Aquifer Storage and Recovery Case Study

Site: El Paso, Texas

Highlights

"Although no technology can double the flow of the Colorado River, or enhance other surface-water and groundwater resources, improved environmental management and conservation can increase the efficient use of available freshwater."

-Zhuping Shang, in his journal article about the El Paso ASR Project

- The El Paso ASTR project was motivated by a desire for water security and with a goal of restoring the depleted Hueco Bolson aquifer that sustains 30-40% of El Paso's annual water demand and is the sole source of drinking water for Ciudad Juarez, Mexico.
- The El Paso ASTR project was brought online in 1985 and consists of 10 injection wells and one infiltration basin.
- Source water consists of reclaimed water from the El Paso Water Utilities (EPWU) Fred Hervey Water Reclamation Plant.
    - 32.1 billion gallons produced by the plant between 1985-2005, two-thirds of that was injected into the Hueco Bolson aquifer.
- Under current conditions, El Paso recovers and uses most, if not all of the water that has been recharged.
- The Texas Water Department Board (TWDP) is conducting a statewide survey to identify aquifers that are suitable for ASR or aquifer recharge projects and will submit a report summarizing their findings to the governor, lieutenant governor, and House speaker by December 15, 2020

The El Paso Water Utility (EPWU also known as EPWater), has operated an ASR project in northeast El Paso, Texas for decades. They are permitted through the Texas Commission for Environmental Quality (TCEQ) under the pertinent standards of the United States Environmental Protection Agency (US EPA) specifically those stipulated for Class V injection wells in the Underground Injection Control Program. As early as the 1980s, the EPWU started to explore alternative water resources in order to augment future water supply. The El Paso ASR project was brought online in 1985 for a number of reasons including the storage of excess reclaimed wastewater with the intention to use it to meet future supply or peak demand. Another reason was to partially restore the depleted aquifer by raising its water level. This would also attenuate or prevent the intrusion of brackish water into the Hueco Bolson aquifer which is the sole source of drinking water for Ciudad Juarez, Mexico, and sustains 30-40% of El Paso's annual water demand [1].

The source water consists of reclaimed water treated at the EPWU's Fred Hervey Water Reclamation Plant. The design capacity of this plant is 10 MGD. Treatment consists of primary, secondary, and tertiary phases. The primary phase is composed of conventional technologies consisting of screening, degritting, and primary settling. The secondary and tertiary phases are composed of biological treatment, chemical coagulation with lime, granular media filtration with granular activated carbon, ozone disinfection, and the addition of chlorine to provide a residual disinfectant. Reclaimed water must meet drinking water standards before injection. These standards were set based on the EPA's Interim Primary Drinking Water Regulations and the Texas Department of Health (TDH) Drinking Water Standards. Of the 32.1 billion gallons of reclaimed wastewater produced by the plant since 1985 (as of 2005), ⅔ were injected into the Hueco Bolson aquifer amounting to about 1.067 billion gallons injected annually. Injection rate peaked in 1990 at 1.86 billion gallons. After 1990, other demands for reclaimed water, primarily for cooling purposes at El Paso Electric Company, diverted significant quantities of treated wastewater from being used in ASR, as shown in Figure 1 [1].

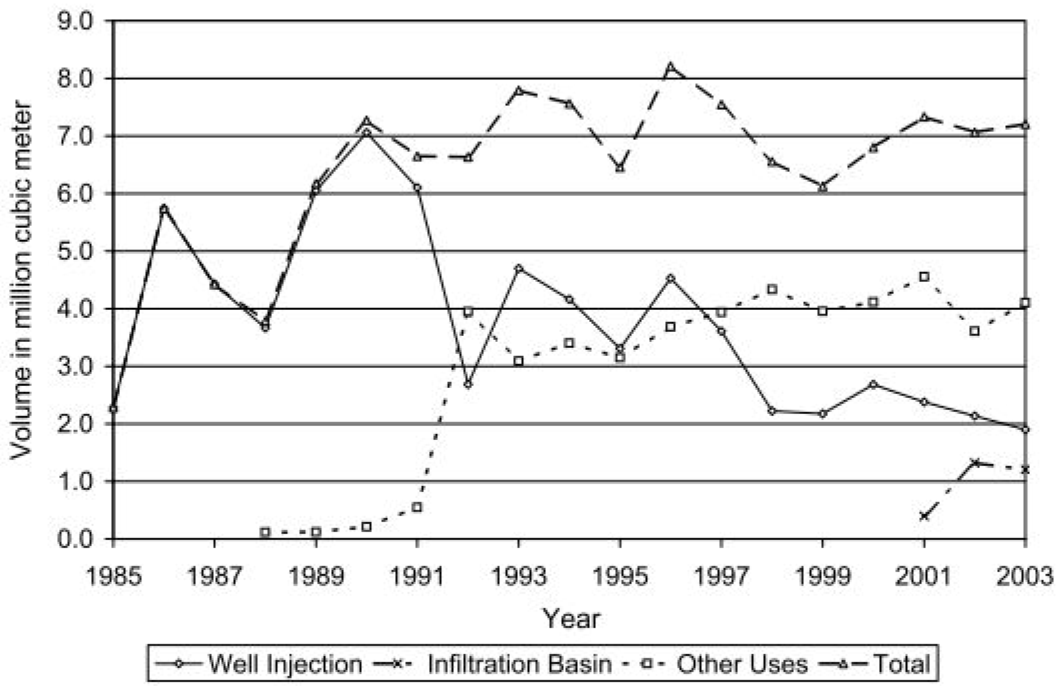

Figure 1: Total reclaimed water production by the Fred Hervey Water Reclamation Plant, and end uses [1].

Treated reclaimed wastewater is stored using 10 recharge wells located in northeast El Paso. Additionally, one pilot infiltration basin in operation since 2001 has received reclaimed water. The wells are screened between 107 and 269 meters below land surface. They were constructed with a 16-in galvanized wire-wrapped screen and a 3.5-in galvanized injection line. These injection lines were placed approximately 50 feet below the static water level in order to reduce the possibility of air entrainment. Injection rates range from 400-700 gpm depending on the hydraulic properties and characterization of the well screen. Despite being equipped with 1,000 gpm pumps for redevelopment, the injection wells are designed for injection-only in order to comply with EPA and TDH requirements on water quality and residence time for recovery. The location of the wells was chosen so that sufficient underground storage would be available and so that maximum recovery of injected water could be achieved, thus minimizing costs. Water is constantly injected and recovered. One of the focuses is long-term storage for water-table recovery and mitigation of further overdraft [1].

Neighboring production wells are located at a range of 782-1006 meters down-gradient from the injection wells, or 230-829 meters up-gradient from the injection wells. This results in residence times of over 5 years for injected water based on simulated groundwater velocity. An aquifer residence time (from injection to recovery) of two years is required by TDH to assure complete inactivation of viruses in the recovered water. Therefore, adequate residence time in the aquifer is provided to allow for additional purification of water prior to being pumped and placed into the distribution system for municipal and/or industrial use. Under current conditions, El Paso recovers and uses most, if not all of the water that has been recharged.

The Hueco Bolson aquifer is an unconfined and semi-confined aquifer, with a long, sediment-filled trough. Water level northeast of El Paso is about 107 meters below the land surface. The majority of the aquifer is unconsolidated to slightly consolidated deposits composed of fine- to medium-grained sand with interbedded lenses of clay, silt, gravel, and caliche. The sediments in the trough are fluvial, evaporitic, alluvial fan, and aeolian in origin and have a maximum thickness of 2,743 meters. Horizontal hydraulic conductivity in the region across injection and recovery sites is approximately 8.13 meters per day, with a coefficient of transmissivity falling in the range of 1,242 cubic meters per day per meter. Significant geochemical interactions between the injected water and native groundwater are not observed; both waters have dominantly sodium-chloride ionic profiles, as shown in Figure 2 below. No deleterious effects on the water quality of either the source water or the native groundwater have been observed as a result of ASR operations [1].

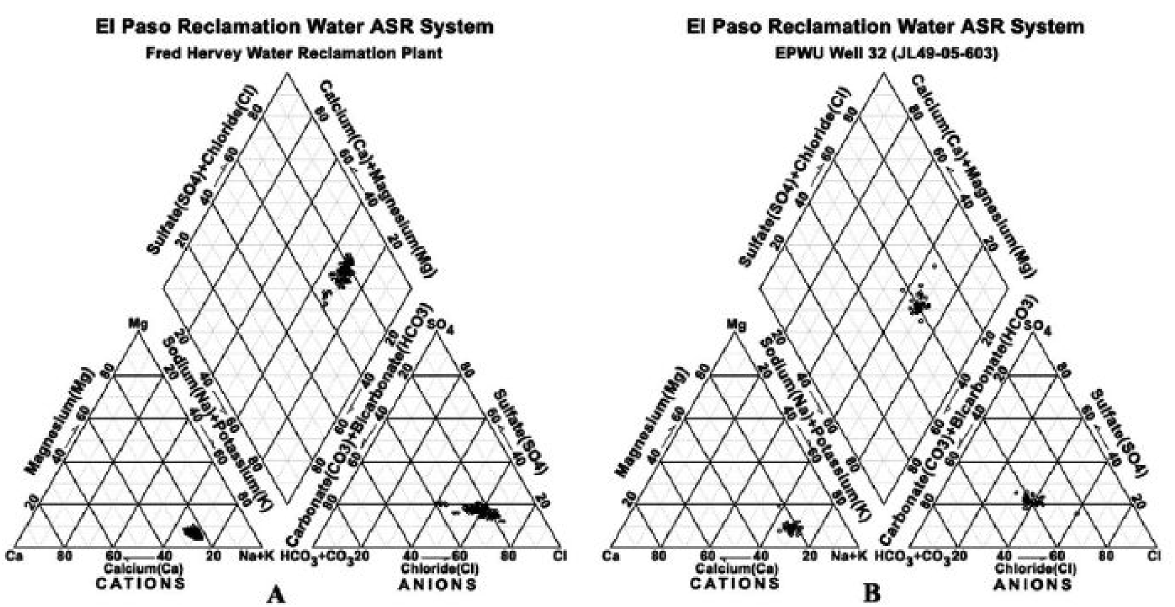

Figure 2: Ionic makeups of the source water (A) and the groundwater near the injection site (B) [1].

Policy Connections

In 2005, there was neither an international treaty nor any interstate compact or agreement regulating the amount of water that could be withdrawn from the Hueco Bolson aquifer. This absence persists despite it being the sole source of drinking water for Ciudad Juarez, a city of over a million people, and providing El Paso, Texas with 30-40% of its annual water supply. This fact highlights the necessity for intergovernmental cooperation on water use, and the potential ramifications of the absence of one [1].

Texas is conducting a very similar project to the project for which this case study has been completed; in 2019 the Texas State Legislature instructed the Texas Water Department Board (TWDP) to conduct a statewide survey to identify aquifers that are suitable for ASR or aquifer recharge projects and submit a report summarizing their findings to the governor, lieutenant governor, and House speaker by December 15, 2020 [2]. Figure 3 displays a map which highlights the active and decommissioned ASR projects in Texas, as well as locations where ASR is being explored.

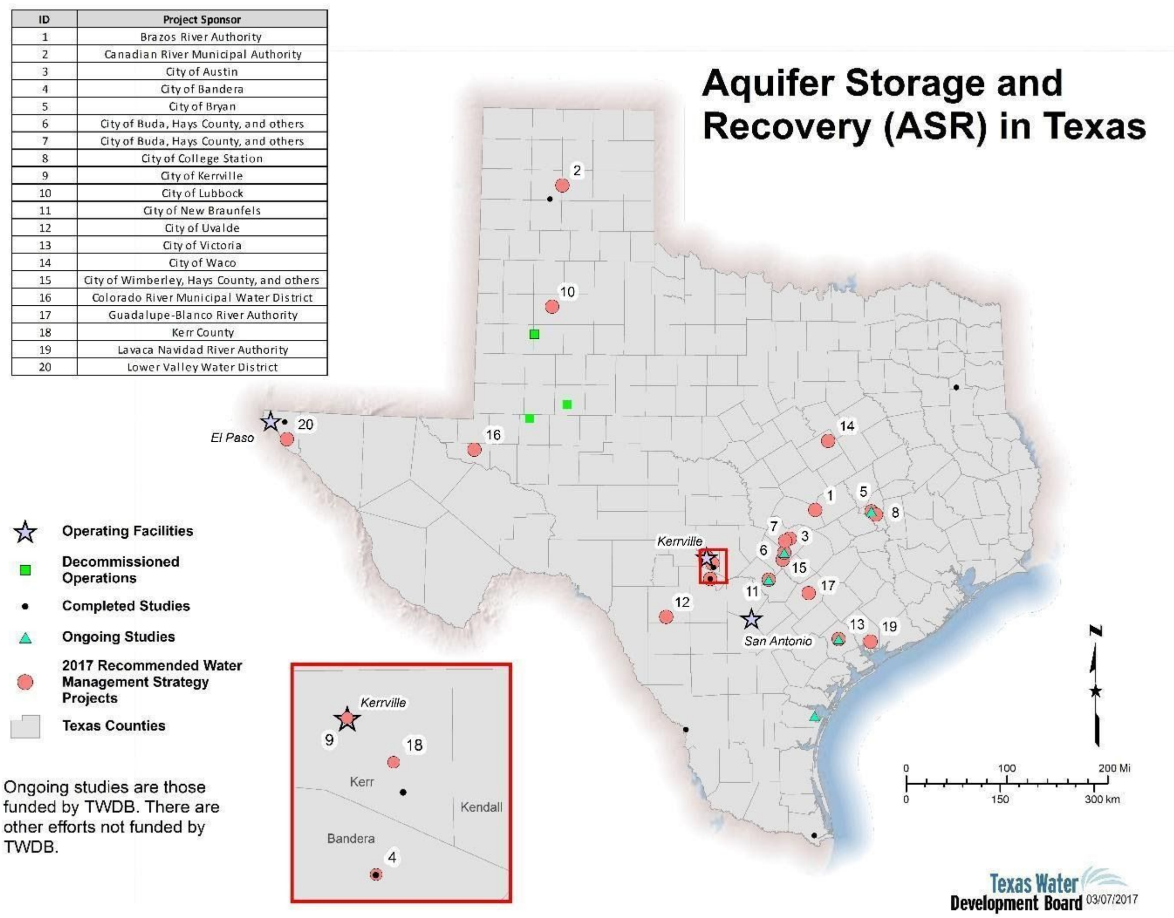

Figure 3: Locations of active, decommissioned, and investigated ASR project sites in Texas [2].

Economic Considerations

In recent years, the city of El Paso has used more of its reclaimed water for purposes other than injection. If reclaimed water is eventually such a hot commodity that injecting it becomes economically unviable, ASR projects may become defunct, or at least scaled back dramatically. Alternatively, reclaimed water used for industrial non-contact cooling applications could be reclaimed for a second time and used for ASR projects [1].

Over the years, it has been anticipated that infiltration basins would become the most viable method for recharge due to their low operation and construction costs and well as relatively simple maintenance [1].

Future Projections

ASR has been an effective water management tool used to decrease the city of El Paso's withdrawals of water from the overdrafted Hueco Bolson aquifer. In 2019 the U.S. Bureau of Reclamation approved EPWater to expand its ASR and aquifer recharge projects, using a combination of reclaimed water, treated river water, and stormwater as source waters. EPWater holds water rights to meet its peak summer use, but during the rest of the year when the utility is not using its full allotment, a portion of that water can be diverted to replenish the aquifer, supporting drought resilience and groundwater sustainability [3]. The city will expand their surface spreading capacity through the construction of an enhanced arroyo infiltration facility. They hope that this site infiltration site may also provide a wetland habitat for native flora and fauna [1,2,3].

References

1. Sheng, Z. (2005). An aquifer storage and recovery system with reclaimed wastewater to preserve native groundwater resources in El Paso, Texas. Journal of Environmental Management, 75(4 SPEC. ISS.), 367–377. https://doi.org/10.1016/j.jenvman.2004.10.007

2. "Aquifer Storage and Recovery." *Innovative Water Technologies - Aquifer Storage and Recovery | Texas Water Development Board*, www.twdb.texas.gov/innovativewater/asr/index.asp.

3. "Aquifer Recharge." *El Paso Water*, www.epwater.org/our_water/water_resources/aquifer_recharge.