Workplan to study clogging associated with managed aquifer recharge at Sand Hollow Reservoir, southwestern Utah

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Background

Sand Hollow Reservoir in Washington County, Utah, is a conjunctive-use 1,400-acre surface-water reservoir and managed aquifer recharge facility operated by the Washington County Water Conservancy District. Between March 2002 and August 2006, approximately 50,000 acre feet were recharged to the underlying Navajo Sandstone aquifer (Heilweil et al., 2007). Recharge rates generally declined during this period (fig. 1). Because of this decrease, annual recharge volumes will soon be less than evaporation losses (fig. 2) and may limit the amount of sustainable withdrawal from production wells located adjacent to the reservoir. In addition to the long-term decline in recharge rates, a seasonal increase in recharge occurs each winter, readily observable by calculating intrinsic permeability (removing water temperature viscosity effects). The winter increase in permeability is likely caused either by a decrease in clogging associated with the seasonal decline of a biofilm layer or an increase in permeability associated with reduction of trapped gas bubbles in the aquifer material underneath the reservoir, caused by a decrease in gas-bubble size with cooler temperature and/or a reduction in biogenic gas production (Heilweil and Susong, 2007). Also, Sand Hollow may eventually receive Colorado River water via the Lake Powell pipeline. Potentially adverse affects, such as mineral precipitation and clogging, associated with mixing of this water with native ground water have not yet been investigated.

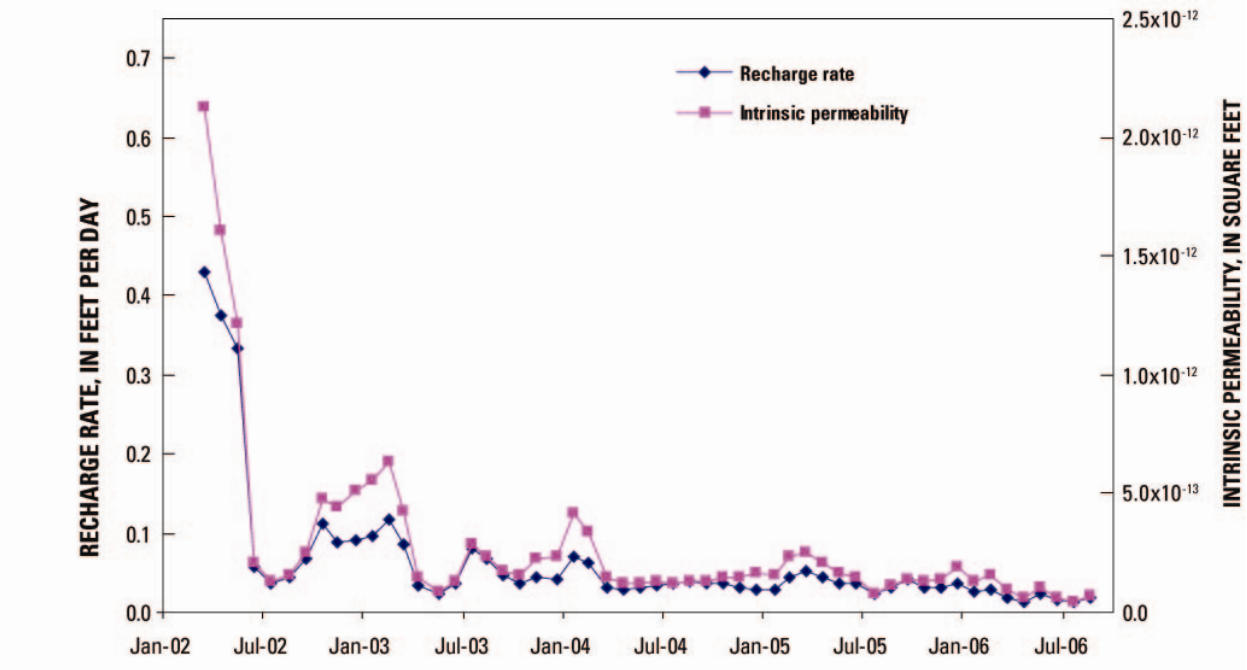

Figure 1. Average monthly recharge rate and intrinsic permeability, Sand Hollow Reservoir, Utah, 2002-06.

Understanding processes controlling clogging and quantifying the different types of clogging is important for the future management of artificial recharge at Sand Hollow. This study proposes to evaluate siltation rates, the chemical composition of the silt (to discern the relative contributions of suspended sediment and eolian dust deposition), current and future (estimated) permeability of the silt layer, the current and future affects of gas clogging, and the possibility of additional clogging from chemical precipitates associated with mixing of artificially recharged and native ground waters. Such information is critical for the future long term management of artificial recharge at Sand Hollow and operation of the production wells adjacent to the reservoir. The findings of this study will provide important information for devising strategies and approaches to maximizing recharge and ground-water recovery.

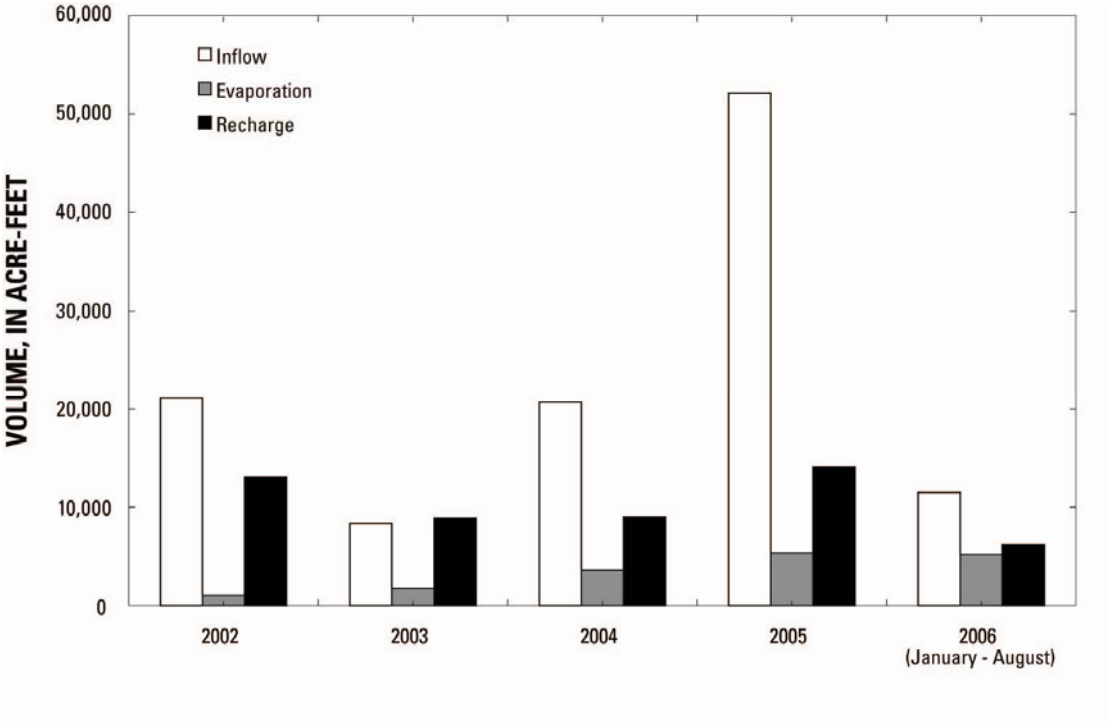

Figure 2. Annual inflow, estimated evaporation, and estimated ground-water recharge at Sand Hollow Reservoir, Utah, 2002-2006

Objectives

The proposed three-year study will focus on understanding clogging processes and quantitatively evaluating sources of clogging. Potential sources of clogging include physical clogging caused by siltation, biofilm development, chemical precipitation from mixing with native ground water, and gas clogging associated with trapped air and/or biogenically produced gases. The investigation will include an analysis of the primary sources of siltation. Possible sources include suspended sediments in the inflowing source water and eolian dust transport/deposition.

The findings of this study will be useful for evaluating alternatives for optimizing future aquifer recharge at Sand Hollow Reservoir. One alternative future management option is the use of submersible surface-restoration equipment, such as Orange County's Basin Cleaning Vehicle (http://www.ocwd.com/_html/bcv.htm) that allows for the removal of find sediments without the need to empty the reservoir (thus avoiding air entrapment upon refilling). Another option is the construction of trench recharge galleries adjacent to the reservoir to take advantage of existing water-delivery and production-well infrastructure.

Approach

FY2008

A combination of field data-collection activities and laboratory analyses will be conducted to evaluate clogging beneath Sand Hollow Reservoir. This will include:

- Vertical core collection of the silt layer at 10 locations beneath the reservoir for (a) laboratory geochemical evaluation of the sources of these silts, and (b) laboratory permeability testing for quantifying physical clogging
- Installation of 10 pairs of shallow drive-point piezometers within the unconsolidated sediments beneath the reservoir for (a) in-situ vertical-gradient (water-level) measurements and permeability evaluation (slug testing), (b) in-situ parameter measurements (temperature, pH, specific conductance, alkalinity, total dissolved-gas pressure, dissolved oxygen, alkalinity), (c) dissolved-gas sample collection to evaluate sources of gas clogging (trapped air or biogenic gases), including seasonal changes
- Laboratory analysis of organically-derived dissolved gases (CO_2, CH_4, and/or H) from long-term monitoring wells and shallow drive-point piezometers to evaluate biogenic gas production
- Laboratory noble-gas analysis (N_2, Ne, Ar, Kr, Xe at University of Utah) of diffusion samples from long-term monitoring wells and shallow drive-point piezometers for quantifying current gas-filled porosity/clogging using closed-equilibrium excess-air gas modeling (Aeshbach-Hertig et al., 1999, 2000)

FY2009

- Comparison of inflow suspended-sediment masses (based on in-flow turbidity meter measurements) to reservoir silt deposition mass calculations based on coring, resulting in an evaluation of the percent of siltation from eolian dust deposition
- Geochemical evaluation of reservoir bottom material, eolian dust, and suspended sediments of inflow water to reservoir to evaluate source of silts
- Geochemical reaction modeling to evaluate the potential of clogging caused by for chemical precipitates from mixing of artificial recharge water with native ground water in the Navajo Aquifer
- Additional tasks based on FY2008 findings

FY2010

- Tasks to be determined based on FY2008 an FY2009 findings

FY2008 Products

An interim report describing initial findings will be coauthored by the IGME, the USGS, and the University of Utah and submitted to the WCWCD by the end of FY2008.

References

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