Bridger Creek Community

Vapor Intrusion Human Health Risk Assessment

Prepared for:
City of Bozeman
Bozeman, MT

Prepared by:
CPF Associates, Inc.
Takoma Park, MD

March 4, 2015

Contents

Bridger Creek Community

Vapor Intrusion Human Health Risk Assessment

March 4, 2015

Executive Summary

The City of Bozeman operated a sanitary landfill north of the City center from 1970 until 2008. After the landfill was in operation, two residential developments, known as Bridger Creek Phase 2 and Bridger Creek Phase 3 ("Bridger Creek Community") were developed near the landfill. In 2012, volatile organic compounds were discovered in off-site soil gas (also called soil vapor). Several investigations have been conducted since the initial discovery including evaluations of volatile organic compounds in the landfill, soil vapor, groundwater, ambient air and the Bridger Creek Community residences. The City of Bozeman, acting proactively, installed vapor mitigation systems in the form of subslab depressurization equipment, in 27 homes to reduce potential vapor exposure while the situation is being analyzed. Questions have also arisen from members of the public regarding the potential for health effects and property value impacts from vapor (soil gas) intrusion into residences. Specifically questions have been raised about whether or not vapor intrusion could cause public health impacts to current and/or future residents of the Bridger Creek Community.

In order to answer these questions, the City commissioned a human health risk assessment (HHRA) from CPF Associates, Inc. ("CPF"). CPF is a scientific research and consulting firm that specializes in environmental impact studies of the management of solid and hazardous waste. The Principal Investigator is Paul C. Chrostowski, Ph.D., QEP. Dr. Chrostowski has an Honors BS in Chemistry from the University of California, Berkeley, an MS in Environmental Science obtained through a United States Public Health Service Traineeship at Drexel University, and a Ph.D. in Environmental Engineering and Science from Drexel University. In addition, Dr Chrostowski has over 40 years' experience in risk analysis and environmental forensics. He is a registered Qualified Environmental Professional (QEP #02970014), the author or co-author of over 130 relevant publications or presentations and has provided expert services to many local governments, the U.S. federal government and private parties. This report has also been subject to external scientific peer review by Robert Scofield, D. Env., M.P.H. Dr. Scofield is Principal Toxicologist and Vice President at GSI Environmental, Inc.

This risk assessment uses methodologies developed by the U.S. Environmental Protection Agency to answer these questions and to perform an analysis regarding the need for mitigation systems. It is not intended to fulfill a specific regulatory requirement but rather is intended to inform residents of the Bridger Creek Community and City officials regarding the consequences of the occurrence of VOCs in the area. Although not being conducted as part of a regulatory program, the methods used in the risk

assessment are those typically applied to baseline risk assessments that support decisions regarding the need for risk management measures and that support risk communication.

The risk assessment was based on hundreds of measurements of volatile organic compounds that have been made over the past several years. Those chemicals anticipated to present the greatest risk that could be associated with vapor intrusion from the landfill were identified by a series of statistical and numerical procedures. This process resulted in benzene, carbon tetrachloride, chloroform, 1,2-dichloroethane, 1,4-dioxane, ethylbenzene, tetrachloroethene, trichloroethene, 1,2,4-trimethylbenzene, and m,p-xylene being identified as chemicals of potential concern in soil gas. All of these chemicals may have multiple sources in addition to their presence in soil gas. None of the VOCs measured in the Bridger Creek residences is unique to landfill gas and the methods used to sample and analyze the VOCs were designed to yield total concentrations rather than concentrations associated with landfill gas only. The risk assessment discussed numerous additional potential sources of these chemicals and provides links whereby residents may learn more about exposures to chemicals contained in common household products.

Health risks for cancer, chronic non-cancer systemic effects, and acute non-cancer effects associated with vapor intrusion were determined for the chemicals of potential concern before mitigation was implemented using standard methods established by the Environmental Protection Agency. In all instances where there was a choice, conservative (health protective) options were used. Two exposure scenarios -- a reasonable maximum exposure and an average or central tendency exposure -- were evaluated for the Bridger Creek community as a whole.

The results of the risk assessment are summarized below[1]:

Health Effect	Reasonable Maximum Exposure	Average Exposure	EPA Criterion	DEQ Criterion
Cancer Risk	4E-06 (4 in 1,000,000)	3E-07 (3 in 10,000,000)	1E-06 to 1E-04 (1 in 1,000,000 to 1 in 10,000)	1E-05 (1 in 100,000)
Chronic Non-cancer Hazard Index	0.3	0.04	1.0	1.0
Acute Hazard Index	0.003	Not applicable	1.0	No criterion

In addition, reasonable maximum exposure cancer risks and chronic non-cancer hazard indices were calculated for each individual residence in the Bridger Creek Community. These calculations were performed for a hypothetical individual who was assumed to reside at a single residence for 26 years, and be inside the home for 24 hours per day and for 350 days per year. The cancer risks ranged from 5E-07 (5 in 10,000,000) to 1E-05 (1 in 100,000) and the non-cancer hazard indices ranged from 0.03 to 0.8.

[1] Technical terms used in this report will be defined in Appendix A and discussed further in the text.

Cancer Risks refer to the probability that an individual could contract cancer under the conditions of chemical exposure discussed in the assessment. The cancer risk values that were calculated for the Bridger Creek community ranged from 3 in 10,000,000 to 4 in 1,000,000 and the cancer risks for individual residences ranged from 5 in 10,000,000 to 1 in 100,000. These may be compared to the Environmental Protection Agency's risk range of 1 in 1,000,000 to 1 in 10,000 and the Montana Department of Environmental Quality's risk criterion of 1 in 100,000. Non-cancer hazards refer to the possibility that a health effect could occur due to either long-term (chronic) or short-term (acute) exposure to a chemical. Hazard index values less than "1" suggest that non-cancer effects are not likely to occur. Chronic non-cancer systemic hazard index values ranged from 0.04 to 0.3 for the Bridger Creek community and from 0.08 to 0.8 for the individual residences. The acute hazard index was 0.003. These hazard indices may be compared to the regulatory criterion of 1. In each case, the potential risks associated with vapor intrusion into the Bridger Creek residences are below the regulatory criteria. In addition, these risks are well below those associated with potentially hazardous activities undertaken by people in everyday life.

It may be concluded that the potential health risks to the Bridger Creek Community associated with subslab volatile organic chemicals prior to mitigation are within acceptable risk ranges established by the Environmental Protection Agency and the Montana Department of Environmental Quality under the conditions of exposure used in this risk assessment. Further it was shown that the risks are substantially lower than those associated with everyday life. The primary reason for these low risks is the fact that the chemicals of concern are generally present at very low concentrations. Overall, using Environmental Protection Agency methods, the potential risks posed by intrusion of subslab soil gas to the community meet generally accepted public health regulatory guidelines. In essence, the baseline risk assessment suggests that the installation of mitigation systems, while a prudent public health implementation of the precautionary principle, was not necessary to meet regulatory risk guidelines.

As a consequence of the installation of mitigation systems, radon measurements were obtained from residences in Bridger Creek Phase 3. These measurements revealed the presence of naturally occurring radon at levels exceeding the Environmental Protection Agency's action level for radon. The cancer risks associated with unmitigated radon in these residences exceeds the potential risks associated with chemical exposure by many orders of magnitude. Overall, installation of the mitigation systems reduced the radon levels to below the Environmental Protection Agency's criterion and reduced the cancer risk by approximately a factor of 10.

1. Introduction/Problem Formulation

The City of Bozeman ("City") operated a sanitary landfill under a Montana Department of Quality (MDEQ) permit from 1970 until 2008. After the landfill began operation, two residential developments, known as the Bridger Creek Phase 2 and Phase 3 subdivisions, were developed near the landfill. In 2012, volatile organic compounds (VOCs) were discovered in off-site soil gas. Several investigations have been conducted since the initial discovery including evaluations of VOCs in the landfill, soil vapor, groundwater, ambient air and the Bridger Creek residences. Mitigation systems have been installed in many homes and monitoring and other activities are continuing. Documents related to the vapor

intrusion studies and mitigation may be found at
http://www.bozeman.net/Projects/BozemanLandfillSoilGasStudy/Home.aspx

In order to answer questions from the public regarding potential health effects associated with components of the soil gas, the City commissioned a human health risk assessment (HHRA) from CPF Associates, Inc. ("CPF"). CPF is a scientific research and consulting firm located near Washington DC that specializes in environmental impact studies of the management of solid and hazardous waste. In addition to risk assessments, CPF conducts epidemiology and community health studies, biomonitoring studies, life cycle analyses and related projects. The Principal Investigator is Paul C. Chrostowski, Ph.D., QEP. Dr. Chrostowski has an Honors BS in Chemistry from the University of California, Berkeley, an MS in Environmental Science obtained through a United States Public Health Service Traineeship at Drexel University, and a Ph.D. in Environmental Engineering and Science from Drexel University. In addition, Dr Chrostowski has over 40 years' experience in risk analysis and environmental forensics. He is a registered Qualified Environmental Professional (QEP #02970014), the author or co-author of over 130 relevant publications or presentations and has provided expert services to many local governments, the U.S. federal government and private parties. Dr. Chrostowski's professional biography is attached to this report as Appendix C. This report has also been subject to external scientific peer review by Robert Scofield, D. Env., M.P.H. Dr. Scofield is Principal Toxicologist and Vice President at GSI Environmental, Inc. All comments received from Dr. Scofield have been incorporated into the analysis and are reflected in this report.

Risk assessment is a scientific practice that has been developed to characterize the probability and magnitude of health impacts associated with exposure to chemicals. The principles of risk assessment were originally detailed in 1983 by the National Academy of Sciences/National Research Council (NAS/NRC). Since that time, detailed guidelines for the performance of risk assessments have been published by EPA and others. Many of these guidelines have been published by EPA's Superfund program which requires risk assessments to determine human health protection. This risk assessment is intended to be consistent with EPA and related federal guidelines.

This risk assessment follows United States Environmental Protection Agency (EPA) and Agency for Toxic Substances Disease Registry (ATSDR) guidance as supplemented by MDEQ guidance. Pertinent guidance documents include:

- National Academy of Sciences 1983. Risk Assessment in the Federal Government: Managing the Process.
- ATSDR 2001 Landfill Gas Primer.
- ATSDR 2008. Evaluating Vapor Intrusion Pathways at Hazardous Waste Sites.
- EPA 1992c. Guidelines for Exposure Assessment. EPA/600/Z-92/001.
- EPA 2005. Guidelines for Carcinogen Risk Assessment. EPA/630/P-03/001F
- EPA 2009. Risk Assessment Guidance for Superfund, Volume I: Part F. Supplemental Guidance for Inhalation Risk Assessment. EPA-540-R-070-002.
- EPA 1989. Risk Assessment Guidance for Superfund Volume I Part A. EPA/540/1-89/002.
- EPA 2001. Risk Assessment Guidance for Superfund, Volume I. Part D. Standardized Planning, Reporting, and Review of Superfund Risk Assessments.

- EPA 1992a. Guidance for Data Usability in Risk Assessment. OSWER Publication 9285.7-09A.

In addition, the scientific and regulatory literature on the behavior and effects of VOCs in the environment has also been consulted where appropriate. Other relevant documents will be cited throughout this report; complete references may be found in Section 8.

This risk assessment is specifically designed to answer questions about current and future health risk for residences in the Bridger Creek subdivisions and surrounding areas when viewed as a community. Although it includes calculations of risks potentially associated with exposure of a hypothetical individual to VOCs in individual residences, these calculations should not be interpreted to reflect actual individual exposures of occupants of these residents. It is not intended to address questions regarding the risks of particular occupants of these residences. There are several reasons why this assessment focuses on the community, residences, and hypothetical receptors rather than actual individuals. First, this is a public document. Risk assessments focusing on individuals require a substantial amount of information regarding someone's personal life including physiological characteristics and behavior patterns (for example, tobacco and alcohol use). If a risk assessment were to be performed on individuals, obtaining and publishing this information could be regarded as an invasion of privacy. Second, this risk assessment is intended to cover both present and future potential exposures. This includes people wishing to relocate to or build in the Bridger Creek Community as well as people wishing to refinance mortgages or engage in other real estate transactions. Relying on existing indoor air measurements alone will not allow for calculation of potential future risks due to variability in indoor air concentrations when compared to subslab soil gas. Third, this risk assessment is designed to be biased toward health protectiveness. This practice, while standard in risk assessment, overestimates exposures and the potential for health effects by using conservative default assumptions regarding human behavior. Risk assessments for real individuals are normally much less conservative than those performed using EPA guidelines.

This HHRA is not intended to fulfill a specific regulatory requirement but rather is intended to inform residents of the Bridger Creek Community and City officials regarding the consequences of the occurrence of VOCs in the area. Although not being conducted as part of a regulatory program, the methods used in the risk assessment are those typically applied to baseline risk assessments that support decisions regarding the need for risk management measures and that support risk communication.

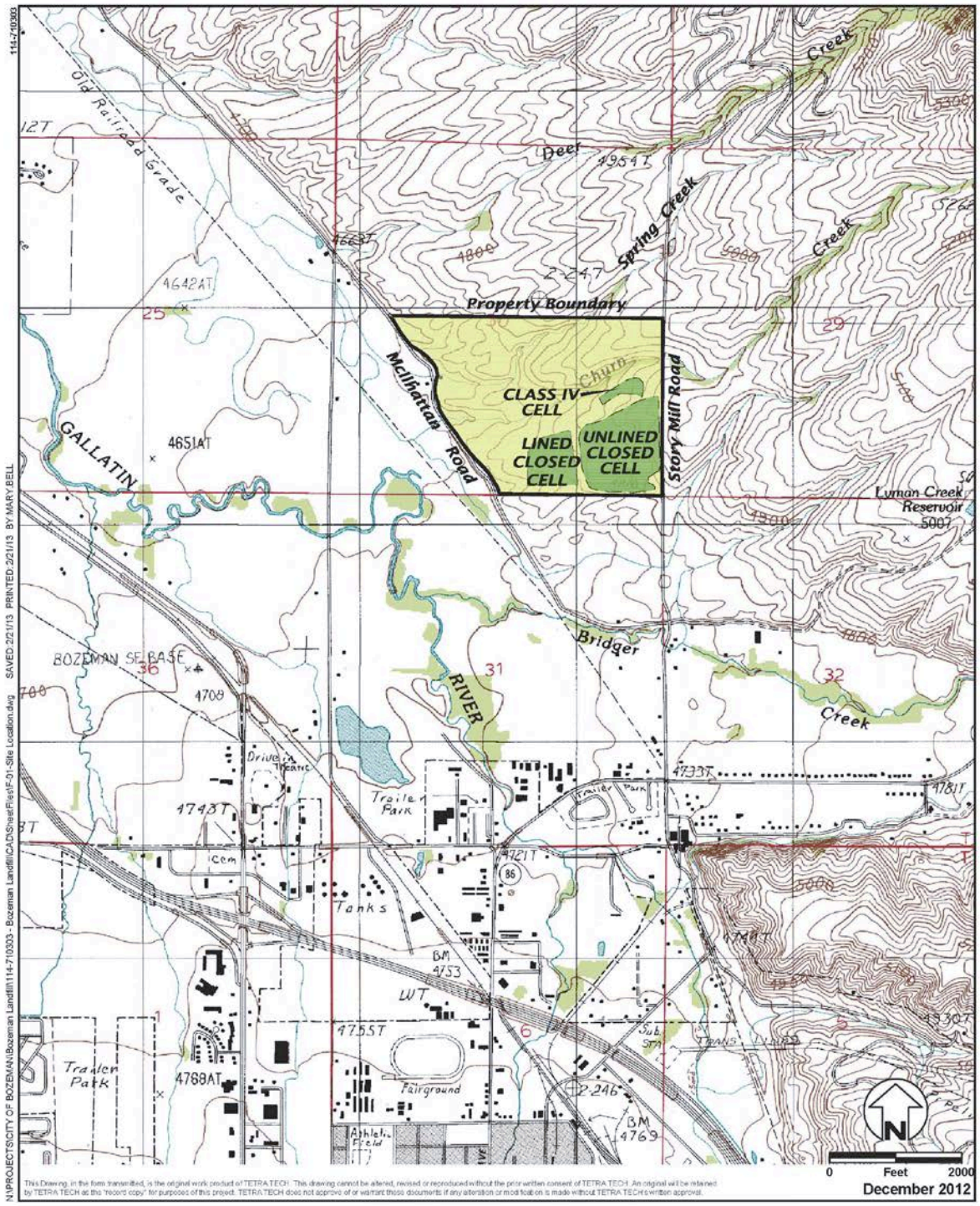
This HHRA opens with a description of the landfill and its setting. It then moves on to the traditional risk assessment components of data evaluation, exposure assessment, toxicity assessment and risk characterization. This is followed by a discussion of the results that interprets the calculated risks and puts them into context with regulatory public health guidelines and risks associated with events in everyday life.

2. History and Setting of Facility

The City operated a sanitary landfill under an MDEQ permit from 1970 until 2008. The landfill is situated on a 200 acre tract between Story Mill Road and McIlhattan Road approximately 2 miles

northeast of downtown Bozeman (Figure 1). The majority of waste disposed of at the landfill has been defined as Class II including food, paper, cardboard, cloth, glass, metal and plastics. Until 1995, waste was disposed of in an unlined cell in the southeastern portion of the property. This cell is approximately 32 acres in extent and contains waste up to 100 feet in thickness. From 1995 through 2008 disposal was conducted in a second cell. This cell is equipped with an impermeable liner and a leachate collection system. Leachate from this cell is disposed of and treated in the municipal waste water system. The lined cell is approximately 12 acres in extent and contains waste up to 100 feet in thickness. In addition to these two cells, there is a Class IV cell in the northwest corner of the property that covers about 3 acres. This cell accepted construction and demolition (C&D) waste in the past and currently has limited activity for handling C&D waste. This type of waste is not usually associated with the chemicals that may cause vapor intrusion. Besides the landfilling, the City operates a yard waste composting operation on the site. Neither the Class IV cell nor the composting operation will be addressed in the risk assessment. Additional information regarding the landfill is available in Maxim (1995) and TetraTech (2007, 2014).

A groundwater monitoring program has been in operation at the landfill since 1981. In 1995, a corrective measures assessment (CMA) was performed for the landfill (Maxim 1995) that evaluated the nature and extent of contamination of groundwater and landfill gas and recommended mitigation measures. As a result, a landfill gas extraction system was installed in the unlined closed cell in 1997. This system consists of 19 landfill gas extraction wells which collect methane gas along with approximately 1,100 pounds of volatile organic compounds (VOCs) per year which are thermally treated using a candlestick flare located on the north side of the unlined closed cell. This system is operated



From USGS 7.5' Bozeman Quad (1987)

114-710303.402

Site Location Map
Bozeman Sanitary Landfill
Bozeman, Montana
FIGURE 1

under an MDEQ permit. The performance of the landfill gas extraction system was evaluated in 2007 (TetraTech 2007) and engineering modifications were made to the existing system. Due to occurrences of VOCs in groundwater, a second CMA was completed in 2014 which summarizes investigations and remedial actions to date (TetraTech 2014). The original reports and permits (MDEQ 2007) may be consulted for additional details on the landfill gas extraction and treatment system.

The landfill property lies on the southwest flank of the Bridger Mountains, immediately upslope of the East Gallatin River floodplain. The location of the landfill is shown on Figure 1. The land closest to the landfill in the west, north, and east directions is relatively undeveloped. This land is largely outside the Bozeman City limits and in unincorporated Gallatin County. The landfill property itself is zoned "PLI" or public lands/institutional. Development in the area of the landfill started in about 1994. This area is zoned "R-3", residential medium density or "R-S", residential suburban. The Bridger Creek residential developments are located to the south. These developments consist of approximately 75 single-family residences located on Augusta Drive, St. Andrews Drive, Turnberry Court, McIlhattan Road, Caddie Court, and Story Mill Road. There were three phases of development in Bridger Creek, two of which are relevant to this investigation[2]. Bridger Creek Subdivision Phase 2 was platted in 1997 and consists of lots along Augusta Drive and McIlhattan Road. Bridger Creek Subdivison Phase 3 was platted in 2000 and consists of lots along St Andrews Drive, Turnberry Court, and Caddie Court. Collectively these developments will be referred to as the Bridger Creek Community. The residences in this area are served with municipal water and sewage, although a few water supply wells exist for irrigation. Further to the south and west is the City Center of Bozeman; for perspective, W. Main Street, Bozeman lies about 2 ¼ miles due south of the center of Bridger Creek Phase 2.

VOCs in off-site soil gas were discovered in late 2012. Soil gas samples were initially analyzed for 62 VOCs and chloroform, benzene, trichloroethene[3], tetrachloroethene, ethylbenzene, and 1,2,4-trimethylbenzene were detected above EPA residential indoor air regional screening levels (RSLs). RSLs are not intended to identify the potential for public health effects. Rather they are indicators that further action may be needed. In this case, that action was expressed as additional monitoring, the installation of soil gas mitigation systems, and performance of this HHRA. Several investigations have occurred since the initial discovery including investigation of the landfill, soil vapor, groundwater, ambient air, and the Bridger Creek residences. Indoor air and subslab soil gas monitoring were conducted in all residences along St. Andrews Drive, Turnberry Court, and Caddie Court in the Bridger Creek Phase 3 Subdivision in addition to four homes on Augusta Drive in the Bridger Creek Phase 2 subdivision. Overall, 37 VOCs have been detected in subslab soil gas and 35 VOCs have been detected in indoor air. Of the detected VOCs, 30% are associated with petroleum products, particularly gasoline and diesel or heating fuel. In addition to indoor air, the City has performed ambient outdoor air monitoring in the residential area and administered a questionnaire to homeowners regarding factors that could be relevant to chemical exposure. These investigations have revealed the presence of VOCs in indoor air and subslab soil gas which are the focus of this risk assessment. As of this writing, mitigation systems have been installed in many homes, monitoring is continuing, and the City of Bozeman is in the

[2] Bridger Creek Subdivision Phase 1 lies to the south of Bridger Creek and is considered to be outside the area of potential impact.

[3] Trichloroethene is also referred to as trichloroethylene. Tetrachloroethene is also referred to as tetrachloroethylene or perchloroethylene.

process of developing a landfill remediation system. Additional information regarding the vapor intrusion studies may be found in the 2014 CMA and at http://www.bozeman.net/Projects/BozemanLandfillSoilGasStudy/Home.aspx

3. Data Summary and Selection of Chemicals of Potential Concern (COPCs)

VOCs are a group or family of numerous chemicals characterized by their properties. In general, they have high vapor pressures and low boiling points which causes them to evaporate from a liquid or solid phase. They are also considered to be ubiquitous, meaning that they occur almost universally in the environment. VOCs may be naturally occurring or human made (anthropogenic). Naturally occurring VOCs, such as terpenes, play important roles in communications between plants and messages from plants to animals. For example, the VOC amyl acetate is emitted by bananas to signal that they are ripe. Some VOCs are considered to be toxic to humans and the natural environment. Many of these are the anthropogenic VOCs which are regulated by various federal and state agencies. Many VOCs occur as mixtures. For example, petroleum products such as gasoline, kerosene, and diesel may contain hundreds of VOCs.

At the Bridger Creek Community, outdoor air, indoor air, crawl space, and subslab soil gas samples were analyzed for over 60 VOCs – in most cases, these are anthropogenic VOCs that have been found in studies elsewhere to be associated with municipal solid waste landfills. Many of these chemicals were not detected, were detected only infrequently, or were detected indoors at levels significantly higher than in soil gas. Subsequent to these occurrences, mitigation systems were installed in 27 residences in Bridger Creek Phase 3 (see Section 6.5 for details).

When conducting a risk assessment, it is standard practice to focus on those chemicals of greatest potential concern to human health and eliminate chemicals that are not of consequence to the risk assessment using a screening process (EPA 1991b, EPA 1996). The chemicals that remain after this process are called chemicals of potential concern or COPCs. These COPCs are then subject to a complete risk assessment as defined by EPA. If the risk assessment shows that particular chemicals exceed risk criteria, they are termed chemicals of concern or COCs. Remedial measures are then developed for the COCs to eliminate the concern.

The chemical analytical data used in this risk assessment were obtained from samples collected by TetraTech under contract to the City of Bozeman. Sampling methods and data management were generally consistent with EPA and MDEQ methodologies. VOCs were analyzed using EPA Method TO-15 by two independent laboratories -- Eurofins Air Toxics, Inc., Folsom California and AccuStar, Medford, MA. Eurofins maintains an accredited lab and participates in EPA's performance evaluation program as well as several state and federal certifications, validations and approvals. The method used, EPA's TO-15 (EPA 1999), was developed to evaluate chemicals regulated under the Clean Air Act. It involves collecting air samples (from soil gas or ambient air) in canisters and transporting them to the laboratory where they are analyzed by Gas Chromatography/Mass Spectrometry. In addition to the air samples, field duplicates, blanks, surrogate recoveries, laboratory control samples and laboratory control

sample duplicates were analyzed. Data were validated[4] by TetraTech using EPA National Functional Guidelines and qualified as appropriate. For this risk assessment, validation reports contained in a pdf file ("Data Validation Reports" dated February 7, 2014[5]) were received from TetraTech and reviewed for data usability. All data not qualified "R" (rejected) were reviewed and considered suitable for use in the risk assessment.

3.1 Data Summary

The VOC data used in this risk assessment were received from TetraTech on May 8, 2014 in the form of an MS Excel spreadsheet labeled "Risk Analysis Database". In addition, letters sent to residents reporting analytical results, and a homeowner mitigation schedule, were used to provide context and additional background on sampling locations and sampling schedules. Letters were contained in several pdf files received from TetraTech in February and March 2014 including:

- Initial indoor air letters
- Phase II letters
- Post mitigation letters
- Subslab letters

Post-mitigation letters and data were used for context only and were not included in the HHRA. The reason for this was to be able to calculate risks for the baseline situation prior to mitigation (the effects of mitigation are discussed later in this document). The mitigation schedule was included in an Excel file received in March 2014 which presented mitigation status as of January 29, 2014, although mitigation data as late as April 2014 were also reviewed. Finally, recourse was made to presentations given at various public meetings in 2013 and 2014.

The data reported in these documents and used in the risk assessment is in the form of mass concentrations or number of micrograms (µg) of chemical per cubic meter (m^3) of air. Some toxicity data referenced below is reported in units of mg/m^3 which is a factor of 1,000 higher than $\mu g/m^3$ (i.e., 1 mg/m3 = 1,000 $\mu g/m^3$). Other sources that may be consulted by readers of this document may report volume concentrations or volume of contaminant per volume of air with typical units of parts-per-billion (ppb) or parts-per million (ppm). These two systems of reporting are not interchangeable and the reader should use caution when comparing results reported using the different systems. Radon results are reported in terms of pico-Curies of radon activity per liter (pCi/L) of air. This is a measurement of the radioactivity of the radon rather than its mass.

Many of the Bridger Creek Community homes have crawl spaces that were sampled as part of site investigations. After careful examination, it was decided not to include these data in the HHRA for a variety of reasons. Crawl spaces may influence the degree of interaction between subslab and indoor air and are not considered to be representative of subslab soil gas. The two most important factors that determine the degree of influence are: 1) whether the crawl space is vented and, if so, the degree of ventilation; and 2) the presence and condition of any water vapor barrier between the lowest floor of the building and the crawl space (EPA

[4] Validation is a process in which laboratory reports are inspected by an independent analyst to determine if the analyses are consistent with EPA requirements.
[5] These reports reflected Eurofins analyses only.

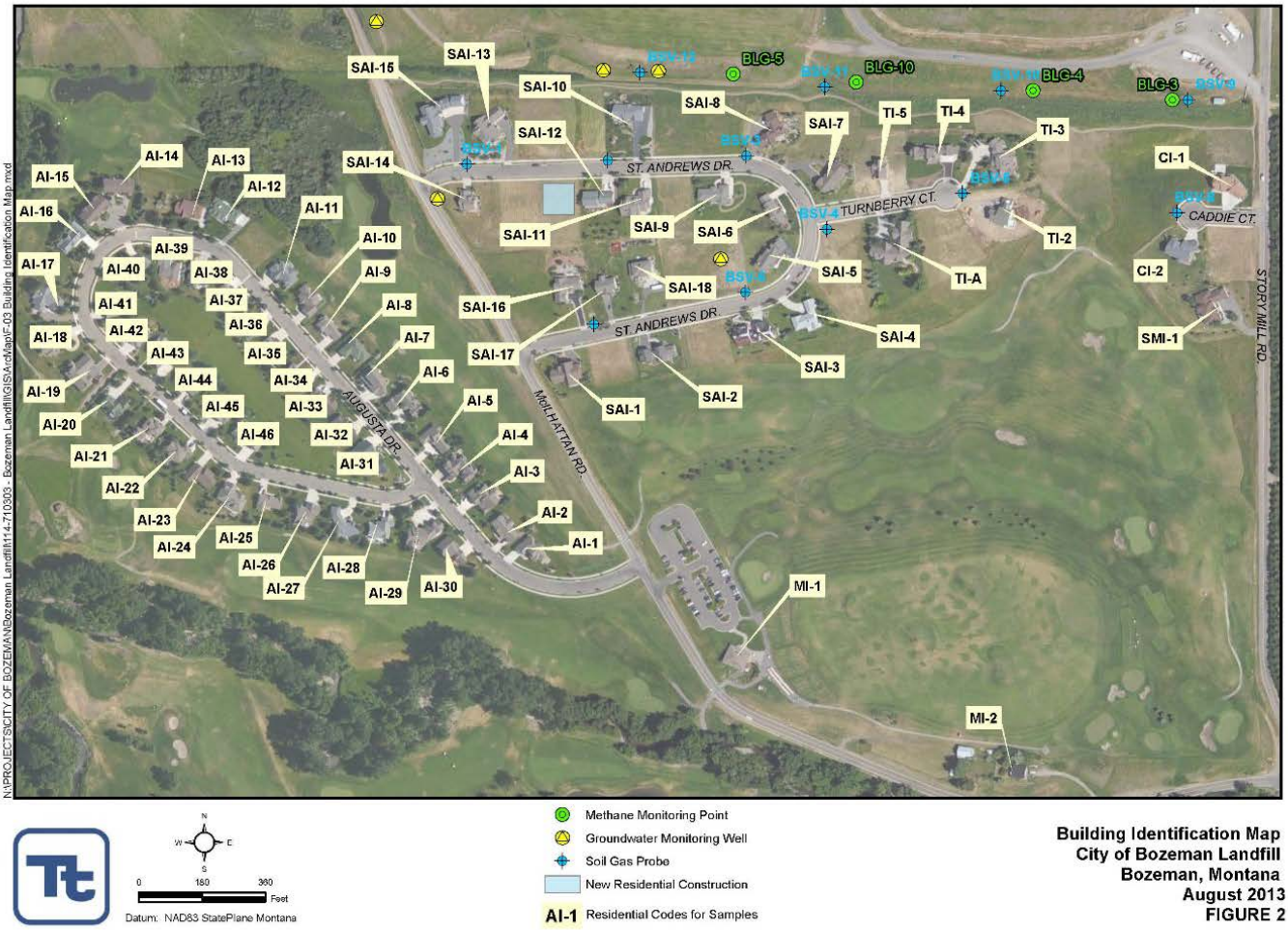
2012). Other variable factors include construction details, pest control practices, spills of materials, and degree of use of the crawl space. These are not known in the case of the Bridger Creek Community residences. Further, people may use crawl spaces as storage and they may contain sources of VOCs such as paint, solvents, cleaners or related materials. Some incidences of this were noted during field investigations at the Bridger Creek community residences. Without detailed knowledge of all of these factors and elimination of any alternative VOC sources from the crawl spaces, reliable interpretation of crawl space measurements would not be possible. Due to this, this risk assessment relies on subslab data which the literature maintains is more accurate.

3.2 Data Evaluation and Selection of COPCs

The data in the excel file were evaluated in a series of steps to identify chemicals of potential concern (COPCs) consistent with MDEQ recommendations (MDEQ 2011). The chemical-specific sampling results were transposed (from the original form of chemicals by column and samples by row, to chemicals by row and samples by column), and compiled so that each individual column reflected one individual sample from one house with a unique sampling date. Quantitative concentrations were not provided by TetraTech for those samples flagged with an ND[6], reflecting a result that was presumably less than the detection or reporting limit. In these cases, TetraTech left the sample concentration cell in the excel file blank. For the purposes of selecting COPCs, only detectable concentrations with values reported by TetraTech were considered. Accordingly, rows with sample quality flags, sample reporting limits and reporting limit flag information were not needed and were removed from the compiled dataset, leaving only the concentration results for each compound. Rows containing other information not needed for the selection of COPCs were also removed (e.g., lab number and name, matrix, sampling time, lab date, dilution, etc.) Sample columns not needed for the selection of COPCs were also removed for ease of data handling (e.g., samples collected in 2014 or post-mitigation, ambient air samples, samples LFI-1 and LFI-2 which were collected from the landfill, and crawl space samples). The sampling information retained at this point for the selection of COPCs included: field sample number, house number, unique ID, sample type (i.e., indoor air, subslab), duplicate, sample description (i.e., sampling location in house such as bedroom, living room, etc.) and sampling date.

Sampling locations for data relied upon in the risk assessment are shown in Figure 2. These sample locations were identified by TetraTech using alphanumeric designations: AI represents Augusta Drive which comprises Bridger Creek Phase 2. SAI and TI represent St. Andrews Drive and Turnberry Court, respectively, which along with CI representing Caddie Court and SMI representing Storymill Road comprise Bridger Creek Phase 3. MI represents McIlhattan Road.

[6] ND represents a chemical that may be present but at a level less than that reliably determined by the analytical method.



The COPC selection process relied on a sequential comparison, first of indoor air concentrations to risk-based regional residential screening levels (RSLs) for the inhalation pathway of exposure and, after this, of indoor air concentrations to subslab concentrations. RSLs were developed by EPA specifically to perform preliminary screening of chemical concentrations at a site. The fact that RSLs may be exceeded does not mean that there is a health risk, but usually means that further evaluation of potential risks is appropriate. The RSLs used in this HHRA were obtained from residential air screening levels provided by EPA in the table "Regional Screening Level (RSL) Resident Air Supporting Table (TR=1E-6, HQ=0.1) May 2014". [7] All non-cancer and cancer risk RSLs were compiled from this table for each compound included in TetraTech's excel data file. The RSLs for trans- and cis-1,2-dichloroethene were obtained from the International Toxicity Estimates for Risk (ITER) database[8] because values were not

[7] RSL source: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/ docs/ resair_sl_table_01run_MAY2014.pdf. Table date May 2014.
[8] Source: https://iter.ctc.com/publicURL/pub_view_list.cfm?crn=156%2D59%2D2

available in EPA's RSL table. The non-cancer RSLs were based on a target hazard quotient (HQ) of 0.1. This is 10 times lower (i.e., more health-protective) than the criterion typically used to evaluate HHRA results. The cancer-based RSLs were based on a target excess lifetime cancer risk of one in one million (1 in 1,000,000 or 1E-6). If RSL air concentration values were available for both endpoints (non-cancer and cancer), the lowest one was used in the COPC screening. Table 1 presents the RSLs and other toxicity criteria for the compounds.

The two COPC screening steps were based on a simplified version of Montana's decision-making process for evaluating sample data as described in its 2011 Vapor Intrusion Guide as well as discussions with Aimee Reynolds, Risk Assessor and Quality Coordinator at MDEQ. Specifically, the following two comparisons were performed:

1) The maximum indoor air concentration (Max IA) reported at each house was compared to the RSL. Sample data considered in this step included all indoor air living space samples (except those from crawl spaces) with detectable concentrations that were collected in 2013 before mitigation.

2) If the maximum indoor air concentration was above the RSL (i.e., max IA > RSL), a second screening step was conducted in which the maximum subslab concentration (Max SS) was compared to the maximum indoor air concentration. Sample data considered in this step included all subslab samples with detectable concentrations that were collected in 2013 before mitigation.

The results of the screening are shown in Table 2. Sample results for a total of 38 compounds available from 31 houses were included in the COPC selection process. The maximum indoor air concentration was found to be above the RSL at 17 houses and, among these, 10 also had maximum subslab concentrations greater than maximum indoor concentrations. As described earlier, exceeding an RSL does not necessarily mean that there is a health risk but it does indicate that further evaluation is appropriate.

This process yielded 10 COPCs including BTEX compounds[9] (1, 2, 4-trimethylbenzene, benzene, ethylbenzene, m,p-xylene), chlorinated solvents (1,2-dichloroethane, carbon tetrachloride, chloroform, tetrachloroethene, trichloroethene), and 1,4-dioxane. The worksheets used in this selection process may be found in Appendix B. The COPCs developed in this process were subsequently used as the basis of the remainder of the risk assessment. It should be kept in mind that these are COPCs for the subslab soil gas contribution to indoor air, not indoor air itself which is subject to many other sources of VOCs.

[9] The term "BTEX" specifically standing for Benzene, Toluene, Ethylbenzene, and Xylenes is used more generally in this report to represent all monoaromatic hydrocarbons derived from petroleum.

Table 1
Risk Screening Levels (RSLs) and Toxicity Values

Compound	CAS #	Inhalation Unit Risk (IUR) $(\mu g/m^3)^{-1}$ (d)	Inhalation Reference Concentration (RfC) (mg/m^3) (d)	Cancer screening level (CSL) (ug/m^3) (a)	Noncancer screening level (NCSL) $(\mu g/m^3)$ (a, b)	RSL (lowest of CSL and NCSL)
1,1,1-trichloroethane	71-55-6		5		520	520
1,1-dichloroethane	75-34-3	1.60E-06		1.8		1.8
1,2,4-trimethylbenzene	95-63-6		7.0E-03		0.73	0.73
1,2-dichloroethane	107-06-2	2.60E-05	7.0E-03	0.11	0.73	0.11
1,4-dioxane	123-91-1	5.00E-06	3.0E-02	0.56	3.1	0.56
2-butanone (MEK)	78-93-3		5		520	520
2-hexanone	591-78-6		3.0E-02		3.1	3.1
2-propanol	67-63-0		7		730	730
4-methyl-2-pentanone	108-10-1		3		310	310
Acetone	67-64-1		31		3,200	3,200
Benzene	71-43-2	7.80E-06	3.0E-02	0.36	3.1	0.36
Bromomethane	74-83-9		5.0E-03		0.52	0.52
Carbon disulfide	75-15-0		0.7		73	73
Carbon tetrachloride	56-23-5	6.60E-06	1.0E-01	0.47	10	0.47
Chlorobenzene	108-90-7		5.0E-02		5.2	5.2
Chloroethane	75-00-3		10		1,000	1,000
Chloroform	67-66-3	2.30E-05	9.8E-02	0.12	10	0.12
Chloromethane	74-87-3		9.0E-02		9.4	9.4
Cis-1,2-dichloroethene (c)	156-59-2		6.0E-02		6.3	6.3
Cumene	98-82-8		0.4		42	42
Cyclohexane	110-82-7		6		630	630
Ethyl benzene	100-41-4	2.50E-06	1	1.1	100	1.1
Freon 11	75-69-4		0.7		73	73
Freon 113	76-13-1		30		3,100	3,100
Freon 12	75-71-8		0.1		10	10
Hexane	110-54-3		0.7		73	73
m,p-Xylene	108-38-3/106-42-3		0.1		10	10
Methyl t-butyl ether (MTBE)	1634-04-4	2.60E-07	3	11	310	11
Methylene chloride	75-09-2	1.00E-08	0.6	100	63	63
o-xylene	95-47-6		0.1		10	10
Propyl benzene	103-65-1		1		100	100
Styrene	100-42-5		1		100	100
Tetrachloroethene	127-18-4	2.60E-07	4.0E-02	11	4.2	4.2
Tetrahydrofuran	109-99-9		2		210	210
Toluene	108-88-3		5		520	520
trans-1,2-dichloroethene (c)	156-60-5		6.0E-02		6.3	6.3
Trichloroethene	79-01-6	4.10E-06	2.0E-03	0.48	0.21	0.21
Vinyl chloride	75-01-4	4.40E-06	0.1	0.17	10	0.17

(a) Risk screening levels (RSLs) obtained from residential air screening levels provided by EPA in the table "Regional Screening Level (RSL) Resident Air Supporting Table (TR=1E-6, HQ=0.1) May 2014". http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/docs/resair_sl_table_01run_MAY2014.pdf.
(b) NCSL based on the HQ=0.1 values in EPA's RSL table.
(c) Noncancer screening levels for trans- and cis-1,2-dichloroethene obtained from RIVM Provisional tolerable air concentration (https://iter.ctc.com/publicURL/pub_view_list.cfm?crn=156%2D59%2D2)
(d) These terms will be discussed in greater detail in Section 5.

Table 2
Data Screening for Selection of Compounds of Potential Concern (COPC) (a)

Compound	Total number of houses tested	Houses meeting first test (Max IA>RSL)(b)	Houses meeting second test (Max SS>Max IA)(c)	COPC
111Trichloroethane	31	0	0	N
11Dichloroethane	31	0	0	N
124Trimethylbenzene	31	29	17	Y
12Dichloroethane	31	26	1	Y
14Dioxane	31	14	2	Y
2Butanone	31	0	0	N
2Hexanone	31	0	0	N
2Propanol	31	1	0	N
4Methyl2pentanone	31	0	0	N
Acetone	31	0	0	N
Benzene	31	28	15	Y
Bromomethane	31	0	0	N
CarbonDisulfide	31	0	0	N
CarbonTetrachloride	31	20	1	Y
Chlorobenzene	31	0	0	N
Chloroethane	31	0	0	N
Chloroform	31	24	9	Y
Chloromethane	31	1	0	N
cis12Dichloroethene	31	0	0	N
Cumene	31	0	0	N
Cyclohexane	31	0	0	N
Ethylbenzene	31	22	11	Y
Freon11	31	0	0	N
Freon113	31	0	0	N
Freon12	31	2	0	N
Hexane	31	2	0	N
MethyleneChloride	31	0	0	N
MethylTertButylEther	31	0	0	N
MpXylene	31	9	3	Y
OXylene	31	5	0	N
Propylbenzene	31	0	0	N
Styrene	31	0	0	N
Tetrachloroethene	31	3	2	Y
Tetrahydrofuran	31	0	0	N
Toluene	31	0	0	N
trans12Dichloroethene	31	1	0	N
Trichloroethene	31	7	3	Y
VinylChloride	31	1	0	N
Total # Compounds	**--**	**17**	**10**	**10**

(a) Sample data considered in the screening included all subslab samples and all indoor air samples (except those from crawl spaces) with detectable concentrations that were collected in 2013 before mitigation. Data were received from TetraTech on May 8, 2014 in the form of an MS Excel spreadsheet labeled "Risk Analysis Database". See Appendix B for details.
(b) First test: Is the maximum indoor air concentration (Max IA) greater than the risk screening level (RSL)?
(c) Second test: Only performed if first test condition was met (i.e., Max IA > RSL). If Max IA > RSL, is the maximum subslab concentration (Max SS) > Max IA??

3.3 Sources of VOCs/COPCs

None of the COPCs are unique to MSW landfills and the COPC selection process should not be construed to represent source identification. The BTEX compounds, including those measured at levels too low to be designated as COPCs (for example, toluene, hexane, cumene), are most commonly associated with petroleum fuels, especially gasoline, kerosene, and other light fuels. In addition to the fuels themselves, they may also be found in vehicle exhaust. Many of them are also found in paints, coatings and solvents such as mineral spirits. The BTEX compounds are also common constituents of tobacco smoke. The chlorinated solvents are typically associated with a variety of activities including dry cleaning, swimming pool maintenance, household cleaners, machine shops, and water disinfection. 1,4-dioxane has been used as a preservative for chlorinated solvents in applications ranging from dry cleaning to septic tank maintenance to machine shop operations and is a common constituent of household detergents (Tanabe & Kawata 2008, Huff 2010). Although 1,4-dioxane survived the COPC designation process, it was not detected in an analysis of landfill gas taken at the entrance to the gas flare at the landfill in December 2013. Since concentrations at the inlet pipe to the flare reflect levels present within the body of the landfill which are expected to be much higher than levels that could occur beyond the landfill boundary, this indicates that 1,4-dioxane may have another source. Chloroform is a water disinfection byproduct that is found at trace levels in Bozeman municipal drinking water in addition to being a common constituent of water that has been treated with household bleach, swimming pool water, and hot tub/spa water. Many potential indoor VOC sources were identified in field surveys conducted by TetraTech during air quality sampling. No attempt was made to quantify these sources or remove them prior to sampling, thus, they may have contributed to the VOC concentrations measured in indoor air. Three of the COPCs – 1,4-dioxane, chloroform, and carbon tetrachloride – were not detected in recent analyses of VOCs at the inlet pipe to the landfill flare (AtmAAInc 2013, eurofins 2014) and thus may not originate from the landfill. By focusing on soil gas measurements, this assessment is designed to separate the effects of vapor intrusion from soil from other sources. However, it should be recognized that the only way other potential contributing sources can be eliminated is to identify and remove them prior to sampling.

In addition to indoor sources, there are numerous outdoor sources of BTEX compounds in the vicinity according to EPA's Envirofacts database and a Google Earth search. BTEX compounds are characteristic of gasoline and related petroleum products and are common in gas stations, garages, machine shops, etc. Prominent among the potential nearby sources are two large petroleum bulk storage terminals located approximately 1 mile from the Bridger Creek developments in addition to a petroleum distribution facility located less than 1 mile from Bridger Creek, roads including an interstate highway, and the Bozeman Industrial Park. Although air emissions from the petroleum bulk facilities are regulated by the MDEQ under permit, this regulation does not entirely preclude fugitive emissions of BTEX. One of these facilities has also been the subject of two leaky underground storage incidents within the past 16 years which resulted in the release of petroleum to the environment. Finally, historical evidence suggests the presence of a rail spur in the vicinity of what is now Bridger Creek Phase 2. Railroad operations are often associated with contamination by benzene, ethylbenzene, toluene,

trichloroethene, xylenes and related materials such as fuel, heating oil, paint removers, and solvents (Shineldecker 1992).

All of the selected COPCs, and most of the VOCs that were measured at concentrations too low to be selected, have been reported in surveys of indoor air (MDEQ 2012, EPA 2011a, Hodgson & Levin 2003) at concentrations consistent with those found in the Bridger Creek homes as shown in Table 3, below:

Table 3
Typical Indoor Air Concentrations of COPCs (µg/m^3)

COPC	EPA 50%-tile	MDEQ 50%-tile	Hodgson & Levin GM/median
Benzene	<0.05-4.7	0.9	2.8
Carbon tetrachloride	<0.15-0.68	<0.85	0.58
Chloroform	<0.02-2.4	<0.93	0.94
1,2-dichloroethane	<0.08-<2.0		0.04
1,4-Dioxane		<0.83	0.11
Ethylbenzene	1-3.7	0.78	2.3
Tetrachloroethene	<0.03-2.2	0.099	1.0
Trichloroethene	<0.02-1.1	<0.048	0.44
1,2,4-Trimethylbenzene			3.9
m,p-Xylene	1.5-14	2.7	6.2

The term "50%-tile" represents the 50th percentile of the data reported by either EPA or MDEQ. Hodgson & Levin reported a geometric mean (GM) or median which are functionally equivalent to the 50%-tile in this case. The "less than" sign (<) designates concentrations that may be present at levels lower than the analytical detection limits. These data are not directly comparable numerically either to each other or to indoor air data obtained from residences in the Bridger Creek subdivisions for a variety of reasons including different sampling and analytical techniques. In addition, the number of data points in the EPA and Hodgson & Levin reports is much larger and covers a longer time period than that in the MDEQ report. Houses with tobacco smokers will typically have higher concentrations than those values reported here. These values, however, can be used as an indicator of the prevalence of low levels of the COPCs in indoor air regardless of source and demonstrate the ubiquity of these compounds in U.S. residences.

Radon was found in the indoor air of many of the residences sampled at concentrations ranging from 0.5 pCi/L to 34 pCi/L. Many of these concentrations exceed the current EPA guideline of 4 pCi/L and are likely to be associated with cancer risks orders of magnitude in excess of those associated with the COPCs[10]. A risk assessment for radon is conducted using slightly different

[10] http://www.epa.gov/radon/pubs/citguide.html

methodology than that for chemicals, thus, this assessment was performed separately and discussed in context with the chemical risk assessment in the risk characterization section.

4. Exposure Assessment

EPA defines exposure as contact between a chemical substance and the exterior of a person. A health effect cannot occur in the absence of exposure. Exposure assessment is the process of measuring or estimating the magnitude, duration, and frequency of human exposure to a chemical substance in the environment[11]. This is a highly significant step in a risk assessment because the potential for a health effect is directly related to the amount of exposure which is based on the magnitude, frequency, and duration of contact. Exposure assessment has several components that will be discussed in the remainder of this section.

4.1 Fate and Transport Analysis

Fate and transport analysis describes the environmental behavior of chemicals following their release. In general terms, chemical fate describes chemical processes such as biodegradation while physical transport describes processes whereby chemicals move from one location to another. During these processes, the concentrations and even the nature of the chemicals may change. For example, benzene may be biologically transformed into the less toxic benzoic acid. Dilution and dispersion may reduce chemical concentrations along a chemical migration pathway.

The fate and transport of VOCs in landfill gas and landfill leachate are well known. The COPCs derived for the Bozeman landfill are commonly reported in municipal waste landfills around the globe. In general, landfill gas is generated at MSW landfills by the biological decomposition (biodegradation) of organic materials that have been disposed of at the site. Landfill gas consists primarily of methane and carbon dioxide, with smaller amounts of nitrogen, oxygen, ammonia, hydrogen, sulfides, carbon monoxide and non-methane organic compounds (NMOCs) including the VOCs (ATSDR 2001, Wood & Porter 1987, Williams 2002). Typically, the NMOCs make up less than one percent (1%) of the volume of landfill gas. The production of gas and generation of heat associated with decomposition creates elevated pressure within the landfill which causes the gas to flow. Landfill gas may also move by diffusion and through areas of high soil permeability. The COPCs in this analysis are hypothesized to be transported along with the rest of the landfill gas.

At the Bozeman landfill, large quantities of landfill gas are trapped in an engineered gas collection system and transported to a flare where they are combusted at high temperature. This process removes VOCs from the landfill along with the landfill gas and combusts them into toxicologically inert materials such as carbon dioxide and water vapor.

Most of the VOCs in landfill gas come either directly from waste that is disposed of in the landfill or indirectly from the decomposition of other materials. As noted above, numerous

[11] See http://www.epa.gov/risk_assessment/exposure.htm.

consumer products contain the COPCs identified in this report. In fact, prior to the recent enactment of regulations restricting their use, there were many more opportunities for consumer products to contain these COPCs. For example, benzene has been found in general performance sealants (caulking, glues, and related materials), laundry starch preparations, lubricating oils, automotive chemicals (including gasoline), industrial specialty chemical products, and scatter rugs (including bathmats and sets)[12]. These materials may also be generated by biological degradation of materials such as paper, yard waste and food waste. Staley et al (2006) found benzene and related BTEX compounds generated from all three of these specific municipal waste streams in addition to mixed MSW. At the Bozeman landfill, gas emissions are thought to be primarily the result of direct emissions from the waste mass rather than from leachate or liquid sources of pure VOCs (TetraTech 2014).

The generation of landfill gas is characterized by various phases (Williams 2002). In the first phase, organic material in solid waste (paper, food waste, garden waste, wood, textiles) starts to break down by processes known as hydrolysis and aerobic degradation. This results primarily in the production of carbon dioxide. Following this, there are three stages of biodegradation including fermentation, acetogenesis, and methanogenesis or methane generation. These processes further break down the waste to organic acids such as acetic acid, more carbon dioxide, and methane. Methane generation starts within a few years of waste being placed in a landfill and continues to occur for the longest phase in the life of a landfill. Any VOCs that are generated by biological activity or that were present in the waste to begin with will be carried in the methane gas that is generated. Initially, methane gas generation increases up to a maximum which is relatively constant for a period of years after which its rate of generation declines and ultimately stops. At some point in the future the phase associated with the generation of methane at the Bozeman landfill will terminate and the generation and transport of VOCs will likely terminate with it. At this point, the main process will be oxidation where any remaining methane will be converted to carbon dioxide and the landfill will stabilize regarding landfill gas generation and VOC transport. Typically, the stable methane production phase lasts about 20 years with a range of 15-30 years (ATSDR 2001, Kjeldsen et al. 2002, Williams 2002). Due to the age of the Bozeman landfill, this suggests that the production of landfill gas at the landfill may have already peaked and both landfill gas generation and VOC transport are in a declining mode. The exact time when this will occur at the Bozeman landfill, however, is a site-specific phenomenon[13].

The chemical processes in various phases of landfill gas also can affect the production and biodegradation of specific VOCs. During methanogenesis, tetrachloroethene typically is biologically transformed by reductive dechlorination to trichloroethene, dichloroethene, vinyl chloride and ethene in sequence. This process may be the source of trichloroethene and vinyl chloride in some soil vapor and subslab gas samples near the landfill. As the landfill ages, methanogenesis will gradually be replaced by oxidation. When this occurs, the sequence will change and the chemical intermediates trichloroethene and dichloromethane may be directly

[12] http://scorecard.goodguide.com/chemical-profiles/consume-rproducts.tcl?edf_substance_id=71-43-2.

[13] This can be modeled with a fair degree of reliability for most landfills; such modeling is outside the scope of this risk assessment.

oxidized to carbon dioxide and chloride salts. It is likely that the absence of significant amounts of vinyl chloride in soil gas at this site is associated with oxidizing conditions that prevail outside of the actively methane-generating portions of the landfill.

The CMA (TetraTech 2014) describes several mechanisms of VOC transport, particularly as it applies to groundwater. Landfill gas migrating from a site tends to follow the path of least resistance. Generally that path is toward the soil surface and the atmosphere, however, if preferential migration pathways (fissures, utility structures, low permeability zones) exist, the landfill gas may also follow those pathways. Groundwater containing VOCs may also migrate in accordance with the principles of hydrogeology transporting VOCs with it. Under the appropriate conditions, the VOCs may volatilize from the groundwater into soil along a path to the surface of the soil and ultimately the atmosphere. Once in the atmosphere, VOCs will disperse and ultimately be degraded by oxidation and photolysis.

As the VOCs migrate through the subsurface away from the landfill, their concentrations are reduced due to diffusion, dilution, and biodegradation. Diffusion is a physicochemical process in which volatile chemicals move from zones of high concentration to those of lower concentration. In soil gas, diffusion is often upward toward the soil surface and the atmosphere. Dilution is the process where the migrating VOCs encounter areas where the soil is occupied by clean air which lowers the concentrations when the VOCs and the air are mixed. Many of the VOCs generated in a landfill are biodegradable, either in the landfill itself, in landfill cover materials (including daily cover), or in the surrounding soil. Regarding the COPCs addressed in this risk assessment, the BTEX compounds are more biodegradable under aerobic conditions and thus would be more likely to biodegrade in soils rather than in the anaerobic environment of the landfill. In general, these compounds are short-lived in the soil environment. For example, the half-life of benzene in soil ranges from 5 days to 16 days (Howard et al. 1991). Many of the chlorinated solvents are more biodegradable under anaerobic conditions and thus will be less likely to biodegrade once they have left the anaerobic environment of the landfill (EPA 2012a).

In addition to subsurface transport, VOCs may be transported by air. As discussed above, the landfill operates a gas collection and treatment system consisting of 19 gas wells that collect landfill gas and direct it to a flare where it is combusted to result in products such as carbon dioxide, water, and salts. It is possible that some VOCs may escape this process and enter the air from the surface of the landfill instead of being collected. In addition, it is possible that some VOCs will not be totally combusted in the flare and will enter the atmosphere. These pathways are likely to be negligible for a variety of reasons. First, the landfill gas extraction system has an operational efficiency of 97%. Second, EPA (1991) notes that flares similar to the one operated at the landfill are 98% efficient in capturing and destroying VOCs. Both of these factors suggest that very little in the way of VOC concentrations will actually escape into the air. The flare system is located north of the closed unlined cell. In addition, the landfill itself is elevated between the Bridger Creek residences and the flare. Both of these factors will create a buffer between the flare and the residences. Finally, the winds in the area mostly blow from the south or southeast toward the north or northwest[14] which means that any emissions from the landfill

[14] Station Graph—Bozeman/Gallatin Field accessed 7/7/14. www.wrcc.dri.edu/cgi-bin/wea_windrose2.pl.

surface or flare will be blown away from the residential area most of the time. The combination of these factors leads to the conclusion that atmospheric emissions from the landfill are not a significant source of VOCs.

The duration of landfill gas generation and the potential biodegradability of the COPCs has ramifications to the risk assessment process. The default exposure assumptions to be used in this risk assessment include a 26-year exposure duration. Given the age of the landfill and the biodegradability of some of the COPCs (especially the BTEX compounds), it is not likely that potential exposure will actually persist over the assumed exposure period.

If VOCs are transported to the soil gas present under homes, they may migrate vertically and contact the foundation or slab on which a home has been built. Under the appropriate conditions, they may be transported through a foundation or slab and enter the lower level of a home. Generally speaking, the concentrations that migrate into the home are substantially lower than the concentrations found in the soil gas. This is a process known as attenuation (EPA 2002, 2012b,c, Johnson & Ettinger 1991, CalEPA 2011). A review of all the data collected to date shows that attenuation is clearly taking place at the Bridger Creek community residences. For example, in one home the current concentration of a COPC was reduced by a factor of 11 from the subslab to the first floor bedroom; in another case, a COPC found beneath the slab was not detected at all in indoor air. This reduction is caused by several factors including resistance to gas transport through concrete and related materials and dilution of incoming gas by ventilation. The amount of this reduction is known as an attenuation factor which is commonly used in exposure calculations for vapor intrusion risk assessments. In the example above, the factor of 11 reduction results in an attenuation factor of 0.09 for this particular COPC at this residence (i.e., 1/11 = 0.09). This will be discussed in greater detail in Section 4.3.5.

In the Bridger Creek community, the residences are built on concrete slabs with or without crawl spaces or basements. Individual slabs range from 2.5 inches to 16 inches in thickness with a typical slab being 3-4 inches thick. Most residences have basements or crawl spaces, have garages, are 1-3 stories in height and use forced-air heating. Since these residences are relatively new and are well maintained, the slabs are more likely to be an effective barrier to vapor intrusion than those in older homes. A few cracks or floor drains were noted during the home sampling, but otherwise the slabs seem to be intact. Most of the indoor air measurements were taken during winter months when the amount of ventilation is assumed to be low. The indoor air concentrations are anticipated to be reduced during other seasons when there is probably more ventilation.

As noted above, there are many indoor sources of the COPCs. VOCs may be emitted into the atmosphere by processes known as evaporation, volatilization, and off-gassing. Evaporation is the process whereby VOCs directly enter the atmosphere from a liquid material. The emission of xylenes from paint thinner or benzene from spilled gasoline are examples of evaporation. Volatilization is used to describe emissions of a VOC from a water solution. Emissions of 1,4-dioxane from liquid detergent or chloroform from a washing machine where bleach is used are

examples of this phenomenon. Off-gassing (sometimes called degassing) refers to the emission of VOCs from solid materials. The emission of benzene from new rugs or tetrachloroethene from dry-cleaned clothes are examples of off-gassing. Emissions from indoor sources are likely to last as long as the sources remain and indoor air has not be sufficiently changed by ventilation. In addition, under some conditions, VOCs inside a residence could migrate under the slab resulting in measureable subslab vapor levels. One scenario where this could occur is a direct spill of a VOC-containing material like gasoline which would penetrate porous materials such as concrete. Another scenario would be initiated by barometric pressure under the slab being lower than that in a residence which could result in gas-phase diffusion of a VOC in indoor air through the porous slab and into the subslab environment.

4.2 Potential Receptors and Exposure Pathways

In risk assessment terminology, a "receptor" is a person who is potentially exposed to a toxicant. For this HHRA, the receptors are the individuals currently or potentially living or working in the Bridger Creek community. This designation does not imply that exposure is occurring, but that that there is a potential for exposure to occur under appropriate conditions. The potential exposure pathway of significance that lead to the City conducting this risk assessment here is migration of landfill gas containing VOCs or migration of groundwater containing VOCs from the landfill toward the subdivisions. This is followed by upward migration of VOCs through soil and foundations or slabs into residences. In a residence, the VOCs will be diluted by air ventilation and the resultant concentrations may be inhaled by receptors.

4.3 Exposure Assumptions

The calculation of exposure requires the use of several numerical values that represent the characteristics of a population. These values are often known as exposure assumptions since they are based on demographics and the scientific and regulatory literature rather than the characteristics of actual people. EPA exposure assessment guidance (EPA1989, 1992b,c, 1993) differentiates between reasonable maximum and central tendency exposure scenarios. A reasonable maximum exposure (RME) characterizes risk to an individual who is at the upper end of the risk distribution. It is intended to be conservative (health protective) but plausible. In the Superfund program, the RME is the highest exposure that is reasonably expected to occur at a site and, in practice, is calculated by combining upperbound (e.g., 90^{th} to 95^{th} percentile) values for some but not all exposure parameters. In contrast, the central tendency exposure (CTE) is intended to represent more of an average or typical case. It is calculated using average or 50^{th} percentile values. Each of the exposure assumptions used in this risk assessment will be discussed in the following sections. The values are also summarized in table 4 which is consistent with the information requirements in EPA's RAGS Part D.

Table 4
Summary of Exposure Factors

Exposure Factor	RME Value	CTE Value
Exposure duration	26 years	12 years
Exposure Frequency	350 days/year	350 days/year
Lifetime	78 years	78 years
Exposure time	24 hours/day	16 hours/day
Attenuation factor	0.1	0.05

4.3.1 Exposure duration is the number of years that a person is expected to remain at a single location within the Bridger Creek community. The RME value of 26 years is a standard EPA default exposure factor (EPA 2014). The CTE value of 12 years is the average value taken from EPA's Exposure Factors Handbook (EPA 2011b).

4.3.2 Exposure frequency is the number of days per year that a person is expected to be at a single location in the Bridger Creek community. A value of 350 days per year is used for both the RME and CTE cases as per EPA guidance.

4.3.3 Lifetime. The MDEQ has recommended the use of a lifetime of 78 years (http://deq.mt.gov/StateSuperfund/frequentlyaskedquestions.mcpx#5). This is in contrast to EPA's use of a lifetime of 70 years (EPA 2014). Based on MDEQ recommendations, the value of 78 years was used for both the RME and CTE scenarios.

4.3.4 Exposure time is the number of hours per day that a person may spend at a given location within the Bridger Creek community. The RME value of 24 hours per day is a standard EPA default exposure factor. The CTE value of 16 hours per day is the average value from EPA's Exposure Factors Handbook (EPA 2011b).

4.3.5 Attenuation factor. The subslab to indoor air attenuation factor (AF) describes the reduction of VOC concentrations from soil gas into indoor air. EPA (2002, 2012b,c) often recommends the use of a generic default attenuation factor of 0.1, meaning that the soil gas concentration is a factor of 10 lower inside than out. This value which represents the 95th percentile of available measurements, will be used as the RME attenuation factor in this risk assessment. CalEPA (2011) performed a statistical analysis of 311 measurements of attenuation factors compiled by EPA. They determined that an attenuation factor of 0.05, representing the 90th percentile of the data was an appropriate value for use in site-specific risk assessments. This value will be used as the CTE attenuation factor. This range of AF values is consistent with observations from Bridger Creek community residence sampling, although there are numerous confounders in the Bridger Creek database. It should be noted that various investigators have criticized these attenuation factors as being unrealistically high. Although suggesting 0.05 as a default, CalEPA also notes that values ranging from 0.0002 to 0.002 may be appropriate. The Oregon DEQ has included an AF of 0.005, representing the median which is a central tendency

measurement in their vapor intrusion guidance. For petroleum hydrocarbons such as the BTEX compounds, Abreu et al (2009) found that values similar to those used in this risk assessment were too high because they did not adequately account for biodegradation. Song et al. (2011) concluded that values similar to those used in this risk assessment were too high because of bias from indoor sources and Folkes et al. (2010) suggested that they were too high because many of the measurements were based on short-term rather than long term data. A recent analysis conducted by Brewer et al. (2014) divided the United States into different climatic regions and calculated the AF based on vapor entry rates and air exchanges rates in buildings. For the region that includes Montana, they determined that the AF was 0.0032. Although the values used in this risk assessment may be too high, they were used in this risk assessment as conservative values in the interests of health protectiveness.

4.4 Exposure Units and Exposure Point Concentrations

Two exposure areas were initially delineated for this HHRA – consistent with development and past practice at the site, Bridger Creek Phase 2 and Bridger Creek Phase 3. The subslab average and range of COPC concentrations in the two units are similar as shown in Table 5, below[15].

Table 5
Average Subslab COPC Concentrations in Bridger Creek Subdivisions
(All concentrations in µg/m^3)

COPC	Bridger Phase 2 Subslab Average	Bridger Phase 2 Subslab Range	Bridger Phase 3 Subslab Average	Bridger Phase 3 Subslab Range
Carbon tetrachloride	0.416	0.1-0.65	0.515	0.31-0.79
1,4-Dioxane	0.683	0.05-1.4	1.014	0.22-3.9
1,2,4-Trimethylbenzene	7.045	0.83-25	5.349	0.3-24
Benzene	5.533	0.1-27	3.149	0.31-17
1,2-Dichloroethane	0.112	0.06-0.2	1.635	0.06-14
Trichloroethene	0.14	0.04-0.24	0.586	0.02-5.6
Tetrachloroethene	1.03	0.22-2.6	7.712	0.06-210
Ethylbenzene	7.041	0.18-22	3.016	0.21-36
m,p-Xylene	26.21	0.54-86	10.48	0.72-86
Chloroform	1.947	0.069-5.7	0.477	0.064-1.6

A preliminary statistical test was conducted to determine if there was a quantitative difference between the Phase 2 and Phase 3 subslab data. These statistical tests should be interpreted with caution for several reasons including the fact that Phase 2 had, in most cases, only 16 measurements while Phase 3 had 54 measurements and that the variability in the data for the two Phases was dissimilar. Both of these factors can cause statistical artifacts to occur, even with the

[15] Refers to average and range of detected concentrations only. Calculated using EPA's ProUCL 5 (EPA 2013 a,b).

use of non-parametric procedures. Measurements for benzene (likely to be the risk driver) were compared for the two areas using the t-test and Wilcoxon-Mann-Whitney test in ProUCL (EPA 2013a,b). The results showed that there was no statistically significant difference between the data for the two phases at a 95% level of confidence. Due to this equivalence, and the fact that there are many more measurements in Bridger Creek Phase 3 compared to Phase 2, the data were combined into a single dataset representing the entire Bridger Creek community for purposes of this risk assessment. Although not necessarily apparent using these simple statistical procedures, there are some suggestions of difference between the two datasets. Bridger Creek Phase 3 appears to be more highly impacted by chlorinated solvents, especially tetrachloroethene, trichloroethene, and 1,2-dichloroethane. These materials have similar uses and often occur together in the environment. On the other hand, Bridger Creek Phase 2 appears to be more highly impacted by the BTEX compounds. This is significant as these compounds are considerably more biodegradable compared to the chlorinated solvents and would be expected to decrease in concentration as they traveled further from the landfill. The concentrations of the BTEX compounds at Bridger Creek Phase 2 is indicative of a separate source. It should be noted that more sophisticated chemometric techniques may identify further differences between the two subdivisions and/or within the subdivisions, or even alternative sources, however, application of these techniques is beyond the scope of this HHRA.

The exposure point concentration (EPC) represents the concentration of a VOC that someone in the Bridger Creek community, future or present, could be exposed to if the VOC migrates into indoor air. EPA (1992b) risk assessment practice is to use the arithmetic average concentration for a COPC based on a set of site sampling results. EPA notes that, because of the uncertainty associated with estimating the true concentration, the 95% upper confidence limit (UCL) of the average should be used. This is intended to provide reasonable confidence that the true site average will not be underestimated. This value is used for both the RME and CTE scenarios. EPA (2013a,b) has developed software, known as ProUCL, for performing these calculations and a comprehensive set of guidance documents (EPA 2013b) indicating how the software should be used. In general, the calculation of the appropriate UCL value depends on the probability distribution of the underlying dataset, variability in the data, number of samples, and number of detected compared to non-detected values. All of these factors are accounted for in EPA's ProUCL software and guidance.

All available subslab analytical data for the exposure units were entered into ProUCL 5 which was used to calculate summary statistics for the two areas combined. Two samples were considered to be anomalous and were not included. Sample AI-7, a subslab duplicate was removed due to lack of reported values or detection limits for several of the COPCs. Sample SAI-2 had elevated detection limits that were reported by the laboratory to have been due to interference by high levels of non-target compounds[16]. This sample was examined using EPA guidance for handling statistical outliers (EPA 2006) and eliminated from inclusion. This left 91 samples in the database. In contrast to the COPC selection process in which measurements

[16] Field observations reported by TetraTech suggest that these chemical interferences were associated with Styrofoam structural insulated panels used in construction of the house and/or a connected shed where chemicals and paint are stored.

flagged as ND or <RL were excluded, ProUCL was used with NDs. After consulting with the Data Validation Reports, it was decided that the reporting limit (RL) would be input for those measurements reported as ND, <DL, or <RL. This was done in the two-column format as per EPA guidance. ProUCL-recommended distribution type and 95% UCL was selected. The outputs from ProUCL are summarized in Table 6 which is consistent with EPA's reporting requirements for RAGS Part D.

The 95% UCL concentrations in the subslab data were then used to estimate indoor air exposure point concentrations using the attenuation factors for the RME (0.1) and CTE (0.05) scenarios discussed in Section 4.3.5. These are shown in Table 7.

Table 6
Subslab COPC Concentration Statistics
(All concentrations in µg/m^3)

COPC	Arithmetic Mean	95% UCL[17]	Maximum	Statistic to Calculate UCL[18]
Benzene	3.53	5.64(L)	27	95%KM(Chebyshev)
Carbon tetrachloride	0.502	0.526(G)	0.790	95%KM(t)
Chloroform	0.79	1.0(L)	5.7	95%KM(Chebyshev)
1,2-dichloroethane	1.09	1.42(O)	14	95%KM(Chebyshev)
1,4-Dioxane	1.27	0.674(G)	7.4	95%KM(t)
Ethylbenzene	3.495	5.8(L)	36	95%KM(Chebyshev)
Tetrachloroethene	11.33	38.0(O)	340	97.5%(Chebyshev)
Trichloroethene	0.797	0.532(L)	5.6	95%KM(BCA)
1,2,4-Trimethylbenzene	5.34	7.66(AG)	25	95%KM(Chebyshev)
m,p-Xylene	12.67	19.91(L)	86	95%KM(Chebyshev)

[17] Letter codes refer to type of underlying data distribution. L=lognormal, G = gamma, AG = approximate gamma, O = other (non-discernible).
[18] Description of the statistical method used to calculate the 95% UCL. Reader is referred to EPA (2013a,b) for more detail.

Table 7
Exposure Point Concentrations
(All concentrations in µg/m^3)

COPC	RME Concentration	CTE Concentration
Benzene	0.564	0.282
Carbon tetrachloride	0.053	0.026
Chloroform	0.100	0.050
1,2-dichloroethane	0.142	0.071
1,4-Dioxane	0.067	0.034
Ethylbenzene	0.580	0.29
Tetrachloroethene	3.80	1.9
Trichloroethene	0.053	0.0265
1,2,4-Trimethylbenzene	0.766	0.383
m,p-Xylene	2.00	1.00

5. Toxicity Assessment

Regulatory and public health agencies have various ways of quantifying the toxicity of chemical substances (toxicants) for use in risk assessments. These methods are based on a fundamental principal of toxicology known as the dose-response relationship. This relationship states that the effects of exposure to a toxic substance will be proportional to the dose or intake of the substance. If the exposure occurs over a short period of time, it is known as an acute exposure and the effects are acute effects which may differ from long-term effects. EPA (2011c) considers acute exposure to refer to continuous exposure over a period of 24 hours or less. Long term exposures may be associated with chronic effects. In toxicology, a chronic exposure usually is considered to occur over several years or more. EPA (2011c) considers chronic exposures to be repeated exposures over a period of 90 days or greater. There is a difference in the nature of the dose-response relationship for chemical substances that may potentially cause cancer (carcinogens) or those that can cause other toxic effects (systemic toxicants) after chronic exposure. These differences will be discussed in subsequent sections. In risk assessment practice, information regarding the toxicity of a chemical substance is expressed as a numerical toxicity factor. The toxicity factors used in this risk assessment are based on EPA guidance (EPA 2003a) and include data from EPA, especially EPA's Integrated Risk Information System (IRIS), the California Environmental Protection Agency (CalEPA), and the federal Agency for Toxic Substances Disease Registry (ATSDR). As will be seen in the sections that follow, the likelihood of contracting cancer under the conditions of exposure is known as a cancer risk, whereas the likelihood of a systemic non-cancer effect is known as a hazard.

5.1 Chronic Chemical Carcinogenicity

Some of the COPCs discussed in this report have been found to be associated with cancer either in humans or laboratory animals following chronic exposure. EPA's risk assessment methods in general are based on a scientific hypothesis that exposure to any concentration of a potential carcinogen, regardless of how small, will result in some cancer risk (probability of contracting cancer). These risks are often characterized as "upperbound" due to the statistical techniques that are used in their derivation. This means that the actual cancer risk could be substantially lower than the calculated risk and could even approach zero.

The potential for cancer risk from inhalation exposure is calculated by multiplying a long term air concentration by a toxicity factor called the inhalation unit risk (IUR). The unit risk is based on a probability of 1 in 1 million (1×10^{-6} or 1E-06) that an individual would contract cancer over a lifetime assuming a long duration of exposure. EPA also evaluates potential carcinogens based on the weight of the scientific evidence that they can cause cancer in humans (EPA 2005). The evidence for a chemical that has only been found to cause cancer in laboratory animals under a limited set of circumstances is judged to be weaker than that for a chemical that has been found to be associated with cancer in humans, especially under relevant conditions of exposure. The toxicity data for the potentially carcinogenic COPCs are shown in Table 8 based on requirements in EPA's RAGS Part D.

Table 8
Toxicity Data for Potentially Carcinogenic COPCs

COPC	Unit Risk ($1/(\mu g/m^3)$)	Weight of Evidence	Information Source[19]
Benzene	7.8E-06	Known	IRIS
Carbon tetrachloride	6.0E-06	Likely	IRIS
Chloroform	2.3E-05	Probable	IRIS
1,2-dichloroethane	2.6E-05	Probable	IRIS
1,4-Dioxane	5.0E-06	Likely	IRIS
Ethylbenzene	2.5E-06	Not classifiable	CalEPA
Tetrachloroethene	2.6E-07	Likely	IRIS
Trichloroethene	4.1E-06	Carcinogenic	IRIS

For these COPCs, the weight of evidence for human carcinogenicity is strongest for benzene and lowest for ethylbenzene. The cancer potency as reflected in the IUR values is highest for 1,2-dichloroethane and for tetrachloroethene.

[19] IRIS = EPA's Integrated Risk Information System; CalEPA = California Environmental Protection Agency.

5.2 Chronic Chemical Systemic Toxicity

In contrast to potential carcinogens, EPA's risk assessment methods for systemic toxicity are based on the hypothesis that there is a concentration threshold, below which toxicity will not occur. EPA has developed toxicity values by applying safety factors to toxicological thresholds. These toxicity values, known as reference concentrations (RfCs), represent concentrations to which the human population, including sensitive subgroups, may be exposed without adverse health effects during a lifetime or part of a lifetime. EPA's risk assessment methods also assume that sub-threshold exposures to several chemicals at the same time could result in health effects to a particular target organ. Thus, if an individual had been simultaneously exposed to three substances that were toxic to the liver at a total concentration which exceeded a threshold, the exposure would be considered to be toxic even if the chemicals individually were below the threshold. Because of this, it is necessary to identify the target organ that has been associated with toxicity for a particular substance. Finally, the uncertainty in the RfC is expressed by the size of the uncertainty and modifying factors (safety factors) use to calculate the RfC from the toxicological data. These factors ensure that the toxicity values are health protective. A low value for these combined factors implies greater certainty in the data. Non-cancer toxicity data for the COPCs based on information requirements in EPA's RAGS Part D are shown in Table 9.

Table 9
Toxicity Data for Chronic Systemic Toxicants

COPC	Inhalation RfC (mg/m^3)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Source[20]
Benzene	3E-02	Blood	300	EPA IRIS
Carbon tetrachloride	1E-01	Liver	100	EPA IRIS
Chloroform	1E-01	Liver	100	EPA IRIS
1,2-dichloroethane	7E-03	Blood	3000	EPA PPRTV
1,4-Dioxane	3E-02	Upper respiratory tract	300	EPA IRIS
Ethylbenzene	1E+00	Developmental	300	EPA IRIS
Tetrachloroethene	4E-02	Nervous system	1000	EPA IRIS
Trichloroethene	2E-03	Thymus/fetal heart	100	EPA IRIS
1,2,4-Trimethylbenzene	7E-03	Blood	3000	EPA PPRTV
m,p-Xylene	1E-01	Nervous system	300	EPA IRIS

[20] PPRTV = EPA's Provisional Peer Reviewed Toxicity Values

For these COPCs, trichloroethene would be considered to be the most chronically toxic and ethylbenzene the least. 1, 2-dichloroethane and 1,2,4-trimethylbenzene are the least scientifically certain of the values while those for chloroform and trichloroethene are most certain.

5.3. Acute Chemical Toxicity

Acute toxicity is also considered by EPA to be a threshold dose-response. In EPA risk assessment practice, acute effects are assessed using acute exposure guideline levels (AEGLs). There are three levels of AEGLs, known as AEGL-1, AEGL-2, and AEGL-3. AEGL-1 levels are the most health protective and are defined as an airborne concentration above which the general population including susceptible individuals could experience notable discomfort, irritation or sensory effects. The effects are not disabling and are transient and reversible on cessation of exposure. AEGL-2 values are less protective and refer to the concentration of a substance above which the general population including susceptible individuals could experience serious health effects. In this risk assessment, AEGL-1 values will be used when available. When these values are not available, AEGL-2 values will be used. AEGL-3 values, which are the least health-protective – will not be used in this HHRA. As with chronic systemic toxicity, effects on target organs may be additive. The AEGL values for the COPCs are shown in Table 10. All of these values are taken from EPA's AEGL website[21].

Table 10
Acute Toxicity Data

COPC	AEGL Value (mg/m^3)	AEGL Type	Target Organ
Benzene	29	1	CNS
Carbon tetrachloride	36	2	CNS
Chloroform	141	2	Reproductive system
1,4-Dioxane	60	1	Eye
Ethylbenzene	144	1	CNS
Tetrachloroethene	240	1	Eye
Trichloroethene	410	1	CNS
1,2,4-Trimethylbenzene	220	1	CNS
m,p-Xylene	560	1	Eye

In contrast to chronic toxicity evaluations, acute hazards are evaluated by comparison to maximum concentration values rather than 95% UCL values since a peak exposure over even a short time period could result in acute effects.

[21] www.epa.gov/oppt/aegl/pubs

5.4 Radon

Radon is an odorless, colorless gas that is formed naturally in geologic materials and which is considered to be radioactive. On a national basis, exposure to radon is thought to be the second highest cause of lung cancer (after smoking) and may result in up to 21,000 cases annually. The MDEQ considers Gallatin County to be in radon zone 1 in which the predicted average indoor radon concentration is greater than EPA's action level of 4 pCi/L. The average indoor radon level in Gallatin County has been calculated by the MDEQ to be 7 pCi/L compared to the national average of 1.3 pCi/L. EPA (2003b) has developed specific methods for the risk assessment of radon exposure that will be used in this report. EPA considers tobacco smoke and radon exposure to be synergistic – in other words the combined effects are greater than would be expected if the effects were additive. Because of this, EPA differentiates between non-smokers and smokers in radon risk assessment. For the general population, the cancer risk is given by 0.002C and for non-smokers, it is given by 0.00062C where C is the radon concentration in pCi/L. In contrast to the chemical risks calculated in this assessment, radon risk assessment techniques have been derived from epidemiological data and are considered to have greater certainty than risks associated with many chemical exposures.

6. Risk Characterization

Risk characterization is the process in which toxicity data is combined with exposure information to yield estimates of risk. This section also interprets the risk values by putting them into context.

6.1 Overall Bridger Creek Community Cancer Risk

EPA risk assessment practice is to calculate the upperbound excess lifetime cancer risk associated with each potentially carcinogenic COPC using a series of standard formulas (EPA 1989, EPA 2009). The first step of the process involves calculating a chronic daily intake (CDI) using the exposure point concentrations and exposure factors discussed above:

$$CDI_c = \frac{EPC \times EF \times ED \times ET}{LT}$$

Where:

CDI_c = chronic daily intake for carcinogenic effects (µg/m^3)
EPC = exposure point concentration (µg/m^3)
EF = exposure frequency (days/year)
ED = exposure duration (years)
ET = exposure time (fraction of 24-hour day)
LT = lifetime (days)

The CDI is then used to calculate the cancer risk for each COPC with potentially carcinogenic effects:

$$Cancer\ Risk = CDI_c \times IUR$$

Where:

CDI_c = chronic daily intake ($\mu g/m^3$)
IUR = inhalation unit cancer risk ($m^3/\mu g$)

In addition to the exposure variables, different conversion factors and constants are used to make sure the dimensions of the variables are consistent with each other.

The total cancer risk for the conditions of exposure is calculated as the sum of the cancer risks for each of the individual COPCs. This calculation is performed both for the RME and CTE cases.

Consistent with EPA practice, calculated cancer risks are rounded off to one significant figure. Cancer risks are expressed as unitless probabilities of an individual developing cancer. For example, a probability of 1×10^{-6} or 1E-06 represents a chance of one in one million that an individual would develop cancer over a lifetime under the conditions of exposure which, in this case, are hypothetical. In essence this unitless probability represents the upperbound increased lifetime cancer risk associated with the exposure above the existing background for developing cancer. Note that this method does not distinguish between types of cancer, but considers the overall probability of developing cancer. In actuality, the various COPCs have been associated with different types of cancer or cancer at different sites and target tissues.

In the United States, roughly one of every two men and one of every three women will contract cancer over a lifetime. These statistics would translate to unitless probabilities of 0.50 for men and 0.33 for women over a lifetime. Cancer incidence for Montana is consistent with overall US rates. Gallatin County has cancer incidences less than a typical Montana County. Based on data from the US Centers for Disease Control, the annual cancer incidence for Gallatin County is 0.004238 (NCI/CDC 2014). For a 78-year lifetime (consistent with the lifetime used in this HHRA), the lifetime cancer probability (rate) would be 0.33 for men and women of all races across all age groups. Regulatory agencies also use risk-based criteria to evaluate the results of a risk assessment. EPA (1991a) considers exposure levels to be acceptable if the resultant lifetime cancer risks are in the range from 1E-06 to 1E-04 (one in one million to one in ten thousand). MDEQ (http://deq.mt.gov/StateSuperfund/frequentlyaskedquestions.mcpx#5) uses the midpoint of this range (1E-05 or one in one hundred thousand) as its cancer risk criterion. The results of the risk assessment for both the RME and the CTE cases are shown in Table 11.

Table 11
Lifetime Upperbound Excess Cancer Risks

COPC	Reasonable Maximum Exposure (RME) Risk	Central Tendency Exposure (CTE) Risk
Benzene	1.4E-06	2.2E-07
Carbon tetrachloride	1.0E-07	1.5E-08
Chloroform	7.4E-07	1.1E-07
1,2-dichloroethane	1.2E-06	1.8E-07
1,4-Dioxane	1.1E-07	1.7E-08
Ethylbenzene	8.0E-08	1.2E-08
Tetrachloroethene	3.2E-07	4.9E-08
Trichloroethene	1.9E-07	2.9E-08
1,2,4-Trimethylbenzene	Not carcinogenic	Not carcinogenic
m,p-Xylene	Not carcinogenic	Not carcinogenic
Total	4E-06	6E-07

The overall cancer risks for the hypothetical conditions of exposure are below EPA's and MDEQ's risk criteria. This will be discussed in further detail in Section 6.4, below.

6.2 Overall Bridger Creek Community Chronic Non-cancer Hazard

Non-cancer hazard represents the potential for developing health effects other than cancer under the conditions of exposure to COPCs evaluated in this risk assessment. EPA risk assessment practice dictates that acceptable exposure levels for chemicals with non-cancer effects should represent concentrations to which human populations, including sensitive subgroups, may be exposed incorporating an adequate margin of safety. The potential for non-cancer hazard is calculated by comparing the exposure point concentrations to the chronic reference concentrations. This comparison results in a value known as the hazard quotient and is calculated using the following series of equations:

$$CDI_{nc} = \frac{EPC \times EF \times ED \times ET}{AT}$$

Where:

CDI_{nc} = non-cancer chronic daily intake ($\mu g/m^3$)
EPC = exposure point concentration ($\mu g/m^3$)
EF = exposure frequency (days/year)
ED = exposure duration (years)
ET = exposure time (fraction of 24-hour day)
AT = averaging time (days) (derived from ED)

The CDI is then used to calculate a hazard quotient for each COPC with non-carcinogenic effects:

$$Chronic\ Hazard\ Quotient\ (HQ) = CDI_{nc}/RfC$$

Where:

CDI_{nc} = non-cancer chronic daily intake ($\mu g/m^3$)
RfC = reference concentration ($\mu g/m^3$)

A hazard quotient greater than 1 indicates that there is a potential for a non-cancer effect to occur whereas a hazard quotient of one or less suggests that the concentration is safe (EPA 1991a). In the case of potential exposure to a mixture of chemicals, EPA considers that the effects may be additive. This is evaluated by calculating an overall hazard index (HI) which is the sum of the individual COPC hazard quotients:

$$HI = \Sigma\ HQ$$

EPA risk assessment practice is to round off hazard quotient values to one significant figure. As with the hazard quotients, a hazard index for the mixture that is greater than 1 indicates the potential for a non-cancer health effect. If this occurs, EPA risk assessment practice requires separating COPCs into subgroups representing effects on various target organs. For example, chloroform and carbon tetrachloride could be separated into a subgroup representing liver effects (hepatotoxicity). The hazard index would then be re-calculated for each subgroup as required. Hazard quotients and hazard indices are shown for the COPCs in this risk assessment in Table 12.

Table 12
Chronic Systemic Non-cancer Hazards

COPC	Chronic Reasonable Maximum Exposure (RME) Hazard Quotient	Chronic Central Tendency Exposure (CTE) Hazard Quotient
Benzene	1.8E-02	2.4E-03
Carbon tetrachloride	5.1E-04	7.0E-05
Chloroform	9.8E-04	1.3E-04
1,2-dichloroethane	2.0E-02	2.6E-03
1,4-Dioxane	2.1E-03	2.8E-04
Ethylbenzene	9.6E-05	7.4E-05
Tetrachloroethene	9.1E-02	1.2E-02
Trichloroethene	2.5E-02	3.5E-03
1,2,4-Trimethylbenzene	1.0E-01	1.4E-02
m,p-Xylene	1.9E-02	2.6E-04
Total Chronic Hazard Index	0.3	0.04

In this case, neither individual hazard quotients nor the overall hazard index exceeds EPA's criterion of 1, thus it can be concluded that chronic non-cancer health effects are not likely to occur under the conditions of exposure for either the RME or CTE scenarios.

6.3 Overall Bridger Creek Community Acute Non-cancer Hazard

Acute hazards are calculated in a manner similar to chronic hazards except that a chronic daily intake is not required and that AEGL values are used rather than RfC values:

$$Acute\ Hazard\ Quotient\ (HQ) = Maximum\ EPC/AEGL$$

$$Acute\ HI = \Sigma HI$$

Due to the nature of acute risk, only one scenario representing exposure to the maximum concentration is included. This scenario also assumes no attenuation since it is hypothetically possible for an individual to have a very short-term exposure to subslab concentrations under certain conditions, for example, when performing construction work. The results are shown in Table 13.

Table 13

Acute Hazards

COPC	Acute RME Hazard Quotient
Benzene	9.3E-04
Carbon tetrachloride	2.2E-05
Chloroform	4.0E-05
1,4-Dioxane	1.2E-04
Ethylbenzene	2.5E-04
Tetrachloroethene	1.4E-03
Trichloroethene	1.4E-05
1,2,4-Trimethylbenzene	1.1E-04
m,p-Xylene	1.5E-04
Total Acute Hazard Index	3E-03

In this case, neither individual hazard quotients nor the overall hazard index exceeds EPA's criterion of 1, thus it can be concluded that acute non-cancer health effects are not likely to occur under the conditions of exposure.

6.4 Individual Residence Cancer Risk and Non-cancer Hazard

In addition to the aggregate risks for the Bridger Creek Community, the RME risks potentially associated with individual residences were also calculated. This was accomplished by using the subslab data from each residence. If multiple values were available, the average value of subslab concentrations was used. For cases where all the values were detected, the arithmetic mean was used to calculate the average while for cases where there were mixed detects and non-detects, the Kaplan-Meier technique (Atweiler & Taylor 2008, Helsel 2010) was used. If a chemical was never detected, however, zero was imputed for the concentration. The RME upperbound cancer risks were then calculated by taking the ratio of the concentrations of the COPCs for the individual residences to the EPC for the Bridger Creek community. This assessment is highly conservative in that it incorporates high end values for exposure frequency, exposure duration, exposure time, and attenuation factor in addition to protective and conservative cancer toxicity factors. The results, which reflect the summed cancer risks across all COPCs for each location, are shown in Table 14.

Table 14
RME Cancer Risks for Individual Residences

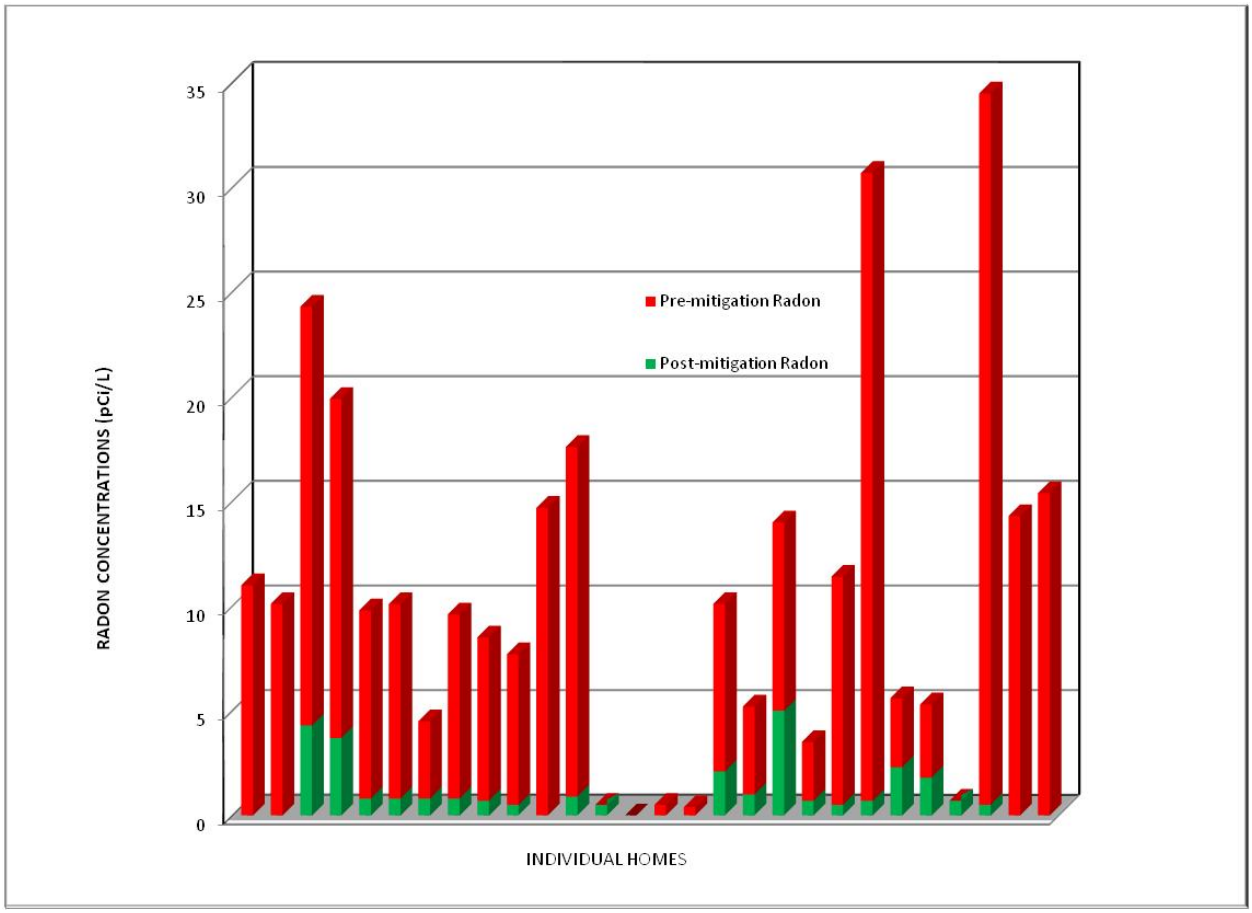
Location Identifier	RME Cancer Risk	RME Hazard Index
[redacted]	6E-06	0.6
[redacted]	1E-06	0.2
[redacted]	2E-06	0.2
[redacted]	6E-07	0.04
[redacted]	4E-06	0.2
[redacted]	8E-07	0.09
[redacted]	1E-06	0.09
[redacted]	3E-06	0.09
[redacted]	4E-07	0.08
[redacted]	7E-07	0.1
[redacted]	1E-06	0.2
[redacted]	2E-06	0.1
[redacted]	7E-07	0.1
[redacted]	1E-06	0.2
[redacted]	4E-06	0.3
[redacted]	5E-06	0.8
[redacted]	1E-06	0.1
[redacted]	3E-06	0.1
[redacted]	1E-06	0.1
[redacted]	1E-05	0.3
[redacted]	8E-07	0.1
[redacted]	2E-06	0.2
[redacted]	1E-06	0.3
[redacted]	2E-06	0.3
[redacted]	2E-06	0.2
[redacted]	2E-06	0.03
[redacted]	2E-06	0.1
[redacted]	1E-06	0.04
[redacted]	5E-07	0.1
[redacted]	2E-06	0.1
[redacted]	7E-06	0.2
[redacted]	2E-06	0.2
[redacted]	1E-06	0.1

The RME cancer risks and hazard indices for the individual residences are consistent with those for the Bridger Creek Community overall. RME cancer risks ranged from 4E-07 to 1E-05; RME hazard indices range from 0.03 to 0.8. No individual RME cancer risk or hazard index exceeds either EPA or MDEQ guidelines for acceptable risk levels.

6.5 Radon Risks

As discussed in Section 5.4, in general, people living in the Bridger Creek community are exposed to radon that originates in geologic materials located under the homes. Although radon is not a VOC, radon tests were conducted as a measure of performance of the mitigation systems installed by the City (See Section 6.7). Most residences were found to have radon levels exceeding EPA's criterion of 4 pCi/L. Figure 3 shows the radon results before (red bars) and after (green bars) installation of the mitigation systems.

Figure 3
Radon Reduction after Mitigation



Overall, the mitigation systems reduced the 95% UCL radon concentrations from15.92 pCi/L before mitigation to 2.46 pCi/L after mitigation which is an 85% reduction. Using EPA's radon risk assessment methodology, the radon risks before mitigation ranged from 4E-02 (4 in 100) for smokers to 1E-02 (1 in one 100) for non-smokers. Following mitigation, these risks decreased to 6E-03 (smokers) and 2E-03 (non-smokers). In general, the results showed that EPA's radon criterion was not exceeded after mitigation, although this criterion is based on other factors in addition to risk assessment.

6.6 Risk Context

Many everyday activities undertaken by people involve risk in some form. Driving a car, smoking a cigarette, or crossing a street can all be considered risky activities because they can result in a negative outcome. Individuals, consciously or unconsciously, assess risks and make decisions about the acceptability of a risk before undertaking an activity. Regulatory agencies also make decisions about risks, for example, when setting regulatory standards for air quality or drinking water.

Covello et al. (1988) discuss several different methods for comparing risks that can often help put the results of a risk assessment into perspective. One of the most common and preferred risk comparison methods involves comparing risks to a regulatory standard or guideline. For example, regulatory and public health agencies have identified benchmark risk levels and regulatory standards to evaluate a wide variety of activities that may pose risks to consumers, communities, or workers. In this risk assessment, all of the cancer risks and chronic and acute hazards were lower than regulatory benchmark risk levels used by EPA or MDEQ.

Another risk comparison method noted by Covello et al. (1988), is to compare risk assessment results to other risks prevailing in society. Research has shown that a person's perception of risk is based on both the actual risk (e.g., the risk that can be calculated based on measured data or through the conduct of a risk assessment) and many personal factors. Some of the personal factors that affect risk perceptions include (Covello and Sandman 2001):

- whether the risk is voluntary (e.g., smoking) or not,
- whether the risk can be controlled by a person (e.g., driving) or not,
- whether the risk is familiar (e.g., use of household cleaners) or not,
- whether the risk has catastrophic potential to cause many deaths or injuries (e.g., airplane crash) or not,
- whether the risk evokes a sense of great fear or anxiety (e.g., Ebola or HIV virus) or not,
- whether the risk is uncertain or can be based on actual measured data, and
- whether the risk results from an activity located near to a person or located farther away at a distant location.

Keeping these personal factors in mind, one can compare the results from this risk assessment and also the EPA and MDEQ benchmark cancer risk levels to other risks prevailing in society. Table 15 presents a variety of lifetime risks generally prevailing in the U.S. The risks of developing cancer associated with vapor intrusion calculated in this risk assessment are much lower than other risks prevailing in society.

Table 15
Risks Associated with Various Events

Activity or Situation	Lifetime Risk
Foodborne illness (incidence)	greater than 1 in 1
Cancer (incidence)	1 in 3
Cigarette smoking (death)	1 in 5
Heart disease (death)	1 in 8
Cancer (death)	1 in 8
Influenza and pneumonia (death)	1 in 90
Unmitigated Bridger Creek radon lung cancer risk	1 in 100 (non-smokers) 4 in 100 (smokers)
Motor vehicle accident (death)	1 in 100
Falls (death)	1 in 190
Criminal homicide	1 in 240
HIV disease (death)	1 in 360
Accidental electrocution	1 in 4,000
Accidental discharge of firearms	1 in 7,100
Drowning (in bathtub)	1 in 11,000
Tornado	1 in 39,000
Lightning	1 in 39,000
Commercial aircraft accident	1 in 40,000
Bee/wasp sting	1 in 80,000
EPA acceptable risk range	1 in 1,000,000 to 1 in 10,000
MDEQ risk criterion	1 in 100,000
Bridger Creek Community RME Upperbound Cancer Risk	4 in 1,000,000

The reader should keep in mind that the estimated risks associated with potential exposure to VOC vapor intrusion at Bridger Creek are hypothetical, upperbound risks while many of the risks in Table 15 are actual risks based on the observed incidence of various adverse effects. For example, the cancer incidence rate in the United States of 1 in 3 or 0.33 is based on many years of data collected by the National Cancer Institute and Centers for Disease Control and Prevention whereas the Bridger Creek Community RME cancer risk is based on hypothetical, upperbound calculations designed to be protective of public health.

6.7 Effect of Mitigation Measures

The City of Bozeman installed mitigation measures in 27 residences in Bridger Creek Phase 3 starting in 2013. These mitigation measures were in the form of subslab depressurization systems. In essence, these systems create low pressure under the slab which removes any soil gas that might be present. The soil gas is then vented at a location where it will not be associated with human exposure indoors. These systems are essentially the same systems used for many years for radon mitigation, thus have a known track record of effectiveness. Radon measurements made before and after the installation of subslab depressurization systems are, in fact, a good indicator of their effectiveness. This is due to the fact that, unlike the COPCs in this risk assessment, soil gas is the only known source of radon[22]. The mitigation systems reduced the 95% UCL radon concentrations from 15.92 pCi/L before mitigation to 2.46 pCi/L after mitigation which is an 85% reduction.

Another way of judging the effectiveness of a subslab depressurization system is by measuring the pressures under the slabs. Since the systems are designed to create a vacuum under the slabs the difference in pressure under the slab compared to the atmospheric pressure indicates how effectively the system is performing. Numerous pressure measurements have been made since the systems were that demonstrate they are systems are functioning as designed.

There have also been decreases in VOCs both in subslab soil gas and indoor air. Most VOCs have seen large decreases in concentrations under the slabs while there have been a few instances of increases in a limited number of VOCs. These apparent increases may be due to natural variability in VOC concentrations or seasonal effects on VOC migration. Similar changes have been measured in indoor air, however, these are more difficult to interpret since it is likely there are multiple sources of these VOCs.

When viewed overall, the changes in radon concentrations, vacuum measurements and changes in both subslab and indoor air VOCs all lead to the conclusion that the mitigation systems are functioning as intended.

6.8 Uncertainty Analysis

The results of any risk assessment inherently reflect some uncertainty because of the many complexities involved in the analysis. In accordance with standard risk assessment practice, this section presents discussions of key uncertainties affecting the risk assessment. In general, uncertainties in risk assessments, including this one, are addressed by using conservative (i.e., health protective) assumptions which collectively produce risk results much more likely to be overestimated than underestimated.

This risk assessment involved the integration of many steps, each of which is characterized by some uncertainty. These steps included the following:

[22] Other potential sources of radon exposure such as indoor use of stone (e.g. granite countertops in kitchens) were not evaluated in this HHRA.

- Selection of COPCs
- Calculating exposure point concentrations
- Calculating potential exposures to humans
- Calculating potential risks using toxicity information derived in some instances from human data but predominantly derived by extrapolation from experimental data produced in animal studies

COPCs were selected using a method developed by the MDEQ. This method is intended to identify those COPCs that are responsible for a majority of the risk that is associated with migration of vapors from subslab soil gas into indoor air. As has been noted several times in this assessment, there are many possible sources of VOCs found in indoor air. One of these may be migration of landfill gas with associated transport of VOCs. None of the VOCs measured in the Bridger Creek residences is unique to landfill gas and the methods used to sample and analyze the VOCs were designed to yield total concentrations rather than concentrations associated with landfill gas only. In the risk assessment, the effects of alternative indoor sources were minimized (although not eliminated) by using subslab soil gas data in conjunction with attenuation factors. This cannot distinguish, however, between alternative subsurface sources (e.g., leaking underground fuel tanks, pipelines, former development at the site).

Two quality assurance checks were performed to determine if the selection of COPCs was sufficiently conservative. One quality check concerned the presence of chemicals under the slab that had not been found in indoor air but which could migrate into indoor air in the future. A search of the database revealed two VOCs, bromomethane and chlorobenzene that had been found in subslab samples but not in indoor air samples. The potential impact of these occurrences was assessed by calculating the worst-case risks associated with exposure to these chemicals if they should penetrate the slabs in the future. These risks are considered to be worst-case because the maximum value rather than the 95% UCL on the mean was used in the calculation. Neither of these chemicals is considered to be carcinogenic to humans, thus only chronic non-cancer hazards were calculated. The hazard index for this scenario was 0.02, thus even if these chemicals did penetrate the slabs in the future, they would not contribute materially to non-cancer hazards. The second quality check involved the question of whether any potential carcinogens that were eliminated by the selection process could cause the calculated risks to exceed regulatory guidelines or risks associated with everyday life. A search of the database showed that only two carcinogens found in subslab vapor had been eliminated – vinyl chloride and methyl-t-butyl ether (MTBE). These two chemicals were detected sporadically and at lower concentrations than the chemicals that were chosen as COPCs and were below the corresponding RSLs. The potential impact of not selecting these chemicals was analyzed by calculating the worst case risk associated with potential exposure by using the maximum concentration for both chemicals. The additional risks associated with this potential exposure was calculated to be 7E-08, thus they would not contribute materially to the overall risk.

In many instances, measurements were reported as being below reporting limits. This could mean that the chemical was not present, was present but not capable of quantification, or was

interfered with by the presence of other chemicals. In some cases, the reporting limits were higher than the risk screening values which theoretically could lead to an underestimation of risk since these measurements were eliminated from the selection of COPCs although not from the estimation of exposure point concentrations. This effect, if present, was likely not significant for two reasons. First, the database is sufficiently large to compensate for these occurrences and second, the methods used by ProUCL to estimate 95% UCLs were selected to take this phenomenon into account.

With respect to the calculation of human exposure, no ventilation measurements were available for any of the residences. In essence, this was compensated for by assuming that the residences were not ventilated. This would have the net impact of over-estimating exposure and risk.

This HHRA relied on a screening level exposure model based on the use of default attenuation factors designed to over-estimate exposure and risk. The calculation of more realistic vapor intrusion rates depends on a variety of factors including pressure differential between the subslab and the building, ventilation, number and area of concrete cracks and joints, temperature differences between indoors and outdoors, wind loading on the building, climatic regimes, and other factors (Patterson & Davis 2009, Brewer et al. 2014). More refined models, ranging from Johnson & Ettinger (1991) to Yao et al. (2011) could be applied and would likely generate less conservative but more realistic results. In addition, this HHRA assumed that any vapors entering a residence would be uniformly dispersed throughout a residence. Especially when combined with the lack of ventilation considerations, this is a highly conservative approach that will likely lead to over-estimation of exposure and risk. Use of a refined model such as EPA's Multi-Chamber Concentration and Exposure Model (MCCEM)[23] would likely yield less conservative indoor air concentrations and more realistic results.

Variable uncertainty results from complexities in the values used in equations in the risk assessment. These uncertainties may stem from measurement, random or systematic errors associated with the numerical values assigned to input parameters. Variable uncertainty may be reducible through additional research or analysis (i.e., better data). Uncertain variables in this risk assessment include exposure frequency, exposure duration, exposure time, lifetime and the value used as an attenuation factor. Values for each of these variables were chosen from EPA guidance and technical literature to reflect reasonable maximum and central tendency exposures. As an example, the risk assessment assumed that people would be exposed to the current exposure point concentrations for a total of 26 years. This represents an overestimate for current exposure as these developments are, on the whole, substantially younger than 26 years. This also represents an overestimate for future exposure because of the effect of mitigation systems in homes. In addition, the generation of landfill gas follows a known cycle. Due to the age of this landfill and the operation of landfill gas collection systems, this landfill has likely passed its peak of gas production and thus the amounts of VOCs being transported are declining. At some point in the future, there will be no detectable VOCs associated with gas generation at the landfill, thus making a 26 year exposure to current concentrations unrealistic. It should also be kept in mind that landfill gas at the landfill itself is being extracted and treated. Analyses of the landfill gas at

[23] http://www.epa.gov/opptintr/exposure/pubs/mccem.htm

the treatment flare shows that significant removal and destruction of VOCs is occurring which is also likely to reduce the overall exposure duration.

In the case of the number of years in a lifetime, MDEQ uses a different basis than EPA which results in an MDEQ lifetime of 78 years compared to an EPA lifetime of 70 years. The MDEQ value was used in the HHRA to be consistent with other risk assessments performed in Montana, however, use of this value could result in a slight under-estimate (about 11%) in cancer risk compared to EPA's values. This difference is too small to have a significant impact on the results and conclusions.

The risk assessment results presented earlier in this report reflect the combination of these potential sources of uncertainty. Collectively, however, the assumptions used in this assessment are considered much more likely to overestimate risks than underestimate them.

One final overall quality assurance check was performed to determine if the risks for residences closest to the landfill had been underestimated by including them in the overall calculation of aggregate risk for the Bridger Creek Community. This was addressed by calculating the risks for the group of residences closest to the landfill. These included locations designated as [redacted], [redacted]. The exact same procedure was used as was used in calculating the RME cancer risk for the Bridger Creek Community as a whole. The RME cancer risk for this group of residences was 9E-06 compared to 4E-06 for the Community overall. Thus, although the risks from this group are slightly elevated, they are still within EPA and MDEQ regulatory guidelines and do not represent a significant difference from the overall risks.

7. Summary and Conclusions

This risk assessment presents a systematic process for evaluating the potential for health effects associated with potential exposure to chemical compounds present in subslab soil gas in the Bridger Creek subdivision community. A formal process consistent with MDEQ guidance was used to identify a group of chemicals, referred to as COPCs, anticipated to be associated with the greatest risk. Ten COPCs were determined by this process (benzene, carbon tetrachloride, chloroform, 1,2-dichloroethane, 1,4-dioxane, ethylbenzene, tetrachloroethene, trichloroethene, 1,2,4-trimethylbenzene, and m,p-xylene). Because of the methodologies used to sample and analyze these chemicals, it was not possible to entirely separate COPCs or other VOCs that may have originated from the landfill versus from other sources. Basically, all of the COPCs have other potential sources that could be responsible for some, if not all, of indoor air concentrations. The COPCs were input to exposure and risk calculations based on EPA methodology. In accordance with EPA guidance, both reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios were assessed. The RME is intended to represent an exposure scenario that is characteristic of the 90^{th} to 95^{th} percentile of exposure whereas the CTE scenario represents more of a typical or average exposure. Health risks for cancer, non-cancer chronic systemic effects, and non-cancer acute effects were calculated for the chemicals of potential concern. The risk values that were calculated showed that the current and/or future

potential risks are within acceptable risk ranges established by the EPA and the MDEQ under the conditions of exposure used in this risk assessment. Further, it was shown that the risks are substantially lower than those associated with many aspects of everyday life. The primary reason for these low risks is the fact that the chemicals of concern are generally present at very low levels. It may be concluded that using EPA methods, the potential risks posed by subslab soil gas to the community meet generally accepted regulatory public health guidelines. Although the risks are currently low, it is anticipated that they will be even lower in the future due to natural aging processes at the landfill and mitigation measures installed by the City.

The process used by the City to monitor the efficacy of the mitigation measures also allowed the calculation of risks associated with naturally occurring radon that could also intrude into residences. Radon is widespread in Gallatin County due to emissions from geologic materials. In contrast to the risk associated with chemical compounds, the radon risk was found to exceed regulatory guidelines. For more information about radon, homeowners or occupants should contact the Gallatin City-County Health Department (http://healthygallatin.org/healthy-homes/air-quality/radon/).

Finally, this investigation revealed suggestive evidence of indoor sources to many of the VOCs. The potential risks associated with indoor VOC sources would be affected by the types of sources (e.g., types of consumer products), the amounts used indoors, and other factors such as ventilation. There are many resources available to people who wish to minimize their exposure to indoor sources of VOCs. EPA's indoor air quality website (http://www.epa.gov/iaq/voc.html) has a substantial amount of general information plus steps that people can take to improve their indoor air quality. Another good source of general information is the Centers for Disease Control and Prevention (http://www.cdc.gov/niosh/topics/indoorenv/chemicalsodors.html). The Agency for Toxic Substances and Disease Registry has specific information about many of the chemicals found in indoor air (http://www.atsdr.cdc.gov/substances/index.asp). The National Institutes of Health has a product-specific data base that can help individuals identify exactly what toxic substances may be contained in common consumer products (http://hpd.nlm.nih.gov/).

8. References

Abreu, LDV et al. 2009. Simulated soil vapor intrusion attenuation factors including biodegradation for petroleum hydrocarbons. Ground Water Monitoring & Remediation. Winter 2009:105-117.

Antweiler, R.C. & Taylor, H.E. 2008. Evaluation of statistical treatments of left-censored environmental data using coincident uncensored data sets. Environ. Sci. Technol. 42:3732-3738.

AtmAAInc 2013. Laboratory Report dated July 16, 2013.

Agency for Toxic Substances and Disease Registry (ATSDR). 2001. Landfill Gas Primer: An Overview for Environmental Health Professionals.

Brewer, R. et al. 2014. Estimation of generic subslab attenuation factors for vapor intrusion investigations. Groundwater Monitoring & Remediation 34:79-92.

California Environmental Protection Agency (CalEPA). 2011. Guidance for the evaluation and mitigation of subsurface vapor intrusion to indoor air. Department of Toxic Substances Control.

Covello, V., Sandman, P.M. and Slovic, P. 1988. Risk Communication, Risk Statistics, and Risk Comparisons: A Manual for Plant Managers. Prepared for Chemical Manufacturers Association, Washington, DC.

Covello, V. and Sandman, P.M. 2001. Risk communication: Evolution and Revolution. In Wolbarst, Ed. 2001. Solutions to an Environment in Peril. John Hopkins University Press.

Environmental Protection Agency (EPA). 1989. Risk Assessment Guidance for Superfund (RAGS). Part A. EPA/540/1-89/002.

Environmental Protection Agency (EPA). 1991a. Role of the baseline risk assessment in Superfund remedy selection decisions. OSWER Directive 9355.0-030.

Environmental Protection Agency (EPA). 1991b. Risk Assessment Guidance for Superfund: Volume 1, Part B. EPA/540/R-92/003.

Environmental Protection Agency (EPA). 1991c. Compilation of Air Pollutant Emission Factors AP-42, 5th Edition.

Environmental Protection Agency (EPA). 1992a. Guidance for Data Usability in Risk Assessment. OSWER Publication 9285.7-09A.

Environmental Protection Agency (EPA) 1992b. Supplemental guidance to RAGS: Calculating the Concentration Term. Publication 9285.7-081.

Environmental Protection Agency (EPA) 1992c. Guidelines for Exposure Assessment. EPA/600/Z-92/001.

Environmental Protection Agency (EPA). 1993, Superfund standard default exposure factors for central tendency and reasonable maximum exposure. Risk Assessment Council.

Environmental Protection Agency (EPA). 1996. Soil screening guidance: user's guide. OSWER Publication 9355.4-23.

Environmental Protection Agency (EPA). 1999. Compendium Method TO-15. Determination of Volatile Organic Compounds In Air Collected In Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry. EPA/625/R-96/010b.

Environmental Protection Agency (EPA). 2001. Risk Assessment Guidance for Superfund (RAGS). Part D: Standardized Planning Reporting, and Review of Superfund Risk Assessments. Publication 9285.7-47.

Environmental Protection Agency (EPA). 2012. OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. EPA 530-D-02-004.

Environmental Protection Agency (EPA). 2003a. Human Health Toxicity Values in Superfund Risk Assessments. OSWER Directive 9285.7-53.

Environmental Protection Agency (EPA). 2003b. EPA assessment of risks from radon in homes. EPA 402-R-03-003.

Environmental Protection Agency (EPA). 2006. Data quality assessment: statistical methods for practitioners. EPA QA/G-9S.

Environmental Protection Agency (EPA). 2008. U.S. EPA's Vapor Intrusion Database: Preliminary Evaluation of Attenuation Factors. OSW March 4, 2008. Also see EPA 2012. Superfund Vapor Intrusion FAQs.

Environmental Protection Agency (EPA). 2009. Risk Assessment Guidance for Superfund (RAGS) Part F: Supplemental Guidance for Inhalation Risk Assessment. EPA-540-R-070-002.

Environmental Protection Agency (EPA). 2011a. Background indoor air concentrations of volatile organic compounds in North American residences (1990-2005). EPA 530-R-10-001.

Environmental Protection Agency (EPA). 2011b. Exposure Factors Handbook. EPA/600/R-09/052F.

Environmental Protection Agency (EPA). 2011c. Integrated Risk Information System (IRIS) Glossary.

Environmental Protection Agency (EPA). 2012a. Conceptual model scenarios for the vapor intrusion pathway. EPA 530-R-10-003.

Environmental Protection Agency (EPA) 2012b. EPA's Vapor Intrusion Database. EPA 530-R-10-002.

Environmental Protection Agency (EPA) 2012c. Superfund Vapor Intrusion FAQs. February 2012.

Environmental Protection Agency (EPA). 2013a. ProUCL Version 5.0.00 technical Guide. EPA/600/R-07/041.

Environmental Protection Agency (EPA). 2013b. ProUCL Version 5.0.00 User Guide. RPA/600/R-07/041.

Environmental Protection Agency (EPA). 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120.

Eurofins. 2014. Laboratory reported dated 1/15/2014.

Folkes, DJ et al. 2007. Vapor intrusion attenuation factors based on long term monitoring data. Proc Ann Intl Conf Soils Sediments Water Energy. Vol 12, Article 38.

Helsel, D. 2010. Much ado about next to nothing: incorporating nondetects in science. Am. Occup. Hyg. 54:257-262.

Hodgson, AT & Levin, H. 2003. Volatile organic compounds in indoor air: a review of concentrations measured in North America since 1990. LBNL-51715.

Howard, P.H. et al. 1991. *Handbook of Environmental Degradation Rates*. Lewis Publishers.

Huff, E.A. 2010. The best and worst laundry detergents with 1,4-dioxane contamination. www.naturalnews.com/028846_laundry_detergents_dioxane.html.

Johnson, PC & Ettinger, RA. 1991. Heuristic model for predicting the intrusion rate of contaminant vapors into buildings. Environ Sci Technol 25:1445-1452.

Kjeldsen, P. et al. 2002. Present and long-term composition of MSW landfill leachate: a review. Crit Revs Environ Sci Technol 32:297-336.

Maxim Technologies 1995. Corrective Measures Assessment: City of Bozeman Sanitary Landfill. Prepared for City of Bozeman.

Montana Department of Environmental Quality (MDEQ). 2007. Air Quality Permit #2951-04 Final 07/05/07.

Montana Department of Environmental Quality (MDEQ). 2011. Montana Vapor Intrusion Guide.

Montana Department of Environmental Quality (MDEQ). 2012. Typical indoor air concentrations of volatile organic compounds in non-smoking Montana residences not impacted by vapor intrusion.

National Cancer Institute/Centers for Disease Control (NCI/CDC). 2014. State Cancer profiles. http://www.statecancerprofiles.cancer.gov/incidencerates.

Patterson, BM & Davis, GB. 2009. Quantification of vapor intrusion pathways into a slab-on-ground building under varying environmental conditions. Environ Sci Technol. 43:650-656.

Shineldecker, C.L. 1992. *Handbook of Environmental Contaminants*. Lewis Publishers.

Song, S. et al. 2011. Evaluation of EPA's empirical attenuation factor database. events.awma.org/education/Final Papers/5-Song.pdf.

Staley, B.F. et al. 2006. Release of trace organic compounds during the decomposition of municipal solid waste components. Environ Sci Technol. 40:5984-5991.

Tanabe, A. & Kawata, K. 2008. Determination of 1,4-dioxane in household detergents and cleaners. J AOAC Int 91:439-44.

TetraTech. 2007. Landfill gas extraction system evaluation. Bozeman Sanitary Landfill. Prepared for City of Bozeman.

TetraTech. 2014. Revised Corrective Measures Assessment, Bozeman Landfill, Gallatin County, Montana. August 17, 2014.

Williams, P.T. 2002. Emissions from solid waste management activities. Issues Environ. Sc. Technol, No. 18:141.

Wood, JA & Porter, ML 2014. Hazardous pollutants in Class II landfills. JAPCA 37:609-615.

Yao, Y-J et al. 2011. Comparison of the Johnson-Ettinger vapor intrusion screening model predictions with full three-dimensional model results. Environ Sci Technol 45:2227-2235.

APPENDIX A –TECHNICAL GLOSSARY

Acute – having a sudden onset or lasting a short time. The word acute may be used to define either the exposure or the effect.

Biodegrade – decompose into more elementary compounds by the action of living organisms like bacteria.

BTEX – term used for benzene, toluene, ethylbenzene and xylene typically found in petroleum products such as gasoline or diesel fuel. In this HHRA, refers to all monoaromatic petroleum hydrocarbons.

Central tendency exposure (CTE) – quantitative estimate of exposure representing an average or typical situation.

Chemicals of Potential Concern (COPCs) – chemicals that are potentially site-related, most likely to be of concern to human health, and whose data are of sufficient quality to use in a risk assessment.

Chronic – involving a stimulus that is lingering or continuing over a long time.

Concentration – the relative amount of a substance in an environmental medium expressed by mass, volume, or number of units.

Detection limit – the lowest concentration of a chemical that can be distinguished reliably from a zero concentration.

Exposure – contact or co-occurrence of a stressor and receptor.

Exposure point concentration (EPC) – that value which represents a conservative estimate of the chemical concentration available from a particular medium or route of exposure.

Exposure scenario – a set of assumptions concerning how an exposure takes place, including assumptions about the exposure setting, chemical characteristics, and activities of a person that can lead to exposure.

Hazard index (HI) – the sum of more than one hazard quotient for multiple substances and/or multiple exposure pathways. The HI is calculated separately for chronic and acute exposures.

Hazard quotient (HQ) – the ratio of an exposure level to a substance to a toxicity value selected for the risk assessment of that substance.

Hydrocarbon – an organic compound containing only hydrogen and carbon occurring often in petroleum, natural gas, and coal.

Integrated Risk Information System (IRIS) – an electronic database that contains EPA's latest descriptive and quantitative toxicology information about chemical constituents.

Medium – the environmental substance (water, soil, air) that is contaminated.

Permeability – the relative ease with which rock, soil, or sediment can transmit a fluid.

Reasonable Maximum exposure (RME) – the highest exposure that is reasonably expected to occur at a site.

Receptor – the person or community that is exposed to the stressor.

Risk—the expected frequency or probability of undesirable effects resulting from exposure to stressors.

Risk assessment – quantitative evaluation of the risk posed to human health by the actual or potential presence or release of hazardous substances.

Stressor – any physical, chemical or biological entity that can induce an adverse response. In this HHRA, limited to chemicals and ionizing radiation from radon.

Toxicant – a poisonous or potentially poisonous substance.

Toxicity -- the degree to which a chemical substance or physical agent elicits a deleterious or adverse effect on the biological system of an organism exposed to the agent over a designated time period.

Toxicity value – a numerical expression of a substance's exposure-response relationship that is used in risk assessments.

Volatile organic compound (VOC) - one of a group of carbon containing compounds that evaporates readily a room temperature. Examples of VOCs include trichloroethene and BTEX.

APPENDIX B – DATA WORKSHEETS

Data Screening (a)

Street	Augusta Drive								Caddie Court				McIlhattan Rd		St. Andrews Drive									
House/Sample Location (c)	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Compound	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >
111Trichloroethane	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
11Dichloroethane	no	--	no	--	no	--	no	--	no	--	no	--	--	--	--	--	no	--	no	--	--	--	--	--
124Trimethylbenzene	*yes*	*yes*	*yes*	no	*yes*	*yes*	*yes*	*yes*	*yes*	--	*yes*	*yes*	*yes*	*yes*	*yes*	no	*yes*	--	*yes*	*yes*	no	--	*yes*	--
12Dichloroethane	*yes*	no	*yes*	--	*yes*	no	*yes*	no	*yes*	--	*yes*	no	--	--	*yes*	no	*yes*	--	no	--	*yes*	--	*yes*	no
14Dioxane	no	--	--	--	--	--	no	--	*yes*	--	no	--	--	--	*yes*	*yes*	*yes*	--	*yes*	no	no	--	--	--
2Butanone	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
2Hexanone	no	--	no	--	no	--	no	--	no	--	no	--	--	--	no	--	no	--	no	--	no	--	no	--
2Propanol	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
4Methyl2pentanone	no	--	no	--	no	--	no	--	no	--	no	--	--	--	no	--	no	--	no	--	no	--	no	--
Acetone	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Benzene	*yes*	*yes*	*yes*	no	*yes*	*yes*	*yes*	*yes*	*yes*	--	*yes*	no	*yes*	no	*yes*	*yes*	*yes*	--	*yes*	*yes*	*yes*	*yes*	*yes*	--
Bromomethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CarbonDisulfide	--	--	no	--	--	--	no	--	no	--	--	--	--	--	no	--	no	--	--	--	no	--	no	--
CarbonTetrachloride	*yes*	no	*yes*	no	*yes*	no	*yes*	no	*yes*	--	*yes*	no	*yes*	--	*yes*	--	no	--	no	--	no	--	*yes*	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform	*yes*	*yes*	*yes*	no	*yes*	no	*yes*	*yes*	*yes*	--	*yes*	--	*yes*	*yes*	*yes*	--	*yes*	--	*yes*	*yes*	--	--	--	--
Chloromethane	no	--	no	--	no	--	no	--	no	--	no	--	*yes*	--	--	--	--	--	no	--	no	--	no	--
cis12Dichloroethene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cumene	--	--	--	--	--	--	no	--	no	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyclohexane	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
EthylBenzene	*yes*	*yes*	*yes*	no	no	--	*yes*	*yes*	*yes*	--	*yes*	*yes*	*yes*	no	*yes*	*yes*	*yes*	--	*yes*	*yes*	no	--	*yes*	no
Freon11	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Freon113	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Freon12	no	--	*yes*	no	no	--	no	--	*yes*	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Hexane	no	--	no	--	no	--	no	--	*yes*	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
MethyleneChloride	--	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	--	--	no	--	--	--
MethylTertButylEther	--	--	--	--	no	--	--	--	no	--	--	--	no	--	no	--	--	--	--	--	--	--	no	--
mpXylene	*yes*	*yes*	no	--	no	--	*yes*	*yes*	*yes*	--	no	--	no	--	no	--	*yes*	--	no	--	no	--	no	--
oXylene	no	--	no	--	no	--	no	--	*yes*	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Propylbenzene	no	--	no	--	--	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	--	--	no	--
Styrene	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Tetrachloroethene	no	--	no	--	no	--	no	--	*yes*	--	no	--	no	--	no	--	--	--	no	--	no	--	no	--
Tetrahydrofuran	no	--	--	--	--	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Toluene	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
trans12Dichloroethene	no	--	--	--	no	--	no	--	--	--	--	--	no	--	no	--	--	--	no	--	--	--	--	--
Trichloroethene	--	--	*yes*	*yes*	*yes*	--	--	--	*yes*	--	no	--	--	--	no	--	no	--	no	--	--	--	*yes*	*yes*
VinylChloride	no	--	--	--	no	--	no	--	*yes*	--	no	--	--	--	--	--	--	--	--	--	no	--	--	--
Totals (number of "yes" results)	7	5	8	1	6	2	7	5	14	0	6	2	6	2	7	3	7	0	5	4	2	1	6	1

IA = indoor air

RSL = risk screening level

SS = sub-slab

-- = Not applicable. If this entry is shown in the "Max IA > RSL" column, it means the compound was not detected in any indoor air samples. If this entry is shown in the "Max SS > Max IA" column, it means the compound was not detected in any sub-slab samples or the second screening step was not conducted (i.e., because the compound was not detected in any indoor air samples or Max IA was not greater than the RSL).

(a) Sample data considered in the screening included all sub-slab samples and all indoor air samples (except those from crawl spaces) with detectable concentrations that were collected before mitigation. Data obtained from Tetra Tech's excel file.

(b) No sub-slab samples were available for CI-1.
(c) Landfill samples are not shown (LFI-1 and LFI-2).

Data Screening (a)

Street	St. Andrews Drive																					
House/Sample Location (c)	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Compound	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >
111Trichloroethane	no	--	--	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
11Dichloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	no	--	--	--	no	--	--	--
124Trimethylbenzene	*yes*	*yes*	*yes*	no	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	no	--	*yes*	*yes*	*yes*	--	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
12Dichloroethane	*yes*	--	--	--	*yes*	--	*yes*	no	*yes*	--	*yes*	--	*yes*	--	*yes*	no	*yes*	no	*yes*	*yes*	*yes*	--
14Dioxane	*yes*	no	*yes*	--	*yes*	*yes*	no	--	no	--	no	--	no	--	*yes*	--	--	--	*yes*	no	no	--
2Butanone	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
2Hexanone	no	--	--	--	no	--	no	--	no	--	no	--	--	--	no	--	--	--	no	--	no	--
2Propanol	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
4Methyl2pentanone	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Acetone	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Benzene	*yes*	*yes*	*yes*	no	*yes*	no	*yes*	*yes*	*yes*	no	no	--	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Bromomethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CarbonDisulfide	--	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	--	--	no	--
CarbonTetrachloride	--	--	--	--	*yes*	--	--	--	*yes*	--	*yes*	no	*yes*	no	no	--	*yes*	no	*yes*	no	*yes*	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloroethane	no	--	--	--	--	--	--	--	--	--	--	--	--	--	no	--	--	--	--	--	--	--
Chloroform	*yes*	--	--	--	*yes*	no	*yes*	no	*yes*	--	*yes*	*yes*	*yes*	*yes*	*yes*	--	--	--	*yes*	*yes*	*yes*	*yes*
Chloromethane	--	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
cis12Dichloroethene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cumene	--	--	no	--	--	--	--	--	--	--	--	--	no	--	--	--	--	--	no	--	--	--
Cyclohexane	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
EthylBenzene	no	--	*yes*	no	*yes*	*yes*	*yes*	*yes*	no	--	no	--	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	no	--	no	--
Freon11	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Freon113	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Freon12	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Hexane	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
MethyleneChloride	--	--	--	--	--	--	--	--	no	--	--	--	no	--	no	--	--	--	no	--	no	--
MethylTertButylEther	--	--	no	--	--	--	--	--	--	--	--	--	no	--	--	--	--	--	no	--	no	--
mpXylene	no	--	*yes*	no	*yes*	*yes*	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
oXylene	no	--	*yes*	no	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Propylbenzene	--	--	no	--	no	--	--	--	no	--	--	--	no	--	no	--	no	--	no	--	no	--
Styrene	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Tetrachloroethene	--	--	no	--	no	--	no	--	no	--	no	--	*yes*	*yes*	no	--	no	--	no	--	no	--
Tetrahydrofuran	no	--	no	--	no	--	--	--	no	--	--	--	no	--	no	--	--	--	no	--	no	--
Toluene	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
trans12Dichloroethene	no	--	--	--	--	--	--	--	no	--	--	--	no	--	no	--	no	--	no	--	no	--
Trichloroethene	no	--	--	--	--	--	--	--	--	--	--	--	no	--	*yes*	--	--	--	*yes*	no	no	--
VinylChloride	--	--	--	--	--	--	--	--	no	--	--	--	no	--	no	--	no	--	no	--	--	--
Totals (number of "yes" results)	5	2	6	0	8	4	5	3	5	1	3	1	7	5	7	2	5	3	7	4	5	3

Data Screening (a)

Street	St. Andrews Drive				Story Mill Road		Turnberry Court									
House/Sample Location (c)	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
Compound	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS > Max	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >	Max IA > RSL?	If Max IA > RSL … then Max SS >
111Trichloroethane	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
11Dichloroethane	no	--	no	--	no	--	no	--	--	--	no	--	--	--	--	--
124Trimethylbenzene	*yes*	no	*yes*	no	*yes*	--	*yes*	*yes*	*yes*	--	*yes*	*yes*	*yes*	*yes*	*yes*	no
12Dichloroethane	*yes*	--	*yes*	--	*yes*	--	*yes*	--	no	--	*yes*	no	no	--	*yes*	no
14Dioxane	--	--	--	--	*yes*	--	*yes*	--	*yes*	--	*yes*	--	*yes*	--	--	--
2Butanone	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
2Hexanone	no	--	--	--	no	--	no	--	no		no	--	no	--	no	--
2Propanol	no	--	no	--	no	--	no	--	no	--	no	--	no	--	*yes*	no
4Methyl2pentanone	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Acetone	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Benzene	*yes*	no	*yes*	no	*yes*	*yes*	*yes*	no	no	--	*yes*	*yes*	no	--	*yes*	no
Bromomethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CarbonDisulfide	no	--	no	--	no	--	no	--	--	--	no	--	no	--	no	--
CarbonTetrachloride	*yes*	*yes*	*yes*	no	*yes*	--	*yes*	--	no	--	no	--	no	--	no	--
Chlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform	--	--	--	--	*yes*	--	*yes*	no	*yes*	*yes*	*yes*	--	*yes*	no	--	--
Chloromethane	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
cis12Dichloroethene	--	--	--	--	--	--	--	--	--	--	no	--	--	--	--	--
Cumene	no	--	no	--	--	--	--	--	--	--	--	--	no	--	no	--
Cyclohexane	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
EthylBenzene	*yes*	no	*yes*	no	*yes*	--	no	--	*yes*	--	*yes*	*yes*	no	--	*yes*	no
Freon11	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Freon113	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Freon12	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Hexane	*yes*	no	no	--	no	--	no	--	no	--	no	--	no	--	no	--
MethyleneChloride	--	--	--	--	--	--	--	--	no	--	--	--	--	--	no	--
MethylTertButylEther	--	--	--	--	--	--	--	--	no	--	no	--	--	--	--	--
mpXylene	*yes*	no	*yes*	no	no	--	no	--	no	--	no	--	no	--	*yes*	no
oXylene	*yes*	no	*yes*	no	no	--	no	--	no	--	no	--	no	--	*yes*	no
Propylbenzene	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Styrene	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Tetrachloroethene	no	--	no	--	--	--	no	--	no	--	no	--	no	--	*yes*	*yes*
Tetrahydrofuran	--	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
Toluene	no	--	no	--	no	--	no	--	no	--	no	--	no	--	no	--
trans12Dichloroethene	--	--	no	--	no	--	no	--	--	--	no	--	*yes*	no	--	--
Trichloroethene	--	--	--	--	no	--	no	--	no	--	*yes*	*yes*	--	--	--	--
VinylChloride	--	--	no	--	--	--	--	--	--	--	--	--	--	--	no	--
Totals (number of "yes" results)	8	1	7	0	7	1	6	1	4	1	7	4	4	1	8	1

FieldSampNo			[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-D Indoor Air	[redacted]-DS Indoor Air	[redacted]-E Indoor Air	[redacted]-ES Indoor Air	[redacted]-Sub-Slab 1	[redacted]-Sub-Slab 2	[redacted]-Sub-Slab 3					
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]				
UniqueID			[redacted]-A Indoor Air 10/04/2013	[redacted]-B Indoor Air 10/04/2013	[redacted]-D Indoor Air 11/1/2013	[redacted]-DS Indoor Air 11/1/2013	[redacted]-E Indoor Air 11/1/2013	[redacted]-ES Indoor Air 11/1/2013	[redacted]-Sub-Slab 1 08/28/2013	[redacted]-Sub-Slab 2 10/29/2013	[redacted]-Sub-Slab 3 10/29/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max	
SampleType			Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Sub-Slab	Sub-Slab	Sub-Slab					
Duplicate																
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Living Room	Bedroom	Living Room	Living Room	Bedroom	Bedroom	Sub-Slab	Sub-Slab	Sub-Slab					
SamDate			10/4/2013	10/4/2013	11/1/2013	11/1/2013	11/1/2013	11/1/2013	8/28/2013	10/29/2013	10/29/2013					
111Trichloroethane	520	ncsl	0.07	0.06	0.04		0.04		0.07		0.09	0.067	0.085	no	--	
11Dichloroethane	1.8	ncsl	0.01	0.02								0.018	NA	no	--	
124Trimethylbenzene	0.73	ncsl	0.94	1.50		2.40	0.92	3.00	2.60	0.99	0.83	3	2.6	***yes***	no	
12Dichloroethane	0.11	csl	0.59	0.62	0.21	0.48	0.25	0.60				0.62	NA	***yes***	--	
14Dioxane	0.56	csl								0.60		NA	0.6	--	--	
2Butanone	520	ncsl	2.90	2.00	0.85	3.40	0.84	3.80	3.30	1.80	1.10	3.8	3.3	no	--	
2Hexanone	3.1	ncsl	0.26							0.61		0.26	0.61	no	--	
2Propanol	730	ncsl	32.00	41.00	9.80	17.00	12.00	22.00	8.30		1.00	41	8.3	no	--	
4Methyl2pentanone	310	ncsl	0.83	0.90	0.38	1.10	0.41	1.20		0.35	0.23	1.2	0.35	no	--	
Acetone	3200	ncsl	40.00	40.00	19.00	52.00	21.00	61.00	19.00	6.10	5.60	61	19	no	--	
Benzene	0.36	csl	0.68	0.71	0.82	2.50	0.84	2.60	1.20	0.11	0.10	2.6	1.2	***yes***	no	
Bromomethane	0.52	ncsl										NA	NA	--	--	
CarbonDisulfide	73	ncsl	0.26			0.37		0.30			0.22	0.37	0.22	no	--	
CarbonTetrachloride	0.47	csl	0.70	0.58	0.20	0.57	0.27	0.56		0.10		0.7	0.1	***yes***	no	
Chlorobenzene	5.2	ncsl										NA	NA	--	--	
Chloroethane	1000	ncsl										NA	NA	--	--	
Chloroform	0.12	csl	0.86	0.93	0.75	0.53	0.77	0.57	0.52	0.07	0.13	0.93	0.52	***yes***	no	
Chloromethane	9.4	ncsl	1.10	1.10	0.75	0.92	0.80	0.96			0.34	1.1	0.34	no	--	
cis12Dichloroethene	6.3	ncsl										NA	NA	--	--	
Cumene	42	ncsl							1.20	0.42	0.80	NA	1.2	--	--	
Cyclohexane	630	ncsl	0.16	0.68	0.34	1.10	0.41	1.30			0.23	1.3	0.23	no	--	
EthylBenzene	1.1	csl	1.40	1.70	0.64	2.50	0.83	2.80	1.40		0.18	2.8	1.4	***yes***	no	
Freon11	73	ncsl	12.00	17.00	1.00	2.60	1.10	3.00	1.60	1.80	2.20	17	2.2	no	--	
Freon113	3100	ncsl	0.56	0.57		0.40		0.44	0.60	0.38	0.61	0.57	0.61	no	--	
Freon12	10	ncsl	34.00	50.00	2.30	5.40	2.30	6.30	4.10	4.80	5.90	50	5.9	***yes***	no	
Hexane	73	ncsl	0.84	0.93	1.40	5.40	1.60	6.00	0.27		0.11	6	0.27	no	--	
MethyleneChloride	63	ncsl				0.47		0.52				0.52	NA	no	--	
MethylTertButylEther	11	csl										NA	NA	--	--	
mpXylene	10	ncsl	4.60	5.90	1.90	9.00	3.00	9.90	4.70	0.59	0.54	9.9	4.7	no	--	
oXylene	10	ncsl	1.30	1.70	0.50	2.70	0.89	3.00	1.80		0.22	3	1.8	no	--	
Propylbenzene	100	ncsl				0.43	0.19	0.48			0.24	0.48	0.24	no	--	
Styrene	100	ncsl	0.26	0.55		0.37	0.21	0.48	0.90			0.55	0.9	no	--	
Tetrachloroethene	4.2	ncsl	0.05	0.19					1.70	2.40	2.60	0.19	2.6	no	--	
Tetrahydrofuran	210	ncsl							0.98	0.63	0.63	NA	0.98	--	--	
Toluene	520	ncsl	26.00	30.00	12.00	34.00	12.00	35.00	6.90	0.40	1.00	35	6.9	no	--	
trans12Dichloroethene	6.3	ncsl										NA	NA	--	--	
Trichloroethene	0.21	ncsl	0.23				0.03		0.24			0.23	0.24	***yes***	***yes***	
VinylChloride	0.17	csl									0.01	NA	0.011	--	--	

FieldSampNo			[redacted]-B Indoor Air	[redacted]-D Indoor Air	[redacted]-DS Indoor Air	[redacted]-E Indoor Air	[redacted]-ES Indoor Air	[redacted]-Sub-Slab 1	[redacted]-Sub-Slab 2	[redacted]-Sub-Slab 3	[redacted]-Sub-Slab 3				
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			
UniqueID			[redacted]-B Indoor Air 10/02/2013	[redacted]-D Indoor Air 10/22/2013	[redacted]-DS Indoor Air 10/22/2013	[redacted]-E Indoor Air 10/22/2013	[redacted]-ES Indoor Air 10/22/2013	[redacted]-Sub-Slab 1 08/22/2013	[redacted]-Sub-Slab 2 10/21/2013	[redacted]-Sub-Slab 3 02/18/2014	[redacted]-Sub-Slab 3 10/21/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max
SampleType			Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Sub-Slab	Sub-Slab	Sub-Slab	Sub-Slab				
Duplicate										Duplicate of SS1					
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Living Room	Upstairs Bedroom	Upstairs Bedroom	Living Room	Living Room	Sub-Slab	Sub-Slab	Sub-Slab	Sub-Slab				
SamDate			10/2/2013	10/22/2013	10/22/2013	10/22/2013	10/22/2013	8/22/2013	10/21/2013	2/18/2014	10/21/2013				
111Trichloroethane	520	ncsl	0.04	0.04		0.04				0.04	0.03	0.041	0.035	no	--
11Dichloroethane	1.8	ncsl		0.01		0.01				0.02	0.01	0.0088	0.023	no	--
124Trimethylbenzene	0.73	ncsl	1.80	2.60	2.90	2.70	3.10	11.00	15.00	15.00	5.80	3.1	15	***yes***	***yes***
12Dichloroethane	0.11	csl	0.66	0.51	0.51	0.55	0.49		0.09	0.14	0.20	0.66	0.2	***yes***	no
14Dioxane	0.56	csl			0.10		0.17		1.40			0.17	1.4	no	--
2Butanone	520	ncsl	4.20	2.90		3.10		11.00		11.00	6.70	4.2	11	no	--
2Hexanone	3.1	ncsl	0.40			0.33						0.4	NA	no	--
2Propanol	730	ncsl	63.00	4.10		4.50		7.80		0.80	8.40	63	8.4	no	--
4Methyl2pentanone	310	ncsl		0.50		0.47		1.20		0.40	2.50	0.5	2.5	no	--
Acetone	3200	ncsl	56.00	36.00	43.00	39.00	42.00	30.00		84.00	28.00	56	84	no	--
Benzene	0.36	csl	1.30	2.20	3.10	2.20	2.80	4.70	14.00	26.00	5.10	3.1	26	***yes***	***yes***
Bromomethane	0.52	ncsl										NA	NA	--	--
CarbonDisulfide	73	ncsl						0.37			0.31	NA	0.37	--	--
CarbonTetrachloride	0.47	csl	0.52	0.51	0.50	0.66	0.50	0.37	0.32	0.46	0.65	0.66	0.65	***yes***	no
Chlorobenzene	5.2	ncsl									0.16	NA	0.16	--	--
Chloroethane	1000	ncsl										NA	NA	--	--
Chloroform	0.12	csl	1.30	1.70	0.78	1.70	0.74	2.50		5.50	2.10	1.7	5.5	***yes***	***yes***
Chloromethane	9.4	ncsl	1.30	1.10		1.20		0.58		0.88	0.81	1.3	0.88	no	--
cis12Dichloroethene	6.3	ncsl										NA	NA	--	--
Cumene	42	ncsl						1.60	2.20	0.75	1.00	NA	2.2	--	--
Cyclohexane	630	ncsl	1.10	3.10	3.80	3.20	3.70	4.30	8.70	3.70	4.40	3.8	8.7	no	--
EthylBenzene	1.1	csl	1.50	2.60	3.40	2.50	3.30	5.50	22.00	20.00	9.80	3.4	22	***yes***	***yes***
Freon11	73	ncsl	1.80	1.70	1.60	1.80	1.70	1.80	1.50	1.40	1.30	1.8	1.8	no	--
Freon113	3100	ncsl	0.64	0.49		0.39		0.52		0.71	0.53	0.64	0.71	no	--
Freon12	10	ncsl	2.60	2.50	2.50	2.40	2.40	2.40	2.40	2.50	2.60	2.6	2.6	no	--
Hexane	73	ncsl	1.90	4.90	8.50	5.20	7.70	6.90	21.00	19.00	7.60	8.5	21	no	--
MethyleneChloride	63	ncsl										NA	NA	--	--
MethylTertButylEther	11	csl						0.03			0.02	NA	0.032	--	--
mpXylene	10	ncsl	5.50	9.90	12.00	9.80	12.00	20.00	86.00	82.00	40.00	12	86	***yes***	***yes***
oXylene	10	ncsl	1.70	3.00	3.70	3.00	3.70	7.20	25.00	24.00	11.00	3.7	25	no	--
Propylbenzene	100	ncsl	0.26	0.40		0.38		1.70	4.20	2.90	1.60	0.4	4.2	no	--
Styrene	100	ncsl	0.68	0.59		0.57		2.20			1.20	0.68	2.2	no	--
Tetrachloroethene	4.2	ncsl		0.05		0.05		0.46			0.22	0.05	0.46	no	--
Tetrahydrofuran	210	ncsl	1.10	0.67		0.74		2.10	2.00	3.30	2.80	1.1	3.3	no	--
Toluene	520	ncsl	15.00	26.00	30.00	26.00	29.00	27.00	130.00	130.00	62.00	30	130	no	--
trans12Dichloroethene	6.3	ncsl	0.05	0.03		0.03					0.14	0.047	0.14	no	--
Trichloroethene	0.21	ncsl										NA	NA	--	--
VinylChloride	0.17	csl		0.03		0.03		0.09				0.033	0.093	no	--

FieldSampNo				[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-F Indoor Air	[redacted]-FS Indoor Air	[redacted]-G Indoor Air	[redacted]-GS Indoor Air	[redacted]-Sub-Slab 1	[redacted]-Sub-Slab 2	[redacted]-Sub-Slab 3					
HouseNo				[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]				
UniqueID				[redacted]-A Indoor Air 10/08/2013	[redacted]-B Indoor Air 10/08/2013	[redacted]-C Indoor Air 10/08/2013	[redacted]-F Indoor Air 10/22/2013	[redacted]-FS Indoor Air 10/22/2013	[redacted]-G Indoor Air 10/22/2013	[redacted]-GS Indoor Air 10/22/2013	[redacted]-Sub-Slab 1 08/26/2013	[redacted]-Sub-Slab 2 10/21/2013	[redacted]-Sub-Slab 3 10/21/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max	
SampleType				Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Sub-Slab	Sub-Slab	Sub-Slab					
Duplicate																		
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis		Hallway	Bedroom	Bedroom	Bedroom	Bedroom	Hallway	Hallway	Sub-Slab	Sub-Slab	Sub-Slab					
SamDate				10/8/2013	10/8/2013	10/8/2013	10/22/2013	10/22/2013	10/22/2013	10/22/2013	8/26/2013	10/21/2013	10/21/2013					
111Trichloroethane	520	ncsl		0.13	0.04	0.03	0.06		0.10		0.21		0.06	0.13	0.21	no	--	
11Dichloroethane	1.8	ncsl		0.01	0.01	0.01	0.01							0.014	NA	no	--	
124Trimethylbenzene	0.73	ncsl		0.81	0.55	0.45	0.98		0.60		25.00	2.30	1.60	0.98	25	*yes*	*yes*	
12Dichloroethane	0.11	csl		0.70	1.10	1.20	1.10	1.10	0.68	0.64	0.07			1.2	0.07	*yes*	no	
14Dioxane	0.56	csl										0.05		NA	0.048	--	--	
2Butanone	520	ncsl		1.50	1.30	1.50	0.97		1.30		4.80		0.53	1.5	4.8	no	--	
2Hexanone	3.1	ncsl		0.26										0.26	NA	no	--	
2Propanol	730	ncsl		3.40	3.50	3.80	50.00	33.00	48.00	27.00	10.00		0.75	50	10	no	--	
4Methyl2pentanone	310	ncsl					0.20		0.16		2.20		0.52	0.2	2.2	no	--	
Acetone	3200	ncsl		18.00	32.00	33.00	38.00	48.00	29.00	30.00	38.00		2.10	48	38	no	--	
Benzene	0.36	csl		0.36	0.40	0.42	0.54	0.74	0.51	0.68	1.30	0.16	0.14	0.74	1.3	*yes*	*yes*	
Bromomethane	0.52	ncsl												NA	NA	--	--	
CarbonDisulfide	73	ncsl									1.60			NA	1.6	--	--	
CarbonTetrachloride	0.47	csl		0.57	0.26	0.42	0.49	0.53	0.56	0.57		0.36	0.37	0.57	0.37	*yes*	no	
Chlorobenzene	5.2	ncsl												NA	NA	--	--	
Chloroethane	1000	ncsl												NA	NA	--	--	
Chloroform	0.12	csl		0.58	0.38	0.42	0.47	0.39	0.41	0.33	0.34		0.08	0.58	0.34	*yes*	no	
Chloromethane	9.4	ncsl		1.20	1.00	1.10	1.10		1.30		0.33		0.12	1.3	0.33	no	--	
cis12Dichloroethene	6.3	ncsl												NA	NA	--	--	
Cumene	42	ncsl									1.90	1.20	0.79	NA	1.9	--	--	
Cyclohexane	630	ncsl		0.14	0.15	0.19	0.14		0.16		0.50			0.19	0.5	no	--	
EthylBenzene	1.1	csl		0.20	0.18	0.18	0.19		0.22		7.00		0.28	0.22	7	no	--	
Freon11	73	ncsl		1.00	1.10	1.00	1.30	1.20	1.30	1.20	2.10	1.30	1.50	1.3	2.1	no	--	
Freon113	3100	ncsl		0.51		0.51	0.44		0.40		0.56		0.46	0.51	0.56	no	--	
Freon12	10	ncsl		2.10	2.00	2.10	2.60	2.40	2.40	2.40	2.90	2.60	2.70	2.6	2.9	no	--	
Hexane	73	ncsl					0.45		0.54		0.84		0.26	0.54	0.84	no	--	
MethyleneChloride	63	ncsl		1.40	1.00	0.96					18.00	1.40	2.10	1.4	18	no	--	
MethylTertButylEther	11	csl		0.02	0.01	0.02					0.03			0.024	0.03	no	--	
mpXylene	10	ncsl		0.63	0.53	0.50	0.59		0.64		30.00		0.94	0.64	30	no	--	
oXylene	10	ncsl		0.22	0.18	0.24	0.20		0.21		11.00		0.41	0.24	11	no	--	
Propylbenzene	100	ncsl									4.40		0.45	NA	4.4	--	--	
Styrene	100	ncsl		0.24		0.18			0.21		2.50		0.20	0.24	2.5	no	--	
Tetrachloroethene	4.2	ncsl		0.07	0.06	0.06	0.07		0.10		0.72		0.40	0.1	0.72	no	--	
Tetrahydrofuran	210	ncsl									3.00	1.20	0.75	NA	3	--	--	
Toluene	520	ncsl		1.50	1.70	1.40	2.20	3.10	2.50	2.90	16.00	0.94	0.69	3.1	16	no	--	
trans12Dichloroethene	6.3	ncsl		5.10	0.89	0.83	0.57		1.00	1.20	0.07		0.03	5.1	0.074	no	--	
Trichloroethene	0.21	ncsl		0.05	0.34	0.33	0.40							0.4	NA	*yes*	--	
VinylChloride	0.17	csl					0.01		0.01				0.03	0.0077	0.025	no	--	

FieldSampNo			[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-F Indoor Air	[redacted]-FS Indoor Air	[redacted]-G Indoor Air	[redacted]-GS Indoor Air	[redacted]-Sub-Slab 1	[redacted]-Sub-Slab 2	[redacted]-Sub-Slab 3						[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air				
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]	[redacted]	[redacted]			
UniqueID			[redacted]-A Indoor Air 10/02/2013	[redacted]-B Indoor Air 10/02/2013	[redacted]-F Indoor Air 10/30/2013	[redacted]-FS Indoor Air 10/30/2013	[redacted]-G Indoor Air 10/30/2013	[redacted]GS Indoor Air 10/30/2013	[redacted]-Sub-Slab 1 08/23/2013	[redacted]-Sub-Slab 2 10/29/2013	[redacted]-Sub-Slab 3 10/29/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max IA?		[redacted]-A Indoor Air 07/12/2013	[redacted]-B Indoor Air 07/12/2013	[redacted]-C Indoor Air 07/12/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max IA?
SampleType			Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Sub-Slab	TT incorrectly labelled this ambient	Sub-Slab						Indoor Air	Indoor Air	Indoor Air				
Duplicate																							
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Upstairs Bedroom	Living Room	Upstairs Bedroom	Upstairs Bedroom	Living Room	Living Room	Garage Sub-Slab	Garage Sub-Slab	Garage Sub-Slab						Second Floor Living Room	First Floor Kitchen	Basement Living Room				
SamDate			10/2/2013	10/2/2013	10/30/2013	10/30/2013	10/30/2013	10/30/2013	8/23/2013	10/29/2013	10/29/2013						7/12/2013	7/12/2013	7/12/2013				
111Trichloroethane	520	ncsl	0.04	0.03	0.03		0.04		0.04		0.02	0.04	0.044	no	--		0.07	0.06	0.07	0.074	NA	no	--
11Dichloroethane	1.8	ncsl			0.01		0.01		0.02			0.0096	0.015	no	--		0.02	0.01	0.06	0.061	NA	no	--
124Trimethylbenzene	0.73	ncsl	7.80	8.10	8.30	9.50	9.20	9.20	9.90	2.00	1.60	9.5	9.9	yes	yes		8.80	5.80	21.00	21	NA	yes	--
12Dichloroethane	0.11	csl	2.00	1.50	1.60	1.50	1.40	1.40	0.06			2	0.058	yes	no		0.85	0.60	0.35	0.85	NA	yes	--
14Dioxane	0.56	csl		0.15				0.07				0.15	NA	no	--		1.20	1.00	1.00	1.2	NA	yes	--
2Butanone	520	ncsl	2.20	2.50	3.40	3.70	3.00	3.90	7.70		0.37	3.9	7.7	no	--		7.00	6.20	6.50	7	NA	no	--
2Hexanone	3.1	ncsl			0.25	0.32		0.40	0.57			0.4	0.57	no	--		1.30	1.30	1.10	1.3	NA	no	--
2Propanol	730	ncsl	17.00	17.00	10.00	9.90	9.60	8.80	15.00		0.21	17	15	no	--		45.00	58.00	39.00	58	NA	no	--
4Methyl2pentanone	310	ncsl		0.92	0.70	0.72	0.59	0.74	2.00	0.30	0.29	0.92	2	no	--		3.40	2.00	2.30	3.4	NA	no	--
Acetone	3200	ncsl	37.00	37.00	48.00	60.00	46.00	51.00	50.00	2.80	2.00	60	50	no	--		120.00	100.00	130.00	130	NA	no	--
Benzene	0.36	csl	1.10	1.00	1.70	2.20	1.60	2.10	5.30	0.39	0.32	2.2	5.3	yes	yes		9.40	8.40	34.00	34	NA	yes	--
Bromomethane	0.52	ncsl										NA	NA	--	--					NA	NA	--	--
CarbonDisulfide	73	ncsl	0.19	0.23	0.15				0.71			0.23	0.71	no	--		0.44	0.35	0.23	0.44	NA	no	--
CarbonTetrachloride	0.47	csl	0.58	0.40	0.48	0.46	0.56	0.46		0.35	0.48	0.58	0.48	yes	no		0.50	0.42	0.39	0.5	NA	yes	--
Chlorobenzene	5.2	ncsl										NA	NA	--	--					NA	NA	--	--
Chloroethane	1000	ncsl										NA	NA	--	--					NA	NA	--	--
Chloroform	0.12	csl	0.66	0.73		0.27		0.27	4.40	0.02		0.73	4.4	yes	yes		3.40	4.20	18.00	18	NA	yes	--
Chloromethane	9.4	ncsl	0.98	0.95	0.96	0.70	1.30	0.64				1.3	NA	no	--		1.50	1.70	1.90	1.9	NA	no	--
cis12Dichloroethene	6.3	ncsl							0.03			NA	0.026	--	--					NA	NA	--	--
Cumene	42	ncsl	0.30						1.00	0.42	0.72	0.3	1	no	--				0.76	0.76	NA	no	--
Cyclohexane	630	ncsl	0.38	0.45	0.70	0.87	0.76	0.83	17.00		0.22	0.87	17	no	--		4.40	5.00	22.00	22	NA	no	--
EthylBenzene	1.1	csl	3.50	3.40	4.20	5.10	4.10	4.90	8.20	0.84	0.71	5.1	8.2	yes	yes		8.40	5.50	21.00	21	NA	yes	--
Freon11	73	ncsl	1.30	1.20	1.30	1.40	1.30	1.20	2.50	1.30	1.40	1.4	2.5	no	--		1.40	1.40	1.50	1.5	NA	no	--
Freon113	3100	ncsl	0.54	0.35	0.42	0.43	0.36	0.40	0.64	0.40	0.49	0.54	0.64	no	--		0.50	0.54		0.54	NA	no	--
Freon12	10	ncsl	2.70	2.50	2.50	2.50	2.30	2.40	3.00	2.70	3.00	2.7	3	no	--		4.80	6.70	15.00	15	NA	yes	--
Hexane	73	ncsl	0.77	0.90	1.60	2.60	1.70	2.30	18.00	0.25	0.13	2.6	18	no	--		21.00	25.00	110.00	110	NA	yes	--
MethyleneChloride	63	ncsl	3.60	3.70	7.90	9.20	8.20	8.30				9.2	NA	no	--		3.20	4.00	7.40	7.4	NA	no	--
MethylTertButylEther	11	csl							0.07			NA	0.068	--	--		0.03			0.033	NA	no	--
mpXylene	10	ncsl	16.00	15.00	19.00	21.00	19.00	20.00	32.00	3.20	2.70	21	32	yes	yes		32.00	22.00	89.00	89	NA	yes	--
oXylene	10	ncsl	5.60	5.20	6.00	6.90	5.90	6.40	10.00	1.10	0.96	6.9	10	no	--		9.50	6.60	27.00	27	NA	yes	--
Propylbenzene	100	ncsl	1.20	1.10	1.20	1.50	1.30	1.50	2.20	0.37	0.34	1.5	2.2	no	--		1.50	0.91	3.70	3.7	NA	no	--
Styrene	100	ncsl	0.47	0.39	0.48		0.44		1.40		0.21	0.48	1.4	no	--		5.60	2.20	2.20	5.6	NA	no	--
Tetrachloroethene	4.2	ncsl			0.06		0.07		0.93	0.79	0.86	0.072	0.93	no	--		0.84	1.40	4.70	4.7	NA	yes	--
Tetrahydrofuran	210	ncsl	1.40	1.50	2.00	2.80	2.00	2.70	2.00	0.56	0.55	2.8	2	no	--		1.60	1.20	1.40	1.6	NA	no	--
Toluene	520	ncsl	14.00	15.00	19.00	21.00	18.00	21.00	45.00	3.50	3.20	21	45	no	--		48.00	37.00	140.00	140	NA	no	--
trans12Dichloroethene	6.3	ncsl	0.04	0.04					0.04			0.036	0.044	no	--					NA	NA	--	--
Trichloroethene	0.21	ncsl							0.04			NA	0.042	--	--		0.42	0.51		0.51	NA	yes	--
VinylChloride	0.17	csl			0.01		0.03		0.10			0.03	0.1	no	--		0.25	0.06		0.25	NA	yes	--

FieldSampNo				[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-Sub-Slab 1	[redacted]-Sub-Slab 2						[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-Sub-Slab 1	[redacted] Sub-Slab 1					
HouseNo				[redacted]	[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]	[redacted]	[redacted]	[redacted]				
UniqueID				[redacted] A Indoor Air 07/23/2013	[redacted]-B Indoor Air 07/23/2013	[redacted]-Sub-Slab 1 09/05/2013	[redacted]-Sub-Slab 2 09/05/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max		[redacted]-A Indoor Air 12/12/2013	[redacted]-B Indoor Air 12/12/2013	[redacted]-Sub-Slab 1 08/27/2013	[redacted]-Sub-Slab 1 12/11/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max	
SampleType				Indoor Air	Indoor Air	Sub-Slab	Sub-Slab						Indoor Air	Indoor Air	Sub-Slab	Sub-Slab					
Duplicate																					
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis		Main Floor Family Room	Basement Family Room	Basement Sub-Slab	Basement Sub-Slab						Main Floor Living Room	Basement	Sub-Slab	Sub-Slab					
SamDate				7/23/2013	7/23/2013	9/5/2013	9/5/2013						12/12/2013	12/12/2013	8/27/2013	12/11/2013					
111Trichloroethane	520	ncsl		0.06	0.22	0.08	0.09	0.22	0.09	no	--		0.07	0.04	0.04	0.07	0.071	0.065	no	--	
11Dichloroethane	1.8	ncsl		0.01	0.01			0.01	NA	no	--						NA	NA	--	--	
124Trimethylbenzene	0.73	ncsl		1.40	2.00	4.00	4.30	2	4.3	***yes***	***yes***		2.10	1.00	3.60	2.30	2.1	3.6	***yes***	***yes***	
12Dichloroethane	0.11	csl		0.53	0.21	0.06	0.04	0.53	0.056	***yes***	no						NA	NA	--	--	
14Dioxane	0.56	csl		0.36	0.33			0.36	NA	no	--						NA	NA	--	--	
2Butanone	520	ncsl		1.60	2.00	4.30	5.90	2	5.9	no	--		9.80	1.90	5.80	1.50	9.8	5.8	no	--	
2Hexanone	3.1	ncsl		0.32	0.41			0.41	NA	no	--						NA	NA	--	--	
2Propanol	730	ncsl		1.60	2.70	1.70	2.00	2.7	2	no	--		15.00	2.50	19.00	3.70	15	19	no	--	
4Methyl2pentanone	310	ncsl		0.29	0.26			0.29	NA	no	--						NA	NA	--	--	
Acetone	3200	ncsl		19.00	32.00	15.00	22.00	32	22	no	--		80.00	8.10	38.00	6.00	80	38	no	--	
Benzene	0.36	csl		0.95	2.30	2.20	2.20	2.3	2.2	***yes***	no		6.00	1.00	1.20		6	1.2	***yes***	no	
Bromomethane	0.52	ncsl						NA	NA	--	--						NA	NA	--	--	
CarbonDisulfide	73	ncsl				0.60	0.66	NA	0.66	--	--				0.41		NA	0.41	--	--	
CarbonTetrachloride	0.47	csl		0.55	0.34	0.46	0.44	0.55	0.46	***yes***	no		0.68	0.60			0.68	NA	***yes***	--	
Chlorobenzene	5.2	ncsl				0.23	0.22	NA	0.23	--	--					0.11	NA	0.11	--	--	
Chloroethane	1000	ncsl						NA	NA	--	--						NA	NA	--	--	
Chloroform	0.12	csl		0.25	0.66			0.66	NA	***yes***	--		0.49	0.23	1.80	0.35	0.49	1.8	***yes***	***yes***	
Chloromethane	9.4	ncsl		1.40	1.60	0.49	0.36	1.6	0.49	no	--		11.00	1.80			11	NA	***yes***	--	
cis12Dichloroethene	6.3	ncsl						NA	NA	--	--						NA	NA	--	--	
Cumene	42	ncsl				1.80	1.60	NA	1.8	--	--				3.00	0.22	NA	3	--	--	
Cyclohexane	630	ncsl		0.23	0.84	0.26	0.33	0.84	0.33	no	--		0.94	1.10	0.38	0.14	1.1	0.38	no	--	
EthylBenzene	1.1	csl		0.93	1.70	2.00	2.00	1.7	2	***yes***	***yes***		2.00	0.65	1.90	0.67	2	1.9	***yes***	no	
Freon11	73	ncsl		1.50	1.40	1.20	1.10	1.5	1.2	no	--		1.90	2.00	1.40	1.40	2	1.4	no	--	
Freon113	3100	ncsl			0.59	0.37	0.52	0.59	0.52	no	--		0.63	0.53	0.46	0.48	0.63	0.48	no	--	
Freon12	10	ncsl		2.60	2.80	2.70	2.90	2.8	2.9	no	--		2.50	2.30	2.30	2.60	2.5	2.6	no	--	
Hexane	73	ncsl		0.88	3.50	0.61	0.53	3.5	0.61	no	--		2.50	1.10	1.10	0.42	2.5	1.1	no	--	
MethyleneChloride	63	ncsl			2.60	2.00	2.10	2.6	2.1	no	--		1.50				1.5	NA	no	--	
MethylTertButylEther	11	csl						NA	NA	--	--		0.02	0.03		0.03	0.028	0.027	no	--	
mpXylene	10	ncsl		3.50	6.60	7.60	7.60	6.6	7.6	no	--		6.80	2.10	6.40	2.20	6.8	6.4	no	--	
oXylene	10	ncsl		1.20	2.20	2.60	2.80	2.2	2.8	no	--		1.60	0.82	2.60	0.98	1.6	2.6	no	--	
Propylbenzene	100	ncsl		0.25	0.36	0.62	0.67	0.36	0.67	no	--		0.46	0.30		0.71	0.46	0.71	no	--	
Styrene	100	ncsl		0.22	0.36	2.00	1.90	0.36	2	no	--		2.40	0.48		0.32	2.4	0.32	no	--	
Tetrachloroethene	4.2	ncsl		0.04	0.24	1.20	1.20	0.24	1.2	no	--		0.31	0.44	0.41	0.11	0.44	0.41	no	--	
Tetrahydrofuran	210	ncsl			0.68	2.00	2.30	0.68	2.3	no	--		11.00	1.20	1.50	1.00	11	1.5	no	--	
Toluene	520	ncsl		5.00	12.00	8.90	8.90	12	8.9	no	--		16.00	3.60	8.00	1.40	16	8	no	--	
trans12Dichloroethene	6.3	ncsl						NA	NA	--	--		0.15	0.06			0.15	NA	no	--	
Trichloroethene	0.21	ncsl		0.02	0.05			0.046	NA	no	--				0.40		NA	0.4	--	--	
VinylChloride	0.17	csl		0.03	0.03	0.03	0.03	0.031	0.033	no	--				0.06	0.03	NA	0.064	--	--	

FieldSampNo			[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-Sub-Slab 1						[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-Sub-Slab 1				
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			
UniqueID			[redacted]-A Indoor Air 07/03/2013	[redacted]-B Indoor Air 07/03/2013	[redacted]-Sub-Slab 1 08/26/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max		[redacted]-A Indoor Air 07/09/2013	[redacted]-B Indoor Air 07/09/2013	[redacted]-C Indoor Air 07/09/2013	[redacted]-Sub-Slab 1 08/29/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max
SampleType			Indoor Air	Indoor Air	Sub-Slab						Indoor Air	Indoor Air	Indoor Air	Sub-Slab				
Duplicate																		
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Main Floor Living Room	Basement Family Room	Basement Sub-Slab Utility Room						Main Floor Living Room	Second Floor	Basement Hallway	Basement Sub-Slab				
SamDate			7/3/2013	7/3/2013	8/26/2013						7/9/2013	7/9/2013	7/9/2013	8/29/2013				
111Trichloroethane	520	ncsl	0.04	0.04	0.064	0.044	0.064	no	--		0.28	0.23	0.04	0.10	0.28	0.097	no	--
11Dichloroethane	1.8	ncsl				NA	NA	--	--						NA	NA	--	--
124Trimethylbenzene	0.73	ncsl	1.10	1.00	10.00	1.1	10	***yes***	***yes***		0.50	0.51		3.30	0.51	3.3	no	--
12Dichloroethane	0.11	csl		0.17		0.17	NA	***yes***	--		0.19	0.30	0.09		0.3	NA	***yes***	--
14Dioxane	0.56	csl	0.26	0.26		0.26	NA	no	--			0.34			0.34	NA	no	--
2Butanone	520	ncsl	3.60	4.80	11.00	4.8	11	no	--			3.40		3.60	3.4	3.6	no	--
2Hexanone	3.1	ncsl	0.58	0.91		0.91	NA	no	--		0.34	0.49	0.36		0.49	NA	no	--
2Propanol	730	ncsl	40.00	21.00		40	NA	no	--		21.00	21.00	4.30	5.50	21	5.5	no	--
4Methyl2pentanone	310	ncsl	0.52	0.69	1.00	0.69	1	no	--		0.68	0.70	0.41		0.7	NA	no	--
Acetone	3200	ncsl	500.00	140.00	20.00	500	20	no	--		45.00	49.00	22.00	13.00	49	13	no	--
Benzene	0.36	csl	0.86	0.99	0.74	0.99	0.74	***yes***	no		0.30	0.34	0.24	9.40	0.34	9.4	no	--
Bromomethane	0.52	ncsl				NA	NA	--	--						NA	NA	--	--
CarbonDisulfide	73	ncsl	0.22	0.25	2.10	0.25	2.1	no	--		0.22	0.17		0.25	0.22	0.25	no	--
CarbonTetrachloride	0.47	csl	0.76	0.56		0.76	NA	***yes***	--		0.39	0.42	0.60	0.53	0.6	0.53	***yes***	no
Chlorobenzene	5.2	ncsl				NA	NA	--	--						NA	NA	--	--
Chloroethane	1000	ncsl				NA	NA	--	--						NA	NA	--	--
Chloroform	0.12	csl	0.30	0.36		0.36	NA	***yes***	--		0.39	0.34	0.18	0.55	0.39	0.55	***yes***	***yes***
Chloromethane	9.4	ncsl	1.40	1.40	0.81	1.4	0.81	no	--		1.60	1.80	1.50	0.26	1.8	0.26	no	--
cis12Dichloroethene	6.3	ncsl				NA	NA	--	--						NA	NA	--	--
Cumene	42	ncsl			1.20	NA	1.2	--	--					0.88	NA	0.88	--	--
Cyclohexane	630	ncsl	0.43	1.30	0.45	1.3	0.45	no	--		0.19	0.59	0.12	0.32	0.59	0.32	no	--
EthylBenzene	1.1	csl	0.92	0.82	3.30	0.92	3.3	no	--		0.41	0.52	0.22	1.90	0.52	1.9	no	--
Freon11	73	ncsl	1.20	1.20	2.10	1.2	2.1	no	--		1.40	1.40	1.90	1.90	1.9	1.9	no	--
Freon113	3100	ncsl	0.43	0.58	0.65	0.58	0.65	no	--		0.50	0.43	0.63	0.66	0.63	0.66	no	--
Freon12	10	ncsl	2.20	2.40	9.80	2.4	9.8	no	--		2.80	2.80	3.20	8.60	3.2	8.6	no	--
Hexane	73	ncsl	1.80	6.40	0.26	6.4	0.26	no	--		0.53	0.59	0.39	1.20	0.59	1.2	no	--
MethyleneChloride	63	ncsl	7.60	8.40		8.4	NA	no	--						NA	NA	--	--
MethylTertButylEther	11	csl			0.02	NA	0.023	--	--						NA	NA	--	--
mpXylene	10	ncsl	2.60	2.20	13.00	2.6	13	no	--		1.20	1.70	0.62	6.30	1.7	6.3	no	--
oXylene	10	ncsl	1.50	0.89	4.90	1.5	4.9	no	--		0.43	0.58	0.26	2.50	0.58	2.5	no	--
Propylbenzene	100	ncsl	0.23	0.22	1.80	0.23	1.8	no	--						NA	NA	--	--
Styrene	100	ncsl	1.80	0.84	1.10	1.8	1.1	no	--		0.26	0.43	0.29	1.50	0.43	1.5	no	--
Tetrachloroethene	4.2	ncsl	0.07	0.22	18.00	0.22	18	no	--		0.34	0.28	0.19	13.00	0.34	13	no	--
Tetrahydrofuran	210	ncsl		1.00	25.00	1	25	no	--					0.55	NA	0.55	--	--
Toluene	520	ncsl	6.00	6.90	7.10	6.9	7.1	no	--		2.00	2.70	1.30	10.00	2.7	10	no	--
trans12Dichloroethene	6.3	ncsl	6.00	1.60		6	NA	no	--						NA	NA	--	--
Trichloroethene	0.21	ncsl			0.24	NA	0.24	--	--					1.10	NA	1.1	--	--
VinylChloride	0.17	csl		0.03		0.03	NA	no	--					0.05	NA	0.047	--	--

FieldSampNo			[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-Sub-Slab 1						[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-Sub-Slab 1				
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			
UniqueID			[redacted]-A Indoor Air 07/03/2013	[redacted]-B Indoor Air 07/03/2013	[redacted]-Sub-Slab 1 08/22/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max		[redacted]-A Indoor Air 07/19/2013	[redacted]-B Indoor Air 07/19/2013	[redacted]-C Indoor Air 07/19/2013	[redacted]-Sub-Slab 1 08/28/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max
SampleType			Indoor Air	Indoor Air	Sub-Slab						Indoor Air	Indoor Air	Indoor Air	Sub-Slab				
Duplicate																		
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Main Floor Office	Basement Hallway	Basement Sub-Slab						Second Floor Hallway	Main Floor Master Bedroom	Main Floor Living Room	Extraction Pipe				
SamDate			7/3/2013	7/3/2013	8/22/2013						7/19/2013	7/19/2013	7/19/2013	8/28/2013				
111Trichloroethane	520	ncsl	0.04	0.04	0.18	0.038	0.18	no	--		0.04		0.04		0.04	NA	no	--
11Dichloroethane	1.8	ncsl				NA	NA	--	--				0.01		0.012	NA	no	--
124Trimethylbenzene	0.73	ncsl	1.30	4.80	7.60	4.8	7.6	*yes*	*yes*		2.10	3.10	2.40		3.1	NA	*yes*	--
12Dichloroethane	0.11	csl	0.29	0.42		0.42	NA	*yes*	--		98.00	350.00	96.00	14.00	350	14	*yes*	no
14Dioxane	0.56	csl		0.26	0.22	0.26	0.22	no	--		0.41	0.53	0.62		0.62	NA	*yes*	--
2Butanone	520	ncsl	4.40	7.80	7.70	7.8	7.7	no	--		20.00	27.00	20.00	6200.00	27	6200	no	--
2Hexanone	3.1	ncsl			0.69	NA	0.69	--	--		1.30	1.40	1.60		1.6	NA	no	--
2Propanol	730	ncsl	9.10	27.00	18.00	27	18	no	--		50.00	54.00	44.00	11.00	54	11	no	--
4Methyl2pentanone	310	ncsl		0.37	0.59	0.37	0.59	no	--		1.50	1.50	1.00		1.5	NA	no	--
Acetone	3200	ncsl	37.00	52.00	52.00	52	52	no	--		100.00	120.00	96.00	2300.00	120	2300	no	--
Benzene	0.36	csl		0.46	0.69	0.46	0.69	*yes*	*yes*		0.66	0.92	0.64	5.90	0.92	5.9	*yes*	*yes*
Bromomethane	0.52	ncsl				NA	NA	--	--						NA	NA	--	--
CarbonDisulfide	73	ncsl		0.20	30.00	0.2	30	no	--		0.66	0.77	0.67		0.77	NA	no	--
CarbonTetrachloride	0.47	csl	0.68	0.81	0.40	0.81	0.4	*yes*	no		0.37		0.34		0.37	NA	no	--
Chlorobenzene	5.2	ncsl				NA	NA	--	--						NA	NA	--	--
Chloroethane	1000	ncsl				NA	NA	--	--		0.45		0.50		0.5	NA	no	--
Chloroform	0.12	csl	0.16	0.34	0.84	0.34	0.84	*yes*	*yes*		0.86	1.00	0.84		1	NA	*yes*	--
Chloromethane	9.4	ncsl	1.10	1.20		1.2	NA	no	--		1.80	2.20	1.80	24.00	2.2	24	no	--
cis12Dichloroethene	6.3	ncsl				NA	NA	--	--						NA	NA	--	--
Cumene	42	ncsl		0.43	0.60	0.43	0.6	no	--						NA	NA	--	--
Cyclohexane	630	ncsl	0.21	5.50	0.47	5.5	0.47	no	--		0.39	0.26	0.21		0.39	NA	no	--
EthylBenzene	1.1	csl	0.61	1.40	3.50	1.4	3.5	*yes*	*yes*		2.40	3.20	2.50	4.80	3.2	4.8	*yes*	*yes*
Freon11	73	ncsl	1.20	2.00	6.20	2	6.2	no	--		1.70	1.60	1.70		1.7	NA	no	--
Freon113	3100	ncsl	0.54	0.51	0.71	0.54	0.71	no	--		0.60		0.38		0.6	NA	no	--
Freon12	10	ncsl	2.30	2.70	95.00	2.7	95	no	--		3.00	3.00	2.80	5.10	3	5.1	no	--
Hexane	73	ncsl		1.40	0.78	1.4	0.78	no	--		0.90	0.82	0.62	4.80	0.9	4.8	no	--
MethyleneChloride	63	ncsl	1.40	3.00	0.56	3	0.56	no	--		1.50			16.00	1.5	16	no	--
MethylTertButylEther	11	csl	0.01	0.01	0.02	0.014	0.018	no	--						NA	NA	--	--
mpXylene	10	ncsl	1.10	3.30	11.00	3.3	11	no	--		7.80	10.00	8.20	14.00	10	14	no	--
oXylene	10	ncsl	0.40	1.10	4.60	1.1	4.6	no	--		2.50	3.40	2.60	4.60	3.4	4.6	no	--
Propylbenzene	100	ncsl		0.68	1.10	0.68	1.1	no	--		0.39		0.37		0.39	NA	no	--
Styrene	100	ncsl	0.91	5.50	2.00	5.5	2	no	--		4.20	8.60	4.50	3.90	8.6	3.9	no	--
Tetrachloroethene	4.2	ncsl	0.47	4.90	210.00	4.9	210	*yes*	*yes*		0.52	0.32	0.37	10.00	0.52	10	no	--
Tetrahydrofuran	210	ncsl	0.68	0.46	1.80	0.68	1.8	no	--		15.00	17.00	13.00	5700.00	17	5700	no	--
Toluene	520	ncsl	2.60	5.00	7.60	5	7.6	no	--		13.00	15.00	13.00	25.00	15	25	no	--
trans12Dichloroethene	6.3	ncsl	0.11	0.13		0.13	NA	no	--		0.03		0.03		0.032	NA	no	--
Trichloroethene	0.21	ncsl		0.06	5.60	0.06	5.6	no	--		0.49	0.04	0.05		0.49	NA	*yes*	--
VinylChloride	0.17	csl		0.02	0.03	0.018	0.034	no	--				0.04		0.035	NA	no	--

FieldSampNo			[redacted]-C Indoor Air	[redacted]-Sub-Slab 1	[redacted]-Sub-Slab 2	[redacted]-Sub-Slab 2						[redacted]-A Indoor Air	[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-D Sub-Slab				
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			
UniqueID			[redacted]-C Indoor Air 09/06/2013	[redacted]-Sub-Slab 1 09/05/2013	[redacted]-Sub-Slab 2 02/10/2014	[redacted]-Sub-Slab 2 09/05/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max		[redacted]-A Indoor Air 07/03/2013	[redacted]-A Indoor Air 08/07/2013	[redacted]-B Indoor Air 07/03/2013	[redacted]-C Indoor Air 07/03/2013	[redacted]-D Sub-Slab 08/07/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max
SampleType			Indoor Air	Sub-Slab	Sub-Slab	Sub-Slab						Indoor Air	Indoor Air	Indoor Air	Indoor Air	Sub-Slab				
Duplicate														Duplicate						
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Main Floor Dining Room	Sub-Slab	Sub-Slab	Sub-Slab						Basement Utility Room	Basement Utility Room	Basement	Main Floor Living Room	Basement Sub-Slab Storage Room				
SamDate			9/6/2013	9/5/2013	2/10/2014	9/5/2013						7/3/2013	8/7/2013	7/3/2013	7/3/2013	8/7/2013				
111Trichloroethane	520	ncsl	0.03	0.039	0.02	0.041	0.025	0.041	no	--		0.04	0.03	0.05	0.03	0.05	0.049	0.054	no	--
11Dichloroethane	1.8	ncsl					NA	NA	--	--		0.09	0.01	0.09		0.01	0.085	0.012	no	--
124Trimethylbenzene	0.73	ncsl	1.80	6.20	2.10	6.00	1.8	6.2	*yes*	*yes*		0.69	1.00	1.10		22.00	1.1	22	*yes*	*yes*
12Dichloroethane	0.11	csl	1.50	0.06		0.06	1.5	0.057	*yes*	no		0.26	0.10	0.26		0.87	0.26	0.87	*yes*	*yes*
14Dioxane	0.56	csl				1.50	NA	1.5	--	--		0.34	0.19	0.71		0.40	0.71	0.4	*yes*	no
2Butanone	520	ncsl	6.90	2.00	2.60	4.70	6.9	4.7	no	--		4.20	2.40	4.50	1.60	10.00	4.5	10	no	--
2Hexanone	3.1	ncsl					NA	NA	--	--		0.52			0.29	0.75	0.52	0.75	no	--
2Propanol	730	ncsl	220.00	4.70	1.20	7.30	220	7.3	no	--		7.10	3.20	7.80	2.80	8.10	7.8	8.1	no	--
4Methyl2pentanone	310	ncsl	1.10	0.61	0.31	0.92	1.1	0.92	no	--		1.10	0.70	1.40		0.62	1.4	0.62	no	--
Acetone	3200	ncsl	62.00	13.00	7.80	79.00	62	79	no	--		64.00	21.00	62.00	21.00	34.00	64	34	no	--
Benzene	0.36	csl	0.94	1.20	2.20	1.30	0.94	2.2	*yes*	*yes*		0.51	1.20	0.52		4.00	1.2	4	*yes*	*yes*
Bromomethane	0.52	ncsl		0.89		1.30	NA	1.3	--	--							NA	NA	--	--
CarbonDisulfide	73	ncsl	0.99			11.00	0.99	11	no	--						0.18	NA	0.18	--	--
CarbonTetrachloride	0.47	csl	0.64		0.39		0.64	0.39	*yes*	no		0.74	0.48	0.54	0.81	0.64	0.81	0.64	*yes*	no
Chlorobenzene	5.2	ncsl					NA	NA	--	--							NA	NA	--	--
Chloroethane	1000	ncsl					NA	NA	--	--							NA	NA	--	--
Chloroform	0.12	csl					NA	NA	--	--		0.16	0.72	0.21	0.08	1.00	0.72	1	*yes*	*yes*
Chloromethane	9.4	ncsl	1.00		1.30	0.61	1	1.3	no	--			1.70		1.20		1.7	NA	no	--
cis12Dichloroethene	6.3	ncsl					NA	NA	--	--							NA	NA	--	--
Cumene	42	ncsl		0.73	0.85	0.78	NA	0.85	--	--			0.24			22.00	0.24	22	no	--
Cyclohexane	630	ncsl	0.61	0.38	0.49	0.66	0.61	0.66	no	--		0.56	0.47	0.53	2.30	0.84	2.3	0.84	no	--
EthylBenzene	1.1	csl	1.30	1.60	0.59	1.70	1.3	1.7	*yes*	*yes*		0.99	1.00	1.00	0.17	10.00	1	10	no	--
Freon11	73	ncsl	1.10	1.30	1.20	1.40	1.1	1.4	no	--		1.20	1.30	1.20	1.20	1.20	1.3	1.2	no	--
Freon113	3100	ncsl	0.42		0.48		0.42	0.48	no	--		0.47	0.54	0.49	0.58	0.51	0.58	0.51	no	--
Freon12	10	ncsl	2.40	6.10	2.40	7.30	2.4	7.3	no	--		2.40	2.50	2.50	2.30	2.90	2.5	2.9	no	--
Hexane	73	ncsl	1.30	1.00	0.73	1.60	1.3	1.6	no	--		1.80	1.60	2.00		1.60	2	1.6	no	--
MethyleneChloride	63	ncsl					NA	NA	--	--		0.35	1.30	0.56	0.50	1.70	1.3	1.7	no	--
MethylTertButylEther	11	csl		0.01		0.01	NA	0.014	--	--		0.04	0.03	0.03			0.035	NA	no	--
mpXylene	10	ncsl	4.30	6.30	1.80	6.60	4.3	6.6	no	--		2.80	3.20	3.10	0.46	49.00	3.2	49	no	--
oXylene	10	ncsl	1.50	2.50	0.80	2.60	1.5	2.6	no	--		1.10	1.10	1.20	0.18	16.00	1.2	16	no	--
Propylbenzene	100	ncsl	0.27	0.73	0.46	0.78	0.27	0.78	no	--		0.34	0.24	0.28		3.80	0.34	3.8	no	--
Styrene	100	ncsl	0.77	0.70	0.27	0.86	0.77	0.86	no	--		0.77	0.43	0.78	0.15	1.40	0.78	1.4	no	--
Tetrachloroethene	4.2	ncsl	0.44	9.00	1.00	8.50	0.44	9	no	--		0.17	0.28	0.25	0.31	1.50	0.31	1.5	no	--
Tetrahydrofuran	210	ncsl		0.95	1.90	1.40	NA	1.9	--	--			0.77	0.34		2.40	0.77	2.4	no	--
Toluene	520	ncsl	9.70	6.30	3.00	7.40	9.7	7.4	no	--		5.30	8.00	5.00	1.20	45.00	8	45	no	--
trans12Dichloroethene	6.3	ncsl	0.04				0.044	NA	no	--		0.08		0.08	0.06	0.02	0.082	0.024	no	--
Trichloroethene	0.21	ncsl		0.02		0.04	NA	0.038	--	--		0.09	0.50	0.11		0.44	0.5	0.44	*yes*	no
VinylChloride	0.17	csl	0.01	0.03		0.02	0.012	0.026	no	--		0.09		0.10			0.095	NA	no	--

FieldSampNo			[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-Sub-Slab 1						[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-Sub-Slab 1				
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]	[redacted]	[redacted]			
UniqueID			[redacted]-B Indoor Air 07/03/2013	[redacted]-C Indoor Air 07/03/2013	[redacted]-Sub-Slab 1 08/27/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max		[redacted]-A Indoor Air 07/09/2013	[redacted]-B Indoor Air 07/09/2013	[redacted]-Sub-Slab 1 08/21/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max
SampleType			Indoor Air	Indoor Air	Sub-Slab						Indoor Air	Indoor Air	Sub-Slab				
Duplicate																	
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Main Floor Living Room	Second Floor	Garage Sub-Slab						Basement Family Room	Main Floor Living Room	Garage Extraction Pipe				
SamDate			7/3/2013	7/3/2013	8/27/2013						7/9/2013	7/9/2013	8/21/2013				
111Trichloroethane	520	ncsl	0.06	0.04	0.19	0.057	0.19	no	--		0.04	0.03	0.05	0.04	0.045	no	--
11Dichloroethane	1.8	ncsl				NA	NA	--	--		0.15	0.05		0.15	NA	no	--
124Trimethylbenzene	0.73	ncsl	1.60	1.20	24.00	1.6	24	***yes***	***yes***		21.00	7.50	15.00	21	15	***yes***	no
12Dichloroethane	0.11	csl	0.88	1.20		1.2	NA	***yes***	--		6.20	1.70		6.2	NA	***yes***	--
14Dioxane	0.56	csl	0.38			0.38	NA	no	--				3.90	NA	3.9	--	--
2Butanone	520	ncsl	5.70	3.10	5.50	5.7	5.5	no	--		6.10	5.80	27.00	6.1	27	no	--
2Hexanone	3.1	ncsl	0.83	0.48		0.83	NA	no	--			0.84	1.20	0.84	1.2	no	--
2Propanol	730	ncsl	18.00	14.00	6.80	18	6.8	no	--		7.90	5.30	27.00	7.9	27	no	--
4Methyl2pentanone	310	ncsl	0.82	0.62	2.50	0.82	2.5	no	--			1.30	2.40	1.3	2.4	no	--
Acetone	3200	ncsl	72.00	50.00	28.00	72	28	no	--		90.00	62.00	310.00	90	310	no	--
Benzene	0.36	csl	0.88	0.79	3.10	0.88	3.1	***yes***	***yes***		18.00	6.70	4.50	18	4.5	***yes***	no
Bromomethane	0.52	ncsl				NA	NA	--	--					NA	NA	--	--
CarbonDisulfide	73	ncsl	0.23		1.20	0.23	1.2	no	--		0.37	0.48	0.45	0.48	0.45	no	--
CarbonTetrachloride	0.47	csl	0.78	0.62		0.78	NA	***yes***	--		0.43	0.48	0.78	0.48	0.78	***yes***	***yes***
Chlorobenzene	5.2	ncsl			0.25	NA	0.25	--	--					NA	NA	--	--
Chloroethane	1000	ncsl				NA	NA	--	--					NA	NA	--	--
Chloroform	0.12	csl	0.22	0.17	0.88	0.22	0.88	***yes***	***yes***				0.11	NA	0.11	--	--
Chloromethane	9.4	ncsl	1.80	1.40	0.48	1.8	0.48	no	--		1.30	1.20		1.3	NA	no	--
cis12Dichloroethene	6.3	ncsl				NA	NA	--	--					NA	NA	--	--
Cumene	42	ncsl			3.00	NA	3	--	--		1.30			1.3	NA	no	--
Cyclohexane	630	ncsl	0.48	0.26	1.60	0.48	1.6	no	--		41.00	15.00	2.10	41	2.1	no	--
EthylBenzene	1.1	csl	1.10	0.94	8.30	1.1	8.3	no	--		23.00	7.70	11.00	23	11	***yes***	no
Freon11	73	ncsl	1.90	1.80	1.60	1.9	1.6	no	--		1.20	1.20	1.60	1.2	1.6	no	--
Freon113	3100	ncsl	0.47	0.58	0.47	0.58	0.47	no	--		0.35	0.42	0.50	0.42	0.5	no	--
Freon12	10	ncsl	2.80	2.40	2.90	2.8	2.9	no	--		2.30	2.50	7.40	2.5	7.4	no	--
Hexane	73	ncsl	1.60	1.10	3.50	1.6	3.5	no	--		81.00	27.00	5.90	81	5.9	***yes***	no
MethyleneChloride	63	ncsl	7.40	0.42		7.4	NA	no	--				0.33	NA	0.33	--	--
MethylTertButylEther	11	csl	0.01	0.01	0.04	0.012	0.042	no	--				0.04	NA	0.035	--	--
mpXylene	10	ncsl	3.50	3.00	35.00	3.5	35	no	--		86.00	29.00	27.00	86	27	***yes***	no
oXylene	10	ncsl	1.40	1.10	13.00	1.4	13	no	--		28.00	9.40	9.80	28	9.8	***yes***	no
Propylbenzene	100	ncsl	0.30	0.31	4.10	0.31	4.1	no	--		4.30	1.40	3.10	4.3	3.1	no	--
Styrene	100	ncsl	0.70	0.51	2.90	0.7	2.9	no	--		2.80	0.97	2.80	2.8	2.8	no	--
Tetrachloroethene	4.2	ncsl	0.23	0.19	0.85	0.23	0.85	no	--		0.33	0.11	9.70	0.33	9.7	no	--
Tetrahydrofuran	210	ncsl	0.78	0.28	4.00	0.78	4	no	--				5.70	NA	5.7	--	--
Toluene	520	ncsl	8.30	7.70	22.00	8.3	22	no	--		120.00	48.00	25.00	120	25	no	--
trans12Dichloroethene	6.3	ncsl	0.05			0.045	NA	no	--					NA	NA	--	--
Trichloroethene	0.21	ncsl	0.13	0.10		0.13	NA	no	--				0.10	NA	0.095	--	--
VinylChloride	0.17	csl				NA	NA	--	--				0.11	NA	0.11	--	--

FieldSampNo			[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-Sub-Slab 1						[redacted]-A Indoor Air					
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]				
UniqueID			[redacted]-A Indoor Air 07/11/2013	[redacted]-B Indoor Air 07/11/2013	[redacted]-C Indoor Air 07/11/2013	[redacted]-Sub-Slab 1 08/22/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max		[redacted]-A Indoor Air 12/20/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max	
SampleType			Indoor Air	Indoor Air	Indoor Air	Sub-Slab						Indoor Air					
Duplicate																	
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Second Floor Hallway	Main Floor Living Room	Basement Play Room	Garage Sub-Slab						Main Floor Kitchen					
SamDate			7/11/2013	7/11/2013	7/11/2013	8/22/2013						12/20/2013					
111Trichloroethane	520	ncsl	0.03	0.03	0.04	0.05	0.036	0.047	no	--			NA	NA	--	--	
11Dichloroethane	1.8	ncsl	0.01	0.01	0.01		0.013	NA	no	--			NA	NA	--	--	
124Trimethylbenzene	0.73	ncsl	18.00	18.00	23.00	12.00	23	12	***yes***	no		18.00	18	NA	***yes***	--	
12Dichloroethane	0.11	csl	1.60	1.60	3.20		3.2	NA	***yes***	--			NA	NA	--	--	
14Dioxane	0.56	csl				0.32	NA	0.32	--	--			NA	NA	--	--	
2Butanone	520	ncsl	6.50	6.80	8.80	10.00	8.8	10	no	--		33.00	33	NA	no	--	
2Hexanone	3.1	ncsl					NA	NA	--	--			NA	NA	--	--	
2Propanol	730	ncsl	13.00	13.00	18.00	7.80	18	7.8	no	--		79.00	79	NA	no	--	
4Methyl2pentanone	310	ncsl	2.30	2.30	3.00	0.79	3	0.79	no	--			NA	NA	--	--	
Acetone	3200	ncsl	87.00	90.00	100.00	110.00	100	110	no	--		1100.00	1100	NA	no	--	
Benzene	0.36	csl	8.10	8.00	13.00	2.00	13	2	***yes***	no			NA	NA	--	--	
Bromomethane	0.52	ncsl					NA	NA	--	--			NA	NA	--	--	
CarbonDisulfide	73	ncsl	0.45	0.34	0.47	0.89	0.47	0.89	no	--			NA	NA	--	--	
CarbonTetrachloride	0.47	csl	0.78	0.63	0.77	0.75	0.78	0.75	***yes***	no			NA	NA	--	--	
Chlorobenzene	5.2	ncsl					NA	NA	--	--			NA	NA	--	--	
Chloroethane	1000	ncsl					NA	NA	--	--			NA	NA	--	--	
Chloroform	0.12	csl				0.36	NA	0.36	--	--			NA	NA	--	--	
Chloromethane	9.4	ncsl	1.70	1.60	1.60		1.7	NA	no	--			NA	NA	--	--	
cis12Dichloroethene	6.3	ncsl					NA	NA	--	--			NA	NA	--	--	
Cumene	42	ncsl	0.92	0.70	1.40		1.4	NA	no	--			NA	NA	--	--	
Cyclohexane	630	ncsl	1.50	1.40	1.70	0.85	1.7	0.85	no	--		340.00	340	NA	no	--	
EthylBenzene	1.1	csl	12.00	12.00	18.00	4.90	18	4.9	***yes***	no		5.90	5.9	NA	***yes***	--	
Freon11	73	ncsl	1.20	1.30	1.40	1.40	1.4	1.4	no	--			NA	NA	--	--	
Freon113	3100	ncsl	0.50	0.47	0.46	0.54	0.5	0.54	no	--			NA	NA	--	--	
Freon12	10	ncsl	2.70	2.80	2.80	4.30	2.8	4.3	no	--			NA	NA	--	--	
Hexane	73	ncsl	5.80	6.10	9.00	1.60	9	1.6	no	--		4.40	4.4	NA	no	--	
MethyleneChloride	63	ncsl				0.58	NA	0.58	--	--			NA	NA	--	--	
MethylTertButylEther	11	csl					NA	NA	--	--			NA	NA	--	--	
mpXylene	10	ncsl	53.00	52.00	78.00	17.00	78	17	***yes***	no		23.00	23	NA	***yes***	--	
oXylene	10	ncsl	17.00	17.00	24.00	6.70	24	6.7	***yes***	no		12.00	12	NA	***yes***	--	
Propylbenzene	100	ncsl	2.80	2.90	4.10	1.90	4.1	1.9	no	--		6.80	6.8	NA	no	--	
Styrene	100	ncsl	2.40	2.50	3.30	3.00	3.3	3	no	--			NA	NA	--	--	
Tetrachloroethene	4.2	ncsl	1.00	0.98	1.20	8.60	1.2	8.6	no	--			NA	NA	--	--	
Tetrahydrofuran	210	ncsl	1.00	1.00	1.40	3.20	1.4	3.2	no	--		13.00	13	NA	no	--	
Toluene	520	ncsl	68.00	68.00	110.00	13.00	110	13	no	--		360.00	360	NA	no	--	
trans12Dichloroethene	6.3	ncsl	0.02		0.02		0.024	NA	no	--		230.00	230	NA	***yes***	--	
Trichloroethene	0.21	ncsl					NA	NA	--	--			NA	NA	--	--	
VinylChloride	0.17	csl	0.03	0.02		0.04	0.025	0.037	no	--			NA	NA	--	--	

FieldSampNo			[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-D Indoor Air	[redacted] Sub-Slab 1						[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-Sub-Slab 1					
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]	[redacted]	[redacted]				
UniqueID			[redacted]-A Indoor Air 06/29/2013	[redacted]-B Indoor Air 06/29/2013	[redacted]-C Indoor Air 06/29/2013	[redacted]-D Indoor Air 06/29/2013	[redacted] Sub-Slab 1 09/06/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max		[redacted]-A Indoor Air 07/12/2013	[redacted]-B Indoor Air 07/12/2013	[redacted]-Sub-Slab 1 09/26/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max	
SampleType			Indoor Air	Indoor Air	Indoor Air	Indoor Air	Sub-Slab						Indoor Air	Indoor Air	Sub-Slab					
Duplicate																				
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Main Floor Bedroom	Main Floor Office	Basement Bedroom	Basement Theatre Room	Basement Sub-Slab						Second Floor Office	Main Floor Living Room	Garage Sub-Slab					
SamDate			6/29/2013	6/29/2013	6/29/2013	6/29/2013	9/6/2013						7/12/2013	7/12/2013	9/26/2013					
111Trichloroethane	520	ncsl			0.03		0.03	0.034	0.033	no	--		0.05	0.03		0.048	NA	no	--	
11Dichloroethane	1.8	ncsl						NA	NA	--	--		0.01			0.0067	NA	no	--	
124Trimethylbenzene	0.73	ncsl	5.90	1.50	7.20	7.00	5.80	7.2	5.8	*yes*	no		9.10	2.00		9.1	NA	*yes*	--	
12Dichloroethane	0.11	csl	0.45	0.52	0.23	0.25	0.06	0.52	0.062	*yes*	no		0.23	0.11		0.23	NA	*yes*	--	
14Dioxane	0.56	csl			0.51	0.66	1.20	0.66	1.2	*yes*	*yes*		0.64	0.28		0.64	NA	*yes*	--	
2Butanone	520	ncsl	8.00	6.20	5.70	7.80	10.00	8	10	no	--		9.80	4.90		9.8	NA	no	--	
2Hexanone	3.1	ncsl			0.45			0.45	NA	no	--		0.95			0.95	NA	no	--	
2Propanol	730	ncsl	300.00	140.00	80.00	110.00	35.00	300	35	no	--		13.00	8.80		13	NA	no	--	
4Methyl2pentanone	310	ncsl		1.50	1.60	2.00	1.80	2	1.8	no	--		2.00	2.70		2.7	NA	no	--	
Acetone	3200	ncsl	85.00	83.00	71.00	80.00	61.00	85	61	no	--		100.00	68.00	240.00	100	240	no	--	
Benzene	0.36	csl	4.70	4.20	4.80	4.70	9.00	4.8	9	*yes*	*yes*		3.20	0.79		3.2	NA	*yes*	--	
Bromomethane	0.52	ncsl						NA	NA	--	--					NA	NA	--	--	
CarbonDisulfide	73	ncsl			1.40		1.00	1.4	1	no	--		0.30	0.54		0.54	NA	no	--	
CarbonTetrachloride	0.47	csl		0.61	0.71	0.84		0.84	NA	*yes*	--		0.42			0.42	NA	no	--	
Chlorobenzene	5.2	ncsl					0.45	NA	0.45	--	--					NA	NA	--	--	
Chloroethane	1000	ncsl						NA	NA	--	--					NA	NA	--	--	
Chloroform	0.12	csl	0.78	1.30	0.41	0.55		1.3	NA	*yes*	--		1.60	0.67		1.6	NA	*yes*	--	
Chloromethane	9.4	ncsl					0.17	NA	0.17	--	--					NA	NA	--	--	
cis12Dichloroethene	6.3	ncsl						NA	NA	--	--					NA	NA	--	--	
Cumene	42	ncsl					3.80	NA	3.8	--	--					NA	NA	--	--	
Cyclohexane	630	ncsl	2.00	1.80	1.50	1.40	0.81	2	0.81	no	--		2.00	0.58		2	NA	no	--	
EthylBenzene	1.1	csl	3.40	2.20	3.00	3.10	4.60	3.4	4.6	*yes*	*yes*		7.10	2.10		7.1	NA	*yes*	--	
Freon11	73	ncsl		1.20	1.20	1.30	1.10	1.3	1.1	no	--		1.30	1.50		1.5	NA	no	--	
Freon113	3100	ncsl			0.49		0.34	0.49	0.34	no	--		0.44	0.44		0.44	NA	no	--	
Freon12	10	ncsl			2.50		2.60	2.5	2.6	no	--		2.80	2.90		2.9	NA	no	--	
Hexane	73	ncsl	9.30	7.70	7.80	7.20	1.40	9.3	1.4	no	--		2.00	0.84		2	NA	no	--	
MethyleneChloride	63	ncsl		0.86	0.80	0.78		0.86	NA	no	--			1.90		1.9	NA	no	--	
MethylTertButylEther	11	csl				0.03	0.03	0.034	0.029	no	--					NA	NA	--	--	
mpXylene	10	ncsl	7.80	3.50	9.10	8.80	17.00	9.1	17	no	--		24.00	5.10		24	NA	*yes*	--	
oXylene	10	ncsl	2.80	1.00	3.30	3.10	5.50	3.3	5.5	no	--		7.80	1.70		7.8	NA	no	--	
Propylbenzene	100	ncsl				1.10	1.10	1.1	1.1	no	--		1.60	0.38		1.6	NA	no	--	
Styrene	100	ncsl	6.90	1.40	2.40	3.50	3.50	6.9	3.5	no	--		3.90	2.00	230.00	3.9	230	no	--	
Tetrachloroethene	4.2	ncsl		0.12	0.18	0.13	1.40	0.18	1.4	no	--					NA	NA	--	--	
Tetrahydrofuran	210	ncsl			0.53	1.50	5.10	1.5	5.1	no	--		4.60	1.80		4.6	NA	no	--	
Toluene	520	ncsl	36.00	25.00	24.00	27.00	19.00	36	19	no	--		40.00	18.00		40	NA	no	--	
trans12Dichloroethene	6.3	ncsl			0.04			0.043	NA	no	--					NA	NA	--	--	
Trichloroethene	0.21	ncsl			0.11			0.11	NA	no	--		0.02			0.015	NA	no	--	
VinylChloride	0.17	csl						NA	NA	--	--					NA	NA	--	--	

FieldSampNo			[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]Sub-Slab 1						[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-Sub-Slab 1				
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]	[redacted]	[redacted]			
UniqueID			[redacted]-A Indoor Air 07/19/2013	[redacted]-B Indoor Air 07/19/2013	[redacted]-C Indoor Air 07/19/2013	[redacted]-Sub-Slab 1 08/22/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max		[redacted]-A Indoor Air 07/02/2013	[redacted]-B Indoor Air 07/02/2013	[redacted]-Sub-Slab 1 08/23/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max
SampleType			Indoor Air	Indoor Air	Indoor Air	Sub-Slab						Indoor Air	Indoor Air	Sub-Slab				
Duplicate																		
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Main Floor Kitchen	Second Floor	Basement Storage Room	Valve Port on Extraction Pipe						Main Floor Office	Main Floor Bedroom	Basement Sub-Slab				
SamDate			7/19/2013	7/19/2013	7/19/2013	8/22/2013						7/2/2013	7/2/2013	8/23/2013				
111Trichloroethane	520	ncsl	0.04	0.05	0.03	0.04	0.047	0.037	no	--		0.03	0.03	0.07	0.033	0.07	no	--
11Dichloroethane	1.8	ncsl	0.02	0.02	0.01		0.019	NA	no	--					NA	NA	--	--
124Trimethylbenzene	0.73	ncsl	0.99	0.99	0.48	7.60	0.99	7.6	*yes*	*yes*		0.62	0.48	8.10	0.62	8.1	no	--
12Dichloroethane	0.11	csl	0.09	0.11	0.06		0.11	NA	no	--		0.30	0.41		0.41	NA	*yes*	--
14Dioxane	0.56	csl	1.20	1.40	0.64	0.85	1.4	0.85	*yes*	no		0.18			0.18	NA	no	--
2Butanone	520	ncsl	2.80	3.30	3.10	140.00	3.3	140	no	--		4.40		10.00	4.4	10	no	--
2Hexanone	3.1	ncsl	0.97	0.99	0.43		0.99	NA	no	--		0.89	0.46	0.80	0.89	0.8	no	--
2Propanol	730	ncsl	4.50	4.70	2.30	5.70	4.7	5.7	no	--		7.10	3.00	4.60	7.1	4.6	no	--
4Methyl2pentanone	310	ncsl	0.72	0.65	0.33	0.71	0.72	0.71	no	--		0.82	0.40	0.97	0.82	0.97	no	--
Acetone	3200	ncsl	47.00	56.00	38.00	60.00	56	60	no	--		49.00	29.00	43.00	49	43	no	--
Benzene	0.36	csl	0.38	0.34	0.30	0.81	0.38	0.81	*yes*	*yes*		0.42		0.74	0.42	0.74	*yes*	*yes*
Bromomethane	0.52	ncsl					NA	NA	--	--					NA	NA	--	--
CarbonDisulfide	73	ncsl				0.59	NA	0.59	--	--		0.19		0.35	0.19	0.35	no	--
CarbonTetrachloride	0.47	csl	0.42	0.41	0.43	0.64	0.43	0.64	no	--		0.43	0.35		0.43	NA	no	--
Chlorobenzene	5.2	ncsl					NA	NA	--	--					NA	NA	--	--
Chloroethane	1000	ncsl					NA	NA	--	--					NA	NA	--	--
Chloroform	0.12	csl	0.27	0.27	0.26	0.79	0.27	0.79	*yes*	*yes*				0.48	NA	0.48	--	--
Chloromethane	9.4	ncsl	2.00	2.00	1.50		2	NA	no	--		1.30	1.20		1.3	NA	no	--
cis12Dichloroethene	6.3	ncsl					NA	NA	--	--					NA	NA	--	--
Cumene	42	ncsl					NA	NA	--	--					NA	NA	--	--
Cyclohexane	630	ncsl	0.13		0.11		0.13	NA	no	--		0.24		0.52	0.24	0.52	no	--
EthylBenzene	1.1	csl	0.52	0.61	2.70	3.30	2.7	3.3	*yes*	*yes*		0.57	0.24	2.80	0.57	2.8	no	--
Freon11	73	ncsl	1.20	1.30	1.30	1.50	1.3	1.5	no	--		1.10	1.00	1.80	1.1	1.8	no	--
Freon113	3100	ncsl	0.58	0.44	0.56		0.58	NA	no	--		0.49	0.48	0.60	0.49	0.6	no	--
Freon12	10	ncsl	2.50	2.40	2.80	4.40	2.8	4.4	no	--		2.60	2.40	12.00	2.6	12	no	--
Hexane	73	ncsl	0.63	0.58	0.69		0.69	NA	no	--		1.00	0.56	0.49	1	0.49	no	--
MethyleneChloride	63	ncsl				0.30	NA	0.3	--	--		30.00	10.00	17.00	30	17	no	--
MethylTertButylEther	11	csl				0.01	NA	0.013	--	--				0.02	NA	0.017	--	--
mpXylene	10	ncsl	0.86	0.86	1.10	12.00	1.1	12	no	--		1.60	0.77	10.00	1.6	10	no	--
oXylene	10	ncsl	0.27	0.27	0.35	4.70	0.35	4.7	no	--		0.49	0.22	4.30	0.49	4.3	no	--
Propylbenzene	100	ncsl			0.30	1.40	0.3	1.4	no	--				1.20	NA	1.2	--	--
Styrene	100	ncsl	0.95	1.20	0.26	1.50	1.2	1.5	no	--		0.46	0.26	1.40	0.46	1.4	no	--
Tetrachloroethene	4.2	ncsl	0.05	0.04	0.09	2.20	0.085	2.2	no	--		0.07	0.05	17.00	0.073	17	no	--
Tetrahydrofuran	210	ncsl		0.64	0.88	140.00	0.88	140	no	--		0.58		2.60	0.58	2.6	no	--
Toluene	520	ncsl	4.40	4.80	3.40	7.70	4.8	7.7	no	--		8.70	4.30	6.80	8.7	6.8	no	--
trans12Dichloroethene	6.3	ncsl	0.04	0.02			0.042	NA	no	--					NA	NA	--	--
Trichloroethene	0.21	ncsl	0.05	0.03	0.02		0.052	NA	no	--				0.08	NA	0.075	--	--
VinylChloride	0.17	csl					NA	NA	--	--		0.03	0.01	0.05	0.026	0.048	no	--

FieldSampNo			[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-Sub-Slab 1						[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-Sub-Slab 1				
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			
UniqueID			[redacted]-A Indoor Air 07/09/2013	[redacted]-B Indoor Air 07/09/2013	[redacted]-Sub-Slab 1 08/27/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max		[redacted]-A Indoor Air 08/24/2013	[redacted]-B Indoor Air 08/24/2013	[redacted]-C Indoor Air 08/24/2013	[redacted]-Sub-Slab 1 08/23/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max
SampleType			Indoor Air	Indoor Air	Sub-Slab						Indoor Air	Indoor Air	Indoor Air	Sub-Slab				
Duplicate																		
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Main Floor Dining Room	Basement Family Room	Basement Sub-Slab						Basement Bedroom	Main Floor Kitchen	Second Floor Bedroom	Sub-Slab				
SamDate			7/9/2013	7/9/2013	8/27/2013						8/24/2013	8/24/2013	8/24/2013	8/23/2013				
111Trichloroethane	520	ncsl	0.04	0.03		0.037	NA	no	--		0.06	0.09	0.05	0.05	0.094	0.05	no	--
11Dichloroethane	1.8	ncsl				NA	NA	--	--						NA	NA	--	--
124Trimethylbenzene	0.73	ncsl	2.80	2.80		2.8	NA	*yes*	--		1.20	0.81	0.64	7.60	1.2	7.6	*yes*	*yes*
12Dichloroethane	0.11	csl	5.30	3.90	0.85	5.3	0.85	*yes*	no			0.19	0.15		0.19	NA	*yes*	--
14Dioxane	0.56	csl				NA	NA	--	--		1.20	1.30	0.53	0.58	1.3	0.58	*yes*	no
2Butanone	520	ncsl	7.70	5.90	26.00	7.7	26	no	--		8.90	4.50	4.20	6.00	8.9	6	no	--
2Hexanone	3.1	ncsl	1.30	0.74		1.3	NA	no	--				0.32	0.58	0.32	0.58	no	--
2Propanol	730	ncsl	41.00	24.00		41	NA	no	--		4.70	16.00	5.90	13.00	16	13	no	--
4Methyl2pentanone	310	ncsl	1.40	1.00		1.4	NA	no	--				0.34	0.44	0.34	0.44	no	--
Acetone	3200	ncsl	86.00	63.00	170.00	86	170	no	--		44.00	42.00	32.00	31.00	44	31	no	--
Benzene	0.36	csl	2.20	2.50		2.5	NA	*yes*	--		0.49	0.46	0.42	0.98	0.49	0.98	*yes*	*yes*
Bromomethane	0.52	ncsl				NA	NA	--	--						NA	NA	--	--
CarbonDisulfide	73	ncsl	0.25			0.25	NA	no	--					0.53	NA	0.53	--	--
CarbonTetrachloride	0.47	csl	0.49	0.47		0.49	NA	*yes*	--						NA	NA	--	--
Chlorobenzene	5.2	ncsl				NA	NA	--	--						NA	NA	--	--
Chloroethane	1000	ncsl				NA	NA	--	--				0.54		0.54	NA	no	--
Chloroform	0.12	csl				NA	NA	--	--				0.26		0.26	NA	*yes*	--
Chloromethane	9.4	ncsl	1.70	1.60	2.40	1.7	2.4	no	--						NA	NA	--	--
cis12Dichloroethene	6.3	ncsl				NA	NA	--	--						NA	NA	--	--
Cumene	42	ncsl			0.72	NA	0.72	--	--						NA	NA	--	--
Cyclohexane	630	ncsl	1.40	1.30	0.66	1.4	0.66	no	--		2.10	0.95	0.47	0.26	2.1	0.26	no	--
EthylBenzene	1.1	csl	2.80	1.90	1.50	2.8	1.5	*yes*	no		0.34	0.24	0.18	3.50	0.34	3.5	no	--
Freon11	73	ncsl	1.20	1.40	1.30	1.4	1.3	no	--		1.60	1.40		1.50	1.6	1.5	no	--
Freon113	3100	ncsl	0.59	0.30		0.59	NA	no	--		2.20	2.40	1.70	2.30	2.4	2.3	no	--
Freon12	10	ncsl	2.70	2.60	3.50	2.7	3.5	no	--		2.70	2.30	2.50	2.70	2.7	2.7	no	--
Hexane	73	ncsl	3.60	3.30		3.6	NA	no	--		9.70	3.10	1.80		9.7	NA	no	--
MethyleneChloride	63	ncsl				NA	NA	--	--						NA	NA	--	--
MethylTertButylEther	11	csl	0.02	0.03		0.031	NA	no	--					0.11	NA	0.11	--	--
mpXylene	10	ncsl	10.00	6.60	5.10	10	5.1	no	--		0.50	0.53	0.36	13.00	0.53	13	no	--
oXylene	10	ncsl	2.90	2.20	2.20	2.9	2.2	no	--		0.18			5.10	0.18	5.1	no	--
Propylbenzene	100	ncsl	0.53	0.55		0.55	NA	no	--					1.40	NA	1.4	--	--
Styrene	100	ncsl	2.10	1.70		2.1	NA	no	--		1.70	0.56	0.27	1.80	1.7	1.8	no	--
Tetrachloroethene	4.2	ncsl	0.09	0.08	11.00	0.093	11	no	--					0.49	NA	0.49	--	--
Tetrahydrofuran	210	ncsl	0.68	0.95	670.00	0.95	670	no	--		3.10	1.20	0.78	2.60	3.1	2.6	no	--
Toluene	520	ncsl	22.00	15.00	6.20	22	6.2	no	--		3.20	2.10	1.80	8.50	3.2	8.5	no	--
trans12Dichloroethene	6.3	ncsl				NA	NA	--	--		0.76		0.18		0.76	NA	no	--
Trichloroethene	0.21	ncsl	1.20	0.47	1.30	1.2	1.3	*yes*	*yes*				0.02		0.016	NA	no	--
VinylChloride	0.17	csl				NA	NA	--	--					0.06	NA	0.058	--	--

FieldSampNo			[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-Sub-Slab 1						[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-Sub-Slab 1				
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			
UniqueID			[redacted]-A Indoor Air 07/03/2013	[redacted]-B Indoor Air 07/03/2013	[redacted]-Sub-Slab 1 08/21/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max		[redacted]-A Indoor Air 07/11/2013	[redacted]-B Indoor Air 07/11/2013	[redacted]-C Indoor Air 07/11/2013	[redacted]-Sub-Slab 1 08/26/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max
SampleType			Indoor Air	Indoor Air	Sub-Slab						Indoor Air	Indoor Air	Indoor Air	Sub-Slab				
Duplicate																		
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Main Floor Living Room	Second Floor Office	Sub-Slab						Main Floor Living Room	Second Floor Bedroom	Basement Family Room	Basement Sub-Slab				
SamDate			7/3/2013	7/3/2013	8/21/2013						7/11/2013	7/11/2013	7/11/2013	8/26/2013				
111Trichloroethane	520	ncsl			0.08	NA	0.078	--	--		0.03	0.02	0.03	0.03	0.029	0.029	no	--
11Dichloroethane	1.8	ncsl				NA	NA	--	--						NA	NA	--	--
124Trimethylbenzene	0.73	ncsl	52.00	48.00	7.70	52	7.7	*yes*	no		6.70	15.00	6.30	16.00	15	16	*yes*	*yes*
12Dichloroethane	0.11	csl				NA	NA	--	--		0.18	0.14	0.14		0.18	NA	*yes*	--
14Dioxane	0.56	csl	1.60			1.6	NA	*yes*	--		0.54	0.68	0.55	1.00	0.68	1	*yes*	*yes*
2Butanone	520	ncsl	12.00	10.00	7.90	12	7.9	no	--		5.50	4.30	4.30	5.30	5.5	5.3	no	--
2Hexanone	3.1	ncsl			0.60	NA	0.6	--	--		1.20	0.62	0.72		1.2	NA	no	--
2Propanol	730	ncsl	21.00	22.00	12.00	22	12	no	--		14.00	13.00	10.00	7.40	14	7.4	no	--
4Methyl2pentanone	310	ncsl	1.70	2.50	0.85	2.5	0.85	no	--		1.00	1.40	0.88	2.50	1.4	2.5	no	--
Acetone	3200	ncsl	120.00	130.00	69.00	130	69	no	--		71.00	70.00	64.00	51.00	71	51	no	--
Benzene	0.36	csl	26.00	25.00	1.60	26	1.6	*yes*	no		1.20	1.70	1.10	1.20	1.7	1.2	*yes*	no
Bromomethane	0.52	ncsl				NA	NA	--	--						NA	NA	--	--
CarbonDisulfide	73	ncsl	0.36	0.32		0.36	NA	no	--		0.32	0.32	0.26	2.00	0.32	2	no	--
CarbonTetrachloride	0.47	csl			0.45	NA	0.45	--	--		0.35	0.60	0.51		0.6	NA	*yes*	--
Chlorobenzene	5.2	ncsl				NA	NA	--	--						NA	NA	--	--
Chloroethane	1000	ncsl				NA	NA	--	--						NA	NA	--	--
Chloroform	0.12	csl			0.08	NA	0.075	--	--		0.54		0.43	0.26	0.54	0.26	*yes*	no
Chloromethane	9.4	ncsl	2.00			2	NA	no	--		1.40	1.40	1.40	0.24	1.4	0.24	no	--
cis12Dichloroethene	6.3	ncsl				NA	NA	--	--						NA	NA	--	--
Cumene	42	ncsl	2.10	2.00	0.55	2.1	0.55	no	--					1.70	NA	1.7	--	--
Cyclohexane	630	ncsl	19.00	21.00	1.60	21	1.6	no	--		0.33	0.28	0.17	0.60	0.33	0.6	no	--
EthylBenzene	1.1	csl	30.00	28.00	4.10	30	4.1	*yes*	no		1.60	2.60	1.50	5.70	2.6	5.7	*yes*	*yes*
Freon11	73	ncsl	1.50	1.60	1.40	1.6	1.4	no	--		1.40	1.30	1.30	1.40	1.4	1.4	no	--
Freon113	3100	ncsl	1.20	1.20	0.78	1.2	0.78	no	--		0.40	0.47	0.66	0.52	0.66	0.52	no	--
Freon12	10	ncsl	2.60	2.70	2.90	2.7	2.9	no	--		2.60	2.60	2.60	3.60	2.6	3.6	no	--
Hexane	73	ncsl	54.00	56.00	1.30	56	1.3	no	--		1.80	1.60	1.60	0.35	1.8	0.35	no	--
MethyleneChloride	63	ncsl			0.43	NA	0.43	--	--						NA	NA	--	--
MethylTertButylEther	11	csl	0.44	0.37	0.33	0.44	0.33	no	--					0.07	NA	0.07	--	--
mpXylene	10	ncsl	140.00	120.00	14.00	140	14	*yes*	no		7.10	12.00	6.40	23.00	12	23	*yes*	*yes*
oXylene	10	ncsl	40.00	36.00	5.60	40	5.6	*yes*	no		2.30	4.00	2.10	8.10	4	8.1	no	--
Propylbenzene	100	ncsl	7.70	7.30	1.30	7.7	1.3	no	--		1.20	2.70	1.20	3.00	2.7	3	no	--
Styrene	100	ncsl	8.40	8.50	1.80	8.5	1.8	no	--		0.62	0.67	0.42	2.20	0.67	2.2	no	--
Tetrachloroethene	4.2	ncsl	0.47	0.47	7.20	0.47	7.2	no	--		0.17	0.13	0.09	3.30	0.17	3.3	no	--
Tetrahydrofuran	210	ncsl	4.90	4.40	4.50	4.9	4.5	no	--		0.76			3.10	0.76	3.1	no	--
Toluene	520	ncsl	220.00	210.00	15.00	220	15	no	--		10.00	13.00	9.60	13.00	13	13	no	--
trans12Dichloroethene	6.3	ncsl				NA	NA	--	--						NA	NA	--	--
Trichloroethene	0.21	ncsl				NA	NA	--	--						NA	NA	--	--
VinylChloride	0.17	csl			0.05	NA	0.045	--	--					0.07	NA	0.067	--	--

FieldSampNo			[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-Sub-Slab 1	[redacted]-Sub-Slab 2						[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-Sub-Slab 1					
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]	[redacted]	[redacted]	[redacted]				
UniqueID			[redacted]-A Indoor Air 08/09/2013	[redacted]-B Indoor Air 08/09/2013	[redacted]-C Indoor Air 08/09/2013	[redacted]-Sub-Slab 1 10/07/2013	[redacted]-Sub-Slab 2 10/07/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max		[redacted]-A Indoor Air 07/09/2013	[redacted]-B Indoor Air 07/09/2013	[redacted]-C Indoor Air 07/09/2013	[redacted]-Sub-Slab 1 09/05/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL ... then Max SS > Max	
SampleType			Indoor Air	Indoor Air	Indoor Air	Sub-Slab	Sub-Slab						Indoor Air	Indoor Air	Indoor Air	Sub-Slab					
Duplicate				Duplicate of SAI-9-A																	
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Basement Family Room	Basement Family Room	Main Floor Living Room	Basement Sub-Slab	Sub-Slab						Second Floor Office	Main Floor Kitchen	Main Floor Kitchen	Sub-Slab					
SamDate			8/9/2013	8/9/2013	8/9/2013	10/7/2013	10/7/2013						7/9/2013	7/9/2013	7/9/2013	9/5/2013					
111Trichloroethane	520	ncsl	0.04			0.04	0.07	0.04	0.07	no	--		0.03	0.03	0.03		0.032	NA	no	--	
11Dichloroethane	1.8	ncsl						NA	NA	--	--		0.03	0.03	0.02		0.026	NA	no	--	
124Trimethylbenzene	0.73	ncsl	2.60	2.90	1.70	1.20	11.00	2.9	11	*yes*	*yes*			0.68	1.50		1.5	NA	*yes*	--	
12Dichloroethane	0.11	csl	0.63	0.71	0.47	0.06	0.34	0.71	0.34	*yes*	no		0.17	0.17	0.14		0.17	NA	*yes*	--	
14Dioxane	0.56	csl	0.40		0.52			0.52	NA	no	--		0.69	0.42			0.69	NA	*yes*	--	
2Butanone	520	ncsl	5.20	3.80	3.50	6.10	11.00	5.2	11	no	--		7.80	12.00	5.40	2200.00	12	2200	no	--	
2Hexanone	3.1	ncsl	0.58		0.64	0.47		0.64	0.47	no	--			2.30	0.98		2.3	NA	no	--	
2Propanol	730	ncsl	37.00	37.00	28.00	20.00	21.00	37	21	no	--		8.50	10.00	6.40		10	NA	no	--	
4Methyl2pentanone	310	ncsl	0.57	0.74	0.55	0.54	3.40	0.74	3.4	no	--		0.63	0.84	0.56		0.84	NA	no	--	
Acetone	3200	ncsl	160.00	140.00	120.00	46.00	54.00	160	54	no	--		100.00	120.00	85.00	180.00	120	180	no	--	
Benzene	0.36	csl	1.30	1.40	1.10		14.00	1.4	14	*yes*	*yes*		0.65	0.58	0.52	1.10	0.65	1.1	*yes*	*yes*	
Bromomethane	0.52	ncsl						NA	NA	--	--						NA	NA	--	--	
CarbonDisulfide	73	ncsl	0.90	0.35				0.9	NA	no	--		0.17		0.15	2.40	0.17	2.4	no	--	
CarbonTetrachloride	0.47	csl				0.40	0.54	NA	0.54	--	--		0.31	0.48	0.40		0.48	NA	*yes*	--	
Chlorobenzene	5.2	ncsl						NA	NA	--	--						NA	NA	--	--	
Chloroethane	1000	ncsl						NA	NA	--	--						NA	NA	--	--	
Chloroform	0.12	csl	12.00	12.00	7.10	1.30	1.60	12	1.6	*yes*	no		0.52	0.48	0.36		0.52	NA	*yes*	--	
Chloromethane	9.4	ncsl	1.50	1.50	1.40	0.41	0.40	1.5	0.41	no	--		1.80		1.40	3.50	1.8	3.5	no	--	
cis12Dichloroethene	6.3	ncsl						NA	NA	--	--						NA	NA	--	--	
Cumene	42	ncsl				0.79	8.80	NA	8.8	--	--					4.80	NA	4.8	--	--	
Cyclohexane	630	ncsl	0.56	0.64	0.55	1.30	12.00	0.64	12	no	--		0.33	0.20	0.23		0.33	NA	no	--	
EthylBenzene	1.1	csl	2.40	2.40	2.00	0.45	36.00	2.4	36	*yes*	*yes*		1.30	1.20	0.78		1.3	NA	*yes*	--	
Freon11	73	ncsl	1.20	1.20	1.20	1.10	1.20	1.2	1.2	no	--		1.30	1.30	1.40	1.30	1.4	1.3	no	--	
Freon113	3100	ncsl	0.63				0.49	0.63	0.49	no	--		0.53	0.66	0.39		0.66	NA	no	--	
Freon12	10	ncsl	2.50	2.50	2.50	2.20	2.20	2.5	2.2	no	--		2.80	2.60	2.80	7.40	2.8	7.4	no	--	
Hexane	73	ncsl	1.60	1.70	1.60		33.00	1.7	33	no	--		1.30	1.40	1.10		1.4	NA	no	--	
MethyleneChloride	63	ncsl				0.33		NA	0.33	--	--						NA	NA	--	--	
MethylTertButylEther	11	csl				0.09	0.10	NA	0.1	--	--						NA	NA	--	--	
mpXylene	10	ncsl	8.80	9.10	7.10	1.30	39.00	9.1	39	no	--		4.50	4.00	2.50		4.5	NA	no	--	
oXylene	10	ncsl	2.40	2.60	2.00	0.57	33.00	2.6	33	no	--		1.20	1.10	0.70		1.2	NA	no	--	
Propylbenzene	100	ncsl				0.46	8.90	NA	8.9	--	--		0.31				0.31	NA	no	--	
Styrene	100	ncsl	0.66	0.73	0.48	0.41		0.73	0.41	no	--		1.70	1.20	0.88		1.7	NA	no	--	
Tetrachloroethene	4.2	ncsl	0.44	0.47	0.36	0.63	0.61	0.47	0.63	no	--					2.80	NA	2.8	--	--	
Tetrahydrofuran	210	ncsl				5.80	5.80	NA	5.8	--	--		1.80	2.10	1.70	1500.00	2.1	1500	no	--	
Toluene	520	ncsl	19.00	18.00	14.00	1.50	85.00	19	85	no	--		8.00	8.00	6.10	1.40	8	1.4	no	--	
trans12Dichloroethene	6.3	ncsl						NA	NA	--	--		0.08	0.07	0.07		0.082	NA	no	--	
Trichloroethene	0.21	ncsl						NA	NA	--	--		0.06	0.02	0.05		0.063	NA	no	--	
VinylChloride	0.17	csl				0.03	0.03	NA	0.03	--	--					0.58	NA	0.58	--	--	

FieldSampNo			[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-D Indoor Air	[redacted]-E Indoor Air	[redacted]-Sub-Slab 1					[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-Sub-Slab 1				
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]				[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			
UniqueID			[redacted] A Indoor Air 07/16/2013	[redacted]-B Indoor Air 07/16/2013	[redacted]-C Indoor Air 07/16/2013	[redacted]-D Indoor Air 07/16/2013	[redacted]-E Indoor Air 07/16/2013	[redacted]-Sub-Slab 1 08/28/2013	Indoor Air Max (exclwlsspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max	[redacted]-A Indoor Air 07/10/2013	[redacted]-B Indoor Air 07/10/2013	[redacted]-C Indoor Air 07/10/2013	[redacted]-Sub-Slab 1 09/05/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max
SampleType			Indoor Air	Indoor Air	Indoor Air	Indoor Air	Indoor Air	Sub-Slab					Indoor Air	Indoor Air	Indoor Air	Sub-Slab				
Duplicate						Duplicate														
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Basement East	Basement West	Main Floor Den	Main Floor Den	Main Floor Master Bedroom	Extraction Pipe					Second Floor Common Area	Main Floor Dining Room	Basement Family Room	Basement Sub-Slab				
SamDate			7/16/2013	7/16/2013	7/16/2013	7/16/2013	7/16/2013	8/28/2013					7/10/2013	7/10/2013	7/10/2013	9/5/2013				
111Trichloroethane	520	ncsl	0.10	0.09	0.17	0.15	0.09		0.17	NA	no	--	0.03	0.03	0.03		0.032	NA	no	--
11Dichloroethane	1.8	ncsl	0.01	0.01	0.01	0.01	0.01		0.012	NA	no	--					NA	NA	--	--
124Trimethylbenzene	0.73	ncsl	1.80	1.60	1.30	1.30	1.00	2.10	1.8	2.1	*yes*	*yes*	1.50	1.30	1.20		1.5	NA	*yes*	--
12Dichloroethane	0.11	csl	0.18	0.39	0.16	0.15	0.15		0.39	NA	*yes*	--	0.11	0.08	0.10		0.11	NA	no	--
14Dioxane	0.56	csl	0.50	0.92	0.40	0.43	0.26		0.92	NA	*yes*	--	1.30	1.30	1.80		1.8	NA	*yes*	--
2Butanone	520	ncsl	2.80	5.30	2.20	2.30	2.10	23.00	5.3	23	no	--	7.00	7.70	7.00	570.00	7.7	570	no	--
2Hexanone	3.1	ncsl	0.35	0.65	0.45	0.56	0.26		0.65	NA	no	--	0.46	0.58	0.43		0.58	NA	no	--
2Propanol	730	ncsl	3.60	6.50	4.90	3.40	3.10		6.5	NA	no	--	16.00	13.00	11.00		16	NA	no	--
4Methyl2pentanone	310	ncsl	0.42	0.37	0.38	0.40	0.32		0.42	NA	no	--	0.62	0.61	0.47		0.62	NA	no	--
Acetone	3200	ncsl	40.00	55.00	35.00	35.00	40.00	66.00	55	66	no	--	58.00	51.00	47.00	730.00	58	730	no	--
Benzene	0.36	csl	0.56	1.70	0.59	0.56	0.52	0.87	1.7	0.87	*yes*	no	0.33	0.26	0.25	2.20	0.33	2.2	no	--
Bromomethane	0.52	ncsl							NA	NA	--	--					NA	NA	--	--
CarbonDisulfide	73	ncsl	0.24	0.24	0.14		0.15	0.76	0.24	0.76	no	--					NA	NA	--	--
CarbonTetrachloride	0.47	csl	0.44	0.54	0.51	0.49	0.48		0.54	NA	*yes*	--	0.40		0.47		0.47	NA	no	--
Chlorobenzene	5.2	ncsl							NA	NA	--	--					NA	NA	--	--
Chloroethane	1000	ncsl							NA	NA	--	--					NA	NA	--	--
Chloroform	0.12	csl	0.34	0.42	0.40	0.38	0.34	0.40	0.42	0.4	*yes*	no	0.24	0.15	0.18	0.29	0.24	0.29	*yes*	*yes*
Chloromethane	9.4	ncsl				3.60			3.6	NA	no	--	1.30			2.30	1.3	2.3	no	--
cis12Dichloroethene	6.3	ncsl							NA	NA	--	--					NA	NA	--	--
Cumene	42	ncsl						0.52	NA	0.52	--	--				10.00	NA	10	--	--
Cyclohexane	630	ncsl		0.59	0.26	0.21	0.21	0.12	0.59	0.12	no	--	1.00	0.71	0.98		1	NA	no	--
EthylBenzene	1.1	csl	0.56	0.85	0.56	0.51	0.47	1.10	0.85	1.1	no	--	2.20	2.10	2.10		2.2	NA	*yes*	--
Freon11	73	ncsl	2.40	2.30	2.10	2.00	2.10	1.30	2.4	1.3	no	--	1.40	1.20	1.30	1.30	1.4	1.3	no	--
Freon113	3100	ncsl	0.70	0.54	0.48	0.38	0.54	0.61	0.7	0.61	no	--	0.48	0.37	0.54		0.54	NA	no	--
Freon12	10	ncsl	2.80	2.70	2.70	2.70	2.80	2.60	2.8	2.6	no	--	3.10	3.00	3.00	5.30	3.1	5.3	no	--
Hexane	73	ncsl	0.75		0.89	0.66	0.64	0.27	0.89	0.27	no	--	1.30	0.81	0.98		1.3	NA	no	--
MethyleneChloride	63	ncsl							NA	NA	--	--	0.70				0.7	NA	no	--
MethylTertButylEther	11	csl							NA	NA	--	--	0.07	0.06	0.06		0.066	NA	no	--
mpXylene	10	ncsl	2.00	2.40	1.80	1.70	1.50	3.50	2.4	3.5	no	--	2.00	1.20	1.20		2	NA	no	--
oXylene	10	ncsl	0.71	0.88	0.61	0.60	0.55	1.40	0.88	1.4	no	--	0.77	0.55	0.56		0.77	NA	no	--
Propylbenzene	100	ncsl	0.26	0.24	0.19	0.24	0.19		0.26	NA	no	--	0.67	0.68	0.58		0.68	NA	no	--
Styrene	100	ncsl	0.28	0.55	0.30	0.31	0.23		0.55	NA	no	--	9.00	9.00	8.70		9	NA	no	--
Tetrachloroethene	4.2	ncsl	0.11	0.15	0.13	0.12	0.13		0.15	NA	no	--	1.00	0.98	1.00	2.70	1	2.7	no	--
Tetrahydrofuran	210	ncsl	1.10	0.85	0.67	0.60	0.66	200.00	1.1	200	no	--	2.20	1.60	1.80	2700.00	2.2	2700	no	--
Toluene	520	ncsl	4.20	30.00	4.80	4.20	3.50	5.80	30	5.8	no	--	3.70	2.70	2.70	2.60	3.7	2.6	no	--
trans12Dichloroethene	6.3	ncsl	0.02		0.02				0.024	NA	no	--					NA	NA	--	--
Trichloroethene	0.21	ncsl		0.06		0.02	0.02		0.057	NA	no	--		0.02	0.02		0.02	NA	no	--
VinylChloride	0.17	csl							NA	NA	--	--					NA	NA	--	--

FieldSampNo			[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-Sub-Slab 1						[redacted]-A Indoor Air	[redacted]-B Indoor Air	[redacted]-C Indoor Air	[redacted]-Sub-Slab 1				
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]					[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			
UniqueID			[redacted]-A Indoor Air 07/11/2013	[redacted]-B Indoor Air 07/11/2013	[redacted]-C Indoor Air 07/11/2013	[redacted]-Sub-Slab 1 09/06/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max		[redacted]-A Indoor Air 07/10/2013	[redacted]-B Indoor Air 07/10/2013	[redacted]-C Indoor Air 07/10/2013	[redacted]-Sub-Slab 1 08/23/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max
SampleType			Indoor Air	Indoor Air	Indoor Air	Sub-Slab						Indoor Air	Indoor Air	Indoor Air	Sub-Slab				
Duplicate																			
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Second Floor Loft	Main Floor Living Room	Basement Utility Room	Basement Sub-Slab						Second Floor Bedroom	Main Floor Living Room	Basement Play Room	Furance Room Sub-Slab				
SamDate			7/11/2013	7/11/2013	7/11/2013	9/6/2013						7/10/2013	7/10/2013	7/10/2013	8/23/2013				
111Trichloroethane	520	ncsl	0.68	0.77	0.69	0.33	0.77	0.33	no	--		0.03	0.03	0.03	0.04	0.031	0.037	no	--
11Dichloroethane	1.8	ncsl	0.02	0.02			0.017	NA	no	--					0.01	NA	0.01	--	--
124Trimethylbenzene	0.73	ncsl	0.52		2.70	3.90	2.7	3.9	*yes*	*yes*		0.80	1.00	1.50	6.70	1.5	6.7	*yes*	*yes*
12Dichloroethane	0.11	csl	0.95	1.00	7.30	0.28	7.3	0.28	*yes*	no		0.10	0.09	0.10	0.08	0.1	0.082	no	--
14Dioxane	0.56	csl	0.70	0.55	0.87		0.87	NA	*yes*	--		0.81	0.38	0.77		0.81	NA	*yes*	--
2Butanone	520	ncsl	3.80	3.40	21.00	5.80	21	5.8	no	--		4.40	4.50	4.80	7.30	4.8	7.3	no	--
2Hexanone	3.1	ncsl	0.37	0.41	0.99		0.99	NA	no	--		0.92	0.76	0.54	0.47	0.92	0.47	no	--
2Propanol	730	ncsl	5.60	4.80	13.00	16.00	13	16	no	--		16.00	15.00	15.00	6.60	16	6.6	no	--
4Methyl2pentanone	310	ncsl	0.43		0.62		0.62	NA	no	--		0.64	0.60	0.42	0.64	0.64	0.64	no	--
Acetone	3200	ncsl	41.00	29.00	58.00	54.00	58	54	no	--		38.00	43.00	47.00	63.00	47	63	no	--
Benzene	0.36	csl	0.30	0.27	1.30	2.10	1.3	2.1	*yes*	*yes*		0.29	0.27	0.29	1.40	0.29	1.4	no	--
Bromomethane	0.52	ncsl					NA	NA	--	--						NA	NA	--	--
CarbonDisulfide	73	ncsl	0.16		0.23	0.33	0.23	0.33	no	--				0.16	0.54	0.16	0.54	no	--
CarbonTetrachloride	0.47	csl	0.36	0.33	0.35		0.36	NA	no	--			0.46	0.37		0.46	NA	no	--
Chlorobenzene	5.2	ncsl					NA	NA	--	--						NA	NA	--	--
Chloroethane	1000	ncsl					NA	NA	--	--						NA	NA	--	--
Chloroform	0.12	csl	0.16	0.18	0.55		0.55	NA	*yes*	--		1.40	1.10	1.40	0.62	1.4	0.62	*yes*	no
Chloromethane	9.4	ncsl	2.20	2.00	2.10		2.2	NA	no	--		1.20	1.50	1.50	1.10	1.5	1.1	no	--
cis12Dichloroethene	6.3	ncsl		0.02			0.018	NA	no	--						NA	NA	--	--
Cumene	42	ncsl				1.00	NA	1	--	--				0.38	0.79	0.38	0.79	no	--
Cyclohexane	630	ncsl	0.23		0.53	1.70	0.53	1.7	no	--			0.21	0.23	0.70	0.23	0.7	no	--
EthylBenzene	1.1	csl	0.32	0.31	1.60	4.10	1.6	4.1	*yes*	*yes*		0.39	0.47	0.94	5.40	0.94	5.4	no	--
Freon11	73	ncsl	1.30	1.20	1.40	2.10	1.4	2.1	no	--		1.20	1.30	1.40	2.40	1.4	2.4	no	--
Freon113	3100	ncsl	0.76	0.49	0.51		0.76	NA	no	--		0.42	0.48	0.49	0.48	0.49	0.48	no	--
Freon12	10	ncsl	2.70	2.60	3.00	58.00	3	58	no	--		2.30	2.50	2.70	4.10	2.7	4.1	no	--
Hexane	73	ncsl	0.43	0.28	0.89	4.10	0.89	4.1	no	--		0.56	0.93	0.66	1.60	0.93	1.6	no	--
MethyleneChloride	63	ncsl					NA	NA	--	--						NA	NA	--	--
MethylTertButylEther	11	csl			0.03		0.026	NA	no	--						NA	NA	--	--
mpXylene	10	ncsl	0.97	0.99	6.70	11.00	6.7	11	no	--		0.95	1.10	1.80	11.00	1.8	11	no	--
oXylene	10	ncsl	0.32	0.33	2.00	3.90	2	3.9	no	--		0.31	0.36	0.55	4.40	0.55	4.4	no	--
Propylbenzene	100	ncsl			0.59	0.84	0.59	0.84	no	--				0.23	1.10	0.23	1.1	no	--
Styrene	100	ncsl		0.35	0.74	2.10	0.74	2.1	no	--		0.99	1.30	1.90	1.40	1.9	1.4	no	--
Tetrachloroethene	4.2	ncsl			1.30	340.00	1.3	340	no	--		0.17	0.19	0.38	17.00	0.38	17	no	--
Tetrahydrofuran	210	ncsl	0.68		1.50	1.20	1.5	1.2	no	--		0.81	1.30	2.10	1.80	2.1	1.8	no	--
Toluene	520	ncsl	2.20	2.00	10.00	18.00	10	18	no	--		5.80	7.30	19.00	13.00	19	13	no	--
trans12Dichloroethene	6.3	ncsl	0.03	0.03			0.033	NA	no	--		26.00	3.50	7.10	2.60	26	2.6	*yes*	no
Trichloroethene	0.21	ncsl	0.25	0.28	3.10	5.50	3.1	5.5	*yes*	*yes*					0.91	NA	0.91	--	--
VinylChloride	0.17	csl				0.05	NA	0.045	--	--					0.05	NA	0.049	--	--

FieldSampNo			[redacted]-A Indoor Air	[redacted] B Indoor Air	[redacted]-Sub-Slab 1	[redacted]-Sub-Slab 2				
HouseNo			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			
UniqueID			[redacted]-A Indoor Air 07/02/2013	[redacted]-B Indoor Air 07/02/2013	[redacted]-Sub-Slab 1 09/04/2013	[redacted]-Sub-Slab 2 09/04/2013	Indoor Air Max (excluding crawlspace)	Subslab Max	Max IA > RSL?	If Max IA > RSL … then Max SS > Max
SampleType			Indoor Air	Indoor Air	Sub-Slab	Sub-Slab				
Duplicate										
SamDescrip	RSL - Residential Air (ug/m3)	RSL Basis	Main Floor Master Bedroom	Basement Storage Room	Extraction Pipe	Extraction Pipe				
SamDate			7/2/2013	7/2/2013	9/4/2013	9/4/2013				
111Trichloroethane	520	ncsl	0.85	5.20	0.58	0.60	5.2	0.6	no	--
11Dichloroethane	1.8	ncsl					NA	NA	--	--
124Trimethylbenzene	0.73	ncsl	10.00	28.00	7.90	8.60	28	8.6	***yes***	no
12Dichloroethane	0.11	csl	0.14	0.35	0.03	0.02	0.35	0.028	***yes***	no
14Dioxane	0.56	csl					NA	NA	--	--
2Butanone	520	ncsl	6.80	24.00	3.10	2.20	24	3.1	no	--
2Hexanone	3.1	ncsl	0.97				0.97	NA	no	--
2Propanol	730	ncsl	910.00	160.00	4.30	3.00	910	4.3	***yes***	no
4Methyl2pentanone	310	ncsl	1.00	3.60	0.46	0.39	3.6	0.46	no	--
Acetone	3200	ncsl	89.00	80.00	15.00	12.00	89	15	no	--
Benzene	0.36	csl	8.10	16.00	0.46	0.41	16	0.46	***yes***	no
Bromomethane	0.52	ncsl			0.95	1.20	NA	1.2	--	--
CarbonDisulfide	73	ncsl	0.31	2.10			2.1	NA	no	--
CarbonTetrachloride	0.47	csl	0.32				0.32	NA	no	--
Chlorobenzene	5.2	ncsl					NA	NA	--	--
Chloroethane	1000	ncsl					NA	NA	--	--
Chloroform	0.12	csl					NA	NA	--	--
Chloromethane	9.4	ncsl	1.50	1.30		0.69	1.5	0.69	no	--
cis12Dichloroethene	6.3	ncsl					NA	NA	--	--
Cumene	42	ncsl	0.55	1.80		0.22	1.8	0.22	no	--
Cyclohexane	630	ncsl	2.50	9.10			9.1	NA	no	--
EthylBenzene	1.1	csl	7.50	23.00	1.20	1.20	23	1.2	***yes***	no
Freon11	73	ncsl	3.20	1.80	1.30	1.00	3.2	1.3	no	--
Freon113	3100	ncsl	0.40	0.79			0.79	NA	no	--
Freon12	10	ncsl	8.50	5.10	6.00	5.20	8.5	6	no	--
Hexane	73	ncsl	14.00	34.00	0.84	0.26	34	0.84	no	--
MethyleneChloride	63	ncsl	11.00	2.90			11	NA	no	--
MethylTertButylEther	11	csl					NA	NA	--	--
mpXylene	10	ncsl	30.00	90.00	5.40	5.30	90	5.4	***yes***	no
oXylene	10	ncsl	9.90	30.00	2.10	2.10	30	2.1	***yes***	no
Propylbenzene	100	ncsl	1.90	5.50	0.93	0.90	5.5	0.93	no	--
Styrene	100	ncsl	1.60	8.00	0.67	0.71	8	0.71	no	--
Tetrachloroethene	4.2	ncsl	0.79	15.00	60.00	62.00	15	62	***yes***	***yes***
Tetrahydrofuran	210	ncsl	0.67	3.40			3.4	NA	no	--
Toluene	520	ncsl	47.00	130.00	4.30	3.80	130	4.3	no	--
trans12Dichloroethene	6.3	ncsl					NA	NA	--	--
Trichloroethene	0.21	ncsl			1.60	1.60	NA	1.6	--	--
VinylChloride	0.17	csl	0.02	0.04	0.01	0.02	0.04	0.018	no	--

APPENDIX C – AUTHOR BIOGRAPHY

PAUL C. CHROSTOWSKI, Ph.D., QEP

CPF Associates, Inc.
7708 Takoma Ave.
Takoma Park, MD 20912
301-585-8062
pc@cpfassociates.com
www.cpfassociates.com

EDUCATION

Ph.D. Environmental Engineering and Science, Drexel University
Philadelphia, PA (1981).

M.S. Environmental Science, Drexel University,
Philadelphia, PA (Environmental Chemistry and Health Specializations, USPHS Traineeship) (1979).

B.S. Chemistry, University of California,
Berkeley, California (American Chemical Society Certified, Honors) (1976).

Continuing professional education in environmental engineering, fate and transport modeling, toxicology, and environmental forensics.

PROFESSIONAL CERTIFICATION

Dr. Chrostowski is a registered Qualified Environmental Professional (QEP) (#02970014)

AWARDS/RECOGNITION

Recipient of 2003 Linn Enslow Memorial Award by NYWEA. Recognized for 30 years of service to ACS Environmental Division.

OVERVIEW OF EXPERIENCE

Dr. Chrostowski is a founding member of Chrostowski, Pearsall, & Foster (CPF Associates, Inc). He is an environmental chemist, health scientist, and engineer with over 40 years experience in environmental work on behalf of both government and private clients. Currently, Dr. Chrostowski's practice is focused on environmental chemistry, environmental engineering, and risk analysis. Previously, he was Director of Environment, Health & Safety programs at The Weinberg Group, Vice President and Senior Science Advisor at ICF/Clement, Senior Scientist at EA Engineering, Science & Technology, Assistant Professor at Vassar College, a consultant in private practice and a pollution control/industrial hygiene technician in industry. Dr. Chrostowski performed pioneering work in the fields of chemical environmental forensics and risk assessment. He has specialized experience in the scientific and technical aspects of federal, state, and international regulatory programs including the environmental impacts of residuals management technologies and environmental impact assessment methodologies. In addition to EPA and OSHA programs, Dr. Chrostowski has developed expertise in human, ecological, and probabilistic risk

assessment, life cycle analysis, application of multivariate statistics, and failure analysis. Dr. Chrostowski's research interests include the environmental behavior of complex mixtures, application of quantitative management tools to environmental strategy development and evaluation, chemometrics, quantitative ecology, biomonitoring, and environmental modeling. Dr. Chrostowski is active in numerous professional societies and expert panels and has authored or co-authored over 130 publications or presentations in the environmental field. In addition to his technical work, Dr. Chrostowski has taught university-level environmental sciences and has presented expert testimony in litigation cases, regulatory, legislative, and permitting hearings and public meetings.

EMPLOYMENT HISTORY

1999-present	President, CPF Associates, Inc.
1993-1999	Director, Environment, Safety & Health practice, The Weinberg Group Inc.
1985-1993	Vice President and Senior Science Advisor, Clement Division of ICF/Kaiser
1984-1985	Senior Scientist, EA Engineering, Science & Technology
1981-1984	Assistant Professor, Vassar College
1979-1984	Consulting scientist in private practice
1976	Information Analyst, Solar Energy Information Center
1974-1976	Research technician, University of California
1970-1972	Laboratory/industrial hygiene technician, C&D Batteries
1968-1970	Laboratory/pollution control technician, Jack Frost Sugar
1964-1968	Petty Officer, 2nd Class, U.S. Navy

SELECTED PROFESSIONAL SOCIETY MEMBERSHIPS

Air and Waste Management Association
American Council of Governmental Industrial Hygienists
American Chemical Society
American Chemical Society Environmental Division
International Society for Environmental Forensics
International Society for Exposure Analysis

PUBLICATIONS

Dr. Chrostowski is the author or co-author of over 130 publications or presentations. A full bibliography and copies of publications are available on request. Selected publications/presentations include:

Durda, J. and Chrostowski, P .C. 1991. Integration of ecological risk assessment and biological assessment in risk management: The Aberdeen experience. Paper presented at 12th Annual Meeting of the Society of Environmental Toxicology & Chemistry, November 3-7, Seattle, Washington.

Chrostowski, P .C. and Durda, J. 1991. Effects of air pollution on the desert tortoise: An ecological risk assessment. Paper presented at 12th Annual Meeting of the Society of Environmental Toxicology & Chemistry, November 3- 7, Seattle, Washington.

Chrostowski, P.C.,Foster, S.A.,Durda, J.L., Preziosi, D. V. 1998. Good Ecological Risk Assessment Practices. SETAC Annual Meeting, Charlotte, NC, November 1998.

Preziosi, D., Durda, J., Chrostowski, P. 2000. Conceptual approaches for addressing

temporal and spatial scales of wading bird populations and contaminant distribution. SETAC Annual Meeting.

Foster, S.A., Chrostowski, P.C., Preziosi, D.V. 2003. A Comparison of Two Mercury Environmental Fate and Transport Models in Evaluating Incinerator Emissions. 2003 Incineration Conference. Orlando, FL May 12-16.

Chrostowski, P.C. & Foster, S.A. 2004. Swimming Pool Shock Treatment. Environ Health 66:26-27.

Langmuir,D., Chrostowski, P., Vigneault, B., and Chaney, R. 2004. Issue Paper on the Environmental Chemistry of Metals. Prepared for USEPA Risk Assessment Forum,

Foster, S. Chrostowski, P.C., Pirages, S., Nealley M. 2006. Applications of the IEM-2M Mercury Fate and Transport Model in Hazardous Waste Combustion Facility Risk Assessment. 2006 Waste Management Meeting. AWMA and USEPA, Arlington, VA.

Chrostowski, P.C. & Foster, S.A.2006. Modeling exposure and risk from chemical weapons releases. Society for Risk Analysis Annual Meeting, Baltimore, MD.

Foster, S.A., Chrostowski, P.C. & Wilsey, S. 2006. The role of landfill gas emission rate calculation methods in solid waste landfill risk assessments. SRA Annual Meeting,

Foster, S.A. & Chrostowski, P.C. 2008. Comprehensive human health and ecological risk assessment of a carbon reactivation facility. SRA Annual Meeting, Boston MA.

Chrostowski, P.C. 2008. Hill's Postulates. In Jorgensen, SE & Fath, BD (Eds) Ecotoxicology. Vol 3 of Encyclopedia of Ecology, pp. 1858-1863. Oxford: Elsevier

Foster, C., Richer, P., Lynch, G., Chrostowski, P., Hoffman, B. and Militana, L. 2008. PM2.5 Ambient Air Monitoring at a Regional Solid Waste Processing and Transfer Facility. Global Waste Management Symposium, Copper Mountain, CO. September 2008.

Foster, S.A., Chrostowski, P.C., and Porter, T.J. 2011. Ultrafine Particles in Combustion Source Emissions. 2011 Annual Society of Risk Analysis Meeting, Charleston, SC (December).

Foster, S. and Chrostowski, P.C. 2012. Human Health and Ecological Impact Analysis for a New Renewable Energy Facility in Florida. WTERT 2012 Bi-Annual Conference. October 18-19, 2012. Columbia University, NY.

Chrostowski, P.C. and Foster, S. 2014. Resolution of a Controversey – Do Waste-to-Energy Plants Cause Public Health Impacts. 29th ISWA Conference.

COMMUNITY PROFESSIONAL SERVICE

Montgomery County MD Energy and Air Quality Advisory Committee
Takoma Park - Montgomery College Neighbors Advisory Committee
Science Fair judge for environmental science projects, Montgomery County, MD
Takoma Park Community Center Citizen's Advisory Committee
Takoma Park Committee on the Environment