LOWER AMERICAN RIVER
FLOW MANAGEMENT STANDARD
TECHNICAL MEMORANDUM
SACRAMENTO RIVER WATER TEMPERATURE MODEL ASSUMPTIONS

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List of Acronyms

2006 FMS	2006 Lower American River Flow Management Standard
CVP	Central Valley Project
DWR	California Department of Water Resources
HEC	Hydrologic Engineering Center
Long-Term Operations FEIS	Coordinated Long-Term Operation of the Central Valley Project and State Water Project Final Environmental Impact Statement
Modified FMS	Modified Lower American River Flow Management Standard
Reclamation	U.S. Department of Interior, Bureau of Reclamation
SRWTM	Sacramento River Water Temperature Model
SWP	California State Water Project
USACE	U.S. Army Corps of Engineers

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1 Introduction

As part of the development of the Modified Flow Management Standard (Modified FMS), the Water Forum used a suite of modeling tools, including CalSim II and the Sacramento River Water Temperature Model (SRWTM). This Technical Memorandum describes the SRWTM and its usage for the Water Forum analysis.

1.1 HEC-5Q

HEC-5Q is a water quality model developed by the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC) to simulate, among other things, water temperatures in reservoirs and rivers associated with operations of multiple reservoirs and branches of streams. The model was developed so temperature could be readily included as a consideration in system planning and management. Using estimates of system flows generated by the flow simulation module, HEC-5, the water quality simulation module, computes the distribution of temperature in the reservoirs and in the associated downstream reaches.

1.2 Sacramento River Water Temperature Model

The SRWTM is an application of HEC-5Q developed by the U.S. Department of Interior, Bureau of Reclamation (Reclamation) for use in evaluating effects of operations of the Reclamation's Central Valley Project (CVP) and the California Department of Water Resources (DWR) State Water Project (SWP) on water temperatures in the Trinity River below Trinity Reservoir, and in the Sacramento River above its confluence with the Feather River. See Figure 1 for a schematic of the SRWTM.

2 Application of the Sacrament River Water Temperature Model

The Water Forum is using the version of the SRWTM developed to support Reclamation's Coordinated Long-Term Operation of the Central Valley Project and State Water Project Final Environmental Impact Statement (Long-Term Operations FEIS), provided to the Water Forum by Reclamation on January 7, 2016. In addition to the HEC-5Q water temperature model, Reclamation's package also included a tool to import CalSim II model output, convert it to a daily timeseries, and configure it for use as an input to the HEC-5Q model.

The Water Forum changed one file from the SRWTM before running the model. It modified the SR_5QCS.dat file so that:

- the model generated Shasta Reservoir profiles on the last day of each month, and
- elements of the code that instructed the model to output profiles for Trinity and Whiskeytown reservoirs were commented out so the model only generated the Shasta Reservoir profiles.

The Water Forum did not make any other changes to the SRWTM file from the version provided by Reclamation. The Water Forum strictly followed the protocols described in the attached "HEC5Q – Sac R Temp Model Protocol" to execute and run the SRWTM.

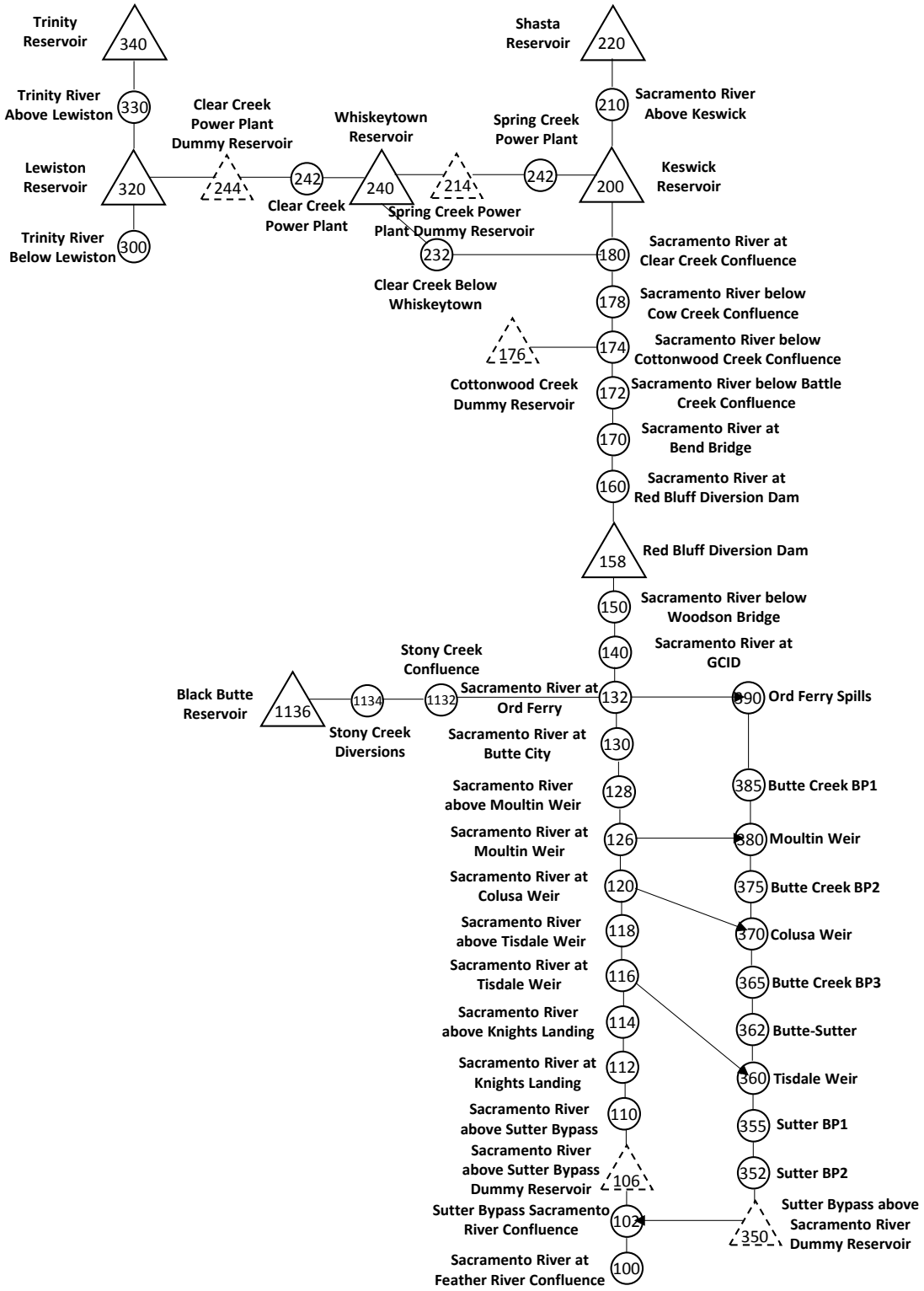

Figure 1. Schematic of the SRWTM.

3 Post-Processing of SRWTM Output

The Water Forum reviewed the standard daily timeseries of riverine temperature output in the SRWTM from the SR_WQ_Report.DSS file for each scenario. Post-processing of the riverine water temperatures consisted of creating exceedance plots by water year-type and month for key locations on the Sacramento River below Shasta Dam.

In addition to the standard riverine temperature output from each model scenario, the Water Forum created timeseries of elevations of specific water temperatures, or isotherms, from data contained in the TR-PRO.2XL output file. To create the isotherm timeseries, the Water Forum developed a post-processor in Microsoft Excel, that went through the following process:

1) Read in data from the TR-PRO.2xl file, as standard output from running the SRWTM;
2) Separate each month's profile (both elevation and temperature) for the period of record;
3) Interpolate elevations for each month for specific water temperatures, ranging from 46°F to 70°F,
4) Convert the elevations for each water temperature into a storage volume, representing the volume of water at or below the specified water temperature for each month; and
5) Write the timeseries of monthly storages for each water temperature to the SR_WQ_Report.DSS file.