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Attn: Tom Barnes,
ESA 626 Wilshire Boulevard, Ste. 1100
Los Angeles, CA 90017
Telephone: 213-599-4300
Fax: 213-599-4301

COMMENTS ON THE CADIZ CONSERVATION, RECOVERY, AND STORAGE PROJECT DRAFT ENVIRONMENTAL IMPACT REPORT

Dr. Newsha Ajami
Pacific Institute
654 13th Street,
Oakland, CA 94612
510-251-1600
www.pacinst.org

Summary

The Pacific Institute, an independent non-partisan research institute in Oakland, California, has reviewed the Draft Environmental Impact Report (DEIR) for the Cadiz Groundwater Recovery and Storage Project, released in December 2011. Based on that review, we find several critical flaws and limitations of the DEIR. Specifically, we find that:

- There are considerable, unresolved uncertainties about natural recharge and evaporation rates, which call into question the viability of the project.
- The project relies on overdrafting the groundwater basin, with highly uncertain recovery times.
- The cumulative water conservation via preventing evaporative loss from the Cadiz and Bristol Dry Lakes is greatly over-estimated.
- The proposed alternative pumping scenario may lead to irreversible perturbations of the groundwater basin.
- The DEIR fails to adequately demonstrate that the springs and groundwater basin are not connected.
- Groundwater overdraft could have significant impacts on the springs and critical desert habitat.
- The Groundwater Management Plan will miss significant impacts after project completion.
- The DEIR ignores the potential impacts of a long-term drought or climate change on recharge and evaporation rates.

Below, we provide additional information on each of these findings. We note that while this brief focuses on natural recharge estimates and the potential impacts of the project on natural springs, the project raises a number of other major concerns not addressed here.

Project Background

Cadiz Inc. (Cadiz) owns approximately 70 square miles (34,000 acres) of property in the Cadiz and Fenner Valleys. The land overlays a vast alluvial groundwater basin within the Fenner Watershed and the Blossom Wash, located in the Eastern Mojave Desert. It is estimated that this basin holds approximately 17 million to 34 million acres-feet (AF) of fresh groundwater (CH2M Hill, 2010). The annual average precipitation (both rainfall and snowfall) ranges from 4 inches in Cadiz Valley to 12 inches in the surrounding mountains. The groundwater basin is naturally recharged through percolation of precipitation in fractured bedrock exposed in mountainous terrains and infiltration of ephemeral stream flow in washes, especially in higher elevations of the watershed. The most recent estimated rate of annual natural recharge in the basin ranges between 5,000-33,000 acre-feet per year (AFY) (Table 1). The basin naturally drains toward the Bristol and Cadiz Dry Lakes, where some of the water evaporates.

Cadiz is proposing to develop a two-phase groundwater recovery and storage project ("the project") that would serve some of the water districts in southern California for the next 50 years. The first phase of the project is designed to extract and convey an average of approximately 50,000 AFY of groundwater from a wellfield in Fenner Gap to southern California water users through the Colorado River Aqueduct (CRA). The second phase is to develop a conjunctive use project to recharge the basin at the Fenner Gap with surplus water from the Colorado River or the State Water Project, when (and if) it is available, and to extract it during drought years. Cadiz has joined forces with a few Southern California water agencies, including Santa Margarita Water Agency (SMWA), Three Valleys Municipal Water District, Suburban Water System, Golden State Water Company, Jurupa Community Services, and California Water Service Company, to help move the project forward. SMWA is currently acting as the lead agency for the project's California Environmental Quality Act (CEQA) environmental review and permitting.

Comments on the Draft Environmental Impact Report

There are Considerable, Unresolved Uncertainties about Natural Recharge and Evaporation Rates, which Call Into Question the Viability of the Project

During the past few decades, there have been several attempts to estimate the natural recharge rate in the basin. Table 1 presents a summary of estimated recharge rates by various research and consulting groups, showing the large variability among the estimates, even when the same methodology was used. In 1975, for example, the California Department of Water Resources estimated that the natural recharge rate was 3,000 AFY (California Department of Water Resources, 1975). More recent estimates range from 5,000 to 30,000 AFY (Durbin, 2000; CH2M Hill, 2011). It is of note that most of the high recharge estimates presented in Table 1 have been commissioned by Cadiz and done in support of the project. Given the importance of recharge to the project, this high degree of uncertainty poses tremendous risk to the viability of the project and its overall environmental impact.

Table 1: A summary of the recharge estimates

Investigator (Date)	Methodology	Estimated Recharge Rate (AFY)
California Department of Water Resources (1975)	Not provided	3,000
Freiwald, USGS (1984)	Darcy's Law	270
Todd, Consulting Engineer (1984 a,b)	Darcy's Law	11,000
GEOSCIENCE Support Services Inc. (1991)	Darcy's Law using site-specific data	6,300
GEOSCIENCE Support Services Inc. (1995)	Darcy's Law using additional site-specific data	13,000-33,000
GEOSCIENCE Support Services Inc. (1999)	Watershed Model	15,000-37,000
US Geological Survey-WRD "Comment Letter" (2000)	Maxey-Eakin Model	5,000
Bredehoeft (2000)	Maxey-Eakin Model	5,000-6,000
Davisson, LLNL (2000)	Maxey-Eakin Model and Isotopic analysis of groundwater	11,000-33,000
CH2M Hill (2010)	INFIL 3.0 Soil-Moisture Budget-USGS	30,000

Project Relies on Overdrafting the Groundwater Basin With Highly Uncertain Recovery Times

Despite the high uncertainties about the recharge, the project as designed is clearly unsustainable, since the proposed average water extraction scenario (50,000 AFY) exceeds even the most optimistic recharge rate (32,000 AFY). Even under this scenario, the groundwater basin is overdrafted by an average of 18,000 AFY, and Cadiz is considering even higher overdraft rates in the early years of the project. Figure 1 illustrates the groundwater storage condition for an annual extraction of 50,000 AFY over 50 years and a 50-year recovery period that commences after the project is terminated under three recharge scenarios: 1) 32,000 AFY, 2) 16,000 AFY, and 3) 5,000 AFY. As shown, under the most optimistic recharge rate, 32,000 AFY (a number provided by Cadiz consultants rather than independent scientists), the groundwater basin needs approximately 30 years to recover to pre-project levels after the end of the 50-year operation. Under the intermediate recharge estimate (16,000 AFY), more than 100 years are required for the groundwater basin to refill and recover. Under the low recharge estimate (5,000 AFY), the groundwater basin effectively never recovers; indeed, we estimate that at least 450 years would be required under current climatic conditions to recover from the 50-year operation under this scenario.

While groundwater levels can recover in some areas and under some conditions, groundwater overdraft raises two major concerns. First, the land might subside and collapse before the underground basin has a chance to refill and recover from overdrafting (Figure 1). Once the land subsides, the potential groundwater storage is permanently lost. They estimate that the cumulative land subsidence in various parts of the basin after 100 years is between 0.2-0.9 feet under Scenario 1 with a recharge rate of 32,000 AFY and between 0.7 and 2.7 feet under Scenario 3 with a recharge rate of 5,000 AFY (GEOSCIENCE Support Services Inc., Sep, 2011a). Second, overdraft can lead to saline water intrusion from surrounding areas. This degradation of the groundwater is a real possibility in this part of the Mojave Desert.

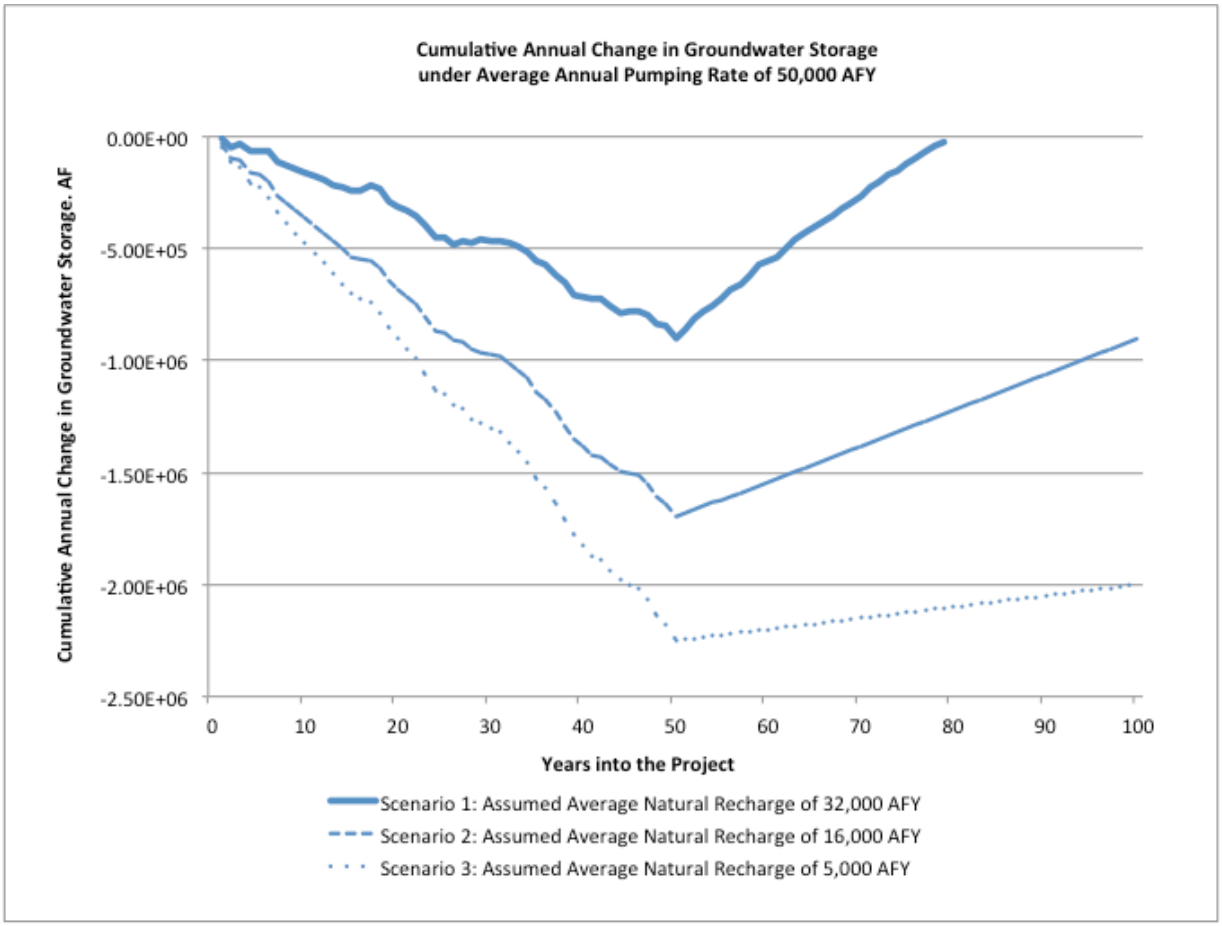

Figure 1: Cumulative Annual Change in Groundwater Storage[1]

[1] This graph was prepared by the Pacific Institute based on the information provided in the DEIR. A similar graph is presented in Appendix H1_Part 1 (Figure 76 in Geoscience, 2011a). The difference between the two graphs under the 32,000 AFY recharge scenario is related to evapotranspiration estimates from the Dry Lakes.

The Cumulative Water "Conservation" via Preventing Evaporative Loss from the Cadiz and Bristol Dry Lakes is Greatly Over-Estimated.

Cadiz claims that the project is maximizing beneficial use of water that otherwise would be lost through evaporation from the Cadiz and Bristol Dry Lakes. By changing the depth of the water table at the Fenner Gap through an average pumping rate of 50,000 AFY, they plan to reverse the groundwater flow to the Dry Lakes playas, preventing evaporative loss ("lost" water) from the Lakes. They argue that the pumping rate should be higher than the assumed 32,000 recharge rate (the high end of estimated recharge rate, Table 1) in order to deplete the groundwater storage and draw down the water depth at the Fenner Gap to the level that would reverse the hydraulic gradient.

In the supplemental study, the Net Water Savings (NWS) is calculated as a difference between Reduced Evaporative Loss (REL) from the Dry lakes and Depletion of Storage (DS) over 100 years, giving the basin an additional 50 years to recover and refill after the project ends and pumping is terminated. Their analysis demonstrates that cumulatively after a 100-year period, a considerable amount of water will be "saved" (preventing evaporative loss from the Dry Lakes) under 32,000 and 16,000 AFY natural recharge rates (1,990,000 AFY and 674,000 AFY, respectively). However, if the natural recharge is only 5,000 AFY the results demonstrate no cumulative net water savings.

A few other things to consider regarding the analysis:

- Analyzing these results after 50 years (by the end of the project term) demonstrates a considerably smaller cumulative NWS of 260,000 AF under the 32,000 AFY natural recharge rate. Therefore, most of the reported water saving of 1,990,000 AF in the DEIR happens after the end of the project when the pumping stops and natural recharge starts replenishing the aquifer storage to its natural state. The DEIR fails to evaluate the consequences if the recharge rate decreases considerably (i.e., under a long-term drought or more permanent climatic changes) and the aquifer is not replenished in the expected rate.
- The project would not have any NWS under the 16,000 AFY natural recharge rate by the end of the project term (50 years), because the proposed average pumping rate (50,000 AFY) will lead to overdrafting of the storage. The groundwater basin may need another 100 years to possibly deliver some net savings, if any (Figure 1).
- Under the 5,000 AFY recharge scenario, there will be no net water saving and the basin will suffer from a considerable and possibly unrecoverable state of storage depletion (Figure 1). Such overdrafting can cause intrusion of saline water from beneath the Dry Lakes playas into the fresh water aquifer and, as noted above, lead to land subsidence.

Proposed Alternative Pumping Scenario May Lead to Irreversible Perturbation of the Groundwater Basin

The project proponents consider an alternative pumping scenario, which would increase the pumping rate to 75,000 AFY for the first 25 years and 25,000 AFY for the remaining 25 years. This scenario is economically more beneficial to Cadiz, as it allows them to extract 550,000 AF more water earlier in the project, thereby maximizing early profits in case the project has to be terminated after 25 years due to environmental impacts. This approach, however, can have significant impacts on the groundwater basin. For example, if the natural recharge rate is 5,000 AFY, this scenario leads to significant non-renewable mining within the first 25 years, which has a higher risk of causing significant and irreversible damage to the groundwater basin. When analyzing this alternative pumping scenario, GEOSCIENCE failed to evaluate the possible impacts under a natural recharge rate of 5,000 AFY.

The DEIR Fails to Adequately Demonstrate that the Springs and Groundwater Basin Are Not Connected

According to the survey conducted by Freiwald (1984) for the US Geological Survey and the Bureau of Land Management, the Lanfair and Fenner Valleys include naturally occurring springs at higher elevations. The closest of these springs to the project's production wells and spreading basin is the Bonanza Spring, which located more than 11 miles north of the Fenner Gap in the Clipper Mountain. The DEIR includes a study and a field survey prepared by CH2M Hill (2011) assessing the possible impacts of the project on these springs -- especially Bonanza Spring -- under various recharge scenarios with an average withdrawal of 50,000 AFY. The technical memorandum states that, "there is **no information** demonstrating a physical connection of the identified springs in the local mountains to groundwater in the alluvial aquifer where Cadiz's pumping will take place" (CH2M Hill 2011, page 1). The DEIR suggests that the springs are therefore not hydraulically connected to the groundwater basin. The lack of evidence of any connection, however, is ***not*** the same as evidence for a lack of connection. This sentence could just as easily have said "there is no information demonstrating that the springs are not connected hydraulically to the alluvial aquifer where Cadiz's pumping will take place." Their subsequent argument that "the project would not likely to have any impact on springs" is, therefore, inaccurate and not based on substantive and conclusive information.

Groundwater Pump Could Have Significant Impacts on the Springs and Critical Desert Habitat

As part of their study, the project proponents developed a conceptual model to analyze possible impacts of the project under the assumption that there exists a hydraulic continuity between groundwater aquifer and the groundwater feeding springs. They assume various hydraulic continuity scenarios and vary the recharge rate and location during their study. The results under most of these cases are

consistent, demonstrating a lag time of about 50 years between the time the project is in operation and the time the springs would be impacted. This lag time is mostly caused by the distance of the springs from the project elements and the rate that impacts migrate through the aquifer. Their results show that a 10 feet drop in groundwater levels could result in a gradual drawdown between 1.5 to 6.5 feet at the springs from the time the project is ended (after 50 years) to 450 years after that until the basin reaches a new steady state. In a parallel study, the GEOSCIENCE Support Services Inc. (GEOSCIENCE 2011b) estimated that at the end of 100 years (50 years after termination of pumping), the water table decline at the wellfield could be 5 and 55 feet for a recharge rate of 32,000 to 5,000 AFY, respectively. This would translate into a much larger decline of water level at the springs after 100 years. Such an impact could effectively eliminate these water sources, which provide water to critical desert habitat.

Groundwater Management Plan Will Miss Significant Impacts After Project Completion

Cadiz has put together a Groundwater Management, Monitoring, and Mitigation Plan (GMMMP). The plan proposes to manage some of the impacts through careful monitoring of the watershed. However, as the model results show, serious impacts may be delayed in time until many years after the project is completed. Real-time and early warning signs can be subtle. Therefore, monitoring during the project term cannot lead to effective and timely impact management and mitigation.

DEIR Ignores the Potential Impacts of a Long-Term Drought or Climate Change on Recharge and Evaporation Rates

Large changes in the natural recharge rates could render all of the project analysis as either incorrect or at least incomplete. If the recharge rate is less than in the past or if the evaporation rates are higher, then the long-term effects of the project might be even more significant than assessed in the DEIR. The DEIR does not include any site-specific analyses demonstrating possible impacts of the climate change on the Cadiz groundwater basin. In their climate change discussions, they rely on various climate change impact studies conducted with a focus on California and Western United States. They conclude that "due to the great uncertainty in the ongoing studies of the effect of climate change on groundwater, it is not possible to predict whether annual recharge rates at the Project site will increase, decrease, or remain the same due to climate change."

Concluding Remarks

Based on our review of the Cadiz DEIR, we find several critical flaws and limitations. Cadiz claims that the project will facilitate the beneficial use of groundwater that would otherwise be "lost" to evaporation at Bristol and Cadiz Dry Lakes. The project proponents' characterization of the water lost to evaporation as non-beneficial, however, is inaccurate in two ways. First, some of the water that evaporates from the basin is "beneficial" to local ecosystems, and these ecosystems would be adversely

affected by removal of this water. Second, the project is intentionally designed to mine groundwater at a rate exceeding natural recharge. In other words, it uses water in excess of the estimates of the water lost to evaporation, which is a non-renewable use of groundwater.

We note, however, that even with the information and range of uncertainties provided by the DEIR, the project is clearly unsustainable from a hydrological and ecological perspective, given both the characteristics of project design and the remaining unresolved uncertainties about the regional hydrology, including a growing uncertainty about the likelihood of availability of any surplus water at all from the Colorado River system – an issue we do not address here but is fundamentally tied to both project recharge and economics.

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