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DEPARTMENT OF WATER RESOURCES

Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh

38th Annual Progress Report to the
State Water Resources Control Board in
Accordance with Water Right Decisions 1485 and 1641

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Foreword

This is the 38th annual progress report of the California Department of Water Resources' San Francisco Bay-Delta Evaluation Program, which is carried out by the Delta Modeling Section. This report is submitted annually by the section to the State Water Resources Control Board pursuant to its Water Right Decision D-1485, Term 9, which is still active pursuant to its Water Right Decision D-1641, Term 8.

This report documents progress in the development and enhancement of computer models for the Delta Modeling Section of the Bay-Delta Office. It also reports the latest findings of studies conducted as part of the program. This report was compiled under the direction of Tara Smith, Program Manager for the Bay-Delta Evaluation Program.

Online versions of previous annual progress reports are available at:
http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/annualreports.cfm.

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Acronyms and Abbreviations

µmhos/cm	micromhos per centimeter
µS/cm	microSiemens per centimeter
ADCP	Argonaut Acoustic Doppler Current Profiler
Banks Pumping Plant or Banks	Harvey O. Banks Pumping Plant
BBID	Byron Bethany Irrigation District
BDCP	Bay-Delta Conservation Plan
BDO	Bay-Delta Office
CBOD	carbonaceous biochemical oxygen demand
CDEC	California Data Exchange Center
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
cm	centimeters
CSB	Control Systems Branch
CU	Consumptive Use Model
CVP	Central Valley Project
DCU	Delta consumptive use
Delta	Sacramento-San Joaquin Delta
DETAW	Delta Evapotranspiration of Applied Water Model
DFD	Delta Field Division
DICU	Delta Island Consumptive Use Model
DIV	total diversion
DO	dissolved oxygen
DSM2	Delta Simulation Model version 2.0
DSM2-GTM	General Transport Model
DWR	California Department of Water Resources
EC	electrical conductivity
ET	evapotranspiration
ETc	crop evapotranspiration
ETo	reference evapotranspiration
Forebay	Clifton Court Forebay
ft	feet

ft/s	feet per second
GIS	geographic information system
HS	Hargreaves-Samani equation
I_A	applied water
I_D	excess irrigation water
IEP	Interagency Ecological Program
Kc	crop coefficient
Ks	stress coefficient
LW_A	leach water applied
LW_D	leach water drained
m	meter
mg/L	milligrams per liter
mph	miles per hour
NAA	No-Action Alternative
NAVD88	North American Vertical Datum of 1988
NCDC	National Climatic Data Center
NCRO	North Central Regional Office
NDO	Net Delta Outflow
NDOI	Net Delta Outflow Index
NG	New Generator
NGVD29	National Geodetic Vertical Datum of 1929
NH_3	ammonia
NMFS	National Marine Fisheries Service
NO_2	nitrite
NO_3	nitrate
NOAA	National Oceanic and Atmospheric Administration
O_2	soil saturation-reduced root-zone oxygen
O&M	DWR Division of Operations and Maintenance
Org-N	organic nitrogen
Org-P	organic phosphorus
PA	Proposed Action
PEST	Parameter Estimation Software
PM	Penman-Monteith equation

PO_4	ortho-phosphate, assumed to represent dissolved phosphorus
PPT	precipitation
PST	Pacific Standard Time
RET	returned flow
RMA	Resource Management Associates
RO	surface runoff
S	seepage
SAP	Systems Applications and Products
SCHIM	Semi-implicit Cross-scale Hydroscience Integrated System Model
SDFPF	John E. Skinner Delta Fish Protective Facility
SEBAL	Surface Energy Balance Algorithm for Land
SM	soil moisture
sq ft	square feet
SWP	State Water Project
taf	thousand acre-feet
UC IPM	Statewide Integrated Pest Management Program at University of California
USGS	U.S. Geological Survey
WY	water year

Preface

Chapter 1. Evaluation of the Recalibrated Martinez Boundary Salinity Generator with DSM2 Version 8.1

The Martinez boundary EC (electrical conductivity) generator for planning studies or forecasting was first developed by the Delta Modeling Section in 2001 (Ateljevich 2001), which was based on the original antecedent flow-salinity relations model, generally referred to as G-Model (Denton and Sullivan 1993), and incorporated tidal variation effect. The Martinez EC generator was recently recalibrated by using PEST, which is mathematically based calibration software (Sandhu and Zhou 2015). This chapter documents the effects of this recalibrated Martinez EC generator on planning studies. The Bay Delta Conservation Plan (BDCP)/California WaterFix simulations using Delta Simulation Model 2 (DSM2), version 8.0.4, during a 16-year planning simulation, 1974–1991, were converted to DSM2 version 8.1 with North American Vertical Datum of 1988 (NAVD88). We (Liu, Zhou, and Sandhu) will refer to the original Martinez EC Generator (Ateljevich 2001) as the Old Generator and the recalibrated Martinez EC Generator as the New Generator (noted as NG in figures). The simulation results were compared with the original results computed for BDCP by using DSM2 version (v)8.0.4. Studying the incremental differences in results between the two versions of DSM2 may reveal whether those differences would significantly affect or change any analysis conclusions in the simulations previously computed for BDCP by using DSM2 v8.0.4.

Chapter 2. DSM2 Nutrients Modeling Sensitivity Analysis

The California Department of Water Resources' Delta Modeling Section is developing a new Delta Simulation Model 2 (DSM2) transport module, called the General Transport Model (DSM2-GTM). Progress on this effort was previously reported in Hsu et al. (2014). When the model development is completed, DSM2-GTM will include sediment, dissolved oxygen (DO), and mercury cycling modules to simulate non-conservative constituents.

Part of the DSM2-GTM development process is to calibrate the DO module that simulates the transport and reaction of water temperature and nine non-conservative constituents that are currently included in the DSM2-QUAL computation. These nine constituents are DO, nitrate (NO_3), nitrite (NO_2), ammonia (NH_3), organic nitrogen (Org-N), carbonaceous biochemical oxygen demand (CBOD), ortho-phosphate (PO4) assumed to represent dissolved phosphorus, organic phosphorus (Org-P), and algae.

In general, there are two types of model calibration approaches — automatic and manual. If the manual calibration approach is used to carry out the DSM2-GTM calibration, choosing which constituent reaction rates to more efficiently calibrate the model could be challenging. To have a better idea regarding which constituent reaction rates may possess more significant effects on the model results, a sensitivity analysis was performed to test how the model results respond when changing certain constituent reaction rates. This chapter summarizes the sensitivity analysis approach and preliminary findings to date. This sensitivity analysis is an initial investigation and is also an on-going exercise along with the DSM2-GTM development.

Chapter 3. Implementing DETAW in Modeling Hydrodynamics and Water Quality in the Sacramento-San Joaquin Delta

Numerical modeling of the hydrodynamics and water quality in the Sacramento-San Joaquin Delta channels requires accounting for in-Delta net channel depletion because of agricultural diversions, including seasonal leaching, seepage from channels to Delta lowland islands, riparian and native vegetation evapotranspiration, and evaporation from free-water surfaces. The California Department of Water Resources has recently developed a new model, the Delta Evapotranspiration of Applied Water Model (DETAW v2.0), which is a significant improvement over current methods for estimating Delta consumptive use and net channel depletion. This report presents the key aspects of DETAW v2.0 and its implementation in the detailed modeling of Delta conditions.

Chapter 4. Clifton Court Forebay Transit Time Modeling Analysis

This chapter is excerpted from Shu and Ateljevich (2017) and summarizes 3D hydrodynamic modeling performed by the California Department of Water Resources' Bay-Delta Office (BDO) to assess flow patterns and transit time in the Clifton Court Forebay (Forebay). The motivation for this work comes from the National Marine Fisheries Service 2009 Biological Opinion, Action IV.4.2 (National Marine Fisheries Service 2011), which prescribes limits on pre-screen losses of salmonids and steelhead in the Forebay and obliges DWR to study methods to reduce this loss. This report focuses on model development that has been completed and a study based on this model of how transit time across the Forebay responds to various filling and dredging actions. The premise underlying this investigation is that fish will benefit from faster transit which reduces their exposure to predators.