California Groundwater Association

An NGWA Affiliate State

700 R Street
Suite 200 Sacramento, CA 95811
cga@groundh2o.org
916-231-2134

CGA STANDARD PRACTICE SERIES

ARTICLE 225 - GRAVEL PACK MATERIALS AND HANDLING

BACKGROUND

Gravel pack materials, commonly referred to as and hereinafter used interchangeably with filter pack materials, are an important component of well construction as these materials are placed in the annular space between the borehole wall and the well casing and screen sections. Quite often, in high-capacity municipal, industrial, and agricultural wells the filter pack is made to particular specifications and is designed to work in conjunction with the geologic formation and the design of the well screen to ensure efficient flow of groundwater into the well. In these applications, the gravel pack material also serves as a filter so that formation materials such as sand are minimized in the screened interval, thus yielding well water with less particulate matter. In other applications, particularly in small diameter domestic wells completed in semi-consolidated or consolidated formations, a coarse material such as washed pea gravel is used in the annular space. In this instance, the gravel pack serves mostly as a stabilizer to prevent the formation from collapsing around the well casing and screen during its service life, and not as a filter medium. Therefore, the physical composition of the filter pack is critical in well design, well yield, and well life.

In addition to issues associated with the physical composition of the filter pack, handling and care of the filter material can have drastic effects on the quality of the water from the well. There have been occasional reports from inspectors with regulatory agencies, such as county Health Departments, that filter pack materials at jobsites are not in satisfactory condition, particularly with respect to cleanliness. Impurities, organic matter, and other contaminants in the filter pack make it difficult to disinfect the well and can have a detrimental effect on water quality. Therefore, this Standard also recommends transport and handling procedures so that the condition of the filter pack material is not compromised before it is placed in the well.

DISCUSSION

Accordingly, the purpose of this Standard is to review the established criteria concerning physical properties for gravel pack materials, as well as their handling. The well designer or contractor can then judge whether available materials from specific sources meet established criteria. Gravel pack material requirements can often be modified when the “ideal” sources are not available, but the material can still be satisfactory for the intended application. However, this Standard is not intended to serve as a review on gravel pack design. Issues such as matching the gravel pack to formation characteristics for “sand free” wells and how to successfully place gravel pack in wells during construction are topics covered elsewhere in standard textbooks and industry references.

Standards for gravel pack materials are contained in many sources such as National Ground Water Association (NGWA) and American Water Works Association (AWWA) reference materials (see Selected References) and are only briefly reviewed here. The average specific gravity of particles should be 2.5, with not more than 1 percent, by weight of materials, having a specific gravity of 2.25 or less. The pack materials should be smooth, rounded, granular, and most commercial filter packs have a coefficient of uniformity of approximately 2.5 (Sterret, 2007). The pack material should be non-soluble in low pH environments (i.e. not acid soluble); and should be durable so as not to degrade or consolidate during or after placement. Pack material should be free of constituents and particles that are detrimental to water quality. Thin, flat or elongated particles, such as crushed rock, with a maximum dimension over 3 times the minimum should not compose over 2 percent by weight. These particles tend to "lock" together causing placement problems (e.g. bridging), decreased permeability of the pack material resulting in lower well yield, and difficulty placing and removing tremie pipe.

The California Department of Water Resources offers guidance on the definition and handling of gravel pack materials. On page 62 of Bulletin 74-81 a "gravel packed well" is defined as a "well in which filter material (sand, gravel, etc.) is placed in the annular space between the casing and the borehole to increase the effective diameter of the well, and to prevent fine-grained material from entering the well during pumping [but after the well is developed.]" The Department of Water Resources Bulletin 74-81, on page 40, clarifies the cleanliness requirement. "Gravel used in gravel-packed well shall come from clean sources and should be thoroughly washed before being placed in the well. Gravel [i.e., filter pack material] purchased from a supplier should be washed at the pit or plant prior to delivery to the well site."

In the past, suitable gravel pack materials for well construction could be specified, and were generally locally and economically available to most project sites in California. More recently, however, sources of supply within the State have become more limited and are likely to become more so in the future. This situation has resulted from the depletion of materials with certain particle sizes. One such factor is the decrease of sand harvesting in the Monterey Bay area. Other factors include non-renewal of operating permits, particularly those in environmentally sensitive areas or near watercourses where wildlife may be affected. Urbanization has also eliminated some quarries that used to be far-removed from city limits. Additionally, seasonal conditions, such as snow, may affect certain sources.

Accordingly, unless out-of-state sources are used, those responsible for the design and construction of wells can be faced with limited choices, particularly where a specific gradation of gravel on a specific date is required. In addition, available materials may be angular and not be ideally "rounded", may not be inert and as durable as desired for long-term stability, or may contain too many "fines".

In addition to problems with filter pack selection and supply, another potential issue arises for the water well contractor who, usually as part of a municipal water well contract, agrees to provide a specific brand or manufacturer and gradation of filter pack material. In addition to the aforementioned issues with potential limited availability, issues have also arisen when the requested filter pack material does not meet the well site sieve analysis even though the supplier has performed a sieve analysis and the water well contractor has receipts proving the appropriate chain of custody to the well site. In this situation the awarding body is likely to reject the filter pack material, the material supplier is likely to fall back on their sieve analysis, and the water well contractor is likely to be requested to provide the appropriate material at no additional cost. One of the typical causes of this scenario seems to be that the material

supplier's sieve analysis was performed at an earlier date on a different part of the pile than where the material shipped on a given date came from. During this time, even if the material is from the same bulk source, which itself can have slight variations, changes can occur in the pile gradation through movement, settlement, and restacking sufficient to slightly change the sieve qualities of the material. This slight change can cause the material to fall outside the original contracted sieve parameters, especially if the awarding body has a "tight" gradation requirement.

This issue is further compounded by transportation and handling of filter pack material on the way to the job site. Due to the vibration and movements during handling and transportation, the larger particles tend to migrate downward while the smaller particles remain towards the top. This can result in sampling bias when performing on the job sieve analyses, especially if proper sampling protocol is not followed. However, the settlement problem is, to a large part, remedied by on- the-job-site handling. The filter pack material is remixed as it is being moved to the well head, while being placed down the borehole, and during the well development process.

RECOMMENDATIONS

The California Groundwater Association recommends the following practices with regard to evaluating gravel pack properties and for the transport and handling of the gravel pack materials:

1. If there is any question about the physical properties of the gravel pack as discussed above, the supplier should furnish a laboratory certificate confirming the properties of the source materials.

2. The material for the sieve analysis should be representative of the filter pack material as a whole.

3. Typical gradation analyses of the gravel pack furnished by the supplier are updated only periodically and may not necessarily be representative of the gradation of the materials actually available on a given date. Sampling should be done to confirm the gradation prior to delivery at the jobsite. If the gravel pack material has been preapproved by the owner or the owner's representative, it is not the contractor's responsibility to guarantee the gradation of the gravel pack at the jobsite.

4. If the gravel pack material has been preapproved by the owner or the owner's representative, the contractor should not be held responsible for changes in gradation during transport or once the material reaches the jobsite if normal precautions are taken during transport.

5. Standard gradations of gravel pack that are commercially and readily available should be utilized whenever feasible. Custom blends are discouraged because of the difficulty in product control, processing, and availability.

6. Crushed rock and other angular material should not be used as a gravel pack in any well, even as a formation stabilizer.

7. Shale, mica, clay, or other organic matter, such as soil, should not be present in the gravel pack materials. Iron, manganese, or other constituents should not be present in a quantity detrimental to water quality.

8. Materials should come from a “clean” source, be handled and transported by “clean” sources, and preferably be washed and dried prior to delivery at the jobsite.

9. If the materials are stored and are not to be used immediately, they should be protected to eliminate contamination from rain, dust, cigarette butts, trash, or other foreign matter.

10. When handling gravel pack material that is piled on the ground, loader operators should not take gravel from the bottom of the pile that has been in contact with the underlying soil. If possible, a barrier should be used under the material to protect it from ground contamination.

SELECTED REFERENCES

American Water Works Association, 1984: AWWA Standard for Water Wells, AWWA A100-84.

California Department of Water Resources, 1981: California Well Standards, Bulletin 74-81.

California Department of Water Resources, 1991: California Well Standards, Bulletin 74-90.

Environmental Protection Agency, 1976: Manual of Water Well Construction Practices, EPA Office of Water Supply, EPA-570/9-75-001.

National Ground Water Association, 1998: Manual of Water Well Construction Practices, 2nd Edition.

Sterret, R. J., 2007: Groundwater & Wells, Third Edition. New Brighton, MN: Johnson Screens.