March 6, 2013

United States Environmental Protection Agency
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW
Atlanta, Georgia 30303-8960

Attention: Ms. Meredith Anderson
Environmental Engineer

Re: **EPA Comments Dated February 8, 2013**
Risk Assessment Work Plan (Revision 1.1)
Walter Coke
3500 35th Avenue North
Birmingham, Jefferson County, Alabama
USEPA ID No. ALD 000 828 848
Terracon Project No. E1127152

Dear Ms. Anderson:

On behalf of Walter Coke, Inc. (Walter Coke), Terracon Consultants, Inc. (Terracon) is pleased to submit the enclosed revisions to the Risk Assessment Work Plan (Revision 1.0) for the above-referenced site. These revisions have been prepared in response to Final Comments dated 2/8/13 for the Risk Assessment Work Plan (RAWP) from the United States Environmental Protection Agency (USEPA) Region 4. The individual comments and responses are provided below:

Specific Comments

USEPA Comment No. 1

Pages 1 and 2, Section 1.0, Introduction

Please add a site layout figure showing each SMA, with the SWMUs and AOCs within each SMA, and add a complete list of SWMUs and AOCs.

Walter Coke Response No. 1

A figure (Figure 1) has been added that shows each SMA, SWMU, and AOC. In addition, a list of the SMA, SWMUs, and AOCs have been added to Section 1.0.

USEPA Comment No. 2

Pages 1 and 2, Section 1.0, Introduction

While the EPA agrees that performing a risk assessment for each SMA is an acceptable approach, each risk assessment must assess different media, chemicals, and exposure scenarios separately within each SMA, as appropriate.

Walter Coke Response No. 2

The following sentence has been added to the last paragraph of Section 1.0.

> Although a risk assessment will be performed separately for each SMA, each risk assessment will assess different media, chemicals, and exposure scenarios separately within each SMA, as appropriate.

USEPA Comment No. 3

Page 4, Section 2.1, Data Collection, Evaluation, and Selection of COPCs

The 2010 EPA ProUCL program is listed in this section. The most recent version of the EPA ProUCL program, currently Version 4.1.01, updated 7/12/11, should be used in this risk assessment (EPA, 2011b).

Walter Coke Response No. 3

The reference has been revised to reflect the most recent version of ProUCL (2011). Section 4, References, has also been revised to reflect this citation as 2011.

USEPA Comment No. 4

Page 4, Section 2.1, Data Collection, Evaluation, and Selection of COPCs

The updated EPA RSLs (dated November 2012) should be included in this section (EPA, 2012a).

Walter Coke Response No. 4

The following sentence has been added to the end of the first paragraph of Section 2.1

> In addition, the most current version of the EPA RSLs (November 2012) will be used in preparation of each risk assessment.

USEPA Comment No. 5

Page 4, Section 2.1, Data Collection, Evaluation, and Selection of COPCs

EPA does not have human health based Regional Screening Levels (RSLs) for sediment, therefore sediment data should be compared to the RSLs for industrial exposure to soil (EPA, 2000e; EPA, 2012a).

Walter Coke Response No. 5

The following sentence has been added to the end of the sixth paragraph of Section 2.1

EPA does not have human health based RSLs for sediment, therefore sediment data will be compared to the RSLs for industrial exposure to soil.

USEPA Comment No. 6

Page 6, Section 2.2.1, Current and Future Industrial/Commercial Workers

In assessing the vapor intrusion pathway, EPA guidance recommends a multiple lines of evidence approach (EPA, 2012b; EPA, 2012c) which provides the best means of evaluating the vapor intrusion pathway. Region 4 believes that sub-slab vapor and indoor air monitoring are better predictors of indoor air, relative to other data types. J&E modeling to support the conceptual site model for the facility may be conducted. However, this is not a substitute for site-specific monitoring or risk quantifications for the current and future worker. A more complete understanding of the on-site vapor intrusion risk is needed.

Walter Coke Response No. 6

The end of the third paragraph of Section 2.2.1 has been modified to read

USEPA's VISL calculator will be utilized to select COPCs for the vapor intrusion pathway and, as explained further in Section 2.2.3.2 below, risks will be quantified using the Johnson Ettinger Model as prescribed in USEPA's vapor intrusion guidance (2002b) during the risk assessment; unless the new guidance has been published or the USEPA Region 4 toxicologist/risk assessor recommends alternative guidance. The model provides very conservative results. If the model indicates there is potential for vapor intrusion, a multiple line of evidence approach will be evaluated as necessary in the CMS.

USEPA Comment No. 7

Page 6, Section 2.2.1, Current and Future Industrial/Commercial Workers

The RAWP does not justify why on-site workers were excluded from the surface water and sediment risk assessment. These receptors may be exposed to site-related constituents in surface water at SMA 1. Incidental ingestion and dermal contact with surface water are the exposure pathways of concern. This pathway may not pose as large a risk to these populations as others; however, the risk may exist. The report should quantify the risks to these populations by answering the questions about the worker exposure. Based on the chemicals known to be at this site, the risk assessment should not disregard this exposure pathway for workers. The corresponding text, figures and tables of this report, as well as the conceptual site model, should be revised.

Walter Coke Response No. 7

The following four exposure pathways were added for the current and future Industial/Commercial Workers:

- Surface water dermal contact
- Surface water ingestion
- Sediment dermal contact
- Sediment ingestion

USEPA Comment No. 8

Page 7, Section 2.2.1, Trespassers and Recreational Users

The RAWP does not justify why recreators, trespassers, and fishers were excluded from the surface water and sediment risk assessment. These receptors may be exposed to site-related constituents in surface water while wading or fishing at SMA 1. The report should quantify the risks to these populations by answering the questions about these populations habits, e.g. whether fishers wade into the water, fish from boats, launch boats, etc. Based on the chemicals known to be at this site, the risk assessment should not disregard this exposure pathway for transients, recreators, and fishers. The corresponding text, figures and tables of this report, as well as the conceptual site model, should be revised.

Walter Coke Response No. 8

The following four exposure pathways were added for the trespasser scenario:

- Surface water dermal contact

- Surface water ingestion
- Sediment dermal contact
- Sediment ingestion

In addition, a Section has been added in Section 2.2.1 for Recreational users and fishers. This section reads:

> There are no portions of the site that present the opportunity for fishing or recreational use. The site is secured and recreation and fishing in any of the water bodies on the facility is prohibited. Therefore these pathways will not be evaluated.

USEPA Comment No. 9

Page 7, Section 2.2.1, Trespassers and Recreational Users

The trespasser age range, body weight (BW) and exposure duration (ED) presented in the RAWP are inconsistent with Region 4 policy. Based on the assumed age range (7 through 16 years) for the adolescent trespasser, an ED value of 10 years (EPA, 2002a) and the BW of 45 kg (EPA, 2008) are recommended in the RME evaluation.

Walter Coke Response No. 9

Table 1 has been modified to adjust these factors to the values requested by EPA.

USEPA Comment No. 10

Page 7, Section 2.2.1, Trespassers and Recreational Users

In reference to the ingestion of fish pathway, there is no discussion about the biota that inhabit the various surface water bodies or about current or future biota harvesting in these surface water bodies. Consequently, it cannot be determined whether ingestion of fish species is a potential human exposure pathway needing evaluation during the HHRA. The document should identify biota that inhabit the creek as well as describe any current or future recreational, commercial, or subsistence harvesting of fish species. Appropriate biota sampling should be conducted during future investigations if this is a current or future human exposure pathway. Figure 1 should also reflect this potential exposure pathway.

Walter Coke Response No. 10

As described in the response to Comment 8, a Section has been added in Section 2.2.1 for Recreational Users and Fishers. This section reads

There are no portions of the site that present the opportunity for fishing or recreational use. The site is secured and recreation and fishing in any of the water bodies on the facility is prohibited. Therefore these pathways will not be evaluated. Thererfore at this time, there is no need for biota sampling.

USEPA Comment No. 11

Page 8, Section 2.2.1, Off-site Residents

The first sentence states "It is not likely that any future on-site receptors will include residents." While this may be accurate, the EPA does not concur that the onsite residential scenario should be eliminated from the assessment at this time. This pathway should be included to demonstrate that it has been considered, with a complete discussion of probable future land use scenarios, institutional controls, and notations indicating that it is low probability and potentially incomplete.

Walter Coke Response No. 11

A section for onsite residents has been added. It reads:

On-site Residents

On-site residences are not present on the site. As part of the CMS, the property will be deed restricted to commercial or industrial use only. Therefore, the on-site residential pathway will not be evaluated during this assessment.

USEPA Comment No. 12

Page 12, Section 2.2.3.2, Intake of Chemicals from Exposure to Groundwater

As in comment #6 above, in assessing the vapor intrusion pathway, EPA guidance recommends a multiple lines of evidence approach (EPA, 2012b; EPA, 2012c) which provides the best means of evaluating the vapor intrusion pathway. Region 4 believes that sub-slab vapor and indoor air monitoring are better predictors of indoor air, relative to other data types. J&E modeling to support the conceptual site model for the facility may be conducted. However, this is not a substitute for site-specific monitoring or risk quantifications for the current and future worker. A more complete understanding of the on-site vapor intrusion risk is needed.

Walter Coke Response No. 12

The bottom of the third paragraph of Section 2.2.3.2 was revised by inserting the following text:

The JE Model will be performed utilizing site-specific data, as appropriate, in combination with EPA's built-in conservative default parameters, where site-specific data are lacking. For example, the most recent groundwater and soil VOC analytical data will be utilized in model runs, along with any information obtained during the recent investigation regarding subsoil type and depth to groundwater. Where uncertainty exists, the most conservative option will be selected. Further, the risk assessment report will be clear to identify all input parameters used while performing the model. Screening of VOCs in groundwater will be performed first, to determine if VOC concentrations are present at sufficient concentrations to warrant quantification of the pathway. As described above in Section 2.1, screening will be performed using the USEPA's VISL calculator. If model output demonstrates that risks via inhalation exceed acceptable levels, a Multiple lines of evidence approach will be recommended including but not limited to a vapor intrusion study.

USEPA Comment No. 13

Page 19, Section 3.1, Characterization of the Ecological Setting

Please include SWMUs 40 and 41 in the ecological evaluation of SMA 1. SWMU should be removed from the SMA 2 list.

Walter Coke Response No. 13

These changes have been made.

USEPA Comment No. 14

Page 21, Section 3.4, Ecological Exposure Assessment

The ADD equation used should also have a component for ingested water, such as ADD_{water} . Water ingestion is not often a major contributor to ecological receptors' intakes of contaminants, but it nonetheless is a potential pathway that should be taken into account.

Walter Coke Response No. 14

The equation was revised to include ADD_{water}; however, this parameter can only be evaluated for those areas with on-site water bodies that have surface water analytical data available.

USEPA Comment No. 15

Page 21, Section 3.4, Ecological Exposure Assessment

The SPUFs, UFs and the BCFs to be used in the ERA to estimate the prey chemical concentrations should be agreed to up front, before the ERA is performed, the same as the life history parameters are being presented for review in this document. This would limit the amount of rework later if some of the uptake factors used are not agreeable to the EPA but are used to put together the draft ERA. EPA Region 4 has some of these uptake factors that are preferred, but before too much time is spent on compiling and reviewing large tables of numbers, it is advised that the COPEC list be narrowed first, if possible, so that not as much compiling or reviewing of numbers will need to be done. One preferred source for uptake factors like these is the 1999 EPA Region 6 Screening Level ERA Protocol document.

Walter Coke Response No. 15

It is recommended that once COPECs have been selected, Walter Coke will develop an interim deliverable for EPA which will include the COPEC list, along with all uptake factors and bioconcentration factors for each chemical. This will allow EPA to review and approve, or make recommendations, as appropriate, prior to quantifying ecological HQs.

The WP was revised to include the following text as the last paragraph of Section 3.4:

> Review of the scientific literature and regulatory guidance will be performed to develop a list of pertinent BCFs and SPUFs for all COPECs to be evaluated in the ERA. An interim deliverable will be prepared and submitted to EPA that includes the COPECs and all uptake factors and bioconcentration factors proposed for use in the ERA. Quantification of ecological hazard quotients will not be performed until concurrence is obtained from EPA on these parameters. Uptake factors and bioconcentration factors will be presented in tables of the risk assessment and their sources will be properly cited.

USEPA Comment No. 16

Page 22, Section 3.5, Ecological Effects Assessment

The TRVs presented in the EPA comments to the “Addendum: Phase 3 RFI Response to EPA Review Comments” document should be used in this ERA effort.

Walter Coke Response No. 16

The following text was inserted as the last sentence of the last paragraph of Section 3.5:

The ERA will only use EPA-approved TRVs, including those provided in EPA's "Addendum: Phase 3 RFI Response to EPA Review Comments"

USEPA Comment No. 17

Table 1, Summary of Human Exposure Assumptions

The particulate emission factor (PEF) for all receptors should be changed from 1.36E+09 m^3/kg to 5.7E+09 m^3/kg for the Atlanta region (climate zone VI) (EPA, 2002a).

Walter Coke Response No. 17

The PEF was revised to 5.7E+09 m^3/kg.

USEPA Comment No. 18

Table 1, Summary of Human Exposure Assumptions

The skin surface area available for contact (SSA) for the trespasser should be changed from 4,600 cm^2 to 5,900 cm^2 (EPA, 2004b), which assumes that the head, hands, forearms, lower legs, and feet are exposed.

Walter Coke Response No. 18

The SSA for the adolescent trespasser was revised to 5,900 cm^2 .

USEPA Comment No. 19

Table 1, Summary of Human Exposure Assumptions

The soil-to-skin adherence factor (AF) value should be changed from 0.4 mg/cm^2 to 0.2 mg/cm^2 (EPA, 2004b), which corresponds to the geometric mean value for the utility worker/heavy equipment operator (EPA, 2004b).

Walter Coke Response No. 19

The AFs for all receptors were revised to 0.2 mg/cm^2.

USEPA Comment No. 20

Table 2, Ecological Receptor's Life History Parameters

EPA requests the following values to be used in the ERA for this site:

EPA preferred Life History (Exposure) Parameters for the Walter Coke site.

Receptor	Body wt, kg	FIR, kg dw/day	WIR, L/day	Home range, ha	% plant	% animal	SIR, decimal % of FIR
Bobwhite	0.14	**0.22**	**0.02**	**8**	**100**	0	**0.093**
Meadow vole	**0.03**	**0.0095**	**0.003**	0.083	**100**	0	0.02
Mallard	**1.134**	**0.117**	0.085	**111**	**100**	0	**0.11**
Muskrat	1.221	**0.11**	**0.12**	0.17	**100**	0	0.02
Robin	0.082	**0.037**	0.0115	**0.16**	**50**	**50**	**0.05**
Red fox	4.6	0.177	0.4115	96	**10.4**	**89.6**	0.028
Woodcock	0.176	**0.061**	**0.018**	10.5	**15.7**	**84.3**	0.104
Shrew	0.013	0.0033	0.0048	0.39	0.13	0.87	0.06
Sandpiper	0.0471	**0.082**	**0.0071**	0.25	0	100	**0.104**
Kestrel	0.12	0.0119	0.0144	154	0	100	**0.01**
Mink	0.726	0.0717	0.062	**8**	0	100	**0.02**
Green Heron	0.158	0.0273	0.0227	**15**	**0**	**100**	**0.02**
Otter	6.73	**0.33**	0.80	295	0	100	**0.094**

Notes on the Table above: The **bolded** values in the Table are different than those in the Terracon report. Most of the changed values come from information in the EPA Wildlife Exposure Factors Handbook. One exception is the SIR for the mallard, which is an average value from the latest Beyer et al. paper: Beyer, W., M. Perry and P. Osenton. 2008. Sediment ingestion rates in waterfowl and their use in environmental risk assessment. Integrated Assessment and Management 4(2):246-251. For the woodcock, it appeared that the values suggested by Terracon/Walter Coke were likely kg dry food/kg BW-day. If they truly were kg dry food/day, then they seemed really high, however Terracon/Walter Coke may use the higher values if they so desire.

Walter Coke Response No. 20

Table 2 has been revised to include the EPA-recommended life history values as presented in the table above.

USEPA Comment No. 21

Figure 2, Preliminary Ecological Conceptual Site Model

For the Primary Release Mechanisms, wastewater should be included as a contaminant release mechanism, as the wastewater processing system makes up some of the exposure area. For the Secondary Source portion of the CSM, direct releases to surface water, such as through the treated wastewater, should also be included.

Walter Coke Response No. 21

Figures 2 and 3 have both been revised to include “treated wastewater effluent” as a component under Historical Source Operations.

USEPA Comment No. 22

Figure 2, Preliminary Ecological Conceptual Site Model

For the herbivorous aquatic bird and mammal receptor category, the insectivorous aquatic bird receptor category, and the piscivorous aquatic bird and mammal receptor category, incidental sediment ingestion should be quantitatively included in the potential exposure/uptake pathways, like incidental soil ingestion is.

Walter Coke Response No. 22

Table 2, ecological life history parameters have been revised as recommended in Comment 20, including revisions to some of the soil intake values. Hence, for any aquatic receptor that will ingest sediment, rather than soil, the soil intake values as presented in Table 2 will be used to quantify chemical intake. For added clarity, the work plan will be revised to include the following sentence as the last sentence of the first paragraph of Section 3.4: As published sediment values are not generally available for aquatic receptors, the soil intake values will be utilized instead, as presented in Table 2.

USEPA Comment No. 23

Figure 2, Preliminary Ecological Conceptual Site Model

Under the Piscivorous Aquatic Bird/Mammal heading, the green heron should be listed instead of the belted kingfisher, as indicated on page 20.

Walter Coke Response No. 23

Figure 3 has been revised to replace the belted kingfisher with the Green Heron.

CLOSING

If you should have any questions, please do not hesitate to contact us at (205) 942-1289.

Sincerely,
Terracon Consultants, Inc.

Terrell W. Rippstein, PG#8
Principal Geologist

Cc: Mr. Don Wiggins – Walter Coke
Mr. Dan Grucza – Walter Energy
ADEM

RISK ASSESSMENT WORK PLAN
(Revision 1.1)

Walter Coke
3500 35th Avenue North
Birmingham, Alabama
US EPA ID No. ALD 000 828 848

March 6, 2013
Terracon Project No. E1127152

Prepared for:
Walter Coke
Birmingham, Alabama

Prepared by:
Terracon Consultants, Inc.
Birmingham, Alabama

March 6, 2013

Walter Coke
3500 35th Avenue North
Birmingham, Alabama 35207

Attention: Mr. Don Wiggins

Re: **Risk Assessment Work Plan (Revision 1.1)**
Walter Coke
3500 35th Avenue North
Birmingham, Alabama 35207
US EPA ID No. ALD 000 828 848
Terracon Project No. E1127152

Dear Mr. Wiggins:

Terracon Consultants, Inc. (Terracon) is pleased to submit this Risk Assessment Work Plan (Revision 1.0) for activities in conjunction with the site referenced above. The Risk Assessment Work Plan presents a summary of the process by which we will calculate clean-up levels for Constituents of Concern (COCs) in the Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) as part of the Corrective Measures Studies being performed for the five SMAs.

Should you have any questions or require additional information, please do not hesitate to contact our office.

Sincerely,
Terracon Consultants, Inc.

Lisa Sharman for

Robin R. Rodriguez, PhD
Risk Assessor

TERRELL W. RIPPSTEIN
ALABAMA LICENSED PROFESSIONAL GEOLOGIST
LIC: 0008

Terrell W. Rippstein, PG #8
Principal Geologist

Terracon Consultants, Inc. 110 12th Street North Birmingham, Alabama 35203
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TABLE OF CONTENTS

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

ADAF	Age-dependent adjustment factor
ADD	Average daily dose
AF	Adherence factor
ABS_d	Absorption fraction, dermal
A_R	Surface area of contaminated road segment
AOC	Area of concern
AT	Averaging time
BCF	Bioconcentration factor
BTF	Biological treatment facility
BW	Body weight
CA	Chemical concentration in air
CF	Conversion factor
COC	Chemical of concern
COPC	Chemical of potential concern
COPEC	Chemical of potential ecological concern
CS	Chemical concentration in soil
Cshw	Chemical concentration remaining in shower water
CSM	Conceptual site model
CW	Chemical concentration in groundwater
DA_{event}	Absorbed dose per event
DAD	Dermal absorbed dose
DC	Dietary composition
DI	Daily intake
EC	Exposure concentration
Eco SSLs	Ecological soil screening levels
ED	Exposure duration
EF	Exposure frequency
ELCR	Excess lifetime cancer risk
ERA	Ecological risk assessment
ERAGS	*Ecological Risk Assessment Guidance for Superfund*
ET	Exposure time
EPC	Exposure point concentration
ERA	Ecological risk assessment
EV	Event frequency
FA	Fraction of chemical absorbed
FCP	Former chemical plant
F_D	Dispersion correction factor
FI	Fraction ingested
F_W	Flow rate, water
HHRA	Human health risk assessment
HI	Hazard index

ACRONYMS AND ABBREVIATIONS (continued)

HQ	Hazard quotient
IR	Ingestion rate
IRIS	Integrated Risk Information System
IUR	Inhalation unit risk
Kp	Dermal permeability coefficient in water
LDA	Land disposal area
LOAEL	Lowest observed adverse effects level
MCL	Maximum contaminant level
NCEA	National Center for Environmental Exposure
NIR	Normalized ingestion rate
NOAEL	No observed adverse effects level
NRWQC	National Recommended Water Quality Criteria
ORD	Office of Research and Development
ORNL	Oak Ridge National Laboratory
PEF	Particle emission factor
PIF	Former pig iron foundry
PPRTV	Provisional Peer Reviewed Toxicity Value
PRG	Preliminary remediation goal
RAGS	*Risk Assessment Guidance for Superfund*
RCRA	Resource Conservation and Recovery Act
RfC	Reference concentration
RfD	Reference dose
RFI	RCRA Facility Investigation
RSL	Regional Screening Levels
SA	Skin surface area
SF	Slope factor
SMA	Solid management area
SPUF	Soil-to-plant uptake factor
SSL	Soil screening level
SWMU	Solid waste management unit
T	Total time
TRV	Toxicity reference value
UCL	Upper confidence limit
UF	Uptake factor
USEPA	United States Environmental Protection Agency
Va	Volume, bathroom
VDEQ	Virginia State Department of Environmental Quality
VF	Volatility factor
VISL	Vapor intrusion screening calculator

RISK ASSESSMENT WORK PLAN (REVISION 1.1)
WALTER COKE
3500 35th AVENUE NORTH
BIRMINGHAM, ALABAMA

Project No. E1127152
March 6, 2013

1.0 INTRODUCTION

This document presents a summary of the approach and methodology proposed for the development of Baseline Human Health Risk Assessments (HHRAs) and Ecological Risk Assessments (ERAs) for the Walter Coke Facility (the Site) located at 3500 35th Avenue North in Birmingham, Jefferson County, Alabama, a currently active industrial facility. Activities conducted at the Site have included: coke manufacturing, chemical manufacturing (toluene sulfonyl acid and sulfones), pig iron production in iron blast furnaces, mineral fiber production, biological treatment of plant wastewater. Previous investigations have been conducted to characterize the nature and extent of contamination at the Site, including Resource Conservation and Recovery Act (RCRA) Facility Investigations (Arcadis and CH2M Hill, 2009). The objective of the proposed HHRAs and ERAs is to analyze the potential adverse effects on humans and the environment that may result, either now or in the future, from the presence of hazardous chemicals at the Site or released from the Site, in the absence of remediation.

The Site occupies approximately 400 acres in Jefferson County, Alabama. The land around the Site is zoned for industrial and residential use. The future land use for the Walter Coke Facility is industrial.

The Site has been subdivided into five Solid Waste Management Areas (SMAs) 1 through 5. SMAs have been designated to organize the site by industrial operation, as follows:

- SMA 1 – Biological Treatment Facility (BTF) Process Areas and Sewers
- SMA 2 – Land Disposal Area (LDA)
- SMA 3 – Coke Manufacturing Plant
- SMA 4 – Former Chemical Plant (FCP)
- SMA 5 – Former Pig Iron Foundry (PIF)

Each of the SMAs has been segregated further into Solid Waste Management Units (SWMUs) or Areas of Concern (AOCs); there are a total of 45 SWMUs and six AOCs at the Walter Coke Facility. The SMAs, SWMUs, and AOCs are shown on Figure 1, and listed below.

SMA	SWMUs and AOCs
BTF PROCESS AREA & SEWERS – SMA 1	SWMU #13 (Equalization Basin) SWMU #14 (pH Neutralization Basin) SWMU #15 (Primary Clarifier) SWMU #16 (Aeration Basin) SWMU #17 (Secondary Clarifier) SWMU #18 (Thickener) SWMU #19 (Digester) SWMU #20 (Dewatering Machine) SWMU #21 (Former Emergency Basin) SWMU #22 (Polishing Pond) SWMU #40 (Historic Drainage Ditch) SWMU #41 (Former Impoundment) AOC A (Pipe Outfall into Ditch next to BTF Area) AOC F (BTF Groundwater Plume)
Land Disposal Area (LDA) – SMA 2	SWMU #4 (BTF Sewer) SWMU #23 (Biological Sludge Disposal Area) SWMU #24 (Blast Furnace Emission Control Sludge Piles A and B) SWMU #25 (Stormwater Ditch) SWMU #38 (Construction Debris Landfill) SWMU #39 (Blast Furnace Emission Control Waste Pile)
Coke Manufacturing Plant (CMP) – SMA 3	SWMU #1 (Quench Towers and Sumps) SWMU #2 (Quench Tower Pump Basins) SWMU #3 (Old Quench Tower Settling Basins) SWMU #5 (Coal Tar Storage Drainage System) SWMU #6 (Spill Area Diesel Tank) SWMU #7 (Coal Tar Collection Sump) SWMU #8 (Flushing Liquor Decanter) SWMU #9 (Flushing Liquor Decanter Sump) SWMU #10 (Coal tar Decanter) SWMU #11(Coal tar Decanter) SWMU #12 (Coal tar Decanter) SWMU #37 (BTF Sewer Tar Trap) AOC E (Coke Plant Groundwater Plume)
Former Chemical Plant (FCP) – SMA 4	SWMU #26 (Main Building) SWMU #27 (Floor Drain System) SWMU #28 (Sulfonation Floor Drain) SWMU #29 (Product Tank Containment Area) SWMU #30 (Centrifuge Waste Water Tank) SWMU #31 (Monohydrate Floor Drain and Sump) SWMU #32 (Drum Storage Area) SWMU #33 (Plant Drum Storage Area) SWMU #34 (Wastewater Neutralization System) SWMU #35 (Mineral Wool Waste Piles) SWMU #36 (Used Oil Tank) SWMU #42 (Former Aboveground Storage tanks [ASTs]) AOC B (Drainage Ditch next to Shuttlesworth Drive and 35th Ave) AOC D (Former Chemical Plant [FCP] Groundwater Plume)
Former Pig Iron Foundry (PIF) – SMA 5	SWMU #43 (Pig Machine Slurry Pits) SWMU #44 (Blast Furnace Ash Boiler Pit) SWMU #45 (Slag Drying Beds) AOC C (Former Pig Iron Foundry)

It is proposed that an HHRA be performed separately for each SMA as the individual exposure units (for a total of five HHRAs), primarily for two reasons: 1) the nature of chemical contamination at one SMA will vary from another, given the industrial operations being performed and 2) the exposure patterns for a given receptor (e.g., the industrial worker) are such that the individual is more likely to be assigned to work in just one SMA, rather than working facility-wide. This receptor is also likely to visit multiple SWMUs within one SMA. If HHRAs were developed for each SWMU, the assumption would be that the receptor spent 100% of his working day at that one SWMU, which is not realistic given the normal working patterns at the Walter Coke Facility. This suggested approach is deemed to be sufficiently conservative for protectiveness of the receptors at the Walter Coke Facility. Although a risk assessment will be performed separately for each SMA, each risk assessment will assess different media, chemicals, and exposure scenarios separately within each SMA, as appropriate.

2.0 HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

The overall risk assessment approach for the proposed HHRAs follows the US Environmental Protection Agency's (USEPA's) standard, four-step human health risk assessment paradigm, including: Hazard Identification, Exposure Assessment, Toxicity Assessment, and Risk Characterization. These steps will be performed according to methodology and procedures published by USEPA in various guidance documents and databases, including (but not limited to):

- USEPA's *Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A).* (1989)
- USEPA's *RAGS Part E, Supplemental Guidance for Dermal Risk Assessment (*2004)
- USEPA's *RAGS Part F, Supplemental Guidance for Inhalation Risk Assessment (*2009)
- USEPA's *RAGS Part B, Development of Risk-Based Preliminary Remediation Goals* (1991)
- USEPA's *Exposure Factors Handbook* (1997a, 2011)
- USEPA's *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (2002a)
- USEPA's *Regional Screening Levels (RSLs)* (currently November 2012)
- USEPA's Vapor Intrusion Screening Level Calculator (2012b)
- USEPA's on-line toxicity database, *Integrated Risk Information System (IRIS)* (2012c)
- USEPA's *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (2002b)
- USEPA's *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposures to Carcinogens* (2005)

Specific subtasks to be performed for this HHRA include:

- Data Collection, Evaluation, and Selection of Chemicals of Potential Concern
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Analysis
- Derivation of Preliminary Remediation Goals

Descriptions presented below summarize procedures and methodologies proposed to accomplish each of the subtasks listed above.

2.1 Data Collection, Evaluation, and Selection of Chemicals of Potential Concern

Previously collected data presented to the EPA in the Phase III RCRA Facility Investigation Report dated March 2009, prepared by Arcadis and CH2MHill, were validated prior to this submittal. Therefore, we will assume the analytical results for surface soil, subsurface soil, groundwater, surface water, and sediment presented in this report are valid as these are the media to be evaluated for this risk assessment. In addition, the most current version of the EPA RSLs (November 2012) will be used in preparation of each risk assessment.

Chemical data will be summarized and tabulated to show pertinent sample statistics for each medium, including: the data population distribution type; the minimum, maximum, and mean concentrations; the appropriate upper confidence limit (UCL) about the mean; and frequency of detection. The USEPA software ProUCL version 4.1.01 (USEPA, 2011) will be utilized to determine the chemical data distributions and UCLs. Censored data (reported at concentrations below detection limits) will be evaluated as described in ProUCL.

Chemicals of potential concern (COPCs) are chemicals retained for quantitative evaluation as they may present health threats to receptors. COPCs will be selected using the screening criteria as described in RAGS Part A (USEPA, 1989) for all chemicals detected at least once. USEPA industrial level RSLs criteria will be used to screen for COPCs by comparing the maximum detected chemical concentrations to the most conservative of either the cancer effects RSL, or 1/10th the noncancer effects RSL, whichever is less. An adjustment is typically made to the noncancer effects RSL to divide the value by 10 to account for the exposure to multiple chemicals. This screening approach ensures that a conservative approach to COPC selection has been performed.

In addition to RSLs based on protectiveness of human health, soil screening levels (SSLs) that describe the potential for chemicals in soil to leach to groundwater will also be utilized, as appropriate. Site-specific SSLs for the protection of groundwater have been calculated, based on site-specific components, and are found in Appendix G of Phase III RCRA Facility Investigation (RFI) Report (Arcadis and CH2M Hill, 2009). If a chemical's SSL is lower than its cancer or non-cancer RSL, it will be used as the screening value for COPC selection.

To develop a list of COPCs for chemicals to be evaluated for the vapor intrusion pathway, the USEPA's Vapor Intrusion Screening Level (VISL) calculator will be used (USEPA, 2012b).

To develop a list of COPCs for chemicals to be evaluated for human health effects from exposure to surface water and sediment, the National Recommended Water Quality Criteria (NRWQC) for Human health [(consumption of water and organisms) EPA, 2012d], will be used. For chemicals without screening levels in the NRWQC, RSLs for tapwater (USEPA, 2012a) will be used. EPA does not have human health based RSLs for sediment; therefore, sediment data will be compared to the RSLs for industrial exposure to soil.

To develop a list of COPCs for chemicals to be evaluated for human health effects from ingestion of groundwater, the EPA RSLs for tapwater (USEPA, 2012a) will be used. For those chemicals without values designated as tapwater RSLs, National Primary Drinking Water Regulations Maximum Contaminant Levels (MCLs) (USEPA, 2012d) will be used.

Tables will be prepared for the HHRA which will include all chemical data statistical parameters, as well as the reason a chemical is either retained or excluded as a COPC.

2.2 Exposure Assessment

The objectives of the exposure assessment are to characterize potentially exposed human receptors at the Site, to identify actual or potential exposure pathways, and to quantify the potential exposure. Thus, the exposure assessment involves several elements, including:

- Identification of the potential receptors/exposure scenarios (as shown in the Conceptual Site Model [CSM])
- Identification of exposure routes (also in the CSM)
- Quantification of exposure point concentrations (EPCs)
- Identification of the exposure models and assumptions used to calculate daily intakes or doses

2.2.1 Receptors and Pathways to be Evaluated

The HHRAs will focus on those receptors that are likely to be exposed to Site media. This approach ensures that potential risks will be characterized and that all potential receptors will be adequately protected. Figure 1 presents the CSM for the Walter Coke Facility, which depicts the path a contaminant follows from its release in the environment to intake by the receptor. The results of the CSM indicate which exposure pathways are complete and will be quantitatively evaluated, as discussed further below.

Current and Future Industrial/Commercial Workers

Current and future industrial/commercial workers are assumed to be adult, full-time workers who may be exposed to contaminants in surface soil (0 - 1 ft). Exposure may be through ingestion, dermal absorption, or inhalation of dust particles. Given the nature of organic contaminants in soil, these workers may also be exposed to volatiles in ambient air. For SMAs which have surface water bodies, industrial/commercial works may be exposed to surface water and sediment via ingestion and dermal absorption. Groundwater is not currently used at the facility for any potable purpose, nor is it anticipated being used in the future. An ordinance has been passed by the City of Birmingham prohibiting groundwater use for potable purposes. However, in the event groundwater may be available for use sometime in the future, the industrial/commercial worker will be evaluated for hypothetical groundwater ingestion, dermal absorption, and for the inhalation of volatiles while showering.

Because some portions of the site are underlain by volatile organic contaminants in groundwater, there may be a potential for the vapor intrusion pathway to be complete. If this is the case, workers may be exposed to volatiles via the inhalation pathway while working indoors. For those portions of the site with volatile organic chemicals (VOCs) measured within 100 ft of the building footprint, vapor intrusion will be evaluated. Currently, USEPA is re-evaluating their recommended vapor intrusion guidance. USEPA's VISL calculator will be utilized to select COPCs for the vapor intrusion pathway and, as explained further in Section 2.2.3.2 below, risks will be quantified using the Johnson Ettinger Model as prescribed in USEPA's vapor intrusion guidance (2002b) during the risk assessment; unless the new guidance has been published or the USEPA Region 4 toxicologist/risk assessor recommends alternative guidance. The model provides very conservative results. If the model indicates there is potential for vapor intrusion, a multiple line of evidence approach will be evaluated as necessary in the CMS.

To summarize, the following pathways will be evaluated for current and future industrial workers:

- Soil ingestion (0 – 1 ft depth, for all soil pathways)
- Soil dermal contact
- Inhalation of soil particles
- Inhalation of VOCs in ambient air
- Inhalation of VOCs inside buildings (where the vapor intrusion pathway is complete)
- Groundwater ingestion
- Groundwater dermal contact
- Inhalation of VOCs while showering (with groundwater)
- Surface water dermal contact
- Surface water ingestion
- Sediment dermal contact
- Sediment ingestion

Industrial/commercial workers are assumed to be long-term employees who work at the facility 40 hours/week, 250 days/year, for a duration of 25 years.

Based on work descriptions, the only Walter Coke employees that work in the vicinity of the surface water or sediment is the person in charge of collecting the effluent discharge samples

Future Construction Workers

Construction activities may occur on-site, allowing a construction worker to be exposed to site contaminants. Construction workers may be exposed to chemicals in soil from the soil surface to the depth of a typical building excavation (e.g., 0 to 10 - 15 ft depth). Construction workers may also be exposed to soil chemicals via dermal absorption or by the inhalation of contaminated dust or VOCs in ambient air.

While construction workers are not likely to be exposed to groundwater for potable purposes, they may be exposed during trenching if groundwater is encountered. For those areas where groundwater may be shallow enough to be encountered, construction workers will be evaluated for their exposure to groundwater via incidental ingestion, dermal absorption, and for the inhalation of VOCs that may collect in the trench. The State of Virginia Department of Environmental Quality (VDEQ) provides a model on their web site to derive the VOC concentration in air that will be used to evaluate the inhalation pathway in a trench (VDEQ, 2010).

Construction workers are not assumed to be employees of the facility. Instead, these are assumed to be workers that only visit the site for a project. In this case, the construction project is assumed to have a duration of one year and the construction worker works 40 hours/week.

To summarize, the following pathways will be evaluated for future construction workers:

- Soil ingestion (0 – 15 ft depth, for all soil pathways)
- Soil dermal contact
- Inhalation of soil particles
- Inhalation of VOCs in ambient air
- Groundwater dermal contact
- Inhalation of VOCs from groundwater while trenching

Trespassers

Walter Coke is a secure facility and has only had one experience of trespassing reported in the last 10 years. However, as there may be an opportunity in the future for a trespasser to visit the Site, this receptor will be evaluated in the risk assessment. The adolescent trespasser is assumed to be a teenager from 7-16 years old. It is assumed that the trespasser makes it onto the Site once a month, for one hour each visit, every year between ages 7 and 16. Trespassers may be exposed to surface soil, and for those SMAs with surface water bodies, they may also be exposed to surface water and sediment.

To summarize, the following pathways will be evaluated for future trespassers:

- Soil ingestion (0 – 1 ft depth, for all soil pathways)
- Soil dermal contact
- Inhalation of soil particles
- Inhalation of volatile organic chemicals in ambient air
- Surface water dermal contact
- Surface water ingestion
- Sediment dermal contact
- Sediment ingestion

<u>Recreational Users and Fishers</u>

There are no portions of the site that present the opportunity for fishing or recreational use. The site is secured and recreation and fishing in any of the water bodies on the facility is prohibited. Therefore these pathways will not be evaluated.

<u>On-site Residents</u>

On-site residences are not present on the site. As part of the CMS, the property will be deed restricted to commercial or industrial use only. Therefore, the on-site residential pathway will not be evaluated during this assessment.

<u>Off-site Residents</u>

In one area of the Site, a small portion of a groundwater plume has crossed the Site boundary. USEPA has previously approved a Vapor Intrusion Work Plan at this facility to investigate this area further, with respect to the need to consider an evaluation of the vapor intrusion pathway. In the event the investigation in this area determines that the vapor intrusion pathway is complete, it will be evaluated in the same manner as described for the industrial/commercial worker.

Exposure parameters and exposure frequencies and durations for the receptors and pathways to be evaluated in the HHRAs are presented in Table 1.

2.2.2 Exposure Point Concentrations

An exposure point is a location where a receptor is reasonably assumed to move at random, throughout the duration of exposure, and where contact with an environmental medium is equally likely at all sub-locations. The chemical concentration developed to represent that exposure is termed the exposure point concentration (EPC). Because of the randomness assumed for exposure, an EPC is derived as an estimate of the true arithmetic mean concentration of a chemical in a medium at an exposure point. However, because the true arithmetic mean concentration cannot be calculated with certainty from a limited number of measurements, USEPA recommends that the 95th percentile upper confidence limit (UCL) of the arithmetic mean at each exposure point be used when calculating exposure and risk at that location (USEPA, 1992). Further, if the 95% UCL exceeds the highest detected concentration, the highest detected value is used instead (USEPA, 1989).

USEPA has developed statistical software to aid the development of EPCs for chemically contaminated site. This software, ProUCL version 4.1.00 (USEPA, 2010), was described above in Section 2.1, and will be utilized to develop EPCs for each environmental media (i.e., soil, surface water, sediment, and groundwater) in each exposure unit (i.e., SMA). For the special case of soil, chemical data will be segregated between surface soil and soils of all depths, that are consistent with the receptors' likely exposure patterns (e.g., surface soil for industrial/commercial workers, soils of all depths for construction workers).

Once the EPCs have been calculated for each media in each exposure unit, a receptors chemical intake can be calculated, as described below.

2.2.3 Estimating Chemical Intake

Methodology proposed to estimate chemical intake from the various exposure pathways is described further below.

2.2.3.1 Intake of Chemicals from Exposure to Soil

Ingestion

Average daily chemical intake for the incidental ingestion of soil will be calculated by use of the following formula (USEPA, 1989):

$$DI_{Ingestion} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

where:

- $DI_{Soil\text{-}Ing}$ = average daily chemical intake via soil ingestion (mg/kg-day)
- CS = chemical concentration in soil (mg/kg)
- IR = ingestion rate (mg soil/day)
- CF = conversion factor (10^{-6} kg/mg)
- FI = fraction ingested from contaminated source (unitless)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time (period over which exposure is averaged, days)

Inhalation

For the purposes of evaluating a receptor's exposure to chemicals in ambient air, as either volatiles or adsorbed to dust particles, the development of the exposure concentration (EC) in air, as recommended by USEPA's *RAGS Part F, Guidance for Inhalation Risk Assessment* (USEPA, 2009), must be performed. The EC is calculated by modeling the contaminant concentrations (CA) in air first, following the methodology presented in USEPA's *Soil Screening Guidance* (USEPA, 2002a). EC will be determined by using the following equation:

$$EC = \frac{CA \times ET \times EF \times ED}{AT}$$

where:

EC = exposure concentration ($\mu g/m^3$)
CA = chemical concentration in air ($\mu g/m^3$)
ET = exposure time (hours/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
AT = averaging time (period over which exposure is averaged, days)

The chemical concentration in air (CA) term will be calculated as follows:

$$CA = CS \times [(1 / PEF) + (1 / VF)]$$

where:

PEF = Particle emission factor (m^3/kg); 1.36E+09 m^3/kg (default value) (USEPA, 2002a)
VF = Volatilization factor (m^3/kg).

For the purposes of calculating chemical concentrations in air, USEPA's default PEF value of 1.36×10^9 m^3/kg will be used industrial/commercial workers, trespassers, and recreational users (USEPA, 2002a). The PEF for construction workers will be calculated separately to estimate inhalation risks associated with site-wide soil exposure associated with a quarter-acre grid. The construction worker PEFs are a sub-chronic PEFs and are calculated using the following equation (USEPA, 2002a):

$$PEF = Q/C_{sr} \times 1/F_D \times [T \times A_R \ / \ (556 \times (W/3)^{0.4} \times ((365-p) / 365) \times \sum VKT)]$$

where:

Q/C_{sr} = inverse ratio of 1-h geometric mean air concentration to the emission flux along a straight road segment bisecting a square site (23.02 g/m^2-s per kg/m^3)
F_D = dispersion correction factor (unitless, 0.185)
T = total time over which construction occurs (s)
A_R = surface area of contaminated road segment (274.213 m^2)

W = mean vehicle weight (tons)
p = number of days with at least 0.01 inches of precipitation (days/year)
$\sum$VKT = sum of fleet vehicle kilometers traveled during the exposure duration (km)

Dermal Absorption

Average daily chemical intake for dermal absorption of chemicals in soil will be calculated by use of the following formula (USEPA, 2004):

$$DAD = \frac{DA_{event} \times EF \times ED \times EV \times SA}{BW \times AT}$$

where:

DAD = dermal absorbed dose (mg/kg-day)
DA_{event} = absorbed dose per event (mg/cm^2-event)
EF = exposure frequency (days/year)
ED = exposure duration (years)
EV = event frequency (events/day)
SA = skin surface area available for contact (cm^2)
BW = body weight (kg)
AT = averaging time (period over which exposure is averaged, days)

The DA_{event} term is calculated by the following formula (USEPA, 2004):

$$DA_{event} = CS \times CF \times AF \times ABS_d$$

where:

DA_{event} = absorbed dose per event (mg/cm^2-event)
CS = chemical concentration in soil (mg/kg)
CF = conversion factor (10^{-6}kg/mg)
AF = adherence factor of soil to skin (mg/cm^2-event)
ABS_d = dermal absorption fraction

2.2.3.2 Intake of Chemicals from Exposure to Groundwater

Ingestion

Average daily chemical intake for the ingestion of groundwater as drinking water will be calculated by use of the following formula (USEPA, 1989):

$$DIIngestion = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

where:

- $DI_{GW\text{-}Ing}$ = average daily chemical intake via groundwater ingestion (mg/L-day)
- CW = chemical concentration in groundwater (mg/L)
- IR = intake rate (L/day)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time (period over which exposure is averaged, days)

<u>Inhalation</u>

The inhalation pathways involving contaminated groundwater are primarily those that are affected by the phase change of dissolved VOCs in groundwater to vapors in air. These pathways include inhalation of vapors inside buildings from vapor intrusion, inhalation of vapors in trenches for construction workers who encounter contaminated groundwater, and individuals who may be exposed to VOCs while showering.

Currently, the USEPA is re-evaluating the methodology to evaluate the vapor intrusion pathway. It is estimated that new guidance may be available before the end of this year. Inhalation of VOCs while indoors, via the vapor intrusion pathway, will be evaluated for off-site residents (if necessary) and on-site industrial/commercial workers by using the Johnson Ettinger Model as prescribed in USEPA's vapor intrusion guidance (2002b); unless the new guidance has been published or the USEPA Region 4 toxicologist/risk assessor recommends alternative guidance. The JE Model will be performed utilizing site-specific data, as appropriate, in combination with EPA's built-in conservative default parameters, where site-specific data are lacking. For example, the most recent groundwater and soil VOC analytical data will be utilized in model runs, along with any information obtained during the recent investigation regarding subsoil type and depth to groundwater. Where uncertainty exists, the most conservative option will be selected. Further, the risk assessment report will be clear to identify all input parameters used while performing the model. Screening of VOCs in groundwater will be performed first, to determine if VOC concentrations are present at sufficient concentrations to warrant quantification of the pathway. As described above in Section 2.1, screening will be performed using the USEPA's VISL calculator. If model output demonstrates that risks via inhalation exceed acceptable levels, a Multiple lines of evidence approach will be recommended including but not limited to a vapor intrusion study.

Inhalation of VOCs by construction workers during trenching or excavation activities will be evaluated following the VDEQ's guidelines for situations where shallow contaminated groundwater may pool in an excavation. The VDEQ spreadsheet (Table 2.13, Groundwater: Construction Worker in a Trench) will be utilized to develop VOC in air concentrations. This table can be found on-line at VDEQ's website: http://www.deq.virginia.gov/Programs/LandProtectionRevitalization/RemediationPrograms/VoluntaryRemediationProgram/VRPRiskAssessmentGuidance/Guidance.aspx.

Modeling is required to estimate the indoor air concentrations of VOCs from groundwater while showering. In this scenario, receptors are assumed to inhale VOCs while showering and during time spent in the bathroom after showering. The shower model will be used to evaluate exposure to COPCs in groundwater for future industrial/commercial workers who may take a shower on site.

The shower model treats the bathroom as one compartment and yields an air concentration averaged over the time of the actual shower and the time spent in the bathroom after the shower. The model was derived by assuming that the chemical volatilizes at a constant rate, instantly mixes uniformly with the bathroom air, and that ventilation with clean air does not occur. This implies that the chemical concentration in the air increases linearly from zero to a maximum at the end of the shower, and then remains constant during the time an individual spends in the bathroom immediately after showering.

The equation used to estimate chemical intake by inhalation during showering is the same as for inhalation of soil above, except for the following:

$$CA = \frac{((CA_{max}/2) \times t_1) + (CA_{max} \times t_2)}{(t_1 + t_2)}$$

where:

$$CA_{max} = CW \times f \times Fw \times t1 \times 1/Va$$

and where:

CW	=	chemical concentration in groundwater (µg/L)
CA	=	chemical concentration in air (µg/m^3)
f	=	fraction volatilized, chemical-specific
Fw	=	water flow rate (L/hr)
t1	=	time of shower (hr)
Va	=	bathroom volume (m^3)
t2	=	time after shower in bathroom (hr)

<u>Dermal Absorption</u>

Average daily chemical intake for dermal absorption of chemicals in groundwater for the construction worker, who may be exposed if groundwater pools in a trench, is calculated using the following formula (USEPA, 2004):

$$ADI_{GW\text{-}Derm} = \frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

where:

$ADI_{GW\text{-}Derm}$ = average daily absorbed chemical dose (mg/kg-day)

CW	=	chemical concentration in groundwater (mg/L), as represented by the EPC
SA	=	skin surface area available for contact (cm^2)
PC	=	chemical-specific dermal permeability constant (cm/hour)
ET	=	exposure time (hours/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (year)
CF	=	conversion factor for water (1 L/1000 cm^3)
BW	=	body weight (kg)
AT	=	averaging time (period over which exposure is averaged, days)

Average daily chemical intake for dermal absorption of chemicals in groundwater via direct contact by industrial/commercial workers during showering, in the event groundwater is available for use at some time in the future, will be calculated by use of the following formula (USEPA, 2004):

$$DAD = \frac{DA_{event} \times EF \times ED \times EV \times SA}{BW \times AT}$$

where:

for organics: $DA_{event} = Cshw \times Kp \times 2\ FA \times SQRT\,(6 \times \mathit{tau} \times t_{event}/p)$

for inorganics: $DA_{event} = Cshw \times Kp \times t_{event}$

and

Cshw	=	CW x f x CF1 x CF2
DAD	=	dermal absorbed dose (mg/kg-day)
DA_{event}	=	absorbed dose per event (mg/cm^2-event)
Cshw	=	concentration remaining in shower water (mg/cm^3)
CW	=	chemical concentration in groundwater (µg/L)
f	=	fraction in shower water after volatilization (NA for inorganics or f = 1)
CF1	=	conversion factor (mg/µg)
CF2	=	conversion factor (L/cm^3)
Kp	=	dermal permeability coefficient in water (cm/hr)
FA	=	fraction of chemical absorbed
t_{event}	=	exposure time in shower (hr)
t*	=	time to reach steady-state (hr)
tau	=	lag time per event (hr)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
EV	=	event frequency (events/day)
SA	=	skin surface area available for contact (cm^2)
BW	=	body weight (kg)

AT = averaging time (period over which exposure is averaged, days)

For construction workers who may be dermally exposed to contaminants in groundwater while trenching, the same formula used for calculating the dermal absorbed dose (DAD), as described just above, except that exposure parameters are selected that better reflect the skin surface area affected and the time/duration of exposure for this scenario.

2.3 Toxicity Assessment

The toxicity assessment will identify the toxicity values (i.e. slope factors and reference doses) for COPCs. These toxicity values will be applied to the estimated doses (intakes), calculated in the exposure assessment, in order to evaluate carcinogenic and noncarcinogenic risk. The Integrated Risk Information System (IRIS) (USEPA, accessed on-line) will be the preferred source of toxicity values, as the Tier 1 option. If a toxicity value is not available through IRIS, USEPA's recommended hierarchy of toxicity databases will be followed (per USEPA, 2003) which suggests that the Tier 2 option should be the Provisional Peer Reviewed Toxicity Values (PPRTVs) developed by The Office of Research and Development(ORD)/National Center for Environmental Assessment (NCEA).

Carcinogenic toxicity tables will be developed containing the following information for each COPC: weight of evidence, and for oral, inhalation, and dermal pathways, tumor site(s), unit risk values, and slope factors (SFs). All data provided will be properly referenced in each table.

Presently, toxicological data do not exist from which dermal SFs can be derived. To evaluate the dermal pathway, USEPA has adopted methodology to obtain dermal SFs by adjusting the oral SFs. The equation for extrapolation of a default dermal SF is as follows:

$$\text{Default Dermal SF} = \text{Oral SF} \; / \; \text{Oral Absorption Factor (\%)}$$

Tables containing dermal SFs will be presented in the HHRA report and will include the oral absorption factor (oral bioavailability) data properly referenced.

Noncarcinogenic toxicity tables will be developed containing the following information for each COPC: critical effect/target organ affected and chronic reference doses (RfDs) and reference concentrations (RfCs). All data provided will be properly referenced in each table.

Oral RfDs are derived from toxicological data and can be obtained from USEPA toxicological databases, such as IRIS. However, for the dermal pathway, oral RfDs are adjusted to derive dermal RfDs in an approach similar as that described above for the derivation of dermal SFs, and as follows:

$$\text{Dermal RfD} = \text{Oral RfD} \times \text{Oral Absorption Factor (\%)}$$

Tables containing dermal RfDs will be presented in the risk assessment report, and will include the oral absorption factor (oral bioavailability) data properly referenced.

The USEPA's *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (USEPA, 2005) indicates that carcinogens that act with a mutagenic mode of action exhibit higher cancer potency for early life exposures than for adult exposures. This guidance recommends potency adjustment factors for mutagenic carcinogens and human exposures occurring prior to 16 years of age. For these HHRAs, age-dependent adjustment factors (ADAFs) of 10 and 3, which are recommended by USEPA for ages 0-2 and >2-16, respectively, will be utilized when evaluating risks from exposure to vinyl chloride.

2.4 Risk Characterization

The objective of the risk characterization step is to integrate the information developed in the exposure assessment and the toxicity assessment into an evaluation of the potential current and future health risks associated with the COPCs at the Site. Potential cancer risk will be calculated by multiplying the estimated lifetime-averaged daily intake that is calculated for a chemical through an exposure route by the exposure route-specific cancer slope factor, as described below.

$$ELCR = DI \times SF$$

where:

ELCR	=	Cancer risk (unitless)
DI	=	Daily intake of chemical (mg/kg-day)
SF	=	Cancer slope factor $(mg/kg\text{-}day)^{-1}$

Excess cancer risk for the inhalation pathway is estimated by utilizing the following formula (USEPA, 2009):

$$CR_{Inhalation} = IUR \times EC$$

where:

$CR_{Inhalation}$	=	cancer risk via the inhalation pathway (unitless)
IUR	=	inhalation unit risk $[(\mu g/m^3)^{-1}]$
EC	=	exposure concentration $(\mu g/m^3)$

The cancer risks will be summed to calculate total risks for all chemicals, for all exposure routes, and for each receptor.

The potential for noncarcinogenic health effects will be evaluated by the calculation of hazard quotients (HQs) and hazard indices (HIs) (which are HQs summed). An HQ is the ratio of the exposure duration-averaged estimated daily intake through a given exposure route to the chemical and route-specific reference dose, calculated as presented below.

$$HQ = DI / RfD$$

where:

HQ = Hazard quotient (unitless)
DI = Daily chemical intake (mg/kg-day)
RfD = Noncancer reference dose (mg/kg-day)

The HQ for the inhalation pathway will be calculated with the following formula (USEPA, 2009):

$$HQ_{Inhalation} = EC / [\text{ Toxicity Value } \times 1000\ \mu g/m3\ ]$$

where:

HQ = hazard quotient via the inhalation pathway (unitless)
EC = exposure concentration ($\mu g/m^3$)
Toxicity Value = inhalation toxicity value (e.g. RfC)

HQs will be totaled to calculate HIs for each receptor scenario. Initially, HIs will be calculated based on all chemicals and exposure routes. Following the calculation of cumulative noncancer risks, any chemicals which exhibit risks greater than 1.0 will be further evaluated to determine if multiple organ affects are demonstrated. If so, chemicals will be segregated by organ effect and cumulative noncancer risks will be reevaluated separately.

Finally, for any chemical which presents an unacceptable level of risk, the total risk will be segregated by site risk and background risk. Excess lifetime cancer risk and non-cancer hazards will be evaluated for chemicals with background concentrations available, and then subtracted from total risk. By this approach, risk managers will be able to discern the risk solely contributed from on-site activities.

2.5 Uncertainty Analysis

A qualitative uncertainty analysis will be provided which presents major assumptions and uncertainties associated with the risk assessment, including general uncertainties associated with the risk assessment process, and site-specific uncertainties associated with the Walter Coke Facility. The predicted direction of each assumption or uncertainty on the estimate of risk (i.e. overestimate, underestimate, or uncertain) will be indicated. The focus will be on those chemicals and exposure pathways that pose a potential cancer risk that exceeds the acceptable risk range of 1E-06 to 1E-04, or have a total HI greater than 1 (USEPA, 1990).

2.6 Preliminary Remediation Goals

Preliminary Remediation Goals (PRGs) will be calculated for every chemical resulting in an unacceptable level of risk. These chemicals will also be known as chemicals of concern (COCs), or risk drivers, as they are the chemicals which would be moved forward to the Corrective Measures Study phase to evaluate alternatives for clean-up to ensure protectiveness. In order to evaluate clean-up strategies, a clean-up level must first be established, hence the need to calculate PRGs for resulting COCs.

The process to calculate PRGs is essentially the risk calculation in reverse (USEPA, 1991). To calculate PRGs, a target risk level is first determined, such as 1E-06, and then the concentration of the COC in soil or groundwater, which would result in that level of risk is determined. The same exposure parameters and pathways are utilized to calculate PRGs as were used to calculate risk. PRGs will be calculated for all resulting COCs, and for all receptors, at the Walter Coke Facility.

3.0 ECOLOGICAL RISK ASSESSMENT

To evaluate the ecological threats that may be presented to wildlife at the Walter Coke Facility, an ecological risk assessment (ERA) will be performed. ERAs evaluate the likelihood that adverse ecological effects may occur or are occurring at a site as a result of exposure to single or multiple chemical stressors. Risks of such effects result from contact between ecological receptors (e.g., plants and animals) and stressors (e.g., environmental contaminants) that are of sufficiently long duration and of sufficient intensity to elicit adverse effects. The primary purpose of an ERA is to identify and describe actual or potential on-site conditions stemming from releases of chemicals that can result in adverse effects to present or future ecological receptors

The overall approach and methodology proposed for development of the ERAs is presented in this section. The predominant guidance to be followed for the development of the ERA will include (but will not be limited to):

- USEPA's Ecological Risk Assessment Guidance for Superfund (ERAGS): Process for Designing and Conducting Ecological Risk Assessments (1997b)
- USEPA Region 4's *Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment* (2001)
- USEPA's Wildlife Exposure Factors Handbook (1993)
- USEPA's Ecological Soil Screening Levels (Eco SSLs) documents, for various metals and some organic chemicals (various years)
- Oak Ridge National Laboratory (ORNL). Various documents and tools available for review at their web site: http://www.esd.ornl.gov/programs/ecorisk/tools.html.
- USEPA's Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (1999)

The development of the ERAs at the Site will be consistent with USEPA's ERAGS document, with efforts consisting of the following steps, described below.

3.1 Characterization of the Ecological Setting

This step is performed by conducting a site visit to evaluate site conditions and the potential for habitat for wildlife receptors, as well as review of pertinent guidance and published literature regarding the potential for certain sensitive species for the regional area. During the previously conducted RFI (Arcadis and CH2M Hill, 2009), habitat surveys were performed to determine which SMAs, SWMUs, and/or AOCs contained habitat of sufficient quality to support wildlife receptors.

Results of the habitat surveys indicated that SMAs 1 and 2 are the only two areas with sufficient habitat, warranting quantification of ecological hazards. The specific SWMUs proposed for further evaluation are as follows:

SMA 1	SMA 2
SWMU 13 – aquatic habitat SWMU 22 – terrestrial and aquatic habitat SWMU 40 – terrestrial habitat SWMU 41 – terrestrial habitat	SWMU 23 – terrestrial habitat SWMU 24 – terrestrial habitat SWMU 25 – terrestrial and aquatic habitats SWMU 38 – terrestrial habitat SWMU 39 – terrestrial habitat

3.2 Stressor Selection

This section of the ERA will identify chemical constituents potentially originating from the site that may pose adverse impacts to the plants and animals. Chemicals detected in environmental media will be compared to USEPA Region 4's published ecological screening concentrations (also known as benchmarks) to derive a list of chemicals of potential ecological concern (COPECs) in soil, surface water, and sediment to be retained for further evaluation. If chemicals are present on-site that do not have Region 4 screening values, additional sources will be sought from other published sources. Likely sources for additional screening values include the Ecological Soil Screening Levels (Eco SSLs) published by USEPA, and found on-line at: http://www.epa.gov/ecotox/ecossl/, as well as the published benchmarks available from Oak Ridge National Laboratory (ORNL), and found on-line at: http://www.esd.ornl.gov/programs/ecorisk/ecorisk.html.

Tables will be developed for each area evaluated that contain all the statistical parameters, as described above in Section 2.1, and will also show the chemicals retained as COPECs, along with the reason for their retention.

3.3 Problem Formulation

This process includes a preliminary review of available information in order to identify the focus of the ERA and develop a plan for ecological risk characterization. An ecological CSM is the final endpoint product of the problem formulation step which identifies habitats and categories of potential receptors, as well as the potential exposure pathways to be further evaluated.

For purposes of planning the ERA efforts, an ecological CSM is developed, provided here as Figure 2. The purpose of the Ecological CSM is to demonstrate complete exposure pathways for terrestrial and aquatic receptors. The Ecological CSM is somewhat similar to the Human Health CSM, with one difference being the addition of food and prey.

Information provided during the development of an ERA includes the selection of surrogate wildlife species to evaluate which cover the broad range of feeding guilds in an ecological setting. For this ERA at the Walter Coke Facility, the following wildlife receptors are proposed for use as representatives of the following specific feeding guilds, noting one surrogate ecological receptor suggested for each feeding guild:

- Herbivore: consumes plants
  - Terrestrial bird – Northern bobwhite
  - Terrestrial mammal – Meadow vole
  - Aquatic bird – Mallard
  - Aquatic mammal - Muskrat
- Omnivore: consumes both plants and animals
  - Terrestrial bird – American robin
  - Terrestrial mammal – Red fox
- Insectivore: consumes insects and macroinvertebrates
  - Terrestrial bird – American woodcock
  - Terrestrial mammal – Short-tail shrew
  - Aquatic bird – Spotted sandpiper
- Carnivore: consumes animals
  - Terrestrial bird – Red-tail hawk
  - Terrestrial mammal - Mink
- Piscivore: consumes fish
  - Aquatic bird – Green heron
  - Aquatic mammal – River otter

3.4 Ecological Exposure Assessment

This process includes further identification of potential exposure pathways (i.e., the course a stressor takes from the source to the receptor) to be evaluated and quantification of exposure (i.e., chemical intake). Wildlife history parameters for each receptor evaluated will be obtained primarily from USEPA's Wildlife Exposure Factors Handbook (1993). These parameters include quantity of soil ingested, water ingested, food ingested, body weights, and so forth. Once the full list of exposure parameters are developed for each receptor, these values can be utilized to develop an estimate of the average daily dose for each receptor, as discussed further below. Table 2 presents preliminary life history parameters for each ecological species to be quantitatively evaluated. As published sediment values are not generally available for aquatic receptors, the soil intake values will be utilized instead, as presented in Table 2.

For terrestrial pathways, the level of exposure is expressed in terms of the potential average daily dose (ADD) using the following equation (USEPA, 1993):

$$ADD_{pot} = ADD_{soil} + ADD_{water} + ADD_{food}$$

where:

ADD_{pot}	=	Potential Average Daily Dose from all sources (mg/kg-day)
ADD_{soil}	=	Average Daily Dose from soil (mg/kg-day)
ADD_{water}	=	Average Daily Dose from water (mg/kg-day) (only for those areas where there is an on-site water body where surface water analytical data are available)
ADD_{food}	=	Average Daily Dose from food (mg/kg-day)

Described below is the general equation that will be used to estimate the daily intake dose through ingestion of soil (USEPA, 1993):

$$ADD_{Soil} = C_{Soil} \times NIR \times FR_{Soil} \times DC_{Soil}$$

where:

C_{Soil}	=	Concentration in soil (mg/kg)
NIR	=	Normalized food ingestion rate (mg/kg-day)
FR_{Soil}	=	Fraction of the total soil intake from foraging area (unitless)
DC_{Soil}	=	Dietary composition, fraction of soil in diet (unitless)

Described below is the general equation used to estimate the daily intake dose through food consumption (USEPA, 1993):

$$ADD_{food} = C_{food} \times NIR \times FR_{food} \times DC_{food}$$

where:

C_{food}	=	Concentration in food ($mg_{chemical}$/ kg_{food})
NIR	=	Normalized food ingestion rate (kg/kg-day)
FR_{food}	=	Fraction of food intake from foraging area (unitless)
DC_{food}	=	Dietary composition, fraction of that type of food in diet (unitless)

No actual analytical data will be collected with respect to chemical concentrations in food at the Site, such as earthworms or plants; hence, estimates of chemical concentrations must be derived by modeling approaches. By multiplying the soil chemical concentrations by the appropriate bioconcentration factor (BCF), as for earthworms, or soil-to-plant uptake factors (SPUFs), for plants, the concentration in the next food chain level or trophic level can be estimated. Review of the scientific literature and regulatory guidance will be performed to develop a list of pertinent BCFs and SPUFs for all COPECs evaluated in the ERA. BCFs and

SPUFs will be presented in tables of the risk assessment and their sources will be properly cited.

For terrestrial top predators, such as the fox or mink, an estimation of the concentration of chemicals in prey species (e.g., voles, shrews) also must be derived. This will be accomplished by multiplying the soil chemical concentration by the appropriate, literature-derived mammalian uptake factor (UF), primarily as reported ORNL publications. UFs for voles and shrews will be presented in tables of the risk assessment and their sources will be properly cited.

Review of the scientific literature and regulatory guidance will be performed to develop a list of pertinent BCFs and SPUFs for all COPECs to be evaluated in the ERA. An interim deliverable will be prepared and submitted to EPA that includes the COPECs and all uptake factors and bioconcentration factors proposed for use in the ERA. Quantification of ecological hazard quotients will not be performed until concurrence is obtained from EPA on these parameters. Uptake factors and bioconcentration factors will be presented in tables of the risk assessment and their sources will be properly cited.

3.5 Ecological Effects Assessment

This step of the process provides information on the toxicity of the chemical stressors to the selected ecological receptors, based upon a review of pertinent guidance and the scientific literature. A detailed table of adverse effects to test species will be provided in the risk assessment to demonstrate a detailed list of Toxicity Reference Values (TRVs) appropriate for all species evaluated. Described below is the tiered approach to be used to compile TRVs for this ERA.

1. Species-specific TRVs will be obtained from values provided in the published scientific literature, as approved by the USEPA Region 4 ecotoxicologist. These published values will be evaluated using the following procedures in order to determine if they can be adopted as TRVs for this ERAs:
   - Benchmarks derived by ORNL are adopted as TRVs if the basis for their derivation (e.g., types of toxicological endpoints and uncertainty factors) is well documented.
   - If the basis for the derivation of benchmarks was not documented, TRVs will be calculated based on toxicological endpoints and uncertainty factors, as appropriate.
2. If species-specific TRVs are not provided in ORNL documents, they will be derived using the following methodology which, is similar to the HHRA RfD model:
   - Review available toxicological data and identify critical studies that provide information necessary for assessing ecological risks; e.g., the type of toxicological effects, the magnitude of exposure and effects associated with various exposure levels. When possible, TRVs will be derived from chronic studies using species that have been selected as representative species for this ERA. However, TRVs may be

extrapolated from surrogate species or shorter-term studies, if toxicological data concerning effects to a particular compound in the representative species are not available in the published literature.

- A TRV for the test species will be derived using the following equation:

$$TRV = \frac{NOAEL}{UFs \times UFc \times UFe \times UFi}$$

where:

NOAEL	=	No-Observed-Adverse-Effect-Level (mg/kg-day), (i.e., the highest level of exposure that is not associated with any adverse effect).
UFs	=	A factor between 1 and 10 for extrapolating toxicity data across test species.
UFc	=	A factor between 1 and 10 if a subchronic study was selected as the critical study instead of a chronic study.
UFe	=	A factor between 1 and 10 when a Lowest-Observed-Adverse-Effect-Level (LOAEL) was selected as the endpoint instead of an NOAEL.
UFi	=	A factor between 1 and 10 to account for uncertainties associated with intraspecies differences.

To provide risk managers with a range of results, a TRV will also be presented (if available) for the lowest-observed-adverse-effect-level (LOAEL). The ERA will only use EPA-approved TRVs, including those provided in EPA's "Addendum: Phase 3 RFI Response to EPA Review Comments".

3.6 Risk Characterization

The risk characterization step of the ERA integrates the results of the exposure and toxicity assessments into a quantitative description of excess risks. Hence, the ADDs developed from the exposure assessment and the TRVs derived from the effects assessment are utilized to derive risks for each receptor-COPEC scenario using the hazard quotient (HQ) approach. The resulting HQs can then be evaluated in order to determine the likelihood that COPECs detected in Site samples pose any adverse impacts to ecological receptors.

Potential risks to selected ecological receptors are derived by integrating the ADD and TRV values of the effects evaluation, as described by the following equation (USEPA, 1997b):

$$HQ = \frac{ADD}{TRV}$$

Where data are available, HQs will be developed by using a NOAEL-derived TRV, as well as a LOAEL-derived TRV. This approach will provide a range of results that may prove to be useful to risk managers as the results of the ERA are interpreted.

An HQ greater than 1.0 (unity) indicates that the chemical of concern may be present in Site media at a concentration that could potentially result in an adverse effect to the species, under the specific scenario evaluated.

For inorganic chemicals in soil which present an HQ greater than 1.0, separate analyses will be performed to quantify the contribution to overall risk that can be attributed to background inorganic chemical concentrations. Again, this approach may prove to be useful to risk managers when interpreting the ERA results.

3.7 Uncertainty Analysis

This process is performed to address potential sources of uncertainty in the ERA and discusses how assumptions used in the analyses may affect the risk assessment conclusions.

4.0 REFERENCES

Arcadis and CH2M Hill. 2009. Phase III RCRA Facility Investigation (RFI). Sloss Industries, Birmingham, Alabama.

US Environmental Protection Agency (USEPA). 2012a. *Regional Screening Levels (RSLs).* Available on-line: http://www.epa.gov/region9/superfund/prg/rsl-table.html.

USEPA. 2012b. *Vapor Intrusion Screening Level Calculator (Version 1.0) and User's Guide*. Office of Solid Waste and Emergency Response, Washington, DC.

USEPA. 2012c. *Integrated Risk Information System* (IRIS). Current, on-line database, http://www.epa.gov/iris.

USEPA. 2012d. National Recommended Water Quality Criteria. Office of Water. Available on-line at: http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm.

USEPA. 2012e. National Primary Drinking Water Regulations, Maximum Contaminant Levels (MCLs). Office of Water. Available on-line at: http://water.epa.gov/drink/contaminants/index.cfm#List

USEPA. 2011. ProUCL Version 4.1.01. Office of Research and Development, Washington, DC.

USEPA. 2009a. *Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*. EPA-540-R-070-002, OSWER 9285.7-82. Office of Superfund Remediation and Technology Innovation, Washington, DC.

USEPA. 2005. *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposures to Carcinogens*. EPA/630/R-03/003F. Risk Assessment Forum. Washington, DC.

USEPA. 2004. *RAGS, Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).* EPA/540/R/99/005, OSWER 9285.7-02EP, PB99-963312. Office of Superfund Remediation and Technology Innovation, Washington, DC.

USEPA. 2003. *Human Health Toxicity Values in Superfund Risk Assessment.* OSWER Directive 9285.7-53. Office of Solid Waste and Emergency Response, Washington, D.C.

USEPA. 2002a. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.* OSWER 9355.4-24. Office of Solid Waste and Emergency Response. Washington, DC.

USEPA. 2002b. *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils*. EPA530-D-02-004 . Office of Emergency and Remedial Response. Washington, DC.

USEPA. 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA 530-D-99-001A. Office of Solid Waste. Washington, DC.

USEPA. 1997a. *Exposure Factors Handbook*. EPA/600/R-09/052F. National Center for Environmental Exposure (NCEA). Office of Research and Development. Washington, DC.

USEPA. 1997b. *Ecological Risk Assessment Guidance for Superfund (ERAGS): Process for Designing and Conducting Ecological Risk Assessments*. Solid Waste and Emergency Response. EPA 540-R-97-006, OSWER 9285.7-25. PB97-963211. Washington, DC.

USEPA. 1993. *Wildlife Exposure Factors Handbook.* Office of Research and Development. EPA/600/R-93/187. Washington, DC.

USEPA. 1992. *Supplemental Guidance to RAGS: Calculating the Concentration Term*. Publication 9285.7-081. Office of Solid Waste and Emergency Response. Washington, DC.

USEPA. 1991. *RAGS, Part B: Development of Risk-Based Preliminary Remediation Goals*. EPA/540/R-92/003. Office of Emergency and Remedial Response. Washington, DC.

USEPA. 1990. *National Contingency Plan*. 40 Code of Federal Regulations, Part 300. Washington, DC.

USEPA. 1989. *RAGS, Volume 1: Human Health Evaluation Manual* (Part A). EPA/540/1-89/002. Office of Emergency and Remedial Response. Washington, DC.

USEPA Region 4. 2001. *Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment.* Updated November 30, 2001:
http://www.epa.gov/region4/waste/ots/ecolbul.html

Virginia Department of Environmental Quality (VDEQ). 2010. *Voluntary Remediation Program Risk Assessment Guidance*. Available online: http://www.deq.virginia.gov/vrprisk/raguide.html.

Table 1
Summary of Human Exposure Assumptions[a]
Walter Coke Facility, Birmingham, Alabama

Exposure Pathway	Parameter	Industrial/Commercial Worker (Adult)	Construction Worker (Adult)	Trespasser (7-16 yrs)	Recreational User (Adult)	Off-Site Resident Adult	Off-Site Resident Child	Parameter Units
General	Body weight (BW)	70	70	45.0	70	70	15	kg
	Exposure frequency (EF)	250	250	12	12	350	350	days/year
	Exposure duration (ED)	25	1	10	25	30	6	year
	Exposure time (ET)	8	8	1	8	24	24	hour/day
	Averaging time - Cancer[b] (AT_C)	25,550	25,550	25,550	25,550	25,550	25,550	days
	Averaging time - Noncancer[c] (AT_{NC})	9,125	365	2,555	9,125	10,500	2,190	days
Ingestion	Soil Intake rate (IR_S)[d]	100	330	100	100	na	na	mg/day
	Drinking water (IR_W)	1	na	na	na	na	na	L/day
Inhalation	Particle Emission Factor (PEF)[d]	5.70E+09	site-specific calc.	5.70E+09	5.70E+09	na	na	m^3/kg
Dermal Absorption	Skin surface area available for contact (SSA)[d] (includes: face, forearms, and hands)	3,300	3,300	5,900	3,300	na	na	cm^2
	Skin surface area during showering	18,000	na	na	na	na	na	cm^2
	Soil to skin adherence factor (SAF)[e]	0.2	0.2	0.2	0.2	na	na	mg/cm^2
	Absorption factors (ABS)[e]: chemical-specific	tbd	tbd	tbd	tbd	na	na	

(a) USEPA, 1997. *Exposure Factors Handbook.*

(b) Averaging time of exposure for carcinogenic effects is calculated as follows: 70-year lifetime exposure (70 years x 365 days/year = 25,550 days)

(c) Averaging time for noncarcinogenic effects is calculated as follows: ED years x 365 days/year

(d) From: USEPA, 2002. *Supplemental Guidance for Developing Soil Screening Levels.*

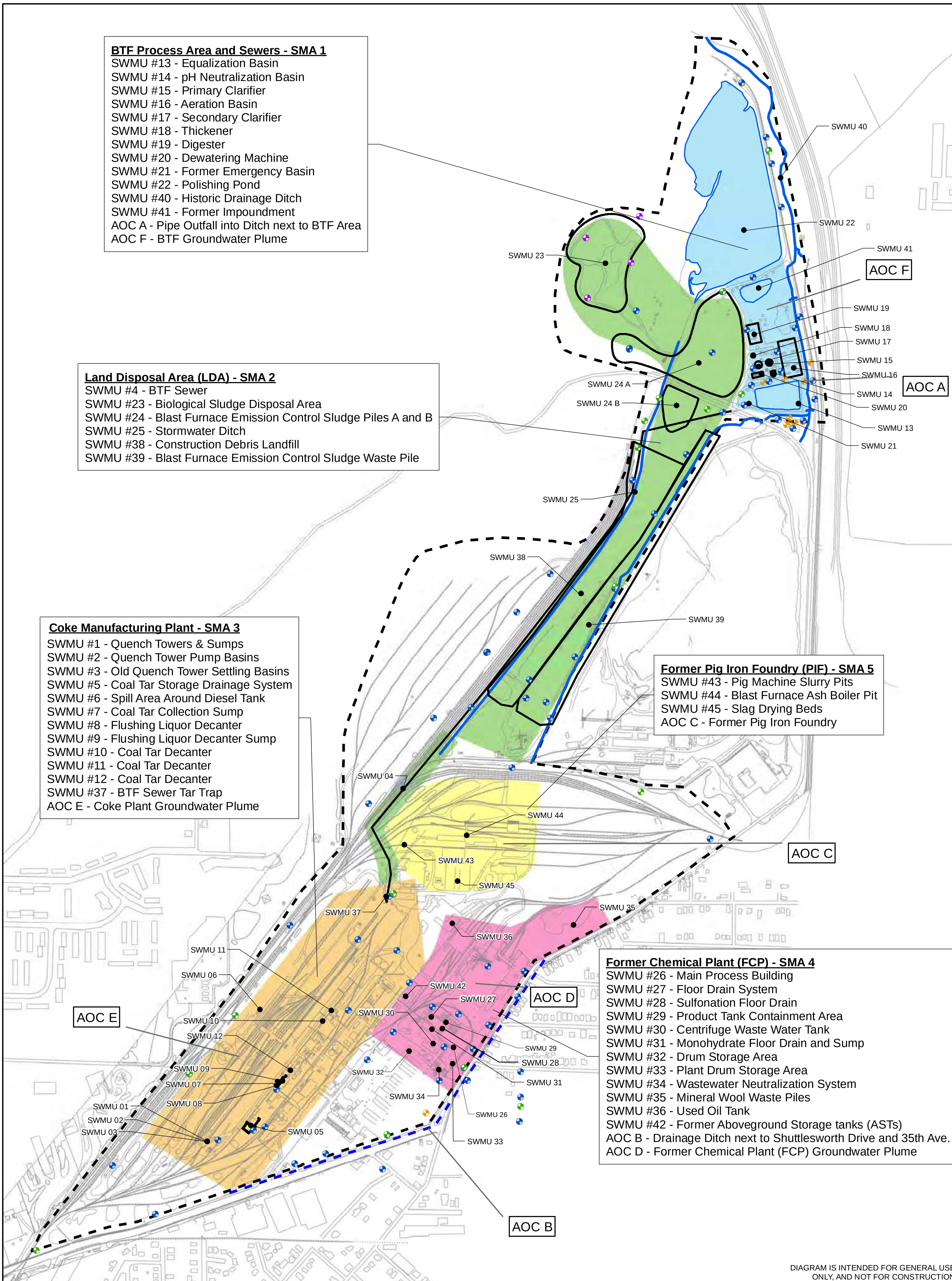
(e) From: USEPA, 2004. *RAGS Part E, Dermal Expsoure Guidance* .

na = not applicable
tbd = to be determined

Table 2
Ecological Receptors' Life History Parameters[1]
Walter Coke Facility, Birmingham, Alabama

Representative Guild	Surrogate Receptor Species	Genersl Foraging Habitat	Body Weight (kg)	Food Ingestion Rate (kg/day-dry)	Water Ingestion Rate (L/day)	Home Range (ha)	Dietary Composition (%)		
							Plant	Animal	Incidental Soil
Herbivores									
Terrestrial bird	northern bobwhite	woodlands, fields and brush	0.14	0.22	0.02	8	100	0	0.093
Terrestrial mammal	meadow vole	grassy fields, marshes	0.03	0.0095	0.003	0.083	100	0	0.02
Aquatic bird	mallard	most wetlands, ponds	1.134	0.117	0.085	111	100	0	0.11
Aquatic mammal	muskrat	most aquatic habitats	1.221	0.11	0.12	0.17	100	0	0.02
Omnivore									
Terrestrial bird	American robin	open woodland	0.082	0.037	0.0115	0.16	50	50	0.05
Terrestrial mammal	red fox	mixed woodlands and open areas	4.6	0.177	0.4115	96	10.4	89.6	0.028
Insectivore									
Terrestrial bird	American woodcock	woodlands, marshes	0.176	0.061	0.018	10.5	15.7	84.3	0.104
Terrestrial mammal	short-tail shrew	most habitat types	0.013	0.0033	0.0048	0.39	0.13	87	0.06
Aquatic bird	spotted sandpiper	most rivers and streams	0.0471	0.082	0.0071	0.25	0	100	0.104
Carnivore									
Terrestrial bird	American kestrel	open fields, forest edge	0.12	0.0119	0.0144	154	0	100	0.01
Terrestrial mammal	mink	most areas near water	0.726	0.0717	0.062	8	0	100	0.02
Piscivore									
Aquatic bird	green heron	most freshwater	0.158	0.0273	0.0227	15	0	100	0.02
Aquatic mammal	river otter	rivers	6.73	0.33	0.80	295	0	100	0.094

(1)Source: USFS. 1993. *Wildlife Exposure Factors Handbook*.
tbd - to be determined



Legend

Proposed Solid Waste Management Areas (SMAs)

- BTF Process Area and Sewer - SMA 1
- Land Disposal Area - SMA 2
- Coke Manufacturing Plant - SMA 3
- Former Chemical Plant - SMA 4
- Former Pig Iron Foundary - SMA 5

Notes:
1) SWMU - Solid Waste Management Unit
2) Management Area boundaries are used for approximation.
3) AOC - Area of Concern

0 250 500 1,000 1,500 2,000 Feet

N

Project Mngr: TWR	Scale: SHOWN	Terracon Consulting Engineers & Scientists	SITE MAP
Checked By: TWR	Date: 7/24/2012	110 12th St. North, Birmingham, Alabama 35203	CLIENT: Walter Coke, 3500 35th Avenue North, Birmingham, AL 35207
Approved By: TWR	Project No: E1127096	Phone: (205) 942-1289 Fax: (205) 443-5302	FIGURE 1
Drawn By: GFA	File Name: Figure 1		

Figure 2. Preliminary Human Health Conceptual Site Model. Walter Coke Facility, Birmingham, Alabama.

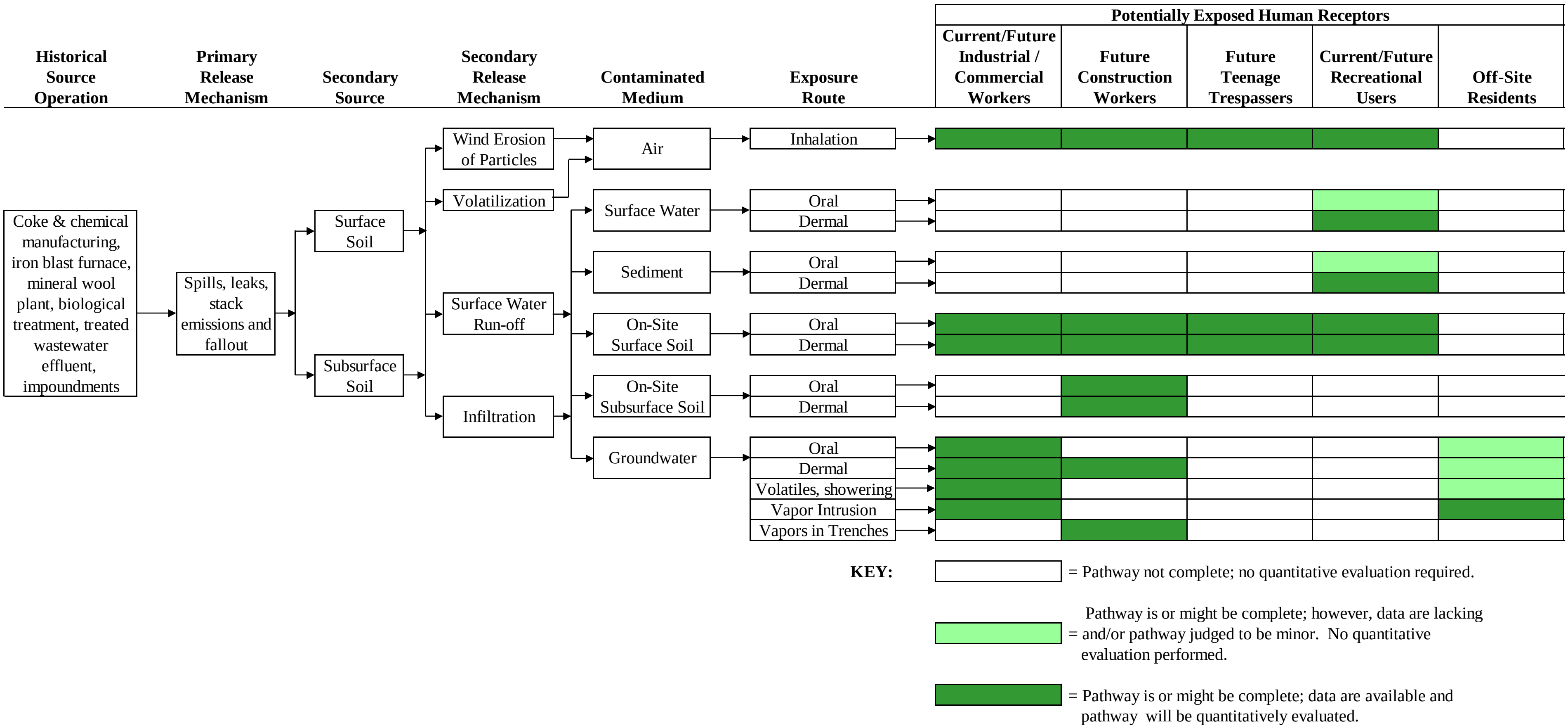


Figure 3. Preliminary Ecological Conceptual Site Model. Walter Coke Facility, Birmingham, Alabama.