Monitoring During Water Well Development: Collecting Pertinent Data and Evaluating the Results

Introduction

Over the years, the practices of water well design and water well construction have evolved considerably from a time when cable tool drilling was the state-of-the-art approach and well designs were uncomplicated. In today's water well industry, well designers and contractors are able to take advantage of advanced technologies of drilling, construction, and materials that are presently available. They routinely combine complex drilling methods with highly durable and corrosion resistant materials to install wells in varied hydrogeologic and water quality conditions. Despite the marked advancements within the industry, however, one constant has been the fact that well owners continue to expect that their completed facilities will provide efficient, productive, and long-term service. Such expectations are both natural and reasonable. Yet, they are only achievable if after construction the well is properly developed and then later redeveloped periodically during its useful life.

At the time of construction, the key development objectives are: 1) to remove remnant drilling fluid and cuttings from the borehole wall, formation, filter pack and well screen; and 2) to create an optimum interface between the filter pack and the water-bearing formation. For filter pack wells, well development also consolidates and stabilizes the filter pack material. Later, during its operation, it is common for a well to experience a decline in efficiency and/or production. When this happens, it should be redeveloped by mechanical and/or chemical treatment methods in order to improve its efficiency and productivity.

Whether during initial development or follow-up redevelopment, it is essential to carefully monitor the well's response over time. It is simply not enough to assume that a well can be developed (or redeveloped) within a fixed number of hours. The proper approach is to carefully monitor the well's responses in real-time and discontinue the work when the well's performance has been restored to a satisfactory level. How that monitoring can be performed is explained in this memorandum.

Development Methods

Well development (and redevelopment) methods are categorized as either mechanical methods or chemical methods. Mechanical methods include: bailing, swabbing with a surge block or dual-swab, airlift pumping, jetting, and pumping with a test pump. Generally, wells are developed initially by swabbing and bailing followed by a period of airlift pumping and/or jetting. The final stage of mechanical developing is usually pumping with a test pump.

Chemical treatments include the use of dispersants (such as polyphosphates) to remove filter cake from the borehole wall and clay fractions in the formations. A common approach is the use of both mechanical and chemical methods to sufficiently improve the well's performance. Mechanical methods are used often to remove biofilm or encrustation prior to chemical treatment.

Monitoring

Real-time monitoring during development is typically conducted by the well cleaning contractor or an engineer acting as the well owner's representative. Most often, one or more parameters (e.g., sand content, turbidity, and specific capacity) are monitored and recorded in order to evaluate how the well is responding; these parameters are discussed below. One other important parameter that should be closely monitored is the number of hours worked by the contractor because often well development is a unit-cost item that is billed by the hour.

A common approach for monitoring during development (or redevelopment) is to check the sand content and turbidity of the discharge during airlift pumping and pumping with the test pump. In fact, most regulators require that all discharges from the well must meet specific physical and/or chemical criteria as defined in a discharge permit (e.g. NPDES) issued to the well owner. Typically, parameters such as turbidity and sand content are included; monitoring of other parameters may also be required.

Common Monitoring Parameters

- **Sand Content.** Sand production can be measured by several methods. Initial development pumping of a new well usually produces considerable quantities of fine sand and silt. Monitoring these discharges can be performed with an Imhoff cone or similar device when the sand content exceeds 50 parts per million (ppm). For sand measurements of quantities less than 50 ppm, a Rossum Sand Tester is recommended. This device will measure sand content as low as 0.5 ppm when operated over a period of approximately 10 minutes. Details of the Rossum Sand Tester are presented in Technical Memorandum 005-7.

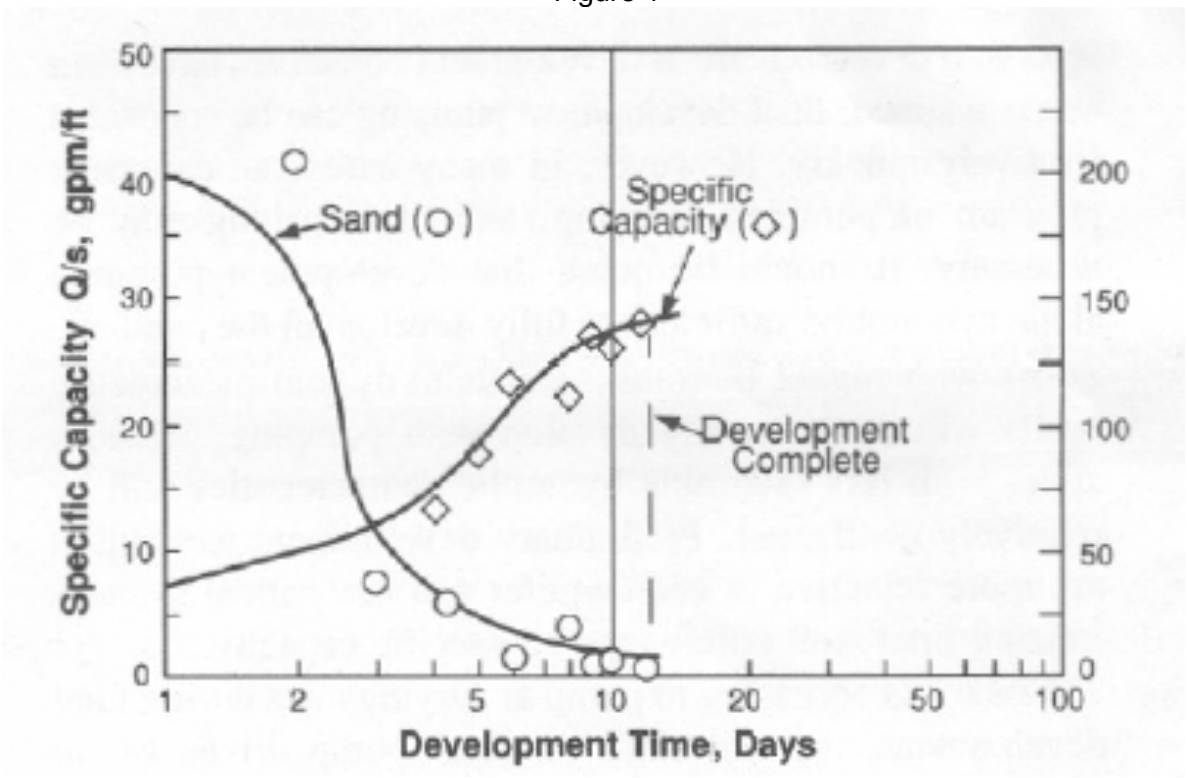
- **Turbidity.** Turbidity refers to the clarity of water and is associated with colloid clay particles, suspended algae, decaying vegetation, and other sources. Turbidity can result in unpleasant tastes and odors, and occasionally encourages the growth of slimes or other organisms. During development, turbidity can be measured in the field (and laboratory) with a turbidimeter which has various ranges sufficient to measure 0.1 to 400 NTU. Turbidity is a key parameter for discharge regulated by NPDES permits.

- **Specific Capacity.** The specific capacity of a well is the yield per unit of drawdown, expressed in gallons per minute per foot of drawdown (gpm/ft). Typically, this parameter is checked as the well is pumped with the test pump. By periodically calculating the specific capacity, it is easy to determine the degree to which the performance of the well has improved. The yield can be measured by various methods, depending upon the pumping rate. Most commonly, yield is measured with a circular orifice weir or totalizing meter. For very low yields, it may be sufficient to use a bucket or 55-gallon drum and stopwatch.

Evaluating Results

Sand content and specific capacity are key parameters used to evaluate the responses of the well to mechanical development (or redevelopment). Figure 1 is an example of a plot of these parameters over time; it shows that the well was developed until 1) the sand content had declined to less than 1 ppm, and 2) the trend of the specific capacity curve indicated no more significant change.

Figure 1



SUMMARY

Monitoring during development is a necessary task if one expects to properly assess the progress of development and its cost for labor and equipment. As shown in Figure 1, when basic parameters are recorded and evaluated, it is a simple matter for the contractor, owner's representative and/or owner to determine when the development work should be terminated. This approach eliminates guess-work because it leads to a results-based decision rather than one simply based on having developed a well for a pre-determined number of hours.

References

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

Roscoe Moss Company, 2005, Rossum Tester: Technical Memorandum 005-7.