Another Source of Income

Drilling dewatering wells for the construction market can be a revenue stream if you do your homework.

By David Giles

While new housing construction may be down in many parts of the country, commercial and public works construction is up. Metropolitan areas like Phoenix, Las Vegas, Denver, and Houston continue to see strong population growth, particularly in downtown developments.

As real estate becomes scarcer in these areas, developers and city planners seek to make use of their property more efficiently, oftentimes by designing their structures to have multiple, below-grade levels. For example, a proposed residential/commercial high-rise building in a congested downtown district may require a deep excavation to make room for multiple levels of underground parking for it residents. Or, a city municipal building may require a deep excavation to allow space for mechanical rooms or more office space for its employees.

And as the excavation goes deeper, the more likely it is to penetrate the water table — and the more likely the need for a temporary dewatering system.

Water Wells vs. Dewatering Wells

Drilling dewatering wells for the underground construction market and drilling water supply wells basically require the same drilling equipment and expertise. However, for drilling contractors looking to get into this business, there are still important things to know.

Analyze the Risk

First and foremost, the dewatering/drilling subcontractor must understand the risk associated with such projects. To a project owner or general contractor, there is nothing more frustrating than a poorly planned, poorly executed dewatering effort that results in cost overruns and project delays.

Dewatering subcontracts are typically lump sum and performance based. The architect/engineer will specify the depth to which to lower the water table, but it will be up to the drilling/dewatering subcontractor to determine how to achieve the desired results. This greatly increases the risk to the subcontractor.

On a multi-million dollar high-rise project, back charges to the drilling/dewatering subcontractor can quickly add up to hundreds of thousands of dollars, potentially bankrupting your company.

Familiarize Yourself with the Site Conditions

To properly determine the dewatering requirements and the appropriate dewatering method for a project, the drilling/dewatering subcontractor — before anything else — must familiarize himself with the soil stratigraphy at the proposed project site and the water table elevation in relation to the depth of excavation. This should also include an analysis of the aboveground conditions such as adjacent bodies of water that may be a source of recharge, or adjacent buildings that may be subject to settlement.

Proper Expectation Setting

Just as an engineer or owner may have unrealistic expectations on how much a water supply well will produce, oftentimes the owner or the owner's engineer will have too high or unrealistic expectations regarding the dewatering contractor's ability to dewater a site. Unrealistic expectations may include plans to excavate in a totally "dry" condition when the subsurface stratigraphy or the project schedule will not allow for it. Or the engineer may expect the contractor to assume the risk for any undesirable side effects of dewatering, such as settlement of adjacent structures or the pumping of contaminated ground water.

And all too often, in a less wise dewatering/drilling subcontractor's eagerness to win a bid, he promises more than he can deliver. Although steps may be taken to minimize these risks, settlement or the migration of a plume of contaminated ground water is nearly impossible to predict.

Given the complex nature of soil and ground water, it is absolutely essential for the dewatering/drilling subcontractor to perform as much upfront analysis of the site as possible, set the appropriate level of expectations, and specify any limitations.

Choosing the Proper Dewatering Method

Dewatering as a specialty construction trade has existed for many decades, borrowing from the water well industry in the effort to more efficiently remove ground water from deep excavations. Over the years, a number of dewatering methods have been established, modified, and improved upon. The most common dewatering techniques include vacuum wellpoints (sand points), deep wells (pumped wells), and eductors (ejectors). Although the applications depend on a multiple of variables, they can be summarized as follows.

A view of the Denver Justice Center excavation and construction site with the dewatering system visible along the perimeter of the excavation. The project is about the size of a city block and extends approximately 32 feet below ground surface. The water table is located approximately 15 feet below the surface.

A TerraFirma employee works on wellhead piping at the Denver Justice Center job site. Ten dewatering wells were installed at the job site.

Vacuum Wellpoints

Vacuum wellpoint systems consist of a series of closely spaced (6 feet to 9 feet) small diameter (1½ inches to 2 inches) PVC sand points installed to surround an excavation. Just as in the water well industry, wellpoints are typically jetted in with a high pressure jetting pump or drilled by wet rotary or hollow stem methods.

Wellpoints extend up to 25 feet below the ground surface, depending upon the depth of the proposed

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excavation and the subsurface conditions. They are connected to a common manifold that in turn is connected to a vacuum wellpoint pump. Ground water is drawn from the soil and into the wellpoint by the vacuum. The water withdrawn from the soil is discharged by way of the centrifugal pump portion of the wellpoint pump, and directed away from the excavation via a discharge pipe.

Vacuum wellpoints are the most economical and versatile of the dewatering methods, capable of performing well in many types of soils, whether pumping just a few gallons per minute or several thousand gallons per minute. Because vacuum is the means by which water is drawn from the soil, wellpoint systems perform exceptionally well in highly stratified soil formations or finer grained sand and silts. However, due to the suction lift limitations of the vacuum wellpoint pump, they are limited to excavations of 15 feet or shallower. Beyond that depth, multiple stages of wellpoints are required or an alternative dewatering system must be considered.

Deep Wells

Deep well dewatering wells, just like a water supply well for a home in the country, is made up of well screen and riser, typically PVC, placed within an oversized borehole. Like the water well, the annular space between the borehole and well screen is filled with a select filter material. The well is developed and fitted with an individual pump, typically an electrically driven submersible pump. Dewatering well construction methods, as in the drilling of water wells, include wet rotary, bucket auger, hollow stem, reverse circulation rotary, and as of late, dual rotary drilling methods.

Deep wells are installed to surround a proposed excavation or to parallel a proposed pipe/trench excavation. Well spacing can range from tens of feet to hundreds of feet, depending on the excavation depth and the soil formation. Discharge from the wells is directed away from the excavation, typically by way of a common PVC or HDPE discharge manifold.

Deep wells are much more limited in their application than wellpoints, and require a greater level of skill from the designer and installation crews. Deep wells are best suited to free flowing, homogenous aquifers that extend many feet below the proposed excavation subgrade. But with the advancement of aquifer analysis, and several years of practical experience, deep wells are being employed more and more on projects that were once considered unsuitable or extremely risky. Unlike wellpoints, the depth to which the water table can be drawn down is not limited.

Eductors

Eductor dewatering systems combine the advantages of the wellpoint and the deep well dewatering systems. Just like the ejector well installed to supply water for the home, a high pressure water supply pump circulates water down the annulus between the well casing, typically 2-inch PVC, and the smaller inner return pipe, typically 1¼-inch PVC.

The supply water is forced through the ejector body located just above the well screen, creating a vacuum within the suction chamber. By this effect, ground water is drawn into the eductor body, co-mingling with the supply water and returning to a recirculation tank via a return header. Excess water from the recirculation tank overflows to the discharge, while the supply water is fed back to the eductor body in a continuous manner. Like wellpoints, eductors are installed to surround an excavation and typically jetted in with a high pressure jetting pump or drilled by wet rotary or hollow stem methods. Eductor spacing can range from 6 feet to 25 feet on center, depending on the excavation depth and the soil formation. Eductor well depths are theoretically unlimited but are unlikely to extend beyond 100 feet.

The ejector body itself is inherently low in efficiency, consuming much energy to produce just a small quantity of ground water, typically just 1 gallon per minute per ejector to 2 gallons per minute per ejector. Therefore, their application is best suited for deep excavations penetrating highly stratified, fine grained soils where low flow is anticipated and high vacuum is required. Eductor wells are not limited by suction lift, as are wellpoints.

The design and installation of an eductor well dewatering system requires a high level of expertise, even more so than the deep well dewatering systems.

Being familiar with the project specifications and conducting an upfront analysis of the subsurface conditions, in an effort to determine the dewatering requirements and methodology as well as to set the proper expectations, cannot be overstressed.

Dewatering System at Denver Construction Site

The ongoing construction of a new criminal detention center in Denver, Colorado, by Hensel Phelps Construction is part of a new multi-million dollar Denver Justice Center. It includes an excavation encompassing nearly an entire city block and

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extending approximately 32 feet below ground surface. The water table is located approximately 15 feet below the ground surface.

Ten 12-inch-diameter dewatering wells were designed and installed by TerraFirma Earth Technologies, extending approximately 50 feet deep, fully penetrating the loosely consolidated alluvial overburden material. Thirty 6-inch-diameter boreholes were advanced using a bucket auger. A biopolymer drilling fluid was used to stabilize the unconsolidated alluvial material during drilling.

The wells continue to pump 24 hours a day, seven days a week at the estimated rate of 85 gpm per well. An estimated total of more than 500 million gallons of water will be pumped by the time the dewatering wells are turned off.

This project is a good example of a properly designed and executed dewatering system. The success of the dewatering can be directly attributed to a few key factors.

Detailed Geotechnical Engineering Study

The successful dewatering can first and foremost be attributed to the owner's willingness to commit to a detailed geotechnical investigation, executed by Kumar & Associates, and to make that document part of the bidding documents. Multiple boreholes were drilled and logged, clearly identifying the water table and the subsurface conditions, including the location of a confining claystone formation (Denver Blue) located at or just below the proposed subgrade. A topographical map of a Denver Blue showed the formation dipping steeply to the south-southeast, with the overlying alluvial soils consisting predominantly of coarse grained sands and sands and gravel. Additionally, a gradational analysis of the alluvial material was provided, giving TerraFirma Earth Technologies an indication of the permeability of the water-bearing alluvial soils.

From this information, TerraFirma was able to then choose the deep well dewatering system methodology as the primary means of controlling the ground water and the bucket auger drilling technique to construct the wells. At this point, what remained to be determined were the well spacing, depth, and flow requirements, as well as identifying to the engineer and general contractor the limitations of the deep well system and any supplemental dewatering that could be expected.

A bucket rig was used at the Denver Justice Center excavation and construction site to drill the boreholes for the well. In all, 30 boreholes were drilled.

Contributions and Collaboration

Due to the proximity of the confining claystone in relation to the subgrade and the intermittent presence of water-bearing sandstone seams and lenses within the claystone formation identified in the geotechnical report, the deep well dewatering system, though the best choice for controlling the ground water, was not going to give the engineer a completely "dry" excavation as required by the specification. Through contributions and collaboration among TerraFirma, Hensel Phelps, and Kumar & Associates, the proper expectations were set and the risks minimized to a reasonable level. Through this same collaboration effort, it was determined that ground water emanating from the poorly defined sandstone seams and lenses within the Denver Blue would best be handled by sumping, essentially saving the owner thousands of dollars.

The excellent correlation between the predicted dewatering results and the actual dewatering results cannot always be achieved. But with the proper information, proper analysis of the information, and collaboration and contributions among the key parties, the chances for success can be greatly increased. *WWJ*