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TECHNICAL MEMORANDUM

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PROJ. NO. 0611-001-01

SUBJECT:___Review and Comments to Long-Term Water Transfers Environmental Impact Statement/Environmental Impact Report (EIS/EIR) - Public Draft

Executive Summary of Comments

The analysis in the EIS/EIR of Groundwater Substitution Measures considered within Alternatives 2 and 3 for Long-Term Water Transfers does not properly account the water available. The analysis of the Groundwater Substitution Measures in the EIS/EIR:

- improperly quantifies the groundwater depletions that would result from groundwater extraction;
- fails to properly account for the timing and quantity of groundwater flow that would have accreted to the rivers as baseflow absent the groundwater extraction;
- fails to accurately quantify the effects of exfiltration from the river to groundwater; and
- as a result significant quantities of water are being double counted as between available surface water and extracted groundwater.

The proposed mitigation measures are inadequate to offset the impacts, in some cases this is due to the inaccurate accounting of water and in other cases it is because the proposed mitigation is too ill-defined to provide substantive protection against impacts.

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Groundwater Resources

The SACFEM 2013 groundwater model utilized for analysis in the EIS/EIR for Groundwater Substitution Measures does not properly account the losses of water in the rivers. This is true due to a number of deficiencies in the model's simulation code, MicroFEM and the SACFEM2013 model's construction.

- SACFEM2013 uses a river stage that does not vary over each time step which in effect makes the river an infinite source of water for each time step.

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- SACFEM2013 does not accurately account the losses of water in the rivers because it does not contain a mathematical algorithm for accounting the flow or quantity of water in the rivers. 3
- SACFEM2013 does not accurately account the water because it treats flow between the river and aquifer as fully-saturated flow even when the model conditions recognize that hydraulically they are detached. 4
- SACFEM2013 has been configured such that extraction from Groundwater Substitution Measures are hydraulically isolated from the river (for example a vertical anisotropy of 500:1 in hydraulic conductivity at the wells in the model substantially isolates them from the rivers) 5
- SACFEM2013 does not represent accurately the depletions to groundwater that must be refilled by natural recharge or other sources due to its handling the rivers as infinite sources during each model time interval 6

SACFEM2013 is not well calibrated to actual conditions of groundwater elevation near rivers and streams. Due to its lack of calibration to actual groundwater elevation conditions, the predictive outcomes are not reliable as a basis for assessing the locations of impact and the degree of impact to Water Supply, Groundwater Resources, Water Quality, and Terrestrial Resource considerations. 7

Neither the quantity of water nor the timing of its removal from surface water is calculated correctly in SACFEM2013 due to the structural deficiencies identified in our review. One of the essential needs in an EIS/EIR on Groundwater Substitution Measures is accurate estimating of the timing of impacts to the flowing rivers and streams; SACFEM2013 does not provide accurate monthly estimates of when peak streamflow depletions will occur if Groundwater Substitution Measures are imposed in large part because of the hydraulic isolation of the pumping from the rivers configured into the model. 8

The magnitude of groundwater depletion is underestimated in SACFEM2013 due to its use of infinite river sources. 9

The Proposed Mitigation GW-1 for aquifer desaturation resulting from Groundwater Substitution Measures, GW-1, will not adequately mitigate the impacts to groundwater users in the Seller's Area. This is due in part to the improper accounting of the exchange of surface water and groundwater in SACFEM2013 which attributes too much of the groundwater elevation variability to seasonal recharge and discharge and does not attribute enough of the variability to long term desaturation. However, the Proposed Mitigation, GW-1, will not adequately mitigate for changes in groundwater storage due to the mitigation measure's reliance upon local groundwater-subbasin management-objectives; those objectives are insufficiently quantified and thereby cannot enable timely mitigation of project impacts from Groundwater Substitution Measures. 10

The mitigation proposed for decreases in groundwater saturation of the uppermost aquifer, GW-1, are inadequately considered. SACFEM2013 does not correctly calculate the drawdown of the unsaturated aquifer and its corresponding increase in the weight of the overburden on under consolidated lithologic layers. This will result in greater impacts from Groundwater Substitution Measures than are recognized in the EIS/EIR due to inelastic subsidence and the resulting permanent loss of aquifer storage in the Seller's Area. The proposed mitigation, GW-1, will only recognize or acknowledge inelastic subsidence 11 due to Groundwater Substitution Measures after it has occurred; thus it cannot restore or offset the permanent impact of subsidence. 11

Water Supply

The "post-processing tool" referred to under evaluations of Water Supply for Water Operations Assessment does not properly account for water as it uses SACFEM2013, CalSim II, and a spreadsheet model called the Transfer Operations Model (TOM). The potential impacts to Water Supply from Groundwater Substitution Measures do not properly account the water the sources available and depleted in the Water Operations Assessment. 12

The CalSim II model utilized for analysis in the EIS/EIR does not properly account the losses of water in the rivers nor the quantities of accretionary flow of groundwater to rivers within the area modeled. Calsim II provides limited useful information to assess potential surface water impacts as the model contains unfounded assumptions, errors, and outdated simulation codes. The very poor precision of the surface water delivery model (CalSim II) used for the baseline assessment on quantities of water moving in and around the CVP and SWP leads to problems in accounting for water losses due to existing groundwater extraction and proposed groundwater extraction as Groundwater Substitution Measures. 13

TOM is utilized in the EIS/EIR to assess Impacts to Water Supply from Groundwater Substitution Measures does not and by virtue of its underpinnings of SACFEM2013 and CalSim II cannot properly account the losses of water in the rivers induced by Groundwater Substitution Measures. TOM simulates water made available under each transfer mechanism, subject to various constraints. TOM uses an assumed priority for transfer mechanisms used to make water available under Project alternatives in the following order: 14

- Groundwater substitution – for alternatives that include this mechanism
- Reservoir release
- Conserved water
- Crop idling – for alternatives that include this mechanism

Priorities for transfer mechanisms are necessary to develop groundwater pumping inputs to SACFEM2013 and simulate all transfers in TOM. Thus TOM appears to bookkeep errors in available water derived in SACFEM2013 and CalSim II. It takes input from SACFEM2013 and CalSim II to bookkeep their inaccurate information but provides no feedback to those models 15

The methodology by which Groundwater Substitution Measures for Long-Term Water Transfers are being considered and analyzed within the EIS/EIR, improperly accounts quantities of water and as a result significant quantities of water are being double counted as between available surface water and extracted groundwater. 16

Due to the improper accounting of water in Water Supply, the proposed mitigation, WS-1, is inadequate to mitigate the impacts to water availability and water flows into and through the Delta during three important periods of time: (1) the period of Groundwater Substitution pumping, April thru September; (2) the Water Transfers window, July thru September; and, (3) the period following the Water Transfers window, October to April. 17

Due to the lack of a specific formulation for the proposed Water Supply mitigation, WS-1, it is unpredictable how the mitigation will be applied. The EIS/EIR references Draft documents on Technical Information for Preparing Water Transfer Proposals (October 2013).[1] Those documents identify the need for estimating the effects of transfer operations on streamflow and describe the use of a streamflow depletion factor; however they provide no basis for Project Agency approval nor for transfer proponents to submit site-specific technical analysis supporting a streamflow depletion factor. That document which is completely relied upon in establishing proposed mitigation, WS-1, states that:

> *"Project Agencies are developing tools to more accurately evaluate the impacts of groundwater substitution transfers on streamflow. These tools may be implemented in the near future and may include a site-specific analysis that could be applied to each transfer proposal."*[2]

This future action provides no established or predictable basis for the mitigation of streamflow depletions due to Groundwater Substitution Measures. Due to the improper accounting of water in both the groundwater and surface water supply models utilized for Water Supply analysis, reliance upon these models or the analysis in this EIS/EIR by the Project Agencies would result in inappropriate estimation of the streamflow depletion factors (SDF) utilized. Examples of appropriate methodologies for quantifying SDF for Water Supply are provided in Appendices A and B. They result in short-term SDF ranging from 8% to 22% of the Groundwater Substitution Measures after the onset of pumping proposed in the EIS/EIR and long-term cumulative SDF ranging from 34% to 108.5% of annual pumping based on evaluation of the 6-year drought from 1987 to 1992. 18

The mitigation proposed for loss of Water Supply, WS-1, due to Groundwater Substitution transfers is insufficient. It does not adequately account for the impact from the resulting reductions of water available in the rivers and groundwater due to the improper accounting of water in the EIS/EIR analyses. As detailed in our analysis the mitigation measure proposed has no basis in fact, and if it did the project proponents would find that mitigation of the impacts from Groundwater Substitution Measures are not likely to meet the Project Purpose and Need and the Project Objectives.

Water Quality

Groundwater Substitution Measures for Long-Term Water Transfers effects on Delta outflows and water quality are not properly considered in the EIR/EIS. The EIS/EIR rates the effects on Delta outflows and the impact to Delta Water Quality as Less Than Significant based on improper accounting of water. The effects and impacts are likely to be Significant and thus will require mitigation.

Reservoir Releases for meeting regulatory requirements and or deliveries to Project Contractors may be diminished by streamflow depletions from <u>current and proposed</u> pumping conditions in areas where groundwater saturation falls below the adjoining river stage. These depletions of water available for transfer via Reservoir Releases are not quantified in the EIS/EIR. The effect of these baseline conditions impacts the availability of water to be transferred down the Sacramento River and through the 19

[1] Department of Water Resources and Bureau of Reclamation, 2013. DRAFT Technical Information for Preparing Water Transfer Proposals – Information to Parties Interested in Making Water Available for Water Transfers in 2014, October.

[2] Ibid, at p. 33.

Sacramento San-Joaquin River Delta to the CVP and SWP pumping stations that pump water south via their respective aqueducts, the Delta-Mendota Canal, and the California Aqueduct. 19

Terrestrial Resources

Terrestrial Resource impacts are not properly accounted in the EIS/EIR due in part to the imprecision and inability of the models to assess dehydration of the soils and groundwater aquifer adjoining both small streams and large rivers.

The Proposed Mitigation, GW-1, for potential impacts to Terrestrial Resources is insufficient to mitigate the impacts since it too is not sufficiently quantified in the EIS/EIR nor in the Groundwater Management Plans (GWMPs) referenced. Existing GWMPs do not contain quantified year on year metrics for subbasin depletion and refill. These GWMPs do not identify acceptable ranges of groundwater elevations for short-term or long-term groundwater that will to sustain primary functions like support for natural riparian communities upon which several endangered species rely. 20

Summary of Impact Statements Addressed from the Review Performed of the EIS/EIR Analyses

The fundamental concept of water accounting errors in the models and conceptualizations applied to six specific evaluations made in the EIS/EIR are addressed herein under four topic headings Groundwater Resources, Water Supply, Water Quality and Terrestrial Resources.

Potential Impact Statements from Table ES-4	**Related Alternative(s)**	**Significance to CEQA**	**Proposed Mitigation**	**Significance After Mitigation Pursuant to CEQA**
Groundwater substitution transfers could cause a reduction in groundwater levels in the Seller Service Area.	2, 3	S	GW-1: Mitigation and Monitoring Plans	LTS
Groundwater substitution transfers could cause subsidence in the Seller Service Area.	2, 3	S	GW-1: Mitigation and Monitoring Plans	LTS
Groundwater substitution transfers could decrease flows in surface water bodies following a transfer while groundwater basins recharge, which could decrease pumping at Jones and Banks Pumping Plants and/or require additional water releases from upstream CVP reservoirs.	2, 3	S	WS-1: Streamflow Depletion Factor	LTS

Potential Impact Statements from Table ES-4	Related Alternative(s)	Significance to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Water transfers could change Delta outflows and could result in water quality impacts.	2, 3, 4	LTS	None	LTS
Groundwater substitution could reduce stream flows supporting natural communities in small streams	2, 3	S	GW-1	LTS
Transfer actions could alter flows in large rivers, altering habitat availability and suitability associated with these rivers	2, 3, 4	LTS	None	LTS

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Detailed Comments to EIS/EIR Analyses

Groundwater Resources

The EIS/EIR evaluates at Section 3.3.2 on Environmental Consequences/Environmental Impacts on Groundwater Levels from the Long-Term Water Transfers lists: (1) increased groundwater pumping costs due to increased pumping depth (i.e. increased depth to water in an extraction well); (2) decreased yields from groundwater due to reduction in the saturated thickness of the aquifer; (3) lowered groundwater table elevation to a level below the vegetative root zone, which could result in environmental effects. It then sets out to evaluate Item (1) under Regional Economics and (3) under Vegetation and Wildlife. Further it states that for Environmental Consequences/Environmental Impacts on Land Subsidence that excessive groundwater extraction from confined and unconfined aquifers could lower groundwater levels and decrease pore-water pressure. It notes that compression of fine-grained deposits is largely permanent and lists various negative consequences that could result. 21

Our review finds the evaluation in the EIS/EIR of impacts to Groundwater Resources from Groundwater Substitution Measures does not properly account for water and as a result is either inaccurate or insufficient to evaluate the potential environmental impacts associated with Groundwater Substitution.

Potential Impact Statements from Table ES-4	Related Alternative(s)	Significance to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Groundwater substitution transfers could cause a reduction in groundwater levels in the Seller Service Area.	2, 3	S	GW-1: Mitigation and Monitoring Plans	LTS

The two assessment methods utilized for Groundwater Resources in the EIS/EIR are a numerical groundwater model, SACFEM2013, and a qualitative assessment for groundwater conditions in the Redding Area Groundwater Basin outside of the numerical groundwater limits.

The SACFEM 2013 groundwater model does not properly account water in an integrated groundwater to surface water system. This is due in part to the shortcomings in the underlying simulation code used, MicroFEM, to construct the SACFEM 2013 groundwater model.[3] The MicroFEM simulation code selected for evaluation of the significance of potential impacts to groundwater lacks some essential mathematics for evaluation of the issues presented by Groundwater Substitution Measures. MicroFEM is a simulation code only for fully saturated groundwater systems whereas to evaluate the potential impacts and 22

[3] The following terms, referenced herein, are typical of industry nomenclature: Algorithm - an operation or calculation (e.g., the Darcy equation); Simulation Code - a sequence of programming language commands that encapsulates one or more algorithms (e.g., California DWR's IWFM program); and, Model - an application of a simulation code to a site-specific question (e.g., in this EIS/EIR-evaluation the use of MicroFEM and its construction into the groundwater model SACFEM2013)

effects of groundwater extraction near rivers in the Sacramento River Basin it is necessary to properly formulate the discharge of water from the rivers when the river at the bottom of its streambed hydraulically detaches from the groundwater aquifer due to aquifer desaturation. While MicroFEM mathematically notes the transition from saturated to unsaturated it calculates the condition of discharge as if it is fully saturated. This is incorrect and produces substantive miscalculation of the rate and quantity of movement of surface water into groundwater and thus the magnitude of the resulting groundwater depletion.

As can be seen in the following illustration (Figure 1) aquifer desaturation and streamflow detachment, will influence the rate of change in groundwater elevations, groundwater flow, and groundwater interaction with surface water bodies, particularly rivers and streams. We address streamflow under Water Supply.

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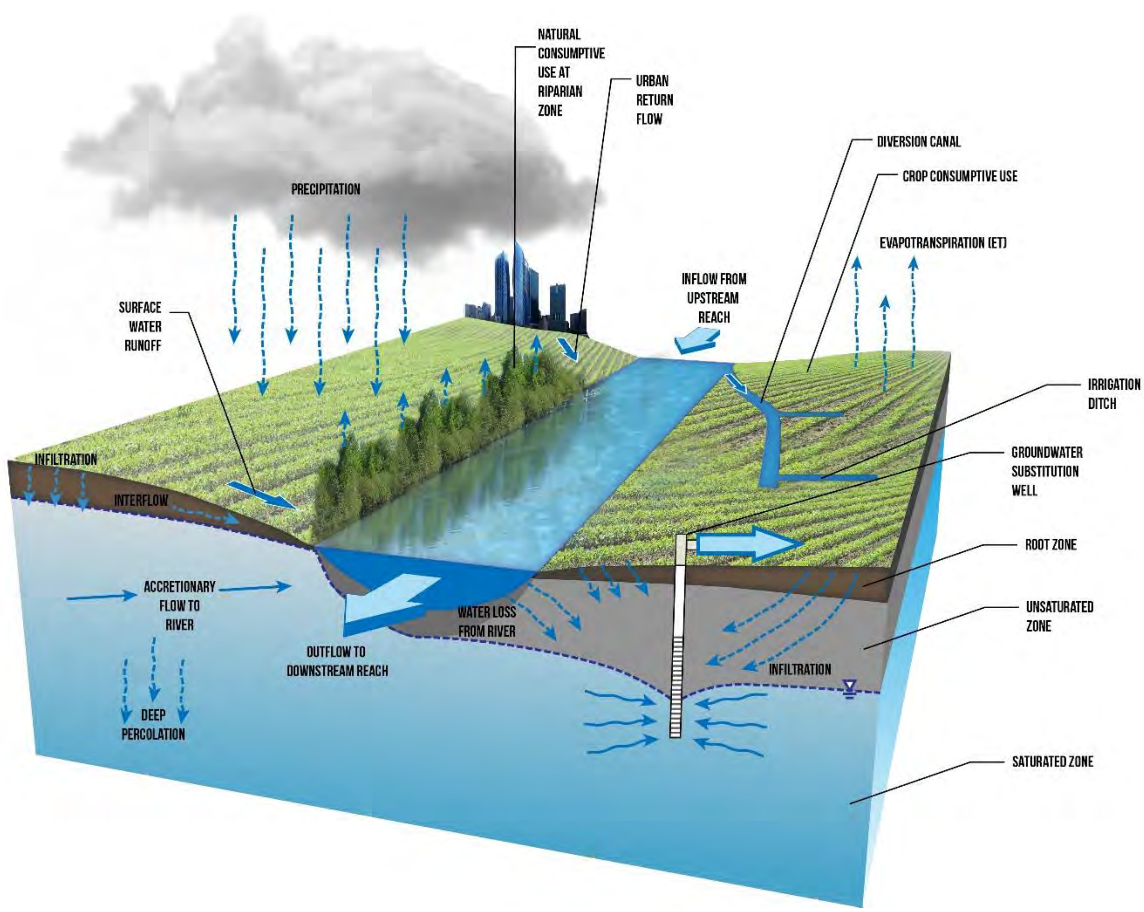

Figure 1 Groundwater Surface Water Interactions in the Hydrologic Cycle

The MicroFEM simulation code lacks the algorithm that would account the water loss from the river under unsaturated and partially saturated conditions. In order to properly account water in the groundwater system and represent the changes in the groundwater elevations as well as the streamflow depletion from the rivers and streams induced by Groundwater Substitution Measures, unsaturated or partially saturated groundwater flow algorithms are essential components of the simulation code and/or the quantitative analysis. 22 Since the MicroFEM simulation code does not have proper algorithms to represent streamflow detachment and the resulting flux to groundwater, then as a result neither does SACFEM2013 model, the model upon which Groundwater Resource evaluations are based.

As far as potential impacts to river stage heights induced by decreases in groundwater elevations from Groundwater Substitution Measures, MicroFEM has no algorithm to calculate a change in river stage height that governs the rate of accretion or depletion to the river. Thus calculation of fluxes into and out of a river are inaccurate. They are either overestimated or underestimated based on the relative head difference between groundwater and surface water. The flow into or out of the groundwater system (called groundwater surface-water flux hereinafter) is never correct in MicroFEM due to this missing algorithm and capability in the simulation code.

For each time step the SACFEM2013 model has a user-input river stage that is invariant for the monthly time step. This results in substantive problems in properly accounting the depletion of water in the groundwater aquifer and in the groundwater surface-water flux. First with regard to accounting the depletion of groundwater SACFEM2013 does not account for the origin of surface water flowing into the groundwater domain. 23 Surface water flowing into the groundwater domain during each monthly time-step is treated as an infinite source of water; there is no formulation of river flow in the MicroFEM simulation code and hence the SACFEM2013 model has no river flow accounting to provide proper accounting of this lost surface water (That water loss accounting appears to be attempted later under the Transfer Operations Model which we address under Water Supply). A useful publication from the U.S. Geological Survey (USGS) from 1998, Ground Water and Surface Water A Single Resource, identifies that the hydrologic cycle demonstrates that groundwater surface-water flux behaves dynamically and that groundwater is not a source but rather the system of surface water and groundwater is a finite resource defined and governed by local and regional hydrologic and hydrogeologic conditions.[4] This dynamic interaction of groundwater surface-water fluxes within the context that it is finite in quantity and temporally controlled is not the manner in which groundwater modeling has been done for use in the EIS/EIR. Since the source of surface water in SACFEM2013 that satisfies the model estimated drawdown is mathematically infinite, an improper accounting of water available in the system occurs. This results in the double counting of available water as between available groundwater for substitution transfer and available surface water to transfer. In summary the accounting of surface water available to recharge an aquifer in SACFEM2013 is not correct due to the fundamental construct of the model.

Due to the SACFEM2013 model requirement of groundwater surface-water flux being calculated as a fully saturated flow condition, groundwater surface-water flux where the model calculated head near a river reach is below the bottom of the streambed is not properly calculated in SACFEM2013. Rates of inflow to groundwater where this occurs within the model domain for a particular model stress period 24 are overestimated due to both the incorrect mathematical formulation as fully saturated flow and the invariant stage height in that river reach for that stress period (or the following stress period if there were some model carryover of surface water depletions). Furthermore the underestimation of groundwater depletion from that same stress period is error that is carried over to the next stress

[4] Winter, T.C., J.W. Harvey, O.L. Franke, and W.M. Alley 1998. Ground Water and Surface Water A Single Resource, USGS Circular 1139, pp. 79, p. 2.

period. This cumulative error in accounting the temporal depletion of groundwater in SACFEM2013 is significant because the model then subsequently does not have correct quantification of the amount of 24 required refill water to replenish groundwater from both natural recharge and delivery and application of irrigation water. Thus there are problems in accounting water correctly in the connected groundwater and surface water system due to errors in SACFEM2013.

Unlike surface water depletions to groundwater, the accretionary flow of groundwater to the river is 25 calculated in SACFEM 2013, but the calculation is inaccurate due to the invariant stage height during each monthly time step in the model.

SACFEM2013 contains an unusual model construction feature with respect to natural or crop consumptive use and evapotranspirational loss of water. It utilizes a calculation module in MicroFEM called Drains to simulate evapotranspirational losses and groundwater discharge to land surface outside 26 of a recognized and model surface water course. Drains were set at land surface rather than at root zone depth. This is altogether an unusual construction and one that reduces the quantity of water removed by vegetation as constructed. Additional details on SACFEM2013 model review and issues noted are provided in Attachment C herein.

SACFEM2013 is not well calibrated to actual conditions of groundwater elevation near rivers and streams. There is almost no mention of model calibration in the EIS/EIR; those two words appear once at page D-13. There are a number of standard references on numerical groundwater modelling that emphasize the importance of model calibration.[5,6,7] The lack of documentation in the EIS/EIR of model calibration such as how it was conducted and what the degree of precision achieved to which outcomes, is a significant omission. Through sources cited in the EIS/EIR we were able to locate calibration information for SACFEM.[8] The peer review cited in the EIS/EIR stated:

> *"Review of the representative and other calibration hydrographs reveals that significant* 27 *calibration issues exists in areas that rely mostly on surface water. This is mainly due to the issues of SacFEM's estimation of stream-aquifer interaction. Calibration quality improves in areas that rely mostly on groundwater."*[9]

The model documentation we reviewed demonstrated local errors in predicting groundwater elevation heads that are greater than 65 feet (see Attachment C).[10] Calibration errors of this magnitude signify that the groundwater elevations for the water table would fall below the bottom of the uppermost layer in SACFEM2013; the significance of this is that MicroFEM simulation code only calculates unconfined flow conditions in the uppermost layer of a particular model such as SACFEM2013. When actual

[5] Reilly, T.E., and Harbaugh, A.W., 2004, Guidelines for evaluating ground-water flow models: U.S. Geological Survey Scientific Investigations Report 2004-5038, 30 p.

[6] ASTM 2001, D 5981-96 (Reapproved 2002), "Standard Guide for Calibrating a Ground-Water Flow Model Application". Published November 1996, 6 p.

[7] ASTM 1994, D 5490-93,"Standard Guide for Comparing Ground-Water Flow Model Simulations to Site-Specific Information"Published January 1994, 7 p.

[8] WRIME, 2011. Peer review of Sacramento valley Finite Element Groundwater Model (SACFEM2013), October.

[9] Ibid, p. 16.

[10] Lawson, Peter, 2009. Documentation of the SacFEM Groundwater Flow Model. CH2MHill Technical Memorandum. Prepared for Bob Niblack, California Department of Water Resources, February. This document is relied upon heavily in the peer review document cited for Section 3.3 of the EIS/EIR: WRIME,2011.

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groundwater elevations fall below the bottom of Layer 1 in a number of locations, the model is miscalculating the groundwater flux. This demonstrates that the SACFEM2013 model was improperly constructed as well as poorly calibrated. Due to its lack of calibration to actual groundwater elevation conditions, the predictive outcomes are not reliable as a basis for assessing the locations of impact and the degree of impact to Water Supply, Groundwater Resources, Water Quality, and Terrestrial Resource considerations. Attachment C herein highlights further critique of the SACFEM2013 based on information found in the EIS/EIR as to the model's construction and documentation that the EIS/EIR relies upon in regard to the model's construction and calibration.

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Neither the quantity of water nor the timing of water's removal from surface water is calculated correctly in SACFEM2013 due to the structural deficiencies identified in our review. One of the essential needs in an EIS/EIR on Groundwater Substitution Measures is accurate estimating of the timing of impacts to the flowing rivers and streams; SACFEM2013 does not provide accurate monthly estimates of when peak streamflow depletions will occur if Groundwater Substitution Measures are imposed in large part because of the hydraulic isolation of the pumping from the rivers configured into the model.

Accurately quantifying the changes in groundwater storage and groundwater elevations associated with Groundwater Substitution Measures is foundational to defining the potential impacts and their magnitude, and the metrics for the proposed mitigation measure GW-1.

Qualitative Assessments for Groundwater Resources

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In section 3.3.1.3.1 Redding Area Groundwater Basin the discussion of Groundwater Production, Levels and Storage does not quantify the quantity of current groundwater pumping or the basin safe-yield without mining out groundwater in any of the six subbasins recognized in DWR Bulletin 118. There is no identification of what impacts to base flows occur from current groundwater extractions for either current Municipal & Industrial (M&I) or applied irrigation. The EIS/EIR does not quantify those groundwater levels (i.e. drawdowns) associated with existing extractions in order to establish what the acceptable groundwater levels (i.e. drawdowns) associated with Groundwater Substitution Measures in this area might be. This is foundational to establish a basis for the proposed mitigation, GW-1, to avoid impacts to existing groundwater users and to avoid impacts to the seasonal base flows in the Sacramento River reaches in the Redding Area Groundwater Basin and those seasonal base flows of the 7 major tributaries to the Sacramento River within the basin. For example our review of the groundwater elevation contours on Figure 3.3-4 indicate that the Sacramento River are between 420 feet and 400 feet above Mean Sea Level between the Clear Creek join and the crossing of the I-5 freeway over the Sacramento at Anderson, CA; since the stream bottom profile of the Sacramento River is approximately 430 feet to 403 feet over this same reach the Sacramento River was losing water in this reach during the Spring of 2013. In addition our review finds that the Sacramento River streambed elevation is above the groundwater elevations of Spring 2013 depicted on Figure 3.3-4 at Colusa, California and southward to the edge of that figure; this means that the Sacramento River from Colusa, California and southward to perhaps Tyndall Landing, California is not only exfiltrating to groundwater, but it is also not gaining the accretionary flow of groundwater that historically occurred in these river reaches.

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In Section 3.3.1.3.2 Sacramento Valley Groundwater Basin the discussion of Geology, Hydrogeology and Hydrology notes that it was estimated by the USGS that from 1962 to 2003 that streamflow leakage (also called direct exfiltration) amounted to 19% of total basin recharge and equated to 2,527,000 acre-feet per year (AFY) or 3,490 cubic feet per second of surface-water flow. This quantity of water does not denote the entirety of the streamflow depletion from the basin which is the: denied accretionary 30 groundwater flow to the rivers and streams within the basin. However, it is noted that this USGS estimated leakage-loss that discharges from the rivers and streams to groundwater is accounted in their CVHM model as surface water removed.[11]

The impact from surface water leakage to support the groundwater elevations reviewed in Section 3.3 is not quantified and the available response of groundwater elevations to Groundwater Substitution Measures is not quantifiable as a result. In other words if one of the principal sources to groundwater is surface water leakage and that leakage has already reached its maximum rate then the impact from further groundwater extraction must take into account that removal from storage and upgradient flow must meet the demand from Groundwater Substitution Measures.

It appears that neither quantitative nor qualitative evaluation of inflow or outflow to rivers and streams has been done in the EIS/EIR using empirical groundwater and surface water elevation data. Our 31 requests for the database of groundwater elevations used in the EIS/EIR did not yield the Spring 2013 groundwater elevation data used to generate Figure 3.3-4. Further neither the report nor the data provided to our request reveal groundwater elevation data for 2013 in the southerly portions of the Sacramento Valley beyond the extent of Figure 3.3.-4. Comparison of empirical (actual) data to mathematical representations in models is essential to assess whether the models are adequately representing the physics of the real-life system being mathematically modeled. Evaluation of empirical data such as land surface, groundwater elevations, and stream stage heights and rated flow rates, enables assessment of the direction of flux and with more sophisticated tools the probable magnitude of flux.

Proposed Mitigation for Potential Effects on Groundwater Resources

The Proposed Mitigation GW-1 for groundwater pressure decreases (a.k.a. groundwater elevations) resulting from Groundwater Substitution Measures, GW-1, will not adequately mitigate the impacts to groundwater users in the Seller's Area. Proposed Mitigation GW-1 is not quantified or quantifiable as to what groundwater pressure decreases will constitute an impact to water users in the Seller's Area.

The groundwater elevations necessary to mitigate streamflow depletions under proposed mitigation, 32 GW-1, as well as the stated impact of lowered groundwater levels for existing groundwater users must be quantifiable or else the proposed mitigation is insufficient to reduce the impacts from Groundwater Substitution Measures. For example in the Spring 2013, the Sacramento River streambed elevations are below groundwater elevations from Red Bluff, California to roughly Princeton, California (i.e. the Sacramento River is gaining flow from accretionary flows of groundwater in this lengthy reach) as depicted on Figure 3.3-4 of the EIS/EIR.

[11] Faunt, C.C., ed., 2009, Groundwater Availability of the Central Valley Aquifer, California: U.S. Geological Survey Professional Paper 1766, 225 p.

The proposed framework for GW-1 is based upon a draft application for preparing water transfer proposals for 2014 from DWR and U.S. Bureau of Reclamation and with the statement that this will be updated as appropriate.[12]

The framework provided for groundwater monitoring and the subsequent proposed mitigation in the EIS/EIR provides no substantive criteria for either monitoring or mitigation. With regard to groundwater monitoring for example at page 3.3-88 under Section 3.3.4.1.2 it states

> *"The monitoring program will incorporate a sufficient number of monitoring wells to accurately characterize groundwater levels and response in the area before, during, and after transfer pumping takes place."*

There is no attempt at defining the minimum number of wells, a spatial resolution laterally or vertically, nor a timeframe. The subsequent subsection on groundwater level measurement requires measurement of groundwater elevations until March of the year following the transfer; this would imply that impacts from one year's transfer are not anticipated to carry over into the following year or it implies that this is the new baseline for the subsequent year's transfer withdrawal. There is no discussion or mention of a multi-year monitoring program in the EIS/EIR with year over year metrics nor are in the draft application guidance for groundwater transfer proposals. A typical application of such a monitoring program using best available science and practice is to establish groundwater elevations in a base year and then metric changes as relative drawdown; in this manner groundwater depletion within a basin or subbasin can be 33
assessed if it is occurring and this would encompass protections against injurious harm to Groundwater Resources if natural recharge is less than normal or slower than one seasonal cycle in providing recovery of the depletion from Groundwater Substitution Measures coupled with other groundwater uses or fluxes. With regard to proposed mitigation for example at Section 3.3.4.1.3, the EIS/EIR states:

"If the seller's monitoring efforts indicate that the operation of wells for groundwater substitution pumping are causing substantial adverse impacts, the seller will be responsible for mitigating any significant environmental impacts that occur."

There is no definition provided of what constitutes a substantial adverse impact. Looking back to Section 3.3.2.2 Significance Criteria one finds:

> *"A net reduction in groundwater levels that would result in adverse environmental effects or effects to non-transferring parties"*

There is no benchmark criterion for mitigation and in fact the EIS/EIR at page 3.3-90 then states:

> *"To ensure that mitigation plans will be feasible, effective, and tailored to local conditions, the plan must include the following elements:*
>
> - *A procedure for the seller to receive reports of purported environmental or effects to non-transferring parties;*
> - *A procedure for investigating any reported effect;*
> - *Development of mitigation options, in cooperation with the affected parties, for legitimate significant effects; and*

[12] Department of Water Resources and Bureau of Reclamation, 2013. DRAFT Technical Information for Preparing Water Transfer Proposals – Information to Parties Interested in Making Water Available for Water Transfers in 2014, October

- *Assurances that adequate financial resources are available to cover reasonably anticipated mitigation needs."*

This text is extremely unclear as to: technically what is the procedure for investigation of effects; what is the meaning of "legitimate significant effects" when a multitude of overlapping influences on groundwater will occur from natural to man-made; and who would be monitoring and reporting on adverse environmental effects if not the Seller's and if so then who would be compensating for that monitoring. Our review finds the GW-1 does not provide adequate mitigation for groundwater decreases in the Seller Service Area as it relies upon poorly defined future actions with no established, reliable, or predictable basis for the monitoring and mitigation. 33

Potential Impact Statements from Table ES-4	**Related Alternative(s)**	**Significance to CEQA**	**Proposed Mitigation**	**Significance After Mitigation Pursuant to CEQA**
Groundwater substitution transfers could cause subsidence in the Seller Service Area.	2, 3	S	GW-1: Mitigation and Monitoring Plans	LTS

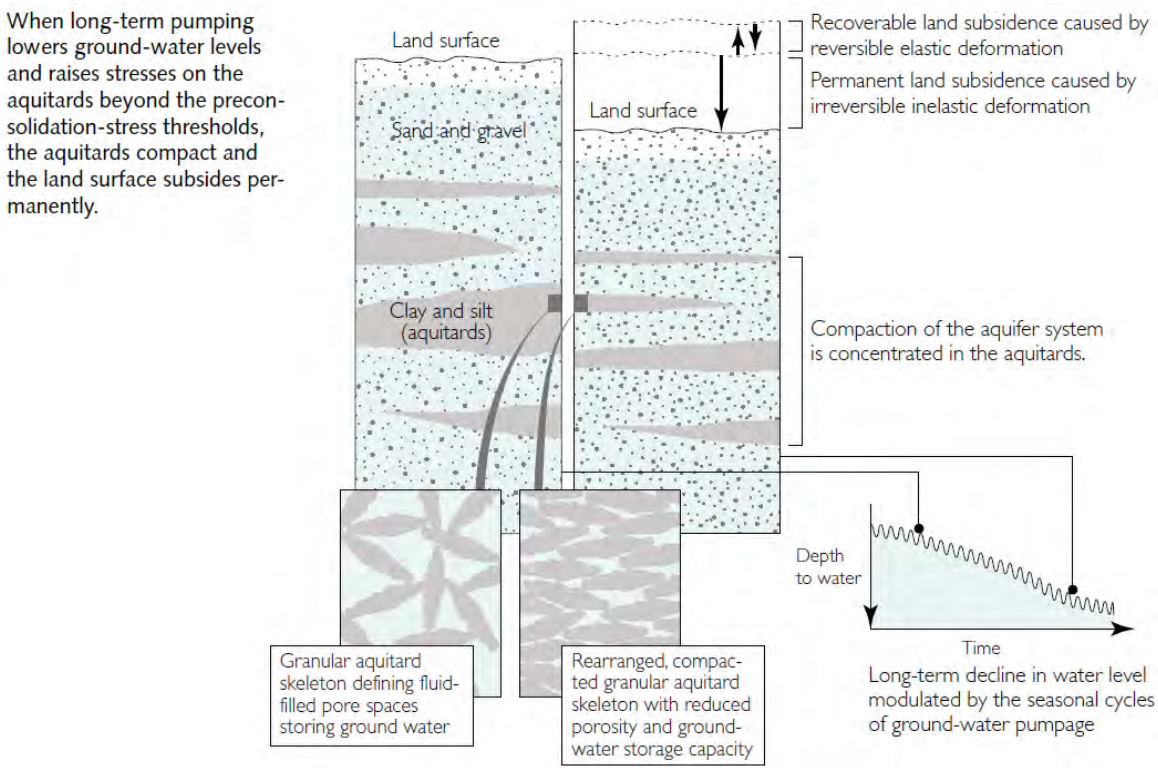

Figure 2 The mechanics of land subsidence due to changes in groundwater elevations, USGS Circular 1182

The groundwater formation in the Seller Service Area west of the Sacramento River is composed of the Tehama Formation.[13] The Tehama Formation has exhibited subsidence in Yolo County. According to the EIS/EIR similar formational and hydrogeologic characteristics exist in the Redding Area Groundwater Basin.

Groundwater elevation changes due to long term pumping can increase the effective stress on subsurface materials that are under-consolidated. This is typical of some aquitards whose skeletal materials are typically composed of fine-grained sediments and when deposited by lower-energy hydraulic processes their ionic mineral boundaries keep them under-consolidated. When the effective stress of the soil column on these aquitards is increased due to dehydration of the aquifers above them, their skeletons compact. This is known as inelastic subsidence and it causes both a permanent loss of groundwater aquifer storage capacity and a depression at the land surface (Figure 2).

The groundwater elevations depicted on Figures 3.3-8 and 3.3-9 demonstrate that groundwater 34
elevations in three of the eleven wells selected are at historic lows and under existing hydrogeologic and hydrologic conditions are on decadal declining trends. Specifically wells 11N05E32R001M, 21N03W33A004M, and 15N03W01N001M are all at historic lows at their last measurement discounting for seasonality. Each of these wells is in the western half of the Sacramento Valley Basin and thus would be expected to be overlying the Tehama Formation with its known under-consolidated units. Further groundwater extraction by Groundwater Substitution Measures will further lower groundwater elevations in both the Redding Area Groundwater Basin and the Sacramento Valley Basin. The assessment of changes in groundwater elevations reported at Table 3.3-5 is based on SACFEM2013 modeling and is incorrect due to the deficiencies and built-in errors noted for SACFEM2013 to accurately represent cumulative drawdown from Groundwater Substitution Measures. Moreover without specific well depth information and screened intervals for the handful of monitoring wells noted it is impossible in our review to assess whether they monitor the groundwater table portions of the aquifers; the unit where desaturation occurs and effective stresses that induce permanent land subsidence generally occur.

Proposed Mitigation

The mitigation proposed for the potential impacts of land subsidence due to decreases in groundwater saturation of the uppermost aquifer, GW-1, is inadequate. The monitoring measures for land subsidence in the EIS/EIR are stated at page 3.3-89 as:

> *"Subsidence monitoring will include determination of land surface elevation in strategic (determined by Reclamation) locations throughout the transfer area at the beginning and end of each transfer year. If the land surface elevation survey indicates an elevation* 35
> *decrease, then the area will require more extensive monitoring…"*

Under this monitoring program approach, permanent inelastic subsidence will have occurred prior to detection. Mitigation is offered in the form of reimbursement for infrastructure (e.g. roadway) structural damage due to permanent subsidence (albeit elastic reversible subsidence would likely also cause infrastructural damage). No mitigation is offered for the permanent loss of aquifer storage capacity.

[13] US Bureau of Reclamation, 2014. "Long-Term Water Transfers Environmental Impact Statement/Environmental Impact Report Public Draft, September, at p. 3.3-17.

Under this program of monitoring and mitigation it has to be noted at Section 3.3.5 Potentially Significant Unavoidable Impacts that this permanent impact of lost aquifer storage capacity is not mitigated by GW-1. Under Sections 3.3.6.1 and 3.3.6.2 for Cumulative Effects for Alternatives 2 and 3, respectively, which include Groundwater Substitution Measures the cumulative effects noted for land subsidence are stated as:

> *"The groundwater substitution pumping associated with the SWP transfers would occur in an area that is historically not subject to significant land subsidence. In the overall area of analysis, land subsidence is occurring in several areas, as described in Section 3.3.1.3.2."*

The statement is inaccurate. The juxtaposition of Seller locations next to historic subsidence in Yolo County makes the statement inaccurate. The EIS/EIR then goes on to say:

> *"…however, the existing subsidence along with future increases in groundwater pumping in the cumulative condition could cause potentially significant cumulative effects. The impacts of the Proposed Action would be reduced through Mitigation Measure GW-1 (Section 3.3.4.1)* 35
> *to less than significant. Therefore, with implementation of Mitigation Measure GW-1, the Proposed Action's incremental contribution to subsidence impacts would not be cumulatively considerable."*

The analysis of changes to groundwater elevations leading to this statement is inaccurate and hence the impacts anticipated are underestimated. Perhaps more to the point the Mitigation Measure, GW-1, as defined will not adequately address the impacts of groundwater drawdown on inelastic subsidence and the resulting permanent loss of aquifer storage in the Seller's Area. The proposed observation of subsidence as mitigation cannot restore or offset the impact of subsidence once it has already occurred.

It is however possible to define a monitoring and mitigation program for the risks and potential impacts of permanent Land Subsidence. Such a program of monitoring and mitigation would require evaluation of historic and current groundwater elevations in the upper groundwater aquifer units over a series of decades long cyclical hydrologic and land use conditions in each Seller Area to determine whether groundwater elevations are at historic lows. If so then mitigation for permanent land subsidence due to Groundwater Substitution Measures would require no Groundwater Substitution Measures for Long Term Water Transfers be approved until groundwater elevations increase above historic lows and within a range that accurate groundwater modeling could demonstrate would not create cumulative lowering of groundwater elevations during the period of approved water transfers.

Water Supply

At Section 3.1.2 on Environmental Consequences/Environmental Impacts on Water Supply the Assessment Methods states:

> *"Impacts to surface water supplies are analyzed by comparing the conditions in water bodies and surface supplies without implementing transfers to the expected conditions of supplies*
> *with implementation"* 36

The quantitative tool to be used in assessing impacts to supplies but not water bodies from water transfers and exports from the Delta is referred to in the EIS/EIR as a "post-processing tool." The "post-processing tool" referred to under evaluations of Water Supply for Water Operations Assessment consists of the use of the SACFEM2013 groundwater model, CalSim II, and a spreadsheet model called the Transfer Operations Model (TOM). Our review will focus on these assessment tools to evaluate potential environmental impacts and consequences from the proposed Long-Term Water Transfers Alternatives.

Section 3.1.2.2 Significance Criteria states:

> *"Impacts on surface water supplies would be considered potentially significant if the long term transfers would:*
>
> - *Result in substantial long-term adverse effects to water supply for beneficial uses"* 36

Putting aside the substantive issue of why short-term adverse effects to water supply for beneficial uses is not considered as a criterion, our review finds the evaluation in the EIS/EIR of impacts to Water Supply from Groundwater Substitution Measures to this criterion is either inaccurate or insufficient to evaluate the potential environmental impacts associated with Groundwater Substitution as the methods of Assessment in the EIS/EIR do not properly account water and as a result cannot be relied upon to assess potential impacts and the means of mitigation or the timing of mitigation needs. Analysis of streamflow depletions due to Groundwater Substitution Measures is not analyzed accurately in the EIS/EIR and the loss of surface water to meet Water Supply needs is not properly accounted. This inaccurate accounting results in a fraction of the groundwater extracted being double counted as available surface water for transfer.

No Action Alternative Evaluations in EIS/EIR

It is notable that the No Action Alternative is to look at the Environmental Consequences/Environmental Impacts in water bodies (presumably rivers and reservoirs) and surface supplies while the evaluation for implementing Long-Term Water Transfers is to look at surface supplies with no mention of evaluating impacts to water bodies such as rivers or reservoirs.

The quantitative tool to be used to aid in assessing impacts to surface water supplies and water bodies is CalSim II for the No Action Alternative. 37

CalSim II works on a monthly time-step to assess SWP and CVP operations. CalSim II generates flows as a water system operational decision support tool. CalSim II is not a hydraulic model and does not include channel characteristics such as channel roughness or cross-section geometry to simulate the water routing. As a result of CalSim II's limitations, the models inability to schedule reservoir releases on a daily basis creates water accounting inaccuracies of losses caused by routing and attenuation of upstream reservoir releases to phenomena such as streamflow depletions. Additionally, CalSim II uses simplified flow routing rules (on a monthly time-step) which result in inaccuracies associated with how the SWP and CVP operate in extreme hydrologic conditions, especially in the driest years (DWR and USBOR, 2004 & Ford et al., 2006).[14,15]

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[14] Department of Water Resources and U.S. Bureau of Reclamation (DWR and USROR, 2004). Peer Review Response: A Report by DWR/Reclamation in Reply to the Peer Review of the CalSim-II Model Sponsored by the CALFED Science Program In December 2003, August, 2004

[15] Ford, D., Grober, L., Harmon, T., Lund, J.(Chair), McKinney, D. (Ford et al., 2006). Review Panel Report San Joaquin River Valley CalSim II Model Review. CALFED Science Program – California Water and Environment Modeling Forum. January 12, 2006.

CalSim II was developed over a decade ago to assess new storage and conveyance facilities in the CVP & SWP systems on a monthly time-step. Use of CalSim II has yielded significant scrutiny on its ability to provide relevant data to assess potential future impacts (Close, A. et al, 2003).[16] The CalSim II model presented in the EIS was used for the baseline conditions (2014 planning horizon) and was not used to assess potential changes resulting in future land use and hydrologic/metrological conditions. The baseline assessment can only assess how the Long-Term Transfer Project would impact the environment if it was in-place from 1970-2003 and therefore cannot assess potential impacts of future conditions that are different than the baseline conditions such as various climate change scenarios. 37

Alternative 2 and 3 Evaluations in EIS/EIR

The EIS/EIR reaches the following conclusion with regard to Potential Impacts to Water Supply from Groundwater Substitution Measures.

Potential Impact Statements from Table ES-4	**Related Alternative(s)**	**Significance to CEQA**	**Proposed Mitigation**	**Significance After Mitigation Pursuant to CEQA**
Groundwater substitution transfers could decrease flows in surface water bodies following a transfer while groundwater basins recharge, which could decrease pumping at Jones and Banks Pumping Plants and/or require additional water releases from upstream CVP reservoirs.	2, 3	S	WS-1: Streamflow Depletion Factor	LTS

The analysis of Environmental Consequences/Environmental Impacts is not done accurately nor with a complete conceptual model of the interactive groundwater and surface water system that constitute the Water Supply. At page 3.1.5 in Section 3.1.2.4.1 the analysis states that groundwater basins are naturally recharged after drawdown by rainfall and surface water to groundwater flux, thereby depleting available in stream flow. It goes on to state that the accretionary flow of groundwater to surface water can be intercepted by groundwater extraction; however, it fails to note that this is a depletion of available surface water and water for other beneficial uses such as the health of the riparian and hyporheic zones. As detailed further in our review that follows a proper conceptual model of the hydrologic system for Water Supply demonstrates that the water deprived for the natural consumptive use, evapotranspiration and potentially evaporation via Groundwater Substitution Measures is the likely conserved-water available. The analysis of Water Supply is improperly conceptualized. 38

Additionally at page 3.1.6 in Section 3.1.2.4.1 the EIS/EIR states:

> *"Transfers would not affect whether the water flow and quality standards are met… but only Reclamation and DWR water supplies"*

[16] Close, A., Haneman, W.M., Labadie, J.W., Loucks D.P. (Chair), Lund, J.R., McKinney, D.C., and Stedinger, J.R. (Close, A. et al.). Strategic Review of CALSIM II and its Use for Water Planning, Management, and Operations in Central California. Submitted to the California Bay Delta Authority Science Program Association of Bay Governments. Oakland, California. December 4, 2003.

The EIS/EIR notes that it is the State and Federal projects responsibility to maintain water quality standards in the Sacramento River, its tributaries, and the Delta. It then anticipates hypothetically that if the streamflow depletion resulting from Groundwater Substitution Measures results in decreased river flows then USBOR and DWR would modify operations by decreasing Delta exports or release of additional water from reservoirs to meet Delta outflow and/or water quality standards; however as documented in Attachment D herein the Federal and State projects were unable to maintain these standards in 2013 due to dry year conditions and a lack of available in-stream flow and releases of water. 38

The quantitative tool used in assessing impacts to supplies but not water bodies from water transfers and exports from the Delta is referred to in the EIS/EIR as a post-processing tool. From Appendix B,

> *"The post-processing tool also includes changes in flows in waterways caused by streamflow depletion from groundwater substitution. Data for the post-processing tool was provided by the SACFEM2013 model, which includes highly variable hydrology (from very wet periods to very dry periods) was used as a basis for simulating groundwater substitution pumping."*

39

The EIS/EIR used two other models, CalSim II and a spreadsheet accounting model referred to as TOM, to attempt to properly account streamflow depletions. A general technical reference from the U.S. Geological Survey (USGS) published in 1998 entitled Ground Water and Surface Water - A Single Resource identifies that the hydrologic cycle demonstrates that groundwater is not a source of water but rather behaves as a reservoir, receiving and releasing water as governed by local and regional hydrologic and hydrogeologic conditions.[17] The use of the combination of three models does not properly account for water and thus the evaluation of *"how long-term transfers could benefit or adversely affect water supplies"* does not accurately identify potential impacts to available-water for Water Supply.

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[17] Winter, T.C., J.W. Harvey, O.L. Franke, and W.M. Alley 1998. Ground Water and Surface Water A Single Resource, USGS Circular 1139, pp. 79, p. 2.

Figure 3 depicts the overall hydrologic cycle in Water Supply. The only source of true supply is precipitation in the form of rain, snow, or dew. Groundwater is not a source but an interactive reservoir.

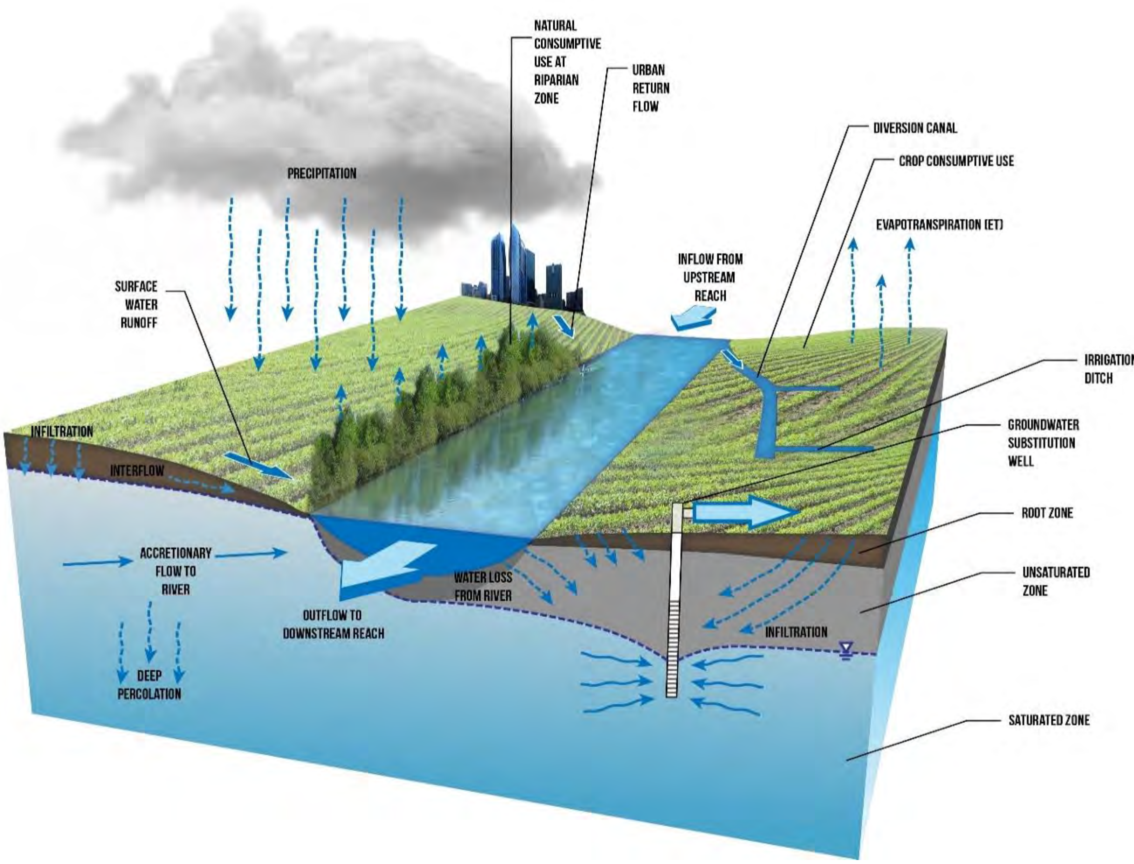

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Figure 3 Hydrologic Cycle Overview with regard to Water Supply Evaluation

For groundwater in the wells near enough to a river to have the cone of depression reach the river within the hydraulic capture zone of the well the following statement applies:

> *"When pumping of a well near a river begins, water is drawn, at first, from the water table in the immediate neighborhood of the well. As the zone of influence widens, however, it begins to draw a part of its flow from the river and, ultimately, the river supplies the entire flow"*
>
> \- Robert Glover and Glenn Balmer[18]

This clear statement on the depletion of a river flow by the same rate as that withdrawn from the well is the opening of Glover and Balmer's 1954 paper on their mathematical analysis of river depletion by extraction from a nearby well. Glover and Balmer's work followed upon the first analysis of the

[18] Glover, R.E. and G.G Balmer. (1954). River depletion resulting from pumping a well near a river. *Transactions, American Geophysical Union,* v. 35

depletion of streamflow induced by an extraction well and its zone of capture done by C.V. Theis of the USGS in 1941.[19]

Dr. Theis commented in his 1941 paper on one aspect of the analysis of the overall effects of extraction in an alluvial river valley on the flow into and from a river:

> *"…the flux 'from the river' will be spoken of in the following treatment, the flux may be either an actual movement of water from the river or a decrease of the customary movement of water to the river"*
>
> - C.V. Theis

This customary movement of water is also commonly known as the accretionary flow of groundwater to the river; it is accretionary flow of groundwater to a river that provides the observable and measurable flow of water in a free-flowing stream during lengthy dry periods when no rain or snowmelt provides the baseflow in a river or stream (i.e. not an ephemeral stream or arroyo). In the illustration below (Figure 4) it can be seen that consistent with Dr. Theis observation on the flux "from the river" the impact to the river is due to loss of accretionary flow to the river and not as a result of direct streamflow 39

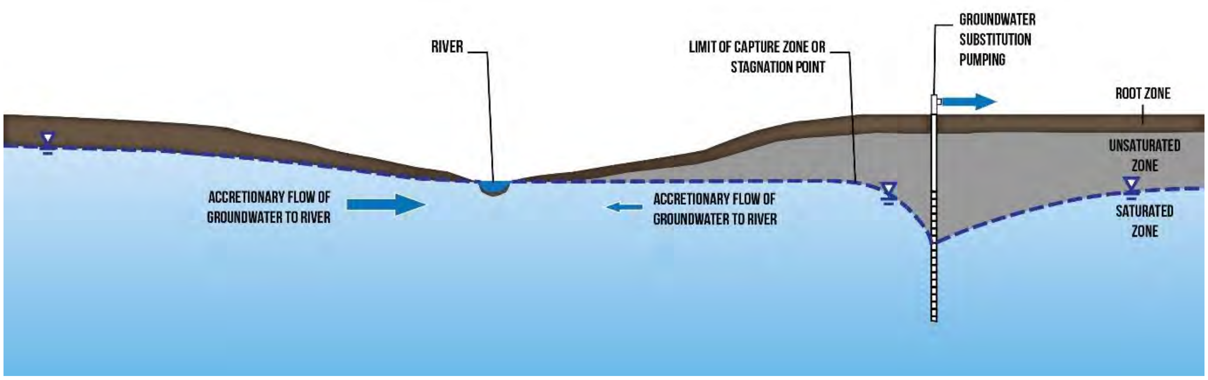

Figure 4 Cross-Sectional View of Extraction Well Depleting the Accretion of Flow to a River

depletion by way of river exfiltration. This phenomena from a well located some distance from the river results in streamflow depletion; the principal difference between this case and the one where the zone of capture to the well reaches the streambed of the river is the timing of the streamflow depletion.

L.K. Wenzel of the USGS in the peer-reviewed Discussion of this seminal paper by Dr. Theis from 1941 offered this observation:

> *"It is possible that in some localities all or a part of the water removed from the well may be obtained indirectly by reducing the amount of water that is transpired by plants from the zone of saturation. This is accomplished, of course, through the lowering of the water-table and capillary fringe to some depth below the roots of the plants."*
>
> - L.K. Wenzel[20]

[19] Theis, C.V., 1941, The effect of a well on the flow of a nearby stream: *Transactions, American Geophysical Union*, v. 22, part 3, p. 734-737.

[20] Wenzel, L.K., 1941, Discussion re: The effect of a well on the flow of a nearby stream: *Transactions, American Geophysical Union*, v. 22, part 3, p. 737-738.

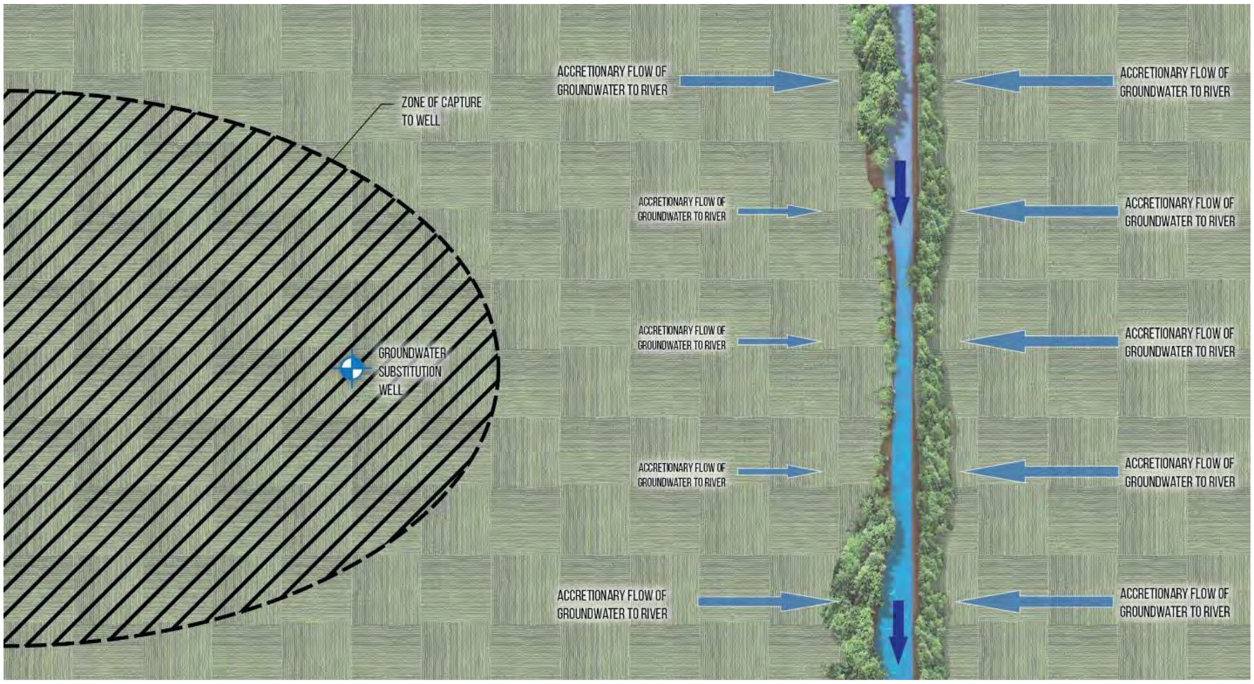

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Figure 5 Plan View of Extraction of Groundwater via a Groundwater Substitution Well from which the Zone of Capture to the Well Does not reach the River

Figure 5 illustrates that extraction pumping far back from a river's edge (e.g. perhaps more than 1-mile) does not capture water directly from the river but instead results in a loss of accretionary flow of groundwater to the river as depicted by the reduced accretionary flow arrows and the diminished riparian zone flora (and in all likelihood impacts the hyporheic fauna near and beneath the riparian zone that supports the food chain for pelagic fish such as salmonids and the habitat for other threatened species). The deprivation of flow to the river from a groundwater extraction well located some distance from the river is ultimately equal to the quantity of extraction; if the flow to the well is drawn from storage then that storage will be replaced eventually by an equivalent quantity of groundwater via direct recharge and indirect groundwater recharge. As Dr. Wenzel's comment notes the only water not deprived to the river or stream is that water that would otherwise have been withdrawn for consumptive use and evapotranspiration by vegetation that is/was able to utilize water from the zone of saturation (i.e. the water table aquifer).

Evaluation of the timing of streamflow depletion due to groundwater extraction wells was made simpler by a further paper by Dr. Theis and his co-author in 1963. The following graphic (Figure 6) describes the timing of impact to a stream or river's quantity of flow based upon two primary criteria, the ration of the aquifer storage coefficient to the aquifer transmissivity, S/T, and the distance between the extraction well and the river.[21] The coefficients are as described in the Explanation in the chart with the X-axis denoting the time since pumping began.

[21] Theis, C.V. and C.S Conover. 1963 "Chart for Determination of the Percentage of Pumped Water being Diverted from a Stream or Drain" *USGS Water Supply Paper 1545-C*. pp. C106-C109.

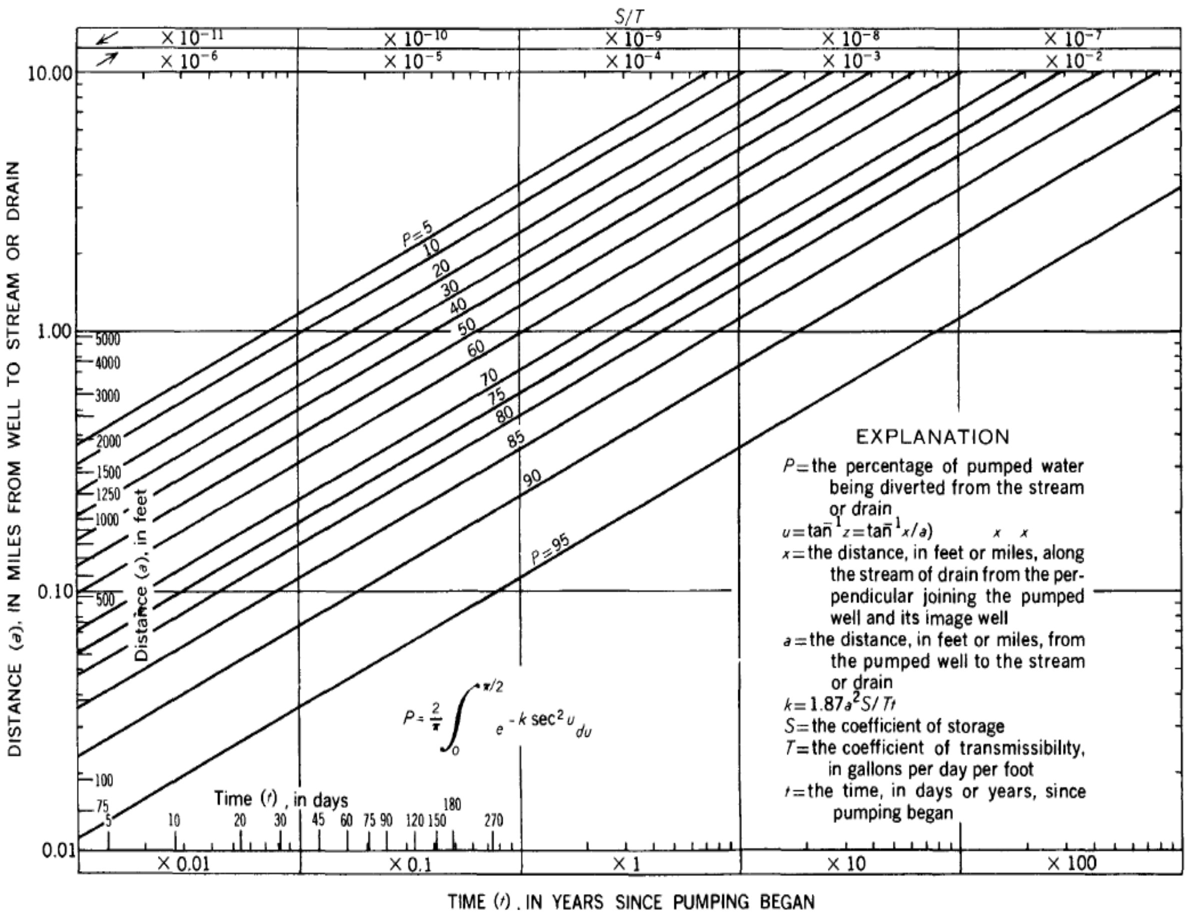

Figure 6 Theis' graphic describing transmissivity and the distance between extraction wells. 39

This method of analysis was then added to by Mahdi Hantush in 1965 by incorporating to the mathematical solution a simplified concept of streambed resistance laterally to groundwater flow by way of a vertical layer of impedance to flow.[22]

This group of two general methods was improved upon further by Jenkins in 1968 in several ways but also in describing the residual effects of "streamflow depletion" (a phrase first coined in Jenkins paper) after pumping ceases. [23] Jenkins' addition to the field of groundwater and surface-water interconnection at river boundaries, enabled season-to-season carryover of depletions of groundwater storage and the resulting streamflow depletion that can take place over more than one annual hydrologic cycle. Wallace et al. (1990) carried out a similar analysis for cyclic pumping of wells.[24]

[22] Hantush, M.S., 1965. Wells near streams with semi-pervious beds. *Journal of Geophysical Research, v. 70*, no. 12: pp2829-2838

[23] Jenkins, C.T., 1968. Techniques for computing rate and volume of stream depletion by wells. *Ground Water, v. 6*, no. 2: pp 37-46.

[24] Wallace, R.B., Y. Darama, and M.D. Annable, 1990. Stream Depletion by Cyclic Pumping. *Water Resources Research v. 26*, no. 6, 1263-1270.

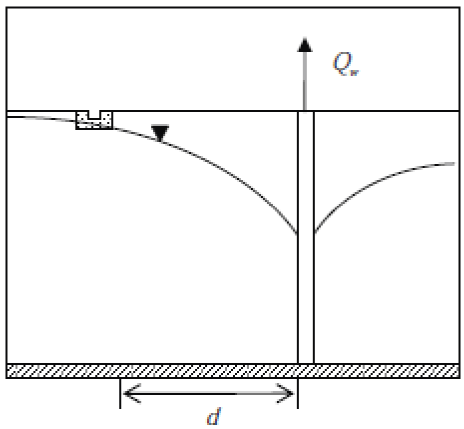

Figure 7 Definition Sketch for a partially penetrating well and a river with semi-pervious layer Hunt (1999)

Subsequently Bruce Hunt (1999) developed an analytical solution to the question of what is the response in a river that has a lower permeability streambed surrounding it than the permeability of the groundwater aquifer to which it is connected including the conceptualization of an extraction well which only partially penetrates the aquifer adjoining the stream.[25] While the bounding conditions of a homogeneous aquifer of infinite extent are applied to each of the aforementioned methods in order to solve the equations of unsteady flow in which a well or wells are actively extracting constitute an idealized case, the inclusion of a semi-pervious streambed fully to the solution provides an even more realistic estimate of the timing of impact on flow in a river or stream (Figure 7).

Lastly, Bruce Hunt (2003) developed an analytical solution to the case of a stream incised into a low permeability layer or formation over top of a more permeable aquifer (Figure 8).[26] 39

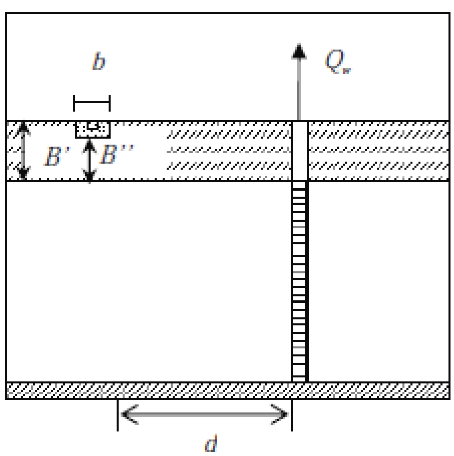

Figure 8 Definition Sketch for flow to well in semipermeable aquifer Hunt (2003)

Each of the four analytical mathematical solutions to the question of the impact of extraction well pumping on flow in a stream and the genesis of the water captured by an extraction well remain valid, particularly where the bounding assumptions are met well by the aquifer being pumped. Various mathematical solvers are available to look at streamflow depletion by the appropriate analytical method for each case including some provide by Dr. Bruce Hunt[27]; the most recent set of solvers for each of these groundwater to surface-water analytical methods was developed by the USGS (2008).[28] The USGS program STRMDEPL08 enables a sequence of time varying pumping during an irrigation season and it allows for year on year carryover of aquifer depletion to be retained in a subsequent year. This program represents "best available science" for near field assessment of groundwater extraction on the flow in nearby streams. Based upon the information provided in the EIS/EIR with regard to stream aquifer relationships our review determined that the conceptual model of Figure 7, Hunt (1999) best fits the conditions described for the Sacramento Valley. An evaluation of streamflow depletions for select wells near rivers was undertaken for the extended drought period of 1987 to 1992

[25] Hunt, B., 1999.. Unsteady stream depletion from ground water pumping. *Ground Water, 37*(1), pp. 98–102.

[26] Hunt, B. 2003. Unsteady Stream Depletion when Pumping from Semiconfined Aquifer. *Journal of Hydrologic Engineering, Vol. 8*, No. 1, pp. 12-19.

[27] http://www.civil.canterbury.ac.nz/staff/bhunt.asp

[28] Reeves, H.W., 2008,STRMDEPL08—An extended version of STRMDEPL with additional analytical solutions to calculate streamflow depletion by nearby pumping wells: U.S. Geological Survey Open-File Report 2008–1166, 22 p.

noted in the EIS/EIR was undertaken and the method and results are presented in Attachment A. These analyses result in a range of streamflow depletion factors (SDF) from in short-term SDF ranging from 8% to 22% by the end of a 1987 extraction scenario proffered in the EIS/EIR and long-term cumulative SDF 39
ranging from 34% to 108.5% of annual pumping based on evaluation of the 6-year drought from 1987 to 1992 again following the extraction scenario proffered in the EIS/EIR due to the cumulative depletion of aquifer storage and the available accretionary flow of groundwater to the river as compared to stream flow from the river to satisfy the capture of water by a groundwater extraction well.

Assessment of SACFEM2013 Model for Water Supply Analysis in the Post Processing Tool

The SACFEM2013 model in the EIR/EIS does not account for the streamflow depletions induced by groundwater pumping along the lines of any of the analytical methods identified above from the literature. SACFEM2013 has no river flow accounting to account water flow depletions. As for potential impacts to surface water flow rates due to groundwater accretions or depletions SACFEM2013 does not account the quantity of water flowing within a river. There simply is no algorithm in the MicroFEM code to account for changing rates of streamflow and dynamically changing river stage associated with streamflow. Hence these potential impacts are not accounted in the SACFEM2103 model.[29] As a result of this missing algorithm in the model the outflow of surface water to groundwater in a river reach where 40
Groundwater Substitution Measures lower the modeled head in the upper aquifer (ignoring the numerous errors in the formulation of well extractions and in the SACFEM2013 model hydraulic parameters)[30] below the river bottom water is not properly accounted in SACFEM2013. The loss of surface water flowing into the groundwater domain to satisfy the extraction well demand via streamflow depletion is not accounted. Thus the available Water Supply will not be properly accounted using SACFEM2013 with respect to both the magnitude of the impacts to Water Supply due to Groundwater Substitution pumping and the timing of such impacts to Water Supply and surface water flow in the rivers. This holds for extraction from any of the 327 groundwater extraction wells proposed as a part of Alternatives 2 and 3. This lack of water accounting affects the ability of the "post-processing tool" to properly evaluate water availability under Water Supply due to the shortcomings of the SACFEM2013 model to calculate changes in river flow.

Further as to the poor accounting of water available to the "post-processing tool," the river outflow is not accounted properly in the SACFEM2013 groundwater model at the river nodes. As mentioned under Groundwater Resources SACFEM2013 sets each river reach's stage height as invariant during a month, 41
irrespective of the groundwater withdrawals. This river stage invariance means that SACFEM2013 calculates as though there is an infinite amount of water in the nearby river (i.e. no streamflow depletion impact on the predicted outflow of water).

[29] SACFEM2013's agricultural groundwater extraction terms were reportedly developed using the Irrigation Demand Calculator (IDC) within the California Dept. of Water Resources, Integrated Water Flow Model (simulation code). The use of only a portion of the IWFM, simulation code and the manner in which it was done leaves the soil moisture model and the groundwater model uncoupled with no feedback between the two models except that perhaps carried by the user from SACFEM back to the IDC model .

[30] SACFEM 2013 formulation places all extraction wells into Layers 2, 3, and 4 and then artificially imposes a vertical anisotropy of 500:1 at each flow layer.

The river inflow (i.e. gaining reaches) is calculated in SACFEM2013. However it is done inaccurately due to the invariant stage height during each monthly time step in the model. This imprecision results in an improper accounting of water. Not surprisingly the peer review for the model done in 2011 found:

> *"Review of the representative and other calibration hydrographs reveals that significant calibration issues exists in areas that rely mostly on surface water. This is mainly due to the issues of SacFEM's estimation of stream-aquifer interaction. Calibration quality improves in* 42
> *areas that rely mostly on groundwater."*[31]

Using this mathematical formulation in the algorithm for groundwater to surface water flux, the degree of exfiltration in each month from the river to groundwater is too high if flow and stage in the river decrease due to Groundwater Substitution Measures or alternatively the degree of exfiltration is too low if Water Transfer flows increase river stage during the transfer period of July to September as more of that water would be depleted from the stream and not available to the Buyer's Area. Thus inputs from SACFEM2013 to TOM for subsequent analysis of Water Supply, are inaccurate.

Review of SACFEM2013 by the aforementioned peer review found that SacFEM2013 deep percolation rates are not supported by the fundamental Irrigation Demand Calculation (IDC) module's methodology (a subcomponent of DWR's Integrated Water Flow Model, IWFM simulation code) and parameters. This results in a disconnection between SacFEM2013 and IDC. They recommended incorporating a feedback loop between the two models (IDC as constructed for SACFEM2013 input, and SACFEM2013) and subjecting them to convergence criteria. Their review states: 43

> *"SACFEM deep percolation rates are not consistent with other data sets and it should be ensured that they are supported by historical land use, crop mix, and agricultural practices."*

It is unknown whether these recommendations from 2011 to SACFEM2013 were incorporated to SACFEM2013 based on the documentation provided in the EIS/EIR and on the documents requested and received from the project proponents. Further review of SACFEM2013 is provided in Attachment C herein.

Lastly with regard to SACFEM2013 and Water Supply considerations we note that unlike Appendix B of the EIS/EIR on the uncertainties and limitations of TOM and CalSim II, there are no statements in Appendix D of the EIS/EIR or the main body of the EIS/EIR as to the uncertainties in the modeling assumptions or stated limitations on the utility and intended uses of the SACFEM2013 groundwater model.

Looking at "Best Available Science" for evaluation of potential impacts in the EIS/EIR there is a 44
simulation code available from DWR, IWFM, which can better evaluate the time varying mass balance between surface water and groundwater inclusive of losses or gains in soil moisture to crop demand and precipitation. The IWFM simulation code's capabilities are summarized in Attachment B herein and documented for the current release by DWR.[32] However, the simulation code with these general capabilities was first publicly released in 2003. Further there is an existing model of the Central Valley in IWFM, C2VSim, which is calibrated for the period 1922 to 2009, which was initially released to the public in 2011. The C2VSim model can be run with either a coarse finite element grid (C2VSim-CG with 1,392

[31] WRIME. 2011. Peer review of Sacramento valley Finite Element Groundwater Model (SACFEM2013), October at page 16
[32] http://baydeltaoffice.water.ca.gov/modeling/hydrology/IWFM/IWFMv4_0/v4_0_331/downloadables/IWFMv4.0.331_TheoreticalDocumentation.pdf.

elements, run-time 6 minutes) or with a fine finite element grid (C2VSim-FG with over 35,000 elements, run-time 6 hours). For both versions, the elements are grouped into 21 water-budget sub-regions. [33] The C2VSim-CG model was utilized in our review to assess the cumulative impacts.[34] DWR notes that both C2VSim versions will also be useful tools for integrated regional water management plans, planning studies, groundwater storage investigations, assessing infrastructure improvements, evaluating ecosystem enhancement scenarios, conducting climate change studies, and assessing the impacts of 44
changes to water operations. The results of our assessment of relative streamflow depletions in several river reaches brought about by projected use of available transfer volumes in the extended drought of suggest that streamflow depletions of 8% to 22% depending upon the year and the river reach will result from a mass balanced model. In our review the use of C2VSim-CG provides a reasonable estimate of what best available science would reveal. Use of C2VSim-FG would likely improve upon the accuracy of the estimated streamflow depletions resulting from Groundwater Substitution Measures on Water Supply.

Assessment of the CalSim II Model for Water Supply Analysis in the Post Processing Tool

As stated previously for the No Action Alternative, the use of CalSim II has yielded significant scrutiny on its ability to provide relevant data to assess potential future impacts (Close, A. et al, 2003).[35] The CalSim II model presented in the EIS was used for the baseline conditions (2014 planning horizon) and was not 45
used to assess potential changes resulting in future land use and hydrologic/metrological conditions. The baseline assessment can only assess how the Long-Term Transfer Project would impact the environment if it was in-place from 1970-2003 and therefore cannot assess potential impacts of future conditions that are different than the baseline conditions such as various climate change scenarios.

CalSim II does not provide adequate loss factors to assess potential project impacts. The CalSim II model describes the physical system (e.g., reservoirs, channels, pumping plants), basic operational rules (e.g., flood-control diagrams, channel capacity, evaporation, minimum flows, salinity requirements), and priorities for allocating water to different uses (water quality, ecosystems, etc.). As a result of CalSim II's complexity, very important water loss characteristics such as stream reaches losses, deep groundwater 46
percolation, and stream-aquifer interactions are generalized as basin "efficiencies" rather than losses for specific reaches or stream-aquifer interactions. The lack of specific loss characteristics within CalSim II yields inaccuracies specific to even seasonal and annual water accounting losses (e.g., stream-aquifer interactions) that have been identified as potential impacts from the proposed Long Term Water Transfers.

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[33] As reported by the DWR at http://baydeltaoffice.water.ca.gov/modeling/hydrology/C2VSim/index_C2VSIM.cfm on November 30, 2014

[34] Informal telephonic requests to DWR's Bay Delta Office for C2VSim-FG on November 13, 2014 revealed that they view the model as not ready yet for public release.

[35] Close, A., Haneman, W.M., Labadie, J.W., Loucks D.P. (Chair), Lund, J.R., McKinney, D.C., and Stedinger, J.R. (Close, A. et al.). Strategic Review of CALSIM II and its Use for Water Planning, Management, and Operations in Central California. Submitted to the California Bay Delta Authority Science Program Association of Bay Governments. Oakland, California. December 4, 2003.

Hydrology modeling within CalSim II uses a "depletion analysis" to estimate the historical and projected level flows (Ford 2006).[36] As a result of this, CalSim II requires a calculation to estimate the aggregate stream inflow for each sub-watershed. This calculation is identified as the "closure term" of the hydrologic mass balance and is also how the model encompasses errors resulting from over/under estimates of water losses. In recent documentation regarding future development of CalSim II into version III, DWR and Reclamation provided a graphic of "closure term" magnitudes. [37] 47

In this graphic from Draper 2008 (Figure 9), the "closure term" represents a significant amount of error in CalSim that has to be accounted for to create a hydrologic mass balance. Note that this graph is in thousands of acre-feet/year. Thus the "closure term" necessary to correct for water budget errors in CalSim ranges from (2,000,000) AFY in deficit to 3,000,000 AFY in surplus. CalSim II does not account for water on an annual basis with precision.

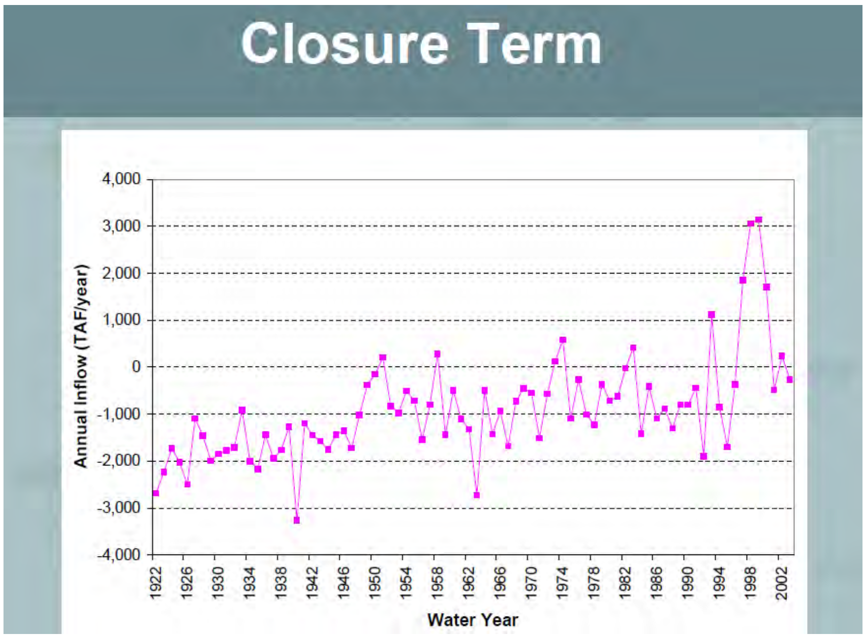

Figure 9 Closure Terms to Correct Accounting Problems in CalSim for Annual Quantities of Water

CalSim II cannot assess how "Long-Term" water transfers would impact future water demands, water supplies, and required water quality and ecosystem management requirements. Hence the analysis of potential impacts to Water Supply based upon CalSim II is insufficient. CalSim II does not provide adequate detail to assess project impacts. The very poor precision of the surface water delivery model (CalSim II) used for the baseline assessment on quantities of water moving in and around the CVP and SWP leads to problems in accounting for water losses due to existing and proposed groundwater extractions.

As noted in the review of CalSim II in Draper (2008) there is a version of CalSim referred to alternately as CalSim III or CalSim 3 that appears to have been in development and use since approximately 2006. 48

[36] Ford, D., Grober, L., Harmon, T., Lund, J.(Chair), McKinney, D. (Ford et al., 2006). Review Panel Report San Joaquin River Valley CalSim II Model Review. CALFED Science Program – California Water and Environment Modeling Forum. January 12, 2006.

[37] Draper, A. CalSim-III Hydrology Development Project, CalSim III Implementation, MWH Americas, California Water and Environmental Modeling Forum Annual Meeting, 2008

> *"The C2VSim-CG model is being used as the basis for the groundwater flow component of CalSim 3, and has also been used to investigate how Sacramento Valley water transfers may affect Delta flows and how an extended drought may impact groundwater levels."*[38]

It would appear that CalSim III represents "Best Available Science" with its focus on improving the 48
significant shortcomings in CalSim II identified in our review and that of others. However, CalSim III was not utilized for the EIS/EIR. An analysis of the outcomes for the project by way of CalSim III use would appear to represent something approaching best available science on the available windows of water for transfer prior to 2003 and post 2003 to present and beyond. The availability and uses of CalSim III by USBOR for the CVP could not be determined during our review.

Assessment of the Transfer Operations Model for Water Supply Analysis in the Post Processing Tool

TOM was developed to analyze effects of the Long-Term Water Transfer Project on the CVP, SWP, major rivers, and the Delta. TOM does not provide a specialized groundwater, hydrology, or hydraulic 49
simulations of the Long-Term Water Transfer Project but rather provides water accounting based upon inputs from SACFEM2013 and CalSim II. As a result of the water accounting approach, the inaccuracies within CalSim II (e.g., water losses, closure term error, etc.) and SACFEM2013 (e.g., stream-aquifer interactions, groundwater elevation predictions, etc.) are carried over into TOM to quantify and assess potential impacts resulting from the Long-Term Water Transfer Project.

Our review of the TOM model provided by the project proponents at our request yielded a number of errors that were also included in the EIS text. Table 1 presents two examples water transfer volumes that were presented in the EIS/EIR Executive Summary Table 2, EIS/EIR descriptive text of each text from section 3.1.1.3, and TOM.

Table 1 – Comparison of Transfer Volumes Within Long-Term Water Transfer Project Documentation

Transfer Description	Table ES-2 (AF)	EIS Section 3.1.1.3 (AF)	TOM (AF)	
Anderson-Cottonwood Irrigation District (Maximum Groundwater Substitution Volume)	5,225	5,225	5,938	50
Garden Highway Mutual Water Company (Maximum Groundwater Substitution Volume)	14,000	12,287	14,000	
Conaway Preservation Group (Maximum Cropland Idling or Crop Shifting Volume)	9,239	9,239	21,349	

Upon review of Table 1, how specific transfer volumes of water are applied in TOM, CalSim II, and SACFEM2013 is neither understood nor constant. Additionally, specific model descriptions of how CalSim II, SACFEM2013 and TOM account for each water transfers are vague. The EIS states that there is a priority of transfer volumes *("…groundwater substitution and reservoir release are more likely transfer mechanisms than crop idling…",* Section B.4.3.1.2) but specifically how each transfer was applied to the

[38] As reported by the DWR at http://baydeltaoffice.water.ca.gov/modeling/hydrology/C2VSim/index_C2VSIM.cfm on November 30, 2014

time series and into each model are not documented. To understand how each transfer volume is 50 applied in each model is essential to properly assess the validity of the analysis of potential impacts.

Within TOM, adjustments in delivered water through the Delta include a portion lost as carriage water which is defined as extra water needed to carry water across the Delta to export facilities. Carriage water is a critical part of the water modeling analyses because the additional water is needed to maintain Delta water quality. Because the majority of the transfer water is made available and diverted upstream of the Delta, TOM assumes carriage percentage adjustments based on the location of the transfer:

- Transfers from the Sacramento River assume a 20 percent carriage water adjustment;
- Transfers to Contra Costa Water District assume a 20 percent carriage water adjustment;
- Transfers from Merced Irrigation District assume a 10 percent carriage water adjustment for 51 water flowing from the San Joaquin River into the Delta.

The use of a single carriage percentage based on location does not adequately address potential impacts to Delta water quality. The concept of carriage water is a complex concept that would require appropriate hydrodynamic models coupled with a hydrology and groundwater model to identify appropriate carriage water volumes over time. The EIS states that the initial estimates for carriage water should later be verified and adjusted and therefore water quality impacts cannot be assessed with the models presented in the EIS/EIR for Long-Term Water Transfers. Additionally, significant stream flow depletion associated with pumping will likely reduce water transfers to the Delta and result in significant water quality impacts and/or limited transfers to water buyers. Therefore, statements with the EIS/EIR claiming limited changes in Delta outflow as well as water quality impacts are unfounded.

Carryover of storage water within reservoirs is one of many factors within the EIS/EIR, TOM and CalSim II that lacks a description of application. In other words there is no detail provided on where each of the water volumes in TOM are derived (e.g. groundwater vs. stored water). As a result of streamflow depletion from Groundwater Substitution Measures, the EIS/EIR identifies that small decreases in water supplies to users could occur when the stored reservoir release transfers decrease carryover storage in reservoirs. These operational controls are very important to how storage facilities would operate during 52 extended dry periods. These operational assumptions within the modeling are not described in the EIS/EIR text or models. Therefore, carryover along with other operational assumptions associated with the Long-Term Water Project is not properly assessed and the resulting operational Water Supply impacts could be significant; these potential and probable impacts to Water Supply are not analyzed in the EIS/EIR for Groundwater Substitution Measures.

Summary of Impact Assessment

Impacts to Water Supply from the Water Operations Assessment are not fully quantified. The improper accounting of water under Groundwater Substitution Measures results in insufficient control on water accounting such that water lost from river flow due to both the impairment of accretionary groundwater flow to support Project operations and the direct losses from river flow to groundwater extraction wells 53 in the Groundwater Substitution program may be counted twice or more. Evaluation of the effects on Water Supply from the Groundwater Substitution Measures requires adequate and accurate analysis of what the sources of water in Water Supply and what appropriate streamflow depletions are for

Groundwater Substitution Measures on top of existing conditions to assess short-term and long-term effects on Water Supply from Long-Term Water Transfers. Further the use of Groundwater Substitution Measures has important impacts to Water Supply in regard to operational flexibility. These have been rated to be Less Than Significant in the EIS/EIR but given the substantive errors noted in assessing available water for Long-Term Water Transfers this likely deserves re-examination. 53

Proposed Mitigation

Due to the improper accounting of water in Water Supply, the proposed mitigation WS-1 is inadequate to mitigate the likely impacts to water availability and water flows into and through the Delta during three important periods of time: (1) the period of Groundwater Substitution pumping, April thru September; (2) the Water Transfers window, July thru September; and, (3) the period following the Water Transfers window, October to April. 54

The Proposed Mitigation WS-1 to address streamflow depletion resulting from Groundwater Substitution Measures is ill defined and will not adequately mitigate the impacts to Water Supply. 55

Due to the lack of a specific formulation for the proposed Water Supply mitigation, WS-1, it is unpredictable how the mitigation will be applied. The EIS/EIR references Draft documents on Technical Information for Preparing Water Transfer Proposals (October 2013).[39] Those documents identify the need for estimating the effects of transfer operations on streamflow and describe the use of a streamflow depletion factor; however they provide no basis for Project Agency approval nor for transfer proponents to submit site-specific technical analysis supporting a streamflow depletion factor. That document which is completely relied upon in establishing proposed mitigation, WS-1, states that: 56

> *"Project Agencies are developing tools to more accurately evaluate the impacts of groundwater substitution transfers on streamflow. These tools may be implemented in the near future and may include a site-specific analysis that could be applied to each transfer proposal."*[40]

This future action provides no established or predictable basis for the mitigation of streamflow depletions due to Groundwater Substitution Measures. Due to the improper accounting of water in both the groundwater and surface water supply models utilized for Water Supply analysis, reliance upon these models or the analysis in this EIS/EIR by the Project Agencies would result in inappropriate estimation of the streamflow depletion factors utilized. Examples of best available science methodologies for quantifying streamflow depletion factors for Water Supply are provided in Attachment A . They result in short-term streamflow depletion factors ranging from in short-term SDF ranging from 8% to 22% of the Groundwater Substitution Measures proposed in the EIS/EIR and long-term cumulative SDF ranging from 34% to 108.5% of annual pumping based on evaluation of the 6-year drought from 1987 to 1992 57

The mitigation proposed for loss of Water Supply, WS-1, due to Groundwater Substitution transfers is insufficient. It does not adequately account for the impact from the resulting reductions of water available in the rivers and groundwater due to the improper accounting of water in the EIS/EIR analyses. 58

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[39] Department of Water Resources and Bureau of Reclamation, 2013. DRAFT Technical Information for Preparing Water Transfer Proposals – Information to Parties Interested in Making Water Available for Water Transfers in 2014, October.

[40] Ibid, at p. 33.

As detailed in our analysis the mitigation measure proposed has no basis in fact, and if it did the project proponents would find that mitigation of the impacts from Groundwater Substitution Measures are not likely to meet the Project Purpose and Need and the Project Objectives. 58

Water Quality

Groundwater Substitution Measures for Long-Term Water Transfers effects on Delta outflows and water quality are not properly considered in the EIR/EIS. The EIS/EIR rates the effects on Delta outflows and the impact to Delta Water Quality as Less Than Significant based on improper accounting of water. The effects and impacts are likely to be Significant and thus will require mitigation. 59

Potential Impact Statements from Table ES-4	Related Alternative(s)	Significance to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Water transfers could change Delta outflows and could result in water quality impacts.	2, 3, 4	LTS	None	LTS

The analysis of Environmental Consequences/Environmental Impacts is not done accurately nor with a complete conceptual model of the interactive groundwater and surface water system depletions that would affect the Federal and State water projects, CVP and SWP, to meet Water Quality requirements. As noted previously the analysis of components for Water Supply is improperly conceptualized and yet finds that streamflow depletion of significance can occur and must be mitigated by application of an appropriately calculated SDF.

Again from page 3.1.6 in Section 3.1.2.4.1 the EIS/EIR states:

> *"Transfers would not affect whether the water flow and quality standards are met…" but only Reclamation and DWR water supplies"* 60

The EIS/EIR anticipates hypothetically that if the streamflow depletion resulting from Groundwater Substitution Measures results in decreased river flows then USBOR and DWR would modify operations by decreasing Delta exports or release of additional water from reservoirs to meet Delta outflow and/or water quality standards; however as documented in Attachment D herein the Federal and State projects were unable to maintain these standards in 2013 due to dry year conditions and a lack of available in-stream flow and releases of water.

Under Assessment Methods at page 3.2-27 in Section 3.2.2.1.1 states that quantitative analysis relies on hydrologic modeling estimated changes in river flow rates and reservoir storage for the CVP and SWP reservoirs and the rivers they influence. The quantitative analysis is left to Appendix B but the main body states that:

> *"If the changes are small and within the normal range of fluctuations (similar to the No Action/No Project Alternative) for that time period, it is … assumed that any water quality impacts would be less than significant"* 61

According to the EIS/EIR:

> *"CalSim II is the latest version of CalSim available for general use. It represents the Central Valley with a node and link structure to simulate natural and managed flows in rivers and canals. It generates monthly flows showing the effect of land use, potential climate change, and water operations on flows throughout the Central Valley."* [41]

With Closure Terms to rectify storage and flow on the order of millions of acre-feet per year (as much as 3,000,000 AFY during the model periods simulated for the EIS/EIR), CalSim II is not an adequate tool for assessing whether flow and required storage changes under the proposed Groundwater Substitution 61
Measures are small, normal or significant to enable the assumption of insignificant water quality impacts. Further CalSim II works on a coarse monthly time-step to assess SWP and CVP operations. However, water quality and ecosystem management decisions require a more detailed weekly or daily time-steps to properly account for potential water availability and timing impacts. CalSim II is not the appropriate modeling system to assess the Long-Term Transfer Project which will cause daily flow changes that require water quality and ecosystem management decisions to mitigate impacts before they occur and does not represent best available science (see earlier comment on CalSim III under Water Supply).

Contracted Reservoir Releases by the Sellers may be diminished by streamflow depletions from current pumping conditions in areas where groundwater saturation falls below the river stage adjoining under existing conditions. These depletions of water available for transfer via Reservoir Releases and are not quantified in the EIS/EIR. The effect of these baseline conditions impacts the availability of water to be 62
transferred down the Sacramento River and through the Sacramento San-Joaquin Rivers Delta to the CVP and SWP pumping stations that pump water south via their respective aqueducts, the Delta-Mendota Canal, and the California Aqueduct.

The quantitative analysis of potential Water Quality impacts to the Sacramento-San Joaquin Delta is provided in Appendix C. Appendix C states at page C-2 that:

> *"The Delta Conditions analysis is performed with the Delta Simulation Model 2 (DSM2). DSM2 setup relies on the output of three additional tools for this Project: CalSim II, the Transfer Operations Model (TOM), and the Delta Island Consumptive Use model (DICU model). CalSim II outputs simulating California's water delivery system to the Delta are used* 63
> *to supply inflow and export boundary conditions to DSM2."*

Use of a CalSim II model with monthly outputs that are crude approximations of actual system performance at best renders use of these outputs to create daily approximations that are supplied to DSM2 useless in assessing the potential for water quality impacts from proposed Groundwater Substitution Measures that will impair the actual timing of surface-water baseflow as a result of streamflow depletion and the quantity of water available to meet Delta Water Quality requirements.

Proposed Mitigation

Our review finds that the Less Than Significant assessment in the EIS/EIR lacks sufficiently accurate analysis as to available flows and storage of water in the Sacramento River watershed by virtue of the 64
precision of the models used in the quantitative assessment. Mitigation is likely required to assure

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[41] EIS/EIR Public Draft Under Review at page C-5

sufficient baseflow and stored water availability for CVP and SWP operating requirements for Water Quality. 64

Terrestrial Resources

Potential Impact Statements from Table ES-4	**Related Alternative(s)**	**Significance to CEQA**	**Proposed Mitigation**	**Significance After Mitigation Pursuant to CEQA**
Groundwater substitution could reduce stream flows supporting natural communities in small streams	2, 3	S	GW-1	LTS

Assessment methods in the EIS/EIR for riparian, wetland, and natural in-stream community (e.g. fauna in the hyporheic zone such as Caddis fly larvae) impacts include SACFEM2013. Reportedly SACFEM2013 predicted changes in groundwater elevations over time were used to assess the potential impacts of groundwater depletion on stream flows in small tributaries and associated natural communities. However, it should be noted that in wetland and riparian habitats, groundwater typically ranges from eight feet to just below the ground surface Faunt (2009).[42] As noted previously under the discussion of Groundwater Resources evaluations, SACFEM2013 contains an unusual model construction feature using model "Drains" with respect to riparian habitats consumptive use of water, its evapotranspiration of water, and groundwater discharge to land surface outside of a recognized and model surface water course. Drains were set at land surface rather than at root zone depth. Thus SACFEM2013 is highly imprecise in its ability to discern where and how much a riparian or riverine habitat is utilizing groundwater or residual soil moisture (see earlier commentary on the decoupling of the soil moisture model from the SACFEM2013 groundwater model) 65

The EIS/EIR notes that:

> *"…groundwater modeling results indicate that shallow groundwater is typically deeper than 15 feet in most locations under existing conditions, and often substantially deeper…"*[43]

Modeling is not the best available science for this analysis when empirical data are available to assess actual or anticipatable depth to a phreatic surface or the capillary fringe of water rising above the phreatic surface in native sediments and soils. For example groundwater elevations of Spring 2013 depicted on Figure 3.3-4 along the Sacramento River main stem from Red Bluff, California to roughly Princeton, California are above the streambed elevations. This indicates that the Sacramento River is gaining flow from accretionary flows of groundwater in this lengthy reach, and the phreatic surface of groundwater would be expected to be eight feet or less below ground surface along the riparian corridor of the river with possible wetlands. Similarly groundwater elevations depicted on Figure 3.3-4

[42] Faunt, C.C., ed., 2009, Groundwater Availability of the Central Valley Aquifer, California: U.S. Geological Survey Professional Paper 1766, 225 p

[43] EIS/EIR Public Draft at page 3.8-32

along the Feather River from Oroville to Live Oak are above the streambed elevations. Conditions for the riparian corridor and potential wetlands may exist based on these data. The areas where groundwater elevations are below the elevation of the bottom of river courses was noted in the discussion of Groundwater Resources; yet an analysis of near river and stream course depths to groundwater or the 65
capillary fringe can be reasonably estimated from the data. Data are better than models for current or historic conditions analysis.

Terrestrial Resource impacts are not properly accounted in the EIS/EIR due in part to the imprecision and inability of the models to assess dehydration of the soils and groundwater aquifer adjoining streams and large rivers.

Proposed Mitigation

Proposed Mitigation GW-1 is not quantified or quantifiable as to what groundwater pressure decreases will constitute an impact to natural communities in and near small streams in the Seller Service Area.

The groundwater elevation changes within a conceptual monitoring plan that would be necessary to mitigate stream flows supporting natural communities in small streams under proposed mitigation, GW- 66
1, must be quantifiable or else the proposed mitigation is insufficient to reduce the impacts from Groundwater Substitution Measures. The proposed mitigation, GW-1, is not sufficiently quantified in the EIS/EIR nor in the Groundwater Management Plans (GWMPs) referenced. Existing GWMPs do not contain quantified year on year metrics for subbasin depletion and refill within acceptable ranges to sustain primary functions like support for natural communities.

Potential Impact Statements from Table ES-4	**Related Alternative(s)**	**Significance to CEQA**	**Proposed Mitigation**	**Significance After Mitigation Pursuant to CEQA**
Transfer actions could alter flows in large rivers, altering habitat availability and suitability associated with these rivers	2, 3, 4	LTS	None	LTS

Much of the discussion of small streams is applicable to large rivers. Additional considerations are noted in the following discussion that demonstrate a finding of Less Than Significant is apparently due to a faulty analysis of the type of impacts, and their foreseeable magnitude and likelihood of creating Significant impact to habitat supported by large rivers.

Water transfers would affect flows in the rivers and creeks adjacent to and downstream of the areas 67
where transfer activities (of all kinds) would occur. Changes in stream flows that would result within the Seller Service Area may affect natural communities, such as riverine, riparian, seasonal wetland, and managed wetland natural communities, which are reliant on CVP and SWP operational outcomes with Water Transfers such as surface-water flow velocity, surface-water quality (in particular water temperature both released and exchanged with groundwater), and the accretion or depletion of

groundwater near surface. These operational outcomes and effects could propagate downstream of the areas/locations where pumping occurs. 67

The extraction scenarios proffered in the EIS/EIR will cumulatively over time and space reduce the available accretionary flow of groundwater to the large rivers in addition to the loss of water directly from the adjoining large river, where proximate to a well or wells, to satisfy the capture of water by 68 groundwater extraction wells used for Long-Term Water Transfers as Groundwater Substitution Measures.

Releases of storage water within reservoirs is one of many factors within TOM and CalSim II that lack a sufficient description for the analyses required here for natural habitat flow requirements. An adequate form of model would incorporate anticipated timing of natural flow impacts and controlled releases for Water Transfers. Again the best available science would include implementation of the IWFM simulation code to an appropriately configured model. Due to the IWFM codes ability to account stream flows dynamically in the simulation code's algorithms the timing and magnitude of flows could be quantified. From this foundational quantification additional models on river flow velocities, bed scour, 69 temperatures and other attributes of Seasonally Varying Flow (SVF) that has been found to be essential to riverine habitat.[44] In other words there is no detail provided on where each of the water volumes in TOM are derived (e.g. groundwater vs. stored water). As a result of streamflow depletion from Groundwater Substitution Measures, the EIS identifies that small decreases in water supplies to users could occur when the stored reservoir release transfers decrease carryover storage in reservoirs. These operational controls are very important to how storage facilities would operate during extended dry periods.

Proposed Mitigation

A reanalysis of the potential impacts of Water Transfers is required using best available science to 70 ascertain the magnitude of potential impacts, system operational constraints on those impacts, and the method and implementation of mitigation, if needed.

Fisheries

The findings of Less Than Significant for Fisheries is not supported by the analytical tools based upon the preceding analyses of Groundwater Resources and Water Supply and should be revisited as to availability of water to support riparian and hyporheic zones along the waterways for habitat support for 71 species of special interest identified in Section 3.7.1.2 and as to timing and quantity impacts of river flows due to streamflow depletions evaluated under Water Supply.

[44] Risley, John, Wallick, J.R., Waite, Ian, and Stonewall, Adam, 2010, Development of an environmental flow framework for the McKenzie River basin, Oregon: U.S. Geological Survey Scientific Investigations Report 2010-5016, 94 p.

ATTACHMENT A

STREAMFLOW DEPLETION CALCULATIONS USING USGS STRMDEPL08 FOR SELECT GROUNDWATER SUBSTITUTION TRANSFER WELLS

Development of Streamflow Depletion Factors for Select Wells

The USGS released in 2008 a numerical code, STRMDEPL08, that solves the analytical solutions of Theis, 1941, Hantush 1954, Hunt 1999, and Hunt 2003 for groundwater interaction with nearby streams. One of the key advantages to STRMDEPL08 is the ability to use time varying flow rates and shorter time steps down to one half of a calendar month.

Six wells in close proximity to streams based upon the input arrays provided for SACFEM2013. The distance to the nearest stream or river was calculated in GIS to the polylines for surface water bodies provided in response to the Delta Water Agency for model input datasets. This was generally found to be a greater distance than represented by the nodal structure of surface water nodes in SACFEM2013 vs. the groundwater extraction well nodes. Hence this is a conservative estimate of configuration with regard to expected streamflow impact (the distance of an extraction well from a stream is a key determinant in the timing and magnitude of the streamflow depletion)

Streambed thickness was set at 1 meter per the model documentation. Stream widths were as provided. Additionally the streambed vertical conductivity was as specified in the SACFEM2013 model dataset. These values were found to range from 1 meter/day to 0.1 meter/day which does not correspond to the Appendix D documentation but was used anyway.

The pumping stress was applied for the extended drought period of 1987 to 1992 for each well. The pumping rate applied for each well was derived from the information provided by the Bureau of Reclamation for their TOM operational analysis model. The total water available for extraction and transfer by the six entities (Sellers) for which a well was evaluated was used. The rate for the well was estimated by dividing the total quantity transferable by the number of wells owned (e.g. Pelger Mutual Water Company). It was then further modified by applying an estimate of Evapotranspiration on the average climatic zone of Yuba City. Groundwater extraction was thereby curved from April to September, the period of water demand for crops in that climate.

The results for 6 wells are depicted on the following pages, first by fraction of annual pumping per month, and then by cumulative extraction by pumping year. The carryover of depletions produces cumulative losses of more than 100% in certain years based upon the annual variability in pumping rates.

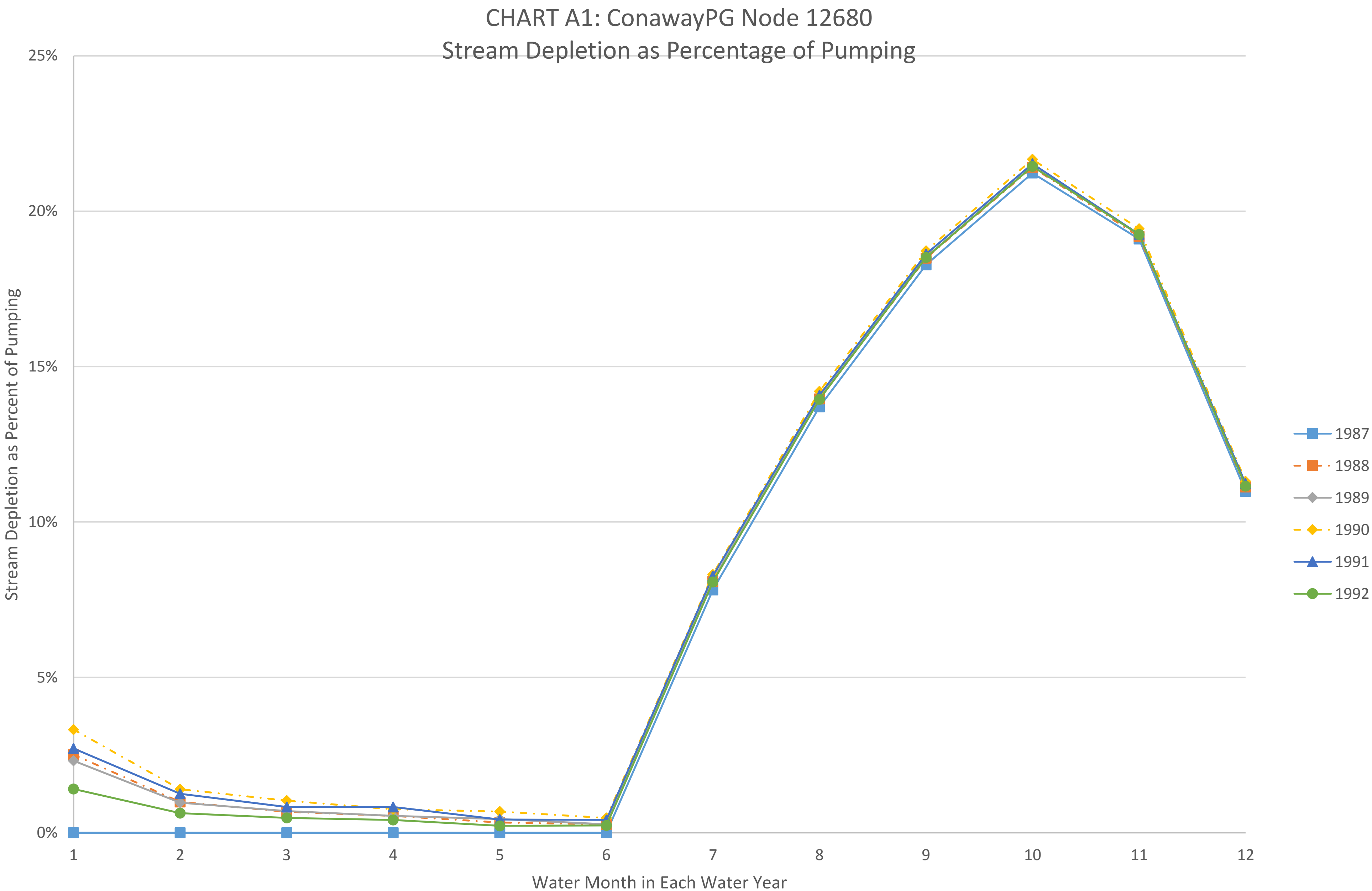


CHART A1: ConawayPG Node 12680
Stream Depletion as Percentage of Pumping
Stream Depletion as Percent of Pumping
25%
20%
15%
10%
5%
0%
1
2
3
4
5
6
7
8
9
10
11
12
Water Month in Each Water Year
1987
1988
1989
1990
1991
1992

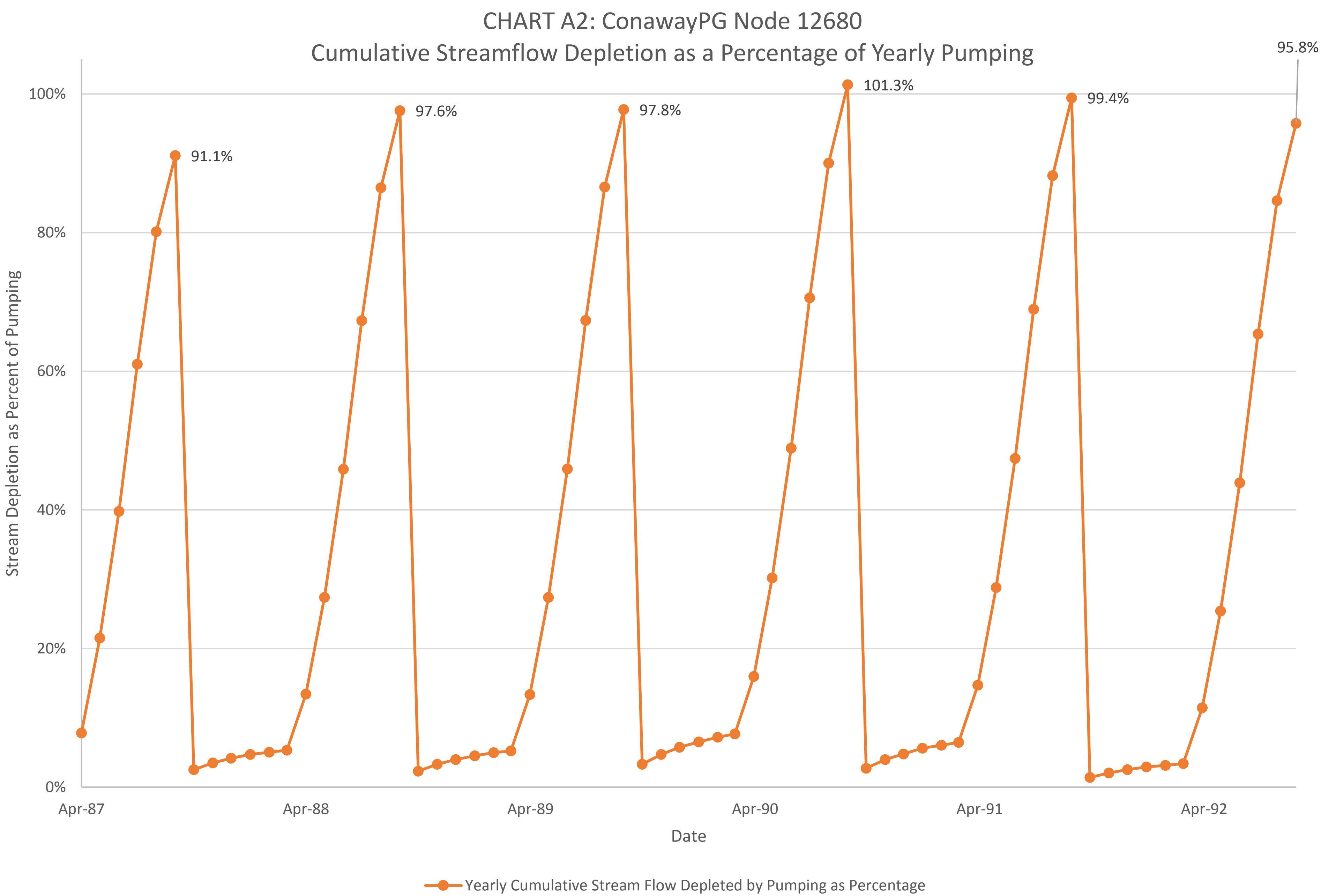


CHART A2: ConawayPG Node 12680
Cumulative Streamflow Depletion as a Percentage of Yearly Pumping
Stream Depletion as Percent of Pumping
100%
80%
60%
40%
20%
0%
91.1%
97.6%
97.8%
101.3%
99.4%
95.8%
Apr-87
Apr-88
Apr-89
Apr-90
Apr-91
Apr-92
Date
Yearly Cumulative Stream Flow Depleted by Pumping as Percentage

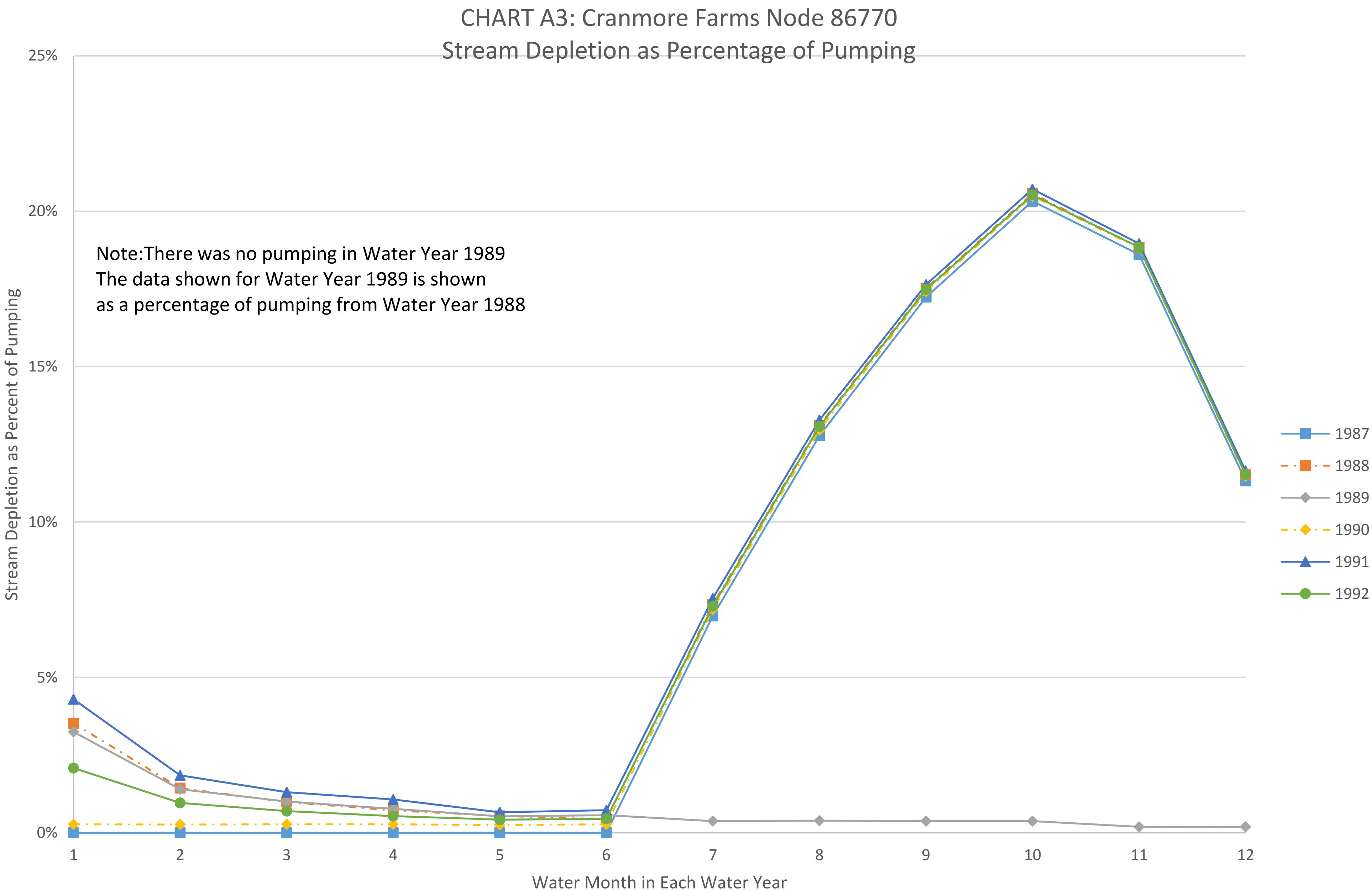


CHART A3: Cranmore Farms Node 86770
Stream Depletion as Percentage of Pumping
Note:There was no pumping in Water Year 1989
The data shown for Water Year 1989 is shown
as a percentage of pumping from Water Year 1988
25%
20%
15%
10%
5%
0%
Stream Depletion as Percent of Pumping
1
2
3
4
5
6
7
8
9
10
11
12
Water Month in Each Water Year
1987
1988
1989
1990
1991
1992

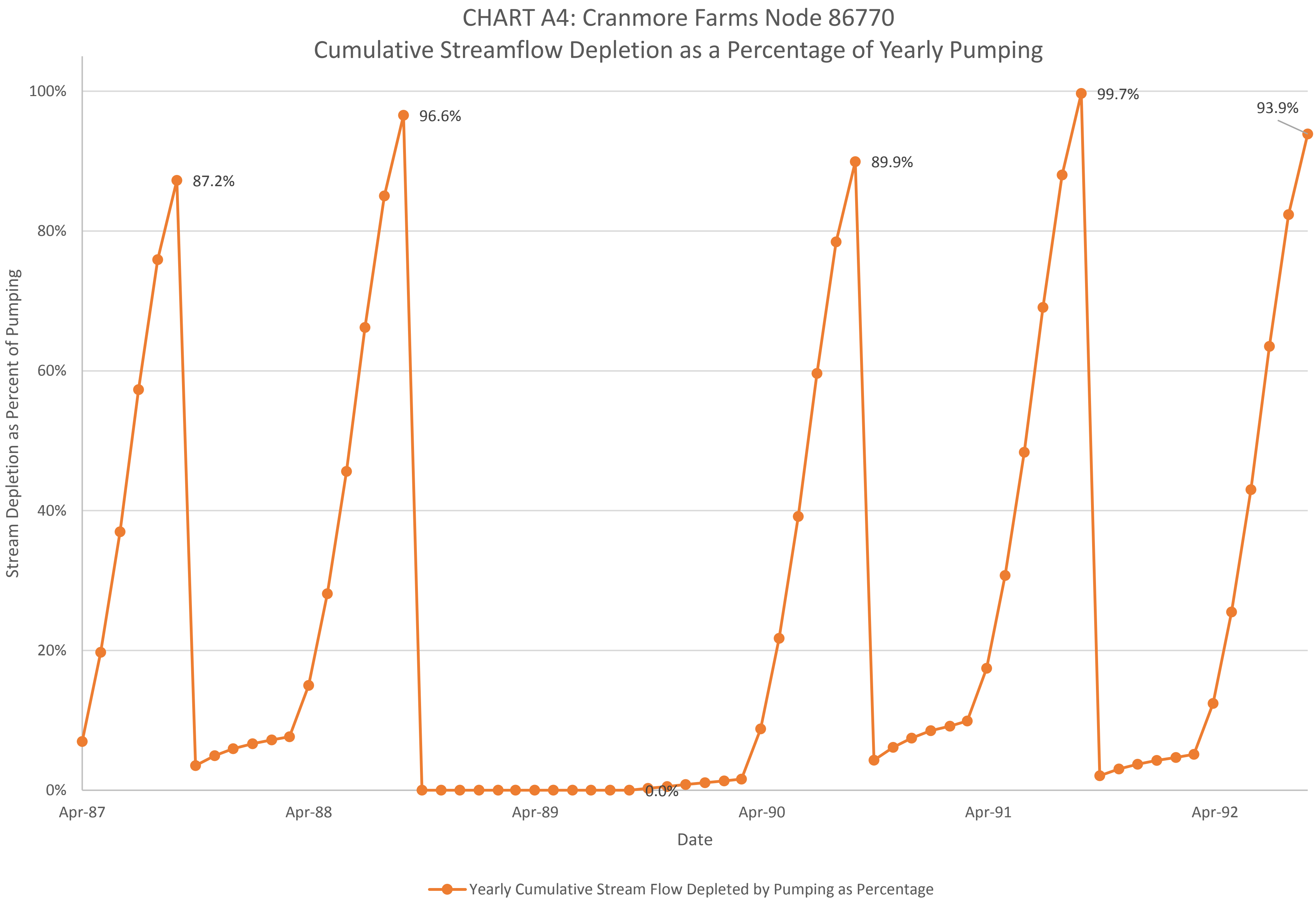


CHART A4: Cranmore Farms Node 86770
Cumulative Streamflow Depletion as a Percentage of Yearly Pumping
Stream Depletion as Percent of Pumping
100%
80%
60%
40%
20%
0%
87.2%
96.6%
0.0%
89.9%
99.7%
93.9%
Apr-87
Apr-88
Apr-89
Apr-90
Apr-91
Apr-92
Date
Yearly Cumulative Stream Flow Depleted by Pumping as Percentage

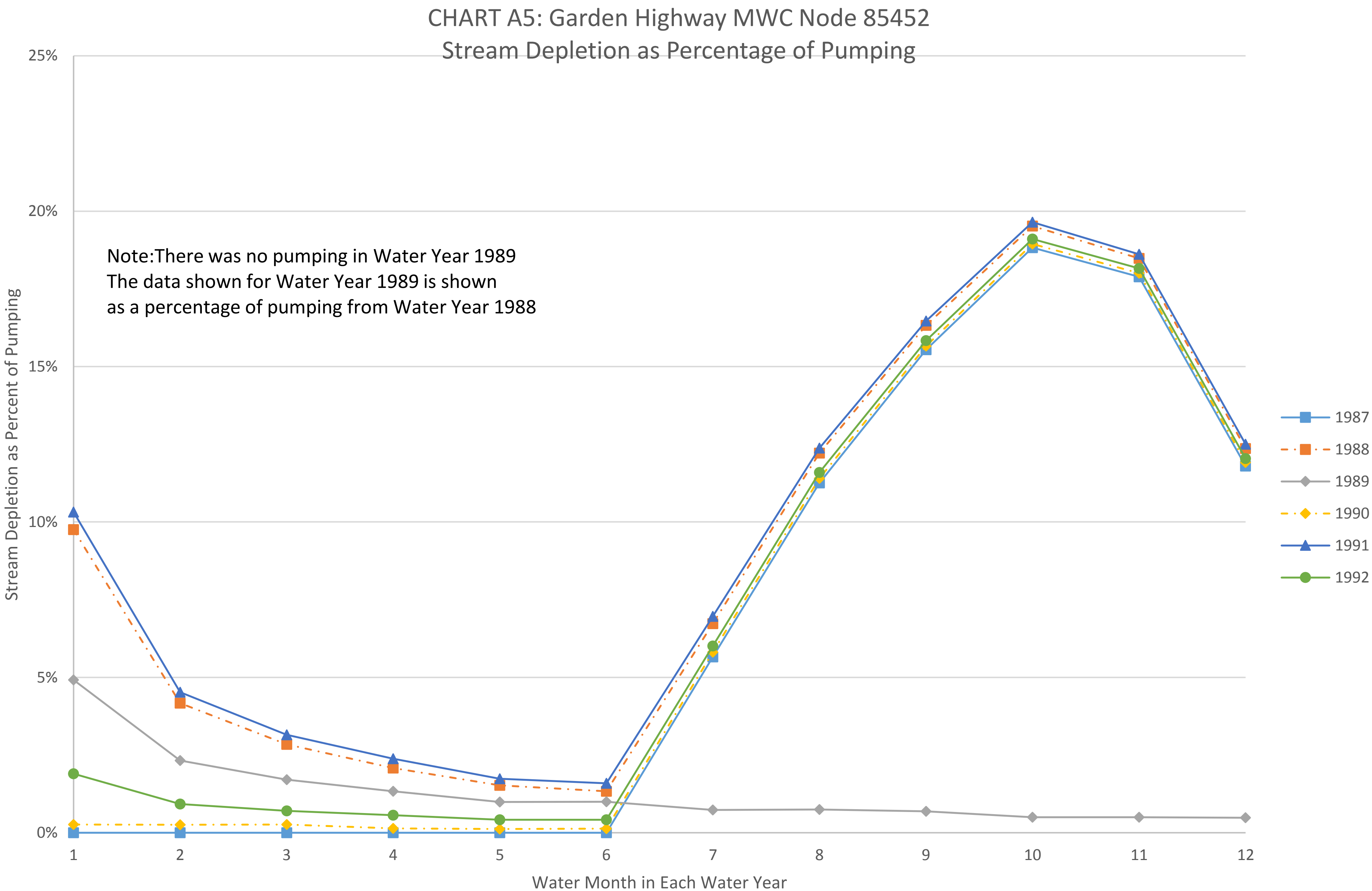


CHART A5: Garden Highway MWC Node 85452
Stream Depletion as Percentage of Pumping
Note:There was no pumping in Water Year 1989
The data shown for Water Year 1989 is shown
as a percentage of pumping from Water Year 1988
Stream Depletion as Percent of Pumping
25%
20%
15%
10%
5%
0%
1
2
3
4
5
6
7
8
9
10
11
12
Water Month in Each Water Year
1987
1988
1989
1990
1991
1992

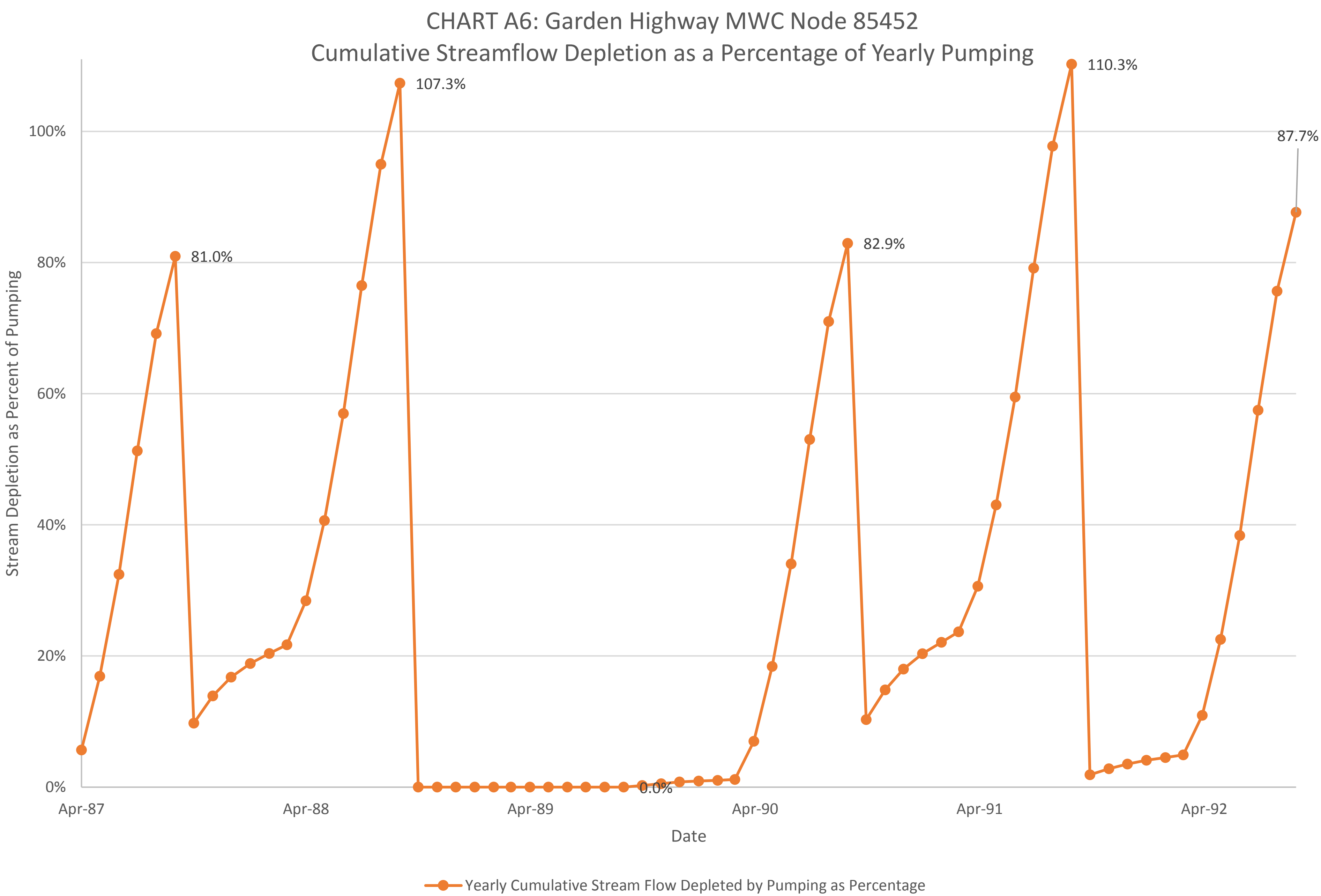


CHART A6: Garden Highway MWC Node 85452
Cumulative Streamflow Depletion as a Percentage of Yearly Pumping
Stream Depletion as Percent of Pumping
100%
80%
60%
40%
20%
0%
81.0%
107.3%
0.0%
82.9%
110.3%
87.7%
Apr-87
Apr-88
Apr-89
Apr-90
Apr-91
Apr-92
Date
Yearly Cumulative Stream Flow Depleted by Pumping as Percentage

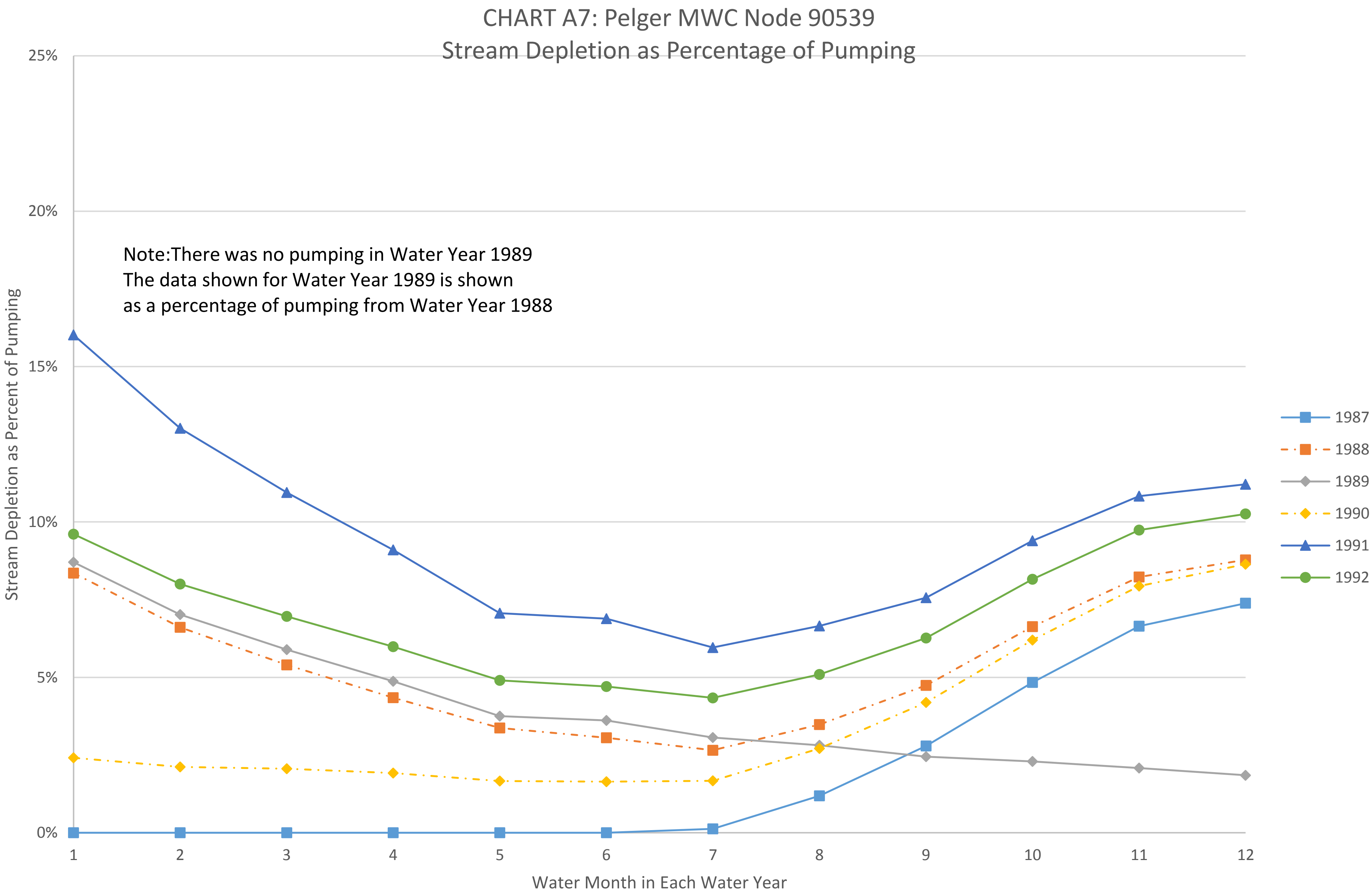


CHART A7: Pelger MWC Node 90539
Stream Depletion as Percentage of Pumping
Note:There was no pumping in Water Year 1989
The data shown for Water Year 1989 is shown
as a percentage of pumping from Water Year 1988
Stream Depletion as Percent of Pumping
25%
20%
15%
10%
5%
0%
1
2
3
4
5
6
7
8
9
10
11
12
Water Month in Each Water Year
1987
1988
1989
1990
1991
1992

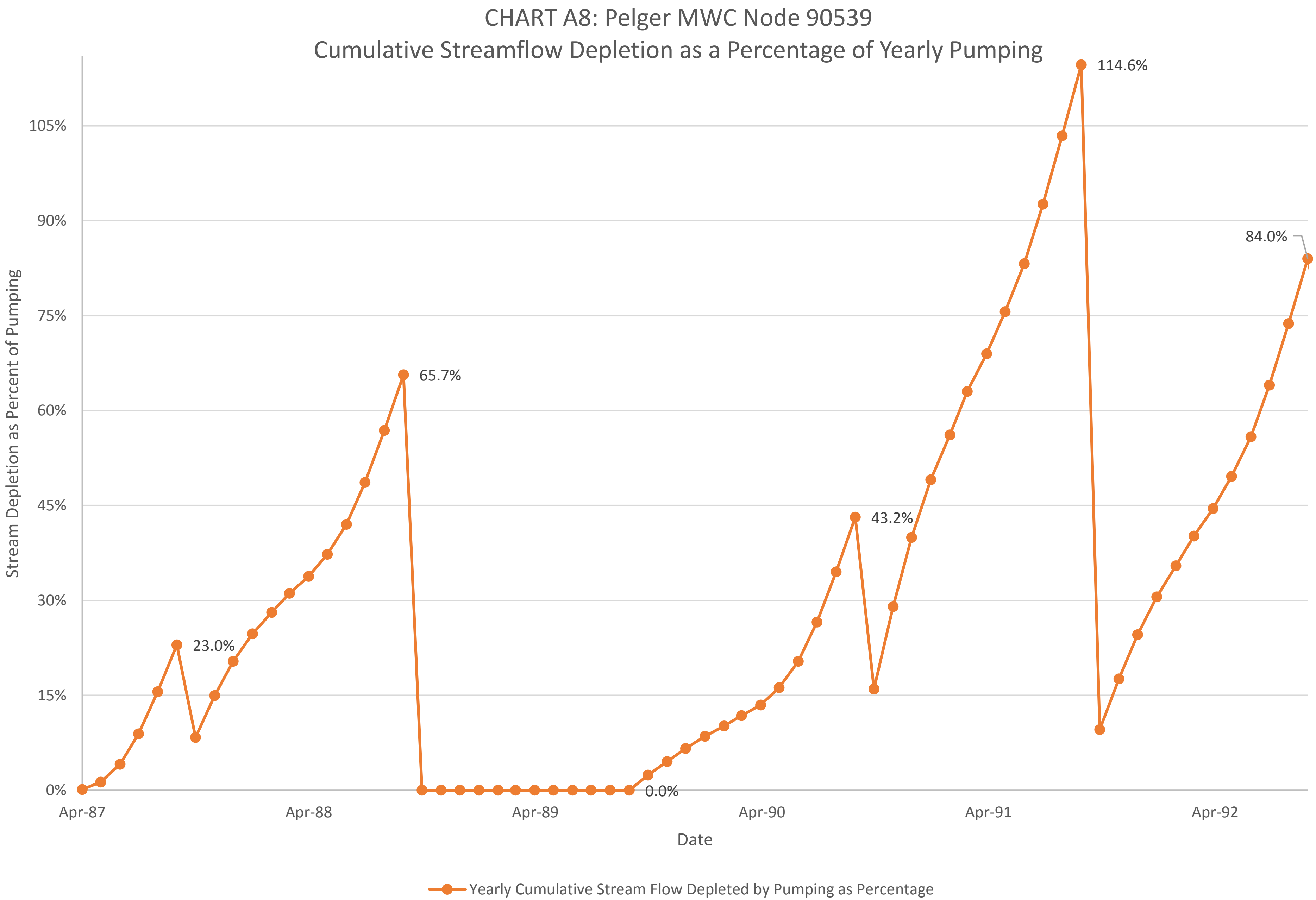


CHART A8: Pelger MWC Node 90539
Cumulative Streamflow Depletion as a Percentage of Yearly Pumping
Stream Depletion as Percent of Pumping
0%
15%
30%
45%
60%
75%
90%
105%
Apr-87
Apr-88
Apr-89
Apr-90
Apr-91
Apr-92
Date
23.0%
65.7%
0.0%
43.2%
114.6%
84.0%
Yearly Cumulative Stream Flow Depleted by Pumping as Percentage

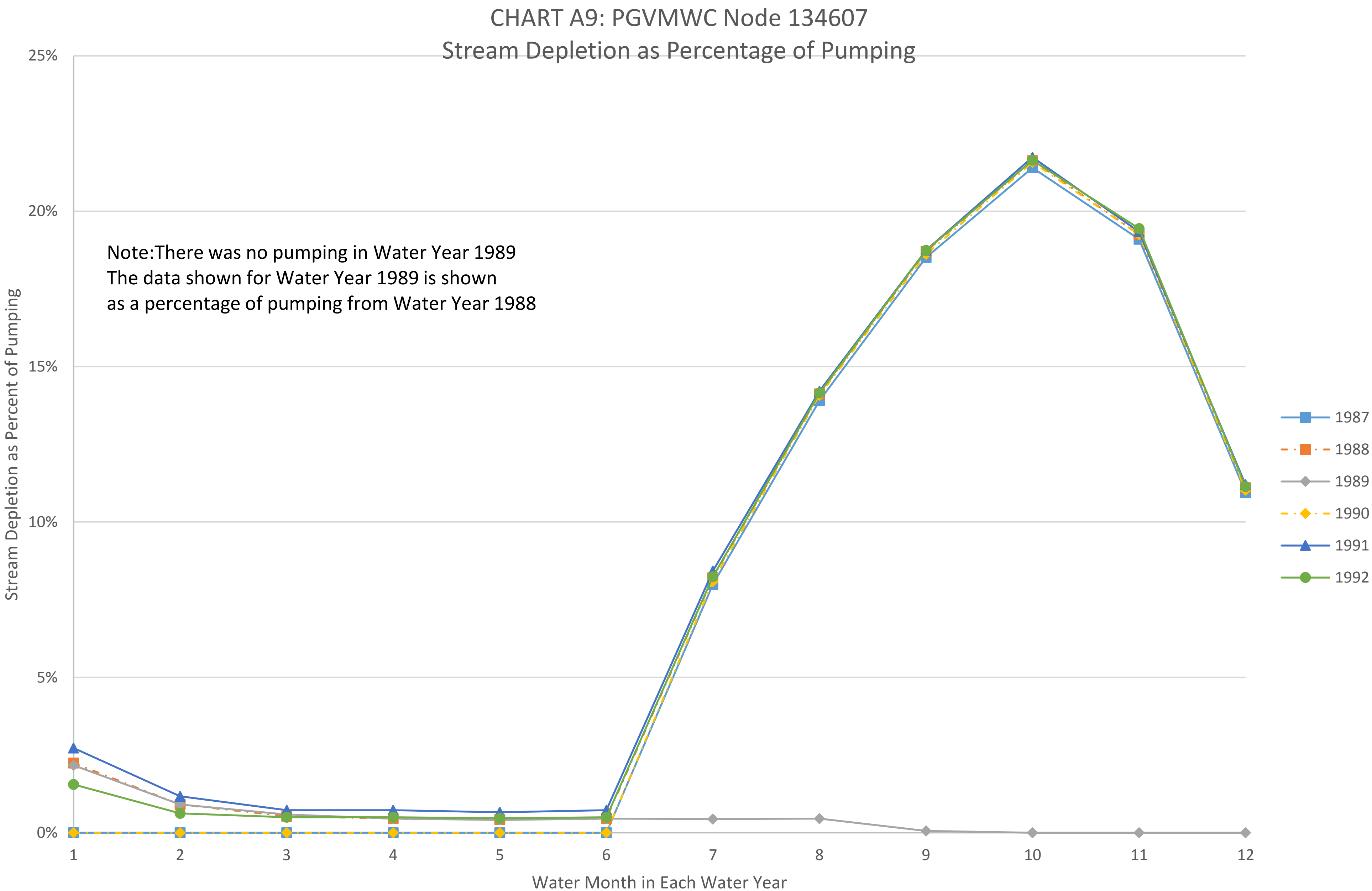


CHART A9: PGVMWC Node 134607
Stream Depletion as Percentage of Pumping
Note:There was no pumping in Water Year 1989
The data shown for Water Year 1989 is shown
as a percentage of pumping from Water Year 1988
Stream Depletion as Percent of Pumping
Water Month in Each Water Year
25%
20%
15%
10%
5%
0%
1
2
3
4
5
6
7
8
9
10
11
12
1987
1988
1989
1990
1991
1992

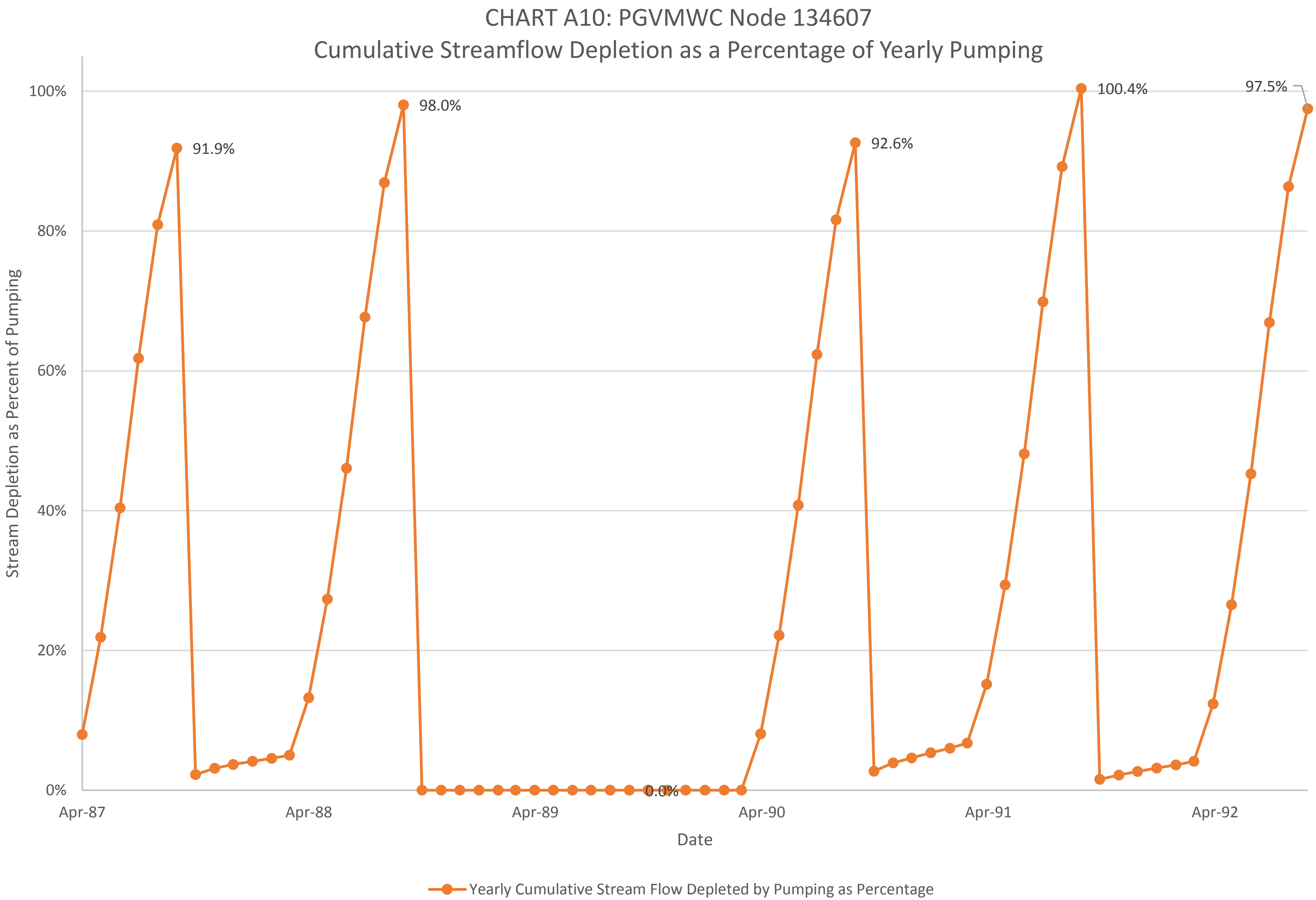


CHART A10: PGVMWC Node 134607
Cumulative Streamflow Depletion as a Percentage of Yearly Pumping
Stream Depletion as Percent of Pumping
100%
80%
60%
40%
20%
0%
91.9%
98.0%
0.0%
92.6%
100.4%
97.5%
Apr-87
Apr-88
Apr-89
Apr-90
Apr-91
Apr-92
Date
Yearly Cumulative Stream Flow Depleted by Pumping as Percentage

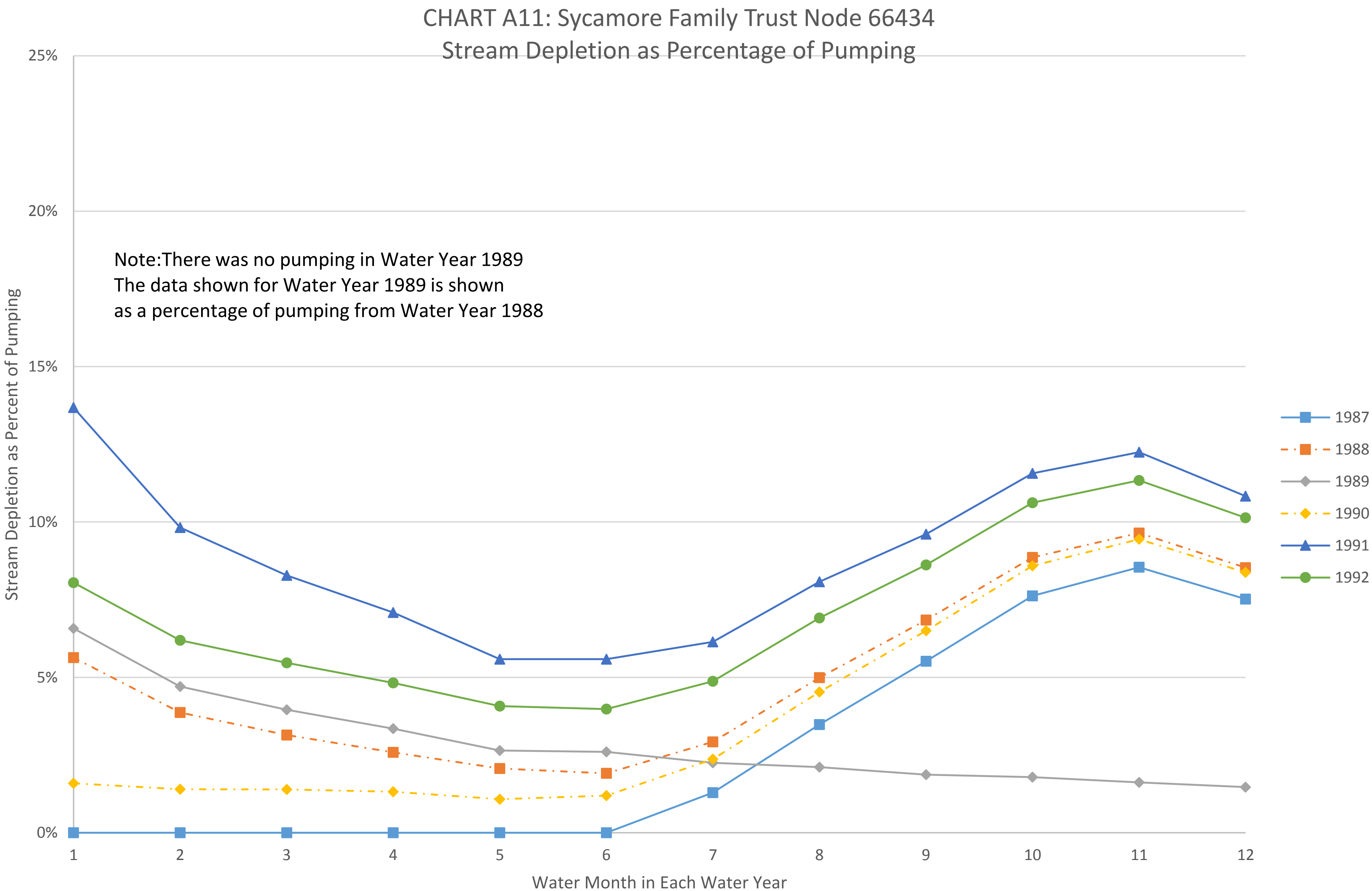


CHART A11: Sycamore Family Trust Node 66434
Stream Depletion as Percentage of Pumping
Note:There was no pumping in Water Year 1989
The data shown for Water Year 1989 is shown
as a percentage of pumping from Water Year 1988
Stream Depletion as Percent of Pumping
Water Month in Each Water Year
25%
20%
15%
10%
5%
0%
1
2
3
4
5
6
7
8
9
10
11
12
1987
1988
1989
1990
1991
1992

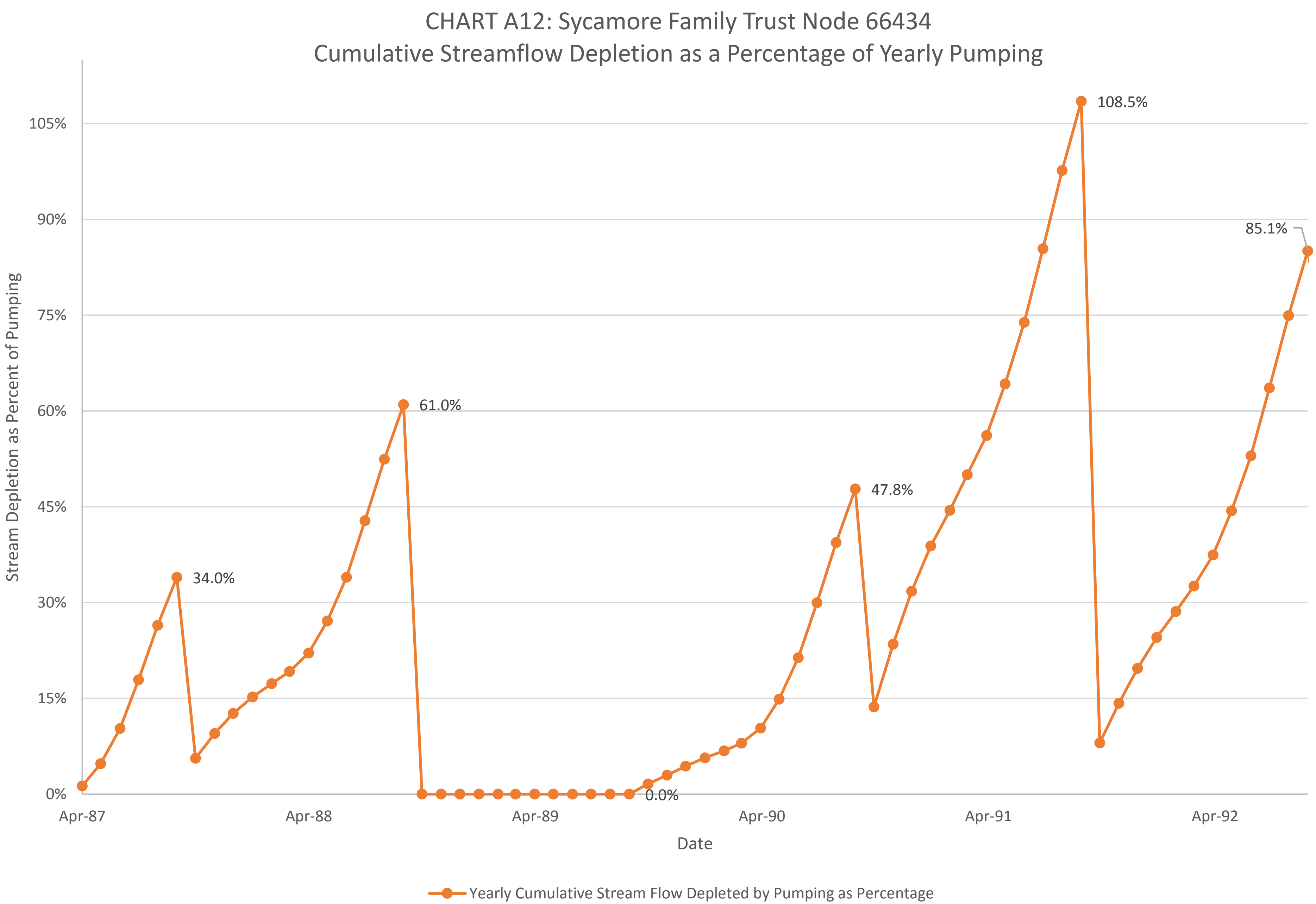


CHART A12: Sycamore Family Trust Node 66434
Cumulative Streamflow Depletion as a Percentage of Yearly Pumping
Stream Depletion as Percent of Pumping
105%
90%
75%
60%
45%
30%
15%
0%
34.0%
61.0%
0.0%
47.8%
108.5%
85.1%
Apr-87
Apr-88
Apr-89
Apr-90
Apr-91
Apr-92
Date
Yearly Cumulative Stream Flow Depleted by Pumping as Percentage

ATTACHMENT B

OVERVIEW OF IWFM SIMULATION CODE CAPABILITIES AND C2VSIM-CG MODEL CONDITIONS ASSESSMENT FOR STREAMFLOWS

Overview of IWFM

The Integrated Water Flow Model (IWFM) is a fully documented FORTRAN based computerized mathematical model that simulates ground water flow, stream flow, and surface water – ground water interactions. IWFM was developed by staff at the California Department of Water Resources (DWR). IWFM is GNU licensed software, and all the source codes, executables, documentation, and training material, are freely available on DWR's website.

The hydrological processes that are simulated in IWFM are the groundwater heads in a multi-layer aquifer system, stream flows, lakes (open water bodies), direct runoff of precipitation, return flow from irrigation water, infiltration, evapotranspiration, vertical moisture movement in the root zone and the unsaturated zone that lies between the root zone and the saturated groundwater system.

The interaction between the aquifer, streams and lakes as well as land subsidence, tile drainage, subsurface irrigation and the runoff from small watersheds adjacent to model domain are also modeled by IWFM.

IWFM is a water resources management and planning model that simulates groundwater, surface water, groundwater-surface water interaction, as well as other components of the hydrologic system. Preserving the non-linear aspects ofthe surface and subsurface flow processes and the interactions among them is an important aspect of the current version of IWFM.

Simulation of groundwater elevations in a multi-layer aquifer system and the flows among the aquifer layers lies in the core of IWFM. Galerkin finite element method is used to solve the conservation equation for the multi-layer aquifer system. Stream flows and lake storages are also modeled in IWFM. Their interaction with the aquifer system is simulated by solving the conservation equations for groundwater, streams and lakes simultaneously.

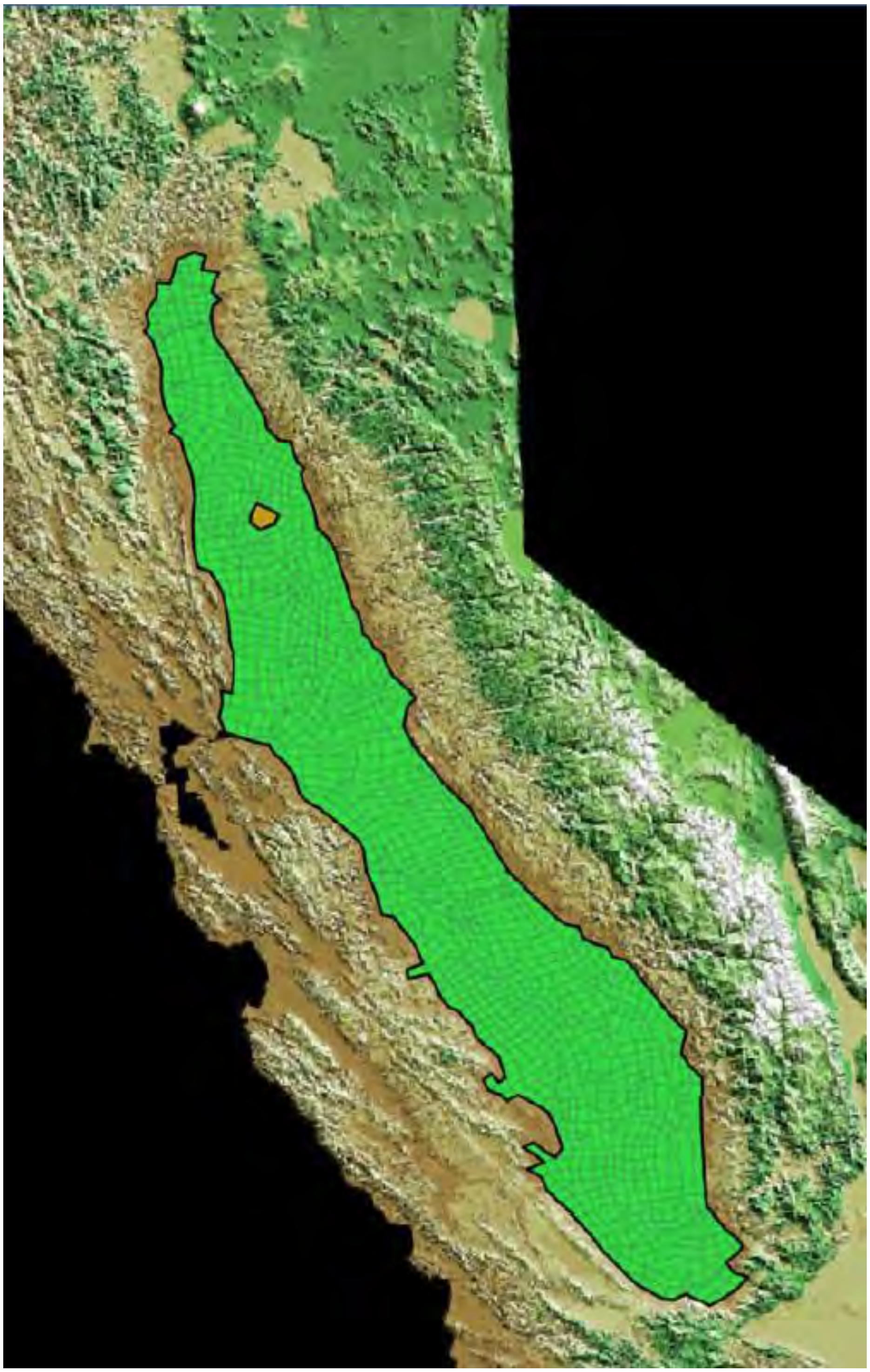
An important aspect of IWFM that differentiates it from the other models in its class is its capability to simulate the water demand as a function of different land use and crop types, and compare it to the historical or projected amount of water supply. The user can specify stream diversion and pumping locations for the source of water supply.

User-specified diversion and pumping amounts can be distributed over the modeled area for agricultural irrigation or urban municipal and industrial use. Based on the precipitation and irrigation rates, and the distribution of land use and crop types over the model domain, the infiltration, evapotranspiration and surface runoff can be computed. Vertical movement of the soil moisture through the root zone and the unsaturated zone that lies between the root zone and the saturated groundwater system can be simulated, and the recharge rates to the groundwater can be computed.

Overview of C2VSim- CG

C2VSIM-CG Boundaries and Grid

The model encompasses approximately 20,000 square miles. The finite-element grid has 1393 nodes, 1392 elements.



Model Layering

There are three explicit groundwater layers in C2VSim with two aquitards layers between the three layers. The bottom of layer 1 was specified to attempt to maintain a minimum saturated thickness of 100 ft except at the model lateral boundaries. The bottoms of layers 1 and 2 were set to incorporate the depth of most groundwater extraction well screens into one or both layers. The bottom of layer 3 was set at the base of fresh water

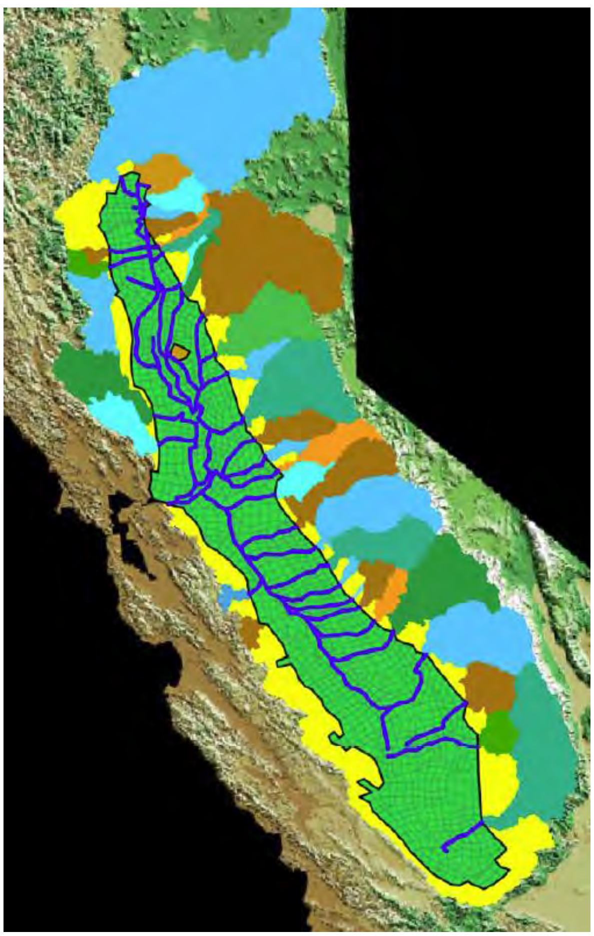
C2VSIM Land Use Process

For the land use process module C2VSIM defines 21 subregions that correspond to the Joint DWR-USBR Depletion Study Drainage Areas (DSAs)

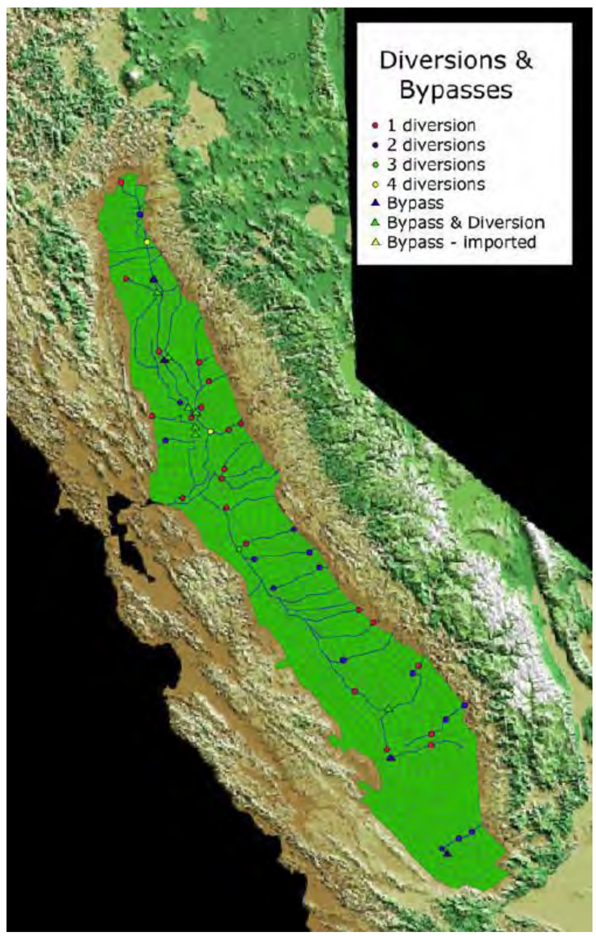
The land use type modules that are simulated in the model are:

- Agriculture
- Urban
- Native
- Riparian

Watersheds and Streams



Major watersheds have gaged flows to C2VSIM streams. Minor watersheds are treated using IWFM Small Watersheds process module.



The model incorporates 72 stream reaches and 97 surface water diversion points. There are two lakes within the model domain. There are also eight flood water bypass canals modeled as surface water diversions in the domain but with their own hydraulic characteristics to differentiate them from other diversion points.

Model Input Parameters

Precipitation Stations and Zones

The model inputs were derived from 32 precipitation stations. Monthly precipitation data from October 1921 to September 2009 were input to the model. Elemental multipliers were used to match the monthly precipitation arrays from the Precipitation Regression Inverse Slope Model (PRISM) 1971-2000 from Oregon State University

Hydraulic Parameters

Horizontal hydraulic conductivity

- 20 – 80 ft/day in layers 1 and 2
- 5 ft/day in layer 3

Vertical hydraulic conductivity

- $5x10^{-5}$ – $1x10^{-3}$ ft/day

Specific yield

- 0.12 – 0.18

Specific storage

- $2x10^{-5}$ ft^{-1}

C2VSIM calibration

C2VSIM calibration was done in an organized sequence of steps. The first step was to update the Conceptual Model for:

- Small watershed delineation
- Precipitation data and stations
- Model Layering and Thicknesses
- Initial heads
- Stream-bed elevations
- Rainfall Runoff Uniform Curve Numbers
- Agricultural root-zone process

The calibration data used included:

- 1976 water level maps for layers 1 & 2
- Head observations at 221wells
- Single screen coincides with model layering
- Measurements before 1977 and after 1997
- No more than one well per model element
- Vertical head gradients at 9 locations
- Average stream accretions and depletions

Calibration was done using PEST with Pilot Points to do inverse parameter fitting to achieve best estimates of parameters to fit through observations (i.e. field data). The calibration sequence used was:

1. Land use process

- Agricultural root-zone process
- Curve numbers

2. Groundwater flow system

- Hydraulic conductivity of layers 1 & 2
- Vertical anisotropy
- Specific yield in layer 1

3. Surface water flow system

- Stream-bed conductivity

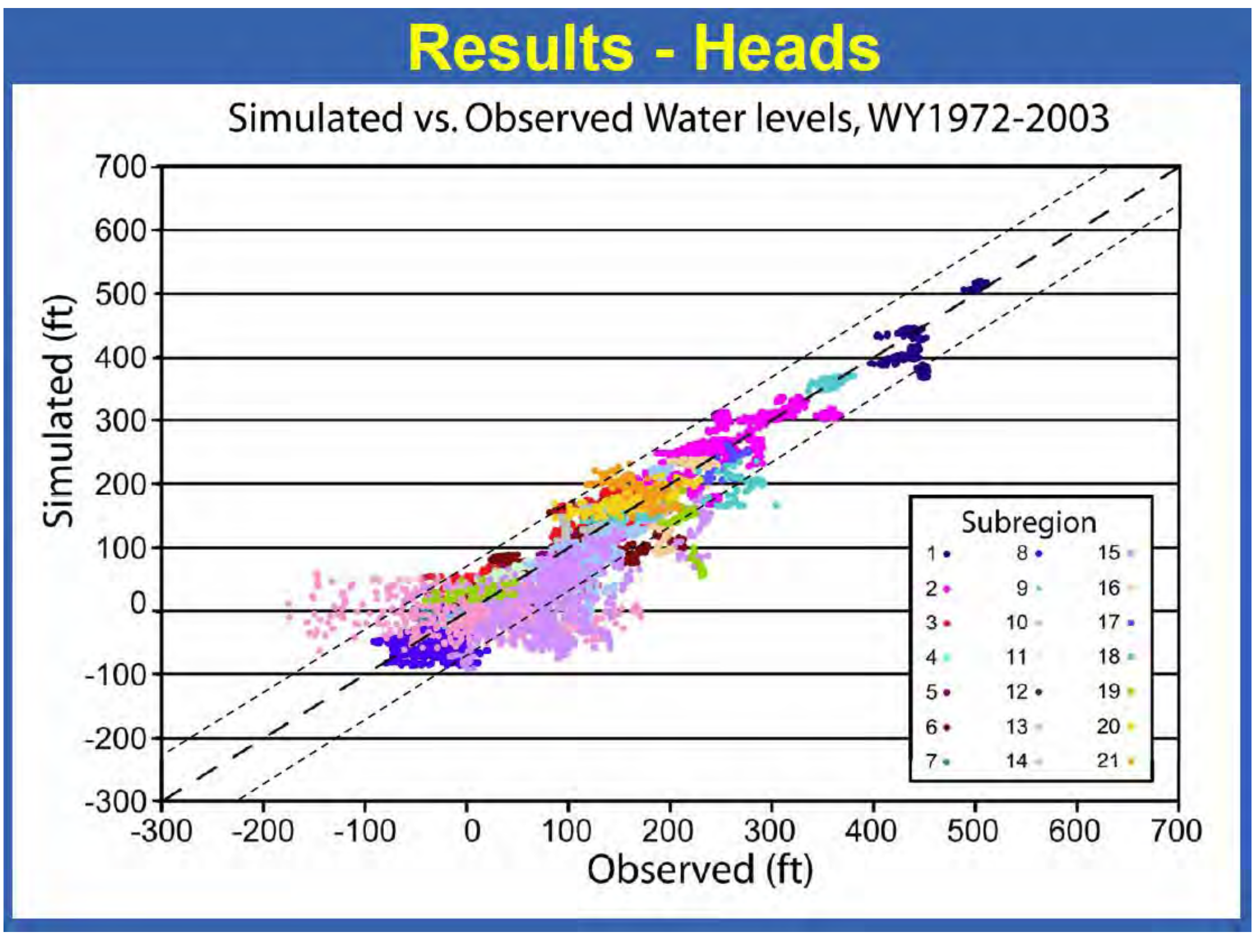
Calibration Results

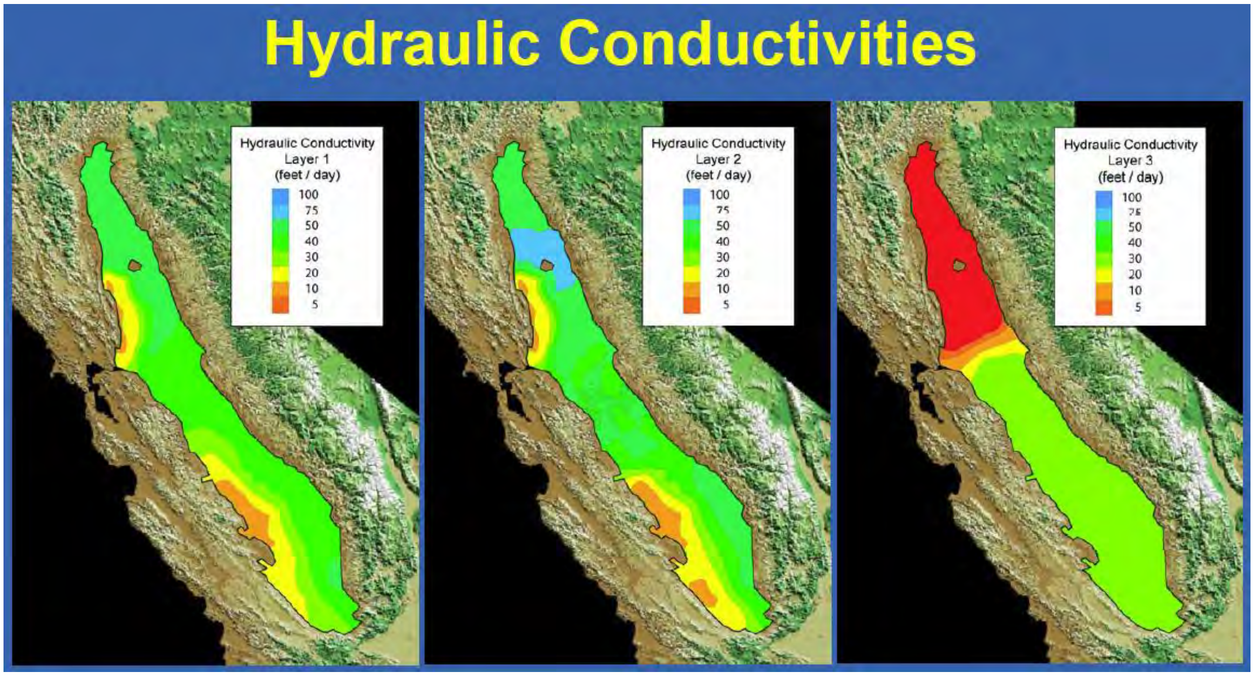
Water Levels:

- Layer 1 generally good
- Layer 2 high beneath Corcoran Clay

Spatial correlation of head residuals

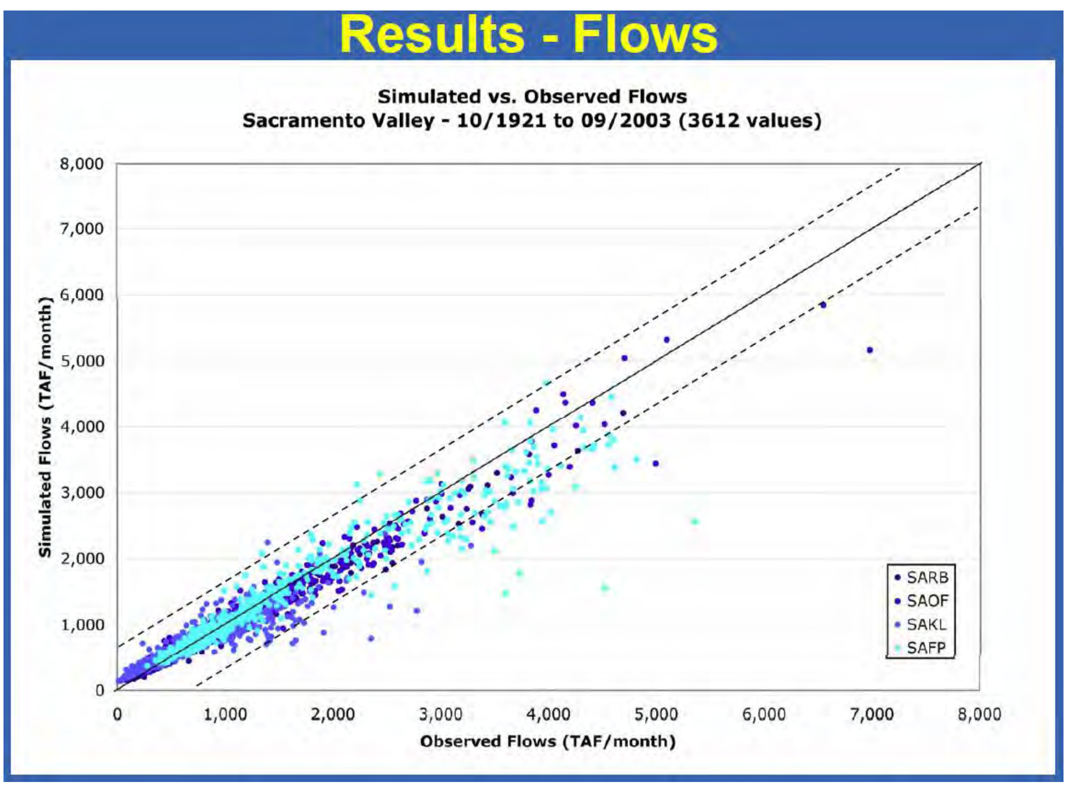
- Reasonable in Sacramento Valley (low on western edge)
- Low in western San Joaquin Valley
- High beneath Corcoran Clay
- Simulated water level trends match observed water level trends on a regional basis



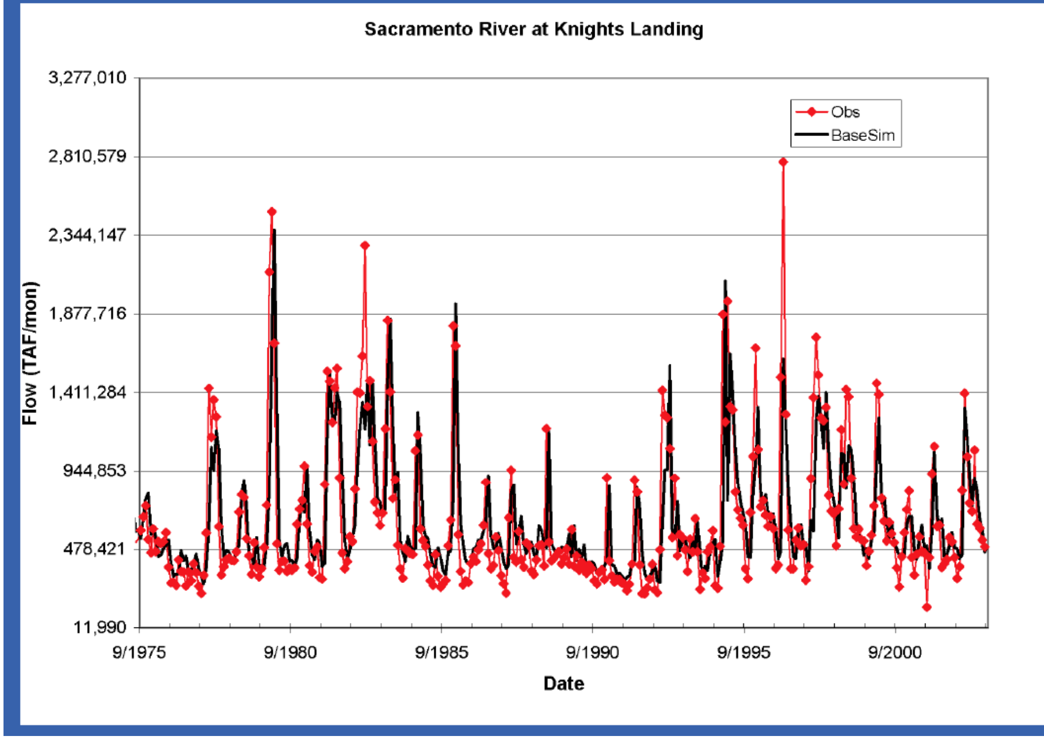


Water Budget Items

C2VSIM shows net groundwater discharge to streams. C2VSIM simulated stream accretions and depletions have same sign as observed, and magnitude is close



Results - Flows



ATTACHMENT C

REVIEW OF SACFEM 2013 CONSTRUCTION AND CALIBRATION

SACFEM2013 Model Notations

SACFEM2013 is built using the MicroFEM simulation code. MicroFEM as a groundwater simulation code cannot accurately calculate some of the key physical processes in the water budget such as evapotranspiration within a shallow groundwater aquifer. It is unable to simulate the physical processes and fully account the changes in surface water flow and groundwater to surface water exchange. A proper basis for the selection of a proprietary model code, that has not been independently verified as to its numerical solution's accuracy, and that does not contain necessary algorithms and proper mathematical formulations to the questions at hand, is not provided in Appendix D. 72

The EIS/EIR in Appendix B states:

> *"SACFEM2013 is a full water budget based, transient groundwater flow model that incorporates all groundwater and surface water budget components on a monthly time-step over the period of simulation. SACFEM2013 provides very high resolution estimates of groundwater levels and stream flow effects due to groundwater pumping within the Sacramento Valley."*

This statement is not accurate and is notably not repeated in the text of Appendix D.

Review of Appendix D on SACFEM2013 Documentation

The documentation of SACFEM2013 is grossly inadequate. The documentation of SACFEM2013 is less than that found for SACFEM in 2011. There is no calibration data provided. No discussion of model residuals or fit to any type of observed data. There is no quantification of model uncertainty or limitations provided in Appendix D. In our review we have been unable to comprehend the model from 73
its documentation. Instead it has required exploring primary data inputs through the GIS database from which it was constructed.

SACFEM2013 is built in Version 4.10 of MicroFEM. No documentation for this version of the code is cited or provided.

Vertical Structure goes to base of the freshwater aquifer and treats that boundary as a no-flow boundary.

Boundary Conditions

Head Dependent Boundaries

Surface Water fluxes

- 50 individual streams are simulated using the "wadi" package in the current version of SACFEM2013
- User specified stream stage 74
    - Transient monthly "varying distributions" of stream-stage height were developed for each reach with no documentation of how this was calculated)
    - User specified stream stage imposes error on model outcomes
- Model calculated head is driver on gradient vs. user specified stage.
- Streambed Conductance (from subformula)
    - D_r = streambed thickness = uniformly assumed to be 1 meter

- K_v = streambed conductivity (
  - Assumed to be 2 meters/day on the eastside, and
  - 5 meters/day on the westside, two exceptions on Eastside for Bear River and Big Chico Creek)
  - **Review and use of model input data K_v as found in the GIS files to the Delta Water Agencies found K_v values in the eastside ranging from 1 meter/day to 0.1 meter/day in the locations selected.** 74
- L = stream length represented by the model node
- A = nodal area
- W = "field width" of the reach represented by L
  - Wetted Stream width taken from aerial photographs at two locations

Appendix D comments that stream length is generally overestimated at river confluences. Manual adjustments were noted without description of how these were calculated.

Streambed elevations were developed from a DEM; there is an odd note of the DEM resolution being lower than stream node resolution when stream node resolution is reported to be on the order of 250 meters and conventional DEM resolution is on the order of 10 to 30 meters with a precision of plus/minus approximately 8 feet.

Drains

SACFEM2013 used the Drain package to simulate the upper land-surface groundwater boundary condition across the domain. Efflux nodes only that are head dependent. Elevation of drain set at land surface. Why were drains not set to the root zone depth to represent ET from the groundwater domain? Formulas provided for the drain stage are underdocumented 75

Specified Flux Boundaries

These denote boundaries where a influx or outflux of water occurs at a set rate per period that is user specified and not model calculated. Specified flux boundaries were set for:

- Deep Percolation
- Mountain Front Recharge
- Urban Pumping

Deep percolation of water

This was reportedly done by surface water budget approach 76

- Water budget estimated using spatial information
  - Land use
  - Cropping patterns
  - Source of Agricultural Water
  - Surface water availability in different year types and locations
  - Spatial distribution of precipitation
- Components
  - Deep percolation of applied water
  - Deep percolation of precipitation
  - Agricultural pumping
- Developed by intersecting

    - GIS data developed by DWR (no citation) – Transient Condition on Land Use
    - With SACFEM model grid 76
- Results in a land use for each groundwater model node
- GIS data on water district and non-district areas derived
- Water source information to the areas(where does this come from? – no citation or methodology described)

Methodology for Surface Water Budget

The methodology is underdocumented. Semi physically based soil moisture accounting model used; it is not clear if this is IDC

Historic precipitation data

Simulates root zone processes and calculates applied water demand and deep percolation past the root zone for each node.

Deep percolation was split between applied water and precipitation. Split was dependent on the season and availability of water from each source

Their calculated values for deep percolation were reportedly compared to DWR Estimated Values for the Year 2000 (no citation). They corresponded with DWR Northern District staff (no citation of who) They adjusted soil parameters in root zone model to reportedly match volumes of percolation to DWR (no citation of DWR data source nor provision of data). 77

Agricultural Pumping calculated from demand for applied water (**no mention found of crop typing or climatic drivers on water demand for applied water**) compared to source water availability from surface sources via GIS intersection of districts

- Split out of groundwater and surface water for certain areas
- Or all groundwater
- Mention of a "level of development simulation of CVP operations" was used to calculate availability of surface water
- Agricultural pumping applied to Layers 2, 3, and 4 only. There is no clear basis for this placement of pumping.

Mountain Front Recharge

Utilized an annual formula from Turner 1991 for a Mediterranean climate and converted the total deep percolation estimated per upper watershed into monthly quantities by looking at streamflows in "ungauged" sections of Deer Creek. Water inserted into Layer 1 at the model boundary. 78

Urban Pumping

Used groundwater use data form Urban Water Management Plans, for population centers above 5,000 people that rely on groundwater. For areas that did not have UWMPs used 271 gpd per person times census to get to groundwater use. Areas of North Sacramento County pumping/usage were stated as consistent with the local SacIGSM model (Note that SacIGSM is built in a predecessor code to IWFM) 79

No Flux Boundaries 80

Bottom of Layer 7, the freshwater interface.

Aquifer Properties

To develop hydraulic conductivity they reportedly used 1,000 wells within model domain with construction information and specific capacity data on Well Completion Reports. Shallow wells (<100 feet) and those with production below 100 gpm were eliminated for aquifer properties (except at the margins of the model domain where aquifers were presumed to be thin). Specific capacity data were 81 converted to calculated transmissivity (T) using an empirical method that is not accurate. A specific capacity can be strongly influenced by turbulent head losses at the well if the pumping rate of the well is high relative to the length of well screen and the well screen open area. The calculated T value was reportedly divided by screen length to derive initial K_h.

They state there is not enough data to define depth dependent K_h. Cooper-Jacob confined aquifer method was assumed in their analysis of aquifer transmissivity.

Peer Review Comments

Deep Percolation

- IDC calculated deep percolation rates are excessive
    - Deep percolation reduction factors were created for IDC outputs before use in SacFEM
- SacFEM deep percolation rates are not supported by the fundamental IDC model methodology 82
  and parameters resulting in a disconnect between SacFEM and IDC.
    - Recommended incorporating a feedback loop between the 2 models and subjecting them to convergence criteria
    - SacFEM deep percolation rates are not consistent with other data sets and it should be ensured that they are supported by historical land use, crop mix, and agricultural practices

Stream Aquifer interaction

- The flow exchanged between streams and aquifers is a function of head difference between groundwater elevation and stream stage with impedance by streambed resistance.
- The assumption of constant stream stage results in stream-aquifer relationship dependent on streambed resistance and groundwater elevation
- Assumption of constant stage is not valid 83
- Recommended that SacFEM use time varied stream stage data

The 2011 peer review contained a primary statement of revisions to SACFEM from 2009 that:

> *"Documentation on SacFEM and the IDC Model – Model documentation, with appropriate level of detail on data collection, analysis, and input data preparation should be developed."*

Model Calibration Information

The following model calibration figures were obtained from the 2009 and 2011 SACFEM model documentation.

DOCUMENTATION OF THE SACFEM GROUNDWATER FLOW MODEL

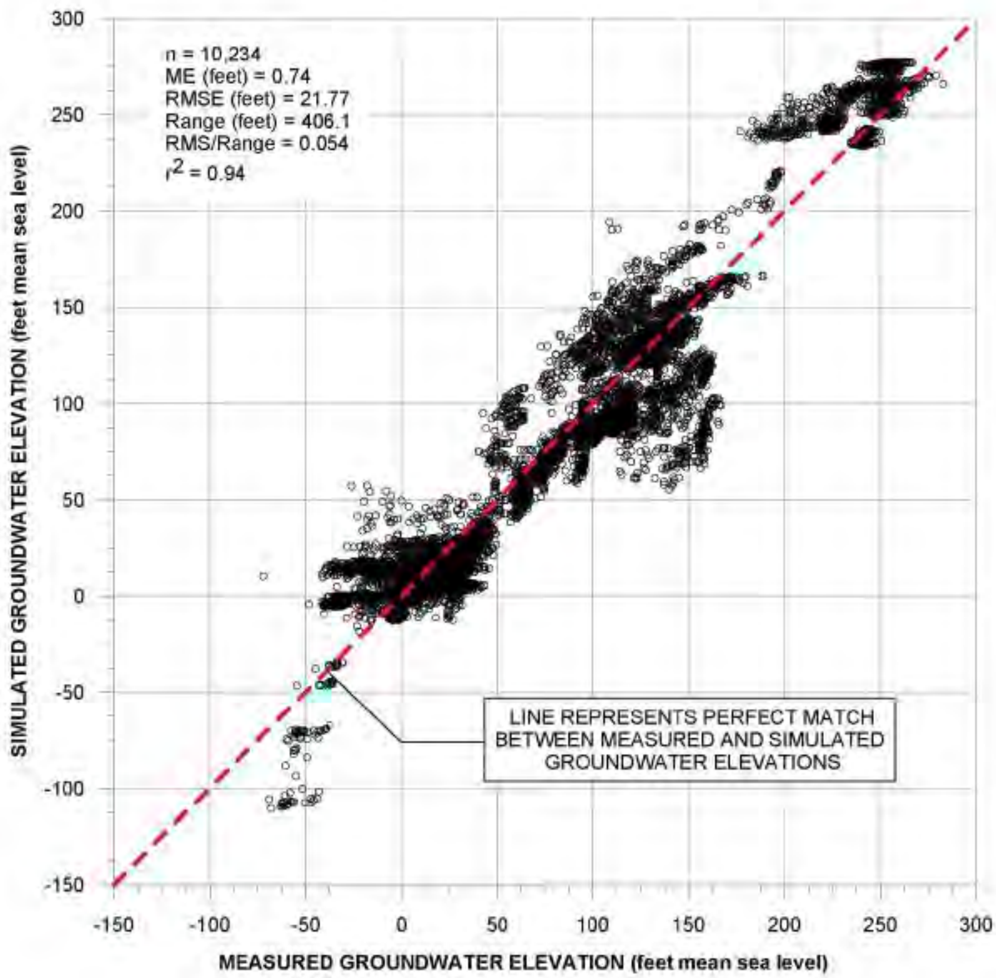
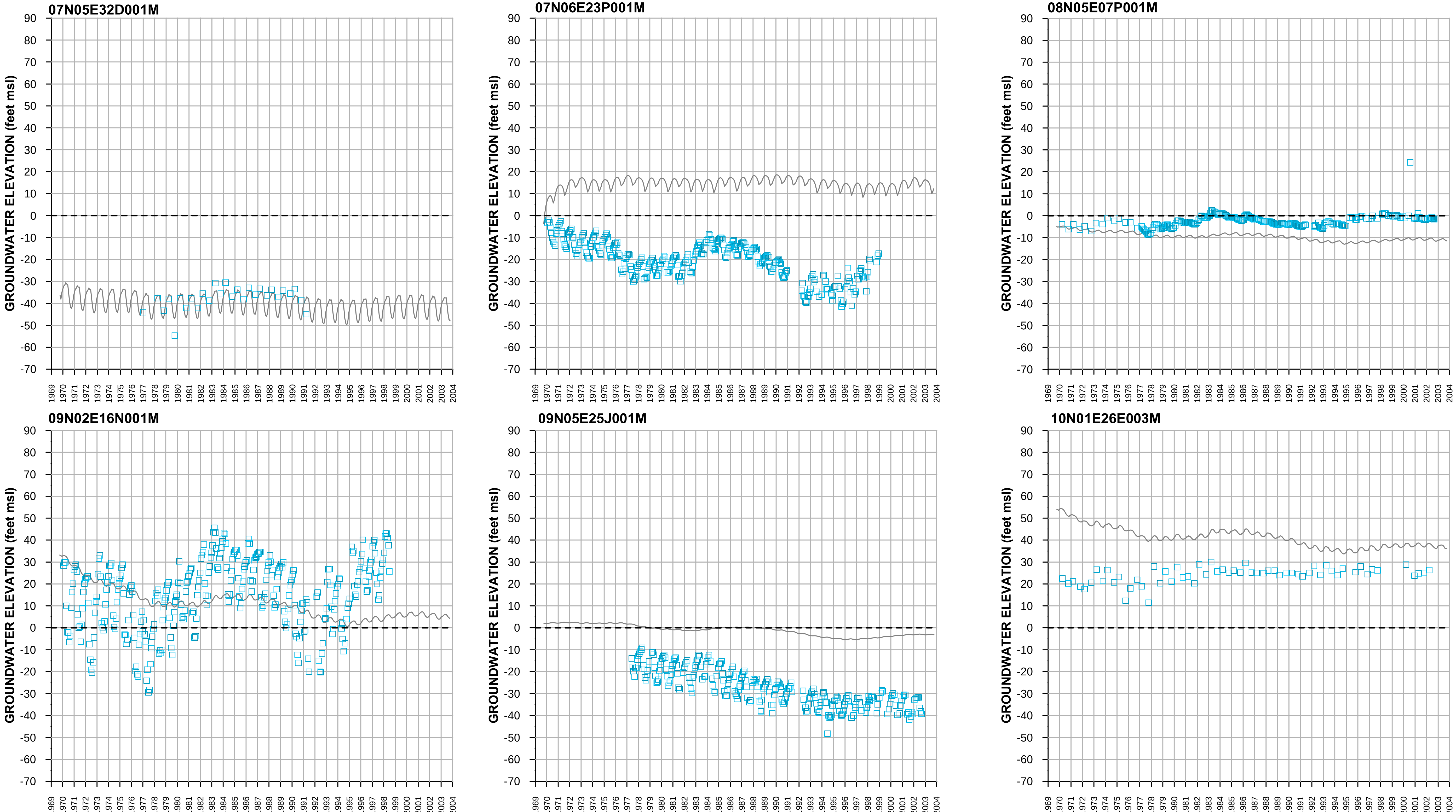


FIGURE B-9
Transient Calibration Scattergram

84

This model calibration demonstrates that in several areas model estimates exceed actual measured data by more than 65 feet, the thickness of Layer 1 in SACFEM2103. This is notable in the region around 150 feet MSL on the attached chart, B-9, found in the 2011 model documentation. Additional calibration figures by well are found on the pages that follow and demonstrate a lack of fit to trend or data at many wells.



LEGEND

- MEASURED GROUNDWATER ELEVATION (feet msl)
- SIMULATED MONTHLY GROUNDWATER ELEVEVATION (feet msl)
- MEAN SEA LEVEL (feet msl)

FIGURE B-10 (PAGE 2 of 11)
TRANSIENT CALIBRATION HYDROGRAPHS
DOCUMENTATION OF THE SACFEM
GROUNDWATER FLOW MODEL
SACRAMENTO VALLEY GROUNDWATER BASIN

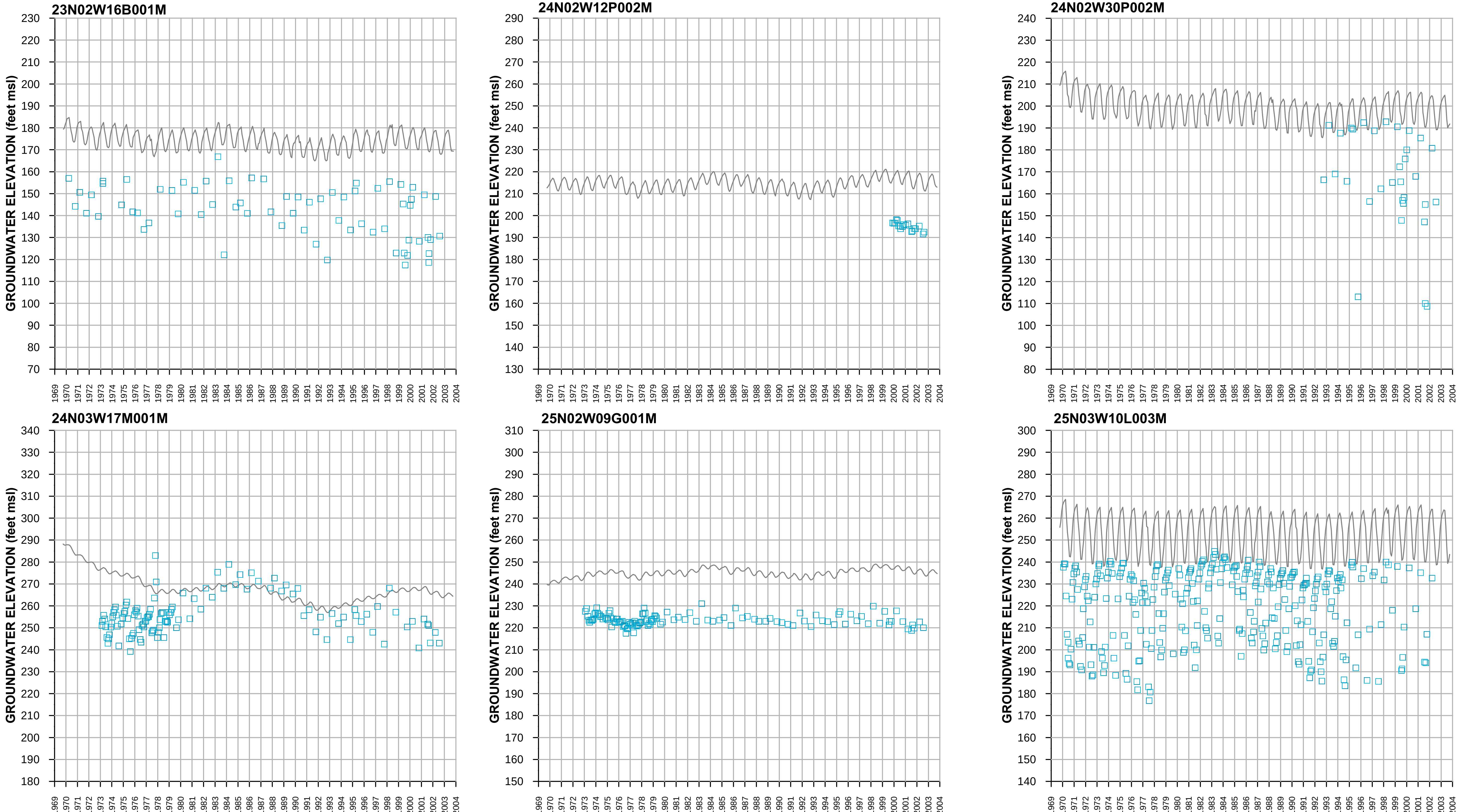
CH2MHILL

HYDROGRAPHS2.grf

FIGURE B-10 (PAGE 8 of 11)
TRANSIENT CALIBRATION HYDROGRAPHS
DOCUMENTATION OF THE SACFEM
GROUNDWATER FLOW MODEL
SACRAMENTO VALLEY GROUNDWATER BASIN

CH2MHILL

HYDROGRAPHS8.grf



LEGEND

- MEASURED GROUNDWATER ELEVATION (feet msl)
- SIMULATED DAILY GROUNDWATER ELEVEVATION (feet msl)
- MEAN SEA LEVEL (feet msl)

FIGURE B-10 (PAGE 10 of 11)
TRANSIENT CALIBRATION HYDROGRAPHS
DOCUMENTATION OF THE SACFEM
GROUNDWATER FLOW MODEL
SACRAMENTO VALLEY GROUNDWATER BASIN

CH2MHILL

ATTACHMENT D

Delta Water Quality Violations 2013

BUREAU OF RECLAMATION
Central Valley Operation Office
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

DEPARTMENT OF WATER RESOURCES
Division of Operations and Maintenance
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

MAY 24 2013

IN REPLY REFER TO:
CVO-100
WTR-4.10

Thomas Howard
Executive Director
State Water Resources Control Board
1001 I Street
Sacramento, California 95814

Subject: April 2013 Exceedence of Salinity Objectives at Emmaton

Dear Mr. Howard:

On April 28, 2013, the Bureau of Reclamation and the Department of Water Resources (collectively the Projects) exceeded the D-1641 salinity objective at Emmaton. Project operations staff notified State Water Resource Control Board (SWRCB) staff of the exceedence by conference call on April 29, 2013, and by e-mail notification to the SWRCB. This letter provides formal notification of the exceedence and background information relevant to the circumstances.

Background information leading to exceedence conditions:
The exceedence of the 14-day running average of 0.45 EC salinity objective at Emmaton for a Sacramento Valley Dry Year type was caused by the interaction of two conditions: low river flows on the lower Sacramento River system culminating at Freeport, and increasing tides during the period of April 21, 2013, through April 25, 2013. Tidal trends and fluctuations are conditions generally anticipated by Project operators as part of salinity objective compliance; however, the low flow conditions on the lower Sacramento River system in late April 2013 was not anticipated by Project operators and is the main factor of the exceedences that have occurred at Emmaton.

Precipitation patterns for water year 2013 have been a scenario of extremes. The months of November and December produced significant rainfall and project reservoir storage correspondingly increased without any significant flood control releases from major project reservoirs. The calendar year precipitation, however, has been dismal. The accumulation of rainfall since January 1 for the long record of the Northern Sierra 8-Station Precipitation Index is approximately 8.8 inches. Currently, this value represents the driest calendar year period in the long precipitation record--even drier than the very dry single years of 1977 and 1924. Creek and small stream flows that enter the Sacramento River system below major reservoirs are running at historically very low levels in response to this long, dry precipitation period. (Attach 8SI plot)

Historically, the initial diversion for rice cultivation and ponding has generally occurred from late April to early May, depending on farmer cultivation and preparation practices and soil moisture conditions, to allow farmers to prepare their fields. Generally, project operators have observed this diversion to rice fields occur over several weeks from late April to early May, and have monitored river conditions and increased reservoir releases as rice cultivation diversion rates increased. It now appears that in 2013, due to the very dry hydrologic conditions since the first of the year, a very large portion of rice fields were cultivated and ready to begin their initial field flooding on a simultaneous schedule during the third week of April. This diversion to rice cultivation, although expected to occur, was unanticipated by Project operators for the sheer size and magnitude of simultaneous initial diversion for rice cultivation that actually occurred valley-wide.

Project operators responded to the increasing diversion rates during this period; by increasing reservoir releases in an attempt to catch up to the lower Sacramento River flow conditions. Figures 1 and 2 illustrate the Projects' reservoir release response to flow conditions in the lower Sacramento River during this period of unprecedented diversions. The first illustration shows Keswick's releases in response to the flow pattern at the Wilkins Slough river gage location. This section of the Sacramento River Basin is controlled exclusively with Shasta/Keswick reservoir releases with an approximate lagged travel time of 2.5 days between Keswick and Wilkins Slough. The second illustration indicates the reservoir releases in response to the flow pattern at the Verona river gage location. Verona flow is influenced by reservoir releases from Keswick Reservoir as well as Oroville Reservoir's releases to the Feather River. The approximate lagged travel time from Keswick is 3.5 days and just over one day from Oroville. Both illustrations show the dramatic increases from project reservoirs in response to low flow conditions observed along the lower Sacramento River. The dramatic increase in overall depletion rates experienced over a period of about ten days was simply not anticipated by project operators and is extreme from a historical perspective. Reservoir release rates of 11,000 cfs from Keswick Reservoir and 5,250 from Oroville Reservoir are more typical of late May than late April even in a dry condition. Folsom Reservoir releases were increased from 1,000 cfs to 1,250 cfs on April 25, 2013, to also contribute to lower Sacramento River flows.

The result of this unusual condition and timing is that Freeport flows entering the Delta were very low for a period of a week to ten days. (See Operational Report). At the same time, pulse flows were entering the Delta from the San Joaquin River at Vernalis as part of the annual pulse flow management from the San Joaquin River Basin. Due to the low flow conditions at Freeport, salinity conditions in the vicinity of Collinsville and Emmaton along the extreme lower Sacramento River and western Delta increased dramatically as tidal conditions increased. (See Operational Report). Project operators responded to the changing conditions by reducing scheduled exports that were anticipated to be near a 1:1 ratio with Vernalis flow in order to maintain Delta outflow conditions necessary to meet X2 objectives at Collinsville. Without adequate flows at Freeport to repel salinity conditions in the lower Sacramento River, salinity levels near Emmaton inevitably exceeded the dry year objective of the maximum 14-day running average of mean at 0.45 salinity. Project reservoir releases stabilized Freeport flows at greater than 10,000 cfs beginning April 28, 2013, and averaged above this rate until compliance of the 14-day 0.45 EC objective at Emmaton was re-established on May 19.

Challenges facing project operations for the remainder of year:
By D-1641 criteria, water year 2013 is classified as a "Dry" year as published in the last Bulletin 120 update for May 1st hydrologic conditions. As previously mentioned, water year 2013 has been a year of extremes with generally wet conditions in November and December and retention of storage in upstream reservoirs, followed by extreme and possibly record dry precipitation conditions since January 1. This pattern of hydrologic conditions will very likely bring challenges for the remainder of this water year. Reservoir storage in Shasta and Oroville is in reasonably good shape, but will be relied upon heavily under adverse hydrologic conditions to balance the goals of Sacramento Valley diversion/depletion, Delta objectives, water supply delivery, and coldwater management. Folsom Reservoir management will be challenged by the overall availability of water and limited coldwater availability. The hydrologic conditions of 2013 and the early advent of significant depletion rates in the Sacramento Valley may indicate that historic high levels of Sacramento Valley depletions are likely during this year's irrigation season. (Projecting seasonal Sacramento Valley depletions, as compared to projecting full natural river flows in Bulletin 120, could be a difficult extrapolation from historic values, and uncertainty in depletion values is always a challenge to project operations.)

If you have any questions or would like more information regarding this notification, please contact Mr. Paul Fujitani of Reclamation at 916-979-2197 or Mr. John Leahigh at 916-574-2722.

Sincerely,

Ronald Milligan, Operations Manager
Central Valley Operations Office
U.S. Bureau of Reclamation

for D. Roose
David H. Roose, Chief
SWP Operations Control Office
Department of Water Resources

Attachment -2

cc: See next page.

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FIGURE 1

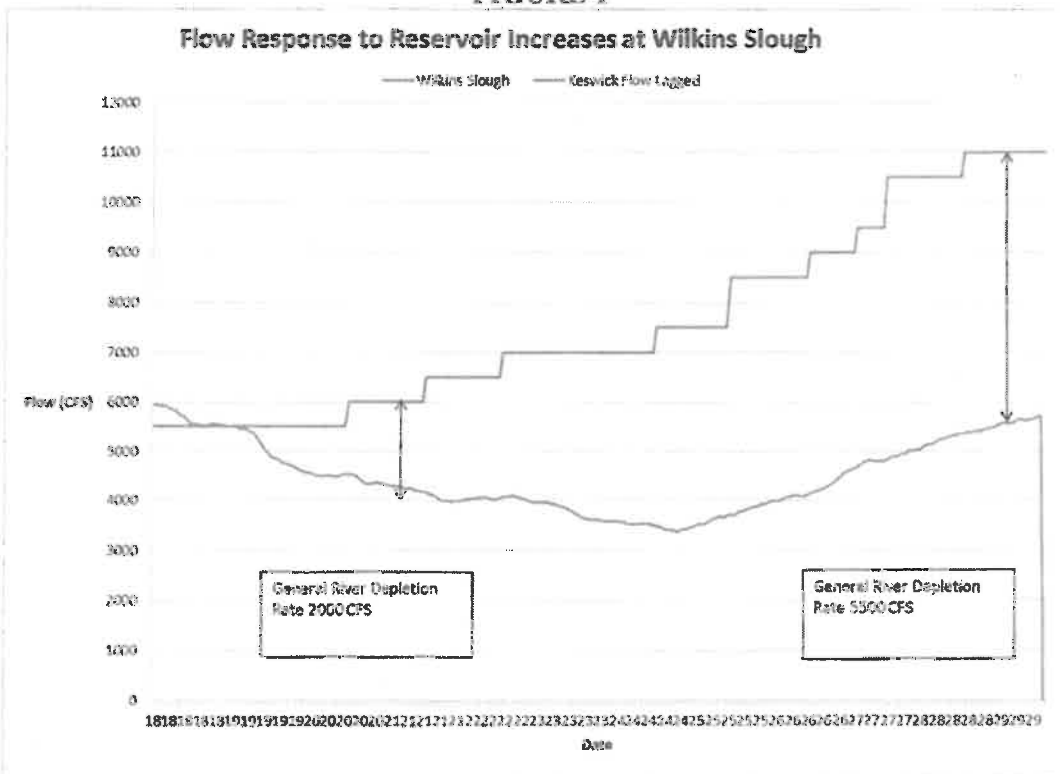
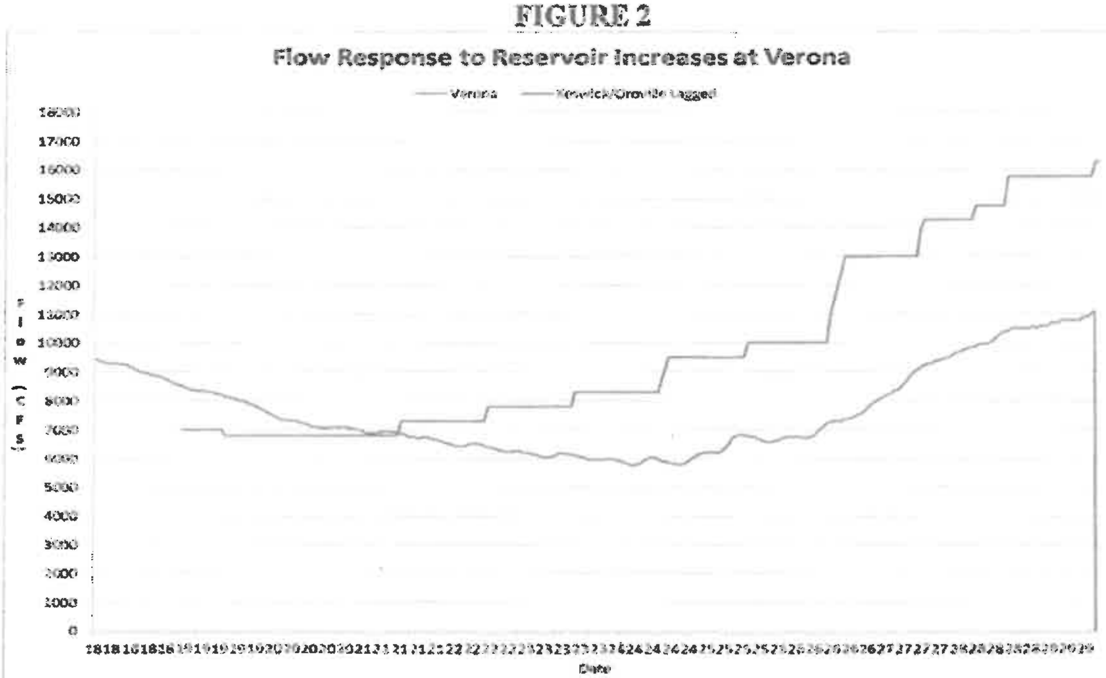
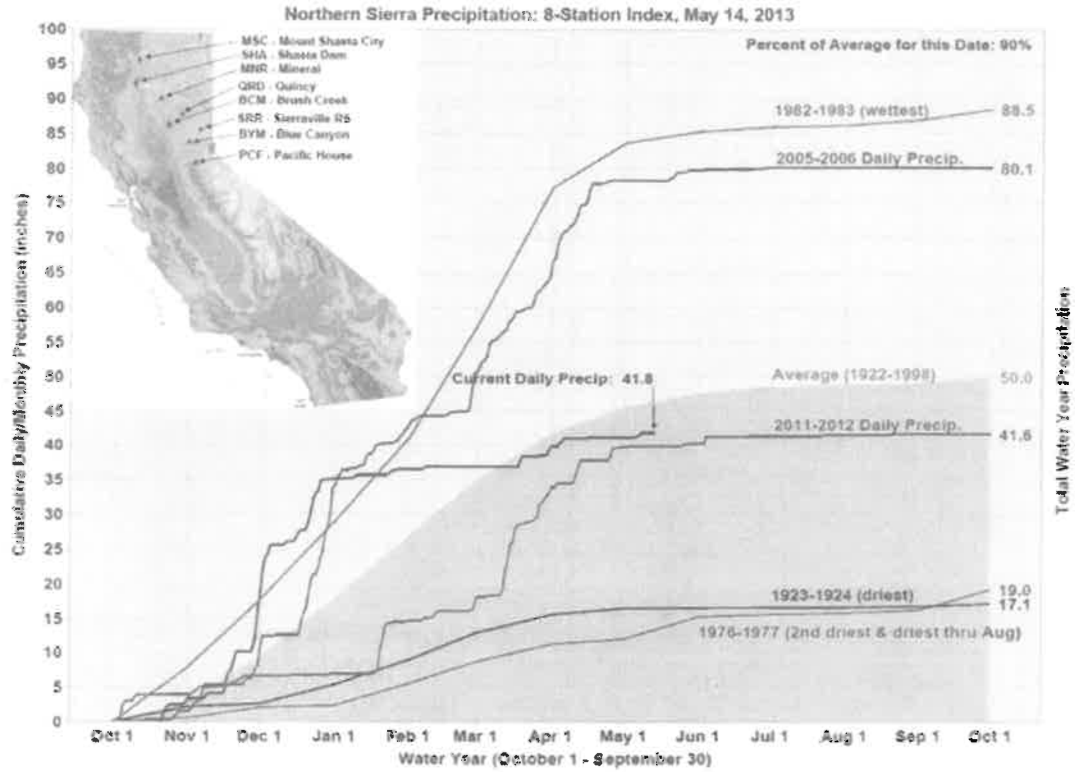


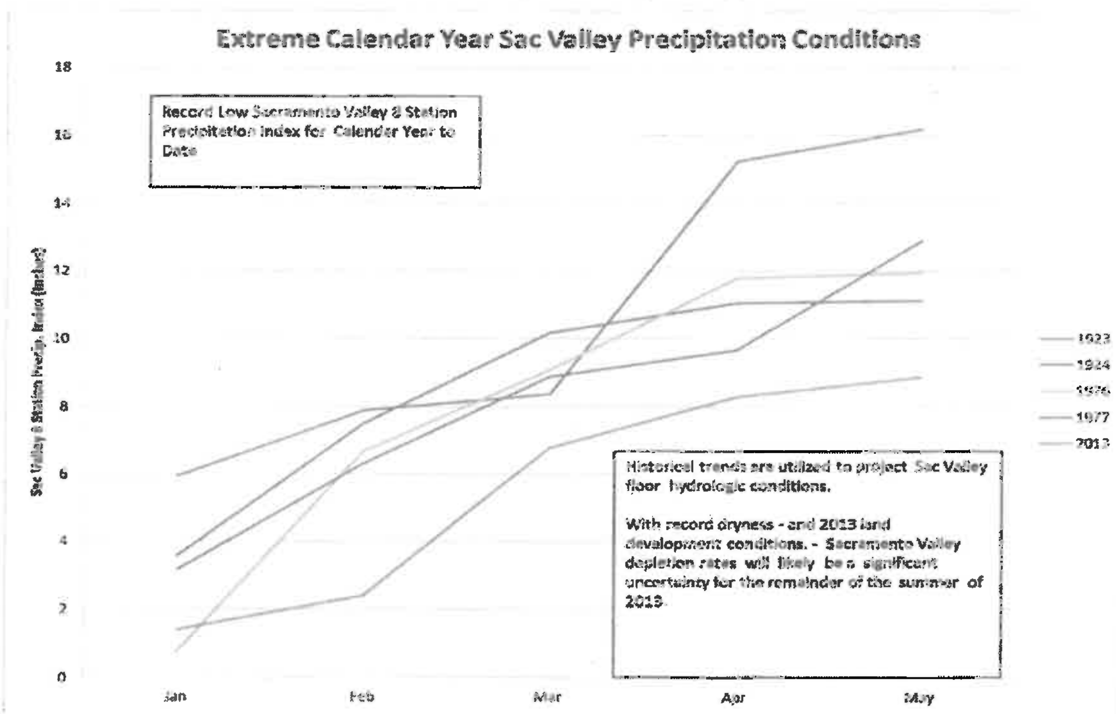
FIGURE 2



8SRI PLOT



Northern Sierra Precipitation: 8-Station Index, May 14, 2013
Percent of Average for this Date: 90%
MSC - Mount Shasta City
SHA - Shasta Dam
MNR - Mineral
QRD - Quincy
BCM - Brush Creek
SRR - Sierraville RS
BYM - Blue Canyon
PCF - Pacific House
1982-1983 (wettest)
88.5
2005-2006 Daily Precip.
80.1
Current Daily Precip: 41.8
Average (1922-1998)
50.0
2011-2012 Daily Precip.
41.6
1923-1924 (driest)
19.0
17.1
1976-1977 (2nd driest & driest thru Aug)
Cumulative Daily/Monthly Precipitation (inches)
Total Water Year Precipitation
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Water Year (October 1 - September 30)



Extreme Calendar Year Sac Valley Precipitation Conditions
Record Low Sacramento Valley 8 Station Precipitation Index for Calender Year to Date
Historical trends are utilized to project Sac Valley floor hydrologic conditions.
With record dryness - and 2013 land development conditions. - Sacramento Valley depletion rates will likely be a significant uncertainty for the remainder of the summer of 2013.
Sac Valley 8 Station Precip. Index (inches)
18
16
14
12
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
1923
1924
1976
1977
2013

Compliance Standards

for the Sacramento - San Joaquin Delta and Suisun Marsh
Sunday, May 19, 2013

Criteria	Standard	Status
Flow/Operational		
% of inflow diverted	35 %	11 %
Habitat Protection, X2 / Flow	1 days at Chipps Island	3 days
* 2days as carryover from April	31 days at Collinsville	19 days
Water Quality		
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	165 days	139 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	42 mg/l
14dm EC at Emmaton	<= 0.45 mS/cm	0.44 mS/cm
14dm EC at Jersey Point	<= 0.45 mS/cm	0.34 mS/cm
Maximum 30 day running average of mean daily EC at:		
Vernalis	<=0.7 mS/cm	0.3 mS/cm
Brandt Bridge	<= 0.7 mS/cm	0.3 mS/cm
Old River Near Tracy	<=0.7 mS/cm	0.4 mS/cm
Old River Near Middle River	<=0.7 mS/cm	mS/cm

SUISUN MARSH:

Suisun Marsh Salinity Control Gates : 1 Open / 0 Closed / 2 Full Tide Open
Flashboard Status : In
Boat Lock Status : Open

California Hydrologic Conditions: (California Cooperative Snow Surveys Forecast, May 1, 2013)

Previous Month's Index (8RI for April.): 2.023 MAF
Water Year Type: Dry
Sacramento valley water year type index (40/30/30) @ 50%:5.8 MAF (Dry)
San Joaquin valley water year type index (60/20/20) @ 75%: 1.6 MAF (Critical)

Electrical Conductivity (EC) in milliSiemens per Centimeter.
Chlorides (Cl) in milligrams per liter
mht - mean high tides
md - mean daily
14 dm - fourteen day running mean
28 dm - twenty-eight day running mean
NR - No Record
NC - Average not computed due to insufficient data.
BR : Below Rating
e - estimated value

Montezuma Slough Gate Operation:
Number of gates operating at either Open, Closed, or Full Tide Open
Flashboard Status : In, Out, or Modified In
Boat Lock Status : Open or Closed

Coordinated Operation Agreement Delta Status:
e = excess Delta conditions
b = balanced Delta cond. w/ no storage withdrawal
s = balanced Delta cond. w/ storage withdrawal
Excess Delta conditions with restrictions:
f = fish concerns
r = E/I ratio concerns

* NDOI, Rio Vista & Vernalis Flows:
- Monthly average is progressive daily mean.
- 7 day average is progressive daily mean for the first six days of the month.

Delta Water Quality Conditions

Date	Antioch Tides		Net Delta Outflow Index	Martinez	Port Chicago		Mallard	Chipps Island		Collinsville	
	High	Half	cfs	mdEC	mdEC	14dm	mdEC	mdEC	14dm	mdEC	14dm
04/20/2013	4.93	3.50	8,211	18.80	11.88	7.15	4.52	3.99	1.64	1.65	0.55
04/21/2013	5.12	3.57	7,471	21.29	13.71	7.53	6.22	5.68	1.90	2.35	0.66
04/22/2013	5.33	3.66	7,059	22.73	15.38	8.08	6.75	6.22	2.20	3.03	0.85
04/23/2013	5.73	3.88	6,849	24.39	15.62	8.80	7.88	7.37	2.65	4.18	1.12
04/24/2013	6.07	4.19	6,605	25.78	18.18	9.65	9.64	9.43	3.23	5.31	1.47
04/25/2013	6.47	4.25	7,038	26.40	18.77	10.49	10.63	10.27	3.86	6.13	1.88
04/26/2013	6.32	4.08	7,896	25.52	17.32	11.21	9.19	8.74	4.38	5.33	2.22
04/27/2013	6.31	4.02	9,030	24.92	16.30	11.84	8.76	8.29	4.86	4.95	2.54
04/28/2013	6.36	4.08	10,396	24.58	15.35	12.44	8.30	7.81	5.31	4.66	2.84
04/29/2013	6.40	4.24	10,578	24.44	14.82	12.96	8.21	7.72	5.75	4.38	3.11
04/30/2013	6.24	4.15	10,798	23.98	13.59	13.56	7.92	7.42	6.21	4.37	3.40
05/01/2013	5.84	3.99	11,146	22.44	11.37	14.10	6.67	6.13	6.60	3.97	3.66
05/02/2013	5.30	3.75	11,614	21.84	12.15	14.52	6.15	5.61	6.93	2.99	3.85
05/03/2013	5.51	3.32	10,635	21.60	12.21	14.73	6.64	6.10	7.20	3.02	4.02
05/04/2013	6.13	4.17	9,908	22.78	12.34	14.84	7.67	7.16	7.42	3.97	4.19
05/05/2013	6.32	4.48	9,485	25.15	12.95	14.79	9.37	8.93	7.66	5.28	4.40
05/06/2013	6.15	4.19	9,388	24.14	11.38	14.50	8.18	7.69	7.76	4.51	4.50
05/07/2013	6.06	4.10	9,350	23.80	11.10	14.17	8.04	7.54	7.77	4.44	4.52
05/08/2013	6.01	4.07	9,129	24.07	10.98	13.65	8.21	7.71	7.65	4.37	4.46
05/09/2013	6.05	4.08	9,695	23.57	9.40	12.98	7.95	7.45	7.45	4.07	4.31
05/10/2013	6.06	4.08	10,994	22.85	8.69	12.37	7.50	6.98	7.32	3.91	4.21
05/11/2013	6.04	4.03	11,743	21.76	7.75	11.76	6.63	6.09	7.17	3.39	4.10
05/12/2013	5.98	4.06	11,861	20.78	7.95	11.23	6.40	5.87	7.03	3.28	4.00
05/13/2013	5.94	4.12	11,402	21.10	7.48	10.70	6.19	5.65	6.88	3.12	3.91
05/14/2013	5.80	4.16	11,153	21.37	6.97	10.23	6.22	5.68	6.76	2.89	3.80
05/15/2013	5.72	4.15	10,114	21.13	5.60	9.82	6.14	5.60	6.72	2.74	3.71
05/16/2013	5.26	4.02	9,550	21.54	2.97	9.16	5.75	5.21	6.69	2.87	3.70
05/17/2013	5.18	3.95	8,987	21.04	2.33	8.46	5.39	4.85	6.60	1.99	3.63
05/18/2013	5.07	3.63	9,399	18.61	2.09	7.69	4.55	4.02	6.38	1.69	3.47
05/19/2013	5.27	3.48	9,727	18.03	1.99	6.91	4.14	3.62	6.00	1.52	3.20

Antioch Tides measured in feet above mean sea level.
Net Delta Ouflow Index calculated from equation as specified in D-1641, revised June 1995.
Chipps Island EC calculated from measurements recorded at Mallard Slough.
Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
14dm : fourteen day running mean
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e - estimated value

Delta Water Quality Conditions

Date	Antioch		Jersey Point		Emmaton		Cache Slough	Good Year Slough	Sunrise Club	Volanti Slough	Beldon Landing	Collinsville
	mdEC	14mdEC	mdEC	14mdEC	mdEC	14mdEC	mdEC	mhtEC	mhtEC	mhtEC	mhtEC	mhtEC
04/20/2013	0.39	0.42	0.23	0.25	0.20	0.20	0.39	5.83	5.06	5.62	5.55	2.04
04/21/2013	0.61	0.42	0.24	0.25	0.22	0.20	0.40	5.92	5.40	6.19	5.60	3.56
04/22/2013	0.87	0.44	0.24	0.25	0.25	0.20	0.42	6.13	5.97	6.77	5.93	4.39
04/23/2013	1.16	0.49	0.25	0.25	0.29	0.21	0.42	6.94	7.31	8.39	7.40	5.37
04/24/2013	1.93	0.60	0.30	0.25	0.71	0.25	0.42	8.71	8.59	10.03	9.00	6.92
04/25/2013	2.36	0.74	0.36	0.26	1.28	0.32	0.43	9.73	8.79	10.32	9.24	7.42
04/26/2013	1.91	0.85	0.33	0.26	1.06	0.39	0.43	10.74	9.36	10.77	9.23	6.54
04/27/2013	1.87	0.95	0.34	0.27	1.00	0.44	0.42	11.60	9.71	11.16	9.59	5.86
04/28/2013	1.93	1.06	0.35	0.27	0.89	0.49	0.43	11.74	9.83	10.73	10.02	5.61
04/29/2013	2.04	1.17	0.36	0.28	0.75	0.53	0.45	11.84	10.00	11.33	10.34	5.73
04/30/2013	1.90	1.28	0.37	0.29	0.64	0.56	0.46	11.91	9.92	11.63	10.50	5.40
05/01/2013	1.33	1.35	0.35	0.30	0.35	0.57	0.51	11.90	9.76	11.44	10.86	4.69
05/02/2013	1.28	1.42	0.32	0.31	0.35	0.58	0.46	11.85	9.95	11.16	10.66	3.85
05/03/2013	1.29	1.49	0.33	0.31	0.38	0.60	0.46	11.87	9.85	11.30	9.99	4.36
05/04/2013	1.55	1.57	0.36	0.32	0.44	0.61	0.48	11.74	10.13	10.74	9.79	5.88
05/05/2013	2.21	1.69	0.44	0.34	0.76	0.65	0.42	11.59	9.35	10.94	9.73	6.92
05/06/2013	1.87	1.76	0.39	0.35	0.67	0.68	0.42	11.57	9.68	10.53	8.64	5.54
05/07/2013	1.71	1.80	0.37	0.36	0.62	0.71	0.43	11.61	9.25	9.83	7.57	5.72
05/08/2013	1.66	1.78	0.36	0.36	0.63	0.70	0.45	11.64	8.67	9.42	7.11	5.77
05/09/2013	1.63	1.73	0.36	0.36	0.61	0.65	0.48	11.79	8.13	9.21	6.63	5.27
05/10/2013	1.48	1.70	0.35	0.36	0.57	0.62	0.50	11.99	7.76	8.60	6.49	5.24
05/11/2013	1.32	1.65	0.34	0.36	0.46	0.58	0.48	12.11	7.49	8.22	6.05	4.24
05/12/2013	1.32	1.61	0.34	0.36	0.41	0.54	0.45	11.82	7.10	7.63	5.50	4.49
05/13/2013	1.18	1.55	0.34	0.36	0.37	0.52	0.45	11.36	6.59	7.07	4.94	3.93
05/14/2013	1.12	1.50	0.34	0.36	0.34	0.50	0.43	11.33	6.13	6.45	4.24	4.30
05/15/2013	1.11	1.48	0.33	0.35	0.37	0.50	0.42	11.16	5.72	5.97	3.88	3.56
05/16/2013	1.03	1.46	0.32	0.35	0.32	0.50	0.40	10.60	5.18	5.67	3.68	
05/17/2013	0.91	1.44	0.31	0.35	0.29	0.49	NR	10.25	5.10	5.62	3.53	3.14
05/18/2013	0.74	1.38	0.30	0.35	0.25	0.48	NR	10.12	5.04	5.56	3.31	2.43
05/19/2013	0.70	1.27	0.29	0.34	0.23	0.44	NR	9.95	4.98	5.51	2.97	2.33

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
mht : mean high tides
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Water Quality Conditions

Date	Bethel Island mdEC	Farrar Park mdEC	Holland Tract mdEC	Bacon Island mdEC	Contra Costa mdEC	Clifton Court mdEC	Tracy Pumping Plant mdEC	Antioch mdCl	Bacon Island mdCl	Contra Costa mdCl	Delta Status
04/20/2013	0.25	0.29	0.28	0.27	0.34	0.57	0.75	54	33	37	f
04/21/2013	0.25	0.29	0.25	0.27	0.32	0.51	0.68	124	32	36	f
04/22/2013	0.24	0.29	0.25	0.27	0.33	0.46	0.60	206	32	37	f
04/23/2013	0.24	0.29	0.25	0.27	0.33	0.43	0.50	298	31	37	f
04/24/2013	0.25	0.28	0.25	0.27	0.32	0.40	0.49	545	31	37	f
04/25/2013	0.26	0.27	0.25	0.26	0.32	0.38	0.42	683	31	36	s
04/26/2013	0.26	0.29	0.26	0.27	0.31	0.35	0.43	537	32	36	s
04/27/2013	0.25	0.29	0.26	0.26	0.32	0.32	0.40	524	34	36	s
04/28/2013	0.26	0.29	0.26	0.28	0.32	0.32	0.35	544	35	36	s
04/29/2013	0.26	0.30	0.26	0.28	0.29	0.31	0.32	581	35	36	s
04/30/2013	0.26	0.30	0.26	0.28	0.31	0.34	0.33	535	34	36	s
05/01/2013	0.27	0.29	0.26	0.27	0.30	0.32	0.33	352	32	36	s
05/02/2013	0.28	0.29	0.21	0.27	0.31	0.33	0.32	337	32	34	s
05/03/2013	0.28	0.29	0.23	0.27	0.31	0.33	0.31	341	32	35	s
05/04/2013	0.28	0.30	0.27	0.27	0.30	0.32	0.31	424	32	35 e	s
05/05/2013	0.29	0.31	0.28	0.28	0.29	0.30	0.28	635	34	35 e	s
05/06/2013	0.29	0.31	0.28	0.28	0.29	0.25	0.28	525	35	33	s
05/07/2013	0.29	0.32	0.28	0.29	0.29	0.24	NR	475	37	33	s
05/08/2013	0.30	0.33	0.29	0.29	0.28	0.24	NR	458	38	33	s
05/09/2013	0.30	0.33	0.29	0.30	0.30	0.25	NR	448	40	34	s
05/10/2013	0.31	0.34	0.30	0.30	0.30	0.26	NR	400	41	35	s
05/11/2013	0.31	0.33	0.30	0.31	0.29	0.28	NR	351	42	35 e	s
05/12/2013	0.31	0.34	0.30	0.31	0.31	0.29	NR	351	43	36 e	s
05/13/2013	0.31	0.33	0.31	0.32	0.32	0.31	NR	307	44	37	s
05/14/2013	0.31	0.33	0.31	0.32	0.32	0.30	NR	288	45	39	s
05/15/2013	0.31	0.34	0.31	0.32	0.32	0.32	NR	283	45	36	s
05/16/2013	0.31	0.34	0.31	0.32	NR	0.34	NR	257	45	40	s
05/17/2013	0.31	0.34	0.31	0.32	NR	0.35	NR	220	46	42	s
05/18/2013	0.31	0.34	0.31	0.33	NR	0.36	NR	166	47	42 e	s
05/19/2013	0.31	0.34	0.31	0.33	NR	0.39	NR	151	47	42 e	s

Electrical Conductivity (EC) units: milliSiemens per Centimeter
Chloride (Cl) units: milligrams per liter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value
Antioch and Bacon Island mdCl are calculated from the respective mdEC values.

Coordinated Operation Agreement Delta Status:
- c = excess Delta conditions
- b = balanced Delta cond. w/ no storage withdrawal
- s = balanced Delta cond. w/ storage withdrawal
- Excess Delta conditions with restrictions:
  - f = fish concerns
  - r = E/I ratio concerns

Delta Water Quality Conditions

South Delta Stations

Date	Vernalis		Brandt Bridge		Old River Near Tracy		Old River Near Middle River	
	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg	md EC	30 day avg
04/20/2013	0.39	0.79	0.52	0.88	0.90	1.10	0.40	0.87
04/21/2013	0.30	0.77	0.41	0.86	0.76	1.09	0.43	0.85
04/22/2013	0.30	0.75	0.42	0.84	0.64	1.08	0.33	0.84
04/23/2013	0.27	0.72	0.32	0.82	0.62	1.07	0.31	0.81
04/24/2013	0.25	0.70	0.30	0.80	0.47	1.05	0.26	0.79
04/25/2013	0.24	0.68	0.24	0.78	0.41	1.02	0.22	0.77
04/26/2013	0.24	0.65	0.22	0.76	0.34	1.00	0.21	0.74
04/27/2013	0.23	0.62	0.21	0.73	0.38	0.97	0.21	0.72
04/28/2013	0.23	0.60	0.21	0.71	0.38	0.94	0.21	0.69
04/29/2013	0.22	0.58	0.21	0.68	0.37	0.91	0.20	0.66
04/30/2013	0.22	0.56	0.20	0.66	0.35	0.88	0.20	0.64
05/01/2013	0.21	0.54	0.20	0.64	0.32	0.85	0.20	0.61
05/02/2013	0.21	0.52	0.20	0.61	0.36	0.82	0.19	0.59
05/03/2013	0.20	0.50	0.20	0.59	0.36	0.80	0.20	0.57
05/04/2013	0.19	0.47	0.19	0.57	0.31	0.77	0.18	0.55
05/05/2013	0.18	0.45	0.18	0.55	0.27	0.74	0.17	0.52
05/06/2013	0.19	0.43	0.17	0.52	0.25	0.72	0.17	0.50
05/07/2013	0.20	0.41	0.18	0.50	0.28	0.69	0.18	0.48
05/08/2013	0.20	0.39	0.20	0.48	0.31	0.67	0.20	0.45
05/09/2013	0.22	0.37	0.20	0.45	0.30	0.64	0.21	0.43
05/10/2013	0.22	0.35	0.22	0.43	0.29	0.62	NR	NC
05/11/2013	0.21	0.33	0.23	0.41	0.29	0.59	NR	NC
05/12/2013	0.21	0.31	0.22	0.38	0.29	0.56	NR	NC
05/13/2013	0.22	0.29	0.22	0.36	0.30	0.53	0.23	NC
05/14/2013	0.26	0.28	0.24	0.34	0.30	0.50	0.25	NC
05/15/2013	0.33	0.27	0.27	0.32	0.31	0.48	0.29	NC
05/16/2013	0.38	0.26	0.32	0.30	0.36	0.45	0.37	NC
05/17/2013	0.40	0.26	0.37	0.28	0.43	0.43	0.44	NC
05/18/2013	0.44	0.26	0.44	0.27	0.47	0.42	0.47	NC
05/19/2013	0.48	0.26	0.47	0.27	0.54	0.40	0.51	NC

Electrical Conductivity (EC) units: milliSiemens per Centimeter
md : mean daily
NR : No Record
NC : Average not computed due to insufficient data
BR : Below Rating
e : estimated value

Delta Hydrology Conditions

Date	Sacramento River at Freeport + SRWTP cfs	Yolo Bypass cfs	East Side Streams cfs	San Joaquin River at Vernalis cfs	Rainfall inches	Clifton Court Forebay Intake cfs	Tracy Pumping Plant cfs	CCWD Pumping Plants cfs	Barker Slough Pumping Plant cfs	BBID Diversion cfs
4/20/2013	8,441	395	591	2,334	0.00	1,193	807	25	56	0
4/21/2013	7,858	398	548	2,545	0.00	1,494	810	25	62	0
4/22/2013	7,645 e	410	519	2,678	0.00	1,694	810	25	62	200
4/23/2013	7,194	439	529	2,935	0.00	1,690	813	25	48	73
4/24/2013	6,360	496	559	3,414	0.00	1,695	821	26	72	72
4/25/2013	7,006	530	570	3,582	0.00	998	817	25	70	67
4/26/2013	8,078	529	542	3,675	0.00	991	815	25	65	53
4/27/2013	9,423	585	502	3,765	0.00	995	814	24	78	66
4/28/2013	10,870	564	509	3,893	0.00	963	815	24	77	0
4/29/2013	11,478	602	512	4,130	0.00	2,421	815	26	83	66
4/30/2013	12,147	616	500	4,064	0.00	2,998	817	27	83	0
5/1/2013	12,415	623	479	3,954	0.00	3,193	814	152	88	66
5/2/2013	11,495	629	463	3,952	0.00	494	3,155	176	94	63
5/3/2013	10,056	623	466	4,043	0.00	494	3,082	226	117	67
5/4/2013	9,028	660	478	4,176	0.00	1,492	1,353	240	96	0
5/5/2013	8,414	665	456	4,105	0.00	1,490	937	245	84	0
5/6/2013	8,445	648	445	3,970	0.00	993	982	245	91	159
5/7/2013	8,390	616	456	3,838	0.00	793	980	243	84	91
5/8/2013	9,212	557	479	3,689	0.00	792	979	243	84	77
5/9/2013	10,884	510	484	3,581	0.00	793	978	257	84	70
5/10/2013	11,824	486	468	3,549	0.00	999	978	261	98	72
5/11/2013	12,068	450	478	3,509	0.00	993	983	258	101	0
5/12/2013	11,480	446	479	3,439	0.00	993	982	260	109	0
5/13/2013	11,425	500	451	3,376	0.00	993	980	266	110	206
5/14/2013	10,836	553	416	2,828	0.00	993	980	252	99	76
5/15/2013	10,928	603	400	2,090	0.00	992	979	236	97	86
5/16/2013	10,499	579	410	1,678	0.00	993	863	207	92	84
5/17/2013	11,073	605	445	1,521	0.00	688	811	190	103	65
5/18/2013	11,534	643	439	1,423	0.00	689	808	185	112	0
5/19/2013	11,854	618	418	1,309	0.00	699	808	202	103	0

SRWTP : Sacramento Regional Water Treatment Plant effluent.
Yolo Bypass : combined measurements of Cache Creek at Rumsey and Freemont Weir.
East Side Streams : combined stream flows of Cosumnes River at Michigan Bar, Mokelumne River at Woodbridge, miscellaneous streams estimated from Dry Creek at Galt (discontinued since Dec. 1997), and Calaveras River based on releases from New Hogan Dam.
Rainfall : incremental daily precipitation measured at Stockton Fire Station #4.
CCWD Pumpling Piants : combined pumping at the Old River, Rock Slough and Middle River Plants.

Delta Hydrology Conditions

Date	Banks Pumping Plant cfs	Delta Gross Channel Depletions cfs	Rio Vista Flow cfs	QWEST cfs	Net Delta Outflow Index cfs	Percent of Inflow Diverted 3 day	Percent of Inflow Diverted 14 day	Delta Status
4/20/2013	1,161	1,900	7,029	1,372	8,211	13.3%	10.4%	f
4/21/2013	1,504	1,900	6,352	1,313	7,471	16.4%	12.6%	f
4/22/2013	1,504	1,900	5,850	1,404	7,059	18.7%	14.2%	f
4/23/2013	1,779	1,900	5,677	1,353	6,849	20.5%	15.7%	f
4/24/2013	1,504	1,950	5,301	1,512	6,605	21.3%	16.7%	f
4/25/2013	810	1,950	4,635	2,609	7,038	20.0%	16.0%	s
4/26/2013	895	1,950	5,229	2,868	7,898	17.7%	14.8%	s
4/27/2013	587	1,950	6,158	3,087	9,030	14.8%	13.4%	s
4/28/2013	985	2,000	7,366	3,247	10,396	13.6%	13.7%	s
4/29/2013	1,684	2,000	8,619	2,181	10,578	15.6%	17.3%	s
4/30/2013	2,348	2,000	9,164	1,856	10,798	18.7%	22.5%	s
5/1/2013	3,279	2,000	9,758	1,616	11,146	21.9%	27.7%	s
5/2/2013	1,123	2,000	9,998	1,850	11,614	22.0%	28.2%	s
5/3/2013	1,034	2,050	9,192	1,704	10,635	21.5%	26.9%	s
5/4/2013	1,654	2,100	7,925	2,226	9,908	20.2%	23.9%	s
5/5/2013	2,095	2,100	7,070	2,646	9,485	19.1%	20.8%	s
5/6/2013	596	2,100	6,543	3,083	9,388	16.4%	16.6%	s
5/7/2013	0	2,150	6,539	3,045	9,350	14.3%	13.7%	s
5/8/2013	0	2,150	6,459	2,905	9,129	12.8%	11.9%	s
5/9/2013	138	2,200	7,099	2,835	9,695	12.5%	11.5%	s
5/10/2013	1,101	2,200	8,501	2,745	10,994	12.4%	11.8%	s
5/11/2013	1,101	2,250	9,278	2,723	11,743	12.2%	12.2%	s
5/12/2013	1,101	2,300	9,440	2,691	11,861	12.1%	12.6%	s
5/13/2013	1,101	2,300	8,928	2,746	11,402	11.7%	12.3%	s
5/14/2013	1,015	2,350	8,918	2,498	11,153	11.7%	12.2%	s
5/15/2013	1,101	2,350	8,504	1,872	10,114	12.0%	12.2%	s
5/16/2013	930	2,400	8,577	1,233	9,550	12.5%	12.4%	s
5/17/2013	732	2,450	8,167	1,095	8,987	12.2%	11.6%	s
5/18/2013	732	2,450	8,690	992	9,399	11.5%	10.8%	s
5/19/2013	732	2,500	9,114	892	9,727	10.9%	10.2%	s

Delta Gross Channel Depletions from Dayflow Table 3.
Rio Vista Flow calculated from Dayflow equation.
QWEST calculated from Dayflow equation.
Net Delta Outflow Index calculated from equation as specified in D-1641, revised June 1995.

Coordinated Operation Agreement Delta Status:
- c = excess Delta conditions
- b = balanced Delta cond. w/ no storage withdrawal
- s = balanced Delta cond. w/ storage withdrawal
- Excess Delta conditions with restrictions:
  - f = fish concerns
  - r = E/I ratio concerns

EXHIBIT B

From: Grober, Les@Waterboards [Les.Grober@waterboards.ca.gov]
Sent: Wednesday, May 29, 2013 8:40 AM
To: ngmplcs@pacbell.net
Subject: FW: USBR and DWR request re delta standards

Attachments: Milligan,R. -2013-05_SWRCB Water Right Decision 1641 Water Year Classification.pdf; CDFW concurrence with proposed changes to Delta WQ standards requested by DWR and Reclamation; NMFS support for change petition to D-1641; FWS concurrence with proposed changes to Delta WQ standards, as requested by Reclamation and DWR; RE: NMFS support for change petition to D-1641

Milligan,R. CDFW NMFS support FWS RE: NMFS
3-05_SWRCB Wrence with propr change petiti.ence with propoort for change

Dante,

Here is the email I sent Melinda yesterday. The last attachment is the email response from Tom.

Les

From: Grober, Les@Waterboards
Sent: Tuesday, May 28, 2013 4:35 PM
To: 'Melinda Terry (melinda@northdw.com)'
Cc: Riddle, Diane@Waterboards
Subject: USBR and DWR request re delta standards

Melinda,

It was nice chatting with you. As we discussed, attached are the following emails/letters: the USBR/DWR request, emails from three fishery agencies, and Tom Howard's 5/24 response to the emails we had received at that point from NMFS and CDFW, as we had not yet gotten a request from USBR/DWR.

I'll send you a copy of the follow-up letter from Craig Wilson, the Delta Watermaster, tomorrow.

Please call or email if you have questions.

Les

Leslie F. Grober, Assistant Deputy Director Hearings and Special Programs Branch Division of Water Rights State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

Telephone: (916) 341-5428
Fax: (916) 341-5400
E-mail: lgrober@waterboards.ca.gov<mailto:lgrober@waterboards.ca.gov>

BUREAU OF RECLAMATION
Central Valley Operation Office
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

DEPARTMENT OF WATER RESOURCES
Division of Operations and Maintenance
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

IN REPLY REFER TO:
CVO-100
WTR-4.10

MAY 24 2013

Thomas Howard
Executive Director
State Water Resources Control Board
1001 I Street
Sacramento, California 95814

Subject: State Water Resources Control Board Water Right Decision 1641 Water Year Classification

Dear Mr. Howard:

The Department of Water Resources (DWR) and the United States Bureau of Reclamation (Reclamation) request that the State Water Resources Control Board (SWRCB) acknowledge that the water year classification for the Sacramento Valley based on the equation provided in Attachment 1, page 188 of Revised Water Rights Decision 1641 (D-1641) does not accurately reflect the unprecedented dry conditions experienced in 2013. Instead, the hydrologic conditions experienced between January and the present are characteristic of a "Critical" water year type. The current miscategorization in water year classification is projected to affect the storage of cold water pool for fisheries purposes due to controlling D-1641 Delta objectives in the May through August period. These objectives are:

1) EC parameters for Sacramento River at Emmaton (Interagency Station Number D-22), San Joaquin River at Jersey Point (Interagency Station Number D-15), South Fork Mokelumne River at Terminous (Interagency Station Number C-13), and San Joaquin River at San Andreas (interagency Station Number C-4) as defined in Table 2 on page 182
2) Delta Outflow, as defined on Table 3 on Page 184.

Water year classification also affects other objectives listed in D-1641 to a lesser degree, but it is not anticipated that those objectives will significantly control Delta operations in 2013.

<u>Summary of Relevant Facts:</u>
D-1641 imposes water quality objectives on the Central Valley Project (CVP) and State Water Project (SWP). Several of the objectives are dependent on the water year type as determined by the May 1, Sacramento Valley Index and the San Joaquin Valley Index. Although the January through April period during 2013 was the driest on record, the November and December precipitation was sufficient to result in a Sacramento Valley classification of "Dry" for water year 2013. The "Dry" water year classification is not representative of the extreme hydrological conditions in Northern California this calendar year and the water quality objectives based on this water year type could result in significant adverse impacts to the cold water pool operations at Shasta Reservoir. In fact, Governor Brown's recent executive order B-21-13 recognizes that, "much of California experienced record dry conditions in January through March 2013, registering historic lows on the Northern Sierra" and "record dry and warm conditions resulted in a snowpack substantially below average, with estimated May water content in the statewide snowpack being only 17 percent of average."

The 2013 water year has been particularly challenging with double the normal precipitation in November and December and historically low values from January into May. The current Northern Sierra 8 Station Precipitation Index from January 1, 2013 through May 15 is about 8.8 inches. Without additional measurable precipitation in May, this figure will represent the driest Northern Sierra 8-Station Precipitation Index for the January through May period on record. Attachment 1 shows the accumulated 8-station precipitation values from January through May for some of the extremely dry years including 1924, 1976, and 1977. The nearly 80 percent of this year's precipitation occurred in the first three months of the water year. and an abnormally large portion of this fell as rain rather than snow as a result of warmer than normal conditions for that time of year. This combined with critically dry conditions in the months since the first of the year has resulted in minimal snow pack in the Sierra Nevada in the critical spring months. The Northern Sierra snowpack was only about 48% of the historical April 1 value and about 17% of normal as of May 1, 2013. Creek and small stream flows that enter the Sacramento River system below major reservoirs are running at historically low levels in response to the extended dry period. DWR's May 1, 2013 Bulletin 120 forecasts an April to July runoff 48% of normal for the Sacramento Valley. Hydrological conditions are not likely to improve and the National Oceanic and Atmospheric Administration has indicated that California is in severe to extreme drought that is likely to persist or intensify into the summer (Attachment 2).

Additionally, unusually high depletions in the Sacramento Valley are adding to the operational challenges the CVP and SWP (collectively, Projects) are facing in meeting the 2013 water year type requirements. Typically, extremely dry years with low Northern Sierra 8-Station Precipitation Index values trigger the Shasta inflow shortage criteria included in water rights settlement contracts that would reduce water supplies for the senior water rights diverters in the Sacramento Valley. Yet, this year the wetter conditions in the fall months were sufficient to require full allocations to the Sacramento Valley and Feather River settlement contractors, increasing demands on Shasta and Oroville storage. Therefore, it is expected that depletions will continue to run at a high rate into the summer. DWR and Reclamation are required to make releases in order to satisfy the senior water rights of the Sacramento River and Feather River settlement contractors, and the Exchange Contractors. These contracts specify the amount of water the Projects must deliver – for the Sacramento River and Exchange Contractors, Reclamation is required to deliver 100% of the contract total in any year where the forecasted inflow to Shasta Reservoir exceeds 3.2 million acre feet (af). This target was met in 2013 – thus Reclamation is mandated to deliver 100% of the contract total, and has no discretion under the contract to reduce these deliveries.

The unusually high stream depletions (Attachment 3) were a major cause of the exceedence of the Emmaton objective that occurred in April and May. This is described in further detail in DWR and Reclamation's letter to SWRCB dated May 24, 2013. The CVP and SWP reservoir systems were in a near normal condition in January, but Reclamation and DWR have drawn heavily on the storage since then due to the extended dry period, low unregulated flow entering the system, and high depletions in the Central Valley. Reservoir releases are currently well above average for this date.

In order to meet the Dry year water quality objectives rather than the Critical objectives, DWR and Reclamation have released significant volumes of water from Oroville, Shasta, and Folsom Reservoirs. The low reservoir inflow and increased storage withdrawal is depleting the cold water pool in the reservoirs that is important to provide adequate instream fishery habitat for anadromous fish in the rivers through the summer and fall.

SWRCB Water Rights Order 90-05 requires that Reclamation operate Shasta Reservoir to meet a daily average temperature of 56 degrees Fahrenheit in the Sacramento River at a location and through periods when higher temperatures will be detrimental to the fishery. Typically, through coordination with the Sacramento River Temperature Task Group (SRTTG), the location selected is between Balls Ferry and Bend Bridge on the Sacramento River. Without recognition of the Sacramento Valley water year type actually experienced in 2013, the projected low reservoir storage and limited cold water pool this year may result in the objective occurring well upstream of Balls Ferry and Reclamation is concerned whether the 56 degree objective can be maintained at any location in the Sacramento River through the fall. The cold water pool is vital to providing adequate habitat to salmon present in the Sacramento River through the summer and into the fall for both the winter-run Chinook salmon and fall-run Chinook salmon. The SRTTG has recommended an initial temperature compliance point of Airport Road located upstream of Balls Ferry due to the limited cold water resources this year.

Due to the unprecedented hydrologic conditions discussed above including the record dry January through May period, extremely low snowpack, and unusually high Sacramento valley depletions, conditions continue to deteriorate and it is clear that meeting the dry year objectives could jeopardize the ability to meet other fisheries objectives later in the year. The reservoir storage that accumulated in the wet fall, which was originally projected to be sufficient to meet the dry year objectives, is falling rapidly due to the abnormally large valley demands and

Reclamation is projecting CVP September carryover storages only about 63% of average.

There is a significant difference between the volume of Delta inflow needed to achieve the Dry and Critical water quality objectives for Jersey Point and Emmation through June 15. If Reclamation and DWR are able to begin operating to the Critical year water quality objectives in May it may be possible to achieve 100,000 to 200,000 af, of cold water benefits in the upstream reservoirs. This savings in cold water storage would improve the chances of meeting the temperature objective at Airport Road. This cold water benefit will help avoid temperature related fish losses in the Sacramento River.

The greatest benefits to the Project's reservoir storage would occur in the May to August 15 period. The compliance locations in the Western Delta and Interior Delta shown in Table 3 on Page 182 (Sacramento River at Emmaton (Interagency Station Number D-22), San Joaquin River at Jersey Point (Interagency Station Number D-15), South Fork Mokelumne River at Terminous (Interagency Station Number C-13), and San Joaquin River at San Andreas Landing (Interagency Station Number C-4) would most likely be the objectives controlling the Project operations during the May to June 15 period and changes at these locations would have the greatest impact on improving upstream storage in the immediate future. The objectives of the Delta outflow compliance location in Table 3 on page 184 often can control Project operations through the summer and operating to a critical year with respect to Delta outflow will also assist in preserving cold water pool.

Currently, DWR and Reclamation are maintaining a Net Delta Outflow well over 9,000 cubic feet per second (cfs) in order to achieve the Dry year objectives for Jersey Point and Emmaton. If the Dry classification is changed to Critical, the controlling D-1641 objective through June would be the Net Delta Outflow Index of at least 7,100 cfs in Table 3, or the export to inflow ratio of 35% in Table 3. From July through August 15, the controlling criteria for either water year classification would most likely shift among the minimum Net Delta Outflow objectives in Table 3, the salinity objectives for Jersey Point and Emmaton in Table 2, the Export to Inflow ratio of 65% in Table 3, or the Contra Costa 250 chloride objective in Table 1.

Table 2 of D-1641 requires an electrical conductivity (EC) no greater than 0.45 mmhos/cm for both Emmaton and Jersey point locations from April 1 to June 15, and 1.67 mmhos/cm for Emmaton and 1.35 mmhos/cm for Jersey Point from June 15 to August 15 under a Dry Year classification. For a Critical year these objectives are 2.78 mmhos/cm from April 1 to August 15 for Jersey Point and Emmaton. Since the X2 outflow objective of 7,100 cfs, which is not linked to the year type designation would probably control in May, and June, there would only be a gradual increase in salinity at Jersey Point and Emmaton through June that is reflective of a Critical year. Water quality at Jersey Point and Emmaton would fluctuate with the tidal and meteorological conditions potentially moving towards a 1.0 to 2.0 mmhos/cm EC range in July. Compliance with the water quality objectives at the Jersey Point and Emmaton locations typically achieves the objectives at Terminous and San Andreas Landing. This gradual increase in salinity levels would be commensurate with those experienced in years with similar hydrologic conditions as those observed in recent months.

Reclamation estimates that from May through August 15 a change in the water year classification from Dry to Critical in the Western Delta and Interior Delta locations in Table 2 could result in a gain of about 115,000 af, in upstream reservoir carryover storage at the end of September. Including the Delta outflow compliance in Table 3 for the same period would increase the gain in reservoir carryover storage to about 185,000 af. There could be reductions in the release from Keswick Reservoir up to about 1,000 cubic feet second in late May and June under a Critical year classification.

D-1641 requires that the number of days less than or equal to 150 mg/l chloride at Contra Costa Pumping Plant be greater than 165 days for a Dry year and 155 days for a Critical year. DWR and Reclamation do not anticipate that this objective would be a controlling criteria for the Projects under either year classification and both objectives would be met. The minimum Net Delta Outflow required from February through June (Collinsville X2 at 7,100 cfs) should be adequate to achieve the Contra Costa objective under either the Dry or Critical classification.

SWRCB recognition of the change in water year type is in the public interest. The change will provide for a water year classification reflective of the extremely dry hydrologic conditions in 2013 and allow the projects to operate in a manner that will provide the maximum benefit to critical beneficial users without unreasonably affecting other designated beneficial uses. As noted above there will be no significant impacts to agricultural or municipal uses, and the change will provide significant benefit to fisheries resources. State and federal agencies have been focused on the protection and improvement of fishery conditions in the Delta watershed, and are in the process of analyzing options for balancing project operations for the numerous different beneficial uses. Approval of the following request would result in water quality conditions in the North Delta that are consistent with the hydrology we are currently experiencing, while preserving cold water storage critical to salmon survival.

Requested Action:

Reclamation and DWR request that the SWRCB recognize the change in year classification need and act immediately. Delaying such recognition to even June 1 will significantly impair Reclamation's ability to meet cold water temperature objectives on the Sacramento River. At present, the controlling D-1641 Delta water quality objectives for the Projects that are linked to the Sacramento Valley Index are Jersey Point in Table 2, Emmaton in Table 2. In addition, Delta Outflow in Table 3, may become a controlling standard and will also impact cold water pool storage starting in the middle of June.

We believe the SWRCB may balance protection of the beneficial uses in light of the critical water year type experienced on the Sacramento River in 2013. Immediate benefits to cold water pool storage can be achieved through the Projects meeting critical water year standards for the Interior and Western Delta salinity standards in Table 2. The compliance points at issue are Sacramento River at Emmaton (Interagency Station Number D-22), San Joaquin River at Jersey

Point (Interagency Station Number D-15), South Fork Mokelumne River at Terminous (Interagency Station Number C-13), and San Joaquin River at San Andreas Landing (Interagency Station Number C-4).

Additional cold water pool benefits can be achieved in July through September with recognition of the critical water year type in Table 3, Water Quality Objectives for Fish and Wildlife Beneficial Uses. As noted above; Delta outflow objectives will likely control project operations in July through September, where agricultural objectives are met under a critical water year designation. A Delta outflow standard reflective of the critical water year type may produce an additional 70,000 af of cold water pool storage.

If you have any questions or would like more information regarding this notification, please contact Mr. Paul Fujitani of Reclamation at 916-979-2197 or Mr. John Leahigh at 916-574-2722.

Sincerely,

for D. Roose

Ronald Milligan, Operations Manager
Central Valley Operations Office
U.S. Bureau of Reclamation

David H. Roose, Chief
SWP Operations Control Office
Department of Water Resources

Attachment -4

cc: Mr. Craig M. Wilson, Delta Watermaster
State Water Resources Control Board
1001 I Street
Sacramento, California 95812

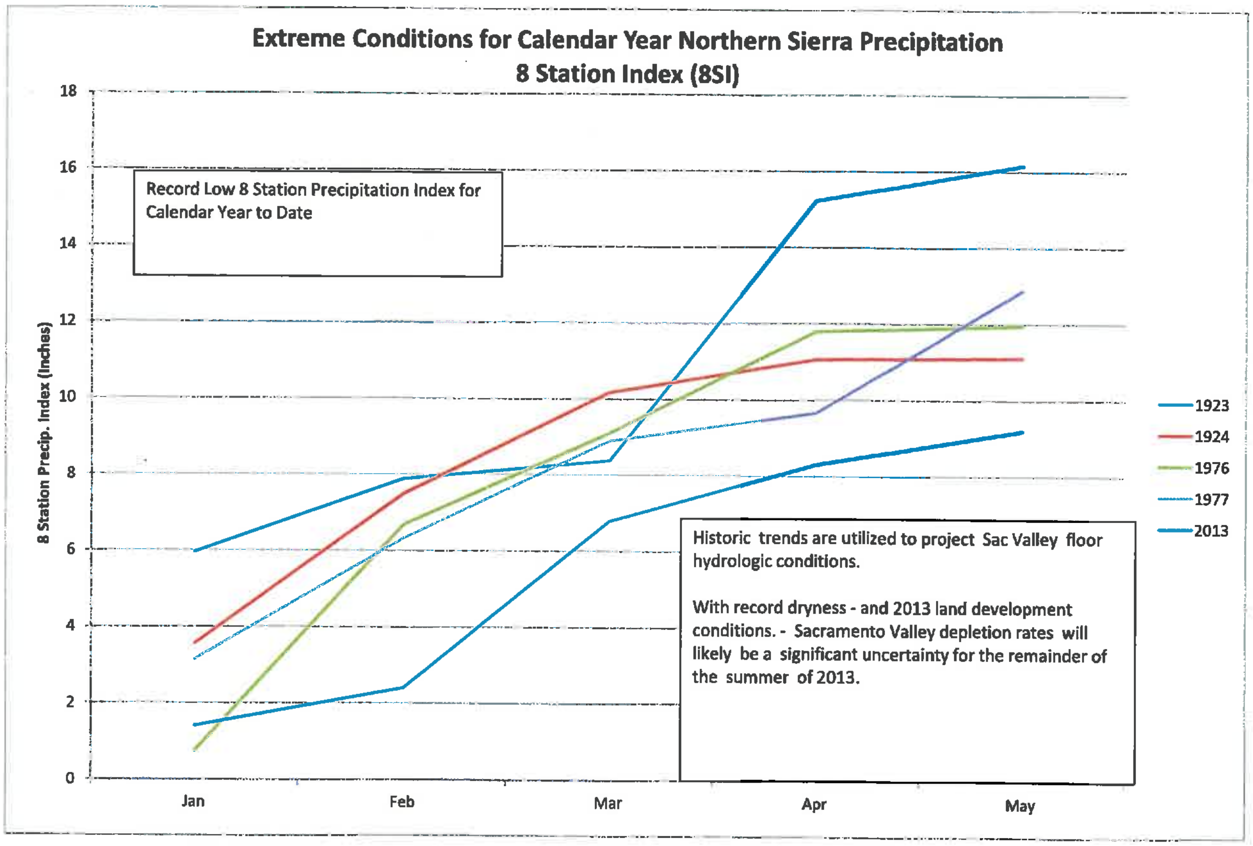
Ms. Maria Rae
Central Valley Office Supervisor
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento, California 95814

Mr. Les Grober
State Water Resources Control Board
Division of Water Rights
1001 I Street
Sacramento, California 95812
(w/encl to each)

Carl Wilcox
California Department of Fish and Wildlife
1416 9th Street
Sacramento, California 95814

Ms. Kim Turner
Assistant Field Supervisor
Bay-Delta Fish & Wildlife Office
U.S. Fish & Wildlife Service
650 Capitol Mall, Suite 8-300
Sacramento, California 95814

Attachment 1



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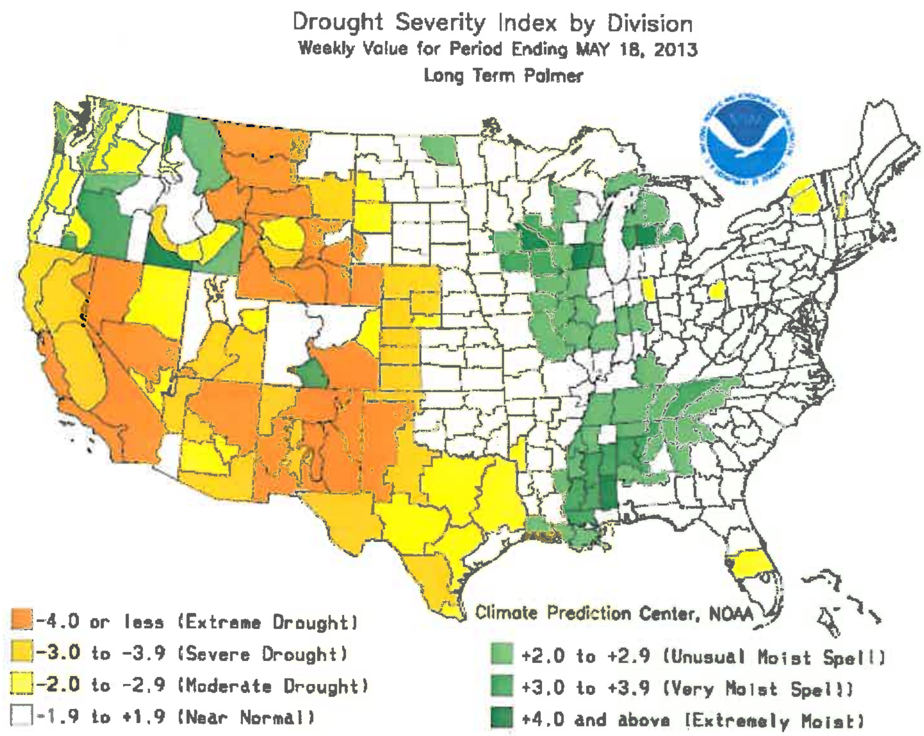

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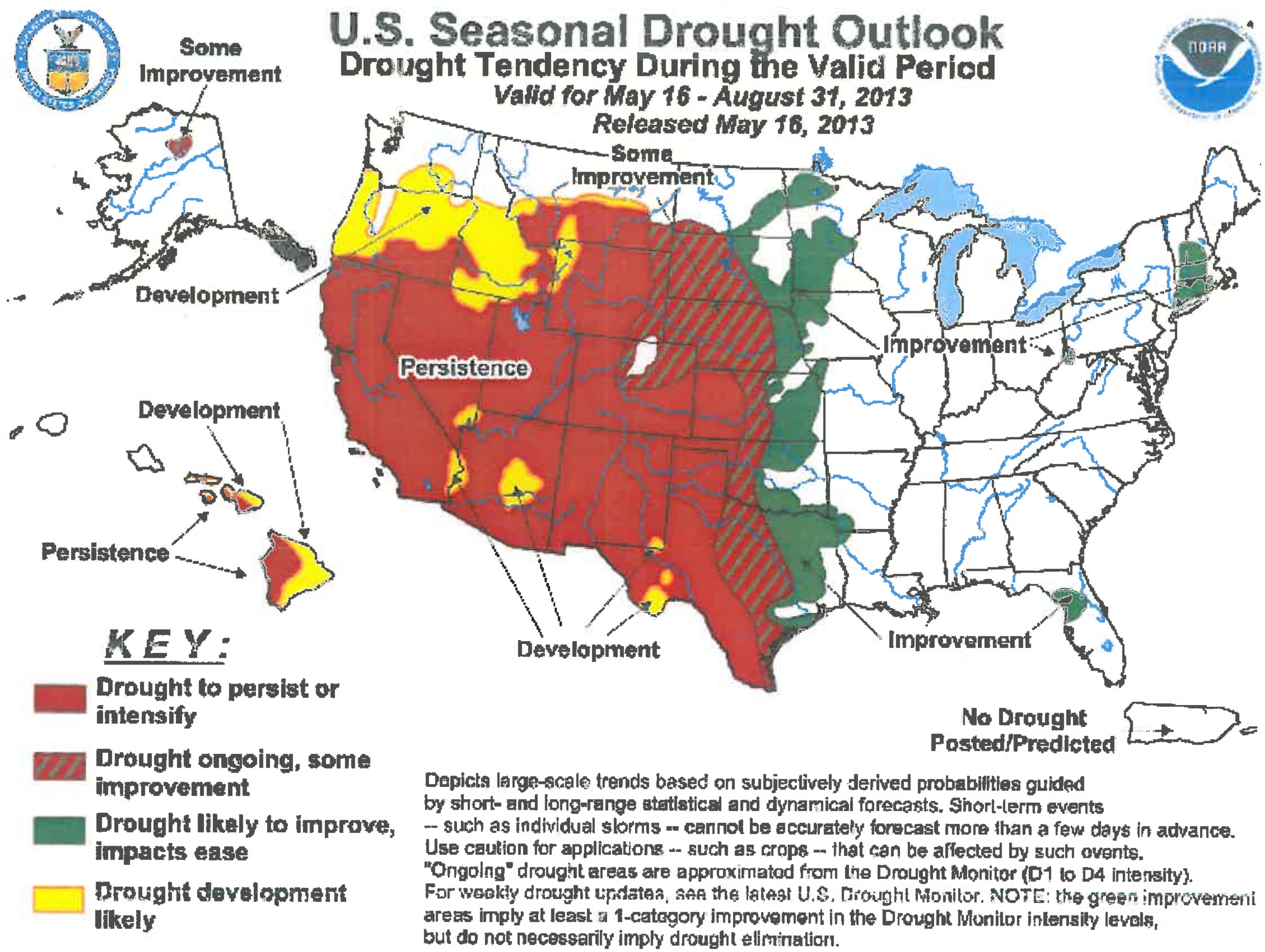
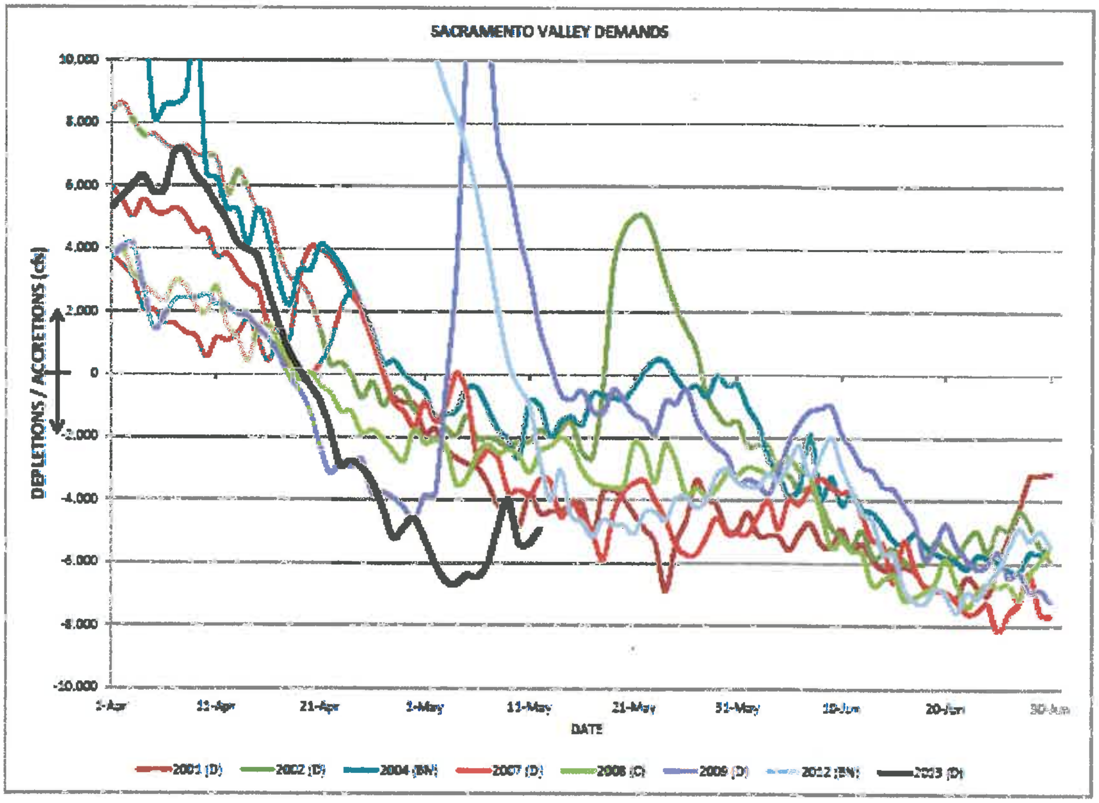


Attachment 4



From: Wilcox, Carl@Wildlife [Carl.Wilcox@wildlife.ca.gov]
Sent: Friday, May 24, 2013 4:04 PM
To: Marcus, Felicia@Waterboards; Howard, Tom@Waterboards; Wilson, Craig@Waterboards; Grober, Les@Waterboards
Cc: Riddle, Diane@Waterboards; Leahigh, John@DWR; pfujitani@usbr.gov; Dibble, Chad@Wildlife; Maria Rea - NOAA Federal; Garwin.Yip@noaa.gov; Jennifer_norris@fws.gov; Kim_S_Turner@fws.gov
Subject: CDFW concurrence with proposed changes to Delta WQ standards requested by DWR and Reclamation

Board Chair Marcus,

This e-mail is to provide California Department of Fish & Wildlife (CDFW) support/concurrence regarding the U.S. Bureau of Reclamation's (Reclamation) and California Department of Water Resources' (DWR) proposal that the SWRCB change the Sacramento Valley Water Year Hydrologic Classification Index (40-30-30) water year type from "dry" to "critical" as it pertains to the Water Quality Objectives for Agricultural Beneficial Uses under D-1641 at the following Western Delta and Interior Delta monitoring stations:

* Sacramento River at Emmaton, Station D-22;
* San Joaquin River at Jersey Point, Station D-15;
* South Fork Mokelumne River at Terminus, Station C-13; and
* San Joaquin River at San Andreas Landing, Station C-4.

This request is to support applying the new water year classification as soon as possible, through August 15, 2013. The biggest benefit to changing the water year type for the specific water quality stations is increased storage in (or conversely, reducing the rate of drawdown of) Shasta Reservoir. This will likely benefit the life history needs of the 2013 cohorts of Chinook salmon, in addition to providing higher carryover storage (than otherwise would be realized) to begin water year 2014.

The proposal was discussed on a conference call today, Friday, May 24, among members of the SWRCB, Reclamation, DWR, U.S. Fish and Wildlife Service (USFWS), CDFW, and National Marine Fisheries Service (NMFS). In addition, the fish agencies conferred on the proposal and concur. The USFWS and NMFS will send separate e-mails expressing their support for the proposal. It is our understanding that a letter making the subject request will be forthcoming this afternoon. CDFW is providing this email concurrence to allow for a timely decision to maximize protection of Shasta storage to protect Chinook salmon. Any change in the formal submission by DWR and Reclamation to the SWRCB this afternoon from what is described above, will require re-evaluation by the CDFW before we could provide our concurrence.

Carl Wilcox
Policy Advisor to the Director for the Delta California Department of Fish and Wildlife
7329 Silverado Trail
Napa, CA 94558
Cell 707-738-4134
Office 707-944-5584
Carl.Wilcox@wildlife.ca.gov

Nomellini, Grilli & McDaniel PLCs

From: Maria Rea - NOAA Federal [maria.rea@noaa.gov]
Sent: Friday, May 24, 2013 4:50 PM
To: Marcus, Felicia@Waterboards; Howard, Tom@Waterboards; Wilson, Craig@Waterboards; Grober, Les@Waterboards; Riddle, Diane@Waterboards
Cc: Garwin.Yip@noaa.gov; RMILLIGAN@usbr.gov; pfujitani@usbr.gov; Leahigh, John@DWR; Dan_Castleberry@r1. Gov; Wilcox, Carl@Wildlife
Subject: NMFS support for change petition to D-1641

Dear Felicia and Tom:

This e-mail is to provide NOAA's National Marine Fisheries Service's (NMFS) support/concurrence regarding the U.S. Bureau of Reclamation's (Reclamation) and California Department of Water Resources' (DWR) proposal. As I understand it, and as discussed on a conference call this morning among members of the SWRCB, Reclamation, DWR, U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and NMFS, Reclamation and DWR will request that the SWRCB change the Sacramento Valley Water Year Hydrologic Classification Index (40-30-30) water year type from "dry" to "critical" as it pertains to the Water Quality Objectives for Agricultural Beneficial Uses under D-1641 at the following Western Delta and Interior Delta monitoring stations:

- Sacramento River at Emmaton, Station D-22;
- San Joaquin River at Jersey Point, Station D-15;
- South Fork Mokelumne River at Terminus, Station C-13; and
- San Joaquin River at San Andreas Landing, Station C-4.

This request is to support applying the new water year classification as soon as possible, through August 15, 2013. The biggest benefit to changing the water year type for the specific water quality stations is increased storage in (or conversely, reducing the rate of drawdown of) Shasta Reservoir. This will likely benefit the life history needs of the 2013 cohorts of Chinook salmon, in addition to providing higher carryover storage (than otherwise would be realized) to begin water year 2014. For example, Reclamation is currently releasing 13,000 cfs from Keswick Dam partly as a result of the Delta Cross Channel being open over the Memorial Day weekend and partly because of the spring tide, but largely to maintain compliance with the Emmaton water quality standard. In addition, the May forecast at the 90% exceedance hydrology indicates that the projected end of September (EOS) carryover storage at Shasta Reservoir is 1.527 million acre feet (MAF). The NMFS biological opinion on the long-term operations of the Central Valley Project and State Water Project does not have a minimum EOS carryover storage requirement in Shasta Reservoir. However, although the requirements in Action I.2.3.C pertain to the February forecast, it does acknowledge and provide for drought exception procedures if a Clear Creek Temperature Compliance Point or 1.9 MAF EOS storage is not achievable, indicating that the forecasted carryover storage of 1.527 MAF is very low.

In addition, the fish agencies conferred on the proposal as discussed this morning, and also concur. The USFWS and CDFW will send separate e-mails expressing their support for the proposal.

Please let me know if you have any questions or need more information. My cell phone number is (916) 799-2359.

- Maria

Maria Rea
Supervisor, Central Valley Office, NOAA Fisheries

Nomellini, Grilli & McDaniel PLCs

From: michael_chotkowski@fws.gov

Sent: Tuesday, May 28, 2013 2:08 PM

To: Marcus, Felicia@Waterboards; Howard, Tom@Waterboards; Wilson, Craig@Waterboards; Grober, Les@Waterboards

Cc: Riddle, Diane@Waterboards; Leahigh, John@DWR; pfujitani@usbr.gov; Dibble, Chad@Wildlife; Maria Rea - NOAA Federal; Garwin.Yip@noaa.gov; Jennifer_norris@fws.gov; Kim_S_Turner@fws.gov

Subject: FWS concurrence with proposed changes to Delta WQ standards, as requested by Reclamation and DWR

Board Chair Marcus,

This email expresses the U.S. Fish and Wildlife Service's (Service) support for the State Water Board's proposal to implement the U.S. Bureau of Reclamation (Reclamation) and California Department of Water Resources (DWR) request to change the 40-30-30 Sacramento Valley water year type from "dry" to "critical," specifically as it pertains to relaxing the D-1641 water quality objectives for agricultural beneficial uses at four stations in the western Delta:

* Sacramento River at Emmaton, Station D-22;
* San Joaquin River at Jersey Point, Station D-15;
* South Fork Mokelumne River at Terminus, Station C-13; and
* San Joaquin River at San Andreas Landing, Station C-4.

The proposed change to the water year type for the specific water quality stations would reduce drawdown of Shasta Reservoir. This will likely benefit the early life history needs of the 2013 cohorts of Chinook salmon, in addition to providing higher carryover storage (than otherwise would be realized) to begin water year 2014. In this unusual year, the biological benefits to imperiled salmon appear large enough to outweigh our concern about the potentially adverse effects of the concomitant reduction in Delta outflow during these months.

The change in EC standard at these stations would occur immediately and last through August 15, 2013. The Service supports implementation of the proposal on a one-time basis that reflects unusual winter-run Chinook concerns this year, so long as implementation does not affect management of OMR flow to protect juvenile delta smelt in accordance with the Service's 2008 OCAP Biological Opinion.

The Service will continue to work cooperatively with its Federal and State partners to ensure that the CVP and SWP operations provide adequate protection for Threatened and Endangered species while delivering water that benefits 25 million agricultural and urban water users throughout California.

Mike Chotkowski
Field Supervisor, Bay-Delta Fish and Wildlife Office
650 Capitol Mall
Sacramento, CA 95814
(916) 930-5632

Nomellini, Grilli & McDaniel PLCs

From: Howard, Tom@Waterboards [Tom.Howard@waterboards.ca.gov]
Sent: Friday, May 24, 2013 5:56 PM
To: Maria Rea - NOAA Federal; Marcus, Felicia@Waterboards; Wilson, Craig@Waterboards; Grober, Les@Waterboards; Riddle, Diane@Waterboards
Cc: Garwin.Yip@noaa.gov; RMILLIGAN@usbr.gov; pfujitani@usbr.gov; Leahigh, John@DWR; Dan_Castleberry@r1. Gov; Wilcox, Carl@Wildlife
Subject: RE: NMFS support for change petition to D-1641

In the interest of making the best use of limited water supplies, and maintaining cold water pool storage in Shasta Reservoir, I want to provide a timely initial response to emails from the National Marine Fisheries Service and the California Department of Fish and Wildlife (fish agencies). The fish agencies support a change in the Sacramento Valley Water Year Hydrologic Classification Index (40-30-30) water year type from "dry" to "critical" as it pertains to the Water Quality Objectives for Agricultural Beneficial Uses under D-1641 at the following Western Delta and Interior Delta monitoring stations:

- Sacramento River at Emmaton, Station D-22;
- San Joaquin River at Jersey Point, Station D-15;
- South Fork Mokelumne River at Terminus, Station C-13; and
- San Joaquin River at San Andreas Landing, Station C-4.

The State Water Board staff will not recommend any action if the projects operate to meet the critically dry year objectives for Western and Central Delta agricultural objectives, instead of operating to meet dry year objectives through August 15, 2013. Our intent to not take any action is conditioned on submittal of a temperature management plan pursuant to State Water Board Order 90-5 within one week of May 28, operation in accordance with the plan, and any further conditions determined by the Executive Director of the State Water Board. Furthermore, the Projects will be required to include an accounting of operations under the change in water year classification.

I will follow-up with an expanded response on Tuesday May 28 after receipt of any requests related to these Delta operations from the Department of Water resources and the United States Bureau of Reclamation.

I believe in the future that more timely exchange of information regarding operational issues will alleviate situations of this nature.

From: Maria Rea - NOAA Federal [mailto:maria.rea@noaa.gov]
Sent: Friday, May 24, 2013 4:50 PM
To: Marcus, Felicia@Waterboards; Howard, Tom@Waterboards; Wilson, Craig@Waterboards; Grober, Les@Waterboards; Riddle, Diane@Waterboards
Cc: Garwin.Yip@noaa.gov; RMILLIGAN@usbr.gov; pfujitani@usbr.gov; Leahigh, John@DWR; Dan_Castleberry@r1. Gov; Wilcox, Carl@Wildlife
Subject: NMFS support for change petition to D-1641

Dear Felicia and Tom:
This e-mail is to provide NOAA's National Marine Fisheries Service's (NMFS) support/concurrence regarding the U.S. Bureau of Reclamation's (Reclamation) and California Department of Water Resources' (DWR) proposal. As I understand it, and as discussed on a conference call this morning among members of the SWRCB, Reclamation, DWR, U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and NMFS, Reclamation and DWR will request that the SWRCB change the Sacramento Valley Water Year Hydrologic Classification Index (40-30-30)

water year type from "dry" to "critical" as it pertains to the Water Quality Objectives for Agricultural Beneficial Uses under D-1641 at the following Western Delta and Interior Delta monitoring stations:

- Sacramento River at Emmaton, Station D-22;
- San Joaquin River at Jersey Point, Station D-15;
- South Fork Mokelumne River at Terminus, Station C-13; and
- San Joaquin River at San Andreas Landing, Station C-4.

This request is to support applying the new water year classification as soon as possible, through August 15, 2013. The biggest benefit to changing the water year type for the specific water quality stations is increased storage in (or conversely, reducing the rate of drawdown of) Shasta Reservoir. This will likely benefit the life history needs of the 2013 cohorts of Chinook salmon, in addition to providing higher carryover storage (than otherwise would be realized) to begin water year 2014. For example, Reclamation is currently releasing 13,000 cfs from Keswick Dam partly as a result of the Delta Cross Channel being open over the Memorial Day weekend and partly because of the spring tide, but largely to maintain compliance with the Emmaton water quality standard. In addition, the May forecast at the 90% exceedance hydrology indicates that the projected end of September (EOS) carryover storage at Shasta Reservoir is 1.527 million acre feet (MAF). The NMFS biological opinion on the long-term operations of the Central Valley Project and State Water Project does not have a minimum EOS carryover storage requirement in Shasta Reservoir. However, although the requirements in Action I.2.3.C pertain to the February forecast, it does acknowledge and provide for drought exception procedures if a Clear Creek Temperature Compliance Point or 1.9 MAF EOS storage is not achievable, indicating that the forecasted carryover storage of 1.527 MAF is very low.

In addition, the fish agencies conferred on the proposal as discussed this morning, and also concur. The USFWS and CDFW will send separate e-mails expressing their support for the proposal.

Please let me know if you have any questions or need more information. My cell phone number is (916) 799-2359.

- Maria

Maria Rea
Supervisor, Central Valley Office, NOAA Fisheries

EXHIBIT C

From: Grober, Les@Waterboards [Les.Grober@waterboards.ca.gov]
Sent: Thursday, May 30, 2013 10:16 AM
To: Terry, Melinda @northdw.com; ngmplcs@pacbell.net
Subject: FW: May 29 2013 Letter to USBR and DWR on Actions to Conserve Cold Water Pool

Attachments: signed response letter 5-29-13.pdf; Milligan,R. -2013-05_SWRCB Water Right Decision 1641 Water Year Classification.pdf

signed Milligan,R.
›nse letter 5-29-3-05_SWRCB W

Here is the follow-up letter.

From: Saechao, Dramy@Waterboards
Sent: Wednesday, May 29, 2013 5:12 PM
To: Roose, David@DWR; RMILLIGAN@usbr.gov
Cc: Howard, Tom@Waterboards; maria.rea@noaa.gov; Wilcox, Carl@Wildlife; Kim_S_Turner@fws.gov; Foresman.Erin@epamail.epa.gov; Terry, Melinda @northdw.com; ngmplcs@pacbell.net; pfujitani@usbr.gov; Leahigh, John@DWR
Subject: May 29 2013 Letter to USBR and DWR on Actions to Conserve Cold Water Pool

Please see the attached May 29, 2013 letter from Craig Wilson, the Delta Watermaster, to the U.S. Bureau of Reclamation and California Department of Water Resources regarding actions to conserve cold water pool in Shasta Reservoir for fishery resources. The letter from the Bureau and Department is also attached.

Questions regarding this matter should be directed to Craig Wilson at cwilson@waterboards.ca.gov<mailto:cwilson@waterboards.ca.gov> or 916-445-5962.

CALIFORNIA
Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

State Water Resources Control Board

Ronald Milligan, Operations Manager
Central Valley Operations Office
U.S. Bureau of Reclamation
3310 El Camino Avenue, Suite 300
Sacramento, CA 95821

David H. Roose, Chief
SWP Operations Control Office
California Department of Water Resources
Division of Operations and Maintenance
3310 El Camino Avenue, Suite 300
Sacramento, CA 95821

Dear Messrs. Milligan and Rosse:

ACTIONS TO CONSERVE COLD WATER POOL IN SHASTA RESERVOIR FOR FISHERY RESOURCES

This letter responds to your May 24, 2013 letter to Thomas Howard, Executive Director for the State Water Resources Control Board (State Water Board) regarding unprecedented dry conditions in the Sacramento Valley and needed actions to protect cold water pool (CWP) resources for fisheries purposes. In your letter you request that the State Water Board acknowledge that the water year classification for the Sacramento Valley contained in State Water Board Decision 1641 (D-1641, Figure 1, page 188) does not accurately reflect the unprecedented dry conditions that have occurred since January of this year, which are characteristic of a critically dry year determination. Specifically, you propose that the Bureau and Department comply with critically dry water year requirements for certain Delta water quality objectives instead of dry year requirements in order to conserve CWP resources in Shasta Reservoir needed to protect Chinook salmon this season.

<u>Background</u>

The State Water Board was first contacted regarding this matter on May 17, 2013, by Maria Rea, Supervisor of the Central Valley Office of the National Marine Fisheries Service (NOAA Fisheries). Ms. Rea emailed Mr. Howard expressing concerns that planned Shasta Reservoir releases to meet Delta water quality objectives required by D-1641 would impact winter-run Chinook salmon by depleting already low Shasta Reservoir CWP resources. Ms. Rea requested that the agencies meet as soon as possible to discuss this matter.

In the midst of these discussions, on May 20, 2013, Governor Edmund G. Brown Jr. issued an Executive Order (B-21-13) outlining California's exceptionally dry water year conditions and ordering that the Department and the State Water Board expedite the review of water transfers to address the dry conditions and water delivery limitations. As outlined in Executive Order B-21-13:

- much of California experienced record dry conditions in January through March 2013, registering historic lows on the Northern Sierra and the San Joaquin precipitation indices; and

- record dry and warm conditions resulted in a snowpack substantially below average, with estimated May water content in the statewide snowpack being only 17 percent of average and with the spring snowmelt season now being well underway.

On May 22, 2013, State Water Board staff met with staff from the Bureau and Department to discuss possible Shasta Reservoir CWP actions. On May 24, 2013, State Water Board staff again met with staff from the Department and Bureau as well as staff from NOAA Fisheries, the U.S. Fish and Wildlife Service (USFWS), and the California Department of Fish and Wildlife (CDFW) (collectively fisheries agencies) to discuss Shasta Reservoir CWP actions. The fisheries agencies agreed on the need to take actions to conserve CWP resources in Shasta Reservoir and concurred with a proposal that the Department and Bureau operate to meet critically dry year requirements for the Western and Interior Delta water quality objectives for the protection of agriculture included in Table 2 of D-1641 (page 182), which include the following stations:

- Sacramento River at Emmaton, Station D-22;
- San Joaquin River at Jersey Point, Station D-15;
- South Fork Mokelumne River at Terminus, Station C-13; and
- San Joaquin River at San Andreas Landing, Station C-4.

The fisheries agencies requested additional time and discussion to consider any further actions related to Delta outflow or other requirements due to potential fisheries related impacts. On May 24 , 2013, Carl Wilcox of the CDFW and Maria Rea of NOAA Fisheries sent emails to State Water Board staff in support of the proposal that the Bureau and Department operate to meet critically dry year conditions for the above mentioned Western and Interior Delta compliance stations through August 15, 2013 (attached). On May 28, 2013, Michael Chotkowski with the USFWS also submitted an email of support for the changes mentioned above (attached).

Prior to receipt of your letter on May 24, 2013, Mr. Howard sent an initial response regarding this matter indicating that, in the interest of making the best use of limited water supplies and maintaining cold water pool storage in Shasta Reservoir, the State Water Board staff will not recommend taking any action if the projects operate to meet the critically dry year objectives for the Western and Interior Delta agricultural objectives, instead of operating to meet dry year objectives through August 15, 2013. Mr. Howard indicated that the intent to not take any action was conditioned on submittal of a temperature management plan pursuant to State Water Board Order 90-5 within one week of May 28, 2013, and operation in accordance with the plan, and any further conditions determined by the Executive Director of the State Water Board. Mr. Howard also indicated that the Bureau and Department will be required to include a water accounting under the change in operations. Mr. Howard indicated that we would follow up after receipt of a specific request from the Bureau and Department.

<u>Proposal</u>

In your letter you propose to meet critically dry year requirements pursuant to D-1641 for the Sacramento Valley, including requirements included in Table 3 for the protection of fish and wildlife, in order to conserve CWP resources. In your letter, you state that, although the January through April period during 2013 was the driest on record, the November and December precipitation was sufficient to result in a Sacramento Valley classification of "dry" for water year 2013. Your letter further states that nearly 80 percent of this water year's precipitation occurred in October, November and December 2012, and an abnormally large portion of this fell as rain rather than snow as a result of warmer than normal conditions for that time of year. This combined with critically dry conditions in the months since the first of the year has resulted in minimal snow pack in the Sierra Nevada in the critical spring months. As of May 1, 2013, the Northern Sierra snowpack was only about 48 percent of the historical April 1 value and about 17 percent of normal. Further, you point out that unusually high stream depletions in the Sacramento Valley have also contributed to reduced storage levels.

Your letter explains that meeting dry year objectives could jeopardize the Bureau and Department's ability to meet objectives designed to protect fisheries later in the year. In particular, the Bureau has expressed concern that it may not be able meet the temperature requirement necessary to protect salmon present in the Sacramento River during the summer and fall if the CWP in Shasta Reservoir continues to be depleted. You state that operating to meet critically dry water year requirements for the Western and Interior Delta from May through August 15 of this year could result in a gain of approximately 115 thousand acre-feet (TAF) of water in upstream reservoirs at the end of September. You indicate that including the Delta outflow requirement (included in Table 3 of D-1641) for the same period would increase the gain in reservoir carryover storage to approximately 185 TAF. You further indicate that compliance with critically dry conditions will result in water quality conditions in the North Delta that are consistent with the current hydrology.

Response to Proposal

Article X, section 2 of the California Constitution sets forth a directive to maximize the reasonable and beneficial use of the State's waters. As such, this constitutional mandate provides an important consideration where statutory water rights provisions vest discretion in the State Water Board. We have reviewed the unique factors of your request and the recommendations of the fisheries agencies. As the person delegated by the State Water Board to act on water right permit terms that apply to conditions in the Delta, I will not object or take any action if the Bureau and Department operate to meet critically dry year objectives for Western and Interior Delta agricultural beneficial uses included in Table 2 of D-1641 instead of operating to meet dry year objectives through August 15, 2013. This conclusion is conditioned as specified in the above mentioned email from the State Water Board's Executive Director Thomas Howard. Specifically, the Bureau and Department shall submit a temperature management plan pursuant to State Water Board Order 90-5 **by June 4, 2013**, and shall operate in accordance with the approved plan to maximize temperature benefits to fisheries resources. The Bureau and Department shall consult with the fisheries agencies concerning temperature management decisions and shall immediately inform the State Water Board regarding any fisheries agencies concerns and proposed resolution of those concerns. The Bureau and Department shall implement additional actions as determined by me or the Executive Director of the State Water Board. The Bureau and Department shall also submit a water accounting to the State Water Board under the change in operations **by August 22, 2013**.

I understand that Delta outflow requirements are not currently controlling operational decisions related to releases from Shasta Reservoir, but likely will be in the next several weeks. In order to determine whether any additional changes to operations to meet Delta outflow or other objectives required by D-1641 should be made to protect CWP resources, the Bureau and Department should immediately consult with the fisheries agencies and State Water Board staff.

I will consider additional actions to conserve CWP resources upon receipt of input from the fisheries agencies on those matters.

In the future, the State Water Board staff and I expect discussions regarding compliance matters to begin as soon as potential issues are identified in order to allow the greatest flexibility to address these issues. The State Water Board will consider whether appropriate coordination took place in a timely manner when considering future enforcement action.

If you have any questions, please contact me at cwilson@waterboards.ca.gov or 916-445-5962. Written correspondence should be addressed as follows:

State Water Resources Control Board
Office of Delta Watermaster
Attn: Craig Wilson
P.O. Box 100
Sacramento, CA 95812

Sincerely,

Craig M. Wilson

Craig Wilson, Delta Watermaster
State Water Resources Control Board

Enclosures

cc: Thomas Howard, Executive Director
State Water Resources Control Board
1001 I Street
Sacramento, CA 95812

Maria Rea,Central Valley Office Supervisor
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento, CA 95814

Carl Wilcox
California Department of Fish and Wildlife
1416 9th Street
Sacramento, CA 95814

Kim Turner, Assistant Field Supervisor
U.S. Fish & Wildlife Service
650 Capitol Mall, Suite 8-300
Sacramento, CA 95814

cc: Continues on next page.

cc: Erin Foresman
USEPA Region 9
C/O NMFS 650 Capitol Mall
Sacramento, CA 95814

Melinda Terry, Manager
North Delta Water Agency
910 K Street, Suite 310
Sacramento, CA 95814

Dante Nomellini Jr.
Central Delta Water Agency
P.O. Box 1461
Stockton, CA 95201

Paul Fujitani
U.S. Bureau of Reclamation
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

John Leahigh
California Department of Water Resources
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

From: Wilcox, Carl@Wildlife [mailto:Carl.Wilcox@wildlife.ca.gov]
Sent: Friday, May 24, 2013 4:04 PM
To: Marcus, Felicia@Waterboards; Howard, Tom@Waterboards; Wilson, Craig@Waterboards; Grober, Les@Waterboards
Cc: Riddle, Diane@Waterboards; Leahigh, John@DWR; pfujitani@usbr.gov; Dibble, Chad@Wildlife; Maria Rea - NOAA Federal; Garwin.Yip@noaa.gov; Jennifer_norris@fws.gov; Kim_S_Turner@fws.gov
Subject: CDFW concurrence with proposed changes to Delta WQ standards requested by DWR and Reclamation

Board Chair Marcus,

This e-mail is to provide California Department of Fish & Wildlife (CDFW) support/concurrence regarding the U.S. Bureau of Reclamation's (Reclamation) and California Department of Water Resources' (DWR) proposal that the SWRCB change the Sacramento Valley Water Year Hydrologic Classification Index (40-30-30) water year type from "dry" to "critical" as it pertains to the Water Quality Objectives for Agricultural Beneficial Uses under D-1641 at the following Western Delta and Interior Delta monitoring stations:

* Sacramento River at Emmaton, Station D-22;
* San Joaquin River at Jersey Point, Station D-15;
* South Fork Mokelumne River at Terminus, Station C-13; and
* San Joaquin River at San Andreas Landing, Station C-4.

This request is to support applying the new water year classification as soon as possible, through August 15, 2013. The biggest benefit to changing the water year type for the specific water quality stations is increased storage in (or conversely, reducing the rate of drawdown of) Shasta Reservoir. This will likely benefit the life history needs of the 2013 cohorts of Chinook salmon, in addition to providing higher carryover storage (than otherwise would be realized) to begin water year 2014.

The proposal was discussed on a conference call today, Friday, May 24, among members of the SWRCB, Reclamation, DWR, U.S. Fish and Wildlife Service (USFWS), CDFW, and National Marine Fisheries Service (NMFS). In addition, the fish agencies conferred on the proposal and concur. The USFWS and NMFS will send separate e-mails expressing their support for the proposal. It is our understanding that a letter making the subject request will be forthcoming this afternoon. CDFW is providing this email concurrence to allow for a timely decision to maximize protection of Shasta storage to protect Chinook salmon. Any change in the formal submission by DWR and Reclamation to the SWRCB this afternoon from what is described above, will require re-evaluation by the CDFW before we could provide our concurrence.

Carl Wilcox
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From: Maria Rea - NOAA Federal [mailto:maria.rea@noaa.gov]
Sent: Friday, May 24, 2013 4:50 PM
To: Marcus, Felicia@Waterboards; Howard, Tom@Waterboards; Wilson, Craig@Waterboards; Grober, Les@Waterboards; Riddle, Diane@Waterboards
Cc: Garwin.Yip@noaa.gov; RMILLIGAN@usbr.gov; pfujitani@usbr.gov; Leahigh, John@DWR; Dan_Castleberry@r1. Gov; Wilcox, Carl@Wildlife
Subject: NMFS support for change petition to D-1641

Dear Felicia and Tom:

This e-mail is to provide NOAA's National Marine Fisheries Service's (NMFS) support/concurrence regarding the U.S. Bureau of Reclamation's (Reclamation) and California Department of Water Resources' (DWR) proposal. As I understand it, and as discussed on a conference call this morning among members of the SWRCB, Reclamation, DWR, U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and NMFS, Reclamation and DWR will request that the SWRCB change the Sacramento Valley Water Year Hydrologic Classification Index (40-30-30) water year type from "dry" to "critical" as it pertains to the Water Quality Objectives for Agricultural Beneficial Uses under D-1641 at the following Western Delta and Interior Delta monitoring stations:

- Sacramento River at Emmaton, Station D-22;
- San Joaquin River at Jersey Point, Station D-15;
- South Fork Mokelumne River at Terminus, Station C-13; and
- San Joaquin River at San Andreas Landing, Station C-4.

This request is to support applying the new water year classification as soon as possible, through August 15, 2013. The biggest benefit to changing the water year type for the specific water quality stations is increased storage in (or conversely, reducing the rate of drawdown of) Shasta Reservoir. This will likely benefit the life history needs of the 2013 cohorts of Chinook salmon, in addition to providing higher carryover storage (than otherwise would be realized) to begin water year 2014. For example, Reclamation is currently releasing 13,000 cfs from Keswick Dam partly as a result of the Delta Cross Channel being open over the Memorial Day weekend and partly because of the spring tide, but largely to maintain compliance with the Emmaton water quality standard. In addition, the May forecast at the 90% exceedance hydrology indicates that the projected end of September (EOS) carryover storage at Shasta Reservoir is 1.527 million acre feet (MAF). The NMFS biological opinion on the long-term operations of the Central Valley Project and State Water Project does not have a minimum EOS carryover storage requirement in Shasta Reservoir. However, although the requirements in Action I.2.3.C pertain to the February forecast, it does acknowledge and provide for drought exception procedures if a Clear Creek Temperature Compliance Point or 1.9 MAF EOS storage is not achievable, indicating that the forecasted carryover storage of 1.527 MAF is very low.

In addition, the fish agencies conferred on the proposal as discussed this morning, and also concur. The USFWS and CDFW will send separate e-mails expressing their support for the proposal.

Please let me know if you have any questions or need more information. My cell phone number is (916) 799-2359.

- Maria

Maria Rea

Supervisor, Central Valley Office, NOAA Fisheries

From: "Chotkowski, Michael" <michael_chotkowski@fws.gov>
Date: May 28, 2013 6:21:50 PM PDT
To: <Felicia.Marcus@waterboards.ca.gov>, <Tom.Howard@waterboards.ca.gov>, <Craig.Wilson@waterboards.ca.gov>, <Les.Grober@waterboards.ca.gov>
Cc: <Diane.Riddle@waterboards.ca.gov>, "Leahigh, John@DWR" <John.Leahigh@water.ca.gov>, PAUL FUJITANI <PFujitani@usbr.gov>, "Dibble, Chad@Wildlife" <Chad.Dibble@wildlife.ca.gov>, Maria Rea - NOAA Federal <maria.rea@noaa.gov>, Garwin Yip - NOAA Federal <garwin.yip@noaa.gov>, "Jen Norris" <jennifer_norris@fws.gov>, Kim <kim_s_turner@fws.gov>, Roger Guinee <roger_guinee@fws.gov>
Subject: Update to: FWS concurrence with proposed changes to Delta WQ standards, as requested by Reclamation and DWR

Board Chair Marcus,

Note: This email supersedes one I sent earlier today, which reflected a misunderstanding on my part. Apologies. Please discard the earlier email and substitute this one.

This email expresses the U.S. Fish and Wildlife Service's (Service) support for the State Water Board's proposal to implement the U.S. Bureau of Reclamation (Reclamation) and California Department of Water Resources (DWR) request to change the 40-30-30 Sacramento Valley water year type from "dry" to "critical," specifically as it pertains to relaxing the D-1641 water quality objectives for agricultural beneficial uses at four stations in the western Delta:

* Sacramento River at Emmaton, Station D-22;
* San Joaquin River at Jersey Point, Station D-15;
* South Fork Mokelumne River at Terminus, Station C-13; and
* San Joaquin River at San Andreas Landing, Station C-4.

The proposed change to the water year type for the specific water quality stations would reduce drawdown of Shasta Reservoir. This will likely benefit the early life history needs of the 2013 cohorts of Chinook salmon, in addition to providing higher carryover storage (than otherwise would be realized) to begin water year 2014.

The change in EC standard at these stations would occur immediately and last through August 15, 2013. The Service supports implementation of the proposal on a one-time basis, so long as implementation does not affect management of OMR flow to protect juvenile delta smelt in accordance with the Service's 2008 OCAP Biological Opinion.

It is our understanding that some discussions related to possible changes in Delta outflow have yet to occur. We will evaluate proposals related to deviations from the D-1641 Delta outflow standards when/if they are proposed.

The Service will continue to work cooperatively with its Federal and State partners to ensure that the CVP and SWP operations provide adequate protection for Threatened and Endangered species while delivering water that benefits 25 million agricultural and urban water users throughout California.

--

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MAY 24 2013

IN REPLY REFER TO:
CVO-100
WTR-4.10

Thomas Howard
Executive Director
State Water Resources Control Board
1001 I Street
Sacramento, California 95814

Subject: State Water Resources Control Board Water Right Decision 1641 Water Year Classification

Dear Mr. Howard:

The Department of Water Resources (DWR) and the United States Bureau of Reclamation (Reclamation) request that the State Water Resources Control Board (SWRCB) acknowledge that the water year classification for the Sacramento Valley based on the equation provided in Attachment 1, page 188 of Revised Water Rights Decision 1641 (D-1641) does not accurately reflect the unprecedented dry conditions experienced in 2013. Instead, the hydrologic conditions experienced between January and the present are characteristic of a "Critical" water year type. The current miscategorization in water year classification is projected to affect the storage of cold water pool for fisheries purposes due to controlling D-1641 Delta objectives in the May through August period. These objectives are:

1) EC parameters for Sacramento River at Emmaton (Interagency Station Number D-22), San Joaquin River at Jersey Point (Interagency Station Number D-15), South Fork Mokelumne River at Terminous (Interagency Station Number C-13), and San Joaquin River at San Andreas (interagency Station Number C-4) as defined in Table 2 on page 182
2) Delta Outflow, as defined on Table 3 on Page 184.

Water year classification also affects other objectives listed in D-1641 to a lesser degree, but it is not anticipated that those objectives will significantly control Delta operations in 2013.

Summary of Relevant Facts:
D-1641 imposes water quality objectives on the Central Valley Project (CVP) and State Water Project (SWP). Several of the objectives are dependent on the water year type as determined by the May 1, Sacramento Valley Index and the San Joaquin Valley Index. Although the January through April period during 2013 was the driest on record, the November and December precipitation was sufficient to result in a Sacramento Valley classification of "Dry" for water year 2013. The "Dry" water year classification is not representative of the extreme hydrological conditions in Northern California this calendar year and the water quality objectives based on this water year type could result in significant adverse impacts to the cold water pool operations at Shasta Reservoir. In fact, Governor Brown's recent executive order B-21-13 recognizes that, "much of California experienced record dry conditions in January through March 2013, registering historic lows on the Northern Sierra" and "record dry and warm conditions resulted in a snowpack substantially below average, with estimated May water content in the statewide snowpack being only 17 percent of average."

The 2013 water year has been particularly challenging with double the normal precipitation in November and December and historically low values from January into May. The current Northern Sierra 8 Station Precipitation Index from January 1, 2013 through May 15 is about 8.8 inches. Without additional measurable precipitation in May, this figure will represent the driest Northern Sierra 8-Station Precipitation Index for the January through May period on record. Attachment 1 shows the accumulated 8-station precipitation values from January through May for some of the extremely dry years including 1924, 1976, and 1977. The nearly 80 percent of this year's precipitation occurred in the first three months of the water year, and an abnormally large portion of this fell as rain rather than snow as a result of warmer than normal conditions for that time of year. This combined with critically dry conditions in the months since the first of the year has resulted in minimal snow pack in the Sierra Nevada in the critical spring months. The Northern Sierra snowpack was only about 48% of the historical April 1 value and about 17% of normal as of May 1, 2013. Creek and small stream flows that enter the Sacramento River system below major reservoirs are running at historically low levels in response to the extended dry period. DWR's May 1, 2013 Bulletin 120 forecasts an April to July runoff 48% of normal for the Sacramento Valley. Hydrological conditions are not likely to improve and the National Oceanic and Atmospheric Administration has indicated that California is in severe to extreme drought that is likely to persist or intensify into the summer (Attachment 2).

Additionally, unusually high depletions in the Sacramento Valley are adding to the operational challenges the CVP and SWP (collectively, Projects) are facing in meeting the 2013 water year type requirements. Typically, extremely dry years with low Northern Sierra 8-Station Precipitation Index values trigger the Shasta inflow shortage criteria included in water rights settlement contracts that would reduce water supplies for the senior water rights diverters in the Sacramento Valley. Yet, this year the wetter conditions in the fall months were sufficient to require full allocations to the Sacramento Valley and Feather River settlement contractors, increasing demands on Shasta and Oroville storage. Therefore, it is expected that depletions will continue to run at a high rate into the summer. DWR and Reclamation are required to make releases in order to satisfy the senior water rights of the Sacramento River and Feather River settlement contractors, and the Exchange Contractors. These contracts specify the amount of water the Projects must deliver – for the Sacramento River and Exchange Contractors, Reclamation is required to deliver 100% of the contract total in any year where the forecasted inflow to Shasta Reservoir exceeds 3.2 million acre feet (af). This target was met in 2013 – thus Reclamation is mandated to deliver 100% of the contract total, and has no discretion under the contract to reduce these deliveries.

The unusually high stream depletions (Attachment 3) were a major cause of the exceedence of the Emmaton objective that occurred in April and May. This is described in further detail in DWR and Reclamation's letter to SWRCB dated May 24, 2013. The CVP and SWP reservoir systems were in a near normal condition in January, but Reclamation and DWR have drawn heavily on the storage since then due to the extended dry period, low unregulated flow entering the system, and high depletions in the Central Valley. Reservoir releases are currently well above average for this date.

In order to meet the Dry year water quality objectives rather than the Critical objectives, DWR and Reclamation have released significant volumes of water from Oroville, Shasta, and Folsom Reservoirs. The low reservoir inflow and increased storage withdrawal is depleting the cold water pool in the reservoirs that is important to provide adequate instream fishery habitat for anadromous fish in the rivers through the summer and fall.

SWRCB Water Rights Order 90-05 requires that Reclamation operate Shasta Reservoir to meet a daily average temperature of 56 degrees Fahrenheit in the Sacramento River at a location and through periods when higher temperatures will be detrimental to the fishery. Typically, through coordination with the Sacramento River Temperature Task Group (SRTTG), the location selected is between Balls Ferry and Bend Bridge on the Sacramento River. Without recognition of the Sacramento Valley water year type actually experienced in 2013, the projected low reservoir storage and limited cold water pool this year may result in the objective occurring well upstream of Balls Ferry and Reclamation is concerned whether the 56 degree objective can be maintained at any location in the Sacramento River through the fall. The cold water pool is vital to providing adequate habitat to salmon present in the Sacramento River through the summer and into the fall for both the winter-run Chinook salmon and fall-run Chinook salmon. The SRTTG has recommended an initial temperature compliance point of Airport Road located upstream of Balls Ferry due to the limited cold water resources this year.

Due to the unprecedented hydrologic conditions discussed above including the record dry January through May period, extremely low snowpack, and unusually high Sacramento valley depletions, conditions continue to deteriorate and it is clear that meeting the dry year objectives could jeopardize the ability to meet other fisheries objectives later in the year. The reservoir storage that accumulated in the wet fall, which was originally projected to be sufficient to meet the dry year objectives, is falling rapidly due to the abnormally large valley demands and

Reclamation is projecting CVP September carryover storages only about 63% of average.

There is a significant difference between the volume of Delta inflow needed to achieve the Dry and Critical water quality objectives for Jersey Point and Emmation through June 15. If Reclamation and DWR are able to begin operating to the Critical year water quality objectives in May it may be possible to achieve 100,000 to 200,000 af, of cold water benefits in the upstream reservoirs. This savings in cold water storage would improve the chances of meeting the temperature objective at Airport Road. This cold water benefit will help avoid temperature related fish losses in the Sacramento River.

The greatest benefits to the Project's reservoir storage would occur in the May to August 15 period. The compliance locations in the Western Delta and Interior Delta shown in Table 3 on Page 182 (Sacramento River at Emmaton (Interagency Station Number D-22), San Joaquin River at Jersey Point (Interagency Station Number D-15), South Fork Mokelumne River at Terminous (Interagency Station Number C-13), and San Joaquin River at San Andreas Landing (Interagency Station Number C-4) would most likely be the objectives controlling the Project operations during the May to June 15 period and changes at these locations would have the greatest impact on improving upstream storage in the immediate future. The objectives of the Delta outflow compliance location in Table 3 on page 184 often can control Project operations through the summer and operating to a critical year with respect to Delta outflow will also assist in preserving cold water pool.

Currently, DWR and Reclamation are maintaining a Net Delta Outflow well over 9,000 cubic feet per second (cfs) in order to achieve the Dry year objectives for Jersey Point and Emmaton. If the Dry classification is changed to Critical, the controlling D-1641 objective through June would be the Net Delta Outflow Index of at least 7,100 cfs in Table 3, or the export to inflow ratio of 35% in Table 3. From July through August 15, the controlling criteria for either water year classification would most likely shift among the minimum Net Delta Outflow objectives in Table 3, the salinity objectives for Jersey Point and Emmaton in Table 2, the Export to Inflow ratio of 65% in Table 3, or the Contra Costa 250 chloride objective in Table 1.

Table 2 of D-1641 requires an electrical conductivity (EC) no greater than 0.45 mmhos/cm for both Emmaton and Jersey point locations from April 1 to June 15, and 1.67 mmhos/cm for Emmaton and 1.35 mmhos/cm for Jersey Point from June 15 to August 15 under a Dry Year classification. For a Critical year these objectives are 2.78 mmhos/cm from April 1 to August 15 for Jersey Point and Emmaton. Since the X2 outflow objective of 7,100 cfs, which is not linked to the year type designation would probably control in May, and June, there would only be a gradual increase in salinity at Jersey Point and Emmaton through June that is reflective of a Critical year. Water quality at Jersey Point and Emmaton would fluctuate with the tidal and meteorological conditions potentially moving towards a 1.0 to 2.0 mmhos/cm EC range in July. Compliance with the water quality objectives at the Jersey Point and Emmaton locations typically achieves the objectives at Terminous and San Andreas Landing. This gradual increase in salinity levels would be commensurate with those experienced in years with similar hydrologic conditions as those observed in recent months.