

Groundwater quality change impacts on a brackish-water reverse osmosis water treatment plant design: the City of Clearwater, Florida

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ABSTRACT

Brackish-water reverse osmosis (BWRO) water treatment facilities commonly utilize groundwater for feed water supply. An increase in feed water salinity over time is common due to upward recharge of the production aquifer caused by higher salinity water occurring in deeper aquifers and upwards leakage or upconing of that water during pumping. The rate of change is based on the leakage value of the lower confining unit and the overall wellfield design and pumping rate. The City of Clearwater Reverse Osmosis Water Treatment Plant Number 2 utilizes feed water from the upper part of the Floridan Aquifer System and the overlying Surficial Aquifer System. The design capacity for the facility was set at 23,674 m³/d (6.25 MGD). The BWRO process was designed to treat feed water with a total dissolved solids (TDS) of 1,500 mg/L. Soon after startup of the BWRO plant, the feed water TDS increased to a range between 2,400 and 3,300 mg/L. Based on the feed water quality the facility has been able to produce only about 9,470 m³/d or about 40% of the design capacity. The groundwater model used to estimate changes in groundwater quality with time produced an inaccurate result, which was based on the choice of an inappropriate conceptual model, selection of the boundary conditions, and some other issues in the model structure. An analysis of the individual production well pumping rates and associated changes in salinity show that the confining units between the aquifers are likely breached by karst conduits. These localized breaches caused rapid and unpredictable increases in feed water salinity under pumping conditions. The BWRO facility will require a re-design of the treatment process with a number of options available to produce the desired product water. Because of the inability to accurately predict long-term changes in feed water quality, there is high risk in the design and operation of BWRO facilities using a karstic aquifer system as a feed water source. The location of the specific vertical conduits that allow upward movement of higher salinity water cannot be accurately predicted in the aquifer system.

Keywords: Brackish-water reverse osmosis desalination; Groundwater quality; Aquifer characteristics; City of Clearwater; Florida

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