GROUNDWATER STEWARDSHIP COMMITTEE

October 2011 Summary of Findings and Recommendations
Cadiz Groundwater Conservation, Recovery and Storage Project

The Groundwater Stewardship Committee (GSC) is a multi-disciplinary panel of earth science and water professionals assembled to provide advice and comment on the proposed Cadiz Conservation, Recovery and Storage Project (Project). The GSC specifically reviewed:

1) Project operating strategies to maximize the beneficial use of groundwater without causing harm to the resource, natural and built environment and community, and

2) proposed monitoring and mitigation strategies to be incorporated into a groundwater management plan for the Project.

Maximizing beneficial use of groundwater is defined as reducing the loss of groundwater to evaporation from the dry lakes by pumping and delivery of this water to meet Southern California water demands. The roster of the GSC members is attached.

Project background.

The Project site is located at the base of the Fenner Valley Watershed and Orange Blossom Wash upgradient of the Bristol and Cadiz Dry Lakes. The combined area of these watersheds is in excess of 1,300 square miles. Cadiz, a private company, owns land, under which the bulk of the groundwater flows, and on which the Project facilities will be located. The GSC understands that the Company has access to the ARZC Railroad right of way that provides private pipeline access to the Colorado River Aqueduct. The GSC understands that Cadiz actively farms approximately 1,500 acres under prior land use approvals and could expand the operation to as many as 9,600 acres.

As proposed, the Project would be implemented in two phases. The first phase emphasizes control of hydraulic gradients by groundwater pumping that would provide for:

1) active capture of natural recharge, within the watershed, and

2) recovery of groundwater, presently in storage, that would otherwise continue to flow under natural gradients toward the dry lakes and be lost to evaporation.

The Project would withdraw an average of 50,000 acre-feet per year (AFY) over a 50-year period, with individual annual extractions varying in any year between 25,000 to 75,000 acre feet to suit the needs of the people of Southern California. The GSC understands that future water conservation would benefit from the dewatered storage in the aquifer (effectively a "subsurface reservoir") and hydraulic control that will allow deep and secure storage of large quantities of imported water. Imported water can be stored as the volume of dewatered storage increases and elimination of hydraulic gradients away from the well field toward the dry lakes. The GSC did

not evaluate the technical proposals for future conservation. However, the GSC supports the general concept and is willing to review or comment upon any such proposals.

GSC findings and recommendations.

The GSC was presented with historical and new technical investigations of geology, hydrogeology, climatic data, groundwater recharge, groundwater conditions, water quality, air quality, and plant and vegetation surveys. These reports document no observed plant or wildlife that relies upon groundwater (except springs in the mountains, which are not dependent upon the alluvial aquifer from which the Project wells will extract groundwater). The GSC reviewed technical reports prepared by Cadiz consultants to evaluate potential impacts for the first phase of the Project in four specific areas including: (1) subsidence; (2) springs; (3) air quality; and (4) water quality degradation.

The most recent evaluation of natural recharge estimate is 32,500 acre-feet per year; however, a range of recharge estimates, higher and lower, has been developed by previous investigators. Therefore, to assess the potential magnitude of impacts, the modeling and impact analysis employed three different recharge scenarios; 5,000 AFY, 16,000 AFY and 32,000 AFY. The Project is designed to extract an average of 50,000 AFY regardless of actual natural recharge, so this range of natural recharge was assessed to examine the impacts of the Project extraction, allowing for conservative natural recharge estimates and assessment of potential impacts.

The anticipated withdrawal of groundwater in the proposed well field will intercept natural recharge and retrieve groundwater in storage that is currently escaping to the dry lakes. The range of potential evaporation from the dry lakes has been estimated to be between 12,000 AFY on the low end and as high as 143,000 AFY on the high end. However, actual evaporation is expected to balance actual recharge, so that long-term average annual recharge is equal to the long-term average annual evaporation off the dry lakes. Although there is some variability in the projected evaporation rates from the dry lakes, assuming the highest evaporation over a 100-year period, as much as 2.2 million acre-feet could be saved from evaporation, and used for public benefit if the Project is implemented as proposed. To achieve this objective, there will be potential drawdown in well-field groundwater levels that may range from 70 feet to 270 feet depending upon the actual quantity of natural recharge, variations in aquifer hydraulic properties, and well-field design. Based on the information available, the committee finds that the average annual extraction of 50,000 AFY for 50 years is feasible and that total average annual extraction of 50,000 AFY can be applied to the cumulative agricultural and Project demands. The GSC understands that if the Project is carried out as proposed, to produce an annual average of 50,000 AFY for delivery to Project participants, the agricultural use of groundwater is expected to cease.

The GSC reviewed and discussed the methods of investigation and evaluation and concludes that these analyses are reasonable and consistent with standard professional practice and adequately assess the four identified areas of potential impacts from the proposed Project, as described below.

Subsidence. Significant subsidence is not expected in any of the scenarios. The Fenner Gap area is underlain by sediments that are not rich in clays and silts, which are normally associated with subsidence. There is increasing silt and clay content in the alluvial aquifer sediments nearer the dry lakes, which is where subsidence, if any, is projected to be 2.7 feet under the lowest natural recharge scenario which creates the highest groundwater drawdown. Permanent compaction due to subsidence would not significantly impact the alluvial aquifer's storage capacity as consolidation of the aquifer will occur in clay and silt intervals, which do not contribute to the useable storage capacity anyway. However, we recommend that the Project managers consult with the railroad and pipeline companies and include extensive monitoring for early warning in the interest of safety. Monitoring through the use of extensometers, designated bench marks, In-SAR (interferometric synthetic aperture radar), and the ability to manage pumping patterns in concert with the monitoring in the event significant subsidence is observed would mitigate problems.

The springs. The springs in the watershed area rely on rainfall recharge of shallow fractured bedrock, and there is no evidence that the springs are dependent on the deep alluvial groundwater system from which the Project proposes to pump groundwater or that they will be affected in any way by the pumping. All of the springs are more than 11 miles away and are located in fractured crystalline (granitic and metamorphic) rocks at substantially higher elevations than the alluvial aquifer from which the Project wells will pump groundwater. Therefore, pumping in the alluvial aquifer in the Project well field should not affect groundwater levels in these crystalline rocks, so it will not adversely impact springs. Nevertheless, the GSC supports ongoing observation of the springs and the flow conditions as proposed, including the closest spring (Bonanza Spring), and several more distant springs (such as Whiskey and Vontrigger) for comparison and to account for climatic changes.

Air quality. The GSC reviewed the technical reports provided on the Bristol and Cadiz Dry Lakes that conclude that these dry lakes do not pose a substantial risk of elevated dust levels arising from the underlying sediments being dewatered. High concentration of chloride salts in the surface soils act to bind the surface soils so as to minimize soil becoming airborne as dust. The GSC also reviewed the technical report on the dry lakes that revealed that plant life in the area of the dry lakes is precipitation and runoff fed and does not rely upon groundwater. The evidence presented in these reports seems conclusive. However, verification monitoring is strongly recommended to confirm these conclusions. Monitoring can be relaxed if these findings are further proven during Project operations.

Water quality. The migration of saline (> 1,000 mg/l) groundwater towards the well field is predicted by modeling to be less than 12,000 feet. The modeling demonstrates that the movement is not increased under the higher drawdown levels that are associated with the lower recharge rates, as these scenarios have low aquifer transmissivity. There are no known or projected beneficial users of fresh (<1,000 mg/l) groundwater in the affected area. However, monitoring and mitigation elements of the groundwater management plan are proposed to monitor this condition. If necessary and appropriate, the migration could potentially be stabilized through either extraction of saline groundwater (which possibly could be used by the salt mines), injection of fresh water to create a barrier to mitigate further migration, or alteration of pumping patterns. These approaches are reasonable.

Concluding summary

The GSC finds that the average annual extraction of 50,000 AFY for 50 years is feasible. The GSC concludes that the monitoring, proposed action criteria, and mitigation elements are reasonable and, if adopted, should provide assurance against harm resulting from the conservation, recovery, and beneficial use of groundwater as proposed in the Project. The GSC recommends that proposed monitoring elements be adopted and incorporated into a groundwater management plan for the Project.

GROUNDWATER STEWARDSHIP COMMITTEE

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