

The Value of Pilot Borehole Drilling in Well Design

Introduction

Boreholes for high capacity, large diameter water wells are usually drilled in two steps. First, a pilot borehole is commonly drilled at a nominal diameter of 9 to 15 inches to its target depth. Normally the target depth is the estimated depth of the proposed production well or somewhat deeper if exploration below the proposed well depth is of interest. The second drilling step is to ream the pilot hole to its full diameter for installation of the well casing and well screen, and placement of the filter pack and annular seal (if any). For guidance on selecting an appropriate borehole diameter, refer to Technical Memorandum 005-4.

Pilot borehole drilling is essentially an exploratory exercise intended to gather site-specific information that is used to characterize the stratigraphy and type of geologic units that underlie the well site. Its value is that it provides the project team (i.e., driller, design engineer and/or hydrogeologist, and well owner) information needed to finalize the well design to meet the actual field conditions. This memorandum describes the type of exploratory information that is usually gathered and its application to water well construction. More detailed information on the various topics is available from the reference list.

Lithologic Log

As the pilot hole is drilled by either conventional mud rotary or reverse-circulation methods, cuttings are returned from the borehole by the drilling fluid. (For air rotary equipment, samples are raised to the surface by a circulating air system). As drilling proceeds, cuttings are collected by the driller or geologist at regular depth intervals (usually 10 feet) and then classified (i.e., logged) in the field by the driller and geologist. Usually, each of them prepares a log. Most well driller's logs consist of functional descriptions of the material type. The typical geologist's log provides more physical details such as color, size, mineralogy, hardness, cementation (if any) and angularity (i.e., roundness). The geologist's lithologic log is generally more reliable for purposes of correlating the stratigraphy between boreholes and selecting samples for laboratory analyses. That is because unlike a driller's log, the geologist utilizes a scientific approach to prepare a log based upon universally understood descriptive terms and a conventional classification system.

Geophysical Logging

After the borehole is completed, the next step is to conduct a downhole geophysical survey, which is usually performed by a geophysicist retained by the subcontractor. The geophysical survey consists of various logs that are used to delineate the depths of the aquifers and nonwater-bearing units, and to determine the depth intervals where blank casing and well screen can be installed. The geophysical logs are usually interpreted by the geophysicist, geologist, or well driller. Several types of geophysical logs can be included; the most common logs for water well projects are the following:

- Electrical resistivity – provides information as to the water-yielding properties of the formations, clay content, water quality and porosity..
- Spontaneous potential – provides information to delineate clay beds and permeable beds, correlate lithology, and make qualitative interpretations on water quality.

- Gamma ray – provides information for correlation (even in cased wells) and delineation of clay and shale beds.

Sieve Analyses

The cuttings collected from the borehole are also used to select the size range (i.e. gradation) of the filter pack. Once the geophysical logs are interpreted and the well design is finalized, drill cuttings from each interval of proposed well screen are selected for sieve analyses. The sieve results are used to select a filter pack for the well. This procedure is described in Technical Memorandum 006-2.

Summary

The drilling and logging of the pilot borehole are key elements in every well construction project. Therefore, the driller and geologist should do all that is necessary to ensure that the information collected, analyzed and interpreted is representative of the various water-bearing and nonwater-bearing strata at the site. Too often, the priority is to drill the pilot borehole quickly to reach the target depth in the shortest possible time. That approach often leads to careless sampling and inaccuracies that can impair utility and productivity of the completed well. It is the author's opinion that the benefits of useful and reliable information gathered from the pilot hole far outweigh the cost of a few hours of rig time.

References

Roscoe Moss Company, 1990, *Handbook of Ground Water Development*, John Wiley and Sons, New York, NY.

Roscoe Moss Company, 2005, Technical Memorandum 005-4: "Borehole Diameter: How Large is Large Enough?".

Roscoe Moss Company, 2006, Technical Memorandum 006-2: "Gravel Pack Design: The Nexus of Theory, Experience and Personal Preference".