Protecting Urban Food Growers from Harmful Chemicals in Soils

Harmful chemical pollutants are often found in urban soils, but following good practices ensures food can be grown safely

- In urban areas, the soil often contains harmful chemicals, including metals like lead (Pb) and petroleum byproducts.[1]
- The **risk** that a chemical will harm our bodies **depends on how hazardous it is**, and **how we are exposed.**
- We can be exposed to harmful chemicals in soil by **breathing in soil dust, eating soil particles,** and **eating plants that have taken up harmful chemicals.**
- **Safe growing practices** protect you and your family from harmful chemicals.
- The **benefits of growing food** usually outweigh **risk** posed from harmful chemicals in soil.[2]

Take these preventative measures to stay safe

1. Use our **guide to risk-based decision making** (next page) to determine if it is safe to grow food in your soil.
2. Follow **healthy growing practices** (this page) to decrease your exposure to harmful chemicals if you believe some might be present in your soil.
3. If you can**, test your soil** (follow the instructions on page 3-5). It's never too late!

Follow Safe Growing Practices

- **Wash produce and hands before eating.** Wash produce with commercial vegetable wash, vinegar solution (2.5 tablespoons vinegar in 1 gallon water), or tap water.
- **Do not let children contact soil.** Protect children from soil if lead levels are greater than 80 mg/kg (ppm)[3], or if other chemicals might be present.
- **Do not track soil inside.** Leave shoes outside. Wear gloves and wash hands with soap and water after working with soil.
- **Do not work with dry soil.** Only work with moist (but not wet) soil to avoid producing dust (especially important during tilling). Water soil for several hours the day before working.
- **Do not leave soil bare.** Mulch beds and paths. Keep soil surface covered to avoid "backsplash" of soil particles onto plants.
- **Plant hedgerows.** Grow shrubs, vines, flowers between crops and street to block vehicle exhaust.
- **Do not plant root vegetables and leafy greens if chemical levels might be high.** Plant root vegetables and leafy greens where lead levels in soil are likely to be lower (away from buildings/in a raised bed) and fruiting crops where lead might be higher (closer to buildings). Only grow ornamentals, no food, within 3 feet of buildings.
- **Do not grow in your soil if chemical levels might be high.** Use raised beds (at least 1' deep) filled with clean soil. If you're growing in the ground, **mix soil** (till 1-2 times) and **add compost** (6 lbs/ft^2, or 2" inches deep) to top 1' of soil to dilute chemicals.[4] Do not grow in 100% compost.

Guide to risk-based decision making

Is it safe to grow food in my soil? You and your soil are unique. Only you can determine your risk, and only you can determine what steps to take to make your risk acceptable to you.

There is no comprehensive set of guidelines[5] that works for everybody, but these decision-making questions that can help you determine level of risk is right for you. County cooperative extension staff can help you answer these questions.

Ask yourself these 9 questions. The more answers you have in the Higher Risk category, the more important it is to avoid growing food in your soil. Raised beds are a good alternative to growing in higher risk areas.

Site Assessment Questions	Lower Risk	Higher Risk
Are chemicals of concern present above background levels?	Fewer chemicals, and/or lower levels of chemicals	More chemicals, and/or higher levels of chemicals
Are there kids in the garden?	No and/or rarely	Yes and/or frequently
How big is the garden?	Small	Large
How much time do you spend in the garden?	Little time	Lots of time
What crops do you grow? (applies for lead but not arsenic)	Fruiting crops (squash, tomatoes, peppers, fruit trees, etc.)	Root vegetables (especially carrots/radishes) and leafy greens
How much garden-produced food do you eat?	Food produced in garden is a small amount of all food eaten	Food produced in garden makes up the majority of food eaten
Is the soil surface covered?	Covered with mulch	Uncovered/bare soil
What is the soil texture?	Clayey soil	Sandy soil
What is the soil pH?	Neutral to alkaline (6.5-8.0)	Acidic (<6.5)

Lower Risk factors: more support for gardening in the ground, less important to follow Safe Growing Practices

Higher Risk factors: more support for raised beds, more important to follow Safe Growing Practices

Test your soil for metals and organic chemicals

- Do some detective work first to find out what to test for based on site history. Different chemicals have different testing fees, so a little preparation can save you money. See page 4 for a list of common chemicals in urban soils.
- Collect soil samples carefully to increase confidence in the test results. See instructions!
- When you get your results, use risk-based decision making (page 2) to understand how the chemicals in your soil might affect you and others.

1st Research your land's history to decide what chemicals to test for

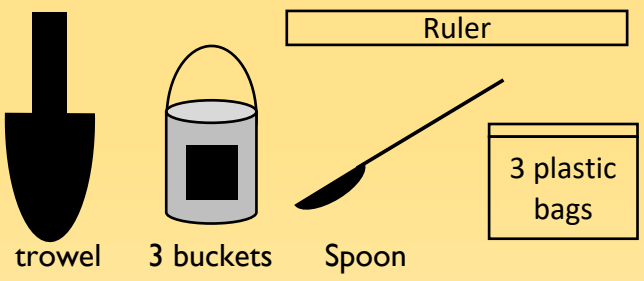
- Testing for chemicals in soil runs from tens to hundreds of dollars per sample, so this detective work can save you money (see list of common chemicals on page 4).
- Find out what your land was used for before, and what was located nearby. Ask neighbors/elders.
- If you're testing soil in a residential neighborhood with houses older than 1978, and/or soil in a high-traffic area, test for lead.
- Look at Sanborn fire insurance maps (https://www.loc.gov/collections/sanborn-maps/) to see historical buildings in the area.
- Consider other sources of pollution like illegally dumped trash, industrial plants, refineries, municipal garbage incinerators.

2nd Figure out what area you will sample

- Divide your space up into areas based on past and future land use (see example on page 5, Figure 1). Each area will be sampled separately. In each area, you should be able to assume the soil has about the same chemical content and/or will have the same use (like growing food).
- Don't mix soil from areas where chemical levels are likely to be higher (like a small front yard, curb strip, or shed/trash area) with samples from areas where levels are likely to be lower (like the middle of the back yard – the best place for growing food).
- Draw maps to remember where your sample areas are!

3rd Gather the tools you will need

- Ruler
- 3 clean buckets
- Shovel or trowel
- 3 quart-sized, labeled plastic bags
- Spoon
- Gloves (clean)
- Paper, etc. to make map



Safety while sampling

- Remember, you don't know what the metal/chemical content of your soil is. Follow these safety guidelines as if your soil contained harmful chemicals.
- Children must not touch soil during sampling.
- Only work with moist soil, to avoid breathing in soil dust. Thoroughly wet down soil 1-2 days before sampling.
- While collecting your samples, **do not touch soil with your bare hands**. Wear gloves. When done, wash your hands and wrists with soap.
- Clean your shoes when done and do not track the soil into your home, car, etc.

4th Collect your samples, following the instructions on the next page

How to collect your soil samples

1. Now that you've divided your space up into areas (see page 3 and example on page 5), work within one area to collect samples.
2. Chemicals in soil aren't usually distributed evenly, so your results will be stronger if you follow the advice of this factsheet and collect a "composite" sample that combines lots of small subsamples, instead of just a few individual samples. For best results, send 3 composite samples (i.e., 3 replicates) from the same area to a lab. Here, we call these 3 replicates the "square ", "triangle", and "circle" samples (see Figure 1-2 next page). Public health guidelines are based on these averages, so follow our instructions to make sure you're following public health guidelines.
3. Plan the composite sample.
    1. Divide your area into sections that are about equally sized.
    2. For best results, use about 30 sections[6], like a 6 x 5 grid, depending on the shape of your space. The more sections, the better. It doesn't matter how big the sections are, as long as they are all about the same size. Mark the grid on your map.
4. To collect each composite sample, sample a small amount of soil (a subsample) from each of the ~30 sections and mix the subsamples together in a bucket. This step often seems complicated at first, but might make more sense once you start. See Figure 2 next page.
    1. In each section, dig a hole 6 inches deep with the trowel or shovel.
    2. Use a spoon to scrape up the side of the hole from the bottom to the top. This should give you about one spoonful. Put the spoonful of soil in the "square" bucket.
    3. Repeat from a different side of the hole and put the soil in the "triangle" bucket, and from a third side of the hole for the "circle" bucket. (Or you can dig 3 separate holes, which gives you better results but takes longer.)
    4. Repeat this process for all ~30 sections. Clean spoon if mud builds up on it, but otherwise you do not need to clean the spoon between sections.
5. When you are done collecting from each section, mix the soil in each bucket very well. Take out a cup (remove rocks) and place in a bag to send to the lab. Air-dry the soil (open the 3 bags) before shipping.

Lab testing

- To find a lab, check with the local agricultural extension or Master Gardener group, for example https://ucanr.edu/sites/MG_Alameda/files/188922.pdf.
- Test fees run from tens to hundreds of dollars per sample, depending on what you are testing for. The lab can help advise you on what to test for.
- Follow lab shipping instructions.
- **See the last page of this handout for how to interpret your results.**

What chemicals are likely to be in my soil?

Common harmful inorganic chemicals in urban soils include lead, arsenic, cadmium, and chromium.

- Lead (Pb) is the most common metal in urban soils, because of historic use of lead paint and leaded gasoline. Older homes (pre-1978) are most likely to have been painted with lead paint.
- Lead exposure has serious negative effects on children's health, including lowered IQs.[7,8]
- Eating soil particles on hands is a common way for children to be exposed to lead. Children can also be exposed to lead inside homes, from paint, soil dust (especially on floors/rugs), and lead water pipes.
- If a building has been painted with lead paint, the soil closer to buildings will probably have the highest levels of lead.[9]

Common harmful organic chemicals include petroleum byproducts (vehicle exhaust particles, automotive fluids), pesticides/herbicides, and chemical residues from burning trash. Industry, power plants, gas stations, and dry cleaners are major sources of metal and organic chemical pollution in soil.

Where and how to sample your soil – in figures

Red: Don't grow food here. Lead and other chemicals likely to be highest.

Yellow: Possible food growing area. Lead and other chemicals somewhat likely to be found here.

Green: Best place to grow food, farthest area from roads and buildings. Lead and other chemicals likely to be lowest.

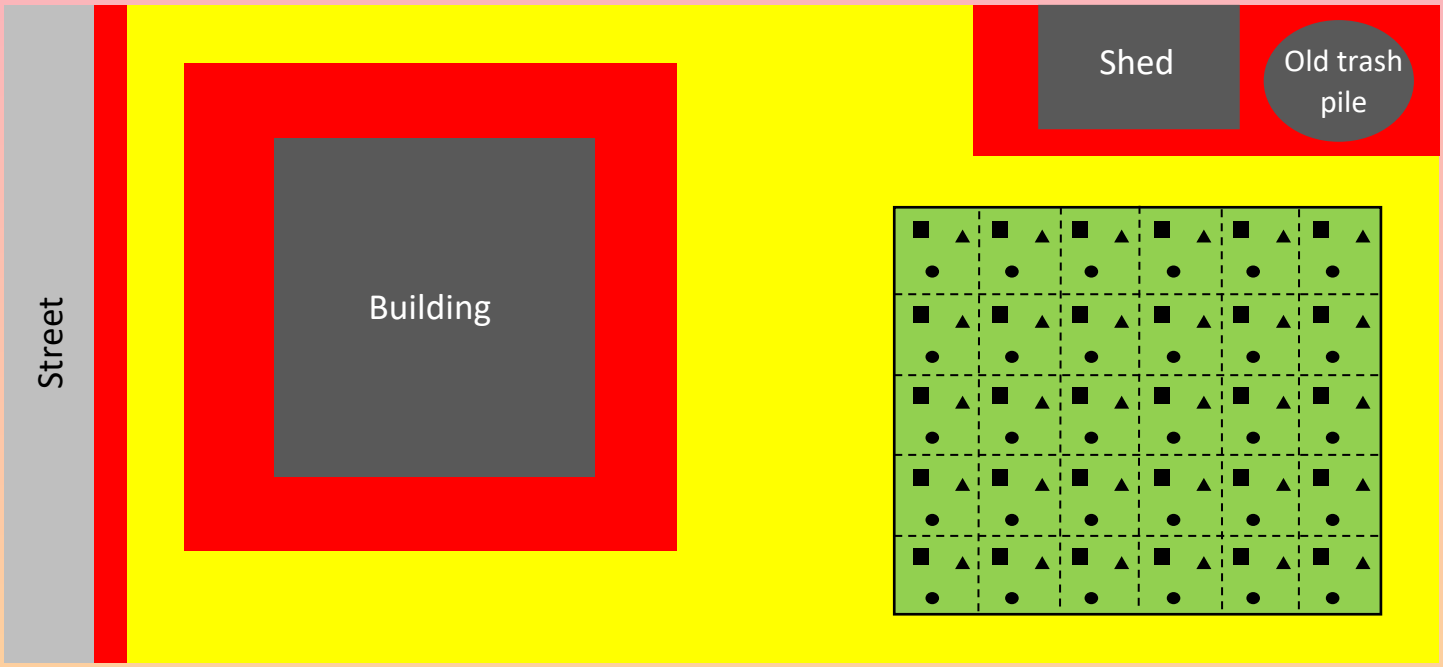
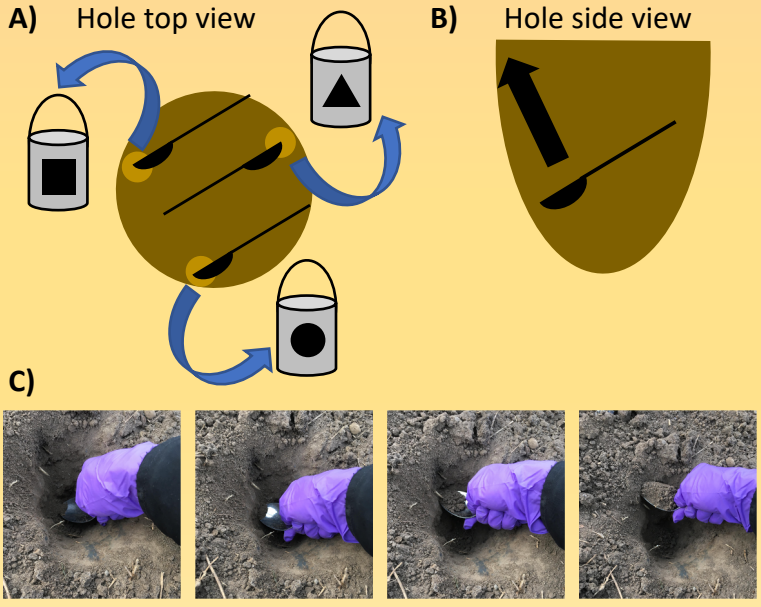


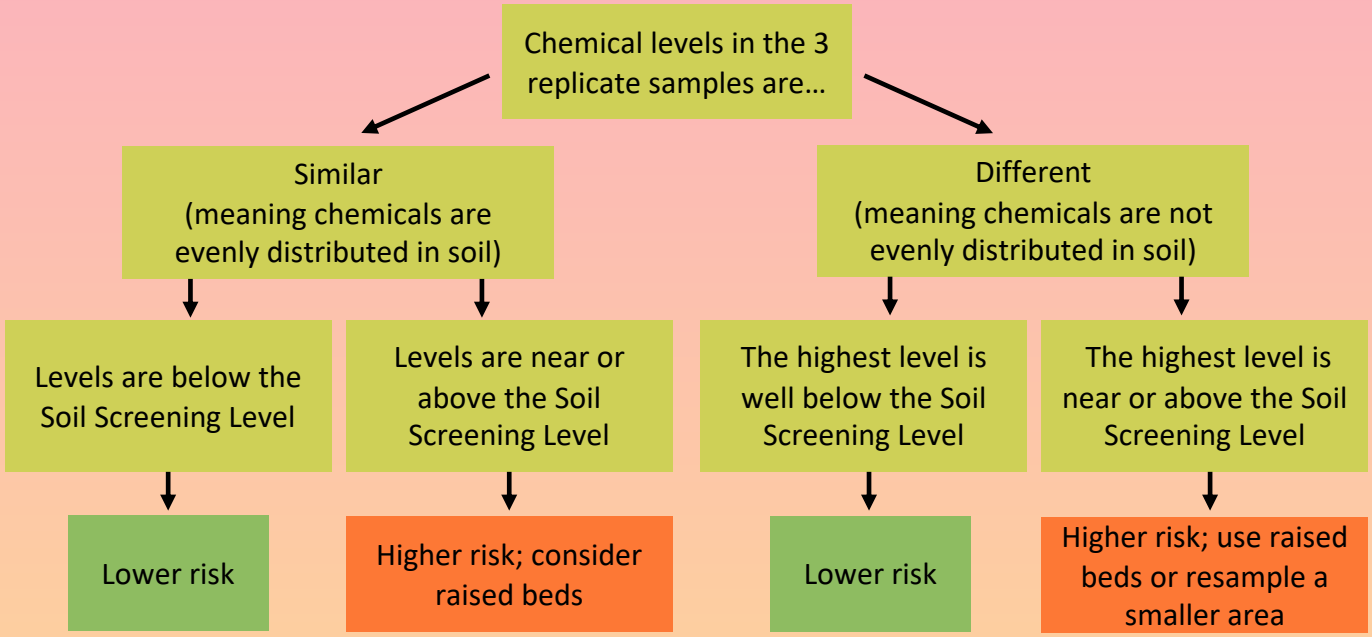
Figure 1. Choosing areas. Choose a food plot location farthest from roads and buildings (green area). Divide area to be sampled into 30 equally sized sections. Red areas are most likely to contain harmful chemicals. If you also want to sample red area soil, sample this soil separately from the food area sample – don't mix the green area and red area soil together. Yellow areas are somewhat likely to contain harmful chemicals, but less so than red areas.

Figure 2. Collect 3 spoonfuls of soil from each of the 30 sections and put them in 3 separate buckets. A) Starting with the first section, dig a 6" deep hole and remove the 3 spoonfuls from different sides of the hole (good option, easier, takes less time). Or, dig 3 holes per section and remove 1 spoonful from each hole (better option, takes more time). Put the first spoonful in a bucket (here, labeled with a square). Repeat this for 2 more buckets (here, triangle and circle buckets). At the end of sampling, each bucket will have 30 spoonfuls of soil in it. **B)** To fill the spoon with soil, drag the spoon along the hole from the bottom to the top. **C)** Make sure to get soil from the bottom, middle, and top of the hole in the spoon.



Interpreting your soil sampling results

- When you receive your results, look at your 3 composite samples for a given area. How similar are the levels of chemicals in the 3 replicates? In urban areas soil quality can vary greatly over small areas.
- Use the chart below to compare the levels in your samples to Residential Soil Screening Levels[5] (guidelines for urban agricultural soils don't exist). Soil Screening Levels can be hard to find. In California, find state guidelines at the Department of Toxic Substance Control[3], and ask for help if you need it.
- Use the risk-based decision-making chart (page 2) to determine how safe it is to grow food in your soil.



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References

For more information on growing food in urban soils, see Defoe et al. Gardening on Lead-Contaminated Soils, K-State Research and Extension MF3166 (2014) and Surles et al. UCANR Factsheet Soils in Urban Agriculture- Testing, Remediation, and Best Management Practices, UC ANR Publication 8552 (2016).

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