

Ferns Remove Arsenic from Soil and Water

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Toxic Cleanup

Six years ago researchers in Florida discovered ferns growing in soil contaminated with arsenic at an abandoned lumber yard. The ferns had been soaking up arsenic from the soil through their roots and storing it in their fronds.

Arsenic, which is poisonous to humans, is used to pressure treat lumber and to make semi-conductor chips. It was once also used to manufacture insecticides and chemical weapons, and it ranks number one on a list of substances to be removed from contaminated sites by the U.S. Department of Health and Human Services' Agency for Toxic Substances and Disease Registry.

The Florida discovery marked the first time a plant had been found to naturally take up arsenic in high concentrations. The fronds of *Pteris vittata*, or brake fern, can be clipped or the entire plant can be dug up and disposed of safely, a process that was patented by the Florida group in 2001.

"It was odd to identify a plant that has such useful characteristics that hadn't yet been discovered," says Bruce Ferguson, CEO of Edenspace, a Virginia-based company that now licenses the patent for the ferns and sells them commercially under the name "edenfern."

Today, the ferns are being used throughout the United States to remove arsenic from soil and drinking water. Edenspace, which specializes in a variety of plants to cleanup toxic substances, has twelve employees and reported \$1.2 million in revenues last year.

Ferns in Washington, D.C.

This summer 2,800 edenferns are being planted in the nation's capital as part of a pilot project to remove arsenic from 600 acres near American University in the Northwest part of Washington, D.C. The area, called Spring Valley, includes residential and university property.

Spring Valley was once used by the US government for research and testing of chemical weapons during World War I, and remnants of these chemicals, including arsenic, are still thought to be underground. The US Army Corps of Engineers began to clean up the area in the 1990s, yet today there are more than 100 private properties that have contaminated soil waiting to be removed and replaced.

Residents, meanwhile, have voiced concern over the Corps removing or damaging big, old trees on their property in the process of digging up contaminated soil. In hopes of removing arsenic in a less destructive manner, the Corps of Engineers has planted the ferns at three locations in Spring Valley.



The ferns aren't genetically modified, but they have been bred to have desirable traits. Image courtesy Edenspace.

“We’ve had positive reactions from residents [about using the ferns] so far, especially from people who have had concerns about their trees,” says Ed Hughes of the Army Corps of Engineers in Baltimore, who is spearheading the cleanup effort.

The Corps plans to test the ferns for arsenic and then dispose of the ferns and fronds in airtight containers. If the arsenic levels are extremely high in the leaves, the plants are disposed of at a hazardous waste facility.

The plants pose an overall low risk and could be dangerous to children or animals only if consumed in large quantities, says Michael Blaylock, director of technology at Edenspace. In comparison to the ferns, household plants such as poinsettias and potato vines are more toxic to pets and people.

New Mexico Drinking Water

The ferns are also being used to remove arsenic from drinking water. In a recent pilot study in Albuquerque, New Mexico, the ferns significantly decreased the level of arsenic in samples of the city’s drinking water.

Some varieties of the plant live hydroponically, or without soil, in the water. City workers set up a staircase of trays holding about 100 ferns with water filtering down from the top through the trays of ferns. About 450 gallons of water were pumped through the system daily.

The city of Albuquerque will probably never use the ferns on a large-scale because it uses chemicals to treat water supplies, as do most large cities.

But the study demonstrated that the low-cost technology could be feasible for the drinking water of rural communities in New Mexico and other parts of the western United States. Parts of the West have high levels of arsenic in drinking water because of naturally occurring volcanic rocks underground.

New strategies are needed to remove arsenic from drinking water cheaply and effectively for big and small cities in the United States. Under the Safe Water Drinking Act, the Environmental Protection Agency recently revised the standards for allowable limits of arsenic in drinking water. The new standards, which take effect in 2006, change the allowable level to ten parts per billion from 50 parts per billion.

In addition to the United States, the ferns could be used in small communities in developing countries such as Bangladesh, which has problems with arsenic in drinking water. The company recently made the ferns available royalty free to parts of the developing world, according to Ferguson.

Growing a Better Fern

The ferns have not been genetically modified, but they have been bred at Edenspace to have desirable traits. The brake fern, which is native to the Southeastern United States, tolerates sun surprisingly well for a fern.



Fern test sites along Van Ness Street in Washington, DC.
Image courtesy Army Corps of Engineers.

Scientists at the company bred the ferns to be more adapted to cold weather, and they also bred larger ferns that take up more arsenic. The ferns are now grown year round in Florida, and can be purchase online for \$4.95 a piece, not including shipping.

“Most people don’t know we’re around,” says Ferguson. Most of his customers are well-versed in environmental issues. He suggests that homeowners might plant them under a deck with pressure-treated wood or in a yard where an old pile of lumber might have been.

“The ferns are easy to grow and inexpensive,” he says. “And they look nice too.”

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Ma, L.Q. *et al.* A fern that hyperaccumulates arsenic. *Nature* 409, 579 (February 1, 2001).

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