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February 3, 2017

Commissioner Karen Douglas, Presiding Member
Commissioner Janea A. Scott, Associate Member
California Energy Commission
1516 Ninth Street
Sacramento, California 95814-5512

Re: High Desert Power Plant Project (97-AFC-01C)
GSI Water Solutions, Inc. Technical Review of the California Department of Fish and Wildlife "Water Balance Study for the Transition Zone of the Mojave River" (TN#: 214837)

Dear Commissioners Douglas and Scott:

Enclosed is the "Technical Review of California Department of Fish and Wildlife ["CDFW"] Water Balance Study for the Transition Zone of the Mojave River Basin" prepared by GSI Water Solutions, Inc. (the "GSI Report") on behalf of High Desert Power Project, LLC.

The CDFW *Water Balance Study for the Transition Zone of the Mojave River Basin* ("Water Balance Study")[1] purports to model some relationship between riparian habitat along the Mojave River, groundwater levels in the Transition Zone ("TZ") of the Alto Subarea in the Mojave River Basin and discharge of recycled water from the Victor Valley Water Reclamation Authority ("VVWRA") Shay Road Plant. The Study does not meet its purported objective. GSI finds that the Water Balance Study is so riddled with technical errors and erroneous analytic approaches that it is fatally flawed. GSI also finds that the proposed thresholds on use of VVWRA recycled water cannot be derived from the Water Balance Study even if the errors are fixed.

Lacking a sound technical basis, the Water Balance Study is obviously not intended to help the Committee objectively evaluate HDPP's petition; it is instead an opportunity for CDFW to collaterally attack the Mojave Judgment and the Memorandum of Understanding between CDFW and VVWRA (the "CDFW-VVWRA MOU"). As explained in the GSI Report, the Water Balance Study is flawed on multiple levels:

- The Water Balance Study produces nonsensical results. The fundamental flaws are best reflected by the Water Balance Study's prediction that the largest water balance *deficits* occur in the *wettest* years.
- The Water Balance Study manipulates raw data related to predicted groundwater storage changes in an attempt to find correlations that do not exist.
    - Annual groundwater level changes should correlate with the water budget *residuals*, not the annual *changes* in water budget residual.
    - The Water Balance Study adjusted the raw data by adding a large constant value, creating an artificial and meaningless relationship with the groundwater level change data.
    - The Water Balance Study inappropriately attempts to use the double mass balance method

[1] TN#: 214837

(explained in the GSI Report) to cure the poor correlation (R^2 of 0.11).

- The estimated wetted channel length reductions cannot be reliably calculated using the *assumed* percolation rates, which were derived from limited and poorly correlated data. VVWRA discharge is only one factor influencing wetted channel length. Percolation rates are not constant over time in a braided stream setting like the Mojave. The estimated wetted channel length reductions may be overestimated by as much as 100%.
- As a check on the percolation rates relied upon by CDFW, GSI calculated the amount of discharge that would have been required to achieve the actual, historical maximum wetted channel length attributed to VVWRA discharges. This quality assurance check finds that the historic discharge rates from VVWRA would have to have been nearly twice the highest actual historical VVWRA discharge rate to match the CDFW modeling predictions.
- The Water Balance Study offers no evidence that riparian vegetation has been negatively impacted by the Judgment's minimum groundwater levels or VVWRA discharges. In fact, TZ vegetation has endured during dry periods and thrived during wet periods, despite the two CDFW proposed triggers having never been met during the entire twenty-four year period of record.

Building on these indefensible premises, CDFW's Water Balance Study culminates in recommendations that collaterally attack the Judgment and the CDFW-VVWRA MOU. CDFW proposes three minimum groundwater level thresholds, two of which have never been met at any time during the entire twenty-four year period of record. In fact, the two levels that have not been met in twenty-four years are more stringent than the minimum groundwater levels in the court-administered Mojave Judgment at the critical well, Well H-2. As to the third minimum groundwater level threshold (10 feet at Well H-2), CDFW proposes that HDPP -- and HDPP only -- be subject to complete termination of VVWRA recycled water use based on this level, a termination not required by either the Judgment or the CDFW-VVWRA MOU. Singling out of HDPP as the only water user in the Adjudicated basin that must cease recycled water use based on these newly-created groundwater levels is contrary to existing law and policy, and violates all notions of due process and fundamental fairness.

The Water Balance Study is riddled with numerous technical errors and flawed analytic approaches. The issues identified above and discussed in detail in the GSI Report represent only a few of the most egregious flaws in the Water Balance Study. We urge the Committee to disregard the Water Balance Study and not allow CDFW to use this Commission proceeding to relitigate the Mojave River Basin Adjudication and the CDFW-VVWRA MOU.

Sincerely,

Jeffery D. Harris
Peter J. Kiel
Samantha Neumyer
Attorneys for High Desert Power Project, LLC

Enclosure

Technical Memorandum

To: Mark Kubow/HDPP

From: Bryan Bondy/GSI
Tim Thompson/GSI

Copy: Jeffery Harris/ES&H
Peter Kiel/ES&H

Date: January 23, 2017

Re: **Technical Review of California Department of Fish and Wildlife Water Balance Study for the Transition Zone of the Mojave River Basin (TN #: 214837)**

1.0 Summary of Key Findings

Pursuant to your request, GSI Water Solutions, Inc. (GSI) has completed a technical review of the document titled *Water Balance Study for the Transition Zone of the Mojave River* prepared by the California Department of Fish and Wildlife (CDFW) dated and docketed December 16, 2016 (referred to herein as the "Water Balance Study"). The Water Balance Study purports to evaluate how much Victor Valley Wastewater Reclamation Authority (VVWRA) recycled water could potentially be redirected to the High Desert Power Plant (HDPP) without causing adverse impacts to riparian vegetation in the Mojave River Basin Transition Zone (TZ).

As detailed below, GSI finds the Water Balance Study has multiple, significant technical errors in the analyses. GSI also finds that the basis for CDFW's Condition of Certification recommendations pertaining to VVWRA recycled water use by HDPP are not supported by the data and analyses.

1. The Water Balance Study's predicted groundwater storage changes ("water balance residuals") are insignificantly small compared to the error range of the study's inputs.
2. The Water Balance Study produced nonsensical results. The largest water balance deficits occurred in the wettest years.
3. The Water Balance Study's predicted groundwater storage changes do not correlate to the actual groundwater level data.
    a. The correlation between the Water Balance Study's predicted residuals and the raw groundwater level data is exceedingly poor (R^2 of 0.11).

b. The Water Balance Study adjusted the raw data by adding a large constant value to the residuals. The addition of a large constant value to the residuals creates an artificial and meaningless relationship with the raw groundwater level change data.
c. The Water Balance Study inappropriately attempts to use the double mass balance method to cure the poor correlation.

4. The estimated wetted channel length reductions cannot be reliably calculated using the assumed percolation rates, which were derived from limited and poorly correlated data. The estimated wetted channel length reductions may be overestimated by as much as 100%.
    a. GSI back-calculated Water Balance Study's estimate of historical maximum wetted channel attributable to VVWRA discharges using the assumed percolation rates and finds that the estimated wetted channel would require nearly twice the amount of VVWRA's actual maximum historical discharge.
5. The proposed minimum groundwater level triggers are not feasible and are not supported.
    a. Two of the three proposed minimum groundwater level triggers have not been met at any time during the entire twenty-four year period monitoring record, and may not ever be met in the future, regardless of changes in VVWRA recycled water discharge.
    b. TZ riparian vegetation has survived despite the two proposed triggers not having been met for at least twenty-four years.

2.0 Water Balance Study Methods

The overall study consists of a historical water balance of the TZ groundwater system and various correlations of the water balance residual with groundwater levels measured in the TZ key monitoring well (07N05W24R08S, a.k.a. "Well H-2" or "Key Well"). The Water Balance Study also includes estimates of potential changes to the wetted channel length of the Mojave River downstream of VVWRA in response to estimated VVWRA discharge reductions. Importantly, based on the Water Balance Study findings, CDFW has proposed that the Condition of Certification include certain recycled water use cessation triggers (tied to groundwater levels) that would apply specifically to HDPP's recycled water use and a vegetation monitoring program.

The historical water balance of the TZ was developed in an attempt to estimate annual gains and losses to the groundwater system (water balance residual) and then correlate those gains and losses with groundwater level changes. The methods utilized by CDFW are summarized as follows:

1. The water balance was developed using the approach developed in a 2003 study by URS[1], which involved developing annual estimates of each TZ inflow and outflow term and then calculating the annual water budget residual (annual change in groundwater storage). Importantly, the water balance was not calibrated against groundwater levels.

2. CDFW then attempts to correlate the water balance residual with Key Well groundwater levels using two different methods:

    a. The first correlation approach is direct; annual changes in the water balance residual are plotted against annual changes in groundwater levels. As described in the next section, the correlation between the predicted water balance residuals and the raw groundwater level data is exceedingly poor (R^2 of 0.11).

[1] URS Corporation, 2003, Mojave River Transition Zone Recharge Project, Phase II Report, Groundwater Supply and Demand in the Transition Zone, Mojave Water Agency, June 13, 2003, 70 pp.

b. The poor results of the direct correlation approach led CDFW to explore a second approach called double mass balance. The double mass balance method involves plotting the cumulative values of one parameter against another, in this case the cumulative water balance residual (as adjusted by CDFW) and cumulative water level change. The cumulative values of well correlated parameters will plot along a straight line, with a change in slope indicating a change in the relationship. As discussed in the next section, the double mass curves are meaningless because of the data adjustment by CDFW (a large constant value was added to each water balance residual prior to calculating the cumulative values), not to mention the fact that the residuals themselves are not valid. The slope of the double mass curve was then used to calculate the mathematical relationship between the water budget residual and groundwater level changes. As discussed in the next section, a double mass curve cannot be used to calculate this relationship.

The last part of the study involved estimating the potential decrease in wetted channel length for a given reduction in VVWRA discharge. The wetted channel length reduction was calculated using estimated percolation rates from URS (2003). As discussed in the following section, the approach is seriously flawed because the percolation rates developed by URS are not valid and because percolation rates are not constant over time in a braided stream setting.

3.0 Technical Review Findings

GSI's key review findings are described below.

A. Water Balance Study Results are Insignificant Compared to the Error Associated with the Study's Inputs and Not Logical

The TZ water balance is not defensible because most of the inputs are not measured or calibrated against field measurements. Importantly, the water balance residual, which CDFW uses to estimate groundwater level changes associated with transference of VVWRA recycled water for HDPP use, is meaningless because the residual is small (1.5% - 4.1%) compared to the errors associated with the estimates for the water balance inputs and outputs, which are commonly 10-20% or more. Notably, the water balance has the curious result of showing the largest water balance *deficits* in the *wettest* years. This is completely contrary to what is expected.

B. Water Balance Residual Relationship with Annual Groundwater Depth Changes is Poor

The water balance residual is the difference between estimated annual inflows and outflows and represents the estimated annual change in groundwater storage for the TZ. In years when the estimated outflow exceeds the inflow, the residual is negative, which suggests there was a reduction in groundwater storage, and vice versa. Years with estimated negative residuals are expected to be correlated with declining groundwater levels (greater groundwater depth), and vice versa.

CDFW attempted to explore these expected relationships by plotting the annual measured groundwater level change against the annual change in water balance residual. CDFW also explored the relationship incorporating a 1-year lag in groundwater level change. Not surprisingly, there is not a meaningful correlation between groundwater level change and the annual change in water balance residual because the water balance residuals are not reliable for the above-described reasons. It is important to

note that even if the water budget residuals were accurate, the correlations would be poor because the annual change in water balance residual is a meaningless term[2].

Annual groundwater level changes would be expected to be correlated with the water budget residuals, not the annual change in water budget residual. GSI explored the relationship between annual water level groundwater level changes and water budget residuals using the raw data from the Water Balance Study, as shown in Figure 1 below.

The exceedingly poor correlation (R^2 of 0.11) between the annual groundwater level change and annual water budget residual is quite evident in Figure 1. For example, there are a number of years in which groundwater level rises are associated with negative water balance residuals and vice versa, as well as a number of years with large positive residuals that are associated with near zero groundwater level changes. These relationships are completely contrary to what is expected and is further evidence that the water balance method as applied in the CDFW report is seriously flawed.

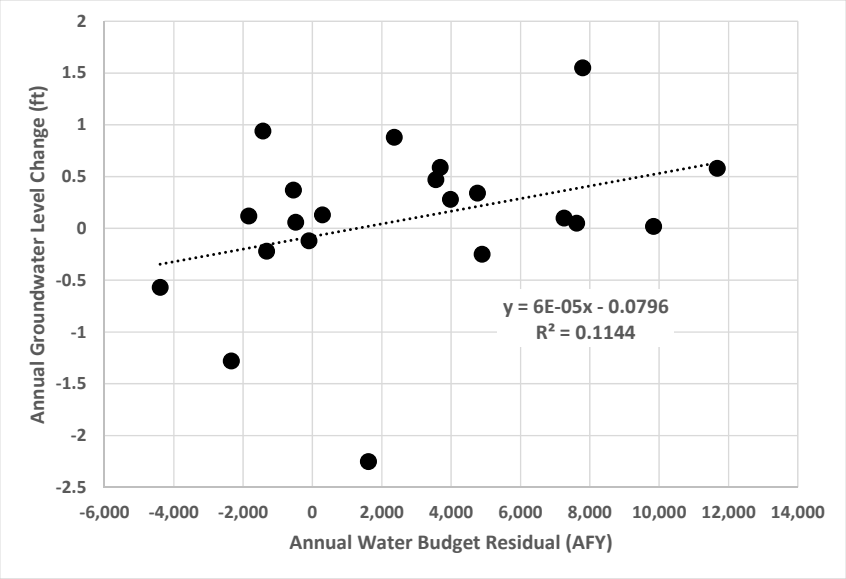

Figure 1. Annual Groundwater Level Change versus Annual Water Budget Residual

Given the problems correlating annual groundwater level changes with the water balance results, CDFW attempted to use a second method of analysis called double mass balance to estimate groundwater level changes associated with a given reduction in VVWRA discharge. The double mass balance method involves plotting the cumulative values of one parameter against another. The cumulative values of well correlated parameters will plot along a straight line, with a change in slope indicating a change in the relationship. It is important to note that the double mass balance curves prepared by CDFW were developed using *adjusted* data instead of the raw data. This approach and the resulting groundwater level change estimates are completely invalid for three reasons:

1. Because the water balance residuals are seriously flawed to begin with (as discussed above), any relationship with groundwater levels is equally flawed.

[2] For example, a negative water balance residual change between two years with positive residuals (e.g. two wet years with the first year wetter than the second) would not be correlated with a decrease in groundwater levels because groundwater levels would likely rise in the second year. However, a negative water balance residual change between a positive and negative residual year (first year wet and the second year dry) would be correlated with a decrease in groundwater levels.

2. The double mass curves are meaningless because a large constant value was added to each water balance residual prior to calculating the cumulative values. The addition of a large constant value to the water balance residual creates an artificial, meaningless relationship with groundwater level changes. It appears the CDFW found it necessary to adjust the data because the raw data do not show a meaningful relationship, as shown in Figure 2 below.

3. The slope of the double mass curve cannot be used to calculate the mathematical relationship between the parameters being investigated because it is the cumulative values of the terms that are plotted on the double mass curve. Thus, even if the water balance residuals were valid, not adjusted, and well correlated with groundwater level changes, calculating the slope of the double mass curve would still be an invalid approach for estimating the groundwater level changes associated with a given water balance residual.

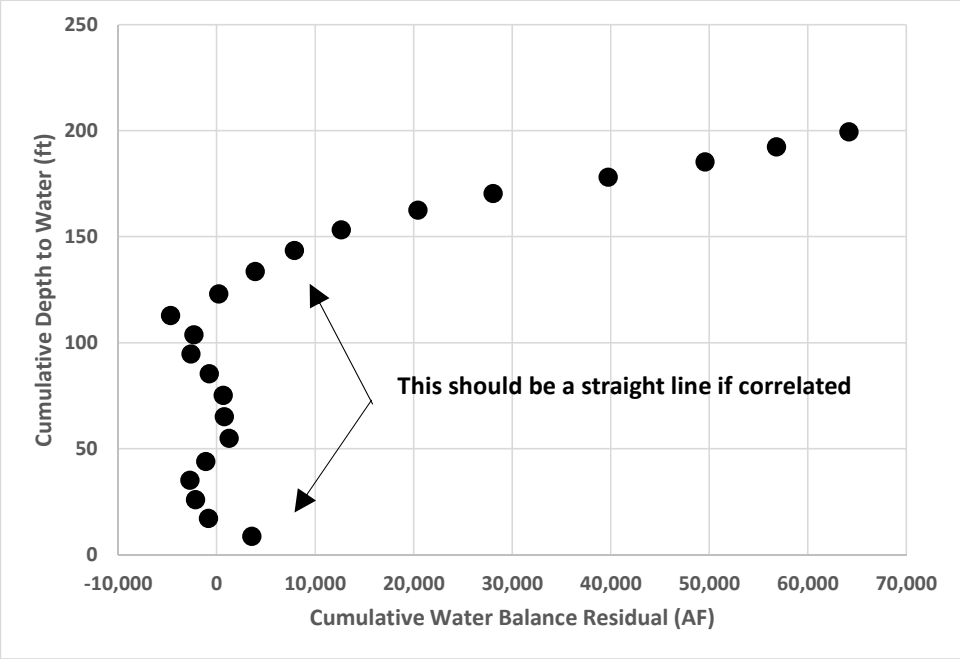

Figure 2. Double Mass Balance Curve Using Raw (non-adjusted) Data

C. Estimation of Potential Changes to Mojave River Wetted Channel Length Downstream of VVWRA is Not Valid

CDFW utilized percolation rates from a 2003 study by URS[3] to estimate the potential decrease in wetted channel length downstream of VVWRA associated with a given discharge reduction. The approach is seriously flawed for two primary reasons.

1. The percolation rates developed by URS are based on very limited data in one case and an exceedingly poor correlation in the other, as depicted in Figure 3 below. The likely reason for the poor correlation is the fact that VVWRA discharge is not the sole factor influencing wetted channel length. Other factors include groundwater levels, vegetation density, and antecedent conditions. For example, for a given VVWRA discharge rate, the wetted channel length will

[3] URS Corporation, 2003, Mojave River Transition Zone Recharge Project, Phase II Report, Groundwater Supply and Demand in the Transition Zone, Mojave Water Agency, June 13, 2003, 70 pp.

likely be longer following a wet winter than following a dry winter. CDFW made no attempt to account for these important factors.

2. The second flaw in the analysis is the assumption that percolation rates are constant. Because the Mojave River is a braided stream[4], percolation rates are highly variable depending on the number of active channels and the combined width of all active channels at any given time. Furthermore, the channel morphology changes dramatically after each stormflow event.

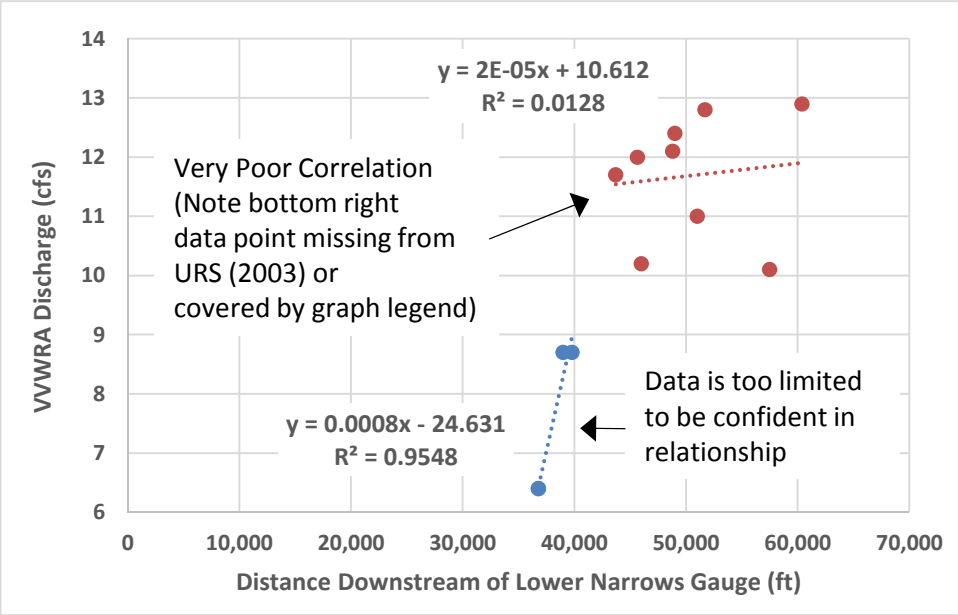

Figure 3. VVWRA Discharge versus Wetted Channel Length

As a check on the percolation rates relied upon by CDFW, GSI back-calculated the amount of discharge that would be required to achieve the historical maximum wetted channel length attributed to VVWRA discharges using the URS percolation rates. The calculation result is 25.2 cubic feet per second (cfs), which is nearly twice the highest historical VVWRA discharge rate used in the analysis. Clearly this simple exercise demonstrates that the estimated percolation rates are too high and, therefore, the predicted impact to wetted channel length is also significantly overstated.

Based on the foregoing, we do not believe specific wetted channel length reductions can be reliably calculated using the data and approach presented and the estimated wetted channel length reductions may be overestimated by as much as 100%.

D. Proposed Groundwater Level Triggers are Not Supported by the Study and are Not Attainable

CDFW proposes that recycled water use by HDPP terminate if:

1. Key Well groundwater level is deeper than 5 feet in early summer
2. Key Well groundwater level is deeper than 7 feet for longer than three consecutive months outside of early summer (when depth should be less than 5 feet)
3. Key Well groundwater level is deeper than 10 feet at any time

[4] A braided stream consists of a network of small channels that split off and rejoin each other, giving a braided appearance.

Based on historical data, the first two proposed triggers are unattainable, even with little to no recycled water use by HDPP[5]. Data from the TZ Key Well clearly show that the first two proposed triggers have not been met at any time during the entire twenty-four year period monitoring record of the Key Well, despite very little recycled water use by HDPP during that period.

Moreover, Figure 4 shows that proposed trigger nos. 1 and 2 have not been met for at least twenty-four years, yet the riparian vegetation has nonetheless survived. This suggests that the groundwater level triggers are unnecessarily conservative.

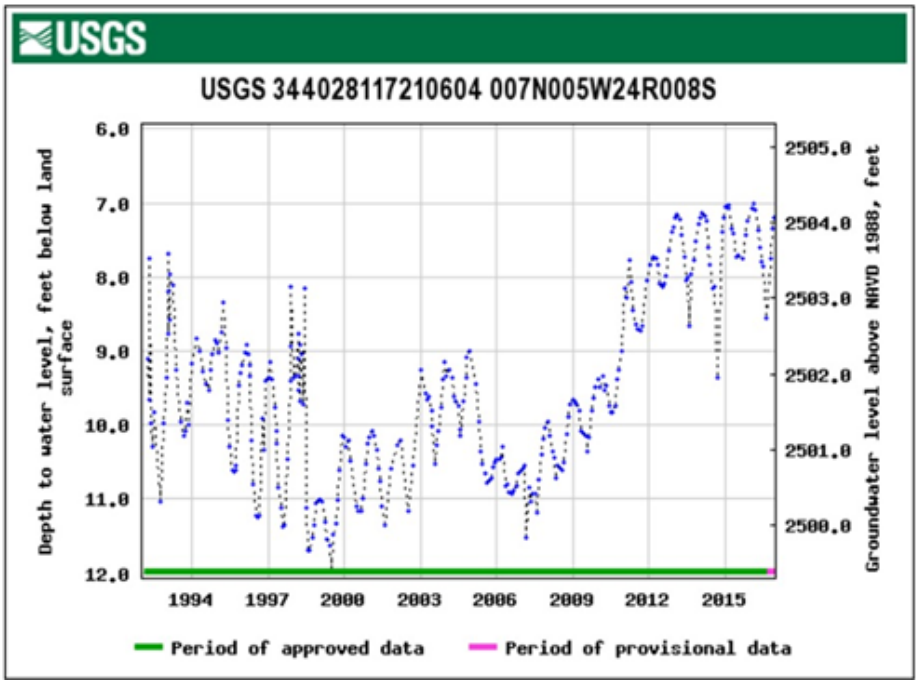

Figure 4. Depth to Groundwater Measured in Transition Zone Key Well H-2

2.0 Conclusions

Based on our review of the Water Balance Study, we conclude the following:

1. The quantitative assessment of potential groundwater level changes and wetted channel lengths are flawed and cannot be relied upon to evaluate potential impacts to riparian vegetation that might result from transference of VVWRA recycled water for use at HDPP.

2. Estimated wetted channel length reductions attributable to transference of VVWRA recycled water for use at HDPP cannot be reliably calculated using the data and approach presented and the estimated wetted channel length reductions may be overestimated by as much as 100%.

3. The groundwater level triggers proposed by CDFW are overly conservative and cannot be attained even with very little recycled water use by HDPP.

[5] Recycled water was not used by HDPP until 2011.

4. Meaningful thresholds on use of VVWRA recycled water cannot be derived from the Water Balance Study even if the identified errors are fixed. A well calibrated groundwater model of the TZ that is based on considerable additional data collection and monitoring would be needed to produce a water balance with the accuracy and precision necessary to develop meaningful and reliable thresholds. Even then, continued monitoring and evaluation would be needed to ensure the thresholds continue to accurately reflect field conditions over time.