Groundwater Monitoring Wells Installed in a Radioactive and Hazardous Waste Landfill Using Direct Push Technology in Lieu of Conventional Drilling Methods - 10037

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ABSTRACT

In 2008, the Department of Energy (DOE) Environmental Management (EM) Headquarters recognized and selected the "X-749/X-120 Area Groundwater Optimization Project" project as an EM High Achievement project for Pollution Prevention. The selection was based on the safety commitment by the project team, their compliance with all quality assurance and quality control requirements, and the project's demonstrated, significant costs savings to DOE. The project will be documented in DOE's 2009 Best Practices in Sustainable Environmental Stewardship database.

The X-749/X-120 Area Groundwater Optimization project was designed to mitigate the off-site migration of the X-749/X-120 Area groundwater contaminant plume from the Portsmouth Gaseous Diffusion Plant (PORTS) and to augment previously implemented remedial actions. This paper presents detailed information on the installation of seven new groundwater monitoring wells within and around the X-749 Contaminated Materials Disposal Facility (X-749 Landfill). The seven monitoring wells were installed utilizing a GeoProbe 8040 direct-push technology (DPT) rig in lieu of conventional drilling methods and techniques (e.g., hollow stem augering). The monitoring wells are performing as designed and continue to provide DOE with the required performance monitoring data for the northern and northwestern barrier walls and the center of the X-749 Landfill.

INTRODUCTION

PORTS, which enriched uranium from 1954 until approximately 2000, is owned by DOE. PORTS is located in a rural area of Pike County, Ohio, on a 5.9-square mile site. Through its managing contractors, DOE is responsible for environmental restoration, waste management, and operation of non-leased facilities at PORTS (DOE 2007a).

X-749/X-120 AREA HISTORY

The X-749/X-120 groundwater contaminant plume is located in the south central section (Quadrant I) of the PORTS facility (see Figure 1). The plume is associated with the former X-120 Goodyear Training Facility and the X-749 Landfill (see Figure 1). The principal contaminants of concern are chlorinated solvents (primarily trichloroethene [TCE]) and technetium-99 (Tc-99) (DOE 2007b).

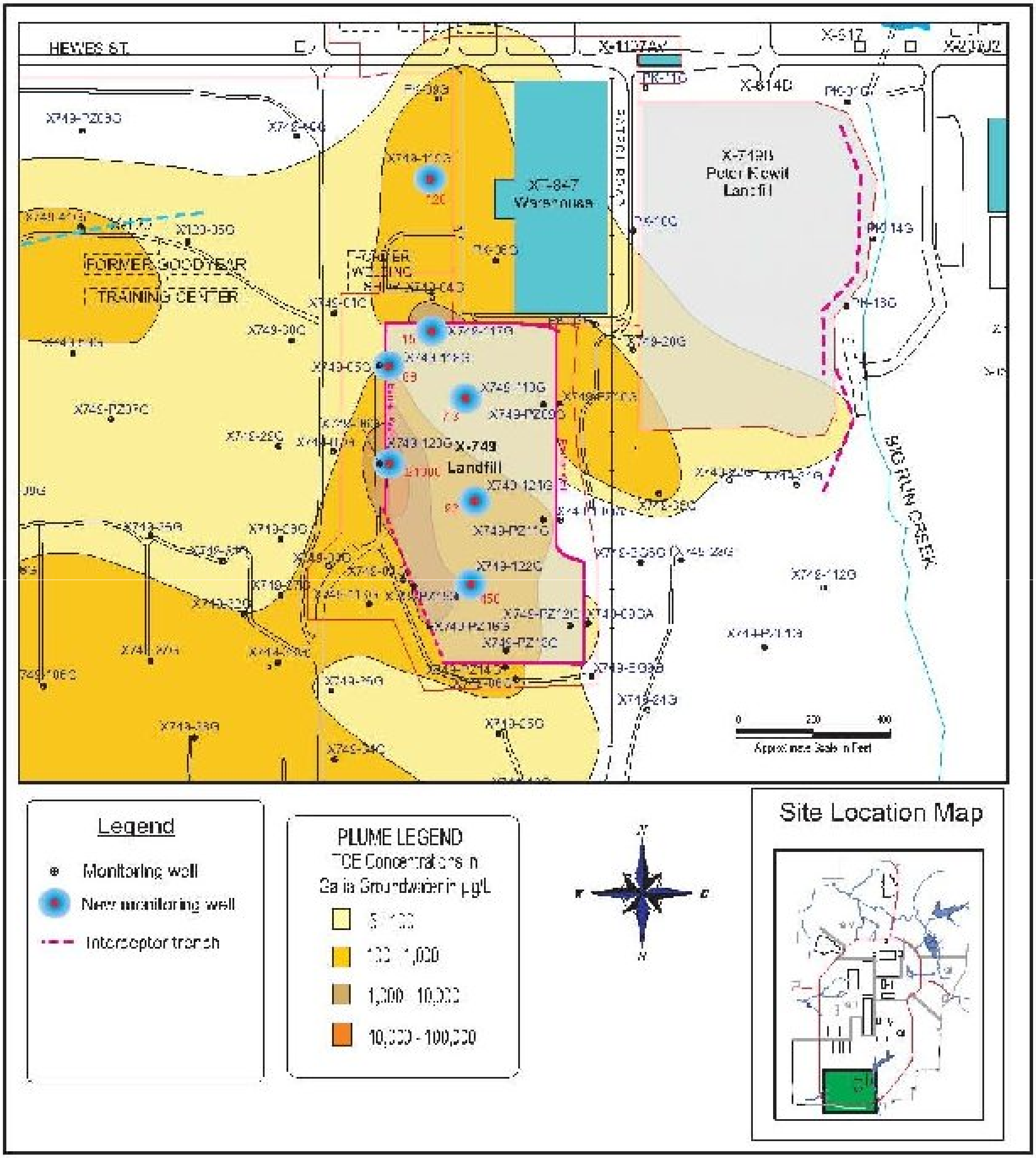

Fig. 1. X-749/X-120 Area Gallia groundwater TCE plume and new monitoring wells.

The former X-120 Goodyear Training Facility was in operation during plant construction in the early 1950s as a machine shop, paint shop, and warehouse space. The X-120 facilities were demolished and removed in the late 1970s. Remedial investigations conducted in the early 1990s detected various volatile organic compounds (VOCs), primarily TCE, in the groundwater.

The X-749 Landfill is located approximately 500 feet southeast of the former X-120 Goodyear Training Facility. The X-749 Landfill comprises northern and southern segments; however, monitoring plans treat the X-749 Landfill as a single unit due to the groundwater plume which lies under both segments of the landfill. Prior to closure, the landfill was used by DOE for disposal of low-level radioactive and hazardous waste generated from uranium enrichment operations at PORTS. In 1989, the 11.5-acre landfill underwent closure in compliance with the Resource Conservation and Recovery Act (RCRA). The closure activity included the installation of slurry walls along the north and west sides of the landfill and a multi-layered landfill cap over the complete facility. These installed features were to serve as source control for groundwater contamination. The captured, contaminated groundwater has continued to be treated at an on-site groundwater treatment facility. Despite the closure actions, post-closure monitoring has shown areas of relatively high and/or increasing TCE and Tc-99 concentrations in groundwater monitoring wells located north and west of the X-749 Landfill (DOE 2009).

In 2001, the Ohio Environmental Protection Agency (EPA) issued the Decision Document for Quadrant I, identifying the selected remedial measures for the X-749 Landfill and the associated groundwater contaminant plume. These measures included installation of a barrier wall around the eastern and southern portions of the X-749 Landfill as source control and installation of a phytoremediation system to help contain groundwater flow and to remove VOCs. The wall was installed in 2001, and the phyto system was installed during 2002-2003. Despite the implementation of these measures, the X-749/X-120 groundwater plume has migrated beyond the southern DOE property boundary (Ohio EPA 2001).

PORTS and X-749/X-120 Area Hydrogeology

The principal groundwater flow system for PORTS is limited to four geologic and hydraulic units: Minford, Gallia, Sunbury Shale, and Berea Sandstone (see Figure 2). The uppermost unconsolidated unit is the Minford, with an approximate thickness of 25 to 30 feet (ft). The Gallia and the silt of the lower Minford constitute the unconsolidated aquifer at PORTS. The Gallia unit underlies the Minford and is relatively thin (3 to 10 ft) in the X-749/X-120 area. The average hydraulic conductivity values for the Gallia and Minford are approximately 40 ft/day and 0.62 ft/day, respectively.

The uppermost bedrock unit is the Sunbury Shale. This unit is typically encountered at a depth of approximately 30 ft below ground surface (bgs) and the Sunbury is considered to be an effective aquitard. The Berea Sandstone underlies the Sunbury Shale and is encountered at depths between 40 to 45 ft bgs. The primary source of water for the hydrogeologic flow system is natural recharge through precipitation. Natural groundwater flow beneath the X-749/X-120 area is directed to the south and east. The flow direction is the same for both the Gallia and Berea units.

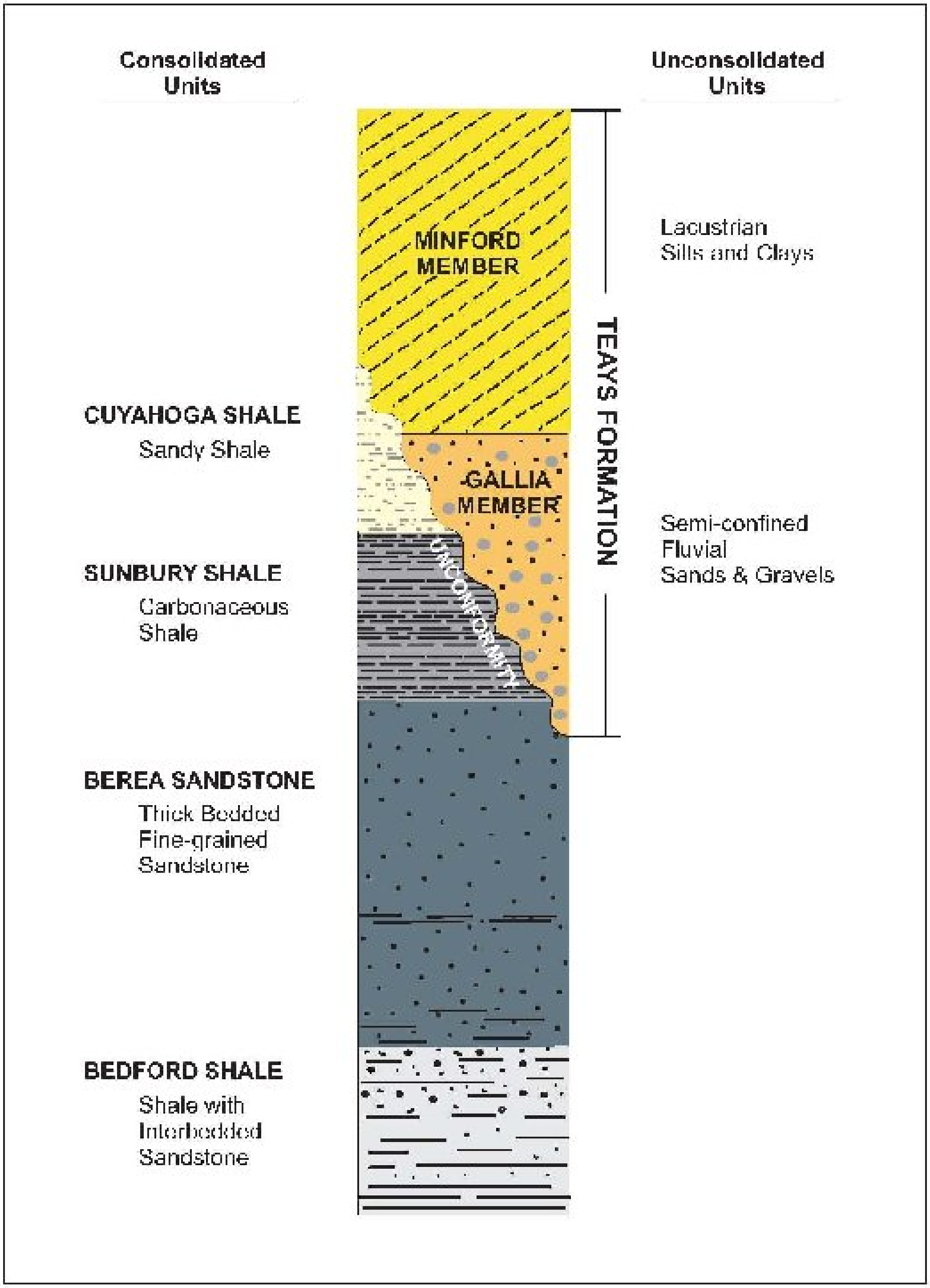

Fig. 2. Generalized stratigraphy at PORTS.

The uppermost geologic unit in the X-749/X-120 Area is the Minford Clay and Silt (Minford) member of the Teays Formation. Where undisturbed, the Minford consists of an upper clay layer which grades into a basil silt layer. Because there is no documentation of Minford removal in this area prior to disposal activities, it is assumed that undisturbed Minford is present beneath landfill material. The unconsolidated sand and gravel deposits of the Gallia Sand and Gravel (Gallia) member of the Teays Formation underlie the Minford.

The uppermost bedrock unit is the Sunbury Shale (Sunbury), a moderate-to-hard, black, fissile shale that often exhibits an upper weathered zone of gray, highly plastic clay. The Sunbury is absent or very thin in areas on the western side of X-749 landfill cap due to erosion by the ancient Portsmouth River. Evidence of this erosion is present in the area of the X-120 Old Training facility, where the Sunbury thins and is sometimes absent. The Berea sandstone (Berea), which underlies the Sunbury, is light gray, hard, fine-grained, thickly bedded sandstone with few joints (DOE 2000).

OPTIMIZATION TASK 5, ADDITIONAL MONITORING LOCATIONS

In 2008, implementation of activities in the *Work Plan for the X-749/X-120 Groundwater Optimization Project* continued to address the groundwater plume that had advanced beyond the DOE property boundary and to enhance remedial activities in the X-749/X-120 area. The X-749/X-120 Area Groundwater Optimization project consisted of eight optimization tasks that were designed to mitigate the off-site migration of the X-749/X-120 Area groundwater contaminant plume from PORTS and to augment previously implemented remedial actions. This paper addresses Optimization Task 5, *Additional Monitoring Locations,* which included the installation of seven new groundwater monitoring wells within and around the X-749 Landfill. The wells were installed to monitor contaminant concentrations within the landfill and to measure the performance of the barrier walls around the landfill.

The X-749/X-120 Area Groundwater Optimization project included sampling of existing groundwater monitoring wells within the X-749/X-120 Area groundwater plume and close to and within the X-749 Landfill. Prior to installation of the seven new monitoring wells per Optimization Task 5, the routine monitoring had identified areas of relatively high and/or increasing contaminant concentrations north and west of the X-749 Landfill. Despite these monitoring results, much was still unknown about the performance of the northern and northwestern barrier walls and conditions within the center of the landfill. DOE determined that such performance monitoring was needed to fully characterize the X-749/X-120 Area groundwater plume (DOE 2007b).

The common industry practice for monitoring well installation has called for conventional drilling methods and techniques (e.g., hollow stem augering). The history of PORTS indicates that disposal techniques within the X-749 Landfill consisted of placing radionuclide-contaminated materials, hazardous waste, abandoned equipment, and scrap material in excavated trenches. The trenches were subsequently covered with earthen material and ultimately by the landfill cap. Extensive review of PORTS engineered landfill drawings did not yield accurate information about the locations of the trenches. The Project Management Team (PMT), DOE, and Ohio EPA therefore determined that conventional drilling techniques, in which sub-surface soils and any encountered contaminants are brought to the surface, would present health and safety risks to workers, the environment, and the public. To enhance worker safety and to reduce worker exposure to potential radiological and hazardous contaminants known to be present in the landfill, DOE and Ohio EPA approved the use of the DPT rig.

The PMT, DOE, and Ohio EPA also concluded that using the DPT rig would reduce the potential for an explosive environment. The possibility of explosive gas generation was impossible to determine because records of early waste disposal provided insufficient detail about the nature and chemical composition of wastes placed into the X-749 Landfill. Conventional drilling methods, such as augering, may create sparks that could ignite trapped methane gas and/or gases present from other liquid volatile organics present in the landfill. In addition to preventing sparks, the DPT method pushes steel rods into the subsurface, helping to seal the borehole as it penetrates, significantly reducing or preventing the escape of methane gas.

Monitoring Well Installation Details

Six of the seven new monitoring wells (X749-117G, X749-118G, X749-119G, X749-120G, X749-121G, and X749-122G) were installed within the X-749 Landfill adjacent to the northern and northwestern barrier walls. One monitoring well (X749-115G) was installed outside the landfill approximately 425 ft due north of the northern barrier wall (see Figure 1). The wells installed within the landfill were designed to provide performance monitoring data for the northern and northwestern barrier walls and conditions within the center of the landfill and to assist in determining contamination in these areas. The well installed due north of the landfill, X749-115G, provided data on contaminant concentrations from the portion of the plume most impacted by the former X-120 facilities (DOE 2009).

Prior to installation of the seven new monitoring wells, DOE and Ohio EPA articulated concern regarding the quantities of waste material and soils to be generated during the drilling activities. The PMT emphasized that the DPT rig would significantly reduce the volume of waste material and soils generated. Conventional drilling methods would have generated 35 drums (262 cu ft) of waste; the DPT method would generate less than 1 drum (3 cu ft), saving DOE approximately $50,000 in waste transport and disposal costs.

The installation of the seven new monitoring wells within in and around the X-749 Landfill commenced in June 2008 utilizing the Geoprobe 7730 DPT rig. Ultimately, drilling activities were completed utilizing a larger, more powerful rig, the Geoprobe 8040 DPT rig (see Figure 3), necessitated by the very dense clay-cobble lithology typical of the Gallia formation within the PORTS lithology.

Figure 3. Geoprobe 8040 DPT rig used for monitoring well installation.

Following installation of well X749-115G, the six remaining monitoring wells were installed within the landfill (see Table I). Table I provides details and construction information for the seven monitoring wells.

Table I. X-749/X-120 Area Monitoring Well Details, and Construction Information.

WELL NUMBER	DATE INSTALLED	EAST COORD (FT)	NORTH COORD (FT)	LAND SURFACE ELEV (FT)	WATER LEVEL MEASURING POINT ELEV (FT)	SCREEN TOP DEPTH (FT)	SCREEN BOTTOM DEPTH (FT)	BORE-HOLE BOTTOM DEPTH (FT)
X749-115G	07/11/08	6983.530	4472.470	666.79	669.04	24.00	29.00	29.25
X749-117G	07/09/08	6987.410	4084.950	680.32	682.84	38.00	43.00	44.00
X749-118G	07/08/08	6876.230	3996.560	682.06	684.33	41.00	46.00	46.00
X749-119G	07/09/08	7075.540	3913.400	680.15	682.61	35.00	40.00	40.50
X749-120G	07/10/08	6878.600	3746.890	683.63	685.83	40.00	45.00	45.25
X749-121G	07/09/08	7099.260	3652.030	679.35	681.67	37.00	42.00	42.25
X749-122G	07/10/08	7089.000	3440.770	683.54	685.94	43.00	48.00	48.25

During installation of the monitoring wells within the landfill, the DPT rig was used to advance two-inch, three-inch, and four-inch diameter Geoprobe rods in excess of 48 ft to bedrock. Boring logs generated during drilling activities and historical cross-sections of the X-749/X-120 Area indicate that soils covering the landfill consist of fill material composed of Minford silt and clay (placed on the landfill during construction). This fill material overlies the native Minford Silt with thicknesses ranging between 15 and 30 feet. The fill is underlain by the Gallia Formation, which ranges in thickness of three to ten feet in thickness and extends to depths ranging between 650 and 635 feet above mean sea level (msl). The Gallia is underlain by the Sunbury shale.

The Geoprobe rods were advanced through the very dense clay-cobble lithology encountered at 30 to 35 ft below the X-749 Landfill cap. Sampling of the subsurface media revealed that the very dense clay-cobble layer was the same encountered during installation of monitoring well X749-115G, further confirming that this material was typical of the Gallia Formation across the X-749/X-120 area. The monitoring wells were installed at depths ranging from 40 ft to 48 ft. Each of the monitoring wells was constructed of 2-inch diameter schedule 40 PVC with a 5-ft PVC 0.010-inch slotted screen set on the Sunbury Shale bedrock. The monitoring well installation activities were completed in July 2008.

The X-749 Landfill cap membrane was breached during installation of the six monitoring wells within the landfill. Following installation of the monitoring well casings, the cap membrane had to be repaired. First, the landfill cap soils were excavated from around each monitoring well location utilizing a small backhoe and appropriate hand tools. Pipe boots were secured around each monitoring well casing and sealed to the landfill cap membrane (see Figure 4). The excavated soils were replaced around each of the monitoring well casings.

Fig. 4. Pipe boot being secured to landfill liner at monitoring well location.

A geophysical or subsite utility survey was conducted to identify all underground utilities, pre-disposed equipment, and other debris before monitoring well locations were finalized. Continuous health and safety, radiological control, and explosive gas monitoring was performed during work activities.

X-749/X-120 AREA MONITORING WELL RESULTS

After installation, the seven new monitoring wells were developed to settle and remove fines from the filter pack. The new wells were sampled for VOCs and Tc-99. Although Tc-99 was not detected in monitoring well X749-115G, TCE was detected at 140 µg/L, a result consistent with TCE concentrations detected in other wells in the same area.

Technetium was detected in three of the six wells installed within the landfill: X749-119G at 14.2 picocuries per liter (pCi/L), X749-120G at 2290 pCi/L, and X749-121G at 771 pCi/L. TCE was detected in each of the six wells. In four wells (X749-117G, X749-118G, X749-119G, and X749-121G), TCE concentrations were 100 micrograms per liter (µg/L) or less. TCE was detected at 22,000 µg/L in well X749-120G, which is on the northwestern barrier wall of the landfill approximately 125 feet north of the beginning of the groundwater collection trench. TCE was detected at 790 µg/L in well X749-122G, which is in the middle of the southern portion of the landfill approximately 125 feet east of the groundwater collection trench (DOE 2009).

CONCLUSION

Monitoring well installation activities were conducted utilizing the Geoprobe 8040 drill rig with DPT in lieu of conventional drilling methods and techniques (e.g., hollow stem augering). The DPT technique was chosen for the following reasons:

- To enhance worker safety and reduce worker exposure to potential radiological and hazardous contaminants of concern (COCs) known to be present in the landfill.

To reduce the potential for an explosive environment created when conventional drilling methods create sparks that may ignite trapped methane gas and/or gases present from other liquid volatile organics to be present in the landfill.

- To reduce the volume of waste soils generated by 35 drums (262 cu ft), saving approximately $50,000 in waste transport and disposal costs.

The monitoring wells are performing as designed and provide DOE with much needed performance monitoring data for the northern and northwestern barrier walls and center of the X-749 Landfill. All of the new wells will be sampled for VOCs semiannually and for Tc-99 in three sampling events. The monitoring wells, successfully installed utilizing the DPT method, meet all DOE safety and quality assurance and quality control requirements (DOE 2009).

REFERENCES

1. DOE 2000. *Quadrant I Cleanup Alternatives Study/Corrective Measures Study Final Report for the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* DOE/OR/12-1248&D6, Bechtel Jacobs Company LLC, Piketon, Ohio.

2. DOE 2007a. *Portsmouth Annual Environmental Report for 2007,* DOE/PPPO/03-0065&D1, United States Department of Energy Portsmouth/Paducah Project Office, May 2009.

3. DOE 2007b. *Work Plan for the X-749/X-120 Area Groundwater Optimization Project at the Portsmouth Gaseous Diffusion Plant Piketon, Ohio,* DOE/PPPO/03-00418&D1, United States Department of Energy Portsmouth/Paducah Project Office, May 2007.

4. DOE 2007c. *2006 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant Piketon, Ohio,* DOE/PPPO/03-0039&D1, United States Department of Energy Portsmouth/Paducah Project Office, March 2007.

5. DOE 2009. *Integrated Groundwater Monitoring Plan for the Portsmouth Gaseous Diffusion Plant Piketon, Ohio,* DOE/PPPO/03-0032&D2, United States Department of Energy Portsmouth/Paducah Project Office, February 2009.

6. Ohio EPA 2001. *Ohio Environmental Protection Agency's Decision Document for Quadrant I of the Portsmouth Gaseous Diffusion Plant.* March 2001.