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

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Chapter 12:
DSM2 Documentation

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12 DSM2 Documentation

12.1 Introduction

This chapter summarizes the Delta Modeling Section's strategy to improve documentation of the Delta Simulation Model 2 (DSM2). This chapter includes a summary of the documentation objectives, an overview of the planned documentation, an overview of the recently released DSM2 tutorial, and a review of the progress to date and future directions.

12.2 Objectives

The DSM2 documentation effort has two main objectives:

- to document the DSM2 model, and
- to standardize documentation for studies conducted using DSM2.

Details of these two objectives are described below.

12.2.1 Documenting DSM2

The primary objective of the DSM2 documentation effort is to describe the DSM2 model. Topics to be included are:

- Model formulation
- Assumptions
- Methodology
- Accuracy
- Appropriate use
- Tutorial for use

12.2.2 Standardizing Documentation of DSM2 Studies

Another objective of the DSM2 documentation effort is to standardize the documentation of studies conducted using DSM2. Topics to be included are:

- Assumptions
- Methodology
- Interpretation of results
- Dissemination of study results

12.3 DSM2 Documentation Overview

The DSM2 documentation will consist of three volumes. The first volume will review the mathematical formulation and verification of DSM2. The calibration and validation of DSM2 will be presented in the second volume. And the third volume will contain the details of how to run DSM2 and it has been given the top priority for documentation preparation.

12.3.1 Volume 1: Formulation and Verification

The first volume of the DSM2 documentation will describe the mathematical formulation used in DSM2 and the verification of the DSM2 code. Although DSM2 consists of three modules (HYDRO-hydrodynamics, QUAL-water quality, and PTM-particle tracking model), the documentation will focus on HYDRO and QUAL since PTM is documented elsewhere (see Chapter 2 of this report; Wilbur, 2001; and Smith, 1998). The mathematical formulation descriptions will include both the theory used to develop DSM2 and summaries of the algorithms that translate the theory into a numerical model.

Verification of a numerical model is the process by which the correct coding of the model algorithms is confirmed. It focuses on analysis of predicted response patterns and conservation balances. The documentation on the HYDRO verification may describe model exercises including:

- Steady, uniform flow in an open-ended channel
- Steady flow through a channel network
- Unsteady flow through a channel network
- Steady flow through a gate
- Hydrograph routing

Similarly, the documentation on the QUAL verification may describe model exercises including:

- Advection of a salinity plume
- Advection of a sharp salinity plume[1]
- Salinity penetration into a channel
- Salinity penetration into a network of channels

12.3.2 Volume 2: Calibration and Validation

The second volume of the DSM2 documentation will describe the DSM2 calibration and validation. The calibration and validation documentation will focus on HYDRO and QUAL since the calibration of PTM is documented elsewhere (see Chapter 2; Wilbur, 2001; and Smith, 1998).

Calibration is the process by which model parameters are adjusted to improve the correspondence between the simulation results and observed data for the calibration time period. Once the model is calibrated, it is validated by running the model for a second time period without adjusting any of the model parameters. The simulation results are compared to observed data to determine if the model provides acceptable results for conditions outside of the calibration time period. The assumptions, approach, and results of the Interagency Ecological Program DSM2 Project Work Team's (IEP-PWT) calibration and validation effort is currently being documented under the direction of Chris Enright of DWR's Environmental Services Office

[1] A sharp salinity plume is one in which the salinity gradient is very steep. Representation of sharp constituent gradients in numerical models is challenging due to numerical dispersion. Thus, examining both mild and sharp constituent gradients is necessary to understand how a particular model, DSM2 in this case, is affected by numerical dispersion.

(DWR-ESO). The IEP-PWT documentation will be included in this volume of the DSM2 documentation.

The second volume of the documentation will also include a section on DSM2 performance conclusions. Whereas the calibration and validation focus on comparing simulation results at specific points in the Delta, the performance conclusions will be based on a larger regional or system-wide view of model results. The accuracy and reliability of DSM2 will be evaluated in various regions under various hydrologic conditions, gate operations, and tidal conditions. Factors such as mixing patterns and flow splits will be analyzed. The performance conclusions will provide users with a better understanding of how DSM2 performs under various hydrologic and operational conditions.

12.3.3 Volume 3: Using DSM2

The third volume of the DSM2 documentation will provide instructions for running DSM2. Thus, the third volume will serve as a DSM2 user's guide. This volume has been assigned the highest priority in the documentation effort. Similar to the first two volumes, this documentation will focus on HYDRO and QUAL.

The third volume of the DSM2 documentation will be divided into three main sections: background information, basic use of DSM2, and advanced use of DSM2. The first section will contain general information that would be useful for users learning about numerical modeling of tidal systems. A brief review of tidal dynamics is provided. A general overview of topics related to modeling tidal estuaries is presented followed by information specific to the Sacramento-San Joaquin Delta and DSM2.

The second section of the DSM2 user's guide will describe basic use of DSM2. The three modes of DSM2 operation (historical, planning, and forecasting) will be discussed. Data requirements and input file structure will be presented. This documentation will evolve as the DSM2 input system evolves (see Chapter 13). Use of DSM2 will be illustrated with tutorial exercises. Sample input files for all tutorial exercises will be provided in the text and will be made available to the user on the DSM2 website.

The user's guide documentation for DSM2 use in historical simulations has been completed. As well as being incorporated into volume three, this documentation has been released as a stand-alone tutorial (see section 12.4).

The third section of the DSM2 user's guide will provide information on advanced usage of DSM2. Sample topics include gate operations, permanent and temporary barriers, object-to-object transfers, mass tracking, and fingerprinting. This section of the documentation will be based on the experience of the Delta Modeling section in actually using DSM2 for studies.

12.4 DSM2 Tutorial

The first completed product of the documentation effort is a DSM2 tutorial. The tutorial introduces the use of HYDRO and QUAL using historical simulations for November and December 1996. These time periods were selected because complete data sets for those time

periods were available. The tutorial includes sample text input files that have been annotated and exercises that illustrate common changes made to the base input files. Information is also provided on sources of observed data for comparison with simulation results. The tutorial text and the sample input files are available on the DSM2 website at http://modeling.water.ca.gov/delta/models/dsm2/index.html.

12.5 Progress and Future Directions

Progress on the DSM2 documentation effort to date includes:

- Developing an outline for all three volumes of the documentation
- Focusing effort on development of the DSM2 user's guide (volume 3)
- Creating a standalone tutorial on use of DSM2 for historical simulations (which is available at http://modeling.water.ca.gov/delta/models/dsm2/index.html)
- Completing documentation on tidal dynamics and modeling of tidal estuaries
- Beginning documentation on specific information related to modeling the Sacramento-San Joaquin Delta and DSM2
- Describing use of DSM2 for water quality fingerprinting (see Chapter 14)

Future directions for the DSM2 documentation include:

- Continuing to document DSM2
- Finishing the DSM2 user's guide (volume 3) is the top priority
- Modifying the DSM2 documentation to reflect changes in the DSM2 input system (such as those described in Chapter 13)
- Providing documentation in HTML format in addition to MS Word and PDF formats
- Incorporating HTML documentation into DSM2 in the form of online help
- Developing standardized methods for documenting DSM2 studies
- Redesigning the DSM2 website to facilitate online dissemination of information

12.6 References

Smith, Tara. (1998). "Chapter 4: DSM2 PTM." *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. 19th Annual Progress Report to the State Water Resources Control Board.* California Department of Water Resources. Sacramento, CA.

Wilbur, Ryan J. (2001). "Chapter 4: Validation of Dispersion Using the Particle Tracking Model in the Sacramento-San Joaquin Delta." *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.* California Department of Water Resources. Sacramento, CA.