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YOSE/General

To: Pat Fleming, DSC
From: Larry Martin, Hydrogeologist, Water Resources Division
Subject: Water supply wells at Tuolumne Meadows

Summary

I have reviewed reports, geologic maps, and well drilling records in our files to assess the potential for obtaining the public water supply at Tuolumne Meadows from a groundwater source, thereby eliminating the need for a surface water treatment plant. I do not recommend attempting to construct wells in this area as hydrogeologic conditions are not favorable for obtaining large quantities of water. Deep wells, constructed in the granite, are not likely to produce any water, or possibly a few gallons per minute if a fracture is encountered. Shallow wells, constructed in the alluvium, are not likely to produce significant quantities of water as the alluvium is not very thick and is not well-sorted enough to be very permeable.

Background

Currently, the public water supply for facilities at Tuolumne Meadows is obtained via a surface water diversion from the Tuolumne River. Peak demand is 75-100,000 gallons per day. Replacement of the surface water source with a groundwater source would greatly reduce water treatment costs and personnel requirements for operating a treatment plant. Yield from a well system would need to be 50-75 gallons per minute to meet the current demand. Greater yield would be desirable so the well(s) would not need to be operated continuously. Two groundwater sources will be considered, a deep well constructed in the granitic rock and shallow well(s) constructed in alluvium along the Tuolumne River.

Geology

Bedrock geologic formations underlying Tuolumne Meadows, and for several miles beyond, are comprised of granitic rocks which are part of the Tuolumne Intrusive Suite. Granite is not permeable unless fracture zones are encountered which are interconnected with other fractures, which are connected with a water source. Granitic rocks in this part of the Tuolumne Intrusive Suite are more massive, rather than fractured. There are many granite domes in the vicinity of Tuolumne Meadows. Domes are formed by exfoliation--the splitting off of rock slabs along curved surfaces. Exfoliation is similar to peeling away layers of an onion. The formation of domes occurs only in massive rock and requires that steeply dipping joints are not open (Bateman, et.al., 1983). Thus, it would appear that the chances of drilling a well into a vertical water-bearing opening in the granite underlying Tuolumne Meadows is poor, since open vertical joints do not coexist with exfoliation domes

The granites are overlain by a thin veneer of glacial till. Glacial till is unsorted material deposited directly by and underneath a glacier without subsequent reworking by meltwater. Till is a heterogeneous mixture of clay, silt, sand, gravel, and boulders. Till is not generally a permeable formation, as the fine-grained material fills the voids between the larger components.

Alluvium occurs along the valley of the Tuolumne River and its tributaries. In some places the alluvium may have been reworked by the river and be very permeable. In other places, the unconsolidated material in the river valleys may be remnants of glacial till that has not been reworked and is not very permeable. Previous test drilling indicates that the alluvial deposits are not very thick (less than 10 feet) and therefore, probably could not be developed as water supply sources.

Previous well drilling

In 1982, a well (Tuolumne Meadow Well No. 1) was constructed to supply the ranger residence at Tuolumne Meadow. The well was completed in granite with perforated casing from 100-120, 140-160, and 220-240 feet below ground surface. The upper 50 feet of the well was sealed with a cement seal, effectively preventing alluvial groundwater from entering the well. Water is obtained from fractures in the granite. These fractures may be interconnected with , and obtaining water as infiltration from the overlying alluvium. The well was test pumped at rates from 3½-7 gallons per minute. Recommended pumping rate for the well is 4 gallons per minute. Alluvium and/or glacial till at this site was 9 feet thick. Granite was encountered at a depth of 9 feet and the remainder of the well (252 feet total depth) was drilled in granite.

Two test wells (Tuolumne Meadow Well No. 2 and 3) were constructed in the Tuolumne Meadows campground in 1993. (These wells are referred to as No. 1 and 2 in the report from HRS Water Consultants.) Drilling sites were selected based on: 1) review of area geologic maps, reports, and existing well records; 2) fracture mapping on aerial photographs of the area; 3) onsite geologic mapping; and 4) meeting with NPS personnel to ascertain, and avoid, culturally and environmentally sensitive areas. Test drilling was conducted near the two highest priority sites in 1993. Both sites were relocated a few hundred feet from the preferred locations to alleviate NPS concerns regarding visual intrusion. Both wells were drilled to 400 feet total depth and did not encounter significant quantities of water.

Well No. 2 passed through 8 feet of alluvium and glacial till with no indication of water on the driller's log. Fractured granite was encountered at a depth of 15-16 feet, yielding about 5 gallons per minute. This fracture zone is interpreted as being near-horizontal exfoliation fractures. Surface casing was cemented in place to a depth of 50 feet. No water was encountered during drilling of the remainder of the well.

Well No. 3 passed through 9 feet of alluvium and glacial till with no indication of water on the driller's log. Fractured granite was encountered at a depth of 15 feet, yielding about 5 gallons per minute. This fracture zone is interpreted as being near-horizontal exfoliation fractures. Temporary surface casing was placed to a depth of 18 feet. No water was encountered during drilling of the remainder of the well.

Discussion

The report from HRS Water Consultants (1994) suggests that chances for successfully completing wells in the Tuolumne Meadows area will be increased if wells are located precisely on near-vertical bedrock fractures. Fracture locations can be interpreted from aerial photographs and geologic mapping. Surface geophysical surveys (conductivity and magnetometer surveys) would help locate subsurface fractures in bedrock. The dominant water-bearing fractures in bedrock underlying Tuolumne Meadows are most likely near-horizontal exfoliation fractures. This type of fracturing does not appear to extend more than about 20-30 feet below ground surface.

Experience drilling in other parts of Yosemite indicates that wells in this type of hydrogeologic setting typically yield only a few gallons per minute. At some sites wells produce 20-25 gallons per minute, but these are exceptional sites. Previous drilling at Tuolumne indicates that the alluvium is neither very thick, nor very permeable and that the near-surface horizontal exfoliation fractures do not yield very much water. Chances of obtaining 20-25 gallons per minute from a well in this area are very low, 5-10 gallons per minute is a more reasonable estimate. Supplying the entire Tuolumne Meadows area with water from shallow groundwater wells could easily require construction of 10 wells. It is unlikely that 10 wells could be located in the area without infringing on wilderness boundaries, or locating the wells so close to one another that interference would result (pumping from one well would reduce the water available to a neighboring well).

California regulations require 50 feet of cement grout as a surface seal for public supply wells. This effectively negates construction of wells in the alluvium unless a waiver can be obtained from state regulatory agencies. Shallow wells completed in the alluvium would likely be classified as “under the influence of surface water” requiring treatment of water as if it were from a surface source. Thus, there would be no cost savings in the treatment of water and no rationale for constructing shallow wells.

References

HRS Water Consultants Inc., 1994, Tests of Existing Wells and Test-Well Site Selection at Hogdon Meadows and White Wolf Campground and Test-Well Drilling and Completion Tuolumne Meadows and White Wolf Campground Yosemite National Park, Prepared for Richard P. Arber Associates Inc., 24 pp.

Huber, N.King, 1987, The Geologic Story of Yosemite National Park, U.S. Geological Survey Bulletin 1595, 64 pp.

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