Aquifer Storage and Recovery Case Study

Site: Roseville, California

Highlights

"A fully implemented ASR program will allow Roseville to prepare for the future by banking water during times of plenty and extracting water during drought conditions. By providing a 'water savings account', Roseville is literally saving for a non-rainy day."

-City of Roseville Website

- ASR projects are common in Southern California where they are used to store large amounts of water for future use. California suffers from severe, persistent droughts that can threaten the reliability of surface water supplies for municipal water systems.
- The long-term goal of the City of Roseville is to operate a network of 13 ASR wells which cumulatively are capable of injecting 10,000 acre-feet of water per year.
- Pilot studies found ASR would provide benefit by storing water during times of plenty and will supplement the total supply of the state during times of scarcity.
- The proposed ASR project in the City of Roseville qualifies for coverage under the General Order adopted on September 19th, 2012 by the State Water Resources Control Board (State Water Board) and requires that injected water be treated pursuant to a municipal water supply permit and not cause violation of groundwater water quality objectives in applicable Water Quality Control Plans.

Summary

The state of California has become the nation's top agricultural producer despite naturally arid conditions in much of the region. Groundwater has played a major role in facilitating this production, as well as making California the most populous state in the country and the seventh largest economy in the world. However, in some areas of the state groundwater has experienced and continues to witness significant overdrafting of groundwater resources. It is estimated that combined overdraft throughout the state is between 1 and 2 million acre-feet per year. Climate change emphasizes the limitations of surface water resources as water exported through the Sacramento-San Joaquin delta is threatened by increasingly prevalent drought conditions. Reliance on groundwater is expected to become an increasingly important factor in the success of meeting the state's future water demands.

ASR projects are one way to increase local storage which can be responsively tapped in periods of high demand and low surface water availability without incurring long-term overdraft. The need for supplementary water resources is especially obvious when examining the percent area of the state of California that has experienced droughts of varying significance through the 21st-century (Fig. 1).

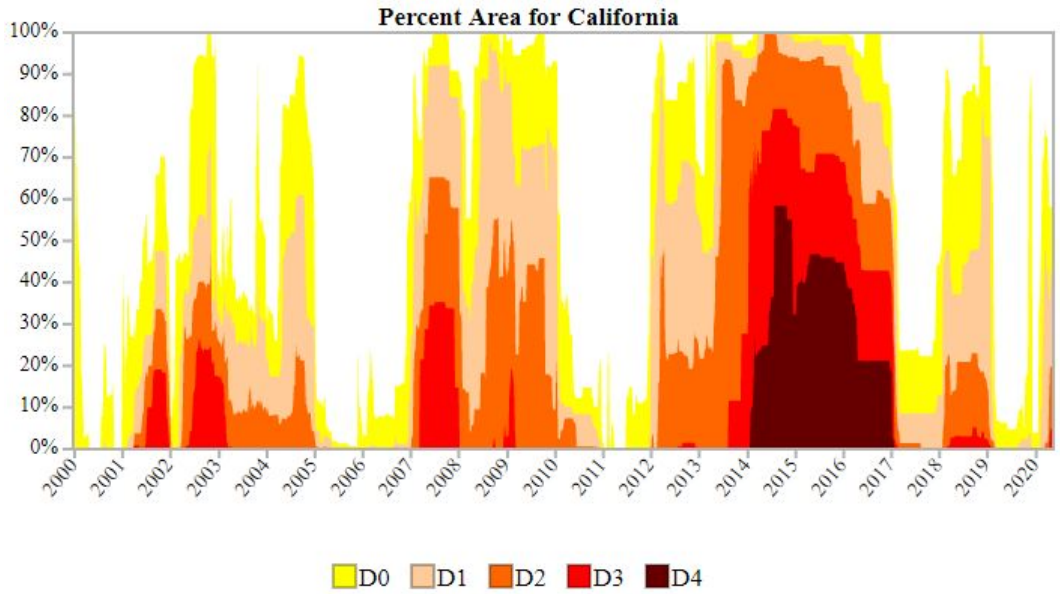

Figure 1: Droughts in California throughout the 21st-century. D0 is the least significant drought, while D4 is the most significant drought. (Source: [1])

The city of Roseville, California is in the process of implementing a city-wide ASR program composed of 13 dual-purpose ASR injection and recovery wells(Figure 2). The status associated with each well is current as of 2014. Eleven of these wells are located within a 14-square mile area on the western side of the city of Roseville while the remaining two are existing water supply wells located on the southeastern side of the City (Fig. 2). These two established wells have been converted for ASR operation but are not currently in use. It is expected that storage of injected water will mostly be in the Mehrten Formation.

Well ID	Year Drilled	Wellhead Retrofitted for ASR	Current Status
Well 4 - Darling Way	1958	2001/2002	Idle
Well 5 - Oakmont	1977	2001/2002	Idle
Well 6 - Diamond Creek Well	2003	2004	Active ASR Well
Well 7 - Woodcreek North	2008	2008	Idle
Well 8 - Hayden Parkway	2005	2014	Idle
Well 9 - West Side Dr #1, W-77	2006	TBD	Pending Installation
Pending – Del Webb	2013	TBD	Pending Installation
Pending – Woodcreek West	---	TBD	Pending Installation
Pending – Fiddymint Road	---	TBD	Pending Installation
Pending – Hewlett Packard	---	TBD	Pending Installation
Pending – Creekview	---	TBD	Pending Installation
Pending – Sierra Visa #1	---	TBD	Pending Installation
Pending – Sierra Vista #2	---	TBD	Pending Installation

Figure 2: List of planned and established ASR wells within the city of Roseville. (Source: [2])

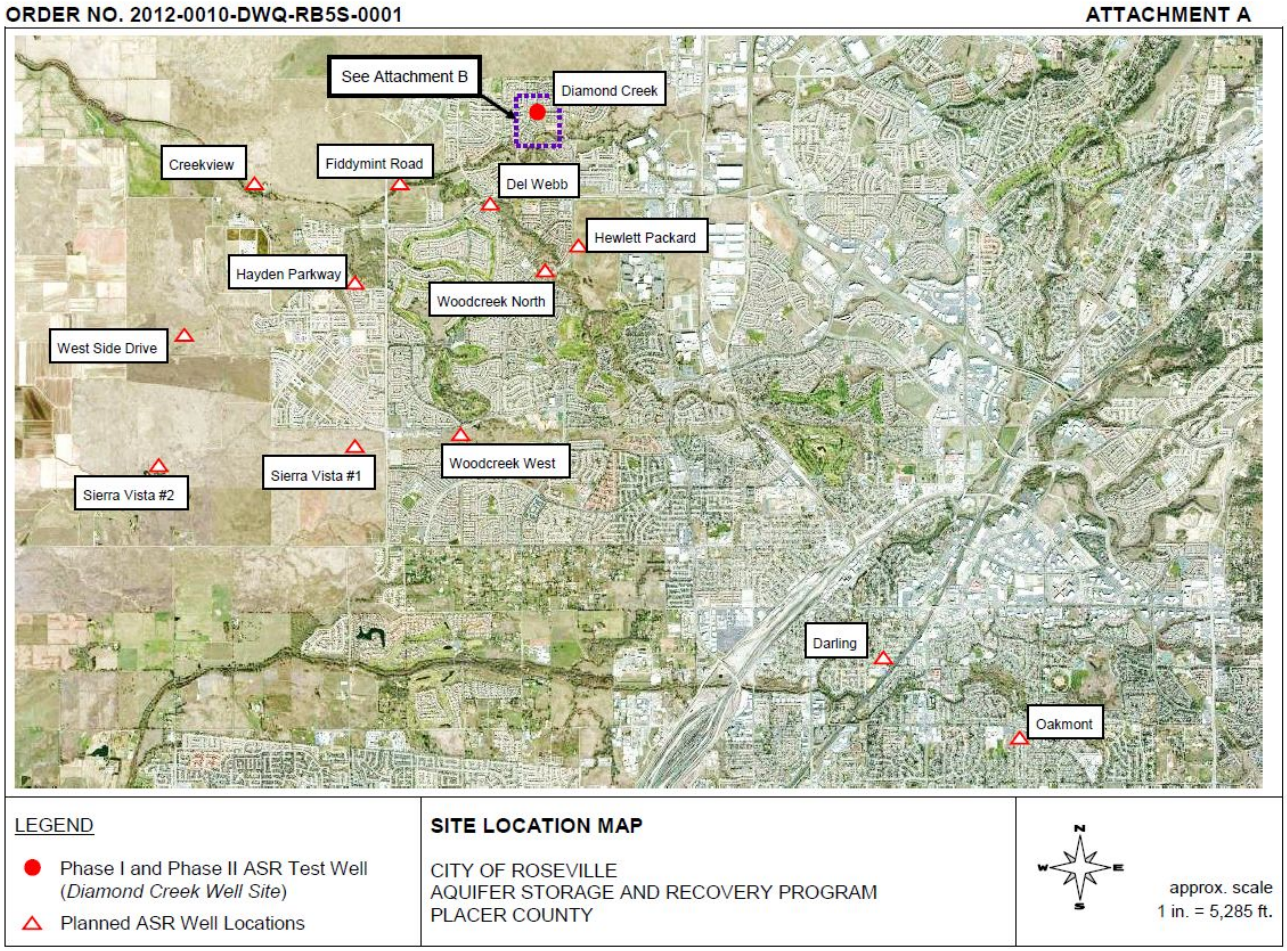

Figure 3: Planned and established ASR wells within the city of Roseville. (Source: [2])

This ASR project administered by the city of Roseville falls under the purview of the General Order and is subject to jurisdiction by the Central Valley Regional Water Quality Control Board (CVRWQCB). The CVRWQCB oversaw the execution of two phases of ASR pilot testing conducted by the city of Roseville. This pilot testing was conducted at the Diamond Creek Well. The pilot test consisted of short-term injection and recovery in a 26-day period between June and September 2004. In this pilot test 158 acre-feet of water from Folsom Lake that was treated at the City of Roseville's Barton Road Water Treatment Plant was injected, underwent a brief storage period and was extracted. The total extraction volume was 439 acre-feet in order to evaluate effects of storage on native groundwater. No appreciable contamination was observed in the recovered water, except for disinfection byproducts (DBPs) consisting of trihalomethanes (THMs) and haloacetic acids (HAAs), which occurred at levels below their respective maximum contaminant limits (MCLs).

The second pilot study was conducted at a much larger scale and occurred over a longer time period from December 2005 to February 2008. A total of 830 acre-feet (270 million gallons) of treated drinking water was injected over a 142-day period, which was followed by a 407-day storage window, and the subsequent withdrawal of 2,140 acre-feet (697 million gallons) which

was delivered to customers. Water quality parameters observed over the course of the second pilot study were documented (Figure 4). These monitoring wells were located both up- and down-gradient (Fig. 5). The results(Figure 4) demonstrated that injection of drinking water into the aquifer media beneath the City of Roseville was not likely to cause exceedances of water quality parameters above California Water Quality Objectives (WQOs). Further antidegradation analysis confirmed that although injection of treated drinking water may cause deleterious effects on groundwater quality with respect to DBPs and fluoride, any degradation was not anticipated to adversely affect any current or potential beneficial uses. In addition, the results of the pilot studies indicated that many water quality parameters within the context of the storage area would improve, and the additional benefits garnered by these improvements would greatly outweigh any potential adverse impact.

Overall, this ASR project was found to provide benefit to all the people of California, as storing water during times of plenty will supplement the total supply of the state during times of scarcity (Figure 6).

Constituent	Units	Injected Water [1]	Groundwater Quality			Applicable WQOs [5]
			Pre-Discharge Baseline [2]	During Storage [3]	Down-gradient [4]	
TDS	mg/L	42 - 59	457	59 - 494	377 - 446	500 – 1,500
EC	µs/cm	85	657	74 - 1,115	604 - 666	---
pH	--	8.14	7.2	6.7 - 7.81	7.1 - 7.4	6.5 - 8.4
Chloroform	µg/L	34 - 39	1.76	<0.5 - 59	1.2 – 2.7	80
Total THMs	µg/L	37 - 41	0.8	0 - 61.8	0.9 - 2.7	80
Total HAAs	µg/L	20.4 – 20.7	<1.0	0 - 20.4	<1.0	60
Dissolved Arsenic	mg/L	<0.001	0.003	0.001 - 0.004	0.002 - 0.004	0.004 - 0.01
Dissolved Arsenic	mg/L	<0.001	0.003	0.001 - 0.004	0.002 - 0.004	0.004 - 0.01
Sodium	mg/L	3 - 4	77	9 - 78	66 - 73	20
Nitrate as Nitrogen	mg/L	0.2	5.0	0.2 - 6.4	5 - 6.3	10
Sulfate	mg/L	2.2 - 8	26	9 - 34	21 - 23	250

[1] Average baseline water quality from Barton Road water treatment plant (May 2004 to December 2005 and Draft EIR, Appendix E Section 5.6)

[2] Baseline data collected from DCMW-1, DCMW-2, and DCMW-3 (May 2004 through December 2005)

[3] Date collected from DCMW-1, DCMW-2, and DCMW-3 (May 2006 through June 2007)

[4] Data from DCMW-3 during Phase II ASR Pilot Study post-extraction recovery (July 2007 through March 2008)

[5] California MCLs or Water Quality Limits

Figure 4: Water quality information pertinent to pilot test phase II. (Source: [2])

Figure 5: Position of monitoring wells around the Diamond Creek ASR well. (Source: [2])

Benefits of ASR	Benefits to Roseville	Benefits to the Region and the State of California
Increase water reliability	✓	✓
Drought reserve	✓	✓
Seasonal storage of available space	✓	✓
Emergency system	✓	✓
Peak hour and maximum day flexibility	✓	
Increase yield of groundwater basin	✓	✓
Balance use and timing of surface water supply	✓	✓
Stabilize/Improvement of specific water quality problems	✓	✓
Avoid fishery/ecosystem impact		✓
Improvement of salt balance		✓

Figure 6: Benefits associated with the Roseville ASR project. (Source: [3])

Policy Connections

This ASR project was deemed to qualify for coverage under the General Order. For more information about the General Order, see associated document "Summary of ASR Regulations". Briefly, the General Order is a stipulation that fast-tracks ASR projects in California that meet certain stringent requirements, such as treating injected water pursuant to a drinking water permit. There is still pilot testing and approval required before operation of qualifying ASR wells can begin, but the General Order allows for Regional Water Quality Boards to use a refined methodology for approval, rather than having to scrutinize each proposed project from the ground up.

Despite this robust regulatory structure at the state level, California is not a primacy state when it comes to the authority over Class V wells as classified by the United States Environmental Protection Agency (US EPA) Underground Injection Control (UIC) program. The means that EPA Region 9 are the ultimate regulatory and permitting authority for ASR projects in California.

Economic Considerations

It is difficult to quantify the economic implications of a major water shortage, but certain they would be drastic and adverse. Implementation of the Roseville ASR project as well as other projects of its kind in the state of California would promote water security and reliability to mitigate the detrimental effects associated with a water shortage.

Future Projections

The City of Roseville ASR project seems to have a clear runway ahead for it to take off. Pilot testing as well as antidegradation analysis has been completed and a final Environmental Impact Report (EIR) have been certified by the City.

References

1. "U.S. Drought Portal." *California | Drought.gov*, 20 Mar. 2020, www.drought.gov/drought/states/california.
2. "NOTICE OF APPLICABILITY (NOA) FOR GENERAL WATER QUALITY ORDER 2012-0010-DWQ-RB5S-0001, AQUIFER STORAGE AND RECOVERY PROGRAM, CITY OF ROSEVILLE, PLACER COUNTY." Received by Ms. Cathy Lee, P.E., 18 Apr. 2013.
3. *Antidegradation Analysis for Aquifer Storage and Recovery (ASR)*. City of Roseville - California, 2011, *Antidegradation Analysis for Aquifer Storage and Recovery (ASR)*.
4. *General Waste Discharge Requirements for Aquifer Storage and Recovery Projects That Inject Drinking Water Into Groundwater*. State Water Resources Control Board - California, 2012, *General Waste Discharge Requirements for Aquifer Storage and Recovery Projects That Inject Drinking Water Into Groundwater*.

5. “Aquifer Storage & Recovery.” *City of Roseville - California*, 2020, roseville.ca.us/residents/utility_exploration_center/aquifer_storage_recovery.