Safer soils for urban food growers

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July 15, 2012

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Harmful chemical pollutants are often found in urban soils

- Example chemicals: metals like **lead (Pb)** and **petroleum byproducts**.[1]
- S**afe growing practices** protect us from chemical exposure
- B**enefits of growing food** usually outweigh **risk** from chemicals[2]

Risk depends on exposure

- R**isk** that a chemical will harm our bodies depends on
  - how hazardous it is
  - how we are exposed
- **Risk = Hazard × Exposure**
  - Lower exposure to decrease the chances of harming health
- Key point: if we're not exposed to a chemical, we're not at risk, even if the chemical is still present

How are we exposed to chemicals?

- Exposure pathways:
  - Eating soil particles
  - Breathing in soil dust
  - Eating plants that contain harmful chemicals inside or on the surface

http://www.biology.arizona.edu/

Common harmful inorganic chemicals

- Metals and metal-like elements
  - Lead (Pb)
  - Arsenic (As)
  - Cadmium (Cd)
  - Chromium (Cr)

- Vehicle emissions, paint, pesticide use, industrial emissions, household waste, and chrome plating are sources of metals

Lead is the most common metal in urban soils

- Sources: 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[10,11]
  - Children metabolize up to 50% of lead they ingest
  - Adults metabolize less than 5%
  - Children are at greatest risk for lead poisoning, though adults are also at risk

Photo: Sarick Matzen

How are we exposed to lead?

- Eating soil particles on hands
  - Common way children are exposed to lead, both outside and inside homes
  - If a building has been painted with lead paint, lead levels in soil near the building will be highest closer to buildings (within 10-15 feet)[6]
- Other common ways children are exposed to lead
  - Lead paint
  - Lead dust (from soil and paint) on floors/rugs
  - Drinking water from lead water pipes

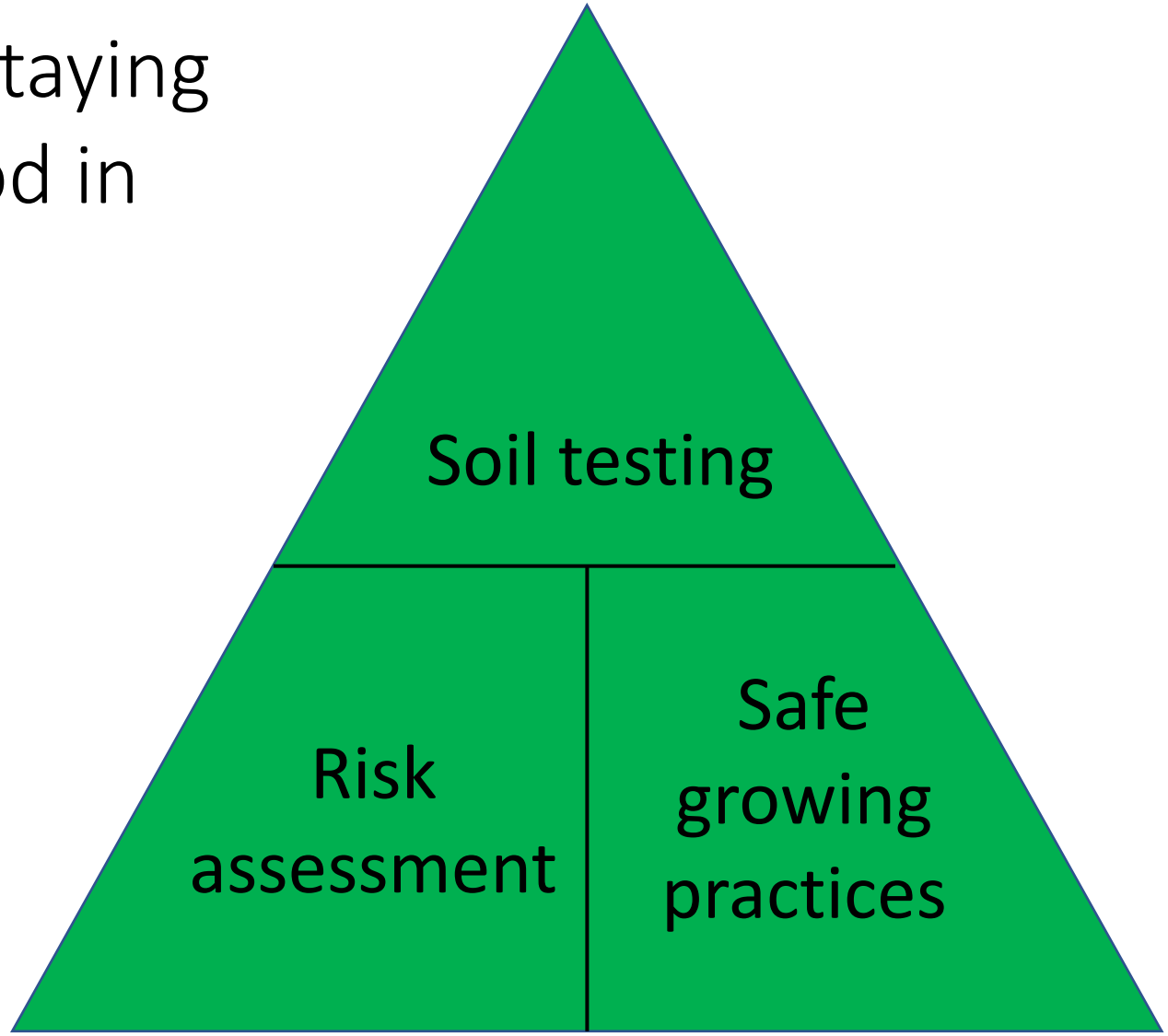
Common harmful organic chemicals

- Petroleum byproducts (vehicle exhaust particles, automotive fluids)
- Pesticides/herbicides
- Chemical residues from burning trash
- Sources: Vehicle emissions, automotive repair, industry, power plants, gas stations, and dry cleaners

Take these preventative measures to stay safe

- **Risk-based decision making**
  - Determine if it is safe to grow food in your soil
- **Healthy growing practices**
  - Decrease exposure to harmful chemicals if some might be present in your soil
- **Test your soil**
  - It’s never too late!

Three approaches to staying safe while growing food in urban soils



Risk assessment

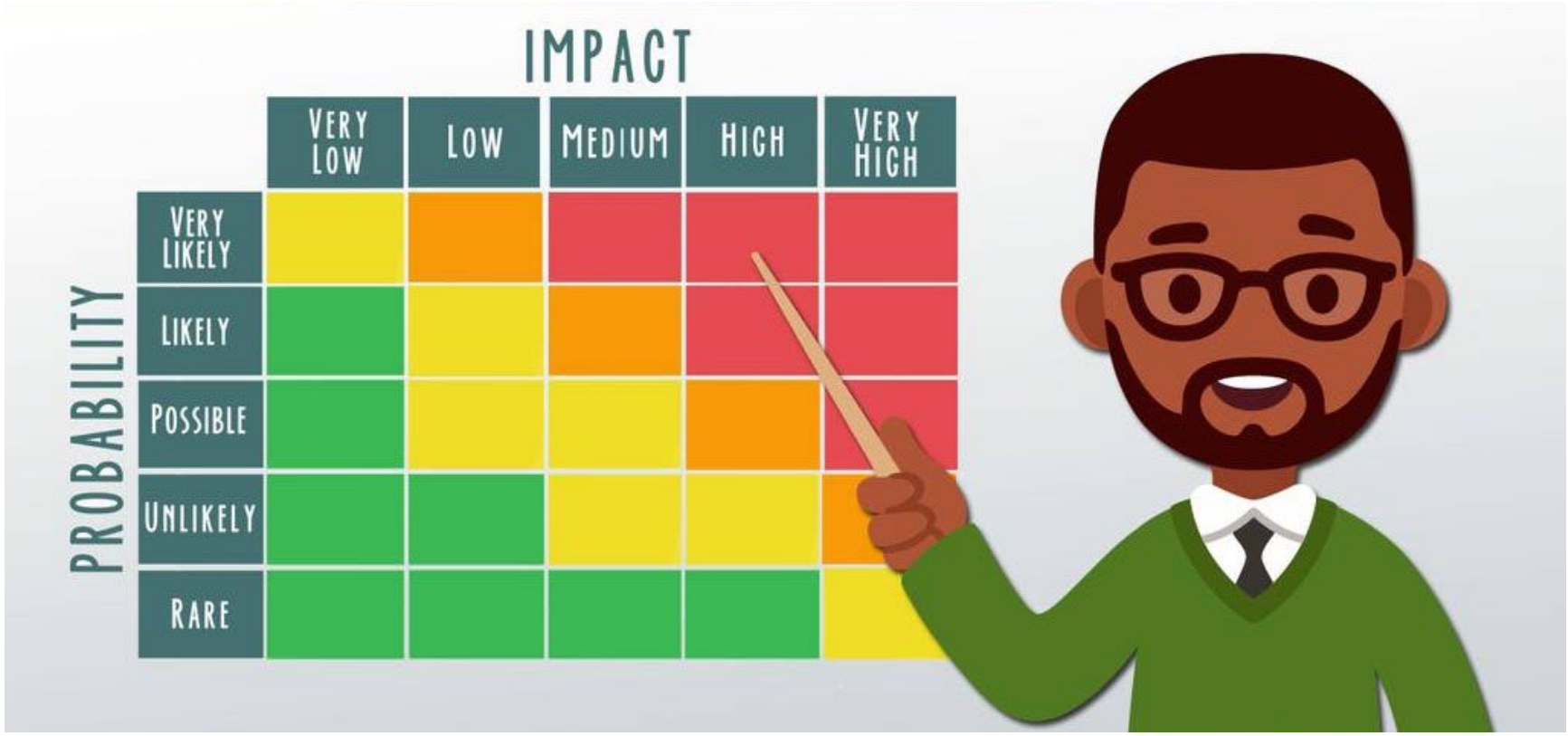


Image: Study.com

Risk assessment: Is it safe to grow food in my soil?

- You and your soil are unique
  - No comprehensive set of guidelines[8] that works for everybody
  - Only you can determine your risk, and only you can determine what steps to take to make your risk acceptable to you
- Use **risk-based decision-making** to determine what level of risk is right for you

Risk-based decision-making questions

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
What size is the garden?	Small	Large
Are there painted buildings older than 1978 nearby?	No	Yes
Is the garden within 10-15 feet of a building?	No	Yes
Has there ever been industry nearby?	No	Yes
How much time do you spend in the garden?	Little time	Lots of time

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

Risk-based decision-making questions

Site Assessment Questions	Lower Risk	Higher Risk
What crops do you grow?	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
How much clay vs. sand is in your soil?	Clayey soil	Sandy soil
What is the soil pH?	Neutral to alkaline (6.5-8.0)	Acidic (<6.5)
How much organic matter is in the soil?	A lot	A little

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

Safe growing practices

Photo: Rebecca Finneran, MSU Extension

Safe growing practices

- **Wash produce and hands before eating**
  - Wash produce with commercial vegetable wash, vinegar (2.5 tablespoons vinegar in 1 gallon water), or tap water[3]
- **Do not let children contact soil**
  - Protect children from soil if lead levels are greater than 80 mg/kg (ppm)[4], or if other chemicals might be present
- **Do not bring soil inside**
  - Leave shoes outside
  - Wear gloves
  - Wash hands with soap and water after working with soil

Safe growing practices

- **Do not work with dry soil**
  - Only work with moist (not wet) soil to avoid producing dust (especially when tilling)
- **Do not leave soil bare.**
  - Mulch beds and paths
  - Keep soil surface covered to avoid “backsplash” of soil particles onto plants
- **Plant hedgerows.**
  - Grow tall shrubs, vines, flowers along street to block vehicle exhaust

Safe growing practices

- **Do not plant root vegetables and leafy greens in soil where chemical levels might be high**
  - Lead levels are likely to be very high within 10 feet of painted, older buildings[5,6]
  - Plant root vegetables and leafy greens where lead levels in soil are likely to be lower (farthest from buildings/in a raised bed)
  - Plant fruiting crops where lead might be higher (closer to buildings)
  - Only grow ornamentals, no food, adjacent to buildings

Safe growing practices

- **Do not grow in your soil if chemical levels might be high**
  - Use raised beds (at least 1 foot 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 foot of soil to dilute chemicals[7]
  - Do not grow in 100% compost

Sampling your soil




Sampling your soil: an overview

- Detective work
  - Find out what to test for based on site history
  - Different chemicals have different testing fees, so a little preparation can save you money
- Collect soil samples
  - Follow our instructions to increase confidence in the test results
- When you get your results, use risk-based decision making to understand how the chemicals in your soil might affect you and others.

Step 1. 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 good detective work can save you money.

Routine Soil Analysis .....$ 20.00 **per sample**

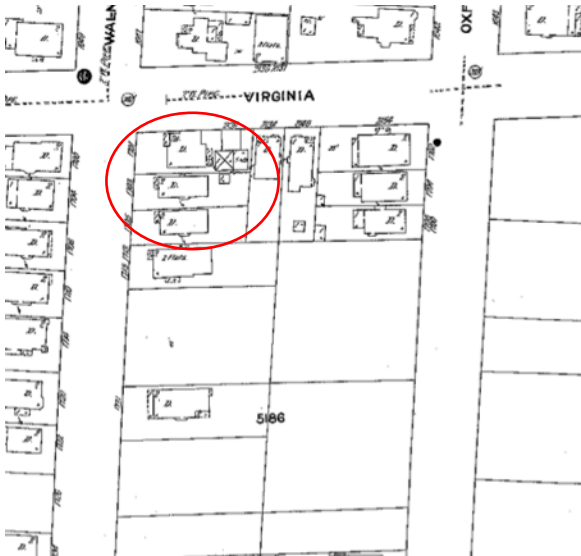
Analysis includes pH, exchangeable acidity, Modified Morgan extractable nutrients (P, K, Ca, Mg, Fe, Mn, Zn, Cu, B, S), lead (Pb), and aluminum (Al), cation exchange capacity, and base saturation, as well as crop-specific lime and nutrient

Total Metals: Lead, Nickel, Cadmium, Chromium, Zinc, Copper ($55.00)	Optional Additional Metals		
	Arsenic ($5.00)	Selenium ($5.00)	Molybdenum ($5.00)
X	☐	☐	☐

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

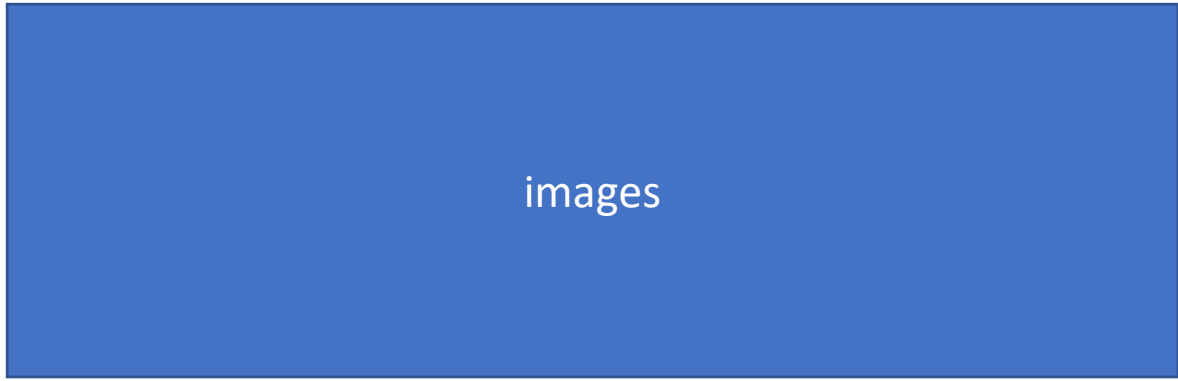
- Find out what your land was used for before, and what was located nearby.
  - If you're testing soil in a residential neighborhood with houses older than 1978, and/or soil in a high-traffic area, test for lead.
  - Look at Sanborn fire insurance maps (https://www.loc.gov/collections/sanborn-maps/) to see historical buildings in the area.

Picture of lead painted housed
(where is my Edmund pict)
Also credit these photos!



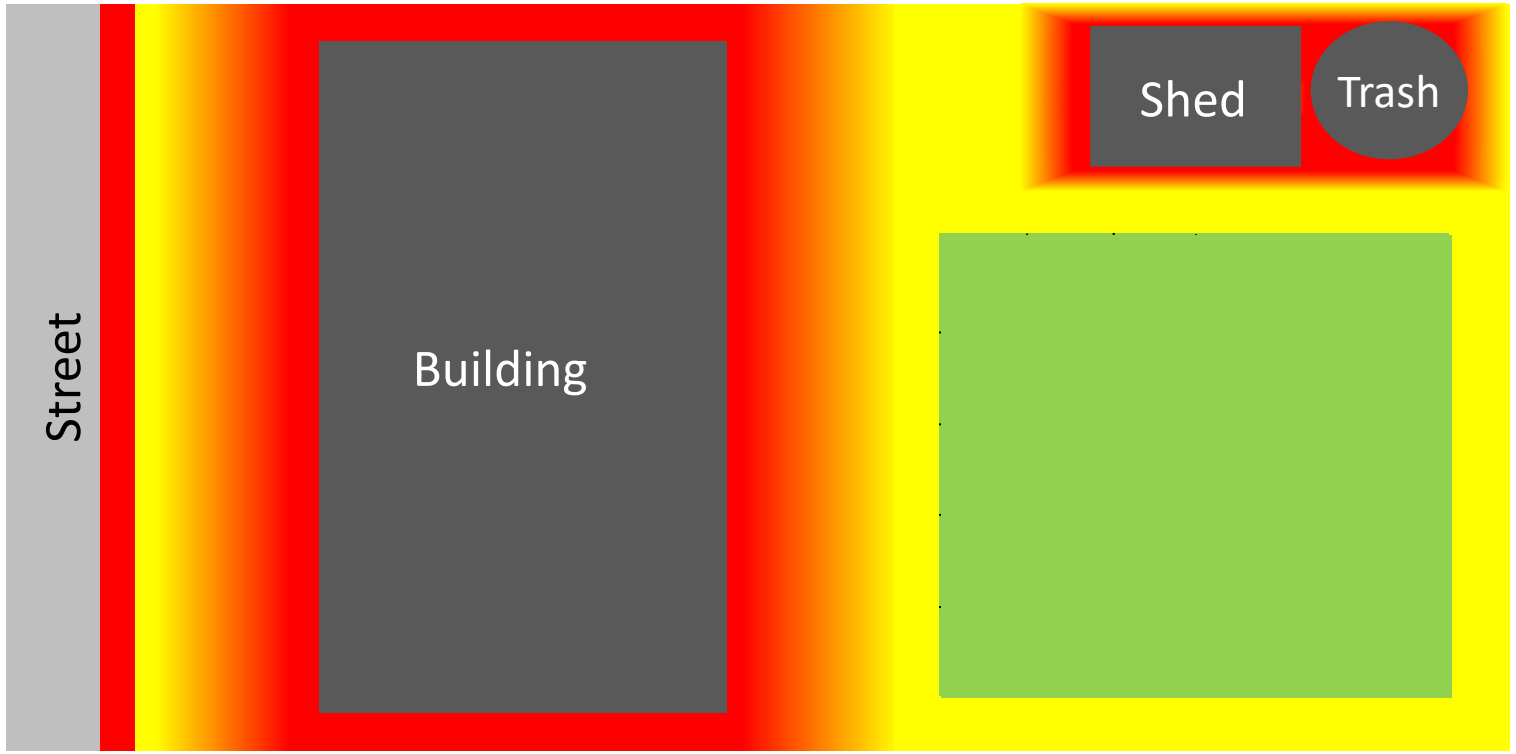
Step 1. Research your land's history to decide what chemicals to test for

- Ask neighbors/elders who have lived in the area a long time
- Consider other sources of pollution
  - Illegally dumped trash
  - Industrial plants
  - Refineries
  - Municipal garbage incinerators
  - Personal auto repair in yards



Step 2. Figure out what area you will sample

- Divide your space up into areas based on likely metal concentrations, past and future land use. Sample each area separately.



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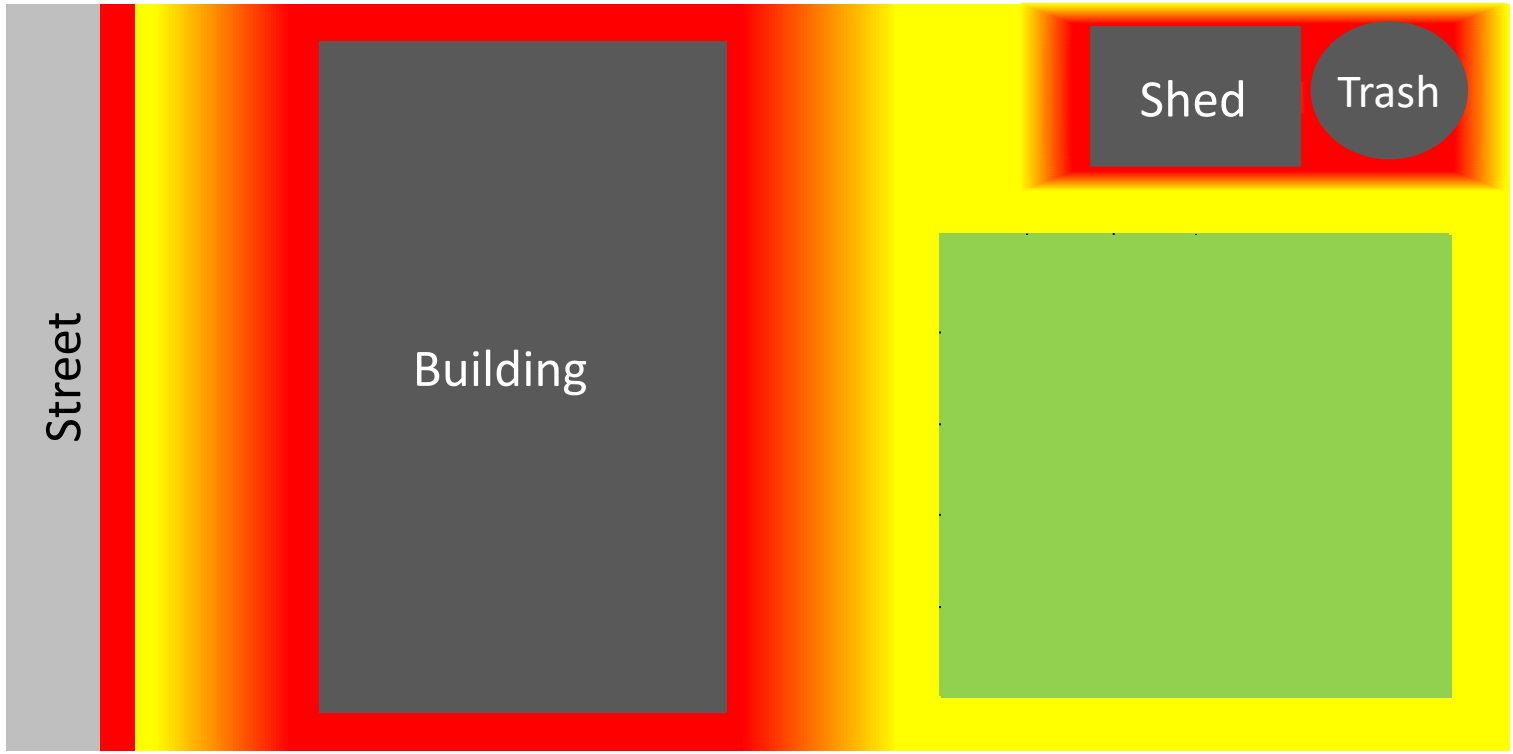

Red: Don’t grow food here. Lead and other chemicals likely to be highest.

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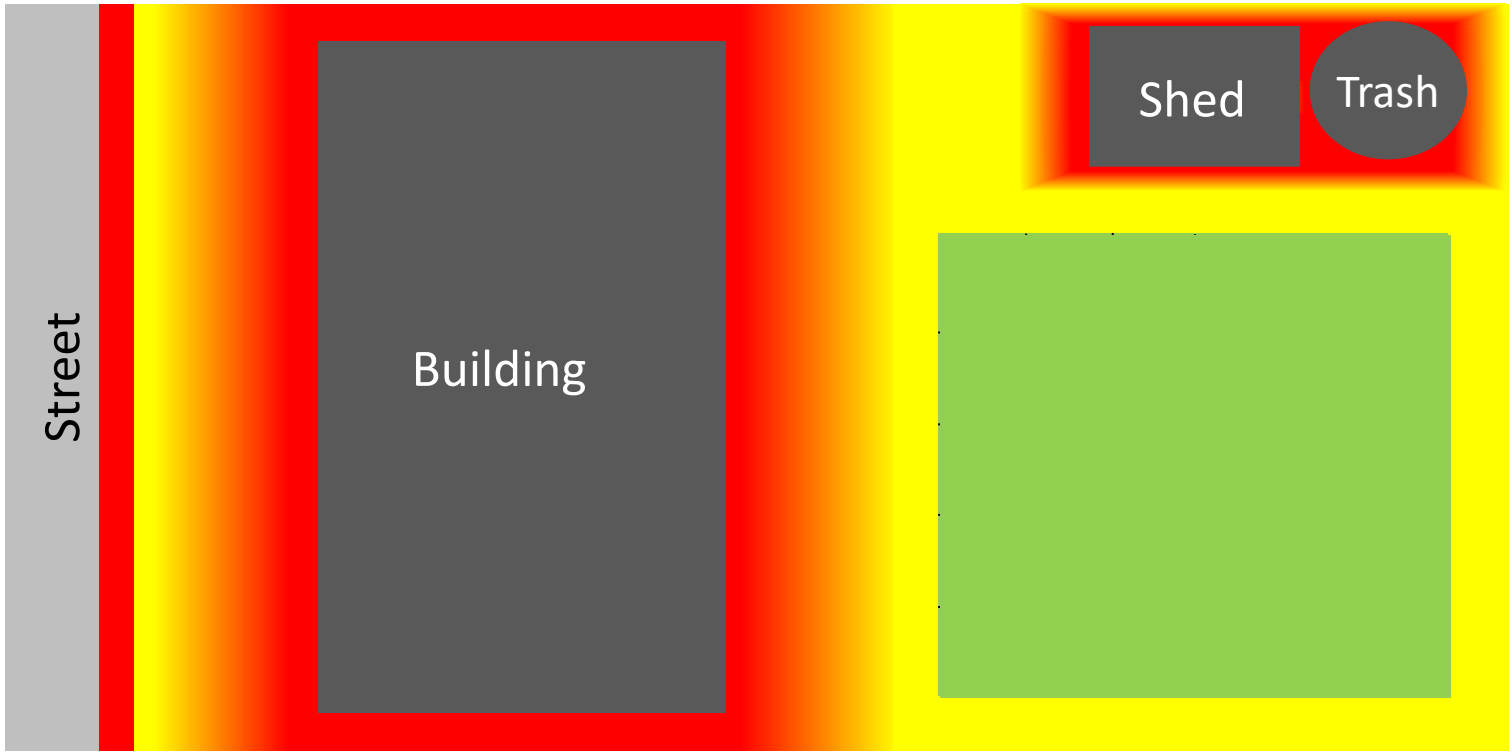

Yellow: Possible food growing area. Lead and other chemicals somewhat likely to be found here.

Step 2. Figure out what area you will sample

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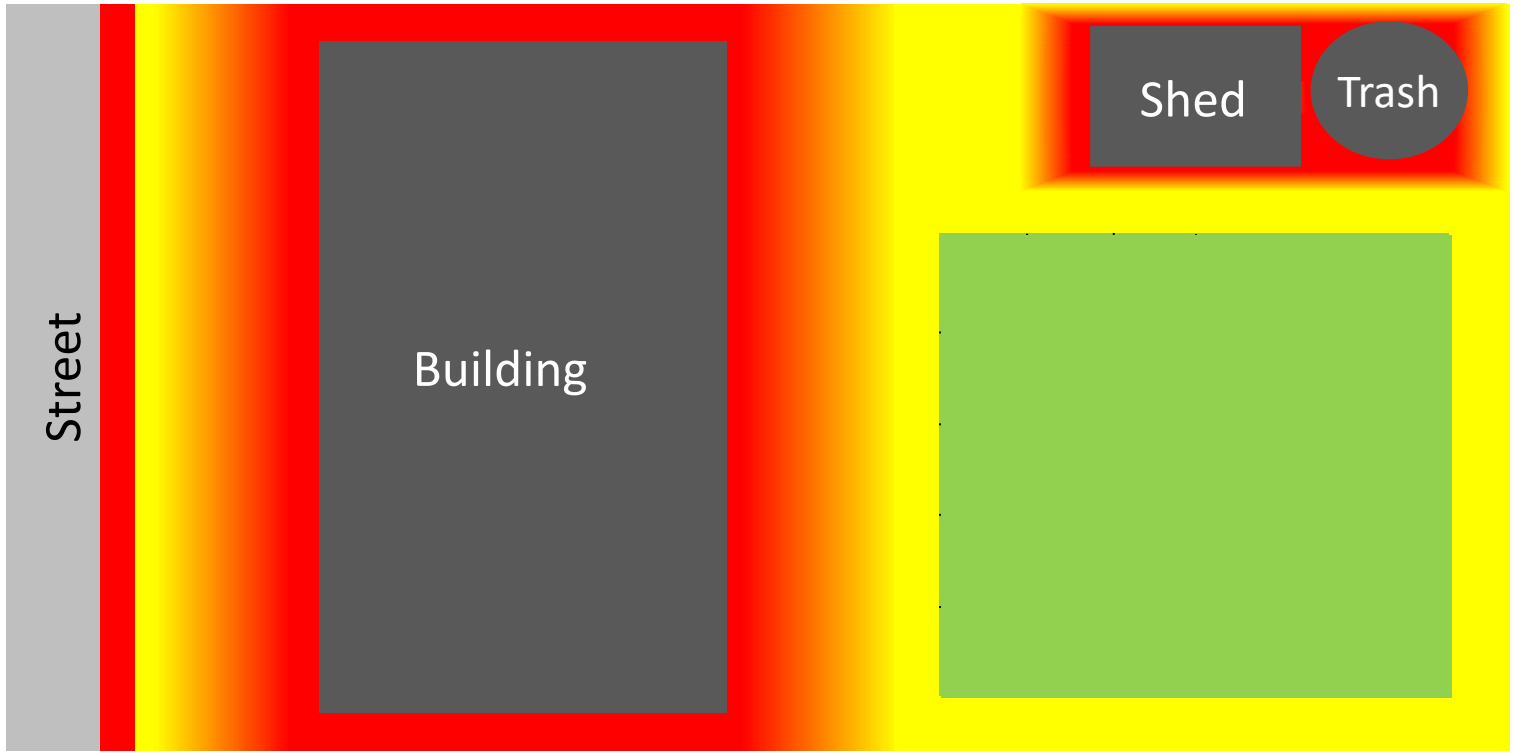
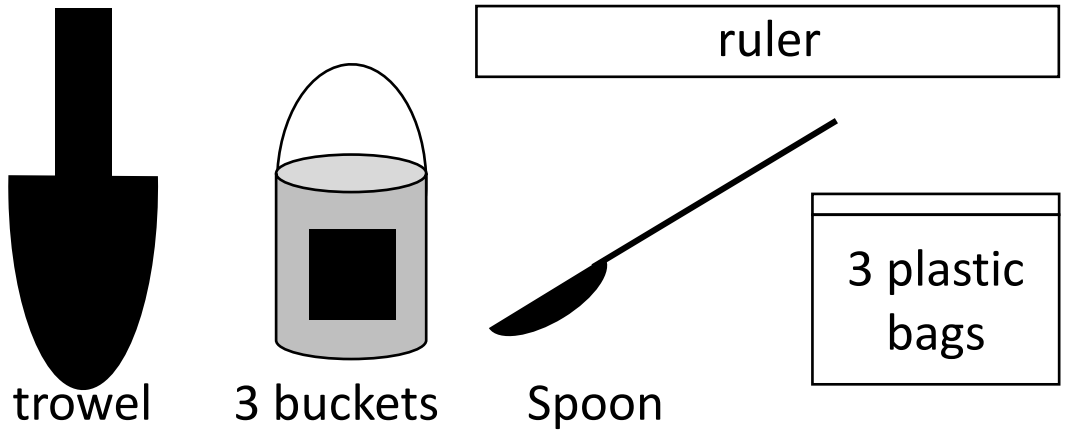


Green: Best place to grow food, farthest area from roads and buildings. Lead and other chemicals likely to be lowest.

Step 3. Gather the tools you will need

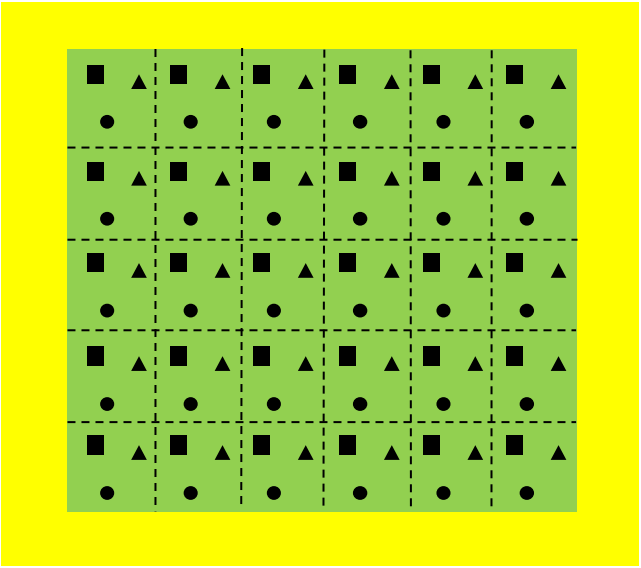
- Ruler
- 3 clean buckets
- Shovel or trowel
- 3 quart-sized, labeled plastic bags
- Spoon
- Gloves (clean)
- Paper, etc. to make map



Step 4. Collect composite samples for best results

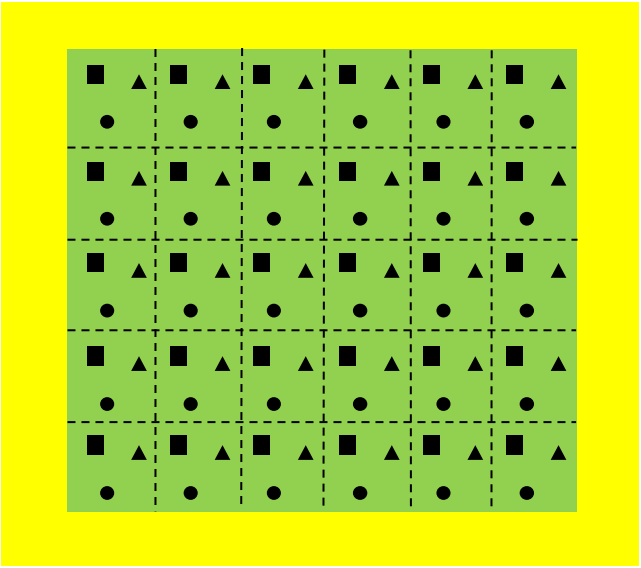
- Chemicals in soil aren't usually distributed evenly
- Results will be stronger if you collect a "composite" sample that combines lots of small subsamples, instead of just a few individual samples.
- Best to collect 3 composite samples (i.e., 3 replicates) from the same area

Here, we call these 3 replicates the "square ", "triangle", and "circle" samples.



Plan the 3 composite samples

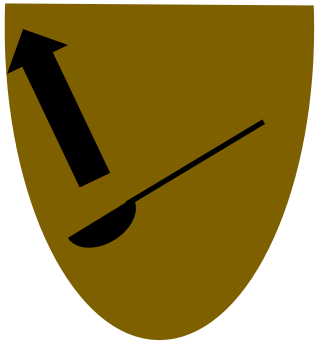
- Divide your area into sections that are about equally sized.
- Use about 30 sections[9], like a 6 x 5 grid, depending on the shape of your space.
- It doesn't matter how big the sections are. They should all be about the same size.
- Mark the grid on your map.
- To collect each of the 3 composite samples, sample a small amount of soil (a subsample) from each of the ~30 sections and mix the subsamples together in a bucket.



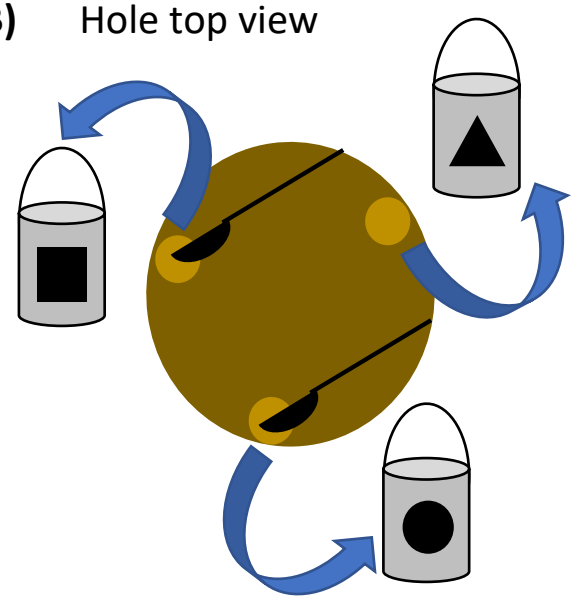
In each section…

- Dig a hole 6 inches deep with the trowel or shovel.
- Use a spoon to scrape up the side of the hole from the bottom to the top.
- Put the spoonful of soil in the “square” bucket.
- 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.

A) Hole side view



B) Hole top view



C)

Step 5. Send samples to the lab

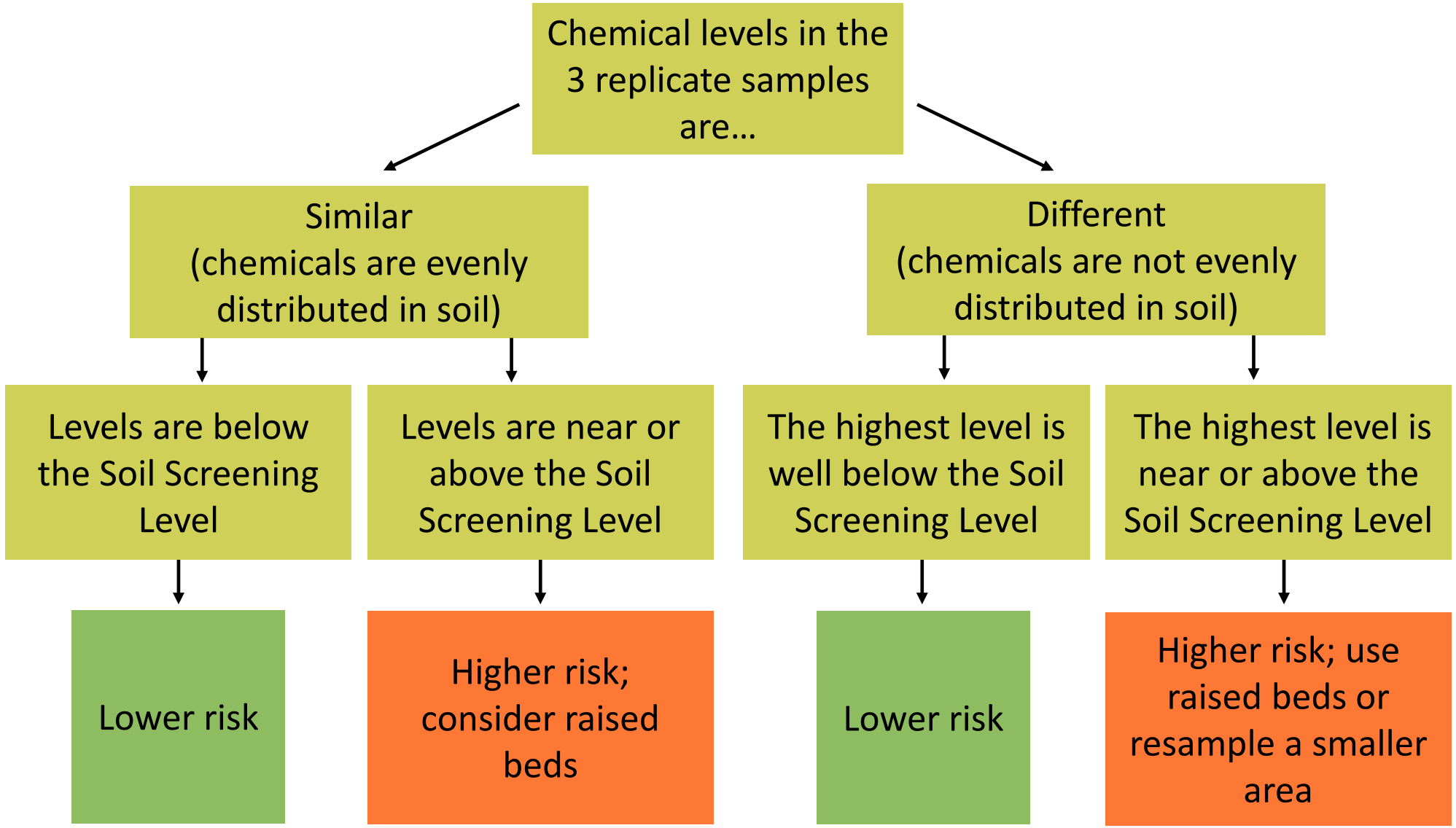
- When you are done collecting from each section, mix the soil in each bucket very well.
- Take out a cup (remove rocks) and place in a bag to send to the lab.
- Air-dry the soil (open the 3 bags) before shipping.

Find a lab

- 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.

Step 6. Interpret soil sample 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.
- Compare the levels in your samples to Residential Soil Screening Levels[4,8]
  - The US EPA does not provide guidelines for chemical levels in urban agricultural soils.
  - In California, find state guidelines at the Department of Toxic Substance Control[3].
- Use the risk-based decision-making chart (page 2) to determine how safe it is to grow food in your soil.


Chemical levels in the 3 replicate samples are…
Similar (chemicals are evenly distributed in soil)
Different (chemicals are not evenly distributed in soil)
Levels are below the Soil Screening Level
Levels are near or above the Soil Screening Level
The highest level is well below the Soil Screening Level
The highest level is near or above the Soil Screening Level
Lower risk
Higher risk; consider raised beds
Lower risk
Higher risk; use raised beds or resample a smaller area

Soil sampling: do it, if you can

- Soil sampling is not for everybody, but those who follow this method feel it’s worth the effort!
- Even if you can’t sample your soil, there are still plenty of ways to protect yourself

Acknowledgements

References

For more information, see Surles et al. UCANR Factsheet Soils in Urban Agriculture- Testing, Remediation, and Best Management Practices, UC ANR Publication 8552 (2016).

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