ATSDR Newsletter for Health Assessors Including APPLETREE Partners

October 2021

Guidance & Clearance

The purpose of this newsletter is to keep you informed about the guidance and resources that are available for use in your health evaluations.

What is in this Newsletter?

The following topics are included in this edition of the ATSDR Newsletter for Health Assessors. An index of all topics covered in previous newsletters has been added to the Public Health Assessment Site Tool (PHAST) Resources page under the heading of ATSDR Health Assessor Newsletter.

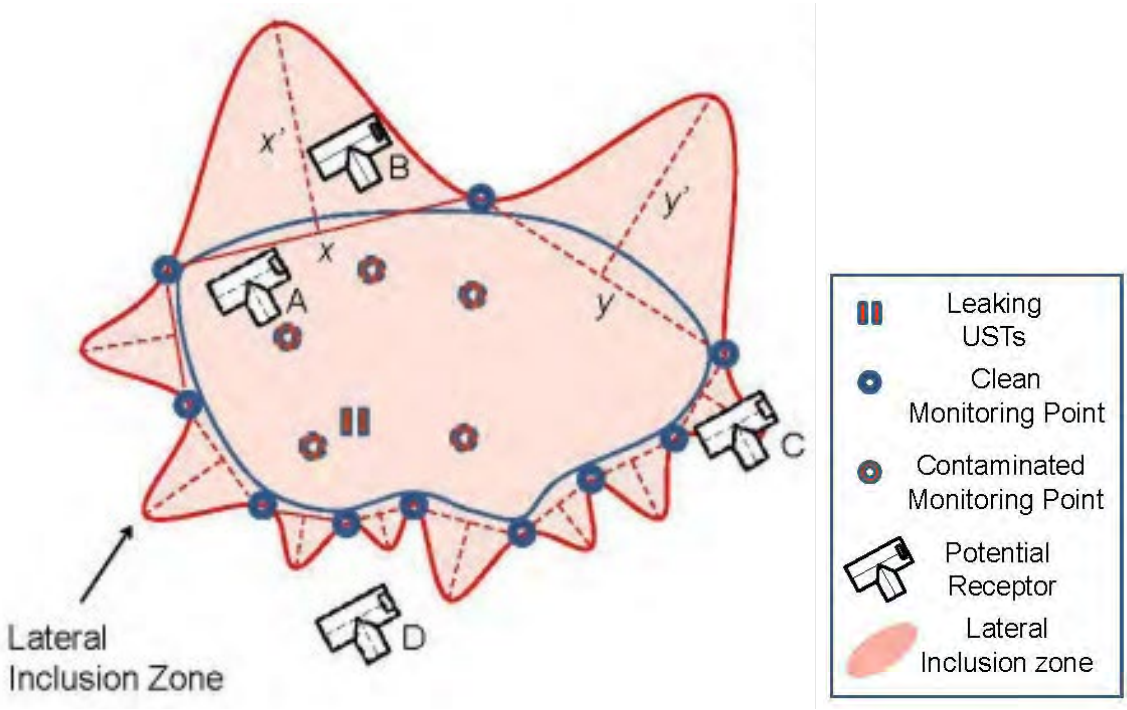
Determining Appropriate Soil Gas and Groundwater Distances for Screening at Vapor Intrusion Sites

The USEPA recommends initially looking at samples within 100 feet of buildings to assess the potential for vapor intrusion [EPA 2015]. This is based on modeling of diffusion in soil and observations that most sites do not find vapor intrusion more than one to two houses past vapor intrusion plumes. However, the initial approach only considers points in space. This article describes EPA's method for determining a *lateral inclusion zone* to estimate the boundaries of a plume for vapor intrusion assessment. Then other factors that affect how far vapors can travel will be discussed.

A lateral inclusion zone is an estimate of the area surrounding a plume through which soil gas may travel, intrude into buildings, and potentially pose a vapor intrusion concern [EPA 2014]. The first step in determining

a lateral inclusion zone is to draw a connector line between each clean sample point[1] to form a plume boundary (see x and y in the figure). Then draw a perpendicular line out from the midpoint of each connector line; the perpendicular line is the same length as the connector line (see x' and y' in the figure). The lateral inclusion zone is a triangle between the clean sampling points and tip of the perpendicular line. Homes A, B, and C in the example below would be targeted for vapor intrusion investigation.

Determining lateral inclusion zones based on monitoring points [Source: EPA 2014]



Health assessors should consider whether contamination boundaries are likely to be stable or moving. New spills may not have reached as far as older spills, but they may migrate more rapidly. New shallow spills (<3 feet deep) may reach their maximum extent within hours to days, whereas dispersion of deeper sources (>30 feet deep) may take months to years. Degradation products with higher vapor pressures, such as vinyl chloride and methane, should be carefully monitored during and after soil or groundwater remediation.

ATSDR has identified sites where soil gas contamination was several hundred feet beyond the predicted plume boundary. This may occur when sampling points are too far apart, are at depths that underestimate the contamination, or are screened against values greater than vapor intrusion comparison values (such as some MCLs). Several other situations may also cause vapor intrusion in buildings beyond 100 feet from contamination that exceeds a vapor intrusion comparison value:

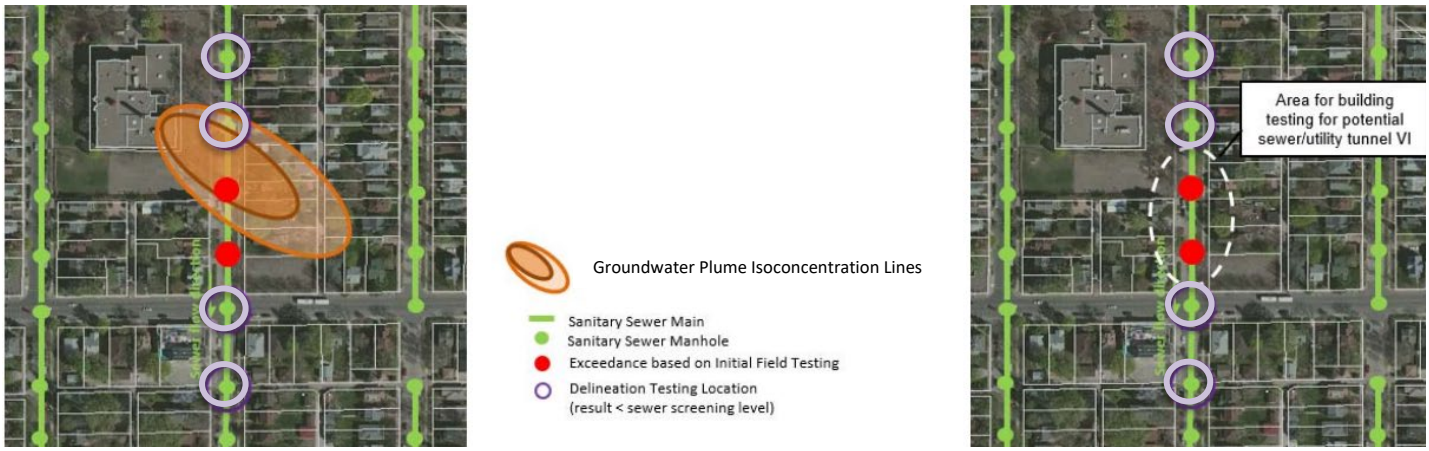
- In situ thermal treatment, air sparging (injecting air into contaminated groundwater to increase contaminant volatilization), landfill aging, and leaking gas lines can generate pressure-driven vapors and thus extend soil gas migration beyond that which travels by just diffusion.
- Surface barriers that limit the direction of soil gas movement, such as asphalt or frozen ground, can increase the lateral extent of contamination.

[1] In this article, we will define "clean sample point" as any sample point that is less than ATSDR's vapor intrusion comparison values.

- Preferential pathways, such as sewers and highly porous zones of soil, can allow vapors to flow freely over long distances.

Sewer transport is an active area of study. Modeling has estimated that VOCs in sewers usually decrease by >80% over 500 feet [Beckley 2020]. A Department of Defense (DoD) study developed a method for collecting grab samples from sewer manholes. The figure below shows how contamination is delineated by stepping out collection points until two consecutive samples are below screening levels upgradient and downgradient of the source. Soil gas comparison values are used to screen the sewer gas samples. If needed, sewer gas mitigation is achieved by sealing, ventilating, or installing backflow valves that prevent liquid and air flow towards buildings from lateral connections.

Sewer Gas Delineation [Source: ESTCP 2018]



In summary, to identify the vapor intrusion boundaries, vapor intrusion may occur in buildings up to 100 feet from a contaminated building with soil gas or groundwater samples exceeding vapor intrusion CVs. In addition, buildings beyond 100 feet may need to be considered, particularly if preferential pathways are present. Make sure to note any qualitative issues with professional judgement as uncertainties.

Contributing author: Tonia Burk (fxt9@cdc.gov), OCHHA

Tips for Evaluating Lead Exposures at Sites, Part 2: Know Your Community

Our series continues with Part 2 of tips for evaluating lead exposures. In this part, we take a closer look at "know your community".

Overview of
Tips for Evaluating Lead Exposures

- **Know your community:** Find out the factors that increase risk for lead exposure**.**
- **Know your samples:** Find out site-specific exposure and sampling conditions.
- **Know your data:** Find out environmental lead levels (soil, water, air, dust, biota).

As you begin to gather information about your site, be sure to include information about the community. Developing a community profile will help. Community-specific information is vital in identifying unique populations within a community which may have different lead exposure risks due to demographic, socioeconomic, or cultural factors. Keep in mind that some sites may have more than one exposed community, and lead exposure may come from non-site sources as highlighted below. Lead exposure concerns may prompt stress and worry among community members, especially parents of young children. ATSDR's Community Stress Resource Center provides guidance to understand, recognize, and address stress related to environmental contamination. See the next article on stress for more details.

ATSDR evaluates lead exposure differently than other chemical exposures because we

- Use blood lead levels (BLLs) as an indicator of community lead exposure
- Gather site-related and non-site-related lead exposure information and community-specific risk factors associated with higher lead exposure mainly from online databases (see below for greater details)
- Partner with stakeholders to implement lead exposure prevention, reduction, and elimination actions

If lead is a contaminant of concern at your site, the following questions need to be addressed.

1. **Do the people exposed to lead from the site have additional, non-site-related characteristics that increase their risk for high blood lead levels?**
   Most health assessors include a demographic map in their reports, but few relate that information to lead exposures. Certain demographic and socioeconomic factors play an important role for lead exposure because they are associated with increased blood lead levels in children. ATSDR's Geospatial Research, Analysis, and Services Program (GRASP), https://intranet.cdc.gov/grasp/request_services.html can provide community-specific information about identified risk factors associated with higher blood lead levels.

A number of factors are associated with higher blood lead levels in the literature, for example:

- **Housing:** living in homes built before 1978, the year lead-based paint was banned, especially those built before 1950 [Bernard 2003, CDC 2020], living in urban areas [Mielke 2010], or living in a rental property [Schleifstein 2011]
- **Lower income**: having a lower income [Dewalt 2015, CDC 2013, Jones 2009, U.S. Census 2010]
- **Race/ethnicity:** Black and Hispanic race/ethnicity [Bernard 2003, CDC 2013a, Jones 2009]
- **Age:** young children (less than 6 years of age) due to their unique activity and behavior patterns, physiological differences, and their rapid growth and development [Rowan 2011, Shannon 2005]
- **Immigrants:** New immigrant and refugee populations [CDC 2021a; 2021b]
- **Cultural practices:** such as the use of some traditional or folk medicines or imported makeup or herbs and hobbies such as making fishing sinkers, bullets, stained glass, and ceramic glazes [UW PEHSU 2018]
- **Consumer products:** such as use of some vitamins, cosmetics, spices, candies or certain foods Sources of Lead | Lead | CDC **[CDC 2021]**

If your site is in a community with one or more of these risk factors, this may increase the likelihood of elevated blood lead levels among community members.

2. Are there other potential sources of lead within your site's community?

A community may experience both site-related and non-site-related lead exposure. **Sometimes, non-site related exposure may be higher than site-related exposure.** Examples of non-site-related environmental sources include:

- Water service lines, plumbing, and fixtures installed before 1986
- Foundries, mining sites, railroads, bridges, highways, battery reclamation or recycling centers, small aircraft airports, etc
- Lead in soil due to paint deterioration and decades of airborne deposition of leaded gasoline and emissions from certain industries, such as smelters and battery recycling facilities

For communities with pre-existing, non-site-related lead exposures, any additional lead exposures from a site may significantly increase blood lead levels. As a result, we must consider this additional lead exposure burden as a health equity component when we evaluate lead contaminated sites. This is especially true for sites with environmental lead levels just below regulatory standards yet high enough to increase predicted blood lead levels by several micrograms per deciliter of blood.

CDC's Childhood Lead Poisoning Prevention Program (Childhood Lead Poisoning Prevention Program | CDC) collect state and county-level surveillance data. These data, while not community-specific, provide some insight into a county's continued need for lead education and remediation efforts and how those rates have changed over time. County rates can also be compared to state rates.

3. What is being done to reduce lead exposures for the community?

A lead-exposed community with no ongoing and/or past activities to reduce lead exposure could increase the need for ATSDR to take immediate public health protective action. Are state health agencies, regional/local public health departments, federal agencies, or private groups or organizations providing health education, testing for lead in environmental media like soil and water, offering blood lead screening in children, or mitigating exposure by, stopping, reducing, or preventing contact with contaminated media?

This information is important to inform ATSDR, EPA, state agencies, and other stakeholders on potential public health actions and the urgency for taking actions.

Contributing author: Carole Hossom (cjd0@cdc.gov), OCHHA

Did You Know? Environmental Contamination Can Contribute to Chronic Stress

Environmental contamination, such as per- and polyfluoroalkyl substances (PFAS) in drinking water, can pose toxicological health risks while also contributing to psychological and social stress in affected communities [Couch and Coles 2011; Gerhardstein et al. 2019]. This stress, though a normal reaction to environmental contamination, can affect people's health and quality of life [Schmitt et al. 2021]. In addition, psychosocial stress and toxicants may interact to modify health risks, making some people more vulnerable to health effects from certain contaminants [McEwen and Tucker 2011]. Sources of stress often include health concerns, uncertainty about exposures and health effects, social conflict, lengthy investigations, loss of trust in institutions, financial strain, and other concerns [Calloway et al., 2020; Sullivan et al. 2021]. Furthermore,

groups that have been socially marginalized (e.g., lower income and communities of color) often face multiple chronic stressors—including environmental contamination—that contribute to health inequities.

ATSDR's new **Community Stress Resource Center** outlines a *3 Keys* framework (Recognize, Prepare, and Partner) for reducing community stress and building resilience as part of public health responses to environmental contamination. Communities have different practical, informational, and social needs and assets. The Resource Center provides guidance and resources to understand, prevent, and address problems that can cause stress related to environmental contamination. Please explore the Resource Center (www.atsdr.cdc.gov/stress) and consider applying it when developing community-specific community engagement, risk communication, and health education strategies. To get started, consider reading this tip sheet for public health professionals and taking the online *Chronic Stress and Environmental Contamination Training*. If you have any questions, please email ATSDRstress@cdc.gov.

Contributing authors: Ben Gerhardstein (fty9@cdc.gov) and Jamie Rayman (fpe7@cdc.gov), OCHHA Loretta Asbury (lob3@cdc.gov), OAD, and Pam Tucker (pgt0@cdc.gov), OCDAPS

ATSDR Public Health Assessment Online Training

The ATSDR Public Health Assessment Training (PHAT) is available online to public health professionals involved or interested in ATSDR's public health assessment process. PHAT is available at https://www.atsdr.cdc.gov/training/pha-training-section1.html.

PHAT includes eight self-paced online modules that teach the basics of conducting a public health assessment (PHA). The modules are based on a realistic environmental health case study and include practice exercises, resources, and references. Each module takes about 2 to 4 hours to complete. You will learn the following from each module:

- Modules 1-3: what ATSDR is, the PHA method, and how to gather and document site information and data
- Module 4: how to evaluate the exposure pathways for contaminants at hazardous waste sites
- Module 5: how to select sampling data appropriately for the PHA
- Module 6: the basics of the screening analysis used in the PHA process
- Module 7: how to conduct a health effects evaluation of possible health effects in exposed community members
- Module 8: how to write and communicate environmental health information in clear language

In addition, Modules 5 and 7 include four Power Point presentations on how to conduct an exposure investigation, define exposure units, estimate an exposure point concentration, and conduct a toxicological evaluation.

We encourage new health assessors to complete the eight PHAT modules in sequence. However, more experienced health assessors might decide to review only those modules that refresh their knowledge, skills, and abilities. All of the PHAT modules have received CDC accreditation, making PHAT fully accredited for

continuing education units. Health assessors can obtain a certificate of completion and/or a continuing education certificate after studying each module and completing an evaluation and a post-test.

PHA Webinars

In addition to PHAT, ATSDR has nine webinars on the PHA process. These webinars are available for ATSDR grantees and staff and last about 1 to 2 hours each.

The PHA webinars provide ATSDR staff and APPLETREE grantees with a forum to meet with ATSDR's subject matter experts (SMEs) and discuss their questions on the PHA process. During the webinars, ATSDR SMEs review main concepts discussed in PHAT and explain how they applied these PHA concepts at real ATSDR sites.

Below is a list of the topics covered by the nine PHA webinars, along with their links.

Webinar 1: ATSDR's Mission, ATSDR's PHA Process, and Gathering Site Information and Data
https://centersfordiseasecontrol.sharefile.com/share/getinfo/s8208b58c2c2043adb1bbbab57f0fecc9

Webinar 2: Evaluation of Exposure Pathways at Sites
https://centersfordiseasecontrol.sharefile.com/share/getinfo/sc03cb7187a4149dfa6b3fa9cdb9d7daf

Webinar 3: Selection of Appropriate Sampling Data for the Health Assessment
https://centersfordiseasecontrol.sharefile.com/share/getinfo/s19669d9928244ad597953b240668f6a3

Webinar 4: PHA Data Screening Analysis
https://centersfordiseasecontrol.sharefile.com/share/getinfo/sdbaab0cbb17647c0b3aa087dceb72287

Webinar 5: Estimating Exposure Concentrations and Exposure Units
https://centersfordiseasecontrol.sharefile.com/share/getinfo/s1c9e64f27fbb4eca9dd506a20ad9fbdb

Webinar 6: Exposure Calculations
https://centersfordiseasecontrol.sharefile.com/share/getinfo/see141bded5e44dd28948493ca0897709

Webinar 7: Toxicological Evaluation
https://centersfordiseasecontrol.sharefile.com/share/getinfo/scedbe009ac014b0093ccb75ffb894878

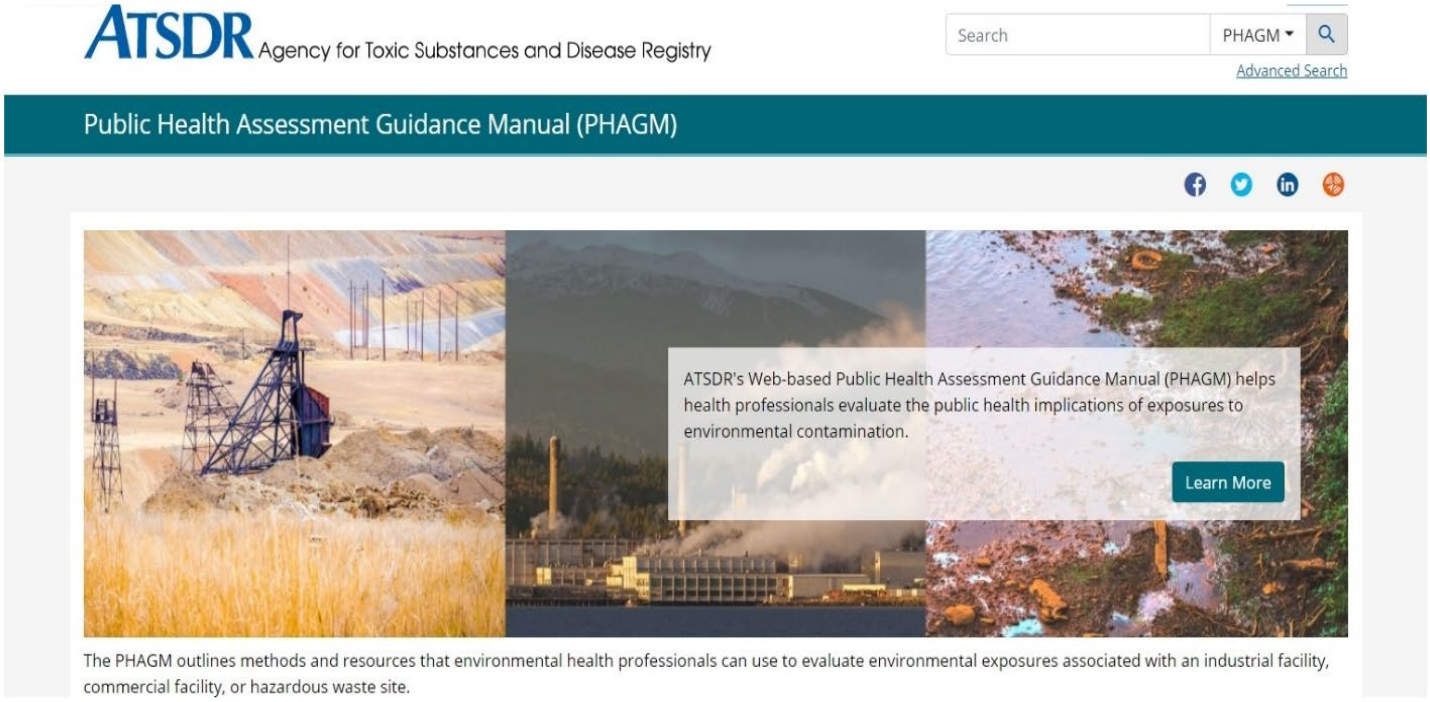
Webinar 8: Clear Writing of Environmental Health Information
https://centersfordiseasecontrol.sharefile.com/share/getinfo/sfdba07be26854f7d8c2a690e4c7d11ef

Webinar 9: Engaging the Community
https://centersfordiseasecontrol.sharefile.com/share/getinfo/s5127ac2e63724c4b97de05c661e043bc

For more information on PHAT or the PHA Webinars, please contact Sandra M. López-Carreras, MS at spc0@cdc.gov

Contributing author: Sandra M. López-Carreras (spc0@cdc.gov), OCDAPS

Update of the ATSDR Public Health Assessment Guidance Manual (PHAGM) to Web-Based Format



ATSDR's 2005 Public Health Assessment Guidance Manual (PHAGM) is being updated into a dynamic web-based format, which offers options for user navigation, enhances readability, and facilitates the ability for ATSDR to make as-needed content updates. This revised manual builds upon the process described in the 2005 manual with updates to reflect ATSDR's most current scientific approaches. It also provides resources that environmental health professionals can use to evaluate environmental exposures associated with an industrial facility, commercial facility, or hazardous waste site.

The new PHAGM website will include the following seven main sections that cover the steps in the PHA process:

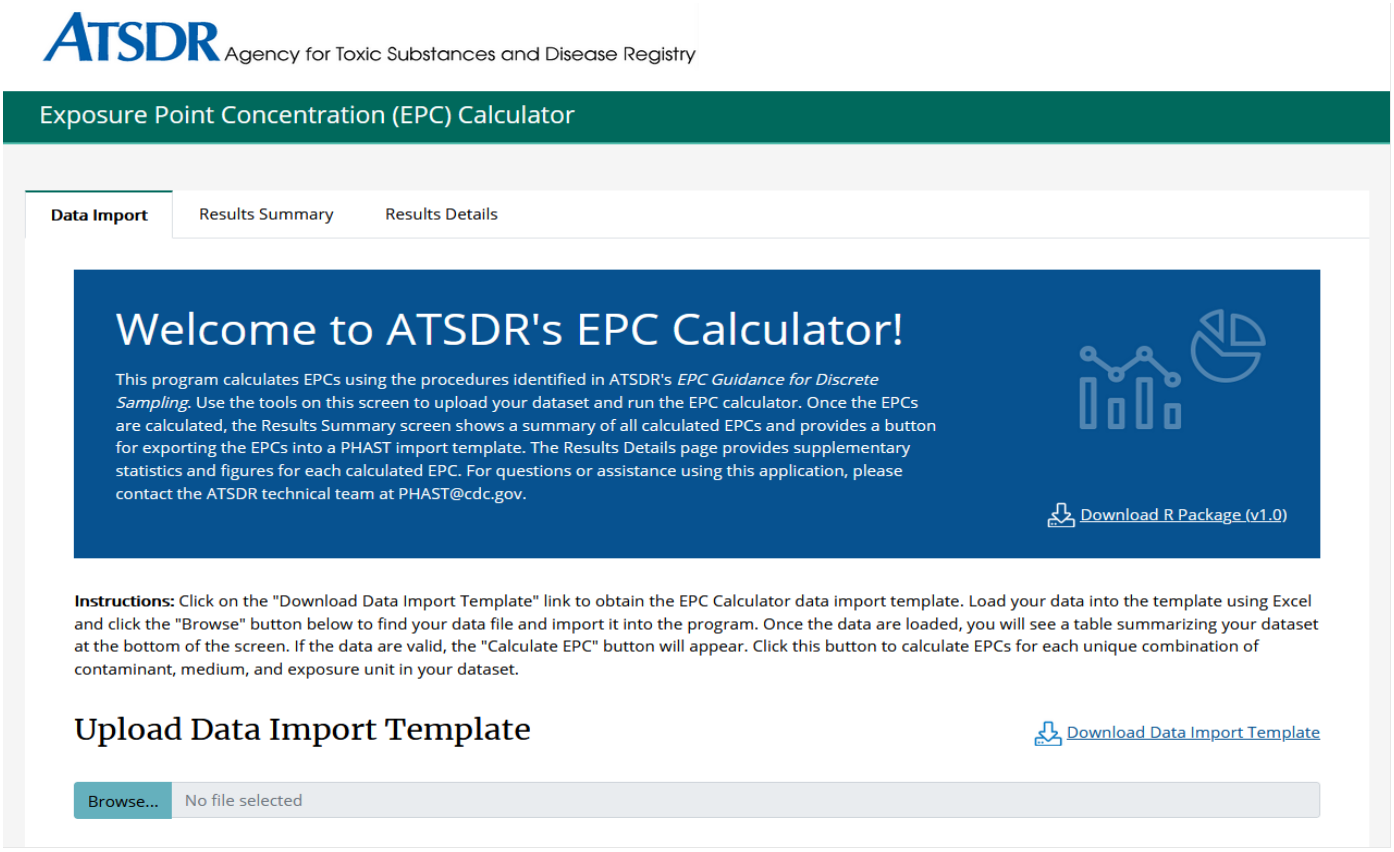
- Understanding the PHA Process
- Who's Involved
- Getting Familiar with the Site
- Engaging the Community
- Selecting the Sampling Data
- Conducting Scientific Evaluations (covers Exposure Pathways, Screening Analysis, EPCs & Exposure Calculations, and In-Depth Tox Analysis)
- Putting It All Together

The PHAGM website will house a toolbox with items such as checklists and templates for use during the PHA process. It will also have a resources page with content, such as ATSDR guidance documents and available data sources. In addition, the PHAGM website will include an extensive glossary containing definitions of terms used in PHAGM and words used by ATSDR in communications with the public. The PHAGM website is anticipated to be launched in the Fall 2021.

Contributing author: Greg Ulirsch (gru1@cdc.gov), OCHHA

Exposure Point Concentration (EPC) Integration into PHAST: A New Tool for Determining Your EPCs

New ATSDR R Shiny Application for Calculating Exposure Point Concentrations

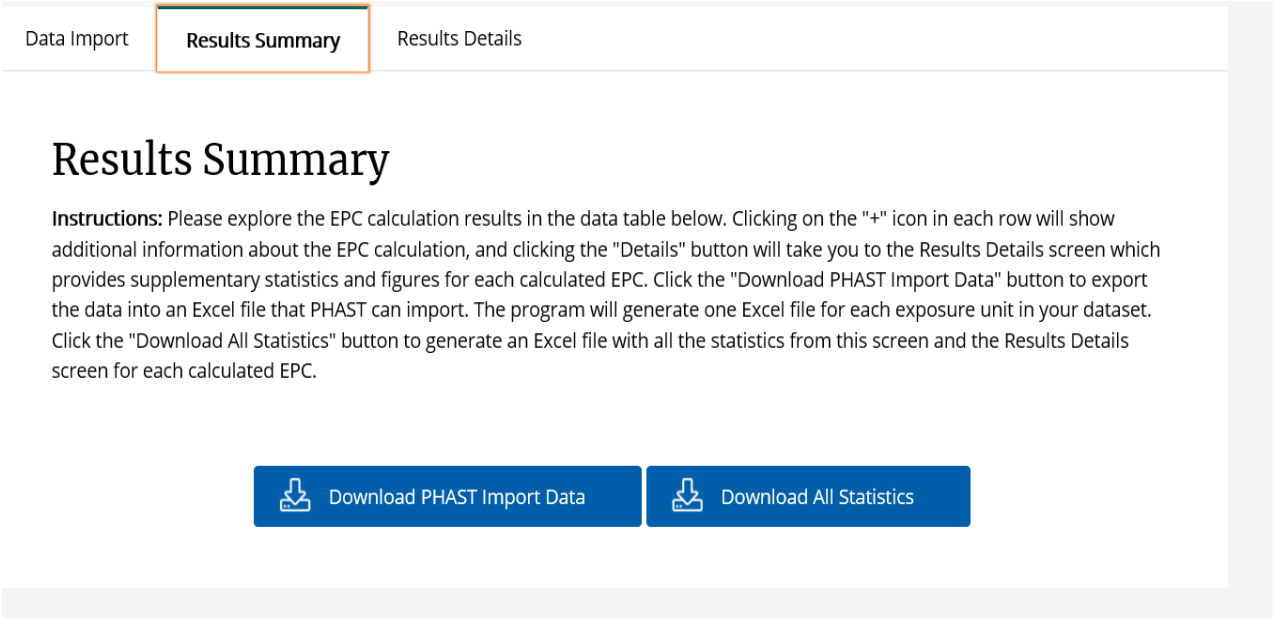


ATSDR is developing a new software tool for automatically calculating exposure point concentrations (EPCs) following the procedures identified in the revised ATSDR's *EPC Guidance for Discrete Sampling (see PHAST Resources page for updated guidance)*. Currently, health assessors must follow multiple steps using existing software programs (R, ProUCL, Excel, etc.) and manually load calculated EPCs into an Excel template for analysis within PHAST. The new tool simplifies this process by automating the EPC calculation procedures identified in ATSDR's guidance and by creating files ready for import into PHAST with the click of a button. The new software tool is being developed as an R Shiny application and will be accessible through a web browser for ATSDR staff and for external partners who have access to PHAST.

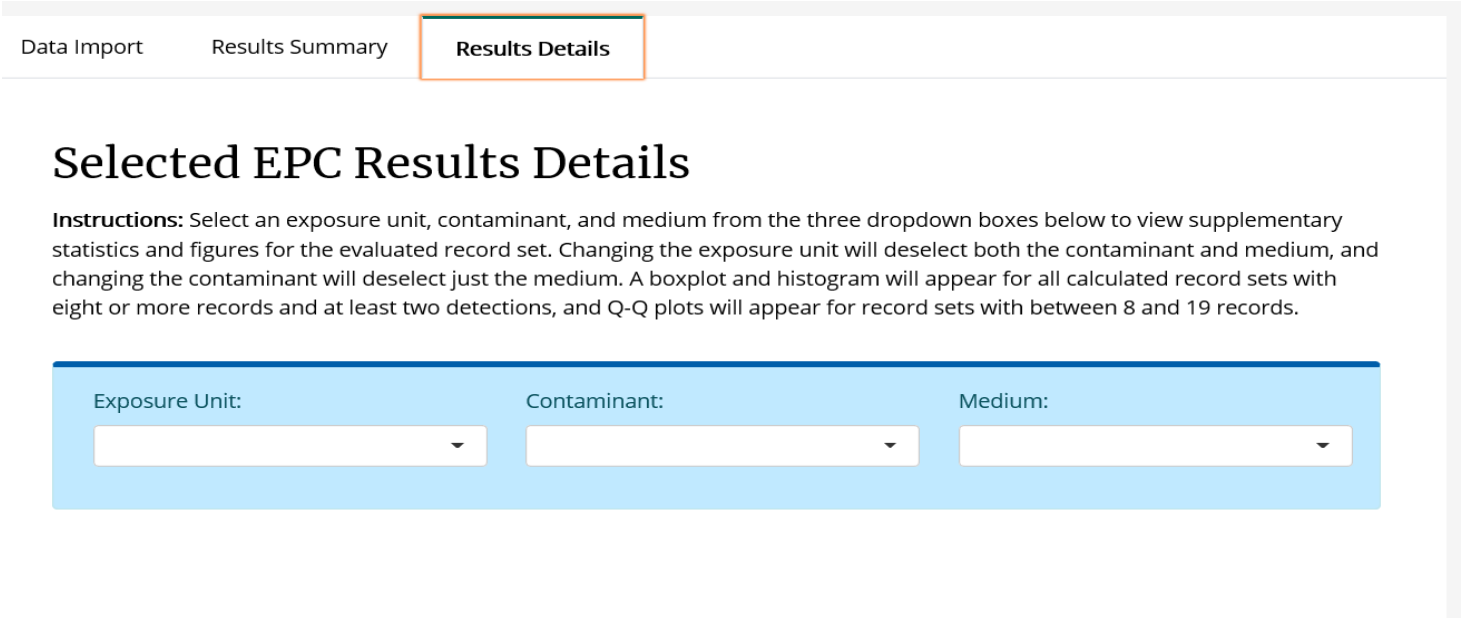
The R Shiny application is being designed with simplicity and ease-of-use in mind. The application includes just three screens:

- The **Data Import** screen (see above) allows health assessors to load raw contaminant data into the application using a simple Excel template. Once the data are loaded, health assessors can click a button to quickly calculate EPCs for all contaminants in their dataset.

- The **Results Summary** screen below contains a table that summarizes the EPC calculation results and a button that health assessors can click to automatically generate pre-formatted data files ready for PHAST import.



- The **Results Details** screen below provides detailed statistics and figures (boxplots, histograms, and QQ plots) with supplementary information on the calculated EPCs. Health assessors can use the information on the Results Details screen to better understand their data and to confirm the validity of the calculated EPCs.



Contributing authors: Greg Ulirsch (gru1@cdc.gov) and James Durant (hzd3@cdc.gov), OCHHA

New ATSDR Guidance Documents and Tools and Where to Find Them

Do you know where to find all the latest ATSDR guidance documents and PHA tools? The table below shows recently released guidance as well as tools coming soon!

All of the latest guidance documents are posted in the Resources Section in PHAST. In addition, all ATSDR Health Assessor Newsletters, and a list of current subject matter experts (SMEs), have been added to the Resources Section of PHAST. When the Web-Based Public Health Assessment Guidance Manual is launched, most guidance (including these newsletters) will be housed there. We are also updating several outdated guidance documents and hope to have those released later in 2021. If you do not see guidance on a specific topic in the Resources Section in PHAST, contact the OCHHA or OCDAPS ADS Office about that topic.

Guidance Topics/PHA Tools		
Shower Model PHAST Module	Fall 2021/Winter 2022	David Mellard
EPC guidance for non-discrete sampling	Fall 2021	Greg Ulirsch; James Durant
EPC guidance for PAHs	Fall 2021/Winter 2022	Greg Ulirsch; James Durant
EPC Calculator	Winter 2022	Greg Ulirsch; James Durant
Web-Based PHAGM Launch	Fall 2021/Winter 2022	Greg Ulirsch

Section References

Determining Appropriate Soil Gas and Groundwater Distances for Screening at Vapor Intrusion Sites

Beckley L, McHugh T. 2020. A conceptual model for vapor intrusion from groundwater through sewer lines. Sci Total Environ. 698: 134283.

[ESTCP]. Department of Defense Environmental Security Technology Certification Program. 2018. Sewers and utility tunnels as preferential pathways for volatile organic compound migration into buildings: Risk factors and investigation protocol. Available at: https://serdp-estcp.org/index.php/content/download/48434/460824/file/ER-201505%20Investigation%20Protocol.pdf

[USEPA]. United States Environmental Protection Agency. 2014. An approach for developing site-specific lateral and vertical inclusion zones within which structures should be evaluated for petroleum vapor intrusion due to release of motor fuel from underground storage tanks. Ground Water Issue. Available at: https://www.epa.gov/sites/production/files/2014-09/documents/epa600r13047.pdf

[USEPA]. United States Environmental Protection Agency. 2015. OSWER technical guide for addressing and mitigating the vapor intrusion pathway from subsurface vapor sources to indoor air. Available at:

https://www.epa.gov/sites/production/files/2015-09/documents/oswer-vapor-intrusion-technical-guide-final.pdf

Tips for Evaluating Lead at Sites Part 2: Knowing Your Community

Bernard SM, McGeehin MA. 2003. Prevalence of blood lead Levels ≥5 µg/dL among U.S. children 1 to 5 years of age and socioeconomic and demographic factors associated with blood lead levels 5 to 10 µg/dL, Third National Health and Nutrition Examination Survey, 1988 -1994. Pediatrics 112:1308. Available at: http://pediatrics.aappublications.org/content/112/6/1308.full.pdf

[CDC]. Centers for Disease Control and Prevention. 2013. Blood lead levels in children aged 1–5 years — United States, 1999–2010 (April 5, 2013). MMWR: Morbidity and Mortality Weekly Report 62(13):245-248. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6213a3.htm?s_cid=mm6213a3_e

[CDC]. Centers for Disease Control and Prevention. 2020. Childhood Lead Poisoning Prevention Sources of Lead April 7, 2020. Available at: Sources of Lead | Lead | CDC. cdc.gov/nceh/lead/prevention/sources.htm

[CDC] Centers for Disease Control and Prevention. 2021a. Lead screening during the domestic medical examination for newly arrived refugees. March 5. Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases, Division of Global Migration and Quarantine. Atlanta: U.S. Department of Health and Human Services. Available at: https://www.cdc.gov/immigrantrefugeehealth/guidelines/lead-guidelines.html

[CDC] Centers for Disease Control and Prevention. 2021b. Childhood Lead Poisoning Prevention Sources of Lead Mach 12, 2021. Available at: About Immigrant, Refugee, and Migrant Health | Immigrant and Refugee Health | CDC

[CDC] Centers for Disease Control and Prevention. 2021c. Childhood Lead Poisoning Prevention Sources of Lead April 21, 2021. Available at: Populations at Higher Risk | Lead | CDC cdc.gov/nceh/lead/prevention/populations.htm

Dewalt FG, Cox DC, O'Haver R, et al. Prevalence of Lead Hazards and Soil Arsenic in U.S. Housing. *J Environ Health*. Dec 2015;78(5):22-9; quiz 52.

Dixon SL, et al. 2009. Exposure of US children to residential dust lead, 1999-2004: II. The contribution of lead-contaminated dust to children's blood lead levels. Environ Health Perspect 117:468-474. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2661919/

Jones RL, et al. 2009. Trends in blood lead levels and blood lead testing among US children aged 1 to 5 years, 1988–2004. Pediatrics 123(3):e376-85 Available at: http://pediatrics.aappublications.org/content/123/3/e376.full.pdf+html

Lee i-Gyung, Chun OK, Song WO. 2005. Determinants of the blood lead level of US women of reproductive age. J Am Coll Nutr 24(1):1-9. Available at: http://www.tandfonline.com/doi/pdf/10.1080/07315724.2005.10719436

Mielke HW. 2010. Estimation of leaded (Pb) gasoline's continuing material and health impacts on 90 US urbanized areas. Environ Int. Available at https://www.sciencedirect.com/science/article/pii/S016041201000156X]

Rowden AK. 2011. Pathophysiology and etiology of lead toxicity. Medscape Reference, Drugs, Diseases, and Procedures. Available at: http://emedicine.medscape.com/article/2060369-overview

Shannon MW, et al. Committee on Environmental Health. 2004-2005. 2005. Lead exposure in children: prevention, detection, and management. J Am Acad Pediatrics 116(4):1036 -1046.

Schleifstein Mark. 2011. Dangerous lead levels found in nearly two-thirds of New Orleans homes, Tulane study says. Times-Picayune. Available online at http://www.nola.com/environment/index.ssf/2011/11/high_levels_of_lead_found_in_6.html

U.S. Census Bureau. 2010 American community survey. Available at: http://www.census.gov/acs/www/

[USEPA] U.S. Environmental Protection Agency. 2013. Integrated science assessment for lead. Available at: http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=255721#Download

[UW PEHSU] University of Washington. 2018. Pediatric Environmental Health Specialty Units. O. Halas, BA; C. Karr, MD, PhD; N. Beaudet, MS, CIH; S. Sathyanarayana, MD, MPH; E. Friedman, MD, MPH; K. Ivicek, MN, RN; M. Willis, BSN, MPH. Last updated August 2018. https://deohs.washington.edu/pehsu/sites/deohs.washington.edu.pehsu/files/May%202019/immigrant%20lead%20exposures%20COMMUNITY%20MEMBERS.pdf http://www.deohs.Washington.edu/pehsu

Additional lead references:

Egan KB, Cornwell CR, Courtney JG, Ettinger AS. Blood lead levels in U.S. children ages 1-11 years, 1976-2016. *Environ Health Perspect*. 2021;129(3)doi:10.1289/EHP7932

Aoki Y, Brody DJ. WIC Participation and Blood Lead Levels among Children 1-5 Years: 2007-2014. *Environ Health Perspect*. Jun 2018;126(6):067011. doi:10.1289/EHP2384

Pfadenhauer LM, Burns J, Rohwer A, Rehfuess EA. 2016. Effectiveness of interventions to reduce exposure to lead through consumer products and drinking water: A systematic review. Environmental research 147:525-536.

Did You Know? Environmental Contamination Can Contribute to Chronic Stress

Calloway EE, Chiappone A, Schmitt HJ, Sullivan D, Gerhardstein B, Tucker PG, Rayman J, Yaroch A. 2020. Exploring community psychosocial stress related to per- and poly-fluoroalkyl substances (PFAS) contamination: lessons learned from a qualitative study. Int. J. Environ. Res. Public Health 17 (23), 8706. https://doi.org/10.3390/ijerph17238706.

Couch SR and Coles CJ. 2011. Community stress, psychosocial hazards, and EPA decision-making in communities impacted by chronic technological disasters. Am. J. Public Health 101 (Suppl. 1), S140–S148. https://doi.org/10.2105/AJPH.2010.300039.

Gerhardstein B, Tucker PG, Rayman J, and Reh CM. 2019. A fresh look at stress and resilience in communities affected by environmental contamination. J. Environ. Health 82 (4), 36–38.

Schmitt HJ, Calloway EE, Sullivan D, Clausen WH, Tucker PG, Rayman J, and Gerhardstein B. 2021. Chronic environmental contamination: A systematic review of psychological health consequences, Science of The Total Environment, Volume 772, 145025, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2021.145025.

Sullivan D, Schmitt H, Calloway E, Clausen W, Tucker P, Rayman J, and Gerhardstein B. 2021. Chronic environmental contamination: A narrative review of psychosocial health consequences, risk factors, and pathways to community resilience, Social Science & Medicine, Volume 276, 113877, ISSN 0277-9536, https://doi.org/10.1016/j.socscimed.2021.113877.

McEwen BS and Tucker P. 2011. Critical biological pathways for chronic psychosocial stress and research opportunities to advance the consideration of stress in chemical risk assessment. Am. J. Public Health 101 (S1), S131–S139.