



The **Hazard Evaluation and Emergency Response (HEER) Office** is part of the Hawai'i Department of Health Environmental Health Administration whose mission is to protect human health and the environment. The HEER Office provides leadership, support, and partnership in preventing, planning for, responding to, and enforcing environmental laws relating to releases or threats of releases of hazardous substances.

Arsenic in Big Island Soils: Questions and Answers on Health Concerns

This fact sheet provides an overview of potential human health concerns associated with arsenic-contaminated soils in Hawai'i. It describes ways to reduce exposure to soil arsenic and resources for further information.

What is arsenic and where is it found on the Big Island of Hawai'i?

Arsenic is a naturally occurring element in the earth's crust. In Hawai'i, low levels of arsenic occur naturally in the soil. However, elevated levels of arsenic have been found at former sugar cane fields, pesticide storage or mixing areas, plantation camps, wood-treatment plants, a canec factory, and at least one former golf course. Because inorganic arsenic is stable in the environment, it can remain in the soil for many years after use. Some of the soil arsenic in former sugar plantation areas can be attributed to widespread use of sodium arsenite (an inorganic arsenic compound) and other arsenic-based herbicides and pesticides in the 1920s through 1940s. Another source was the use of inorganic arsenic as an insecticide in canec. Made from waste sugar cane fiber, canec was widely used for ceilings or walls in home and commercial construction projects during the 1930s through 1960s (see *Arsenic in Canec Ceilings and Wallboard in Hawai'i* (Fact Sheet)). Arsenic was also an ingredient in wood preservatives and certain types of fertilizers.



Estimated extent of former sugar cane cultivation on Hawai'i, 1920-1937 (orange areas). Elevated soil arsenic, related to use of arsenic-based herbicides in the 1920s through 1940s, may be found in these areas.

A recent soil study at former sugar cane fields in Hilo, Pahoa, and Keaau suggests that arsenic in these areas is higher than naturally-occurring levels. Due to high rainfall in these areas, it may have been necessary to apply larger amounts of pesticides to control weed growth, compared to other areas of Hawai'i. To date, testing at other former sugar plantations in the state has not identified high arsenic in the majority of former fields. Not all former fields have been tested, however, and the Hawaii Department of Health (HDOH) is continuing its research on the topic.



How are people exposed to arsenic?

• **Soil** – Naturally-occurring iron and aluminum oxides in Hawai'i's volcanic soils tightly bind arsenic to the soil, reducing potential health risks. Regularly swallowing small amounts of soil with high levels of arsenic over many years is still a potential health risk, however. This is especially a concern in young children. Most children put their hands and toys in their mouths, and these have small amounts of soil and dust on them. Eating unusually large amounts (teaspoons or more) of contaminated soil would greatly increase a child's exposure. Dirt on hands or home-grown produce after gardening or working outdoors can also result in accidental arsenic exposure. In order to minimize potential health risks, it is important to prevent additional exposure to inorganic arsenic from non-food sources. Inhalation of arsenic in dust is possible, but in most circumstances this is a very minor source of exposure. Arsenic in soil is not absorbed through bare skin in significant amounts.



Children are at risk of arsenic exposure from unintentionally eating soil.

• **Food** –Organic arsenic is found in shellfish and fish from many areas of the world. Organic arsenic compounds are generally not considered toxic or harmful. Our diets also contain very low amounts of inorganic arsenic. In most cases, a person would be exposed to less inorganic arsenic from contaminated soil, than from a normal diet. In a typical local diet, small amounts of inorganic arsenic come from foods like rice, fish, chicken, and seaweed. No negative health effects have been reported from organic or inorganic arsenic in these foods. Produce grown in soil with elevated arsenic is considered safe to eat, if washed to remove contaminated soil and dust. Arsenic is not generally taken up by edible plants, because it binds strongly to Hawaiian soils. The HDOH tested produce growing in community gardens with elevated soil arsenic, and found arsenic levels similar to those of produce from grocery stores in the mainland U.S.

• **Water** - Arsenic has not been detected in any of the State's public drinking water. In some parts of the world, arsenic in drinking water is a concern. In Hawai'i, this is not the case. HDOH has implemented a water quality-testing program for all public water systems in the state, including testing for arsenic.

What are the human health concerns of arsenic exposure?

People exposed to very high levels of arsenic over many years can exhibit darkened spots on the skin, thickening or warts on the palms and soles of the feet, heart and blood vessel damage, and inflammation of the liver. Long-term exposure to high levels of arsenic is associated with increased cancer risk.

These symptoms have been identified in countries where drinking water is highly contaminated with arsenic. At the levels present in most arsenic-contaminated soils, health risks would arise after continuous, daily exposure over many years. These health effects have *not* been documented from soil arsenic exposure in Hawai'i. Increases in cancer risk from low-to-moderate levels of arsenic are extremely hard to associate with past chemical exposures, especially because of the relatively small population sizes that occur in many regions of Hawai'i. Therefore, as an added precaution, HDOH recommends limiting exposure to elevated levels of arsenic whenever possible. Additionally, arsenic does not build up in the body, so arsenic levels in the body will start to decrease once exposure stops.



Who should test for soil arsenic?

People living, working, or attending school on lands formerly used by sugar plantations and other facilities associated with arsenic use could potentially be exposed to arsenic in soil. Soil arsenic levels vary significantly over short distances, so the only way to accurately identify elevated levels is to test a particular area of soil. A guide to assist homeowners in testing soil is available from the HEER Office website (reference and link provided below). For new residential or commercial developments, testing may be conducted by environmental consultants as part of the environmental site assessment process required by the owner, buyer, or lending institution.

How are soil arsenic testing data evaluated?

Even if it is swallowed, not all soil arsenic is available for absorption into the body. The arsenic that is tightly bound to soil particles will not be absorbed, and is basically nontoxic. Only a certain amount will dissolve in

the digestive system, and potentially contribute to human health risks. Laboratory tests are used to determine this amount, called the “bioaccessible” arsenic level.



Soil sample collection from a small garden on Hawai'i. Located on former sugar cane land, the garden has potentially elevated soil arsenic levels from past herbicide use. Soil testing for arsenic can confirm if levels are elevated.

If soil contains arsenic above naturally-occurring levels (24 milligrams per kilogram [mg/kg]), the HDOH recommends additional testing for bioaccessible arsenic. Bioaccessibility testing on iron-rich, volcanic Hawaiian soils has shown that only 5% to 20% of the total arsenic in soil is potentially available for absorption in the body. This means that 80% to 95% of the arsenic is too tightly bound to the soil to pose a potential risk.

HDOH makes its final health risk determinations based on bioaccessible arsenic levels, *not* total arsenic levels. In soil, levels of up to 23 mg/kg bioaccessible arsenic are suitable for unrestricted land use—including homes, schools and daycare centers. Properties with higher arsenic levels may require exposure prevention strategies for residential or school uses. HDOH provides additional guidance in interpreting arsenic data for properties, and in determining what steps, if any, should be taken to reduce exposure.

How can I test to see if I have been exposed to arsenic?

Any arsenic exposure testing should be recommended and conducted by a doctor or trained medical professional. Testing will show if the level of arsenic in the body is higher or lower than the average person, and may be useful in cases of very high exposure, or where health symptoms suggest arsenic-related illness. For former sugar cane plantations, HDOH does not generally recommend human exposure testing. This is because people typically get exposed to more arsenic from the diet than from contaminated soil. Tests are available to measure arsenic in urine, blood, or hair and fingernails. The urine test is considered the most reliable but it only determines exposure within the last few days. Because the diet is an important source of arsenic exposure, most people will have a measurable amount of food-related arsenic in the body, and testing cannot show if the arsenic came from soil or food, or whether a person's health will be affected as a result. On the Big Island, limited urine arsenic testing was conducted on people living near gardens with elevated soil arsenic. The study, conducted by HDOH and the federal Agency for Toxic Substance and Disease



Registry (ATSDR), found arsenic levels similar to those detected in other populations who eat regular and frequent amounts of seafood and rice.

What can I do to prevent exposure to contaminated soil?

Accidentally swallowing soil is the main way you would be exposed. If soil tests show elevated levels of soil arsenic on your land, or you live or work in an area that may have elevated soil arsenic levels, you can protect yourself and others by taking the following precautions:

- If you work with contaminated soil, old arsenic-treated wood, or canec, use common protective gear to reduce exposure. This may include long sleeves, safety glasses, or a dust mask. Shower and change into clean clothes right after working with these materials, and avoid spreading dirt from clothes or shoes into your vehicle or house.
- If you have bare soil on your property, maintain grass, other vegetative cover, or some kind of surface material over the soil. Cover dog runs with old rugs or other materials to eliminate bare dirt areas.
- Do not track soil into the home, and clean up right away if soil is tracked in. Remove shoes before entering the house. Keep pets from tracking soil into your home.
- Do not allow children to play in bare dirt. Keep toys and pacifiers clean, along with other items that go into children's mouths.
- Wash and wipe hands and face thoroughly after working or playing outside, especially before meals and snacks.
- Do not garden directly in the dirt. Any planter boxes or raised garden beds should contain clean soil. If you garden, remove loose soil from fruits, vegetables and herbs before bringing them in the house.
- Before eating or preparing home-grown produce for cooking, wash with a brush to remove any remaining dirt. Root and tuber vegetables, such as sweet potato, should be peeled before eating.

Further Information

For questions about this fact sheet or further information on HEER Office guidance related to soil arsenic, contact:

Hawai'i Department of Health, Hazard Evaluation and Emergency Response Office
919 Ala Moana Boulevard, Room 206
Honolulu, Hawai'i 96814 Telephone: (808) 586-4249

Please visit our Soil Arsenic Guidance and Information webpage to find useful resources and more detailed information:

<http://eha-web.doh.hawaii.gov/eha-cma/Leaders/HEER/soil-arsenic-guidance-and-information>

HDOH, 2010. *Arsenic in Canec Ceilings and Wallboard in Hawai'i* (Fact Sheet)

HDOH, 2008. *Homeowner's Guide to Soil Testing for Arsenic*

Additional references are located on the HEER website <http://eha-web.doh.hawaii.gov/eha-cma/Org/HEER>

HDOH, 2012. Hawaiian Islands Soil Metal Background Evaluation Report

<http://eha-web.doh.hawaii.gov/eha-cma/Leaders/HEER/Background%20Metals%20in%20Hawaiian%20Islands%20Soils>

HDOH, 2011. Summary of Pesticide and Dioxin Contamination Associated with Former Sugarcane Operations

[http://www.hawaiidoh.org/tgm-guidance/Pesticide-Dioxin%20Summary%20\(HDOH%20Dec%202011\).pdf](http://www.hawaiidoh.org/tgm-guidance/Pesticide-Dioxin%20Summary%20(HDOH%20Dec%202011).pdf)

HDOH, 2011. Update to Soil Action Levels for Inorganic Arsenic and Recommended Soil Management Practices

<http://hawaii.gov/health/environmental/hazard/docs/hdoharsenicsoilactionlevelsnov2011revsept2012.pdf>

Federal Government

To learn about recommendations from the Federal Government regarding arsenic, you can also contact the Agency for Toxic Substances and Disease Registry, ToxFAQs internet address <http://www.atsdr.cdc.gov/toxfaq.html>

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