

At Work on Groundwater Treatment

Directional drilling is one option for installing horizontal wells. ▶

Using Horizontal Wells for Groundwater Remediation

Horizontal wells have been successfully installed at hundreds of sites worldwide to treat and manage contaminated groundwater and soils. Many of these projects have demonstrated that horizontal wells save overall remediation costs by cleaning up the site more quickly than vertical wells and by lowering maintenance and operating costs.

The Department of Energy (DOE) has supported the development, demonstration and application of horizontal environmental wells. At the Savannah River Site (SRS) demonstration, the goal was to test the feasibility of installing horizontal wells in unconsolidated sediments using directional drilling technology. Four systems of directional drilling and horizontal well installations were successfully demonstrated and evaluated at SRS.

- Short-radius technology.
- Modified short-radius (petroleum) technology.
- Mini-rig (utility) technology.
- Midi-rig (river crossing) technology.

Seven wells were successfully installed at depths of 35 to 175 ft., with horizontal screen sections ranging from 150 to 400 ft., using steel, stainless steel, PVC, HDPE and fiberglass. The wells were utilized to demonstrate in situ air stripping, in situ bioremediation and thermally enhanced soil vapor extraction.

Evaluation of the horizontal well installation performance at SRS was based on whether the wellbore was drilled in the proper location with minimum damage to the host formation, whether the well materials were successfully installed in the wellbore and whether the well

could meet the designated remediation objectives.

Benefits

Horizontal well remediation systems are usually faster, cheaper and more effective than vertical wells. They provide

- improved access to contaminants at sites with surface restrictions (e.g., buildings, tanks),
- improved hydraulic control along leading edge of contaminant plume or at property boundary,
- minimal surface disturbance because wellheads may be required,
- ability to monitor beneath contaminant sources (e.g., tanks, pits, lagoons),
- increased surface-area contact with contaminants,
- reduced operating expenses because fewer wells may be required, and
- access to off-site contamination to be treated by on-site operations.

Horizontal wells can be installed by directional drilling or by trenching and backfilling (if specific site conditions allow it). Directional drilling methods use specialized bits coupled with electronic transmitters in the drillhead to locate and steer as the borehole is advanced. Components required for directional drilling include a drilling rig, a mud system, drill bits, reaming bits and a guidance system. Directional drilling can be used to install impermeable or permeable barriers and can be



combined with fracturing technology in low permeability sediments.

The SRS demonstrations identified two important factors for consideration during the design of horizontal environmental wells. Trips in and out of the wellbore should be minimized to maintain wellbore stability and well materials should be adequately flexible to negotiate curves.

Cost

Horizontal wells cost more to install but much less to maintain than vertical wells. In addition, one horizontal well takes the place of many vertical wells. Costs of horizontal wells range widely based on drilling method and size of rig; type of drilling tool, drilling fluid and guidance system; vertical depth and total wall length; site geology; well materials; and number of personnel on site. A cost comparison of the directional drilling methods used at SRS is shown in Table 1.

Design Issues

During the SRS demonstrations several pre-drilling activities were identified.

- A thorough description of the target zone and surrounding geology/hydrogeology should be made available to the well designers and the drilling subcontractor.
- A description of the well completion requirements such as well screen size, filter pack size and specifications of the well material should be made available.

At SRS, a horizontal well used for vapor extraction was five times more efficient than a vertical well. Modeling studies have predicted more rapid cleanup (5 years versus 20 years) using horizontal wells as opposed to vertical wells.

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Table 1: Cost Comparisons of the Directional Drilling Technologies Tested

	Short Radius Technology	Modified Petroleum Technology	Utility Technology	River Crossing Technology
Demonstration cost	\$963,730	\$235,350	NA	\$230,000
Linear feet of well installed	768 ft.	788 ft.	-	1,440 ft.
Project cost/ft.	\$1,255/ft.	\$299/ft.	NA	\$160/ft.
Average industry cost/ft.	\$150–250/ft.	\$150–250/ft.	NA	\$227/ft.

NA – not available; work was performed by an industrial partnership, no drilling costs were available.