Appendix 4A

Evaluation of and Revisions to Integrated Modeling Platform

MONTGOMERY & ASSOCIATES
Water Resource Consultants

DRAFT TECHNICAL MEMORANDUM

DATE:	February 12, 2021, Revised September 7, 2021	**PROJECT #:** 9520
TO:	Corning Sub-basin GSA, Tehama County Flood Control and Water Conservation District GSA	
FROM:	Lisa Porta, Patrick Wickham, and Charles Brush (Hydrolytics)	
PROJECT:	Corning Subbasin Groundwater Sustainability Plan	
SUBJECT:	Evaluation of and Revisions to Integrated Modeling Platform	

INTRODUCTION

Groundwater modeling is an integral part of Groundwater Sustainability Plan (GSP) development, allowing Groundwater Sustainability Agency (GSA) management teams and technical staff to fill gaps in historical data, develop water budgets, project future conditions, and predict the efficacy of projects and management actions on meeting sustainable management criteria. The selected integrated model platform will be used during GSP development and implementation to process water budgets, simulate groundwater conditions, and estimate pumping, and output water level hydrographs and contours, to assist with the evaluation of potential scenarios to sustainably manage the Subbasin.

This technical memorandum (TM) is divided into four parts, describing the process undertaken for model platform selection, model revisions, recommended future updates for GSP implementation, and model calibration verification.

- Part 1: Describe available models and summarize the pros and cons and recommend a platform for the Corning Subbasin GSP.
- Part 2: Describe current model characteristics of the Corning Subbasin area and compare actual information and data.
- Part 3: Describe model revisions undertaken for GSP development and make recommendations for future model revisions to be completed during implementation of the GSP.
- Part 4: Perform model calibration verification to ensure model accuracy and simulation performance.

PART 1: RECOMMENDATIONS FOR MODEL PLATFORM

Introduction and Regulatory Background

The modeling platform selected for development of the Corning Subbasin GSP must comply with several sets of criteria. First, the modeling platform must comply with the Sustainable Groundwater Management Act (SGMA) requirements as spelled out in the SGMA legislation and GSP Regulations. The selected modeling platform must also address current and projected future aquifer status with regard to each of the undesirable results. The California Department of Water Resources' (DWR) *Modeling Best Management Practices* document (DWR, 2016) provides a detailed guidance on considerations for integrated hydrologic model development and use for GSP requirements.

SGMA enabling legislation (23 CCF §352.4(f)) requires that the selected modeling platform:

- Include publicly available supporting documentation
- Be based on field or laboratory measurements and calibrated against site-specific field data
- Use public-domain open-source software

In addition, the modeling platform used for the Corning Subbasin GSP must have the capability to:

- Simulate historical and current conditions
- Simulate a 50-year future baseline scenario repeating historical hydrology
- Incorporate 50 years of projected future climate change impacts on precipitation, evapotranspiration, and water supplies
- Provide historical, current, and projected future status with respect to each sustainability indicator
- Identify the magnitude and distribution of undesirable results at sufficient spatial and temporal resolutions
- Quantify groundwater flows between the Corning Subbasin and adjacent subbasins
- Evaluate historical, current, and projected future groundwater pumping levels and stream-groundwater interactions
- Incorporate potential future land use changes, urban growth assumptions, and changes in water supplies and demands

- Provide estimates of groundwater storage changes at a spatial resolution that supports evaluation of proposed projects and management actions

Selecting the appropriate modeling platform provides for an important tool for developing consensus in the subbasin. The model, input data sets, and simulation results provide:

- A platform to collect and coordinate data
- Quantified and detailed historical water budgets
- A focal point for stakeholder engagement
- An ongoing tool for adaptive water management

Summary of Available Model Platforms

Model selection criteria and some of the available models in the Sacramento Valley were reviewed on behalf of the Northern Sacramento Valley Integrated Regional Water Management Technical Assistance Committee (RMC, 2017). Many aspects of this review are summarized below.

Five numerical groundwater flow models are potentially available for use in preparing a GSP for the Corning Subbasin. These are briefly described below.

California Central Valley Groundwater-Surface Water Simulation Model (C2VSim)

The DWR released the updated fine-grid version of the California Central Valley Groundwater-Surface Water Simulation Model (C2VSimFG) version 1.0 including detailed model documentation in December 2020 (DWR, 2020). C2VSimFG is the latest in a series of integrated hydrologic models developed by DWR and other agencies beginning in the early 1990s. C2VSimFG is an integrated regional hydrologic model that simulates water movement through the land surface, surface water, and groundwater flow systems with the publicly available Integrated Water Flow Model (IWFM) software. C2VSimFG simulates Central Valley hydrology on a monthly time step from October 1921 through September 2015. C2VSimFG uses a finite element grid to discretize the Central Valley into 32,537 variably sized elements with an average area of 407 acres (Figure 1). Elements are small near surface water features and increase in size to fairly large elements in areas with native vegetation. The Corning Subbasin contains 675 model elements averaging 307 acres with element areas ranging from a minimum of 38 acres to a maximum of 1,102 acres. Historical land use is provided for 25 crop and land use categories within each model element and varies annually. The Central Valley aquifer is simulated with four layers of variable thickness. C2VSimFG total aquifer thickness in the Corning Subbasin ranges from approximately 330 feet along the western boundary to approximately 2,590 feet along the eastern boundary. The C2VSimFG model simulates the aquifer with four layers, with the top model layer representing the unconfined zone, the second layer representing a confined zone where most pumping occurs, the third layer representing a confined zone with little pumping, and the bottom layer representing saline connate water with little to no pumping.

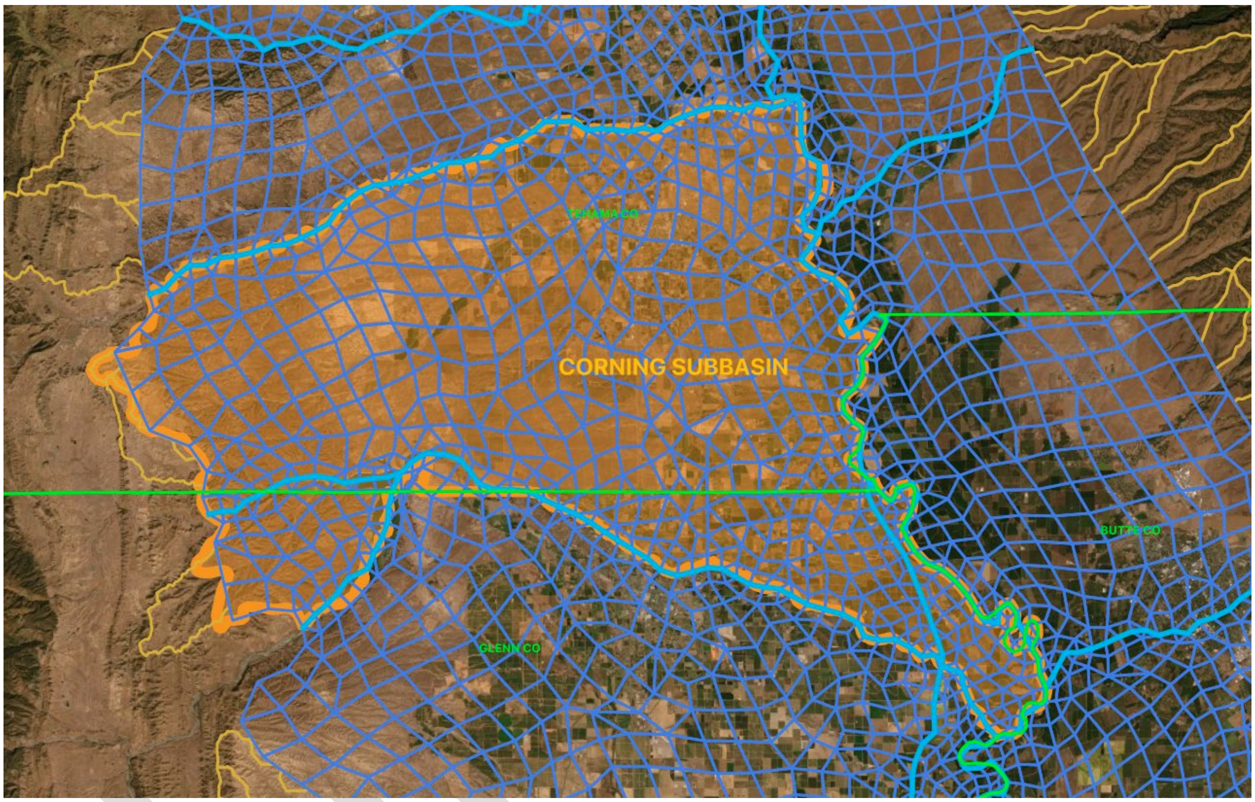

Figure 1. C2VSimFG finite element grid, ungagged watersheds and stream network within and around the Corning Subbasin

Sacramento Valley Groundwater-Surface Water Simulation Model (SVSim)

The California Department of Water Resources (DWR) is currently developing the Sacramento Valley Groundwater-Surface Water Simulation Model (SVSim) and released a beta version of the model in April 2020. SVSim is an integrated regional hydrologic model that simulates water movement through the land surface, surface water and groundwater flow systems with the publicly available IWFM software, and most of the data in this model is derived from the C2VSimFG model (land use, surface water diversions, etc.). SVSim simulates Sacramento Valley hydrology on a monthly time step from October 1921 through September 2015. SVSim uses a finite element grid to discretize the Sacramento Valley into 23,767 variably sized elements with an average area of 205 acres (Figure 2). Elements are extremely small near surface water features and increase in size to fairly large elements in areas with native vegetation. The Corning Subbasin contains 1,175 model elements averaging 176 acres with element areas ranging from a minimum of 3.7 acres to a maximum of 1,297 acres. Historical land use was derived from C2VSimFG and varies annually, with 25 crop and land use categories within each model element. The Central Valley aquifer is simulated with nine layers of variable thickness. SVSim total aquifer thickness in the Corning Subbasin ranges from approximately 200 feet along the western boundary to approximately 2,580 feet along the eastern boundary. The Central Valley aquifer is simulated with nine layers of variable thickness, with the top three layers generally fixed at 35, 35, and 40 ft thick, with the remaining total aquifer thickness divided among the remaining six layers.

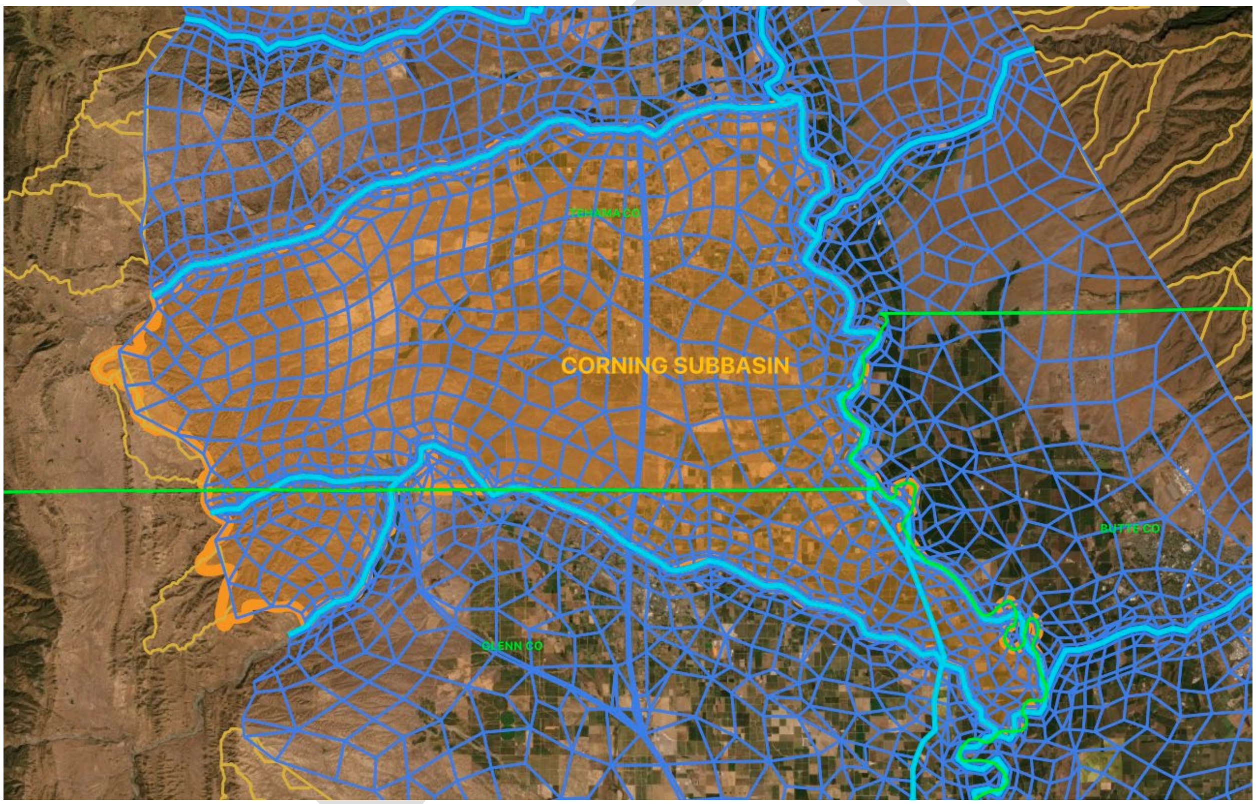

Figure 2. SVSim finite element grid, ungagged watersheds and stream network within and around the Corning Subbasin

Central Valley Hydrologic Model (CVHM)

The US Geological Survey (USGS) released the Central Valley Hydrologic Model (CVHM) in 2009 (Faunt *et al.*, 2009). CVHM is an integrated regional hydrologic model that simulates water movement through the land surface, surface water and groundwater flow systems using the publicly available MODFLOW-FMP software. CVHM simulates Central Valley hydrology on a monthly time step from April 1961 through September 2003. CVHM uses a finite differences grid to discretize the Central Valley into 43,169 identically sized cells, 20,478 of which are active, with an area of 42,560 acres or one square mile (Figure 3). The Corning Subbasin contains 325 model cells. Historical land use is provided in fixed multi-year periods, with each cell containing one crop. The aquifer is simulated with 10 layers of fixed thicknesses extending to a depth of 1,800 feet in the Sacramento Valley, with a top layer thickness of 50 ft and underlying layers generally thickening with depth. Aquifer hydraulic parameters were based on a texture model developed from approximately 8,500 Central Valley well construction logs.

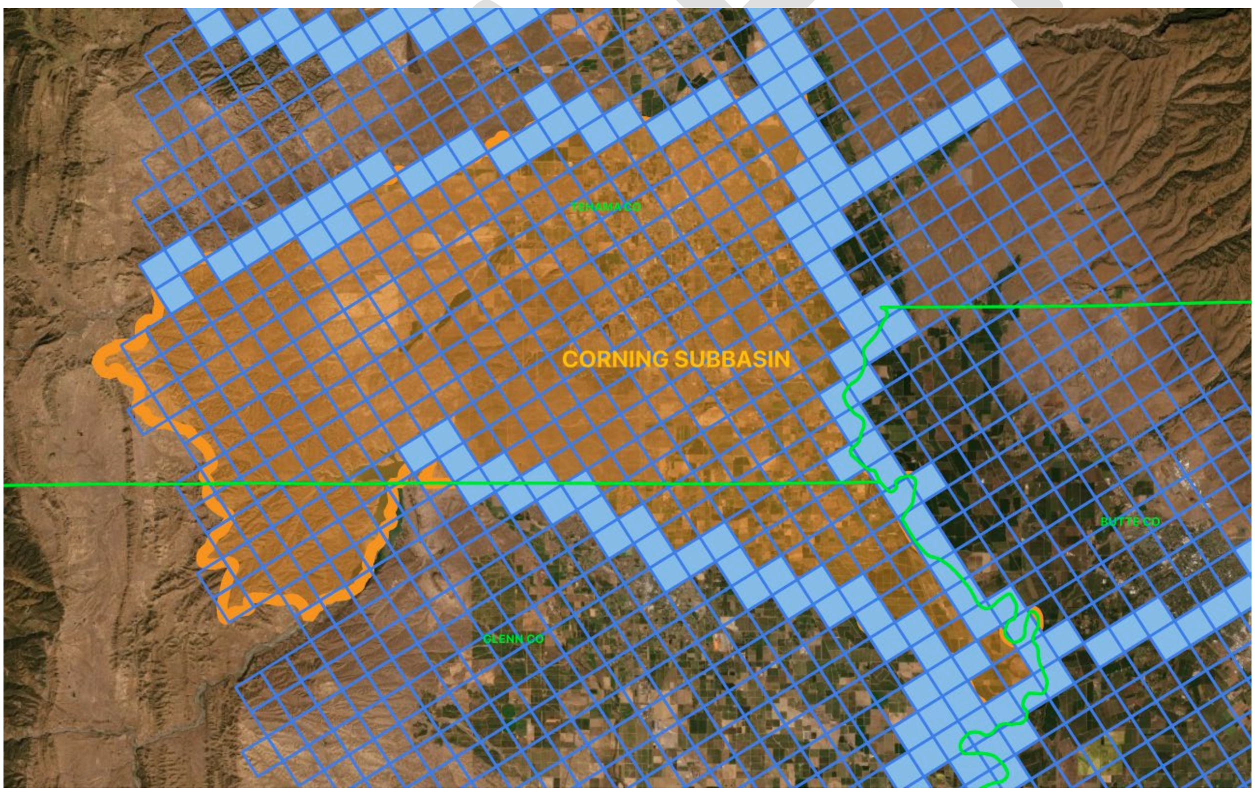

Figure 3. CVHM finite difference grid and stream network within and around the Corning Subbasin

Sacramento Valley Finite Element Groundwater Model (SacFEM)

The US Bureau of Reclamation (USBR) released the Sacramento Valley Finite Element Groundwater Model (SacFEM) in 2015 (CH2M Hill and MBK Engineers, 2015). SacFEM uses IWFM Demand Calculator (IDC) to simulate land surface processes and a MicroFEM finite element groundwater flow model to simulate water movement through the groundwater flow system. Interactions between the groundwater and surface water flow systems are modeled using constant head boundaries that do not dynamically calculate stream-groundwater flows. SacFEM runs on a monthly time step from October 1969 through September 2010. SacFEM uses a finite element grid to discretize the Sacramento Valley into approximately 300,000 variably sized elements. The SacFEM model is not appropriate for GSP development because it is not a true integrated hydrologic model and does not accurately calculate stream-groundwater flows. In addition, SacFEM uses the MicroFEM platform, which is a proprietary model code and not in the public domain, as required by SGMA.

Stony Creek Fan Model

Local water agencies funded development of the Stony Creek Fan model (SCF), published in 2003 (WRIME, 2003). SCF is an integrated hydrologic model developed with the Integrated Groundwater-Surface Water Model (IGSM) software, a predecessor to DWR's IWFM. SCF runs on a monthly time step from October 1969 through September 2000. The SCF model covers the Corning Subbasin and the portion of the Colusa Subbasin north of Williams and Colusa with 2,105 variably sized finite elements and simulates the groundwater flow system with four layers. The SCF model is not appropriate for GSP development because the model boundaries do not extend northward or eastward beyond the Corning Subbasin, it does not include recent information, and it would require a significant resource investment to update the SCF for use in GSP development.

Recommended Model Platform for Corning Subbasin GSP

Table 1 presents a comparison of the three models that could be used to support Corning Subbasin GSP development, C2VSimFG, SVSim and CVHM. All three models meet most SGMA requirements. The simulation periods for the C2VSimFG and SVSim models extend through 2015, while the CVHM simulation extends only to 2003. The C2VSimFG model, with two public beta releases and a final non-beta release including model documentation, is more mature than the SVSim model, which has not yet been released to the public in any form.

Table 1 Applicability of the C2VSimFG, SVSim and CVHM Models for SGMA

Model	**C2VSimFG**	**SVSim**	**CVHM**
Simulation Area	Central Valley	Sacramento Valley	Central Valley
Developer	DWR	DWR	USGS
Release Date	12/2020	4/2020 (beta)	2009
Code	IWFM	IWFM	MODFLOW-FMP
Public-Domain Code and Documentation?	Yes	Partial	Yes
Simulation Period	1922-2015	1922-2015	1961-2003
Developed and calibrated with field data?	Yes	Yes	Yes
Cells in Corning Subbasin	675	1,175	325
Cell area in Corning Subbasin	38 – 1,102 Ac	3.7 – 1,297 Ac	42,560 Ac
Dynamically simulate ungagged watersheds?	Yes	Yes	No
Includes recent conditions?	Yes	Yes	No
Adequate calibration period?	Yes	Yes	Yes
Can extend to 50-yr future simulation?	Yes	Yes	Yes
Can add future climate change assumptions?	Yes	Yes	Yes
Can incorporate potential future land use changes?	Yes	Yes	Yes
Can incorporate potential future water supply and demand changes?	Yes	Yes	Yes
Can evaluate sustainability indicators?	Yes	Yes	Yes
Can help identify sustainable management criteria?	Yes	Yes	Yes

* Expected model and update release dates in parentheses.

The C2VSimFG version 1.0 model is recommended for development of the Corning Subbasin GSP. This model is being actively developed, enhanced, and supported by the DWR SGMA Program and is a recommended option for GSP development; in fact, DWR based SGMA reporting requirements on IWFM output. DWR has released an updated version of this model every year since 2018 and is expected to actively support this model in the future. The C2VSimFG Beta model (2018 release) with local modifications was successfully used to develop GSPs for the Kern Subbasin (Todd Groundwater, 2020). The C2VSimFG Beta model (2019 release) is currently being used to support GSP development in the neighboring Colusa Subbasin.

SGMA Compliance

This section provided a brief assessment of the representativeness and applicability of the selected model platform for SGMA compliance.

The modeling platform must be capable of assessing historical, current, and future sustainability indicators, minimum thresholds and monitoring objectives to characterize subbasin status with regard to each of six undesirable results described in the SGMA legislation:

- Chronic lowering of groundwater levels
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable degradation of groundwater quality
- Significant and unreasonable land subsidence
- Depletions of interconnected surface waters that have significant and unreasonable adverse impacts on beneficial uses of surface water

The C2VSimFG model is compliant with SGMA legislation and GSP regulations because:

- C2VSimFG is an integrated hydrologic model capable of evaluating the predominant undesirable results applicable to the Corning Subbasin
- C2VSimFG is being actively developed and supported by the DWR SGMA Program for use in GSP development
- C2VSimFG complies with all SGMA modeling and reporting requirements
- C2VSimFG has the most up-to-date and detailed historical data of all available models
- C2VSimFG extends beyond the Corning Subbasin allowing evaluation of groundwater interactions with adjoining subbasins
- C2VSim has the capability to evaluate sustainability indicators and support identification of appropriate sustainable management criteria
- C2VSimFG spatial resolution and supporting software support evaluation of both regional and localized management programs and projects
- C2VSimFG historical data can be readily used for development of current and future baseline simulations
- C2VSimFG is easily modified to develop future scenarios that incorporate projected climate change, land use changes, urban growth projections, and changes to water supply and water demand

The C2VSimFG model is the best choice for use in developing the Corning Subbasin GSP. Some local refinements to C2VSimFG may be required for the model to be compatible with all GSP requirements and adequately evaluate the impacts of proposed projects and management actions. Recommendations for model improvements are provided in the sections below.

PART 2: MODEL EVALUATION

While the full C2SimFG model area spans the entire Central Valley, only model inputs and simulation results in the northern Sacramento Valley are relevant for the purposes of Corning GSP development and implementation. Simulating processes across the entire valley significantly adds to model runtime, potentially delaying analysis of model results. Therefore, a submodel of C2VSimFG was developed and evaluated, termed the Northern Sacramento (NSac) submodel. The NSac submodel area encompasses the northern portion of the Sacramento Valley as shown on Figure 5 and Figure 6. The runtime of this submodel is under 10 minutes, in contrast to the approximately five-hour runtime of the full C2VSimFG. Relevant simulation results (groundwater levels, water budget values, etc.) in the Corning Subbasin are identical for the full C2VSimFG model and the NSac submodel.

The rest of this TM focuses on the NSac model descriptions and primarily on data and assumptions within the Corning Subbasin simulation area.

Model Assumptions and Data

This section provides a brief summary of model assumptions and data that are most relevant for the NSac model. More detail regarding the C2VSimFG model functionalities is provided in the DWR C2VSimFG report (DWR, 2020).

Model Boundary Conditions

The following subsections summarize model boundaries. Figure 5 through Figure 7 illustrate the full C2VSim FG V1.0 model, the NSac Submodel, and the NSac Submodel around Corning Subbasin, respectively.

<u>*Lateral Boundaries*</u>

The model represents the extent of the alluvial aquifer boundaries as established by DWR.

<u>*Vertical Boundaries*</u>

The model’s lowermost vertical no-flow boundary corresponds to the basement complex of relatively impermeable igneous and metamorphic rocks underlying the model area, mainly corresponding to the Great Valley Sequence (DWR, 2020). The model's uppermost vertical boundary corresponds to available ground surface elevation data (DWR, 2020).

NSac Model Southern Boundary

Development of the NSac model required implementation of a timeseries specified flow boundary condition on the southern boundary of the submodel, running from roughly Willows to Oroville (Figure 5; Figure 6). Input to this boundary condition is derived from a historical run of the full C2VSim FG V 1.0 model.

Small Watershed Inflows

Flows at the lateral model boundaries are simulated using a system of small watersheds along the main model element boundary (Figure 5, Figure 6). DWR delimited each small watershed in the C2VSimFG model based on the area providing rainfall runoff upstream of each model boundary node using the National Hydrography Dataset (USGS, 2013). Precipitation runoff and infiltration, evapotranspiration of native vegetation, overland stream flow and groundwater storage are dynamically simulated for each small watershed. Surface flows from each small watershed are routed through the model area to simulated streams based on stream channels delineated from topographic maps. Subsurface flows from the groundwater component of each small watershed enter the model through the adjoining groundwater node.

Stream Inflows

Stream inflows at the model boundaries were derived from streamflow gauge data or estimated using other nearby historical streamflow data where local gauge data were unavailable (DWR, 2020).

Model Data Inputs

The following subsections summarize select model data inputs, including mention of refinements made to the NSac model. Table 2 below summarizes data inputs to C2VSimFG V1.0, originally presented in DWR, 2020.

Climate

Precipitation inputs to the model are based on output from the Parameter-elevation Relationships on Independent Slopes Model (PRISM), calculated as area-weighted averages from PRISM 800 m x 800 m monthly precipitation grids (DWR, 2020). These precipitation data were assigned to each small watershed and model element using area-weighting. Evapotranspiration (ET) rates were derived using data from the DWR Water Use Efficiency Branch, refined using local evapotranspiration data. ET was further refined in the NSac model area as discussed in Part 3 of this TM.

Geology and Hydrology

Hydrogeologic properties including aquifer parameters and stratigraphy were developed using a USGS texture model and available lithologic logs for wells and borings from multiple DWR datasets (DWR, 2020). Stream configuration, stream bed parameters, and stream geometry were likewise developed using multiple USGS and DWR data sources (DWR, 2020).

Land Use

As described in the C2VSimFG model documentation, land use types are divided into four principal classifications (non-ponded agriculture, ponded agriculture, urban, and native vegetation) and 28 operational land use categories. Within agricultural lands, individual land use designations are present for both non-ponded and ponded crops. Major land use categories are summarized in Table 3, including discussion of land use subcategories when applicable. Sources used to develop spatial designation of land use categories include DWR County Surveys, DWR LandIQ remote sensing, DWR Digitized Quad land use maps, and local land use refinements (DWR, 2020). Further refinements were implemented to land use input data in the NSac model, as described in Part 3.

Urban Water Demand

Modeled urban water demands, encompassing municipal demand and rural residential demand, were based on California Water Plan's Detailed Analysis Units and County Boundaries, populations derived from U.S. Census Bureau Urban water demand, and per capita water use based on local Urban Water Management Plans and other data provided by urban water suppliers (DWR, 2020).

Initial Groundwater Heads

Groundwater elevations at the start of simulation were developed for each model layer using groundwater level observations from DWR's CASGEM and Water Data Library datasets (DWR, 2020).

Surface Water Diversions and Deliveries

Surface water diversions from river nodes are designated as timeseries inputs to the model including volumetric portions designated as delivery, non-recoverable loss (evaporative losses), and recoverable loss (recharged to groundwater). These are derived from available reports of surface water diversions and deliveries (DWR, 2020). Surface water diversions were refined within the NSac model as described in Part 3.

Table 2. C2VSimFG Input Data and Sources [DWR, 2020]

Major Data Category	Minor Data Category	Data Source	Report Section
Hydrogeological Data	Geologic Stratification	USGS, DWR NCRO, DWR SCRO, C2VSimCG	3.3
Hydrogeological Data	Aquifer Parameters	Texture Analysis (DWR DIRWM, USGS, YWA)	4.4
Hydrological Data	Stream Configuration	C2VSimCG, DWR	3.2.4
Hydrological Data	Stream Inflow	USGS, CalSim3, CVGSM, USACE, DWR, CDEC, Water Master Reports, Friant Kern Water Authority	3.5.2.3
Hydrological Data	Stream Geometry	DWR's CVFED HEC-RAS Model, C2VSimCG, CDEC	3.5.2.1
Hydrological Data	Stream Bed Parameters	Texture Analysis (DWR DIRWM, USGS, YWA), C2VSimCG	3.5.2.2
Hydrological Data	Calibration Gages	USGS, CDEC	4.5.1
Hydrological Data	Surface Drainage Watersheds	USGS	3.6
Hydrological Data	Precipitation	PRISM	3.5.1
Agricultural Water Demand	Land Use	DWR County Surveys, LandIQ, Digitized Quad, Tehama Pulp Farm, Decadal estimates, CDFW CVPIA, San Joaquin and Kern County, USDA CDL	3.10.2
Agricultural Water Demand	Evapotranspiration	Cal-SIMETAW, Local information	3.10.4
Agricultural Water Demand	Soil Properties	SSURGO	3.10.3
Agricultural Water Supply	Groundwater Pumping	SVSim, Kern local model	3.11.2
Agricultural Water Supply	Surface Water Deliveries	DWR BDO, CalSim3, Local sources, USBR	3.11.1
Urban Water Demand	Population	U.S. Census Bureau, UWMPs	3.10.7
Urban Water Demand	Per Capita Water Use	UWMPs	3.10.7 3.10.7
Urban Water Supply	Surface Water Deliveries	DWR BDO, CalSim3, Local sources, USBR	3.11.1
Other	Boundary Conditions	DWR, EBMUD, USACE	3.7
Other	Initial Conditions	CASGEM, WDL	3.9
Other	Small Watersheds	USGS NHD, PRISM	3.7
Other	Calibration Wells	WDL	4.4.1

Table 3. Modeled Land Use Categories

Land Use Category	Description
Urban	Municipal and rural residential zoning
Native – Native Vegetation	Undeveloped land with native vegetation
Native – Riparian	Undeveloped land along riparian corridors
Agricultural – Non-ponded Crops	20 subcategories of crops including row crops, trees, vineyards, and idle land use
Agricultural – Ponded Crops and Managed Wetlands	5 subcategories for rice and wetlands, accounting for rice decomposition patterns and wetland seasonality

Model Simulation Processes

Groundwater Flow

Groundwater flow between model elements and between layers is simulated by IWFM on a monthly timestep, including calculation of groundwater in storage. IWFM also simulates unsaturated zone and root zone flow and storage.

Surface Water Flow and Groundwater Surface Water Interaction

Storage of streamflow is not tracked within the model, meaning that there is instantaneous routing of stream flows for each monthly timestep. Streamflow is simulated using a flow-state relationship derived from rating tables, and the wetted perimeter at each stream node is constant and does not change with respect to stream stage (DWR, 2020). Groundwater surface water interaction is simulated using IWFM stream package version 4.2.

Groundwater Pumping

Groundwater pumping is simulated by IWFM. For agricultural land use, the model code calculates crop demand given known land use and ET, then subtracts the available surface water application, and pumps the remaining required water. Similarly, for urban land use, the model calculates demand from urban and rural residential water demand inputs, subtracts available surface water from the urban demand, and pumps groundwater to meet the remaining demand. In the Corning Subbasin all urban demands are satisfied by groundwater pumping.

Irrigation Demand Calculator (IDC)

Model water demands are simulated as part of the root-zone package within IWFM. This component is part of the main IWFM program, and is also available as a separate program called the IWFM Demand Calculator (IDC). NSac utilizes version 4.11 of the root zone package which simulates demand for both ponded and non-ponded crops, along with native and riparian vegetation, and urban use. Each of these distinct land use classifications has an associated land use file, evapotranspiration rate, and a variety of other input files that dictate local operations and management (DWR, 2020).

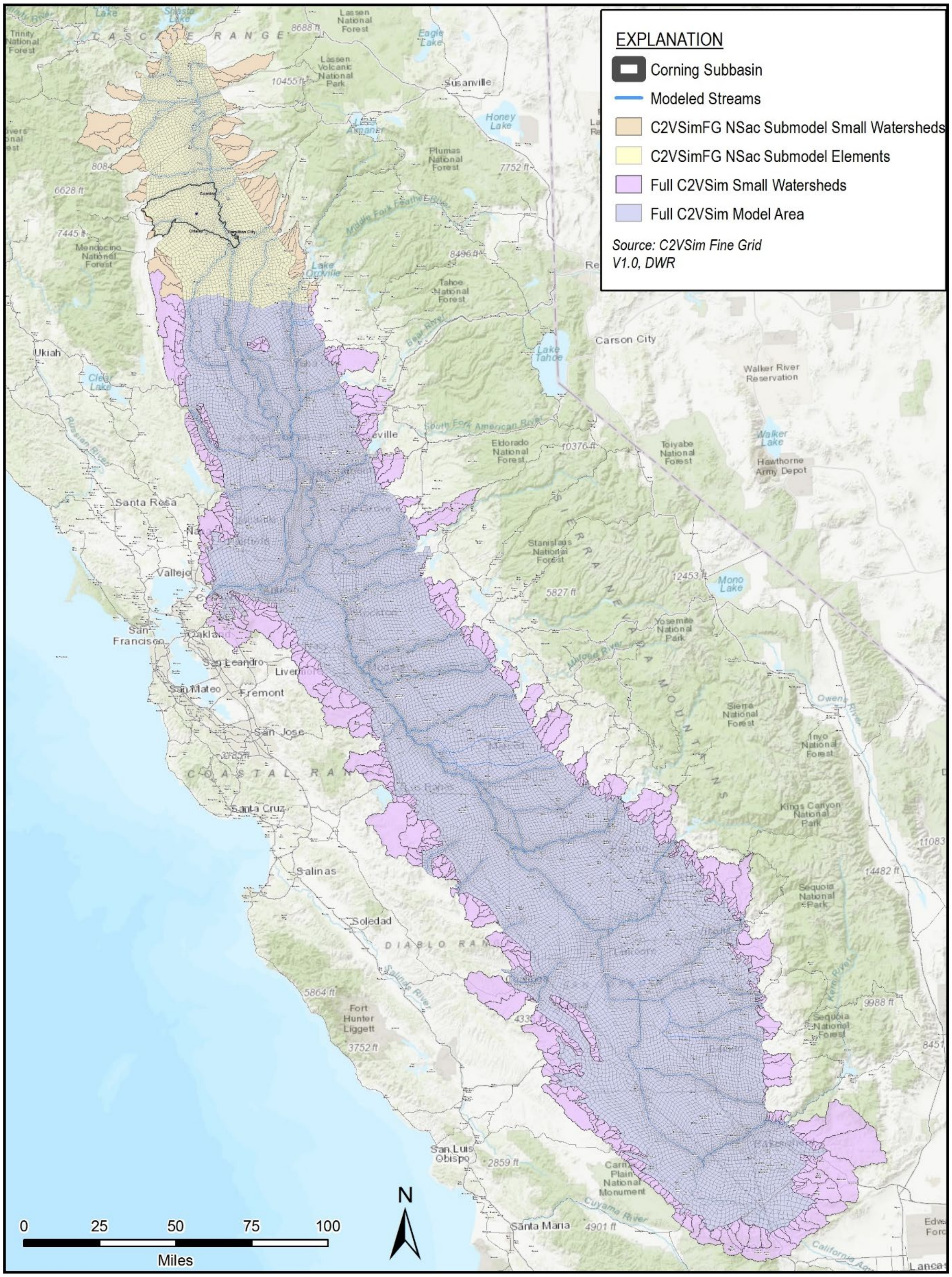

Figure 4. NSac Submodel and Corning Subbasin Within Full C2VSimFG Model

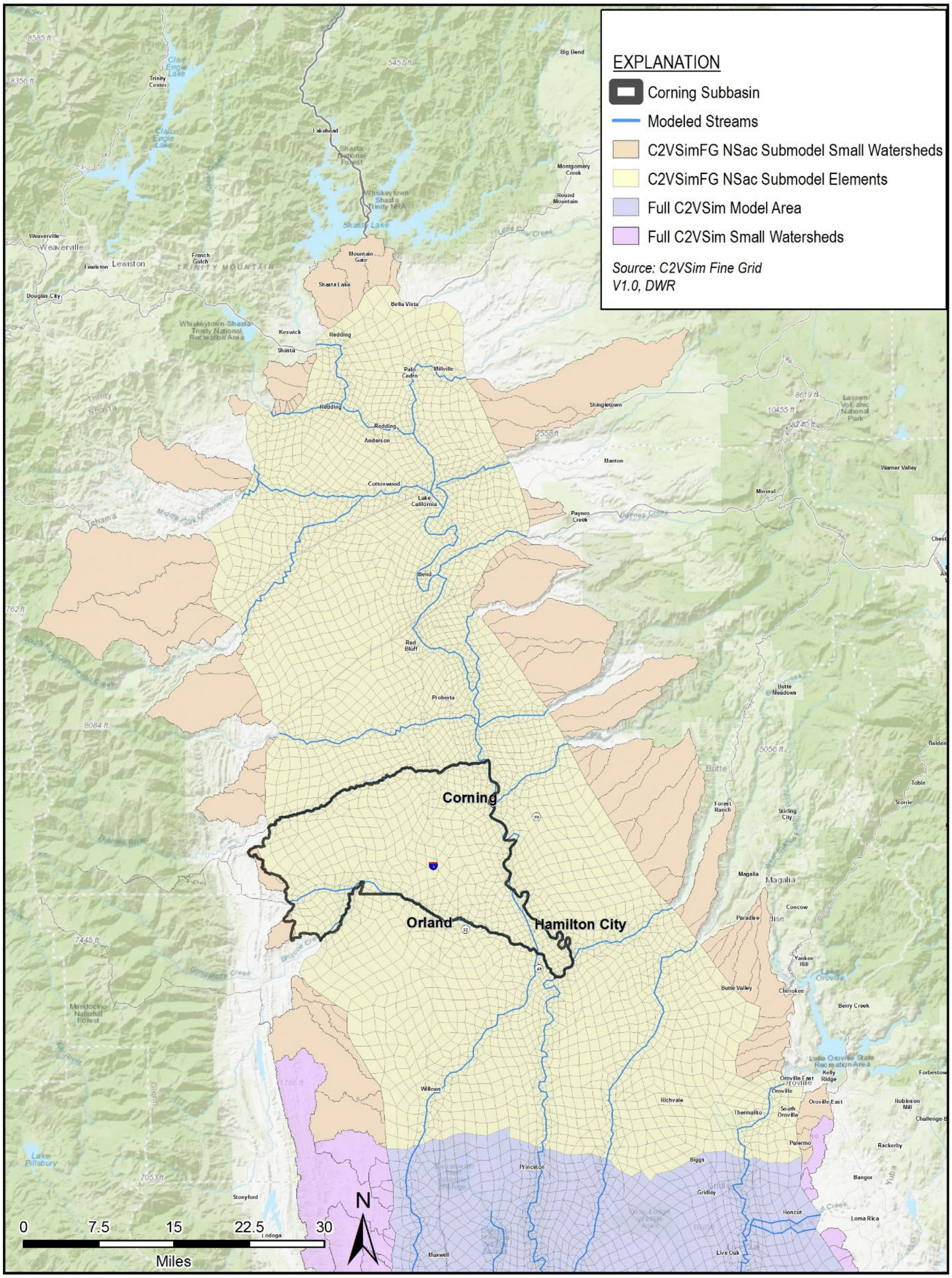

Figure 5. NSac Submodel and Corning Subbasin

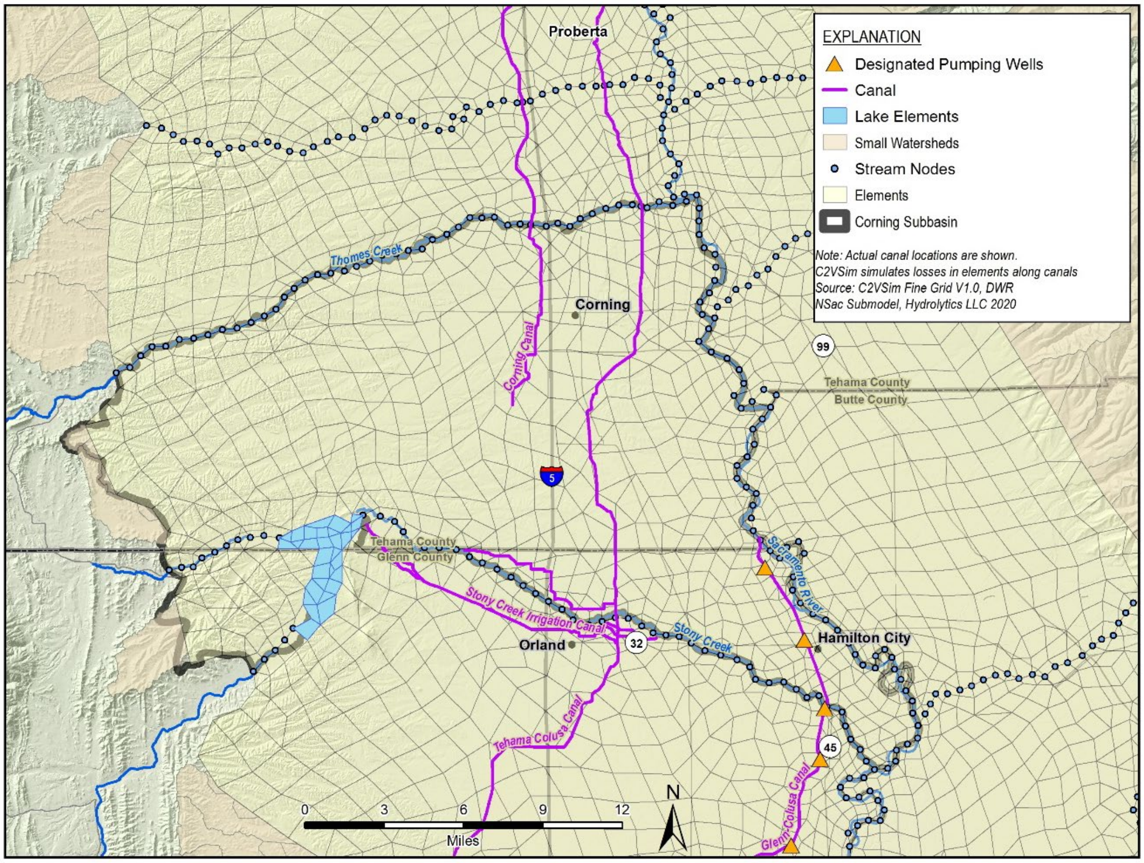

Figure 6. C2VSim NSac Submodel Finite Difference Grid and Stream Network Around Corning Subbasin

Comparison to Hydrogeologic Conceptual Model

As described in the Corning Subbasin GSP hydrogeologic conceptual model (Section 3.1), the Corning Subbasin is composed primarily of the Tehama Formation and the Tuscan Formation, overlain by multiple formations and deposits of quaternary alluvium. The bottom of the Subbasin is defined by the occurrence of saline and brackish connate water in the Upper Princeton Valley Fill Formation and the Great Valley Sequence, or relatively impermeable basement rocks. Concurrent deposition of the Tehama and the Tuscan formations, coupled with the heterogenous nature of both units, results in a complex interconnected aquifer network containing both unconfined and confined portions. Despite the presence of confined and semi-confined groundwater in parts of the Subbasin, extensive heterogeneity produces continuity of groundwater flow through the Subbasin.

The Corning Subbasin hydrogeologic conceptual model is well represented within C2VSimFG. As discussed above, C2VSimFG simulates 4 aquifer layers representing an unconfined zone (Layer 1), a confined zone with significant pumping (Layer 2), a confined zone with little pumping (Layer 3), and a connate water zone with little to no pumping (Layer 4). These simulated layers correspond well to the hydrogeological and water use conditions present in the Subbasin. Largely unpumped connate water in Layer 4 represents the saline and brackish formations which underlie the Subbasin.

Within the Corning Subbasin, model layers represent the following hydrogeologic conditions:

- Layer 1 simulates the unconfined portions of the Tehama Formation, the Tuscan Formation, and overlying quaternary alluvium.
- Layer 2 simulates the confined* portions of the Tehama and Tuscan formations which are extensively pumped by deeper municipal and agricultural wells.
- Layer 3 simulates the deeper confined portions of the Tehama and Tuscan formations which are largely unpumped.
- Layer 4 represents portions of the brackish formations underlying the Tehama and Tuscan formations, including the Upper Princeton Valley Fill formations and the Great Valley Sequence.

**There are no modeled aquitards separating any of the four model layers in the Corning Subbasin area.*

Model layer thicknesses correspond well to geologic cross-sections and to production well maximum screened depths, and therefore, the numerical model is largely consistent with the hydrogeologic conceptual model. Further, cross section B-B’ presented on Figure 8 displays model layer stratigraphy just south of the Corning Subbasin and corresponds well to geologic cross sections presented in the Hydrogeologic Conceptual Model (HCM) (DWR, 2020).

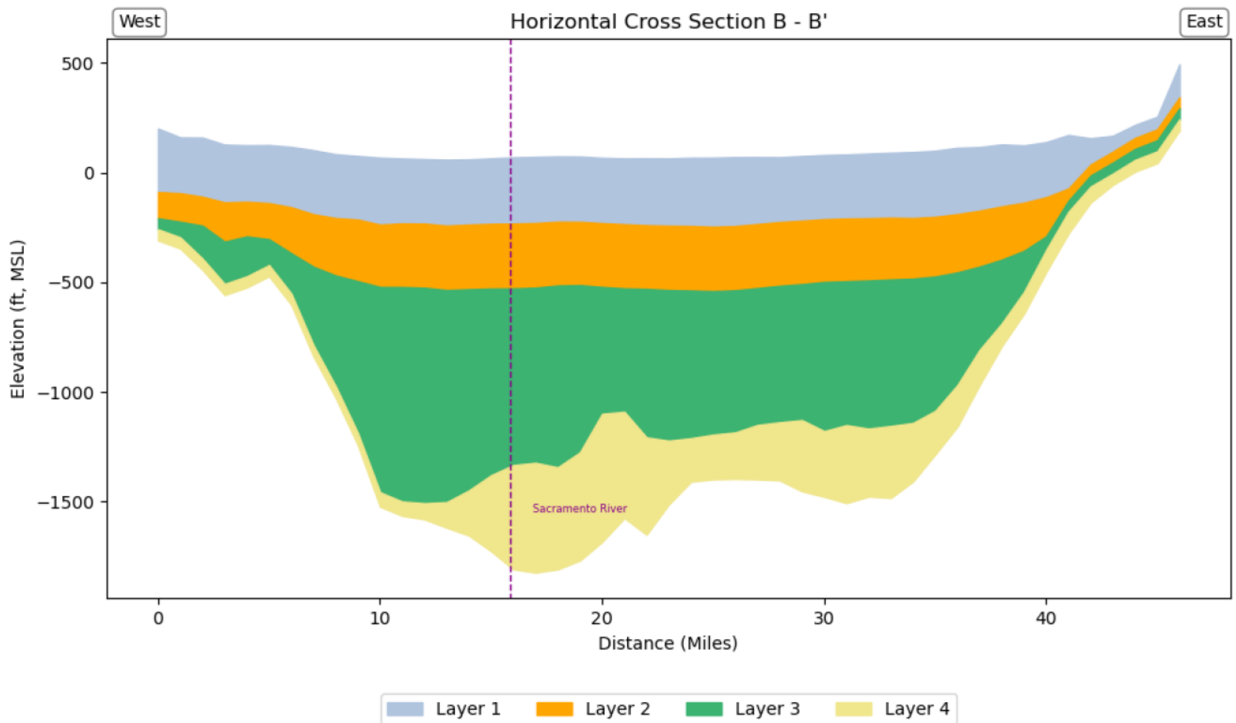

Figure 7. C2VSim FG Stratigraphic Cross Section B-B' [DWR, 2020]

Applicability of Model for GSP Development

The planned use of NSac model for GSP development includes:

- Develop historic, current, and future groundwater and surface water budgets
- Support Sustainable Management Criteria development
- Evaluate projects and management actions against Sustainable Management Criteria

Develop Historic, Current, and Future Water Budgets

As discussed throughout this document, the model includes the major functionalities to compute surface water and groundwater budgets for the Subbasin. In addition, the IDC provides additional functionality to develop land use water budgets that correlate the water demand with the available water supply by source type and allows for additional discussions and water supply reliability assessments as required in the GSP.

Develop Sustainable Management Criteria

Each of the six sustainability indicators has a specific metric for evaluation and development of minimum thresholds, measurable objectives, interim milestones, and undesirable results, as described in the GSP Regulations, Subarticle 3. The graphic below provides a summary by DWR of the metrics defined in the GSP regulations for each sustainability indicator. In addition, groundwater levels can be used as a proxy where a correlation can be established, as described in the Sustainable Management Criteria (SMC) Best Management Practices (DWR, 2017).

Sustainability Indicators	Lowering GW Levels	Reduction of Storage	Seawater Intrusion	Degraded Quality	Land Subsidence	Surface Water Depletion
Metric(s) Defined in GSP Regulations	• Groundwater Elevation	• Total Volume	• Chloride concentration isocontour	• Migration of Plumes • Number of supply wells • Volume • Location of isocontour	• Rate and Extent of Land Subsidence	• Volume or rate of surface water depletion

A brief evaluation of the use of NSac for SMC development is provided below.

Lowering Groundwater Levels

The model simulates water levels and therefore, it can be used to develop applicable sustainability criteria related to lowering groundwater levels.

Reduction of Storage

This sustainability indicator requires the total volume of groundwater pumped to be reported and incorporated in management actions. Since the model includes actual urban groundwater pumping data and assumptions for rural residential and agricultural pumping, it can be used to estimate the sustainability criteria related to reduction of storage.

Seawater Intrusion

This sustainability indicator is not applicable for this GSP, as discussed in Section 3.2.

Degraded Water Quality

NSac does not include solute transport and therefore cannot be used to directly evaluate water quality constituents of concern and related sustainability criteria. SMCs for degraded water quality can be developed with existing datasets and monitoring networks.

Land Subsidence

Subsidence mapping performed by DWR and USGS in the northern Sacramento Valley does not indicate significant land surface subsidence due to groundwater withdrawals in the Corning Subbasin. C2VSimFG and NSac include the capability to simulate land subsidence due to groundwater withdrawals, but this component is not currently activated in the C2VSimFG model or the NSac submodel. However, water levels can be used as a proxy to determine applicable land subsidence SMCs, and therefore, the model is adequate for this indicator provided that a correlation is established between groundwater levels and subsidence.

Surface Water Depletion

The GSP regulations state that surface water depletion evaluations only apply to "interconnected surface water," defined as: "surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted." Surface water depletions require SMC such as: "depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use," per the GSP regulations.

One of the critical applications of the NSac for SGMA compliance will be to provide estimates of "the quantity and timing" of historical depletion of interconnected surface water (§354.16(f)) and compare future projections of those depletions against thresholds specified by the SMC. Using a model to quantify depletion of interconnected surface water requires that the model accurately simulate locations of interconnected surface water. The NSac model generally reproduces the magnitude of observed stream-aquifer interaction, indicating it is a suitable tool for quantifying stream depletion.

Evaluate Projects and Management Actions

Conceptually, the existing model can be generally used to evaluate projects and management actions.

Management actions related to pumping reductions or land use changes can be easily incorporated into the model. Projects related to developing recharge ponds, or injection wells, are also easily incorporated. This model is better suited for assessing magnitude of changes rather than absolute groundwater elevations for future scenarios. Therefore, when assessing the effects of simulated proposed projects and actions, the project outputs from the various scenarios should be compared to the baseline conditions, without projects and actions, to determine the relative change in groundwater elevations as compared to base conditions.

Potential Model Uncertainties

This section provides brief documentation of model uncertainty that has been identified during the review, and considerations for the GSP

Several iterations of C2VSimFG calibration and data development by DWR have increased model accuracy and precision, supplemented by refinements made to the NSac model as discussed in Part 3 and Part 4. However, C2VSimFG V1.0 is largely designed for assessing historical regional groundwater conditions across the Central Valley, and therefore model simulation contains some level of uncertainty common to most large regional groundwater models. Specific sources of model uncertainty are discussed in the bullets below.

- As described further in Part 4 of this memo, simulated groundwater heads vary from historical observations in some wells, particularly in the central and western portion of the Subbasin. While this uncertainty was present and considered acceptable by DWR in the base version of C2VSimFG, and simulation of groundwater heads have improved with model refinements described in Part 3, any uncertainty in groundwater head prediction should be considered upon review of projected SMC, water budgets, and simulations of projects and management actions.
- Analysis by DWR has indicated C2VSimFG V1.0 soil and unsaturated zone properties display high variability, resulting in unreasonable estimates of agricultural water demands in some areas of the regional model (DWR, 2020). These uncertainties were addressed in the NSac model with local refinements as discussed in Part 3.
- Shallow groundwater uptake by crops is currently not activated in C2VSimFG V1.0, potentially creating uncertainty in simulation of near-surface groundwater elevations in areas where groundwater elevations are very close to the land surface.
- Simulated groundwater elevations are generally higher than observed in the Northern Sacramento Valley portion of C2VSimFG. The changes described in Part 3 have reduced the discrepancy between simulated and observed heads throughout much of the Corning Subbasin.

As DWR continues to develop and enhance the C2VSimFG model, and as more data are collected in the Corning Subbain, the C2VimFG and NSac models will be further refined to resolve local inconsistencies and reduce uncertainties.

PART 3: MODEL REFINEMENTS

Model Refinements Implemented for GSP Development

Through model evaluation and review of collected data and information from local water districts and existing reports, model adjustments and refinements were implemented to produce a more accurate model that better reflects local Corning Subbasin conditions and is suitable for water budget and future scenario development. These adjustments were mostly focused on land surface and water use assumptions and are summarized in the bullets below and described in further detail in the following paragraphs.

- Refined surface water delivery areas and delivery volumes from canal delivery areas to individual water districts based on historical records and allocations
- Refined groundwater pumping depths within the Corning Subbasin to match well completion records provided by DWR
- Reviewed detailed historical urban water usage for Corning and Hamilton City
- Replaced the boundary condition representing Black Butte Lake with a simulated lake feature, and modified Stony Creek to conform to this lake feature
- Used WY1988 land use data for WY1974-1988, as pre-1988 land use in the C2VimFG model was inaccurate
- Modified water management parameters to better represent observed water use patterns
- Incorporated all wells with groundwater elevation measurements into the model for further calibration verification
- Applied minor adjustments to hydrogeologic model parameters to better match historical observations after incorporating the above model changes
- Refined land surface values (Curve Numbers) for native vegetation to better reflect actual precipitation recharge
- Updated initial conditions to remove large changes in groundwater heads in the initial time steps
- Refined some crop input data (Attachment 1):
    - Reviewed and refined crop evapotranspiration coefficients*
    - Reviewed and refined crop applied water demands from 2010-2015*

**See Attachment 1"Crop ET and Applied Water C2VSim Modifications" for more detail.*

Surface Water Deliveries

Corning Subbasin agricultural water users receive water from several surface water sources. The Corning and Tehama-Colusa canals serve water districts with water diverted from the Sacramento River, the Orland Unit Water Users Association (OUWUA) receives water from Stony Creek, and riparian agricultural users divert water from Thomes Creek and the Sacramento River. These delivery areas were adjusted within the model for improved estimation of surface water use in the Subbasin. The refined surface water diversions and application areas in the Corning Subbasin are presented on Figure 9.

In the C2VSimFG V1.0 model, all surface water deliveries for the Corning Canal are lumped into a single delivery zone. To better reflect actual surface water delivery areas, this Corning Canal zone was divided into three zones representing Corning WD, Thomes Creek WD and Proberta WD. Detailed monthly Corning Canal delivery data for these areas were then developed and incorporated into the C2VSimFG model.

Similarly, in the C2VSimFG model, all surface water deliveries for the Tehama-Colusa Canal are lumped into a single zone for the canal's entire service area. The Tehama-Colusa Canal delivery area for Kirkwood WD was adjusted to match the boundaries of Kirkwood WD, and the Tehama-Colusa Canal delivery areas for other districts south of Stony Creek were adjusted to remove Kirkwood WD and all other delivery areas north of Stony Creek.

OUWUA receives deliveries through two canals which serve areas on either side of Stony Creek. In the C2VSimFG V1.0 model, both canals deliver water to the entire OUWUA service area. The OUWUA delivery area was divided into two areas corresponding to the delivery areas of the North canal (Corning Subbasin) and South canal (Colusa Subbasin). OUWUA historical diversion data for the two canals were reviewed for completeness and accuracy. Riparian delivery areas along Thomes Creek were also reviewed and slightly refined to better allocate surface water deliveries to these areas.

For all diversions within the Corning Subbasin, available historical diversion data were collected and analyzed to ensure model accuracy. For many diversions, particularly Colusa Canal to Corning WD and Tehama-Colusa Canal to Kirkwood WD, pre-refinement surface water applications were much higher than historical allotments. Refinement of these surface water diversion areas and volumes adds accuracy to model simulation of surface water application and associated changes in groundwater level.

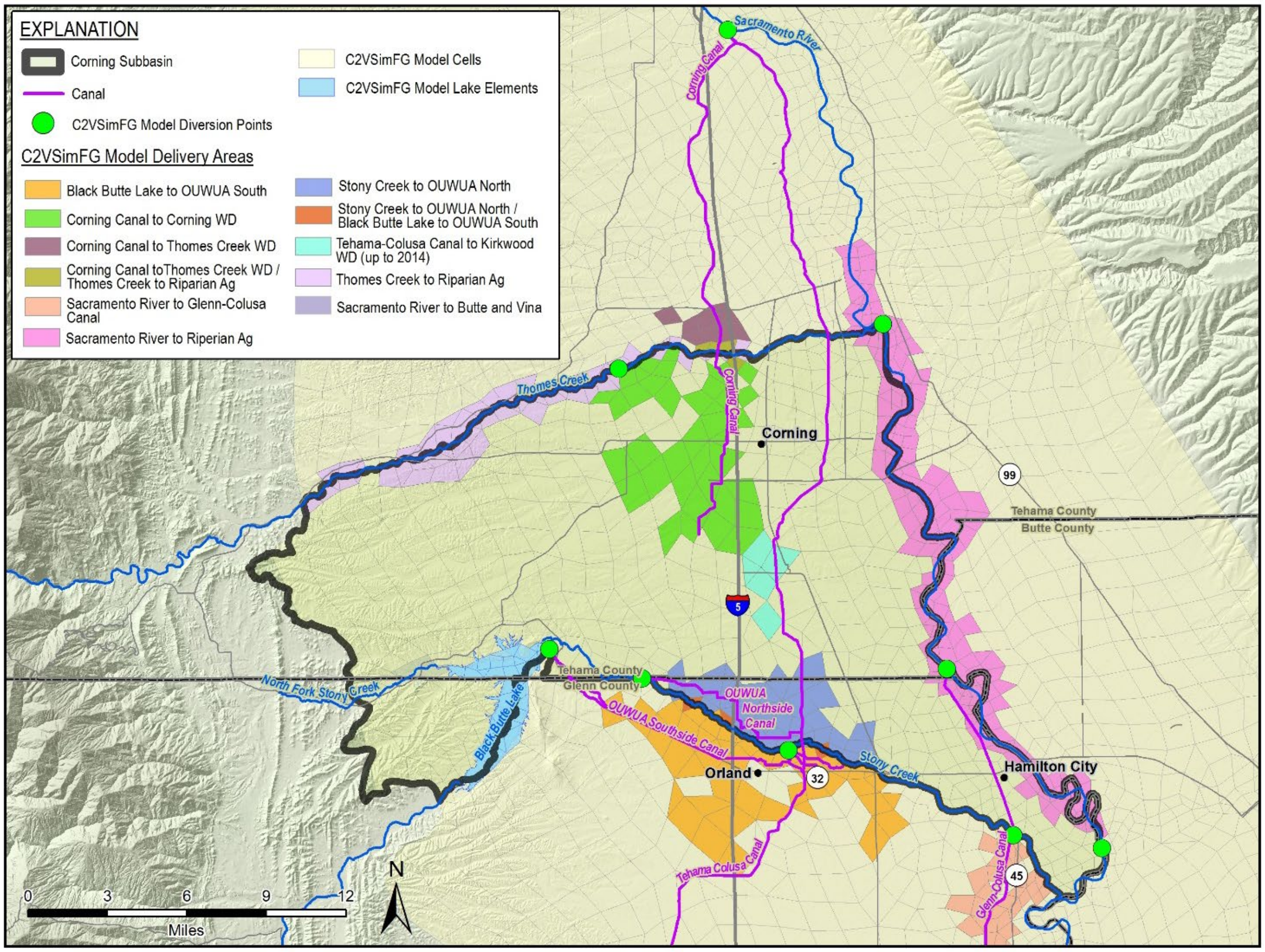

Figure 8. Refined Corning Subbasin Surface Water Diversions and Delivery Areas

Groundwater Pumping Depths

As part of model review, detailed well completion reports provided by DWR were analyzed to determine the pumping zones for domestic, agricultural, public supply, and industrial wells in the Corning Subbasin (Table 3, Figure 10). Based on these analyses, most wells appear to extract water from a zone extending from the water table to a depth of less than 400 ft below ground surface (Table 1, Figure 5). This zone corresponds to the top layer of the C2VSimFG groundwater component representing unconfined conditions. Two types of public supply wells were identified in the well completion reports database, with deeper wells serving the larger municipal areas of the City of Corning and Hamilton City, and shallower wells serving smaller communities such as mobile home parks and campgrounds. The depths of agricultural irrigation wells varied significantly across the Corning Subbasin and were further analyzed by township-range quadrant.

Table 4 Well Screen Depths in the Corning Subbasin

Well Type	Less than 400 ft	Greater than 400 ft
Domestic	99%	1%
Irrigation	67%	33%
Public Supply	83%	17%
Industrial	95%	5%

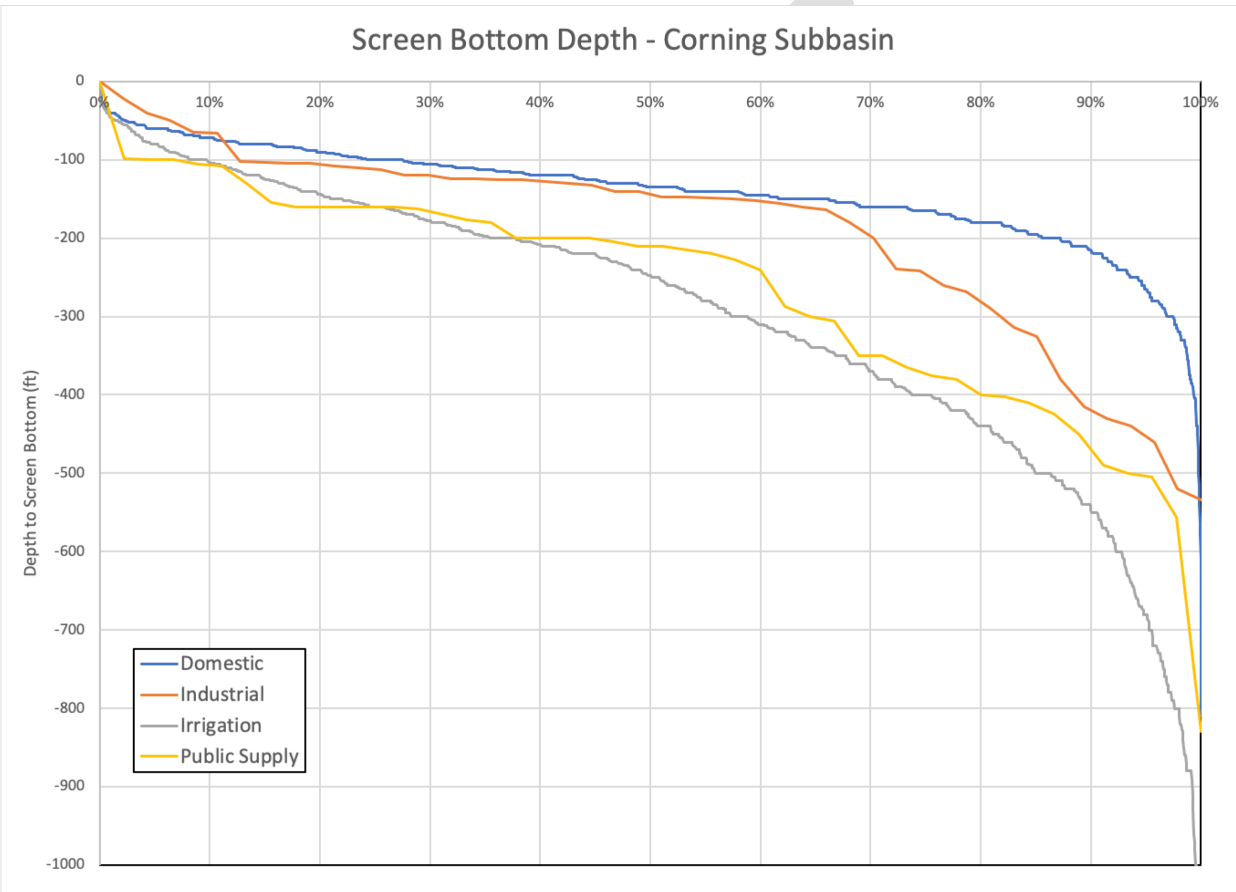

Figure 9. Well Screen Depths in the Corning Subbasin

The pumping depths in the C2VSimFG V1.0 model generally conform to the pumping depths observed in the analysis of well depth data. This pumping distribution was retained for the NSac model.

Agricultural irrigation wells generally only have a short section of casing near the land surface and are generally screened for most of their completed depth. The volume of water entering the well at a given depth is controlled by the aquifer transmissivity, with more water entering higher transmissivity zones which generally occur closer to the land surface. Pumping zones for agricultural irrigation wells were allocated between the top two model layers based on the proportion of screen depths in each township-range quadrant, with an adjustment to account for greater water inflow in the higher transmissivity zone.

Urban Water Use

Agricultural water use in the Subbasin is far larger than urban water use, and only two main population centers using groundwater supply exist in the Subbasin: City of Corning and Hamilton City. Urban water use in the C2VSimFG model was found to be similar to observed pumped urban water as obtained from the two urban areas and was not altered.

Black Butte Lake

Black Butte Lake on Stony Creek was built in 1963 by the US Army Corp of Engineers for flood protection to the west of the Orland Buttes. At capacity, the lake holds 143,700 acre-feet of water with a surface area of 4,560 acres. The crest elevation is 515 ft, and depth at capacity is 115 ft. No studies reporting lake discharges to groundwater have been identified, but a lake with over 100 ft of standing water would generally be expected to discharge water to the aquifer through the lake bottom. The C2VSimFG V1.0 model simulates Black Butte Lake with a general head boundary condition. This boundary condition results in an average net discharge of 2,650 acre-feet of water per year from the groundwater aquifer to Black Butte Lake.

Daily Black Butte Lake inflow and outflow data for WY 1974-2015 were provided by the US Army Corps of Engineers. The data were combined with precipitation and evaporation estimates from the C2VSimFG model to develop estimated monthly water budgets for Black Butte Lake. Lake discharge to groundwater is a residual term in this budget and is therefore affected by errors in other inflow and outflow terms but indicates lake discharge to groundwater in most months.

The general head boundary condition for Black Butte Lake was removed from the NSac model and replaced with a simulated lake, using IWFM Lake Component version 4. The new lake covers 33 model elements. The three stream reaches representing the North Fork, South Fork and main stem of Stony Creek were modified to remove segments crossing these elements, and the North Fork and South Fork reaches were modified to discharge into Black Butte Lake. Land surface altitudes at model nodes inside the lake were modified in the Preprocessor Stratigraphy file to adjust the lake volume to approximate the reported lake volume. Lake elevation was specified to match historical lake elevation records. To simplify lake simulation in this initial implementation, lake discharge is not explicitly connected to the Stony Creek inflows; rather reservoir releases are exported out of the model, and inflows to Stony Creek main stem are simulated as an inflow in the model similar to other model boundary stream inflows. In the initial implementation, lake bottom conductance was set at a very low value of 0.001 ft/day, which resulted in an average annual discharge of 1,420 acre-feet from the lake into the aquifer. This change results in a net increase of approximately 4,000 acre-feet per year to the groundwater flow system. If reliable estimates of groundwater discharges for Black Butte Lake become available, the lake bottom conductance can be adjusted to match them.

Land Use

Annual land use in the C2VSimFG model is derived from historical DWR land use survey data. Agricultural crop acreages in the C2VSimFG model changed significantly between WY1987 and WY1988. This change is related to DWR's switch from estimated land use values to reliance on land use surveys (Figure 11). Therefore, land use data for the historical period prior to WY1988 was replaced with WY1988 land use data to remove this inconsistency.

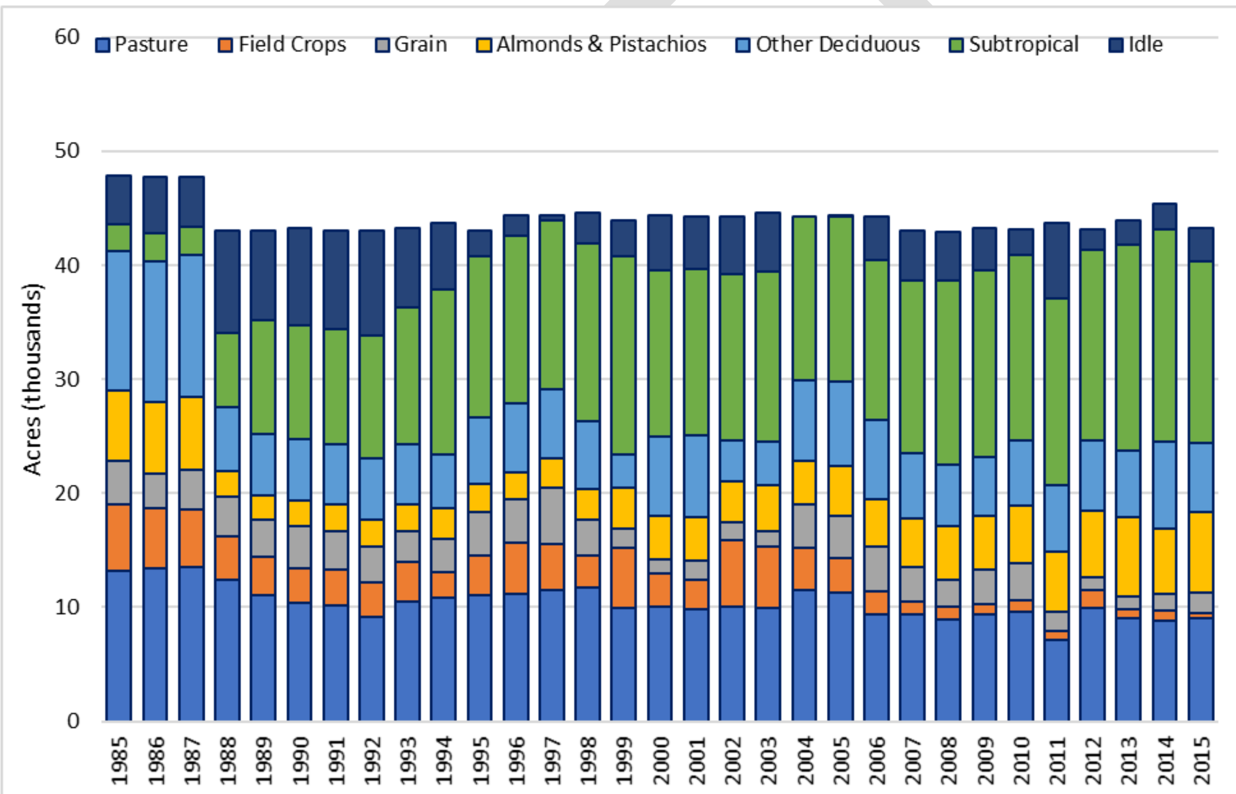

Figure 10. Land Use in the C2VSim FG V1.0 Model

Water Management Parameters

Simulated water usage for each crop was compared to historical water usage estimates. Target soil moisture fractions were adjusted for three crop categories: Almond and Pistachio, Citrus and Subtropical, and Pasture. The C2VSimFG model treats grain as a dry-lend crop. Grain irrigation was turned on in Subregion 2, which includes the Corning Subbasin, to simulation the occasional irrigation of grains in dry years. Pasture ET was reduced by 20% in the Corning area to better reflect available measured ET data. More about adjustment of crop parameters can be found in the Attachment 1.

Observation Wells

C2VSimFG V1.0 designated observation wells for hydrograph output across the central valley, for use in regional calibration and model observation. Most of these observation wells are not applicable to the Corning Subbasin and were replaced with designated observation wells in and around the Corning Subbasin. This more precise observation network will allow for comparison of model output with known hydrographs in the Subbasin. All wells with a historical groundwater elevation record were incorporated into the NSac observation well network, including a number of wells directly surrounding the Subbasin.

Parameter Adjustment

Incorporation of a simulated lake feature representing Black Butte Lake resulted in groundwater flows in the southwest portion of the Corning Subbasin that were different from those in the calibrated C2VSimFG V1.0 model. Groundwater parameters and streambed conductance parameters in the Corning Subbasin were adjusted to better match observed groundwater heads.

Curve Number Refinement

Groundwater levels in the western portion of the Corning Subbasin in areas without significant agricultural crops were consistently high throughout the simulation period. Curve number values, which control the partition of precipitation between infiltration and runoff, were modified for native vegetation in this area to increase runoff and reduce infiltration. This brought groundwater levels throughout the simulation closer to observed values.

Updated Initial Conditions

Groundwater heads in some areas rose significantly during the initial simulation time steps in the C2VSimFG model (see Figure 13 below). Initial conditions in the NSac model were modified to remove these large changes during the initial simulation time steps. This included adjusting initial groundwater heads and initial soil moisture levels in the root zone and unsaturated zone.

Recommended Model Refinements for GSP Implementation

This section provides a list of secondary model refinements that can be evaluated during the 5-year GSP update.

Small Watershed Subsurface Inflows

Simulated heads are generally higher than observed in the Northern Sacramento Valley portion of C2VSimFG. This may result from an over-approximation of subsurface inflows from small watersheds along the model boundaries in this area. This is difficult to assess owing to very limited historical data on surface water flows and groundwater elevations in the western portion of the Corning Subbasin that is comprised of mainly native vegetation. Establishing surface water flow measurement stations and groundwater observation wells in several representative areas in the western portion of the Corning Subbasin would help quantify water availability in these areas and resolve the source of any errors and could significantly improve model simulation accuracy in the western part of the subbasin.

Extend Model Simulation Time Period

During five-year GSP updates, the model time period should be extended to simulate more current conditions and evaluate the changes to the water budget and verify availability of groundwater in storage with newer information.

Potential for Improved Calibration

As discussed in Part 4 below, NSac model is well calibrated and suitable for GSP development. However, there is always potential to improve the performance of any model. As GSP development and implementation proceeds in the coming years, more detailed information on crop water use, surface water and groundwater flows, aquifer geology, local groundwater heads, and so on will be collected. This information should be incorporated into the model at regular intervals to improve the model's representation of the Corning Subbasin groundwater flow system. Model recalibration entails significant effort but would increase simulation precision of groundwater elevations and likely lend accuracy to generation of water budget components. Model recalibration should be considered as part of future model development as new information is incorporated into the model. This work can be done during the five-year GSP updates.

PART 4: CALIBRATION VERIFICATION

The C2VSimFG V1.0 was calibrated and approved by DWR for use in GSP development. Since several modifications were made to this model to create the NSac submodel and add details to the Corning Subbasin area, model performance checks were undertaken for the NSac model to ensure calibration was still acceptable or improved after model refinements. Performance checks presented here include graphs of measured vs observed groundwater heads, spatial mapping of RMSE, spatial mapping of average residuals, and graphs of measured vs observed streamflow.

Overall, model performance is still acceptable and may have improved after implementation of model refinements. The following subsections describe these calibration checks in more detail.

Simulated Versus Observed Groundwater Elevation

A fundamental test of groundwater model calibration and simulation accuracy is to plot timeseries of simulated and measured (observed) groundwater elevations. This allows a simple visual analysis of model accuracy and precision, based on how well simulated elevations resemble measured observations. It is important to review how well the model generally reflects elevations at a site, and how well the model estimates seasonal or climactic fluctuations. These plots of measured and observed groundwater elevation were created for every well in the Subbasin.

Figure 12 and Figure 13 display select plots of simulated vs observed groundwater elevations in the unconfined (layer 1) and confined aquifer (layers 2 and 3) respectively. These figures compare groundwater elevations (head) generated by the current version of the NSac model "NSac Model" with groundwater elevations generated by the base C2VSim FG V1.0 model published by DWR (DWR, 2020). In general, the current model appears to predict general groundwater head and seasonal groundwater fluctuations very well in layer 1. Here the accuracy and precision of simulated elevations is similar to or improved from the DWR model, which is expected given the majority of revisions made to NSac model were at the surface, which would primarily affect the unconfined model layer 1. The model's simulation of groundwater head in the deeper aquifer units (layers 2 and 3) is also improved from the base DWR model, however simulation in these layers is generally less accurate when compared to layer 1. This improvement is most likely due to changes in groundwater pumping estimates resulting from adjustments affecting crop water use and improvements in surface water delivery volumes and areas, modifications to groundwater pumping distributions, incorporation of Black Butte Lake, and adjustments to aquifer parameters.

Across the Northern Sacramento Valley, simulated groundwater elevations often trend higher than observed elevations in both models. This may be related to over-approximation of subsurface inflow from small watersheds in the Northern Sacramento Valley. In some locations, seasonal variations present in observed data are not captured by the model. This appears particularly prominent at agricultural pumping wells and may be the result of local drawdowns from groundwater pumping not being reflected by the larger element-scale of the model. Collection of more detailed pumping and water use data, and incorporation into the NSac model could improve simulation accuracy. Current model performance is sufficient for the development and implementation of a complete GSP.

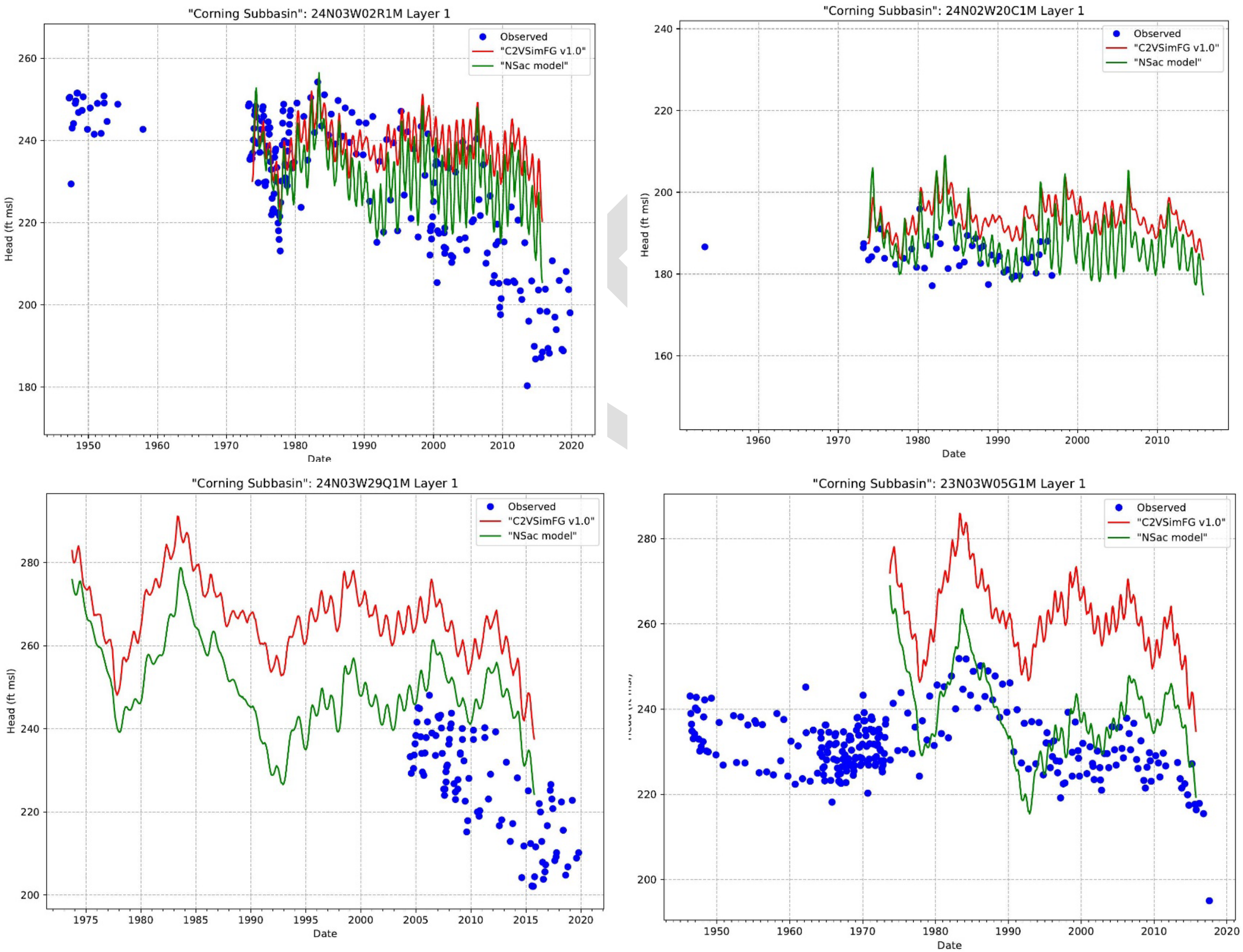

Figure 11. Simulated VS Observed Groundwater Elevation Plots in Layer 1 (Unconfined Aquifer)

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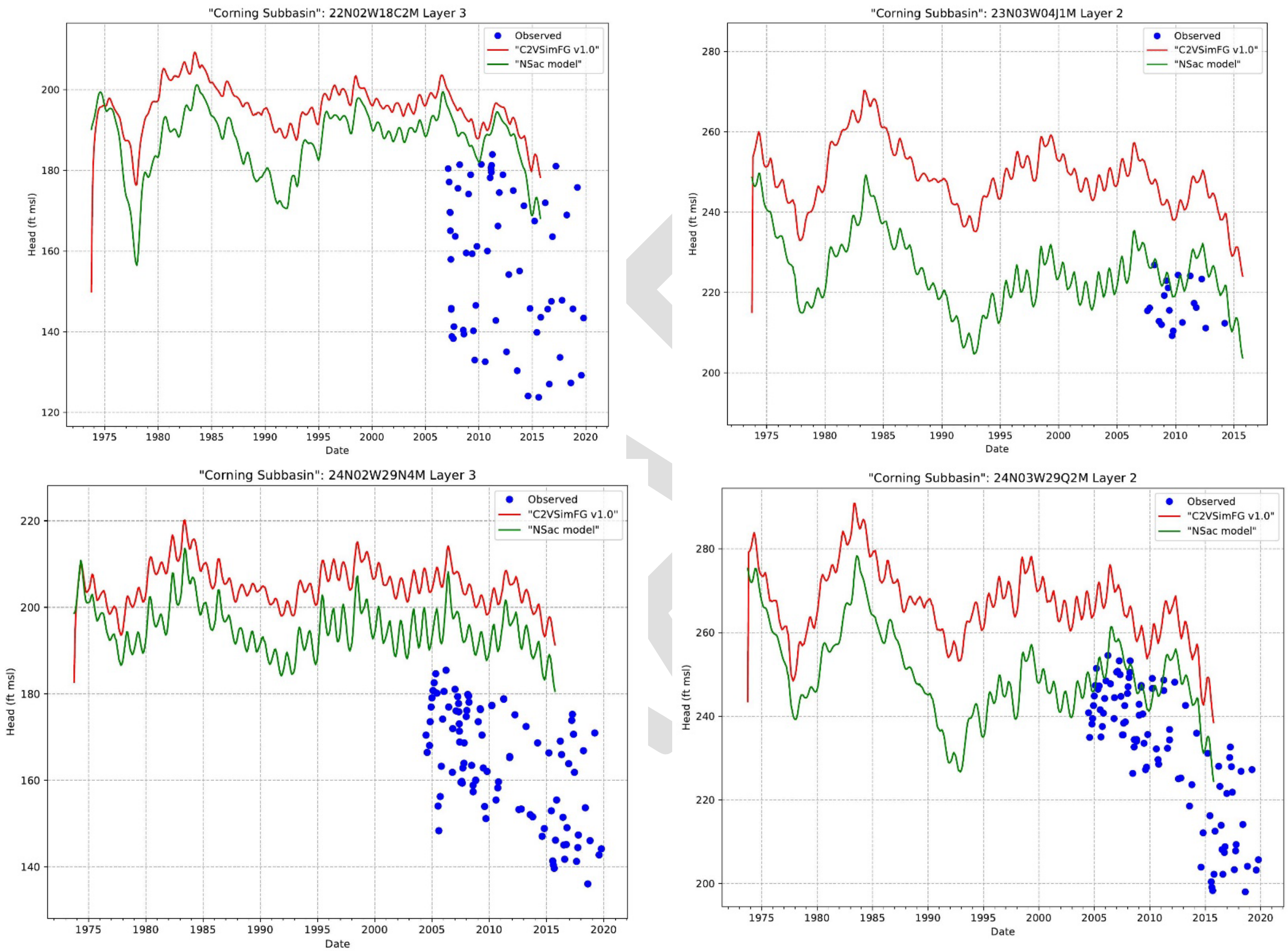

Figure 12. Simulated VS Observed Groundwater Elevation Plots in Layer 2 and 3 (Confined Aquifer)

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Simulated Versus Observed Streamflow

In addition to analyzing how well the model predicts groundwater elevations, the performance of the surface water components can be evaluated by plotting simulated and observed streamflow together as shown on Figure 14. Simulated streamflow at Thomes Creek, Stony Creek, and the Sacramento River in the Corning Subbasin closely resembles measured streamflow gauge data where available. Calibration curves plotting simulated and observed streamflow against each other, shown on Figure 15, likewise demonstrate high correlation between model simulation and observations (R^2 >0.98). These calibration curves generally predict higher accuracy at lower flow volumes. Overall, these results indicate model streamflow simulation is adequate for GSP development purposes.

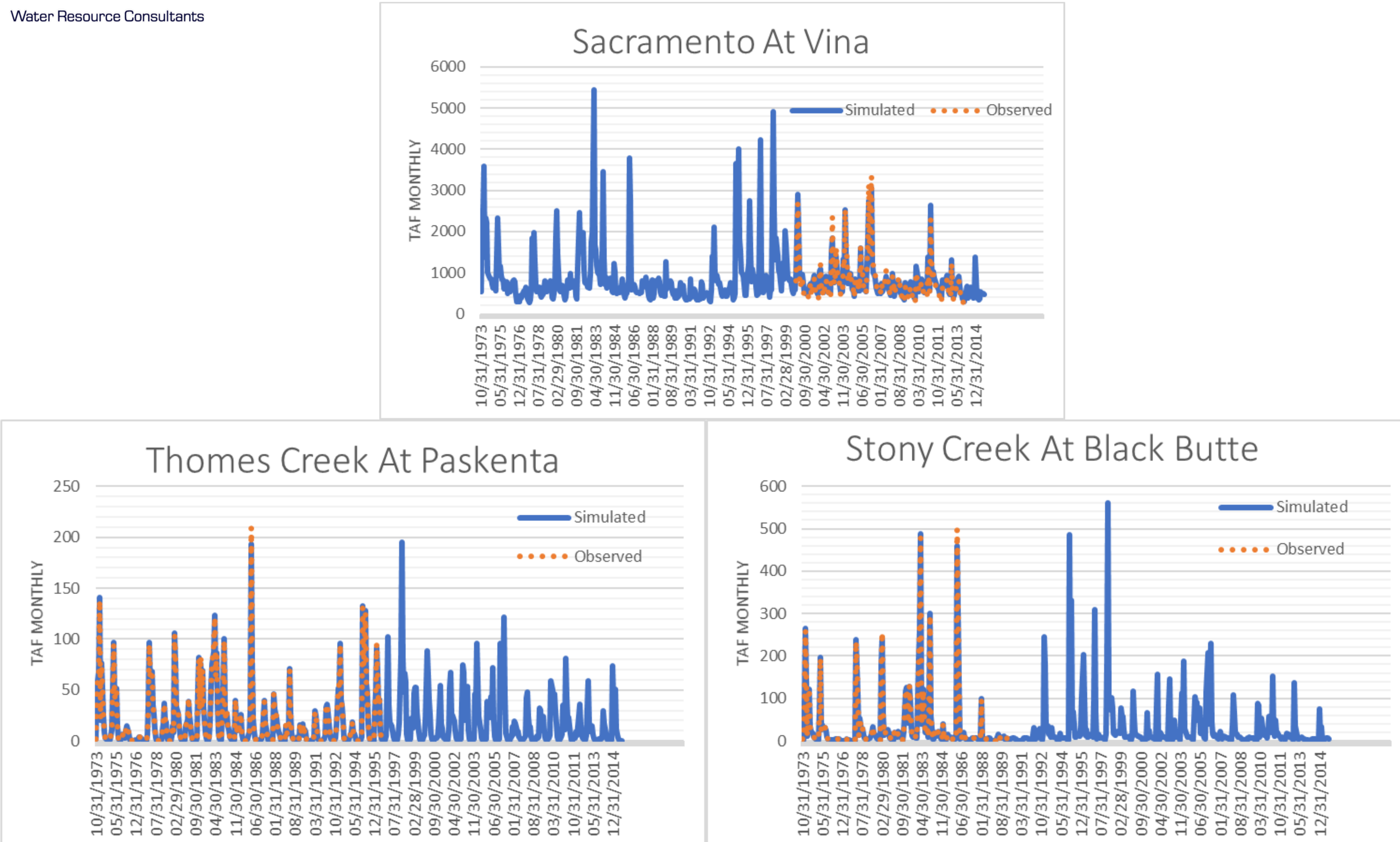

Figure 13. Simualted and Observed Streamflow

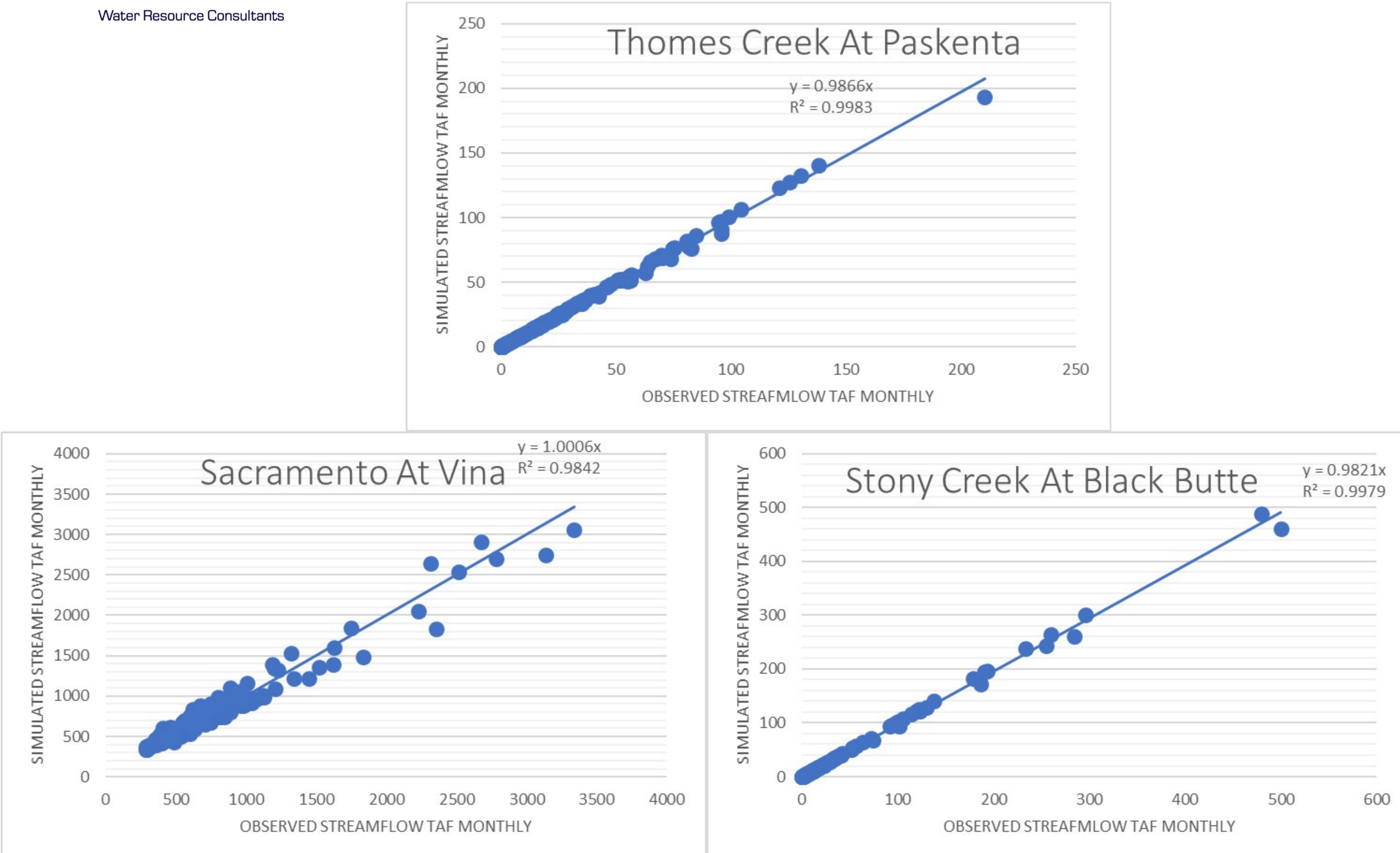

Figure 14. Simulated and Observed Streamflow Calibration Curves

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LIST OF ACRONYMS

C2VSimFG ....California Central Valley Groundwater-Surface Water Simulation Model

CASGEM.............California Statewide Groundwater Elevation Monitoring

CVHM..................Central Valley Hydrologic Model

DWR ....Department of Water Resources
ET.........................Evapotranspiration
GSA......................Groundwater Sustainability Agency
GSP ....Groundwater Sustainability Plan
HCM ....Hydrogeologic Conceptual Model
IDC.......................IWFM Demand Calculator
IGSM....................Integrated Groundwater-Surface Water Model
IWFM...................Integrated Water Flow Model
NSac ....Northern Sacramento submodel
OUWUA ....Orland Unit Water Users Association
PRISM..................Parameter-elevation Relationships on Independent Slopes Model
SacFEM................Sacramento Valley Finite Element Groundwater Model
SCF ....Stony Creek Fan model
SGMA ....Sustainabile Groundwater Management Act
SMC ....Sustainable Management Criteria
TM........................Technical memorandum
USBR ....US Bureau of Reclamation
USGS ....US Geological Survey

Attachment 1

Modifications to C2VSimFG for the Corning Subbasin

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Technical Memorandum

To: Lisa Porta, Montgomery & Associates

From: Davids Engineering

Date: October 21, 2020

Subject: **Modifications to C2VSimFG for the Corning Subbasin**

Overview

This memorandum describes modifications to DWR's C2VSim Fine Grid integrated hydrologic model to support water budget development for the Corning Subbasin. Specifically, modifications were made to model inputs based on comparison of crop evapotranspiration (ET) and applied water demands to independent estimates.

Crop Evapotranspiration

Average annual evapotranspiration estimates from 2000 to 2015 for C2VSim Subregion 2, which contains the Corning Subbasin were reviewed for consistency with other available evapotranspiration estimates. Sources of ET estimates relied upon include the following:

- DWR – DWR has developed and published ET estimates to support update of the California Water Plan using the CalSimETAW model, which relies upon reference ET from the California Irrigation Management Information System (CIMIS) and published crop coefficient values. Average 2000-2015 ET values for the Red-Bluff-Orland Detailed Analysis Unit (DAU) were assembled.
- Cal Poly – The Cal Poly Irrigation Training and Research Center publishes estimates of crop ET to support the development of water balances. Average ET values for typical, dry, and wet years are available. These values were assembled and averaged.
- METRIC – The Mapping EvapoTranspiration at high Resolution with Internal Calibration (METRIC) energy balance model uses Landsat satellite imagery and ground-based reference ET information to estimate actual ET by crops and other surfaces. Average ET values for the Sacramento Valley by crop were assembled from an analysis completed using METRIC for 2017.

Annual ET estimates from C2VSim and from the other sources described above are summarized in Table 1, along with the average estimated acreage of each crop in the corning Subbasin for 2000 to 2015. In the table, grey cells indicate that estimates were not available from a given source.

Based on review of the estimates, it was decided to reduce C2VSim estimates of ET for pasture, which is typically grazed and may not be fully irrigated, by approximately 6.9 inches on average (15%).

Table 1. Annual Evapotranspiration Estimates for Corning Subbasin Crops (inches).

Crop	Acres	C2VSim	DWR	Cal Poly	METRIC
Alfalfa	2,402	42.2	44.0	45.0	45.2
Almonds & Pistachios	9,148	45.9	50.5	41.2	39.1
Corn	1,317	27.4	25.8	30.8	35.9
Cotton	0	32.6	29.9	35.4	
Dry Beans	237	24.3	23.8		34.5
Grain	3,173	11.5	21.2	18.1	29.7
Idle	6,477	5.6		8.4	24.2
Melons	246	25.5	23.8	21.0	30.5
Misc. Field Crops	288	29.2	34.3	18.6	35.3
Olives	16,882	34.2	39.9	40.4	28.5
Onions & Garlic	18	31.0	36.3	40.3	
Other Deciduous	10,777	38.4	38.0	27.6	38.7
Pasture	11,577	45.7	48.3	46.3	28.3
Safflower	32	24.8	22.0	26.8	33.9
Sugar Beets	9	38.4	39.8	33.9	
Tomatoes	1	32.2	32.1	26.3	37.4
Truck Crops	640	31.7	31.1	22.5	26.3
Vineyards	10	32.3	32.2	30.6	27.9

Applied Water Demands

Average annual applied water estimates from 2000 to 2015 for C2VSim Subregion 2 were reviewed for consistency with other available estimates. Sources of applied water estimates relied upon include the following:

- GCID – Glenn-Colusa Irrigation District has developed applied water estimates representing assumed duties for purposes of its annual landowner water application. These values were assembled based on the district's 2020 application. For almonds and pistachios, an average duty was estimated assuming a combination of young and mature trees.
- UC – The University of California Cooperative Extension publishes cost and return studies for the Sacramento Valley that describe production of individual crops, including typical irrigation amounts. Irrigation estimates for recent studies were assembled.

Annual applied water estimates from C2VSim and from the other sources described above are summarized in Table 2, along with the average estimated acreage of each crop in the corning Subbasin for 2000 to 2015. In the table, grey cells indicate that estimates were not available from a given source.

In addition to reviewing applied water estimates, the average Consumptive Use Fraction (CUF) for each crop from 2000 to 2015 was reviewed. CUF[1] is analogous to irrigation efficiency and can be used to provide further insight into applied water demand estimates. Average C2VSim CUF estimates from 2000 to 2015 are summarized in Table 3.

[1] Calculated as annual ET of applied water divided by applied water.

Table 2. Annual Applied Water Estimates for Corning Subbasin Crops (inches).

Crop	Acres	C2VSim	GCID	UC
Alfalfa	2,402	46.6	54.0	42.0
Almonds & Pistachios	9,148	51.8	38.2	38.0
Corn	1,317	29.4	51.6	31.0
Cotton	0	40.8	39.6	36.0
Dry Beans	237	24.9	30.0	22.0
Grain	3,173	0.0	24.0	6.0
Idle	6,477	0.0		
Melons	246	28.0	19.2	
Misc. Field Crops	288	31.0		
Olives	16,882	34.7	38.4	18.0
Onions & Garlic	18	36.7	18.0	
Other Deciduous	10,777	42.5	43.2	30.0
Pasture	11,577	49.7	36.0	54.0
Safflower	32	25.2	26.4	17.5
Sugar Beets	9	39.6		36.0
Tomatoes	1	38.4	24.0	27.5
Truck Crops	640	35.3		
Vineyards	10	37.2		

Table 3. C2VSim Crop Consumptive Use Fraction Estimates.

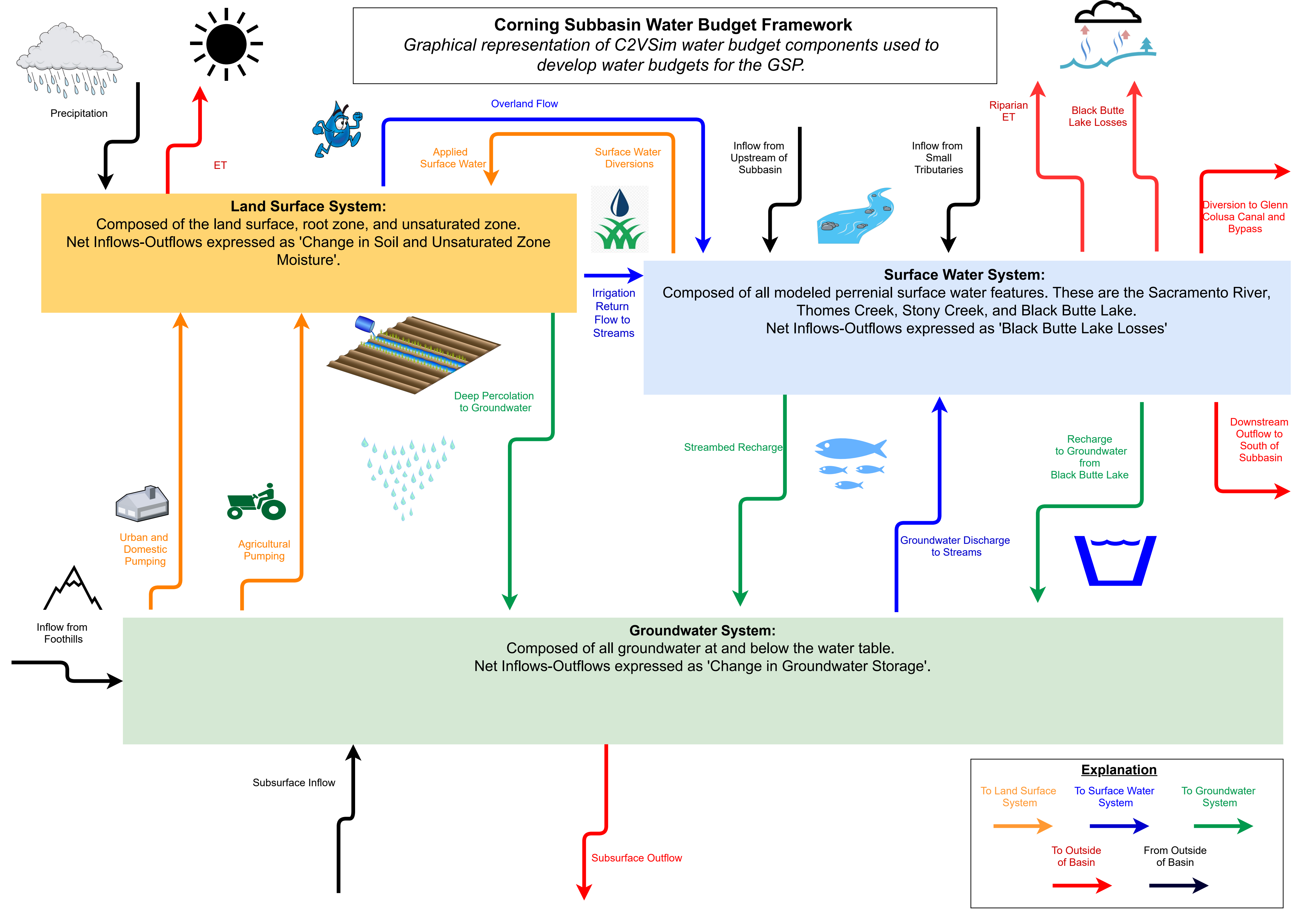
Name	Acres	CUF
Alfalfa	2,402	0.64
Almonds & Pistachios	9,148	0.67
Corn	1,317	0.61
Cotton	0	0.54
Dry Beans	237	0.61
Grain	3,173	
Idle	6,477	
Melons	246	0.61
Misc. Field Crops	288	0.63
Olives	16,882	0.67
Onions & Garlic	18	0.59
Other Deciduous	10,777	0.66
Pasture	11,577	0.69
Safflower	32	0.61
Sugar Beets	9	0.69
Tomatoes	1	0.59
Truck Crops	640	0.64
Vineyards	10	0.60

Based on review of applied water estimates and CUF values by crop, the following modifications were made to C2VSim for the Corning Subbasin:

- The irrigation period for grain was modified to allow for a single irrigation in the month of April, resulting in an average annual irrigation depth of approximately 5 inches.
- The Target Soil Moisture Fraction (TSMF) for pasture was modified to result in an average CUF of approximately 0.60.
- The Target Soil Moisture Fraction (TSMF) for almonds and pistachios and for olives was modified to result in an average CUF of approximately 0.80.

Appendix 4B

Interaction of Water Budget Components as Simulated by C2VSimFG V1.0


Corning Subbasin Water Budget Framework
Graphical representation of C2VSim water budget components used to develop water budgets for the GSP.
Precipitation
ET
Overland Flow
Applied Surface Water
Surface Water Diversions
Inflow from Upstream of Subbasin
Inflow from Small Tributaries
Riparian ET
Black Butte Lake Losses
Diversion to Glenn Colusa Canal and Bypass
Land Surface System:
Composed of the land surface, root zone, and unsaturated zone.
Net Inflows-Outflows expressed as 'Change in Soil and Unsaturated Zone Moisture'.
Irrigation Return Flow to Streams
Surface Water System:
Composed of all modeled perrenial surface water features. These are the Sacramento River, Thomes Creek, Stony Creek, and Black Butte Lake.
Net Inflows-Outflows expressed as 'Black Butte Lake Losses'
Deep Percolation to Groundwater
Streambed Recharge
Recharge to Groundwater from Black Butte Lake
Downstream Outflow to South of Subbasin
Groundwater Discharge to Streams
Urban and Domestic Pumping
Agricultural Pumping
Inflow from Foothills
Groundwater System:
Composed of all groundwater at and below the water table.
Net Inflows-Outflows expressed as 'Change in Groundwater Storage'.
Subsurface Inflow
Subsurface Outflow
Explanation
To Land Surface System
To Surface Water System
To Groundwater System
To Outside of Basin
From Outside of Basin

Appendix 4-C. Development of Projected Water Budgets with Climate Change

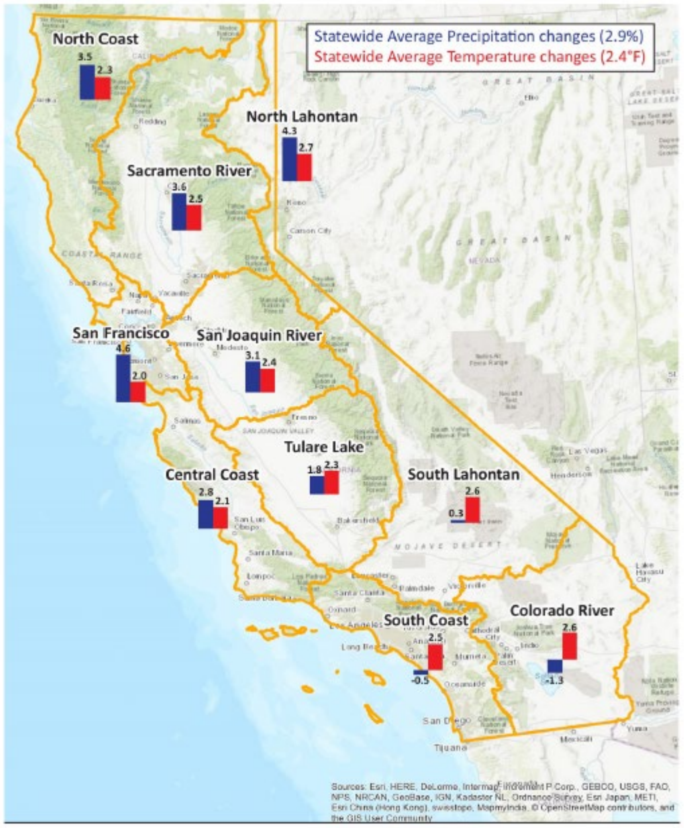
The following paragraphs describe how precipitation, evapotranspiration, stream inflow, and surface water diversions were adjusted for the 2030 and 2070 projected water budgets. All data are available from DWR and can be downloaded from the SGMA Data Viewer[1]. A complete description of these datasets and how they were developed by DWR can be found in the *Guidance for Climate Change Data Use During Sustainability Plan Development*[2].

Precipitation and Evapotranspiration: Precipitation and evapotranspiration model inputs were altered for projected scenarios using monthly change factors over a Variable Infiltration Capacity (VIC) grid developed by DWR utilizing data from multiple global circulation models (DWR, 2018). These data are available through 2011, allowing for direct adjustment of historical data from 1973 to 2011. For years 2012-2015, an average monthly change factor from 1973-2011 is calculated and used to adjust the historical data. In this way the general changes observed from 1973-2011 are applied where an associated VIC date is not available. The statewide trends in precipitation and temperature (associated with evapotranspiration [ET]) seen in this dataset are displayed on Figure 1 for the 2030 and 2070 scenarios. In both scenarios, precipitation and ET are projected to increase in the Northern Sacramento Valley, with the 2070 period displaying larger increases in precipitation and ET (Figure 1).

The influence of these change factors on precipitation and ET in the Corning Subbasin is displayed on Figure 2 and Figure 3 respectively, which show general increase in precipitation and ET on an annual basis. Figure 4 and Figure 5 display average monthly change factors for model subregion 2 containing the Corning Subbasin. Precipitation has increased seasonality in the projected data, with increased precipitation in the rainy season and decreased precipitation in the dry season. Due to year-round increases in temperature, ET is increased for all months.

[1] https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#waterbudget

[2] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Climate-Change-Guidance_Final_ay_19.pdf



Average Precipitation Change (%)

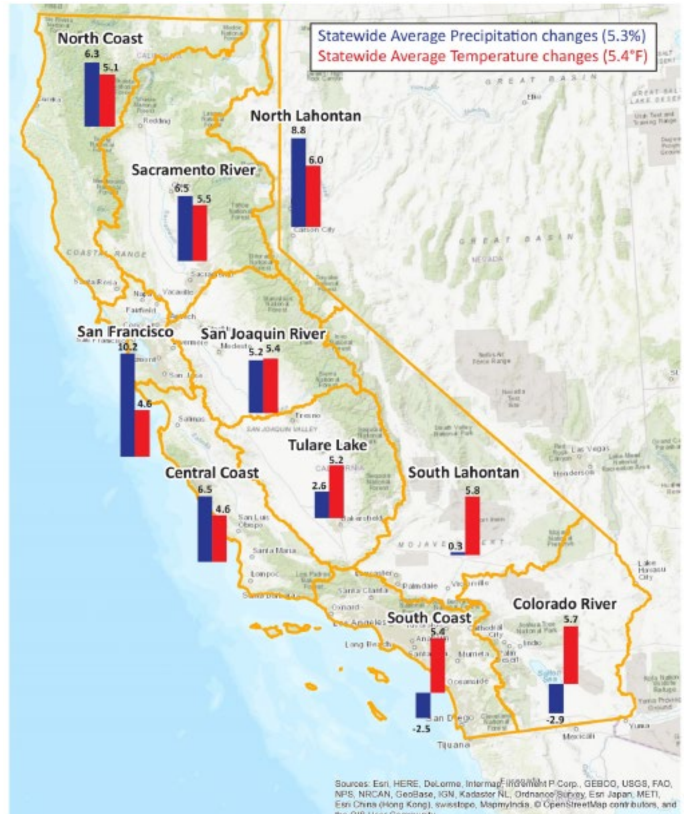
Average Temperature Change (°F)

Hydrologic Region

HTD: Historical Temperature Detrended

Reference: Water Storage and Investment Program Technical Reference, California Water Commission, 2016.

Figure A-13. Projected Changes in Climate Conditions for 2030
Source: California Water Commission, 2016



Average Precipitation Change (%)

Average Temperature Change (°F)

Hydrologic Region

HTD: Historical Temperature Detrended

Reference: Water Storage and Investment Program Technical Reference, California Water Commission, 2016.

Figure A-14. Projected Changes in Climate Conditions for 2070
Source: California Water Commission, 2016

Figure 1. Precipitation and ET Changes in The Sacramento Valley(DWR, 2018)

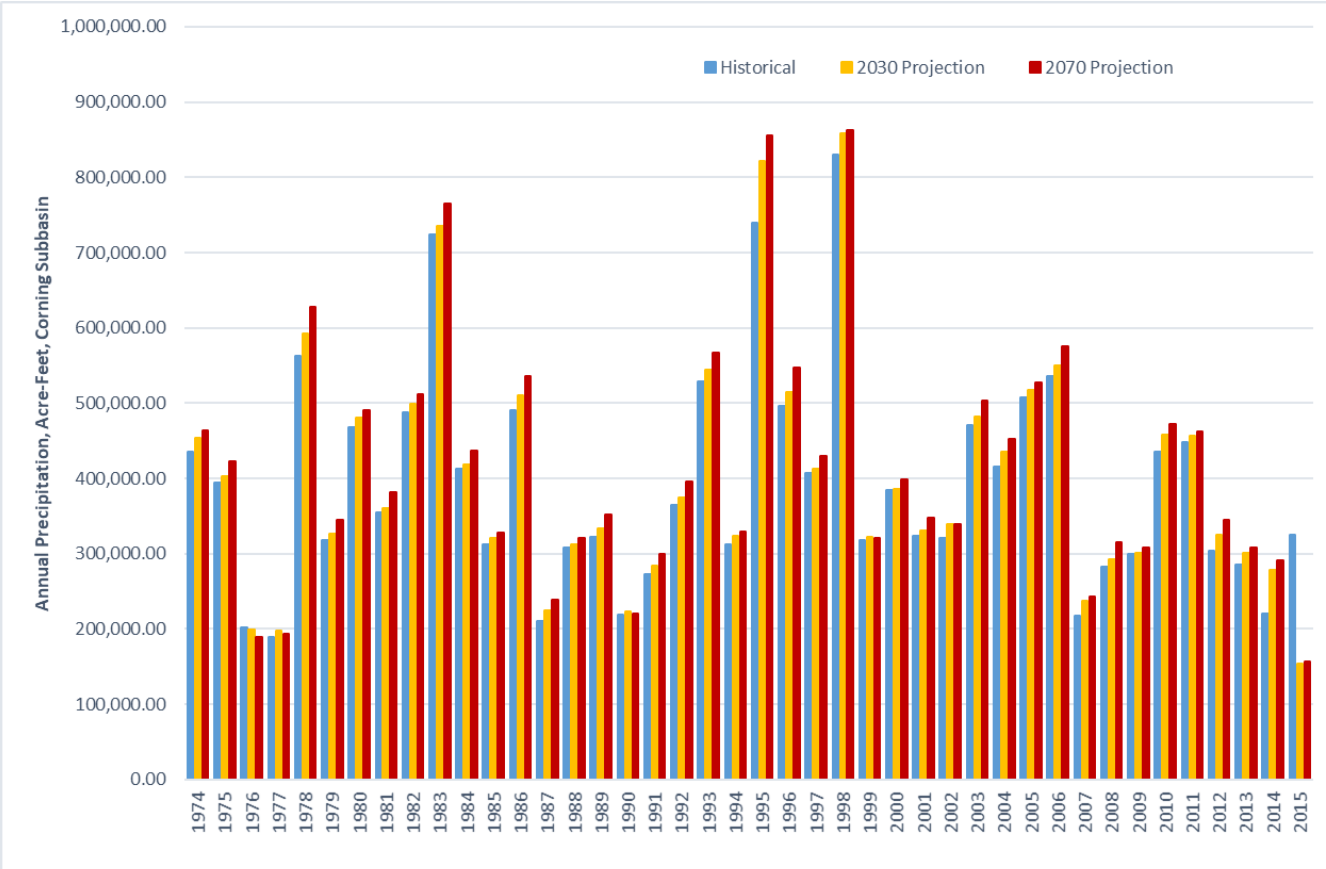


Figure 2. Corning Subbasin Precipitation in Current and Projected Scenarios

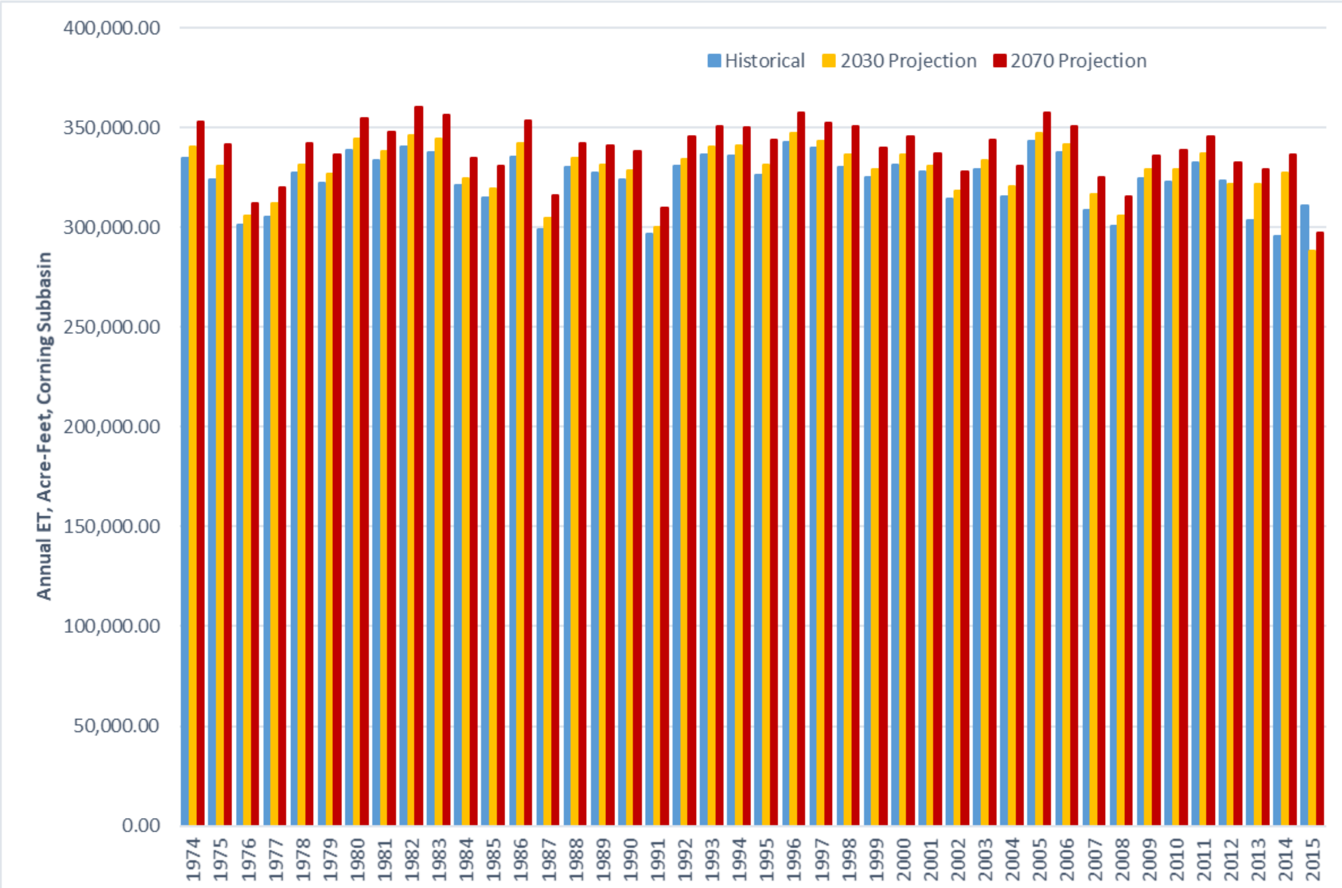


Figure 3. Corning Subbasin ET in Current and Projected Scenarios

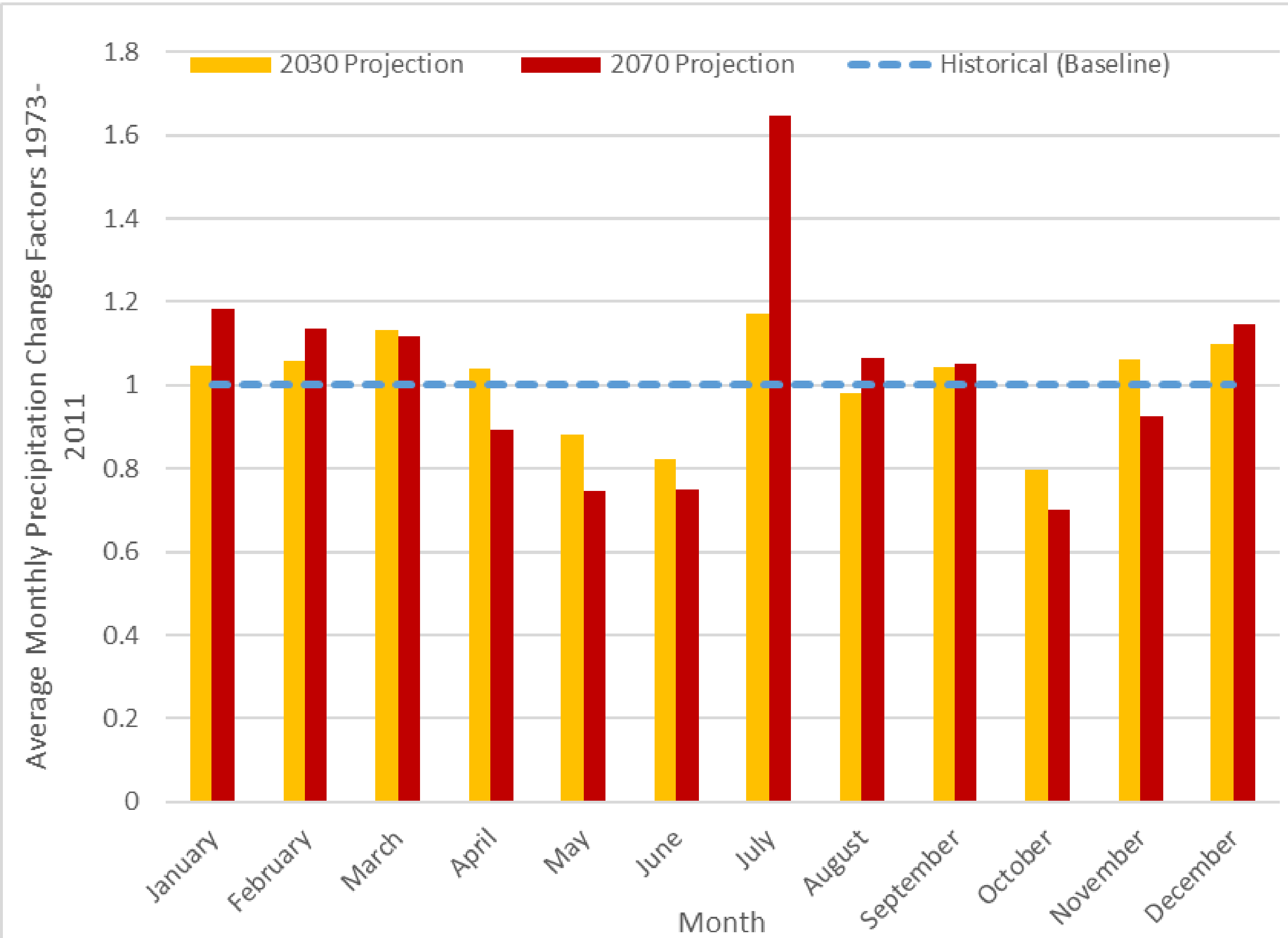


Figure 4. Corning Subbasin Average Monthly Precipitation Change Factors in Projected Scenarios

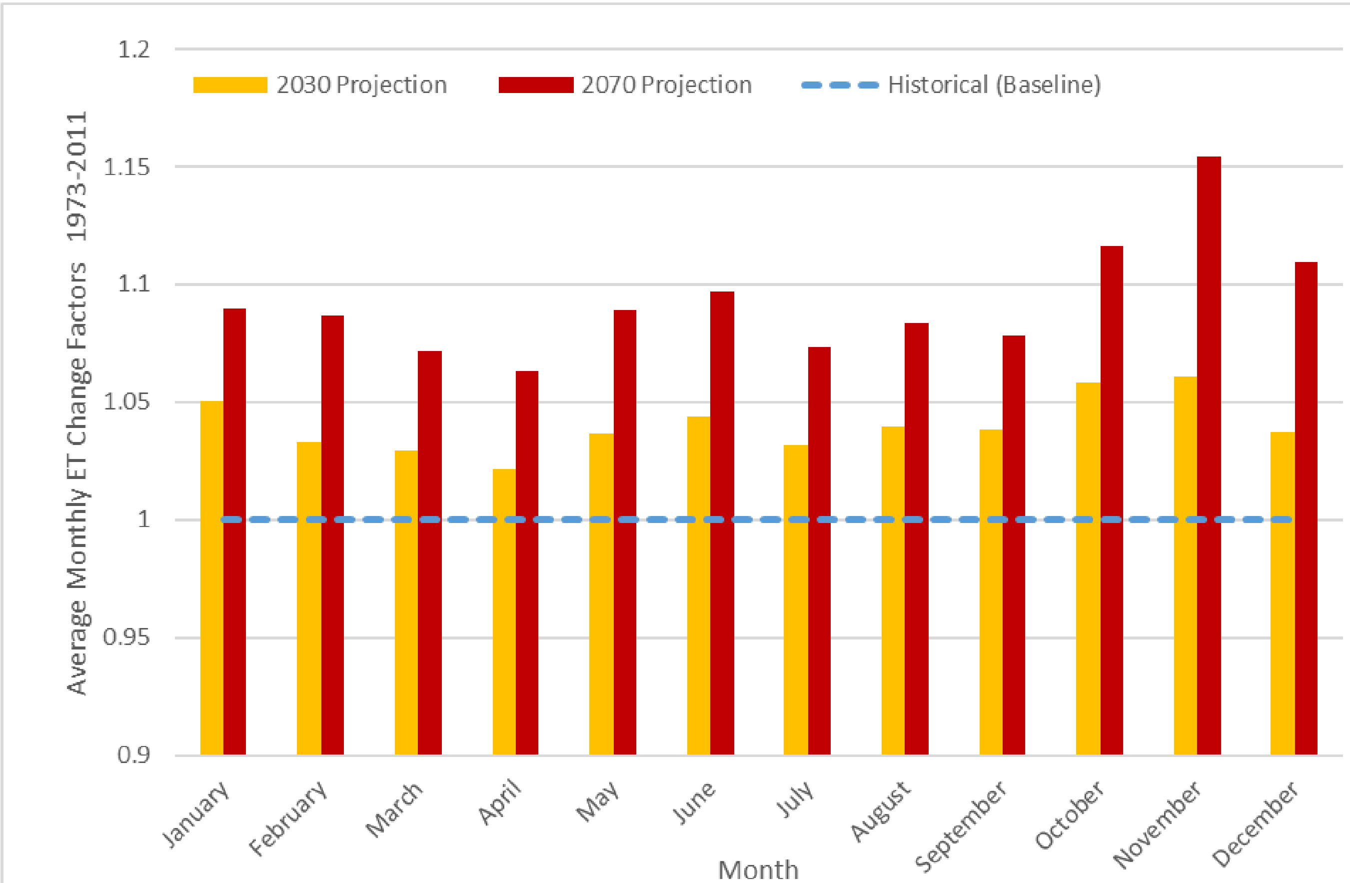


Figure 5. Corning Subbasin Average Monthly ET Change Factors in Projected Scenarios

Stream inflows: Stream inflows for the Sacramento River at Keswick Dam, Thomes Creek (close to the model boundary), and reservoir releases from Black Butte Dam to Stony Creek were replaced with streamflows projected by CalSim II for 2030 and 2070 conditions. Where an equivalent CalSim II date was not available, an average monthly change factor was used to adjust historical streamflow data. Average monthly HUC8 streamflow change factors were used for releases from Black Butte Lake to Stony Creek where a CalSim II date was not available, as the resulting flows were more reflective of expected variation.

Stream inflows for all other streams were adjusted using HUC8 streamflow monthly change factors. Where an applicable HUC8 streamflow date was not available, an average monthly change factor was used. Similar to the precipitation datasets, both CalSiM II output and HUC8 change factors predict increased streamflow in the wet season and decreased streamflow in the dry season.

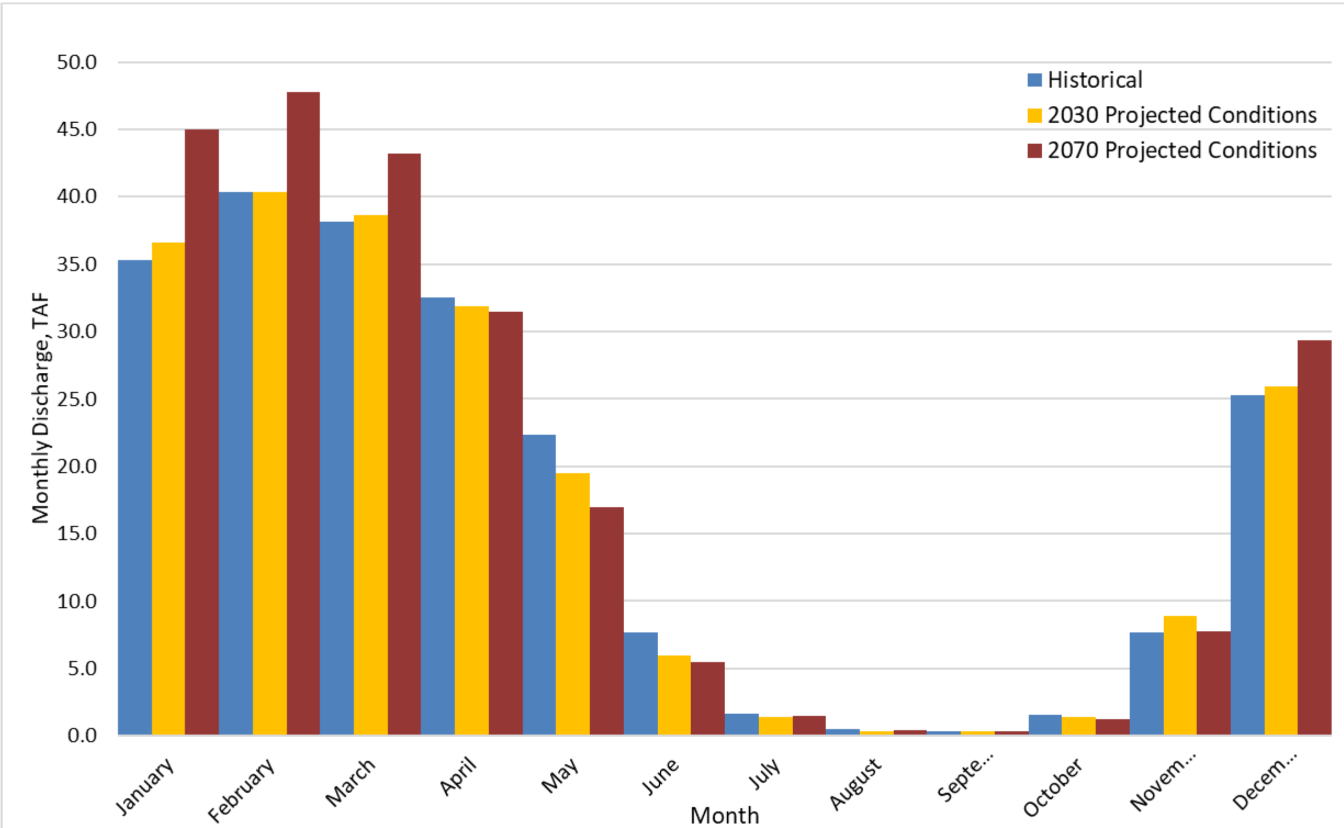


Figure 6. Thomes Creek Model Boundary Monthly Average Inflow in Historical and Projected Scenarios

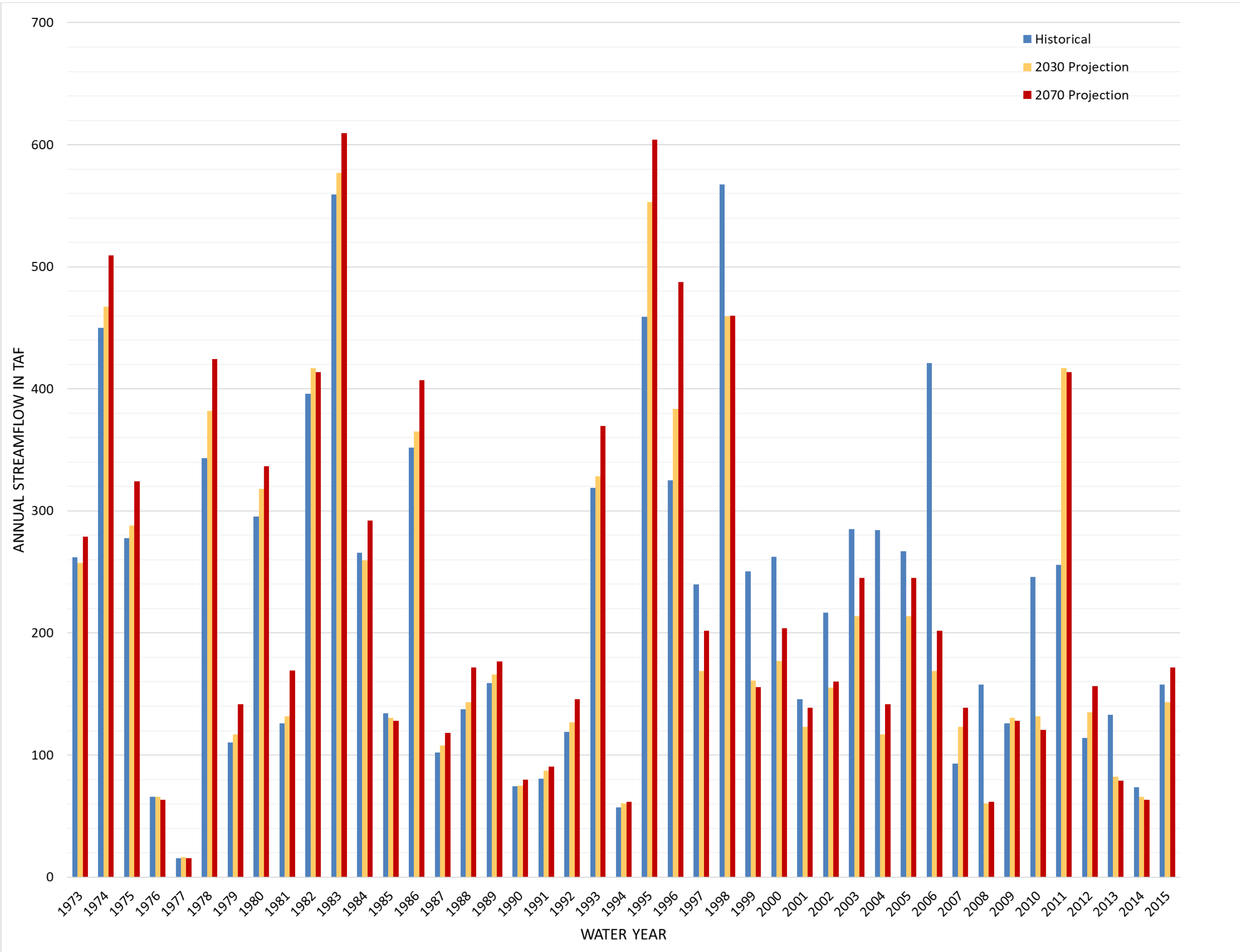


Figure 7. Thomes Creek Model Boundary Annual (WY) Inflow in Historical and Projected Scenarios

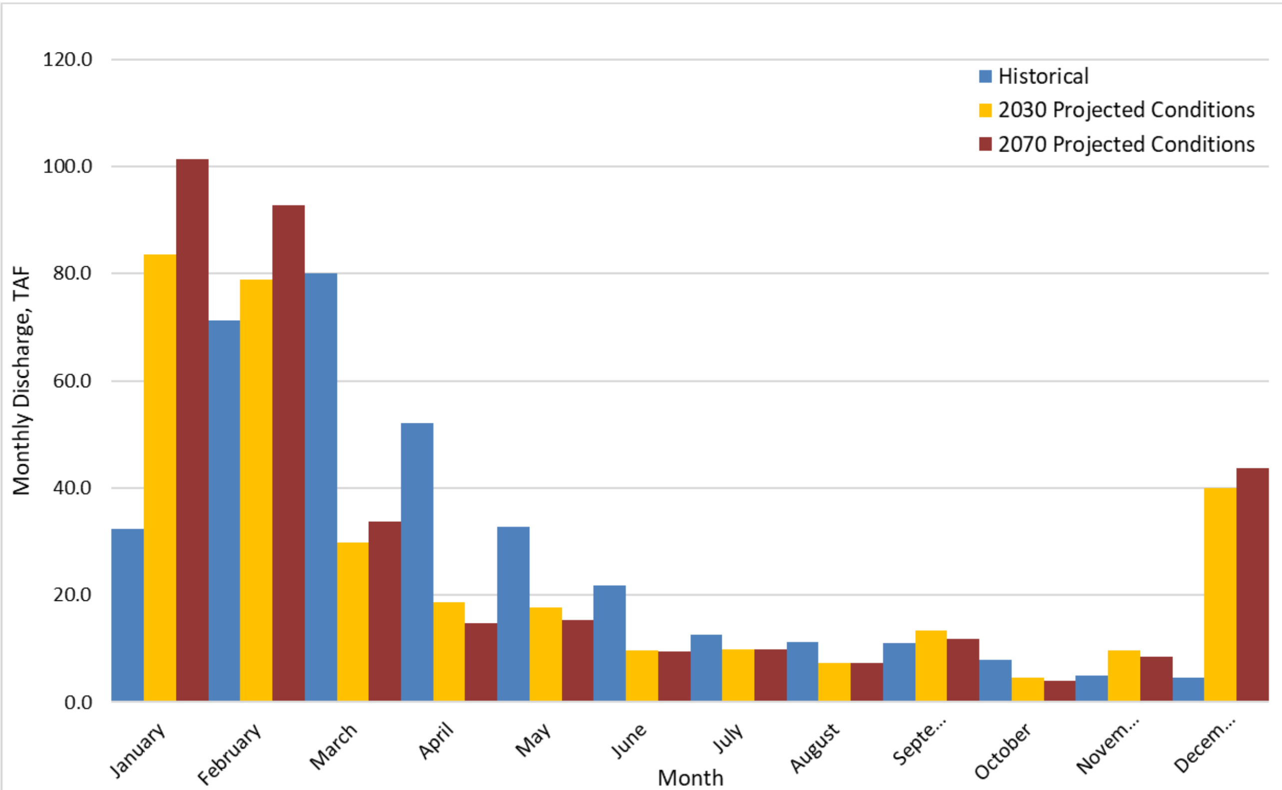


Figure 8. Stony Creek Release from Black Butte Lake Monthly Average Inflow in Historical and Projected Scenarios

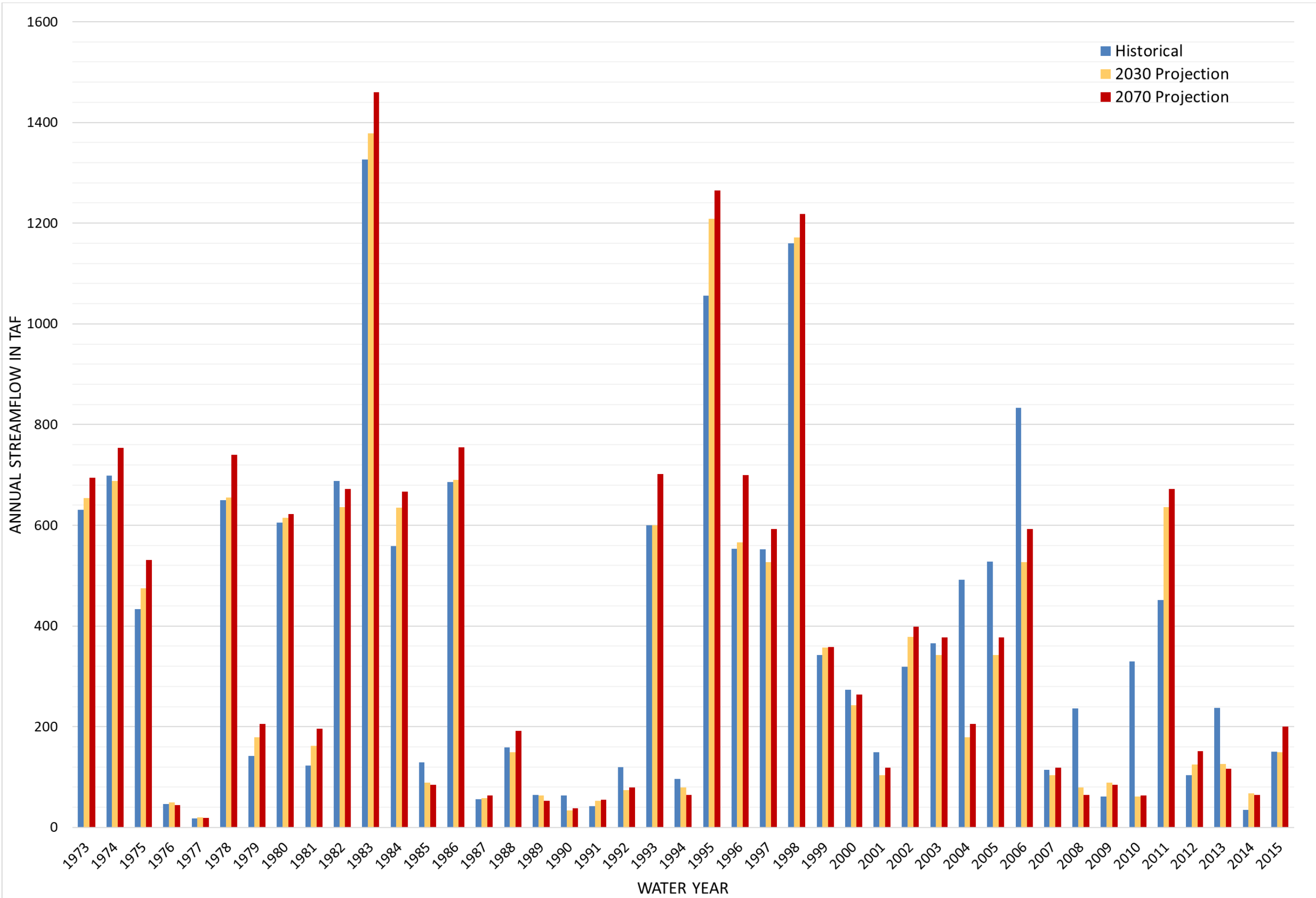


Figure 9. Stony Creek Release from Black Butte Lake Annual (WY) Inflow in Historical and Projected Scenarios

Diversions: All stream diversions (except for the Glenn-Colusa Canal diversions) were kept at 2015 values for the projected scenarios, for consistency with the current timeframe and to reflect the most recently available historical data in the model. Glenn-Colusa Canal diversions were adjusted using CalSim II output for the 2030 and 2070 conditions. Where an equivalent CalSim II date was not available, an average monthly change factor from 2000 onward was used.

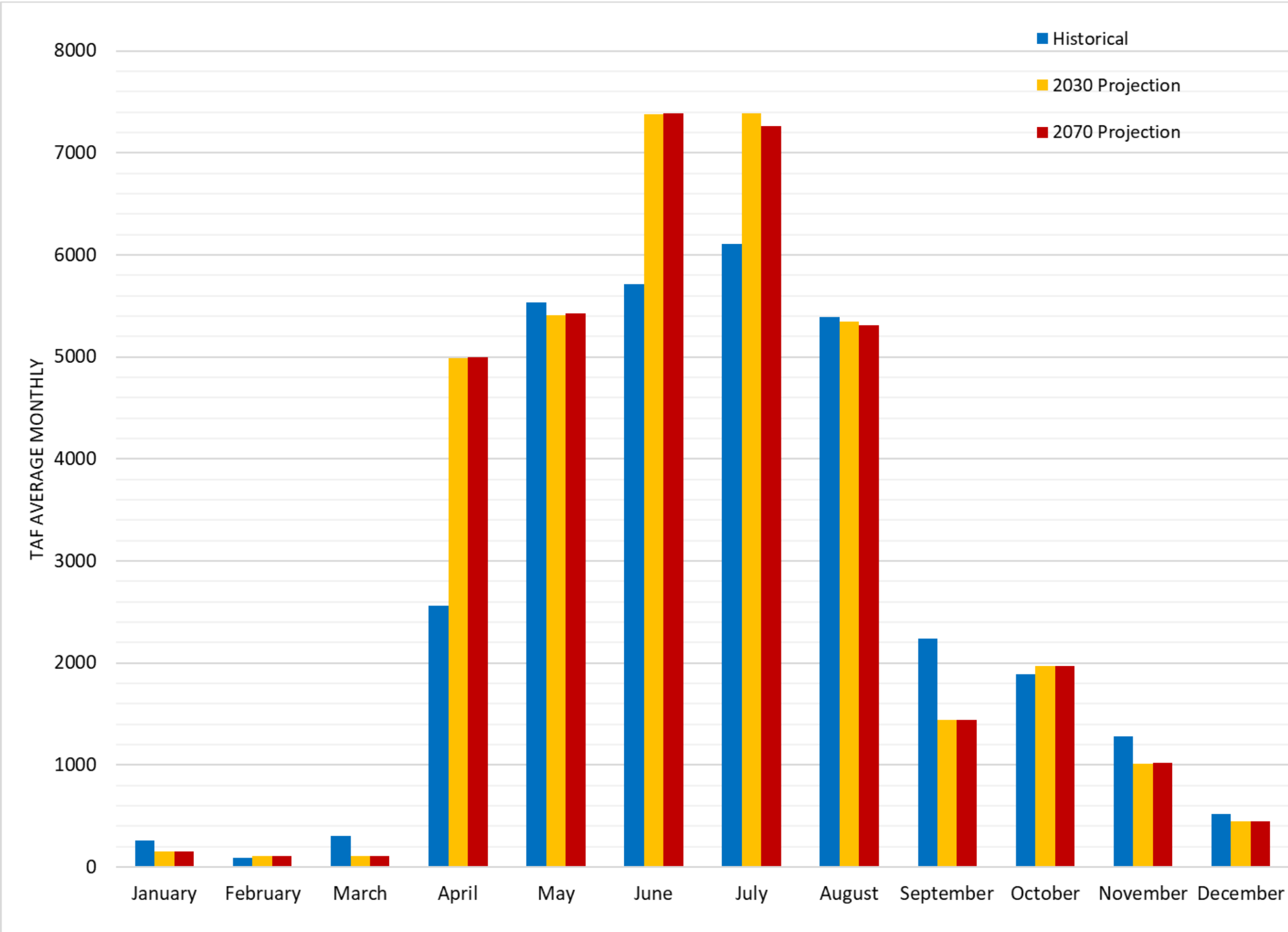


Figure 10. GCID Average Monthly Diversion in Historical and Projected Scenarios

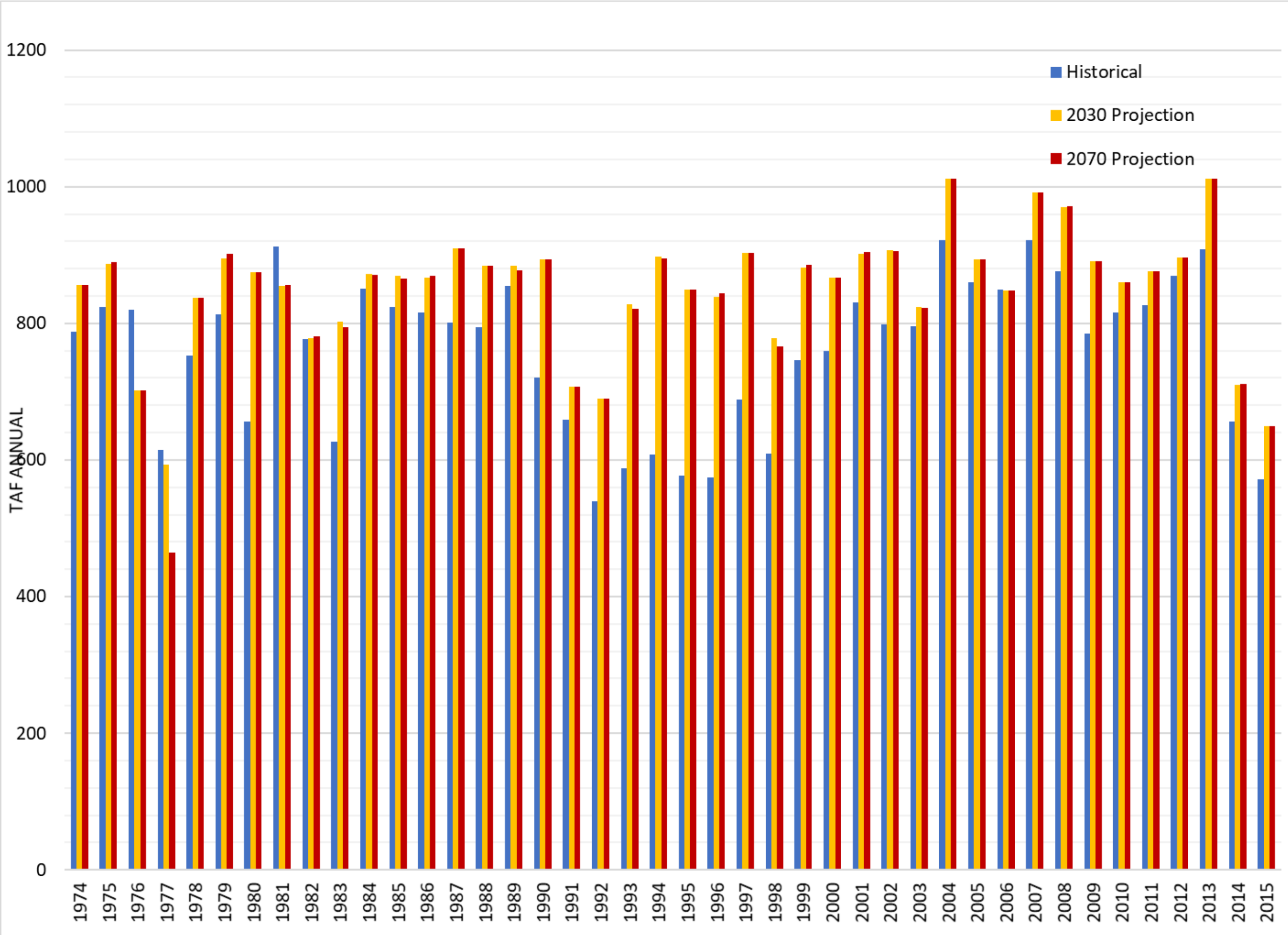


Figure 11. GCID Canal Annual (WY) Diversions in Historical and Projected Scenarios

Reference

California Department of Water Resources (DWR), 2018, Guidance Document for the Sustainable Management of Groundwater, Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development

Appendix 4D

Water Budget Tables

Appendix 4D. Water Budget Tables

The tables in this appendix contain annual water budget information for all water budgets presented in section 4 of the Corning GSP. All budget components are rounded to the nearest 100 acre-feet, which may result in some discrepancy between the inflows minus outflows and change in storage.

The water budget tables are organized as follows:

- Historical Period Water Budgets
- Current Period Water Budgets
- Projected 2030 Period Water Budgets
- Projected 2070 Period Water Budgets

Historical Period Water Budgets

Table 4D-1. Historical Groundwater Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Deep Percolation to Groundwater	161,200	52%	116,350	176,100	212,600
	Streambed Recharge	51,100	16%	46,400	56,150	53,500
	Inflow from Colusa	17,700	6%	16,650	18,550	18,600
	Inflow from Red Bluff	44,500	14%	43,950	45,550	44,500
	Inflow from Butte	1,500	<1%	1,350	1,400	1,800
	Inflow from Los Molinos	21,300	7%	21,200	22,000	20,800
	Inflow from Vina	10,700	3%	21,200	22,000	20,800
	Inflow from Foothills	1,500	<1%	1,100	1,650	1,900
	Recharge to Groundwater from Black Butte Lake	2,600	1%	2,100	2,750	3,000
Outflows	Urban and Domestic Pumping	3,600	1%	3,650	3,850	3,500
	Agricultural Pumping	132,300	43%	141,400	127,700	122,600
	Outflow to Colusa	32,200	11%	32,350	31,450	32,200
	Outflow to Red Bluff	12,300	4%	11,750	12,050	13,500
	Outflow to Butte	1,500	0%	1,550	1,600	1,300
	Outflow to Los Molinos	12,900	4%	11,800	12,200	14,600
	Outflow to Vina	26,200	9%	25,000	25,650	28,200
	Groundwater Discharge to Streams	84,200	28%	70,250	83,900	104,400
Storage	Annual Change of Groundwater in Storage	6,900	-	-38,350	35,850	47,300
	Cumulative Change of Groundwater in Storage from WY 1974 to WY 2015	290,300	-	-	-	-

* Percent contribution of component to average total inflow/outflow. Small discrepancies between inflow minus outflow and change in storage may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-2. Historical Annual Groundwater Budget

Water Year	Deep Percolation to Groundwater	Streambed Recharge	Inflow from Colusa	Inflow from Red Bluff	Inflow from Butte	Inflow from Los Molinos	Inflow from Vina	Inflow from Foothills	Recharge to Groundwater from Black Butte Lake	Urban and Domestic Pumping	Agricultural Pumping	Outflow to Colusa	Outflow to Red Bluff	Outflow to Butte	Outflow to Los Molinos	Outflow to Vina	Groundwater Discharge to Streams	Annual Change of Groundwater in Storage	% Error
1974	206,400	62,200	15,800	42,900	1,900	14,700	12,300	1,600	3,700	2,200	117,800	44,100	15,100	1,100	19,800	32,000	107,100	22,200	0.03%
1975	129,200	59,100	17,000	43,400	1,700	17,200	10,600	1,300	3,000	2,300	122,800	39,000	14,000	1,200	15,400	28,800	90,900	-32,100	0.07%
1976	61,600	44,600	14,800	43,400	1,500	17,900	9,400	700	1,800	2,400	130,000	32,800	12,300	1,300	14,100	28,400	68,800	-94,300	-0.05%
1977	50,700	26,700	10,700	42,400	1,400	18,000	10,500	600	600	2,400	149,700	34,500	10,300	1,400	12,900	23,400	57,100	-130,200	0.06%
1978	188,000	86,500	17,100	43,600	1,300	20,100	13,000	1,800	4,100	2,500	118,100	37,200	11,500	1,700	12,400	21,200	79,200	91,700	0.00%
1979	139,500	65,700	17,800	43,500	1,600	20,000	8,900	1,000	2,800	2,600	132,400	35,100	10,500	1,300	12,400	25,100	65,500	15,800	0.03%
1980	252,400	63,500	18,900	41,600	1,600	19,700	9,900	1,500	2,900	2,800	113,900	35,000	12,200	1,400	15,100	30,100	98,700	102,700	0.02%
1981	152,200	56,800	17,900	42,200	1,800	20,000	9,700	1,500	3,600	2,800	132,200	37,100	11,600	1,200	13,500	28,300	79,300	-400	0.03%
1982	264,400	63,100	18,300	39,400	1,800	20,000	11,200	1,800	3,300	2,900	105,500	35,300	13,800	1,300	16,400	28,900	108,500	110,700	0.00%
1983	292,600	56,100	20,100	39,600	2,000	20,500	11,100	2,500	3,700	3,000	100,100	29,500	16,200	1,200	17,500	28,200	131,200	121,200	0.02%
1984	155,400	53,300	19,000	42,800	2,300	21,000	13,700	1,600	3,000	3,100	142,400	35,100	14,700	900	14,800	27,400	102,500	-28,800	0.00%
1985	128,600	49,600	17,700	42,600	1,900	20,600	12,300	1,100	2,600	3,100	130,400	33,700	13,400	1,100	13,800	25,800	86,300	-30,500	-0.04%
1986	214,500	52,800	18,600	41,600	1,800	20,500	12,200	1,800	2,500	3,200	125,400	32,200	14,000	1,300	14,800	25,900	104,400	44,900	0.05%
1987	104,100	42,800	16,000	41,900	2,000	20,500	11,100	1,000	2,200	3,200	149,300	34,700	12,600	1,000	12,700	24,800	68,400	-65,300	0.08%
1988	128,100	53,200	16,200	42,200	1,600	20,800	11,200	1,000	2,100	3,300	142,700	33,200	12,000	1,400	12,200	23,700	69,000	-20,900	-0.07%
1989	132,600	56,200	13,800	42,000	1,500	20,800	11,400	900	3,300	3,400	129,000	36,900	11,800	1,400	12,000	21,700	66,500	-200	0.00%
1990	115,500	47,700	15,000	41,300	1,500	20,200	10,400	800	1,700	3,500	143,900	33,300	11,200	1,400	12,100	23,900	64,400	-39,600	0.00%
1991	110,000	41,100	12,900	42,000	1,500	20,700	11,600	800	2,600	3,600	147,900	36,900	9,900	1,300	11,100	21,000	61,100	-49,700	0.04%
1992	151,900	54,500	15,900	44,000	1,500	21,100	11,400	1,200	3,500	3,700	147,000	34,900	9,500	1,300	10,800	21,600	64,200	12,000	0.00%
1993	226,600	64,900	18,600	45,500	1,500	21,600	10,800	1,600	3,600	3,700	128,000	28,100	10,500	1,400	11,900	23,600	85,100	102,100	0.08%
1994	143,300	47,400	18,300	44,600	1,700	20,900	10,600	900	1,500	3,800	149,900	33,300	10,200	1,100	12,100	26,000	69,400	-16,600	0.00%
1995	276,200	60,800	18,800	44,300	1,500	21,500	10,600	2,000	3,400	3,800	131,400	31,200	11,700	1,600	13,600	27,700	105,100	112,900	0.02%
1996	181,800	52,800	18,100	48,000	1,800	22,700	10,200	1,800	3,200	3,900	147,600	31,100	11,400	1,200	11,800	26,800	90,100	16,400	0.03%
1997	178,700	49,800	17,600	48,200	1,700	22,400	10,400	1,500	1,700	3,900	152,600	32,900	11,300	1,200	12,200	28,000	92,100	-2,000	-0.06%
1998	274,100	54,200	21,400	48,400	1,700	22,500	12,000	2,700	3,300	3,900	116,900	25,000	13,300	1,400	14,200	27,500	114,900	123,100	0.02%
1999	150,800	45,700	17,900	49,300	2,100	23,400	11,400	1,500	2,900	3,900	141,200	32,100	12,700	900	12,400	23,900	93,200	-15,500	0.07%
2000	161,400	49,000	17,200	49,300	1,600	23,400	10,300	1,800	2,600	4,200	147,500	34,800	12,000	1,300	11,800	23,000	86,800	-5,000	0.06%
2001	134,900	46,300	17,300	48,700	1,500	22,700	10,000	1,500	2,100	4,400	144,000	33,200	11,700	1,300	11,200	23,500	76,100	-20,600	0.07%
2002	175,900	50,000	17,700	48,700	1,300	23,000	10,400	1,400	2,300	4,600	149,100	35,800	11,700	1,600	11,100	26,000	84,200	6,500	0.03%
2003	189,000	52,600	18,900	48,300	1,400	23,200	10,800	1,900	3,200	4,500	134,000	29,600	11,900	1,500	11,700	25,100	88,400	42,600	0.00%
2004	188,600	47,600	18,400	49,400	1,600	23,900	9,800	2,000	2,200	5,000	156,400	32,300	11,900	1,400	11,100	25,600	87,900	11,400	0.15%
2005	185,400	46,100	20,800	47,900	1,400	23,100	9,900	2,100	3,000	4,500	108,800	26,500	13,000	1,700	12,100	26,400	93,300	53,300	0.03%
2006	246,000	38,500	20,200	46,800	1,500	22,600	9,400	2,500	2,800	4,800	104,600	24,600	13,700	1,500	14,100	31,400	115,800	79,700	0.03%
2007	95,800	39,000	24,000	46,300	1,500	22,400	9,100	1,300	1,400	4,400	126,800	21,600	13,200	1,300	12,100	30,900	78,200	-48,200	0.21%
2008	120,000	45,100	21,500	45,000	900	22,600	9,300	1,300	2,000	4,600	136,200	26,100	12,900	2,100	11,100	28,000	74,800	-28,100	0.00%
2009	103,800	44,900	18,100	44,400	700	22,200	8,600	1,100	2,100	4,500	130,700	26,200	12,300	2,400	11,100	27,700	67,000	-36,300	0.12%
2010	167,400	53,600	19,100	44,900	900	22,700	9,800	1,800	2,600	4,500	114,800	29,400	12,700	2,200	11,600	26,800	80,300	40,300	0.06%
2011	193,200	47,000	19,300	43,600	1,300	22,100	9,400	1,700	2,400	4,500	85,200	27,200	13,700	1,800	13,300	30,000	101,300	62,700	0.09%
2012	111,400	40,600	18,900	42,700	1,100	21,800	9,400	1,400	1,800	3,900	117,900	27,100	13,600	1,800	12,400	28,000	83,200	-39,200	0.16%
2013	115,900	46,200	19,000	43,600	800	23,000	10,200	1,400	1,300	3,900	142,600	28,400	12,900	2,200	11,000	27,100	73,700	-40,600	0.08%
2014	70,300	35,300	14,600	43,100	700	21,600	11,100	1,100	1,800	3,900	152,700	27,800	11,800	2,400	10,700	21,700	60,100	-91,900	0.20%
2015	104,000	52,400	13,900	45,900	700	23,200	12,300	1,300	1,800	3,900	157,300	34,500	11,000	2,600	9,500	20,900	61,700	-45,900	0.00%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-3. Historical Land Surface Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Precipitation	391,800	65%	282,000	427,350	516,700
	Applied Groundwater	135,900	22%	144,900	131,550	126,100
	Applied Surface Water	79,000	13%	75,900	80,500	83,200
Outflows	Deep Percolation to Groundwater	157,000	26%	112,250	171,700	208,000
	Evapotranspiration	292,200	48%	280,850	297,750	303,000
	Overland Flow	136,000	22%	72,350	151,550	212,700
	Return Flow to Streams	19,900	3%	18,900	20,750	21,000
Storage	Change in Soil and Unsaturated Zone Storage	1,700	-	18,600	-2,200	-18,700

* Percent contribution of component to average total inflow/outflow. Small discrepancies between inflow minus outflow and change in storage may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF

Table 4D-4. Historical Annual Land Surface Budget

Water Year	Precipitation	Applied Groundwater	Applied Surface Water	Deep Percolation to Groundwater	Evapotranspirati on	Overland Flow	Return Flow to Streams	Change in Soil and Unsaturated Zone Storage	% Error
1974	435,200	120,100	105,700	201,800	299,900	134,000	26,100	-700	-0.02%
1975	394,600	125,100	105,500	124,500	290,600	132,600	25,200	52,400	-0.02%
1976	202,200	132,400	71,100	58,000	270,200	16,100	15,600	45,700	0.02%
1977	189,200	152,100	36,600	48,500	274,000	15,600	12,600	27,400	-0.05%
1978	562,200	120,600	83,300	183,300	296,800	249,600	17,000	19,500	-0.01%
1979	317,300	135,100	98,700	134,400	288,200	88,300	20,300	19,900	0.00%
1980	468,400	116,700	101,000	246,600	308,100	160,300	21,700	-50,500	-0.01%
1981	355,400	135,000	114,300	146,000	300,700	102,400	23,100	32,700	-0.03%
1982	487,100	108,400	96,200	258,500	309,200	150,100	23,200	-49,400	0.01%
1983	724,100	103,100	83,300	287,100	307,400	349,100	17,400	-50,300	-0.02%
1984	412,700	145,500	104,400	149,300	287,800	180,100	21,500	24,000	-0.02%
1985	312,500	133,500	95,900	122,800	282,800	82,300	19,900	34,200	-0.02%
1986	490,900	128,600	90,700	209,200	304,300	198,300	18,100	-19,700	0.00%
1987	210,900	152,500	93,700	99,300	267,200	46,200	17,700	26,900	-0.04%
1988	308,500	146,000	86,300	123,600	299,300	79,100	16,300	22,600	-0.02%
1989	321,900	132,300	87,100	128,100	296,500	69,200	22,800	24,700	0.00%
1990	219,500	147,400	69,300	112,000	292,000	32,100	14,300	-14,100	-0.02%
1991	272,000	151,500	69,800	106,500	264,800	86,100	15,000	20,900	0.00%
1992	365,200	150,700	65,700	148,600	296,300	118,800	14,800	3,100	0.00%
1993	528,000	131,700	71,700	222,600	310,900	214,200	15,500	-31,700	-0.01%
1994	312,700	153,600	78,100	139,400	311,400	67,700	16,100	9,700	0.02%
1995	739,400	135,300	67,200	272,500	307,400	406,500	16,100	-60,500	-0.01%
1996	495,600	151,400	81,800	177,500	322,100	197,000	21,800	10,600	-0.03%
1997	407,000	156,400	80,900	174,300	322,200	130,500	22,800	-5,200	-0.05%
1998	829,800	120,900	54,600	270,900	316,300	449,100	16,000	-47,000	0.00%
1999	317,300	145,200	84,200	146,200	302,300	70,300	21,700	6,300	-0.02%
2000	384,200	151,700	86,400	156,800	312,400	117,600	24,500	11,200	-0.03%
2001	324,000	148,400	83,900	130,400	302,700	84,500	24,100	14,900	-0.05%
2002	321,200	153,700	87,500	171,200	281,200	100,500	22,200	-12,600	-0.02%
2003	471,100	138,500	74,100	185,000	303,800	176,700	21,500	-3,300	0.00%
2004	414,900	161,400	81,100	184,400	288,000	172,400	24,000	-11,200	-0.03%
2005	507,400	113,300	67,400	181,600	312,600	171,000	24,200	-1,200	-0.01%
2006	535,100	109,400	56,900	242,700	284,300	226,800	17,400	-69,800	0.00%
2007	217,100	131,200	82,000	91,400	256,000	33,500	28,800	20,700	-0.02%
2008	281,900	140,800	83,400	115,600	246,400	103,900	28,300	11,900	0.00%
2009	299,900	135,200	66,400	100,100	281,000	78,700	18,200	23,500	0.00%
2010	435,600	119,300	67,400	163,700	287,200	151,800	20,000	-400	0.00%
2011	448,100	89,700	70,500	189,300	285,300	141,100	26,200	-33,600	0.00%
2012	303,400	121,800	74,300	107,200	289,100	73,400	18,400	11,400	0.00%
2013	285,700	143,400	74,400	111,700	268,700	83,600	20,200	19,300	0.00%
2014	220,700	156,700	39,700	68,000	264,200	46,100	12,100	26,700	0.00%
2015	324,800	161,300	46,100	101,500	279,200	125,400	13,300	12,800	0.00%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-5. Historical Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Subbasin	10,993,400	96%	7,512,500	10,570,850	16,276,700
	Inflow from Small Tributaries	67,600	1%	34,000	68,400	114,400
	Overland Flow	235,800	2%	123,650	258,400	374,800
	Irrigation Return Flows to Streams	30,800	<1%	30,900	31,100	30,800
	Groundwater Discharge to Stream	90,400	1%	71,550	89,550	117,800
Outflows	Streambed Recharge	53,500	0%	56,650	62,300	41,400
	Downstream Outflow South of Subbasin	10,380,600	91%	741,100	615,350	446,500
	Riparian ET	36,400	<1%	38,350	36,150	34,200
	Surface water diversions	78,900	1%	65,000	65,350	111,500
	Diversion to Glenn Colusa Canal and Bypass	787,100	7%	767,450	816,300	806,200
	Recharge to Groundwater from Black Butte Lake	17,800	<1%	17,150	18,150	18,500
	Black Butte Lake Losses	63,700	1%	56,550	64,400	72,500

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF

Table 4D-6. Historical Annual Surface Water Budget

Water Year	Inflow from Upstream of Subbasin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow South of Subbasin	Riparian ET	Surface water diversions	Diversion to Glenn Colusa Canal and Bypass	Recharge to Groundwater from Black Butte Lake	Black Butte Lake Losses	% Error
1974	20,319,300	96,600	250,300	30,600	112,300	46,500	19,523,800	36,100	79,700	1,028,800	19,300	75,100	0.00%
1975	12,440,800	62,300	223,500	29,800	84,300	54,800	11,746,400	37,300	80,000	823,600	18,200	80,400	0.00%
1976	8,312,000	12,100	27,200	25,700	68,900	68,200	7,439,900	40,100	44,000	819,300	16,400	18,100	0.00%
1977	5,335,000	6,500	22,200	25,600	63,800	44,900	4,711,800	35,900	39,800	614,500	13,800	-7,800	0.00%
1978	11,664,300	107,600	423,800	26,200	83,100	111,200	11,173,400	33,700	44,000	829,500	19,400	93,800	0.00%
1979	7,502,700	41,400	147,600	29,400	67,100	92,600	6,724,500	39,500	55,500	812,900	17,800	45,300	0.00%
1980	11,990,400	79,300	269,400	29,700	117,000	62,400	11,456,700	34,800	44,800	809,000	17,900	60,000	0.00%
1981	8,231,600	45,100	172,800	31,700	81,000	58,800	7,341,800	38,700	90,400	912,500	18,900	101,000	0.00%
1982	16,244,500	109,600	269,100	29,900	126,400	50,400	15,723,300	32,300	135,000	779,400	18,900	40,000	0.00%
1983	23,384,400	169,000	611,400	27,400	166,700	37,700	23,217,500	30,000	138,800	840,400	19,200	75,300	0.00%
1984	13,710,400	93,800	310,400	31,800	113,700	39,600	13,096,000	40,400	100,500	895,900	18,400	69,400	0.00%
1985	8,551,200	32,800	132,100	30,400	91,700	46,700	7,769,300	39,300	69,700	824,300	17,900	71,000	0.00%
1986	13,537,400	107,600	348,700	29,500	124,900	43,700	12,974,000	35,600	71,400	953,500	17,700	52,100	0.00%
1987	7,851,600	34,200	85,000	30,100	74,900	51,500	7,041,100	38,400	64,200	800,800	17,000	62,900	0.00%
1988	7,917,100	29,500	139,200	29,500	70,700	67,900	7,153,500	36,500	57,000	794,900	17,100	59,000	0.00%
1989	8,226,600	50,200	130,400	32,700	70,200	79,800	7,390,800	35,600	61,500	855,000	19,000	68,400	0.00%
1990	6,724,000	27,300	57,800	28,300	68,900	61,300	5,977,300	35,300	60,200	721,300	16,500	34,300	0.00%
1991	5,999,600	33,100	151,000	27,600	66,000	51,200	5,395,100	34,600	51,200	658,500	17,600	69,100	0.00%
1992	6,038,800	36,100	192,100	28,100	68,300	70,400	5,545,300	36,800	71,800	540,000	19,400	79,700	0.00%
1993	11,575,200	96,800	374,600	26,500	95,300	78,400	11,294,100	34,600	82,900	588,400	19,500	70,300	0.00%
1994	6,908,800	33,400	104,000	29,700	69,300	53,900	6,313,500	37,300	80,300	608,300	16,300	35,400	0.00%
1995	18,969,000	182,300	723,000	29,000	109,900	46,700	19,006,900	30,800	107,500	682,800	19,000	119,500	0.00%
1996	13,472,600	93,000	323,200	32,600	93,200	42,800	13,165,400	36,300	107,700	574,400	18,900	68,900	0.00%
1997	14,391,400	107,000	251,700	33,600	91,200	41,500	13,874,200	38,200	92,000	763,000	16,800	49,300	0.00%
1998	20,572,800	170,700	761,700	27,400	139,600	39,400	20,591,600	26,700	205,400	684,600	19,200	105,300	0.00%
1999	12,872,000	69,700	125,500	32,900	102,900	35,000	12,188,200	36,500	116,700	746,700	18,500	61,200	0.00%
2000	13,039,000	68,900	210,100	35,100	82,800	47,400	12,439,500	37,100	70,100	760,100	18,200	63,700	0.00%
2001	8,153,100	38,300	135,500	35,800	76,500	51,200	7,381,500	39,800	64,100	830,400	17,300	54,800	0.00%
2002	9,162,300	47,400	173,500	34,900	84,000	46,400	8,459,600	40,700	62,800	798,300	17,600	76,600	0.00%
2003	12,311,500	81,300	309,900	31,100	96,400	52,900	11,787,300	35,500	48,800	796,300	19,100	90,200	0.00%
2004	12,850,600	70,800	295,700	35,100	80,900	38,000	12,185,400	39,600	59,600	936,500	17,300	56,700	0.00%
2005	10,070,000	56,300	279,900	33,900	115,600	43,700	9,474,100	31,500	46,700	860,200	18,800	80,500	0.00%
2006	18,903,300	140,000	421,600	33,400	145,000	20,800	18,538,800	34,000	66,900	881,900	18,600	82,000	0.00%
2007	8,066,700	31,800	62,700	38,900	74,800	36,200	7,138,400	43,400	69,900	921,600	16,300	49,000	0.00%
2008	7,986,700	38,100	171,800	38,600	68,100	47,300	7,173,200	43,800	76,000	875,800	17,100	70,100	0.00%
2009	7,286,400	35,300	132,700	30,700	67,500	60,300	6,521,100	40,900	57,800	784,600	17,200	70,700	0.00%
2010	8,941,700	59,500	257,400	32,600	84,100	61,800	8,257,100	34,800	114,200	815,300	18,200	73,900	0.00%
2011	12,779,200	86,200	252,800	32,600	120,600	39,400	12,146,500	30,000	147,500	826,000	17,800	64,200	0.00%
2012	8,171,200	48,800	121,200	30,300	90,700	41,900	7,393,100	37,500	68,800	870,100	16,800	33,800	0.00%
2013	8,630,000	47,500	153,400	31,700	69,700	57,300	7,750,200	40,600	101,800	908,500	16,100	57,700	0.00%
2014	5,991,800	24,300	80,000	26,500	65,000	51,700	5,336,300	36,300	45,400	656,300	16,500	45,100	0.00%
2015	6,637,300	36,500	218,800	28,100	55,400	74,300	6,167,200	33,500	60,300	575,900	17,000	47,900	0.00%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-7. Sacramento River Historical Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Basin	10,538,700	97%	7,305,050	10,100,650	15,489,500
	Inflow from Small Tributaries	56,800	<1%	32,050	56,850	91,800
	Overland Flow	194,800	2%	102,750	213,200	309,300
	Irrigation Return Flows to Streams	25,400	<1%	25,650	25,950	24,700
	Groundwater Discharge to Stream	88,700	1%	71,200	89,150	113,000
Outflows	Streambed Recharge	7,300	<1%	13,600	2,550	1,500
	Downstream Outflow South of Subbasin	10,067,200	92%	6,707,900	9,625,850	15,183,700
	Riparian ET	21,200	<1%	23,350	20,150	19,000
	Agricultural Diversions	21,500	<1%	24,350	20,950	17,700
	Flow to Glenn Colusa Canal	759,200	7%	767,200	795,400	735,000
	Flow to Flood Bypass	28,000	<1%	250	20,900	71,200

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF

Table 4D-8. Historical Annual Sacramento River Budget

Water Year	Inflow from Upstream of Basin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow South of Subbasin	Riparian ET	Agricultural Diversions	Flow to Glenn Colusa Canal	Flow to Flood Bypass	% Error
1974	19,522,200	80,700	209,800	22,200	103,400	3,300	18,871,600	20,100	14,400	788,100	240,700	0.03%
1975	11,900,000	48,000	180,700	22,600	84,300	6,400	11,372,500	20,700	12,300	823,600	0	0.11%
1976	8,205,600	12,100	23,200	20,800	68,900	28,700	7,433,600	23,700	25,300	819,300	0	0.69%
1977	5,306,500	6,500	18,300	20,600	63,800	33,500	4,710,600	25,300	31,700	614,500	0	1.23%
1978	10,913,200	79,600	343,400	20,800	83,100	0	10,573,200	19,100	18,200	752,800	76,700	0.00%
1979	7,279,000	38,400	121,500	23,000	67,100	10,900	6,661,300	22,700	21,100	812,900	0	0.29%
1980	11,301,300	63,700	219,800	23,500	117,000	0	10,877,400	19,500	19,500	655,600	153,300	0.00%
1981	7,982,300	37,000	140,300	25,400	81,000	1,000	7,301,000	22,600	28,800	912,500	0	0.03%
1982	15,479,300	95,000	225,900	22,600	126,400	0	15,138,100	17,800	13,900	776,700	2,700	0.00%
1983	22,028,200	123,300	499,000	19,700	145,900	0	21,953,100	16,200	6,400	627,000	213,300	0.00%
1984	13,087,300	78,500	255,100	25,000	113,700	2,400	12,624,600	23,100	13,500	851,200	44,700	0.04%
1985	8,321,900	32,500	108,500	24,100	91,700	2,800	7,706,000	22,800	22,900	824,300	0	0.06%
1986	12,801,900	84,600	286,700	22,900	124,900	0	12,326,100	20,100	21,100	815,500	138,000	0.00%
1987	7,694,700	34,200	73,600	24,400	74,900	15,000	7,034,400	24,900	26,600	800,800	0	0.38%
1988	7,662,700	28,600	114,000	23,900	70,700	13,500	7,043,600	24,200	23,600	794,900	0	0.34%
1989	8,046,000	48,000	111,900	25,500	70,200	16,100	7,383,600	21,500	25,300	855,000	0	0.39%
1990	6,582,700	27,300	48,800	22,700	68,900	9,900	5,969,200	23,300	26,700	721,300	0	0.29%
1991	5,859,800	32,000	125,100	22,900	66,000	15,800	5,387,900	23,100	20,600	658,500	0	0.51%
1992	5,814,000	28,900	156,800	23,500	68,300	8,300	5,496,000	22,900	24,200	540,000	0	0.27%
1993	10,889,400	79,700	309,000	23,300	95,300	0	10,770,200	19,100	18,700	588,400	0	0.00%
1994	6,747,400	32,800	87,500	24,500	69,300	9,900	6,299,100	22,500	21,700	608,300	0	0.28%
1995	17,850,200	139,200	590,900	23,600	109,900	2,300	17,993,300	17,000	18,500	577,400	105,300	0.02%
1996	12,838,200	79,900	271,300	27,200	93,200	100	12,695,500	20,300	19,400	574,400	0	0.00%
1997	13,775,000	95,700	211,600	27,900	91,200	5,100	13,385,600	21,200	26,500	689,000	74,000	0.07%
1998	19,385,200	116,400	615,500	23,700	130,900	0	19,551,000	14,500	21,500	609,900	74,700	0.00%
1999	12,437,800	63,300	104,600	26,800	102,700	600	11,941,400	20,300	26,300	746,700	0	0.01%
2000	12,681,600	60,700	173,400	28,800	82,500	4,400	12,210,300	20,600	31,600	760,100	0	0.07%
2001	7,917,700	33,200	111,200	29,300	76,200	5,400	7,285,300	21,900	24,600	830,400	0	0.13%
2002	8,730,700	43,800	145,700	29,100	83,800	1,100	8,187,400	22,900	23,300	798,300	0	0.03%
2003	11,830,200	70,600	256,800	27,400	96,100	1,000	11,443,900	19,600	20,300	796,300	0	0.02%
2004	12,309,400	57,200	244,800	29,700	80,400	2,100	11,737,700	22,700	22,400	922,500	14,000	0.03%
2005	9,442,800	44,200	229,700	26,800	115,200	0	8,962,300	17,200	18,800	860,200	0	0.00%
2006	18,013,400	115,400	354,200	28,900	122,300	0	17,713,000	19,100	20,100	849,900	32,000	0.00%
2007	7,863,800	31,800	54,100	33,400	74,200	9,800	7,079,100	23,900	22,900	921,600	0	0.24%
2008	7,648,600	36,400	140,900	32,800	67,300	11,100	6,991,900	24,600	22,500	875,800	0	0.28%
2009	7,114,900	35,300	111,400	27,600	66,600	17,700	6,506,800	22,700	23,900	784,600	0	0.48%
2010	8,510,700	48,300	213,200	28,600	83,500	900	8,030,200	18,800	19,000	815,300	0	0.02%
2011	12,244,800	73,400	215,000	28,000	119,700	0	11,822,900	16,100	15,800	826,000	0	0.00%
2012	8,000,800	45,400	104,700	26,100	89,400	3,100	7,352,600	20,200	20,300	870,100	0	0.08%
2013	8,303,400	45,700	128,800	26,700	68,500	16,100	7,602,900	23,200	22,300	908,500	0	0.38%
2014	5,881,800	24,300	65,600	23,800	63,400	23,100	5,333,000	24,000	22,500	656,300	0	0.76%
2015	6,418,900	32,900	180,000	24,900	54,400	24,200	6,064,400	23,400	23,200	571,200	4,700	0.72%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-9. Stony Creek and Black Butte Lake Historical Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Basin	450,000	94%	189,750	463,900	801,600
	Inflow from Small Tributaries	2,800	1%	300	2,950	6,100
	Overland Flow	21,500	4%	11,950	24,100	32,800
	Irrigation Return Flows to Streams	4,400	1%	4,150	4,200	5,000
	Groundwater Discharge to Stream	1,700	<1%	350	400	4,800
Outflows	Streambed Recharge	19,200	4%	19,550	29,400	10,600
	Downstream Outflow to Sacramento River	313,400	65%	63,500	329,600	646,500
	Riparian ET	10,500	2%	10,250	11,200	10,600
	Surface Water Diversions	55,900	12%	39,650	42,700	91,700
	Recharge to Groundwater from Black Butte Lake	17,800	4%	17,150	18,150	18,500
	Black Butte Lake Losses	63,700	14%	56,550	64,400	72,500

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF

Table 4D-10. Historical Annual Stony Creek and Black Butte Lake Budget

Water Year	Inflow from Upstream of Basin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow to Sacramento River	Riparian ET	Surface Water Diversions	Recharge to Groundwater from Black Butte Lake	Black Butte Lake Losses	% Error
1974	799,000	3,700	21,100	7,100	8,900	19,400	652,200	11,000	62,900	19,300	75,100	-0.01%
1975	539,600	3,400	21,600	6,200	0	21,300	373,900	11,300	65,700	18,200	80,400	0.00%
1976	82,400	0	3,200	3,700	0	19,500	6,300	11,100	17,900	16,400	18,100	0.00%
1977	21,900	0	3,200	3,800	0	7,000	1,200	6,700	7,900	13,800	-7,800	0.35%
1978	766,200	7,700	38,900	4,400	0	70,600	600,200	10,000	23,300	19,400	93,800	-0.01%
1979	210,900	500	15,300	5,300	0	59,700	63,200	12,300	33,700	17,800	45,300	0.00%
1980	684,600	4,500	26,300	4,900	0	28,800	579,300	10,700	23,600	17,900	60,000	0.00%
1981	245,000	1,800	17,700	4,800	0	35,500	40,800	11,900	61,100	18,900	101,000	0.04%
1982	758,500	3,900	23,700	5,800	0	19,100	585,200	9,800	118,800	18,900	40,000	0.01%
1983	1,412,700	12,900	54,000	6,100	20,700	10,400	1,264,400	9,100	128,200	19,200	75,300	-0.01%
1984	633,700	4,200	29,000	5,200	0	15,000	471,300	12,300	85,800	18,400	69,400	-0.01%
1985	210,600	0	13,900	4,700	0	19,300	63,400	11,800	45,900	17,900	71,000	-0.04%
1986	750,200	6,100	30,300	5,300	0	14,500	647,900	10,900	48,800	17,700	52,100	0.00%
1987	137,700	0	7,500	4,500	0	17,400	6,700	8,900	37,100	17,000	62,900	-0.20%
1988	237,100	0	13,500	4,300	0	28,000	109,800	8,200	32,800	17,100	59,000	0.00%
1989	156,500	0	10,700	5,500	0	33,300	7,200	9,800	35,100	19,000	68,400	-0.06%
1990	115,100	0	5,700	4,600	0	26,700	8,100	7,500	32,400	16,500	34,300	-0.08%
1991	130,600	0	14,200	3,900	0	17,200	7,200	7,600	30,100	17,600	69,100	-0.07%
1992	217,500	1,800	19,100	3,800	0	37,500	49,300	9,500	46,900	19,400	79,700	-0.04%
1993	684,800	4,900	34,600	2,300	0	40,500	523,900	10,600	61,700	19,500	70,300	0.01%
1994	146,300	0	9,600	4,500	0	24,700	14,400	11,300	58,300	16,300	35,400	0.00%
1995	1,175,100	12,200	62,800	4,500	0	6,300	1,013,600	9,600	86,600	19,000	119,500	0.00%
1996	631,600	3,100	26,800	4,500	0	10,200	469,900	11,400	86,700	18,900	68,900	0.00%
1997	609,600	2,300	21,000	4,900	0	6,300	488,600	12,200	64,400	16,800	49,300	0.03%
1998	1,258,800	16,100	70,500	2,900	8,700	2,300	1,040,600	8,500	181,100	19,200	105,300	0.00%
1999	415,600	1,400	10,700	4,900	200	6,200	246,800	11,500	88,600	18,500	61,200	0.00%
2000	348,300	1,600	19,000	5,400	300	14,800	229,200	11,700	37,100	18,200	63,700	-0.03%
2001	217,000	1,000	13,900	5,500	300	18,800	96,300	12,400	38,100	17,300	54,800	0.00%
2002	410,000	700	16,100	4,800	300	13,900	272,200	12,900	38,500	17,600	76,600	0.05%
2003	478,700	2,300	27,300	2,900	300	20,700	343,300	11,200	26,900	19,100	90,200	0.02%
2004	543,900	3,700	26,400	4,400	500	8,800	447,700	12,100	36,300	17,300	56,700	0.00%
2005	621,300	3,400	27,800	6,200	400	12,500	511,800	10,000	25,500	18,800	80,500	0.00%
2006	914,400	6,900	34,200	3,700	22,600	0	825,800	10,500	45,000	18,600	82,000	-0.01%
2007	174,400	0	5,600	4,600	600	1,900	59,300	13,200	45,500	16,300	49,000	0.00%
2008	320,100	200	17,800	4,900	800	10,700	181,300	13,600	51,000	17,100	70,100	0.00%
2009	144,900	0	12,800	2,200	1,000	14,500	14,300	12,300	32,000	17,200	70,700	-0.06%
2010	420,100	2,600	24,700	3,100	600	27,500	226,900	10,900	93,800	18,200	73,900	-0.02%
2011	522,200	2,700	21,100	3,800	900	6,500	323,600	9,600	129,100	17,800	64,200	-0.02%
2012	147,200	200	10,400	3,300	1,400	14,000	40,500	11,700	45,700	16,800	33,800	0.00%
2013	304,900	300	13,600	4,100	1,300	13,800	147,300	11,900	77,400	16,100	57,700	0.00%
2014	90,600	0	8,100	1,800	1,600	8,700	3,300	6,300	22,400	16,500	45,100	-0.20%
2015	210,600	100	20,500	2,300	1,000	23,800	102,800	6,000	37,100	17,000	47,900	-0.04%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-11. Thomes Creek Historical Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Basin	226,700	89%	115,600	242,000	370,800
	Inflow from Small Tributaries	8,000	3%	1,600	8,600	16,600
	Overland Flow	19,500	8%	8,950	21,050	32,700
	Irrigation Return Flows to Streams	1,100	<1%	1,100	1,000	1,100
	Groundwater Discharge to Stream	0	0%	0	0	0
Outflows	Streambed Recharge	27,000	11%	23,500	30,350	29,300
	Downstream Outflow to Sacramento River	222,000	87%	97,900	235,750	385,200
	Riparian ET	4,700	2%	4,800	4,850	4,600
	Surface water diversions	1,500	1%	950	1,750	2,100

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF

Table 4D-12. Historical Annual Thomes Creek Budget

Water Year	Inflow from Upstream of Basin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow to Sacramento River	Riparian ET	Surface water diversions	% Error
1974	450,000	12,300	19,400	1,400	0	23,800	452,000	5,000	2,400	-0.02%
1975	277,700	10,900	21,300	1,000	0	27,000	276,600	5,200	1,900	0.06%
1976	65,900	0	800	1,300	0	20,000	41,800	5,300	800	0.15%
1977	15,600	0	800	1,200	0	4,400	9,000	3,900	200	0.57%
1978	343,400	20,200	41,500	1,000	0	40,600	358,500	4,600	2,500	-0.02%
1979	110,100	2,500	10,800	1,200	0	22,100	97,300	4,400	800	0.00%
1980	295,400	11,000	23,300	1,300	0	33,600	290,900	4,700	1,800	0.00%
1981	125,900	6,400	14,800	1,400	0	22,300	121,600	4,200	500	-0.07%
1982	395,800	10,700	19,400	1,500	0	31,300	389,200	4,600	2,300	0.00%
1983	559,300	32,800	58,300	1,600	0	27,300	615,900	4,700	4,200	-0.02%
1984	265,900	11,100	26,200	1,600	0	22,200	276,400	5,100	1,100	0.00%
1985	134,400	300	9,600	1,700	0	24,600	115,600	4,700	1,000	0.07%
1986	352,100	16,900	31,700	1,300	0	29,200	366,700	4,600	1,400	0.02%
1987	102,100	0	4,000	1,200	0	19,100	82,900	4,600	500	0.19%
1988	137,700	900	11,700	1,300	0	26,400	120,500	4,200	600	-0.07%
1989	158,900	2,200	7,800	1,700	0	30,300	134,800	4,300	1,200	0.00%
1990	74,500	0	3,400	900	0	24,800	48,300	4,600	1,200	-0.13%
1991	80,600	1,000	11,700	800	0	18,300	71,400	3,900	500	0.00%
1992	119,200	5,300	16,200	800	0	24,600	111,900	4,300	700	0.00%
1993	318,700	12,300	31,000	900	0	38,000	317,600	4,800	2,500	0.00%
1994	57,000	600	7,000	700	0	19,400	42,000	3,600	300	0.00%
1995	459,000	30,900	69,300	900	0	38,200	515,400	4,100	2,500	-0.02%
1996	325,100	10,000	25,000	900	0	32,500	322,400	4,600	1,600	-0.03%
1997	239,700	9,000	19,200	800	0	30,100	232,900	4,700	1,000	0.00%
1998	567,600	38,200	75,600	800	0	37,000	638,800	3,700	2,800	-0.01%
1999	250,500	5,000	10,200	1,200	0	28,300	231,900	4,700	1,900	0.04%
2000	262,500	6,600	17,800	800	0	28,100	253,400	4,800	1,400	0.00%
2001	145,800	4,100	10,400	1,000	0	27,000	127,400	5,500	1,400	0.00%
2002	216,800	2,900	11,800	1,000	0	31,400	195,100	4,900	1,000	0.04%
2003	285,100	8,400	25,800	800	0	31,200	282,500	4,700	1,600	0.03%
2004	284,200	9,900	24,500	1,000	0	27,200	286,800	4,800	900	-0.03%
2005	267,100	8,700	22,400	900	0	31,200	261,200	4,400	2,400	-0.03%
2006	421,100	17,700	33,100	800	0	20,800	445,700	4,400	1,800	0.00%
2007	92,900	0	3,000	900	0	24,500	64,400	6,300	1,600	0.00%
2008	157,600	1,500	13,000	900	0	25,500	139,600	5,500	2,400	0.00%
2009	125,800	0	8,400	900	0	28,100	99,200	5,900	1,800	0.07%
2010	245,900	8,600	19,500	900	0	33,500	235,000	5,000	1,500	-0.04%
2011	256,000	10,100	16,700	800	0	32,900	243,800	4,300	2,600	0.00%
2012	114,000	3,200	6,000	900	0	24,900	90,800	5,600	2,800	0.00%
2013	133,100	1,500	11,000	900	0	27,400	111,400	5,500	2,200	0.00%
2014	73,500	0	6,300	900	0	19,900	54,100	6,000	600	0.12%
2015	157,600	3,400	18,300	800	0	26,200	149,900	4,100	0	-0.06%

* All values are in acre-feet, rounded to nearest 100 AF.

Current Period Water Budgets

Table 4D-13. Current Groundwater Budget Summary, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Deep Percolation to Groundwater	141,800	47%	97,650	157,450	185,800
	Streambed Recharge	57,900	19%	51,200	63,400	62,200
	Inflow from Colusa	14,500	5%	13,000	15,050	16,200
	Inflow from Red Bluff	48,100	16%	47,550	48,250	48,800
	Inflow from Butte	1,000	<1%	850	900	1,100
	Inflow from Los Molinos	24,100	8%	24,100	24,250	24,100
	Inflow from Vina	12,300	4%	24,100	24,250	24,100
	Inflow from Foothills	1,600	1%	1,250	1,700	2,000
	Recharge to Groundwater from Black Butte Lake	2,000	1%	1,700	2,300	2,300
Outflows	Urban and Domestic Pumping	4,900	2%	4,900	4,900	4,900
	Agricultural Pumping	153,000	51%	163,400	149,550	142,800
	Outflow to Colusa	34,000	11%	34,950	34,450	31,700
	Outflow to Red Bluff	10,300	3%	9,900	10,200	11,000
	Outflow to Butte	2,300	1%	2,350	2,350	2,100
	Outflow to Los Molinos	9,600	3%	9,050	9,500	10,700
	Outflow to Vina	20,000	7%	19,050	19,800	21,500
	Groundwater Discharge to Streams	67,900	22%	56,900	68,400	82,200
Storage	Annual Change of Groundwater in Storage	1,100	-	-50,700	25,850	47,200
	Cumulative Change of Groundwater in Storage from WY 1974 to WY 2015	56,100	-	-	-	-

* Percent contribution of component to average total inflow/outflow. Small discrepancies between inflow minus outflow and change in storage may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF. .

Table 4D-14. Current Annual Groundwater Budget

Simulation Water Year	Deep Percolation to Groundwater	Streambed Recharge	Inflow from Colusa	Inflow from Red Bluff	Inflow from Butte	Inflow from Los Molinos	Inflow from Vina	Inflow from Foothills	Recharge to Groundwater from Black Butte Lake	Urban and Domestic Pumping	Agricultural Pumping	Outflow to Colusa	Outflow to Red Bluff	Outflow to Butte	Outflow to Los Molinos	Outflow to Vina	Groundwater Discharge to Streams	Annual Change of Groundwater in Storage	% Error
1	194,200	77,500	16,200	48,000	900	24,300	11,800	2,100	2,100	4,900	149,500	33,700	10,600	2,700	9,500	21,200	70,400	74,000	0.16%
2	131,600	63,200	16,200	48,600	800	24,000	9,000	1,600	1,900	4,900	148,800	29,500	10,600	2,300	9,600	21,000	64,900	4,900	0.13%
3	74,200	44,400	13,800	47,100	800	23,400	9,900	1,100	1,100	4,900	152,300	30,000	10,100	2,400	9,500	21,300	56,300	-71,300	0.14%
4	68,200	31,400	10,700	45,200	500	23,400	11,900	900	400	4,900	163,200	38,800	8,600	2,700	8,500	18,100	47,100	-99,600	0.16%
5	190,800	79,100	13,900	46,500	700	24,700	13,700	2,100	3,000	4,900	146,100	41,400	10,200	2,900	8,500	18,200	66,800	75,500	0.00%
6	112,700	61,600	15,300	47,700	800	23,900	9,900	1,200	1,900	4,900	162,500	31,200	9,200	2,300	8,600	19,800	53,900	-17,700	0.11%
7	194,400	61,800	16,700	47,500	1,100	23,900	10,700	1,700	1,900	4,900	139,000	30,600	10,300	2,100	10,000	22,500	77,900	62,200	0.06%
8	113,900	55,800	15,800	48,800	900	24,100	10,100	1,700	2,400	4,900	160,400	28,300	9,600	2,200	9,300	21,300	61,100	-23,700	0.04%
9	202,200	63,200	16,400	48,800	1,100	24,200	11,300	2,000	2,100	4,900	129,300	30,400	10,500	2,200	10,600	22,200	84,100	77,000	0.03%
10	266,100	54,600	20,100	48,300	1,400	23,400	11,400	2,600	2,500	4,900	126,000	25,100	12,600	1,900	13,200	23,100	110,200	113,500	-0.02%
11	125,900	53,200	17,500	49,600	1,500	24,100	13,700	1,800	2,100	4,900	169,500	28,000	12,300	1,600	11,100	22,100	83,600	-44,000	0.10%
12	97,200	49,600	15,400	48,300	900	23,500	13,200	1,300	1,600	4,900	156,800	30,000	11,600	2,500	10,500	20,500	69,500	-55,300	0.00%
13	171,200	56,200	15,100	48,000	900	24,000	13,600	1,900	1,700	4,900	152,300	32,200	11,600	2,500	10,600	20,000	83,900	14,600	0.00%
14	75,900	44,900	13,300	47,900	900	24,100	12,900	1,100	1,600	4,900	177,100	30,500	10,400	2,200	9,100	19,000	54,300	-85,300	0.18%
15	109,700	57,300	12,400	47,400	800	24,600	13,800	1,100	1,500	4,900	169,600	37,100	10,100	2,600	8,600	17,800	55,900	-38,000	0.00%
16	100,800	58,900	10,600	47,100	800	24,800	15,000	1,000	2,500	4,900	152,500	38,700	9,900	2,500	8,300	16,100	53,100	-24,600	0.04%
17	94,300	51,500	11,000	46,000	1,000	24,300	14,000	900	1,200	4,900	159,000	38,400	9,500	2,200	8,500	16,600	50,900	-45,900	0.04%
18	93,500	46,300	10,000	45,400	800	24,800	14,800	900	2,000	4,900	161,500	41,000	8,700	2,300	7,800	15,900	48,500	-52,200	0.04%
19	128,400	62,500	11,800	46,600	800	25,400	14,400	1,300	2,900	4,900	165,200	41,100	8,500	2,500	7,600	15,700	50,200	-1,900	0.10%
20	205,100	72,100	15,700	49,000	900	25,500	11,800	1,600	2,900	4,900	139,000	35,300	9,000	2,300	8,400	18,400	67,800	99,400	0.03%
21	107,200	50,700	15,300	48,300	800	23,600	10,600	1,000	1,100	4,900	156,000	30,100	8,800	2,300	9,100	21,100	57,000	-30,800	0.04%
22	244,900	68,400	15,000	47,700	1,200	24,200	12,600	2,100	2,900	4,900	136,600	36,100	10,000	2,100	10,300	21,600	88,600	108,400	0.10%
23	161,600	61,200	16,200	50,000	1,200	24,400	11,200	1,800	2,700	4,900	153,400	30,000	10,300	2,000	10,100	21,100	76,000	22,500	0.00%
24	152,800	55,200	15,500	48,800	1,000	23,700	11,600	1,600	1,400	4,900	150,300	31,400	10,700	2,200	11,000	23,400	80,200	-2,700	0.06%
25	258,400	58,700	16,800	48,400	1,300	23,500	13,800	2,800	2,900	4,900	121,500	29,700	12,500	2,000	12,800	22,600	102,500	118,100	0.00%
26	120,400	49,600	16,300	49,500	1,400	24,000	12,400	1,600	2,600	4,900	147,700	28,900	12,000	1,800	11,400	21,100	81,800	-32,200	0.14%
27	135,300	53,700	15,200	48,900	900	24,000	12,300	1,800	2,300	4,900	153,100	32,000	11,500	2,300	10,800	19,800	76,400	-16,600	0.07%
28	104,700	50,200	14,700	48,800	800	23,500	12,100	1,500	2,000	4,900	152,800	31,500	11,300	2,400	10,300	19,400	64,900	-39,600	0.15%
29	137,100	58,800	14,900	48,900	900	24,100	12,800	1,400	2,100	4,900	171,700	33,800	11,100	2,400	9,800	21,100	68,800	-22,800	0.07%
30	168,800	62,100	15,100	49,300	1,000	24,600	12,800	2,000	3,000	4,900	149,600	34,300	10,800	2,300	10,000	20,000	74,100	32,600	0.03%
31	171,800	56,600	15,600	49,700	900	24,200	10,900	2,000	2,000	4,900	171,400	32,700	10,900	2,300	10,400	22,000	76,300	2,600	0.06%
32	170,400	56,400	16,200	49,300	1,100	23,600	11,800	2,200	2,800	4,900	129,000	29,900	11,600	2,300	11,100	20,100	81,500	43,200	0.06%
33	218,700	52,200	16,700	48,900	1,400	23,500	11,500	2,500	2,700	4,900	152,100	30,600	12,000	1,900	12,200	23,500	96,600	44,000	0.08%
34	79,400	50,600	15,400	49,100	1,100	23,500	12,100	1,300	1,300	4,900	168,600	30,300	11,500	1,900	10,400	21,800	64,400	-80,100	0.04%
35	101,600	58,300	14,000	48,800	800	24,100	13,500	1,300	2,000	4,900	177,900	35,700	10,800	2,400	9,100	18,800	60,900	-56,500	0.15%
36	91,800	52,300	11,800	48,100	800	24,200	13,900	1,100	2,100	4,900	164,300	36,300	10,100	2,600	8,800	17,900	55,000	-54,000	0.08%
37	162,700	67,300	14,500	48,600	900	24,600	13,100	1,900	2,600	4,900	138,200	37,200	10,500	2,500	9,200	17,300	67,400	48,600	0.12%
38	181,200	61,400	16,100	48,400	1,300	23,800	11,200	1,700	2,400	4,900	125,300	31,500	10,800	2,100	10,300	21,200	83,800	57,300	0.09%
39	102,400	49,200	15,700	47,500	1,100	23,100	11,500	1,400	1,800	4,900	148,000	29,200	10,700	1,900	10,300	21,300	69,600	-42,500	0.12%
40	110,800	57,300	14,700	47,200	900	24,000	12,800	1,400	1,400	4,900	172,400	33,700	10,400	2,300	9,100	21,400	62,100	-46,000	0.07%
41	74,100	43,100	10,900	45,900	800	23,800	13,800	1,100	1,800	4,900	164,100	36,600	9,400	2,400	8,600	18,200	50,600	-79,800	0.14%
42	113,800	59,800	11,600	46,800	600	24,500	14,700	1,300	1,900	4,900	172,200	41,900	9,400	2,800	8,200	18,000	54,200	-36,600	0.00%
43	200,500	85,300	14,100	49,300	900	25,200	13,200	2,100	2,200	4,900	145,000	41,000	9,500	2,700	8,700	19,100	65,400	96,300	0.05%
44	138,500	69,700	14,600	49,800	800	24,700	9,700	1,600	2,000	4,900	148,800	34,700	9,700	2,300	9,000	19,600	61,100	21,100	0.06%
45	77,100	46,800	12,000	48,000	800	23,900	10,700	1,100	1,200	4,900	152,300	34,700	9,500	2,300	9,000	20,200	53,700	-65,200	0.09%
46	69,100	33,400	9,600	45,800	500	23,900	13,200	1,000	400	4,900	163,300	44,100	8,100	2,600	8,200	17,300	45,200	-96,900	0.05%
47	194,900	84,200	12,900	47,000	700	25,200	14,800	2,100	3,000	4,900	146,100	47,200	9,800	2,900	8,200	17,300	64,100	84,300	0.00%
48	113,400	64,500	13,800	48,200	900	24,300	10,700	1,200	1,900	4,900	162,500	35,500	8,800	2,300	8,400	18,800	52,000	-14,600	0.11%
49	198,500	66,000	15,500	47,900	1,100	24,300	11,300	1,700	1,900	4,900	139,000	35,000	10,000	2,100	9,700	21,400	75,000	70,900	0.05%
50	115,400	58,000	14,500	49,200	1,000	24,300	10,500	1,700	2,400	4,900	160,400	31,600	9,400	2,200	9,100	20,600	59,500	-20,800	0.04%
51	205,300	66,200	15,400	49,200	1,100	24,400	11,700	2,000	2,100	4,900	129,300	33,800	10,300	2,200	10,400	21,500	82,000	82,600	0.11%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-15. Current Land Surface Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Precipitation	389,500	66%	278,850	425,850	502,100
	Applied Groundwater	157,800	27%	168,100	154,450	147,700
	Applied Surface Water	46,200	8%	46,300	46,150	46,300
Outflows	Deep Percolation to Groundwater	139,300	23%	95,150	154,950	183,300
	Evapotranspiration	302,100	51%	292,150	305,600	311,800
	Overland Flow	136,800	24%	72,350	155,750	204,300
	Return Flow to Streams	15,100	3%	15,050	14,700	15,700
Storage	Change in Soil and Unsaturated Zone Storage	200	-	19,700	2,650	-19,300

* Percent contribution of component to average total inflow/outflow. Small discrepancies between inflow minus outflow and change in storage may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF .

Table 4D-16. Current Annual Land Surface Budget

Simulation Water Year	Precipitation	Applied Groundwater	Applied Surface Water	Deep Percolation to Groundwater	Evapotranspiration	Overland Flow	Return Flow to Streams	Change in Soil and Unsaturated Zone Storage	% Error
1	435,200	154,400	46,100	191,700	312,700	141,300	16,700	-26,800	0.02%
2	394,600	153,700	46,100	129,100	301,500	137,400	14,100	12,400	-0.02%
3	202,200	157,100	46,000	71,700	279,000	18,400	15,700	20,600	-0.02%
4	189,200	168,100	46,100	65,700	283,300	18,100	14,600	21,600	0.02%
5	562,200	151,000	46,200	188,300	307,000	257,400	15,600	-8,900	0.00%
6	317,300	167,300	46,100	110,200	298,500	92,900	14,000	15,100	0.00%
7	468,400	143,900	46,100	191,900	317,800	165,500	13,300	-30,100	0.00%
8	355,400	165,300	46,100	111,400	310,500	107,100	16,000	21,800	0.00%
9	487,100	134,200	46,100	199,700	320,400	155,600	17,100	-25,400	0.00%
10	724,100	130,900	46,100	263,600	319,100	356,500	20,200	-58,400	0.01%
11	412,700	174,400	46,100	123,400	297,000	184,600	14,100	14,000	0.02%
12	312,500	161,700	46,100	94,700	291,800	85,700	15,700	32,400	0.00%
13	490,900	157,200	46,100	168,700	314,000	204,600	15,700	-8,900	0.01%
14	210,900	182,000	46,100	73,400	275,400	49,600	14,700	25,900	0.00%
15	308,500	174,500	46,100	107,200	308,000	83,100	14,300	16,400	0.02%
16	321,900	157,400	46,400	98,300	305,900	72,900	18,700	29,800	0.02%
17	219,500	163,900	47,200	91,800	302,100	34,900	15,700	-13,800	-0.02%
18	272,000	166,400	46,100	90,900	275,000	90,000	14,300	14,300	0.00%
19	365,200	170,100	46,100	125,900	307,600	124,100	14,600	9,200	0.00%
20	528,000	143,900	46,100	202,600	315,200	218,800	13,200	-31,700	-0.01%
21	312,700	160,900	46,100	104,700	313,800	70,400	13,400	17,300	0.02%
22	739,400	141,500	46,100	242,400	307,200	414,800	13,200	-50,600	0.00%
23	495,600	158,300	46,200	159,100	320,400	202,000	13,800	4,600	0.03%
24	407,000	155,200	46,100	150,300	317,000	134,900	13,400	-7,300	0.00%
25	829,800	126,400	46,300	255,900	313,100	456,900	18,900	-42,300	0.00%
26	317,300	152,600	48,300	117,900	303,000	72,400	15,000	9,800	0.02%
27	384,200	158,000	46,100	132,800	308,600	122,200	13,600	11,100	0.00%
28	324,000	157,700	48,200	102,100	304,600	87,500	15,400	20,300	0.00%
29	321,200	176,600	46,100	134,600	290,300	103,400	14,400	1,100	0.02%
30	471,100	154,500	46,200	166,300	307,600	181,400	15,600	700	0.03%
31	414,900	176,200	46,100	169,300	291,600	176,300	14,000	-13,900	-0.02%
32	507,400	133,900	46,100	167,900	323,200	175,500	15,600	5,100	0.01%
33	535,100	157,000	46,100	216,200	316,000	231,400	18,200	-43,600	0.00%
34	217,100	173,500	46,100	76,900	283,500	35,400	14,000	26,800	0.02%
35	281,900	182,800	46,100	99,100	274,900	105,800	14,300	16,800	-0.02%
36	299,900	169,200	46,100	89,300	300,700	81,200	14,000	29,900	0.02%
37	435,600	143,100	46,200	160,200	301,800	155,000	17,100	-9,400	0.03%
38	448,100	130,200	46,100	178,700	313,100	144,200	13,100	-24,700	0.00%
39	303,400	152,800	46,100	99,900	300,700	75,600	15,500	10,600	0.00%
40	285,700	174,300	46,100	108,300	279,600	86,000	14,200	18,000	0.00%
41	220,700	169,000	46,100	71,600	272,900	48,100	16,200	27,000	0.00%
42	324,800	177,100	46,000	111,300	289,300	128,600	14,400	4,300	0.00%
43	435,200	149,800	46,100	198,000	312,400	139,500	15,900	-34,800	0.02%
44	394,600	153,700	46,100	136,000	301,500	137,400	14,100	5,400	0.00%
45	202,200	157,100	46,000	74,600	279,000	18,400	15,700	17,700	-0.02%
46	189,200	168,100	46,100	66,600	283,300	18,100	14,600	20,700	0.02%
47	562,200	151,000	46,200	192,400	307,000	257,400	15,600	-13,000	0.00%
48	317,300	167,300	46,100	110,900	298,500	92,900	14,000	14,400	0.00%
49	468,400	143,900	46,100	196,000	317,800	165,500	13,300	-34,200	0.00%
50	355,400	165,300	46,100	112,900	310,500	107,100	16,000	20,300	0.00%
51	487,100	134,200	46,100	202,800	320,400	155,600	17,100	-28,400	-0.01%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-17. Current Sacramento River Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Basin	10,849,400	97%	7,551,900	10,253,800	15,719,100
	Inflow from Small Tributaries	57,400	1%	31,450	57,250	92,000
	Overland Flow	193,300	2%	100,900	215,750	294,300
	Irrigation Return Flows to Streams	24,600	<1%	25,350	24,350	24,000
	Groundwater Discharge to Stream	61,200	1%	48,600	60,950	78,400
Outflows	Streambed Recharge	18,500	<1%	29,850	11,350	-9,000
	Downstream Outflow South of Subbasin	10,547,900	94%	7,106,750	9,982,050	15,581,300
	Riparian ET	20,400	<1%	22,500	19,600	18,300
	Agricultural Diversions	23,200	<1%	23,200	23,200	23,200
	Flow to Glenn Colusa Canal	571,200	5%	571,200	571,200	571,200
	Flow to Flood Bypass	4,700	<1%	4,700	4,700	4,700

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-18. Current Annual Sacramento River Budget

Simulation Water Year	Inflow from Upstream of Basin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow South of Subbasin	Riparian ET	Agricultural Diversions	Flow to Glenn Colusa Canal	Flow to Flood Bypass	% Error
1	19,771,900	96,200	215,300	24,200	54,000	20,600	19,522,700	19,100	23,200	571,200	4,700	0.20%
2	12,113,900	59,800	185,500	24,600	56,800	29,600	11,792,100	19,800	23,200	571,200	4,700	0.47%
3	8,569,900	18,500	25,400	24,900	45,800	44,400	8,018,400	22,600	23,200	571,200	4,700	1.02%
4	5,556,400	9,800	20,600	25,200	40,800	45,900	4,983,600	24,100	23,200	571,200	4,700	1.61%
5	11,438,500	81,700	350,200	23,900	53,700	7,300	11,323,200	18,200	23,200	571,200	4,700	0.12%
6	7,750,700	39,700	126,000	25,000	45,500	26,300	7,339,700	21,700	23,200	571,200	4,700	0.66%
7	11,987,800	64,500	224,400	23,500	74,200	1,900	11,754,800	18,600	23,200	571,200	4,700	0.03%
8	8,655,900	37,400	144,900	24,800	52,500	19,300	8,275,500	21,600	23,200	571,200	4,700	0.43%
9	15,702,600	95,200	230,800	23,200	83,900	900	15,518,700	17,000	23,200	571,200	4,700	0.01%
10	22,213,100	123,400	505,100	22,900	112,400	0	22,362,200	15,500	23,200	571,200	4,700	0.00%
11	13,395,700	78,600	259,100	25,600	79,700	5,200	13,212,400	22,000	23,200	571,200	4,700	0.08%
12	8,601,400	32,500	111,400	24,800	64,500	16,700	8,197,100	21,700	23,200	571,200	4,700	0.38%
13	13,075,800	84,600	292,200	24,100	85,100	4,400	12,939,000	19,200	23,200	571,200	4,700	0.07%
14	7,994,800	34,200	76,800	26,200	47,900	33,900	7,523,100	23,700	23,200	571,200	4,700	0.83%
15	7,979,800	28,600	117,800	25,500	43,500	33,100	7,539,900	23,100	23,200	571,200	4,700	0.80%
16	8,289,800	48,000	115,500	25,500	42,800	37,400	7,864,400	20,500	23,200	571,200	4,700	0.88%
17	6,724,200	27,300	51,200	26,100	41,500	28,600	6,220,300	22,200	23,200	571,200	4,700	0.83%
18	5,899,000	32,000	128,400	25,000	37,400	34,300	5,466,500	22,000	23,200	571,200	4,700	1.11%
19	5,862,300	28,900	161,700	25,600	37,700	26,700	5,468,700	21,800	23,200	571,200	4,700	0.87%
20	11,048,300	79,700	313,100	23,300	54,100	5,300	10,895,800	18,200	23,200	571,200	4,700	0.09%
21	6,844,300	32,800	89,800	24,500	50,500	20,400	6,401,000	21,500	23,200	571,200	4,700	0.58%
22	18,010,800	139,200	597,700	23,400	81,100	4,100	18,232,800	16,200	23,200	571,200	4,700	0.04%
23	13,026,400	79,900	275,900	24,600	68,900	2,600	12,854,000	19,800	23,200	571,200	4,700	0.04%
24	13,984,800	95,700	215,200	24,100	75,500	12,500	13,763,100	20,700	23,200	571,200	4,700	0.17%
25	19,513,200	116,400	621,800	21,800	107,800	0	19,767,500	14,200	23,200	571,200	4,700	0.00%
26	12,627,300	63,300	105,600	26,000	83,200	3,300	12,283,200	19,800	23,200	571,200	4,700	0.05%
27	12,870,300	60,700	177,700	24,500	68,300	15,800	12,566,500	20,100	23,200	571,200	4,700	0.24%
28	8,099,300	33,200	114,200	26,400	63,200	20,900	7,694,700	21,400	23,200	571,200	4,700	0.50%
29	8,927,600	43,800	147,600	25,800	59,900	14,100	8,569,200	22,300	23,200	571,200	4,700	0.31%
30	11,986,700	70,600	262,300	24,500	68,100	8,500	11,785,400	19,100	23,200	571,200	4,700	0.14%
31	12,523,800	57,200	248,000	25,700	64,800	13,700	12,284,600	22,200	23,200	571,200	4,700	0.21%
32	9,597,700	44,200	233,700	22,500	91,400	0	9,373,500	16,800	23,200	571,200	4,700	0.00%
33	18,163,500	115,400	357,500	24,700	97,000	2,700	18,137,600	18,700	23,200	571,200	4,700	0.03%
34	8,069,100	31,800	56,200	25,400	60,300	22,200	7,598,200	23,400	23,200	571,200	4,700	0.54%
35	7,774,500	36,400	142,200	26,100	52,400	23,600	7,384,800	24,000	23,200	571,200	4,700	0.59%
36	7,223,000	35,300	114,100	25,300	48,700	32,200	6,792,800	22,200	23,200	571,200	4,700	0.86%
37	8,624,000	48,300	216,200	24,500	60,100	5,500	8,350,100	18,400	23,200	571,200	4,700	0.12%
38	12,358,400	73,400	216,900	22,700	90,700	0	12,147,300	15,700	23,200	571,200	4,700	0.00%
39	8,175,600	45,400	106,500	24,900	66,100	6,600	7,793,000	19,700	23,200	571,200	4,700	0.16%
40	8,487,800	45,700	131,000	25,400	52,200	28,000	8,092,400	22,700	23,200	571,200	4,700	0.64%
41	5,907,200	24,300	67,500	25,100	44,900	34,400	5,412,000	23,400	23,200	571,200	4,700	1.13%
42	6,412,100	32,900	182,900	25,800	41,000	32,800	6,040,000	22,900	23,200	571,200	4,700	0.97%
43	19,748,200	96,200	213,300	23,900	46,700	24,100	19,485,700	19,100	23,200	571,200	4,700	0.24%
44	12,098,400	59,800	185,500	24,600	51,300	33,000	11,767,800	19,800	23,200	571,200	4,700	0.53%
45	8,561,600	18,500	25,400	24,900	41,900	47,500	8,003,100	22,600	23,200	571,200	4,700	1.09%
46	5,550,600	9,800	20,600	25,200	37,200	49,300	4,970,900	24,100	23,200	571,200	4,700	1.73%
47	11,431,800	81,700	350,200	23,900	50,100	10,400	11,309,900	18,200	23,200	571,200	4,700	0.17%
48	7,748,000	39,700	126,000	25,000	42,600	29,200	7,331,200	21,700	23,200	571,200	4,700	0.73%
49	11,984,800	64,500	224,400	23,500	69,200	2,200	11,746,400	18,600	23,200	571,200	4,700	0.04%
50	8,654,100	37,400	144,900	24,800	50,600	21,300	8,269,700	21,600	23,200	571,200	4,700	0.48%
51	15,701,200	95,200	230,800	23,200	81,000	1,100	15,514,200	17,000	23,200	571,200	4,700	0.01%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-19. Stony Creek and Black Butte Lake Current Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Basin	451,100	94%	182,150	467,950	782,400
	Inflow from Small Tributaries	2,800	1%	350	3,050	5,600
	Overland Flow	21,600	4%	11,850	24,800	31,600
	Irrigation Return Flows to Streams	3,600	1%	3,250	3,600	4,200
	Groundwater Discharge to Stream	1,200	<1%	1,350	1,150	1,200
Outflows	Streambed Recharge	31,100	6%	23,700	43,050	31,800
	Downstream Outflow to Sacramento River	306,100	64%	52,050	303,850	630,400
	Riparian ET	9,000	2%	8,400	9,950	9,400
	Surface Water Diversions	47,300	10%	38,400	54,850	54,300
	Recharge to Groundwater from Black Butte Lake	17,100	4%	16,500	17,450	17,500
	Black Butte Lake Losses	69,800	15%	59,850	71,400	81,600

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-20. Current Annual Stony Creek and Black Butte Lake Groundwater Budget

Simulation Water Year	Inflow from Upstream of Basin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow to Sacramento River	Riparian ET	Surface Water Diversions	Recharge to Groundwater from Black Butte Lake	Black Butte Lake Losses	% Error
1	799,000	3,900	22,100	5,300	500	46,000	603,600	9,900	56,700	17,100	97,400	0.01%
2	539,600	3,500	22,200	2,600	1,100	41,000	347,400	10,200	54,900	16,600	98,800	0.02%
3	82,400	0	3,400	2,800	1,800	10,300	5,100	6,500	26,500	15,400	26,600	0.00%
4	21,900	0	3,400	3,300	1,400	4,700	800	5,400	10,000	13,300	-4,100	-0.33%
5	766,200	7,700	40,200	5,100	400	56,000	571,600	8,900	53,600	17,900	111,400	0.02%
6	210,900	500	15,900	3,000	900	48,900	40,800	11,000	56,400	16,500	57,700	-0.04%
7	684,600	4,500	27,100	2,500	900	33,600	528,300	9,500	56,700	16,600	74,800	0.01%
8	245,000	1,800	18,200	5,100	800	36,100	40,500	11,000	52,300	17,500	113,600	-0.04%
9	758,500	3,900	24,500	5,000	1,000	30,800	625,400	8,800	56,300	17,400	54,200	0.00%
10	1,412,700	12,900	55,400	7,300	1,600	900	1,317,800	8,100	56,700	17,800	88,700	-0.01%
11	633,700	4,200	29,600	2,600	1,600	28,200	480,800	10,900	53,800	17,100	80,900	0.00%
12	210,600	0	14,400	4,200	1,400	23,800	54,700	10,000	45,100	16,800	80,200	0.00%
13	750,200	6,100	31,200	5,300	1,600	30,200	631,700	9,100	45,600	16,700	61,000	0.01%
14	137,700	0	7,900	2,600	1,500	13,500	5,300	8,100	36,700	16,100	69,800	0.13%
15	237,100	0	13,900	2,600	1,200	25,400	100,500	7,300	38,900	16,300	66,200	0.08%
16	156,500	0	10,900	5,300	1,300	23,600	9,200	8,300	40,400	18,000	74,600	-0.06%
17	115,100	0	5,900	2,600	1,000	21,600	5,000	7,000	35,200	15,900	39,900	0.00%
18	130,600	0	14,700	2,700	1,000	12,100	5,300	7,300	33,200	16,900	74,300	-0.07%
19	217,500	1,800	19,700	2,600	700	39,700	48,700	9,500	40,400	18,500	85,600	-0.04%
20	684,800	4,900	34,900	2,400	900	49,000	517,200	9,400	56,700	18,600	76,900	0.01%
21	146,300	0	9,900	2,600	600	32,400	14,600	9,300	47,000	15,800	40,300	0.00%
22	1,175,100	12,200	64,000	2,500	900	29,500	1,019,600	8,400	54,000	18,400	124,800	0.00%
23	631,600	3,100	27,500	2,500	1,100	36,700	473,400	10,400	53,200	18,300	73,700	0.02%
24	609,600	2,300	21,500	2,500	900	27,200	483,100	9,800	46,700	16,400	53,600	0.00%
25	1,258,800	16,100	71,500	9,800	1,300	12,400	1,152,800	7,500	56,700	18,800	109,300	0.00%
26	415,600	1,400	11,000	2,500	1,500	23,700	261,900	10,100	53,400	18,000	64,800	0.02%
27	348,300	1,600	19,500	2,600	1,600	28,500	194,800	10,200	55,600	17,800	66,700	0.00%
28	217,000	1,000	14,300	2,500	1,600	28,900	76,500	9,900	46,400	17,000	57,500	0.08%
29	410,000	700	16,500	2,700	1,300	33,700	240,500	10,300	50,100	17,400	79,200	0.00%
30	478,700	2,300	27,600	4,700	1,300	38,600	302,900	9,800	51,900	18,800	92,600	0.00%
31	543,900	3,700	27,000	2,600	1,700	30,200	409,300	11,000	52,600	17,000	58,800	0.00%
32	621,300	3,400	28,700	5,500	1,600	38,200	456,000	8,900	56,700	18,500	82,400	-0.03%
33	914,400	6,900	35,200	4,000	2,100	17,000	777,200	9,700	56,700	18,400	83,600	0.00%
34	174,400	0	5,700	2,600	1,800	28,800	32,800	10,100	46,300	16,200	50,400	-0.05%
35	320,100	200	18,100	2,500	1,900	37,400	155,600	10,400	51,200	17,000	71,200	0.00%
36	144,900	0	13,100	2,600	1,800	17,700	5,800	9,000	41,200	17,200	71,600	-0.06%
37	420,100	2,600	25,100	5,000	1,300	50,900	244,400	9,500	56,500	18,200	74,600	0.00%
38	522,200	2,700	21,600	2,500	1,500	38,100	364,700	8,500	56,700	17,800	64,700	0.00%
39	147,200	200	10,700	3,200	1,800	29,600	22,000	10,000	50,500	16,900	34,100	0.00%
40	304,900	300	13,900	2,600	1,600	28,800	168,600	9,100	42,600	16,200	58,000	0.00%
41	90,600	0	8,400	5,000	1,800	11,200	2,600	5,700	24,600	16,600	45,100	0.00%
42	210,600	100	20,800	2,600	1,100	28,700	100,200	5,500	35,800	17,200	47,900	-0.04%
43	799,000	3,900	21,900	5,300	600	58,900	590,600	9,900	56,700	17,200	97,400	0.00%
44	539,600	3,500	22,200	2,600	1,100	51,300	337,300	10,200	54,900	16,700	98,700	-0.02%
45	82,400	0	3,400	2,800	1,700	12,000	4,200	6,300	25,800	15,500	26,400	0.11%
46	21,900	0	3,400	3,300	1,400	5,100	700	5,400	9,800	13,400	-4,200	-0.67%
47	766,200	7,700	40,200	5,100	300	64,200	563,500	8,900	53,600	18,000	111,200	0.01%
48	210,900	500	15,900	3,000	800	52,000	37,800	11,000	56,300	16,600	57,500	-0.04%
49	684,600	4,500	27,100	2,500	700	41,900	520,100	9,500	56,700	16,700	74,600	-0.01%
50	245,000	1,800	18,200	5,100	700	39,200	37,700	10,900	52,100	17,600	113,400	-0.04%
51	758,500	3,900	24,500	5,000	900	37,500	618,800	8,800	56,200	17,400	54,000	0.01%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-21. Thomes Creek Current Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Basin	227,500	89%	110,600	237,150	371,500
	Inflow from Small Tributaries	8,100	3%	1,750	8,800	15,700
	Overland Flow	19,400	8%	8,850	21,750	30,900
	Irrigation Return Flows to Streams	1,000	<1%	1,100	1,000	1,000
	Groundwater Discharge to Stream	0	0%	0	0	0
Outflows	Streambed Recharge	30,800	12%	24,950	33,800	36,000
	Downstream Outflow to Sacramento River	220,600	86%	92,650	230,300	378,600
	Riparian ET	4,500	2%	4,600	4,550	4,400
	Surface water diversions	0	0%	0	0	0

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-22. Current Annual Thomes Creek Groundwater Budget

Simulation Water Year	Inflow from Upstream of Basin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow to Sacramento River	Riparian ET	Surface water diversions	% Error
1	450,000	13,500	20,400	1,000	0	43,800	436,400	4,600	0	0.02%
2	277,700	10,900	21,700	1,000	0	34,100	272,100	4,900	0	0.06%
3	65,900	0	900	1,000	0	23,700	39,100	5,000	0	0.00%
4	15,600	0	1,000	1,100	0	5,300	8,400	3,900	0	0.56%
5	343,400	20,200	42,100	1,000	0	45,800	356,400	4,500	0	0.00%
6	110,100	2,500	11,200	1,100	0	24,900	95,600	4,300	0	0.08%
7	295,400	11,000	23,700	1,000	0	40,600	286,200	4,200	0	0.03%
8	125,900	6,400	15,200	1,100	0	26,000	118,700	3,700	0	0.13%
9	395,800	10,700	19,800	900	0	41,500	381,600	4,200	0	-0.02%
10	559,300	32,800	58,900	800	0	36,900	610,700	4,300	0	-0.02%
11	265,900	11,100	26,700	1,100	0	26,400	273,600	4,700	0	0.03%
12	134,400	300	9,900	1,000	0	27,100	114,100	4,400	0	0.00%
13	352,100	16,900	32,100	1,000	0	31,800	366,100	4,200	0	0.00%
14	102,100	0	4,200	1,100	0	21,700	81,400	4,300	0	0.00%
15	137,700	900	12,000	1,100	0	29,300	118,500	4,000	0	-0.07%
16	158,900	2,200	8,200	1,000	0	33,200	133,100	4,000	0	0.00%
17	74,500	0	3,600	1,000	0	27,400	47,300	4,500	0	-0.13%
18	80,600	1,000	12,000	1,100	0	20,000	70,900	3,800	0	0.00%
19	119,200	5,300	16,600	1,100	0	26,700	111,200	4,200	0	0.07%
20	318,700	12,300	31,400	1,000	0	42,300	316,500	4,700	0	-0.03%
21	57,000	600	7,100	1,000	0	21,900	40,400	3,500	0	-0.15%
22	459,000	30,900	69,900	1,000	0	42,400	514,300	4,000	0	0.02%
23	325,100	10,000	25,500	1,000	0	34,500	322,700	4,400	0	0.00%
24	239,700	9,000	19,600	1,000	0	30,600	234,100	4,700	0	-0.04%
25	567,600	38,200	76,400	800	0	36,900	642,500	3,700	0	-0.01%
26	250,500	5,000	10,400	1,000	0	28,800	233,400	4,500	0	0.07%
27	262,500	6,600	18,200	1,000	0	28,400	255,300	4,600	0	0.00%
28	145,800	4,100	10,800	1,000	0	27,400	128,900	5,300	0	0.06%
29	216,800	2,900	12,200	1,100	0	32,100	195,900	4,800	0	0.09%
30	285,100	8,400	26,400	1,000	0	33,100	283,200	4,500	0	0.03%
31	284,200	9,900	25,000	1,100	0	28,600	286,900	4,600	0	0.03%
32	267,100	8,700	22,900	900	0	33,500	261,800	4,300	0	0.00%
33	421,100	17,700	33,700	1,000	0	26,800	442,500	4,200	0	0.00%
34	92,900	0	3,200	1,100	0	27,100	64,000	6,100	0	0.00%
35	157,600	1,500	13,300	1,100	0	28,000	139,800	5,700	0	0.00%
36	125,800	0	8,700	1,100	0	30,400	99,500	5,800	0	-0.07%
37	245,900	8,600	19,900	1,000	0	36,800	233,800	4,700	0	0.04%
38	256,000	10,100	17,100	900	0	38,200	241,600	4,300	0	0.00%
39	114,000	3,200	6,200	1,000	0	28,300	90,700	5,500	0	-0.08%
40	133,100	1,500	11,400	1,100	0	30,400	111,200	5,500	0	0.00%
41	73,500	0	6,500	1,100	0	21,400	54,000	5,700	0	0.00%
42	157,600	3,400	18,700	1,100	0	27,600	149,300	3,900	0	0.00%
43	450,000	13,500	20,300	1,000	0	45,900	434,200	4,600	0	0.02%
44	277,700	10,900	21,700	1,000	0	35,400	270,900	4,900	0	0.03%
45	65,900	0	900	1,000	0	24,000	38,800	5,000	0	0.00%
46	15,600	0	1,000	1,100	0	5,300	8,400	3,900	0	0.56%
47	343,400	20,200	42,100	1,000	0	46,200	356,000	4,500	0	0.00%
48	110,100	2,500	11,200	1,100	0	25,000	95,500	4,300	0	0.08%
49	295,400	11,000	23,700	1,000	0	41,000	285,800	4,200	0	0.03%
50	125,900	6,400	15,200	1,100	0	26,200	118,500	3,800	0	0.07%
51	395,800	10,700	19,800	900	0	41,900	381,100	4,200	0	0.00%

* All values are in acre-feet, rounded to nearest 100 AF.

Projected 2030 Period Water Budgets

Table 4D-23. Projected 2030 Groundwater Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Deep Percolation to Groundwater	141,600	46%	97,800	157,250	185,300
	Streambed Recharge	60,900	20%	53,350	66,850	65,800
	Inflow from Colusa	14,900	5%	13,550	15,700	16,900
	Inflow from Red Bluff	49,200	16%	48,650	49,350	49,900
	Inflow from Butte	900	<1%	750	850	1,100
	Inflow from Los Molinos	24,500	8%	24,400	24,750	24,400
	Inflow from Vina	12,100	4%	24,400	24,750	24,400
	Inflow from Foothills	1,100	<1%	950	1,100	1,300
	Recharge to Groundwater from Black Butte Lake	2,100	1%	1,700	2,350	2,300
Outflows	Urban and Domestic Pumping	4,900	<1%	4,900	4,900	4,900
	Agricultural Pumping	159,300	2%	169,100	156,850	149,000
	Outflow to Colusa	34,800	52%	35,750	35,050	32,400
	Outflow to Red Bluff	10,100	<1%	9,650	9,950	10,900
	Outflow to Butte	2,400	11%	2,450	2,450	2,300
	Outflow to Los Molinos	9,300	3%	8,800	9,100	10,300
	Outflow to Vina	20,300	1%	19,200	20,250	22,000
	Groundwater Discharge to Streams	65,500	3%	54,550	66,100	80,400
Storage	Annual Change of Groundwater in Storage	400	-	-51,050	24,950	46,500
	Cumulative Change of Groundwater in Storage from WY 1974 to WY 2015	21,200	-	-	-	-

* Percent contribution of component to average total inflow/outflow. Small discrepancies between inflow minus outflow and change in storage may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF. .

Table 4D-24. Projected 2030 Annual Groundwater Budget

Simulation Water Year	Deep Percolation to Groundwater	Streambed Recharge	Inflow from Colusa	Inflow from Red Bluff	Inflow from Butte	Inflow from Los Molinos	Inflow from Vina	Inflow from Foothills	Recharge to Groundwater from Black Butte Lake	Urban and Domestic Pumping	Agricultural Pumping	Outflow to Colusa	Outflow to Red Bluff	Outflow to Butte	Outflow to Los Molinos	Outflow to Vina	Groundwater Discharge to Streams	Annual Change of Groundwater in Storage	% Error
1	192,500	77,900	17,400	48,500	800	24,000	12,300	1,600	2,100	4,900	152,700	33,300	10,900	2,800	9,500	22,100	73,700	66,700	0.13%
2	130,400	65,600	18,100	49,100	800	23,900	9,900	1,300	1,900	4,900	154,900	28,500	10,800	2,400	9,700	22,600	66,600	400	0.07%
3	72,700	43,100	14,100	47,800	800	23,200	10,600	1,000	1,100	4,900	158,500	29,500	10,300	2,300	9,700	21,400	54,600	-77,000	0.09%
4	69,300	38,500	11,000	45,700	500	23,800	12,300	900	300	4,900	167,900	38,400	8,500	2,700	8,200	18,800	44,600	-92,100	0.20%
5	191,400	82,200	14,000	47,100	700	25,100	14,000	1,500	2,900	4,900	151,700	42,600	10,100	3,000	8,300	19,100	66,300	72,500	0.11%
6	108,000	63,900	16,000	48,600	800	24,200	9,600	1,100	1,900	4,900	167,300	31,100	9,100	2,400	8,500	20,500	53,300	-23,600	0.22%
7	195,400	64,900	17,100	48,800	1,000	24,300	11,000	1,300	1,900	4,900	146,500	32,300	10,300	2,300	9,700	22,400	75,900	61,200	0.05%
8	111,800	60,900	16,000	49,800	800	24,400	10,200	1,200	2,400	4,900	167,100	29,400	9,500	2,300	9,100	21,700	59,100	-25,800	0.07%
9	207,300	64,700	16,700	49,800	1,100	24,300	11,400	1,300	2,100	4,900	134,700	32,900	10,400	2,300	10,300	22,500	82,400	78,100	0.05%
10	258,400	57,100	20,600	49,100	1,400	23,300	11,300	1,500	2,600	4,900	131,900	25,200	12,700	1,900	12,800	23,600	106,000	106,100	0.05%
11	120,600	57,000	18,000	50,500	1,400	24,500	13,200	1,100	2,100	4,900	176,000	28,500	12,000	1,700	10,600	22,000	77,800	-45,400	0.10%
12	95,900	50,600	15,500	49,400	700	23,700	12,500	900	1,700	4,900	162,400	32,000	11,500	2,600	10,200	20,500	65,000	-58,200	0.00%
13	177,000	61,100	14,900	48,800	900	24,500	13,900	1,200	1,800	4,900	158,700	35,600	11,300	2,600	10,200	20,000	81,700	18,900	0.06%
14	76,900	47,000	14,100	48,900	800	24,300	12,300	800	1,600	4,900	182,000	31,700	10,200	2,300	8,900	19,200	53,000	-85,800	0.13%
15	106,100	58,800	12,900	48,700	700	24,900	14,100	900	1,500	4,900	177,300	38,500	9,900	2,600	8,400	18,100	53,800	-44,900	0.00%
16	102,700	61,900	11,700	48,600	700	25,200	15,100	1,100	2,400	4,900	158,100	40,000	9,800	2,600	8,200	16,100	51,500	-21,800	0.00%
17	88,200	49,300	11,000	47,900	800	24,800	13,800	1,000	1,300	4,900	164,500	41,200	9,300	2,300	8,300	15,900	47,900	-56,500	0.13%
18	101,600	54,300	10,100	47,100	700	25,700	15,300	800	2,000	4,900	167,600	43,900	8,400	2,400	7,500	15,700	46,800	-39,800	0.08%
19	124,200	63,700	11,000	48,300	700	26,300	15,100	900	2,900	4,900	172,600	43,300	8,200	2,500	7,300	15,700	46,800	-8,400	0.07%
20	202,400	77,200	15,300	50,800	900	26,500	12,400	1,200	2,900	4,900	147,500	38,300	8,800	2,400	7,900	18,000	63,200	98,300	0.08%
21	112,600	50,800	14,500	49,800	700	24,400	10,400	900	1,200	4,900	163,400	32,300	8,600	2,300	8,800	19,600	54,300	-29,200	0.11%
22	251,900	76,600	15,200	49,100	1,100	24,700	13,100	1,300	3,000	4,900	144,100	38,000	10,200	2,200	10,000	21,700	88,000	116,800	0.02%
23	162,200	68,400	17,100	51,700	1,100	24,800	10,800	1,200	2,800	4,900	158,800	30,600	10,300	2,100	9,700	21,100	71,700	30,700	0.06%
24	150,200	58,300	16,400	50,100	900	24,200	11,500	1,000	1,400	4,900	158,400	31,900	10,300	2,200	10,500	23,500	76,400	-4,400	0.10%
25	259,300	58,500	17,200	49,200	1,300	24,000	13,200	1,800	3,000	4,900	128,600	31,100	12,100	2,100	12,300	23,100	103,700	109,400	0.05%
26	119,200	54,700	17,400	51,000	1,300	24,400	11,900	1,200	2,600	4,900	157,300	28,900	11,300	1,800	10,800	21,400	77,700	-30,800	0.14%
27	130,700	57,600	15,900	50,000	900	24,500	11,800	1,100	2,400	4,900	159,800	32,300	10,800	2,500	10,100	20,800	73,900	-20,300	0.03%
28	104,000	45,500	15,100	49,700	700	23,700	11,200	1,100	2,000	4,900	159,000	32,200	10,600	2,600	10,000	19,800	63,700	-50,300	0.20%
29	140,600	58,400	15,500	50,300	800	24,600	12,500	1,100	2,100	4,900	177,200	34,700	10,300	2,600	9,300	20,900	66,400	-20,800	0.13%
30	161,600	64,800	15,100	50,400	1,000	25,000	13,300	1,200	3,000	4,900	154,800	34,800	10,100	2,300	9,500	19,700	69,400	29,900	0.00%
31	184,300	60,100	17,800	50,700	800	24,700	10,500	1,200	2,100	4,900	175,900	32,300	10,500	2,400	10,000	22,600	76,800	16,300	0.14%
32	166,900	59,800	17,300	50,300	1,000	24,000	10,900	1,300	2,900	4,900	135,100	29,300	11,300	2,400	10,700	20,300	78,100	42,100	0.06%
33	218,500	55,100	18,300	49,900	1,200	23,900	10,900	1,300	2,700	4,900	158,800	29,700	11,700	2,000	11,600	23,700	93,900	45,200	0.08%
34	83,000	52,800	17,300	49,900	1,000	23,700	11,100	900	1,300	4,900	171,600	29,700	11,100	2,000	10,100	22,300	63,200	-74,400	0.21%
35	105,900	60,900	15,600	49,600	700	24,400	12,400	900	2,000	4,900	184,200	34,900	10,500	2,600	9,000	19,500	59,800	-53,100	0.04%
36	92,500	54,100	13,200	49,100	700	24,500	12,500	800	2,100	4,900	171,500	35,200	9,800	2,700	8,600	18,800	54,000	-56,200	0.08%
37	163,000	69,400	15,300	49,400	700	24,900	12,300	1,100	2,600	4,900	143,700	36,800	10,300	2,700	9,000	17,900	65,300	47,900	0.06%
38	183,900	62,400	17,500	49,600	1,200	24,200	10,300	1,100	2,400	4,900	131,000	30,500	10,600	2,200	10,000	21,600	82,800	58,800	0.06%
39	105,300	54,900	16,600	49,100	1,000	23,800	10,300	900	1,800	4,900	168,200	30,000	10,400	2,000	9,600	21,900	64,100	-47,800	0.15%
40	115,000	57,600	16,400	48,100	800	24,100	11,500	900	1,400	4,900	168,400	32,900	10,200	2,500	9,000	20,800	60,000	-32,900	0.00%
41	84,200	46,200	12,000	47,300	700	23,900	12,400	900	1,800	4,900	174,000	36,700	9,500	2,500	8,600	18,900	50,800	-76,800	0.13%
42	94,400	63,900	11,600	47,200	500	24,500	13,100	600	1,900	4,900	181,200	42,800	9,300	2,900	7,900	18,600	45,700	-55,700	0.04%
43	184,000	90,800	14,600	50,100	800	25,600	13,700	1,100	2,200	4,900	148,400	42,000	9,400	3,100	8,200	19,700	64,000	83,000	0.05%
44	138,200	75,900	16,000	50,900	800	24,800	10,200	1,000	2,000	4,900	154,900	34,500	9,600	2,500	8,800	21,100	59,900	23,300	0.09%
45	75,500	46,700	12,000	49,100	800	23,900	11,100	700	1,200	4,900	158,500	34,600	9,300	2,200	9,000	20,100	50,300	-68,100	0.09%
46	71,100	41,800	9,800	46,500	500	24,500	13,500	600	400	4,900	167,900	44,300	7,800	2,600	7,800	18,000	41,600	-86,500	0.14%
47	194,900	87,700	12,800	47,700	700	25,700	14,900	1,200	3,000	4,900	151,700	48,500	9,600	3,000	7,900	18,300	62,500	82,200	0.00%
48	109,700	67,600	14,300	49,200	800	24,700	10,200	900	1,900	4,900	167,300	35,800	8,600	2,400	8,100	19,400	50,400	-17,800	0.07%
49	201,100	70,100	15,800	49,400	1,000	24,800	11,500	1,100	2,000	4,900	146,500	36,800	9,900	2,200	9,300	21,300	72,200	73,400	0.08%
50	113,000	63,600	14,700	50,200	900	24,700	10,700	1,000	2,400	4,900	167,100	32,800	9,200	2,300	8,900	21,000	57,000	-22,000	0.00%
51	211,400	68,900	15,700	50,300	1,100	24,600	11,700	1,200	2,200	4,900	134,700	36,800	10,100	2,300	10,100	21,700	79,600	86,700	0.05%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-25. 2030 Projected Land Surface Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Precipitation	400,000	66%	281,950	441,750	519,400
	Applied Groundwater	164,100	27%	173,850	161,750	153,900
	Applied Surface Water	46,300	8%	46,350	46,200	46,400
Outflows	Deep Percolation to Groundwater	139,100	23%	95,300	154,750	182,800
	Evapotranspiration	310,700	51%	301,150	313,200	320,800
	Overland Flow	145,000	24%	72,850	169,650	218,800
	Return Flow to Streams	15,300	3%	15,250	14,950	15,700
Storage	Change in Soil and Unsaturated Zone Storage	400	-	-	-	-

* Percent contribution of component to average total inflow/outflow. Small discrepancies between inflow minus outflow and change in storage may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF .

Table 4D-26. Projected 2030 Annual Land Surface Budget

Simulation Water Year	Precipitation	Applied Groundwater	Applied Surface Water	Deep Percolation to Groundwater	Evapotranspiration	Overland Flow	Return Flow to Streams	Change in Soil and Unsaturated Zone Storage	% Error
1	453,100	157,600	48,300	190,000	322,900	152,000	18,800	-24,700	0.00%
2	402,100	159,800	46,200	127,900	312,200	140,300	14,300	13,200	0.03%
3	199,000	163,400	46,100	70,100	285,800	16,200	15,100	21,100	0.05%
4	198,200	172,800	46,100	66,800	293,700	20,200	15,200	21,000	0.05%
5	592,100	156,600	46,300	188,900	314,300	284,500	16,800	-9,600	0.01%
6	326,800	172,200	46,200	105,500	307,400	97,400	14,200	20,700	0.00%
7	481,100	151,400	46,200	192,900	326,500	176,400	13,200	-30,400	0.01%
8	360,600	172,000	46,200	109,300	319,100	111,000	16,200	23,300	-0.02%
9	498,800	139,600	46,200	204,800	330,000	164,200	14,500	-28,900	0.00%
10	735,100	136,700	46,100	255,900	328,600	367,900	19,500	-54,000	0.00%
11	418,000	180,900	46,100	118,000	304,300	190,400	14,200	17,900	0.03%
12	320,200	167,300	46,200	93,400	300,500	90,000	16,300	33,400	0.02%
13	510,900	163,600	46,200	174,500	324,200	220,800	16,100	-14,900	0.00%
14	224,600	186,800	46,100	74,400	284,500	56,900	15,300	26,400	0.00%
15	312,800	182,200	46,100	103,600	315,200	88,100	14,800	19,400	0.00%
16	333,200	163,000	46,500	100,200	313,500	80,100	19,300	29,600	0.00%
17	223,600	169,400	47,300	85,600	310,600	36,200	15,800	-8,000	0.02%
18	283,500	172,500	47,400	99,100	281,700	100,800	15,600	6,200	0.00%
19	374,700	177,500	46,100	121,700	315,100	132,600	14,800	14,000	0.02%
20	543,800	152,400	46,200	199,900	322,800	235,600	13,400	-29,400	0.01%
21	323,500	168,300	46,100	110,100	323,100	76,700	13,800	14,200	0.00%
22	821,900	149,000	46,200	249,400	315,700	496,300	13,800	-58,200	0.01%
23	514,700	163,700	46,200	159,700	328,200	217,100	13,800	5,700	0.01%
24	413,400	163,300	46,100	147,700	325,000	141,000	13,900	-4,800	0.00%
25	858,600	133,500	46,300	256,800	322,200	483,400	18,400	-42,400	0.00%
26	321,900	162,100	46,100	116,700	310,200	78,100	13,500	11,600	0.00%
27	385,800	164,700	46,200	128,200	317,200	123,000	13,700	14,400	0.03%
28	331,200	163,900	48,300	101,500	311,400	93,200	15,700	21,700	-0.02%
29	338,800	182,100	46,200	138,100	299,100	116,500	14,600	-1,300	0.02%
30	481,800	159,700	46,200	159,100	315,900	189,800	15,800	7,100	0.00%
31	435,600	180,800	46,200	181,800	300,100	190,900	14,300	-24,500	0.00%
32	516,900	140,000	46,100	164,400	330,500	185,700	15,800	6,500	0.01%
33	550,600	163,600	46,100	216,000	323,500	245,200	18,700	-43,100	0.00%
34	237,000	176,500	46,100	80,500	295,100	42,800	14,000	27,300	-0.02%
35	292,400	189,100	46,100	103,400	283,300	113,600	14,500	12,700	0.02%
36	300,800	176,400	46,100	90,000	308,600	81,600	13,900	29,100	0.02%
37	457,400	148,600	46,200	160,500	311,100	170,600	17,500	-7,400	-0.02%
38	456,800	135,900	46,100	181,400	321,200	150,400	12,800	-27,100	0.02%
39	324,400	173,100	46,100	102,800	301,000	105,400	15,000	19,400	0.00%
40	300,800	170,200	46,100	112,500	302,600	83,100	14,000	4,900	0.00%
41	278,200	178,900	46,100	81,700	308,100	72,700	14,000	26,700	0.00%
42	153,800	186,100	46,100	91,900	268,300	15,200	14,600	-4,000	0.00%
43	453,100	153,300	48,400	181,500	321,800	149,300	19,300	-17,200	0.02%
44	402,100	159,800	46,200	135,700	312,200	140,300	14,300	5,500	0.02%
45	199,000	163,400	46,100	73,000	285,800	16,200	15,100	18,200	0.05%
46	198,200	172,800	46,100	68,600	293,700	20,200	15,200	19,300	0.02%
47	592,100	156,600	46,300	192,400	314,300	284,500	16,800	-13,100	0.01%
48	326,800	172,200	46,200	107,200	307,400	97,400	14,200	19,000	0.00%
49	481,100	151,400	46,200	198,600	326,500	176,400	13,200	-36,100	0.01%
50	360,600	172,000	46,200	110,500	319,100	111,000	16,200	22,100	-0.02%
51	498,800	139,600	46,200	208,900	330,000	164,200	14,500	-33,000	0.00%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-27. Projected 2030 Sacramento River Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Basin	10,442,900	97%	7,051,600	10,138,100	15,179,800
	Inflow from Small Tributaries	32,200	0%	15,700	32,350	54,000
	Overland Flow	205,600	2%	101,950	236,000	316,300
	Irrigation Return Flows to Streams	25,200	0%	25,950	24,800	24,500
	Groundwater Discharge to Stream	56,600	1%	45,350	55,350	73,600
Outflows	Streambed Recharge	24,900	<1%	38,050	19,450	11,400
	Downstream Outflow South of Subbasin	9,844,800	91%	6,322,700	9,535,400	14,742,000
	Riparian ET	21,400	0%	23,400	20,700	19,200
	Agricultural Diversions	23,200	0%	23,200	23,200	23,200
	Flow to Glenn Colusa Canal	843,600	8%	828,450	883,250	847,500
	Flow to Flood Bypass	4,700	0%	4,700	4,700	4,700

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-28. Projected 2030 Annual Sacramento River Surface Water Budget

Simulation Water Year	Inflow from Upstream of Basin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow South of Subbasin	Riparian ET	Agricultural Diversions	Flow to Glenn Colusa Canal	Flow to Flood Bypass	% Error
1	18,403,900	54,800	231,100	26,600	60,500	15,800	17,857,600	19,700	23,200	855,800	4,700	0.17%
2	10,836,800	39,000	193,100	25,100	58,600	22,600	10,194,500	20,600	23,200	887,000	4,700	0.40%
3	6,141,300	13,900	24,300	25,100	51,600	37,200	5,465,000	23,700	23,200	702,300	4,700	1.18%
4	5,715,700	5,700	22,900	26,000	33,800	56,900	5,101,800	24,900	23,200	592,700	4,700	1.94%
5	13,163,000	49,900	387,200	24,300	48,700	20,400	12,768,800	19,100	23,200	836,800	4,700	0.30%
6	7,292,800	16,900	131,800	25,400	43,500	34,300	6,530,100	22,500	23,200	895,600	4,700	0.91%
7	11,139,600	37,200	240,800	23,800	68,800	3,600	10,584,200	19,600	23,200	874,900	4,700	0.06%
8	8,298,000	22,000	151,800	25,200	48,000	32,700	7,607,400	22,600	23,200	854,500	4,700	0.76%
9	15,647,200	49,800	245,500	23,300	79,500	800	15,220,600	17,900	23,200	778,100	4,700	0.01%
10	20,665,200	87,400	525,900	22,900	111,800	0	20,565,600	16,500	23,200	803,100	4,700	0.00%
11	12,762,400	45,900	272,300	26,000	70,200	17,600	12,236,100	23,000	23,200	872,200	4,700	0.27%
12	7,465,400	20,700	115,400	25,300	62,200	27,300	6,742,100	22,600	23,200	869,300	4,700	0.71%
13	13,410,200	51,900	316,600	24,600	74,900	9,200	12,954,300	20,100	23,200	866,700	4,700	0.13%
14	7,298,100	15,500	89,000	26,700	47,100	40,000	6,473,900	24,500	23,200	910,000	4,700	1.07%
15	7,158,300	14,100	130,000	26,300	40,400	43,500	6,388,800	24,200	23,200	884,600	4,700	1.18%
16	7,477,100	22,300	129,600	26,400	40,700	43,900	6,718,500	21,300	23,200	884,500	4,700	1.13%
17	5,895,500	13,100	54,100	26,500	37,800	40,900	5,040,900	23,000	23,200	894,300	4,700	1.35%
18	5,827,000	10,900	143,000	26,800	31,600	45,500	5,236,200	23,000	23,200	706,600	4,700	1.50%
19	6,616,800	12,900	173,200	26,000	28,800	46,200	6,070,500	22,900	23,200	690,200	4,700	1.34%
20	10,171,700	42,900	339,200	24,000	46,400	18,900	9,730,500	19,400	23,200	827,500	4,700	0.36%
21	7,227,800	16,700	98,900	25,100	45,200	36,800	6,428,500	22,400	23,200	898,200	4,700	0.99%
22	19,035,900	89,800	695,000	24,000	71,900	8,300	19,013,100	17,200	23,200	850,000	4,700	0.08%
23	12,847,100	44,400	296,900	24,900	61,300	13,800	12,373,600	20,800	23,200	838,400	4,700	0.21%
24	13,655,100	47,700	228,800	24,800	68,200	19,500	13,052,100	21,800	23,200	903,300	4,700	0.28%
25	19,003,600	85,100	664,500	22,400	104,000	1,600	19,056,500	15,100	23,200	778,300	4,700	0.02%
26	12,673,800	36,000	114,700	24,700	70,900	13,100	11,976,100	20,900	23,200	882,100	4,700	0.20%
27	12,277,900	35,200	178,900	24,900	62,200	23,500	11,639,500	21,200	23,200	867,000	4,700	0.37%
28	7,187,200	19,100	124,300	26,800	62,800	21,700	6,446,900	22,400	23,200	901,200	4,700	0.58%
29	9,100,100	24,300	169,800	26,300	55,300	22,400	8,395,500	23,100	23,200	906,800	4,700	0.48%
30	12,190,100	35,900	276,900	24,800	60,300	19,400	11,696,300	20,000	23,200	824,400	4,700	0.31%
31	12,371,700	40,000	269,900	26,100	62,800	13,600	11,694,400	22,900	23,200	1,011,700	4,700	0.21%
32	9,465,800	30,800	251,600	23,000	75,500	1,500	8,905,400	17,800	23,200	894,100	4,700	0.03%
33	17,338,800	66,100	376,400	25,400	93,000	1,500	17,001,900	19,700	23,200	848,600	4,700	0.02%
34	7,944,200	20,000	67,000	25,700	57,900	27,000	7,044,400	24,000	23,200	991,500	4,700	0.66%
35	7,621,100	17,700	152,500	26,600	50,300	30,500	6,814,500	24,900	23,200	970,400	4,700	0.77%
36	7,064,400	12,800	115,900	25,600	45,700	39,400	6,283,300	23,300	23,200	890,500	4,700	1.08%
37	8,425,400	24,400	234,700	24,900	57,400	14,800	7,844,100	19,300	23,200	860,700	4,700	0.34%
38	11,982,800	37,400	232,800	22,900	82,900	900	11,437,700	16,600	23,200	875,600	4,700	0.02%
39	8,099,100	27,000	153,000	26,000	57,500	18,800	7,397,400	22,400	23,200	896,100	4,700	0.45%
40	8,154,700	17,600	118,300	25,300	50,900	28,500	7,277,100	22,200	23,200	1,011,100	4,700	0.68%
41	5,917,700	13,500	100,400	25,700	44,600	39,500	5,300,100	23,900	23,200	710,400	4,700	1.29%
42	5,409,900	7,200	21,000	26,500	32,600	49,700	4,744,700	25,900	23,200	649,000	4,700	1.79%
43	18,225,700	43,900	228,000	26,500	45,800	26,300	17,640,200	19,700	23,200	855,800	4,700	0.28%
44	10,748,800	34,300	193,100	25,100	48,600	30,600	10,083,900	20,600	23,200	887,000	4,700	0.55%
45	6,090,700	11,300	24,300	25,100	44,800	42,900	5,399,500	23,700	23,200	702,300	4,700	1.37%
46	5,682,400	4,500	22,900	26,000	28,000	62,100	5,056,200	24,900	23,200	592,700	4,700	2.13%
47	13,131,400	49,200	387,200	24,300	43,200	24,600	12,726,800	19,100	23,200	836,800	4,700	0.36%
48	7,276,600	16,500	131,800	25,400	38,800	38,300	6,504,700	22,500	23,200	895,600	4,700	1.02%
49	11,125,200	36,900	240,800	23,800	64,700	6,900	10,562,200	19,600	23,200	874,900	4,700	0.12%
50	8,289,500	21,900	151,800	25,200	45,200	35,300	7,593,300	22,600	23,200	854,500	4,700	0.82%
51	15,638,800	49,700	245,500	23,300	75,300	1,100	15,207,600	17,900	23,200	778,100	4,700	0.01%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-29. Projected 2030 Stony Creek and Black Butte Lake Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Basin	442,300	93%	182,800	458,900	761,200
	Inflow from Small Tributaries	6,300	1%	3,150	7,050	9,900
	Overland Flow	22,900	5%	11,900	27,150	33,600
	Irrigation Return Flows to Streams	3,500	1%	3,050	3,650	4,100
	Groundwater Discharge to Stream	800	<1%	850	700	700
Outflows	Streambed Recharge	32,900	7%	24,300	44,550	35,500
	Downstream Outflow to Sacramento River	312,300	66%	54,400	313,900	642,100
	Riparian ET	9,200	2%	8,700	9,850	9,500
	Surface Water Diversions	44,500	9%	36,950	49,750	51,100
	Recharge to Groundwater from Black Butte Lake	17,100	4%	16,500	17,500	17,500
	Black Butte Lake Losses	60,000	13%	60,950	61,850	53,800

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-30. Projected 2030 Annual Stony Creek and Black Butte Lake Surface Water Budget

Simulation Water Year	Inflow from Upstream of Basin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow to Sacramento River	Riparian ET	Surface Water Diversions	Recharge to Groundwater from Black Butte Lake	Black Butte Lake Losses	% Error
1	801,300	10,900	23,600	5,300	400	44,600	602,800	9,700	52,800	17,000	114,600	0.00%
2	491,500	7,200	22,500	2,700	1,000	42,300	393,800	10,000	48,200	16,600	14,000	0.00%
3	96,700	1,400	3,100	2,600	1,600	12,000	1,700	8,700	33,400	15,400	34,200	0.00%
4	21,400	100	3,800	2,600	1,400	7,900	1,200	5,800	10,800	13,200	-9,600	0.00%
5	760,100	12,700	44,300	5,900	300	51,500	580,800	8,900	51,100	17,800	113,000	0.02%
6	206,000	4,400	16,500	3,100	800	48,300	91,900	10,000	45,300	16,500	18,800	0.00%
7	690,800	6,500	29,200	2,500	700	36,300	540,200	9,800	52,200	16,700	74,500	0.00%
8	241,500	5,300	18,700	5,100	800	39,600	86,000	10,000	45,800	17,500	72,300	0.07%
9	735,800	11,000	25,700	2,900	700	31,600	564,800	9,200	52,300	17,400	100,800	0.00%
10	1,405,100	14,600	57,800	9,100	1,200	8,700	1,354,800	8,600	56,700	17,800	41,200	0.00%
11	603,000	6,300	30,400	2,600	1,300	29,300	572,300	10,700	48,800	17,100	-34,700	0.02%
12	209,200	2,500	15,300	4,300	1,000	25,400	28,400	9,000	42,300	16,800	110,400	0.00%
13	753,700	9,000	33,400	5,200	1,200	35,500	628,800	9,500	46,000	16,700	65,900	0.01%
14	143,300	2,600	8,800	2,600	1,000	15,800	4,500	9,600	38,600	16,200	73,600	0.00%
15	200,100	3,500	14,600	2,600	800	23,500	92,800	9,000	38,000	16,400	41,900	0.00%
16	155,300	4,400	11,700	5,300	1,000	22,500	10,700	8,900	36,200	17,900	81,700	-0.11%
17	115,200	2,700	6,400	2,600	500	10,600	2,600	6,400	23,000	15,900	68,900	0.00%
18	124,600	2,100	16,600	2,700	800	18,700	6,300	8,400	35,900	17,000	60,400	0.07%
19	215,100	3,200	20,800	2,500	300	29,400	12,500	9,700	40,800	18,500	131,000	0.00%
20	630,000	9,000	37,500	2,400	600	48,700	531,800	9,200	40,100	18,700	31,100	-0.01%
21	147,400	3,000	10,700	2,600	300	26,100	10,400	8,800	45,600	15,800	57,200	0.06%
22	1,224,100	13,500	76,500	2,500	700	34,500	1,179,400	8,600	45,100	18,500	31,200	0.00%
23	636,900	8,300	29,700	2,500	400	44,500	487,900	10,800	48,000	18,300	68,500	-0.03%
24	596,700	7,600	22,200	2,500	500	33,400	453,800	9,500	49,400	16,400	67,100	-0.02%
25	1,182,200	15,700	73,500	10,000	800	11,000	1,160,300	7,700	55,300	18,800	29,000	0.01%
26	373,800	6,400	11,900	2,500	1,100	33,600	270,800	10,500	54,200	18,100	8,500	0.00%
27	338,800	6,800	19,800	2,500	800	34,800	162,200	10,600	52,300	17,900	91,000	-0.03%
28	216,000	4,400	14,900	2,500	1,100	25,900	38,600	10,400	43,500	17,100	103,300	0.04%
29	421,800	5,900	18,400	2,600	800	33,500	309,100	9,700	42,800	17,400	37,000	0.00%
30	472,200	8,000	28,900	4,900	700	39,500	276,700	9,400	43,300	18,900	127,000	-0.02%
31	557,900	6,800	29,200	2,600	1,100	33,900	429,800	11,200	56,600	17,100	49,000	0.00%
32	609,700	7,500	30,400	5,400	1,200	42,600	440,400	9,400	56,700	18,600	86,500	0.00%
33	855,500	11,100	37,200	4,200	1,300	22,700	718,700	10,100	56,700	18,500	82,600	0.00%
34	179,800	2,600	6,700	2,500	1,000	32,100	38,800	10,300	47,200	16,300	48,000	-0.05%
35	315,900	4,400	19,900	2,600	1,100	41,100	135,700	11,900	56,400	17,100	81,800	-0.03%
36	143,600	3,800	13,000	2,600	1,100	18,700	7,600	8,700	38,000	17,200	73,900	0.00%
37	386,800	7,900	27,600	5,100	900	53,600	229,100	10,100	54,700	18,300	62,600	-0.02%
38	491,200	8,400	22,100	2,400	800	38,300	361,600	9,000	52,800	17,900	45,300	0.00%
39	136,700	3,400	17,200	2,700	1,200	35,700	24,100	10,700	46,800	16,900	26,900	0.06%
40	327,100	4,400	13,100	2,600	500	31,000	180,200	8,700	41,200	16,200	70,300	0.03%
41	84,100	4,100	13,300	2,500	1,400	15,800	5,400	5,900	20,200	16,500	41,700	-0.09%
42	214,200	0	2,900	2,600	500	32,100	88,600	6,500	33,900	17,100	42,000	0.00%
43	801,300	10,600	23,400	5,700	0	62,700	585,800	9,500	52,400	17,200	113,600	-0.02%
44	491,500	7,200	22,500	2,700	400	56,100	381,500	9,300	47,400	16,700	13,200	0.02%
45	96,700	1,400	3,100	2,600	1,000	13,400	1,200	8,500	32,800	15,600	33,400	-0.10%
46	21,400	100	3,800	2,600	900	8,500	1,000	5,800	10,500	13,200	-10,100	-0.35%
47	760,100	12,700	44,300	5,900	0	58,600	574,900	8,500	50,700	18,000	112,200	0.01%
48	206,000	4,400	16,500	3,100	200	51,100	89,600	9,700	45,100	16,600	18,000	0.04%
49	690,800	6,500	29,200	2,500	0	45,000	531,900	9,600	52,000	16,800	73,800	-0.01%
50	241,500	5,300	18,700	5,100	200	42,200	83,800	9,800	45,600	17,600	71,600	0.07%
51	735,800	11,000	25,700	2,900	100	39,400	557,200	9,200	52,100	17,500	100,100	0.00%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-31. Projected 2030 Thomes Creek Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Basin	224,800	86%	107,200	233,400	370,400
	Inflow from Small Tributaries	13,300	5%	3,850	15,100	24,100
	Overland Flow	20,900	8%	8,700	24,450	33,700
	Irrigation Return Flows to Streams	1,000	<1%	1,100	1,050	1,000
	Groundwater Discharge to Stream	0	0%	0	0	0
Outflows	Streambed Recharge	30,900	12%	24,650	33,950	36,600
	Downstream Outflow to Sacramento River	224,500	86%	91,700	235,200	388,100
	Riparian ET	4,600	2%	4,550	4,700	4,500
	Surface water diversions	0	0%	0	0	0

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-32. Projected 2030 Annual Thomes Creek Surface Water Budget

Simulation Water Year	Inflow from Upstream of Basin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow to Sacramento River	Riparian ET	Surface water diversions	% Error
1	467,200	23,600	22,300	1,000	0	46,500	462,800	4,700	0	0.02%
2	288,100	18,700	22,500	1,000	0	35,800	289,500	5,100	0	-0.03%
3	65,700	100	800	1,100	0	24,600	37,900	5,200	0	0.00%
4	16,200	0	1,100	1,100	0	5,600	8,800	4,000	0	0.00%
5	381,900	27,600	47,500	1,000	0	47,000	406,300	4,700	0	0.00%
6	117,100	6,300	12,100	1,100	0	25,700	106,400	4,400	0	0.07%
7	318,300	16,400	25,700	1,000	0	41,600	315,300	4,400	0	0.03%
8	131,600	7,500	15,900	1,100	0	26,200	126,000	3,800	0	0.06%
9	417,200	20,200	21,500	900	0	42,300	413,100	4,400	0	0.00%
10	577,000	43,300	62,100	900	0	39,300	639,500	4,500	0	0.00%
11	259,400	15,000	27,100	1,100	0	27,100	270,600	4,800	0	0.03%
12	130,600	2,200	10,200	1,100	0	27,900	111,600	4,500	0	0.07%
13	365,300	21,800	34,600	1,000	0	31,900	386,300	4,400	0	0.02%
14	108,000	2,500	5,000	1,100	0	22,500	89,700	4,400	0	0.00%
15	143,400	4,400	13,400	1,100	0	29,300	128,900	4,000	0	0.06%
16	166,100	9,500	9,300	1,000	0	34,700	147,100	4,100	0	0.00%
17	74,900	2,600	3,700	1,100	0	27,500	50,200	4,600	0	0.00%
18	87,200	5,000	14,400	1,100	0	20,500	83,200	4,000	0	0.00%
19	126,700	6,100	17,900	1,100	0	27,000	120,400	4,400	0	0.00%
20	328,500	21,000	33,900	1,000	0	43,200	336,300	4,900	0	0.00%
21	60,500	3,000	8,200	1,100	0	22,100	47,100	3,600	0	0.00%
22	552,900	44,300	87,400	1,000	0	45,200	636,000	4,200	0	0.03%
23	383,600	20,100	28,600	1,000	0	36,400	392,300	4,600	0	0.00%
24	169,000	15,400	21,200	1,100	0	25,000	177,700	4,000	0	0.00%
25	459,600	45,000	81,800	900	0	36,000	547,100	4,100	0	0.02%
26	160,800	12,800	11,200	1,000	0	23,500	157,800	4,400	0	0.05%
27	177,000	11,200	18,600	1,000	0	24,100	178,700	4,900	0	0.05%
28	123,200	5,300	12,200	1,000	0	22,200	115,600	3,900	0	0.00%
29	155,300	10,200	14,200	1,100	0	27,900	149,000	4,000	0	-0.06%
30	213,700	17,600	27,600	1,000	0	30,000	225,400	4,600	0	-0.04%
31	275,800	15,900	27,500	1,100	0	29,300	286,300	4,600	0	0.03%
32	250,000	16,800	25,100	1,000	0	33,600	254,900	4,400	0	0.00%
33	407,100	26,800	36,100	1,000	0	27,200	439,400	4,300	0	0.02%
34	89,300	1,300	4,300	1,100	0	26,300	63,400	6,100	0	0.21%
35	151,000	8,000	13,400	1,200	0	27,600	140,300	5,700	0	0.00%
36	119,000	1,400	8,700	1,100	0	29,400	94,800	5,900	0	0.08%
37	233,600	15,000	21,000	1,000	0	36,400	229,200	4,900	0	0.04%
38	246,700	17,900	17,800	900	0	37,700	241,100	4,500	0	0.00%
39	109,300	11,100	14,100	1,100	0	28,800	101,100	5,700	0	0.00%
40	129,700	4,200	9,000	1,100	0	29,100	109,600	5,200	0	0.07%
41	71,500	2,100	7,600	1,100	0	22,100	54,700	5,500	0	0.00%
42	153,400	0	700	1,200	0	27,100	123,900	4,300	0	0.00%
43	467,200	21,800	21,800	1,000	0	49,900	457,000	4,700	0	0.04%
44	288,100	18,700	22,500	1,000	0	38,000	287,300	5,100	0	-0.03%
45	65,700	100	800	1,100	0	25,000	37,400	5,200	0	0.15%
46	16,200	0	1,100	1,100	0	5,600	8,800	4,000	0	0.00%
47	381,900	27,600	47,500	1,000	0	47,700	405,700	4,700	0	-0.02%
48	117,100	6,300	12,100	1,100	0	26,000	106,100	4,400	0	0.07%
49	318,300	16,400	25,700	1,000	0	42,400	314,500	4,400	0	0.03%
50	131,600	7,500	15,900	1,100	0	26,500	125,700	3,900	0	0.00%
51	417,200	20,200	21,500	900	0	43,200	412,100	4,400	0	0.02%

* All values are in acre-feet, rounded to nearest 100 AF.

Projected 2070 Period Water Budgets

Table 4D-33. 2070 Annual Groundwater Budget Summary, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Deep Percolation to Groundwater	140,300	45%	96,500	156,500	184,000
	Streambed Recharge	66,100	21%	57,300	73,100	71,800
	Inflow from Colusa	14,300	5%	12,800	14,850	16,200
	Inflow from Red Bluff	49,800	16%	49,350	50,100	50,400
	Inflow from Butte	800	<1%	650	850	1,000
	Inflow from Los Molinos	25,000	8%	24,900	25,300	24,800
	Inflow from Vina	12,600	4%	24,900	25,300	24,800
	Inflow from Foothills	1,100	<1%	850	1,100	1,200
	Recharge to Groundwater from Black Butte Lake	2,100	1%	1,750	2,400	2,300
Outflows	Urban and Domestic Pumping	4,900	2%	4,900	4,900	4,900
	Agricultural Pumping	167,300	54%	177,400	164,950	156,500
	Outflow to Colusa	37,400	12%	38,250	38,150	34,800
	Outflow to Red Bluff	9,800	3%	9,350	9,600	10,600
	Outflow to Butte	2,500	1%	2,500	2,500	2,300
	Outflow to Los Molinos	8,900	3%	8,400	8,650	9,800
	Outflow to Vina	20,100	6%	18,950	19,900	21,800
	Groundwater Discharge to Streams	61,500	20%	51,050	61,800	75,500
Storage	Annual Change of Groundwater in Storage	-400	-	-53,950	25,700	47,400
	Cumulative Change of Groundwater in Storage from WY 1974 to WY 2015	-19,700	-	-	-	-

* Percent contribution of component to average total inflow/outflow. Small discrepancies between inflow minus outflow and change in storage may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-34. Projected 2070 Annual Groundwater Budget

Simulation Water Year	Deep Percolation to Groundwater	Streambed Recharge	Inflow from Colusa	Inflow from Red Bluff	Inflow from Butte	Inflow from Los Molinos	Inflow from Vina	Inflow from Foothills	Recharge to Groundwater from Black Butte Lake	Urban and Domestic Pumping	Agricultural Pumping	Outflow to Colusa	Outflow to Red Bluff	Outflow to Butte	Outflow to Los Molinos	Outflow to Vina	Groundwater Discharge to Streams	Annual Change of Groundwater in Storage	% Error
1	193,100	80,800	17,300	48,500	800	24,200	12,300	1,600	2,100	4,900	160,400	33,600	11,000	2,900	9,400	22,300	73,000	62,800	0.11%
2	127,300	68,600	17,300	49,500	800	24,200	10,300	1,400	1,900	4,900	162,200	29,400	10,900	2,400	9,400	22,200	64,100	-4,600	0.13%
3	66,800	44,600	13,500	48,300	700	23,400	10,800	1,000	1,100	4,900	168,200	30,200	10,100	2,300	9,300	21,200	51,900	-88,300	0.19%
4	67,100	40,900	10,300	46,200	500	24,000	12,800	900	300	4,900	177,700	40,600	8,300	2,700	7,900	18,800	42,000	-100,300	0.20%
5	189,600	88,300	13,200	47,500	700	25,600	15,200	1,500	2,900	4,900	156,300	45,400	10,000	3,200	7,900	19,200	63,000	74,300	0.08%
6	109,300	67,700	15,100	49,300	700	24,800	10,500	1,100	1,900	4,900	175,100	33,600	8,900	2,500	8,100	20,000	50,900	-23,900	0.11%
7	192,300	71,600	16,200	49,800	900	24,800	11,500	1,200	1,900	4,900	156,800	34,600	10,000	2,300	9,100	22,000	70,700	59,300	0.14%
8	113,200	65,100	15,400	50,600	800	24,800	10,600	1,200	2,400	4,900	175,400	31,000	9,300	2,400	8,600	21,400	56,100	-25,300	0.11%
9	204,500	69,400	16,200	50,300	1,000	24,700	11,400	1,200	2,100	4,900	139,400	35,200	10,100	2,400	9,900	22,300	77,300	79,200	0.03%
10	256,600	62,100	19,700	49,500	1,300	23,500	11,200	1,500	2,600	4,900	137,400	26,800	12,500	2,000	12,300	23,800	101,200	106,900	0.05%
11	122,100	59,300	17,400	51,100	1,300	24,900	13,100	1,100	2,100	4,900	182,900	29,700	11,800	1,700	10,200	22,500	75,300	-47,000	0.14%
12	89,600	52,500	14,200	49,800	700	23,900	12,900	900	1,700	4,900	169,300	33,700	11,300	2,600	9,900	19,900	60,400	-65,900	0.04%
13	180,900	64,800	14,300	49,300	900	25,100	15,000	1,200	1,800	4,900	165,100	38,200	11,000	2,600	9,800	19,800	77,600	24,000	0.08%
14	74,700	50,800	13,100	49,400	800	24,800	12,800	800	1,600	4,900	188,100	33,400	10,000	2,300	8,500	18,600	50,200	-87,600	0.17%
15	107,700	63,400	12,500	49,400	600	25,500	14,800	900	1,500	4,900	186,800	40,800	9,600	2,700	8,000	17,800	50,300	-44,700	0.04%
16	98,800	64,600	10,800	49,100	700	25,700	16,200	1,000	2,500	4,900	163,400	43,200	9,500	2,600	7,800	16,100	47,900	-26,200	0.07%
17	92,100	54,900	10,600	48,600	800	25,600	14,900	900	1,300	4,900	176,300	44,900	8,900	2,300	7,800	15,900	44,700	-56,200	0.08%
18	100,000	57,400	9,900	47,700	600	26,300	16,000	800	2,000	4,900	174,900	46,400	8,200	2,500	7,300	15,200	44,500	-43,200	0.00%
19	126,800	68,600	11,000	49,000	700	27,000	15,800	900	2,900	4,900	179,500	45,600	7,900	2,500	6,900	15,700	44,000	-4,600	0.10%
20	201,100	85,100	15,300	51,600	800	26,900	13,300	1,200	3,000	4,900	158,200	40,000	8,800	2,500	7,500	18,600	59,900	97,600	0.08%
21	105,200	52,200	12,800	50,200	700	24,900	11,200	900	1,200	4,900	172,600	35,200	8,200	2,300	8,300	19,100	49,900	-41,500	0.12%
22	246,600	86,300	14,600	49,800	1,100	25,300	14,400	1,300	3,000	4,900	151,700	42,100	9,900	2,300	9,300	21,200	81,400	119,400	0.05%
23	167,700	76,100	16,300	52,300	1,000	25,400	11,200	1,200	2,800	4,900	168,500	32,900	10,200	2,100	9,200	21,400	67,300	37,400	0.03%
24	150,400	62,700	15,600	51,000	1,000	24,800	11,900	1,000	1,500	4,900	168,400	34,500	9,900	2,200	9,800	23,900	72,300	-6,300	0.09%
25	242,800	67,700	15,800	49,600	1,200	24,400	13,700	1,700	3,000	4,900	137,300	34,700	11,600	2,100	11,400	22,200	92,700	102,900	0.02%
26	119,100	62,500	16,900	50,800	1,000	24,800	11,300	1,200	2,600	4,900	166,400	30,800	10,800	2,100	10,200	21,700	70,700	-27,600	0.07%
27	132,500	63,700	15,200	50,400	800	25,000	11,700	1,100	2,400	4,900	168,400	34,700	10,300	2,500	9,600	21,200	69,100	-18,100	0.07%
28	106,300	50,300	14,400	50,300	700	24,200	11,000	1,000	2,000	4,900	167,800	34,400	10,100	2,600	9,400	19,700	59,400	-48,400	0.12%
29	136,900	64,200	14,900	50,900	700	25,000	12,700	1,000	2,200	4,900	185,700	37,500	9,800	2,700	8,900	20,800	61,800	-23,900	0.10%
30	160,400	71,800	14,000	51,100	900	25,600	13,700	1,200	3,100	4,900	162,000	38,100	9,700	2,400	9,000	19,800	65,600	30,200	0.03%
31	183,200	67,000	17,200	51,500	800	25,200	10,800	1,100	2,100	4,900	183,500	35,000	10,100	2,500	9,400	22,200	71,800	19,100	0.11%
32	161,400	66,800	16,400	51,200	1,000	24,500	10,900	1,200	2,900	4,900	144,600	32,000	10,800	2,400	10,000	20,000	71,800	39,800	0.00%
33	221,300	60,600	17,600	50,700	1,200	24,300	10,900	1,300	2,700	4,900	165,200	31,600	11,300	2,000	11,100	23,700	89,700	51,100	0.00%
34	81,400	56,900	16,400	50,500	900	24,100	10,900	800	1,400	4,900	178,700	31,400	10,700	2,000	9,600	22,100	59,100	-75,500	0.12%
35	107,200	65,900	14,800	50,400	600	25,000	13,000	900	2,100	4,900	191,900	37,400	10,100	2,700	8,500	19,200	56,900	-52,200	0.18%
36	90,200	58,300	12,500	49,900	600	25,000	13,200	800	2,100	4,900	179,700	37,900	9,500	2,800	8,200	18,800	50,700	-59,900	0.00%
37	161,400	76,400	14,500	50,300	700	25,400	13,400	1,100	2,700	4,900	153,600	41,200	9,900	2,700	8,500	17,500	60,600	46,700	0.09%
38	180,500	69,600	16,500	50,400	1,100	24,800	10,500	1,000	2,500	4,900	140,900	33,400	10,200	2,300	9,400	20,500	75,800	59,400	0.03%
39	106,100	59,200	15,600	49,700	1,000	24,300	10,100	900	1,900	4,900	175,400	32,000	10,000	2,000	9,000	21,500	59,700	-46,100	0.15%
40	114,500	62,200	15,500	48,900	700	24,600	11,800	800	1,400	4,900	176,600	35,900	9,800	2,500	8,600	20,500	56,100	-34,400	-0.04%
41	84,600	50,500	11,200	48,000	600	24,500	13,000	800	1,800	4,900	182,200	39,600	9,100	2,600	8,200	18,500	47,700	-78,100	0.13%
42	94,300	69,300	11,100	48,000	400	25,100	13,900	600	1,900	4,900	189,000	46,200	9,000	3,000	7,600	18,400	42,600	-56,100	0.00%
43	184,000	100,700	14,100	50,700	700	26,400	14,400	1,100	2,200	4,900	156,800	45,600	9,200	3,300	7,700	19,300	59,700	87,200	0.15%
44	136,500	82,000	14,600	51,800	800	25,500	10,900	1,000	2,000	4,900	162,200	38,000	9,400	2,500	8,400	20,400	55,800	23,300	0.06%
45	70,600	50,000	11,000	49,800	800	24,400	11,700	700	1,200	4,900	168,200	37,800	8,900	2,200	8,500	19,600	46,500	-76,600	0.09%
46	69,100	45,500	9,000	47,200	500	25,000	14,700	600	400	4,900	177,700	48,600	7,400	2,600	7,400	18,000	38,100	-92,900	0.09%
47	193,200	95,100	11,800	48,300	700	26,500	16,700	1,200	3,100	4,900	156,300	53,400	9,300	3,100	7,500	18,200	58,500	85,100	0.08%
48	112,200	73,000	13,100	50,100	800	25,600	11,700	900	2,000	4,900	175,100	40,200	8,300	2,400	7,700	18,500	47,100	-15,300	0.17%
49	198,700	78,700	14,800	50,600	1,000	25,600	12,500	1,000	2,000	4,900	156,800	41,000	9,500	2,300	8,700	20,500	66,300	74,600	0.08%
50	114,900	68,600	13,700	51,200	800	25,300	11,300	1,100	2,500	4,900	175,400	35,900	8,800	2,300	8,300	20,500	53,400	-20,300	0.07%
51	209,900	75,000	15,000	51,100	1,100	25,100	11,900	1,100	2,200	4,900	139,400	40,400	9,700	2,300	9,600	21,200	73,800	91,000	0.03%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-35. Projected 2070 Land Surface Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Precipitation	413,700	65%	290,250	460,400	536,600
	Applied Groundwater	172,100	27%	182,150	169,850	161,400
	Applied Surface Water	46,400	7%	46,350	46,200	46,700
Outflows	Deep Percolation to Groundwater	137,800	22%	93,950	154,000	181,400
	Evapotranspiration	319,800	51%	309,200	322,550	331,300
	Overland Flow	158,500	25%	81,400	188,200	235,000
	Return Flow to Streams	15,400	2%	15,450	15,000	15,700
Storage	Change in Soil and Unsaturated Zone Storage	600	-	-	-	-

* Percent contribution of component to average total inflow/outflow. Small discrepancies between inflow minus outflow and change in storage may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF

Table 4D-36. Projected 2070 Annual Land Surface Budget

Simulation Water Year	Precipitation	Applied Groundwater	Applied Surface Water	Deep Percolation to Groundwater	Evapotranspiration	Overland Flow	Return Flow to Streams	Change in Soil and Unsaturated Zone Storage	% Error
1	463,000	165,300	48,300	190,600	334,400	159,900	18,800	-27,200	0.01%
2	423,000	167,100	46,200	124,700	322,100	158,400	14,500	16,500	0.02%
3	189,700	173,100	46,100	64,300	291,200	13,300	17,000	23,000	0.02%
4	193,000	182,600	46,100	64,600	300,400	18,000	14,400	24,200	0.02%
5	627,900	161,200	46,200	187,100	324,800	314,600	16,800	-7,900	-0.01%
6	345,100	180,000	46,200	106,800	316,200	114,800	14,300	19,200	0.00%
7	490,000	161,700	46,200	189,800	335,700	189,400	13,300	-30,400	0.01%
8	382,000	180,300	46,200	110,700	327,700	129,800	16,600	23,800	-0.02%
9	511,400	144,300	46,200	202,000	343,200	170,200	13,100	-26,800	0.03%
10	765,700	142,300	46,200	254,100	340,100	396,500	17,200	-53,800	0.01%
11	436,600	187,800	46,100	119,600	314,100	206,500	14,600	15,700	0.00%
12	327,300	174,200	46,200	87,100	311,000	92,300	16,400	40,900	0.00%
13	535,400	170,000	46,200	178,400	335,100	242,600	16,400	-20,900	0.00%
14	238,800	193,000	46,100	72,100	295,100	65,700	16,000	28,900	0.02%
15	320,600	191,700	46,100	105,200	322,300	99,900	14,900	16,100	0.00%
16	351,700	168,300	46,700	96,300	322,900	93,300	17,200	36,900	0.02%
17	220,100	181,200	47,200	89,600	319,200	37,700	15,500	-13,600	0.02%
18	298,800	179,800	47,400	97,400	290,600	113,700	16,100	8,000	0.04%
19	395,500	184,400	46,100	124,300	325,400	149,400	15,300	11,600	0.00%
20	566,400	163,100	46,100	198,600	332,200	260,700	13,600	-29,500	0.00%
21	329,300	177,500	46,100	102,700	330,900	84,700	14,300	20,200	0.02%
22	856,100	156,600	46,100	244,100	326,900	532,200	14,200	-58,600	0.00%
23	547,000	173,300	48,300	165,200	337,500	248,900	16,300	700	0.00%
24	429,800	173,300	46,100	147,900	333,100	160,600	13,700	-6,100	0.00%
25	863,300	142,200	46,200	240,300	335,300	491,700	17,400	-33,200	0.02%
26	320,100	171,300	48,100	116,600	319,900	77,900	15,800	9,200	0.02%
27	398,200	173,200	46,200	129,900	325,200	137,000	13,900	11,500	0.02%
28	348,000	172,700	48,100	103,800	317,500	110,900	15,700	20,800	0.02%
29	338,700	190,600	46,200	134,400	307,800	118,800	14,800	-300	0.00%
30	503,800	166,900	46,200	157,900	325,500	210,400	15,900	7,200	0.00%
31	452,200	188,400	46,200	180,700	309,300	207,700	14,600	-25,600	0.01%
32	527,800	149,500	46,100	158,900	339,600	200,300	16,300	8,100	0.03%
33	575,900	170,100	46,100	218,800	332,100	267,800	18,200	-45,000	0.03%
34	242,700	183,600	46,100	78,900	302,900	48,700	14,300	27,600	0.00%
35	315,800	196,800	46,100	104,600	292,500	134,500	14,900	12,100	0.02%
36	307,800	184,600	46,200	87,700	314,800	92,200	14,300	29,400	0.04%
37	471,500	158,500	46,200	158,900	319,600	188,200	16,900	-7,400	0.00%
38	461,700	145,800	46,100	178,000	328,900	160,200	13,200	-26,800	0.02%
39	345,200	180,300	46,100	103,600	311,600	120,900	15,200	20,300	0.00%
40	307,800	178,500	46,200	112,000	308,900	93,500	14,100	3,900	0.02%
41	291,000	187,100	46,100	82,100	316,700	84,200	14,400	26,800	0.00%
42	157,100	193,900	46,100	91,800	277,100	17,100	15,000	-3,900	0.00%
43	463,000	161,700	48,300	181,500	333,100	157,400	20,300	-19,300	0.00%
44	423,000	167,100	46,200	134,000	322,100	158,400	14,500	7,300	0.00%
45	189,700	173,100	46,100	68,100	291,200	13,300	17,100	19,200	0.00%
46	193,000	182,600	46,100	66,600	300,400	18,000	14,400	22,200	0.02%
47	627,900	161,200	46,200	190,700	324,800	314,600	16,800	-11,500	-0.01%
48	345,100	180,000	46,200	109,700	316,200	114,800	14,300	16,200	0.02%
49	490,000	161,700	46,200	196,200	335,700	189,400	13,300	-36,900	0.03%
50	382,000	180,300	46,200	112,400	327,700	129,800	16,600	22,000	0.00%
51	511,400	144,300	46,200	207,400	343,200	170,200	13,100	-32,200	0.03%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-37. Sacramento River 2070 Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Basin	10,700,800	97%	7,076,500	10,478,300	15,689,000
	Inflow from Small Tributaries	33,400	<1%	15,300	34,500	56,500
	Overland Flow	226,200	2%	114,150	263,750	342,700
	Irrigation Return Flows to Streams	25,800	<1%	26,450	25,500	25,300
	Groundwater Discharge to Stream	49,300	<1%	38,900	48,450	64,500
Outflows	Streambed Recharge	31,000	<1%	44,000	26,450	16,600
	Downstream Outflow South of Subbasin	10,115,400	92%	6,357,150	9,890,000	15,265,400
	Riparian ET	22,700	<1%	24,750	22,000	20,500
	Agricultural Diversions	23,200	<1%	23,200	23,200	23,200
	Flow to Glenn Colusa Canal	838,600	8%	817,500	884,150	847,600
	Flow to Flood Bypass	4,700	<1%	4,700	4,700	4,700

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF

Table 4D-38. Projected 2070 Annual Sacramento River Surface Water Budget

Simulation Water Year	Inflow from Upstream of Basin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow South of Subbasin	Riparian ET	Agricultural Diversions	Flow to Glenn Colusa Canal	Flow to Flood Bypass	% Error
1	18,752,800	58,600	248,900	27,100	60,000	18,500	18,224,300	20,800	23,200	855,800	4,700	0.19%
2	11,297,600	40,300	216,500	25,500	54,700	28,500	10,666,600	21,800	23,200	889,700	4,700	0.49%
3	6,135,900	12,300	20,000	26,200	46,000	42,900	5,441,900	25,400	23,200	702,300	4,700	1.37%
4	5,039,000	4,500	21,000	26,200	30,500	60,400	4,541,600	26,600	23,200	464,700	4,700	2.33%
5	13,908,600	55,900	431,300	24,700	42,700	27,700	13,550,300	20,000	23,200	837,300	4,700	0.38%
6	7,524,500	17,300	155,700	26,000	38,500	38,900	6,770,000	23,800	23,200	901,500	4,700	1.00%
7	11,382,700	37,800	259,800	24,500	61,700	13,700	10,828,800	21,100	23,200	874,900	4,700	0.23%
8	8,521,800	22,700	180,400	25,900	42,400	35,800	7,850,000	23,900	23,200	855,600	4,700	0.81%
9	15,532,100	50,300	255,200	23,400	68,300	1,600	15,099,800	18,800	23,200	781,200	4,700	0.02%
10	21,681,300	91,900	568,500	24,200	99,900	700	21,625,700	17,500	23,200	794,000	4,700	0.01%
11	13,025,000	47,500	299,100	26,500	66,400	22,400	12,519,100	24,100	23,200	871,000	4,700	0.33%
12	7,083,400	18,900	115,600	25,700	56,800	33,100	6,350,900	23,700	23,200	864,900	4,700	0.90%
13	14,392,800	54,600	348,600	25,200	66,300	19,500	13,949,000	21,200	23,200	870,000	4,700	0.26%
14	7,320,800	15,600	102,600	27,500	42,700	43,400	6,502,500	25,500	23,200	910,000	4,700	1.15%
15	7,741,800	14,800	146,500	26,800	31,500	52,100	6,971,000	25,700	23,200	884,600	4,700	1.30%
16	7,728,900	22,400	148,500	25,800	33,600	52,800	6,978,600	22,200	23,200	877,700	4,700	1.32%
17	6,356,000	12,000	56,900	27,100	28,400	51,500	5,482,300	24,500	23,200	894,300	4,700	1.58%
18	5,222,800	10,700	163,300	27,600	28,900	46,100	4,648,500	24,200	23,200	706,600	4,700	1.68%
19	6,685,200	13,100	194,000	26,700	22,800	51,800	6,147,700	24,000	23,200	690,200	4,700	1.48%
20	10,012,900	48,900	378,200	24,600	40,900	22,800	9,612,200	20,900	23,200	821,600	4,700	0.43%
21	7,096,700	15,700	110,600	26,000	37,200	45,500	6,293,800	23,900	23,200	895,000	4,700	1.24%
22	19,304,300	94,900	751,800	24,600	61,300	16,700	19,323,800	18,500	23,200	850,000	4,700	0.16%
23	14,093,500	48,600	340,300	27,800	53,800	21,800	13,647,400	22,400	23,200	844,300	4,700	0.30%
24	14,947,900	51,700	265,600	25,400	60,200	27,500	14,368,500	23,300	23,200	903,500	4,700	0.36%
25	19,704,100	87,500	686,500	23,100	81,000	4,600	19,767,300	16,500	23,200	765,700	4,700	0.05%
26	12,613,100	35,200	114,800	27,400	61,000	21,900	11,893,600	22,200	23,200	885,700	4,700	0.34%
27	12,881,900	36,000	201,000	25,500	54,800	30,300	12,251,300	22,800	23,200	867,000	4,700	0.46%
28	7,608,800	18,000	145,600	27,200	54,100	29,900	6,867,200	23,700	23,200	904,900	4,700	0.76%
29	9,150,300	23,100	174,500	26,900	48,400	29,200	8,435,100	24,600	23,200	906,300	4,700	0.62%
30	13,060,700	38,100	312,200	25,600	52,800	28,500	12,588,700	21,300	23,200	823,000	4,700	0.42%
31	12,953,800	43,200	297,300	26,700	56,100	18,900	12,293,800	24,300	23,200	1,012,300	4,700	0.28%
32	9,383,300	28,800	268,800	24,700	66,900	10,200	8,820,800	19,400	23,200	894,200	4,700	0.21%
33	18,283,000	70,100	419,500	25,700	85,400	2,200	17,984,200	20,800	23,200	848,500	4,700	0.02%
34	8,030,000	19,400	75,200	26,300	51,200	33,500	7,123,300	25,300	23,200	992,100	4,700	0.81%
35	7,949,200	19,300	183,900	27,200	44,800	33,900	7,165,600	26,000	23,200	971,000	4,700	0.82%
36	7,100,200	13,100	129,400	26,300	39,400	45,600	6,319,000	24,800	23,200	891,100	4,700	1.24%
37	8,725,300	27,100	264,400	25,400	50,300	21,000	8,162,000	20,700	23,200	860,800	4,700	0.46%
38	12,136,000	39,500	249,600	23,600	68,500	1,900	11,593,500	18,100	23,200	875,800	4,700	0.03%
39	8,164,800	29,100	175,400	26,500	50,700	25,600	7,473,100	23,500	23,200	896,300	4,700	0.61%
40	8,190,600	17,600	131,600	25,900	44,100	34,800	7,311,600	23,700	23,200	1,011,800	4,700	0.82%
41	5,964,600	13,500	117,300	26,400	37,900	45,400	5,350,500	25,200	23,200	710,600	4,700	1.46%
42	5,472,300	7,000	23,900	27,000	25,700	56,400	4,795,100	27,200	23,200	649,400	4,700	2.01%
43	18,544,600	47,500	246,100	27,200	39,300	34,300	17,966,000	20,800	23,200	855,800	4,700	0.36%
44	11,195,800	35,600	216,500	25,500	41,400	38,900	10,536,400	21,800	23,200	889,700	4,700	0.67%
45	6,078,500	9,800	20,000	26,200	36,600	50,600	5,364,900	25,400	23,200	702,300	4,700	1.63%
46	5,001,000	3,400	21,000	26,200	22,600	67,600	4,487,500	26,600	23,200	464,700	4,700	2.63%
47	13,867,800	55,100	431,300	24,700	35,300	33,500	13,495,600	20,000	23,200	837,300	4,700	0.46%
48	7,501,700	16,800	155,700	26,000	32,000	44,500	6,734,700	23,800	23,200	901,500	4,700	1.14%
49	11,363,000	37,500	259,800	24,500	56,100	18,400	10,798,500	21,100	23,200	874,900	4,700	0.31%
50	8,509,100	22,600	180,400	25,900	38,500	39,300	7,829,600	23,900	23,200	855,600	4,700	0.89%
51	15,519,800	50,300	255,200	23,400	64,100	3,600	15,081,100	18,800	23,200	781,200	4,700	0.05%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-39. Stony Creek and Black Butte Lake Projected 2070 Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Basin	447,800	93%	184,350	467,850	768,500
	Inflow from Small Tributaries	6,600	1%	3,250	7,400	10,400
	Overland Flow	25,100	5%	13,350	30,200	36,300
	Irrigation Return Flows to Streams	3,400	1%	3,150	3,300	3,700
	Groundwater Discharge to Stream	600	<1%	650	500	600
Outflows	Streambed Recharge	36,500	8%	25,300	49,600	41,700
	Downstream Outflow to Sacramento River	339,000	70%	63,900	343,400	688,300
	Riparian ET	9,400	2%	8,850	10,200	9,800
	Surface Water Diversions	43,600	9%	36,350	48,100	50,700
	Recharge to Groundwater from Black Butte Lake	17,100	4%	16,550	17,550	17,600
	Black Butte Lake Losses	37,700	8%	53,800	40,450	11,400

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF

Table 4D-40. Projected 2070 Annual Stony Creek and Black Butte Lake Surface Water Budget

Simulation Water Year	Inflow from Upstream of Basin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow to Sacramento River	Riparian ET	Surface Water Diversions	Recharge to Groundwater from Black Butte Lake	Black Butte Lake Losses	% Error
1	819,400	11,300	24,500	5,300	400	46,800	666,400	10,100	52,800	17,000	67,600	0.02%
2	493,100	8,000	25,600	2,600	1,000	42,800	453,400	9,800	46,700	16,600	-39,100	0.02%
3	87,900	1,400	2,600	3,700	1,600	11,000	1,600	8,400	30,500	15,400	30,200	0.10%
4	18,200	0	3,300	2,700	1,400	8,100	700	6,100	10,300	13,200	-12,600	-0.78%
5	789,100	13,300	49,000	5,700	200	55,300	669,800	8,900	47,100	17,800	58,200	0.02%
6	203,900	5,100	19,400	2,800	800	48,500	119,700	10,300	45,000	16,500	-8,000	0.00%
7	699,600	6,300	31,100	2,500	600	43,600	548,200	10,000	46,100	16,700	75,600	-0.01%
8	257,000	5,800	21,900	5,100	700	41,500	120,300	10,300	45,000	17,500	55,900	0.00%
9	742,300	10,800	26,400	2,600	600	39,300	592,900	9,600	52,000	17,400	71,500	0.00%
10	1,442,600	15,500	62,600	5,400	1,100	16,200	1,428,300	9,100	56,700	17,900	-900	-0.01%
11	623,600	6,800	33,000	2,600	1,200	27,600	606,400	10,500	50,000	17,100	-44,400	0.00%
12	202,000	2,300	15,900	4,300	900	24,500	30,000	8,800	38,300	16,900	107,000	-0.04%
13	775,500	9,700	36,800	5,200	1,100	33,500	699,000	9,200	45,400	16,800	24,400	0.00%
14	147,800	2,800	10,100	2,600	900	19,200	4,800	10,300	41,100	16,200	72,700	-0.06%
15	204,000	3,800	16,400	2,600	600	24,300	138,400	8,500	36,000	16,400	3,700	0.04%
16	149,600	4,400	14,100	5,000	800	18,300	6,800	8,500	35,200	17,900	87,100	0.06%
17	107,300	2,600	6,600	2,600	400	11,400	2,600	7,000	25,200	16,000	57,300	0.00%
18	111,400	2,100	18,700	2,700	700	20,000	6,600	8,300	38,100	17,000	45,500	0.07%
19	216,300	3,500	23,500	2,600	100	31,600	16,400	9,900	42,000	18,600	127,400	0.04%
20	640,100	9,100	41,600	2,500	500	56,900	628,600	9,500	40,500	18,700	-60,500	0.01%
21	142,900	3,000	12,000	2,600	200	19,800	5,500	9,100	42,500	15,900	67,900	0.00%
22	1,204,600	14,600	83,400	2,500	500	47,000	1,228,900	9,000	43,600	18,500	-41,300	-0.01%
23	693,800	9,000	34,800	2,600	300	49,700	621,500	11,200	45,900	18,400	-6,300	0.01%
24	642,500	8,300	25,500	2,500	400	33,600	521,900	9,600	49,600	16,500	48,000	0.00%
25	1,096,200	15,800	75,400	6,400	500	27,500	1,188,100	8,400	55,300	18,900	-103,900	0.00%
26	353,700	6,400	11,900	2,500	900	44,200	261,400	10,900	53,800	18,100	-13,000	0.00%
27	339,800	7,400	22,000	2,500	500	40,200	180,700	11,000	51,100	17,900	71,300	0.00%
28	215,700	4,500	17,900	2,500	800	28,400	51,800	10,600	44,700	17,100	88,700	0.04%
29	415,100	6,100	18,900	2,600	500	39,700	321,000	9,800	45,400	17,400	9,700	0.05%
30	487,500	8,500	32,100	4,400	400	43,600	309,900	9,800	42,600	18,900	108,100	0.00%
31	583,400	7,200	32,000	2,600	800	42,400	448,700	11,700	56,500	17,200	49,700	-0.03%
32	622,100	7,300	33,000	2,400	900	51,500	438,900	10,200	56,700	18,700	89,600	0.02%
33	893,500	11,600	40,500	5,500	900	29,700	745,500	10,700	56,700	18,600	90,900	-0.01%
34	180,300	2,800	7,800	2,600	700	34,900	42,800	10,400	45,900	16,300	43,900	0.00%
35	353,700	5,100	23,400	2,600	800	44,000	164,100	12,400	56,200	17,100	91,800	0.00%
36	132,200	3,900	14,700	2,600	900	19,200	7,200	9,100	36,200	17,300	65,200	0.06%
37	394,500	8,100	30,700	4,800	600	59,800	239,000	10,800	53,900	18,300	56,800	0.02%
38	460,800	8,200	23,600	2,400	500	48,700	334,100	9,600	52,300	18,000	32,800	0.00%
39	126,000	3,700	19,700	2,600	900	38,800	22,000	10,700	46,100	17,000	18,400	-0.07%
40	354,000	4,300	14,800	2,600	200	34,100	205,300	8,800	39,800	16,300	71,800	-0.05%
41	75,500	4,100	15,500	2,500	1,200	16,400	5,700	5,900	20,100	16,600	34,200	-0.10%
42	227,700	0	3,200	2,600	200	34,100	101,300	6,700	32,400	17,200	42,000	0.00%
43	819,400	11,000	24,300	5,600	0	73,300	641,500	9,700	52,300	17,200	66,200	0.01%
44	493,100	8,000	25,600	2,600	100	58,200	439,800	9,100	45,600	16,800	-40,200	0.02%
45	87,900	1,400	2,600	3,700	800	13,000	1,100	7,700	29,700	15,600	29,200	0.10%
46	18,200	0	3,300	2,700	700	8,600	500	6,000	10,000	13,300	-13,300	-0.80%
47	789,100	13,300	49,000	5,700	0	62,000	664,400	8,800	46,600	18,000	57,100	0.02%
48	203,900	5,100	19,400	2,800	0	51,900	117,100	9,900	44,600	16,700	-9,000	0.00%
49	699,600	6,300	31,100	2,500	0	53,900	539,000	9,600	45,500	16,800	74,600	0.01%
50	257,000	5,800	21,900	5,100	0	44,200	118,200	10,100	44,700	17,700	55,000	-0.03%
51	742,300	10,800	26,400	2,600	0	49,300	583,400	9,600	51,800	17,600	70,500	-0.01%

* All values are in acre-feet, rounded to nearest 100 AF.

Table 4D-41. Thomes Creek Projected 2070 Surface Water Budget, Annual Average by Water Year Type

	Component	Average	% Contribution*	Average in Critically Dry/Dry Years	Average in Below Normal/Above Normal Years	Average in Wet Years
Inflows	Inflow from Upstream of Basin	245,200	86%	117,750	258,350	400,300
	Inflow from Small Tributaries	14,300	5%	4,300	16,200	25,700
	Overland Flow	23,400	8%	10,150	27,800	36,700
	Irrigation Return Flows to Streams	1,100	0%	1,100	1,050	1,000
	Groundwater Discharge to Stream	0	0%	0	0	0
Outflows	Streambed Recharge	32,300	11%	-25,250	-35,550	-38,700
	Downstream Outflow to Sacramento River	246,800	87%	-103,200	-262,850	-420,300
	Riparian ET	4,800	2%	-4,800	-5,000	-4,800
	Surface water diversions	0	0%	0	0	0

* Percent contribution of component to average total inflow/outflow. Small discrepancies between total inflow and outflow may occur due to rounding. All values are in acre-feet, rounded to nearest 100 AF

Table 4D-42. Projected 2070 Annual Thomes Creek Surface Water Budget

Simulation Water Year	Inflow from Upstream of Basin	Inflow from Small Tributaries	Overland Flow	Irrigation Return Flows to Streams	Groundwater Discharge to Stream	Streambed Recharge	Downstream Outflow to Sacramento River	Riparian ET	Surface water diversions	% Error
1	509,400	25,500	24,100	1,100	0	49,100	505,800	5,000	0	0.04%
2	324,400	21,800	26,200	1,000	0	37,100	331,100	5,300	0	-0.03%
3	63,100	100	500	1,100	0	23,700	35,600	5,500	0	0.00%
4	15,700	0	900	1,100	0	5,400	8,100	4,300	0	-0.56%
5	424,400	30,000	53,900	1,000	0	48,900	455,500	4,900	0	0.00%
6	141,800	8,000	14,900	1,100	0	26,900	134,200	4,600	0	0.06%
7	336,600	16,600	27,900	1,000	0	42,300	335,100	4,800	0	-0.03%
8	169,100	9,400	19,300	1,100	0	27,500	167,300	4,000	0	0.05%
9	413,700	19,600	21,900	1,000	0	42,900	408,600	4,600	0	0.02%
10	609,500	46,000	67,700	900	0	42,000	677,300	4,800	0	0.00%
11	292,100	16,500	29,800	1,200	0	29,000	305,400	5,000	0	0.06%
12	128,000	1,400	10,400	1,100	0	28,800	107,300	4,800	0	0.00%
13	407,000	23,400	39,600	1,100	0	32,600	433,700	4,600	0	0.04%
14	118,300	3,400	6,100	1,200	0	23,300	101,000	4,500	0	0.16%
15	171,900	6,400	15,900	1,200	0	29,300	161,700	4,300	0	0.05%
16	176,500	9,400	11,100	1,100	0	36,200	157,400	4,300	0	0.10%
17	79,900	2,500	4,500	1,100	0	27,500	55,500	4,900	0	0.11%
18	90,600	5,300	16,000	1,100	0	21,800	87,100	4,200	0	-0.09%
19	145,600	7,100	20,800	1,100	0	28,100	141,700	4,600	0	0.11%
20	369,500	22,500	38,700	1,000	0	46,000	380,400	5,300	0	0.00%
21	61,500	2,700	9,200	1,100	0	22,100	48,600	3,900	0	-0.13%
22	604,200	48,000	94,800	1,000	0	47,900	695,600	4,500	0	0.00%
23	487,700	22,800	34,200	1,100	0	39,900	500,900	4,900	0	0.02%
24	201,800	17,100	24,700	1,100	0	26,300	214,100	4,200	0	0.04%
25	460,100	45,500	83,100	900	0	39,200	545,800	4,500	0	0.02%
26	155,600	13,400	11,000	1,100	0	25,900	150,400	4,700	0	0.06%
27	203,800	12,300	21,200	1,100	0	26,100	207,100	5,300	0	-0.04%
28	138,600	5,300	15,400	1,100	0	22,800	133,500	4,000	0	0.06%
29	160,300	10,400	14,700	1,200	0	28,700	153,700	4,200	0	0.00%
30	245,200	18,700	31,500	1,100	0	32,200	259,300	4,800	0	0.07%
31	308,500	17,400	30,700	1,100	0	31,100	321,600	4,900	0	0.03%
32	260,400	16,000	27,800	1,000	0	35,400	264,900	4,800	0	0.03%
33	431,800	28,200	39,900	1,000	0	29,500	466,900	4,500	0	0.00%
34	95,400	1,400	5,200	1,100	0	27,000	69,700	6,400	0	0.00%
35	169,000	10,000	17,000	1,200	0	28,800	162,300	6,000	0	0.05%
36	125,700	1,500	10,600	1,100	0	30,200	102,500	6,200	0	0.00%
37	252,800	14,800	24,200	1,000	0	38,000	249,700	5,200	0	-0.03%
38	260,600	18,600	19,600	1,000	0	39,400	255,600	4,800	0	0.00%
39	112,700	12,100	16,800	1,100	0	29,400	107,300	6,000	0	0.00%
40	139,300	4,000	10,800	1,100	0	29,300	120,200	5,600	0	0.06%
41	75,300	2,200	9,200	1,100	0	23,000	58,900	5,800	0	0.11%
42	170,200	0	900	1,200	0	28,100	139,700	4,500	0	0.00%
43	509,400	23,900	23,600	1,000	0	54,000	499,000	4,900	0	0.00%
44	324,400	21,800	26,200	1,000	0	40,200	327,900	5,300	0	0.00%
45	63,100	100	500	1,100	0	24,200	35,200	5,500	0	-0.15%
46	15,700	0	900	1,100	0	5,500	8,000	4,300	0	-0.56%
47	424,400	30,000	53,900	1,000	0	50,000	454,500	4,900	0	-0.02%
48	141,800	8,000	14,900	1,100	0	27,300	133,900	4,600	0	0.00%
49	336,600	16,600	27,900	1,000	0	43,400	334,000	4,800	0	-0.03%
50	169,100	9,400	19,300	1,100	0	28,100	166,700	4,100	0	0.00%
51	413,700	19,600	21,900	1,000	0	44,200	407,400	4,600	0	0.00%

* All values are in acre-feet, rounded to nearest 100 AF.