DRILL LOGGING - TECHNIQUES AND THEIR IMPORTANCE

INTRODUCTION

A number of factors go in to locating and completing a new well. First and foremost a well must be drilled into an aquifer that has a clean, reliable, and adequate volume of water on a continuous basis. Once the location is established a test well should be drilled to validate the hydrological characteristics of the aquifer previous to drilling a production well. Ultimately the production well should be engineered for the specific ground conditions in which the well is completed. Data regarding these conditions can only be acquired when the test well is drilled; there will be no other opportunity. It is therefore critical that contract engineers who oversee this work make sure these data are collected timely and accurately.

Properly logged drill cuttings provide data critical to the successful design and completion of production water wells. This document discusses the various types of data that contribute to proper well design, how to collect these data, and who is qualified to perform this important job. Accurate information about the strata penetrated by a well will measurably enhance the possibility that the well will provide adequate, sand-free water through time. Professionals qualified to perform this work should know the information discussed herein; this document is intended to provide community leaders with a summary of information that will aid in the proper and complete execution of work performed or sub let by their contract engineers. In our experience, most engineering firms do not utilize a geologist when drilling water wells. If the city would like to accept the recommendations herein, they may need to discuss this aspect with their engineers when designing the project.

WHO IS QUALIFIED

Idaho Department of Water Resources policy requires drillers to submit logs of wells they complete. Though these logs are helpful they tend not to contain accurate details of rock type, grain size or fracture density, so generally do not contribute to a properly engineered well. Driller's logs are commonly acceptable for low-volume domestic wells. High-capacity wells needed by municipalities, however, will benefit from accurate data by fostering the best design to attain the maximum production level.

Persons familiar with geological logging techniques and who have a strong working knowledge of geology should complete the logging. Professionals in Idaho who have this knowledge generally retain certification by the Idaho State Board of Registration for Professional Geologists. Additionally, Title 54, Chapter 28 of Idaho state law requires that persons who perform geological work maintain a license by this board. Registration with the state board does not guarantee quality, but it is perhaps the best and

easiest way to create a pool of potentially qualified contractors from which to choose. Drillers typically do not retain a license to practice geology in the state of Idaho.

TYPES OF DATA

Strata penetrated by wells falls into two general types of material; loose, unconsolidated material generally found at lands surface, and hard, lithified rock that underlies the surficial sediments. An aquifer bearing exploitable quantities of water can occur in either type of material. The physical properties of these materials vary from place to place, and can often vary over short vertical or horizontal distances. The following discussion provides information about the types of material, and the type data collected about that material, that a typical well may encounter.

UNCONSOLIDATED SURFICIAL MATERIAL

Loose, unconsolidated material generally resides at or near lands surface, above bedrock. The elements most important to water production from this type of strata include the amount of clay that is present and the grain size of the smallest non-clay fraction. Course sand will produce larger volumes of water than fine sand; either will produce less if clay is present in interstitial spaces. A screen or well casing through which the water passes must have holes sized to accommodate the particles present in the aquifer. If it does not, as with knife-cut perforations, grains smaller than the hole will enter the well. Though this seems an obvious design flaw, many water wells are completed using knife-cut perforations. Wells developed in unconsolidated material such as sand and gravel should generally be completed using an engineered well screen.

LOGS OF UNCONSOLIDATED MATERIAL

A good log of unconsolidated material includes characteristics of each unique stratigraphic interval. These characteristics include a description of the lithology, grain size distribution, unit thickness, and distribution of water. The drillers log will likely include some of these items, but a geologic log will greatly enhance it's value. The log should have a column that displays the lithologies graphically as well as text descriptions. Sedimentary beds generally have lateral continuity. With accurate drill logs the beds can be traced from hole to hole, providing a mechanism to correlate productive and non-producing zones, and to understand how water enters and travels through the sediments.

Properly engineered well screens require an accurate assessment of grain size distribution in the aquifer, which is accomplished by performing a sieve analysis. Sieve analyses can be completed off-site by a geotechnical consultant, but will require representative samples from each water-bearing interval. Some screen manufacturers will perform the sieve analyses free of charge if guaranteed that their product will be used.

SAMPLING PROCEDURES IN UNCONSOLIDATED MATERIAL

Sampling procedures will vary depending on the type of drill-rig used. Experienced and qualified drillers generally know which techniques will work best with their machinery. Perhaps the most important consideration is to capture the finest grain-size material. With powerful air-rotary machinery much of the fine-grained material can blow away if not caught and preserved. When drilling with water instead of air the finest grain material may wash away with the fluid. Samples should be collected from each 5-foot drill interval or smaller through water producing zones. The samples should fully represent the zones through which they were collected, and weigh at least one pound each.

HARD, LITHIFIED ROCK

Lithified rock, or bedrock, can host productive aquifers. Parameters that constrain water flow through bedrock include the quantity and size of interconnected pore space, the size and concentration of interconnected fractures, and the distribution of natural parting surfaces such as sedimentary bedding planes or volcanic flow layering. Specific features most important to water flow will vary with the type of rock. For example, fracturing may be most important in a vitreous quartzite whereas natural parting surfaces might be most critical in a volcanic flow. Many of these features are not directly apparent in cuttings from the types of drill rigs generally used in water well drilling. A trained observer, however, can interpret their presence based on drilling penetration rate, the lithology of rocks drilled, or from textures present in the drill cuttings.

Engineered well screens are commonly not needed or used for holes drilled in bedrock. Some ground conditions such as strong faulting and fracturing or highly friable material such as in poorly cemented sandstone may require a screen, so the decision regarding a well screen must be made after drilling a test well. A good lithologic log constructed by a geologist will provide the best information to the engineers who will design the well.

LOGS OF LITHIFIED BEDROCK

A good log of bedrock will include a detailed description of the lithology, a column that shows the lithologies graphically, and a complete description of the water-producing zones. Understanding the material drilled, particularly in bedded rocks like sediments or volcanics is critical to fully understanding the geometry of the overall ground water flow system, from point of entry into the aquifer, to where it enters the well. When a good lithologic well log supplements an equally good geologic map these become very powerful tools in the pursuit of fully understanding and developing the ground water system. Should the community need additional water in the future this understanding will reveal great benefit.

SAMPLING PROCEDURES IN LITHIFIED ROCK

The correct design of a well in bedrock may not require samples of the cuttings, unless a well screen is anticipated. If so, the procedures will be similar to sampling in unconsolidated material.

CONSEQUENCES OF POOR, OR NO DATA

The cost of initially collecting data in order to properly design a well is clearly higher than if these data were not collected. The true cost, however, surfaces down the road when a well that ceases to work properly cannot be repaired or retrofit. Often the only solution is to drill a new well because too little is known to repair the original well. For instance, casings in wells with knife-cut perforations cannot generally be extracted, and therefore the wells may not be repairable after initial installation. Often these wells need retrofitting because they should have originally been designed with an engineered screen.

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