An Urban Drought Reserve Enabled by State Groundwater Recharge Legislation: The Bear Canyon Recharge Project, Albuquerque, New Mexico

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ABSTRACT For decades, the city of Albuquerque, NM, relied solely on groundwater for its municipal water supply. However, concerns about long-term sustainability of its local groundwater resources spurred the Albuquerque Bernalillo County Water Utility Authority (the Water Authority) to pursue a groundwater recharge project which could serve as a drought reserve for future municipal use. Aided by new favorable state groundwater recharge legislation and funding, the Water Authority developed the Bear Canyon Recharge Project. The project utilizes portions of the Water Authority's Colorado River water that is unused in a given year, delivering the water to an unlined arroyo channel where it infiltrates into local aquifers. As the first groundwater recharge project successfully implemented in New Mexico, the Bear Canyon Recharge Project required significant local effort to navigate the institutional and regulatory necessities that arose in implementing an onstream recharge project. The project illustrates that state support can be necessary but not sufficient for local implementation of groundwater recharge and points the way for other water utilities in the state who may be looking to implement groundwater recharge projects. KEYWORDS groundwater, managed aquifer recharge, institutions

Overview	
Location	Albuquerque, New Mexico
Groundwater challenges	Declining groundwater levels
Managed aquifer recharge (MAR) motivating factors	Concern for urban water supplies during drought and interest in storing unused shares of Colorado River water for future use
MAR project goal	Develop a drought reserve for municipal use
Recharge method	In-stream infiltration
Water source	Surface water imported from the Colorado River basin via the San Juan—Chama Project
Key actor(s)	Albuquerque Bernalillo County Water Utility Authority (Water Authority)
Nonregulatory challenges	Technical—Demonstrating that water would recharge to the aquifer instead of evaporating; demonstrating that recharged water would meet water quality standards
Regulatory issues	As the first groundwater recharge project in New Mexico, this project dealt with regulatory uncertainties in how permits would be evaluated and approved
Milestones	1999—New Mexico passes the Groundwater Storage and Recovery Act 2005—State study identifies four potential recharge projects across New Mexico, including the Bear Canyon Recharge Project 2008—The Water Authority receives a demonstration permit from the New Mexico Office of the State Engineer (OSE) for the Bear Canyon Recharge Project and conducts the first recharge activities to demonstrate feasibility 2014—The New Mexico OSE issues a permit for full-scale operation of the Bear Canyon Recharge Project and full-scale operations begin
Current status	Fully implemented
Cost	US$1.5 million (estimated) for initial permitting and construction); US$60,000 (estimated) for yearly cost and operation

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INTRODUCTION

The Bear Canyon Recharge Project is the first groundwater recharge project implemented in New Mexico. To recharge the aquifer, the project uses imported water from the Colorado River Basin, recharged in an unlined arroyo channel.[1] The recharged water serves as a municipal drought supply for Albuquerque and is not regularly withdrawn.

The project provides a recent demonstration of how favorable state legislation and financial backing can catalyze new approaches to water management involving groundwater recharge, but also that state-level action must be complemented by local effort for successful implementation. The project was enabled by financial and legislative support from the State of New Mexico, which authorized the project for local benefit. Support included a state-funded study identifying the Bear Canyon Arroyo as ideal for recharge and a state grant for the initial stages of the project. The development of the recharge project was further facilitated by the passage of comprehensive and specific state recharge and recovery legislation.

The case study further highlights the importance of having the Albuquerque Bernalillo County Water Utility Authority (the Water Authority), an agency with significant resources, serve as the first "test case" of the state's new groundwater recharge permitting statute. By collaborating closely, the Water Authority and State of New Mexico were able to work through regulatory issues raised by the new statute. The project illustrates the challenges facing first movers on novel water management approaches generally and the broader benefits that can accrue as their success points to a path for other projects and agencies to follow.

CASE EXAMINATION

Methods

This case study forms part of the journal's special collection entitled "Institutional Dimensions of Groundwater Recharge." The collection examines empirical examples of managed aquifer recharge (MAR) from across the United States to provide insights on the institutional structures and motivations of MAR implementation. An in-depth description of the special collection and its objectives along with a discussion of the wider context of groundwater management concerns that MAR aims to address is included in Miller et al. [1]. Each of the case studies in the collection examines a different physical and institutional design for MAR. Case studies were developed through an analysis of documents and expert interviews. Documents reviewed include reports from governmental agencies implementing the MAR projects, permits and reports from regulatory agencies, state laws and regulations, academic literature and technical reports, and news articles. Interviews were conducted with key individuals involved in development of each project including government officials, regulators, and project implementors.

Local Background

Bernalillo County, home to the city of Albuquerque, is the most populous county in New Mexico. The county sits over the Santa Fe Group aquifer system which, up until 2008, served as the region's sole source of municipal water supply [2]. Water resources in the area are managed by Albuquerque Bernalillo County Water Authority (Water Authority), which serves approximately 678,000 customers [3].[2]

The region has experienced significant groundwater overdraft, as is common in many areas of the arid southwestern United States. After widespread groundwater pumping commenced in the early twentieth century, groundwater levels across Bernalillo County dropped between 40 and 120 feet (figure 1) [5]. The potential for land subsidence as a result of declining water levels raised concerns about sole local reliance on groundwater as a water source and about the overall sustainability of the aquifer [4]. Furthermore, scientific studies throughout the 1990s demonstrated that pumping of the local aquifers was occurring at rates twice as high as natural replenishment [6]. The studies also revealed the aquifer to be smaller than previously believed [7]. In light of these studies, the Water Authority began to plan and implement a strategy for both groundwater recharge and diversification of the city's water supplies. The main components of the strategy included reducing reliance on the aquifer by promoting conservation, developing groundwater recharge projects, and using alternative water sources.[3]

1. The water is chlorinated because it also serves as a water source for irrigating 1,000 acres of greenspace. Water used to irrigate that greenspace is required to be chlorinated because of its potential to come into human contact. Personal Communication, DB Stephens & Associates.

2. Agriculture uses in the area are served by the Middle Rio Grande Conservancy District. Personal Communication, ABCWUA. See also [4].

3. Notably, Albuquerque did not draw water from the Rio Grande. It opened its water drinking treatment plant in 2008 and has only been delivering surface water for 10 years. Hayden [8].

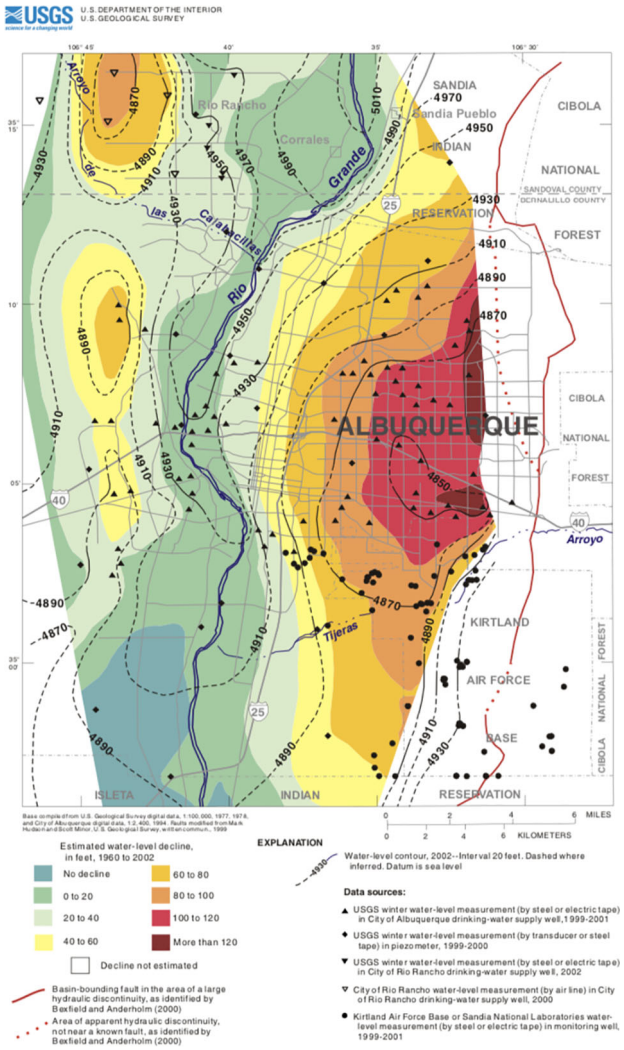

FIGURE 1. Estimated water level declines in the Santa Fe Group Aquifer System, Predevelopment to 2002 (Bexfield and Anderholm, 2002).

Groundwater Storage and Recovery in New Mexico

In 1999, New Mexico passed the New Mexico Groundwater Storage and Recovery Act (the Act). Influenced in part by lobbying from representatives of the Water Authority, the Act contains provisions to support and enable recharge projects with the potential to improve water and environment quality, reduce groundwater level declines, reduce operations and management costs, promote water conservation, serve the public welfare of the state, and lead to more effective use of New Mexico's water resources.[4]

The Act enables governmental entities such as municipalities, irrigation districts, and other defined classes to obtain a permit for groundwater recharge projects.[5] The Act requires groundwater storage and recovery facilities to obtain two state permits: an underground storage and recovery permit (USR permit) from the New Mexico Office of the State Engineer (OSE)[6] and a discharge permit from the New Mexico Environment Department (NMED). USR permits specify a "recoverable amount" for each recharge project. The recoverable amount is the "amount of water, as determined by the state engineer, that has reached the aquifer, remained within the area of hydrologic effect and is conducive to recovery without impairment to existing users."[7] Discharge permits set water quality standards for the project [10].

An application for a USR permit costs US$5,000, plus US$5.00 per acre-foot of the annual capacity of the proposed project, to a maximum of US$50,000.[8] Additionally, USR owners must pay a fee of US$0.50 per acre-foot for water held in storage each year. When applying for a permit, the governmental entity submitting the application must provide evidence of, among other things, financial and technical capability, the source and quality of the source water, the quality of the water in the receiving aquifer, evidence the applicant holds a valid water right, and a project plan.[9] The project plan must:

(a) show that the project will not cause harm to users of land and water within the area of hydrologic effect,
(b) demonstrate that the project is hydrologically feasible,

4. N.M. Stat. Ann. § 72-5A-2.

5. N.M. Stat. Ann. § 72-5A-4(A). As defined by the Act, governmental entities include "the interstate stream commission, and Indian nation, tribe or pueblo or state political subdivision, including a municipality, county, acequia, irrigation district or conservancy district." N.M. Stat. Ann. § 72-5A-3(C). Notably, this definition does not allow private entities to obtain a recharge permit. Such a limitation means that private projects, such as the one sponsored by Ducks Unlimited and discussed in the Heyborne Ponds case study, would not be possible in New Mexico. Milman et al. [9].

6. The Groundwater Storage and Recovery Act gave authority to the New Mexico Office of the State Engineer (OSE) to permit groundwater recharge projects and laid out the steps for obtaining a permit. Pursuant to the Groundwater Storage and Recovery Act, OSE issued Section 19.25.8 of the New Mexico Administrative Code which added details to the application process and requirements, the hydrologic, technical and financial capability report requirements, and the permit terms and conditions for projects. http://164.64.110.134/parts/title19/19.025.0008.html.

7. N.M. Stat. Ann. § 72-5A-9.

8. N.M. Stat. Ann. § 72-5A-4(B)(1).

9. N.M. Stat. Ann. § 72-5A-4(B)(2)-(15).

(c) demonstrate that the project will not impair existing water rights or the state's interstate obligations,
(d) demonstrate that the project will not be contrary to the conservation of water within the state, and
(e) demonstrate that the project will not be detrimental to the public welfare of the state.[10]

USR permits are not considered effective until an applicant obtains all required permits from other state and federal agencies.[11] The OSE may also permanently revoke or suspend a USR permit if the permit holder fails to follow the permit terms and conditions.[12]

In order to receive a full-scale permit from the OSE, each USR project must first receive a demonstration project permit and operate a demonstration project for a period of time that is determined on a project by project basis by the OSE. If the project meets the requirements set by the OSE (i.e., demonstrates enough water is being recharged), it can be considered for a full-scale operations permit.

Once water is recharged to an aquifer, it is considered the property of the project owner rather than public water.[13] Recharged water is not subject to the state forfeiture provision, which normally holds that water unused for 4 years is forfeited.[13] Water recovered from storage can only be used for the purposes for which it was authorized prior to storage, unless the applicant applies for a change in the purpose of use.[14] Illegal recovery or use of stored water is punishable by a fine of US$10,000 per day.[15]

Taking Pressure Off Groundwater Resources: The 2008 San Juan-Chama Drinking Water Project

New Mexico holds an allotment of 11.25% of the water from the Upper Colorado Basin states' annual allocation of 7.5 MAF under the Colorado River Compact [11] or roughly 843,750 AFY. Although a majority of the Colorado River Compact allocation is utilized for irrigation

FIGURE 2. A map of the San Juan Chama Project, which supplies water to both the San Juan-Chama Drinking Water Project and the Bear Canyon Recharge Project. Source: ABCWUA.

purposes, the state diverts approximately 96,200 acre-feet per year through the U.S. Bureau of Reclamation's San Juan-Chama Project [12]. Water is diverted from the San Juan River (a tributary of the Colorado River) to a reservoir near the confluence of Willow Creek and the Rio Chama (a tributary to the Rio Grande; figure 2) [12, 13]. Stored water is released from the reservoir into the Rio Chama to make water deliveries downstream.

In the early 1990s, it became clear that Albuquerque's unchecked use of the Santa Fe Group aquifer system was unsustainable. Investigations showed the aquifer's size had been overestimated. To meet increasing water demand, the Water Authority needed to find an alternate primary water source. The Water Authority decided to begin treating and distributing San Juan-Chama Project surface water that it had previously purchased and was at that time leasing to other utilities. The San Juan-Chama Drinking Water Project (SJCDWP) began operation in 2008 and now provides 60–70% of Albuquerque's

10. These requirements (such as what amounts to "detrimental to public welfare") are not defined specifically in the statute. N.M. Stat. Ann. § 72-5A-4(B)(11).
11. N.M. Stat. Ann. § 72-5A-6(C).
12. N.M. Stat. Ann. § 72-5A-11.
13. N.M. Stat. Ann. § 72-5A-8(A).
14. N.M. Stat. Ann. § 72-5A-8(B).
15. N.M. Stat. Ann. § 72-5A-12(2). Other violations of permit conditions—those not related to the illegal recovery or use of stored water—are punishable by a fine of US$100 per day of violation. N.M. Stat. Ann. § 72-5A-12(1).

water supply [14]. The switch to surface water diversion allowed the city to begin to restore the overtaxed Santa Fe Group aquifer system and use it as an emergency source of clean water in the case of contamination of San Juan-Chama water or drought [12, 15].

Restoring the Groundwater Levels: The Bear Canyon Recharge Project

In 2005, a state study identified four potential groundwater recharge projects across New Mexico. The report included the Bear Canyon Arroyo as a possible candidate, citing Albuquerque's ready supply of water for the project, favorable hydrogeology at the arroyo, and existing infrastructure to transport the water to the site [10].

In 2008, the Water Authority received a demonstration permit from the OSE for the Bear Canyon Recharge Project. The demonstration project released diverted water from the San Juan-Chama Project into an arroyo to infiltrate into the aquifer during the winter months. Following the successful completion of the demonstration project, the Water Authority received a permit for full-scale operation of the Bear Canyon Recharge Project, which allowed them to recharge up to 3,000 AFY beginning in November 2014.

THE RECHARGE PROCESS. The Water Authority holds a perpetual contract for 48,200 AFY from the San Juan-Chama Project, which is delivered to the Rio Chama and flows into the Rio Grande [16]. Water is pulled from the Rio Grande through Ranney wells located about 60 ft. below the riverbed. This water is chlorinated at the point of diversion and delivered by the existing North I-25 Reclamation and Reuse System to a nonpotable reservoir tank located at the top of the existing Arroyo del Oso Reservoir.[16]

To conduct recharge, water is released from the reservoir tank through an outfall pipe into a half-mile-long unlined segment of an arroyo. As water flows through the arroyo channel, it infiltrates into the streambed sediments. A flow meter measures the amount of water released from the outfall into the arroyo. From the streambed, the water flows through the unsaturated zone between the land surface and groundwater table (the vadose zone) and into the underlying aquifer (figure 3)

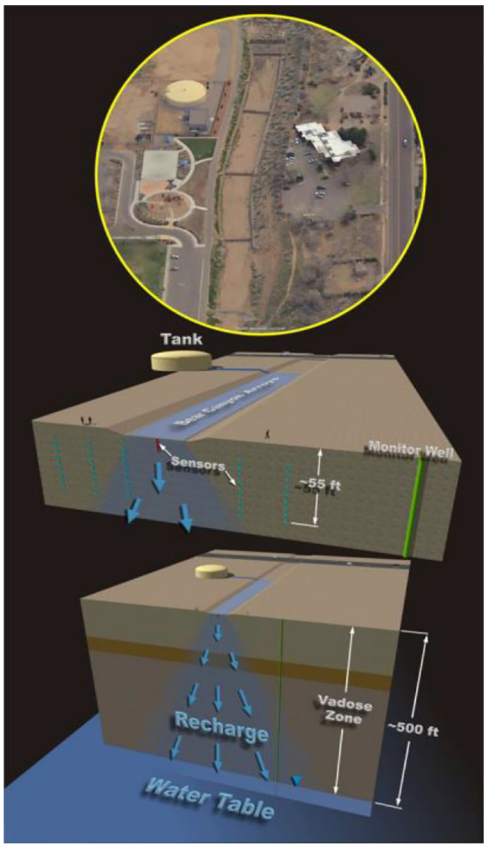

FIGURE 3. The Bear Canyon Recharge Project releases water from a storage tank to an unlined segment of an arroyo. Source: ABCWUA.

[19]. Because water is not directly injected, the Water Authority is not required to treat the water to drinking water standards before infiltration.[17]

Instream infiltration used in the project takes advantage of favorable hydrogeologic conditions along Bear Canyon Arroyo.[18] Notably, the source water for recharge is similar in quality to native groundwater. The arroyo used in the project overlies portions of the ancestral Rio Grande and the groundwater located beneath the recharge site is the result of alluvial groundwater recharge which occurred thousands of years ago.[18]

The Bear Canyon Recharge Project is permitted to release a maximum of 5.6 million gallons per day from the outfall pipe for recharge, with a maximum of 3,000 AFY [18]. Currently, the Water Authority recharges the arroyo every other year, so that it can replenish the water

16. Personal Communication, DB Stephens & Associates. Water in the reservoir is used to irrigate Arroyo del Oso soccer fields and golf courses. U.S. Bureau of Reclamation [17], Moore [18].

17. Personal Communication, DB Stephens & Associates. Moore et al. [20].

18. Personal Communication, DB Stephens & Associates.

stored in the reservoir from two calendar years during one recharge event. Each recharge event recharges 600 AF.[18]

Recharge can occur anytime that the arroyo is dry during the months of October through March. The Water Authority must immediately halt recharge for 24 h if surface water flow is detected in the channel used for recharge, for two reasons. First, in the event of native surface flow during a storm event, water intended for recharge would flow past the infiltration reach rather than being recharged. The second reason for this requirement pertains to liability. Although the project is operated in the cold and dry winter months, precipitation during the recharge period is still possible. Precipitation combined with active recharge could exacerbate the risk that stormwater flows through the arroyo could overflow a paved pathway located at the end of the arroyo and form an icing hazard.

ACCOUNTING. The Water Authority developed a robust accounting system in order to demonstrate to both the public and regulators that (1) the water being released into the arroyo channel would infiltrate into the aquifer rather than evaporate and (2) the water being recharged would meet quality standards.18 To monitor instream infiltration during the demonstration phase, water was tracked at various points along its flow path from the arroyo bed, through the vadose zone, and into the underlying aquifer [18]. Temperature sensors, heat dissipation sensors, lysimeters, and neutron logging are used to track water and the rate of infiltration as it moves to the water table [18]. Lysimeters were also installed at various depths to monitor the quality of water as it moves toward the aquifer [18]. Results from the project's demonstration phase showed little water was lost through evapotranspiration in the vadose zone or during storage [18].

Based on extensive monitoring during the demonstration phase, 97% of the water discharged to the instream reach is considered to reach storage. This estimate accounts for 1% loss of water to evaporation, 1.5% attributed to vadose zone storage, and 0.5% attributed to meter uncertainty. The Bear Canyon project overall has a storage limit of 10,000 AF.[19] Currently, 1,405 AF are in storage.[20]

19. New Mexico Office of the State Engineer. *USR-2 (Bear Canyon Underground Storage and Recovery Project) Modified Conditions of Approval.* Copy on file with author.

20. Personal Communication, ABCWUA.

The amount of recoverable water is calculated every year, based on the net amount of recharged water remaining in storage after accounting for all recharge inflows and recovery outflows for the year. Throughout the year, the Water Authority submits monthly reports of daily discharge amounts to OSE. No later than June 30 of every year, the Water Authority is required to submit an annual report for the preceding recharge period. This report must include:

1. the total quantity of stored and recovered water;
2. the water quality of the stored water, the receiving aquifer, and the recovered water; and
3. a measurement of the static level of the water table.[21]

The USR permit for the Bear Canyon Recharge Project also requires the Water Authority to inform the OSE of its conservation efforts and an estimate of both its monthly and annual per capita water use.[19] After the report is filed, but before the start of each recharge season, the Water Authority and OSE meet and use this reported information to review the recharge, operating plan, and modeling of the project and to update the calculated amount of recharge credits.

In addition, the project is subject to the terms of a discharge permit issued by the NMED Ground Water Quality Bureau for water released from the reservoir tank to the arroyo. The discharge permit determines applicable water quality standards for the project and monitoring terms. Water quality standards are set by the New Mexico Water Quality Control Commission. The project must meet all New Mexico primary drinking water maximum contaminant levels and cannot exceed total nitrogen of 10 mg/L. If an exceedance occurs, the Water Authority must immediately cease discharging water into the arroyo, notify NMED, and create a corrective action plan to remedy the exceedance [21]. Groundwater is sampled at least three times each year—once before the recharge period begins, 1 month after it begins, and 1 month before it ends [21]. Water held for recharge in the storage tank is similarly tested 1 month before recharge operations begin and again 1 month before recharge operations stop [21]. Similar to the OSE permit, the Water Authority submits yearly water quality reports to NMED for the project [21]. If the Water Authority plans not to operate the

21. N.M. Stat. Ann. § 72-5A-10.

project in a given year, it must give notice to NMED prior to the recharge operation season.

RECOVERY. Recharged water is recovered through the Water Authority's existing groundwater well network. As of 2019, the Water Authority has not needed to recover a significant amount water as part of this project as water supplies from other sources have been sufficient to supply customers' needs. About 300 AF was recovered to demonstrate the ability to recover water and to establish the procedure and accounting method for doing so with the OSE.[20]

COSTS AND FINANCING. The Bear Canyon Recharge Project received initial financial support from the State of New Mexico, with ongoing costs paid for by ratepayers. The project was originally funded by New Mexico's US$10 million Water Innovation Fund (WIF). Under the WIF, the New Mexico Department of Finance and Administration conducted a study that identified potential groundwater recharge projects to implement in New Mexico [10]. The WIF provided initial funding for the identified projects, including the Bear Canyon demonstration project [10], for which the Water Authority received US$500,000 for the initial project demonstration phase.[22] Expansion to the full-scale project was funded by ratepayers. Altogether, the initial capital cost of the project required significant up-front investment, totaling approximately US$1.5 million over the first 4 years.[23] The estimated ongoing operations and maintenance cost for the project is US$60,000 per year, which is paid for by ratepayers as part of the Water Authority's charges for water and wastewater services.[20]

Success Factors and Challenges

Two major external factors contributed to the success of the Bear Canyon Recharge Project: (1) the passage of groundwater recharge specific legislation and (2) heavy state investment through studies and grants.

New Mexico's specific legal requirements for recharge projects provided the Water Authority with a relatively clear process for obtaining proper permits and agency approval. However, the time line for the creation and implementation of the Bear Canyon Recharge Project illustrates both the helpfulness and the implementation realities of creating specific legal requirements for groundwater recharge projects. As the first recharge project in New Mexico, obtaining the permits for the Bear Canyon Recharge Project took a significant amount of time. Not including a few years during which the project was stalled, the total time from pursuing the demonstration project and receiving the final full-scale permit took approximately 6 years of cumulative work.[20] This long time frame indicates that although legal affirmation of the right to recharge and a clearly defined process of how to do so are important for enabling MAR, a burdensome and lengthy permitting process can slow the development of MAR projects in spite of apparent legal clarity, at least for first movers. Similarly, the OSE requirement that groundwater recharge and recovery projects complete a demonstration phase has both positive and negative sides. On one hand, requiring a demonstration phase guarantees that projects will work as designed and prevents the potential waste of water and money to inefficient projects. On the other hand, requiring a demonstration phase may lead to higher project costs and a greater investment of time. As more recharge projects are implemented in New Mexico, permit applicants and state agencies overseeing the process will likely iron out the permitting requirements and the times required for permitting may decrease.

Second, New Mexico dedicated state resources to investigate potential recharge sites and identified the Bear Canyon site as an ideal candidate for groundwater recharge. The state also provided financial support by funding the initial demonstration phase through the state Water Innovation Fund which took some financial burden away from the Water Authority. Without the US$500,000 grant awarded under the Water Innovation Fund, the Water Authority would have had to fund the project entirely on its own. Given the newness of recharge at that time and the novelty of recharge in the state, state funding made local acceptance easier. Overall, the state's involvement lowered the risk exposure of the Water Authority and made taking a chance on a new type of water supply project more palatable.

Finally, although the Bear Canyon Recharge Project itself has been successful from a technical standpoint, the project is permitted to store only a relatively small amount of water compared to the needs of Albuquerque. Although recovery operations have been demonstrated, the project has not yet fully proven itself by operating during a drought. To help shore up its supply even

22. Personal Communication, DB Stephens & Associates. Reese [22].

23. This cost included drilling costs, equipment installation, and permitting. Personal Communication, DB Stephens & Associates.

further, the Water Authority is developing an additional recharge facility, which is currently in the demonstration phase of permitting.[24]

CONCLUSION

The Bear Canyon Recharge Project is New Mexico's first fully implemented MAR project after the passage of the 1999 New Mexico Groundwater and Storage Recovery Act. Although offering a relatively modest recharge effort of only 600 AF during recharge events, the project adds a new management tool to the Water Authority's efforts to restore groundwater levels in the Albuquerque area after decades of aquifer overuse. Moreover, storing water in the aquifer allows the city to withstand potential disruptions in water supply should the SJCDWP experience a service disruption.

Access to adequate funding was integral to the project's success. As the largest water utility in New Mexico with an annual operation budget of well over US$170 million, the Water Authority has the ability to take on innovative projects that other agencies may lack the funds for or the institutional capacity to implement. With its significant funds and institutional structure, the Water Authority was able to spend the necessary time and money to iron out permitting and technical requirements for the Bear Canyon Recharge Project. State financial support also played a key role in the implementation of the project. The extensive research taken by the state to discover favorable recharge sites specifically supported the development of this project. Funding for the demonstration phase of the project was largely taken from the WIF, with Water Authority ratepayers able to provide a funding source for ongoing operation costs. This additional funding and agreement from stakeholders was pertinent to the project's success.

Groundwater legislation from the state also made the project possible. By creating a clear statutory path that outlined the obligations, responsibilities, and standards for both recharge applicants and state agencies, New Mexico headed off potential confusion over which laws and regulations applied to the project. Without this type of direct legislative guidance, it is unclear whether the OSE and the Water Authority would have been able to bring the project to fruition without a substantial delay. Nevertheless, although legislative action enabled and spurred action, the development and implementation of the Bear Canyon project took significant effort on the part of local proponents. Particularly given that it was the first project implemented under the new laws, local leadership was crucial for developing a project with a viable set of technical, accounting, and regulatory components.

In addition to the added benefit of water supply security for the city, implementation of the Bear Canyon Recharge Project further provided a larger statewide benefit by serving as a pathfinding project for the New Mexico Groundwater Storage and Recovery Act. Lessons learned from this process will hopefully save other smaller water agencies time and money in the future as they implement their own groundwater recharge projects. Ultimately, the Bear Canyon Recharge Project is just one resource in the Water Authority's water supply portfolio, yet as the first recharge project in New Mexico, it is a locally pathbreaking one. It has proved the feasibility of developing such a project in the state, leading the Water Authority to develop further groundwater recharge and recovery operations and paving the way for other agencies to do the same.

KEY TERMS AND ACRONYMS

(Act) *New Mexico Groundwater Storage and Recovery Act*—A state law passed in 1999 which set up a statutory procedure to apply for, and receive, a groundwater recharge permit from the OSE.

(AF) *Acre-feet*—A volume of water that would cover one acre at the height of one foot. Equivalent to 325,851 gallons or 1,233 cubic meters.

(AFY) *Acre-feet per year*—Denotes the number of acre-feet allocated, recharged, or diverted in a calendar year.

(Bear Canyon Recharge Project, or project) *Bear Canyon Recharge Project*—A groundwater recharge project within the City of Albuquerque which releases surface water into an unlined arroyo.

(MAR) *Managed Aquifer Recharge*—Intentionally inducing water to flow into an aquifer, typically through a project that utilizes specific infrastructure.

(NMED) *New Mexico Environment Department*—The New Mexico state agency responsible for monitoring water quality in the state. NMED is responsible for overseeing the water quality of groundwater recharge projects in New Mexico and issuing discharge permits.

24. This project, called the Drinking Water Treatment Plant Large-Scale Recharge Project, will use injection wells to store up to 5,000 AFY of potable San Juan-Chama water. Ewing [23], Daniel B. Stephens & Associates, Inc. [24].

(OSE) *New Mexico Office of the State Engineer*—The New Mexico state agency responsible for allocation and management of water resources in the state. OSE is one of the permitting authorities for groundwater recharge projects in New Mexico.

(SJCDWP) *San Juan-Chama Drinking Water Project*—A water supply project operated by the Water Authority. Water supplied by the San Juan-Chama Project is diverted by the Water Authority to a treatment facility, where it is then distributed to the citizens of Albuquerque for use.

San Juan-Chama Project—An interbasin water transfer project operated by the U.S. Bureau of Reclamation. The Water Authority holds rights to 48,200 AFY from the project.

(Water Authority) *Albuquerque Bernalillo County Water Utility Authority*—The water utility authority for the City of Albuquerque, New Mexico, and the surrounding Bernalillo County area.

(WIF) *Water Investment Fund*—A statewide fund that provided initial funding to promising water projects.

AUTHOR CONTRIBUTIONS

KM researched and wrote the original draft. MB and MK contributed to research and writing. MK conceptualized, secured funding for, and managed the project.

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COMPETING INTERESTS

The authors have no competing interests.

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