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LEAD IN OAKLAND SOILS

Introduction

- *Best practices in the garden*
- *Lead immobilization*

In recent years West Oakland has been turning towards urban gardening as a way to increase access to healthy, nutritious, and low cost produce that is, unfortunately, absent from the neighborhood. Oakland is home to one of the largest ports on the West Coast. It was the end point for the transcontinental railroad, as well was a location for boat and car manufacturing. As a result, Oakland's soils have been exposed to many pollutants. For people interested in gardening or who have children who play in West Oakland, understanding Oakland's industrial past and its legacy in the soil is crucial for developing safe practices that minimize risks from soil contaminants such as lead.

Lead is the most pervasive pollutant in Oakland soil. Lead can be a serious problem causing nervous system damage, developmental issues, and other problems for children. But lead can be effectively neutralized. Soils with high levels of lead can be used as long as the necessary precautions are taken.

The purpose of this guide is to provide reliable information regarding the risks of lead in Oakland's soil. It is intended to give homeowners options about good gardening practices and possible remediation approaches such as lead immobilization.



Soil

Healthy soil is essential for plants to grow in your garden. When a property has been used for industrial or commercial activities, the soil may be nutrient deficient, highly compacted and potentially contaminated. These soils can be improved and made healthy again so that your garden plants can grow and thrive. The necessary nutrients for plant growth may be absent but even more worrisome may be toxins such as lead. It is possible to get your soil screened for both nutrients and lead.

Lead Testing

A variety of environmental consulting firms can do this for you or you can do it yourself. If you choose to have a consulting firm test your soil Alameda County provides a list of inspector/risk assessors in the Bay Area at the link below. If you choose to do it yourself, sending your own soil samples to be tested at a lab is easy and safe. For more information on soil testing visit Alameda County's Website:

<http://www.aclppp.org/leadpoisoning/testing.htm>

Left: West Oakland, Calif. (on right of ship channel), Alameda, Calif. on left

Benefits of Gardening

- *Helps to decrease the bioavailability of lead*
- *Nutritious food helps buffer the body against lead absorption*

Gardening is wonderful for many reasons, but for lead-contaminated soil, gardening is highly recommended for two reasons. First, proper care of your soil, meaning the regular addition of compost or fertilizer to support plant growth, will lock the lead up in pyromorphite crystals and decrease the bioavailability of the lead. Second, eating fruits and vegetables on a regular basis helps to buffer the body against lead absorption. For soil with moderately high levels of lead it is actually recommended to garden.

There is some concern that plants may absorb the lead and make the plants inedible. However there is little evidence to indicate this to be true. The greatest danger that lead in soil poses to humans is the residue of the soil splashed on to low growing parts of the plant. That is why it is vital to employ best management practices. Only in soil that contains 1200 ppm (parts per million) or more is it advisable not to grow produce for food.

More than anything else, gardening is highly recommended because the produce provided by a garden can help to protect the body against lead absorption. Studies show that a child who has a nutritious diet will absorb less lead than a child who does not. A well-balanced diet can do as much to help prevent lead poisoning as remediating the soil.



Bioavailability

The risks of lead in soil may also be much lower than a soil test for lead suggests because of the bioavailability of the contaminant in the soil.

Bioavailability of a contaminant is the amount that can be taken up by your body. Not all forms of lead can be absorbed in to the blood stream; some just pass straight through the body. It depends on the characteristics of the site and the soil. Treatment of soil rich in lead with phosphate and compost may reduce the bioavailability of lead in soil through chemical immobilization.

Phytotechnologies & Lead

Phytoextraction, or using plants to extract heavy metals such as lead, is NOT an effective way to remove lead. Lead in soil is generally not readily available for plant uptake.

Table 1: Crops to plant and precautions for children, based on amount of lead in soil.

Amount of lead	Garden use	Child use
Below 80ppm	No restrictions	No restrictions
80-500ppm	Any crop is safe to plant, wash all crops	Use caution, encourage children to wash their hands after playing in soil and minimize contact with bare soil. Wash toys; take precautions not to track dirt into the house. Take lead blood test if possible. Ensure calcium-rich, well-balanced diet.
500-1200ppm	Don't plant lettuce, spinach, chard or herbs. But collards, kale, cabbage are OK to plant. Limit root crops (i.e., carrots). Potatoes are OK if peeled and washed well. Take extra precaution to wash all produce grown.	Use caution, encourage children to wash their hands after playing in soil and minimize contact with bare soil. Wash toys; take precautions not to track dirt into the house. County recommends lead blood test if possible. Ensure calcium-rich, well balanced diet.
Above 1200ppm	It is not advisable to grow produce for food. Do not plant leafy greens or root crops. If produce is grown take extra precaution to wash all produce grown.	Not advisable for children to play in soil. In addition to the precautions above, restrict/closely monitor children playing on exposed soil.

Best Management Practices in the Garden

These practices can help minimize exposure to lead.

- Locate garden away from old painted buildings and roads with heavy traffic.
- Use a thick layer of organic material such as compost or mulch. Place landscape fabric between areas with lead contaminated soil and new clean soil.
- Watch over small children to stop them from eating soil through hand-to-mouth play.
- Wash hands immediately after gardening and before eating to avoid eating soil.
- Wear gloves as a barrier between your hands and the soil.
- Throw away the outer leaves of greens, especially from the base or exterior of plants, before washing. Soil particles are most likely to be located on the outer leaves of leafy plants.
- Wash produce using running water.
- Peel root vegetables, which are in direct contact with soil.
- Avoid bringing contaminated soil into the home by:
 - Cleaning tools, gloves and shoes before bringing them indoors, or leave tools, gloves, and shoes outdoors.
 - Placing highly soiled clothes in a bag before bringing them indoors, and wash them promptly in a separate load.
 - Washing off excess soil from crops, especially root crops and leafy vegetables, before bringing them indoors.



Raised beds at South Prescott Fishbone Project, Oakland, CA

Raised Beds

Building raised beds and growing plants in containers is the most common way to reduce the chances of coming into contact with toxics in urban gardens known to be contaminated. The clean soil and organic matter used to build the raised bed creates a physical barrier between the gardeners/plants and possible contamination in the ground soils. Mulch walkways or maintain strong grass cover to keep soil between beds from children. For information on building raised beds check out EPA's factsheet on urban gardening at

<http://clu.in.org/ecotools/urbangardens.cfm>

Lead Immobilization

- Reduce bioavailability
- Limit exposure

In addition to the best management practices, other steps can be taken to minimize the risk even more. Another option is lead immobilization.

The idea of lead immobilization is not to take the lead out of the soil, but to chemically change it to a form that is not bioavailable. The type of lead that was found in paint and gasoline is very toxic to humans and can be easily absorbed by the human body. However, there is a lead compound called pyromorphite which passes right through the human body without being absorbed. The goal of lead immobilization is to use phosphates to change the dangerous soil to pyromorphite. When phosphate comes into contact with lead a chemical reaction takes place that transforms the lead to pyromorphite crystals. There are many soil amendments that contain the necessary phosphate to complete the chemical reaction. The phosphate is mixed with the soil. In some cases it can be covered with sod or another ground cover to limit exposure to lead even more. Composts and fertilizers contain phosphates, so gardeners who mix these substances into their soil on a regular basis are already immobilizing lead.

This method is effective in treating lead because it addresses the two greatest risks of exposure: First, the phosphate immobilization reduces bioavailability, essentially making the lead less toxic. Second, laying down a green cap (i.e. sod) reduces direct contact with the soil, therefore reducing the potential for children to accidentally eat contaminated soil.



Artistic representation of lead immobilization at the EPA field office in West Oakland, California



Fishbones



Zero-emission vehicles used onsite

Case Study: South Prescott Fishbone Project

In a small area of West Oakland there are high rates of lead poisoning in children as well as high rates of lead in the soil due to a history of industrial contamination. EPA decided to take action to clean up these soils. By working with the community and using the latest research in lead cleanups, EPA chose an innovative and sustainable way to clean up the soil. Instead of removing all the soil in the yards in this small neighborhood and hauling it away, EPA used phosphate immobilization to reduce the bioavailability of the lead. They mixed fishbone in to the soil to immobilize the lead. They did this in a sustainable way by using mostly zero emissions vehicles and reusing supplies. They also hired many local residents and created jobs for the community.

How to do Lead Immobilization Yourself

An individual can do lead immobilization as long as the appropriate amendments are added to the soil in sufficient quantities. Although the regular addition of phosphate through gardening is a good choice it is not always the easiest or the fastest. The process described below may only need to be done once to significantly reduce the risks of lead.



There are a variety of additives that will immobilize the lead, each with its own pros and cons. Lead immobilization is a fairly new technique and it has not yet been determined which additive is the most effective. The following are possible amendments:

- Triple Super Phosphate (TSP) is fast acting and contains no nitrogen but will still increase the acidity of the soil. This is the best option for gardeners.
- Fishbone is an organic additive, does not have nitrogen and does not generate any acidity when mixed with soil. However it is slow to react, needs higher quantities, and it is not as widely available.
- Di Ammonium Phosphate (DAP), DAP is fast acting and widely available but it will add high levels of nitrogen to the soil. Nitrogen causes excessive plant growth but inhibits seed production so it is bad for growing fruits and vegetables. DAP will also increase the acidity of the soil and limestone may be needed to neutralize it.
- Mono Ammonium Phosphate (MAP). MAP is also fast acting but has similar issues to DAP. However it contains half as much nitrogen, so half the problem.



Sandwich-board signs mark where EPA is working and keep the community informed.

Table 2: The amount of phosphate is given for a yard that has 1000ppm (parts per million) of lead. If the soil has less lead, then less phosphate should be used; if the soil has more lead, more should be used. For example a yard with 500ppm of lead should use only half as much of these amendments.

Amendments	Amount to use per sq ft for soil with 1000ppm	Where to get it	Estimated costs*
DAP	10 grams (dry weight)	Local gardening/hardware stores or online	\$2.25 per lbs
MAP	9 grams (dry weight)	Local gardening/hardware stores or online	\$.65 per lbs
TSP	12 grams (dry weight)	Local gardening/hardware stores or online	\$3.25 per lbs
Fishbone (appetite II)	75 grams	www.pimsnw.com	\$5 per lbs

*These prices are subject to change and do not include shipping and handling fees

Steps for Lead Immobilization

1. Remove all existing vegetation and debris from the soil using a hoe, shovel, rake, or other appropriate tools.
2. Spread fishbone or spray fertilizer over the soil. TSP, DAP, and MAP are all dissolvable in water and should be mixed with water and sprayed on soil.
3. Mix in additive using a rototiller or garden fork. Make sure that the additive is mixed in 8 inches deep.
4. If you...
 - Plan to garden directly in the soil these three steps are enough.
 - Do not plan to garden, lay down sod or another sort of ground cover to limit exposure even more.
 - Use fishbone, it is also advisable to lay down sod or another ground cover because the reaction time is slower therefore additional protection is needed.



The crew in West Oakland removing vegetation and debris

Equipment

It is worthwhile to invest in the basic gardening equipment for day-to-day work in the garden but for more specialized work, such as building a raised bed or rototilling, the Oakland Public Library provides a tool lending library. Oakland residents can rent gardening, carpentry, and other tools free of charge. For more information on the tool lending library visit them online at <http://www.oaklandlibrary.org/locations/tool-lending-library> or call (510) 597-5089.



Conclusion

Lead in soil can be dangerous, but as long as proper precautions are taken, contaminated yards have the potential to be safe gardens or play spaces. This guide is designed to help West Oakland homeowners understand the dangers associated with lead, and learn how to effectively mitigate them.

Additional Resources:

More information on Lead hazards available at : www.aclppp.org or www.epa.gov/lead

More information on creating an urban garden is available at: www.epa.gov/brownfields/urbanag

More information on gardening in Oakland is available at: www.cityslickerfarms.org

More information on the South Prescott Fishbone Project available at: www.southprescottcommunityforum.org

Visit the EPA field office:

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