Testing, Testing . . .

Simple Technology Improves Groundwater Monitoring along the Columbia River

By Theresa L. Gilbride

Mention groundwater monitoring technology, and the image that most often comes to mind is that of a well installed by heavy equipment and having a large permanent installation sticking out of the ground. But what if the location is culturally or environmentally sensitive, difficult to reach with conventional well-drilling equipment, or subject to flooding?

That is the situation facing Pacific Northwest National Laboratory (PNNL) and cleanup contractor hydrologists who monitor a highly sensitive stretch of the Columbia River—the shoreline that borders the Hanford Site in southeastern Washington State, scene of the nation's largest environmental cleanup project.

Since the earliest days of the Manhattan Project, throughout the Cold War, and now during cleanup, the U.S. Department of Energy and its predecessors have supported detailed monitoring of the site, including the river shore, for contaminants that could potentially leave the site through natural pathways and processes.

***Above:** Scenic view of Hanford Reach. The 51-mile stretch of free-flowing Columbia River and accompanying 195 000 acres of shrub-steppe that borders the Hanford Site from Priest Rapids Dam to near the town of Richland in eastern Washington were designated as the Hanford Reach National Monument by presidential proclamation in June 2000. The reach is a spawning ground for salmon, prime habitat for waterfowl, and a popular recreation area.*

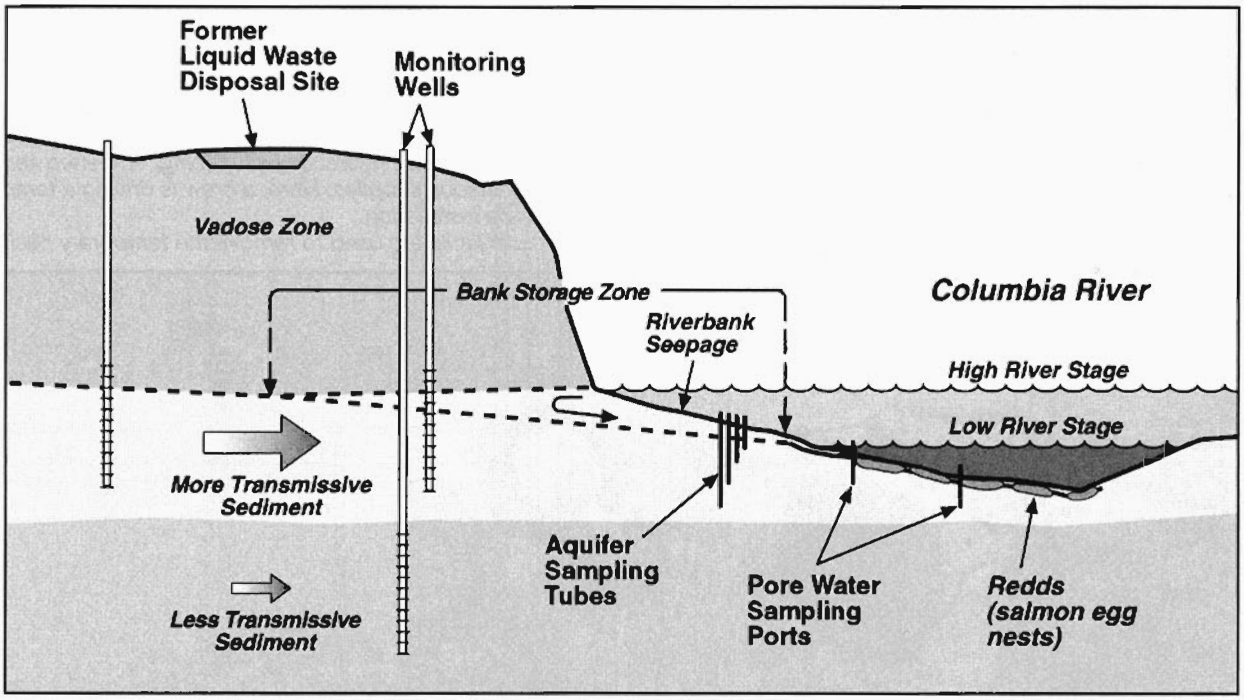
Careful monitoring of shoreline conditions helps assure the public that the DOE has identified all areas where contamination is present and has a good knowledge of how that contamination is moving through environmental pathways. New technologies make the job easier and less intrusive.

Fluor Hanford, prime contractor at the former plutonium production complex, oversees groundwater remedial actions for the DOE. PNNL provides the science and technology base for remedial actions and also conducts much of the environmental monitoring activity.

Important Mission

Monitoring the discharge of groundwater from Hanford to the Columbia River as it flows past the site is important for several reasons:

- Some of the discharging groundwater is contaminated with waste constituents from past disposal operations at the site. Water quality data from river shore monitoring



Cross section showing water sample collection sites along the river.

sites aid in evaluating alternatives for environmental restoration activities.

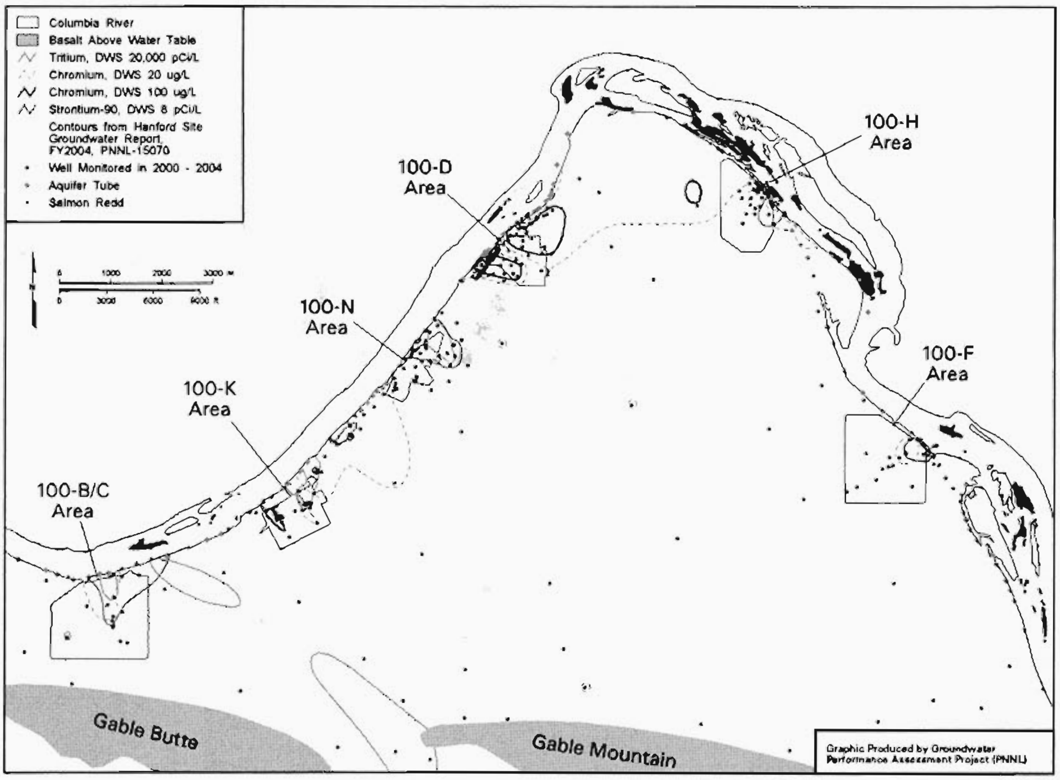
- Data also are useful for monitoring the impact of cleanup operations on groundwater conditions.
- Careful monitoring of shoreline conditions helps assure the public that the DOE has identified all areas where contamination is present and has a good knowledge of how that contamination is moving through environmental pathways.

Routine shoreline activities have long included collection of water and sediment samples from springs that appear along riverbanks, as well as the collection of river water samples and other shoreline sediments. Pore water sampling, which entails sampling from pipes embedded in the river bottom below the low-water level, checks riverbed areas that are suitable for salmon egg nests, or "redds."

Cost-Effective Innovation

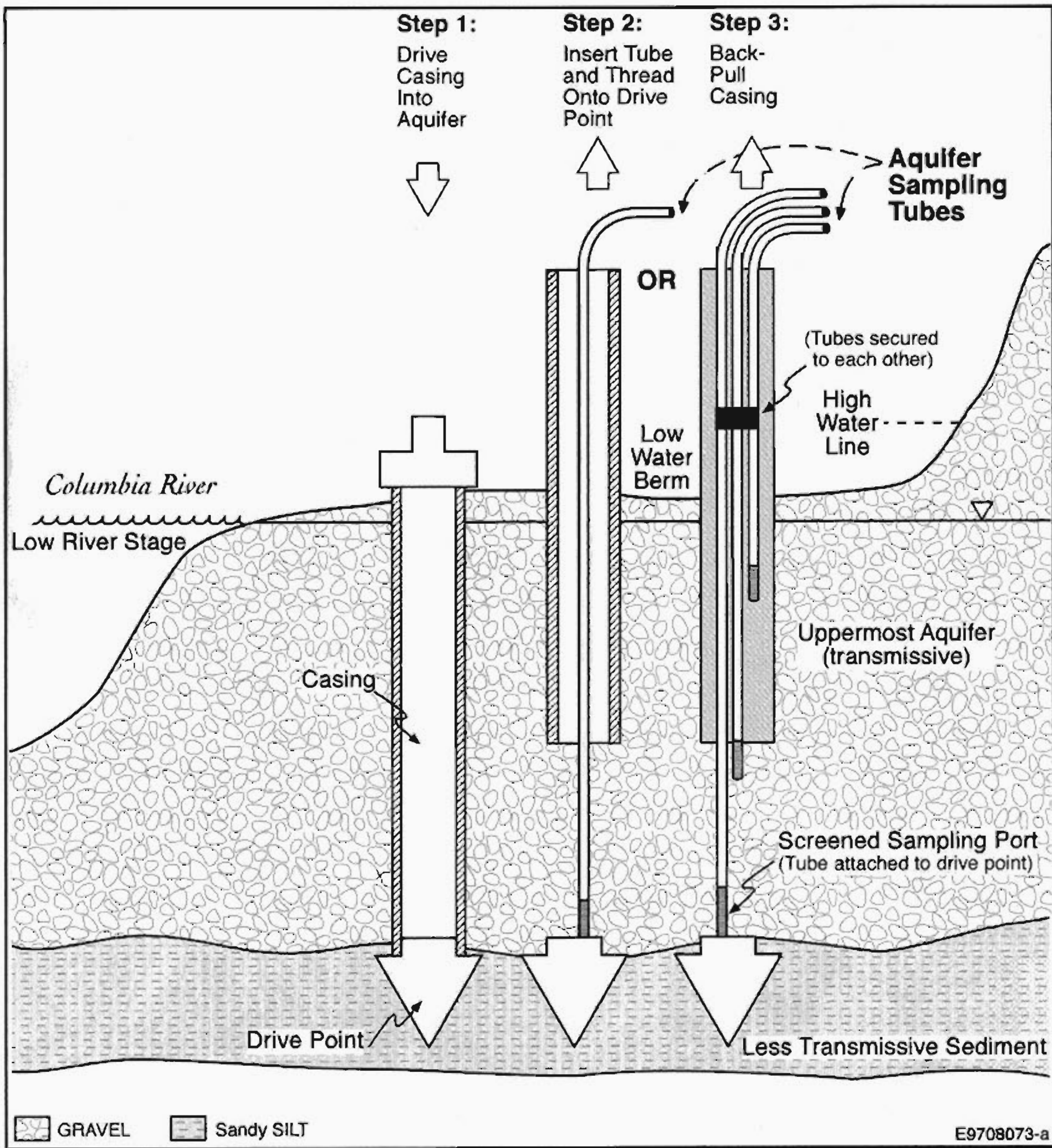
In 1995, the DOE began encouraging the development and implementation of innovative methods to conduct Hanford groundwater monitoring as close as possible to locations where groundwater discharges to the river. Members of the Hanford Site Environmental Restoration Contractor team developed a simple and cost-effective method for sampling aquifers along the shoreline.

Called aquifer tubes, the system uses quarter-inch plastic tubing inserted like long straws into the ground to depths of 6 to 30 feet or more. Hydrologists draw water up through the tubes and analyze it for detectable levels of heavy metals or radionuclide contaminants that might be reaching the river from aquifers underneath the site. When the tubes aren't being sampled, they are covered with polyvinyl chloride (PVC) pipe and river rocks to protect them from browsing animals and to help the site blend in with the shoreline.

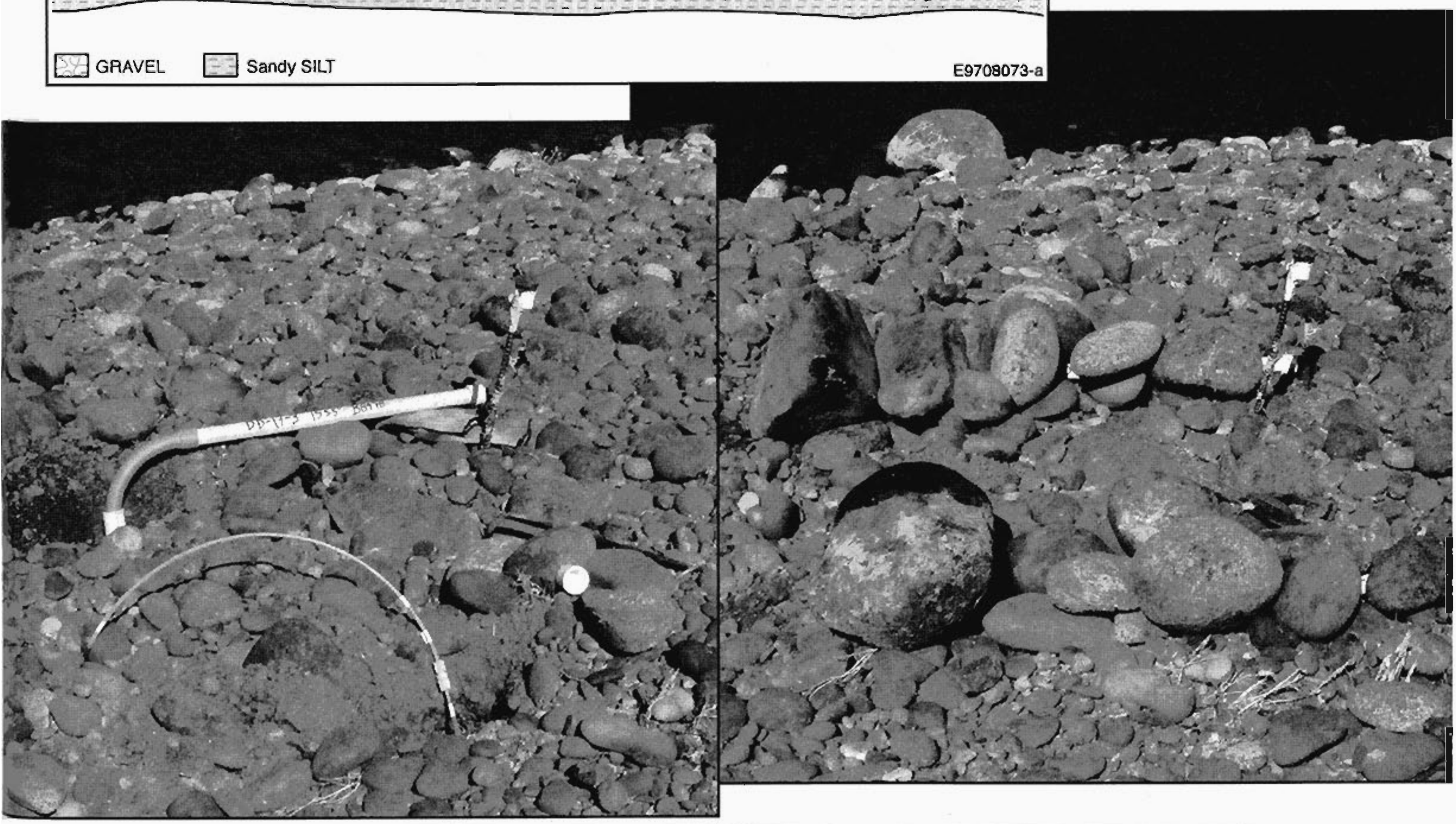


The tube network covers a large segment of the Columbia River shoreline on the Hanford Site at intervals of approximately one-half mile.

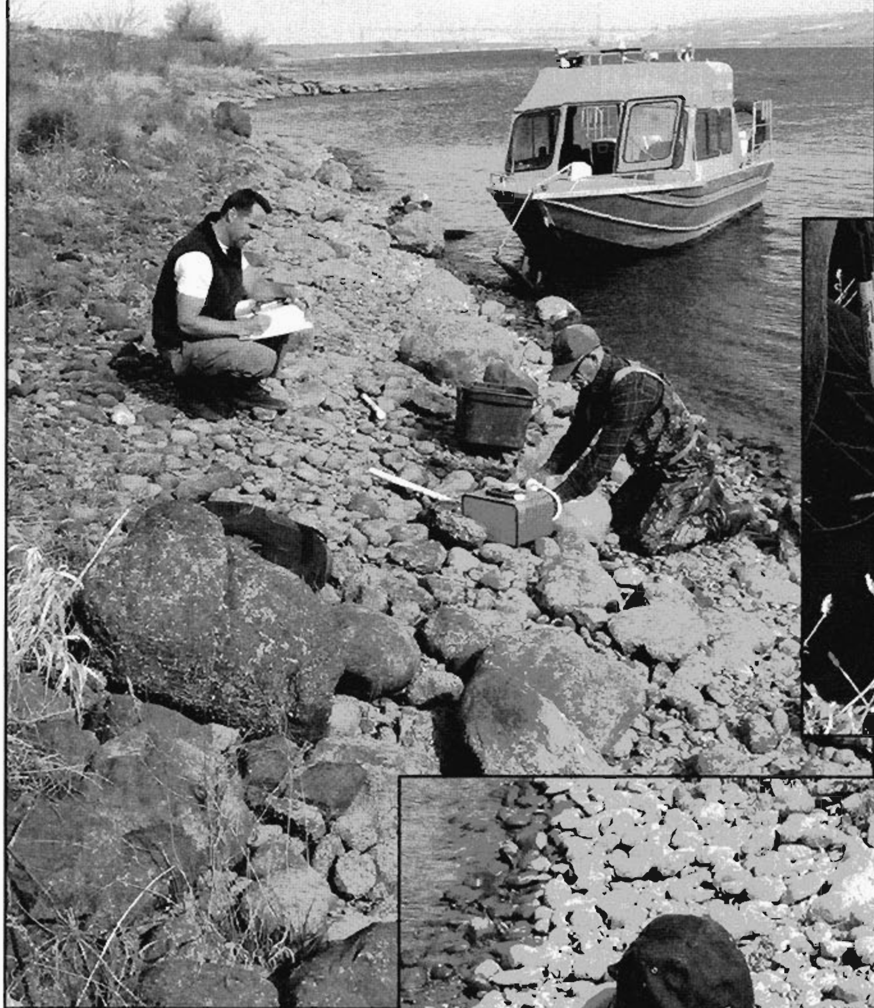
Left: *Traditional groundwater monitoring well operations require a road to transport heavy equipment to a site.*
Below & Bottom Left: *In contrast, efficient, easy-to-install, and cost-effective aquifer tubes are ideal for monitoring groundwater along a river or other surface water body. At Hanford, a crew of four can typically complete installations at up to three sites per day, depending on geologic conditions. Hand-carried installation equipment is readily available and consists of an air-driven hammer (fence post driver), hydraulic jack, tubing, screened sampling ports, and other miscellaneous supplies. Here, a crew is driving a temporary casing for an aquifer tube installation.*
Bottom Right: *Hydraulic jacks are used to remove the temporary casing.*



***Left:** Installation steps for aquifer tubes.*



***Below:** The surface expression of a tube consists of a short section of PVC pipe that is covered with local materials, such as cobbles, to make it nearly invisible to the casual observer.*



Water samples are collected from the tubes each year in the fall. Access to the sites is normally by boat. Water is withdrawn from the tubes using a portable pump.

Unlike traditional groundwater monitoring wells, which require a road to transport heavy equipment to the site for installation and sampling access, aquifer tubes can be installed and sampled with handheld equipment. Tube sites can be accessed on foot or by boat, minimizing disturbance to ecologically or culturally sensitive areas. "We call it 'leave no tracks' monitoring," said PNNL hydrologist Bob Peterson.

The first tubes were installed as part of a one-time effort to sample groundwater at the shoreline near Hanford's nine decommissioned nuclear reactors. Researchers checked the tubes a year later and were surprised to find they were still usable. Encouraged by that finding, more tube sites were added in 1997 and 2004. Coverage now includes 320 tubes located at 132 sites.

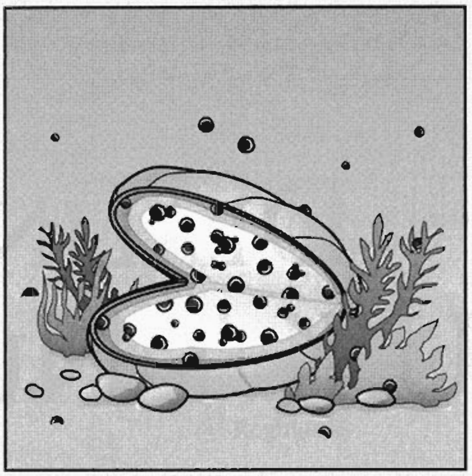
Unexpected Discoveries

The network design purposely includes sites where

The New Canaries

Looking for a 21st century version of the canary in the mine shaft, Pacific Northwest National Laboratory researchers are investigating the Asiatic clams that live in shallow areas along the Columbia River shoreline as environmental sentinels— organisms that can be early indicators of possible damage to an ecosystem.

The Asiatic clam is relatively immobile its entire life and filter-feeds on plankton. These characteristics make it a candidate organism for monitoring potential contaminants in groundwater seeping into the river from shoreline springs.



Asian clams: *PNNL scientists are studying the feasibility of using bivalves as an early warning tool for detecting damage to shoreline ecosystems from natural or human causes.*

Scientists are examining the clams for biomarkers, molecular signatures associated with complex ecosystem functions. Biomarkers are triggered by something that upsets the system, from radionuclides, chemicals, viruses, and bacteria to localized changes in water temperature and global warming. The presence or absence of biomarkers provides an early warning that a dangerous stressor, or combination of stressors, is present.

Researchers envision the use of biomarkers to predict eco-damage and human or animal disease. Because problems would be identified and characterized at the early response stage, rather than at the disease stage, accidental or intentional releases to the environment could be quickly detected and controlled, minimizing loss of life and economic damages.

contamination is not expected. Samples from the tubes provide assurance that these areas are free of contamination. They can also detect unanticipated occurrences of contamination. For example, a previously undetected chromium plume in groundwater was discovered during development activities and initial installations in the area surrounding two of the reactors.

Inland monitoring wells were few and did not reveal the presence of the plume. Subsequent characterization of the plume has led to extensive groundwater remedial actions, including a barrier wall to restrict the discharge of the plume into the river and a pump-and-treat system to remove chromium from the aquifer.

Data from aquifer tubes also have confirmed the presence of a "zone of interaction" along much of the shoreline where groundwater mixes with river water. Within that zone, contaminant concentrations are reduced by the mixing of clean river water with groundwater, thus reducing the concentrations of contaminants entering the free-flowing stream of the river.

By equipping a site with tubes installed at multiple depths in the aquifer, data are collected from the zone of interaction. Water movement and quality in this zone are highly variable because of daily river stage fluctuations and the mixing of river and groundwater.

Potential Applications

While not a direct replacement for groundwater monitoring wells, aquifer tubes provide supplemental coverage in areas where it would not be possible to install a monitoring well because of access constraints. The lower costs associated with the tubes permit broader coverage of potentially contaminated areas given a fixed amount of funding, Peterson said.

"The sampling tube methodology has the potential for a wide variety of applications at other locations," Peterson said. "The simple equipment and installation logistics mean the aquifer tubes can be employed almost anywhere there is a need to monitor shallow groundwater systems or the saturated sediment zone associated with surface water bodies."

For example, the tubes could be used to monitor subsurface agricultural discharge, river bottom habitat, estuary health, site remediation, and total maximum daily load for groundwater influx to streams and lakes. Installations could even be adapted to incorporate in-situ instrumentation for around-the-clock monitoring, Peterson said. ■

Theresa Gilbride is a writer and editor at PNNL.