (ug/L)	Source	Publication Year
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	1	Static	250,000	200,000	340,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	2	Static	250,000	200,000	340,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	3	Static	250,000	200,000	340,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	4	Static	250,000	200,000	340,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Menidia beryllina	Inland silverside	Fish	LC50	4	Static	250,000	NR	NR	J.Hazard.Mater. 1(4):303-318 (OECDG Data File)	1977
Cyprinodon variegatus	Sheepshead minnow	Fish	NOEC	4	Static	80,000	NR	NR	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981

Range of LC50 values = 250,000 ug/L
Range of LC50 values divided by 100 = 2500 ug/L
Single NOEC value = 80,000 ug/L

1,2-Dichloroethane										
Species Scientific Name	Species Common Name	Species Group	Endpoint	Exposure Duration (Days)	Exposure Type	LC50, EC50, or NOEC (ug/L)	Min Conc. tested (ug/L)	Max Conc. Tested (ug/L)	Source	Publication Year
Artemia salina	Brine shrimp	Crustaceans	EC50	1	Static	36,400	30,600	43,000	Environ.Pollut.Ser.A 38:273-281	1985
Artemia salina	Brine shrimp	Crustaceans	EC50	1	Static	79,700	69,700	90,600	Environ.Pollut.Ser.A 38:273-281	1985
Artemia salina	Brine shrimp	Crustaceans	EC50	1	Static	93,640	77,000	113,600	Aquat.Toxicol. 5(3):245-254	1984
Artemia salina	Brine shrimp	Crustaceans	LC50	1	Static	320,000	NR	NR	J.Water Pollut.Control Fed. 46(1):63-77	1974
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	1	Static	NR	130,000	230,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	2	Static	NR	130,000	230,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	3	Static	NR	130,000	230,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	4	Static	NR	130,000	230,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Pleuronectiformes	Sole order	Fish	LC50	4	Flow through	115,000	NR	NR	Proc.R.Soc.Lond,B Biol.Sci. 189:305-332	1975
Cyprinodon variegatus	Sheepshead minnow	Fish	NOEC	4	Static	130,000	NR	NR	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Ophryotrocha labronica	Polychaete	Worms	LC50	4	Renewal	400,000	NR	NR	Water Res. 9(7):607-612	1975
Ophryotrocha labronica	Polychaete	Worms	LC50	4	Static	900,000	NR	NR	Water Res. 9(7):607-612	1975

Range of LC50 and EC50 values = 36,400 ug/L to 900,000 ug/L
Range of LC50 and EC50 values divided by 100 = 364 ug/L to 9,000 ug/L
Single NOEC value = 130,000 ug/L

1,1,2,2-Tetrachloroethane

Species Scientific Name	Species Common Name	Species Group	Endpoint	Exposure Duration (Days)	Exposure Type	LC50 or NOEC (ug/L)	Min Conc. tested (ug/L)	Max Conc. Tested (ug/L)	Source	Publication Year
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	1	Static	19,000	14,000	20,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	2	Static	16,000	12,000	20,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	3	Static	13,000	5,100	33,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	4	Static	12,000	4,700	32,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	NOEC	4	Static	8,800	NR	NR	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981

Range of LC50 values = 12,000 ug/L to 19,000 ug/L
Range of LC50 values divided by 100 = 120 ug/L to 190 ug/L
Single NOEC value = 8,800 ug/L

Tetrachloroethene										
Species Scientific Name	Species Common Name	Species Group	Endpoint	Exposure Duration (Days)	Exposure Type	LC50, EC50, or NOEC (ug/L)	Min Conc. tested (ug/L)	Max Conc. Tested (ug/L)	Source	Publication Year
Skeletonema costatum	Diatom	Algae, Moss, Fungi	EC50	1	Static	200	NR	NR	Chemosphere 33(5):865-877	1996
Skeletonema costatum	Diatom	Algae, Moss, Fungi	EC50	2	Static	200	NR	NR	Chemosphere 33(5):865-877	1996
Skeletonema costatum	Diatom	Algae, Moss, Fungi	EC50	3	Static	200	NR	NR	Chemosphere 33(5):865-877	1996
Acartia tonsa	Calanoid copepod	Crustaceans	LC50	4	Static	13,200	11,300	15,400	Rep.No.4398, Final Report, EPA Contract No.68-01-6201, NUS Corp., Houston, TX :196 p.	1983
Crangon septemspinosa	Bay shrimp, Sand shrimp	Crustaceans	LC50	4	Static	17,400	15,300	19,800	Rep.No.4398, Final Report, EPA Contract No.68-01-6201, NUS Corp., Houston, TX :196 p.	1983
Gammarus annulatus	Scud	Crustaceans	LC50	4	Static	9,100	5,900	14,100	Rep.No.4398, Final Report, EPA Contract No.68-01-6201, NUS Corp., Houston, TX :196 p.	1983
Palaemonetes pugio	Daggerblade grass shrimp	Crustaceans	LC50	4	Static	1,300	1,100	1,500	Rep.No.4398, Final Report, EPA Contract No.68-01-6201, NUS Corp., Houston, TX :196 p.	1983
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	1	Static	52,000	NR	NR	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	2	Static	52,000	NR	NR	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	4	Static	NR	29,000	52,000	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	4	Static	9,800	8,800	11,000	Rep.No.4398, Final Report, EPA Contract No.68-01-6201, NUS Corp., Houston, TX :196 p.	1983
Menidia beryllina	Inland silverside	Fish	LC50	4	Static	28,100	27,300	28,900	Rep.No.4398, Final Report, EPA Contract No.68-01-6201, NUS Corp., Houston, TX :196 p.	1983
Pleuronectiformes	Sole order	Fish	LC50	4	Flow through	5,000	NR	NR	Proc.R.Soc.Lond.B Biol.Sci. 189:305-332	1975
Cyprinodon variegatus	Sheepshead minnow	Fish	NOEC	4	Static	29,000	NR	NR	Bull.Environ.Contam.Toxicol. 27(5):596-604 (OECDG Data File)	1981
Neanthes arenaceodentata	Polychaete worm	Worms	LC50	4	Static	1,300	1,100	1,500	Rep.No.4398, Final Report, EPA Contract No.68-01-6201, NUS Corp., Houston, TX :196 p.	1983

Range of LC50 and EC50 values = 200 ug/L to 52,000 ug/L
Range of LC50 and EC50 values divided by 100 = 2 ug/L to 520 ug/L
Single NOEC value = 29,000 ug/L

1,1,2-Trichloroethane										
Species Scientific Name	Species Common Name	Species Group	Endpoint	Exposure Duration (Days)	Exposure Type	LC50 (ug/L)	Min Conc. tested (ug/L)	Max Conc. Tested (ug/L)	Source	Publication Year
Ophryotrocha labronica	Polychaete	Worms	LC50	4	Renewal	160,000	NR	NR	Water Res. 9(7):607-612	1975
Ophryotrocha labronica	Polychaete	Worms	LC50	4	Renewal	225,000	NR	NR	Water Res. 9(7):607-612	1975
Ophryotrocha labronica	Polychaete	Worms	LC50	4	Static	400,000	NR	NR	Water Res. 9(7):607-612	1975
Ophryotrocha labronica	Polychaete	Worms	LC50	4	Static	500,000	NR	NR	Water Res. 9(7):607-612	1975

Range of LC50 values = 160,000 ug/L to 500,000 ug/L
Range of LC50 values divided by 100 = 1,600 ug/L to 5,000 ug/L

Trichloroethene										
Species Scientific Name	Species Common Name	Species Group	Endpoint	Exposure Duration (Days)	Exposure Type	Calculated EC50 or LC50 (ug/L)	Min Conc. tested (ug/L)	Max Conc. Tested (ug/L)	Source	Publication Year
Skeletonema costatum	Diatom	Algae, Moss, Fungi	EC50	4	Static	150,000	139,000	162,000	Bull.Environ.Contam.Toxicol. 37(6):830-836	1986
Skeletonema costatum	Diatom	Algae, Moss, Fungi	EC50	4	Static	95,000	79,000	143,000	Bull.Environ.Contam.Toxicol. 37(6):830-836	1986
Americamysis bahia	Opossum shrimp	Crustaceans	LC50	4	Static	14,000	12,000	26,000	Bull.Environ.Contam.Toxicol. 37(6):830-836	1986
Americamysis bahia	Opossum shrimp	Crustaceans	LC50	4	Static	27,000	19,000	36,000	Bull.Environ.Contam.Toxicol. 37(6):830-836	1986
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	4	Static	52,000	43,000	64,000	Bull.Environ.Contam.Toxicol. 37(6):830-836	1986
Cyprinodon variegatus	Sheepshead minnow	Fish	LC50	4	Static	99,000	83,000	118,000	Bull.Environ.Contam.Toxicol. 37(6):830-836	1986
Pleuronectiformes	Sole order	Fish	LC50	4	Flow through	16,000	NR	NR	Proc.R.Soc.Lond.B Biol.Sci. 189:305-332	1975

Range of EC50 and LC50 values = 14,000 ug/L to 150,000 ug/L
Range of EC50 and LC50 values divided by 100 = 140 ug/L to 1,500 ug/L