



# Cornell Waste Management Institute

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## Soil Contaminants and Best Practices for Healthy Gardens

### Why are Soil Contaminants a Concern?

Soil quality is affected by many factors, including past and present land use and nearness to pollution sources. Soil test results and site history can provide information to guide efforts to improve garden quality and protect the health of gardeners, their families, and others in the community.

There is no clear line of what is considered “safe”. If contaminant levels exceed agency guidelines or are higher than levels recommended by other sources, it is wise to reduce the exposure of children and adults. Children are especially vulnerable to harmful health effects, so it is particularly important to address any concerns about soil contaminants in areas where children play or where fruits or vegetables are grown for food. The practices outlined below will help improve soil quality and limit people’s contact with soil contaminants.

### Best Practices for Healthy Gardens

#### Gardening and Land Use Practices

- ◆ Incorporate or top dress the garden area with clean materials such as uncontaminated soil, compost, manure, or peat moss.
- ◆ Adjust soil pH to near neutral. Most metals are more bioavailable in more acid soils and can harm plants or animals when pH is too low.
- ◆ Mulch walkways and other areas to reduce dust and soil splashback onto crops, or maintain healthy grass or other ground cover.
- ◆ Don’t grow edible produce directly adjacent to buildings, where lead levels are likely highest.
- ◆ Build raised beds with clean soil to grow food crops in more contaminated areas. A layer of landscape fabric will prevent plant roots from entering the contaminated soil below the bed.



- ◆ For raised beds and other garden projects, don’t use certain types of treated lumber that may have chemicals that will further contaminate the soil. In the past, some commercially-available treated lumber contained copper, chromium, and arsenic.
- ◆ In more contaminated areas, first consider whether the practices outlined here can sufficiently reduce the amount of contaminants in contact with crops. This can be verified by testing the soil or plant tissue.
- ◆ If it is not possible to protect crops from contamination, consider growing crops that are less likely to be contaminated (see page 3).
- ◆ Because of the many benefits of eating fresh fruits and vegetables, growing ornamental plants instead of food crops should only be considered as a last resort.

#### CWMI Resources for Healthy Soils

<http://cwmi.css.cornell.edu/soilquality.htm>

- ◆ Sources and Impacts of Contaminants in Soils
- ◆ Guide to Soil Testing and Interpreting Results
- ◆ Best Practices for Healthy Gardens
- ◆ More Information about Arsenic and Lead



*Site history information and measures of soil quality, including levels of lead and other contaminants, can help guide efforts to create healthy gardens.*

### Food Preparation Practices

- ◆ Wash produce well to remove soil particles. A 1% vinegar solution (1 part vinegar to 100 parts water) can be used.
- ◆ Peel root crops.
- ◆ Discard outer leaves of leafy vegetables since soil may cling to them.

### General Practices

- ◆ Wash hands and other exposed skin areas that come into contact with soil, especially before eating or preparing food.
- ◆ Use gloves when handling soil, and change gloves when wet or soiled.
- ◆ Watch children carefully to prevent them from eating soil.
- ◆ Frequently wash toys and pacifiers.
- ◆ Cover contaminated soil with clean soil, mulch or other materials, or keep these areas well vegetated.
- ◆ Limit access to more contaminated areas. Don't store things there, especially toys. Consider restricting access to these areas (by installing fences or lattice).
- ◆ Keep soil outdoors:
  - Take off shoes.
  - Use doormats.
  - Clean floors often with a damp mop. Vacuum cleaners put dust in the air, unless they are equipped with a high efficiency particulate air filter.
  - Wash boots and tools outside.
- ◆ Clean or replace filters on heating and cooling systems.
- ◆ Reduce exposure from pets that go outside.
  - Wash pets.
  - Wash hands after handling pets.
  - Limit pets' access to more contaminated areas.
- ◆ Seal pressure-treated wood (and re-seal as needed).

### How Do Plants Get Contaminated?

There are three main ways that heavy metals such as lead could contaminate garden crops. This information is important to help select the best crops for a particular situations.

(1) *Deposition from the air*: This used to be a major source of lead contamination in urban areas until leaded gasoline was phased out completely in the 1980s. Some lead deposition still occurs due to wind-blown dust from contaminated soils and streets. Other airborne contaminants can also end up on plants. This is a particular problem for leafy crops, which have a high surface area in contact with airborne particles.

(2) *Uptake into plant roots*: In most situations, unless soil is acidic (low pH) or very low in organic matter, not much lead is transferred from contaminated soils to garden crops through plant roots. However, roots are likely to have a higher concentration of lead than leaves and stems, and fruits or seeds are likely to be lowest in lead of all plant parts. Cadmium and some other heavy metals of concern are more readily taken up from contaminated soils into roots and plant tops.

(3) *Direct contamination by garden soil*: Root and tuber crops are more likely to be contaminated than other types of crops because they are in direct contact with soil. Leafy vegetables (lettuce, spinach, collard greens) are also easily contaminated by soil splash and dust. Washing leafy crops can remove up to 80% of lead contamination, and much of the lead can be removed from vegetables such as carrots and potatoes by peeling. However, in situations where lead contamination is moderate to severe, growing these types of crops directly in the contaminated soil is probably not the best choice.

Luckily, there are several natural barriers that limit heavy metal transfer into crops.

- ◆ *Soil-Root Barrier*: Some toxic metals (such as lead) have low solubility in most soils, and do not readily enter the plant through roots.
- ◆ *Root-Shoot Barrier*: Most toxic metals bind relatively strongly in roots, and movement to other plant parts is limited.
- ◆ *Shoot-Fruit Barrier*: Most toxic metals are largely excluded from entering the reproductive parts (fruits, seeds) of the crop, remaining instead in the vegetative parts.

## Which Garden Crops Are Suitable to Grow in Contaminated Soils?

Some garden crops can take advantage of these natural barriers. However, the physical contamination of crops by soil dust, splash or aerial deposition can often bypass the natural barriers of protection. Practices to reduce the physical contamination of garden food crops and to reduce human exposure therefore become important.

In addition to what is known about contamination pathways, the results of past research also provide some information about the potential for heavy metal transfer into garden crops. All of this information allows for recommendations for garden crops that are most and least suitable for growing directly in contaminated soils. These resources will be updated and expanded in the future as new information and research findings become available.



### Most Suitable

◆ *Vegetable Fruits and Seeds*: tomatoes, eggplant, peppers, okra (seed pods only), squash (summer and winter), corn, cucumber, melons, peas and beans (shelled or cleaned very thoroughly), onions (bulb only)

◆ *Tree Fruits*: apples, pears

◆ *Berries*: blueberries, strawberries, raspberries, blackberries (if cleaned very thoroughly)

### Least Suitable\*

◆ *Green Leafy Vegetables*: lettuce, spinach, Swiss chard, beet leaves, cabbage, kale, collards

◆ *Other Vegetables*: broccoli, cauliflower

◆ *Root Crops*: carrots, potatoes, turnips

\*Given the many health benefits of consuming fresh fruits and vegetables, every attempt should be made to use the steps outlined on the previous pages to create healthy garden conditions to grow a variety of desirable crops. However, eating fruits and vegetables grown in contaminated soils may have both benefits and risks.

In particular, the vegetables on the Least Suitable list should preferably be grown in areas where contamination is not a concern or where clean soil materials and composts have been used to create soils with low levels of contamination. This can be verified through soil testing if needed. Note that constructing raised beds with clean materials will help create healthy gardens in many situations, but may not eliminate airborne contaminants or soil dust and splashback from other areas.

## **Where Can I Get More Information?**

**Cornell Waste Management Institute Resources for Healthy Soils:** <http://cwmi.css.cornell.edu/soilquality.htm>

- ◆ Sources and Impacts of Contaminants in Soils ◆ Guide to Soil Testing and Interpreting Results
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### **Other Resources**

Agency for Toxic Substances and Disease Registry, Department of Health and Human Services, Atlanta. Provides information to prevent harmful exposures and diseases related to toxic substances. Accessible at: <http://www.atsdr.cdc.gov/>

California Office of Environmental Health Hazard Assessment. A database with toxicity information on many chemicals. Accessible at: <http://www.oehha.ca.gov/risk/ChemicalDB/index.asp>

Cleanup Levels for hazardous waste sites. Links to many federal, state and international websites that address soil clean up levels. Accessible at: <http://cleanuplevels.com/>

National Pesticide Information Center. Provides information about pesticides and related topics. Accessible at: <http://npic.orst.edu/>

New York State Department of Environmental Conservation. Brownfield and Superfund Regulation, 6 NYCRR Part 375 - Environmental Remediation Programs. Accessible at: <http://www.dec.ny.gov/chemical/34189.html>

Penn State University. Agronomy Fact Sheets: Environmental Soil Issues. Information about lead in residential soils, garden use of treated lumber, and other issues. Accessible at: <http://cropsoil.psu.edu/extension/esi.cfm>

US Environmental Protection Agency. Office of Solid Waste and Emergency Response. Soil Screening Guidance: Quick Reference Fact Sheet, EPA/540/F-95/041. Accessible at: [http://www.epa.gov/superfund/health/conmedia/soil/pdfs/fact\\_sht.pdf](http://www.epa.gov/superfund/health/conmedia/soil/pdfs/fact_sht.pdf)

US Environmental Protection Agency. US Office of Solid Waste and Emergency Response. Superfund Soil Screening Guidance: Technical Background Document, EPA/540/R95/128. Accessible at: <http://www.epa.gov/oerrpage/superfund/health/conmedia/soil/introtbd.htm>

US Environmental Protection Agency. Integrated Risk Information System (IRIS). Searchable database with information on the toxicity of numerous chemicals. Accessible at: <http://cfpub.epa.gov/ncea/iris/index.cfm>

Washington State University Cooperative Extension. Gardening on Lead- and Arsenic-Contaminated Soils. Additional information about arsenic and lead in garden soils. Accessible at: <http://cru.cahe.wsu.edu/CEPublications/eb1884/eb1884.pdf>

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