Macaroni Lofts, LLC
Birmingham, Alabama
ADEM VCP Site #: 461-073-120

Fact Sheet

A Voluntary Cleanup Program (VCP) Cleanup Plan comprised of a Certification of Compliance with Soil Management Plan and Environmental Covenant, has been found to be technically adequate by the Alabama Department of Environmental Management (ADEM) for the Macaroni Lofts, LLC site in Birmingham, Alabama. This fact sheet has been prepared to briefly advise the public of the principal legal and policy issues of the VCP.

I. VCP PROCESS

The VCP provides a mechanism for the implementation of a cleanup program that encourages applicants to voluntarily assess, remediate, and reuse rural and urban areas of actual or perceived contamination. The program does not relieve any "responsible person" for the liability for administrative, civil, or criminal fines or penalties which are otherwise authorized by law and imposed as a result of the illegal or unpermitted disposal of solid waste, hazardous waste, hazardous constituents, hazardous substances, petroleum products, and/or pollutants to the land, air, or waters of the State on an identified property. The program is designed to expedite the voluntary cleanup process and has been designed for entry at any stage of the cleanup process as long as all applicable criteria have been met up to the point of entry.

II. PROCEDURES FOR REACHING A FINAL DECISION

ADEM is proposing to issue Macaroni Lofts, LLC a final decision for the site remediation. The Cleanup Plan includes implementation of an environmental covenant with use restrictions.

ADEM Admin Code R. 335-15-6-.02 requires that the public be given a 30-day comment period from the date of the notice. The comment period will begin on September 1, 2021, which is the date of publication of the public notice in major local newspaper(s) of general circulation and will end on October 1, 2021.

All persons wishing to comment on any of the conditions of the VCP Remediation should submit their comments in writing to ADEM, Permits and Services Division, 1400 Coliseum Blvd. (Zip 36110). P.O. Box 301463 (Zip 36130-1463) Montgomery, Alabama, ATTENTION: Mr. Russell Kelly. Written comments on the VCP activities should be submitted to ADEM and be received by 5:00 p.m. on October 1, 2021.

ADEM will consider all written comments received during the comment period while making a final decision on this issue. When ADEM makes its final decision, notice will be given to the applicant and each person who has submitted written comments or requested notice of the final decision.

III. FACILITY DESIGN

Bullock Environmental has completed Site Investigation activities under the VCP at the Macaroni Lofts, LLC site located at 1329 4th Avenue South, Birmingham, Jefferson County, Alabama. The site was originally a macaroni factory from 1902 to approximately 1930. From the 1950s through 1971, tenants occupied various portions of the building as warehouses and a furniture (and/ or woodworking) shop. From 1972 through 2001, the facility was used for automotive repair. It has been vacant since 2001. Due to the presence of elevated levels of arsenic and chromium in the subsurface soil, a soil management and removal plan is incorporated into the VCP. Also as part of the remedial strategy an environmental covenant will be placed on the property with institutional controls based on the proposed future use.

IV. TECHNICAL CONTACT

Pamela Monaghan, Project Manager
Engineering Services Section
Industrial Hazardous Waste Branch
Land Division
Alabama Department of Environmental Management
1400 Coliseum Boulevard (Zip 36110)
P.O. Box 301463 (Zip 36130-1463)
Montgomery, Alabama
(334) 271-7848

bullock environmental, llc 4924 5th avenue south, birmingham, alabama 35222 t 205.876.1715 f 205.443.9413

July 27, 2021

Ms. Pamela L Monaghan
IHWB Engineering Services Section
Alabama Department of Environmental Management
P.O. Box 301463
Montgomery, Alabama 36130-1463

Subject: **Certificate of Compliance & Request for Letter of Concurrence**
Proposed Macaroni Lofts Development
1329 4th Avenue South
Birmingham, Jefferson County, Alabama
ADEM Site #: 461-073-120
Bullock Environmental, LLC Project #: 18-ORIO01

Dear Ms. Monaghan:

As you know, Bullock Environmental, LLC (Bullock) submitted a Minor Modification request to the Alabama Department of Environmental Management (ADEM) on July 23, 2021, regarding the property referenced above. Bullock prepared this Minor Modification to reflect the change in entity (Applicant) name from Orion Enterprises, Inc. to Macaroni Lofts, LLC. ADEM's response, also dated July 23, 2021, which acknowledged both receipt of this request as well as the fees necessary to process the Minor Modification to the Application, concluded "the application modification appears to be complete."

With the Applicant now formally changed to reflect the current ownership entity, Bullock submits the following information for ADEM's review:

1. The *Certificate of Compliance & Request for Letter of Concurrence*, dated June 18, 2018 (submitted at that time on behalf of the Orion Enterprises, Inc., the former Applicant) on behalf of the current Applicant, Macaroni Lofts, LLC;
2. Remaining tasks required before issuance of the Letter of Concurrence; and
3. Supplemental documentation validating the findings from the June 18, 2018, *Certificate of Compliance & Request for Letter of Concurrence.*

Each item enumerated above is detailed further below.

JUNE 18, 2018, CERTIFICATE OF COMPLIANCE & REQUEST FOR LETTER OF CONCURRENCE

This document (included as **Attachment 1**) provided a summary and analysis of previous assessments (completed between 2003 and 2015) and included supplemental information addressing potential human health exposure risks regarding certain chemicals of concern (COCs) identified in the subsurface. The *Certificate of Compliance & Request for Letter of Concurrence* presented the following conclusions and recommendations:

> *"Analysis of the COCs detected in onsite soil and groundwater during investigations completed from 2003 to 2015 indicates no complete exposure pathway exists representing a viable risk to*

current or future occupants of the Site. With regard to sub-slab vapor, the potential exposure risk has been evaluated and ruled out as a concern based on:

1. *The absence of a defined soil or groundwater source on the Site;*
2. *The square footage of the building footprint (with increased, associated air exchange rates);*
3. *The height of the ceiling;*
4. *The thickness of the concrete slab/foundation;*
5. *The fine-grained material present beneath the Site; and*
6. *Use of the EPA-approved Johnson & Ettinger model (and associated median-range AF) to account for these building-specific parameters.*

Considering the absence of a viable exposure risk posed by the COCs detected in soil, groundwater, and sub-slab vapor, Bullock recommends no additional assessment or corrective action at the Site. Instead, an environmental covenant will function as an adequate remedy for the Site. The proposed environmental covenant would restrict ground-floor residential use on the parcel and prohibit the use of onsite groundwater for consumption or irrigation purposes. This instrument will both protect human health and the environment while facilitating the Site's continued redevelopment into productive reuse. Finally, Bullock has prepared a soil management plan (attached) to establish protocols during future construction and repaving activities. In the unlikely event that such work requires the management of this material, Macaroni Lofts, LLC will have this plan in place to mitigate the potential risks identified in subsurface soil.

Upon execution of the environmental covenant ..., Bullock requests a Letter of Concurrence from ADEM releasing the site from further assessment or corrective action under the Alabama Land Recycling and Economic Redevelopment Act (ALRERA)/ Voluntary Cleanup Program. This Certificate of Compliance has been prepared in accordance with the ADEM Administrative Code 335-15-4-.06."

ADEM reviewed this document in June 2018 and deemed its conclusions and recommendations to be appropriate; however, before formally approving the *Certificate of Compliance*, the Applicant would need to submit a draft environmental covenant to ADEM for review and approval.

REMAINING TASKS REQUIRED BEFORE ISSUING LETTER OF CONCURRENCE

Following approval of the draft covenant, ADEM would then approve the *Certificate of Compliance; however, formal approval of the Certificate of Compliance will not occur until the following steps are complete*:

1. Applicant's payment to ADEM of Environmental Covenant administrative fee ($13,705.00);
2. Expiration of the 30-day public notice period of the draft covenant;
3. Execution of the environmental covenant (by both the Applicant and ADEM);
4. Submittal and signing into the registry the filing of the environmental covenant (onto the deed) with the Jefferson County Court of Probate;
5. Delivery of the recorded covenant (stamped and certified by the Court of Probate) to ADEM; and
6. Applicant's payment to ADEM of Letter of Concurrence administrative fee ($4,210.00).

Upon completion of items 1 through 6 above, the Certificate of Compliance would be ready for approval with subsequent issuance of a Letter of Concurrence - with Conditions to Macaroni Lofts, LLC, referencing the institutional controls contained in the recorded environmental covenant.

SUPPLEMENTAL DOCUMENTATION VALIDATING THE FINDINGS FROM THE JUNE 18, 2018, *CERTIFICATE OF COMPLIANCE & REQUEST FOR LETTER OF CONCURRENCE.*

As summarized above, the June 18, 2018, *Certificate of Compliance and Request for Letter of Concurrence* concluded "no complete exposure pathway exists representing a viable risk to current or future occupants of the Site." Considering the absence of such exposure risks, Bullock recommended no additional assessment or corrective action. However, since delivering these conclusions and recommendations to ADEM, EPA has implemented certain changes to Vapor Intrusion Screening Level (VISL) calculator (beginning in approximately November 2018). These modifications prompted Bullock to re-evaluate the vapor intrusion risks using the current EPA standards to ensure the 2018 conclusions and recommendations remain valid and accurate. To that end, Bullock entered the highest groundwater and soil vapor concentrations for benzene and naphthalene into the updated VISL calculator to confirm the findings presented in June 2018.

Groundwater

As detailed in **Attachment 2**, Bullock entered the maximum groundwater concentrations for benzene and naphthalene (0.006 mg/L and 0.014 mg/L, respectively) into the VISL calculator and, accounting for the fine-grain material present in the subsurface (silty clay, as documented in boring logs for each location on the Site), modified the default attenuation factor (AF) of 0.001 to 0.0005, as recommended in Section 6.5.3 (Table 6-1) of the U.S. EPA Office of Solid Waste and Emergency Response (OSWER) Publication 9200.2-154 *Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (June 2015).

The output from the VISL calculator revealed the cumulative Estimated Increased Lifetime Cancer Risk (IELCR) for vapor intrusion to be 7.82 E^{-7}, below the most conservative EICLR threshold of 1.0 E^{-6} which is endorsed by ADEM. Likewise the cumulative Hazard Quotient (HQ) for non-cancer risk was determined to be 1.48 E^{-2}, well below the ADEM-endorsed 0.1 HQ threshold.

Soil/Sub-Slab Vapor

Likewise, Bullock entered the maximum benzene concentration (64 $\mu g/m^3$) and naphthalene (139 $\mu g/m^3$) concentration detected in sub-slab vapor into the VISL calculator with no changes to the default AF value of 0.03 for sub-slab vapor.

The output from the VISL calculator revealed the cumulative Increased Estimated Lifetime Cancer Risk (IELCR) for vapor intrusion to be 1.28 E^{-5} above the ADEM-endorsed EICLR threshold of 1.0 E^{-6}). The cumulative Hazard Quotient (HQ) for non-cancer risk, however, was determined to be 3.32 E^{-1} (below the ADEM-endorsed 0.1 HQ threshold. However, employing the site-specific elements (depth to groundwater and silty clay) into the mathematical models (updated in 2019) based on the analytical solutions of Johnson and Ettinger (1991) for contaminant partitioning and subsurface vapor transport into buildings (also included in **Attachment 2**), the cumulative IELCR for vapor intrusion decreases to 5.0 E^{-9} significantly below the ADEM-endorsed EICLR threshold of 1.0 E^{-6}.

As summarized above and detailed in **Attachment 2**, while slight changes have occurred in the evaluation of vapor intrusion risks since the submittal of the June 2018 document, use of current, accepted methodologies confirm the validity of the conclusions and recommendations presented at that time.

Considering the information presented above, Bullock requests ADEM's approval of the June 18, 2018, *Certificate of Compliance & Request for Letter of Concurrence* following the execution and recordation of the environmental covenant and remittance of the remaining fees payable to ADEM (totaling

$17,915.00). Upon completion of these items, Bullock requests a *Letter of Concurrence* from ADEM releasing the Site from further assessment or corrective action under the Alabama Land Recycling and Economic Redevelopment Act (ALRERA)/Voluntary Cleanup Program.

If you have any questions or comments concerning the content and recommendations of this report, please call us at (205) 876-1715. You can also respond by email to doug.bullock@bullockenvironmental.com.

Sincerely,
Bullock Environmental, LLC

Douglas A. Bullock, CHMM
Principal

Attachments:
1. June 18, 2018, *Certificate of Compliance & Request for Letter of Concurrence*
2. VISL Calculator - Default Scenario (Maximum Groundwater Concentrations)
   VISL Calculator - Default Scenario (Maximum Soil Vapor Concentrations)
   Supporting Site-Specific Risk Calculations (Johnson & Ettinger Model, 2019)

ATTACHMENT A

bullock environmental, llc 2811 crescent avenue, suite 101, birmingham, alabama 35209 t 205.876.1715 f 205.443.9413

June 18, 2018

Ms. Dixie Beatty
Redevelopment Section
Alabama Department of Environmental Management
P.O. Box 301463
Montgomery, Alabama 36130-1463

Subject: **Certificate of Compliance & Request for Letter of Concurrence**
1329 4th Avenue South Property
Birmingham, Jefferson County, Alabama
ADEM Site #: 461-073-1230
Bullock Environmental, LLC Project #: 18-ORIO01

Dear Ms. Beatty:

In response to our discussion on May 25, 2018, Bullock Environmental, LLC (Bullock), on behalf of Orion Enterprises, Inc., submits the following *Certificate of Compliance* for the above-referenced Site. Considering the assessments documented in the *Voluntary Property Assessment Plan (VPAP)* approved by the Alabama Department of Environmental Management (ADEM) on October 21, 2015, the chemicals of concern (COCs) detected in onsite soil, groundwater, and soil vapor do not appear to pose a risk to current or future occupants of the site.

Bullock's review of these documents indicates that no contaminant source has been identified on the Site. Moreover, none of the data collected from previous investigations demonstrate that such an onsite contaminant source exists. Nonetheless, while soil and groundwater sampling results from three separate assessments (completed in 2003, 2012, and 2015) indicate no viable exposure risk, sub-slab vapor samples collected during the 2015 investigation leave open the possibility of an indoor inhalation risk through exposure to benzene and naphthalene from subsurface vapor sources (unrelated to an onsite source, based on the data collected from these assessments). The following *Certificate of Compliance* (prepared in accordance with requirements set forth in ADEM Administrative Code 335-15-4-.06 and supported by the protocols detailed in the U.S Environmental Protection Agency [EPA] Office of Solid Waste & Emergency Response [OSWER] Publication 9200.2-154, *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*, June 2015, hereafter "EPA 2015 Vapor Intrusion Guidance" document) demonstrates that no viable risk exists with respect to potential vapor intrusion.

The following sections present a brief summary of the Site's historical use, assessments conducted to date, and the basis of our request for a *Letter of Concurrence*.

SITE HISTORY & PREVIOUS ASSESSMENTS

The Site was originally developed in 1902 as a macaroni factory; the existing building still includes a portion of the original structure. The macaroni factory operated until at least 1930. At times, various tenants apparently occupied portions of the building; these tenants included (among others) warehouse storage and a used furniture (and/or woodworking) shop. The furniture operation was present from 1950 to 1971. HESCO, an automotive repair facility, operated in the building from 1972 to 2001. The building has reportedly been vacant since approximately 2001.

2003 PHASE I/LIMITED PHASE II ESA

In May 2003, Gallet & Associates, Inc. completed a Phase I/Limited Phase II Environmental Site Assessment (ESA) which documented a former gasoline station (Citgo) immediately south (upgradient) and a former automobile repair shop and furniture repair shop on the Site. Field investigations included the installation of three borings and the collection of groundwater samples (B-1, B-2, B-3) for analysis of benzene, toluene, ethylbenzene, total xylenes (BTEX), methyl-tertiary butyl ether (MTBE), and polynuclear aromatic hydrocarbons (PAHs). Borings B-1 and B-2 were installed on the Site while boring B-3 was installed on the property across 4th Avenue South (north of the Site). Review of the analytical results from this investigation revealed no detectable PAH concentrations in onsite groundwater (borings B-1 or B-2) with only trace levels of toluene, xylenes, and MTBE at concentrations less than one-tenth their respective Maximum Contaminant Levels (MCLs) or screening values. These findings resulted in a recommendation for no further assessment at that time.

Gallet issued an addendum to the above Phase I ESA, dated August 6, 2003, and provided additional insight into the opinions rendered in the May 2003 ESA. The letter indicated the low-level concentrations of petroleum compounds noted in B-1 and B-2 were indicative of impacts from the adjacent Citgo gasoline filling station which was located immediately south of the Site. It was Gallet's opinion that the low-level PAH impacts in groundwater at B-3 were unrelated to the impacts at B-1 and B-2 and may have been associated with diesel fuel or motor oil on the offsite (downgradient) facility across 4th Avenue South.

2012 PHASE I ESA

On October 1, 2012, United Consulting, Inc. (United) completed a Phase I ESA at the Site on behalf of the University of Alabama at Birmingham (UAB). During the Phase I ESA reconnaissance, United personnel identified oil staining on the wooden floor of the second floor and indicated that this may have been associated with former automotive parts storage by HESCO. An elevator motor was also noted on the second floor with associated oil staining reported around the motor. United also identified minor staining (de minimis in nature) on the ground floor of the building.

Historically, the properties directly surrounding the Site included machine and print shops, blacksmiths, a crane company and pattern shop, the Birmingham Railway Light and Power Company Barn, Paint, and Repair Shop, Birmingham Belt RR, Gilb and Son Brass Foundry, and gasoline stations. A crane company with a pattern shop was also present immediately east and southeast. United concluded that these historical operations were likely upgradient from the Site.

Based on its review of the regulatory history, United identified 21 regulated facilities within the search distances set forth by the American Society of Testing & Materials (ASTM) Phase I ESA Standard. The Site was listed as a Resource Conservation & Recovery Act (RCRA)-Non Generator and a Facility Index System (FINDS) facility. It was also listed as a historical RCRA-Small Quantity Generator (SQG) of hazardous waste based on former automotive repair operations conducted by HESCO (1972-2001). Twenty additional listings were also noted within the surrounding area, three of which (Goodwin Oil Co., Quality Press, and Dayton Superior) were identified as potential *recognized environmental conditions* (RECs) with respect to the Site based on anticipated groundwater flow (to the northwest).

United concluded the following as RECs relative to the Site in 2012:

- Historical operations in the Site building including a used furniture (and/or woodworking) shop, a paint spray room, and HESCO (an automotive repair facility);

- Heavy oil staining observed on the second floor and at the elevator pit;
- Groundwater impacts at the Site documented from prior Limited Phase II Report (***Note: no COCs were detected in onsite groundwater during the 2003 Limited Phase II ESA at concentrations exceeding applicable MCLs or screening values.***);
- Three historical upgradient regulated facilities: Goodwin Oil Co. (former Citgo), Quality Press, and Dayton Superior (***Note: analytical results from 2003 Limited Phase II ESA indicated no impact to onsite groundwater at concentrations exceeding applicable MCLs or screening values from these potential offsite sources.)***;
- Historical properties directly surrounding the Site and anticipated to be upgradient from the Site included: machine and print shops, blacksmiths, a pattern shop, the Birmingham Railway Light and Power Company Barn, Paint, and Repair Shop, Birmingham Belt RR, Gilb and Son Brass Foundry, and gasoline stations (***See comment above relating to absence of COCs in onsite groundwater at concentrations exceeding applicable MCLs or screening values in 2003***), and;
- The vapor encroachment condition (VEC) from the documented groundwater impacts and possible other associated impacts (***See comment above relating to absence of COCs in onsite groundwater at concentrations exceeding applicable MCLs or screening values in 2003***).

Based on these conclusions, United completed additional Site investigations in 2012 and 2015. The results from each investigation are summarized below.

2012 SITE INVESTIGATION

The 2012 Phase II ESA included the installation of five direct push borings (DP-1 through DP-5). United collected soil samples from each boring for analysis of RCRA metals, volatile organic compounds (VOCs), and semi-VOC (SVOCs) according to EPA Methods 6010B, 8260B, and 8270C, respectively. United also collected one soil sample from boring DP-5 for analysis of polychlorinated biphenyls (PCBs) due to its proximity to the elevator shaft (with noted de minimis staining during the Phase I ESA). Groundwater samples were collected from borings DP-1 and DP-3 for analysis of the same compounds (with PCB analysis on the groundwater sample from DP-3). Additionally, United personnel collected soil gas samples from three locations (SG-1 through SG-3) beneath the building slab for analysis of VOCs.

2015 SITE INVESTIGATION

The 2015 investigation included the installation of five additional borings, four of which were adjacent to the 2012 boring locations (DP-1, DP-3, DP-4, and DP-5) and the fifth (EB-1) installed outside the building near the southwest corner of the Site. Field personnel collected soil samples from each boring for analysis of the same compounds listed above while groundwater samples were collected from two locations (EB-1 and DP-5A). Finally, United collected soil gas samples from four locations (V-1 through V-4) for analysis of VOCs.

RESULTS OF 2012 AND 2015 INVESTIGATION ACTIVITIES

Review of the analytical results obtained from the assessment efforts summarized above revealed the following:

Soil: Arsenic and chromium were present in each soil sample at concentrations exceeding applicable screening values for a commercial setting. Low-level PAH concentrations were detected in select soil samples; United reported that benzo(a)pyrene was present in soil at concentrations exceeding the Soil Screening Level (SSL) protective of underlying groundwater formation.

Groundwater: Naphthalene was detected in well DP-1 in 2012 (0.014 milligrams per liter, mg/L) above its tap water screening value of 0.00017 mg/L while benzene was detected in well DP-5A in 2015 (0.006 mg/L) above its associated MCL of 0.005 mg/L. Bullock notes that the predicted indoor air concentration of naphthalene, based on the maximum detected groundwater concentration noted above, would be 0.0252 micrograms per cubic meter (µg/m^3), below the current Vapor Intrusion Screening Level (VISL) of 0.361 µg/m^3 established by EPA.

Soil Vapor: Analysis of the soil vapor concentrations revealed numerous compounds present above laboratory reporting limits; however, only benzene and naphthalene appeared to exceed their respective VISLs established by EPA in 2015. Benzene was detected in soil gas sample V-3 at a concentration of 64 µg/m^3, above its associated screening value of 52 µg/m^3, while naphthalene was detected in soil gas sample V-4 at a concentration of 164 µg/m^3, above its associated screening value of 12 µg/m^3.

VOLUNTARY CLEANUP PROGRAM APPLICATION & VPAP

United, on behalf of UAB, submitted an Application and VPAP for the Site in September 2015. ADEM approved the VPAP in a letter dated October 21, 2015. The VPAP summarized the assessment activities outlined above and concluded with the following recommendations.

> *"Presently, UAB Educational Foundation desires to acquire the Subject Site and subsequently* ***raze the existing building and improve the Subject Site with a surface parking lot.*** *An Environmental Covenant will be proposed to address potential pathways of exposure including inhalation, ingestion of soil and groundwater, dermal contact with soil, and soil leaching to groundwater."*
>
> *"With this in mind, United Consulting proposes to use the soil and groundwater data collected on the Subject Site in 2003, 2012, 2015, and relevant data from published USGS information relative to possible metals background conditions in the initial risk assessment process concerning potential soil and groundwater pathways.* ***The initial risk assessment will utilize commercial standards to support the re-use of the Subject Site as a parking lot.*** *The previous data collected and analyzed from 2003, 2012, and 2015 will be utilized in performing the risk assessment relative to that media.*

Bullock notes that the intended Site use differs from that described in the approved VPAP. Instead of converting the Site into a surface parking lot, Orion Enterprises, Inc. intends to use the existing structure for a mixed-use development with commercial/retail operations on the ground floor and residential units on the second and third levels of the building. As such, future plans will not include demolition or onsite grading activities. Development plans will be limited to interior renovations and exterior building improvements with repaving of the existing lot and landscaping; no significant soil disturbance is anticipated. Additionally, Orion Enterprises, Inc. should generate no solid waste requiring offsite disposal.

ANALYSIS OF DATA FROM PREVIOUS INVESTIGATIONS

Review of the information collected during the Site investigations summarized above indicates the following with respect to COCs in onsite soil, groundwater, and soil vapor:

Soil: Arsenic and chromium, while present in subsurface soil (greater than one foot below land surface) at concentrations exceeding their respective EPA Regional Screening Levels (RSLs), do not represent a viable exposure risk based on the current or future Site conditions (i.e., covered by building slab and/or present beneath paved parking area). With regard to the benzo(a)pyrene concentrations reported in three locations above the SSL, Bullock notes that this compound was not present in soil at a concentration ex-

ceeding the current screening value (May 2018 RSL) for a receptor in a commercial setting. Finally, analysis of groundwater samples did ***not*** indicate detectable levels of benzo(a)pyrene. As such, this constituent does not appear to represent a threat to current or future occupants through relevant exposure pathways nor has it leached to or impacted the underlying groundwater formation. While not articulated in the historical investigation reports, numerous additional compounds (including barium, mercury, toluene, 2-methylnaphthalene, benzo(a)anthracene, benzo(b)fluoranthene, dibenzofuran, fluorene, indeno(1,2,3-cd)pyrene, and pyrene) were detected in soil at concentrations exceeding their respective SSLs but below the established RSLs for a commercial setting. It is noteworthy that, like benzo(a)pyrene, none of these compounds were detected above laboratory reporting limits (or their associated groundwater screening/action levels) in the underlying groundwater formation. **Table 1** (attached) summarizes these findings.

Groundwater: As demonstrated in the attached VISL calculator, the naphthalene and benzene concentrations detected in onsite groundwater (DP-1 and DP-5A) do not create an exposure risk through indoor inhalation of vapors from the underlying groundwater formation (assuming the conservative defaults integrated into the EPA Calculator). The VISL Calculator with associated groundwater concentrations is included as an attachment to this *Certificate of Compliance*. **Table 2** (attached) summarizes the findings from previous investigation activities and includes the output from the VISL Calculator.

Soil Gas/Vapor: The maximum benzene and naphthalene concentrations detected in sub-slab vapor samples (64 µg/m^3 and 139 µg/m^3, respectively) represent a potential exposure risk through indoor inhalation (see attached VISL Calculator with maximum concentrations included).

In sum, Site investigations completed to date demonstrate no evidence of a contaminant source on the Site. However, sub-slab vapor samples collected during the 2015 investigation suggest the possibility that an exposure pathway exists through indoor inhalation from subsurface vapor sources (through exposure to benzene and naphthalene). The following section presents the rationale and supporting regulatory framework to demonstrate that no viable risk exists with respect to the indoor vapor intrusion exposure pathway.

BUILDING-SPECIFIC ATTENUATION FACTORS FOR COMMERCIAL STRUCTURES

EPA distinguishes between two distinct levels of assessment for vapor intrusion as follows:

1. A preliminary analysis, which utilizes available and readily ascertainable information to develop an initial understanding of the potential for human health risks to be posed by vapor intrusion, would typically be performed as part of an ***initial site assessment***; and
2. ***A detailed investigation, which is generally recommended when the preliminary analysis indicates that subsurface contamination with vapor-forming chemicals may be present underlying or near buildings***. A detailed investigation of the vapor intrusion pathway is typically performed as part of the site investigation stage.

The approach for assessing vapor intrusion will vary from site to site because each site will differ in the available data when vapor intrusion is being evaluated. Therefore, EPA's 2015 Vapor Intrusion Guidance document recommends a framework for planning and conducting vapor intrusion investigations rather than a prescriptive step-by-step approach to be applied at every site. "*VOC concentrations in soil gas attenuate, or decrease, as the VOCs move from the source through the soil and into indoor air. This reduction in VOC concentration from a measurement point in the subsurface to indoor air is referred to as attenuation and occurs because the VOC emissions into a building are mixed with the natural flow of ambient air through the building* (Conceptual Model Scenarios of the Vapor Intrusion Pathway, 02/24/2012, EPA)."

The following sections detail the application of this recommended approach.

When deriving a Site-specific AF for Sub-slab to Indoor Air, identifying the rate of attenuation of soil gas to indoor air is a critical step in estimating indoor air concentrations from levels detected in sub-slab soil gas. The AF is computed as the VOC indoor air concentration divided by the corresponding concentration in sub-slab soil gas:

$$AF = \frac{C_{Indoor}}{C_{sub\text{-}slab}}$$

Where:
AF = attenuation factor (unit-less)
C_{Indoor} = indoor air concentration ($\mu g/m^3$)
$C_{sub\text{-}slab}$ = sub-slab soil gas concentration ($\mu g/m^3$)

The smaller the AF, the more attenuation is occurring. In a practical sense, the AF is the measure of how soil and building properties limit the intrusion of organic vapors as they migrate into a structure. The objective in estimating an empirical AF for vapor intrusion is to minimize bias while accounting for the structural differences between residential and commercial structures (or "non-residential" buildings - Section 1.3.2 of the EPA 2015 Vapor Intrusion Guidance document).

EPA has established a default AF equal to 0.03 (Section 6.5.3 of the EPA 2015 Vapor Intrusion Guidance document). However, this default value, characterized by EPA as "a conservative generic value," is *intended for initial screening purposes* only. With regard to the VISL Calculator (2015a), Section 1.4.2 of the same Guidance document states that EPA developed this tool to facilitate the "calculation of site-specific screening levels and/or candidate cleanup levels based on user-defined target risk levels, exposure scenarios, and **semi-site-specific or site-specific attenuation factors**." As such, the use of building-specific data is encouraged to develop a more accurate Site Conceptual Exposure Model (SCEM).

As stated in Appendix A.4 of EPA's 2015 Vapor Intrusion Guidance document, *"There are theoretical considerations to support expectations that larger nonresidential buildings that are constructed on thick slabs will have lower attenuation factors than residential buildings. These considerations include:*

- *Given that the size (e.g., interior height and footprint area) and air exchange rate tend to be larger for many nonresidential buildings (see, for example, Table A-5), it is expected that building ventilation rates for many nonresidential buildings would be higher than those for residential buildings. A higher ventilation rate is expected to result in greater overall vapor dilution as vapors migrate from a subsurface vapor source into a building. On this basis, many nonresidential buildings would be expected to have lower attenuation factors than those for residential buildings, all else being equal.*
- *Comparing buildings with slab-on-grade construction, nonresidential buildings tend to have thicker slabs than residential buildings. With thicker slabs, a given amount of differential settling would be expected to lead to less cracking in the slab and would be less likely to create cracks that extend across the entire slab thickness. Buildings with thicker slabs would, therefore, be expected to exhibit lower soil gas entry rates, all else being equal."*

Specific variables related to the Site building which would affect the overall AF include the following:

1. Ceiling height: 12 feet on the Site versus eight-foot EPA default value.
2. Larger Building Footprint: Approximately 10,000 square feet [sf] on the Site versus 1,500-sf EPA default value.
3. Slab Thickness: Eight inches on the Site versus six-inch EPA default value.

4. Building Ventilation: Increased air exchange rate based on footprint approximately six times larger on the Site than EPA default value.
5. Fine-grained soil on the Site versus coarse-grained material (sand) assumed in EPA defaults.

As indicated in the graph below, these factors combine to result in a lower overall vapor intrusion potential (Figure 2-3 EPA 2015 Vapor Intrusion Guidance document).

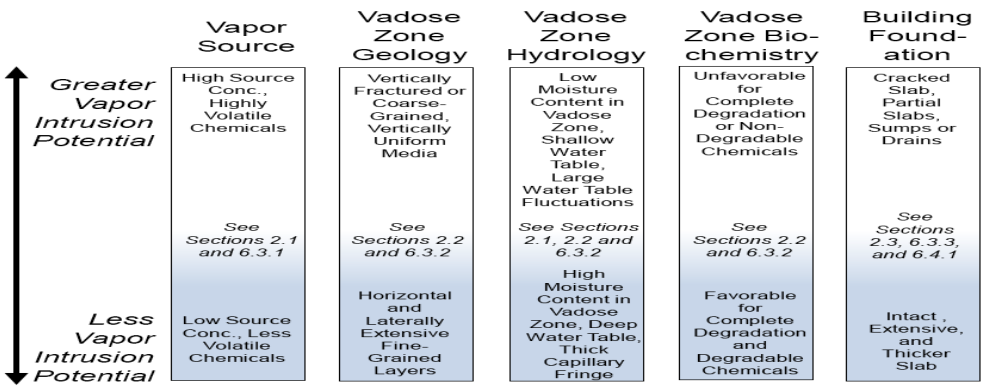


Figure 2-3 Some Factors That Affect Vapor Intrusion

Using the equation presented above, the anticipated indoor air concentration is calculated by multiplying the sub-slab vapor concentration by the AF.

USE OF EPA DEFAULT AF

Application of the EPA default AF (0.03) to the maximum benzene concentration (64 µg/m^3) and naphthalene (139 µg/m^3) concentration detected in sub-slab vapor (see equations below) yields predicted indoor air concentrations of 1.92 µg/m^3 (benzene) and 4.17 µg/m^3 (naphthalene), greater than the target commercial indoor air RSLs of 1.6 µg/m^3 and 0.36 µg/m^3 for these compounds. The VISL Calculator with supporting output for this scenario is included as an attachment to this *Certificate of Compliance*.

Benzene (Default AF)

$$C_{Indoor} = C_{sub\text{-}slab} \times AF$$

Where:
AF = 0.03
$C_{sub\text{-}slab}$ = sub-slab soil gas concentration of benzene (64 µg/m^3)
C_{Indoor} = predicted indoor air concentration of benzene (1.92 µg/m^3)

Naphthalene (Default AF)

$$C_{Indoor} = C_{sub\text{-}slab} \times AF$$

Where:
AF = 0.03
$C_{sub\text{-}slab}$ = sub-slab soil gas concentration of naphthalene (139 µg/m^3)

C_{Indoor} = predicted indoor air concentration of naphthalene (4.17 µg/m^3)

USE OF BUILDING-SPECIFIC AF

Accounting for the building-specific variables noted above, Bullock reduced the AF from the default value of 0.03 to 0.002 based on the analytical solutions of Johnson and Ettinger (1991) for contaminant partitioning and subsurface vapor transport into buildings. These models account for the building-specific variables noted above and derive a median-range AF (0.0001 to 0.05, using default soil gas advection rate [$Q_{soil}/Q_{building}$] through the building envelope) and associated predicted indoor air concentration based on these inputs.

As demonstrated from these models (attached), use of the median-range building-specific AF of 0.002, with the maximum concentrations for benzene and naphthalene in sub-slab vapor, result in the following.

Benzene (Building-Specific AF)

$$C_{Indoor} = C_{sub\text{-}slab} \times AF$$

Where:
AF = 0.002
C_{Indoor} = 0.128 µg/m^3
$C_{sub\text{-}slab}$ = sub-slab soil gas concentration of benzene (64 µg/m^3)

Naphthalene (Building-Specific AF)

$$C_{Indoor} = C_{sub\text{-}slab} \times AF$$

Where:
AF = 0.002
C_{Indoor} = 0.278 µg/m^3
$C_{sub\text{-}slab}$ = sub-slab soil gas concentration of naphthalene (139 µg/m^3)

As indicated in the calculations above, application of the building-specific AF (0.002) reduces the predicted indoor air concentrations to levels below those established for indoor commercial air (EPA RSLs May 2018). Bullock further notes that the maximum concentrations of benzene and naphthalene in sub-slab vapor are not representative of the overall site conditions. The maximum benzene concentration (64 µg/m^3) was detected in sample V-1 with the remaining sub-slab vapor samples containing 16.8 µg/m^3, 0.84 µg/m^3, and 1.9 µg/m^3, respectively. Similarly, the maximum naphthalene concentration in sub-slab vapor (139 µg/m^3) was detected in sample V-4 with the remaining vapor samples containing <0.001 µg/m^3, 5.5 µg/m^3, and 7.0 µg/m^3, respectively.

Considering the building-specific AF value derived from the variables incorporated into the EPA 2015 Vapor Intrusion Guidance document, combined with the maximum benzene and naphthalene concentrations measured in sub-slab vapor (which presents the most conservative representation of potential exposure conditions), there is no indication that an exposure risk to current or future receptors exists at the Site through inhalation of vapors from subsurface sources.

CONCLUSIONS & RECOMMENDATIONS

Analysis of the COCs detected in onsite soil and groundwater during investigations completed from 2003 to 2015 indicates no complete exposure pathway exists representing a viable risk to current or future oc-

cupants of the Site. With regard to sub-slab vapor, the potential exposure risk has been evaluated and ruled out as a concern based on:

1. The absence of a defined soil or groundwater source on the Site;
2. The square footage of the building footprint (with increased, associated air exchange rates);
3. The height of the ceiling;
4. The thickness of the concrete slab/foundation;
5. The fine-grained material present beneath the Site; and
6. Use of the EPA-approved Johnson & Ettinger model (and associated median-range AF) to account for these building-specific parameters.

Considering the absence of a viable exposure risk posed by the COCs detected in soil, groundwater, and sub-slab vapor, Bullock recommends no additional assessment or corrective action at the Site. Instead, an environmental covenant will function as an adequate remedy for the Site. The proposed environmental covenant would restrict ground-floor residential use on the parcel and prohibit the use of onsite groundwater for consumption or irrigation purposes. This instrument will both protect human health and the environment while facilitating the Site's continued redevelopment into productive reuse. Finally, Bullock has prepared a soil management plan (attached) to establish protocols during future construction and repaving activities. In the unlikely event that such work requires the management of this material, Orion Enterprises, Inc. will have this plan in place to mitigate the potential risks identified in subsurface soil.

Upon execution of the environmental covenant (to be handled after closing - estimated date of October 2018), Bullock requests a *Letter of Concurrence* from ADEM releasing the site from further assessment or corrective action under the Alabama Land Recycling and Economic Redevelopment Act (ALRERA)/ Voluntary Cleanup Program. This *Certificate of Compliance* has been prepared in accordance with the ADEM Administrative Code 335-15-4-.06.

If you have any questions or comments concerning the content and recommendations of this report, please call us at (205) 876-1715. You can also respond by email to doug.bullock@bullockenvironmental.com.

Sincerely,
Bullock Environmental, LLC

Douglas A. Bullock, CHMM
Principal

Attached:
Table 1: Chemicals of Concern in Soil
Table 2: Chemicals of Concern in Groundwater
VISL Calculator - Default Scenario (Groundwater Concentrations)
VISL Calculator - Default Scenario (Maximum Concentrations)
Calculations for Building-Specific Attenuation Factor (Johnson & Ettinger Model)
Soil Management Plan

Table 1
Chemicals of Concern in Soil
1329 4th Avenue South
Birmingham, Jefferson County, Alabama
Bullock Environmental, LLC Project #: 18-ORIO01

Client Sample ID					2012							2015				
					DP-1 (1-3)	DP-2 (1-3)	DP-2 (14-16)	DP-3 (1-3)	DP-4 (3-5)	DP-5 (1-1.5)	DP-5 (8-10)	DP-1A (9-10)	DP-3A 4-5)	DP-4A (8-10)	DP-5A (3-4)	EB-1 (1')
Date Collected					10/22/12	10/22/12	10/22/12	10/22/12	10/22/12	10/22/12	10/22/12	7/21/15	7/21/15	7/21/15	7/21/15	7/21/15
Method	Analyte	Units	SSL	RSL	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
6010B	ARSENIC	mg/kg	2.90E-01	3.00E+00	**7.09E+00**	**7.24E+00**	**1.40E+01**	**1.39E+01**	**1.95E+01**	**3.55E+01**	**1.30E+01**	**1.71E+01**	**6.80E+00**	**7.70E+00**	**7.80E+00**	**2.35E+01**
6010B	BARIUM	mg/kg	8.20E+01	2.20E+04	9.41E+01	1.05E+02	4.97E+01	1.53E+02	1.70E+02	1.29E+02	4.18E+01	3.16E+02	9.91E+01	3.98E+01	1.11E+02	3.80E+02
6010B	CADMIUM	mg/kg	NE	9.80E+01	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6.10E-01
6010B	CHROMIUM	mg/kg	1.80E+05	6.30E+00	**2.93E+01**	**2.75E+01**	**4.93E+01**	**3.02E+01**	**2.77E+02**	**1.78E+01**	**7.26E+01**	**3.74E+01**	**2.31E+01**	**2.57E+01**	**2.82E+01**	**1.32E+01**
6010B	LEAD	mg/kg	1.40E+01	8.00E+02	2.50E+01	4.14E+01	3.01E+01	2.69E+02	1.40E+02	1.07E+02	1.36E+01	1.21E+02	2.79E+01	1.23E+01	2.49E+01	9.94E+01
7471A	MERCURY	mg/kg	1.00E-01	4.60E+00	1.40E-01	9.89E-01	2.75E-01	BDL	2.01E-01	2.43E-01	BDL	9.80E-02	4.50E-02	1.50E-01	8.60E-02	1.30E-01
8260B	ACETONE	mg/kg	2.90E+00	6.70E+04	BDL	1.40E-01	BDL	9.10E-02	BDL	NA	BDL	BDL	BDL	BDL	BDL	2.40E-02
8260B	METHYLCYLOHEXANE	mg/kg	NE	NE	BDL	BDL	9.50E+00	BDL	BDL	NA	BDL	BDL	BDL	BDL	BDL	BDL
8260B	TOLUENE	mg/kg	6.90E-01	4.70E+03	BDL	BDL	4.90E+00	BDL	BDL	NA	BDL	BDL	BDL	BDL	BDL	BDL
8270C-SIM	2-METHYLNAPHTHALENE	mg/kg	1.90E-02	3.00E+02	9.00E-01	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8270C-SIM	ACENAPHTHENE	mg/kg	5.50E-01	4.50E+03	5.00E-01	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8270C-SIM	ANTHRACENE	mg/kg	5.80E+00	2.30E+04	9.30E-01	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8270C-SIM	BENZO(A)ANTHRACENE	mg/kg	1.10E-02	2.10E+01	1.80E+00	BDL	BDL	BDL	9.10E-01	BDL	BDL	BDL	BDL	BDL	BDL	4.30E-01
8270C-SIM	BENZO(A)PYRENE	mg/kg	2.90E-02	2.10E+00	1.50E+00	BDL	BDL	BDL	9.10E-01	BDL	BDL	BDL	BDL	BDL	BDL	3.90E-01
8270C-SIM	BENZO(B)FLUORANTHENE	mg/kg	3.00E-01	2.10E+01	2.20E+00	BDL	BDL	BDL	1.20E+00	BDL	BDL	BDL	BDL	BDL	BDL	4.90E-01
8270C-SIM	BENZO(G,H,I)PERYLENE	mg/kg	NE	NE	1.20E+00	BDL	BDL	BDL	7.20E-01	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8270C-SIM	BENZO(K)FLUORANTHENE	mg/kg	2.90E+00	2.10E+02	8.40E-01	BDL	BDL	BDL	4.80E-01	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8270C-SIM	CARBAZOLE	mg/kg	NE	NE	8.30E-01	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8270C-SIM	CHRYSENE	mg/kg	9.00E+00	2.10E+03	1.80E+00	BDL	BDL	BDL	9.20E-01	BDL	BDL	BDL	BDL	BDL	BDL	4.50E-01
8270C-SIM	DIBENZOFURAN	mg/kg	1.50E-02	1.00E+02	6.60E-01	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8270C-SIM	FLUORANTHENE	mg/kg	8.90E+00	3.00E+03	4.00E+00	BDL	BDL	BDL	1.90E+00	BDL	BDL	BDL	BDL	BDL	BDL	9.70E-01
8270C-SIM	FLUORENE	mg/kg	5.40E-01	3.00E+03	6.50E-01	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8270C-SIM	INDENO(1,2,3-CD)PYRENE	mg/kg	9.80E-01	2.10E+01	1.10E+00	BDL	BDL	BDL	5.90E-01	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8270C-SIM	NAPHTHALENE	mg/kg	5.40E-04	1.70E+01	3.80E+00	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
8270C-SIM	PHENANTHRENE	mg/kg	NE	NE	4.20E+00	BDL	BDL	BDL	1.30E+00	BDL	BDL	BDL	BDL	BDL	BDL	7.90E-01
8270C-SIM	PYRENE	mg/kg	1.30E+00	2.30E+03	2.90E+00	BDL	BDL	BDL	1.50E+00	BDL	BDL	BDL	BDL	BDL	BDL	7.00E-01
8081	PCBS	mg/kg			BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Notes:
All concentrations presented in milligrams per kilogram (mg/kg), parts per million
EPA RSL = Regional Screening Level established by Environmental Protection Agency (EPA) Region 9 for Industrial Soil (May 2018)
NA = Not Analyzed
Bolded/highlighted cells = Concentration exceeds corresponding EPA RSL BDL=Below Laboratory Detection Limits
Shaded Cell = Detected Concentration but below EPA RSL for Industrial Soil or Soil Screening Level (SSL)
Ft. BLS= feet below land surface
NE=Not Established

Table 2
Chemicals of Concern in Groundwater
1329 4th Avenue South
Birmingham, Jefferson County, Alabama
Bullock Environmental, LLC Project #: 18-ORiO01

Client Sample ID					2003		2012		2015	
					B-1	B-2	DP-1	DP-3	EB-1	DP-5A
Date Collected					05/2003	05/2003	10/22/2012	10/22/2012	07/231/2015	7/21/15
Method	Analyte	Units	VISL-GW	**RSL* / MCL**	Result	Result	Result	Result	Result	Result
6010B	ARSENIC	mg/l	NE	1.00E-02	NS	NS	BDL	BDL	BDL	**1.1E-02**
6010B	BARIUM	mg/l	NE	2.00E+00	NS	NS	BDL	0.068	BDL	BDL
6010B	CHROMIUM	mg/l	NE	1.00E-01	NS	NS	BDL	BDL	1E-02	2.4E-02
6010B	LEAD	mg/l	NE	1.50E-02	NS	NS	BDL	BDL	**3.1E-02**	**2.000E-02**
7470A	MERCURY	mg/l	3.70E-03	2.00E-03	NS	NS	BDL	BDL	BDL	BDL
8270C-SIM	NAPHTHALENE	mg/l	2.00E-02	1.70E-04	BDL	BDL	**1.4E-02**	BDL	BDL	BDL
8260B	ACETONE*	mg/l	9.50E+04	1.40E+00	NS	NS	BDL	BDL	5.2E-03	1.4E-02
8260B	BENZENE	mg/l	6.90E-03	5.00E-03	BDL	BDL	BDL	BDL	1.7E-03	**6.00E-03**
8260B	BROMOMETHANE*	mg/l	7.30E-02	7.50E-04	NS	NS	BDL	BDL	BDL	1E-03
8260B	ETHYLBENZENE	mg/l	1.50E-02	7.00E-01	BDL	BDL	BDL	BDL	BDL	4.4E-03
8260B	2-BUTANONE (MEK)*	mg/l	9.40E+03	5.60E-01	NS	NS	BDL	BDL	BDL	8.5E-04
8260B	MTBE*	mg/l	2.00E+00	1.40E-02	8.5E-03	4.5E-03	BDL	BDL	7.2E-04	BDL
8260B	TOLUENE	mg/l	8.10E+01	1.00E+00	1.6E-03	2.3E-03	BDL	BDL	4.1E-03	1.4E-02
8260B	1,1,1-TRICHLOROETHANE	mg/l	3.10E+00	2.00E-01	NS	NS	BDL	BDL	BDL	1.2E-03
8260B	XYLENES, TOTAL	mg/l	1.60E-01	1.00E+01	BDL	0.0028	BDL	BDL	2.4E-03	1.09E-02
8260B	PCBS	mg/l	—	—	NS	NS	NS	BDL	NS	NS

Notes
All concentrations presented in milligrams per liter (mg/L), parts per million
EPA RSL = Regional Screening Level (RSL) for Tapwater established by Environmental Protection Agency (EPA) Region 9 (2018)
EPA MCL = Maximum Contaminant Level MCL established by Environmental Protection Agency (EPA)
* = EPA RSL for Tapwater used
NA = Not analyzed
Bolded/highlighted cells = Concentration exceeds corresponding EPA RSL
Shaded Cell = Detected Concentration but below EPA MCL tap water
NE = Not Established
VISL-GW= Vapor Intrusion Screening Level for Groundwater (June 2015 Vapor Intrusion Guidance document)

Maximum Groundwater Concentrations with Predicted Indoor Air Concentrations & Calculated Risk

OSWER VAPOR INTRUSION ASSESSMENT

Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.45, November 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (°C)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m³)	VI Carcinogenic Risk CR	VI Hazard HQ	Inhalation Unit Risk IUR (ug/m³)⁻¹	IUR Source*	Reference Concentration RfC (mg/m³)	RFC Source*	Mutagenic Indicator
75-07-0	Acetaldehyde		–	–	–	2.20E-06	I	9.00E-03	I	
67-64-1	Acetone		–	–	–			3.10E+01	A	
75-05-8	Acetonitrile		–	–	–			6.00E-02	I	
107-02-8	Acrolein		–	–	–			2.00E-05	I	
79-10-7	Acrylic Acid		–	–	–			1.00E-03	I	
107-13-1	Acrylonitrile		–	–	–	6.80E-05	I	2.00E-03	I	
309-00-2	Aldrin		–	–	–	4.90E-03	I			
107-18-6	Allyl Alcohol		–	–	–			1.00E-04	X	
107-05-1	Allyl Chloride		–	–	–	6.00E-06	CA	1.00E-03	I	
7664-41-7	Ammonia		–	–	–			1.00E-01	I	
75-85-4	Amyl Alcohol, tert-		–	–	–			3.00E-03	X	
12674-11-2	Aroclor 1016		–	–	–	2.00E-05	S			
11104-28-2	Aroclor 1221		–	–	–	5.70E-04	S			
11141-16-5	Aroclor 1232		–	–	–	5.70E-04	S			
53469-21-9	Aroclor 1242		–	–	–	5.70E-04	S			
12672-29-6	Aroclor 1248		–	–	–	5.70E-04	S			
11097-69-1	Aroclor 1254		–	–	–	5.70E-04	S			
11096-82-5	Aroclor 1260		–	–	–	5.70E-04	S			
103-33-3	Azobenzene		–	–	–	3.10E-05	I			
56-55-3	Benz[a]anthracene		–	–	–	1.10E-04	CA			Mut
71-43-2	Benzene	6.0E+00	1.36E+00	8.7E-07	1.0E-02	7.80E-06	I	3.00E-02	I	
100-44-7	Benzyl Chloride		–	–	–	4.90E-05	CA	1.00E-03	P	
92-52-4	Biphenyl, 1,1'-		–	–	–			4.00E-04	X	
111-44-4	Bis(2-chloroethyl)ether		–	–	–	3.30E-04	I			
542-88-1	Bis(chloromethyl)ether		–	–	–	6.20E-02	I			
10294-34-5	Boron Trichloride		–	–	–			2.00E-02	P	
7637-07-2	Boron Trifluoride		–	–	–			1.30E-02	CA	
107-04-0	Bromo-2-chloroethane, 1-		–	–	–	6.00E-04	X			
108-86-1	Bromobenzene		–	–	–			6.00E-02	I	
74-97-5	Bromochloromethane		–	–	–			4.00E-02	X	
75-27-4	Bromodichloromethane		–	–	–	3.70E-05	CA			
75-25-2	Bromoform		–	–	–	1.10E-06	I			
74-83-9	Bromomethane		–	–	–			5.00E-03	I	
106-99-0	Butadiene, 1,3-		–	–	–	3.00E-05	I	2.00E-03	I	
78-92-2	Butyl alcohol, sec-		–	–	–			3.00E+01	P	
75-15-0	Carbon Disulfide		–	–	–			7.00E-01	I	
56-23-5	Carbon Tetrachloride		–	–	–	6.00E-06	I	1.00E-01	I	
463-58-1	Carbonyl Sulfide		–	–	–			1.00E-01	P	
12789-03-6	Chlordane		–	–	–	1.00E-04	I	7.00E-04	I	
7782-50-5	Chlorine		–	–	–			1.50E-04	A	
10049-04-4	Chlorine Dioxide		–	–	–			2.00E-04	I	
75-68-3	Chloro-1,1-difluoroethane, 1-		–	–	–			5.00E+01	I	
126-99-8	Chloro-1,3-butadiene, 2-		–	–	–	3.00E-04	I	2.00E-02	I	
108-90-7	Chlorobenzene		–	–	–			5.00E-02	P	
98-56-6	Chlorobenzotrifluoride, 4-		–	–	–			3.00E-01	P	
75-45-6	Chlorodifluoromethane		–	–	–			5.00E+01	I	
67-66-3	Chloroform		–	–	–	2.30E-05	I	9.80E-02	A	
74-87-3	Chloromethane		–	–	–			9.00E-02	I	
107-30-2	Chloromethyl Methyl Ether		–	–	–	6.90E-04	CA			
76-06-2	Chloropicrin		–	–	–			4.00E-04	CA	
8007-45-2	Coke Oven Emissions		–	–	–	6.20E-04	I			Mut
98-82-8	Cumene		–	–	–			4.00E-01	I	
57-12-5	Cyanide (CN-)		–	–	–			8.00E-04	S	
110-82-7	Cyclohexane		–	–	–			6.00E+00	I	
108-94-1	Cyclohexanone		–	–	–			7.00E-01	P	
110-83-8	Cyclohexene		–	–	–			1.00E+00	X	

OSWER VAPOR INTRUSION ASSESSMENT

Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.45, November 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (°C)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m³)	VI Carcinogenic Risk CR	VI Hazard HQ	Inhalation Unit Risk IUR (ug/m³)⁻¹	IUR Source*	Reference Concentration RfC (mg/m³)	RFC Source*	Mutagenic Indicator I
72-55-9	DDE, p,p'-		--	--	--	9.70E-05	CA			
96-12-8	Dibromo-3-chloropropane, 1,2-		--	--	--	6.00E-03	P	2.00E-04	I	Mut
106-93-4	Dibromoethane, 1,2-		--	--	--	6.00E-04	I	9.00E-03	I	
74-95-3	Dibromomethane (Methylene Bromide)		--	--	--			4.00E-03	X	
764-41-0	Dichloro-2-butene, 1,4-		--	--	--	4.20E-03	P			
1476-11-5	Dichloro-2-butene, cis-1,4-		--	--	--	4.20E-03	P			
110-57-6	Dichloro-2-butene, trans-1,4-		--	--	--	4.20E-03	P			
95-50-1	Dichlorobenzene, 1,2-		--	--	--			2.00E-01	H	
106-46-7	Dichlorobenzene, 1,4-		--	--	--	1.10E-05	CA	8.00E-01	I	
75-71-8	Dichlorodifluoromethane		--	--	--			1.00E-01	X	
75-34-3	Dichloroethane, 1,1-		--	--	--	1.60E-06	CA			
107-06-2	Dichloroethane, 1,2-		--	--	--	2.60E-05	I	7.00E-03	P	
75-35-4	Dichloroethylene, 1,1-		--	--	--			2.00E-01	I	
78-87-5	Dichloropropane, 1,2-		--	--	--	1.00E-05	CA	4.00E-03	I	
542-75-6	Dichloropropene, 1,3-		--	--	--	4.00E-06	I	2.00E-02	I	
77-73-6	Dicyclopentadiene		--	--	--			3.00E-04	X	
75-37-6	Difluoroethane, 1,1-		--	--	--			4.00E+01	I	
94-58-6	Dihydrosafrole		--	--	--	1.30E-05	CA			
108-20-3	Diisopropyl Ether		--	--	--			7.00E-01	P	
68-12-2	Dimethylformamide		--	--	--			3.00E-02	I	
57-14-7	Dimethylhydrazine, 1,1-		--	--	--			2.00E-06	X	
540-73-8	Dimethylhydrazine, 1,2-		--	--	--	1.60E-01	CA			
513-37-1	Dimethylvinylchloride		--	--	--	1.30E-05	CA			
123-91-1	Dioxane, 1,4-		--	--	--	5.00E-06	I	3.00E-02	I	
106-89-8	Epichlorohydrin		--	--	--	1.20E-06	I	1.00E-03	I	
106-88-7	Epoxybutane, 1,2-		--	--	--			2.00E-02	I	
111-15-9	Ethoxyethanol Acetate, 2-		--	--	--			6.00E-02	P	
110-80-5	Ethoxyethanol, 2-		--	--	--			2.00E-01	I	
141-78-6	Ethyl Acetate		--	--	--			7.00E-02	P	
140-88-5	Ethyl Acrylate		--	--	--			8.00E-03	P	
75-00-3	Ethyl Chloride (Chloroethane)		--	--	--			1.00E+01	I	
97-63-2	Ethyl Methacrylate		--	--	--			3.00E-01	P	
100-41-4	Ethylbenzene		--	--	--	2.50E-06	CA	1.00E+00	I	
75-21-8	Ethylene Oxide		--	--	--	8.80E-05	CA	3.00E-02	CA	
151-56-4	Ethyleneimine		--	--	--	1.90E-02	CA			
50-00-0	Formaldehyde		--	--	--	1.30E-05	I	9.80E-03	A	
64-18-6	Formic Acid		--	--	--			3.00E-04	X	
98-01-1	Furfural		--	--	--			5.00E-02	H	
765-34-4	Glycidyl		--	--	--			1.00E-03	H	
76-44-8	Heptachlor		--	--	--	1.30E-03	I			
1024-57-3	Heptachlor Epoxide		--	--	--	2.60E-03	I			
39635-31-9	Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)		--	--	--	1.10E-03	E	1.30E-03	E	
118-74-1	Hexachlorobenzene		--	--	--	4.60E-04	I			
38380-08-4	Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)		--	--	--	1.10E-03	E	1.30E-03	E	
69782-90-7	Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)		--	--	--	1.10E-03	E	1.30E-03	E	
52663-72-6	Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)		--	--	--	1.10E-03	E	1.30E-03	E	
32774-16-6	Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)		--	--	--	1.10E+00	E	1.30E-06	E	
87-68-3	Hexachlorobutadiene		--	--	--	2.20E-05	I			
77-47-4	Hexachlorocyclopentadiene		--	--	--			2.00E-04	I	
67-72-1	Hexachloroethane		--	--	--	1.10E-05	CA	3.00E-02	I	
822-06-0	Hexamethylene Diisocyanate, 1,6-		--	--	--			1.00E-05	I	
110-54-3	Hexane, N-		--	--	--			7.00E-01	I	
591-78-6	Hexanone, 2-		--	--	--			3.00E-02	I	
302-01-2	Hydrazine		--	--	--	4.90E-03	I	3.00E-05	P	
7647-01-0	Hydrogen Chloride		--	--	--			2.00E-02	I	
74-90-8	Hydrogen Cyanide		--	--	--			8.00E-04	I	

OSWER VAPOR INTRUSION ASSESSMENT

Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.45, November 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (°C)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m³)	VI Carcinogenic Risk CR	VI Hazard HQ	Inhalation Unit Risk IUR (ug/m³)⁻¹	IUR Source*	Reference Concentration RfC (mg/m³)	RFC Source*	Mutagenic Indicator
7664-39-3	Hydrogen Fluoride		--	--	--			1.40E-02	CA	
7783-06-4	Hydrogen Sulfide		--	--	--			2.00E-03	I	
67-63-0	Isopropanol		--	--	--			2.00E-01	P	
7439-97-6	Mercury (elemental)		--	--	--			3.00E-04	I	
126-98-7	Methacrylonitrile		--	--	--			3.00E-02	P	
67-56-1	Methanol		--	--	--			2.00E+01	I	
110-49-6	Methoxyethanol Acetate, 2-		--	--	--			1.00E-03	P	
109-86-4	Methoxyethanol, 2-		--	--	--			2.00E-02	I	
96-33-3	Methyl Acrylate		--	--	--			2.00E-02	P	
78-93-3	Methyl Ethyl Ketone (2-Butanone)		--	--	--			5.00E+00	I	
60-34-4	Methyl Hydrazine		--	--	--	1.00E-03	X	2.00E-05	X	
108-10-1	Methyl Isobutyl Ketone (4-methyl-2-pentanone)		--	--	--			3.00E+00	I	
624-83-9	Methyl Isocyanate		--	--	--			1.00E-03	CA	
80-62-6	Methyl Methacrylate		--	--	--			7.00E-01	I	
25013-15-4	Methyl Styrene (Mixed Isomers)		--	--	--			4.00E-02	H	
1634-04-4	Methyl tert-Butyl Ether (MTBE)		--	--	--	2.60E-07	CA	3.00E+00	I	
75-09-2	Methylene Chloride		--	--	--	1.00E-08	I	6.00E-01	I	Mut
2385-85-5	Mirex		--	--	--	5.10E-03	CA			
64742-95-6	Naphtha, High Flash Aromatic (HFAN)		--	--	--			1.00E-01	P	
91-20-3	Naphthalene	1.4E+01	2.52E-01	7.0E-07	1.9E-02	3.40E-05	CA	3.00E-03	I	
13463-39-3	Nickel Carbonyl		--	--	--	2.60E-04	CA	1.40E-05	CA	
98-95-3	Nitrobenzene		--	--	--	4.00E-05	I	9.00E-03	I	
75-52-5	Nitromethane		--	--	--	8.80E-06	P	5.00E-03	P	
79-46-9	Nitropropane, 2-		--	--	--	2.70E-03	H	2.00E-02	I	
62-75-9	Nitrosodimethylamine, N-		--	--	--	1.40E-02	I	4.00E-05	X	Mut
924-16-3	Nitroso-di-N-butylamine, N-		--	--	--	1.60E-03	I			
10595-95-6	Nitrosomethylethylamine, N-		--	--	--	6.30E-03	CA			
111-84-2	Nonane, n-		--	--	--			2.00E-02	P	
32598-14-4	Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)		--	--	--	1.10E-03	E	1.30E-03	E	
74472-37-0	Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)		--	--	--	1.10E-03	E	1.30E-03	E	
31508-00-6	Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)		--	--	--	1.10E-03	E	1.30E-03	E	
65510-44-3	Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)		--	--	--	1.10E-03	E	1.30E-03	E	
57465-28-8	Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)		--	--	--	3.80E+00	E	4.00E-07	E	
109-66-0	Pentane, n-		--	--	--			1.00E+00	P	
75-44-5	Phosgene		--	--	--			3.00E-04	I	
7803-51-2	Phosphine		--	--	--			3.00E-04	I	
123-38-6	Propionaldehyde		--	--	--			8.00E-03	I	
103-65-1	Propyl benzene		--	--	--			1.00E+00	X	
115-07-1	Propylene		--	--	--			3.00E+00	CA	
107-98-2	Propylene Glycol Monomethyl Ether		--	--	--			2.00E+00	I	
75-56-9	Propylene Oxide		--	--	--	3.70E-06	I	3.00E-02	I	
100-42-5	Styrene		--	--	--			1.00E+00	I	
7446-11-9	Sulfur Trioxide		--	--	--			1.00E-03	CA	
1746-01-6	TCDD, 2,3,7,8-		--	--	--	3.80E+01	CA	4.00E-08	CA	
70362-50-4	Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)		--	--	--	1.10E-02	E	1.30E-04	E	
630-20-6	Tetrachloroethane, 1,1,1,2-		--	--	--	7.40E-06	I			
79-34-5	Tetrachloroethane, 1,1,2,2-		--	--	--	5.80E-05	CA			
127-18-4	Tetrachloroethylene		--	--	--	2.60E-07	I	4.00E-02	I	
811-97-2	Tetrafluoroethane, 1,1,1,2-		--	--	--			8.00E+01	I	
109-99-9	Tetrahydrofuran		--	--	--			2.00E+00	I	
7550-45-0	Titanium Tetrachloride		--	--	--			1.00E-04	A	
108-88-3	Toluene		--	--	--			5.00E+00	I	
76-13-1	Trichloro-1,2,2-trifluoroethane, 1,1,2-		--	--	--			3.00E+01	H	
120-82-1	Trichlorobenzene, 1,2,4-		--	--	--			2.00E-03	P	
71-55-6	Trichloroethane, 1,1,1-		--	--	--			5.00E+00	I	
79-00-5	Trichloroethane, 1,1,2-		--	--	--	1.60E-05	I	2.00E-04	X	

OSWER VAPOR INTRUSION ASSESSMENT

Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.45, November 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (°C)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m³)	VI Carcinogenic Risk CR	VI Hazard HQ	Inhalation Unit Risk IUR (ug/m³)⁻¹	IUR Source*	Reference Concentration RfC (mg/m³)	RFC Source*	Mutagenic Indicator
79-01-6	Trichloroethylene		--	--	--	see note	I	2.00E-03	I	TCE
96-18-4	Trichloropropane, 1,2,3-		--	--	--			3.00E-04	I	Mut
96-19-5	Trichloropropene, 1,2,3-		--	--	--			3.00E-04	P	
121-44-8	Triethylamine		--	--	--			7.00E-03	I	
420-46-2	Trifluoroethane, 1,1,1-		--	--	--			2.00E+01	P	
526-73-8	Trimethylbenzene, 1,2,3-		--	--	--			5.00E-03	P	
95-63-6	Trimethylbenzene, 1,2,4-		--	--	--			7.00E-03	P	
126-72-7	Tris(2,3-dibromopropyl)phosphate		--	--	--	6.60E-04	CA			
108-05-4	Vinyl Acetate		--	--	--			2.00E-01	I	
593-60-2	Vinyl Bromide		--	--	--	3.20E-05	H	3.00E-03	I	
75-01-4	Vinyl Chloride		--	--	--	4.40E-06	I	1.00E-01	I	VC
108-38-3	Xylene, m-		--	--	--			1.00E-01	S	
95-47-6	Xylene, o-		--	--	--			1.00E-01	S	
106-42-3	Xylene, P-		--	--	--			1.00E-01	S	
1330-20-7	Xylenes		--	--	--			1.00E-01	I	

Notes:

(1) **Inhalation Pathway Exposure Parameters (RME):**

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Averaging time for carcinogens	(yrs)	ATc_R_GW	70	ATc_C_GW	70	ATc_GW	70
Averaging time for non-carcinogens	(yrs)	ATnc_R_GW	26	ATnc_C_GW	25	Atnc_GW	25
Exposure duration	(yrs)	ED_R_GW	26	ED_C_GW	25	ED_GW	25
Exposure frequency	(days/yr)	EF_R_GW	350	EF_C_GW	250	EF_GW	250
Exposure time	(hr/day)	ET_R_GW	24	ET_C_GW	8	ET_GW	8

(2) **Generic Attenuation Factors:**

Source Medium of Vapors		Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Groundwater	(-)	AFgw_R_GW	0.001	AFgw_C_GW	0.001	AFgw_GW	0.001
Sub-Slab and Exterior Soil Gas	(-)	AFss_R_GW	0.03	AFss_C_GW	0.03	AFss_GW	0.03

(3) **Formulas**

Cia, target = MIN(Cia,c; Cia,nc)

Cia,c (ug/m3) = TCR x ATc x (365 days/yr) x (24 hrs/day) / (ED x EF x ET x IUR)

Cia,nc (ug/m3) = THQ x ATnc x (365 days/yr) x (24 hrs/day) x RfC x (1000 ug/mg) / (ED x EF x ET)

(4) **Special Case Chemicals**

Trichloroethylene	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
	mIURTCE_R_GW	1.00E-06	mIURTCE_C_GW	0.00E+00	mIURTCE_GW	0.00E+00
	IURTCE_R_GW	3.10E-06	IURTCE_C_GW	4.10E-06	IURTCE_GW	4.10E-06

Mutagenic Chemicals

The exposure durations and age-dependent adjustment factors for mutagenic-mode-of-action are listed in the table below:

Note: This section applies to trichloroethylene and other mutagenic chemicals, but not to vinyl chloride.

Age Cohort	Exposure Duration (years)	Age-dependent adjustment factor
0 - 2 years	2	10
2 - 6 years	4	3
6 - 16 years	10	3
16 - 26 years	10	1

Mutagenic-mode-of-action (MMOA) adjustment factor 25 This factor is used in the equations for mutagenic chemicals.

Vinyl Chloride

See the Navigation Guide equation for Cia,c for vinyl chloride.

OSWER VAPOR INTRUSION ASSESSMENT

Groundwater Concentration to Indoor Air Concentration (GWC-IAC) Calculator Version 3.45, November 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)
Average Groundwater Temperature (°C)	Tgw	25	Enter average of the stabilized groundwater temperature to correct Henry's Law Constant for groundwater target concentrations

CAS	Chemical Name	Site Groundwater Concentration Cgw (ug/L)	Calculated Indoor Air Concentration Cia (ug/m³)	VI Carcinogenic Risk CR	VI Hazard HQ	Inhalation Unit Risk IUR (ug/m³)⁻¹	IUR Source*	Reference Concentration RfC (mg/m³)	RFC Source*	Mutagenic Indicator

Notation:

I = IRIS: EPA Integrated Risk Information System (IRIS). Available online at: http://www.epa.gov/ncea/iris/index.html

P = PPRTV. EPA Provisional Peer Reviewed Toxicity Values (PPRTVs). Available online at: http://hhpprtv.ornl.gov/pprtv.shtml

A = Agency for Toxic Substances and Disease Registry (ATSDR) Minimum Risk Levels (MRLs). Available online at: http://www.atsdr.cdc.gov/mrls/index.html

CA = California Environmental Protection Agency/Office of Environmental Health Hazard Assessment assessments. Available online at: http://www.oehha.ca.gov/risk/ChemicalDB/index.asp

H = HEAST. EPA Superfund Health Effects Assessment Summary Tables (HEAST) database. Available online at: http://epa-heast.ornl.gov/heast.shtml

S = See RSL User Guide, Section 5

X = PPRTV Appendix

Mut = Chemical acts according to the mutagenic-mode-of-action, special exposure parameters apply (see footnote (4) above).

VC = Special exposure equation for vinyl chloride applies (see Navigation Guide for equation).

TCE = Special mutagenic and non-mutagenic IURs for trichloroethylene apply (see footnote (4) above).

Yellow highlighting indicates site-specific parameters that may be edited by the user.

Blue highlighting indicates exposure factors that are based on Risk Assessment Guidance for Superfund (RAGS) or EPA vapor intrusion guidance, which generally should not be changed.

Pink highlighting indicates VI carcinogenic risk greater than the target risk for carcinogens (TCR) or VI Hazard greater than or equal to the target hazard quotient for non-carcinogens (THQ).

Maximum Soil Vapor Concentrations with Predicted Indoor Air Concentrations (Using EPA Default AF) & Calculated Risk

OSWER VAPOR INTRUSION ASSESSMENT

Sub-slab or Exterior Soil Gas Concentration to Indoor Air Concentration (SGC-IAC) Calculator Version 3.45, November 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR_SG	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ_SG	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)

CAS	Chemical Name	Site Sub-slab or Exterior Soil Gas Concentration Csg (ug/m³)	Calculated Indoor Air Concentration Cia (ug/m³)	VI Carcinogenic Risk CR	VI Hazard HQ	Inhalation Unit Risk IUR (ug/m³)⁻¹	IUR Source*	Reference Concentration RfC (mg/m³)	RFC Source*	Mutagenic Indicator I
75-07-0	Acetaldehyde		--	--	--	2.20E-06	I	9.00E-03	I	
67-64-1	Acetone	1.9E+02	5.58E+00	No IUR	4.1E-05			3.10E+01	A	
75-05-8	Acetonitrile		--	--	--			6.00E-02	I	
107-02-8	Acrolein		--	--	--			2.00E-05	I	
79-10-7	Acrylic Acid		--	--	--			1.00E-03	I	
107-13-1	Acrylonitrile		--	--	--	6.80E-05	I	2.00E-03	I	
309-00-2	Aldrin		--	--	--	4.90E-03	I			
107-18-6	Allyl Alcohol		--	--	--			1.00E-04	X	
107-05-1	Allyl Chloride		--	--	--	6.00E-06	CA	1.00E-03	I	
7664-41-7	Ammonia		--	--	--			1.00E-01	I	
75-85-4	Amyl Alcohol, tert-		--	--	--			3.00E-03	X	
12674-11-2	Aroclor 1016		--	--	--	2.00E-05	S			
11104-28-2	Aroclor 1221		--	--	--	5.70E-04	S			
11141-16-5	Aroclor 1232		--	--	--	5.70E-04	S			
53469-21-9	Aroclor 1242		--	--	--	5.70E-04	S			
12672-29-6	Aroclor 1248		--	--	--	5.70E-04	S			
11097-69-1	Aroclor 1254		--	--	--	5.70E-04	S			
11096-82-5	Aroclor 1260		--	--	--	5.70E-04	S			
103-33-3	Azobenzene		--	--	--	3.10E-05	I			
56-55-3	Benz[a]anthracene		--	--	--	1.10E-04	CA			Mut
71-43-2	Benzene	6.4E+01	1.92E+00	1.2E-06	1.5E-02	7.80E-06	I	3.00E-02	I	
100-44-7	Benzyl Chloride		--	--	--	4.90E-05	CA	1.00E-03	P	
92-52-4	Biphenyl, 1,1'-		--	--	--			4.00E-04	X	
111-44-4	Bis(2-chloroethyl)ether		--	--	--	3.30E-04	I			
542-88-1	Bis(chloromethyl)ether		--	--	--	6.20E-02	I			
10294-34-5	Boron Trichloride		--	--	--			2.00E-02	P	
7637-07-2	Boron Trifluoride		--	--	--			1.30E-02	CA	
107-04-0	Bromo-2-chloroethane, 1-		--	--	--	6.00E-04	X			
108-86-1	Bromobenzene		--	--	--			6.00E-02	I	
74-97-5	Bromochloromethane		--	--	--			4.00E-02	X	
75-27-4	Bromodichloromethane		--	--	--	3.70E-05	CA			
75-25-2	Bromoform		--	--	--	1.10E-06	I			
74-83-9	Bromomethane		--	--	--			5.00E-03	I	
106-99-0	Butadiene, 1,3-		--	--	--	3.00E-05	I	2.00E-03	I	
78-92-2	Butyl alcohol, sec-		--	--	--			3.00E+01	P	
75-15-0	Carbon Disulfide	2.9E+03	8.67E+01	No IUR	2.8E-02			7.00E-01	I	
56-23-5	Carbon Tetrachloride	4.4E+00	1.32E-01	6.5E-08	3.0E-04	6.00E-06	I	1.00E-01	I	
463-58-1	Carbonyl Sulfide		--	--	--			1.00E-01	P	
12789-03-6	Chlordane		--	--	--	1.00E-04	I	7.00E-04	I	
7782-50-5	Chlorine		--	--	--			1.50E-04	A	
10049-04-4	Chlorine Dioxide		--	--	--			2.00E-04	I	
75-68-3	Chloro-1,1-difluoroethane, 1-		--	--	--			5.00E+01	I	
126-99-8	Chloro-1,3-butadiene, 2-		--	--	--	3.00E-04	I	2.00E-02	I	
108-90-7	Chlorobenzene		--	--	--			5.00E-02	P	
98-56-6	Chlorobenzotrifluoride, 4-		--	--	--			3.00E-01	P	
75-45-6	Chlorodifluoromethane		--	--	--			5.00E+01	I	
67-66-3	Chloroform	3.4E+00	1.02E-01	1.9E-07	2.4E-04	2.30E-05	I	9.80E-02	A	
74-87-3	Chloromethane	2.7E+01	8.16E-01	No IUR	2.1E-03			9.00E-02	I	
107-30-2	Chloromethyl Methyl Ether		--	--	--	6.90E-04	CA			
76-06-2	Chloropicrin		--	--	--			4.00E-04	CA	
8007-45-2	Coke Oven Emissions		--	--	--	6.20E-04	I			Mut
98-82-8	Cumene		--	--	--			4.00E-01	I	
57-12-5	Cyanide (CN-)		--	--	--			8.00E-04	S	
110-82-7	Cyclohexane	3.3E+01	9.75E-01	No IUR	3.7E-05			6.00E+00	I	
108-94-1	Cyclohexanone		--	--	--			7.00E-01	P	

OSWER VAPOR INTRUSION ASSESSMENT

Sub-slab or Exterior Soil Gas Concentration to Indoor Air Concentration (SGC-IAC) Calculator Version 3.45, November 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR_SG	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ_SG	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)

CAS	Chemical Name	Site Sub-slab or Exterior Soil Gas Concentration Csg (ug/m³)	Calculated Indoor Air Concentration Cia (ug/m³)	VI Carcinogenic Risk CR	VI Hazard HQ	Inhalation Unit Risk IUR (ug/m³)⁻¹	IUR Source*	Reference Concentration RfC (mg/m³)	RFC Source*	Mutagenic Indicator I
110-83-8	Cyclohexene		--	--	--			1.00E+00	X	
72-55-9	DDE, p,p'-		--	--	--	9.70E-05	CA			
96-12-8	Dibromo-3-chloropropane, 1,2-		--	--	--	6.00E-03	P	2.00E-04	I	Mut
106-93-4	Dibromoethane, 1,2-		--	--	--	6.00E-04	I	9.00E-03	I	
74-95-3	Dibromomethane (Methylene Bromide)		--	--	--			4.00E-03	X	
764-41-0	Dichloro-2-butene, 1,4-		--	--	--	4.20E-03	P			
1476-11-5	Dichloro-2-butene, cis-1,4-		--	--	--	4.20E-03	P			
110-57-6	Dichloro-2-butene, trans-1,4-		--	--	--	4.20E-03	P			
95-50-1	Dichlorobenzene, 1,2-		--	--	--			2.00E-01	H	
106-46-7	Dichlorobenzene, 1,4-		--	--	--	1.10E-05	CA	8.00E-01	I	
75-71-8	Dichlorodifluoromethane	3.1E+00	9.30E-02	No IUR	2.1E-04			1.00E-01	X	
75-34-3	Dichloroethane, 1,1-		--	--	--	1.60E-06	CA			
107-06-2	Dichloroethane, 1,2-		--	--	--	2.60E-05	I	7.00E-03	P	
75-35-4	Dichloroethylene, 1,1-		--	--	--			2.00E-01	I	
78-87-5	Dichloropropane, 1,2-		--	--	--	1.00E-05	CA	4.00E-03	I	
542-75-6	Dichloropropene, 1,3-		--	--	--	4.00E-06	I	2.00E-02	I	
77-73-6	Dicyclopentadiene		--	--	--			3.00E-04	X	
75-37-6	Difluoroethane, 1,1-		--	--	--			4.00E+01	I	
94-58-6	Dihydrosafrole		--	--	--	1.30E-05	CA			
108-20-3	Diisopropyl Ether		--	--	--			7.00E-01	P	
68-12-2	Dimethylformamide		--	--	--			3.00E-02	I	
57-14-7	Dimethylhydrazine, 1,1-		--	--	--			2.00E-06	X	
540-73-8	Dimethylhydrazine, 1,2-		--	--	--	1.60E-01	CA			
513-37-1	Dimethylvinylchloride		--	--	--	1.30E-05	CA			
123-91-1	Dioxane, 1,4-		--	--	--	5.00E-06	I	3.00E-02	I	
106-89-8	Epichlorohydrin		--	--	--	1.20E-06	I	1.00E-03	I	
106-88-7	Epoxybutane, 1,2-		--	--	--			2.00E-02	I	
111-15-9	Ethoxyethanol Acetate, 2-		--	--	--			6.00E-02	P	
110-80-5	Ethoxyethanol, 2-		--	--	--			2.00E-01	I	
141-78-6	Ethyl Acetate		--	--	--			7.00E-02	P	
140-88-5	Ethyl Acrylate		--	--	--			8.00E-03	P	
75-00-3	Ethyl Chloride (Chloroethane)		--	--	--			1.00E+01	I	
97-63-2	Ethyl Methacrylate		--	--	--			3.00E-01	P	
100-41-4	Ethylbenzene	1.1E+02	3.18E+00	6.5E-07	7.3E-04	2.50E-06	CA	1.00E+00	I	
75-21-8	Ethylene Oxide		--	--	--	8.80E-05	CA	3.00E-02	CA	
151-56-4	Ethyleneimine		--	--	--	1.90E-02	CA			
50-00-0	Formaldehyde		--	--	--	1.30E-05	I	9.80E-03	A	
64-18-6	Formic Acid		--	--	--			3.00E-04	X	
98-01-1	Furfural		--	--	--			5.00E-02	H	
765-34-4	Glycidyl		--	--	--			1.00E-03	H	
76-44-8	Heptachlor		--	--	--	1.30E-03	I			
1024-57-3	Heptachlor Epoxide		--	--	--	2.60E-03	I			
39635-31-9	Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)		--	--	--	1.10E-03	E	1.30E-03	E	
118-74-1	Hexachlorobenzene		--	--	--	4.60E-04	I			
38380-08-4	Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)		--	--	--	1.10E-03	E	1.30E-03	E	
69782-90-7	Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)		--	--	--	1.10E-03	E	1.30E-03	E	
52663-72-6	Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)		--	--	--	1.10E-03	E	1.30E-03	E	
32774-16-6	Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)		--	--	--	1.10E+00	E	1.30E-06	E	
87-68-3	Hexachlorobutadiene		--	--	--	2.20E-05	I			
77-47-4	Hexachlorocyclopentadiene		--	--	--			2.00E-04	I	
67-72-1	Hexachloroethane		--	--	--	1.10E-05	CA	3.00E-02	I	
822-06-0	Hexamethylene Diisocyanate, 1,6-		--	--	--			1.00E-05	I	
110-54-3	Hexane, N-	6.6E+01	1.98E+00	No IUR	6.4E-04			7.00E-01	I	
591-78-6	Hexanone, 2-	6.4E+00	2.52E-01	No IUR	1.9E-03			3.00E-02	I	
302-01-2	Hydrazine		--	--	--	4.90E-03	I	3.00E-05	P	

OSWER VAPOR INTRUSION ASSESSMENT

Sub-slab or Exterior Soil Gas Concentration to Indoor Air Concentration (SGC-IAC) Calculator Version 3.45, November 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR_SG	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ_SG	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)

CAS	Chemical Name	Site Sub-slab or Exterior Soil Gas Concentration Csg (ug/m³)	Calculated Indoor Air Concentration Cia (ug/m³)	VI Carcinogenic Risk CR	VI Hazard HQ	Inhalation Unit Risk IUR (ug/m³)⁻¹	IUR Source*	Reference Concentration RfC (mg/m³)	RFC Source*	Mutagenic Indicator
7647-01-0	Hydrogen Chloride		--	--	--			2.00E-02	I	
74-90-8	Hydrogen Cyanide		--	--	--			8.00E-04	I	
7664-39-3	Hydrogen Fluoride		--	--	--			1.40E-02	CA	
7783-06-4	Hydrogen Sulfide		--	--	--			2.00E-03	I	
67-63-0	Isopropanol		--	--	--			2.00E-01	P	
7439-97-6	Mercury (elemental)		--	--	--			3.00E-04	I	
126-98-7	Methacrylonitrile		--	--	--			3.00E-02	P	
67-56-1	Methanol		--	--	--			2.00E+01	I	
110-49-6	Methoxyethanol Acetate, 2-		--	--	--			1.00E-03	P	
109-86-4	Methoxyethanol, 2-		--	--	--			2.00E-02	I	
96-33-3	Methyl Acrylate		--	--	--			2.00E-02	P	
78-93-3	Methyl Ethyl Ketone (2-Butanone)	3.8E+01	1.14E+00	No IUR	5.2E-05			5.00E+00	I	
60-34-4	Methyl Hydrazine		--	--	--	1.00E-03	X	2.00E-05	X	
108-10-1	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	8.1E+00	2.43E-01	No IUR	1.8E-05			3.00E+00	I	
624-83-9	Methyl Isocyanate		--	--	--			1.00E-03	CA	
80-62-6	Methyl Methacrylate		--	--	--			7.00E-01	I	
25013-15-4	Methyl Styrene (Mixed Isomers)		--	--	--			4.00E-02	H	
1634-04-4	Methyl tert-Butyl Ether (MTBE)	1.4E+00	4.20E-02	8.9E-10	3.2E-06	2.60E-07	CA	3.00E+00	I	
75-09-2	Methylene Chloride	7.5E+01	2.24E+00	1.8E-09	8.5E-04	1.00E-08	I	6.00E-01	I	Mut
2385-85-5	Mirex		--	--	--	5.10E-03	CA			
64742-95-6	Naphtha, High Flash Aromatic (HFAN)		--	--	--			1.00E-01	P	
91-20-3	Naphthalene	1.6E+02	4.92E+00	1.4E-05	3.7E-01	3.40E-05	CA	3.00E-03	I	
13463-39-3	Nickel Carbonyl		--	--	--	2.60E-04	CA	1.40E-05	CA	
98-95-3	Nitrobenzene		--	--	--	4.00E-05	I	9.00E-03	I	
75-52-5	Nitromethane		--	--	--	8.80E-06	P	5.00E-03	P	
79-46-9	Nitropropane, 2-		--	--	--	2.70E-03	H	2.00E-02	I	
62-75-9	Nitrosodimethylamine, N-		--	--	--	1.40E-02	I	4.00E-05	X	Mut
924-16-3	Nitroso-di-N-butylamine, N-		--	--	--	1.60E-03	I			
10595-95-6	Nitrosomethylethylamine, N-		--	--	--	6.30E-03	CA			
111-84-2	Nonane, n-		--	--	--			2.00E-02	P	
32598-14-4	Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)		--	--	--	1.10E-03	E	1.30E-03	E	
74472-37-0	Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)		--	--	--	1.10E-03	E	1.30E-03	E	
31508-00-6	Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)		--	--	--	1.10E-03	E	1.30E-03	E	
65510-44-3	Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)		--	--	--	1.10E-03	E	1.30E-03	E	
57465-28-8	Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)		--	--	--	3.80E+00	E	4.00E-07	E	
109-66-0	Pentane, n-		--	--	--			1.00E+00	P	
75-44-5	Phosgene		--	--	--			3.00E-04	I	
7803-51-2	Phosphine		--	--	--			3.00E-04	I	
123-38-6	Propionaldehyde		--	--	--			8.00E-03	I	
103-65-1	Propyl benzene		--	--	--			1.00E+00	X	
115-07-1	Propylene	1.8E+02	5.40E+00	No IUR	4.1E-04			3.00E+00	CA	
107-98-2	Propylene Glycol Monomethyl Ether		--	--	--			2.00E+00	I	
75-56-9	Propylene Oxide		--	--	--	3.70E-06	I	3.00E-02	I	
100-42-5	Styrene	3.0E+00	9.00E-02	No IUR	2.1E-05			1.00E+00	I	
7446-11-9	Sulfur Trioxide	2.0E+00	6.00E-02	No IUR	1.4E-02			1.00E-03	CA	
1746-01-6	TCDD, 2,3,7,8-		--	--	--	3.80E+01	CA	4.00E-08	CA	
70362-50-4	Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)		--	--	--	1.10E-02	E	1.30E-04	E	
630-20-6	Tetrachloroethane, 1,1,1,2-		--	--	--	7.40E-06	I			
79-34-5	Tetrachloroethane, 1,1,2,2-		--	--	--	5.80E-05	CA			
127-18-4	Tetrachloroethylene	6.7E+02	2.01E+01	4.3E-07	1.1E-01	2.60E-07	I	4.00E-02	I	
811-97-2	Tetrafluoroethane, 1,1,1,2-		--	--	--			8.00E+01	I	
109-99-9	Tetrahydrofuran		--	--	--			2.00E+00	I	
7550-45-0	Titanium Tetrachloride		--	--	--			1.00E-04	A	
108-88-3	Toluene	2.1E+02	6.39E+00	No IUR	2.9E-04			5.00E+00	I	
76-13-1	Trichloro-1,2,2-trifluoroethane, 1,1,2-		--	--	--			3.00E+01	H	

OSWER VAPOR INTRUSION ASSESSMENT

Sub-slab or Exterior Soil Gas Concentration to Indoor Air Concentration (SGC-IAC) Calculator Version 3.45, November 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR_SG	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ_SG	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)

CAS	Chemical Name	Site Sub-slab or Exterior Soil Gas Concentration Csg (ug/m³)	Calculated Indoor Air Concentration Cia (ug/m³)	VI Carcinogenic Risk CR	VI Hazard HQ	Inhalation Unit Risk IUR (ug/m³)⁻¹	IUR Source*	Reference Concentration RfC (mg/m³)	RFC Source*	Mutagenic Indicator
120-82-1	Trichlorobenzene, 1,2,4-		--	--	--			2.00E-03	P	
71-55-6	Trichloroethane, 1,1,1-	2.1E+02	6.30E+00	No IUR	2.9E-04			5.00E+00	I	
79-00-5	Trichloroethane, 1,1,2-		--	--	--	1.60E-05	I	2.00E-04	X	
79-01-6	Trichloroethylene	5.3E+00	1.59E-01	5.3E-08	1.8E-02	see note	I	2.00E-03	I	TCE
96-18-4	Trichloropropane, 1,2,3-		--	--	--			3.00E-04	I	Mut
96-19-5	Trichloropropene, 1,2,3-		--	--	--			3.00E-04	P	
121-44-8	Triethylamine		--	--	--			7.00E-03	I	
420-46-2	Trifluoroethane, 1,1,1-		--	--	--			2.00E+01	P	
526-73-8	Trimethylbenzene, 1,2,3-		--	--	--			5.00E-03	P	
95-63-6	Trimethylbenzene, 1,2,4-	1.9E+02	5.58E+00	No IUR	1.8E-01			7.00E-03	P	
126-72-7	Tris(2,3-dibromopropyl)phosphate		--	--	--	6.60E-04	CA			
108-05-4	Vinyl Acetate		--	--	--			2.00E-01	I	
593-60-2	Vinyl Bromide		--	--	--	3.20E-05	H	3.00E-03	I	
75-01-4	Vinyl Chloride		--	--	--	4.40E-06	I	1.00E-01	I	VC
108-38-3	Xylene, m-		--	--	--			1.00E-01	S	
95-47-6	Xylene, o-		--	--	--			1.00E-01	S	
106-42-3	Xylene, P-		--	--	--			1.00E-01	S	
1330-20-7	Xylenes	7.9E+02	2.38E+01	No IUR	5.4E-02			1.00E-01	I	

Notes:

(1) **Inhalation Pathway Exposure Parameters (RME):**

Exposure Scenario	Units	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Averaging time for carcinogens	(yrs)	ATc_R_SG	70	ATc_C_SG	70	ATc_SG	70
Averaging time for non-carcinogens	(yrs)	ATnc_R_SG	26	ATnc_C_SG	25	ATnc_SG	25
Exposure duration	(yrs)	ED_R_SG	26	ED_C_SG	25	ED_SG	25
Exposure frequency	(days/yr)	EF_R_SG	350	EF_C_SG	250	EF_SG	250
Exposure time	(hr/day)	ET_R_SG	24	ET_C_SG	8	ET_SG	8

(2) **Generic Attenuation Factors:**

Source Medium of Vapors		Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
Groundwater	(-)	AFgw_R_SG	0.001	AFgw_C_SG	0.001	AFgw_SG	0.001
Sub-Slab and Exterior Soil Gas	(-)	AFss_R_SG	0.03	AFss_C_SG	0.03	AFss_SG	0.03

(3) **Formulas**

Cia, target = MIN(Cia,c; Cia,nc)

Cia,c (ug/m3) = TCR x ATc x (365 days/yr) x (24 hrs/day) / (ED x EF x ET x IUR)

Cia,nc (ug/m3) = THQ x ATnc x (365 days/yr) x (24 hrs/day) x RfC x (1000 ug/mg) / (ED x EF x ET)

(4) **Special Case Chemicals**

Trichloroethylene	Residential Symbol	Residential Value	Commercial Symbol	Commercial Value	Selected (based on scenario) Symbol	Selected (based on scenario) Value
	mIURTCE_R_SG	1.00E-06	mIURTCE_C_SG	0.00E+00	mIURTCE_SG	0.00E+00
	IURTCE_R_SG	3.10E-06	IURTCE_C_SG	4.10E-06	IURTCE_SG	4.10E-06

Mutagenic Chemicals

Note: This section applies to trichloroethylene and other mutagenic chemicals, but not to vinyl chloride.

The exposure durations and age-dependent adjustment factors for mutagenic-mode-of-action are listed in the table below:

Age Cohort	Exposure Duration (years)	Age-dependent adjustment factor
0 - 2 years	2	10
2 - 6 years	4	3
6 - 16 years	10	3
16 - 26 years	10	1

OSWER VAPOR INTRUSION ASSESSMENT

Sub-slab or Exterior Soil Gas Concentration to Indoor Air Concentration (SGC-IAC) Calculator Version 3.45, November 2015 RSLs

Parameter	Symbol	Value	Instructions
Exposure Scenario	Scenario	Commercial	Select residential or commercial scenario from pull down list
Target Risk for Carcinogens	TCR_SG	1.00E-06	Enter target risk for carcinogens (for comparison to the calculated VI carcinogenic risk in column F)
Target Hazard Quotient for Non-Carcinogens	THQ_SG	1	Enter target hazard quotient for non-carcinogens (for comparison to the calculated VI hazard in column G)

CAS	Chemical Name	Site Sub-slab or Exterior Soil Gas Concentration Csg (ug/m³)	Calculated Indoor Air Concentration Cia (ug/m³)	VI Carcinogenic Risk CR	VI Hazard HQ	Inhalation Unit Risk IUR (ug/m³)⁻¹	IUR Source*	Reference Concentration RfC (mg/m³)	RFC Source*	Mutagenic Indicator

Mutagenic-mode-of-action (**MMOA**) adjustment factor 25 This factor is used in the equations for mutagenic chemicals.

Vinyl Chloride See the Navigation Guide equation for Cia,c for vinyl chloride.

Notation:

I = IRIS, EPA Integrated Risk Information System (IRIS). Available online at: http://www.epa.gov/iris/subst/index.html

P = PPRTV, EPA Provisional Peer Reviewed Toxicity Values (PPRTVs). Available online at: http://hhpprtv.ornl.gov/pprtv.shtml

A = Agency for Toxic Substances and Disease Registry (ATSDR) Minimum Risk Levels (MRLs). Available online at: http://www.atsdr.cdc.gov/mrls/index.html

CA = California Environmental Protection Agency/Office of Environmental Health Hazard Assessment assessments. Available online at: http://www.oehha.ca.gov/risk/ChemicalDB/index.asp

H = HEAST, EPA Superfund Health Effects Assessment Summary Tables (HEAST) database. Available online at: http://epa-heast.ornl.gov/heast.shtml

S = See RSL User Guide, Section 5

X = PPRTV Appendix

Mut = Chemical acts according to the mutagenic-mode-of-action, special exposure parameters apply (see footnote (4) above).

VC = Special exposure equation for vinyl chloride applies (see Navigation Guide for equation).

TCE = Special mutagenic and non-mutagenic IURs for trichloroethylene apply (see footnote (4) above).

Yellow highlighting indicates site-specific parameters that may be edited by the user.

Blue highlighting indicates exposure factors that are based on Risk Assessment Guidance for Superfund (RAGS) or EPA vapor intrusion guidance, which generally should not be changed.

Pink highlighting indicates VI carcinogenic risk greater than the target risk for carcinogens (TCR) or VI Hazard greater than or equal to the target hazard quotient for non-carcinogens (THQ).

Benzene J&E Model with Building-Specific Variables Included for derivation of AF

Model Input **Site Name/Run Number:** Example, Run 1

Note:
-Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.
-Dotted outline cells indicate default values that may be changed with justification.
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Source medium		Source	Sub-slab Soil Gas				
Soil gas concentration	(ug/m3)	Cmedium	64		NA		
Depth below grade to soil gas sample	(m)	Ls	0.50		Vary - 50	NA	
Average vadose zone temperature	(°C)	Ts	25	25	3-30		
Calc: Source vapor concentration	(ug/m3)	Cs	64				
Calc: % of pure component saturated vapor concentration	(%)	%Sat	0.000%				

Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Chemical Name		Chem	Benzene				
CAS No.		CAS	71-43-2				
Toxicity Factors							
Unit risk factor	$(ug/m^3)^{-1}$	IUR	7.80E-06	7.80E-06	NA	NA	
Mutagenic compound		Mut	No	NA	NA	NA	
Reference concentration	(mg/m^3)	RfC	3.00E-02	3.00E-02	NA	NA	

Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Pure component water solubility	(mg/L)	S	1.79E+03	1.79E+03	NA	NA	
Henry's Law Constant @ 25°C	(atm-m^3/mol)	Hc	5.55E-03	5.55E-03	NA	NA	
Calc: Henry's Law Constant @ 25°C	(dimensionless)	Hr	2.27E-01	2.27E-01			
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	2.27E-01	2.27E-01			
Diffusivity in air	(cm2/s)	Dair	8.95E-02	8.95E-02	NA	NA	
Diffusivity in water	(cm2/s)	Dwater	1.03E-05	1.03E-05	NA	NA	

Building Characteristics:

Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)
Specify Qsoil and Qbuilding separately; calculate ratio

	Units	Symbol	Value	Default	Potential Span	CV	Flag

Building setting		Bldg_Setting	Commercial	Commercial		
Foundation type		Found_Type	Slab-on-grade	Slab-on-grade		
Depth below grade to base of foundation	(m)	Lb	0.20	0.20	0.1 - 2.44	NA
Foundation thickness	(m)	Lf	0.20	0.20	0.1 - 0.25	NA
Fraction of foundation area with cracks	(-)	eta	0.001	0.001	0.00019-0.0019	1.00
Enclosed space floor area	(m2)	Abf	1500.00	1500.00	80-1000	NA
Enclosed space mixing height	(m)	Hb	3.00	3.00	2.13 - 3.05	NA
Indoor air exchange rate	(1 / hr)	ach	1.50	1.50	.3-4.1	NA
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0030	0.0030	0.0001 - 0.05	1.24
Calc: Building ventilation rate	(m3/hr)	Qb	6750.00	6750.00	NA	0.30
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	20.25	20.25	NA	NA

Model Input **Site Name/Run Number:** Example, Run 1

Chemical Name: Benzene CAS No. 71-43-2

Depth below grade to soil gas sample: 0.50 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Stratum A (Top of soil profile):							
Stratum A SCS soil type		SCS_A	Clay				
Stratum A thickness (from surface)	(m)	hSA	6.00				
Stratum A total porosity	(-)	nSA	0.459	0.459	NA	0.20	
Stratum A water-filled porosity	(-)	nwSA	0.215	0.215	0.098 - 0.33	0.25	
Stratum A bulk density	(g/cm^3)	rhoSA	1.430	1.430	NA	0.05	
Stratum B (Soil layer below Stratum A):							
Stratum B SCS soil type		SCS_B	Clay				
Stratum B thickness	(m)	hSB	6.00				
Stratum B total porosity	(-)	nSB	0.459	0.459	NA	0.20	
Stratum B water-filled porosity	(-)	nwSB	0.215	0.215	0.098 - 0.33	0.25	
Stratum B bulk density	(g/cm^3)	rhoSB	1.430	1.430	NA	0.05	
Stratum C (Soil layer below Stratum B):							
Stratum C SCS soil type		SCS_C	Not Present				
Stratum C thickness	(m)	hSC	0.00				
Stratum C total porosity	(-)	nSC			NA	NA	
Stratum C water-filled porosity	(-)	nwSC			NA	NA	
Stratum C bulk density	(g/cm^3)	rhoSC			NA	NA	
Stratum containing soil gas sample							
Stratum A, B, or C		src_soil	Stratum B				
					NA	NA	
					NA		
					NA		

Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Target risk for carcinogens	(-)	Target_CR	1.00E-06	1.00E-06	NA	NA	
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA	
Exposure Scenario		Scenario	Commercial	Commercial			
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA	
Averaging time for non-carcinogens	(yrs)	ATnc	25	25	NA	NA	
Exposure duration	(yrs)	ED	25	25	NA	NA	
Exposure frequency	(days/yr)	EF	250	250	NA	NA	

Exposure time	(hrs/24 hrs)	ET	8	8	NA	NA	
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA	NOTE

Model Output **Site Name/Run Number:** Example, Run 1

Chemical Name: Benzene CAS No. 71-43-2

Range is based on the r
values, as reported in th

Source to Indoor Air Attenuation Factor	Units	Symbol	Value	Range	Default	Default Range
Soil gas to indoor air attenuation coefficient	**(-)**	**alpha**	**3.0E-03**	1.0E-04 - 5.0E-02	**3.0E-03**	1.0E-04 - 5.0E-02
Predicted Indoor Air Concentration	**Units**	**Symbol**	**Value**	**Range**	**Default**	**Default Range**
Indoor air concentration due to vapor intrusion	(ug/m3)	**Cia**	**1.9E-01**	6.4E-03 - 3.2E+00	**1.9E-01**	6.4E-03 - 3.2E+00
Note: $C_{Indoor} = 0.278\ \mu g/m^3$ with AF=2.0-3	(ppbv)		**6.0E-02**	2.0E-03 - 1.0E+00	**6.0E-02**	2.0E-03 - 1.0E+00
Predicted Vapor Conc. Beneath Foundation	**Units**	**Symbol**	**Value**	**Range**	**Default**	**Default Range**
Subslab vapor concentration	(ug/m3)	**Css**	**6.4E+01**	6.4E+01 - 6.4E+01	**6.4E+01**	6.4E+01 - 3.2E+04
	(ppbv)		**2.0E+01**	2.0E+01 - 2.0E+01	**2.0E+01**	2.0E+01 - 1.0E+04
Diffusive Transport Upward Through Vadose Zone	**Units**	**Symbol**	**Value**	**Range**	**Default**	**Default Range**
Effective diffusion coefficient through Stratum A	(cm2/sec)	DeffA	3.9E-03	-	3.9E-03	-
Effective diffusion coefficient through Stratum B	(cm2/sec)	DeffB	3.9E-03	-	3.9E-03	-
Effective diffusion coefficient through Stratum C	(cm2/sec)	DeffC		-		-
				-		-
Effective diffusion coefficient through unsaturated zone	(cm2/sec)	DeffT	3.9E-03	-	3.9E-03	-
Critical Parameters		**Symbol**	**Value**	**Range**	**Default**	**Default Range**
α for diffusive transport from source to building with dirt floor foundation	(-)	A_Param	1.1E-03	-	1.1E-03	
Pe (Peclet Number) for transport through the foundation (advection / diffusion)	(-)	B_Param	1.9E+03	6.3E+01 - 3.2E+04	1.9E+03	6.3E+01 - 3.2E+04
α for convective transport from subslab to building	(-)	C_Param	3.0E-03	1.0E-04 - 5.0E-02	3.0E-03	1.0E-04 - 5.0E-02

Interpretation

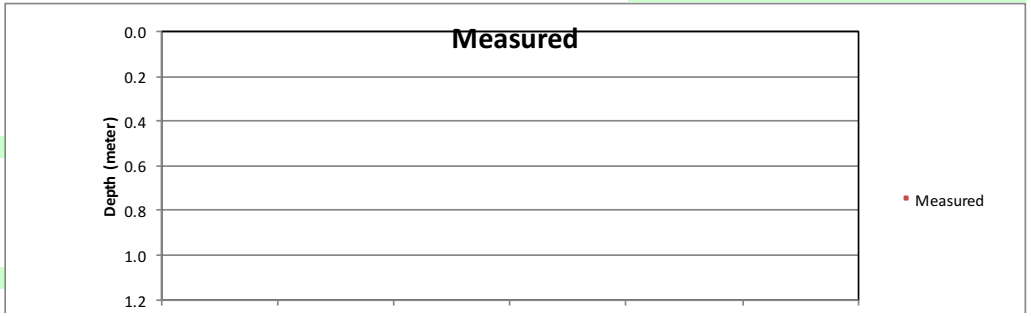
Advection is the dominant mechanism across the foundation.
Diffusion through soil and advection through foundation both control intrusion.

Critical Parameters

Hb, Ls, DeffT, ach, Qsoil_Qb

Non-Critical Parameters

Concentration versus Depth Profile



Naphthalene J&E Model with Building-Specific Variables Included for derivation of AF

Model Input **Site Name/Run Number:** Example, Run 1

Note:
-Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.
-Dotted outline cells indicate default values that may be changed with justification.
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Source medium		Source	Sub-slab Soil Gas				
Soil gas concentration	(ug/m3)	Cmedium	139		NA		
Depth below grade to soil gas sample	(m)	Ls	0.50		Vary - 50	NA	
Average vadose zone temperature	(°C)	Ts	25	25	3-30		
Calc: Source vapor concentration	(ug/m3)	Cs	139				
Calc: % of pure component saturated vapor concentration	(%)	%Sat	0.024%				

Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Chemical Name		Chem	Naphthalene				
CAS No.		CAS	91-20-3				
Toxicity Factors							
Unit risk factor	$(ug/m^3)^{-1}$	IUR	3.40E-05	3.40E-05	NA	NA	
Mutagenic compound		Mut	No	NA	NA	NA	
Reference concentration	(mg/m^3)	RfC	3.00E-03	3.00E-03	NA	NA	

Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Pure component water solubility	(mg/L)	S	3.10E+01	3.10E+01	NA	NA	
Henry's Law Constant @ 25°C	$(atm\text{-}m^3/mol)$	Hc	4.40E-04	4.40E-04	NA	NA	
Calc: Henry's Law Constant @ 25°C	(dimensionless)	Hr	1.80E-02	1.80E-02			
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	1.80E-02	1.80E-02			
Diffusivity in air	(cm2/s)	Dair	6.05E-02	6.05E-02	NA	NA	
Diffusivity in water	(cm2/s)	Dwater	8.38E-06	8.38E-06	NA	NA	

Building Characteristics:

Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)
Specify Qsoil and Qbuilding separately; calculate ratio

	Units	Symbol	Value	Default	Potential Span	CV	Flag

Building setting		Bldg_Setting	Commercial	Commercial		
Foundation type		Found_Type	Slab-on-grade	Slab-on-grade		
Depth below grade to base of foundation	(m)	Lb	0.20	0.20	0.1 - 2.44	NA
Foundation thickness	(m)	Lf	0.20	0.20	0.1 - 0.25	NA
Fraction of foundation area with cracks	(-)	eta	0.001	0.001	0.00019-0.0019	1.00
Enclosed space floor area	(m2)	Abf	1500.00	1500.00	80-1000	NA
Enclosed space mixing height	(m)	Hb	3.00	3.00	2.13 - 3.05	NA
Indoor air exchange rate	(1 / hr)	ach	1.50	1.50	.3-4.1	NA
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0030	0.0030	0.0001 - 0.05	1.24
Calc: Building ventilation rate	(m3/hr)	Qb	6750.00	6750.00	NA	0.30
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	20.25	20.25	NA	NA

Model Input **Site Name/Run Number:** Example, Run 1

Chemical Name: Naphthalene CAS No. 91-20-3

Depth below grade to soil gas sample: 0.50 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Stratum A (Top of soil profile):							
Stratum A SCS soil type		SCS_A	Silty Clay				
Stratum A thickness (from surface)	(m)	hSA	6.00				
Stratum A total porosity	(-)	nSA	0.481	0.481	NA	0.20	
Stratum A water-filled porosity	(-)	nwSA	0.216	0.216	0.11 - 0.32	0.25	
Stratum A bulk density	(g/cm^3)	rhoSA	1.380	1.380	NA	0.05	
Stratum B (Soil layer below Stratum A):							
Stratum B SCS soil type		SCS_B	Clay				
Stratum B thickness	(m)	hSB	6.00				
Stratum B total porosity	(-)	nSB	0.459	0.459	NA	0.20	
Stratum B water-filled porosity	(-)	nwSB	0.215	0.215	0.098 - 0.33	0.25	
Stratum B bulk density	(g/cm^3)	rhoSB	1.430	1.430	NA	0.05	
Stratum C (Soil layer below Stratum B):							
Stratum C SCS soil type		SCS_C	Not Present				
Stratum C thickness	(m)	hSC	0.00				
Stratum C total porosity	(-)	nSC			NA	NA	
Stratum C water-filled porosity	(-)	nwSC			NA	NA	
Stratum C bulk density	(g/cm^3)	rhoSC			NA	NA	
Stratum containing soil gas sample							
Stratum A, B, or C		src_soil	Stratum B				
					NA	NA	
					NA		
					NA		

Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Target risk for carcinogens	(-)	Target_CR	1.00E-06	1.00E-06	NA	NA	
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA	
Exposure Scenario		Scenario	Commercial	Commercial			
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA	
Averaging time for non-carcinogens	(yrs)	ATnc	25	25	NA	NA	
Exposure duration	(yrs)	ED	25	25	NA	NA	
Exposure frequency	(days/yr)	EF	250	250	NA	NA	

Exposure time	(hrs/24 hrs)	ET	8	8	NA	NA	
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA	NOTE

Model Output

Site Name/Run Number: Example, Run 1

Chemical Name: Naphthalene **CAS No.** 91-20-3

Range is based on the r
values, as reported in th

Source to Indoor Air Attenuation Factor	Units	Symbol	Value	Range	Default	Default Range
Soil gas to indoor air attenuation coefficient	(-)	alpha	2.0E-03	1.0E-04 - 5.0E-02	2.0E-03	1.0E-04 - 5.0E-02
Predicted Indoor Air Concentration	**Units**	**Symbol**	**Value**	**Range**	**Default**	**Default Range**
Indoor air concentration due to vapor intrusion	(ug/m3)	Cia	2.78E-01	1.4E-02 - 7.0E+00	2.78E-01	1.4E-02 - 7.0E+00
	(ppbv)		5.27E-02	2.7E-03 - 1.3E+00	5.27E-02	2.7E-03 - 1.3E+00
Predicted Vapor Conc. Beneath Foundation	**Units**	**Symbol**	**Value**	**Range**	**Default**	**Default Range**
Subslab vapor concentration	(ug/m3)	Css	**1.4E+02**	1.4E+02 - 1.4E+02	**1.4E+02**	1.4E+02 - 7.0E+04
	(ppbv)		**2.7E+01**	2.7E+01 - 2.7E+01	**2.7E+01**	2.7E+01 - 1.3E+04
Diffusive Transport Upward Through Vadose Zone	**Units**	**Symbol**	**Value**	**Range**	**Default**	**Default Range**
Effective diffusion coefficient through Stratum A	(cm2/sec)	DeffA	3.2E-03	-	3.2E-03	-
Effective diffusion coefficient through Stratum B	(cm2/sec)	DeffB	2.6E-03	-	2.6E-03	-
Effective diffusion coefficient through Stratum C	(cm2/sec)	DeffC		-		-
				-		-
Effective diffusion coefficient through unsaturated zone	(cm2/sec)	DeffT	2.9E-03	-	2.9E-03	-
Critical Parameters		**Symbol**	**Value**	**Range**	**Default**	**Default Range**
α for diffusive transport from source to building with dirt floor foundation	(-)	A_Param	7.8E-04	-	7.8E-04	
Pe (Peclet Number) for transport through the foundation (advection / diffusion)	(-)	B_Param	2.3E+03	7.8E+01 - 3.9E+04	2.3E+03	7.8E+01 - 3.9E+04
α for convective transport from subslab to building	(-)	C_Param	3.0E-03	1.0E-04 - 5.0E-02	3.0E-03	1.0E-04 - 5.0E-02

Interpretation

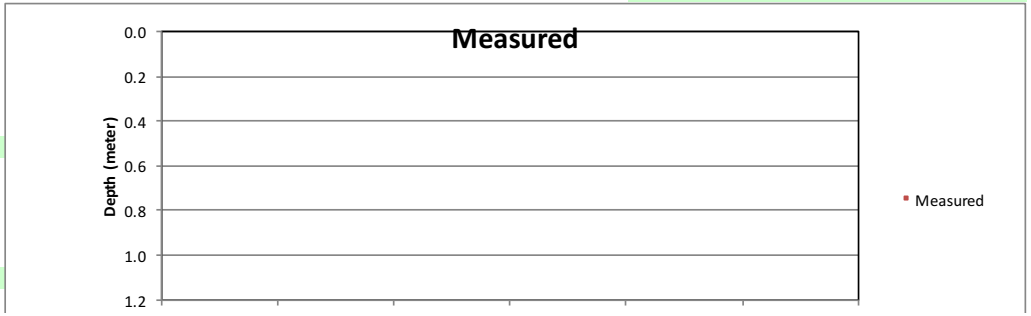
Advection is the dominant mechanism across the foundation.
Diffusion through soil and advection through foundation both control intrusion.

Critical Parameters

Hb, Ls, DeffT, ach, Qsoil_Qb

Non-Critical Parameters

Concentration versus Depth Profile



bullock environmental, llc 4924 5th avenue south, birmingham, alabama 35222 t 205.876.1715 f 205.443.9413

SOIL MANAGEMENT PLAN
1329 4th Avenue South Property
Proposed Macaroni Lofts
Birmingham, Jefferson County, Alabama
ADEM Site #: 461-073-120
Bullock Environmental, LLC Project #: 18-ORIO01

Bullock Environmental, LLC (Bullock) presents the following Soil Management Plan in advance of potential grading activities to be completed at the above-referenced property (hereafter the "Site"). This plan details the process for removing onSite soil from designated areas of the Site, stockpiling the material on the Site, and returning it to the excavation in compacted lifts.

As described in previous assessment reports, certain chemical of concern (COCs) were detected in onsite soil at concentrations slightly exceeding applicable screening values (RSLs) published by the Environmental Protection Agency (EPA) and endorsed by the Alabama Department of Environmental Management (ADEM). These COCs include the following.

- Arsenic and chromium were present in each soil sample at concentrations exceeding applicable screening values for a commercial setting;
    - Arsenic was detected at concentrations ranging from 6.8 milligrams per kilogram (mg/kg) in boring DP-3A (4-5 feet below grade) to 35.5 mg/kg (DP-5 1-1.5 feet below grade); and
    - Chromium was detected at concentrations ranging from 13.2 mg/kg in boring EB-1 (one foot below grade) to DP-5 277 mg/kg in boring DP-4 (3-5 feet below grade).
- No other Resource Conservation & Recovery Act (RCRA) metals were detected above RSLs in any of the soil samples collected; and
- No volatile organic compounds (VOCs) or polynuclear aromatic compounds (PAHs) were detected above RSLs in the soil samples collected at the Site.

Bullock notes that future Site development will be limited to building renovations and potential repaving of the exterior lot. As such, contact with the subsurface material is unlikely; however, in the event that exterior repaving work requires grading or other soil management activities which may result in contact/management of the underlying material, handling and management of soil (potentially containing concentrations of arsenic and chromium at concentrations exceeding EPA-established RSLs) during future Site preparation activities should be conducted as follows.

Handling

Onsite personnel should don Level D personal protective equipment (PPE) to minimize contact with potentially affected media. Beyond the standard PPE required for construction Sites (hard hats, safety glasses, steel-toed boots, etc.), workers who handle the soil should do so with protective gloves, including but not limited to standard work gloves or impermeable material such as latex or nitrile. To minimize potential ingestion of particulates, field personnel should have on hand a water truck to maintain adequate moisture on the ground surface to mitigate fugitive dust.

Management

Onsite grading activities which may result in the generation of potentially regulated solid waste should include measures for segregation, analysis, and determination of its character by a representative designated by the Site owner. This material should be stockpiled in a designated area on the Site and covered with polyethylene until it is returned to designated excavation areas in compacted lifts. Onsite personnel are to maintain the polyethylene cover on the stockpiled soil and ensure it remains intact through daily inspections. This process should continue until all material is transferred back designated areas through grading and placement and compaction activities detailed in the construction plans.

If you have any questions regarding the information presented above, please feel free to contact me at your convenience. You can also respond by email to doug.bullock@bullockenvironmental.com.

Sincerely,

BULLOCK ENVIRONMENTAL, LLC

Douglas A. Bullock, CHMM
Principal

ATTACHMENT B

2021 SUPPORTING DOCUMENTS

Commercial Air Inputs

Variable	Commercial Air Default Value	Form-input Value
AF_{gw} (Attenuation Factor Groundwater) unitless	0.001	0.0005
AF_{ss} (Attenuation Factor Sub-Slab) unitless	0.03	0.03
AT_{w} (averaging time - composite worker)	365	365
ED_{w} (exposure duration - composite worker) yr	25	25
EF_{w} (exposure frequency - composite worker) day/yr	250	250
ET_{w} (exposure time - composite worker) hr	8	8
THQ (target hazard quotient) unitless	0.1	0.1
LT (lifetime) yr	70	70
TR (target risk) unitless	1.0E-06	1.0E-06

Output generated 26JUL2021:10:44:17

Commercial Vapor Intrusion Screening Levels (VISL)

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; U = user provided; G = see RSL User's Guide Section 5; CA = cancer; NC = noncancer.

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? ($C_{vp} > C_{i,a}$,Target?)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? ($C_{hc} > C_{i,a}$,Target?)	Target Indoor Air Concentration (TCR=1E-06 or THQ=0.1) MIN($C_{ia,c}$,$C_{ia,nc}$) (µg/m³)	Toxicity Basis	Target Sub-Slab and Near-source Soil Gas Concentration (TCR=1E-06 or THQ=0.1) C_{sg},Target (µg/m³)	Target Groundwater Concentration (TCR=1E-06 or THQ=0.1) C_{gw},Target (µg/L)	Is Target Groundwater Concentration < MCL? (C_{gw} < MCL?)
Benzene	71-43-2	Yes	Yes	Yes	Yes	1.57E+00	CA	5.24E+01	1.39E+01	No (5)
Naphthalene	91-20-3	Yes	Yes	Yes	Yes	3.61E-01	CA	1.20E+01	4.01E+01	--

Pure Phase Vapor Concentration C_{vp}\ (25 °C)\ (µg/m³)	Maximum Groundwater Vapor Concentration C_{hc}\ (µg/m³)	Temperature for Maximum Groundwater Vapor Concentration (°C)	Lower Explosive Limit LEL (% by volume)	LEL Ref	IUR $(ug/m^3)^{-1}$	IUR Ref	RfC (mg/m³)	RfC Ref	Mutagenic Indicator	Carcinogenic VISL TCR=1E-06 $C_{ia,c}$ (µg/m³)	Noncarcinogenic VISL THQ=0.1 $C_{ia,nc}$ (µg/m³)
3.98E+08	4.06E+08	25	1.20	CRC	7.80E-06	I	3.00E-02	I	No	1.57E+00	1.31E+01
5.86E+05	5.58E+05	25	0.90	CRC	3.40E-05	C	3.00E-03	I	No	3.61E-01	1.31E+00

Output generated 26JUL2021:10:44:17

Commercial Vapor Intrusion Risk

Chemical	CAS Number	Site Groundwater Concentration C_{gw} \ (μg/L)	Site Indoor Air Concentration $C_{i,a}$ \ (μg/m³)	VI Carcinogenic Risk CDI (μg/m³)	VI Carcinogenic Risk CR	VI Hazard CDI (mg/m³)	VI Hazard HQ	IUR (ug/m³)$^{-1}$	IUR Ref	Chronic RfC (mg/m³)	RfC Ref	Temperature (℃)\ for Groundwater Vapor Concentration	Mutagen?
Benzene	71-43-2	6	6.81E-01	5.55E-02	4.33E-07	1.55E-04	5.18E-03	7.80E-06	I	3.00E-02	IRIS	25	No
Naphthalene	91-20-3	14	1.26E-01	1.03E-02	3.49E-07	2.87E-05	9.58E-03	3.40E-05	C	3.00E-03	IRIS	25	No
**Sum*		-	-	-	*7.82E-07*	-	*1.48E-02*	-		-		-	

Chemical Properties

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	MW	MW Ref	Vapor Pressure VP (mm Hg)	VP Ref	S (mg/L)	S Ref	MCL (ug/L)	HLC (atm-m ^{3}/mole)	Henry's Law Constant (unitless)
Benzene	71-43-2	Yes	Yes	78.12	PHYSPROP	9.48E+01	PHYSPROP	1.79E+03	PHYSPROP	5	5.55E-03	2.27E-01
Naphthalene	91-20-3	Yes	Yes	128.18	PHYSPROP	8.50E-02	PHYSPROP	3.10E+01	PHYSPROP	-	4.40E-04	1.80E-02

H` and HLC Ref	Henry's Law Constant Used in Calcs (unitless)	Normal Boiling Point BP (K)	BP Ref	Critical Temperature T_c\ (K)	T_c\ Ref	Enthalpy of vaporization at the normal boiling point $\Delta H_{v,b}$\ (cal/mol)	$\Delta H_{v,b}$\ Ref	Lower Explosive Limit LEL (% by volume)	LEL Ref
PHYSPROP	2.27E-01	353.15	PHYSPROP	5.62E+02	CRC	7342.26	CRC	1.20	CRC
PHYSPROP	1.80E-02	491.05	PHYSPROP	7.48E+02	CRC	10325.05	CRC	0.90	CRC

Commercial Air Inputs

Variable	Commercial Air Default Value	Form-input Value
AF_{gw} (Attenuation Factor Groundwater) unitless	0.001	0.001
AF_{ss} (Attenuation Factor Sub-Slab) unitless	0.03	0.03
AT_{w} (averaging time - composite worker)	365	365
ED_{w} (exposure duration - composite worker) yr	25	25
EF_{w} (exposure frequency - composite worker) day/yr	250	250
ET_{w} (exposure time - composite worker) hr	8	8
THQ (target hazard quotient) unitless	0.1	0.1
LT (lifetime) yr	70	70
TR (target risk) unitless	1.0E-06	1.0E-06

Commercial Vapor Intrusion Screening Levels (VISL)

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; U = user provided; G = see RSL User's Guide Section 5; CA = cancer; NC = noncancer.

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? ($C_{vp} > C_{i,a}$,Target?)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? ($C_{hc} > C_{i,a}$,Target?)	Target Indoor Air Concentration (TCR=1E-06 or THQ=0.1) MIN($C_{ia,c}$,$C_{ia,nc}$) (µg/m³)	Toxicity Basis	Target Sub-Slab and Near-source Soil Gas Concentration (TCR=1E-06 or THQ=0.1) C_{sg},Target (µg/m³)	Target Groundwater Concentration (TCR=1E-06 or THQ=0.1) C_{gw},Target (µg/L)	Is Target Groundwater Concentration < MCL? (C_{gw} < MCL?)
Benzene	71-43-2	Yes	Yes	Yes	Yes	1.57E+00	CA	5.24E+01	6.93E+00	No (5)
Naphthalene	91-20-3	Yes	Yes	Yes	Yes	3.61E-01	CA	1.20E+01	2.01E+01	--

Pure Phase Vapor Concentration C_{vp}\ (25 °C)\ (µg/m³)	Maximum Groundwater Vapor Concentration C_{hc}\ (µg/m³)	Temperature for Maximum Groundwater Vapor Concentration (°C)	Lower Explosive Limit LEL (% by volume)	LEL Ref	IUR (ug/m³)$^{-1}$	IUR Ref	RfC (mg/m³)	RfC Ref	Mutagenic Indicator	Carcinogenic VISL TCR=1E-06 $C_{ia,c}$ (µg/m³)	Noncarcinogenic VISL THQ=0.1 $C_{ia,nc}$ (µg/m³)
3.98E+08	4.06E+08	25	1.20	CRC	7.80E-06	I	3.00E-02	I	No	1.57E+00	1.31E+01
5.86E+05	5.58E+05	25	0.90	CRC	3.40E-05	C	3.00E-03	I	No	3.61E-01	1.31E+00

Commercial Vapor Intrusion Risk

Chemical	CAS Number	Site Sub-Slab and Exterior Soil Gas Concentration C_{sg} \ ($\mu g/m^3$)	Site Indoor Air Concentration $C_{i,a}$ \ ($\mu g/m^3$)	VI Carcinogenic Risk CDI ($\mu g/m^3$)	VI Carcinogenic Risk CR	VI Hazard CDI (mg/m^3)	VI Hazard HQ	IUR $(ug/m^3)^{-1}$	IUR Ref	Chronic RfC (mg/m^3)	RfC Ref	Temperature (°C)\ for Groundwater Vapor Concentration	Mutagen?
Benzene	71-43-2	64	1.92E+00	1.57E-01	1.22E-06	4.38E-04	1.46E-02	7.80E-06	I	3.00E-02	IRIS	25	No
Naphthalene	91-20-3	139	4.17E+00	3.40E-01	1.16E-05	9.52E-04	3.17E-01	3.40E-05	C	3.00E-03	IRIS	25	No
*Sum		-	-	-	1.28E-05	-	3.32E-01	-		-		-	

Chemical Properties

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	MW	MW Ref	Vapor Pressure VP (mm Hg)	VP Ref	S (mg/L)	S Ref	MCL (ug/L)	HLC (atm-m ^{3}/mole)	Henry's Law Constant (unitless)
Benzene	71-43-2	Yes	Yes	78.12	PHYSPROP	9.48E+01	PHYSPROP	1.79E+03	PHYSPROP	5	5.55E-03	2.27E-01
Naphthalene	91-20-3	Yes	Yes	128.18	PHYSPROP	8.50E-02	PHYSPROP	3.10E+01	PHYSPROP	-	4.40E-04	1.80E-02

H` and HLC Ref	Henry's Law Constant Used in Calcs (unitless)	Normal Boiling Point BP (K)	BP Ref	Critical Temperature T_c (K)	T_c Ref	Enthalpy of vaporization at the normal boiling point $\Delta H_{v,b}$ (cal/mol)	$\Delta H_{v,b}$ Ref	Lower Explosive Limit LEL (% by volume)	LEL Ref
PHYSPROP	2.27E-01	353.15	PHYSPROP	5.62E+02	CRC	7342.26	CRC	1.20	CRC
PHYSPROP	1.80E-02	491.05	PHYSPROP	7.48E+02	CRC	10325.05	CRC	0.90	CRC

Model Input

Site Name/Run Number: Example, Run 1

Note:
-Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.
-Dotted outline cells indicate default values that may be changed with justification.
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Source medium		Source	Groundwater				
Groundwater concentration	(ug/L)	Cmedium	6		NA		
Depth below grade to water table	(m)	Ls	5.20		Vary - 50	NA	
Average groundwater temperature	(°C)	Ts	25	25	3 - 25		
Calc: Source vapor concentration	(ug/m3)	Cs	1362				
Calc: % of pure component saturated vapor concentration	(%)	%Sat	0.000%				

Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Chemical Name		Chem	Benzene				
CAS No.		CAS	71-43-2				
Toxicity Factors							
Unit risk factor	$(ug/m^3)^{-1}$	IUR	7.80E-06	7.80E-06	NA	NA	
Mutagenic compound		Mut	No	NA	NA	NA	
Reference concentration	(mg/m^3)	RfC	3.00E-02	3.00E-02	NA	NA	

Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Pure component water solubility	(mg/L)	S	1.79E+03	1.79E+03	NA	NA	
Henry's Law Constant @ 25°C	$(atm\text{-}m^3/mol)$	Hc	5.55E-03	5.55E-03	NA	NA	
Calc: Henry's Law Constant @ 25°C	(dimensionless)	Hr	2.27E-01	2.27E-01			
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	2.27E-01	2.27E-01			
Diffusivity in air	(cm2/s)	Dair	8.95E-02	8.95E-02	NA	NA	
Diffusivity in water	(cm2/s)	Dwater	1.03E-05	1.03E-05	NA	NA	

Building Characteristics:

Select Building Assumptions

- (●) Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)
- ( ) Specify Qsoil and Qbuilding separately; calculate ratio

	Units	Symbol	Value	Default	Potential Span	CV	Flag

Building setting		Bldg_Setting	Commercial	Commercial		
Foundation type		Found_Type	Slab-on-grade	Slab-on-grade		
Depth below grade to base of foundation	(m)	Lb	0.20	0.20	0.1 - 2.44	NA
Foundation thickness	(m)	Lf	0.20	0.20	0.1 - 0.25	NA
Fraction of foundation area with cracks	(-)	eta	0.001	0.001	0.00019-0.0019	1.00
Enclosed space floor area	(m2)	Abf	1500.00	1500.00	80-1000	NA
Enclosed space mixing height	(m)	Hb	3.00	3.00	2.13 - 3.05	NA
Indoor air exchange rate	(1 / hr)	ach	1.50	1.50	.3-4.1	NA
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0030	0.0030	0.0001 - 0.05	1.24
Calc: Building ventilation rate	(m3/hr)	Qb	6750.00	6750.00	NA	0.30
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	20.25	20.25	NA	NA

Model Input **Site Name/Run Number:** Example, Run 1

Chemical Name: Benzene CAS No. 71-43-2

Depth below grade to water table: 5.20 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Stratum A (Top of soil profile):							
Stratum A SCS soil type		SCS_A	Silty Clay				
Stratum A thickness (from surface)	(m)	hSA	5.20				
Stratum A total porosity	(-)	nSA	0.481	0.481	NA	0.20	
Stratum A water-filled porosity	(-)	nwSA	0.216	0.216	0.11 - 0.32	0.25	
Stratum A bulk density	(g/cm^3)	rhoSA	1.380	1.380	NA	0.05	
Stratum B (Soil layer below Stratum A):							
Stratum B SCS soil type		SCS_B	Not Present				
Stratum B thickness	(m)	hSB					
Stratum B total porosity	(-)	nSB			NA	NA	
Stratum B water-filled porosity	(-)	nwSB			NA	NA	
Stratum B bulk density	(g/cm^3)	rhoSB			NA	NA	
Stratum C (Soil layer below Stratum B):							
Stratum C SCS soil type		SCS_C	Not Present				
Stratum C thickness	(m)	hSC					
Stratum C total porosity	(-)	nSC			NA	NA	
Stratum C water-filled porosity	(-)	nwSC			NA	NA	
Stratum C bulk density	(g/cm^3)	rhoSC			NA	NA	
Stratum directly above the water table							
Stratum A, B, or C		src_soil	Stratum A				
Height of capillary fringe	(m)	hcz	1.923	1.923	NA	NA	
Capillary zone total porosity	(-)	ncz	0.481	0.481	NA	0.20	
Capillary zone water filled porosity	(-)	nwcz	0.424	0.424	NA	0.19	

Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Target risk for carcinogens	(-)	Target_CR	1.00E-06	1.00E-06	NA	NA	
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA	
Exposure Scenario		Scenario	Commercial	Commercial			
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA	
Averaging time for non-carcinogens	(yrs)	ATnc	25	25	NA	NA	
Exposure duration	(yrs)	ED	25	25	NA	NA	
Exposure frequency	(days/yr)	EF	250	250	NA	NA	

Exposure time	(hrs/24 hrs)	ET	8	8	NA	NA	
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA	NOTE

Model Output **Site Name/Run Number:** Example, Run 1

Chemical Name: Benzene CAS No. 71-43-2

Range is based on the
values, as reported in th

Source to Indoor Air Attenuation Factor	Units	Symbol	Value	Range	Default	Default Range
Groundwater to indoor air attenuation coefficient	(-)	alpha	1.7E-06	1.6E-06 - 1.7E-06	1.7E-06	1.6E-06 - 1.7E-06
Predicted Indoor Air Concentration	**Units**	**Symbol**	**Value**	**Range**	**Default**	**Default Range**
Indoor air concentration due to vapor intrusion	(ug/m3)	Cia	2.3E-03	2.2E-03 - 2.3E-03	2.3E-03	2.2E-03 - 2.3E-03
	(ppbv)		7.1E-04	7.0E-04 - 7.1E-04	7.1E-04	7.0E-04 - 7.1E-04
Predicted Vapor Conc. Beneath Foundation	**Units**	**Symbol**	**Value**	**Range**	**Default**	**Default Range**
Subslab vapor concentration	(ug/m3)	Css	7.5E-01	4.5E-02 - 2.2E+01	7.5E-01	2.2E+01 - 2.3E+01
	(ppbv)		2.4E-01	1.4E-02 - 7.0E+00	2.4E-01	7.0E+00 - 7.1E+00
Diffusive Transport Upward Through Vadose Zone	**Units**	**Symbol**	**Value**	**Range**	**Default**	**Default Range**
Effective diffusion coefficient through Stratum A	(cm2/sec)	DeffA	4.6E-03	-	4.6E-03	-
Effective diffusion coefficient through Stratum B	(cm2/sec)	DeffB		-		-
Effective diffusion coefficient through Stratum C	(cm2/sec)	DeffC		-		-
Effective diffusion coefficient through capillary zone	(cm2/sec)	DeffCZ	4.0E-05	-	4.0E-05	-
Effective diffusion coefficient through unsaturated zone	(cm2/sec)	DeffT	1.0E-04	-	1.0E-04	-
Critical Parameters		**Symbol**	**Value**	**Range**	**Default**	**Default Range**
α for diffusive transport from source to building with dirt floor foundation	(-)	A_Param	1.7E-06	-	1.7E-06	
Pe (Peclet Number) for transport through the foundation (advection / diffusion)	(-)	B_Param	1.6E+03	5.3E+01 - 2.6E+04	1.6E+03	5.3E+01 - 2.6E+04
α for convective transport from subslab to building	(-)	C_Param	3.0E-03	1.0E-04 - 5.0E-02	3.0E-03	1.0E-04 - 5.0E-02

Interpretation

Advection is the dominant mechanism across the foundation.
Diffusion through soil is the overall rate limiting process.

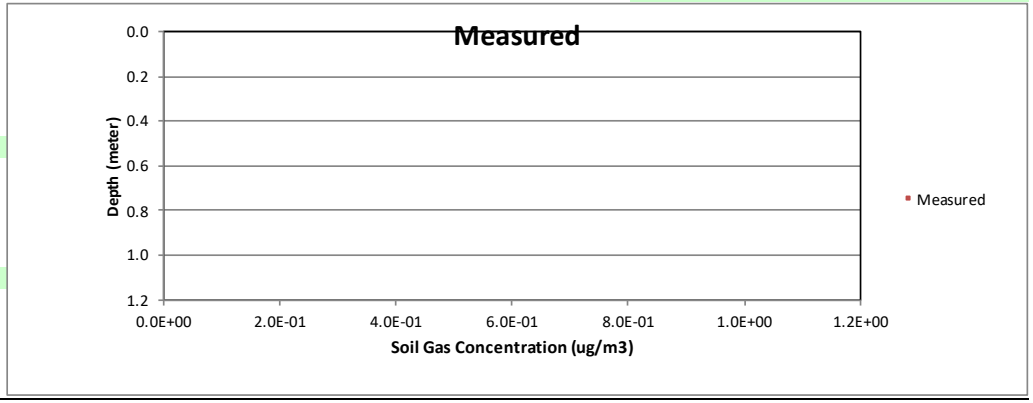
Critical Parameters

Hb, Ls, DeffT, ach

Non-Critical Parameters

Qsoil_Qb, Lf, DeffA, eta

Concentration versus Depth Profile



Model Output **Site Name/Run Number:** Example, Run 1

Chemical Name: Benzene CAS No. 71-43-2

Risk Calculations	Units	Symbol	Value	Range	Default	Range
Risk-Based Target Screening Levels	Scenario: Commercial					
Target risk for carcinogens	(-)	Target_CR	1E-06	-	1E-06	-
Target hazard quotient for noncarcinogens	(-)	Target_HQ	1	-	1	-
Target indoor air concentration	**(ug/m3)**	**Target_IA**	**1.57E+00**	-	**1.57E+00**	-
	(ppbv)		**4.92E-01**	-	**4.92E-01**	-
Target groundwater concentration	**(ug/L)**	**Target_GW**	**4.17E+03**	**4.2E+03 - 4.2E+03**	**4.17E+03**	**4.2E+03 - 4.2E+03**
Incremental Risk Estimates						
Incremental cancer risk from vapor intrusion	**(-)**	**Cancer_Risk**	**1.44E-09**	**1.4E-09 - 1.4E-09**	**1.44E-09**	**1.4E-09 - 1.4E-09**
Hazard quotient from vapor intrusion	**(-)**	**HQ**	**1.72E-05**	**1.7E-05 - 1.7E-05**	**1.72E-05**	**1.7E-05 - 1.7E-05**

Model Input **Site Name/Run Number:** Example, Run 1

Note:
-Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.
-Dotted outline cells indicate default values that may be changed with justification.
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Source medium		Source	Groundwater				
Groundwater concentration	(ug/L)	Cmedium	14		NA		
Depth below grade to water table	(m)	Ls	5.20		Vary - 50	NA	
Average groundwater temperature	(°C)	Ts	25	25	3 - 25		
Calc: Source vapor concentration	(ug/m3)	Cs	252				
Calc: % of pure component saturated vapor concentration	(%)	%Sat	0.043%				

Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Chemical Name		Chem	Naphthalene				
CAS No.		CAS	91-20-3				
Toxicity Factors							
Unit risk factor	$(ug/m^3)^{-1}$	IUR	3.40E-05	3.40E-05	NA	NA	
Mutagenic compound		Mut	No	NA	NA	NA	
Reference concentration	(mg/m^3)	RfC	3.00E-03	3.00E-03	NA	NA	

Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Pure component water solubility	(mg/L)	S	3.10E+01	3.10E+01	NA	NA	
Henry's Law Constant @ 25°C	$(atm\text{-}m^3/mol)$	Hc	4.40E-04	4.40E-04	NA	NA	
Calc: Henry's Law Constant @ 25°C	(dimensionless)	Hr	1.80E-02	1.80E-02			
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	1.80E-02	1.80E-02			
Diffusivity in air	(cm2/s)	Dair	6.05E-02	6.05E-02	NA	NA	
Diffusivity in water	(cm2/s)	Dwater	8.38E-06	8.38E-06	NA	NA	

Building Characteristics:

Select Building Assumptions

- (●) Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)
- ( ) Specify Qsoil and Qbuilding separately; calculate ratio

	Units	Symbol	Value	Default	Potential Span	CV	Flag

Building setting		Bldg_Setting	Commercial	Commercial		
Foundation type		Found_Type	Slab-on-grade	Slab-on-grade		
Depth below grade to base of foundation	(m)	Lb	0.20	0.20	0.1 - 2.44	NA
Foundation thickness	(m)	Lf	0.20	0.20	0.1 - 0.25	NA
Fraction of foundation area with cracks	(-)	eta	0.001	0.001	0.00019-0.0019	1.00
Enclosed space floor area	(m2)	Abf	1500.00	1500.00	80-1000	NA
Enclosed space mixing height	(m)	Hb	3.00	3.00	2.13 - 3.05	NA
Indoor air exchange rate	(1 / hr)	ach	1.50	1.50	.3-4.1	NA
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0030	0.0030	0.0001 - 0.05	1.24
Calc: Building ventilation rate	(m3/hr)	Qb	6750.00	6750.00	NA	0.30
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	20.25	20.25	NA	NA

Model Input **Site Name/Run Number:** Example, Run 1

Chemical Name: Naphthalene CAS No. 91-20-3

Depth below grade to water table: 5.20 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Stratum A (Top of soil profile):							
Stratum A SCS soil type		SCS_A	Silty Clay				
Stratum A thickness (from surface)	(m)	hSA	5.20				
Stratum A total porosity	(-)	nSA	0.481	0.481	NA	0.20	
Stratum A water-filled porosity	(-)	nwSA	0.216	0.216	0.11 - 0.32	0.25	
Stratum A bulk density	(g/cm^3)	rhoSA	1.380	1.380	NA	0.05	
Stratum B (Soil layer below Stratum A):							
Stratum B SCS soil type		SCS_B	Not Present				
Stratum B thickness	(m)	hSB					
Stratum B total porosity	(-)	nSB			NA	NA	
Stratum B water-filled porosity	(-)	nwSB			NA	NA	
Stratum B bulk density	(g/cm^3)	rhoSB			NA	NA	
Stratum C (Soil layer below Stratum B):							
Stratum C SCS soil type		SCS_C	Not Present				
Stratum C thickness	(m)	hSC					
Stratum C total porosity	(-)	nSC			NA	NA	
Stratum C water-filled porosity	(-)	nwSC			NA	NA	
Stratum C bulk density	(g/cm^3)	rhoSC			NA	NA	
Stratum directly above the water table							
Stratum A, B, or C		src_soil	Stratum A				
Height of capillary fringe	(m)	hcz	1.923	1.923	NA	NA	
Capillary zone total porosity	(-)	ncz	0.481	0.481	NA	0.20	
Capillary zone water filled porosity	(-)	nwcz	0.424	0.424	NA	0.19	

Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag
Target risk for carcinogens	(-)	Target_CR	1.00E-06	1.00E-06	NA	NA	
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA	
Exposure Scenario		Scenario	Commercial	Commercial			
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA	
Averaging time for non-carcinogens	(yrs)	ATnc	25	25	NA	NA	
Exposure duration	(yrs)	ED	25	25	NA	NA	
Exposure frequency	(days/yr)	EF	250	250	NA	NA	

Model Output **Site Name/Run Number:** Example, Run 1

Chemical Name: Naphthalene CAS No. 91-20-3

Range is based on the
values, as reported in th

Source to Indoor Air Attenuation Factor	Units	Symbol	Value	Range	Default	Default Range
Groundwater to indoor air attenuation coefficient	(-)	alpha	5.3E-06	5.1E-06 - 5.3E-06	5.3E-06	5.1E-06 - 5.3E-06
Predicted Indoor Air Concentration	**Units**	**Symbol**	**Value**	**Range**	**Default**	**Default Range**
Indoor air concentration due to vapor intrusion	(ug/m3)	Cia	1.3E-03	1.3E-03 - 1.3E-03	1.3E-03	1.3E-03 - 1.3E-03
	(ppbv)		2.6E-04	2.4E-04 - 2.6E-04	2.6E-04	2.4E-04 - 2.6E-04
Predicted Vapor Conc. Beneath Foundation	**Units**	**Symbol**	**Value**	**Range**	**Default**	**Default Range**
Subslab vapor concentration	(ug/m3)	Css	4.5E-01	2.7E-02 - 1.3E+01	4.5E-01	1.3E+01 - 1.3E+01
	(ppbv)		8.5E-02	5.1E-03 - 2.4E+00	8.5E-02	2.4E+00 - 2.6E+00
Diffusive Transport Upward Through Vadose Zone	**Units**	**Symbol**	**Value**	**Range**	**Default**	**Default Range**
Effective diffusion coefficient through Stratum A	(cm2/sec)	DeffA	3.2E-03	-	3.2E-03	-
Effective diffusion coefficient through Stratum B	(cm2/sec)	DeffB		-		-
Effective diffusion coefficient through Stratum C	(cm2/sec)	DeffC		-		-
Effective diffusion coefficient through capillary zone	(cm2/sec)	DeffCZ	1.3E-04	-	1.3E-04	-
Effective diffusion coefficient through unsaturated zone	(cm2/sec)	DeffT	3.3E-04	-	3.3E-04	-
Critical Parameters		**Symbol**	**Value**	**Range**	**Default**	**Default Range**
α for diffusive transport from source to building with dirt floor foundation	(-)	A_Param	5.3E-06	-	5.3E-06	
Pe (Peclet Number) for transport through the foundation (advection / diffusion)	(-)	B_Param	2.3E+03	7.8E+01 - 3.9E+04	2.3E+03	7.8E+01 - 3.9E+04
α for convective transport from subslab to building	(-)	C_Param	3.0E-03	1.0E-04 - 5.0E-02	3.0E-03	1.0E-04 - 5.0E-02

Interpretation

Advection is the dominant mechanism across the foundation.
Diffusion through soil is the overall rate limiting process.

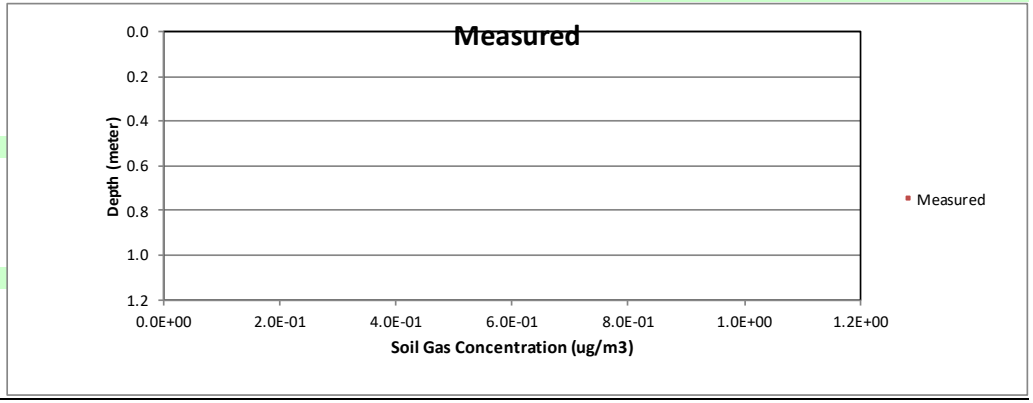
Critical Parameters

Hb, Ls, DeffT, ach

Non-Critical Parameters

Qsoil_Qb, Lf, DeffA, eta

Concentration versus Depth Profile



Model Output **Site Name/Run Number:** Example, Run 1

Chemical Name: Naphthalene CAS No. 91-20-3

Risk Calculations		Units	Symbol	Value	Range	Default	Range
Risk-Based Target Screening Levels	Scenario: Commercial						
Target risk for carcinogens		(-)	Target_CR	1E-06	-	1E-06	-
Target hazard quotient for noncarcinogens		(-)	Target_HQ	1	-	1	-
Target indoor air concentration		**(ug/m3)**	**Target_IA**	**3.61E-01**	-	**3.61E-01**	-
		(ppbv)		**6.88E-02**	-	**6.88E-02**	-
Target groundwater concentration		**(ug/L)**	**Target_GW**	**3.76E+03**	**3.8E+03 - 4.0E+03**	**3.76E+03**	**3.8E+03 - 4.0E+03**
Incremental Risk Estimates							
Incremental cancer risk from vapor intrusion		**(-)**	**Cancer_Risk**	**3.73E-09**	**3.5E-09 - 3.7E-09**	**3.73E-09**	**3.5E-09 - 3.7E-09**
Hazard quotient from vapor intrusion		**(-)**	**HQ**	**1.02E-04**	**9.7E-05 - 1.0E-04**	**1.02E-04**	**9.7E-05 - 1.0E-04**

[MACARONI LOFTS]
[FORMER UAB EDUCATIONAL FOUNDATION PROPERTY]
[1329 4th AVENUE SOUTH PROPERTY]

ENVIRONMENTAL COVENANT

Macaroni Lofts, LLC, an Alabama limited liability company ("**Grantor**") grants an Environmental Covenant (hereinafter "**Environmental Covenant**" or "**Covenant**") this ___ day of _____, 2021, to the following entities pursuant to The Alabama Uniform Environmental Covenants Act, Ala. Code §§ 35-19-1 to 35-19-14 (2014 Cum. Supp.) (hereinafter "**Act**" or the "**Act**"), and the regulations promulgated thereunder: the Alabama Department of Environmental Management ("**ADEM**").

WHEREAS, Grantor is the owner of certain real property located in the City of Birmingham, Alabama, at 1329 4th Avenue South, Birmingham, Jefferson County, Alabama (formerly known as the UAB Educational Foundation Property) (hereinafter the "**Property**"), more particularly described in **Exhibit A** attached hereto;

WHEREAS, this instrument is an Environmental Covenant developed and executed pursuant to the Act and the regulations promulgated thereunder;

WHEREAS, during the course of the environmental due diligence performed by Grantor and/or its predecessor in interest on the Property, certain levels of arsenic and chromium were detected above Environmental Protection Agency (EPA) Industrial Regional Screening Levels ("RSLs") in subsurface soils on the Property. Benzene, naphthalene, lead, and arsenic were detected above their respective EPA Maximum Contaminant Levels (MCLs) or RSLs for tapwater in the groundwater beneath the Property, (hereinafter collectively referred to as the "**Identified Contaminants**");

WHEREAS, the environmental due diligence work revealed that, at some unknown time in the past prior to Grantor's acquisition, a release or leak of the Identified Contaminants occurred in isolated locations on or near the Property;

WHEREAS, pursuant to the Brownfields Redevelopment and Voluntary Cleanup Program ("**VCP**"), the Property was accepted into the VCP (Site No. 461-073-120), the Property Assessment Plan was approved on or about October 21, 2015, and the VCP Application for New Owner (Orion Enterprises, Inc.) was submitted to ADEM on or about May 25, 2018. Grantor, by and through its predecessor (Orion Enterprises, Inc.), has prepared and submitted to ADEM a VCP Certificate of Compliance dated July 27, 2021;

WHEREAS, the VCP Certificate of Compliance requires the implementation of those institutional controls identified in Paragraph 2 of this Covenant to address the effects, if any, of the Identified Contaminants that remain in place in certain portions of the Property;

WHEREAS, the selected "remedial action" for the Property, which has now been implemented, provides in part, for the following actions:

- Implementation of this Environmental Covenant

WHEREAS, the purpose of this Covenant is to ensure protection of human health and the environment by placing restrictions on the Property to reduce the risk to human health to below target risk levels for those Identified Contaminants that remain beneath the Property;

WHEREAS, with ADEM's concurrence, some concentrations of Identified Contaminants shall remain in place beneath the Property. These Identified Contaminants include:

Subsurface Soils: arsenic and chromium

Groundwater: benzene, naphthalene, lead, and arsenic

WHEREAS, notwithstanding the fact that only certain areas beneath the Property contain concentrations of the Identified Contaminants, Grantor has elected to place this Covenant and certain restrictions on the entire Property;

WHEREAS, further information concerning the Identified Contaminants and the activities to correct the effects of the Identified Contaminants may be obtained by contacting Chief, Land Division, ADEM, or his or her designated representative, at 1400 Coliseum Boulevard, Montgomery, Alabama, 36110;

WHEREAS, the Administrative Record concerning the Property is located at Alabama Department of Environmental Management, 1400 Coliseum Boulevard, Montgomery, Alabama 36110;

NOW, THEREFORE, Grantor hereby grants this Environmental Covenant to ADEM, and declares that the Property shall hereinafter be bound by, held, sold, used, improved, occupied, leased, hypothecated, encumbered, and/or conveyed subject to Restrictive Covenants.

1. **DEFINITIONS**

Owner. "Owner" means the titleholder of the Property pursuant to a valid conveyance or other transfer of title pursuant to applicable law.

2. **USE RESTRICTIONS**

The following shall not take place on the Property without obtaining prior written approval from ADEM through modification of this covenant:

(A) The use of onsite groundwater for potable or irrigation purposes from or on the Property shall not be allowed, and this groundwater use limitation shall remain in place in perpetuity unless and until ADEM otherwise provides written authorization to remove this limitation;

(B) Future site improvements on the Property, including construction and/or repaving activities, shall not disturb or remove the soil, unless such soils are characterized

and handled in accordance with the Soil Management Plan (included in the July 27, 2021, Certificate of Compliance) as well as applicable ADEM Solid Waste Regulations;

(C) In accordance with the recommendations set forth in the July 27, 2021 Certificate of Compliance, ground-level floors of each structure on the Property shall not be used for residential purposes (as described in Section 6.1 of the February 2017 ADEM Alabama Risk-Based Corrective Action Guidance Manual, which includes schools and daycares); residential use shall be permissible at levels above the ground floor (e.g., second floor levels) or higher above the ground floor level of structures for any development on or within the Property.

3. **GENERAL PROVISIONS**

A. **Restrictions to Run with the Land.** This Covenant runs with the land pursuant to Ala. Code §35-19-5 (2014 Cum Supp.); is perpetual, unless modified or terminated pursuant to the terms of this Covenant pursuant to Ala. Code §35-19-9 (Cum Supp. 2014); is imposed upon the entire Property unless expressly stated as applicable only to a specific portion thereof; inures to the benefit of and passes with each and every portion of the Property; and binds the Owner, all persons using the land, all persons, their heirs, successors and assigns having any right, title or interest in the Property, or any part thereof who have subordinated those interests to this Covenant, and all persons, their heirs, successors and assigns who obtain any right, title or interest in the Property, or any part thereof after the recordation of this Covenant.

B. **Notices Required.** In accordance with Ala. Code §35-19-4(b) (2014 Cum Supp.), the Owner shall send written notification, pursuant to Section I, below, following transfer, or prior to proposed changes in zoning or use of (as such uses are described in Section 2(A) and 2(B) above), applications for building permits for, or proposals for site work affecting the contamination on, the Property. Said notification shall be sent within fifteen (15) days of each event listed in this Section.

C. **Registry/Recordation of Environmental Covenant; Amendment; or Termination.** Pursuant to Ala. Code §35-19-12(b) (2014 Cum Supp.), this Covenant and any amendment or termination thereof, shall be contained in ADEM's registry for environmental covenants. After an environmental covenant, amendment, or termination is filed in the registry, a notice of the covenant, amendment, or termination may be recorded in the land records in lieu of recording the entire covenant in compliance with §35-19-12(b). Grantor shall be responsible for filing the Covenant within thirty (30) days of the final required signature upon this Covenant.

D. **Right of Access.** The Owner acknowledges ADEM's reasonable right of access to the Property for implementation or enforcement of this Covenant pursuant to applicable law.

E. **ADEM Reservations.** Notwithstanding any other provision of this Covenant,

ADEM retains all of its access authorities and rights provided for under Alabama State Law, as well as all of its rights to require additional land/water use restrictions, as well as all of its enforcement authorities under Alabama State environmental statutes.

F. **Representations and Warranties.** As of the Effective Date, to the best of Grantor's knowledge, Grantor hereby represents and warrants to the other signatories hereto:

(i) That the Grantor has the power and authority to enter into this Covenant, to grant the rights and interests herein provided and to carry out all obligations hereunder;

(ii) That the Grantor is the sole owner of the Property and holds fee simple title which is free, clear and unencumbered except as identified in the title policy obtained by Grantor as part of its acquisition of the Property;

(iii) That the Grantor has identified all other parties that hold any interest (e.g., encumbrance) in the Property and notified such parties of the Grantor's intention to enter into this Covenant;

(iv) That this Covenant will not materially violate, contravene, or constitute a material default under, any other agreement, document, or instrument to which Grantor is a party, by which Grantor may be bound or affected;

(v) That this Covenant will not materially violate or contravene any zoning law or other law regulating use of the Property;

(vi) That this Covenant does not authorize a use of the Property which is otherwise prohibited by a recorded instrument that has priority over the Covenant.

G. **Compliance Enforcement.** In accordance with Ala. Code §35-19-11(b) (2014 Cum Supp.), the terms of the Covenant may be enforced by the parties to this Covenant; any person to whom this Covenant expressly grants power to enforce; or a municipality or other unit of local government in which the real property subject to the Covenant is located, in accordance with applicable law. Failure to timely enforce compliance with this Covenant or the use or activity limitations contained herein by any person shall not bar subsequent enforcement by such person and shall not be deemed a waiver of the person's right to take action to enforce any non-compliance. Nothing in this Covenant shall restrict ADEM, or the Grantor, from exercising any authority under applicable Alabama State law.

H. **Modifications/Termination.** Any modifications or terminations to this Covenant must be made in accordance with Ala. Code §§35-19-9 and 35-19-10 (2014 Cum Supp.).

I. **Notices.** Any document or communication required to be sent pursuant to the terms

of this Covenant shall be sent to the following persons:

ADEM

Chief, Land Division
Alabama Department of Environmental Management
1400 Coliseum Boulevard
Montgomery, Alabama 36110

Grantor

Ms. Kathleen Okrongley
Macaroni Lofts, LLC
300 Richard Arrington Blvd N
Suite 900
Birmingham, AL 35203

J. **No Property Interest Created in ADEM.** This Covenant does not in any way create any interest by ADEM in the Property that is subject to the Covenant. Furthermore, the act of approving this Covenant does not in any way create any interest by ADEM in the Property in accordance with Ala. Code §35-19-3(b) (2014 Cum. Supp.).

K. **Severability.** If any provision of this Covenant is found to be unenforceable in any respect, the validity, legality, and enforceability of the remaining provisions shall not in any way be affected or impaired.

L. **Governing Law.** This Covenant shall be governed by and interpreted in accordance with the laws of the State of Alabama.

M. **Recordation.** In accordance with Ala. Code §35-19-8(a) (2014 Cum. Supp.), Grantor shall record this Covenant and any amendment or termination of the Covenant in every county in which any portion of the real property subject to this Covenant is located. Grantor agrees to record this Covenant within fifteen (15) days after the date of the final required signature upon this Covenant.

N. **Effective Date.** The effective date of this Covenant shall be the date upon which the fully executed Covenant has been recorded, in accordance with Ala. Code §35-19-8(a) (2014 Cum. Supp).

O. **Distribution of Environmental Covenant.** Within fifteen (15) days of filing this Covenant, the Grantor shall distribute a recorded and date stamped copy of the recorded Covenant in accordance with Ala. Code §35-19-7(a) (2014 Cum Supp.). However, the validity of this Covenant will not be affected by the failure to provide a copy of the Covenant as provided herein.

P. **ADEM References.** All references to ADEM shall include successor agencies, departments, divisions, or other successor entities.

Q. **Grantor**. All references to Grantor shall include all other successor entities.

Property owner has caused this Environmental Covenant to be executed pursuant to The Alabama Uniform Environmental Covenants Act, on this 13th day of August 2021.

IN TESTIMONY WHEREOF, the parties have hereunto set their hands this the day and year first above written.

Macaroni Lofts, LLC

This Environmental Covenant is hereby approved by Macaroni Lofts, LLC, this 10th day of August, 2021.

Macaroni Lofts, LLC

By: _____
Kathleen Okrongley
One of three Members of Macaroni Lofts, LLC

STATE OF Alabama)
)
COUNTY OF Jefferson)

I, Catherine Lynn Marques, a Notary in and for said County in said State or Commonwealth, hereby certify that Kathleen Okrongley, whose name as one of three members of Macaroni Lofts, LLC is signed to the foregoing conveyance and who is known to me, acknowledged before me on this day that, being informed of the contents of the conveyance, (s)he, as such officer and with full authority executed the same voluntarily for and as the act of said corporation.

Given under my hand this the 10 day of August, 2021.

Notary Public: _____

My Commission Expires: _____

CATHERINE LYNN MARQUES NOTARY PUBLIC ALABAMA STATE AT LARGE

MY COMMISSION EXPIRES APRIL 08, 2022

Macaroni Lofts, LLC

By: _____

Robert Sprain, Managing Member
TRA, LLC

One of three Members of Macaroni Lofts, LLC

STATE OF Alabama)
)
COUNTY OF Jefferson)

I, Stacy R Aycock, a Notary Public in and for said County in said State or Commonwealth, hereby certify that Robert Sprain, Managing Member of TRA, LLC, which is one of three members of Macaroni Lofts, LLC is signed to the foregoing conveyance and who is known to me, acknowledged before me on this day that, being informed of the contents of the conveyance, (s)he,as such officer and with full authority executed the same voluntarily for and as the act of said corporation.

Given under my hand this the 11 day of August, 2021.

Notary Public: _____

My Commission Expires: STACY R. AYCOCK, Notary Public
Alabama State at Large
My Commission Expires: 03/27/2023

[REMAINDER OF THE PAGE LEFT INTENTIONALLY BLANK]

Macaroni Lofts, LLC

By: _____

Robert Sprain, Managing Member
SS-CRE, LLC

One of three Members of Macaroni Lofts, LLC

STATE OF Alabama)
)
COUNTY OF Jefferson)

I, Stacy R. Aycock, a Notary Public in and for said County in said State or Commonwealth, hereby certify that Robert Sprain, Managing Member of SS-CRE, LLC, which is one of three members of Macaroni Lofts, LLC, is signed to the foregoing conveyance and who is known to me, acknowledged before me on this day that, being informed of the contents of the conveyance, (s)he,as such officer and with full authority executed the same voluntarily for and as the act of said corporation.

Given under my hand this the 11 day of August, 2021.

Notary Public: _____

My Commission Expires:

STACY R. AYCOCK, Notary Public
Alabama State at Large
My Commission Expires: 03/27/2023

[REMAINDER OF THE PAGE LEFT INTENTIONALLY BLANK]

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

This Environmental Covenant is hereby approved by the State of Alabama this ___ day of _____, 2021.

By: _____

Stephen A. Cobb
Chief, Land Division
Alabama Department of Environmental Management

STATE OF ALABAMA)
)
COUNTY OF MONTGOMERY)

I, the undersigned Notary Public in and for said County in said State, hereby certify that Stephen A. Cobb, whose name as Chief, Land Division, Alabama Department of Environmental Management is signed to the foregoing conveyance and who is known to me, acknowledged before me on this day that, being informed of the contents of the conveyance, he approved the same voluntarily on the day the same bears date and with full authority to do so.

Given under my hand this the ____ day of_____, 2021.

Notary Public: _____

My Commission Expires: _____

EXHIBIT A
[LEGAL DESCRIPTION]

A plot of land in the City of Birmingham, Alabama, described as follows:

Lots 1, 2, and 3, in Block 155, Subdivision 155-29-1-2, Map Book 102, page 19, according to the present plan and survey of the City of Birmingham, as made by the Elyton Land Company.

SUBORDINATION AGREEMENT

CommerceOne Bank, an Alabama banking corporation, 2100 Southbridge Pkwy, #385, Birmingham, Alabama 35209, is the holder of a Mortgage, Security Agreement, Assignment of Leases and Rents and Fixture Filing dated November 14, 2018 and recorded as Inst. #2018117137 in the Probate Office of Jefferson County, Alabama, and a Mortgage, Security Agreement, Assignment of Leases and Rents and Fixture Filing dated November 14, 2019 and recorded as Inst. #2019120229 in the Probate Office of Jefferson County, Alabama granted by Macaroni Lofts, LLC, an Alabama limited liability company (the "Mortgages").

CommerceOne Bank hereby assents to the grant of the attached Environmental Covenant granted by Macaroni Lofts, LLC, an Alabama limited liability company, to the Alabama Department of Environmental Management ("ADEM") and agrees that the Mortgage shall be subject to said Environmental Covenant and to the rights, covenants, restrictions and easements created by and under said Environmental Covenant insofar as the interests created under the Mortgage affect the Property or Impacted Area identified in the Environmental Covenant and as if for all purposes said Environmental Covenant had been executed, delivered and recorded prior to the execution, delivery and recordation and/or registration of the Mortgage.

The execution of this Subordination Agreement by CommerceOne Bank shall not subject such person to liability for environmental remediation pursuant to (Applicable Alabama Legal Authorities), provided that such person shall not otherwise be liable for environmental remediation under another provision of law.

The execution of this Subordination Agreement by CommerceOne Bank shall not be presumed to impose any affirmative obligation on the person with respect to said Environmental Covenant.

CommerceOne Bank's act of subordinating its prior interest in the Property to said Environmental Covenant shall not affect the priority of that interest in relation to any other interests that exist in relation to the property.

CommerceOne Bank further assents specifically to the subsequent recordation and/or registration of a modification to the Environmental Covenant, in accordance with the terms as referenced in the Environmental Covenant and agrees that the Mortgage shall be subject to the Modified Environmental Covenant and to the rights, covenants, restrictions, and easements created thereby and there under insofar as the interests created under the Mortgage affect the Property or Impacted Areas as so modified and as if for all purposes said Modified Environmental Covenant had been executed, delivered and recorded prior to the execution, delivery and recordation of the Mortgage.

Commerce One Bank has caused this instrument to be executed this 13th day of

August, 2021.

COMMERCEONE BANK

By: _____
Name: J DAVID SIZEMORE
Title: CLO

NOTARY ACKNOWLEDGEMENT

STATE OF ALABAMA)
) ss:
COUNTY OF JEFFERSON)

On August 13, 2021, before me, the undersigned, Notary Public, personally appeared J David Sizemore as the CLO of Commerce One Bank, personally known to me to or proved to me on the basis of satisfactory evidence to be the person whose name is subscribed to the within instrument and acknowledged to me that he/she executed the same in his/her authorized capacity, and that by his/her signature on the instrument the person, or the entity upon behalf of which the person acted, executed the instrument.

WITNESS my hand and official seal.

_____ (SEAL)
Notary Public Signature
Name:
My Commission Expires: 05/25/2022

ALEXANDRIA MERRILL
NOTARY PUBLIC, ALABAMA STATE AT LARGE
MY COMMISSION EXPIRES MAY 25, 2022