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Standard Guide for Installation of Direct Push Ground Water Monitoring Wells¹

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1. Scope

1.1 This guide describes various direct push ground water monitoring wells and provides guidance on their selection and installation for obtaining representative ground water samples and monitoring water table elevations. Direct push wells are used extensively for monitoring ground water quality in unconsolidated formations. This guide also includes discussion of some groundwater sampling devices which can be permanently emplaced as monitoring wells.

1.2 This guide does not address the single event sampling of ground water using direct push water samplers as presented in Guide D 6001. The methods in this guide are often used with other tests such as direct push soil sampling (Guide D 6282) and the cone penetrometer test (Guide D 6067). The present guide does not address the installation of monitoring wells by rotary drilling methods such as those presented in Practice D 5092. Techniques for obtaining ground water samples from monitoring wells are covered in Guide D 4448.

1.3 The installation of direct push ground water monitoring wells is limited to unconsolidated soils and sediments including clays, silts, sands, and some gravels and cobbles. Penetration may be limited, or damage may occur to equipment, in certain subsurface conditions; some of which are discussed in 5.5. Information in this guide is limited to ground water monitoring in the saturated zone.

1.4 This guide does not purport to comprehensively address all of the methods and issues associated with monitoring well installation. Users should seek input from qualified professionals for the selection of proper equipment and methods that would be the most successful for their site conditions. Other methods may be available for monitoring well installation, and qualified professionals should have flexibility to exercise judgement concerning alternatives not covered in this guide. The practice described in this guide is current at the time of issue; however, new, alternative, and innovative methods may become available prior to revisions. Therefore, users should consult with manufacturers or producers prior to specifying program requirements.

1.5 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgement. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- D 653 Terminology Relating to Soil, Rock, and Contained Fluids²
- D 4448 Guide for Sampling Ground Water Monitoring Wells³
- D 4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)²
- D 5088 Practice for Decontamination of Field Equipment Used at Non-Radioactive Waste Sites²
- D 5092 Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers²
- D 5254 Practice for Minimum Set of Data Elements²
- D 5299 Guide for Decommissioning Monitoring Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities²
- D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock²
- D 5474 Guide for Selection of Data Elements for Ground Water Investigation²

¹ This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Ground Water. Current edition approved Nov. 10, 2001. Published January 2002.

² Annual Book of ASTM Standards, Vol 04.08.

³ Annual Book of ASTM Standards, Vol 11.04.



- D 5521 Guide for Development of Ground Water Monitoring Wells in Granular Aquifers²
- D 5730 Guide for Site Characterization for Environmental Purposes with Emphasis on Soil, Rock, the Vadose Zone, and Ground Water²
- D 6001 Guide for Direct Push Water Sampling for Geoenvironmental Investigations⁴
- D 6067 Guide for Electronic Cone Penetrometer Testing for Environmental Site Characterization⁴
- D 6282 Guide for Direct Push Soil Sampling for Environmental Site Characterization⁴
- D 6286 Guide for Selection of Drilling Methods for Environmental Site Characterization⁴
- D 6452 Guide for Purging Methods for Wells Used for Groundwater Quality Investigations⁴
- D 6564 Guide for Field Filtration of Ground Water Samples⁴
- D 6634 Guide for the Selection of Purging and Sampling Devices for Ground Water Sampling Wells⁴

3. Terminology

3.1 Terminology used within this standard is in accordance with D 653.

4. Summary of Guide

4.1 This guide provides information to be used by experienced ground water professionals for investigation of the subsurface and ambient ground water conditions.

4.2 This guide outlines a variety of field methods for installing direct push ground water monitoring wells. Installation methods include: (1) soil probing using combinations of dynamic (percussion or vibratory) driving with, or without, additions of static (constant) force; (2) static force from the surface using hydraulic penetrometer or drilling equipment; and (3) incremental drilling combined with direct push methods. Methods for installation of annular seals and annular grouts are also discussed as well as abandonment grouting.

4.3 This guide addresses considerations for selection and use of direct push well systems and installation techniques that may be classified into two main categories; exposed screen techniques and protected screen techniques. In exposed screen techniques, the screened casing may serve as the drive rod, or may surround a drive rod that is removed following installation. In protected screen techniques, the well may be advanced along with a protective outer casing, or may be lowered into a driven casing that is subsequently removed. Alternatively, the screen, riser, and a retractable shield may be driven simultaneously and all remain in the ground.

4.4 The interval to be tested is determined in advance by prior investigation, or by soil or water sampling during direct push driving. A screen section, either protected or unprotected, is connected to riser pipes and either driven on the outside of, or placed inside of direct push rods. With some monitoring well designs, it may be necessary to add sand pack and seals to isolate the screened test zone as the rods are retracted. The top of the installation is usually completed in a manner consistent

with regulatory requirements. The well can be developed to remove mobile sediments. Water levels can be measured, and water samples are taken as required in the sampling plan.

5. Significance and Use

5.1 The direct push ground method is a rapid and economical procedure for installing ground water monitoring wells to obtain representative ground water samples and location-specific hydrogeologic measurements. Direct push installations may offer an advantage over conventional rotary drilled monitoring wells (Practice D 5092) for ground water investigations in unconsolidated formations because they reduce disturbance to the formation, and eliminate or minimize drill cuttings. At facilities where contaminated soils are present, this can reduce hazard exposure for operators, local personnel, and the environment, and can reduce investigative derived wastes. Additionally, smaller equipment can be used for installation, providing better access to constricted locations.

5.2 Direct push monitoring wells generally do not extend to depths attainable by drilling. They are also typically smaller in diameter than drilled wells, thereby reducing purge water volumes, sampling time, and investigative derived wastes. Practice D 5092 monitoring wells are used when larger diameters and/or sample volumes are required, or at depths to which it is difficult to install direct push wells. Direct push monitoring wells should be viable for monitoring for many years.

5.3 Prior to construction and installation of a direct push well or any other type of ground water well the reader should consult appropriate local and state agencies regarding regulatory requirements for well construction in the state. A regulatory variance may be required for installation of direct push monitoring wells in some states.

5.4 To date, published comparison studies between drilled monitoring wells and direct push monitoring wells have shown comparability (1, 2, 3, 4, 5). However, selection of direct push monitoring wells over conventional rotary drilled wells should be based on several criteria, such as site accessibility and penetrability, stratigraphic structure, depth to groundwater, and aquifer transmissivity.

5.5 Typical penetration depths for installation of ground water monitoring wells with direct push equipment depend on many variables. Some of the variables are the size and type of the driving system, diameter of the drive rods and monitoring well, and the resistance of the earth materials being penetrated. Some direct push systems are capable of installing ground water monitoring wells to depths in excess of 100 feet, and larger direct push equipment, such as the vibratory sonic type drill (Guide D 6286) are capable of reaching much greater depths, sometimes in excess of 400 ft. However, installation depths of 10 to 50 feet are most common. Direct push methods cannot be used to install monitoring wells in consolidated bedrock (for example, granite, limestone, gneiss), but are intended for installation in unconsolidated materials such as clays, silts, sands, and some gravels. Additionally, deposits containing significant cobbles and boulders (for example, some glacial deposits), or strongly cemented materials (for example, caliche) are likely to hinder or prevent penetration to the desired monitoring depth.

⁴ Annual Book of ASTM Standards, Vol 04.09.



5.6 For direct push methods to provide accurate ground water monitoring results, precautions must be taken to ensure that cross-contamination by “smearing” or “drag-down” (that is, driving shallow contamination to deeper levels) does not occur, and that hydraulic connections between otherwise isolated water bearing strata are not created. Similar precautions as those applied during conventional rotary drilling operations (Guide D 6286) should be followed.

5.7 There have been no conclusive comparisons of effectiveness of sealing between drilled monitoring wells and direct push monitoring wells. As with drilled monitoring wells, sealing methods must be carefully applied to be effective.

5.8 Selection of direct push monitoring wells versus conventional rotary drilled monitoring wells should be based on many issues. The advantages and disadvantages of the many available types of driving equipment and well systems must be considered with regard to the specific site conditions. Specific well systems and components, as well as direct push driving equipment, are described in Section 7.

5.9 *Advantages:*

5.9.1 Minimally intrusive and less disturbance of the natural formation conditions than many conventional drilling techniques.

5.9.2 Rapid and economical.

5.9.3 Smaller equipment with easier access to many locations.

5.9.4 Use of shorter screens can eliminate connections between multiple aquifers providing better vertical definition of water quality than long well screens.

5.9.5 Generates little or potentially no contaminated drill cuttings.

5.9.6 Less labor intensive than most conventional drilling techniques.

5.10 *Disadvantages:*

5.10.1 Cannot be used to install monitoring devices in consolidated bedrock and deposits containing significant cobbles and boulders.

5.10.2 Small diameter risers and screens limit the selection of useable down-hole equipment for purging and sampling.

5.10.3 Difficulty installing sand pack in small annular space if gravity installation of sand pack is used.

5.10.4 Difficulty installing grout in same annular space unless appropriately designed equipment is used.

6. Pre-Installation Considerations

6.1 *Site Characterization*—Successful installation of direct push ground water monitoring wells must be preceded by appropriate site characterization activities. These activities may include reconnaissance, research, conceptual model development, exploratory field investigations, and confirmation and re-evaluation of any existing flow models.

6.2 For the installation to be successful, it is imperative that the target aquifer be located accurately. As with any well installation, the geologic conditions must be understood and the stratigraphy must be known. Although direct push wells can monitor thinner aquifers, with more precision, they may be ineffective if incorrectly placed. In thicker aquifers, and when seeking dense non-aqueous phase liquids, screens may need to be located in the bottom of the water-bearing stratum. Wells

placed without determination of nearby geologic conditions can be ineffective and possibly dangerous. Geologic investigations should look for perched aquifers and use installation methods which will avoid any crosscontamination of the unit.

6.3 Environmental site characterization approaches are described in Guide D 5730. Proper site characterization for monitoring well placement is reviewed in Practice D 5092 on Monitoring Well Design.

6.3.1 *Characterization Tools*—In geologic settings amenable to the use of direct push ground water monitoring wells, other direct push methods and tools can likely also be used to effectively characterize the site. For example, the Cone Penetrometer Test (CPT) (Guide D 6067) is an effective tool for mapping stratigraphy and locating target layers. Other sensors, such as electrical conductivity and optical detectors have been placed on CPT and other direct push systems. Direct push soil sampling (Guide D 6282) and water sampling (Guide D 6001) can be used in advance to locate strata of concern. Direct push characterization experience at a site can guide the user in well design or device selection.

6.3.2 *Sampling During Installation*—Many direct push systems can take soil or water samples as part of the well installation process. For example, two-tube systems described in direct push soil sampling Guide D 6282 can be used to collect soil samples while driving. When the target aquifer is reached, the well screen system can be installed in the casing. Sampling data taken prior to well installation can confirm the target stratum has been reached.

6.3.3 *Sampling Systems*—There is a wide variety of direct push ground water sampling systems which can also be used for ground water monitoring. Direct push water sampling Guide D 6001 describes exposed screen versus protected screen samplers. Guide D 6282 describes the differences in two-tube and single-rod direct push soil sampling systems.

6.4 *Access and Clearances*—The selection of driving equipment should consider the accessibility of the installation site. The site should be surveyed for accessibility. Utility clearances may be required. Certain driving methods are incompatible with nearby hazards (for example, flammables). Also check for overhead utility lines during the site survey.

6.5 *Well Size Selection*—Driving resistance can govern the selection of an appropriate well diameter. Driving resistance can be evaluated by direct push testing on the site prior to well installation. Larger diameter monitoring wells may be easy to install on soft or loose ground sites. Smaller diameter monitoring wells may facilitate deeper installation on sites that are more resistant to penetration, but also present additional considerations for use as discussed below.

6.5.1 The availability of appropriate well development and sampling equipment for use in small-diameter monitoring wells may be limited. Many conventional down-hole pumps for purging and sampling are too large for use in small-diameter screens and risers.

6.5.2 Small diameter monitoring wells, because they are generally less rigid than larger diameter monitoring wells, require special attention during backfilling to maintain vertical alignment. This may include the use of centralizers.