

Phytoremediation of Arsenic-Contaminated Soils

Edenspace Systems Corporation
15100 Enterprise Court, Suite 100
Dulles, VA 20151-1217
Telephone: 877-961-8777
<http://www.edenspace.com>

Environmental Problem

Weathered lumber in decks, docks, playground equipment, and gardens can leach significant amounts of arsenic into soil and water, where it poses health risks to people and animals. By 1990, the United States used approximately 37 million lb of arsenic annually in the production of chromated copper arsenate (CCA), a wood preservative. Currently, there is no cost-effective method to clean up arsenic-contaminated soils. The levels of arsenic found in soil under CCA-treated decks have been as high as 20 times the background level and substantially above most state and federal standards.

Although EPA regulations now limit the use of CCA to the treatment of wood in forest products and other primarily nonresidential applications, the existing stock of CCA-treated wood products (containing more than 600,000 metric tons of arsenic) will continue to leach arsenic into the soil for years to come. *In situ* phytoremediation of contaminated soil could greatly reduce the amount of soil sent to hazardous waste landfills by collecting and concentrating the arsenic in a much smaller volume of plant biomass.

SBIR Technology Solution

With support from EPA's SBIR Program, Edenspace Systems Corporation developed an arsenic phytoremediation technology for *in situ* treatment of soils contaminated with CCA. With this technology, ferns accumulate arsenic in their harvestable fronds at levels up to 100 times the underlying soil concentration, facilitating efficient removal and disposal of CCA-derived arsenic while preserving topsoil. The plants then are harvested for recycling or landfill disposal.

Edenspace Systems has demonstrated two methods using fluid extraction for concentrating and refining recovered arsenic for storage and future recycling, with recovery rates greater than 70%. Phytoextraction and recycling of CCA arsenic for reuse in industry offers two major benefits: (1) recapture and proper disposal of arsenic leached to the environment from CCA-treated lumber; and (2) reduced primary production (mining) of arsenic, thereby reducing the total level of anthropogenic arsenic in the environment.

This technology is scalable from very small sites (e.g., gardens) to large sites (e.g., lumber storage areas). An acres-wide storage site for CCA lumber can be treated with high-volume agricultural techniques, whereas a small area under a wood deck can be addressed using home gardening skills. Edenspace Systems is particularly interested in developing the technique for use by individual homeowners, enabling them directly and flexibly to address CCA risks in the "microenvironment" around their homes. EPA has indicated that

such activities are covered by the Household Waste Exclusion to the Resource Conservation and Recovery Act, allowing the ferns to be disposed of as ordinary waste in the same way that soil contaminated by lead-based paint may be disposed of, facilitating the reduction of environmental risk to the homeowner.

Commercialization Information

There is a strong customer interest in phytoremediation of soil arsenic deposited from CCA-treated wood, with a projected U.S. market of \$162-\$194 million



Ferns following transplantation for remediation of CCA: (a) over an entire area, and (b) closeup of ferns.

4 years after product introduction. Currently, there is no commercial competition for Edenspace Systems' CCA arsenic phytoremediation. For the foreseeable future, the innovation of this technology, combined with Edenspace Systems' existing intellectual property protection, should provide the company with an excellent competitive position.

Edenspace Systems is marketing the arsenic extracting fern under the trade name edenfern™. Sales of edenfern™ to government agencies, businesses, and homeowners totaled \$22,000 in the initial year of sales. Treatability studies are being conducted for six potential arsenic-contaminated sites, and a multiyear field cleanup is underway with the U.S. Army Corps of Engineers at Spring Valley in Washington, DC. Potential customers include wood treatment companies and distributors, homeowners, farmers, transportation and utility companies, schools, and other industry and government organizations.

Company History and Awards

Incorporated in Delaware in October 1998, and headquartered in Dulles, Virginia, Edenspace Systems Corporation is a leader in the commercial use of living plants in innovative systems to remove lead, arsenic, uranium, chlorides (salts), and other minerals from the environment. As of December 31, 2004, Edenspace Systems had 9 employees and revenues of \$1.1 million. Edenspace Systems owns or licenses 17 patents. In 2003, Edenspace announced a strategic partnership with Fujita Corporation, a large Japanese environmental contractor, to introduce Edenspace Systems' phytoremediation technology in Japan.

Current Edenspace Systems customers include EPA, the Departments of Agriculture and Energy, US. Army Corps of Engineers, National Institutes of Health, state environmental agencies, universities, private companies, and homeowners in the United States and Japan. Edenspace Systems received the

1999 DaimlerChrysler Environmental Excellence Award for saving the automotive company more than \$1 million through a lead phytoextraction project.



SBIR Impact

- EPA regulations now limit the use of chromated copper arsenate (CCA), but the existing stock of CCA-treated wood products will continue to leach arsenic into the soil for years to come.
- Edenspace Systems developed an arsenic phytoremediation technology, using edenfern™, for *in situ* treatment of soils contaminated with CCA.
- No other method of arsenic remediation offers such great potential for recovering captured arsenic.
- Sales of edenfern™ were made to government agencies, businesses, and homeowners in the initial year of sales.