Urban Farms:

How to Assess & Minimize the Risk of Exposure to Soil Contaminants

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Here's what we want our soil to look like…

- Crumbly
- Lots of pores—large and small
- Plant roots
- Earthworms
- Dark color

What you see a lot of….

Urban soil=disturbed soil

- Construction
- Debris
- Dumping
- Filling and Leveling
- Compaction
- Erosion

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University of California
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ANR Publication 8552 | January 2016
www.anrcatalog.ucanr.edu
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Soils in Urban Agriculture: Testing, Remediation, and Best Management Practices

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Urban agriculture, including community and school gardens and small farms in cities, has become a popular means of obtaining fresh local produce. San Francisco, San Diego, Los Angeles, and several other California municipalities have changed policies to facilitate these activities.

Soils are an important consideration for individuals, community groups, and local governments becoming involved in urban agriculture. In many situations, urban soil has been contaminated and degraded by past uses and activity, including industry, unauthorized dumping, construction, heavy traffic, and adjacent buildings where lead-based paint has been applied. Elevated levels of lead in particular are fairly common in urban soils and pose health risks, especially to young children who can ingest soil while playing or helping in gardens. Ongoing exposure to lead can damage the nervous system, interfere with brain development, and create other health problems. Arsenic, cadmium, copper, zinc, and other naturally occurring trace elements in soils, especially heavy metals, can also be elevated to unsafe levels by past land uses.

Although soil degradation and contamination are important concerns and should be addressed, they are not always a problem with urban agriculture sites. A study conducted at several community gardens in the Los Angeles area by University of California researchers found that "in nearly all cases concentrations of trace elements were well within natural ranges" (Hodel and Chang 2002). In contrast, a study conducted in San Francisco found that "a majority of the gardens exceeded the California Human Health Screening Level for arsenic, cadmium, and lead" (Gorospe 2012).

Fertile soil. *Photo:* G. Heilig.

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What is soil contamination?

- Trash
- Pesticides
- Heavy metals
- Lead

How do lead (and other heavy metals) get from the soil into a person?

- Mostly from
  - Breathing in dust
  - Putting fingers in mouth

What about from plants?

- Less concern than dust and hands!
- Plants don’t absorb much lead.

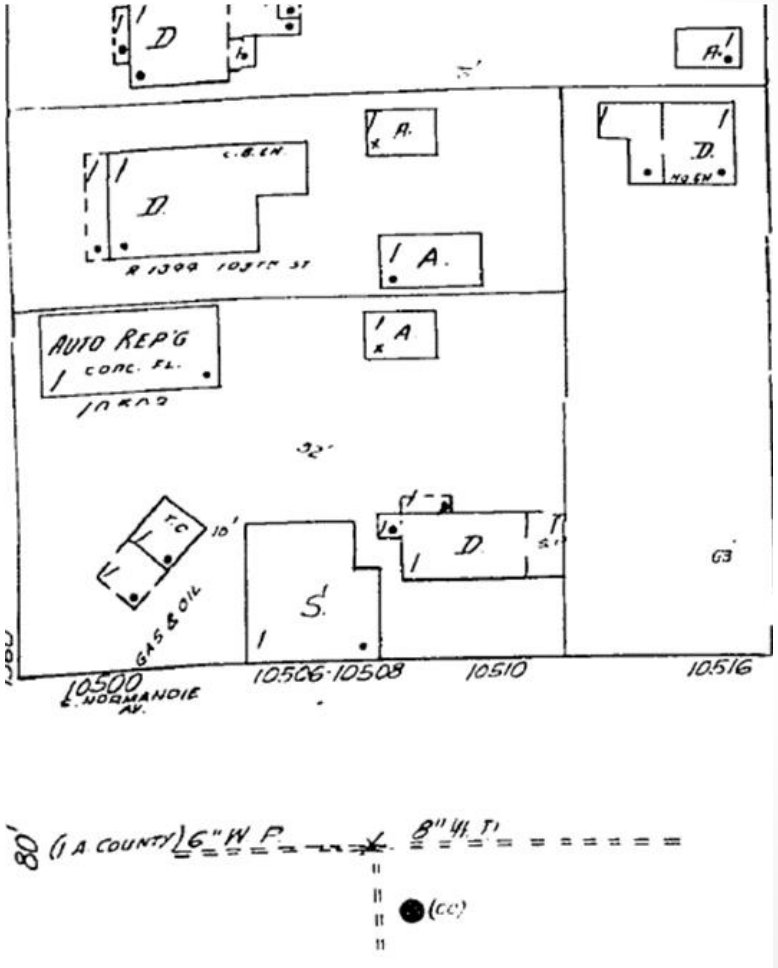
No matter what your site, try to learn about its history

Vacant Lots

School Yards

Research site history & status

- What was there before?
  - Neighbors
  - Old maps online
  - Look for high-risk uses
- What's there now?
- What's it near?
  - Freeway
  - Old homes



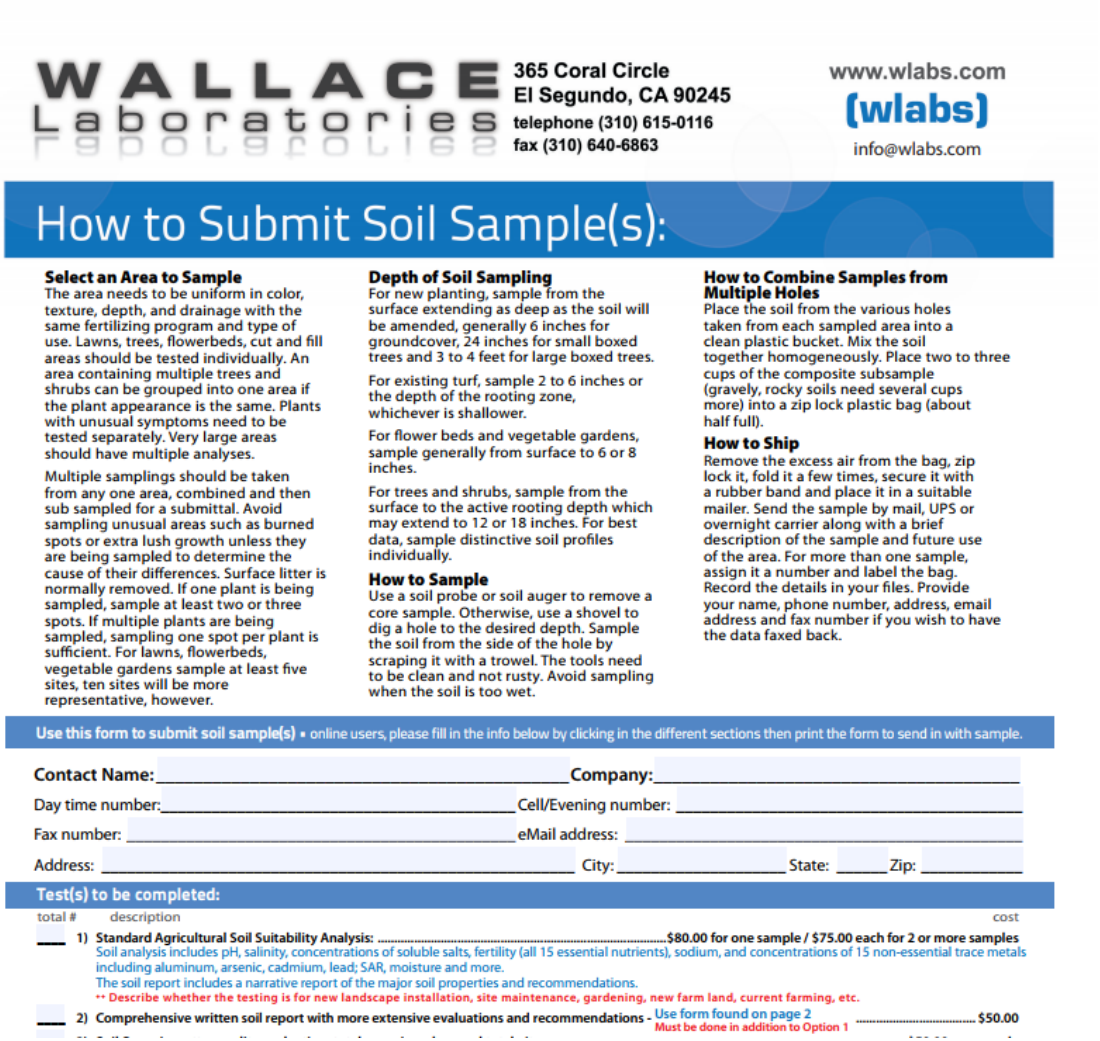
US Environmental Protection Agency recommends…

- *"At a minimum, the soil test should include pH, percent organic matter, nutrients, micronutrients, and metals, including lead."*

Risk Related to Former Site Use

- Lower Risk
  - Residential
  - Green space
- Higher Risk
  - Parking lots
  - Junkyards
  - Auto repair
  - Dry cleaners
  - Gas stations
  - Railyards
  - Illegal dumping

Research soil testing labs



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How to Submit Soil Sample(s):

Select an Area to Sample
The area needs to be uniform in color, texture, depth, and drainage with the same fertilizing program and type of use. Lawns, trees, flowerbeds, cut and fill areas should be tested individually. An area containing multiple trees and shrubs can be grouped into one area if the plant appearance is the same. Plants with unusual symptoms need to be tested separately. Very large areas should have multiple analyses.

Multiple samplings should be taken from any one area, combined and then sub sampled for a submittal. Avoid sampling unusual areas such as burned spots or extra lush growth unless they are being sampled to determine the cause of their differences. Surface litter is normally removed. If one plant is being sampled, sample at least two or three spots. If multiple plants are being sampled, sampling one spot per plant is sufficient. For lawns, flowerbeds, vegetable gardens sample at least five sites, ten sites will be more representative, however.

Depth of Soil Sampling
For new planting, sample from the surface extending as deep as the soil will be amended, generally 6 inches for groundcover, 24 inches for small boxed trees and 3 to 4 feet for large boxed trees.

For existing turf, sample 2 to 6 inches or the depth of the rooting zone, whichever is shallower.

For flower beds and vegetable gardens, sample generally from surface to 6 or 8 inches.

For trees and shrubs, sample from the surface to the active rooting depth which may extend to 12 or 18 inches. For best data, sample distinctive soil profiles individually.

How to Sample
Use a soil probe or soil auger to remove a core sample. Otherwise, use a shovel to dig a hole to the desired depth. Sample the soil from the side of the hole by scraping it with a trowel. The tools need to be clean and not rusty. Avoid sampling when the soil is too wet.

How to Combine Samples from Multiple Holes
Place the soil from the various holes taken from each sampled area into a clean plastic bucket. Mix the soil together homogeneously. Place two to three cups of the composite subsample (gravely, rocky soils need several cups more) into a zip lock plastic bag (about half full).

How to Ship
Remove the excess air from the bag, zip lock it, fold it a few times, secure it with a rubber band and place it in a suitable mailer. Send the sample by mail, UPS or overnight carrier along with a brief description of the sample and future use of the area. For more than one sample, assign it a number and label the bag. Record the details in your files. Provide your name, phone number, address, email address and fax number if you wish to have the data faxed back.

Use this form to submit soil sample(s) • online users, please fill in the info below by clicking in the different sections then print the form to send in with sample.

Contact Name: _____ **Company:** _____

Day time number: _____ Cell/Evening number: _____

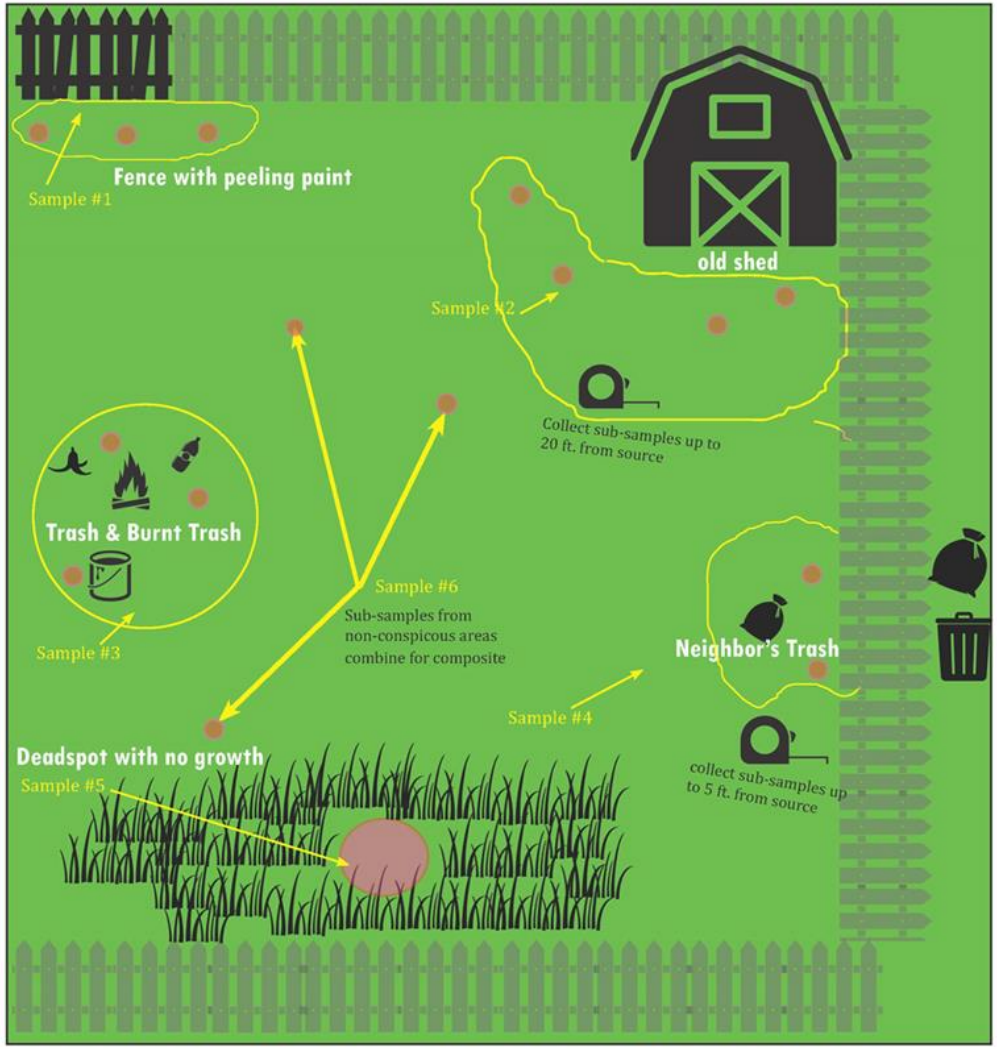
Fax number: _____ eMail address: _____

Address: _____ City: _____ State: _____ Zip: _____

Test(s) to be completed:

total #	description	cost
___	1) **Standard Agricultural Soil Suitability Analysis:** Soil analysis includes pH, salinity, concentrations of soluble salts, fertility (all 15 essential nutrients), sodium, and concentrations of 15 non-essential trace metals including aluminum, arsenic, cadmium, lead; SAR, moisture and more. The soil report includes a narrative report of the major soil properties and recommendations. ** Describe whether the testing is for new landscape installation, site maintenance, gardening, new farm land, current farming, etc.	$80.00 for one sample / $75.00 each for 2 or more samples
___	2) **Comprehensive written soil report with more extensive evaluations and recommendations** - Use form found on page 2 Must be done in addition to Option 1	$50.00

Sampling Plan



Composite sample

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February 5, 2015

vtborel@ucanr.edu
ATTN: Valerie Borel
University of California Cooperative Extension
700 W. Main Street
Alhambra, CA 91801

RE: Unidad Park, Community Gardens

Dear Valerie,

Summary Data

description	Sample 1, 2, 3	Sample 4, 5, 6	Sample 7, 8, 9	Sample 10, 11, 12	Sample 13, 14, 15	Sample 16, 17, 18	Average	target
pH	7.66	7.81	7.69	7.71	7.59	7.73	7.70	6.5-7.9
salinity	0.76	0.94	1.11	1.01	1.01	0.67	0.92	0.5-3
chloride	42	59	78	63	71	25	56	<150
nitrate	16	11	20	31	11	22	18	20-30
phosphorus	117.0	124.6	97.7	98.7	132.6	64.8	105.9	8-20
potassium	362	397	457	357	318	196	348	60-180
iron	57.14	57.73	47.55	49.18	72.67	54.95	56.54	4-15
manganese	22.83	23.74	19.52	21.37	25.26	17.68	21.74	0.6-3
zinc	20.80	21.83	15.67	15.43	25.20	12.84	18.63	1-3
copper	7.06	7.21	6.10	6.23	7.17	5.27	6.51	0.2-3
boron	0.72	1.59	0.61	0.79	0.63	0.61	0.82	0.2-0.5
magnesium	219	259	193	206	250	192	220	25-100
sodium	140	186	164	151	195	110	157	<200
sulfur	51	80	68	61	123	39	70	25-100
lead	5.60	6.21	5.01	4.04	5.51	3.91	5.05	<15
SAR	1.7	2.1	2.3	1.9	1.9	1.4	1.9	<3

The soils are moderately alkaline with pH values ranging from 7.59 to 7.81. The salinities are moderate with values ranging from 0.67 millimho/cm to 1.11 millimho/cm.

The soils have high fertility except for moderate nitrogen and low soluble calcium. Manganese, copper and zinc are high but should not limit plant growth for herbaceous plants. Woody stemmed plants may not thrive.

Lead is moderate at 5 parts per million on average. The soils should be safe for growing and consumption of leafy green vegetables.

Most of the soils are hydrophobic. It is difficult to wet. Water beads up on the surface. This is most likely due to the high organic matter content of soil.

Soil Analyses **Plant Analyses** **Water Analyses**

Recommendations

Apply gypsum to the soils at a rate of 30 pounds per 1,000 square feet. Till the gypsum into the top six inches of soil.

Periodic addition of nitrogen is needed. Nitrogen is routinely needed since it leaches. The frequency of application will depend on the soil type, rate of plant growth, amount of irrigation, quantity of leaching, type of soil amendments used for soil preparation, etc.

Choose one of the following, or other preferred source of nitrogen. Rates are per 1,000 square feet. The frequency of application is about once per quarter except for the slow-release materials:

- Yara's Viking Ship calcium ammonium nitrate (27-0-0) – 4 pounds
- Ammonium nitrate (34-0-0) – 3 pounds
- Urea (46-0-0) – 2 pounds in warm weather
- Blood meal – 8 pounds
- Ureaformaldehyde (38-0-0) – 8 pounds
- Coated urea – as labeled
- Feather meal – 15 pounds

Monitor the soils with periodic testing.

Sincerely,

John S. Wallace
JSW:n

Table 2. EPA TRW Lead Committee recommended best management practices for gardening in lead-contaminated areas

Soil-lead concentration (ppm)	Category	Recommendations	
		Gardening practices	Choosing plants*
<100	low risk	No specific remedial action needed. Wash hands, produce, and clothes (good gardening and housekeeping practices).	No restrictions of crop types.
>100–400[†] 400–1,200	potential risk	Increasing use of good gardening and housekeeping practices as described in the section "Best Management Practices."[§] Relocate garden to lower-risk garden areas. Increasing use of soil amendments (e.g., compost, clean fill), barriers (e.g., mulch), and other remedial measures up to and including raised beds and containers. Ensure that gardeners wear gloves and use tools to reduce soil contact and ingestion.	Decrease planting of root vegetables or relocate root crop planting to lower-risk areas. Increase use of soil amendments and barriers to reduce soil deposition onto leafy vegetables. Increase planting of fruiting vegetables, vegetables that grow on vines, and fruit trees.
>1,200	high risk	All of the above good gardening and housekeeping practices. Raised beds, soil containers, soil replacement (i.e., excavate contaminated soil and replace with soil containing low lead concentrations) are strongly recommended.[‡] Consider finding other locations for garden. Restrict child access to only established safe areas. Restrict all gardening by or for children in contaminated soils.	Select plants with shallow roots for raised beds or areas with replacement soil to ensure that roots do not reach contaminated soil that is left in place (if any); otherwise, no restrictions.

Source: U.S. EPA 2014.

Notes:

*Sources: See U.S. EPA 2014, pp. 20–21.

[†]While 400 ppm lead in soil is considered an appropriate screening level for residential soil-lead, the TRW recommends that 100 ppm be used as the low end of the range of soil lead concentrations to mitigate exposure to lead in soil when gardening is an important exposure pathway. Lacking the information to support a quantitative approach for estimating risk for gardening scenario to support establishing acceptable concentration of lead in garden areas, best professional judgment was used to establish the low end of the range. This soil concentration is below the 400 ppm soil screening level for lead because the gardening exposure pathway includes other sources of lead exposure not sufficiently accounted for in the soil screening level. The basis for the Soil Screening Level (SSL) is children playing in lead contaminated soil and some other exposures, with the predominant source of exposure from direct soil ingestion or ingestion of soil manifested as house dust. Scientific limitations when it was developed did not allow the SSL for lead to adequately account for consuming home-grown produce. In developing an acceptable concentration of lead in soil for home garden exposures, the same child receptor would be exposed if accompanying the adult in the garden and also exposed through consumption of lead in and on the produce grown in the soil. Hence, the garden-based level is lower than the SSL and reasonable steps to mitigate exposure to lead while gardening in soil lead concentrations between 100–400 ppm would be appropriate. The TRW acknowledges that background soil lead concentrations in some communities may exceed the guidance values recommended for garden areas. Mitigation may be necessary for those communities.

[§]See U.S. EPA 2014, p. 10.

[‡]Twenty-four (24) inches of clean soil cover is generally considered adequate for gardening; however, site specific conditions should also be considered. A 24-inch barrier normally is necessary to prevent contact of contaminated soil at depth with plant roots, root vegetables, and clean soil that is mixed via deep rototilling. Raised garden beds could cost effectively add 24 inches of clean soil (U.S. EPA 2003).

Soil test results will determine

- Based on how much lead is in your soil, if gardening is:
  - Low risk (Less than 100 ppm lead)
  - Potential Risk (100-1200 ppm lead)
  - High Risk (higher than 1,200 ppm)
- And what are possible next steps

Low Risk

- Garden as usual
- Grow crops you like
- Wash your hands after working in garden
- Wash garden produce
- Peel root crops like carrots and beets

Potential Risk

- Use more compost and mulch.
- Wear gloves
- Consider gardening in raised beds or containers

Potential Risk: More restrictions on what to grow

- Root crops—grow less.
- Leafy vegetables- grow less
- Fruiting crops—grow more

Leafy vegetables-more concern

Fruit-less concern

High Risk

- Soil removal and replace with clean soil
- Or… garden only in containers and deep raised beds
- Or… don’t grow food there
- Restrict access for children

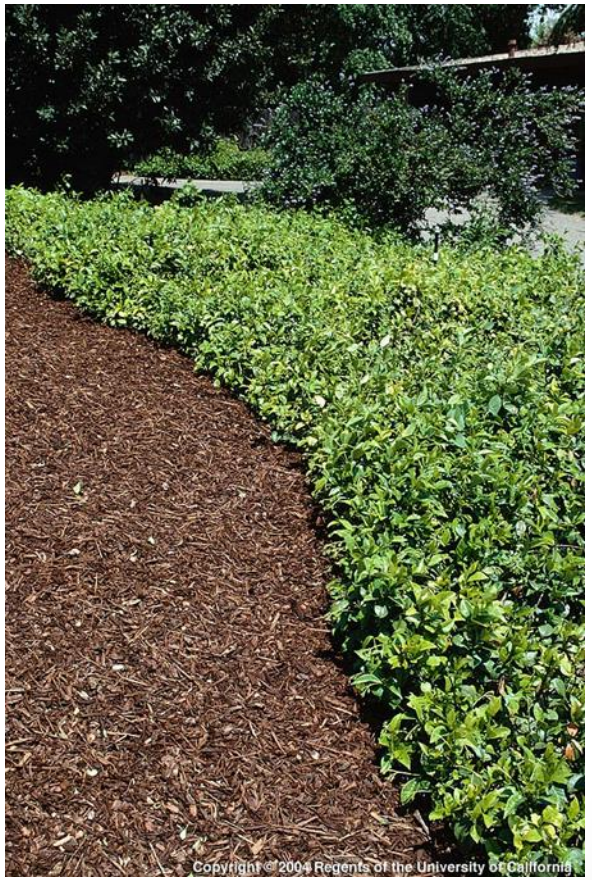
Alternatives to In-Ground

Best practices for working in urban soils

- Add organic matter
- Wear gloves
- Wash hands
- Wash produce
- Closed-toe shoes

Always-cover bare soil

- Eliminate dust
- Mulch with
  - Wood chips
  - Compost



Questions about soil testing and remediation?

- Rachel Surls
  ramabie@ucanr.edu