



JOHNS HOPKINS
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Soil Safety Resource Guide for Urban Food Growers



About the authors

This guide was developed by the *Johns Hopkins Center for a Livable Future*. Our mission is to promote research and to develop and communicate information about the complex interrelationships among diet, food production, environment and human health, to advance an ecological perspective in reducing threats to the health of the public and to promote policies that protect health, the global environment and the ability to sustain life for future generations.

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Summary

The potential health, social, environmental, and economic benefits of urban farms and gardens are far-reaching. For example, studies have found associations between urban community gardens and increased access to healthy food, opportunities for exercise, stronger social cohesion in neighborhoods, and higher property values. And like any green space, urban farms and gardens offer essential ecosystem services like moderating temperatures and reducing storm water runoff. Perhaps most importantly, urban green spaces provide educational opportunities for urban residents, for whom a farm or garden may be their only regular experience of nature.

There are also potential health risks associated with growing food in urban settings. Urban soils may harbor contaminants such as lead, petroleum products, and asbestos. People may come into contact with these contaminants if they work or play in contaminated soil, or eat food that was grown in it. In some cases, exposure to soil contaminants can increase disease risks, especially for young children.

Farmers and gardeners can be alerted to the presence of contaminants by testing their soil and investigating prior uses of their land. Contact with potential contaminants can be minimized by following best practices, such as locating plots away from busy roads, thoroughly washing produce, and peeling root vegetables. While risk exists no matter where our food comes from, these precautions can keep soil contaminant risks to a minimum.

What this guide covers

This guide covers some of the basics on urban soil contaminants. Detailed information on soil contaminants is already provided by other organizations, so rather than duplicating their efforts, we compiled a list of some of the available online resources.

Whom this guide is for

This guide was written with urban community gardeners in mind. It may also be of interest to urban farmers, gardening support institutions, agricultural extension agents, and anyone who is interested in learning more about soil contaminant issues.

Because we are based in Baltimore, Maryland, some of the suggested resources are specific to our city. Most of the information, however, can be generalized to any urban area.

Why we wrote this guide

In 2012, we partnered with the *Community Greening Resource Network*—Baltimore's gardening support network—to assess what gardeners know (and don't know) about soil contaminants, and what their concerns are. We used our findings to help inform city agencies, garden leaders, local nonprofits, and other groups working to promote safer gardening practices. A research article based on this study is available [online at PLOS ONE](#).

We developed this resource guide, in tandem with our research, to help direct people to information about soil contaminant issues in urban settings.

Benefits of urban growing spaces

The table below summarizes some of the evidence linking urban farming and gardening to health, social, environmental, and economic benefits.

Activity	Associated benefits
Participating in a community garden	Increased vegetable consumption ¹⁻⁴ Increased access to fresh produce and/or culturally appropriate food ⁵⁻⁷ Increased physical activity ⁸ Stronger communities ^{6,9} Saving money on food ^{6,7}
Gardening	Improved cardiovascular health ^{10,11} Mental health benefits ¹²⁻¹⁴

Land type	Associated benefits
Community gardens	Higher property values ¹⁵
Urban green spaces	Increased attention span ¹⁶⁻¹⁸ Decreased crime rates ¹⁹ Ecosystem services, e.g., air filtration, temperature moderation, reduced storm water runoff, habitats and forage for beneficial organisms ^{20,21}

Urban soil contaminants

Urban soils may harbor contaminants, such as lead, petroleum products, and asbestos.

Some soil contaminants, such as trace elements, occur naturally in the environment. Many of these are mined for use in industrial and agricultural products. Other contaminants are synthesized in labs.

Contaminants may be released into the environment by human activities, such as burning coal, and by natural events, such as volcanic eruptions. Urban soils are often closer to pollution sources, such as industrial areas, busy roads, waste dumps, demolition sites, and building fires. As a result, many soil contaminants are present at higher concentrations in urban areas.²²

Among trace elements, lead, mercury, arsenic, and cadmium are of particular concern to human health because of their frequency, toxicity and potential for human exposure.²³ These elements are often referred to as “heavy metals”.

Studies suggest urban gardeners are generally familiar with lead.²⁴ There are other potential soil contaminants, however, that urban farmers and gardeners should also be mindful of, such as petroleum-based fuels and oils, certain pesticides, flame retardants, refrigerants, cleaning solvents, and other industrial chemicals (see examples in the table below).²⁵

Contaminant	Potential sources
Lead	Burning coal, lead-acid batteries, leaded gasoline, lead-based paints, solder
Cadmium	Burning coal, rechargeable batteries, TVs, steel, phosphate fertilizer, galvanized water pipes
Arsenic	Certain pesticides, iron and steel production, treated lumber, burning coal
Chromium	Metal plating, treated lumber
Organic chemicals	Fuels, oils, pesticides, plastics, lubricants, refrigerants, cleaning solvents, preservatives, flame retardants
Asbestos	Attic and wall insulation, insulated water pipes, roofing shingles, ceiling and floor tiles, cement, automobile parts
Biohazards	Untreated human and animal waste, septic tanks, municipal waste water

Adapted from: Brevik EC (2013) Soils and human health: an overview. In: Brevik EC, Burgess LC, editors. Soils and human health. CRC Press. pp. 29–56.

How people can be exposed soil contaminants

Growers can be exposed to contaminants by inadvertently ingesting soil, inhaling contaminated dust, or via direct skin contact. Soil ingestion is of particular concern among children, who may ingest larger quantities of soil than adults (e.g., by putting their hands in their mouths), absorb higher levels of certain contaminants into their bloodstream,²⁷ and are generally more sensitive to their effects.

People who eat produce grown in contaminated soil may also ingest soil particles on the surfaces of plants.²⁸ Peeling root vegetables, removing outer leaves, and thoroughly washing produce can remove surface contaminants.

In cases where crops are grown in highly contaminated soils, certain contaminants may accumulate inside the tissues of certain plants. Because contaminants tend to accumulate in root tissues, this is generally more of a concern for root vegetables.²⁹⁻³¹

Investigating levels of soil contaminants

There are ways to investigate levels of contaminants in a farm or garden plot. The following steps should always be taken before undertaking an urban growing project.

Investigating site history

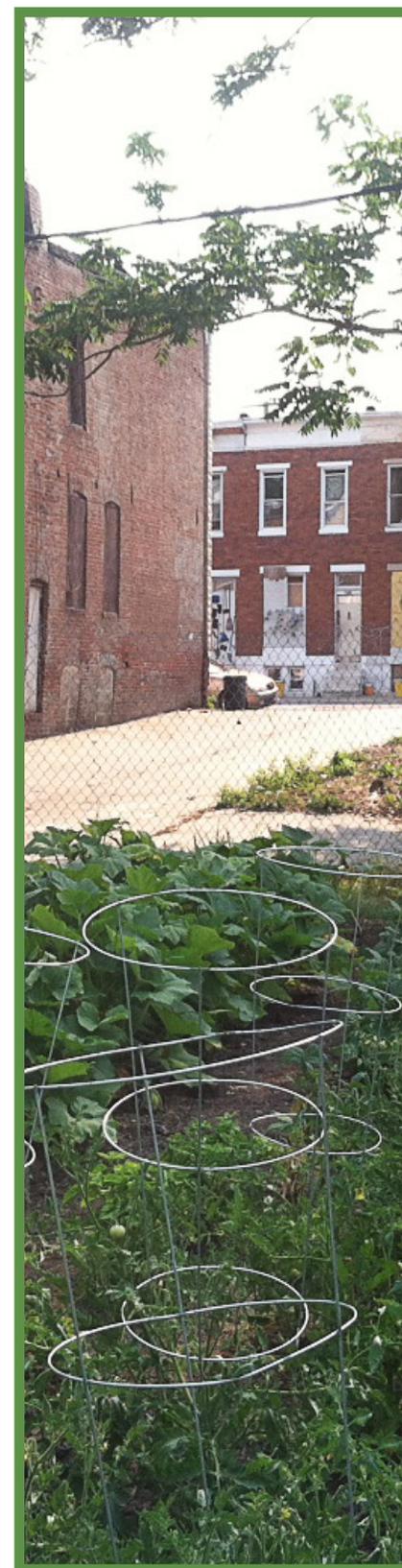
Knowing the past uses of a farm or garden site can alert growers to the presence of potential contaminants.

A vacant lot, for example, may be the former site of a dry cleaning operation that may have left behind a legacy of carcinogenic cleaning solvents. Adjacent land use is also important. A potential garden site, for example, may have at one time neighbored a gas station, factory, or the site of a chemical spill.

Many urban growers learn about prior land use from first-hand knowledge, or from people living in the community.²⁴ While oral histories are a good starting point, there are other resources that can supplement local knowledge, such as federal and state environmental agencies. Some information on historical land use can be found via Sanborn Maps, which include building information since 1867 for over 12,000 U.S. towns and cities. Some [Sanborn Maps](#) are free to the public and available online, though maps dated after 1970 may require purchase.

For residents of Baltimore City, the Johns Hopkins Center for a Livable Future provides an [interactive map](#) showing the locations of community gardens, school gardens, and urban farms in Baltimore City along with current and prior hazardous waste sites identified by the Environmental Protection Agency or the Maryland Department of the Environment.

See *Resources* on page 7, below, for more information on site history.



Testing soil for contaminants

A number of institutions offer affordable soil testing. This process usually involves requesting a test kit, collecting soil samples, and mailing the samples in for analysis. Because levels of contaminants can vary spatially across a farm or garden, it is important to collect samples from multiple locations within a site.³²

The results of a soil test may reveal levels of contaminants that are too high to grow food safely. Questions of exactly what levels are safe, however, are difficult to answer. Farmers and gardeners often refer to *screening levels* set by the U.S. Environmental Protection Agency. Sites with contaminants above these levels, however, are not necessarily unsafe for gardening, particularly if children are not active in the garden and steps are taken to minimize exposure to contaminants.

It is important to note that soil testing labs often only test for lead and other more common contaminants. They do not test for every possible contaminant. For this reason, one cannot assume a negative test result is a “clean bill of health” without considering the presence of other contaminants. This is why investigating site history is an important complement to soil testing.

See *Resources* on page 7, for more information on soil testing.

Recommended best practices for growing food in urban settings

Even if urban growers don't know exactly what is in their soil, they can take precautions to minimize their exposure to any contaminants that may be present. Not every recommended practice is necessary for every site.

- Wear gloves, and wash hands after working in soil and before eating.
- Take care not to track dirt from the farm or garden into the house.
- Thoroughly wash produce before storing or eating.
- Peel root crops, and remove outer leaves of leafy vegetables.
- Build plots away from existing roads and railways, or build a hedge or fence to reduce windblown contamination from mobile sources and busy streets.
- Cover existing soil and walkways with mulch, landscape fabric, stones, or bricks.
- Use mulch in plots to reduce dust and soil splash, reduce weed establishment, regulate soil temperature and moisture, and add organic matter.
- Use soil amendments to maintain neutral pH, add organic matter, and improve soil structure.
- Add topsoil or clean fill from certified soil sources. State or local environmental programs, extension services, or nurseries may be able to recommend safe sources for soil and fill.
- Build raised beds or container gardens. Raised beds can be made by mounding soil into windrows or by building containers. Sided beds can be made from wood, synthetic wood, stone, concrete block, brick, or naturally rot-resistant woods such as cedar and redwood.

Adapted from the U.S. Environmental Protection Agency, 2011.³³

Cautions about raised beds

Surveys suggest urban gardeners may view raised beds as an easy and effective solution to managing soil contaminant risks.²⁴ Although raised beds can greatly reduce exposure to contaminants, they have some limitations that urban growers should be mindful of:

- Raised beds built in contaminated areas do not remedy the presence of contaminated soil surrounding the beds, which may be kicked up by people working or playing around the beds. People may inhale or accidentally ingest contaminated soil once it is airborne.³⁴ These risks are generally higher for children.
- When building a raised bed, care must be taken to ensure it is filled with clean, uncontaminated soil, and that safe materials are used for containers of sided beds. Railroad ties and copper arsenate treated lumber, for example, have been shown to leach harmful chemicals into the surrounding soil.³⁵
- Depending on the depth of a raised bed and the plants grown in it, roots may extend into contaminated soils below the bed. A water-permeable fabric cover or geotextile may be installed as the bottom layer of a raised bed to further reduce exposure to underlying soil.²⁶

See *Resources* on page 7, below, for more information on best practices.



Resources

The Johns Hopkins Center for a Livable Future is not responsible for the content of the following documents and websites. The following is not a comprehensive listing of resources on soil contaminant issues.

General

Urban Soil Safety.

The Johns Hopkins Center for a Livable Future, 2014.

www.jhsph.edu/clffurbansoilsafety/

Urban Gardening: Managing the Risks of Contaminated Soil.

Environmental Health Perspectives, 2013.

<http://ehp.niehs.nih.gov/121-a326/>

Soil Facts: Minimizing Risks of Soil Contaminants in Urban Gardens.

North Carolina Cooperative Extension Service, 2012.

www.soil.ncsu.edu/publications/Soilfacts/AG-439-78_Urban_Soil_Contaminants.pdf

Brownfields and Urban Agriculture: Interim Guidelines for Safe Gardening Practices.

U.S. Environmental Protection Agency, 2011.

www.epa.gov/swerosps/bfurbanag/pdf/bf_urban_ag.pdf

Problem Soils.

University of Massachusetts Extension. 2011.

extension.umass.edu/landscape/fact-sheets/problem-soils

Reusing Potentially Contaminated Landscapes: Growing Gardens in Urban Soils.

U.S. Environmental Protection Agency, 2011.

www.clu-in.org/download/misc/urban_gardening_fact_sheet.pdf

Soil Contaminants in Community Gardens.

University of Wisconsin Extension, 2011.

learningstore.uwex.edu/Assets/pdfs/A3905-03.pdf

Urban Gardens and Soil Contamination: A Gardener's Guide to Healthy Soil.

University of Minnesota Extension, 2010.

misadocuments.info/Urban_Soil_Contaminants.pdf

Container and Raised Bed Gardening.

Purdue Extension, 2009.

www.hort.purdue.edu/ext/ho-200.pdf

Soil Contaminants and Best Practices for Healthy Gardens.

Cornell Waste Management Institute, 2009.

cwmi.css.cornell.edu/Soil_Contaminants.pdf

The Use of Soil Amendments for Remediation, Revitalization and Reuse.
U.S. Environmental Protection Agency, 2007.

<http://www.clu-in.org/download/remed/epa-542-r-07-013.pdf>

Urban Soil Primer.

USDA Natural Resources Conservation Service, 2005.

http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052835.pdf

Soil Contamination and Urban Agriculture.

McGill School of Environment, McGill University, 2002.

www.ruaf.org/sites/default/files/guide%20on%20soil%20contamination.pdf

Urban Community Gardeners' Knowledge and Perceptions of Soil Contaminant Risks.
Johns Hopkins Center for a Livable Future, 2014.

<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0087913>

Lead

Home Gardens and Lead: What You Should Know about Growing Plants in Lead-Contaminated Soil.

University of California Agriculture and Natural Resources, 2010.

anrcatalog.ucdavis.edu/pdf/8424.pdf

Lead in the Home Garden and Urban Soil Environment.

University of Minnesota Extension, 2010.

<http://www.extension.umn.edu/garden/yard-garden/soils/lead-in-home-garden/>

Evaluating and Reducing Lead Hazard in Gardens and Landscapes.

Oregon State University Extension Service, 2008.

<http://extension.oregonstate.edu/news/release/2008/04/reducing-lead-hazard-garden-and-landscape-soils/>

Lead in Garden Soils.

Maryland Cooperative Extension, 2001.

https://extension.umd.edu/sites/default/files/images/programs/hgic/Publications/HG18_Lead_in_Garden_Soils.pdf

Site history in Baltimore, Md., and the greater U.S.

Cleanups in My Community. U.S. Environmental Protection Agency.

Maps of areas where hazardous waste is being or has been cleaned up throughout the U.S.

www.epa.gov/cimc/

Baltimore City Farms, Food Gardens, and Environmental Remediation Sites Map.

The Johns Hopkins Center for a Livable Future.

www.jhsph.edu/clf/urbansoilsafety/

Land Restoration Project Map. Maryland Department of the Environment.
Map of hazardous waste sites in Maryland: www.mde.state.md.us/programs/Land/Maryland-BrownfieldVCP/mapping/Pages/programs/landprograms/errp_brownfields/mapping/index.aspx
Details on individual sites: www.mde.state.md.us/programs/Land/MarylandBrownfieldVCP/mapping/Pages/programs/landprograms/errp_brownfields/mapping/errp_factsheets.aspx

Digital Sanborn Maps, 1867-1970.
<http://sanborn.umi.com/>
Tutorial on using Sanborn Maps: www.prattlibrary.org/special/camtasia.aspx?id=1316

Maryland Land Use / Land Cover maps. Maryland Department of Planning. www.mdp.state.md.us/OurWork/landuse.shtml

The Geography of Baltimore City: Sources. Baltimore City Archives. baltimorecityhistory.net/research-at-the-baltimore-city-archives/the-geography-of-baltimore-city-sources/

Soil testing guidance

Understanding Your Test Results: Lead in Soil and Chicken Eggs.
 Cornell University College of Agriculture and Life Sciences and Cooperative Extension, 2012.
<http://cwmi.css.cornell.edu/healthysoils.htm>

Understanding Your Test Results: Metals in Garden Soils and Vegetables.
 Cornell University College of Agriculture and Life Sciences and Cooperative Extension, 2012.
<http://cwmi.css.cornell.edu/healthysoils.htm>

Guide to Soil Testing and Interpreting Results.
 Cornell Waste Management Institute, 2009.
cwmi.css.cornell.edu/guidetosoil.pdf

Selecting and Using a Soil Testing Laboratory.
 University of Maryland Cooperative Extension, 2008.
<https://extension.umd.edu/hgic/soils/selecting-and-using-soil-testing-laboratory-hg-110>

U.S. Environmental Protection Agency soil screening levels

Screening Levels: <http://www.epa.gov/region9/superfund/prgl/>

Soil Screening Guidance: www.epa.gov/superfund/health/conmedia/soil/index.htm#fact

Soil testing labs

Agricultural Analytical Services Laboratory, Penn State College of Agricultural Sciences.
<http://agsci.psu.edu/aasl>

Soil and Plant Tissue Testing Laboratory, UMASS Amherst.

soiltest.umass.edu/

Soil Testing Program, University of Delaware.

ag.udel.edu/dstp/

Farming and gardening support institutions in Baltimore, Md.

Baltimore Farm Alliance.

www.farmalliancebaltimore.org/

Baltimore Green Space.

baltimoregreenspace.org/

Baltimore Office of Sustainability.

www.baltimoresustainability.org/

Baltimore Orchard Project.

<http://www.baltimoreorchard.org/>

Baltimore Urban Agriculture Task Force.

www.baltimoreurbanag.org/

Community Greening Resource Network (CGRN).

www.parksandpeople.org/greening/resource-network/

Maryland Master Gardeners.

<https://extension.umd.edu/mg>

Power in Dirt.

www.powerindirt.com/

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