Cleaning up Hanford's contaminated groundwater

OREGON DEPARTMENT OF ENERGY

Hanford's groundwater is extensively contaminated, primarily from the disposal of more than 440 billion gallons of contaminated liquids. Liquid waste disposal was not stopped at Hanford until 1997.

A Hanford worker checks equipment at a groundwater monitoring well. Hundreds of such wells are used to monitor the contamination in the groundwater and the effectiveness of cleanup efforts.

Oregon Department of Energy
625 Marion St. NE
Salem, OR 97301
503-378-4040 or toll-free in Oregon 1-800-221-8035
www.oregon.gov/energy

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Contaminated liquids were routinely disposed to the soil

For more than 40 years, the U.S. Department of Energy (DOE) and its predecessor agencies produced plutonium for America's nuclear weapons program at the Hanford nuclear site in southeastern Washington. That process created large amounts of radioactive and chemically hazardous waste. The most hazardous of the liquid waste was pumped into underground storage tanks. The remainder – an estimated 440 billion gallons of contaminated liquid – was dumped to the soil in ponds, trenches and ditches, and sometimes injected directly into the groundwater. In addition, leaking storage tanks and unplanned spills added to the contaminated liquids in the soil. DOE assumed most of the contaminants would bind to the soil. Many did not, and the groundwater beneath Hanford has become extensively contaminated. Some of this contaminated groundwater enters the Columbia River, causing localized contamination where plumes enter the river, but impacts to downriver water quality are considered negligible due to dilution by the river flow.

Cleanup of the Hanford Site has been underway since 1989, and will likely continue for another 40 years or more. Eliminating the flow of contaminants in groundwater to the Columbia River and eventually cleaning up the groundwater is one of the most difficult challenges for the Hanford cleanup.

Hanford's groundwater

Groundwater is water that is found underground in the cracks and spaces in soil. Groundwater is stored in – and typically moves slowly through – layers of soil, sand and fractured rocks called aquifers. Aquifer materials are permeable because they contain large connected spaces that allow water to flow. The speed at which groundwater flows depends on the slope of the water table, the size of the spaces in the soil or rock, how well the spaces are connected and the rate at which new water is supplied to the aquifer.

Hanford's sub-surface is extremely complex – an effect of ice-age floods that repeatedly deposited layers of soil and rock. As a result, the direction of the groundwater flow and the speed at which the groundwater moves vary widely.

Hanford's Central Plateau sits about 200 feet above the groundwater and is 7 to 12 miles from the Columbia River. The Central Plateau is where 177 underground waste storage tanks are located and where most of the liquid waste disposal occurred. It takes years or decades for groundwater in this area to reach the river. In some areas groundwater contaminants can reach the river in weeks or months.

A mix of contaminants

Many different chemicals and radioactive materials are present in Hanford's groundwater. Contaminants include chemicals such as carbon tetrachloride, chromium and nitrate, and radioactive materials such as uranium, strontium 90, technetium 99, tritium and iodine 129. More than 70 square miles of groundwater is contaminated above regulatory standards. Of those contaminants, chromium, nitrate, uranium, technetium, tritium and strontium have reached the Columbia River. These materials can be harmful to people and the environment.

The Tri-Party Agreement, which sets milestones for Hanford cleanup actions, includes target dates and some firm deadlines related to groundwater cleanup. DOE is working to meet a target of stopping chromium from entering the Columbia River near Hanford's shut-down reactors by December 31, 2012 and a target to stop strontium 90 from entering the river near the N Reactor by December 31, 2016. Some milestones require the expansion of groundwater treatment systems.

Inside a pump-and-treat facility at Hanford's 100-H Area, near the Columbia River.

Treatment methods

Hanford has operated groundwater pump-and-treat systems since 1994 and has greatly increased their capacity in recent years. These systems pump contaminated groundwater out of the ground and remove contaminants through different treatment processes. The cleaned water is then injected back to the ground. Pump-and-treat systems are operational at three of Hanford's reactor areas along the Columbia River and on the Central Plateau. Hanford's largest pump-and-treat system, which will treat carbon tetrachloride and other contaminants in Hanford's Central Plateau, is scheduled to go on-line during the summer of 2012.

Pump-and-treat systems have limitations, so in recent years, Hanford has also experimented with a number of other technologies.

An underground chemical barrier was created near Hanford's D Reactor to convert hexavalent chromium in groundwater into a less mobile and less toxic form as water flowed through the barrier. Parts of the barrier have failed, making pump-and-treat necessary to augment that portion of the barrier that is working.

A different type of chemical barrier, using calcium phosphate, was formed near Hanford's N Reactor. As radioactive strontium in groundwater flows through the barrier, it binds to the calcium phosphate (also called apatite). This barrier shows promise and is being expanded.

Hanford has also tried a process called biostimulation, using molasses and vegetable oil to feed tiny microorganisms (bacteria) in the soil, consuming oxygen in the groundwater in the process. This alters the chemistry of soil and groundwater and changes chromium to a less mobile and less toxic form.

Hanford's groundwater cleanup remains a work in progress. Pump-and-treat and other processes will need to occur for several decades to come. In the meantime, DOE will need to continue to find and remediate the contaminant sources in the soil to help avoid re-contaminating the groundwater for centuries to come.