February 1, 2012

Mr. Seth Shteir
California Desert Field Representative
National Parks Conservation Association
61325 Twentynine Palms Highway, Suite B
Joshua Tree, California 92252

RE: Cadiz Groundwater Project, Hydrogeologic Review of Draft Environmental Impact Report

Dear Mr. Shteir:

Johnson Wright, Inc. (JWI) is providing the following comments concerning the Draft Environmental Impact Report (DEIR) described above. Overall, the supporting documentation concerning the structural geology and stratigraphy of the project area (Kenney Geoscience, 2011) is complete and provides the necessary foundation to base subsequent hydrogeologic analyses. Additionally, JWI did not provide comments regarding the analysis of the potential for groundwater-dependent vegetation (HydroBio, 2011). This letter provides a summary of findings, a brief description of the proposed project and JWI's scope, our detailed comments regarding the hydrogeologic documentation in the DEIR and our conclusions.

SUMMARY OF FINDINGS

The Proposed Project is unique in its planned scope and magnitude. This is due to the planned reduction in storage and associated planned development of a large cone of depression resulting from project pumping. Among the purposes of the DEIR are the need to evaluate the potential of the proposed project to impact desert springs, mining operations on dry lake beds, limited surrounding landowners, and several federally-designated wilderness areas present in the area. To conduct such a project in this case is a high risk activity given that per the analysis in the DEIR, should an impact occur to a spring or other sensitive receptor, there are no means to prevent the condition from initially worsening, and recovery from taking as long as a century or substantially more time. Therefore a project of this type demands a higher level of confidence in the results of the analysis than is provided by the hydrogeologic impact analyses. Based on JWI's review of the hydrogeologic analyses and monitoring and mitigation plan, insufficiencies with the environmental review stem from the following fixable areas:

- Either the conceptual model, or the numerical representation of the conceptual model, is flawed based on it requiring hydrogeologically unreasonable parameters to calibrate the numerical flow model;
- Issues with the development of the numerical model may include the need to expand the grid in the Cadiz dry lake area, and potential data input errors;
- The report contains insufficient detail on key scope areas for a comprehensive evaluation; and,

- The proposed monitoring and mitigation measures include inadequate milestones and decision points needed to address analytical deficiencies and/or uncertainty, while being protective of the environment as described in the DEIR.

In order to conduct our review, JWI requested a copy of the numerical model and associated files to evaluate the numerical model, and run sensitivity or alternative scenarios as part of a quality assurance/ quality control aspect of our review. It is our understanding that access to those files was denied. Therefore, the comments provided rely entirely on the DEIR and supporting documentation.

PROPOSED PROJECT SUMMARY

The proposed project, unique and size and scope, would extract approximately 50,000 acre-feet per year (AFY) of groundwater over a 50-year period for export to various water districts/agencies in Southern California. The estimated annual recharge based on the analysis provided by consultants for Cadiz, Inc. (Cadiz, the project proponent) is approximately 32,500 AFY. Based on the documentation provided in the DEIR and supporting documentation, it is stated that no significant impacts will occur as a result of pumping as planned whether the natural recharge is the estimated 32,500 AFY, or as low as 5,000 AFY. Based on these estimates, groundwater storage declines would range from 875,000 AF to more than 2.2 million AF depending on the recharge estimate used. As analyzed by the DEIR, the water use by the proposed project has the potential to impact desert springs, mining operations on dry lake beds, limited surrounding landowners, and several federally-designated wilderness areas present in the area. The upper portions of the Fenner and Orange Blossom Wash watersheds lie within the Mojave National Preserve.

JWI APPROACH

The comments provided by JWI are with the goal of identifying insufficiencies or asking for clarification in the analysis wherever needed that materially affect the environmental analysis. Upon fixing identified insufficiencies, and reevaluating the proposed project under that new light, informed decision making regarding the proposed project can be made. JWI's review focused on the geologic and hydrologic analyses presented in both the DEIR and supporting documentation. JWI reviewed the following selected sections of the DEIR and supporting documentation:

- HydroBio report entitled, "Vegetation, Groundwater Levels and Potential Impacts from Groundwater Pumping Near Bristol and Cadiz Playas, San Bernardino County, California (HydroBio, 2011);
- Groundwater Management, Monitoring, and Mitigation Plan for The Cadiz Groundwater Conservation, Recovery and Storage Project (Cadiz, 2011);
- Assessment of Effects of the Cadiz Groundwater Conservation Recovery and Storage Project Operations on Springs (CH2M Hill, 2011);
- Cadiz Groundwater Modeling and Impact Analysis (Geoscience Support Services, Inc. (GSSI), 2011)
- GSSI Addendum to September 1, 2011 Cadiz Groundwater Modeling and Impact Analysis (GSSI, 2011c);
- Cadiz Groundwater Conservation and Storage Project (CH2M Hill, 2010);

- Geological Structural Evaluation of the Fenner Gap Region Located Between the Southern Marble Mountains and Ship Mountains, San Bernardino County, California (Kenney Geoscience, 2011);
- Geohydrologic Assessment of the Fenner Gap Area (GSSI, 2011); and,
- Supplemental Assessment of Pumping Required for the Cadiz Groundwater Conservation, Storage and Recovery Project (GSSI, 2011).

REVIEW OF TECHNICAL ANALYSES

Comments Regarding Geohydrologic Assessment of the Fenner Gap Area

The following comments refer to GSSI (2011a). This report is very complete in terms of geologic logging and well construction details. The report also appears reasonable with respect to calculation of aquifer parameters as presented with one exception as described below. However, there is a lack of sufficient key data (described below) to adequately evaluate the interpretation of the aquifer results. The following is a list of general questions and comments regarding this geohydrologic assessment report and associated aquifer testing that should be incorporated into the assessment.

1. Page 4 – Photograph

A caption concerning the photograph is needed here. The photograph shows a flowing stream on the floor of Fenner Gap. This flowing water must have been derived from either pumped groundwater or surface runoff immediately after a storm event as there is no flowing water typically on the floor of Fenner Gap and the inclusion of the photograph without context is misleading as to the typical conditions present.

2. Page 5 – Purpose and Scope

Substantial hydrologic work has been conducted at the proposed project area over the past 20 years, and it should be used as an existing data resource that the new work can enhance, as opposed to recreating it. However, this geohydrologic assessment appears to start the process anew, and provides little discussion as to how the newly developed data fits into the overall framework of previous investigations and results. Are the aquifer test results conducted since 2009 consistent with previous test results in the area? Why or why not? For the most part, wells previously installed at Cadiz were excluded from the analyses. Why? Has the conceptual model for the Fenner Gap area changed significantly or has the current investigation simply confirmed previous information?

3. Page 6 – Section 2.4 Field Reconnaissance

What was the purpose of the pumping ongoing on November 11, 2009? Was there an aquifer test ongoing (if so results should be reported)? Also, given that pumping was operating prior to the aquifer testing that was conducted later in November, 2009, had there been periodic groundwater level monitoring conducted on TW-1 and TW-2 and associated monitoring wells prior to the aquifer testing to assure that true static groundwater levels were established prior to aquifer testing? This is particularly of importance as full recovery from the step discharge test run on TW-1 had not been achieved prior to initiating the constant discharge test at TW-1 during 2009 (Figures 10 and 13) and the use of an improper static groundwater level could affect parameter evaluation.

4. Page 12 – Photograph

The photograph shows that the fanglomerate has been lithified (evident by both the competence of the core and the natural fracture characteristics presented). Given the ragged nature of the sharp fracture visible, that particular fracture does not appear to be a natural fracture but is more probably a break that occurred during the coring, or boxing of the core. If the material in the photograph is typical, it can be expected that the hydraulic conductivity of the fanglomerate should be substantially less than unconsolidated basin fill material.

5. Page 16 – Section 4.2.5 – *"Granitic and metamorphic basement rock forms the subsurface margins of the aquifer system within the project area (Freiwald, 1984). This basement rock is generally impermeable but can have significantly increased permeability along well developed fracture zones which are associated with the numerous faults that cross Fenner Gap."*

This is an important statement as the figures depicting modeled hydraulic conductivities do not provide reference to model zonation for aquifer parameters and in what areas for instance hydraulic conductivity values represent specific hydrogeologic units. For example where are fractured granitic rocks of higher permeability modeled as opposed to other granitic rocks? This would allow for the appropriateness of model zonation to be more readily evaluated given the absence of available model files.

6. Page 21 - Section 4.4 Analysis of Pumping Test Data

There is insufficient detail presented to evaluate the aquifer test data and results. There are no details regarding the actual operation of the aquifer tests. For example, at what distance away from the discharging well or monitored wells did discharge take place and where did the discharge go? Could percolation of discharged water have influenced groundwater-level data for example at MW-6 where according to Figure 8, there appears to have been no seal emplaced other than the surface concrete pad?

Results of pumping rate monitoring during testing are not presented. How was flow rate monitored, at what frequency, and within what parameters were pumping rates to be maintained during testing? Were those parameters achieved?

For new wells, discharge permits are commonly required…were any required or obtained for this project?

These are standard data that should be reported for aquifer testing reports as documented by ASTM, and in other references (for example Kruseman and de Ridder, 2000). The pumping rate data (which can be presented in graphical form) would provide key information for example to evaluate changes in drawdown characteristics as presented in the aquifer test figures.

7. Figures and Associated Text

Late time recovery data analyzed for TW-2 appear to be matching the fully recovered data therefore resulting in a very high transmissivity estimate. Although the well appears to be fully recovered, without the aquifer test data (even the hand measured water level measurements typically collected for backup purposes) it is difficult to discern if the well had fully recovered. Also, there appears to be a typographical error concerning the date of the TW-2 recovery test in the table summarizing aquifer test results.

It is noted on Figure 18 that groundwater elevations were corrected for barometric pressure changes. What was the magnitude of those corrections?

Comments Regarding Recharge Estimation / INFIL3.0 Analysis

A modeling analysis has been completed by CH2M Hill (2010) using the U.S. Geological Survey programs INFIL3.0 and MODFLOW to re-evaluate the estimated groundwater recharge that was previously estimated by Geoscience Support Services (1999). Based on these efforts, the average annual "recoverable" water quantities for the Fenner Watershed area are estimated at 30,191 acre-feet per year (AFY) and 2,256 AFY for Orange Blossom Wash (32,447 AFY combined).

Estimating groundwater recharge in arid or semiarid regions can be a difficult and complex task. Groundwater recharge in arid and semi-arid areas is dependent on a complex set of spatial and temporal hydrologic parameters and processes dependent on local climate, land surface properties and subsurface characteristics. Indeed, surface hydrology generating recharge in arid and semi-arid areas is complex and extremely difficult to quantify using conventional methods of analysis (Wheatear, 2010). Because of these difficulties, estimating recharge in desert environments can be more easily arrived at (for basins in hydrologic balance) by estimating discharge. Discharge components are generally much more precisely quantifiable.

As part of our review and analysis, JWI used a discharge evaluation in the comments that follow based on more recent evapotranspiration data than were used in the CH2M Hill analysis. Continuous micrometeorological data collected over a four year period in Death Valley were used to estimate evapotranspiration rates over the area evaluated (DeMeo, et.al. 2003). The JWI analysis resulted in more consistent and generally improved estimates of groundwater discharge than in previous studies (San Juan, et.al. 2004). The resulting midpoint evapotranspiration rate estimates were 0.13 feet per year (ft/yr) for salt-encrusted playa and 0.15 ft/yr for bare-soil playa. Assuming the 0.15 ft/yr evapotranspiration rate, it can be assumed that there is 8,947 AFY of evapotranspiration losses from the Bristol and Cadiz playas (based on the area in which evapotranspiration takes place in the model). Taking the JWI analysis one step further and adding the estimated annual pumpage from the basin of approximately 5,000 AFY (and assuming that the basin is in hydrologic balance or inflow equals outflow), an estimated recharge of approximately 14,000 AFY (plus the volume of spring discharge) can be inferred. Of note is that total spring charge has not been estimated in the DEIR. The JWI estimated recharge of approximately 14,000 AFY plus spring discharge is very similar to the best estimate of Davisson (2000, 2012). The Davisson estimate will be discussed in more detail later in this document.

The following are more detailed comments on the recharge estimation report (CH2M Hill, 2010):

1. Page ES-3, Paragraph 2. *"Total recoverable water, therefore, is equal to the amount of recharge to the groundwater system in the Fenner Watershed, which is approximately equal to the amount of groundwater flow through Fenner Gap through the alluvial and carbonate rock units."*

With respect to that statement, total recoverable water would actually be the amount of recharge to the groundwater system minus any evapotranspiration losses from springs and spring vegetation.

2. Page ES-5, Validation of Recoverable Water Estimate, Paragraph 1. *"A three-dimensional groundwater flow model of the Fenner Gap area was developed for the purposes of validating the 30,000 AFY estimate of steady-state groundwater flow through the Fenner Gap…"*

The three-dimensional model described was constructed using the U.S. Geological Survey program MODFLOW. The description of model construction needs additional detail. Given that calibrated hydraulic conductivity values described appear to vary considerably from those calibrated hydraulic conductivity values described in the Impact Analysis (Geoscience Support Services, 2011) it is unclear on what assumptions the CH2M Hill numerical model was based. For example, evapotranspiration losses from the playas play a key role in the hydrologic budget, how was playa evapotranspiration modeled?

3. Page 2-2, Section 2.1.3., Vegetation.

This section does not appear to include riparian habitat at springs for example at Bonanza Spring.

4. Figures 2-10 through 2-12. Figures presenting soil characteristics.

As is indicated by the figures, and for the purposes of the recharge evaluation, large areas (in the hundreds of square miles) are assumed to have similar characteristics. Given the local landscape, it is clear that substantial generalization is incorporated into these figures and the resulting analyses. More detailed mapping of surface conditions would not likely be feasible under typical project constraints. Therefore, in order to account for these generalizations or unknowns, the INFIL3.0 modeling should be subject to a sensitivity analysis of input parameters (i.e., evaluate the effect of altering input parameters on model results) to evaluate sensitive parameters that may have a high degree of uncertainty leading to overall model uncertainty.

5. Page 3-2. Comparison of Storage estimates.

In keeping with this presentation regarding storage volumes, the following recharge volumes are provided to put in perspective the amount of groundwater estimated to recharge the Fenner and Orange Blossom Watersheds:

- This is greater than the natural recharge to the Coastal Plain of Orange County basin (29K AFY) (California Department of Water Resources, 2004).
- This is greater than the combined recharge from stream flow in the Bishop Creek to Big Pine Creek region (and inclusive of intermediate streams) of the eastern Sierra Nevada (Danskin, 1991).

6. Page 4-8, Section 4.1.8.1 Comparison to Most Recent Recoverable Water Estimates. *"INFIL3.0 simulation results compare favorably to GSSI (1999) watershed water balance modeling results and the Davisson and Rose (2000) Maxey-Eakin recoverable water estimate of 29,815 AFY…"*

This section misrepresents the results of the work by Davisson and Rose. Davisson and Rose presented a range of groundwater recharge estimates (referred to as recoverable water in the CH2M Hill report) ranging between 7,864 AFY to 29,185 AFY. Personal communications (Davisson, 2012) indicate that a best estimate of groundwater recharge based on their work would be an estimate closer to their regional precipitation-elevation curve of 16,214 AFY. The 29,185 AFY estimate was a maximum estimate. Therefore, the estimated recharge developed by CH2M Hill (2010) and Geoscience Support Services (1999) generally represent a two-fold increase in estimated recharge in comparison to other estimates.

7. Page 4-10, Last Full Paragraph.

Evapotranspiration work by the U.S. Geological Survey is referenced for evaluating evapotranspiration rates and associated discharge from Bristol and Cadiz dry lakes. However, more recent, follow-up work by the U.S. Geological Survey is not referenced. See the discussion provided above for Page 4-13, Section 4.2.2 Numerical Model Development

This section references a numerical model developed by CH2M Hill that varies substantively from that presented by the GSSI model previously discussed. A discussion is needed concerning the differences between the two models, why this model (which was apparently completed prior to the GSSI model) is reliable given the substantial differences in hydrologic parameters used, results of sensitivity analyses and calibration, etc. Standard documentation of numerical groundwater flow modeling efforts as described in Anderson and Woessner (1992) or by ASTM and other references are lacking regarding this effort and therefore do not provide substantive support for the estimated groundwater recharge. Therefore additional information is needed to support the statements provided.

8. Page 4-17, Section 4.2.4 Discussion of Groundwater Flow Model Results

Please describe why carbonate rock units from the Death Valley region which are correlative with those carbonate units in the project area, and which have been extensively studied were not evaluated in lieu of more distant carbonate rocks (Edwards Aquifer in Texas) which may or may not have similar characteristics?

Comments Regarding Groundwater Modeling and Impact Analysis

Numerical groundwater flow and solute transport modeling was conducted for the impact analysis of the proposed project (GSSI, 2011b). Numerical models are ideal tools to evaluate transient, three-dimensional groundwater issues in that the complexities of the groundwater system can be evaluated in detail, and assumptions of how the groundwater system works can be tested for internal consistency. As will be discussed in the detailed modeling comments that follow in this document, there appears to be a problem associated with the conceptual model as highlighted by the numerical modeling effort.

Overall, the model software used, construction (with caveat described below in Point #6) including discretization, and packages used, were appropriate given the conditions present. However, the problem arises with either the estimated recharge, or the aquifer parameters (either in values or spatial representation) that results in the need for unrealistically high evapotranspiration rates to be required to calibrate the model. As stated in the impact analysis, these evapotranspiration rates were needed to allow the amount of water to discharge from the Bristol and Cadiz Playas to accommodate the estimated recharge rate. This issue was also apparent in previous modeling (GSSI, 1998) where in lieu of high evapotranspiration rates, an unrealistic extinction depth (100 feet below ground surface which has been changed to 15 feet in the current analysis) was used to accommodate the amount of discharge needed to calibrate the model given the estimated recharge.

The following provide additional comments regarding the groundwater modeling and impact analysis.

Page 8, First Full Paragraph – *The purpose of the sensitivity scenarios was to evaluate the potential ranges of worst case impacts by (1) reducing the amount of available natural recharge, and (2) increasing the distances between the wells within the proposed project wellfield."*

This "sensitivity" analysis does not represent the form of a sensitivity analysis that is standard practice for modeling exercises such as this and as described in ASTM, Anderson and Woessner (1992) and other references. Performing a sensitivity analysis is a standard part of evaluating the calibration of a modeling effort. The purpose of the sensitivity analysis is to evaluate the uncertainty in the calibrated model caused by uncertainty in aquifer parameters, stresses and boundary conditions. In a sensitivity analysis, these model parameters and conditions are changed systematically to evaluate how changes in each result in changes in head. The more a change in the parameter or condition causes a greater change in head, the more sensitive the parameter is. Sensitive parameters for which there are little ground-truthed information (for instance a sensitive hydraulic conductivity zone for which there are no aquifer test data) will indicate greater uncertainty in the predictive capability of the model. This is key area where this analysis is lacking and should be completed to comply with standard practice.

Second, as conducted, the sensitivity analysis is problematic in that changes in model results resulting from natural recharge are not comparable as the head distribution is affected by changes in model construction (well locations), aquifer parameters and evapotranspiration rates for the lower recharge scenarios therefore mixing results and assumptions. If two wellfield configurations were to be evaluated, each configuration should have been tested against each of the separate recharge scenarios. As these analyses currently stand, the "sensitivity" analyses actually represent separate simulations based on differing assumptions.

1. Page 9 – Groundwater Elevations

Unfortunately the presentation of the development of the cones of depression are very limited (presenting only end of pumping, and 50 years after pumping ceases) groundwater elevations. Well hydrographs should be included that show how groundwater elevations change over time given the management scenario. This is evident in the drawdown maps but not in the groundwater elevation maps due to the 100-foot contour interval. Given that drawdown continues to expand areally after 100 years, the hydrograph timeframes should expand out to the timeframe at which that condition ceases to exist. This is particularly of importance in evaluating the effectiveness of the groundwater monitoring and mitigation plan and its meaning in relation to proposed project groundwater pumping and the ability for the project to achieve project objectives or meaningful time-dependent groundwater elevation and or spring flow protective procedures.

2. Page 9 – Groundwater Level Drawdown

A significant issue with the project appears to be the delayed response in the aquifer by the proposed project pumping. As shown on the associated figures of project pumping (Figures 64 and 65 for example – see northeast extent of drawdown), the extent of the cone of depression is more extensive in the 100-year scenario (after 50 years of recovery) versus the 50-year scenario (at the end of project pumping). This is the case with all scenarios. This indicates that should unforeseen impacts occur as a result of project pumping, and even if project pumping is halted immediately, the impacts will continue to manifest for an extended period of time (greater than the length of time pumping was conducted) before recovery begins to take place. Therefore, the aquifer system will be very difficult to manage under the monitoring and mitigation plan. Please discuss this issue and why the system is so slow to recover.

3. Page 12 – Groundwater in Storage

There appears to be some discrepancy in pumping or storage terms as presented. The change in storage of an aquifer is equal to the groundwater inflow (recharge) minus the outflow (pumping, evapotranspiration). In the case of this project's two "sensitivity" scenarios the outflow (assuming entirely pumping) would be 50,000 AFY for 50 years. Based on the two scenarios (16,000 AFY of recharge; and 5,000 AFY of recharge) the storage loss after 50 years then would be a minimum of 1.8 million AFY, and 2.25 million AFY, respectively for the two scenarios. These are somewhat higher than the model predicted storage losses. The storage losses presented above would be minimums as there would be a period during the initial years of the project where there would also be losses due to evapotranspiration from the playas (and springs which will be a lesser quantity) that would increase these storage losses. Please discuss the change in storage described above in comparison to model-predicted storage loss estimates of 1.68 million AFY, and 2.16 million AFY, respectively. Without clarification, the discrepancy is indicative of a significant data input error in the model with respect to either insufficient pumping rate or an excessive amount of recharge. This is an issue JWI could have evaluated prior to commenting had model files been available.

4. Please discuss any other groundwater "conservation" or "exportation" projects in which a project has been approved that had planned storage losses of this magnitude for comparison.

5. Page 27 – Computer Code

Please describe if a commercially available modeling platform (Groundwater Vistas, GMS, Visual MODFLOW) was used to construct the model.

6. Page 32 – Hydraulic Conductivity

Hydraulic conductivity value ranges used appear to be reasonable based on aquifer testing although based on the photograph of fanglomerate core; it is hard to conceive that the fanglomerate presented in the photograph of fanglomerate core presented in the geohydrologic assessment would yield hydraulic conductivities of up to 60 ft/day. Additionally, as described earlier, the areal distribution of specific hydraulic conductivities associated with specific aquifer units is not readily apparent in the figures where zonation is instead represented by hydraulic conductivity only.

The hydraulic conductivity discussion raises additional questions about the sensitivity runs in that again, changes in the effect of natural recharge on the model results have been minimized by recalibrating the aquifer parameters thereby minimizing the effect of the change in recharge. Essentially, instead of evaluating the model sensitivity to recharge based on the calibrated numerical representation of the groundwater system, three distinct numerical groundwater flow models with differing conceptual models in relation to well field design, aquifer parameterization and evapotranspiration have been developed.

7. Page 36 – Evapotranspiration

A summary of the comments associated with this section are provided above. Evapotranspiration rate was a calibrated parameter and again, evapotranspiration rate was allowed to vary substantially between recharge scenarios even though evapotranspiration would be unlikely to change given that the playa soils would remain unchanged, climate factors would be unchanged, and assuming the groundwater levels would be above the extinction depth allowing evapotranspiration to take place.

Of note is that evapotranspiration rates of greater than 50 ft/year for Cadiz Dry Lake and 20 ft/year for Bristol Dry Lake are substantially above the pan evaporation rate (nearly five times the pan evapotranspiration rate for Cadiz Dry Lake). These are geologically unreasonable evapotranspiration rates for use in the model as described earlier. According to the text, "*maximum evapotranspiration rates used were based on model calibration results in order to obtain a more reasonable evapotranspiration from the dry lakes and a better match between the model-calculated and observed water levels.*" That the evapotranspiration rates had to be increased to the extent described above indicates that there is a problem elsewhere in the model.

The text also states that "*Results show an average of 19 inches/year over those cells where evapotranspiration is occurring in this run which is a reasonable average.*" This is approximately ten times the U.S. Geological Survey's evapotranspiration rate from playa soils in Death Valley described earlier and remains high.

The text states that, "*For Cadiz Dry Lake, the maximum evapotranspiration rate was adjusted by a factor of approximately 2.5 from the maximum evapotranspiration rate of the Bristol Dry Lake due to the fact that most of the Cadiz Dry Lake area is outside of model boundary.*" This statement suggests that the model grid was either not widespread enough (thereby improperly constructed) or that there was a flaw in the logic behind evapotranspiration calibration. Concentrating evapotranspiration discharge in one location as a means to calibrate groundwater elevations when a substantial portion of the discharge from evapotranspiration is not taking place at that location in which groundwater levels are being calibrated is not appropriate. This would be analogous to a hypothetical significant discharging production well at a distant location being moved to this location in the model to assist with model calibration. This issue suggests the need to expand the grid to encompass Cadiz Dry Lake.

The high evapotranspiration rates appear to be symptomatic of the amount of water that is needed to be discharged from the playa based on the existing recharge estimate. This symptom was present in the previous modeling (GSSI, 1999) where in lieu of the evapotranspiration rates being increased to the extent they are in the current analysis, the issue was resolved with an extinction depth of 100 feet below ground surface which as described in the current analyses is geologically unreasonable (current extinction depth used is 15 feet below ground surface).

8. Page 39 – Section 6.2 Steady State Model Calibration – Text states, "*Twelve water level targets located in the Fenner Gap area were carried over from the Fenner Gap model (see Appendix A); however, a water level of five feet was added to each water level measurement based on transient water level data suggesting an approximately 5 ft. decline in heads in the Fenner Gap from predevelopment conditions.*"

Given the limited pumping that has occurred in the Fenner Gap area in the past, please discuss the implications that five feet of groundwater level decline has occurred, and continues to occur over a significant area. It is stated in GSSI (2011c) that, "Therefore, the stresses caused by Cadiz agricultural pumping have not created sufficient recharge (from vertical leakage or induced recharge) to sufficiently stabilize water levels." The aquifer nonetheless, has not been able to stabilize with only approximately 5,000 AFY of pumping. The aquifer has been unable to reach an equilibrium condition with this amount of limited pumping. This is not an encouraging trend when the proposed pumping is an order of magnitude greater. This expanded pumping is not likely to "increase recharge" thereby ameliorating the problem. This is illustrated by the calibration graphs (Figures 32 through 34) which show groundwater level declines over time in the Fenner Gap area as opposed to groundwater-level declines that would temporarily occur as a response to pumping and would stabilize as a new equilibrium is reached. Also, the vertical scale of the hydrographs is expanded substantially making discerning groundwater level trends difficult. The vertical scale should be decreased to be more useful in evaluating changes and fluctuations in groundwater levels.

Comments regarding model calibration described earlier apply to Section 6.2 and Section 6.3 (transient calibration).

9. Page 43 – Section 6.4 Sensitivity Analysis.

The sensitivity analysis (to evaluate model uncertainty) performed is not in accordance with standard practice. The only parameters in which a typical sensitivity analysis was conducted were for specific yield/storativity and vertical leakance which in our experience modeling alluvial groundwater basins of the desert southwest are commonly the least sensitive parameters in the flow model. Aquifer parameters such as hydraulic conductivity (on a zonal basis), evapotranspiration rate, recharge and other solute transport characteristics should be tested for sensitivity in accordance with the method used for specific yield/storativity and vertical leakance.

10. Page 44 – Section 7.1 Description of Model Scenarios

The "sensitivity" scenarios involved changing model parameters which are not sensitivity scenarios, but are separate, recalibrated models or simulations. The changes in model parameters will serve to minimize any effect of changing the recharge or well field distribution of wells.

11. Page 49 – Impact Analysis

The impact analysis suffers in reliability as a result of the modeling issues previously described. Of note is the issue of the continuously expanding outer limits of the cone of depression after 100 years. Additionally, the cone of depression is anticipated to extend to elevations approaching the head at Bonanza Spring, thereby potentially affecting this important spring. This indicates that decades after the project ceases pumping, additional impacts may still be identified as a result of earlier pumping. This also indicates that if an impact is identified at a spring or for a surrounding groundwater user, changes to groundwater management (if pumping is still occurring) may be too late to adequately be protective of surrounding receptors. Additionally increased hydraulic gradients upgradient from the project as a result of expansion of the cone of depression, will result in greater subsurface underflow to the south out of the upper Fenner Watershed (beneath Mojave National Preserve) the effects of which are not understood and/or adequately described.

With respect to climate change, it can be expected that as less precipitation occurs as snowfall which is anticipated to be observed during the length of the proposed project pumping period, less of that water will likely recharge the aquifer. This issue does not appear to be addressed in the impact analysis. This rises in importance in that despite the reporting of the impact analysis being based on a maximum simulation period of 100 years, simulations extending 500 years and greater have been conducted as part of an assessment of springs (CH2M Hill, 2011).

12. Page 54 – Table regarding Groundwater in Storage

The text describing the table states, "*The following table summarizes the cumulative annual changes in groundwater storage at the end of 50 years (end of project pumping) and 100 years (end of model simulation) for each model scenario….").* Of note is that the table then presents time for groundwater storage to recover after project pumping is stopped ranging from years 117 to 440. It is clear then that end of model simulation was not 100 years. Please describe why model impacts were not evaluated beyond 100 years, particularly in light of the continuously expanding cone of depression after 100 years as shown in the "sensitivity" scenarios presented.

13. Page 56-58 – Findings – Groundwater Elevations, Drawdown, and Depth to Groundwater

In addition to the conditions described, groundwater elevations in the outer edges of the cone of depression continue to decrease after 50 years of nonpumping (the 100-year scenario) due to continued expansion of the areal extent of the cone of depression. This continued expansion of the cone of depression will be uncontrollable by groundwater management activities in the basin.

As described earlier, the predicted changes in groundwater surface (and associated drawdown) suffer in their reliability due to the modeling issues described earlier.

14. Page 58 – Findings – Groundwater in Storage

Please describe the differences in predicted changed in storage produced by the Groundwater Equation (inflow minus outflow equals change in storage) and those predicted in the model as described in the earlier comments.

15. Page 61 – Model Limitations and Uncertainty

The uncertainty of the model has not been tested in an adequate manner. The use of programs such as MODFLOW2000 and PEST greatly simplifies the sensitivity analysis process and it is unclear why this aspect of calibration evaluation was neglected or not presented. Although the aquifer parameters including specific yield/storativity and vertical leakance have been tested, the more likely sensitive parameters such as hydraulic conductivity from individual parameter zones, and evapotranspiration rate which were used as calibrated parameters have not. Additionally, given the issues associated with the need to use unrealistically high evapotranspiration rates to calibrate the model, and serve as a mechanism to discharge sufficient water to allow the volumes of recharge to enter the modeled domain and maintain calibration, there is a problem with the conceptual model, or the representation of the conceptual model. Therefore, there is substantial uncertainty associated with any of the predictive results provided in this impact analysis.

Comments Regarding Assessment of Effects of the Cadiz Groundwater Conservation Recovery and Storage Project on Operations at Springs (CH2M Hill, 2011)

A spring assessment and associated modeling analysis has been completed by CH2M Hill (2011) using the U.S. Geological Survey programs MODFLOW to evaluate the effect of project pumping on springs. Discharge at springs generally occurs as a combination of both free discharge of flowing water and evapotranspiration from groundwater dependent vegetation and evaporation from soil in the subsurface. Therefore the discharge of a spring can be substantially greater than the free flowing water observable at the surface. A number of figures are missing from the report (Figures 1 through 15 for example. Please clarify whether Plates 1 through 15 are the missing figures. Geochemical results of spring sampling appear to be missing as well.

The analysis provided utilizes groundwater flow model results but it is unclear (given that this is a CH2M Hill report) whether the numerical model used by CH2M Hill for evaluating underflow beneath Fenner Gap, or the GSSI model used to conduct the impact analysis was used in the evaluation. The description of the extent of drawdown does not appear to match with those in the impact analysis (GSSI, 2011).

Finally, an assessment of the springs should have included a geochemical analysis of springs to evaluate sourcing. Instead, the effort appears to spend more time and resources identifying the dryness of the desert environment. Figures of a dry wash with a bullet point identifying that no water is present, or photographs of dry voids in carbonate rocks high in the Marble Mountains where no springs are known does not contribute to the overall understanding of those springs present and potential effects of the project on those springs. Of note is the absence of a photograph of Bonanza Spring, the closest spring to the proposed extraction well field. The results of the canvassing and accounting of existing springs in the basin, including a discussion of the results of the geochemical sampling noted as having taken place and a spring discharge estimate would have provided more beneficial information with respect to the groundwater budget and overall groundwater flow system.

REVIEW OF BASIN PLAN FOR THE CADIZ GROUNDWATER CONSERVATION, RECOVERY & STORAGE PROJECT

1. As a general comment, in all cases attributability of impacts, significance and changes in groundwater management associated with the project will be under the sole auspices of the Fenner Valley Mutual Water Company consisting of the purchasers of the groundwater from the project. Local stakeholders including Mojave National Preserve, U.S. Bureau of Land Management, local landowners, etc., appear to be excluded from the management process and

therefore, the lack of that stakeholder involvement will result in a lack of oversight over the project operations and mitigation if necessary.

2. The project as planned proposes to substantially reduce the volume of groundwater in storage and reduce groundwater levels over much of the groundwater basin. Given the large scope of the project, and the sheer size of the planned cone of depression, it may take many years before groundwater level and/or spring impacts are identified. As shown in the impact analysis by the cone of depression that continues to expand even after 50 years of shutdown (at year 100) by the time an impact occurs, it will likely be too late to make substantive changes in groundwater management to mitigate the problem. This will be particularly true for those impacts that begin to arise after the project has already ceased pumping. Proactive groundwater management is lacking that would prevent unintended impacts from occurring to surrounding land owners and sensitive receptors.
3. Given the serious issues raised in this letter concerning the hydrologic assessment of the project, and the uncertainty of the impact analysis, the absence of a more rigorous spring monitoring program with specified thresholds and triggers for reduced or ceasing pumping is not appropriate. Visual observations of changes in spring flow will only begin to be obvious when a significant impact to the spring is already occurring. Given the lag in time between shutting off pumping and the growth of the outer edges of the cone of depression, an observed impact will likely be already too late to be protective of the spring and associated habitat. The spring monitoring / mitigation plan needs to be re-evaluated and more in depth investigation into the springs present is needed. Current efforts have been inadequate.
4. The technical review panel should include technical representatives representing the local stakeholders (i.e., landowners, U.S. Bureau of Land Management, etc.). As presented the technical review panel will consist of one member of Fenner Valley Mutual Water Company, San Bernardino County (under MOU with Fenner Valley Mutual Water Company), and a joint pick between the County and the FVMWC.

CONCLUSIONS

As described earlier, the proposed project is unique in its planned scope and the magnitude of the planned reduction in storage and associated planned development of such a large cone of depression due to project pumping. To conduct such a project in this case is a high risk enterprise given that per the analysis in the DEIR, should a significant impact occur to a spring, or other sensitive receptor, there are no means to address the impact and recovery may take a century or substantially more time. As shown in the supporting documentation to the DEIR, impacts will continue to propagate after pumping ceases. Therefore a project of this type demands a higher level of confidence than is provided by the hydrogeologic impact analyses. Based on JWI's review of the hydrogeologic analyses and monitoring and mitigation plan, insufficiencies with the environmental review of the proposed project stem from the following areas:

- The conceptual model appears flawed based on it requiring hydrogeologically unreasonable parameters to calibrate the numerical flow model;
- The report contains insufficient detail on key scope areas for a comprehensive evaluation; and,

- Inadequate stipulation of milestones and decision points associated with monitoring and mitigation measures needed to address analytical deficiencies and/or uncertainty and be protective of the environment as described in the DEIR.

Based on the bullets listed above and as described in our detailed comments, the DEIR in its current form does not provide an adequate review of the hydrogeologic conditions and potential impacts of the proposed project. Further, by not providing explicit milestones and decision points as a basis for project groundwater management and mitigation, there are insufficient proactive, protective means to overcome the uncertainty associated with technical analyses as presented. Should you have any questions or comments, please contact us at 925-403-4200. We appreciate the opportunity to assist with you with this matter.

Sincerely,

Johnson Wright, Inc.

Andrew Zdon, P.G., C.E.G., C.Hg.
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