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. CALIFORNIA WATER AND ENVIRONMENTAL MODELING FORUM

MINUTES OF THE STEERING COMMITTEE

For March 20, 2009

(This meeting was held at the Solano Irrigation District Office in Vacaville.)

Decisions	• Move all of the CWEMF funds to River City Bank
Action Items	• Stacy, Rich, and Lisa will check in with River city Bank and report back to Paul on the monetary benefits of CDs versus Money Market Accounts. • The E.D. will draft up something capturing the thoughts on today's "sessions development discussion" for the annual meeting and have it for the next Steering Committee meeting. • The E.D. will determine how the funding for the CALSIM II review was done last year.
Parking Lot Items	• Decide whether CWEMF annual meetings will continue at Asilomar or at an alternate location. • Determine how annual meeting sessions will be selected.
Motions	•

REFERENCES HANDED OUT:

1. Executive Directors Report.
2. CWEMF Workshop Status
3. Distinguished Life Membership Award form (new)
4. Press Release: Career Achievement Award letter presented to Ray Hoagland
5. Press Release: Hugo Fischer Award letter presented to Pete Smith
6. The Award of Professional Development Hours (PDF) form
7. Letter of Appreciation sent to Daniel Dooley of UC system
8. Overview Papers of Sacramento/San Joaquin Delta Water Quality

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MINUTES

1. **INTRODUCTIONS/DESIGNATION OF QUORUM** – The meeting was opened with 16 persons in attendance, and 2 proxies. A quorum was declared. There was some general discussion of whether we should keep our annual meetings at Asilomar and where else we could hold them, and how sessions should be formed for the annual meeting. The discussions were very general and no decisions were made on either item. However, down-payments have been made for Years 2010 and 2011. Decisions should be made soon before more deposits are made.

2. **EXECUTIVE DIRECTORS REPORT** – The E.D. comments are feathered into many of the topics below.

3. **SECRETARY'S REPORT** – The minutes for the past meeting of January 16, 2009 were reviewed and approved.

4. **TREASURER'S REPORT** – Stacy gave the treasurer's report. There is $68,000 total in both funds, of which $36,000 is in the general fund (checking), and $32,000 in the peer review fund (savings). There was a discussion on moving our account from Sterling Bank to River City Bank, as the interest rates are about the same and River City Bank is more accessible. A discussion arose as to how much of our funds to keep liquid and how much to keep in CDs or Money Market Accounts. Keeping the peer review funds liquid might be the best. A decision was made to move all of the funds to River City Bank. Stacy, Rich, and Lisa will check in and report back to Paul on the benefits of CDs versus Money Market Accounts.

5. **ANNUAL MEETING –**

a. **Letters of Achievement -** The E.D. showed the press releases that he sent out on Pete Smith and Ray Hoagland on their achieving the Hugo Fischer Award and the Career Achievement Award.

b. **Abstracts** – All of the abstracts from the Asilomar speakers were received before the annual meeting, which facilitated the E.D. in getting them printed out for distribution.

c. **Attendance** - The CWEMF had 117 persons in attendance (55 of these were first time participants), from 44 organizations. Additionally, there were eight students. . There were 23 sessions with 70 talks. Thirty new memberships were obtained.

d. **PDHs** – Eight persons requested forms for attesting to their obtaining the PDHs.

e. **Hugo Fischer Awards** – The E.D. ordered two new Hugo FischerAwards.

f. **Our Take** – We took in $19,650 at Asilomar, and spent $14,154, for a net of $5,496. We did not have to pay for any additional rooms this year.

g. **Evaluation** – 42 evaluations were turned in after the fact using Monkey Evaluator, representing 36% of the attendees.

h. **Keynote Speaker** – A letter of appreciation was sent to Mr. Daniel Dooley, VP of the UC system for Agriculture and Natural Resources and Senior VP for external affairs. The DWR and CWEMF document "Strategic Analysis Framework" was referenced in the letter and a copy sent, as there may be some future tie between Mr. Dooley's work and the State Water Plan.

i. **Meeting Rooms** – There were some concerns about the proximity and size of the meeting rooms. This is beyond our control, as Asilomar assigns the rooms according to the sizes of the group actually staying on the Asilomar grounds. We will try to reserve earlier and actually request the Fred Farr Forum, in case this helps. However, there is to be some discussion at a separate Steering Committee meeting as to whether we will continue at Asilomar, and money has to be paid when making advance reservations. So some decisions will have to be made somewhere along the line.

j. **Sessions** – Make sure Moderators stay on time. It is ideal to have three speakers per session, to allow for Q & A, with a maximum of four speakers.

k. **Pop-Up Talks** – It seemed to be good to have the pop-up speakers right after the business meeting, as it drew more people into the business meeting.

l. **Registration** – In order to accommodate people who come in to the registration desk when the E.D. or other CWEMF helper is not there, in the future the E.D. will leave his cell phone number on the table for people to call for help. There will be a sign that directs the newcomers to pick up a map and agenda, and to seek out the E.D. later for registration.

m. **Proceedings** – Should CWEMF attempt to put out a Proceedings? This may be time consuming and costly. Contact CALFED and see what their experience is in putting out their Annual Science Conference Proceedings. There was some discussion on possible other signature products that CWEMF might consider. Or should we have papers on line? Sometimes it is hard to get papers, but we can get the Power Points. Perhaps we should follow an incremental path, first putting the papers on line and then later publish small products, and see how this goes regarding time commitments. Would we have to edit the papers? It was felt no, that we would just require normal standards that other non-edited publications do. Perhaps we should use our CWEMF website to present papers on. On papers we could just say "not peer reviewed". Should we put our products on CDs rather than on web sites, to control distribution?

n. **Determining Future Sessions** – There was lots of discussion on how to go about this in the future, so that all persons who are interested in having a session can be considered. The following were some of the items discussed:

(1) Announce on line (to our CWEMF mailing list, and other lists) that we are looking for proposed session topics or speakers, and if someone has an interesting topic to contact us. Ask them to spread the word to other interested parties.

(2) Putting the Power Points on our web site gives citable references for researchers.

(3) Put out an announcement in a journal that we are looking for speakers and abstracts.

(4) CWEMF determines the theme, and then asks for sessions appropriate to that theme. Or, should CWEMF not determine a theme so that session topics are not locked in?

(5) Let session organizers select their speakers.

(6) People proposing the sessions would need to get the speakers.

(7) It was mentioned that if we end up with too many sessions or speakers we can ask them to do a poster or a pop-up talk at Asilomar, or else sponsor a workshop on that topic back in Sacramento.

(8) It was thought that it may not be a good idea to ask outsiders for sessions.

(9) If someone proposes a session, then they may logically be the one to moderate it.

(10) Should we have a separate student session? Would it be attended? Or should students do pop-up talks? How can we get the students to participate?

(11) Lisa will be thinking about how to advertise for sessions.

(12) The E.D. will draft up something capturing the above thoughts on sessions development and have it for the next Steering Committee meeting.

o. **TMDL modeling session** – Models have been used much in TMDL developments. Perhaps a session at Asilomar should be devoted to this.

6. **TECHNICAL WORKSHOPS** –

a. Delta Hydrodynamic Modeling – CALFED is planning on some workshops in this area. They may be looking into 3-D modeling. There workshops may be aimed at the validation of hydrodynamic models. There may be a joint IEP/CALFED workshop on particle tracking modeling. Can CWEMF help on these workshops. CALFED may ask individual CWEMF members.

b. DSM2 V7 Training

c. Data Visualization – Tara will continue checking to see if there are local people knowledgeable enough of data visualization to help us have a CWEMF workshop.

d. Real-Time Modeling – A lot of interest expressed, but no firm ideas.

d. San Joaquin River Restoration Plan – We should check with Peter Vorster to see if another workshop is desirable soon, or whether the presentations at Asilomar presented everything at this point in time.

e. Long-Term Salt Build-Up (and Groundwater Overdraft?) in the San Joaquin Valley – This topic has been dormant for a while, but some interest was expressed today to think about continuing it at some time. Would consist of water supply models, economic and agriculture models, and water treatment models. (George, Nigel, Lisa, Mark, have expressed possible interest)

f.. Wadeable Streams – The question arose as to what would the topic would consist of (i.e. modeling, or a scientific topic that would support modeling)

g. Biological Opinions - Modeling for Delta Smelt and Chinook salmon Bo restrictions.

h. Process Models for Non-Conservative Constituents in the Delta – Nutrient modeling and model development

i. Conjunctive Management – combining analytical and numerical techniques

j. South Delta Salinity Objectives – It was mentioned that perhaps a workshop and peer review could be done on how soil salinity is affecting crop yields in the South Delta, and what the salinity objectives there should be.

7. **PEER REVIEWS**

a. Delta Guiding Principles – This is on hold. Wait until Pete Smith is available possibly this coming summer.

b. Groundwater Model –Was this on the Hydrogeosphere model?

c. Comparison of Four Delta Hydrodynamic Models (to each other) – Mike Fleenor, Jay Lund. Being done (by UCD?) for the SWRCB.

d. Funding for Peer Reviews - Michael Tansey was curious how the last peer review for CalSim II was done, in case the process can be repeated for future peer reviews. The E.D. will check into this.

8. **MODEL USER'S GROUPS** –

a. DSM-2 - The DSM-2 users Group is still functioning.

b. WARMF – Lisa will check with Nigel to see if this users group has been meeting.

9. **PROPOSAL FOR DELTA WATER QUALITY MODELING** WORKSHOP–

a. The following information was presented by Fred Lee - Now that the Delta Vision Group has suggested several alternate water transport scenarios of transporting Sacramento River water around and through the Delta to the export pumps, the water

quality conditions resulting from such scenarios should be considered for investigation. Fred suggested that CWEMF consider becoming involved in helping to establish a modeling approach to address water quality changes in the Delta as impacted by the alterations in flow. The current ability to reliably model flow and water quality conditions in the Delta is limited. The proposed CWEMF involvement could be the stimulus to help define the information gaps and approaches that are needed to develop the models to guide the management of flow in the Delta as it impacts water quality.

There are currently many violations of numeric water quality objectives (WQO) in the Delta, and there is also impairment of water quality conditions in the Delta without violation of numeric WQOs (see Fred's handout summary of these conditions embedded at the end of these minutes). The key question is how the new flow scenarios will affect the existing water quality violations and impairments. The water quality conditions created in each Delta channel will depend upon how constituents are transported through the Delta with the new flow scenarios. Drawing of generally high quality Sacramento River water through the Delta channels tends to dilute the concentrations of some pollutants there, while by-passing the river water around the Delta channels may increase the concentrations of some pollutants in those Delta channels. Also, the allowable contaminant loads specified in existing Delta TMDLs may have to be modified if water transfer conditions change.

To properly evaluate the impact of alterations in Sacramento River flow through/around the Delta and the export pumping of Delta water, reliable models of transport, fate, and transformation of pollutants in Delta channels need to be developed. For each water quality problem mentioned above, consideration may have to be given to develop a model that can be used to predict the location, duration, and magnitude of water quality impairment in each of the Delta channels. The modeling required will be different than most past Delta modeling. Chemical and biological transformation kinetics, rate coefficients, partitioning between the water column and sediments, and speciation between chemical parameters may have to be considered in many cases. Models developed for many of the parameters must be able to incorporate water column and sediment interactions. The recent work of Stephenson, Foe, and others on mercury fate and transport in the Delta is an example of the type of study and modeling effort that may be needed for some of the constituents and conditions for which there are problems.

b. Discussion that ensued - Mention was made that CALFED has developed some conceptual models in their Sacramento-San Joaquin Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) for some of the water quality parameters or conditions existing in the Delta, and that perhaps these could be used as a starting point for some of the mathematical models that may be needed. Fred proposed to have his workshop this coming Fall, which purpose would be to help define the information gaps and modeling approaches that are needed (as a result of the Delta Vision flow scenarios) to guide the management of flow in the Delta as it impacts water quality. Following the workshop a white paper could be written presenting the results of the workshop's findings.

11. **ADJOURNED** – 1:30 pm. Next meeting is on May 29, 2009, at Solano Irrigation District Office in Vacaville.

Respectfully Submitted
George Nichol, Secretary, CWEMF

ATTENDANCE

Paul Hutton	Convener, MWD
Rich Satkowski	Executive Director, CWEMF
Stacy Tanaka	Treasurer, Watercourse Engineering Inc
George Nichol	Secretary, SWRCB
G. Fred Lee	GFL & Associates
Tara Smith	DWR
Erik Reyes	DWR
Lisa Holm	USBR
Marianne Guerin	Vice Convener, RMA
Hubert Morel-Seytoux	Hydroprose
Mark Gowdy	SWRCB
Lucinda Shih	CCWD
Peter Baker	Stillwater Sciences
Michael Tansey	USBR
Mike Deas	Watercourse Engineering Inc.
Jay Lund	UCD

Proxies: Nigel Quinn, Steve Culberson

Summary
Water Quality Modeling Associated with
Altered Sacramento River Flows in & around the Delta

G. Fred Lee PhD, PE, BCEE and Anne Jones-Lee PhD

- As part of implementing the Delta Vision Strategy for addressing resource management issues in the Delta, the flow of the Sacramento River in & around the Delta, and the USBR and DWR export projects' pumping of Delta water, will be changed.
  - These changes will impact Delta water quality.
- Delta water quality is impaired by discharges of chemicals from various sources to Delta tributaries and directly to the Delta.
  - Discharges cause violations of numeric water quality objectives (WQO)
  - Violations lead to Clean Water Act 303(d) listings & TMDLs to control pollutant sources
    - Salinity, mercury, organophosphate pesticides (DDT, toxaphene), aquatic life toxicity, dioxin/furans, copper, zinc, boron, low DO
- There are water quality impairments in Delta channels without violation of numeric WQOs
  - TOC, nutrients, pyrethroid pesticides, excessive siltation, sediment toxicity, PPCPs, PBCPs, pharmaceuticals and hormones, unregulated chemicals
- Magnitude, location, & duration of water quality impairments depend on the flow of water through Delta channels.
  - Flow in many Delta channels depends on flow of the Sacramento River through the Delta and the pumping of water by the export projects
- Flow of Sacramento River in the Delta and projects' export pumping impact the location, duration, and magnitude of water quality impairment in water in Delta channels.
- To properly evaluate the impact of alterations in Sacramento River flow through/around the Delta and the export pumping of Delta water, models of transport, fate, and transformation of pollutants in Delta channels need to be developed
  - For each source of chemical pollutant, develop a model that can be used to predict the location, duration, and magnitude of water quality impairment in each of the Delta channels as impacted by altered flow of the Sacramento River and projects' export pumping of Delta water
- CWEMF could/should be a leader in formulating Delta water quality modeling to address alterations in Sacramento River flow and export pumping of Delta water
  - Modeling information needed for TMDLs to evaluate the impact of reducing loads of pollutants from various sources on Delta channel water quality
- Recommended approach
  - Develop a "white paper" on the need for this modeling and to provide guidance on how this modeling should be developed
  - Develop a workshop on this modeling

Background information on this issue is available in:

Lee, G. F., and Jones-Lee, A. "Review of Need for Modeling of the Impact of Altered Flow through and around the Delta on Delta Water Quality Issues" Report to CWEMF Steering Committee, March (2009). http://www.gfredlee.com/SJR-Delta/Model-Impact-Flow-Delta.pdf

Background
Review of Need for Modeling of the Impact of Altered Flow through and around the Delta on Delta Water Quality Issues

G. Fred Lee, PhD, PE, BCEE Anne Jones-Lee, PhD
G. Fred Lee & Associates
El Macero, California
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March 2009

The Sacramento San Joaquin Delta is formed from the confluence of the Sacramento and San Joaquin Rivers with lesser contributions from other tributaries such as the Mokelumne River. Figure 1 presents a map of the Delta showing the numerous interconnected channels before discharge to upper San Francisco Bay. Major exports of Delta water occur at the south western area of the Delta at the federal (USBR) and state DWR pumping stations. Except near the upper San Francisco Bay the Delta is a freshwater tidal system with appreciable tidal currents in each of the channels. The tributary and tidal flows in the Delta are major factors in affecting Delta water quality.

Delta Water Quality Issues

Delta's water quality is impaired due to excessive concentrations of several potential pollutants. Violations of water quality objectives (WQO)/standards leads to violations of Clean Water Act (CWA) Section 303(d) which requires that the Central Valley Regional Water Quality Control Board (CVRWQCB) develop a Total Maximum Daily Load (TMDL) to control the sources of the pollutants that cause the violation of the WQO. This listing of WQO violations is prepared by the CVRWQCB, State Water Resources Control Board (SWRCB) and the US EPA. Lee (2008) has summarized the current WQO violations and other impairments of water quality in Delta tributaries and channels.

This 303(d) listing includes in addition to listing the WQO violations includes a location in the Delta channels where these violations have been found to occur. Lee and Jones-Lee (2004) have discussed the Delta water quality standards violations as known in 2002 and other water quality impairments of the beneficial uses of the Delta waters that while do not at that time and today causes WQO violations since there are no WQOs for the parameters causing the water quality impairment. This type of situation occurs for nutrients (N and P compounds), TOC. pyrethroid pesticides, etc.

Lee and Jones-Lee (2007a) presented updated information based on the 2006 303(d) CWA listing at the California/Nevada American Water Works fall meeting. The updated 303(d) listing is available at
http://www.swrcb.ca.gov/water_issues/programs/tmdl/303d_lists2006_epa.shtml. Figures 2 and 3 present a chart of existing and potential CWA Section 303(d) impaired waterbodies and the constituents responsible for the listing.

Basically, the 2007 discussion of the WQO violations data is the same as the 2004 results. At this time the CVRWQCB/SWRCB/USEPA is developing an updated listing of WQO violations

that should be available in a year or so. With increased attention being given to Delta water quality issues it is possible that there will be changes in the 303(d) listings for the Delta channels.

Figure 1 Map of the Delta

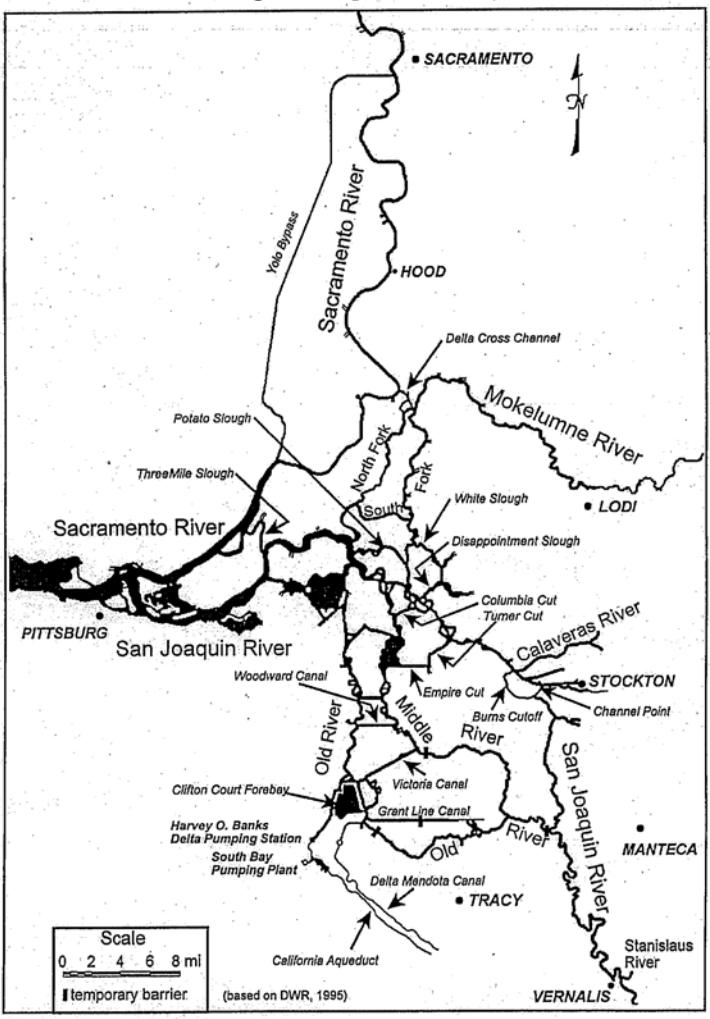

Figure 2

2006 CWA 303(d) List of "Impaired" Delta Waterbodies (SWRCB, June 2007)

	Location (see key below)													Potential Sources (see key below)				
Pollutant*/Stressor	CD	ED	SE	ND	NW	SD	SC	WD	SJ	MS	OR	MR	MDR	Ag	R/S	SU	AM	Other
Chlorpyrifos	X	X	X	X	X	X	X	X						X	X			
Diazinon	X	X	X	X	X	X	X	X						X	X			
DDT	X	X	X	X	X	X	X	X	X					X				
Group A Pesticides (legacy)	X	X	X	X	X	X	X	X	X					X				Formerly-used pesticides
EC/TDS			X		X	X		X	X					X				
Exotic Species	X	X	X	X	X	X	X	X								X		
Mercury	X	X	X	X	X	X	X	X	X								X	
Unknown Toxicity	X	X	X	X	X	X	X	X	X					X		X		
Dioxin/Furan							X											Point source; McCormick/Baxter; Contaminated sediment
Pathogens							X			X					X			Non-boating recreation; tourism
PCBs				X			X									X		Point source
Low DO											X		X			X		Hydromodification
							X								X			WWTP ammonia
										X					X			
Copper												X					X	
Zinc												X					X	
Boron									X					X				
Toxaphene									X							X	X	

Location Designations
CD - Central Delta
ED - Eastern Delta
SE - South Delta export area
ND - North Delta
NW - Northwestern Delta
SD - Southern Delta
SC - Stockton Ship Channel
WD - Western Delta
SJ - Lower San Joaquin River
MS - Mormon Slough
OR - Old River - South Delta
MR - Lower Mokelumne River
MDR - Middle River

Group A Pesticides	
aldrin	heptachlor epoxide
dieldrin	hexachlorocyclohexane
chlordane	(incl. lindane)
endrin	endosulfan
heptachlor	toxaphene

Pyrethroids
bifenthrin
lambda cyhalothrin
efenvalerate/fedvalerate
permethrin

Source Designations
Ag - Agriculture
R/S - Urban runoff/Storm sewers
SU - Source unknown
AM - Abandon mine
WWTP - Domestic wastewaters

CWA - Clean Water Act

* Violates water quality objective

Figure 3

Delta Impaired Waters Not Listed on CWA 303(d)

Should Be Listed	Known Impairments
Nutrients - N & P	Excessive growth of algae & macrophytes
TOC/DOC	Trihalomethanes formed in water treatment
Pyrethroid pesticides used in agriculture & urban areas	Watercolumn & sediment toxicity
Could Be Listed - Need Investigation for Potential Impacts	**Sources**
PBDE - polybrominated diphenylethers	Domestic wastewater discharges
PPCP - pharmaceutical & personal care products	Domestic wastewater discharges
Pharmaceuticals & hormones	Dairy & animal husbandry operations
Other unregulated chemicals	Various

Water quality characteristics of the Delta is determined by exceedance of WQOs, impairment of the designated beneficial uses of the Delta independent of whether a WQO violation is found/designated by the regulatory agencies. According to the Delta Protection Commission, http://www.delta.ca.gov/plan/water.asp, the Central Valley Regional Water Quality Control Board has designated the following beneficial uses in the Delta:

- Municipal and Domestic Supply
- Agricultural Supply: Irrigation and Stock Watering
- Industrial Process and Service Supply
- Groundwater Recharge
- Freshwater Replenishment
- Navigation
- Hydroelectric Power Generation
- Water-Contact and Nonwater-Contact Recreation
- Freshwater Habitat
- Preservation of Rare and Endangered Species
- Fish Migration/Fish Spawning

This listing is derived from the CVRWQCB Basin Plan at http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/. The key beneficial uses for the Delta are municipal and domestic water supply, agricultural water supply, water contact and non water contact recreation, freshwater habitat, preservation of rare and endangered species and fish migration/fish spawning.

Impact of Delta Channel Flow and Export Pumping on Delta WQO

Beginning in 1999 with support by the William Jennings (DeltaKeeper) Drs. G. Fred Lee and Anne Jones-Lee became involved in SJR Deep Water Ship Channel (DWSC) low DO issues as advisors to the SJR DO TMDL Steering Committee. The focus of this activity was on the first seven miles of the DWSC near the Port of Stockton. The Lee and Jones-Lee activity evolved into their becoming the principal investigators for a $ 2 million several year study on the causes of the low DO and the sources of oxygen demand that causes this problem. Lee and Jones developed a series of reports on this activity including a synthesis report (Lee and Jones-Lee 2003) and a supplement Lee and Jones-Lee (2004a). These and the other papers and reports on these issues are available on the Lee and Jones-Lee website, www.gfredlee.com, www.gfredlee.com at http://www.gfredlee.com/psjriv2.htm.

As discussed by Lee and Jones-Lee (2003a,b, 2004a,b, and Lee et al. 2004) and as summarized in Lee and Jones-Lee (2004b) the flow (direction and magnitude) of water in the Delta channels is highly influenced/controlled by diversion of Delta water by the Delta US Bureau and Reclamation (USBR) and Department of Water Resources (DWR) federal and state export projects at Tracy and Banks to Central Valley, San Francisco Bay area and southern California. At times until recently from about 8,000 to 13,500 cfs of Delta water is exported by these pumps. As documented by the studies of Lee and Jones-Lee with DeltaKeeper support, most of the water diverted by the export projects is Sacramento River water that is drawn through the Delta to the export pumps. These export caused altered flows through the Delta channels have impacted the location/magnitude/duration of WQO objective violations in the Delta channels. Subsequently, Monsen et al. (2007) have develop a paper that present the same information on the impact of the state and federal south Delta export projects on altering the flow in the Delta as Lee and Jones-Lee discussed in their earlier studies.

The distribution of pollutants added to the Delta from the tributaries such as the San Joaquin River, Sacramento Rivers and the other tributaries as well as within Delta sources including irrigated agriculture discharges which are the sources of the pollutants that cause the WQO violations in Delta channels are distributed in the Delta based on the location and magnitude of export pumping by the export projects. At this time there is essentially little or no understanding of how the export projects altered flow through the channel impact the WQO violations in the Delta. While as discussed by Lee and Jones-Lee (2005a,b) the SWRCB water right Decision 1641 required that all water diversions permits include that the permittee determine the impact of the diversion on water quality, this requirement has not been enforced by the SWRCB.

The 2007 Judge Wranger court rulings designed to better protect certain fish in the Delta from the adverse impacts of the pumps have significantly influenced the water diversions by these export projects that can take place. These issues are discussed in,
http://www.sfgate.com/cgi-bin/article.cgi?file=/c/a/2007/09/01/MNPCRT83Q.DTL.
The restriction on export projects pumping of Delta water has stimulated renewed interest in developing an alternative approach to taking water from the of Sacramento River/Delta including the development of a "peripheral cannel" to take Sacramento River water just below Sacramento and thereby eliminate the drawing of Sacramento River through the Delta to the export pumps. Another approach that is being discussed is a "through Delta" armored channel that would

largely eliminate the interaction of Sacramento River water with the waters in many of the Delta channels that are being impacted by the past and current export of water from the Delta. The adoption of the currently being discussed alternative approaches for exporting Sacramento River water around and/or through the Delta will also impact the occurrence, location, and magnitude WQO violations and water quality/beneficial uses that occur in Delta channels.

One of major conclusions of the Lee and Jones-Lee studies of the low DO problem in the DWSC was that the export pumping of south western Delta waters at Tracy and Banks at times greatly decreased the amount of SJR water that enters the Delta at Vernalis. At discussed in Lee and Jones-Lee (2003a, 2004a) the magnitude of the DO depression in the DWSC was directly related to the amount of SJR flow through the DWSC. At low SJR flow through the DWSC the DO depression in the DWSC was increased due to the longer hydraulic residence time in the DWSC that enabled a greater exertion of the oxygen demand load that enters the DWSC from the City of Stockton wastewater discharges just upstream of the DWSC. This situation occurs when the Head of Old River Barrier was not in and the export project pumps are drawing most of the SJR Vernalis water into the south Delta via the Head of Old River. Altering the SJR flow through the DWSC as a result of altering the Sacramento River flow into/or around the Delta and export pumping location will impact the low DO problem in the DWSC. It will also impact the path that the SJR associated pollutants that enter the Delta at Vernalis take in the Delta.

As discussed by Lee and Jones-Lee (2006a,b, 2007a,b,c) for many of the pollutants that cause WQO violations in the Delta that are derived from San Joaquin River and in Delta sources, the export projects drawing of generally high quality Sacramento River water through the Delta tends to dilute the concentration of some pollutants in Delta channel waters. The diversion of Sacramento River around the Delta or in an isolated facility through the Delta has the potential to greatly adversely impact Delta water quality due to reduced dilution of the pollutants from some sources by the export projects drawing Sacramento River through the Delta. At this time the potential adverse impacts of altered approach for exporting Sacramento River water on Delta water quality is poorly understood. As part of developing the altered approach for exporting Sacramento River water around/through the Delta, a high priority should be given to developing the an understanding of how the water quality designated beneficial uses in the Delta channels is impacted. This understanding should be focused on developing models that can be used to related altered flow in the Delta channels as influenced by water diversions on WQO violations in those Delta channels where WQO violations have been found or could be found under altered flow in the channels.

Need For Delta Water Quality Modeling

The Delta water quality models would be used to guide the types of studies needed to develop the information needed to support the decisions to predict the impact of altered Delta channel flow as a result of altered Sacramento River diversion on Delta channel water quality and on the impact of water diversions from the Delta on Delta water quality. The California Water and Environmental Modeling Forum (CWEMF) can/should play a major role in formulating this modeling approach.

As an example of this type of modeling is the work that Dr. Chris Foe of the CVRWQCB has been doing on the methyl mercury (MeHg) concentration and fate in the Delta. Methyl mercury

is the form of mercury that bioaccumulate in fish to a sufficient extent to cause the fish to represent a threat to the health of those who use the fish as food. Through comprehensive field studies he has been able to formulate information on the fate and transport of MeHg to the Delta and most important it transport/fate in the Delta including the role of Delta wetlands as a source of MeHg that results in increased bioaccumulation in Delta fish. His model will be available for review in 2009. Information on these issues is available at Stephenson et al. (2008).

The Delta water quality models can be used to guide the potential impact of altering Sacramento River flow through/around the Delta on excessive bioaccumulation of mercury in Delta fish. This modeling approach will also provide guidance on implementing wetland restoration projects in the Delta on developing areas that impact the conversion of total mercury to methyl mercury.

Similar models need to be developed for the organochlorine legacy pesticides such as DDT and its transformation products and PCBs. These chemicals are bioaccumulating in some Delta fish to be a human heath threat to those who use these fish as food. These chemicals are present in waters added to the Delta and are released from Delta sediments to bioaccumulate to excessive levels in Delta fish. As discussed by Lee and Jones-Lee (2002) at this time there is essentially no understanding of the sources of the organochlorine chemicals that are bioaccumulating to excessive levels in Delta fish as well as how altering the flow of the Sacramento and San Joaquin Rivers into the Delta will impact the excessive bioaccumulation of these chemicals in edible fish. A modeling effort directed to developing the information on these issues is needed to evaluate how altering flow to and around the Delta will impact the water quality issues associated with organochlorine legacy chemicals such as DDT and PCBs. This modeling must include consideration of water column and sediments.

A particularity important group of chemicals that impact Delta water quality/beneficial uses are the aquatic plant nutrients, N & P compounds. As demonstrated in the presentations on nutrient related water quality issues in the CWEMF Delta nutrient modeling workshop, and as summarized Lee and Jones-Lee (2008) in the workshop synopsis at, http://www.gfredlee.com/SJR-Delta/CWEMF_WS_synopsis.pdf, there is need to understand the source or nutrients that lead to excessive aquatic plant growth that impairs Delta water quality related beneficial uses as well as the importance of nutrient loads to development of desirable fish populations in the Delta. There is no doubt that altering the flow of the Sacramento River and San Joaquin River into and through the Delta will impact excessive aquatic plant growth that is detrimental to the beneficial uses of the Delta and promote the development of desirable fish populations. As discussed by Lee and Jones-Lee (2008) in developing nutrient control programs there is need to balance nutrient control programs in the Delta watershed and within the Delta to minimize water quality impairments due to excessive aquatic plant growth in the Delta and in downstream water supply reservoirs versus desirable fish production in the Delta.

It is understood that the current understanding of water modeling in the Delta is limited. The proposed CWEMF modeling effort devoted to Delta water quality modeling could be the stimulus to define the information gaps and approaches that are needed to develop the models to guide the management of flow in the Delta as it impacts Delta water quality.

Characteristics of Delta Water Quality Models

Jones-Lee and Lee (2008, 2009) have reviewed the approach that should be used to evaluate/model the water quality impact of a chemical that is introduced into a waterbody. An excerpt from these publications is appended to this report. For each potential source of a potential pollutant there is need to evaluate the concentration in the source, the rate of dilution and transport in the receiving waters and the kinetics and thermodynamics of the potential transformations of the pollutant that impact the concentration of toxic/available forms of the pollutant. These transformations are shown in Figure 4-1. The importance of the initial rate and amount of dilution determine the potential impact of acute (short term toxicity) which as shown in Figure 4-2 the WQO that should be used to evaluate the violation of the WQO.

Apply this modeling approach to the Delta channels requires that a comprehensive monitoring program be conducted for each channel water column and sediments that has a WQO violation. An Evaluation Monitoring approach as described by Jones-Lee and Lee (1998) that examines whether a WQO violation represents a real significant impairment of the beneficial uses of the waterbody or represents an administrative exceedance of the worst case water criteria/standard/objective. This approach focuses on examining the impact of chemicals rather than their concentrations. This monitoring should try to be conducted under the range of export/flow conditions that are occurring in the Delta channels.

Through developing an understanding of the sources, transport and transformation of chemicals that potentially impact water quality it will be possible to better define how water exports within and upstream of the Delta impact the beneficial uses of the Delta. These models will define the studies that need to be conducted to define the potential impacts of altering the flow into/around and export of water from the Delta on Delta water quality. The monitoring and continued modeling development should continue after an altered flow is implemented.

Impact of Exports on Chinook Salmon Home Steam Water Chemical Signal

One of the major issues of concern in managing Delta resources is the impact of altering Delta flow patterns as influenced by Delta flow exports on fishery resources. As part of the investigation of the impact of flow diversions on SJR DWSC low DO problem Lee and Jones-Lee (2003b) conducted studies to determine the fate of the SJR water that enters the Delta during periods of normal federal and state export pumping of south Delta water. As they found the export pumping caused the SJR water that enters the DWSC to be mixed with Sacramento River water and drawn into Turner Cut to Middle River and to the export pumps. This export pumping induced flow pattern carried all SJR pollutants that made it past the Head of Old River diversion to be transported into the Central Delta where the impacts due to WQO violations and impacts would occur. Without the export pumping the SJR pollutants would have been transported to the northern area of the Delta. Further, as discussed by Lee and Jones-Lee (2003b) this prevented all of the upper San Joaquin River Chinook Salmon homing signal from reaching the north western Delta and thereby help to guide the fall run Chinook Salmon to their SJR home stream waters upstream of the Delta. This could lead to increased straying and thereby impairing the reproduction of fall run Chinook Salmon in the SJR watershed. A summary of these issues is appended to this report. It will be important that any diversions of Delta waters consider the impact on fall run Chinook Salmon home stream signal to the SJR watershed.

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4.3 AQUATIC CHEMISTRY*

There is a general lack of understanding and consideration of the importance of aquatic chemistry in water quality evaluation and management. Aquatic chemistry can be complex and not easily modelled, and requires a more in-depth understanding than many in the field possess. It can also be more challenging to explain why the removal of particular "chemicals" in a situation is not warranted for water quality protection than it is to cause the development of a treatment works. That notwithstanding, it has been well known since the late 1960s that the total concentrations of potentially toxic constituents in the water column and/or sediment are an unreliable basis for estimating the water quality impacts on the beneficial uses of a waterbody as designated by the Clean Water Act.

The reason why total concentrations of a selected chemical(s) are unreliable in assessing water quality or use-impairment is that many chemical constituents in aquatic systems exist in a variety of chemical forms, only some of which are toxic or otherwise available to adversely affect water quality. This is shown conceptually in the aquatic chemistry "wheel" presented in Figure 4.1. Different forms of a chemical can have vastly different degrees of impact on the beneficial uses of a waterbody (such as aquatic life propagation, or the wholesomeness of aquatic life used as food). The forms in which a chemical exists in a particular aquatic system depend on the nature and levels of detoxification materials in the water and sediments. These materials, such as organic carbon, sulfides, carbonates, hydrous oxides and clay minerals, react with potentially toxic forms of chemicals, yielding chemical forms that are non-toxic, less toxic, or otherwise less available to aquatic life. The reactions that actually take place, and the toxicity/availability of the various forms of chemicals that are created through those reactions, depend both on the nature of the particular contaminant and on the characteristics of the aqueous environment being considered.

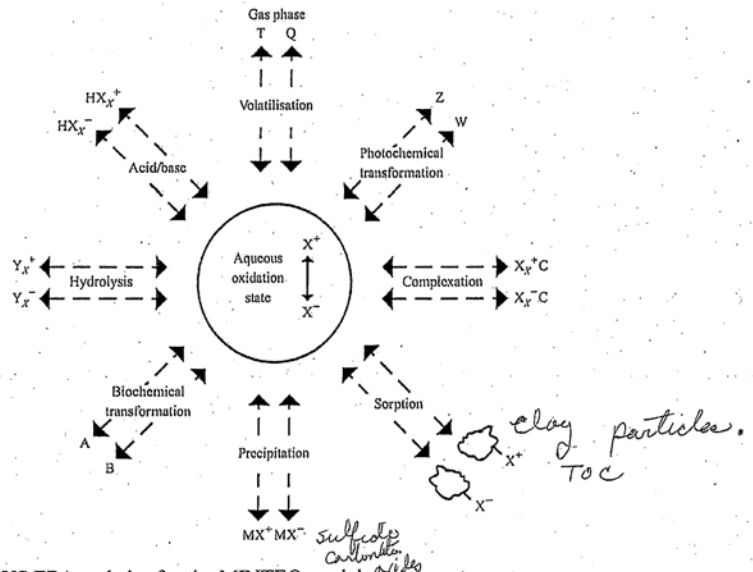
Represented at the "hub" of the wheel in Figure 4.1 is a chemical in its readily available state. The spokes about the hub represent reactions into which a chemical can enter in aqueous environmental settings (volatilisation, photochemical transformation, complexation, adsorption and absorption, precipitation, biochemical transformation, hydrolysis, and acid/base transformation), and the resulting products formed. The bioavailability of those transformation products can be more or less than that of the available form at the hub. The extent to which a particular chemical participates in each of these reactions to generate the transformation products depends on the nature of the chemical and the characteristics of the aqueous environmental setting, and is controlled by the kinetics (rates) and thermodynamics (positions of equilibrium) of the reactions. The total concentration of a chemical includes the most available form at the hub as well as the less-available/unavailable transformation products at the spokes of the diagram. Using the total concentration of a chemical contaminant as a measure of impact presumes that all of the forms are equally and totally available The Stumm and Morgan (1996) graduate-level text, *Aquatic Chemistry,* provides information on the chemical issues that need to be considered in evaluating the "chemistry" of a potential pollutant in aquatic systems.

While shown simplistically in Figure 4.1, these reactions are often not readily modelled mathematically in a manner that accurately represents a real aquatic system. Rarely is information developed on the amounts of the active forms of detoxification components of water and/or sediments, or on the characteristics of the reactions that occur with the potentially toxic or available forms. Therefore it is not possible to predict, based on typical chemical analyses, the toxic or available forms of potential pollutants such as heavy metals, selected organics or nutrients, that impact on the beneficial uses of a waterbody of concern to the public.

How about TIEs?

In order to try to better represent aquatic chemistry in water quality assessment, the US EPA developed the MINTEQA2 exposure assessment model. Information on that model and its use is available at: http://www.epa.gov/ceampubl/mmedia/minteq/index.htm.

Figure 4.1: Aquatic chemistry of chemical constituents



According to the US EPA website for the MINTEQ model:
"MINTEQA2 is an equilibrium speciation model that can be used to calculate the equilibrium composition of dilute aqueous solutions in the laboratory or in natural aqueous systems. The model is useful for calculating the equilibrium mass distribution among dissolved species, adsorbed species, and multiple solid phases under a variety of conditions including a gas phase with constant partial pressures. A comprehensive data base is included that is adequate for solving a broad range of problems without need for additional user-

supplied equilibrium constants. The model employs a pre-defined set of components that includes free ions such as Na^+ and neutral and charged complexes (e.g., H_4SiO_4, $Cr(OH)^{2+}$). The data base of reactions is written in terms of these components as reactants . An ancillary program, PRODEFA2, serves as an interactive pre-processor to help produce the required MINTEQA2 input files."

MINTEQA2 can be used to some extent to describe the position of equilibrium for the potential reactions that a chemical may undergo in an aqueous environmental system. However, it does not account for the kinetics of those reactions – that is, the rates at which equilibrium is attained – and hence the actual concentrations of the various forms expected in a particular system. The rates of some of the reactions that govern the distribution of the components of potential pollutants are sufficiently slow that equilibrium may not be achieved in runoff waters as they mix with receiving waters. Site-specific studies are needed to determine whether this situation exists for a particular chemical and runoff. Nor do the MINTEQ models include information on the concentration of each of the chemical species that may impact on aquatic-life-related beneficial uses, or on how the concentrations of specific chemical species change with time. Thus, although the MINTEQA2 model is useful in describing the aquatic chemistry of a constituent, it must be used in conjunction with site-specific investigations of the site to which it is being applied.

So use Aquatox Release 3 or site-specific investigations.

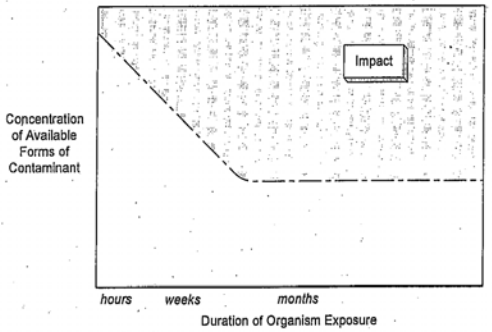
DURATION OF EXPOSURE

In addition to considering the bioavailability of the chemical species present in a given aquatic system, it is necessary to consider the duration of exposure that aquatic life of concern can receive as the runoff waters mix into the receiving waters. Figure 4.2 illustrates the general relationship among the concentration of available chemical forms, duration of organism exposure, and laboratory toxicity measurement ("impact"). As shown, comparatively high concentrations of the available forms of a toxic chemical can be tolerated by some forms of aquatic life without impact as long as the duration of exposure is sufficiently short. As the duration of exposure is increased, the concentration of available forms that can be tolerated without impact lessens, until, for many chemicals, a concentration is reached to which an organism can be exposed for a lifetime or over critical life stages without adverse impact.

How this relationship is manifested in an aquatic environment can be influenced by the characteristics of the organisms of concern, the nature of the discharge being considered, as well as the hydrodynamics of the receiving water. Some discharges, such as stormwater runoff, are short-term and episodic in nature; organisms would be unlikely to be exposed to the discharge for a substantial duration. Mobile organisms such as fish may move in and out of an effluent/receiving water mixing area, altering the exposure they receive to contaminants in the discharge. There can be characteristics of a discharge, such as its temperature, that attract fish to it; other characteristics may repel fish. These discharge characteristics thus affect the exposure that a mobile organism may receive. There may also be zones of passage in a receiving water such that a mobile organism may avoid exposure altogether. To model the potential water quality impacts of stormwater runoff reliably it is necessary to conduct site-specific studies of the mixing of the runoff waters with the receiving waters. Since the concentrations of potential pollutants in runoff are typically the

greatest at the point at which the runoff enters the receiving water, there is concern about whether there can be toxicity to aquatic life at or near the point of runoff entry. There is also concern about toxicity in areas outside the mixing zone of runoff with the receiving water. The concentrations of runoff-associated contaminants in those areas are typically substantially lower than those in the runoff water itself. Potential impacts both within the mixing zone and outside it need to be addressed. One of the difficulties with the application of some states' regulations to stormwater runoff is that they do not allow a mixing zone for runoff-associated constituents in the receiving waters. Such a regulatory approach presumes that the concentrations in the discharge persist in the receiving water, which is rarely the case.

Figure 4.2: Critical concentration/duration of exposure relationship.



In summary, it is not possible to develop a simple mathematical model for the water quality impacts of potential pollutants in urban stormwater runoff. The nature and availability of the actual chemical species present in the particular runoff and receiving water, as well as the site-specific, complex, and variable exposure an organism may receive in the receiving water, require that a different approach be used to evaluate the water quality impacts of urban stormwater and agricultural runoff.

* Derived from Jones-Lee, A., and Lee, G. F., "Modelling Water Quality Impacts of Stormwater Runoff: Why Hydrologic Models Are Insufficient," Chapter 4 IN: **Modelling of Pollutants in Complex Environmental Systems**, Volume I, ILM Publications, St. Albans, Hertfordshire, UK, pp.83-95 (2009). http://www.gfredlee.com/Runoff/HydrologicModelsInadeq.pdf

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