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Guidance for San Francisco Residents and Public Agencies: Lead Hazard Risk Assessment and Management of Urban Gardens and Farms

I. Introduction and Purpose

Gardening is beneficial to public health, both by creating greater access to fresh food and through promoting outdoor physical activity. However, urban gardening may result in lead hazard exposure to individuals by either direct contact with lead in soil or lead hazards on adjacent painted surfaces, or by the consumption of food grown in lead-contaminated soil. Children participating in gardening activities are at greatest risk from these hazards. The purpose of this guidance is to reduce the human health risks from exposure to lead from urban gardening in San Francisco. This guidance includes protocols for conducting Lead Hazard Risk Assessment (LHRA) for urban gardens or farms and for managing and mitigating identified hazards.

II. Background

Human and childhood exposure to lead is a well documented and a significant preventable environmental health problem. Chronic exposure can damage the nervous system, impair brain development, result in iron deficiency and anemia, and harm the kidneys and other major organs. Young children are at greatest risk to harm from lead exposure because their brains and nervous systems are still forming. Studies of children show that even small amounts of lead in the body can make it hard for children to learn, pay attention, and succeed in school. *Lead can readily cross the placenta so lead exposure to pregnant women can also harm the developing fetus.*

In the context of urban gardens, exposure to lead is most likely to come from contaminated soil. When children play outdoors, lead-contaminated dirt and dust can get on hands, clothes, toys, food and pets. Most commonly, ingestion of lead occurs from touching or handling soil and later putting hands or fingers into the mouth. Some children seek nourishment from eating soil and therefore direct ingestion of lead in soil may occur. Peeling, flaking, and other deteriorated paint conditions can expose children to lead if they touch those deteriorated surfaces and later put their hands or fingers into their mouths. In some cases, chips of lead-based paint may also be picked up and eaten. Soil and dust containing lead can also be tracked into the home by people and pets.

Evidence suggests that many urban gardening sites in San Francisco may be contaminated with lead. Most urban gardens will be in close proximity to residential buildings and greater than 90% of residential buildings in San Francisco have at one time been painted with lead-based paint. In the course of time, lead paint dust and debris has been deposited in soil adjacent to all pre-1979 buildings due to routine preparation techniques used prior to repainting as well as the normal paint weathering process. Safe work practices disturbing paint on building exteriors were not required until 1998, so migration of lead paint dust and deposition into the soil were common.

Urban gardening sites adjacent to busy roadways may be contaminated via past deposition of lead from lead gas vehicle emissions. Additionally, many sites with an industrial or commercial history can be expected to have lead in soil contamination as well as other heavy metals.

III. Steps in Lead Hazard Risk Assessment

A. Conduct a visual assessment of the site

Any pre-1979 building surfaces with damaged or deteriorated paint should be presumed to be a potential lead hazard (See Article 11, Section 581(10) of the San Francisco Health Code). Therefore we recommend a visual assessment of the painted surfaces adjacent to the garden before constructing a garden for food production or other gardening activities. If damaged or deteriorating painted surfaces are visible adjacent to a garden, this is sufficient evidence to document a lead paint hazard. In such settings, the soil adjacent to the damaged or deteriorating paint is also presumed to contain lead. Visible chips, dust or debris in the soil from paint sources may be additional direct evidence of lead hazards**.** *In cases, where lead paint hazards in a pre-1979 building or adjacent soil contamination are visible, additional soil sampling is not required. Resources should instead be directed to control and mitigation.*

B. Assess the historic uses garden site and adjacent sites

Current and past uses that may contribute lead to the site include: previous renovation activities, any auto repair/painting operation; construction, carpentry, battery recycling and plumbing businesses. Query the site's property owner and neighboring property owners and review Sanborn property maps available at the public library to begin to know the site's history. Further information about prior industrial uses can be obtained from websites of the California Department of Toxic Substances Control (DTSC) (http://www.envirostor.dtsc.ca.gov/public/) and the State Water Resources Control Board (SWRCB) (http://www.geotracker.swrcb.ca.gov/). SFDPH Environmental Health is another source of information on current industrial uses of the site and adjacent sites; one may submit a file review request to the Hazardous Materials Unified Program Agency (HMUPA) by calling 415-252-3920 or using the form given at: http://www.sfdph.org/dph/EH/HMUPA/HMUPAFileSearchProc.asp. To investigate past permit history and structures which may have been demolished (a common source of lead in soil), use Internet Explorer with the street address or block and lot number to consult the SF Planning Department's website (http://propertymap.sfplanning.org), in conjunction with the SF Tax Assessor Real Estate Information System (http://gispub02.sfgov.org/website/sfparcel/INDEX.htm).

C. Conducting bulk soil sampling for laboratory analysis

C.1 For large garden and farm projects

For large garden or farm sites, hiring of a consultant with capability to measure lead in soil with the use of x-ray fluorescence equipment (known as XRF) may be cost-effective compared to bulk soil sampling for laboratory analysis.

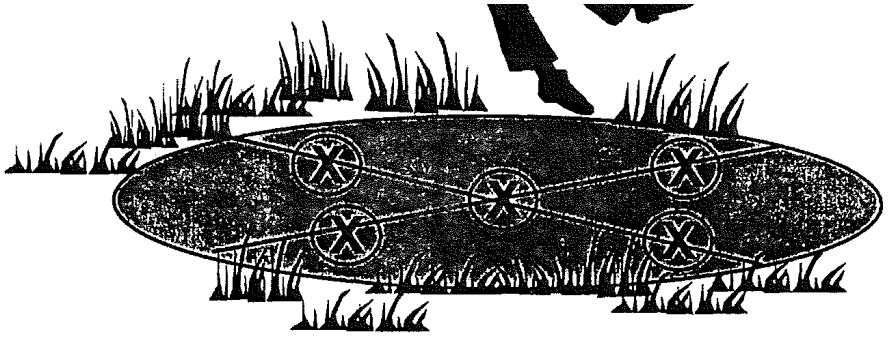
C.2 For sites with prior industrial use

If the garden project is a former commercial or industrial site, median strip, old right-of-way, or has an unknown history, you are advised to hire an environmental consulting firm specializing in hazardous waste characterization or an individual who is a State Registered Environmental Assessor (REA) to characterize the hazards and design a Lead Hazard Control and Remediation Plan for your site. The Attachment 2--Soil Sampling Protocol (B) provides a sampling methodology that you can discuss with your environmental consultant. In these situations of non-residential land use, soil sampling needs to be conducted to at least an 18-inch depth, and analyzed by a lab meeting state qualification for hazardous materials analysis. At a minimum, soil samples should be analyzed for lead, chromium, nickel, zinc, copper and arsenic.

C.3 For sites with residential use only

If the site's history is exclusively residential, *and* no paint chips or debris are visible, then lead hazard soil sampling can be conducted following the Attachment 1--Soil Sampling Protocol (A) for residential sites. This sampling protocol is consistent with HUD (Housing and Urban Development) Guidelines. The top half inch of soil is sampled because this is the most likely place to find the deposition of lead-based paint dust and debris. It is important to use a National Lead Laboratory Accreditation Program (NLLAP) laboratory to analyze the samples.

Tests of soil for lead may miss contamination if not conducted properly. Taking a few individual samples at specific points will not produce a representative assessment of soil lead content for the entire area of concern, (http://www.epa.gov/lead/pubs/nllap.htm).



Bare soil should be divided by an x-shaped grid. Subsamples should then be collected at equidistant points along each axis.

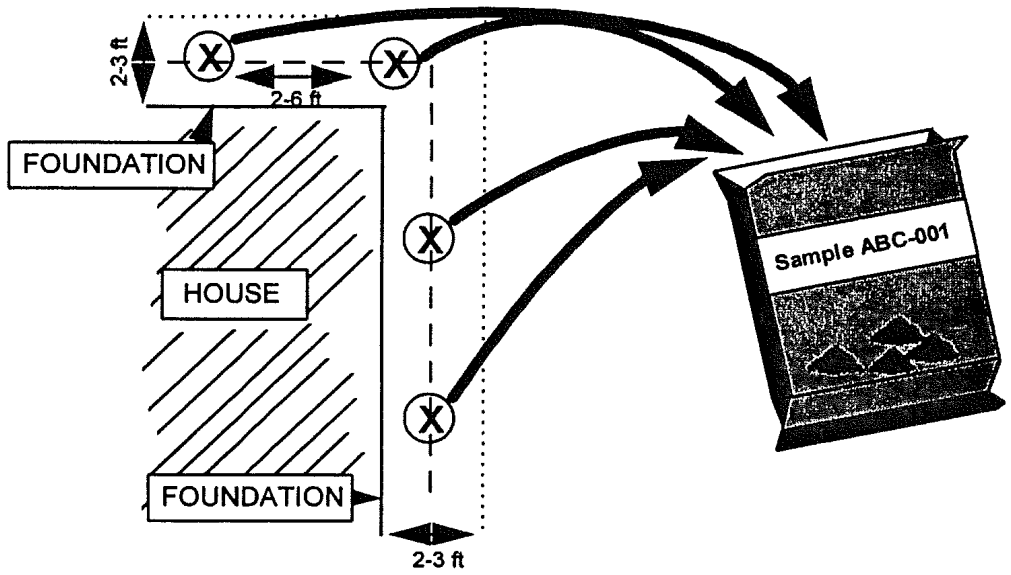


Illustration: For samples collected along a building foundation drip line, sub-samples of the top half inch (1 cm) of soil should be collected at least two to six feet apart. Each sub-sample is then combined in a single container to make up the composite sample.

D. Evaluate sampling results against health-based risk standards

Soil with lead levels of 80 parts per million (ppm) represents a potential hazard to children and should direct garden planners to being implementing lead hazard mitigation and exposure controls (see below) prior to engagement in gardening activities. This risk-based threshold is based on the work of the CalEPA Office of Environmental Health Hazard Assessment (OEHHA) finalized in September 2009. Based on a thorough review of the evidence, OEHHA determined that an increase in children's blood lead of one microgram per deciliter of blood (1 µg/dl) may lead to significant health risks to children. OEHHA further estimated that a soil lead concentration of 80 ppm would result to an incremental increase in blood lead (BLL) of up to 1 µg/dL in about 10 percent of children, (http://oehha.ca.gov/risk/pdf/LeadCHHSL51809.pdf).

Note that US Environmental Protection Agency (EPA) and California Department of Public Health (CDPH) use 400 ppm or greater of lead in bare soil as their definition of a lead in soil hazard and the CalEPA State Water Resources Control Board (SWRCB) uses 200 ppm or greater of lead for their definition of clearance prior to land use development. Neither of those values is based on the prevention of significant health effects to children.

IV. Lead Hazard Control and Remediation Steps

A. Control and Remediation of Lead Paint Hazards

Deteriorated painted surface must be safely prepared and repainted or resurfaced. Lead-safe work practices must be employed to prevent further contamination. Federal law requires that lead-safe work practices be followed in accord with the U.S. Environmental Protection Agency (EPA) Renovation, Repair and Painting rule. Additionally, the California Department of Public Health (CDPH) Accreditation, Certification, and Work Practices for Lead-Based Paint and Lead Hazards (Title 17,

California Code Regulations, Division 1, Chapter 8) law specifies numerous requirements that pertain to lead professionals and to the abatement of lead paint and lead hazards that is performed in public and residential buildings. In San Francisco, anyone disturbing painted surfaces on steel structures or pre-1979 buildings must also comply with the safe work practices required by San Francisco Building Code Chapter 34, Section 3425, "Work Practices for Lead-Based Paint on Pre-1979 Buildings and Steel Structures," enforced by SF Department of Building Inspection, Housing Inspection Services.

Lead-safe work practices include these simple procedures:

1) Post the site and notify occupants and neighbors according to the requirements of SF Building Code Chapter 34, Section 3425.
2) Contain the work area to prevent migration of dust and debris.
3) Avoid paint prep methods that generate large amounts of lead paint dust (e.g., dry scraping, power sanding) or use tools and methods that fully capture the dust.
4) Clean up thoroughly.
5) Dispose of waste properly; contact Recology at: www.sfhazwaste.com.

B. Control and Remediation of Lead in Soil Hazards

If children may be involved in urban gardening activities or the soil is intended to produce edibles *and* a lead hazard has been indicated by visual assessment, site history or lead in soil analysis showing 80 ppm or greater, one of the following lead in soil hazard remediation methods should be used:

1. Create a barrier layer over lead-containing soil: If you choose to leave lead-containing soil in place, install a durable weed cloth barrier layer or similar material and optionally, a second barrier layer of chicken wire or similar material that can alert you if you are ever digging deep enough to damage the weed cloth. Then install 12-18 inches of new clean soil on top, deep enough to allow your edibles to grow.

2. Remove the lead-containing soil and replace with clean soil: Removing soil contaminated with lead can be costly. If you choose this method, remove the lead-containing soil to a depth of at least 6 inches, the presumed depth of most lead paint and dust deposits according to US Housing and Urban Development (HUD) Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing. Dispose of the lead-containing soil by contacting Recology at www.sfhazwaste.com. Add 12-18 inches of new clean soil on top, deep enough to allow your edibles to grow.

See Attachment 3--Control and Remediation of Lead in Soil Hazards protocol for further details about these options prior to garden construction. We do not recommend growing edibles in lead-containing soil over 80 parts per million lead, because lead from the soil can be absorbed into the plants and be unknowingly ingested by individuals who eat the edibles. Lastly, wash your produce well before eating.
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For more information on these Guidelines, contact Karen.Cohn@sfdph.org (252-3898) or Joe.Walseth@sfdph.org (252-3956) at DPH Children's Environmental Health Promotion.

References and Resources

1) US Environmental Protection Agency (EPA) Renovation, Repair and Painting Rule, booklet *Renovate Right*: http://www.epa.gov/lead/pubs/renovaterightbrochure.pdf

2) California Department of Public Health (CDPH), Accreditation, Certification, and Work Practices for Lead-Based Paint and Lead Hazards (Title 17, California Code Regulations, Division 1, Chapter 8): http://www.cdph.ca.gov/programs/CLPPB/Pages/LRCProgOver.aspx and http://www.cdph.ca.gov/programs/CLPPB/Documents/Title17.pdf

3) San Francisco Department of Building Inspection SF Building Code Chapter 34, Section 3425, "Work Practices for Lead-Based Paint on Pre-1979 Buildings and Steel Structures," brochure: http://www.sfdbi.org/ftp/uploadedfiles/dbi/Key_Information/WorkPracticesLeadBasedPaint.pdf

4) San Francisco Health Code Article 11 Section 581(10) Prohibited Public Health Nuisances: http://library.municode.com/index.aspx?clientId=14136&stateId=5&stateName=California

5) US ATDSR. May 1992. *Analysis Paper: Impact of Lead-Contaminated Soil on Public Health;* http://www.ibiblio.org/london/agriculture/feedback/dirtfarmer/msg00116.html

6) Cal/EPA OEHHA Residential California Human Health Lead Screening Level which was finalized in September 2009 and can be found at: http://www.oehha.ca.gov/risk/pdf/LeadCHHSL091709.pdf

7) Cal/EPA OEHHA "Child-Specific Benchmark Change in Blood Lead Concentration for School Site Risk Assessment," finalized in April 2007 and can be found at: http://www.oehha.ca.gov/public_info/public/kids/pdf/PbHGV041307.pdf

Worker Protection

Use gloves and hand washing to protect yourself from exposure during and after sampling. If you are an employee conducting sampling for lead, your employer is responsible to implement the Cal/OSHA General Industry Lead Standard, Title 8 CCR Section 5198. For City and County of San Francisco employees, your Department will have additional policy in place to protect you from lead exposure. (Reference http://www.cdph.ca.gov/programs/olppp/Documents/gsummary.pdf)

Case Study

The photographs shown here illustrate a community garden constructed adjacent to a residential building exterior with significant sections of peeling lead-based paint. A community group, including neighborhood children, constructed the garden with raised beds (upper photo). During the garden construction phase, children worked adjacent to the wall with damaged paint (lower photo).

Although the project coordinators tested the native soil for lead, they were unaware of all the elements of lead hazard risk assessment. For that reason, they did not evaluate the lead hazard risk from the significantly deteriorated paint on the wall adjacent to the garden. The damaged paint on this wall could easily be touched by the public.

The gardeners sampled the native soil and their results led them to believe that no lead hazards were present. Consequently, the garden was constructed and edibles were planted adjacent to the lead hazards from the deteriorated paint on the wall. It cost additional time and money to safely remediate these lead hazards as containment was needed to protect the recent plantings from the remediation activities.

ATTACHMENT 1
SOIL SAMPLING FOR LABORATORY ANALYSIS PROTOCOL (A)
For Residential Sites

The following are the specifics for the U.S. Department of Housing and Urban Development (HUD) lead hazard risk assessment protocol for soil sampling based on the ASTM E1727-05 guidelines.

Lab Sample Collection Field List:

- Spoon, scoop, or trowel
- Hard shell containers (centrifuge tubes work best) or Ziploc plastic bags, double bag the sample
- Disposable gloves (optional)
- Soil Sampling Form
- Sketch of soil sampling plot plan

a. Samples are collected with a clean spoon or trowel to acquire the top half inch (1 cm) of soil and should be placed in a container. Each composite sample should consist of approximately equal soil sub samples collected from 3-10 distinct locations roughly equidistant from each other along an axis. Include any paint chips as part of the soil sample with their locations marked on a map of the site. Take additional composite samples consisting of 5 to 10 sub samples in an X-shaped grid pattern for the other bare soil areas. The number of sub samples will vary depending on the size of the bare soil area. Each sub sample should contain approximately the same volume of soil.

   For samples collected along a building foundation drip line (e.g., when exterior work was conducted on all faces of the building), sub samples should be collected at least two to six feet apart. Each sub sample is then placed in a single container to make up a composite sample.

b. Approximately one quarter (1/4) to one half (1/2) cup of soil per composite sample should be collected and placed in a clean hard-shelled plastic container or a sealable bag.

c. Wipe the trowel or spoon with baby wipes or rinse with water between each set of composite samples, and wash hands thoroughly after sampling is completed using baby wipes or soap and water. Alternatively, wear disposable gloves during soil sampling.

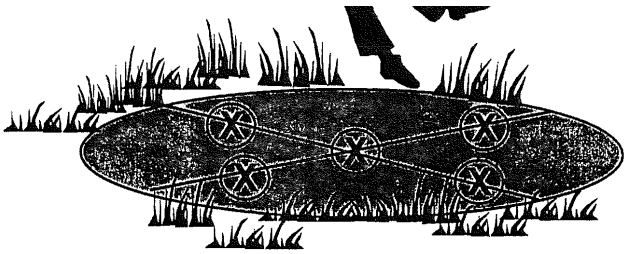
d. Label the sample container with a permanent marker with the sample number, property address and the date that the samples were collected. Record the sample number, sample location, and the site location on the Soil Sampling Form.

e. Plot the sample locations on the sampling map you sketched.

f. Send soil samples to an EPA recognized laboratory (17 CCR 36000) for lead analysis. See the link for a list of EPA approved NLLAP laboratories (http://www.epa.gov/lead/pubs/nllap.htm).

g. Record the laboratory sample ID number and the result, and whether the result is at or above the 80 ppm criteria recommended in these guidelines for human health risk and food production.

h. Proceed to soil control and remediation methods if soil lead level is ≥ 80 ppm.



Bare soil should be divided by an x-shaped grid. Subsamples should then be collected at equidistant points along each axis.

ATTACHMENT2
SOIL SAMPLING FOR LABORATORY ANALYSIS--PROTOCOL (B)
For Commercial, Industrial, Non-Residential or Unknown Sites

The following protocol provide a methodology for soil sampling at project sites that have known use as commercial, industrial, median strips or other right-of-ways, or for sites with unknown history. These sites should be assessed by environmental consulting firms specializing in hazardous waste characterization or by individuals who are State Registered Environmental Assessors (REAs), who will design and conduct the sampling as well as the control and remediation of identified hazards.

Lab Sample Collection Field List:

- Sampling tube, auger or spade
- Clean plastic pail
- Sample containers from lab using for analysis
- Disposable gloves (optional)
- Sample bag
- Soil Sampling Form
- Sketch of soil sampling plot plan

a. Create a grid to conduct a random sampling pattern based on where soil has been identified as potentially contaminated from the site history research. Depending on the size of your project site, it is recommended to work within three horizon layers to obtain a composite sample of 3-4 sub samples within approximately one square foot. These layers would be from: 1) 0-6 inches, 2) 6-12 inches, and 3) 12-18 inches. Each horizon layer would be one composite sample so that instead of 12 samples to the lab, you would be sending only three samples.

b. Samples are collected with a probe, auger, or spade and should be placed in. Place cores in a clean plastic pail. Mix them together thoroughly, breaking up the cores. If soil is muddy, dry it before mixing. If soil crumbles easily, dry after mixing.

c. Fill the sample bag to the line with air-dry soil. Discard the rest. Label and number the sample container with a permanent marker with sample number, property address and the date the samples were collected. Record the sample number, sample location, and the site location on the Soil Sampling Form.

d. Identify the sample and record the location using a chain of custody form provided by the lab.

e. Plot the sample locations on the sampling map you sketched and keep in your files for your records, and to develop a management plan.

f. Send soil samples to an EPA recognized laboratory (17 CCR 36000) for analysis. See the link for a list of EPA approved NLLAP laboratories (http://www.epa.gov/lead/pubs/nllap.htm).

g. Lab analysis should be requested for five metals: chromium, nickel, lead, copper and zinc. For a former industrial site with combustible solvent activities, also test for polynuclear aromatics (PNAs).

h. Record the laboratory sample ID number and the result, and whether the lead result is at or above the 80 ppm criteria recommended in these guidelines for human health risk and food production.

i. Proceed to soil control and remediation of identified hazards, which should be designed and conducted by environmental consulting firms specializing in hazardous waste characterization or by individuals who are State Registered Environmental Assessors (REAs).

Source: *Soil Sampling for High Yield Agriculture:* by Dr. Harold Reetz (www.rainbowplantfood.com/agronomics).

ATTACHMENT 3
LEAD IN SOIL CONTROL AND REMEDIATION

The following recommends soil treatment and soil removal methods for sites with known residential history. For your gardening project, we have broken up construction into three phases with tasks for each phase:

Pre-construction of the garden:

1. Because of the possibility of bare soil exposure to children through hand to mouth activity, soils with lead levels exceeding **80 ppm** should not be used for gardening unless some control for lead is implemented. Children should not be involved in phase of garden construction until all potential lead hazards have been adequately addressed.
2. Decide whether to remove any soil with greater than **80 ppm** lead from areas that will be used for food production or to construct raised beds with a barrier over the original soil. Implement surface coverings and/or land use controls for areas that will not be used for food production.
3. For areas not intended for food production, impermanent surface coverings, including grass (as seed or sod), other ground covers (e.g., ivy), artificial turf, bark, mulch, and gravel may be used. If the area to be controlled is heavily traveled, surface coverings such as grass are not appropriate.
4. Use fine water mist to contain dust and clean equipment to prevent dispersion of lead.
5. If grass is selected, consult with the local agriculture extension service or a reputable local nursery to determine what grasses are appropriate for the locale, soil type, and sun/shade characteristics. Properly prepare the soil prior to seeding or sodding.
6. You may also implement land use controls such as fencing, warning signs, and thorny bushes to limit access to areas with lead-contaminated soil that will not be used for food production.

Construction of an edibles garden:

1. **Create a barrier layer over lead-containing soil:** If you choose to leave lead-containing soil in place, install a durable weed cloth barrier layer or similar material and optionally, a second barrier layer of chicken wire or similar material that can alert you if you are ever digging deep enough to damage the weed cloth. Then install 12-18 inches of new clean soil on top, deep enough to allow your edibles to grow.
2. **Remove the lead-containing soil and replace with clean soil:** If you choose this method, remove the lead-containing soil to a depth of at least 6 inches, the presumed depth of most lead paint and dust deposits according to US Housing and Urban Development (HUD) Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing. Dispose of the lead-containing soil by contacting Recology at www.sfhazwaste.com. Add 12-18 inches of new clean soil on top, deep enough to allow your edibles to grow.

General landscaping:

1. If bark or gravel is selected as a ground cover, apply the covering at least 6 to 12 inches deep. New bark, gravel, or other materials should not contain more than **80 ppm** of lead. These materials should be tested before use unless previous testing data are available.
2. For general gardens **not** involved in food production, add organic matter to the soil. Organic compounds bind lead and make it less available to the plant. When adding organic matter, the pH should also be maintained above 6.5. Good sources of organic matter include composted leaves, neutral (non-acid) peat, and well-rotted manure. Avoid using leaf mulch obtained along highways or city streets as it may contain high lead levels. Children should not be involved in this process.

Post-construction after initial project has been completed:

1. Control water erosion by proper grading and installation of drainage channels (drainage channels may need to be fenced if they are accessible).
2. Control wind erosion by periodic watering, windbreaks, or foot-traffic controls.
3. If you are uncomfortable doing a final evaluation of the site, you may hire a certified lead hazard risk assessor or inspector technician to conduct a clearance examination and provide a report on the adequacy of lead hazard controls at the garden site from a list at the CDPH website: http://www.cdph.ca.gov/programs/CLPPB/Pages/LRCCertList-SF.aspx
   Note that risk assessors use the state and federal definition of lead in soil hazard of 400 ppm, so you should instruct your risk assessor that you are using **80 ppm** as the precautionary standard.

Source: HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* pursuant to Title X of the Housing and Community Development Act of 1992. http://www.hud.gov/offices/lead/lbp/hudguidelines/index.cfm