Demonstration/Validation of Long-Term Monitoring Wells Installed by Direct Push Technologies

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Abstract: A hindrance to the acceptance of direct push (DP) wells for long-term compliance monitoring is lack of scientific studies that compare the performance of conventionally drilled monitoring wells to those installed using direct push technology (DPT). This project evaluates the potential for using DPT for long-term monitoring (LTM), and also evaluates the potential for reduced installation and sampling costs associated with traditional monitoring wells. Five demonstration sites are being used for this study. At these sites, DP wells were placed adjacent to new or existing conventionally installed (hollow-stem auger) wells. These DP wells were designed to match the screen lengths and depths of the conventional wells, and were installed and developed in accordance with ASTM, federal, and state guidelines. Groundwater samples are being collected in accordance with EPA/540/S-95/504, *Low-Flow Ground-Water Sampling Procedures*. Samples are being collected from approximately 90 wells during five separate sampling rounds. These samples are being analyzed for a variety of groundwater contaminants and for inorganic anions and cations. Results from the organic and inorganic analyses, as well as groundwater quality parameters measured during sampling, are being subjected to statistical testing for evaluation and comparison of the different well types.

During environmental site characterization, remediation, and compliance efforts, groundwater monitoring wells have served as the conventional tool-of-choice for accessing groundwater samples. A typical sequence of events in the life cycle of a contaminated site would include the discovery of a release, an initial source removal response, initial site characterization efforts, generation of a conceptual model, detailed site characterization efforts, remedial design, remedial system installation efforts, system performance monitoring, compliance monitoring, and site closure. Monitoring wells are generally installed at key steps in this sequence of events. Wells are typically installed to define the extent of the contaminant plume, determine where and how fast it is migrating, select an optimal remediation alternative, evaluate the effectiveness of a remedial

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option as well as be part of the remedial option itself, in addition to serving as monitoring tools for compliance purposes. In most cases, critical decisions are based on data collected from wells that are installed using drilling methods.

During site assessment, it is necessary to detect, delineate, and identify contaminants and to further characterize the subsurface. Current practice often requires multiphase efforts within many visits, using geophysical methods as well as soil borings and monitoring well installations. Site characterization and monitoring can contribute to one-third or more of the total remediation costs. Recent increases in the application of DPT have led to more rapid site characterization and development of more detailed conceptual models of hydrogeologic structure. Recently developed DP groundwater access technologies provide the potential to collect faster, cheaper groundwater samples than from conventionally drilled wells. So far, the most extensive use of these technologies has been only as initial site characterization tools. They are not widely accepted for LTM at remedial action sites. Direct comparisons between conventionally drilled wells and DP wells need to be conducted to validate the usefulness of DP wells for LTM. If DP wells can be demonstrated to perform as well as drilled wells, widespread regulatory acceptance of these cost-effective methods should be forthcoming.

One of the objectives of this project is to determine whether or not monitoring wells installed using DPT will provide groundwater samples that have similar contaminant concentrations as those installed using conventional drilling methods. The field demonstration is designed to validate the quality of groundwater data produced by DPT wells against the baseline standard of conventionally drilled wells. The benefit of validating DPT and promoting its acceptance and use for groundwater sampling would be to reduce the cost of well installations and LTM at remedial action sites.

This project undertakes a rigorous sampling effort to establish a database of water quality and chemical analytical results comparing samples from both DP-installed and conventionally drilled well types. Assuming the null hypothesis that there is no difference in the measured groundwater parameters between the two well types, these data are first evaluated using the non-parametric Kolmogorov-Smirnov normality test to test the assumption of normality. Based upon the results of the normality tests, these data are subsequently evaluated using the Student's *t* Test, if normally or log-normally distributed, or the Wilcoxon Matched-Pair Signed Rank test if otherwise distributed. In order to perform a thorough investigation of this question, additional statistical tests are being performed as needed and as allowed by the size and quality of the data set.

The five field sites included in the study represent a variety of geologic conditions as well as a cross-section of regulatory domains. DP wells have been installed adjacent to, and paired with, existing auger-drilled wells at the following facilities: Tyndall AFB, FL, Hanscom AFB, MA, Dover AFB, DE; NFESC, CA, and CRREL, NH. Figure 1 illustrates the well types being evaluated. Figure 2 illustrates an example of a well cluster design. Five sampling rounds are being conducted over a 15-month period, during which groundwater samples are being collected and the parameters typically examined with long-term site compliance monitoring are being evaluated (*e.g.*, chemical concentrations, oxidation-reduction potential, pH, temperature, conductivity, turbidity, dissolved oxygen). The target analytes for this project include: tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, vinyl chloride, BTEX, 1,4-

dichlorobenzene, trichloroethane, and MTBE. Chemical analysis of field samples follows the guidelines set forth in EPA's SW-846 methods.

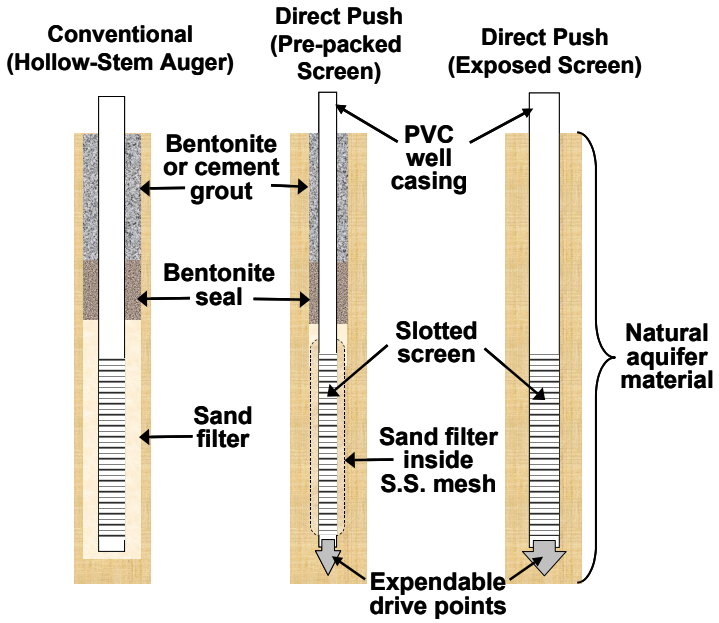

Figure 1 -- DP wells and conventionally drilled well types evaluated using LTM

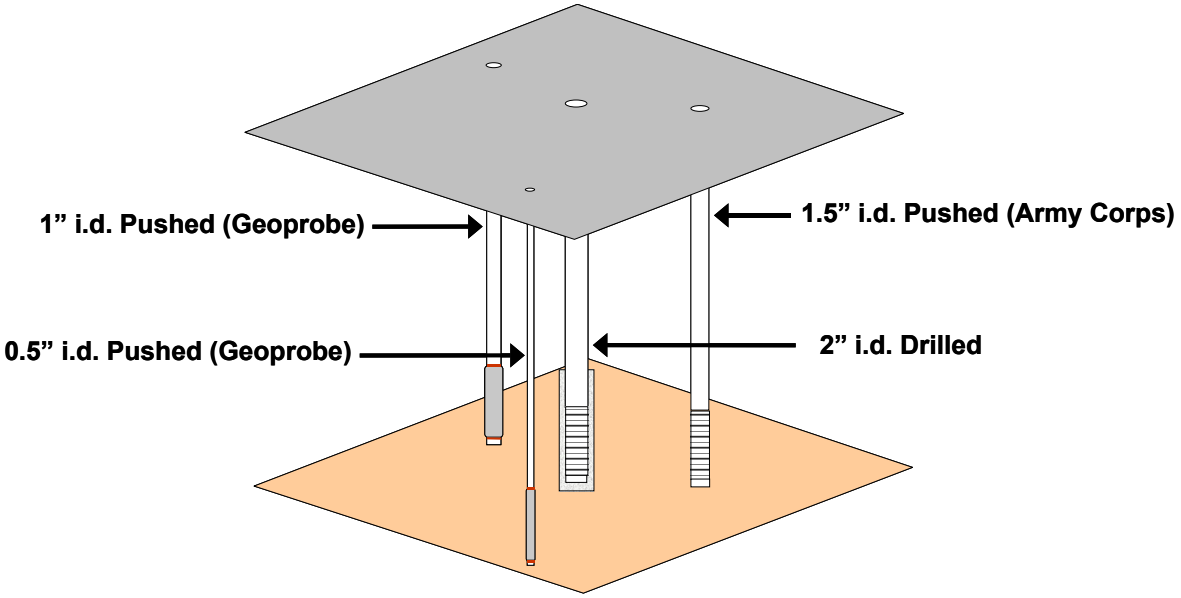

Figure 2. Typical well cluster design

Two complete data sets have been collected thus far from four of the five sites, and the third sampling round is in progress. Technical problems associated with the deep water table and small diameter wells/pumps at the CRREL site have delayed sampling there. Partial data of the results thus far are available for both the inorganic and organic analytes from four types of DP wells. The inorganic data indicate a strong agreement between samples from DP and conventional well types, while the organic data exhibit more scatter than the inorganics. This is attributed to the non-uniform distribution of the contaminant in the aquifer.