

# *Final Draft*

U.S. DEPARTMENT OF THE NAVY  
INSTALLATION RESTORATION PROGRAM

---

## VOLUME II

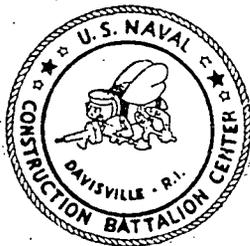
# DPDO FILM PROCESSING DISPOSAL AREA REMEDIAL INVESTIGATION REPORT:

# HUMAN HEALTH RISK ASSESSMENT TECHNICAL REPORT & APPENDICES A-C

---

NAVAL CONSTRUCTION BATTALION CENTER  
DAVISVILLE, RHODE ISLAND

Contract No. N62472-86-C-1282  
November, 1993



Prepared For:  
Northern Division  
Naval Facilities Engineering Command  
Lester, Pennsylvania

**TRC**

TRC Environmental Corporation

# *Final Draft*

U.S. DEPARTMENT OF THE NAVY  
INSTALLATION RESTORATION PROGRAM

---

## **VOLUME II**

# **DPDO FILM PROCESSING DISPOSAL AREA REMEDIAL INVESTIGATION REPORT:**

## **HUMAN HEALTH RISK ASSESSMENT TECHNICAL REPORT & APPENDICES A-C**

---

**NAVAL CONSTRUCTION BATTALION CENTER  
DAVISVILLE, RHODE ISLAND**

Contract No. N62472-86-C-1282  
November, 1993

Prepared For:  
Northern Division  
Naval Facilities Engineering Command  
Lester, Pennsylvania

# **TRC**

TRC Environmental Corporation

---

5 Waterside Crossing  
Windsor, CT 06095  
☎ (203) 289-8631 Fax (203) 298-6399

A TRC Company

Printed on Recycled Paper

## TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
EXECUTIVE SUMMARY .....	ii
1.0 BASELINE HEALTH RISK ASSESSMENT .....	1-1
1.1 Objectives .....	1-1
1.2 Methodology .....	1-2
2.0 HAZARD IDENTIFICATION .....	2-1
2.1 Site Description .....	2-1
2.2 Data Collection .....	2-1
2.3 Data Evaluation .....	2-2
2.4 Summary of Soil Gas Data .....	2-7
2.5 Summary of Surface Soil Data .....	2-7
2.6 Summary of Subsurface Soil Data .....	2-9
2.7 Summary of Ground Water Data .....	2-11
2.8 Selection of Constituents of Potential Concern .....	2-11
3.0 DOSE-RESPONSE ASSESSMENT .....	3-1
3.1 Toxicity Information for Carcinogenic Effects .....	3-1
3.2 Toxicity Information for Non-Carcinogenic Effects .....	3-2
3.3 Constituents for Which EPA Has Not Developed Toxicity Criteria .....	3-4
4.0 EXPOSURE ASSESSMENT .....	4-1
4.1 Selection of Exposure Scenarios and Pathways .....	4-1
4.2 Estimation of Exposure Point Concentrations .....	4-2
4.3 Estimation of Constituent Exposure Doses .....	4-4
5.0 RISK CHARACTERIZATION .....	5-1
5.1 Quantitative Risk Assessment .....	5-1
5.2 Qualitative Analysis of Risks .....	5-5
6.0 UNCERTAINTY ASSESSMENT .....	6-1
6.1 Uncertainties Associated with the Hazard Identification .....	6-1
6.2 Uncertainties Associated with the Dose-Response Assessment .....	6-1
6.3 Uncertainties Associated with the Exposure Assessment .....	6-2
6.3.1 Environmental Sampling and Analysis .....	6-3
6.3.2 Current and Future Land Use .....	6-3
6.3.3 Exposure Pathways .....	6-4
6.3.4 Exposure Parameter Values .....	6-6
6.4 Uncertainties Associated with the Risk Characterization .....	6-9
7.0 REFERENCES .....	7-1

## LIST OF TABLES

### TABLE

- 1 SUMMARY OF BACKGROUND DATA FOR INORGANICS IN SOIL
- 2 SUMMARY STATISTICS FOR CONSTITUENTS DETECTED IN SOIL
- 3 SUMMARY STATISTICS FOR CONSTITUENTS DETECTED IN GROUND WATER
- 4 CONSTITUENTS OF POTENTIAL CONCERN IN SOIL AND GROUND WATER
- 5 SUMMARY OF TOXICITY VALUES ASSOCIATED WITH CARCINOGENIC EFFECTS: ORAL
- 6 SUMMARY OF TOXICITY VALUES ASSOCIATED WITH CARCINOGENIC EFFECTS: INHALATION
- 7 SUMMARY OF TOXICITY VALUES ASSOCIATED WITH NON-CARCINOGENIC EFFECTS: ORAL
- 8 SUMMARY OF TOXICITY VALUES ASSOCIATED WITH NON-CARCINOGENIC EFFECTS: INHALATION
- 9 EXPOSURE POINT CONCENTRATIONS FOR CONSTITUENTS OF POTENTIAL CONCERN IN SOIL
- 10 EXPOSURE POINT CONCENTRATIONS FOR CONSTITUENTS OF POTENTIAL CONCERN IN GROUND WATER
- 11 SUMMARY OF EXPOSURE PARAMETER VALUES
- 12 EXPOSURE AND RISK ESTIMATES FOR SCENARIO 1 - TRESPASSER
- 13 EXPOSURE AND RISK ESTIMATES FOR SCENARIO 2 - COMMERCIAL WORKER
- 14 EXPOSURE AND RISK ESTIMATES FOR SCENARIO 3 - CONSTRUCTION WORKER

LIST OF TABLES

(Continued)

TABLE

- 15 EXPOSURE AND RISK ESTIMATES FOR SCENARIO 4 - RESIDENT
- 16 SUMMARY OF RISK ESTIMATES FOR SCENARIO 4 - RESIDENT
- 17 SUMMARY OF RISK ESTIMATES FOR ALL SCENARIOS

LIST OF FIGURES

FIGURE

- 1 NCBC LOCUS PLAN
- 2 SITE 08: PHASE I SAMPLING LOCATIONS
- 3 SITE 08: PHASE II SAMPLING LOCATIONS
- 4 NCBC: PHASE II REMEDIAL INVESTIGATION BACKGROUND SURFACE SOIL SAMPLE LOCATIONS

APPENDICES

APPENDIX

- A SURFACE SOIL, SUBSURFACE SOIL AND GROUND WATER DATA FOR CONSTITUENTS OF POTENTIAL CONCERN
- B TOXICOLOGICAL PROFILES FOR CONSTITUENTS OF POTENTIAL CONCERN
- C EXPOSURE DOSE EQUATIONS, INPUT VALUES, AND MODELS BY SCENARIO

## EXECUTIVE SUMMARY

A Remedial Investigation (RI) was conducted at the Defense Property Disposal Office, Film Processing Disposal Area (Site 08) at the U.S. Navy Construction Battalion Center in Davisville, Rhode Island (NCBC Davisville). The RI was conducted by TRC Environmental Corporation (TRC) as part of the Department of Defense Installation Restoration Program, which is similar to the U.S. Environmental Protection Agency's (EPA's) Superfund Program. The NCBC Davisville facility is currently listed on the U.S. EPA National Priorities List (NPL).

The Phase I RI (TRC-ECI, 1991b) and the Phase I Human Health Risk Assessment (HHRA) (TRC-ECI, 1991a) present the results of Phase I field activities and assessment of potential health risks for the following NCBC Davisville sites:

- Site 02 - Battery Acid Disposal Area
- Site 03 - Solvent Disposal Area
- Site 05 - Former Transformer Oil Disposal Area
- Site 06 - Solvent Disposal Area
- Site 07 - Calf Pasture Point
- Site 08 - Film Processing Disposal Area
- Site 09 - Allen Harbor Landfill
- Site 10 - Camp Fogarty
- Site 11 - Fire Fighting Training Area
- Site 13 - Disposal Area Northwest of Buildings W-3, W-1, T-1

A Phase II RI is currently underway at the above-listed sites.

This volume, Volume II of the Phase II RI for Site 08, presents the results of the Phase II Human Health RA for this site, describing the constituents of potential concern, assessing potential exposure pathways and constituent toxicity, and characterizing the potential health risks. The Phase II HHRA for Site 08 incorporates the data collected during Phase I, and herein replaces the results and conclusions of the Phase I HHRA. The Phase II RI field activities and data for Site 08 are described in detail in Volume I. Two additional Phase II reports for the NCBC facility were submitted for review in November 1993: one containing the RI and HHRA for Sites 02, 03, 06, 07, 10, 11 and 13 (TRC, 1993a, b), and another containing the RI and HHRA for Site 09 (TRC, 1993c, d). The Phase II HHRA for Site 05 has been postponed pending further consideration of the Phase II data.

## PURPOSE AND METHODOLOGY

The primary objectives of the HHRA conducted for Site 08 include the following:

- Examine exposure pathways and constituent concentrations in environmental media;
- Estimate the potential for adverse effects associated with the constituents of potential concern under current and future land use conditions;
- Provide a risk management framework upon which decisions can be made regarding what actions, if any, should be taken at the site;
- Identify site or land use conditions that present unacceptable risks; and
- Provide a basis from which recommendations for future activities at the site can be made which are protective of human health.

The risk assessment follows guidelines established by EPA in the Supplemental Risk Assessment Guidance for the Superfund Program, Part 1 - Guidance for Public Health Risk Assessments (1989b) and the Interim Final Risk Assessment Guidance for Superfund, Volume I (Human Health Evaluation Manual - Part A) (1989a).

## HAZARD IDENTIFICATION

Constituents of potential concern have been evaluated and identified for the various media identified at Site 08. Field investigations at the site, conducted in two separate phases, included the collection of soil gas, surface soil, subsurface soil, and ground water samples. Constituents observed as a result of the two phases of investigation consisted of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides and polychlorinated biphenyls (PCBs), and inorganics. For each medium, the analytical data were evaluated following EPA guidelines. The constituents of potential concern were identified on the basis of this evaluation, and a determination was made as to which constituents would be addressed qualitatively and/or quantitatively in the risk assessment. For some constituents, data not verified as "hits" were used in the quantitative risk assessment in accordance with current guidance.

## DOSE-RESPONSE ASSESSMENT

The toxic effects of each constituent of potential concern were evaluated, including effects associated with the exposure pathways and concentrations at which such effects may be expected to occur, when available. For oral and inhalation exposure, chronic and subchronic non-carcinogenic reference doses (RfDs) (in milligrams of constituent per kilogram body weight per day (mg/kg-d)) and cancer slope factors (expressed as unit risk per mg/kg-d) were identified. Oral toxicity values were used to assess the potential cancer and non-cancer risks from dermal exposures. Differences in oral versus dermal absorption were taken into account through the use of relative absorption factors (RAFs) in the exposure assessment.

## EXPOSURE ASSESSMENT

The exposure assessment involved considerations of potential receptor populations and migration pathways by which constituents could potentially be transported to other media. Specific exposure scenarios were developed to represent potential situations in which humans may be exposed to on-site constituents.

Potential migration pathways included the following:

- Migration of surface soil constituents directly via surface runoff, windblown dust, or tracking (tires, shoes, etc.);
- Migration of surface soil constituents indirectly via precipitation, leaching and subsequent ground water migration, via volatilization to ambient air, or via uptake by plants or animals and subsequent human consumption;
- Migration of subsurface soil constituents via precipitation, leaching or subsequent ground water migration; and
- Migration of ground water constituents via ground water flow.

Potential human exposure scenarios developed for evaluation included the following:

- Scenario 1 (Current Trespasser) - Exposure to youths aged 9 to 18 years through direct access to the site.
- Scenario 2 (Current or Future Commercial/Industrial Worker) - Exposure to adult employees through future use of the site.

Scenario 3 (Future Construction Worker) - Exposure to adult workers for a one year period assuming construction of commercial or residential buildings.

- Scenario 4 (Future Resident) - Exposure to children (0 to 6 years of age) and youths/adults (7 to 30 years of age) through future residential use of the site.

Assumptions used in evaluating each exposure scenario were developed to be conservative yet representative of current and anticipated conditions. Uncertainties associated with these assumptions were addressed for each scenario.

For each constituent of potential concern, a geometric mean and maximum detected concentration were determined. Using the mean and maximum concentrations, constituent exposure doses (in mg/kg-d) were quantified for each constituent in each scenario-specific pathway. Per EPA Region I guidance (1989b), the exposure doses based on maximum concentrations are referred to as estimates of reasonable maximum exposure (RME).

#### RISK CHARACTERIZATION

Human health risks were presented with regard to potential effects from the constituents of potential concern. These effects may include potential risks of cancer or non-cancerous (systemic) effects. Cancer risk levels, the lifetime incremental probabilities of excess cancer due to exposure to the site constituents, take into account exposure concentrations and the carcinogenic potencies of the constituents. Cancer risks are calculated by multiplying exposure dose by the appropriate cancer slope factor for each constituent and exposure route. The cancer risk estimates are presented in scientific notation, where a lifetime risk of 1E-04 represents a lifetime risk of one in ten thousand.

Potential risks from exposures to non-carcinogens were evaluated using RfDs. The associated constituent-specific risk was quantitated by the Hazard Quotient (HQ), which is the ratio of the exposure dose to the RfD. For each pathway, the constituent-specific HQs were summed across constituents to determine the pathway hazard index (HI).

The calculated cancer risks and non-cancer HIs were evaluated using the available regulatory guidance. The calculated risk is compared to the acceptable lifetime cancer risk range (1E-04 to 1E-06) for evaluating the need for remediation, as stated in 40 CFR Part 300 (EPA, 1990b). EPA (1990b) considers a cancer risk of 1E-06 as the point of departure for determining

risk-based remediation goals. For non-carcinogenic risks, a target HI of unity is used. When the total HI for an exposed individual or group of individuals exceeds unity, there may be concern for potential non-cancer health effects. Thus, the cancer risk level and HI ratio that constitute a potential concern are  $> 1E-06$  and  $> 1E+00$ , respectively.

The estimated cancer and non-cancer risks for each pathway by scenario are summarized in Table ES-1.

As shown, the estimated pathway-specific cancer risks for Scenario 1 (Trespasser) and Scenario 3 (Construction Worker) fall approximately between a factor of 10 and 10,000 below  $1E-06$ . Pathway-specific risks ranged between  $7E-07$  and  $5E-05$  for Scenario 2 (Commercial/Industrial Worker) and Scenario 4 (Resident). Exposure to carcinogenic PAHs, Aroclor-1260, arsenic, and beryllium in soil (all scenarios) and arsenic and beryllium in ground water (Scenario 4 only) accounts for most of the estimated cancer risks. However, it should be noted that most of the detected concentrations of PAHs (total) in surface and subsurface soil fall within the range reported in the literature for rural soils (0.01 to 1 mg/kg) (Menzie et al., 1992) and the range observed in NCBC background samples (non-detected to 1.1 mg/kg), with a smaller number falling within the upper range of typical urban background (1 to 3 mg/kg) (Menzie et al., 1992). The data reported by Menzie et al. (1992) (geographic location not specified) provide an additional basis for evaluating the concentrations of PAHs detected on site relative to those reported for various land use categories (e.g., forest, rural, urban). For Aroclor-1260 in surface soil, a comparison to NCBC background (non-detected to 0.096 mg/kg as shown in Appendix G of Volume I of the Phase II RI for Sites 02, 03, 06, 07, 10, 11, 13; TRC, 1993a) and literature background data (non-detected to 0.033 mg/kg in a U.S. national forest; ATSDR, 1987b) indicates that while the three Phase I detected concentrations (0.190 to 0.450 mg/kg) are slightly higher than background, the five detected Phase II concentrations (0.020 to 0.052 mg/kg) are within background. Aroclor-1260 was detected in only 1/12 subsurface soil samples at a concentration (0.023 mg/kg) below background. It should also be noted that all of the detected concentrations for arsenic in soil are within background concentrations at NCBC Davisville and eastern U.S. locations. In addition, comparison of detected arsenic concentrations in Site 08 ground water to levels detected in other NCBC Davisville upgradient samples indicates arsenic levels may not be elevated. That is, only one of the three samples contained arsenic

ES - 1  
 SUMMARY OF CANCER AND NON-CANCER RISK ESTIMATES FOR ALL SCENARIOS  
 NCBC DAVISVILLE - SITE 08

Pathway	CANCER RISKS							
	Scenario 1 (Trespasser)		Scenario 2 (Commercial/Industrial Worker)		Scenario 3 (Construction Worker)		Scenario 4 (Resident)	
	Geometric Mean	RME	Geometric Mean	RME	Geometric Mean	RME	Geometric Mean	RME
Incidental ingestion of soil	4E-07	9E-07	2E-06	5E-06	5E-07	8E-07	2E-05	5E-05
Dermal contact with soil	6E-08	2E-07	7E-07	2E-06	3E-08	3E-08	2E-06	5E-06
Inhalation of particulates	--	--	--	--	6E-10	1E-09	--	--
Ingestion of ground water	--	--	--	--	--	--	5E-05	6E-05

= Cancer risk > 1E-6

Pathway	NON-CANCER HAZARD INDICES							
	Scenario 1 (Trespasser)		Scenario 2 (Commercial/Industrial Worker)		Scenario 3 (Construction Worker)		Scenario 4 (Resident)	
	Geometric Mean	RME	Geometric Mean	RME	Geometric Mean	RME	Geometric Mean	RME
Incidental ingestion of soil	8E-04	2E-03	2E-03	5E-03	1E-02	2E-02	4E-02	2E-01
Dermal contact with soil	2E-06	7E-06	1E-05	3E-05	1E-05	1E-05	1E-04	3E-04
Inhalation of particulates	--	--	--	--	1E-05	2E-05	--	--
Ingestion of ground water	--	--	--	--	--	--	4E+00	7E+00

= Hazard index > 1E+0

concentrations at levels greater than those reported at other NCBC upgradient locations. For beryllium in soil, none of the detected concentrations exceed eastern U.S. background, while only three of the twenty-four (3/24) detected surface soil concentrations and 1/11 detected subsurface soil concentrations exceed site background. A comparison of the detected beryllium concentration in Site 08 ground water to levels detected in other NCBC Davisville upgradient samples (ranging up to 1.1 mg/l) indicates beryllium concentrations are not elevated. With the exception of ground water ingestion under the residential scenario, the pathway-specific HIs fall well below 1E+00. The elevated HIs for ingestion of ground water (4E+00 to 7E+00) are primarily attributable to manganese. It should be noted, however, that the detected concentrations of manganese in Site 08 ground water (0.36 to 1.3 mg/l) are not elevated relative to the concentrations of manganese detected in upgradient wells at other NCBC Davisville sites (non-detected to 2.2 mg/l). An upgradient well is not available at Site 08. Finally, potable use of ground water at Site 08 is not presently occurring and is not likely to occur in the future.

Most of the cancer risks estimated in the Phase II HHRA are comparable or slightly higher than those estimated in the Phase I HHRA. Slightly lower cancer risks were estimated in Phase II for dermal contact with surface soil in the trespasser scenario (mean and RME). Unlike the Phase II HHRA, all of the non-cancer HIs in Phase I fell well below 1E+00. The elevated HIs in Phase II are attributable to manganese in ground water. Ground water data were not collected and therefore potential exposures and risks from ground water ingestion not evaluated in Phase I.

#### UNCERTAINTY ASSESSMENT

The uncertainty assessments for each component of the HHRA identified the major sources of uncertainty as follows:

- Assumptions about current and potential future land use at the site; pathways through which actual or potential receptors may be exposed, and the magnitude, frequency, and duration of potential exposures to environmental media at the site;
- Exclusion of constituents from quantitative evaluation in the HHRA due to lack of quantitation or missing toxicity data;

The use of models to estimate concentrations of constituents in fugitive dust (Scenario 3 only);

- Data uncertainties due to infrequent detections, limited numbers of samples, or qualified data (e.g., estimated concentrations, elevated sample quantitation limits (SQLs));
- Considerations of naturally occurring or background concentrations of COCs with regard to potential exposures and health risks;
- Toxicity assessment (e.g., toxicity values based on animal data, use of benzo(a)pyrene toxicity values for other carcinogenic PAHs); and
- Potential interactions between carcinogens and between non-carcinogens which could lead to increased or diminished carcinogenic responses or toxicity.

## 1.0 BASELINE HEALTH RISK ASSESSMENT

### 1.1 Objectives

This report provides a quantitative human health risk assessment (HHRA) for Site 08, the Defense Property Disposal Office, Film Processing Disposal Area located at the Naval Construction Battalion Center (NCBC) in Davisville, Rhode Island. Its primary objectives are to identify the constituents of potential concern in the environmental media, characterize the potential land uses (current and future) and exposure pathways, and estimate the potential for adverse effects for the identified constituents and exposure conditions. The HHRA follows guidelines established by the U.S. Environmental Protection Agency (EPA, 1989a and 1989b).

Specific exposure scenarios are considered and developed which represent potential situations in which humans may be exposed to constituents originating from the site. Efficacy of specific remedial programs is not included as part of this analysis.

Human health risks associated with the site are presented with regard to potential effects from the constituents of potential concern. These effects may include potential risks of cancer or non-cancerous (systemic) effects. A quantitative HHRA for carcinogens involves calculations of the lifetime incremental probabilities of cancer that take into account exposure concentrations and the carcinogenic potencies of the constituents. Potential risks from exposures to non-carcinogens are evaluated using reference dose (RfD) values. The associated constituent-specific risk is quantitated by the Hazard Quotient (HQ), which is the ratio of the exposure dose to the RfD. For each pathway, the constituent-specific HQs are summed across constituents to determine the pathway hazard index (HI).

Ultimately, the HHRA presented in this report is expected to be used within a risk management framework. In making decisions concerning what actions, if any, should be taken at a site (including, for example, the collection of additional data or implementation of a remedial program), the results of the HHRA should be used in concert with other information on the site. The HHRA will also identify site or land use conditions that present unacceptable risks. The results of the HHRA also identify constituents and exposure pathways contributing the greatest risk to the receptor population. From this information, recommendations for future activities at the site can be made such that public health is protected.

This HHRA focuses most strongly on the baseline conditions at the site. However, the results of this study will help decision makers focus on the constituents, media, pathways and receptors of greatest concern at the site, thereby helping to identify future remedial alternatives for the site.

## 1.2 Methodology

The methodology is structured utilizing the most current methods accepted by the EPA as described in the Region I Supplemental Risk Assessment Guidance for the Superfund Program, Part 1 - Guidance for Public Health Risk Assessments (1989b) and the Interim Final Risk Assessment Guidance for Superfund, Volume I (Human Health Evaluation Manual - Part A) (1989a). Where assumptions are made, they are realistic but conservative, i.e., protective of public health. In keeping with accepted practices for conducting such assessments, all assumptions are carefully discussed and an assessment made of the uncertainty associated with the overall health risk estimates.

Following the guidelines accepted by the EPA, the basic components of the HHRA are organized and presented for the site as follows:

- Hazard Identification;
- Dose-Response Assessment;
- Exposure Assessment;
- Risk Characterization; and
- Uncertainty Assessment.

Each of these components are discussed in detail in relation to the site.

## 2.0 HAZARD IDENTIFICATION

### 2.1 Site Description

Site 08, known as the Defense Property Disposal Office, Film Processing Disposal Area, is a flat mowed, grassy field, approximately 40 feet by 80 feet located in a portion of the NCBC Davisville facility known as West Davisville. The site is adjacent to an empty warehouse (Building 314). A paved road passes through the site and a 20-foot high chain link fence topped with barbed wire designates the eastern boundary of the site. Unknown quantities of waste liquids containing photographic constituents, formaldehyde, acetic acid, potassium hydroxide, and sulfuric acid were discharged onto the pavement outside of Building 314 as a result of silver recovery processes performed on photographic wastes during a 6-month period in 1973. The site is not currently used for any naval activities. The Rhode Island Port Authority owns the Devils Foot Road Disposal Area which is located adjacent to the eastern boundary of Site 08. The location of NCBC Davisville is shown in Figure 1. Figures 2 and 3 depict the sample locations for the Phase I and II RIs, respectively.

### 2.2 Data Collection

Sample collection during the Phase I and II remedial investigations at Site 08 included a soil gas survey, surface soil sampling, soil boring sampling, and ground water sampling (Phase II only). Phase I and II samples were analyzed by Compuchem Laboratories, Inc. in North Carolina and by Pace, Inc. in New Hampshire, respectively.

The soil gas survey was performed during Phase II in January 1993. A total of 27 soil gas points were installed for soil gas measurement. All soil gas samples were collected at a depth of three feet below grade. Each sample was subjected to dual analysis: 1) modified EPA Method 601 for 12 chlorinated volatile organic compounds (VOCs), and 2) modified EPA Method 602 for benzene, toluene, ethylbenzene, and xylenes (BTEX).

Surface soil samples were collected at a total of 16 locations (10 in Phase I and 6 in Phase II). The 10 Phase I surface soil samples were collected from a depth of 0 to 6 inches below grade, while the six Phase II surface soil samples were obtained from 0 to 1 foot below grade. In addition to the 16 surface soil samples, eight surface boring samples (from soil borings and monitoring well borings) were collected from a depth of 0 to 2 feet below grade

using a split spoon. All 24 surface soil and surface boring samples (heretofore called surface soil samples) were analyzed for the Target Compound List (TCL) and the Target Analyte List (TAL). One of these samples was also analyzed using the Toxicity Characteristic Leaching Procedure (TCLP).

Subsurface soil samples were collected at a total of 13 locations (5 in Phase I and 8 in Phase II). Phase I subsurface soil samples were obtained from a depth of 3.5 feet. Phase II subsurface soil samples were collected at 2 to 4 or 4 to 6 feet below grade. All Phase I and 7 Phase II subsurface soil samples (i.e., 12 samples total) were analyzed for TCL and TAL. One Phase I sample was also submitted for analysis using TCLP.

Four ground water monitoring wells were installed during Phase II (three shallow and one deep). Unfiltered and filtered ground water samples were collected from each well. Ground water samples were analyzed for TCL, TAL, and cyanide.

### **2.3 Data Evaluation**

In order to organize the Phase I and Phase II RI data into a form manageable and appropriate for the baseline HHRA, the following steps were followed during the data evaluation process and are consistent with current EPA guidance (1989a, 1989b, 1992b):

- 1) Gather and sort all data by medium (i.e. surface soil, subsurface soil and ground water);
- 2) Evaluate methods of analysis;
- 3) Evaluate sample quantitation limits;
- 4) Evaluate data qualifiers and codes;
- 5) Evaluate blank data;
- 6) Evaluate tentatively identified constituents (TICs);
- 7) Evaluate duplicate data;
- 8) Evaluate sample recollect data;
- 9) Evaluate background data;

- 10) Develop data sets by medium; and
- 11) Develop a set of constituents of potential concern from the entire data set.

Briefly, the specific methods used for Site 08, which correlate with the previously described steps, include the following:

- 1) All analytical data was initially sorted by media. Surface soil is defined as Phase I soil samples taken at the 0-0.5 foot interval, and Phase II soil samples taken across the 0-1 and 0-2 foot intervals. Soil samples taken from the 2-10 foot interval are considered subsurface soil samples.
- 2) An evaluation of analytical methods was not considered necessary as all data used was analyzed by EPA's Superfund Contract Laboratory Program (CLP) procedures.
- 3) Sample quantitation limits (SQLs) greater than 10 times the "normal" SQL are considered extremely elevated for the purposes of this HHRA. For example, given a "normal" SQL of 330 mg/kg for an SVOC in soil, a reported SQL of 33,000 mg/kg is considered extremely elevated, while a reported SQL of 500 mg/kg is not considered extremely elevated. Based on this criterion, unusually high SQLs were reported for one or more Phase I samples for benzoic acid, DDT, and Aroclor-1260 in soil. Although non-detects with extremely high SQLs may be removed from data sets (EPA, 1989a), these non-detects are retained for the purposes of this HHRA based on the bias towards sampling in areas of suspected contamination during the Phase I and Phase II sampling programs. As described by Region I (EPA, 1989b), non-detects in samples from a biased sampling program have a greater probability of being contaminated than non-detects from an unbiased program. In calculating exposure point concentrations, a value of one-half the SQL is assigned to non-detects with extremely elevated SQLs.

For other non-detects (i.e., those without unusually high SQLs), a value of either the SQL or one-half the SQL are assigned. If a constituent was likely to be present below the SQL, then a value of one-half the SQL is assigned to the non-detect. A value equal to the SQL is used for constituents likely to be present at concentrations close to or greater than the SQL.

SQLs which are halved for the purposes of calculating exposure point concentrations are italicized and shaded in Appendix A.

- 4) Data validation qualifiers are also assessed during the data evaluation process. As indicated in EPA guidance (EPA, 1989a, 1989b, 1992b), unqualified data and data qualified with a "J" qualifier are treated as detectable concentrations. Data

qualified with "UJ" or "U" qualifiers are treated as non-detectable concentrations. As described in 3) above, non-detects are assigned a value equal to the SQL or one-half the SQL. With the exception of data qualified with an "R" or data for constituents not detected in any medium, all data are included in the HHRA. As described by EPA (1989a, 1992b), "J", "U", and "R" qualifiers are defined as follows:

- "J" - Value is estimated, either for a tentatively identified constituent (TIC) or when a constituent is present but the value is less than the contract required quantitation limit (CRQL). Data qualified as estimated may be biased high or low (i.e., may overestimate or underestimate the actual concentrations).
- "U" - Constituent was analyzed for, but not detected. The value reported in the NCBC data sets corresponds to the SQL.
- "UJ" - Constituent was analyzed for, but not detected. The "J" qualifier signifies that the SQL is estimated.
- "R" - Quality control assessment indicates the data are unusable and are therefore rejected for use in risk assessment. Both the presence and concentration of the constituent are uncertain.

Note: EPA (1992b) refers to EPA (1989a) for a continued discussion on the potential use of qualified data in risk assessments.

- 5) Field and laboratory blanks are used to segregate actual site contamination from cross contamination from field or laboratory procedures. As indicated in EPA (1989a, 1992b), sample results are considered positive only if concentrations exceeded ten times the concentration of a common laboratory contaminant in a blank, or five times the concentration of a constituent that is not considered a common laboratory contaminant. If less than five or ten times the blank concentration, the constituent is treated as non-detected in that sample and, per EPA Region I (1988c and 1988d), the SQL assumed to be equal to the value initially reported for the constituent in that sample.

Validation using Phase II laboratory method blanks was conducted by Heartland Environmental Services, Inc. Evaluation of Phase II field, trip, and rinseate blanks (as provided in Appendix D of Volume I of the Phase II RI for Site 08 (TRC, 1993e)) is performed as part of this HHRA. TRC was unable to locate blank data for Phase I during the preparation of this Phase II HHRA. As a result, Phase I values reported as detected are assumed to be detected. In Phase II soil, acetone, bis(2-ethylhexyl)phthalate, and several inorganics (copper, iron, lead, magnesium, manganese, and zinc) were detected in one or more field trip,

or rinseate blanks. As shown as bolded and shaded values in Appendix A, selected samples for acetone and lead in soil are considered non-detected based on the evaluation of blank contamination. For the other constituents detected in the soil blanks, all of the soil concentrations reported as hits exceed the blank concentrations and are therefore treated as detected in this HHRA.

Carbon disulfide, bis(2-ethylhexyl)phthalate, and selenium in Phase II ground water are considered non-detected based on a review of non-laboratory blanks. Carbon disulfide and selenium were detected in ground water at concentrations (0.0095 mg/l for carbon disulfide at 08-MW3D/4S and 0.0013 mg/l (at 08-MW03S) to 0.0027 mg/l at 08-MW1S for selenium) less than five times the concentrations reported in the rinseate blank (0.007 mg/l for carbon disulfide and 0.0018 for selenium in RB-311). Bis(2-ethylhexyl)phthalate, a common laboratory contaminant, was detected at concentrations (0.006 to 0.120 mg/l) less than 10 times the level detected in the rinseate blank (0.014 mg/l in RB-311).

- 6) As shown in Appendix C of Volume I of the Phase II RI for Site 08 (TRC, 1993e), tentatively identified constituents (TICs) were reported in surface soil, subsurface soil, and ground water. Trimethyl silanol and one unknown were the only tentatively identified VOCs detected in ground water. No tentatively identified VOCs were reported for any soil samples. A number of semi-volatile organic compounds (SVOCs) were tentatively identified in all three media, especially in surface and subsurface soils where as many as 50 SVOCs were tentatively identified. Up to 17 unknown SVOCs were also tentatively identified in surface and subsurface soils. Due to the uncertainty associated with TICs, these constituents are not included in the quantitative assessments of exposure and risk. TRC was unable to locate TIC data for Phase I during the preparation of this Phase II HHRA.
- 7) Sample and duplicate data are compared and a determination made as to whether these data should be averaged. Sample and duplicate sample concentrations are averaged if the two values are within 35% of each other for soil and 20% for water. Otherwise, the sample concentration and sample qualifiers are used. If the values are averaged, the constituent is treated as detected if reported as detected in the sample and/or duplicate. The difference between the sample and duplicate concentrations is estimated as:

$$\begin{array}{l} \text{Relative} \\ \text{Percent} \\ \text{Difference} \end{array} = \frac{|\text{Sample} - \text{Duplicate}|}{\text{Average}} \times 100\%$$

Three duplicate surface soil samples (MW41, SS18, and B61) and one duplicate ground water sample (08-MW4S) were collected (all during Phase II). No duplicate samples were obtained at Site 08 during the Phase I RI. As a result of

the duplicate evaluation described above, some of the sample and duplicate concentrations are averaged. The evaluated/combined data are shown in Appendix A of this HHRA. Appendix D of Volume I of the Phase II RI for Site 08 (TRC, 1993e) contains the concentrations reported separately for the four samples and their respective duplicates.

- 8) Sample recollection data are also evaluated as part of the overall data evaluation. Since sample recollect (SRC) and duplicate sample recollect (SDRC) data are typically obtained as a result of quality control parameters not being met in the initial sample analysis, the recollection data for a sample are used in place of the original data for that sample. Similar to the approach for duplicates described in 7) above, either the SRC concentration or the average of the SRC and SDRC concentrations is used depending on the variability between the two values. Specifically, the SRC and SDRC values are averaged if the two values are within 35% of each other for soil and 20% for water. Otherwise, the SRC concentration and qualifier are used. If the values are averaged, the constituent is treated as detected if reported as detected in the SRC and/or SDRC samples.

Two sets of SRC/SDRC surface soil samples were collected during Phase I (S-08-06-00-SRC/SDRC and S-08-09-00-SRC/SDRC). No SRC/SDRC samples were collected at Site 08 during Phase II. As a result of the SRC/SDRC evaluation described above, some of the Phase I SRC and SDRC concentrations are averaged. The evaluated/combined data are shown in Appendix A of this HHRA. Appendix H of the Phase I RI (TRC-ECI, 1991b) contains the concentrations reported separately for the SRC and SDRC samples.

- 9) A total of 22 background soil samples were collected during Phase II (see Figure 4). Background samples were collected in unimpacted areas located as close to the NCBC sites as possible. Identification of areas at or near each site that have not been impacted by NCBC activities was made on the basis of historical aerial photographs. For Sites 02, 07, 09, and 10, unimpacted areas were identified on site. For Sites 06, 11, and 13, background locations were identified in wooded areas located east of these sites. The concentrations of inorganics in the NCBC background samples are used as a screening method to evaluate whether these constituents in site surface soils are naturally occurring or of anthropogenic origin. Constituents of anthropogenic origin (i.e., present as a result of human activities) may or may not be site-related. An inorganic is excluded from the HHRA if the detected concentrations consistently fall below the maximum background concentration reported for the NCBC facility and for the eastern U.S. While site-specific data are preferable, regional information such as the USGS data for the eastern U.S. is often based on a greater number of samples and provides additional information on what levels of constituents are representative of background. Table 1 provides the range of background concentrations for each inorganic constituent at NCBC Davisville. As shown, the

maximum detected background concentrations at NCBC consistently fall below those reported for eastern U.S. soils. Organic constituents present in background samples are not considered naturally occurring and are not used to evaluate the presence and concentration of organics in site samples (EPA, 1992b). Background ground water data for the NCBC facility or national/regional data are unavailable.

- 10) Tables 2 and 3 provide summary statistics (i.e., frequency and range of detects) for constituents detected in soils (surface and subsurface) and ground water, respectively.

#### **2.4 Summary of Soil Gas Data**

No VOCs were detected at any of the 27 soil gas sampling locations.

#### **2.5 Summary of Surface Soil Data**

Table 2 presents a summary of the analytical data associated with constituents detected in surface soil and subsurface soil, organized by class, including VOCs, SVOCs, pesticides/polychlorinated biphenyls (PCBs) and inorganics. This table includes only those constituents considered detected based on the previously described data validation. Each class of constituents is discussed in detail below.

##### **■ Volatile Organics**

The most frequently detected VOC in surface soil was methylene chloride (5/24) at 0.004 to 0.007 mg/kg. Chloroform was detected in 4/24 samples at 0.001 to 0.003 mg/kg. The third and least frequently detected VOC in surface soil was acetone (2/24) at 0.075 to 0.089 mg/kg. In general, the detected concentrations of these VOCs are low (near or below the SQLs reported for these constituents in other samples).

##### **■ Semi-Volatile Organics**

Thirteen SVOCs were detected in surface soil including benzoic acid, 11 polycyclic aromatic hydrocarbons (PAHs), and one phthalate ester.

Benzoic acid was analyzed for presence in Phase I only. It was detected in 4/10 surface soil samples at 0.049 to 0.13 mg/kg. Unusually high SQLs (up to 1.9 mg/kg) were reported for benzoic acid.

The most frequently detected carcinogenic PAHs (seven carcinogenic PAHs were detected) were benzo(a)anthracene, benzo(a)pyrene, benzo(b/k)fluoranthene, and chrysene all detected in 10/24 surface soil samples. The detected concentrations of carcinogenic PAHs range from 0.04 mg/kg (indeno(1,2,3-cd)pyrene) to 0.14 mg/kg (dibenzo(a,h)anthracene). Pyrene was the most frequently detected non-carcinogenic PAH (four non-carcinogenic PAHs were detected) and was found in 11/24 samples at 0.081 to 0.48 mg/kg. The majority of detected PAH concentrations fall below the SQLs reported for these constituents in other samples.

Bis(2-ethylhexyl)phthalate was detected in 10/24 samples at concentrations of 0.04 to 0.29 mg/kg. The majority of detected concentrations for bis(2-ethylhexyl)phthalate are below the SQLs reported for this constituent in other samples.

#### ■ Pesticides/PCBs

4'4'-DDT was the only pesticide detected in surface soil. It was detected in 2/24 samples at 0.0029 and 0.029 mg/kg. Aroclor-1260, the only PCB detected, was found in 8/24 samples at concentrations of 0.02 to 0.450 mg/kg. For DDT and Aroclor-1260, the detected concentrations are generally above the SQLs reported for these constituents in other samples.

#### ■ Inorganics

Twenty-one inorganics were detected in surface soil at Site 08, with 13 present in all 24 samples. Cadmium (2/24), cyanide (2/24), mercury (3/24), and silver (2/24) were detected least frequently. The range of background concentrations at NCBC Davisville (as determined from data collected in unimpacted areas at Sites 02, 07, 09 and 10, and wooded areas east of Sites 06, 11 and 13 during the Phase II RI (TRC, 1993a)) was exceeded in a few isolated samples for barium (1/24), beryllium (3/24), cadmium (1/24), calcium (1/24), chromium (2/24), cobalt (1/24), copper (4/24), cyanide (3/24), iron (1/24), lead (3/24), magnesium (5/24), mercury (1/24), nickel (2/24), potassium (4/24), silver (2/24), thallium (1/24), vanadium (1/24) and zinc

(1/24). None of the inorganic concentrations exceeded those reported for eastern U.S. soils (USGS, 1984). The SQLs for inorganics are not unusually high.

## 2.6 Summary of Subsurface Soil Data

Table 2 also presents a summary of the analytical data associated with constituents detected in subsurface soil, organized by class including VOCs, SVOCs, pesticides/PCBs, and inorganics. Although subsurface soil is defined by Region I as soil located to depths of ten feet, soil samples were collected only to a maximum depth of six feet at Site 08 due to the presence of the water table at this depth. For the purposes of evaluating exposures to subsurface soil, this HHRA assumes soil samples from two to six feet are representative of subsurface soil down to a 10 foot depth. Each class of constituents is discussed in detail as follows.

### ■ Volatile Organics

Four VOCs were detected in subsurface soil (all in 1/12 samples) including chloroform at 0.001 mg/kg, ethylbenzene at 0.003 mg/kg, methylene chloride at 0.006 mg/kg, and xylene (total) at 0.21 mg/kg. With the exception of xylene, the detected concentrations are below the SQLs reported for these constituents in other samples.

### ■ Semi-Volatile Organics

Ten SVOCs were detected in subsurface soil including benzoic acid, eight PAHs, and one phthalate ester. Most of these were detected in 1/12 samples, with the exception of benzoic acid (1/5), benzo(b/k)fluoranthene (2/12), and bis(2-ethylhexyl)phthalate (4/12).

Benzoic acid was detected in 1/5 Phase I samples at 0.045 mg/kg, a level considerably below the SQLs reported for this constituent in other samples (1.7 to 3.5 mg/kg). Benzoic acid was not analyzed for presence in Phase II samples.

Three carcinogenic PAHs were detected in subsurface soil, in 1/12 samples at concentrations of 0.042 mg/kg (chrysene) to 0.054 mg/kg (benzo(b/k)fluoranthene). Of the five non-carcinogenic PAHs detected (all in 1/12 samples), 2-methylnaphthalene was detected at the highest concentration (2.4 mg/kg). With the exception of fluorene and 2-methylnaphthalene, the detected concentrations for the PAHs are less than the SQLs reported for these constituents in

other samples. The SQL for PAHs in Sample B12 (2.8 mg/kg) is unusually elevated relative to the other SQLs reported for PAHs in other samples.

Bis(2-ethylhexyl)phthalate was found in 4/12 samples at 0.12 to 0.47 mg/kg. Bis(2-ethylhexyl)phthalate was detected at levels below the SQLs reported for this constituent in other samples.

#### ■ Pesticides/PCBs

No pesticides were detected in subsurface soil. The only PCB detected in subsurface soil, Aroclor-1260, was found in 1/12 samples at 0.023 mg/kg. This detected concentration is less than the SQLs reported for other samples. Unusually high SQLs for Aroclor-1260 were reported for samples S-08-05-03 (3.5 mg/kg) and S-08-09-03 (7.0 mg/kg). Possible explanations for elevated SQLs in general include matrix interferences and/or elevated target compound concentrations.

#### ■ Inorganics

Twenty inorganics were detected in subsurface soil at Site 08. A number of inorganics were detected in all 12 subsurface soil samples including aluminum, barium, calcium, chromium (total), iron, magnesium, manganese, and zinc. The detected concentrations for inorganics ranged from 0.24 mg/kg for selenium to 11,000 mg/kg for iron, with the majority falling between 1 and 500 mg/kg.

The range of site background concentrations for specific inorganics (as determined from data collected in unimpacted areas at Sites 02, 07, 09 and 10, and wooded areas near Sites 06, 11 and 13 during the Phase II RI (TRC, 1993a)) was exceeded in 1/12 samples for beryllium (at 1.4 mg/kg), calcium (at 930 mg/kg), cyanide (0.4 mg/kg), manganese (169 mg/kg), and sodium (482 mg/kg). There were 2/12 exceedances of site background for chromium (1.4 and 11.6 mg/kg) and 3/12 exceedances for potassium (777, 999, and 1,360 mg/kg). No other sample concentrations exceeded site background. All detected subsurface soil concentrations fall within background concentrations reported for eastern U.S. soils (USGS, 1984).

SQLs for inorganics in subsurface soil are not unusually high. However, detected concentrations for cadmium (Phase I), cyanide (Phase I), and silver (Phase II) fall below the reported SQLs for these constituents in other samples.

## 2.7 Summary of Ground Water Data

Table 3 presents a summary of the analytical data for constituents detected in Phase II ground water samples. Ground water samples were not collected in Phase I. This table includes only those constituents considered detected based on the previously described data validation. Each class of constituents is discussed in detail below, with the exception of SVOCs and pesticides/PCBs, which were not detected at any ground water sampling location.

### ■ **Volatile Organics**

Acetone was the only VOC detected in ground water. It was found in 2/4 samples at 0.040 and 0.092 mg/l. The SQLs for these constituents in other samples are less than the detected concentrations.

### ■ **Inorganics**

Sixteen inorganics were detected in ground water. Eight of these were detected in all four samples including aluminum, barium, calcium, iron, magnesium, manganese, potassium, and sodium. Detected concentrations ranged from 0.0003 mg/l (beryllium) to 28.8 mg/l (sodium). Concentrations for arsenic, beryllium, chromium, cobalt, copper, cyanide, lead, and vanadium were in the 0.001 mg/l (i.e., 1  $\mu$ g/l) range. With the exception of beryllium, the detected concentrations are greater than the SQLs reported for other samples.

## 2.8 Selection of Constituents of Potential Concern

A number of general factors are considered in selecting the constituents of potential concern for each medium (i.e., soil and ground water). These factors include: (i) detection frequency, (ii) range of detected concentrations, (iii) comparison to available background data (inorganics in soil only), and (iv) chemical toxicity. The purpose of the selection process is to identify the site-related constituents which are likely to contribute significantly to the estimates

of risk. Tables 2 and 3 summarize the range of concentrations for constituents detected in soil and ground water, respectively. Constituents are excluded from further consideration in the HHRA based on one or more of the following:

- The constituent was not detected in any medium, or if detected, was found in each medium at a frequency less than 5% (with a minimum requirement of 20 samples).
- The detected concentrations of inorganics in soil consistently fall within the range reported for site and eastern U.S. (USGS, 1984) background. As described in Section 2.3 and summarized in Table 1, background samples were collected from Sites 02, 07, 09, and 10 and in wooded areas near Sites 06, 11, and 13 during the Phase II RI for the NCBC facility (TRC, 1993a). Although the background data collected at or near the NCBC facility is site-specific, regional or national data (e.g., the USGS data set) are generally based on larger numbers of samples and provide a further basis for determining whether or not concentrations of inorganics detected on site are representative of background.

Note: the ranges of site background concentrations are consistently within those reported for eastern U.S. soils.

- Based on a qualitative detection-toxicity screen, a constituent is unlikely to significantly contribute to site risk. Factors considered in this screening include frequency and level of detection, comparison to background, and constituent toxicity. For example, a constituent is excluded as a COC if most of the detected concentrations fall within background, the detected concentrations are low and the constituent is associated with low toxicity. The qualifier "low" is defined as low relative to other constituents in the same chemical class.

A detailed rationale is provided below for each detected constituent which is excluded as a COC from the HHRA.

The selected constituents of potential concern in soil and in ground water are shown in Table 4. In soil, three VOCs, 13 SVOCs, two pesticides/PCBs, and six inorganics are selected as constituents of potential concern. Most of these were also evaluated in the Phase I HHRA. Four of the constituents of potential concern in Phase I (i.e., silver, fluorene, acenaphthene, and 2-methylnaphthalene) are not considered further in Phase II. Silver was detected only in 2/24 surface soil samples (28 mg/kg in Phase I and 0.47 mg/kg in Phase II) and was not detected in subsurface soil. Silver is excluded from Phase II based on low detected frequency and since it did not contribute significantly to risk in Phase I. Fluorene is excluded from Phase II since it

was detected in 0/24 surface soil samples and in 1/12 subsurface soil samples (1.1 mg/kg in Phase I). Fluorene is also associated with lower toxicity relative to other constituents selected for evaluation. Acenaphthene is eliminated from the Phase II HHRA since it is not considered detected in either surface or subsurface soil in Phase II. Although reported as detected in Phase II surface soil sample S-08-09-00-S, acenaphthene was not detected in either of the recollected Phase II samples for this location (i.e., S-08-09-00-SRC or S-08-09-00-SDRC) and as described in Section 2.3 is not considered detected for the purposes of this Phase II HHRA. 2-Methylnaphthalene is excluded from the Phase II HHRA since it was not detected in surface soil samples and detected at 2.4 mg/kg in a single subsurface soil sample in Phase I. 2-Methylnaphthalene was not detected in subsurface soil in Phase II.

In addition to these four constituents, 18 other constituents detected in surface and/or subsurface soil were not included in the Phase I HHRA and are subsequently excluded from the Phase II HHRA. The rationale for not selecting these constituents as COCs is provided below:

VOCs (2):

Ethylbenzene: Non-detected in surface soil; low detection frequency and low detected concentration in subsurface soil (1/12 at 0.003 mg/kg); moderate oral and inhalation RfDs

Xylenes: Non-detected in surface soil; low detection frequency and moderate detected concentration in subsurface soil (1/12 at 0.21 mg/kg); moderate oral and low inhalation RfDs

Inorganics (16):

Aluminum: Detected in surface soil (24/24) and subsurface soil (12/12) at concentrations within site and eastern U.S. background

Antimony: Non-detected in surface soil; Detected in 8% (1/12) subsurface soil samples at concentration within site and eastern U.S. background

Barium: 23/24 of the detected surface soil and 12/12 of the detected subsurface soil concentrations within site background; All detected concentrations within eastern U.S. background

Calcium: 23/24 of the detected surface soil and 11/12 of the detected subsurface soil concentrations within site background; All detected concentrations within eastern U.S. background; Essential element

Cadmium: Detected at <5% (1/24) in surface soil; Non-detected in subsurface soil

Cobalt: 21/22 of the detected surface soil and 10/10 of the detected subsurface soil concentrations within site background; All detected concentrations within eastern U.S. background

Copper: 20/24 of the detected surface soil and 11/11 of the detected subsurface soil concentrations within site background; All detected concentrations within eastern U.S. background

Iron: 23/24 of the detected surface soil and 12/12 of the detected subsurface soil concentrations within site background; All detected concentrations within eastern U.S. background; Essential element

Magnesium: 19/24 of the detected surface soil and 12/12 of the detected subsurface soil concentrations within site background; All detected concentrations within eastern U.S. background; Essential element

Manganese: 24/24 of the detected surface soil and 11/12 of the detected subsurface soil concentrations within site background; All detected concentrations within eastern U.S. background

Mercury: 2/3 of the detected surface soil concentrations within site background; All detected surface soil concentrations within eastern U.S. background; Non-detected in subsurface soil

Potassium: 20/24 of the detected surface soil and 6/9 of the detected subsurface soil concentrations within site background; All detected concentrations within eastern U.S. background; Essential element

Selenium: 6/6 of the detected surface soil and 1/1 of the detected subsurface soil concentrations within site and eastern U.S. background

Sodium: Non-detected in surface soil; Detected in 8% (1/12) subsurface soil samples at concentration within eastern U.S. background; Essential element

Vanadium: 23/24 of the detected surface soil and 11/11 of the detected subsurface soil concentrations within site background; All detected concentrations within eastern U.S. background

Zinc: 23/24 of the detected surface soil and 12/12 of the detected subsurface soil concentrations within site background; All detected concentrations within eastern U.S. background.

In ground water, one VOC and 12 inorganics are selected as constituents of potential concern. Carbon disulfide, bis(2-ethylhexyl)phthalate, and selenium are excluded based on the levels of rinseate blank contamination (i.e., all of the reported concentrations for these constituents fall below five times (carbon disulfide, selenium) or ten times (bis(2-ethylhexyl)-phthalate) the concentrations detected in the rinseate blank. Although detected in ground water, calcium, iron, magnesium, potassium, and sodium are excluded from further consideration based on their low potential for contributing to health risk (i.e., their essential nutrient status). Ground water data were not collected for Site 08 during the Phase I RI.

### 3.0 DOSE-RESPONSE ASSESSMENT

This section presents information on the non-carcinogenic and carcinogenic effects associated with the identified constituents of potential concern. If available, non-cancer and cancer toxicity values from EPA's (1993) Integrated Risk Information System (IRIS) database or EPA's (1992a) Health Effects Assessment Summary Tables (HEAST) are used. For those constituents without the above mentioned toxicity criteria, a qualitative discussion of risk is provided in Section 5.2. The cancer and non-cancer values used in the HHRA are presented in Tables 5 to 8. Appendix B provides brief toxicity profiles which summarize the bases for these values.

#### 3.1 Toxicity Information for Carcinogenic Effects

For potential carcinogens, risks are estimated as probabilities. The constituent-specific slope factors for carcinogens (in units of mg/kg-d) are generally estimated through the use of mathematical extrapolation models (e.g., the linearized multistage model). These models estimate the largest possible linear slope, within a 95 % confidence interval, at low extrapolated doses. Thus, the slope factor is characterized as a 95 % upper bound estimate, such that the true risk is not likely to exceed the upper bound estimate and may be lower. In addition to identifying cancer slope factors, the EPA classifies constituents with regard to their relative carcinogenicity. The classification scheme is as follows (U.S. EPA, 1992a):

<u>Classification</u>	<u>Basis</u>
Group A Human Carcinogen	Sufficient evidence of carcinogenicity in humans.
Group B1 Probable Human Carcinogen	Limited evidence in humans.
Group B2 Probable Human Carcinogen	Sufficient evidence in animals with inadequate or lack of evidence in humans.
Group C Possible Human Carcinogen	Limited evidence in animals with inadequate or lack of evidence in humans.

<u>Classification</u>	<u>Basis</u>
Group D Not classifiable as to Human Carcinogenicity	Inadequate or lack of evidence.
Group E Evidence of Non-carcinogenicity for Humans	No evidence in adequate studies.

Tables 5 and 6 summarize the available toxicity data for carcinogenic effects related to oral and inhalation exposures, respectively. For each constituent of potential concern, the tables contain the available cancer slope factors, EPA's weight-of-evidence classification, the type of cancer, and the source of the cancer slope factor. For assessing the potential risks from dermal exposures, the available oral slope factors are used. Adjustments for differences in oral and dermal absorption are addressed through the use of RAFs in the exposure estimates per Region I guidance (EPA, 1989b). As indicated by Region I (EPA, 1989b), the cancer slope factor for benzo(a)pyrene is assigned to the other carcinogenic polycyclic aromatic hydrocarbons (PAHs) evaluated in the HHRA. For lead, the National Ambient Air Quality Standard (NAAQS) for lead is used to assess inhalation exposures in Scenario 3 (construction). EPA (1992a) references the NAAQS in its comment on the chronic reference concentration (RfC). In the absence of inhalation slope factors, oral slope factors are cross-assigned to inhalation provided that the oral slope factors are not based on contact site tumors. Standard assumptions about breathing rate and body weight are used to convert inhalation slope factors expressed in  $(\text{mg}/\text{m}^3)^{-1}$  to units of dose (i.e.,  $(\text{mg}/\text{kg}\cdot\text{d})^{-1}$ ).

### 3.2 Toxicity Information for Non-Carcinogenic Effects

The evaluation of risk from non-carcinogenic health hazards is based on the use of reference doses (RfDs). RfDs have units of  $\text{mg}/\text{kg}\cdot\text{d}$ , and are estimates of daily exposure to the population (including sensitive subpopulations) that are likely to be without appreciable risk of deleterious effects for the defined exposure period (subchronic or chronic). The RfD is calculated by dividing the no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) derived from animal or human studies by an uncertainty factor, which is

multiplied by a modifying factor. RfDs incorporate uncertainty factors which serve as a conservative downward adjustment of the numerical value and reflect scientific judgment regarding the data used to estimate the RfD. For example, a factor of 10 is used to account for variations in human sensitivity (i.e., to protect sensitive subpopulations) when the data stems from human studies involving average, healthy subjects. An additional factor of 10 may also be used for each of the following:

- extrapolation from chronic animal studies to humans,
- extrapolation from a LOAEL to a NOAEL, and
- extrapolation from subchronic to chronic studies.

Finally, based on the level of certainty of the study and database, an additional modifying factor (between zero and ten) may be used. In establishing an RfD, the EPA assigns it a level of confidence: low, medium, or high.

The toxicity data for non-carcinogenic effects associated with oral and inhalation exposures are summarized in Tables 7 and 8, respectively. Included in these tables are the available RfDs, EPA's confidence level in the RfD, the critical effect, the source of the RfD, and the uncertainty and modifying factors used in setting the RfD. For evaluating the potential non-cancer risks from dermal exposures, the available oral RfDs are used. Differences in oral and dermal absorption are addressed through the use of RAFs in the exposure estimates per Region I guidance (EPA, 1989b).

In the absence of inhalation RfDs for a constituent, the oral RfDs are cross-assigned to inhalation provided that the effects from oral exposure were systemic (i.e., not evident at the point of contact). For Scenario 3 (construction worker), chronic RfDs are used to estimate subchronic risks if subchronic RfDs are unavailable. While the duration of childhood exposures in Scenario 4 (resident) is subchronic (i.e., <7 years), chronic RfDs are used since the overall duration for future residents (childhood and youth/adult exposures combined) is 30 years. Standard assumptions about breathing rate and body weight are used to convert reference concentrations (RfCs) expressed in mg/m<sup>3</sup> to units of dose (i.e., mg/kg-d).

### 3.3 Constituents for Which EPA Has Not Developed Toxicity Criteria

Constituents for which EPA (1992a, 1993) has not developed toxicity values are excluded from the quantitative risk characterization. A qualitative risk evaluation of these constituents (aluminum, cobalt and magnesium) is provided in Section 5.2. Lead is also not assessed quantitatively with regard to its potential carcinogenic or oral non-cancer effects. A qualitative risk evaluation of lead is provided in Section 5.2.

#### 4.0 EXPOSURE ASSESSMENT

This exposure assessment and associated tables and appendices i) identify the exposure scenarios and pathways of interest, ii) calculate the exposure point concentrations used in quantifying constituent exposures, iii) estimate the constituent-specific exposure doses for each pathway and scenario, and iv) provide an overview of the uncertainties associated with the exposure assessment.

#### 4.1 Selection of Exposure Scenarios and Pathways

The most critical aspect of a technically sound exposure assessment is the identification of exposure routes, together with the identification of human receptors. Site 08 in West Davisville currently consists of a mowed grassy field adjacent to a warehouse (Building 314). It is used occasionally as a vehicle parking area. Previously, it was used as the Defense Property Disposal Office, Film Processing Disposal Area. A paved road passes through the site and a chain-linked fence borders the site to the east. Chain-linked fences in combination with locked gates and a patrolling security force currently limit public access to all NCBC Davisville sites. Residential areas are located west and north of West Davisville. A number of schools are located within an approximate one-mile radius of West Davisville. West Davisville is also bordered on the west by Conrail railroad tracks. The entire NCBC Davisville base is scheduled to close within one year. For the purposes of this risk assessment (RA), it is assumed that existing Site 08 property may be available for residential development or commercial/industrial use in the future.

Based on a consideration of potential current and future land uses at Site 08, the general human exposure scenarios identified in the Phase I HHRA (TRC-ECI, 1991a) are also selected for the purposes of the Phase II HHRA. These scenarios include:

##### Scenario 1 - Trespasser (Current)

This scenario evaluates exposure to youths currently trespassing at Site 08. Although security measures are in place at NCBC Davisville, trespassing of youths has been noted at a number of the sites (e.g., Calf Pasture Point and Allen Harbor Landfill). Therefore, trespassing exposure of youths to site constituents is included in the Site 08 HHRA.

Exposures to trespassers are assumed to occur through incidental ingestion of and dermal contact with surface soil.

#### Scenario 2 - Commercial/Industrial Worker (Current or Future)

Exposures of current or future commercial/industrial workers are considered in this scenario. While exposure of base workers to site constituents is possible for one year until closure of the NCBC Davisville base, the potential exists for exposure to commercial/industrial employees at Site 08 in the future. Exposures to commercial/industrial workers are assumed to occur through incidental ingestion of and dermal contact with surface soil.

#### Scenario 3 - Construction Worker (Future)

This scenario considers future exposures of on-site construction workers. Construction workers may be exposed to site constituents during future construction of commercial or residential buildings at Site 08. This scenario is also intended to address potential outdoor worker exposures from other activities (e.g., utility work). Exposures to construction workers are assumed to occur through incidental ingestion of and dermal contact with subsurface soil, and through the inhalation of suspended subsurface soil particulates.

#### Scenario 4 - Resident (Future)

Exposure of future on-site residents are evaluated in this scenario. Pursuant to residential development of Site 08, adults and children living on the site may be exposed to site constituents in the future. Exposures to residents are assumed to occur through incidental ingestion of and dermal contact with surface and subsurface soil, and through the ingestion of ground water. The Phase I HHRA assumed residential exposure to surface soil, not surface and subsurface soil combined.

Each scenario includes a particular potential "receptor population", and a consideration of the pathways by which those receptors may encounter constituents of potential concern.

#### **4.2 Estimation of Exposure Point Concentrations**

As specified in the Region I Supplemental Risk Assessment Guidance (EPA, 1989b), two types of exposure point concentrations are identified for each constituent of potential concern in each medium: the geometric mean and the maximum detected concentration.

The geometric mean may be calculated as follows:

$$Y_{ij\bar{}} = 10^{\frac{\log(X_{i_1} \times X_{i_2} \times \dots \times X_{i_n})}{n}}$$

where:

- $Y_{ij\bar{}}$  = geometric mean of all sample concentrations of constituent i in medium j  
 $X_i$  = the concentration for constituent i in each of n samples  
n = the number of samples

The maximum detected concentration is also used to assess potential exposures and risks. Exposure estimates based on maximum concentrations are referred to estimates of reasonable maximum exposure (RME). Collectively, these two exposure point concentrations allow for average and upper bound estimates of health risk. The data used to determine the geometric means and maximum concentrations of constituents in soil and ground water are provided in Appendix A.

The exposure point concentrations for constituents adsorbed to suspended particulates (expressed in milligrams of particulate-adsorbed constituent per cubic meter of air; mg/m<sup>3</sup>) are calculated using an EPA (1988a) fugitive dust model. The fugitive dust calculations are provided at the end of Appendix C. The fugitive dust concentration is combined with the constituent concentrations in soil to estimate the concentrations of the particulate-adsorbed constituents in air. This approach conservatively assumes that the concentration of constituents in the dust (mg/kg) is equal to the concentration of these constituents in soil (mg/kg). This approach also conservatively assumes that VOCs remain sorbed to dust (i.e., it does not consider the losses of airborne VOCs through volatilization and washout in precipitation).

As indicated in Section 2.3, non-detect values are included in the calculation of exposure point concentrations (i.e., soil and ground water concentrations) either as one-half the SQL or as the SQL itself. These non-detected values include detection limits associated with a "U" or "UJ" qualifier. For each constituent in each medium, non-detects are evaluated in light of the range of SQLs and the range of detected concentrations ("hits"). A non-detect is assigned a value equal to the SQL if the constituent is likely to be present at concentrations equal to or

above the SQL. A value equal to one-half the SQL is assigned if the data indicate the constituent is present at concentrations below the SQL or if the SQL is unusually elevated (EPA, 1989a). In calculating exposure point concentrations, sample and duplicate sample concentrations are averaged for a sample if the two values are within 35% for soil and 20% for water. Otherwise, the sample concentration is used. Three duplicate samples were collected for surface soil, and one for ground water. As a result of the evaluation of duplicates, some of the duplicate concentrations were averaged with the reported sample concentrations.

Tables 9 and 10 provide the soil and ground water exposure point concentrations used in the four scenarios: surface soil (0 to 2 feet) for Scenarios 1 (current trespassing) and 2 (current or future commercial/industrial use), subsurface (2 to 10 feet) for Scenario 3 (future construction), surface and subsurface soil combined (0 to 10 feet) for Scenario 4 (future residential), and ground water for Scenario 4 (future residential).

#### 4.3 Estimation of Constituent Exposure Doses

The estimated constituent exposure doses (mean and RME) for each pathway and scenario are presented along with the risk estimates in Tables 12 to 15. A discussion of the risk estimates is provided in Section 5. The equations and input parameters used to estimate these exposure doses are provided by scenario in Appendix C. The input parameters are also summarized and compared with Phase I values in Table 11. The exposure doses are calculated following Region I (EPA, 1989b) guidance and are expressed in milligrams constituent per kilogram body weight per day (mg/kg-d).

The generic equation for calculating constituent exposure dose is:

$$\text{Exposure Dose} = \frac{\text{Conc} \times \text{ConRate} \times \text{RAF} \times \text{ExpFreq} \times \text{ExpDur}}{\text{BW} \times \text{AT}}$$

where:

Conc = exposure point concentration (either the geometric mean or the maximum detected concentration) (mg/kg for soil, mg/l for water)  
 ConRate = amount of contaminated medium contacted per unit time or event (mg/d for soil, l/d for water)

RAF	=	relative absorption factor (--)
ExpFreq	=	frequency of exposure (hr/d, d/yr)
ExpDur	=	duration of exposure (yr)
BW	=	body weight (kg)
AT	=	time period over which the exposure is averaged (25550 d for cancer; ExpDur x 365 d/yr for non-cancer)

The RAFs take into account the difference in absorption between the exposure pathways and mediums of interest in the HHRA and the pathway and medium used in the laboratory study from which the toxicity values were derived. The RAF values used in the Phase II HHRA correspond to those recommended as defaults by Region I (EPA, 1989b).

The constituent dose for each receptor in each of the scenarios is based on numerous parameters with varying degrees of uncertainty. The exposure parameters used in calculating the constituent doses and the rationale for selecting them are summarized in Table 11. As indicated, this table also provides a comparison of the input parameters for the Phase I and Phase II HHRAs.

Key exposure parameters and assumptions for each scenario are described below:

Scenario 1 - Trespasser (Current)

Appendix C presents in detail the exposure pathways, equations, and input values for the current trespasser scenario. For this scenario, local youths aged 9 to 18 years are assumed to trespass on Site 08 one day per week during the spring, summer, and fall for a total of 39 days per year. The youths are also assumed to trespass every year while they are 9 to 18 years old for an exposure duration of 10 years. While trespassing, exposure to site-constituents is assumed to occur through the incidental ingestion of and dermal contact with surface soil (0 to 2 feet). As shown in Table 11, the specific input values for the Phase II trespasser scenario generally agree with those used in Phase I (TRC-ECI, 1991a). In Phase II, the body weight has been changed from 50 to 49.2 kilograms (kg) (EPA, 1990a).

Scenario 2 - Commercial/Industrial Worker (Current or Future)

The exposure pathways, equations, and input values for the base or commercial worker scenario are provided in Appendix C. For this scenario, standard EPA (1991) assumptions are used to characterize potential exposures to current base workers or to commercial/industrial workers in the future. Specifically, these workers are assumed to work 250 days per year for 25 years. During each working day, exposure to site constituents is assumed to occur through the incidental ingestion of and dermal contact

with surface soil (0 to 2 feet). As shown in Table 11, the Phase II commercial/industrial worker scenario assumes a smaller soil ingestion rate, greater exposure frequency, and a slightly shorter exposure duration than the Phase I HHRA (TRC-ECI, 1991a). In Phase II, the soil ingestion rate has been changed from 100 to 50 milligrams per day (mg/d) (EPA, 1991), the exposure frequency from 78 to 250 days per year (d/yr) (EPA, 1991), and the exposure duration from 30 to 25 years (EPA, 1991).

### Scenario 3 - Construction Worker (Future)

The exposure pathways, equations, and input values for the future construction scenario are provided in Appendix C. This scenario considers a future worker involved in on-site construction, excavation, or utility work. Workers are assumed exposed for 250 days over a one-year period. Similar to Phase I (TRC-ECI, 1991a), worker exposure to site constituents is assumed to occur through incidental ingestion of and dermal contact with subsurface soils (2 to 10 feet). The Phase II construction scenario also evaluates worker exposure through inhalation of suspended subsurface soil particulates. Additional changes in exposure assumptions have also been made in the Phase II construction scenario. As shown in Table 11, the exposure frequency has been changed from 10 to 250 d/yr, the exposure duration from 30 to 1 year, the soil ingestion rate from 100 to 480 mg/d (EPA, 1991), and the dermal contact rate from 500 to 1,000 mg/d (EPA, 1989b). The lower dermal contact rate of 500 mg/d (based on a SA of 2,000 cm<sup>2</sup>) is recommended for normal residential or recreational activities, while the higher rate of 1,000 mg/d (based on a SA of 4,000 cm<sup>2</sup>) is more appropriate for activities potentially resulting in higher exposures (e.g., gardening).

### Scenario 4 - Resident (Future)

Appendix C summarizes the exposure pathways, equations, and input values for the future residential scenario. For this scenario, future residents are assumed exposed for 350 d/yr for 30 years, with six years of exposure as a child and 24 years of exposure as an adult. Residential exposure to site constituents is assumed to occur through incidental ingestion of and dermal contact with surface and subsurface soils (0 to 10 feet), and ingestion of ground water. As shown in Table 11, the Phase II residential scenario differs from the Phase I (TRC-ECI, 1991a) approach in several areas. In Phase II, ingestion of ground water is added as an exposure pathway since ground water data for Site 08 were recently collected. In Phase II, the exposure frequency has also been changed from 78 and 143 to 350 d/yr (EPA, 1991), the exposure duration from 70 to 30 years (EPA, 1991), and the child body weight from 16 to 14.5 kg (EPA, 1991). The revised exposure assumptions are consistent with current EPA (1991) guidance.

## 5.0 RISK CHARACTERIZATION

### 5.1 Quantitative Risk Assessment

The results of the quantitative risk analysis are presented in two forms. In the case of human health effects associated with exposure to potential carcinogens, risk estimates are expressed as the lifetime probability of additional cancer risk associated with the given exposure. The cancer risk estimates are calculated as the cancer-based exposure dose (mg/kg-d) times the slope factor ((mg/kg-d)<sup>-1</sup>). In numerical terms, these risk estimates are presented in scientific notation in this report. Thus, a lifetime risk of 1E-04 means a lifetime incremental risk of one in ten thousand; a lifetime risk of 1E-06 means an incremental lifetime risk of one in one million and so on.

For estimating risks to individual non-carcinogens, the hazard quotient (HQ) is used. The HQ is calculated as the non-cancer exposure dose (mg/kg-d) divided by the RfD (mg/kg-d). Subchronic RfDs are used to estimate risks for scenarios involving short-term exposures (i.e., construction), while chronic RfDs are used for those scenarios involving long-term exposures (i.e., trespassing, commercial/industrial, and residential). The HQs are summed across constituents to calculate a hazard index (HI) for each pathway in each scenario.

Cancer and non-cancer health risks are discussed below for the trespasser (Scenario 1 - current use), commercial/industrial worker (Scenario 2 - current or future use), construction worker (Scenario 3 - future use), and resident (Scenario 4 - future use) scenarios. The estimated cancer risks and non-cancer HIs may be compared to available regulatory guidelines. Under Superfund (EPA, 1990b), a risk range of 1E-06 to 1E-04 is generally acceptable, while risks above 1E-04 typically imply a need for remediation. A cancer risk of 1E-06 is considered the point of departure for determining risk-based remediation goals. Regarding non-carcinogenic health hazards, (EPA, 1989a) states that:

"When the total hazard index for an exposed individual or group of individuals exceeds unity, there may be concern for potential non-cancer health effects."

Thus, the cancer risk and hazard index ratios that may constitute a concern are  $>1E-06$  and  $>1E+00$ , respectively. Tables 12 through 16 present cancer risk levels and HIs for each scenario. The results for each receptor and exposure pathway (e.g., incidental ingestion of and

dermal contact with soil) are presented on a separate page of each table. Table 17 summarizes the cancer risk estimates and HIs for each pathway by scenario.

Cancer risks and non-cancer HIs are discussed in the subsequent sections for each scenario and pathway analyzed. These risk levels are presented as a range in which both the average value (based on the geometric mean concentrations) and the RME value (based on the maximum concentrations detected on-site) are provided. In certain cases, the mean risk estimate exceeds the RME due to the inclusion of SQLs in determining the geometric mean concentrations. For a number of constituents (e.g., PAHs in subsurface soil), the concentrations detected fall below the values assigned to non-detects (i.e., one-half the SQLs) such that the geometric mean exceeds the maximum detected value. Given the uncertainty associated with characterizing constituent concentrations in samples reported as non-detected, the uncertainty in the mean risk estimates likely exceeds that related to the estimates of RME risk.

#### Scenario 1: Trespasser Scenario (Current): Cancer Risks and Non-Cancer HIs

The estimated cancer risks and non-cancer HIs for this scenario are provided in Table 12. In this scenario, cancer risks and non-cancer HIs are calculated for incidental ingestion of and dermal contact with surface soil.

As shown, the total cancer risks for incidental ingestion of soil range from 4E-07 (mean) to 9E-07 (RME). These levels, which fall below 1E-06, are attributable to incidental ingestion of carcinogenic PAHs, Aroclor-1260, arsenic, and beryllium in soil. The total cancer risks for dermal contact with soil also fall below 1E-06, with an estimated range of 6E-08 (mean) and 2E-07 (RME). Dermal contact with the carcinogenic PAHs and Aroclor-1260 account for most of these estimated risks.

The total HIs estimated for incidental ingestion of soil are well below 1E+00 and range from 8E-04 (mean) to 2E-03 (RME). Ingestion of inorganics in soil, primarily arsenic, accounts for the majority of these HIs. For dermal contact with soil, the total pathway HIs range from 2E-06 (mean) to 7E-06 (RME).

### Scenario 2: Commercial/Industrial Worker Scenario (Current or Future): Cancer Risks and Non-Cancer HIs

The estimated cancer risks and non-cancer HIs for this scenario are provided in Table 13. In this scenario, cancer risks and non-cancer HIs are calculated for incidental ingestion of and dermal contact with surface soil.

As shown, the total cancer risks for incidental ingestion of soil range from 2E-06 (mean) to 5E-06 (RME). These levels, which are two and five times above 1E-06, are attributable to incidental ingestion of carcinogenic PAHs, Aroclor-1260, arsenic, and beryllium in soil. The total cancer risks for dermal contact with soil range from 7E-07 (mean) and 2E-06 (RME). While the mean risk estimate falls below 1E-06, the RME risk estimate exceeds it by a factor of two. Dermal contact with the carcinogenic PAHs and Aroclor-1260 account for most of these estimated risks.

The total HIs estimated for incidental ingestion of soil are well below 1E+00 and range from 2E-03 (mean) to 5E-03 (RME). Ingestion of inorganics in soil, primarily arsenic, accounts for the majority of these HIs. For dermal contact with soil, the total pathway HIs range from 1E-05 (mean) to 3E-05 (RME). Dermal contact with DDT in soil contributes about 40 to 50% of the estimated pathway HIs.

### Scenario 3: Construction Worker Scenario (Future): Cancer Risks and Non-Cancer HIs

The estimated cancer risks and non-cancer HIs for this scenario are provided in Table 14. In this scenario, cancer risks and non-cancer HIs are calculated for incidental ingestion of and dermal contact with subsurface soil, and inhalation of suspended subsurface particulates.

As shown, the total cancer risks for incidental ingestion of soil range from 5E-07 (mean) to 8E-07 (RME). These levels, which fall below 1E-06, are attributable to incidental ingestion of carcinogenic PAHs, Aroclor-1260, arsenic, and beryllium in soil. Beryllium alone accounts for 40 to 70% of the estimated pathway risks. The total cancer risks for dermal contact are 3E-08 for both the mean and the RME. Both of these risk levels are less than 1E-06 and are primarily driven by dermal contact with carcinogenic PAHs and Aroclor-1260. The cancer risks estimated for inhalation of particulates (6E-10 (mean) and 1E-09 (RME)) are several orders of

magnitude below the 1E-06 risk level. The highest constituent-specific cancer risks for inhalation are estimated for arsenic and chromium VI.

The total HIs estimated for each of the three pathways are well below 1E+00 and collectively range from 1E-05 (mean for dermal contact) to 2E-02 (RME for incidental ingestion). Ingestion of inorganics in soil, primarily arsenic, beryllium, chromium VI, and nickel, account for the majority of the HIs for this pathway. For dermal contact with soil, dermal contact with bis(2-ethylhexyl)phthalate contributes the most to the estimated HIs for this pathway. Almost all of the estimated HIs for particulate inhalation are attributable to lead. The HIs for lead are based on an RfD estimated from the EPA's NAAQS for this inorganic. The NAAQS for lead is referenced by EPA (1992a) in regard to the chronic RfC.

#### Scenario 4: Resident Scenario (Future): Cancer Risks and Non-Cancer HIs

The estimated cancer risks and non-cancer HIs for children (aged 0 to 6 years) and youths/adults (aged 7 to 30 years) are provided in Table 15. Table 16 provides the risk estimates summed across childhood and youth/adult exposures. In this scenario, cancer risks and non-cancer HIs are calculated for incidental ingestion of and dermal contact with surface and subsurface soil, and ingestion of ground water.

As shown in Table 16, the total cancer risks for incidental ingestion of soil range from 2E-05 (mean) to 5E-05 (RME). These risk levels exceed 1E-06 by factors of 20 and 50, respectively. Most of the total cancer risks for this pathway are attributable to carcinogenic PAHs, Aroclor-1260, arsenic, and beryllium in soil. Roughly 50 to 75% of the total ingestion risks are attributable to childhood exposures (see Table 15).

The total cancer risks for dermal contact with soil range from 2E-06 (mean) to 5E-06 (RME). These risks are two and five times above 1E-06 and are primarily driven by dermal contact with carcinogenic PAHs and Aroclor-1260. Childhood exposures contribute roughly 50 to 60% of the total dermal risks (see Table 15).

The cancer risks estimated for ingestion of ground water (5E-05 (mean) and 6E-05 (RME)) are 50- and 60-fold greater than 1E-06. Arsenic and beryllium are the two, roughly equal contributors to these cancer risks. The risks associated with ground water ingestion are

estimated for a single residential receptor over a 30 year period (i.e., risks for childhood versus youth/adult exposures are not calculated separately).

The total HIs estimated for incidental ingestion of soil and dermal contact with soil are below 1E+00 and range from 1E-04 (mean for dermal contact with soil) to 2E-01 (RME for incidental ingestion of soil). Ingestion of inorganics in soil, primarily arsenic, account for the majority of the HIs for this pathway. For dermal contact with soil, dermal contact with DDT contributes the most to the estimated HIs for this pathway. The HIs associated with ingestion of ground water exceed 1E+00 and range from 4E+00 (mean) to 7E+00 (RME). Ingestion of manganese in ground water accounts for all of the elevated HI.

## 5.2 Qualitative Analysis of Risks

As indicated in Section 3.3, two constituents of potential concern, including aluminum, and cobalt are not evaluated in the quantitative HHRA due to the lack of EPA (1992a, 1993) toxicity criteria. Further, although evaluated for inhalation, lead is not assessed quantitatively with regard to its potential carcinogenic or oral non-cancer effects. A qualitative assessment for these three constituents is provided below.

### ■ **Inorganics**

EPA (1992a, 1993) has not established any toxicity values for aluminum, and considers the available data inadequate for quantitative risk assessment. However, the exclusion of aluminum from the quantitative assessment for ground water ingestion in Scenario 4 (residential) is unlikely to significantly underestimate risk for this scenario. First, nine other inorganics in ground water are quantitatively evaluated in the HHRA. Second, the other pathways evaluated for Scenario 4 (i.e., ingestion of and dermal contact with soil) are generally associated with greater exposure and therefore potential risk than is ingestion of ground water. Finally, aluminum is not considered a constituent of potential concern in soil since the detected concentrations fall below the values reported for on-site and eastern U.S. locations. Aluminum was detected in ground water at concentrations ranging from 0.3 to 3.4 mg/l.

Currently, no toxicity values for cobalt have been published by the EPA (1992a, 1993). Cobalt is an essential component of vitamin B12, which is required for the production of red

blood cells (see Appendix C). Cobalt, a constituent of potential concern in ground water only, was detected in 2 of 4 ground water samples at concentrations ranging from 0.002 and 0.005 mg/l. Cobalt is not a constituent of potential concern in soil since all but one of the detected soil concentrations is within background levels for NCBC Davisville and eastern U.S. soils. In addition to quantitatively evaluating nine inorganics in the ground water ingestion pathway for Scenario 4 (resident), this scenario addresses incidental ingestion of and dermal contact with soil. Overall, the lack of an RfD for cobalt is not likely to significantly underestimate the risk for the ground water ingestion pathway or significantly alter the interpretation of the Scenario 4 results.

Although lead is quantitatively evaluated in the non-cancer inhalation assessment, exclusion of this inorganic from the other evaluations (i.e., cancer and oral non-cancer) may underestimate risk to some degree. While EPA has not identified any slope factors for lead, it considers lead a "B2" - probable human carcinogen. Further, non-cancer effects are possible following both inhalation and oral exposures. In addition, the toxicity value used to assess inhalation exposure in this HHRA is estimated from EPA's NAAQS for this inorganic, and is likely associated with a large degree of uncertainty. Despite the toxicity associated with lead, concentrations of lead in Site 08 soil are not extremely elevated. Although 3 of 24 surface soil concentrations (maximum of 171 mg/kg) exceed the range of site background (5.1 to 89.6 mg/kg), the remaining concentrations in surface and subsurface soil fall within eastern U.S. background (< 10 to 300 mg/kg). Further, the on-site lead concentrations are less than DEM's 300 mg/kg lead in soil policy level.

## **6.0 UNCERTAINTY ASSESSMENT**

### **6.1 Uncertainties Associated with the Hazard Identification**

The primary sources of uncertainty associated with the hazard identification are the environmental sampling and analysis, and the subsequent selection of COCs. Uncertainties associated with environmental sampling and analysis are discussed in Section 6.3.

The selection of COCs is intended to identify those constituents which are likely to contribute the most to potential health risks. Most of the uncertainty in the COC selection is associated with the uncertainties in the environmental sampling and analysis. For example, while it is reasonable to assume a constituent is not likely to be site-related if it is detected in less than 5% of the samples, it is possible for a sampling program to be unintentionally biased such that the location where a constituent was disposed of was sampled only once. Using a 5% criterion in this situation might result in the exclusion of such a constituent from the HHRA. It is important to note, however, that in most cases hot spots or visually contaminated locations tend to be over-represented rather under-represented in a sampling program. It is also possible for degradation products of site-related constituents to be detected infrequently or in localized areas initially, only to become more widespread over time. Despite these uncertainties, the COC selection process is intended to be conservative with an aim towards being inclusive, rather than limited in nature.

### **6.2 Uncertainties Associated with the Dose-Response Assessment**

There are several main sources of uncertainty related to the toxicity information. First, the availability and quality of toxicity data affects the ability of experts to derive toxicity criteria and the quality/certainty of the toxicity criteria that are derived. The exclusion of constituents without toxicity criteria from the risk assessment also represents a potential source of uncertainty.

The uncertainty associated with the toxicity values for each constituent also contributes to the overall uncertainty in the risk characterization of the site. The possible sources of uncertainty for a given constituent include: the number of available studies, the quality of these studies, the consistency among the study results (e.g., across species, strains, sex and exposure pathways), the plausibility of the biological mechanism, and the existence and nature of a

dose-response relationship. The quality of individual species is influenced by some of these same factors as well as the test species, the dose used, the route of exposure, the length of exposure, and other study design issues (e.g., sample size and statistical power). For example, animal to human extrapolation, high dose to low dose extrapolation, and short-term to long-term extrapolation often introduce considerable uncertainty into the derivation of toxicity values.

An additional source of uncertainty in the toxicity assessment is the use of toxicity values for one constituent for other structurally similar constituents (e.g., PAHs), and the use of oral toxicity values to assess the potential risks from dermal exposures.

Although the assignment of the benzo(a)pyrene cancer slope factors to other carcinogenic PAH constituents follows current Region I guidance (EPA, 1989b), this approach likely creates a considerable overestimate of risk since benzo(a)pyrene is one of the most potent PAH constituents (Rugen, 1989; ICF-Clement, 1987; EPA, 1985).

For assessing risks from dermal exposures, a correction factor was not used to adjust the oral RfDs and slope factors. Differences in absorption following oral and dermal exposures are addressed through the use of RAFs in the exposure estimates per Region I guidance (EPA, 1989b). The toxicity of constituents is likely to vary depending on the route of exposure (e.g., oral vs. dermal). For example, the toxicologic effects of arsenic could be greater or less by the dermal route of exposure. Since the skin is an important target site for arsenic, and since systemic detoxification after oral exposure limits the amount of active toxicant reaching the skin (ATSDR, 1989a) the potential exists for direct dermal contact to exert greater toxic potency. However, the dermal absorption rate is much below that for oral exposure.

### **6.3 Uncertainties Associated with the Exposure Assessment**

Assumptions are inherent in any assessment of exposure and risk. This section identifies and quantifies to the extent possible the uncertainties associated with the exposure assessment for Site 08. The major areas of uncertainty include the environmental sampling and analysis, selection of current and future land uses, selection of exposure pathways, and the selection of specific exposure parameters.

### 6.3.1 Environmental Sampling and Analysis

As described previously, soil and ground water samples were collected and analyzed for a variety of constituents including VOCs, SVOCs, pesticides, PCBs, and inorganics. There are several potential sources of uncertainty associated with the collection and analysis of these samples. First, the list of constituents analyzed for presence in the samples, although fairly comprehensive, may not reflect all of the constituents present at Site 08. Second, the number of samples analyzed (e.g., of subsurface soil and ground water) may not be sufficiently large to characterize with high confidence the distribution of constituent concentrations in each medium. Further, the sampling locations may not accurately reflect the range, frequency, and distribution of constituents at the site. This phenomenon could lead to an under- or over-representation of (for example) the frequency and magnitude of hot-spot concentrations. Finally, there are uncertainties associated with the analytical methods and instruments used in the analysis of samples. For example, the values reported as non-detected may actually range from non-detect (i.e., not present) up to the value of the SQL. The replacement of non-detects with a value equal to the SQL or one-half the SQL is intended to be reasonably conservative, but could over- or underestimate the actual constituent concentrations present in the environmental media.

The U.S. EPA (1988a) model used to estimate the concentrations of particulate-adsorbed constituents in air is also associated with uncertainty. The key model assumptions include the time frame during which dust emissions occur (e.g., during construction, excavation, or utility work) and the use of a yearly average wind speed. The potential impact of these assumptions will be to underestimate risk if these construction activities occur for a longer period of time than originally estimated, or, if daily wind speeds exceed the annual average wind speed. Similarly, the risk will be overestimated if the reverse were to occur. The assumption that all of Site 08 will be disturbed (e.g., excavated) likely overestimates the potential risks from exposure to particulates.

### 6.3.2 Current and Future Land Use

Currently, Site 08 is comprised of a grassy field adjacent to a warehouse (Building 314). Future land use is uncertain for this site. Continued commercial/industrial use (e.g., through

conversion of the NCBC Davisville base) is possible. Development of the site for residential use is also possible given the presence of residential areas to the west and north of West Davisville.

Under current land use, the HHRA considers the potential risks to trespassers. The future land use scenarios included in the HHRA are commercial/industrial use, construction, and residential use. These four scenarios are intended to represent the spectrum of reasonably likely land uses, but do not necessarily reflect all theoretically possible exposure scenarios at Site 08. Further, the risks associated with these scenarios are conditioned on these land uses occurring.

Observations made at other sites (e.g., Calf Pasture Point and Allen Harbor Landfill) indicate youths may be trespassing at the NCBC Davisville base. The main sources of uncertainty for this scenario are the assumptions about trespasser exposure frequency and duration. Although the values used for these parameters (i.e., exposure frequency and duration) are reasonable and conservative, they are unlikely to contribute significantly to the overall uncertainty associated with the estimated risks.

Current zoning for the site is commercial/industrial, and the site could conceivably be reopened for private industrial or commercial use. Consequently, the uncertainty associated with Scenario 2 is expected to be relatively low. The uncertainty associated with Scenario 3 is also anticipated to be low. This scenario, which evaluates the potential risks to workers engaged in construction, excavation, or utility activities is fairly plausible given the likelihood of these activities in the future. Given the current zoning, the residential scenario (Scenario 4) is probably associated with the greatest degree of uncertainty. Although a change of zoning is possible, it is considerably less plausible than the trespassing, commercial/industrial use, and construction scenarios, and is therefore likely to contribute significantly to an overestimation of risk for the site.

### 6.3.3 Exposure Pathways

As outlined previously, two exposure pathways (dermal contact with and incidental ingestion of surface soils) are evaluated for Scenarios 1 (trespassing) and 2 (commercial/industrial). Inhalation of airborne dust is not included as an exposure pathway for Scenario 2. Although it is possible that areas of the site could be excavated while

commercial/industrial workers are present, it is unlikely that the risks associated with such an exposure would be of concern. That is, risks associated with inhalation of airborne dust under the future construction scenario (in which the potential for exposures to airborne dust is greater than under a commercial/industrial scenario) are orders of magnitude lower than the other potential exposure pathways evaluated (incidental ingestion of soil, dermal contact with soil).

For Scenario 3 (construction), three exposure pathways are evaluated: dermal contact with and incidental ingestion of subsurface soils, and inhalation of airborne dust. Inhalation of volatiles in soil gas is not included as an exposure pathway for this scenario. Surface and subsurface soils contain low levels of two VOCs (chloroform and methylene chloride) which were detected infrequently. Both VOCs are carcinogenic via the oral and inhalation routes. Exclusion of the inhalation of volatiles in soil gas pathway is not expected to contribute to an underestimation of risk. This conclusion is based upon an evaluation of cancer risks associated with ingestion of these two VOCs in soil. For chloroform, the cancer slope factor for inhalation is approximately 10 times greater than for the oral route. Cancer risks associated with ingestion exposure for Site 08 are low (ranging from  $1.5E-12$  to  $4.1E-13$ ). For methylene chloride, the oral slope factor is approximately 6 times greater than the inhalation slope factor. Risks associated with this ingestion exposure are also low ( $3.8E-12$  to  $3.0E-12$ ).

For Scenario 4 (residential), incidental ingestion of and dermal contact with surface and subsurface soils, and ingestion of ground water are evaluated. Inhalation of VOCs introduced through basement walls (from ground water) is not included in this scenario. Acetone was the only VOC detected in ground water at Site 08. This VOC was detected at relatively low concentrations (ranging from 0.04 to 0.092 mg/l). The weight-of-evidence class associated with acetone is "D" - no evidence of carcinogenicity, and an inhalation RfD is not available. Thus, there is some degree of uncertainty associated with exclusion of acetone as a potential VOC moving through basement walls. Lack of detection of other VOCs in ground water indicates little uncertainty is associated with the exclusion of this pathway in Scenario 1.

The exposure pathways selected for inclusion in the HHRA are intended to be representative of the most likely routes of exposure, but do not necessarily reflect all theoretically possible means of contact between the identified receptors and the environmental

media. The risks associated with these exposure pathways are conditioned upon the land uses and exposure routes occurring.

#### 6.3.4 Exposure Parameter Values

Table 11 summarizes the assumptions used to estimate exposure (i.e., soil ingestion rate, exposure frequency, etc.). The exposure estimates produced for each receptor in each scenario are based on numerous variables with varying degrees of uncertainty. This discussion will focus on these parameters, and the associated range of uncertainty. Table 11 is separated into those parameters which apply to all scenarios (i.e., global variables), and those which apply specifically to an individual scenario.

##### ■ **Global Variables (All Scenarios)**

Table 11 lists the parameters and associated values which are used in each of the scenarios. The body weight ranges for children (age 9-18 years and 0-6 years) are derived from EPA (1990a). The actual values used represent an average body weight for each of the groups. Similarly, for adults (18-65 years), a range of body weights is presented, along with the average body weight (70 kg) for the group. While there is a range of body weights for each age group, these ranges are not large, and are not expected to contribute a significant degree of uncertainty to this assessment.

For Scenario 1, the exposure duration (ED) for children is assumed to be 10 years, based upon the age range of children (9 to 18) likely to trespass onto the site. In theory, this duration might range from 1 to 18 years, however, it is unlikely that children younger than 9 years of age would visit the site. For Scenario 2, commercial/industrial employees are expected to spend 25 years on site, which is representative of the amount of time expected for employment at one location. For Scenario 3 (construction), adults are assumed to have an ED of 1 year, which is a reasonable time period for construction on the site. Finally, the exposure durations used for Scenario 4 are separated into categories for children and youths/adults. Children are analyzed separately for the first six years of life at the site, while youths/adults are assumed to have a combined ED equal to 24 years. The total residential exposure duration of 30 years is the national upper-bound (90th percentile) time at one residence.

The ranges associated with ED are only large when considering youths/adults. Despite this range, the values used are expected to provide conservative estimates and will likely overstate the potential risk.

Averaging time (AT) is the time period over which exposures are averaged. Uncertainty is expected to be minimal for the AT used to estimate cancer risk since it equals lifetime duration multiplied by 365 d/yr. The non-cancer AT equals the ED multiplied by 365 d/yr and will therefore be more uncertain given the underlying uncertainty in ED.

The ranges of relative absorption factors (RAF) for organic and inorganic constituents may vary from no differences in absorption to large differences in absorption. This range is likely to contribute a large degree of uncertainty to the exposure estimates. The values chosen for RAF are representative for classes of constituents, and are provided by EPA Region I (EPA, 1989b).

The soil contact rate (SCR) established by EPA Region I (EPA, 1989b) is based upon three parameters: soil deposition rate, skin surface area and percent (fraction) exposed. Each of these parameters contains some degree of uncertainty. Soil deposition rate (also known as soil adherence factor) may range up to 2.77 mg/cm<sup>2</sup> for Kaolin clay (EPA, 1989a). The value used by EPA Region I of 0.5 mg/cm<sup>2</sup> was chosen as a reasonable estimate following a literature review (EPA, 1989b). Thus, a five fold difference exists between the actual value used and an upper bound estimate of adherence. Region I guidance suggests the use of a skin surface area (SA) of 2,000 cm<sup>2</sup> for normal residential or recreational activities. This value is based on the SA of the hands, forearms, feet and lower legs of a young child or the hands and feet of an adult (EPA, 1989b). In this HHRA, a SA of 2,000 cm<sup>2</sup> is used for Scenarios 1 (trespassing), 2 (commercial/industrial), and 4 (residential). A SA of 4,000 cm<sup>2</sup>, the value Region I recommends for activities involving greater contact with soil, is used for Scenario 3 (construction). A large degree of uncertainty is associated with both of these values, and is dependent on age and area exposed. For example, the area exposed could theoretically range from zero to the total body SA (e.g., 19,400 cm<sup>2</sup> for men). Finally, a factor of 50% is applied to account for the percentage of SA actually covered with soil (EPA, 1989b). This factor is not likely to contribute much uncertainty to the assessment.

■ **Scenario 1 - Trespasser (Current)**

The exposure frequency (EF), which may range from 1 to 365 d/yr, may introduce the greatest degree of uncertainty into this scenario. The value used (39 d/yr for youths) is based on 1 d/wk during the spring summer and fall. The soil ingestion rate may also vary over a large range of values, but the values used are not expected to introduce a large degree of uncertainty into the exposure estimates.

■ **Scenario 2 - Commercial/Industrial Worker (Current or Future)**

The EF for Scenario 2 is not expected to contribute a large degree of uncertainty to the exposure assessment. Of the possible range of values (1-365 days/year), the value chosen (250 days/year) is likely representative of actual exposure.

■ **Scenario 3 - Construction Worker (Future)**

Of the parameters presented in Table 11, the modeled ambient dust concentration is expected to contribute the largest degree of uncertainty to the exposure estimates for this scenario. Exposure point concentrations available at the site include concentrations in soils and ground water. Since airborne concentrations of constituents (e.g., fugitive dust) were not sampled during the field program, the exposure point concentrations for this medium must be modeled. Although it is always more accurate to have sampling data, the use of transport models represents a good faith attempt to estimate unknown values from known ones.

■ **Scenario 4 - Resident (Future)**

The greatest uncertainty for this scenario is likely to be associated with the soil ingestion rate for children aged 0 to 6 years and the dermal contact rates for children and youths/adults. While a soil ingestion rate of 200 mg/d will be a conservative value for most children, it likely will underestimate exposures to children exhibiting pica behavior for whom a much greater rate (e.g., up to 5,000 mg/d (EPA, 1989b) would be appropriate. Given the conservative assumptions incorporated into the HHRA, the use of 200 mg/d for child soil ingestion is not likely to significantly underestimate the overall risk estimates. As discussed, the dermal contact

rates will over- or underestimate potential risks depending on the actual surface areas exposed and the level of soil loading on the skin.

#### 6.4 Uncertainties Associated with the Risk Characterization

The uncertainties associated with the risk characterization may be categorized into two groups: those related to the components of the risk estimates (i.e., the estimates of exposure and toxicity) and those inherent in the risk characterization methodologies. Summation of risks across constituents is a key source of uncertainty in the risk characterization portion of the HHRA.

##### Uncertainties Surrounding Summation of Risks Across Constituents

For the risk estimation of cancer and of chronic non-cancer health effects, risks for all constituents in each pathway have been summed to yield the risk for each pathway. This is a conservative approach, since, in general, different constituents do not have the same target organ or mechanism of action. Thus, their toxic effects may be, at least in some cases, independent and not additive. Further, constituents may antagonize one another through competition for enzymes and binding sites, and by inhibition of pathways needed for constituent transport (absorption, cellular uptake, etc.) or metabolic activation. However, it is also possible that certain constituents can be synergistic such as is the case when promotor-type carcinogen greatly enhances the expression of genetic damage induced by a low dose of an initiator.

##### Uncertainties Associated with Constituents Significantly Contributing to the Cancer Risks

The constituents contributing the most to the estimated pathway cancer risks include the carcinogenic PAHs in soil, Aroclor-1260 in soil, arsenic in soil and ground water, beryllium in soil and ground water, and chromium VI (inhalation of particulates). Elevated cancer risks were estimated for Scenario 2 (commercial/industrial workers) and Scenario 4 (resident). Cancer risks are above 1E-06 for individual PAHs in Scenario 4 (resident) only. The largest uncertainty associated with the cancer risks for PAHs in all scenarios is the use of EPA's slope factors for benzo(a)pyrene for the other carcinogenic PAHs. As discussed in Section 5.4, this approach likely overestimates the potential risks from exposure to carcinogenic PAHs. Further, the slope

factors for benzo(a)pyrene are based on animal studies at doses much higher than those anticipated for exposures to humans. Regarding the exposure point concentrations, the use of one-half the unusually elevated SQL for PAHs of 2.8 mg/kg at subsurface location B-12 contributes to the uncertainty in the geometric mean estimates for these constituents. In general, most of the detected concentrations for PAHs are below the whole SQLs. For surface soil, samples SS-13, B-31 and B-41 were collected under or near the paved road and may have been impacted by the asphalt. Finally, most of the concentrations of PAHs (total) detected in soil and subsurface soil fall within the range reported in the literature for rural soils (0.01 to 1 mg/kg) (Menzie et al, 1992) and the range observed in NCBC background samples (non-detected to 1.1 mg/kg), with a smaller number falling within the upper range of typical urban background (1 to 3 mg/kg) (Menzie et al., 1992). In surface soil, PAHs were detected in 12/24 sample locations with eight of the detected concentrations of total PAHs falling in the range reported for rural soils and NCBC background and four in the upper range for typical urban background. In subsurface soil, PAHs were detected in only 2/12 sample locations, with both containing concentrations of total PAHs similar to those reported for rural soils and NCBC background. As described by Menzie et al. (1992), these background data on PAHs were obtained from a literature review and a review of background sampling data presented in site investigation reports (geographic location not specified). The data obtained were apparently collected in the 1970s and 1980s. These survey data provide an additional basis for evaluating the concentrations of PAHs detected on site relative to those reported for various land use categories (e.g., forest, rural, urban). While elevated risks were estimated for PAHs, the estimates are based on the cross-assignment of the benzo(a)pyrene slope factors and on concentrations which appear to represent typical levels in rural and urban areas and NCBC background.

The cancer risk for Aroclor-1260 exceeds  $1E-06$  in Scenario 4 only. For Aroclor-1260 in surface soil, a comparison to NCBC background (non-detected to 0.096 mg/kg as shown in Appendix G of Volume I of the Phase II RI for Sites 02, 03, 06, 07, 10, 11, 13; TRC; 1993a) and literature background data (non-detected to 0.033 mg/kg in a U.S. national forest; ATSDR; 1987b) indicates that while the three Phase I detected concentrations (0.190 to 0.450 mg/kg) are slightly higher than background, the five detected Phase II concentrations (0.020 to 0.052 mg/kg) are within background. Aroclor-1260 was detected in only 1/12 subsurface soil samples

at a concentration (.0023 mg/kg) below background. An additional source of uncertainty associated with the cancer risks estimated for Aroclor-1260 is the use of animal data to derive the oral slope factor for PCBs. The oral slope factor for PCBs is derived from a study involving dietary exposure of rats to Aroclor-1260. Similar to other carcinogenic assessments, this slope factor is based on extrapolation of the dose-response observed at high doses to the low exposures likely to be experienced by humans. The cross-assignment of the oral slope factor to inhalation in this HHRA (Scenario 3 only) is also associated with uncertainty since the risks from inhalation may be greater or less than those observed following ingestion. Aroclor-1260 was detected in 8 of 24 surface soil samples at 0.02 to 0.45 mg/kg, and in 1 of 12 subsurface soil samples at 0.023 mg/kg. Aroclor-1260 was not present in ground water.

Although risks elevated above  $1E-06$  were estimated for arsenic in soil (Scenario 4 only), the detected soil concentrations (maximum of 2.6 mg/kg in a surface soil sample) fall within those reported for background locations at NCBC Davisville (0.59 to 8.1 mg/kg) and in the eastern U.S. ( $<0.1$  to 73 mg/kg). The oral and inhalation slope factors for arsenic are not a major source of uncertainty since they are based on long-term human exposures to arsenic in drinking water and airborne arsenic, respectively. Overall, while the toxicity assessment for arsenic is associated with minimal uncertainty, the available background data indicate site concentrations are within background and may not be site-related.

In ground water, arsenic was detected in three out of four samples (3/4) collected at Site 08. No upgradient samples were collected at Site 08. However, comparison of detected arsenic concentrations in Site 08 ground water to levels detected in other NCBC Davisville upgradient samples indicates arsenic levels may not be elevated. That is, only one of the three samples contained arsenic concentrations at levels greater than those reported at other NCBC upgradient locations. The oral slope factor for arsenic is not a major source of uncertainty since it is based on long-term human exposures to arsenic in drinking water. Finally, potable use of ground water at Site 08 is not presently occurring and is not likely to occur in the future.

Beryllium soil concentrations also appear to be within site and eastern U.S. background levels. Three surface and one subsurface sample exceed site background (non-detect up to 0.77 mg/kg). All of the detected concentrations fall within the range reported for eastern U.S. soils ( $<1$  to 7 mg/kg). While the inhalation slope factor for beryllium is based on human

workplace exposures, the oral slope factor is derived from a drinking water study in rats and is associated with the uncertainty typical of animal-based toxicity values. The highest cancer risk estimates for beryllium are for ingestion of soil in Scenarios 2 and 4 based on the oral slope factor. The low detected concentrations relative to background and the conservative approach used to derive the oral slope factor suggest the HHRA overestimates the potential site-related risks from beryllium.

In ground water, beryllium was detected in one out of four samples (at a concentration of 0.34 mg/l) collected at Site 08. No upgradient samples were collected at Site 08. However, comparison of the detected beryllium concentration in Site 08 ground water to levels detected in other NCBC Davisville upgradient samples (ranging up to 1.1 mg/l) indicates beryllium concentrations are not elevated. The oral slope factor for beryllium is derived from a drinking water study in rats and is associated with the uncertainty typical of animal-based toxicity values. Finally, potable use of ground water at Site 08 is not presently occurring and is not likely to occur in the future.

The largest source of uncertainty in the chromium VI inhalation cancer risks for Scenario 3 (construction) (all  $<1E-06$ ) is the basis for the exposure point concentrations. The concentrations of on-site chromium were reported as total chromium. In calculating the concentration of chromium VI, this HHRA assumes a 7:1 ratio with 7/8 chromium III and 1/8 chromium VI based on a personal communication with EPA Region II (EPA, 1990c). This approach could over- or underestimate the actual concentrations and therefore risks for chromium VI. There are additional uncertainties associated with the fugitive dust model used to calculate the concentration of particulate-sorbed chromium VI in air. Chromium (total) was detected in all 24 surface and all 12 subsurface soil samples at concentrations up to 15.5 mg/kg. None of the chromium (total) concentrations exceed those reported for background locations at NCBC Davisville (non-detect up to 11 mg/kg) or in the eastern U.S. (1 to 1,000 mg/kg). The chromium VI slope factor is associated with minimal uncertainty since it is based on inhalation exposures in humans.

Uncertainties Associated with Constituents Significantly Contributing to the Non-Cancer HIs

Ingestion of ground water (Scenario 4) was the only pathway for which the HIs exceed unity. The constituent contributing the most to the elevated pathway HI is manganese. Manganese was detected in all four ground water samples. The chronic water RfD for manganese is based on an epidemiological study of people exposed to manganese in their drinking water. The uncertainties associated with this RfD are low. Although an upgradient well is not available at Site 08, a comparison to manganese concentrations in upgradient wells at other NCBC Davisville sites (non-detected to 2.2 mg/l) indicates that manganese concentrations detected in Site 08 ground water (0.36 to 1.3 mg/l) are not elevated. Further, potable use of ground water at Site 08 is not presently occurring and is not likely to occur in the future.

## 7.0 REFERENCES

- Agency for Toxic Substances and Disease Registry (ATSDR). 1987a. Toxicological Profile for Di(2-ethylhexyl)phthalate. Draft for Public Comment. December.
- Agency for Toxic Substances and Disease Registry (ATSDR). 1987b. Toxicological Profile for Selected PCBs. Draft for Public Comment. November.
- Agency for Toxic Substances and Disease Registry (ATSDR). 1989. Toxicological Profile for Polycyclic Aromatic Hydrocarbons. Draft for Public Comment. October.
- Agency for Toxic Substances and Disease Registry (ATSDR). 1989a. Toxicological Profile for Arsenic. March.
- Agency for Toxic Substances and Disease Registry (ATSDR). 1989b. Toxicological Profile for Di-n-butylphthalate. Draft for Public Comment. October.
- Goyer, Robert A., 1986. Toxic Effects of Metals. In Cassarett and Doull's Toxicology: The Basic Science of Poisons (C.D. Klaasen, M.O. Amdur and J. Doull, Eds.), 3rd ed., Chpt 19, pp. 582-635. Macmillan Publishing Co., New York.
- Howard, P.H., 1990. Handbook of Environmental Fate and Exposure Data for Organic Chemicals: Volume I. Michigan: Lewis Publishers, Inc.
- ICF - Clement Assoc., 1987. Comparative potency approach for estimation of the total cancer risk associated with exposures to mixtures of polycyclic aromatic hydrocarbons in the environment. Final Report.
- Menzie, C.A., B.B. Potocki, and J. Santodonato. 1992. Exposure to Carcinogenic PAHs in the Environment. Environ. Sci. Technol., 26(7):1278-1284.
- Montgomery, J.H. and L.M. Welkom, 1990. Ground Water Chemicals Desk Reference. Michigan: Lewis Publishers, Inc.
- Oak Ridge National Lab. 1984. Multiple-Pathway Screening-Level Assessment of a Hazardous Waste Incineration Facility.
- Rugen, P.J., Stern, C.D., and Lamm, S.H., 1989. Comparative carcinogenicity of the PAHs as a basis for acceptable exposure levels (AELs) in drinking water. Regulatory Toxicol. Pharmacol. 9:273-283.

- TRC Environmental Consultants, Inc. (TRC-ECI). 1991a. Risk Assessment for the Naval Construction Battalion Center, Davisville, Rhode Island. Draft Final Report. U.S. Department of Navy Installation Restoration Program Contract No. N62472-85-C-1026. May.
- TRC Environmental Consultants, Inc. (TRC-ECI). 1991b. Remedial Investigation for the Naval Construction Battalion Center, Davisville, Rhode Island. Draft Final Report. U.S. Department of Navy Installation Restoration Program Contract No. N62472-85-C-1026. May.
- TRC Environmental Corporation (TRC). 1993a. Naval Construction Battalion Center, Davisville, Rhode Island. Remedial Investigation Report. Volume I. Draft Report. Contract No. N62472-86-C-1282. November.
- TRC Environmental Corporation (TRC). 1993b. Naval Construction Battalion Center, Davisville, Rhode Island. Remedial Investigation Report. Volume II: Human Health Risk Assessment. Draft Report. Contract No. N62472-86-C-1282. November.
- TRC Environmental Corporation (TRC). 1993c. Allen Harbor Landfill, Naval Construction Battalion Center, Davisville, Rhode Island. Remedial Investigation Report. Draft Report. Contract No. N62472-86-C-1282. November.
- TRC Environmental Corporation (TRC). 1993d. Allen Harbor Landfill, Naval Construction Battalion Center, Davisville, Rhode Island. Volume II: Human Health Risk Assessment. Draft Report. Contract No. N62472-86-C-1282. November.
- TRC Environmental Corporation (TRC). 1993e. DPDO Film Processing Disposal Area, Naval Construction Battalion Center, Davisville, Rhode Island. Remedial Investigation. Draft Report. Contract No. N62472-86-C-1282. April.
- U.S. Environmental Protection Agency (EPA). 1979. Water-Related Environmental Fate of 126 Criteria Pollutants. EPA 440/4-76-029a.
- U.S. Environmental Protection Agency (EPA). 1985. Methods for Assessing Exposure to Chemical Substances. Volume 2. Methods for Exposure to Chemical Substances in the Ambient Environment. Office of Toxic Substances. EPA 56015-85-002.
- U.S. Environmental Protection Agency (EPA). 1986. Superfund Public Health Evaluation Manual. EPA/540/1-86/060. October.
- U.S. Environmental Protection Agency (EPA). 1988a. Compilation of Air Pollution Emission Factors, Volume I: Stationary and Air Sources (AP-42).

- U.S. Environmental Protection Agency (EPA). 1988b. Superfund Exposure Assessment Manual. April.
- U.S. Environmental Protection Agency (EPA). Region I. 1988c. Laboratory Data Evaluation Functional Guidelines for Evaluating Organic Analyses. February/November.
- U.S. Environmental Protection Agency (EPA). Region I. 1988d. Laboratory Data Evaluation Functional Guidelines for Evaluating Inorganic Analyses. June/November.
- U.S. Environmental Protection Agency (EPA). 1989a. Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part A). Interim Final. EPA/540/1-89/002.
- U.S. Environmental Protection Agency (EPA). Region I. 1989b. Supplemental Risk Assessment Guidance for the Superfund Program. Draft Final. EPA 901/5-89-001. June.
- U.S. Environmental Protection Agency (EPA). 1990a. Exposure Factors Handbook. OHEA EPA/600/8-89/043.
- U.S. Environmental Protection Agency (EPA). 1990b. 40 CFR Part 300. National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule. March 8.
- U.S. Environmental Protection Agency (EPA). 1990c. Personal communication with TRC Environmental Corporation (TRC). (Name of specific EPA contact not recorded).
- U.S. Environmental Protection Agency (EPA). 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03. March.
- U.S. Environmental Protection Agency (EPA). 1992a. Health Effects Assessment Summary Tables (HEAST). Annual Update. Annual FY-1992. OHEA ECAO-CIN-821. March.
- U.S. Environmental Protection Agency (EPA). 1992b. Guidance for Data Useability in Risk Assessment (Part A). Final. PB92-963356. April.
- U.S. Environmental Protection Agency (EPA). 1993. Integrated Risk Information System (IRIS) Database.
- U.S. Geological Survey (USGS). 1984. Elemental Concentrations in Soils and Other Surficial Materials of the Conterminous United States. USGS Professional Paper #1270, Washington, D.C.: U.S. Government Printing Office.

**TABLES**

TABLE 1  
SUMMARY OF BACKGROUND DATA FOR INORGANICS IN SOIL  
NCBC DAVISVILLE - SITE 08

Constituent	Soil Background Data	
	NCBC Site Background Phase II (a) (mg/kg)	Eastern U.S. Background (b) (mg/kg)
<b>INORGANICS</b>		
Aluminum	1170-12600	7000-100000
Antimony	ND-3	ND-8.8
Arsenic *	0.59-8.1	ND-73
Barium	5.6-19.8	10-1500
Beryllium *	ND-0.77	ND-7
Cadmium	ND-0.46	NA
Calcium	62.7-628	100-280000
Chromium *	ND-11	1-1000
Copper	ND-15	ND-700
Cyanide *	ND-0.17	NA
Iron	3810-13200	100-100000
Lead *	3.4-55.9	ND-300
Magnesium	325-1220	50-50000
Manganese	21.8-150	ND-7000
Mercury	ND-0.06	ND-3.4
Nickel *	ND-7.5	ND-700
Silver	ND-0.22	NA
Sodium	ND-139	ND-50000
Thallium	ND-0.24	NA
Vanadium	3.3-24.6	ND-300
Zinc	10.3-172	ND-2900

(a) Site background samples taken from unimpacted areas at Sites 02, 07, 09, and 10, and wooded areas east of Sites 06, 11, and 13.

(b) U.S.G.S. 1984

\* = Constituents of potential concern in soil

NA = not available

ND = not detected

TABLE 2  
SUMMARY STATISTICS FOR CONSTITUENTS DETECTED IN SOIL  
NCBC DAVISVILLE - SITE 08

Constituent	Surface Soil					Subsurface Soil				
	Number of Samples	Times Detected	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Location Of Maximum Detected	Times Sought	Frequency of Detection	Minimum Detected (mg/kg)	Maximum Detected (mg/kg)	Location Of Maximum Detected
<b>VOLATILE ORGANICS</b>										
Acetone *	24	2	0.075	0.089	SS-08	ND				
Chloroform *	24	4	0.001	0.003	SS-03	12	1	0.001	0.001	S-08-07-03
Ethylbenzene	ND					12	1	0.003	0.003	S-08-09-03
Methylene chloride *	24	5	0.004	0.007	MW21	12	1	0.006	0.006	08-MW32
Xylenes (total)	ND					12	1	0.21	0.21	S-08-09-03
<b>SEMIVOLATILE ORGANICS</b>										
Benzoic acid *	10	4	0.049	0.13	SS-07	5	1	0.045	0.045	S-08-07-03
Benzo(a)anthracene *	24	10	0.045	0.41	SS-03	ND				
Benzo(a)pyrene *	24	10	0.047	0.33	SS-03	ND				
Benzo(b/k)fluoranthene *	24	10	0.086	0.65	SS-03	12	2	0.054	0.560	08-B52
Benzo(g,h,i)perylene *	24	4	0.038	0.19	SS-03	ND				
bis(2-Ethylhexyl)phthalate *	24	10	0.04	0.29	SS-01	12	4	0.12	0.47	S-08-06-03
Chrysene *	24	10	0.065	0.5	SS-03	12	1	0.042	0.042	S-08-05-03
Dibenzo(a,h)anthracene *	24	2	0.14	0.19	SS13	ND				
Fluoranthene *	24	10	0.093	0.57	SS-03	12	1	0.046	0.046	S-08-05-03
Fluorene	ND					12	1	1.1	1.1	S-08-09-03
Indeno(1,2,3-cd)pyrene *	24	5	0.04	0.2	SS-03	ND				
2-Methylnaphthalene	ND					12	1	2.4	2.4	S-08-09-03
Phenanthrene *	24	9	0.046	0.11	SS-07	12	1	0.17	0.17	S-08-09-03
Pyrene *	24	11	0.081	0.48	SS-03	12	1	0.057	0.057	S-08-05-03
<b>PESTICIDES/PCB'S</b>										
4,4'-DDT *	24	2	0.0029	0.029	SS-09	ND				
Aroclor-1260 *	24	8	0.02	0.450	SS-03	12	1	0.023	0.023	08-B12
<b>INORGANICS</b>										
Aluminum	24	24	2380	6330	SS11	12	12	1940	5390	08-B33
Antimony	ND					12	1	2.8	2.8	08-B33
Arsenic *	24	24	0.51	2.6	SS-09	12	10	0.36	0.84	S-08-05-03
Barium	24	24	6.9	32.6	SS-07	12	12	6.5	19.3	S-08-06-03
Beryllium *	24	24	0.29	1.4	SS-07	12	11	0.34	1.4	S-08-05-03
Cadmium	24	1	0.36	0.36	B41	ND				
Calcium	24	24	123	1470	B51/B61	12	12	98.7	930	S-08-05-03
Chromium *	24	24	2.5	15.5	SS-07	12	12	1.4	11.6	S-08-06-03
Cobalt	24	22	1	7.9	SS-07	12	10	0.92	3.4	S-08-09-03
Copper	24	24	2.6	87.3	SS-07	12	11	1.8	8.1	08-MW12
Cyanide *	24	2	0.23	0.39	B11	12	1	0.4	0.4	08-B22
Iron	24	24	3550	16800	SS-07	12	12	2860	11000	S-08-05-03
Lead *	24	18	6.8	171	SS-07	12	8	2.6	13.4	08-B52
Magnesium	24	24	311	2050	B41	12	12	189	966	S-08-06-03
Manganese	24	24	57.3	120	B41	12	12	32.4	169	S-08-05-03
Mercury	24	3	0.04	0.1	SS-01	ND				
Nickel *	24	18	2.2	30.8	SS-07	12	4	2.4	5.8	08-MW12
Potassium	24	24	224	1050	SS-07	12	9	333	1360	S-08-06-03
Selenium	24	6	0.21	0.31	MW21	12	1	0.24	0.24	08-B33
Silver	24	2	0.47	28	SS-04	ND				
Sodium	ND					12	1	482	482	S-08-07-03
Vanadium	24	24	2.9	25.4	SS-07	12	11	1.8	8.3	08-B33
Zinc	24	24	20.6	197	SS-07	12	12	26.1	68.5	S-08-05-03

\* = Constituents of potential concern in soil  
ND = Not detected

TABLE 3  
SUMMARY STATISTICS FOR CONSTITUENTS DETECTED IN GROUND WATER  
NCBC DAVISVILLE - SITE 08

Constituents	Ground Water				
	Times Sought	Frequency of Detection	Minimum Detected (ug/L)	Maximum Detected (ug/L)	Location Of Maximum Detected
VOLATILES					
Acetone *	4	2	40	92	08-MW3S
INORGANICS (a)					
Aluminum *	4	4	289	3380	08-MW3S
Arsenic *	4	3	1	1.8	08-MW2S
Barium *	4	4	11.7	41.9	08-MW1S
Beryllium *	4	1	0.34	0.34	08-MW2S
Calcium	4	4	4450	27100	08-MW4S
Chromium *	4	3	4.1	7.1	08-MW3S
Cobalt *	4	2	2.4	4.7	08-MW3S
Copper *	4	3	2.0	7.9	08-MW2S
Cyanide *	4	1	3.1	3.1	08-MW3S
Iron	4	4	1970	12900	08-MW3S
Lead *	4	3	2.4	3.3	08-MW3S
Magnesium	4	4	1360	4035	08-MW3D/08-MW4S
Manganese *	4	4	361	1300	08-MW3S
Potassium	4	4	3020	13000	08-MW2S
Sodium	4	4	8110	28800	08-MW3S
Vanadium *	4	1	4.6	4.6	08-MW3S

(a) Unfiltered sample data

\* = Constituents of potential concern in ground water

TABLE 4  
 CONSTITUENTS OF POTENTIAL CONCERN IN SOIL AND GROUND WATER  
 NCBC DAVISVILLE - SITE 08

SOIL	GROUND WATER
VOLATILE ORGANICS (3)	VOLATILE ORGANICS (1)
Acetone Chloroform Methylene chloride	Acetone
SEMIVOLATILE ORGANICS (13)	INORGANICS (11)
Benzoic acid Benzo(a)anthracene Benzo(a)pyrene Benzo(b/k)fluoranthene Benzo(g,h,i)perylene Bis(2-ethylhexyl)phthalate Chrysene Dibenz(a,h)anthracene Fluoranthene Indeno(1,2,3-cd)pyrene Phenanthrene Pyrene	Aluminum Arsenic Barium Beryllium Chromium Cobalt Copper Cyanide Lead Manganese Vanadium
PESTICIDES/PCBs (2)	
DDT, 4,4- Aroclor-1260	
INORGANICS (6)	
Arsenic Beryllium Chromium Cyanide Lead Nickel	

TABLE 5  
SUMMARY OF TOXICITY VALUES ASSOCIATED WITH CARCINOGENIC EFFECTS: ORAL  
NCBC DAVISVILLE - SITE 08

CONSTITUENT	SLOPE FACTOR (SF) ORAL (mg/kg-day) <sup>-1</sup>	WEIGHT-OF EVIDENCE CLASS	TYPE OF CANCER	SF BASIS/ SOURCE
<b>VOLATILE ORGANICS</b>				
Acetone	NA	D		NA/IRIS, HEAST
Chloroform	6.1E-03	B2	Kidney	Water/IRIS
Methylene chloride	7.5E-03	B2	Liver	Water/IRIS
<b>SEMIVOLATILE ORGANICS</b>				
Benzoic acid	NA	D		NA/IRIS, HEAST
Benzo(a)anthracene (a)	7.3E+00	B2	Forestomach	Diet/IRIS
Benzo(a)pyrene	7.3E+00	B2	Forestomach	Diet/IRIS
Benzo(b,k)fluoranthene (a)	7.3E+00	B2	Forestomach	Diet/IRIS
Benzo(g,h,i)perylene	NA	D		NA/IRIS, HEAST
Bis(2-ethylhexyl)phthalate	1.4E-02	B2	Liver	Diet/IRIS
Chrysene (a)	7.3E+00	B2	Forestomach	Diet/IRIS
Dibenz(a,h)anthracene (a)	7.3E+00	B2	Forestomach	Diet/IRIS
Fluoranthene	NA	D		NA/IRIS, HEAST
Indeno(1,2,3-cd)pyrene (a)	7.3E+00	B2	Forestomach	Diet/IRIS
Phenanthrene	NA	D		NA/IRIS, HEAST
Pyrene	NA	D		NA/IRIS, HEAST
<b>PESTICIDES / PCB'S</b>				
DDT, 4,4-	3.4E-01	B2	Liver	Diet/IRIS
Aroclor-1260	7.7E+00	B2	Liver	Diet/IRIS
<b>INORGANICS</b>				
Aluminum	NA			NA/IRIS, HEAST
Arsenic (b)	1.8E+00	A	Skin	Water/IRIS
Barium	NA			NA/IRIS, HEAST
Beryllium	4.3E+00	B2	Multiple Sites	Water/IRIS
Chromium III	NA			NA/IRIS, HEAST
Chromium VI	NA			NA/IRIS, HEAST
Cobalt	NA			NA/IRIS, HEAST
Copper	NA	D		NA/IRIS, HEAST
Cyanide	NA			NA/IRIS, HEAST
Lead	NA	B2	Kidney	Oral/IRIS
Manganese	NA			NA/IRIS, HEAST
Nickel	NA			NA/IRIS, HEAST
Vanadium	NA			NA/IRIS, HEAST

IRIS = U.S. EPA, 1993 (or most recent file), Integrated Risk Information System (IRIS) Database  
HEAST = U.S. EPA (ECAO), 1992, Health Effects Assessment Summary Tables (HEAST): Annual Update  
NA = Toxicity value not available

(a) Cancer slope factor for benzo(a)pyrene  
(b) Estimated from unit risk of 5E-5 (ug/l)<sup>-1</sup>

TABLE 6  
SUMMARY OF TOXICITY VALUES ASSOCIATED WITH CARCINOGENIC EFFECTS: INHALATION  
NCBC DAVISVILLE - SITE 08

CONSTITUENT	SLOPE FACTOR (SF) INHALATION (mg/kg-day) <sup>-1</sup>	WEIGHT-OF EVIDENCE CLASS	TYPE OF CANCER	SF BASIS/ SOURCE
<b>VOLATILE ORGANICS</b>				
Acetone	NA	D		NA/IRIS, HEAST
Chloroform	8.1E-02	B2	Liver	Gavage/IRIS, HEAST
Methylene chloride	1.6E-03	B2	Liver, Lung	Inhalation/IRIS
<b>SEMIVOLATILE ORGANICS</b>				
Benzoic acid	NA	D		NA/IRIS, HEAST
Benzo(a)anthracene (a)	6.1E+00	B2	Respiratory Tract	HEAST
Benzo(a)pyrene	6.1E+00	B2	Respiratory Tract	HEAST
Benzo(b/k)fluoranthene (a)	6.1E+00	B2	Respiratory Tract	HEAST
Benzo(g,h,i)perylene	NA	D		NA/IRIS, HEAST
Bis(2-ethylhexyl)phthalate (b)	1.4E-02	B2	Liver	Diet/IRIS
Chrysene (a)	6.1E+00	B2	Respiratory Tract	HEAST
Dibenz(a,h)anthracene (a)	6.1E+00	B2	Respiratory Tract	HEAST
Fluoranthene	NA	D		NA/IRIS, HEAST
Indeno(1,2,3-cd)pyrene (a)	6.1E+00	B2	Respiratory Tract	HEAST
Phenanthrene	NA	D		NA/IRIS, HEAST
Pyrene	NA	D		NA/IRIS, HEAST
<b>PESTICIDES / PCB'S</b>				
DDT, 4,4-	3.4E-01	B2	Liver	Diet/IRIS, HEAST
Aroclor-1260 (b)	7.7E+00	B2	Liver	Diet/IRIS
<b>INORGANICS</b>				
Aluminum	NA			NA/IRIS, HEAST
Arsenic	5.0E+01	A	Respiratory Tract	IRIS, HEAST
Barium	NA			NA/IRIS, HEAST
Beryllium	8.4E+00	B2	Lung	IRIS, HEAST
Chromium III	NA			NA/IRIS, HEAST
Chromium VI	4.1E+01	A	Lung	IRIS, HEAST
Cobalt	NA			NA/IRIS, HEAST
Copper	NA	D		NA/IRIS, HEAST
Cyanide	NA			NA/IRIS, HEAST
Lead	NA	B2	Kidney	NA/IRIS, HEAST
Manganese	NA			NA/IRIS, HEAST
Nickel (c)	8.4E-01	A	Lung and Nasal	HEAST
Vanadium	NA			NA/IRIS, HEAST

IRIS = U.S. EPA, 1993 (or most recent file), Integrated Risk Information System (IRIS) Database  
HEAST = U.S. EPA (EPA), 1992, Health Effects Assessment Summary Tables (HEAST): Annual Update  
NA = Toxicity value not available

- (a) Cancer slope factor for benzo(a)pyrene  
(b) Oral toxicity value (based on non-contact site tumors) assigned to inhalation.  
(c) Cancer slope factor for nickel refinery dust

TABLE 7  
SUMMARY OF TOXICITY VALUES ASSOCIATED WITH NONCARCINOGENIC CHRONIC EFFECTS: ORAL  
NCBC DAVISVILLE - SITE 08

CONSTITUENT	CHRONIC RFD (ORAL) (mg/kg-day)	CONFIDENCE LEVEL (a)	CRITICAL EFFECT	ORAL RFD BASIS/SOURCE	UNCERTAINTY FACTOR	MODIFYING FACTOR (b)
<b>VOLATILE ORGANICS</b>						
Acetone	1.0E-01	Low	Increased liver and kidney weight Liver lesions Liver toxicity	Gavage/IRIS	1000	1
Chloroform	1.0E-02	Medium		Capsule/IRIS	1000	1
Methylene chloride	6.0E-02	Medium		Water/IRIS	100	1
<b>SEMIVOLATILE ORGANICS</b>						
Benzoic acid	4.0E+00	Medium	None observed	Diet/IRIS	1	1
Benzo(a)anthracene	NA			NA/IRIS,HEAST		
Benzo(a)pyrene	NA			NA/IRIS,HEAST		
Benzo(b/k)fluoranthene	NA			NA/IRIS,HEAST		
Benzo(g,h,i)perylene (c)	4.0E-02	Medium	Decreased body weight gain Increased relative liver weight	Gavage/HEAST	10000	NA
Bis(2-ethylhexyl)phthalate	2.0E-02			Diet/IRIS	1000	1
Chrysene	NA			NA/IRIS,HEAST		
Dibenz(a,h)anthracene	NA			NA/IRIS,HEAST		
Fluoranthene	4.0E-02	Low	Kidney, liver, blood, and clinical effects	Gavage/IRIS	3000	1
Indeno(1,2,3-cd)pyrene	NA			NA/IRIS,HEAST		
Phenanthrene (c)	4.0E-02			Gavage/HEAST	10000	NA
Pyrene	3.0E-02	Low	Kidney effects	Gavage/IRIS	3000	1
<b>PESTICIDES / PCB'S</b>						
DDT, 4,4-	5.0E-04	Medium	Liver lesions	Diet/IRIS	100	1
Aroclor-1260	NA			NA/IRIS,HEAST		
<b>INORGANICS</b>						
Aluminum	NA			NA/IRIS,HEAST		
Arsenic	3.0E-04	Medium	Hyperpigmentation, keratosis, possible vascular effects	Water/IRIS	3	1
Barium	7.0E-02	Medium		Increased blood pressure	Water/IRIS	3
Beryllium	5.0E-03	Low	None observed	Water/IRIS	100	1
Chromium III	1.0E+00	Low	None observed	Diet/IRIS	100	10
Chromium VI	5.0E-03	Low	None observed	Water/IRIS	500	1
Cobalt	NA			NA/IRIS,HEAST		
Copper (d)	3.7E-02	Medium	Local gastrointestinal irritation Weight loss, thyroid effects	Oral/HEAST	100	5
Cyanide	2.0E-02			Diet/IRIS		
Lead	NA			NA/IRIS,HEAST		
Manganese (e)	1.4E-01	NA	Central nervous system effects	Diet/IRIS	1	1
Nickel (f)	2.0E-02	Medium	Reduced body and organ weight	Diet/IRIS	300	1
Vanadium	7.0E-03		None observed	Water/HEAST	100	

IRIS = U.S. EPA, 1993 (or most recent file), Integrated Risk Information System (IRIS) Database  
HEAST = U.S. EPA (EPAO), 1992, Health Effects Assessment Summary Tables (HEAST): Annual Update  
NA = Toxicity value not available

- (a) Confidence level not specified in HEAST
- (b) Modifying factor not specified in HEAST
- (c) Toxicity value for naphthalene
- (d) Value derived from current drinking water standard of 1.3 mg/l
- (e) Value for food ingestion; RFD for water ingestion is 5E-3 mg/kg-day
- (f) Toxicity value for nickel (soluble salts)

TABLE 7 (continued)  
 SUMMARY OF TOXICITY VALUES ASSOCIATED WITH NONCARCINOGENIC SUBCHRONIC EFFECTS: ORAL  
 NCBC DAVISVILLE - SITE 08

CONSTITUENT	SUBCHRONIC RFD (ORAL) (mg/kg-day)	CONFIDENCE LEVEL (a)	CRITICAL EFFECT	ORAL RFD BASIS/SOURCE	UNCERTAINTY FACTOR (b)
<b>VOLATILE ORGANICS</b>					
Acetone	1.0E+00		Increased liver and kidney weights, nephrotoxicity Liver lesions Liver toxicity	Gavage/HEAST	100
Chloroform	1.0E-02			Capsule/HEAST	1000
Methylene chloride	6.0E-02			Water/HEAST	100
<b>SEMIVOLATILE ORGANICS</b>					
Benzoic acid	4.0E+00		None observed	Diet/HEAST	1
Benzo(a)anthracene	NA			NA/HEAST	
Benzo(a)pyrene	NA		Decreased body weight gain Increased relative liver weight	NA/HEAST	10000
Benzo(b,k)fluoranthene	NA			NA/HEAST	
Benzo(g,h,i)perylene (c)	4.0E-02			Gavage/HEAST	
Bis(2-ethylhexyl)phthalate	2.0E-02		Kidney, liver, and blood effects	Diet/HEAST	1000
Chrysene	NA			NA/HEAST	
Dibenz(a,h)anthracene	NA		Decreased body weight gain Renal effects	NA/HEAST	10000
Fluoranthene	4.0E-01			Gavage/HEAST	
Indeno(1,2,3-cd)pyrene	NA		Renal effects	NA/HEAST	300
Phenanthrene (c)	4.0E-02			Gavage/HEAST	
Pyrene	3.0E-01		Gavage/HEAST	300	
<b>PESTICIDES / PCB'S</b>					
DDT, 4,4-	5.0E-04		Liver lesions	Diet/HEAST	100
Aroclor-1260	NA			NA/HEAST	
<b>INORGANICS</b>					
Aluminum	NA		Keratosi s and hyperpigmentation Increased blood pressure	NA/HEAST	3
Arsenic	3.0E-04			Water/HEAST	
Barium	7.0E-02		None observed	Water/HEAST	3
Beryllium	5.0E-03			Water/HEAST	100
Chromium III	1.0E+00		None observed	Diet/HEAST	1000
Chromium VI	2.0E-02			Water/HEAST	100
Cobalt	NA		Local gastrointestinal irritation	NA/HEAST	NA
Copper (d)	3.7E-02			Oral/HEAST	
Cyanide	2.0E-02		Decreased body weight, thyroid effects, myelin degeneration	Diet/HEAST	500
Lead	NA			NA/HEAST	
Manganese	1.0E-01		Central nervous system effects Decreased body and organ weight	Diet/HEAST	1
Nickel (e)	2.0E-02			Diet/HEAST	300
Vanadium	7.0E-03		None observed	Water/HEAST	100

HEAST = U.S. EPA (EPAO), 1992, Health Effects Assessment Summary Tables (HEAST): Annual Update  
 NA = Toxicity value not available

- (a) Confidence level not specified in HEAST
- (b) Modifying factor not specified in HEAST
- (c) Toxicity value for naphthalene
- (d) Value derived from current drinking water standard of 1.3 mg/l
- (e) Toxicity value for nickel (soluble salts)

TABLE 8  
SUMMARY OF TOXICITY VALUES ASSOCIATED WITH NONCARCINOGENIC CHRONIC EFFECTS: INHALATION  
NCBC DAVISVILLE - SITE 08

CONSTITUENT	CHRONIC RFD (INHALATION) (mg/kg-day)	CONFIDENCE LEVEL (a)	CRITICAL EFFECT	ORAL RFD BASIS/ SOURCE	UNCERTAINTY FACTOR	MODIFYING FACTOR (b)
<b>VOLATILE ORGANICS</b>						
Acetone	NA			NA/IRIS, HEAST		
Chloroform (c)	1.0E-02	Medium	Liver lesions	Capsule/IRIS	1000	1
Methylene chloride (d)	8.6E-01		Liver toxicity	HEAST	100	
<b>SEMIVOLATILE ORGANICS</b>						
Benzoic acid (c)	4.0E+00	Medium	None observed	Diet/IRIS	1	1
Benzo(a)anthracene	NA			NA/IRIS, HEAST		
Benzo(a)pyrene	NA			NA/IRIS, HEAST		
Benzo(b/k)fluoranthene	NA			NA/IRIS, HEAST		
Benzo(g,h,i)perylene (c,e)	4.0E-02		Decreased body weight gain	Gavage/HEAST	10000	NA
Bis(2-ethylhexyl)phthalate (c)	2.0E-02	Medium	Increased relative liver weight	Diet/IRIS	1000	1
Chrysene	NA			NA/IRIS, HEAST		
Dibenz(a,h)anthracene	NA			NA/IRIS, HEAST		
Fluoranthene (c)	4.0E-02	Low	Kidney, liver, blood, and clinical effects	Gavage/IRIS	3000	1
Indeno(1,2,3-cd)pyrene	NA			NA/IRIS, HEAST		
Phenanthrene (c,e)	4.0E-02		Decreased body weight gain	Gavage/HEAST	10000	NA
Pyrene (c)	3.0E-02	Low	Kidney effects	Gavage/IRIS	3000	1
<b>PESTICIDES / PCB'S</b>						
DDT, 4,4- (c)	5.0E-04	Medium	Liver lesions	Diet/IRIS	100	1
Aroclor-1260	NA			NA/IRIS, HEAST		
<b>INORGANICS</b>						
Aluminum	NA			NA/IRIS, HEAST		
Arsenic (c)	3.0E-04	Medium	Hyperpigmentation, keratosis, possible vascular effects	Water/IRIS	3	1
Barium (c)	7.0E-02	Medium	Increased blood pressure	Water/IRIS	3	1
Beryllium (c)	5.0E-03	Low	None observed	Water/IRIS	100	1
Chromium III (c)	1.0E+00	Low	None observed	Diet/IRIS	100	10
Chromium VI (c)	5.0E-03	Low	No effects reported	Water/IRIS	500	1
Cobalt	NA			NA/IRIS, HEAST		
Copper	NA			NA/IRIS, HEAST		
Cyanide (c)	2.0E-02	Medium	Weight loss, thyroid effects	Diet/IRIS	100	5
Lead (f)	4.3E-04			HEAST		
Manganese (g)	1.1E-04	Medium	Respiratory symptoms, psychomotor disturbances	IRIS	300	3
Nickel (a,h)	2.0E-02	Medium	Reduced body and organ weights	Diet/IRIS	300	1
Vanadium (c)	7.0E-03		None observed	Water/HEAST	100	

IRIS = U.S. EPA, 1993 (or most recent file), Integrated Risk Information System (IRIS) Database  
HEAST = U.S. EPA (ECAO), 1992, Health Effects Assessment Summary Tables (HEAST): Annual Update  
NA = Toxicity value not available

- (a) Confidence level not specified in HEAST
- (b) Modifying factor not specified in HEAST
- (c) Oral toxicity value (based on systemic effects) assigned to inhalation.
- (d) Value derived from RfC of 3E+0 mg/m3.
- (e) Toxicity value for naphthalene
- (f) Value derived from NAAQS of 1.5E+0 ug/m3.
- (g) Value derived from RfC of 4E-4 mg/m3.
- (h) Toxicity value for nickel (soluble salts)

TABLE 8 (continued)  
SUMMARY OF TOXICITY VALUES ASSOCIATED WITH NONCARCINOGENIC SUBCHRONIC EFFECTS: INHALATION  
NCBC DAVISVILLE - SITE 08

CONSTITUENT	SUBCHRONIC RFD (INHALATION) (mg/kg-day)	CONFIDENCE LEVEL (a)	CRITICAL EFFECT	ORAL RFD BASIS/SOURCE	UNCERTAINTY FACTOR (b)
<b>VOLATILE ORGANICS</b>					
Acetone	NA			NA/HEAST	
Chloroform (c)	1.0E-02		Liver lesions	Capsule/HEAST	1000
Methylene chloride (d)	8.6E-01		Liver toxicity	HEAST	100
<b>SEMIVOLATILE ORGANICS</b>					
Benzoic acid (c)	4.0E+00		None observed	Diet/HEAST	1
Benzo(a)anthracene	NA			NA/HEAST	
Benzo(a)pyrene	NA			NA/HEAST	
Benzo(b/k)fluoranthene	NA			NA/HEAST	
Benzo(g,h,i)perylene (c,e)	4.0E-02		Decreased body weight gain	Gavage/HEAST	10000
Bis(2-ethylhexyl)phthalate (c)	2.0E-02		Increased relative liver weight	Diet/HEAST	1000
Chrysene	NA			NA/HEAST	
Dibenz(a,h)anthracene	NA			NA/HEAST	
Fluoranthene (c)	4.0E-01		Kidney, liver, and blood effects	Gavage/HEAST	300
Indeno(1,2,3-cd)pyrene	NA			NA/HEAST	
Phenanthrene (c,e)	4.0E-02		Decreased body weight gain	Gavage/HEAST	10000
Pyrene (c)	3.0E-01		Renal effects	Gavage/HEAST	300
<b>PESTICIDES / PCB'S</b>					
DDT, 4,4- (c)	5.0E-04		Liver lesions	Diet/HEAST	100
Aroclor-1260	NA			NA/HEAST	
<b>INORGANICS</b>					
Aluminum	NA			NA/HEAST	
Arsenic (c)	3.0E-04		Keratosi s and hyperpigmentation	Water/HEAST	3
Barium (c)	7.0E-02		Increased blood pressure	Water/HEAST	3
Beryllium (c)	5.0E-03		None observed	Water/HEAST	100
Chromium III (c)	1.0E+00		None observed	Diet/HEAST	1000
Chromium IV (c)	2.0E-02		None observed	Water/HEAST	100
Cobalt	NA			NA/HEAST	
Copper	NA			NA/HEAST	
Cyanide (c)	2.0E-02		Weight loss, thyroid effects, myelin degeneration	Diet/HEAST	500
Lead (f)	4.3E-04			HEAST	
Manganese (g)	1.1E-04		Respiratory effects, psychomotor disturbances	HEAST	900
Nickel (c,h)	2.0E-02		Decreased body and organ weights	Diet/HEAST	300
Vanadium (c)	7.0E-03		None observed	Water/HEAST	100

HEAST = U.S. EPA (EPA), 1992, Health Effects Assessment Summary Tables (HEAST): Annual Update  
NA = Toxicity value not available

- (a) Confidence level not specified in HEAST
- (b) Modifying factor not specified in HEAST
- (c) Oral toxicity value (based on systemic effects) assigned to inhalation.
- (d) Value derived from RIC of 3E+0 mg/m3.
- (e) Toxicity value for naphthalene
- (f) Value derived from NAAQS of 1.5E+0 ug/m3.
- (g) Value derived from RIC of 4E-4 mg/m3.
- (h) Toxicity value for nickel (soluble salts)

TABLE 9  
EXPOSURE POINT CONCENTRATIONS FOR CONSTITUENTS  
OF POTENTIAL CONCERN IN SOIL  
NCBC DAVISVILLE - SITE 08

CONSTITUENT	SURFACE SOIL (a) CONCENTRATION (mg/kg)		SUBSURFACE SOIL (b) CONCENTRATION (mg/kg)		SOIL (c) CONCENTRATION (mg/kg)	
	GEOMETRIC MEAN	MAXIMUM	GEOMETRIC MEAN	MAXIMUM	GEOMETRIC MEAN	MAXIMUM
<b>VOLATILE ORGANICS</b>						
Acetone	1.70E-02	8.90E-02	ND	ND	1.72E-02	8.90E-02
Chloroform	3.87E-03	3.00E-03	3.75E-03	1.00E-03	3.83E-03	3.00E-03
Methylene chloride	7.31E-03	7.00E-03	7.65E-03	6.00E-03	7.42E-03	7.00E-03
<b>SEMIVOLATILE ORGANICS</b>						
Benzoic Acid	1.17E-02	1.30E-01	5.52E-01	4.50E-02	1.24E-02	1.30E-01
Benzo(a)anthracene	1.35E-01	4.10E-01	ND	ND	1.95E-01	4.10E-01
Benzo(a)pyrene	1.39E-01	3.30E-01	ND	ND	1.64E-01	3.30E-01
Benzo(b)/(k)fluoranthene	2.87E-01	6.50E-01	3.80E-01	5.60E-01	3.15E-01	6.50E-01
Benzo(g,h,i)perylene	1.58E-01	1.90E-01	ND	ND	1.78E-01	1.90E-01
bis(2-Ethylhexyl)phthalate	1.37E-01	2.90E-01	3.76E-01	4.70E-01	1.91E-01	4.70E-01
Chrysene	1.54E-01	5.00E-01	2.01E-01	4.20E-02	1.68E-01	5.00E-01
Dibenzo(a,h)anthracene	1.84E-01	1.90E-01	ND	ND	1.97E-01	1.90E-01
Fluoranthene	1.78E-01	5.70E-01	2.03E-01	4.60E-02	1.86E-01	5.70E-01
Indeno(1,2,3-cd)pyrene	1.46E-01	2.00E-01	ND	ND	1.69E-01	2.00E-01
Phenanthrene	1.24E-01	1.10E-01	2.13E-01	1.70E-01	1.48E-01	1.70E-01
Pyrene	1.73E-01	4.80E-01	2.06E-01	5.70E-02	1.83E-01	4.80E-01
<b>PESTICIDES/PCB'S</b>						
DDT, 4,4-	7.24E-03	2.90E-02	ND	ND	8.30E-03	2.90E-02
Aroclor-1260	7.38E-02	4.50E-01	8.84E-02	2.30E-02	7.84E-02	4.50E-01
<b>INORGANICS</b>						
Arsenic	8.74E-01	2.60E+00	5.22E-01	8.40E-01	7.36E-01	2.60E+00
Beryllium	4.84E-01	1.40E+00	5.86E-01	1.40E+00	5.16E-01	1.40E+00
Chromium III (d)	4.86E+00	1.36E+01	3.54E+00	1.02E+01	4.38E+00	1.36E+01
Chromium VI (d)	6.95E-01	1.94E+00	5.06E-01	1.45E+00	6.25E-01	1.94E+00
Cyanide	2.32E-01	3.90E-01	2.36E-01	4.00E-01	2.33E-01	4.00E-01
Lead	1.66E+01	1.71E+02	6.27E+00	1.34E+01	1.20E+01	1.71E+02
Nickel	5.44E+00	3.08E+01	4.33E+00	5.80E+00	5.04E+00	3.08E+01

(a) Surface soil exposure point concentrations, used in the trespasser and commercial/industrial worker scenarios, determined using samples taken at a depth of 0-2 feet.

(b) Subsurface soil exposure point concentrations, used in the construction worker scenario, determined using samples taken at a depth of 2-10 feet.

(c) Soil exposure point concentrations, used in the resident scenario, determined using samples taken at a depth of 0-10 feet.

(d) Concentrations for chromium reported as total chromium; ratio 7:1 (i.e., 7/8 chromium III and 1/8 chromium VI) used to estimate exposure point concentrations for chromium III and chromium VI.

ND = Not detected

TABLE 10  
 EXPOSURE POINT CONCENTRATIONS FOR CONSTITUENTS  
 OF POTENTIAL CONCERN IN GROUND WATER  
 NCBC DAVISVILLE - SITE 08

CONSTITUENT	GROUND WATER (a) CONCENTRATIONS (mg/L)	
	GEOMETRIC MEAN	MAXIMUM
VOLATILES		
Acetone	2.46E-02	9.20E-02
INORGANICS		
Aluminum	1.21E+00	3.38E+00
Arsenic	1.19E-03	1.80E-03
Barium	2.17E-02	4.19E-02
Beryllium	4.54E-04	3.40E-04
Chromium III (b)	4.17E-03	6.21E-03
Chromium VI (b)	5.96E-04	8.88E-04
Cobalt	2.59E-03	4.70E-03
Copper	3.83E-03	7.90E-03
Cyanide	2.06E-03	3.10E-03
Lead	2.11E-03	3.30E-03
Manganese	7.35E-01	1.30E+00
Vanadium	3.34E-03	4.60E-03

- (a) Ground water samples used in residential scenario.  
 Unfiltered sample data used to calculate inorganic exposure point concentrations.
- (b) Concentrations for chromium reported as total chromium; ratio 7:1 (i.e., 7/8 chromium III and 1/8 chromium VI) used to estimate exposure point concentrations for chromium III and chromium VI.

TABLE 11  
SUMMARY OF EXPOSURE PARAMETER VALUES  
NCBC DAVISVILLE - SITE 08

PARAMETER	VALUE OR RANGE	VALUE USED IN PHASE I	VALUE USED IN PHASE II	RATIONALE FOR PHASE II VALUE	REFERENCE
Scenarios 1-4: Global variables					
Body Weight (kg)					
- Child (Scenario 4)	11.6-17.4	16	14.5	Value based on average of males and females between 0-6 yrs	EPA 1990a
- Youth (Scenario 1)	36.0-61.2	50	49.2	Value based on average of males and females between 9-18 yrs	EPA 1990a
- Youth/Adult (Scenarios 1-4)	67.2-73.4	70	70	Value based on average of males and females between 18-65 yrs	EPA 1989a
Exposure Duration (yr)					
-Scenario 1	1-70	10	10	Based on age of youths likely to enter the site.	
-Scenario 2	1-70	30	25	National upper-bound (90th percentile) at one job.	EPA 1991
-Scenario 3	1-70	30	1	Time spent doing construction, excavation, or utility work.	
-Scenario 4					
Child	0-6	6	6	Based upon child living all six years at the residence.	
Youth/Adult	7-70	64	24	Based on national upper-bound (90th percentile) at one residence.	EPA 1991
Averaging Time					
- Cancer risks	NA	25,550	25,550	Value based upon 70 year life expectancy.	EPA 1989a
- Noncancer risks					
Scenario 1	365-25,550	3650	3650	Value based upon exposure duration.	
Scenario 2	365-25,550	10950	9,125	Value based upon exposure duration.	
Scenario 3	365-25,550	10950	365	Value based upon exposure duration.	
Scenario 4					
Child	365-2,190	2,190	2,190	Value based upon exposure duration.	
Youth/Adult	365-25,550	23360	8760	Value based upon exposure duration.	
Relative Absorption Factors (--)					
- Ingestion of soil					
VOCs		1	1		EPA, 1989b
PAHs		1	1		EPA, 1989b
PCBs		0.3	0.3		EPA, 1989b
Pesticides		0.3 or 1	0.3 or 1	For constituents with high and low soil sorption, respectively	EPA, 1989b
Inorganics		1	1		EPA, 1989b
Lead		0.5 or 0.3	0.5 or 0.3	For children and youths/adults, respectively	EPA, 1989b
- Dermal contact with soil					
VOCs		0.5	0.5		EPA, 1989b
PAHs		0.05	0.05		EPA, 1989b
PCBs		0.05	0.05		EPA, 1989b
Pesticides		0.05 or 0.5	0.05 or 0.5	For constituents with high and low soil sorption, respectively	EPA, 1989b
Inorganics		0.01	0	Based on negligible absorption of inorganics through the skin	EPA, 1989b
Lead		0.01	0	Based on negligible absorption of inorganics through the skin	EPA, 1989b
- Inhalation of dust or ingestion of ground water		1	1	For all constituents	EPA, 1989b
Adherence Factor for Soil (mg/cm <sup>2</sup> )	0-2.77	0.5	0.5	Based upon Region I review of soil adherence to hands.	EPA 1989b
Fraction Surface Area Exposed (--)	0-1	0.5	0.5		EPA 1989b
Scenario 1-4: Constituent Concentration Justification Surface and subsurface soils; Ground Water				The geometric mean and maximum concentrations used in estimating exposure were calculated using the methods described previously	

TABLE 11 (continued)  
SUMMARY OF EXPOSURE PARAMETER VALUES  
NCBC DAVISVILLE - SITE 08

PARAMETER	VALUE OR RANGE	VALUE USED IN PHASE I	VALUE USED IN PHASE II	RATIONALE FOR PHASE II VALUE	REFERENCE
<b>Scenario 1 - Trespasser (Current)</b>					
Exposure Frequency(d/yr) (a)	1-365	39	39	Based on 1 d/wk during spring, summer, and fall	
<b>Dermal Contact With Constituents in Soils</b>					
Skin Surface Area (cm <sup>2</sup> )	0-18,150	2000	2000	Based on hands, forearms, feet, and lower legs.	EPA 1989b
<b>Ingestion of Constituents In Soils</b>					
Ingestion Rate (mg/d)	0-480	100	100	Soil ingestion rate for those over 6 years of age.	EPA 1991
<b>Scenario 2 - Commercial/Industrial Worker (Current or Future)</b>					
Exposure Frequency (d/yr) (a)	1-365	78	250	Based on an estimate of the number of days at work.	EPA 1991
<b>Dermal Contact with Constituents In Soils</b>					
Skin Surface Area (cm <sup>2</sup> )	0-18,150	2000	2000	Based on hands and feet.	EPA 1989b
<b>Ingestion of Constituents in Soils</b>					
Ingestion Rate (mg/d)	0-480	100	50	Based upon minimal contact with the soil.	EPA 1991
<b>Scenario 3 - Construction Worker (Future)</b>					
Exposure Frequency (d/yr) (a)	1-365	10	250	Number of days spent doing construction, excavation, or utility work	
<b>Dermal Contact with Constituents In Soils</b>					
Skin Surface Area (cm <sup>2</sup> )	0-18,150	2000	4000	Based on increased exposure relative to normal residential or recreational activities	EPA 1989b
<b>Ingestion of Constituents in Soils</b>					
Ingestion Rate (mg/d)	0-480	100	480	Based upon extensive contact with the soil.	EPA 1991
<b>Inhalation Of Airborne Constituents Absorbed to Dust</b>					
Ambient Dust Concentration (kg/m <sup>3</sup> )	variable	--	3.5E-9	Based on EPA (1988) fugitive dust model	
Inhalation Rate (m <sup>3</sup> /hr)	0.5-3.9	--	2.5	Based upon moderate exertion.	EPA 1991
Exposure Time (hr/d)	1-24	--	8	Based upon an eight hour work day.	
<b>Scenario 4 - Resident (Future)</b>					
Exposure Frequency (d/yr) (a)	1-365	78 or 143	350	Based on two weeks spent away from home.	EPA 1991
<b>Dermal Contact with Constituents in Soil</b>					
Skin Surface Area (cm <sup>2</sup> )	0-18,150	2000	2000	Based on child's hands, forearms, feet, and lower legs, and adult's hands and feet	EPA 1989b
<b>Ingestion of Constituents in Soil</b>					
<b>Ingestion Rate (mg/d)</b>					
Child	0-480	200	200	Children, 1-6 years old.	EPA 1989a
Youth/Adult	0-480	100	100	Age groups greater than 6 years old.	EPA 1989a
<b>Ingestion of Constituents in Water</b>					
<b>Ingestion Rate (l/d)</b>					
Adult	--	--	2	Adult, 90th percentile	EPA 1989a

TABLE 12  
 SCENARIO 1 - CURRENT TRESPASSER (YOUTHS AGED 9 TO 18 YEARS)  
 EXPOSURE AND RISK ESTIMATES  
 INCIDENTAL INGESTION OF SOIL  
 NCBC DAVISVILLE - SITE 08

Constituent	Soil Concentrations (a)		Exposure Estimates					Toxicity Values		Risk Estimates			
	Geometric Mean Soil Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Relative Absorption Factor (-)	Mean Dose (Cancer) (mg/kg-d)	RME Dose (Cancer) (mg/kg-d)	Mean Dose (Noncancer) (mg/kg-d)	RME Dose (Noncancer) (mg/kg-d)	Cancer Slope Factor (Oral) (mg/kg-d) <sup>-1</sup>	Noncancer Reference Dose (Oral) (mg/kg-d)	Mean Cancer Risk (-)	RME Cancer Risk (-)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)
<b>VOLATILE ORGANICS</b>													
Acetone	1.7E-02	8.9E-02	1	5.3E-10	2.8E-09	3.7E-09	1.9E-08	NA	1.0E-01	NA	NA	3.7E-08	1.9E-07
Chloroform	3.9E-03	3.0E-03	1	1.2E-10	9.3E-11	8.4E-10	6.5E-10	6.1E-03	1.0E-02	7.3E-13	5.7E-13	8.4E-08	6.5E-08
Methylene chloride	7.3E-03	7.0E-03	1	2.3E-10	2.2E-10	1.6E-09	1.5E-09	7.5E-03	6.0E-02	1.7E-12	1.6E-12	2.6E-08	2.5E-08
<b>SEMIVOLATILE ORGANICS</b>													
Benzoic acid	1.2E-02	1.3E-01	1	3.6E-10	4.0E-09	2.5E-09	2.8E-08	NA	4.0E+00	NA	NA	6.4E-10	7.1E-09
Benzo(a)anthracene	1.3E-01	4.1E-01	1	4.2E-09	1.3E-08	2.9E-08	8.9E-08	7.3E+00	NA	3.1E-08	9.3E-08	NA	NA
Benzo(a)pyrene	1.4E-01	3.3E-01	1	4.3E-09	1.0E-08	3.0E-08	7.2E-08	7.3E+00	NA	3.1E-08	7.5E-08	NA	NA
Benzo(b)/(k)fluoranthene	2.9E-01	6.5E-01	1	8.9E-09	2.0E-08	6.2E-08	1.4E-07	7.3E+00	NA	6.5E-08	1.5E-07	NA	NA
Benzo(g,h,i)perylene	1.6E-01	1.9E-01	1	4.9E-09	5.9E-09	3.4E-08	4.1E-08	NA	4.0E-02	NA	NA	8.6E-07	1.0E-06
Bis(2-ethylhexyl)phthalate	1.4E-01	2.9E-01	1	4.2E-09	9.0E-09	3.0E-08	6.3E-08	1.4E-02	2.0E-02	5.9E-11	1.3E-10	1.5E-06	3.1E-06
Chrysene	1.5E-01	5.0E-01	1	4.8E-09	1.6E-08	3.3E-08	1.1E-07	7.3E+00	NA	3.5E-08	1.1E-07	NA	NA
Dibenz(a,h)anthracene	1.8E-01	1.9E-01	1	5.7E-09	5.9E-09	4.0E-08	4.1E-08	7.3E+00	NA	4.2E-08	4.3E-08	NA	NA
Fluoranthene	1.8E-01	5.7E-01	1	5.5E-09	1.8E-08	3.9E-08	1.2E-07	NA	4.0E-02	NA	NA	9.6E-07	3.1E-06
Indeno(1,2,3-cd)pyrene	1.5E-01	2.0E-01	1	4.5E-09	6.2E-09	3.2E-08	4.3E-08	7.3E+00	NA	3.3E-08	4.5E-08	NA	NA
Phenanthrene	1.2E-01	1.1E-01	1	3.8E-09	3.4E-09	2.7E-08	2.4E-08	NA	4.0E-02	NA	NA	6.7E-07	6.0E-07
Pyrene	1.7E-01	4.8E-01	1	5.4E-09	1.5E-08	3.7E-08	1.0E-07	NA	3.0E-02	NA	NA	1.2E-06	3.5E-06
<b>PESTICIDES / PCB'S</b>													
DDT, 4,4-	7.2E-03	2.9E-02	0.3	6.7E-11	2.7E-10	4.7E-10	1.9E-09	3.4E-01	5.0E-04	2.3E-11	9.2E-11	9.4E-07	3.8E-06
Aroclor-1260	7.4E-02	4.5E-01	0.3	6.9E-10	4.2E-09	4.8E-09	2.9E-08	7.7E+00	NA	5.3E-09	3.2E-08	NA	NA
<b>INORGANICS</b>													
Arsenic	8.7E-01	2.6E+00	1	2.7E-08	8.1E-08	1.9E-07	5.6E-07	1.8E+00	3.0E-04	4.7E-08	1.4E-07	6.3E-04	1.9E-03
Beryllium	4.8E-01	1.4E+00	1	1.5E-08	4.3E-08	1.1E-07	3.0E-07	4.3E+00	5.0E-03	6.5E-08	1.9E-07	2.1E-05	6.1E-05
Chromium III	4.9E+00	1.4E+01	1	1.5E-07	4.2E-07	1.1E-06	2.9E-06	NA	1.0E+00	NA	NA	1.1E-06	2.9E-06
Chromium VI	6.9E-01	1.9E+00	1	2.2E-08	6.0E-08	1.5E-07	4.2E-07	NA	5.0E-03	NA	NA	3.0E-05	8.4E-05
Cyanide	2.3E-01	3.9E-01	1	7.2E-09	1.2E-08	5.0E-08	8.5E-08	NA	2.0E-02	NA	NA	2.5E-06	4.2E-06
Lead	1.7E+01	1.7E+02	0.3	1.5E-07	1.6E-06	1.1E-06	1.1E-05	NA	NA	NA	NA	NA	NA
Nickel	5.4E+00	3.1E+01	1	1.7E-07	9.6E-07	1.2E-06	6.7E-06	NA	2.0E-02	NA	NA	5.9E-05	3.3E-04

(a) Surface soil concentrations

Where:

Dose = [Concentration x UC x IR x RAF x EF x ED] / [BW x AT]  
 Cancer Risk = Dose x Slope Factor  
 Hazard Quotient = Dose / Reference Dose

Unit Conversion (UC) = 1E-06 kg/mg  
 Ingestion Rate (IR) = 100 mg/d  
 Relative Absorption Factor (RAF) = CS Chemical-specific (-)  
 Exposure Frequency (EF) = 39 d/yr  
 Exposure Duration (ED) = 10 yr  
 Body Weight (BW) = 49.2 kg  
 Averaging Time (AT) = 25550 d (cancer)  
 3650 d (noncancer)

	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
TOTAL:	4E-07	9E-07	8E-04	2E-03

 = Cancer risk > 1E-6 or hazard quotient/index > 1E+0

TABLE 12 (cont)  
 SCENARIO 1 - CURRENT TRESPASSER (YOUTHS AGED 9 TO 18 YEARS)  
 EXPOSURE AND RISK ESTIMATES  
 DERMAL CONTACT WITH SOIL  
 NCBC DAVISVILLE - SITE 08

Constituent	Soil Concentrations (a)		Exposure Estimates				Toxicity Values		Risk Estimates				
	Geometric Mean Soil Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Relative Absorption Factor (-)	Mean Dose (Cancer) (mg/kg-d)	RME Dose (Cancer) (mg/kg-d)	Mean Dose (Noncancer) (mg/kg-d)	RME Dose (Noncancer) (mg/kg-d)	Cancer Slope Factor (Oral) (mg/kg-d) <sup>-1</sup>	Noncancer Reference Dose (Oral) (mg/kg-d)	Mean Cancer Risk (-)	RME Cancer Risk (-)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)
<b>VOLATILE ORGANICS</b>													
Acetone	1.7E-02	8.9E-02	0.5	1.3E-09	6.9E-09	9.2E-09	4.8E-08	NA	1.0E-01	NA	NA	9.2E-08	4.8E-07
Chloroform	3.9E-03	3.0E-03	0.5	3.0E-10	2.3E-10	2.1E-09	1.6E-09	6.1E-03	1.0E-02	1.8E-12	1.4E-12	2.1E-07	1.6E-07
Methylene chloride	7.3E-03	7.0E-03	0.5	5.7E-10	5.4E-10	4.0E-09	3.8E-09	7.5E-03	6.0E-02	4.3E-12	4.1E-12	6.6E-08	6.3E-08
<b>SEMIVOLATILE ORGANICS</b>													
Benzoic acid	1.2E-02	1.3E-01	0.05	9.1E-11	1.0E-09	6.4E-10	7.1E-09	NA	4.0E+00	NA	NA	1.6E-10	1.8E-09
Benzo(a)anthracene	1.3E-01	4.1E-01	0.05	1.0E-09	3.2E-09	7.3E-09	2.2E-08	7.3E+00	NA	7.6E-09	2.3E-08	NA	NA
Benzo(a)pyrene	1.4E-01	3.3E-01	0.05	1.1E-09	2.6E-09	7.5E-09	1.8E-08	7.3E+00	NA	7.9E-09	1.9E-08	NA	NA
Benzo(b)(k)fluoranthene	2.9E-01	6.5E-01	0.05	2.2E-09	5.0E-09	1.6E-08	3.5E-08	7.3E+00	NA	1.6E-08	3.7E-08	NA	NA
Benzo(g,h,i)perylene	1.6E-01	1.9E-01	0.05	1.2E-09	1.5E-09	8.6E-09	1.0E-08	NA	4.0E-02	NA	NA	2.1E-07	2.6E-07
Bis(2-ethylhexyl)phthalate	1.4E-01	2.9E-01	0.05	1.1E-09	2.2E-09	7.4E-09	1.6E-08	1.4E-02	2.0E-02	1.5E-11	3.1E-11	3.7E-07	7.9E-07
Chrysene	1.5E-01	5.0E-01	0.05	1.2E-09	3.9E-09	8.3E-09	2.7E-08	7.3E+00	NA	8.7E-09	2.8E-08	NA	NA
Dibenz(a,h)anthracene	1.8E-01	1.9E-01	0.05	1.4E-09	1.5E-09	1.0E-08	1.0E-08	7.3E+00	NA	1.0E-08	1.1E-08	NA	NA
Fluoranthene	1.8E-01	5.7E-01	0.05	1.4E-09	4.4E-09	9.6E-09	3.1E-08	NA	4.0E-02	NA	NA	2.4E-07	7.7E-07
Indeno(1,2,3-cd)pyrene	1.5E-01	2.0E-01	0.05	1.1E-09	1.6E-09	7.9E-09	1.1E-08	7.3E+00	NA	8.3E-09	1.1E-08	NA	NA
Phenanthrene	1.2E-01	1.1E-01	0.05	9.6E-10	8.5E-10	6.7E-09	6.0E-09	NA	4.0E-02	NA	NA	1.7E-07	1.5E-07
Pyrene	1.7E-01	4.8E-01	0.05	1.3E-09	3.7E-09	9.4E-09	2.6E-08	NA	3.0E-02	NA	NA	3.1E-07	8.7E-07
<b>PESTICIDES / PCB'S</b>													
DDT, 4,4-	7.2E-03	2.9E-02	0.05	5.6E-11	2.2E-10	3.9E-10	1.6E-09	3.4E-01	5.0E-04	1.9E-11	7.6E-11	7.9E-07	3.1E-06
Aroclor-1260	7.4E-02	4.5E-01	0.05	5.7E-10	3.5E-09	4.0E-09	2.4E-08	7.7E+00	NA	4.4E-09	2.7E-08	NA	NA
<b>INORGANICS</b>													
Arsenic	8.7E-01	2.6E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.8E+00	3.0E-04	NA	NA	NA	NA
Beryllium	4.8E-01	1.4E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.3E+00	5.0E-03	NA	NA	NA	NA
Chromium III	4.9E+00	1.4E+01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	1.0E+00	NA	NA	NA	NA
Chromium VI	6.9E-01	1.9E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	5.0E-03	NA	NA	NA	NA
Cyanide	2.3E-01	3.9E-01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	2.0E-02	NA	NA	NA	NA
Lead	1.7E+01	1.7E+02	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	NA	NA	NA
Nickel	5.4E+00	3.1E+01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	2.0E-02	NA	NA	NA	NA

(a) Surface soil concentrations

Where:

Dose = [Concentration x UC x CR x RAF x EF x ED] / [BW x AT]

Cancer Risk = Dose x Slope Factor

Hazard Quotient = Dose / Reference Dose

Unit Conversion (UC) = 1E-06 kg/mg  
 Dermal Contact Rate (CR) = 500 mg/d  
 Relative Absorption Factor (RAF) = CS Chemical-specific (-)  
 Exposure Frequency (EF) = 39 d/yr  
 Exposure Duration (ED) = 10 yr  
 Body Weight (BW) = 49.2 kg  
 Averaging Time (AT) = 25550 d (cancer)  
 3650 d (noncancer)

	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
TOTAL:	6E-08	2E-07	2E-06	7E-06

 = Cancer risk > 1E-6 or hazard quotient/index > 1E+0

TABLE 13  
 SCENARIO 2 - CURRENT OR FUTURE COMMERCIAL/INDUSTRIAL WORKER (ADULTS AGED 18 TO 70 YEARS)  
 EXPOSURE AND RISK ESTIMATES  
 INCIDENTAL INGESTION OF SOIL  
 NCBC DAVISVILLE - SITE 08

Constituent	Soil Concentrations (a)		Exposure Estimates					Toxicity Values		Risk Estimates			
	Geometric Mean Soil Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Relative Absorption Factor (-)	Mean Dose (Cancer) (mg/kg-d)	RME Dose (Cancer) (mg/kg-d)	Mean Dose (Noncancer) (mg/kg-d)	RME Dose (Noncancer) (mg/kg-d)	Cancer Slope Factor (Oral) (mg/kg-d) <sup>-1</sup>	Noncancer Reference Dose (Oral) (mg/kg-d)	Mean Cancer Risk (-)	RME Cancer Risk (-)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)
<b>VOLATILE ORGANICS</b>													
Acetone	1.7E-02	8.9E-02	1	3.0E-09	1.6E-08	8.3E-09	4.4E-08	NA	1.0E-01	NA	NA	8.3E-08	4.4E-07
Chloroform	3.9E-03	3.0E-03	1	6.8E-10	5.2E-10	1.9E-09	1.5E-09	6.1E-03	1.0E-02	4.1E-12	3.2E-12	1.9E-07	1.5E-07
Methylene chloride	7.3E-03	7.0E-03	1	1.3E-09	1.2E-09	3.6E-09	3.4E-09	7.5E-03	6.0E-02	9.6E-12	9.2E-12	6.0E-08	5.7E-08
<b>SEMIVOLATILE ORGANICS</b>													
Benzoic acid	1.2E-02	1.3E-01	1	2.0E-09	2.3E-08	5.7E-09	6.4E-08	NA	4.0E+00	NA	NA	1.4E-09	1.6E-08
Benzo(a)anthracene	1.3E-01	4.1E-01	1	2.4E-08	7.2E-08	6.6E-08	2.0E-07	7.3E+00	NA	1.7E-07	5.2E-07	NA	NA
Benzo(a)pyrene	1.4E-01	3.3E-01	1	2.4E-08	5.8E-08	6.8E-08	1.6E-07	7.3E+00	NA	1.8E-07	4.2E-07	NA	NA
Benzo(b)(k)fluoranthene	2.9E-01	6.5E-01	1	5.0E-08	1.1E-07	1.4E-07	3.2E-07	7.3E+00	NA	3.7E-07	8.3E-07	NA	NA
Benzo(g,h,i)perylene	1.6E-01	1.9E-01	1	2.8E-08	3.3E-08	7.7E-08	9.3E-08	NA	4.0E-02	NA	NA	1.9E-06	2.3E-06
Bis(2-ethylhexyl)phthalate	1.4E-01	2.9E-01	1	2.4E-08	5.1E-08	6.7E-08	1.4E-07	1.4E-02	2.0E-02	3.3E-10	7.1E-10	3.3E-06	7.1E-06
Chrysene	1.5E-01	5.0E-01	1	2.7E-08	8.7E-08	7.5E-08	2.4E-07	7.3E+00	NA	2.0E-07	6.4E-07	NA	NA
Dibenz(a,h)anthracene	1.8E-01	1.9E-01	1	3.2E-08	3.3E-08	9.0E-08	9.3E-08	7.3E+00	NA	2.3E-07	2.4E-07	NA	NA
Fluoranthene	1.8E-01	5.7E-01	1	3.1E-08	1.0E-07	8.7E-08	2.8E-07	NA	4.0E-02	NA	NA	2.2E-06	7.0E-06
Indeno(1,2,3-cd)pyrene	1.5E-01	2.0E-01	1	2.5E-08	3.5E-08	7.1E-08	9.8E-08	7.3E+00	NA	1.9E-07	2.6E-07	NA	NA
Phenanthrene	1.2E-01	1.1E-01	1	2.2E-08	1.9E-08	6.1E-08	5.4E-08	NA	4.0E-02	NA	NA	1.5E-06	1.3E-06
Pyrene	1.7E-01	4.8E-01	1	3.0E-08	8.4E-08	8.4E-08	2.3E-07	NA	3.0E-02	NA	NA	2.8E-06	7.8E-06
<b>PESTICIDES / PCB'S</b>													
DDT, 4,4-	7.2E-03	2.9E-02	0.3	3.8E-10	1.5E-09	1.1E-09	4.3E-09	3.4E-01	5.0E-04	1.3E-10	5.2E-10	2.1E-06	8.5E-06
Aroclor-1260	7.4E-02	4.5E-01	0.3	3.9E-09	2.4E-08	1.1E-08	6.6E-08	7.7E+00	NA	3.0E-08	1.8E-07	NA	NA
<b>INORGANICS</b>													
Arsenic	8.7E-01	2.6E+00	1	1.5E-07	4.5E-07	4.3E-07	1.3E-06	1.8E+00	3.0E-04	2.7E-07	8.0E-07	1.4E-03	4.2E-03
Beryllium	4.8E-01	1.4E+00	1	8.5E-08	2.4E-07	2.4E-07	6.8E-07	4.3E+00	5.0E-03	3.6E-07	1.1E-06	4.7E-05	1.4E-04
Chromium III	4.9E+00	1.4E+01	1	8.5E-07	2.4E-06	2.4E-06	6.6E-06	NA	1.0E+00	NA	NA	2.4E-06	6.6E-06
Chromium VI	6.9E-01	1.9E+00	1	1.2E-07	3.4E-07	3.4E-07	9.5E-07	NA	5.0E-03	NA	NA	6.8E-05	1.9E-04
Cyanide	2.3E-01	3.9E-01	1	4.1E-08	6.8E-08	1.1E-07	1.9E-07	NA	2.0E-02	NA	NA	5.7E-06	9.5E-06
Lead	1.7E+01	1.7E+02	0.3	8.7E-07	9.0E-06	2.4E-06	2.5E-05	NA	NA	NA	NA	NA	NA
Nickel	5.4E+00	3.1E+01	1	9.5E-07	5.4E-06	2.7E-06	1.5E-05	NA	2.0E-02	NA	NA	1.3E-04	7.5E-04

(a) Surface soil concentrations

Where:

Dose = [Concentration x UC x IR x RAF x EF x ED] / [BW x AT]  
 Cancer Risk = Dose x Slope Factor  
 Hazard Quotient = Dose / Reference Dose

Unit Conversion (UC) = 1E-06 kg/mg  
 Ingestion Rate (IR) = 50 mg/d  
 Relative Absorption Factor (RAF) = CS Chemical-specific (-)  
 Exposure Frequency (EF) = 250 d/yr  
 Exposure Duration (ED) = 25 yr  
 Body Weight (BW) = 70 kg  
 Averaging Time (AT) = 25550 d (cancer)  
 9125 d (noncancer)

	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
TOTAL:	2E-06	5E-06	2E-03	5E-03

☐ = Cancer risk > 1E-6 or hazard quotient/index > 1E+0

TABLE 13 (cont)  
 SCENARIO 2 - CURRENT OR FUTURE COMMERCIAL/INDUSTRIAL WORKER (ADULTS AGED 18 TO 70 YEARS)  
 EXPOSURE AND RISK ESTIMATES  
 DERMAL CONTACT WITH SOIL  
 NCBC DAVISVILLE - SITE 08

Constituent	Soil Concentrations (a)		Exposure Estimates					Toxicity Values		Risk Estimates			
	Geometric Mean Soil Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Relative Absorption Factor (--)	Mean Dose (Cancer) (mg/kg-d)	RME Dose (Cancer) (mg/kg-d)	Mean Dose (Noncancer) (mg/kg-d)	RME Dose (Noncancer) (mg/kg-d)	Cancer Slope Factor (Oral) (mg/kg-d) <sup>-1</sup>	Noncancer Reference Dose (Oral) (mg/kg-d)	Mean Cancer Risk (--)	RME Cancer Risk (--)	Mean Hazard Quotient (--)	RME Hazard Quotient (--)
<b>VOLATILE ORGANICS</b>													
Acetone	1.7E-02	8.9E-02	0.5	1.5E-08	7.8E-08	4.2E-08	2.2E-07	NA	1.0E-01	NA	NA	4.2E-07	2.2E-06
Chloroform	3.9E-03	3.0E-03	0.5	3.4E-09	2.6E-09	9.5E-09	7.3E-09	6.1E-03	1.0E-02	2.1E-11	1.6E-11	9.5E-07	7.3E-07
Methylene chloride	7.3E-03	7.0E-03	0.5	6.4E-09	6.1E-09	1.8E-08	1.7E-08	7.5E-03	6.0E-02	4.8E-11	4.6E-11	3.0E-07	2.9E-07
<b>SEMIVOLATILE ORGANICS</b>													
Benzoic acid	1.2E-02	1.3E-01	0.05	1.0E-09	1.1E-08	2.9E-09	3.2E-08	NA	4.0E+00	NA	NA	7.2E-10	8.0E-09
Benzo(a)anthracene	1.3E-01	4.1E-01	0.05	1.2E-08	3.6E-08	3.3E-08	1.0E-07	7.3E+00	NA	8.6E-08	2.6E-07	NA	NA
Benzo(a)pyrene	1.4E-01	3.3E-01	0.05	1.2E-08	2.9E-08	3.4E-08	8.1E-08	7.3E+00	NA	8.9E-08	2.1E-07	NA	NA
Benzo(b)(k)fluoranthene	2.9E-01	6.5E-01	0.05	2.5E-08	5.7E-08	7.0E-08	1.6E-07	7.3E+00	NA	1.8E-07	4.1E-07	NA	NA
Benzo(g,h,i)perylene	1.6E-01	1.9E-01	0.05	1.4E-08	1.7E-08	3.9E-08	4.6E-08	NA	4.0E-02	NA	NA	9.7E-07	1.2E-06
Bis(2-ethylhexyl)phthalate	1.4E-01	2.9E-01	0.05	1.2E-08	2.5E-08	3.3E-08	7.1E-08	1.4E-02	2.0E-02	1.7E-10	3.5E-10	1.7E-06	3.5E-06
Chrysene	1.5E-01	5.0E-01	0.05	1.3E-08	4.4E-08	3.8E-08	1.2E-07	7.3E+00	NA	9.8E-08	3.2E-07	NA	NA
Dibenz(a,h)anthracene	1.8E-01	1.9E-01	0.05	1.6E-08	1.7E-08	4.5E-08	4.6E-08	7.3E+00	NA	1.2E-07	1.2E-07	NA	NA
Fluoranthene	1.8E-01	5.7E-01	0.05	1.6E-08	5.0E-08	4.3E-08	1.4E-07	NA	4.0E-02	NA	NA	1.1E-06	3.5E-06
Indeno(1,2,3-cd)pyrene	1.5E-01	2.0E-01	0.05	1.3E-08	1.7E-08	3.6E-08	4.9E-08	7.3E+00	NA	9.3E-08	1.3E-07	NA	NA
Phenanthrene	1.2E-01	1.1E-01	0.05	1.1E-08	9.6E-09	3.0E-08	2.7E-08	NA	4.0E-02	NA	NA	7.6E-07	6.7E-07
Pyrene	1.7E-01	4.8E-01	0.05	1.5E-08	4.2E-08	4.2E-08	1.2E-07	NA	3.0E-02	NA	NA	1.4E-06	3.9E-06
<b>PESTICIDES / PCB'S</b>													
DDT, 4,4-	7.2E-03	2.9E-02	0.05	6.3E-10	2.5E-09	1.8E-09	7.1E-09	3.4E-01	5.0E-04	2.2E-10	8.6E-10	3.5E-06	1.4E-05
Aroclor-1260	7.4E-02	4.5E-01	0.05	6.4E-09	3.9E-08	1.8E-08	1.1E-07	7.7E+00	NA	5.0E-08	3.0E-07	NA	NA
<b>INORGANICS</b>													
Arsenic	8.7E-01	2.6E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.8E+00	3.0E-04	NA	NA	NA	NA
Beryllium	4.8E-01	1.4E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.3E+00	5.0E-03	NA	NA	NA	NA
Chromium III	4.9E+00	1.4E+01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	1.0E+00	NA	NA	NA	NA
Chromium VI	6.9E-01	1.9E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	5.0E-03	NA	NA	NA	NA
Cyanide	2.3E-01	3.9E-01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	2.0E-02	NA	NA	NA	NA
Lead	1.7E+01	1.7E+02	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	NA	NA	NA
Nickel	5.4E+00	3.1E+01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	2.0E-02	NA	NA	NA	NA

(a) Surface soil concentrations

Where:

Dose = [Concentration x UC x CR x RAF x EF x ED] / [BW x AT]  
 Cancer Risk = Dose x Slope Factor  
 Hazard Quotient = Dose / Reference Dose

Unit Conversion (UC) = 1E-06 kg/mg  
 Dermal Contact Rate (CR) = 500 mg/d  
 Relative Absorption Factor (RAF) = CS Chemical-specific (--)  
 Exposure Frequency (EF) = 250 d/yr  
 Exposure Duration (ED) = 25 yr  
 Body Weight (BW) = 70 kg  
 Averaging Time (AT) = 25550 d (cancer)  
 9125 d (noncancer)

	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
TOTAL:	7E-07	2E-06	1E-05	3E-05

 = Cancer risk > 1E-6 or hazard quotient/index > 1E+0

TABLE 14  
 SCENARIO 3 - FUTURE CONSTRUCTION WORKER (ADULTS AGED 18 TO 70 YEARS)  
 EXPOSURE AND RISK ESTIMATES  
 INCIDENTAL INGESTION OF SOIL  
 NCBC DAVISVILLE - SITE 08

Constituent	Soil Concentrations (a)		Exposure Estimates					Toxicity Values		Risk Estimates			
	Geometric Mean Soil Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Relative Absorption Factor (-)	Mean Dose (Cancer) (mg/kg-d)	RME Dose (Cancer) (mg/kg-d)	Mean Dose (Noncancer) (mg/kg-d)	RME Dose (Noncancer) (mg/kg-d)	Cancer Slope Factor (Oral) (mg/kg-d) <sup>-1</sup>	Noncancer Reference Dose (Oral) (mg/kg-d)	Mean Cancer Risk (-)	RME Cancer Risk (-)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)
<b>VOLATILE ORGANICS</b>													
Acetone	ND	ND	1	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	1.0E+00	NA	NA	NA	NA
Chloroform	3.7E-03	1.0E-03	1	2.5E-10	6.7E-11	1.8E-08	4.7E-09	6.1E-03	1.0E-02	1.5E-12	4.1E-13	1.8E-06	4.7E-07
Methylene chloride	7.6E-03	6.0E-03	1	5.1E-10	4.0E-10	3.6E-08	2.8E-08	7.5E-03	6.0E-02	3.8E-12	3.0E-12	6.0E-07	4.7E-07
<b>SEMIVOLATILE ORGANICS</b>													
Benzoic acid	5.5E-01	4.5E-02	1	3.7E-08	3.0E-09	2.6E-06	2.1E-07	NA	4.0E+00	NA	NA	6.5E-07	5.3E-08
Benzo(a)anthracene	ND	ND	1	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.3E+00	NA	NA	NA	NA	NA
Benzo(a)pyrene	ND	ND	1	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.3E+00	NA	NA	NA	NA	NA
Benzo(b)(k)fluoranthene	3.8E-01	5.6E-01	1	2.5E-08	3.8E-08	1.8E-06	2.6E-06	7.3E+00	NA	1.9E-07	2.7E-07	NA	NA
Benzo(g,h,i)perylene	ND	ND	1	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	4.0E-02	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	3.8E-01	4.7E-01	1	2.5E-08	3.2E-08	1.8E-06	2.2E-06	1.4E-02	2.0E-02	3.5E-10	4.4E-10	8.8E-05	1.1E-04
Chrysene	2.0E-01	4.2E-02	1	1.4E-08	2.8E-09	9.5E-07	2.0E-07	7.3E+00	NA	9.9E-08	2.1E-08	NA	NA
Dibenz(a,h)anthracene	ND	ND	1	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.3E+00	NA	NA	NA	NA	NA
Fluoranthene	2.0E-01	4.6E-02	1	1.4E-08	3.1E-09	9.5E-07	2.2E-07	NA	4.0E-01	NA	NA	2.4E-06	5.4E-07
Indeno(1,2,3-cd)pyrene	ND	ND	1	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.3E+00	NA	NA	NA	NA	NA
Phenanthrene	2.1E-01	1.7E-01	1	1.4E-08	1.1E-08	1.0E-06	8.0E-07	NA	4.0E-02	NA	NA	2.5E-05	2.0E-05
Pyrene	2.1E-01	5.7E-02	1	1.4E-08	3.8E-09	9.7E-07	2.7E-07	NA	3.0E-01	NA	NA	3.2E-06	8.9E-07
<b>PESTICIDES / PCB'S</b>													
DDT, 4,4-	ND	ND	0.3	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.4E-01	5.0E-04	NA	NA	NA	NA
Aroclor-1260	8.8E-02	2.3E-02	0.3	1.8E-09	4.6E-10	1.2E-07	3.2E-08	7.7E+00	NA	1.4E-08	3.6E-09	NA	NA
<b>INORGANICS</b>													
Arsenic	5.2E-01	8.4E-01	1	3.5E-08	5.6E-08	2.4E-06	3.9E-06	1.8E+00	3.0E-04	6.1E-08	9.9E-08	8.2E-03	1.3E-02
Beryllium	5.9E-01	1.4E+00	1	3.9E-08	9.4E-08	2.8E-06	6.6E-06	4.3E+00	5.0E-03	1.7E-07	4.0E-07	5.5E-04	1.3E-03
Chromium III	3.5E+00	1.0E+01	1	2.4E-07	6.8E-07	1.7E-05	4.8E-05	NA	1.0E+00	NA	NA	1.7E-05	4.8E-05
Chromium VI	5.1E-01	1.5E+00	1	3.4E-08	9.7E-08	2.4E-06	6.8E-06	NA	2.0E-02	NA	NA	1.2E-04	3.4E-04
Cyanide	2.4E-01	4.0E-01	1	1.6E-08	2.7E-08	1.1E-06	1.9E-06	NA	2.0E-02	NA	NA	5.5E-05	9.4E-05
Lead	6.3E+00	1.3E+01	0.3	1.3E-07	2.7E-07	8.8E-06	1.9E-05	NA	NA	NA	NA	NA	NA
Nickel	4.3E+00	5.8E+00	1	2.9E-07	3.9E-07	2.0E-05	2.7E-05	NA	2.0E-02	NA	NA	1.0E-03	1.4E-03

(a) Subsurface soil concentrations

Where:

$$\text{Dose} = [\text{Concentration} \times \text{UC} \times \text{IR} \times \text{RAF} \times \text{EF} \times \text{ED}] / [\text{BW} \times \text{AT}]$$

$$\text{Cancer Risk} = \text{Dose} \times \text{Slope Factor}$$

$$\text{Hazard Quotient} = \text{Dose} / \text{Reference Dose}$$

Unit Conversion (UC) =

Ingestion Rate (IR) =

Relative Absorption Factor (RAF) =

Exposure Frequency (EF) =

Exposure Duration (ED) =

Body Weight (BW) =

Averaging Time (AT) =

1E-06 kg/mg

480 mg/d

CS Chemical-specific (-)

250 d/yr

1 yr

70 kg

25550 d (cancer)

365 d (noncancer)

	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
TOTAL:	5E-07	8E-07	1E-02	2E-02

 = Cancer risk > 1E-6 or hazard quotient/index > 1E+0

TABLE 14 (cont)  
 SCENARIO 3 - FUTURE CONSTRUCTION WORKER (ADULTS AGED 18 TO 70 YEARS)  
 EXPOSURE AND RISK ESTIMATES  
 DERMAL CONTACT WITH SOIL  
 NCBC DAVISVILLE - SITE 08

Constituent	Soil Concentrations (a)		Exposure Estimates					Toxicity Values		Risk Estimates			
	Geometric Mean Soil Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Relative Absorption Factor (-)	Mean Dose (Cancer) (mg/kg-d)	RME Dose (Cancer) (mg/kg-d)	Mean Dose (Noncancer) (mg/kg-d)	RME Dose (Noncancer) (mg/kg-d)	Cancer Slope Factor (Oral) (mg/kg-d) <sup>-1</sup>	Noncancer Reference Dose (Oral) (mg/kg-d)	Mean Cancer Risk (-)	RME Cancer Risk (-)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)
<b>VOLATILE ORGANICS</b>													
Acetone	ND	ND	0.5	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	1.0E+00	NA	NA	NA	NA
Chloroform	3.7E-03	1.0E-03	0.5	2.6E-10	7.0E-11	1.8E-08	4.9E-09	6.1E-03	1.0E-02	1.6E-12	4.3E-13	1.8E-06	4.9E-07
Methylene chloride	7.6E-03	6.0E-03	0.5	5.3E-10	4.2E-10	3.7E-08	2.9E-08	7.5E-03	6.0E-02	4.0E-12	3.1E-12	6.2E-07	4.9E-07
<b>SEMIVOLATILE ORGANICS</b>													
Benzoic acid	5.5E-01	4.5E-02	0.05	3.9E-09	3.1E-10	2.7E-07	2.2E-08	NA	4.0E+00	NA	NA	6.8E-08	5.5E-09
Benzo(a)anthracene	ND	ND	0.05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.3E+00	NA	NA	NA	NA	NA
Benzo(a)pyrene	ND	ND	0.05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.3E+00	NA	NA	NA	NA	NA
Benzo(b)/(k)fluoranthene	3.8E-01	5.6E-01	0.05	2.7E-09	3.9E-09	1.9E-07	2.7E-07	7.3E+00	NA	1.9E-08	2.9E-08	NA	NA
Benzo(g,h,i)perylene	ND	ND	0.05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	4.0E-02	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	3.8E-01	4.7E-01	0.05	2.6E-09	3.3E-09	1.8E-07	2.3E-07	1.4E-02	2.0E-02	3.7E-11	4.6E-11	9.2E-06	1.1E-05
Chrysene	2.0E-01	4.2E-02	0.05	1.4E-09	2.9E-10	9.8E-08	2.1E-08	7.3E+00	NA	1.0E-08	2.1E-09	NA	NA
Dibenz(a,h)anthracene	ND	ND	0.05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.3E+00	NA	NA	NA	NA	NA
Fluoranthene	2.0E-01	4.6E-02	0.05	1.4E-09	3.2E-10	9.9E-08	2.3E-08	NA	4.0E-01	NA	NA	2.5E-07	5.6E-08
Indeno(1,2,3-cd)pyrene	ND	ND	0.05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.3E+00	NA	NA	NA	NA	NA
Phenanthrene	2.1E-01	1.7E-01	0.05	1.5E-09	1.2E-09	1.0E-07	8.3E-08	NA	4.0E-02	NA	NA	2.6E-06	2.1E-06
Pyrene	2.1E-01	5.7E-02	0.05	1.4E-09	4.0E-10	1.0E-07	2.8E-08	NA	3.0E-01	NA	NA	3.4E-07	9.3E-08
<b>PESTICIDES / PCB'S</b>													
DDT, 4,4-	ND	ND	0.05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.4E-01	5.0E-04	NA	NA	NA	NA
Aroclor-1260	8.8E-02	2.3E-02	0.05	6.2E-10	1.6E-10	4.3E-08	1.1E-08	7.7E+00	NA	4.8E-09	1.2E-09	NA	NA
<b>INORGANICS</b>													
Arsenic	5.2E-01	8.4E-01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.8E+00	3.0E-04	NA	NA	NA	NA
Beryllium	5.9E-01	1.4E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.3E+00	5.0E-03	NA	NA	NA	NA
Chromium III	3.5E+00	1.0E+01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	1.0E+00	NA	NA	NA	NA
Chromium VI	5.1E-01	1.5E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	2.0E-02	NA	NA	NA	NA
Cyanide	2.4E-01	4.0E-01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	2.0E-02	NA	NA	NA	NA
Lead	6.3E+00	1.3E+01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	NA	NA	NA
Nickel	4.3E+00	5.8E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	2.0E-02	NA	NA	NA	NA

(a) Subsurface soil concentrations

Where:

$$\text{Dose} = [\text{Concentration} \times \text{UC} \times \text{CR} \times \text{RAF} \times \text{EF} \times \text{ED}] / [\text{BW} \times \text{AT}]$$

$$\text{Cancer Risk} = \text{Dose} \times \text{Slope Factor}$$

$$\text{Hazard Quotient} = \text{Dose} / \text{Reference Dose}$$

Unit Conversion (UC) = 1E-06 kg/mg  
 Dermal Contact Rate (CR) = 1000 mg/d  
 Relative Absorption Factor (RAF) = CS Chemical-specific (-)  
 Exposure Frequency (EF) = 250 d/yr  
 Exposure Duration (ED) = 1 yr  
 Body Weight (BW) = 70 kg  
 Averaging Time (AT) = 25550 d (cancer)  
 365 d (noncancer)

	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
TOTAL:	3E-08	3E-08	1E-05	1E-05

 = Cancer risk > 1E-6 or hazard quotient/index > 1E+0

TABLE 14 (cont)  
 SCENARIO 3 - FUTURE CONSTRUCTION WORKER (ADULTS AGED 18 TO 70 YEARS)  
 EXPOSURE AND RISK ESTIMATES  
 INHALATION OF PARTICULATES  
 NCBC DAVISVILLE - SITE 08

Constituent	Soil Concentrations (a)		Exposure Estimates				Toxicity Values		Risk Estimates			
	Geometric Mean Soil Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Mean Dose (Cancer) (mg/kg-d)	RME Dose (Cancer) (mg/kg-d)	Mean Dose (Noncancer) (mg/kg-d)	RME Dose (Noncancer) (mg/kg-d)	Cancer Slope Factor (Inhalation) (mg/kg-d) <sup>-1</sup>	Noncancer Reference Dose (Inhalation) (mg/kg-d)	Mean Cancer Risk (-)	RME Cancer Risk (-)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)
<b>VOLATILE ORGANICS</b>												
Acetone	ND	ND	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	NA	NA	NA
Chloroform	3.7E-03	1.0E-03	3.7E-14	9.9E-15	2.6E-12	6.9E-13	8.1E-02	1.0E-02	3.0E-15	8.0E-16	2.6E-10	6.9E-11
Methylene chloride	7.6E-03	6.0E-03	7.6E-14	5.9E-14	5.3E-12	4.2E-12	1.6E-03	8.6E-01	1.2E-16	9.5E-17	6.2E-12	4.8E-12
<b>SEMIVOLATILE ORGANICS</b>												
Benzoic acid	5.5E-01	4.5E-02	5.5E-12	4.5E-13	3.8E-10	3.1E-11	NA	4.0E+00	NA	NA	9.6E-11	7.8E-12
Benzo(a)anthracene	ND	ND	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.1E+00	NA	NA	NA	NA	NA
Benzo(a)pyrene	ND	ND	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.1E+00	NA	NA	NA	NA	NA
Benzo(b)/(k)fluoranthene	3.8E-01	5.6E-01	3.8E-12	5.5E-12	2.6E-10	3.9E-10	6.1E+00	NA	2.3E-11	3.4E-11	NA	NA
Benzo(g,h,i)perylene	ND	ND	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	4.0E-02	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	3.8E-01	4.7E-01	3.7E-12	4.7E-12	2.6E-10	3.3E-10	1.4E-02	2.0E-02	5.2E-14	6.5E-14	1.3E-08	1.6E-08
Chrysene	2.0E-01	4.2E-02	2.0E-12	4.2E-13	1.4E-10	2.9E-11	6.1E+00	NA	1.2E-11	2.5E-12	NA	NA
Dibenz(a,h)anthracene	ND	ND	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.1E+00	NA	NA	NA	NA	NA
Fluoranthene	2.0E-01	4.6E-02	2.0E-12	4.6E-13	1.4E-10	3.2E-11	NA	4.0E-01	NA	NA	3.5E-10	8.0E-11
Indeno(1,2,3-cd)pyrene	ND	ND	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.1E+00	NA	NA	NA	NA	NA
Phenanthrene	2.1E-01	1.7E-01	2.1E-12	1.7E-12	1.5E-10	1.2E-10	NA	4.0E-02	NA	NA	3.7E-09	2.9E-09
Pyrene	2.1E-01	5.7E-02	2.0E-12	5.6E-13	1.4E-10	3.9E-11	NA	3.0E-01	NA	NA	4.8E-10	1.3E-10
<b>PESTICIDES / PCB'S</b>												
DDT, 4,4-	ND	ND	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.4E-01	5.0E-04	NA	NA	NA	NA
Aroclor-1260	8.8E-02	2.3E-02	8.8E-13	2.3E-13	6.1E-11	1.6E-11	7.7E+00	NA	6.7E-12	1.8E-12	NA	NA
<b>INORGANICS</b>												
Arsenic	5.2E-01	8.4E-01	5.2E-12	8.3E-12	3.6E-10	5.8E-10	5.0E+01	3.0E-04	2.6E-10	4.2E-10	1.2E-06	1.9E-06
Beryllium	5.9E-01	1.4E+00	5.8E-12	1.4E-11	4.1E-10	9.7E-10	8.4E+00	5.0E-03	4.9E-11	1.2E-10	8.1E-08	1.9E-07
Chromium III	3.5E+00	1.0E+01	3.5E-11	1.0E-10	2.5E-09	7.0E-09	NA	1.0E+00	NA	NA	2.5E-09	7.0E-09
Chromium VI	5.1E-01	1.5E+00	5.0E-12	1.4E-11	3.5E-10	1.0E-09	4.1E+01	2.0E-02	2.1E-10	5.9E-10	1.8E-08	5.0E-08
Cyanide	2.4E-01	4.0E-01	2.3E-12	4.0E-12	1.6E-10	2.8E-10	NA	2.0E-02	NA	NA	8.2E-09	1.4E-08
Lead	6.3E+00	1.3E+01	6.2E-11	1.3E-10	4.3E-09	9.3E-09	NA	4.3E-04	NA	NA	1.0E-05	2.2E-05
Nickel	4.3E+00	5.8E+00	4.3E-11	5.7E-11	3.0E-09	4.0E-09	8.4E-01	2.0E-02	3.6E-11	4.8E-11	1.5E-07	2.0E-07

(a) Subsurface soil concentrations

Where:

Dose = [Concentration x TSP x IR x RAF x EF x ED] / [BW x AT]  
 Cancer Risk = Dose x Slope Factor  
 Hazard Quotient = Dose / Reference Dose

Dust Concentration (TSP) = 3.54E-09 kg/m3  
 Inhalation Rate (IR) = 2.5 m3/hr  
 Relative Absorption Factor (RAF) = 1 for all chemicals (-)  
 Exposure Frequency (EF) = 8 hr/d  
 250 d/yr  
 Exposure Duration (ED) = 1 yr  
 Body Weight (BW) = 70 kg  
 Averaging Time (AT) = 25550 d (cancer)  
 365 d (noncancer)

	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
TOTAL:	6E-10	1E-09	1E-05	2E-05

 = Cancer risk > 1E-6 or hazard quotient/index > 1E+0

TABLE 15  
 SCENARIO 4 - FUTURE RESIDENT (CHILD 0 TO 6 YEARS)  
 EXPOSURE AND RISK ESTIMATES  
 INCIDENTAL INGESTION OF SOIL  
 NCBC DAVISVILLE - SITE 08

Constituent	Soil Concentrations (a)		Exposure Estimates					Toxicity Values		Risk Estimates			
	Geometric Mean Soil Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Relative Absorption Factor (-)	Mean Dose (Cancer) (mg/kg-d)	RME Dose (Cancer) (mg/kg-d)	Mean Dose (Noncancer) (mg/kg-d)	RME Dose (Noncancer) (mg/kg-d)	Cancer Slope Factor (Oral) (mg/kg-d) <sup>-1</sup>	Noncancer Chronic Reference Dose (Oral) (mg/kg-d)	Mean Cancer Risk (-)	RME Cancer Risk (-)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)
<b>VOLATILE ORGANICS</b>													
Acetone	1.7E-02	8.9E-02	1	2.0E-08	1.0E-07	2.3E-07	1.2E-06	NA	1.0E-01	NA	NA	2.3E-06	1.2E-05
Chloroform	3.8E-03	3.0E-03	1	4.3E-09	3.4E-09	5.1E-08	4.0E-08	6.1E-03	1.0E-02	2.6E-11	2.1E-11	5.1E-06	4.0E-06
Methylene chloride	7.4E-03	7.0E-03	1	8.4E-09	7.9E-09	9.8E-08	9.3E-08	7.5E-03	6.0E-02	6.3E-11	6.0E-11	1.6E-06	1.5E-06
<b>SEMIVOLATILE ORGANICS</b>													
Benzoic acid	1.2E-02	1.3E-01	1	1.4E-08	1.5E-07	1.6E-07	1.7E-06	NA	4.0E+00	NA	NA	4.1E-08	4.3E-07
Benzo(a)anthracene	1.9E-01	4.1E-01	1	2.2E-07	4.6E-07	2.6E-06	5.4E-06	7.3E+00	NA	1.6E-06	3.4E-06	NA	NA
Benzo(a)pyrene	1.6E-01	3.3E-01	1	1.9E-07	3.7E-07	2.2E-06	4.4E-06	7.3E+00	NA	1.4E-06	2.7E-06	NA	NA
Benzo(b)/(k)fluoranthene	3.2E-01	6.5E-01	1	3.6E-07	7.4E-07	4.2E-06	8.6E-06	7.3E+00	NA	2.6E-06	5.4E-06	NA	NA
Benzo(g,h,i)perylene	1.8E-01	1.9E-01	1	2.0E-07	2.2E-07	2.4E-06	2.5E-06	NA	4.0E-02	NA	NA	5.9E-05	6.3E-05
Bis(2-ethylhexyl)phthalate	1.9E-01	4.7E-01	1	2.2E-07	5.3E-07	2.5E-06	6.2E-06	1.4E-02	2.0E-02	3.0E-09	7.5E-09	1.3E-04	3.1E-04
Chrysene	1.7E-01	5.0E-01	1	1.9E-07	5.7E-07	2.2E-06	6.6E-06	7.3E+00	NA	1.4E-06	4.1E-06	NA	NA
Dibenz(a,h)anthracene	2.0E-01	1.9E-01	1	2.2E-07	2.2E-07	2.6E-06	2.5E-06	7.3E+00	NA	1.6E-06	1.6E-06	NA	NA
Fluoranthene	1.9E-01	5.7E-01	1	2.1E-07	6.5E-07	2.5E-06	7.5E-06	NA	4.0E-02	NA	NA	6.1E-05	1.9E-04
Indeno(1,2,3-cd)pyrene	1.7E-01	2.0E-01	1	1.9E-07	2.3E-07	2.2E-06	2.6E-06	7.3E+00	NA	1.4E-06	1.7E-06	NA	NA
Phenanthrene	1.5E-01	1.7E-01	1	1.7E-07	1.9E-07	2.0E-06	2.2E-06	NA	4.0E-02	NA	NA	4.9E-05	5.6E-05
Pyrene	1.8E-01	4.8E-01	1	2.1E-07	5.4E-07	2.4E-06	6.3E-06	NA	3.0E-02	NA	NA	8.1E-05	2.1E-04
<b>PESTICIDES / PCB'S</b>													
DDT, 4,4-	8.3E-03	2.9E-02	0.3	2.8E-09	9.9E-09	3.3E-08	1.2E-07	3.4E-01	5.0E-04	9.6E-10	3.4E-09	6.6E-05	2.3E-04
Aroclor-1260	7.8E-02	4.5E-01	0.3	2.7E-08	1.5E-07	3.1E-07	1.8E-06	7.7E+00	NA	2.1E-07	1.2E-06	NA	NA
<b>INORGANICS</b>													
Arsenic	7.4E-01	2.6E+00	1	8.3E-07	2.9E-06	9.7E-06	3.4E-05	1.8E+00	3.0E-04	1.5E-06	5.2E-06	3.2E-02	1.1E-01
Beryllium	5.2E-01	1.4E+00	1	5.8E-07	1.6E-06	6.8E-06	1.9E-05	4.3E+00	5.0E-03	2.5E-06	6.8E-06	1.4E-03	3.7E-03
Chromium III	4.4E+00	1.4E+01	1	5.0E-06	1.5E-05	5.8E-05	1.8E-04	NA	1.0E+00	NA	NA	5.8E-05	1.8E-04
Chromium VI	6.3E-01	1.9E+00	1	7.1E-07	2.2E-06	8.3E-06	2.6E-05	NA	5.0E-03	NA	NA	1.7E-03	5.1E-03
Cyanide	2.3E-01	4.0E-01	1	2.6E-07	4.5E-07	3.1E-06	5.3E-06	NA	2.0E-02	NA	NA	1.5E-04	2.6E-04
Lead	1.2E+01	1.7E+02	0.5	6.8E-06	9.7E-05	7.9E-05	1.1E-03	NA	NA	NA	NA	NA	NA
Nickel	5.0E+00	3.1E+01	1	5.7E-06	3.5E-05	6.7E-05	4.1E-04	NA	2.0E-02	NA	NA	3.3E-03	2.0E-02

(a) Surface and subsurface soil concentrations

Where:

Dose = [Concentration x UC x IR x EF x ED x RAF] / [BW x AT]  
 Cancer Risk = Dose x Slope Factor  
 Hazard Quotient = Dose / Reference Dose

Unit Conversion (UC) = 1E-06 kg/mg  
 Ingestion Rate (IR) = 200 mg/d (child 0 to 6 yr)  
 Relative Absorption Factor (RAF) = CS Chemical-specific (-)  
 Exposure Frequency (EF) = 350 d/yr (child 0 to 6 yr)  
 Exposure Duration (ED) = 6 yr (child 0 to 6 yr)  
 Body Weight (BW) = 14.5 kg (child 0 to 6 yr)  
 Averaging Time (AT) = 25550 d (cancer)  
 2190 d (noncancer)

	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
TOTAL:	1E-05	3E-05	4E-02	1E-01

☐ = Cancer risk > 1E-6 or hazard quotient/index > 1E+0

TABLE 15 (cont)  
 SCENARIO 4 - FUTURE RESIDENT (YOUTH/ADULT 7 TO 24 YEARS)  
 EXPOSURE AND RISK ESTIMATES  
 INCIDENTAL INGESTION OF SOIL  
 NCBC DAVISVILLE - SITE 08

Constituent	Soil Concentrations (a)		Exposure Estimates					Toxicity Values		Risk Estimates			
	Geometric Mean Soil Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Relative Absorption Factor (-)	Mean Dose (Cancer) (mg/kg-d)	RME Dose (Cancer) (mg/kg-d)	Mean Dose (Noncancer) (mg/kg-d)	RME Dose (Noncancer) (mg/kg-d)	Cancer Slope Factor (Oral) (mg/kg-d) <sup>-1</sup>	Noncancer Chronic Reference Dose (Oral) (mg/kg-d)	Mean Cancer Risk (-)	RME Cancer Risk (-)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)
<b>VOLATILE ORGANICS</b>													
Acetone	1.7E-02	8.9E-02	1.0	8.1E-09	4.2E-08	2.4E-08	1.2E-07	NA	1.0E-01	NA	NA	2.4E-07	1.2E-06
Chloroform	3.8E-03	3.0E-03	1.0	1.8E-09	1.4E-09	5.2E-09	4.1E-09	6.1E-03	1.0E-02	1.1E-11	8.6E-12	5.2E-07	4.1E-07
Methylene chloride	7.4E-03	7.0E-03	1.0	3.5E-09	3.3E-09	1.0E-08	9.6E-09	7.5E-03	6.0E-02	2.6E-11	2.5E-11	1.7E-07	1.6E-07
<b>SEMIVOLATILE ORGANICS</b>													
Benzoic acid	1.2E-02	1.3E-01	1.00	5.8E-09	6.1E-08	1.7E-08	1.8E-07	NA	4.0E+00	NA	NA	4.2E-09	4.5E-08
Benzo(a)anthracene	1.9E-01	4.1E-01	1.00	9.1E-08	1.9E-07	2.7E-07	5.6E-07	7.3E+00	NA	6.7E-07	1.4E-06	NA	NA
Benzo(a)pyrene	1.6E-01	3.3E-01	1.00	7.7E-08	1.5E-07	2.2E-07	4.5E-07	7.3E+00	NA	5.6E-07	1.1E-06	NA	NA
Benzo(b)/(k)fluoranthene	3.2E-01	6.5E-01	1.00	1.5E-07	3.1E-07	4.3E-07	8.9E-07	7.3E+00	NA	1.1E-06	2.2E-06	NA	NA
Benzo(g,h,i)perylene	1.8E-01	1.9E-01	1.00	8.4E-08	8.9E-08	2.4E-07	2.6E-07	NA	4.0E-02	NA	NA	6.1E-06	6.5E-06
Bis(2-ethylhexyl)phthalate	1.9E-01	4.7E-01	1.00	9.0E-08	2.2E-07	2.6E-07	6.4E-07	1.4E-02	2.0E-02	1.3E-09	3.1E-09	1.3E-05	3.2E-05
Chrysene	1.7E-01	5.0E-01	1.00	7.9E-08	2.3E-07	2.3E-07	6.8E-07	7.3E+00	NA	5.8E-07	1.7E-06	NA	NA
Dibenz(a,h)anthracene	2.0E-01	1.9E-01	1.00	9.3E-08	8.9E-08	2.7E-07	2.6E-07	7.3E+00	NA	6.8E-07	6.5E-07	NA	NA
Fluoranthene	1.9E-01	5.7E-01	1.00	8.7E-08	2.7E-07	2.5E-07	7.8E-07	NA	4.0E-02	NA	NA	6.4E-06	2.0E-05
Indeno(1,2,3-cd)pyrene	1.7E-01	2.0E-01	1.00	7.9E-08	9.4E-08	2.3E-07	2.7E-07	7.3E+00	NA	5.8E-07	6.9E-07	NA	NA
Phenanthrene	1.5E-01	1.7E-01	1.00	7.0E-08	8.0E-08	2.0E-07	2.3E-07	NA	4.0E-02	NA	NA	5.1E-06	5.8E-06
Pyrene	1.8E-01	4.8E-01	1.00	8.6E-08	2.3E-07	2.5E-07	6.6E-07	NA	3.0E-02	NA	NA	8.4E-06	2.2E-05
<b>PESTICIDES / PCB'S</b>													
DDT, 4,4-	8.3E-03	2.9E-02	0.30	1.2E-09	4.1E-09	3.4E-09	1.2E-08	3.4E-01	5.0E-04	4.0E-10	1.4E-09	6.8E-06	2.4E-05
Aroclor-1260	7.8E-02	4.5E-01	0.30	1.1E-08	6.3E-08	3.2E-08	1.8E-07	7.7E+00	NA	8.5E-08	4.9E-07	NA	NA
<b>INORGANICS</b>													
Arsenic	7.4E-01	2.6E+00	1	3.5E-07	1.2E-06	1.0E-06	3.6E-06	1.8E+00	3.0E-04	6.1E-07	2.1E-06	3.4E-03	1.2E-02
Beryllium	5.2E-01	1.4E+00	1	2.4E-07	6.6E-07	7.1E-07	1.9E-06	4.3E+00	5.0E-03	1.0E-06	2.8E-06	1.4E-04	3.8E-04
Chromium III	4.4E+00	1.4E+01	1	2.1E-06	6.4E-06	6.0E-06	1.9E-05	NA	1.0E+00	NA	NA	6.0E-06	1.9E-05
Chromium VI	6.3E-01	1.9E+00	1	2.9E-07	9.1E-07	8.6E-07	2.7E-06	NA	5.0E-03	NA	NA	1.7E-04	5.3E-04
Cyanide	2.3E-01	4.0E-01	1	1.1E-07	1.9E-07	3.2E-07	5.5E-07	NA	2.0E-02	NA	NA	1.6E-05	2.7E-05
Lead	1.2E+01	1.7E+02	0.3	1.7E-06	2.4E-05	4.9E-06	7.0E-05	NA	NA	NA	NA	NA	NA
Nickel	5.0E+00	3.1E+01	1	2.4E-06	1.4E-05	6.9E-06	4.2E-05	NA	2.0E-02	NA	NA	3.5E-04	2.1E-03

(a) Surface and subsurface soil concentrations

Where:

Dose = [Concentration x UC x IR x EF x ED x RAF] / [BW x AT]  
 Cancer Risk = Dose x Slope Factor  
 Hazard Quotient = Dose / Reference Dose

Unit Conversion (UC) = 1E-06 kg/mg  
 Ingestion Rate (IR) = 100 mg/d (youth/adult 7 to 24 yr)  
 Relative Absorption Factor (RAF) = CS Chemical-specific (-)  
 Exposure Frequency (EF) = 350 d/yr (youth/adult 7 to 24 yr)  
 Exposure Duration (ED) = 24 yr (youth/adult 7 to 24 yr)  
 Body Weight (BW) = 70 kg (youth/adult 7 to 24 yr)  
 Averaging Time (AT) = 25550 d (cancer)  
 8760 d (noncancer)

	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
TOTAL:	6E-06	1E-05	4E-03	2E-02

☐ = Cancer risk > 1E-6 or hazard quotient/index > 1E+0

TABLE 15 (cont)  
 SCENARIO 4 - FUTURE RESIDENT (CHILD 0 TO 6 YEARS)  
 EXPOSURE AND RISK ESTIMATES  
 DERMAL CONTACT WITH SOIL  
 NCBC DAVISVILLE - SITE 08

Constituent	Soil Concentrations (a)		Exposure Estimates				Toxicity Values		Risk Estimates				
	Geometric Mean Soil Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Relative Absorption Factor (-)	Mean Dose (Cancer) (mg/kg-d)	RME Dose (Cancer) (mg/kg-d)	Mean Dose (Noncancer) (mg/kg-d)	RME Dose (Noncancer) (mg/kg-d)	Cancer Slope Factor (mg/kg-d) <sup>-1</sup>	Noncancer Chronic Reference Dose (Oral) (mg/kg-d)	Mean Cancer Risk (-)	RME Cancer Risk (-)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)
<b>VOLATILE ORGANICS</b>													
Acetone	1.7E-02	8.9E-02	0.5	2.4E-08	1.3E-07	2.8E-07	1.5E-06	NA	1.0E-01	NA	NA	2.8E-06	1.5E-05
Chloroform	3.8E-03	3.0E-03	0.5	5.4E-09	4.3E-09	6.3E-08	5.0E-08	6.1E-03	1.0E-02	3.3E-11	2.6E-11	6.3E-06	5.0E-06
Methylene chloride	7.4E-03	7.0E-03	0.5	1.1E-08	9.9E-09	1.2E-07	1.2E-07	7.5E-03	6.0E-02	7.9E-11	7.4E-11	2.0E-06	1.9E-06
<b>SEMIVOLATILE ORGANICS</b>													
Benzoic acid	1.2E-02	1.3E-01	0.05	1.8E-09	1.8E-08	2.0E-08	2.1E-07	NA	4.0E+00	NA	NA	5.1E-09	5.4E-08
Benzo(a)anthracene	1.9E-01	4.1E-01	0.05	2.8E-08	5.8E-08	3.2E-07	6.8E-07	7.3E+00	NA	2.0E-07	4.2E-07	NA	NA
Benzo(a)pyrene	1.6E-01	3.3E-01	0.05	2.3E-08	4.7E-08	2.7E-07	5.5E-07	7.3E+00	NA	1.7E-07	3.4E-07	NA	NA
Benzo(b)(k)fluoranthene	3.2E-01	6.5E-01	0.05	4.5E-08	9.2E-08	5.2E-07	1.1E-06	7.3E+00	NA	3.3E-07	6.7E-07	NA	NA
Benzo(g,h,i)perylene	1.8E-01	1.9E-01	0.05	2.5E-08	2.7E-08	2.9E-07	3.1E-07	NA	4.0E-02	NA	NA	7.4E-06	7.9E-06
Bis(2-ethylhexyl)phthalate	1.9E-01	4.7E-01	0.05	2.7E-08	6.7E-08	3.2E-07	7.8E-07	1.4E-02	2.0E-02	3.8E-10	9.3E-10	1.6E-05	3.9E-05
Chrysene	1.7E-01	5.0E-01	0.05	2.4E-08	7.1E-08	2.8E-07	8.3E-07	7.3E+00	NA	1.7E-07	5.2E-07	NA	NA
Dibenz(a,h)anthracene	2.0E-01	1.9E-01	0.05	2.8E-08	2.7E-08	3.3E-07	3.1E-07	7.3E+00	NA	2.0E-07	2.0E-07	NA	NA
Fluoranthene	1.9E-01	5.7E-01	0.05	2.6E-08	8.1E-08	3.1E-07	9.4E-07	NA	4.0E-02	NA	NA	7.7E-06	2.4E-05
Indeno(1,2,3-cd)pyrene	1.7E-01	2.0E-01	0.05	2.4E-08	2.8E-08	2.8E-07	3.3E-07	7.3E+00	NA	1.7E-07	2.1E-07	NA	NA
Phenanthrene	1.5E-01	1.7E-01	0.05	2.1E-08	2.4E-08	2.5E-07	2.8E-07	NA	4.0E-02	NA	NA	6.1E-06	7.0E-06
Pyrene	1.8E-01	4.8E-01	0.05	2.6E-08	6.8E-08	3.0E-07	7.9E-07	NA	3.0E-02	NA	NA	1.0E-05	2.6E-05
<b>PESTICIDES / PCB'S</b>													
DDT, 4,4-	8.3E-03	2.9E-02	0.05	1.2E-09	4.1E-09	1.4E-08	4.8E-08	3.4E-01	5.0E-04	4.0E-10	1.4E-09	2.7E-05	9.6E-05
Aroclor-1260	7.8E-02	4.5E-01	0.05	1.1E-08	6.4E-08	1.3E-07	7.4E-07	7.7E+00	NA	8.5E-08	4.9E-07	NA	NA
<b>INORGANICS</b>													
Arsenic	7.4E-01	2.6E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.8E+00	3.0E-04	NA	NA	NA	NA
Beryllium	5.2E-01	1.4E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.3E+00	5.0E-03	NA	NA	NA	NA
Chromium III	4.4E+00	1.4E+01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	1.0E+00	NA	NA	NA	NA
Chromium VI	6.3E-01	1.9E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	5.0E-03	NA	NA	NA	NA
Cyanide	2.3E-01	4.0E-01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	2.0E-02	NA	NA	NA	NA
Lead	1.2E+01	1.7E+02	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	NA	NA	NA
Nickel	5.0E+00	3.1E+01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	2.0E-02	NA	NA	NA	NA

(a) Surface and subsurface soil concentrations

Where:

$$\text{Dose} = [\text{Concentration} \times \text{UC} \times \text{CR} \times \text{EF} \times \text{ED} \times \text{RAF}] / [\text{BW} \times \text{AT}]$$

$$\text{Cancer Risk} = \text{Dose} \times \text{Slope Factor}$$

$$\text{Hazard Quotient} = \text{Dose} / \text{Reference Dose}$$

Unit Conversion (UC) =

Dermal Contact Rate (CR) =

Relative Absorption Factor (RAF) =

Exposure Frequency (EF) =

Exposure Duration (ED) =

Body Weight (BW) =

Averaging Time (AT) =

1E-06 kg/mg

500 mg/d

CS Chemical-specific (-)

350 d/yr (child 0 to 6 yr)

6 yr

14.5 kg (child 0 to 6 yr)

25550 d (cancer)

2190 d (noncancer)

	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
TOTAL:	1E-06	3E-06	9E-05	2E-04

 = Cancer risk > 1E-6 or hazard quotient/index > 1E+0

TABLE 15 (cont)  
 SCENARIO 4 - FUTURE RESIDENT (YOUTH/ADULT 7 TO 24 YEARS)  
 EXPOSURE AND RISK ESTIMATES  
 DERMAL CONTACT WITH SOIL  
 NCBC DAVISVILLE - SITE 08

Constituent	Soil Concentrations (a)		Exposure Estimates					Toxicity Values		Risk Estimates			
	Geometric Mean Soil Concentration (mg/kg)	Maximum Soil Concentration (mg/kg)	Relative Absorption Factor (-)	Mean Dose (Cancer) (mg/kg-d)	RME Dose (Cancer) (mg/kg-d)	Mean Dose (Noncancer) (mg/kg-d)	RME Dose (Noncancer) (mg/kg-d)	Cancer Slope Factor (Oral) (mg/kg-d) <sup>-1</sup>	Noncancer Reference Dose (Oral) (mg/kg-d)	Mean Cancer Risk (-)	RME Cancer Risk (-)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)
<b>VOLATILE ORGANICS</b>													
Acetone	1.7E-02	8.9E-02	0.5	2.0E-08	1.0E-07	5.9E-08	3.0E-07	NA	1.0E-01	NA	NA	5.9E-07	3.0E-06
Chloroform	3.8E-03	3.0E-03	0.5	4.5E-09	3.5E-09	1.3E-08	1.0E-08	6.1E-03	1.0E-02	2.7E-11	2.1E-11	1.3E-06	1.0E-06
Methylene chloride	7.4E-03	7.0E-03	0.5	8.7E-09	8.2E-09	2.5E-08	2.4E-08	7.5E-03	6.0E-02	6.5E-11	6.2E-11	4.2E-07	4.0E-07
<b>SEMIVOLATILE ORGANICS</b>													
Benzoic acid	1.2E-02	1.3E-01	0.05	1.5E-09	1.5E-08	4.2E-09	4.5E-08	NA	4.0E+00	NA	NA	1.1E-09	1.1E-08
Benzo(a)anthracene	1.9E-01	4.1E-01	0.05	2.3E-08	4.8E-08	6.7E-08	1.4E-07	7.3E+00	NA	1.7E-07	3.5E-07	NA	NA
Benzo(a)pyrene	1.6E-01	3.3E-01	0.05	1.9E-08	3.9E-08	5.6E-08	1.1E-07	7.3E+00	NA	1.4E-07	2.8E-07	NA	NA
Benzo(b)/(k)fluoranthene	3.2E-01	6.5E-01	0.05	3.7E-08	7.6E-08	1.1E-07	2.2E-07	7.3E+00	NA	2.7E-07	5.6E-07	NA	NA
Benzo(g,h,i)perylene	1.8E-01	1.9E-01	0.05	2.1E-08	2.2E-08	6.1E-08	6.5E-08	NA	4.0E-02	NA	NA	1.5E-06	1.6E-06
Bis(2-ethylhexyl)phthalate	1.9E-01	4.7E-01	0.05	2.2E-08	5.5E-08	6.6E-08	1.6E-07	1.4E-02	2.0E-02	3.1E-10	7.7E-10	3.3E-06	8.0E-06
Chrysene	1.7E-01	5.0E-01	0.05	2.0E-08	5.9E-08	5.8E-08	1.7E-07	7.3E+00	NA	1.4E-07	4.3E-07	NA	NA
Dibenz(a,h)anthracene	2.0E-01	1.9E-01	0.05	2.3E-08	2.2E-08	6.8E-08	6.5E-08	7.3E+00	NA	1.7E-07	1.6E-07	NA	NA
Fluoranthene	1.9E-01	5.7E-01	0.05	2.2E-08	6.7E-08	6.4E-08	2.0E-07	NA	4.0E-02	NA	NA	1.6E-06	4.9E-06
Indeno(1,2,3-cd)pyrene	1.7E-01	2.0E-01	0.05	2.0E-08	2.3E-08	5.8E-08	6.8E-08	7.3E+00	NA	1.4E-07	1.7E-07	NA	NA
Phenanthrene	1.5E-01	1.7E-01	0.05	1.7E-08	2.0E-08	5.1E-08	5.8E-08	NA	4.0E-02	NA	NA	1.3E-06	1.5E-06
Pyrene	1.8E-01	4.8E-01	0.05	2.2E-08	5.6E-08	6.3E-08	1.6E-07	NA	3.0E-02	NA	NA	2.1E-06	5.5E-06
<b>PESTICIDES / PCB'S</b>													
DDT, 4,4-	8.3E-03	2.9E-02	0.05	9.7E-10	3.4E-09	2.8E-09	9.9E-09	3.4E-01	5.0E-04	3.3E-10	1.2E-09	5.7E-06	2.0E-05
Aroclor-1260	7.8E-02	4.5E-01	0.05	9.2E-09	5.3E-08	2.7E-08	1.5E-07	7.7E+00	NA	7.1E-08	4.1E-07	NA	NA
<b>INORGANICS</b>													
Arsenic	7.4E-01	2.6E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.8E+00	3.0E-04	NA	NA	NA	NA
Beryllium	5.2E-01	1.4E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.3E+00	5.0E-03	NA	NA	NA	NA
Chromium III	4.4E+00	1.4E+01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	1.0E+00	NA	NA	NA	NA
Chromium VI	6.3E-01	1.9E+00	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	5.0E-03	NA	NA	NA	NA
Cyanide	2.3E-01	4.0E-01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	2.0E-02	NA	NA	NA	NA
Lead	1.2E+01	1.7E+02	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	NA	NA	NA
Nickel	5.0E+00	3.1E+01	0	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	2.0E-02	NA	NA	NA	NA

(a) Surface and subsurface soil concentrations

Where:

Dose = [Concentration x UC x CR x EF x ED x RAF] / [BW x AT]

Cancer Risk = Dose x Slope Factor

Hazard Quotient = Dose / Reference Dose

- Unit Conversion (UC) = 1E-06 kg/mg
- Dermal Contact Rate (CR) = 500 mg/d
- Relative Absorption Factor (RAF) = CS Chemical-specific (-)
- Exposure Frequency (EF) = 350 d/yr (youth/adult 7 to 24 yr)
- Exposure Duration (ED) = 24 yr (youth/adult 7 to 24 yr)
- Body Weight (BW) = 70 kg (youth/adult 7 to 24 yr)
- Averaging Time (AT) = 25550 d (cancer)
- 8760 d (noncancer)

	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
TOTAL:	1E-06	2E-06	2E-05	5E-05

  = Cancer risk > 1E-6 or hazard quotient/index > 1E+0

TABLE 16  
 SCENARIO 4 - FUTURE RESIDENT (CHILD AND YOUTH/ADULT EXPOSURES COMBINED)  
 SUMMARY OF RISK ESTIMATES  
 INCIDENTAL INGESTION OF AND DERMAL CONTACT WITH SOIL  
 NCBC DAVISVILLE - SITE 08

Chemical	Incidental Ingestion of Soil				Dermal Contact with Soil			
	Mean Cancer Risk (-)	RME Cancer Risk (-)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)	Mean Cancer Risk (-)	RME Cancer Risk (-)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)
<b>VOLATILE ORGANICS</b>								
Acetone	NA	NA	2.5E-06	1.3E-05	NA	NA	3.4E-06	1.8E-05
Chloroform	3.7E-11	2.9E-11	5.6E-06	4.4E-06	6.1E-11	4.7E-11	7.6E-06	6.0E-06
Methylene chloride	8.9E-11	8.4E-11	1.8E-06	1.7E-06	1.4E-10	1.4E-10	2.5E-06	2.3E-06
<b>SEMIVOLATILE ORGANICS</b>								
Benzoic acid	NA	NA	4.5E-08	4.7E-07	NA	NA	6.2E-09	6.5E-08
Benzo(a)anthracene	2.3E-06	4.8E-06	NA	NA	3.7E-07	7.8E-07	NA	NA
Benzo(a)pyrene	1.9E-06	3.9E-06	NA	NA	3.1E-07	6.2E-07	NA	NA
Benzo(b)(k)fluoranthene	3.7E-06	7.6E-06	NA	NA	6.0E-07	1.2E-06	NA	NA
Benzo(g,h,i)perylene	NA	NA	6.5E-05	6.9E-05	NA	NA	8.9E-06	9.5E-06
Bis(2-ethylhexyl)phthalate	4.3E-09	1.1E-08	1.4E-04	3.4E-04	6.9E-10	1.7E-09	1.9E-05	4.7E-05
Chrysene	2.0E-06	5.9E-06	NA	NA	3.2E-07	9.5E-07	NA	NA
Dibenz(a,h)anthracene	2.3E-06	2.2E-06	NA	NA	3.7E-07	3.6E-07	NA	NA
Fluoranthene	NA	NA	6.8E-05	2.1E-04	NA	NA	9.3E-06	2.8E-05
Indeno(1,2,3-cd)pyrene	2.0E-06	2.3E-06	NA	NA	3.2E-07	3.8E-07	NA	NA
Phenanthrene	NA	NA	5.4E-05	6.2E-05	NA	NA	7.4E-06	8.5E-06
Pyrene	NA	NA	8.9E-05	2.3E-04	NA	NA	1.2E-05	3.2E-05
<b>PESTICIDES / PCB'S</b>								
DDT, 4,4-	1.4E-09	4.7E-09	7.3E-05	2.5E-04	7.3E-10	2.6E-09	3.3E-05	1.2E-04
Aroclor-1260	2.9E-07	1.7E-06	NA	NA	1.6E-07	9.0E-07	NA	NA
<b>INORGANICS</b>								
Arsenic	2.1E-06	7.3E-06	3.6E-02	1.3E-01	NA	NA	NA	NA
Beryllium	3.6E-06	9.7E-06	1.5E-03	4.1E-03	NA	NA	NA	NA
Chromium III	NA	NA	6.4E-05	2.0E-04	NA	NA	NA	NA
Chromium VI	NA	NA	1.8E-03	5.7E-03	NA	NA	NA	NA
Cyanide	NA	NA	1.7E-04	2.9E-04	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	3.7E-03	2.2E-02	NA	NA	NA	NA
<b>TOTAL</b>								
	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
	2E-05	5E-05	4E-02	2E-01	2E-06	5E-06	1E-04	3E-04

☐ = Cancer risk > 1E-6 or hazard quotient/index > 1E+0

TABLE 16 (cont)  
 SCENARIO 4 - FUTURE RESIDENT (30 YEAR EXPOSURE)  
 SUMMARY OF RISK ESTIMATES  
 INGESTION OF GROUND WATER  
 NCBC DAVISVILLE - SITE 08

Chemical	Ingestion of Ground Water			
	Mean Cancer Risk (--)	RME Cancer Risk (--)	Mean Hazard Quotient (-)	RME Hazard Quotient (-)
VOLATILE ORGANICS				
Acetone	NA	NA	6.7E-03	2.5E-02
INORGANICS				
Aluminum	NA	NA	NA	NA
Arsenic	2.5E-05	3.8E-05	1.1E-01	1.6E-01
Barium	NA	NA	8.5E-03	1.6E-02
Beryllium	2.3E-05	1.7E-05	2.5E-03	1.9E-03
Chromium	NA	NA	1.1E-04	1.7E-04
Cobalt	NA	NA	NA	NA
Copper	NA	NA	2.8E-03	5.8E-03
Cyanide	NA	NA	2.8E-03	4.2E-03
Lead	NA	NA	NA	NA
Manganese	NA	NA	4.0E+00	7.1E+00
Vanadium	NA	NA	1.3E-02	1.8E-02

	Mean Cancer Risk	RME Cancer Risk	Mean Hazard Index	RME Hazard Index
TOTAL	5E-05	6E-05	4E+00	7E+00

▨ = Cancer risk > 1E-6 or hazard quotient/index > 1

TABLE 17  
SUMMARY OF CANCER AND NON-CANCER RISK ESTIMATES FOR ALL SCENARIOS  
NCBC DAVISVILLE - SITE 08

Pathway	CANCER RISKS							
	Scenario 1 (Trespasser)		Scenario 2 (Commercial/Industrial Worker)		Scenario 3 (Construction Worker)		Scenario 4 (Resident)	
	Geometric Mean	RME	Geometric Mean	RME	Geometric Mean	RME	Geometric Mean	RME
Incidental ingestion of soil	4E-07	9E-07	2E-06	5E-06	5E-07	8E-07	2E-05	5E-05
Dermal contact with soil	6E-08	2E-07	7E-07	2E-06	3E-08	3E-08	2E-06	5E-06
Inhalation of particulates	--	--	--	--	6E-10	1E-09	--	--
Ingestion of ground water	--	--	--	--	--	--	5E-05	6E-05

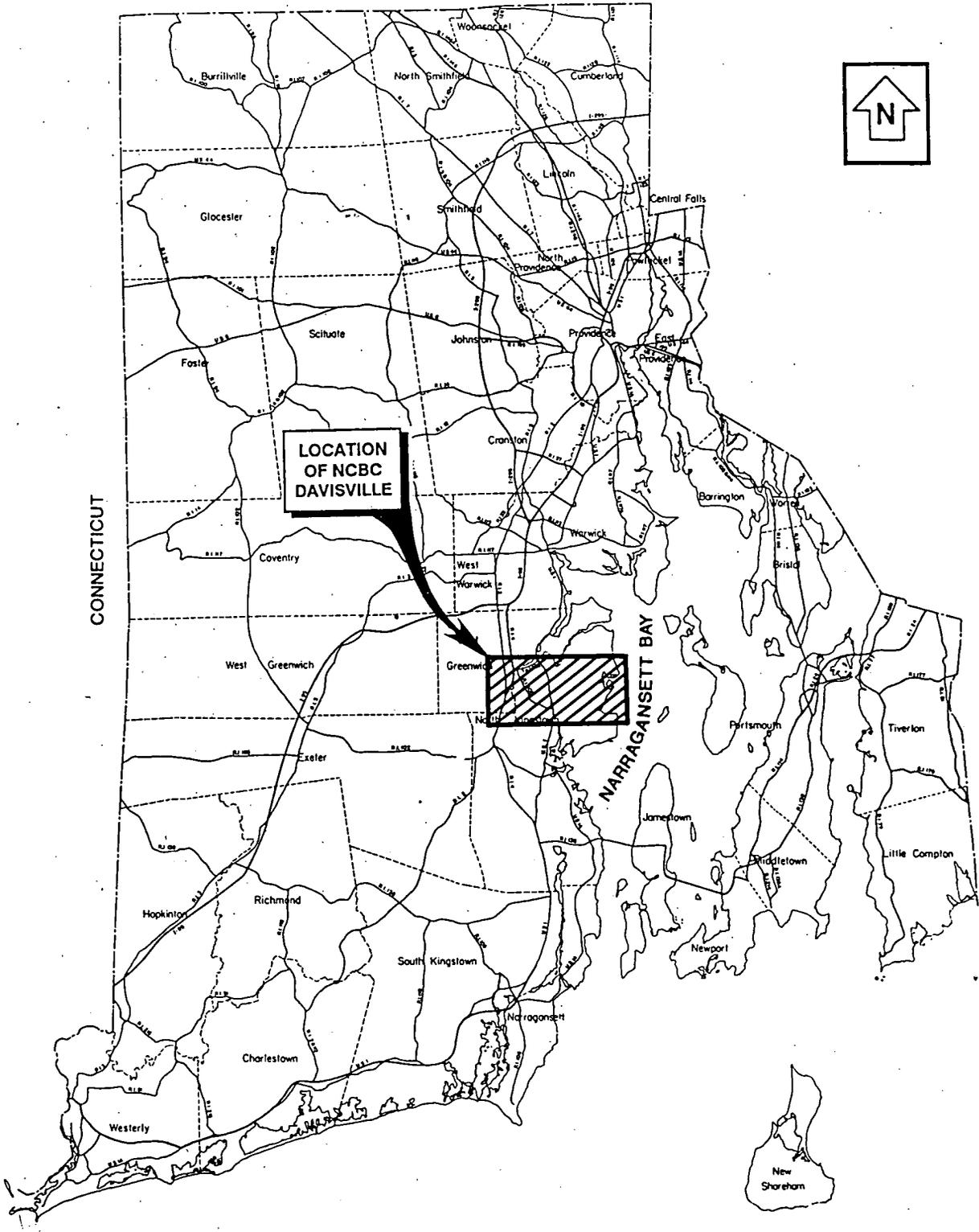
☐ = Cancer risk > 1E-6

Pathway	NON-CANCER HAZARD INDICES							
	Scenario 1 (Trespasser)		Scenario 2 (Commercial/Industrial Worker)		Scenario 3 (Construction Worker)		Scenario 4 (Resident)	
	Geometric Mean	RME	Geometric Mean	RME	Geometric Mean	RME	Geometric Mean	RME
Incidental ingestion of soil	8E-04	2E-03	2E-03	5E-03	1E-02	2E-02	4E-02	2E-01
Dermal contact with soil	2E-06	7E-06	1E-05	3E-05	1E-05	1E-05	1E-04	3E-04
Inhalation of particulates	--	--	--	--	1E-05	2E-05	--	--
Ingestion of ground water	--	--	--	--	--	--	4E+00	7E+00

☐ = Hazard index > 1E+0

**FIGURES**

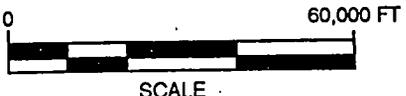
MASSACHUSETTS



LOCATION OF NCBC DAVISVILLE

CONNECTICUT

NARRAGANSETT BAY



**TRC**  
TRC Environmental Corporation

5 Waterside Crossing  
Windsor, CT 06095  
(203) 289-8631

NAVAL CONSTRUCTION  
BATTALION CENTER

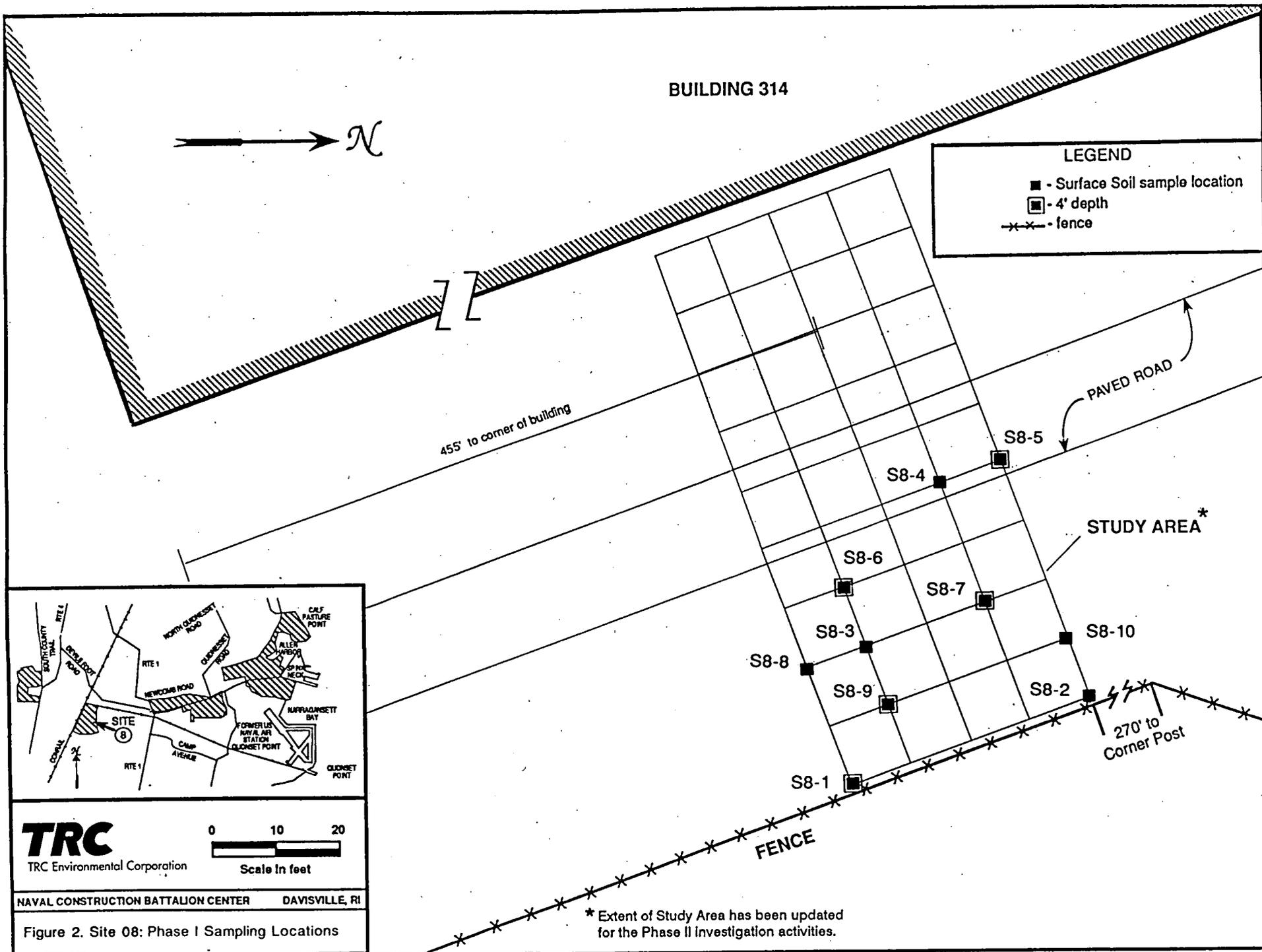
DAVISVILLE  
RHODE ISLAND

**FIGURE 1.**  
**NCBC SITE LOCATION PLAN**

SOURCE: RHODE ISLAND PLANNING OFFICE

Date: 1/93

Drawing No. 12215-N41-01



**TRC**

TRC Environmental Corporation

0 10 20



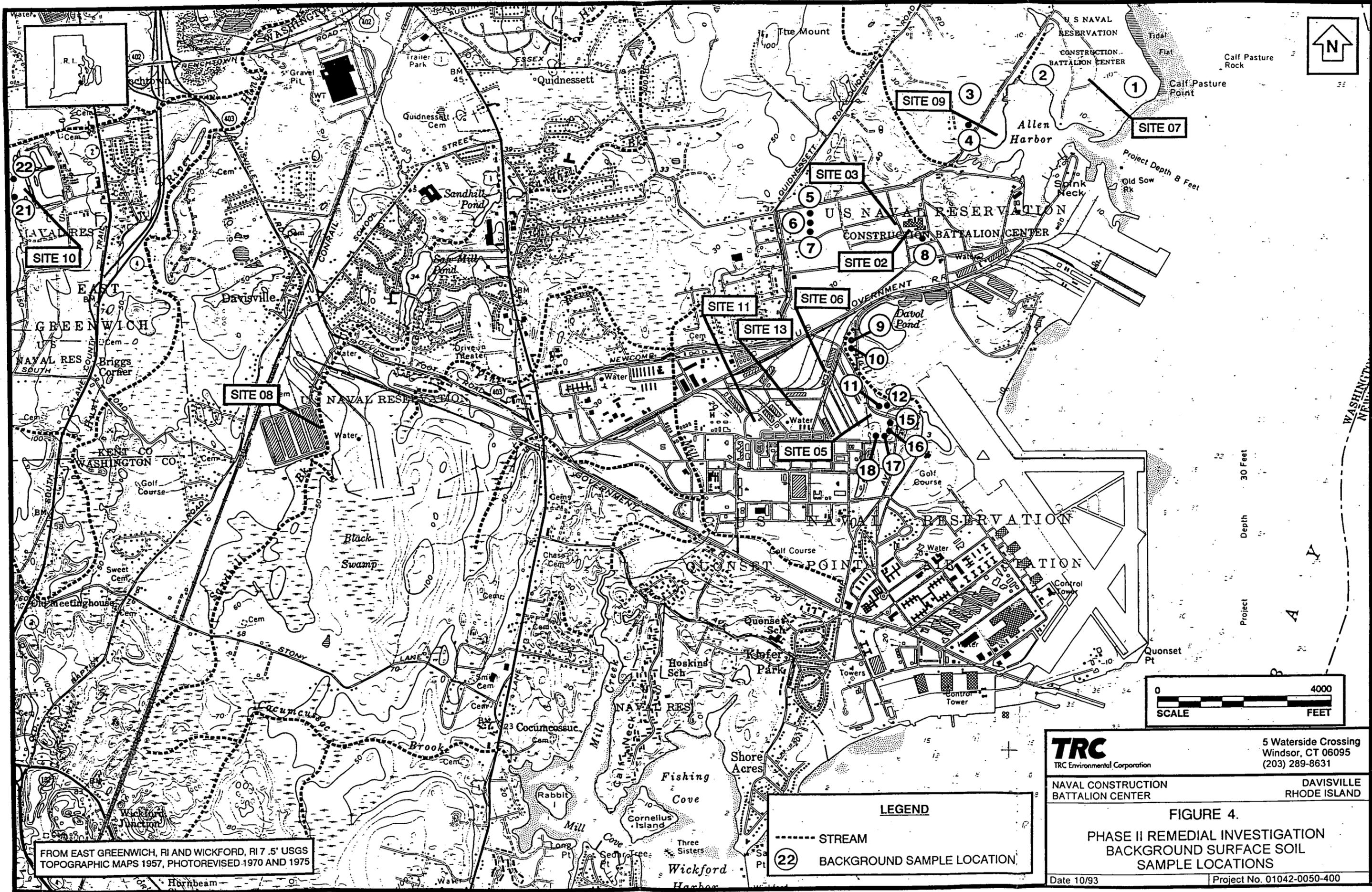
Scale in feet

NAVAL CONSTRUCTION BATTALION CENTER DAVISVILLE, RI

Figure 2. Site 08: Phase I Sampling Locations

\* Extent of Study Area has been updated for the Phase II Investigation activities.



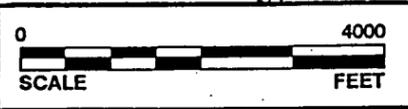


FROM EAST GREENWICH, RI AND WICKFORD, RI 7.5' USGS TOPOGRAPHIC MAPS 1957, PHOTOREVISED 1970 AND 1975

**LEGEND**

----- STREAM

22 BACKGROUND SAMPLE LOCATION



**TRC**  
TRC Environmental Corporation  
5 Waterside Crossing  
Windsor, CT 06095  
(203) 289-8631

NAVAL CONSTRUCTION BATTALION CENTER

DAVISVILLE RHODE ISLAND

**FIGURE 4.**  
**PHASE II REMEDIAL INVESTIGATION**  
**BACKGROUND SURFACE SOIL**  
**SAMPLE LOCATIONS**

Date 10/93 Project No. 01042-0050-400

**APPENDIX A**

**SURFACE SOIL, SUBSURFACE SOIL, AND GROUND WATER  
DATA FOR CONSTITUENTS OF POTENTIAL CONCERN**

**NCBC DAVISVILLE - SITE 08**

TABLE A-1  
SURFACE SOIL DATA FOR  
CHEMICALS OF POTENTIAL CONCERN  
NCBC DAVISVILLE - SITE 08

Phase I

TRC SAMPLE IDENTIFICATION: SAMPLE DEPTH:	SS-01 0-0.5'	SS-02 0-0.5'	SS-03 0-0.5'	SS-04 0-0.5'	SS-05 0-0.5'	SS-06 (a) 0-0.5'	SS-07 0-0.5'	SS-08 0-0.5'	SS-09 (a) 0-0.5'	SS-10 0-0.5'
<b>VOLATILE ORGANICS (ug/kg)</b>										
Acetone	6.0	12	19	11	12	11	13	89	29	75
Chloroform	6.0	6.0	3.0	5.0	5.0	5.0	2.0	1.0	5.0	2.0
Methylene chloride	12	12	18	26	25	15	28	23	37	27
<b>SEMIVOLATILE ORGANICS (ug/kg)</b>										
Benzoic acid	1900	1900	1800	1700	1900	88	130	1800	130	49
Benzo(a)anthracene	50	45	410	54	86	68	100	72	360	59
Benzo(a)pyrene	60	53	330	47	93	79	130	80	360	59
Benzo(b/k)fluoranthene	120	86	650	110	230	213	340	140	720	130
Benzo(g,h,i)perylene	380	48	190	350	390	340	82	38	360	420
bis(2-Ethylhexyl)phthalate	290	40	70	67	68	88	170	78	77	110
Chrysene	70	65	500	82	110	95	170	110	360	84
Dibenzo(a,h)anthracene	380	390	140	350	390	340	410	370	360	420
Fluoranthene	130	110	570	93	140	150	230	150	360	120
Indeno(1,2,3-cd)pyrene	380	41	200	350	40	340	58	43	360	420
Phenanthrene	65	57	84	47	64	53	110	75	360	46
Pyrene	89	81	480	87	120	130	170	150	360	95
<b>PESTICIDES/PCBs (ug/kg)</b>										
4,4'-DDT	19	19	18	17	29	17	20	18	18	20
Aroclor-1260	190	190	450	190	190	165	230	180	180	200
<b>INORGANICS (mg/kg)</b>										
Arsenic	0.77	1	1	0.74	1.3	0.64	1.9	0.89	2.6	1.3
Beryllium	0.68	0.71	0.65	0.63	1.2	0.33	1.4	0.72	0.34	0.47
Chromium	5.9	5.7	6.4	7.8	8.3	5.4	16	5.6	5.0	14
Cyanide	0.58	0.59	0.57	0.52	0.59	0.52	0.62	0.56	0.55	0.64
Lead	26	43	52	30	58	33	171	21	23	160
Nickel	8.3	8.5	8.2	7.5	8.5	6.1	31	10.2	6.9	9.2

Nondetects

(a) SRC and SDRC (duplicate) averaged if concentrations within 35%; otherwise SRC concentration used.

SQL halved prior to EPC calculation

Value treated as non-detect  
based on evaluation of blanks

TABLE A-1  
SURFACE SOIL DATA FOR  
CHEMICALS OF POTENTIAL CONCERN  
NCBC DAVISVILLE - SITE 08

Phase II

TRC SAMPLE IDENTIFICATION: SAMPLE DEPTH:	MW11 0-2'	MW21 0-2'	MW31/ MW41 (b) 0-2'	SS11 0-1'	SS12 0-1'	SS13 0-1'	SS14 0-1'	SS15/ SS18 (c) 0-1'	SS16 0-1'	B11 0-2'
VOLATILE ORGANICS (ug/kg)										
Acetone	43	10	11	12	12	11	11	56	12	12
Chloroform	11	10	11	12	12	11	11	11	12	12
Methylene chloride	5.0	7.0	7.0	6.0	4.0	11	11	11	12	12
SEMIVOLATILE ORGANICS (ug/kg)										
Benzoic acid										
Benzo(a)anthracene	350	390	360	380	370	350	360	370	360	360
Benzo(a)pyrene	350	390	360	380	370	350	360	370	360	360
Benzo(b/k)fluoranthene	700	780	720	760	740	700	720	740	720	720
Benzo(g,h,i)perylene	350	390	360	380	370	350	360	370	360	360
bis(2-Ethylhexyl)phthalate	350	390	360	380	370	350	360	370	360	360
Chrysene	350	390	360	380	370	200	360	370	360	360
Dibenzo(a,h)anthracene	350	390	360	380	370	190	360	370	360	360
Fluoranthene	350	390	360	380	370	350	360	370	360	360
Indeno(1,2,3-cd)pyrene	350	390	360	380	370	350	360	370	360	360
Phenanthrene	350	390	360	380	370	350	360	370	360	360
Pyrene	350	390	360	380	370	340	360	370	360	360
PESTICIDES/PCBs (ug/kg)										
4,4'-DDT	3.5	3.9	3.6	3.8	3.6	3.5	3.6	3.7	3.6	3.6
Aroclor-1260	34	39	20	38	36	35	52	45	23	36
INORGANICS (mg/kg)										
Arsenic	0.71	0.72	0.61	0.87	0.93	0.71	0.57	0.70	0.51	0.74
Beryllium	0.48	0.45	0.43	0.46	0.40	0.41	0.34	0.36	0.38	0.41
Chromium	4.8	4.8	3.0	6.4	4.2	5.5	2.6	3.6	2.5	4.8
Cyanide	0.19	0.18	0.19	0.20	0.19	0.17	0.18	0.19	0.19	0.39
Lead	5.6	3.9	6.8	11	8.2	13	5.5	10	8.4	4.9
Nickel	4.6	2.3	2.8	6	3.5	3.2	2.2	2.6	2.4	5.3

Nondetects

SQL halved prior to EPC calculation

Value treated as non-detect  
based on evaluation of blanks

- (b) MW31 and MW41 (duplicate) averaged if concentrations within 35%;  
otherwise MW31 concentration used
- (c) SS15 and SS18 (duplicate) averaged if concentrations within 35%;  
otherwise SS15 concentration used

TABLE A-1  
 SURFACE SOIL DATA FOR  
 CHEMICALS OF POTENTIAL CONCERN  
 NCBC DAVISVILLE - SITE 08

TRC SAMPLE IDENTIFICATION: SAMPLE DEPTH:	B21 0-2'	B31 0-2'	B41 0-2'	B51/ B61 (d) 0-2'
<b>VOLATILE ORGANICS (ug/kg)</b>				
Acetone	82	11	11	11
Chloroform	11	11	11	11
Methylene chloride	11	11	11	12
<b>SEMIVOLATILE ORGANICS (ug/kg)</b>				
Benzoic acid				
Benzo(a)anthracene	360	360	230	395
Benzo(a)pyrene	360	360	250	395
Benzo(b/k)fluoranthene	720	720	580	790
Benzo(g,h,i)perylene	360	360	370	395
bis(2-Ethylhexyl)phthalate	360	360	370	395
Chrysene	360	360	370	395
Dibenzo(a,h)anthracene	360	360	370	395
Fluoranthene	360	360	310	395
Indeno(1,2,3-cd)pyrene	360	360	370	395
Phenanthrene	360	360	370	395
Pyrene	360	360	470	395
<b>PESTICIDES/PCBs (ug/kg)</b>				
4,4'-DDT	3.6	3.6	3.7	3.4
Aroclor-1260	36	36	37	40
<b>INORGANICS (mg/kg)</b>				
Arsenic	1.00	0.79	0.76	0.94
Beryllium	0.37	0.42	0.29	0.37
Chromium	4.0	4.8	9.0	8.3
Cyanide	0.19	0.19	0.23	0.20
Lead	4.9	4.6	40	12
Nickel	4	4.6	7.4	5.1

Nondetects

SQL halved prior to EPC calculation

Value treated as non-detect  
 based on evaluation of blanks

(d) B51 and B61 (duplicate) averaged if  
 concentrations within 35%  
 otherwise B51 concentration used

TABLE A-2  
 SUBSURFACE SOIL DATA FOR  
 CHEMICALS OF POTENTIAL CONCERN  
 NCBC DAVISVILLE - SITE 08

TRC SAMPLE IDENTIFICATION: SAMPLE DEPTH:	Phase I					Phase II			
	S-08-01-03 3.5'	S-08-05-03 3.5'	S-08-06-03 3.5'	S-08-07-03 3.5'	S-08-09-03 3.5'	08-MW12 4-6'	08-MW32 2-4'	08-B12 2-4'	08-B22 2-4'
VOLATILES (ug/kg)									
Acetone	13	11	11	11	34	11	40	43	11
Chloroform	5.0	5.0	5.0	1	6.0	11	12	12	11
Methylene chloride	15	14	16	21	110	11	6.0	12	11
SEMIVOLATILES (ug/kg)									
Benzoic Acid	1800	1700	1700	45	3500				
Benzo(a)anthracene	360	360	360	360	720	350	370	2800	360
Benzo(a)pyrene	360	360	360	360	720	350	370	2800	360
Benzo(b/k)fluoranthene	360	54	360	360	720	700	740	5600	720
Benzo(g,h,i)perylene	360	360	360	360	720	350	370	2800	360
bis(2-Ethylhexyl)phthalate	440	280	470	360	120	350	370	2800	360
Chrysene	360	42	360	360	720	350	370	2800	360
Dibenzo(a,h)anthracene	360	360	360	360	720	350	370	2800	360
Fluoranthene	360	46	360	360	720	350	370	2800	360
Indeno(1,2,3-cd)pyrene	360	360	360	360	720	350	370	2800	360
Phenanthrene	360	360	360	360	170	350	370	2800	360
Pyrene	360	57	360	360	720	350	370	2800	360
PESTICIDES/PCBs (ug/kg)									
DDT, 4,4-	18	350	17	18	700	3.6	3.7	3.5	3.5
Aroclor-1260	180	3500	170	180	7000	36	37	23	35
INORGANICS (mg/kg)									
Arsenic	0.54	0.84	0.46	0.67	0.47	0.61	0.39	0.42	0.36
Beryllium	0.73	1.4	0.71	0.76	0.77	0.66	0.34	0.51	0.48
Cadmium	0.97	0.96	0.93	0.94	0.96	0.52	0.62	0.44	0.55
Chromium	11	3.1	12	3.3	5.5	3.4	2.1	5.0	3.2
Cyanide	0.55	0.54	0.54	0.55	0.54	0.18	0.20	0.18	0.40
Lead	2.6	5.1	6.9	13	10	7.3	3.4	8.0	5.8
Nickel	7.9	7.8	7.6	7.7	7.8	5.8	2.1	4.0	2.4

Nondetects

SQL halved prior to EPC calculation

Value treated as non-detect  
 based on evaluation of blanks

TABLE A-2  
 SUBSURFACE SOIL DATA FOR  
 CHEMICALS OF POTENTIAL CONCERN  
 NCBC DAVISVILLE - SITE 08

TRC SAMPLE IDENTIFICATION: SAMPLE DEPTH:	08-B33 4-6'	08-B42 2-4'	08-B52 2-4'
<b>VOLATILES (ug/kg)</b>			
Acetone	65	11	10
Chloroform	11	11	10
Methylene chloride	11	11	10
<b>SEMIVOLATILES (ug/kg)</b>			
Benzoic Acid			
Benzo(a)anthracene	390	350	360
Benzo(a)pyrene	390	350	360
Benzo(b/k)fluoranthene	780	700	560
Benzo(g,h,i)perylene	390	350	360
bis(2-Ethylhexyl)phthalate	390	350	360
Chrysene	390	350	360
Dibenzo(a,h)anthracene	390	350	360
Fluoranthene	390	350	360
Indeno(1,2,3-cd)pyrene	390	350	360
Phenanthrene	390	350	360
Pyrene	390	350	360
<b>PESTICIDES/PCBs (ug/kg)</b>			
DDT, 4,4-	39	36	36
Aroclor-1260	39	36	36
<b>INORGANICS (mg/kg)</b>			
Arsenic	0.82	0.41	0.51
Beryllium	0.38	0.38	0.49
Cadmium	0.5	0.48	0.53
Chromium	4.7	1.4	3.5
Cyanide	0.21	0.18	0.2
Lead	5.1	4.0	13
Nickel	4.6	1.6	1.8

Nondetects

SQL halved prior to EPC calculation

Value treated as non-detect  
 based on evaluation of blanks

TABLE A-3  
GROUND WATER DATA FOR CHEMICALS OF POTENTIAL CONCERN  
NCBC DAVISVILLE - SITE 08

TRC SAMPLE IDENTIFICATION:	Phase II			
	08-MW1S	08-MW2S	08-MW3S	08-MW3D/ 08-MW4S (a)
VOLATILES (ug/L)				
Acetone	10	40	92	10
INORGANICS (ug/L)				
Aluminum	707	2850	3380	319
Arsenic	1.0	1.8	1.1	1.0
Barium	42	20	23	12
Beryllium	1.0	0.34	1.0	1.0
Chromium	4.1	5.9	7.1	3.0
Cobalt	2.0	2.4	4.7	2.0
Copper	2.0	7.9	6.8	2.0
Cyanide	1.8	1.8	3.1	1.8
Lead	2.5	2.4	3.3	1.0
Manganese	361	741	1300	840
Vanadium	3.0	3.0	4.6	3.0

Nondetects

SQL halved prior to EPC calculation

(a) 08-MW3D and 08-MW4S (duplicate)  
averaged if concentrations within 20%;  
otherwise 08-MW3D concentration used.

**APPENDIX B**  
**TOXICOLOGICAL PROFILES**  
**FOR CONSTITUENTS OF POTENTIAL CONCERN**  
**NCBC DAVISVILLE - SITE 08**

## APPENDIX B

### TOXICOLOGICAL PROFILES FOR CONSTITUENTS OF POTENTIAL CONCERN

#### C.1 Volatiles

##### Acetone

The chronic oral RfD for acetone is 1E-01 mg/kg-d (EPA, 1993) and is based on a subchronic oral study in rats. Acetone was administered by gavage for 90 days to groups of albino rats at doses of 0, 100, 500 or 2,500 mg/kg-d. The LOAEL was 500 mg/kg-d and the critical effects were increased liver and kidney weights and nephrotoxicity. An uncertainty factor of 1,000 was applied to the NOEL of 100 mg/kg-d to obtain the RfD. The uncertainty factor was used to account for inter- and intraspecies variability and the use of subchronic data. The confidence level in this RfD is low. The subchronic oral RfD for acetone is 1E+00 (EPA, 1992a). Since inhalation RfDs for acetone are not available at this time (EPA, 1992a, 1993), the oral RfDs are cross-assigned to inhalation.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1993).

##### Chloroform

The chronic oral RfD for chloroform is 1.0E-2 mg/kg-d (EPA, 1993) and is based upon a chronic dog study. Beagle dogs received chloroform orally in a toothpaste base by capsule at a dose of 15 or 30 mg/kg-d for 6 days/week for 7.5 years. The LOAEL was 15 mg/kg-d (converted to 12.9 mg/kg-d) and the critical effects observed were fatty cyst formation in the liver and an increase in serum SGPT and SGOT levels. An uncertainty factor of 1,000 was applied to the LOAEL to obtain the RfD. This uncertainty factor was used to account for interspecies variability, individual sensitivity, and the use of a LOAEL rather than a NOAEL. The confidence level in the RfD is medium. The subchronic oral RfD for chloroform is also 1.0E-2 mg/kg-d (EPA, 1992a). Although inhalation RfDs are unavailable (EPA, 1992a, 1993), the oral RfDs are cross-assigned to inhalation since the effects observed via oral exposure were systemic.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "B2" - probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1993). Chloroform has been shown to produce kidney and/or hepatocellular tumors in rats, mice and beagle dogs. EPA's (1993) oral slope factor for chloroform is  $6.1E-03$  (mg/kg-d)<sup>-1</sup>. The inhalation unit risk factor is  $2.3E-05$  (mg/m<sup>3</sup>)<sup>-1</sup> ( $8.1E-02$  (mg/kg-d)<sup>-1</sup>) (EPA, 1992a, 1993).

#### Methylene Chloride

The chronic oral RfD for methylene chloride is  $6E-02$  mg/kg-d (EPA, 1993) and is based on a drinking water bioassay in rats. Rats were given methylene chloride at doses of 5, 50, 125 or 250 mg/kg-d in drinking water for 2 years. The LOAEL was 52.58 and 58.32 mg/kg-d for males and females, respectively and the critical effect was liver toxicity. The NOAELs were 5.85 and 6.47 mg/kg-d for males and females, respectively and an uncertainty factor of 100 was applied to these NOAELs to obtain the RfD. This uncertainty factor was used to account for inter- and intraspecies variability. The confidence level in the RfD is medium. The subchronic oral RfD is also  $6E-02$  mg/kg-d (EPA, 1992a).

The chronic inhalation RfD for methylene chloride is  $8.6E-01$  mg/kg-d ( $3E+00$  mg/m<sup>3</sup>) (EPA, 1992a). This value is based upon a chronic inhalation study in rats. Rats were exposed intermittently to methylene chloride in air for 2 years. The NOAEL was 694.8 mg/m<sup>3</sup> and an uncertainty factor of 100 was applied to obtain the RfD. The subchronic inhalation RfD is also  $8.6E-01$  mg/kg-d (EPA, 1992a).

The EPA weight of evidence classification for human carcinogenicity is "B2" - probable human carcinogen (sufficient evidence in animals, inadequate or lack of evidence in humans) (EPA, 1993). Methylene chloride has been shown to induce increased incidence of hepatocellular neoplasms and alveolar/bronchiolar neoplasms in male and female mice, and increased incidence of benign mammary tumors in both sexes of rats, salivary gland sarcomas in male rats and leukemia in female rats. An oral slope factor of  $7.5E-03$  (mg/kg-d)<sup>-1</sup> (EPA, 1993) calculated as the arithmetic mean of slope factors derived from an inhalation mouse study and an oral/drinking water study in mice has been established. An inhalation slope factor of

$1.6E-03$  (mg/kg-d)<sup>-1</sup> ( $4.7E-07$  (mg/m<sup>3</sup>)<sup>-1</sup>) (EPA, 1993) has been established based upon the induction of adenomas and carcinomas (liver and lung) in mice following inhalation exposure.

## C.2 Semi-Volatiles

### Benzoic Acid

The chronic oral RfD for benzoic acid is  $4E+00$  mg/kg-d (EPA, 1993) and is based on FDA data regarding the amounts of benzoic acid and sodium benzoate produced as a food preservative. The FDA estimated a daily per capita intake of 0.9-34 mg for benzoic acid and 34-328 mg for sodium benzoate. At these levels, there are no reports of toxic effects in humans. These constituents have Generally Recognized as Safe (GRAS) status by FDA. Therefore, the upper ranges can be considered NOAELs for benzoic acid and sodium benzoate. No uncertainty factors are applied and based on conversion factors, the chronic oral RfD for benzoic acid has been established at 312 mg/day for a 70 kg human or 4 mg/kg-d. The confidence in the RfD is medium. The subchronic oral RfD for benzoic acid is also  $4.0E+0$  mg/kg-d (EPA, 1992a). In the absence of inhalation RfDs (EPA, 1992a, 1993), the oral RfDs for benzoic acid are cross-assigned to inhalation. No effects were observed following oral exposures.

The EPA weight of evidence classification for the human carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1993).

### Benzo(a)anthracene

EPA (1992a, 1993) has not established oral or inhalation RfDs for benzo(a)anthracene.

The EPA (1993) weight of evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence). Although oral and inhalation oral slope factors for benzo(a)anthracene have not been established (EPA, 1992a, 1993), this constituent has been shown to produce liver, lung and skin cancer in animals. Per EPA Region I guidance (EPA, 1993a), the oral and inhalation slope factors for benzo(a)pyrene ( $7.3$  and  $6.1$  (mg/kg-d)<sup>-1</sup>, respectively) are assigned to this B2 carcinogen.

#### Benzo(a)pyrene

EPA (1992a, 1993) has not established oral or inhalation RfDs for benzo(a)pyrene.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1993). Benzo(a)pyrene has been shown to produce lung and stomach cancer in animals. EPA's (1993) oral slope factor of  $7.3 \text{ (mg/kg-d)}^{-1}$  for benzo(a)pyrene is based on forestomach tumors observed in mice following up to 196 days of dietary exposure to benzo(a)pyrene. The inhalation slope factor for benzo(a)pyrene is  $6.1 \text{ (mg/kg-d)}^{-1}$ . EPA (1992a) established this slope factor based on respiratory tract tumors observed in hamsters after 96.4 weeks of intermittent inhalation exposure.

#### Benzo(b)fluoranthene

EPA (1992a, 1993) has not established oral or inhalation RfDs for benzo(b)fluoranthene.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1993). Although oral and inhalation slope factors for benzo(b)fluoranthene have not been established (EPA, 1992a, 1993), this constituent has been shown to produce lung and thorax carcinomas, lung adenomas and skin tumors in animals. Per EPA Region I guidance (EPA, 1993a), the oral and inhalation slope factors for benzo(a)pyrene ( $7.3$  and  $6.1 \text{ (mg/kg-d)}^{-1}$ , respectively) are assigned to this B2 carcinogen.

#### Benzo(ghi)perylene

EPA (1992a, 1993) has not established oral or inhalation RfDs for benzo(ghi)perylene. Per EPA Region I guidance, the oral RfDs for naphthalene ( $4\text{E-}02 \text{ mg/kg-d}$  for chronic and subchronic) are cross-assigned to benzo(ghi)perylene.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1993).

#### Benzo(k)fluoranthene

EPA (1992a, 1993) has not established oral or inhalation RfDs for benzo(k)fluoranthene.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1993). Although oral and inhalation slope factors for benzo(k)fluoranthene have not been established (EPA, 1992a, 1993), this constituent has been shown to produce lung and thorax carcinomas, lung adenomas and skin tumors in animals. Per EPA Region I guidance (EPA, 1993a), the oral and inhalation slope factors for benzo(a)pyrene (7.3 and 6.1 (mg/kg-d)<sup>-1</sup>, respectively) are assigned to this B2 carcinogen.

#### Bis(2-ethylhexyl)phthalate

The chronic oral RfD for Bis(2-ethylhexyl)phthalate (BEHP) is 2.0E-02 mg/kg-d (EPA, 1993) and is based on a subchronic feeding study in guinea pigs. Guinea pigs received 19 or 64 mg/kg-d BEHP in their food for 1 year. There were no treatment related toxic effects, however both dose groups had increased liver weights. An uncertainty factor of 1,000 was applied to the LOAEL of 19 mg/kg-d to obtain the RfD. This uncertainty factor was used to account for inter- and intraspecies variability, and a less-than-lifetime exposure. The confidence level in the RfD is medium. The subchronic oral RfD for BEHP is also 2.0E-2 mg/kg-d (EPA, 1992a). Since EPA (1992a, 1993) has not established inhalation RfDs for BEHP, the oral RfDs are cross-assigned to inhalation.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence). The oral slope factor for BEHP is 1.4E-02 (mg/kg-d)<sup>-1</sup> (EPA, 1993) and is based on BEHP's ability to produce liver tumors in animals. Since a quantitative estimate of carcinogenic risk from inhalation exposure is not available (EPA, 1992a, 1993), the oral slope factor is cross-assigned to inhalation.

#### Chrysene

The available data is inadequate for quantitative non-cancer risk assessment (EPA, 1992a, 1993).

The EPA weight of evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence)

(EPA, 1993). Although oral and inhalation slope factors for chrysene have not been established (EPA, 1992a, 1993), this constituent has been shown to produce carcinomas and malignant lymphomas in mice after intraperitoneal exposure, and skin carcinomas in mice after dermal exposure. Per EPA Region I guidance (EPA, 1993a), the oral and inhalation slope factors for benzo(a)pyrene (7.3 and 6.1 (mg/kg-d)<sup>-1</sup>, respectively) are assigned to this B2 carcinogen.

#### Dibenzo(a,h)anthracene

EPA (1992a, 1993) has not established oral or inhalation RfDs for dibenzo(a,h)anthracene.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1993). Although oral and inhalation slope factors for dibenzo(a,h)anthracene have not been established (EPA, 1992a, 1993), this constituent has been shown to produce lung and mammary tumors after oral administration, skin carcinomas after dermal exposure, and fibrosarcomas after subcutaneous injection in animals. Per EPA Region I guidance (EPA, 1993a), the oral and inhalation slope factors for benzo(a)pyrene (7.3 and 6.1 (mg/kg-d)<sup>-1</sup>, respectively) are assigned to this B2 carcinogen.

#### Fluoranthene

The chronic oral RfD for fluoranthene is 4.0E-02 mg/kg-d (EPA, 1993) and is based on a subchronic gavage study in mice. Mice received 0, 125, 250, or 500 mg/kg-d fluoranthene by oral gavage for 13 weeks. The LOAEL was 250 mg/kg-d and the critical effects seen were neuropathy, increased salivation, kidney toxicity, increased liver enzymes and hematological/clinical changes. An uncertainty factor of 3000 was applied to the NOAEL of 125 mg/kg-d to obtain the RfD. This uncertainty factor was used to account for inter- and intraspecies variability, the use of subchronic rather than chronic data, and the lack of additional supporting data. The confidence level in the RfD is low. The subchronic oral RfD for fluoranthene is 4.0E-1 mg/kg-d (EPA, 1992a). Since EPA (1992a, 1993) has not established inhalation RfDs for fluoranthene and the oral RfDs are based on systemic effects, the oral RfDs for fluoranthene are cross-assigned to inhalation.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1993).

#### Indeno(1,2,3-cd)pyrene

EPA (1992a, 1993) has not established oral or inhalation RfDs for indeno(1,2,3-cd)pyrene.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1993). Although oral and inhalation slope factors for indeno(1,2,3-cd)pyrene have not been established (EPA, 1992a, 1993), this constituent has been shown to produce lung and thorax tumors following lung implantation, and skin tumors following dermal exposure in animals. Per EPA Region I guidance (EPA, 1993b), the oral and inhalation slope factors for benzo(a)pyrene (7.3 and 6.1 (mg/kg-d)<sup>-1</sup>, respectively) are assigned to this B2 carcinogen.

#### Phenanthrene

The available data is inadequate for quantitative non-cancer risk assessment (EPA, 1992a, 1993). Per EPA Region I guidance, the oral RfD for naphthalene (4E-02 mg/kg-d for chronic and subchronic) are cross-assigned to phenanthrene.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1993).

#### Pyrene

The chronic oral RfD for pyrene is 3E-02 mg/kg-d (EPA, 1993) and is based on a subchronic gavage study in mice. Mice received 0, 75, 125, or 250 mg/kg-d pyrene by oral gavage for 13 weeks. The LOAEL was 125 mg/kg-d and the critical effects seen were toxic effects to the kidney including changes to the renal tubular pathology and decreased kidney weight. An uncertainty factor of 3000 was applied to the NOAEL of 75 mg/kg-d to obtain the RfD. This uncertainty factor was used to account for inter- and intraspecies variability, the use of subchronic rather than chronic data, and the lack of additional supporting data. The confidence level in the RfD is low. The subchronic oral RfD for pyrene is 3E-01 mg/kg-d

(EPA, 1992a). In the absence of inhalation RfDs for pyrene (EPA, 1992a, 1993), the oral RfDs are cross-assigned to inhalation in this HHRA.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1993).

### C.3 Pesticides/PCBs

#### 4,4'-DDT

The chronic oral RfD for 4,4'-DDT is 5E-04 mg/kg-d (EPA, 1993) and is based on a subchronic feeding study in rats. Rats received 0, 1, 5, 10, or 50 ppm 4,4'-DDT in their food for 15 to 27 weeks. The LOAEL was 0.25 mg/kg-d (5 ppm diet) and the critical effects seen were histopathological effects to the liver. An uncertainty factor of 100 was applied to the NOAEL of 0.05 mg/kg-d (1 ppm diet) to obtain the RfD. This uncertainty factor was used to account for intra- and interspecies variability. The confidence in the RfD is medium. The subchronic oral RfD for 4,4'-DDT is also 5E-04 mg/kg-d (EPA, 1992a). In the absence of EPA non-cancer toxicity values for inhalation (EPA, 1992a, 1993), the oral RfDs for 4,4'-DDT are cross-assigned to inhalation.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1993). This constituent has been shown to produce liver tumors in mice and rats. The oral slope factor for 4,4'-DDT is 3.4E-01 (mg/kg-d)<sup>-1</sup> (EPA, 1993) and is based upon liver tumors in mice and rats following dietary exposure to 4,4'-DDT. On the basis of route-to-route extrapolation, the inhalation slope factor for 4,4'-DDT has been set at 3.4E-01 (mg/kg-d)<sup>-1</sup> (9.7E-05 (mg/m<sup>3</sup>)<sup>-1</sup> (EPA, 1992a, 1993).

#### PCBs

EPA (1992a, 1993) has not established oral or inhalation RfDs for any individual Aroclor or for PCBs combined.

The EPA weight of evidence classification for the carcinogenicity of PCBs is "B2" - probable human carcinogen (sufficient animal evidence, inadequate/no human evidence (EPA, 1993). PCBs have been shown to produce liver tumors in rats and mice. In humans, the

available data are inadequate but provide suggestive evidence of excess risk of liver cancer from ingestion and inhalation or dermal contact. An oral slope factor of 7.7 mg/kg-d has been established for PCBs (EPA, 1993) based on a dietary study in rats. Liver lesions and carcinomas were observed in rats exposed to 100 ppm Aroclor-1260 in corn oil for 16 months, followed by 50 ppm exposure for 8 months and a basal diet for 5 months. Since a quantitative estimate of carcinogenic risk from inhalation exposure is not available (EPA, 1992a, 1993), the oral slope factor is cross-assigned to inhalation. Aroclor-specific slope factors are not available.

#### C.4 Inorganics

##### Aluminum

Aluminum is one of the most abundant metals in the earth's crust, and it is ubiquitous in air, water and soil (Goyer, 1986). The toxicity of aluminum can be divided into three major categories: (1) the effect of aluminum constituents on the gastrointestinal tract; (2) the effect of inhalation of aluminum constituents; and (3) systemic toxicity of aluminum (Alfrey, 1981). Aluminum constituents can alter absorption of other elements in the gastrointestinal tract (i.e., fluoride, calcium, iron, cholesterol, phosphorus) and alter gastrointestinal tract motility by inhibition of acetylcholine-induced contractions. Inhalation of aluminum dusts can lead to the development of pulmonary fibrosis producing both restrictive and obstructive pulmonary disease (Schaver, 1948). A progressive fatal neurologic syndrome has been noted in patients on long-term intermittent hemodialysis treatment for chronic renal failure (Alfrey et al., 1972) and may be due to aluminum intoxication. Symptoms in these patients include a speech disorder followed by dementia, convulsions and myoclonus. Aluminum content of brain, muscle and bone tissues is increased in these patients. Sources of the excess aluminum may be from oral aluminum hydroxide commonly given to these patients or from aluminum in dialysis fluid derived from tap water used to prepare the dialysate fluid.

The available data have been evaluated and found to be inadequate for quantitative non-cancer risk assessment (EPA, 1992a). EPA (1992a, 1993) has not evaluated aluminum with regard to its potential human carcinogenicity.

### Arsenic

Symptoms of arsenic intoxication consist of fever, anorexia, hepatomegaly, melanosis, and cardiac arrhythmia. Other features include upper respiratory tract symptoms, peripheral neuropathy, and gastrointestinal, cardiovascular and hematopoietic effects. Liver injury is characteristic of longer term or chronic exposure (Goyer, 1986).

The chronic oral RfD is  $3E-04$  mg/kg-d (EPA, 1993). The critical effects associated with ingestion of arsenic in water and food are keratosis, hyperpigmentation and possible complications at a dose of 0.8 mg/kg-d in humans. An uncertainty factor of 3 was applied to the LOAEL of 0.8 mg/kg-d to obtain the RfD. This uncertainty factor was used to account for the lack of reproductive toxicity data and for individual sensitivity. The confidence in the RfD is medium. The subchronic oral RfD is also  $3E-04$  mg/kg-d (EPA, 1992a). In the absence of inhalation RfDs (EPA, 1992a, 1993), the oral RfDs are cross-assigned to inhalation.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "A" - a human carcinogen (EPA, 1993). Exposure to arsenic by the oral route is known to produce skin cancer, while inhalation will cause lung cancer. The slope factors for these carcinogenic effects are  $1.8$  (mg/kg-d)<sup>-1</sup> ( $5E-05$  (mg/l)<sup>-1</sup>) for ingestion and  $5E+01$  (mg/kg-d)<sup>-1</sup> ( $4.3E-03$  (mg/m<sup>3</sup>)<sup>-1</sup>) for inhalation (EPA, 1992a, 1993).

### Barium

Symptoms of accidental poisoning from ingestion of soluble barium salts has resulted in gastroenteritis, muscular paralysis, decreased pulse rate, and ventricular fibrillation and extra-systoles (Goyer, 1986).

The chronic oral RfD for barium is  $7E-02$  mg/kg-d (EPA, 1991a) and is based upon drinking water studies in humans and various rodent studies. In one human study, barium (as barium chloride) was administered in drinking water at 0 mg/L for weeks 0-2; 5 mg/L for weeks 3-6; and 10 mg/L for weeks 7-10. A NOAEL of 10 mg/L was identified in this study which corresponds to 0.21 mg/kg-d. An uncertainty factor of 3 was applied to the NOAEL to obtain this RfD. This uncertainty factor was used to account for the use of subchronic rather than chronic data. The confidence level in this RfD is medium. The subchronic oral RfD is also  $7E-02$  mg/kg-d (EPA, 1992a).

Occupational poisoning to barium is uncommon, but a benign pneumoconiosis (baritosis) may result from inhalation of barium sulfate dust and barium carbonate. It is not incapacitating and is usually reversible with cessation of exposure. In the absence of inhalation RfDs for barium (EPA, 1992a, 1993), the oral RfDs are cross-assigned to inhalation in this HHRA.

Barium has not been evaluated by EPA for evidence of human carcinogenic potential (EPA, 1992a, 1993).

### Beryllium

The major toxicologic effects of beryllium are on the lung. It may produce an acute chemical pneumonitis, hypersensitivity or chronic granulomatous pulmonary disease (berylliosis) (Goyer, 1986).

The chronic oral RfD for beryllium is  $5E-03$  mg/kg-d (EPA, 1993). This value is based upon a chronic drinking water study in rats. Beryllium was administered to rats over their lifetime at a concentration of 0 or 5 ppm (0.54 mg/kg-d) in drinking water. There were no observed adverse effects. An uncertainty factor of 100 was applied to the NOAEL to obtain the RfD. This uncertainty factor was used to account for inter- and intraspecies variability. The confidence level for the RfD is low. The subchronic oral RfD is also  $5E-03$  mg/kg-d (EPA, 1992a). Since EPA (1992a, 1993) has not established inhalation RfDs for beryllium, the oral RfDs are cross-assigned to inhalation.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1993). Beryllium constituents have been shown to induce malignant lung tumors via inhalation in rats and monkeys and osteogenic sarcoma via intravenous or intramedullary injection in rabbits. The oral slope factor for beryllium is  $4.3$  (mg/kg-d)<sup>-1</sup> (EPA, 1993) and is based on tumors at multiple sites in rats exposed to beryllium in drinking water. The inhalation slope factor for beryllium is  $8.4E+00$  (mg/kg-d)<sup>-1</sup> ( $2.4E-03$  (mg/m<sup>3</sup>)<sup>-1</sup>) (EPA, 1992a, 1993) and is based upon lung cancer deaths among workers exposed to beryllium via inhalation.

### Cadmium

Ingestion of cadmium results in nausea, vomiting and abdominal pain. Inhalation of cadmium fumes may result in an acute chemical pneumonitis and pulmonary edema (Goyer, 1986).

The chronic oral RfDs for cadmium are 5E-04 mg/kg-d (water) and 1E-03 mg/kg-d (food) (EPA, 1993). The critical effects associated with chronic ingestion of cadmium are proteinuria and renal damage in humans. An uncertainty factor of 10 was applied to the NOAELs (0.005 mg/kg-d for water and 0.01 mg/kg-d for food) in order to determine the RfDs. This uncertainty factor was used to account for intrahuman variability. The confidence level for the RfDs is high. In the absence of subchronic oral RfDs (EPA, 1992a), the chronic oral RfDs are used to assess subchronic exposures. Since inhalation RfDs are also unavailable (EPA, 1992a, 1993), the chronic oral RfD for water is used to evaluate inhalation exposures.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "B1" - a probable human carcinogen (limited human and sufficient animal evidence). The inhalation of cadmium has been shown to produce respiratory tract cancers in humans and various tumors in rats and mice following inhalation and injection exposures. Based on the human data, an inhalation slope factor of 6.1 (mg/kg-d)<sup>-1</sup> (1.8E-03 (mg/m<sup>3</sup>)<sup>-1</sup>) has been established (EPA, 1992a, 1993). There are no positive cancer studies of orally ingested cadmium suitable for quantitation (EPA, 1993).

### Chromium III

Note: The concentrations for chromium on-site were reported as total chromium. In this HHRA, total chromium is broken down to chromium III and chromium VI based on a 7:1 ratio (i.e., 7/8 chromium III and 1/8 chromium VI).

The chronic oral RfD for chromium III is 1E+00 mg/kg-d (EPA, 1993). This RfD is based on no observed effects in rats chronically exposed to Cr<sub>2</sub>O<sub>3</sub> in their diet. An uncertainty factor of 100 and a modifying factor of 10 were applied to the NOAEL of 1400 mg/kg-d in determining the RfD. The uncertainty factor was used to account for inter- and intraspecies variability, while the modifying factor was used to reflect uncertainty in the NOAEL. The confidence in the RfD is low. The subchronic oral RfD is also 1.0E+0 mg/kg-d (EPA, 1992a).

Since EPA (1992a, 1993) has not established inhalation RfDs, the oral RfDs are cross-assigned to inhalation for the purposes of this HHRA.

EPA (1992a, 1993) has not classified chromium III with regard to its potential human carcinogenicity.

#### Chromium VI

Note: The concentrations for chromium on-site were reported as total chromium. In this HHRA, total chromium is broken down to chromium III and chromium VI based on a 7:1 ratio (i.e., 7/8 of total chromium is chromium III; 1/8 of total chromium of chromium VI).

The chronic oral RfD for chromium VI is 5E-03 mg/kg-d (EPA, 1993) and is based upon a study in which no adverse effects were observed in rats which received 0 to 11 mg/l or 25 mg/l chromium in drinking water for 1 year. No adverse effects were seen in humans drinking well water contaminated with 1 mg/l chromium VI for 3 years. An uncertainty factor of 500 was applied to the NOAEL to obtain the RfD. This uncertainty factor was used to account for variability across and within species and the less-than-lifetime exposure duration in the key study. The confidence level in the RfD is low. The subchronic oral RfD for chromium VI is 2.0E-2 mg/kg-d (EPA, 1992a). In the absence of inhalation RfDs (EPA, 1992a, 1993), the oral RfDs are cross-assigned to inhalation for the purposes of this HHRA.

The EPA weight of evidence classification for carcinogenicity of this constituent by the inhalation route is "A" - a human carcinogen (sufficient evidence in humans) (EPA, 1993). Chromium VI produces lung tumors in humans and an inhalation slope factor of 4.2E+01 (mg/kg-d)<sup>-1</sup> ((1.2E-02 mg/m<sup>3</sup>)<sup>-1</sup>) has been established based upon an epidemiologic study of chromate production workers. There is insufficient evidence for carcinogenicity of this constituent by the oral route.

#### Cobalt

Cobalt is essential as a component of vitamin B12 which is required for the production of red blood cells. Cobalt is well absorbed orally, probably in the small intestine. Excessive cobalt intake is known to result in cardiomyopathy. One ppm cobalt was added to beer to enhance its foaming properties and the resultant signs and symptoms were those of congestive

heart failure. Autopsy findings revealed a ten-fold increase in the cardiac levels of cobalt. Occupational exposure may result in respiratory symptoms (Goyer, 1986).

No oral or inhalation RfDs have been established by EPA (1992a, 1993). EPA (1992a, 1993) has also not evaluated cobalt as to its potential human carcinogenicity.

#### Copper

The subchronic and chronic oral RfD for copper is reported as 1.3 mg/l (3.7E-02 mg/kg-d), which is the current drinking water standard for copper (EPA, 1992a). This value is based on human exposure to a single dose of 5.3 mg copper which resulted in local gastrointestinal tract irritation. The oral RfD is not cross-assigned to inhalation since it is based on gastrointestinal irritation.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1993).

#### Cyanide

The chronic oral RfD for cyanide is 2E-02 mg/kg-d (EPA, 1993) and is based upon a chronic study in which rats were administered food fumigated with cyanide. At doses of 4.3 or 10.8 mg/kg-d, cyanide produced no treatment related effects on growth rate, no gross signs of toxicity and no histopathological lesions. An uncertainty factor of 100 and a modifying factor of 5 were supplied to the NOAEL of 10.8 mg/kg-d to obtain the RfD. The uncertainty and modifying factors were used to account for interspecies variability, individual sensitivity, and the apparent tolerance to cyanide when administered in food rather than water or by gavage. The confidence level in the RfD is medium. The subchronic oral RfD for cyanide is also 2E-02 mg/kg-d (EPA, 1992a). Since inhalation RfDs for cyanide are not available at this time (EPA, 1992a, 1993), the oral RfDs are cross-assigned to inhalation for the purposes of this HHRA.

The EPA weight of evidence classification for the human carcinogenic potential of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1993).

### Lead

The health effects of lead have been well characterized through decades of medical and scientific observation. Some of these effects include cognitive and motor defects in children, lead induced anemias, increased susceptibility to viral infections and in chronic adult lead poisoning, peripheral neuropathies. It appears that some of these effects particularly the changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold (Goyer, 1986).

Based on the available data, EPA has considered it inappropriate to develop an oral RfD for inorganic lead (EPA, 1992a, 1993). EPA (1992a, 1993) has also not established an inhalation RfD for lead. In the absence of an inhalation RfD, a non-cancer inhalation toxicity value of  $4.3E-04$  mg/kg-d is estimated from the National Ambient Air Quality Standard (NAAQS) for lead of  $1.5E+00$  mg/m<sup>3</sup>. This value is not cross-assigned to ingestion.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "B2" - a probable human carcinogen (sufficient animal evidence, inadequate/no human evidence) (EPA, 1993). Lead has been shown to produce renal tumors in rats and mice following dietary and subcutaneous exposure. However, due to the many uncertainties associated with quantifying the dose-response for lead carcinogenicity, EPA (1992a, 1993) has not established slope factors for lead.

### Magnesium

Following inhalation, magnesium oxide can produce metal fume fever. Conjunctivitis, nasal inflammation, respiratory irritation are other symptoms of industrial inhalation exposure. Subcutaneous exposure of animals to magnesium has resulted in persistent (but reversible) lesions and gas gangrene. Intoxication following oral exposure is unlikely but may occur as evidenced by decreased blood pressure and respiratory paralysis (Goyer, 1986).

EPA (1992a, 1993) has not quantitatively evaluated magnesium with regard to its non-cancer effects or its potential for human carcinogenicity.

### Manganese

Exposure to manganese results in two types of toxicities. The first, the result of acute inhalation exposure, results in manganese pneumonitis. The second, and more serious of the two, results from chronic exposure to manganese either by the oral or inhalation routes. Chronic manganese poisoning results in a psychiatric disorder characterized by psychological and motor difficulties (Goyer, 1986).

EPA (1993) has established two chronic oral RfDs for manganese:  $5\text{E-}03$  mg/kg-d for water ingestion and  $1.4\text{E-}01$  mg/kg-d for food ingestion. The chronic water RfD is based on an epidemiological study of people exposed to manganese in their drinking water. Central nervous system effects occurred at a LOAEL of  $6\text{E-}02$  mg/kg-d. An uncertainty factor of 1 was applied to the reported NOAEL of  $5\text{E-}03$  mg/kg-d to obtain the RfD. The chronic food RfD is based on three studies of dietary exposure to manganese in humans. No adverse effects were reported for dietary exposures up to  $1.6\text{E-}01$  mg/kg-d. An uncertainty factor of 1 was applied to the selected NOAEL of  $1.4\text{E-}01$  mg/kg-d in deriving the chronic food RfD. A confidence level is not reported for these RfDs. The chronic RfD for inhalation is  $1\text{E-}04$  mg/kg-d ( $4\text{E-}04$  mg/m<sup>3</sup>) (EPA, 1993) and is based upon a study of occupational exposure to inorganic manganese. An uncertainty factor of 300 and a modifying factor of 3 were applied to the LOAEL of  $3.4\text{E-}01$  mg/m<sup>3</sup> to obtain the RfD. These factors were used to account for individual sensitivity, the use of a LOAEL rather than a NOAEL, and the use of less-than-chronic exposure data. The confidence level in these RfDs is medium.

The EPA weight of evidence classification for the carcinogenicity of this constituent is "D" - not classifiable as to human carcinogenicity (EPA, 1993).

### Nickel

Nickel is a common allergen which results in allergic contact dermatitis (Goyer, 1986).

The chronic oral RfD for nickel (soluble salts) is  $2\text{E-}02$  mg/kg-d (EPA, 1993) and is based on a chronic feeding study in rats. At the LOAEL of 50 mg/kg-d, decreased body and organ weights were observed. An uncertainty factor of 300 was applied to the reported NOAEL of 5 mg/kg-d to obtain the RfD. This uncertainty factor was used to account for variability across and within species and observed inadequacies in the available reproductive studies. The

confidence level in the RfD is medium. The subchronic oral RfD is also 2E-02 mg/kg-d (EPA, 1992a). In the absence of inhalation RfDs (EPA, 1992a, 1993), the oral RfDs for nickel (soluble salts) are cross-assigned to inhalation for the purposes of this HHRA.

The EPA weight of evidence classification for carcinogenicity of nickel (refinery dust) by the inhalation route is "A" - a human carcinogen. Nickel (refinery dust) produces lung and nasal tumors and an inhalation slope factor of  $8.4E-01 \text{ (mg/kg-d)}^{-1}$  ( $2.4E-04 \text{ (mg/m}^3\text{)}^{-1}$ ) has been established (EPA, 1993). This value is based on lung tumors among sulfide nickel matte refinery workers in several countries. There is insufficient evidence for carcinogenicity of nickel (refinery dust) by the oral route.

#### Vanadium

Vanadium is an ubiquitous element. Industrial exposure to vanadium may lead to bronchitis and bronchopneumonia. Vanadium overexposure may also cause skin and eye irritation, gastrointestinal distress, nausea, vomiting, abdominal pain, cardiac palpitation, tremor, nervous depression and kidney damage (Goyer, 1986). Ingestion of vanadium constituents may produce gastrointestinal disturbances, slight abnormalities of clinical chemistry related to renal function and nervous system effects.

The chronic oral RfD for vanadium is 7E-03 mg/kg-d (EPA, 1992a) and is based on a chronic drinking water study in rats. No critical effects were observed in rats following lifetime administration of 5 ppm vanadium in drinking water (converted to 0.7 mg/kg-d). An uncertainty factor of 100 was applied to the NOAEL to obtain the RfD. The subchronic oral RfD is also 7E-03 mg/kg-d (EPA, 1992a).

Short-term inhalation exposure to high levels of vanadium has been shown to produce toxic effects in the lung, kidney, liver, adrenals and bone marrow in experimental animals (Waters, 1977). In the absence of inhalation RfDs for vanadium (EPA, 1992a, 1993), the oral RfDs are cross-assigned to inhalation in this HHRA.

EPA (1992a, 1993) has not evaluated vanadium with regard to its potential carcinogenicity in humans.

## **APPENDIX C**

**EXPOSURE DOSE EQUATIONS, INPUT VALUES, AND MODELS BY SCENARIO**

**NCBC DAVISVILLE - SITE 08**

**APPENDIX C**  
**EXPOSURE DOSE EQUATIONS, INPUT VALUES,**  
**AND MODELS BY SCENARIO**

Based on a consideration of potential current and future land uses at Site 08, the general human exposure scenarios identified in the Phase I HHRA (TRC-ECI, 1991a) are also selected for the purposes of the Phase II HHRA. These scenarios include:

Scenario 1 - Trespasser (Current)

This scenario evaluates exposure to youths currently trespassing at Site 08. Although security measures are in place at NCBC Davisville, trespassing of youths has been noted at a number of the sites (e.g., Calf Pasture Point and Allen Harbor Landfill). Therefore, trespassing exposure of youths to site constituents is included in the Site 08 HHRA. Exposures to trespassers are assumed to occur through incidental ingestion of and dermal contact with surface soil.

Scenario 2 - Commercial/Industrial Worker (Current or Future)

Exposures of current or future commercial/industrial workers are considered in this scenario. While exposure of base workers to site constituents is possible for one year until closure of the NCBC Davisville base, the potential exists for exposures to commercial/industrial employees at Site 08 in the future. Exposures to commercial/industrial workers are assumed to occur through incidental ingestion of and dermal contact with surface soil.

Scenario 3 - Construction Worker (Future)

This scenario considers future exposures of on-site construction workers. Construction workers may be exposed to site constituents during future construction of commercial or residential buildings at Site 08. This scenario is also intended to address potential outdoor worker exposures from other activities (e.g., utility work). Exposures to construction workers are assumed to occur through incidental ingestion of and dermal contact with subsurface soil, and through the inhalation of suspended subsurface soil particulates.

Scenario 4 - Resident (Future)

Exposure of future on-site residents are evaluated in this scenario. Pursuant to residential development of Site 08, adults and children living on the site may be exposed to site constituents in the future. Exposures to residents are assumed to occur through incidental ingestion of and dermal contact with surface and subsurface soil, and through the ingestion of ground water.

## EXPOSURE EQUATIONS

### SCENARIO 1: Current Use - Trespassing (Youths)

#### Dermal Contact with Constituents in Soil

Equation:

$$\text{Exposure Dose (mg/kg-d)} = \frac{\text{CS} \times \text{UC} \times \text{CR} \times \text{RAF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

CS	=	Chemical Concentration in Soil at depths of 0 to 2 feet (mg/kg)
UC	=	Unit Conversion ( $10^{-6}$ kg/mg)
CR	=	Skin Contact Rate (mg/d)
RAF	=	Relative Absorption Factor (unitless)
EF	=	Exposure Frequency (events/yr)
ED	=	Exposure Duration (yr)
BW	=	Body Weight (kg)
AT	=	Averaging Time - period over which exposure is averaged (d)

#### Specific Parameter Values:

CR	=	500 mg/d ( $0.5 \text{ mg/cm}^2 \times 2,000 \text{ cm}^2 \times .5$ )
RAF	=	Volatile Organic Compounds: 0.50
		Semi-Volatile Organic Compounds:
		PAHs 0.05
		PCBs: 0.05
		Pesticides:
		High soil sorption (DDT) 0.05
		Low soil sorption 0.50
		Inorganics: Negligible (i.e., zero)
EF	=	39 d/yr, based upon trespassing on site 1 d/wk during spring, summer and fall
ED	=	10 yr
BW	=	49.2 kg (youths 9-18 yr old)
AT	=	3,650 d for non-cancer risks
		25,550 d for cancer risks

#### ● Ingestion of Constituents in Soil

Equation:

$$\text{Exposure Dose (mg/kg-d)} = \frac{\text{CS} \times \text{UC} \times \text{IR} \times \text{RAF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

CS = Chemical Concentration in Soil (mg/kg)  
UC = Unit Conversion ( $10^{-6}$  kg/mg)  
IR = Ingestion Rate (mg soil/d)  
RAF = Relative Absorption Factor (unitless)  
EF = Exposure Frequency (d/yr)  
ED = Exposure Duration (yr)  
BW = Body Weight (kg)  
AT = Averaging Time - period over which exposure is averaged (d)

Specific Parameter Values:

IR = 100 mg/d, which is typical for this age group  
RAF = Volatile Organic Compounds: 1.0  
Semi-Volatile Organic Compounds:  
PAHs 1.0  
PCBs: 0.3  
Pesticides:  
High soil sorption (DDT) 0.3  
Low soil sorption 1.0  
Inorganics:  
Lead (Youths/Adults) 0.3  
All Others 1.0  
EF = 39 d/yr  
ED = 10 yr  
BW = 49.2 kg (youths 9-18 yr old)  
AT = 3,650 d for non-cancer risks  
25,550 d for cancer risks

SCENARIO 2: Current or Future Use - Commercial (Adults)

Dermal Contact with Constituents in Soil

Equation:

$$\text{Exposure Dose (mg/kg-d)} = \frac{\text{CS} \times \text{UC} \times \text{CR} \times \text{RAF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

CS = Chemical Concentration in Soil at depths of 0 to 2 feet (mg/kg)  
UC = Unit Conversion ( $10^{-6}$  kg/mg)  
CR = Skin Contact Rate (mg/d)  
RAF = Relative Absorption Factor (unitless)  
EF = Exposure Frequency (events/yr)

ED = Exposure Duration (yr)  
 BW = Body Weight (kg)  
 AT = Averaging Time - period over which exposure is averaged (d)

Specific Parameter Values:

CR = 500 mg/d  
 RAF = Volatile Organic Compounds: 0.50  
       Semi-Volatile Organic Compounds:  
       PAHs 0.05  
       PCBs: 0.05  
       Pesticides:  
       High soil sorption (DDT) 0.05  
       Low soil sorption 0.50  
       Inorganics: Negligible (i.e., zero)  
 EF = 250 d/yr  
 ED = 25 yr  
 BW = 70 kg  
 AT = 9,125 d for non-cancer risks  
       25,550 d for cancer risks

Ingestion of Constituents in Soil

Equation:

$$\text{Exposure Dose (mg/kg-d)} = \frac{\text{CS} \times \text{UC} \times \text{IR} \times \text{RAF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

CS = Chemical Concentration in Soil (mg/kg)  
 UC = Unit Conversion (10<sup>-6</sup> kg/mg)  
 IR = Ingestion Rate (mg soil/d)  
 RAF = Relative Absorption Factor (unitless)  
 EF = Exposure Frequency (d/yr)  
 ED = Exposure Duration (yr)  
 BW = Body Weight (kg)  
 AT = Averaging Time - period over which exposure is averaged (d)

Specific Parameter Values:

IR = 50 mg/d  
 RAF = Volatile Organic Compounds: 1.0  
       Semi-Volatile Organic Compounds:  
       PAHs 1.0  
       PCBs: 0.3

		Pesticides:	
		High soil sorption (DDT)	0.3
		Low soil sorption	1.0
		Inorganics:	
		Lead (Adults)	0.3
		All Others	1.0
EF	=	250 d/yr	
ED	=	25 yr	
BW	=	70 kg	
AT	=	9,125 d for non-cancer risks	
		25,550 d for cancer risks	

SCENARIO 3: Future Use - Construction (Adults)

Dermal Contact with Constituents in Soil

Equation:

$$\text{Exposure Dose (mg/kg-d)} = \frac{\text{CS} \times \text{UC} \times \text{CR} \times \text{RAF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

CS	=	Chemical Concentration in Soil at depths of 2 to 10 feet (mg/kg)
UC	=	Unit Conversion (10 <sup>-6</sup> kg/mg)
CR	=	Skin Contact Rate (mg/d)
RAF	=	Relative Absorption Factor (unitless)
EF	=	Exposure Frequency (events/yr)
ED	=	Exposure Duration (yr)
BW	=	Body Weight (kg)
AT	=	Averaging Time - period over which exposure is averaged (d)

Specific Parameter Values:

CR	=	1,000 mg/d	
RAF	=	Volatile Organic Compounds:	0.50
		Semi-Volatile Organic Compounds:	
		PAHs	0.05
		PCBs:	0.05
		Pesticides:	
		High soil sorption (DDT)	0.05
		Low soil sorption	0.50
		Inorganics:	Negligible (i.e., zero)
EF	=	250 d/yr	
ED	=	1 yr	
BW	=	70 kg	

AT = 365 d for non-cancer risks  
 25,550 d for cancer risks

Ingestion of Constituents in Soil

Equation:

$$\text{Exposure Dose (mg/kg-d)} = \frac{\text{CS} \times \text{UC} \times \text{IR} \times \text{RAF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

CS = Chemical Concentration in Soil (mg/kg)  
 UC = Unit Conversion (10<sup>-6</sup> kg/mg)  
 IR = Ingestion Rate (mg soil/d)  
 RAF = Relative Absorption Factor (unitless)  
 EF = Exposure Frequency (d/yr)  
 ED = Exposure Duration (yr)  
 BW = Body Weight (kg)  
 AT = Averaging Time - period over which exposure is averaged (d)

Specific Parameter Values:

IR = 480 mg/d  
 RAF = Volatile Organic Compounds: 1.0  
       Semi-Volatile Organic Compounds:  
       PAHs 1.0  
       PCBs: 0.3  
       Pesticides:  
       High soil sorption (DDT) 0.3  
       Low soil sorption 1.0  
       Inorganics:  
       Lead (Adults) 0.3  
       All Others 1.0  
 EF = 250 d/yr  
 ED = 1 yr  
 BW = 70 kg  
 AT = 365 d for non-cancer risks  
       25,550 d for cancer risks

● Inhalation of Airborne Constituents Absorbed to Dust

Equation:

$$\text{Exposure Dose (mg/kg-d)} = \frac{\text{CS} \times \text{CD} \times \text{IR} \times \text{RAF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

CS = Constituent Concentration in Soil (mg/kg)  
CD = Ambient Dust Concentration (kg/m<sup>3</sup>)  
IR = Inhalation Rate (m<sup>3</sup>/d)  
RAF = Relative Absorption Factor (unitless)  
EF = Exposure Frequency (d/yr)  
ED = Exposure Duration (yr)  
BW = Body Weight (kg)  
AT = Averaging Time - period over which exposure is averaged (d)

Specific Parameter Values:

IR = 20 m<sup>3</sup>/d for adults under moderate exertion  
RAF = 1.0 for all constituents  
EF = 250 d/yr  
ED = 1 yr  
BW = 70 kg  
AT = 365 d for non-cancer risks  
25,550 d for cancer risks

SCENARIO 4: Future Use - Residential (Children and Youths/Adults)

Dermal Contact with Constituents in Soil

Equation:

$$\text{Exposure Dose (mg/kg-d)} = \frac{\text{CS} \times \text{UC} \times \text{CR} \times \text{RAF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

CS = Chemical Concentration in Soil (mg/kg)  
UC = Unit Conversion (10<sup>-6</sup> kg/mg)  
CR = Skin Contact Rate (mg/d)  
RAF = Relative Absorption Factor (unitless)  
EF = Exposure Frequency (events/yr)  
ED = Exposure Duration (yr)  
BW = Body Weight (kg)  
AT = Averaging Time - period over which exposure is averaged (d)

Specific Parameter Values:

CR = 500 mg/d  
RAF = Volatile Organic Compounds: 0.50

		Semi-Volatile Organic Compounds:	
		PAHs	0.05
		PCBs:	0.05
		Pesticides:	
		High soil sorption (DDT)	0.05
		Low soil sorption	0.50
		Inorganics:	Negligible (i.e., zero)
EF	=	350 d/yr	
ED	=	30 yr total (24 yr as youths/adults, 6 yr as children)	
BW	=	70 kg for youths/adults, 14.5 kg for children (0-6 yr old)	
AT	=	2,190 and 25,550 d for child non-cancer and cancer risks, respectively 8,760 and 25,550 d for youth/adult non-cancer and cancer risks, respectively	

### Ingestion of Constituents in Soil

Equation:

$$\text{Exposure Dose (mg/kg-d)} = \frac{\text{CS} \times \text{UC} \times \text{IR} \times \text{RAF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

CS	=	Chemical Concentration in Soil (mg/kg)
UC	=	Unit Conversion ( $10^{-6}$ kg/mg)
IR	=	Ingestion Rate (mg soil/d)
RAF	=	Relative Absorption Factor (unitless)
EF	=	Exposure Frequency (d/yr)
ED	=	Exposure Duration (yr)
BW	=	Body Weight (kg)
AT	=	Averaging Time - period over which exposure is averaged (d)

Specific Parameter Values:

IR	=	100 mg/d for youths/adults; 200 mg/d for children (0-6 yr old)																						
RAF	=	<table> <tr> <td>Volatile Organic Compounds:</td> <td>1.0</td> </tr> <tr> <td>Semi-Volatile Organic Compounds:</td> <td></td> </tr> <tr> <td>PAHs</td> <td>1.0</td> </tr> <tr> <td>PCBs:</td> <td>0.3</td> </tr> <tr> <td>Pesticides:</td> <td></td> </tr> <tr> <td>High soil sorption (DDT)</td> <td>0.3</td> </tr> <tr> <td>Low soil sorption</td> <td>1.0</td> </tr> <tr> <td>Inorganics:</td> <td></td> </tr> <tr> <td>Lead (Children)</td> <td>0.5</td> </tr> <tr> <td>Lead (Youths/Adults)</td> <td>0.3</td> </tr> <tr> <td>All Others</td> <td>1.0</td> </tr> </table>	Volatile Organic Compounds:	1.0	Semi-Volatile Organic Compounds:		PAHs	1.0	PCBs:	0.3	Pesticides:		High soil sorption (DDT)	0.3	Low soil sorption	1.0	Inorganics:		Lead (Children)	0.5	Lead (Youths/Adults)	0.3	All Others	1.0
Volatile Organic Compounds:	1.0																							
Semi-Volatile Organic Compounds:																								
PAHs	1.0																							
PCBs:	0.3																							
Pesticides:																								
High soil sorption (DDT)	0.3																							
Low soil sorption	1.0																							
Inorganics:																								
Lead (Children)	0.5																							
Lead (Youths/Adults)	0.3																							
All Others	1.0																							

EF = 350 d/yr  
 ED = 30 yr total (24 yr as youths/adults, 6 yr as children)  
 BW = 70 kg for youths/adults, 14.5 kg for children 0-6 yr old  
 AT = 2,190 and 25,550 d for child non-cancer and cancer risks, respectively  
 8,760 and 25,550 d for youth/adult non-cancer and cancer risks, respectively

● Ingestion of Constituents in Drinking Water

Equation:

$$\text{Exposure Dose (mg/kg-d)} = \frac{\text{CW} \times \text{IR} \times \text{RAF} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

where:

CS = Chemical Concentration in Water (mg/l)  
 IR = Ingestion Rate (l/d)  
 RAF = Relative Absorption Factor (unitless)  
 EF = Exposure Frequency (d/yr)  
 ED = Exposure Duration (yr)  
 BW = Body Weight (kg)  
 AT = Averaging Time - period over which exposure is averaged (d)

Specific Parameter Values:

IR = 2.0 l/d  
 RAF = 1.0 for all constituents  
 EF = 350 d/yr  
 ED = 30 yr  
 BW = 70 kg  
 AT = 10,950 d for non-cancer risks  
 25,550 d for cancer risks

EXPOSURE POINT MODELS

Model Estimates of Fugitive Dust Generation

Emissions estimates were calculated for activities resulting in soil disturbance, such as heavy equipment operation and wind erosion, which may occur over the site during the construction scenario.

The potentially significant components of fugitive dust at this site are:

- 1) Wind erosion of dust from surfaces without vegetative cover, and

2) Dust from loading/unloading of excavated soil.

Fugitive dust from wind erosion over exposed soil and from loading/unloading activities was calculated using EPA (1988a). All model inputs are presented in Table B-1. The model is described below.

The component due to wind erosion may be calculated as:

$$E = a \cdot I \cdot K \cdot C \cdot L \cdot V \cdot A \cdot T$$

where:

E	=	Emission rate (kg/d)
a	=	Fraction of total wind losses (wind erosion of soil) that remain suspended
I	=	Soil erodibility
K	=	Soil roughness factor
C	=	Climatic factor
L	=	Field length factor
V	=	Vegetative cover factor
A	=	Area of the site
T	=	Time conversion factor

Most of these values are specified in U.S. EPA (1988a) for worst-case treatments. The climatic factor is read from a map and multiplied by 0.01 as specified. The variables "a" and "I" are determined based on site soil characteristics. The following values were used:

a	=	0.01
I	=	134 tons acre <sup>-1</sup> yr <sup>-1</sup>
K	=	1 (worst-case for flat terrain)
C	=	0.04 (based on values for the Northeast region)
L	=	0.7 (based on small reclamation area (i.e., <1,000 ft))
V	=	1 (no vegetative cover-worst case)
A	=	0.0826 acres
T	=	1 yr/365 d

The second component is due to loading/unloading of soils due to excavation activities and can be accounted for by:

$$E = \frac{k \cdot (0.0016) \cdot (U/2.2)^{1.3}}{(M/2)^{1.4}}$$

and

$$E_{cd} = V \cdot D \cdot E / T$$

where:

E	=	Emission factor due to loading/dumping (kg/Mg)
k	=	Particle size multiplier
U	=	Mean wind speed (m/s)
M	=	Soil moisture (%)
$E_{cd}$	=	Emission rate due to loading/dumping (kg/d)
V	=	Volume of soil excavated (m <sup>3</sup> )
D	=	Density of soil (Mg/m <sup>3</sup> )
T	=	Time conversion factor (days of excavation)

Using conservative assumptions and appropriate guidelines (EPA, 1988a):

k	=	0.74
U	=	4.74 m/s
M	=	5%
V	=	917.5 m <sup>3</sup>
D	=	1.5 Mg/m <sup>3</sup>
T	=	30 d

The emission rates for wind erosion and loading/dumping are presented in Table C-1. The total fugitive emissions rate (from wind activity and loading/dumping) is also presented in Table B-1.

The dust concentration on site is calculated by:

$$C_s = \frac{E}{w \cdot W \cdot H} \cdot C_f$$

where:

$C_s$	=	Dust concentration on site (kg/m <sup>3</sup> )
E	=	Total emission rate (kg/d)
w	=	Wind speed = 4.74 m/s
W	=	Width (entire site) = 18.3 m
H	=	Breathing height = 2 m
$C_f$	=	Factor for converting from days to seconds = 1.16E-05 d/s

The total fugitive dust concentration on-site is shown in Table B-1.

The concentration of a constituent and the suspended in air is estimated by a simple product of the constituent concentration in soil to fugitive dust concentration:

$$A_c = CC \cdot C_s \cdot C_f$$

where:

$A_c$	=	Concentration of suspended constituent (mg/m <sup>3</sup> )
CC	=	Constituent concentration in soil (mg/kg)
$C_s$	=	Dust concentration on site (mg/m <sup>3</sup> )
$C_f$	=	Conversion factor (kg/mg)

This equation is included in the calculation of exposure dose to construction workers from inhaled particulates in Table 14.

TABLE C-1  
 CALCULATION OF AMBIENT DUST CONCENTRATION  
 NCBC DAVISVILLE - SITE 08

WIND EROSION DUST EMISSION RATE = $a * I * K * C * L * V'$											
VEGETATIVE COVER FACTOR (V')	UNSHelterED FIELD WIDTH FACTOR (L')	CLIMATIC FACTOR (C)	SURFACE ROUGHNESS FACTOR (K)	SOIL ERODIBILITY (I) (ton/acre/year)	PORTION AS SUSPENDED PARTICULATES (a)	EMISSION FACTOR (E) (ton/acre/yr)	CONVERSION FACTOR (kg/ton)	EMISSION FACTOR (E) (kg/acre/year)	TIME CONSTANT (year/day)	AREA (acres)	WIND EROSION EMISSION RATE (kg/day)
1	0.7	0.04	1	134	0.010	3.8E-02	907.18	3.4E+01	0.0027	0.0826	7.59E-03
LOADING AND DUMPING DUST EMISSION RATE = $k * 0.0016 * (U / 2.2)^{1.3} / (M / 2)^{1.4}$											
MOISTURE CONTENT CONSTANT	MATERIAL MOISTURE CONTENT (M) (%)	WIND SPEED CONSTANT	MEAN WIND SPEED (U) (m/s)	PARTICLE SIZE CONSTANT	PARTICLE SIZE MULTIPLIER (k)	EMISSION FACTOR (E) (kg/Mg)	TIME (days)	DENSITY OF SOIL (D) (Mg/m3)	VOLUME OF SOIL EXCAVATED (m3)	LOADING AND DUMPING EMISSION RATE (kg/day)	
2	5	2.2	4.74	1.60E-03	0.74	8.9E-04	30	1.5	1019	4.54E-02	
TOTAL FUGITIVE DUST CONCENTRATION = $(E * c) / (b * w * s)$											
WIND EROSION EMISSION RATE (kg/day)	LOADING AND DUMPING EMISSION RATE (kg/day)	TOTAL EMISSION RATE (E) (kg/day)	CONVERSION FACTOR (c) (day/sec)	BREATHING HEIGHT (b) (m)	SITE WIDTH (w) (m)	WIND SPEED (s) (m/s)	TOTAL SUSPENDED DUST CONC. ON-SITE (kg/m3)				
7.59E-03	4.54E-02	5.30E-02	1.16E-05	2	18.3	4.74	3.54E-09				

**TRC**

TRC Environmental Corporation

1-800-TRC-5601

Offices in California, Colorado, Connecticut, Illinois, Louisiana, Massachusetts, New Jersey, New York, North Carolina, Texas, Utah, Washington, Washington, D.C., and Puerto Rico

A TRC Company

 Printed on Recycled Paper