

Article 200 – Performance "Guarantees" in Well Drilling Specifications

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BACKGROUND

With increasing frequency, well drilling contractors are being called upon to submit bids on wells (particularly municipal) where the Specifications and Contract(s) contain provisions for "well performance guarantees". Such "guarantees" must be met by the Contractor in order to receive full payment for his work. If not met to the satisfaction of the Project Engineer or other contracting authority, the risk for providing an "acceptable" well is often placed solely on the Contractor. Accepting such risk may often result in financially punitive consequences for the Contractor in meeting the terms of the contract for final completion and payment.

Engineer, for purposes of this Standard Practice series, shall be construed to mean: engineer, geologist, hydrologist, or other earth science professional and shall be gender neutral. Therefore, the purpose of this position paper is to:

1. Discuss what we consider to be the subjective terminology of the "performance guarantee" and recommend the alternative terminology "performance requirements."
2. Review what items should properly (and which should not) be considered as performance requirements for well acceptance.
3. Provide recommendations (language) for those items which we consider suitable as performance requirements to be included in Specifications and Contracts.

"WELL PERFORMANCE GUARANTEE"

Webster's dictionary states that a guarantee is *"a promise or assurance, especially one in writing, that something is of specified quality, content, benefit, etc., or that it will perform satisfactorily for a given length of time"*. While it is one thing to "guarantee" the physical construction of a well, based on tangible items which can be categorized for measurement and payment, no drilling contractor wants to be placed in the position of "guaranteeing" the water-yielding potential of a particular site and formation. For example, a 16-inch diameter well with 100 feet of screen may have a design yield of 2000 gpm, but in reality if the formation at a specific site can only yield 100 gpm even in a highly efficient well, logically no "performance guarantee" can be met by the Contractor. Similarly, no "performance guarantee" can be met if the well is not designed properly by others in the first place, even though in the bid and construction process this is pointed out to the Project Engineer or other contracting authority by the Contractor.

PERFORMANCE REQUIREMENTS

General

Following are provisions which are commonly found in specifications and have been used to determine the effectiveness of the Contractor's performance of well construction:

- items such as type and length of screen, casing, cement seal, etc. which are tangible and can be confirmed during construction
- sand content and turbidity
- plumbness and alignment
- specific capacity/transmissivity using Theis equation or some variation of this
- engineering "guarantee", even when well is designed by others

Discussion

Items of measurement and payment such as casing and screen types, diameters, and lengths are usual measurement and payment items, and as such are not usually a problem for compliance. The sand content issue is discussed in a separate CGA guideline and is commented on in Recommendations. Plumbness and alignment are also the subject of a separate guideline in the CGA Standard Practice Series.

Specific capacity

Performance "guarantee" provisions in specifications may call for use of the Theis equation or a variation thereof to predict or guarantee the production from a well to be drilled.

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This may be dangerous in a real-world setting. Darcy's Law and the Theis Nonequilibrium Equation provide the most powerful tools that we have for understanding aquifers and the relationships among wells and aquifers. (i.e. U.S.G.S. Water Supply Paper 2220).

The equations, however, assume ideal, uniform aquifer conditions that are not supported by the complexities of real-world aquifers. For example, alluvial aquifers (stream deposits, alluvial fans, etc.) are characterized by linear channels with widely-changing conditions in any direction; changes in thickness; hydrologic barriers due to pinching out; and interruption of aquifer layers by unknown faults that may not reach the surface.

Predictions based on mapping and test hole drilling are extrapolations of interpretations downward from the surface and between and beyond drill holes. If the Theis equation is to be used to guarantee how much water a well will produce, samples from wells must be truly representative, and there must be enough test holes to determine whether the Theis assumptions are reasonably achieved or the extent to which they are violated by the type and complexities of the aquifer and how the well relates to the aquifer. With enough drilling, sampling, and testing, an estimate for short-term production may be reasonable. This would still not assure accuracy in the expected rate of production, nor would this address what changes might occur in the rate of production if the pumping depression expands beyond the immediate locality, or if changes in recharge or interference with other wells occur over time.

In summary, the determination of specific capacity as measured by theoretical calculations, such as the Theis equation, results in too great a range of accuracy to be used as a basis for rejection of a well for failure to achieve contract efficiency standards. It is unreasonable to require a Contractor to guarantee the performance of a well based on what, under the best circumstances, is still an interpretation of an incomplete body of knowledge about the aquifer that provides the water to that well.

Design Guarantees

A typical design guarantee clause reads essentially as follows:

"Final well design including screen locations, slot size, gravel pack diameter, and completed well depth shall be determined by the Engineer based upon information obtained during the drilling of the test/bore hole. These selections shall not, however, relieve Contractor from meeting all construction and performance guarantees where part of this contract."

"Should the Contractor believe the design furnished by the Engineer will adversely affect Contractor's ability to achieve the contract guarantees, Contractor shall immediately inform the owner in writing of its concerns. The notification shall include a written report, with accompanying engineering analysis, giving Contractor's recommendations for satisfactory completion of a well which will achieve all specifications, guarantees, and the predicted water yield."

In effect, this type of guarantee clause requires that the Contractor duplicate all the engineering calculations for the project and then guarantee that such calculations and the resulting design achieve some theoretical production or efficiency standard. The immediate question raised is that if the Contractor has to be the guarantor of the engineering work, what is the purpose of having an engineer involved in the project in the first place? The money would be better spent on more expensive materials and construction techniques which typically produce higher capacity and more efficient wells.

This type of guarantee is grossly unfair to the Contractor for any number of other reasons:

1. Well design is not an exact science. In most alluvial formations in California, underground conditions can be highly variable even over short distances. Aquifer thicknesses, depth of saturation and transmissivity may change considerably from nearby existing wells, and therefore design assumptions may not be accurate. In many instances even an optimally designed and perfectly constructed well will not achieve predicted production rates simply because the aquifer at that site does not have sufficient capacity.
2. Sieve analysis of formation samples brought to the surface after they have gone through drilling is not always consistent with how the samples are found in-situ. Fine materials in particular are very difficult to capture, and their under-reporting in a sample can lead to the selection of too coarse a sand pack and screen to meet sand guarantees, except at reduced inflow velocities.
3. Other problems in analysis of drilling cuttings include difficulty in determining the degree of consolidation of the formation, and of ascertaining the amount of crushing the sample has undergone in drilling. Both factors will adversely affect yield predictions, which frequently are the assumptions upon which other contract guarantees are based.
4. Even assuming the above factors can be controlled, optimal well design is generally a less important factor in the ultimate well performance than efficient construction techniques. Large diameter deep well boreholes are very unstable and continue to degrade over the period they are left open. For that reason, casing, screen and gravel pack materials are generally delivered to the site at the start of

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drilling for immediate use when the borehole is completed. The extended engineering review time contemplated by this type of guarantee specification is inimical to good construction practices. Whatever the slight benefit which might be gained in revising the design is more than lost in excessive fluid infiltration, wall caking, and increased annular diameters (all of which impede well development).

5. Yet another problem with this type of guarantee is that it places the Engineer and Contractor in an adversarial relationship. Typically, the goal of the engineer is to design a well to produce as much water as efficiently as possible. The Contractor, on the other hand, is constrained in meeting this same goal by the possible construction difficulties which it creates and will naturally recommend more conservative designs and techniques.

For example, higher fluid viscosities are often prudent to assure borehole stability. However, the use of additives will also make the ultimate well more difficult to develop and may inhibit final yield. Similarly, greater screen slot size and larger gravel pack may lead to higher well efficiency, but at some point the well will also produce unacceptable amounts of sand.

If the contract allows the Engineer to shift the liability for deficient design to the contractor, then that Engineer no longer has to recognize and balance these various competing factors. The Engineer is free to specify a well that in theory can be constructed, but only at a substantial risk of failure during construction.

The Contractor is then left in the unenviable position of either taking on all the risk, or else trying to challenge the specification at some point in the process. The real loser generally is the customer, who, due to the Contractor's reluctance to get into such situations must pay a higher price for the work, and may still find himself in the middle of a construction dispute even before the project is finished.

No contract should shift engineering responsibility to the Contractor, any more than the Engineer should be responsible for the Contractor's defective construction. Given that the Engineer has probably disclaimed any warranty of quality or quantity of water yielded by the project in the first place, any request for such assurance from the Contractor is not justifiable.

RECOMMENDATIONS

The California Groundwater Association recommends that contractual well "guarantees" in specifications and contracts should be limited as follows:

1. The Contractor should be obligated to provide the design engineer with adequate and representative formation samples. Sampling methodology should be agreed to prior to start of construction. The Contractor shall also be responsible for ordering the proper materials, using correct construction techniques, and assuring all construction conforms to the specifications.
2. The design Engineer should be solely responsible for designing the type and grading of the gravel pack, the screen slot sizing, and the placement of materials. These selections should be made prior to the start of construction so that the materials can be on-site ready for use. Except for spacing of the screen within the casing string, material selections should not be altered during construction except where the original design is clearly inferior. If the Engineer feels existing information is insufficient to pre-design the well, information should be gathered from a test hole or other on-site method.
3. The design Engineer is responsible for oversight to assure that the well is constructed to design specifications. The design Engineer shall measure the gravel pack volume in relation to annulus volume for the entire screen section, confirm the proper selection and placement of materials, and record all test data. Any discrepancy shall be noted and the contractor shall take immediate steps to remedy suspected problems.
4. Well efficiency guarantees utilizing specific capacity as a function of transmissivity, particularly those calculated from a single well data source using the Theis and similar equations should be regarded as invalid and therefore inappropriate for a contract specification. Specific capacity predictions as used in well specifications should be viewed as targets for planning purposes only and never written as standards for acceptance of the well.
5. Sand guarantees, while properly required of the Contractor, should recognize that two major causes of sand failure, i.e. improper screen and gravel pack selection, and overpumping the formation, are beyond the Contractor's control. Therefore, a well that the Contractor can show was properly constructed to contract specifications and standard practices of professional associations, such as CGA, should be exempt from contractual sand guarantees.
6. Redesign or the providing of engineering guarantees by the Contractor is inappropriate for wells drilled under the supervision/inspection of a licensed engineer or registered geologist.

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