-----Original Message-----
From: Los Vaqueros [mailto:lvstudies@hotmail.com]
Sent: Tue 4/21/2009 5:07 PM
To: Andrea Nocito
Subject: FW: LV Expansion DIES/EIR comments

_____

To: lvstudies@hotmail.com
Subject: LV Expansion DIES/EIR comments
From: AFate@cd.cccounty.us
Date: Tue, 21 Apr 2009 16:58:12 -0700

Hi Marguerite -

Attached please find comments from the East Contra Costa County Habitat Conservancy.

Abby

****
Abigail Fateman
Contra Costa County
Department of Conservation and Development
651 Pine Street
4th Floor, North Wing
Martinez, CA 94553
(925) 335-1272
(925) 335-1299 (fax)

April 21, 2009

EAST CONTRA COSTA COUNTY HABITAT CONSERVANCY

City of Brentwood

City of Clayton

City of Oakley

City of Pittsburg

Contra Costa County

Marguerite Naillon
Special Projects Manager
Contra Costa Water District
P.O. Box H2O
Concord, CA 94524
Attn: Los Vaqueros Reservoir Expansion Project DEIS/EIR

Re: Los Vaqueros Resrvoir Expansion Draft EIS/EIR

Dear Ms. Naillon:

The East Contra Costa County Habitat Conservancy (ECCCHC) appreciates the opportunity to respond to the Draft Environmental Impact Report (DEIR) for the proposed Los Vaqueros Reservoir Expansion. The ECCCHC is a Joint Exercise of Powers Authority formed by the Cities of Brentwood, Clayton, Oakley and Pittsburg and Contra Costa County to implement key conservation measures of the East Contra Costa County Habitat Conservation Plan / Natural Community Conservation Plan (HCP/NCCP or Plan). The HCP/NCCP is intended to provide an effective framework to protect and restore natural resources in eastern Contra Costa County, while improving and streamlining the environmental permitting process for impacts on endangered species. The Plan sets forth requirements for land acquisition, habitat restoration and habitat enhancement and management to benefit species and natural communities. The HCP/NCCP inventory area is located in the eastern portion of Contra Costa County and includes areas that will be impacted by the proposed reservoir expansion.

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The ECCCHC is cooperating with the East Bay Regional Park District (EBRPD) in their acquisition of a 190-acre property located at 6100 Armstrong Road (Property) adjacent to the Byron Airport Habitat Management Lands (See Figure A: Local Vicinity Map). EBRPD entered into a Purchase and Sale Agreement for the Property on March 8, 2008 and EBRPD and the ECCCHC have executed an agreement for cooperating in EBRPD's purchase of the Property. EBRPD intends to assume title to the Property by June 30, 2009. The Property will become part of the HCP/NCCP Preserve System.

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The Property is being purchased for existing on-site biological resources as well for its potential to support a significant wetland restoration project. The North Fork of Brushy Creek runs across the property. There are also a number of wetlands on site (a delineation of existing wetlands has been performed and is available upon request). The ECCCHC and EBRPD have developed detailed constructions plans and specifications for the restoration of wetlands and parts of the creek on the northern part of the Property (See Figure B: Restoration Project Overview.) With the cooperation of the ECCCHC, EBRPD intends to solicit bids and award a construction contract for this project in summer of 2009.

Los Vaqueros Expansion, Draft Environmental Impact Report
April 21, 2009
Page 2 of 2

The Draft EIS/EIR identifies Armstrong Road as the proposed alignment for a potential new Transfer-Bethany Pipeline that would be constructed under Alternatives 1 and 2 in the DEIR. Wetland and wildlife resources exist on both sides of the Armstrong Road in this area. The Property lies on the west side of Armstrong Road and existing wetland resources are located immediately adjacent to the road where a berm protects the road from flooding. The creek and wetland restoration project planned for construction this summer on the Property will have features located throughout the property, but the greatest concentration of restored features will be located along the lowest part of the Property, the eastern edge adjacent to Armstrong Road. The Byron Airport Habitat Management Lands on the eastside of the road contains a number of restored and preserved wetland features, including a linear pond feature which parallels Armstrong Road on the east. Impacts to existing and planned wetland resources in this vicinity should be avoided and minimized. Any impacts that cannot be avoided and minimized should be fully mitigated. | 3

We would be happy to discuss this potential conflict with the Contra Costa Water District and other concerned parties to explore opportunities for avoiding and minimizing impacts to resources on the Property.

Thank you for you consideration of these comments.

Sincerely,

John Kopchik
Executive Director
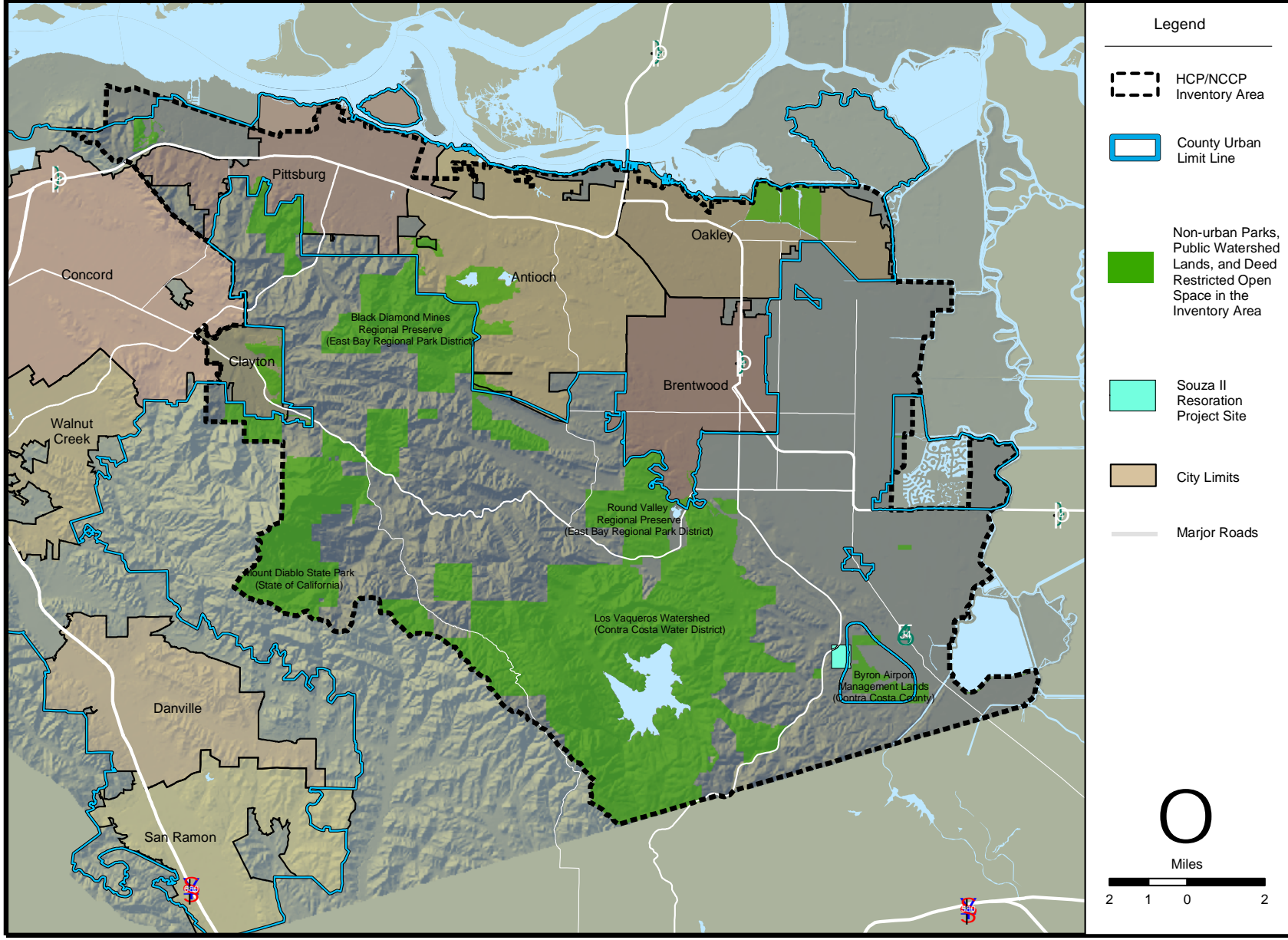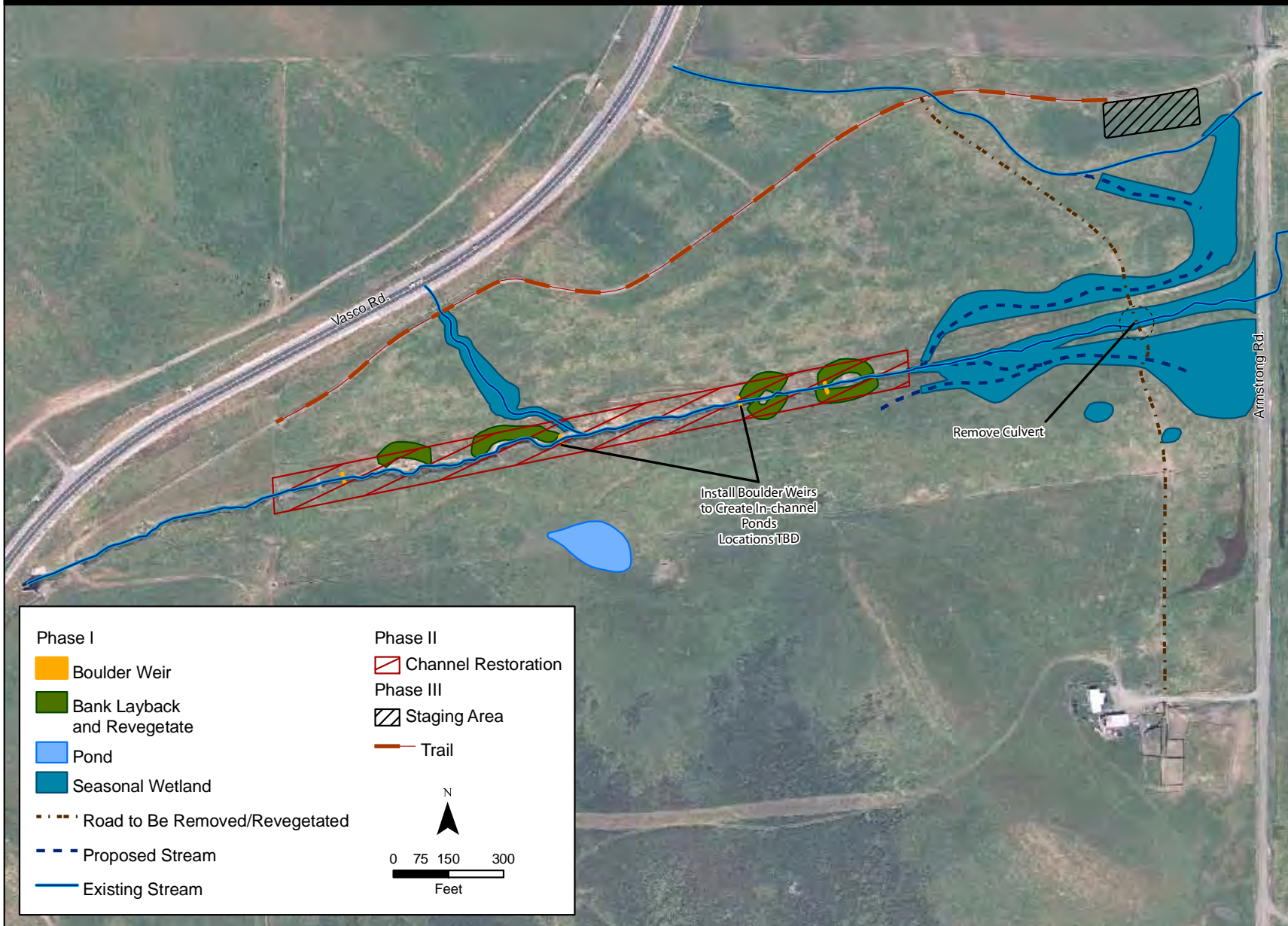
Figure A. 6100 Armstrong Road, Byron CA Vicinity Map

Legend

- - - HCP/NCCP Inventory Area

County Urban Limit Line

Non-urban Parks, Public Watershed Lands, and Deed Restricted Open Space in the Inventory Area

Souza II Resoration Project Site

City Limits

Marjor Roads

Figure B. Restoration Project Overview

Install Boulder Weirs
to Create In-channel
Ponds
Locations TBD

Remove Culvert

Vasco Rd.

Armstrong Rd.

Phase I

Boulder Weir

Bank Layback
and Revegetate

Pond

Seasonal Wetland

Road to Be Removed/Revegetated

Proposed Stream

Existing Stream

Phase II

Channel Restoration

Phase III

Staging Area

Trail

N

0   75 150   300
Feet

_____

Subject: Los Vaqueros EIR
Date: Mon, 20 Apr 2009 09:07:05 -0700
From: Craig_Murray@ci.richmond.ca.us
To: wmoore@mp.usbr.gov
CC: axharris@sbcglobal.net; lvstudies@hotmail.com

Louis Moore
Bureau of Reclamation
2800 Cottage Way, MP-700
Sacramento CA 95825

In regards to expanding the subject Reservoir over two and a half times its current size, please find
comments below:

*   Develop bicycle and trail access from the south visitor area to the north visitor area;
*   Develop a paved multi-use path that is open to the public;
*   Consider placing lights and benches and tables for visiting public;
*   Develop bicycle-able connections to neighboring parks;
*   Develop Reservoir with Green features

1

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Regards,

= Craig K. Murray =

Craig K. Murray, SR/WA

Development Project Manager II

Richmond Community Redevelopment Agency

1401 Marina Way South

Richmond, CA 94804

Bus: (510) 307-8140

Direct: (510) 621-1262

Fax: (510) 307-8149

Craig_Murray@ci.richmond.ca.us

_____

Windows LiveT: Life without walls. Check it out.
<http://windowslive.com/explore?ocid=TXT_TAGLM_WL_allup_1b_explore_042009>

P.O. Box 262
1540 Discovery Bay Blvd., Ste. "A"
Discovery Bay, CA 94514

Office: 925-634-2351
Fax: 925-634-2089
Web: www.rd800.org

RECEIVED

MAY 07 2009

ASST.GEN.MGR.

Greg Gartrell   May 5, 2009
Assistant General Manager
Contra Costa Water District
P.O. Box H20
Concord, CA 94524-2099

Re: Los Vaqueros Expansion Project – Comments on Draft Environmental Impact Report

Dear Mr. Gartrell:

For the past fifteen years, Reclamation District No. 800 (Byron Tract) (RD 800) has enjoyed a very cooperative agreement with Contra Costa Water District (CCWD), which has benefited both of our districts and all of the residents of Contra Costa County. In the spirit of that cooperative relationship, our District very much appreciates the opportunity to comment on the Draft Environmental Impact Report for the expansion of Los Vaquerous Reservoir (Draft EIR) and we have the following comments.

As I mentioned above, RD 800 and CCWD have had a very cooperative agreement over the past fifteen years. Because of that relationship, RD 800 assumes that any work that CCWD may need to undertake within the boundaries of RD 800 will be treated as if it were subject to our 1994 agreement. That agreement, as you know, generally requires that CCWD facilities built on land held by RD 800 to meet our District's construction standards and not interfere with our District's operations. Moreover, in the event that CCWD's construction activities, operational activities, or maintenance activities have an adverse effect on or create liability for RD 800 or its residents/landowners, the 1994 agreement requires CCWD to repair the damage or otherwise make RD 800 or its residents/landowners whole for the damage or adverse effects. RD 800 proposes that all of the activities that are part of the Los Vaqueros expansion project be subject to these assurances, which would be memorialized by another amendment to the 1994 agreement.   1

RD 800's engineers, Kjeldsen, Sinnock and Neudeck, Inc., have reviewed the Draft EIR and have a number of technical comments, which are attached to this comment letter and incorporated herein by reference.

Thank you again for the opportunity to comment on the Draft EIR. Please feel free to call if you have any questions regarding these comments.

We look forward to the completion of the project and the continuation of the cooperative relationship between RD 800 and CCWD.

Very truly yours,

Jeffrey D. Conway
District Manager

cc: Board of Trustees

995393.2

KJELDSEN, SINNOCK & NEUDECK, INC.
CIVIL ENGINEERS AND LAND SURVEYORS

STEPHEN K. SINNOCK
CHRISTOPHER H. NEUDECK

KENNETH L. KJELDSEN
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711 NORTH PERSHING AVENUE
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TELEPHONE (209) 946-0268
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E-MAIL ksn@ksninc.com

0855-0420i
04-001

April 9, 2009

Mr. David Aladjem
Downey Brand
621 Capitol Mall, 18th Floor
Sacramento, CA 95814

>   Re: Review of the Draft EIR/EIS, February 2009, for the
>   Los Vaqueros Reservoir Expansion Project
>   Reclamation District 800 – Byron Tract

Dear Mr. Aladjem:

On behalf of RD 800, KSN has performed a review of the referenced Draft EIR/EIS. A list of technical comments and/or concerns is as follows:

- **Impact 4.2.1 – Deliveries of Water to Other Users**: The EIR/EIS acknowledges that "each of the alternatives would alter the quantity, location, and timing of water diversions from the Delta to varying degrees" and states that the "analysis addresses the potential for these changes to affect deliveries of water to other users". However, it appears that the EIR/EIS only addresses changes to Central Valley Project (CVP) and State Water Project (SWP) annual exports. It does not include effects on agricultural diversions to local Delta farmers nor to the water borne community of Discovery Bay. Furthermore, the EIR/EIS does not clearly provide information regarding proposed CCWD diversions from the Old River (existing and new) and AIP pump stations and compare them with current levels. Specifically, it would be useful to know the total annual export volume, timing of exports throughout the year, and maximum flow rates from the above-mentioned pump stations for both the proposed and current conditions in order to fully understand the effects on water deliveries to other users.

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- **Impacts 4.2.2 & 4.2.3 – Changes to Delta Water Quality**: Table 4.2-16 of the EIR/EIS is intended to "present the number of days of standards violations in the Existing and Future Without Project conditions, and the changes in the number of days that standards could be violated under the project alternatives". However, it is unclear as to exactly what the listed days represent. Do the listed days refer to the number of days per year that a standards violation will occur? If so, most of the listed days exceed the number of days in a year. Furthermore, many of the listed changes from existing condition appear to be significant (up to a 12% change), contrary to the text which states that "statistical analysis confirms that no statistically significant changes exist in the numbers of potential violations". Additional clarification regarding Table 4.2-16 needs to be provided. Also, the EIR/EIS does not address impacts to water quality at the tidal bays and interior lake

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Page 2

circulation waters of Discovery Bay. These waters are extremely sensitive to any sort of degradation of water quality due to the lack of any natural inflow and the sole reliance on tidal flows to flush out these waters.

- **Impact 4.2.4 – Delta Water Levels**: The EIR/EIS states that "Delta water users have a substantial interest in maintaining Delta water levels so that their siphons and pumps, installed at fixed elevations, can continue to divert water onto Delta islands for agricultural irrigation". According to Table 4.2-19, it appears that maximum water level decreases are generally less than 0.1' with the exception of Alternative No. 3. A larger water level decrease as indicated with Alternative No. 3 could conceivably lead to devastating results for a farmer if the decrease occurred in the middle of a watering cycle and disrupted the operability of the siphon. Further information regarding quantities and timing of CCWD diversions would be useful in order to fully understand the effects on Delta water levels (see comments to Impact 4.2.1).

- **Impact 4.5.6 – Risks Associated with Dam Failure**: The EIR/EIS states that "Contra Costa County has prepared a current emergency evacuation plan that reflects the inundation scenario associated with the existing facility" and that "this inundation map would be updated and submitted as part of the design process". However, the potential flooding of an urban area such as Discovery Bay in the event of a dam failure is a significant impact which merits careful analysis and mitigation at this point in the planning process. The EIR/EIS needs to include a plan of the probable path that floodwaters will flow in the event of a dam failure along with a discussion of structural protective measures (e.g. additional levees) that may be required to contain floodwaters and protect populated areas. An updated inundation map and emergency evacuation plan needs to be developed now in order to identify necessary mitigation measures.

- **Impact 4.5.6 – Risks Associated with Levee Failure**: The EIR/EIS states that "a new setback levee would be constructed" and "construction activities for the new intake… would not be initiated until after completion of the setback levee". It goes on to state that "CCWD would be required to design and construct levee modifications with input and approval of RD 800". RD 800 acknowledges that the EIR/EIS adequately emphasizes the importance of not interfering with RD 800 flood protection operations. Also, RD 800 expects that CCWD will adhere to the same ongoing mitigation strategy that has been in place since 1994 as impacts to RD 800 facilities continue to be addressed.

- **Impact 4.8.1 – Temporary Impacts to Farmland**: The EIR/EIS states that CCWD will "ensure that the existing drainage systems at proposed project sites needed for farming activities function as necessary to avoid disrupting agriculture". Near the locations of the existing and proposed Old River pump stations are drainage facilities that serve the majority of Byron Tract and not just farming activities solely. RD 800 would like the EIR/EIS to emphasize the importance of not interfering with any of RD 800 drainage operations. Also, RD 800 expects that CCWD will adhere to the same ongoing mitigation strategy that has been in place since 1994 as impacts to RD 800 facilities continue to be addressed.
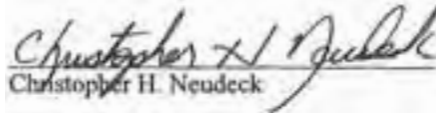
In summary, the main concern of RD 800 is the lack of information detailing the projected total volumes, timing, and maximum flow rates of CCWD diversions from Old River

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April 9, 2009
Page 3

and comparing them to current conditions. Without this information, it is difficult to fully
understand and determine the adverse effects that the Los Vaqueros Reservoir Expansion Project
will have on beneficial Delta uses.

Sincerely,
KJELDSEN, SINNOCK & NEUDECK, INC.

Christopher H. Neudeck

cc. Jeffrey D. Conway, gen. mgr

From: Diane Moore [mailto:DMoore@valleywater.org]
Sent: Tuesday, April 21, 2009 9:53 AM
To: 'lvstudies@hotmail.com'
Cc: Marguerite Naillon; 'wmoore@mp.usbr.gov'; Kellye Kennedy; Sandy Oblonsky
Subject: Comment Letter on LVE Draft EIS/EIR

Dear Ms. Naillon and Mr. Moore:
Enclosed please find the Santa Clara Valley Water District's Comment Letter on the LVE Draft
EIS/EIR.
A hard copy will be sent to each of you in addition to the electronic document.
If you have any questions, please contact Kellye Kennedy at (916) 447-1534 or (408) 202-2561.

Sincerely,

Diane Moore
Project Coordinator
Santa Clara Valley Water District
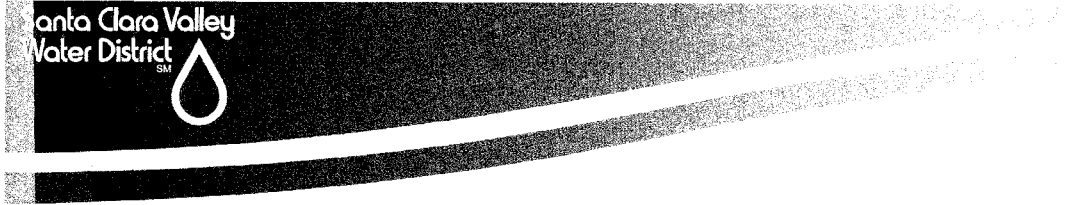
anta Clara Valley
Water District SM

April 21, 2009

Marguerite Naillon
Contra Costa Water District
P.O. Box H2O
Concord, CA 94524

Louis Moore
Bureau of Reclamation
2800 Cottage Way, MP-700
Sacramento, CA 95825-1898

Subject: Los Vaqueros Reservoir Expansion Project Draft Environmental Impact
Statement/Environmental Impact Report

Dear Ms. Naillon and Mr. Moore:

The Santa Clara Valley Water District (District) thanks you for this opportunity to provide comments on the subject Draft Environment Impact Statement/Environmental Impact Report (Draft EIS/EIR). The District is identified as one of three South Bay water agencies who may benefit from the Los Vaqueros Expansion Project (LVE Project) Project through improved water supply reliability and water quality. The Draft EIS/EIR states that the evaluation of benefits of this report is intended to provide information to potential project participants. After our review of the document we are concerned that the estimated fishery and water supply reliability benefits may be overstated and believe that the Draft EIS/EIR is deficient because it does not include an evaluation of the Los Vaqueros Expansion Project (LVE Project) within the context of current and developing understanding of Delta risk factors (e.g. seismicity), nor does it contemplate any relationship to the Bay-Delta Conservation Plan (BDCP) and Delta Habitat Conservation and Conveyance Plan (DHCCP) processes. Our comments related to these issues and others are as follows:

1. Fishery Benefits or "Environmental Water"

It is our understanding that fishery benefits are achieved when State Water Project (SWP) supplies are delivered to the SBA contractors through Banks Pumping Plant under no project conditions, but, with the project, would instead be diverted through Contra Costa Water District's (CCWD) positive-barrier fish screens. The Central Valley Project (CVP) and State Water Project (SWP) Delta export pumping would be reduced correspondingly. CCWD estimates 100

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Page 1 of 7

to 150 TAF per year of water would qualify as "environmental water" under Alternative 1. Dedicated storage for environmental water is an additional component under Alternative 2. This is storage to be used for delta fish protection, refuge delivery, in-stream flows, or other environmental purposes. We question the actual benefit to fish by diverting SBA deliveries through the LVE facilities instead of Banks Pumping Plant.

Since the State and Federal pumps will already be constrained by Old and Middle River (OMR) flow restrictions imposed by the biological opinions, it would seem the actual benefits would be minimal. Because the maximum State and Federal pumping limits will already correspond to a level that the U.S. Fish and Wildlife Service and the National Marine Fishery Service consider safe for covered species, it is unlikely that further reduction in pumping provided by the LVE Project would provide significant added benefits.

Page 4.3-89 through 4.3-94: According to the particle tracking analysis, there is very little change in percent entrainment for particles released at most locations in the Delta when comparing the with and without project alternatives. At a particular point strongly subject to the influence of CCWD and SWP and CVP pumps (Middle River at Empire Cut) Table 4.3-23 indicates that entrainment under alternatives may be reduced by up to 10% for buoyant, passively drifting particles in the spring. It appears that this reduction is at least partially due to the assumption that a portion of the particles do not pass through CCWD's Old River and AIP screens (see pg. C7-38, screen exclusion efficiency calculation); however, this method does not determine the ultimate fate of the larvae that are not entrained in the AIP intake. These excluded larvae could be impinged or entrained in other diversion facilities, reducing the anticipated benefits of the project. The EIR/EIS does not address this issue.

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The analysis of reduction in entrainment index associated with the alternatives (see Table 4.3-22 and Appendix C-7) appears to exaggerate the percent reduction because it does not compare the reduction to entrainment caused by total CVP and SWP pumping, but instead limits the comparison to CCWD pumping and CVP and SWP pumping for SBA contractors only (see pg 4.3-88). The analysis should compare the reduction in entrainment index associated with the alternatives relative to the total entrainment of both CCWD and total CVP and SWP pumping without the proposed project. Doing this would result in substantially lower and potentially insignificant reductions and would be a more accurate representation of the potential benefits provided.

Appendix C: As indicated on page C3-13 and Tables C4-3, C4-8, C4-13, and C4-18, additional water diverted for environmental purposes under Alternative 2 would take place in a manner similar to water diverted to restore Delta supply to SBA contractors (described below). About the same increase in pumping (20 thousand acre-feet (TAF)/month, or 330 cubic feet per second (cfs)) would occur during periods of restricted OMR flow, and, as discussed below, these diversion will likely impact the CVP and SWP's ability to meet OMR flow constraints. Diversions at the SWP and CVP pumps could be reduced to compensate for CCWD's increased diversions. This would constitute an impact on the SWP and CVP, and on the District as a contractor of both projects.

2. Water Supply Reliability Benefits

In the Draft EIS/EIR, CCWD envisions that direct diversions and additional water supplies stored in an expanded Los Vaqueros Reservoir would partially restore delivery reductions to the SBA contractors that are occurring due to regulatory restrictions at the SWP and CVP Delta export pumps. This would be water over and above what CCWD is estimating would be delivered to the SBA contractors in the absence of the project and constitutes about 20 TAF/yr (see Table 4.2-4). This water is anticipated to be supplied through additional diversions during Delta "excess" conditions for either direct delivery or for storage in Los Vaqueros Reservoir for later release (page C3-13). These additional diversions are also anticipated to increase CCWD's deliveries by about 3 TAF per year during extended droughts.

Our review of the modeling analysis in Appendix C shows that CCWD's analysis assumes that CCWD is not subject to Old and Middle River ("OMR") flow constraints imposed annually from December through June by the USFWS biological opinion. That is, when limits are set on reverse OMR flows that constrain pumping at Banks and Jones pumping plants, CCWD assumes it can divert water without consideration of these OMR constraints. Tables C4-3, C4-8, C4-13, and C4-18 show that under both Alternatives 1 and 2, additional diversions of approximately 20 TAF per month, totaling approximately triple those under the no-project scenario, occur December through June and are presumed to be unconstrained by restrictions placed on OMR reverse flows during this period. We believe this assumption is problematic. CCWD's diversions from the Old River and Victoria Canal intakes will contribute to OMR reverse flows; consequently, any increase in CCWD's diversions when OMR reverse flows are restricted could result in an impact to the SWP and CVP. The existing biological opinion currently limits OMR reverse flow to -1250 to -5000 cfs from December through June; CCWD's estimated increase in diversions of approximately 20 TAF per month corresponds to an increased diversion rate of 330 cfs, which is substantial when compared to these flow restrictions.

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CCWD contemplates diversion of water under its Los Vaqueros water rights as well as diversion of water under its CVP contract. CCWD's water rights for Los Vaqueros Reservoir are junior to the SWP and CVP rights; the EIS/EIR states that "CCWD's separate Los Vaqueros water rights are subject to permit terms and conditions to ensure they do not adversely affect the CVP and SWP operations under the water rights held by Reclamation and DWR." (Page 4.2-9). If indeed CCWD were allowed the diversions projected in the EIR/EIS during periods of OMR restriction, there is a substantial risk that diversions at the SWP and CVP pumps would be reduced to compensate for those diversions. We believe this would constitute an impact on the SWP and CVP.

3. Dry year storage and increased emergency water storage

We understand that an expanded Los Vaqueros Reservoir is anticipated to provide additional water to SBA contractors and CCWD during dry years and would help these agencies to ameliorate shortages caused by natural disasters and other emergencies. CCWD's modeling results indicate that approximately 60% of its increased diversions under Alternatives 1 and 2 would occur when OMR flow restrictions apply. As explained in the prior paragraph, we find this assumption problematic. Therefore, we believe the quantity of additional water that could be stored, and consequently provide dry year and/or emergency water benefits, is likely overestimated.

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4. Impact analysis (p. 4.2-43 through 4.2-54) is insufficient:

The evaluation of whether project alternatives would adversely alter deliveries of water to other users is based on a comparison of CALSIM model results to "no project" conditions.

a. The analysis bases its evaluation of impacts to SWP and CVP exports on a comparison of average annual total exports in various hydrologic year types, which is consistent with the limitations of the CALSIM modeling tool. However, the impact of additional diversions under Alternatives 1 and 2 will be felt most keenly during periods when OMR flows are restricted. For instance, diversions for the LVE project of approximately 300 cfs, as modeled, could result in significant reductions in SWP and CVP exports when OMR flows are moderately to severely restricted. Water diverted into the LVE project would be pulled from Victoria Canal, which draws directly from Middle River, and also from Old River-Diversions for the LVE project could very well increase reverse flows on Old and Middle Rivers. Consequently, there is a risk that those reverse flow increases would need to be offset by reductions in SWP and CVP pumping to satisfy OMR restrictions. If this occurs during a hot June, for instance, when San Luis Reservoir is being drawn down at its maximum rate and exports are insufficient to meet immediate demands for water, a reduction in SWP and CVP pumping caused by CCWD diversions would be a significant impact, even if more water were exported later in the year such that the total amount of water pumped over the course of the year is unaffected. The point here is that a simple comparison of total annual exports is insufficient to evaluate the real impacts of this proposed project on other water users. The document should provide a discussion of how actual CVP and SWP real-time operational decision-making could be affected by the proposed project, preferably through consultation with DWR and CVP project operators.

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b. Many of the comparisons in Tables 4.2-9 through 4.2-14 show *increases* in CVP and SWP exports over no-project conditions; this is strange, given that the CVP and SWP exports shown in Tables 4.2-9 through 4.2-14 do not include "delta supply restoration" deliveries to SBA contractors in Alternative 1. The EIS/EIR states that deliveries increase under the alternatives but does not evaluate how this could possibly be the case. Alternatives 1 and 2

divert more water from the delta for CCWD's proposed project – how could this translate into increased annual exports by the CVP and SWP? The lack of both explanation and apparent rationale for this result suggests that the CALSIM model may be overestimating CVP or SWP deliveries under the alternatives, or that the percent change from existing conditions estimated by the model is within the range of model error. Please provide some explanation for these values.

c. Table 4.2-12 indicates that annual CVP exports could be decreased by approximately 18.5 TAF in below-normal years under 2005 level of development (LOD) if Alternatives 1 and 2 are implemented. Notwithstanding our concerns about the accuracy of these CALSIM results, an 18.5 TAF reduction in below normal years is substantial, particularly if this occurs during a multi-year drought. Similarly, annual SWP exports are projected to drop 21.7 TAF under the 2030 LOD under severe fishery restrictions for Alternative 1 (Table 4.2-12). Again, this is a significant and unacceptable reduction in below-normal years.

5. Impact analysis of project alternatives on Old and Middle River reverse flows is inadequate.

On page 4.3-85, the EIS/EIR states that project alternatives "could cause small positive and negative changes in the net flow. The changes attributable to the project alternatives are generally very small, rarely greater than 200 cfs." However, as shown on Tables 4.3-20 and 4.3-21, the OMR flow values shown are long-term monthly averages; the use of long term averages masks large impacts in individual months and years and hydrologic year types. The analysis should provide the maximum reverse flows and frequencies as well as increases in reverse flows by year type. Even with the dampening effect of long-term averages, an increase in reverse flows of nearly 200 cfs constitutes an increase in reverse flows of nearly 90% in May (2005 LOD). Looking at percentage increase above the baseline, other substantial increases in reverse flows can be seen in Tables 4.3-20 and 4.3-21 (approximately 40% increase in March under moderate fishery restrictions, 50% increase in May under 2030 LOD severe restrictions, and 20% increase in March under 2030 LOD with moderate restrictions, to name a few examples). On page 4.3-85, the EIS/EIR concludes that these increases in reverse flows are insignificant on the basis of a comparison to maximum approach velocities at fish screens to avoid entrainment of delta smelt. This comparison seems inappropriate because it compares the effect of increasing reverse flows (larger is worse for fish) to required flows moving (typically downstream) across fish screens (larger is better for fish). The rationale for this comparison is unclear.

The impact of the project alternatives on OMR flows is relevant in that the State and Federal project operators will likely respond to those impacts by reducing exports to SWP and CVP contractors during periods when OMR reverse flow restrictions are limiting exports. For example, an increase in reverse flows of -200 cfs in a month could result in a commensurate decrease in SWP or CVP exports of 200 cfs, or a water cost of 12,000 acre-feet. This is a

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substantial amount of water, particularly in drier years when every acre-foot of water is both valuable and scarce. The EIS/EIR does not convincingly evaluate the proposed project's potential for significantly impacting the water supply of SWP and CVP contractors.

6. Coordination with the BDCP and DHCCP

We recommend evaluating an LVE Project in coordination with the BDCP and DHCCP planning efforts and in addition, evaluating a new LVE Project alternative that could be integrated with potential outcomes and facilities now under investigation in the BDCP and DHCCP planning efforts. The Draft EIS/EIR implies that the BDCP was not included in the cumulative impact analysis because it does not meet the criteria of a "reasonably and foreseeable" project. While that may be the case for the Draft EIS/EIR, it is reasonable to assume that the development of the BDCP will be far enough along that it should be analyzed and included in the final LVE Project EIS/EIR.

The BDCP is a planning and environmental permitting process being conducted pursuant to the Endangered Species Act and is expected to result it take permits for the SWP and CVP as part of a comprehensive habitat conservation/natural communities conservation plan. The LVE Project as described in the Draft EIS/EIR will require very closely coordinated operations with both the SWP and CVP. It's imperative that the decision makers for the LVE Project understand how this project will work in coordination with the BDCP and such information is not included in the EIS/EIR.

7. Specific Comments on the Executive Summary

Page ES-2, 3rd paragraph: The sentence about the advisory vote is misleading. There's no mention of the constraints imposed by the ballot measure (though they are appropriately included later on page ES-7).

Page ES-3, 2nd bullet under Purpose & Need: It's not "insufficient quantities of water"; it's "insufficient access to available water supplies in the system" that's been more of a problem in recent years. There have been significant limitations in the amount of water able to be pumped by the SWP/CVP over the last two years because of operating constraints imposed by the Endangered Species Act.

Page ES-7, Last sentence: We agree that the LVE Project planning and potential implementation is independent of Delta Vision planning efforts; however, we disagree with the statement that decisions on how to proceed with an LVE Project are not tied to the implementation of the Delta Vision Strategic Plan. The District, one of the local agencies identified as a potential participant, is considering the BDCP in our decision making process and believe Reclamation, DWR and the other SBA Contractors are doing the same. This paragraph should be modified to reflect how the LVE Project will be coordinated with the parallel planning efforts of the Delta Vision Strategic Plan and BDCP.

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Page ES-31, "Delta Sustainability": The last sentence states that the LVE Project can be coordinated with the long-term (Delta) solutions as they are developed. As previously stated, we believe the BDCP and other efforts underway need to be recognized as reasonably foreseeable solutions and the document should describe and analyze how these efforts would be coordinated.

9 Cont.

In conclusion, we request CCWD and Reclamation redo the modeling analysis to address the concerns expressed in this letter. We continue to have many questions regarding the operations, financial feasibility of the LVE Project and the proposed cost allocation but understand that these issues are being addressed in the draft feasibility report scheduled to be available for public review later this year. We encourage Reclamation and CCWD to coordinate closely with the District and other CVP and SWP Contractors in their financial assessments of the proposed LVE Project.

10

Again, thank you for this opportunity to provide comments on the Draft EIS/EIR and we look forward to further discussions of these issues in the near future.

Sincerely,

Sandy Oblonsky
Assistant Officer
Office of Water Utility Enterprise Planning

Cc: Zone 7 Water Agency, Attn: Kurt Arends; Alameda County Water District, Attn: Eric Cartwright

Bcc: G. Zlotnick, J. Maher, C. Kao, F. Brewster; A. Fowler, B. Cabral, E. Cote

------ Forwarded Message
From: Los Vaqueros <lvstudies@hotmail.com>
Date: Tue, 21 Apr 2009 13:10:58 -0700
To: Andrea Nocito <a.nocito@circlepoint.com>
Conversation: Comments on the Draft EIS/EIR SRCSD
Subject: FW: Comments on the Draft EIS/EIR SRCSD

Subject: Comments on the Draft EIS/EIR SRCSD
Date: Tue, 21 Apr 2009 11:57:27 -0700
From: brennanv@sacsewer.com
To: lvstudies@hotmail.com
CC: wmoore@mp.usbr.gov

Attached is a comment letter from the Sacramento Regional County Sanitation District on the Draft EIS/EIR for the Los Vaqueros Reservoir Expansion Project. Please contact me if you have questions or desire more information.

Vicki Brennan
Secretary to Stan Dean
Policy and Planning Group
Sacramento Regional County Sanitation District
Sacramento Area Sewer District
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SRCSD

Wastewater Treatment

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Stan R. Dean
Plant Manager

Wendell H. Kido
District Manager

Marcia Maurer
Chief Financial Officer

April 21, 2009

Marguerite Naillon, Special Projects Manager
Contra Costa Water District
Attn: Los Vaqueros Reservoir Expansion Project DEIS/EIR
P.O. Box H2O
Concord, CA 94524

Subject: Comments in Response to the Draft Environmental Impact Statement and Environmental Impact Report for the Los Vaqueros Reservoir Expansion Project

Dear Ms. Naillon:

Sacramento Regional County Sanitation District (SRCSD) appreciates the opportunity to offer comments on the Draft Environmental Impact Statement/Environmental Impact Report (Draft EIS/EIR) prepared to evaluate the environmental impacts of expansion of Los Vaqueros Reservoir (Los Vaqueros Expansion Project). The expansion project and the associated environmental evaluation are of interest to SRCSD.

SRCSD provides wastewater collection and treatment services to 1.3 million residents of the greater Sacramento area. SRCSD designed and operates its treatment system in accordance with its National Pollutant Discharge Elimination System (NPDES) permit, issued by the State of California, providing protection of beneficial uses of the Sacramento River and Sacramento-San Joaquin Delta. We are very concerned with sustainability of the Delta and believe that any changes to the hydrology of the Delta must carefully evaluate environmental impacts of those changes to ensure a healthy ecosystem. SRCSD's comments relate to the cumulative impacts analysis of the Draft EIS/EIR and the water quality related impacts of diverting additional water on the fisheries and aquatic resources of Old River and the Delta.

The Draft EIS/EIR analyzes the cumulative water quality impacts to which the Project may contribute by considering "a list of reasonably foreseeable future projects and actions affecting Future Without Project conditions." (Draft EIS/EIR at p. 4.1-5.) The list of reasonably foreseeable future projects, however, does not include either SRCSD's 2020 Master Plan, which calls for improvement and expansion of the Sacramento Regional Wastewater Treatment Plant (SRWTP), or the Bay Delta Conservation Plan (BDCP), which proposes measures aimed at conservation and management of aquatic ecosystems and natural communities affected by diversions of water from the

Sacramento Regional County Sanitation District

Marguerite Naillon
April 17, 2009
Page 2

San Francisco Bay Delta. The Draft EIS/EIR explains that the BDCP "is in the early stages of planning, and quantitative information available from that planning process is insufficient for inclusion in this cumulative impacts analysis." (Draft EIS/EIR at p. 4.2-69.) Our comments on these two areas are discussed in more detail below.

SRCSD's 2020 Master Plan contemplates increasing SRWTP discharge to the Sacramento River to 218 million gallons a day, monthly average dry weather flow. While SRCSD has found that the proposed improvement and expansion of SRWTP facilities would have no significant effect on water quality in the Sacramento River or the Delta, Contra Costa Water District (CCWD) has alleged several potential water quality impacts associated with the 2020 Master Plan. This is of course a subject of current litigation, but it remains true that increased discharge from the SRWTP is reasonably foreseeable both as to increases beyond current flows to the permitted flow of 181 mgd, and to flows of up to 218 mgd. If CCWD continues to maintain that the 2020 Master Plan will affect Delta water quality in the coming years, then the 2020 Master Plan needs to be included in the list of reasonably foreseeable future projects considered in the cumulative impacts analysis of the Draft EIS/EIR.

1

Although the BDCP is in the planning stage, over the past few months the BDCP Steering Committee has released drafts of conveyance alternatives, water operations conservation measures, habitat restoration measures, "other stressors" conservation measures, and several other documents that indicate the likely direction of the BDCP and its effect on Delta diversions. These documents are available from the California Department of Water Resources at http://resources.ca.gov/bdcp/current_documents_and_working_drafts.html. Even assuming the BDCP may have been too speculative for inclusion in the cumulative impacts analysis at the time of the release of the Notice of Preparation for the Los Vaqueros Expansion Project, the BDCP has developed substantially in recent months. Because the BDCP will undoubtedly have substantial effects on the physical configuration of the Delta, Delta pumping operations and Delta hydrology, the Draft EIS/EIR should consider the draft BDCP measures in its cumulative impacts analysis.

2

Neither the Delta Fisheries and Aquatic Resources (Draft EIS/EIR section 4.3) nor the Delta Hydrology and Water Quality (Draft EIS/EIR section 4.2) sections of the Draft EIS/EIR specifically examine the potential impacts of diverting additional water on the water temperature, dissolved oxygen (DO), and other important water quality conditions in regimes of the Old River and downstream water bodies and the associated potential impacts on aquatic biological resources (e.g., direct physiological effects, thermal/DO barriers). Given the highly impacted condition of the Delta with regards to fish populations, we feel that such an assessment is necessary for any project that proposes to divert additional water from Delta water bodies.

3

SRCSD appreciates the opportunity to provide these comments on the Draft EIS/EIR. Please advise SRCSD when the Final EIR and responses to comments are available and include SRCSD on the mailing and notice list for receipt of notice of any hearing on the Project and EIR. Pursuant to CEQA, Public Resources Code section 21092.2, please provide SRCSD with a copy of any Notice of Determination filed for the Project. Please contact me at 916 -875-9101, if you have any questions.

Sincerely,

Stan R. Dean
District Manager

cc: Louis Moore, Bureau of Reclamation
Mary Snyder, SRCSD

Andrea Nocito, Senior Project Associate
a.nocito@circlepoint.com * 415.227.1100 x104
415.994.4670 Blackberry
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135 Main Street, Suite 1600, San Francisco, CA 94105

-----Original Message-----
From: Los Vaqueros [mailto:lvstudies@hotmail.com]
Sent: Tue 4/21/2009 11:02 AM
To: Andrea Nocito
Subject: FW: Los Vaqueros Reservoir Expansion Project Draft EIS/EIR Comments

_____

Subject: Los Vaqueros Reservoir Expansion Project Draft EIS/EIR Comments
Date: Tue, 21 Apr 2009 10:41:36 -0700
From: ADvorak@swc.org
To: lvstudies@hotmail.com; wmoore@mp.usbr.gov
CC: terlewine@swc.org; mnaillon@ccwater.com

Please see the attached SWC letter regarding the Los Vaqueros Reservoir Expansion Project Draft EIS/EIR.
Please let me know if you have any questions or comments.

Cheers!

Allison Dvorak
Water Resource Specialist
State Water Contractors
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April 21, 2009

Marguerite Naillon
Contra Costa Water District
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lvstudies@hotmail.com
wmoore@mp.usbr.gov

RE: **Los Vaqueros Reservoir Expansion Project Draft EIS/EIR**

Dear Ms. Naillon:

The State Water Contractors (SWC) submits these comments regarding the Draft Environmental Impact Statement/Environmental Impact Report (DEIS/EIR) for the Contra Costa Water District (CCWD) and US Bureau of Reclamation (Reclamation) Los Vaqueros Reservoir Expansion Project (reservoir expansion project). As described in the DEIS/EIR, CCWD and Reclamation propose through the reservoir expansion project to enlarge the existing reservoir, build a new intake and pump station and conveyance facilities, provide modified and new power supply facilities, and replace and enhance recreation facilities. Implementation of the reservoir expansion project is intended to develop water supplies for environmental water management for Delta fisheries and improve water supply reliability and water quality for urban users in the San Francisco Bay Area.

The SWC is an organization representing 27 of the 29 public water entities[1] that hold contracts with the California Department of Water Resources (DWR) for the delivery of water from the State Water Project (SWP). Collectively, the members of the SWC provide all, or a part, of the water supply delivered to approximately 25 million Californians, roughly two-thirds of the State's population, and to over 750,000 acres of irrigated agriculture. The members of the SWC provide this water to retailers, who, in turn, serve it to consumers throughout the San Francisco Bay Area, the San Joaquin Valley, the Central Coast, and Southern California.

The SWP supply delivered through the Sacramento-San Joaquin Delta constitutes a significant portion of the supplies available to SWC members. As a result, the SWC is very interested in matters affecting the quantity and quality of water supplies in the Delta. Additionally, the South Bay water agencies identified as potential beneficiaries of water supply reliability and water quality improvements are SWC member agencies (i.e., South Bay Aqueduct (SBA) contractors: Alameda County Flood Control and Water Conservation District, Zone 7 (Zone 7), Alameda County Water District (ACWD), and Santa Clara Valley Water District (SCVWD)).

---

[1] Alameda County Zone 7 Water Agency, Alameda County Water District, Antelope Valley-East Kern Water Agency, Casitas MWD on behalf of the Ventura County Flood Control District, Castaic Lake Water Agency, Central Coast Water Authority on behalf of the Santa Barbara FC&WCD, City of Yuba City, Coachella Valley Water District, County of Kings, Crestline-Lake Arrowhead Water Agency, Desert Water Agency, Dudley Ridge Water District, Empire West-Side Irrigation District, Kern County Water Agency, Littlerock Creek Irrigation District, The Metropolitan Water District of Southern California, Mojave Water Agency, Napa County FC&WCD, Oak Flat Water District, Palmdale Water District, San Bernardino Valley MWD, San Gabriel Valley MWD, San Gorgonio Pass Water Agency, San Luis Obispo County FC&WCD, Santa Clara Valley Water District, Solano County Water Agency, and Tulare Lake Basin Water Storage District.

2

Marguerite Naillon
April 21, 2009

As described in the DEIS/EIR, diversions from the CCWD Old River and Victoria Canal intakes would be used to fill the enlarged reservoir, make direct deliveries to the SBA contractors, and/or make direct deliveries to CCWD. Currently, the Central Valley Project (CVP) and SWP Delta exports are regulated under the US Fish and Wildlife Service (FWS) Operations Criteria and Plan (OCAP) Biological Opinion (BO) during the period of December through June based on allowable Old and Middle River (OMR) reverse flows. Hydrodynamically, diversions from the CCWD Old River and Victoria Canal intakes contribute to reverse flows in OMR, impacting the ability of the SWP and CVP to export Delta water supply. It appears from the description in the DEIS/EIR that the effect of CCWD Old River and Victoria Canal diversions on OMR reverse flows and the subsequent potential effect on SWP and CVP water supply were not considered in the DEIS/EIR water supply analysis. If the reservoir expansion project may potentially affect SWP and CVP water supply, an additional consideration for inclusion in the analysis would be CCWD's water right permit D-1629. Consideration of the effects of CCWD Old River and Victoria Canal diversions on Old and Middle River flows and constraints imposed on these diversions under CCWD's water right permit D-1629 will likely affect the water supply benefits identified in the DEIS/EIR.

Due to the hydrodynamic characteristics of the Delta, OMR flows are difficult to estimate in the context of a modeling analysis. The analysis included in the DEIS/EIR relied on an average of three methods used to estimate OMR flow: a DWR method and two US Geological Survey (USGS) methods. In its Calsim and CalLite modeling, DWR now uses an OMR flow estimation method developed by Paul Hutton (MWD) (Attachment 1). The method developed by Hutton to estimate OMR flow has been shown to more accurately predict OMR flows given hydrologic conditions and may alter the water supply affects demonstrated in the DEIS/EIR.

As previously stated, the CVP and SWP Delta exports are currently regulated under the FWS OCAP BO. Additionally, the National Marine Fisheries Service (NMFS) OCAP BO will be released June 2, 2009 and may include additional Delta hydrologic constraints. The analysis in the DEIR/EIS included consideration of interim OMR flow constraints, but did not include consideration of the operational constraints outlined in FWS OCAP BO which are currently regulating CVP and SWP Delta export operations. Consideration of the FWS OCAP BO and NMFS OCAP BO operational constraints would likely alter the identified effects of the reservoir expansion project.

Based on the observations described above, the SWC believes the water supply reliability benefits demonstrated in the DEIS/EIR are questionable and likely over-stated. To more accurately reflect the effects of the reservoir expansion project, the analysis should be revised to include the following: (1) consideration of CCWD Old River and Victoria Canal diversion effects on OMR flow, (2) compliance with CCWD's water rights permit D-1629, (3) use of the Hutton OMR flow equation, (4) use of operational constraints as outlined in the FWS OCAP BO, and (5) consideration of additional hydrologic constraints in the NMFS OCAP BO.

In addition to concerns with the water supply analysis, the SWC has concerns regarding the Delta fishery analysis. A proposed benefit of the reservoir expansion project is identified as a fishery benefit associated with changing the diversion location of a portion of SBA contractor water supply from CVP and SWP Delta export pumps to the CCWD Old River and Victoria Canal diversions with improved fish screens relative to those at the CVP and SWP Delta export pumps. The particle tracking modeling used in the DEIS/EIR analysis appears to unrealistically assume that 100% of particles entering the CCWD Old River and Victoria Canal diversions are at the same time screened from entrainment at those diversion locations and also prevented from entrainment at other diversion locations. This analysis approach leads to an overestimation of the fishery benefits associated with the changed diversion location.

Due to these concerns, the SWC believes the fishery benefits identified in the DEIS/EIR are likely over-stated. To more accurately reflect the effects of the reservoir expansion project, the analysis should be revised to: (1) address effects of the CCWD Old River and Victoria Canal diversion on movement of
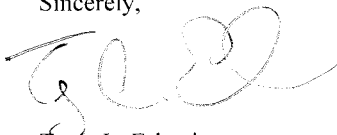
3

Marguerite Naillon
April 21, 2009

Delta fish species and (2) utilize screen efficiencies in the particle tracking modeling so that particles are not removed from the system when they encounter the CCWD Old River and Victoria Canal diversions.

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Finally, the Bay Delta Conservation Plan (BDCP) and the Delta Vision are current efforts to develop a long-term solution for Delta water supply and ecosystem conditions. Although these efforts are still in the planning process, information from these efforts suggests that the Delta infrastructure, hydrologic and hydrodynamic regime, and ecosystem conditions may be substantially changed from the current condition. These changes would likely alter the proposed operations and benefits of the reservoir expansion project identified in the DEIR/EIS. Due to the potential changed conditions in the Delta, the analysis of project effects should include an analysis of how the reservoir expansion project would operate in coordination with the BDCP and Delta Vision efforts.

3

We appreciate your consideration of our comments. If you have any questions, please feel free to contact me at (916) 447-7357.

Sincerely,

Terry L. Erlewine
General Manager

cc: Louis Moore, US Bureau of Reclamation

Attachment 1

A Model to Estimate Combined Old & Middle River Flows

By

Paul Hutton, Ph.D., P.E.
Metropolitan Water District of Southern California

FINAL
April 2008

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Executive Summary

Introduction

The abundances of Delta smelt (*Hypomesus transpacificus*) and other pelagic fish species have declined dramatically over the last several years. These population declines are thought to be influenced by chemical pesticide exposure, food-web alterations, and water project entrainment. Studies are ongoing by the Interagency Ecological Program and others to define and understand the nature of these population declines (Armor and Sommer 2006). One such study found a correlation between Delta smelt salvage at the CVP-SWP export pumps and combined Old and Middle River flows near Bacon Island (Smith et.al. 2006). This correlation was a motivating factor to limit upstream (reverse) flows in Old and Middle Rivers (NRDC vs. Kempthorne 2007).

The current configuration of the Delta relies on Old and Middle Rivers to convey water from the Sacramento River to the CVP-SWP export pumps, a pathway that results in reverse flows. Since regulation of these reverse flows can have significant impacts on water project operations, accurate methods are needed to forecast Old and Middle River (OMR) flows.

This report reviews the hydraulics of OMR flows, evaluates the performance and limitations of existing empirical models to predict OMR flow, and documents the development of a new model of OMR flow. The new model was designed as a long-term planning tool that can be incorporated into CALSIM; however, the model also has applicability to short-term operations planning.

Hydraulics of OMR Flow

The USGS gauges tidal flows in Old and Middle Rivers at Bacon Island. Several hydraulic forces determine the volume and direction of flows at these locations. These hydraulic forces, as described in Section 2, may contribute to downstream (positive) flow or may contribute to upstream (reverse) flow. See Figure ES-1.

Performance of Existing Empirical Models of OMR Flow

Currently available empirical OMR flow models can produce widely different estimates. These differences motivated an effort to evaluate the performance and limitations of existing models and to explore methods of addressing these limitations. See Section 3 for details on the evaluation of existing models.

New Empirical Model of OMR Flow

The new empirical OMR flow model presented in Sections 4 through 6, herein referred to as the MWD model, is founded on a simple control volume or water balance. The model is calibrated with data generated by DWR's Delta Simulation Model (DSM2) and validated with field observations. Many, but not all, of the water balance terms are

A Model to Estimate Combined OMR Flows
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routinely measured or are estimated though currently available methods. Statistical methods were used to estimate unknown water balance terms.

<u>Water Balance.</u> If the influence of tides is ignored, the following south Delta water balance can be defined to describe OMR flow in term of other riverine flows and diversions:

OMR flow	=	San Joaquin River flow @ Vernalis
	+	Indian Slough flow @ Old River
	–	San Joaquin River flow downstream of HOR
	–	Clifton Court Forebay diversions
	–	Jones Pumping Plant diversions
	–	CCWD Old River Intake diversions
	–	South Delta net channel depletion

Indian Slough flow is defined in the above water balance to be positive when flowing upstream (east) into Old River. The assumed sign convention is opposite that used in the DSM2 model. Indian Slough is tidally influenced, so net flows may be positive or negative. Net channel depletion is defined to be positive when depletions exceed accretions. Net channel depletions may be negative in the winter when local precipitation and drainage returns are greater than channel diversions. Table ES-1 summarizes the water balance by month for the period 1998-2006. CCWD's Old River diversion became operational in late 1997; therefore, data prior to 1998 were excluded from the table.

<u>Estimating Unknown Water Balance Terms.</u> The above water balance provides a foundation for the MWD model. Since most of the water balance terms are measured in the field or estimated through currently available methods, these terms are defined as independent variables in the MWD model. Two key water balance terms, Indian Slough flow at Old River and San Joaquin River flow downstream of the head of Old River (HOR), are not measured in the field or estimated through currently available methods. Therefore, regression equations were developed with DSM2 data to predict these terms. Table ES-2 summarizes regression equations and statistics for predicting San Joaquin River flow downstream of HOR. The final MWD model form and coefficients are summarized in Table ES-3.

<u>Model Uncertainty.</u> Model uncertainty was quantified by computing safety factors or "buffers" needed to avoid exceeding an OMR flow objective with 95% confidence. These buffers are summarized in Table ES-4 and key observations are highlighted below:

- Longer flow averaging periods can be forecasted with greater certainty, and therefore can rely on smaller buffers to meet OMR flow objectives. Buffers required to meet 7-day averaged flow objectives are approximately twice as large as buffers required to meet 14-day averaged flow objectives.
- Three-day forecasts can be estimated with greater certainty than 5-day forecasts, and therefore can rely on smaller buffers. Buffers required for a 5-day forecast are approximately 50% greater than those required for a 3-day forecast.

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The current OMR flow objective is generally specified as a 7-day average; therefore, buffers for 7-day averaged flows are most applicable for short-term forecasting. Buffers for 14-day averaged flows serve as reasonable proxies for long-term planning studies. The 7-day buffers are overly conservative, given that much of the 7-day uncertainty is due to tidal effects that can be anticipated by operations planners.

Findings and Conclusions

Model Development & Application. The following findings and conclusions relate to MWD model development and application:

- The model, which was formulated as a water balance and calibrated with DSM2 data, provides (1) superior validation to observed data and (2) more robust sensitivity to key hydrologic variables. The model should be adopted as a planning tool for predicting OMR flow. Model performance as a short-term forecasting tool could be enhanced by including a tidal influence term.
- Clifton Court Forebay diversion is a better measure than Banks Pumping in predicting OMR flow. This consideration is important for short-term forecasting. For long term planning, the distinction is less important.

Potential Control Measures. The following findings and conclusions relate to potential measures to control OMR flow:

- Comparison of model estimates with observed OMR flows was used to develop planning "buffers" to account for estimate uncertainty.
  o Longer flow averaging periods can be forecasted with greater certainty, and therefore can rely on smaller buffers to meet OMR flow objectives. Buffers required to meet 7-day averaged flow objectives are approximately twice as large as buffers required to meet 14-day averaged flow objectives. The 7-day buffers are overly conservative, given that much of the 7-day uncertainty is due to tidal effects that can be anticipated by operations planners.
  o 3-day forecasts can be estimated with greater certainty than 5-day forecasts, and therefore can rely on smaller buffers. Buffers required for a 5-day forecast are approximately 50% greater than those required for a 3-day forecast.
- The only south Delta agricultural barrier that has a significant impact on OMR flow is the Grant Line Canal. This finding seems reasonable given that the Grant Line Canal barrier provides the greatest flow restriction. Therefore, any future Delta smelt protections should focus on operation of this barrier.
- Water savings will result from delaying or prohibiting installation of HOR and Grant Line Canal barriers. Studies are needed to determine if delayed installation would require export curtailments to meet south Delta water levels.
- Measures that increase San Joaquin River flows at Vernalis would be effective in controlling OMR flow. Such measures would be even more effective if the Paradise

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Hutton

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Cut weir operation was modified to allow more San Joaquin River water into the south Delta.

References

Armor, C.S., and T.R. Sommer (2006). Pelagic Organism Decline 2005-2006: Overview of Program and Progress, 4th Biennial CALFED Science Conference 2006, October 23-25, 2006, Sacramento Convention Center.

NRDC vs. Kempthorne (2007). Interim Remedial Order Following Summary Judgment and Evidentiary Hearing, Case 1:05-cv-1207-oww-gsa, DRAFT, December 11.

Smith, P.E., C.A. Ruhl, and J. Simi (2006). Hydrodynamic Influences on Historical Patterns in Delta Smelt Salvage, 4th Biennial CALFED Science Conference 2006, October 23-25, 2006, Sacramento Convention Center.

9

Table ES-1
Monthly Average South Delta Water Balance (cfs): 1998-2006

Month	Old & Middle Rivers	San Joaquin River @ Vernalis	Indian Slough @ Old River	South Delta Net Channel Depletions	San Joaquin River d/s HOR	Clifton Court Forebay Diversions	Jones Pumping Plant Diversions	CCWD Diversions @ Old River	Water Balance [1]	Difference (9) – (1)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Jan	-5850	4034	377	185	-1554	-5125	-3642	-98	-5824	26
Feb	-4275	6307	268	356	-2520	-4560	-3895	-139	-4183	92
Mar	-3043	8288	181	41	-3589	-4311	-3598	-99	-3085	-43
Apr	-718	8681	-14	-163	-3856	-2932	-2238	-144	-665	53
May	1271	8873	-193	-392	-4574	-1116	-1205	-116	1276	5
Jun	-2361	7503	6	-719	-3396	-2700	-2894	-191	-2392	-31
Jul	-7496	4785	294	-926	-2120	-5209	-4209	-154	-7539	-43
Aug	-9298	2621	440	-671	-1168	-6082	-4326	-135	-9320	-23
Sep	-8962	2368	476	-383	-1105	-5918	-4291	-118	-8971	-10
Oct	-7403	2633	414	-252	-1434	-4455	-4220	-94	-7407	-4
Nov	-6639	2490	388	-184	-1284	-4099	-3912	-74	-6675	-36
Dec	-5927	2246	359	-103	-741	-4378	-3266	-35	-5917	10

[1] Sum of Columns (2) thru (8)

Table ES-2
Regression Analysis Results:
Statistical Model of San Joaquin River Flow Downstream of Head of Old River

$$Q_{SJR\ d/s\ HOR} (cfs) = A * Q_{Vernalis} (cfs) + B * Q_{South\ Delta\ Diversions} (cfs) + C$$

HORB	GLC Barrier	Vernalis (cfs)	N	A	B	C	R2	SEE (cfs)	Comments
Out	Out	< 16,000	7167	0.499	-0.0312	-161	0.996	112	
Out	Out	16000-28000	622	0.276	0	3128	0.991	84	Weir allows flow in Paradise Cut
Out	Out	> 28000	214	0.327	0	1677	0.983	180	Weir allows flow in Paradise Cut, but at a lower rate
Out	In	All	2055	0.554	-0.0168	-45	0.918	127	
In (Spring)	Out/In	All	586	0.916	0	-146	0.978	219	
In (Fall)	Out/In	All	1251	0.747	-0.0109	-24	0.961	109	

N= number of observations; R2=coefficient of determination; SEE=standard error of estimate

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Table ES-3
MWD OMR Flow Model Coefficients

$$Q_{OMR} \text{ (cfs)} = A * Q_{Vernalis} + B * Q_{South Delta Diversions} + C$$

Where: $Q_{South Delta Diversions} = Q_{CCF} + Q_{Jones} + Q_{CCWD} + Q_{South Delta NCD}$

HORB	GLC Barrier	Vernalis (cfs)	A	B	C
Out	Out	< 16,000	0.471	-0.911	83
Out	Out	16,000-28,000	0.681	-0.940	-3008
Out	Out	> 28,000	0.633	-0.940	-1644
Out	In	All	0.419	-0.924	-26
In (Spring)	Out/In	All	0.079	-0.940	69
In (Fall)	Out/In	All	0.238	-0.930	-51

Table ES-4
OMR Flow Buffers with 95% Confidence (cfs)

Month	14-Day Averaged OMR Flow			7-Day Averaged OMR Flow		
	3-Day Forecast	5-Day Forecast	≥ 14 Day Forecast	3-Day Forecast	5-Day Forecast	≥ 7 Day Forecast
Dec	300	450	700	600	850	1000
Jan	250	350	450	500	700	800
Feb	250	350	500	500	700	850
Mar	200	300	300	350	550	600
Apr	300	450	700	600	900	1050
May	300	450	850	600	950	1200
Jun	250	350	700	450	650	850
12 Months	300	400	750	550	850	1000

Notes on USGS Observed Data Used to Develop Buffers:
1) 24-hour averages were computed from raw 15-minute data
2) 24-hour data were filled based on correlations between Old and Middle Rivers
3) The period Jan 1, 1990 thru Sep 30, 2006 were used to develop buffers except as noted below:
   a. Events when OMR flow was > 0 cfs were excluded from buffer calculations
   b. The period Jun 1, 2004 thru Dec 31, 2004 were excluded from buffer calculations (Jones Tract levee failure)

Other Note:
1) ≥14 Day and ≥7 Day forecasts assume no knowledge of antecedent conditions.

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Figure ES-1
Hydraulic Forces Contributing to OMR Flow
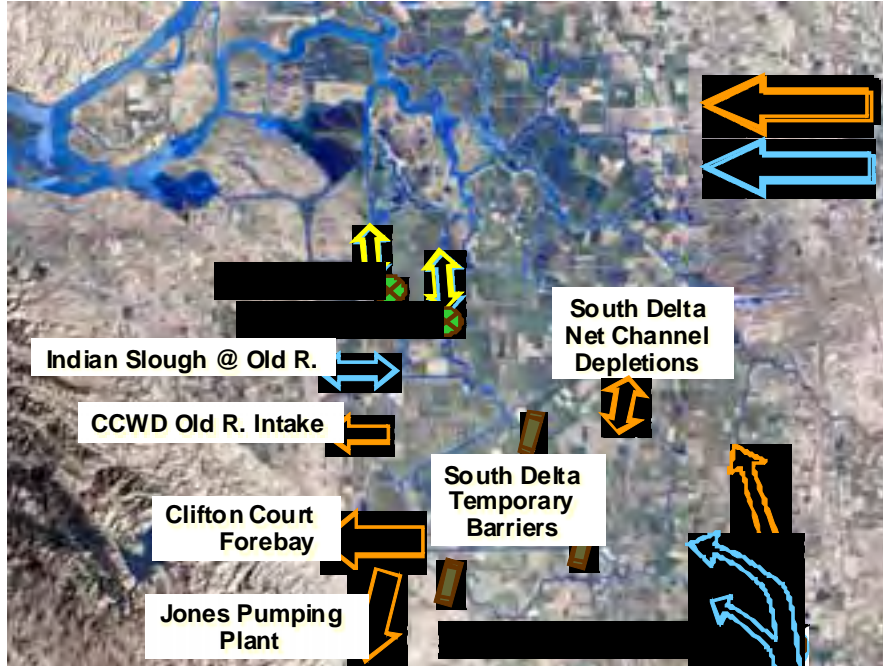
Several hydraulic forces determine the volume and direction of flows in Old and Middle Rivers. These forces may contribute to downstream (positive) flow or may contribute to upstream (reverse) flow.

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Section 1
Introduction

The abundances of Delta smelt (*Hypomesus transpacificus*) and other pelagic fish species have declined dramatically over the last several years. These population declines are thought to be influenced by chemical pesticide exposure, food-web alterations, and water project entrainment. Studies are ongoing by the Interagency Ecological Program and others to define and understand the nature of these population declines (Armor and Sommer 2006). One such study found a correlation between Delta smelt salvage at the CVP-SWP export pumps and combined Old and Middle River flows near Bacon Island (Smith et.al. 2006). This correlation was a motivating factor to limit upstream (reverse) flows in Old and Middle Rivers (NRDC vs. Kempthorne 2007).

The current configuration of the Delta relies on Old and Middle Rivers to convey water from the Sacramento River to the CVP-SWP export pumps, a pathway that results in reverse flows. Since regulation of these reverse flows can have significant impacts on water project operations, accurate methods are needed to forecast Old and Middle River (OMR) flows.

This report reviews the hydraulics of OMR flows, evaluates the performance and limitations of existing empirical models to predict OMR flow, and documents the development of a new model of OMR flow. The new model was designed as a long-term planning tool that can be incorporated into CALSIM; however, the model also has applicability to short-term operations planning.

References

Armor, C.S., and T.R. Sommer (2006). Pelagic Organism Decline 2005-2006: Overview of Program and Progress, 4th Biennial CALFED Science Conference 2006, October 23-25, 2006, Sacramento Convention Center.

NRDC vs. Kempthorne (2007). Interim Remedial Order Following Summary Judgment and Evidentiary Hearing, Case 1:05-cv-1207-oww-gsa, DRAFT, December 11.

Smith, P.E., C.A. Ruhl, and J. Simi (2006). Hydrodynamic Influences on Historical Patterns in Delta Smelt Salvage, 4th Biennial CALFED Science Conference 2006, October 23-25, 2006, Sacramento Convention Center.

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Section 2
Background

This section identifies hydraulic forces that determine OMR flows and discusses relative influences and control of these hydraulic forces. This section also provides a brief introduction to existing models of OMR flow.

Hydraulics of OMR Flow

The USGS gauges tidal flows in Old and Middle Rivers at Bacon Island. Several hydraulic forces determine the volume and direction of flows at these locations. These hydraulic forces, as described below, may contribute to downstream (positive) flow or may contribute to upstream (reverse) flow. See Figure 2-1.

San Joaquin River Inflows to Old and Middle Rivers. The San Joaquin River provides downstream flow to Old and Middle Rivers at the confluence of the San Joaquin and Old Rivers; this location is typically referred to as the Head of Old River (HOR). Under high flow conditions, the San Joaquin River also provides downstream flow through Paradise Cut. San Joaquin River flows upstream of the Delta are influenced by several factors, including reservoir releases along the Stanislaus River (New Melones), the Tuolumne River (New Don Pedro) and the Merced River (McClure). Total contributions from the San Joaquin River to Old and Middle Rivers are strongly influenced by physical structures such as an overflow rock weir at Paradise Cut and seasonal installation of a fish barrier at the Head of Old River. Total contributions from the San Joaquin River are also influenced (but to a lesser degree) by south Delta water levels, which are in turn influenced by seasonal installation of agricultural barriers, tides, and water diversions from the south Delta. Typically 60 to 80% of the San Joaquin River flow volume diverts into Old River and contributes to downstream OMR flows when the fish barrier at the HOR is not installed. The remaining volume flows past Stockton through the main stem of the San Joaquin River.

Water Diversions from the South Delta. Net flow in Old and Middle Rivers is upstream when south Delta water diversions exceed contributions from the San Joaquin River. South Delta water diversions include the SWP Clifton Court Forebay Intake, the CVP Jones Pumping Plant, the CCWD Los Vaqueros Intake on Old River, and local agricultural diversions. All south Delta water diversions contribute equally, on a per unit basis, to OMR reverse flows.

Indian Slough hydraulically bypasses the Old River gauging station at Bacon Island. Under high flow conditions, this bypass results in unmeasured net downstream flow at Old River. Under low flow conditions, this bypass results in unmeasured net upstream flow at Old River. The practical implication of Indian Slough is that, under low flow conditions, south Delta water diversions have less than a 1-to-1 effect on gauged OMR reverse flows. If this bypass did not exist, a 1-to-1 effect would exist (ignoring the influence of south Delta water diversions on the HOR flow split), i.e. an additional 100

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cfs south Delta diversion would result in 100 cfs of additional reverse flow measured in Old and Middle Rivers.

Tides. The tide is another hydraulic force that determines the volume and direction of flows in Old and Middle Rivers. Flood and ebb tides influence flows within a day; spring and neap tides influence flows within a month. Numerical filtering of OMR flow data can remove much, but not necessarily all, of the influence associated with tides.

Relative Influence of Hydraulic Forces That Determine OMR Flows

In relative terms, south Delta water diversions have the largest influence on OMR flows. San Joaquin River inflows have a large, but smaller, influence on these flows. As discussed above, numerical filtering (e.g. 14-day averages) reduces the influence of tides on OMR flows.

Table 2-1 shows that, of the primary south Delta water diversions, the Clifton Court Forebay and Jones diversions are the largest and have been of similar magnitude in recent years. CCWD and local agricultural diversions are smaller; however, agricultural diversions can be significant during the irrigation season. The table also shows that San Joaquin River inflow is a large hydraulic force in determining OMR flows.

Control of Hydraulic Forces That Determine OMR Flows

Given the above discussion, reverse flows on Old and Middle Rivers may be effectively controlled through manipulation of water diversions and San Joaquin River inflows. Both the CVP and SWP play major roles in manipulating these hydraulic forces. In fact, the CVP plays an even greater role than the SWP.

While the SWP and CVP have similar control of reverse flows on Old and Middle Rivers through their respective operations of Clifton Court Forebay and Jones Pumping Plant, the CVP plays a much greater role in controlling San Joaquin River inflows to the south Delta. Both projects participate in operation of the HOR barrier, a structure that influences inflow to the south Delta (see above discussion). However, the CVP has additional control of inflow through its operation of New Melones and Millerton Reservoirs.

Existing Empirical Models of OMR Flow

Although physics-based models have been available for several years to predict OMR flows, empirical models were developed as easy to use and understand alternatives. The utility of such models is even greater now that water project operations are controlled by OMR flow objectives.

DWR developed several regression equations to estimate daily OMR flow (DWR 1986). The empirical model currently used by DWR relates OMR flow to (1) combined SWP-

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CVP exports and (2) San Joaquin River flow at Vernalis. SWP export data represent flows at Clifton Court Forebay intake rather than pumping at Banks Pumping Plant.

USGS also developed a set of regression equations to fill missing OMR flow data (Ruhl et.al. 2006). In addition to combined SWP-CVP exports and San Joaquin River flow at Vernalis, this empirical model also relates OMR flow to south Delta temporary barrier installation. However, the model does not distinguish between installation of the HOR barrier (HORB) and installation of the three agricultural barriers.

The empirical OMR flow models developed by DWR and USGS have been used by the author and others to assess water supply impacts of proposed Delta smelt protective actions. The DWR empirical model has also been used in recent months for water project operations planning. The author has noted that these models can produce widely different impact estimates, depending on hydrology and operations.

Physics-based hydrodynamic models, such as DWR's Delta Simulation Model (DSM2), the Fischer Delta Model (FDM), and the Resources Management Associates (RMA) Delta Model, necessarily provide high-frequency estimates of flow in Old and Middle Rivers. Of the existing hydrodynamic models, this report focuses on DSM2 in subsequent evaluation of performance and limitations.

Proposal to Develop New Empirical Model

The differences noted above motivated an effort to evaluate the performance and limitations of existing empirical models of OMR flow, and to explore methods of addressing these limitations. While this effort has a special focus on developing a new planning model that can be used within CALSIM and other long-term analyses, its results may also benefit operations planning.

References

DWR (1986). New Flow Equations for the San Joaquin River at Stockton and for Old and Middle Rivers, Office Memorandum from Jim Snow to Richard Jones, April 17.

C.A. Ruhl, P.E. Smith, J.J. Simi, and J.R. Burau (2006). The Pelagic Organism Decline and Long-Term Trends in Sacramento-San Joaquin Delta Hydrodynamics, 4th Biennial CALFED Science Conference 2006, October 23-25, 2006, Sacramento Convention Center.
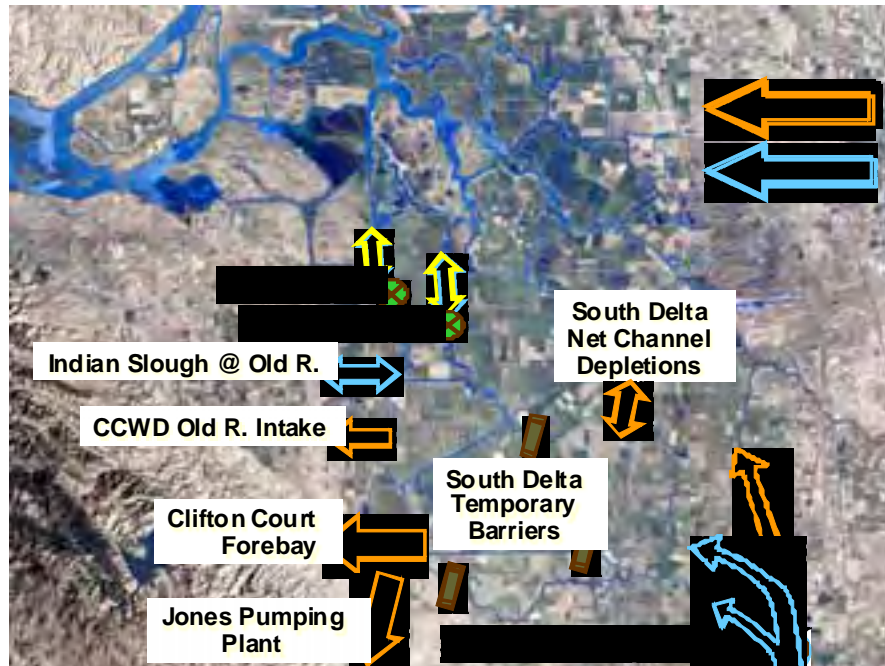
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Table 2-1
Average South Delta Water Diversions
December-June 1998-2006

Month	San Joaquin River (cfs)[1]	South Delta Net Channel Depletions (cfs)[2]	SWP (cfs)	CVP (cfs)	CCWD (cfs)
December	2250	100	4400	3300	40
January	4030	-190	5100	3600	100
February	6310	-360	4600	3900	140
March	8290	-40	4300	3600	100
April	8680	160	2900	2200	140
May	8870	390	1100	1200	120
June	7500	720	2700	2900	190

[1] Measured at Vernalis
[2] Estimated. Agricultural return flows are often larger than agricultural diversions in high-precipitation months, resulting in negative net channel depletions.

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Figure 2-1
Hydraulic Forces Contributing to OMR Flow

Indian Slough @ Old R.

CCWD Old R. Intake

Clifton Court Forebay

Jones Pumping Plant

South Delta Temporary Barriers

South Delta Net Channel Depletions

Several hydraulic forces determine the volume and direction of flows in Old and Middle Rivers. These forces may contribute to downstream (positive) flow or may contribute to upstream (reverse) flow.

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Section 3
Performance and Limitations of Existing Models

As discussed in the previous sections, DWR and USGS have developed empirical models to predict daily OMR flow. The performance and limitations of these models, along with the performance of the physics-based DSM2 model in predicting OMR flow, are now discussed.

Data Used to Evaluate Performance of Existing Models

Observed OMR flow data for the period January 1, 1990 through September 30, 2006 were used to evaluate the performance of existing models. The following periods were excluded from the evaluation:

- Jan-Feb 1997. Vernalis flow data are suspect during this period due to flood conditions along the San Joaquin River. January 1997 data were also excluded from the USGS model development (Ruhl et.al. 2006).
- Jun-Dec 2004. Data collected during and after the Jones Tract levee breach were excluded due to the unique hydraulic conditions in the south Delta associated with island flooding and pump-off.

OMR flow data were obtained from the USGS National Water Information System (NWIS) website (USGS 2007). Pertinent data sites are the Old River @ Bacon Island (11313405) and the Middle River @ Bacon Island (11312676). Data provided on the web site are tidally filtered with a Godin filter and reported as daily values. The data record begins in January 1987 and continues up to the present. Raw 15-minute OMR flow data were also obtained directly from USGS staff (P. Smith 2007a). Calendar day average flows were computed from the raw data to estimate 7-day and 14-day average flows. As with most long-term data records, the OMR flow data record includes gaps. Correlations between observed Old River and Middle River flows were utilized to estimate OMR flow when one of the two flow records was available. Correlation statistics are provided in Table 3-1.

Data for daily averaged Jones Pumping Plant exports were obtained from DWR's DAYFLOW database (DWR 2007a). DWR's Operations Control Office provided data for daily averaged Clifton Court inflow (A. Sandhu 2007). Forebay stage measurements are used by DWR, along with Banks exports, to compute daily Clifton Court inflows.

South Delta temporary barrier operations data (installation and removal) were obtained from DWR Delta Simulation Model (DSM2) input files and summarized in Table 3-2. Details on historical installation and removal are available elsewhere (DWR 2007b).

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Mathematical Form of Existing Models

Model forms assumed by the DWR and USGS OMR flow models, along with model constants, are provided in Table 3-3.

Evaluation of Existing Model Performance

DSM2. High frequency (15-minute) OMR flow data were extracted from a DSM2 simulation of historical hydrology and operations for the period January 1, 1990 through December 31, 2006. These data were tidally filtered with a Godin filter and averaged by calendar day.   The resulting DSM2 data are compared with observed data in Figure 3-1. Differences with observed data are within ± 600 cfs over 70% of the time. Differences are greater than ± 1400 cfs less than 5% of the time. The DSM2 model shows a modest bias to under-predict OMR flow. The bias appears to be seasonal and is most pronounced during the months of June through November. A possible explanation for the observed bias is that south Delta net channel depletion estimates are higher than actual depletions.

Figure 3-2 shows that daily averaged DSM2 estimates of Clifton Court Forebay diversions can be considerably different from observed values. Differences between computed and observed values are considerably lower for longer averaging periods. Given the importance of Clifton Court Forebay diversions in determining OMR flow (and presumably other hydrodynamic characteristics in the central and south Delta), DSM2 input modifications appear to be warranted. One possible modification would be to more accurately specify forebay gate operations in DSM2 simulations. Another possible modification would be to specify Clifton Court Forebay diversions directly as a boundary condition.

DWR Empirical Model. OMR daily flows predicted by the DWR model are compared with tidally filtered observed data in Figures 3-3. Differences with observed data are within ±600 cfs about 40% of the time. Differences are greater than ±1400 cfs about 25% of the time. The DWR model shows a strong bias toward over-estimating OMR flow. This bias has the effect of under-estimating water supply impacts associated with potential OMR flow regulations. This bias is particularly pronounced in April and May. By not accounting for HORB installation, the model implicitly assumes that more San Joaquin River water will enter the south Delta and contribute to positive OMR flow than would actually occur.   The bias is also pronounced during the late spring and summer months of June through September. By not accounting for in-Delta net channel depletions (highest during the irrigation season) and south Delta agricultural barrier installation, the model assumes that more San Joaquin River water will contribute to downstream OMR flow than would actually occur.

USGS Model. OMR daily flows predicted by the USGS model are compared with tidally filtered observed data in Figure 3-4. Similar to the DWR model, differences with observed data are within ±600 cfs about 45% of the time and are greater than ±1400 cfs

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about 25% of the time. Unlike the DWR model, the USGS model does not show a general predictive bias. However, the model tends to under-predict in January through March and over-predict in June through August. The late spring and summer over-prediction bias is likely due to lack of accounting for in-Delta net channel depletions during the irrigation season.

Model Limitations

The DWR and USGS empirical models have several limitations when used to answer "what if" questions within a planning analysis framework. These limitations are discussed below:

- Modified Operational Regimes. A typical planning application will be to evaluate required export reductions to meet prescribed OMR flows. It is anticipated that several of these operational regimes will be at levels of OMR flow and Delta exports that have been rarely observed in the historical record. Therefore, the existing models may not be adequately calibrated in the regions of interest for planning applications. This limitation is common to models that are calibrated with historically observed data. This limitation can be addressed by calibrating a model with hydrodynamic data that covers a wider operational range than observed historically. A numerical model such as DSM2 can produce such data.
- Modified South Delta Barrier Operations. Another possible planning application would be to evaluate how changes in south Delta barrier operations impact OMR flow. Such an application is timely, as the recent court decision (NRDC vs. Kempthorne 2007) prohibits HORB installation during the spring. The DWR model does not account for barrier operation. The USGS model does not distinguish between HORB operation and agricultural barrier operation. Neither model account for the influence of Paradise Cut on OMR flow. These limitations can be addressed by including specific barrier operations as independent variables.
- Modified Net Channel Depletions. One possible planning application would be to evaluate how changes in Delta land use impacts OMR flow. Neither model accounts for seasonal variability associated with in-Delta net channel depletions. This limitation can be addressed by including net channel depletions as an independent variable.
- Modified Vernalis Flow. Another possible planning application would be to evaluate how different San Joaquin River water operations upstream of Vernalis (e.g. Friant settlement releases) effect OMR flow. Under low and moderate flow regimes, the USGS model is not a function of Vernalis flow. This limitation can be addressed by including San Joaquin River flow as an independent variable.
- Consistent Model Analysis. Given the recent court decision, it is anticipated that an OMR flow model will be implemented in CALSIM. Given that CALSIM hydrology and operations are often used as input to the DSM2 model, Delta-related components of the CALSIM model should be designed to be consistent with DSM2. For example, see a discussion on development of CALSIM's flow-salinity routine (Hutton and Seneviratne 2001). It is unlikely that the existing empirical OMR flow models will provide a consistent model analysis between CALSIM and DSM2.

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References

DWR (2007a). DAYFLOW Database, http://www.iep.ca.gov/dayflow/output/index.html

DWR (2007b). South Delta Temporary Barriers Operating Schedule, http://baydeltaoffice.water.ca.gov/

Hutton, P. and S. Seneviratne (2001). Chapter 8: An Assessment of Delta Carriage Water Requirements Using a New CALSIM Flow-Salinity Routine, *Methodology for flow and salinity estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. 22nd Annual Progress Report to the State Water Resources Control Board.* DWR. August.

NRDC vs. Kempthorne (2007). Interim Remedial Order Following Summary Judgment and Evidentiary Hearing, Case 1:05-cv-1207-oww-gsa, DRAFT, December 11.

Sandhu, A. (2007). Personal communication, August 28.

Smith, P. (2007a). Personal communication, October 10.

USGS (2007). National Water Information System (NWIS), http://waterdata.usgs.gov/ca/nwis/

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Table 3-1
Correlations Used to Fill OMR Data Gaps
$Q_{Old River}$ (cfs) = A * $Q_{Middle River}$ (cfs) + B

Data Type	$Q_{Middle River}$	N	A	B	R2	SEE (cfs)
Tidally Filtered	< -4000 cfs	1682	0.578	-663	0.634	298
Tidally Filtered	≥ -4000 cfs	2881	0.836	367	0.977	388
Calendar Day Average	< -4000 cfs	1774	0.640	-345	0.643	383
Calendar Day Average	≥ -4000 cfs	3079	0.834	369	0.970	443

N= number of observations; R2=coefficient of determination; SEE=standard error of estimate

Table 3-2
South Delta Temporary Barrier Operations: 1990-2006

Year	HORB (Spring) In	HORB (Spring) Out	HORB (Fall) In	HORB (Fall) Out	Old River In	Old River Out	Middle River In	Middle River Out	Grant Line Canal In	Grant Line Canal Out
1990	---	---	Sep11	Nov27	---	---	Apr4	Sep29	---	---
1991	---	---	Sep13	Nov23	Aug26	Sep28	Apr4	Sep27	---	---
1992	Apr22	Jun5	Sep10	Dec3	Apr21	Oct1	Apr9	Sep29	---	---
1993	---	---	Nov10	Dec6	Jun2	Sep29	Jun17	Sep23	---	---
1994	Apr23	May18	Sep9	Nov29	Apr25	Oct4	Apr25	Sep30	---	---
1995	---	---	---	---	Aug8	Sep30	Aug10	Oct12	---	---
1996	May7	May17	Oct3	Nov20	---	---	May20	Sep29	Jul11	Oct3
1997	Apr10	May15	---	---	Apr17	Oct2	Apr5	Sep27	Jun5	Sep27
1998	---	---	---	---	---	---	---	---	---	---
1999	---	---	---	---	May25	Sep28	May19	Sep30	Jun4	Sep24
2000	Apr15	Jun1	Oct3	Dec8	Apr17	Sep30	Apr16	Sep30	Jun1	Sep29
2001	Apr25	May30	Oct7	Nov26	Apr27	Nov15	Apr21	Nov14	May4	Nov13
2002	Apr16	May24	Oct4	Nov21	Apr16	Nov19	Apr16	Nov21	Jun7	Nov18
2003	Apr16	May16	Sep22	Nov5	Apr15	Nov15	Apr15	Nov12	Apr16	Nov11
2004	Apr13	May21	Sep20	Nov2	Apr16	Nov13	Apr13	Nov11	Apr15	Nov12
2005	---	---	Sep29	Nov8	May31	Nov9	May12	Nov8	Jul13	Nov15
2006	---	---	---	---	Jul18	Nov17	Jul8	Nov18	Jul19	Nov21

Table 3-3
DWR and USGS OMR Flow Model Constants
Q_{OMR} (cfs) = A * $Q_{VERNALIS}$ (cfs) + B* $Q_{EXPORTS}$ (cfs) + C

OMR Equation	$Q_{VERNALIS}$	Barriers	A	B	C
DWR	All	All	0.58	-0.913	0
USGS	<10,000 cfs	In	0	-0.8129	-365
USGS	<10,000 cfs	Out	0	-0.8738	1137
USGS	≥10,000 cfs	All	0.7094	-0.7094	-4619

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Figure 3-1
Comparison of Predicted & Observed OMR Flow: DSM2 Model
**January 1, 1990 – September 30, 2006 (Tidally Filtered Daily Values)**
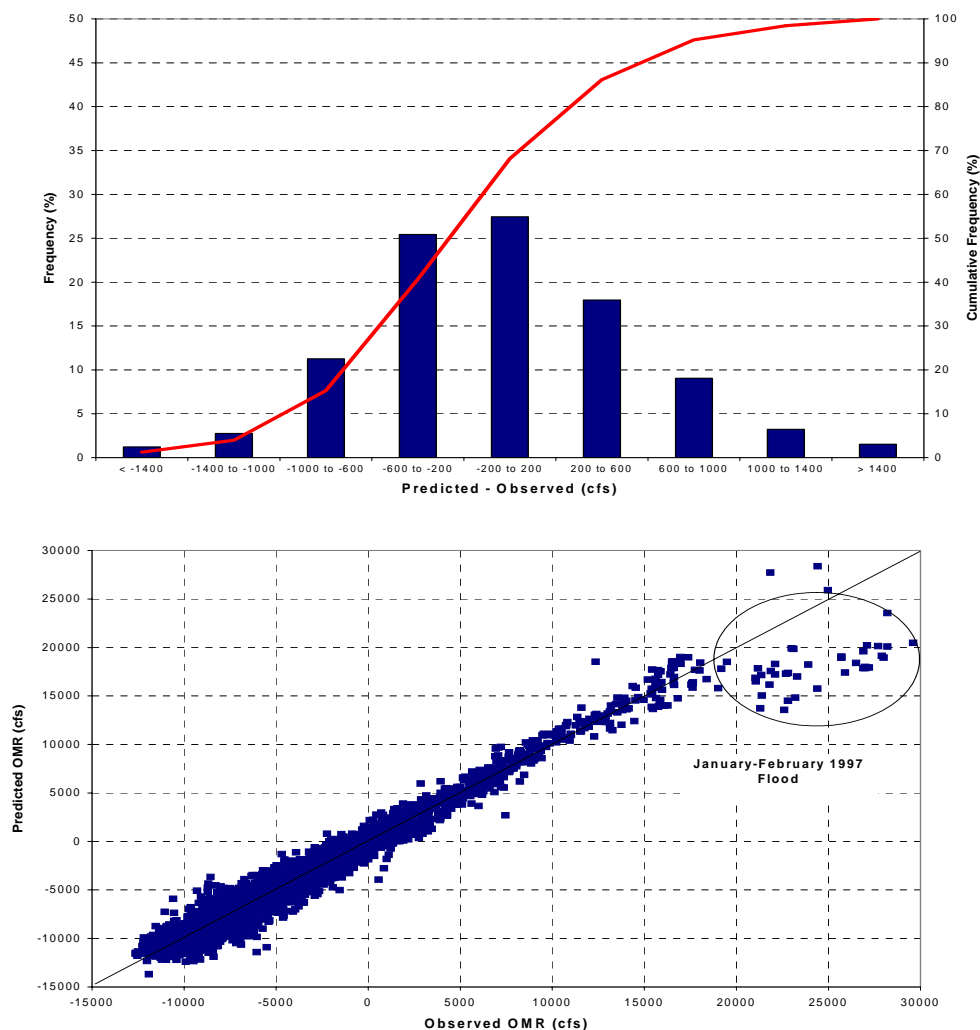
Differences with observed data are within ± 600 cfs over 70% of the time. Differences are greater than ± 1400 cfs less than 5% of the time. The DSM2 model shows a modest bias to under-predict OMR flow. Data corresponding to the 1997 flood (Jan-Feb 1997) were excluded from the evaluation. Vernalis flow data are suspect during early 1997 due to flood conditions along the San Joaquin River. In contrast to the DWR and USGS OMR model evaluations, data collected during and after the Jones Tract levee breach were included in the DSM2 evaluation because the unique hydraulic conditions in the south Delta associated with island flooding and pump-off were simulated by DSM2.

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Figure 3-2
Difference Between Predicted & Observed Clifton Court Forebay Diversions
**DSM2 Model January 1, 1990 – September 30, 2006 (24-hr Daily Values)**
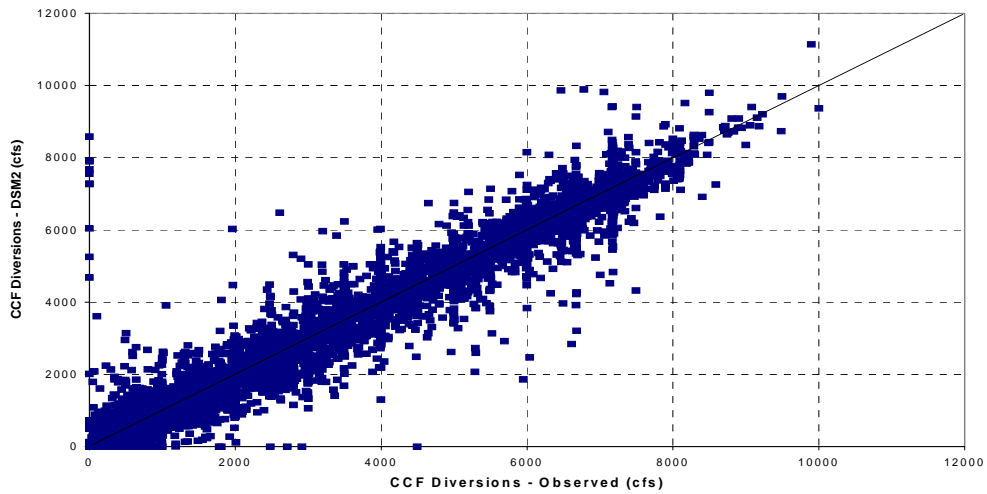
The above figure shows that DSM2 estimates for Clifton Court Forebay diversions can be considerably different from observed values. Given the importance of Clifton Court Forebay diversions in determining OMR flow, modifications to DSM2 appear to be warranted.

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Figure 3-3
Comparison of Predicted & Observed OMR Flow: DWR Model
January 1, 1990 – September 30, 2006 (Tidally Filtered Daily Values)
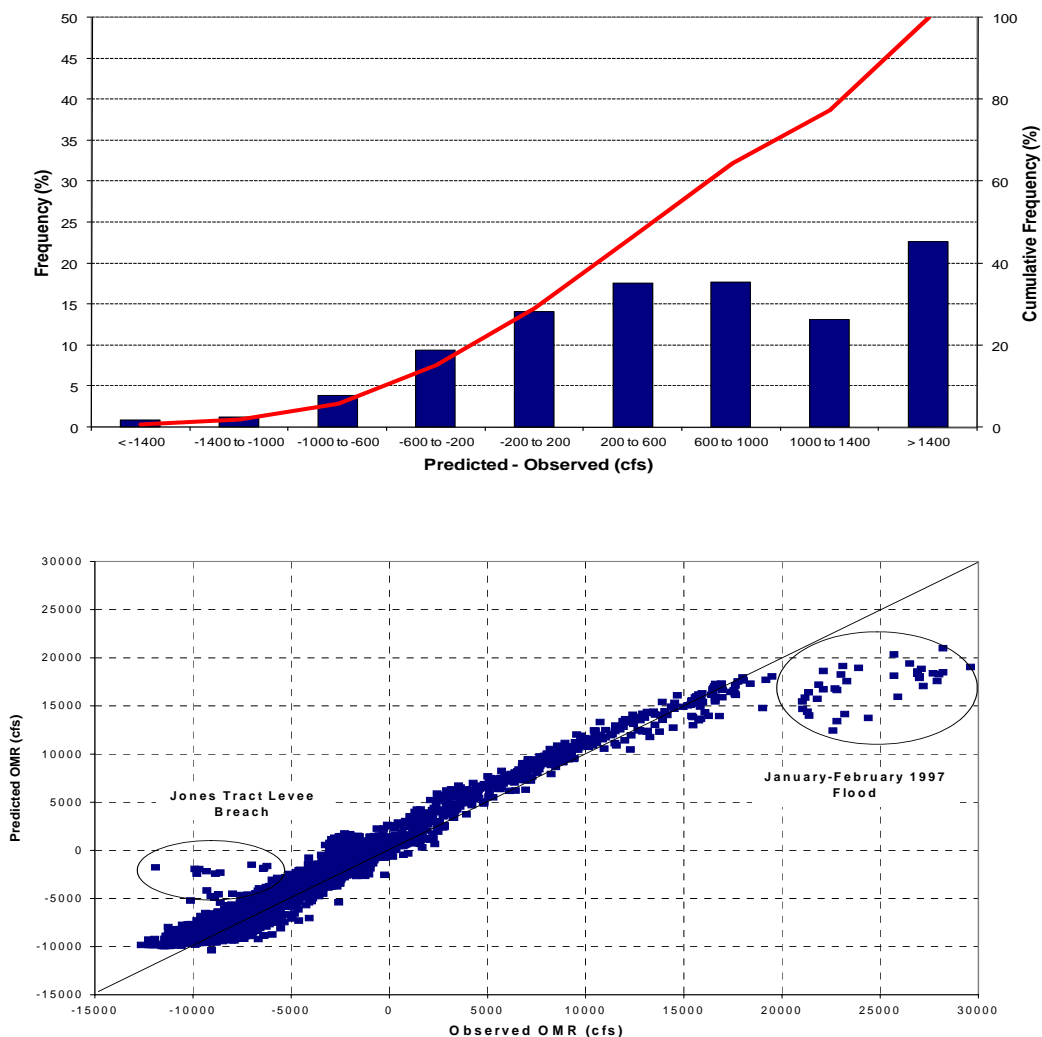
Differences with observed data are within ±600 cfs about 40% of the time. Differences are greater than ±1400 cfs about 25% of the time. The DWR model shows a strong bias toward over-estimating OMR flow. This bias has the effect of under-estimating water supply impacts associated with potential OMR flow regulations. Data corresponding to the 1997 flood (Jan-Feb 1997) and the Jones Tract levee breach (Jun-Dec 2004) were excluded from the evaluation. Vernalis flow data are suspect during early 1997 due to flood conditions along the San Joaquin River. Data collected during and after the Jones Tract levee breach were excluded due to the unique hydraulic conditions in the south Delta associated with island flooding and pump-off.

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Figure 3-4
Comparison of Predicted & Observed OMR Flow: USGS Model
January 1, 1990 – September 30, 2006 (Tidally Filtered Daily Values)
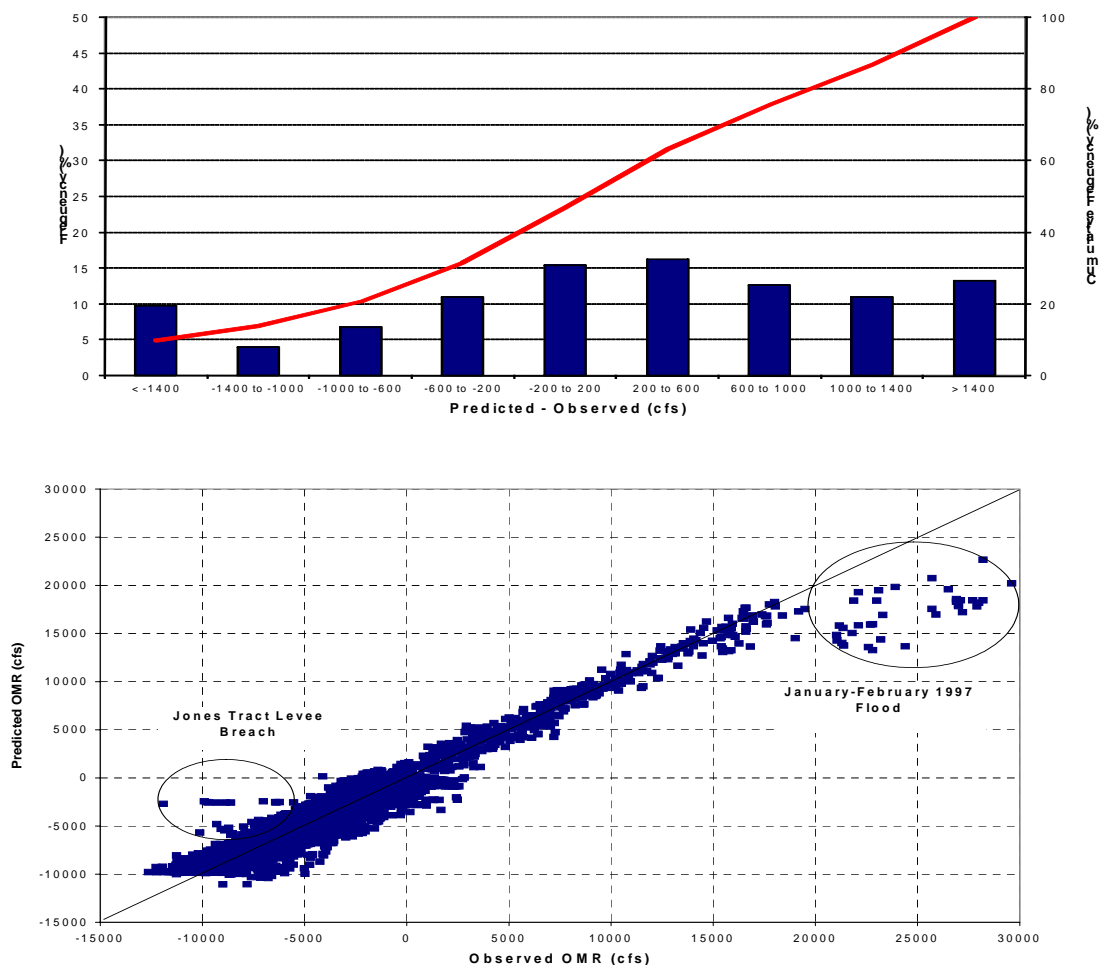
Similar to the DWR model, differences with observed data are within ±600 cfs about 45% of the time and are greater than ±1400 cfs about 25% of the time. Unlike the DWR model, the USGS model does not show a general predictive bias. Data corresponding to the 1997 flood (Jan-Feb 1997) and the Jones Tract levee breach (Jun-Dec 2004) were excluded from the evaluation. Vernalis flow data are suspect during early 1997 due to flood conditions along the San Joaquin River. Data collected during and after the Jones Tract levee breach were excluded due to the unique hydraulic conditions in the south Delta associated with island flooding and pump-off.

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Section 4
Methods: Developing a South Delta Water Balance

The new OMR flow model presented in this report is founded on a simple control volume
or water balance and calibrated with data generated by DSM2. Definition and
development of the water balance is presented in this section. Many, but not all, of the
water balance terms are routinely measured or are estimated though currently available
methods. A statistical method to estimate these unknown water balance terms is
presented in Section 5. Results from Section 5 are incorporated into the water balance
and presented in Section 6 as the new OMR flow model.

Data Used to Calibrate OMR Flow Model

The new OMR flow model was originally calibrated with DSM2 data generated to
simulate 1990-2006 historical conditions. Data from three additional DSM2 simulations
were used to validate the initial model calibration:

- Validation Study 1: 1990-2006 historical conditions without Clifton Court and Jones
  Pumping Plant diversions
- Validation Study 2: 1990-2006 historical conditions without temporary barrier
  installation
- Validation Study 3: 1990-2006 historical conditions without (1) Clifton Court and
  Jones Pumping Plant diversions and (2) temporary barrier installation.

The initial model calibration provided excellent validation with data from Studies 2 and
3. RMS errors were similar to those calculated with the calibration data. The initial
model calibration did not validate as well with data from Study 1. RMS errors were
higher in the summer months of July, August and September. This result suggested that
the Old River flow split in the initial model calibration was biased when south Delta
diversions were high and temporary barriers were installed. As a remedy, the new OMR
flow model was recalibrated with the original data set plus data from Validation Study 1.

Section 3 identified several limitations associated with the use of existing empirical OMR
models for planning purposes. Some of these limitations are linked to the shortcomings
of existing field data used to calibrate the models. The use of DSM2 data for model
calibration addresses these limitations in the following ways:

- Modified Operational Regimes. A numerical model such as DSM2 can produce data
  that cover a wider operational range than observed historically. For example, see the
  above discussion on the use of Validation Study 1 data to calibrate the new OMR
  flow model. Therefore, a model calibrated with DSM2 data will not rely on
  extrapolation to evaluate new operational regimes.
- Modified Net Channel Depletions. The true relationship between net channel
  depletions and OMR flow is difficult to discover in the observed data, presumably
  because of the limited accuracy of current depletion estimates. However, the

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relationship between net channel depletions and DSM2-simulated OMR flow is mathematically defined and is therefore more distinct.

- Consistent Model Analysis. An OMR flow model calibrated with DSM2 data, if implemented in CALSIM, will allow for consistent analysis between CALSIM and DSM2.

DSM2 South Delta Water Balance

Section 2 described several hydraulic forces that determine the volume and direction of flows in Old and Middle Rivers. If the influence of tides is ignored, the following south Delta water balance can be defined to describe OMR flow in term of other riverine flows and diversions:

OMR flow =   San Joaquin River flow @ Vernalis
                    +   Indian Slough flow @ Old River
                    −   San Joaquin River flow downstream of HOR
                    −   Clifton Court Forebay diversions
                    −   Jones Pumping Plant diversions
                    −   CCWD Old River Intake diversions
                    −   South Delta net channel depletion

Indian Slough flow is defined in the above water balance to be positive when flowing upstream (east) into Old River. The assumed sign convention is opposite that used in the DSM2 model. Indian Slough is tidally influenced, so net flows may be positive or negative. Net channel depletion is defined to be positive when depletions exceed accretions. Net channel depletions may be negative in the winter when local precipitation and drainage returns are greater than channel diversions.

The flow in Tom Paine Slough is regulated such that ebbs are not allowed to return to the south Delta. An exact water balance would treat flow into Tom Paine Slough as a diversion from the south Delta, and net channel depletions along the slough would not be explicitly accounted for. This refinement was investigated and, although it improved the water balance marginally, it was not adopted for the sake of simplicity.

The above water balance provides a foundation for the proposed OMR flow model, herein referred to as the MWD model. Data used to compute the south Delta water balance and to calibrate the MWD model are listed in Table 4-1. DSM2 boundary conditions are used in the water balance for San Joaquin River flows at Vernalis and for diversions at Jones Pumping Plant and CCWD Old River intake. Computed data from DWR's Delta Island Consumptive Use (DICU) model (DWR 1995) are used in the water balance for south Delta net channel depletions. DSM2 computed data are used in the water balance for flows at Indian Slough at Old River and San Joaquin River downstream of HOR and for diversions at Clifton Court Forebay. The resulting south Delta water balance was averaged by month for eight years (1998-2006) and is summarized in Table 4-2. CCWD's Old River diversion became operational in late 1997; therefore, data prior to 1998 were excluded from the table.

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If the south Delta water balance accounted for all mechanisms, it should exactly equal the DSM2-computed OMR flow. However, given that tidal influences are ignored, some differences are expected. Figures 4-1 and 4-2 compare 14-day averaged OMR flow from DSM2 with the south Delta water balance. The water balance closely approximates the OMR flow on a 14-day average basis. As shown in Figure 4-2, the south Delta water balance is within ± 150 cfs of the DSM2 estimate about 85% of the time and within ± 350 cfs 97% of the time.

Figure 4-3 illustrates the periodic behavior of the differences between DSM2-computed OMR flow and the south Delta water balance. The residuals exhibit periodic behavior when computed from 7-day averaged data. As shown in the figure, the phasing is not well predicted from the Martinez tidal range. Tidal range is defined as the difference between daily maximum and daily minimum water levels.

References

DWR (1995). *Estimation of Delta Island Diversions and Return Flows*. Division of Planning, February.

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Table 4-1
DSM2 Data Used in South Delta Water Balance and MWD OMR Model Calibration

Data Type	Data Location	DSM2 Channel or Node	Observed or Computed Data
River Flow	Old River @ Bacon Island	Channel 106	Computed
River Flow	Middle River @ Bacon Island	Channels 144 and 145	Computed
River Flow	San Joaquin River @ Vernalis	Node 1	Observed
River Flow	Indian Slough @ Old River	Channel 236	Computed
River Flow	San Joaquin River d/s HOR	Channel 8	Computed
Diversion	Clifton Court Forebay	Node 72	Computed
Diversion	Jones Pumping Plant	Node 181	Observed
Diversion	CCWD Intake @ Old River	Diversion from Channel 90	Observed
Diversion	South Delta Net Channel Depletions	Diversions/returns from several nodes	Computed [1]
Temporary Barrier Operation	Head of Old River Fish Barrier	Channel 54	Observed
Temporary Barrier Operation	Grant Line Canal Agricultural Barrier	Channel 206	Observed
Temporary Barrier Operation	Old River Agricultural Barrier	Channel 79	Observed
Temporary Barrier Operation	Middle River Agricultural Barrier	Channel 134	Observed

[1] From DICU model (DWR 1995)

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Table 4-2
Monthly Average South Delta Water Balance (cfs): 1998-2006

Month	Old & Middle Rivers	San Joaquin River @ Vernalis	Indian Slough @ Old River	South Delta Net Channel Depletions	San Joaquin River d/s HOR	Clifton Court Forebay Diversions	Jones Pumping Plant Diversions	CCWD Diversions @ Old River	Water Balance [1]	Difference (9) – (1)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Jan	-5850	4034	377	185	-1554	-5125	-3642	-98	-5824	26
Feb	-4275	6307	268	356	-2520	-4560	-3895	-139	-4183	92
Mar	-3043	8288	181	41	-3589	-4311	-3598	-99	-3085	-43
Apr	-718	8681	-14	-163	-3856	-2932	-2238	-144	-665	53
May	1271	8873	-193	-392	-4574	-1116	-1205	-116	1276	5
Jun	-2361	7503	6	-719	-3396	-2700	-2894	-191	-2392	-31
Jul	-7496	4785	294	-926	-2120	-5209	-4209	-154	-7539	-43
Aug	-9298	2621	440	-671	-1168	-6082	-4326	-135	-9320	-23
Sep	-8962	2368	476	-383	-1105	-5918	-4291	-118	-8971	-10
Oct	-7403	2633	414	-252	-1434	-4455	-4220	-94	-7407	-4
Nov	-6639	2490	388	-184	-1284	-4099	-3912	-74	-6675	-36
Dec	-5927	2246	359	-103	-741	-4378	-3266	-35	-5917	10

[1] Sum of Columns (2) thru (8)

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Figure 4-1
Comparison of OMR Flow and South Delta Water Balance
14-day Averaged DSM2 Data: 1990-2006
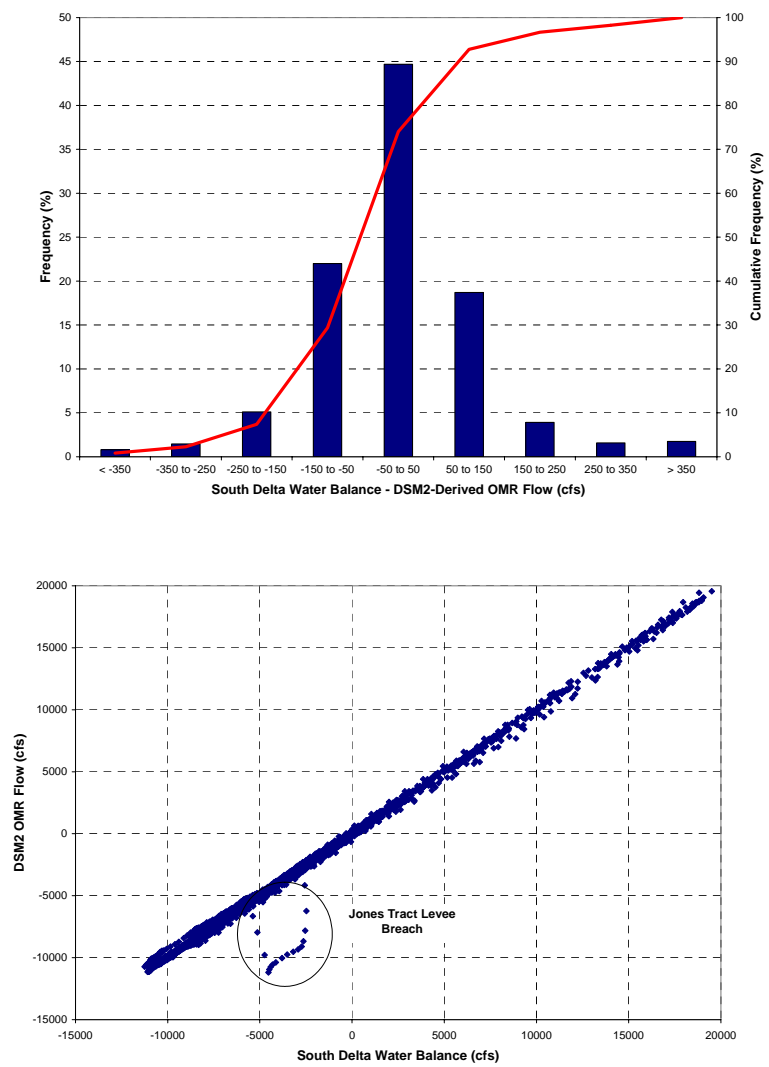
*The south Delta water balance closely approximates DSM2-simulated OMR flow on a 14-day
average basis. The south Delta water balance is within ± 150 cfs of the DSM2 estimate about
85% of the time and within ± 350 cfs 97% of the time. The water balance does not account for
unique hydraulic conditions in the south Delta associated with Jones Tract island flooding and
pump-off during and after the levee failure.*

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Figure 4-2
Comparison of Water Balance Residual and Martinez Tidal Range
7-day DSM2 Averages: Jul 1994 - Dec 1994
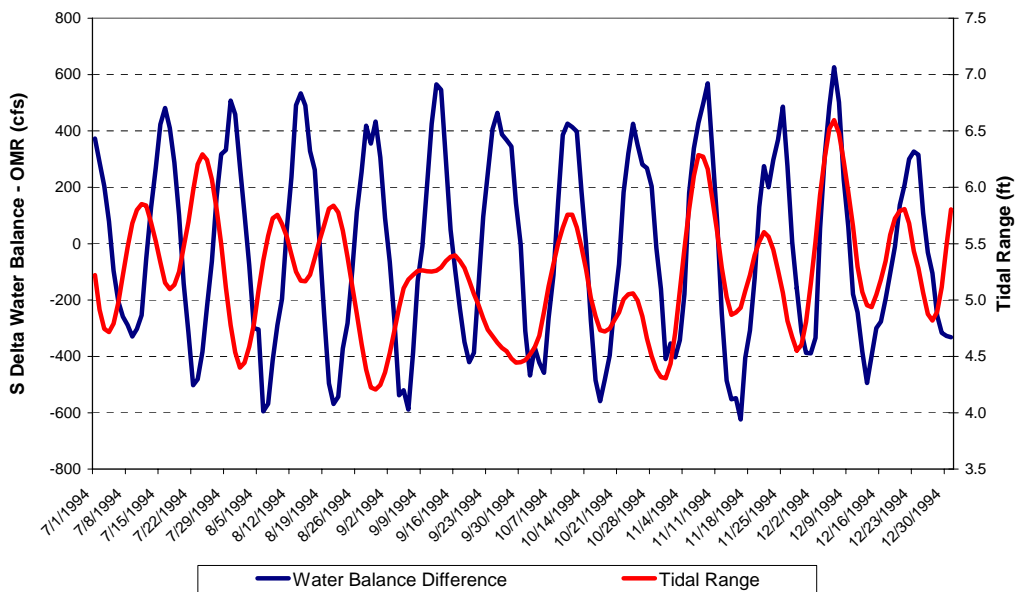
The residuals between DSM2-computed OMR flow and the south Delta water balance exhibit periodic behavior when computed from 7-day averaged data. As shown in the figure, the phasing is not well predicted from the Martinez tidal range. Tidal range is defined as the difference between daily maximum and daily minimum water levels.

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Section 5
Methods: Developing Statistical Relationships for Unknown Water Balance Terms

As discussed in the previous section, a south Delta water balance developed with DSM2 data provides a foundation for the MWD OMR flow model. Since most of the water balance terms are measured in the field or estimated through currently available methods, these terms are defined as independent variables in the MWD model. Two key water balance terms, Indian Slough flow at Old River and San Joaquin River flow downstream of HOR, are not measured in the field or estimated through currently available methods. Therefore, regression equations were developed with DSM2 data to predict these terms.

Indian Slough Flow @ Old River

Figure 5-1 shows a linear relationship between 14-day averaged Indian Slough flow and 14-day OMR flow, as provided by DSM2, where positive flow is defined as flowing upstream (east) into Old River. Regression statistics are provided in Table 5-1. All data points generated in the DSM2 simulation of historical conditions were used to develop the relationship. This relationship suggests that, as OMR downstream flow increases, Indian Slough flow decreases (or moves downstream in a westerly direction away from Old River). A practical implication of this relationship is that, under low flow conditions, south Delta water diversions have less than a 1-to-1 effect on gauged Old and Middle River reverse flows. If this bypass did not exist, a 1-to-1 effect would exist (ignoring the influence of south Delta water diversions on the HOR flow split), i.e. an additional 100 cfs south Delta diversion would result in 100 cfs of additional reverse flow measured in Old and Middle Rivers.

A similar regression analysis was performed with daily averaged flows. The resulting relationship was nearly identical to the relationship developed with 14-day averaged flows; however, the data scatter was greater.

An attempt was made to refine the above relationship by removing data corresponding to periods when the south Delta water balance does not compare favorably with DSM2 generated OMR flows. Removing data from two specific periods (January-February 1997 flood and June-December 2004 Jones Tract levee breach) did not result in a more refined relationship, however.

A residuals analysis revealed a strong seasonal trend that was correlated with net channel depletions in Indian Slough and Rock Slough. For the same OMR flow, Indian Slough flows into Old River are higher when local net channel depletions are lower. The 14-day averaged Indian Slough flow relationship was improved by adding an additional term for local depletions (see Table 5-1). Curiously, CCWD diversions from Rock Slough did not appear to be a statistically significant factor in estimating Indian Slough flow.

Although the refined Indian Slough relationship provided better correspondence with DSM2 data, it was not incorporated into the final model discussed in Section 6. The better fit with DSM2 data did not translate into a better fit with observed data, probably

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due to difficulties in estimating net channel depletions in Indian Slough and Rock Slough. Therefore, it was determined that the additional model complexity was not warranted.

San Joaquin River Flow Downstream of HOR

Figure 5-2 shows a linear relationship between daily averaged San Joaquin River flow downstream of HOR and daily averaged San Joaquin River flow at Vernalis as provided by DSM2. As shown in the figure, the relationship is strongly influenced by operation of the HORB. When the HORB is not installed, San Joaquin River flows downstream of HOR increase as Vernalis flows increase. When the HORB is installed in the fall (partial) and spring (full), less water is diverted into Old River and San Joaquin River flows downstream of HOR increase at a faster rate as Vernalis flows increase. The actual flow split is dictated by culvert and weir operation and installed barrier height; these factors vary between fall and spring and also vary from year to year.

Focusing on lower-flow periods when the HORB is not installed, Figure 5-3 shows that installation of the Grant Line Canal barrier influences the flow split at HOR. Installation of the Grant Line Canal barrier results in a larger fraction of Vernalis flow remaining in the San Joaquin River downstream of the HOR by increasing water levels in the south Delta. Limited data suggests that the influence on HOR flow split is due solely to Grant Line Canal barrier installation rather than concurrent installation of all agricultural barriers. This conclusion is based on 95 data points simulated during the following periods: Jul 11-Oct 2, 1996, Nov 8-14, 2005, and Nov 17-20, 2006. During these periods, the Grant Line Canal barrier is installed alone or with one additional agricultural barrier. The flow split during these periods is consistent with periods when all agricultural barriers are installed.

The HOR flow split is also influenced by south Delta diversions when the HORB and Grant Line Canal barriers are not installed. South Delta diversions result in a smaller fraction of Vernalis flow remaining in the San Joaquin River downstream of the HOR by decreasing water levels in the south Delta. Figure 5-4 compares the flow split at low and high south Delta diversions. The figure shows that, as Vernalis flows increase, the influence of south Delta diversions on the HOR flow split diminishes.

An overflow weir is installed on Paradise Cut at the junction with the San Joaquin River. When Vernalis flows exceed 16,000 cfs, some flow is diverted into the south Delta at Paradise Cut before reaching the HOR (Hildebrand, A. 2007). The relationship between daily averaged Paradise Cut flow and daily averaged Vernalis flow, as provided by DSM2, is shown in Figure 5-5. Therefore, at higher Vernalis flows, a smaller fraction of Vernalis flow moves downstream of the HOR. The figure shows a change in slope when Vernalis and Paradise Cut flows exceed 28,000 cfs and 7,000 cfs, respectively.

The relationship between daily averaged San Joaquin River flow downstream of HOR and daily averaged San Joaquin River flow at Vernalis shows more data scatter at low Vernalis flows. Incorporating San Joaquin River net channel depletions between Vernalis and HOR did not reduce the observed scatter. By using daily averaged data, the

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proposed relationships assume tidal influence is negligible. As Vernalis flows decrease, this assumption becomes less valid. Under these conditions, downstream flows sometimes reverse and are dominated by tidal conditions. Regression analysis results are summarized in Table 5-2. Residuals analysis confirms that the flow split is influenced by tidal conditions when Vernalis flows are low to modest.

The regression analysis implies that the HOR flow split, defined as the ratio of Old River flow to Vernalis flow, decreases as Vernalis flows increase and approaches 0.5 at high Vernalis flows. The implied ratio is approximately 0.6-0.8 at moderate flow levels, depending on south Delta diversions. And as discussed above, under low flow conditions, tidal conditions can cause San Joaquin River flows downstream of HOR to reverse and result in all flow moving through Old River.

DWR has recently collected flow data on the San Joaquin River downstream of HOR at Lathrop (Mayr, S. 2007). Figure 5-6 compares these 24-hour daily averaged flow measurements for the period October 19, 2005 through September 30, 2006 with (1) estimates produced by the statistical relationship and (2) USGS flow measurements at Stockton (Smith, P. 2007b). All three data sets are generally consistent with two notable exceptions:

- The statistical relationship underestimates the peak flow of 14,000 to 15,000 cfs observed at Lathrop and Stockton in mid-April 2006.
- The observed data at Lathrop deviates from statistical estimates and Stockton measurements in late April and May 2006.

References

Hildebrand, A. (2007). Personal communication, September 18.

Mayr, S. (2007). Personal communication, October 15.

Smith, P. (2007b). Personal communication, November 9.

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Table 5-1
Regression Analysis Results:
Statistical Models of Indian Slough Flow at Old River
$Q_{Indian\ Slough}$ (cfs) = A * Q_{OMR} (cfs) + B * $Q_{Local\ Diversions}$ (cfs) + C

Model	N	A	B	C	R2	SEE (cfs)
Preferred	6194	-0.0638	0	-72	0.952	71
Alternate	6193	-0.0669	-0.679	-36	0.990	33

N= number of observations; R2=coefficient of determination; SEE=standard error of estimate

Table 5-2
Regression Analysis Results:
Statistical Model of San Joaquin River Flow Downstream of Head of Old River

$Q_{SJR\ d/s\ HOR}$ (cfs) = A * $Q_{Vernalis}$ (cfs) + B * $Q_{South\ Delta\ Diversions}$ (cfs) + C

HORB	GLC Barrier	Vernalis (cfs)	N	A	B	C	R2	SEE (cfs)	Comments
Out	Out	< 16,000	7167	0.499	-0.0312	-161	0.996	112	
Out	Out	16000-28000	622	0.276	0	3128	0.991	84	Weir allows flow in Paradise Cut
Out	Out	> 28000	214	0.327	0	1677	0.983	180	Weir allows flow in Paradise Cut, but at a lower rate
Out	In	All	2055	0.554	-0.0168	-45	0.918	127	
In (Spring)	Out/In	All	586	0.916	0	-146	0.978	219	
In (Fall)	Out/In	All	1251	0.747	-0.0109	-24	0.961	109	

N= number of observations; R2=coefficient of determination; SEE=standard error of estimate

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Figure 5-1
Flow Relationship Between Indian Slough @ Old River and OMR
14-Day Averaged DSM2 Data 1990-2006
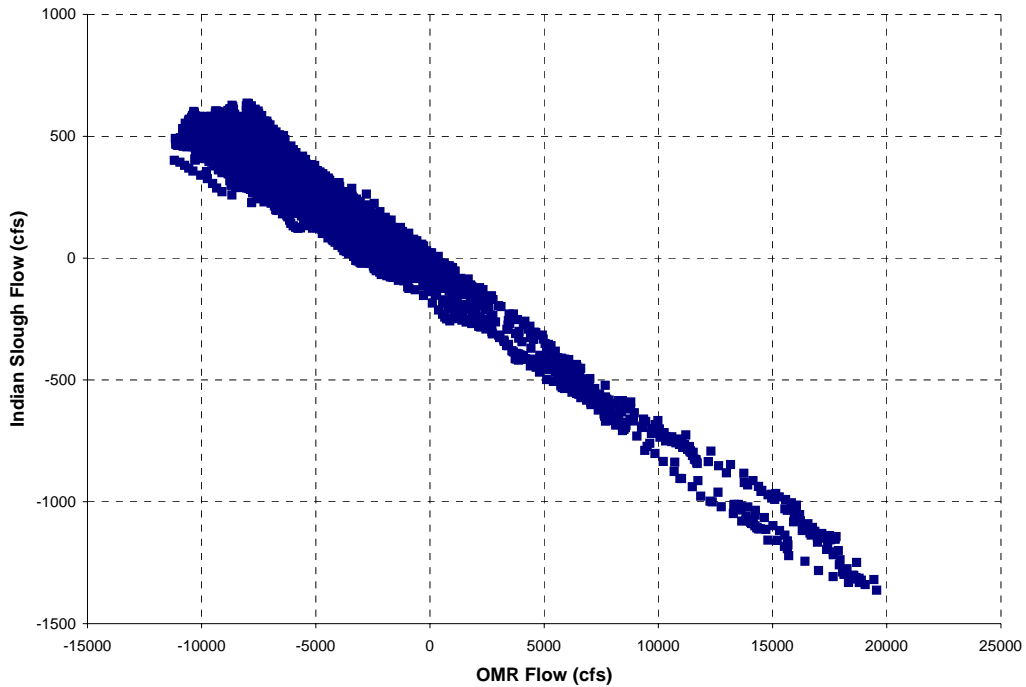
The above figure shows an inverse linear relationship between 14-day averaged Indian Slough flow and 14-day averaged OMR flow, where positive flow is defined as flowing upstream (east) into Old River. Thus, as OMR flows increase, Indian Slough flows decrease (or move downstream in a westerly direction away from Old River). A practical implication of this relationship is that, under low flow conditions, south Delta water diversions have less than a 1-to-1 effect on Old and Middle River reverse flows.

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Figure 5-2
Flow Relationship Between San Joaquin River d/s HOR & Vernalis
Influence of HORB
Daily Average DSM2 Data 1990-2006
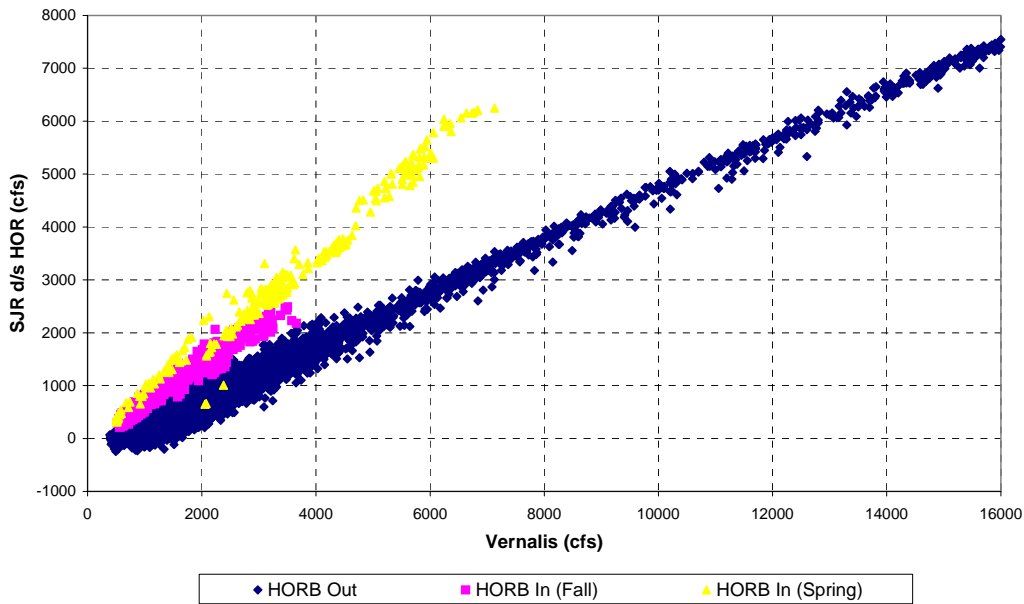
The above figure shows a linear relationship between daily averaged San Joaquin River flow downstream of HOR and daily averaged San Joaquin River flow at Vernalis. The relationship is strongly influenced by operation of the HORB. When the HORB is installed in the fall (partial) and spring (full), less water is diverted into Old River and San Joaquin River flows downstream of HOR increase at a faster rate as Vernalis flows increase.

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Figure 5-3
Flow Relationship Between San Joaquin River d/s HOR & Vernalis
Influence of Grant Line Canal Barrier
Daily Average DSM2 Data 1990-2006 (HORB Out)
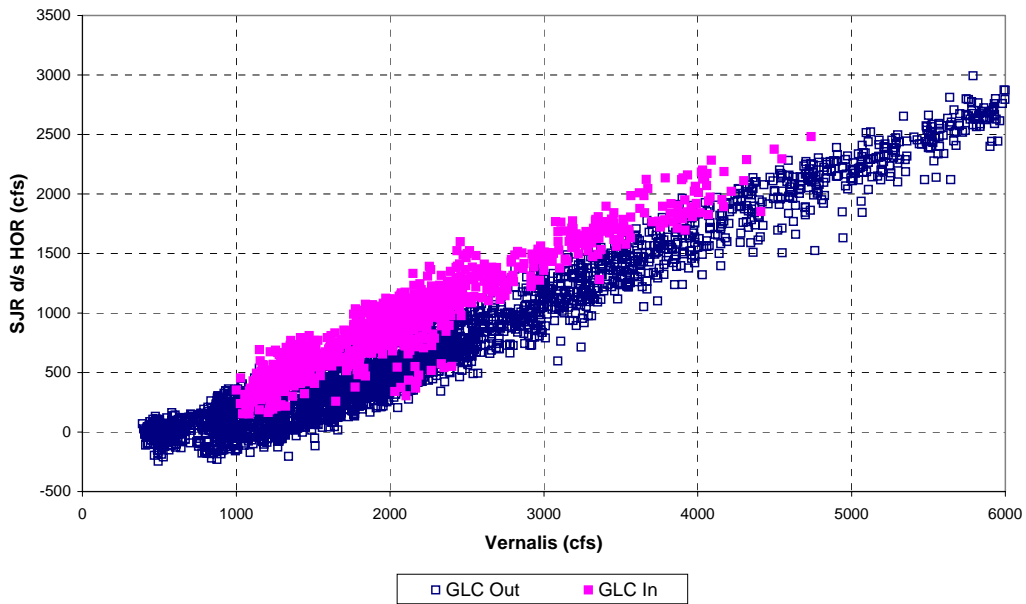
Installation of the Grant Line Canal barrier results in a larger fraction of Vernalis flow moving in the San Joaquin River downstream of the HOR by increasing water levels in the south Delta.

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Figure 5-4
Flow Relationship Between San Joaquin River d/s HOR & Vernalis
Influence of South Delta Diversions
Daily Average DSM2 Data 1990-2006 (HORB & GLC Barriers Out)
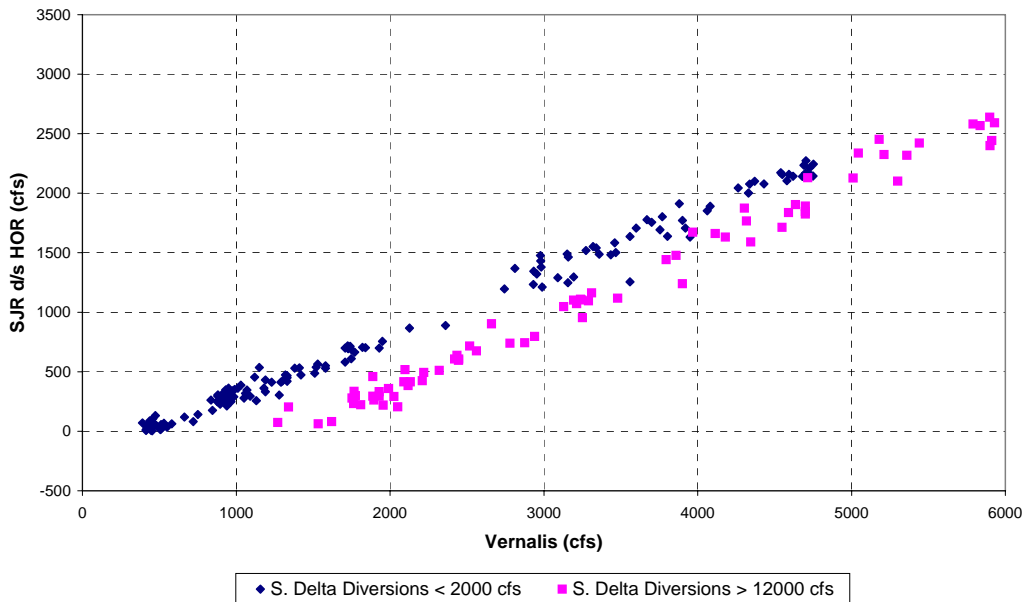
The HOR flow split is influenced by south Delta diversions when the HORB and Grant Line Canal barriers are not installed. South Delta diversions result in a smaller fraction of Vernalis flow remaining in the San Joaquin River downstream of the HOR by decreasing water levels in the south Delta. The figure shows that, as Vernalis flows increase, the influence of south Delta diversions on the HOR flow split diminishes.

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Figure 5-5
Flow Relationship Between San Joaquin River at Paradise Cut & Vernalis
Daily Average DSM2 Data 1990-2006
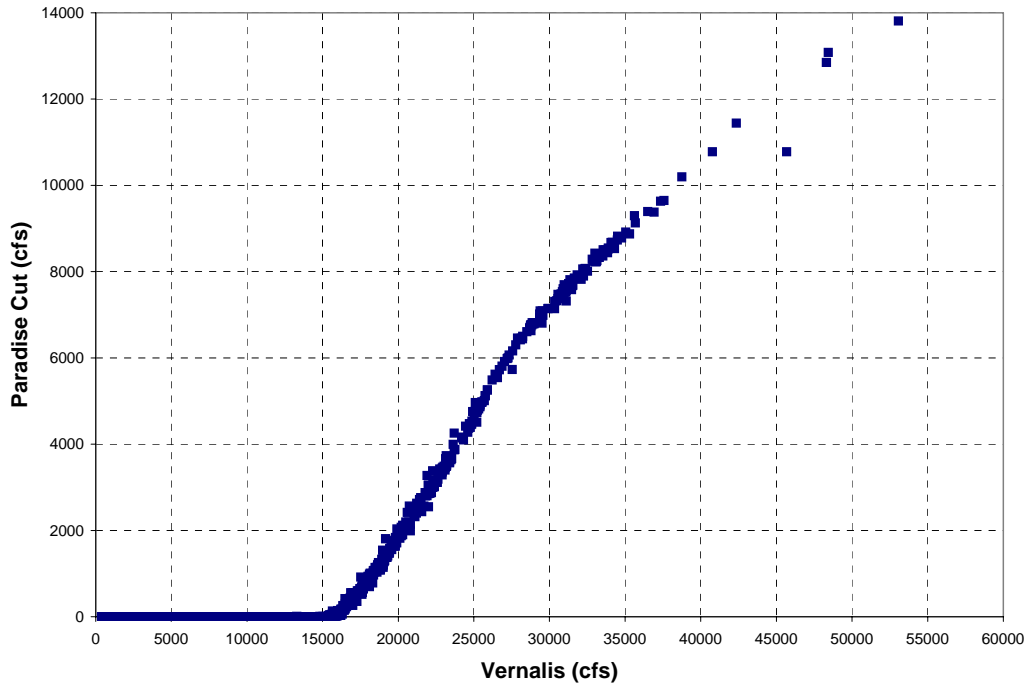
*An overflow weir is installed on Paradise Cut at the junction with the San Joaquin River. When
Vernalis flows exceed 16,000 cfs, some flow is diverted into the south Delta at Paradise Cut
before reaching the HOR. Thus, at higher Vernalis flows, a smaller fraction of Vernalis flow
moves downstream of the HOR. The figure shows a change in slope when Vernalis and Paradise
Cut flows exceed 28,000 cfs and 7,000 cfs, respectively.*

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Figure 5-6
Comparison of Predicted & Observed San Joaquin River Flow Downstream of HOR
October 19, 2005 – September 30, 2006
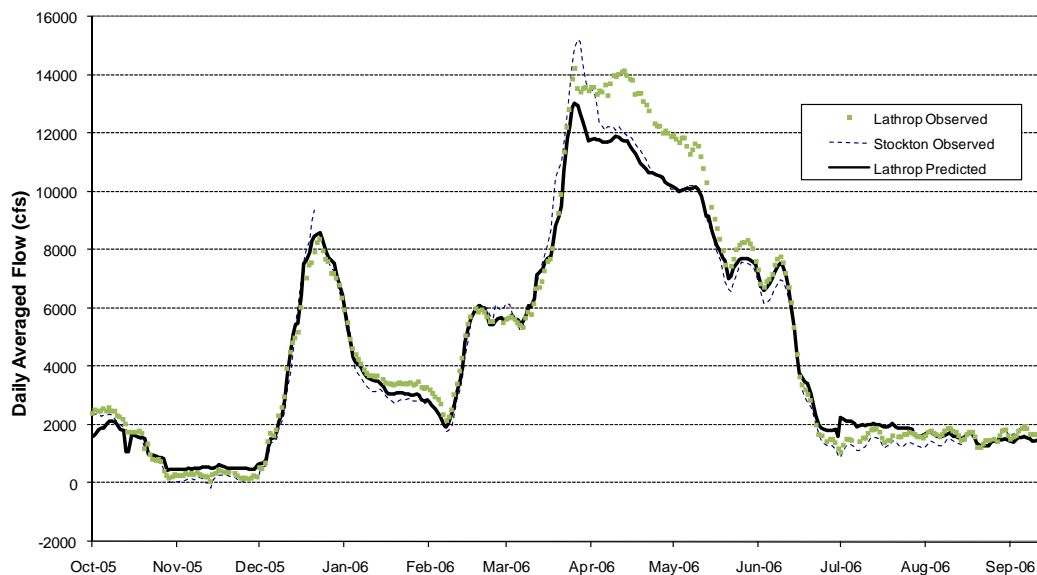
DWR has recently collected flow data on the San Joaquin River downstream of HOR at Lathrop (Mayr, S. 2007). These flow data are generally consistent with predictions from the statistical relationship and are generally consistent with USGS measurements at Stockton (Smith, P. 2007b). However, the observed data at Lathrop deviates from predicted values and Stockton measurements in late April and May 2006.

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Section 6
Results

Predictive equations for OMR flow were developed by incorporating the statistical relationships for Indian Slough at Old River and San Joaquin River downstream of HOR (developed in Section 5) into the south Delta water balance presented in Section 4. The resulting MWD model is a function of Vernalis flow, south Delta diversions, and south Delta barrier operations. South Delta diversions are the sum of Clifton Court Forebay diversions, Jones Pumping Plant diversions, CCWD diversions at Old River, and south Delta net channel depletions. Model constants are provided in Table 6-1.

Comparison with DSM2 Data

Figure 6-1 compares 14-day averaged OMR flows as generated by DSM2 and the MWD model for the 1990-2006 period. The MWD model estimates are within ± 150 cfs of the DSM2 OMR estimates more than 75% of the time and are within ± 350 cfs 98% of the time.

Comparison with Observed Data

Daily averaged OMR flows predicted by the MWD model are compared with daily averaged observed data in Figure 6-2. Differences with observed data are within ± 600 cfs about 60% of the time. Differences are greater than ± 1400 cfs about 5% of the time. Similar to the DSM2 model, the MWD model shows a modest bias to underestimate OMR flow. Time series comparisons of predicted and observed 14-day averaged OMR flow are shown in Appendix 6A.

Model Uncertainty

Model uncertainty was evaluated by computing safety factors or "buffers" needed to avoid exceeding an OMR flow objective with 95% confidence. A buffer of 300 cfs indicates that, for a flow objective of -5000 cfs, operations decisions would be based on meeting a more stringent flow of -4700 cfs. Larger buffers result in higher water costs. The following forecast applications were evaluated:

- 3-day forecast of 14-day averaged OMR flows
- 5-day forecast of 14-day averaged OMR flows
- 3-day forecast of 7-day averaged OMR flows
- 5-day forecast of 7-day averaged OMR flows

Buffers required for the months of December through June are summarized in Table 6-2. Probability exceedence curves associated with 14-day and 7-day averages are presented in Appendix 6B. The exceedence curves may be used to select buffers with confidence levels other than 95%.

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A 3-day forecast of 14-day averaged OMR flows takes advantage of 11 observed values; a 5-day forecast of 14-day averaged OMR flows takes advantage of only 6 observed values. Similarly, a 3-day forecast of 7-day averaged OMR flows takes advantage of 4 observed values; a 5-day forecast of 7-day averaged OMR flows takes advantage of 7 observed values. The buffer values and exceedence curves associated with the "MWD Equation" assume no knowledge of antecedent conditions.

The table and exceedence curves show that longer flow averaging periods can be forecasted with greater certainty, and therefore can rely on smaller buffers (and lower water costs) to meet OMR flow objectives. Buffers required to meet 7-day averaged flow objectives are approximately twice as large as buffers required to meet 14-day averaged flow objectives.

The table and exceedence curves also show that 3-day forecasts can be estimated with greater certainty than 5-day forecasts, and therefore can rely on smaller buffers. Buffers required for a 5-day forecast are approximately 50% greater than those required for a 3-day forecast. When no knowledge of antecedent conditions are available for a forecast (e.g. a 7-day averaged OMR flow forecasted beyond 7 days), required buffers are approximately twice as large as those required for a 3-day forecast.

Buffer size does not vary greatly between months, although April and May tend to be somewhat higher. Because the buffers were developed from measured data, the April and May buffers represent data that measures the influence of HORB operations. It is anticipated that the MWD model will provide more accurate OMR flow estimates for conditions when the HORB is not installed; therefore, buffer requirements for April and May could be more consistent with other months.

Tables 6-3 and 6-4 compare planning-level estimates of water costs associated with 300 cfs and 600 cfs operations buffers. These estimates are useful for comparison only, as the assumed OMR objectives only roughly approximate the recent court ruling. The 300 cfs buffer is representative of a 3-day forecast of 14-day averaged OMR flows; the 600 cfs buffer is representative of a 3-day forecast of 7-day averaged OMR flows.

The annual costs of a 300 cfs buffer range from 90-150 TAF for a -750 cfs OMR objective and from 20-70 TAF for a -5000 cfs OMR objective, depending on water year type. The annual costs of a 600 cfs buffer range from 190-230 TAF for a -750 cfs OMR objective and from 50-140 TAF for a -5000 cfs OMR objective.

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Table 6-1
MWD OMR Flow Model Coefficients

$$Q_{OMR} \text{ (cfs)} = A * Q_{Vernalis} + B * Q_{South\ Delta\ Diversions} + C$$

Where: $Q_{South\ Delta\ Diversions} = Q_{CCF} + Q_{Jones} + Q_{CCWD} + Q_{South\ Delta\ NCD}$

HORB	GLC Barrier	Vernalis (cfs)	A	B	C
Out	Out	< 16,000	0.471	-0.911	83
Out	Out	16,000-28,000	0.681	-0.940	-3008
Out	Out	> 28,000	0.633	-0.940	-1644
Out	In	All	0.419	-0.924	-26
In (Spring)	Out/In	All	0.079	-0.940	69
In (Fall)	Out/In	All	0.238	-0.930	-51

Table 6-2
OMR Flow Buffers with 95% Confidence (cfs)

Month	14-Day Averaged OMR Flow			7-Day Averaged OMR Flow		
	3-Day Forecast	5-Day Forecast	MWD Equation	3-Day Forecast	5-Day Forecast	MWD Equation
Dec	300	450	700	600	850	1000
Jan	250	350	450	500	700	800
Feb	250	350	500	500	700	850
Mar	200	300	300	350	550	600
Apr	300	450	700	600	900	1050
May	300	450	850	600	950	1200
Jun	250	350	700	450	650	850
12 Months	300	400	750	550	850	1000

Notes on USGS Observed Data Used to Develop Buffers:
1) 24-hour averages were computed from raw 15-minute data
2) 24-hour data were filled based on correlations between Old and Middle Rivers
3) The period Jan 1, 1990 thru Sep 30, 2006 was used to develop buffers except as noted below
      3a) Events when OMR flow was > 0 cfs were excluded from buffer calculations
      3b) The period Jun 1, 2004 thru Dec 31, 2004 was excluded from buffer calculations (Jones Tract levee failure)

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Table 6-3
Export Reductions Required to Meet a 300 cfs OMR Buffer
**January-June with No South Delta Barrier Operations**
(TAF per year)

Water Year Type	OMR > -750 cfs			OMR > -5000 cfs		
	Without Buffer	With Buffer	Water Cost	Without Buffer	With Buffer	Water Cost
73-Year Average	1540	1650	110	380	430	50
Wet	1390	1480	90	310	350	40
Above Normal	1800	1920	120	480	540	60
Below Normal	1840	1960	150	480	550	70
Dry	1710	1830	120	450	510	60
Critical	890	990	100	190	210	20

Table 6-4
Export Reductions Required to Meet a 600 cfs OMR Buffer
January-June with No South Delta Barrier Operations
(TAF per year)

Water Year Type	OMR > -750 cfs			OMR > -5000 cfs		
	Without Buffer	With Buffer	Water Cost	Without Buffer	With Buffer	Water Cost
73-Year Average	1540	1760	220	380	490	110
Wet	1390	1580	190	310	400	90
Above Normal	1800	2030	230	480	610	130
Below Normal	1840	2070	230	480	620	140
Dry	1710	1940	230	450	580	130
Critical	890	1090	200	190	240	50

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Figure 6-1
Comparison of DSM2 and MWD Model OMR Flow Predictions
14-Day Averaged Flows 1990-2006
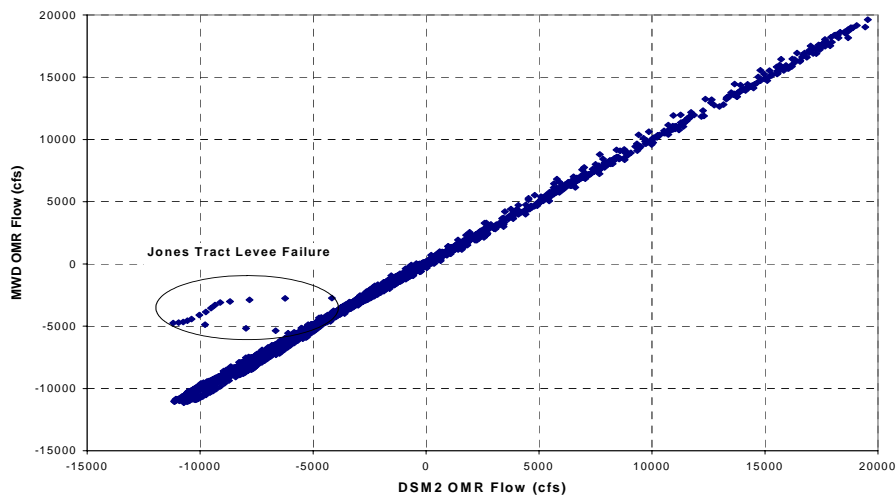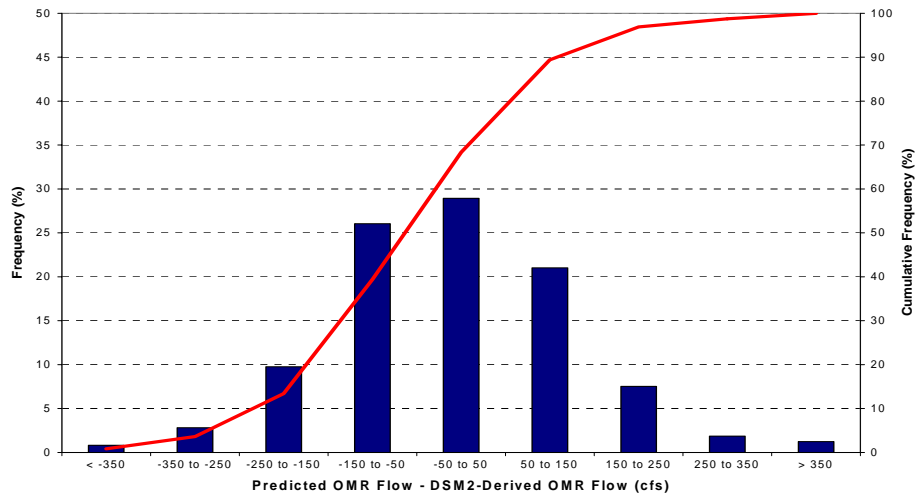
The MWD model closely approximates DSM2-simulated OMR flow on a 14-day average basis. The MWD model estimates are within ± 150 cfs of the DSM2 OMR estimates more than 75% of the time and are within ± 350 cfs 98% of the time. The MWD model does not account for unique hydraulic conditions in the south Delta associated with Jones Tract island flooding and pump-off during and after the levee failure.

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Figure 6-2
Comparison of Predicted & Observed OMR Flow: MWD Model
January 1, 1990 – September 30, 2006
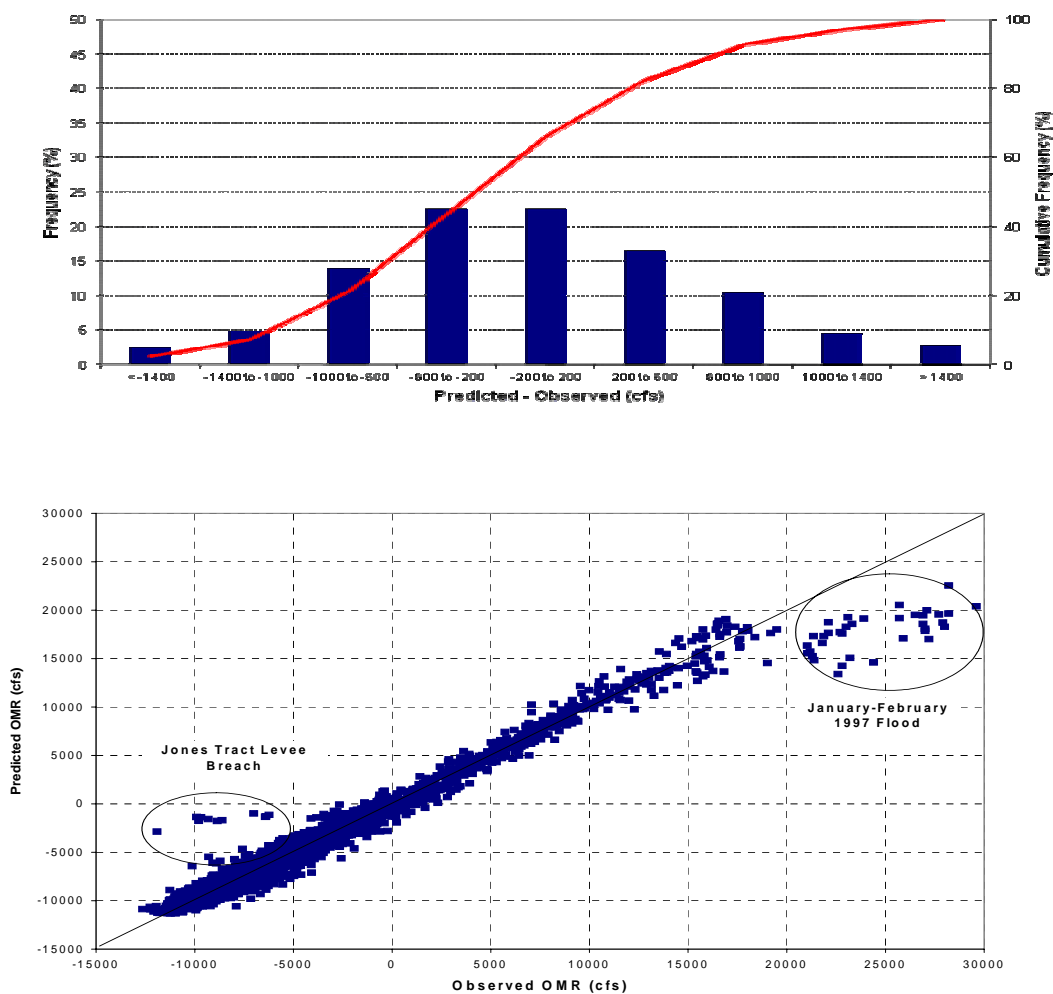
Differences with observed data are within ± 600 cfs over 60% of the time. Differences are greater than ± 1400 cfs about 5% of the time. As with the DSM2 model, the MWD model shows a modest bias to underestimate OMR flow. Data corresponding to the 1997 flood (Jan-Feb 1997) and the Jones Tract levee breach (Jun-Dec 2004) were excluded from the evaluation. Vernalis flow data are suspect during early 1997due to flood conditions along the San Joaquin River. Data collected during and after the Jones Tract levee breach were excluded due to the unique hydraulic conditions in the south Delta associated with island flooding and pump-off.

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Appendix 6A
MWD Model Time Series Graphs

Figures

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Figure 6A-1
Observed & Predicted 14-Day OMR Flow
1990-91

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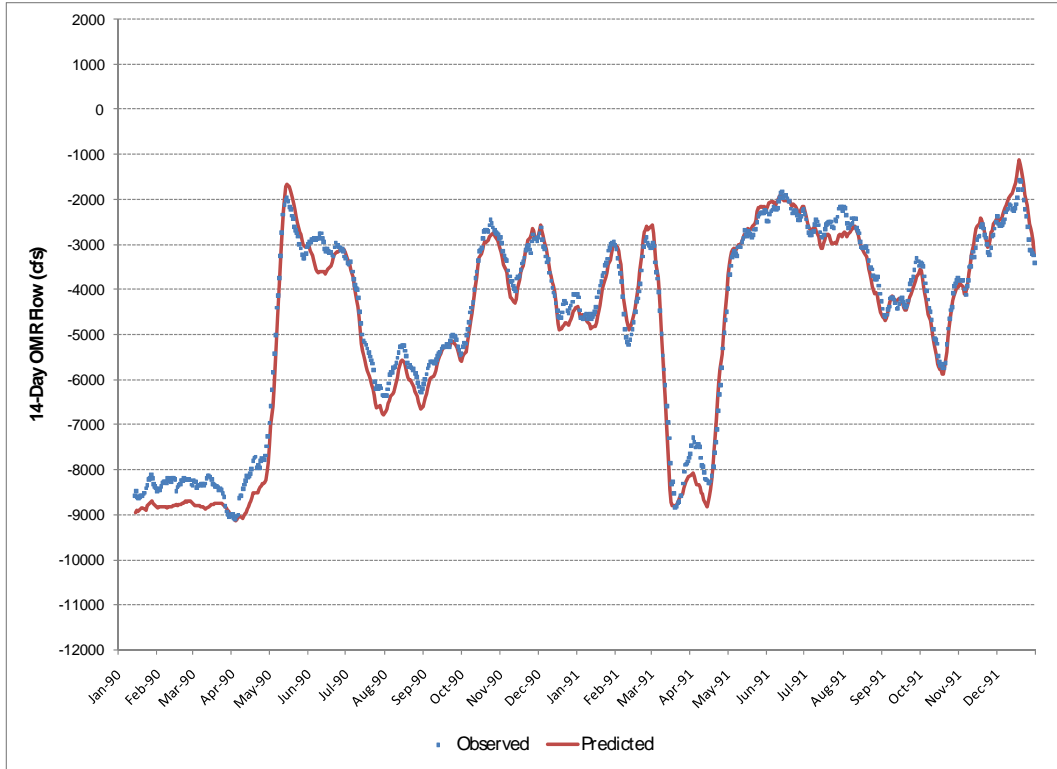
Figure 6A-2
Observed & Predicted 14-Day OMR Flow
1992-93

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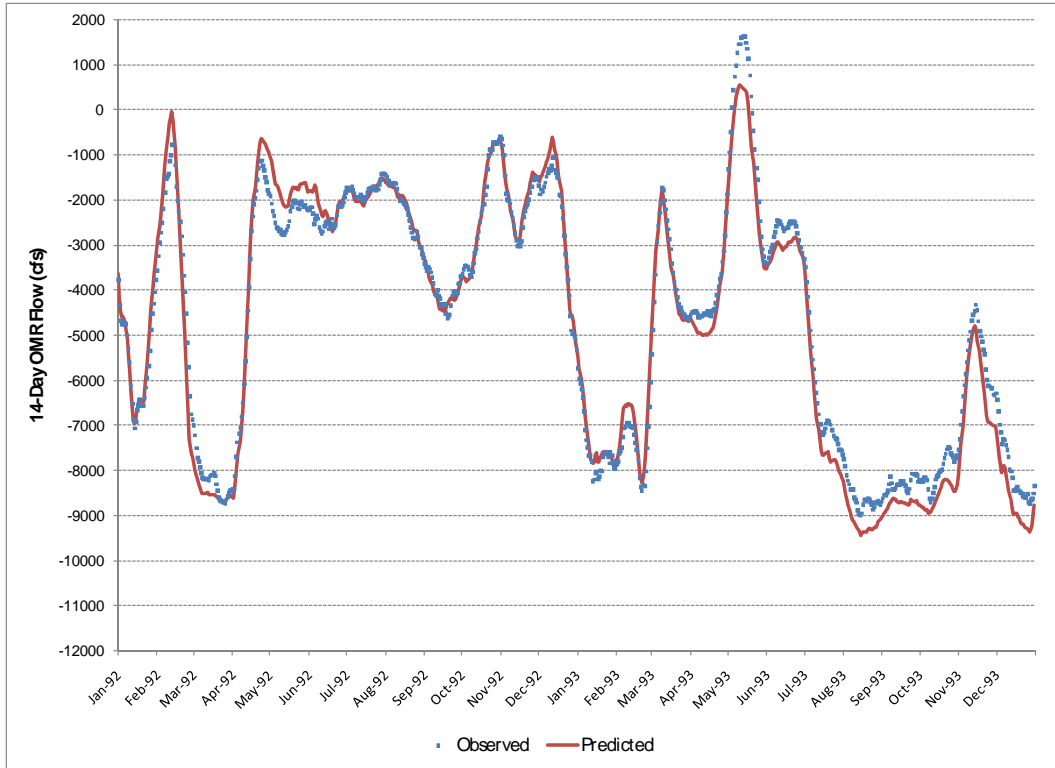
Figure 6A-3
Observed & Predicted 14-Day OMR Flow
1994-95

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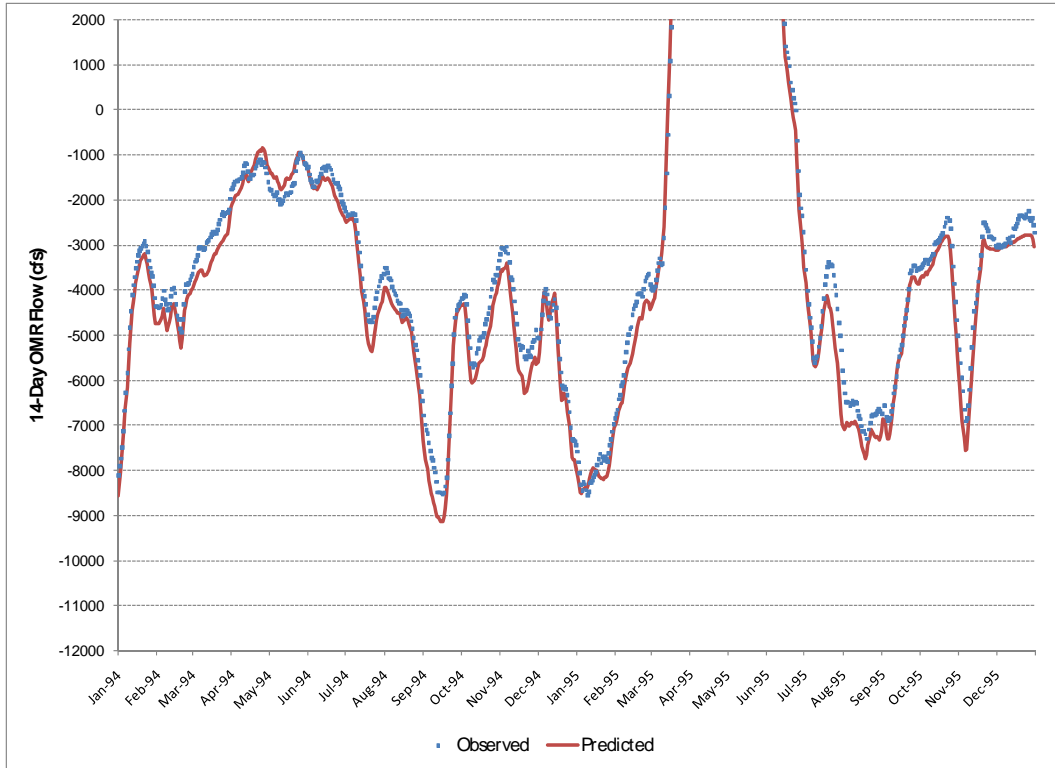
**Figure 6A-4
Observed & Predicted 14-Day OMR Flow
1996-97**

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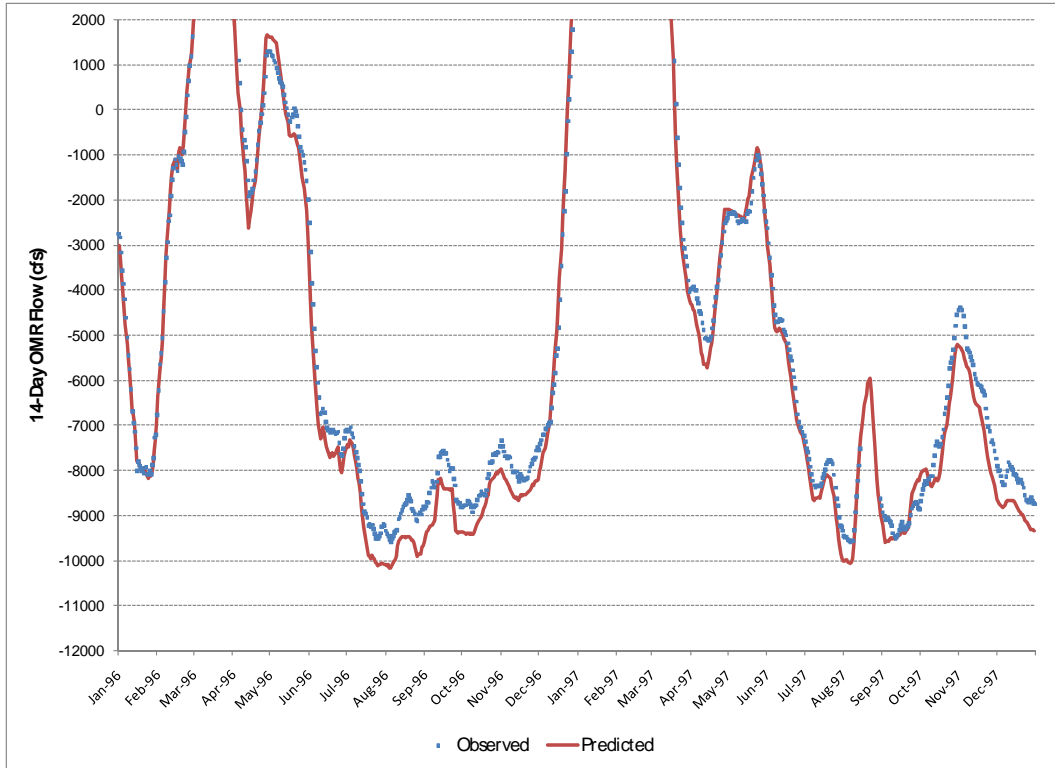
Figure 6A-5
Observed & Predicted 14-Day OMR Flow
1998-99

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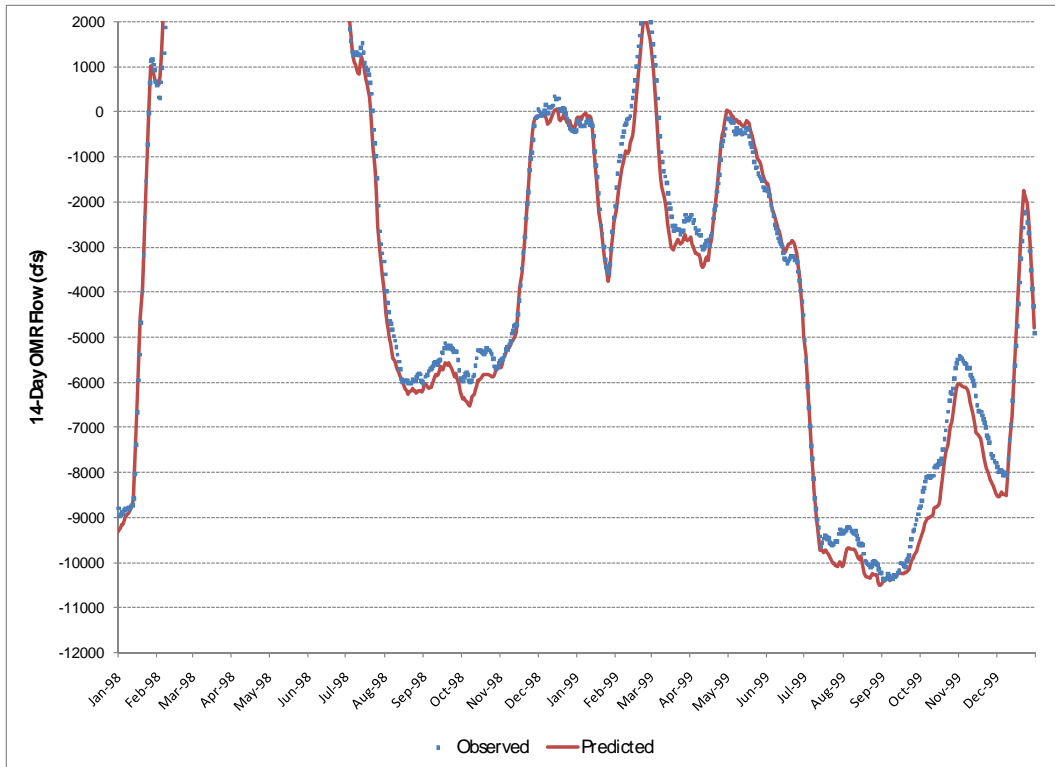
Figure 6A-6
Observed & Predicted 14-Day OMR Flow
2000-01

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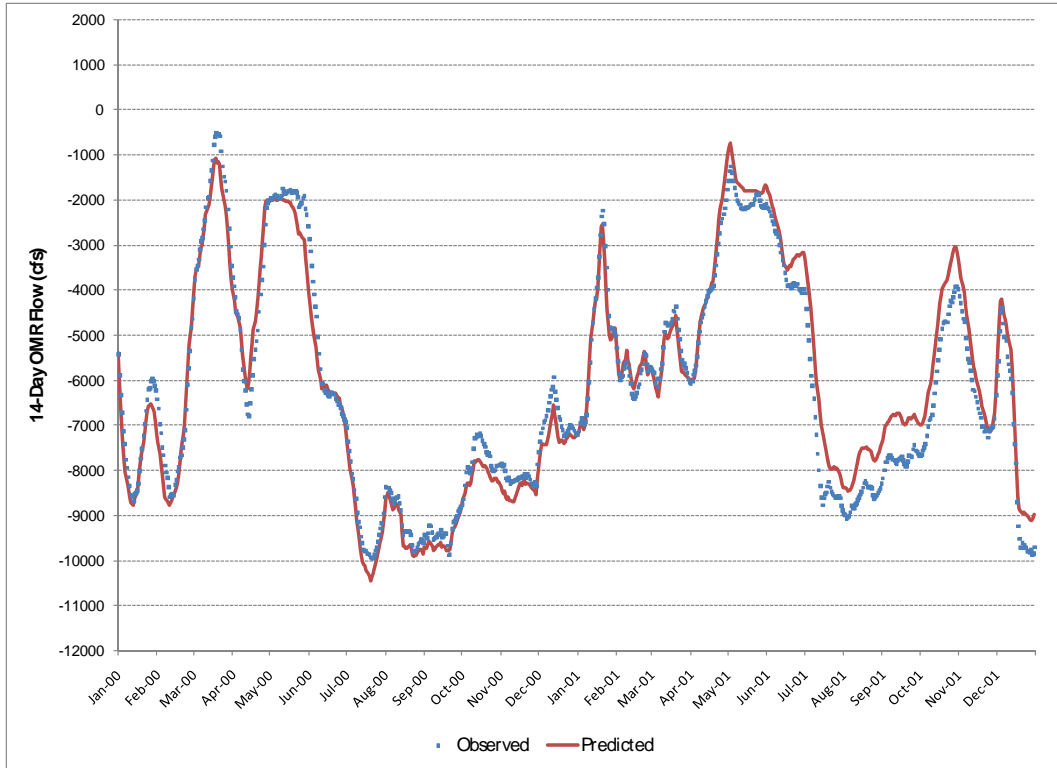
Figure 6A-7
Observed & Predicted 14-Day OMR Flow
2002-03

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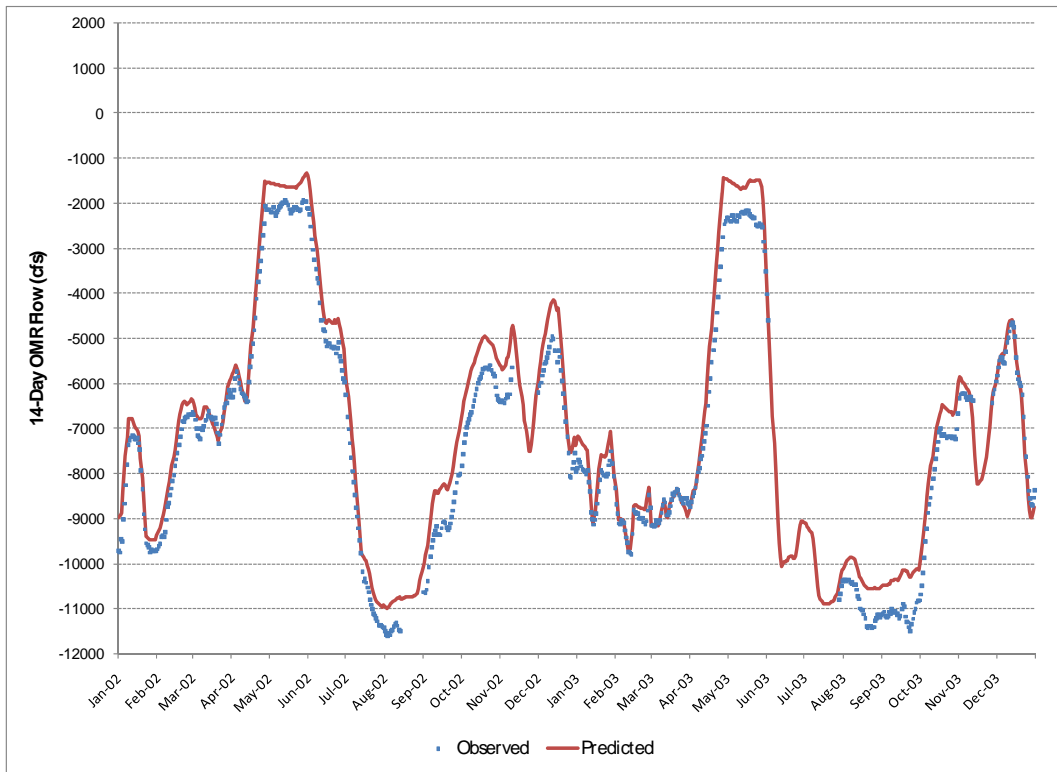
Figure 6A-8
Observed & Predicted 14-Day OMR Flow
2004-05

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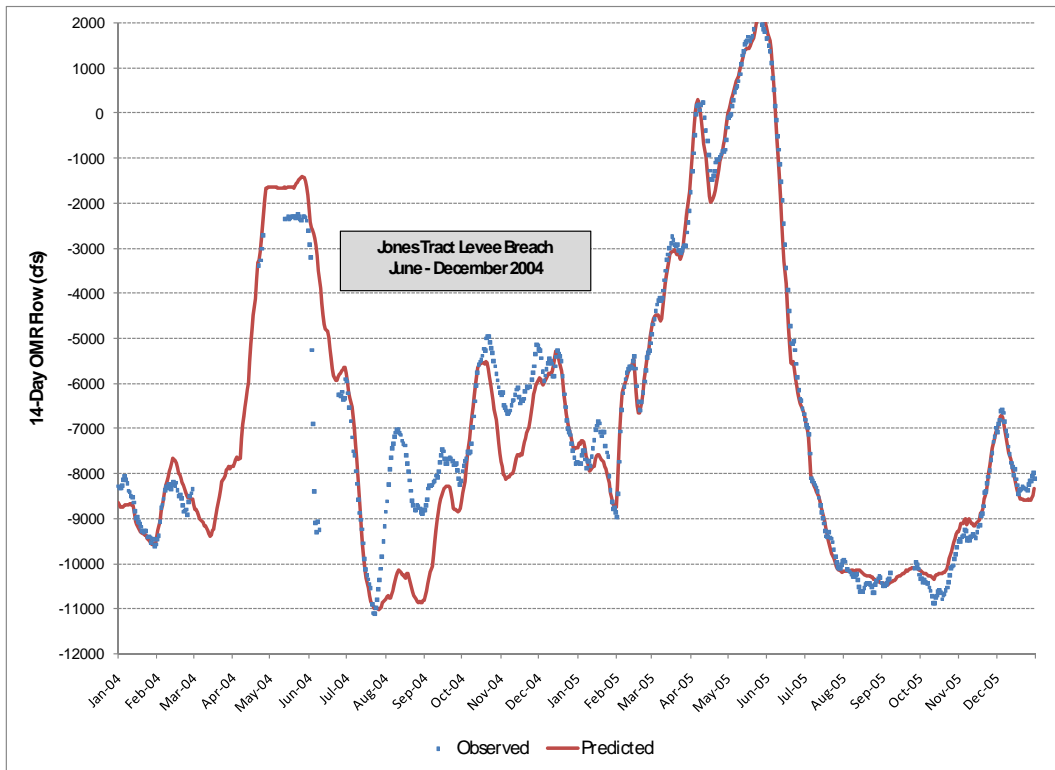
Appendix 6B
MWD Model Probability Exceedence Graphs

Figures

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Figure 6B-1
14-Day OMR Flow
Forecast Model Performance
December

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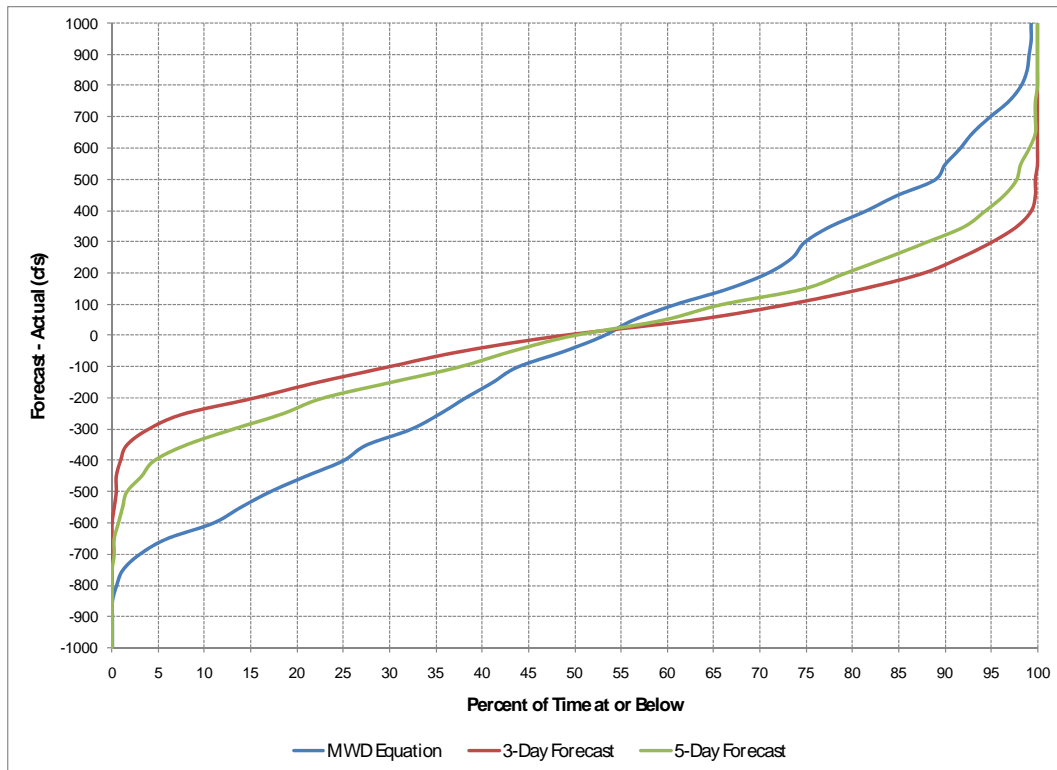
Figure 6B-2
14-Day OMR Flow
Forecast Model Performance
January

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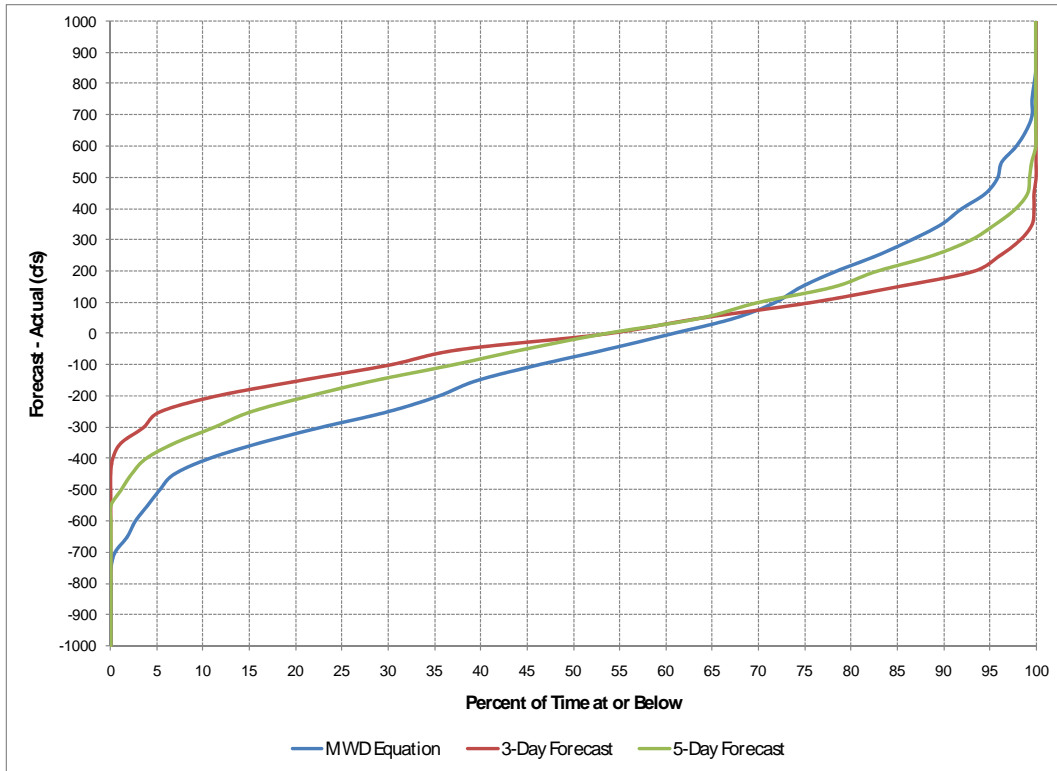
Figure 6B-3
14-Day OMR Flow
Forecast Model Performance
February

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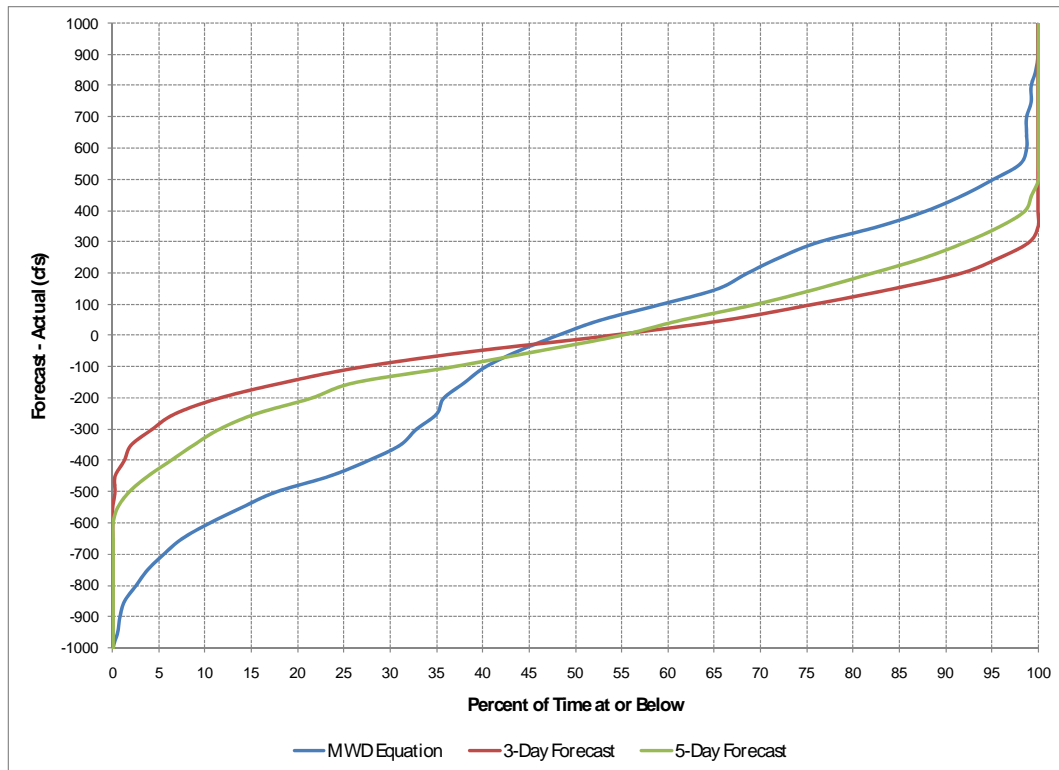
Figure 6B-4
14-Day OMR Flow
Forecast Model Performance
March

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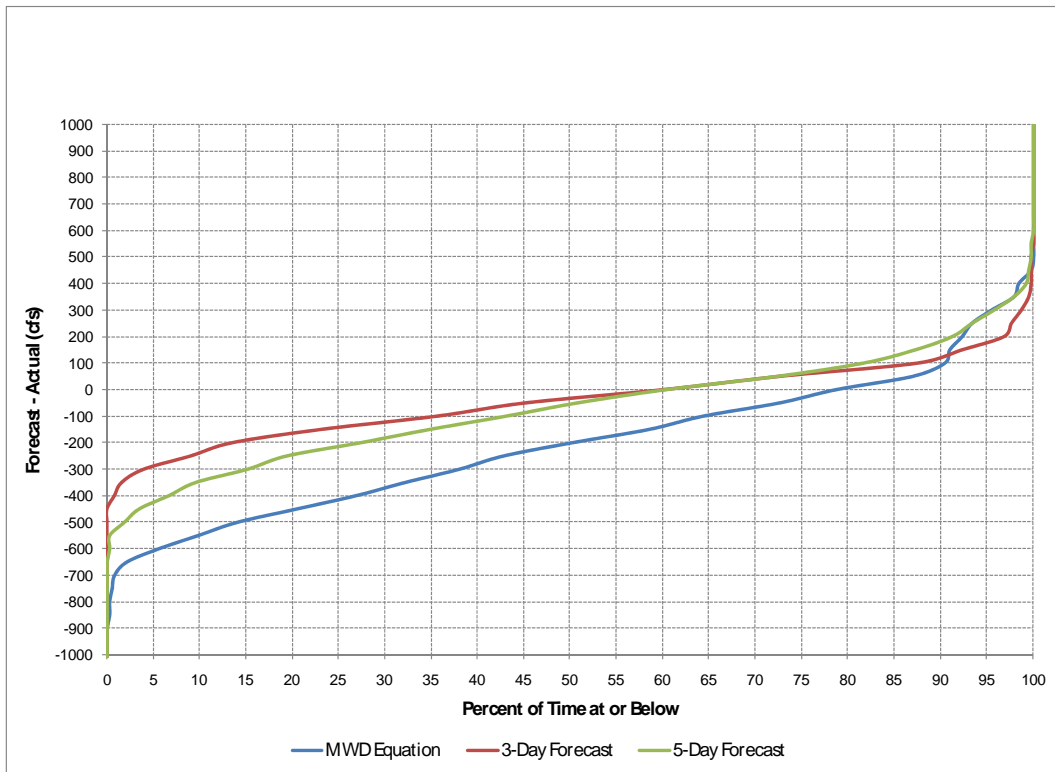
Figure 6B-5
14-Day OMR Flow
Forecast Model Performance
April

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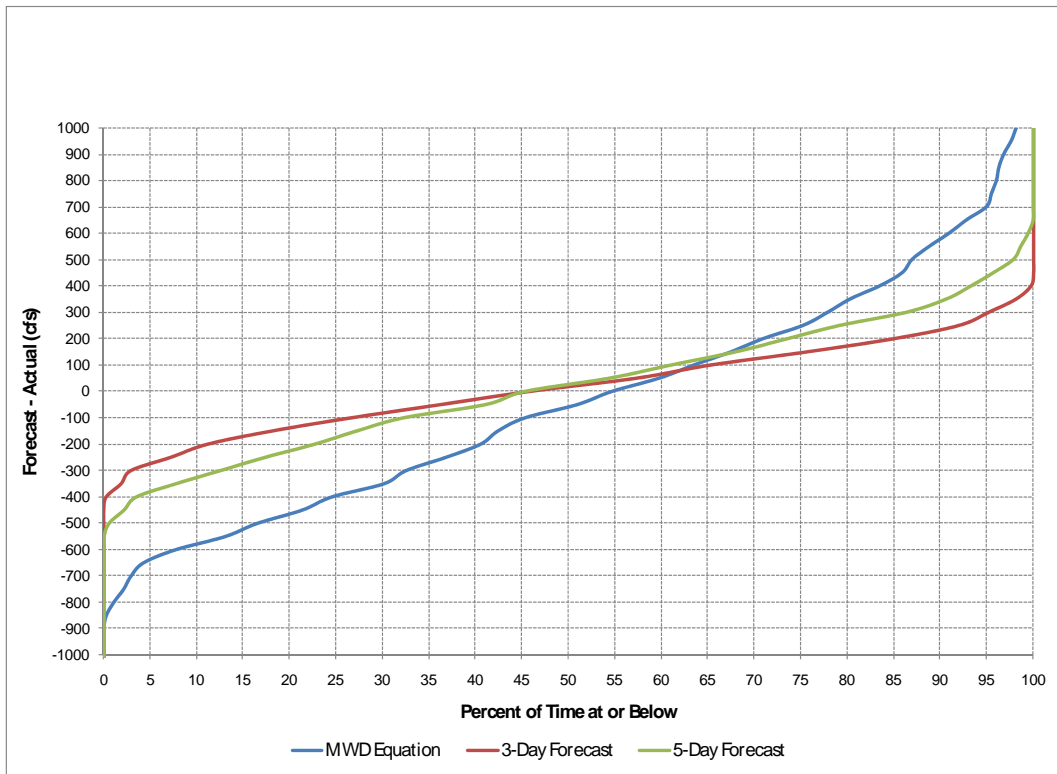
Figure 6B-6
14-Day OMR Flow
Forecast Model Performance
May

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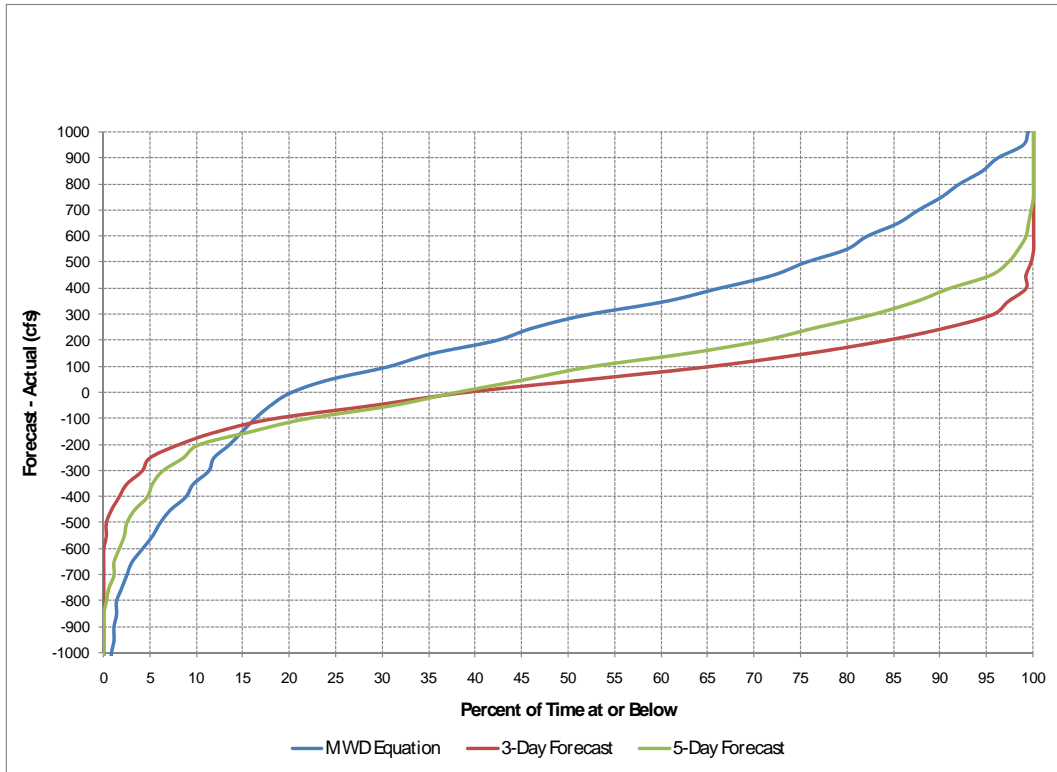
Figure 6B-7
14-Day OMR Flow
Forecast Model Performance
June

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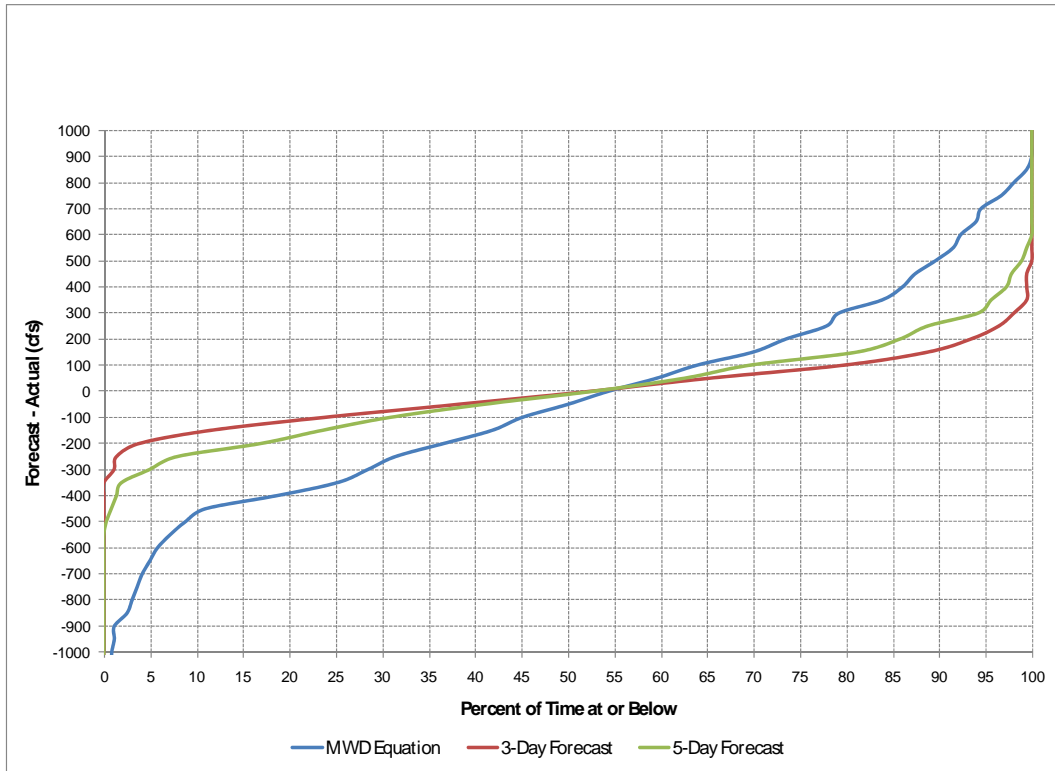
Figure 6B-8
7-Day OMR Flow
Forecast Model Performance
December

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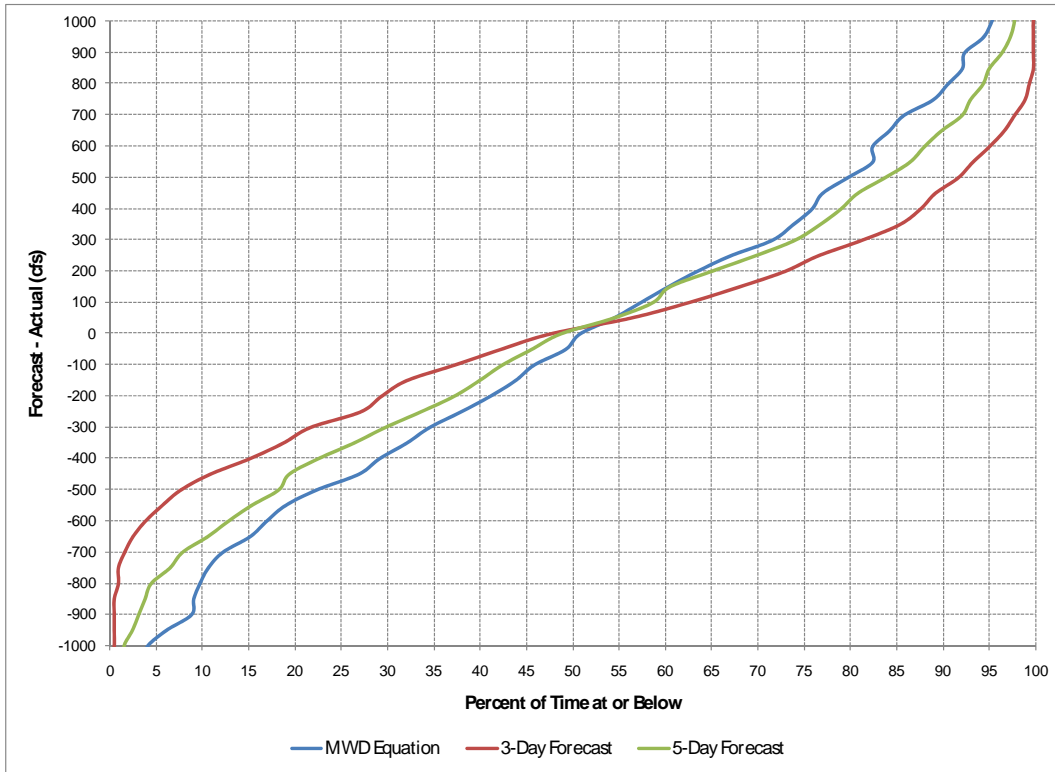
Figure 6B-9
7-Day OMR Flow
Forecast Model Performance
January

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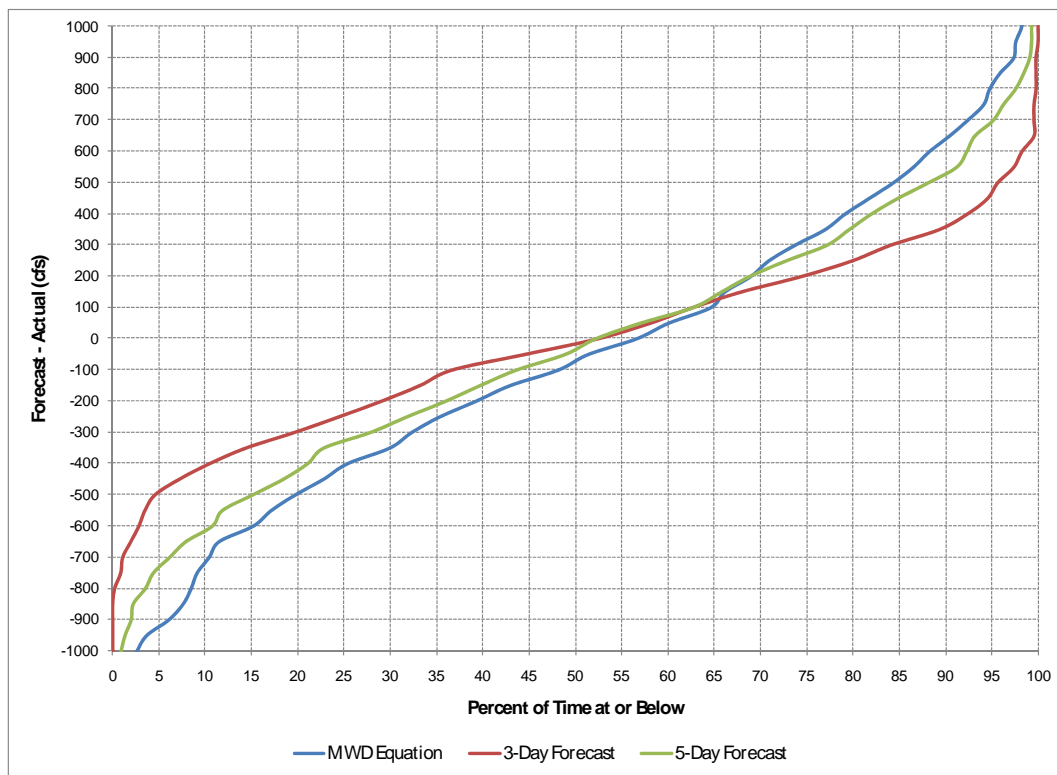
Figure 6B-10
7-Day OMR Flow
Forecast Model Performance
February

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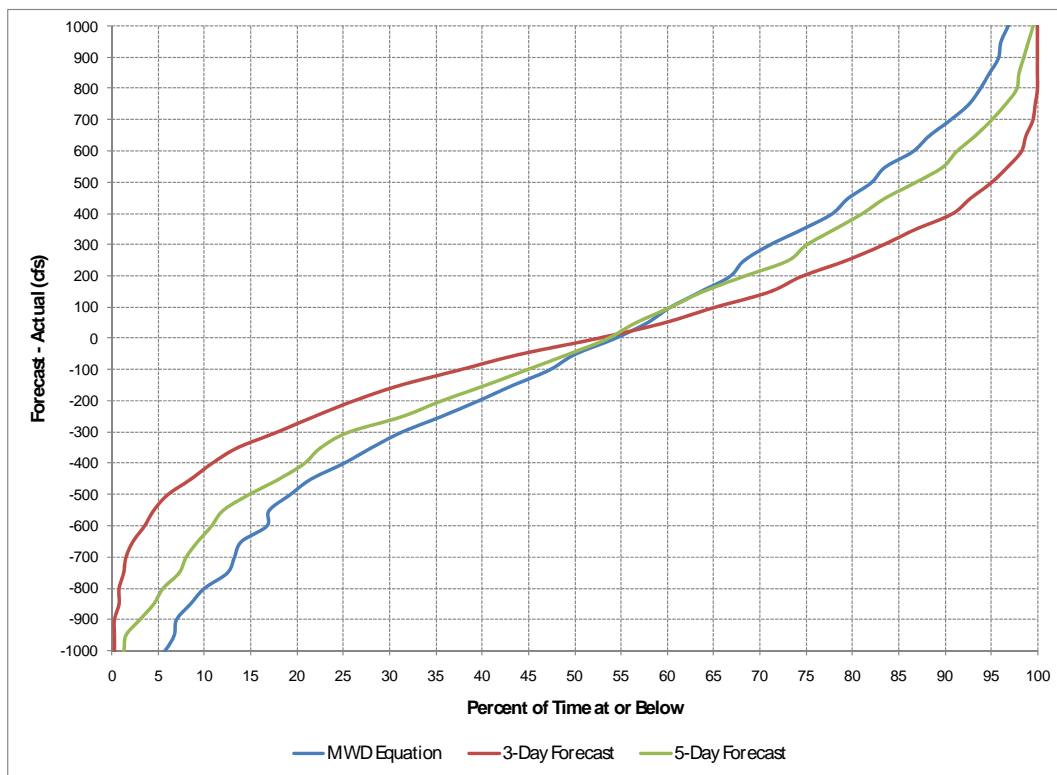
Figure 6B-11
7-Day OMR Flow
Forecast Model Performance
March

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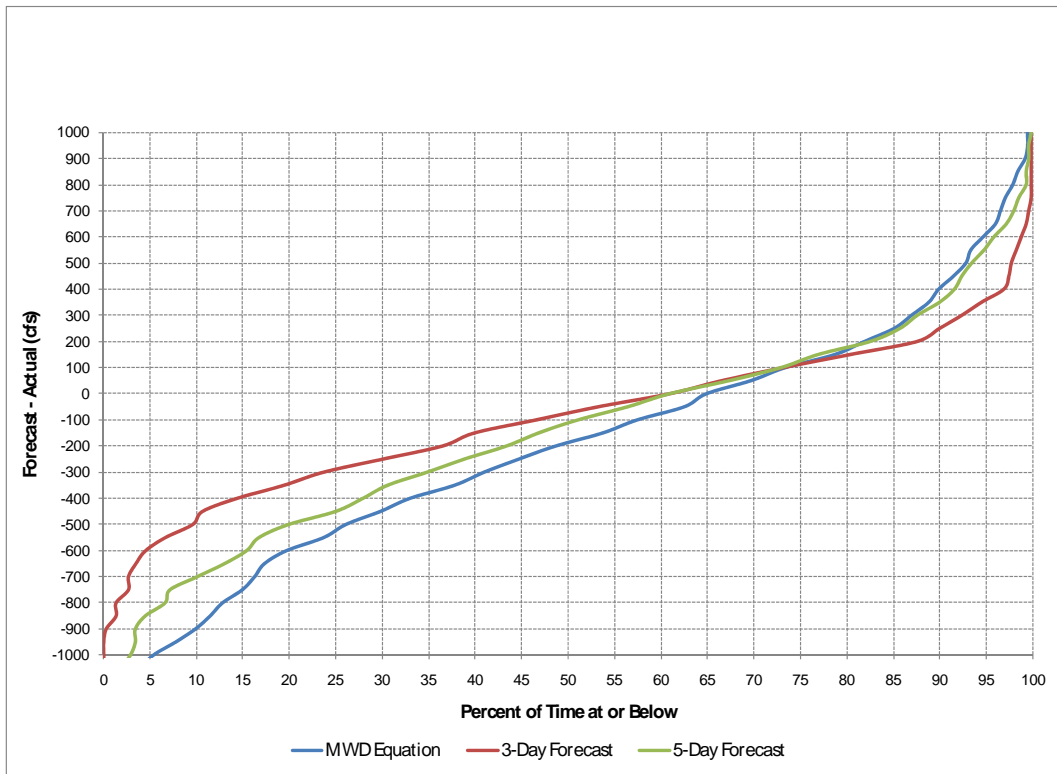
Figure 6B-12
7-Day OMR Flow
Forecast Model Performance
April

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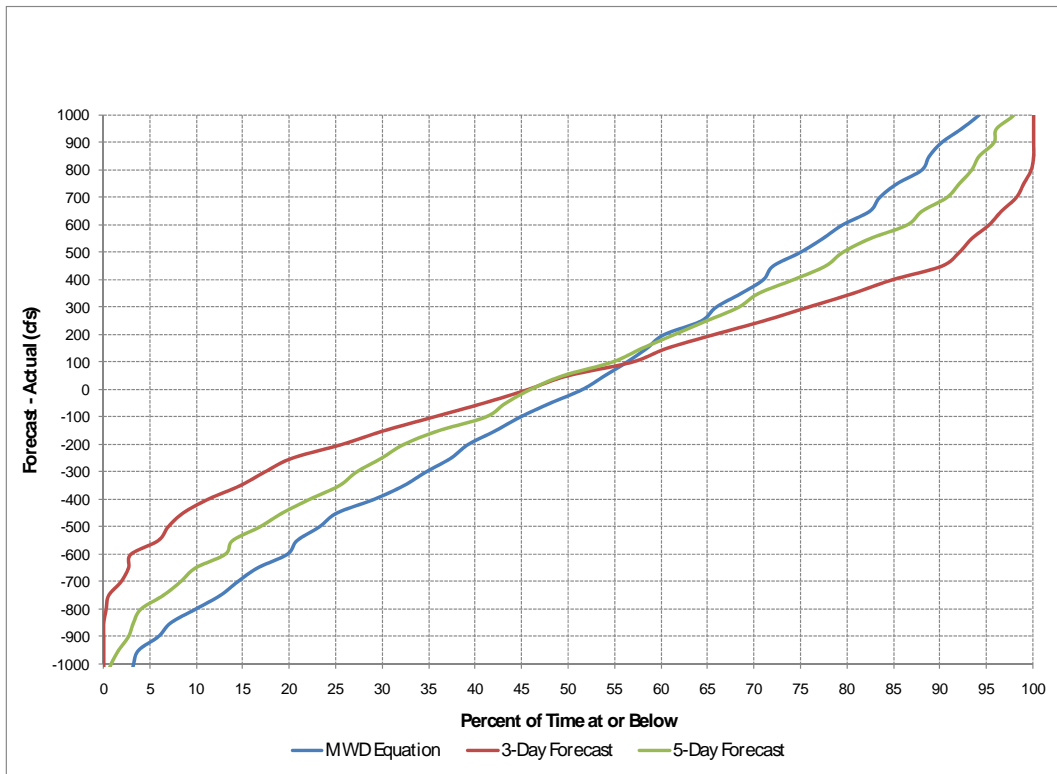
Figure 6B-13
7-Day OMR Flow
Forecast Model Performance
May

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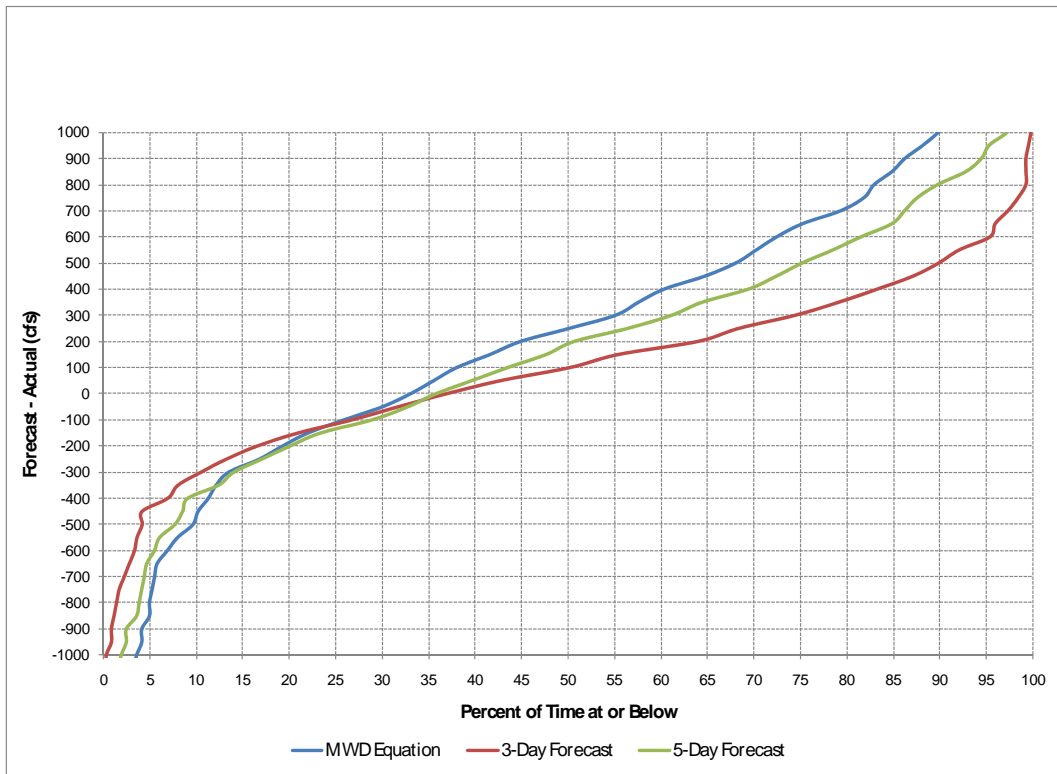
Figure 6B-14
7-Day OMR Flow
Forecast Model Performance
June

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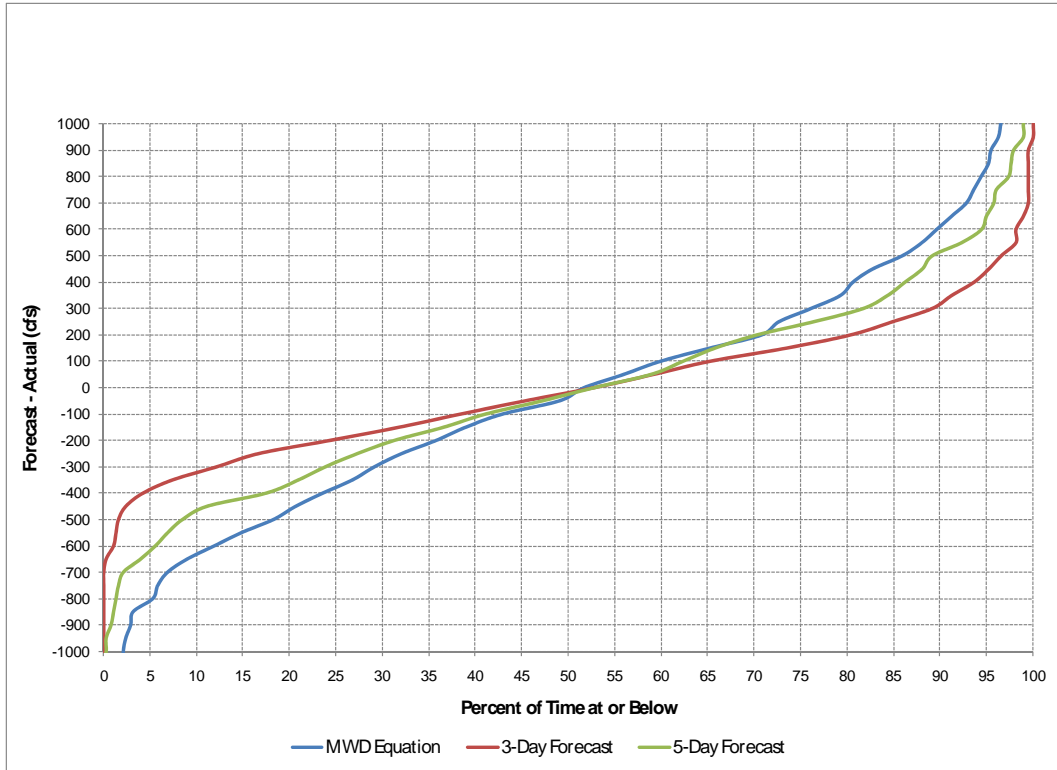
Section 7
Discussion

Comparison with Other Models

Validation With Observed Data. The MWD model provides significantly better estimates of daily averaged observed OMR flow compared with existing statistically-based models. The MWD model performance is similar to that of DSM2 on a daily averaged basis. Compare Figure 6-2 with Figures 3-3 and 3-4.

Tables 7-1 through 7-3 summarize, by month, absolute differences or residuals between model predictions and measured OMR flows. Table 7-1 summarizes residuals for daily (tidally filtered) averaged estimates. Tables 7-2 and 7-3 summarize residuals for 7-day and 14-day averaged estimates, respectively. Some observations are outlined below.

- The MWD model, with few exceptions, provides the lowest residuals for each month.
- The DWR model provides the lowest residuals in February and the USGS model provides the lowest residuals in November for the 7-day and 14-day averaged estimates.
- All models show a general decrease in residuals as the averaging period increases. The decrease is most pronounced with the MWD model.
- The USGS model gives the highest residuals during the winter months (December-March).
- The DWR model generally gives the highest residuals in the remaining months.

Baseline Estimates. Appendix 7A compares average OMR flow estimates by month for a 73-year average and by 40-30-30 water year type. Baseline estimates assume Delta hydrology and operations as represented in CALSIM (CALSIM 2007); baseline estimates also assume south Delta temporary barrier installations are triggered by San Joaquin River flows (DWR 2003). The following discussion is limited to the months of January through June, as these are the months when OMR flow restrictions are imposed by the recent court decision (recognizing that restrictions may sometimes occur in late December).

The DWR model consistently provides the highest OMR flow estimate over the 73-year average. This observation is consistent with the finding that the DWR model shows a strong bias toward over-estimating OMR flow (see Section 3). The DWR estimates are particularly high relative to the other models in April, May and June under all water year types. The high April-May estimates result because the DWR model does not account for HORB installation.

The USGS model estimates tend to deviate from the other model estimates in February and March. The USGS model gives lower OMR estimates during wetter water years and gives higher OMR estimates during dryer water years. The former observation is consistent with the finding that the USGS model tends to under-predict OMR flow in

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January through March (see Section 3). This deviation probably occurs because the USGS model does not consider the relationship between Vernalis flow and OMR flow under most hydrologic conditions.

The MWD model consistently provides the lowest OMR flow estimates in June. This deviation probably results because the MWD model considers the relationship between south Delta net channel depletions and OMR flow (net channel depletions are typically high in June).

Export Reductions Necessary to Meet OMR Flow Restrictions. Table 7-4 compares estimated export reductions necessary to meet January through June OMR flows greater than –750 cfs and –5000 cfs. These flow restrictions are generally representative of those imposed by the recent court decision. In wet, above and below normal years, the MWD model consistently gives estimates that fall between the DWR model estimates (low) and USGS model estimates (high). The MWD model consistently gives the highest estimate for export reductions in dry and critical years.

Sensitivity Analysis. The MWD model was compared with the other OMR flow models through sensitivity analysis.

Figure 7-1 compares predicted relationships between combined CVP-SWP exports and OMR flow for three typical hydrologic conditions: January, April-May and June. Some observations are outlined below.

- The MWD and DWR models show similar sensitivity under a typical January condition. The USGS model suggests lower exports are required to maintain OMR flows. As discussed above, the USGS model validates relative poorly to observed data in winter months, tending to under-predict OMR flows. This deviation probably occurs because the USGS model does not consider the relationship between Vernalis flow and OMR flow under most hydrologic conditions.

- The MWD and USGS models show similar sensitivity under a typical spring condition when the HORB is installed. The DWR model suggests higher exports are permitted to maintain OMR flows. As discussed above, the DWR model validates relatively poorly to observed data in April-May and has a strong bias to over-predict OMR flows. The high April-May estimates result because the DWR model does not account for HORB installation. MWD model estimates fall between the USGS and DWR model estimates when the HORB is not installed.

- The MWD model suggests lower exports are required to maintain OMR flows in June. This finding is consistent with the above discussion on baseline estimates. This deviation from the other models probably results because the MWD model considers the relationship between south Delta net channel depletions and OMR flow (net channel depletions are typically high in June).

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Table 7-5 provides another model sensitivity analysis, summarizing marginal water costs and savings associated with applying various Delta actions during January thru June when OMR flow restrictions are in place. Some observations are outlined below.

- The DWR model is, by definition, insensitive to changes in barrier operations. The USGS model is more sensitive than the MWD model to changes in GLC barrier operations and less sensitive to changes in HORB operations. Both models show barrier installation is more costly when OMR flow requirements are more stringent.
- The DWR and USGS models are, by definition, insensitive to changes in south Delta net channel depletions. The MWD model shows a small water savings associated with a 50% reduction in south Delta net channel depletions.
- While all models show savings associated with a 20% increase in Vernalis flows, the USGS model is less sensitive than the MWD and DWR models. The USGS model sensitivity is limited to high flow periods when Vernalis flows exceed 10,000 cfs.

Discussion on Model Input

South Delta Net Channel Depletions. The MWD model requires estimates of south Delta net channel depletions to predict OMR flow. While Delta-wide estimates of net channel depletions are available, estimates for south Delta net channel depletions are generally not available. The ratio of Delta-wide net channel depletions that represents south Delta net channel depletions was computed each month for the 1990-2006 period to arrive at an average ratio. These ratios are summarized in Table 7-6. Based on this analysis, it is recommended that a ratio of 0.25 be used to estimate south Delta net channel depletions from Delta-wide net channel depletions. This ratio is consistent with a ratio of 0.2889 proposed by DWR (DWR 1986).

Clifton Court Forebay Diversions. The MWD model, as well as the DWR and USGS models, requires estimates of Clifton Court Forebay diversions to predict OMR flow. For many planning applications, estimates of forebay diversions may not be available. Under such conditions, estimates of Banks Pumping Plant diversions would be the best available data for model input. As shown in Figure 7-2, differences between forebay diversions and Banks pumping can be significant at a daily time scale. These differences collapse, however, as data is averaged over longer time scales such as a 14-day average. Clifton Court Forebay diversions are related to Banks Pumping Plant diversions through the following water balance:

Clifton Court Forebay diversions = Banks Pumping Plant diversions + Byron-Bethany Irrigation District net diversions ± Change in Forebay storage

Findings and Conclusions

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Model Development & Application. The following findings and conclusions relate to MWD model development and application:

- The model, which was formulated as a water balance and calibrated with DSM2 data, provides (1) superior validation to observed data and (2) more robust sensitivity to key hydrologic variables. The model should be adopted as a planning tool for predicting OMR flow. Including a tidal influence term could enhance model performance.
- Clifton Court Forebay diversion is a better measure than Banks Pumping in predicting OMR flow. This consideration is important for short-term forecasting. For long term planning, the distinction is less important.

Potential Control Measures. The following findings and conclusions relate to potential measures to control OMR flow:

- Comparison of model estimates with observed OMR flows was used to develop planning "buffers" to account for estimate uncertainty.
    - Longer flow averaging periods can be forecasted with greater certainty, and therefore can rely on smaller buffers to meet OMR flow objectives. Buffers required to meet 7-day averaged flow objectives are approximately twice as large as buffers required to meet 14-day averaged flow objectives.
    - 3-day forecasts can be estimated with greater certainty than 5-day forecasts, and therefore can rely on smaller buffers. Buffers required for a 5-day forecast are approximately 50% greater than those required for a 3-day forecast.
- The only south Delta agricultural barrier that has a significant impact on OMR flow is the Grant Line Canal. This finding seems reasonable given that the Grant Line Canal barrier provides the greatest flow restriction. Therefore, any future Delta smelt protections should focus on operation of this barrier.
- Water savings will result from delaying or prohibiting installation of HORB and Grant Line Canal barriers. But will delayed installation require export curtailments to meet south Delta water levels?
- Measures that increase San Joaquin River flows at Vernalis would be effective in controlling OMR flow. Such measures would be even more effective if the Paradise Cut weir operation was modified to allow more San Joaquin River water into the south Delta.

References

CALSIM (2007). Study OCAP_2001D10A_TODAY_B2

DWR (2003). Proposed Temporary Barrier Operations for 2001 and 2020 Base Case SDIP 16-Year DSM2 Simulations, Office Memorandum from Jamie Anderson to Parviz Nader-Tehrani, January 23.

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Table 7-1
Comparison of OMR Flow Model Residuals by Month
Daily (Tidal) Averaged Estimates

Month	N	Absolute Difference (cfs)		
		DWR Model	USGS Model	MWD Model
Jan	496	585	1026	560
Feb	452	636	1126	688
Mar	503	676	1025	608
Apr	501	1204	884	547
May	527	1588	845	578
Jun	452	1277	945	503
Jul	478	1179	1145	555
Aug	489	973	947	525
Sep	475	854	766	551
Oct	465	875	684	554
Nov	442	701	528	526
Dec	465	699	848	656
All	5745	944	900	571

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Table 7-2
Comparison of OMR Flow Model Residuals by Month
7-Day Averaged Estimates

Month	N	Absolute Difference (cfs)		
		DWR Model	USGS Model	MWD Model
Jan	483	467	877	420
Feb	452	487	1035	522
Mar	491	619	965	493
Apr	494	1099	847	506
May	522	1654	841	523
Jun	452	1269	886	416
Jul	466	1216	1124	487
Aug	477	980	972	534
Sep	469	884	813	615
Oct	465	911	774	625
Nov	430	690	512	546
Dec	465	540	712	501
All	5666	909	866	515

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Table 7-3
Comparison of OMR Flow Model Residuals by Month
14-Day Averaged Estimates

Month	N	Absolute Difference (cfs)		
		DWR Model	USGS Model	MWD Model
Jan	469	312	709	251
Feb	452	373	1013	407
Mar	485	517	882	358
Apr	479	913	778	346
May	515	1663	761	383
Jun	452	1236	764	338
Jul	458	1236	1065	386
Aug	457	949	921	385
Sep	462	776	684	389
Oct	465	783	609	453
Nov	416	633	310	375
Dec	465	411	604	357
All	5575	824	761	369

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Table 7-4
Comparison of Export Reductions Required to Meet OMR Restrictions
January-June with No South Delta Barrier Operations
(TAF per year)

Water Year Type	OMR > -750 cfs			OMR > -5000 cfs		
	DWR Model	USGS Model	MWD Model	DWR Model	USGS Model	MWD Model
73-Year Average	1300	1640	1540	320	440	380
Wet	1110	1680	1390	250	460	310
Above Normal	1520	2130	1800	420	640	480
Below Normal	1570	2000	1840	380	530	480
Dry	1510	1570	1710	410	390	450
Critical	760	690	890	180	150	190

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Table 7-5
January-June Marginal Water Costs & Savings of Various Delta Actions[1]
(TAF per year)

Action	OMR > -750 cfs			OMR > -5000 cfs		
	DWR Model	USGS Model	MWD Model	DWR Model	USGS Model	MWD Model
GLC Installation	0	-170	-30	0	-50	-10
GLC and HORB Installation	0	-210	-120	0	-50	-40
50% Reduction of Net Channel Depletions	0	0	30	0	0	<10
20% Increase in Vernalis Flow	150	90	140	50	30	50

[1] Marginal costs and savings measured against 73-year average export reductions presented in Table 7-3. Savings are denoted by a positive value; costs are denoted by a negative value.

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Table 7-6
Fraction of Delta-Wide Net Channel Depletions
Contributing to South Delta Net Channel Depletions: 1990-2006

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	0.01	(1)	0.36	0.27	0.20	0.27	0.25	0.25	0.24	0.24	0.23	0.23
1991	0.36	0.26	(1)	0.28	0.28	0.31	0.25	0.26	0.25	0.22	0.22	0.22
1992	(1)	0.13	0.09	0.26	0.27	0.27	0.25	0.25	0.24	0.24	0.21	(1)
1993	0.12	0.20	0.32	0.23	0.22	0.30	0.25	0.25	0.24	0.21	0.24	0.24
1994	0.04	0.08	0.28	0.25	0.20	0.27	0.25	0.25	0.24	0.22	0.28	0.36
1995	0.12	0.32	0.14	0.23	0.29	0.30	0.25	0.25	0.24	0.22	0.22	(2)
1996	0.21	0.23	0.35	0.22	0.28	0.29	0.25	0.25	0.24	0.22	0.24	0.11
1997	0.18	0.23	0.25	0.26	0.26	0.26	0.25	0.25	0.24	0.23	0.29	0.34
1998	0.18	0.21	0.05	0.23	0.10	0.28	0.25	0.25	0.24	0.21	0.25	0.21
1999	0.18	0.10	(2)	0.23	0.25	0.27	0.25	0.25	0.23	0.22	0.23	0.22
2000	0.13	0.20	0.25	0.26	0.28	0.28	0.25	0.25	0.23	0.22	0.21	0.21
2001	0.19	0.07	0.35	0.27	0.28	0.27	0.25	0.25	0.24	0.23	0.24	0.15
2002	0.17	0.47	0.27	0.25	0.28	0.28	0.25	0.25	0.24	0.22	0.24	0.09
2003	0.12	0.05	0.49	0.62	0.29	0.29	0.25	0.26	0.24	0.22	0.23	0.74
2004	0.15	0.14	0.25	0.25	0.26	0.27	0.24	0.25	0.23	0.23	0.23	0.09
2005	0.18	0.21	0.01	0.20	0.26	0.29	0.25	0.25	0.24	0.22	0.22	(1)
2006	0.16	(1)	0.12	0.13	0.25	0.28	0.25	0.25	0.24	0.22	0.23	0.23
avg	0.16	0.19	0.24	0.26	0.25	0.28	0.25	0.25	0.24	0.22	0.24	0.24

(1) Negative ratios removed from calculation of averages
(2) Extreme outliers removed from calculation of averages

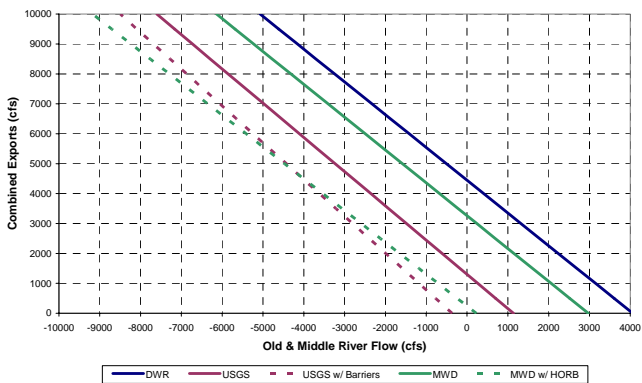A Model to Estimate Combined OMR Flows
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Figure 7-1
Predicted Relationships Between OMR Flow and Exports
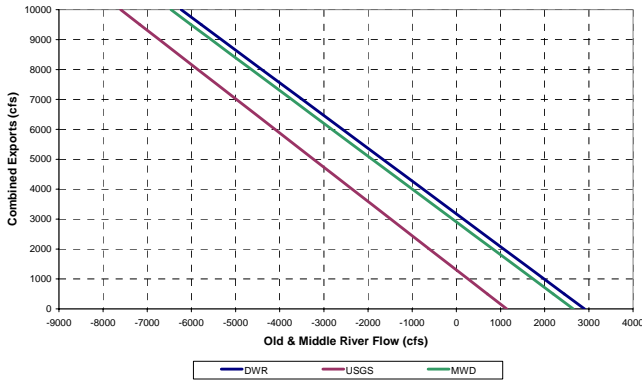

Typical January
Vernalis = 5000 cfs
South Delta NCD = -300 cfs
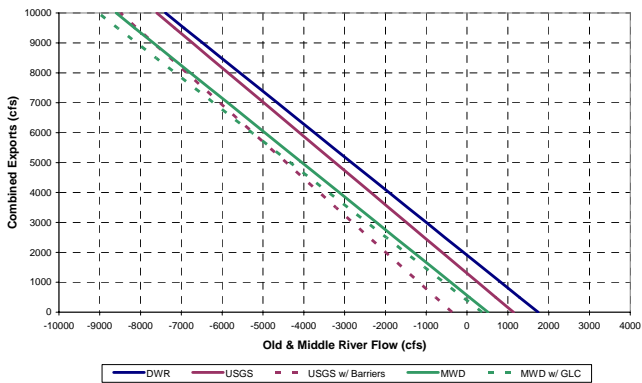
Typical April-May
Vernalis = 7000 cfs
South Delta NCD = 350 cfs

Typical June
Vernalis = 3000 cfs
South Delta NCD = 1000 cfs

A Model to Estimate Combined OMR Flows
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Figure 7-2
Comparison of Clifton Court Forebay & Banks Pumping Plant Diversions
Daily Averaged Observed Data January 1, 1990 – September 30, 2006
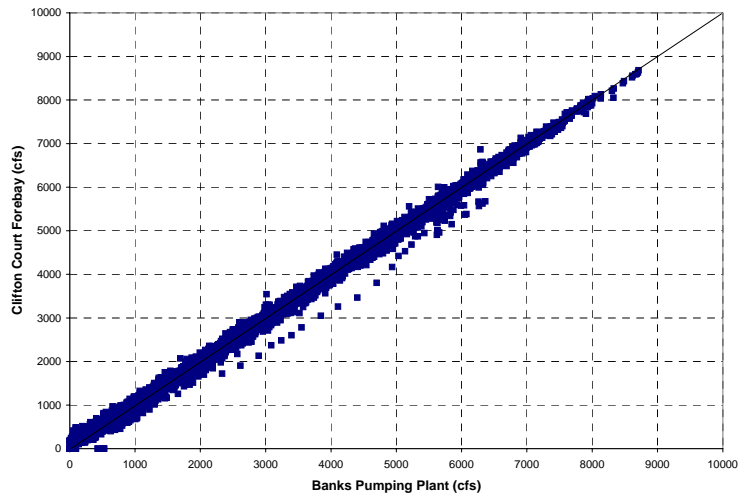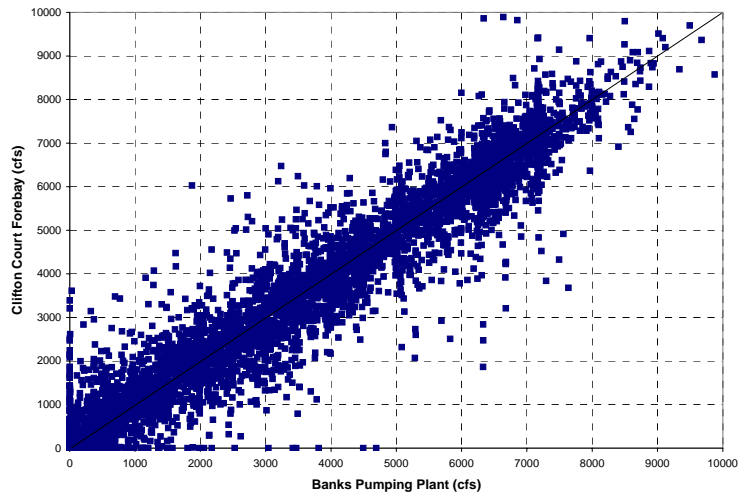
Differences between forebay diversions and Banks pumping can be significant at a daily time scale (see top graph). These differences collapse as data is averaged over a 14-day average (see bottom graph).

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Appendix 7A
Comparison of CALSIM Baseline OMR Flow Estimates

Figures

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Figure 7A-1
Comparison of CALSIM Baseline OMR Flow Estimates
73-Year Averages
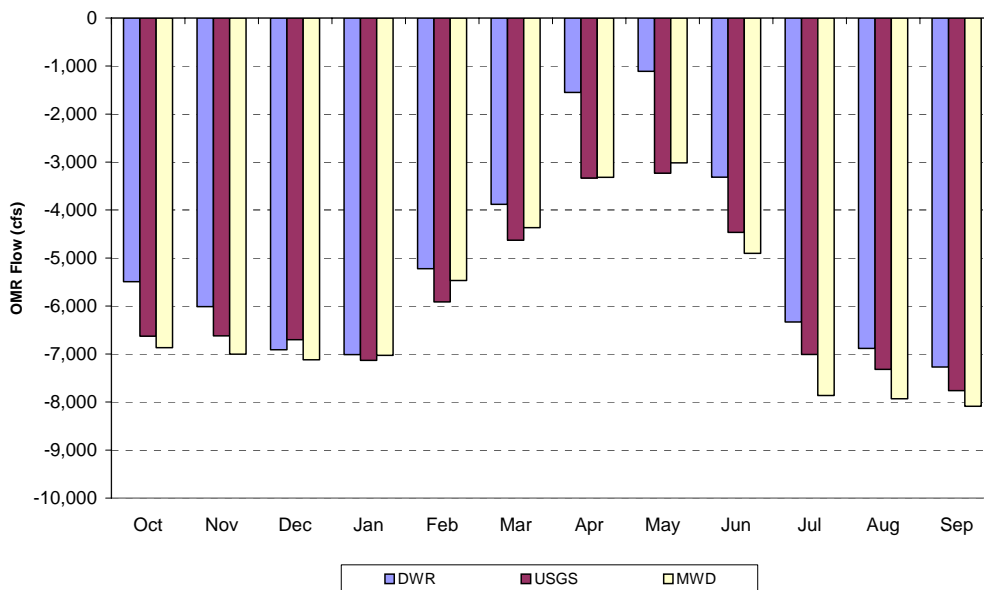
The DWR model consistently provides the highest OMR flow estimate over the 73-year average. This observation is consistent with the finding that the DWR model shows a strong bias toward over-estimating OMR flow (see Section 3). The DWR estimates are particularly high relative to the other models in April, May and June under all water year types. The high April-May estimates result because the DWR model does not account for HORB installation.

The MWD model consistently provides the lowest OMR flow estimates in June. This deviation probably results because the MWD model considers the relationship between south Delta net channel depletions and OMR flow (net channel depletions are typically high in June).

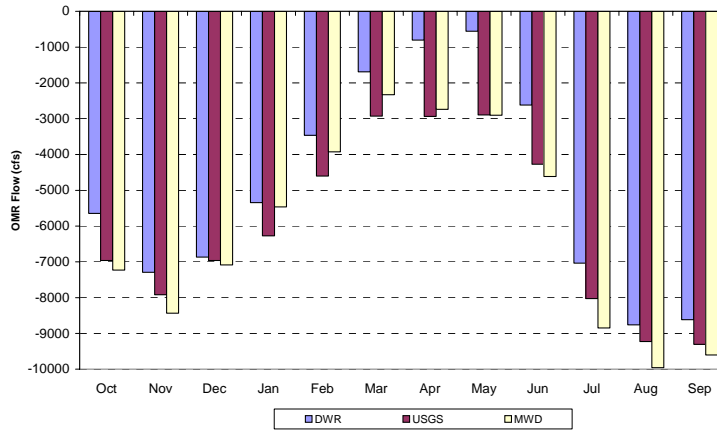A Model to Estimate Combined OMR Flows
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Figure 7A-2
Comparison of CALSIM Baseline OMR Flow Estimates
Wet Years

Figure 7A-3
Comparison of CALSIM Baseline OMR Flow Estimates
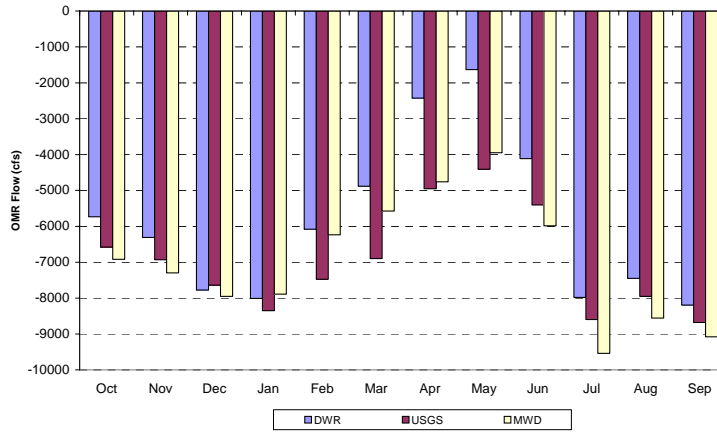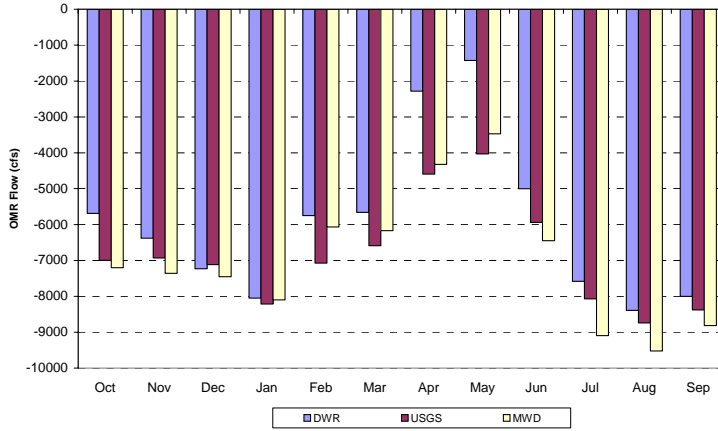**Above Normal Years**

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Figure 7A-4
Comparison of CALSIM Baseline OMR Flow Estimates
Below Normal Years

Figure 7A-5
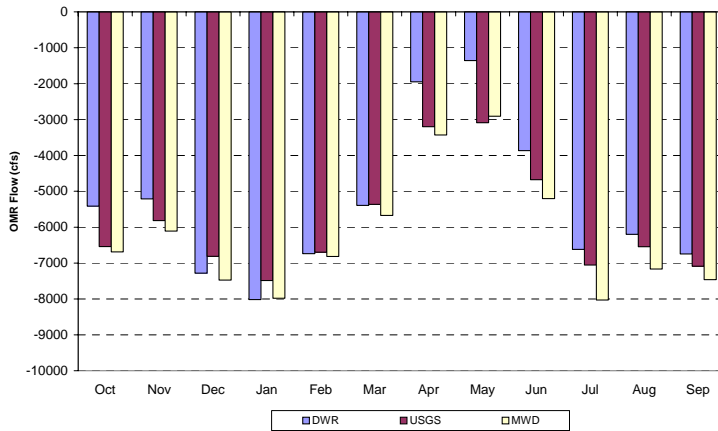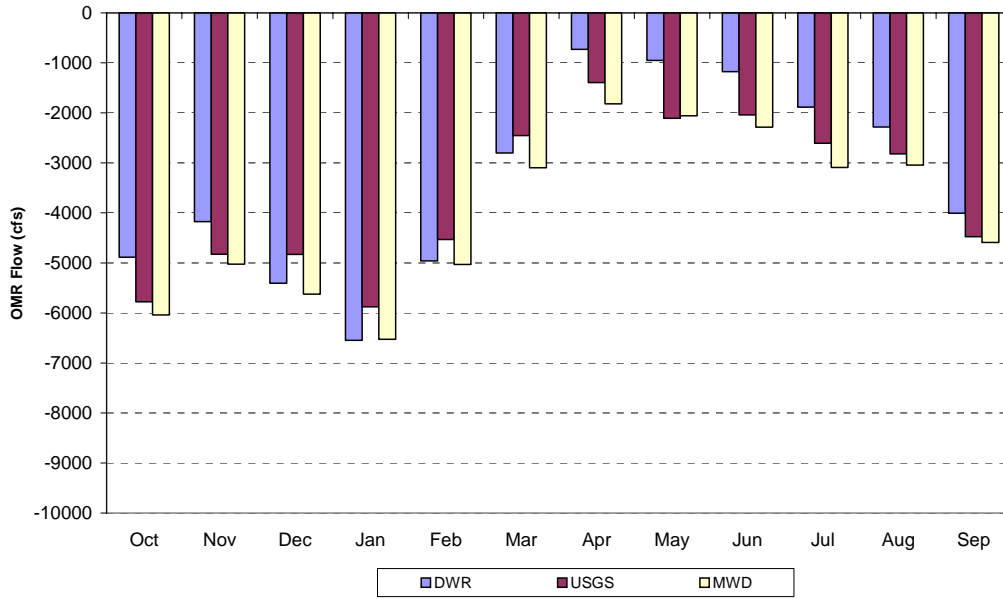**Comparison of CALSIM Baseline OMR Flow Estimates**
Dry Years

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Figure 7A-6
Comparison of CALSIM Baseline OMR Flow Estimates
Critical Years

A Model to Estimate Combined OMR Flows
April 2008
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-----Original Message-----
From: Los Vaqueros [mailto:lvstudies@hotmail.com]
Sent: Tue 4/21/2009 4:24 PM
To: Andrea Nocito
Subject: FW: LVE EIS/EIR - Zone 7 Comment Letter

_____

From: bledesma@zone7water.com
To: lvstudies@hotmail.com; mnaillon@ccwater.com
CC: wmoore@mp.usbr.gov; Eric.Cartwright@acwd.com; KKennedy@valleywater.org;
karends@zone7water.com; mlim@zone7water.com
Date: Tue, 21 Apr 2009 16:22:14 -0700
Subject: LVE EIS/EIR - Zone 7 Comment Letter

Dear Ms. Naillon,

Please find attached a letter outlining our comments on the Los Vaqueros Expansion Project EIS/EIR; a
hardcopy will follow in the mail.

Sincerely,

Brad Ledesma

Zone 7 Water Agency

(925) 454-5038

ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
100 NORTH CANYONS PARKWAY   LIVERMORE, CA 94551   PHONE (925) 454-5000   FAX (925) 454-5723

April 21, 2009

Marguerite Naillon, Special Projects Manager
Contra Costa Water District
Attn: Los Vaqueros Reservoir Expansion Project DEIR/EIS
P.O. Box H2O
Concord, CA 94524
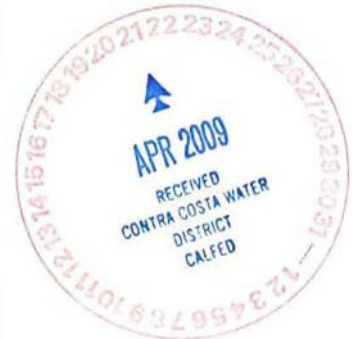
Subject: **Los Vaqueros Reservoir Expansion Project (LVE Project)
Draft Environmental Impact Report/Statement (Draft EIR/EIS)
SCH #2006012037**

Dear Ms. Naillon:

Zone 7 Water Agency (Zone 7) appreciates Contra Costa Water District (CCWD) providing us
with the opportunity to review and comment on the referenced California Environmental Quality
Act (CEQA)/National Environmental Policy Act (NEPA) document. Zone 7 has reviewed the
CEQA/NEPA document in the context of Zone 7's mission to provide a reliable supply of high
quality water to the Livermore-Amador Valley. Based on our review, we offer the following two
general comments for your consideration:

1.   More Coordination with Other Related Planning Processes

The Draft EIR/EIS indicates that the LVE Project is independent of the Delta Vision and
Strategic Plan, is not tied to completion or implementation of the Bay Delta Conservation
Plan, and is subject to its own biological opinion; it appears that the Delta Habitat
Conservation and Conveyance Plan is not mentioned. These other planning processes will
provide the framework to accomplish the long-term goals necessary for protecting and
enhancing the Delta as a valuable environmental and water supply resource.

Consequently, it is unclear whether the LVE Project will accomplish the long-term
benefits described in the Draft EIR/EIS for the LVE Project, including protection of key
Delta species and enhanced water supply reliability and water quality, without fully
incorporating these other related planning processes. We understand that CCWD is on
the BDCP Steering Committee so this comment is only by way of clarification.

Based on several meetings with CCWD in the past, Zone 7 understands the constraints
governing the current Draft EIR/EIS and therefore, would like to continue to work with
CCWD staff to improve our understanding of the relationship between the LVE Project
goals and these other planning processes, and how these goals can be accomplished
compatibly.

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2.   Better Define and Clarify Water Supply Reliability Benefit

The Draft EIR/EIS clearly states that the LVE Project derives its water supply reliability
benefit by changing the timing and location of diversions from the Delta. The SBA
contractors, however, completed a recent analysis that indicates CCWD did not consider
the potential benefits of an alternative conveyance facility and how this facility may or
may not influence the supply reliability benefits provided by the LVE Project; moreover,
this analysis also indicates that discrepancies exist between modeling completed by
CCWD and the Department of Water Resources (DWR).

2

As a SWP Contractor and a potential partner in the LVE Project, Zone 7 urges CCWD to
work with DWR and the Bureau of Reclamation to coordinate the LVE Project with any
proposed alternative conveyance facility, and reconcile any potential discrepancies
between the models completed for the LVE Project and the SWP.

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Zone 7 is committed to providing a reliable supply of high quality water to the Livermore-
Amador Valley, and is developing a long-term water supply plan to address the uncertain future
presented by potential impacts of climate change and the most recent regulatory constraints
imposed in the Delta.

We look forward to continuing to work with CCWD staff to help address these concerns as the
LVE Project is one potential water supply option that Zone 7 would like to continue to evaluate.
If you have any questions or comments, please feel free to contact Brad Ledesma or Mary Lim at
925-454-5000.

Sincerely,

G.F. Duerig
General Manager

cc: Louis Moore, U.S. Bureau of Reclamation
       Eric Cartwright, Alameda County Water District
       Kellye Kennedy, Santa Clara Valley Water Agency
       Kurt Arends, Brad Ledesma, Mary Lim