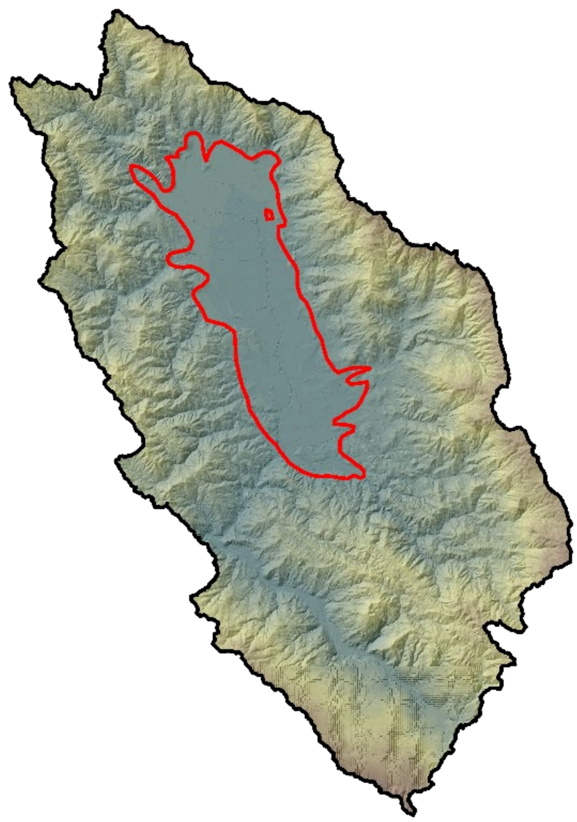
Potter Valley Integrated Flow Model Documentation



Potter Valley Water Supply Reliability Study

Prepared for:
Sonoma County Water Agency

Prepared by
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Acronyms and Abbreviations

Acronym	Meaning
3D	three-dimensional or three dimensions
AFY	acre-foot or acre-feet per year
AG	agricultural water use
ASCII	American Standard Code for Information Exchange
ASR	aquifer storage and recovery
Basin	Potter Valley Groundwater Basin
bgs	below ground surface
cfs	cubic foot/feet per second
cm/s	centimeter(s) per second
CW3E	Center for Western Weather and Water Extremes
DEM	digital elevation model
EFRR	East Fork Russian River
ESI	Environmental Simulations Inc.
ET	evapotranspiration
GHB	general head boundary
GUI	graphical user interface
gpm	gallons per minute
HFM	hydrogeologic framework model
HSG	hydrologic soil group
K_h	horizontal hydraulic conductivity
K_v	vertical hydraulic conductivity
LiDAR	light detection and ranging
MAR	managed aquifer recharge
MR	mean residual
N/A	not applicable
NAVD88	North American Vertical Datum of 1988
NSE	Nash-Sutcliffe Efficiency
NLCD	National Land Cover Database
NRCS	Natural Resources Conservation Service
PG&E	Pacific Gas & Electric Company
PRISM	Parameter-elevation Regressions on Independent Slopes Model
PVID	Potter Valley Irrigation District

Acronym	Meaning
PVIFM	Potter Valley Integrated Flow Model
PVP	Potter Valley Project
R^2	coefficient of determination
Reliability Study	Potter Valley Water Supply Reliability Study
RMSR	root mean squared residual
RRIHM	Russian River Integrated Hydrologic Model
SFR	streamflow routing
Sonoma Water	Sonoma County Water Agency
S_s	specific storage
SSURGO	Soil Survey Geography
S_y	specific yield
USGS	US Geological Survey
UZF	unsaturated zone flow
WY	Water Year

1. Introduction

On behalf of the Sonoma County Water Agency (Sonoma Water), Jacobs Engineering Group (Jacobs) has developed the Potter Valley Integrated Flow Model (PVIFM) of an area encompassing the Potter Valley Groundwater Basin (Basin) in Mendocino County, California (Figure 1-1). The PVIFM was developed to support Sonoma Water's Potter Valley Water Supply Reliability Study (Reliability Study) by evaluating potential water management strategies in the Basin. This PVIFM documentation was prepared by Jacobs and describes PVIFM objectives, development and calibration.

1.1 Background

For more than 100 years, the Potter Valley has received imports of water from the Pacific Gas & Electric Company's (PG&E's) Potter Valley Project (PVP), which transfers water from the Eel River watershed into the Russian River Watershed. As part of the ongoing water supply agreement with PG&E and its own water rights license, the Potter Valley Irrigation District (PVID) uses a portion of imported PVP water for agricultural purposes in Potter Valley. The remaining water not used by PVID flows down the East Fork Russian River (EFRR) into Lake Mendocino, providing a critical source of water for beneficial users in Mendocino, Sonoma, and Marin Counties, and for ecosystems along the Russian River.

In 2019, PG&E announced that it would not proceed with relicensing the PVP and would instead enter into a license surrender and decommissioning process, with the intention to remove the Scott and Cape Horn dams and end water diversion operations to the Russian River. In response, the Mendocino County Inland Water and Power Commission, the Round Valley Indian Tribes, and Sonoma Water formed a new entity, the Eel-Russian Project Authority, and submitted a proposal to PG&E to preserve water diversions into the Russian River, while also prioritizing upstream and downstream fish migration in the Eel River. The proposed New Eel-Russian Facility would facilitate ongoing water diversions through the PVP's tunnel between the Eel River and Russian River, while providing for fish migration by removing Scott and Cape Horn dams. Unlike the PVP, which historically has maintained year-round water diversions, the proposed facility would use run-of-river operations, where diversions would occur only when Eel River flows meet as-yet-undefined thresholds for fish passage. As a result, the magnitude and timing of diversions are uncertain, but would change markedly from previous PVP operations, with water transfers likely only occurring when flow thresholds are met during the wet season and ceasing during the dry season.

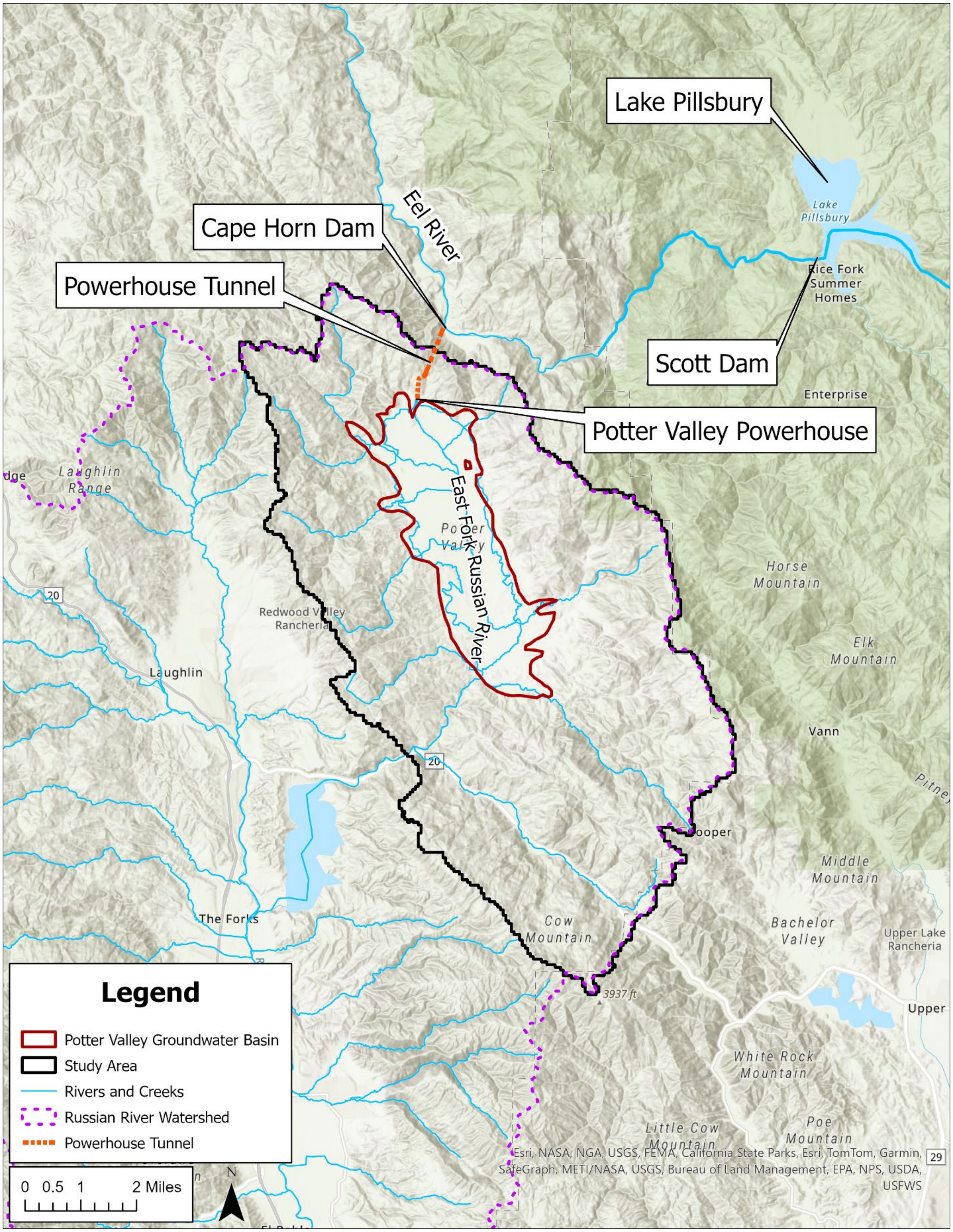


Figure 1-1. Study Area

Given the uncertainties surrounding the magnitude and timing of future water availability, PVID may need to rely on other sources for agricultural irrigation (e.g., groundwater, groundwater storage, and/or surface-water storage). Sonoma Water's Reliability Study aims to support water supply reliability planning for the Potter Valley through evaluation of hydrogeologic conditions, historical and current agricultural water use and irrigation practices, and potential future agricultural water supply, storage, and demand management strategies in Potter Valley.

1.2 Modeling Objectives

To support Sonoma Water's Reliability Study, an integrated surface water-groundwater model was needed to establish a decision-support tool that simulates surface water and groundwater conditions throughout Potter Valley. PVIFM was developed to support the Reliability Study. PVIFM modeling objectives are as follows:

- Help to identify and prioritize groundwater data gaps and reduce uncertainty in groundwater supply in Potter Valley.
- Develop surface water and groundwater budgets for the Basin.
- Support decision-making associated with water management in Potter Valley.

1.3 Model Function

To achieve the modeling objectives, PVIFM was developed and calibrated to industry standards using available data and professional judgment. PVIFM is a three-dimensional (3D) model that was constructed and calibrated to simulate monthly surface water and groundwater flow conditions for the time period from October 2010 through September 2022 (that is, water years [WYs] 2011 through 2022) in a 94-square-mile area encompassing the Basin. To achieve the modeling objectives, the team used the following software:

- US Geological Survey (USGS) code MODFLOW-NWT (USGS 2011), which is a Newton formulation for MODFLOW-2005 (USGS 2005a)
- Groundwater Vistas version 8, which is a graphical user interface (GUI) used to help manage input and output files and inspect spatial distributions of parameters of interest (Environmental Simulations Incorporated [ESI] 2020)
- FloPy, which is a Python package used to create, run, and post-process MODFLOW models (Bakker et al. 2016)

1.4 Model Assumptions and Limitations

PVIFM development included the following assumptions and limitations:

- Subsurface geologic materials, including both consolidated bedrock and granular unconsolidated material (for example, gravel, sand, silt, and clay) are all modeled as equivalent porous media.
- Groundwater and surface water are modeled as a single-density, incompressible fluid.
- Monthly stress periods, using a single time step within each stress period, have been incorporated into the simulations. As such, variations in flow processes that occur within a given month are not explicitly simulated; instead, monthly average flow rates are implemented.
- Mathematical models like PVIFM can only approximate surface and subsurface-flow processes, despite their high degree of precision. A major cause of uncertainty in these types of models is the discrepancy between the coverage of measurements needed to understand site conditions and the coverage of measurements generally made under the constraints of limited time and budget (Rojstaczer 1994).

Given these assumptions and limitations, numerical flow models like PVIFM should be considered insight tools rather than tools that can predict the future with certainty. Important planning decisions that use output from PVIFM must be made with an understanding of the uncertainty in and sensitivity to model input parameters. Any planning decisions should also consider other site data, local and regional drivers, professional judgment, and the inclusion of safety factors.

2. Conceptual Model Overview

Previous studies and available datasets were compiled and evaluated to help to form a conceptual understanding of the Basin to support development of the PVIFM. Through conceptual model development, a general understanding of Basin water budget components, aquifer characteristics, and water use within the Basin were formulated. Through development and calibration of PVIFM, further evaluation of these water budget components and physical characteristics of the basin will occur to help refine the conceptual understanding of the Basin. PVIFM will provide a characterization of water budget components, including quantification of their magnitude and variability to help refine the understanding of the Basin and the primary inflow and outflow terms. The following section presents an overview of the Basin conceptual model, values presented here were revisited during PVIFM development and calibration, as described in Section 4.

The Basin encompasses an area of approximately 13 square miles within the Russian River Watershed, which is part of the northern Sonoma and southeastern Mendocino Counties in California. Potter Valley is approximately 8 miles long and up to 2 miles wide, and is within a structural depression bounded primarily by bedrock of the Franciscan Complex (DWR 2004). The Basin is generally defined by material of unconsolidated alluvial sediments and older valley-fill deposits. The primary water-bearing unit consists of alluvial material along with terrace and continental deposits (USGS 1965). The bedrock surrounding the Basin has low permeability and therefore has not historically been relied upon as a direct source of groundwater supply through wells constructed in the bedrock; however, the surrounding bedrock is a source of water to the Basin. Alluvial materials in the Basin are primarily fine-grained, consisting of silt and clay, with some sand and thin lenses of gravel. Coarse-grained deposits are limited in extent and generally disconnected. In general, minimal characterization of Basin material has been conducted over the years; however, similar deposits in the Santa Rosa valley have been characterized to contain specific yield values of 5% to 8% (USGS 1958). According to well logs compiled by the USGS (USGS 2023), estimates of specific well capacities in the Basin ranged from 0.009 to 12 gallons per minute (gpm) per foot of drawdown.

Groundwater within the Basin flows generally from north to south, with groundwater flow converging towards the center of the Basin along the EFRR. Groundwater flow towards the EFRR is generally driven by recharge along the margins of the Basin and the EFRR, which is incised below the floodplain causing the water table to drain towards the central portion of the Basin (USGS 1965).

USGS is developing a 3D hydrogeologic framework model (HFM) to further characterize groundwater basins in the Russian River Watershed. According to USGS' HFM, 20 to 1,000 feet of consolidated sediments underlies 20 to 240 feet of unconsolidated sediments; both of which are locally overlayed by up to 66 feet of channel alluvial material along the EFRR and tributary creeks (USGS 2023).

Groundwater inflows to the Basin generally include groundwater recharge from precipitation, groundwater recharge from the EFFR, creeks tributary to the EFRR, irrigation canals and laterals, groundwater recharge from water applied to fields, and subsurface inflow from the surrounding bedrock area (USGS 1965). Based on 30-year precipitation averages from Parameter-elevation Regressions on Independent Slopes Model (PRISM) datasets, the Basin receives about 38 to 42 inches per year on average. Measured groundwater levels are generally shallow, showing rebounds in water levels during the winter and spring months due to groundwater recharge from precipitation. Imported water from the PVP, from which PVID has appropriative rights of up to a maximum of 50 cubic feet per second (cfs), passes through the Potter Valley Powerhouse at the northern end of the valley. Imported water from PVP provides streamflow to the EFRR and PVID's East and West Canals. Groundwater recharge along PVID's conveyance systems and through the application of imported water to fields occurs throughout the Basin. The upland bedrock areas around the Basin receive precipitation at rates of about 42 to 54 inches per year. Several tributary creeks drain the bedrock area surrounding the Basin and flow into the EFRR, including Busch Creek, Williams Creek, Burright Creek, Cold Creek and others. Additional details regarding PVID infrastructure are provided in Section 3.3.3.3. Bedrock surrounding the Basin provides inflows to the Basin as water drains from the bedrock into the Basin.

Outflows from the Basin include groundwater discharge to streams and canals, evapotranspiration (ET), and small amounts of groundwater pumping to meet domestic and irrigation demands. Groundwater flow in the Basin generally converges on the EFRR where groundwater generally discharges to the EFRR (that is, the EFRR is generally a "gaining stream" throughout the Basin). The EFRR flows south through the Basin leaving Potter Valley and flows toward Lake Mendocino. Some groundwater is intercepted along its flow path by groundwater wells or is partially consumed by ET. Agricultural areas in the Basin have experienced about 30 inches per year of ET on average based on 2016 through 2021 estimates of ET from OpenET.[1] Because surface water has been historically available from the PVP, and because finer-grained material is present, reliance upon groundwater for water supply in the Basin has generally been low. However, groundwater pumping wells for irrigation and domestic water use have been

[1] OpenET is an online platform for mapping ET at the scale of individual fields.

drilled and are used throughout the Basin. Well yields are typically low due to the prevalence of fine-grained material throughout the Basin. According to available well logs from DWR, reported well yields range from 1 to 200 gpm, with several wells yielding approximately 50 to 75 gpm (USGS 1965; DWR 2004). Given the consistent, ample, year-round supply of imported PVP water during much of the past 100 years, groundwater resources in Potter Valley make up a small proportion of the Basin's water supply. As a result, the Basin's groundwater resources have been poorly characterized, apart from early studies by USGS (USGS 1965).

3. Numerical Model Construction

The team used the following steps to translate elements of the conceptual model into a form that was suitable for numerical modeling:

- Selecting a modeling code
- Establishing a model domain and developing a model grid
- Spatially distributing surface parameter values
- Spatially distributing subsurface parameter values
- Selecting a time-discretization approach appropriate for evaluating the field problem and achieving the modeling objectives
- Establishing initial flow conditions
- Establishing flow boundary conditions

The following sections describe the methodology for executing these design steps.

3.1 Code Selection

To develop the PVIFM, the team selected USGS code MODFLOW-NWT (USGS 2011) for this modeling effort, in conjunction with the GUI Groundwater Vistas version 8 (ESI 2020), and FloPy (Bakker et al. 2016). MODFLOW-NWT is an updated formulation built on the MODFLOW-2005 (USGS 2005a) framework. MODFLOW-NWT accommodates development of a 3D, physically based, spatially distributed, integrated groundwater-surface water flow model. MODFLOW-NWT code was selected for the following reasons:

- **Compatibility across models.** Compatibility with USGS modeling software; USGS is developing the Russian River Integrated Hydrologic Model (RRIHM) (USGS 2023). Once completed, RRIHM will simulate hydrologic conditions over the Russian River Watershed, which covers about 1,300 square miles (without Santa Rosa Plain) of urban, agricultural, and forested lands in northern Sonoma and southern Mendocino Counties. MODFLOW-NWT is compatible with RRIHM modeling software.
- **Documented history and performance.** MODFLOW-NWT is based on MODFLOW-2005, which is well-documented and has been used extensively in groundwater evaluations worldwide for many years. MODFLOW-NWT contains an improved solution scheme that can handle a variety of complex, variably saturated flow conditions, which are relevant to groundwater conditions in the Potter Valley.

- **Benchmarked and verified.** MODFLOW-NWT has been benchmarked and verified; thus, the numerical solutions generated by the code have been compared with analytical solutions, subjected to scientific review, and used on other modeling projects. Verification of the code confirms that MODFLOW-NWT can accurately solve the governing equations that constitute the mathematical model.
- **Extensive boundary conditions and available modular packages.** MODFLOW-NWT accommodates a comprehensive suite of groundwater and surface water boundary conditions and additional modular packages that are relevant to groundwater conditions in Potter Valley.

3.1.1 Numerical Assumptions

MODFLOW-NWT, along with available modular MODFLOW packages, have the capability to mathematically represent two interconnected hydrologic flow regimes: surface flow and subsurface flow. The surface-flow regime, as configured for PVIFM, includes runoff, channel flow, and interaction with the subsurface. The subsurface-flow regime underlies the surface-flow regime and includes variably saturated zones representing porous media through which groundwater flows and can interact with the surface-flow regime. Interactions between the surface- and subsurface-flow regimes are established through the Unsaturated-Zone Flow (UZF) and Agricultural Water Use (AG) modular packages of MODFLOW-NWT. In general, input data to the UZF and AG packages include precipitation and potential ET, land use, root zone and irrigation parameterization, rainfall-runoff process parameterization, and land surface water balance tracking areas. Within the UZF and AG packages, these types of input data establish conditions for the simulation of the rainfall-runoff and irrigation processes. This includes the partitioning of natural and anthropogenic sources of water into runoff to streams, ET, and infiltration. As routing of water from these sources is simulated, the UZF and AG packages communicate with the other MODFLOW-NWT packages to simulate flow interactions between surface processes and between surface and subsurface processes. For example, runoff that is calculated through the UZF package (as configured for PVFIM) is routed to nearby Streamflow Routing (SFR) package segments, providing an inflow of water to nearby stream channels.

From a water-supply and outdoor-water-demand standpoint, the AG package facilitates linkages between surface water and groundwater supplies and areas representing agricultural fields, whereas the UZF package facilitates the simulation of ET demand. The UZF package first simulates ET of soil moisture in the unsaturated zone and then ET of shallow groundwater when the water table is within assigned rooting depths. Water sources including precipitation, surface water, and groundwater can all contribute to increases in soil moisture through infiltration depending on the configuration of the AG package. Each of these sources of supply play a role in the numerical simulation of the surface- and subsurface-flow regimes, depending on the area and the specific water management activities within that area. Additional details on the specific configuration of the UZF and AG packages and associated boundary conditions in PVIFM are provided in Section 3.7.

3.1.2 Scientific Basis

The theory and numerical techniques that are incorporated into MODFLOW-NWT have been scientifically tested. The governing equations for rainfall-runoff, streamflow, and variably saturated subsurface flow have been solved by several modeling codes over the past few decades, on a wide range of field problems. Therefore, the scientific basis of the theory and the numerical techniques for solving these equations have been well-established.

3.1.3 Data Formats

Multiple American Standard Code for Information Interchange (ASCII) data files were used to establish the structure and parameterization of PVIFM. Table 3-1 shows the pertinent input files for PVIFM.

Table 3-1. PVIFM Input File Descriptions

File Extension	Version	Purpose	Parameters
DIS (USGS 2000a)	N/A	• Discretization package establishes information on how time and space are subdivided. • Establishes whether the numerical solution is steady state or transient.	• Grid cell dimensions • Layer interface elevations • Stress-period durations • Number of time steps per stress period • Time step multiplier • Stress period type (steady state or transient)
BAS (USGS 2000a)	BAS6 v1.3.0	• Basic package establishes active and inactive cells and initial heads.	• IBOUND array by layer (active domain) • Initial heads by layer
UPW (USGS 2011)	1	• Upstream weighting package contains aquifer hydraulic parameters, which constrain flow between model cells.	• Horizontal and vertical hydraulic conductivity • Groundwater storage parameters
OC (USGS 2000a)	N/A	• Output control file specifies the type of runtime information to write to output files.	• User-defined print and save statements

File Extension	Version	Purpose	Parameters
NWT (USGS 2011)	1.3.0	• Newton solver solves the governing-flow equations.	• Solver iteration and closure terms • Backtracking and other solver options
SFR (USGS 2005b)	SFR7 v1.3.0	• SFR constrains streamflow and groundwater-surface water interaction.	• Stream segment and reach information • Channel geometry and elevation information • Slope and resistance terms • Optional flow rules and constraints, such as surface water diversions or conveyance-capacity constraints • Streamflow-tolerance solver criteria • Streambed properties
GAGE (USGS 2000b)	N/A	• Establishes streamflow gauging station locations in PVIFM and generates output files containing simulated gauge station information at each gauge location.	• Specified SFR segment and reach for each gauge location • Output file unit number convention and naming of gauge locations
UZF (USGS 2006)	UZF1 v1.5	• Establishes infiltration rates. • Routes runoff within user-defined watersheds to designated SFR segments. • Establishes the vertical flow and retention of water through the unsaturated zone to the saturated zone. • Simulates unsaturated zone ET.	• Soil characteristics, such as saturated vertical hydraulic conductivity, porosity, and initial moisture content • Rootzone characteristics, such as extinction depths, and extinction water content • Definition of how runoff is routed from model grid cells to SFR segments • Potential ET rates • Infiltration rates at ground surface
WEL (USGS 2000a)	1.3.0	• Establishes rural domestic groundwater pumping in PVIFM.	• Specified groundwater pumping rate by stress period • Model layer designations

File Extension	Version	Purpose	Parameters
AG (Niswonger 2020)	1.3.0	• Establishes linkages of surface water and groundwater supplies with irrigated areas.	• Collection of cells that make up irrigated areas • Surface water diversion and/or supplemental groundwater pumping well locations and linkage to irrigated areas • Fractions of ET met through linked surface water diversions and/or supplement wells
NAM (USGS 2000a)	N/A	• Name file specifies names of input and output files.	• No parameters are included

N/A = not applicable

Output from PVIFM includes standard USGS MODFLOW output file formats including ASCII and binary file types. Several optional output files are generated from PVIFM based on user-specified configurations. Table 3-2 summarizes the primary output files from PVIFM but does list all optional output files.

Table 3-2. PVIFM Output File Descriptions

File Name or Extension	File Content
LST	ASCII listing file containing runtime information included in the simulation
HDS	Binary file containing cell-by-cell modeled groundwater elevations for all output times
CBC	Binary file containing cell-by-cell subsurface flows for all output times
UZFCB2	Binary file containing cell-by-cell unsaturated zone flows for all output times
SFR.OUT	ASCII file containing reach-specific stream inflows, outflows, and other physical parameters of the stream reach for all output times

3.2 Model Domain

A numerical model must use discrete space to represent the hydrologic system. The simplest way to discretize space is to subdivide the study area into many subregions (grid blocks or cells) of the same size. This grid-building strategy was implemented for this modeling effort and is described in the following subsections.

3.2.1 Areal Characteristics of Model Grid

The PVIFM grid mathematically represents a 94-square-mile area that includes the Basin and its surrounding watershed. The watershed surrounding the Basin was included in the PVIFM extent to simulate surface and subsurface flows in the bedrock upland areas and how these flows interact with the Basin. Storage of winter recharge and slow drainage of the upland bedrock areas into the Basin around the Basin margins will be an increasingly important source of water to the Basin as transfers of water from the Eel River decrease in the future. The model grid is aligned north-south and east-west and georeferenced to the 1983 North American Datum of the Universal Transverse Mercator Zone 10 North coordinate system, in units of meters. The projection, datum, and units were selected to be compatible with the RRIHM (USGS 2023). The PVIFM boundary follows the watershed boundary of the contributing area surrounding the Basin and crosses the EFRR at a southwestern point of the domain.

Figure 3-1 shows the PVIFM domain, which is partitioned into grid blocks (cells) horizontally spaced on 100-meter (approximately 328-foot) centers, resulting in 24,404 active cells per model layer. The 100-meter cell spacing allows for sufficient spatial resolution to achieve the modeling objectives discussed in Section 1.2. Where PVIFM cells coincide with RRIHM model cells, there are nine PVIFM model cells for each RRIHM model cell, which has dimensions of 300 by 300 meters (984 by 984 feet).

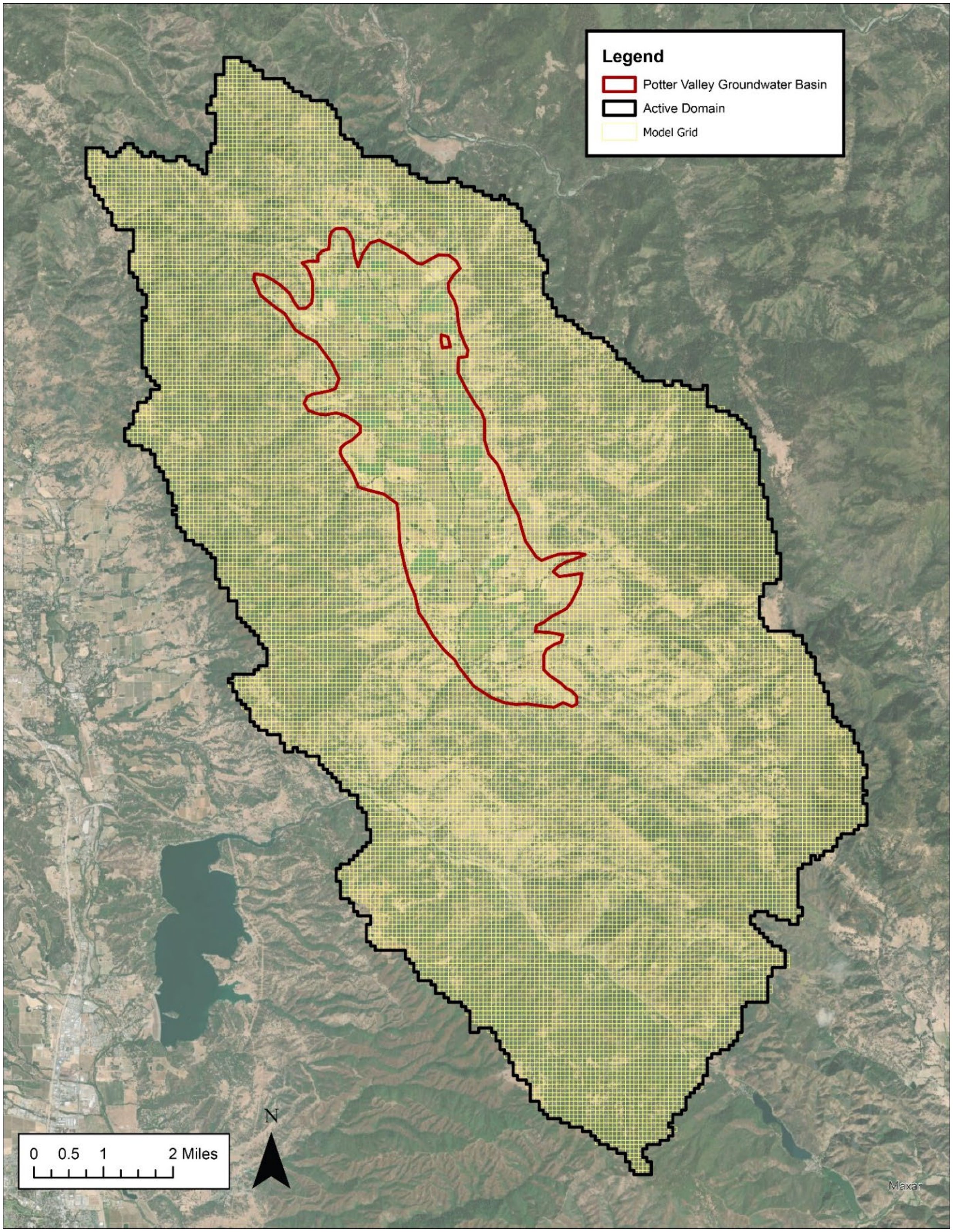


Figure 3-1. Active Model Domain and Grid

3.2.2 Vertical Characteristics of Model Grid

Vertical characteristics of the PVIFM grid were adapted from the version of the USGS HFM that was still in progress when PVIFM was in development. The USGS HFM includes a compilation of soil boring logs and geophysical gravity data to help evaluate hydrogeologic conditions of the Russian River Watershed, including Potter Valley. The HFM subdivides the Basin into three distinct zones comprised of channel alluvium, young and old sediments, and bedrock. Figure 3-2 shows fence diagrams of PVIFM model layering based on the USGS 3D HFM onto the PVIFM model grid. All elevation values assigned in PVIFM are referenced to the North American Vertical Datum of 1988 (NAVD88) in units of meters. The vertical discretization from the HFM was translated onto the PVIFM grid. Table 3-3 presents a summary of the model layers included in PVIFM, including the resulting model layer thicknesses and depth of layer bottom resulting from the adaptation of the HFM onto the PVIFM grid.

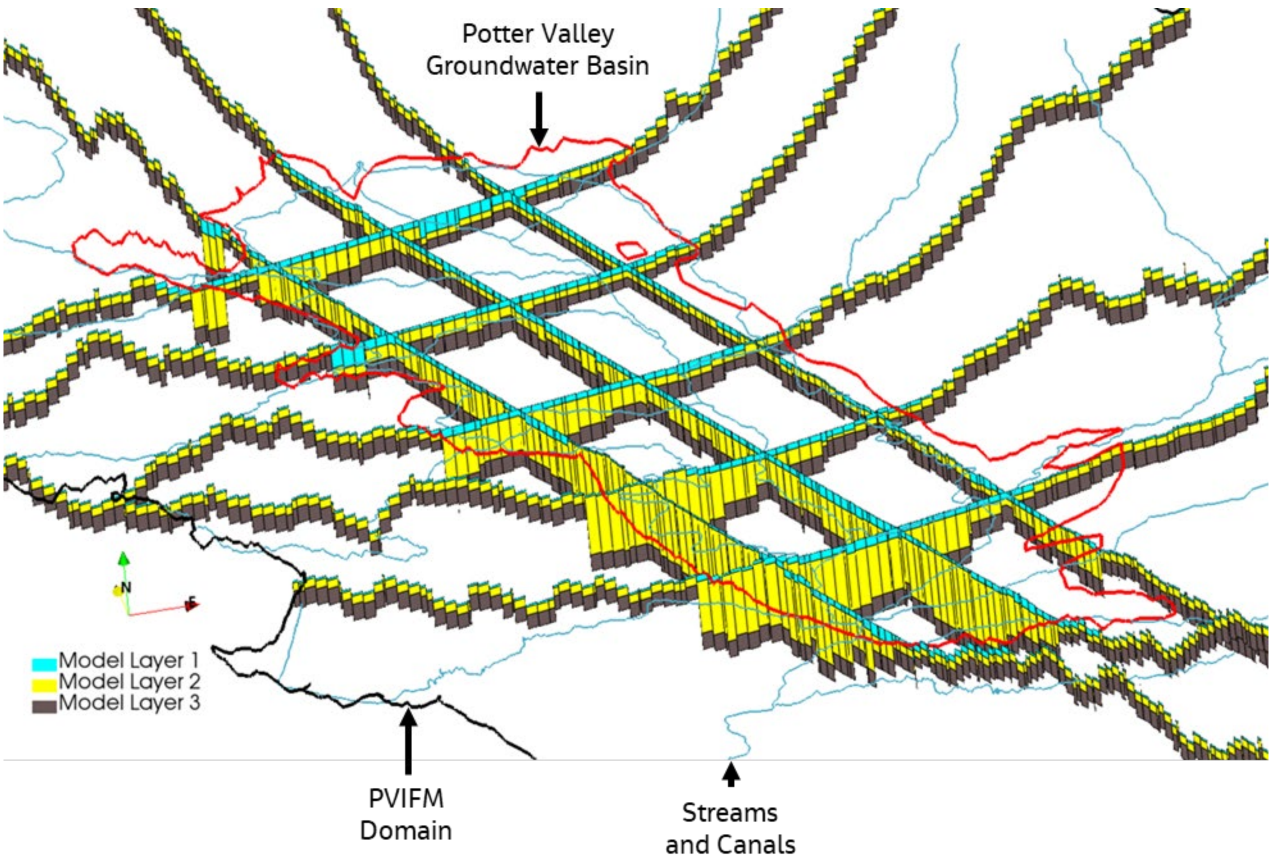


Figure 3-2. Fence Diagram of PVIFM Layering as Adapted from the USGS 3D HFM

Table 3-3. Summary of PVIFM Layers

Model Layer	Description	Model Layer Thickness (feet)	Depth of Layer Bottom (feet bgs)
1	Channel Alluvium and Bedrock	24 to 335	24 to 335
2	Young and Old Sediments and Bedrock	3 to 722	56 to 755
3	Bedrock	164 to 4,216	876 to 4,322

bgs = below ground surface

As shown in Table 3-3, bedrock is represented in all model layers. The distinction between alluvium and bedrock is achieved through assignment of different hydraulic conductivity values, as discussed in Section 3.4.1.

3.3 Surface Parameters

The surface parameters required by PVIFM are the land surface elevations, stream channel characteristics, and land cover characteristics.

3.3.1 Topography

A topographic surface was developed to cover the entire extent of the PVIFM domain based on available digital elevation model (DEM) data. The topographic surface was developed based on available 1-meter light detection and ranging (LiDAR) data accessed through USGS' National Map Viewer.

Land surface elevations were assigned as the top elevation of Model Layer 1 representing modeled ground surface elevations. Elevation data were processed using ArcGIS Pro software. Figure 3-3 illustrates the land surface elevations incorporated into the top of the PVIFM grid.

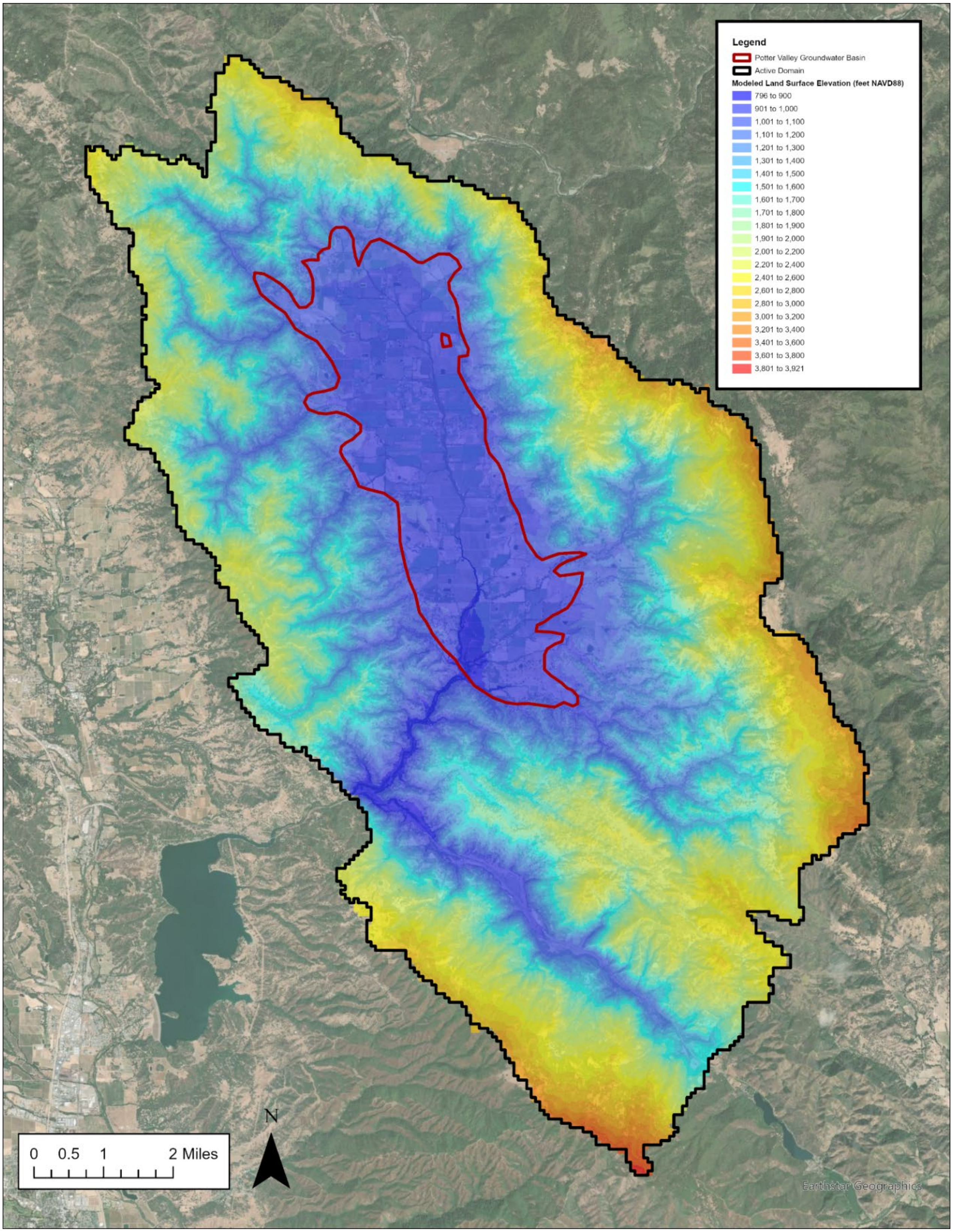


Figure 3-3. Modeled Land Surface Elevations

3.3.2 Stream Channel Features

The stream channel network used in PVIFM was adapted from USGS hydrography datasets to serve as a starting point for development of the SFR package. Figure 3-4 presents the stream network incorporated into PVIFM. The SFR package requires definition of stream channel segments that are intersected with the model grid to obtain stream channel networks. Stream channel parameters required for the calculation of streamflow routing are specified throughout the SFR network. As a starting point, parameter values were idealized for all stream segments. With this setup, stream channel width was set to 50 feet, streambed hydraulic conductivity was set to 0.2 foot per day (7.1×10^{-5} centimeters per second [cm/s]), and the Manning's roughness coefficient was set to 0.04, which is reasonable for a natural stream channel (Chow 1959). For this version of PVIFM, the same Manning's roughness coefficient of 0.04 was assigned for PVID canals and the EFRR. Variations in Manning's roughness coefficient could be considered in the future based on different channel or canal lining conditions. Parameter values associated with SFR were modified during the calibration process as necessary to achieve acceptable goodness of fit in matching calibration target values. The calibration targets, process, and results are discussed in Section 4.

3.3.3 Land Cover and Agricultural Operations

Soils, land use and vegetation, local water use conditions, and ET influence groundwater and surface water conditions throughout Potter Valley. The following describes how land cover was incorporated into PVIFM.

3.3.3.1 Soils

Soil survey information was compiled from the Natural Resources Conservation Service (NRCS) Soil Survey Geography (SSURGO) geodatabase for the PVIFM domain (NRCS 2019). The primary soil characteristic evaluated from SSURGO was the hydrologic soil group (HSG) to help characterize the relative permeability of soils within the PVIFM domain. Figure 3-5 presents HSG classifications in the PVIFM domain. The distribution of HSGs was compared to geophysical data collected by Jacobs during earlier phases of the Reliability Study (Sonoma Water 2024). In general, HSG distribution coincided well with data collected during the geophysical investigation where higher permeability soils (that is, HSG classification A or B) are present in the northwest portion of the Basin. The team used HSG distribution to help define hydraulic conductivity zones in Model Layer 1, which is discussed in Section 3.4.1.

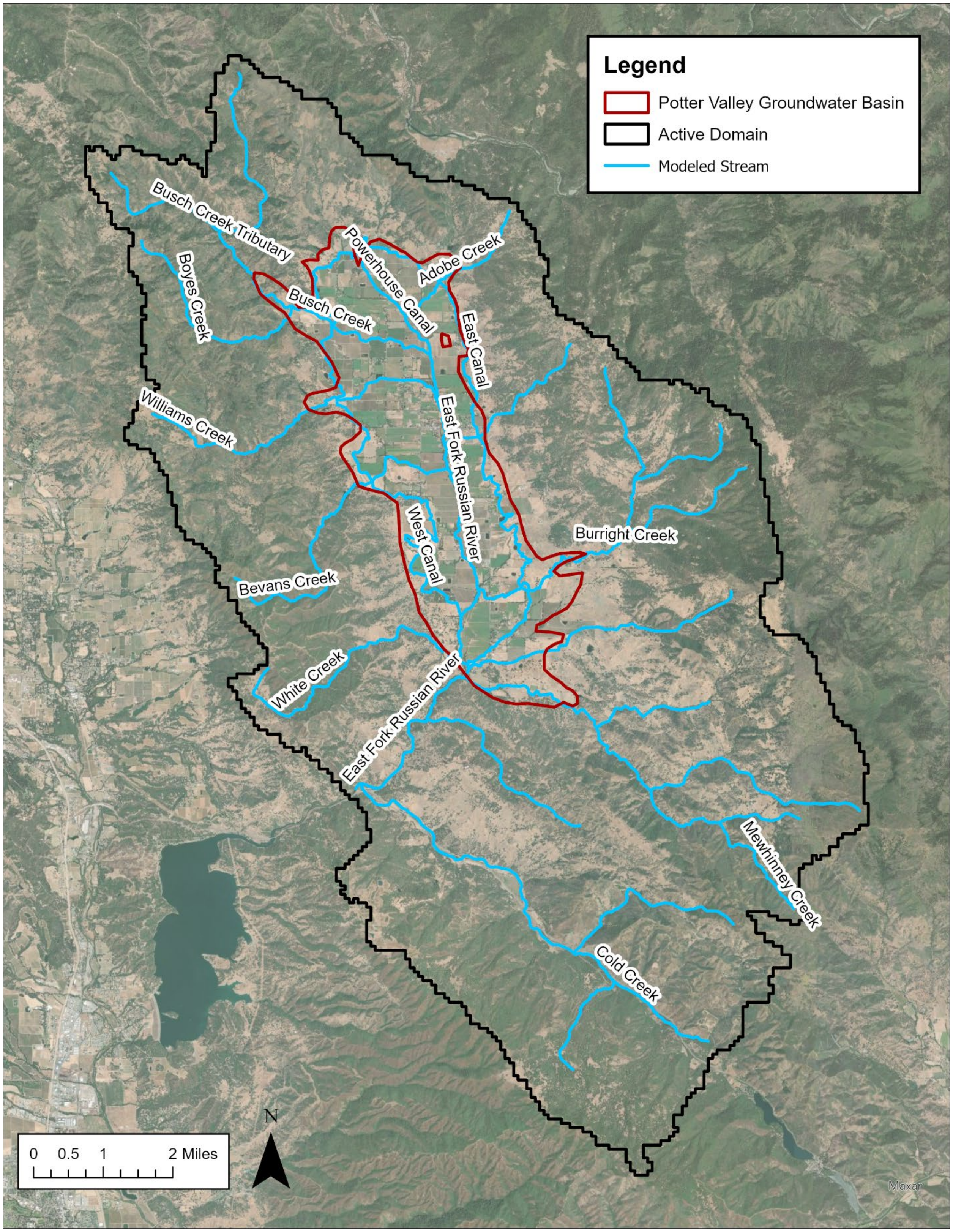


Figure 3-4. Modeled Streams

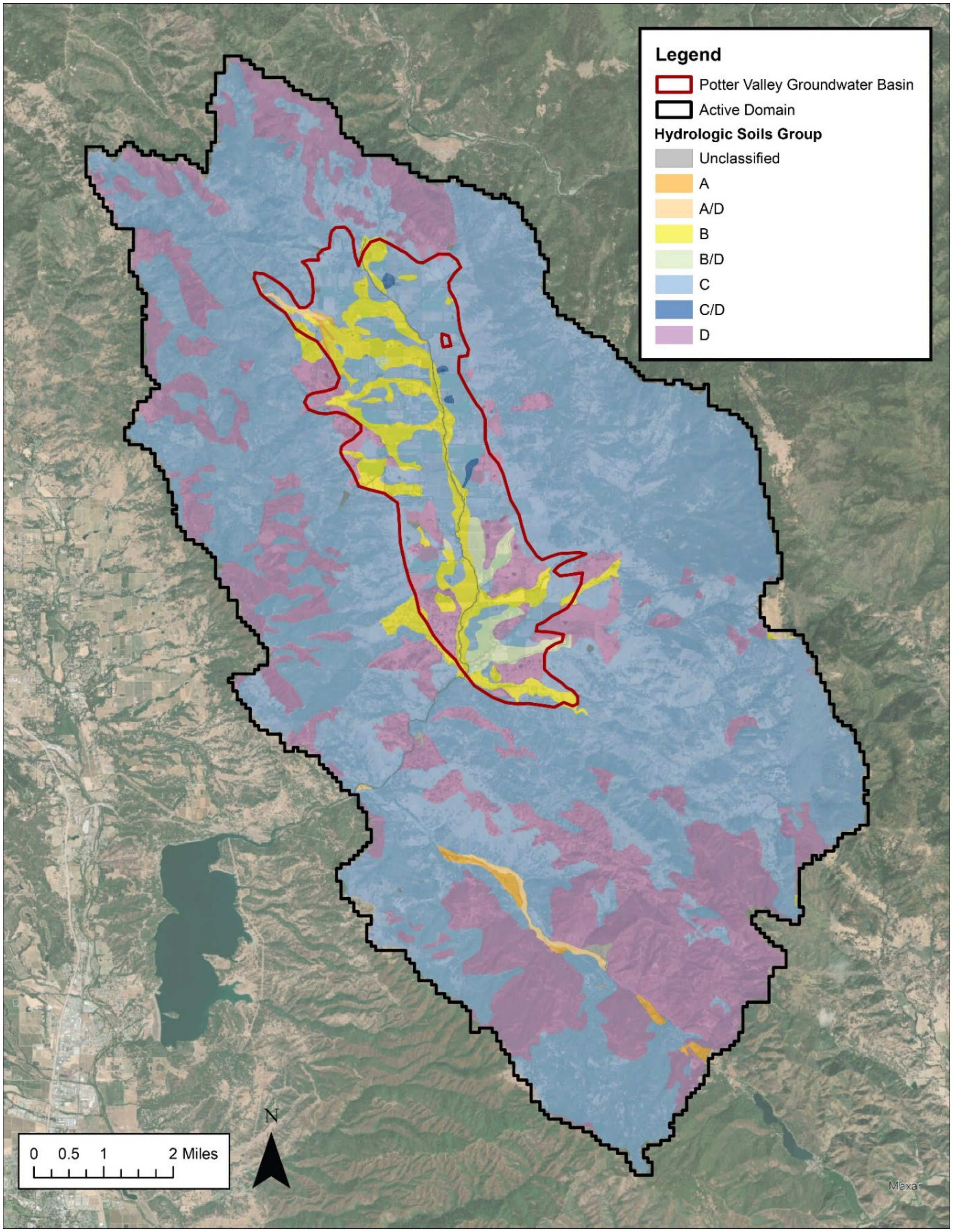


Figure 3-5. Hydrologic Soils Groups

Additional soil properties including porosity, residual water content, extinction water content, and the Brooks-Corey epsilon coefficient are required as input to UZF. These parameters influence the retention characteristics of the unsaturated zone. Initial porosity values in PVIFM were set to values of 0.25 for the alluvial material in the Basin and 0.05 for bedrock material outside of the Basin. Residual water content was initially calculated internally by the UZF package as the porosity minus the specific yield for the alluvial material within the Basin and bedrock material outside of the Basin. The UZF documentation indicates that the value of the extinction water content should be between the residual water content and porosity. Thus, the initial extinction water was assigned a value 1% greater than the residual water content. The Brooks-Corey epsilon coefficient was initially set to a value of 4.0 for both alluvial and bedrock areas of PVIFM based on the value used in the RRIHM. Although parameter values associated with unsaturated soils were varied during the calibration process, a configuration of the UZF package was ultimately retained that no longer depended on these parameters, as described in Section 4.3.

3.3.3.2 Land Use and Vegetation

Land use and vegetation were evaluated using the 2019 USGS National Land Cover Database (NLCD) (USGS 2018) and land use status reports provided by PVID. The NLCD was used to develop a representation of land cover that would form the basis for assignment of vegetation rooting depths throughout the PVIFM domain. Three major categories of agriculture, shrubs, and trees were developed using information shown in Figure 3-6 to define zones for assigning rooting depths. Initial rooting depths were assigned as 6, 8, and 20 feet for the agriculture, shrubs, and trees, respectively (Allen et al. 1998; Nature Conservancy 2021). A more detailed discussion on agricultural cropping patterns within the PVID is discussed in Section 3.3.3.3.

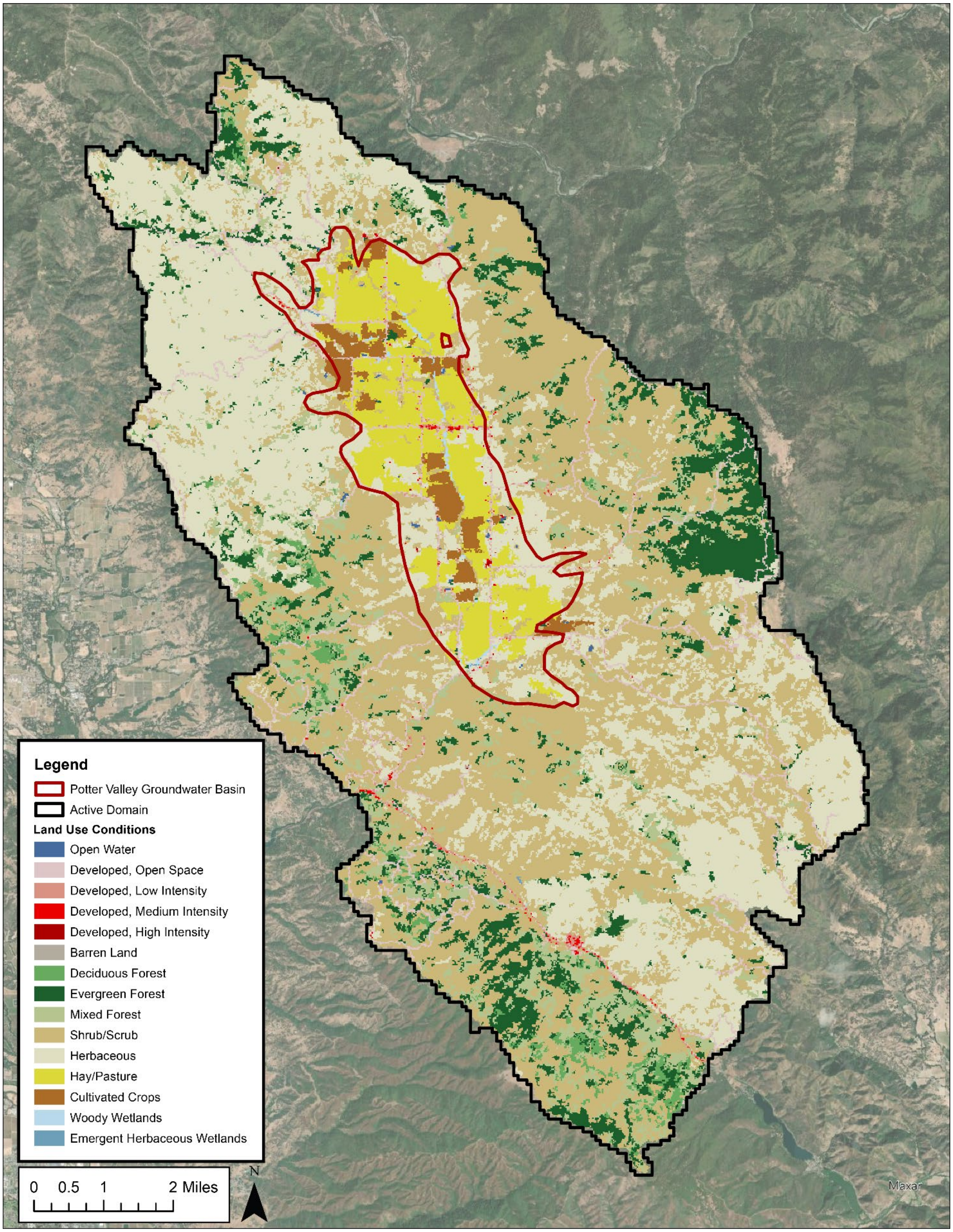


Figure 3-6. 2019 Land Use Conditions

3.3.3.3 Potter Valley Irrigation District

PVID operates a system of canals and lateral ditches within Potter Valley and provides irrigation water to local users. PVID receives imported water from the PVP at Lake Van Arsdale into the diversion tunnel to the PG&E Powerhouse in Potter Valley (Figure 1-1). From the PG&E Powerhouse, water is diverted at the East and West Weir into PVID's East and West Canals, which convey water to PVID customers. Additional diversions into the East and West Canal occur downstream from the East and West Weir from the Powerhouse Canal at the West Pump, West Diversion, and East Pump. Flows not diverted into the East and West Canals remain in the Powerhouse Canal and eventually flow into the EFRR. Figure 3-7 shows the primary PVID conveyance features, irrigated areas split into East and West Divisions, and the primary canal inflow and diversion locations associated with importing water from the PVP to Potter Valley.

Table 3-4 presents an annual summary of measured canal surface water inflows and deliveries for WYs 2011 through 2022. Water diverted from the PVP is represented by the Measured Water Entering Diversion Tunnel to Powerhouse, ranging from 31,805 acre-feet per year (AFY) to 100,590 AFY, representing the total water imported to the Potter Valley for PVID use and to provide streamflow to the EFRR. Once through the Powerhouse, water is diverted into the PVID East and West Canals at the East and West Weir (Figure 3-7). Diversions at the East and West Weir ranged from 5,495 to 15,290 AFY. Flow not diverted at the East and West Weir flow downstream through the Powerhouse Canal, where additional diversions occur at the East Pump, West Pump, and West Diversion into PVID's East and West Canals (Figure 3-7). Water diverted from the Powerhouse Canal for PVID use ranged from 1,634 to 9,615 AFY. Total water diverted to PVID, representing the total water diverted into the East and West Canals, ranges from 7,768 to 19,693 AFY and the total PVID deliveries to customers ranged from 8,620 to 13,562 AFY. In general, differences between the total water delivered to PVID and PVID deliveries results from PVID needing to maintain certain flows and stages along the canals to convey water throughout the system. Any water conveyed through the East and West Canals that is not diverted to as part of PVID deliveries eventually flows to the EFRR.

Water diverted into PVID's East and West Canals is conveyed to customers throughout Potter Valley to support agricultural operations. Table 3-5 shows annual PVID irrigated area by crop type for WYs 2011 through 2022. The primary crop types in Potter Valley are grapes and pasture/hay. In general, no significant changes in crop types have occurred throughout PVID over the 12-year period listed in Table 3-5.

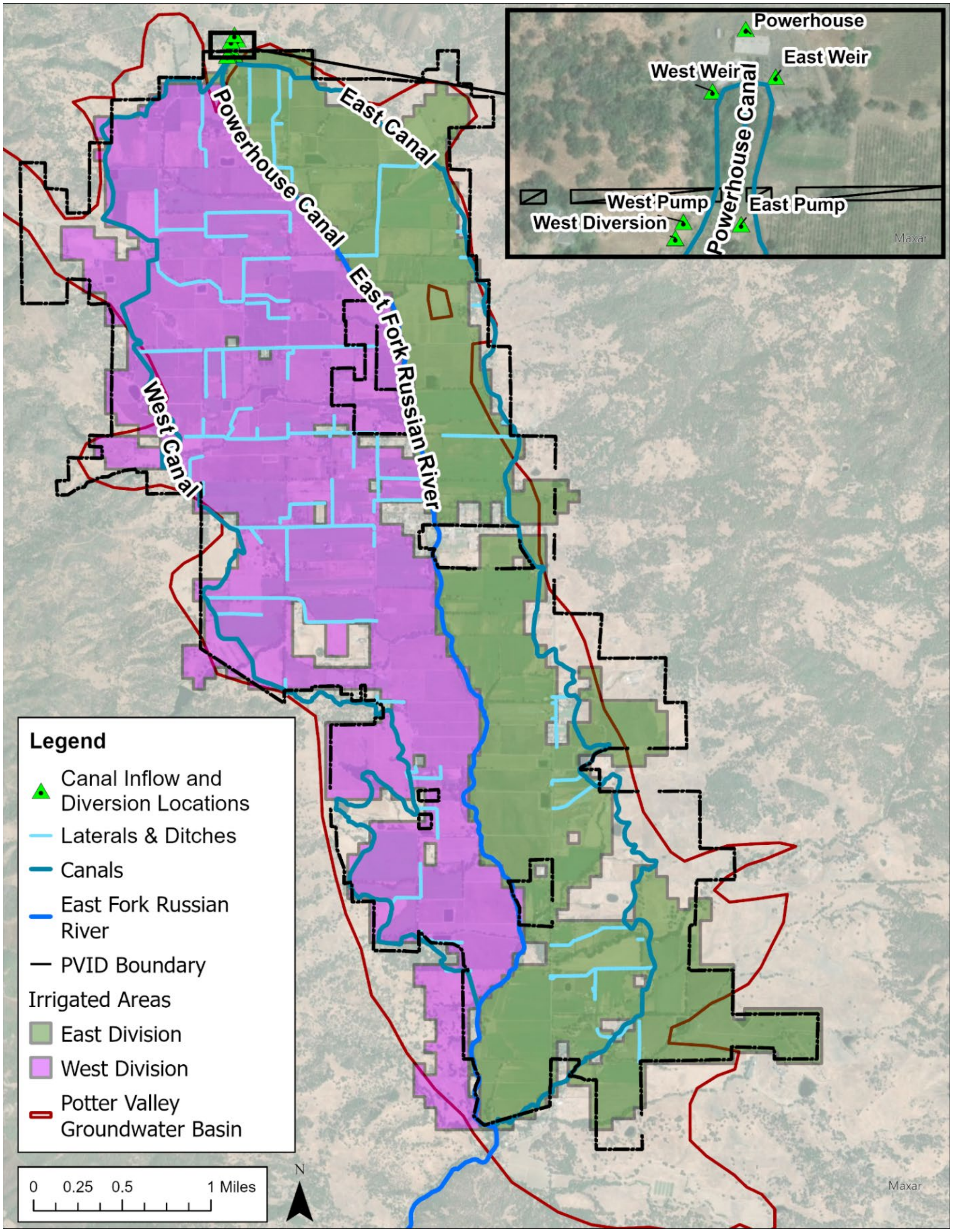


Figure 3-7. Irrigated Areas

Table 3-4. Summary of Annual Measured Canal Surface Water Inflows and Deliveries

Water Year	Measured Water Entering Diversion Tunnel to Powerhouse (AF)	Measured Water Diverted into PVID East & West Canals[a] (AF)	Measured Water Removed from Powerhouse Canal at East Pump, West Pump, and West Diversion[b] (AF)	Measured Total Water Delivered to PVID[c] (AF)	Measured East Canal Deliveries (AF)	Measured West Canal Deliveries (AF)	Measured Total PVID Deliveries (AF)
2011	100,590	11,982	1,991	13,973	4,433	5,200	9,633
2012	69,007	12,275	3,384	15,659	4,974	6,859	11,833
2013	67,640	15,290	4,403	19,693	5,413	7,774	13,187
2014	38,940	11,702	6,722	18,424	5,492	7,619	13,111
2015	37,055	8,246	9,615	17,861	5,762	7,800	13,562
2016	46,253	6,832	9,414	16,246	4,894	6,557	11,451
2017	67,035	6,596	8,091	14,687	4,381	5,688	10,069
2018	48,696	6,778	8,145	14,923	4,596	5,789	10,385
2019	65,641	5,495	6,386	11,881	4,044	4,576	8,620
2020	58,457	6,909	8,540	15,449	4,697	6,099	10,796
2021	31,805	6,090	1,678	7,768	3,787	4,925	8,712
2022	42,605	12,335	1,634	13,969	3,972	5,300	9,272

AF = acre-feet

Notes:

[a] Term based on values reported in PVID's water use reports called "PG&E CEDC FOR E-5 & E-6."

[b] Term based on values reported in PVID's water use reports called "Lic. 5246 USE AT DIVERSION," and represents additional PVID diversions into the East and West Canals.

[c] Term represents the sum of water diverted into PVID East & West Canals and Total Water Removed from Powerhouse Canal at East Pump, West Pump, and West Diversion.

Table 3-5. PVID Irrigated Area by Crop Type

Water Year	Fallow	Grazing	Grapes	Pears	Pasture/Hay	Farm Crops	Cannabis	Total Area
2011	N/A	N/A	2,018	209	2,525	72	N/A	4,824
2012	N/A	N/A	2,018	209	2,525	72	N/A	4,824
2013	N/A	N/A	1,966	208	2,571	67	N/A	4,812
2014	N/A	N/A	1,966	208	2,571	67	N/A	4,812
2015	N/A	N/A	1,966	208	2,571	67	N/A	4,812
2016	190	449	1,979	205	2,658	84	N/A	5,565
2017	171	549	2,140	195	2,406	80	N/A	5,541
2018	171	549	2,140	195	2,398	80	N/A	5,533
2019	107	663	2,157	195	2,323	77	37	5,559
2020	107	693	2,137	195	2,327	77	37	5,573
2021	100	966	2,198	143	2,159	51	37	5,654
2022	91	926	2,198	143	2,161	74	27	5,620

N/A = not applicable

3.3.3.4 Evapotranspiration Estimates

Monthly remotely sensed ET estimates were obtained from OpenET for calendar year 2016 through 2021, which was the period of data available from OpenET that overlapped with the PVIFM simulation period when this model was developed (Table 3-6). Monthly raster data from OpenET are available with a 30-meter by 30-meter pixel resolution. Monthly ET raster data were averaged across PVIFM model cells to create an ET dataset that covers every model cell in PVIFM. Figure 3-8 shows an example monthly gridded ET dataset for June 2018. Because ET data from OpenET are only available for a portion of the simulation period, an approach to calculate cell-by-cell average monthly ET values was implemented. Average monthly values were then applied to calendar years 2010 through 2015 and 2022 (refer to “No Data” entries in Table 3-6); thus, the ET dataset for these years contain the same total annual ET.

Table 3-6. Availability of OpenET Data and Annual Irrigated Lands Evapotranspiration

Calendar Year	Irrigated Lands ET[a] (AF)
2010	No Data (11,654)
2011	No Data (11,654)
2012	No Data (11,654)
2013	No Data (11,654)
2014	No Data (11,654)
2015	No Data (11,654)
2016	11,914
2017	11,631
2018	11,698
2019	11,718
2020	11,374
2021	11,590
2022	No Data (11,654)

[a] Values estimated from OpenET. The value in parentheses represents the average of the values listed for 2016 through 2021.

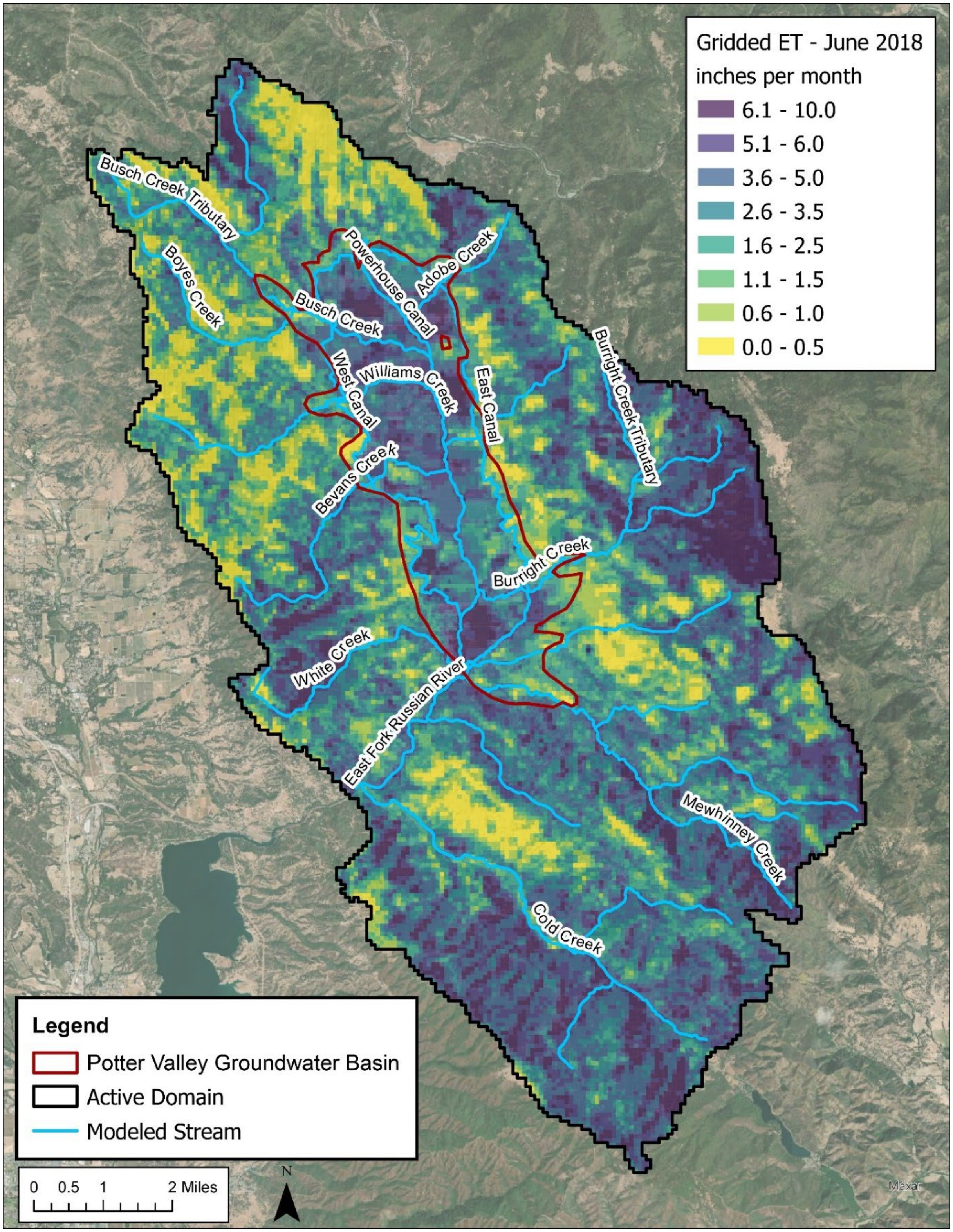


Figure 3-8. Example Distribution of Evapotranspiration in June 2018 from OpenET

3.4 Subsurface-Flow Parameters

The subsurface hydraulic parameters required by PVFIM are the horizontal hydraulic conductivity (K_h), vertical hydraulic conductivity (K_v), specific yield (S_y), and specific storage (S_s).

3.4.1 Hydraulic Conductivity

Hydraulic properties from RRIHM and professional judgment formed the basis for the initial K_h and K_v values incorporated into PVIFM. Figure 3-9 presents the initial hydraulic property zones assumed in PVIFM. Initial K_h values in PVIFM were initially set to values of 0.88 feet per day (3.1×10^{-4} cm/s) and 0.002 feet per day (7.1×10^{-7} cm/s) for the alluvial material within the Basin (Model Layers 1 and 2) and bedrock material outside of the Basin (Model Layers 1 through 3), respectively. The K_v for the alluvial and bedrock material were initially set to values of 0.23 feet per day (8.1×10^{-5} cm/s) and 0.0005 feet per day (1.8×10^{-7} cm/s), respectively. Section 4 describes the modification of these values during the calibration process.

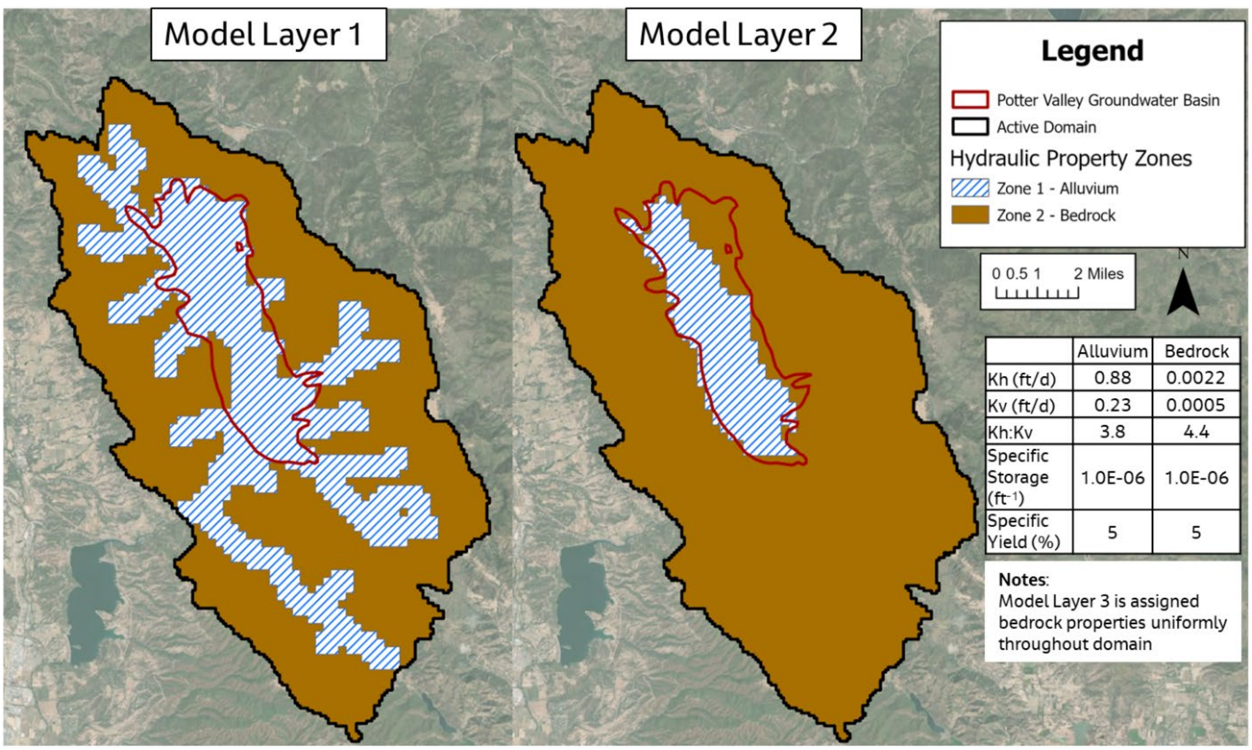


Figure 3-9. Initial Hydraulic Property Zones

3.4.2 Groundwater Storage

Groundwater storage (also known as storativity) is handled through the assignment of two parameters, including the S_y and S_s. Model Layers 1, 2 and 3 are set as convertible layers to allow transmissivity to vary temporally and spatially according to the layer's saturated thickness and K_h. These model layers require the user to input both S_y and S_s values, which can vary on a cell-by-cell basis. If a model cell during a given stress period is fully saturated (or confined), then the model computes a storativity as the product of the S_s and cell thickness. If a model cell during a given stress period is partially saturated (or unconfined), then the model uses the S_y. The PVIFM was initially assigned a uniform S_y of 5%, and S_s values of 1×10^{-6} per foot (USGS 1967; USGS 2001) based on literature values and professional judgment (Figure 3-9). Section 4 describes the modification of these values during the calibration process.

3.5 Simulation Period and Time Discretization

Annual precipitation data collected at the PG&E Powerhouse were evaluated along with the availability of PVID operational data to determine an appropriate simulation timeframe for calibration of PVIFM. Figure 3-10 shows the measured annual precipitation at the PG&E Powerhouse, which varied from 19.6 to 65.3 inches per year over the period of WYs 2000 through 2022. For PVIFM calibration, the period covering WYs 2011 through 2022 was selected based on hydrologic variability and availability of PVID operational data. The WYs 2011 through 2022 exhibit a range of wet (that is, WYs 2010 through 2011 and WYs 2016 through 2017) and dry (that is, WYs 2012 through 2015 and WYs 2020 through 2021) hydrologic sequences that are advantageous for evaluating the Basin's response to hydrologic variability to support the Reliability Study. The 12-year simulation period was then subdivided into monthly stress periods with a single time step per stress period to adequately simulate seasonal hydrologic processes.

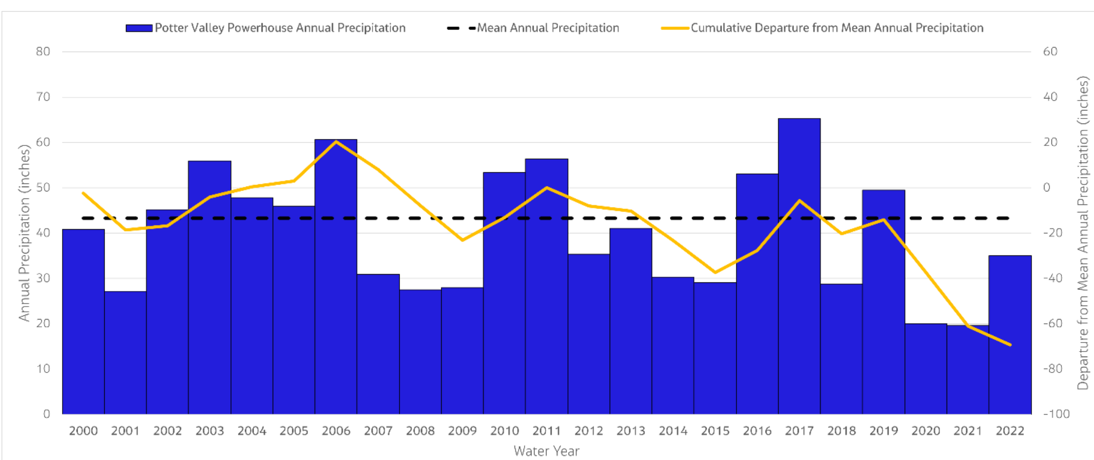


Figure 3-10. Annual Precipitation, 2000 through 2022

3.6 Initial Flow Conditions

The establishment of transient PVIFM simulations necessitates establishment of initial flow conditions in the hydrologic system. Initial conditions refer to the initial distribution of groundwater elevations throughout the model domain. Initial conditions for the calibration simulations were established in a spin-up manner. This step involved assigning initial heads intended to approximate January 2010 conditions and then allowing the monthly stress periods to work through monthly conditions through September 2010 (that is, the end of the spin-up period). This spin-up period is necessary because it is not possible to assign initial conditions in the SFR features of PVIFM. As such, the SFR features start out as dry conditions, and must be allowed some simulation time to wet up and begin routing water in a manner that is consistent with the intended month-to-month hydrologic variations. The first 9 months of the simulation include a series of wet and dry months deemed adequate to initialize streamflow along the SFRs. Given the need for a spin-up period, model output data from the spin-up period are not included in the assessment of calibration or water budgets. Presentation of calibration results and water budgets described in Section 4 are representative of October 1, 2010 through September 30, 2022 (that is, WYs 2011 through 2022).

3.7 Boundary Conditions

Boundary conditions are mathematical statements/rules that specify head (that is, groundwater elevation) or water flux at selected locations within the model domain. The following three types of boundary conditions were used in PVIFM during calibration.

- **Specified flux.** Water fluxes are assigned to selected model cells and remain unchanged during a monthly stress period. A specified-flux boundary condition can either represent an inflow or an outflow boundary condition, whereby positive values indicate water inflow rates and negative values indicate outflow rates.
- **Head-dependent flux.** Head and hydraulic-conductance values are assigned to selected model cells and water fluxes are computed by the model code across the boundary using an appropriate governing-flow equation, based on the head assigned to the boundary condition and the simulated groundwater elevation. A head-dependent flux boundary condition is also a two-way boundary condition, depending on the direction of the hydraulic gradient (into or out of the modeled aquifer system).
- **No-flow.** Water can flow along the boundary, but not across it.

Table 3-7 summarizes these boundary conditions for PVIFM, and Figure 3-11 illustrates locations and types of boundary conditions used to calibrate PVIFM.

Table 3-7. Summary of PVIFM Boundary Conditions for Calibration

Hydrologic Process	Boundary Condition Type
Precipitation	Specified Flux
Stream and Canal Inflows	Specified Flux
Canal Diversions	Specified Flux[a]
Groundwater Pumping	Specified Flux[a]
Groundwater Recharge from Precipitation and Applied Water	Head-dependent Flux[a]
Runoff	Head-dependent Flux
Subsurface Evapotranspiration	Head-dependent Flux[a]
Groundwater-Surface water Interaction	Head-dependent Flux
Groundwater Discharge to Land Surface	Head-dependent Flux
Subsurface Inflow/Outflow to Surrounding Areas	Head-dependent Flux

Notes:

[a] Processed and managed through the UZF and AG packages, which include some aspects of both specified flux and head-dependent boundary conditions.

No-flow boundaries are simulated at lateral boundaries of the active domain at cells not already assigned a general head boundary or specified fluxes and at the bottom of Model Layer 3.

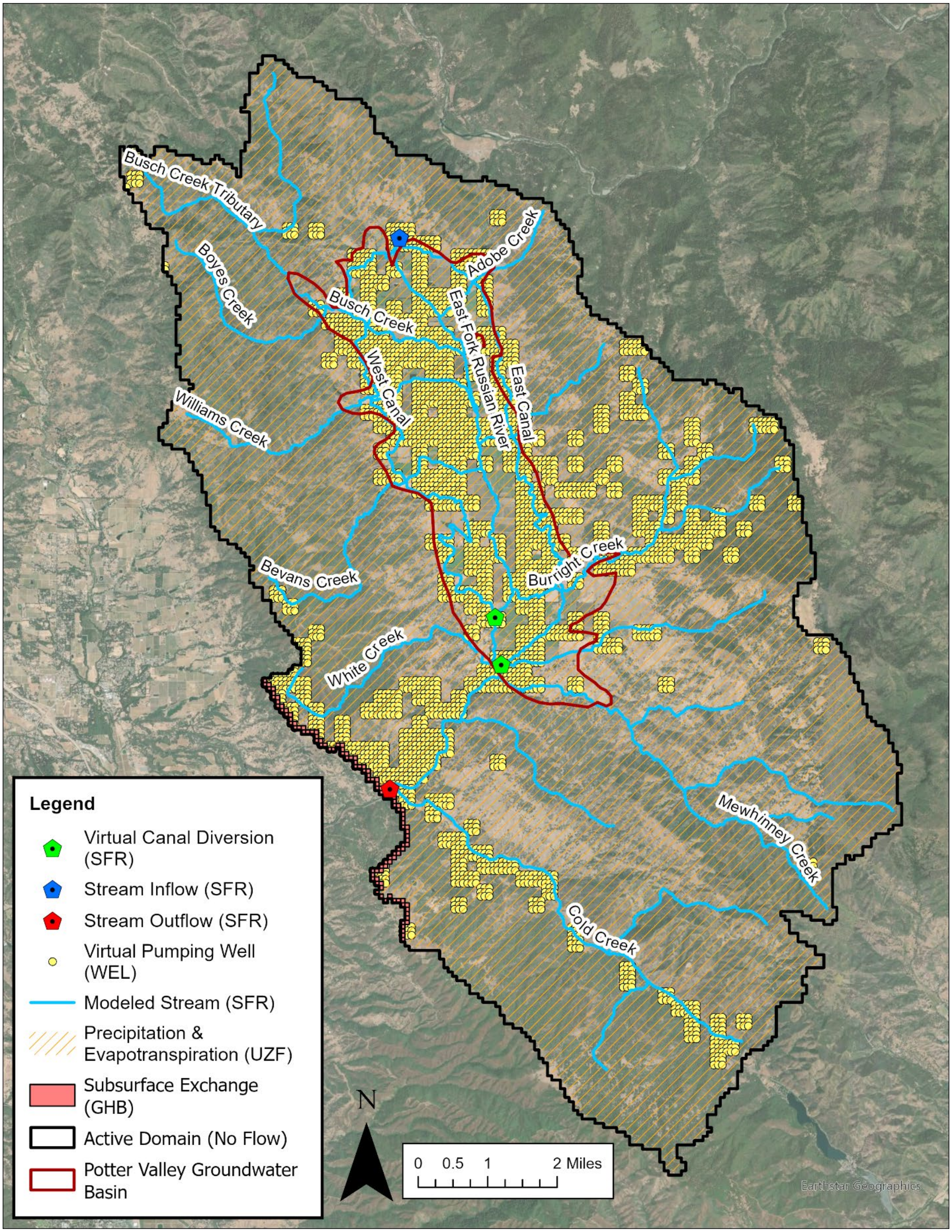


Figure 3-11. Boundary Conditions

3.7.1 Specified Fluxes

The following section describes boundary conditions in the PVIFM where either a volumetric or linear flux is used to simulate various flow processes.

3.7.1.1 Precipitation

Monthly precipitation data measured at the PG&E Powerhouse were provided by PVID staff during the Potter Valley Field Reconnaissance task of the Reliability Study. PG&E Powerhouse precipitation rates were incorporated into the UZF package of PVIFM as specified fluxes. Precipitation values from the Potter Valley Powerhouse were scaled based on developed orographic precipitation factors to incorporate spatial variability in precipitation throughout the PVIFM domain.

The initial step in developing orographic factors was to sample PRISM 30-year normal annual average precipitation values (PRISM 2023) onto PVIFM grid cells. PRISM 30-year normal values for each grid cell were then divided by the 30-year normal annual average precipitation at the PG&E Powerhouse. The fraction at each grid cell represents the potential spatial variability distribution of precipitation not captured by a single measurement station at the PG&E Powerhouse. Figure 3-12 presents the developed orographic precipitation factors that were used to scale the monthly Potter Valley Powerhouse precipitation values for the PVIFM simulation period.

The applied orographic precipitation factors range from a reduction in precipitation of 13% to an increase in precipitation of 23%. Reductions in precipitation because of the orographic factors occur throughout the Basin and valley floor where orographic effects are less likely to influence rates of precipitation. Increases in precipitation tend to occur in the upper tributaries with the largest changes occurring at the northern and southern ends of the PVIFM domain.

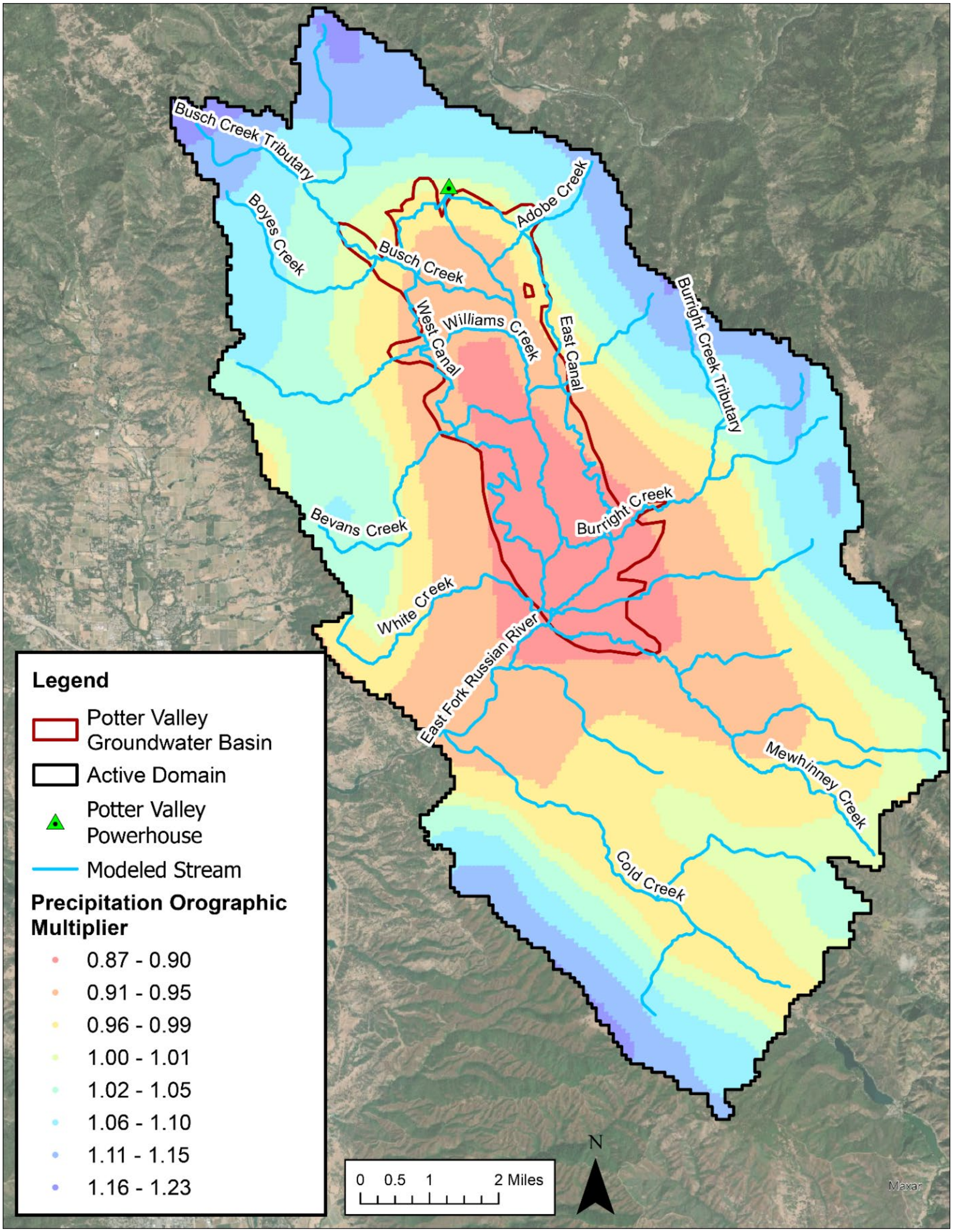


Figure 3-12. Precipitation Orographic Multipliers

3.7.1.2 Stream and Canal Surface Water Inflows

Stream and canal surface water inflows were incorporated into PVIFM to account for imports of water from the PVP as described in Section 3.3.3.3. PVID's diversions at the East Weir, East Pump, West Weir, West Pump, and West Diversion (Figure 3-7) were lumped into two separate East Canal and West Canal Inflows, with the remaining flow from the Powerhouse flowing down the Powerhouse Canal to the EFRR (Figure 3-7). These three stream inflow terms are simulated in the SFR package to account for surface water inflows to Potter Valley and are simulated at the Stream Inflow (SFR) point location in the northern end of Potter Valley (Figure 3-11). Monthly specified fluxes for each of these inflow terms were developed based on data provided by PVID (Table 3-4). Table 3-8 shows the estimated annual canal inflows assigned in the SFR at the upstream end of the East, West, and Powerhouse Canals. Monthly East and West Canal inflows were estimated by splitting the measured total PVID use (Table 3-4) into two separate terms based on the fraction of total PVID deliveries that occurred from the East and West Canals, respectively. Estimated Powerhouse Canal inflow was computed by subtracting the measured total PVID use (Table 3-4) from the measured water entering the diversion tunnel to Powerhouse (Table 3-4) to account for the remaining imported water that flows into the EFRR.

Table 3-8. Estimated Annual Canal Inflows

Water Year	Estimated East Canal Inflow (AF)	Estimated West Canal Inflow (AF)	Estimated Powerhouse Canal Inflow (AF)
2011	6,403	7,571	86,616
2012	6,520	9,139	53,348
2013	8,102	11,591	47,947
2014	7,626	10,799	20,515
2015	7,604	10,257	19,194
2016	6,959	9,286	30,007
2017	6,360	8,328	52,348
2018	6,647	8,276	33,773
2019	5,574	6,307	53,761
2020	6,649	8,800	43,008
2021	3,516	4,252	24,037
2022	6,004	7,965	28,636

3.7.1.3 Canal Diversions

As shown in Figure 3-11, two virtual diversions are simulated in PVIFM to represent diversions from PVID's East and West Canals that deliver surface water to PVID customers. The term "virtual" indicates the fact that these two diversion locations do not coincide with physical diversions. These virtual diversions were implemented in the modeling process to represent the collection of physical diversions located throughout PVID. Assignment of diversions at their physical locations was not possible because data provided by PVID represent total diversions from the East and West Canals only, rather than for individual diversions. Thus, these virtual diversions are simulated to reflect surface water supplies that are used to meet total applied water (irrigation) demands within the East and West Divisions of PVID. Maximum diversion rates are incorporated in the SFR package as specified fluxes that define the maximum diversion rate that can occur within a month. The specified-flux data for these diversions are based on PVID reported deliveries from the East and West Canals as discussed in Section 3.3.3.3.

Modeled diversion rates are constrained by the specified maximum diversion rate but are also constrained by the availability of surface water in the canal upstream of the canal diversion location. If the surface water available upstream of the diversion location is less than the maximum diversion rate, then the simulated diversion rate is automatically adjusted by the modeling software to reflect the surface water availability in the canal. Additionally, modeled surface water diversion rates depend on the need (that is, the applied water demand) for surface water supplies in the linked irrigated area. Applied water demand is simulated through the AG package, which establishes the linkage between an irrigated area and canal diversion location. Irrigated areas are defined based on the assumed East and West Divisions of PVID (Figure 3-7) and are linked with the East and West Canal diversions, respectively. Modeled diversion rates aim to minimize the ET deficit computed by the AG package while working within the maximum diversion rate and surface water availability constraints. An assessment of PVIFM's ability to simulate the specified maximum diversion rates was completed during calibration and is discussed in Section 4.

3.7.1.4 Rural Domestic Groundwater Pumping

Rural domestic groundwater pumping rates and distributions were adapted from the RRIHM WEL package for simulation in PVIFM. Groundwater pumping using the WEL package is assigned on a cell-by-cell basis where the pumping is distributed across a model cell as a virtual pumping well (Figure 3-11). The term "virtual" indicates that these point locations do not coincide with individual wells, but rather represent domestic wells operating within 100-meter by 100-meter model cells. Given the difference in grid resolution between PVIFM (100-meter by 100-meter cells) and RRIHM (300-meter by 300-meter cells), the representation of rural domestic groundwater pumping from each RRIHM cell was subdivided across nine PVIFM cells.

3.7.2 Head-dependent Fluxes

The following describes boundary conditions in PVIFM where the flux used to simulate various hydrologic processes are dependent upon heads (that is, simulated groundwater elevations compared to the boundary condition elevation) and the conductance assigned to the boundary condition.

3.7.2.1 Groundwater Recharge from Precipitation and Applied Water

Infiltration and groundwater recharge from precipitation and applied water is simulated through the UZF package. As precipitation and applied water are introduced to model cells as an inflow to the UZF water budget, the UZF package determines how much infiltration can occur based on the rate of inflow for that month, the vertical hydraulic conductivity of Model Layer 1, and the depth to groundwater in each model cell. Infiltrated water can then contribute either to soil moisture storage or groundwater recharge, or it can be consumed via ET as water passes through the root zone to the water table. Groundwater recharge from precipitation and applied water boundary process is simulated areally, where applicable, across the top of the model domain. For example, the application of water for irrigation only occurs in the areas defined as being irrigated through the AG package. These irrigated areas are the East and West Division of PVID that were defined based on the extent of irrigated areas within PVID (Figure 3-7).

3.7.2.2 Runoff

Runoff is simulated through the UZF package. Any inflow rates of precipitation and applied water that are greater than the vertical hydraulic conductivity of Model Layer 1 is routed to and distributed across the nearest SFR segment as runoff. Additionally, if the modeled water table is at ground surface, then the inflow of water is rejected due to a lack of available storage in the unsaturated zone. Water in excess of available unsaturated zone storage capacity is also routed to selected SFR segments as runoff. Figure 3-13 shows the modeled watershed boundaries that define the collections of model cells and their respective SFR segment to which runoff is routed.

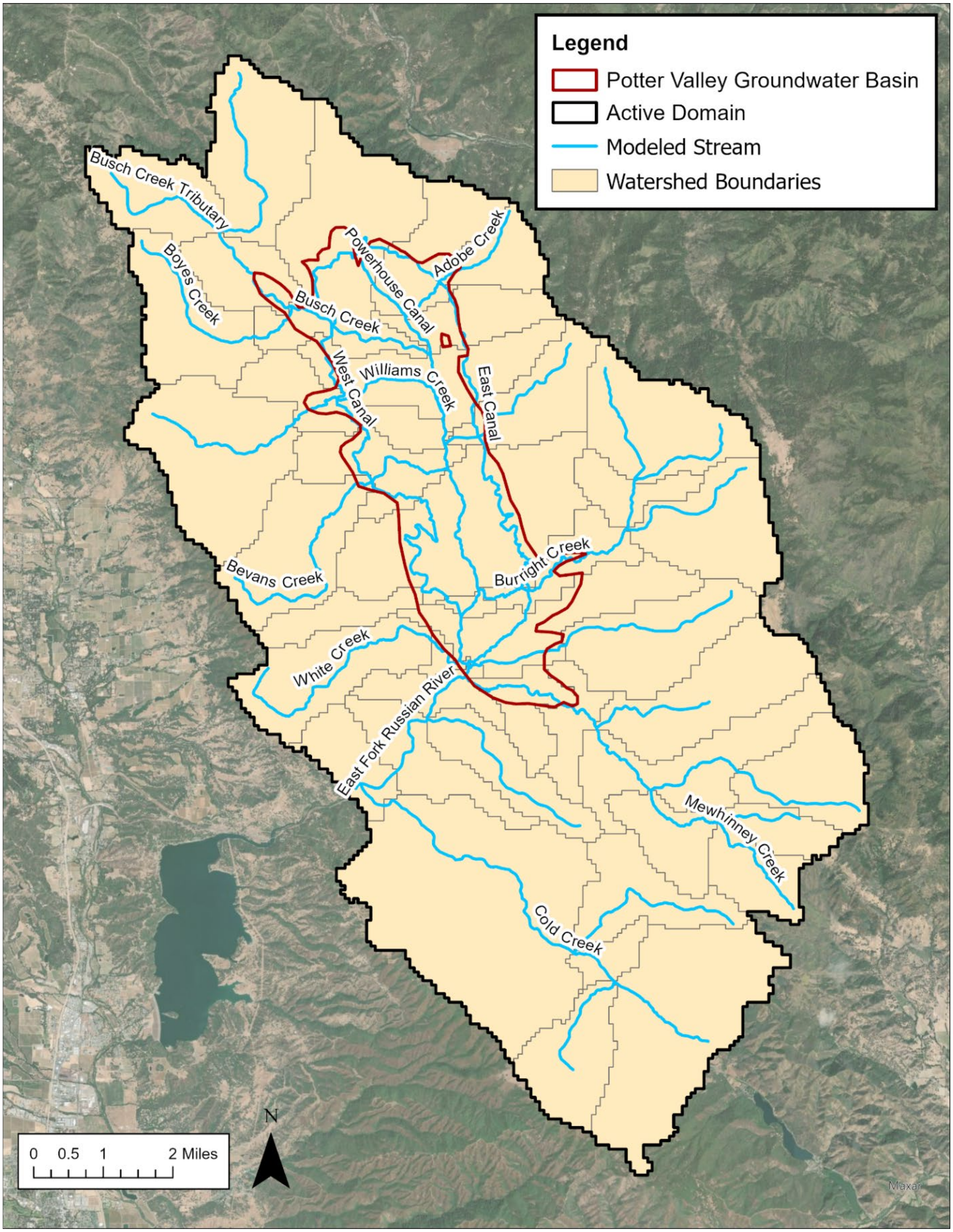


Figure 3-13. Modeled Watersheds for Runoff Routing

3.7.2.3 Subsurface Evapotranspiration

Subsurface ET is managed through the UZF package, whereby ET rates are specified to represent the potential ET or maximum ET demand rate that can occur within a stress period. Plants can utilize shallow groundwater and soil moisture stored in the unsaturated zone as a source of supply to meet potential ET demands. Access to shallow groundwater and soil moisture depends on assigned crop rooting depths and soil parameters including porosity, extinction depth water content, residual water content, and the elevation of the water table during a given month of the simulation. This boundary condition is applied areally across the top of the model domain (Figure 3-11). As described in Section 3.3.3.4, ET demands were established based on estimates from OpenET. Modifications were ultimately made to this boundary condition during calibration, as described in Section 4.3.

3.7.2.4 Groundwater-Surface Water Interaction

Groundwater-surface water interaction at streams and canals is simulated with the SFR package (Figure 3-11). The SFR package accounts for stream segments that can gain water from and lose water to the underlying aquifer, based on the hydraulic gradient between the modeled water table and modeled stage (surface water elevation) in the SFR reach during a given month in the simulation. The monthly gaining or losing flux is computed based on the hydraulic gradient, streambed hydraulic conductivity, channel geometry, and thickness of the stream bed. Section 3.3.2 discussed the initial stream channel characteristics.

3.7.2.5 Groundwater Discharge to Land Surface

Groundwater discharge to land surface is simulated through the UZF package and occurs when the water table intersects the ground surface of a model cell not already representing an SFR reach. Water that discharges to land surface is routed to nearby SFR segments in the same manner as runoff from infiltration and saturation excess as discussed in Section 3.7.2.2.

3.7.2.6 Subsurface Exchange with Surrounding Areas

A general head boundary (GHB) condition was included along the margins of the PVIFM domain where the EFRR flows out of the PVIFM domain toward Lake Mendocino (Figure 3-11). GHB cells were all assigned a uniform boundary head value of 769 feet NAVD88, which is intended to represent the water surface elevation of Lake Mendocino. GHB cells were also assigned a horizontal hydraulic conductivity value consistent with the hydraulic property zone of the GHB cell and a distance term of about 15,000 feet to reflect the distance between the boundary cell and Lake Mendocino. The GHB was incorporated to reflect potential subsurface exchanges of water with areas that are downgradient of the PVIFM domain.

3.7.3 No-flow Boundaries

The lateral model boundary cells depicted in Figure 3-11 that are not assigned other boundary conditions, and the bottom of Model Layer 3, are assigned the no-flow boundary condition. Inherent with the assignment of no-flow boundaries is the assumption that these boundaries coincide with locations of groundwater divides. These lateral and deep model boundaries were purposely located far enough from cells representing the Basin to avoid adverse boundary effects that could result from conceptual errors along the margin of the model domain.

4. Model Calibration

Model calibration is the process of adjusting numerical model parameters within reasonable ranges to adequately replicate measured field conditions of interest. The numerical model described here was calibrated in accordance with the ASTM International (ASTM) Standard D5981, *Standard Guide for Calibrating a Groundwater Flow Model Application* (ASTM 2018).. As described in Section 3.5, WYs 2011 through 2022 were selected as the historical water budget period, and therefore these years also constitute the model calibration period. This section discusses the calibration targets, process, and results, including the historical water budgets.

4.1 Calibration Targets

Quantitative and qualitative calibration targets were selected to evaluate progress during calibration of PVIFM. Time-varying heads and measured streamflows at gauging stations served as quantitative calibration targets. Figure 4-1 shows the calibration target locations for heads (that is, groundwater elevations) and streamflows. Calibration involved adjusting K_h, K_v, storage parameters, UZF parameters, and SFR parameters within reasonable ranges until there was adequate consistency between modeled and calibration target values. Calibration summary statistics were computed for head and selected streamflow targets to provide a quantitative measure of PVIFM's ability to replicate target values. Head and monthly streamflow calibration were evaluated at wells with available data during the calibration period and at the USGS stream gauge near Calpella, respectively, using the following summary statistics:

- **Residual,** computed as the modeled value minus the target (measured) value (computed for heads and monthly streamflows)
- **Mean residual (MR)**, computed as the sum of all residuals divided by the number of observations (computed for heads and monthly streamflows)
- **Root mean squared residual (RMSR)**, computed as the square root of the mean of all squared residuals (computed for heads only)
- **RMSR divided by the range of target head values (RMSR/Range)** (computed for heads only)
- **Coefficient of determination (R^2)**, computed as the square of the correlation coefficient (computed for heads and monthly streamflows)
- **Nash-Sutcliffe Efficiency (NSE)**, computed as one minus the ratio of the error variance of the modeled time series divided by the variance of the observed time series (computed for monthly streamflows only) (Nash and Sutcliffe 1970)

During the quantitative calibration effort, Jacobs executed work with the following general goals:

- Minimize global bias in residuals (for example, all modeled values being too high or too low as compared with the target values)
- Minimize the spatial bias of residuals in key subareas of the model domain
- Minimize residuals, MR, RMSR, and RMSR/Range values
- Strive for R^2 and NSE values as close to 1.0 as possible

In addition to establishing quantitative targets, qualitative targets were also used to aid in the calibration process. Calibration summary statistics were not computed for qualitative calibration targets. The qualitative targets used for the modeling effort are as follows:

- General groundwater flow patterns throughout the model domain
- Monthly streamflows recorded at the Center for Western Weather and Water Extremes (CW3E) stream gauges located in the watershed upgradient from the Basin (fewer data are available for these stream gauges)
- Simulation of PVID irrigation deliveries that match measured deliveries to PVID customers
- Simulation of subsurface ET at rates that are similar to OpenET rates

Targets classified as “qualitative” are important and should not be dismissed. The main distinction is that summary statistics are not computed for qualitative targets. Inclusion of multiple types of calibration targets and having a well-defined HFM are good standards of practice for reducing the effects of non-uniqueness when developing numerical groundwater models. In the context of numerical groundwater models, “non-uniqueness” refers to the fact that multiple combinations of model parameters can produce similar or identical modeled estimates. Essentially, different parameter sets can fit the measured data equally well, making it a challenge (or impossible) to uniquely determine true underlying system characteristics.

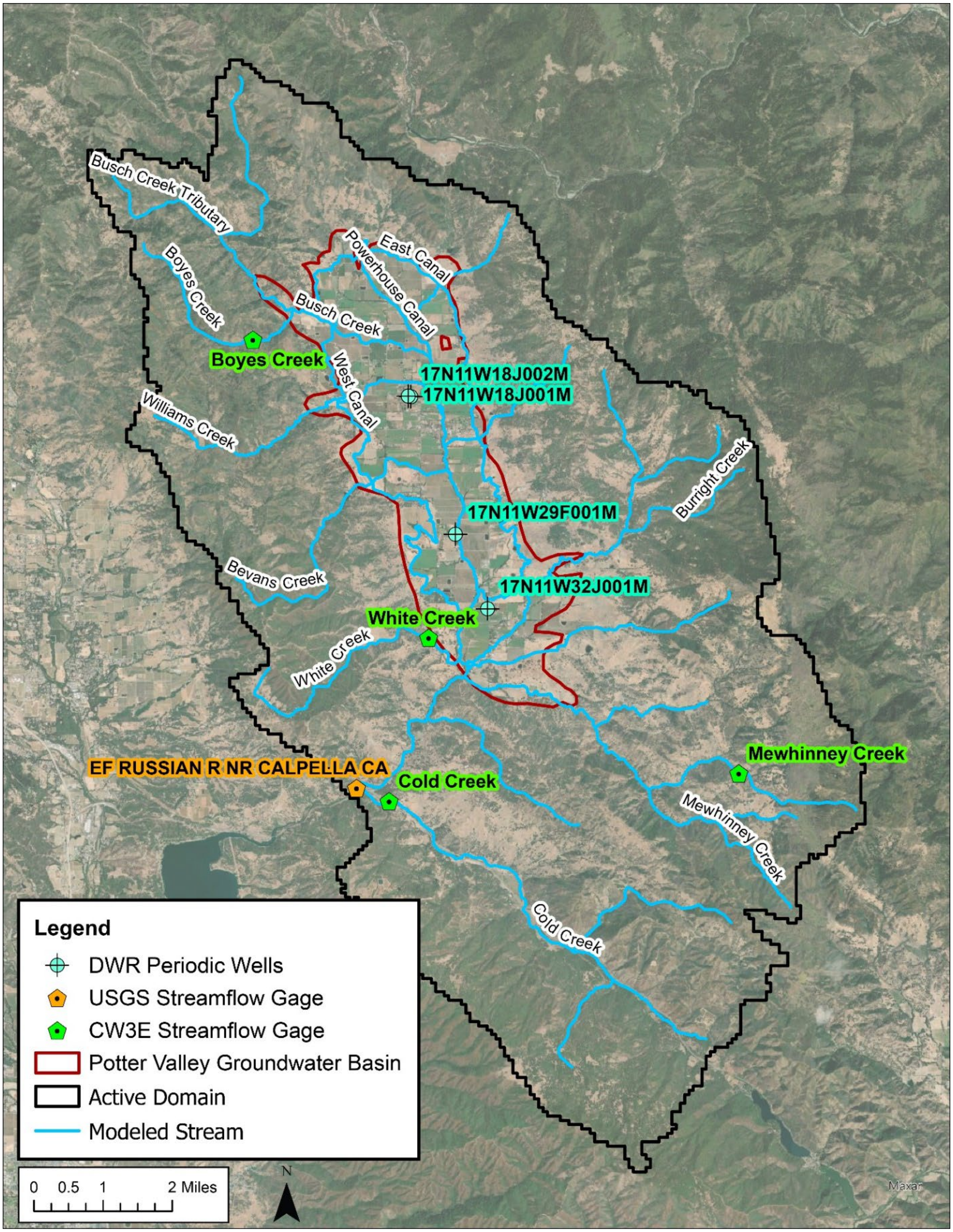


Figure 4-1. Calibration Target Locations

4.2 Calibration Process

The calibration process focused on defining UZF parameter values, surface and subsurface parameter values, and boundary-condition parameter values within reasonable ranges until there was an adequate match to both quantitative and qualitative targets. The main parameters adjusted during the calibration process were K_h, K_v, storage parameters, and UZF and SFR parameters (Table 4-1). A combination of manual calibration and automated calibration using PEST software version 17.3 (Doherty 2021a, 2021b) were used to adjust parameters values within reasonable ranges to minimize quantitative calibration summary statistics.

The product resulting from this calibration process was an integrated groundwater-surface water flow model that incorporates important aspects of the HFM and the professional judgment of engineers and scientists familiar with the study area. The following section describes calibration results.

Table 4-1. Calibrated Parameters and Ranges Evaluated during Calibration

Calibration Parameter	Alluvium	Bedrock	Alluvium (Coarse-Grained)	Alluvium/ Bedrock
Calibrated K_h (feet per day)	1.44	2.8E-02 to 2.8E-03	8.52	0.23
K_h Range in PEST (feet per day)	0.01 to 1.5	2.8E-05 to 0.28	1.45 to 50	1.2E-03 to 0.45
Calibrated K_v (feet per day)	0.29	2.8E-02 to 2.8E-03	1.7	7.0E-02
K_v Range in PEST (feet per day)	1E-02 to 0.3	2.8E-05 to 0.056	1.45 to 5	2.8E-02 to 1
Calibrated K_h:K_v	5	1	5	3.5
K_h:K_v Range in PEST	1 to 10	1 to 5	1 to 10	1 to 5
Calibrated Specific Storage (per foot)	1.0E-04	1.0E-04 to 1.0E-06	1.0E-04	2.3E-05
Specific Storage Range in PEST (per foot)	1.0E-07 to 1.0E-04	1.0E-09 to 1.0E-04	1.0E-07 to 1.0E-04	1.0E-07 to 1.0E-04
Calibrated Specific Yield (%)	15	1	15	3.5
Specific Yield Range in PEST (%)	1 to 20	0.1 to 5	1 to 20	1 to 5
Calibrated SFR Bed Thickness (feet)	1.61	1.61	1.61	1.61
SFR Bed Thickness Range in PEST (feet)	0.328 to 3.28	0.328 to 3.28	0.328 to 3.28	0.328 to 3.28
Calibrated SFR Bed K_v (feet per day)	0.28	0.28	0.28	0.28
SFR Bed K_v Range in PEST (feet per day)	9.8E-05 to 0.98	9.8E-05 to 0.98	9.8E-05 to 0.98	9.8E-05 to 0.98
Calibrated Monthly Potential ET Multiplier	1.2 to 10	1.2 to 10	1.2 to 10	1.2 to 10
Monthly Potential ET Multiplier Range in PEST	0.9 to 10	0.9 to 10	0.9 to 10	0.9 to 10
Calibrated Rooting Depth (feet)	6 to 20	6 to 20	6 to 20	6 to 20
Rooting Depth Range in PEST (feet)	1.5 to 30	1.5 to 30	1.5 to 30	1.5 to 30
Calibrated Global Precipitation Factor	0.78	0.78	0.78	0.78
Global Precipitation Factor Range in PEST	0.75 to 1	0.75 to 1	0.75 to 1	0.75 to 1

4.3 Initial Observations of PVIFM Mass Balances

Although mass balance discrepancies associated with the groundwater flow process and the AG package were well within industry standards throughout the course of calibrating PVIFM, larger mass balance discrepancies were noted in the UZF water budget. Mass balance discrepancies arise when a model cannot completely resolve the system of equations in a user-defined set of constraints for a given stress period, which results in over- or underestimating terms in the UZF water balance. Various approaches were explored to reduce UZF mass balance discrepancies, including modifying the NWT-solver and time-discretization settings, modifying UZF parameters, and using various configurations of UZF package components. The primary modification to PVIFM that resolved UZF mass balance discrepancies involved turning off the unsaturated zone flow component of the UZF package. To be clear, the UZF package was not turned off; only the unsaturated zone flow component that controls retention characteristics of the modeled unsaturated zone was turned off. With this component turned off, routing of precipitation and applied water into infiltration and runoff still occurs in the model; however, soil moisture storage is no longer tracked as a component of the UZF water budget, and infiltration is transferred without delay to the underlying modeled water table as groundwater recharge. Thus, groundwater recharge equals infiltration in this configuration, which is consistent with how traditional MODFLOW models handle groundwater recharge. In general, the assumption of infiltration equaling groundwater recharge is reasonable in the Basin due to consistently shallow depth to water and the likely presence of higher soil moisture due to application of surface water.

One downside of this UZF package configuration is that it precludes representing the unsaturated zone and unsaturated ET in the rooting zone above the modeled water table. However, shallow groundwater ET can still occur where rooting depths intersect the modeled water table. This retains some ability to simulate subsurface ET with no UZF mass balance discrepancies, and was deemed a reasonable compromise.

Sensitivity simulations were evaluated during this phase of calibration to evaluate the potential ramifications of turning off the unsaturated zone flow component of the UZF package in selected subareas of the model domain. These sensitivity simulations focused on an example projection that PVIFM will ultimately evaluate to support decision-making rather than focusing solely on the impacts to calibration. Sensitivity simulations included the following assumptions:

- Specified SFR inflows into East, West, and Powerhouse Canals were set to zero (no PVP imports)

- ET demands throughout PVIFM remained the same as those in the calibration version of PVIFM
- Maximum SFR diversions (PVID measured deliveries) remained the same as those in the calibration version of PVIFM

Through simulating no imported water from PVP, influence of the UZF package configuration could be evaluated by analyzing the groundwater system's response to no PVP imports, and the modeled subsurface ET under insufficient surface water supplies across multiple configurations of the UZF package. The team noted that groundwater system response and modeled subsurface ET were similar across different configurations of PVIFM with the unsaturated zone flow component of the UZF package turned on or off in selected subareas.

Ultimately, sacrificing explicit simulation of the unsaturated zone to resolve mass balance discrepancies was determined to be the most appropriate version of PVIFM to retain, thus achieving modeling objectives (Section 1.2). With the unsaturated zone component of the UZF package turned off, PVIFM continues simulating subsurface ET through shallow groundwater ET, which occurs when the water table is within crop rooting depths.

4.4 Calibration Results

The following subsections describe calibration results for time-varying groundwater levels, streamflow, general groundwater flow patterns, deliveries, and subsurface ET. Calibrated values for key parameters and boundary conditions are also presented in this section. Attachment 1 is a table of calibration targets, simulated targets, and target residuals.

4.4.1 Groundwater Levels

Limited groundwater level data were available for PVIFM's simulation period. Most of the groundwater level data needed during the PVIFM simulation period were only available at two wells (17N11W19J001M and 17N11W19J002M) (Figure 4-1), which are 200 feet apart in the northern half of the Basin. Table 4-2 lists calibration statistics for groundwater levels. In general, modeled heads were within approximately 2 feet of the limited number of target heads. However, there are insufficient data to conclude whether PVIFM systematically biases heads too high across the model domain. As additional groundwater-level data are collected at existing and new monitoring wells in Potter Valley, they should be used to update the calibration of PVIFM as part of future model updates.

Table 4-2. Calibration Summary Statistics for Groundwater Elevations

Calibration Statistic	Value	Unit
MR	0.07	Feet
RMSR	1.61	Feet
Range	10.7	Feet
RMSR/Range	15.05	Percent
R^2	0.45	Unitless
Number of Values	51	Unitless

Overall trends and dynamics of simulated groundwater levels were further evaluated in comparison to the HFM and observed conditions in the Basin to assess PVIFM's ability to simulate local groundwater conditions. Figure 4-2 displays groundwater-level hydrographs to show how the transient modeled and measured groundwater levels compare at the four groundwater level calibration wells shown in Figure 4-1.

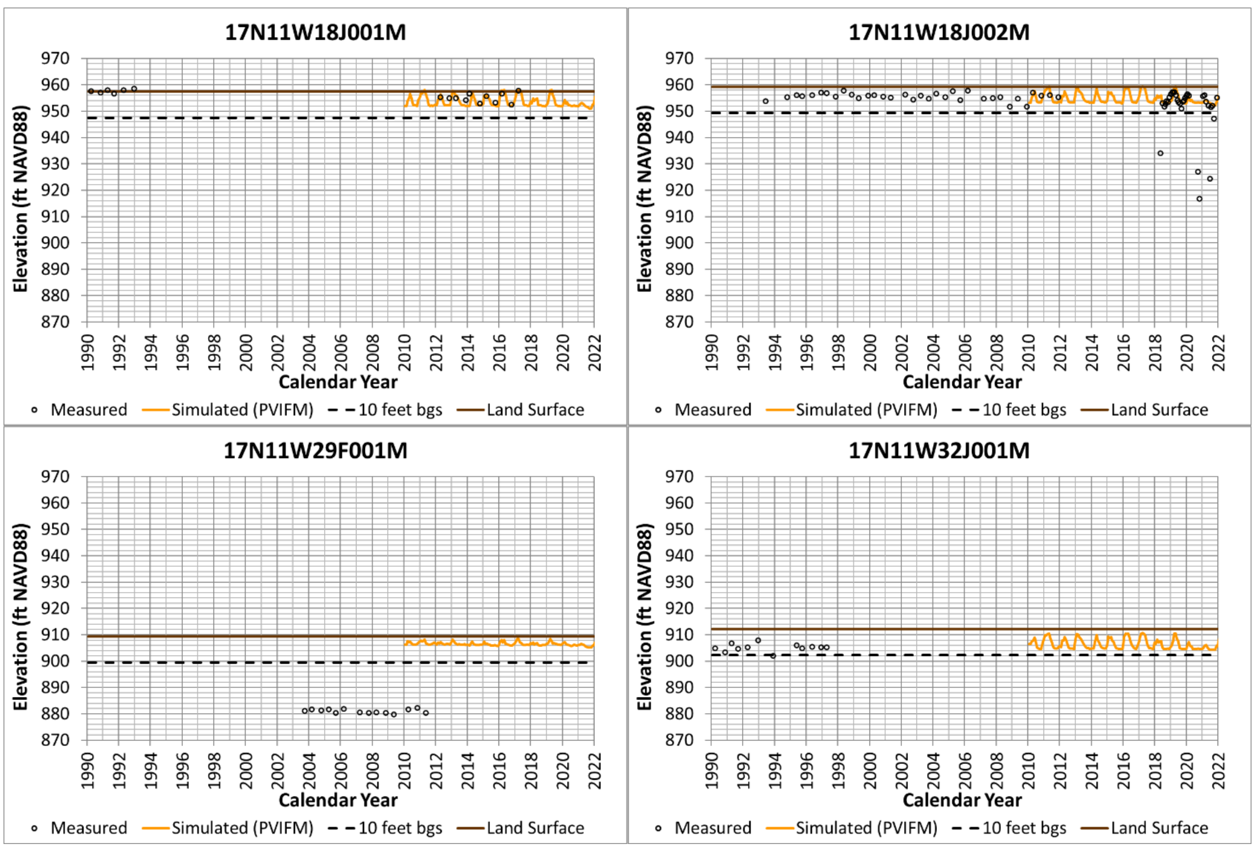


Figure 4-2. Modeled and Measured Groundwater-level Hydrographs

No well construction information was available for these four monitoring wells to help inform screening interval elevations. Thus, the simulated hydrographs presented in Figure 4-2 represent groundwater elevations in Model Layer 1 at each well. These hydrographs present the timeframe of calendar year 1990 through 2022 to display measured groundwater level data that are available prior to the simulation period of PVIFM. Additionally, a 10-foot bgs dashed line was added to each hydrograph to provide a sense of the relative shallowness of groundwater levels.

The 10-foot bgs line was selected based on discussions with Sonoma Water staff about the instrumentation of new wells in Potter Valley, where measured depths to groundwater are generally within 10 feet of ground surface. In general, transient simulated groundwater levels are reasonably consistent with measured groundwater levels and are within the 10-foot bgs threshold throughout the simulation period. The exception to this is where pumping groundwater levels are apparent between 2018 and 2020 at Well 17N11W18J002M. No attempt was made to replicate pumping groundwater levels in wells.

Well 17N11W29F001M has measured groundwater elevation data that were collected prior to PVFIM's simulation period. In general, measured groundwater elevations appear suspect compared to other depth-to-water conditions observed throughout the Basin. Well 17N11W29F001M is close to the EFRR in an area where the channel is deeply incised. Groundwater elevation trends at Well 17N11W29F001M could be the result of an inaccurate ground surface elevation due to an incorrect location, where the well may exist farther up on the bank of the EFRR, rather than down in the incised channel as the location of the well would suggest. Thus, calibrating to depth-to-water conditions exhibited at Well 17N11W29F001M was not an objective of the calibration process. Well 17N11W32J001M does not have measured data within the PVIFM simulation period; however, simulated groundwater levels appear reasonable assuming trends from the 1990 to 1998 timeframe are consistent in more recent years.

Figure 4-3 illustrates the modeled water table during March 2013, which is typically depicted by groundwater levels in Model Layer 1. However, there are small portions of the Basin where Model Layer 1 goes dry. Thus, the water table in these areas is typically defined by Model Layer 2. WY 2013 had an annual rainfall of approximately 41 inches, which is close to the annual average of 43 inches (Figure 3-10). Thus, the modeled water table shown in Figure 4-3 is intended to represent typical groundwater conditions. The intent of Figure 4-3 is to illustrate general groundwater flow through the Basin. Given the sharp contrast in groundwater levels between the Basin and the surrounding bedrock area, two contour intervals are shown in Figure 4-3 with a 10-foot contour interval within

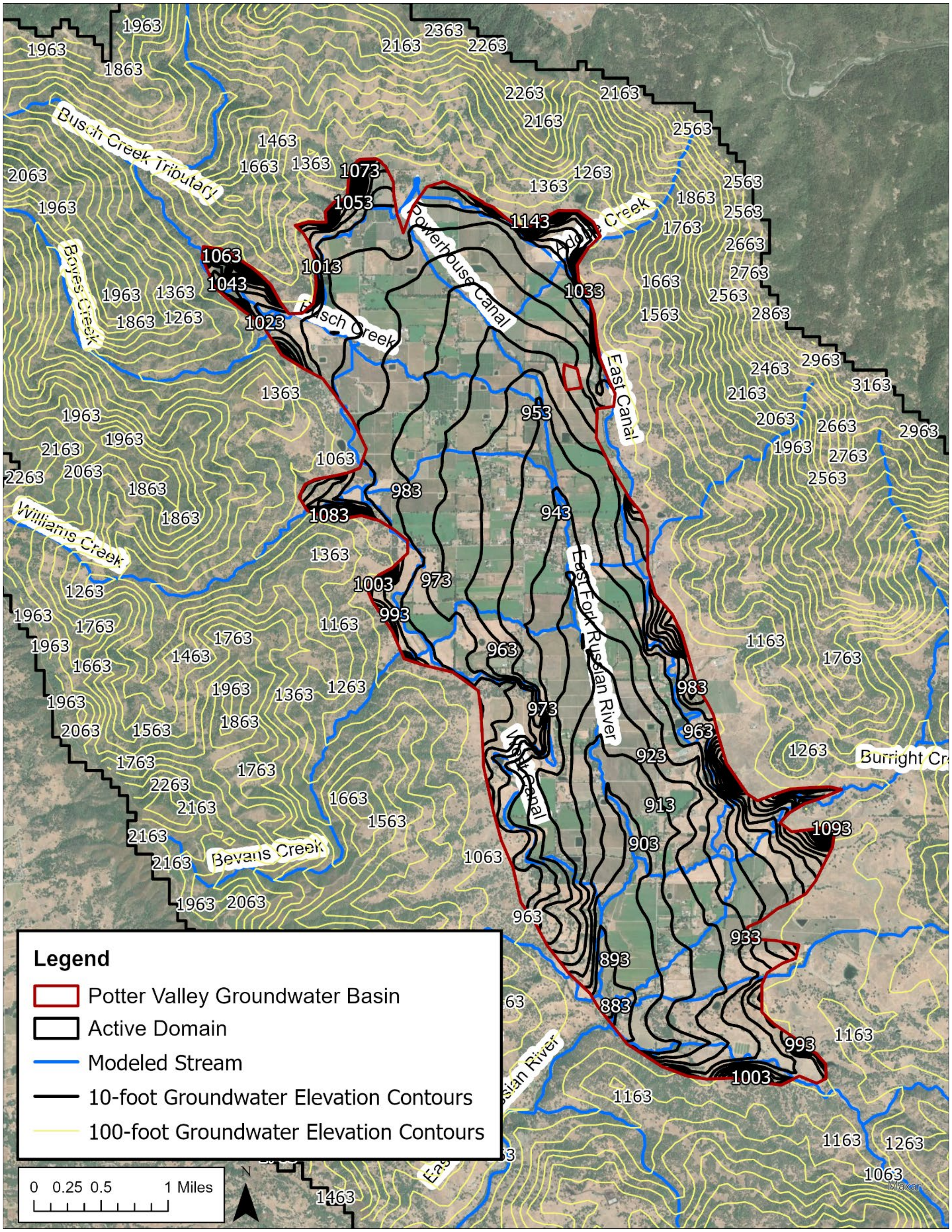


Figure 4-3. Modeled Water Table in March 2013

the Basin where there is less relief in the water table and a 100-foot contour interval outside of the Basin where there is greater relief in the water table. The water table is generally steeper near the margins of the Basin where the topography steepens and the alluvium thins. In general, groundwater flows toward the EFRR (EFRR is a gaining stream), which drains Potter Valley. No groundwater pumping depressions are noted in the groundwater contours due to the minimal groundwater pumping that occurs in the Basin. Overall groundwater flow patterns shown in Figure 4-3 are consistent with the conceptual understanding of groundwater flow through the Basin.

4.4.2 Streamflows

Figures 4-4 to 4-8 show the modeled versus measured and target streamflow, monthly average streamflow, and cumulative monthly streamflow for each of the five streamflow target locations (Figure 4-1). Figures 4-4 to 4-7 show comparisons of modeled versus measured streamflow at four streamflow gauging stations managed by the CW3E at the University of California, San Diego that were used for a limited study in the Russian River Watershed (Sumargo et al. 2020). The CW3E gauges are located on EFRR tributaries.

The CW3E gauges have a limited period of record of measured streamflow during the simulation period of PVIFM. Generally, PVIFM initially tended to overestimate streamflow at each of the CW3E gauges. Due to this overestimation and limited improvement by adjusting other model parameters, a precipitation factor of 78% was applied globally in the model to reduce precipitation by 22% in all model cells. After adjusting precipitation, PVIFM matched seasonal trends in streamflow reasonably well; however, it overestimated streamflow throughout the year at the Mewhinney Creek and Cold Creek gauges, and during WY 2019 at the White Creek and Boyes Creek gauges. Simulated streamflow tends to underestimate streamflow at Boyes Creek throughout most of the year and during the summer months at the Mewhinney Creek and White Creek gauges. Variability in the PVIFM's ability to simulate streamflow at the CW3E gauges tends to indicate additional spatial variability in precipitation or watershed characteristics that may not be fully captured by PVIFM. Specifically, simulated streamflow at Cold Creek and Mewhinney Creek tend to overestimate streamflows more than the other gauges, which may indicate a difference in precipitation patterns or rainfall-runoff characteristics in these watersheds as compared to others upgradient from Potter Valley.

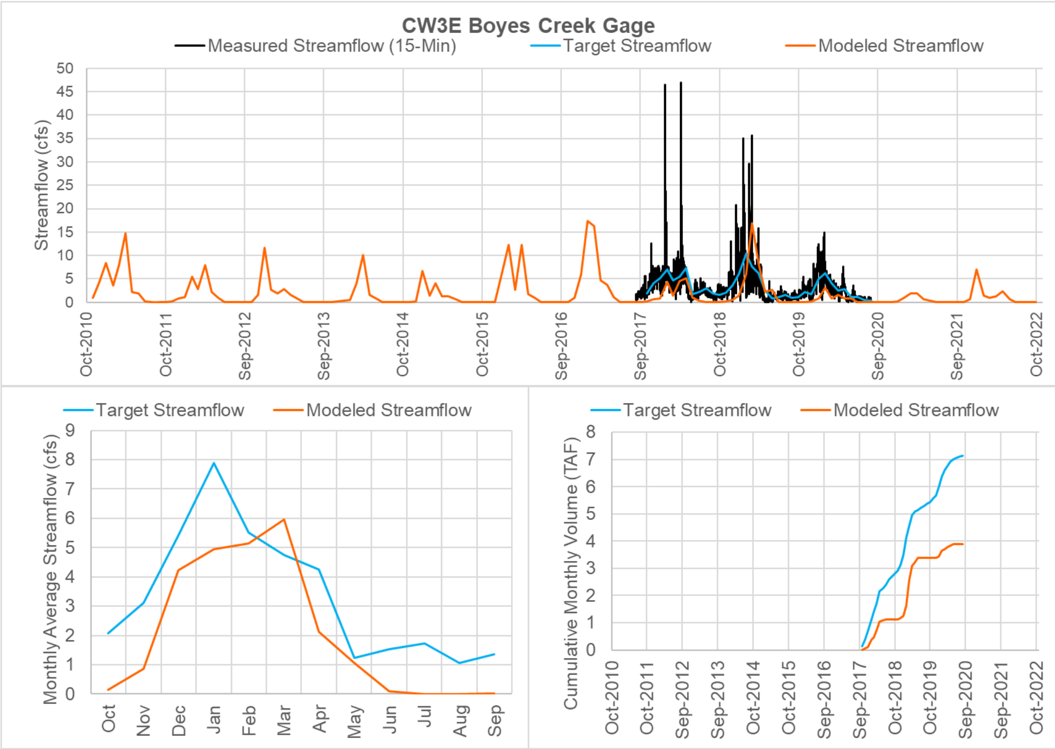


Figure 4-4. Modeled and Measured Streamflows at Boyes Creek

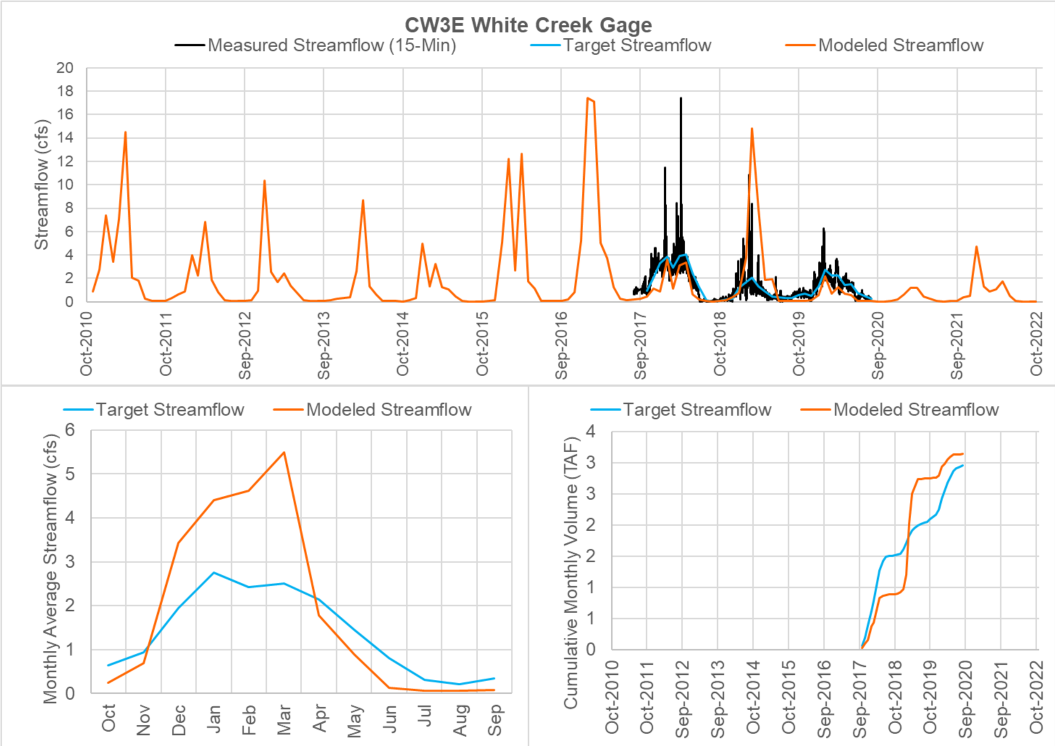


Figure 4-5. Modeled and Measured Streamflows at White Creek

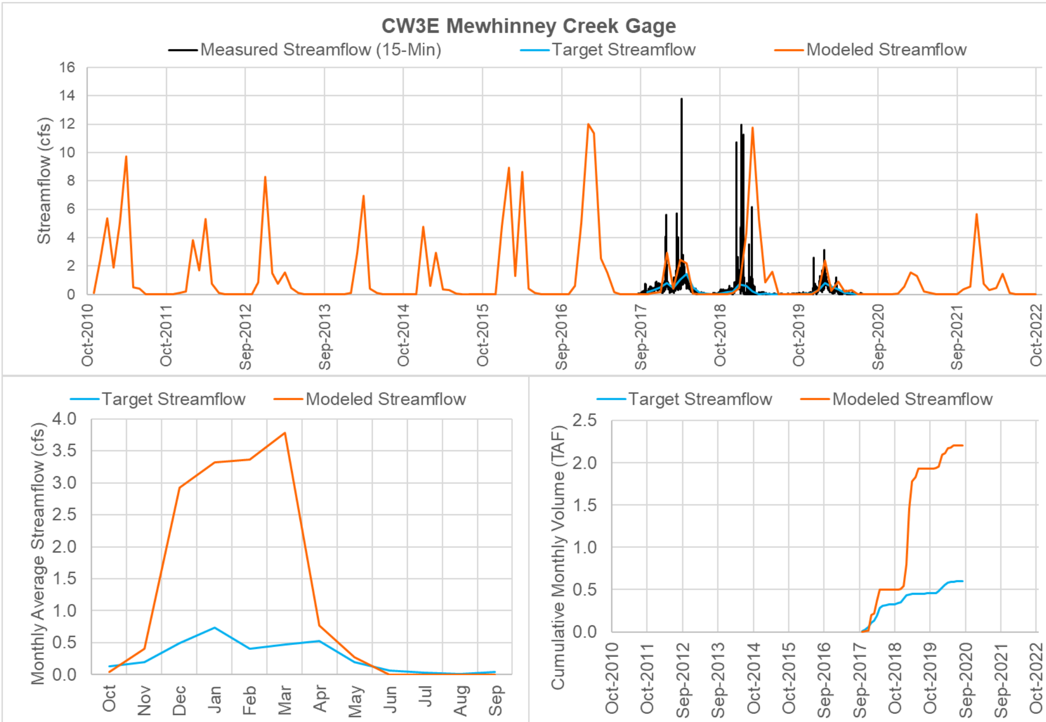


Figure 4-6. Modeled and Measured Streamflows at Mewhinney Creek

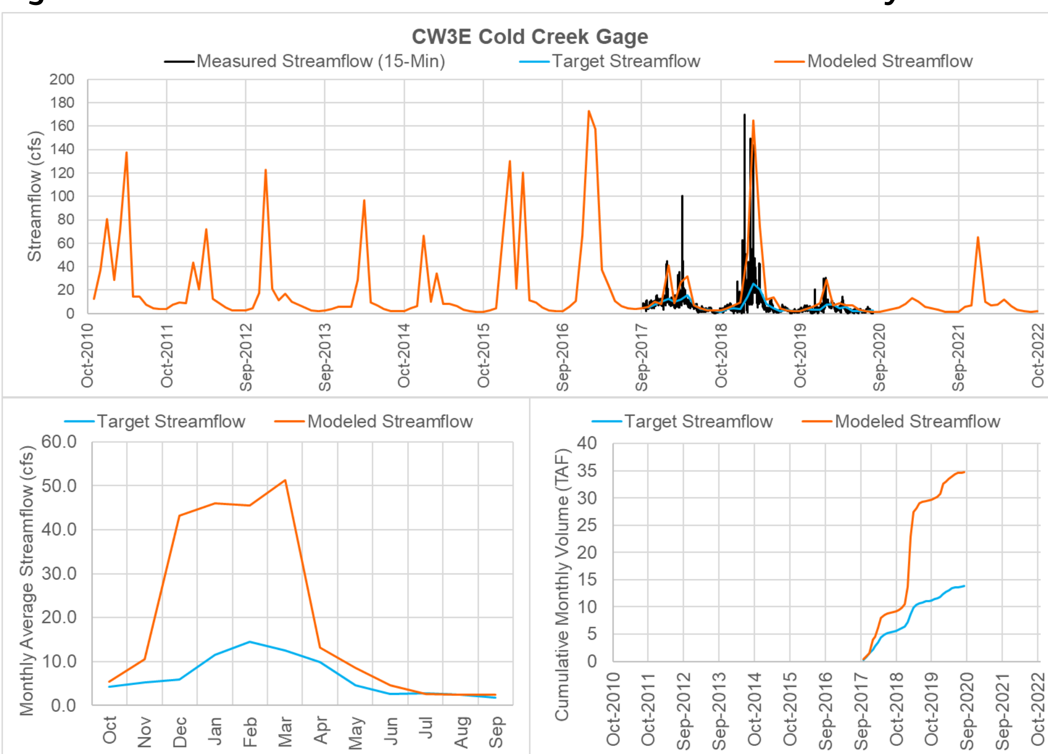


Figure 4-7. Modeled and Measured Streamflows at Cold Creek

Given the limited flexibility in representing rainfall-runoff partitioning in UZF, including the lack of depression storage, surface evaporation, and canopy interception, PVIFM's ability to replicate the rainfall-runoff partitioning process is limited. Although PVIFM tends to overestimate runoff in tributary creeks, a larger emphasis was placed on matching streamflow at the USGS gauge near Calpella rather than the CW3E gauges during the calibration process.

Figure 4-8 shows modeled versus target streamflow at the USGS gauge in the EFRR near Calpella. This gauge coincides with the location at which the EFRR leaves the PVIFM domain. Given the location of the USGS gauge and its long period of record, greater effort was focused on trying to match EFRR streamflows leaving the domain. Overall, PVIFM represents the monthly streamflow dynamics at the USGS gauge reasonably well. On average, PVIFM tends to slightly overestimate streamflow in January through March and underestimate in April through September. Like the tributary creeks, the representation of the rainfall-runoff process in PVIFM tends to overestimate runoff contributions in the Basin. The underestimation of baseflow conditions during July through September months suggests that modeled groundwater levels may be too low during these months.

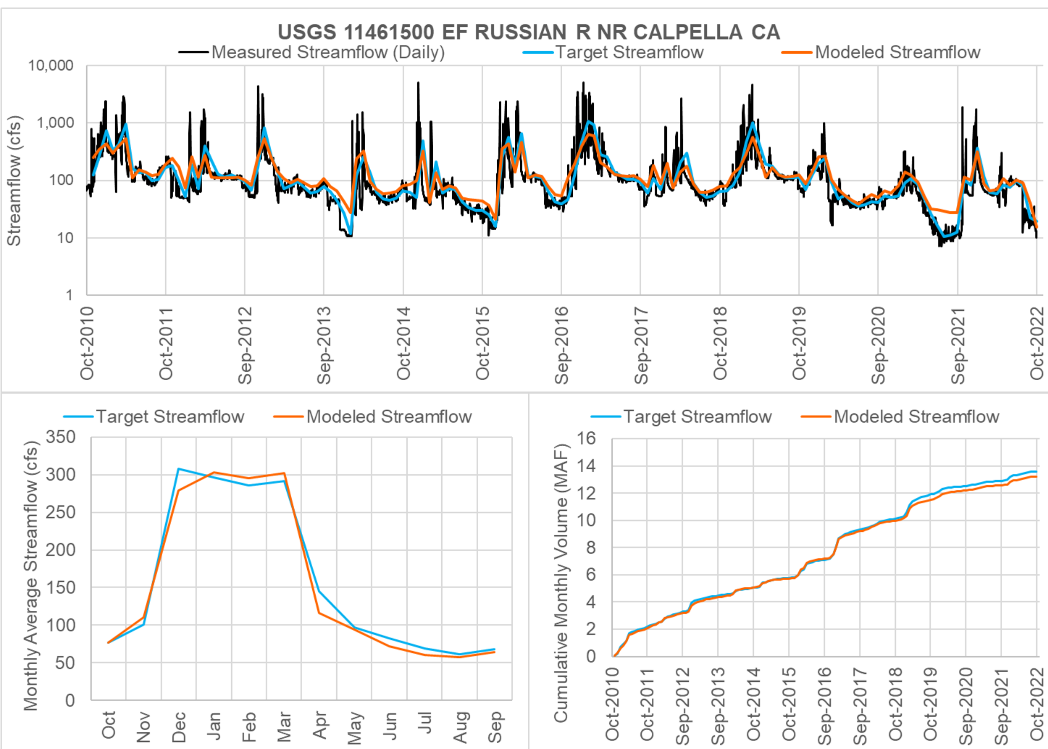


Figure 4-8. Modeled and Measured Streamflows at EFRR Near Calpella

Table 4-3 shows the calibration summary statistics for streamflow at the USGS gauge near Calpella. The NSE statistic is a standard statistic computed to evaluate a model's performance on replicating historical streamflow conditions. The closer the NSE is to a value of 1.0, the better the model can replicate accurate streamflow. As the NSE approaches zero, it indicates that the model is only able to estimate streamflow as well as the mean of the squared residual of the streamflow dataset. Additionally, if the NSE becomes negative, then the average target streamflow is a better predictor for streamflow than the model (Nash and Sutcliffe 1970).

Table 4-3. Calibration Summary Statistics for Streamflow at the USGS Stream Gauge Near Calpella

Calibration Statistic	Value	Unit
MR	-4	cfs
R^2	0.95	Unitless
NSE	0.94	Unitless
Number of Values	144	Unitless

cfs = cubic feet per second

Note:

Residual is computed by subtracting the target (measured) streamflow value from the modeled streamflow value.

Calibration statistics for the USGS stream gauge near Calpella are within acceptable ranges. Overall, the ability of PVIFM to model the inflows of water into the Basin and match the general flow of water through and from the Basin and domain is adequate for achieving the modeling objectives described in Section 1.2.

4.4.3 Subsurface Evapotranspiration

Figure 4-9 shows the modeled versus target ET for Potter Valley, where target ET is defined as the monthly OpenET estimates of ET throughout Potter Valley. Given that modeled ET depends on the availability of shallow groundwater to meet ET demands, it is important to evaluate PVIFM's ability to simulate ET rates that are similar to ET rates from OpenET. Overall, PVIFM captures monthly and annual estimated ET patterns in all months with a relatively small underestimation of target ET during April through June and August through September. Achieving this level of calibration for ET required including multipliers on the potential ET term in the UZF package that were applied separately to the cells representing the Basin and bedrock areas. Individual multipliers for each month were applied uniformly through the simulation period to increase the maximum amount of ET that can occur within a stress period. Basin potential ET multipliers ranged from 1.2 in the April through June period to 1.4 in the June through September period, while bedrock multipliers ranged from 1.25 in the April through June period to 10 in the July through September period. Dashed lines have been added to the plots in Figure 4-9 that represent ±15% of the OpenET values for Potter Valley. According to Volk et al. (2024), the accuracy of OpenET estimates can range from 10 to 20% of actual ET. Thus, 15% of the target ET was deemed as an adequate target to achieve for simulation of ET in PVIFM.

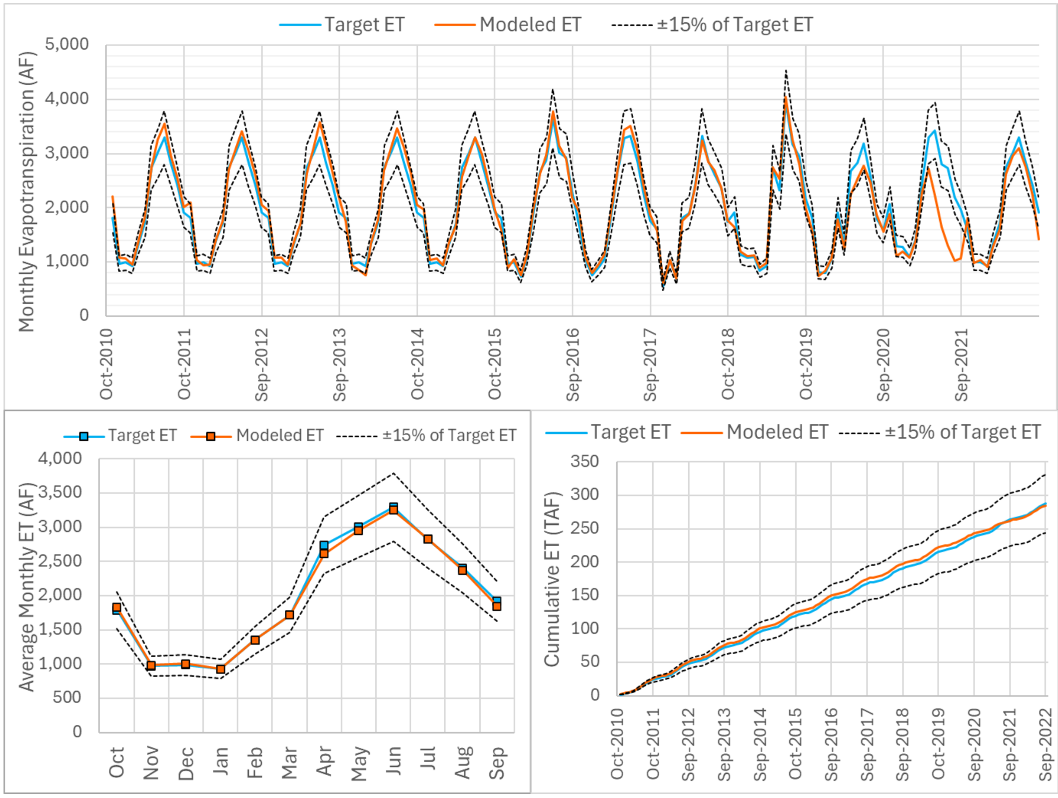


Figure 4-9. Modeled and Target Evapotranspiration Across Potter Valley

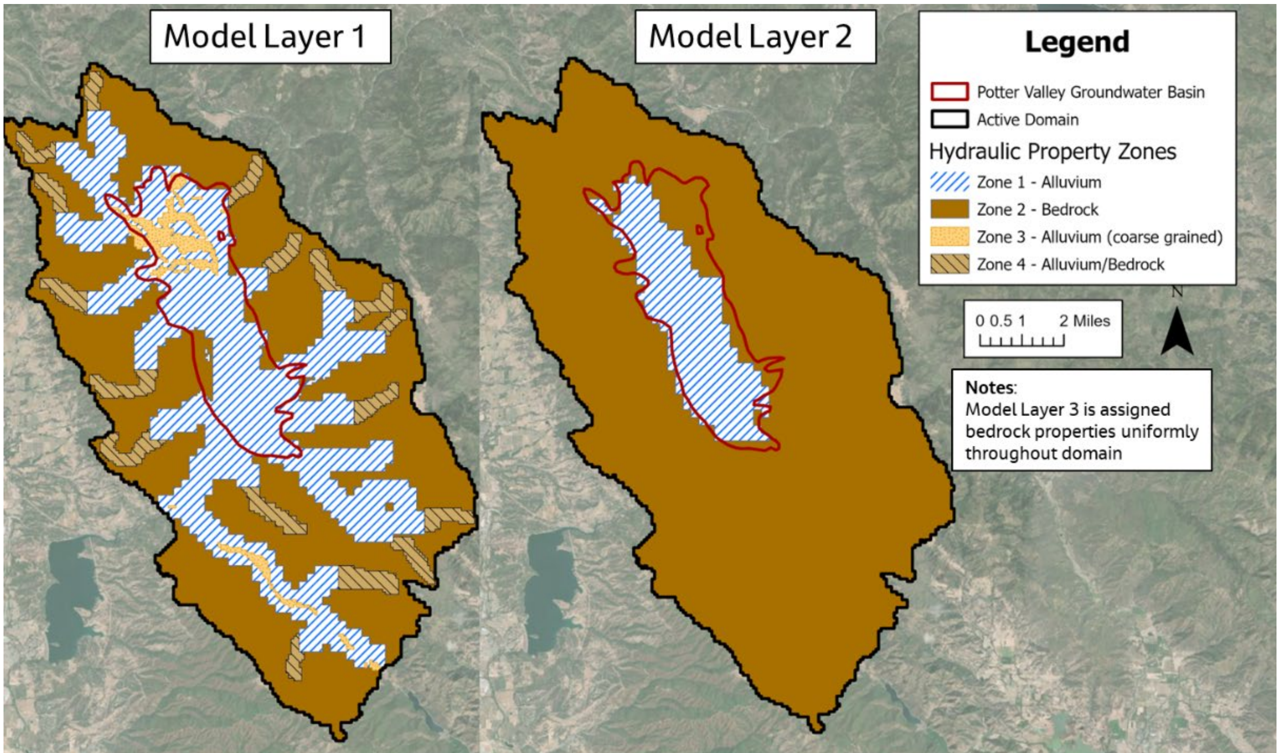
4.4.4 Surface Parameters

Stream channel parameters were refined during the calibration process to better represent channel geometries and to improve groundwater-level calibration in the Basin. The team implemented an approach to develop irregularly shaped channel cross sections for all SFR segments to replace the simplified rectangular channel shapes that were initially incorporated into PVIFM. Incorporating irregularly shaped channels allows for a more dynamic representation of stream depth, width, and conductance, which are dynamically computed during the simulation by the modeling software. Channel cross sections were developed using the 1-meter DEM data used earlier to define modeled land surface elevations in PVIFM. Attachment 2 contains modeled eight-point stream channel cross sections incorporated into PVIFM during calibration. Additionally, the representation of K_v of the streambed was updated to represent a harmonic mean of the SFR Bed K_v and the underlying aquifer material K_v. This calculation was implemented based on a uniform SFR Bed K_v, SFR bed thickness, vadose zone thickness, and the Model Layer 1 K_v from the model cell in which the SFR reach is located. This approach was incorporated to account for potential differences in SFR Bed K_v and Model Layer 1 K_v due to the SFR's lack of representation of unsaturated zone infiltration from streams and canals. Factoring in the Model Layer 1 K_v can help scale the rate of recharge from the SFR to the water table below the stream.

Modifications were also made to the streambed elevations that define the thalweg of stream channels in the SFR package on a cell-by-cell basis. Groundwater levels are generally shallow in the Basin; thus, the assigned streambed elevations can influence simulated groundwater levels due to the head-dependent nature of the groundwater-surface water interactions in PVIFM. Due to the averaging of elevation values over the 100-meter by 100-meter cell dimensions in PVIFM to define streambed elevations, there is uncertainty in the degree of incision that should be assigned in different reaches of channels. Given that the groundwater levels are generally shallow and the sensitivity of streambed elevations on controlling groundwater levels, streambed elevations within the Basin were adjusted to improve groundwater-level calibration throughout the Basin. These adjustments resulted in SFR channel incisions relative to the top elevation of the 100-meter by 100-meter cell in Model Layer 1 of 0 to 48 feet with an average of 4 feet The large SFR streambed top elevation adjustments were necessary on the fringes of the Basin in areas where topography begins to steepen and the 100-meter by 100-meter elevation value from the DEM is skewed by steep topography. As a result, the originally sampled elevations were not representative of the elevations where the streambed resides.

4.4.5 Subsurface Parameters

Refinements were made to hydraulic conductivity and storage-related parameter values initially assigned in PVIFM to improve the fit to the target data. The primary refinement made to hydraulic conductivity occurred in the northwest portion of the Basin where higher permeability materials were inferred from the data that were processed from the geophysical investigation conducted in 2023 (Sonoma Water 2024). Figure 4-10 shows the final calibrated hydraulic property zones and calibrated subsurface properties. Modifications were made to the hydraulic conductivity and storage values to improve calibration of groundwater levels, streamflow, and ET. An additional zone was added to Model Layer 1 in the northwest portion of the Basin to reflect coarser-grained sediments inferred from the geophysical investigation in the Basin. This additional alluvium zone was developed based on soils with HSG category B (Figure 3-5) to reflect materials that exhibit better drainage than other portions of the Basin. Because the K_v of Model Layer 1 controls the rainfall-runoff partitioning, modeled groundwater recharge was sensitive to the K_v assigned to Model Layer 1. Modifications made to K_v values in Model Layer 1 during the calibration process were aimed at striking a balance among fits to target groundwater levels, streamflows, and subsurface ET.



	Alluvium	Bedrock	Alluvium (coarse grained)	Alluvium/Bedrock
Kh (ft/d)	1.44	0.0283 to 0.0028	8.52	0.23
Kv (ft/d)	0.29	0.0283 to 0.0028	1.70	0.07
Kh:Kv	5.0	1.0	5.0	3.5
Specific Storage (ft^{-1})	1.0E-04	1.0E-04 to 1.0E-06	1.0E-04	2.30E-05
Specific Yield (%)	15	1 to 3	15	5

Figure 4-10. Final Calibrated Hydraulic Property Zones

By turning off the unsaturated zone flow component of UZF, the soil properties discussed in Section 3.3.3.1 became irrelevant because the physical processes that use these parameters were no longer active. Due to the change in configuration of the UZF package, no modifications were made to soil parameters during the calibration process.

4.4.6 Numerical Mass Balance

It is a standard practice to confirm that simulations achieve an adequate mass balance. The percent discrepancy in the mass balance for each stress period ranged from -0.57% to 0.95% in the calibration simulation with a cumulative percent discrepancy of 0.18%. Thus, PVIFM achieved good numerical mass balances associated with the groundwater flow process and the AG package. Because the flow component of the UZF package was turned off, there were no longer any mass balance discrepancies associated with the UZF package (that is, UZF mass balance discrepancy = 0%).

4.5 Surface Water and Groundwater Budgets

Simulated surface water and groundwater budgets were developed to characterize the volumetric rate of water entering and leaving the surface water and groundwater flow systems and achieve the second modeling objective, *develop surface water and groundwater budgets for the Basin* (Section 1.2). This section describes historical water budgets for Potter Valley for the water budget area shown in Figure 4-11. The Potter Valley water budget area was defined to cover the extents of the Basin and PVID's boundary to account for the areas in which surface water and groundwater are actively managed in Potter Valley.

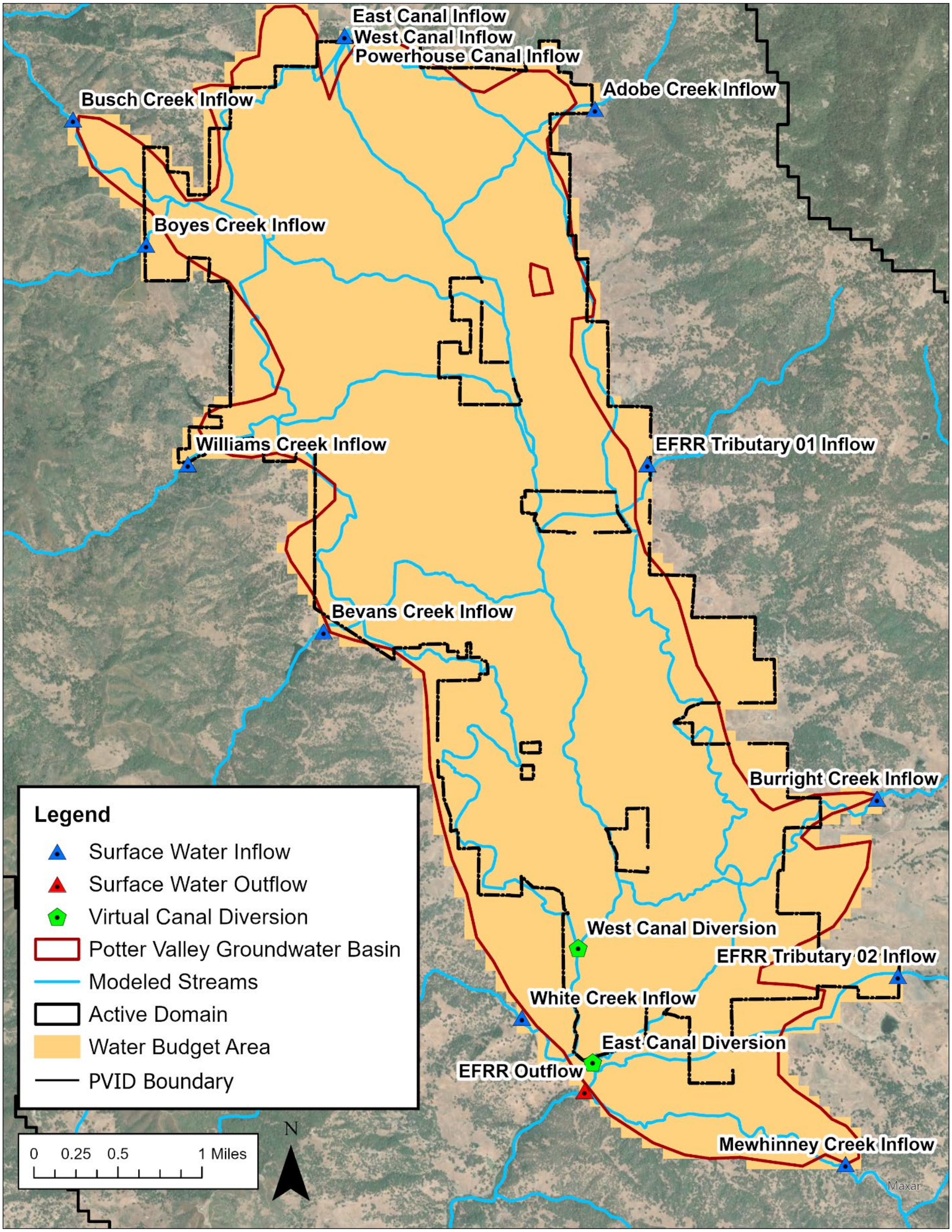


Figure 4-11. Water Budget Area

Separate water budgets have been developed for the surface water and groundwater systems. Figure 4-12 illustrates how these two systems relate to each other and highlights the relevant software code packages from which each water budget term is computed. Because the unsaturated zone flow component of the UZF package was ultimately turned off for the calibrated version of PVIFM, the unsaturated zone ET term displayed in Figure 4-12 is no longer an active component of the vadose zone, as indicated by the red X crossing out that process. Thus, unsaturated zone ET is not simulated with this configuration of PVIFM and all subsurface ET is modeled as shallow groundwater ET, as indicated by the red oval around that process in Figure 4-12.

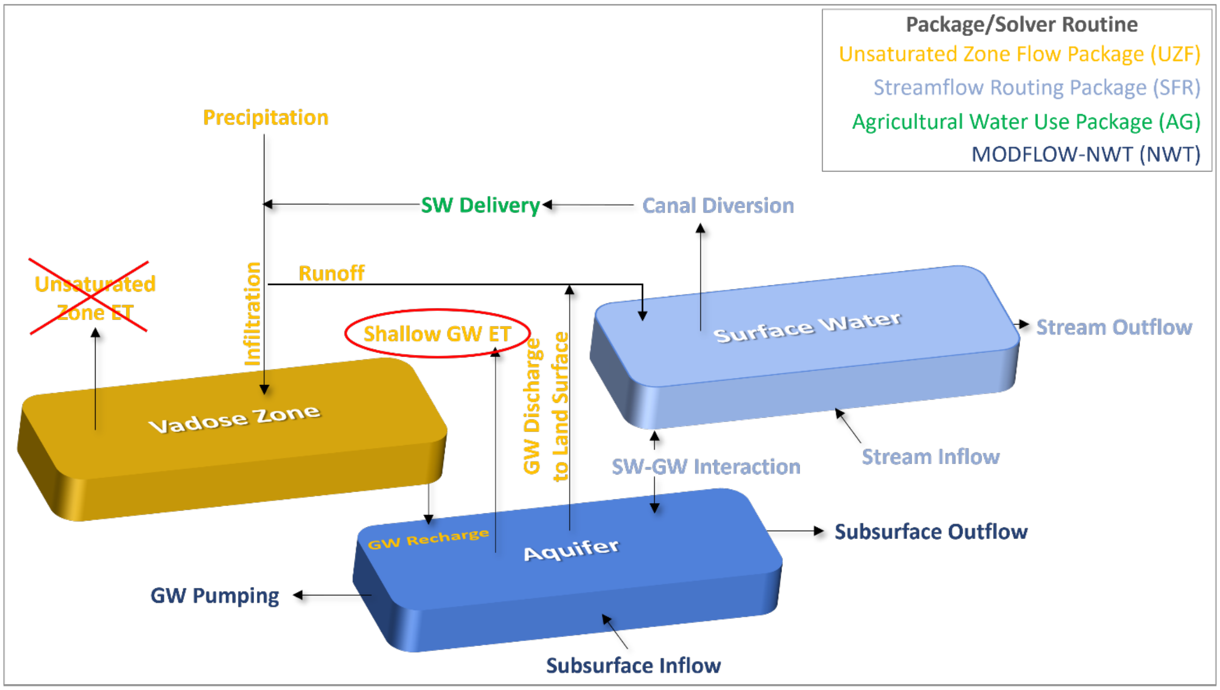


Figure 4-12. Water Budget Diagram for Calibrated Version of PVIFM

4.5.1 Surface Water Budget

Table 4-4 summarizes the simulated average annual surface water budget for the Basin over the 12-year calibration period. A table including monthly values for the surface water budget is included in Attachment 3. According to PVIFM, the major surface water inflows to Potter Valley occur through the Powerhouse Canal (41,102 AFY) and other streams (23,427 AFY), where "Other Streams" represent inflows from all tributary creeks other than Busch Creek (Figure 4-11). The next largest surface water inflow term is the East Canal Inflow (8,462 AFY). These three surface water inflow terms make up 80% of the total surface water inflows. The largest surface water outflow term from Potter Valley is the stream outflow to Lake Mendocino at approximately 91,258 AFY (86% of the surface water outflows).

Table 4-4. Summary of Simulated Potter Valley Surface Water Budget

Surface Water Budget Component	Inflow or Outflow	Average Annual Flow (AF) WYs 2011–2022
East Canal Inflow	Inflow	8,462
West Canal Inflow	Inflow	6,438
Powerhouse Canal Inflow	Inflow	41,102
Busch Creek Inflow	Inflow	4,635
Other Streams Inflow	Inflow	23,427
Runoff from Precipitation[a]	Inflow	7,712
Runoff from Applied Water[a]	Inflow	941
Groundwater Discharge to East Canal	Inflow	547
Groundwater Discharge to West Canal	Inflow	599
Groundwater Discharge to Powerhouse Canal	Inflow	358
Groundwater Discharge to EFRR	Inflow	964
Groundwater Discharge to Other Streams	Inflow	1,629
Total Surface Water Inflow	**Inflow**	**96,814**
Stream Outflow to Lake Mendocino	Outflow	91,258
East Canal Diversion	Outflow	4,550
West Canal Diversions	Outflow	5,929
Groundwater Recharge from East Canal	Outflow	640
Groundwater Recharge from West Canal	Outflow	1,306
Groundwater Recharge from Powerhouse Canal	Outflow	633
Groundwater Recharge from East Fork Russian River	Outflow	621
Groundwater Recharge from Other Streams	Outflow	888
Total Surface Water Outflow	**--**	**105,825**

Notes:

Values are representative of the water budget area shown in Figure 4-11.

[a] PVIFM outputs a single monthly runoff term that represents runoff from all potential sources. To differentiate between runoff from precipitation and runoff from applied water, the lumped runoff term was summed for October through May months to represent runoff from precipitation, and for June through September months to represent runoff from applied water.

4.5.2 Groundwater Budget

Table 4-5 presents a summary of the simulated average annual groundwater budget for the water budget area shown in Figure 4-11 over the 12-year calibration period. A table including monthly values for the groundwater budget is included in Attachment 4. According to PVIFM, major groundwater inflows to the Basin are the groundwater recharge from precipitation (18,187 AFY) and groundwater recharge from applied water (8,157 AFY). The groundwater recharge term simulated in PVIFM is a lumped term and does not explicitly simulate groundwater recharge attributed to different sources of water (for example, precipitation versus applied water). Thus, these separate values have been reported by summarizing the monthly lumped groundwater recharge term across different months of the year, assuming that there is a specific seasonality to rainfall and application of water for irrigation purposes. These two groundwater inflow terms make up 80% of the total groundwater inflows. The largest groundwater outflow term from the Basin is shallow groundwater ET (23,690 AFY). The next largest groundwater outflow is groundwater discharge to land surface (2,765 AFY). These two groundwater outflow terms make up 80% of the total groundwater outflows.

An average change in groundwater storage of -105 AFY indicates a slight reduction (deficit) in overall groundwater storage over the 12-year calibration period. Most of this reduction in groundwater storage is attributed to the last two-to-three years of the calibration period, as evidenced by the slight downward trend in groundwater levels near the end of the 12-year calibration period (Figure 4-2). WYs 2020 and 2021 also exhibit the steepest cumulative departure from mean annual precipitation since WY 2000, as shown in Figure 3-10. Thus, this magnitude of deficit in groundwater storage is not alarming given the reduction in precipitation near the end of the calibration period. For context, a deficit of 105 AFY represents 0.3% of the total groundwater inflows and outflows. Additional assessment of longer-term groundwater storage trends would require groundwater-level measurements over longer timeframes.

Table 4-5. Summary of Potter Valley Groundwater Budget

Groundwater Budget Component	Inflow or Outflow	Average Annual Flow (AF) WYs 2011-2022
Groundwater Recharge from Precipitation[a]	Inflow	18,187
Groundwater Recharge from Applied Water[a]	Inflow	8,157
Groundwater Recharge from East Canal	Inflow	640
Groundwater Recharge from West Canal	Inflow	1,306
Groundwater Recharge from Powerhouse Canal	Inflow	633
Groundwater Recharge from EFRR	Inflow	621
Groundwater Recharge from Other Streams	Inflow	888
Subsurface Inflow from Surrounding Areas	Inflow	2,526
Total Groundwater Inflow	**Inflow**	**32,958**
Shallow Groundwater ET	Outflow	23,690
Domestic Pumping	Outflow	2,158
Agricultural Pumping	Outflow	0
Groundwater Discharge to East Canal	Outflow	547
Groundwater Discharge to West Canal	Outflow	599
Groundwater Discharge to Powerhouse Canal	Outflow	358
Groundwater Discharge to EFRR	Outflow	964
Groundwater Discharge to Other Streams	Outflow	1,629
Groundwater Discharge to Land Surface	Outflow	2,765
Subsurface Outflow to Surrounding Areas	Outflow	353
Total Groundwater Outflow	**Outflow**	**33,063**
Change in Groundwater Storage	--	-105

Values are representative of the water budget area shown in Figure 4-11.

[a] PVIFM outputs a single monthly groundwater recharge term that represents recharge from all potential sources. To differentiate between recharge from precipitation and recharge from applied water, the lumped recharge term was summed for October through May months to represent recharge from precipitation, and for June through September months to represent recharge from applied water.

4.5.3 Potter Valley Irrigation District Agricultural Operations

PVIFM includes a representation of PVID's agricultural operations in Potter Valley. Water budget terms processed from PVIFM and measured data representing PVID's operations are summarized in Table 4-6. Through PVP imports, nearly 15,000 AFY of water flows into PVID's canals, of which approximately 10,500 AFY is delivered to PVID customers. Through accumulation of runoff and groundwater discharge, and water not diverted for customer use, approximately 3,800 AFY remains in the East and West Canals prior to discharging to the EFRR at the southern end of Potter Valley. PVIFM simulates approximately 20,450 AFY of crop ET compared to 18,500 AFY estimated from OpenET. Overall, the representation of PVID operations in PVIFM is adequate for the intended use of evaluation of water management strategies in Potter Valley.

Table 4-6. Potter Valley Irrigation District Agricultural Operations Summary, Average Annual Flow in Acre-Feet for Water Years 2011–2022

Water Budget Component	East Canal/Division	West Canal/Division	Total
Simulated Canal Inflow	8,462	6,438	14,900
Simulated Canal Diversions	4,550	5,929	10,479
Measured Canal Diversions	4,669	6,132	10,801
Canal Outflow to EFRR	1,799	1,968	3,767
Simulated Crop ET	8,956	11,495	20,451
OpenET Crop ET	7,988	10,425	18,413

5. Recommendations

As described in Section 1.2, one of the modeling objectives was to help identify and prioritize groundwater data gaps and reduce uncertainty in groundwater supply in Potter Valley. Future refinements of PVIFM should consider the following potential sources of data to the extent they are available (in no particular order of importance):

- **Groundwater-level data** from existing Potter Valley wells that were instrumented with recording water-level devices starting in 2024
- **Precipitation data** from recently added CW3E precipitation gauges within the PVIFM domain (Sumargo et al. 2020)
- **Mapping of lined and unlined portions of PVID canals** to improve simulations of groundwater-surface-water interactions along these canals
- **Diversion rates or maximum diversion capacities** at each individual PVID diversion and the association of individual diversions with their associated delivery areas, if available.
- **Estimates of aquifer hydraulic properties**, such as transmissivity and K_v from enhanced well development activities at new monitoring wells being constructed in 2024
- **Estimates of aquifer hydraulic properties**, such as transmissivity, groundwater storage, and K_v from formal aquifer testing at potential future aquifer storage and recover (ASR) well locations
- **Estimates of infiltration capacities of surficial soils** on fields at potential managed aquifer recharge (MAR) locations
- **Locations and pumping rates of active wells** in Potter Valley that are operated for indoor use, irrigation, and/or frost protection
- **Water management activities associated with ponds** located throughout Potter Valley

Additional model parameter sensitivity should also be explored in the future to further support decision-making. Addressing these items during future PVIFM updates would help reduce uncertainty in projections, effectively manage the Basin, and improve water supply reliability.

6. References

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Attachment 1
Table of Calibration Target Values

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Measured GWE	17112	29	5/3/2012	feet NAVD88	955.3	955.2	1.0	-0.1
Measured GWE	17112	35	11/27/2012	feet NAVD88	954.9	952.2	1.0	-2.7
Measured GWE	17112	40	4/24/2013	feet NAVD88	954.9	956.0	1.0	1.2
Measured GWE	17112	48	12/11/2013	feet NAVD88	954.2	952.1	1.0	-2.1
Measured GWE	17112	51	3/4/2014	feet NAVD88	956.5	954.7	1.0	-1.8
Measured GWE	17112	51	3/4/2014	feet NAVD88	956.5	954.7	1.0	-1.8
Measured GWE	17112	58	10/23/2014	feet NAVD88	952.8	952.1	1.0	-0.6
Measured GWE	17112	63	3/25/2015	feet NAVD88	955.6	956.0	1.0	0.4
Measured GWE	17112	70	10/20/2015	feet NAVD88	953.2	952.1	1.0	-1.1
Measured GWE	17112	75	3/16/2016	feet NAVD88	956.5	957.5	1.0	1.0
Measured GWE	17112	82	10/24/2016	feet NAVD88	952.4	952.0	1.0	-0.3
Measured GWE	17112	87	3/29/2017	feet NAVD88	957.7	958.2	1.0	0.6
Measured GWE	17113	11	11/16/2010	feet NAVD88	955.8	955.3	1.0	-0.5
Measured GWE	17113	17	5/25/2011	feet NAVD88	956.1	957.4	1.0	1.3
Measured GWE	17113	24	12/15/2011	feet NAVD88	955.3	953.8	1.0	-1.5
Measured GWE	17113	103	7/11/2018	feet NAVD88	953.0	953.4	1.0	0.4
Measured GWE	17113	104	8/22/2018	feet NAVD88	951.6	953.3	1.0	1.8
Measured GWE	17113	105	9/19/2018	feet NAVD88	952.6	953.3	1.0	0.7
Measured GWE	17113	106	10/8/2018	feet NAVD88	953.8	953.2	1.0	-0.6
Measured GWE	17113	107	11/8/2018	feet NAVD88	953.4	953.0	1.0	-0.4
Measured GWE	17113	108	12/17/2018	feet NAVD88	955.3	953.5	1.0	-1.8
Measured GWE	17113	109	1/14/2019	feet NAVD88	956.4	954.1	1.0	-2.3
Measured GWE	17113	110	2/19/2019	feet NAVD88	957.2	956.0	1.0	-1.2
Measured GWE	17113	111	3/11/2019	feet NAVD88	957.1	959.2	1.0	2.2
Measured GWE	17113	112	4/8/2019	feet NAVD88	957.1	959.3	1.0	2.3
Measured GWE	17113	113	5/20/2019	feet NAVD88	956.0	957.5	1.0	1.5
Measured GWE	17113	114	6/17/2019	feet NAVD88	954.1	956.2	1.0	2.1
Measured GWE	17113	115	7/15/2019	feet NAVD88	953.3	953.6	1.0	0.4
Measured GWE	17113	116	8/19/2019	feet NAVD88	952.7	953.3	1.0	0.7
Measured GWE	17113	117	9/18/2019	feet NAVD88	950.9	953.2	1.0	2.3
Measured GWE	17113	118	10/23/2019	feet NAVD88	953.6	953.1	1.0	-0.5
Measured GWE	17113	119	11/13/2019	feet NAVD88	953.9	953.0	1.0	-0.9

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Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Measured GWE	17113	120	12/10/2019	feet NAVD88	954.9	953.0	1.0	-1.9
Measured GWE	17113	121	1/9/2020	feet NAVD88	955.8	954.3	1.0	-1.5
Measured GWE	17113	122	2/6/2020	feet NAVD88	956.4	955.4	1.0	-1.0
Measured GWE	17113	123	3/10/2020	feet NAVD88	955.8	954.0	1.0	-1.8
Measured GWE	17113	134	2/2/2021	feet NAVD88	955.6	954.1	1.0	-1.4
Measured GWE	17113	135	3/1/2021	feet NAVD88	956.0	954.3	1.0	-1.6
Measured GWE	17113	136	4/2/2021	feet NAVD88	953.5	953.9	1.0	0.4
Measured GWE	17113	138	6/1/2021	feet NAVD88	952.1	953.1	1.0	1.0
Measured GWE	17113	140	8/3/2021	feet NAVD88	951.4	952.5	1.0	1.1
Measured GWE	17113	141	9/7/2021	feet NAVD88	952.1	952.1	1.0	0.1
Measured GWE	17113	142	10/5/2021	feet NAVD88	947.0	952.2	1.0	5.2
Measured GWE	17113	144	12/15/2021	feet NAVD88	955.1	953.9	1.0	-1.2
Measured GWE	17113	145	1/12/2022	feet NAVD88	956.5	956.8	1.0	0.3
Measured GWE	17113	146	2/8/2022	feet NAVD88	955.8	956.4	1.0	0.7
Measured GWE	17113	147	3/22/2022	feet NAVD88	954.7	955.3	1.0	0.6
Measured GWE	17113	148	4/12/2022	feet NAVD88	950.7	955.2	1.0	4.5
Measured GWE	17113	149	5/24/2022	feet NAVD88	955.0	955.3	1.0	0.3
Measured GWE	17113	150	6/9/2022	feet NAVD88	953.3	953.7	1.0	0.4
Measured GWE	17113	151	7/6/2022	feet NAVD88	952.5	953.3	1.0	0.8
Measured GWE	56335	11	11/16/2010	feet NAVD88	882.2	955.3	0.0	73.1
Measured GWE	56335	17	5/25/2011	feet NAVD88	880.2	957.4	0.0	77.2
Monthly Streamflow	USGS EFRR	10	10/31/2010	acre-feet per month	7765.9	7282.0	1.0	-483.8
Monthly Streamflow	USGS EFRR	11	11/30/2010	acre-feet per month	15286.6	19858.7	1.0	4572.1
Monthly Streamflow	USGS EFRR	12	12/31/2010	acre-feet per month	45347.1	34385.8	1.0	-10961.3
Monthly Streamflow	USGS EFRR	13	1/31/2011	acre-feet per month	20653.7	20988.6	1.0	334.9
Monthly Streamflow	USGS EFRR	14	2/28/2011	acre-feet per month	23309.0	28822.2	1.0	5513.2
Monthly Streamflow	USGS EFRR	15	3/31/2011	acre-feet per month	58474.7	48334.1	1.0	-10140.6
Monthly Streamflow	USGS EFRR	16	4/30/2011	acre-feet per month	9746.8	7465.0	1.0	-2281.8
Monthly Streamflow	USGS EFRR	17	5/31/2011	acre-feet per month	8380.8	9659.0	1.0	1278.3
Monthly Streamflow	USGS EFRR	18	6/30/2011	acre-feet per month	8247.3	7366.5	1.0	-880.8
Monthly Streamflow	USGS EFRR	19	7/31/2011	acre-feet per month	6130.3	6065.9	1.0	-64.4
Monthly Streamflow	USGS EFRR	20	8/31/2011	acre-feet per month	6376.3	6599.4	1.0	223.2

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly Streamflow	USGS EFRR	21	9/30/2011	acre-feet per month	9818.2	10134.2	1.0	316.1
Monthly Streamflow	USGS EFRR	22	10/31/2011	acre-feet per month	11319.9	12720.9	1.0	1401.0
Monthly Streamflow	USGS EFRR	23	11/30/2011	acre-feet per month	5813.6	7439.2	1.0	1625.6
Monthly Streamflow	USGS EFRR	24	12/31/2011	acre-feet per month	3185.1	4899.0	1.0	1713.9
Monthly Streamflow	USGS EFRR	25	1/31/2012	acre-feet per month	11707.2	16833.8	1.0	5126.5
Monthly Streamflow	USGS EFRR	26	2/29/2012	acre-feet per month	4095.5	8311.7	1.0	4216.3
Monthly Streamflow	USGS EFRR	27	3/31/2012	acre-feet per month	24232.3	23858.4	1.0	-373.8
Monthly Streamflow	USGS EFRR	28	4/30/2012	acre-feet per month	13358.7	7433.8	1.0	-5924.8
Monthly Streamflow	USGS EFRR	29	5/31/2012	acre-feet per month	7796.6	6904.3	1.0	-892.3
Monthly Streamflow	USGS EFRR	30	6/30/2012	acre-feet per month	6747.8	5667.4	1.0	-1080.4
Monthly Streamflow	USGS EFRR	31	7/31/2012	acre-feet per month	7704.4	5552.2	1.0	-2152.2
Monthly Streamflow	USGS EFRR	32	8/31/2012	acre-feet per month	6819.0	5749.7	1.0	-1069.3
Monthly Streamflow	USGS EFRR	33	9/30/2012	acre-feet per month	5700.5	4922.2	1.0	-778.3
Monthly Streamflow	USGS EFRR	34	10/31/2012	acre-feet per month	4132.0	4185.8	1.0	53.8
Monthly Streamflow	USGS EFRR	35	11/30/2012	acre-feet per month	9877.7	8419.6	1.0	-1458.1
Monthly Streamflow	USGS EFRR	36	12/31/2012	acre-feet per month	51305.3	44096.8	1.0	-7208.4
Monthly Streamflow	USGS EFRR	37	1/31/2013	acre-feet per month	15267.4	16620.1	1.0	1352.8
Monthly Streamflow	USGS EFRR	38	2/28/2013	acre-feet per month	7991.8	9097.9	1.0	1106.1
Monthly Streamflow	USGS EFRR	39	3/31/2013	acre-feet per month	4445.6	7532.9	1.0	3087.3
Monthly Streamflow	USGS EFRR	40	4/30/2013	acre-feet per month	4837.7	5796.3	1.0	958.6
Monthly Streamflow	USGS EFRR	41	5/31/2013	acre-feet per month	5921.3	6255.6	1.0	334.4
Monthly Streamflow	USGS EFRR	42	6/30/2013	acre-feet per month	4540.2	4100.6	1.0	-439.6
Monthly Streamflow	USGS EFRR	43	7/31/2013	acre-feet per month	3744.6	3455.2	1.0	-289.4
Monthly Streamflow	USGS EFRR	44	8/31/2013	acre-feet per month	3886.0	3710.0	1.0	-176.0
Monthly Streamflow	USGS EFRR	45	9/30/2013	acre-feet per month	4653.2	4710.6	1.0	57.4
Monthly Streamflow	USGS EFRR	46	10/31/2013	acre-feet per month	3966.0	4242.8	1.0	276.9
Monthly Streamflow	USGS EFRR	47	11/30/2013	acre-feet per month	2719.3	3585.2	1.0	865.9
Monthly Streamflow	USGS EFRR	48	12/31/2013	acre-feet per month	1629.4	2626.6	1.0	997.1
Monthly Streamflow	USGS EFRR	49	1/31/2014	acre-feet per month	719.4	1786.9	1.0	1067.5
Monthly Streamflow	USGS EFRR	50	2/28/2014	acre-feet per month	6664.5	9750.8	1.0	3086.3
Monthly Streamflow	USGS EFRR	51	3/31/2014	acre-feet per month	15906.8	29125.6	1.0	13218.8
Monthly Streamflow	USGS EFRR	52	4/30/2014	acre-feet per month	8193.7	5855.6	1.0	-2338.1

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly Streamflow	USGS EFRR	53	5/31/2014	acre-feet per month	3861.4	4145.3	1.0	283.9
Monthly Streamflow	USGS EFRR	54	6/30/2014	acre-feet per month	2850.3	2434.3	1.0	-415.9
Monthly Streamflow	USGS EFRR	55	7/31/2014	acre-feet per month	2785.4	2383.9	1.0	-401.5
Monthly Streamflow	USGS EFRR	56	8/31/2014	acre-feet per month	3031.3	2348.4	1.0	-682.9
Monthly Streamflow	USGS EFRR	57	9/30/2014	acre-feet per month	3951.1	3669.9	1.0	-281.2
Monthly Streamflow	USGS EFRR	58	10/31/2014	acre-feet per month	3787.6	4114.1	1.0	326.5
Monthly Streamflow	USGS EFRR	59	11/30/2014	acre-feet per month	2987.1	3756.4	1.0	769.3
Monthly Streamflow	USGS EFRR	60	12/31/2014	acre-feet per month	30282.6	21986.3	1.0	-8296.3
Monthly Streamflow	USGS EFRR	61	1/31/2015	acre-feet per month	2896.1	5040.2	1.0	2144.2
Monthly Streamflow	USGS EFRR	62	2/28/2015	acre-feet per month	11818.3	11253.5	1.0	-564.8
Monthly Streamflow	USGS EFRR	63	3/31/2015	acre-feet per month	3750.7	4949.0	1.0	1198.3
Monthly Streamflow	USGS EFRR	64	4/30/2015	acre-feet per month	4326.0	5103.8	1.0	777.9
Monthly Streamflow	USGS EFRR	65	5/31/2015	acre-feet per month	4273.4	1656.2	1.0	-2617.2
Monthly Streamflow	USGS EFRR	66	6/30/2015	acre-feet per month	2564.6	1990.8	1.0	-573.8
Monthly Streamflow	USGS EFRR	67	7/31/2015	acre-feet per month	2047.5	1606.5	1.0	-441.0
Monthly Streamflow	USGS EFRR	68	8/31/2015	acre-feet per month	1850.8	1593.2	1.0	-257.6
Monthly Streamflow	USGS EFRR	69	9/30/2015	acre-feet per month	1814.9	1633.7	1.0	-181.2
Monthly Streamflow	USGS EFRR	70	10/31/2015	acre-feet per month	1574.1	1614.3	1.0	40.2
Monthly Streamflow	USGS EFRR	71	11/30/2015	acre-feet per month	934.2	1242.9	1.0	308.7
Monthly Streamflow	USGS EFRR	72	12/31/2015	acre-feet per month	15365.8	21721.5	1.0	6355.7
Monthly Streamflow	USGS EFRR	73	1/31/2016	acre-feet per month	34365.4	41425.3	1.0	7059.9
Monthly Streamflow	USGS EFRR	74	2/29/2016	acre-feet per month	10658.6	10654.3	1.0	-4.2
Monthly Streamflow	USGS EFRR	75	3/31/2016	acre-feet per month	40114.5	40699.0	1.0	584.5
Monthly Streamflow	USGS EFRR	76	4/30/2016	acre-feet per month	7241.7	6859.1	1.0	-382.5
Monthly Streamflow	USGS EFRR	77	5/31/2016	acre-feet per month	7335.5	7662.8	1.0	327.3
Monthly Streamflow	USGS EFRR	78	6/30/2016	acre-feet per month	6628.8	5798.2	1.0	-830.5
Monthly Streamflow	USGS EFRR	79	7/31/2016	acre-feet per month	3941.4	3428.5	1.0	-512.8
Monthly Streamflow	USGS EFRR	80	8/31/2016	acre-feet per month	2582.5	2163.6	1.0	-418.9
Monthly Streamflow	USGS EFRR	81	9/30/2016	acre-feet per month	2308.8	2077.3	1.0	-231.5
Monthly Streamflow	USGS EFRR	82	10/31/2016	acre-feet per month	2859.2	3448.1	1.0	589.0
Monthly Streamflow	USGS EFRR	83	11/30/2016	acre-feet per month	7211.9	5999.9	1.0	-1212.0
Monthly Streamflow	USGS EFRR	84	12/31/2016	acre-feet per month	28905.3	26175.1	1.0	-2730.2

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly Streamflow	USGS EFRR	85	1/31/2017	acre-feet per month	65730.3	58914.7	1.0	-6815.5
Monthly Streamflow	USGS EFRR	86	2/28/2017	acre-feet per month	50966.5	49388.4	1.0	-1578.1
Monthly Streamflow	USGS EFRR	87	3/31/2017	acre-feet per month	17093.6	15469.1	1.0	-1624.5
Monthly Streamflow	USGS EFRR	88	4/30/2017	acre-feet per month	15322.3	11277.8	1.0	-4044.5
Monthly Streamflow	USGS EFRR	89	5/31/2017	acre-feet per month	8737.4	7982.2	1.0	-755.2
Monthly Streamflow	USGS EFRR	90	6/30/2017	acre-feet per month	7194.1	6272.0	1.0	-922.0
Monthly Streamflow	USGS EFRR	91	7/31/2017	acre-feet per month	6382.4	5942.5	1.0	-439.9
Monthly Streamflow	USGS EFRR	92	8/31/2017	acre-feet per month	6425.5	6212.9	1.0	-212.5
Monthly Streamflow	USGS EFRR	93	9/30/2017	acre-feet per month	5599.3	5433.6	1.0	-165.7
Monthly Streamflow	USGS EFRR	94	10/31/2017	acre-feet per month	3664.7	4173.4	1.0	508.8
Monthly Streamflow	USGS EFRR	95	11/30/2017	acre-feet per month	6444.3	7742.7	1.0	1298.4
Monthly Streamflow	USGS EFRR	96	12/31/2017	acre-feet per month	4347.2	5637.4	1.0	1290.2
Monthly Streamflow	USGS EFRR	97	1/31/2018	acre-feet per month	11024.7	14925.7	1.0	3901.0
Monthly Streamflow	USGS EFRR	98	2/28/2018	acre-feet per month	4182.0	4598.6	1.0	416.6
Monthly Streamflow	USGS EFRR	99	3/31/2018	acre-feet per month	12734.1	11211.7	1.0	-1522.4
Monthly Streamflow	USGS EFRR	100	4/30/2018	acre-feet per month	17797.7	12698.7	1.0	-5099.0
Monthly Streamflow	USGS EFRR	101	5/31/2018	acre-feet per month	5607.7	5204.1	1.0	-403.6
Monthly Streamflow	USGS EFRR	102	6/30/2018	acre-feet per month	3677.4	3006.9	1.0	-670.5
Monthly Streamflow	USGS EFRR	103	7/31/2018	acre-feet per month	3135.9	2744.9	1.0	-390.9
Monthly Streamflow	USGS EFRR	104	8/31/2018	acre-feet per month	3265.0	3015.1	1.0	-249.9
Monthly Streamflow	USGS EFRR	105	9/30/2018	acre-feet per month	3790.4	3722.2	1.0	-68.3
Monthly Streamflow	USGS EFRR	106	10/31/2018	acre-feet per month	4058.2	4430.3	1.0	372.1
Monthly Streamflow	USGS EFRR	107	11/30/2018	acre-feet per month	4956.7	5912.1	1.0	955.4
Monthly Streamflow	USGS EFRR	108	12/31/2018	acre-feet per month	8337.7	7261.2	1.0	-1076.5
Monthly Streamflow	USGS EFRR	109	1/31/2019	acre-feet per month	28099.8	19580.7	1.0	-8519.1
Monthly Streamflow	USGS EFRR	110	2/28/2019	acre-feet per month	56481.3	48707.4	1.0	-7773.9
Monthly Streamflow	USGS EFRR	111	3/31/2019	acre-feet per month	26679.5	25918.8	1.0	-760.7
Monthly Streamflow	USGS EFRR	112	4/30/2019	acre-feet per month	11466.5	7376.0	1.0	-4090.5
Monthly Streamflow	USGS EFRR	113	5/31/2019	acre-feet per month	10852.6	10722.9	1.0	-129.7
Monthly Streamflow	USGS EFRR	114	6/30/2019	acre-feet per month	7640.3	6267.4	1.0	-1372.9
Monthly Streamflow	USGS EFRR	115	7/31/2019	acre-feet per month	6794.4	5607.5	1.0	-1186.9
Monthly Streamflow	USGS EFRR	116	8/31/2019	acre-feet per month	6775.9	6021.7	1.0	-754.3

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly Streamflow	USGS EFRR	117	9/30/2019	acre-feet per month	6795.4	6286.6	1.0	-508.8
Monthly Streamflow	USGS EFRR	118	10/31/2019	acre-feet per month	4298.0	4610.2	1.0	312.3
Monthly Streamflow	USGS EFRR	119	11/30/2019	acre-feet per month	7533.2	7804.0	1.0	270.8
Monthly Streamflow	USGS EFRR	120	12/31/2019	acre-feet per month	12119.2	12223.8	1.0	104.6
Monthly Streamflow	USGS EFRR	121	1/31/2020	acre-feet per month	15107.5	16490.2	1.0	1382.7
Monthly Streamflow	USGS EFRR	122	2/29/2020	acre-feet per month	5165.4	6391.4	1.0	1226.0
Monthly Streamflow	USGS EFRR	123	3/31/2020	acre-feet per month	2951.4	4969.6	1.0	2018.2
Monthly Streamflow	USGS EFRR	124	4/30/2020	acre-feet per month	3266.8	3484.3	1.0	217.5
Monthly Streamflow	USGS EFRR	125	5/31/2020	acre-feet per month	2521.0	2807.3	1.0	286.3
Monthly Streamflow	USGS EFRR	126	6/30/2020	acre-feet per month	2154.1	1499.9	1.0	-654.1
Monthly Streamflow	USGS EFRR	127	7/31/2020	acre-feet per month	2336.5	2001.3	1.0	-335.2
Monthly Streamflow	USGS EFRR	128	8/31/2020	acre-feet per month	2600.9	2436.5	1.0	-164.4
Monthly Streamflow	USGS EFRR	129	9/30/2020	acre-feet per month	2445.6	2130.9	1.0	-314.7
Monthly Streamflow	USGS EFRR	130	10/31/2020	acre-feet per month	3283.4	3350.9	1.0	67.4
Monthly Streamflow	USGS EFRR	131	11/30/2020	acre-feet per month	3022.8	2848.5	1.0	-174.3
Monthly Streamflow	USGS EFRR	132	12/31/2020	acre-feet per month	3320.3	3602.4	1.0	282.1
Monthly Streamflow	USGS EFRR	133	1/31/2021	acre-feet per month	5558.5	5297.1	1.0	-261.4
Monthly Streamflow	USGS EFRR	134	2/28/2021	acre-feet per month	6036.9	6446.3	1.0	409.5
Monthly Streamflow	USGS EFRR	135	3/31/2021	acre-feet per month	5306.4	5948.3	1.0	641.9
Monthly Streamflow	USGS EFRR	136	4/30/2021	acre-feet per month	2886.0	3094.4	1.0	208.5
Monthly Streamflow	USGS EFRR	137	5/31/2021	acre-feet per month	1617.1	1975.3	1.0	358.2
Monthly Streamflow	USGS EFRR	138	6/30/2021	acre-feet per month	969.9	1556.9	1.0	587.0
Monthly Streamflow	USGS EFRR	139	7/31/2021	acre-feet per month	657.9	1347.5	1.0	689.6
Monthly Streamflow	USGS EFRR	140	8/31/2021	acre-feet per month	694.8	1330.2	1.0	635.4
Monthly Streamflow	USGS EFRR	141	9/30/2021	acre-feet per month	755.7	1292.5	1.0	536.8
Monthly Streamflow	USGS EFRR	142	10/31/2021	acre-feet per month	6302.5	2646.7	1.0	-3655.8
Monthly Streamflow	USGS EFRR	143	11/30/2021	acre-feet per month	4962.6	4356.9	1.0	-605.7
Monthly Streamflow	USGS EFRR	144	12/31/2021	acre-feet per month	22836.5	21252.5	1.0	-1584.0
Monthly Streamflow	USGS EFRR	145	1/31/2022	acre-feet per month	7286.3	5963.9	1.0	-1322.4
Monthly Streamflow	USGS EFRR	146	2/28/2022	acre-feet per month	3460.0	4010.2	1.0	550.2
Monthly Streamflow	USGS EFRR	147	3/31/2022	acre-feet per month	3646.2	4667.3	1.0	1021.1
Monthly Streamflow	USGS EFRR	148	4/30/2022	acre-feet per month	4879.3	6529.1	1.0	1649.7

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly Streamflow	USGS EFRR	149	5/31/2022	acre-feet per month	4728.4	4717.6	1.0	-10.8
Monthly Streamflow	USGS EFRR	150	6/30/2022	acre-feet per month	5849.3	5198.9	1.0	-650.3
Monthly Streamflow	USGS EFRR	151	7/31/2022	acre-feet per month	5035.8	4665.5	1.0	-370.3
Monthly Streamflow	USGS EFRR	152	8/31/2022	acre-feet per month	1401.9	1504.9	1.0	102.9
Monthly Streamflow	USGS EFRR	153	9/30/2022	acre-feet per month	1154.4	278.1	1.0	-876.3
Monthly Streamflow	CW3E Cold Creek	94	10/31/2017	acre-feet per month	321.9	361.2	1.0	39.4
Monthly Streamflow	CW3E Cold Creek	95	11/30/2017	acre-feet per month	463.9	617.5	1.0	153.6
Monthly Streamflow	CW3E Cold Creek	96	12/31/2017	acre-feet per month	630.9	517.4	1.0	-113.5
Monthly Streamflow	CW3E Cold Creek	97	1/31/2018	acre-feet per month	782.5	2513.2	1.0	1730.7
Monthly Streamflow	CW3E Cold Creek	98	2/28/2018	acre-feet per month	565.2	491.5	1.0	-73.7
Monthly Streamflow	CW3E Cold Creek	99	3/31/2018	acre-feet per month	750.0	1629.8	1.0	879.9
Monthly Streamflow	CW3E Cold Creek	100	4/30/2018	acre-feet per month	935.2	1906.2	1.0	971.0
Monthly Streamflow	CW3E Cold Creek	101	5/31/2018	acre-feet per month	449.9	431.4	1.0	-18.5
Monthly Streamflow	CW3E Cold Creek	102	6/30/2018	acre-feet per month	245.3	267.5	1.0	22.3
Monthly Streamflow	CW3E Cold Creek	103	7/31/2018	acre-feet per month	183.2	171.0	1.0	-12.2
Monthly Streamflow	CW3E Cold Creek	104	8/31/2018	acre-feet per month	170.3	157.3	1.0	-13.0
Monthly Streamflow	CW3E Cold Creek	105	9/30/2018	acre-feet per month	94.9	169.3	1.0	74.4
Monthly Streamflow	CW3E Cold Creek	106	10/31/2018	acre-feet per month	230.1	267.4	1.0	37.2
Monthly Streamflow	CW3E Cold Creek	107	11/30/2018	acre-feet per month	271.8	409.4	1.0	137.6
Monthly Streamflow	CW3E Cold Creek	108	12/31/2018	acre-feet per month	257.4	592.3	1.0	335.0
Monthly Streamflow	CW3E Cold Creek	109	1/31/2019	acre-feet per month	871.1	3193.5	1.0	2322.5
Monthly Streamflow	CW3E Cold Creek	110	2/28/2019	acre-feet per month	1409.3	9165.3	1.0	7756.0
Monthly Streamflow	CW3E Cold Creek	111	3/31/2019	acre-feet per month	1266.9	4541.6	1.0	3274.7
Monthly Streamflow	CW3E Cold Creek	112	4/30/2019	acre-feet per month	472.2	724.8	1.0	252.5
Monthly Streamflow	CW3E Cold Creek	113	5/31/2019	acre-feet per month	285.1	861.1	1.0	576.0
Monthly Streamflow	CW3E Cold Creek	114	6/30/2019	acre-feet per month	115.6	285.7	1.0	170.1
Monthly Streamflow	CW3E Cold Creek	115	7/31/2019	acre-feet per month	219.0	155.0	1.0	-64.1
Monthly Streamflow	CW3E Cold Creek	116	8/31/2019	acre-feet per month	120.4	137.7	1.0	17.2
Monthly Streamflow	CW3E Cold Creek	117	9/30/2019	acre-feet per month	111.7	126.9	1.0	15.2
Monthly Streamflow	CW3E Cold Creek	118	10/31/2019	acre-feet per month	227.4	254.2	1.0	26.8
Monthly Streamflow	CW3E Cold Creek	119	11/30/2019	acre-feet per month	194.8	334.0	1.0	139.1
Monthly Streamflow	CW3E Cold Creek	120	12/31/2019	acre-feet per month	206.5	533.7	1.0	327.2

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly Streamflow	CW3E Cold Creek	121	1/31/2020	acre-feet per month	483.5	1780.5	1.0	1296.9
Monthly Streamflow	CW3E Cold Creek	122	2/29/2020	acre-feet per month	453.9	406.6	1.0	-47.2
Monthly Streamflow	CW3E Cold Creek	123	3/31/2020	acre-feet per month	282.2	553.3	1.0	271.1
Monthly Streamflow	CW3E Cold Creek	124	4/30/2020	acre-feet per month	343.1	401.6	1.0	58.6
Monthly Streamflow	CW3E Cold Creek	125	5/31/2020	acre-feet per month	116.7	420.5	1.0	303.8
Monthly Streamflow	CW3E Cold Creek	126	6/30/2020	acre-feet per month	111.7	188.3	1.0	76.6
Monthly Streamflow	CW3E Cold Creek	127	7/31/2020	acre-feet per month	123.6	117.2	1.0	-6.4
Monthly Streamflow	CW3E Cold Creek	128	8/31/2020	acre-feet per month	151.7	99.7	1.0	-52.0
Monthly Streamflow	CW3E White Creek	94	10/31/2017	acre-feet per month	60.1	27.4	1.0	-32.7
Monthly Streamflow	CW3E White Creek	95	11/30/2017	acre-feet per month	121.8	66.7	1.0	-55.1
Monthly Streamflow	CW3E White Creek	96	12/31/2017	acre-feet per month	202.6	54.7	1.0	-147.9
Monthly Streamflow	CW3E White Creek	97	1/31/2018	acre-feet per month	237.9	222.0	1.0	-15.9
Monthly Streamflow	CW3E White Creek	98	2/28/2018	acre-feet per month	163.0	62.8	1.0	-100.2
Monthly Streamflow	CW3E White Creek	99	3/31/2018	acre-feet per month	241.8	193.1	1.0	-48.7
Monthly Streamflow	CW3E White Creek	100	4/30/2018	acre-feet per month	242.0	199.8	1.0	-42.2
Monthly Streamflow	CW3E White Creek	101	5/31/2018	acre-feet per month	148.6	37.4	1.0	-111.2
Monthly Streamflow	CW3E White Creek	102	6/30/2018	acre-feet per month	76.5	11.5	1.0	-65.0
Monthly Streamflow	CW3E White Creek	103	7/31/2018	acre-feet per month	7.2	5.1	1.0	-2.1
Monthly Streamflow	CW3E White Creek	104	8/31/2018	acre-feet per month	1.5	2.8	1.0	1.3
Monthly Streamflow	CW3E White Creek	105	9/30/2018	acre-feet per month	6.3	5.1	1.0	-1.3
Monthly Streamflow	CW3E White Creek	106	10/31/2018	acre-feet per month	12.7	9.5	1.0	-3.3
Monthly Streamflow	CW3E White Creek	107	11/30/2018	acre-feet per month	14.4	21.7	1.0	7.3
Monthly Streamflow	CW3E White Creek	108	12/31/2018	acre-feet per month	73.3	47.1	1.0	-26.1
Monthly Streamflow	CW3E White Creek	109	1/31/2019	acre-feet per month	102.4	235.0	1.0	132.6
Monthly Streamflow	CW3E White Creek	110	2/28/2019	acre-feet per month	116.0	823.8	1.0	707.8
Monthly Streamflow	CW3E White Creek	111	3/31/2019	acre-feet per month	82.0	483.6	1.0	401.6
Monthly Streamflow	CW3E White Creek	112	4/30/2019	acre-feet per month	53.0	110.4	1.0	57.4
Monthly Streamflow	CW3E White Creek	113	5/31/2019	acre-feet per month	28.3	118.7	1.0	90.4
Monthly Streamflow	CW3E White Creek	114	6/30/2019	acre-feet per month	22.9	3.5	1.0	-19.3
Monthly Streamflow	CW3E White Creek	115	7/31/2019	acre-feet per month	20.3	3.5	1.0	-16.8
Monthly Streamflow	CW3E White Creek	116	8/31/2019	acre-feet per month	21.7	3.7	1.0	-18.0
Monthly Streamflow	CW3E White Creek	117	9/30/2019	acre-feet per month	35.4	3.6	1.0	-31.8

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly Streamflow	CW3E White Creek	118	10/31/2019	acre-feet per month	44.1	4.5	1.0	-39.6
Monthly Streamflow	CW3E White Creek	119	11/30/2019	acre-feet per month	31.1	9.5	1.0	-21.6
Monthly Streamflow	CW3E White Creek	120	12/31/2019	acre-feet per month	83.0	35.5	1.0	-47.5
Monthly Streamflow	CW3E White Creek	121	1/31/2020	acre-feet per month	168.0	136.2	1.0	-31.8
Monthly Streamflow	CW3E White Creek	122	2/29/2020	acre-feet per month	129.7	40.0	1.0	-89.7
Monthly Streamflow	CW3E White Creek	123	3/31/2020	acre-feet per month	137.5	77.2	1.0	-60.3
Monthly Streamflow	CW3E White Creek	124	4/30/2020	acre-feet per month	87.6	40.8	1.0	-46.7
Monthly Streamflow	CW3E White Creek	125	5/31/2020	acre-feet per month	91.3	34.6	1.0	-56.6
Monthly Streamflow	CW3E White Creek	126	6/30/2020	acre-feet per month	45.4	3.4	1.0	-41.9
Monthly Streamflow	CW3E White Creek	127	7/31/2020	acre-feet per month	31.0	4.3	1.0	-26.7
Monthly Streamflow	CW3E White Creek	128	8/31/2020	acre-feet per month	16.9	3.4	1.0	-13.5
Monthly Streamflow	CW3E Boyes Creek	94	10/31/2017	acre-feet per month	121.8	10.2	1.0	-111.5
Monthly Streamflow	CW3E Boyes Creek	95	11/30/2017	acre-feet per month	245.9	40.1	1.0	-205.8
Monthly Streamflow	CW3E Boyes Creek	96	12/31/2017	acre-feet per month	319.2	55.0	1.0	-264.2
Monthly Streamflow	CW3E Boyes Creek	97	1/31/2018	acre-feet per month	432.4	269.2	1.0	-163.1
Monthly Streamflow	CW3E Boyes Creek	98	2/28/2018	acre-feet per month	260.4	77.9	1.0	-182.5
Monthly Streamflow	CW3E Boyes Creek	99	3/31/2018	acre-feet per month	335.7	274.2	1.0	-61.5
Monthly Streamflow	CW3E Boyes Creek	100	4/30/2018	acre-feet per month	436.0	309.0	1.0	-127.0
Monthly Streamflow	CW3E Boyes Creek	101	5/31/2018	acre-feet per month	107.0	56.9	1.0	-50.1
Monthly Streamflow	CW3E Boyes Creek	102	6/30/2018	acre-feet per month	135.4	21.5	1.0	-113.9
Monthly Streamflow	CW3E Boyes Creek	103	7/31/2018	acre-feet per month	185.6	2.4	1.0	-183.1
Monthly Streamflow	CW3E Boyes Creek	104	8/31/2018	acre-feet per month	115.2	0.7	1.0	-114.5
Monthly Streamflow	CW3E Boyes Creek	105	9/30/2018	acre-feet per month	90.6	2.3	1.0	-88.3
Monthly Streamflow	CW3E Boyes Creek	106	10/31/2018	acre-feet per month	126.2	9.7	1.0	-116.5
Monthly Streamflow	CW3E Boyes Creek	107	11/30/2018	acre-feet per month	210.4	33.7	1.0	-176.7
Monthly Streamflow	CW3E Boyes Creek	108	12/31/2018	acre-feet per month	369.7	93.1	1.0	-276.6
Monthly Streamflow	CW3E Boyes Creek	109	1/31/2019	acre-feet per month	636.2	370.6	1.0	-265.6
Monthly Streamflow	CW3E Boyes Creek	110	2/28/2019	acre-feet per month	427.9	940.6	1.0	512.8
Monthly Streamflow	CW3E Boyes Creek	111	3/31/2019	acre-feet per month	385.7	516.3	1.0	130.6
Monthly Streamflow	CW3E Boyes Creek	112	4/30/2019	acre-feet per month	152.3	128.2	1.0	-24.0
Monthly Streamflow	CW3E Boyes Creek	113	5/31/2019	acre-feet per month	54.1	161.2	1.0	107.1
Monthly Streamflow	CW3E Boyes Creek	114	6/30/2019	acre-feet per month	66.2	5.0	1.0	-61.2

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly Streamflow	CW3E Boyes Creek	115	7/31/2019	acre-feet per month	99.1	0.7	1.0	-98.4
Monthly Streamflow	CW3E Boyes Creek	116	8/31/2019	acre-feet per month	56.8	0.0	1.0	-56.7
Monthly Streamflow	CW3E Boyes Creek	117	9/30/2019	acre-feet per month	70.1	0.8	1.0	-69.4
Monthly Streamflow	CW3E Boyes Creek	118	10/31/2019	acre-feet per month	133.8	4.1	1.0	-129.7
Monthly Streamflow	CW3E Boyes Creek	119	11/30/2019	acre-feet per month	99.8	10.0	1.0	-89.7
Monthly Streamflow	CW3E Boyes Creek	120	12/31/2019	acre-feet per month	307.9	50.7	1.0	-257.2
Monthly Streamflow	CW3E Boyes Creek	121	1/31/2020	acre-feet per month	385.4	197.3	1.0	-188.1
Monthly Streamflow	CW3E Boyes Creek	122	2/29/2020	acre-feet per month	237.8	50.5	1.0	-187.3
Monthly Streamflow	CW3E Boyes Creek	123	3/31/2020	acre-feet per month	155.2	101.3	1.0	-53.9
Monthly Streamflow	CW3E Boyes Creek	124	4/30/2020	acre-feet per month	169.2	48.2	1.0	-121.0
Monthly Streamflow	CW3E Boyes Creek	125	5/31/2020	acre-feet per month	65.2	51.3	1.0	-13.9
Monthly Streamflow	CW3E Boyes Creek	126	6/30/2020	acre-feet per month	69.7	2.2	1.0	-67.5
Monthly Streamflow	CW3E Boyes Creek	127	7/31/2020	acre-feet per month	36.1	0.0	1.0	-36.1
Monthly Streamflow	CW3E Boyes Creek	128	8/31/2020	acre-feet per month	25.6	0.1	1.0	-25.4
Monthly Streamflow	CW3E Mewhinney Creek	94	10/31/2017	acre-feet per month	9.9	0.0	1.0	-9.9
Monthly Streamflow	CW3E Mewhinney Creek	95	11/30/2017	acre-feet per month	18.2	5.6	1.0	-12.5
Monthly Streamflow	CW3E Mewhinney Creek	96	12/31/2017	acre-feet per month	30.4	9.2	1.0	-21.2
Monthly Streamflow	CW3E Mewhinney Creek	97	1/31/2018	acre-feet per month	49.4	181.4	1.0	132.0
Monthly Streamflow	CW3E Mewhinney Creek	98	2/28/2018	acre-feet per month	24.3	21.5	1.0	-2.8
Monthly Streamflow	CW3E Mewhinney Creek	99	3/31/2018	acre-feet per month	63.8	149.5	1.0	85.7
Monthly Streamflow	CW3E Mewhinney Creek	100	4/30/2018	acre-feet per month	85.7	130.7	1.0	45.0
Monthly Streamflow	CW3E Mewhinney Creek	101	5/31/2018	acre-feet per month	30.8	3.8	1.0	-27.0
Monthly Streamflow	CW3E Mewhinney Creek	102	6/30/2018	acre-feet per month	7.1	0.0	1.0	-7.1
Monthly Streamflow	CW3E Mewhinney Creek	103	7/31/2018	acre-feet per month	3.4	0.0	1.0	-3.4
Monthly Streamflow	CW3E Mewhinney Creek	104	8/31/2018	acre-feet per month	0.8	0.0	1.0	-0.8
Monthly Streamflow	CW3E Mewhinney Creek	105	9/30/2018	acre-feet per month	3.2	0.0	1.0	-3.2
Monthly Streamflow	CW3E Mewhinney Creek	106	10/31/2018	acre-feet per month	11.2	0.5	1.0	-10.7
Monthly Streamflow	CW3E Mewhinney Creek	107	11/30/2018	acre-feet per month	13.1	5.8	1.0	-7.3
Monthly Streamflow	CW3E Mewhinney Creek	108	12/31/2018	acre-feet per month	43.3	29.4	1.0	-13.9
Monthly Streamflow	CW3E Mewhinney Creek	109	1/31/2019	acre-feet per month	37.9	266.0	1.0	228.1
Monthly Streamflow	CW3E Mewhinney Creek	110	2/28/2019	acre-feet per month	11.6	654.1	1.0	642.5
Monthly Streamflow	CW3E Mewhinney Creek	111	3/31/2019	acre-feet per month	2.4	326.3	1.0	323.9

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly Streamflow	CW3E Mewhinney Creek	112	4/30/2019	acre-feet per month	3.5	50.7	1.0	47.2
Monthly Streamflow	CW3E Mewhinney Creek	113	5/31/2019	acre-feet per month	1.1	97.5	1.0	96.4
Monthly Streamflow	CW3E Mewhinney Creek	114	6/30/2019	acre-feet per month	1.3	1.3	1.0	0.0
Monthly Streamflow	CW3E Mewhinney Creek	115	7/31/2019	acre-feet per month	1.0	0.0	1.0	-1.0
Monthly Streamflow	CW3E Mewhinney Creek	116	8/31/2019	acre-feet per month	0.9	0.0	1.0	-0.9
Monthly Streamflow	CW3E Mewhinney Creek	117	9/30/2019	acre-feet per month	2.0	0.0	1.0	-2.0
Monthly Streamflow	CW3E Mewhinney Creek	118	10/31/2019	acre-feet per month	2.7	0.2	1.0	-2.4
Monthly Streamflow	CW3E Mewhinney Creek	119	11/30/2019	acre-feet per month	2.9	1.6	1.0	-1.2
Monthly Streamflow	CW3E Mewhinney Creek	120	12/31/2019	acre-feet per month	18.1	17.9	1.0	-0.2
Monthly Streamflow	CW3E Mewhinney Creek	121	1/31/2020	acre-feet per month	48.8	147.6	1.0	98.8
Monthly Streamflow	CW3E Mewhinney Creek	122	2/29/2020	acre-feet per month	33.4	15.7	1.0	-17.7
Monthly Streamflow	CW3E Mewhinney Creek	123	3/31/2020	acre-feet per month	21.0	54.3	1.0	33.3
Monthly Streamflow	CW3E Mewhinney Creek	124	4/30/2020	acre-feet per month	5.8	11.5	1.0	5.7
Monthly Streamflow	CW3E Mewhinney Creek	125	5/31/2020	acre-feet per month	5.3	19.2	1.0	13.9
Monthly Streamflow	CW3E Mewhinney Creek	126	6/30/2020	acre-feet per month	2.3	0.0	1.0	-2.3
Monthly Streamflow	CW3E Mewhinney Creek	127	7/31/2020	acre-feet per month	1.4	0.0	1.0	-1.4
Monthly Streamflow	CW3E Mewhinney Creek	128	8/31/2020	acre-feet per month	0.2	0.0	1.0	-0.2
Monthly ETa	PV Water Budget Area	10	10/31/2010	acre-feet per month	1341.2	2208.8	1.0	867.6
Monthly ETa	PV Water Budget Area	11	11/30/2010	acre-feet per month	721.9	1077.5	1.0	355.7
Monthly ETa	PV Water Budget Area	12	12/31/2010	acre-feet per month	737.5	1064.6	1.0	327.1
Monthly ETa	PV Water Budget Area	13	1/31/2011	acre-feet per month	693.2	948.7	1.0	255.6
Monthly ETa	PV Water Budget Area	14	2/28/2011	acre-feet per month	1004.3	1388.2	1.0	384.0
Monthly ETa	PV Water Budget Area	15	3/31/2011	acre-feet per month	1293.5	1807.6	1.0	514.1
Monthly ETa	PV Water Budget Area	16	4/30/2011	acre-feet per month	2071.2	2747.3	1.0	676.1
Monthly ETa	PV Water Budget Area	17	5/31/2011	acre-feet per month	2260.9	3251.4	1.0	990.5
Monthly ETa	PV Water Budget Area	18	6/30/2011	acre-feet per month	2464.2	3551.7	1.0	1087.5
Monthly ETa	PV Water Budget Area	19	7/31/2011	acre-feet per month	2109.1	2979.3	1.0	870.2
Monthly ETa	PV Water Budget Area	20	8/31/2011	acre-feet per month	1794.5	2539.0	1.0	744.5
Monthly ETa	PV Water Budget Area	21	9/30/2011	acre-feet per month	1427.7	2018.8	1.0	591.1
Monthly ETa	PV Water Budget Area	22	10/31/2011	acre-feet per month	1341.2	2095.0	1.0	753.8
Monthly ETa	PV Water Budget Area	23	11/30/2011	acre-feet per month	721.9	1043.5	1.0	321.7
Monthly ETa	PV Water Budget Area	24	12/31/2011	acre-feet per month	737.5	943.3	1.0	205.8

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly ETa	PV Water Budget Area	25	1/31/2012	acre-feet per month	693.2	948.0	1.0	254.9
Monthly ETa	PV Water Budget Area	26	2/29/2012	acre-feet per month	1040.1	1402.3	1.0	362.1
Monthly ETa	PV Water Budget Area	27	3/31/2012	acre-feet per month	1293.5	1761.4	1.0	467.9
Monthly ETa	PV Water Budget Area	28	4/30/2012	acre-feet per month	2071.2	2710.7	1.0	639.4
Monthly ETa	PV Water Budget Area	29	5/31/2012	acre-feet per month	2260.9	3092.0	1.0	831.2
Monthly ETa	PV Water Budget Area	30	6/30/2012	acre-feet per month	2464.2	3413.2	1.0	949.0
Monthly ETa	PV Water Budget Area	31	7/31/2012	acre-feet per month	2109.1	3047.4	1.0	938.3
Monthly ETa	PV Water Budget Area	32	8/31/2012	acre-feet per month	1794.5	2595.6	1.0	801.1
Monthly ETa	PV Water Budget Area	33	9/30/2012	acre-feet per month	1427.7	2060.5	1.0	632.7
Monthly ETa	PV Water Budget Area	34	10/31/2012	acre-feet per month	1341.2	1935.0	1.0	593.8
Monthly ETa	PV Water Budget Area	35	11/30/2012	acre-feet per month	721.9	1074.9	1.0	353.0
Monthly ETa	PV Water Budget Area	36	12/31/2012	acre-feet per month	737.5	1079.5	1.0	342.0
Monthly ETa	PV Water Budget Area	37	1/31/2013	acre-feet per month	693.2	958.0	1.0	264.8
Monthly ETa	PV Water Budget Area	38	2/28/2013	acre-feet per month	1004.3	1358.3	1.0	354.0
Monthly ETa	PV Water Budget Area	39	3/31/2013	acre-feet per month	1293.5	1714.3	1.0	420.7
Monthly ETa	PV Water Budget Area	40	4/30/2013	acre-feet per month	2071.2	2637.6	1.0	566.3
Monthly ETa	PV Water Budget Area	41	5/31/2013	acre-feet per month	2260.9	3107.7	1.0	846.9
Monthly ETa	PV Water Budget Area	42	6/30/2013	acre-feet per month	2464.2	3587.2	1.0	1123.0
Monthly ETa	PV Water Budget Area	43	7/31/2013	acre-feet per month	2109.1	3152.2	1.0	1043.2
Monthly ETa	PV Water Budget Area	44	8/31/2013	acre-feet per month	1794.5	2627.1	1.0	832.6
Monthly ETa	PV Water Budget Area	45	9/30/2013	acre-feet per month	1427.7	2201.7	1.0	773.9
Monthly ETa	PV Water Budget Area	46	10/31/2013	acre-feet per month	1341.2	1742.5	1.0	401.3
Monthly ETa	PV Water Budget Area	47	11/30/2013	acre-feet per month	721.9	939.6	1.0	217.8
Monthly ETa	PV Water Budget Area	48	12/31/2013	acre-feet per month	737.5	855.5	1.0	118.1
Monthly ETa	PV Water Budget Area	49	1/31/2014	acre-feet per month	693.2	759.8	1.0	66.7
Monthly ETa	PV Water Budget Area	50	2/28/2014	acre-feet per month	1004.3	1351.4	1.0	347.2
Monthly ETa	PV Water Budget Area	51	3/31/2014	acre-feet per month	1293.5	1766.0	1.0	472.5
Monthly ETa	PV Water Budget Area	52	4/30/2014	acre-feet per month	2071.2	2696.9	1.0	625.7
Monthly ETa	PV Water Budget Area	53	5/31/2014	acre-feet per month	2260.9	3105.2	1.0	844.3
Monthly ETa	PV Water Budget Area	54	6/30/2014	acre-feet per month	2464.2	3469.4	1.0	1005.2
Monthly ETa	PV Water Budget Area	55	7/31/2014	acre-feet per month	2109.1	3112.9	1.0	1003.8
Monthly ETa	PV Water Budget Area	56	8/31/2014	acre-feet per month	1794.5	2644.2	1.0	849.7

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly ETa	PV Water Budget Area	57	9/30/2014	acre-feet per month	1427.7	2051.8	1.0	624.1
Monthly ETa	PV Water Budget Area	58	10/31/2014	acre-feet per month	1341.2	1973.8	1.0	632.6
Monthly ETa	PV Water Budget Area	59	11/30/2014	acre-feet per month	721.9	1039.5	1.0	317.6
Monthly ETa	PV Water Budget Area	60	12/31/2014	acre-feet per month	737.5	1061.1	1.0	323.6
Monthly ETa	PV Water Budget Area	61	1/31/2015	acre-feet per month	693.2	935.8	1.0	242.6
Monthly ETa	PV Water Budget Area	62	2/28/2015	acre-feet per month	1004.3	1363.0	1.0	358.7
Monthly ETa	PV Water Budget Area	63	3/31/2015	acre-feet per month	1293.5	1674.3	1.0	380.8
Monthly ETa	PV Water Budget Area	64	4/30/2015	acre-feet per month	2071.2	2576.3	1.0	505.1
Monthly ETa	PV Water Budget Area	65	5/31/2015	acre-feet per month	2260.9	2976.0	1.0	715.2
Monthly ETa	PV Water Budget Area	66	6/30/2015	acre-feet per month	2464.2	3298.5	1.0	834.3
Monthly ETa	PV Water Budget Area	67	7/31/2015	acre-feet per month	2109.1	2990.4	1.0	881.3
Monthly ETa	PV Water Budget Area	68	8/31/2015	acre-feet per month	1794.5	2507.1	1.0	712.6
Monthly ETa	PV Water Budget Area	69	9/30/2015	acre-feet per month	1427.7	1960.3	1.0	532.6
Monthly ETa	PV Water Budget Area	70	10/31/2015	acre-feet per month	1341.2	1597.4	1.0	256.1
Monthly ETa	PV Water Budget Area	71	11/30/2015	acre-feet per month	721.9	891.7	1.0	169.8
Monthly ETa	PV Water Budget Area	72	12/31/2015	acre-feet per month	737.5	1053.3	1.0	315.8
Monthly ETa	PV Water Budget Area	73	1/31/2016	acre-feet per month	546.2	751.6	1.0	205.3
Monthly ETa	PV Water Budget Area	74	2/29/2016	acre-feet per month	821.3	1136.2	1.0	314.9
Monthly ETa	PV Water Budget Area	75	3/31/2016	acre-feet per month	1417.8	1963.9	1.0	546.1
Monthly ETa	PV Water Budget Area	76	4/30/2016	acre-feet per month	2026.9	2632.6	1.0	605.7
Monthly ETa	PV Water Budget Area	77	5/31/2016	acre-feet per month	2171.9	2979.1	1.0	807.3
Monthly ETa	PV Water Budget Area	78	6/30/2016	acre-feet per month	2752.9	3773.7	1.0	1020.8
Monthly ETa	PV Water Budget Area	79	7/31/2016	acre-feet per month	2258.3	3146.8	1.0	888.5
Monthly ETa	PV Water Budget Area	80	8/31/2016	acre-feet per month	2186.9	2896.8	1.0	709.8
Monthly ETa	PV Water Budget Area	81	9/30/2016	acre-feet per month	1710.5	2176.6	1.0	466.2
Monthly ETa	PV Water Budget Area	82	10/31/2016	acre-feet per month	1250.7	1920.2	1.0	669.5
Monthly ETa	PV Water Budget Area	83	11/30/2016	acre-feet per month	794.3	1113.5	1.0	319.2
Monthly ETa	PV Water Budget Area	84	12/31/2016	acre-feet per month	563.7	800.6	1.0	236.8
Monthly ETa	PV Water Budget Area	85	1/31/2017	acre-feet per month	684.2	962.1	1.0	277.9
Monthly ETa	PV Water Budget Area	86	2/28/2017	acre-feet per month	798.0	1142.5	1.0	344.5
Monthly ETa	PV Water Budget Area	87	3/31/2017	acre-feet per month	1401.4	1946.2	1.0	544.8
Monthly ETa	PV Water Budget Area	88	4/30/2017	acre-feet per month	1996.0	2666.8	1.0	670.9

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly ETa	PV Water Budget Area	89	5/31/2017	acre-feet per month	2491.3	3435.6	1.0	944.3
Monthly ETa	PV Water Budget Area	90	6/30/2017	acre-feet per month	2494.2	3505.3	1.0	1011.0
Monthly ETa	PV Water Budget Area	91	7/31/2017	acre-feet per month	2143.7	3077.5	1.0	933.8
Monthly ETa	PV Water Budget Area	92	8/31/2017	acre-feet per month	1643.3	2345.1	1.0	701.8
Monthly ETa	PV Water Budget Area	93	9/30/2017	acre-feet per month	1298.3	1865.4	1.0	567.0
Monthly ETa	PV Water Budget Area	94	10/31/2017	acre-feet per month	1183.5	1572.0	1.0	388.5
Monthly ETa	PV Water Budget Area	95	11/30/2017	acre-feet per month	415.7	618.5	1.0	202.8
Monthly ETa	PV Water Budget Area	96	12/31/2017	acre-feet per month	781.1	1043.4	1.0	262.3
Monthly ETa	PV Water Budget Area	97	1/31/2018	acre-feet per month	522.3	699.8	1.0	177.4
Monthly ETa	PV Water Budget Area	98	2/28/2018	acre-feet per month	1375.9	1762.6	1.0	386.7
Monthly ETa	PV Water Budget Area	99	3/31/2018	acre-feet per month	1438.4	1887.6	1.0	449.1
Monthly ETa	PV Water Budget Area	100	4/30/2018	acre-feet per month	1840.7	2403.2	1.0	562.6
Monthly ETa	PV Water Budget Area	101	5/31/2018	acre-feet per month	2500.3	3242.7	1.0	742.4
Monthly ETa	PV Water Budget Area	102	6/30/2018	acre-feet per month	2121.1	2844.2	1.0	723.0
Monthly ETa	PV Water Budget Area	103	7/31/2018	acre-feet per month	1949.7	2690.9	1.0	741.2
Monthly ETa	PV Water Budget Area	104	8/31/2018	acre-feet per month	1766.2	2368.5	1.0	602.2
Monthly ETa	PV Water Budget Area	105	9/30/2018	acre-feet per month	1293.3	1778.6	1.0	485.2
Monthly ETa	PV Water Budget Area	106	10/31/2018	acre-feet per month	1418.1	1641.9	1.0	223.8
Monthly ETa	PV Water Budget Area	107	11/30/2018	acre-feet per month	836.3	1196.4	1.0	360.1
Monthly ETa	PV Water Budget Area	108	12/31/2018	acre-feet per month	805.1	1104.6	1.0	299.5
Monthly ETa	PV Water Budget Area	109	1/31/2019	acre-feet per month	810.9	1115.5	1.0	304.6
Monthly ETa	PV Water Budget Area	110	2/28/2019	acre-feet per month	617.7	900.8	1.0	283.1
Monthly ETa	PV Water Budget Area	111	3/31/2019	acre-feet per month	684.4	986.6	1.0	302.3
Monthly ETa	PV Water Budget Area	112	4/30/2019	acre-feet per month	2071.8	2740.6	1.0	668.8
Monthly ETa	PV Water Budget Area	113	5/31/2019	acre-feet per month	1742.7	2538.2	1.0	795.5
Monthly ETa	PV Water Budget Area	114	6/30/2019	acre-feet per month	2972.9	4045.8	1.0	1072.9
Monthly ETa	PV Water Budget Area	115	7/31/2019	acre-feet per month	2369.2	3254.5	1.0	885.3
Monthly ETa	PV Water Budget Area	116	8/31/2019	acre-feet per month	2194.3	2802.4	1.0	608.2
Monthly ETa	PV Water Budget Area	117	9/30/2019	acre-feet per month	1619.1	2012.0	1.0	392.9
Monthly ETa	PV Water Budget Area	118	10/31/2019	acre-feet per month	1325.7	1561.0	1.0	235.3
Monthly ETa	PV Water Budget Area	119	11/30/2019	acre-feet per month	596.3	736.0	1.0	139.7
Monthly ETa	PV Water Budget Area	120	12/31/2019	acre-feet per month	583.5	838.5	1.0	255.0

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly ETa	PV Water Budget Area	121	1/31/2020	acre-feet per month	783.9	1062.0	1.0	278.1
Monthly ETa	PV Water Budget Area	122	2/29/2020	acre-feet per month	1431.7	1790.5	1.0	358.8
Monthly ETa	PV Water Budget Area	123	3/31/2020	acre-feet per month	999.0	1247.0	1.0	248.0
Monthly ETa	PV Water Budget Area	124	4/30/2020	acre-feet per month	2010.9	2231.0	1.0	220.0
Monthly ETa	PV Water Budget Area	125	5/31/2020	acre-feet per month	2116.1	2537.2	1.0	421.1
Monthly ETa	PV Water Budget Area	126	6/30/2020	acre-feet per month	2369.3	2770.4	1.0	401.1
Monthly ETa	PV Water Budget Area	127	7/31/2020	acre-feet per month	1904.1	2462.5	1.0	558.3
Monthly ETa	PV Water Budget Area	128	8/31/2020	acre-feet per month	1345.7	1867.5	1.0	521.8
Monthly ETa	PV Water Budget Area	129	9/30/2020	acre-feet per month	1181.7	1561.0	1.0	379.2
Monthly ETa	PV Water Budget Area	130	10/31/2020	acre-feet per month	1528.1	1886.8	1.0	358.7
Monthly ETa	PV Water Budget Area	131	11/30/2020	acre-feet per month	966.7	1112.4	1.0	145.7
Monthly ETa	PV Water Budget Area	132	12/31/2020	acre-feet per month	954.0	1195.8	1.0	241.8
Monthly ETa	PV Water Budget Area	133	1/31/2021	acre-feet per month	811.4	1080.1	1.0	268.7
Monthly ETa	PV Water Budget Area	134	2/28/2021	acre-feet per month	1058.7	1383.9	1.0	325.3
Monthly ETa	PV Water Budget Area	135	3/31/2021	acre-feet per month	1820.1	2261.2	1.0	441.1
Monthly ETa	PV Water Budget Area	136	4/30/2021	acre-feet per month	2481.2	2717.8	1.0	236.6
Monthly ETa	PV Water Budget Area	137	5/31/2021	acre-feet per month	2542.9	2231.8	1.0	-311.1
Monthly ETa	PV Water Budget Area	138	6/30/2021	acre-feet per month	2074.9	1651.3	1.0	-423.6
Monthly ETa	PV Water Budget Area	139	7/31/2021	acre-feet per month	2029.3	1308.4	1.0	-720.9
Monthly ETa	PV Water Budget Area	140	8/31/2021	acre-feet per month	1630.5	1026.8	1.0	-603.7
Monthly ETa	PV Water Budget Area	141	9/30/2021	acre-feet per month	1463.4	1058.0	1.0	-405.4
Monthly ETa	PV Water Budget Area	142	10/31/2021	acre-feet per month	1179.6	1807.1	1.0	627.5
Monthly ETa	PV Water Budget Area	143	11/30/2021	acre-feet per month	736.5	985.1	1.0	248.6
Monthly ETa	PV Water Budget Area	144	12/31/2021	acre-feet per month	737.5	1039.3	1.0	301.8
Monthly ETa	PV Water Budget Area	145	1/31/2022	acre-feet per month	693.2	913.9	1.0	220.7
Monthly ETa	PV Water Budget Area	146	2/28/2022	acre-feet per month	1004.3	1271.7	1.0	267.5
Monthly ETa	PV Water Budget Area	147	3/31/2022	acre-feet per month	1293.5	1599.2	1.0	305.7
Monthly ETa	PV Water Budget Area	148	4/30/2022	acre-feet per month	2071.2	2621.9	1.0	550.7
Monthly ETa	PV Water Budget Area	149	5/31/2022	acre-feet per month	2260.9	2959.0	1.0	698.1
Monthly ETa	PV Water Budget Area	150	6/30/2022	acre-feet per month	2464.2	3094.7	1.0	630.5
Monthly ETa	PV Water Budget Area	151	7/31/2022	acre-feet per month	2109.1	2751.0	1.0	642.0
Monthly ETa	PV Water Budget Area	152	8/31/2022	acre-feet per month	1794.5	2227.7	1.0	433.2

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly ETa	PV Water Budget Area	153	9/30/2022	acre-feet per month	1427.7	1416.9	1.0	-10.9
Monthly ETa	PVIFM Domain	10	10/31/2010	acre-feet per month	7092.3	11092.8	1.0	4000.5
Monthly ETa	PVIFM Domain	11	11/30/2010	acre-feet per month	3385.7	4085.4	1.0	699.7
Monthly ETa	PVIFM Domain	12	12/31/2010	acre-feet per month	3277.3	3863.0	1.0	585.7
Monthly ETa	PVIFM Domain	13	1/31/2011	acre-feet per month	3616.2	4105.9	1.0	489.7
Monthly ETa	PVIFM Domain	14	2/28/2011	acre-feet per month	5477.6	6338.1	1.0	860.5
Monthly ETa	PVIFM Domain	15	3/31/2011	acre-feet per month	7272.3	8519.3	1.0	1247.0
Monthly ETa	PVIFM Domain	16	4/30/2011	acre-feet per month	12874.6	13738.7	1.0	864.1
Monthly ETa	PVIFM Domain	17	5/31/2011	acre-feet per month	14819.9	19913.2	1.0	5093.3
Monthly ETa	PVIFM Domain	18	6/30/2011	acre-feet per month	18240.4	24126.2	1.0	5885.8
Monthly ETa	PVIFM Domain	19	7/31/2011	acre-feet per month	13177.5	10853.1	1.0	-2324.4
Monthly ETa	PVIFM Domain	20	8/31/2011	acre-feet per month	10607.9	7214.3	1.0	-3393.6
Monthly ETa	PVIFM Domain	21	9/30/2011	acre-feet per month	9208.8	5513.1	1.0	-3695.7
Monthly ETa	PVIFM Domain	22	10/31/2011	acre-feet per month	7092.3	9663.9	1.0	2571.5
Monthly ETa	PVIFM Domain	23	11/30/2011	acre-feet per month	3385.7	3865.9	1.0	480.2
Monthly ETa	PVIFM Domain	24	12/31/2011	acre-feet per month	3277.3	3319.0	1.0	41.7
Monthly ETa	PVIFM Domain	25	1/31/2012	acre-feet per month	3616.2	4009.0	1.0	392.8
Monthly ETa	PVIFM Domain	26	2/29/2012	acre-feet per month	5673.3	6288.6	1.0	615.3
Monthly ETa	PVIFM Domain	27	3/31/2012	acre-feet per month	7272.3	8155.2	1.0	882.9
Monthly ETa	PVIFM Domain	28	4/30/2012	acre-feet per month	12874.6	13296.9	1.0	422.3
Monthly ETa	PVIFM Domain	29	5/31/2012	acre-feet per month	14819.9	18124.0	1.0	3304.1
Monthly ETa	PVIFM Domain	30	6/30/2012	acre-feet per month	18240.4	16602.0	1.0	-1638.3
Monthly ETa	PVIFM Domain	31	7/31/2012	acre-feet per month	13177.5	8953.7	1.0	-4223.9
Monthly ETa	PVIFM Domain	32	8/31/2012	acre-feet per month	10607.9	6260.6	1.0	-4347.3
Monthly ETa	PVIFM Domain	33	9/30/2012	acre-feet per month	9208.8	4870.8	1.0	-4338.0
Monthly ETa	PVIFM Domain	34	10/31/2012	acre-feet per month	7092.3	5220.6	1.0	-1871.8
Monthly ETa	PVIFM Domain	35	11/30/2012	acre-feet per month	3385.7	3926.4	1.0	540.7
Monthly ETa	PVIFM Domain	36	12/31/2012	acre-feet per month	3277.3	3812.5	1.0	535.1
Monthly ETa	PVIFM Domain	37	1/31/2013	acre-feet per month	3616.2	4051.6	1.0	435.4
Monthly ETa	PVIFM Domain	38	2/28/2013	acre-feet per month	5477.6	6096.9	1.0	619.3
Monthly ETa	PVIFM Domain	39	3/31/2013	acre-feet per month	7272.3	7967.1	1.0	694.8
Monthly ETa	PVIFM Domain	40	4/30/2013	acre-feet per month	12874.6	12845.3	1.0	-29.2

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly ETa	PVIFM Domain	41	5/31/2013	acre-feet per month	14819.9	16422.1	1.0	1602.2
Monthly ETa	PVIFM Domain	42	6/30/2013	acre-feet per month	18240.4	19822.6	1.0	1582.2
Monthly ETa	PVIFM Domain	43	7/31/2013	acre-feet per month	13177.5	9198.1	1.0	-3979.4
Monthly ETa	PVIFM Domain	44	8/31/2013	acre-feet per month	10607.9	6255.7	1.0	-4352.2
Monthly ETa	PVIFM Domain	45	9/30/2013	acre-feet per month	9208.8	9741.9	1.0	533.1
Monthly ETa	PVIFM Domain	46	10/31/2013	acre-feet per month	7092.3	3026.1	1.0	-4066.2
Monthly ETa	PVIFM Domain	47	11/30/2013	acre-feet per month	3385.7	3108.4	1.0	-277.3
Monthly ETa	PVIFM Domain	48	12/31/2013	acre-feet per month	3277.3	2670.3	1.0	-607.0
Monthly ETa	PVIFM Domain	49	1/31/2014	acre-feet per month	3616.2	2838.8	1.0	-777.3
Monthly ETa	PVIFM Domain	50	2/28/2014	acre-feet per month	5477.6	5940.5	1.0	462.9
Monthly ETa	PVIFM Domain	51	3/31/2014	acre-feet per month	7272.3	8080.2	1.0	807.9
Monthly ETa	PVIFM Domain	52	4/30/2014	acre-feet per month	12874.6	13148.0	1.0	273.4
Monthly ETa	PVIFM Domain	53	5/31/2014	acre-feet per month	14819.9	17097.4	1.0	2277.5
Monthly ETa	PVIFM Domain	54	6/30/2014	acre-feet per month	18240.4	14407.5	1.0	-3832.9
Monthly ETa	PVIFM Domain	55	7/31/2014	acre-feet per month	13177.5	8390.3	1.0	-4787.3
Monthly ETa	PVIFM Domain	56	8/31/2014	acre-feet per month	10607.9	6002.5	1.0	-4605.4
Monthly ETa	PVIFM Domain	57	9/30/2014	acre-feet per month	9208.8	5255.8	1.0	-3953.0
Monthly ETa	PVIFM Domain	58	10/31/2014	acre-feet per month	7092.3	6499.8	1.0	-592.5
Monthly ETa	PVIFM Domain	59	11/30/2014	acre-feet per month	3385.7	3737.3	1.0	351.6
Monthly ETa	PVIFM Domain	60	12/31/2014	acre-feet per month	3277.3	3720.3	1.0	443.0
Monthly ETa	PVIFM Domain	61	1/31/2015	acre-feet per month	3616.2	3939.7	1.0	323.5
Monthly ETa	PVIFM Domain	62	2/28/2015	acre-feet per month	5477.6	6054.3	1.0	576.6
Monthly ETa	PVIFM Domain	63	3/31/2015	acre-feet per month	7272.3	7766.8	1.0	494.5
Monthly ETa	PVIFM Domain	64	4/30/2015	acre-feet per month	12874.6	12452.6	1.0	-422.0
Monthly ETa	PVIFM Domain	65	5/31/2015	acre-feet per month	14819.9	13749.4	1.0	-1070.5
Monthly ETa	PVIFM Domain	66	6/30/2015	acre-feet per month	18240.4	12342.6	1.0	-5897.7
Monthly ETa	PVIFM Domain	67	7/31/2015	acre-feet per month	13177.5	8124.3	1.0	-5053.2
Monthly ETa	PVIFM Domain	68	8/31/2015	acre-feet per month	10607.9	5599.8	1.0	-5008.1
Monthly ETa	PVIFM Domain	69	9/30/2015	acre-feet per month	9208.8	5008.9	1.0	-4199.9
Monthly ETa	PVIFM Domain	70	10/31/2015	acre-feet per month	7092.3	2638.7	1.0	-4453.6
Monthly ETa	PVIFM Domain	71	11/30/2015	acre-feet per month	3385.7	2747.6	1.0	-638.1
Monthly ETa	PVIFM Domain	72	12/31/2015	acre-feet per month	3277.3	3675.4	1.0	398.0

Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly ETa	PVIFM Domain	73	1/31/2016	acre-feet per month	4548.1	5163.8	1.0	615.6
Monthly ETa	PVIFM Domain	74	2/29/2016	acre-feet per month	5749.4	6621.1	1.0	871.7
Monthly ETa	PVIFM Domain	75	3/31/2016	acre-feet per month	8457.9	9757.3	1.0	1299.4
Monthly ETa	PVIFM Domain	76	4/30/2016	acre-feet per month	12502.7	13048.6	1.0	545.9
Monthly ETa	PVIFM Domain	77	5/31/2016	acre-feet per month	16290.3	19511.8	1.0	3221.4
Monthly ETa	PVIFM Domain	78	6/30/2016	acre-feet per month	19426.4	15837.0	1.0	-3589.3
Monthly ETa	PVIFM Domain	79	7/31/2016	acre-feet per month	17031.5	9944.4	1.0	-7087.1
Monthly ETa	PVIFM Domain	80	8/31/2016	acre-feet per month	15479.9	6991.4	1.0	-8488.5
Monthly ETa	PVIFM Domain	81	9/30/2016	acre-feet per month	12953.2	5124.8	1.0	-7828.4
Monthly ETa	PVIFM Domain	82	10/31/2016	acre-feet per month	8071.1	11005.5	1.0	2934.4
Monthly ETa	PVIFM Domain	83	11/30/2016	acre-feet per month	4645.6	5326.4	1.0	680.8
Monthly ETa	PVIFM Domain	84	12/31/2016	acre-feet per month	2747.2	3101.1	1.0	353.9
Monthly ETa	PVIFM Domain	85	1/31/2017	acre-feet per month	3204.5	3658.3	1.0	453.8
Monthly ETa	PVIFM Domain	86	2/28/2017	acre-feet per month	4104.8	4873.8	1.0	769.0
Monthly ETa	PVIFM Domain	87	3/31/2017	acre-feet per month	8545.9	9940.8	1.0	1394.9
Monthly ETa	PVIFM Domain	88	4/30/2017	acre-feet per month	13488.9	14433.4	1.0	944.5
Monthly ETa	PVIFM Domain	89	5/31/2017	acre-feet per month	17785.8	22549.7	1.0	4763.9
Monthly ETa	PVIFM Domain	90	6/30/2017	acre-feet per month	20656.3	16151.4	1.0	-4504.9
Monthly ETa	PVIFM Domain	91	7/31/2017	acre-feet per month	12656.6	9304.7	1.0	-3351.9
Monthly ETa	PVIFM Domain	92	8/31/2017	acre-feet per month	9912.7	6335.8	1.0	-3576.9
Monthly ETa	PVIFM Domain	93	9/30/2017	acre-feet per month	6531.5	4424.4	1.0	-2107.1
Monthly ETa	PVIFM Domain	94	10/31/2017	acre-feet per month	6130.2	3063.8	1.0	-3066.4
Monthly ETa	PVIFM Domain	95	11/30/2017	acre-feet per month	1926.5	2189.0	1.0	262.6
Monthly ETa	PVIFM Domain	96	12/31/2017	acre-feet per month	3024.4	3111.6	1.0	87.2
Monthly ETa	PVIFM Domain	97	1/31/2018	acre-feet per month	2086.6	2220.1	1.0	133.4
Monthly ETa	PVIFM Domain	98	2/28/2018	acre-feet per month	6790.7	7171.4	1.0	380.7
Monthly ETa	PVIFM Domain	99	3/31/2018	acre-feet per month	8073.2	8660.5	1.0	587.2
Monthly ETa	PVIFM Domain	100	4/30/2018	acre-feet per month	10886.3	11083.9	1.0	197.6
Monthly ETa	PVIFM Domain	101	5/31/2018	acre-feet per month	17040.3	19833.0	1.0	2792.7
Monthly ETa	PVIFM Domain	102	6/30/2018	acre-feet per month	15280.9	12593.0	1.0	-2687.9
Monthly ETa	PVIFM Domain	103	7/31/2018	acre-feet per month	11159.4	8401.3	1.0	-2758.2
Monthly ETa	PVIFM Domain	104	8/31/2018	acre-feet per month	9151.6	5972.8	1.0	-3178.8

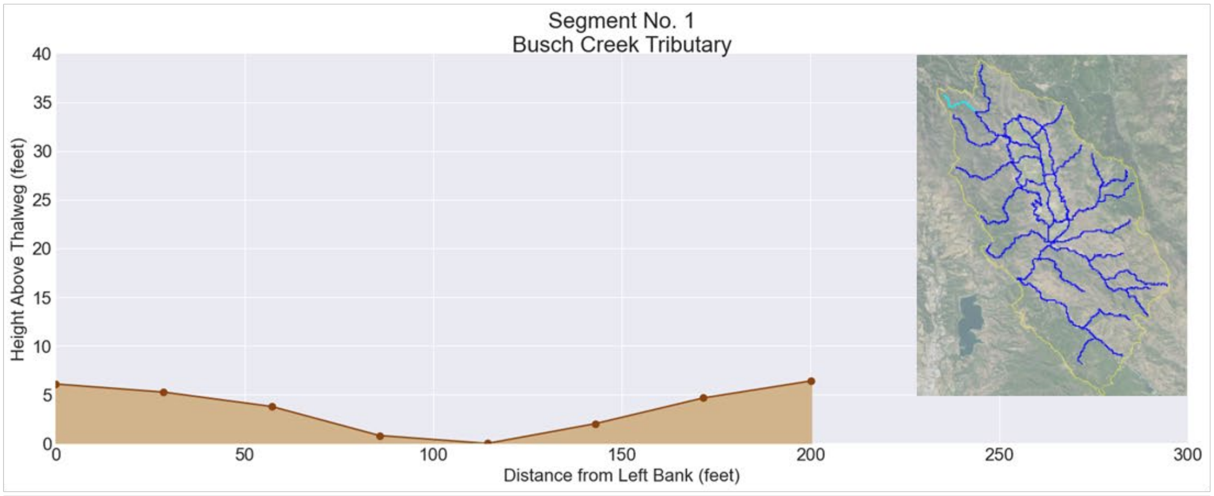
Attachment 1 Table of Calibration Target Values

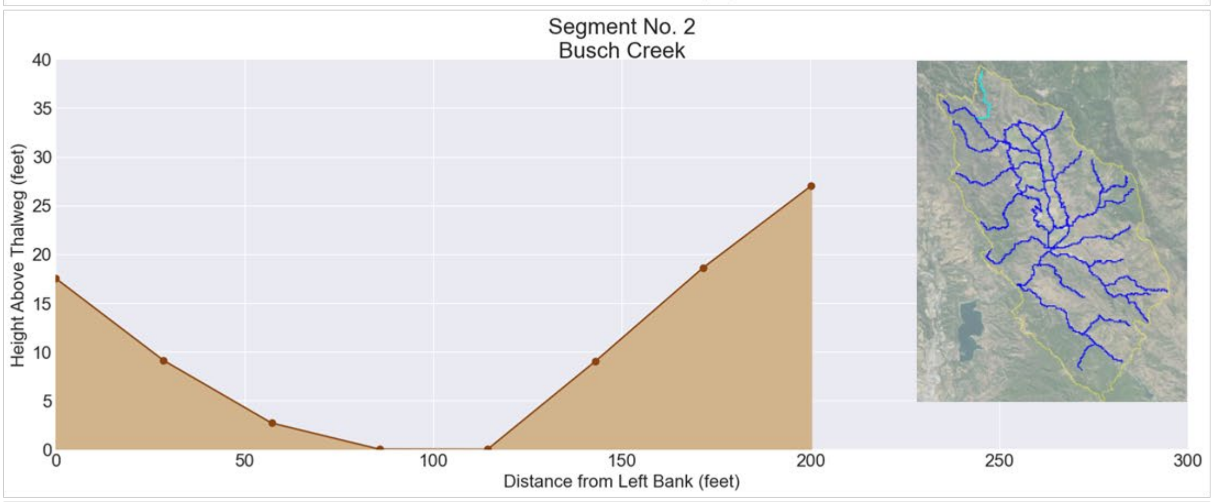
Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly ETa	PVIFM Domain	105	9/30/2018	acre-feet per month	6234.7	4287.3	1.0	-1947.4
Monthly ETa	PVIFM Domain	106	10/31/2018	acre-feet per month	7245.0	4035.0	1.0	-3210.0
Monthly ETa	PVIFM Domain	107	11/30/2018	acre-feet per month	3546.0	3791.7	1.0	245.8
Monthly ETa	PVIFM Domain	108	12/31/2018	acre-feet per month	4170.7	4518.2	1.0	347.5
Monthly ETa	PVIFM Domain	109	1/31/2019	acre-feet per month	4661.5	5071.4	1.0	410.0
Monthly ETa	PVIFM Domain	110	2/28/2019	acre-feet per month	3469.2	3996.8	1.0	527.7
Monthly ETa	PVIFM Domain	111	3/31/2019	acre-feet per month	2775.5	3187.7	1.0	412.3
Monthly ETa	PVIFM Domain	112	4/30/2019	acre-feet per month	12089.6	12677.8	1.0	588.2
Monthly ETa	PVIFM Domain	113	5/31/2019	acre-feet per month	9349.5	12950.3	1.0	3600.8
Monthly ETa	PVIFM Domain	114	6/30/2019	acre-feet per month	20677.8	27288.4	1.0	6610.6
Monthly ETa	PVIFM Domain	115	7/31/2019	acre-feet per month	15059.5	10348.1	1.0	-4711.4
Monthly ETa	PVIFM Domain	116	8/31/2019	acre-feet per month	13408.9	6973.0	1.0	-6435.8
Monthly ETa	PVIFM Domain	117	9/30/2019	acre-feet per month	11827.9	5548.8	1.0	-6279.1
Monthly ETa	PVIFM Domain	118	10/31/2019	acre-feet per month	6731.1	2821.8	1.0	-3909.3
Monthly ETa	PVIFM Domain	119	11/30/2019	acre-feet per month	2213.1	1775.3	1.0	-437.7
Monthly ETa	PVIFM Domain	120	12/31/2019	acre-feet per month	1943.3	2153.6	1.0	210.3
Monthly ETa	PVIFM Domain	121	1/31/2020	acre-feet per month	3344.9	3569.5	1.0	224.6
Monthly ETa	PVIFM Domain	122	2/29/2020	acre-feet per month	7645.7	7800.9	1.0	155.3
Monthly ETa	PVIFM Domain	123	3/31/2020	acre-feet per month	6230.0	6252.9	1.0	22.8
Monthly ETa	PVIFM Domain	124	4/30/2020	acre-feet per month	14186.7	11958.5	1.0	-2228.2
Monthly ETa	PVIFM Domain	125	5/31/2020	acre-feet per month	14445.8	13203.7	1.0	-1242.1
Monthly ETa	PVIFM Domain	126	6/30/2020	acre-feet per month	19483.3	12687.9	1.0	-6795.4
Monthly ETa	PVIFM Domain	127	7/31/2020	acre-feet per month	11866.2	6803.8	1.0	-5062.4
Monthly ETa	PVIFM Domain	128	8/31/2020	acre-feet per month	8586.8	4945.1	1.0	-3641.7
Monthly ETa	PVIFM Domain	129	9/30/2020	acre-feet per month	9524.9	4131.9	1.0	-5393.0
Monthly ETa	PVIFM Domain	130	10/31/2020	acre-feet per month	7284.3	2904.3	1.0	-4380.0
Monthly ETa	PVIFM Domain	131	11/30/2020	acre-feet per month	4597.5	3259.9	1.0	-1337.5
Monthly ETa	PVIFM Domain	132	12/31/2020	acre-feet per month	4501.1	4254.8	1.0	-246.3
Monthly ETa	PVIFM Domain	133	1/31/2021	acre-feet per month	3851.4	4127.1	1.0	275.7
Monthly ETa	PVIFM Domain	134	2/28/2021	acre-feet per month	5567.9	5901.9	1.0	333.9
Monthly ETa	PVIFM Domain	135	3/31/2021	acre-feet per month	9551.3	9755.1	1.0	203.8
Monthly ETa	PVIFM Domain	136	4/30/2021	acre-feet per month	14093.3	11379.6	1.0	-2713.7

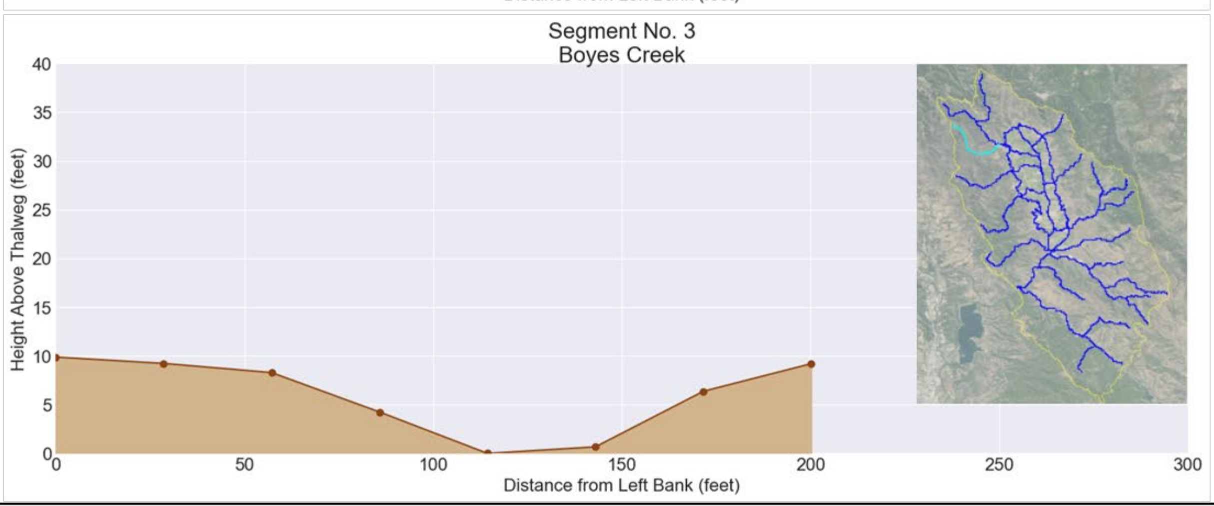
Attachment 1 Table of Calibration Target Values

Target Type	Target Location	Stress Period	Date	Target Units	Target Value	Simulated Value	Target Weight	Residual
Monthly ETa	PVIFM Domain	137	5/31/2021	acre-feet per month	14007.6	9017.8	1.0	-4989.8
Monthly ETa	PVIFM Domain	138	6/30/2021	acre-feet per month	13917.4	8497.0	1.0	-5420.4
Monthly ETa	PVIFM Domain	139	7/31/2021	acre-feet per month	11291.9	5526.3	1.0	-5765.7
Monthly ETa	PVIFM Domain	140	8/31/2021	acre-feet per month	7107.5	3120.4	1.0	-3987.1
Monthly ETa	PVIFM Domain	141	9/30/2021	acre-feet per month	8180.7	4478.3	1.0	-3702.4
Monthly ETa	PVIFM Domain	142	10/31/2021	acre-feet per month	8671.0	12399.0	1.0	3727.9
Monthly ETa	PVIFM Domain	143	11/30/2021	acre-feet per month	4310.6	4595.8	1.0	285.2
Monthly ETa	PVIFM Domain	144	12/31/2021	acre-feet per month	3277.3	3671.1	1.0	393.8
Monthly ETa	PVIFM Domain	145	1/31/2022	acre-feet per month	3616.2	3895.2	1.0	279.1
Monthly ETa	PVIFM Domain	146	2/28/2022	acre-feet per month	5477.6	5792.9	1.0	315.3
Monthly ETa	PVIFM Domain	147	3/31/2022	acre-feet per month	7272.3	7409.8	1.0	137.5
Monthly ETa	PVIFM Domain	148	4/30/2022	acre-feet per month	12874.6	12607.1	1.0	-267.5
Monthly ETa	PVIFM Domain	149	5/31/2022	acre-feet per month	14819.9	15708.5	1.0	888.6
Monthly ETa	PVIFM Domain	150	6/30/2022	acre-feet per month	18240.4	17085.1	1.0	-1155.3
Monthly ETa	PVIFM Domain	151	7/31/2022	acre-feet per month	13177.5	7838.4	1.0	-5339.1
Monthly ETa	PVIFM Domain	152	8/31/2022	acre-feet per month	10607.9	5316.3	1.0	-5291.6
Monthly ETa	PVIFM Domain	153	9/30/2022	acre-feet per month	9208.8	6431.8	1.0	-2777.1

Attachment 2
Modeled Eight-point Stream Channels







Notes:

1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend

- Modeled Stream
- Highlighted Segment of Modeled Stream

Figure 2-1
Modeled Eight-point Stream Channels
Potter Valley Water Supply Reliability Study
Task 6: Model Development and Calibration
Potter Valley, California

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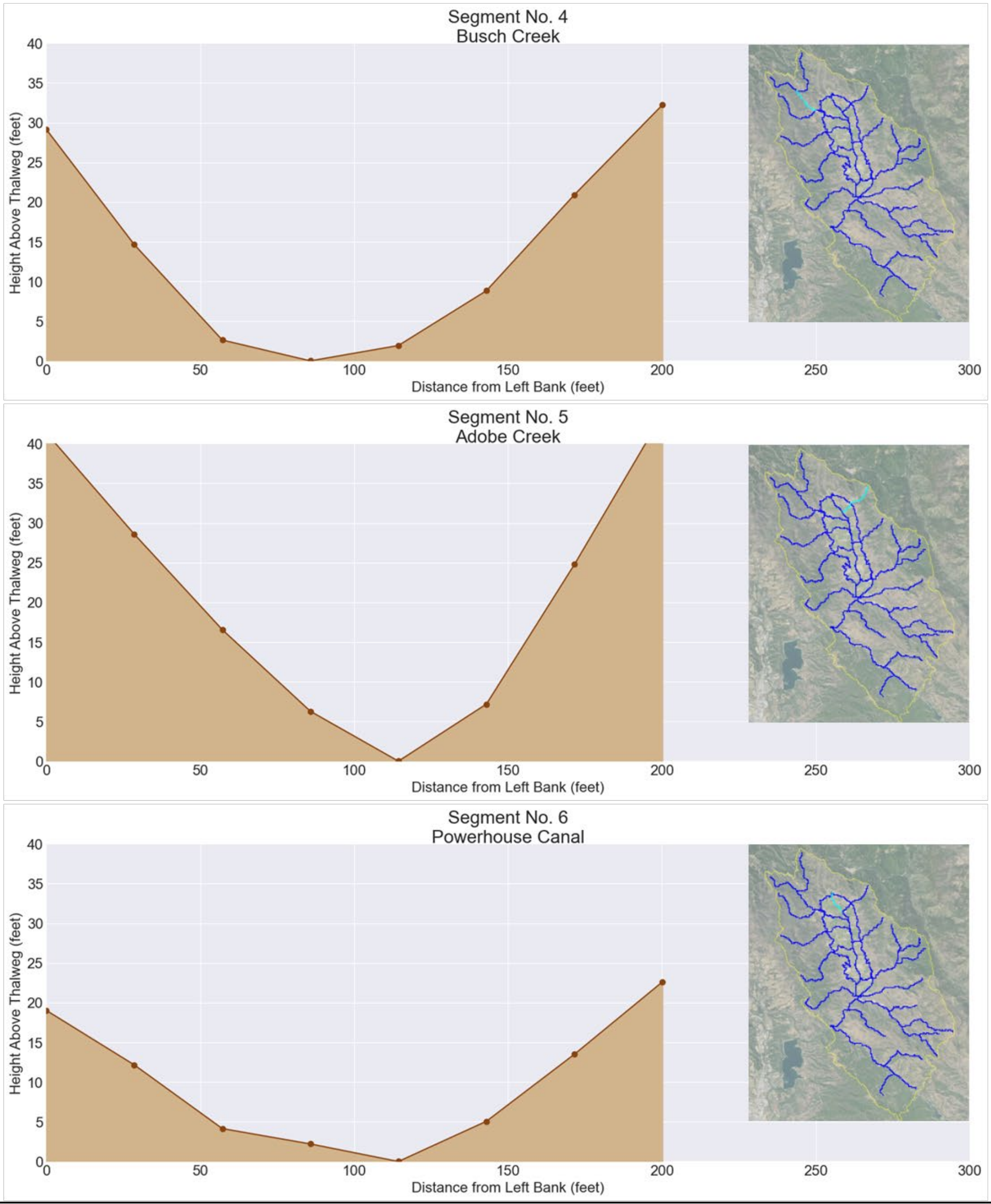

Notes:

1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend

Modeled Stream

Highlighted Segment of Modeled Stream

Figure 2-2

Modeled Eight-point Stream Channels

Potter Valley Water Supply Reliability Study

Task 6: Model Development and Calibration

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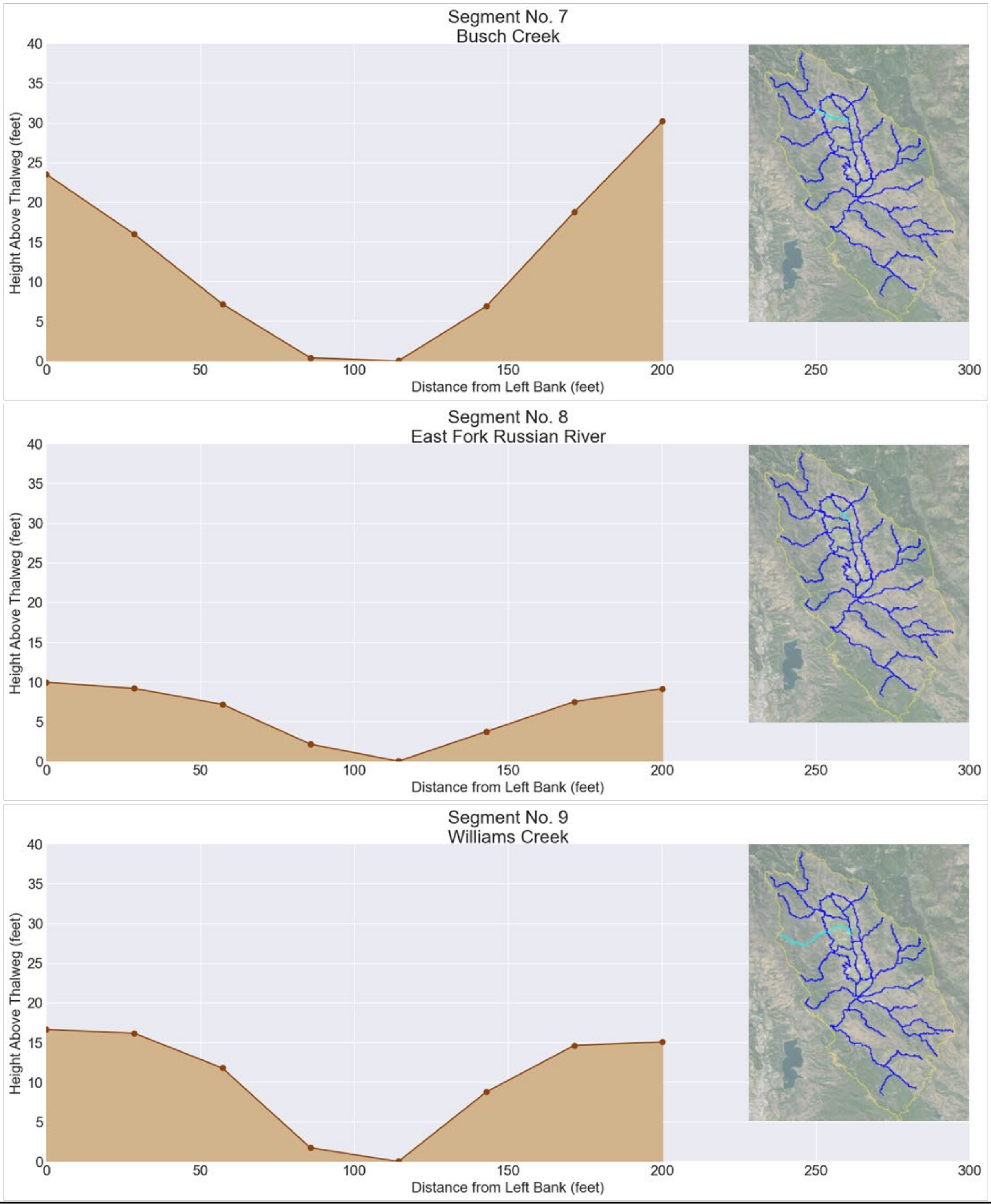

Notes:

1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend

- Modeled Stream
- Highlighted Segment of Modeled Stream

Figure 2-3
Modeled Eight-point Stream Channels
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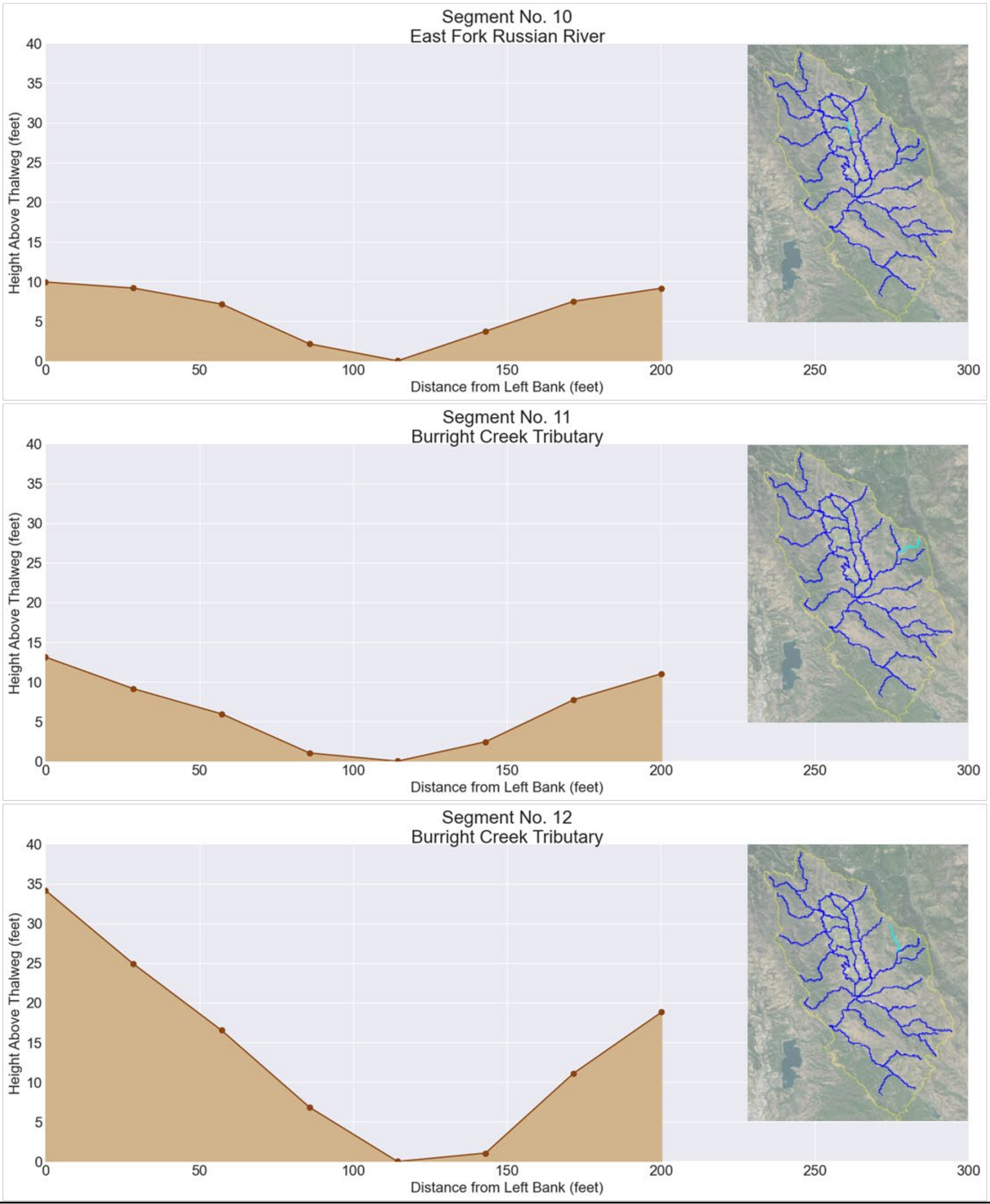
Potter Valley, California

Jacobs

\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm



Notes:

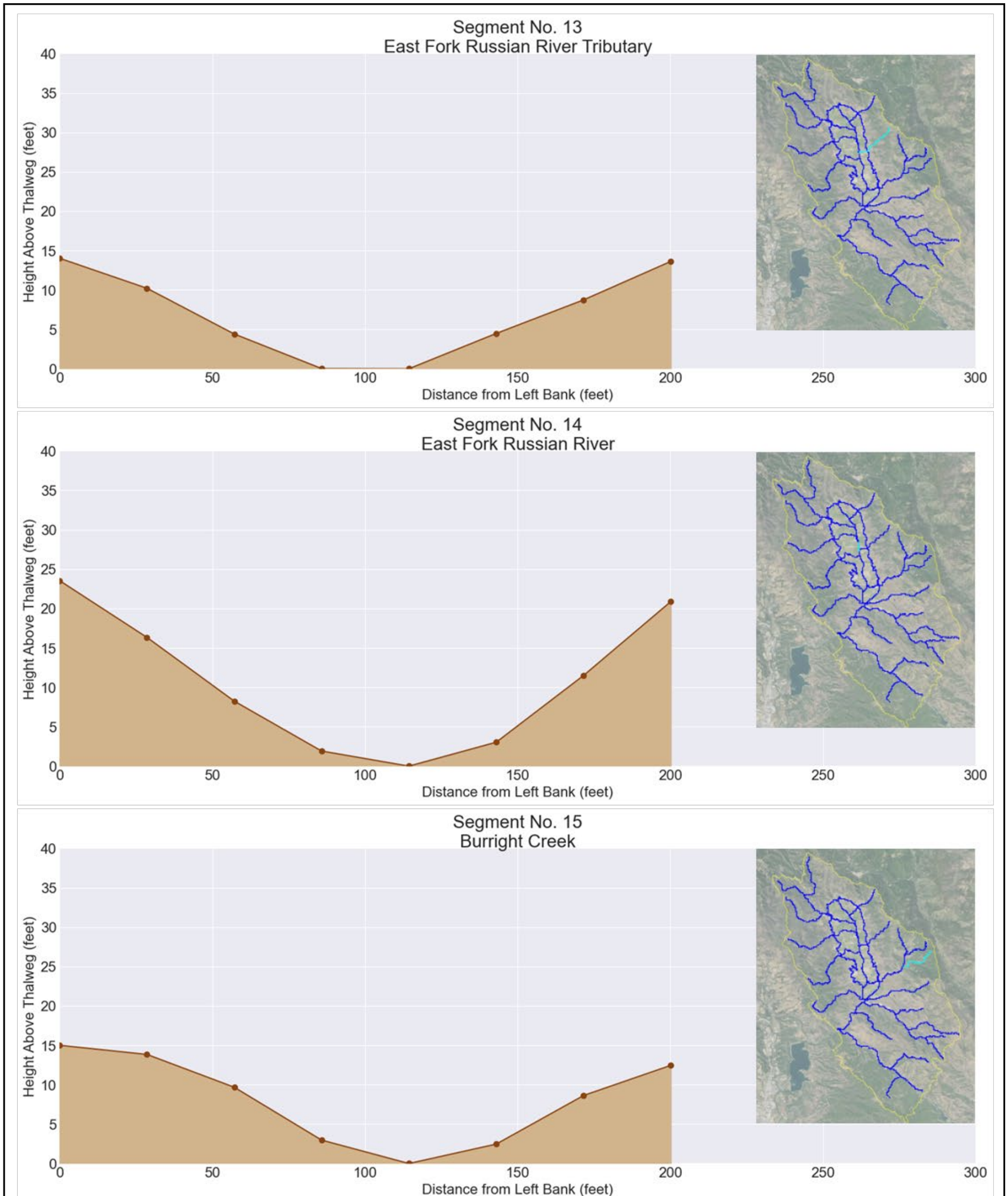
1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend

- Modeled Stream
- Highlighted Segment of Modeled Stream

Figure 2-4
Modeled Eight-point Stream Channels
Potter Valley Water Supply Reliability Study
Task 6: Model Development and Calibration
Potter Valley, California

\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm



Notes:

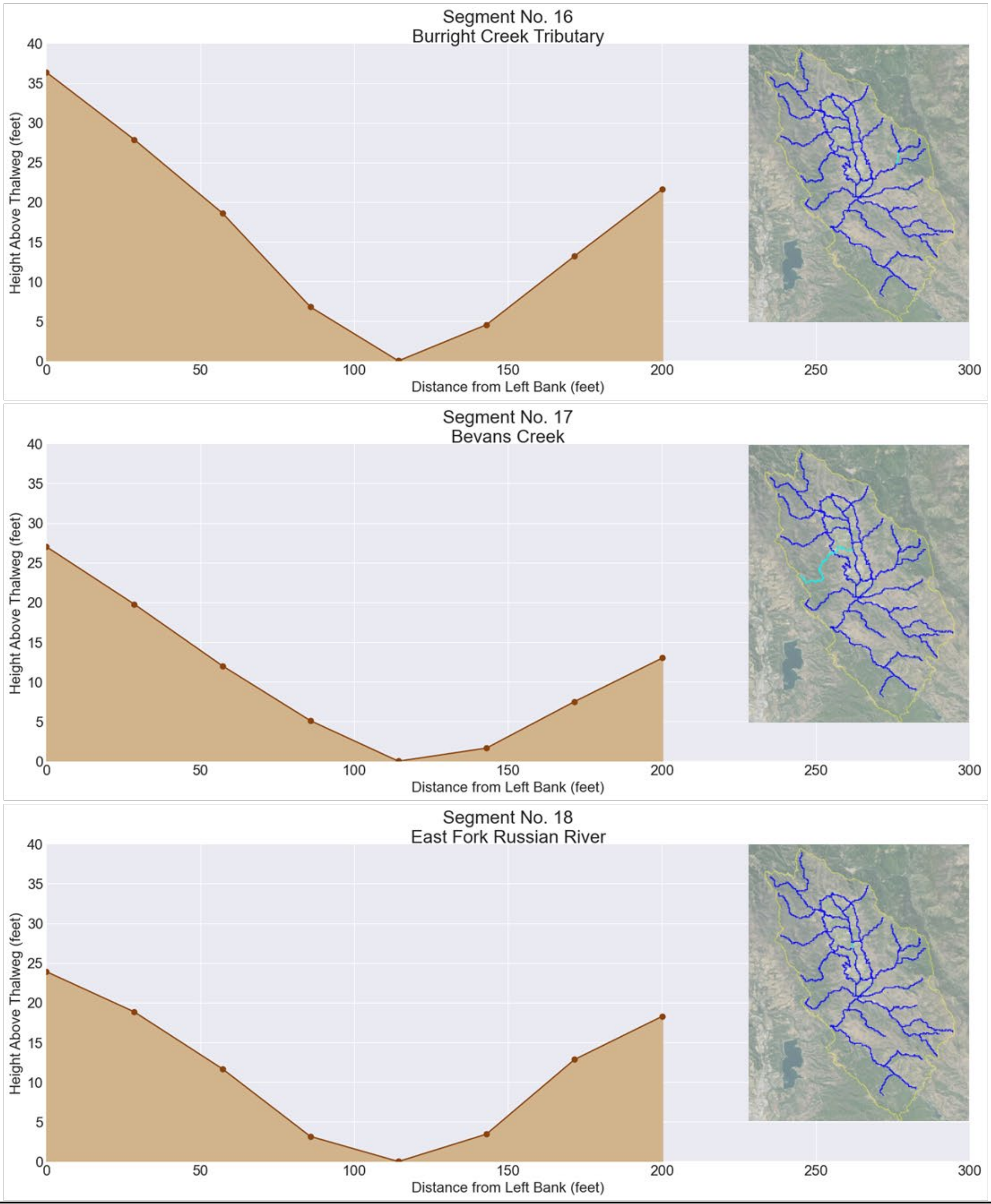
1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend

- Modeled Stream
- Highlighted Segment of Modeled Stream

Figure 2-5
Modeled Eight-point Stream Channels
Potter Valley Water Supply Reliability Study
Task 6: Model Development and Calibration
Potter Valley, California

\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm



Notes:

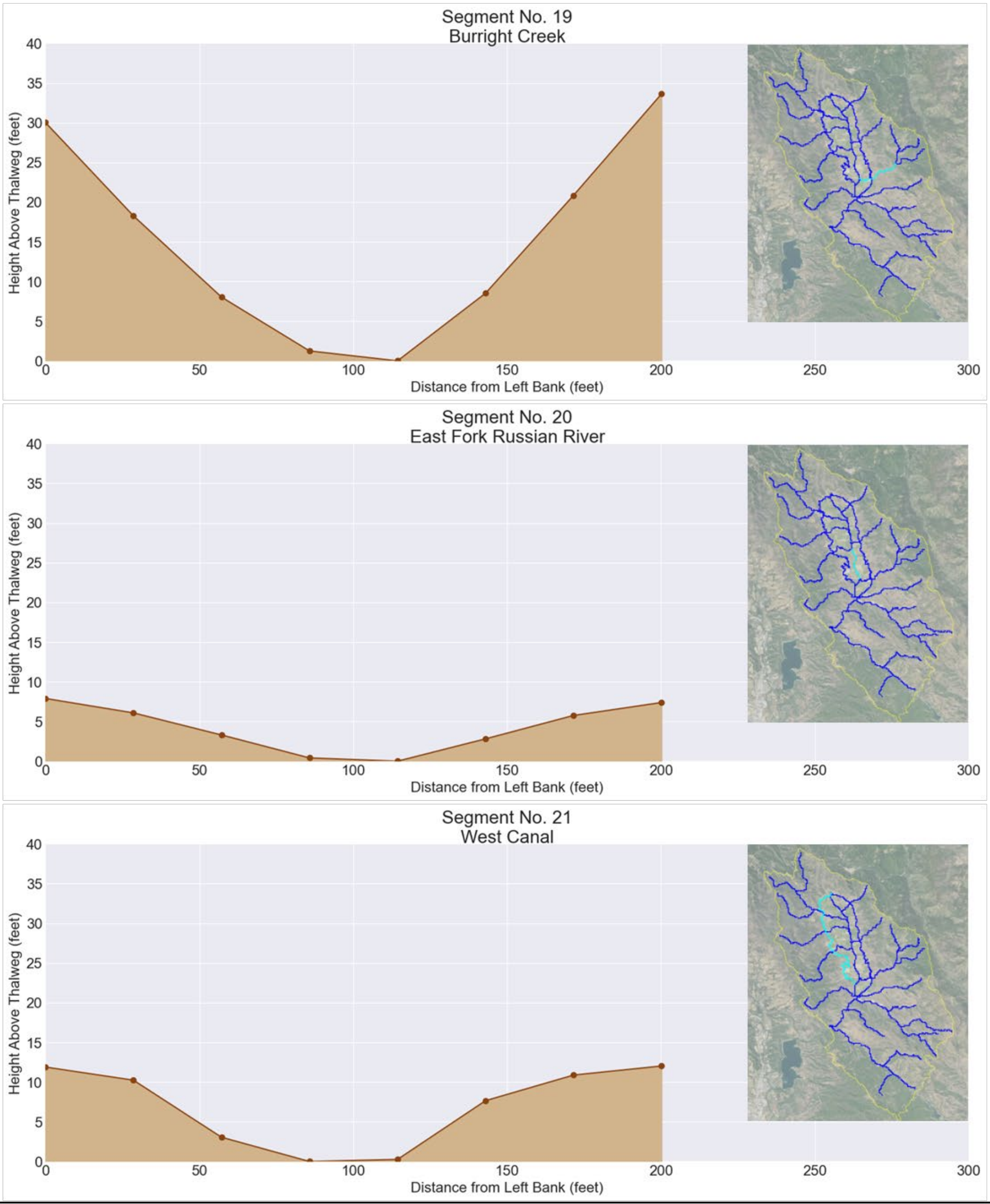
1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend

- Modeled Stream
- Highlighted Segment of Modeled Stream

Figure 2-6
Modeled Eight-point Stream Channels
Potter Valley Water Supply Reliability Study
Task 6: Model Development and Calibration
Potter Valley, California

\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm



Notes:
1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend
- Modeled Stream
- Highlighted Segment of Modeled Stream

Figure 2-7
Modeled Eight-point Stream Channels
Potter Valley Water Supply Reliability Study
Task 6: Model Development and Calibration
Potter Valley, California

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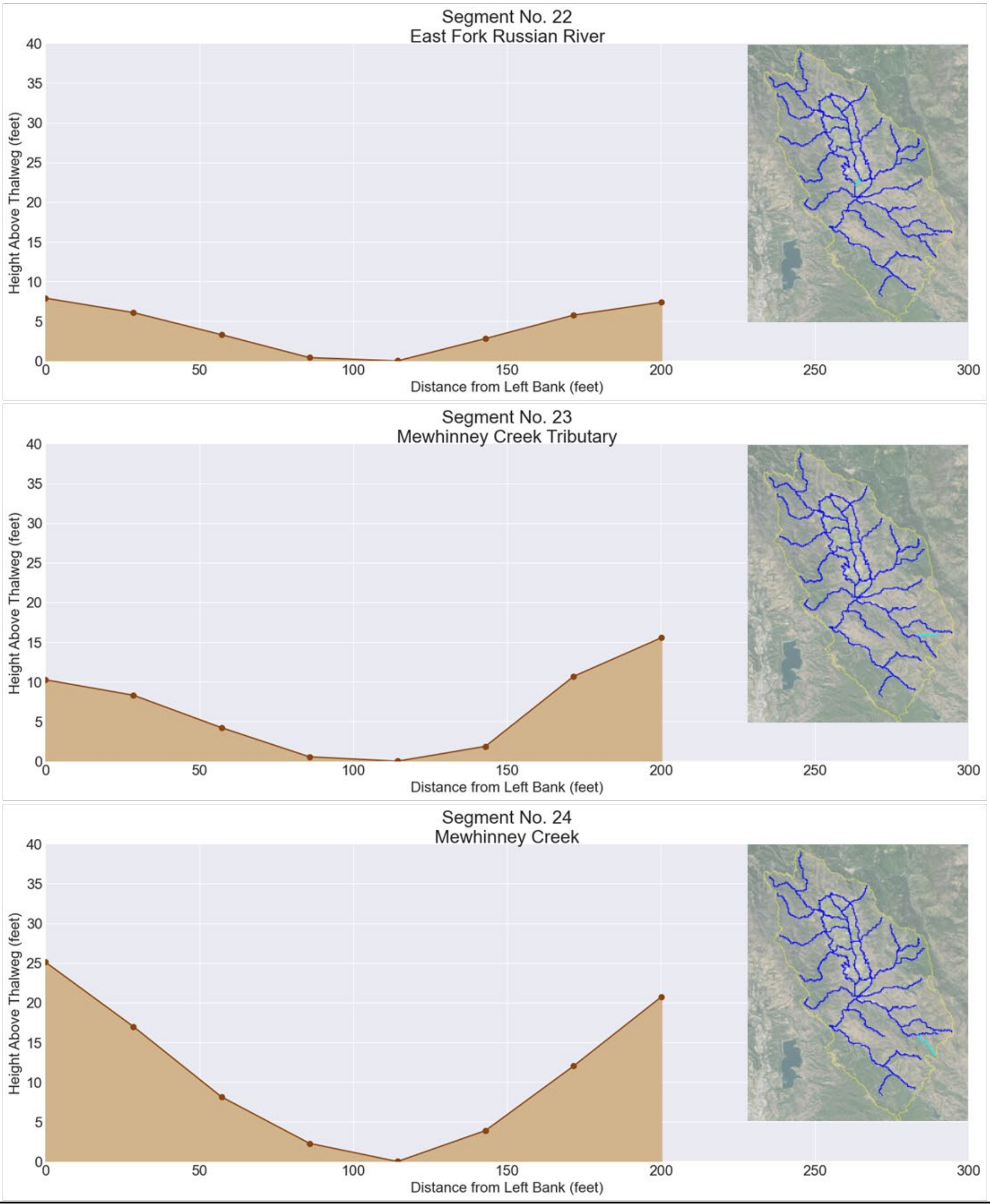
\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm



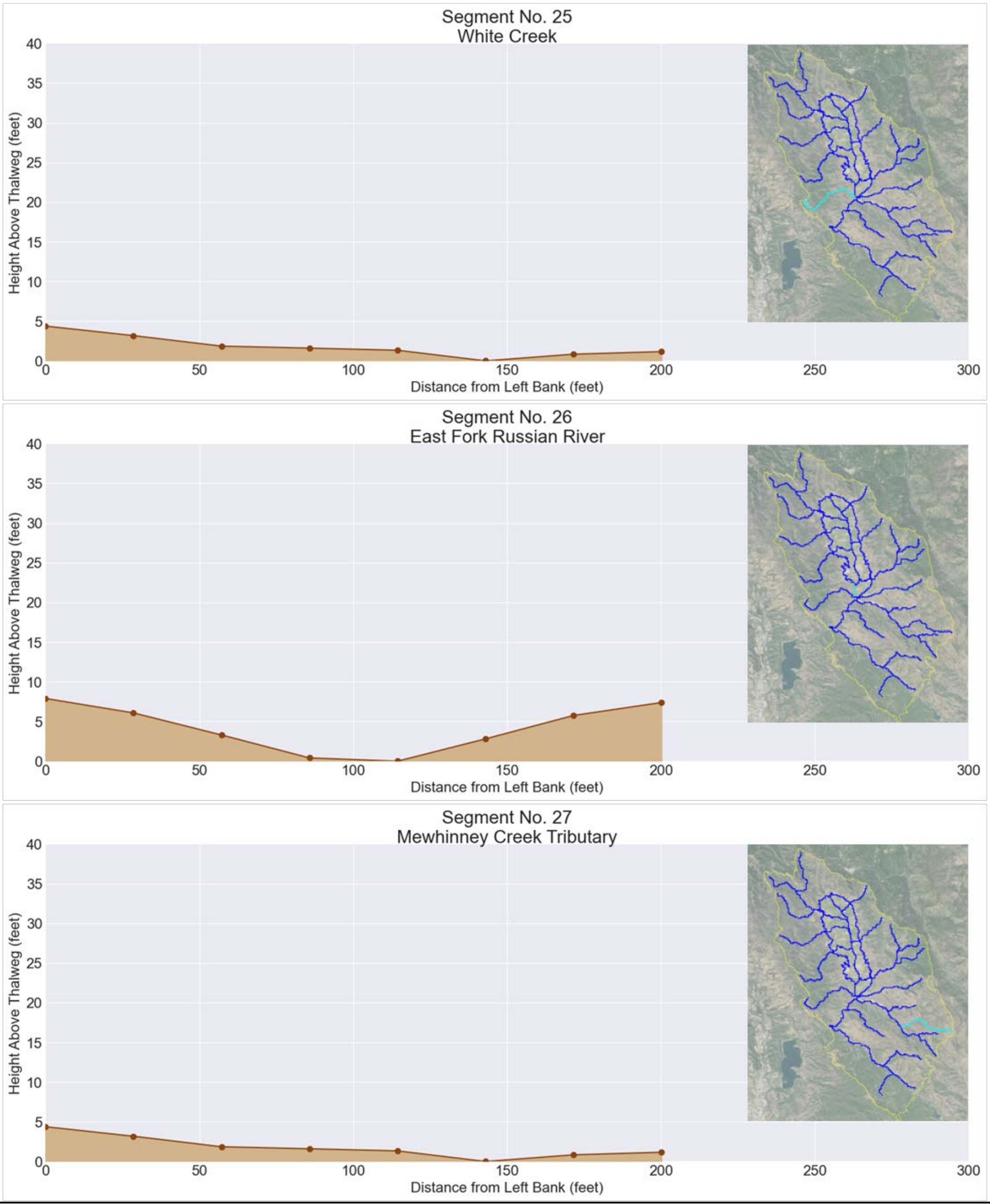
Notes:
1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend
- Modeled Stream
- Highlighted Segment of Modeled Stream

Figure 2-8
Modeled Eight-point Stream Channels
Potter Valley Water Supply Reliability Study
Task 6: Model Development and Calibration
Potter Valley, California

Jacobs

\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm



Notes:

1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

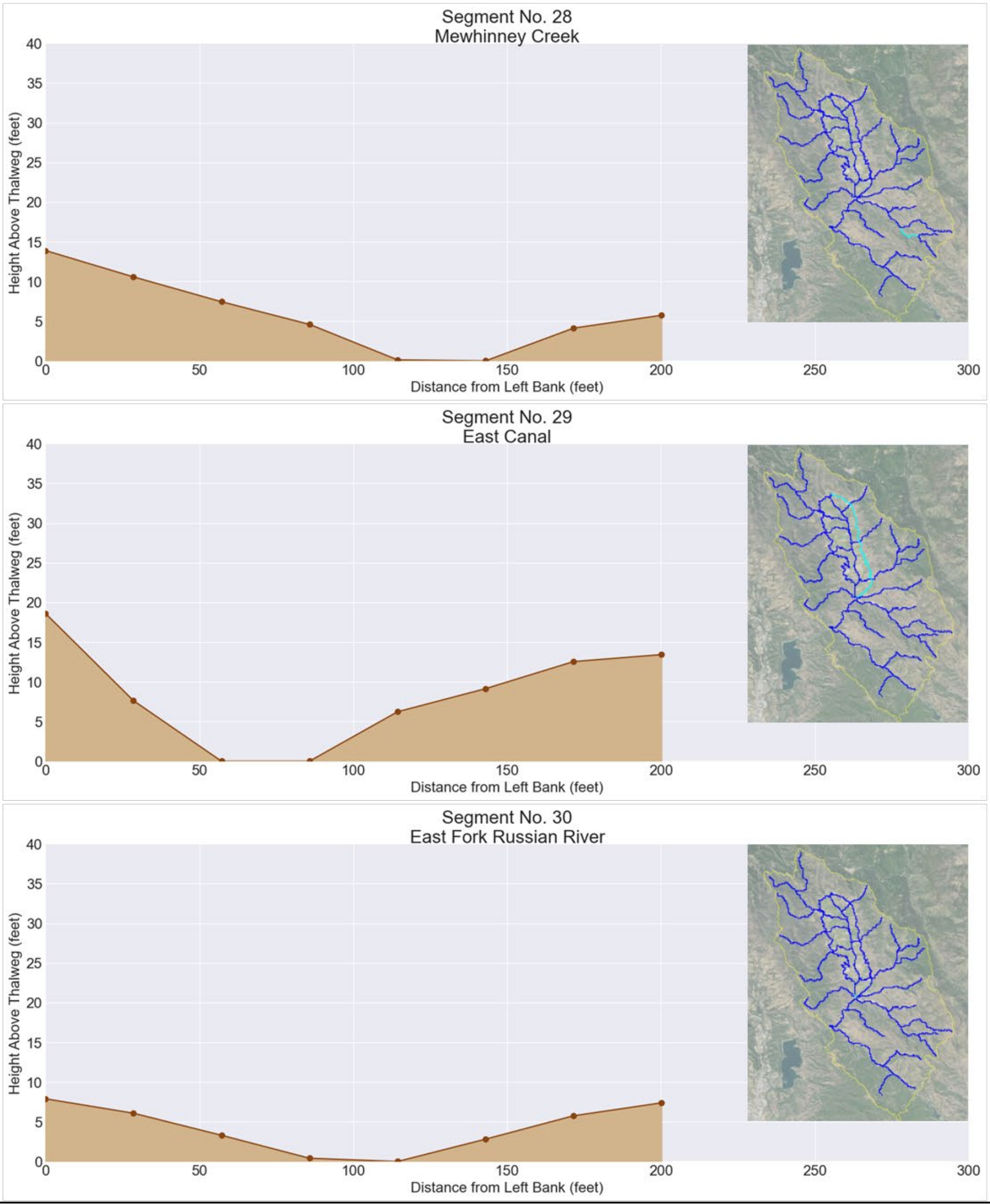
Map Legend

- Modeled Stream
- Highlighted Segment of Modeled Stream

Figure 2-9
Modeled Eight-point Stream Channels
Potter Valley Water Supply Reliability Study
Task 6: Model Development and Calibration
Potter Valley, California

Jacobs

\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm



Notes:

1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend

Modeled Stream

Highlighted Segment of Modeled Stream

Figure 2-10

Modeled Eight-point Stream Channels

Potter Valley Water Supply Reliability Study

Task 6: Model Development and Calibration

Potter Valley, California

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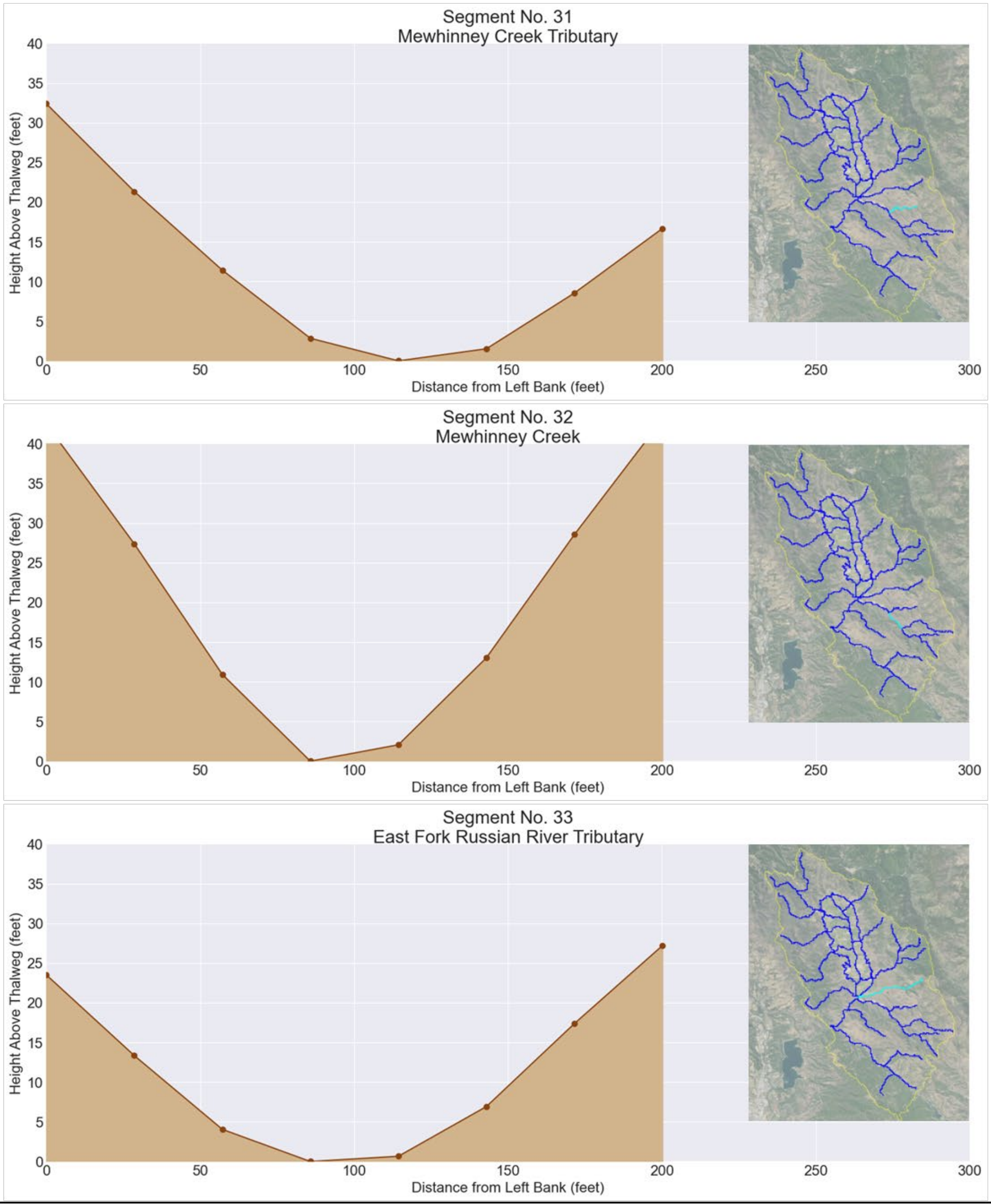
\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm



Notes:

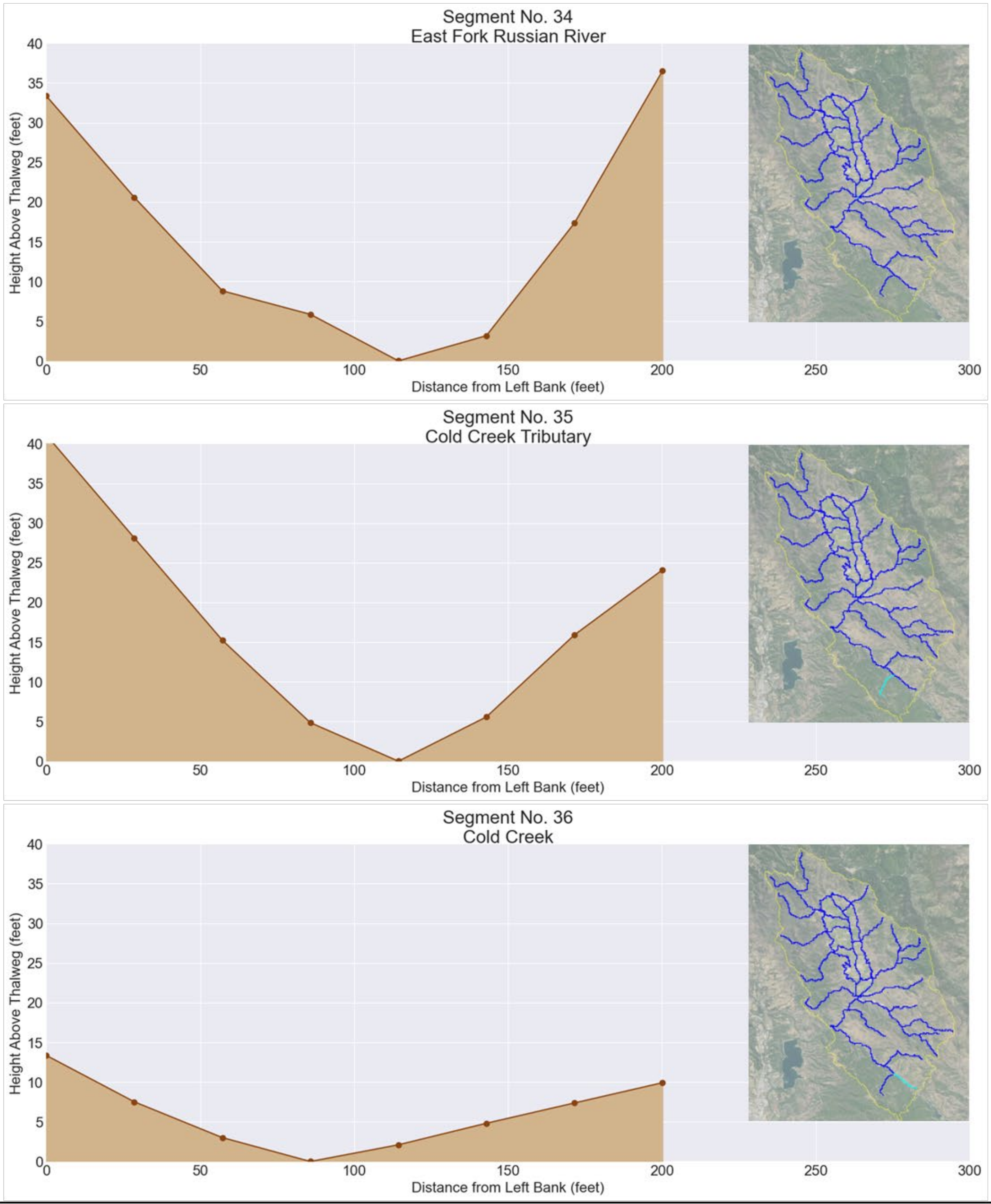
1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend

- Modeled Stream
- Highlighted Segment of Modeled Stream

Figure 2-11
Modeled Eight-point Stream Channels
Potter Valley Water Supply Reliability Study
Task 6: Model Development and Calibration
Potter Valley, California

\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm



Notes:

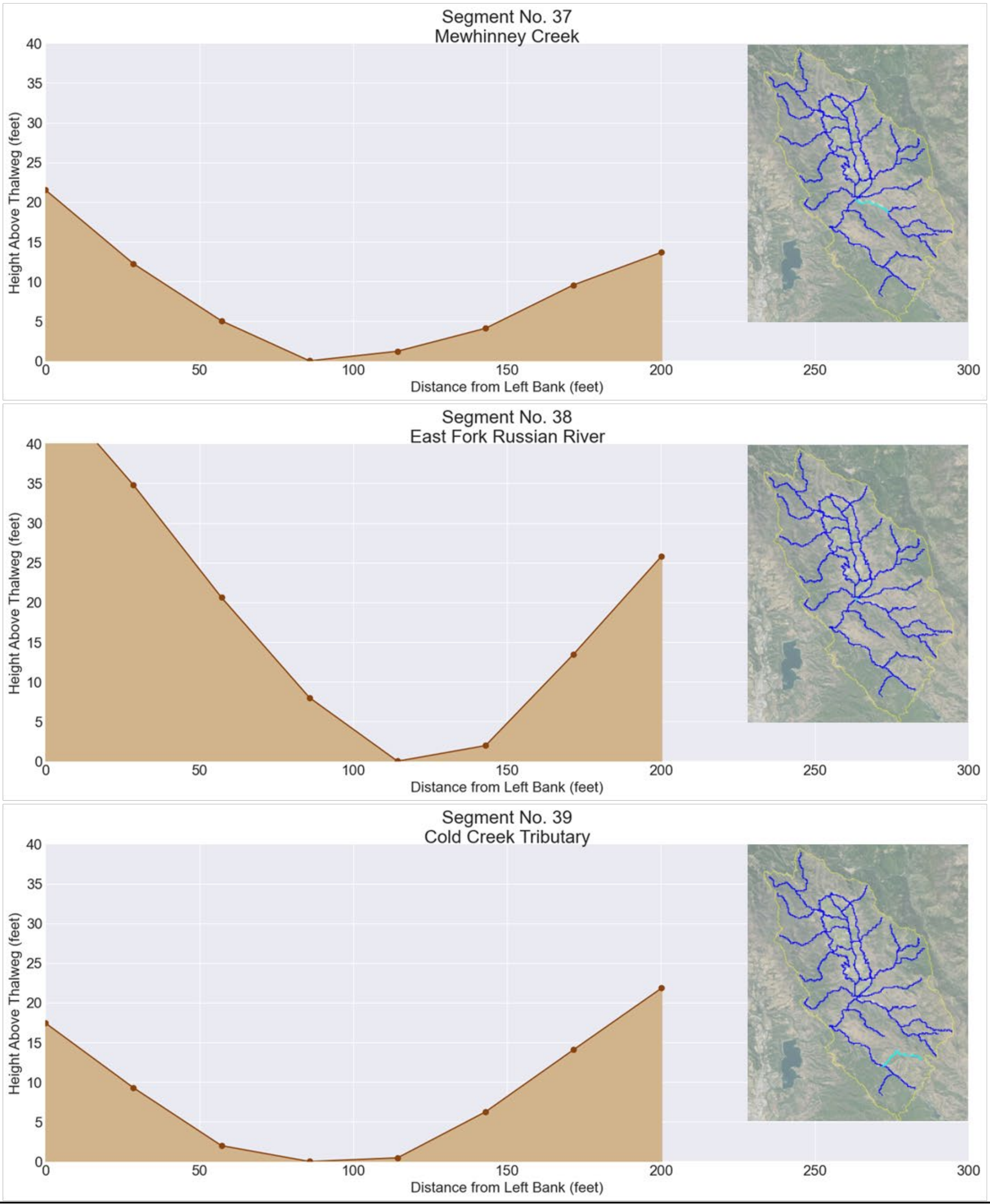
1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend

- Modeled Stream
- Highlighted Segment of Modeled Stream

Figure 2-12
Modeled Eight-point Stream Channels
Potter Valley Water Supply Reliability Study
Task 6: Model Development and Calibration
Potter Valley, California

\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm



Notes:

1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend

Modeled Stream

Highlighted Segment of Modeled Stream

Figure 2-13

Modeled Eight-point Stream Channels

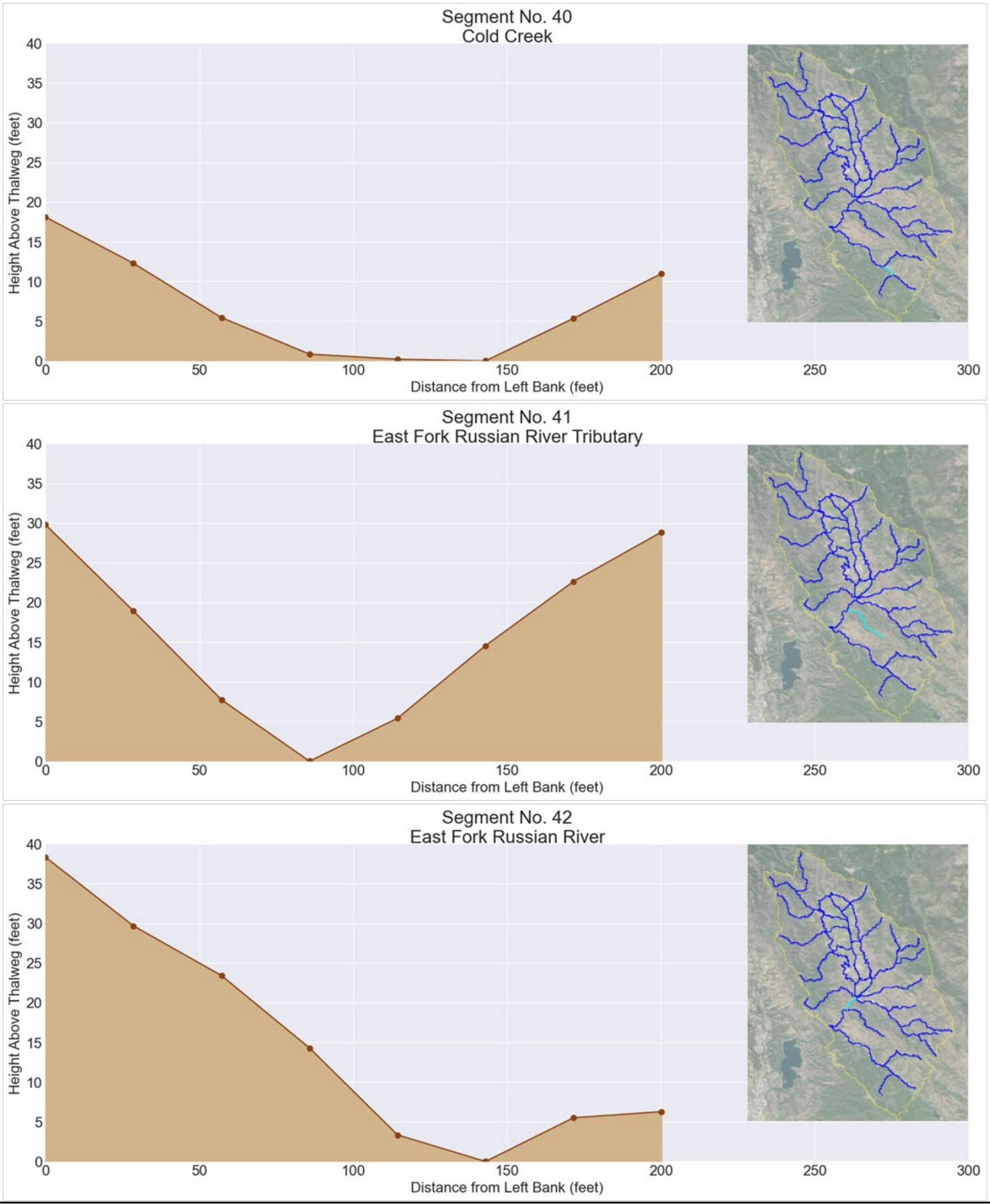
Potter Valley Water Supply Reliability Study

Task 6: Model Development and Calibration

Potter Valley, California

Jacobs

\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm



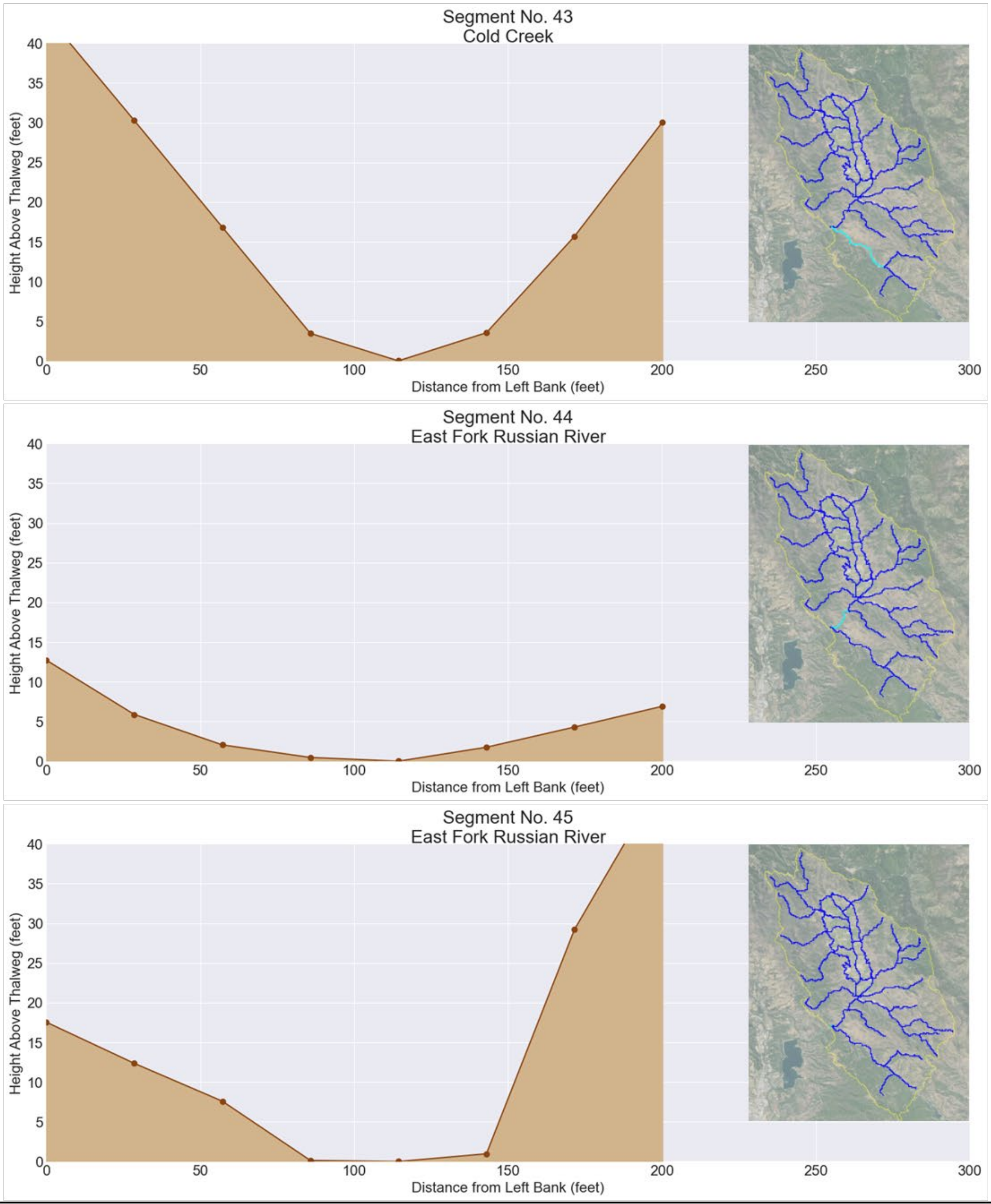
Notes:
1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend
- Modeled Stream
- Highlighted Segment of Modeled Stream

Figure 2-14
Modeled Eight-point Stream Channels
Potter Valley Water Supply Reliability Study
Task 6: Model Development and Calibration
Potter Valley, California

Jacobs

\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm



Notes:

1. Vertical axes are exaggerated by 20 times the horizontal axes.
2. "Left Bank" refers to the left side of the channel when facing the downstream direction for the stream segment.

Map Legend

- Modeled Stream
- Highlighted Segment of Modeled Stream

Figure 2-15
Modeled Eight-point Stream Channels
Potter Valley Water Supply Reliability Study
Task 6: Model Development and Calibration
Potter Valley, California

\\odin\proj\\Attachment_A_Modeled_8Pt_StreamChannels.pptm

Attachment 3
Monthly Surface Water Budget Table

Attachment 3 Monthly Surface Water Budget Table

Date	East Canal Inflow	West Canal Inflow	Powerhouse Canal Inflow	Busch Creek Inflow	Other Streams Inflow	Runoff from Precipitation	Irrigation Return Flows	GW Discharge to Streams and Canals	Total Inflow	Stream Outflow to Lake Mendocino	East Canal Diversions	West Canal Diversions	GW Recharge from Streams and Canals	Total Outflow
10/31/2010	639	585	3,185	159	811	1,349	0	574	7,303	6,172	390	426	243	7,231
11/30/2010	0	0	9,459	807	3,851	1,177	0	522	15,817	16,900	0	0	290	17,190
12/31/2010	0	0	11,401	1,611	8,485	2,281	0	661	24,439	27,929	0	0	328	28,257
1/31/2011	22	22	12,394	661	3,408	840	0	508	17,856	18,566	0	0	311	18,877
2/28/2011	18	18	9,821	1,323	7,293	1,932	0	560	20,967	23,662	0	0	311	23,973
3/31/2011	0	0	5,934	2,815	15,429	5,087	0	909	30,174	37,258	2	1	340	37,602
4/30/2011	228	371	3,679	342	1,453	239	0	430	6,742	6,194	246	151	313	6,904
5/31/2011	689	396	5,766	305	1,300	332	0	348	9,136	8,396	162	281	430	9,270
6/30/2011	765	784	6,171	28	148	0	220	232	8,348	6,706	573	559	476	8,313
7/31/2011	1,595	1,548	4,855	8	68	0	279	227	8,579	5,645	1,180	1,216	490	8,531
8/31/2011	2,153	1,217	5,194	7	52	0	327	232	9,184	6,218	890	1,575	462	9,145
9/30/2011	1,461	1,461	8,756	7	49	0	332	215	12,283	9,797	990	990	468	12,244
10/31/2011	324	37	10,905	53	255	568	0	341	12,483	12,010	4	34	367	12,415
11/30/2011	59	59	5,118	163	583	515	0	379	6,878	6,600	0	0	258	6,858
12/31/2011	71	71	2,785	197	712	195	0	293	4,325	4,078	0	0	304	4,382
1/31/2012	138	49	2,592	1,105	5,579	1,554	0	607	11,624	13,309	11	30	247	13,598
2/29/2012	83	83	2,410	457	2,458	438	0	406	6,337	6,680	0	0	238	6,918
3/31/2012	29	22	2,784	1,502	8,056	1,877	0	618	14,887	18,107	15	19	271	18,412
4/30/2012	79	86	3,994	331	1,432	257	0	368	6,546	6,348	53	49	307	6,757
5/31/2012	1,117	556	5,171	152	572	236	0	259	8,064	6,143	500	1,000	466	8,109
6/30/2012	1,790	1,464	4,481	11	59	0	251	203	8,259	5,241	1,133	1,385	472	8,230
7/31/2012	1,958	1,510	4,507	6	45	0	320	219	8,566	5,278	1,212	1,571	466	8,528
8/31/2012	1,901	1,453	4,671	6	41	0	356	229	8,656	5,496	1,166	1,525	432	8,619
9/30/2012	1,589	1,129	3,929	5	32	0	309	218	7,211	4,683	881	1,240	378	7,183
10/31/2012	1,073	532	2,905	17	75	272	0	241	5,115	3,751	332	670	333	5,087
11/30/2012	100	100	2,563	386	1,545	1,524	0	631	6,850	7,006	0	0	179	7,186
12/31/2012	42	42	8,133	2,376	12,507	4,087	0	877	28,063	34,398	0	0	341	34,740
1/31/2013	5	5	10,017	512	2,571	734	0	537	14,380	14,841	0	0	251	15,093
2/28/2013	24	24	5,958	279	1,366	280	0	341	8,272	8,188	0	0	252	8,439
3/31/2013	188	121	1,855	461	2,431	449	0	413	5,917	6,065	54	83	265	6,467

Attachment 3 Monthly Surface Water Budget Table														
Date	East Canal Inflow	West Canal Inflow	Powerhouse Canal Inflow	Busch Creek Inflow	Other Streams Inflow	Runoff from Precipitation	Irrigation Return Flows	GW Discharge to Streams and Canals	Total Inflow	Stream Outflow to Lake Mendocino	East Canal Diversions	West Canal Diversions	GW Recharge from Streams and Canals	Total Outflow
4/30/2013	778	537	2,871	245	1,021	279	0	307	6,040	4,947	352	509	347	6,156
5/31/2013	1,688	1,380	3,750	134	506	316	0	269	8,041	5,588	916	1,120	446	8,071
6/30/2013	1,774	1,264	2,693	13	77	0	359	254	6,432	3,679	968	1,358	387	6,393
7/31/2013	2,341	1,486	1,998	6	44	0	347	239	6,461	3,204	1,090	1,716	414	6,424
8/31/2013	2,086	1,679	2,096	5	39	0	335	233	6,474	3,484	1,140	1,417	398	6,438
9/30/2013	1,492	932	3,109	8	49	0	424	263	6,277	4,443	562	900	330	6,235
10/31/2013	614	442	3,427	14	58	127	0	187	4,869	3,859	257	357	378	4,851
11/30/2013	344	0	2,393	60	154	208	0	242	3,402	3,100	0	29	255	3,384
12/31/2013	127	127	1,469	95	235	134	0	226	2,414	2,119	0	0	296	2,416
1/31/2014	80	80	548	119	342	126	0	223	1,518	1,266	0	0	274	1,540
2/28/2014	17	17	475	736	3,675	1,394	0	561	6,876	7,659	0	0	182	7,841
3/31/2014	113	31	662	1,944	10,369	2,843	0	769	16,731	21,488	29	107	261	21,885
4/30/2014	187	106	3,307	236	951	183	0	355	5,326	5,030	32	57	306	5,425
5/31/2014	1,464	1,231	2,225	123	442	242	0	273	5,999	3,523	952	1,132	415	6,022
6/30/2014	2,031	1,432	1,270	7	44	0	244	215	5,244	2,084	1,130	1,602	400	5,216
7/31/2014	2,189	1,569	1,159	5	39	0	308	226	5,496	2,166	1,208	1,686	402	5,462
8/31/2014	2,123	1,476	1,164	5	36	0	357	241	5,404	2,146	1,171	1,684	369	5,370
9/30/2014	1,509	1,114	2,417	5	28	0	262	206	5,541	3,475	713	966	361	5,515
10/31/2014	662	549	3,012	15	73	281	0	245	4,837	3,715	350	422	316	4,804
11/30/2014	93	93	2,058	91	237	494	0	359	3,426	3,191	0	0	196	3,387
12/31/2014	76	76	1,799	1,429	7,043	2,579	0	763	13,766	16,757	0	0	238	16,994
1/31/2015	25	25	1,947	270	1,190	289	0	425	4,171	4,154	0	0	192	4,347
2/28/2015	58	0	1,882	692	3,806	803	0	431	7,671	8,761	0	8	214	8,983
3/31/2015	173	87	2,693	224	925	185	0	304	4,592	4,215	67	111	298	4,691
4/30/2015	1,015	746	2,821	192	754	288	0	281	6,096	4,424	584	795	364	6,168
5/31/2015	1,491	1,085	0	99	334	185	0	221	3,415	1,126	824	1,131	355	3,437
6/30/2015	1,578	1,284	1,322	5	31	0	173	176	4,570	1,697	1,091	1,341	420	4,550
7/31/2015	1,918	1,312	840	5	31	0	253	200	4,559	1,425	1,102	1,610	396	4,532
8/31/2015	1,860	1,335	625	4	27	0	253	203	4,308	1,427	1,040	1,449	367	4,283
9/30/2015	1,307	1,010	697	4	22	0	197	188	3,426	1,466	703	909	328	3,405

Attachment 3 Monthly Surface Water Budget Table														
Date	East Canal Inflow	West Canal Inflow	Powerhouse Canal Inflow	Busch Creek Inflow	Other Streams Inflow	Runoff from Precipitation	Irrigation Return Flows	GW Discharge to Streams and Canals	Total Inflow	Stream Outflow to Lake Mendocino	East Canal Diversions	West Canal Diversions	GW Recharge from Streams and Canals	Total Outflow
10/31/2015	736	662	889	5	31	93	0	156	2,572	1,333	414	460	353	2,559
11/30/2015	102	102	450	31	80	130	0	207	1,102	863	0	0	226	1,089
12/31/2015	28	28	881	1,444	6,984	2,653	0	816	12,832	16,167	0	0	235	16,402
1/31/2016	0	0	1,472	2,514	13,778	5,326	0	972	24,061	31,061	0	0	249	31,310
2/29/2016	0	0	4,326	376	2,583	768	0	547	8,600	8,959	0	0	172	9,131
3/31/2016	33	36	4,072	2,271	13,415	4,595	0	891	25,314	31,109	39	36	310	31,494
4/30/2016	84	25	3,874	293	1,218	196	0	403	6,092	5,884	11	37	297	6,230
5/31/2016	710	552	5,565	198	706	237	0	294	8,262	6,863	444	572	436	8,315
6/30/2016	1,815	1,244	4,648	16	44	0	214	205	8,185	5,356	950	1,386	474	8,166
7/31/2016	2,095	1,587	2,159	6	37	0	269	226	6,379	3,180	1,181	1,558	429	6,349
8/31/2016	2,058	1,547	796	6	24	0	239	215	4,885	1,946	1,082	1,441	394	4,862
9/30/2016	1,625	1,177	876	6	16	0	193	190	4,082	1,862	772	1,066	365	4,066
10/31/2016	467	183	1,661	36	104	524	0	375	3,349	2,885	56	142	215	3,298
11/30/2016	0	0	2,630	239	979	793	0	472	5,113	5,067	0	0	174	5,241
12/31/2016	0	0	7,345	1,274	6,990	2,162	0	687	18,458	21,023	0	0	265	21,288
1/31/2017	0	0	5,655	3,435	18,860	6,850	0	1,074	35,873	45,170	0	0	338	45,508
2/28/2017	0	0	4,346	2,917	16,293	5,938	0	1,011	30,504	37,950	0	0	288	38,237
3/31/2017	0	0	3,556	880	4,746	1,235	0	717	11,135	12,308	2	1	204	12,515
4/30/2017	77	178	3,712	609	3,112	689	0	546	8,922	9,242	66	28	258	9,594
5/31/2017	823	510	5,465	205	798	192	0	293	8,286	7,031	326	527	472	8,357
6/30/2017	1,563	1,250	4,950	9	99	0	221	214	8,306	5,731	911	1,139	487	8,269
7/31/2017	2,105	1,455	4,435	8	92	0	321	237	8,652	5,539	1,055	1,526	484	8,604
8/31/2017	1,885	1,545	4,572	7	91	0	362	250	8,711	5,842	1,075	1,312	431	8,661
9/30/2017	1,409	1,238	4,022	9	119	0	337	243	7,377	5,048	890	1,013	378	7,330
10/31/2017	1,041	665	2,480	41	202	225	0	234	4,887	3,639	335	524	360	4,859
11/30/2017	112	112	4,421	166	732	1,027	0	504	7,074	6,826	0	0	193	7,019
12/31/2017	0	0	3,739	180	655	182	0	279	5,036	4,883	0	0	210	5,092
1/31/2018	0	0	2,632	975	4,673	1,260	0	547	10,086	11,694	0	0	221	11,915
2/28/2018	0	0	2,523	216	847	127	0	242	3,956	3,881	0	0	189	4,070
3/31/2018	0	0	2,672	776	3,735	570	0	396	8,149	9,073	2	1	267	9,343

Attachment 3 Monthly Surface Water Budget Table														
Date	East Canal Inflow	West Canal Inflow	Powerhouse Canal Inflow	Busch Creek Inflow	Other Streams Inflow	Runoff from Precipitation	Irrigation Return Flows	GW Discharge to Streams and Canals	Total Inflow	Stream Outflow to Lake Mendocino	East Canal Diversions	West Canal Diversions	GW Recharge from Streams and Canals	Total Outflow
4/30/2018	132	219	3,297	877	3,596	656	0	424	9,200	10,215	66	39	324	10,644
5/31/2018	538	598	3,826	130	382	121	0	213	5,807	4,581	412	371	491	5,855
6/30/2018	1,747	1,176	1,859	23	89	0	203	193	5,290	2,617	893	1,326	438	5,274
7/31/2018	1,777	1,309	1,813	7	51	0	255	204	5,416	2,484	1,051	1,427	420	5,382
8/31/2018	1,801	1,329	1,836	6	45	0	245	201	5,463	2,774	959	1,299	403	5,435
9/30/2018	1,129	1,238	2,677	6	62	0	241	198	5,552	3,472	878	801	370	5,521
10/31/2018	263	169	3,860	18	105	124	0	173	4,713	4,036	114	160	391	4,701
11/30/2018	0	0	4,481	91	342	373	0	267	5,554	5,316	0	5	219	5,539
12/31/2018	0	0	4,360	282	954	546	0	353	6,494	6,404	0	0	233	6,637
1/31/2019	0	0	4,157	1,292	5,645	1,497	0	568	13,158	15,516	0	0	259	15,775
2/28/2019	0	0	3,459	3,022	16,009	5,379	0	895	28,765	36,872	0	0	299	37,170
3/31/2019	0	0	2,656	1,577	8,532	2,663	0	793	16,221	19,898	2	1	214	20,115
4/30/2019	0	0	3,963	330	1,492	228	0	372	6,386	6,314	11	1	232	6,559
5/31/2019	312	269	6,292	408	1,890	420	0	377	9,968	9,489	172	200	390	10,251
6/30/2019	1,304	968	5,444	9	39	0	153	178	8,095	5,854	726	978	519	8,076
7/31/2019	1,584	1,502	4,909	7	25	0	234	199	8,460	5,363	1,254	1,322	495	8,435
8/31/2019	1,718	1,410	4,897	6	24	0	217	185	8,457	5,804	959	1,169	502	8,434
9/30/2019	1,126	1,255	5,282	6	25	0	209	177	8,080	6,080	807	724	447	8,057
10/31/2019	950	711	3,554	13	37	154	0	176	5,596	4,221	403	539	413	5,576
11/30/2019	0	0	7,041	61	101	194	0	184	7,581	7,319	0	3	242	7,564
12/31/2019	0	0	9,802	205	605	723	0	386	11,722	11,443	0	0	284	11,727
1/31/2020	0	0	7,787	735	3,349	884	0	463	13,218	14,166	0	0	293	14,459
2/29/2020	0	0	4,998	153	530	107	0	194	5,983	5,797	0	0	233	6,030
3/31/2020	345	203	2,146	288	1,170	241	0	303	4,696	4,165	132	223	361	4,880
4/30/2020	567	225	1,991	137	457	112	0	194	3,683	2,906	116	294	416	3,731
5/31/2020	901	387	1,159	116	453	155	0	205	3,376	2,207	236	549	422	3,414
6/30/2020	1,370	1,278	840	5	25	0	119	145	3,784	1,217	1,023	1,097	432	3,769
7/31/2020	1,744	1,395	1,158	5	28	0	192	167	4,688	1,818	1,073	1,342	433	4,666
8/31/2020	1,751	1,503	1,213	4	27	0	265	203	4,966	2,268	1,064	1,240	369	4,941
9/30/2020	1,173	947	1,317	4	13	0	169	173	3,796	1,999	649	804	330	3,782

Attachment 3 Monthly Surface Water Budget Table														
Date	East Canal Inflow	West Canal Inflow	Powerhouse Canal Inflow	Busch Creek Inflow	Other Streams Inflow	Runoff from Precipitation	Irrigation Return Flows	GW Discharge to Streams and Canals	Total Inflow	Stream Outflow to Lake Mendocino	East Canal Diversions	West Canal Diversions	GW Recharge from Streams and Canals	Total Outflow
10/31/2020	1,100	843	2,544	5	21	130	0	144	4,786	3,100	541	706	424	4,771
11/30/2020	0	146	2,227	24	48	109	0	158	2,711	2,498	5	0	195	2,697
12/31/2020	33	33	2,655	79	155	198	0	237	3,391	3,137	0	0	246	3,383
1/31/2021	39	39	2,702	213	855	488	0	363	4,699	4,569	0	0	262	4,831
2/28/2021	0	0	2,592	310	1,641	342	0	280	5,165	5,438	0	0	218	5,656
3/31/2021	0	0	2,908	282	1,384	177	0	239	4,990	5,066	2	4	261	5,333
4/30/2021	624	687	2,105	101	344	91	0	173	4,126	2,610	596	438	510	4,154
5/31/2021	623	361	1,349	56	216	56	0	121	2,782	1,561	252	413	571	2,797
6/30/2021	552	492	1,314	5	55	0	50	94	2,562	1,299	380	348	523	2,550
7/31/2021	431	322	1,270	4	26	0	39	81	2,173	1,200	204	209	550	2,163
8/31/2021	425	329	1,211	4	39	0	42	83	2,134	1,173	214	205	532	2,123
9/30/2021	426	264	1,159	3	21	0	44	86	2,003	1,133	161	225	475	1,994
10/31/2021	104	76	1,056	44	397	478	0	359	2,513	2,083	69	90	220	2,461
11/30/2021	54	54	2,568	144	595	239	0	277	3,931	3,735	0	0	278	4,013
12/31/2021	66	66	2,556	1,387	6,889	1,592	0	624	13,180	16,064	0	0	277	16,341
1/31/2022	0	0	2,807	275	1,294	264	0	357	4,997	5,064	0	0	173	5,237
2/28/2022	48	48	2,460	159	643	108	0	215	3,680	3,469	0	0	269	3,737
3/31/2022	693	285	2,434	200	876	211	0	256	4,954	4,022	190	462	379	5,052
4/30/2022	586	549	2,154	353	1,780	373	0	324	6,120	5,517	304	324	338	6,483
5/31/2022	835	812	3,355	102	353	159	0	208	5,826	4,197	589	606	454	5,846
6/30/2022	1,116	711	4,511	6	29	0	138	144	6,656	4,899	485	761	493	6,638
7/31/2022	1,790	1,390	3,876	5	26	0	206	162	7,454	4,504	1,060	1,365	501	7,430
8/31/2022	1,649	1,310	392	4	21	0	148	169	3,693	1,343	862	1,085	383	3,674
9/30/2022	0	0	0	5	18	0	56	108	188	95	0	0	80	174

Attachment 4
Monthly Groundwater Budget Table

Attachment 4 Monthly Groundwater Budget Table

Date	GW Recharge from Precipitation	GW Recharge from Applied Water	GW Recharge from East Canal	GW Recharge from West Canal	GW Recharge from Powerhouse Canal	GW Recharge from EFRR	GW Recharge from Other Streams	Subsurface inflow from surrounding areas	Total Inflows	ET of Shallow GW	Domestic Pumping	Agricultural Pumping	GW Discharge to East Canal	GW Discharge to West Canal	GW Discharge to Powerhouse Canal	GW Discharge to EFRR	GW Discharge to Other Streams	GW Discharge to Land Surface	Subsurface outflow from surrounding areas	Total Outflows	Change in Storage
10/31/2010	5,829	0	28	74	47	34	61	244	6,317	2,209	201	0	97	91	42	132	213	301	34	3,320	2,997
11/30/2010	2,663	0	10	42	62	75	100	256	3,208	1,078	134	0	88	71	32	93	238	442	30	2,206	1,002
12/31/2010	3,251	0	10	40	65	90	124	290	3,870	1,065	116	0	107	99	40	123	293	690	31	2,564	1,306
1/31/2011	1,203	0	18	63	75	77	78	290	1,804	949	116	0	63	66	41	107	232	486	29	2,089	-285
2/28/2011	2,742	0	13	45	64	80	109	274	3,327	1,388	105	0	81	84	40	107	249	586	27	2,667	660
3/31/2011	4,428	0	9	37	44	86	164	345	5,113	1,808	116	0	154	160	47	160	387	1,006	34	3,872	1,241
4/30/2011	962	0	43	108	52	37	73	316	1,591	2,747	134	0	46	60	35	99	191	186	29	3,527	-1,936
5/31/2011	2,190	0	54	134	74	77	92	310	2,931	3,251	195	0	37	49	36	59	166	197	29	4,019	-1,088
6/30/2011	0	1,998	75	156	86	103	56	257	2,731	3,552	238	0	28	39	32	38	95	136	32	4,190	-1,459
7/31/2011	0	2,244	90	182	80	88	49	232	2,965	2,979	279	0	30	36	31	47	83	155	38	3,678	-713
8/31/2011	0	2,278	81	177	80	82	43	211	2,952	2,539	280	0	28	40	31	50	83	166	38	3,255	-303
9/30/2011	0	1,814	77	148	93	106	44	191	2,473	2,019	245	0	28	34	34	43	77	190	35	2,705	-232
10/31/2011	3,148	0	28	78	94	103	64	213	3,728	2,095	201	0	58	54	39	56	134	241	32	2,910	818
11/30/2011	1,861	0	25	60	57	38	78	216	2,335	1,044	134	0	47	51	35	93	154	247	28	1,833	502
12/31/2011	349	0	43	87	47	28	99	219	872	943	116	0	25	29	29	83	127	171	26	1,549	-677
1/31/2012	4,178	0	15	46	37	31	119	249	4,675	948	116	0	87	90	41	136	253	425	28	2,124	2,551
2/29/2012	1,408	0	25	66	39	24	83	234	1,879	1,402	109	0	45	52	32	103	174	238	25	2,180	-301
3/31/2012	3,923	0	15	43	37	45	131	275	4,469	1,761	116	0	93	98	40	124	263	488	29	3,012	1,457
4/30/2012	1,586	0	37	90	55	44	81	261	2,154	2,711	134	0	40	50	33	83	163	163	27	3,404	-1,250
5/31/2012	1,612	0	76	159	74	78	79	249	2,327	3,092	195	0	22	36	32	55	114	148	26	3,720	-1,393
6/30/2012	0	2,467	93	181	75	81	42	209	3,148	3,413	237	0	22	35	30	48	67	122	30	4,004	-856
7/31/2012	0	2,575	89	176	77	82	43	194	3,236	3,047	279	0	29	39	31	53	68	143	35	3,724	-488
8/31/2012	0	2,470	81	164	74	72	41	179	3,081	2,596	280	0	31	39	31	60	68	154	35	3,294	-213
9/30/2012	0	1,936	72	144	66	59	38	163	2,478	2,060	245	0	28	35	30	62	65	147	33	2,705	-227
10/31/2012	1,977	0	59	124	58	46	46	170	2,480	1,935	201	0	29	35	29	67	81	136	30	2,543	-63
11/30/2012	4,936	0	13	33	37	22	74	202	5,317	1,075	134	0	100	106	41	148	237	339	29	2,209	3,108
12/31/2012	4,659	0	10	33	59	86	153	262	5,262	1,079	116	0	152	163	52	148	363	846	33	2,952	2,310
1/31/2013	994	0	16	46	64	60	66	264	1,510	958	116	0	71	68	36	120	240	453	30	2,092	-582
2/28/2013	581	0	29	60	55	41	66	232	1,064	1,358	105	0	33	39	31	86	152	221	25	2,050	-986
3/31/2013	1,797	0	34	83	36	20	91	255	2,316	1,714	116	0	38	51	34	115	175	230	27	2,500	-184
4/30/2013	1,885	0	58	123	50	37	79	238	2,470	2,638	134	0	27	38	30	79	133	152	25	3,256	-786
5/31/2013	2,272	0	82	166	63	61	74	228	2,946	3,108	195	0	25	36	32	68	108	156	25	3,753	-807
6/30/2013	0	3,270	74	158	59	56	40	200	3,857	3,587	237	0	33	45	30	67	79	128	30	4,236	-379
7/31/2013	0	2,601	86	177	59	54	39	186	3,202	3,152	279	0	29	43	29	65	72	139	35	3,843	-641
8/31/2013	0	2,339	84	166	59	49	40	173	2,910	2,627	280	0	30	39	29	68	68	141	35	3,317	-407
9/30/2013	0	2,672	56	124	59	51	39	165	3,166	2,202	245	0	37	44	30	69	83	167	34	2,911	255
10/31/2013	590	0	69	132	67	65	46	168	1,137	1,742	201	0	20	25	27	48	67	105	30	2,265	-1,128
11/30/2013	1,255	0	27	94	46	30	59	166	1,677	940	134	0	27	27	24	74	91	131	26	1,474	203

Attachment 4 Monthly Groundwater Budget Table

Date	GW Recharge from Precipitation	GW Recharge from Applied Water	GW Recharge from East Canal	GW Recharge from West Canal	GW Recharge from Powerhouse Canal	GW Recharge from EFRR	GW Recharge from Other Streams	Subsurface inflow from surrounding areas	Total Inflows	ET of Shallow GW	Domestic Pumping	Agricultural Pumping	GW Discharge to East Canal	GW Discharge to West Canal	GW Discharge to Powerhouse Canal	GW Discharge to EFRR	GW Discharge to Other Streams	GW Discharge to Land Surface	Subsurface outflow from surrounding areas	Total Outflows	Change in Storage
12/31/2013	464	0	59	100	42	22	73	171	931	856	116	0	16	21	24	76	89	112	24	1,334	-403
1/31/2014	525	0	55	90	29	13	87	169	968	760	116	0	15	17	21	81	89	101	23	1,223	-255
2/28/2014	5,353	0	13	31	17	15	106	188	5,723	1,351	105	0	86	84	32	135	223	275	24	2,315	3,408
3/31/2014	4,837	0	13	41	21	38	149	249	5,348	1,766	116	0	127	134	43	150	315	580	31	3,262	2,086
4/30/2014	1,064	0	41	102	52	37	75	237	1,608	2,697	134	0	39	46	32	84	153	134	27	3,346	-1,738
5/31/2014	2,023	0	82	167	52	43	72	226	2,665	3,105	195	0	25	34	30	74	109	132	27	3,731	-1,066
6/30/2014	0	2,558	88	182	49	43	38	192	3,150	3,469	237	0	25	37	27	63	64	101	30	4,053	-903
7/31/2014	0	2,674	88	177	51	45	40	180	3,255	3,113	279	0	29	40	28	64	65	120	35	3,773	-518
8/31/2014	0	2,620	81	164	48	38	38	167	3,156	2,644	280	0	31	41	28	73	67	132	35	3,331	-175
9/30/2014	0	1,793	71	141	59	53	37	154	2,308	2,052	245	0	27	33	27	59	61	128	33	2,665	-357
10/31/2014	2,201	0	53	107	59	50	47	164	2,681	1,974	201	0	34	36	29	65	81	133	30	2,583	98
11/30/2014	2,412	0	24	55	40	19	58	172	2,780	1,040	134	0	49	50	31	103	126	193	27	1,753	1,027
12/31/2014	5,131	0	12	33	30	32	130	226	5,594	1,061	116	0	124	127	46	157	309	529	31	2,500	3,094
1/31/2015	429	0	23	58	33	15	64	225	847	936	116	0	47	46	32	126	174	237	27	1,741	-894
2/28/2015	2,242	0	14	53	30	24	93	212	2,668	1,363	105	0	54	59	29	104	185	296	25	2,220	448
3/31/2015	523	0	46	101	46	28	78	225	1,047	1,674	116	0	26	34	29	87	129	153	25	2,273	-1,226
4/30/2015	2,169	0	65	134	51	37	77	210	2,743	2,576	134	0	24	33	30	78	116	142	24	3,157	-414
5/31/2015	1,851	0	84	170	12	15	74	202	2,408	2,976	195	0	20	30	8	77	86	97	24	3,513	-1,105
6/30/2015	0	2,309	90	179	55	57	39	173	2,902	3,299	237	0	21	30	28	50	48	77	29	3,819	-917
7/31/2015	0	2,667	88	177	47	44	40	164	3,227	2,990	278	0	26	35	26	60	54	97	33	3,599	-372
8/31/2015	0	2,343	84	168	42	35	38	154	2,864	2,507	280	0	26	33	24	66	54	101	33	3,124	-260
9/30/2015	0	1,774	73	143	41	34	37	143	2,245	1,960	245	0	24	28	23	62	51	93	31	2,517	-272
10/31/2015	854	0	77	147	47	40	41	144	1,350	1,597	201	0	17	19	23	51	47	67	28	2,050	-700
11/30/2015	1,220	0	44	86	29	16	51	144	1,590	892	134	0	23	22	20	74	68	81	24	1,338	252
12/31/2015	7,094	0	10	30	22	29	144	207	7,536	1,053	116	0	142	142	44	166	322	431	31	2,447	5,089
1/31/2016	4,121	0	7	29	18	48	147	264	4,634	752	116	0	172	174	46	185	397	1,043	34	2,919	1,715
2/29/2016	1,193	0	11	39	39	27	57	250	1,616	1,136	109	0	74	70	26	137	240	404	29	2,225	-609
3/31/2016	4,480	0	12	37	42	67	151	310	5,099	1,964	116	0	147	165	50	159	371	891	35	3,898	1,201
4/30/2016	632	0	37	93	53	39	75	287	1,216	2,633	134	0	45	58	34	91	175	163	30	3,363	-2,147
5/31/2016	1,518	0	67	139	74	72	84	274	2,228	2,979	195	0	28	41	35	60	130	161	29	3,658	-1,430
6/30/2016	0	2,388	92	186	79	80	38	223	3,086	3,774	238	0	23	37	30	49	66	106	32	4,355	-1,269
7/31/2016	0	2,560	94	180	63	55	38	206	3,196	3,147	279	0	26	41	29	61	69	121	38	3,811	-615
8/31/2016	0	2,362	93	179	45	38	38	190	2,945	2,897	280	0	26	38	25	62	62	107	39	3,536	-591
9/30/2016	0	1,726	83	156	46	42	38	173	2,264	2,177	245	0	23	32	24	55	57	101	36	2,750	-486
10/31/2016	3,850	0	29	71	42	25	48	195	4,260	1,920	201	0	59	65	31	97	125	163	33	2,694	1,566
11/30/2016	2,999	0	11	32	30	22	80	209	3,383	1,113	134	0	69	64	25	119	195	259	30	2,008	1,375
12/31/2016	3,776	0	9	29	50	60	116	251	4,291	801	116	0	109	110	37	133	298	592	33	2,229	2,062
1/31/2017	4,615	0	7	32	40	85	174	317	5,270	962	116	0	188	208	52	184	443	1,232	37	3,422	1,848

Attachment 4 Monthly Groundwater Budget Table

Date	GW Recharge from Precipitation	GW Recharge from Applied Water	GW Recharge from East Canal	GW Recharge from West Canal	GW Recharge from Powerhouse Canal	GW Recharge from EFRR	GW Recharge from Other Streams	Subsurface inflow from surrounding areas	Total Inflows	ET of Shallow GW	Domestic Pumping	Agricultural Pumping	GW Discharge to East Canal	GW Discharge to West Canal	GW Discharge to Powerhouse Canal	GW Discharge to EFRR	GW Discharge to Other Streams	GW Discharge to Land Surface	Subsurface outflow from surrounding areas	Total Outflows	Change in Storage
2/28/2017	3,519	0	7	28	33	71	149	332	4,139	1,143	105	0	175	197	46	172	420	1,171	36	3,465	674
3/31/2017	2,102	0	12	42	33	32	84	365	2,670	1,946	116	0	102	112	35	152	316	497	37	3,313	-643
4/30/2017	2,406	0	28	64	48	37	82	345	3,010	2,667	134	0	65	92	38	111	240	301	34	3,682	-672
5/31/2017	810	0	73	153	77	79	90	319	1,601	3,436	195	0	27	46	34	52	134	159	31	4,114	-2,513
6/30/2017	0	1,941	93	173	82	94	46	260	2,689	3,505	238	0	22	41	30	40	80	135	33	4,124	-1,435
7/31/2017	0	2,395	90	173	81	91	49	238	3,117	3,077	279	0	28	46	31	47	86	164	38	3,796	-679
8/31/2017	0	2,180	82	154	75	74	46	218	2,829	2,345	280	0	31	44	31	57	87	181	36	3,092	-263
9/30/2017	0	1,726	69	133	66	63	47	197	2,301	1,865	245	0	31	38	30	58	86	182	33	2,568	-267
10/31/2017	1,122	0	66	129	57	47	61	198	1,680	1,572	201	0	25	32	27	58	91	152	29	2,187	-507
11/30/2017	3,611	0	15	37	50	29	62	215	4,019	619	134	0	74	82	38	119	191	323	27	1,607	2,412
12/31/2017	170	0	26	21	41	33	88	218	597	1,043	116	0	29	16	19	84	130	171	25	1,633	-1,036
1/31/2018	3,281	0	11	44	27	27	112	240	3,742	700	116	0	75	72	30	136	234	406	27	1,796	1,946
2/28/2018	353	0	26	20	33	28	82	210	752	1,763	105	0	25	16	16	74	113	112	23	2,247	-1,495
3/31/2018	3,032	0	22	55	33	35	122	242	3,541	1,888	116	0	49	47	23	98	179	229	26	2,655	886
4/30/2018	3,013	0	36	78	48	45	117	243	3,580	2,403	134	0	51	67	34	90	182	241	26	3,228	352
5/31/2018	837	0	83	167	70	79	92	233	1,561	3,243	195	0	20	29	30	47	88	100	26	3,778	-2,217
6/30/2018	0	2,099	91	180	56	57	53	202	2,738	2,844	237	0	19	30	27	50	67	107	28	3,409	-671
7/31/2018	0	2,312	89	171	59	57	44	188	2,920	2,691	279	0	25	34	27	53	64	118	33	3,324	-404
8/31/2018	0	2,102	87	168	59	50	39	173	2,678	2,368	280	0	23	32	27	57	61	114	34	2,996	-318
9/30/2018	0	1,680	74	137	61	54	43	159	2,208	1,779	245	0	26	27	27	56	63	126	32	2,381	-173
10/31/2018	940	0	63	127	72	77	52	165	1,496	1,642	201	0	21	22	26	41	63	92	28	2,136	-640
11/30/2018	2,584	0	23	30	50	46	70	172	2,975	1,196	134	0	42	24	20	70	111	161	26	1,784	1,191
12/31/2018	2,394	0	18	40	43	35	96	192	2,818	1,105	116	0	48	36	23	95	150	222	26	1,821	997
1/31/2019	3,934	0	11	37	36	45	130	221	4,414	1,116	116	0	88	83	33	123	241	419	28	2,247	2,167
2/28/2019	4,827	0	7	30	29	72	161	253	5,379	901	105	0	159	170	45	156	366	931	31	2,864	2,515
3/31/2019	2,385	0	9	32	25	38	109	303	2,901	987	116	0	124	126	40	164	339	821	34	2,751	150
4/30/2019	1,094	0	26	44	44	41	77	284	1,610	2,741	134	0	46	39	23	87	177	166	29	3,442	-1,832
5/31/2019	2,045	0	46	112	71	69	92	284	2,719	2,538	195	0	38	57	37	71	174	234	29	3,373	-654
6/30/2019	0	1,651	95	198	84	102	40	228	2,398	4,046	238	0	20	32	30	36	60	97	34	4,593	-2,195
7/31/2019	0	2,430	95	185	81	92	42	209	3,134	3,255	279	0	26	35	31	47	59	118	40	3,890	-756
8/31/2019	0	2,094	93	187	83	96	43	194	2,790	2,802	280	0	25	32	30	41	57	116	39	3,422	-632
9/30/2019	0	1,625	82	154	80	89	43	178	2,251	2,012	245	0	25	27	29	40	56	123	36	2,593	-342
10/31/2019	1,034	0	75	154	69	67	48	178	1,625	1,561	201	0	21	22	28	45	61	110	31	2,080	-455
11/30/2019	924	0	26	17	69	73	58	174	1,341	736	134	0	26	11	19	46	82	147	27	1,228	113
12/31/2019	3,249	0	15	45	69	65	89	199	3,731	839	116	0	57	45	29	89	166	274	27	1,642	2,089
1/31/2020	2,724	0	14	43	56	59	120	217	3,233	1,062	116	0	65	56	31	106	205	340	27	2,008	1,225
2/29/2020	5	0	21	16	52	53	91	196	434	1,790	109	0	19	11	17	55	92	107	24	2,224	-1,790
3/31/2020	1,563	0	64	131	41	23	102	207	2,131	1,247	116	0	23	36	31	91	122	151	25	1,842	289

Attachment 4 Monthly Groundwater Budget Table

Date	GW Recharge from Precipitation	GW Recharge from Applied Water	GW Recharge from East Canal	GW Recharge from West Canal	GW Recharge from Powerhouse Canal	GW Recharge from EFRR	GW Recharge from Other Streams	Subsurface inflow from surrounding areas	Total Inflows	ET of Shallow GW	Domestic Pumping	Agricultural Pumping	GW Discharge to East Canal	GW Discharge to West Canal	GW Discharge to Powerhouse Canal	GW Discharge to EFRR	GW Discharge to Other Streams	GW Discharge to Land Surface	Subsurface outflow from surrounding areas	Total Outflows	Change in Storage
4/30/2020	922	0	78	152	51	43	91	194	1,531	2,231	134	0	14	22	25	52	81	85	23	2,667	-1,136
5/31/2020	2,056	0	82	158	47	43	92	196	2,674	2,537	195	0	17	26	24	53	85	87	24	3,048	-374
6/30/2020	0	2,040	104	191	48	49	40	170	2,642	2,770	237	0	15	22	23	43	42	65	28	3,245	-603
7/31/2020	0	2,285	96	185	55	55	41	162	2,879	2,462	278	0	21	26	25	46	48	90	32	3,028	-149
8/31/2020	0	2,206	84	163	49	34	39	152	2,727	1,867	280	0	27	27	27	70	52	115	32	2,497	230
9/30/2020	0	1,361	73	143	48	33	34	139	1,831	1,561	245	0	21	22	25	62	44	93	31	2,104	-273
10/31/2020	1,253	0	85	166	67	65	41	140	1,817	1,887	201	0	16	18	25	42	43	82	28	2,342	-525
11/30/2020	1,192	0	53	10	46	36	50	140	1,527	1,112	134	0	20	7	18	56	58	73	25	1,503	24
12/31/2020	1,969	0	40	56	49	31	70	153	2,368	1,196	116	0	28	20	26	74	89	106	25	1,680	688
1/31/2021	2,795	0	26	69	43	24	101	170	3,228	1,080	116	0	46	41	31	102	143	180	25	1,764	1,464
2/28/2021	1,903	0	21	28	33	29	107	163	2,284	1,384	105	0	37	20	19	78	127	150	23	1,943	341
3/31/2021	1,763	0	30	21	43	42	124	185	2,208	2,261	116	0	28	14	16	67	114	105	25	2,746	-538
4/30/2021	1,292	0	101	207	59	52	91	172	1,974	2,718	134	0	15	22	23	45	68	68	24	3,117	-1,143
5/31/2021	650	0	115	219	64	83	91	170	1,392	2,232	195	0	11	14	21	23	52	48	24	2,620	-1,228
6/30/2021	0	779	114	210	66	87	46	154	1,456	1,651	237	0	9	11	20	19	36	42	25	2,050	-594
7/31/2021	0	405	118	225	69	95	41	149	1,102	1,308	278	0	7	9	19	16	30	36	26	1,729	-627
8/31/2021	0	410	115	222	66	85	43	142	1,083	1,027	280	0	6	8	18	18	33	38	25	1,453	-370
9/30/2021	0	740	103	204	61	68	39	132	1,347	1,058	245	0	6	8	18	22	32	35	24	1,448	-101
10/31/2021	5,267	0	31	67	34	19	68	164	5,650	1,807	201	0	59	47	29	97	127	106	26	2,499	3,151
11/30/2021	1,458	0	35	73	45	30	94	166	1,901	985	134	0	34	26	28	72	117	128	24	1,548	353
12/31/2021	5,008	0	15	42	36	37	148	208	5,494	1,039	116	0	100	94	43	132	256	376	28	2,184	3,310
1/31/2022	602	0	19	30	30	21	73	208	983	914	116	0	41	24	23	111	158	204	25	1,616	-633
2/28/2022	27	0	50	67	43	27	81	181	476	1,272	105	0	16	19	24	64	93	106	21	1,720	-1,244
3/31/2022	1,367	0	61	151	47	29	91	194	1,940	1,599	116	0	18	25	28	77	108	135	22	2,128	-188
4/30/2022	3,301	0	51	108	44	33	102	196	3,835	2,622	134	0	33	41	31	83	136	149	23	3,252	583
5/31/2022	1,600	0	79	165	65	67	80	193	2,249	2,959	195	0	21	25	29	51	82	103	24	3,489	-1,240
6/30/2022	0	1,896	87	184	82	101	39	171	2,560	3,095	237	0	17	23	28	29	47	82	28	3,586	-1,026
7/31/2022	0	2,299	99	196	78	87	41	161	2,961	2,751	279	0	19	25	28	40	49	102	32	3,325	-364
8/31/2022	0	1,858	92	185	37	28	40	152	2,392	2,228	280	0	20	23	22	59	46	76	32	2,786	-394
9/30/2022	0	930	20	6	3	10	41	147	1,157	1,417	245	0	20	5	2	36	45	41	28	1,839	-682