ARTICLE 227 - WELL DEVELOPMENT
(Practical Considerations and Applications)

California Groundwater Association
An NGWA Affiliate State
700 R Street
Suite 200 Sacramento, CA 95811
cga@groundh2o.org
916-231-2134

BACKGROUND

Development of a well following construction, prior to testing and service, is probably one of the least understood (by the owner) and generally underused methodologies in the well construction process, and yet it is one of the most important in achieving the maximum efficiency and yield from a newly constructed well. With proper well design and construction, effective development generally results in a well that pumps minimal sand according to use with little or no turbidity. All drilling methods, to a greater or lesser extent, result in consolidation of aquifer materials around the borehole, invasion of an unconsolidated formation by drilling mud, or cause, in a bedrock formation, plugging of fractures by drilling fluids and/or cuttings. These conditions all have the effect of reducing porosity and permeability of the water-bearing formations penetrated by a well. Therefore, the purpose of development is to mitigate these effects to the most practical extent, resulting in a higher yield and improved specific capacity of the well. Proper development may improve an unsatisfactory low-yield well into a useable one, and in the case of a large diameter well, make a good producing well into a better and more efficient one.

There are many reasons why the most effective development operations may not be employed. Often, the reasons are economic, as in the case of a domestic well project where after a short period of airlifting, no funds may be available for additional development time, and the owner is not convinced of its necessity. In a municipal well contract, sometimes development activities are provided for on a lump-sum basis, with no provision for additional hourly work, and any further required development must be completed at the Contractor's expense. Disposal of development water is an increasing concern, and in many cases is prohibitive as in trying to properly develop a large diameter well on a small site with little or no water retention capacity. Large or even small quantities of turbid development water are usually prohibited from being discharged in storm drains or local surface drainages by local and/or regional jurisdictions.

It is not the intent of this standard to provide a "cookbook" approach or discuss in detail all methodologies for well development. Such discussion can be found in standard textbooks and industry manuals (refer to Selected References). This standard emphasizes certain basic practices that should be followed, in order to reach the practical limits to the most effective development in the shortest possible time. Contractual issues in specifications and bid items for development actives are also considered.

These Standards are not meant to apply to monitoring wells constructed for water quality sampling purposes, nor do they necessarily apply to development procedures used in projects involving rehabilitation of old wells. Also, more aggressive methods of well development such as hydraulic fracturing, or use of downhole explosives are also excluded, although these procedures may be effective in certain situations.

DISCUSSION

In a well drilled by the rotary method using either direct or reverse circulation, the goal to be achieved in development is to disturb and dislodge the unwanted fines that have entered the gravel pack and formation (particularly on the face of the borehole wall) during the drilling process, and then physically remove them from the well. A similar development process may also be needed for a hard-rock well. As mentioned previously, fractures can also become plugged with formation fines such as clay, and larger cuttings, and these must be loosened and removed. Bulletins 74-81 and 74-90, for example, note methods that may be used for these development procedures, but do not elaborate on their use, and include:

- Water jetting with a jetting tool
- Swabbing by use of a surge plunger
- Surging with compressed air
- Backwashing and surging with test pump
- Introduction of chemicals to disperse clays
- Combinations of the above

In general, with all these methods, the most prudent and effective procedure is to start slowly, and work up to more aggressive activity. This is particularly true in the case of PVC casing and screen that may be easily damaged by downhole tools if development is too aggressive. Well design will play an important part in how quickly the well "cleans up". A screen section with a relatively thin gravel pack in the annular space will take less time to develop than a screen section with a thick gravel pack. In straight rotary drilling, care in maintaining proper solids control during drilling should result in less build-up of a filter cake, and thus require less development time. Chemical agents can usually help in the development process, but their use is most effective after a certain amount of physical agitation and removal of fines has occurred by mechanical methods.

Pumping and surging with a test pump is usually the final stage of the development process, and one where the effectiveness of the development can be monitored more easily, based on criteria such as achieving "sand-free" water (Refer to Article 230 of Standard Practice Series), acceptable turbidity levels, and satisfactory specific capacity and yield.

The above mentioned development activities all take time, and in a well drilling project, it is difficult in advance to set a time limit. In preparing specifications and bid items, an anticipated time for the work can be specified, but additional development should be allowed for on an hourly basis. Often, a little more development time initially will result in much more efficient and satisfactory well performance during its economic life.

RECOMMENDATIONS

The California Groundwater Association recommends the following be considered with respect to well development in newly constructed wells:

- Well design should consider the eventual ease or difficulty of development, along with other factors. For example, incorporating an excessive annular space between screen sections and borehole wall resulting in a thick gravel pack will take more time to develop or may be impossible to effectively develop, and should be avoided in design. Continuous wire wrapped screen sections will be easier to develop with jetting tools than slotted pipe or louvered casing. Long sections of screen of any type will obviously take more development time, in any event.

- In direct circulation rotary drilling, proper control of drilling fluid properties will not only improve the drilling process, but maintaining proper viscosity and solids content will prevent excessive mud-cake buildup and formation damage. The end result is that less time will be needed for effective development.

- Chemical treatment with dispersants should not be employed too early in the process, as agitation and removal of fines by physical means should be completed first. Manufacturer's instructions for use should be precisely followed with respect to procedures such as contact time, and a one-stage or two-stage process of treatment may be required to be fully effective in development. Disposal of resulting development water, even if neutralized, should be completed in accordance with applicable regulatory requirements for such discharge and disposal.

- Economics should be considered as the development process proceeds. In later stages of development, relatively small incremental improvement in such conditions as turbidity and sand content may not be worth the additional funds spent on more pumping and surging or relatively expensive chemical treatment, etc.

- Development activities conducted on a lump sum basis for such projects as municipal wells may result in less than satisfactory results. The Contractor cannot work interminably to satisfy some criteria that are not realistically attainable. Lump sum contracts may also work against the best economic interests of Owner, inasmuch as development may take much less time than called for in a lump sum amount. Accordingly, specifications and bid items should provide for development on a unit price per hour basis. Development time is defined as the total time used in this activity, including inserting and removing development tools in the well. Development should be continued until satisfactory results, as mutually agreed upon between the Owner and Contractor, are achieved.

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Selected References

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