



# Groundwater Sampling and Monitoring with Direct Push Technologies

An Online Continuing Education Course for Engineers

**Course Number: EN-4012**

**Credit: 4 Hours / 4 PDH / 4 CPD**

# Groundwater Sampling and Monitoring with Direct Push Technologies

## Section 1: Introduction

### Abbreviations

The following acronyms will be used throughout this course:

ASTM	American Society for Testing and Materials
CPT	cone penetrometer testing
CSP	centrifugal submersible pump
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DPT	direct push technology
DQO	data quality objectives
FID	flame ionization detector
GC	gas chromatograph
ID	inner diameter
LIF	laser-induced fluorescence
LNAPL	light non-aqueous phase liquid
MIP	membrane interface probe
OD	outer diameter
ORP	oxidation/reduction potential
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PE	polyethylene
PP	polypropylene
PTFE	polytetrafluoroethylene
PVC	polyvinyl chloride
QC	quality control
RCRA	Resource Conservation and Recovery Act
ROST	Rapid Optical Screening Tool
SC	specific conductivity
SVOC	semi-volatile organic compound
TCE	trichloroethene
EPA	United States Environmental Protection Agency
UV	ultraviolet
VOC	volatile organic compound

## **Background**

Direct push technology (DPT, also known as “direct drive,” “drive point,” or “push technology”) refers to a growing family of tools used for performing subsurface investigations by driving, pushing, and/or vibrating small-diameter hollow steel rods into the ground. By attaching sampling tools to the end of the steel rods they can be used to collect soil, soil-gas, and groundwater samples. DPT rods can also be equipped with probes that provide continuous in-situ measurements of subsurface properties (e.g., geotechnical characteristics and contaminant distribution). Interest in understanding how DPT groundwater collection methods compare with traditional monitoring well sampling methods has steadily increased since the mid-1980s, when DPT first started being used for this purpose. Although environmental professionals recognize that DPT provides a cost-effective alternative to conventional approaches to subsurface sampling, some have been reluctant to use it for groundwater sampling because of uncertainty regarding the quality of samples that the technology can provide. The guidance in the course is designed to encourage more widespread consideration of DPT by clarifying how DPT can be used to meet a variety of data quality requirements for a variety of site conditions.

## **Scope and Limitations**

This course focuses on groundwater sampling issues related to DPT, in particular those regarding the quality and usability of the groundwater data. Two general types of DPT groundwater sampling methods are discussed: “point-in-time” or “grab” sampling and sampling with direct push installed monitoring wells. Other uses of DPT, such as soil sampling, soil-gas sampling, and deployment of continuous logging equipment, generally are not controversial; therefore, they are not discussed at length. In addition, this course assumes a basic level of understanding of DPT equipment.

This course is not intended to replace the knowledge and advice of an experienced hydro geologist. Site-specific situations may dictate that an expert familiar with site conditions and project goals be involved in the planning and implementation of any groundwater sampling event. Furthermore, Federal and State regulatory requirements can vary substantially among jurisdictions and the appropriate regulatory and State agencies must be consulted to ensure that legal requirements are met.

## **Advantages and Limitations of Direct Push Technologies**

Direct push technologies are a valuable tool for environmental investigations because they can offer a number of advantages over conventional well installation and sampling methods and can provide many other types of data to a project team (e.g., in-situ detection of contaminants, real-time geotechnical data). Some of the typical advantages of using DPT over monitoring wells drilled and installed with conventional tools, such as hollow stem augers, include:

- Faster sampling capability that helps to provide more data, thereby improving site decision making and facilitates the use of a dynamic work plan strategy;
- In general, lower cost when greater data density is needed;
- Greater variety of equipment and methods resulting in greater flexibility in meeting project goals;
- Capability of collecting depth-discrete groundwater samples to locate contaminated layers;
- Better vertical profiling capability for generating three-dimensional profiles of a site that improve the conceptual site model; and
- Less investigation-derived waste generated, thereby saving additional time and money while minimizing the potential for exposure to hazardous substances.

However, DPT cannot completely replace the use of conventional monitoring wells. Rather, DPT provides environmental professionals with additional choices from which to select equipment and methods for collecting groundwater samples. Conventional methods still have a number of potential advantages over DPT, including:

- Fewer limitations for deployment in a variety of geologic and hydrogeologic settings. For example, conventional DPT may not be able to penetrate some caliches, bedrock, or unconsolidated layers with significant amounts of gravel or cobbles. DPT is not recommended where telescoped wells are needed to prevent contaminant migration below confining layers;
- Deeper limit of subsurface penetration than DP rigs in most geologic settings; and
- Easier collection of large sample volumes.

Consequently, DPT and conventional monitoring well technologies may both be useful for groundwater sampling. They can provide environmental professionals with a variety of options to collect data sufficient for decision making, even when high quality groundwater samples are needed.

## Course Layout

This course is divided into four major sections designed to expose the student to potential issues and solutions regarding groundwater sampling with DPT:

- Section 2: Summary of Direct Push Technology Groundwater Sampling Methods: provides an overview of the different types of equipment available with DPT to collect groundwater.
- Section 3: Data Quality Objectives for Groundwater Sampling: provides the student with a summary of groundwater data quality issues that should be considered while planning a groundwater sample collection activity.
- Section 4: Recommended Methods for Collecting Representative Groundwater Samples: provides the student with information on filter packs, well development, and low-flow sampling methods as they relate to DPT.

- Section 5: Recommended Methods for Minimizing the Potential for Cross-Contamination: provides the student with information on drag-down, hydraulic conduits, decontaminating equipment, and decommissioning DPT boreholes.

## **Section 2: Summary of Direct Push Technology**

### **Groundwater Sampling Methods**

DPT groundwater sampling equipment generally falls into one of two broad categories:

**Point-in-time groundwater samplers:** These tools or devices, also referred to as “temporary samplers” or “grab samplers,” are used to rapidly collect samples to define groundwater conditions during one sampling event. They are usually less than two inches outside diameter (OD) and are generally constructed of steel or stainless steel. Direct push methods (percussion or static weight) are used to advance point-in-time samplers below the static water level in unconsolidated formations. Generally, groundwater flows into the sampler from an exposed screen under ambient hydrostatic pressure. Groundwater may be collected from the sampler using bailers or pumps, or the sampler may be retracted to the surface to obtain the water sample. Once sampling is completed, these devices are removed and the boring should be abandoned in accordance with local regulations.

**DPT-installed groundwater monitoring wells:** These monitoring wells are installed by direct push methods to permit short-term or long-term monitoring of groundwater and are usually two inches in diameter or less and constructed of PVC and/or stainless steel. Since monitoring wells are installed for periods of several months to several years, the annulus of the boring around the well casing is usually sealed to prevent migration of contaminants into the aquifer. Surface protection is required to prevent tampering with the well. A slotted or screened section permits groundwater to flow into the well under ambient hydrostatic pressure. Groundwater may be collected from monitoring wells using bailers, various pumps, or passive sampling devices.

Point-in-time sampling tools are typically used during site characterization to identify plume boundaries or hot spots. They cannot be used for long-term monitoring or trend analysis since the boreholes need to be decommissioned upon completion of sampling. In contrast, temporary and permanent monitoring wells are typically used to provide trend analysis of contaminant groundwater concentrations over an extended period of time. DPT can be used to install small-diameter (e.g., up to 2 inches outside diameter [OD]) monitoring wells.

Ideally, both DPT point-in-time and monitoring well groundwater sampling equipment should be used together to maximize their effectiveness. Point-in-time sampling techniques are generally better for identifying plume boundaries, hot spots, preferred pathways, or other monitoring points of interest. Once this information is collected, DPT monitoring wells, as well as conventional monitoring wells, can be optimally placed to provide project teams with the most useful monitoring data.

This section summarizes the various types of point-in-time sampling tools and DPT monitoring well installation techniques. Since DPT groundwater sampling methods are often used to their best advantage in combination with other specialized DPT measurement and logging tools, these associated tools are also discussed at the end of this section. This information is intended to provide the student with an easily accessible summary of available DPT tools. Other resources listed in the Introduction could also be used for a more comprehensive survey of available tools and their capabilities. Table 1 provides a list of some of the major DPT equipment available for groundwater investigations. It summarizes the capabilities of the equipment and helps the student to sort through the variety of tools and how they may be useful for specific project goals.

## Point-in-Time Sampling

A variety of point-in-time sampling tools are used for site characterization, including:

- Sealed-Screen
- Multi-Port
- Open-Well

With these techniques, the hydraulic conductivity of the same area can be determined in minutes while fine-grained sediments recharge inhibits the tool from being recharged while the DPT

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According to the hydraulic head conditions, fine-grained sediments takes situations where slow recharge may be left in place to

### Sealed-Screen Sample

Sealed-screen samplers consist of a 3- to 5-foot screen nested within a sealed, water-tight tool body. Because the screen is not exposed to the formation as the sampler is advanced into the subsurface, the screen does not become plugged or damaged. In addition, the potential for cross contamination is greatly reduced and a true depth-discrete sample that is representative of the target sampling zone can be collected. The sample volume collected with some sealed-screen samplers is limited by the volume of the sample chamber (e.g., 500 mL for the Hydropunch I™; 1.2 L for the Hydropunch II™; and 35 to 120 mL for each vial in the BAT™).

To collect the sample, the sealed-screen sampler is advanced to the target sampling depth and the protective outer rod is retracted, exposing the screen to groundwater. Groundwater flows through the screen under the hydraulic head conditions that exist at that depth and into the drive rods or sample chamber. O-ring seals placed between the drive tip and the tool body help ensure that the sampler is water tight as it is driven to the target sampling interval. The integrity of the seal can often be checked by lowering an electronic water level indicator into the sampler prior to retracting the protective outer rod.