Georgia Department of Natural Resources

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Lonice C. Barrett, Commissione
Environmental Protection Divisio
Carol A. Couch, Ph.D., Directc
Hazardous Waste Management Branc
Phone 404/656-7802 FAX 404/651-942

FILE COPY

April 14, 2004

Dr. Lon D. Marlowe
Executive Director
Columbus State University Foundation
and Foundation Properties, Inc.
Room 108 Richards Hall
4225 University Avenue
Columbus, Georgia 31907

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

RE: Limitation of Liability for the Former Columbus Manufactured Gas Plant Property, Columbus, Muscogee County, Georgia

Dear Dr. Marlowe:

The Georgia Environmental Protection Division (EPD) has completed its review of the prospective purchaser compliance status report (CSR) submitted by the Columbus State University Foundation (CSUF) for the above-referenced property. The CSR, including the certification of compliance with risk reduction standards, was submitted as an application for a limitation of liability pursuant to Section 12-8-200 et. seq. of the Hazardous Site Reuse and Redevelopment Act (Act). The subject property is identified as "...2.690 acres more or less on that certain map or plat entitled, "Survey of City Lots 1, 2 & Part of City Lot 3, Part of Water Lots 34, 35, 36, & 37, Part of Right-of-Way of Bay Avenue and Adjacent Land, Columbus, Muscogee County, Georgia" prepared by Hobbs Smith & Assoc., Inc., under date of March 11, 2004. The full legal description of the property is provided in an attachment to this letter. The above–referenced property is depicted on the survey plat dated March 11, 2004, submitted in support of the CSR on March 30, 2004.

Based upon data submitted by CSUF, EPD concurs with the certification that the subject property is in compliance with the Type 4 soil risk reduction standard (RRS) of Section 391-3-19-.07 of the Hazardous Site Response Rules (Rules). Section 12-8-207 of the Act, as amended and effective July 1, 2002, states that upon the Director's approval of the prospective purchaser corrective action plan or concurrence with the certification of compliance with risk reduction standards for soil and source material contained in Section 391-3-19-.07 of the Rules, whichever first occurs, a prospective purchaser shall not be liable to the state or any third party for costs incurred in the remediation of, equitable relief relating to, or damages resultant from the preexisting release, nor shall the prospective purchaser be required to certify compliance with the RRS for groundwater, perform corrective action, or otherwise be liable for any preexisting releases to groundwater associated with the qualifying property.

This letter provides the Director's concurrence with the certification of compliance for the subject property and therefore grants the limitation of liability discussed above to the prospective purchaser, CSUF. As stated in Section 12-8-208(c) of the Act, "[t]he limitation of liability provided by this article shall be fully transferable to the heirs, assigns, and designees of the person to whom such limitation of liability is granted; provided, however, that in no event shall the Director's approval of a corrective action plan or concurrence with a certification of compliance operate to absolve from liability any party deemed to be a person who has contributed to or is contributing to a release at the qualifying property. A transfer of the title to the qualifying property or any portion thereof from the prospective purchaser back to the owner of the property from which the property was purchased, any other party deemed to be a person who has contributed or is contributing to a release at the property, or any person disqualified from obtaining a limitation of liability under Code Section 12-8-206 shall terminate any limitation of liability applicable to the transfer or under this article." This limitation of liability applies to all releases identified in the CSR and is subject to all conditions set forth in the Act.

This letter will also serve as a receipt for the $3,000.00 application review fee received February 20, 2004. No additional review fees will be invoiced. If you have any questions, or need further assistance, please contact Madeleine Kellam at 404/657-8645.

Sincerely,

Carol A. Couch, Ph.D.
Director

Attachment: Legal Descriptions of Former Columbus Manufactured Gas Plant Property, Muscogee County, Georgia

c: Jennifer Kaduck, EPD
Richard Bishop, City of Columbus
Edward Sprouse, PSST&F
Allan Kamensky, PSST&F
Darahyl Dennis, Georgia Power
Bill Mundy, EPD
Tim Cash, EPD

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ATTACHMENT

Legal Description
Former Columbus Manufactured Gas Plant Property
Columbus, Muscogee County, Georgia

Legal Description
2.690 acres

All that lot, tract or parcel of land situate, lying and being in Columbus, Muscogee County, Georgia and being more particularly described as follows:

COMMENCE at an iron pin located at the point of intersection formed by the northerly right-of-way line of Dillingham Street and the westerly right-of-way line of Bay Avenue; run thence south 85 degrees 27 minutes 58 seconds west along the northerly right-of-way line of Dillingham Street for a distance of 126.18 feet to an iron pin; run thence north 43 degrees 06 minutes 21 seconds west for a distance of 38.62 feet to an iron pin; run thence north 23 degrees 35 minutes 00 seconds west for a distance of 49.46 feet to an iron pin; run thence north 15 degrees 07 minutes 38 seconds west for a distance of 49.91 feet to an iron pin; run thence north 06 degrees 41 minutes 54 seconds west for a total distance of 71.33 feet to an iron pin; run thence north 01 degree 02 minutes 03 seconds east for a distance of 110.93 feet to an iron pin; run thence north 47 degrees 47 minutes 50 seconds east for a distance of 105.59 feet to an iron pin; run thence north 01 degree 50 minutes 34 seconds east for a total distance of 205.19 feet to an iron pin; run thence north 17 degrees 34 minutes 50 seconds east for a distance of 59.97 feet to an iron pin; run thence north 34 degrees 36 minutes 22 seconds east for a distance of 42.13 feet to an iron pin; run thence north 38 degrees 21 minutes 44 seconds east for a distance of 78.50 feet to an iron pin; run thence south 89 degrees 05 minutes 02 seconds east for a distance of 50.28 feet to an iron pin located on the westerly right-of-line of Bay Avenue; run thence south 27 degrees 49 minutes 30 seconds west along the westerly right-of-way line of Bay Avenue for a distance of 4.83 feet to an iron pin; continuing on the westerly right-of-way line of Bay Avenue run thence south 00 degrees 54 minutes 38 seconds west for a distance of 350.01 feet to an iron pin; continuing on the westerly right-of-way line of Bay Avenue run thence south 00 degrees 54 minutes 38 seconds west for a distance of 366.23 feet to an iron pin which marks the POINT OF BEGINNING.

Said property is shown and designated as 2.690 acres more or less on that certain map or plat entitled, "Survey of City Lots 1, 2 & Part of City Lot 3, Part of Water Lots 34, 35, 36, & 37, Part of Right-of-Way of Bay Avenue and Adjacent Land, Columbus, Muscogee County, Georgia" prepared by Hobbs Smith & Assoc., Inc., under date of March 11, 2004.

Georgia Department of Natural Resources
2 Martin Luther King Jr. Drive, S.E., Suite 1154, Atlanta, Georgia 30334
Lonice C. Barrett, Commissioner
Environmental Protection Division
Carol A. Couch, Ph.D., Director
404/656-7802

Memorandum

Date: April 14, 2004

To: Madeleine Kellam, Unit Coordinator
Brownfields Development Unit

Through: Jim Brown, Unit Coordinator
Risk Assessment Unit

From: Brooke Davis, Assessment Analyst
Risk Assessment Unit

Subject: **Former Columbus MGP Site - Brownfields Compliance Status Report (CSR)**

A review of the brownfields compliance status report for the Former Columbus Manufactured Gas Plant Site has been completed per your request. The following comments are provided to assist with your review of the site. These comments do not impact the certification of compliance submitted for the site, and it is your decision as to whether or not to require the report to be modified to address these comments.

1. **RRS and VF for Isopropylbenzene**
   There are discrepancies with the reported calculated RRS values and volatilization factor (VF) for isopropylbenzene. The VF EPD is using (253 mg^3/kg) for the calculations is lower than the factor used in the submittal (14,053 mg^3/kg). All of the resulting RRS are lower, however, they do not cause the soil values at the site to exceed.

2. **RRS for Lead**
   The value of 400 mg/kg listed in Table F-4 is the default Type 3 RRS, and is indicated as such in the footnote. If a site specific Type 4 RRS for lead has been developed for the site, that value should be listed in Table F-4, but if one has not been developed, than no value for lead should be listed in columns describing Type 4 exposure scenarios.

3. **References for Physical/Chemical Properties of Regulated Substances**
   The GA EPD Guidance for determining Type 1 and Type 3 RRS is not an appropriate reference for chemical and physical properties of regulated substances. This document has not been updated since it was originally circulated in 1995 and many of the values listed in the associated tables have changed. The values needing revision have been changed based on our last set of comments, but please contact the risk assessment unit for more up to date references if additional revisions to the report will be made.

If you have any questions or comments regarding this review, please feel free to call me at 7-8666.

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Georgia Department of Natural Resources
2 Martin Luther King Jr. Drive, S.E., Suite 1154, Atlanta, Georgia 30334
Lonice C. Barrett, Commissioner
Environmental Protection Division
Carol A. Couch, Ph.D., Director
404/656-7802

Memorandum

Date: April 1, 2004

To: Madeleine Kellam, Unit Coordinator
Brownfields Development Unit

Through: Jim Brown, Unit Coordinator
Risk Assessment Unit

From: Brooke Davis, Assessment Analyst
Risk Assessment Unit

Subject: **Former Columbus MGP Site - Brownfields Compliance Status Report (CSR)**

A review of the brownfields compliance status report for the Former Columbus Manufactured Gas Plant Site has been completed per your request. The following comments are provided to assist with your review of the site.

1. **Toxicity Values (Table F-2)**
There are a couple of discrepancies in regards to toxicity values. Please review and revise the following toxicity values:

   a) Chromium – the oral reference dose should be listed as 3.0E-03 mg/kg-day and the inhalation reference dose should be listed as 8.0E-06 mg/kg-day. The inhalation cancer slope factor should be listed as 1.2 $(mg/kg\text{-}day)^{-1}$. All of these values are found in IRIS.
   b) Polyaromatic Hydrocarbons (PAHs) – the inhalation slope factors listed for all of the PAHs are incorrect. The correct value for benzo(a)pyrene (which the other PAH compounds are based on) should be 3.1 $(mg/kg\text{-}day)^{-1}$. Also, indeno(a,h)anthracene should have an inhalation cancer slope factor listed (it currently doesn't have one listed). The reference for benzo(a)pyrene is NCEA. The TEFs for the other PAHS are based on the relative potency of each compound relative to benzo(a)pyrene. The conversions are listed in the Region 4 Guidance.

   Additionally, there are no toxicity values listed for certain compounds. Please list all surrogates and appropriate toxicity values for each compound.

2. **RRS for Benzo(k)fluoranthene (Tables F-4 and F-5)**
The RRS values for the groundskeeper, adult visitor and child visitor are all the same for benzo(k)fluoranthene. Please explain.

3. **RRS for Lead, Petroleum Hydrocarbons and Surrogates(Tables F-4 and F-5)**
There are no RRS listed for lead, petroleum hydrocarbons and surrogates. Please include the appropriate RRS for the referenced compounds for all exposure scenarios.

4. **Volatilization Factors**
EPD found several discrepancies with regards to the listed RRS for several constituents. The issue is that the volatilization factors (VFs) differ from the values that EPD has derived. In looking over Table F-3, several of the H and K_{oc} values are incorrect which contribute to the VF. Please see the correct VF values below and revise the RRS accordingly:

Constituent	Volatilization Factor (m^3/kg)
1,2-Dichlorobenzene	18700
1,4-Dichlorobenzene	16600
Naphthalene	72300
1,3,5-Trimethylbenzene	11400
Benzene	2920
Chlorobenzene	7720
Ethylbenzene	6700
Toluene	4810
Xylenes	7680

5. **VF Inputs**
On several individual tables, there is a VF listed but a value of zero listed for α (see benzo(a)anthracene for an example). Please explain and/or revise.

6. **Site Soil Concentrations**
Please include a table with the maximum surface and subsurface soil concentrations at the site. These values need to be compared to the derived RRS.

If you have any questions or comments regarding this review, please feel free to call me at 7-8666.

Concise Statement of Findings

The purpose of this Compliance Status Report is to meet the requirements for a Limitation of Liability for the purchase of a portion (Subject Property) of the former Fieldcrest Substation and Columbus Manufactured Gas Plant Site/Columbus Riverwalk Park (Site) by the Columbus State University Foundation (CSUF). Although CSUF is not purchasing the entire Site, this CSR is written to certify compliance for the entire Site and to serve as an application for the Limitation of Liability for the Subject Property. The Site, located immediately northwest of the intersections of Bay Avenue and Dillingham Street in Muscogee County, Columbus, Georgia, is currently in compliance with Type 4 Risk Reduction Standards for soil as stated in the HSRA Rules (§391-3-19-.07(9)). Groundwater baselines have been set based on recent groundwater monitoring data. The Site does not pose a risk to future workers or visitors to the Site based upon non-residential risk calculations and evaluation of Site data.

The pre- and post-remediation environmental investigations, and remediation activities detailed in this report were performed by Georgia Power Company and other potentially responsible parties (PRPs), Atlantic Environmental Services, Inc. and Remediation Technologies, Inc., IT Corporation, Williams Environmental Services, Inc., SBX Technologies, Inc., and RMT, Inc. The purposes of the Compliance Status Report are to:

- Apply for a Limitation of Liability for the Subject Property under the Georgia Hazardous Waste Management Act, Article 9 – Hazardous Site Reuse and Redevelopment, as amended August 2002 [OCGA 12-8-200],
- Determine the compliance status of the former Fieldcrest Substation and Columbus Manufactured Gas Plant Site / Columbus Riverwalk Park with regard to Georgia Hazardous Site Response Act Risk Reduction Standards for soil, and
- Establish current baseline groundwater quality conditions at the Site.

Site assessment activities were begun in 1990 and continued periodically through January 2004.

The constituents of interest defined for this Site were manufactured gas plant (MGP) residuals including tars and light oils, which were removed from or added to the gas streams during production. In addition, gas purifier wastes potentially containing primarily complexed cyanide, and coal ash were potential sources of impacts. The chemicals characteristically associated with these residuals and MGP processes and investigated for include volatile aromatic hydrocarbons (VOCs), phenols, polynuclear aromatic hydrocarbons (PAHs), and

cyanide. Additionally, Resource Conservation and Recovery Act metals (RCRA 8 Metals) were analyzed in surface soil in 2004 to establish a baseline for this Site being a potential Brownfield site.

The Site underwent successful remediation in 1992. Remediation activities were conducted to excavate and dispose or insitu stabilize impacted soil above remedial goals. It was determined that the process of stabilizing the impacted soils, and the exothermic reaction resulting from the curing of the stabilization agent (Type II Portland Cement) would remediate and/or allow for the natural attenuation of impacted groundwater on the Site. A total of 85,450 cubic yards of material were excavated and segregated for disposal, or reuse based upon the Site remedial goals. A total of 92,000 cubic yards of Site soil were stabilized into the top of saprolite. Following remediation, the City of Columbus constructed the Columbus Riverwalk park and recreation area over the Site. In addition, following remediation a groundwater-monitoring plan was implemented requiring quarterly sampling the first year and semiannual sampling each subsequent year, with an evaluation of results at the end of five years to determine if additional monitoring was required. Groundwater monitoring was discontinued after the August 1997 sampling event following an evaluation of five years of data per the Post-Remediation Groundwater Monitoring Plan. Two additional rounds of groundwater analysis were conducted in 2000 and 2003 that confirmed the success of the remediation at the Site.

Certification of Compliance with Risk Reduction Standards

I certify under penalty of law that this report and all attachments were prepared under my direction in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Based on my review of the findings of this report with respect to the risk reduction standards of the Rules of Hazardous Site Response, Rule 391-3-19-07 and the Georgia Hazardous Waste Management Act, Article 9 – Hazardous Site Reuse and Redevelopment, as amended August 2002 [OCGA 12-8-200], I have determined this Subject Property, consisting of:

- Said property is shown and designated as 2.690 acres more or less on that certain map or plat entitled, "Survey of City Lots 1, 2 & Part of City Lot 3, Part of Water Lots 34, 35, 36, & 37, Part of Right-of-Way of Bay Avenue and Adjacent Land, Columbus, Muscogee County, Georgia" prepared by Hobbs Smith & Assoc., Inc., under date of March 11, 2004

as shown in Appendix A, is currently in compliance with Type 4 Risk Reduction Standards for soil. Groundwater monitoring has established a baseline for Site groundwater quality for purposes of the granting of a Limitation of Liability through Article 9 referenced above. The groundwater quality baseline is based upon non-detect results for BTEX, PAHs, and total cyanide at the following practical quantification limits (PQL): a) less than the PQL of 2 µg/L for benzene, toluene, ethylbenzene, b) less than the PQL of 5 µg/L for total xylenes, c) less than the PQL of 10 µg/L for each PAH listed on Table 5 of this CSR, and d) less than the most recent maximum contaminant level (50 µg/L) for total cyanide.

Certified by:

Lon D Marlowe

Dr. Lon D. Marlowe
Executive Director of CSU Foundation and Foundation Properties, Inc.

April 7, 2004
Date

Section 1
Introduction

On behalf of Columbus State University Foundation (CSUF), RMT Inc. has prepared this Compliance Status Report (CSR) for the former Fieldcrest Substation and Columbus Manufactured Gas Plant (MGP) Site, currently the Columbus Riverwalk Park in Columbus, Georgia, for review by the Georgia Environmental Protection Division, Hazardous Waste Division (EPD). The CSR is intended for review by the EPD for consideration for a Limitation of Liability for a portion of the Site (Subject Property) relative to the Georgia Hazardous Waste Management Act, Article 9 – Hazardous Site Reuse and Redevelopment, as amended August 2002 (Article 9) [OCGA 12-8-200]. The prospective purchaser, CSUF, intends to purchase this Subject Property (see Figure 2) from the City of Columbus. CSUF intends to use the Subject Property for a park, landscaping, and educational purposes. The Site (see Figure 3) is located immediately northwest of the intersections of Dillingham Street and Bay Avenue; coordinates North 897292.594, East 2040674.807 [Georgia State Plane, West Zone]. The Site is approximately 4.04 acres. The Subject Property, for which the Limitation of Liability is being requested, is the eastern part of the Site, which is approximately 2.690 acres. Descriptions of the Site and Subject Property are given in Section 2.1 of this CSR. To reiterate, the CSR is written for the entire Site and a Limitation of Liability is being requested only for the Subject Property.

Most recently, prior to the Site's development as a park, it was the location of a United Cities Gas Service Center and a small Georgia Power Company (GPC) substation. Historically the Site was the location of the Columbus MGP. The Site underwent an extensive environmental investigation and was remediated by Georgia Power Company and other PRPs under EPD oversight in the early 1990s. The Georgia Power Fieldcrest substation underwent an investigation in 2003. It was determined that no remedial action was necessary.

The objective of this CSR is to certify compliance with risk reduction standards for soil in accordance with Article 9, and to establish baseline conditions of groundwater quality prior to requesting a Limitation of Liability from the EPD, and the purchasing of the property by CSUF. Article 9 references the Georgia Hazardous Site Response Act (HSRA) regulations pertaining to risk reduction standards. Although the former MGP Site was assessed and remediated prior to the passage of HSRA in 1992, this CSR follows the general HSRA guidelines. Historical information from the assessment and remediation of the former MGP Site, recently collected soil sample results, and institutional controls for the Site will be used to demonstrate compliance with risk reduction standards.

Section 2
Site Background

2.1 Current Site Description and Surrounding Land Use

The Site is currently being used as a public access park and recreational area for the City of Columbus' Riverwalk. A site location map is provided as Figure 1. As a park, the Site is covered in grass and trees with a concrete walkway running alongside the Chattahoochee River. The Site is located in the southwest section of the central business district of Columbus, Georgia, Muscogee County, between the Chattahoochee River and Bay Avenue. The Site (shown in Figure 3) is bordered on the south by Dillingham Street and on the north by a continuation of the Columbus Riverwalk. Surrounding land use is light commercial offices, and retail. The entire Site is approximately 4 acres.

The Subject Property is on the eastern part of the Site. The Subject Property is shown on Figure 2 and a detailed legal description is presented in Appendix A. The total area of the Subject Property is 2.690 acres.

2.2 Site History - Land Use and Operations

The first known development of the Site was for a Manufactured Gas Plant (MGP). MGP operations were conducted on the Site by the Gas Light Company of Columbus, which was chartered in 1854. The Gas Light Company of Columbus was located on property originally owned by the City of Columbus. Manufactured gas was produced at the Site from 1854 until 1931 by three different processes: extraction from wood (1854-1865), extraction from coal (1865-1928), and carbureted water gas (1918-1931). Manufacturing operations ceased in 1931 when natural gas was introduced to the area. Since that time, the Site has been used for various natural gas industrial service activities.

The Fieldcrest Electrical 115/12 KV Substation was operated by GPC on the southeast corner of the Site from 1957 until 2003, at which time it was decommissioned, an environmental assessment was conducted, and site restoration was completed. CSUF is the prospective purchaser of this property, which is currently owned by GPC.

The MGP Site was the subject of extensive assessment activities in 1990 and 1991. These assessment activities were conducted to determine the extent of MGP constituents and residuals present in soil and groundwater. Following assessment activities, a site remediation plan was developed that utilized an insitu solidification process to stabilize and immobilize the contaminants and residuals of concern. Site remediation began in January 1992 and was

completed in June 1992. Following remediation, the City of Columbus completed construction of the Columbus Riverwalk, which includes the former MGP Site.

In response to the enactment of the HSRA Program, on April 1, 1996, the Columbus City Manager submitted a post-remediation HSRA release notification to the EPD. In correspondence dated May 23, 1996, the EPD stated that, based upon the release notification data, there was no reason to believe that a release exceeding a reportable quantity has occurred at the Site. Therefore, the Site was not listed on the Georgia Hazardous Site Inventory.

2.3 Physical Setting

2.3.1 Regional Geology

The average ground elevation of the Site is 234 feet above mean sea level (msl). The bank along the Chattahoochee River has a steep 2:1 slope from 234 feet to 190 feet msl. The Site is situated in Muscogee County at the boundary between the Piedmont Physiographic Province and the Coastal Plain Physiographic Province known as the Fall Line. The Piedmont is composed of crystalline metamorphic rocks with scattered igneous intrusions upon which the Coastal Plain sediment onlap at the Fall Line. The bedrock in the area consists of granites, gneisses, granite-gneisses, and schists.

The bedrock is uncomformably overlain by the Tuscaloosa Formation in the Columbus area. The crystalline rocks had been deeply weathered by the time the Tuscaloosa sediments were deposited on them. Basal conglomeratic beds within the Tuscaloosa Formation contain angular gravel fragments of resistant vein quartz, reflecting the weathered character of the bedrock.

The Tuscaloosa Formation crops out in the Chattahoochee River area near Columbus. The formation is wedge-shaped, dipping south-southeastward and is approximately 250 feet thick in the Chattahoochee River Valley near Columbus. The Tuscaloosa Formation dates from the Cretaceous period and generally consists of fine- to coarse-grained gravelly, arkosic, micaceous, cross-bedded, slightly indurated, non-marine sand with layers of mottled clay and silt. (Eargle, 1955; Marsalis and Friddell, 1975).

Stream alluvium and undifferentiated terrace deposits are present along the banks of the Chattahoochee River at the Site. These deposits vary in thickness and aerial extent and generally are composed of sands and gravel.

2.3.2 Site Geology

The Site lithology consists of fill materials overlying stream alluvium and undifferentiated terrace deposits that make up the banks of the river. The alluvium is underlain throughout the Site by a clayey saprolite (Chapman and Cutler, 1991). The fill

material consists of imported river sands, coal and cinder fragments, construction debris, and miscellaneous trash. During previous pre-remediation site investigations, refractory brick, wood, and clinker were also observed in the fill material. The fill material is underlain by unconsolidated sediments. These sediments generally are fine sand and silt or silty sand with occasional clay lenses grading in color from brown-gray to light brown-orange. The thickness of this horizon varies across the Site. The fine silty sand tends to coarsen with depth and grade into a generally light brown to orange, medium to coarse-grained sand and gravel. The unconsolidated sediments underlying the Site were not indurated and are likely alluvial terrace deposits and not part of the Cretaceous Tuscaloosa Formation. Saprolite, or weathered bedrock, was encountered below the coarse sand and gravel. The saprolite is weathered granite-gneiss and varies in color from gray-brown, to rust-brown, to mottled light gray and yellow, to red. Due to the remedial efforts in 1992, a section of the subsurface at the Site, approximately 92,000 cubic yards, consists of Site sediments stabilized with Portland Type II cement from an elevation of 226 feet to 190 feet msl.

2.3.3 Site Hydrogeology

In the vicinity of the Site, groundwater generally flows from east to west perpendicular to and discharging into the Chattahoochee River. Groundwater at the Site flows around the stabilized material and then discharges directly into the river. At the Site, the depth of the top of the water table is approximately 30 to 33 feet below grade. The water table aquifer is approximately 10 feet thick and is underlain by the saprolite layer. The saprolite acts as a low permeability aquiclude separating or restricting flow between the water table aquifer and groundwater in the bedrock beneath the saprolite. The crystalline bedrock underlying the area generally is impermeable and yields little water except where fractures exist.

2.3.4 Surface Water

The Site is bordered on the west by the Chattahoochee River. Seasonal variations in rainfall and runoff cause a characteristic cycle of high base flows from January to April, followed by receding based flows until October, after which the river tends to remain low until December. The river stage varies several feet during the day because of the regulation of flow across dams located upstream of Columbus.

Section 3
Pre-Remediation Site Investigations

Three site investigations were conducted on the Site prior to remediation. Phase I and Phase II site investigations were conducted for the former MGP in 1990 and 1991. The third investigation was conducted in October of 1991 to obtain additional soil data on impacted materials for remedial design.

MGP residuals and the associated chemical constituents were the focus of these investigations. MGP residuals included tars and light oils, which were removed from or added to the gas streams during production. In addition, gas purifier wastes potentially containing primarily complexed cyanide, and coal ash were potential sources of impacts. The chemicals characteristically associated with these residuals and MGP processes include VOCs, phenols, PAHs, and cyanide.

3.1 Phase I Investigation

A Phase I site investigation (Columbus, Georgia MGP Site Phase I Site Assessment Information) was completed by Atlantic Environmental Services, Inc. and Remediation Technologies, Inc. in March 1991. The investigation activities included advancing eleven borings (H-1 through H-11) and the installation of eight monitoring wells (MW-1, 2, 3, 4, 5S, 5D, 6 and 7) between December 1990 and February 1991. The locations of these borings and monitoring wells can be seen on Figure 4. All of the monitoring wells (except MW-5D) were installed in the shallow water table aquifer, which was approximately 31 to 40 feet below grade. Well MW-5D was installed in the bedrock aquifer at a depth of approximately 65 feet. Thirteen soil samples, and eleven groundwater samples were collected onsite and analyzed for MGP materials. Three surface water samples, and three sediment samples were collected from the Chattahoochee River adjacent to the Site and analyzed for MGP materials. Sample analysis confirmed the presence of MGP constituents in the soil and groundwater. Toxicity Characteristic Leaching Procedure (TCLP) analysis conducted on MGP tar impacted soil indicated that the impacted soil was not characteristically hazardous. The soil and groundwater results of this sampling effort are presented in Appendix B and C, respectively.

3.2 Phase II Investigation

IT Corporation completed a Phase II investigation of the Site (Columbus, Georgia Manufactured Gas Plant Site Investigation and Remediation Report) in August 1991 to further delineate the extent of the MGP materials and to assist in the development of a remediation method. The field investigation was conducted in June and July of 1991 and consisted of advancing fifteen

soil borings (B-13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28 and 29) and installing one monitoring well (MW-8). The locations of these borings can be seen in Figure 4. Eleven soil samples were collected for analysis of MGP parameters. During the investigation, all nine monitoring wells at the Site were sampled and analyzed for MGP parameters. Additionally, two wells (MW-4 and MW-7) were also sampled and analyzed for primary water quality parameters (calcium, iron, magnesium, sodium, fluoride, chloride, nitrate, sulfate, total organic carbon, pH, and specific conductance). The results of the Phase II investigation soil and groundwater analysis are presented in Appendix B and C, respectively.

3.3 Benchmark Soil Sampling

The third investigation, conducted in October of 1991, was performed to obtain additional data on impacted materials for remedial design. Benchmark Engineering compiled the data from this fieldwork into a report entitled "Analytical Results of Soil Sampling" dated February 1992. The fieldwork included advancing fourteen borings (BH-1A, BH-8A, BH-11A, and B-30 through B-40) from which seventy-four samples were taken for analysis of MGP constituents. The results of these analyses are shown in Appendix B and the locations are shown in Figure 4

Section 4
Remedial Activities

The "Quality Control Report, Columbus MGP Site, Columbus Georgia" prepared by Benchmark Engineering, dated November 1992, presents the details of the remedial activities conducted at the Site. Site remediation began in January 1992 and was completed in June 1992. The objective of the remediation was to excavate and dispose of or insitu stabilize impacted soil above remedial goals established by the EPD. It was determined that the process of stabilizing the impacted soils, and the exothermic reaction resulting from the curing of the stabilization agent (Type II Portland Cement) would remediate and/or allow for the natural attenuation of impacted groundwater on the Site.

The final outline of the excavation/stabilization area is shown in Figure 3. The Site was excavated to an elevation of 226 feet msl. Part of the Site was further excavated to an elevation 212 feet msl. A total of 85,450 cubic yards of material were excavated and segregated for disposal, or reuse based upon the Site remedial goals. Some materials were screened of rubble and debris and returned to the Site for stabilization. The affected soils not returned to the Site for stabilization were sent to the Subtitle D, Live Oak Landfill in Conley, Georgia that was operated by Waste Management, Inc. Soil was classified as affected and requiring remediation based on the following remedial goals:

- Total Petroleum Hydrocarbons (TPH) > 500 mg/kg
- Polynuclear Aromatic Hydrocarbons (PAHs) > 200 mg/kg
- Carcinogenic polynuclear aromatic hydrocarbons (PAHs) > 100 mg/kg
- Benzene, Ethylbenzene, Toluene, Total Xylenes (BTEX) > 100 mg/kg

The stabilization process involved blending Type II Portland Cement with the soil using a crane-mounted, eight-foot-diameter hollow-stem auger with injection nozzles. An overlapping drill pattern was used to form a monolithic block of stabilized material containing 10 percent cement keyed one foot into the saprolite layer. Twenty-five percent cement was added to each of the overlapped columns along the Chattahoochee River, which were keyed into saprolite three feet to form a stable wall. Soil in a 30-foot to 50-foot wide area in front of the wall, along the Chattahoochee River, was excavated to the top of saprolite in preparation for the City of Columbus' construction of a combined sewer and the Columbus Riverwalk. A total of 92,000 cubic yards of Site soil was stabilized into the top of saprolite. After stabilization, excess treated material was removed and disposed at the Columbus Municipal Landfill. The final grade of the

stabilized block was 226 feet msl. A 60-mil HDPE liner was placed on top of and slightly overlapping the sides of the stabilized block. Three feet of compacted fill, one foot of clay and two feet of topsoil were placed immediately above the liner to bring the Site to a final grade of 230 feet msl. The unused non-affected material was stockpiled at the sand borrow pit operated by the City of Columbus for reuse by the City as daily cover at the Muscogee County Landfill. Following remediation, during construction of the Columbus Riverwalk park and recreation area, additional fill was added to the Site. A recent Site survey showed an elevation of approximately 232.6 feet msl.

Following the completion of remedial activities at the Site, GPC and the PRPs presented to EPD the results of the remediation in the "Quality Control Report, Columbus MGP Site, Columbus Georgia" prepared by Benchmark Engineering, dated November 1992. The Quality Control Report concluded that the remediation had achieved soil remediation goals. A post-remediation groundwater monitoring plan was developed, submitted to the EPD, and implemented to confirm the effectiveness of the remediation and to monitor for potential releases of MGP constituents to groundwater from the stabilized soil block. The results of this monitoring program are presented in the Section 5.2 of the CSR.

Section 5
Post-Remediation Site Investigation & Groundwater Monitoring

5.1 Soil – Historic Data Evaluation, Site Surface Soil and Substation Investigation

5.1.1 Historic Soil Data Relevant to Brownfield Evaluation

In order to determine the compliance status of the Site relative to risk reduction standards, it was necessary to determine which of the historic MGP soil data are relevant to current Site conditions. The following method was used to determine which previously collected sample data no longer represent soils present at the Site. First, it was determined which sample locations were located within the footprint of the excavation/stabilization area. Next, the elevations of the sample intervals were compared to excavation and stabilization elevations. Surface elevations were obtained from soil boring logs. When the boring logs did not indicate the surface elevation, an elevation of 234 feet msl was assumed. Sample locations within the smaller excavation area (referred to in Section 4 of the CSR), which had a final excavation grade of 224 feet msl, with sample interval elevations higher than 224 feet msl were assumed to be excavated from the Site. Sample locations within the remaining excavation area, which had a final excavation grade of 212 feet msl, with sample interval elevations higher than 212 feet msl were assumed to be excavated. All borings in the excavation/stabilization area that were not excavated were assumed to be stabilized. The stabilized samples were no longer considered to be soil, and, thus, were not considered to be relevant. A list of the pre-remediation MGP samples collected and their status relative to the Brownfield site evaluation are presented in Table 1. The analytical results for the previously collected MGP soil samples that represent current soil conditions (those samples not excavated or stabilized) are presented in Table 2 and the locations of these samples are shown on Figure 6. It should be noted that not all of these relevant samples are located in the Subject Property being purchased by CSUF.

5.1.2 Former Georgia Power Substation Assessment

The GPC Fieldcrest Electric Substation, formerly present in the southeast corner of the Site, ceased operations in 1999. SBX Technologies, Inc. performed a site investigation on behalf of GPC in July 2003. The investigation was to determine the presence or absence, and concentrations of polychlorinated biphenyls (PCBs) in the soil and former

equipment concrete pads in the substation. A total of forty-nine soil samples were collected from forty-six locations. The results of the soil analysis are shown in Table 3. The locations of the soil samples are shown in Figure 5. All but two of the soil results were less than the laboratory detection limit. The two soil samples with PCB detections had concentrations below the HSRA Type 1 Risk Reduction Standard of 1.55 mg/kg and the Region 4 EPA Toxic Substances Control Act (TSCA) remedial goal of 1.0 mg/kg for unrestricted site use. As a result, no remedial action was required for the soils at the substation. See the "Retired Fieldcrest Electric Substation Site Investigation, August 13, 2003" in Appendix D for more detailed information.

5.1.3 2004 Surface Soil Investigation

Following remediation, during construction of the Columbus Riverwalk park and recreation area, additional fill was added to the Site. A recent Site survey showed an elevation of approximately 232.6 feet msl indicating approximately two to three feet of fill material was added to the Site following remediation of the Site by GPC and the PRPs. To enable the evaluation of this fill material relative to risk reduction standards for the Brownfield program, a representative soil-sampling program was designed and implemented by RMT, Inc. In January 2004, eleven soil samples were collected at the Site using a 200 by 100 foot grid, oriented north and south respectively. These samples (SB-100 to SB-111) were analyzed for BTEX, PAHs and the list of eight RCRA metals. The analytical results are presented in Table 4. Figure 6 shows the locations of these samples in addition to the locations of the historic samples that are still relevant to the current Site.

Samples were collected from the surface to a depth of two feet using pre-cleaned hand-augers dedicated to each sample location. Soil remaining after packing the sample containers was returned to the borehole, which was then brought to grade with clean sand. Soil samples collected during the investigation were secured in ice-filled coolers and shipped by courier to the Georgia Power Laboratory located in Smyrna, Georgia (EPD Laboratory Certification No. E57554). Laboratory work orders, and chain-of-custody (COC) documents, which included information on project name and number, sampler(s) signature, project manager's name, sample matrix, sample identification/station ID number, date and time of sample collection, requested analyses and any other pertinent comments for the laboratory, were placed within each cooler for shipment. Soil samples were analyzed for BTEX by USEPA Analytical Method 8260A, PAHs by USEPA Analytical Method 8270C and for the list of eight RCRA metals using USEPA Analytical Method 6010B. Laboratory analytical data sheets and COC's are in Appendix E.

5.2 Groundwater Monitoring

A post-remediation monitoring plan was developed by IT Corporation in March 1992 to confirm the effectiveness of the remediation plan and to monitor for potential releases to groundwater of MGP constituents from the Site and stabilized block of soil. The plan entitled "Columbus Manufactured Gas Plant Site: Post remediation Monitoring Plan" was submitted to EPD. As per the plan, ten groundwater monitoring wells were installed (nine shallow wells and one downgradient bedrock well) in 1993. Figure 7 shows the location of the post-remediation groundwater monitoring wells. The plan required quarterly sampling the first year and semiannual sampling each subsequent year, with an evaluation of results at the end of five years to determine if additional monitoring was required. The groundwater was analyzed for VOCs, PAHs and cyanide. Table 5 shows the list of individual constituents that were monitored. The results of the monitoring were evaluated after five years, as specified in the monitoring plan. Based on the prevalence of non-detected results, the monitoring was discontinued after the August 1997 sampling event. Additional voluntary monitoring was conducted by GPC in September of 2000 and in the spring of 2003. In total, after remedial action at the site, fourteen rounds of sampling were performed. Table 6 shows a comparison between the data collected prior to remediation, and the post-remediation monitoring data including the 2000 and 2003 sampling events results. The post-remediation monitoring wells are not in the same locations as the pre-remediation wells. Therefore, the pre-remediation well closest to the post-remediation well was used for comparison. The comparison shows that total PAHs decreased from a high of 6449 µg/L pre-remediation to non-detect (< 10 µg/L per constituent) after remediation. Similarly, total BTEX concentrations declined from 634 µg/L to non-detect, with the exception of one benzene hit (1.99 µg/L) in well GPC-10 in January 1997. This detected concentration was below the USEPA Safe Drinking Water Act Maximum Contaminant Level (MCL) of 5 µg/L. Total cyanide concentrations have also decreased from the pre-remediation levels. With the exception of the first sampling event, all results have been less than the total cyanide MCL of 200 µg/L. The monitoring plan called for the statistical analysis of monitoring results. However, because the majority of results were non-detect, statistical analysis was not performed on PAHs and BTEX. In the final monitoring report, a linear regression was performed on total cyanide results from wells with adequate numbers of non-detect to perform statistical analyses. The analysis showed that total cyanide concentrations were decreasing with time. The conclusion drawn from the monitoring results was that the remediation efforts at the Site were successful. (Final Post-remediation Monitoring Report: Second Semiannual Sampling Event, January 1998).

The results of the 2000 and 2003 analyses will be used as a baseline for groundwater conditions at the Site for the purposes of the EPD granting a Limitation of Liability as defined in Article 9, and prior to the purchase of the Subject Property.

Section 6
Potential Receptors Survey

6.1 Potential Environmental Receptors

The former Columbus MGP Site is located in the northwest quadrant of the United States Geological Survey (USGS) Columbus, Georgia-Alabama Quadrangle. Information on special concern animals, plants, and natural communities for the Site was obtained from the Georgia Department of Natural Resources Natural Heritage Program. The Rare Natural Elements list on the Georgia Natural Heritage Program web site (www.ganet.org/dnr/wild) was published on June 11, 2003. Rare species information from this database indicates the occurrence of the following rare species in the northwest quadrant of the USGS Columbus, Georgia-Alabama Quadrangle.

- Georgia Protected Species: *Alasmidonta triangulata* Southern Elktoe, *Croomia pauciflora* Croomia, *Elliptio arctata* Delicate Spike, *Elliptio fraterna* Brother Spike, *Elliptio nigella* Winged Spike, *Elliptio purpurella* Inflated Spike, Macrochelys *temminckii* Alligator Snapping Turtle.

- Federally Protected, Candidate, or Partial Status Species: *Elliptoideus sloatianus* Purple Bankclimber, *Lampsilis binominata* Lined Pocketbook, *Lampsilis subangulata* Shinyrayed Pocketbook, *Lasmigona subviridis* Green Floater, *Medionidus penicillatus* Gulf Moccasinshell, *Pleurobema pyriforme* Oval Pigtoe, *Rhus michauxii* Dwarf Sumac, *Strophitus subvexus* Southern Creekmussel.

6.2 Potential Exposure Routes – Human and Environmental

The area defined as the Site is nonresidential property, and is currently being used as a park. The area is currently grassed or paved. CSUF intends to use the Subject Property for park, landscaping and educational purposes. With this future use, the site will likely not change its current condition of being primarily covered with grass.

The Site is bordered by the Chattahoochee River on the west, and groundwater from the Site flows directly into the river. Because groundwater flows directly into the river after crossing the Site, there was no need to conduct a well survey. No wells other than post-remediation monitoring wells are present onsite. The City of Columbus potable water treatment plant intake from the Chattahoochee River is located upstream of the site. Thus, groundwater at the Site is not a potential exposure route. In addition, in 1996 the EPD reviewed an HSRA notification containing soil and groundwater data submitted for the Site and determined the site

not have a release exceeding a reportable quantity and would not be listed on the Georgia Hazardous Site Inventory.

There are currently no direct soil exposure routes due to the presence of vegetative cover or pavement cover, and there is no direct exposure route anticipated with the future land use due to the presence of vegetative or pavement cover. In addition, at least two feet of clean fill cover the Site. Furthermore, there are no constituent concentrations that exceed the Type 4 Risk Reduction Standards for soil (see Section 7 for description of the Risk Reduction Standards analysis). To calculate Type 4 Risk Reduction Standards for soil the four most likely human receptor scenarios during the future development of the Site were considered: groundskeeper, adult and child visitor, and a hypothetical construction worker if the Site is ever redeveloped. A comparison of the Type 4 Risk Reduction Standards to the Site soil data indicated that concentrations of constituents in soil were below the Risk Reduction Standards, indicating the exposure under the human exposure scenarios above are within acceptable limits.

Potential environmental receptors may include burrowing species of animals that can inhabit or frequent urban areas. Because the site has been developed and landscaping is and will be maintained, the environmental species identified in Section 6.1 are not anticipated to inhabit the Site.

Section 7
Risk Reduction Standards

The objective of this CSR is to certify compliance with risk reduction standards for soil in accordance with Article 9, and to establish baseline conditions of groundwater quality prior to requesting a Limitation of Liability from the EPD and purchasing the property. Article 9 references the HSRA regulations pertaining to derivation of risk reduction standards and evaluating a site's data relative to risk reduction standards. Although the former MGP Site was assessed and remediated prior to the passage HSRA in 1992, this CSR follows the HSRA guidelines for determining and evaluating Site data relative to Site risk reduction standards. To determine Site compliance with Risk Reduction Standards, historical soil data determined relevant to current Site conditions from the assessment and remediation of the former MGP Site, and recently collected soil sample results were compared to the HSRA Type 3 and Type 4 non-residential Risk Reduction Standards. The evaluation determined that the soil surrounding the stabilized/solidified material is in Compliance with Type 4 Risk Reduction Standards for soil. The stabilized/solidified portion of the Site was reviewed relative to the definition of soil and source material as defined in the HSRA Rules (§391-3-19-.02(x) and (y)). The review is discussed in Section 7.3 below.

In addition, historical and recent groundwater monitoring data collected in 2000 and 2003 were evaluated to establish baseline conditions for groundwater quality at the Site.

7.1 Type 3 Risk Reduction Standards for Unconsolidated Soil

HSRA Rule 391-3-19-.07(8) and "Guidance on Target Soil Concentrations for Type 3 Risk Reduction Standards, March 9, 1995" (Guidance) were used to determine Type 3 Risk Reduction Standards in soil. Per the Rules and Guidance, the subsurface soils, defined as those soils from the land surface to the water table, were compared to the maximum of the following: Appendix I notification concentration of the HSRA Rules; Appendix III Table 1 value multiplied by 100; and Appendix III, Table 2. The surface soils, define as those soils from the land surface to a depth of two feet, were compared to the lesser of the following: the Type 3 Risk Reduction Standard for subsurface soils; calculated value for noncancer toxic effects using Equation 7 of Risk Assessment Guidance for Superfund (RAGS), Part B; and calculated value for cancer risk using Equation 6 of RAGS, Part B. Both of the calculated values were based on standard non-residential (industrial worker) exposure assumptions from Table 3 of Appendix III of the HSRA regulations. When Type 3 Risk Reduction Standard values were not available for subsurface soil, the calculated values for surface soil were used.

Table 7 shows a comparison of the maximum detected concentrations in surface soil and subsurface soil to Type 3 Risk Reduction Standards. As demonstrated in Table 7, all of the surface soil samples were below their respective Type 3 Risk Reduction Standards. However, the following constituents exceeded Type 3 Risk Reduction Standards for subsurface soils at some sample locations: benzo(a)pyrene, benzo(b,k)fluoranthrene, chrysene, benzo(a)anthracene, indeno(1,2,3-cd)pyrene , dibenzo(a,h)anthracene, naphthalene, pyrene, and benzene. Therefore, Type 4 Risk Reduction Standards for soil at the Site were derived and are evaluated below.

7.2 Type 4 Risk Reduction Standards for Unconsolidated Soil

Type 4 Risk Reduction Standards for soil were calculated according to the criteria specified in the Rules (§391-3-19-.07(9)). The Type 4 Risk Reduction Standards for soil were determined as the lesser of the noncancer and cancer constituent concentrations using specified RAGS equations. RAGS, Part B Equation 7 was used to calculate the noncancer concentration using a Target Hazard Index of 1. Equation 6 from RAGS, Part B was used to calculate the cancer concentration using an estimated excess cancer risk of less than 10^{-5}. RAGS, Part B Equation 8 was used to determine the soil-to-air volatilization factor for use in RAGS Equations 6 and 7.

Type 4 Risk Reduction Standards were calculated for four different scenarios for different periods of Site development. The primary future end use of the Site is similar to its current land use – that of a park. The receptor that would most likely have any exposure and the longest exposure duration is a facility groundskeeper. It is assumed that the groundskeeper would be the only receptor with a repeated exposure to the surface soils at the Site. Thus, the maximum detected surface soil concentrations are compared to the groundskeeper Type 4 Risk Reduction Standards in Table 8. It was assumed that the groundskeeper would work one day a week for 25 years. Others visiting the Site are assumed to be more transient in their visits to the Site and likely would not be exposed to the soil.

Other potential receptors for the current and future uses of the Site are adult and child visitors. It is assumed that they would only be potentially exposed to surface soils. Thus, the maximum surface soil concentrations are compared to adult and child visitor Type 4 RRS in Table 8. It is assumed that these visitors would visit the Site three times every two weeks for 3.5 hours per visit (or 5.25 hr/week). These values were assumed based on information provided in the Exposure Factors Handbook, which indicates 5.5 hr/wk being spent during leisure activities and 207 min/d being spent by children while at a park).

A potential future scenario to represent a time in the future if the site is ever redeveloped was also evaluated. A construction worker exposed to all soils (surface and subsurface) was considered for this scenario. Thus, the maximum detected soil concentrations are compared to the construction worker Type 4 Risk Reduction Standards in Table 8. This table shows that all soil at the Site meets the Type 4 Risk Reduction Standards for the construction worker scenario.

The exposure assumptions for the construction worker are values recommended by the Illinois Environmental Protection Agency, which assumes a thirty-day exposure. See Appendix F for detailed information regarding the exposure assumptions and risk calculations.

Values for the chemical specific factors were taken from current available literature. Slope factors and reference doses were taken from the Integrated Risk Information system (IRIS). Where values were not published in IRIS, they were taken from the EPA Region 9 Preliminary Remediation Goals Table or from the EPD Guidance on Target Soil Concentrations for Type 1 and Type 3 Risk Reduction Standards. Physicochemical properties of the chemicals (such as diffusivity, Henry's law constant, and organic carbon-water partition coefficient) were taken from the EPA Region 9 Phys-Chem Data table or the EPD Guidance on Target Soil Concentrations for Type 1 and Type 3 Risk Reduction Standards. If any of the physicochemical parameters (diffusivity, Henry's law constant, and organic carbon-water partition coefficient) were not available, the inverse of the soil-to-air volatilization factor was set to zero, as per the EPD Guidance on Target Soil Concentrations for Type 1 and Type 3 Risk Reduction Standards. The chemical specific parameters used can be found in Appendix F.

Table 8 shows that the Site soil is in compliance with Type 4 Risk Reduction Standards since the maximum soil concentrations did not exceed any of the Type 4 Risk Reduction Standard scenarios. Fourteen rounds of groundwater sampling and analysis have been conducted since 1993. The last thirteen rounds of groundwater sampling had results that were either non-detect or below MCLs (see Table 6) since May 1993, demonstrating that the Site soil: 1) does not leach to groundwater at levels of concern, and 2) is in compliance with Type 4 Risk Reduction Standards (§391-3-19-.07(9)(d)1). Additionally, as stated in the restrictive covenants (see Appendix G), appropriate health and safety measures will be implemented during any construction on the Site to protect construction workers.

7.3 Evaluation of the Stabilized/Solidified Material

Remediation at the Site included the stabilization and solidification of 92,000 cubic yards of MGP impacted soil and aquifer materials. The stabilization/solidification met corrective action plan performance criteria for unconfined compressive strength, permeability, and Toxicity Characteristic Leaching Procedure (TCLP) limits established for the stabilized/solidified material. These performance criteria are described in detail in the "Work Plan, Columbus MGP Site, December 10, 1991", prepared by Benchmark Engineering that was submitted to the EPD. For the Brownfield CSR, the stabilized/solidified material remaining in the subsurface onsite was evaluated relative to the definition of soil and source material as defined in the HSRA Rules (§391-3-19-.02(x) and (y)).

As stated in §391-3-19-.02(x), the definition of soil is, "any unconsolidated earth material ...". The stabilized/solidified block of material was consolidated by mixing impacted soil with 10% to 25% Type II Portland cement using a crane-mounted, eight-foot-diameter hollow-stem auger

with injection nozzles. Therefore, this material does not conform to the definition of "soil" as stated in the Rules.

As stated in §391-3-19-.02(y), the definition of source material is, "any material that includes or contains regulated substances that act or may likely act as a reservoir for migration of regulated substances to groundwater, soil, surface water, or air, or acts as a source for direct exposure." Following remediation, beginning in 1993, a groundwater monitoring plan was implemented requiring quarterly sampling the first year and semiannual sampling each subsequent year, with an evaluation of results at the end of five years to determine if additional monitoring was required. Groundwater monitoring was discontinued after the August 1997 sampling event following an evaluation of five years of data. Additional voluntary monitoring was conducted by GPC in September, of 2000 and in the spring of 2003. Fourteen rounds of groundwater monitoring have been conducted since 1993. The groundwater monitoring data has demonstrated that the stabilized material has not leached constituents to groundwater, and therefore does not, "act as a reservoir for migration of regulated substances to groundwater, soil, surface water". Details of the groundwater monitoring are in Section 5.2 of the CSR.

Ten years after the completion of the remediation, the Electric Power Research Institute (EPRI) conducted and evaluation of the effectiveness and current state of the insitu solidification/stabilization remediation conducted at the Site. This study involved the collection, inspection and testing of drill cores from the stabilized/solidified soils and liner, and soil covering these materials. Testing included geotechnical testing of structural characteristics, solid phase geochemistry testing, solidified media contaminant laboratory analysis, leachability testing of solidified media, and groundwater modeling of the Site. The study concluded that, "After 10 years the structural integrity and geochemical nature of the solidified mass continues to exceed the original performance standards established prior to implementation of S/S (solidification/stabilization). These data reveal no evidence that the long-term future integrity of the Site would be less stable than current Site conditions. Therefore, the utilization of S/S at the Site was an appropriate long-term treatment method for contaminated MGP soils." (EPRI, 2003) This EPRI study further confirmed that the stabilized/solidified block of material does not, "act or may likely act as a reservoir for migration of regulated substances to groundwater, soil, surface water, or air, or acts as a source for direct exposure ", and therefore does not conform to the definition of "source material" as stated in the Rules.

To further mitigate any risk of exposure and to preserve the integrity of the stabilized soil block, the block was covered with a 60-mil HDPE liner. The integrity of the stabilized/solidified material and HDPE liner will be protected by restrictive covenants that will run with the property as part of the property transfer to CSUF. These restrictive covenants are in Appendix G, and are summarized in Section 8 of the CSR.

In consideration of the information presented above, the Site meets the requirements of Type 4 Risk Reduction Standards for soil, and based upon the fourteen rounds of post-remediation monitoring results, it is proposed that no additional groundwater monitoring be required for Type 4 Risk Reduction Standard approval.

7.4 Baseline Conditions for Groundwater

As presented in Section 5.2, groundwater at the Site has been monitored following remediation since 1992, resulting in a total of fourteen monitoring events. The monitoring implemented after remediation of the site was discontinued after the August 1997 sampling event because the monitoring had shown five years of non-detected concentrations of BTEX and PAHs with a few minor exceptions and low levels of total cyanide. Recent groundwater sampling conducted in 2000 and 2003 confirmed these results. Thus, the baseline for groundwater quality can be set at the most recent, 2003 sampling event results. The baseline for groundwater is as follows:

- PAHs – less than the practical quantification limit (PQL) (10 µg/L for each PAH)
- BTEX - less than the practical quantification limit (2 µg/L for benzene, toluene and ethylbenzene; 5 µg/L for xylenes)
- Total cyanide – less than the most recent maximum contaminant level (50 µg/L)

Section 8
Restrictive Covenants

In order to preserve the integrity of the stabilized/solidified soil block and HDPE liner covering the stabilized material, restrictive covenants that will run with the property have been proposed as part of the property transfer to CSUF. These restrictive covenants are in presented in Appendix G. The position of the stabilized/solidified material within the Site is shown on Figure 3. To reiterate, the soils that surround and cover the stabilized soil block are in compliance with Type 4 Risk Reduction Standards, and the stabilized material does not meet the definitions of either soil or source material. Based upon groundwater monitoring the stabilized material does not provide a reservoir for contaminants to migrate to soil, groundwater, surface water, or air. The stabilized/solidified material is covered by a 60-mil HDPE liner, overlain by three feet of compacted fill, overlain by one foot of compacted clay, which is overlain by two to three feet of topsoil to bring the Site to current grade. A baseline for the Groundwater quality has been set based on evaluation of historical groundwater monitoring and recent events conducted in 2000 and 2003.

The covenants are summarized as follows.

- No current or future owner of the Site properties shall perform any "activity" that can or has the potential to compromise the integrity of the stabilized/solidified material, the overlying HDPE liner, the two feet of compacted fill immediately overlying the liner, or within two feet of the sides of the solidified mass. In addition, groundwater monitoring wells have been installed and are maintained by GPC on portions of the Site, and cannot be disturbed or abandoned without prior consultation with GPC.

- "Activity" is defined as, but not limited to, constructing buildings, structural foundations or supports, aspects of construction involving subgrade penetration, placement of subgrade utilities, subgrade irrigation systems, etc.

- Any future plans for the Site that involve activities described, but not limited to, those above, shall be submitted to GPC for review and approval to ensure compliance with the requirements of the restrictive covenants.

- "If such plans include the construction of a building into or over any portion of the ...(Site), those plans shall also include (construction and maintenance of) a vapor extraction system, designed to ensure that vapors potentially emanating from the ...(solidified mass)... in the future do not collect within the building... unless (this) requirement is otherwise waived in writing by GPC." Waiver of this requirement would

require the presentation of other alternative vapor migration control/mitigation methods and supporting data.

- Any future construction activities shall be accompanied by the preparation and implementation of "an environmental health and safety plan to address the possible exposure of workers to the potential hazards which may exist on the (Site)."

- As part of any such construction activity, "any materials taken from the (Site)...shall be handled and transported in accordance with all applicable laws and regulations and shall be disposed of at a disposal facility permitted to take such materials and in accordance with all applicable laws and regulations. In no event shall the two feet of compacted fill immediately above the liner in the Restricted Area be disturbed. Should suspected or confirmed hazardous substances, wastes or materials be encountered during excavation, grading or construction activities on the (Site), the (builder/constructor or its representatives) shall cease all soil disturbing activities in the affected area, shall immediately notify GPC, and shall refrain from recommencing soil disturbing activities in the affected area until receiving further notice from GPC. Should the (builder/constructor or its representatives) at any time otherwise obtain knowledge of any hazardous substance, waste or material on the (Site), the (builder/constructor or its representatives) shall immediately notify GPC."

- "GPC shall have the right to enter onto the (Site) at any reasonable time to perform any environmental investigation or remediation of the (Site), including without limitation, sampling, analysis, removal or remediation of soil, water, air, groundwater, source material and/or stabilized soils; installation, maintenance or closure of new and existing groundwater monitoring wells; and installation or maintenance of any equipment or related structure on the (Site)."

(Declaration of Covenants and Cross Easements, 2004, see Appendix G)

Section 9
Status of Compliance

Site compliance was evaluated as stated in Georgia Hazardous Waste Management Act, Article 9 – Hazardous Site Reuse and Redevelopment, as amended August 2002 [OCGA 12-8-200]. Historical soil data determined to be relevant to current Site conditions from the assessment and remediation of the former MGP Site, and recently collected soil sample results were compared to the HSRA Type 3 and Type 4 non-residential Risk Reduction Standards derived for the Site. Type 4, site-specific, Risk Reduction Standards for soil were calculated according to the criteria specified in the Rules (§391-3-19-.07(9)). The surface soil meets both the Type 3 Risk Reduction Standards (which model an industrial worker who works at the facility 250 days per year for 25 years) and the Type 4 Risk Reduction Standards (which represent a groundskeeper who works at the site one day per week for 25 years and an adult and child who visit the park 78 times a year). Additionally, all of the soil (surface and subsurface) meets the Type 4 Risk Reduction Standards that model a hypothetical future construction worker who works at the Site for 30 days during a construction phase.

A portion of the Site contains stabilized/solidified material covered by a 60-mil HDPE liner. This material does not conform to the definitions of soil or source material as stated in the HSRA Rules (§391-3-19-.02(x) and (y)). It has been shown through groundwater monitoring of the Site since remediation, performance testing during remediation, and in the ten year study (EPRI, 2003) following remediation, that the stabilized/solidified material has, and continues to, exceed performance standards set for remediation and has remained immobile. Fourteen rounds of groundwater sampling and analysis have been conducted since 1993. Laboratory analytical results have been non-detect or below MCLs (see Table 6) since May 1993, demonstrating that the Site soils have not leached to groundwater at levels of concern. The 60-mil liner, three feet of compacted fill, one foot of clay, and two feet of topsoil were placed immediately over the stabilized/solidified material as part of remediation, and prevent the stabilized material from acting as a source for direct exposure. As a result of this evaluation the Site as a whole is in compliance with Type 4 Risk Reduction Standards.

Groundwater monitoring data collected from fourteen monitoring events conducted from 1992 to 1997, September of 2000, and March of 2003 was used to establish a baseline for groundwater quality at the Site. The groundwater quality baseline was determined based upon the following: a) less than the PQL of 2 µg/L for benzene, toluene, ethylbenzene, b) less than the PQL of 5 µg/L for total xylenes, c) less than the PQL of 10 µg/L for each PAH listed on Table 5 of this CSR, and d) less than the most recent maximum detected concentration (50 µg/L) for total cyanide.

Appendix F
Risk Reduction Standards

Table F-1. Summary of Soil Intake Parameters

Standard Parameters

Parameter	Value	Definition	Source
THI	1	Target hazard index	EPD
TR	0.00001	Target excess individual lifetime cancer risk	EPD
PEF	4.6E+09 mg^3/kg	Particulate Emission factor	EPD
OC	0.02	Organic carbon content of soil	
LS	45 m	Length of side of contaminated area	EPD
V	2.25 m/s	Wind speed in mixing zone	EPD
DH	2 m	Diffusion height	EPD
p_s	2.65 g/cm^3	Soil density	EPD
A	2E+07 cm^2	Area of contamination	EPD
T	7.9E+08 s	Exposure interval	EPD
E	0.35	True soil porosity	EPD

Receptor-Specific Parameters

Parameter	Type 3 Indust Wkr	Type 4 Const Wkr	Type 4 Grounds-keeper	Type 4 Adult Visitor	Type 4 Child Visitor	Definition	Source
BW	70	70	70	70	15	Body weight (kg)	EPD
AT_{nc}	25	1	25	30	6	Averaging time (noncarcinogens) yr	EPD; PJ (visitor)
AT_c	70	70	70	70	70	Averaging time (carcinogens) yr	EPD; PJ (visitor)
ED	25	1	25	30	6	Exposure duration (yr)	EPD; IEPA; EPD; PJ; PJ
EF	250	30	52	78	78	Exposure frequency (d/yr)	EPD; IEPA; PJ; EFH*
IR_{soil}	50	480	100	100	200	Soil ingestion rate (mg/d)	EPD; EFH; PJ; EPD; EPD
IR_{air}	20	20	20	5.6	4.2	Inhalation rate (m3/d)	EPD; EFH* (visitor)

Sources:

IEPA	Illinois Environmental Protection Agency - Tiered Approach to Corrective Action Objectives (TACO) Title 35 Illinois Administrative Code Part 742. - Appendix C
EFH	Exposure Factors Handbook
PJ	Professional judgement
EPD	EPD of the Georgia Department of Natural Resources Environmental Protection Division Chapter 391-3-19; Hazardous Site Response
IRIS	
RAGS	Risk Assessment Guidance for Superfund, Part B (EPA, Dec. 1991)
Region 3	EPA Region III Risk-Based Concentration Table (4/13/2000)
Region 9	EPA Region 9 Preliminary Remediation Goals Table (10/01/99)
SSG	Soil Screening Guidance: User's Guide (EPA, July 1996)
Water 9	EPA Computer Model, Version 1.0.0

* Inhalation rate and exposure frequency based on the following assumptions:

	3.5	hr/visit	(EFH: Table 15-109, kids spend 207 min when at a park)
EF	78	visits/yr	(3 visits every two week - based on EFH: Table 15-156 mean time spent doing active liesure: 5.5 hr/wk)
IR_{air}	1.6	m^3/hr	(EFH: Table 5-23 for moderate outdoor activities for adult)
	1.2	m^3/hr	(EFH: Table 5-23 for moderate outdoor activities for young child)

Table F-2. Cancer Slope Factors and Reference Doses for Detected Constituents

Analyte	RfDo (mg/kg-d)	RfDi (mg/kg-d)	CSFo $(mg/kg-d)^{-1}$	CSFi $(mg/kg-d)^{-1}$	Surrogate
Inorganics					
Barium	0.07 i	0.00014 h			
Cadmium	0.0005 i			6.3 i	
Chromium	0.003 i	0.000028 i		42 i	
Lead *					
Mercury	0.0003 i	0.00008598 i			
Silver	0.005 i				
SVOCs					
1,2-Dichlorobenzene	0.09 i	0.057 h			
1,4-Dichlorobenzene	0.03 n	0.23 i	0.024 h	0.022 n	
1-Methylnaphthalene	0.004 i				2-Methylnaphthalene
2-Methylnaphthalene	0.004 i				
Acenaphthene	0.06 i				
Acenaphthylene	0.06 i				Acenaphthene
Anthracene	0.3 i				
Benzo(a)Anthracene			0.73 n	0.31 c	
Benzo(a)pyrene			7.3 i	3.1 c	
Benzo(b)Fluoranthene			0.73 n	0.31 c	
Benzo(g,h,i)perylene **					
Benzo(k)Fluoranthene			0.073 n	0.031 c	
Chrysene			0.0073 n	0.0031 c	
Chrysene & benzo(a)anthracene			0.73 n	0.31 c	Benzo(a)Anthracene
Dibenzo(ah)Anthracene			7.3 n	3.1 c	
Fluoranthene	0.04 i				
Fluorene	0.04 i				
Indeno(1,2,3-cd)Pyrene			0.73 n	0.31 c	
Indeno(1,2,3-cd)pyrene & Dibenzo(a,h)anthracene			7.3 n	3.1 c	Dibenzo(ah)Anthracene
Naphthalene	0.02 i	0.00086 i			
Phenanthrene **					
Phenanthrene & Anthracene	0.3 i				Anthracene
Pyrene	0.03 i				
VOCs					
1,2,3-Trimethylbenzene	0.05 s	0.0017 s			1,3,5-Trimethylbenzene
1,3,5-Trimethylbenzene	0.05 n	0.0017 n			
Acetone	0.9 i				
Benzene	0.004 i	0.008598 i	0.055 i	0.029 i	
Bromodichloromethane	0.02 i	0.0571 e	0.062 i		
Chlorobenzene	0.02 i	0.017 n			
Ethylbenzene	0.1 i	0.29 i		0.00385 n	
Isopropylbenzene	0.1 i	0.11 i			
n-Butylbenzene	0.04 n				
n-Propylbenzene	0.04 n				
p-Isopropylbenzene	0.1 i	0.11 i			Isopropylbenzene
Sec-Butylbenzene	0.04 n				
Tert-Butylbenzene	0.04 n				
Toluene	0.2 i	0.11 i			
Xylenes	0.2 i	0.029 i			
PCBs					
Aroclor 1242			2 [9]	2 [9]	

Notes:

c: Based on comments from the EPD

i: Integrated Risk Information System

e: GA EPD - Guidance on Target Soil Concentrations for Type 1 and Type 3 Risk Reduction Standards

n: NCEA

[9]: EPA Region 9 PRG Table

*: Default HSRA Lead number used so no toxicity information provided

**: No toxicity information; Type III RRS used

Table F-3. Physical and Chemical Properties of Constituents

Analyte	Di (cm^2/s)		H ($atm\text{-}m^3/mol$)		Koc (cm^3/g)		EPD VF (m^3/kg)*	Surrogate
rganics								
arium								
Cadmium								
Chromium								
Lead								
Mercury	0.13	e	0.0115	e	0.29	e		
Silver								
SVOCs								
1,2-Dichlorobenzene	0.069	9	0.0019	9	1200	e	18700	
1,4-Dichlorobenzene	0.069	9	0.0024	9	1120	e	16600	
1-Methylnaphthalene								2-Methylnaphthalene
2-Methylnaphthalene								
Acenaphthene	0.0421	e	0.0075	e	5620	e		
Acenaphthylene								Acenaphthene
Anthracene	0.0324	e	0.0046	e	1400	e		
Benzo(a)Anthracene	0.051	e	0.00015	e	219000	e		
Benzo(a)pyrene	0.05295	e	1.55E-06	e	631000	e		
Benzo(b)Fluoranthene	0.0226	e	0.00025	e	631000	e		
Benzo(g,h,i)perylene								
Benzo(k)Fluoranthene					0.000055	e		
Chrysene	0.048	e	0.000095	e	219000	e		
Chrysene & benzo(a)anthracene								
Dibenzo(ah)Anthracene					3310000	e		
Fluoranthene					42700	e		
luorene	0.061	9	0.000077	9	8130	e		
eno(1,2,3-cd)Pyrene					1820000	e		
Naphthalene	0.059	9	0.00048	9	1290	e	72300	
Phenanthrene								
Phenanthrene & Anthracene								
Pyrene	0.027	9	0.000011	9	83200	e		
VOCs								
1,2,3-Trimethylbenzene	0.075		0.0077		820			1,3,5-Trimethylbenzene
1,3,5-Trimethylbenzene	0.075	9	0.0077	9	820	9	11400	
Acetone	0.1093	e	0.0012	e	0.258	e		
Benzene	0.09234	e	0.005566	e	63.1	e	2920	
Bromodichloromethane	0.03	9	0.0016	9	55	9		
Chlorobenzene	0.07627	e	0.004538	e	378	e	7720	
Ethylbenzene	0.0707	e	0.008043	e	1000	e	6700	
Isopropylbenzene	0.075	9	0.012	9	2510	e	253	
n-Butylbenzene	0.075	9	0.013	9	2800	9		
n-Propylbenzene	0.075	9	0.013	9	2800	9		
p-Isopropylbenzene								n-Propylbenzene
Sec-Butylbenzene	0.075	9	0.019	9	2200	9		
Tert-Butylbenzene	0.075	9	0.013	9	2200	9		
Toluene	0.08301	e	0.006356	e	269	e	4810	
Xylenes	0.07597	e	0.005635	e	1200	e	7680	
PCBs								
Aroclor 1242	0.05571	e						

GA EPD - Guidance on Target Soil Concentrations for Type 1 and Type 3 Risk Reduction Standards
9: EPA Region 9 Phys-Chem Data table
*: VF values requested by the EPD to be used

Table F-4. Summary of Type 3 and 4 Calculations (mg/kg)

Analyte	Type 3 Industrial Wkr			Type 4 SB Const. Wkr			Type 4 SS Groundskeeper		
	Carcin.	Noncarc.	RRS	Carcin.	Noncarc.	RRS	Carcin.	Noncarc.	RRS
Inorganics									
rium	NA	137,155	100,000*	NA	123,645	100,000*	NA	336,671	100,000*
admium	105,152	1,022	1,022	21,906,759	887	887	505,541	2,457	2,457
Chromium	15,773	6,076	6,076	3,286,014	5,318	5,318	75,831	14,672	14,672
Lead **									
Mercury	NA	613	613	NA	532	532	NA	1,474	1,474
Silver	NA	10,220	10,220	NA	8,872	8,872	NA	24,567	24,567
SVOCs									
1,2-Dichlorobenzene	NA	5,290	5,290	NA	35,343	35,343	NA	24,722	24,722
1,4-Dichlorobenzene	103	14,766	103	15,678	40,069	15,678	476	57,212	476
1-Methylnaphthalene ***			8,176			7,097			19,654
2-Methylnaphthalene	NA	8,176	8,176	NA	7,097	7,097	NA	19,654	19,654
Acenaphthene	NA	122,640	100,000*	NA	106,458	100,000*	NA	294,808	100,000*
Acenaphthylene ***			100,000*			100,000*			100,000*
Anthracene	NA	613,200	100,000*	NA	532,292	100,000*	NA	1,474,038	100,000*
Benzo(a)Anthracene	78	NA	78	1,681	NA	1,681	178	NA	178
Benzo(a)pyrene	7.84	NA	7.84	170	NA	170	19	NA	19
Benzo(b)Fluoranthene	78	NA	78	1,701	NA	1,701	188	NA	188
Benzo(g,h,i)perylene ****									
Benzo(k)Fluoranthene	784	NA	784	17014	NA	17014	1885	NA	1885
Chrysene	7,179	NA	7,179	168,523	NA	100,000*	18,017	NA	18,017
Chrysene & benzo(a)anthracene ***			78			1,681			178
Dibenzo(ah)Anthracene	7.8	NA	7.8	170	NA	170	19	NA	19
Fluoranthene	NA	81,760	81,760	NA	70,972	70,972	NA	196,538	100,000*
Fluorene	NA	81,760	81,760	NA	70,972	70,972	NA	196,538	100,000*
Indeno(1,2,3-cd)Pyrene	78	NA	78	1,701	NA	1,701	188	NA	188
Indeno(1,2,3-cd)pyrene & benzo(a,h)anthracene ***			7.8			170.1			18.8
aphthalene	NA	315	315	NA	2,464	2,464	NA	1,504	1,504
Phenanthrene ****									
Phenanthrene & Anthracene ***	NA	613,200	100,000*	NA	532,292	100,000*	NA	1,474,038	100,000*
Pyrene	NA	61,320	61,320	NA	53,229	53,229	NA	147,404	100,000*
VOCs									
1,2,3-Trimethylbenzene ***			99			818			475
1,3,5-Trimethylbenzene	NA	99	99	NA	818	818	NA	475	475
Acetone	NA	1,839,600	100,000*	NA	1,596,875	100,000*	NA	4,422,115	100,000*
Benzene	14	126	14	2649	929	929	67	598	67
Bromodichloromethane	923	2,458	923	20,032	13,501	13,501	2,219	11,147	2,219
Chlorobenzene	NA	660	660	NA	4,828	4,828	NA	3,122	3,122
Ethylbenzene	249	9,469	249	51,874	56,427	51,874	1,197	43,507	1,197
Isopropylbenzene	NA	148	148	NA	1,223	1,223	NA	709	709
n-Butylbenzene	NA	81,760	81,760	NA	70,972	70,972	NA	196,538	100,000*
n-Propylbenzene	NA	81,760	81,760	NA	70,972	70,972	NA	196,538	100,000*
p-Isopropylbenzene ***			81,760			70,972			100,000*
Sec-Butylbenzene	NA	81,760	81,760	NA	70,972	70,972	NA	196,538	100,000*
Tert-Butylbenzene	NA	81,760	81,760	NA	70,972	70,972	NA	196,538	100,000*
Toluene	NA	2,686	2,686	NA	21,186	21,186	NA	12,829	12,829
Xylenes	NA	1,135	1,135	NA	9,237	9,237	NA	5,441	5,441
PCBs									
Aroclor 1242	29	NA	29	621	NA	621	69	NA	69

* 100,000 used because the calculated value is greater than 100,000 and, thus, inherently waste-like

** Default HSRA Lead number

*** Surrogates: 2-Methylnaphthalene used for 1-Methylnaphthalene

Acenaphthene for Acenaphthylene Benzo(a)anthracene used for Chrysene & benzo(a)anthracene

Isopropylbenzene used for p-Isopropylbenzene 1,3,5-Trimethylbenzene used for 1,2,3-Trimethylbenzene

Dibenzo(a,h)anthracene used for Indeno(1,2,3-cd)pyrene & Dibenzo(a,h)anthracene

**** No toxicity information; Type III RRS used

Table F-4. Summary of Type 3 and 4 Calculations (mg/kg)

Analyte	Type 4 SS Adult Visitor			Type 4 SS Child Visitor		
	Carcin.	Noncarc.	RRS	Carcin.	Noncarc.	RRS
Inorganics						
Barium	NA	227,917	100,000*	NA	24,512	24,512
Cadmium	1,003,057	1,638	1,638	1,432,938	175	175
Chromium	150,459	9,814	9,814	214,941	1,052	1,052
Lead **						
Mercury	NA	983	983	NA	105	105
Silver	NA	16,378	16,378	NA	1,755	1,755
SVOCs						
1,2-Dichlorobenzene	NA	51,464	51,464	NA	11,390	11,390
1,4-Dichlorobenzene	778	68,176	778	790	9,034	790
1-Methylnaphthalene ***			13,103			1,404
2-Methylnaphthalene	NA	13,103	13,103	NA	1,404	1,404
Acenaphthene	NA	196,538	100,000*	NA	21,058	21,058
Acenaphthylene ***			100,000*			21,058
Anthracene	NA	982,692	100,000*	NA	105,288	100,000*
Benzo(a)Anthracene	103	NA	103	56	NA	56
Benzo(a)pyrene	10	NA	10	6	NA	6
Benzo(b)Fluoranthene	105	NA	105	56	NA	56
Benzo(g,h,i)perylene ****						
Benzo(k)Fluoranthene	1047	NA	1047	561	NA	561
Chrysene	10,337	NA	10,337	5,582	NA	5,582
Chrysene & benzo(a)anthracene *			103			56
Dibenzo(ah)Anthracene	10	NA	10	6	NA	6
Fluoranthene	NA	131,026	100,000*	NA	14,038	14,038
Fluorene	NA	131,026	100,000*	NA	14,038	14,038
Indeno(1,2,3-cd)Pyrene	105	NA	105	56	NA	56
Indeno(1,2,3-cd)pyrene & Dibenzo(a,h)anthracene ***			10.5			5.6
Naphthalene	NA	3,446	3,446	NA	905	905
Phenanthrene ****						
Phenanthrene & Anthracene ***	NA	982,692	100,000*			110
Pyrene	NA	98,269	98,269	NA	10,529	10,529
VOCs						
1,2,3-Trimethylbenzene ***			1126			318
1,3,5-Trimethylbenzene	NA	1126	1126	NA	318	318
Acetone	NA	2,948,077	100,000*	NA	315,865	100,000*
Benzene	125	1321	125	155	323	155
Bromodichloromethane	1,233	20,546	1,233	660	3,855	660
Chlorobenzene	NA	6,871	6,871	NA	1,671	1,671
Ethylbenzene	2,375	84,377	2,375	3,393	16,867	3,393
Isopropylbenzene	NA	1,683	1,683	NA	477	477
n-Butylbenzene	NA	131,026	100,000*	NA	14,038	14,038
n-Propylbenzene	NA	131,026	100,000*	NA	14,038	14,038
p-Isopropylbenzene ***			100,000*			14,038
Sec-Butylbenzene	NA	131,026	100,000*	NA	14,038	14,038
Tert-Butylbenzene	NA	131,026	100,000*	NA	14,038	14,038
Toluene	NA	29,553	29,553	NA	7,853	7,853
Xylenes	NA	12,774	12,774	NA	3,535	3,535
PCBs						
Aroclor 1242	38	NA	38	20	NA	20

* 100,000 used because the calculated value is greater than 100,000 and, thus, inherently waste-like

** Default HSRA Lead number

*** Surrogates: 2-Methylnaphthalene used for 1-Methylnaphthalene

Acenaphthene for Acenaphthylene

Benzo(a)anthracene used for Chrysene & benzo(a)anthracene

Isopropylbenzene used for p-Isopropylbenzene

1,3,5-Trimethylbenzene used for 1,2,3-Trimethylbenzene

Dibenzo(a,h)anthracene used for Indeno(1,2,3-cd)pyrene & Dibenzo(a,h)anthracene

**** No toxicity information; Type III RRS used

Soil Risk Reduction Standards for Barium

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	137,155	123,645	336,671	227,917	24,512
RRS	137,155	123,645	336,671	227,917	24,512

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-}6 \text{ kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.07 mg/kg/d	Oral chronic reference dose
RfDi	0.0001 mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	NA cm^2/s	Molecular diffusivity
H	NA atm-m^3/mol	Henry's law constant
Koc	NA cm^3/g	Organic carbon - water partition coeff
Kd	NA cm^3/g	= Koc x OC
Kas =	NA g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	NA m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}$
a =	NA cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}{Dei \times E}$
Dei =	NA cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{}$ Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Cadmium

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	105,152	21,906,759	505,541	1,003,057	1,432,938
C_{NC} (mg/kg)	1,022	887	2,457	1,638	175
RRS	1,022	887	2,457	1,638	175

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.0005 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	6.3 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	NA cm^2/s	Molecular diffusivity
H	NA atm-m^3/mol	Henry's law constant
Koc	NA cm^3/g	Organic carbon - water partition coeff
Kd	NA cm^3/g	= Koc x OC
Kas =	NA g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	NA m^3/kg	Soil-to-Air Volatilization Factor
		$LS \times V \times DH \times (3.14 \times a \times T)^{0.5}$
a =	NA cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}{Dei \times E}$
		$E + p_s(1\text{-}E)/Kas$
Dei =	NA cm^2/s	Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Chromium

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	15,773	3,286,014	75,831	150,459	214,941
C_{NC} (mg/kg)	6,076	5,318	14,672	9,814	1,052
RRS	6,076	5,318	14,672	9,814	1,052

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-}6 \text{ kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.003 mg/kg/d	Oral chronic reference dose
RfDi	0.0000 mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	42 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	NA cm^2/s	Molecular diffusivity
H	NA atm-m^3/mol	Henry's law constant
Koc	NA cm^3/g	Organic carbon - water partition coeff
Kd	NA cm^3/g	= Koc x OC
Kas =	NA g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	NA m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}$
a =	NA cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}{Dei \times E}$
Dei =	NA cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{}$ Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Mercury

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	613	532	1,474	983	105
RRS	613	532	1,474	983	105

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-}6 \text{ kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.0003 mg/kg/d	Oral chronic reference dose
RfDi	0.0001 mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.13 cm^2/s	Molecular diffusivity
H	0.0115 atm-m^3/mol	Henry's law constant
Koc	0.29 cm^3/g	Organic carbon - water partition coeff
Kd	0.0058 cm^3/g	= Koc x OC
Kas =	81.29 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	28 m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}$
a =	0.08669 cm^2/s	$\frac{Dei \times E}{E + p_s(1\text{-}E)/Kas}$
Dei =	0.0919 cm^2/s	Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Silver

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	10,220	8,872	24,567	16,378	1,755
RRS	10,220	8,872	24,567	16,378	1,755

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-}6 \text{ kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.005 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	NA cm^2/s	Molecular diffusivity
H	NA atm-m^3/mol	Henry's law constant
Koc	NA cm^3/g	Organic carbon - water partition coeff
Kd	NA cm^3/g	= Koc x OC
Kas =	NA g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	NA m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}$
a =	NA cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}{Dei \times E}$
Dei =	NA cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{\text{Effective diffusivity (Di x E0.33)}}$

Soil Risk Reduction Standards for 1,2-Dichlorobenzene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	5,290	35,343	24,722	51,464	11,390
RRS	5,290	35,343	24,722	51,464	11,390

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.09 mg/kg/d	Oral chronic reference dose
RfDi	0.0570 mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
VF =	18,700 m^3/kg	Soil-to-Air Volatilization Factor

Soil Risk Reduction Standards for 1,4-Dichlorobenzene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	103	15,678	476	778	790
C_{NC} (mg/kg)	14,766	40,069	57,212	68,176	9,034
RRS	103	15,678	476	778	790

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.03 mg/kg/d	Oral chronic reference dose
RfDi	0.2293 mg/kg-d	Inhalation chronic reference dose
SFo	0.024 $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	0.022 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
VF =	16,600 m^3/kg	Soil-to-Air Volatilization Factor

Soil Risk Reduction Standards for 2-Methylnaphthalene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	8,176	7,097	19,654	13,103	1,404
RRS	8,176	7,097	19,654	13,103	1,404

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.004 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	NA cm^2/s	Molecular diffusivity
H	NA atm-m^3/mol	Henry's law constant
Koc	NA cm^3/g	Organic carbon - water partition coeff
Kd	NA cm^3/g	= Koc x OC
Kas =	NA g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	NA m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}$
a =	NA cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}{Dei \times E}$
Dei =	NA cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{\text{Effective diffusivity (Di x E0.33)}}$

Soil Risk Reduction Standards for Acenaphthene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	122,640	106,458	294,808	196,538	21,058
RRS	122,640	106,458	294,808	196,538	21,058

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10^{-6} \text{ kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.06 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.0421 cm^2/s	Molecular diffusivity
H	0.0075 atm-m^3/mol	Henry's law constant
Koc	5620 cm^3/g	Organic carbon - water partition coeff
Kd	112.4 cm^3/g	= Koc x OC
Kas =	0.00 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	35,527 m^3/kg	Soil-to-Air Volatilization Factor
		$LS \times V \times DH \times (3.14 \times a \times T)^{0.5}$
a =	0.00002 cm^2/s	$A \times 2 \times Dei \times E \times Kas \times 10^{-3}$ / $Dei \times E$
Dei =	0.0298 cm^2/s	$E + p_s(1\text{-}E)/Kas$ Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Anthracene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	613,200	532,292	1,474,038	982,692	105,288
RRS	613,200	532,292	1,474,038	982,692	105,288

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.3 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.0324 cm^2/s	Molecular diffusivity
H	0.0046 atm-m^3/mol	Henry's law constant
Koc	1400 cm^3/g	Organic carbon - water partition coeff
Kd	28 cm^3/g	= Koc x OC
Kas =	0.01 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	25,799 m^3/kg	Soil-to-Air Volatilization Factor
		$LS \times V \times DH \times (3.14 \times a \times T)^{0.5}$
a =	0.00003 cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}{Dei \times E}$
Dei =	0.0229 cm^2/s	$\frac{E + p_s(1\text{-}E)}{Kas}$ Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Benz(a)Anthracene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	78	1,681	178	103	56
C_{NC} (mg/kg)	NA	NA	NA	NA	NA
RRS	78	1,681	178	103	56

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	NA mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	0.73 $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	0.31 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.051 cm^2/s	Molecular diffusivity
H	0.00015 atm-m^3/mol	Henry's law constant
Koc	219000 cm^3/g	Organic carbon - water partition coeff
Kd	4380 cm^3/g	= Koc x OC
Kas =	0.00 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	1,425,207 m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}$
a =	1.03E-08 cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}{Dei \times E}$
Dei =	0.0361 cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{\text{Effective diffusivity (Di x E0.33)}}$

Soil Risk Reduction Standards for Benzo(a)pyrene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	7.8	170	19	10	6
C_{NC} (mg/kg)	NA	NA	NA	NA	NA
RRS	7.8	170	19	10	6

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-}6 \text{ kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	NA mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	7.3 $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	3.1 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.05295 cm^2/s	Molecular diffusivity
H	0.00000155 atm-m^3/mol	Henry's law constant
Koc	631000 cm^3/g	Organic carbon - water partition coeff
Kd	12620 cm^3/g	= Koc x OC
Kas =	0.00 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	23,356,213 m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}$
a =	3.83E-11 cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}{Dei \times E}$
Dei =	0.0374 cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{}$ Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Benzo(b)fluoranthene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	78	1,701	188	105	56
C_{NC} (mg/kg)	NA	NA	NA	NA	NA
RRS	78	1,701	188	105	56

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	NA mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	0.73 $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	0.31 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.0226 cm^2/s	Molecular diffusivity
H	0.00025 atm-m^3/mol	Henry's law constant
Koc	631000 cm^3/g	Organic carbon - water partition coeff
Kd	12620 cm^3/g	= Koc x OC
Kas =	0.00 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	2,814,991 m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}$
a =	2.64E-09 cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}{Dei \times E}$
Dei =	0.0160 cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{\text{Effective diffusivity (Di x E0.33)}}$

Soil Risk Reduction Standards for Benzo(k)fluoranthrene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	784	17,014	1,885	1,047	561
C_{NC} (mg/kg)	NA	NA	NA	NA	NA
RRS	784	17,014	1,885	1,047	561

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-}6 \text{ kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

(used values for benzo(k)fluoranthene)

Parameter	Value	Definition
RfDo	NA mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	0.073 $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	0.031 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	NA cm^2/s	Molecular diffusivity
H	NA atm-m^3/mol	Henry's law constant
Koc	0.000055 cm^3/g	Organic carbon - water partition coeff
Kd	0.0000011 cm^3/g	= Koc x OC
Kas =	NA g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	NA m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}$
a =	NA cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}{Dei \times E}$
Dei =	NA cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{\text{Effective diffusivity (Di x E0.33)}}$

Soil Risk Reduction Standards for Chrysene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	7,179	168,523	18,017	10,337	5,582
C_{NC} (mg/kg)	NA	NA	NA	NA	NA
RRS	7,179	168,523	18,017	10,337	5,582

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

(used values for chrysene)

Parameter	Value	Definition
RfDo	NA mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	0.0073 $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	0.0031 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.048 cm^2/s	Molecular diffusivity
H	0.000095 atm-m^3/mol	Henry's law constant
Koc	219000 cm^3/g	Organic carbon - water partition coeff
Kd	4380 cm^3/g	= Koc x OC
Kas =	0.00 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	1,845,977 m^3/kg	Soil-to-Air Volatilization Factor
		$LS \times V \times DH \times (3.14 \times a \times T)^{0.5}$
a =	6.13E-09 cm^2/s	$A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}$ / $Dei \times E$
Dei =	0.0339 cm^2/s	$E + p_s(1\text{-}E)/Kas$ Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Dibenzo(ah)Anthracene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	7.8	170	19	10	6
C_{NC} (mg/kg)	NA	NA	NA	NA	NA
RRS	7.8	170	19	10	6

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-}6 \text{ kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	NA mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	7.3 $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	3.1 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	NA cm^2/s	Molecular diffusivity
H	NA atm-m^3/mol	Henry's law constant
Koc	3310000 cm^3/g	Organic carbon - water partition coeff
Kd	66200 cm^3/g	= Koc x OC
Kas =	NA g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	NA m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}$
a =	NA cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}{Dei \times E}$
Dei =	NA cm^2/s	$E + p_s(1\text{-}E)/Kas$ Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Fluoranthene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	81,760	70,972	196,538	131,026	14,038
RRS	81,760	70,972	196,538	131,026	14,038

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-}6 \text{ kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.04 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	NA cm^2/s	Molecular diffusivity
H	NA atm-m^3/mol	Henry's law constant
Koc	42700 cm^3/g	Organic carbon - water partition coeff
Kd	854 cm^3/g	= Koc x OC
Kas =	NA g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	NA m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}$
a =	NA cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}{Dei \times E}$
Dei =	NA cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{}$ Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Fluorene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	81,760	70,972	196,538	131,026	14,038
RRS	81,760	70,972	196,538	131,026	14,038

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.04 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.061 cm^2/s	Molecular diffusivity
H	0.000077 atm-m^3/mol	Henry's law constant
Koc	8130 cm^3/g	Organic carbon - water partition coeff
Kd	162.6 cm^3/g	= Koc x OC
Kas =	0.00 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	350,446 m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}$
a =	1.70E-07 cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}{Dei \times E}$
Dei =	0.0431 cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{}$ Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Indeno(1,2,3-cd)Pyrene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	78	1,701	188	105	56
C_{NC} (mg/kg)	NA	NA	NA	NA	NA
RRS	78	1,701	188	105	56

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	NA mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	0.73 $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	0.31 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	NA cm^2/s	Molecular diffusivity
H	NA atm-m^3/mol	Henry's law constant
Koc	1820000 cm^3/g	Organic carbon - water partition coeff
Kd	36400 cm^3/g	= Koc x OC
Kas =	NA g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	NA m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}$
a =	NA cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}{Dei \times E}$
Dei =	NA cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{}$ Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Napthalene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	315	2,464	1,504	3,446	905
RRS	315	2,464	1,504	3,446	905

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.02 mg/kg/d	Oral chronic reference dose
RfDi	0.0009 mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
VF =	72,300 m^3/kg	Soil-to-Air Volatilization Factor

Soil Risk Reduction Standards for Pyrene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	61,320	53,229	147,404	98,269	10,529
RRS	61,320	53,229	147,404	98,269	10,529

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.03 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.027 cm^2/s	Molecular diffusivity
H	0.000011 atm-m^3/mol	Henry's law constant
Koc	83200 cm^3/g	Organic carbon - water partition coeff
Kd	1664 cm^3/g	= Koc x OC
Kas =	0.00 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	4,458,307 m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}$
a =	1.05E-09 cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}{Dei \times E}$
Dei =	0.0191 cm^2/s	$\frac{E + p_s(1-E)/Kas}{}$ Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for 1,3,5-Trimethylbenzene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	99	818	475	1126	318
RRS	99	818	475	1,126	318

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-}6 \text{ kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.05 mg/kg/d	Oral chronic reference dose
RfDi	0.0017 mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
VF =	11,400 m^3/kg	Soil-to-Air Volatilization Factor

Soil Risk Reduction Standards for Acetone

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	1,839,600	1,596,875	4,422,115	2,948,077	315,865
RRS	1,839,600	1,596,875	4,422,115	2,948,077	315,865

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.9 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.1093 cm^2/s	Molecular diffusivity
H	0.0012 atm-m^3/mol	Henry's law constant
Koc	0.258 cm^3/g	Organic carbon - water partition coeff
Kd	0.00516 cm^3/g	= Koc x OC
Kas =	9.53 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	218 m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}$
a =	0.05098 cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}{Dei \times E}$
Dei =	0.0773 cm^2/s	$\frac{E + p_s(1-E)/Kas}{\text{Effective diffusivity (Di x E0.33)}}$

Soil Risk Reduction Standards for Benzene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	14	2,649	67	125	155
C_{NC} (mg/kg)	126	929	598	1321	323
RRS	14	929	67	125	155

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.004 mg/kg/d	Oral chronic reference dose
RfDi	0.0086 mg/kg-d	Inhalation chronic reference dose
SFo	0.055 $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	0.029 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
VF =	2,920 m^3/kg	Soil-to-Air Volatilization Factor

Soil Risk Reduction Standards for Bromodichloromethane

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	923	20,032	2,219	1,233	660
C_{NC} (mg/kg)	2,458	13,501	11,147	20,546	3,855
RRS	923	13,501	2,219	1,233	660

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.02 mg/kg/d	Oral chronic reference dose
RfDi	0.0571 mg/kg-d	Inhalation chronic reference dose
SFo	0.062 $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.03 cm^2/s	Molecular diffusivity
H	0.0016 atm-m^3/mol	Henry's law constant
Koc	55 cm^3/g	Organic carbon - water partition coeff
Kd	1.1 cm^3/g	= Koc x OC
Kas =	0.06 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	8,963 m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}$
a =	0.00025 cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}{Dei \times E}$
Dei =	0.0212 cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{\text{Effective diffusivity (Di x E0.33)}}$

Soil Risk Reduction Standards for Chlorobenzene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	660	4,828	3,122	6,871	1,671
RRS	660	4,828	3,122	6,871	1,671

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.02 mg/kg/d	Oral chronic reference dose
RfDi	0.0170 mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
VF =	7,720 m^3/kg	Soil-to-Air Volatilization Factor

Soil Risk Reduction Standards for Ethylbenzene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	249	51,874	1,197	2,375	3,393
C_{NC} (mg/kg)	9,469	56,427	43,507	84,377	16,867
RRS	249	51,874	1,197	2,375	3,393

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.1 mg/kg/d	Oral chronic reference dose
RfDi	0.2900 mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	0.00385 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
VF =	6,700 m^3/kg	Soil-to-Air Volatilization Factor

Soil Risk Reduction Standards for Isopropylbenzene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	148	1,223	709	1,683	477
RRS	148	1,223	709	1,683	477

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.1 mg/kg/d	Oral chronic reference dose
RfDi	0.11 mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.075 cm^2/s	Molecular diffusivity
H	0.012 atm-m^3/mol	Henry's law constant
Koc	2510 cm^3/g	Organic carbon - water partition coeff
VF =	253 m^3/kg	Soil-to-Air Volatilization Factor

Soil Risk Reduction Standards for n-Butylbenzene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	81,760	70,972	196,538	131,026	14,038
RRS	81,760	70,972	196,538	131,026	14,038

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-}6 \text{ kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.04 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.075 cm^2/s	Molecular diffusivity
H	0.013 atm-m^3/mol	Henry's law constant
Koc	2800 cm^3/g	Organic carbon - water partition coeff
Kd	56 cm^3/g	= Koc x OC
Kas =	0.01 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	14,261 m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}$
a =	0.00010 cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}{Dei \times E}$
Dei =	0.0530 cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{\text{Effective diffusivity (Di x E0.33)}}$

Soil Risk Reduction Standards for n-Propylbenzene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	81,760	70,972	196,538	131,026	14,038
RRS	81,760	70,972	196,538	131,026	14,038

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-}6 \text{ kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.04 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.075 cm^2/s	Molecular diffusivity
H	0.013 atm-m^3/mol	Henry's law constant
Koc	2800 cm^3/g	Organic carbon - water partition coeff
Kd	56 cm^3/g	= Koc x OC
Kas =	0.01 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	14,261 m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}$
a =	0.00010 cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-}3}{Dei \times E}$
Dei =	0.0530 cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{\text{Effective diffusivity (Di x E0.33)}}$

Soil Risk Reduction Standards for Sec-Butylbenzene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	81,760	70,972	196,538	131,026	14,038
RRS	81,760	70,972	196,538	131,026	14,038

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.04 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.075 cm^2/s	Molecular diffusivity
H	0.019 atm-m^3/mol	Henry's law constant
Koc	2200 cm^3/g	Organic carbon - water partition coeff
Kd	44 cm^3/g	= Koc x OC
Kas =	0.02 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	10,447 m^3/kg	Soil-to-Air Volatilization Factor $\frac{LS \times V \times DH \times (3.14 \times a \times T)^{0.5}}{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}$
a =	0.00019 cm^2/s	$\frac{A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}}{Dei \times E}$
Dei =	0.0530 cm^2/s	$\frac{E + p_s(1\text{-}E)/Kas}{\text{Effective diffusivity (Di x E0.33)}}$

Soil Risk Reduction Standards for Tert-Butylbenzene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	81,760	70,972	196,538	131,026	14,038
RRS	81,760	70,972	196,538	131,026	14,038

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.04 mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.075 cm^2/s	Molecular diffusivity
H	0.013 atm-m^3/mol	Henry's law constant
Koc	2200 cm^3/g	Organic carbon - water partition coeff
Kd	44 cm^3/g	= Koc x OC
Kas =	0.01 g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	12,638 m^3/kg	Soil-to-Air Volatilization Factor
		$LS \times V \times DH \times (3.14 \times a \times T)^{0.5}$
a =	0.00013 cm^2/s	$A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}$ / $Dei \times E$
Dei =	0.0530 cm^2/s	$E + p_s(1\text{-}E)/Kas$ Effective diffusivity (Di x E0.33)

Soil Risk Reduction Standards for Toluene

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	2,686	21,186	12,829	29,553	7,853
RRS	2,686	21,186	12,829	29,553	7,853

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.2 mg/kg/d	Oral chronic reference dose
RfDi	0.1100 mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
VF =	4,810 m^3/kg	Soil-to-Air Volatilization Factor

Soil Risk Reduction Standards for Xylenes

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	NA	NA	NA	NA	NA
C_{NC} (mg/kg)	1,135	9,237	5,441	12,774	3,535
RRS	1,135	9,237	5,441	12,774	3,535

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	0.2 mg/kg/d	Oral chronic reference dose
RfDi	0.0290 mg/kg-d	Inhalation chronic reference dose
SFo	NA $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	NA $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
VF =	7,680 m^3/kg	Soil-to-Air Volatilization Factor

Soil Risk Reduction Standards for Aroclor 1242

	Type 3 Industrial Wkr	Type 4 SB Const. Wkr	Type 4 SS Groundskeeper	Type 4 SS Adult Visitor	Type 4 SS Child Visitor
C_C (mg/kg)	28.6	621	69	38	20
C_{NC} (mg/kg)	NA	NA	NA	NA	NA
RRS	28.6	621	69	38	20

Carcinogenic Effects

$$C_C \text{ (mg/kg)} = \frac{TR \times BW \times AT_c \times 365 \text{ d/yr}}{EF \times ED \times [(SFo \times 10\text{^-6 kg/mg} \times IR_{soil}) + (SFi \times IR_{air} \times [1/VF + 1/PEF])]}$$

(RAGS, Part B, Equation 6)

Noncarcinogenic Effects

$$C_{NC} \text{ (mg/kg)} = \frac{THI \times BW \times AT_{nc} \times 365}{ED \times EF \times [(1/RfDo \times 10^{-6} \times IR_{soil}) + ((1/RfDi \times IR_{air}) \times (1/VF + 1/PEF))]}$$

(RAGS, Part B, Equation 7)

Chemical Specific Parameters

Parameter	Value	Definition
RfDo	NA mg/kg/d	Oral chronic reference dose
RfDi	NA mg/kg-d	Inhalation chronic reference dose
SFo	2 $(mg/kg\text{-}d)^{-1}$	Oral cancer slope factor
SFi	2 $(mg/kg\text{-}d)^{-1}$	Inhalation cancer slope factor
Di,a	0.05571 cm^2/s	Molecular diffusivity
H	NA atm-m^3/mol	Henry's law constant
Koc	NA cm^3/g	Organic carbon - water partition coeff
Kd	NA cm^3/g	= Koc x OC
Kas =	NA g/cm^3	Soil/air partition coeff ((H/Kd) x 41)
VF =	NA m^3/kg	Soil-to-Air Volatilization Factor $LS \times V \times DH \times (3.14 \times a \times T)^{0.5}$
a =	NA cm^2/s	$A \times 2 \times Dei \times E \times Kas \times 10\text{^-3}$ / $Dei \times E$
Dei =	0.0394 cm^2/s	$E + p_s(1\text{-}E)/Kas$ Effective diffusivity (Di x E0.33)