Fact Sheets

SRS

Tritium Phytoremediation Project: BGC Southwest Plume Cleanup

Background

Located in the center of the Savannah River Site exists an area where radioactive and hazardous wastes were disposed since the early 1950s. It occupies about 330 acres and is composed of several adjacent facilities; collectively, it is referred to as the Burial Ground Complex (BGC).

In the southern area of the BGC, the Old Radioactive Waste Burial Ground (ORWBG) occupies about 76 acres. The ORWBG was the original disposal location and operated between 1952 and 1972 with a small quantity of waste being disposed of in 1974. As an interim measure, a soil cover at least 4 feet thick was installed over the ORWBG to reduce ground-level radiation levels, to reduce the amount of rainwater from coming in contact with the buried waste, and to reduce the spread of waste contamination to the groundwater. This action was completed in February 1998 with final closure currently being planned under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as agreed in the SRS Federal Facility Agreement.

As a result of the past waste disposal at the BGC, the underlying groundwater has become contaminated with two primary materials: tritium, a radioactive isotope of hydrogen, and volatile organic compounds (principally trichloroethylene) found in solvents used for decontamination and degreasing. Four distinct BGC plumes are identified. Two of them, the Southeast Plume (SEP) and the Southwest Plume (SWP) originate from ORWBG.

Environmental Concerns

The SWP poses the greatest remedial priority because it is currently seeping tritium-contaminated groundwater to the surface where it eventually flows to Fourmile Branch, a nearby stream. Even when this tritium-contaminated groundwater mixes with water in Fourmile Branch, tritium levels still exceed regulatory standards. Prior to implementing a corrective action, the SWP accounted for approximately 70 percent of the tritium releases to Fourmile Branch and about 30 percent of the total tritium releases to all SRS streams.

Because tritium is simply a hydrogen atom with two neutrons instead of none, its chemical behavior is essentially the same as regular hydrogen. In water, which has two atoms of hydrogen and one atom of oxygen, tritium isotopes very easily replace one or both of the normal hydrogen atoms. This behavior presents a unique clean-up challenge because, on a large scale, there is no technology that removes or separates tritium from groundwater.

The other major contaminant, solvent, is either below detection limits or health based standards when the groundwater reaches Fourmile or Upper Three Runs, another major Site stream.

Environmental Remediation Actions

SRS developed a way to reduce the amount of tritium-contaminated water discharging to Fourmile Branch from the SWP by performing a series of relatively simple, passive, surface water management actions. This effort is the ***Tritium Phytoremediation Project***. While these actions – which are interim measures – are being taken, a more comprehensive corrective action plan is being developed to address the entire SWP and its affected areas.

The scope of the interim measures involves the installation of a small sheet pile dam, approximately 5 to 7 feet high and 340 feet wide. The dam impounds a small pond. An irrigation system is then used to pump water from the pond to nearly 30 acres of the adjacent natural forest. This remediation process is a form of phytoremediation.

In this process, the trees (a mix of pines and hardwoods) and other plants take up the tritium-contaminated water through their root system and release trace amounts of tritium to the atmosphere through their foliage, a natural process called transpiration. Dose studies indicate that tritium releases from the irrigated forest are well below regulatory standards.

In February 2001, the irrigation system for the phytoremediation technology began operations. This technology was designed to reduce tritium discharges to Fourmile Branch by 25 percent. Since the dam began retaining water in October 2000, the tritium concentrations in the discharges to Fourmile Branch have actually been reduced by over 50 percent.

Frequently Asked Questions about Tritium and Phytoremediation

What is tritium?

Tritium is a radioactive form (radioactive isotope) of hydrogen. The normal hydrogen atom (also called protium) has one proton and one electron and accounts for 99.985 percent of natural hydrogen. Like hydrogen, tritium has one proton and one electron, but differs because it also has two neutrons. Tritium is radioactive because the two neutrons give it too much energy to be stable. Each atom of tritium will release that excess energy in the form of low energy beta particle, whereupon the atom becomes a stable isotope of helium. This release of excess energy is called radioactive decay. Tritium has a radioactive half-life of about 12.3 years, which means that in time half of the original tritium atoms will have decayed to helium.

Tritium occurs naturally – but very rarely – in the environment; it is formed when cosmic radiation reacts with gases in the upper atmosphere. Natural tritium combines with oxygen to form water and reaches the earth's surface as rain.

Practically speaking, however, the tritium existing on Earth is manmade, both from being manufactured in reactors as a component for nuclear weapons and creation in the atmosphere from above-ground nuclear test explosions.

Tritium was produced at SRS to support the national defense program. Much of the materials that were contaminated during the production of tritium were disposed of as low-level radioactive waste at the Burial Ground Complex. At the ORWBG, about 3 million curies (a measurement of radioactivity) were buried since the mid-1950s. Because of radioactive decay, there is only about 470,000 curies left.

What is phytoremediation and how does it work? How effective is it?
Phytoremediation (the prefix *phyto-* meaning *plant*) is the direct use of plants to clean up (remediate) pollutants (contamination) from soil and water. Using natural processes, plants can break down (degrade), trap and hold (filter and contain), or transpire (release to the atmosphere in a modified form) contaminants. Phytoremediation, also referred as phyto-bioremediation, is still an evolving cleanup technology and many studies are being conducted to better understand the interactions that occur among contaminants, soil, air, water, plants, and even microorganisms living around plants.

The ***Tritium Phytoremediation Project*** at the SWP is an interim remediation action and currently the only tritium phytoremediation project at SRS. The project has effectively reduced tritium concentrations in water discharges to Fourmile Branch by more than 50 percent since October 2000 when the dam began retaining water.

Is phytoremediation safe?
Yes, the cleanup of tritium by phytoremediation is safe. Calculations that predict the tritium movement through and behavior in the atmosphere were performed specifically for the ***Tritium Phytoremediation Project*** to assure public and environmental safety. These studies indicated that radiation doses to workers are too small to measure directly but are estimated at 4.1 millirem (mrem) per year; doses to offsite populations (the public) are even smaller because of time and distance. When compared to the radiation doses encountered during normal and routine life activities of 360 mrem per year, the levels from phytoremediation are negligible.

What will SRS do with the trees after phytoremediation is completed?
SRS will do nothing with the trees. Over time, the trees will cleanse themselves of the tritium. As the trees take up uncontaminated rain water, most of the remaining tritiated water will be transpired and replaced with clean water. The trees will naturally flush out the remaining amount of tritium. Depending on rainfall, this self-cleansing can take several months. While the tritium is naturally flushed from the trees, access to them will be controlled and harvesting prohibited.

How is SRS proposing to use phytoremediation otherwise?
SRS hopes to apply the technological and regulatory approaches deployed at the ***Tritium Phytoremediation Project*** on other contaminated sites. Eventually, this technology will be deployed at other DOE facilities. Other studies have been conducted at SRS to remediate groundwater contaminated with volatile organic compounds (VOC).