From: Gilbert-Snyder, Paul <pgilbert@ebmud.com>
Sent: Monday, July 28, 2014 4:50 PM
To: 'BDCP.comments@noaa.gov'
Cc: Gilbert-Snyder, Paul
Subject: BDCP comments
Attachments: BDCP Comments with Attachments 7-28-2014 (2).pdf

Attached please find the East Bay Municipal Utility District's comments on the Draft BDCP and BDCP Draft EIR/EIS.

Thank you,

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BDCP1633

EAST BAY
MUNICIPAL UTILITY DISTRICT

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July 28, 2014

BDCP Comments
Ryan Wulff, NMFS
650 Capitol Mall, Suite 5-100
Sacramento, CA 95814

SUBJECT: Comments on the Bay Delta Conservation Plan and Environmental Impact Report/Environmental Impact Statement

Dear Mr. Wulff:

The East Bay Municipal Utility District (EBMUD) appreciates this opportunity to review and provide comments on the Bay Delta Conservation Plan (BDCP, or Plan) and the draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS). The proposed project is enormous in both scope and complexity and it is critical that all interested and potentially impacted parties have a thorough and realistic understanding of the project's impacts, costs, and funding mechanisms. While EBMUD supports the efforts of DWR and USBR to secure improved supply reliability for the users of the export projects, we continue to be concerned about a number of issues, some of which we commented on when the documents were originally provided as administrative drafts in early 2013, that remain unaddressed.

For the BDCP to be successful, it will require support from a broad constituency. The BDCP must focus on a project that is implementable from financial, technical, and political perspectives. The very slow progress being made on the so-called "near term projects" in the Delta should serve as a cautionary tale for what is truly implementable. Unfortunately, after eight years of struggling to define the project and develop a financing strategy, the BDCP has not demonstrated a clear understanding of legitimate concerns and objections raised by many stakeholders and entities such as the Delta Independent Science Board and the Independent Review Panel. The BDCP and EIR/EIS consistently understate uncertainties and rely on a poorly defined and underfunded "adaptive management" program to address the unknowns at some time in the future.

Despite the clear dedication of the BDCP and EIR/EIS authors in addressing the complexities related to new conveyance and the other conservation measures, the Plan remains incomplete because it does not analyze any version of the portfolio alternative proposed by EBMUD and other stakeholders. BDCP proponents insist that additional storage, water use efficiency, Delta levee improvement, regional coordination, and alternative supplies will be addressed in other processes, but the BDCP is claiming an enormous share of public resources and political attention. We recognize the challenges of moving forward on multiple fronts; however, a narrower focus on the existing BDCP goals is destined to lead to more conflict and delay.

Draft EIR/EIS is Incomplete and Inadequate

The draft EIR/EIS is incomplete and inadequate. It has failed to consider significant impacts and depends on optimistic projections that have no basis in fact. The draft Implementing Agreement (IA), integral to the understanding of how the BDCP will function, is also incomplete and largely based on conjecture about future agreements and conditions. Since the documents are incomplete, the comments that follow are necessarily incomplete and subject to additional comment as a recirculated EIR/supplemental EIS and IA are completed.

Fundamentally flawed modeling

The climate change scenario violates CEQA and NEPA because the No Action Alternative (NAA) assumes certain changes as the result of climate change, and that the export projects' water operations would continue as if the climate changes were not taking place. As a result, under the NAA major California reservoirs are projected to operate to dead pool conditions in approximately 10% of years. Such operations do not reflect what "would reasonably be expected to occur" and do not include "predictable actions" (as required by CEQA and NEPA) that would likely be taken by water managers to avoid such conditions. This years' experience at Folsom Reservoir demonstrates the lengths to which water managers will go to avoid depleting water levels approaching the dead pool. The NAA is unrealistic and no confidence can be placed in the EIR/EIS comparisons between the NAA and the project alternatives. Unfortunately, the flawed modeling fails to meet the CEQA and NEPA standards to provide the public with accurate information on the potential impacts of the project. Attachment 1 provides further discussion and documentation on this technical issue.

Incomplete assessment of Mokelumne fishery impacts

The EIR/EIS documents fail to provide a complete assessment of the potential impacts on the Mokelumne River fisheries as required by CEQA/NEPA. As we have noted previously, the BDCP frequently assumes that the Mokelumne is "part of" either the San Joaquin or Sacramento Rivers. It inappropriately either extrapolates results to the Mokelumne River from studies conducted on those river systems, or combines data from different systems to determine "overall" impacts on a species while failing to identify specific impacts on Mokelumne populations.

Specific to the conservation measures, the only actions directed at the Mokelumne River involve the construction of 1,500 acres of seasonal floodplain which have uncertain benefits. The only modeled result from building the habitat is that it will increase residency time of Mokelumne and Cosumnes River origin water within the central Delta. Increasing the residency time of Mokelumne and Cosumnes River origin water may adversely affect juvenile salmonid survivability, and the EIR/EIS fails to include that potential impact. Throughout the document the poor survival outcome for salmonids migrating via the central Delta is described in detail using results from studies focused on Sacramento origin salmonids, not Mokelumne and Cosumnes.

Likewise, the EIR/EIS discusses the influence of DCC operations on migrating adult fall-run salmon. As far back as 1989 the operation of the DCC was identified as a potential impact to salmonid migration in the first meeting of the multi-agency Mokelumne River Technical Advisory Committee. The Lower Mokelumne River Partnership, which includes representatives from CDFW, USFWS, and NMFS worked with USBR to develop a low-risk study plan looking at the effects of DCC closures on migrating salmon. Moreover, both USFWS and CDFW provided comments supporting continued evaluation of DCC closures to improve salmon returns to both the Sacramento and Mokelumne River systems. Yet, no such evaluations are presented as part of the BDCP nor are any other studies or actions focused on Mokelumne origin salmonids proposed in the document. While the hazards and low survival of migratory fish passing through the central Delta are recognized, no attempt is made to determine or overcome the uncertainties involved in the limited measures targeting the area.

The Mokelumne is a distinct river system and the Mokelumne fish face conditions that are significantly different than those in the San Joaquin and Sacramento Rivers. It is essential that the BDCP assess impacts specifically on the Mokelumne fishery, as the Mokelumne River contributes a very high percentage of non-Sacramento-origin salmonid return in the Central Valley. Attachment 2 provides additional technical comments and recommendations regarding fishery impacts.

Assurances not justified given significant uncertainties

Hidden costs of "No Surprises" assurances: A key component of the BDCP is the assurances that will be granted to the project proponents in the form of long-term operating permits. Under both the federal ESA and the NCCP Act, assurances ("No Surprises" benefits) are available to permittees in exchange for commitments to implement conservation measures in accordance with an approved HCP/NCCP. As described in Chapter 6 in the BDCP, under the No Surprises rule, "[i]f the status of a species addressed under an HCP unexpectedly worsens because of unforeseen circumstances, the primary obligation for implementing additional conservation measures would be the responsibility of the Federal government, other government agencies, or other non-Federal landowners who have not yet developed an HCP." (BDCP at 6-29 through 30 [citing 63 Fed. Reg. 8867].)

The core concern for EBMUD is about how the assurances provided to BDCP permittees might affect non-permittees; specifically, where will the water and funding come from to implement additional measures that may be required? The BDCP leaves many related questions unanswered.

Assurances must be proportional to the certainty that the BDCP will be effective. *See, e.g.*, Fish and Game Code § 2820(f)(1) (listing factors CDFW must consider in determining the level of assurances to be provided to permittees). Unfortunately, the BDCP, a habitat conservation plan/natural community conservation plan of unprecedented scope and complexity, is pervaded by uncertainties regarding costs, funding, operations, conservation measure implementation, conservation measure outcomes, and the "silver bullet" of adaptive management.

As the Independent Review Panel (Panel) noted in its March 2014 review of the draft EIR/EIS, "many of the critical justifications behind the supposed benefits of the conservation measures are highly uncertain." The Panel further noted; "Uncertainty plus uncertainty is more uncertainty. Uncertainty never averages or cancels out uncertainty." Given the high uncertainties, it is difficult to imagine how any long-term assurances could be granted to the permittees.

Adaptive management is ill-defined and significantly underfunded: The BDCP relies heavily on the concept of adaptive management. The Panel noted that the "foundation of the BDCP is weak" and the "burden to ensure covered species benefit, if not recovery, depends on adaptive management."

Adaptive management is defined as a structured, iterative process of decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. Critical to adaptive management is effective system monitoring that provides accurate, timely, and useful information for iterative decision making. Unfortunately, the BDCP fails to demonstrate a firm commitment to the adaptive management process. Active ecological monitoring, independent scientific review, and feedback systems are lacking in the BDCP. The adaptive management program offered by the BDCP is ill-defined and lacking in scientific rigor and adequate funding.

For adaptive management to provide any degree of success, it must either be implemented as a specific and mandatory conservation measure, or in some other way be made a firm and clear commitment of the BDCP with appropriate levels of dedicated funding.

In Appendix 8A, costs associated with monitoring actions for many of the conservation measures have been subsumed under a general category of administrative costs. Such an approach heightens the risk of underfunding a critical element of adaptive management. A transparent, comprehensive and dedicated budget must be developed that covers all the adaptive management costs, including active monitoring, independent scientific review, and feedback systems. The budget should also reflect the fact that there is significant uncertainty in the system and the monitoring and review must be sufficient to track the system responses.

EBMUD has extensive experience with biological monitoring of the Mokelumne fishery as well as the costs involved in comprehensive ecosystem monitoring. The cost estimates provided in the BDCP for adaptive management are significantly underestimated and demonstrate a serious misunderstanding of the needs associated with the implementation of an adaptive management program as complex as that required for the BDCP. For example, the cost estimate presented in Appendix 8A-122 for Monitoring Action 16-2 is unrealistically low. The plan estimates a program cost for MA16-2 of $3.5 million over 5 years, but based on EBMUD's experience with fish tagging, the cost of tags alone will be about $4.9 million, not including staff time, data analysis, or camera monitoring equipment. In this one example, the monitoring costs are underestimated by nearly 50%, suggesting a broader concern with the cost estimates of the entire adaptive management program.

A poorly conceived and underfunded adaptive management program is more likely to result in poor performance that will negatively affect covered species and produce unexpected or "unforeseen" circumstances. The inadequate planning for adaptive management increases the risk that government agencies and others will be forced to fund additional measures for protecting the species.

Impact of assurances on water supplies: If USBR provides water from federal facilities as an element of "additional measures" it undertakes in the BDCP, it is reasonable to expect that such action would reduce the water supplies available to CVP contractors that are not BDCP permittees. In the Conservation Strategy chapter (3.4.23.4) there is a reference to "voluntary sellers [of] long-term access to water for the purposes of, among other things, enhancing environmental conditions in the Delta." However, the existence of such voluntary sellers is speculative and section 3.4.23.1 states that adaptive management actions will be "water-neutral" for BDCP permittees. Therefore, a zero-sum situation might easily ensue in which CVP contractual obligations are directly in conflict with assurances for yield under the BDCP. It is likely that adaptive management will require increased Delta flows and with the "water-neutral" assurance, those increased flows could only derive from non-permittees. The BDCP does not address how such a situation would be managed or resolved.

In a similar vein, water right holders could be subject to the same risk. Despite a commitment from the current Governor that other water users will not be harmed by the BDCP, it can be expected that the BDCP permittees would exert great effort to ensure that their investment "paid off". Once the BDCP has been permitted, the agencies will be under increased obligation to implement the conservation measures in all circumstances, foreseeable and otherwise. Water right holders could be subject to increased flow releases to meet water quality standards, or to address adverse changes in the status of covered species, as a "backstop" for the assurances granted to BDCP permittees.

Finally, the implementation of additional measures by the federal and state agencies will require funding. The inclusion of "non-Federal landowners" along with the Federal and other parties responsible for funding such measures is of concern for two reasons. First, the term "non-Federal landowners" is not defined, therefore many water users could fall into that category. And second, "non-Federal landowners" are not cited in the language of the rule itself.

As noted below, the failure of Chapter 8 to identify firm funding sources for virtually the entire Plan, let alone procedures for dealing with unforeseen circumstances, leaves open significant questions about whether non-permittee water users could be exposed to costs of BDCP implementation, whether in the form of water supplies or dollar funds.

Unrealistic cost estimates and speculative funding sources

Failure to comply with ESA and NCCPA: The BDCP does not comply with ESA and NCCP Act standards for cost estimates and funding projections. As in previous drafts of the BDCP, Chapter 8 provides inadequate information for a reasoned assessment of how the BDCP will be paid for, and by whom.

At a threshold level, Chapter 8 (Implementation Costs and Funding Sources) does not meet the requirements of the NCCP Act, which requires an Implementation Agreement detailing, among other things: 1) provisions "specifying the actions [CDFW] shall take... if the plan participant fails to provide adequate funding"; and 2) "mechanisms to ensure adequate funding to carry out the conservation actions identified in the plan" (Fish and Game Code Section 2820(b)(3)).

Similarly, the federal ESA requires that HCPs specify "the applicant will ensure that adequate funding for the plan will be provided" for conservation actions that minimize and mitigate impacts on covered species. The statute, applicable case law, and guidance documents provide that the BDCP:

- Must "ensure" funding over the lifetime of the permit;
- Cannot rely on federal funding to "ensure" funding of the plan in light of the "Anti-Deficiency Act and the availability of appropriated funds";
- Must provide "remedies for failure to meet funding obligations by signatory measures";
- "Cannot rely on speculative future actions of others" for funding; and
- Must be backed by a guarantee by the applicant to ensure funding for all plan elements.[1]

The BDCP meets none of these conditions, and in fact relies on arguments that are expressly in contradiction to the statutory requirements.

In essence, the BDCP will rely on funding from three primary sources: state and federal water contractors, two state water bonds, and continuing and expanded federal appropriations. Each of these three sources is fraught with uncertainties that pose fundamental challenges to the financial viability of the Plan.

State and federal contractors: Chapter 8 provides barely any elaboration on the statement that "funding of CM1 Water Facilities and Operation will come from state and federal contractors." Critical information is lacking on:

- The respective financial obligation of urban and agricultural contractors;

[1] 16 USC 1539(a)(2)(B)(iii); *National Wildlife Federation v. Babbit*, 128 F.Supp.2d 1274, 1294-95 (E.D. Cal., 2000); *Southwest Center for Biological Diversity v. Bartel*, 470 F.Supp.2d 1118, 1155 (S.D. Cal., 2006); HCP Handbook, pp. 3-33 to 3-34.

- The ability and willingness to pay on the part of the agricultural contractors, who will use approximately 70% of the yield;
- How the $2 billion obligation previously assigned to the Friant Water Users will be paid;
- The financial obligation, if any, of the CVP contractors who are not BDCP permittees regarding Level 2 refuge supplies; and
- The respective financial obligation of the CVP and SWP contractors.

On this last point, the Plan states that "The actual funding share that is provided by the state versus federal water contractors for CM1 will be determined near the time that permits are issued for the BDCP." Delaying important financing decisions to the end of the permitting process effectively precludes the opportunity for the public to identify, evaluate, and communicate any concerns. This is particularly relevant given the possibility that the state (and therefore its taxpayers) might have to be the guarantor of any default by the Plan permittees, or that a statewide water use surcharge might be enacted to cover unmet costs.

<u>State water bonds:</u> The BDCP assumes that two water bonds, totaling more than $3.7 billion and 91% of the state share of the non-conveyance BDCP costs, will be approved by the voters. Given that the bond bills currently before the legislature dedicate no more than $1.5 billion to Delta sustainability, this projection of state bond funding for the BDCP is unrealistically optimistic even if a bond measure were to pass.

The case *Southwest Center for Biological Diversity v. Bartel* directly addresses reliance on funding from a future bond requiring voter approval. In the case of *Southwest Ctr. for Biological Diversity v. Bartel*, 470 F.Supp.2d 1118 (S.D. Cal. 2006), the Court noted that "the uncertainty of these ideas is readily apparent," that such funding is speculative in light of future voter approval requirements, and that relying on future bonds does not meet the requirement to ensure funding of an HCP under the ESA. (See id. at 1156.)

Further, under the NCCP Act, the reliance on speculative future funding from state water bonds gives no reasonable assurance of maintaining "rough proportionality between impacts on habitat or covered species and conservation measures" (Fish and Game Code Section 2820(b)(3)(B)). Nor can reliance on speculative future state water bonds meet the requirement for the Implementation Agreement to include mechanisms to ensure adequate funding. Fish and Game Code Section 2820(b)(8).

<u>Continuing and expanded federal appropriations:</u> Several very optimistic assumptions are required to accept the Plan's projections of future federal funding. The discussion begins with a description of the CVPIA Restoration Fund, and an expectation that this over-subscribed source could be used to fund several conservation measures in the BDCP. In an equally hopeful manner, the Plan projects future federal funding based on past appropriations to a wide variety of existing programs that are already committed to supporting other actions. However, the evidence is entirely in support of the opposite

trend: federal funding for a huge array of discretionary programs has been declining for years, with no sign that a reversal can be expected.

Impacts on EBMUD facilities

Impacts on existing and proposed Mokelumne Aqueducts: The BDCP and EIR/EIS need to address a likely conflict between a future EBMUD cross-Delta tunnel and the proposed BDCP tunnels. EBMUD owns the land and subsurface rights along the alignment of the Mokelumne Aqueducts. Ninety miles of aqueducts traverse the Delta from Pardee Reservoir in the east to Walnut Creek in the west. In their east-west crossing of the Delta, the aqueducts pass over Lower Roberts Island, Upper Jones Tract, Woodward Island, and Palm-Orwood Tract. EBMUD has begun planning for a cross-Delta tunnel that could replace its existing above-ground aqueducts. In a telephone conversation on March 12, 2012, and in a follow up email on March 23, 2012, EBMUD staff discussed with DWR the potential conflicts between a BDCP tunnel and EBMUD's planned cross-Delta tunnel. EBMUD's design for its cross-Delta aqueduct places the EBMUD tunnels within an elevation range of -100 ft msl to -143 ft msl. Tunnel design will be developed further in the future, and subsequent design phases may identify a tunnel profile outside of these elevations. The proposed BDCP tunnels will intersect the EBMUD property, existing aqueducts, and planned cross-Delta tunnel. Despite prior notification given by EBMUD to DWR, the BDCP documents fail to note the potential conflict, analyze the resulting environmental impacts, or propose mitigation. In fact, Chapter 13.1.5 of the BDCP Conceptual Engineering Report – which is the only mention, to our knowledge, of the Mokelumne Aqueduct crossing in the available BDCP documents – erroneously concludes that "no conflicts are anticipated" with regard to the Mokelumne Aqueduct crossing. The BDCP EIR/EIS must address this reasonably foreseeable conflict, and EBMUD expects the BDCP to avoid tunneling within the -100 to -143 msl elevation range at the site of the tunnel intersection and also to provide an appropriate additional buffer between the two facilities.

Attachment 3 provides additional documentation to clarify EBMUD's existing and planned facilities, and it is incorporated into this comment letter by reference. The EIR/EIS must address how the BDCP proponents will mitigate the environmental impacts that will result from conflicts with EBMUD's existing and planned facilities. As explained in detail in Attachment 3, the BDCP tunnel threatens to expose the Mokelumne Aqueducts and their deep foundations to substantial adverse effects resulting from soil settlement/subsidence, undermining, lateral earth movement, construction vibrations and vibration induced settlement. Attachment 3 also provides detailed mitigation measures that will be necessary to protect the existing aqueduct facilities. Protecting this existing infrastructure is especially important given its vital role in the provision of reliable and safe drinking water service to the approximately 1.3 million people within EBMUD's service area. Accordingly, not only is the BDCP tunnel likely to cause significant direct impacts along the Mokelumne Aqueduct and EBMUD's right-of-way, it also poses a significant risk of indirect environmental impacts resulting from the potential suspension of water service that could occur if its impacts on EBMUD's facilities are not appropriately mitigated. For similar reasons, as discussed in Attachment 3, the BDCP tunnel is also likely to cause significant cumulative impacts when considered in conjunction with EBMUD's future cross-Delta tunnel project. Because the DEIR/EIS failed entirely to consider these significant impacts, a supplemental DEIS/recirculated DEIR must be prepared and made available for public comment. *See* CEQA Guidelines § 15088.5 (setting forth standard for EIR recirculation); 40 C.F.R. § 1502.9(c)(1).

Impacts on Freeport Regional Water Project: The EIR/EIS fails to address adverse impacts that the BDCP intake facilities may have on operations of the existing Freeport Regional Water Project (FRWP) facilities. Modeling simulations performed with DSM2 by DWR, and confirmed by independent DSM2 modeling, show that proposed BDCP operations will cause a significant increase in reverse flows in the Sacramento river in the vicinity of Freeport, and such flow changes will adversely impact FRWP operations. Interruption of FRWP operations poses a risk of indirect environmental impacts resulting from the potential suspension of water service that could occur if FRWP operations were curtailed as the result of reverse flows. The modeling results show that eventual wetland restoration in certain areas will mitigate these impacts, but such restorations should be undertaken concurrently with, or in advance of, the conveyance construction so as not to delay the mitigation. Attachment 4 provides additional details regarding this issue.

Unfounded "optimistic bias" present throughout the documents

In a number of critical aspects, the BDCP relies on optimal conditions and outcomes to achieve its goals. In its draft report released in May, the Delta Independent Science Board states that "Expectations for the effectiveness of conservation actions are too optimistic" for the purposes of counterbalancing any negative impacts of water diversions and changes in flow. In other words, there is well-grounded doubt that the proposed ecosystem measures will be able to contribute to the recovery of the listed species to the extent assumed.

As noted by the Independent Review Panel, the BDCP and EIR/EIS authors used "professional judgment" rather than scientific data to understate or ignore uncertainties and arrive at conclusions that are more positive than the science suggests. Such scientifically unsupported "optimistic bias" present throughout the entire BDCP process is disconcerting. It implies an unwillingness of the project proponents to view the project realistically. The findings of the numerous peer reviews strongly suggest that the EIR/EIS has failed to adhere to best available science as required by the ESA, NCCPA, and Delta Reform Act. It is critical that the EIR/EIS be thorough, non-biased, and realistic. EBMUD is greatly concerned that unjustified assurances granted through the BDCP will result in fiscal and resource responsibilities being shifted to non-BDCP permittees.

Finally, in Chapter 8 the BDCP asserts that "The potential funding sources described in this chapter have been made conservatively. That is, costs may be lower than estimated, or actual funding from state and federal sources may exceed these projections." This claim is unsubstantiated, and ignores the distinct possibility that costs may be higher than expected, and that actual funding from state and federal sources may be substantially less than the projections. We believe the costs associated with implementing a viable adaptive management program have not been given serious consideration. And on a broader level, the BDCP simply has not been realistic about the range of possible outcomes in cost and performance. The proposed BDCP tunnels are unprecedented in their scale and magnitude, which would seem to heighten the uncertainties over the cost estimates of construction and operation. Nonetheless, the BDCP fails to consider the likely cost overruns and instead notes that "costs may be lower than estimated." The BDCP and draft EIR/EIS rely on unfounded optimistic bias in both restoration effectiveness and financial projections, and therefore fail to comply with the ESA and NCCP Act standards for use of best available science and cost estimates and funding projections.

The following documents are attached:

- Attachment 1 – Report on Review of Bay Delta Conservation Program Modeling
- Attachment 2 – Mokelumne Fisheries
- Attachment 3 – Existing and Future EBMUD Facilities, BDCP Impacts and Proposed Mitigations
- Attachment 4 – BDCP Impacts on Freeport Regional Water Project

We appreciate this opportunity to provide comments on the BDCP documents. If you have any questions about these comments, please contact Doug Wallace at 510-287-1370.

Sincerely,

Richard G. Sykes
Director of Water and Natural Resources

Attachments

cc: Charles Bonham, California Department of Fish and Wildlife
Mark Cowin, California Department of Water Resources
Randy Fiorini, Delta Stewardship Council
Campbell Ingram, Sacramento – San Joaquin Delta Conservancy
Ren Lohoefener, U.S. Fish and Wildlife Service
David Murillo, U.S. Department of Interior, Bureau of Reclamation
Maria Rea, National Marine Fisheries Service

RGS:PGS:dec

Attachment 1

Report on Review of Bay Delta Conservation Program Modeling

Report on Review of Bay Delta Conservation Program Modeling

Foreword

Since December 2012, MBK Engineers and Dan Steiner (collectively "Reviewers") have assisted various parties in evaluating the operations modeling that was performed for the Bay Delta Conservation Plan (BDCP). To assist in understanding BDCP and the potential implications, stakeholders[1] requested that the Reviewers review the CalSim II modeling studies performed as part of the BDCP (hereafter "BDCP Studies" or "BDCP Model").

An initial review led the Reviewers to conclude that the BDCP Model, which serves as the basis for the environmental analysis contained in the BDCP Environmental Impact Report/Statement (EIR/S), provides very limited useful information to understand the effects of the BDCP. The BDCP Model contains erroneous assumptions, errors, and outdated tools, which result in impractical or unrealistic Central Valley Project (CVP) and State Water Project (SWP) operations. The unrealistic operations, in turn, do not accurately depict the effects of the BDCP.

The Reviewers revised the BDCP Model to depict a more accurate, consistent version of current and future benchmark hydrology so that the effects of the BDCP could be ascertained. The BDCP Model was also revised to depict more realistic CVP and SWP operations upon which to contrast the various BDCP alternatives. The Reviewers made significant efforts to coordinate with and inform the U.S. Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR) managers and modelers, and CVP and SWP operators of the Reviewers' modifications, assumptions, and findings. Where appropriate, the Reviewers also used Reclamation and DWR's guidance and direction to refine the Reviewers' analysis.

This Report summarizes: (1) the Reviewers' independent analysis and review of the BDCP Model, publicly released for the BDCP's Draft EIR/S in December 2013, (2) the Reviewers' updates and corrections made to the BDCP Model, and (3) comparisons between the original BDCP Model and the independent Model as revised by the Reviewers.

[1] The entities who funded this report are Contra Costa Water District, East Bay Municipal Utility District, Friant Water Authority, Northern California Water Association, North Delta Water Agency, San Joaquin River Exchange Contractors Water Authority, San Joaquin Tributaries Authority, and Tehama Colusa Canal Authority.

Contents

1 EXECUTIVE SUMMARY

Purpose of this Report

The CalSim II model is the foundational model for analysis of the BDCP, including the effects analysis in the Draft BDCP and the impacts evaluation in the Draft BDCP Environmental Impact Report/Statement (EIR/S). Results from CalSim II are used to examine how water supply and reservoir operations are modified by the BDCP. The results are also used by subsequent models to determine physical and biological effects, such as water quality, water levels, temperature, Delta flows, and fish response. Any errors and inconsistencies identified in the underlying CalSim II model are therefore present in subsequent models and adversely affect the results of later analyses based on those subsequent models.

The purpose of this Report is to examine the underlying CalSim II model used in support of the BDCP EIR/EIS and to analyze proposed operational scenarios contained in the BDCP. In undertaking the analysis for this Report, the Reviewers examined the model used in support of BDCP, the 2010 version of the CalSim II Model (BDCP Model), as well as the information contained in the Public Review Draft BDCP, released in December 2013. There are three basic reasons why the BDCP Model cannot be used to determine the effects of the BDCP: 1) the no action alternatives do not depict reasonable operations due to climate change assumptions, 2) operating criteria used in the BDCP Alternative 4 result in unrealistic operations, and 3) updates to CalSim II since the BDCP modeling was performed almost 4 years ago alter model results.

Given that it was not possible to determine how the BDCP may affect CVP and SWP operations or water system flows and conditions using the BDCP Model, independent modeling was performed to assess the potential effects of the BDCP. The first phase of this independent modeling effort was development of an updated without project baseline, which is similar to the no action alternative but with current, improved assumptions. The 2010 version of the CalSim II Model was used as the basis for the BDCP Model. The most recent version of CalSim II is the 2013 version used by DWR in its 2013 State Water Project Water Delivery Reliability Report (2013 CalSim II Model), and has undergone significant revision to not only correct errors in the 2010 model, but also to reflect regulatory changes that adversely affect the accuracy and dependability of the 2010 CalSim II Model. The BDCP was developed and analyzed using the 2010 CalSim II Model, and the changes and improvements reflected in the 2013 CalSim II Model were not used for the BDCP. For the purpose of the Reviewers' analysis and this Report, the 2013 CalSim II Model was further modified to incorporate additional updates, assumptions, and fixes. Some of these most recent Reviewer modifications have been accepted by both DWR and Reclamation, and are now incorporated into the CalSim II models that DWR and Reclamation use in conducting their own analyses. The second phase of the independent modeling effort (described in Section 4.2) incorporated the facilities and operations for the BDCP described as Alternative 4 H3 in the Draft EIR/EIS.

The manner in which the CVP and SWP are operated in the "With Project" and "Without Project" modeling scenarios significantly influences the BDCP "effects analysis". Modeling scenarios must depict how the actual system operates or how it might operate so that realistic effects can be determined. Modeling results from CalSim II are used to examine the effects of BDCP on water supply and reservoir operations, and the modeling results are also used by subsequent models to determine physical and biological effects, such as water quality, water levels, temperature, Delta flows, and fish response. If CalSim II modeling does not appropriately characterize operations in both the "With Project" and "Without Project" scenarios, the effects based on CalSim II will also not be appropriately characterized. The independent model provides a more accurate platform to assess the operations of the BDCP and isolates the effects of the BDCP from climate change. Comparing the results of the independent model to those of the BDCP model reveals significant differences in water operations and potential environmental impacts.

Key Conclusions

Assumptions, errors, and outdated tools used in the BDCP Model results in impractical or unrealistic CVP and SWP operations. Therefore, the BDCP Model provides very limited useful information to illustrate the effects of the BDCP.

Methodology used to incorporate climate change contains errors and does not incorporate reasonably foreseeable adaptation measures:

Climate change assumptions were incorrectly applied, yielding non-sensible results.

Climate change hydrology in the Upper San Joaquin River basin was incorporated incorrectly into the BDCP Model. Although inflow to Millerton Lake is expected to *decrease* under future climate scenarios, the error in the BDCP Model causes the amount of stored water in Millerton Lake to *increase* by inappropriately reducing water deliveries to the Friant Division. BDCP erroneously overestimates Millerton Lake storage, which causes an overestimation of reservoir releases and available water downstream. Because overall CVP operations and the San Joaquin River are interconnected, this error causes problems throughout the CVP system. With the coordinated operations of the CVP and SWP, this error can affect the SWP system.

Incorporation of climate change ignores reasonably foreseeable adaptation measures.

The BDCP Model uses assumed future climate conditions that obscure the effects of implementing the BDCP. The future conditions assumed in the BDCP model include changes in precipitation, temperature, and sea level rise. The result of this evaluation is that the modeled changes in water project operations and subsequent environmental impacts are caused by three different factors: (1) sea level rise; (2) climate change; and (3) implementation of the alternative that is being studied.

Including climate change, without adaptation measures, results in insufficient water needed to meet all regulatory objectives and user demands. For example, the BDCP Model results that include climate change indicate that during droughts, water in reservoirs is reduced to the minimum capacity possible. Reservoirs have not been operated like this in the past during extreme droughts and the current drought also provides evidence that adaptation measures are called for long in advanced to avoid draining the reservoirs. In this aspect, the BDCP Model simply does not reflect a real future condition. Foreseeable adaptations that the CVP and SWP could make in response to climate change include: (1) updating operational rules regarding water releases from reservoirs for flood protection; (2) during severe droughts, emergency drought declarations could call for mandatory conservation and changes in some regulatory criteria similar to what has been experienced in the current and previous droughts; and (3) if droughts become more frequent, the CVP and SWP would likely revisit the rules by which they allocate water during shortages and operate more conservatively in wetter years. The modifications to CVP and SWP operations made during the winter and spring of 2014 in response to the drought supports the likelihood of future adaptations. The BDCP Model is, however, useful in that it reveals that difficult decisions must be made in response to climate change. But, in the absence of making those decisions, the BDCP Model results themselves are not informative, particularly during drought conditions. With future conditions projected to be so dire without the BDCP, the effects of the BDCP appear positive simply because it appears that conditions cannot get any worse (i.e., storage cannot be reduced below its minimum level). However, in reality, the future condition will not be as depicted in the BDCP Model. The Reviewers recommend that Reclamation and DWR develop more realistic operating rules for the hydrologic conditions expected over the next half-century and incorporate those operating rules into any CalSim II Model that includes climate change.

The BDCP Model does not accurately reflect reasonably foreseeable conditions and changes in CVP and SWP operations due to the BDCP:

BDCP's "High Outflow Scenario" is not sufficiently defined for analysis.

The effects of many critical elements of the BDCP cannot be analyzed because those elements are not well-defined. The Reviewers recommend that the BDCP be better defined and a clear and concise operating plan be developed so that the updated CalSim II model can be used to assess effects of the BDCP.

The High Outflow Scenario (HOS) requires additional water (Delta outflow) during certain periods in the spring. The BDCP Model places most of the responsibility for meeting this new additional outflow requirement on the SWP. However, the SWP may not actually be responsible for meeting this new additional outflow requirement. This is because the Coordinated Operations Agreement ("the COA") would require a water allocation adjustment that would keep the SWP whole. Where one project (CVP or SWP) releases water to meet a regulatory requirement, the COA requires a water balancing to ensure the burden does not fall on only one of the projects. The BDCP Model is misleading because it fails to adjust project operations, as required by the COA, to "pay back" the water "debt" to the SWP due to these additional Delta outflow requirements. Unless there is a significant revision to COA, the BDCP Model overstates the impacts of increased Delta outflow on the SWP and understates the effects on the CVP.

Furthermore, after consulting with DWR and Reclamation project operators and managers, the Reviewers conclude that there is no apparent source of CVP or SWP water to satisfy both the increased Delta outflow requirements and pay back the COA "debt" to the SWP without substantially depleting upstream water storage. It appears, through recent public discussions regarding the HOS, that BDCP anticipates additional water to satisfy the increased Delta outflow requirement and to prevent the depletion of cold water pools will be acquired through water transfers from upstream water users. However, this approach is unrealistic. During most of the spring, when BDCP proposes that Delta outflow be increased, agricultural water users are not irrigating. This means that there is not sufficient transfer water available to meet the increased Delta outflow requirements and therefore, additional release of stored water from the reservoirs would be required. Releasing stored water to meet the increased Delta outflow requirements could potentially impact salmonids on the Sacramento and American River systems due to reductions in the available cold water pool.

Simulated operation of BDCP's dual conveyance, coordinating proposed North Delta diversion facilities with existing south Delta diversion facilities, is inconsistent with the project description.

The Draft BDCP and associated Draft EIR/EIS specify criteria for how much flow can be diverted by the new North Delta Diversion (NDD) facilities and specify when to preferentially use either the NDD facilities or the existing South Delta diversion (SDD) facilities. However, the BDCP Model contains an artificial constraint that prevents the NDD facilities from taking water as described in the BDCP project description. In addition to affecting diversions from the NDD, this artificial constraint contains errors that affect the No Action Alternative (NAA) operation. This error has been fixed by DWR and Reclamation in the more recent 2013 CalSim II Model; however, the error remains in the BDCP Model. Additionally, the BDCP Model does not reflect the summer operations of the SDD that are described in the Draft EIR/EIS as a feature of the BDCP project intended to prevent water quality degradation in the south Delta. The net effect of these two errors is that the BDCP Model significantly underestimates the amount of water diverted from the NDD facilities and overestimates the amount of water diverted from the SDD. The further decrease in flows through the Delta, in comparison to what is presented in the BDCP Draft EIR/EIS, would likely result in even greater degradation in Delta water quality than reported.

The BDCP Model contains numerous coding and data issues that significantly skew the analysis and conflict with actual real-time operational objectives and constraints

Operating rules used in the BDCP Model, specifically regarding Alternative 4, result in impractical or unrealistic CVP and SWP operations. Reservoir balancing rules cause significant drawdown of upstream reservoirs during spring and summer months while targeting dead pool level in San Luis from September through December resulting in artificially low Delta exports and water shortages. CVP allocation rules are set to artificially reduce south of Delta allocations during wetter years resulting in underestimates of diversions at the NDD and the SDD. Operating rules for the Delta Cross Channel Gate do not reflect how the gates may be operated in “With Project” conditions.

Operational logic is coded into the CalSim II model to simulate how DWR and Reclamation would operate the system under circumstances for which there are no regulatory or other definitive rules. This attempt to specify (i.e., code) the logic sequence and relative weighting so that a computer can simulate “expert judgment” of the human operators is a critical element to the CalSim II model. In the BDCP version of the CalSim II model, some of the operational criteria for water supply allocations and existing facilities such as the Delta Cross Channel and San Luis Reservoir are inconsistent with real-world conditions.

The BDCP Model, as modified by the Reviewers, corrected some of the inconsistencies between the operational criteria in the BDCP Model and real-world conditions, and confirmed these changes with CVP and SWP operators. By correcting the operational criteria, the modified BDCP model (Independent Model) output is more accurate and consistent with real-world operational objectives and constraints.

Independent modeling of the BDCP revealed differences in CVP and SWP operations and water deliveries from the analysis disclosed for the Draft EIR/EIS.

The independent model provides a more accurate platform to assess the operations of the BDCP and isolates the effects of the BDCP from climate change. Comparing the results of the independent model to those of the BDCP model reveals significant differences in water operations and potential environmental impacts. The independent model ”Without Project” baseline was compared to the independent model’s version of Alternative 4 H3-ELT of the BDCP. The updated changes in water operations from the independent model are compared to changes in operations reported in the BDCP Draft EIR/EIS for the equivalent alternatives. The difference between the updated independent model results and those reported in the BDCP Draft EIR/EIS are presented below.

- The amount of water exported (diverted from the Delta) may be approximately 200 Thousand Acre-Feet (TAF) per year *higher* than the amount disclosed in the Draft EIR/S. This total represents:
  - approximately 40 TAF/yr more water diverted and delivered to the SWP south of Delta contractors, and
  - approximately 160 TAF/yr more water diverted and delivered to the CVP south of Delta contractors.
- The BDCP Model estimates that, under the No Action Alternative at the Early Long Term (NAA – ELT) (without the BDCP), total average annual exports for CVP and SWP combined are estimated to be 4.73 million acre-feet (MAF) and in the Independent Model Future No Action (FNA) combined exports are 5.61 MAF. The BDCP Model indicates an increase in exports of approximately 540 TAF and the Independent Model shows an increase of approximately 750 TAF in Alt 4.

- Delta outflow would decrease by approximately 200 TAF/yr compared to the quantity indicated in the Draft EIR/S.
  - This lesser amount of Delta outflow has the potential to cause more significant water quality and supply impacts for in-Delta beneficial uses and additional adverse effects on species. To determine the potential effects of the reduced amount of Delta outflow, additional modeling is needed using tools such as DSM2.
- The BDCP Model does not accurately reflect the location of the diversions that the SWP and CVP will make from the Delta.
  - When the errors in the BDCP Model are corrected, the Independent Model reveals that the NDD could divert approximately 680 TAF/yr more than what is disclosed in the BDCP Draft EIR/S.
  - Conversely, the quantity of water diverted through the existing SDD would be approximately 460 TAF/yr less than what is projected in the BDCP Draft EIR/S.
  - This difference in the location of diversions has the potential to reduce water quality in the Central and South Delta in ways that were not analyzed in the BDCP Draft EIR/S

Additional Observations and Recommendations

This review identified and remedied several modeling deficiencies that should be used by others as the BDCP and other projects move forward. However, the work done to date by the Reviewers does not capture all of the improvements necessary to depict the effects of the BDCP accurately. There are many operational uncertainties in the BDCP that require attention and must be addressed. The Reviewers offer several recommendations so that future CalSim II modeling of the BDCP will yield more meaningful results.

1. Ensure model operations of existing facilities are consistent with contemporary real world operations to the extent possible.
   a. Ensure reservoirs are not routinely drawn down to dead pool as part of 'normal' operations.
2. Given the expected changes in hydrologic conditions over the next half century, realistic operating rules for all CVP and SWP facilities, including the BDCP, must be developed.
   a. Develop a 'drought' operations plan that includes adaptations.
   b. Alter reservoir flood release operations to match the assumed shift in precipitation patterns.
   c. Perform a sensitivity analysis using a range of possible future climates.
3. BDCP operations must be defined in a clear and concise manner.
   a. Transfer water required to make an alternative feasible should be identified so the effects of that transfer can be determined.
   b. Adaptive management limits and targets must be better defined
   c. Changes to the existing COA to accommodate the BDCP must be defined.
   d. Modeled export operations spilt between the north and south intakes must be consistent with the project description.
   e. Changes in the DCC operations should be defined.
   f. Refined reservoir balancing rules

The BDCP Model must be revised prior to drawing conclusions regarding the environmental effects of the BDCP. The BDCP Model is an outdated version of the CalSim II model, which contains known errors. Only by incorporating the changes made to date by the Reviewers, incorporating the additional recommended changes above, and potential additional refinements can the effects of the BDCP be determined. Reasonable conclusions can only be drawn once these changes are made to the BDCP Model; therefore, the Reviewers recommend that Reclamation and DWR make these changes.

2 INTRODUCTION

The Public Draft BDCP has been prepared by DWR, with assistance and input from Reclamation and various entities that receive water from the SWP and CVP. The BDCP is being prepared to comply with the federal Endangered Species Act, and certain other federal and state mandates. The BDCP proposes a number of Conservation Measures that, if implemented, are believed to provide some benefit to various species covered by the BDCP in the Delta. The Conservation Measures proposed in the Public Draft BDCP include new conveyance facilities and modified operations of the SWP and CVP, as well as other Conservation Measures addressing water quality, predation, and other habitat-related measures. The BDCP has been in development for several years. DWR also has prepared a Public Draft EIR/EIS in an attempt to satisfy CEQA and NEPA. Both the Public Draft BDCP and the Public Draft EIR/EIS were released for public review and comment in December 2013. This Report analyzes the BDCP as proposed and analyzed in the documents released in December 2013.

The Public Draft EIR/EIS considered several water facility and operational configurations, ultimately identifying "Alternative 4" as the preferred alternative under CEQA. (Public Draft EIR/EIS, Section 3.1.1) In addition to identifying physical facilities, the Public Draft EIR/EIS identifies an operational scenario (Alternative 4, Operation Scenario H) as the proposed operation regime for the new and existing facilities. (Public Draft EIR/EIS, Section 3.1.1, Section 5.3.3.9.) Alternative 4, Operational Scenario H is further divided into four sub-operational scenarios, which vary depending on Fall and Spring Delta outflow requirements. Those sub-scenarios are: Alternative 4 Operational Scenario H1 (Alternative 4 H1); Alternative 4 Operational Scenario H2 (Alternative 4 H2); Alternative 4 Operational Scenario H3 (Alternative 4 H3); and Alternative 4 Operational Scenario H4 (Alternative 4 H4). (Public Draft EIR/EIS, section 5.3.3.9.)

In general the differences between the various operational sub-scenarios are as follows. Alternative 4 H1 does not include enhanced spring outflow requirements or Fall X2 requirements. Alternative 4 H2 includes enhanced spring outflow requirements but not Fall X2 requirements. Alternative 4 H3 does not include enhanced spring outflow requirements but includes Fall X2 requirements. Alternative 4 H4 includes both enhanced spring outflow requirements and Fall X2 requirements. (Public Draft EIR/EIS, section 5.3.3.9.) This Report focuses on Alternative 4 H4 and Alternative 4 H3.

The task of the Reviewers was to review the CalSim II modeling which provides the foundational analysis of the BDCP. Results from CalSim II are used to examine how water supply and reservoir operations are modified by the BDCP, and the results are also used by subsequent models to determine physical and biological effects, such as water quality, water levels, temperature, Delta flows, and fish response. Any errors and inconsistencies identified in the underlying CalSim II model are therefore present in subsequent models and adversely affect the results of later analyses based on those subsequent models.

The model used in support of BDCP is the 2010 version of the CalSim II Model (BDCP Model), as well as the information contained in the Public Review Draft BDCP, released in December 2013. Since its development in 2010, the 2010 version of the CalSim II Model has undergone significant revision to not only correct errors in the model, but also to reflect regulatory changes that adversely affect the accuracy and dependability of the 2010 CalSim II Model. The updated version of CalSim II is the model used by DWR in its 2013 State Water Project Water Delivery Reliability Report (2013 CalSim II Model). The BDCP was developed and analyzed using the 2010 CalSim II Model; the changes and improvements reflected in the 2013 CalSim II Model were not used for the BDCP.

The initial review conducted by the Reviewers led to the conclusion that the BDCP Model provides very limited useful information to illustrate the effects of the BDCP. Assumptions, errors, and outdated tools used in the BDCP Model result in impractical or unrealistic CVP and SWP operations. Because of the unrealistic operations included in the BDCP Model, the Reviewers revised the BDCP Model to depict a more accurate, consistent version of current and future benchmark hydrology. The BDCP Model was also revised to depict more realistic CVP and SWP operations upon which to contrast the various BDCP alternatives. The Reviewers made significant efforts to coordinate with or inform Reclamation and DWR managers and modelers, and CVP and SWP operators of the Reviewers' modifications, assumptions, and findings. Where appropriate, the Reviewers also used Reclamation's and DWR's guidance and direction to refine the Reviewers' analysis. Although there are many models used to evaluate various effects of BDCP, this analysis and review focused on water operations analysis using the BDCP Model (CalSim II).

Purpose and Use of the CalSim II Model

The CalSim II model is a computer program jointly developed by DWR and Reclamation. CalSim II presents a comprehensive simulation of SWP and CVP operations, and it is used by DWR as a planning tool to predict future availability of SWP water. CalSim II is widely recognized as the most prominent water management model in California, and it is generally accepted as a useful and appropriate tool for assessing the water delivery capability of the SWP and the CVP.

Broadly speaking, the model estimates, for various times of the year, how much water will be diverted, will serve as instream flows (e.g., flow in the rivers at various locations, such as Delta outflow), and will remain in the reservoirs. Within the context of the BDCP, the CalSim II model is also used to estimate the amount of water that will be diverted from BDCP's proposed NDD facilities. Thus, for BDCP, the CalSim II model estimates how much water will be diverted at the NDD facilities, how much flow will remain in the Sacramento River below Hood (the approximate location of the NDD facilities), how much water will be diverted through the existing SDD facilities at Tracy, how much flow will leave the Delta by flowing out to the Bay, and how much water will remain in storage in the reservoirs. The location and timing of the diversion and the amount of water remaining instream are significant because they can cause impacts on species, water quality degradation, and the like.

The coding and assumptions included in the CalSim II model drive the results it yields. Data and assumptions, such as the amount of precipitation runoff at a certain measuring station over time or the demand for water by specific water users over time, are input into the model. The criteria that are used to operate the CVP and the SWP (including current regulatory requirements) are included in the model as assumptions; because of the volume of water associated with the CVP and the SWP, these operational criteria significantly influence the model's results. Additionally, operational logic is coded into the CalSim II model to simulate how DWR and Reclamation would operate the system under circumstances for which there are no regulatory or otherwise definitive rules (e.g., when to move water from upstream storage to south of Delta storage). This attempt to specify (i.e., code) the logic sequence and relative weighting that humans will use as part of their "expert judgment" is a critical element to the CalSim II model.

The model's ability to reliably predict the effects of a proposed action depends on the accuracy of its coding and its representation of operations criteria. In other words, the model's results will be only as good as its data, coding, assumptions, and judgment and knowledge of the modelers. For this reason, a detailed operating plan of existing facilities and the proposed facility is essential to create an accurate model of how a proposed action will change – i.e., affect – existing water operations. In reviewing the BDCP Model it became apparent that coding errors and operating assumptions are inconsistent with the actual purposes and objectives of the CVP and SWP, thus limiting the utility and accuracy of the results. Through collaboration and verification with CVP and SWP operators, the BDCP Model flaws were corrected in the revised BDCP Model (Independent Model) and the potential effects of the BDCP were re-analyzed.

3 REVIEW OF BDCP CALSIM II MODELING

The CalSim II model is the foundational model for analysis of the BDCP, including the effects analysis in the Draft BDCP and the impacts evaluation in the Draft EIR/EIS. Results from CalSim II are used to examine how water supply and reservoir operations are modified by the BDCP, and the results are also used by subsequent models to determine physical and biological effects, such as water quality, water levels, temperature, Delta flows, and fish response. Any errors and inconsistencies identified in the underlying CalSim II model are therefore present in subsequent models and adversely affect the results of later analyses based on those subsequent models.

The Reviewers' analysis of the BDCP Model is summarized in three categories: (3.1) assessment of climate change assumptions, implementation, and effects; (3.2) assessment of general assumptions and operations; and (3.3) assessment of the assumptions and operational criteria for inclusion of the new BDCP facilities. The issues discussed in (3.1) and (3.2) are relevant for all modeling scenarios, both baseline scenarios that do not include BDCP and with project scenarios that evaluate BDCP or the Alternatives. The issues discussed in (3.3) are specific to the inclusion of the BDCP as defined in the Draft Plan and identified as Alternative 4 in the Draft EIR/EIS.

3.1 Climate Change

Implementation of Climate Change

The analysis presented in the BDCP Documents attempts to incorporate the effects of climate change at two future climate periods: the early long term (ELT) at approximately the year 2025; and the late long term (LLT) at approximately 2060. As described in the BDCP documents[2], other analytical tools were used to determine anticipated changes to precipitation and air temperature that is expected to occur under ELT and LLT conditions. Projected precipitation and temperature was then used to estimate runoff into from the watersheds over an 82-year period of variable hydrology; these time series were then used as inputs into the BDCP Model. A second aspect of climate change, the anticipated amount of sea level rise, is incorporated into the BDCP CalSim II model by modifying flow-salinity relationships that estimate salinity within the Delta based on sea level and flows within Delta channels.

This Report does not evaluate the analytical processes by which reservoir inflows and runoff were developed, nor does it evaluate the modified flow-salinity relationships that are assumed due to sea level rise; those items could be the focus of another independent review. This Report is limited to evaluating how the modified flows were incorporated into the BDCP Model and whether the operation of the CVP and SWP water system in response to the modified flows and the modified flow-salinity relationship is reasonable for the ELT and LLT conditions. This work reviews the assumed underlying hydrology and simulated operation of the CVP/SWP, assumed regulatory requirements, and the resultant water delivery reliability.

Assessment of Climate Change Assumptions and Implementation

To assess climate change, the three Without Project (or "baseline" or "no action") modeling scenarios were reviewed: No Action Alternative (NAA)[3], No Action Alternative at the Early Long Term (NAA – ELT), and No Action Alternative at the Late Long Term (NAA –LLT). Assumptions for NAA, NAA-ELT, and NAA-LLT are provided in the Draft BDCP EIR/EIS Appendix 5A, Section B, Table B-8. The only difference between these scenarios is the climate-related changes made for the ELT and LLT conditions (Table 1).

[2] BDCP EIR/EIS Appendix 5A, Section A and BDCP HCP/NCCP Appendix 5.A.2
[3] NAA is also called the Existing Biological Conditions number 2 (EBC-2) in the Draft Plan.

Table 1. Scenarios used to evaluate climate change

	Climate Change Assumptions	
Scenario	**Hydrology**	**Sea Level Rise**
No Action Alternative (NAA)	None	None
No Action Alternative at Early Long Term (NAA-ELT)	Modified reservoir inflows and runoff for expected conditions at 2025	15 cm
No Action Alternative at Early Long Term (NAA-LLT)	Modified reservoir inflows and runoff for expected conditions at 2060	45 cm

The differences between the NAA and NAA-ELT reveal the effects of the climate change assumptions under ELT conditions; similarly, the differences between the NAA and NAA-LLT reveal the effects of the climate change assumptions under LLT conditions. Numerous comparisons between NAA, NAA-ELT, and NAA-LLT are discussed in the Technical Appendix of this report; issues that shaped our conclusions are discussed below.

Climate change implementation is incorrect, yielding non-sensible results.

Climate change hydrology in the Upper San Joaquin River basin (above Friant Dam) was incorporated incorrectly into the BDCP Model, resulting in non-sensible results. Because overall CVP operations and the San Joaquin River are interconnected, this error causes problems throughout the CVP system. With the coordinated operations of the CVP and SWP, this error can affect the SWP system.

Specifically, under climate change, inflow to Millerton Lake is expected to decrease (BDCP DEIR/S, Appendix 29B). However, when climate change was implemented into the BDCP Model, it was done incorrectly such that: (1) the inflow into Millerton Lake *was not adjusted* for climate change and is thus overestimated, and yet (2) the flood control operations and water allocation decisions for Millerton Lake *were adjusted* for climate change as if the inflow was reduced. The net effect is that storage in Millerton Lake is overestimated; in fact, the BDCP model indicates that the amount of water stored in Millerton Lake will actually be increased as a result of climate change even though the inflow to the lake is projected to be reduced (i.e., non-sensible). This error results in the overestimation of Millerton Lake storage causing an overestimation of reservoir releases for flood control purposes and available water downstream at the Mendota Pool; these unreasonably high flood releases are then diverted by CVP exchange contractors in lieu of taking CVP Delta water, which means that either CVP Delta exports are reduced or the water is backed up into San Luis Reservoir (SLR), overestimating SLR storage. Furthermore, any excess water from the Millerton Lake that is not diverted at Mendota Pool would continue downstream and ultimately increase Vernalis flow, which subsequently affects Delta exports. Ultimately, changes in exports have the potential to affect upstream reservoir releases (i.e., from Lake Shasta) as well.

This is a situation where one seemingly minor error cascades through the entire system. This error exists in all BDCP Model scenarios (baselines and project alternatives) that have climate change incorporated at either ELT or LLT conditions. In other words, all model results reported in the BDCP and associated Draft EIR/S contain this error, with the only exception of the Existing Biological Conditions baselines numbers 1 and 2 (EBC1 and EBC2), which are evaluated in the BDCP.

Effects of climate change create unrealistic operations.

Review of the BDCP Model output for the Without Project condition with climate change assumptions for the ELT or LLT (NAA-ELT and NAA-LLT, respectively) reveal that the model is operated beyond its usable range. The purpose of CalSim II is to simulate how the CVP and SWP systems would be operated in order to meet regulatory requirements and water delivery objectives based on a certain amount of precipitation and runoff. When the precipitation patterns and resultant runoff were changed in the BDCP Model for climate change, the logic regarding how the system is operated to meet the regulatory and water delivery objectives was not changed. The net effect is that neither the regulatory criteria nor the delivery objectives are met.

With rising temperatures and shifting precipitation patterns with less snow, temperature criteria on the Sacramento River will become increasingly more difficult to meet. For instance, the BDCP Model includes an assumption that equilibrium temperatures in the Sacramento River between Shasta and Gerber will increase on an average annual basis by 1.6°F by 2025 (ELT) by 3.3°F by 2060 (LLT). NMFS 2009 Biological Opinion specifies temperature targets of 56°F in the Sacramento River between Balls Ferry and Bend Bridge for the protection of salmon. Because of lower storage conditions in Shasta Lake and the magnitude of temperature increase in the assumptions is so large, the BDCP Model shows that the probability of exceeding the mortality threshold in the Sacramento River at Bend Bridge in August and September increases from approximately 80% in the No Action Alternative to 90% to 95% by 2025 (under ELT conditions) and to 95% to 100% by 2060 (under LLT conditions). This significant difference shows the overwhelming influence that the climate change assumptions have on the BDCP Model results.

Reservoir Storage: Under the climate change scenarios, reservoir storage (particularly in the CVP system) is operated very aggressively so that the reservoirs are drawn down to an extremely low level (termed “dead pool”) in approximately 1 of every 10 years, even without the BDCP. At dead pool level, little or no water can be released from the reservoir – not for fish, not for drinking water, not for agriculture. For example, since Folsom Reservoir became operational in 1955, the storage has never been drawn down to reach dead pool (which is approximately 100,000 acre-feet); the lowest storage level on record was 147,000 acre-feet at the end of September 1977. However, the BDCP Model predicts that, under climate change, the reservoir will be about 100,000 acre-feet or about 30% lower than its historical low in 10% of years. Some municipalities, such as the city of Folsom, are entirely dependent on reservoir releases for drinking water. Reaching dead pool would cut municipal deliveries below the level required to maintain public health and safety. In reality, and to avoid such dire circumstances, the CVP and SWP would likely request that regulatory agencies modify standards to conserve storage and would likely mandate conservation (or rationing) by water users. Similar steps were taken in early in 2014 to reduce water diversions and reservoir releases for fishery needs and Delta requirements. Emergency measures such as these are not simulated in the model, so the BDCP Model does not reflect reasonable future operations with climate change.

With the predicted changes in precipitation and temperature implemented in the BDCP Model, there is simply not enough water available to meet all regulatory objectives and water user demands. Yet the BDCP Model continues its normal routine and thus fails to meet its objectives. In this aspect, the BDCP Model simply does not simulate reality. For instance, if the ELT and LLT conditions actually occur, the CVP and SWP would likely adapt to protect water supplies and the environment. Examples of reactions to climate change would likely include: (1) updating operational rules regarding water releases for flood protection; (2) during severe droughts, emergency drought declarations could call for mandatory conservation and changes in some regulatory criteria similar to what has been experienced in the current and previous droughts ; and (3) if droughts become more frequent, the CVP and SWP would likely revisit the rules by which they allocate water during shortages and operate more conservatively in wetter years. The likelihood of an appropriate operational response to climate change is supported by the many modifications to CVP and SWP operations made during the winter and spring of 2014 to respond to the current drought. The BDCP Model is, however, useful in that it reveals that difficult decisions must be made.

Conclusions Regarding Climate Change Assumptions and Implementation

Water Code section 85320, subdivision (b)(2)(C) requires consideration of, among other things, the “potential effects of climate change, possible sea level rise up to 55 inches, and possible changes in total precipitation and runoff patterns on the conveyance alternatives and habitat restoration activities considered in the environmental impact report". In examining the possible effects of climate change, it is not appropriate to assume that current project operations will remain static and not respond to climate change. The BDCP's simplistic approach of assuming a linear operation of the CVP and SWP produces results that are not useful for dealing with the complex problem of climate change because it does not reflect the way in which the CVP and the SWP would actually operate whether or not the BDCP is implemented. The Reviewers recommend a sensitivity analysis be conducted to develop a better understanding of the range of possible responses to climate change by the CVP and SWP, and the regulatory structures that dictate certain project operations.

Including climate change, without adaptation measures, results in insufficient water needed to meet all regulatory objectives and user demands. For example, the BDCP Model results that include climate change indicate that during droughts, water in reservoirs is reduced to the minimum capacity possible. Reservoirs have not been operated like this in the past during extreme droughts and the current drought also provides evidence that adaptation measures are called for long in advanced to avoid draining the reservoirs. In this aspect, the BDCP Model simply does not reflect a real future condition. Foreseeable adaptations that the CVP and SWP could make in response to climate change include: (1) updating operational rules regarding water releases for flood protection; (2) during severe droughts, emergency drought declarations could call for mandatory conservation; and (3) if droughts become more frequent, the CVP and SWP would likely revisit the rules by which they allocate water during shortages and operate more conservatively in wetter years. The modifications to CVP and SWP operations made during the winter and spring of 2014 in response to the drought supports the likelihood of future adaptations. The BDCP Model is, however, useful in that it reveals that difficult decisions must be made in response to climate change. But, in the absence of making those decisions, the BDCP Model results themselves are not informative, particularly during drought conditions. With future conditions projected to be so dire without the BDCP, the effects of the BDCP appear positive simply because it appears that conditions cannot get any worse (i.e., storage cannot be reduced below its minimum level). However, in reality, the future condition will not be as depicted in the BDCP Model. The Reviewers recommend that Reclamation and DWR develop more realistic operating rules for the hydrologic conditions expected over the next half-century and incorporate those operating rules into the any CalSim II Model that includes climate change.

3.2 General Assumptions and Operations

BDCP CalSim II Assumptions

The assumptions for these runs are defined in the December 2013 Draft BDCP[4] and associated Draft EIR/S.

Each of the no action alternatives assumes the same regulatory requirements, generally representing the existing regulatory environment at the time of study formulation (February 2009), including Stanislaus ROP the National Marine Fisheries Services (NMFS) Biological Opinion (BO) (June 2009) Actions III.1.2 and III.1.3, Trinity Preferred EIS Alternative, NMFS 2004 Winter-run BO, NMFS BO (June 2009) Action I.2.1, SWRCB WR90-5, CVPIA (b)(2) flows, NMFS BO (June 2009) Action I.2.2, ARFM NMFS BO (June 2009) Action II.1, no SJRRP flow modeled, Vernalis SWRCB D1641 Vernalis flow and WQ and NMFS BO (June 2009) Action IV.2.1, Delta D1641 and NMFS Delta Actions including Fall X2 Fish & Wildlife Service (FWS) BO (December 2008) Action 4, Export restrictions including NMFS BO (June 2009) Action IV.11.2v Phase II, OMR FWS BO (December 2008) Actions 1-3 and NMFS BO (June 2009) Action IV.2.3v.

The modeling protocols for the recent USFWS BO (2008) and NMFS BO (2009) have been cited as being cooperatively developed by Reclamation, NMFS, U.S. Fish and Wildlife Service (USF&WS), California Department of Fish and Wildlife (CDF&W), and DWR.

[4] BDCP EIR/EIS Appendix 5A

Each of the BDCP no action alternatives (NAA, NAA-ELT, and NAA-LLT) uses the same New Melones Reservoir and other San Joaquin River operations. At the time of these studies' formulation, the NMFS BO (June 2009) had been recently released. Also, the San Joaquin River Agreement (SJRA), including the Vernalis Adaptive Management Program (VAMP) and its incorporation into D1641 for Vernalis flow requirements were either still in force or being discussed for extension. As a component of study assumptions, the protocols of the SJRA and an implementation of the NMFS BO for San Joaquin River operations (including New Melones Reservoir operations) are included in the studies. These protocols, in particular the inclusion of VAMP which has now expired, are not appropriate as an assumption within either the No Action or Alternative Scenarios within a full disclosure of BDCP impacts. Although appropriate within the identification of actions, programs and protocols present at the time of the NOI/NOP, they are not representative of current or reasonably foreseeable operations. Also, the BDCP Model assumes no San Joaquin River Restoration Program releases in the future operation of the Friant Division of the CVP. While assuming no difference in the current and future operation of the Friant Division avoids another difference in existing and projected future hydrology of the San Joaquin River, the assumption does not recognize the existence of the San Joaquin River Restoration Program. Results of CVP and SWP operations, in particular as affected by export constraints dependent on San Joaquin River flows and their effect on OMR, E/I and I/E diversion constraints, would be different with a different set of assumptions for San Joaquin River operations, in a manner similar to the cascading effect described above in connection with climate change.

Finally, the habitat restoration requirements in the 2008 FWS BO and the 2009 NMFS BO are not included in the NAA baselines. Although the restoration is required to be completed either with or without completion of the BDCP, the restoration was only analyzed as part of the with project scenarios.

Conclusions Regarding General Assumptions and Operations

The benchmark study upon which the BDCP Model was built contains inaccuracies that affect the analysis.

CalSim II is continuously being improved and refined. As the regulatory environment changes and operational and modeling staff work together to improve the model's capability to simulate actual operations, the model is continually updated. The BDCP Model relied upon a version of CalSim II that dates back to 2009, immediately after the new biological opinions (BiOps) from the NMFS and the United States Fish and Wildlife Service (USFWS) significantly altered the operational criteria of the CVP and SWP. In the last 4 to 5 years, DWR, Reclamation, and outside modeling experts have worked together to improve the model. Changes include better (more realistic) implementation of the new BiOps and numerous fixes to the code. Since CalSim II is undergoing continual improvements, there will always be "vintage" issues in that by the time a project report is released, the model is likely slightly out of date. However, in this case - with the major operational changes that have occurred in the new regulatory environment – many issues have been identified and fixed in the last 4 to 5 years that have a significant effect on model results. CalSim II modeling for the DWR 2013 Delivery Reliability Report contains numerous modeling updates and fixes that significantly alter results of the BDCP Model. A key modeling revision in the 2013 DWR modeling was fixing an error regarding artificial minimum instream flow requirements in the Sacramento River at Hood. An "artificial" minimum instream flow requirement had been specified; the requirement is artificial in that it does not represent a regulatory requirement, but rather is a modeling technique to force upstream releases to satisfy Delta needs.

3.3 Assumptions and Operational Criteria for inclusion of proposed BDCP facilities

To evaluate the assumptions and operations of the proposed BDCP facilities, the Reviewers analyzed the output from the BDCP Model and examined the internal workings of the models. This approach allows for evaluation of not only the possible effects of the BDCP, also but whether the assumptions and operational criteria are implemented appropriately to reflect the project description and reasonably foreseeable actions.

Assessment of Assumptions and Operations in coordination with new BDCP facilities

BDCP's Alternative 4 has four possible sets of operational criteria, termed the Decision Tree, that differ based on the "X2" standards[5] that they contemplate:

- Low Outflow Scenario (LOS), otherwise known as operational scenario H1, assumes existing spring X2 standard and the removal of the existing Fall X2 standard;
- High Outflow Scenario (HOS), otherwise known as H4, contemplates the existing Fall X2 standard and providing additional outflow during the spring;
- Evaluated Starting Operations (ESO), otherwise known as H3, assumes continuation of the existing X2 spring and fall standards;
- Enhanced spring outflow only (not evaluated in the December 2013 Draft BDCP), scenario H2, assumes additional spring outflow and no Fall X2 standards.

While it is not entirely clear how the Decision Tree would work in practice, the general concept is that prior to operation of the new facility, implementing authorities would select the appropriate Scenario (from amongst the four choices) based on their evaluation of targeted research and studies to be conducted during planning and construction of the facility.

For this analysis, the Reviewers analyzed the HOS (or H4) scenario because the BDCP[6] indicates that the initial permit will include HOS operations that may be later modified at the conclusion of the targeted research studies. The HOS includes the existing Fall X2 requirements but adds additional outflow requirements in the spring. The model code was reviewed and discussed with DWR and Reclamation, who acknowledged that although the SWP was bearing the majority of the responsibility for meeting the additional spring outflow in the modeling, the responsibility would need to be shared with the CVP[7]. In subsequent discussions, DWR and Reclamation have suggested that the additional water may be purchased from other water users. However, the actual source of water for the additional outflow has not been defined. While not how the projects would actually be operated, since the BDCP Model assumes that the SWP bears the majority of the responsibility for meeting the additional outflow, the Reviewers' analysis of the BDCP Model results for HOS is limited to the evaluation of how the SWP reservoir releases on the Feather River translate into changes in Delta outflow and exports.

Our remaining analysis examines the ESO (or H3) scenario (labeled Alt 4-ELT or Alt 4-LLT in this section) because it employs the same X2 standards as are implemented in NAA-ELT and NAA-LLT. This allowed the Reviewers to focus the analysis on the effects of the BDCP operations independent of the possible change in the X2 standard.

The differences between the without project scenario (NAA-ELT) and the corresponding with project scenario (Alt4 H3-ELT) should reveal the effects of the project under ELT conditions. However, as discussed above, implementation of climate change assumptions and the occurrence of unrealistic operations likely obfuscates the effects of the BDCP. Although the modeling approach may provide a relative comparison between equal foundational operations, the Reviewers are hesitant to place any confidence in the computed differences shown between the NAA-ELT and Alt4-ELT Scenarios. Numerous comparisons between NAA-ELT and Alt4 H3-ELT are discussed in the technical appendix of this report; issues that shaped our conclusions are discussed below.

[5] X2 is a salinity standard that requires outflows sufficient to attain a certain level of salinity at designated locations in the Delta at certain times of year.
[6] Draft BDCP, Chapter 3, Section 3.4.1.4.4
[7] August 7, 2013 meeting with DWR, Reclamation, and CH2M HILL

Assumptions for the "High Outflow Scenario" are unrealistic.

The HOS is one branch of the BDCP Decision Tree, also identified as Alternative 4, operational scenario H4 in the DEIR/EIS. The HOS requires additional water (Delta outflow) during certain periods in the spring, in excess of the current regulatory requirements. The BDCP Model assumes that if the required additional Delta outflow cannot be met by reducing exports, this increased Delta outflow will be met by releases made by the SWP's Oroville Reservoir. The assumptions regarding how much water to release from Oroville to attempt to meet the proposed regulations and how much and when to refill Oroville are unrealistic.

According to the Draft EIR/EIS[8], the HOS will reduce SWP south of Delta water deliveries for municipal and industrial (M&I) water users 7% below the level that they would receive without the BDCP (on average). During dry and critical years, SWP south of Delta water deliveries for M&I and agricultural water users will drop 17% below the level that they would receive without the BDCP. In other words, according to the BDCP Model results SWP Contractors would get less water than they would otherwise get without BDCP.

CVP and SWP obligations for providing flow to satisfy Delta outflow requirements is described in the Coordinated Operations Agreement (COA). Because the CVP and SWP share responsibility for meeting required Delta outflow based on specific sharing in the agreement, it is not reasonable to conclude that CVP water supplies would increase an average of 70 TAF while SWP water supplies decrease on average of 100 TAF under the HOS. The manner in which this alternative is modeled is inconsistent with existing agreements and operating criteria. If the increases in outflow were met based on COA, there would likely be reductions in Shasta and Folsom storage that would likely cause adverse environmental impacts, which have not been modeled or analyzed in the BDCP EIR/S.

Furthermore, there is no apparent source of water to satisfy the increased outflow requirements and pay back the COA debt. It appears, through recent public discussions regarding the HOS that BDCP anticipates additional water to satisfy the increased Delta outflow requirement and to prevent the depletion of cold water pools will be acquired through water transfers from upstream water sources. However, this approach is unrealistic. During most of the spring, when BDCP proposes that Delta outflow be increased, agricultural water users are not irrigating. This means that there is not sufficient transfer water available to meet the increased Delta outflow requirements without releasing stored water from the reservoirs.

San Luis Reservoir operational assumptions produce results that are inconsistent with real world operations.

San Luis Reservoir (SLR) is an off-stream reservoir located south of the Delta and jointly owned and operated by CVP and SWP. The reservoir is used to store water that is exported from the Delta when available and used to deliver water to CVP and SWP Contractors when water demands exceed the amount of water that can be pumped from the Delta. The decision of when to move water that is stored in upstream reservoirs, such as Shasta, Folsom, or Oroville, through the Delta for export to fill SLR is based on the experience and expert judgment of the CVP and SWP operators.

CalSim II attempts to simulate the expert judgment of the operators by imposing artificial operating criteria; the criteria are artificial in the sense that they are not imposed by regulatory or operational constraints but rather imposed as a tool to simulate expert judgment. One such artificial operating criteria is the SLR target storage level: CalSim II attempts to balance upstream Sacramento Basin CVP and SWP reservoirs with storage in SLR by setting artificial target storage levels in SLR, such that the CVP and SWP will release water from upstream reservoirs to meet target levels in SLR. The artificial target storage will be met as long as there is ability to convey

[8] Draft EIR/EIS, Appendix 5A-C, Table C-13-20-2

water (under all regulatory and physical capacity limits) and as long as water is available in upstream reservoirs. SLR target storage criteria are also sometimes described in section 4.2 as the "San Luis rule-curve".

In the BDCP Model, CVP and SWP reservoir operating criteria for Alternative 4 H3 ELT differ from the corresponding without project scenario (e.g. NAA-ELT). The difference in criteria and result is primarily driven by changes to the artificial constraint used to determine when to fill SLR: the SLR target storage. In Alternative 4 H3 ELT, SLR target storage is set very high in the spring and early summer months, and then reduced in August and set to SLR dead pool from September through December. This change in SLR target storage relative to the no action alternative causes upstream reservoirs to be drawn down from June through August and then recuperate storage by cutting releases in September. This change to the artificial operating criteria SLR target storage causes changes in upstream cold water pool management and affects several resource areas.

In addition to changes in upstream storage conditions, changes in SLR target storage cause SLR storage to drop below a water supply concern level (300,000 acre-feet) in almost 6 out of every 10 years under ELT conditions and more than 7 out of every 10 years under LLT conditions for Alternative 4 H3. When storage in SLR drops below this 300,000 acre-foot level, algal blooms in the reservoir often cause water quality concerns for drinking water at Santa Clara Valley Water District. The change in SLR target storage also causes SLR levels to continue to drop and reach dead pool level for the SWP in 4 out of every 10 years and also dead pool level for the CVP in 1 out of every 10 years under the ELT conditions.

Reaching dead pool level in SLR creates shortages to water users south of the Delta. Although some delivery shortages are due to California Aqueduct capacity constraints, the largest annual delivery shortages are a result of inappropriately low SLR target storage. Average annual Table A shortages due to artificially low SLR storage levels increased from 3 TAF in the NAA-ELT scenario to 35 TAF in the Alt4-ELT scenario. Such shortages occurred in 2% of simulated years in the NAA-ELT scenario and 23% of years in the Alt4-ELT scenario. In addition to the inability to satisfy Table A allocations, low storage levels cause loss of SWP Contractors' Article 56 water stored in SLR. Average annual Article 56 shortages were 43 TAF in the Alt4-ELT scenario because of low San Luis storage and 5 TAF in the NAA-ELT scenario. Low San Luis storage causes Article 56 shortages in 27% of simulated years in the Alt4-ELT scenario as compared to 5% of simulated years in the NAA-ELT. Another consequence of low storage levels in SLR is a shift in water supply benefits from Article 21 to Table A.

In summary, the operational assumptions for SLR are unrealistic in Alternative 4 because they create problems in upstream storage reservoirs and create shortages for south of Delta water users that would not occur in the real world. In reaching this conclusion, the Reviewers met with operators from CVP and SWP to review the BDCP Model results and discussed real-time operations. The operators provided guidance in selection of superior assumptions, which results in more realistic operations in the independent model (see Section 4).

<u>Delta Cross Channel operational assumptions overestimate October outflow</u>

When south Delta exports are low due to regulatory limits, and upstream reservoirs are making releases to meet the instream flow objectives at Rio Vista, operators have the ability to close the Delta Cross Channel (DCC) in order to reduce the required reservoir releases (by closing the DCC a greater portion of water released from the reservoirs stays in the Sacramento River to meet the Rio Vista requirements). As long as the Delta salinity standards are met, operators have indicated that they would indeed close the DCC in this manner (as was done in October and November 2013). In the BDCP Model, the DCC is not closed in this manner. The net result is that the BDCP Model overestimates outflow under such circumstances typically occurring in October.

The overestimated outflow leads to incorrect conclusions regarding the effects of BDCP. For instance, an actual increase in fall outflow could be beneficial for the endangered fish species delta smelt (USFWS, 2008). Therefore, by overestimating outflow in October, the BDCP studies likely overestimate the benefit to delta smelt (Mount et al, 2013). Similarly, an actual increase in fall outflow would reduce salinity in the western Delta, which could be beneficial for in-Delta diverters; therefore, overestimating outflow in October artificially reduces salinity, incorrectly reducing the net impacts on in-Delta diverters.

Conclusions Regarding Assumptions and Operations in coordination with new BDCP facilities

BDCP's "High Outflow Scenario" is not sufficiently defined for analysis.

The HOS requires additional water (Delta outflow) during certain periods in the spring. The BDCP Model places most of the responsibility for meeting this new additional outflow requirement on the SWP. However, the SWP may not actually be responsible for meeting this new additional outflow requirement. This is because the COA, as it is currently being implemented, would require a water allocation adjustment that would keep the SWP whole. Where one project (CVP or SWP) releases water to meet a regulatory requirement, the COA requires a water balancing to ensure the burden does not fall inappropriately among the projects. The BDCP Model is misleading because it fails to adjust project operations, as required by the COA, to "pay back" the water "debt" to the SWP due to these additional Delta outflow requirements. Unless there is a significant revision to COA, the BDCP Model overstates the impacts of increased Delta outflow on the SWP and understates the effects on the CVP.

Furthermore, after consulting with DWR and Reclamation project operators and managers, the Reviewers conclude that there is no apparent source of CVP or SWP water to satisfy both the increased Delta outflow requirements and pay back the COA "debt" to the SWP without substantially depleting upstream water storage. It appears, through recent public discussions regarding the HOS, that BDCP anticipates additional water to satisfy the increased Delta outflow requirement and to prevent the depletion of cold water pools will be acquired through water transfers from upstream water users. However, this approach is unrealistic because during most of the spring, when BDCP proposes that Delta outflow be increased, agricultural water users are not typically irrigating. This means that there is not sufficient transfer water available to meet the increased Delta outflow requirements without releasing stored water from the reservoirs. Releasing stored water to meet the increased Delta outflow requirements could potentially impact salmonids on the Sacramento and American River systems.

Simulated operation of BDCP's dual conveyance, coordinating proposed North Delta diversion facilities with existing south Delta diversion facilities, is inconsistent with the project description.

The Draft BDCP and associated Draft EIR/EIS specify criteria for how much flow can be diverted by the new NDD facilities and specify when to preferentially use either the NDD facilities or the existing SDD facilities. However, the BDCP Model contains an artificial constraint that prevents the NDD facilities from taking water as described in the BDCP project description. In addition to affecting diversions from the NDD, this artificial constraint contains errors that affect the NAA operation. This error has been fixed by DWR and Reclamation in more recent versions of the model; however, the error remains in the BDCP Model. Additionally, the BDCP Model does not reflect the Summer operations of the SDD that are described in the Draft EIR/EIS as a feature of the BDCP project intended to prevent water quality degradation in the south Delta. The net effect of these two errors is that the BDCP Model significantly underestimates the amount of water diverted from the NDD facilities and overestimates the amount of water diverted from the SDD.

BDCP Model contains numerous coding and data issues that skew the analysis and conflict with actual real-time operational objectives and constraints

Operational logic is coded into the CalSim II model to simulate how DWR and Reclamation would operate the system under circumstances for which there are no regulatory or other definitive rules. This attempt to specify (i.e., code) the logic sequence and relative weighting so that a computer can simulate "expert judgment" of the human operators is a critical element to the CalSim II model. In the BDCP Model, some of the operational criteria for water supply allocations and existing facilities such as the Delta Cross Channel and SLR are inconsistent with real-world conditions.

4 INDEPENDENT MODELING

The Independent Modeling effort originally stemmed from reviews of BDCP Model during which the Reviewers discovered that the BDCP Model did not provide adequate information to determine the effects of the BDCP. There are three basic reasons why the Reviewers cannot assess how the BDCP will affect water operations: 1) NAAs do not depict reasonable operations under the described climate change assumptions, 2) operating criteria used in the BDCP Alternative 4 result in unrealistic operations, and 3) updates to CalSim II since the BDCP modeling was performed almost 4 years ago will likely alter model results to a sufficient degree that conclusions based on the BDCP modeling will likely be different than those disclosed in the Draft EIR/EIS. Given that it is not possible to determine how BDCP may affect CVP and SWP operations or water system flows and conditions with the BDCP model, Independent Modeling was performed to assess potential effects due to the BDCP.

To revise the models, the Reviewers consulted with operators at DWR and Reclamation to improve the representation of operational assumptions. Additionally, the Reviewers consulted with modelers at DWR and Reclamation to share findings, to strategize on the proper way to incorporate the guidance received from the operators, and to present revised models to DWR and Reclamation for their review. This collaborative and iterative process differed considerably from a standard consulting contract where the work product is not shared beyond the client-consultant until a final version is complete. To the contrary, consultations with agency experts were conducted early and repeatedly to ensure the revisions would reflect reasonable operations and to provide an independent review.

The first phase of this Independent Modeling effort (described in Section 4.1) was development of an updated without project baseline (similar to the NAA but with current, improved assumptions). The Independent Modeling does not incorporate climate change because the climate change hydrological assumptions developed by BDCP cause unrealistic operation of the system absent commensurate changes to operating criteria.

After the baseline was complete and reviewed, the second phase of this effort (described in Section 4.2) incorporated the facilities and operations for the BDCP described as Alternative 4 H3 in the Draft EIR/EIS, and otherwise known as the Evaluated Starting Operations (ESO) scenarios in the BDCP. During this phase, the issues that were identified during the Reviewers' initial review were corrected (see Section 3.3) along with corrections made to resolve additional issues that were revealed as improvements were incorporated. Finally, results of the Independent Modeling and potential effects of the BDCP on water supply and instream flows are discussed in Section 4.3.

4.1 Improvements to CalSim II Assumptions

For this effort, the most up to date modeling tools were provided by DWR and Reclamation and further improvements were added to the CalSim II assumptions in coordination with DWR and Reclamation staff. Many of the improvements have since been incorporated into DWR and Reclamation's model and others are under review.

Revisions incorporated by DWR and Reclamation for the 2013 baseline

DWR and Reclamation provided CalSim II models used for the 2013 SWP Delivery Reliability Report (DRR) for use in this Independent Modeling effort. The 2013 SWP DRR, Technical Addendum, and associated models are now available on DWR's website[9]. Assumptions used for this Independent Modeling effort are consistent with the 2013 SWP DRR and are listed in Table 4 of the Technical Addendum.

[9] http://baydeltaoffice.water.ca.gov/swpreliability/

CalSim II is continuously being improved to better represent CVP and SWP operations and fix known problems. The Technical Addendum to the 2013 SWP DRR contains a list of updates and fixes that have occurred since the last SWP DRR was released in 2011. Among these changes and fixes are key items that directly affect operation of facilities proposed in the BDCP Alternative 4; these items are listed on pages 4-6 of the 2013 SWP DRR Technical Addendum.

A key component of this package of modeling revisions was fixing an error regarding artificial minimum instream flow requirements in the Sacramento River at Hood. An "artificial" minimum instream flow requirement had been specified; the requirement is artificial in that it does not represent a regulatory requirement, but rather is a modeling technique.

Additional Revisions to CalSim II Assumptions

As part of the Independent Modeling effort, a number of changes were made to the 2013 SWP DRR version of CalSim II to better represent the existing facilities, regulatory requirements, and water user demands. These revisions are described in the Technical Appendix and summarized here:

- San Joaquin River Restoration Program (SJRRP) was not incorporated. This modification was made to be consistent with the BDCP assumptions, but also allows the identification of the separate effect of the BDCP void of the combined effect with SJRRP flows. Although inclusion of the SJRRP is necessary in the documentation of BDCP, the Independent Modeling did not include it.
- VAMP operations were not incorporated because the VAMP program has expired and is no longer being implemented.
- Tuolumne River basin was updated.
- Folsom Reservoir operations for flood control were updated.
- Additional water demands on the Feather River were incorporated to represent existing agricultural diversions used for rice decomposition.
- Diversions by East Bay Municipal Utility District (EBMUD) from the Sacramento River at Freeport were modified to better represent the EBMUD CVP water service contract.
- Minimum flow requirements for Wilkins Slough and Red Bluff were corrected for September 1933.
- CVP M&I demands are updated to reflect current assumptions used by Reclamation.
- Modifications were made to more accurately reflect refilling of New Bullards Bar Reservoir in coordination with transfers made under the Yuba Accord.
- Los Vaqueros Reservoir capacity was updated to reflect a recent expansion of the reservoir that was completed in 2012.

4.2 Improvements to BDCP Operations

After the baseline was completed and reviewed (as summarized above in Section 4.1), the facilities and operations associated with BDCP Alternative 4 H3 in the Draft EIR/EIS, otherwise known as the Evaluated Starting Operations (ESO) scenarios in the Draft Plan, were incorporated into the model. During this phase, the issues that were identified during the Reviewers' initial review (see Section 3.3) were corrected along with correcting additional issues that were revealed as improvements were incorporated. These revisions are described in the Technical Appendix and summarized here:

- San Luis Reservoir operation
- Delta Cross Channel gate operation in October
- Delivery allocation adjustment for CVP SOD contractors

- Folsom/Shasta balance
- North Delta Diversion bypass criteria
- Wilkins Slough minimum flow requirement

In the Independent Modeling, San Luis rule-curve logic was refined for both SWP and CVP operations. San Luis rule-curve is used to maintain an appropriate balance between San Luis Reservoir (SLR) storage and North of Delta reservoirs. The key considerations in formulating rule-curve are 1) ensuring that sufficient water is available in SLR to meet contract allocations when exports alone are insufficient due to various operational constraints and 2) minimize SLR carryover storage to low point criteria (both CVP and SWP) and Article 56 carryover (only SWP). The basic premise is to maintain SLR storage no higher than necessary to satisfy south of Delta obligations to avoid excessive drawdown of upstream storage.

In the BDCP NAA and the Independent Modeling FNA, the model has a priority to release excess stored water that will likely be released for flood control purposes from Shasta and Folsom storage for export at Jones Pumping Plant to storage in SLR in the late summer and early fall months. The purpose was to get a head start on filling SLR for the coming water year if there is a high likelihood of Shasta or Folsom spilling. This was an assumed CVP/SWP adaptation to the export reductions in the winter and spring months due to the salmon and smelt biological opinions. However, with the NDD facility in Alt 4, winter and spring export restrictions impact CVP exports much less and there is no longer a reason to impose this risk on upstream storage. As such, the weights, or prioritizations, of storage in Shasta and Folsom were raised so that excess water would not be released specifically to increase CVP San Luis storage Reservoir above rule-curve. This was changed in Alt 4 and not the FNA to better reflect how the system may operate under these different conditions.

The BDCP Alt 4 results in significantly more October surplus Delta outflow as compared to the baseline. The cause of this Delta surplus at a time when the Delta is frequently in balance is a combination of proposed through-Delta export constraints Old and Middle River (OMR) flow criteria and no through-Delta exports during the San Joaquin River October pulse period), Rio Vista flow requirements, and DCC gate operations. In DWR's BDCP studies, it was assumed that the DCC gates would be open for the entire month of October thereby requiring much higher Sacramento River flows at Hood in order to meet the Rio Vista flow requirement than if the DCC gates were closed. Whereas in the Independent Modeling of the BDCP it was assumed that the DCC gates were closed for a number of days during the month such that the 7,000 cfs NDD bypass criteria would be sufficient to meet the weekly average Rio Vista flow requirements. The intent was to minimize surplus Delta outflow while meeting Delta salinity standards and maintaining enough bypass flow to use the NDD facility for SDD. This is an approximation of what is likely to occur in real-time operations under similar circumstances. Further gate closures may be possible as salinity standards allow if operators decide to preserve upstream storage at the expense of NDD diversions. This type of operation would require additional model refinements.

CVP SOD Ag service and M&I allocations are limited by both system wide water supply (storage plus inflow forecasts) and Delta export constraints; whereas similar CVP NOD allocations are dependent solely on water supply. This frequently results in SOD water service contractors receiving a lower contract year allocation than NOD water service contractors, especially under the Biological Opinion export restrictions. However, with the NDD facility operations as proposed under Alt 4 H3, the CVP can largely bypass these Delta export restrictions and the export capacity constraint on CVP SOD allocations was determined to be overly conservative. Therefore, the export capacity component of CVP SOD allocations was removed in the BDCP Alternative and both SOD and NOD CVP allocations are equal and based only on water supply.

For the Independent Modeling, CVP operations were refined in the BDCP Alternative to provide maximum water supply benefits to CVP contractors while protecting Trinity, Shasta, and Folsom carryover storage in the drier years. As a whole, this was accomplished with refinements to allocation logic and San Luis rule-curve. However, in the initial study runs, an imbalance between Folsom and Shasta was created; while there was a total positive impact to upstream storage in dry years, there was a negative impact to Folsom storage. This was resolved by inserting Folsom protections in the Shasta-Folsom balancing logic. With these protections, the positive carryover impacts were distributed to Trinity, Shasta, and Folsom.

The daily disaggregation method for implementing NDD bypass criteria as implemented in DWR's BDCP model was left mostly intact for the Independent Modeling. However, to properly fit the bypass criteria implementation within the latest CalSim operations formulation certain modifications were made. Modifications are as follows:

1. No NDD operations occur in cycles 6 through 9 so that Delta operations and constraints can be fully assessed without NDD interference.
2. Cycles 10 and 11 (Daily 1 and Daily 2 respectively) were added to determine NDD operations given various operational constraints including the NDD bypass criteria.
3. From July to October, bypass criteria are based on monthly average operations (no daily disaggregation). Given the controlled reservoir releases at this time and the constant bypass criteria (5,000 cfs from July to September and 7,000 cfs in October), this was determined to be a reasonable assumption. This also simplified coordination of DCC gate operations with NDD in October which will be discussed later.
4. When warranted by conditions in cycle Daily 1 (cycle 10), the bypass criteria in May and June were allowed to be modeled on a monthly average basis in cycle Daily 2 (cycle 11). This allowed a reduction in the number of cycles necessary to determine the fully allowed diversion under the bypass criteria when the Delta was in balance and additional upstream releases were made to support diversions from the North Delta.

Currently in CalSim II, relaxation of the Wilkins Slough minimum flow requirement is tied to CVP NOD Ag Service Contractor allocations. This does not reflect actual operations criteria where relaxation of the flow requirement is dependent solely on storage conditions at Shasta. From the comparative analysis perspective of our CalSim planning studies, this introduces a potential problem: changes in CVP NOD Ag Service allocations can result in unrealistic changes in required flow at Wilkins Slough, and such changes in Wilkins Slough required flow can result in unrealistic impacts to Shasta storage. To bypass this problem, we assumed that the required flow at Wilkins Slough in the alternative was equal to the baseline.

4.3 Independent Modeling output and analysis of BDCP Effects

Analysis for this effort was focused on BDCP Alt 4 with existing spring and Fall X2 requirements, which corresponds to "Alternative 4 H3" in the Decisions Tree. This modeling is performed without climate change, and includes refined operating criteria for the NDD, CVP and SWP reservoirs, DCC gate closures, and water supply allocations. This modeling includes all Project features that are included in Alt 4 in the BDCP Model. The key Project features incorporated into BDCP are displayed in Figure 1 and summarized as:

- North Delta Diversion capacity of 9,000 cfs
- NDD bypass flow requirements
- 25,000 acres of additional tidal habitat
- Notched Fremont Weir to allow more flow into Yolo Bypass
- Additional positive Old and Middle River flow requirements
- Removal of the San Joaquin River I/E ratio (NMFS 2009)
- Changed location for Emmaton water quality standard in SWRCB D-1641
- Additional Sacramento River flow requirement at Rio Vista

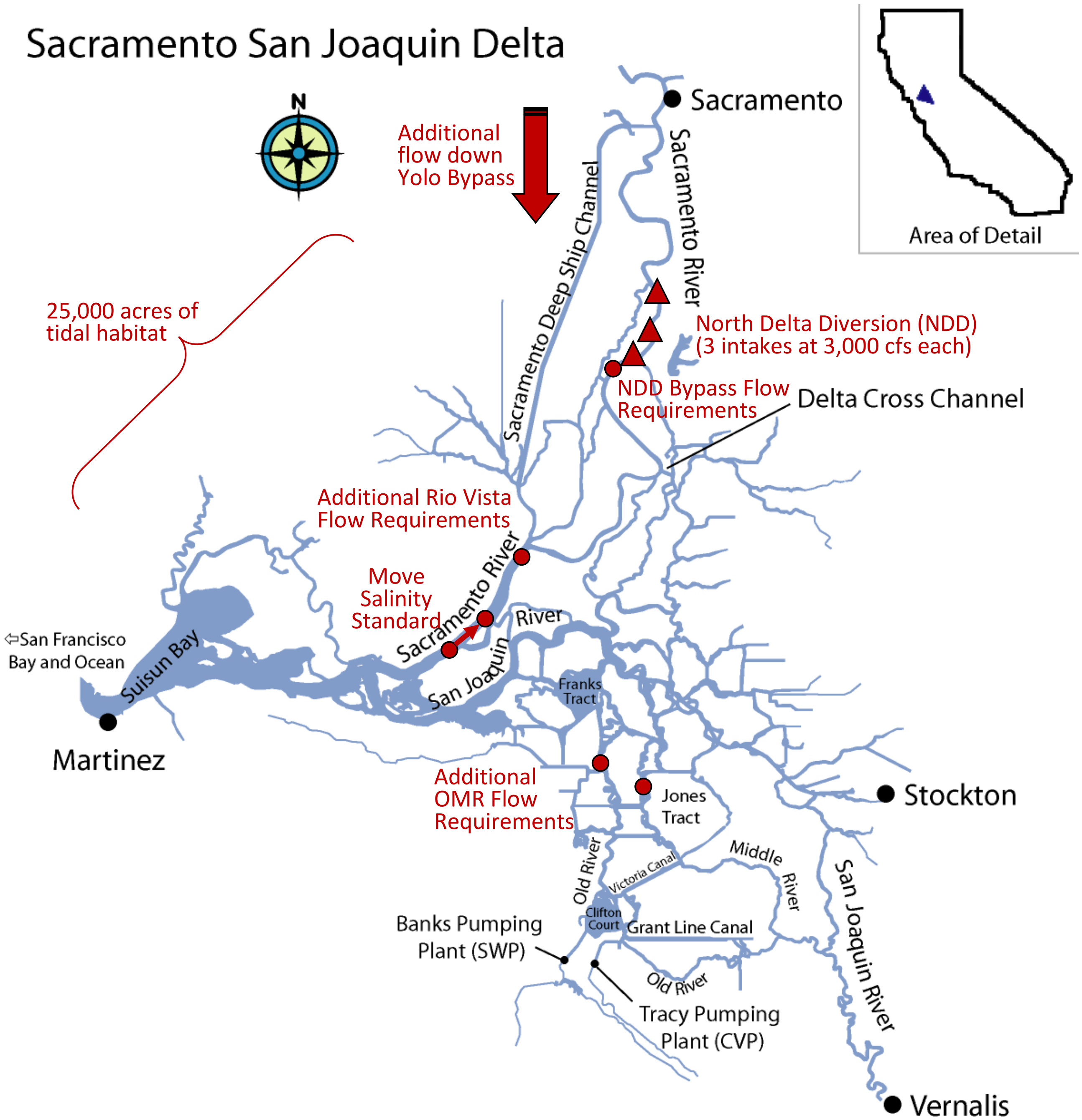

Figure 1. Map of Delta with location of key BDCP facilities and regulatory changes
Annual maximum and minimum storage in San Luis for the (a) CVP and (b) SWP under ELT conditions for the no action alternative (NAA_ELT) and BDCP Alternative 4 H3 (Alt4_ELT).

For the purpose of describing results of the Independent Modeling, the revised baseline scenario without climate change, originally termed No Action Alternative (NAA) in the BDCP Draft EIR/EIS, is referred to as the Future No Action (FNA) in this discussion. Additionally, in the Independent Modeling, Alternative 4 operational scenario H3 without climate change is simply referred to as “Alt 4”. The results for the Independent Modeling are illustrated in the Technical Attachment. Key results are presented below.

The change in conditions between FNA and Alt 4 is indicative of the effects of the BDCP on water supply and Delta flows. An effect of the BDCP is an anticipated increase in Delta export and corresponding decrease in Delta Outflow. Table 2 illustrates the estimated change in Delta Outflow by year type, amounting to an average annual 0.76 MAF. Table 3 illustrates the corresponding change in exports by year type, and also illustrates the estimated change in geographical source of export water. With the BDCP it is anticipated that exports from the South Delta (via through Delta conveyance) will decrease by 2.53 MAF. Exports derived from the North Delta (via the tunnels) will amount to 3.28 MAF.

Table 2. Change in Delta outflow due to the BDCP (Alt 4 minus FNA) (Million Acre-Feet)
Reduction in the quantity of water that leaves the Delta by flowing west into San Francisco Bay by water year type.

Water Year Type	FNA Delta Outflow	Change in Delta Outflow
Wet	28.6	-1.2
Above Normal	17.1	-1.0
Below Normal	9.9	-0.68
Dry	7.3	-0.39
Critical	5.1	-0.13
Average	15.6	**-0.76**

Table 3. Change in quantity of water exported due to the BDCP (Alt 4 minus FNA) (Million Acre-Feet)
Reduction in the quantity of water exported from the existing South Delta export facilities and corresponding increase in the quantity exported from the proposed facilities in the North Delta, by water year type.

Water year Type	FNA Total Delta Export	Change in South Delta Exports (through Delta)	Change in North Delta Exports (through tunnels)	Change in Total Exports
Wet	6.0	-3.8	5.0	1.2
Above Normal	5.2	-2.9	4.4	1.5
Below Normal	5.1	-2.4	3.2	0.8
Dry	4.2	-1.8	1.8	0.07
Critical	2.8	-0.7	0.7	0.02
Average	**4.9**	**-2.53**	**3.28**	**0.75**

Table 4. Change in quantity of CVP water exported by SWP facilities (Alt 4 minus FNA) (Thousand Acre-Feet)
Quantity of water exported at Banks Pumping Plant for later use by CVP contractors is increased in all water year types except the driest years (critical designation).

Water Year Type	FNA CVP water exported by SWP	Change in CVP water exported by SWP
Wet	58	229
Above Normal	44	208
Below Normal	66	117
Dry	86	7
Critical	38	-9
Average	60	**123**

The Independent Modeling shows that implementation of the BDCP could shift a portion of the SWP exports from summer to winter and spring because the proposed NDD facilities can export water at times when the existing SDD facilities are constrained due to fishery concerns. As a result of this shift in timing, capacity is available at the SWP facilities during the summer months. The BDCP Model assumes that CVP could utilize the SWP facilities (Table 4) at any time when the CVP facilities are fully utilized; this sharing of diversion facilities is termed “joint point of diversion” or JPOD. Additional criteria to meet specific water quality and water level objectives are defined in response plans required by the State Water Board’s water right decision D-1641. BDCP Model assumes that these additional criteria are met; the Independent Modeling continues this assumption without making any judgment as to whether the criteria would be met. An evaluation of this would require additional hydrodynamic modeling.

The Independent Modeling shows higher average annual CVP carryover (end of September) storage than the NAA by about 28 TAF. During dryer years when upstream storage is lower there is an increase in carryover and during wetter years when storage is higher there are storage decreases (Table 5). Upstream SWP storage, Table 6, behaves in a similar manner as CVP storage, there are decreases in wetter years and increased in dryer years.

CVP San Luis Reservoir fills in about 40% of years in Alt 4 compared to about 20% in the FNA. CVP San Luis reaches dead pool in about 25% of years in both the FNA and Alt 4. SWP San Luis Reservoir fills in about 43% of years in Alt 4 compared to about 18% in the FNA. SWP San Luis reaches dead pool in about 25% of years in Alt 4 and about 30% of years in the FNA.

Table 5. Change in CVP upstream carryover storage (Alt 4 minus FNA) (Thousand Acre-Feet)
CVP carryover (end of September) storage decreases in wetter years when FNA storage is highest and increases in dryer years when FNA storage is lowest

Water Year Type	FNA CVP Upstream Storage	Change in CVP Upstream Storage
Wet	5578	-8
Above Normal	5200	-150
Below Normal	4717	-1
Dry	4049	66
Critical	2285	258
Average	4558	**28**

Table 6. Change in SWP upstream carryover storage (Alt 4 minus FNA) (Thousand Acre-Feet)
SWP carryover (end of September) storage decreases in wetter years when FNA storage is highest and increases in dryer years when FNA storage is lowest

Water Year Type	FNA SWP Upstream Storage	Change in SWP Upstream Storage
Wet	2407	33
Above Normal	1934	-150
Below Normal	1517	14
Dry	1194	157
Critical	968	127
Average	1709	**44**

5 COMPARING INDEPENDENT MODELING AND BDCP MODEL

The Independent Modeling effort originally stemmed from reviews of DWR's BDCP Model where the Reviewers through their independent analysis found that BDCP Model does not provide adequate information to determine how BDCP may affect the system. Based on the premise that the Independent Modeling portrays a more accurate characterization of how the CVP/SWP system may operate under Alt 4, this comparison is meant to demonstrate the differences between results of a more accurate and realistic analysis and the BDCP Model. Differences in results between these modeling efforts are believed to provide insight regarding how effects that BDCP will have on the actual CVP/SWP system differ from modeling used to support the Draft EIR/S.

Although thorough comparisons of modeling were performed, only key differences are illustrated for the purpose of this comparison.

Conclusions regarding BDCP effects

Based on the Independent Modeling, the amount of water exported (diverted from the Delta) may be approximately 200 thousand acre-feet (TAF) per year higher than the amount disclosed in the Draft EIR/S. This total represents

- approximately 40 TAF/yr more water diverted and delivered to the SWP south of Delta contractors, and
- approximately 160 TAF/yr more water diverted and delivered to the CVP south of Delta contractors.

The BDCP Model estimates that, under the NAA ELT (without the BDCP), total average annual exports for CVP and SWP combined are estimated to be 4.73 million acre feet (MAF) and in the Independent Modeling FNA combined exports are 5.61 MAF. The BDCP Model indicates an increase in exports of approximately 540 TAF and the Independent Modeling shows an increase of approximately 750 TAF in Alt 4.

The Independent Modeling suggests that Delta outflow would decrease by approximately 200 TAF/yr compared to the amount indicated in the Draft EIR/S.

- This lesser amount of Delta outflow has the potential to cause greater water quality and supply impacts for in-Delta beneficial uses and additional adverse effects on species. To determine the potential effects of the reduced amount of outflow, additional modeling is needed using tools such as DSM2.

The BDCP Model does not accurately reflect the location of the diversions that the SWP and CVP will make from the Delta.

- When the errors in the model are corrected, it reveals that the North Delta intakes could divert approximately 680 TAF/yr more than what was disclosed in the BDCP Draft EIR/S, and
- the amount of water diverted at the existing South Delta facilities would be approximately 460 TAF/yr less than what is projected in the BDCP Draft EIR/S.

Hydrologic modeling of BDCP alternatives using CalSim II has not been refined enough to understand how BDCP may affect CVP and SWP operations and changes in Delta flow dynamics. Better defined operating criteria for project alternatives is needed along with adequate modeling rules to analyze how BDCP may affect water operations. Without a clear understanding of how BDCP may change operations, affects analysis based on this modeling may not produce reliable results and should be revised as improved modeling is developed.

6 GLOSSARY

acre-foot The volume of water (about 325,900 gallons) that would cover an area of 1 acre to a depth of 1 foot. This is enough water to meet the annual needs of one to two households.

agricultural water supplier As defined by the California Water Code, a public or private supplier that provides water to 2,000 or more irrigated acres per year for agricultural purposes or serves 2,000 or more acres of agricultural land. This can be a water district that directly supplies water to farmers or a contractor that sells water to the water district.

annual Delta exports The total amount of water transferred ("exported") to areas south of the Delta through the Harvey O. Banks Pumping Plant (SWP) and the C. W. "Bill" Jones Pumping Plant (CVP) in 1 year.

appropriative water rights Rights allowing a user to divert surface water for beneficial use. The user must first have obtained a permit from the State Water Resources Control Board, unless the appropriative water right predates 1914.

Article 21 water Water that a contractor can receive in addition to its allocated Table A water. This water is only available if several conditions are met: (1) excess water is flowing through the Delta; (2) the contractor can use the surplus water or store it in the contractor's own system; and (3) delivering this water will not interfere with Table A allocations, other SWP deliveries, or SWP operations.

biological opinion A determination by the U.S. Fish and Wildlife Service or National Marine Fisheries Service on whether a proposed federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of designated "critical habitat." If jeopardy is determined, certain actions are required to be taken to protect the species of concern.

CalSim-II A computer model, jointly developed by DWR and the U.S. Bureau of Reclamation, that simulates existing and future operations of the SWP and CVP. The hydrology used by this model was developed by adjusting the historical flow record (1922–2003) to account for the influence of changes in land uses and regulation of upstream flows.

Central Valley Project (CVP) Operated by the U.S. Bureau of Reclamation, the CVP is a water storage and delivery system consisting of 20 dams and reservoirs (including Shasta, Folsom, and New Melones Reservoirs), 11 power plants, and 500 miles of major canals. CVP facilities reach some 400 miles from Redding to Bakersfield and deliver about 7 million acre-feet of water for agricultural, urban, and wildlife use.

cubic feet per second (cfs) A measure of the rate at which a river of stream is flowing. The flow is 1 cfs if a cubic foot (about 7.48 gallons) of water passes a specific point in 1 second. A flow of 1 cubic foot per second for a day is approximately 2 acre-feet.

Delta exports Water transferred ("exported") to areas south of the Delta through the Harvey O. Banks Pumping Plant (SWP) and the C. W. "Bill" Jones Pumping Plant (CVP).

Delta inflow The combined total of water flowing into the Delta from the Sacramento River, San Joaquin River, and other rivers and waterways.

exceedence plot For the SWP, a curve showing SWP delivery probability (especially for Table A water)—specifically, the likelihood that SWP Contractors will receive a certain volume of water under current or future conditions.

incidental take permit A permit issued by the U.S. Fish and Wildlife Service or National Marine Fisheries Service, under Section 10 of the federal Endangered Species Act, to private nonfederal entities undertaking otherwise lawful projects that might result in the "take" of an endangered or threatened species. In California, an additional permit is required and take may be authorized under Section 2081 of the California Fish and Game Code through issuance of either an incidental take permit or a consistency determination. The California Department of Fish and Wildlife is authorized to accept a federal biological opinion as the take authorization for a State-listed species when a species is listed under both the federal and California Endangered Species Acts.

riparian water rights Water rights that apply to lands traversed by or adjacent to a natural watercourse. No permit is required to use this water, which must be used on riparian land and cannot be stored for later use. Riparian rights attach only to the "natural" flow in the water course and do not apply to abandoned flows or stored water releases.

State Water Project (SWP) Operated by DWR, a water storage and delivery system of 33 storage facilities, about 700 miles of open canals and pipelines, four pumping-generating plants, five hydroelectric power plants, and 20 pumping plants that extends for more than 600 miles in California. Its main purpose is to store and distribute water to 29 urban and agricultural water suppliers in Northern California, the San Francisco Bay Area, the San Joaquin Valley, the Central Coast, and Southern California. The SWP provides supplemental water to 25 million Californians (almost two-thirds of California's population) and about 750,000 acres of irrigated farmland. Water deliveries have ranged from 1.4 million acre-feet in a dry year to more than 4.0 million acre-feet in a wet year.

SWP Contractors Twenty-nine entities that receive water for agricultural or municipal and industrial uses through the SWP. Each contractor has executed a long-term water supply contract with DWR. Also sometimes referred to as "State Water Contractors."

Table A water (Table A amounts) The maximum amount of SWP water that the State agreed to make available to an SWP Contractor for delivery during the year. Table A amounts determine the maximum water a contractor may request each year from DWR. The State and SWP Contractors also use Table A amounts to serve as a basis for allocation of some SWP costs among the contractors.

urban water supplier As defined by the California Water Code, a public or private supplier that provides water for municipal use directly or indirectly to more than 3,000 customers or supplies more than 3,000 acre-feet of water in a year. This can be a water district that provides the water to local residents for use at home or work, or a contractor that distributes or sells water to that water district.

Water Rights Decision 1641 (D-1641) A regulatory decision issued by the State Water Resources Control Board in 1999 (updated in 2000) to implement the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta. D-1641 assigned primary responsibility for meeting many of the Delta's water quality objectives to the SWP and CVP, thus placing certain limits on SWP and CVP operations.

water year In reports on surface water supply, the period extending from October 1 through September 30 of the following calendar year. The water year refers to the September year. For example, October 1, 2010, through September 30, 2011 is the 2011 water year.

Review of Bay Delta Conservation Program Modeling

by MBK Engineers and Daniel B. Steiner, Consulting Engineer

Technical Appendix

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1 INTRODUCTION

Since December 2012, MBK Engineers and Dan Steiner (collectively "Reviewers") have assisted various parties in evaluating the operations modeling that was performed for the Bay Delta Conservation Plan (BDCP). To assist in understanding BDCP and the potential implications, stakeholders[1] requested that the Reviewers review the CalSim II modeling studies performed as part of the BDCP (hereafter "BDCP Studies" or "BDCP Model").

An initial review led the Reviewers to conclude that the BDCP Model, which serves as the basis for the environmental analysis contained in the BDCP Environmental Impact Report/Statement (EIR/S), provides very limited useful information to understand the effects of the BDCP. The BDCP Model contains erroneous assumptions, errors, and outdated tools, which result in impractical or unrealistic Central Valley Project (CVP) and State Water Project (SWP) operations. The unrealistic operations, in turn, do not accurately depict the effects of the BDCP.

The Reviewers revised the BDCP Model to depict a more accurate, consistent version of current and future benchmark hydrology so that the effects of the BDCP could be ascertained. The BDCP Model was also revised to depict more realistic CVP and SWP operations upon which to contrast the various BDCP alternatives. The Reviewers made significant efforts to coordinate with and inform the U.S. Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR) managers and modelers, and CVP and SWP operators of the Reviewers' modifications, assumptions, and findings. Where appropriate, the Reviewers also used Reclamation and DWR's guidance and direction to refine the Reviewers' analysis.

This technical appendix summarizes: (1) the independent review of the CalSim II modeling publicly released for the BDCP's Draft Environmental Impact Report/Statement (EIRS), (2) the corrections and revisions made to the assumptions in the CalSim II model, and (3) comparisons between the BDCP and independent modeling results. The detailed information in this appendix is summarized in our main report.

[1] The entities who funded this report are Contra Costa Water District, East Bay Municipal Utility District, Friant Water Authority, Northern California Water Association, North Delta Water Agency, San Joaquin River Exchange Contractors Water Authority, San Joaquin Tributaries Authority, and Tehama Colusa Canal Authority.

2 REVIEW OF BDCP CALSIM II MODELING

2.1 Climate Change

Implementation of Climate Change

The analysis presented in the BDCP Documents attempts to incorporate the effects of climate change at two future climate periods: the early long term (ELT) at approximately the year 2025; and the late long term (LLT) at approximately 2060. As described in the BDCP documents[2], other analytical tools were used to determine anticipated changes to precipitation and air temperature that is expected to occur under ELT and LLT conditions. Projected precipitation and temperature was then used to determine how much water is expected to flow into the upstream reservoirs and downstream accretions/depletions over an 82-year period of variable hydrology; these time series were then used as inputs into the CalSim II operations model. A second aspect of climate change, the anticipated amount of sea level rise, is incorporated into the CalSim II model by modifying a subroutine that determines salinity within the Delta based on flows within Delta channels. The effects of sea level rise will manifest as a need for additional outflow when water quality is controlling operations to prevent seawater intrusion.

This report does not review the analytical processes by which reservoir inflows and runoff were developed, nor does it evaluate the modified flow-salinity relationships that are assumed due to sea level rise; those items could be the focus of another independent review. This review is limited to evaluating how the modified flows were incorporated into CalSim II and whether the operation of the CVP and SWP water system in response to the modified flows and the modified flow-salinity relationship is reasonable for the ELT and LLT conditions. This work reviews the assumed underlying hydrology and simulated operation of the CVP/SWP, assumed regulatory requirements, and the resultant water delivery reliability.

CalSim II Assumptions

To assess climate change, the three without Project (or "baseline" or "no action") modeling scenarios were reviewed: No Action Alternative (NAA)[3], No Action Alternative at the Early Long Term (NAA – ELT), and No Action Alternative at the Late Long Term (NAA –LLT). Assumptions for NAA, NAA-ELT, and NAA-LLT are provided in the Draft EIR[4]. The only difference between these scenarios is the climate-related changes made for the ELT and LLT conditions (Table 1).

Table 1. Scenarios used to evaluate climate change

	Climate Change Assumptions	
Scenario	**Hydrology**	**Sea Level Rise**
No Action Alternative (NAA)	None	None
No Action Alternative at Early Long Term (NAA-ELT)	Modified reservoir inflows and runoff for expected conditions at 2025	15 cm
No Action Alternative at Early Long Term (NAA-LLT)	Modified reservoir inflows and runoff for expected conditions at 2060	45 cm

[2] BDCP EIR/EIS Appendix 5A, Section A and BDCP HCP/NCCP Appendix 5.A.2
[3] NAA is also called the Existing Biological Conditions number 2 (EBC-2) in the Draft Plan.
[4] BDCP EIR/EIS Appendix 5A, Section B, Table B-8

The differences between the NAA and NAA-ELT reveal the effects of the climate change assumptions under ELT conditions; similarly, the differences between the NAA and NAA-LLT reveal the effects of the climate change assumptions under LLT conditions.

Regulatory requirements

Each of the no action alternatives assumes the same regulatory requirements, generally representing the existing regulatory environment at the time of study formulation (February 2009), including Stanislaus ROP NMFS BO (June 2009) Actions III.1.2 and III.1.3, Trinity Preferred EIS Alternative, NMFS 2004 Winter-run BO, NMFS BO (June 2009) Action I.2.1, SWRCB WR90-5, CVPIA (b)(2) flows, NMFS BO (June 2009) Action I.2.2, ARFM NMFS BO (June 2009) Action II.1, no SJRRP flow modeled, Vernalis SWRCB D1641 Vernalis flow and WQ and NMFS BO (June 2009) Action IV.2.1, Delta D1641 and NMFS Delta Actions including Fall X2 FWS BO (December 2008) Action 4, Export restrictions including NMFS BO (June 2009) Action IV.11.2v Phase II, OMR FWS BO (December 2008) Actions 1-3 and NMFS BO (June 2009) Action IV.2.3v.

The modeling protocols for the recent USFWS BO (2008) and NMFS BO (2009) have been cited as being cooperatively developed by Reclamation, NMFS, U.S. Fish and Wildlife Service (USF&WS), California Department of Fish and Wildlife (CDF&W), and DWR.

Each of the BDCP no action alternatives (NAA, NAA-ELT, and NAA-LLT) uses the same New Melones Reservoir and other San Joaquin River operations. At the time of these studies' formulation, the National Marine Fisheries Services (NMFS) Biological Opinion (BO) (June 2009) had been recently released. Also, the San Joaquin River Agreement (SJRA, including the Vernalis Adaptive Management Program [VAMP]) and its incorporation into D1641 for Vernalis flow requirements were either still in force or being discussed for extension. As a component of study assumptions, the protocols of the SJRA and an implementation of the NMFS BO for San Joaquin River operations (including New Melones Reservoir operations) is included in the studies. These protocols, in particular the inclusion of VAMP which has now expired, is not appropriate as an assumption within either the No Action or Alternative Scenarios. Although appropriate within the identification of actions, programs and protocols present at the time of the NOI/NOP, they are not representative of current or reasonably foreseeable operations. Also, modeling of the future operation of the Friant Division of the CVP assumes no San Joaquin River Restoration Program releases. While assuming no difference in the current and future operation of the Friant Division avoids another difference in existing and projected future hydrology of the San Joaquin River, the assumption does not recognize the existence of the San Joaquin River Restoration Program. Results of CVP and SWP operations, in particular as affected by export constraints dependent on San Joaquin River flows and their effect on OMR, E/I and I/E diversion constraints, would be different with a different set of assumptions for San Joaquin River operations.

Finally, the habitat restoration requirements in the 2008 FWS BO and the 2009 NMFS BO are not included in the No Action Alternative baselines. Although the restoration is required to be completed either with or without completion of the BDCP, the restoration was only analyzed as part of the with project scenarios.

Model Results

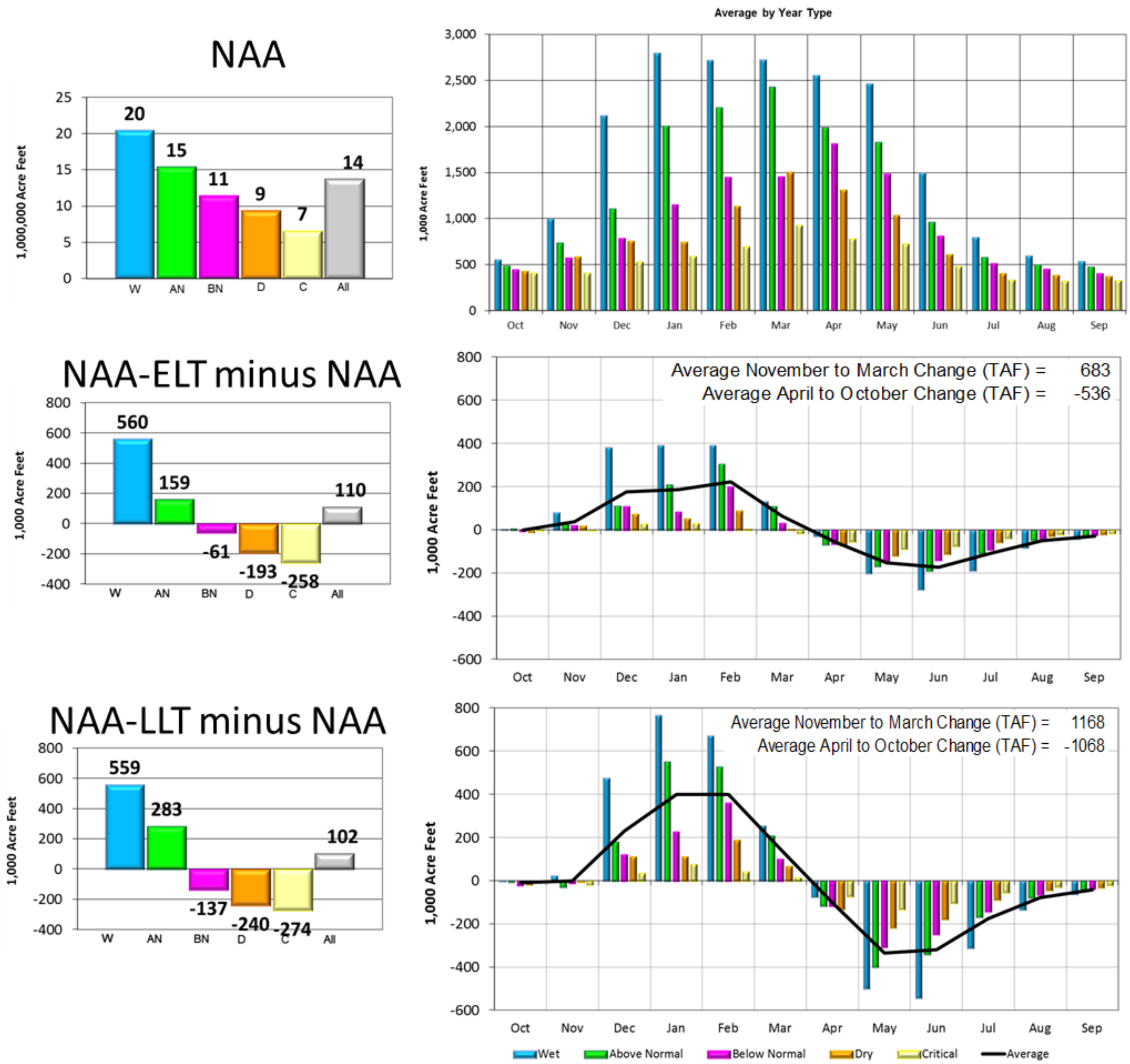
Inflow and Reservoir Storage in the Sacramento River Basin

The significance of changed hydrology between the three without project baselines is illustrated in Figure 1 below. The figure illustrates the projected combined inflow of Trinity, Shasta, Oroville, and Folsom Reservoirs under the three NAA baselines. Numerous modeling projections for climate change have been developed, and in this BDCP group of Scenarios Trinity, Shasta, and Oroville inflow are projected to increase overall, but with a significant shift from spring runoff to winter runoff and increases in wetter years with decreases in dryer years. Folsom Reservoir inflow is projected to remain about the same at the time of the NAA-ELT Scenario but decreases by the time of the NAA-LLT Scenario. The spring to winter shift in runoff is also projected for Folsom Reservoir inflow.

If climate change resulted in such drastic inflow changes, there is argument that certain underlying operating criteria such as instream flow requirements and flood control diagrams would require change in recognition of the changed hydrology. Regarding current environmental flow requirements carried into the NAA Scenarios, we question an assumed operation that continues to attempt to meet temperature targets when flow releases are unlikely to meet the target and thus a sustainable operation plan is not possible. For example, the CVP and SWP are unlikely to draw reservoirs to dead pool as often as the models depict. The NAA-ELT and NAA-LLT model Scenarios show project reservoirs going to dead pool in 10% of years; such operation would result in cutting upstream urban area deliveries below what is needed for public health and safety in 10% of years and would lead to water temperature conditions that would likely not achieve the assumed objectives. Again in short, the Scenarios that include climate change do not provide a reasonable underlying CVP/SWP operation with a changed hydrology from which to impose a Project upon to understand how BDCP Alternatives will affect the water system and water users.

In our opinion, the CalSim II depicted operations that incorporate climate change are not reasonably foreseeable and do not represent a likely future operation of the CVP/SWP. Although an argument is typically made that these study baselines will be used in a comparison analysis with Project Alternatives tiering from these baselines, we believe that the depicted operations do not represent credible CVP/SWP operations and we have no confidence in the results and they are inappropriate as the foundation of a Project Alternative. As such, although the modeling approach may provide a relative comparison between equal foundational operations, we are apprehensive to place much confidence in the computed differences shown between the NAA and Project Alternative Scenarios.

Figure 1. Projected Inflow to Trinity, Shasta, Oroville, and Folsom Reservoirs – NAA, NAA-ELT and NAA-LLT



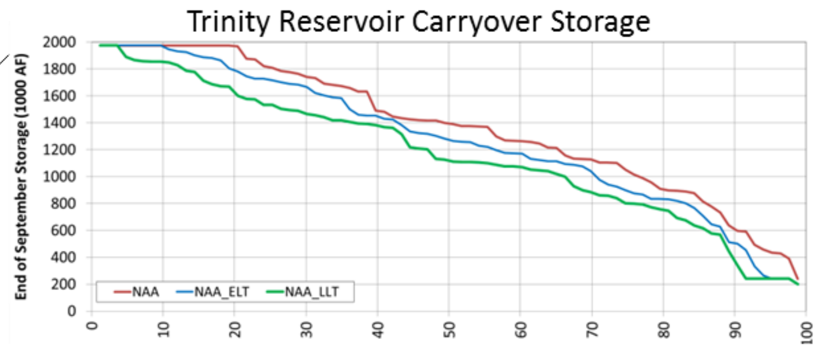
Carryover Storage in the Sacramento River Basin

For upstream CVP and SWP reservoirs the assumed shift of inflows due to climate change (Figure 1) along with a continuing need to satisfy exports demands significantly affects carryover storage. The CVP and SWP simply cannot satisfy water demands and regulatory criteria imposed on them in the NAA-ELT and NAA-LLT modeling scenarios.

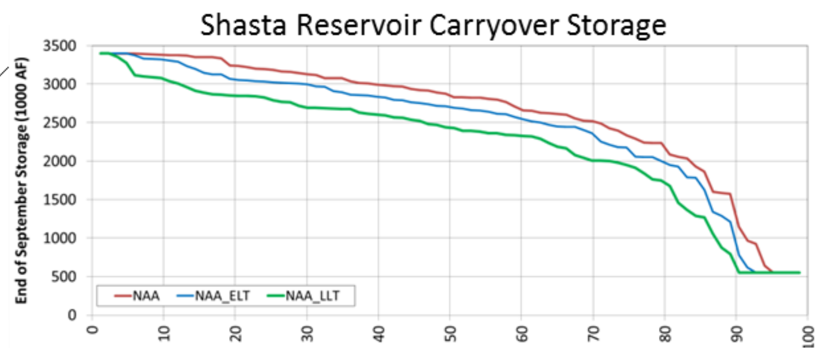
Figure 2 illustrates the typical change in carryover storage as shown for Trinity, Shasta, Oroville, and Folsom Reservoirs. The relatively high frequency (approximately 10% of time) of minimum storage occurring at CVP reservoirs illustrates our questioning of credible operations in the studies.

Figure 2. Projected Shasta Reservoir Carryover Storage, NAA, NAA-ELT and NAA-LLT

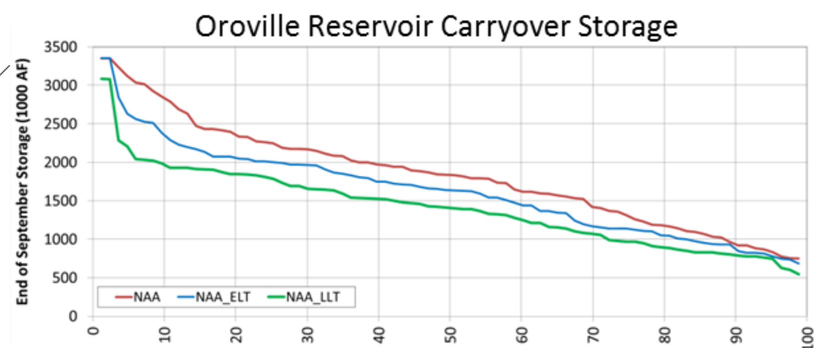
Trinity – Year Type	NAA_ELT minus NAA	NAA_LLT minus NAA
W	-62	-187
AN	-79	-198
BN	-102	-170
D	-138	-271
C	-126	-216
All	-97	-209



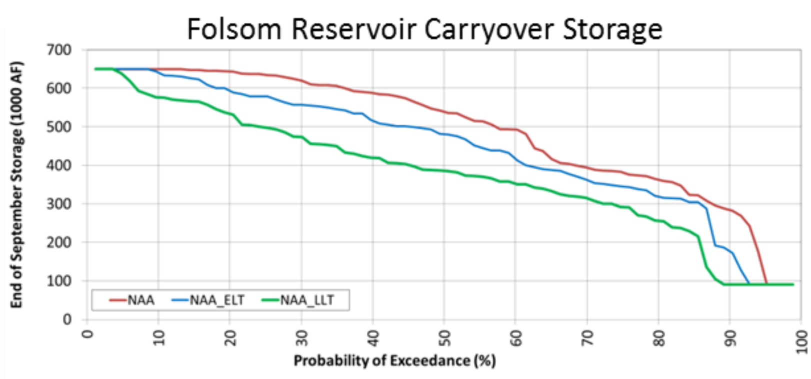
Shasta – Year Type	NAA_ELT minus NAA	NAA_LLT minus NAA
W	-117	-331
AN	-199	-452
BN	-152	-340
D	-154	-463
C	-192	-377
All	-154	-386



Oroville – Year Type	NAA_ELT minus NAA	NAA_LLT minus NAA
W	-296	-588
AN	-225	-460
BN	-229	-513
D	-180	-296
C	-54	-159
All	-213	-430



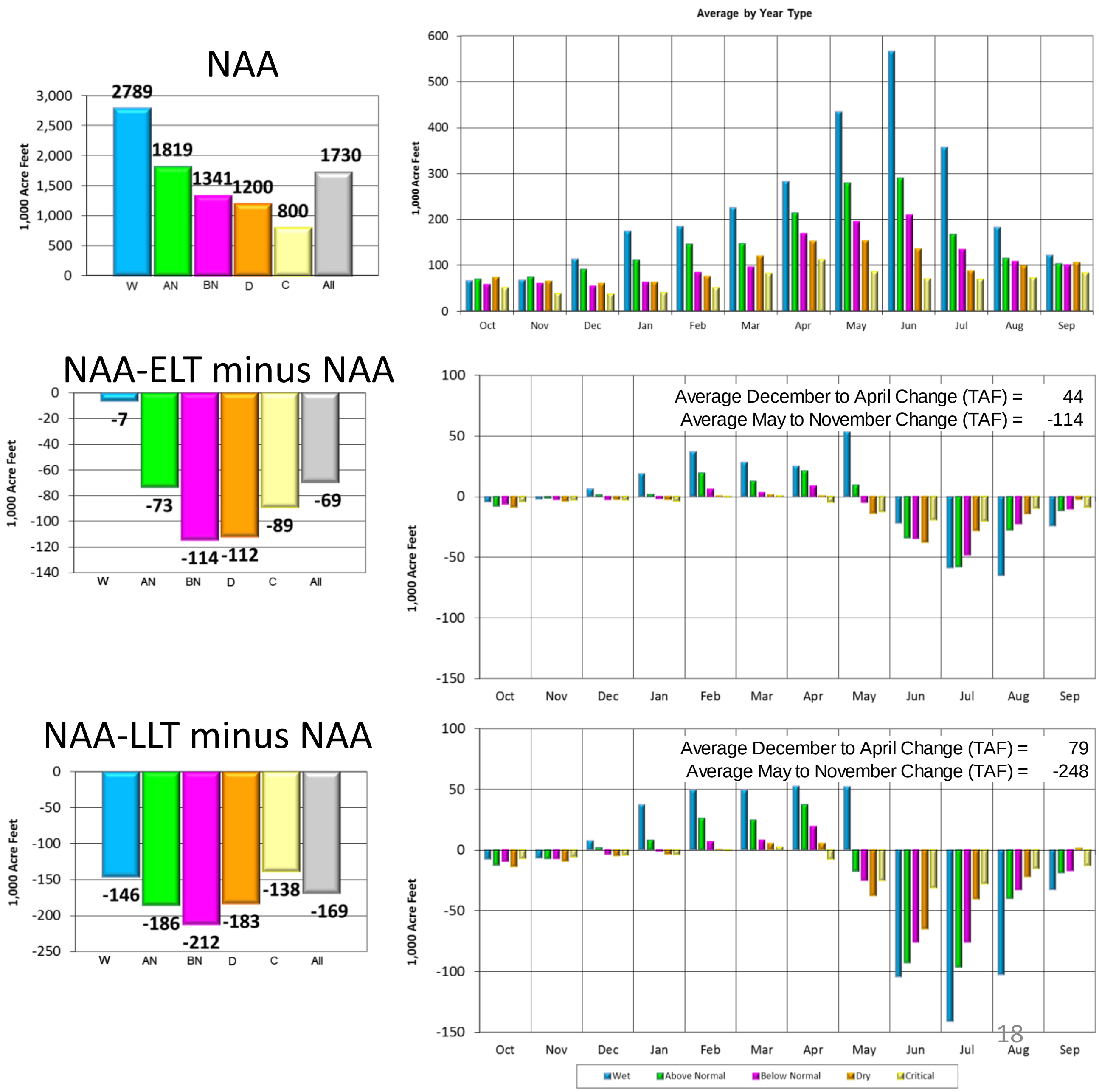
Folsom – Year Type	NAA_ELT minus NAA	NAA_LLT minus NAA
W	-42	-115
AN	-54	-128
BN	-58	-136
D	-43	-112
C	-43	-68
All	-47	-113



Inflow and Carryover Storage in the San Joaquin River Basin

San Joaquin Valley reservoirs are depicted with an overall decrease in annual runoff with some shifting of runoff from spring to winter, but mostly just decreases in spring runoff due to a decline in snowmelt runoff during late spring[5]. Figure 3 illustrates the assumed effects of climate change upon inflow to Millerton Lake.

Figure 3. Projected Inflow to Millerton Lake –NAA, NAA-ELT and NAA-LLT



The hydrology differences imposed in the NAA Scenarios of the Friant Division are described above, and its appropriateness may be subject to additional debate and Alternative assumptions. However, our review found that implementation of Millerton Reservoir inflow as affected by climate change was improperly performed.

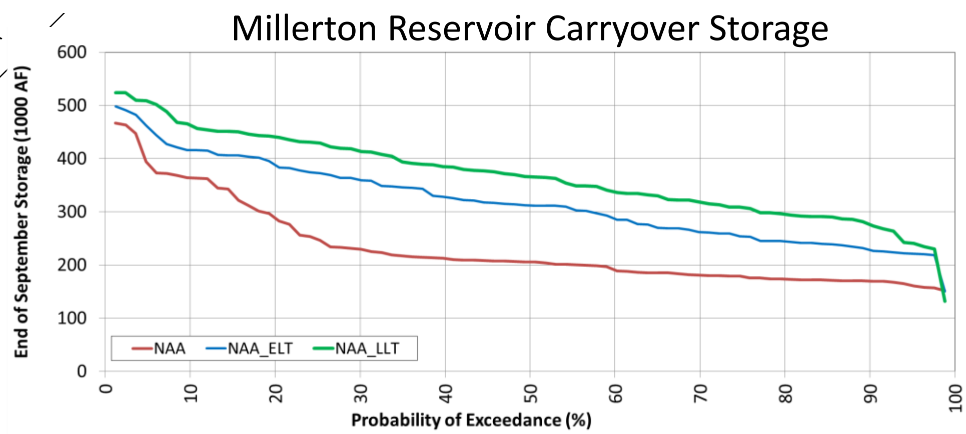
[5] BDCP Appendix 5A.2

Inflow to Millerton Reservoir in this version of CalSim is input in three separate time series for purposes of depicting the hydrology of potential upper basin reservoirs. Climate change hydrology was inconsistently incorporated at Millerton Reservoir and misapplied to the water supply and flood control operations. The result is an unrealistic operation for river releases and canal diversions. Figure 3 illustrates the projected ELT and LLT changes in Millerton Reservoir inflow incorporated in these studies. On face value of the input data, regardless of Friant Dam river release assumptions the effect of climate change at Millerton Lake will affect water deliveries.

Evidence of the inconsistent inflow problem is shown in the result for the comparison of carryover storage of Millerton Reservoir under the NAA, NAA-ELT, and NAA-LLT Scenarios (Figure 4). Carryover storage is higher in the ELT and LLT Scenarios due to climate change effects to inflow incorporated in reservoir operations but not in the computation of water supply deliveries. Thus, water deliveries are suppressed and the reservoir ends the year with greater storage.

Figure 4. Millerton Reservoir Carryover Storage, NAA, NAA-ELT and NAA-LLT Scenarios

	Year Type	NAA_ELT minus NAA	NAA_LLT minus NAA
Millerton	W	56	103
	AN	82	137
	BN	99	161
	D	87	131
	C	131	166
	All	87	136



CVP Water Service Contractor's water allocations are based on available CVP supplies, Figure 5 contains exceedance probability plots of deliveries and allocation percentages to these contractors. Table 2 contains average annual allocation to these CVP Water Service Contractors. Water supplies to these contractors decrease in the ELT and LLT relative to NAA Conditions.

Table 2. CVP Water Service Contractor Allocation Summary

	NAA	NAA-ELT	NAA-LLT
North of Delta Agricultural Service Contractors	61%	53%	46%
South of Delta Agricultural Service Contractors	48%	44%	39%
North of Delta M&I Contractors	85%	81%	77%
South of Delta M&I Contractors	79%	77%	74%

CVP Sacramento River Settlement, San Joaquin River Exchange, and Refuge deliveries are based on Shasta Criteria and are 100% in most years and 75% in "Shasta critical" years[6]. Figure 6 contains exceedance probability charts for annual water deliveries to CVP contractors whose allocations are based on Shasta Criteria. In the NAA-ELT and NAA-LLT modeling scenarios, the Sacramento River Settlement and Refuge deliveries are reduced due to water shortages that occur more often under the climate change assumptions.

SWP Water Supply

Corresponding with the CVP operation is the projected operation of the SWP under No Action Conditions. These illustrations are shown to provide a comparison to SWP storage and exports, particularly during drought. A comparison of SWP exports to CVP SOD deliveries shows that each project exports about the same amount of water during drought.

Average annual SWP Table A water supply allocations are 62% for NAA, 61% for NAA-ELT, and 57% for NAA-LLT. Figure 7 contains an exceedance probability plot summary of SWP deliveries. SWP North of Delta deliveries to the Feather River Service Area in both the ELT and LLT are less than NAA during about 10% of the time.

[6] A "Shasta critical" year is determined when the forecasted full natural inflow into Shasta Lake is equal to or less than 3.2 million acre-feet.

Figure 5. CVP Water Service Contractor Delivery Summary

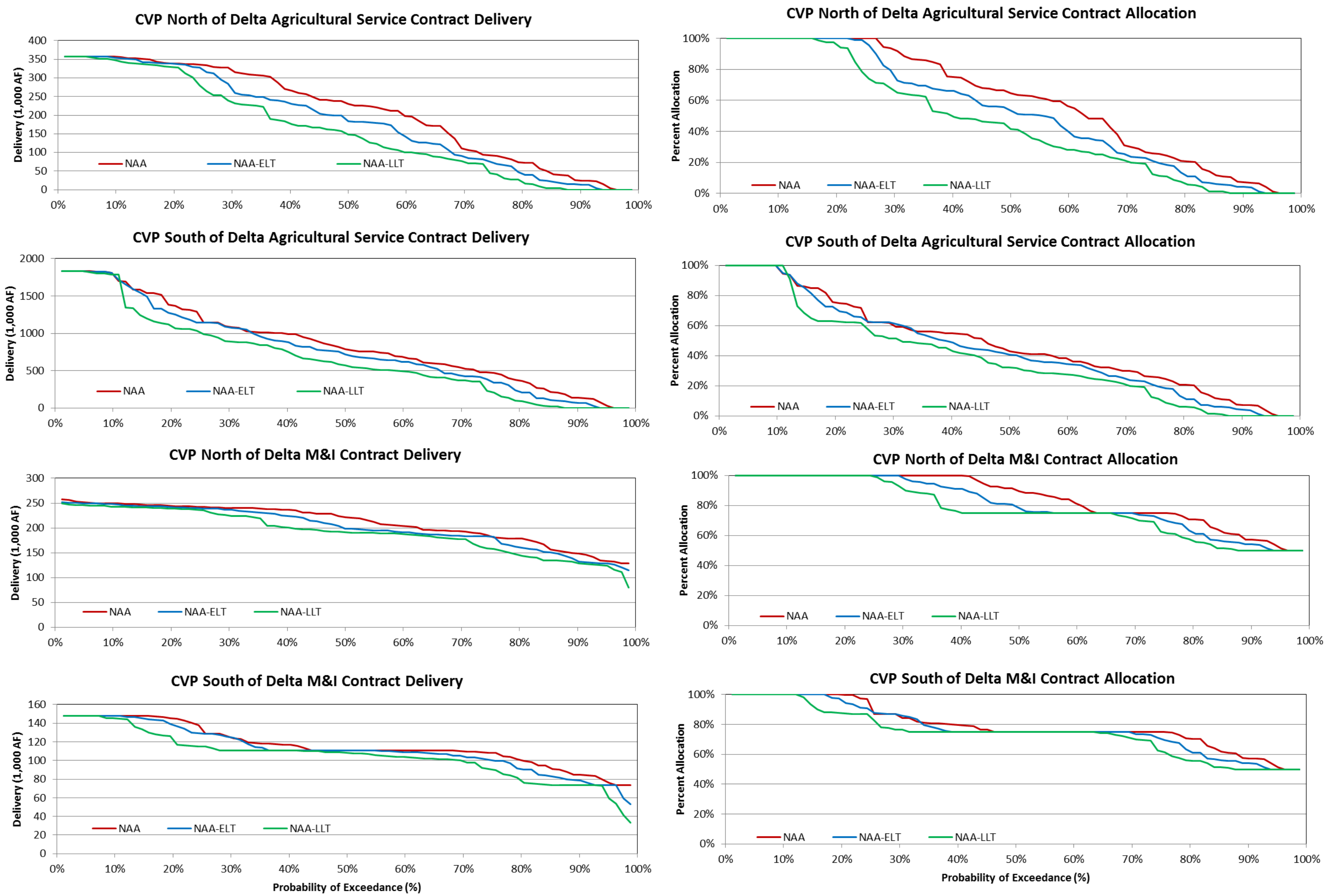


Figure 6. CVP Contractor Delivery Summary for Contractors with Shasta Criteria Allocations

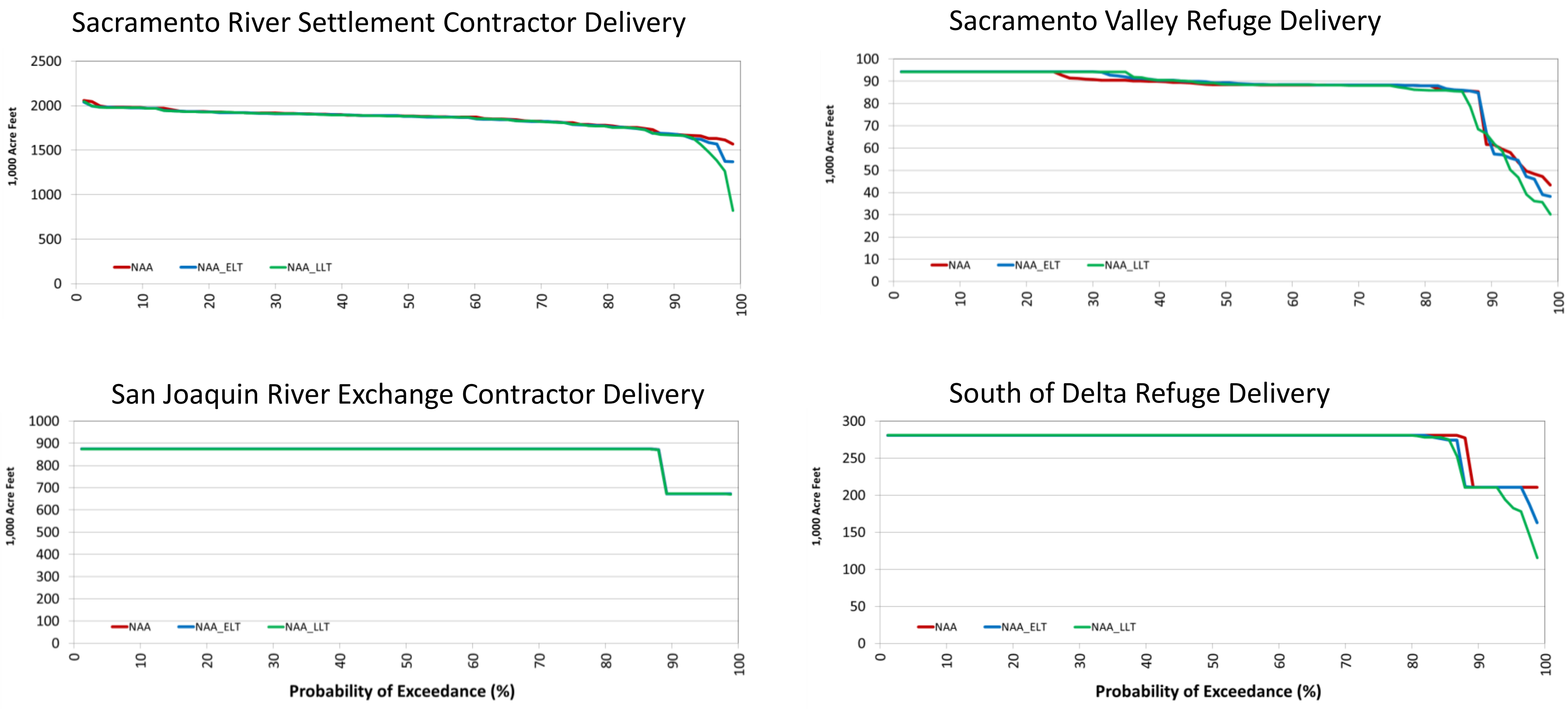
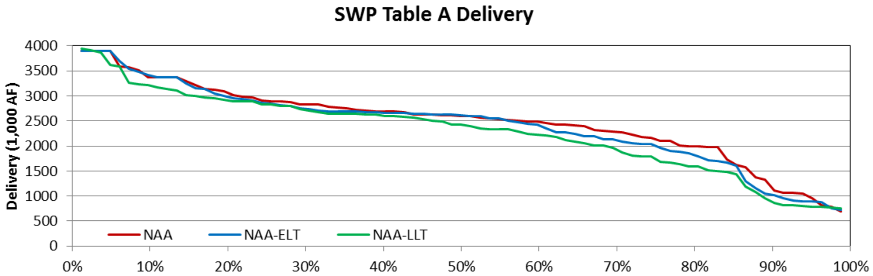
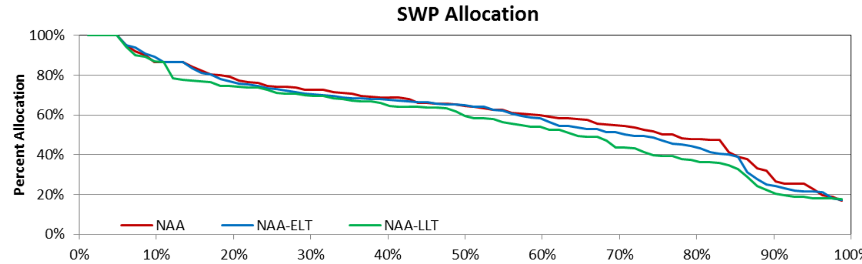
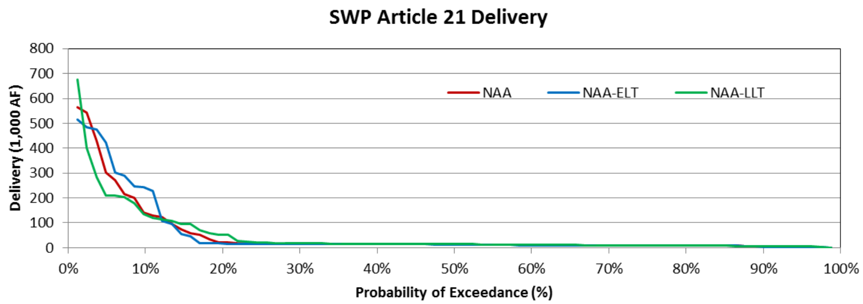
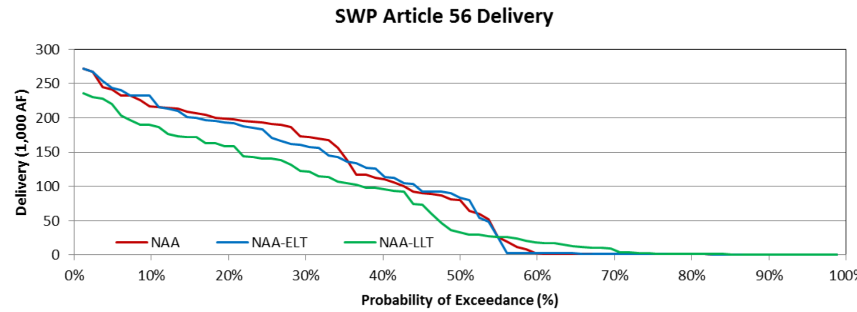


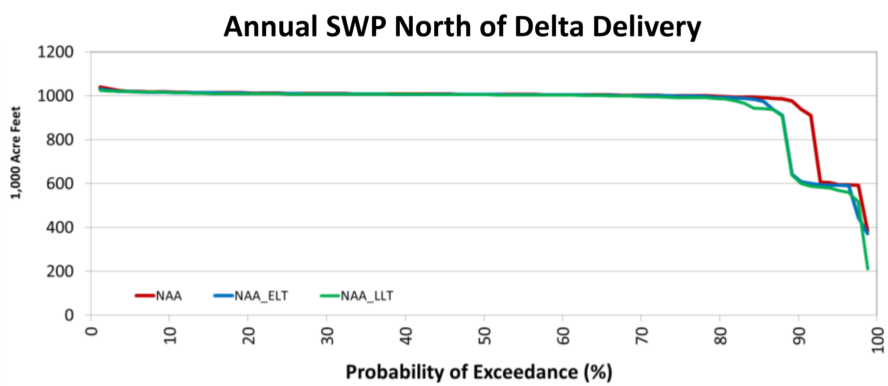
Figure 7. SWP Delta Delivery Summary











CVP/SWP Exports

Exports of the CVP and SWP have been projected to change due to a combination of climate change effects on water availability (primary effect), flow requirements for salinity control (sea level rise), additional in-basin water demands, and to a small extent greater export potential (DMC-CA intertie). Figure 8 illustrates the simulation of CVP exports and combined CVP/SWP exports under NAA, NAA-ELT, and NAA-LLT Scenarios. Under NAA average annual CVP exports are about 2.24 MAF (2.18 at Jones PP) and are about 100 TAF less in the NAA-ELT Scenario and 230 TAF less in the NAA-LLT. Annual average SWP exports are about 2.61 MAF in the NAA and are 68 TAF less in the NAA-ELT and 212 TAF less in the NAA-LLT. Annual average combined CVP/SWP exports are about 4.9 MAF in the NAA modeling (Figure 9) and about 170 TAF and 460 TAF less in the NAA-ELT and NAA-LLT respectively.

Figure 8. CVP Exports at Jones PP, NAA, NAA-ELT and NAA-LLT

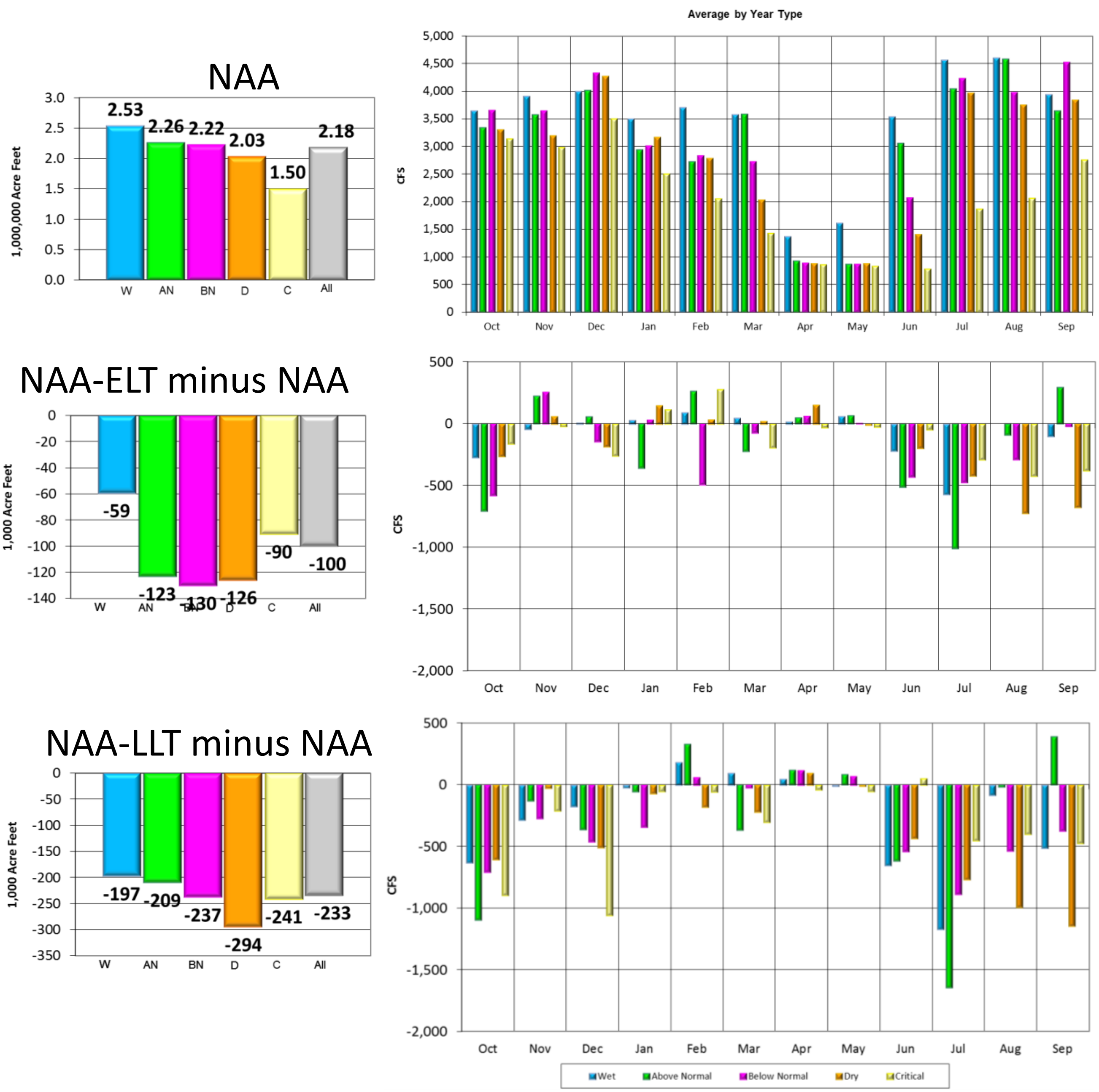
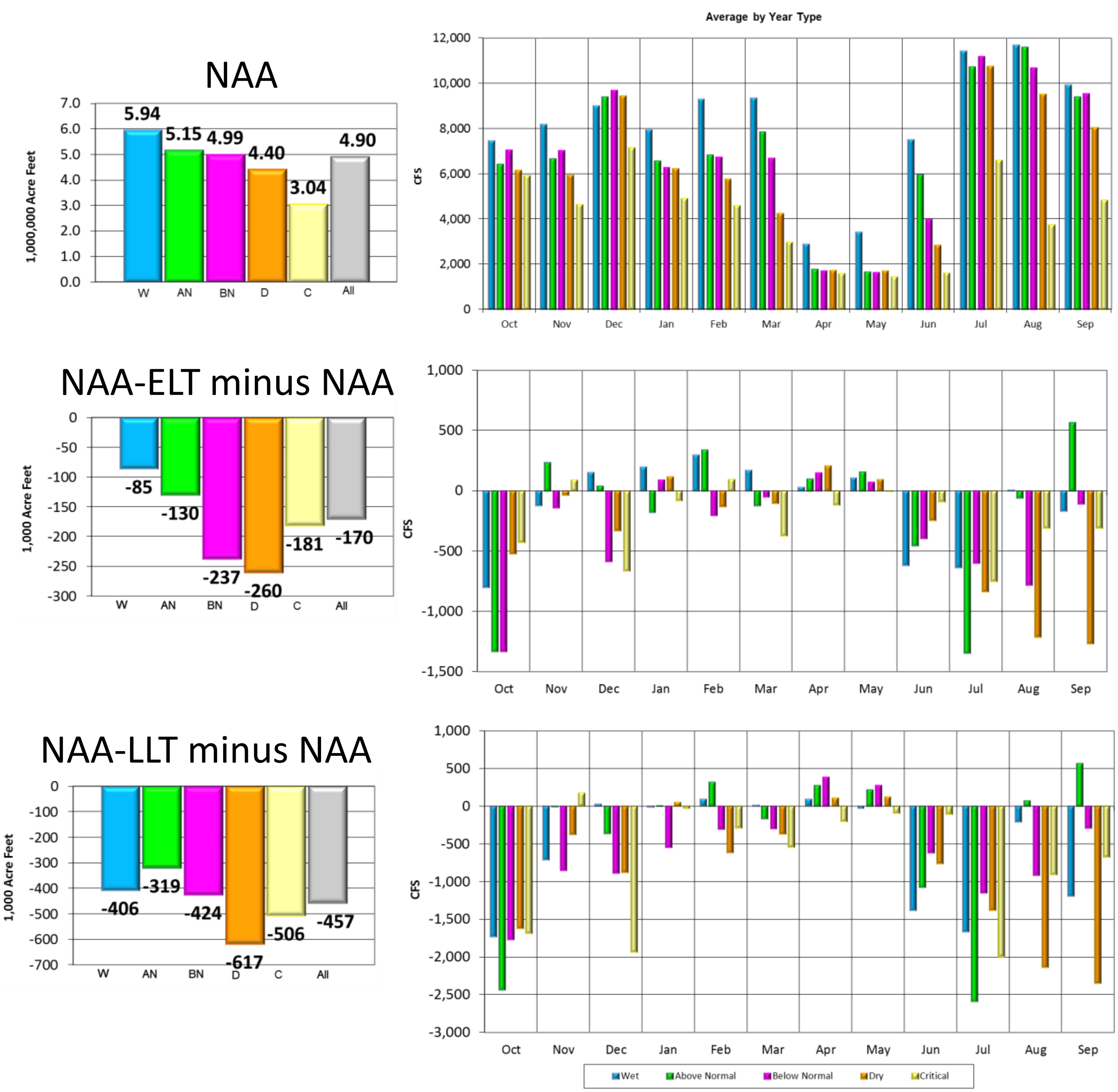


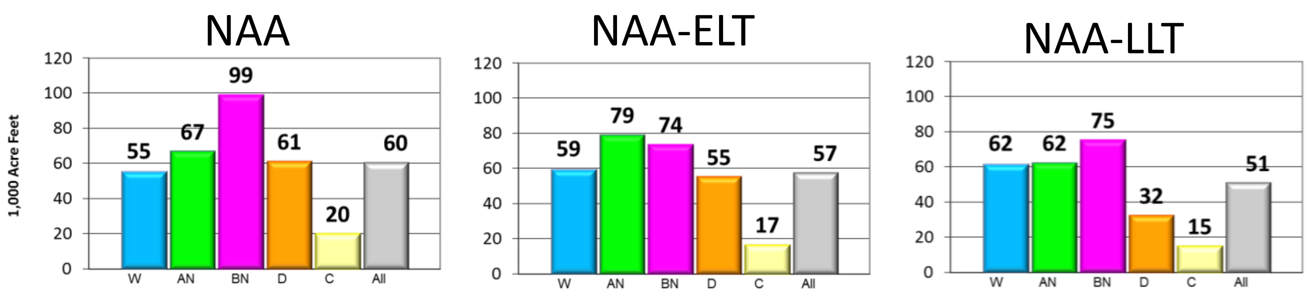
Figure 9. Total CVP/SWP Exports, NAA, NAA-ELT and NAA-LLT



Joint Point of Diversion

The NAA Alternatives do not make use of Joint Point of Diversion (JPOD), however CVP water is pumped at Banks to satisfy the Cross Valley Canal (CVC) contracts. **Figure** 10 shows annual Banks wheeling for CVC for the NAA, NAA-ELT and NAA-LLT.

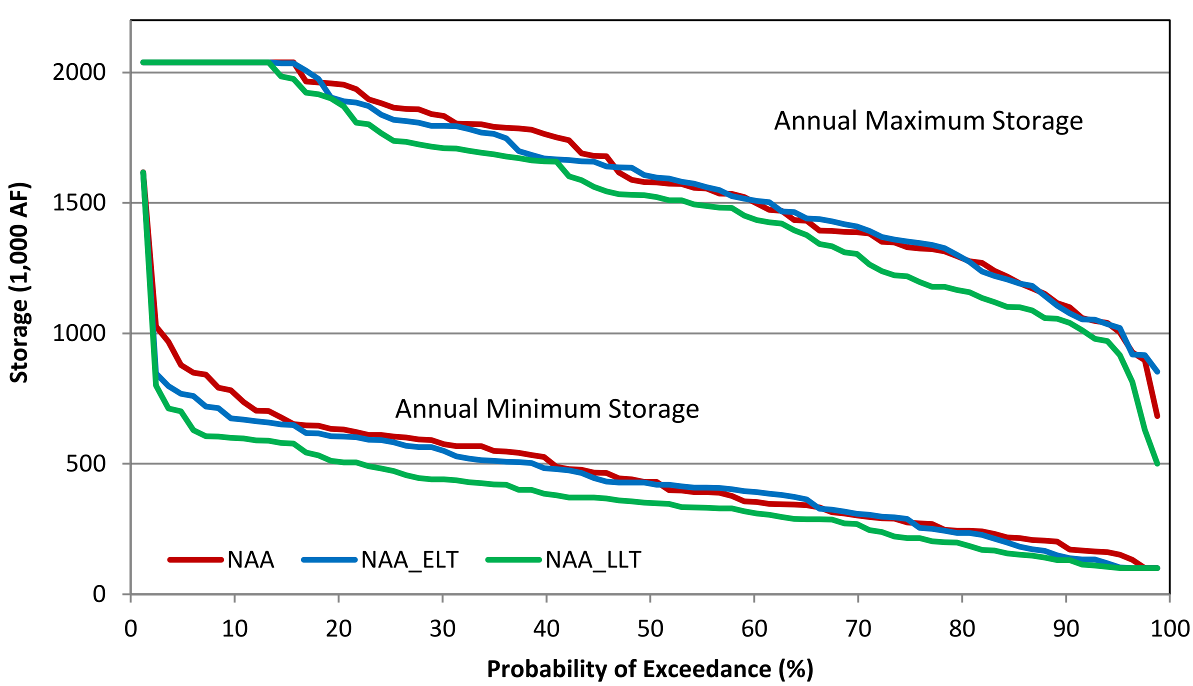
Figure 10. Cross Valley Canal Wheeling at Banks



San Luis Reservoir Operations

Modeling protocols will use San Luis Reservoir to store water when available and provide supply as exports are constrained by hydrology or regulatory constraints. Figure 11 illustrates the projected operation of San Luis Reservoir under the NAA, NAA-ELT, and NAA-LLT Scenarios. The annual maximum storage shows that the ability to fill San Luis Reservoir is somewhat similar for NAA and NAA-ELT but with less ability to fill in the NAA-LLT. The frequency of a low annual low point of San Luis Reservoir is exacerbated in the NAA-LLT Scenario. In all the Scenarios, San Luis Reservoir is heavily exercised. As currently projected, San Luis Reservoir will only fill as the result of very favorable hydrologic conditions including the availability of spill water from Friant or the Kings River system that offsets DMC water demands at the Mendota Pool.

Figure 11. San Luis Reservoir Storage – NAA, NAA-ELT and NAA-LLT



Sacramento River Temperature

CalSim II results, along with meteorological data, are used in temperature models that simulate reservoir temperature and river temperature. The BDCP modeling provided by DWR for review included the Sacramento

River temperature model and results for the No Action and Alternatives. Each BDCP Alternative used temperature target criteria for the upper Sacramento River as is used for the Existing Conditions modeling scenario. Equilibrium temperatures, a calculated model input that approximately depicts the effective air temperature for interaction with water temperature in the model, between Shasta and Gerber are increased by an annual average of 1.6°F for the ELT Scenarios and by 3.3°F for LLT Scenarios. Figure 12 contains monthly exceedance probability charts of temperature at Bend Bridge in the Sacramento River for April through October for the Existing Conditions and NAA-ELT Scenarios. There is about a 1 degree increase in average monthly temperature for the April through October period. Figure 13 contains similar information as Figure 12, but compares modeling results for the NAA-LLT and Existing Conditions Scenarios, there is often a 2°F increase in the NAA-LLT relative to Existing Conditions.

The increase in equilibrium temperatures combined with decreases in storage would lead to water temperature conditions that would likely not achieve the assumed objectives. Figure 12 and Figure 13 illustrate an increase in the probability that a water temperature target of 56°F would be exceeded at Bend Bridge under both the NAA-ELT and NAA-LLT Scenarios. The probability of exceedance increases approximately 5% to 20% depending on the month for the NAA-ELT Scenario and approximately 10% to 40% for the NAA-LLT Scenario.

Figure 12. Temperature Exceedance Sacramento River at Bend Bridge Existing, No Action Alternative, ELT

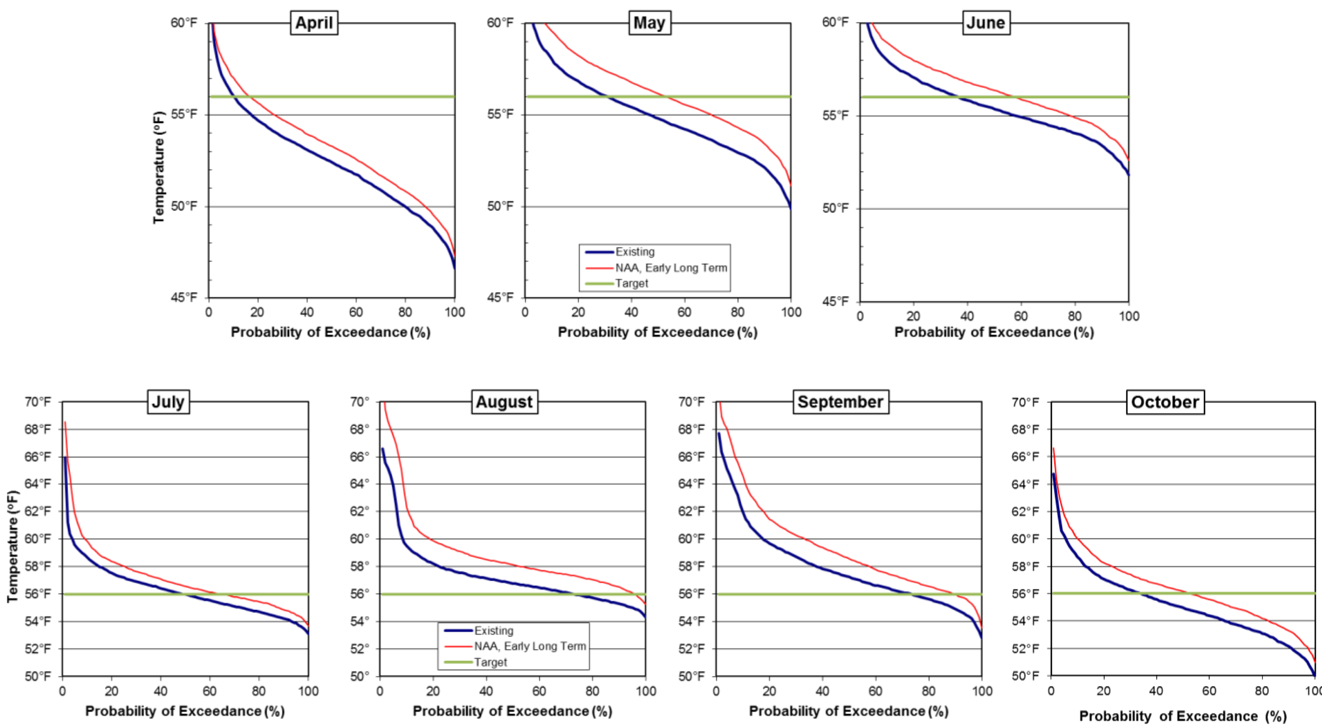
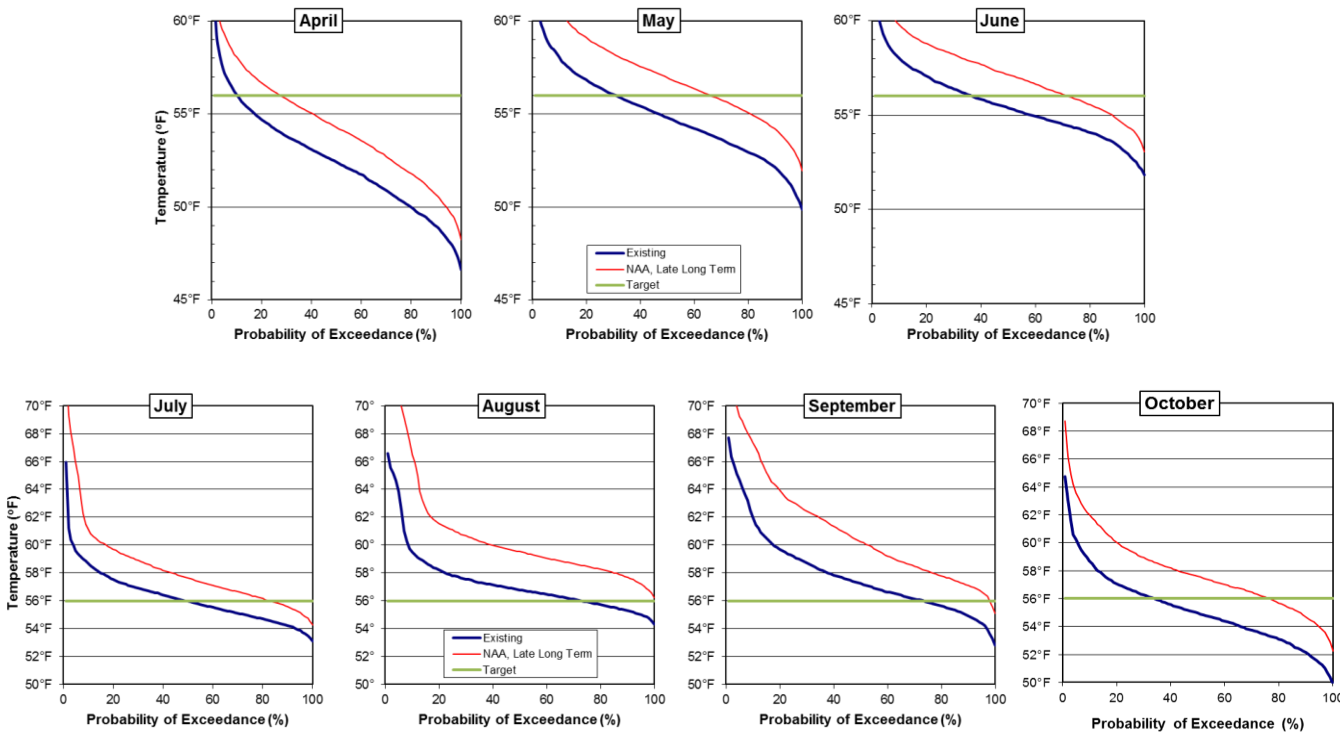


Figure 13. Temperature Exceedance Sacramento River at Bend Bridge Existing, No Action Alternative, LLT



Conclusions regarding Climate Change Assumptions and Implementation

In examining the possible effects of climate change, it is not appropriate to assume that current project operations will remain static and not respond to climate change. The BDCP's simplistic approach of assuming a linear operation of the CVP and SWP produces results that are not useful for dealing with the complex problem of climate change because it does not reflect the way in which the CVP and the SWP would actually operate whether or not the BDCP is implemented. Reviewers recommend a sensitivity analysis be conducted to develop a better understanding of the range of possible responses to climate change by the CVP and SWP, and the regulatory structures that dictate certain project operations.

Including climate change, without adaptation measures, results in insufficient water needed to meet all regulatory objectives and user demands. For example, the BDCP Model results that include climate change indicate that during droughts, water in reservoirs is reduced to the minimum capacity possible. Reservoirs have not been operated like this in the past during extreme droughts and the current drought also provides evidence that adaptation measures are called for long in advanced to avoid draining the reservoirs. In this aspect, the BDCP Model simply does not reflect a real future condition. Foreseeable adaptations that the CVP and SWP could make in response to climate change include: (1) updating operational rules regarding water releases for flood protection; (2) during severe droughts, emergency drought declarations could call for mandatory conservation; and (3) if droughts become more frequent, the CVP and SWP would likely revisit the rules by which they allocate water during shortages and operate more conservatively in wetter years. The modifications to CVP and SWP operations made during the winter and spring of 2014 in response to the drought supports the likelihood of future adaptations. The BDCP Model is, however, useful in that it reveals that difficult decisions must be made in response to climate change. But, in the absence of making those decisions, the BDCP Model results themselves are not informative, particularly during drought conditions. With future conditions projected to be so dire without the BDCP, the effects of the BDCP appear positive simply because it appears that conditions cannot get any worse (i.e., storage cannot be reduced below its minimum level). However, in reality, the future condition will not be as depicted in the BDCP Model. The Reviewers recommend that Reclamation and DWR develop more realistic operating rules for the hydrologic conditions expected over the next half-century and incorporate those operating rules into the any CalSim II Model that includes climate change.

2.2 BDCP Operation

The next step of our analysis centered on reviewing BDCP modeling of the with project scenarios as described in the December 2013 Draft BDCP and described as Alternative 4 in the Draft EISR.

Description of the BDCP Project

At the time of review, this Alternative was coined Alt 4 and represented a dual conveyance facility. The two DWR analyses reviewed were identified as:

- Alt 4 (dual conveyance) – ELT
  The same system demands and facilities as described in the NAA-ELT with the following primary changes: three proposed North Delta Diversion (NDD) intakes of 3,000 cfs each; NDD bypass flow requirements; additional positive OMR flow requirements and elimination of the San Joaquin River I/E ratio and the export restrictions during VAMP; modification to the Freemont Weir to allow additional seasonal inundation and fish passage; modified Delta outflow requirements in the spring and/or fall (defined in the Decision Tree discussed below); movement of the Emmaton salinity standard; redefinition of the EI ratio; and removal of current permit limitations for the south Delta export facilities. Set within the ELT environment.
- Alt 4 (dual conveyance) – LLT
  The same as the previous Scenario except established in the LLT environment.

The BDCP contemplates a dual conveyance system that would move water through the Delta's interior or around the Delta through an isolated conveyance facility. The BDCP CalSim II files contained a set of studies evaluating the projected operation of a specific version of such a facility. The Alternative was imposed on two baselines: the NAA-ELT scenario and the NAA-LLT scenario.

The changes (benefits or impacts) of the operation due to Alt 4 are highly dependent upon the assumed operation of not only the BDCP facilities and the changed regulatory requirements associated with those facilities, but also by the assumed integrated operation of the CVP and SWP facilities. The modeling of the NAA Scenarios introduced a significant change in operating protocols suggested primarily for reaction to climate change. We consider the extent of the reaction not necessarily representing a likely outcome, and thus have little confidence that the NAA baselines are a "best" (or even valid) representation of a baseline from which to compare an action Alternative. However, a comparison review of the Alternative to the NAA baselines illuminates operational issues in the BDCP modeling and provides insight as to where benefits or impacts may occur as additional studies are provided.

Since the effects of climate changes are more severe in the LLT than in the ELT, this review focuses on the ELT modeling because the results are less skewed by the climate change assumptions and problems.

BDCP's Alternative 4 has four possible sets of operational criteria, termed the Decision Tree, that differ based on the "X2" standards[7] that they contemplate:

- Low Outflow Scenario (LOS), otherwise known as operational scenario H1, assumes existing spring X2 standard and the removal of the existing fall X2 standard;

[7] X2 is a salinity standard that requires outflows sufficient to attain a certain level of salinity at designated locations in the Delta at certain times of year.

- High Outflow Scenario (HOS), otherwise known as H4, contemplates the existing fall X2 standard and providing additional outflow during the spring;
- Evaluated Starting Operations (ESO), otherwise known as H3, assumes continuation of the existing X2 spring and fall standards;
- Enhanced spring outflow only (not evaluated in the December 2013 Draft BDCP), scenario H2, assumes additional spring outflow and no fall X2 standards.

While it is not entirely clear how the Decision Tree would work in practice, the general concept is that the prior to operation of the new facility, implementing authorities would select the appropriate Scenario (from amongst the four choices) based on their evaluation of targeted research and studies to be conducted during planning and construction of the facility.

For our analysis, we reviewed the HOS (or H4) scenario because the BDCP[8] indicates that the initial permit will include HOS operations that may be later modified at the conclusion of the targeted research studies. The HOS includes the existing fall X2 requirements but adds additional outflow requirements in the spring. We reviewed the model code and discussed the operations with DWR and Reclamation, who acknowledged that although the SWP was bearing the majority of the responsibility for meeting the additional spring outflow in the modeling, the responsibility would need to be shared with the CVP[9]. In subsequent discussions, DWR and Reclamation have suggested that the additional water may be purchased from other water users. However, the actual source of water for the additional outflow has not been defined. Since the BDCP modeling assumes that SWP bears the majority of the responsibility for meeting the additional outflow, yet this is not how the project will be operated in reality, our review of the BDCP modeling results for HOS is limited to the evaluation of how the SWP reservoir releases on the Feather River translate into changes in Delta outflow and exports.

Our remaining analysis examines the ESO (or H3) scenario (labeled Alt 4-ELT or Alt 4-LLT in this section) because it employs the same X2 standards as are implemented in the No Action Alternatives NAA-ELT and NAA-LLT. This allows us to focus our analysis on the effects of the BDCP operations independent of the possible change in the X2 standard.

High Outflow Scenario (HOS or H4) Results

In Alt 4-ELT H4 Feather River flows during wetter years are increased more than 3,000 cfs in April and May and then decreased in most year types during July and August, while September flow is only decreased in wetter years. Figure 14 shows average monthly change in Feather River flow by water year type. Accompanying the changes in Feather River flow are changes in Oroville Reservoir storage levels, Figure 15 contains average monthly changes in Oroville storage. Alt4-ELT H4 end of June storage in Oroville during wetter years is about 480 TAF lower than the NAA-ELT while critical year storage is about 400 TAF higher. Counter to the reduction in Oroville storage, CVP average upstream carryover storage increases about 80 TAF and critical year increases by 380 TAF. Figure 16 contains average monthly changes in Delta outflow, increases in Feather River spring time flows are generally not used to increase Delta outflow, but are allowed to support increases in Delta exports.

Figure 17 displays changes in average monthly Delta exports, there are increases when diverting higher upstream spring releases in wetter years, while there are decreases during summer months in most years. Figure 18

[8] Draft BDCP, Chapter 3, Section 3.4.1.4.4
[9] August 7, 2013 meeting with DWR, Reclamation, and CH2M HILL

contains an average annual summary of project deliveries, total CVP deliveries increase by about 70 TAF while SWP deliveries decrease by about 100 TAF. Dryer year SWP deliveries decrease by 250 to 400 TAF, while wet year deliveries increase by 200 TAF. Total CVP deliveries increase in wetter years by exporting increased releases from Oroville.

The overall effect of the HOS appears to be increases in Oroville releases that support both CVP and SWP exports in wetter years, with modest increases in Delta outflow. There is also a decrease in SWP reliability through large delivery reductions in dryer years accompanied by Oroville storage increases. In addition to increases in dry and critical year storage in Oroville, total CVP dry and critical year carryover increases by 100 TAF and 380 TAF respectively with negligible reductions in wetter years types.

CVP and SWP obligation for providing flow to satisfy Delta outflow requirements is described in the Coordinated Operations Agreement (COA). Because the CVP and SWP share responsibility for meeting required Delta outflow based on specific sharing agreement, it doesn't seem reasonable that CVP water supplies would increase while SWP water supplies decrease under this Alternative. The manner in which this alternative is modeled is inconsistent with existing agreements and operating criteria. If the increases in outflow were met based on COA, there would likely be reductions in Shasta and Folsom storage that may cause adverse environmental impacts.

Figure 14. Changes in Feather River Flow, Alt 4 H4 ELT minus NAA-ELT

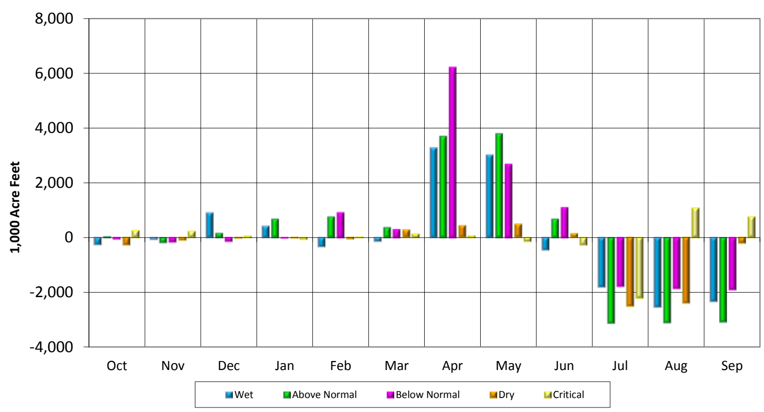


Figure 15. Changes in Oroville Storage, Alt 4 H4 ELT minus NAA-ELT

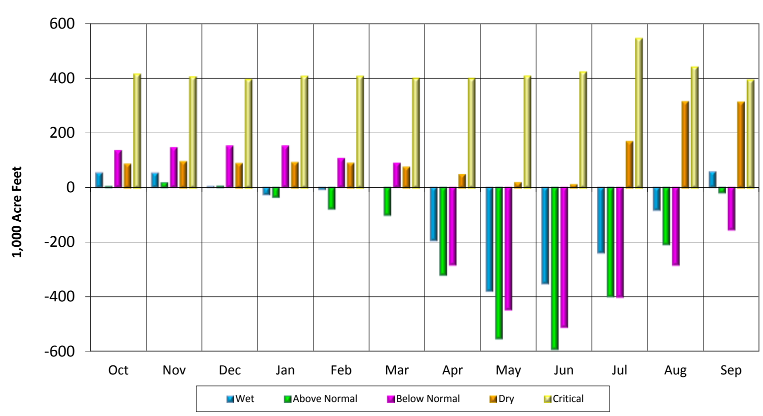


Figure 16. Changes in Delta Outflow, Alt 4 H4 ELT minus NAA-ELT

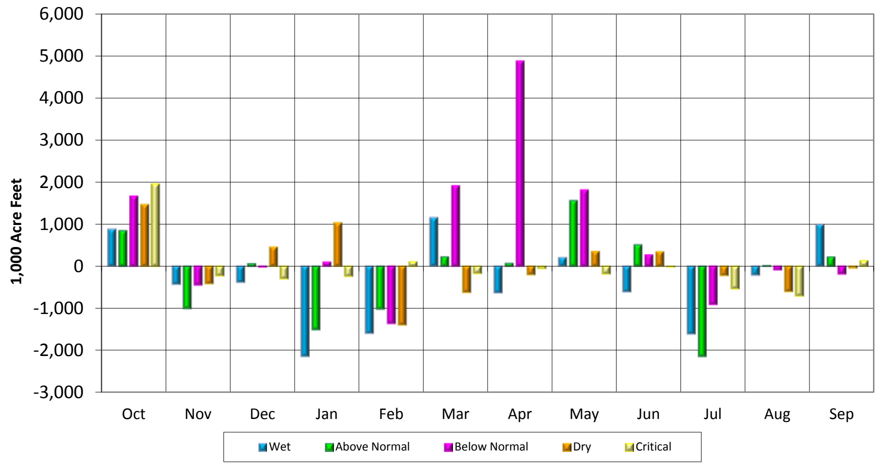


Figure 17. Changes in Delta Export, Alt 4 H4 ELT minus NAA-ELT

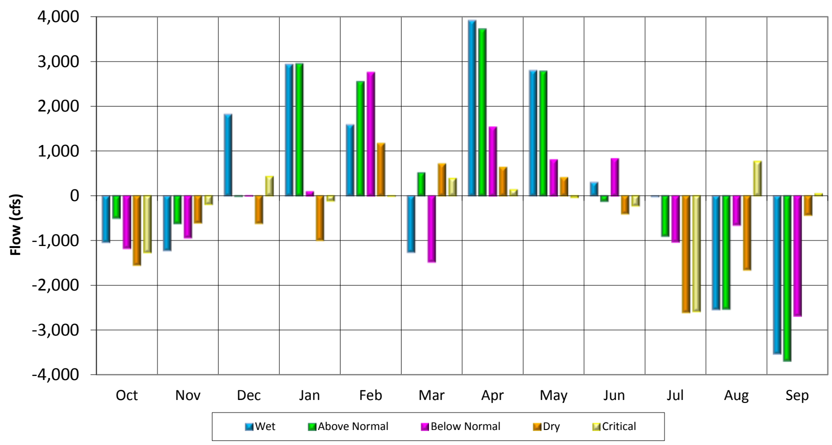
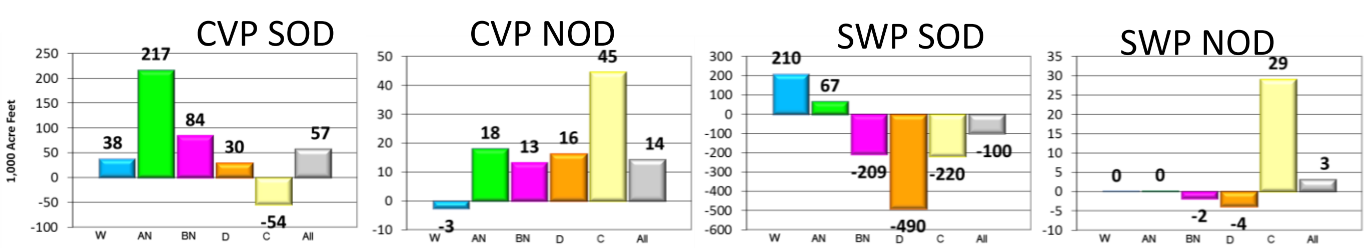


Figure 18. Changes in CVP and SWP Deliveries, Alt 4 H4 ELT minus NAA-ELT

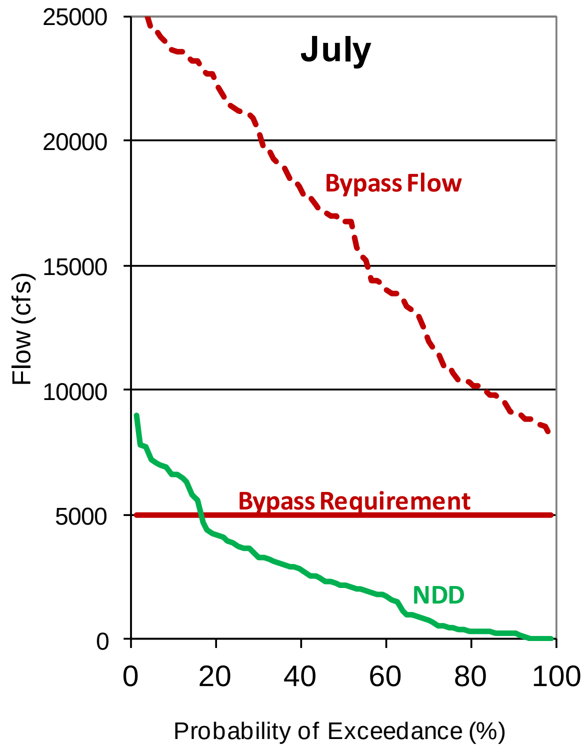


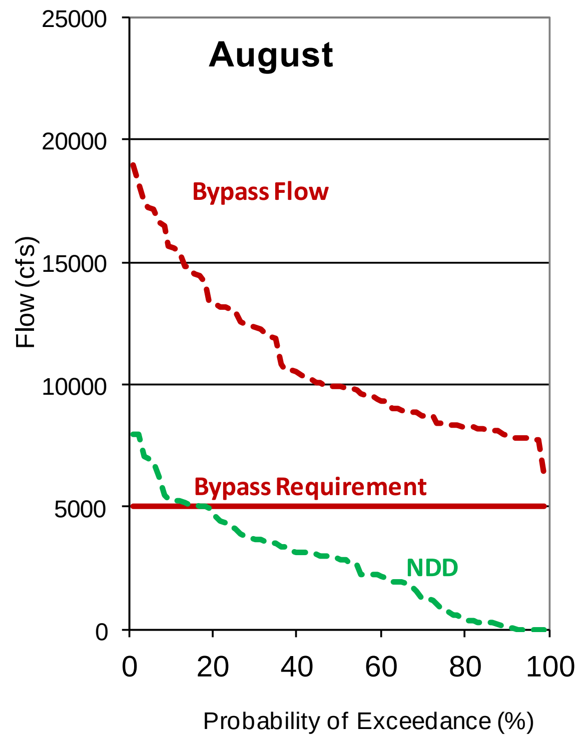
Evaluated Starting Operations (ESO or H3) Results

North Delta Diversion Intakes

Sacramento River flow below the North Delta Diversion (NDD) must be maintained above the specified bypass flow requirement, therefore the NDD rates are limited to the Sacramento River flow above the bypass requirement. Due to an error in CalSim II that specifies an unintended additional bypass requirement, modeling performed for the BDCP EIRS often bypasses more Sacramento River flow than is specified in the BDCP project description. This error has been fixed in the most recent public releases of CalSim II, but BDCP modeling has not been updated to reflect these fixes. Figure 19 contains exceedance probability plots showing the Sacramento River required bypass, Sacramento River bypass flow, NDD, and excess Sacramento River flow to the Delta as modeling for BDCP. As can be seen in Figure 19, the bypass flow is always above the bypass requirement in July and August. The BDCP version of CalSim sets a requirement for Sacramento River inflow to the Delta needed to satisfy all Delta flow, quality, and export requirements, this requirement should be removed when modeling the NDD.

Figure 19. NDD, Bypass Requirement, Bypass Flow, and Excess Sacramento R. flow for Alt 4-ELT

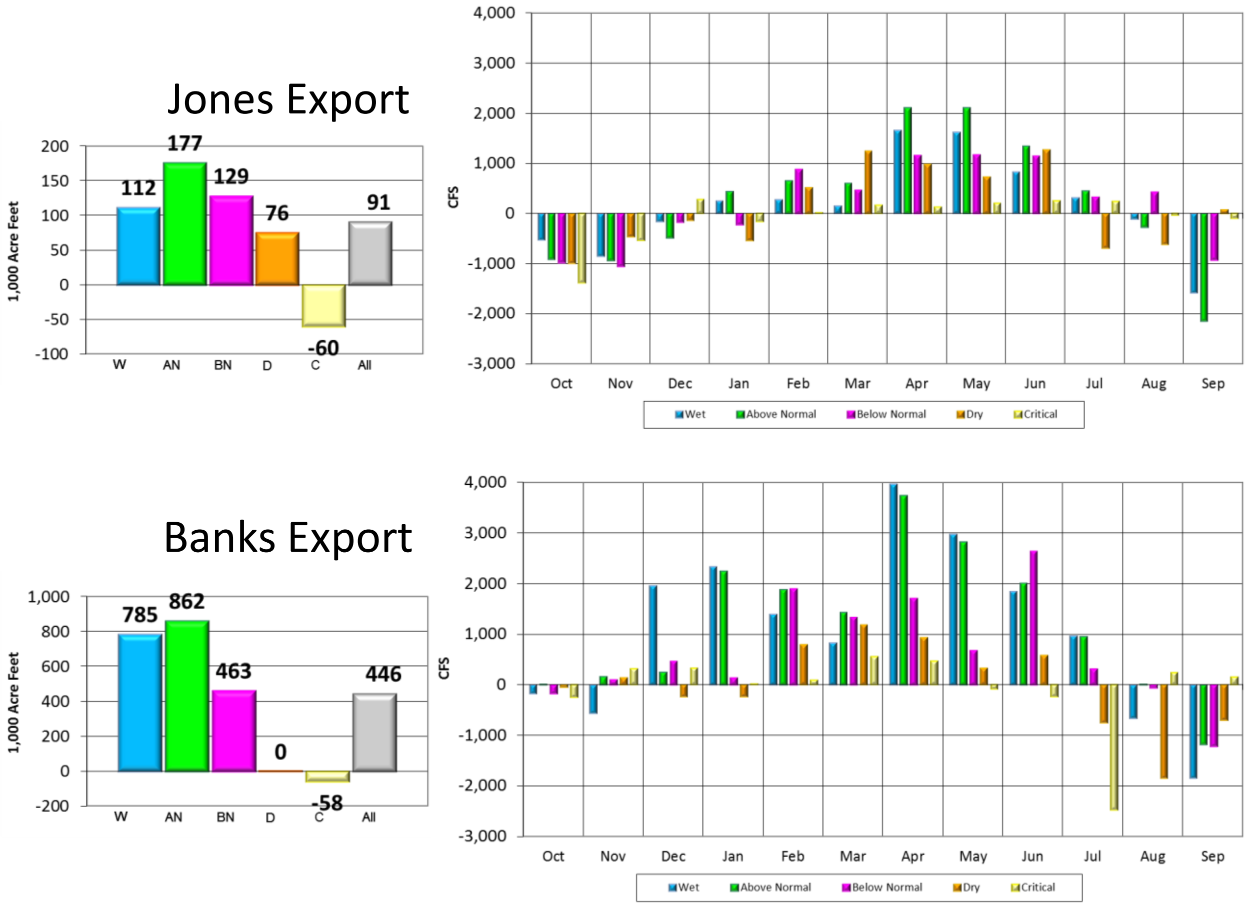




CVP/SWP Exports

Overall the Alt 4 will increase exports compared to the NAA-ELT, with the majority of the increased exports realized by the SWP. Figure 20 illustrates a comparison between the NAA-ELT and Alt 4-ELT of CVP and SWP exports. On average, total combined exports under Alt 4–ELT are projected to increase by 537 TAF from 4.73 MAF to 5.26 MAF compared to the NAA-ELT.

Figure 20. Change in CVP (Jones) and SWP (Banks) Exports (Alt 4-ELT minus NAA-ELT)



With the addition of the North Delta Diversion facility, the water exported dramatically shifts from South Delta diversions to North Delta diversions. Figure 21 illustrates the change in routing of South of Delta exports under Alt 4 compared to the NAA-ELT. On average, export through the South Delta facility are projected to decrease by 2.1 MAF and the North Delta diversions will export 2.6 MAF which includes the 2.1 MAF shifted from the South Delta facility plus the additional 537 TAF of increased exports.

Figure 21. Change in Conveyance Source of Exports (Alt 4-ELT minus NAA-ELT)

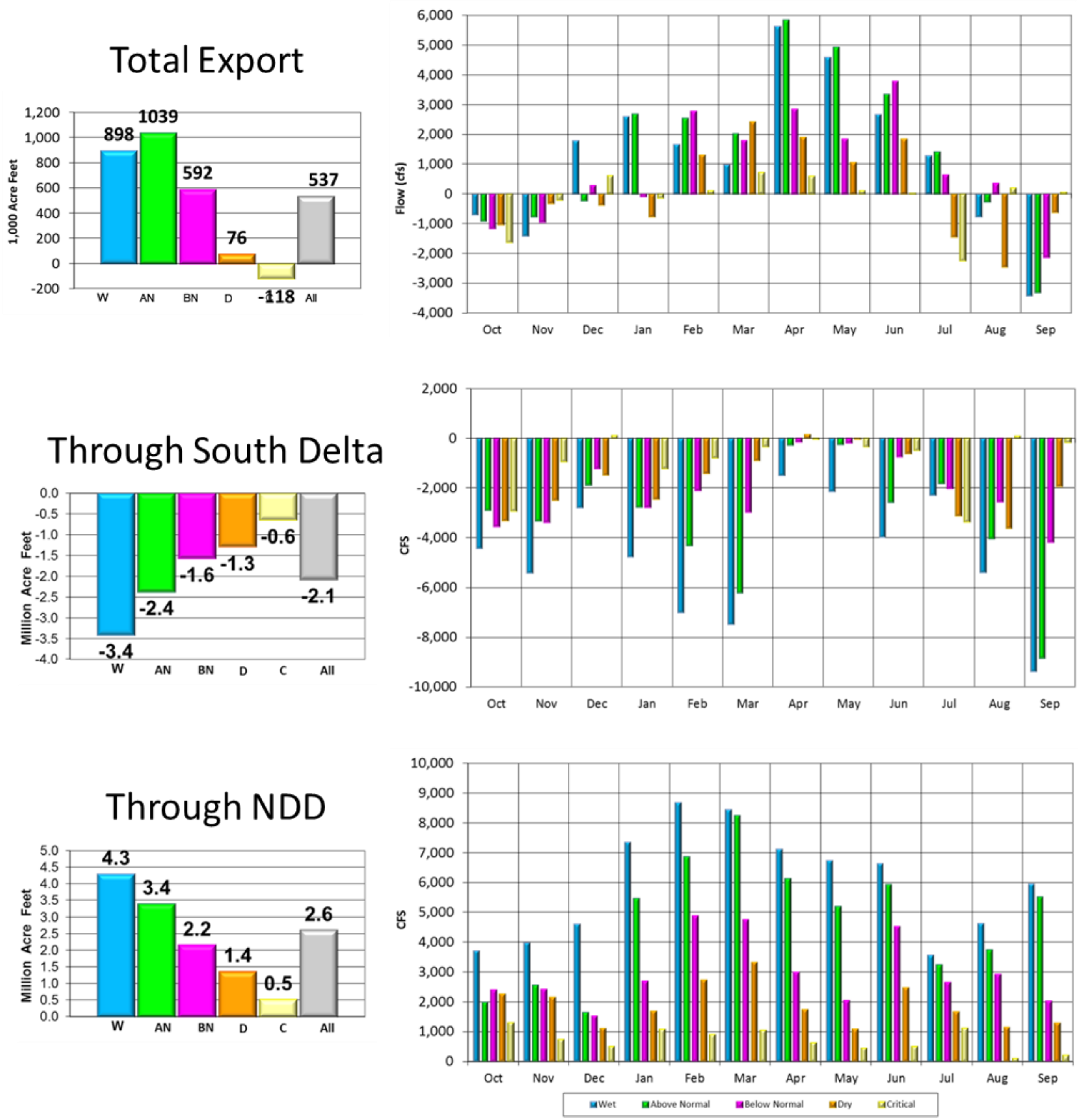
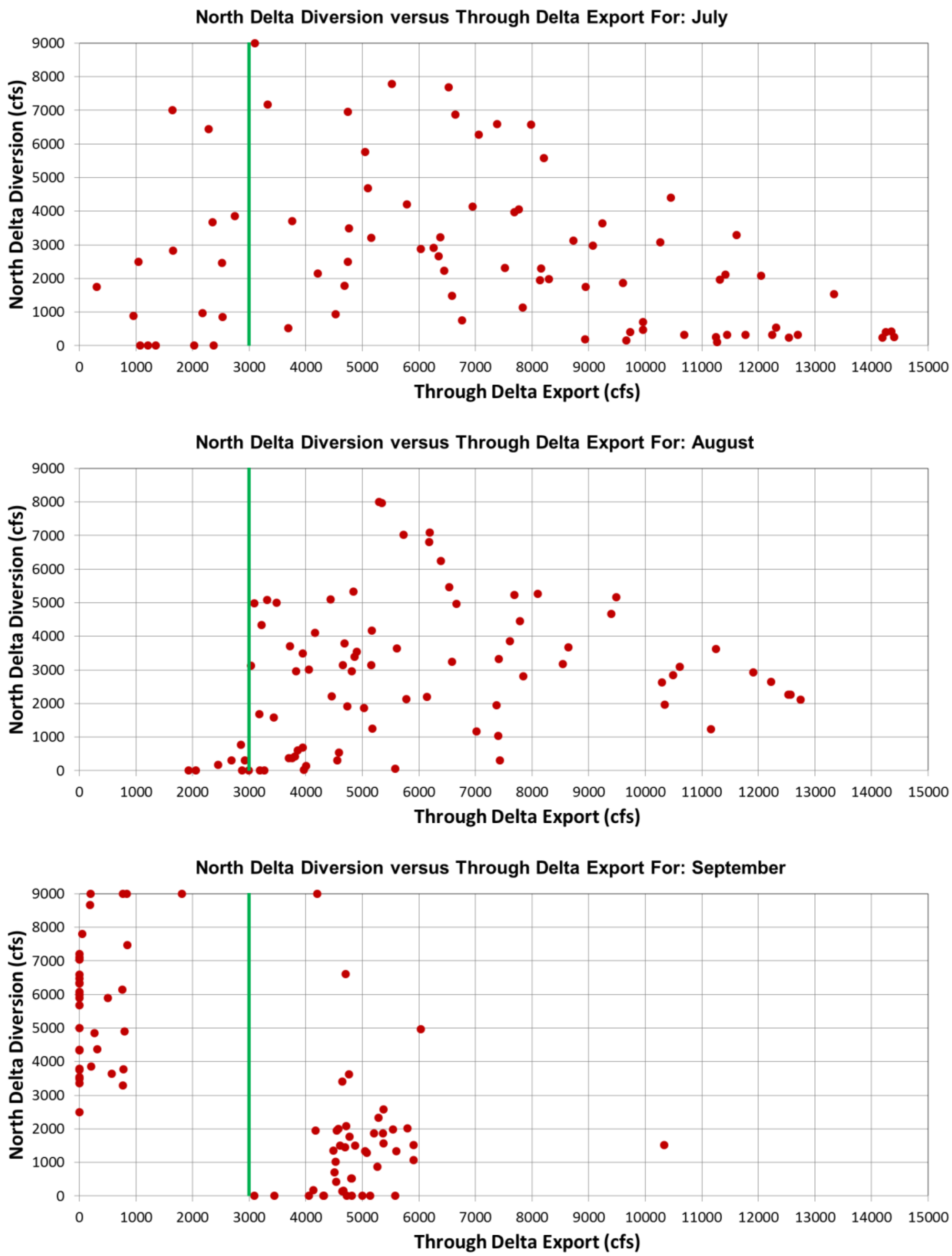


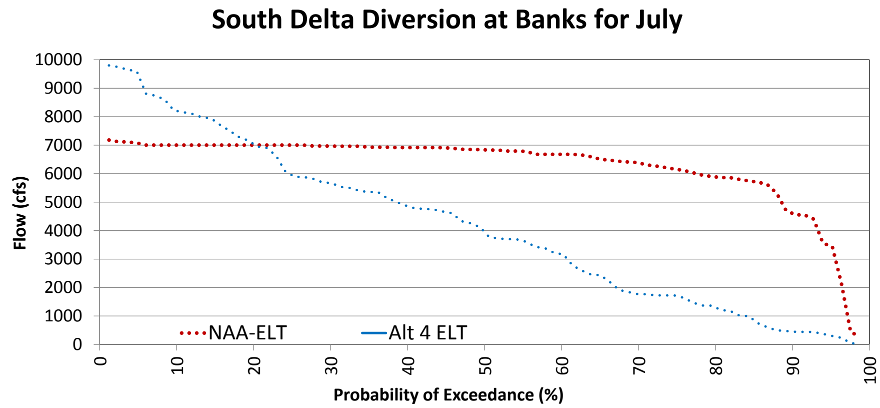
Figure 22 contains figures for July, August, and September for Alt 4-ELT that plot NDD against SDD. In the months of July to September SDD are occasionally very high, exceeding 14,000 cfs in July, with minimal NDD. This occurs due to outdated model code that imposes an instream flow requirement in Sacramento River flow below Hood in excess of the bypass criteria prescribed in the BDCP. There are numerous occurrences when bypass flows prescribed in the BDCP are exceeded and SDD are higher than expected. On the other hand, there are also many times when NDD are above minimum pumping levels and SDD are below the BDCP prescribed 3,000 cfs threshold indicated by the green line in Figure 22. For unknown reasons, the model code requiring SDD to be greater than 3,000 cfs before NDDs occur from July through September is deactivated in the BDCP modeling of this Alternative.

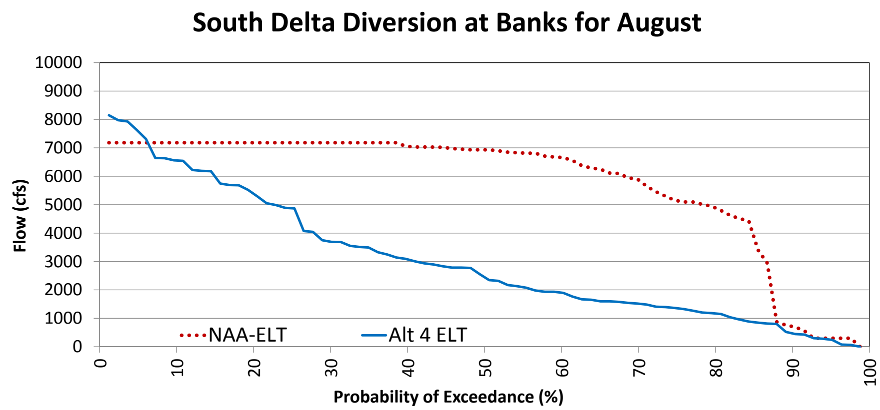
Figure 22. Alt 4-ELT North Delta Diversion Versus South Delta Diversion for July, August, and September

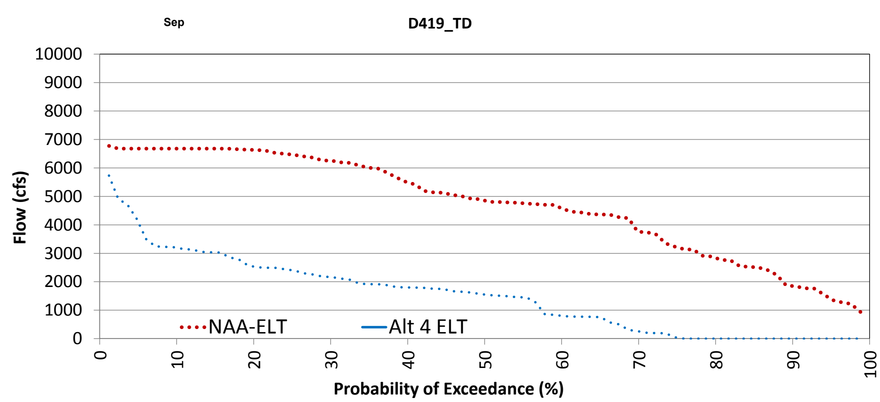


South Delta Diversion at Banks is not limited to existing permit capacity of 6,680 cfs and pumping may reach full capacity of 10,300 cfs in July, August, and September. Figure 23 contains exceedance probability charts of South Delta Diversion at Banks for July, August, and September. The chart for July shows SDD at Banks exceeding existing permit capacity 20% of years, in August this occurs in about 7% of years. There are South Delta diversions at Banks 25% of the time in September while diversions from the Sacramento River may range from 2,500 cfs to 7,500 cfs.

Figure 23. South Delta Diversion at Banks





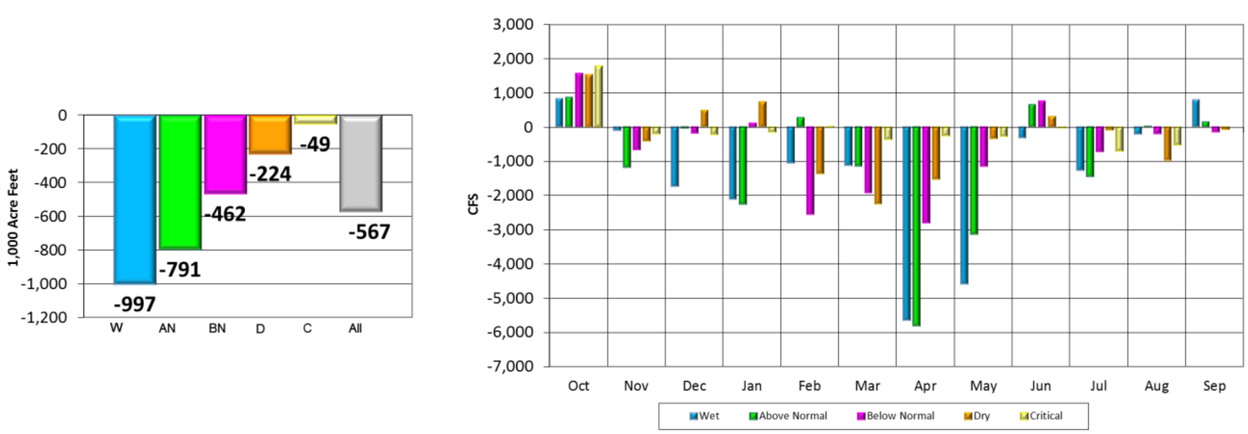


Generally exports increase during winter and spring months due to the ability to avoid fishery concerns by diverting at the North Delta rather than South Delta.

Delta Outflow

Figure 24 illustrates a comparison of Delta outflow between the NAA-ELT and Alt 4-ELT. Decreases in Delta outflow are the result of the CVP and SWP ability to increase Delta exports in Alt 4-ELT. The apparent increase in Delta outflow in October is partially due to additional export restrictions though Old and Middle River flow requirements. However, the increase in October Delta outflow is also due to an unrealistic operation of the Delta Cross Channel. The additional export restrictions cause the flow standards imposed at Rio Vista to be the controlling point in CVP and SWP operations; the water quality standards are all being met and do not require flows above the amount needed to satisfy the Rio Vista standard. Meeting the Rio Vista flow standards without closing the Delta Cross Channel gate results in releasing more water from upstream reservoirs than would otherwise be necessary. This occurs because a certain amount of the water released to meet the Rio Vista flow standards would flow into the Central Delta at location of the Delta Cross Channel gate. This water would not make it to Rio Vista and therefore would not be counted towards meeting the Rio Vista flow standards. However, due to the BDCP model's assumed restrictions on exports at this time, this water could not be pumped from the South Delta facilities and thus ends up as "extra" Delta outflow. By closing the Delta Cross Channel gate, the operators would assure that all of the water released to meet the Rio Vista flow standards would be counted towards those standards. The BDCP model's assumptions that the Delta Cross Channel gate would not be closed are not practical or a sensible operation as the operators confirmed they would close the gate during these conditions to avoid the unnecessary loss of water supplies (as was done in October and November 2013). The assumption in the BDCP model to maintain the gate in the open position causes it to overstate the amount of Delta outflow.

Figure 24. Delta Outflow Change (Alt 4-ELT minus NAA-ELT)



CVP/SWP Reservoir Carryover Storage

CVP/SWP reservoir operating criteria in the Alt4-ELT scenario differs from the NAA-ELT scenario. This difference is primarily driven by changes in both CVP and SWP San Luis Reservoir target storage. CalSim II balances upstream Sacramento Basin CVP and SWP reservoirs with storage in San Luis Reservoir by setting target storage levels in San Luis Reservoir. CalSim II will release water from upstream reservoirs to meet target levels in San Luis Reservoir and the target storage will be met as long as there is capacity to convey water and water is available in upstream reservoirs. In Alt 4 the San Luis Reservoir target storage is set very high in the spring and early summer months, and then reduced in August and set to San Luis Reservoir dead pool from September through December. This change in San Luis target storage relative to the NAA causes upstream reservoirs to be drawn down from June through August and then recuperate storage relative to the NAA by cutting releases in September; Alt 4 upstream storage then remains close to the NAA during fall months. These operational criteria cause changes in upstream cold water pool management and affect several resource areas. Figure 25, Figure 26, Figure 27, and Figure 28 contain exceedance charts for carryover storage and average monthly changes in storage by Sacramento Valley Water Year Type for North of Delta CVP and SWP reservoirs.

San Luis Reservoir Operations

In addition to changes in upstream storage conditions, changes in San Luis Reservoir target storage cause San Luis Reservoir storage to reach dead pool in many years with subsequent SOD delivery shortages. Although some delivery shortages are due to California Aqueduct capacity constraints, the largest annual delivery shortages are a result of inappropriately low target storage levels. Average annual Table A shortages due to artificially low San Luis reservoir storage levels increased from 3 TAF in the NAA-ELT scenario to 35 TAF in the Alt4-ELT scenario. (Shortages due only to a lack of South of Delta conveyance capacity were not included in these averages.) Such shortages occurred in 2% of simulated years in the NAA-ELT scenario and 23% of years in the Alt4-ELT scenario. In addition to the inability to satisfy Table A allocations, low storage levels cause loss of SWP contractors' Article 56 water stored in San Luis Reservoir. Average annual Article 56 shortages were 43 TAF in the Alt4-ELT scenario because of low San Luis storage and 5 TAF in the NAA-ELT scenario. Low San Luis storage causes Article 56 shortages in 27% of simulated years in the Alt4-ELT scenario as compared to 5% of simulated years in the NAA-ELT. Another consequence of low storage levels in San Luis Reservoir is a shift in water supply benefits from Article 21 to Table A. As seen in Figure 29 and Figure 30 San Luis Reservoir storage fills more regularly in the Alt 4-ELT scenario, but is exercised to a lower point more often.

Figure 25. Trinity Reservoir Carryover Storage and Average Monthly Changes (Alt 4-ELT minus NAA-ELT) in Storage by Water Year Type

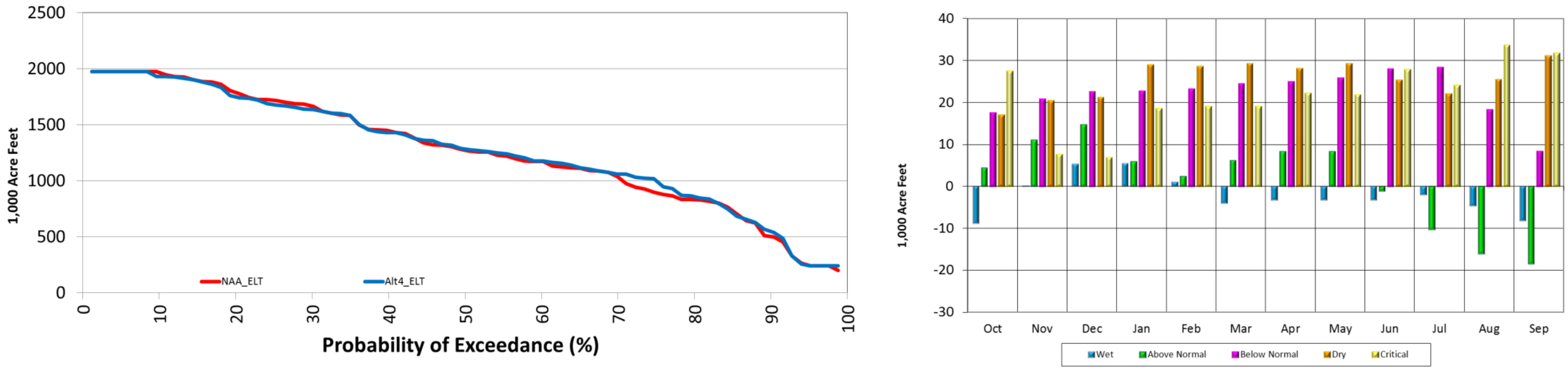


Figure 26. Shasta Reservoir Carryover Storage and Average Monthly Changes (Alt 4-ELT minus NAA-ELT) in Storage by Water Year Type

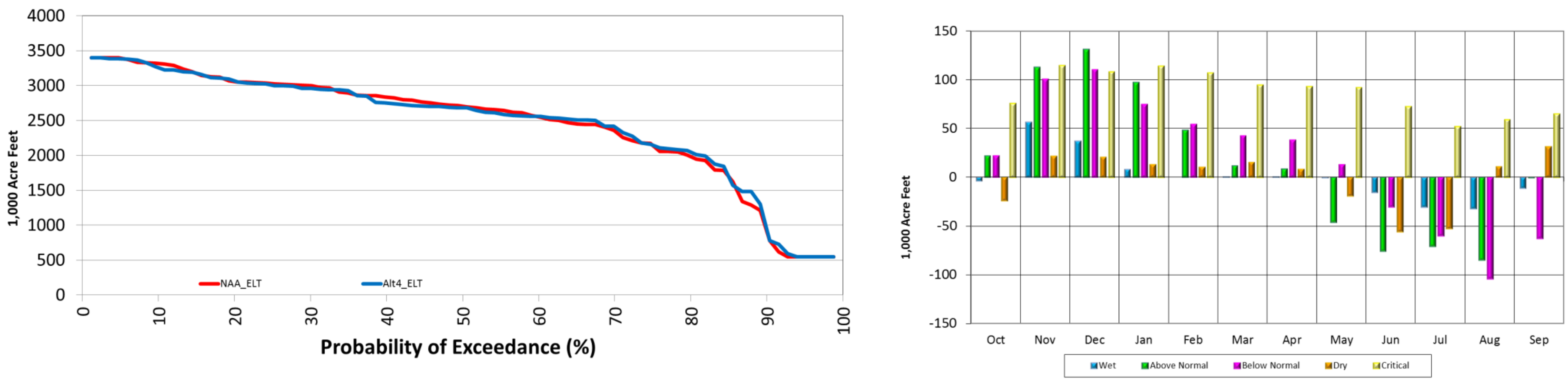
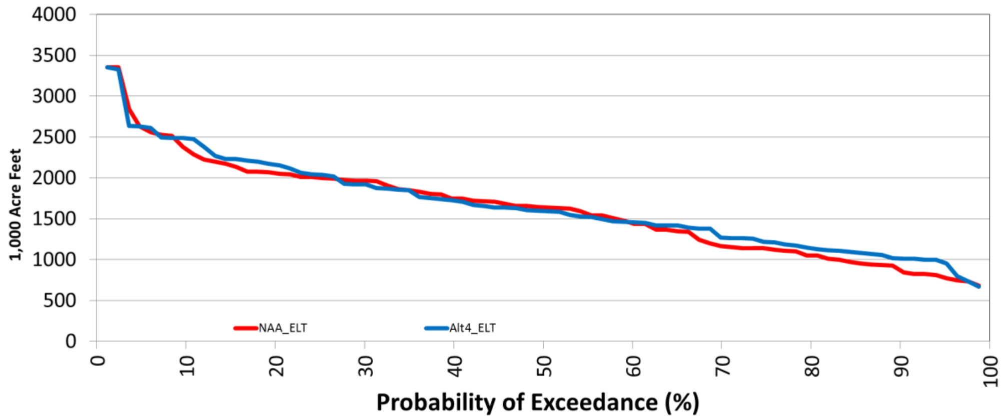


Figure 27. Oroville Reservoir Carryover Storage and Average Monthly Changes (Alt 4-ELT minus NAA-ELT) in Storage by Water Year Type



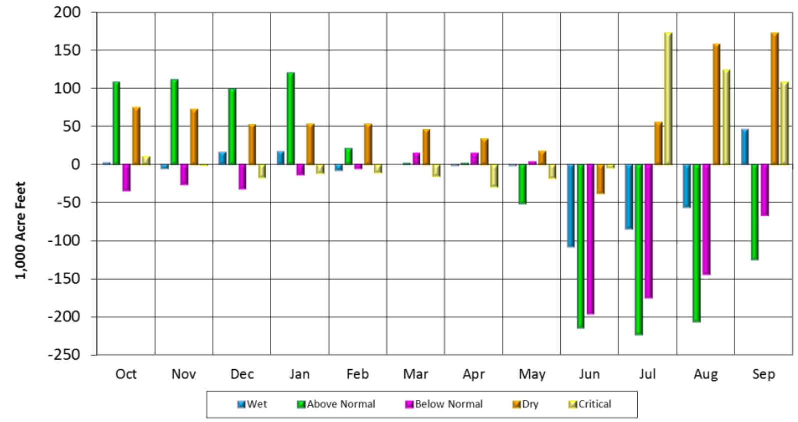
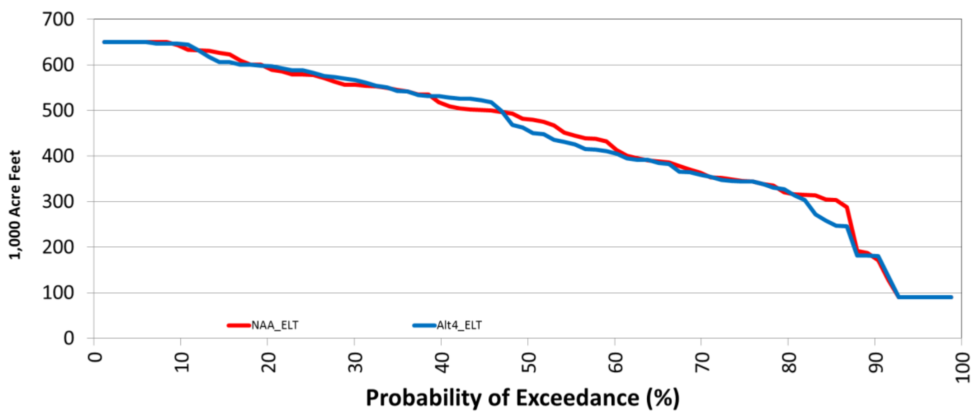


Figure 28. Folsom Reservoir Carryover Storage and Average Monthly Changes (Alt 4-ELT minus NAA-ELT) in Storage by Water Year Type



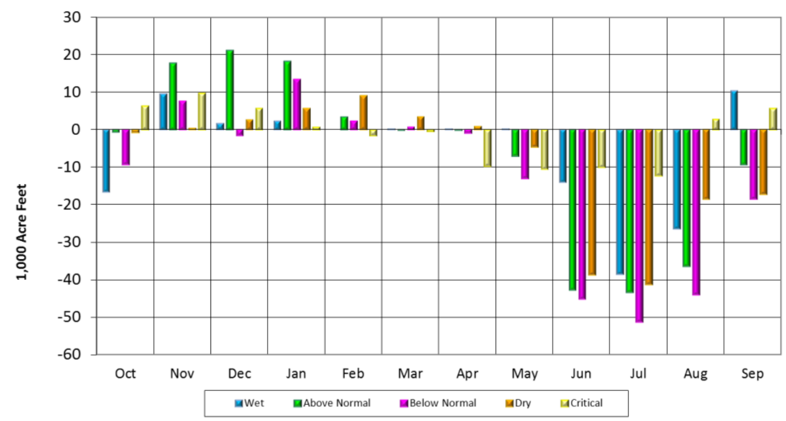


Figure 29. Federal Share of San Luis Reservoir (Alt 4-ELT and NAA-ELT)

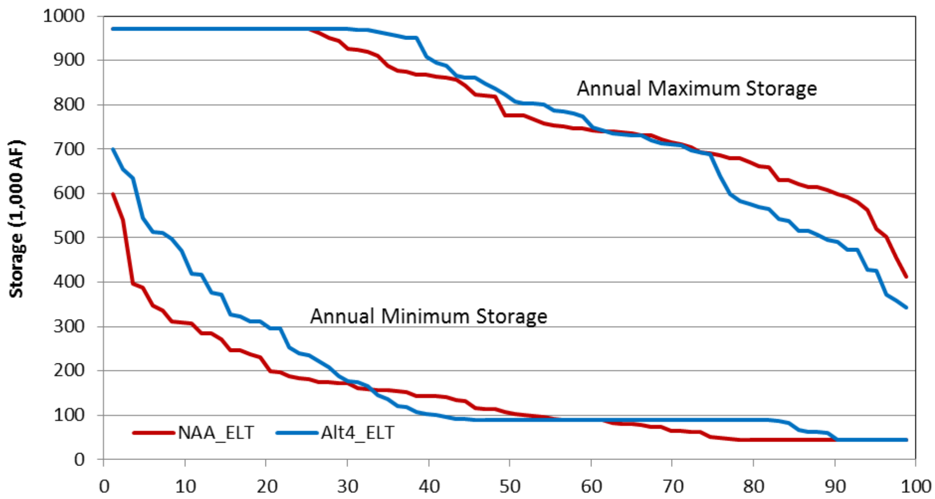
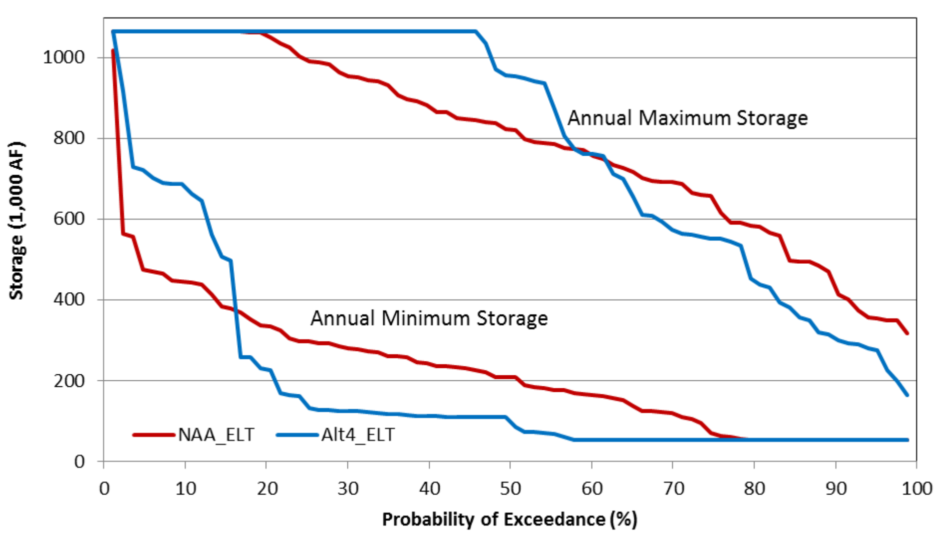


Figure 30. State Share of San Luis Reservoir (Alt 4-ELT and NAA-ELT)



CVP Water Supply

The changes in water supply to CVP customers, based on customer type and water year type is shown in Table 3. Alt 4-ELT shows an average increase of approximately 109,000 AF of delivery accruing to CVP customers with CVP SOD agricultural contractors receiving most of the benefit. Changes in Sacramento River Settlement contract deliveries are not an anticipated benefit of the BDCP, increases in these deliveries in Alt 4-ELT relative to the NAA-ELT are due to the shortages in the NAA-ELT from climate change that are reduced in Alt 4-ELT. Although the BDCP modeling demonstrates minor benefits to NOD CVP service contractors, this increase is not an anticipated benefit of the BDCP.

Consistent with modeling for the NAA-ELT Scenario, San Joaquin River Exchange Contractors receive full deliveries in accordance with contract provisions. Figure 31 compares CVP Service Contract delivery of Alt 4-ELT to the NAA-ELT Scenario. Increases in delivery generally occur in below and above normal years.

Table 3. CVP Delivery Summary (Alt 4-ELT and NAA-ELT)

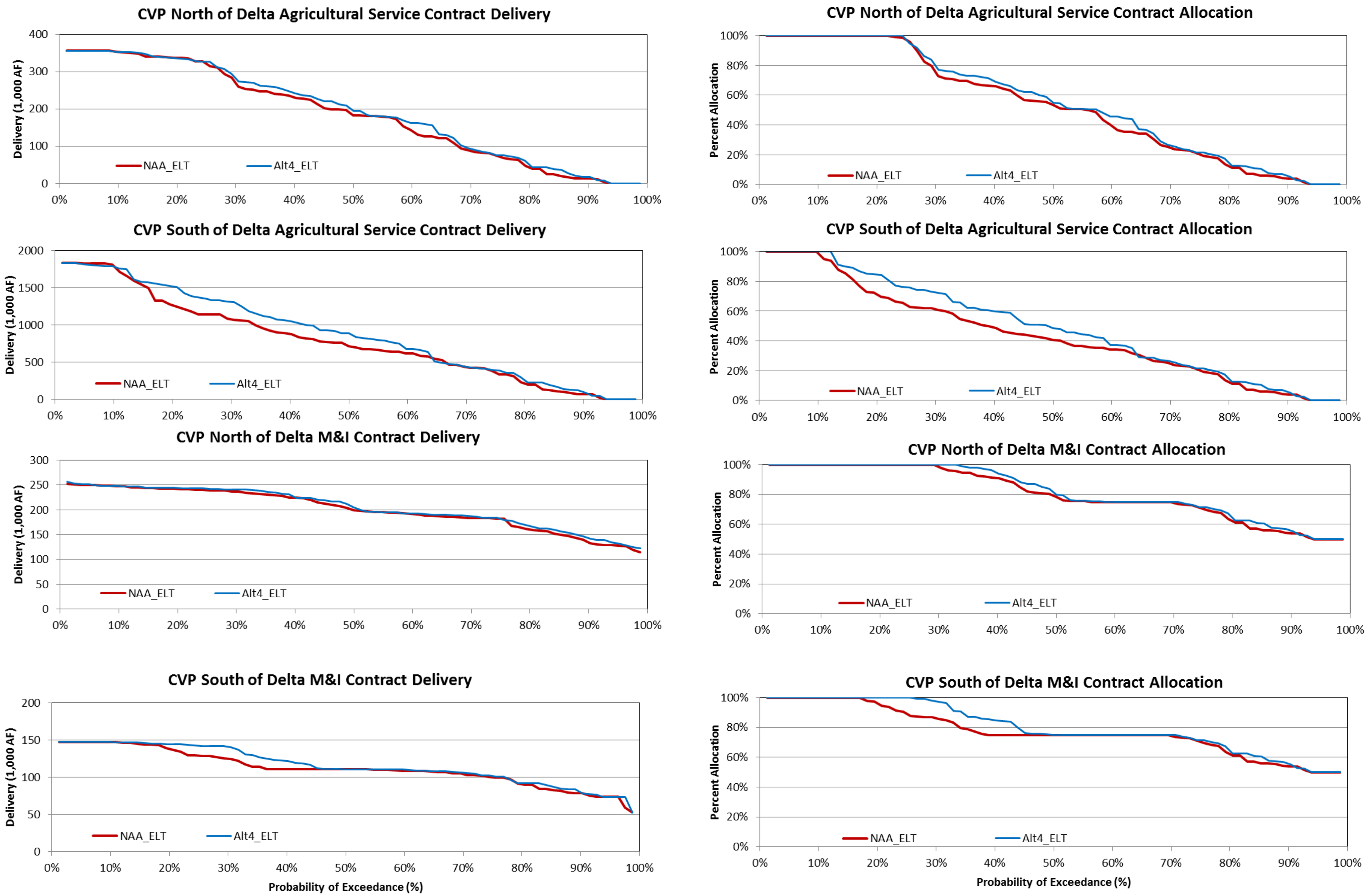
NAA-ELT (1,000 AF)

	AG NOD	AG SOD	Exchange	M&I NOD	M&I SOD	Refuge NOD	Refuge SOD	Sac. Setlmnt	CVP NOD Total	CVP SOD Total
All Years	**187**	**796**	**852**	**201**	**112**	**86**	**271**	**1846**	**2321**	**2215**
W	309	1364	875	236	134	90	281	1856	2491	2837
AN	246	908	802	214	110	83	257	1716	2258	2246
BN	146	596	875	198	108	92	281	1899	2335	2044
D	95	440	864	175	100	90	277	1890	2250	1864
C	29	152	741	140	79	64	223	1674	1908	1376

Difference: Alt4-ELT minus NAA-ELT (1,000 AF)

	AG NOD	AG SOD	Exchange	M&I NOD	M&I SOD	Refuge NOD	Refuge SOD	Sac. Setlmnt	CVP NOD Total	CVP SOD Total
All Years	8	90	0	4	4	1	0	3	15	94
W	1	68	0	1	3	2	1	-2	1	72
AN	14	199	0	3	12	1	0	-1	17	211
BN	17	153	0	5	4	0	0	0	22	158
D	10	48	0	5	2	1	-1	-1	15	49
C	3	6	0	5	2	-1	2	26	33	12

Figure 31. CVP Service Contract Deliveries (Alt 4-ELT and NAA-ELT)



SWP Water Supply

Similar in nature, but larger in magnitude are changes in SWP deliveries. Figure 32 and Table 4 illustrate the benefits of Alt 4-ELT in comparison to the NAA-ELT Scenario. These studies show an increase in average annual SWP SOD deliveries of approximately 408,000 AF, but a reduction in critical year deliveries of approximately 177,000 AF. There is an overall reduction in Article 56 deliveries. Typically in modeling and in actual SWP operations, increases in Table A correspond with increases in Article 56. The reason that Article 56 deliveries decrease overall is that insufficient quantities of water are carried over in San Luis and Article 56 contractors are subsequently shorted. SWP delivery increase is slightly less than increases in Banks export because there is increased wheeling for the Cross Valley Canal contractors with BDCP.

Table 4. SWP Delivery Summary (Alt 4-ELT and NAA-ELT)

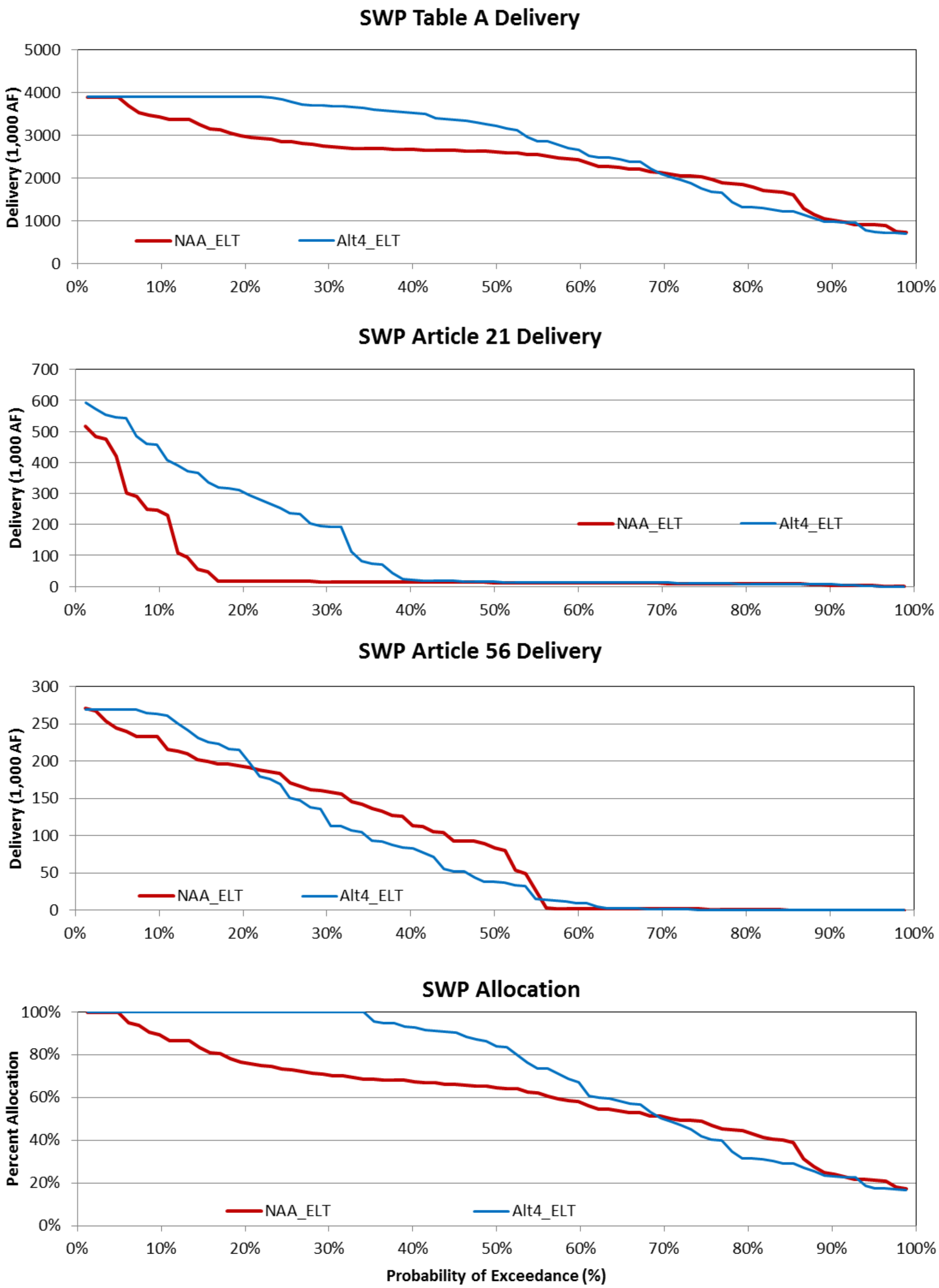
NAA-ELT (1,000 AF)

	Table A	Art. 21	Art. 56	Total
All Years	**2425**	**52**	**90**	**2567**
W	3112	79	112	3303
AN	2467	34	57	2559
BN	2515	48	109	2673
D	2033	43	88	2165
C	1172	28	47	1246

Difference: Alt4-ELT minus NAA ELT (1,000 AF)

	Table A	Art. 21	Art. 56	Total
All Years	339	75	-6	408
W	587	159	5	751
AN	728	99	-24	803
BN	525	44	2	571
D	-120	19	-10	-111
C	-146	-19	-12	-177

Figure 32. SWP Contract Deliveries (Alt 4-ELT and NAA-ELT)



Freemont Weir Modifications and Yolo Bypass Inundation

A component of the BDCP Alternative 4 is a modification to the Freemont Weir to allow water to flow into the Yolo Bypass when the Sacramento River is at lower flow than is currently needed. Currently, the Sacramento River does not flow over the Freemont Weir until flow reaches about 56,000 cfs. With the proposed modification Sacramento River flow may enter the Yolo Bypass at much lower flow levels. Figure 33 and Figure 34 contains charts that compare Freemont Weir flow into the Yolo Bypass to Sacramento River flow at the weir, Figure 33 show this relationship for the NAA-ELT and Figure 34 shows this same relationship for Alt 4-ELT.

Although CalSim II is a monthly time-step model, it contains an algorithm that estimates daily flow. Therefore, average monthly flows displayed in Figure 33 shows Sacramento River entering the Yolo Bypass at flow levels less than 56,000 cfs, when this occurs water is flowing over the Freemont Weir for a portion of the month. There is a 100 cfs minimum flow diversion from the Sacramento River diversion to the Yolo Bypass from September through June in Alt 4-ELT.

Figure 35 and Figure 36 contains average monthly flow from the Sacramento River over the Freemont Weir to the Yolo Bypass for the NAA-ELT (Figure 35), average monthly difference between Alt 4-ELT and NAA-ELT (Figure 36), and the annual average difference between Alt 4-ELT and NAA-ELT (Figure 37). In the NAA-ELT scenario flow over the Freemont Weir generally occurs in wet years, this flow is extended to all year types and all months except July and August in Alt 4-ELT. The average annual increase in flow is about 430 TAF.

Figure 33. Fremont Weir vs. Sacramento River NAA-ELT

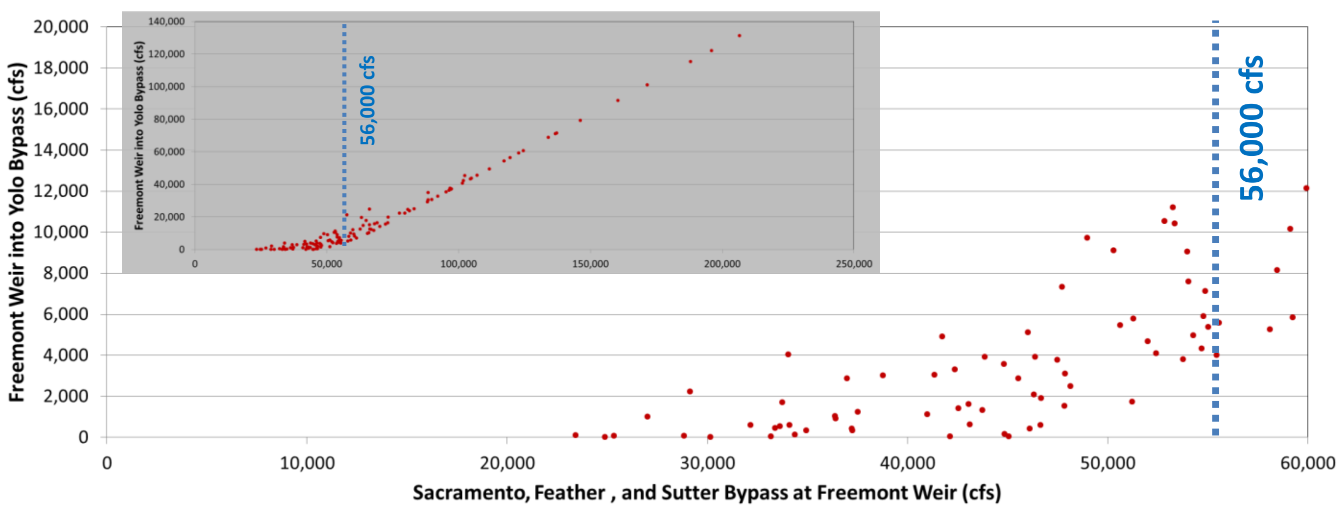


Figure 34. Fremont Weir vs. Sacramento River Alt 4-ELT

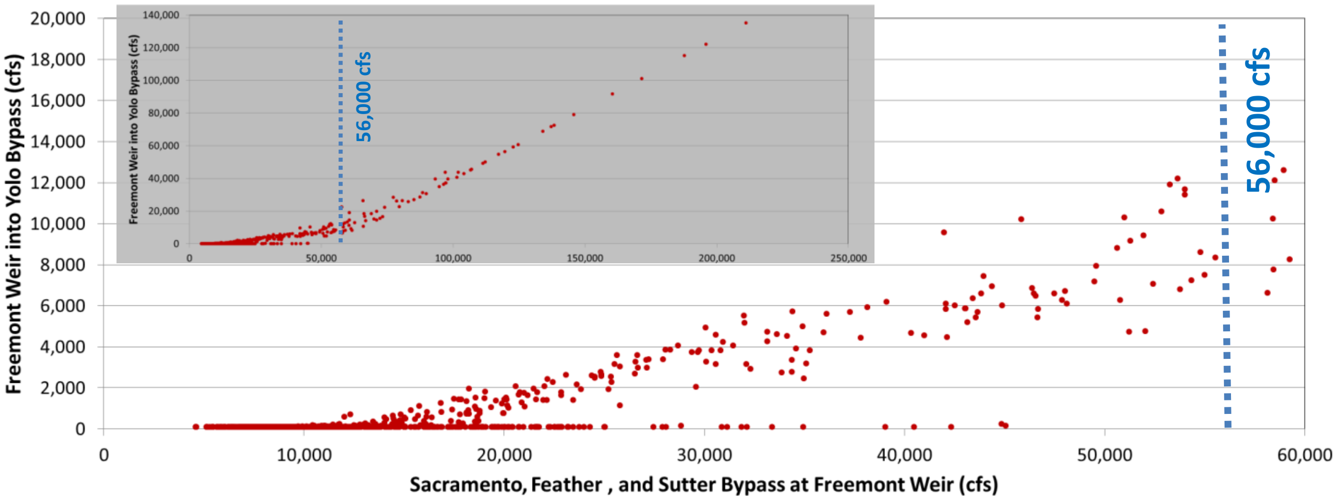


Figure 35. Average Fremont Weir Flow to Bypass by Water Year Type NAA-ELT

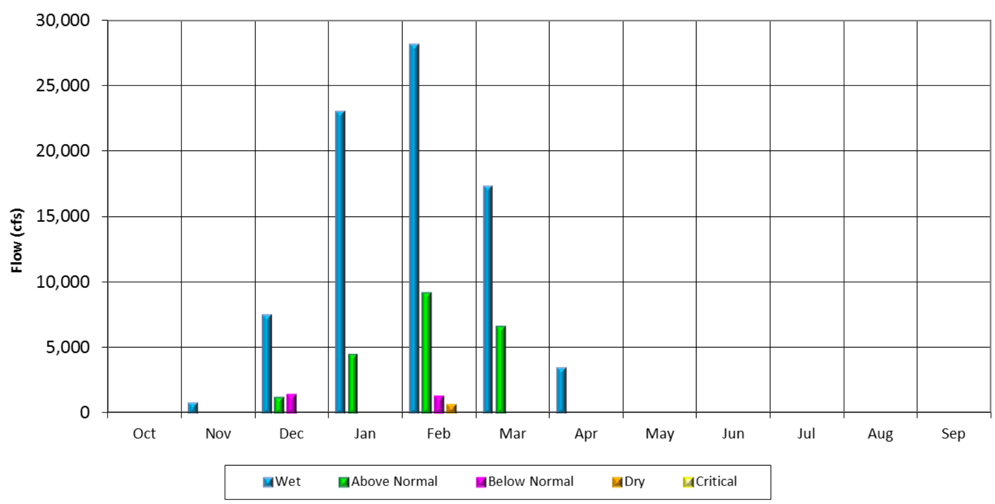


Figure 36. Average Fremont Weir Flow to Bypass by Water Year Alt 4 ELT minus NAA-ELT

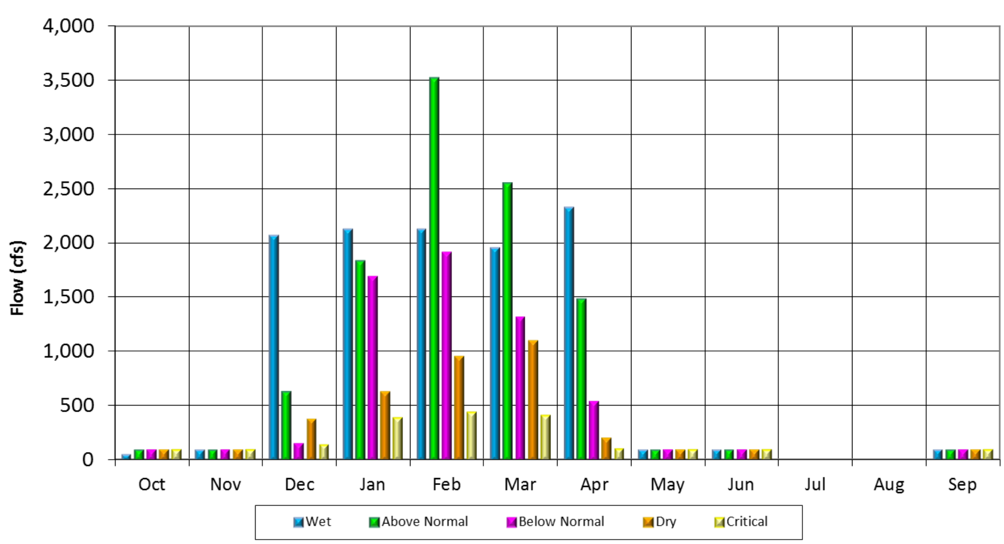
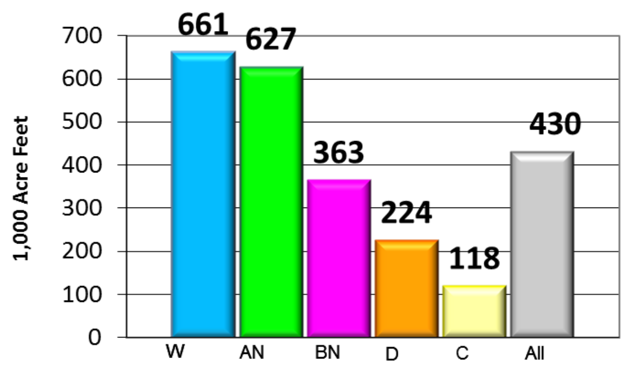


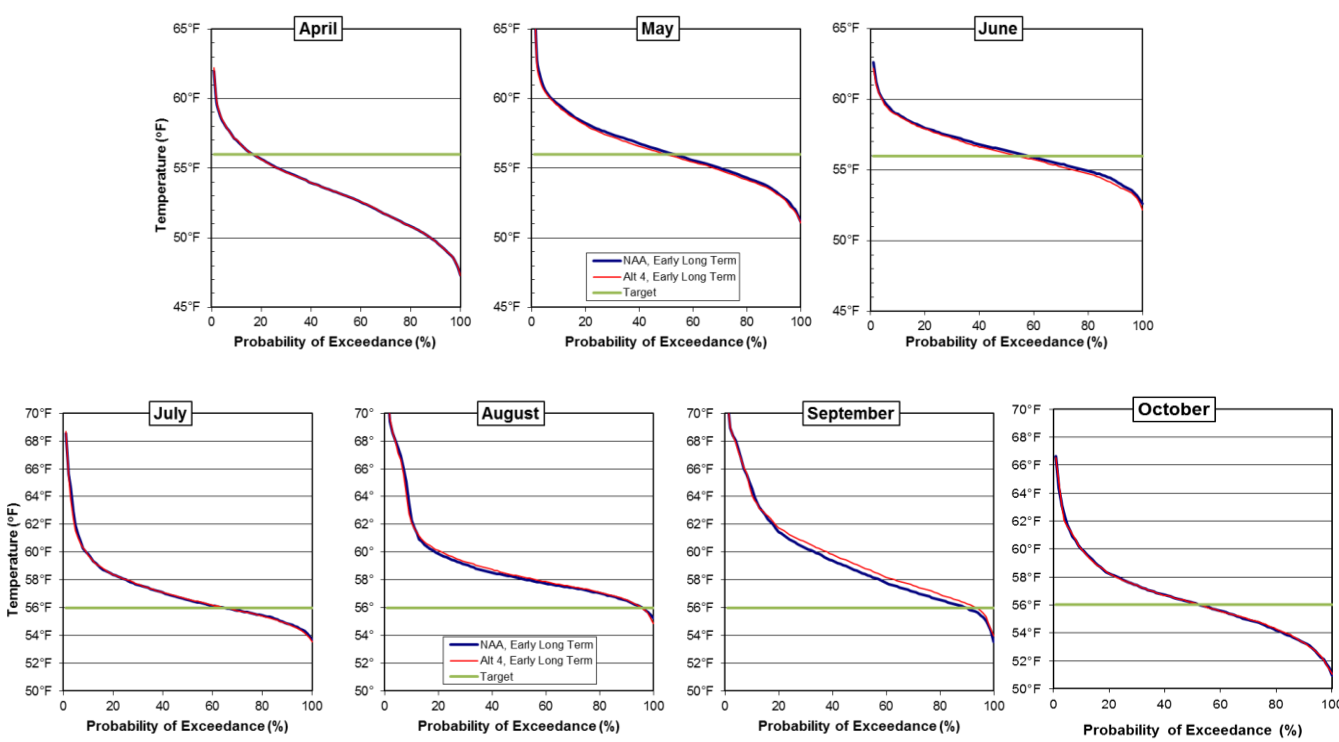
Figure 37. Annual Change in Fremont Weir Flow to Bypass Alt 4-ELT minus NAA-ELT



Sacramento River Temperature

Figure 38 contains exceedance probability plots of Sacramento River temperature at Bend Bridge for the NAA-ELT and Alt 4-ELT. For the months of April through July modeling shows few changes in upper Sacramento River water temperature. The Alt 4-ELT scenario shows temperature increases in August relative to the NAA-ELT. In about 75% of years modeling shows about 0.5°F increase in Alt 4-ELT relative to the NAA-ELT. The temperature models will meet inputted target temperatures until Shasta Lake cold water is depleted, this typically occurs in September. This is the likely reason temperature increases in modeling tend to occur in September.

Figure 38. Sacramento River Temperature at Bend Bridge NAA-ELT and Alt 4-ELT



Conclusions regarding CalSim II modeling of BDCP Alternative 4

BDCP's "High Outflow Scenario" is not sufficiently defined for analysis.
The High Outflow Scenario (HOS) requires additional water (Delta outflow) during certain periods in the spring. The BDCP Model places most of the responsibility for meeting this new additional outflow requirement on the SWP. However, the SWP may not actually be responsible for meeting this new additional outflow requirement. This is because the COA, as it is currently being implemented, would require a water allocation adjustment that would keep the SWP whole. Where one project (CVP or SWP) releases water to meet a regulatory requirement, the COA requires a water balancing to ensure the burden does not fall inappropriately among the projects. The BDCP Model is misleading because it fails to adjust project operations, as required by the COA, to "pay back" the water "debt" to the SWP due to these additional Delta outflow requirements. Unless there is a significant revision to COA, the BDCP Model overstates the impacts of increased Delta outflow on the SWP and understates the effects on the CVP.

Furthermore, after consulting with DWR and Reclamation project operators and managers, the Reviewers conclude that there is no apparent source of CVP or SWP water to satisfy both the increased Delta outflow requirements and pay back the COA "debt" to the SWP without substantially depleting upstream water storage. It appears, through recent public discussions regarding the HOS, that BDCP anticipates additional water to satisfy the increased Delta outflow requirement and to prevent the depletion of cold water pools will be acquired through water transfers from upstream water users. However, this approach is unrealistic because during most of the spring, when BDCP proposes that Delta outflow be increased, agricultural water users are not typically irrigating. This means that there is not sufficient transfer water available to meet the increased Delta outflow requirements without releasing stored water from the reservoirs. Releasing stored water to meet the increased Delta outflow requirements could potentially impact salmonids on the Sacramento and American River systems

Simulated operation of BDCP's dual conveyance, coordinating proposed North Delta diversion facilities with existing south Delta diversion facilities, is inconsistent with the project description.
The Draft BDCP and associated Draft EIR/EIS specify criteria for how much flow can be diverted by the new North Delta Diversion (NDD) facilities and specify when to preferentially use either the NDD facilities or the existing South Delta Diversion (SDD) facilities. However, the BDCP Model contains an artificial constraint that prevents the NDD facilities from taking water as described in the BDCP project description. In addition to affecting diversions from the NDD, this artificial constraint contains errors that affect the NAA operation. This error has been fixed by DWR and Reclamation in more recent versions of the model; however, the error remains in the BDCP Model. Additionally, the BDCP Model does not reflect the Summer operations of the SDD that are described in the Draft EIR/EIS as a feature of the BDCP project intended to prevent water quality degradation in the south Delta. The net effect of these two errors is that the BDCP Model significantly underestimates the amount of water diverted from the NDD facilities and overestimates the amount of water diverted from the SDD.

BDCP modeling contains numerous coding and data issues that skew the analysis and conflict with actual real-time operational objectives and constraints
logic is coded into the CalSim II model to simulate how DWR and Reclamation would operate the system under circumstances for which there are no regulatory or other definitive rules. This attempt to specify (i.e., code) the logic sequence and relative weighting so that a computer can simulate "expert judgment" of the human operators is a critical element to the CalSim II model. In the BDCP Model, some of the operational criteria for water supply allocations and existing facilities such as the Delta Cross Channel and San Luis Reservoir are inconsistent with real-world conditions.

3 INDEPENDENT MODELING

The Independent Modeling effort originally stemmed from reviews of BDCP Model during which the Reviewers discovered that the BDCP Model did not provide adequate information to determine the effects of the BDCP. There are three basic reasons why the Reviewers cannot assess how the BDCP will affect water operations: 1) NAAs do not depict reasonable operations under the described climate change assumptions, 2) operating criteria used in the BDCP Alternative 4 result in unrealistic operations, and 3) updates to CalSim II since the BDCP modeling was performed almost 4 years ago will likely alter model results to a sufficient degree that conclusions based on the BDCP modeling will likely be different than those disclosed in the Draft EIR/EIS. Given that it is not possible to determine how BDCP may affect CVP and SWP operations or water system flows and conditions with the BDCP model, Independent Modeling was performed to assess potential effects due to the BDCP.

To revise the models, the Reviewers consulted with operators at DWR and Reclamation to improve the representation of operational assumptions. Additionally, the Reviewers consulted with modelers at DWR and Reclamation to share findings, to strategize on the proper way to incorporate the guidance received from the operators, and to present revised models to DWR and Reclamation for their review. This collaborative and iterative process differed considerably from a standard consulting contract where the work product is not shared beyond the client-consultant until a final version is complete. To the contrary, consultations with agency experts were conducted early and repeatedly to ensure the revisions would reflect reasonable operations and to provide an independent review.

The first phase of this Independent Modeling effort was development of an updated without project baseline (similar to the NAA but with current, improved assumptions). The Independent Modeling does not incorporate climate change because the climate change hydrological assumptions developed by BDCP cause unrealistic operation of the system absent commensurate changes to operating criteria.

After the baseline was complete and reviewed, the second phase of this effort incorporated the facilities and operations for the BDCP described as Alternative 4 H3 in the Draft EIR/EIS, and otherwise known as the Evaluated Starting Operations (ESO) scenarios in the BDCP. During this phase, the issues that were identified during the Reviewers' initial review were corrected along with corrections made to resolve additional issues that were revealed as improvements were incorporated. Finally, results of the Independent Modeling and potential effects of the BDCP on water supply and instream flows are discussed.

3.1 Changes to CalSim II Assumptions

Revisions approved by DWR and Reclamation for the 2013 baseline

DWR and Reclamation provided CalSim II models used for the 2013 SWP Delivery Reliability Report (DRR) for use in this independent modeling effort. Changes to these models were made for this effort and provided to DWR and Reclamation, many of these changes have since been incorporated into DWR and Reclamation's model and others are under review.

The CalSim II model used for the 2013 SWP DRR is located on DWR's web site at: http://baydeltaoffice.water.ca.gov/modeling/hydrology/CalSim/Downloads/CalSimDownloads/CalSim-IIStudies/SWPReliability2013/index.cfm. Documentation for this model is described in the report titled: "*Draft Technical Addendum to the State Water Project Delivery Reliability Report 2013*", also located on DWR's web site at: http://baydeltaoffice.water.ca.gov/swpreliability/. Key modeling assumptions used for this effort are consistent with the 2013 SWP DRR and are listed in Table 4 of the Technical Addendum.

CalSim II is continuously being worked on and improved to better represent CVP and SWP operations and fix known problems. The Technical Addendum to the 2013 SWP DRR contains a description of updates and fixes that have occurred since modeling was performed for the BDCP Draft EIRS. Among these changes and fixes are key items that directly affect operation of facilities proposed in BDCP Alternative 4, these items are described on page 4 of 2013 SWP DRR Technical Addendum. Key among these fixes is the correction of the Sacramento River flow requirement for Delta inflow that causes NDD bypass to exceed requirements.

A key component of this independent modeling effort is the development of an acceptable CalSim II Future No-Action (FNA) model scenario. The purpose for developing the FNA Scenario is to produce an operational scenario that is realistic enough to understand how changes proposed in the BDCP will affect operations. The process of developing the FNA involved research and development of CalSim II model updates and several meetings with Reclamation and DWR modeling and operations staff. In addition to changes in the FNA Scenario, CalSim II was updated to better reflect operation of the NDD, CVP and SWP reservoir balancing, DCC gate operations, and CVP/SWP water supply allocations.

Additional Revisions to CalSim II Assumptions

The following changes were made to the 2013 SWP DRR version of CalSim II for this effort:

- San Joaquin River Basin
    - Turned off San Joaquin River Restoration Program (SJRRP) The SJRRP will cause a change to San Joaquin River inflow to the Delta not associated with the BDCP. To avoid adding complications to the identification of BDCP export benefits the SJRRP was not incorporated into the analysis.
    - Tuolumne: updated time-series, lookup tables, and wresl code
    - Turned off SJRA (VAMP) releases
- Updated Folsom flood diagram
- Rice decomposition demand diversions from Feather River
- Dynamic EBMUD diversion at Freeport
- SEP1933 correction to daily disaggregated minimum flow requirements at Wilkins Slough and Red Bluff
- CVP M&I demands are updated to reflect assumptions used by Reclamation
- Yuba Accord Transfer
- Los Vaqueros Reservoir capacity

<u>San Joaquin River Basin</u>

BDCP modeling depicted San Joaquin River Basin operations generally consistent with the actions, programs and protocols in place at the time of NOI/NOP issuance. Some of those conditions are now not representative of current development or operations. With the exception of the assumption for the SJRRP, the independent modeling has revised San Joaquin River Basin operations to reflect more contemporary LOD assumptions. In future level analyses the independent modeling similarly assumes no SJRRP, but only for analysis simplicity concerning BDCP export benefits. Additional analyses may be useful in understanding effects of collectively implementing the BDCP and SJRRP.

The San Joaquin River Basin (SJR) is depicted for current conditions, primarily affected by the operations of the Stanislaus, Tuolumne, Merced, and upper San Joaquin River tributaries. The upper San Joaquin River is currently modeled in a “pre-“ SJRRP condition, consistent with the 2005 CalSim version. The FNA Scenario also models the upper San Joaquin River without the SJRRP. The SJR depicts near-term operations including SWRCB D-1641 flow and water quality requirements at Vernalis met when hydrologically possible with New Melones operations. The Vernalis flow objective is set by SWRCB D-1641 February-June base flow requirements. There are no pulse flow requirements during April and May, and there is no acquired flow such as VAMP or Merced water. D1641 Vernalis water quality requirements are set at 950/650 EC to provide an operational buffer for the requirement. New

Melones is operated to provide RPA Appendix 2E flows as fishery releases and maintains the DO objective in the Stanislaus River through a flow surrogate. Stanislaus River water right holders (OID/SSJID) are provided deliveries up to land use requirements as occasionally limited due to operation agreement (formula). CVP Stanislaus River contractors are provided allocations up to 155 TAF per year in accordance with proposed 3-level plan based on the New Melones Index (NMI). For modeling purposes during the worst drought sequence periods, CVP Stanislaus River contractors and OID/SSJID diversions are additionally cut to maintain New Melones Reservoir storage no lower than 80 TAF. Merced River is operated for Federal Energy Regulatory Commission (FERC) and Davis-Grunsky requirements, and provides October flows as a condition of Merced ID's water rights. The Tuolumne River is operated to its current FERC requirements and current water use needs and has been updated to recent conditions.

Folsom Lake Flood Control Diagram

During wetter years, inflow to Folsom Lake is sufficient to keep the reservoir full while satisfying all demands downstream. When this condition occurs in actual operations, operators increase releases during summer months to maintain higher instream flows and prevent large releases in the fall to evacuate Folsom to satisfy flood control storage requirements. To prevent the model from keeping the reservoir full going into the fall months and then making large releases to comply with flood control storage requirements, the maximum allowable storage during summer months is ramped from full storage in June to flood control levels in the fall. Although this is a common modeling tool, Folsom storage level for the end of September was set too low in the SWP DRR model causing unnecessary releases and resulting in Folsom storage being lower than desired. An adjustment was made to achieve a more realistic summer drawdown for Folsom.

Feather River Rice Decomposition Demand

Demand for rice straw decomposition (decomp) water from Thermalito Afterbay was added to the model and updated to reflect historical diversion from Thermalito in the October through January period. There are approximately 110,000 acres of rice in the Feather River Service Area irrigated primarily with water diverted from Thermalito Afterbay. Although decomp water demand for the Sacramento River has been included in CalSim II since about 2006, this demand has been absent for the Feather River. Inclusion of decomp demand in the version of CalSim II used for this effort results in an increase in Feather River diversion in fall months of about 160,000 AF.

Dynamic EBMUD Diversion at Freeport

Previously the EBMUD operation was pre-determined and input to CalSim II as a time-series. The below criteria was implemented in CalSim II model code to achieve a dynamic representation of EBMUD diversion from the Sacramento River at Freeport.

The EBMUD water service contract is unique. EBMUD's total system storage must be forecast to be below 500 TAF on October 1 for CVP water to be available under the EBMUD contract. In years when this occurs, we assume EBMUD will take the minimum of 65 TAF of CVP water or their CVP allocation (133 TAF * CVP M&I allocations) in the first and second years of any multi-year period when CVP water is available under their contract. In the third year, EBMUD would be limited to 35 TAF of CVP water (assuming diversion of 65 TAF in years one and two) because their contract limits cumulative CVP water over three consecutive years to 165 TAF. The 65, 65, 35 TAF annual diversion pattern then repeats if water is available for four or more consecutive years under the EBMUD contract.

Wilkins Slough Minimum Flow Requirement

Wilkins Slough minimum flow requirements, C129_MIF, includes an adjustment for daily operations based on work with the Sacramento River Daily Operations Model (SRDOM). The flow adjustment for daily flows for September 1933 in the state variable input file appeared unreasonable in the previous model. The flow adjustment in this month was approximately 1,860 cfs and was requiring release of approximately 100 TAF out of Shasta. Review of the entire time-series of daily adjustments showed the adjustment in this month was an order of magnitude greater than in any other September in the simulation period. The year 1933 is a critically dry year, and the third of four consecutive Shasta Critical years. Historical precipitation records from the consumptive use models for the Sacramento Valley, which serves as the basis of much of the CalSim hydrology, were reviewed to ensure there was no unusual precipitation in this month that may create variations in daily flows. It was determined that this daily adjustment is in error. The daily adjustment for this time-step was set to 10 cfs, the value for August 1933.

CVP M&I Demands

Reclamation M&I contractor demands upstream from the Delta have not been adequately represented in CalSim II until Reclamation updated the model in 2012. A more accurate representation of CVP M&I demands, developed in 2012, was incorporated into the model for this effort.

Yuba Accord Water Transfer

In CalSim, Yuba Accord Water Transfers are limited to releases from New Bullards Bar Reservoir. The release is picked up at Banks Pumping Plant or stored in Oroville and Shasta for later release. The additional release from New Bullards Bar is represented in CalSim through an inflow arc. The subsequent refill of New Bullards Bar is represented in CalSim through a diversion arc. In CalSim II, refill is assumed to always occur in the winter following the transfer. However, in the SWP DRR model, there were a few years in which no transfers took place but refill still occurred in the following winter. This was fixed in the updated baseline by capping refill to the previous summer's total transfer.

Los Vaqueros Reservoir

Expansion of Los Vaqueros Reservoir was completed in 2012. Storage capacity was increased from 103 TAF to 160 TAF. In DWR's BDCP studies, Los Vaqueros capacity was set to 103 TAF. The independent modeling increases Los Vaqueros capacity to 160 TAF.

3.2 Changes to BDCP Operations

San Luis Reservoir Rule-Curve Logic Change

In the independent modeling, San Luis rule-curve logic was refined for both SWP and CVP operations. San Luis rule-curve is used to maintain an appropriate balance between San Luis Reservoir storage and North of Delta reservoirs. The key considerations in formulating rule-curve are as follows:

- Ensure that sufficient water is available in San Luis Reservoir to meet contract allocations when exports alone are insufficient due to various operational constraints.
- Minimize San Luis Reservoir carryover storage to low point criteria (both CVP and SWP) and Article 56 carryover (only SWP). The basic premise is to maintain Reservoir San Luis storage no higher than necessary to satisfy south of Delta obligations to avoid excessive drawdown of upstream storage.

In DWR's BDCP studies, there were significant shortages in Table A and Article 56 deliveries because of an improper balance between upstream and San Luis Reservoir storage. The updated SWP rule-curve logic reduces these shortages but does not eliminate them. Also, the updated CVP rule-curve logic allows for higher CVP allocations without increasing risk of shorting SOD contractors.

Upstream Storage Release to Fill San Luis Reservoir Above Needed Supply

In the BDCP NAA and the independent modeling FNA, the model has a priority to release excess stored water that will likely be released for flood control purposes from Shasta and Folsom storage for export at Jones Pumping Plant to storage in San Luis Reservoir in the late summer and early fall months. The purpose was to get a head start on filling San Luis Reservoir for the coming water year if there is a high likelihood of Shasta or Folsom spilling. This was an assumed CVP/SWP adaptation to the export reductions in the winter and spring months due to the salmon and smelt biological opinions. However, with the NDD facility in Alt 4, winter and spring export restrictions impact CVP exports much less and there is no longer a reason to impose this risk on upstream storage. As such, the weights, or prioritizations, of storage in Shasta and Folsom were raised so that excess water would not be released specifically to increase CVP San Luis storage Reservoir above rule-curve. This was changed in Alt 4 and not the FNA to better reflect how the system may operate under these different conditions.

Delivery allocation adjustment for CVP SOD Ag service and M&I contractors

CVP SOD Ag service and M&I allocations are limited by both systemwide water supply (storage plus inflow forecasts) and Delta export constraints; whereas similar CVP NOD allocations are dependent solely on water supply. This frequently results in SOD water service contractors receiving a lower contract year allocation than NOD water service contractors, especially under the Biological Opinion export restrictions. However, with the NDD facility operations as proposed under Alt 4 H3, the CVP can largely bypass these Delta export restrictions, and the export capacity constraint on CVP SOD allocations was determine to be overly conservative. Therefore, the export capacity component of CVP SOD allocations was removed in the BDCP Alternative and both SOD and NOD CVP allocations are equal and based only on water supply.

Folsom/Shasta Balance

CVP operations were refined in the BDCP Alternative to provide maximum water supply benefits to CVP contractors while protecting Trinity, Shasta, and Folsom carryover storage in the drier years. As a whole, this was accomplished with refinements to allocation logic and San Luis rule-curve. However, in initial study runs, an imbalance between Folsom and Shasta was created; while there was a total positive impact to upstream storage in dry years, there was a negative impact to Folsom storage. This was resolved by inserting Folsom protections in the Shasta-Folsom balancing logic. With these protections, the positive carryover impacts were distributed to Trinity, Shasta, and Folsom.

North Delta Diversion Bypass Criteria

The daily disaggregation method for implementing NDD bypass criteria as implemented in DWR's BDCP model was left mostly intact for the updated BDCP studies. However, there were modifications to properly fit the bypass criteria implementation within the latest CalSim operations formulation. Modifications are as follows:

1. No NDD operations occur in cycles 6 through 9 so that Delta operations and constraints can be fully assessed without NDD interference.
2. Cycles 10 and 11 (Daily 1 and Daily 2 respectively) were added to determine NDD operations given various operational constraints including the NDD bypass criteria.
3. From July to October, bypass criteria are based on monthly average operations (no daily disaggregation). Given the controlled reservoir releases at this time and the constant bypass criteria (5,000 cfs from July to September and 7,000 cfs in October), this was determined to be a reasonable assumption. This also simplified coordination of DCC gate operations with NDD in October which will be discussed later.
4. When warranted by conditions in cycle Daily 1 (cycle 10), the bypass criteria in May and June were allowed to be modeled on a monthly average basis in cycle Daily 2 (cycle 11). This allowed a reduction in the number of cycles necessary to determine the fully allowed diversion under the bypass criteria when

the Delta was in balance and additional upstream releases were made to support diversions from the North Delta.

Delta Cross Channel Gate Reoperation in October

The BDCP Alt 4 results in significantly more October surplus Delta outflow as compared to the baseline. The cause of this Delta surplus at a time when the Delta is frequently in balance is a combination of proposed through-Delta export constraints (OMR flow criteria and no through-Delta exports during the San Joaquin River October pulse period), Rio Vista flow requirements, and DCC gate operations. In DWR's BDCP studies, it was assumed that the DCC gates would be open for the entire month of October thereby requiring much higher Sacramento River flows at Hood in order to meet the Rio Vista flow requirement than if the DCC gates were closed. Whereas in the independent BDCP modeling it was assumed that the DCC gates were closed for a number of days during the month such that the 7,000 cfs NDD bypass criteria would be sufficient to meet the weekly average Rio Vista flow requirements. The intent was to minimize surplus Delta outflow while meeting Delta salinity standards and maintaining enough bypass flow to use the NDD facility for SOD exports. This is an approximation of what is likely to occur in real-time operations under similar circumstances. Further gate closures may be possible as salinity standards allow if operators decide to preserve upstream storage at the expense of NDD diversions. This type of operation would require additional model refinements.

Wilkins Slough minimum flow requirement

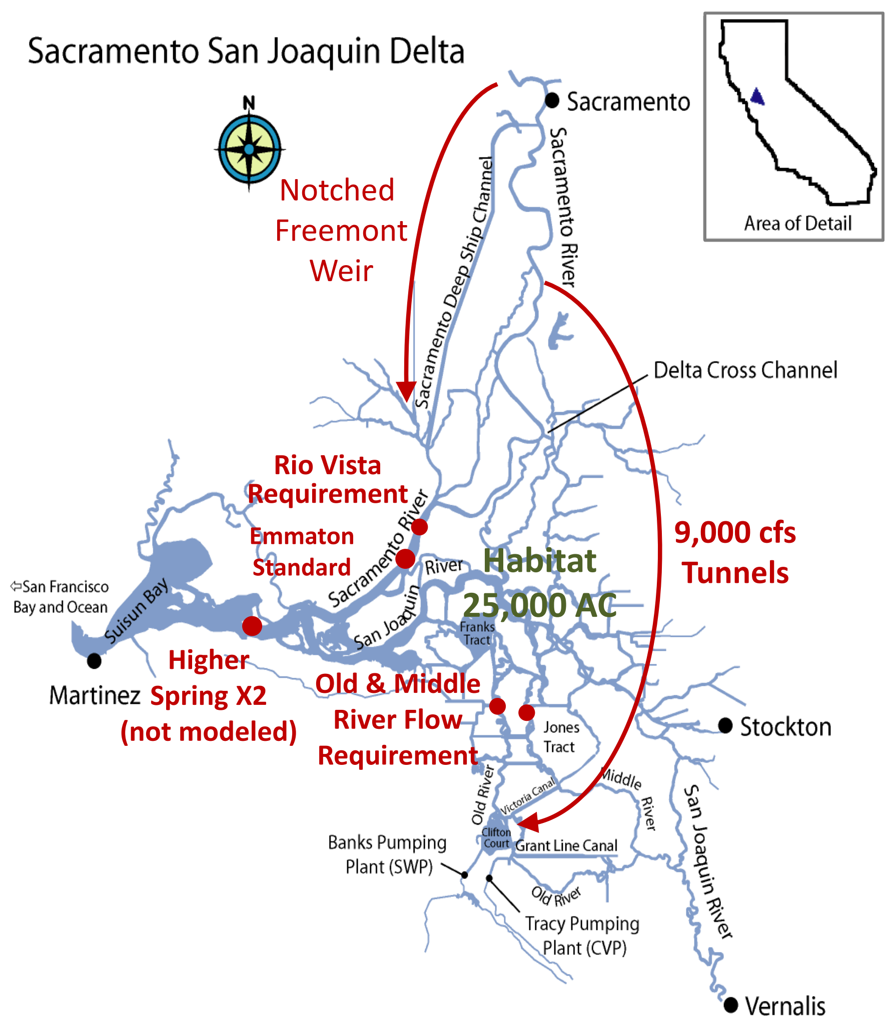
Currently in CalSim II, relaxation of the Wilkins Slough minimum flow requirement is tied to CVP NOD Ag Service Contractor allocations. This does not reflect actual operations criteria where relaxation of the flow requirement is dependent solely on storage conditions at Shasta. From the comparative analysis perspective of our CalSim planning studies, this introduces a potential problem: changes in CVP NOD Ag Service allocations can result in unrealistic changes in required flow at Wilkins Slough, and such changes in Wilkins Slough required flow can result in unrealistic impacts to Shasta storage. To bypass this problem, we assumed that the required flow at Wilkins Slough in the alternative was equal to the baseline.

3.3 Alternative 4 Modeling results

Analysis for this effort was focused on BDCP Alt 4 with existing spring and fall X2 requirements, which corresponds to "Alternative 4 H3" in the Decisions Tree. This modeling is performed without climate change, and includes refined operating criteria for the NDD, CVP and SWP reservoirs, DCC gate closures, and water supply allocations. This modeling includes all Project features that are included in Alt 4 in the BDCP modeling. The Project features are displayed in Figure 39 and summarized as:

- NDD capacity of 9,000 cfs
- Bypass flow requirements for operation of the NDD
- Additional positive OMR flow requirements
- No San Joaquin River I/E ratio
- Changed location for Emmaton water quality standard in SWRCB D-1641
- Additional Sacramento River flow requirement at Rio Vista
- 25,000 acres of additional tidal habitat
- Notched Fremont Weir

Figure 39. Alt 4 Features

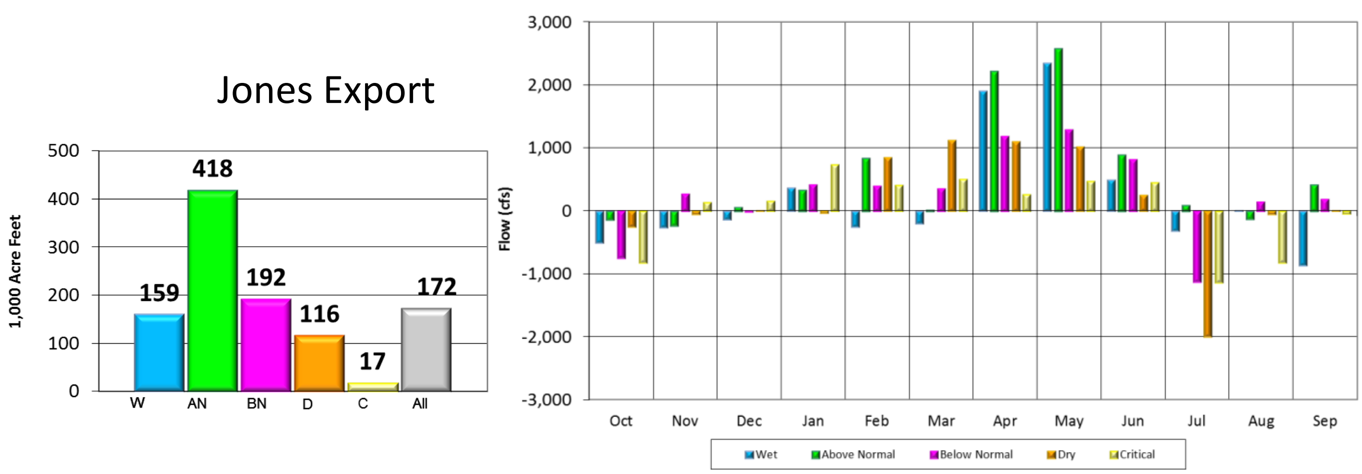


For the purpose of describing results of the independent modeling, the revised Future No Action model scenario is labeled “FNA” and the revised BDCP Alt 4 scenario is labeled “Alt 4”.

CVP/SWP Delta Exports

Average annual exports at Jones pumping plant are about 170 TAF higher in the Alt 4 Scenario compared to the FNA scenario, as seen in Figure 40. Increases generally occur from January through June when Old & Middle River (OMR) criteria limit use of Jones PP in the FNA Scenario. Decreases occur in July in drier year types because the increased ability to convey water in spring months reduces the need to convey water stored in upstream reservoirs in July. Reductions in Jones export in October are partially a function of increases in OMR flow requirements.

Figure 40. Change in Delta Exports at Jones Alt 4 minus FNA



Similar to export at Jones, Banks exports are generally higher from January through June because use of NDD allows pumping that is not possible in the FNA Scenario, as seen in Figure 41. Banks exports are increased during summer months of wetter year types. This is due to earlier wheeling for CVP Cross Valley Canal contractors (without NDD Banks capacity isn’t typically available until Fall in wet years) and wheeling of CVP water through Joint Point of Diversion (JPOD). CVP export at Banks is displayed in **Figure 42**. In wetter years, upstream CVP reservoirs hold more water than can be exported at Jones pumping plant, this water is typically spilled in the FNA scenario. CVP water stored in upstream reservoirs can be released in July, August, and September to support south of Delta beneficial use of water through use of JPOD in Alt 4.

Figure 41. Change in Delta Exports at Banks Alt 4 minus FNA

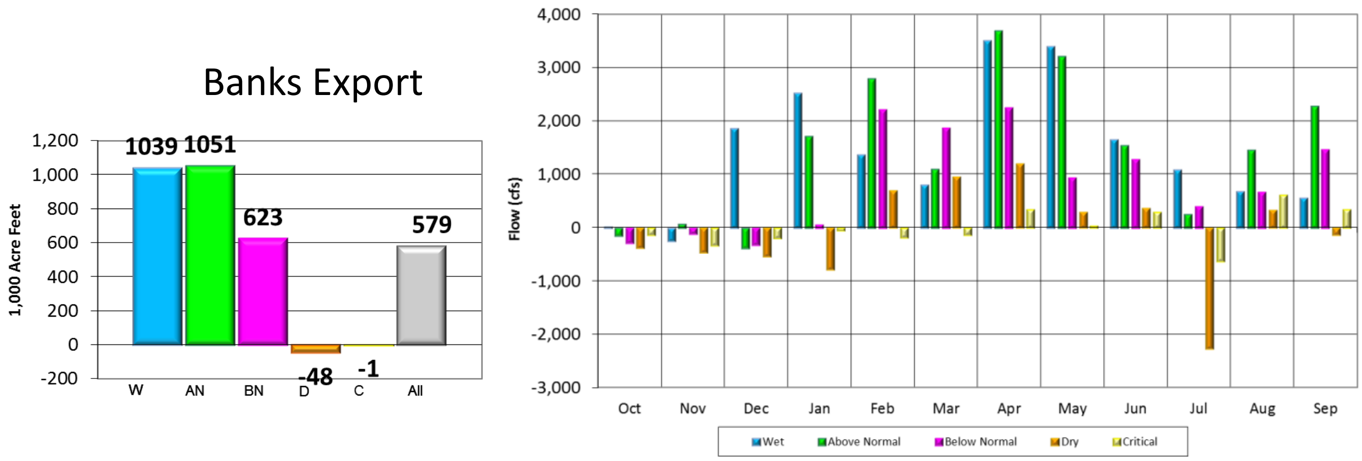
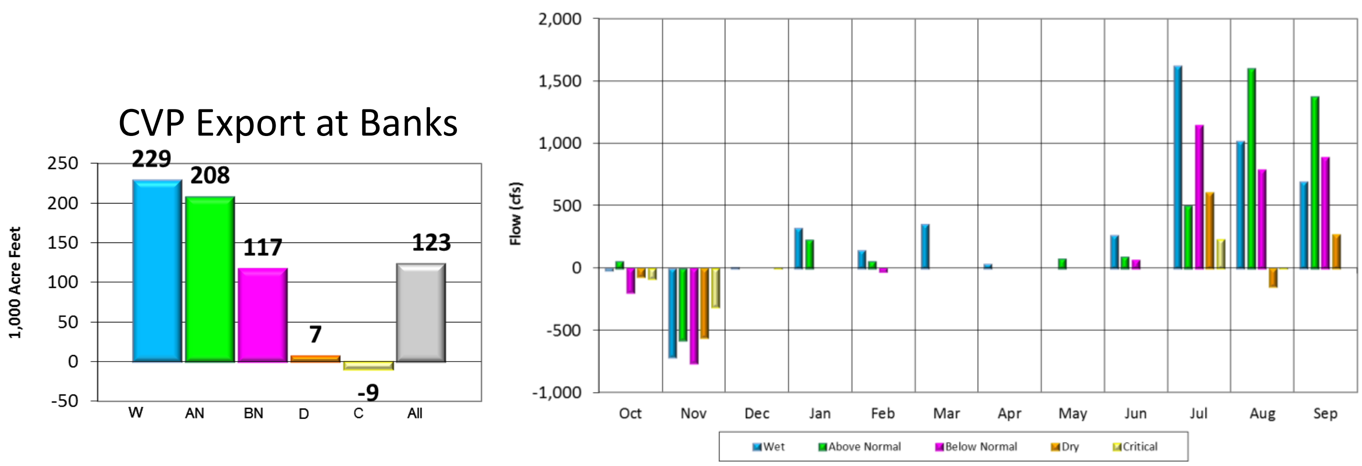


Figure 42. Change in CVP Delta Exports at Banks Alt 4 minus FNA

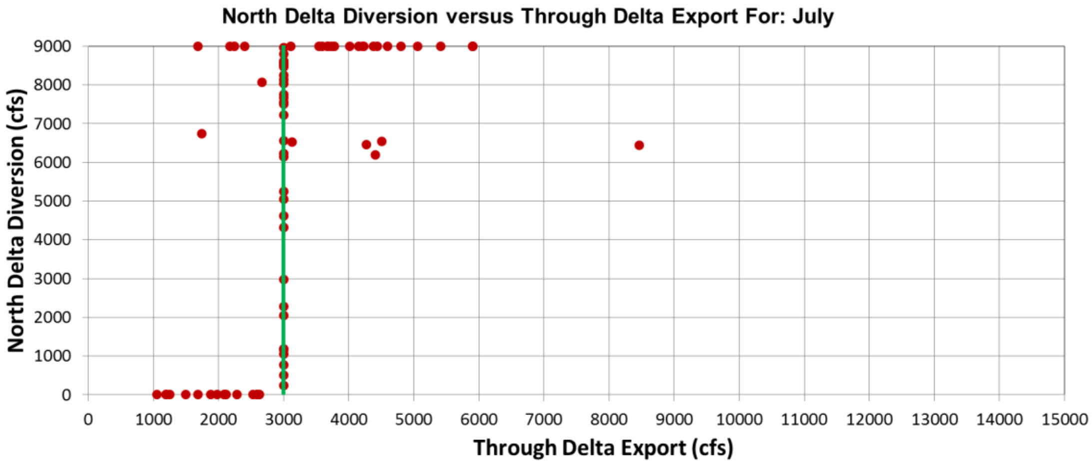


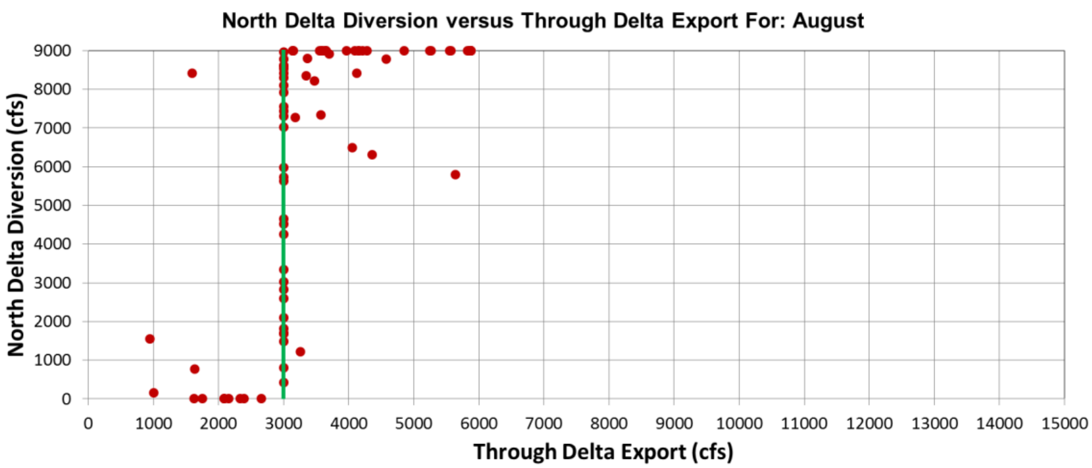
Changes in total, South Delta, and North Delta exports are displayed in Figure 43. Average annual increase in total Delta exports is about 750 TAF, the increases primarily occur in wetter year types with lesser increases in dryer years. South Delta export decreases about 2.53 MAF in Alt 4 relative to the FNA. Export through the NDD is 3.28 MAF in Alt 4, about 58% of total exports are diverted from the North Delta.

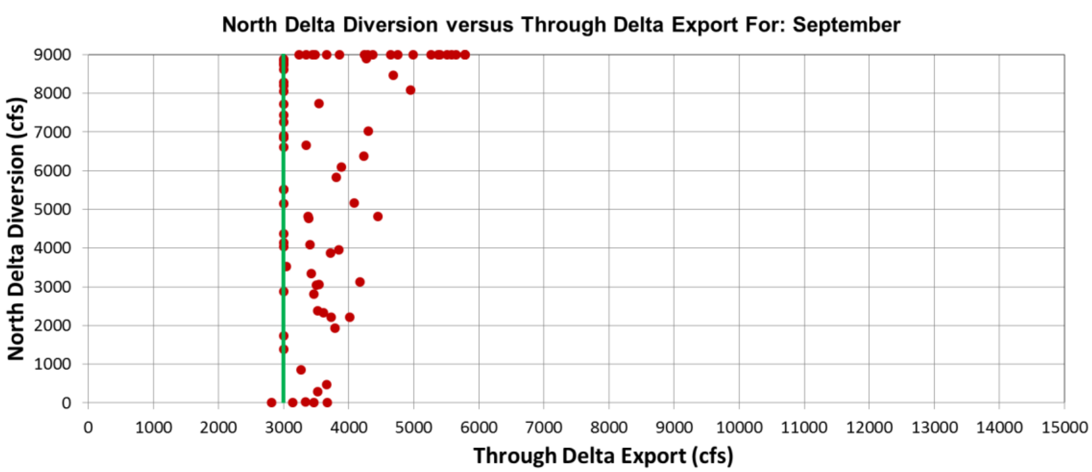
Figure 43. Change in Conveyance Source of Exports (Alt 4 minus FNA)

Figure 44 contains modeling results from Alt 4 for July, August, and September that plot NDD against SDD (Through Delta Export). There are many occasions when SDD are 3,000 cfs, which is due to criteria specifying that SDD during this time period need to be at least 3,000 cfs prior to diverting at the NDD facility. Although there are about six occurrences in July and three in August where the model did not satisfy this criterion, this issue has not yet been addressed for this modeling effort.

Figure 44. Alt 4 North Delta Diversion Versus South Delta Diversion for July, August, and September



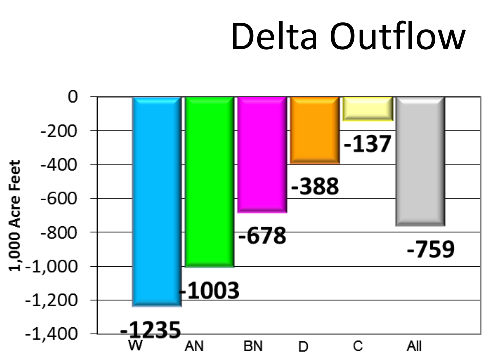


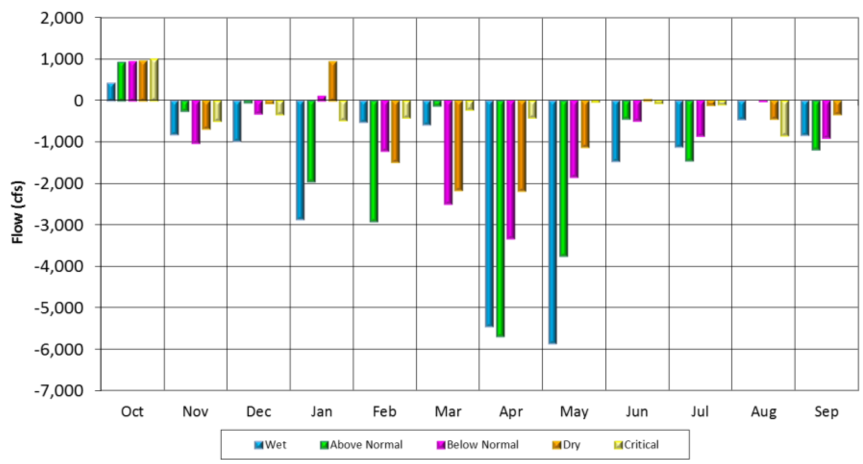


Delta Outflow

Figure 45 contains annual and monthly average changes in Delta outflow by water year type, average annual Delta outflow decreases about 760 TAF in the Alt 4 Scenario relative to the FNA Scenario. The decrease is primarily due to increases in Delta exports, which are about 750 TAF on average. Larger decreases generally occur in January through May when exports are constrained in the FNA Scenario and in the Alt 4 Scenario the NDD can be used to export water. Delta outflow increases in October due to the combination of additional OMR flow requirements that restrict exports and Sacramento River flow requirements at Rio Vista. The additional surplus Delta outflow in Alt 4 was minimized through coordination of the Delta Cross Channel Gate operations with the Rio Vista flow requirements and North Delta Diversion bypass requirements.

Figure 45. Changes in Delta Outflow (Alt 4 minus FNA)





Carryover Storage

Figure 46, Figure 47, Figure 48, and Figure 49 contain exceedance charts for carryover storage and average monthly changes in storage by Sacramento Valley Water Year Type for CVP and SWP upstream reservoirs. CVP/SWP reservoirs tend to be higher in the Alt 4 Scenario relative to the FNA on an average basis. Generally, CVP/SWP reservoirs are higher in storage in dryer year types and can be lower in wetter year types.

Ability to convey stored water from upstream CVP/SWP reservoirs to south of Delta water users is increased in Alt 4 relative to the FNA. Therefore, when upstream reservoirs are at higher storage levels more water is released to satisfy south of Delta water demands. This is the primary reason Shasta, Oroville, and Folsom tend to be lower during summer months of wetter years.

Currently, and in the FNA Scenario, the CVP and SWP ability to export natural flow, or unstored water, is constrained due to SWRCB D-1641 and requirements in the salmon and smelt biological opinions. With the greater ability to export unstored water during winter and spring months in the Alt 4 Scenario, compared to FNA, there is generally a reduced reliance on stored water to satisfy south of Delta demands. The increased ability to export unstored water allows the CVP and SWP to maintain higher storage levels in upstream reservoirs during dryer year types while still maintaining south of Delta deliveries. Carryover storage in the Alt 4 Scenario tends to be higher than the FNA Scenario at lower storage levels, and Alt 4 storage is lower in wetter years when storage levels are higher. In the wettest of years there is enough water in the system that both scenarios have similar carryover storage conditions.

Figure 46. Trinity Reservoir Carryover Storage and Average Monthly Changes in Storage by Water Year Type

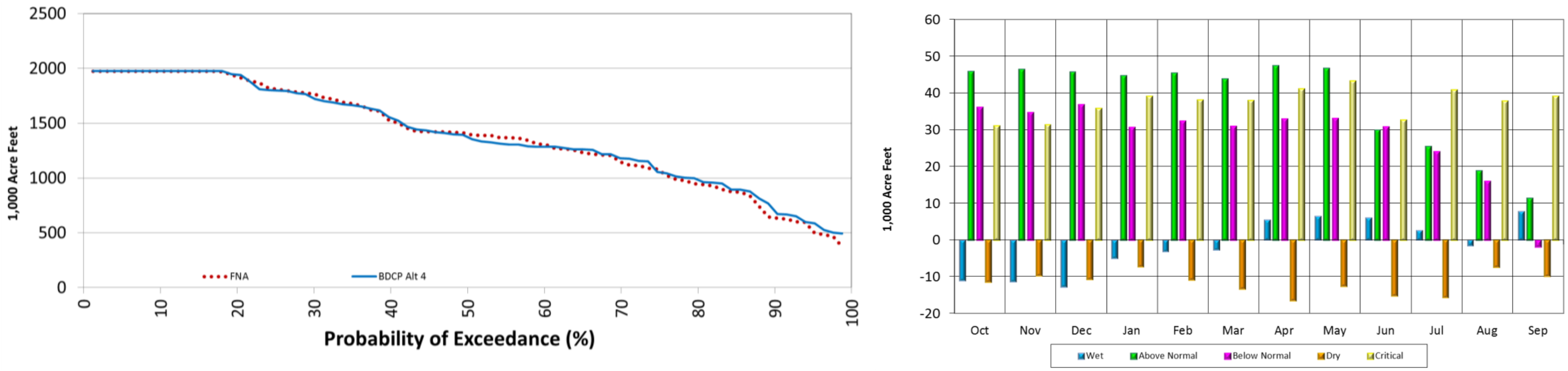


Figure 47. Shasta Reservoir Carryover Storage and Average Monthly Changes in Storage by Water Year Type

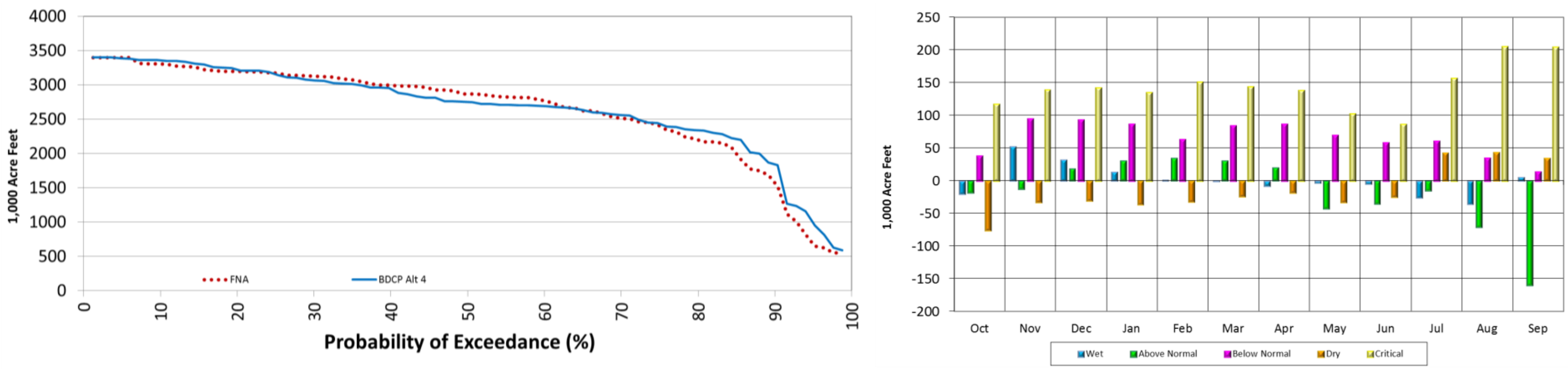


Figure 48. Oroville Reservoir Carryover Storage and Average Monthly Changes in Storage by Water Year Type

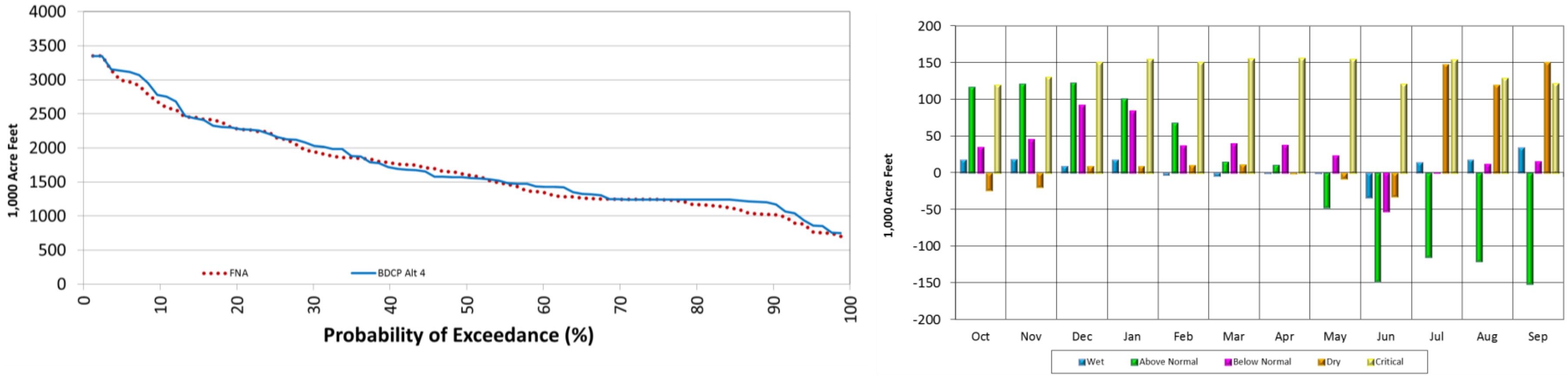
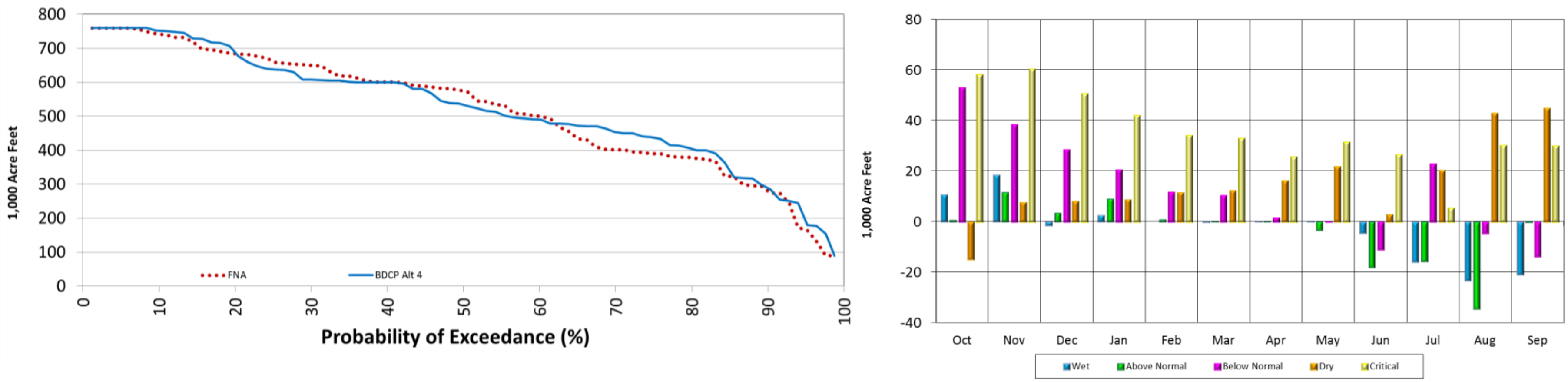


Figure 49. Folsom Reservoir Carryover Storage and Average Monthly Changes in Storage by Water Year Type



San Luis Reservoir Operations

As seen in Figure 50 and Figure 51 below, both CVP and SWP portions of San Luis Reservoir storage fills more regularly in the Alt 4 Scenario. As described earlier in this document, low point in both CVP and SWP San Luis Reservoir is managed to satisfy water supply obligations the model makes during the spring of each year. This is a complex balance involving available upstream storage, available conveyance capacity, delivery allocations, and south of Delta demand patterns. Considering this myriad of variables, there are times when low point in San Luis Reservoir is higher in the Alt 4 Scenario than the FNA Scenario and times when the opposite is true.

Figure 50. SWP San Luis

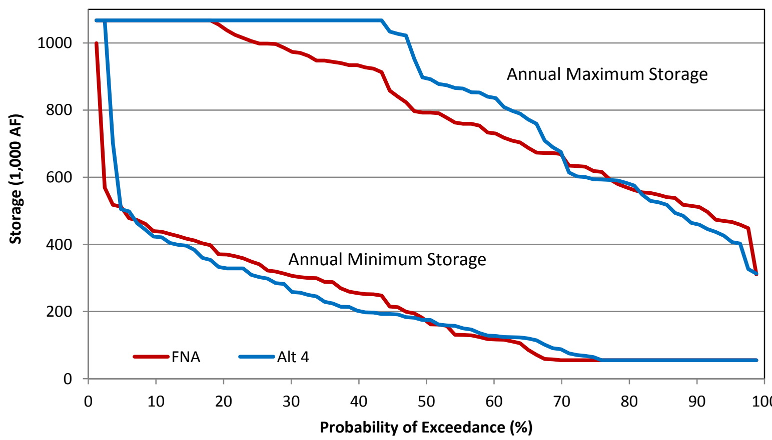
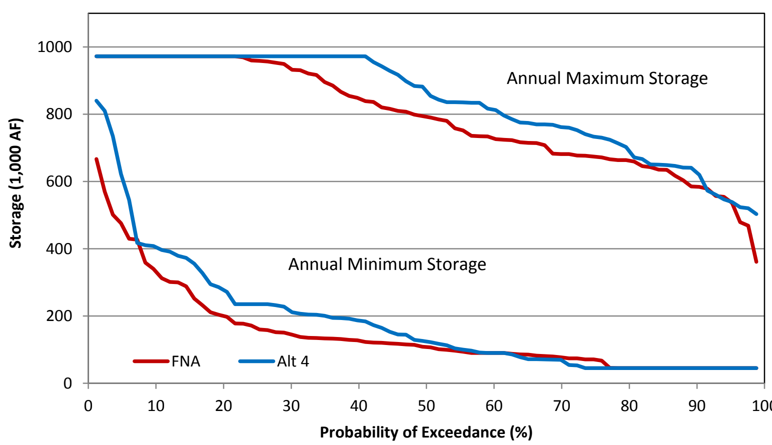


Figure 51. CVP San Luis



CVP Water Supply

As can be seen in Table 5, the independent modeling analysis shows an average increase of approximately 262 TAF of delivery accruing to CVP customers in the Alt 4 Scenario relative to the FNA Scenario, mostly occurring to CVP SOD agricultural customers. Delivery increases are greater in wetter year types with lower increases in dryer years. Figure 52 contains exceedance probability plots for CVP water service contractor deliveries and allocations. Changes in Sacramento River Settlement and San Joaquin River Exchange Contractor deliveries do not occur in the modeling analysis and are not an anticipated benefit of the BDCP. Although modeling demonstrates minor changes to NOD CVP service contractors, this increase is not an anticipated benefit of the BDCP.

Table 5. CVP Delivery Summary

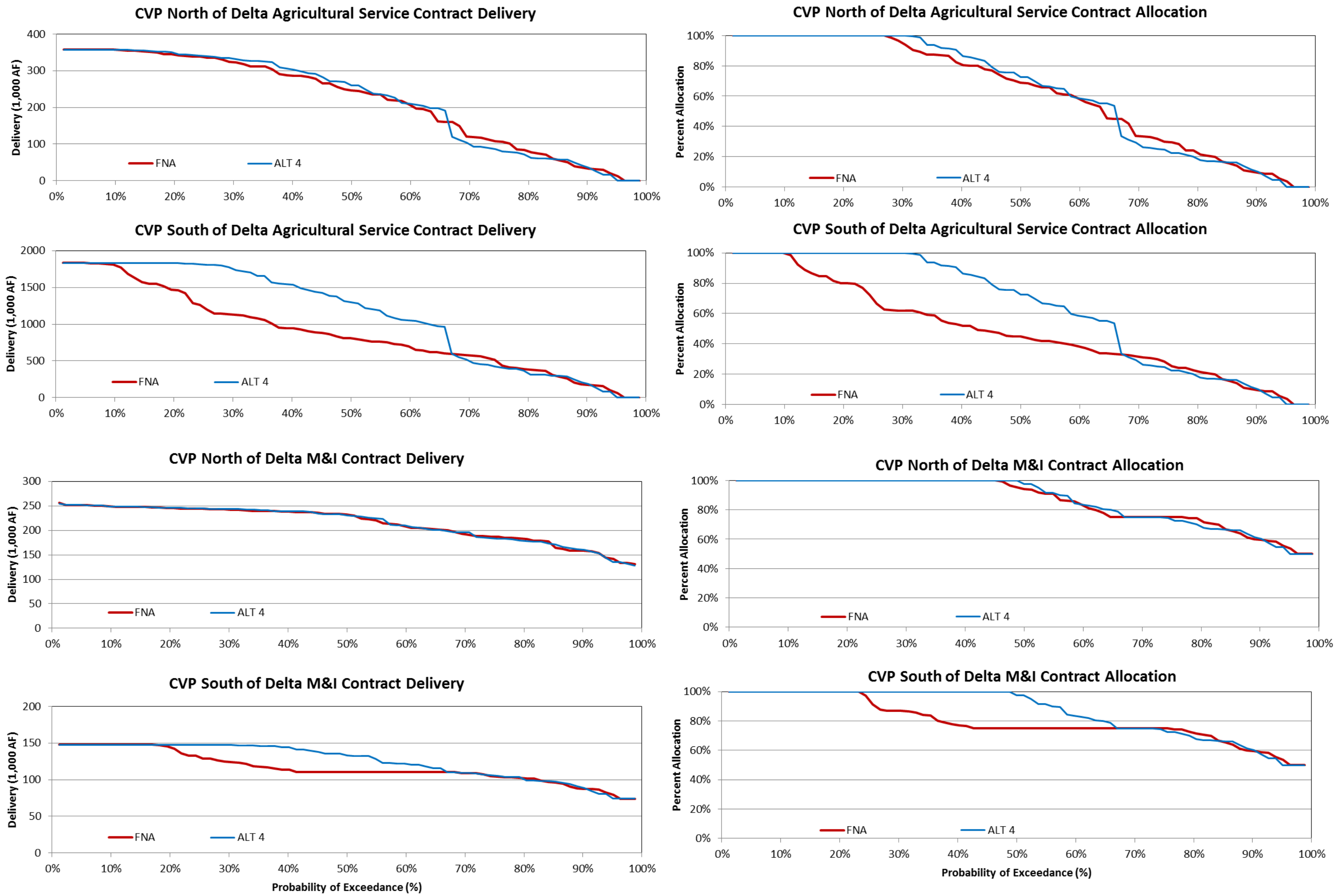
Average Annual CVP deliveries by Water Year Type FNA (1,000 AF)

	AG NOD	AG SOD	Exchange	M&I NOD	M&I SOD	Refuge NOD	Refuge SOD	Sac. Setlmnt	CVP NOD Total	CVP SOD Total
All Years	**220**	**882**	**852**	**214**	**116**	**87**	**273**	**1860**	**2380**	**2306**
W	327	1408	875	241	135	90	280	1856	2515	2881
AN	284	999	802	221	113	83	258	1716	2304	2341
BN	206	725	875	217	111	90	281	1900	2413	2176
D	138	569	864	195	106	88	277	1896	2317	2000
C	43	202	741	157	87	71	234	1754	2025	1447

Difference: Alt 4 minus FNA (1,000 AF)

	AG NOD	AG SOD	Exchange	M&I NOD	M&I SOD	Refuge NOD	Refuge SOD	Sac. Setlmnt	CVP NOD Total	CVP SOD Total
All Years	2	251	0	0	9	0	0	0	2	260
W	0	305	0	0	10	0	1	0	0	316
AN	10	492	0	1	14	1	0	-2	10	504
BN	12	354	0	5	16	0	-2	1	19	366
D	-10	67	0	-4	4	1	0	-1	-15	72
C	2	27	0	2	2	1	0	-1	4	29

Figure 52. CVP Water Supply Delivery and Allocation



SWP Water Supply

The independent analysis shows an increase in average annual SWP SOD deliveries of approximately 450 TAF, but a reduction in critical year deliveries of approximately 116 TAF. Annual average Article 21 deliveries increase by about 100 TAF and Article 56 increases by about 18 TAF. Figure 53 contains exceedance probability plots for SWP SOD deliveries for the FNA and Alt 4 Scenarios, each of these plots show increases in higher delivery years. Although Table A deliveries increase in 65% of years, there are decreases in 35% of the dryer years (see Table 6).

Table 6. SWP Delivery Summary

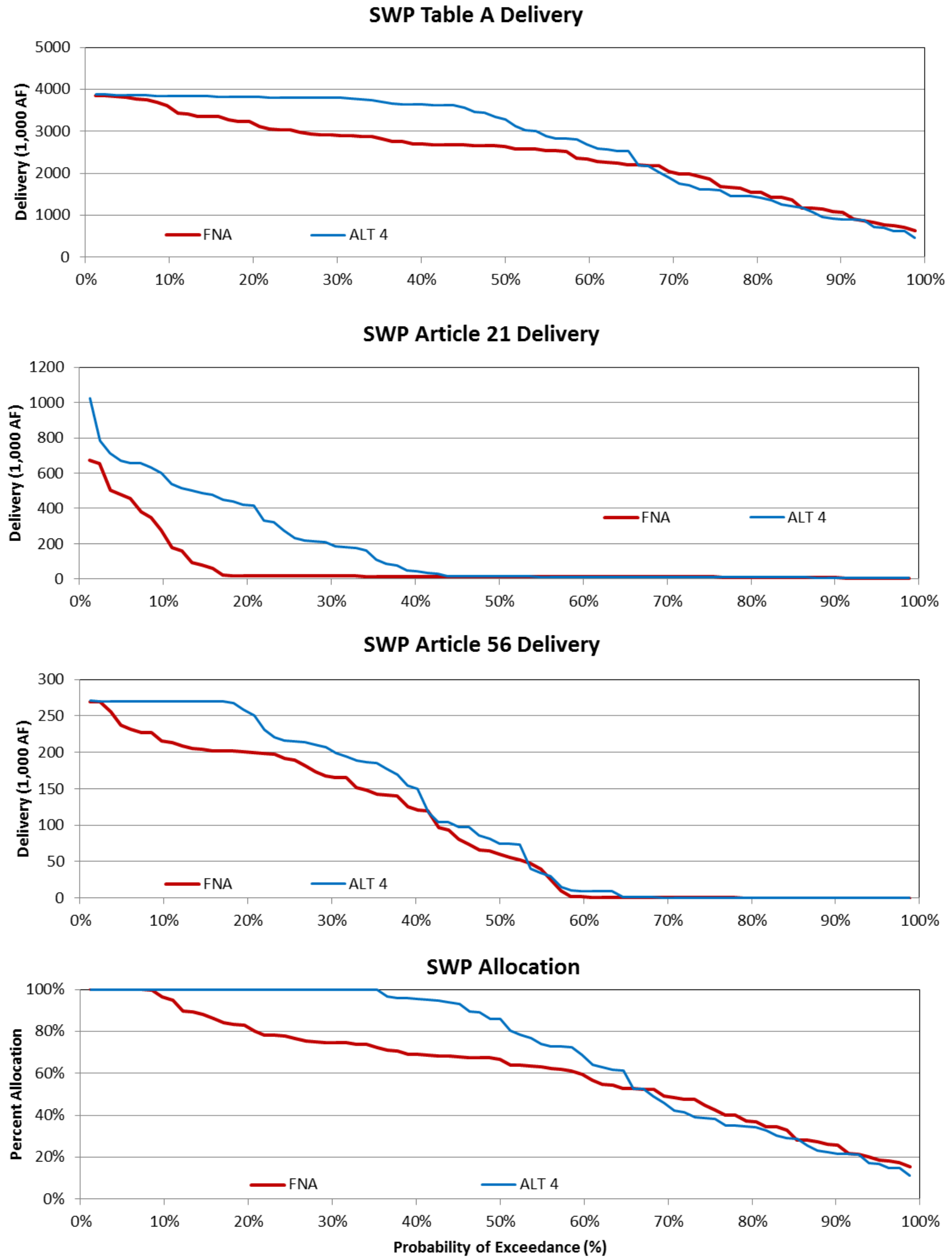
FNA

	Table A	Art. 21	Art. 56	Total
All Years	**2426**	**64**	**90**	**2580**
W	3221	98	121	3440
AN	2628	86	81	2794
BN	2527	82	95	2703
D	1809	14	70	1893
C	1105	17	48	1170

Difference Alt4 minus FNA

	Table A	Art. 21	Art. 56	Total
All Years	328	102	18	448
W	525	220	14	759
AN	636	98	-1	733
BN	565	50	31	647
D	-63	41	27	6
C	-124	-8	16	-116

Figure 53. SWP Delivery for Alt 4 and FNA



4 COMPARING INDEPENDENT MODELING AND BDCP MODELING

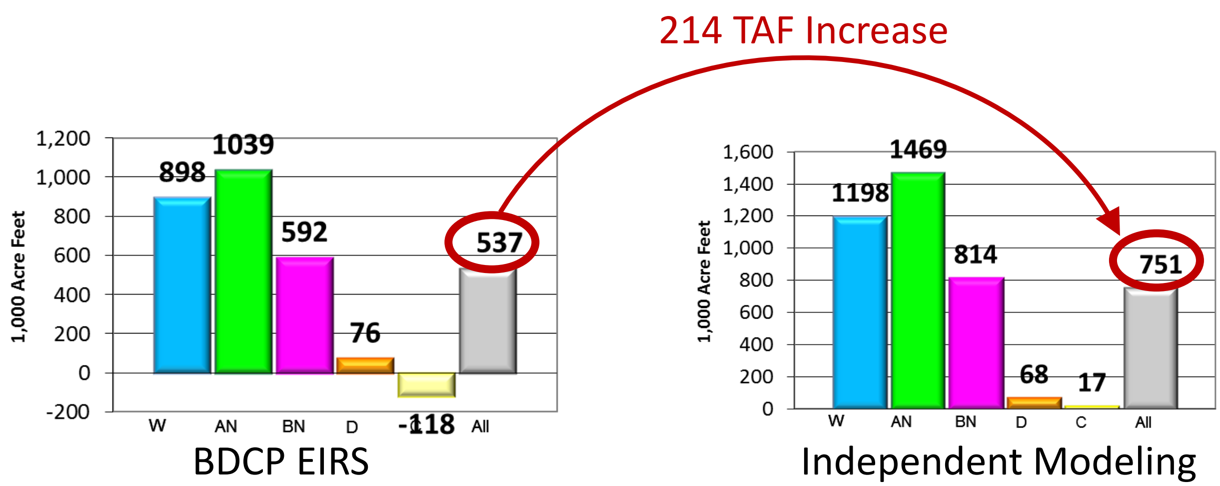
The independent modeling effort originally stemmed from reviews of DWR's BDCP modeling where we found that BDCP modeling does not provide adequate information to determine how BDCP may affect the system. Based on the premise that the independent modeling portrays a more accurate characterization of how the CVP/SWP system may operate under Alt 4, this comparison is meant to demonstrate the differences between results of a more accurate analysis and BDCP modeling. Differences in results between these modeling efforts are believed to provide insight regarding how effects that BDCP will have on the actual CVP/SWP system differ from modeling used to support the Draft EIRS.

Although thorough comparisons of modeling were performed, only key differences are illustrated for the purpose of this comparison.

Delta Exports

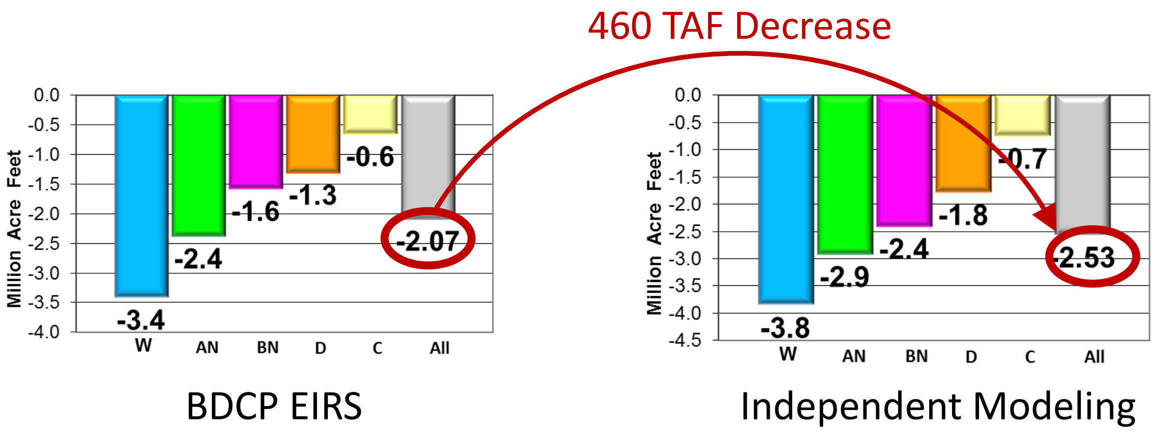
Figure 54 displays changes in the Delta exports for the BDCP modeling (Alt 4-ELT minus NAA-ELT) and for the independent modeling (Alt 4 minus FNA). Independent modeling analysis shows about 200 TAF greater increases in exports than the BDCP modeling. A large component of this difference is due to fixes of known modeling issues, as described in the 2013 SWP DRR. This difference is also attributable to more realistic reservoir operations, more efficient DCC gate operations, changes in water supply allocation logic, and more efficient operation of the NDD.

Figure 54. Result Difference: Delta Exports



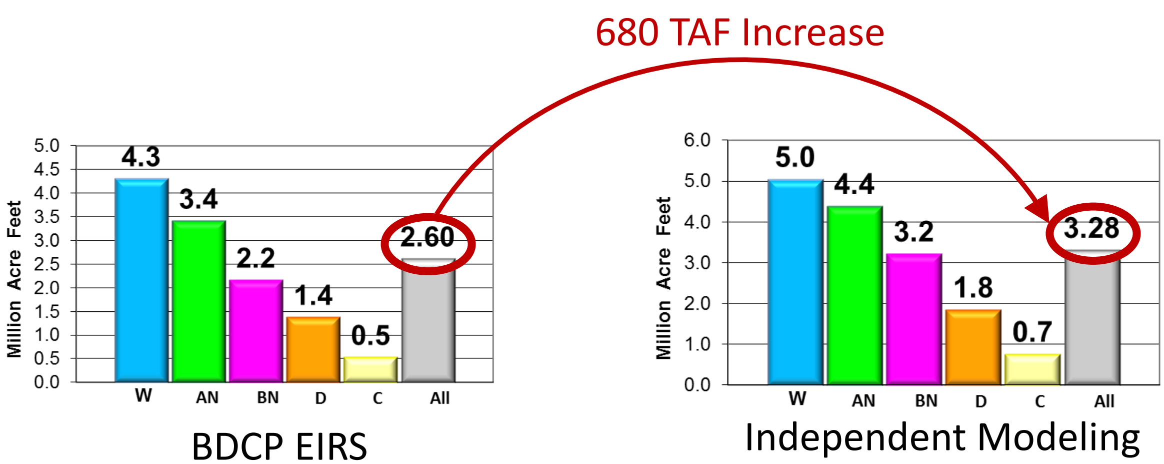
Average annual SDD are decreased by about 460 TAF in the independent analysis compared to the BDCP modeling. A large component of this difference is due to fixes of known modeling issues, as described in the 2013 SWP DRR. These fixes prevent "artificial" bypass criteria from limiting use of the NDD beyond what is intended in the BDCP project description. This difference is also attributable to more efficient DCC gate operations and more efficient operation of the NDD. Figure 55 demonstrates the difference between the BDCP and independent analysis, where SDD decrease by 2.07 MAF in the BDCP analysis and by 2.53 MAF in the independent analysis.

Figure 55. Result Difference: South Delta Diversion



Use of the NDD is 680 TAF greater in the independent analysis relative to the BDCP analysis. A large component of this difference is due to fixes of known modeling issues, as described in the 2013 SWP DRR. These fixes prevent "artificial" bypass criteria from limiting use of the NDD beyond what is described in the BDCP project description. Figure 56 compares average annual NDD in the BDCP to the independent analysis.

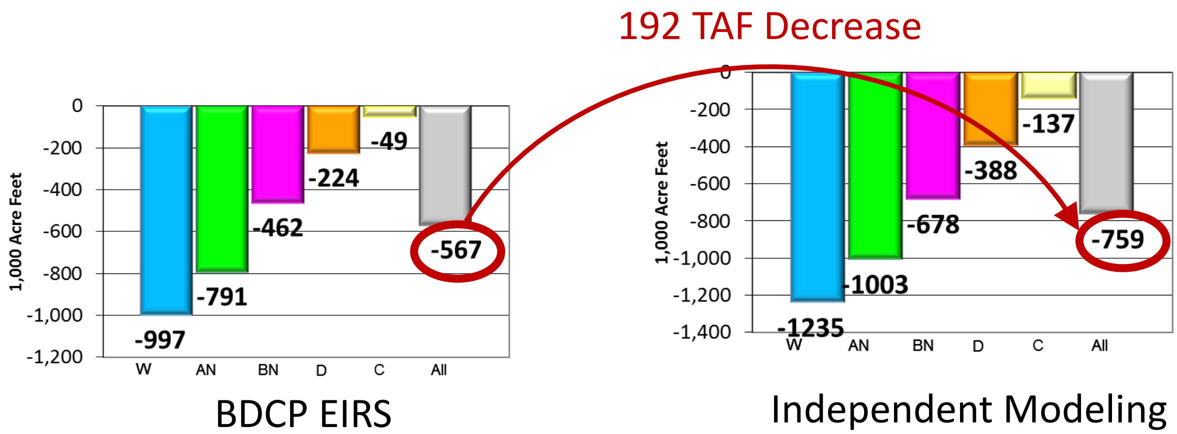
Figure 56. Result Difference: North Delta Diversion



Delta Outflow

Total Delta exports in the independent analysis are about 200 TAF greater than the BDCP modeling analysis with a corresponding decrease in Delta outflow in the independent analysis of about 200 TAF. Figure 57 compares average annual changes in Delta outflow between the independent analysis and BDCP modeling, BDCP modeling shows a decrease of about 567 TAF and the independent analysis shows a decrease of about 759 TAF.

Figure 57. Result Difference: Net Delta Outflow



Reservoir Storage

Reservoir operating rules for Alt4 in the BDCP EIRS modeling are changed relative to the NAA. In the BDCP EIRS modeling of Alt 4 rules are set to releases more water from upstream reservoirs to San Luis Reservoir from late winter through July, reduce releases in August, and then minimize releases to drive San Luis Reservoir to dead pool from September through December. This operation is inconsistent with actual operations and causes reductions in upstream storage from May through August. Figure 58 and Figure 59 contain exceedance probability plots of carryover storage and average monthly changes in storage by water year type for Shasta and Folsom for the BDCP and independent modeling. Although carryover storage for Alt 4 and the NAA is similar in the BDCP EIRS modeling, there is drawdown from June through August that may cause impacts to cold water pool management. In the independent modeling upstream reservoirs are drawn down more in years when storage is available while dryer year storage is maintained at higher levels, this is illustrated in the carryover plots for Shasta and Folsom in Figure 58 and Figure 59.

Figure 58. Result Difference: Shasta Storage

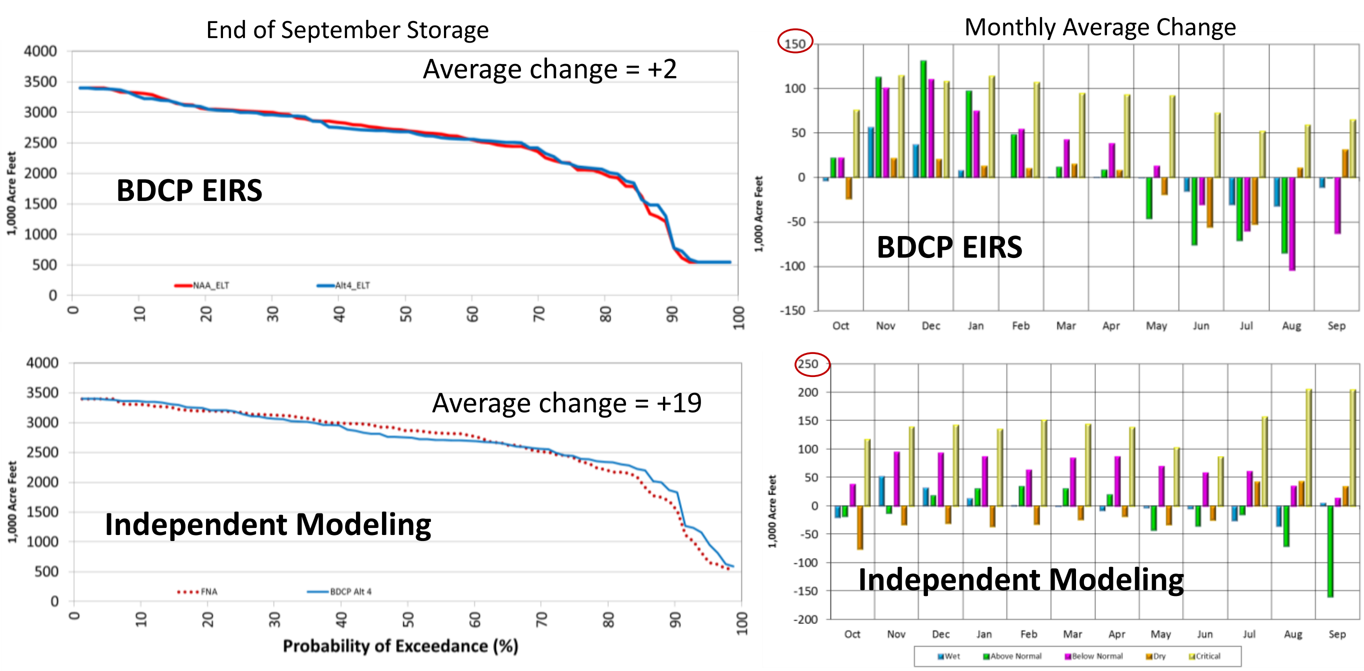
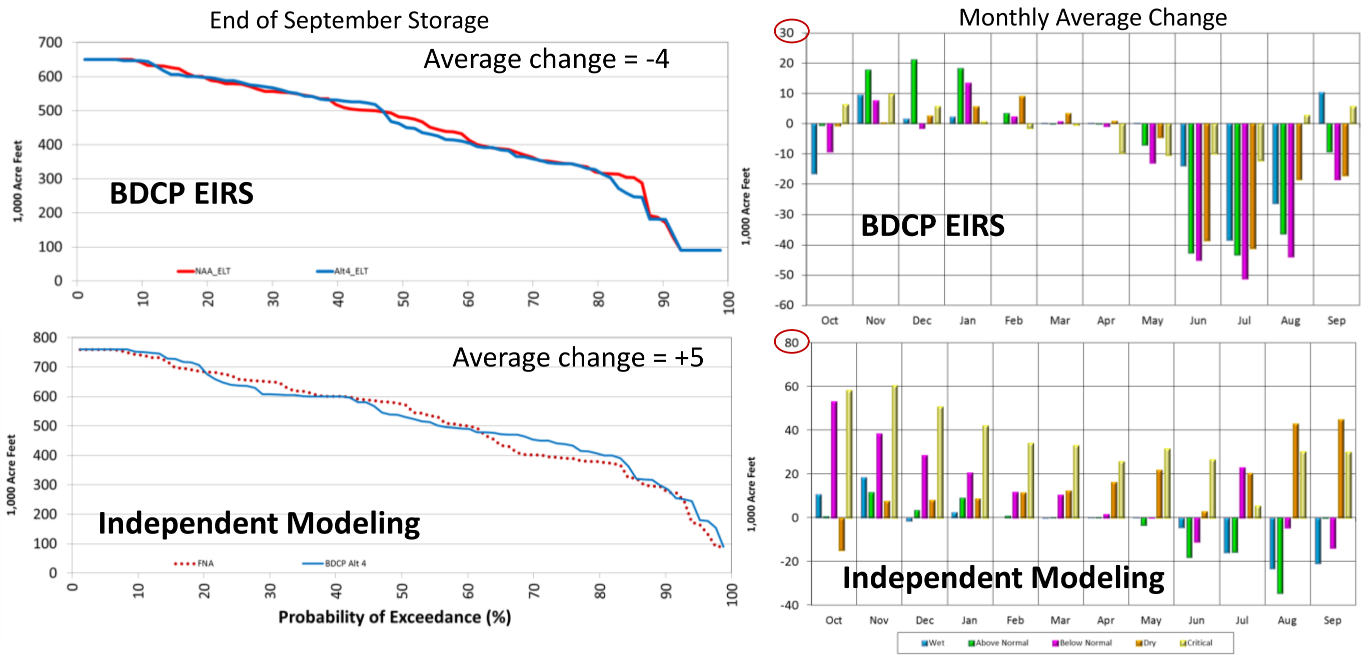


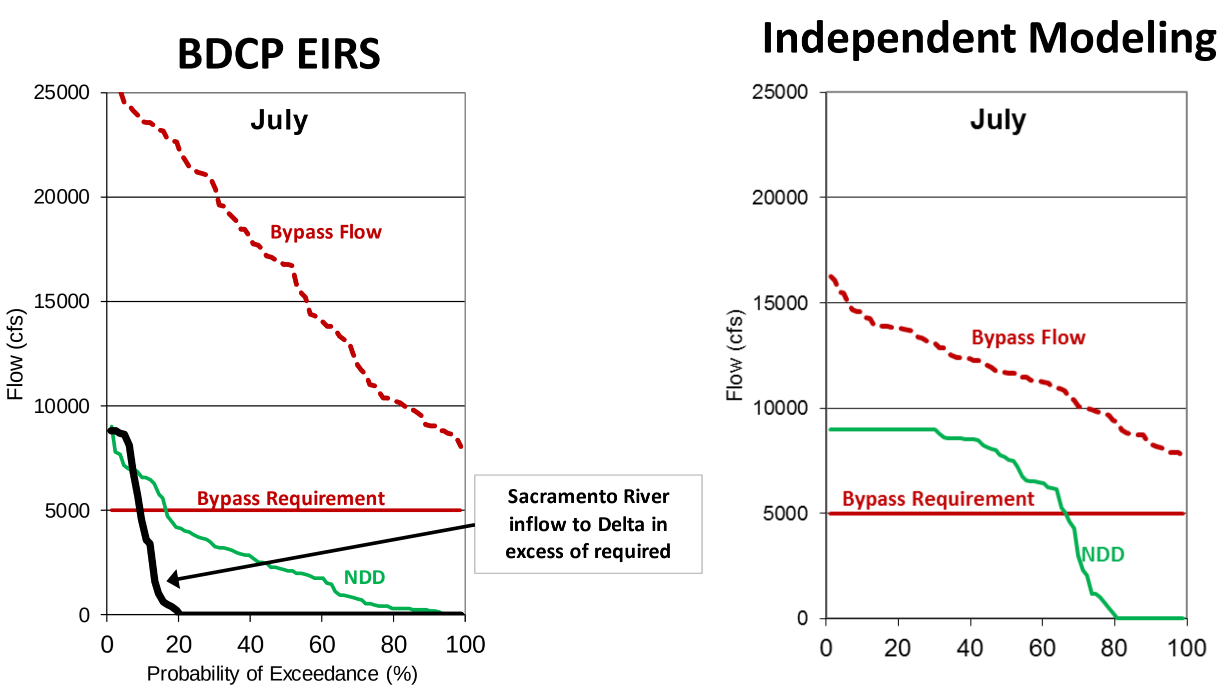
Figure 59. Result Difference: Folsom Storage



North Delta Diversions

Independent modeling shows greater NDD during July and other months because the BDCP EIRS modeling includes artificially high Sacramento River bypass flow requirements. Figure 60 contains exceedance probability plots of Sacramento River required bypass, Sacramento River bypass flow, NDD, and excess Sacramento River flow to the Delta. As can be seen in Figure 60, bypass flow is always above the bypass requirement. The BDCP version of CalSim sets a requirement for Sacramento River inflow to the Delta that the independent modeling does not need in order to satisfy Delta requirements, therefore the NDD is higher in the independent modeling.

Figure 60. NDD, and Sacramento River Flow



Delta flows below the NDD facility

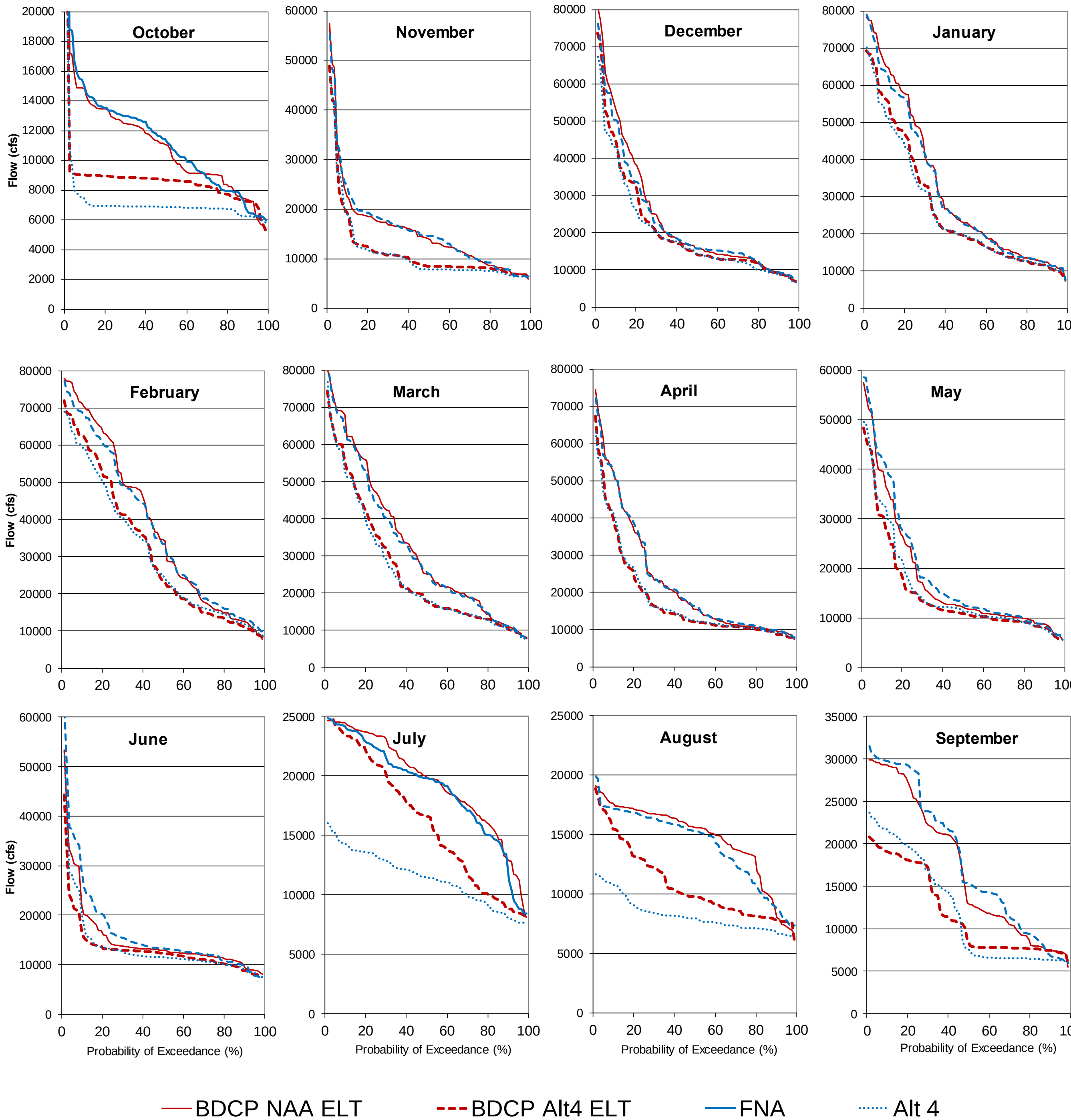
Figure 61 contains monthly exceedance probability plots for Sacramento River below the NDD for the following scenarios: 1) BDCP NAA-ELT, 2) BDCP Alt 4-ELT, 3) independent modeling FNA, and 4) independent modeling Alt 4. The most significant differences in flow changes occur in October, July, August, and September. Changes in Sacramento River flow entering the Delta are a key indicator of changes in interior Delta flows, water levels, and water quality.

For the month of October the independent modeling shows flow below the NDD to be about 2,000 cfs lower than the BDCP modeling. The difference in this month is largely due to reoperation (closure) of the cross channel gate to lessen the amount of Sacramento River flow at Hood necessary to maintain Rio Vista flow requirements downstream of the cross channel gates.

The most substantial difference between the BDCP and independent modeling occurs in July and August. The differences in these two months are primarily attributable to model fixes that have occurred since the BDCP modeling was performed. In the independent modeling, July flows are reduced on average about 7,500 cfs while BDCP shows a reduction of about 3,300 cfs. In the independent modeling August flows are reduced on average about 5,900 cfs while BDCP shows a reduction of about 3,900 cfs.

In the independent modeling September flows are reduced by about 6,100 cfs while BDCP modeling shows a reduction of about 5,300 cfs. The independent modeling shows Sacramento River flow entering the Delta to be about 7,000 cfs 50% of the time, BDCP modeling show Sacramento River flow is about 8,000 cfs 50% of the time.

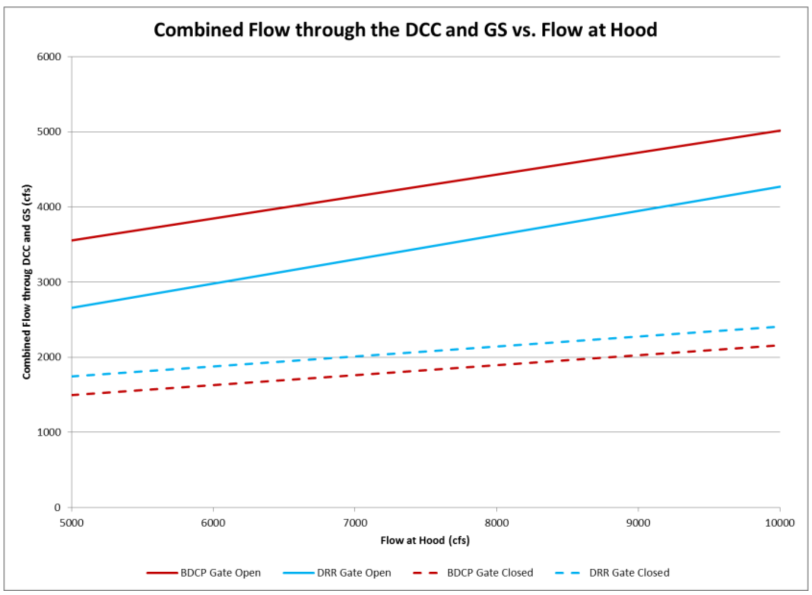
Figure 61. Sacramento River below Hood



Sacramento River water entering the Central Delta

In CalSim, flow through the DCC gate and Georgianna Slough from the Sacramento River into the Central Delta is assumed to be linearly dependent on flow at Hood. There are two linear relationships; one is used when the DCC gates are closed, and the other is used when the DCC gates are open. The 2013 SWP Delivery Reliability Report CalSim II modeling, and therefore our independent modeling, used different linear flow relationships than BDCP. The BDCP and 2013 DRR (and independent) flow relationships for both the open and closed gate conditions are compared in Figure 62. When Sacramento River flow at Hood is in the range from 5,000 cfs to 10,000 cfs the balance between Hood flow, required flow at Rio Vista, and DCC gate operation can affect upstream reservoir operations, SOD exports, and Delta outflow. As shown in Figure 62, given the same flow at Hood and DCC gates closed, the independent analysis will show slightly higher flow into the Central Delta (12% to 17% difference for the Hood flows in the 5,000 cfs to 10,000 cfs range). With DCC gates open the same flow at Hood, the independent analysis will show lower flow into the Central Delta (-15% to -25% difference for the Hood 5,000 cfs to 10,000 cfs range). Figure 63 and Figure 64 show the differences through the DCC and combined flow through the DCC and Georgiana Slough.

Figure 62. Flow through Delta Cross Channel and Georgiana Slough versus Sacramento River Flow at Hood



In addition to the differences in flow equations for portion of Sacramento River entering the interior Delta through the DCC and Georgiana Slough, the DCC gate operations were modified for the month of October. In the independent modeling, the DCC gate is operated to balance the amount of Sacramento River flow needed to meet flow standards at Rio Vista on the Sacramento River and flow needed to meet western Delta water quality. This changed operation often results in DCC gate closures for about 15 days during the month of October. The reduction in flow through the DCC during October can be seen in Figure 64.

Figure 63. Cross Channel Flow

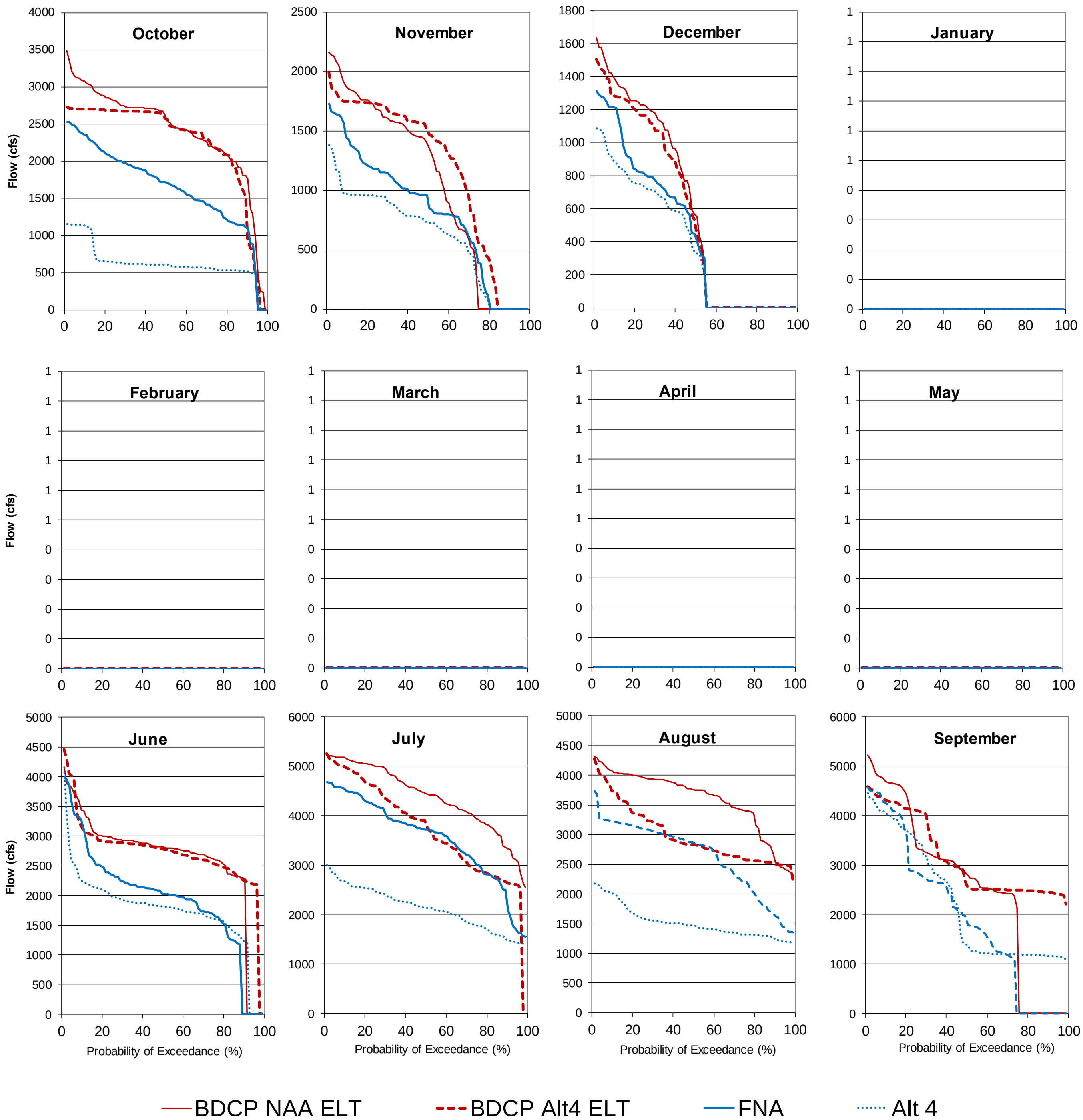
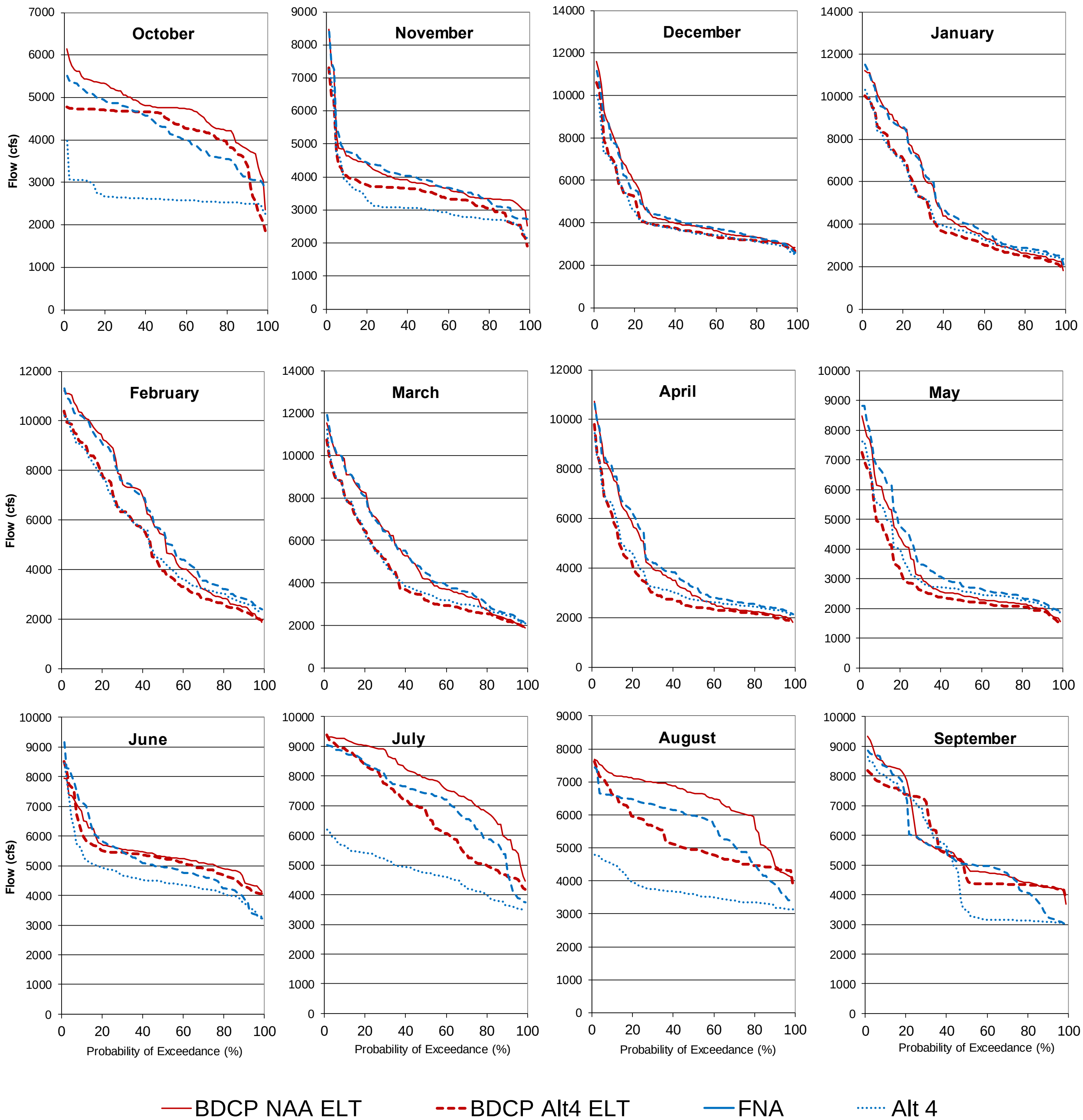


Figure 64. Flow through Delta Cross Channel and Georgiana Slough



Conclusions regarding BDCP effects

Based on the Independent Modeling, the amount of water exported (diverted from the Delta) may be approximately 200 thousand acre-feet (TAF) per year higher than the amount disclosed in the Draft EIR/S. This total represents

- approximately 40 TAF/yr more water diverted and delivered to the SWP south of Delta contractors, and
- approximately 160 TAF/yr more water diverted and delivered to the CVP south of Delta contractors.

The BDCP Model estimates that, under the NAA ELT (without the BDCP), total average annual exports for CVP and SWP combined are estimated to be 4.73 million acre feet (MAF) and in the Independent Modeling FNA combined exports are 5.61 MAF. The BDCP Model indicates an increase in exports of approximately 540 TAF and the Independent Modeling shows an increase of approximately 750 TAF in Alt 4.

The Independent Modeling suggests that Delta outflow would decrease by approximately 200 TAF/yr compared to the amount indicated in the Draft EIR/S.

- This lesser amount of Delta outflow has the potential to cause greater water quality and supply impacts for in-Delta beneficial uses and additional adverse effects on species. To determine the potential effects of the reduced amount of outflow, additional modeling is needed using tools such as DSM2.

The BDCP Model does not accurately reflect the location of the diversions that the SWP and CVP will make from the Delta.

- When the errors in the model are corrected, it reveals that the North Delta intakes could divert approximately 680 TAF/yr more than what was disclosed in the BDCP Draft EIR/S, and
- the amount of water diverted at the existing South Delta facilities would be approximately 460 TAF/yr less than what is projected in the BDCP Draft EIR/S.

Hydrologic modeling of BDCP alternatives using CalSim II has not been refined enough to understand how BDCP may affect CVP and SWP operations and changes in Delta flow dynamics. Better defined operating criteria for project alternatives is needed along with adequate modeling rules to analyze how BDCP may affect water operations. Without a clear understanding of how BDCP may change operations, affects analysis based on this modeling may not produce reliable results and should be revised as improved modeling is developed.

Attachment 2

Mokelumne Fisheries

Attachment 2
Mokelumne Fisheries

Background

The lower Mokelumne River flows nearly 30 miles from the base of EBMUD's Camanche Dam to the tidal influence of the Sacramento-San Joaquin River Delta (Delta). The river is inhabited by a number of resident fish species and three anadromous species, including Pacific lamprey, fall-run Chinook salmon and steelhead. EBMUD's Lower Mokelumne River Management Plan was implemented in 1993 to provide a reliable water supply and to sustain and enhance the lower Mokelumne River fisheries, especially fall-run Chinook salmon and steelhead, and other aquatic and riparian resources. The 1998 Joint Settlement Agreement (JSA) between EBMUD, the California Department of Fish and Game, and the US Fish and Wildlife Service built upon the Lower Mokelumne River Management Plan. The JSA provides even more protection for lower Mokelumne River resources in addition to those undertaken by EBMUD under the 1993 plan. JSA improvements include a 10-fold or greater increase in water available for downstream release in dry and above-normal years along with substantial improvement to release (ramping rates) and coldwater pool management. The JSA also called for both in-river and riparian enhancement work that EBMUD has completed and is continuing to expand upon. EBMUD is committed to protecting the Mokelumne fisheries resource.

The Mokelumne is uniquely situated and classified. The 2009 "Central Valley Salmon and Steelhead Recovery Plan" developed by NOAA provides a thorough background of the various "diversity group" classifications within the Central Valley. It is important to understand that while the Mokelumne River is technically a tributary to the San Joaquin River, it is actually classified within the "northern Sierra Nevada diversity group," which is composed of streams tributary to the Sacramento River from the east as opposed to San Joaquin tributaries. The north and south forks that feed into the San Joaquin River are entirely within the Delta and serve as the primary conveyance channels for Sacramento River water destined for the State and Federal projects. In addition to the Mokelumne's unique classification, the outmigrating Mokelumne juvenile fish face unique challenges as the result of being a "between" system. The Mokelumne migration pathways are complex and very different than the migration pathways of other Delta tributaries.

Although the Mokelumne River provides a relatively small volumetric inflow to the Delta, it supports a disproportionately large fish population. EBMUD has invested heavily in ecosystem restoration projects and fish studies to ensure a healthy Mokelumne fish population. A key reason for the success is the Lower Mokelumne River Partnership (Partnership), comprised of representatives from EBMUD, CDFW, and USFWS. Working cooperatively with the many stakeholders involved within the Mokelumne watershed, the Partnership has implemented many projects related to habitat improvement, research, and monitoring. One of the most successful projects has been the ongoing spawning habitat improvement project, which has resulted in over 55,000 cubic yards of gravel being placed within the river. In 2013, more than 1,000, or about 2/3 of all the redds (spawning nests) built in the Mokelumne River, were built within the project area. Additionally, since 2000 the Mokelumne River Fish Hatchery has transitioned from a facility dependent on egg imports to meet its production goals to one that can meet its goals using only Mokelumne origin broodstock.

Despite the ecological importance of the river and comments provided in June 2013, the draft BDCP inadequately assesses its impacts on the Mokelumne fishery. Although the Effects Analysis presented in Chapter 5 of the draft BDCP recognizes the Mokelumne as a tributary (central Delta versus San Joaquin) the analyses primarily lump it as "part of" either the San Joaquin or Sacramento Rivers. It inappropriately either extrapolates results from studies conducted on those river systems to the Mokelumne River, or it combines data from different systems to determine "overall" impacts on a species but fails to identify specific impacts on Mokelumne populations. The Mokelumne is a distinct river system and the Mokelumne fish face conditions that are significantly different from those in the San Joaquin and Sacramento Rivers. It is essential that the BDCP assess impacts specifically on the Mokelumne fishery.

DCC Operations

Within Chapter 3 there is still a lack of clarity regarding operations of the DCC. In 3.4.1.3.3 it states that there will be less than a 10% change in volume and frequency of flow diverted through the DCC. Yet, on 3.4-38 it states that reduced reliance on through-Delta conveyance via DCC will substantially reduce effects of existing flow anomalies such as weak and reduced flows. With an estimated volumetric change of less than 10% it does not appear there will be significant changes to the anomalies within the central Delta. Moreover, any substantial changes in operations are geared towards wetter years. In dry years there will be no changes to DCC operations.

Without specific DCC operating criteria and associated impact analysis, the conclusions regarding fisheries impacts are less than certain. As in our June 6, 2013 letter, we recommend adding the following:

- Improve description of DCC operations under the project scenarios. Specifically, focusing on modeling the movement of water from the DCC through the Mokelumne forks and to its ultimate destination (pumps or Delta outflow). What portion of the water conveyed through DCC will be exported? How will the percentage of water exported via the Mokelumne forks change seasonally or based on water year-type?
- Conduct studies focusing on survival and migratory pathways of young-of-year (YOY) Chinook salmon entering interior Delta via the Mokelumne and Cosumnes rivers under differing DCC operations.

Effects Analysis (Chapter 5)

While the plan now recognizes that the description of Mokelumne River in regards to its status (central delta tributary versus San Joaquin tributary) differs amongst various existing State and Federal documents, there is limited or no analysis focusing on Mokelumne origin salmonids. As an example, on page 5.5.5-40 it states that operations under the BDCP have considerable potential to reduce straying into the Sacramento River region. This conclusion is based, in part, on studies involving Merced River hatchery fish and reduced south Delta exports. The only data related to the Mokelumne River involves minor to no increases of Mokelumne water reaching Collinsville based on DSM2 fingerprinting.

However, the document fails to identify that one of the leading factors driving straying of Mokelumne origin Chinook salmon is the operation of the DCC. Both USFWS and CDFW recognize that DCC operations have the potential to affect pathway selection and ultimately straying rates of Mokelumne salmon to the Sacramento River basin, primarily the American River. The bulk of the existing straying data for the San Joaquin system is in fact made up of Mokelumne origin fish straying to the Sacramento River system. Since uncertain limited changes are proposed for DCC operations, it is very unlikely that significant reductions in stray rates of Mokelumne origin salmonids (included as San Joaquin origin salmon) would be achieved.

To a large degree the BDCP effects analysis fails to properly assess the potential impacts to salmonids originating from Central Delta tributaries, including the Mokelumne River. The reliance on study results from other systems to reach conclusions regarding Mokelumne issues results in inaccurate assumptions and conclusions. Conversely, the effects analysis identifies the need for specific studies focusing on interior Delta passage issues, but no timelines are presented. We recommend working with the Lower Mokelumne River Partnership to develop and execute studies focusing on Mokelumne origin juvenile and adult salmonids passage and survival through the interior Delta. The results of site specific research studies will allow for more rigorous analysis of effects of any proposed BDCP alternative.

Conservation Measure (CM) 15 (Localized Reduction of Predatory Fishes)
Aside from the 1,500 acres of potential habitat under the Cosumnes – Mokelumne Restoration Opportunity Area, CM-15 is one of the few other actions in the BDCP that could directly improve survival of juvenile salmonids within the central Delta. Predation, along with entrainment, has been identified as one of the key factors leading to reduced survival of salmonids using the migratory pathway. Currently the measure is being implemented as a pilot project and the funding provided may not be sufficient to keep the program going. Moreover, the sampling locations do not directly identify any locations within the central Delta. With limited options to improve conditions within the central Delta the control of predator populations, particularly hotspots, needs to be elevated to an ongoing effort with the appropriate funding allocated. Limiting study locations to those listed will not help improve conditions for covered and non-covered species in the central Delta.

Conservation Measures and Monitoring Action Costs
A key component of adaptive management is having well thought out monitoring programs in place in order to provide the feedback data required to make the appropriate management changes. Equally important to a successful project is adequate funding to complete the required monitoring. Larger projects involving greater levels of uncertainty need to insure that the known components are addressed appropriately, and that contingency planning (operational and financial) is incorporated into the monitoring feedback loop. Within the BDCP documentation there are numerous examples where the uncertainties involved have led to inadequate proposed monitoring and funding.

Overall, the budget estimates for the Monitoring Actions (MA) under the Conservation Measures (CM) appear to be significantly lower than the likely actual costs. Two examples are the estimated costs for CM 15 (Localized Reduction of Predatory Fish) and CM 16 (Nonphysical

Barriers). Under CM 15 and MA15-2 there appear to be two different estimates for annual monitoring costs. In 8.2.3.15 of Chapter 8 it has an approximate cost for reducing predators of approximately $1.84 million a year (excluding abandoned vessel and structure removal) (approximately $460,000 per crew). However, the plan calls for no more than a pilot program that could be used to develop a larger program. Under the required MA15-2 (Appendix 8A-121) it states an annual monitoring cost of $300,000. No cost breakdowns are given for MA15-2 and it is unclear where the equipment will come from or what the sampling frequency will be. Considering the level of effort required to monitor distribution of predators throughout the Delta and at hotspots, the estimated budget for MA15-2 is significantly below actual costs.

CM 16 calls for the installation of up to 7 nonphysical barriers within the Delta. Under MA16-2 (Appendix 8A-122) it states that the annual monitoring cost for one nonphysical barrier will be $250,000. The monitoring program will be similar to a previous study and involve the release of 1,000 acoustically tagged juvenile salmon. The cost per tag is approximately $350 and the total cost for tags for 1,000 salmon would be $350,000. Using the criteria laid out in the assumptions the cost in tags alone (no cameras, staff, analysis, etc.) in years 1-5 would be about $4.9 million. Table 8.A-47 states monitoring cost for CM16 in years 1-5 will be $3.5 million. Either the monitoring program assumptions are not accurate or the costs are significantly underestimated by at least $1.5 million, or 40%.

The cost differences above are significant and made more so by the fact that some contingency percentage has been added to each component. Carrying these inconsistencies through the other BDCP monitoring programs could result in a significant funding gap for the monitoring portion of the BDCP, with potentially serious ramifications for the adaptive management program as a whole.

Technical and Brief Comments

Effectiveness monitoring for restored habitats under CM4 – CM6 should include a measure of non-native predatory fish populations/densities. One success criterion is presence of covered fish species in the area, but other criteria should include survival rates and impacts from predators. One of the primary uncertainties regarding the creation of seasonal floodplain habitats is how they may be used by non-native fish, particularly in years when they may not drain due to high flow events.

5.5.6.1 states that out of basin steelhead stock are used as broodstock for the Mokelumne Hatchery. This practice was discontinued in 2008.

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ATTACHMENT 3

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Explanation of Abbreviations

BDCP	Bay Delta Conservation Plan
CEQA	California Environmental Quality Act
CER	Conceptual Engineering Report
CVP	Central Valley Project
DEIR/EIS	Draft Environmental Impact Report/Environmental Impact Statement
Delta	Sacramento-San Joaquin River Delta
DWR	California Department of Water Resources
EIR/EIS	Environmental Impact Report/Environmental Impact Statement
FESA	Federal Endangered Species Act
HCP	Habitat Conservation Plan
msl	Mean Sea Level
NCCP	Natural Communities Conservation Plan
NCCPA	California Natural Community Conservation Planning Act
NEPA	National Environmental Policy Act
NMFS	U.S. Department of Commerce, National Marine Fisheries Service
psi	Pounds per square inch
Reclamation	U.S. Department of Interior, Bureau of Reclamation
ROW	Right-of-way
SWP	State Water Project
TBM	Tunnel Boring Machine
USFWS	U.S. Department of Interior, Fish and Wildlife Service

EXECUTIVE SUMMARY

The proposed Bay-Delta Conservation Plan Delta conveyance tunnel implementation could have significant and adverse impacts on the integrity and operation of the EBMUD Mokelumne Aqueducts. The new BDCP Delta conveyance could also have significant and adverse impacts on any future facilities of EBMUD that traverse the Delta, including a Mokelumne Delta tunnel project that would cross the proposed BDCP Delta conveyance route on Woodward Island. Before the new BDCP Delta Conveyance can be implemented, the public is being offered, consistent with the California Environmental Quality Act and the National Environmental Policy Act, the opportunity to comment on the effects of the BDCP on the human environment, including the opportunity to propose potential measures to mitigate for significant environmental effects. The construction and operation of the BDCP Delta conveyance tunnels could affect the existing Mokelumne Aqueducts and the proposed EBMUD Delta tunnel through the following mechanisms:

- Disrupt EBMUD water service operations
- Direct interference with the Aqueducts deep foundations
- Undermining and adversely impacting deep foundations
- Settlement due to lost ground associated with normal tunnel activities
- Settlement due to lowered groundwater level
- Seepage and associated piping into BDCP Conveyance Tunnels during the Tunnels' lifespan resulting in lost ground and settlement
- Tunnel lining failure of BDCP Conveyance Tunnels resulting in settlement or sinkholes
- BDCP Conveyance Tunnel construction shafts cause lateral earth movement and stress on Existing Mokelumne Aqueducts
- Settlement due to lowered groundwater level
- Damage to existing Mokelumne Aqueducts due to roads constructed for the BDCP Conveyance Tunnel Project crossing or parallel to the Mokelumne Aqueducts
- Damage to existing Mokelumne Aqueduct due to BDCP related utilities crossing or parallel to the Aqueducts
- New BDCP related electrical transmission line tower foundations affect existing Mokelumne Aqueducts
- Stray Electrical Currents Effecting Mokelumne Aqueducts or EBMUD Delta Tunnel

- Vertical Position (Elevation) of BDCP Conveyance Tunnels interferes with the Delta Tunnel
- Additional costs for Delta Tunnel construction and operation due to BDCP Conveyance Tunnels

Mitigation measures have been proposed to avoid, reduce, and compensate for these potentially significant effects on EBMUD facilities, operations and future plans.

1.0 INTRODUCTION

East Bay Municipal Utility District ("EBMUD") has prepared these comments on the Bay Delta Conservation Plan ("BDCP") Draft Environmental Impact Report / Environmental Impact Statement ("DEIR/EIS"), specifically related to how the California Environmental Quality Act ("CEQA") Preferred Alternative conveyance features would impact the facilities and operations of the existing 82-mile long Mokelumne Aqueduct System comprised of three large diameter steel pipelines that are above ground in the Delta region. Additionally, these comments also address how the CEQA Preferred Alternative conveyance features would impact EBMUD future plans to replace the existing Mokelumne Aqueducts through the Delta with a large diameter deep tunnel, the Mokelumne Aqueducts Delta Tunnel ("Delta Tunnel"). As part of the comments, EBMUD has proposed required mitigation measures to avoid or lessen potential impacts on EBMUD's existing facilities and recommended mitigation measures to avoid conflicts with the proposed future Delta Tunnel Project.

1.1 Purpose of BDCP Conveyance Tunnels

The BDCP CEQA preferred plan is to tunnel north/south through the Delta with two large diameter water conveyance tunnels that cross the existing Mokelumne Aqueducts alignment. EBMUD comments relate to the CEQA preferred plan. Other Delta conveyance options discussed in the DEIR/EIS would present a different set of concerns for EBMUD and are not addressed at this time. EBMUD is concerned that the construction and operation of the future BDCP water conveyance tunnels would adversely affect the existing Mokelumne Aqueducts and would interfere with the plan to replace the pipelines with a Mokelumne Aqueducts Delta Tunnel in the future. Specific comments are required on any conflicts that may arise between the proposed BDCP conveyance water tunnels and the Mokelumne Aqueducts existing and future facilities. These comments will address but are not limited to design and engineering, direct interferences, direct and secondary effects, geology and soils, construction impacts, and operational impacts.

1.2 Project Description

The "project", for the purposes of this technical memorandum, is composed of three discrete sets of physical facilities, two related to EBMUD operations, one existing and one proposed, and one related to the BDCP CEQA preferred project. The layout of these facilities is illustrated in **Figure 1 - Mokelumne Aqueducts and Proposed Delta Tunnel Plan**. The existing Mokelumne Aqueduct pipelines through the Delta are herein described as the Existing

Mokelumne Aqueducts, and the proposed EBMUD tunnel is herein described as the proposed Delta Tunnel. The BDCP CEQA preferred project is herein described as the BDCP Conveyance Tunnels, and is referenced in the BDCP DEIR/EIS as "Alternative 4 – Dual Conveyance with Modified Pipeline/Tunnel and Intakes 2, 3, and 5".

1.3 Limitations of Study

This review is only to evaluate and provide engineering and geologic related comments on how the tunnel conveyance portion of the BDCP Dual Conveyance affects the Existing Mokelumne Aqueducts and proposed Delta Tunnel, and does not include an evaluation of any other conveyance alternatives or conservation measures included in the BDCP DEIR/EIS. Only the BDCP DEIR/EIS and the Conceptual Engineering Report ("CER") have been used in this evaluation to describe the proposed BDCP Conveyance Tunnels features and the associated potential impacts and mitigation measures. Furthermore, this review only evaluates the potential effects of the BDCP Conveyance Tunnels, which has been developed to the conceptual design level, on the existing Mokelumne Aqueducts and the future Delta Tunnel as currently proposed by EBMUD. Future design development during the preliminary design phase of the BDCP Dual Conveyance may result in modifications to the horizontal alignment and vertical profile, tunnel diameter, and overall tunnel design and alter the potential impacts on the proposed Delta Tunnel.

2.0 EBMUD FACILITIES DESCRIPTIONS

2.1 Existing Mokelumne Aqueducts

The existing Mokelumne Aqueduct system consists of three large diameter pipelines as follows:

- Aqueduct No. 1: 65-inch diameter
- Aqueduct No. 2: 67-inch diameter
- Aqueduct No. 3: 87-inch diameter

These steel pipelines have a combination of riveted and welded joints, and operate at internal pressures of several hundred psi that vary with location and operational condition. The aqueducts have several burial and support configurations depending on the aqueduct and the location including: 1) buried, 2) buried on piles, 3) elevated on piles, and 4) dredged river crossings including simple burial, on piles, and with armoring mats.

The western reach of the aqueducts cross the Delta from approximately Holt to Bixler (approximately 10.5 miles) and are primarily elevated on pile supported bents at intervals of 20 to 42 feet. The piles are a combination of timber and precast concrete with depths typically ranging from 30 to 50 feet and as deep as 60 feet, with a minimum elevation of -65 feet msl. Within this reach at river and slough crossings, the aqueducts are buried in dredged trenches with a variety of foundation systems as detailed above.

The BDCP Conveyance Tunnels are shown in the DEIR/EIS to cross the EBMUD Aqueducts in the middle of Woodward Island, which is within the Delta area, and is shown on **Figure 1 - Mokelumne Aqueducts and Proposed Delta Tunnel Plan.** Within the crossing location, all three Aqueducts are elevated and on piles, with pile tips ranging from approximately 30 to 50 feet deep, corresponding to elevations of -40 to -60 feet msl.

2.2 Proposed Delta Tunnel

EBMUD has been evaluating risks to the Existing Mokelumne Aqueducts and potential structural alternatives through both short-term and long-term measures since at least 2007 when the EBMUD Board of Directors approved Motion Number 185-07 to accept the staff report "Strategy for Protecting the Mokelumne Aqueducts in the Delta" (EBMUD, 2007). The Board directed staff to use the report's findings and recommendations in planning future water conveyance capital improvement programs and in participating in state-wide Delta initiatives. The staff report evaluated various long-term measures and concluded that a deep tunnel across the Delta would be the most cost-effective solution to mitigate the hazards and risks associated with seismic, scour, flooding, liquefaction and lateral spreading.

The proposed Delta Tunnel has been developed to the conceptual design level. The conceptual design identifies the proposed horizontal alignment and vertical profile for the proposed Delta Tunnel. However, refinements to the Delta Tunnel alignment and profile may occur in the future and would be fixed at the completion of the preliminary design phase. Based on work to date, the tunnel is envisioned to follow the existing EBMUD Aqueducts beginning near Interstate 5 in Stockton at the east, to Bixler at the west, a distance of 16.6 miles. Seven shafts, at approximate three mile intervals, are planned for the Delta Tunnel Project for construction and future access to the carrier pipes.

Based on the conceptual design, the proposed Delta Tunnel is expected to have an excavated diameter of approximately 21 feet and will be constructed using pressurized face tunnel boring machines (TBMs) and supported with precast concrete segments. The tunnel would house twin 87 inch (inside diameter) pressurized steel carrier pipes secured with cellular concrete backfill.

The proposed Delta Tunnel profile has been selected to be within vertical envelope or band typically 42 to 52 feet high. This band represents the tunnel diameter plus allowances for a range of likely profiles to be determined during the preliminary design phase. The band is a profile that varies in vertical position (elevation) and thickness (height) along the proposed tunnel alignment. At the highest point the crown is at an elevation of -48 feet, and at the lowest point the invert is at an elevation of -141 feet msl. At the location of the proposed BDCP Conveyance Tunnels, the proposed Delta Tunnel would be constructed within an elevation band between elevation -89 feet msl at the tunnel crown to -141 feet msl at the tunnel invert as shown in **Figure 2 — Proposed Tunnel Profile**.

3.0 BDCP DUAL CONVEYANCE – ALTERNATIVE 4

3.1 Tunnels and Shafts

As stated in Chapter 3 "Description of Alternatives" of the BDCP DEIR/EIS, Alternative 4 – Dual Conveyance Tunnels would consist of twin 40-foot-inside-diameter tunnels to convey water 30.2 miles from a new intermediate forebay on Glanville Tract to an expanded Clifton Court Forebay. The tunnel would be designed as a gravity-fed system, and would not, therefore, be pressurized. The tunnel would cross the Existing Mokelumne Aqueducts right-of-way on Woodward Island.

The proposed tunnels would be constructed with large-diameter TBMs through launch/retrieval shafts at approximately 3-mile intervals. Figure 3-21 of the EIR/EIS shows the tunnels with a "Typical depth of 100 ft. msl".

The DWR's Conceptual Engineering Report (2010), referenced within the DEIR/EIS, states: "the tunnel invert is assumed to be at 100 feet below mean sea level (msl) primarily to avoid peat deposits" and goes on to state that it would be lowered down to 160 feet below msl at the San Joaquin River and the Stockton Deep Water Ship Channel. Figure 11-6 of this report shows the tunnels with an invert depth of approximately 150 feet below msl. Moreover, in a recent update to the CER dated October 2013, for the Modified Pipeline Tunnel Option, the preliminary tunnel inverts range from 122 feet below msl at the north end of the North Tunnel at Intake No. 2 to 163 feet below msl at the North Clifton Court Forebay.

Based on a review of the DEIR/EIS and the CER (2010, 2013), the inverts of the 40-foot-diameter BDCP conveyance tunnels could range between elevations -100 to -163.

Figure 3-9 of the DEIR/EIS (alignment of alternative 4 tunnels) shows shafts approximately 1.5 miles to the north and to the south of the EBMUD Mokelumne Aqueduct. However, we note that the shaft locations could change in subsequent design phases, and include shafts near the EBMUD Mokelumne Aqueducts and proposed Delta Tunnel. If shafts are located near EBMUD facilities there would be substantial impacts from construction and operation that are not included in these review comments.

As noted in the CER and in conjunction with experience on other projects, the horizontal alignment and vertical profile for tunnels are typically fixed at the end of preliminary design. Therefore, changes in the final depth and profile of the BDCP conveyance tunnels could occur during the preliminary design phase.

3.2 Transmission Facilities and Other Requirements

Chapter 3 "Description of Alternatives" of the BDCP DEIR/EIS states that Alternative 4 – Dual Conveyance would require new transmission lines running from the existing electrical power grid to project substations. To deliver power to construct and operate the water conveyance facilities, it is assumed that the system would be split to connect to the existing grid in two different locations, one in the northern section of the alignment and one in the southern section.

In the latest available version of the CER, multiple transmission line routes are shown. The two new primary transmission line corridors are routed in a north-south direction. A number of the alternatives follow the general north-south alignment of the BDCP conveyance tunnels, crossing the Existing Mokelumne Aqueducts as well as the proposed Delta Tunnel alignment at Woodward Island (CER, 2013; Figure 3-25). ,

Chapter 3 of the DEIR/EIS "Description of Alternatives" also states that there would be borrow areas and areas identified for the storage and/or disposal of spoil, reusable tunnel material (RTM), and dredged material.

3.3 Operations

The DEIR/EIS (Pg. 3-27, line 27 and 28), states: "… to facilitate the gravity-fed system proposed under Alternative 4 (instead of being pressurized and pumped through an intermediate pumping plant)". Based on this statement, it is not known if the tunnels would be operated in an *open channel* condition, as a *full pipe* condition, or a combination depending on the operational requirements.

4.0 BDCP DRAFT EIR/EIS REVIEW PROCESS

The BDCP DEIR/EIS provides information relevant to the requirements of CEQA and NEPA to inform the public and decision-makers of the impacts on the human environmental of implementing actions undertaken or authorized by state and federal agencies, respectively. Both CEQA and NEPA require that agencies allow the public an opportunity to comment on draft CEQA and NEPA documents on substantive issues relative to the undertaking and its effects on the human environment. This document is in support of EBMUD asserting its rights under CEQA and NEPA to provide formal comments on the BDCP DEIR/EIS on substantive issues of concern to the continued reliable delivery of water to EBMUD customers at a reasonable cost.

As stated in the BDCP DEIR/EIS Chapter 1 “Introduction”, the BDCP is a long-term multiple purpose plan that consists of a Habitat Conservation Plan (“HCP”) and a Natural Community Conservation Plan (“NCCP”) for the Delta. It is being developed pursuant to the Federal Endangered Species Act (“FESA”), the California Natural Community Conservation Planning Act (“NCCPA”), and other pertinent environmental laws and policies. The BDCP sets out a comprehensive conservation strategy for the Delta designed to restore and protect ecosystem health, water supply, and water quality within a stable regulatory framework through the following.

- New and/or modified State water conveyance facilities and operations of the State Water Project (“SWP”) and Central Valley Project (“CVP”),
- Conservation, protection, restoration, and enhancement of habitats for native fish, wildlife, and plants within the Delta,
- Actions to address other ecological stressors to covered aquatic species in the Delta,
- Adaptive management of water conveyance facilities operations; the protection, restoration and enhancement of habitats; and measures to reduce other ecological stressors.

The BDCP, EIR/EIS, and supporting documentation will provide the basis for decisions concerning the applications for issuance of endangered species take permits for restoration activities and facility and operational changes in the SWP and authorizations related to operational changes in the CVP. The BDCP EIR/EIS will also be used to support the decisions of DWR and the participating water contractors to implement the actions of the BDCP, including the ultimate selected water conveyance option.

4.1 DEIR/EIS Public Review Process

As required by the CEQA and NEPA and their implementing regulations, the DEIR/EIS is circulated for public review and comment prior to a decision to implement the project. Comments are due on July 29, 2014. Responses to substantive comments will be included in the FEIR/EIS.

This document provides pertinent information to support EBMUD's comments on the DEIR/EIS relating specifically to engineering and geological issues of concern to EBMUD's Existing Mokelumne Aqueducts as well as the proposed Delta Tunnel from the construction and operations of the BDCP Conveyance Tunnels alternative, including appurtenance features such as shafts and transmission lines.

4.2 Lead Agencies Preferred Project

The CEQA/NEPA Lead Agencies are DWR for CEQA and Reclamation, the USFWS, and the NMFS, acting as lead agencies for compliance with NEPA. DWR has selected Alternative 4 – Dual Conveyance Tunnels with Modified Pipeline/Tunnel and Intakes 2, 3, and 5 as the CEQA Preferred Alternative. This alternative is also the subject of a separate document, the "Bay Delta Conservation Plan" which is intended as the draft HCP and NCCP, consistent with the FESA and NCCPA.

The Federal Lead Agencies have not selected a preferred NEPA alternative, leaving some doubt as to the actual project that will be jointly selected for implementation and approved as the HCP/NCCP.

4.3 Level of Detail

The BDCP DEIR/EIS contains conceptual level engineering detail, which is a work in progress which concepts will undoubtedly change during future design development. This level of detail does not allow preliminary or final design level comments to be made as part of this review, and also makes it difficult to provide adequate comments on the sufficiency of DEIR/EIS to identify impacts and appropriate mitigation measures. Therefore, it is necessary as part of this review, to provide comments to the Lead Agencies on the recommendation for further detailed discussions EBMUD will expect to occur prior to final design decisions being made on the location and depths of the BDCP Conveyance Tunnels including appurtenances. See comments below in Section 5.0 regarding the consequences of the low level of detail.

5.0 BDCP DEIR/EIS Review Comments and Proposed Mitigation Measures

Sections of the BDCP DEIR/EIS has been reviewed and several issues of concern have been identified that may potentially impact EBMUD's existing Mokelumne Aqueducts and its future plans for replacing the Aqueducts with a single deep tunnel, the Delta Tunnel. All Chapters were scanned for references to EBMUD and the Mokelumne Aqueduct. Chapter 20 "Public Services and Utilities" addresses potential impacts and proposed mitigation measures concerning effects to water service providers. In Section 20.3.1 "Methods for Analysis", the DEIR states that construction activities were reviewed to assess the potential for effects on water service providers and infrastructure. As stated in Section 20.3.2 "Determination of Effects" alternatives were also considered to have an effect on public services and utilities if construction would result in disruption substantial enough to require temporary or permanent relocation of existing utility systems. In these sections of the DEIR/EIS, the potential impacts are discussed in a general nature with few specifics. Because the EIR/EIS will be used to support the implementation of the major conveyance facilities, and is intended to be at a project specific level, considerably more detail concerning specific impacts on individual utilities and development of specific mitigation measures is appropriate for the FEIR/EIS. This document provides the specific information on substantive issues related to EBMUD facilities that would be expected to be included in the FEIR/EIS.

Section 20.3.3.9 "Alternative 4 – Dual Conveyance Tunnels with Modified Pipeline/Tunnel and Intakes 2, 3, and 5 (9,000 cfs; Operational Scenario H)" Impact UT-6: "Effects on Regional or Local Utilities as a Result of Constructing the Proposed Water Conveyance Facilities" states that the water conveyance alignment and associated physical structures could interfere with the Mokelumne Aqueduct. This is the first reference to EBMUD's Mokelumne Aqueduct System. No further specific information on how the Mokelumne Aqueduct would be affected is given in this Chapter. A commitment is made to coordinate with utilities on relocations and modifications so that utility providers and local agencies can integrate potential other construction projects with the construction of the Conveyance Tunnels. The DEIR/EIS states that "Because relocation and disruption of existing utility infrastructure would be required under this alternative and would have the potential to create effects through the relocation of facilities, this would be an adverse effect."

Mitigation Measures UT-6a, UT-6b, and UT-6c are stated to be available to reduce the severity of this effect, but the conclusion is that with coordination with all utility providers and local agencies to integrate with other construction projects, the impact would not be adverse. Mitigation Measure UT-6a "Verify Locations of Utility Infrastructure", Mitigation Measures

UT-6b "Relocate Utility Infrastructure in a Way That Avoids or Minimizes Any Effect on Operational Reliability" and Mitigation Measure UT-6c "Relocate Utility Infrastructure in a Way That Avoids or Minimizes Any Effect on Worker and Public Health and Safety" do not contain adequate information or detail for EBMUD to determine what all the impacts may be and whether there will be substantial unmitigated effects to the existing Mokelumne Aqueducts and its future plan to construct the Delta Tunnel.

During the preparation of the DEIR/EIS, DWR representatives Mr. Gordon Enas and Mr. Alan Davis corresponded with Garth Hall from EBMUD concerning Right of Way (ROW) issues at the Mokelumne Aqueducts crossing. These email conversations occurred during April and May of 2012. During those email exchanges, the BDCP representatives were made aware of the need for a tunnel easement to be negotiated for construction of the Dual Tunnel below the Mokelumne Aqueducts and furthermore, that EBMUD was in the process of initial project planning for a cross-Delta Tunnel beneath the existing Mokelumne Aqueduct. Mr. Hall suggested that engineering staff meet soon after the CEQA documentation is published so that design implications could be considered.

Design of the BDCP tunnels presented in the DEIR/EIS is at a very conceptual level and does not contain sufficient detail to perform a thorough review. There are many aspects of the design which are either undetermined or could change with subsequent engineering development which could impact the existing Mokelumne Aqueducts and the proposed Delta Tunnel. These items include but are not limited to tunnel profile and depth, shaft locations, tunnelling method(s), tunnel operation as open channel or pressurized, the use of a secondary lining, and the location of construction support facilities. Due to these uncertainties, the present review of potential impacts and appropriate mitigation measures is incomplete and will need to be revisited in the future upon further design refinement of the BDCP tunnels. The following comments and proposed mitigation measures presented below provide the analysis on potential adverse effects to EBMUD facilities, operations and Capital Improvement Plans, and potential mitigation measures that will need to be considered, negotiated, and included as part of any ROW agreement with BDCP implementing agencies based upon the information currently available. These comments also provide details on conflicts and potential resolutions for conflicts between the two tunnelling projects.

5.1 Effects on Existing Mokelumne Aqueducts and Proposed Mitigation Measures

Construction of the Dual Tunnel could adversely impact the existing EBMUD aqueducts in several ways including:

1) Direct interference,

2) Common or routine ground movement and settlement,

3) Sinkholes caused by major ground loss,

4) Long-term ground loss or movement, and

5) The need to sink a recovery or maintenance shaft.

5.1.1. BDCP Tunnels Cross EBMUD ROW

At the location where the proposed BDCP Conveyance tunnels cross the Mokelumne Aqueducts, EBMUD owns the ROW within which the Aqueducts are situated.

Impact: Disruption of EBMUD water service operations

The concerns of EBMUD are to:

1) Protect EBMUD water service customers from outages due to damage to the Mokelumne Aqueducts from construction and/or operation of the BDCP Conveyance Tunnels,

2) Avoid costly repairs to EBMUD facilities, and

3) Avoid potential consequential third party damages from aqueduct failure such as from flooding and scour.

Proposed Mitigation Measures: Fully comply with a ROW agreement addressing all potential impacts on EBMUD facilities

The BDCP implementing agencies will need to secure a tunnel ROW agreement with EBMUD in order to construct the BDCP Conveyance Tunnel in the ROW beneath the existing Mokelumne Aqueduct. EBMUD suggests that this process begin immediately in order for the BDCP Conveyance Tunnels design work to include appropriate safeguards as outlined in the impacts and mitigation measures below. EBMUD's ROW procedures are appended to this attachment (Appendix A).

5.1.2. Effects on Existing Mokelumne Aqueducts Due to BDCP Conveyance Tunnels Construction

Construction of the BDCP Conveyance Tunnels could result in adverse impacts such as settlement and sinkholes on the existing Mokelumne Aqueducts alignment. The potential impacts could occur in several ways as detailed below with associated suggested mitigation measures.

Impact: Direct interference with the Aqueducts' deep foundations

Piles supporting the aqueducts extend to a depth of approximately 60 feet and an elevation of -65 feet msl in some areas. If the two BDCP Conveyance Tunnels are relatively shallow, the tunnels would intersect the piles. Encountering the piles during tunnel construction would result in major complications and would cause settlement of the Mokelumne Aqueduct piles and pipeline with associated risk for damage and failure.

Proposed Mitigation Measures for direct interference

Locate the BDCP Conveyance Tunnels at a depth, or low enough elevation, to avoid direct interference.

Impact: Undermining and adversely impacting deep foundations

The BDCP Conveyance Tunnels would likely be constructed within the zone of influence for the Mokelumne Aqueduct piles and could reduce the ground support for the piles and/or cause settlement of the piles. This could occur even if the tunnels do not directly encounter the piles. The effects due to the occurrence of the impacts described below would be settlement and differential settlement of the aqueducts. Depending on the magnitude of the settlement the aqueducts would be damaged or there could be failure of the aqueducts.

Impact: Settlement due to lost ground or vibrations associated with normal tunnel activities

Common tunnelling methods result in lost ground especially from stress redistribution in the ground, face losses, overcut of the shield, and uncompensated losses around the segmental lining. Additionally, tunnelling and other construction activities can cause vibrations resulting in pile support system settlement and potential rupture of the existing Mokelumne Aqueducts. The effects of the lost ground migrates upward resulting in loose soils and causing settlement within a zone of influence. Although tunnelling equipment and methods may be employed to control the ground (e.g., utilization of a pressurized face TBM), unexpected situations may arise resulting in a major ground loss (ground run or inflow). Such a ground loss could result in major settlements extending above the tunnels possibly to the ground surface. Even if loosened ground associated with tunnel construction did not directly cause settlement of the aqueducts, the loosened ground would be more susceptible to liquefaction with associated ground movements during seismic events. Any settlement or vibration can cause a rupture in the existing Mokelumne Aqueducts causing loss of water supply to EBMUD customers, flooding and scour of the area surrounding the rupture site causing further structural damage, and damage to adjacent landowners and levees.

Proposed Mitigation Measures for Undermining and Settlement:

To mitigate adverse undermining and settlement impacts during construction of the dual underground openings, the ground must be controlled while tunnelling in order to avoid ground loss at the face. The primary means for achieving this are:

1) Completion of a thorough exploration program of subsurface conditions in the vicinity of the intersection alignments, and zone of influence,
2) Obtain construction records of piles supporting the Mokelumne Aqueducts and position the tunnel at suitable depth to avoid adverse impacts,
3) Placement of the tunnel in soils that reduce construction impacts,
4) Placement of the tunnel with suitable cover to attenuate settlement,
5) Selection of appropriate tunnelling equipment and methods for the ground conditions,
6) Engaging qualified and experienced contractors,
7) Implement construction controls to reduce, detect, and address complications. Monitor muck volumes relative to the theoretical volume of the ground being excavated. To determine the magnitude of settlement there should be a ground monitoring program during construction such as with surface points, extensometers, and inclinometers. If potential damaging ground movements are detected compensation grouting can sometimes be used to reduce settlements,
8) Ground treatment with a zone of influence at and/or above the tunnels prior to tunnelling to form a more stable ground mass. Ground treatment can include jet grouting, permeation grouting, ground freezing, and potentially other methods prior to tunnelling through this area,
9) In the event that voids occur due to ground loss from tunnelling, compensation grouting can be used to fill voids and/or densify the ground to mitigate potential ground settlement to the existing Mokelumne Aqueducts and/or impacts to the integrity of the deep tunnels.

5.1.3. Effects on Existing Mokelumne Aqueducts due to Groundwater Issues

Although the current approach to tunnelling and shaft construction does not involve dewatering, complications during construction could result in lowering of the groundwater table, or the groundwater table may be lowered to address a construction complication.

Impact: Settlement due to lowered groundwater level

If the groundwater table is lowered for any reason, such as tunnelling, it would likely result in consolidation from an increase in effective stress on soft soils. This settlement would impart an increase risk on the existing Mokelumne Aqueducts.

Proposed Mitigation Measures:

Use project construction methods that avoid dewatering near the existing Mokelumne Aqueducts.

Earth pressure balance tunnel machines, if not operated correctly, can create significant ground disturbance including potential "frac-out" disturbing soils to the ground surface.

5.1.4. Effects on Existing Mokelumne Aqueducts due to Ground Loss Caused by BDCP Tunnels

The lining for the Dual Conveyance Tunnels is currently designed to be precast concrete segments. Unlike many water conveyance tunnels, there is no interior or secondary lining inside the concrete segments.

The presence of the BDCP Conveyance Tunnels could result in adverse impacts such as settlements and sinkholes on the existing Mokelumne Aqueducts throughout the lifetime of the BDCP Conveyance Tunnels. The potential impacts could occur in several ways as detailed below with associated suggested mitigation measures.

Impact: Seepage and associated piping into BDCP Conveyance Tunnels during the Tunnels' lifespan

Although the segmental lining would be bolted and gasketed, long-term degradation of the joints or lining may result in water seeping into the tunnels. This water inflow could carry soil particles resulting in piping, ground loss, settlement, and, potentially, sinkholes. Depending on the magnitude of the ground loss, the existing Mokelumne Aqueducts could be damaged or there could be failure of the aqueducts due to settlement.

Proposed Mitigation Measures:

Mitigation measures to address the potential for infiltration are based on avoidance, detection, and remediation including: design of the segmental lining for long term performance, tight quality controls during construction, inspection during and upon completion of construction, and routine inspections during the tunnel operational life. Another mitigation strategy is the use of a higher level of design and longer design life for the segments which may include additional reinforcement, stronger or more durable concrete, a more robust gasket system, and stronger joints. The likelihood of this event can be reduced with the use of a secondary lining or carrier pipe surrounded with backfill grout inside the segmental concrete lining.

In the event that seepage or water inflow is detected during construction or during the operational life of the tunnels, the situation can be addressed with permeation (cement or chemical) grouting immediately outside the lining to cut off groundwater flow. Additionally, compensation grouting can be used to restore lost ground and/or to densify the ground to prevent the upward migration of settlement.

Impact: Tunnel lining failure of BDCP Conveyance Tunnels

Long-term degradation of the segmental concrete lining may result in failure of the lining. In the event that the tunnel lining fails or there is a collapse of the tunnel, it would result in major ground movement extending to the ground surface and potentially a sinkhole. With such an event, the resulting settlement would likely result in failure of the existing Mokelumne Aqueducts.

Proposed Mitigation Measures:

Mitigation measures to address the collapse or failure of a BDCP Conveyance Tunnel are based on avoidance, detection, and remediation including:

1) Design of the segmental lining for long term performance,
2) Inspection during and upon completion of construction, and routine inspections during the operational life of the tunnels,
3) Geotechnical instrumentation monitoring program around the tunnels beneath the aqueducts,
4) Use of a higher level of design and longer design life for the segments which may include the need for a more robust lining system,
5) Additional reinforcement, stronger or more durable concrete, multiple gaskets, and stronger joints,
6) Use of a carrier pipe surrounded with backfill grout inside the segmental concrete lining.

Settlement within the crossing zone should be measured for the long-term life of the tunnel. In the event that structural deficiencies of the segmental concrete lining are detected, the situation can be addressed with one or more of the following actions:

1) The lining can be improved with localized structural patches,
2) Permeation (cement or chemical) grouting can be used immediately outside the lining,
3) New secondary lining can be placed for full 360 degrees inside the segmental concrete lining,

4) Additionally, compensation grouting can be used to restore lost ground and/or densify the ground to prevent the upward migration of settlement.

5.1.5. BDCP Project Shaft Location Conflicts

Shafts for the Dual Conveyance Tunnels are shown in the DEIR/EIS to be located over a mile to the north and to the south of the existing Mokelumne Aqueducts. At these locations and distances, the shafts would not be expected to have direct impacts on the existing Mokelumne Aqueducts. However, shaft locations near the existing Mokelumne Aqueducts are possible during future design development, if a different tunnel alternative is implemented such as shown on Figure 3-2 of the DEIR/EIS, or if a rescue or maintenance shaft were deemed necessary during construction due to problems with the TBM.

Impact: BDCP Conveyance Tunnel construction shafts cause lateral earth movement and additional loads on Existing Mokelumne Aqueduct

Construction of the Dual Conveyance Tunnels Shafts could result in ground movements, especially lateral displacements, in the vicinity of the shafts. These ground movements could result in detrimental impacts on the existing Mokelumne Aqueducts and its pile foundations.

Proposed Mitigation Measures:

To mitigate adverse ground movement impacts, construction must control lost ground during shaft construction. The impacts resulting from ground movements can be reduced, although not eliminated, by controlling ground loss and providing ground support during shaft construction. The primary means for achieving this are:

1) Thorough exploration of subsurface conditions, including obtaining construction records of piles supporting the Mokelumne Aqueducts and positioning the tunnels at suitable depth,
2) Careful selection of shaft construction methods to provide stable lateral support for excavations,
3) Engaging qualified and experienced contractors,
4) Construction controls to reduce, detect, and address complications. To determine the magnitude of ground movement there should be a ground monitoring program during construction such as with surface points, extensometers, and inclinometers,
5) Treat the ground (ground treatment) in the vicinity of the shafts, Aqueducts, and Aqueduct foundations prior to construction to form a more stable ground mass, such as with jet grouting.

Impact: Settlement due to lowered groundwater level

If the groundwater table is lowered for any reason, it would likely result in consolidation from an increase in effective stress on soft soils, especially the peat. This settlement would impart an increase risk on the existing Mokelumne Aqueducts.

Proposed Mitigation Measures:

Use project construction methods that avoid dewatering near the existing Mokelumne Aqueducts.

5.1.6. Access Roads and Utilities

The DEIR/EIS does not provide details of likely haul routes and utilities necessary for construction of the BDCP Conveyance Tunnels. However, these support facilities will be necessary, and they may have adverse impacts on the existing Mokelumne Aqueducts.

Impact: Damage to existing Mokelumne Aqueducts due to roads crossing or parallel to Mokelumne Aqueducts

Access roads to support construction activities may cross over (or under) the existing Mokelumne Aqueducts. These roads may result in adverse loadings, ground settlement, vibrations, direct impacts, and other unforeseen damages to the Mokelumne Aqueducts.

Proposed Mitigation Measures:

To reduce the potential for damage, layout and design of BDCP Conveyance Tunnels support or access roads need to include consideration of the existing Mokelumne Aqueducts. These evaluations need to include review of the Mokelumne Aqueduct design and conditions at the proposed interface locations.

Impact: Damage to existing Mokelumne Aqueducts due to utilities crossing or parallel to Mokelumne Aqueducts

Utilities such as water and gas lines to support construction activities may cross over (or under) the existing Mokelumne Aqueducts. Construction of these utilities may result in ground settlement, direct impacts, and other unforeseen damages to the Mokelumne Aqueducts.

Proposed Mitigation Measures:

To reduce the potential for damage to the existing Mokelumne Aqueducts, layout and design of BDCP Conveyance Tunnels and support utilities need to include consideration of the location of the existing Mokelumne Aqueducts. These evaluations need to include review of the Mokelumne Aqueduct design and ground conditions at the proposed interface locations and development of appropriate protection methods.

5.1.7. New Transmission Lines

The DEIR/EIS provides limited details of likely electrical transmission line corridors being considered for supplying construction power for the BDCP Conveyance Tunnels (BDCP, 2013; Figure 3-25). The current proposed transmission corridor has a north-south alignment which parallels the BDCP Conveyance Tunnel on Woodward Island. The new transmission lines may have adverse impacts on the existing Mokelumne Aqueducts.

Impact: Tower foundations affect existing Mokelumne Aqueducts

Transmission line foundations located near the existing Mokelumne Aqueducts may adversely impact the Aqueducts from lateral ground movements and settlements.

Proposed Mitigation Measures:

Locate transmission towers far enough from the existing Mokelumne Aqueducts to influence the pile foundations and thus avoid adverse impacts. Design and construct the tower foundations using methods to avoid adverse impacts. During construction use a monitoring program to detect and address ground movement before damages occur.

Impact: Stray electrical currents effecting Mokelumne Aqueducts

Overhead electrical power transmission lines can induce voltages on pipelines that may cause AC induced corrosion (for buried pipeline sections) and create an electrical shock hazard for people, depending on the location of the transmission lines. AC induced corrosion is a significant issue resulting in metal loss on existing buried pipelines. Voltages can also be induced onto both buried pipelines and elevated pipelines similar to existing Mokelumne Aqueducts (containing a grounding system) located in close proximity to electrical power transmission grounding systems. Loss of structural integrity of the overhead transmission line could result in transmission line falling and coming into direct contact with the existing Mokelumne Aqueducts.

Proposed Mitigation Measures:

Mitigation measures can include modelling the steady state induced voltages caused by the electrical power transmission lines to determine the extent of any interference and installation of appropriate protection or correction action if the induced voltages are determined to be above applicable industry standards. Placement of a guard structure, directly located over the existing Mokelumne Aqueducts would prevent falling wires from direct contact with existing aqueducts.

5.2 Effects on Proposed Delta Tunnel and Proposed Mitigation Measures

The impacts of construction of the BDCP Conveyance Tunnels on the proposed EBMUD Delta Tunnel are similar to the impacts identified for the existing Mokelumne Aqueducts. However, in most instances the impacts are more severe do to the closer proximity of the proposed BDCP Conveyance Tunnels to the proposed Delta Tunnel. These impacts result from ground loss, settlement, vibrations, direct interference, and settlement from a lowered groundwater table. The results of these impacts are damage and potentially failure of the pipelines (e.g., carrier pipes) within the proposed EBMUD Delta Tunnel. However, it is likely that these impacts will be more acute due to a close proximity of the tunnels (small vertical separation), sensitivity of the pipelines within the tunnel, and the difficult access to repair damages to the integrity of the pipelines.

In addition, the following impacts and proposed mitigation measures are unique to the conflicts between the BDCP Conveyance Tunnels and EBMUD's Delta Tunnel.

5.2.1. BDCP Tunnels Cross EBMUD ROW

At the location where the proposed BDCP Dual Conveyance Tunnels cross the existing Mokelumne Aqueducts, EBMUD owns the ROW, surface and subsurface rights.

Impact: Disruption of EBMUD water service operations

The primary concern of EBMUD is to avoid damage and service disruption to the EBMUD Delta Tunnel after it is constructed, which would endanger water service to its customers and result in costly repairs. The second concern of EBMUD is to avoid costly measures by EBMUD to prevent direct interference or construction impacts in the event that the BDCP Conveyance Tunnels are constructed first.

Proposed Mitigation Measures: Negotiate ROW agreement

The BDCP Conveyance Tunnels implementing agencies will need to obtain a tunnel ROW agreement with EBMUD in order to gain access to excavate tunnels through the ROW that is proposed to contain the EBMUD Delta Tunnel. EBMUD suggests that this process begin immediately in order for the BDCP Conveyance Tunnels design to include appropriate safeguards as outlined in the impacts and mitigation measures in the sections above and below.

5.2.2. BDCP Conveyance Tunnels and Delta Tunnel Vertical Alignment Interference

The alignments of the BDCP Conveyance Tunnels and the EBMUD Delta Tunnel cross on Woodward Island. Due to each projects design requirements, the vertical depths or alignments of each may impact whether a gravity or pressurized flow operating system is required, the need for a more robust lining system and/or requirements for ground improvement, higher construction cost of a deeper vertical alignment, and/or higher operating costs over the project life cycle. Overall, there are potential impacts to operation and operational costs for each project. Regardless of which tunnel project is constructed first, the BDCP Conveyance Tunnels will need to avoid impacting the design and construction of the EBMUD Delta Tunnel as well as potential long term operational impacts.

Impact: Vertical Position (Elevation) of BDCP Conveyance Tunnels interferes with the Delta Tunnel

The two tunnel systems cannot be located at the same elevation. Additionally, vertical separation and buffer zones will be necessary between the tunnels to avoid adverse impacts on both tunnel systems. A summary of the main concerns follows:

1) The first tunnel project constructed will result in a zone of loosened soil above the tunnel and likely extending to the ground surface. With the second tunnel positioned above the first, this zone of loosened soil will likely make construction of the second tunnel more difficult due to necessary ground control and mitigation of lost ground.
2) With the second tunnel positioned below the first, ground loss and settlement from construction of the second tunnel would adversely impact and endanger the first tunnel from settlement and potential construction irregularities.

Proposed Mitigation Measures:

Require tunnel sequencing, vertical placement, and construction methods to eliminate direct conflict and reduce adverse impacts:

1) The vertical alignment of the BDCP Conveyance Tunnels will need to avoid interference with the vertical alignment of the Delta Tunnel.
2) Coordinate design of both projects such that the deeper tunnel is constructed first. This approach would greatly reduce construction impacts for the second tunnel(s) on the first tunnel(s). Depending on schedules for both projects, it may be beneficial to accelerate construction of the deeper tunnel prior to construction of the shallower tunnel(s) to avoid the most serious adverse impacts.
3) Provide appropriate separation between the two tunnel projects to reduce adverse impacts. The separation distance needs to be addressed during design development of

each project with consideration of ground conditions, construction methods, ground improvement, lining types and designs, and other factors.

4) Use ground improvement such as jet grouting, ground freezing, or alternative methods to stabilize the ground, reducing interference or impacts during construction, and facilitating construction.
5) Use very strict construction controls to reduce ground movements during tunnelling. Measures may include pressurized face tunnelling methods (EPB or slurry), monitoring the rate and volume of ground/muck removal during tunnelling, use of thick pressurized slurry in the TBM annulus/overcut, rapid grouting outside the lining segments after placement, and compensation grouting.
6) Implement ground surface monitoring during construction.
7) Have in place contingency plans in place to address irregularities that may arise during tunnel construction.

Impact: Additional costs for Delta Tunnel construction and operation due to BDCP Conveyance Tunnels

The presence, or future presence, of the BDCP Conveyance Tunnels may result in higher construction costs to EBMUD to avoid interference and/or to use construction methods to avoid adverse impacts and higher operation costs. The measures which may be necessary for EBMUD to implement include but are not limited to the following:

1) Deeper profile position for the Delta Tunnel: This would increase the costs of the shafts, and would make tunneling less efficient due to higher tunneling pressures, and transporting muck and supplies through the deeper shafts.
2) Higher profile position for the Delta Tunnel: This would result in higher risk of damage to the tunnel and pipelines from seismic liquefaction and long term settlements.
3) Ground improvement: It may be necessary to use ground improvement such as grouting or ground freezing to avoid detrimental impacts to the BDCP Conveyance Tunnels.
4) Special tunneling methods: To tunnel below or in the vicinity of the BDCP Conveyance Tunnels it may be necessary to use higher face pressure when tunneling, advance more slowly, controls contact grouting behind the segments, use a more robust segmental lining system, and use additional instrumentation and ground monitoring.
5) Pipeline operations: A deeper tunnel or different tunnel configuration may result in additional operational costs such as higher friction losses, higher pumping costs, and sediment accumulation in the pipelines.

Proposed Mitigation Measures:

Measures to mitigate these costs include the mitigation measures presented above for interference. Mitigation would likely be more efficient if some of the measures were implemented prior to or during construction of the BDCP Conveyance Tunnels, rather than later with construction of the Delta Tunnel. Mitigation also would include compensation to EBMUD for the extra costs incurred to accommodate the Conveyance Tunnels through the EBMUD ROW.

Impact: Stray electrical currents effecting Delta Tunnel

If the BDCP Conveyance Tunnels pipelines have an impressed current cathodic protection system on the steel pipe, the EBMUD Delta Tunnel may be impacted by stray currents flowing onto the pipeline and becoming part of the return path to the source instead of just the surrounding soil. This phenomenon could create anodic metal dissolution (electrolysis) where the stray current leaves the pipeline. The localized corrosion rate can be a significant issue resulting in pipeline failure.

Proposed Mitigation Measures:

Mitigation measures will include determining the potential for electrical current based on the existing soil conditions, utility separation, and tunnel construction materials. Mitigation may consist of electrical isolation between tunnel systems and draining of the collected current by installing appropriate electrical grounding of the EBMUD Delta Tunnel, or addition of active cathodic protection systems on the EBMUD Delta Tunnel.

6.0 REFERENCES

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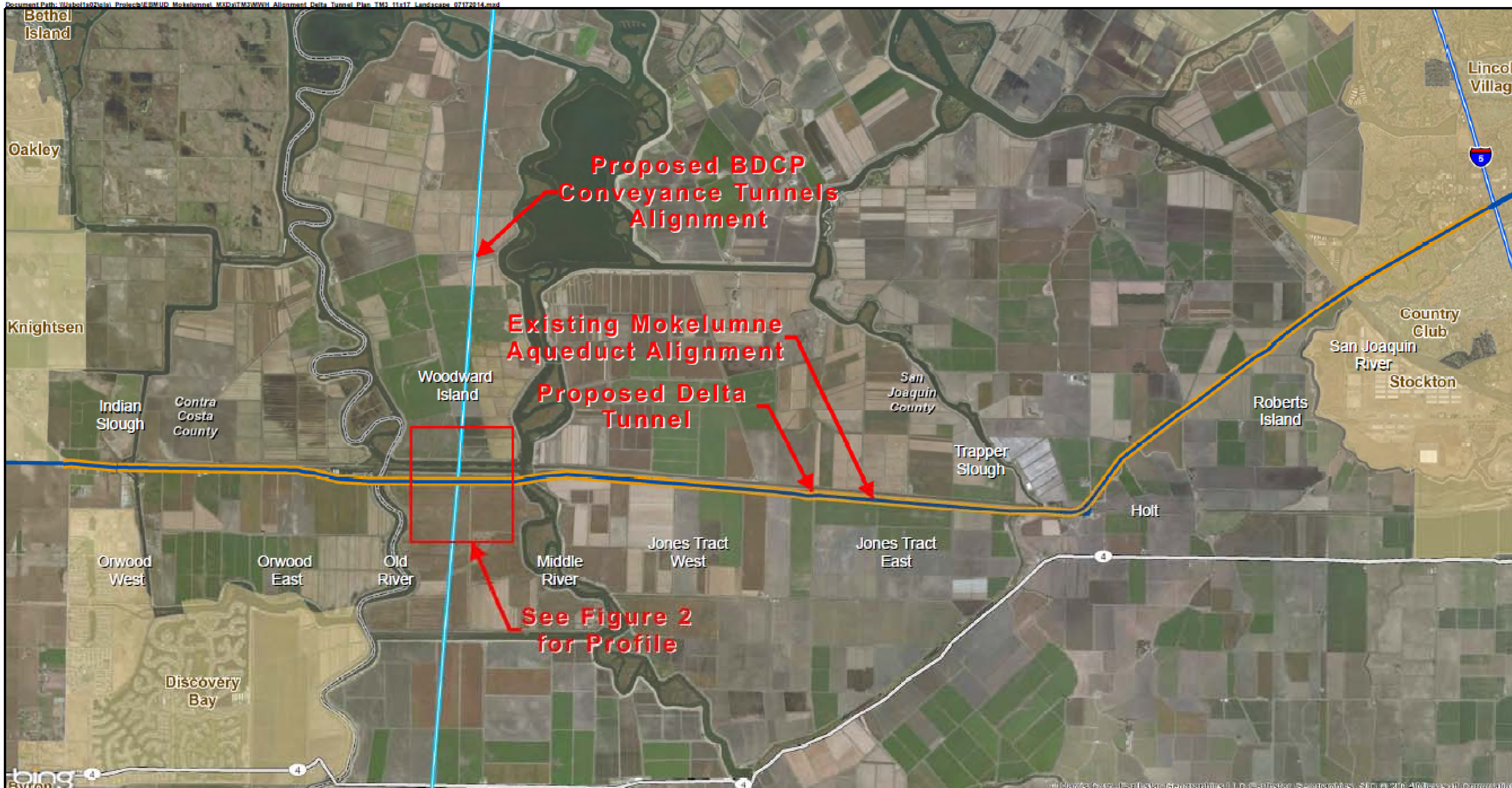
FIGURES



LEGEND

- Proposed Delta Tunnel Alignment
- Existing Mokelumne Aqueduct Alignment
- Approximate Proposed BDCP Alignment
- Interstate
- Highway
- County

Date Saved: 7/16/2014

N W E S

0 1 2
Miles

TITLE: Mokelumne Aqueducts and Delta Tunnel Plan

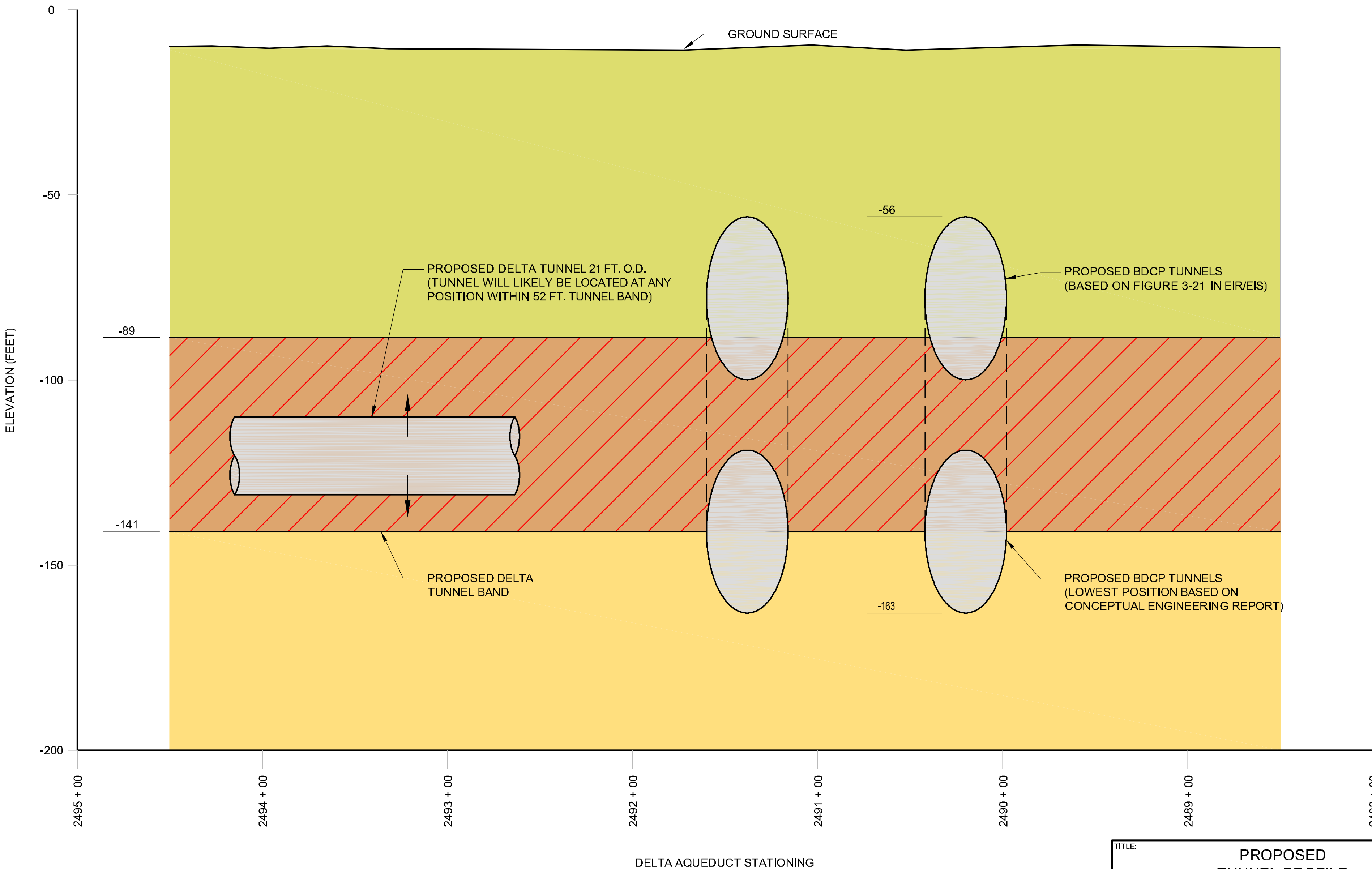
PROJECT: Mokelumne Aqueducts Delta Tunnel Study

DATA REFERENCE(S): Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US

EBMUD MWH

FIGURE 1

D:\pwdirectory jen\dms13808\10504305 Detail Sheet



TITLE:	PROPOSED TUNNEL PROFILE
PROJECT:	Mokelumne Aqueducts Delta Tunnel Study - TM3
DATA REFERENCES:	
EBMUD	MWH
	FIGURE: 2

BDCP1633

Appendix A

EBMUD

Procedure 718

BDC 1633

EFFECTIVE 26 JUL 13

SUPERSEDES 06 FEB 12

LEAD DEPARTMENT O&M

RAW WATER AQUEDUCT RIGHT-OF-WAY NON-AQUEDUCT USES

PURPOSE - To establish procedures and criteria for review and authorization of surface and sub-surface use of District-owned property containing raw water aqueducts and raw water pipelines for purposes other than installation, maintenance, and operation of District raw water aqueducts.

Forms Used

L-14	Limited Land Use Permit
K-47	Work Request Agreement
N-15	Certificate of Public Liability Insurance
N-17	Certificate of Workers' Compensation Insurance
	Application for Use of EBMUD Property or Request for Information
	General Fund Receipts for Miscellaneous Payments

Authority and Responsibility

Use, development, and control of fee-owned rights-of-way for District and non-District uses must be consistent with water supply operation and security and the rights and obligations of the District. District and non-District uses of District-owned aqueduct rights-of-way may be permitted when they conform to Policy 7.01, Aqueduct Rights-of-Way Maintenance.

- No use of District aqueduct properties by others will be permitted as a condition to meet city/county zoning requirements or to obtain any land use permit, approval, or entitlement affecting properties not owned by the District.
- No use of District properties by others will be permitted except under terms of a written agreement.
- Use of raw water aqueduct rights-of-way for District purposes shall have the concurrence of the Aqueduct Section Superintendent.
- Use of aqueduct rights-of-way for District treated water lines shall include all applicable aqueduct protections required for similar third-party utility water line crossings.

For all raw water aqueducts and pipelines, acceptable long-term uses of the rights-of-way include but are not limited to: utility crossings, road crossings, limited agriculture, equestrian and pedestrian trails, parks, oil and gas leases, and District-owned ground water wells. Acceptable, long-term uses of rights-of-way and easements for future raw water aqueducts will be evaluated upon facility completion. Such uses will be authorized by letter, limited land use permits, revocable licenses, leases or easements, as appropriate. All approved uses will conform to the requirements and limitations described in Requirements for Entry or Use of Mokelumne, Lafayette, and Moraga Aqueducts and Raw Water Pipeline Rights-of-Way (Requirements for Entry or Use) (Supplement No.1 to Procedure 718) and all other conditions as specified in the written approval, permit or easement for each individual use.

The Water Supply Division is responsible for monitoring permitted uses and detecting and preventing unauthorized uses of raw water aqueduct rights-of- way. The Office of General Counsel and the Manager of Real Estate Services will be consulted when an unauthorized user will not voluntarily desist.

The Water Supply Division is responsible for coordinating the development of recommendations with respect to the terms and conditions to be stipulated when a District or non-District use of a raw water aqueduct right-of-way is to be permitted.

The Director of Engineering and Construction shall be consulted when needed to supply location analysis or to determine what structural, grading, drainage, corrosion protection or other engineering measures are required and to obtain estimates of engineering, design and inspection costs.

Inquiries and Applications for Use

For all raw water aqueducts and pipelines, applications and inquiries for use of raw water aqueduct rights-of-way shall be processed by the Water Supply Division. Applications for non-District uses will not be processed unless accompanied by the appropriate application fees outlined in Supplement No. 2 to Procedure 718, Fees and Documentation Charges, Use of Aqueduct Rights-of-Way by Others.

The Water Supply Division is responsible for:

- Providing requirements for use of the District's raw water aqueduct rights-of-way to applicants and to other District departments requesting use of the right-of-way. See Supplement No. 1, Requirements for Entry or Use.
- Checking for completeness to ensure compliance with the requirements for entry or use of raw water aqueduct rights-of-way contained in Requirements for Entry or Use plus any other conditions applicable to the proposed use.
- Collecting engineering, plan review and construction inspection costs and documentation of insurance coverage, if necessary.
- Monitoring existing encroachments and inspection of the construction of new approved encroachments.
- Providing information to the Engineering and Construction Department for technical input regarding additional permit requirements or special restrictions that may be applicable (in addition to those outlined in Supplement No. 1, attached) and for update of District raw water aqueduct right-of-way drawings.
- Collecting application fees and charges associated with the preparation and execution of revocable licenses.
- Assuring proper environmental documentation.

Real Estate Services is responsible for:

- Advising the Manager of Water Supply Division of any real estate matters which relate to a specific proposed use.
- Collecting application fees and charges, preparing and executing limited land use permits, leases, easements, and all other property-related agreements (except for revocable licenses and temporary entry permits) and recommending fees and charges appropriate to the property use allowed, and for securing payment. See Supplement No. 2, Fees and Documentation Charges, Use of Aqueduct Rights-of-Way by Others.
- Maintaining records relating to rights-of-way crossings and use, and providing information to the Survey Section and Engineering Services Division for the update of District raw water aqueduct right-of-way drawings.

Types of Permit License or Easement

The Manager of Water Supply Division shall keep available the forms listing the general requirements set forth in Requirements for Entry or Use for each of the following:

<u>Temporary Entry/Temporary Construction Permit</u>

For temporary access to raw water aqueduct right-of-way such as for surveying, potholing, construction, for temporary access via the District's right-of-way to property adjacent to the right-of-way, and other similar short-term situations.

Revocable License and Revocable Landscape License

For pipelines, sewers, storm drains, overhead and underground cables, public trails, landscaping and other crossings or lateral encroachments.

Limited Land Use Permit

Provides for agricultural or other surface use of the right-of-way for a period not to exceed one year (vehicular parking is prohibited). These permits are renewable annually if inspection reveals satisfactory conformance to conditions of permit.

Easement

For streets, highways, large pipelines, canals and railroads, and other permanent publicly owned encroachments. Easements are officially recorded with the county having jurisdiction. The fee or consideration will be significant and based on the value of the property being encumbered.

The Manager of Water Supply Division shall request review of any proposed revisions to application forms and lists of requirements from the Engineering and Construction Department, Real Estate Services Division, Office of General Counsel, and the District's Pipe Committee.

Processing Applications

Temporary Entry Permits

The Manager of Water Supply Division may issue temporary entry permits including standard and temporary conditions relating to the use. The Manager of Real Estate Services and the Office of General Counsel will be consulted regarding unusual circumstances.

Revocable Licenses

The Water Supply Division, if warranted, shall conduct a field investigation to determine requirements for aqueduct protection and, in consultation with the Design Division or the Pipeline Infrastructure Division, will set forth the engineering and operating requirements.

The Manager of Water Supply Division shall then specify any and all requirements, including special conditions to the applicant, discuss the terms and conditions of the license agreement as well as any processing, design and inspection costs and license fee. The Manager of Water Supply Division may then enter into a standard license agreement with relevant special conditions on behalf of the District. The Manager of Real Estate Services and the Office of General Counsel shall be consulted regarding any unusual circumstances.

Copies of all revocable licenses issued by the Water Supply Division shall be provided to the Manager of Real Estate Services.

Limited Land Use Permits

The Manager of Water Supply Division shall convey the District's requirements to the applicant and investigate to determine any special conditions.

Real Estate Services shall prepare the Limited Land Use Permit (Form L-14) in duplicate, including special conditions or stipulations, accompanied by a District-prepared location sketch that will refer to aqueduct stationing and other appropriate location identifiers, including adjacent aqueduct structures.

Engineering and Construction shall prepare the District-prepared location sketch.

After payment of the stipulated consideration determined by Real Estate Services, the Manager of Water Supply Division shall review and execute the permit. These copies are then returned to the Manager of Real Estate Services, together with any stipulated consideration.

Forty-five days before expiration of a Limited Land Use Permit, the Manager of Real Estate Services shall notify the Manager of Water Supply Division, who shall investigate the permittee's operations. If renewal of the permit is recommended, the permit will be renewed by letter from the Manager of Real Estate Services.

Leases and Easements

The Manager of Water Supply Division shall conduct a field investigation to determine requirements for aqueduct protection and, in consultation with the Design Division or Pipeline Infrastructure Division, if necessary, will set forth the engineering and operating requirements.

If structural or corrosion protective facilities are required, the Manager of Water Supply Division shall request the Manager of Design Division or Pipeline Infrastructure Division to proceed with the required design or plan reviews. (During design, the designer will communicate with the applicant's engineer.) Upon completion of design, the plans will be delivered to the applicant via the Manager of Water Supply Division, who will arrange for inspection as required.

The Manager of Real Estate Services shall discuss with the applicant the terms of the agreement and the amount of the consideration, including any processing, design, and inspection costs. Real Estate Services shall obtain an appraisal and engineering estimates, if necessary.

Upon agreement with the applicant, the Manager of Real Estate Services, shall draft, for review and approval by the Water Supply Division and Office of General Counsel, an agreement granting the applicant the property interest under the terms and for the consideration as approved. Real Estate Services shall assure that evidence of insurance is provided, if required. The lease or easement shall be submitted to the District's Board of Directors for approval, if required by Procedure 108. Two copies of the lease or easement shall be sent to the applicant with instructions to sign and return the copies, together with the consideration, to the Manager of Real Estate Services. Easements shall be recorded and the applicant shall provide the Manager of Real Estate Services with the recording data.

Approvals

District uses of the raw water aqueduct right-of-way shall be confirmed in writing listing any special conditions which may apply to the proposed use to the requesting District departments by the Manager of Water Supply Division.

Terminations

If the Water Supply Division terminates any permit or license, the Manager of Real Estate Services and the Design Division shall be so notified by memo.

Appeals

The final determination of the terms and conditions appropriate for District uses of aqueduct properties rests with the Director of Operations and Maintenance.

The final determination of the terms and conditions appropriate for a specific third party applicant rests with the General Manager and the Board of Directors. Appeals by third parties directed to the Board of Directors shall be forwarded to the General Manager for resolution.

Records

The Manager of Real Estate Services shall maintain a file containing copies of all documents relating to right-of-way crossings or uses and is responsible for the assignment of right-of-way crossing numbers to approved documents.

The Engineering Services Division of the Engineering and Construction Department shall maintain working sets of right-of-way prints for each District raw water aqueduct right-of-way. These prints shall be updated following:

1. Grant of Revocable License or Easement. Notice to be supplied by the Manager of Real Estate Services.

2. Completion of crossing construction covered by license or easement. Notice, including “as built” location data, to be supplied by the applicant to the Water Supply Division for transmittal to the Engineering and Construction Department. This notice will be routed through the Engineering and Construction Department., as necessary, then to the Manager of Real Estate Services. After right-of-way tracings are revised, new prints will be released to those having sets.

3. Termination of any raw water aqueduct right-of-way use. Notice to be supplied by the Manager of Real Estate Services.

Revised prints shall be released following all right-of-way drawing revisions.

Requirements and Fees

Requirements for use of raw water aqueduct right-of-way and fees for the processing of applications and documents related to such uses are included in the documents Requirements for Entry or Use and Fees and Documentation Charges, Use of Aqueduct Rights-of-Way by Others, respectively (see Supplement No. 2, attached). The Manager of Water Supply Division is responsible for periodic review and updating of Requirements for Entry or Use. The Manager of Real Estate Services is responsible for review and updating of Fees and Documentation Charges, Use of Aqueduct Rights-of-Way by Others.

References

Policy 7.01 – Aqueduct Rights-of-Way Maintenance
Procedure 108 – Real Estate Transactions
Procedure 436 – Miscellaneous Accounts Receivable and Cash Receipts

Requirements for Entry or Use of Mokelumne, Lafayette, and Moraga Aqueduct and Raw Water Pipeline Rights-of-Way (attached)
Fees and Documentation Charges Use of Aqueduct Rights-Of- Way by Others (attached)
Schedule of Rates and Charges to Customers of the East Bay Municipal Utility District – Real Property Use Application Fees – Resolution 33046-97

BDCP1633

REQUIREMENTS FOR ENTRY OR USE OF MOKELUMNE, LAFAYETTE, AND MORAGA AQUEDUCTS and RAW WATER PIPELINE RIGHTS-OF-WAY

SUPPLEMENT NO. 1 TO PROCEDURE 718

East Bay Municipal Utility District
1804 West Main Street, **Stockton, CA 95203**
(209) 946-8000

1. Requests for encroachment rights or for other uses of the District's raw water aqueduct and pipeline properties shall be directed to the Manager of Water Supply Division, 1804 West Main Street, , Stockton, California 95203. Property uses shall only be permitted subject to appropriate written permit, license, easement, or lease agreement.

2. Requests for property uses shall be in writing and accompanied by a completed application, plan and profile drawings of the area and work involved. District aqueduct stationing and adjacent above-ground structures must be shown. Applicant's horizontal and vertical control must be correlated to the District's. Drawings and maps shall be full size (11x17inch) or half-size (8½ x 11 inch). Application must include complete insurance documentation.

3. The applicant must agree to indemnify and hold harmless the District from any loss, claim, or liability which may arise by reason of applicant's use of District property and may be required to provide insurance coverage.

4. All requests for uses of District property must be consistent with requirements and limitations set forth by Procedure 718 and will be reviewed and approved on a case-by-case basis.

5. District land and facilities shall be restored to a condition as good as that which existed before applicant's entry on the right-of-way.

6. Applicant's use of property shall not increase District costs or interfere with District access, operations, maintenance, or repair of its facilities.

7. The applicant must pay the District the appraised value of the easement or lease, if appropriate, for the rights granted to the applicant. Appropriate environmental documentation must be completed in accordance with the California Environmental Quality Act before the rights can be granted.

8. For any District-approved encroachment, the applicant must pay the District for any of the following measures, as needed:

    a. Design of structural protective measures
    b. Design of fences or other structures
    c. Corrosion control protective measures
    d. District engineering, plan review, and inspection of activities
    e. Environmental documentation
    f. Application, permit or license fees.

9. The plan for the execution of the work must be approved by the District.

10. The type and weight of equipment working over the aqueduct must be approved by the District.

11. The use of vibratory compaction equipment is prohibited on the aqueduct right-of-way unless otherwise approved by EBMUD. Allowable compaction effort, allowable equipment, and maximum depth of each lift of fill shall be subject to District review and approval before start of construction.

12. A minimum of 48 hours notice must be given to the District before work commences. To contact the District by telephone, call: the Aqueduct Section's Stockton Office at (209) 946-8000.

13. A preconstruction meeting is required prior to start of work.

14. No building or portions of buildings shall be constructed on the property. No other types of structures shall be constructed unless specific approval is given by the District.

15. No longitudinal encroachments such as drainage ditches; gas, phone, or electrical lines; pipelines, or roads will be permitted. All property line fences (including footings) must be located completely outside the aqueduct property lines.

16. No pile driving will be allowed within 100 feet of the aqueducts.

17. Railroad, freeway and highway crossings of the aqueduct right-of-way shall be on permanent bridges with a minimum vertical clearance of 14 feet 6 inches between the finished ground surface and the underside of the bridge. Crossings on grade will be over structurally-encased aqueducts with a sleeve for a fourth aqueduct.

18. Street and road crossings constructed on grade shall incorporate protection of the aqueducts. Protective measures will be designed by the District or by applicant’s licensed engineer to District standards with specific District approval of each design.

19. Existing aqueduct protective measures such as concrete slabs shall not be cut, penetrated, or otherwise disturbed. If a protective measure is cut, penetrated, or disturbed, it shall be replaced with a new protective measure, designed by a District engineer or applicant’s licensed engineer to District standards with specific District approval of design.

20. Traffic control fences or approved barriers shall be installed along each side of the street, road or trail before opening to the public.

21. Temporary construction fences and barricades shall be installed by contractor as directed by the District.

22. No geotechnical exploration such as drilling or boring shall be allowed on an Aqueduct right-of-way.

23. Any changes in finished grade must be approved by the Aqueduct Section. Earthfills or cuts on adjacent property shall not encroach onto District property except where authorized for vehicular crossings on grade and where the District determines that there will be no detrimental effect on the aqueducts or their maintenance.

24. Crossings shall be at an angle not less than 45 degrees to the aqueducts and on a constant grade across District property.

25. Sanitary sewers, water lines or petroleum product lines crossing above the aqueducts must be encased in a steel or polyvinyl chloride (PVC), or reinforced concrete pipe conduit or be imbedded in reinforced concrete with a minimum vertical clearance of two (2) feet between the casing/embedment and the top of District aqueducts unless other protective measures are provided.

26. All pipelines crossing below the aqueducts must be encased in a steel or reinforced concrete conduit and provide a minimum of three (3) feet of clearance between the casing and the bottom of the District aqueducts.

27. Trenchless construction methods such as horizontal directional drilling or jack-and-bore between the top of the aqueducts and the bottom of the protective structure (slab) are prohibited.

28. On pressurized pipe crossings, shutoff valves shall be provided outside and adjacent to both sides of District property.

29. At the point of crossing, steel pipeline crossings and steel casings shall incorporate electrolysis test leads, bond leads, and leads necessary for interference testing. Corrosion control devices, when required, must be approved by the District.

30. Cathodic protection for steel encasements must be installed as follows:

- Provide a dielectric coating to the exterior surface of the steel casing within the District's right-of-way, 16 mil epoxy or equivalent.

- Provide galvanic protection to the portion of the steel casing within the District's right-of-way in accordance with the National Association of Corrosion Engineers RP-01-69.

- If the carrier pipe is constructed of ductile iron or steel, provide electrical isolation between the carrier and casing using casing insulators; redwood skids are not permitted.

- Provide test results to the District demonstrating the adequacy of the cathodic protection system, and the adequacy of the electrical isolation of the carrier (if metallic) from the casing. The District reserves the right to witness any such tests.

31. Gravity drainage of District property shall be maintained. Open channels constructed across the right-of-way shall be paved with reinforced concrete. Headwalls, inlets, and other appurtenances shall be located outside District property. Drainage facilities shall be provided outside the District's property at the top and/or toe of fill slopes or cuts constructed adjacent to District property to assure adequate drainage.

32. Overhead electrical power conductors across the property shall be a minimum of 30 feet above ground. Communication and cable TV crossings shall be a minimum of 20 feet above the ground. Supporting poles or towers shall be located outside the aqueduct right-of-way.

33. Buried electrical cables passing over the aqueducts shall be installed in PVC conduit and encased in red concrete across the entire width of the right-of-way. In some cases, PVC-coated steel conduit with a red concrete cap may be substituted. All other buried cables shall be installed in conduits and marked in the appropriate Underground Service Alert (USA) colored marking materials and with surface signs installed at 4-foot intervals that include the utility name, type, and emergency contact information across the entire width of the aqueduct right-of-way. The minimum vertical clearance between the conduit and the top of the District's aqueducts is two (2) feet unless other protective measures are provided.

34. Electrical or telecommunications cables passing under the aqueducts shall be encased in conduit and marked at both edges of the aqueduct right-of-way with the appropriate USA color coded markers. The minimum vertical clearance between the conduit and the bottom of the District's aqueducts is two feet. For directional bored conduits the minimum vertical clearance is five feet.

35. Vehicular parking and storage of equipment or material on aqueduct property are specifically prohibited.

36. Extraction of oil and gas from aqueduct properties may be permitted under appropriate lease agreements.

37. All District survey monuments and markers shall be undisturbed. If any District survey markers or monuments must be disturbed, they will be replaced or relocated by the District at applicant's expense prior to the start of any ground disturbing work.

38. All aqueduct crossings involving mechanical excavation on the right-of-way require potholing of all three aqueducts at the site of the proposed crossing. Visible reference markings showing the aqueduct alignments and depths to top of pipe shall be maintained for the duration of any mechanical excavation on District property. Excavations within two (2) feet of aqueducts shall be made by hand. Entry permits are required for pothole work.

39. All grading or excavating of the right-of-way requires USA notification and the maintenance of a current inquiry identification number.

40. Certified six-sack mix is the minimum acceptable concrete batch to be used on the aqueduct right-of-way. Concrete compression strength shall be 3,000 per square inch (PSI) or better at 28 days. If samples do not reach 3,000 PSI at 28 days, the entire section of slab or encasement related to that sample must be removed and replaced at applicant's expense.

41. Each truckload of concrete to be placed on the aqueduct right-of-way may be sampled by the District. No water may be added to the mix after sampling.

42. Maximum allowable slump is three inches. All concrete exceeding three inches will be rejected and cannot be used on the aqueduct right-of-way.

43. No traffic will be allowed over protective slabs until 3,000 PSI is reached.

44. All work areas shall be inspected by the District for final approval. As-built drawing submittals are required for District approval.

EBMUD

FEES AND DOCUMENTATION CHARGES
USE OF AQUEDUCT RIGHTS-OF-WAY BY OTHERS

SUPPLEMENT NO. 2 TO PROCEDURE 718

TYPE OF DOCUMENT	APPLICATION FEE
Fee Title (Outright purchase of District property)	$2,000
Easement (Rights for permanent use of District property such as access, utilities, etc.)	$1,000
Quitclaim (Removal of District's right, title, and interest to property)	$1,000
Revocable License (Permission to use District property for periods exceeding one year. Subject to revocation)	$500

Revocable License and Application Fees:

Applicant	Application	Property Rights	Total
Government Agencies	May be Waived	$1,000	$1,000
Public Utilities	May be Waived	$1,000	$1,000
Privately Owned Public Utilities (AT&T, PG&E, etc.)	$500	$1,000	$1,500
Developers & other profit-seeking activities	$500	$1,000	$1,500
Private, nonprofit organizations	$500	$1,000	$1,500

Lease (The right to occupy and use District land for a specified time period)	$600
Telecommunication Lease (The right to occupy and use District land for a specified time period)	$2,000
Information Only (Request for information requiring research of District records)	$60/hr
Processing and Review of Watershed Land Use Proposals (Request for District to perform a formal evaluation of watershed land use proposal)	$60/hr ***(Plus all other District costs)***
Property Entry Permits, Rights of Entry, Temporary Construction Permits (Permission for temporary access onto District property)	$100
Limited Land Use Permit (Allows landscaping, gardening, or other minor surface use of District property; subject to annual renewal)	$25

1. In addition to the above charges, applicants will be required to reimburse the District for its costs of engineering, surveying, and inspection of the proposed use of encroachment.

2. Fair market value for property rights conveyed shall also be paid by the applicant, where appropriate including all costs (appraisal, recordation, title report, etc.).

Attachment 4

BDCP Impacts on Freeport Regional Water Project

Attachment 4
BDCP Impacts on Freeport Regional Water Project

This document focusses on three technical areas:

(1) assumed EBMUD diversions via Freeport Regional Water Project (FRWP) as a Central Valley Project North of Delta Municipal and Industrial (CVPNoDM&I) contractor[1];

(2) potential impacts to the ability to operate the FRWP due to reverse flow events[2] on the Sacramento River; and

(3) bypass flow requirements on the Sacramento River that relate to the reverse flow issue.

Summary

- While the assigned EBMUD diversion schedules at Freeport are consistent with the Freeport Project EIR/EIS, the assumed EBMUD diversions that serve as boundary conditions for the Calsim2 model and included in the project alternative and no action scenarios appear to be inconsistent with recent Calsim2 model updates or improvements incorporated into the BDCP modeling. In some cases contract year diversions exceed CVPNoDM&I allocations, some contract year diversions are reduced under *Late Long Term* (LLT) scenarios relative to *Early Long Term* (ELT) scenarios without explanation, and future level-of-development scenarios[3] do not account for the increased frequency of diversions planned for by EBMUD that are consistent with the terms of the District's LTRC with the Central Valley Project.
- Modeling simulations performed with DSM2 by DWR, which have been confirmed by independent DSM2 modeling, show a significant impact to the potential operation of the FRWP due to operation of the BDCP intakes. While ecosystem restoration actions included as part of the project description are shown to mitigate the potential increase in reverse flow events that would adversely impact FRWP, until the restoration component of the project is successfully implemented mitigation is required to reduce the potential impacts to less than significant.
- The proposed bypass flow rules are expected to limit the frequency of reverse flow events on the Sacramento River and, therefore, serve to limit the extent of reverse flow events on the Sacramento River that would impact FRWP operation. Therefore, the proposed bypass flow rules are a key component of the operating rules proposed as part of the project. The extent that the bypass flow rules are expected to constrain actual project operations, the implementation of the bypass rules, and the degree of regulatory oversight with respect to the bypass flow rules, however, is not clear from the project documentation. Clarification and potential assurances related to the proposed bypass flow rules is an important aspect of understanding and limiting potential project impacts to FRWP operation.

[1] As specified by Longterm Renewal Contract Between the United States and East Bay Municipal Utility District Providing for Project Water Service from the American River Division Contract No. 14-06-200-5183A-LTR1.

[2] Reverse flow events considered impactful meet certain reverse flow criterion defined later in this report.

[3] *I.e.* ELT and LLT cases.

Background

This analysis is based upon technical modeling results provided by the California Department of Water Resources (DWR) and used to support BDCP project documentation. The data reviewed include Calsim2 and DSM2 model output in seven modeling scenarios described below. MBK Engineers performed updated Calsim2 modeling that provided the District additional technical information necessary to analyze the BDCP project effects[4]. The MBK analysis is used as supplemental, supporting information in related technical areas.

The focus of this analysis is threefold (1) analyze assumptions related to EBMUD diversions via the FRWP facilities in terms of accuracy and consistency with both the Longterm Renewal Contract (LTRC) and recent planning studies undertaken by EBMUD, (2) to discern the frequency of reverse flow events in each of the model scenarios available, and (3) comment on the proposed bypass flow rules in terms of limiting the likelihood of reverse flow events under project operations.

With respect to the issue of analyzing the accuracy of assumptions concerning the quantity and timing of diversions at the FRWP intake, areas of concern relate to consistency in the annual (contract) year allocation and the overall CVPNoDM&I allocations. Furthermore, the diversion patterns need to be consistent with relevant anticipated diversions as triggered by the LTRC and including the increased frequency of active years of diversion with increasing level-of-development.

A reverse flow event is any event in which water flows up the mainstem of the Sacramento River north towards the City of Sacramento. However, discerning whether a given reverse flow is a potential impact to the operation of the FRWP the following criteria are applied. A reverse flow event is considered to have an impact on operation of FRWP intake if the upstream advective transport during the reverse flow event exceeds a threshold of 0.9 miles, the trigger for an automatic shutdown of the intake. A filter process was run on each model simulation output timeseries of velocity [ft/sec] at the FRWP intake to identify when the upstream advective transport at Freeport during the reverse flow events[5] exceeds 0.9 miles.

Modeling study names and descriptions analyzed are summarized in Table 1, which includes seven scenarios provided by DWR and four scenarios generated from the MBK analysis.

[4] Consultant team with MBK Engineers has been hired by a multi-agency group that includes EBMUD to (1) update the Calsim2 model assumptions based on the best available information, and (2) to simulate *existing* and *BDCP Alt 4* cases with updated assumptions and without climate change effects included to better elucidate potential project benefits and impacts. CCWD staff utilized the Calsim2 results and California Department of Water Resources DSM2 model and set-up for the BDCP to perform refined long-term simulations of hydrodynamics and water quality effects under the various scenarios. Specifically, CCWD performed DSM2 studies for the four model scenarios described briefly in Table 1 (attached). DSM2 model output for each scenario is 15-minute time steps covering January 31, 1921 through September 30, 2003. This output period represents 2,898,433 data points per time series.

[5] *I.e.* when velocity is less than or equal to zero.

Technical Findings and Comments

Freeport Diversions
This section presents the technical findings related to the frequency and magnitude of the EBMUD diversions via the FRWP that serves as a boundary condition for the Calsim2 model. The following analysis is focused on a review of the seven model simulations provided by DWR used to support the project documentation (see Table 1).

- Existing condition scenarios[6] are assumed to be 2005 level-of-development and do not include Freeport diversions. This is a documented assumption in file *Public Draft BDCP EIR-EIS Chapter 5 Appendix 5A - BDCP EIR-EIS Modeling Technical Appendix - Parts A & B.pdf* page 5A-B134[7].

- In all No Action and Project simulations[8], the Freeport diversion schedule is generally consistent (in magnitude and frequency) with the 2020 Freeport diversion schedule[9] from the Freeport EIR/EIS[10]. This is also a documented assumption in *Public Draft BDCP EIR-EIS Chapter 5 Appendix 5A - BDCP EIR-EIS Modeling Technical Appendix - Parts A & B.pdf* page 5A-B134[11].

- For a given scenario *i.e.* No Action *or* Alternative 4 Project cases, Freeport diversions are reduced in the LLT scenario relative to the ELT scenario in a subset of the years that show a diversion (5 years[12] out of 23 active years or 22% in the No Action scenarios, and 4 years[13] out of 23 active years or 17% in the Alternative 4 scenarios). An examination of the CVPNoDM&I percent allocations does not explain the reductions in the diversions[14].

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[6] Simulation EX_ROA0_SPR0_CC0 and EX_No_FallX2_ROA0_SPR0_CC0.
[7] Excerpt, line 18 of the page cited:
Freeport Regional Water Project (FRWP) is not included
[8] Simulations NAA_ELT_ROA0_SLR15_CC5, NAA_LLT_ROA0_SLR45_CC5, NAA_ROA0_SLR0_CC0, ALT4_ELT_ROA25_SLR15_CC5, and ALT4_LLT_ROA65_SLR45_CC5.
[9] EBMUDSIM model archive reference study ID #6336.
[10] Results are generally within round-off tolerance +0.2% accounted for by conversion of 100MGD to 154.7cfs that is rounded to 155cfs in the Calsim2 work.
[11] Excerpt of lines 28-30 of the page cited:
Freeport Regional Water Project (FRWP) is included at full demand (EBMUD CVP contracts and SCWA CVP contract and new appropriative water rights and water acquisitions as modeled in the FRWP EIS/R)
[12] Contract years that are reduced in *LLT* relative to *ELT* under the *No Action* scenarios are 1933, 1934, 1977, 1990, and 1991.
[13] Contract years that are reduced in LLT relative to ELT under the *Alt 4 Project* scenarios are 1933, 1934, 1977, and 1991.
[14] For example, consider the ELT and LLT diversions for contract year 1933 under the *No Action* scenario, the EBMUD diversion at Freeport is 71,958AF in the ELT case and 65,664AF in the LLT case with CVPNoDM&I percent allocations equal to 53% in both the ELT and LLT studies which would allow for an allocation of 133,000AF*0.53=70,490AF. Note that the ELT diversion is approximately 0.2% higher than that computed from the percentage allocation which is explained by the round-off error in the conversion of 100MGD diversion in a month to the cfs equivalent of 154.7cfs rounded to 155cfs. What is unclear, however, is why the diversion is reduced

Furthermore, in one of the cases identified, the reductions that occur in selected contract years under the LLT condition relative to the ELT are not accounted for over the multi-year diversion sequence when the contract limitation constraining the consecutive three-year diversion sum to 165 TAF is in effect[15]. Note in the case of the 1990-1992 sequence, the 165 TAF 3-year contractual constraint is controlling in the ELT allocations leading to a relatively low diversion in year 3[16], but the LLT case reduces the diversion in the second year (1991)[17] and diversions in the third year (1992) are not increased by the amount the second year is reduced[18] such that this contract limitation is still controlling as it should be consistent with the contract provisions as documented[19].

- While the Freeport diversions schedule is consistent with the Freeport EIR/EIS, the diversion assignments in many years are incompatible with the CVPNoDM&I output from Calsim2. This indicates updates or changes to the Calsim2 operating rules from the time of the completion of the Freeport EIR/EIS to the BDCP project. Table 2 shows the breakdown for each simulation. Recall that there are no diversion assignments in the existing conditions. Under the *No Action* scenario roughly 43% of the diversions exceed the CVPNoDM&I percentage allocation. Similarly, in the *Alt4 Project* scenarios 43% and 39% of the diversions exceed the CVPNoDM&I percentage allocations for the ELT and LLT model studies, respectively.

- EBMUD's CVP contract conditions are summarized as footnote 5 in **Table B-19: American River Diversions Assumed in the Existing Conditions and No Action Alternative[20].** The third item listed, "(3) Diversions allowed only when EBMUD total storage drops below 500 TAF" is not fully accurate as stated and needs to be revised as follows, "(3) Diversions allowed only when projected October 1 EBMUD total storage drops below 500 TAF". The key revision to the listed item is the word "projected" to indicate that this is a projected or simulated storage *without* supplemental supplies that is used to trigger both supplemental supplies as well as the District's drought management program[21]. Also, the storage threshold applies to a specific date of the year, October 1[22]. As written, the criteria could be

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to *less than* that of the calculated value based on the 53% allocation under the LLT condition *i.e.* why is the diversion reduced to a 49% allocation for the LLT simulation when the CVPNoDM&I allocation is 53%?

[15] Where BDCP documentation clearly lists this contract provision as a modeled constraint of the Calsim2 study, see file *Public Draft BDCP EIR-EIS Chapter 5 Appendix 5A - BDCP EIR-EIS Modeling Technical Appendix - Parts A & B.pdf* page 5A-B137, where the last five lines of the table are referencing footnote "\5" of the table that presents the contractual limitations governing this specific CVP contractor where listed item (2) is excerpted as:

(2) 165 TAF maximum diversion amount over any 3 year period

[16] *I.e.* roughly 20TAF in 1992.

[17] *I.e.* from 78,192AF to 75,177AF for the respective ELT and LLT simulations under the *No Action* scenario and from 78,192AF to 68,679AF for the respective ELT and LLT simulations under the *ALT4 Project* scenario.

[18] *I.e.* roughly 4TAF in the no action case and about 10TAF in the action case

[19] See footnote 15.

[20] *Ibid*.

[21] For more information on the District's drought management program, the reader is referred to Chapter 3 of the UWMP 2010 available online at: http://www.ebmud.com/water-and-wastewater/water-supply/urban-water-management-plan, last accessed April 24th 2014.

[22] In practice where a monthly model is utilized, the end-of-September storage is used to represent the October 1 storage criteria.

misinterpreted to apply in any month of the year in which total storage drops below the 500 TAF threshold, and that is clearly inconsistent with the contract[23].

- As EBMUD demand increases at future levels-of-development, more years become eligible under the criteria defined by the District's LTRC as more years have projected end-of-September total system storage projected to be less than 500 TAF. The frequency of contract years with active diversions increases from roughly 22% to 34% from 2005 to 2040 level-of-development. Approximately 10 additional years show active diversions in 2040 compared to 2005 for the 1921 through 2003 hydrology[24]. Furthermore, the frequency is expected to increase beyond 2040 with growing customer demand. The Freeport diversion schedule utilized in both No Action and Alternative 4 Project scenarios is consistent with the 2020 Freeport diversion schedule and is, therefore, appropriate for use in the ELT studies; however, this diversion schedule is not accurate in terms of frequency and magnitude of diversions in the LLT studies. The increased frequency of diversions and the magnitude of the contract year diversions is non-negligible and could have a significant effect on Calsim2 results that is cascading to the other model studies that tier off of the Calsim2 results which could potentially affect the impacts assessment.

Reverse Flows
This section presents the technical analysis findings with respect to the reverse flows impacting FRWP operations. The analysis is based upon the DSM2 modeling output provided by DWR to EBMUD. Additional analysis using modeling performed by MBK Engineers and CCWD is also utilized to further clarify the potential effects of the proposed project.

- DWR DSM2 model output was provided for each of the seven simulations listed in Table 1. Model results provided spanned October 1, 1974 through September 20 1991 on 15-minute intervals. Table 3 presents the number of reverse flow events with advective transport exceeding 0.9 miles that would cause a shutdown of FRWP for each of the seven DWR model simulations. Figure 1 shows the number of reverse flow events per year over the hydrologic period simulated.

  Based on the results, reverse flow events generally increased over the planning horizon from the existing case without restoration (30) to the no action ELT case (70) increasing further still for the no action LLT (178). Among these three runs, the main factor changing is the anticipated effects of climate change represented by changes to the hydrology and sea level

[23] For precise language of the contract, see §3(a)(1) page 12, lines 253-254 of Longterm Renewal Contract Between the United States and East Bay Municipal Utility District Providing for Project Water Service from the American River Division Contract No. 14-06-200-5183A-LTR1 abbreviated throughout this report as the Longterm Renewal Contract or LTRC.
[24] For example, under 2005LOD with customer demand set to 214MGD, projected end-of-September total system storage (EOSTSS) is >500TAF in 1947. However, under 2040LOD with customer demand set to 230MGD, the projected EOSTSS drops below the 500TAF threshold and, therefore, becomes an eligible year for supplemental supplies under the CVP contract via the FRWP facilities. Note also that 1947 is generally a high allocation year where the CVPNoDM&I allocation is on the order of 70% (varying from 66% to 75% depending on the model study). A 70% allocation of 133TAF would result in a potential diversion of 93TAF which is clearly a non-negligible diversion that could potentially affect the modeling results and, therefore, the impacts assessment.

rise that clearly increases the frequency of impactful reverse flow events.

The Alternative 4 Project scenario, which includes the new facilities and the restoration action, significantly reduces the instances of the reverse flow events. For example, comparing the No Action ELT and Alternative 4 ELT simulations, the number of reverse flow instances impacting the Freeport operation are reduced from 70 instances to 14 instances and for the LLT scenarios the No Action cases shows 178 instances which are reduced to 21 instances under the Alternative 4 Project simulation. However, for the simulations provided by DWR, the project runs include both the new infrastructure and the restoration and, therefore, these two components of the project cannot be analyzed in isolation to determine their relative effect of either component on the reverse flow metric.

- Additional modeling performed by CCWD simulated the full hydrologic period that was simulated with Calsim2[25]. This modeling provided additional clarifying information regarding the effect of the two components of the project isolating the effect of restoration. Four DSM2 model simulations were analyzed as described in Table 1. The number of reverse flow events for the full 83-year period of record and shorter 19-year period that would result in a shutdown of FRWA are presented in Table 4. The distribution of the number of reverse flow events per year is plotted in Figure 2.

  When comparing the Base Case without restoration, essentially representing a No Action Scenario without climate change, to the Action Case, which includes the new facilities and the restoration, a significant reduction from 203 to 55 reverse flows instances is obtained for the hydrologic period of 1921 through 2003 and 55 to 12 instances when limited to the 19 years of hydrology[26] (see Table 4). Note however that the effect of the 25,000-acre restoration—consistent with the ELT scenario from the DWR modeling—is isolated by performing a Base Case and Action Case simulation with and without the restoration. With respect to the Base Case, the restoration reduces the number of reverse flow instances that would shut down the FRWP intake from 203 to 49 for 1921 through 2003 hydrology and from 55 to 11 cases for the shorter period spanning 1972 through 1991. With respect to the Action Case, 237 reverse flow instances that would shut down the FRWP intake are identified for the 1921 through 2003 hydrology which drops to 55 instances when the 25,000-acres of restoration are included. For the shorter period of hydrology from 1972 through 1991, the number of reverse flow instances that would shut down the FRWP intake drops from 64 without restoration included to 12 instances when the restoration is included. Thus, if restoration is not included in the Base Case, there are 203 reverse flow instances that would shut down the FRWP intake, increasing to 237 instances under the Action Case without restoration for 1921 through 2003 hydrology. For the shorter 19-year period of hydrology from 1972 through 1991, the Base Case shows 55 instances of reverse flows that would shut down the FRWP intake, increasing to 64 instances under the Action Case when the restoration is not included. **In conclusion, the results show a potential impact of the BDCP intakes on the FRWP, and the impact is mitigated by the proposed restoration.**

[25] *I.e.* January 31, 1921 2400hrs to September 30, 2003 2400hrs.
[26] *I.e.* 1972 through 1991.

However, until the restoration projects are effectively implemented, the BDCP intakes would have an adverse impact on the FRWP.

- Table B-9 DSM2 Inputs page 5A-B73 reports that the period simulated is a 16-year period 1976 through 1991. This represents a shortened hydrologic period simulated relative to the Calsim2 model that simulates an 83-year period from 1921 through 2003. The shortened 16-year period covers the two main drought periods[27]; however, this shorter 16-year period is skewed towards drier year types (see Figure 3). On the basis of the Sacramento Valley Water Year Hydrologic Classification, the Dry and Critical year types are the most frequent (at 56%) relative to Wet, Above Normal, and Below Normal year types (44%) in the 1976 through 1992 period. For the longer period of hydrology simulated with Calsim2, the wetter year types (*i.e.* Wet, Above Normal, and Below Normal) account for 66% of the 83-year period whereas the Dry and Critical year types account for 37%. While reverse flow events are expected to occur in the drier year types which are over-represented in the shorter 16-year period, the purpose of the impacts analysis is to discern the impact of the proposed project as compared to the no project or no action. Considering that the project effects are greatest in the wetter year types when regulatory constraints on the system are less restrictive to project operations, the approach of simulating a shorter period that is relatively dry means that the impacts analysis is based on a period in which the project operation is more constrained. Furthermore, since DSM2 boundary conditions are available for the full 83-year period of record, the reason to limit the DSM2 model to a shorter and drier hydrologic period seems arbitrary. Simulating a longer hydrologic period with more variation in hydrologic conditions seems more appropriate to base the analysis of potential impacts of the proposed project.

Bypass Flow Criteria

Bypass rules are presented and described in Appendix 5A[28]. The bypass rules are described as proposed rules, "which govern the amount of water required to remain in the river before any diversion can occur. Bypass rules are designed with the intent to avoid increased upstream tidal transport from downstream channels, …". These bypass rules are a key basis of the operating rules governing the project operations particularly in the context of the reverse flow issue on the Sacramento River. It is unclear whether these operating rules are intended to govern the actual operation of the proposed project once constructed. Are the proposed rules considered guidelines for the operation of the project or are they considered strict operating constraints that will be implemented as part of the project? Will the proposed bypass rules be incorporated into the operating permit(s) for the project? What is the process or procedure for changes to the proposed rules and what regulatory agencies if any are involved with monitoring and enforcement of the bypass rules? In order to have confidence that the project will not have additional impacts on FRWP, the bypass flow criteria need to be adopted as strict operating rules.

[27] The 1976-1977 drought and five years of the six-year 1987-1992 drought

[28] See file *Public Draft BDCP EIR-EIS Chapter 5 Appendix 5A - BDCP EIR-EIS Modeling Technical Appendix - Parts A & B.pdf* pages 5A-A21 and 5A-A22; also 5A-B26 and 5A-B27.

Table 1: BDCP DSMII Model Scenarios with Description†.

Study Name	Description
Modeling Studies Generated by DWR Supporting the Public Project Documentation	
EX_ROA0_SLR0_CC0	Existing conditions with Fall X2 requirement; no sea level rise, no climate change, and no restoration
EX_No_FallX2_ROA0_SLR0_CC0	Existing conditions without Fall X2 requirement; no sea level rise, no climate change, and no restoration
NAA_ELT_ROA0_SLR15_CC5	No action/no project alternative representing ~2025 case no restoration sea level rise of 15cm and corresponding climate change
NAA_LLT_ROA0_SLR45_CC5	No action/no project alternative representing ~2060 case no restoration sea level rise of 45cm and corresponding climate change
NAA_ROA0_SLR0_CC0	General no action alternative: no restoration, no sea level rise, no climate change
ALT4_ELT_ROA25_SLR15_CC5	Action case representing ~2025 case with project completed: 25,000 acres of tidal marsh restoration completed, sea level rise of 15cm and corresponding climate change
ALT4_LLT_ROA65_SLR45_CC5	Action case representing ~2060 case with project completed: 65,000 acres of tidal marsh restoration completed, sea level rise of 45cm and corresponding climate change
Modeling Studies Generated by the MBK Analysis	
MBK_FutBase_CC0_SLR0	Updated baseline using existing SWP/CVP conveyance; no climate change; no sea level rise; no tidal marsh
MBK_FutBase_CC0_SLR0_ROA25	Same as MBK_FutBase_CC0_SLR0 with the additional 25,000 acres of tidal marsh as defined in the BDCP models for the Early Long Term (ELT). • To isolate the effect of tidal marsh restoration in the current system of SWP/CVP conveyance, compare this run to MBK_FutBase_CC0_SLR0.
MBK_BDCP_ALT4_CC0_SLR0_ROA0	BDCP Alt 4, operational scenario H3 (aka the Evaluated Starting Operations, or ESO); no climate change; no sea level rise; no tidal marsh. • To isolate the effect of the new conveyance system/operations if no tidal marsh is constructed, compare this run to MBK_FutBase_CC0_SLR0.
MBK_BDCP_ALT4_CC0_SLR0_ROA25	BDCP Alt 4, operational scenario H3 (aka the Evaluated Starting Operations, or ESO); no climate change; no sea level rise; with the 25,000 acres of tidal marsh as defined in the BDCP models for the Early Long Term (ELT) • To isolate the effect of the new conveyance system/operations assuming the full 25,000 acres of tidal marsh is constructed as assumed in the modeling, compare this run to MBK_FutBase_CC0_SLR0_ROA25. • To isolate the effect of tidal marsh restoration under the new conveyance system/operations, compare this run to MBK_BDCP_ALT4_CC0_SLR0_ROA0. • To see the combined effect of the new conveyance system/operations and the 25,000 acres of tidal marsh, compare this run to MBK_FutBase_CC0_SLR0. Note: this is the type of comparison that is done in the BDCP EIR/S (*i.e.* total effect of new conveyance plus assumed tidal marsh).

† Developed by D. Sereno (CCWD) where output folders provided include DSM2 output from Hydro and Qual where the latter output contains electrical conductivity (EC), a surrogate for salinity as well as fingerprinting results. Input time series for all scenarios were developed by MBK Engineers using Calsim2.

Table 2: Cross Comparison of Central Valley Project North of Delta Municipal & Industrial (CVPNoDM&I) Percentage Allocations with Assigned EBMUD Contract Year Diversion.

	Model Simulation ID						
	EX_ROA0_SLR0_CC0	EX_No_FallX2_ROA0_SLR0_CC0	NAA_ELT_ROA0_SLR15_CC5	NAA_LLT_ROA0_SLR45_CC5	NAA_ROA0_SLR0_CC0	ALT4_ELT_ROA25_SLR15_CC5	ALT4_LLT_ROA65_SLR45_CC5
Number of Years Contract Allocation is ≤ CVPNoDM&I percent Allocation	0	0	13	13	16	13	14
Number of Years Contract Allocation is > CVPNoDM&I percent Allocation	0	0	10	10	7	10	9
Total Number of Contract Years with Non-Zero Diversion Allocation	0	0	23	23	23	23	23

Table 3: Reverse Flow Events with Advective Transport Exceeding 0.9 Miles for DWR Modeling Studies, 1974-1991 Hydrology.

Model Study	Brief Description	Number of Events
EX_ROA0_SLR0_CC0	Existing Case, Includes Fall X2	25
EX_No_FallX2_ROA0_SLR0_CC0	Existing Case, No Fall X2	30
NAA_ELT_ROA0_SLR15_CC5	No Action Case, Early	70
NAA_LLT_ROA0_SLR45_CC5	No Action Case, Late	178
NAA_ROA0_SLR0_CC0	No Action Case, General	22
ALT4_ELT_ROA25_SLR15_CC5	Action Case, Early	14
ALT4_LLT_ROA65_SLR45_CC5	Action Case, Late	21

Table 4: **Reverse Flow Events with Advective Transport Exceeding 0.9 Miles for MBK Modeling Studies, 1921-2003 Hydrology and 1974-1991 Hydrology.**

Model Study	Brief Description	Number of Events 1921-2003 Hydrology	Number of Events 1974-1991 Hydrology
MBK_FutBase_CC0_SLR0	Base Case	203	55
MBK_BDCP_ALT4_CC0_SLR0_ROA0	Action Case	237	64
MBK_FutBase_CC0_SLR0_ROA25	Base Case with Restoration	49	11
MBK_BDCP_ALT4_CC0_SLR0_ROA25	Action Case with Restoration	55	12

Figure 1: **Reverse Flow Events per Year with Advective Transport Exceeding 0.9 Miles for DWR Modeling Studies, 1974-1991 Hydrology.**

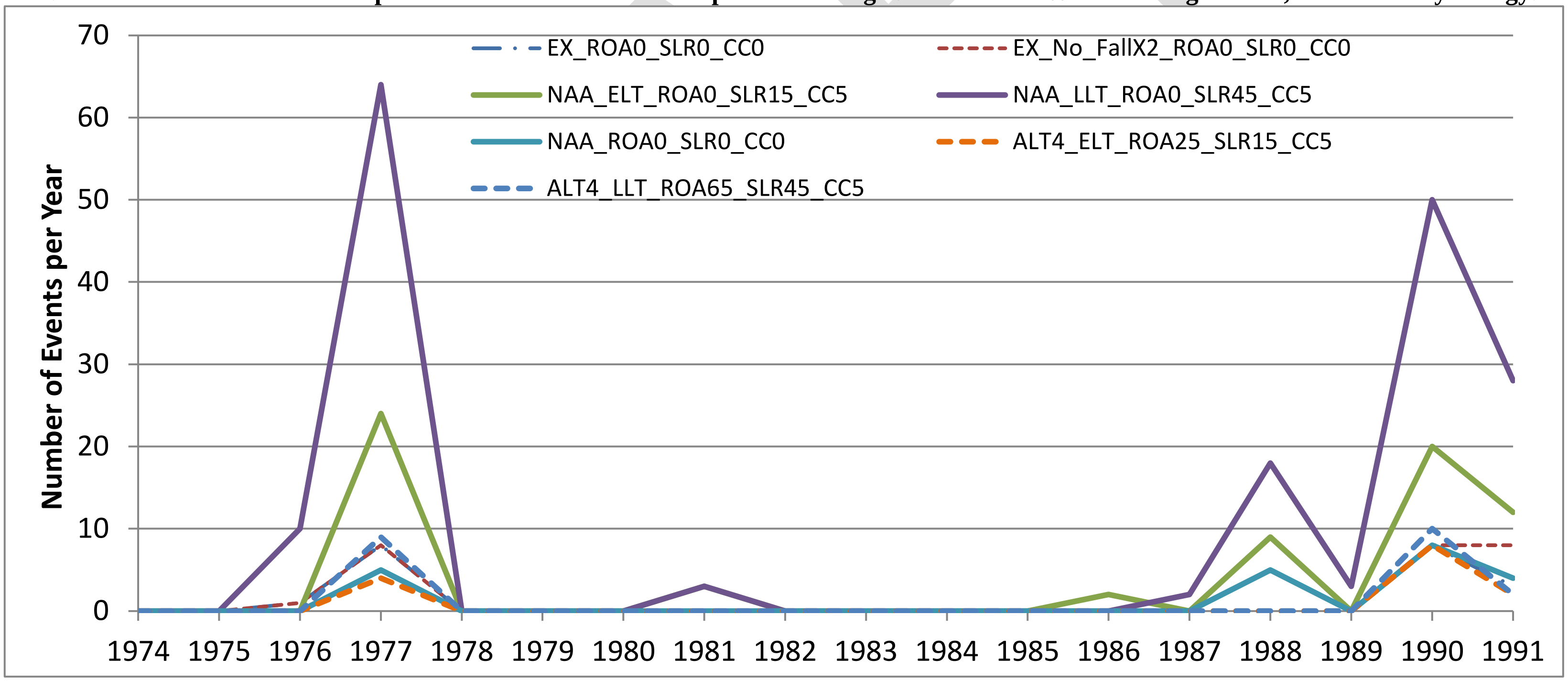

Figure 2: Reverse Flow Incidents per Year with Advective Transport Exceeding 0.9 Miles for MBK Modeling Studies, 1921-2003 Hydrology.

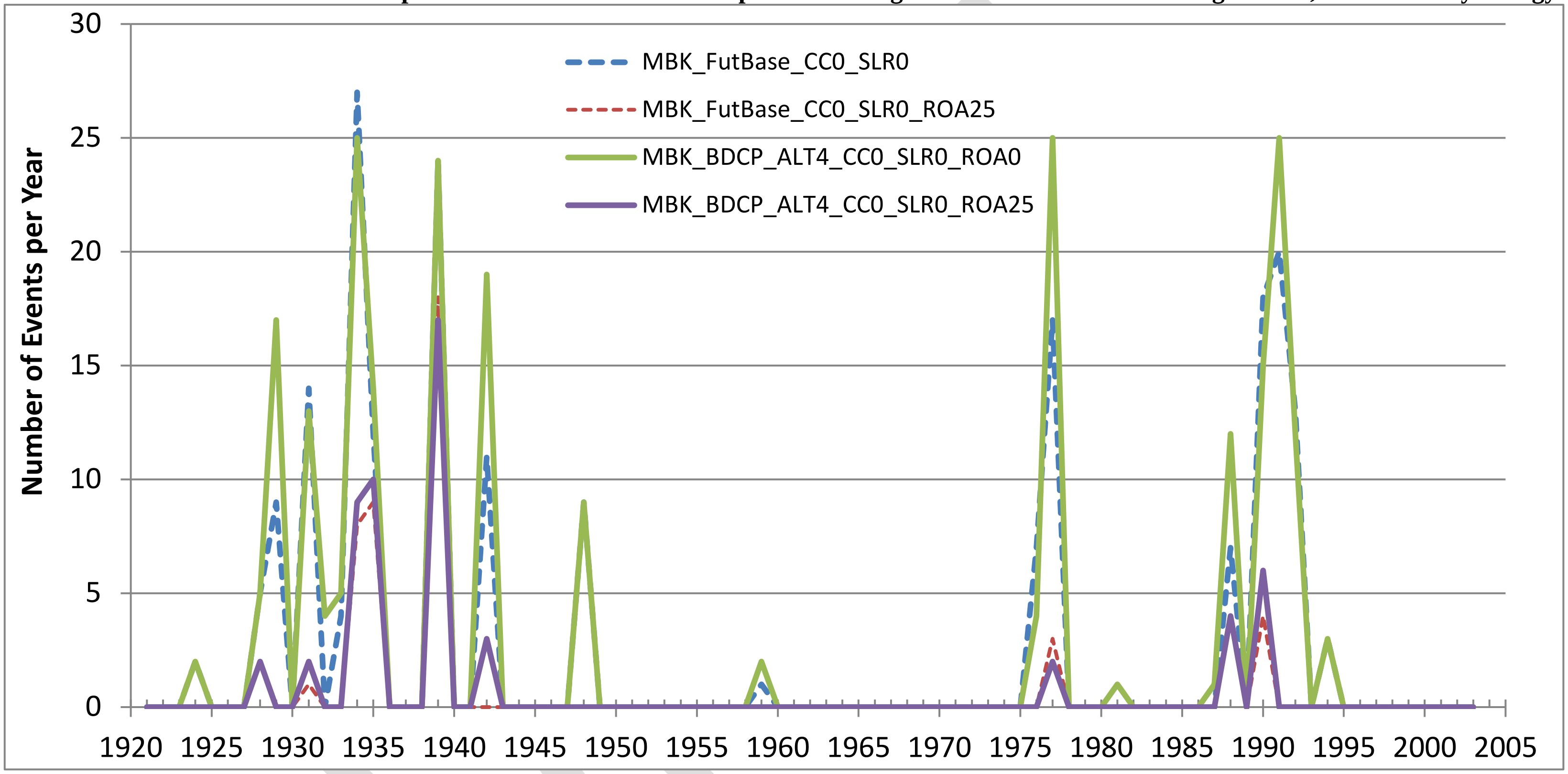

Figure 3: **Sacramento Valley Water Year Hydrologic Classification Frequency for Calsim2 Hydrologic Period (1921-2003, 83 years) with DSM2 Hydrologic Period (1976-1991, 16 years).**