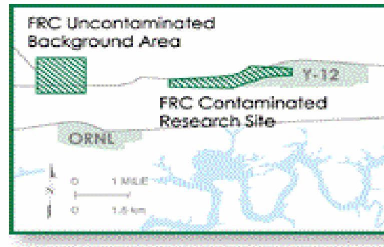


Fact Sheet

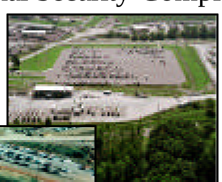
Field-scale research to immobilize uranium in groundwater: a two-part approach

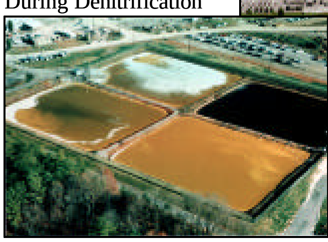
Uranium contamination at the NABIR FRC

Uranium is a major groundwater contaminant at U.S. Department of Energy (DOE) sites. Of the different forms of uranium, uranium VI is of particular concern because it is mobile in subsurface environments and may migrate to locations where it can be taken up by plants and animals. Uranium IV is of less concern because it is exists as a non-mobile and insoluble mineral. Few technically feasible, cost-effective options for remediating groundwater contaminated with uranium currently exist. However, a new and promising approach is immobilization, achieved by converting uranium VI into uranium IV.

Sites like those near former waste ponds within Oak Ridge's Y-12 National Security Complex—now capped and serving as a parking lot—pose a formidable remediation challenge for two main reasons. First, in addition to high levels of uranium in the groundwater, these sites are marked by acidic conditions and high concentrations of nitrate, chlorinated solvents, and metals such as aluminum and nickel. Acidic conditions and high nitrate concentrations interfere with the ability of naturally occurring microorganisms to transform uranium VI into uranium IV.

S-3 Disposal Ponds During Denitrification





Currently a parking lot

Second, bedrock beneath the site is shallow, highly fractured, weathered, and unconsolidated. This geologic setting means that groundwater that contains and transports contaminants flows in complex, not easily predictable ways. Therefore, characterizing, remediating, and monitoring subsurface contamination can be difficult.

Field research to immobilize uranium

A research team headed by Craig Criddle (Stanford University, criddle@stanford.edu) and Philip Jardine (Oak Ridge National Laboratory, jardinepm@ornl.gov) is conducting a research project to evaluate rates and mechanisms by which naturally occurring microorganisms transform uranium VI to uranium IV. The overall plan is to combine above-ground and subsurface activities. Above-ground efforts will remove contaminants that interfere with microbially mediated uranium transformation. Subsurface efforts will focus on immobilizing uranium in groundwater.

NABIR and the NABIR FRC—in brief

Historic research and production activities at sites owned by the U.S. Department of Energy (DOE) and its predecessor agencies created a legacy of below-ground contamination. Considering only contaminated groundwater, DOE currently is responsible for remediating 1.7 trillion gallons, equivalent to approximately four times the daily U.S. water consumption.

DOE's Natural and Accelerated Bioremediation Research (**NABIR**) Program (www.lbl.gov/NABIR) was created to help address some of the more difficult remediation challenges the agency faces. NABIR provides the scientific foundation for the development of bioremediation strategies for below-ground metal and radionuclide contamination. NABIR supports laboratory, field, and theoretical research in microbiology, ecology, chemistry, geology, and computer science. Research is focused on bioremediation of uranium technetium, plutonium, chromium, lead, and mercury.

The **NABIR FRC** (www.esd.ornl.gov/nabirfrc) provides contaminated and uncontaminated field sites in which program investigators can conduct research and obtain samples useful in exploring how naturally occurring microorganisms can help remediate below-ground metal and radionuclide contamination in place.

- **Above ground.** In essence, the above-ground activities condition the groundwater in preparation for *in situ* bioremediation of uranium. This conditioning consists of a series of processes, including a fluidized bed reactor and pH adjustment that aim to remove aluminum, nitrate, and other groundwater contaminants. Conditioning groundwater in this way allows greater experimental control to assess the impacts of different subsurface characteristics on bioremediation.

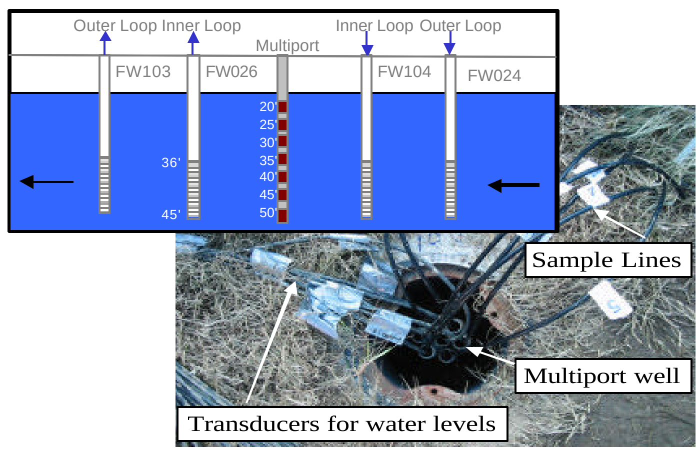
- **Below ground.** In the subsurface, the research team will conduct experiments by injecting and re-circulating this conditioned groundwater in a series of wells, attempting to transform uranium VI into immobile uranium IV by stimulating microorganisms occurring naturally at the research site. This series of injection-extraction recirculation wells will create a subsurface bioreactor, a contained area in which biological organisms transform chemicals from one form to another.

Together, these studies will strengthen understanding of the microbiology and geochemistry needed to convert uranium VI into uranium IV *in situ*. Further, researchers hope that the above-ground pre-treatment scheme proves to be a cost-effective means of remediating mixtures of metals, solvents, nitrate, and radionuclides in highly contaminated source zones.

This multi-year project is being conducted in phases. The first two fieldwork phases have been completed; Phase 3 began in the summer of 2003. Phase 1 focused on characterizing the subsurface environment of the research plot. Phase 2 consisted of installing recirculation wells to enable the creation of a subsurface bioreactor as well as the above-ground pre-treatment facility. In Phase 3, the assembled system is being used to conduct controlled bioremediation experiments.

Above-ground, groundwater conditioning

Below-ground, a series of recirculating wells create a subsurface bioreactor



For more information about this project, see http://public.ornl.gov/nabirfrc/awards.cfm and http://evpilot.stanford.edu/Reasearch/Oakridge/oakridgepics/oakridgeintro.html or contact

Craig Criddle
Stanford University
criddle@stanford.edu

or

Philip Jardine
Oak Ridge National Laboratory
jardinepm@ornl.gov

For more information about the NABIR FRC, see http://www.esd.ornl.gov/nabirfrc/, or contact

David B. Watson, FRC Manager
Oak Ridge National Laboratory
watsondb@ornl.gov

or

Paul E. Bayer, NABIR Field Activities Manager
U.S. Department of Energy, SC-74
paul.bayer@science.doe.gov