Chapter 5 Demand Sites and Catchments – Upper Watersheds

The portion of the watersheds above the valley floor boundary are referred to as the upper watersheds and serve as the main supply of water for Sacramento Valley water users. In SacWAM, the flows from these watersheds are simulated using one of two user-selected approaches. The first is the use of input flow timeseries developed by DWR. These flows are input into SacWAM as headflows on fictitious streams that have the same name as the DWR inflow timeseries. These inflows are listed in Table 6-1 and described in Section 6.1.1.

The second approach to generating upper watershed flows is the use of the catchment object. In SacWAM, these objects have been set to use the Soil Moisture Model. This model is described in Yates, Sieber et al. (2005) and in the WEAP help file (Calculation Algorithms - Evapotranspiration, Runoff, Infiltration and Irrigation - Soil Moisture Method). These catchment objects provide a representation of rainfall-runoff processes including snow accumulation and melt, infiltration, surface runoff, ET, interflow, deep percolation, and baseflow. By adding a hydrological model of the upper watersheds to SacWAM, the inflow boundary of the model shifts from specified inflows to meteorological inputs (precipitation, temperature, wind speed, and humidity) across the upper watersheds. Using this approach permits analysis based on climate model outputs or synthetic meteorology. The creation of these catchment objects was based on work done in earlier modeling efforts including Young et al. (2009); Yates, Purkey et al. (2009); Mehta et al. (2011); and Joyce et al. (2011).

The documentation that follows describes the spatial analysis required to parameterize the catchment objects, the water management infrastructure, the operations rules for the water management infrastructure, and the calibration of the model to natural and managed flows.

5.1 Delineation of Upper Watersheds

Several spatial analysis steps were necessary to prepare geographic data for import to WEAP. First, watersheds were subdivided into subwatersheds based on the location of points of interest where the model needs to simulate flows. Typically this is at dams and stream gauges. Second, each subwatershed was subdivided into elevation bands and a single catchment was created to represent the land area within each elevation band. This was done in order to properly represent the variation in climate that is a function of elevation. Third, each elevation band, in each subwatershed, was sub-divided into different land cover classifications. Within the catchment object, all hydrological calculations are performed for each of these individual land cover classes. A more detailed description of these three steps is provided below.

5.1.1 Selection of Pour Points

Pour points were created at the locations of dams and USGS stream gauges as specified by SWRCB (Table 5-1).

Table 5-1. Attributes of the Pour Points Used in the Model

Watershed	Name	Latitude	Longitude	WEAP_Name
American R	Folsom Lake inflows*	38.71148	-121.15087	P508_American_01
	NF American R at NF Dam*	38.93748	-121.02316	P508_American_02
	MF American R above confluence with NF*	38.91493	-121.02540	P508_American_03
	SF American R nr Placerville*	38.77157	-120.81303	P508_American_04
	Union Valley Reservoir	38.86606	-120.44081	P508_American_05
	Ice House Reservoir	38.82355	-120.36155	P508_American_06
	Loon Lake	38.98761	-120.33170	P508_American_07
	French Meadows Reservoir	39.11095	-120.47017	P508_American_08
	Hell Hole Reservoir	39.05784	-120.41276	P508_American_09
Antelope Ck	Antelope Ck nr Red Bluff*	40.20007	-122.12251	P504_Antelope_01
Battle Ck	Battle Ck nr Cottonwood*	40.39810	-122.14651	P504_Battle_01
Bear R	Camp Far West Reservoir local inflows	39.05017	-121.31463	P508_Bear_01
	Lake Combie	39.01382	-121.04178	P508_Bear_02
	Rollins Reservoir	39.13581	-120.95260	P508_Bear_03
Big Chico Ck	Big Chico Ck nr Chico*	39.77542	-121.75341	P504_BigChico_01
Butte Ck	Butte Ck*	39.72636	-121.70803	P504_Butte_01
Cache Ck	Cache Ck above Rumsey local inflows	38.91024	-122.27961	P505_Cache_01
	Clear Lake inflow*	38.92520	-122.61398	P505_Cache_02
	Indian Valley inflow*	39.08058	-122.53654	P505_Cache_03
Calaveras R	Calaveras R at DU boundary	38.07331	-120.92668	P604_Calaveras_01
	New Hogan inflow	38.15053	-120.81357	P604_Calaveras_02
Clear Ck	Clear Ck at DU boundary*	40.51581	-122.52535	P502_Clear_01
	Whiskeytown Reservoir	40.59941	-122.53941	P502_Clear_02
Cosumnes R	Cosumnes R*	38.50861	-121.04417	P604_Cosumnes_01
	Jenkinson Lake	38.71679	-120.56931	P604_Cosumnes_02
	Camp Ck Diversion Tunnel	38.72466	-120.52505	P604_Cosumnes_03
Cottonwood Ck	NF and MF Cottonwood Ck nr Olinda*	40.38445	-122.47645	P502_Cottonwood_01
	SF Cottonwood Ck nr Olinda*	40.32576	-122.44505	P502_Cottonwood_02
Cow Ck	Sum of Cow Cks	40.55511	-122.23131	P504_Cow_01
Deer Ck	Deer Ck nr Vina*	40.01387	-121.94729	P504_Deer_01
Delta	Los Vaqueros Reservoir	37.83713	-121.72798	P601_Delta_01
Dry Ck of the Yuba R	Merle Collins Reservoir inflows*	39.32244	-121.31348	P508_DryofYuba_01
Elder Ck	Elder Ck nr Paskenta*	40.02442	-122.51086	P502_Elder_01
Feather R	Lake Oroville inflow	39.54301	-121.49225	P508_Feather_01
	Ponderosa Dam inflow*	39.54927	-121.30327	P508_Feather_02
	Little Grass Valley Reservoir*	39.72521	-121.02006	P508_Feather_05
	NF Feather R at Pulga*	39.79436	-121.45166	P508_Feather_07
	Lake Almanor Inflows*	40.17377	-121.08589	P508_Feather_08
	MF Feather R nr Merrimac*	39.70817	-121.27079	P508_Feather_09
	Sly Ck Reservoir inflows	39.58238	-121.11566	P508_Feather_04
	Miocene Diversion Dam	39.81391	-121.57109	P508_Feather_03
	Hendricks Diversion Dam*	39.93811	-121.53220	P508_Feather_06
Jackson Ck	Amador Reservoir Inflow	38.30356	-120.88944	P604_Jackson_01
Little Chico Ck	Little Chico Ck	39.73349	-121.77160	P504_LittleChico_01
Littlejohns Ck	Littlejohns d/s of Rock Ck confluence	37.91374	-120.96217	P603_Littlejohns_01
Marsh Ck	Marsh Ck*	37.89338	-121.72128	P601_Marsh_01
Mill Ck	Mill Ck nr Los Molinos*	40.05457	-122.02413	P504_Mill_01
Mokelumne R	Dry Ck d/s of Sutter Ck	38.35954	-120.98954	P604_Dry_01
	Camanche Reservoir inflow*	38.22614	-121.02190	P604_Mokelumne_01
	Pardee Reservoir inflow*	38.25710	-120.85037	P604_Mokelumne_02
	Mokelumne R nr Mokelumne Hill*	38.31264	-120.72019	P604_Mokelumne_03
Pit R	Pit R nr Montgomery Ck*	40.84323	-122.01625	P501_Pit_01
	Muck Valley-Clarks Valley watershed boundary	40.96967	-121.16871	P501_Pit_02
	Goose Lake-Upper Pit watershed boundary	41.69688	-120.40137	P501_Pit_03
Putah Ck	Lake Berryessa inflows*	38.51344	-122.10464	P505_Putah_01

Table 5-1. Attributes of the Pour Points Used in the Model cont.

Watershed	Name	Latitude	Longitude	WEAP_Name
Sacramento R	McCloud R above Shasta Lake*	40.95824	-122.21972	P501_McCloud_01
	Shasta Lake inflows*	40.71830	-122.41856	P501_Sacramento_01
	Sacramento R at Delta*	40.93955	-122.41427	P501_Sacramento_02
	Paynes and Sevenmile Cks*	40.26344	-122.18707	P504_Sacramento_96
Stony Ck	Stony Ck below Black Butte Dam nr Orland*	39.81828	-122.32429	P502_Stony_01
	Stony Gorge Reservoir local inflows*	39.58579	-122.53271	P502_Stony_02
	East Park Reservoir inflow*	39.36184	-122.51640	P502_Stony_03
Thomes Ck	Thomes Ck at Paskenta*	39.88704	-122.52778	P502_Thomes_01
Trinity R	Lewiston Lake local inflows	40.72723	-122.79306	P102_Trinity_01
	Trinity Reservoir (Claire Engle Lake) inflows	40.80100	-122.76271	P102_Trinity_02
Yuba R	Deer Ck inflow to Yuba R*	39.22447	-121.26853	P508_Yuba_01
	Englebright Reservoir local inflows*	39.23992	-121.26904	P508_Yuba_02
	New Bullard Bar Reservoir	39.39320	-121.14244	P508_Yuba_03
	Scott's Flat Reservoir	39.27266	-120.93077	P508_Yuba_04
	Oregon Ck below Log Cabin Dam nr Camptonville*	39.43944	-121.05806	P508_Yuba_05
	Middle Yuba R below Our House Dam*	39.41167	-120.99694	P508_Yuba_06
	Slate Ck below Div Dam nr Strawberry*	39.61556	-121.05167	P508_Yuba_07
	North Yuba R below Goodyears Bar*	39.52528	-120.93750	P508_Yuba_08
	Bowman Lake	39.44902	-120.65271	P508_Yuba_09
	Lake Spaulding	39.32730	-120.64337	P508_Yuba_10
	Jackson Meadows Reservoir	39.50865	-120.55639	P508_Yuba_11
	Fordyce Lake	39.37978	-120.49638	P508_Yuba_12

Key: Ck=Creek; Div=Diversion; MF=Middle Fork; NF=North Fork; nr=near; R=River; SF=South Fork.
* Indicates there is a USGS gauge associated with the pour point.

NHDPlus **flow accumulation** rasters were used to ensure pour points were located on streams. The NatGeo basemap (available in ESRI's ArcGIS) was used to guide pour-point placement at dam inflows. Stream gauge locations were based on the coordinates and descriptions available in USGS Water Data reports (available here: http://wdr.water.usgs.gov).

5.1.2 Delineation of Subwatersheds

A **pour point grid** was created from the pour points shapefile using the Snap Pour Points tool and the **flow accumulation** raster as the input accumulation raster, with a snap distance of 5 m.

Subwatersheds were delineated using the pour point grid and NHDPlus **flow direction grids** for regions 18b and 18c, using the *Watershed* tool, and resulting in **upper watershed rasters**.

The *Raster-to-Polygon* tool was used to convert the watershed rasters to features, which were then unioned and clipped to the DU boundary. Gaps were disallowed so that polygons would be created for any spaces between watersheds stemming from minor discrepancies between the pour-point delineated watersheds and the HUC-12 boundaries (e.g. around the closed basins). Closed basins that fell within the 1801, 1802, and 1804 HUC-4s were added to upper watersheds based on HUC-8 and HUC-10 divisions.

A layer was created of the gaps between the watersheds and the DU boundary by making a dummy layer that encompassed all of the area that potentially held gaps, clipping this to the DU and then erasing from it the upper watersheds layer with an xy tolerance of 0 (automatically converted to two times the resolution). The gaps layer was merged with the upper watersheds and features that had not been assigned to a pour point (i.e. the gap features) were selected and multi-part features exploded.

Gap features >10km^2 were assigned a pour point value of "Uncaptured: River Name," where River Name is the stream/river into which the area drains. These areas are not captured by the gauge on their respective streams. In the two cases that a gap area drained into more than one river and each drainage area was greater than 10km^2, the gap areas were divided along HUC-12 boundaries, and the resulting uncaptured areas assigned to their respective rivers.

The remaining gap features—those <10km^2—were again selected and the Eliminate tool was run to join these sliver polygons with the neighboring polygon with which they shared the longest border. The Eliminate tool was run twice to get rid of all the slivers, resulting in a final **upper watersheds** layer (Figure 5-1).

A field was added to the upper watersheds layer—WEAP_sws. This was populated by PXXX_river_XX where PXXX was already established and the XX suffix was chosen so that 01 was located at the basin outlet and the highest numbers represented the headwaters.

5.1.3 Elevation Bands

Elevation data are NHDPlus' **NEDsnapshot** reclassified (Table 5-2), using the default setting of "double precision" to produce a **reclassified elevation grid**.

Table 5-2. Reclassification of Elevation Data

Original values (centimeters)	New value (meters)
-2180–50,000	500
50,000–100,000	1,000
100,000–150,000	1,500
150,000–200,000	2,000
200,000–250,000	2,500
250,000–300,000	3,000
300,000–350,000	3,500
350,000–400,000	4,000
400,000–450,000	4,500
No Data	No Data

The Raster-to-Polygon tool was used to convert these grids to shapefiles, simplify polygons left unchecked, and the shapefiles were merged and clipped to the upper watersheds to produce a **reclassified elevation shapefile**.[8]

[8] In order to prepare the NED 18b and 18c regions for merging, a buffer was erased from the outside edge of 18b to reduce discrepancies between the datasets where they overlapped. This was accomplished by dissolving 18b, creating a -10km buffer around it, and erasing the buffered footprint from the 18c polygon layer. The clipped 18c and buffered 18b were unioned with gaps disallowed and dissolved to achieve one feature per elevation band.

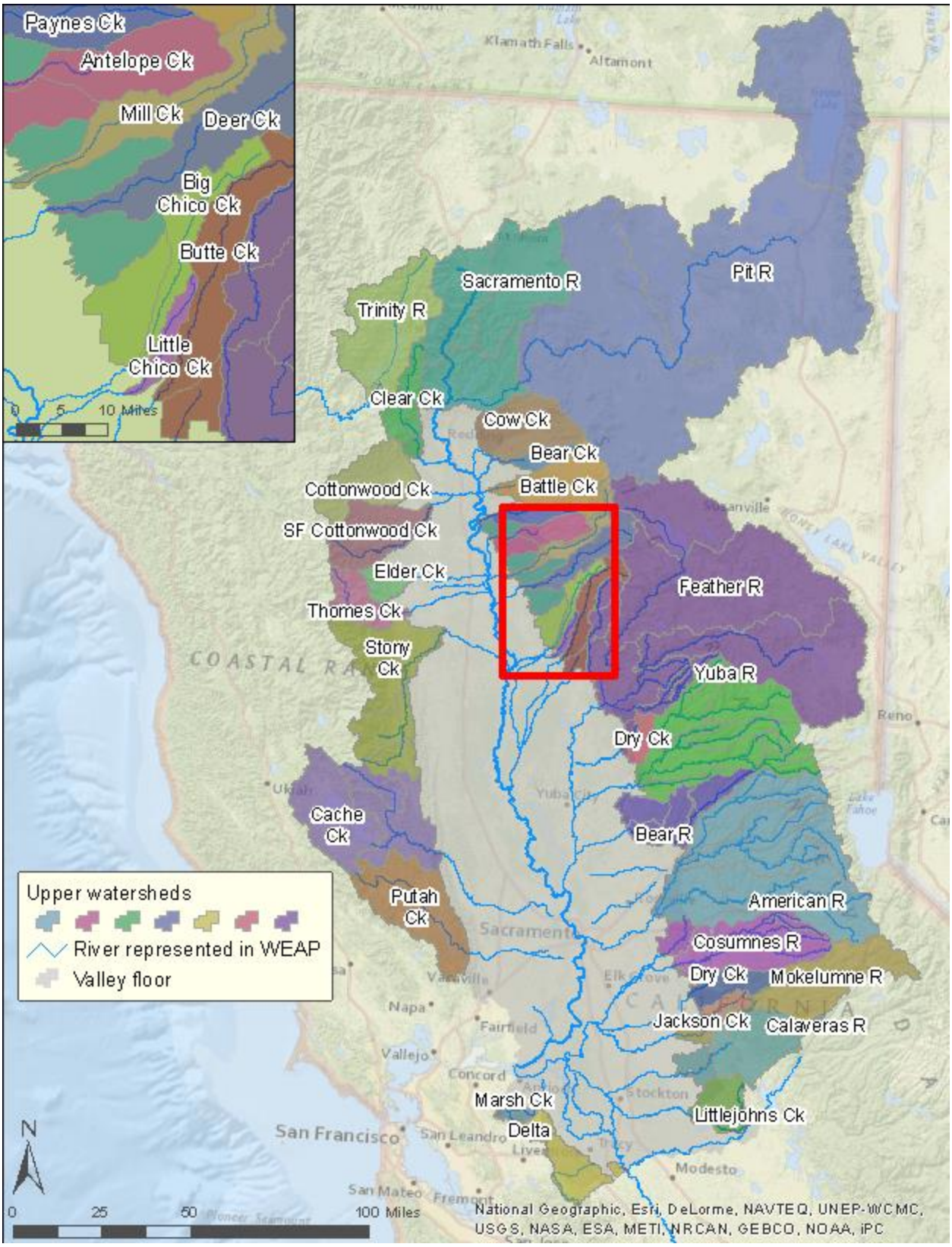


Figure 5-1. Upper Watersheds

Red rectangle delineates zoomed in inset area.

5.1.4 Creation of WEAP Catchments

Upper watersheds and the **reclassified elevation shapefile** were intersected to form **catchments**. Nine elevation bands split the 92 subwatersheds of the 34 watersheds into 351 catchments. The attribute table for catchments, including areas for each polygon, was exported from ArcGIS into a **catchment analysis** file. A pivot table was used to calculate relative area in each elevation band within a subwatershed. When an extreme elevation band (highest or lowest band in the subwatershed) occupied less than 15.5% of the total area of a subwatershed, this elevation band was lumped with the adjacent elevation band in the same subwatershed. If the sum of the areas of these combined elevation bands was still less than 15.5%, it was lumped with the next adjacent elevation band in the same subwatershed. Through this process, the number of catchments for use in WEAP was reduced to 194 (Table 5-3).

Table 5-3. WEAP Catchments

Watershed	Subwatersheds	Catchments
American	9	22
Antelope	2	5
Battle	1	3
Bear	1	2
Bear	4	6
BigChico	2	4
Butte	2	5
Cache	3	6
Calaveras	3	4
Clear	2	4
Cosumnes	4	7
Cottonwood	2	6
Cow	1	3
Deer	1	3
Delta	2	3
Dry	1	2
DryofYuba	1	2
Elder	1	4
Feather	10	21
Jackson	2	3
LittleChico	1	2
Littlejohns	1	1
Marsh	1	2
McCloud	1	3
Mill	1	3
Mokelumne	3	6
Paynes	1	2
Pit	3	6
Putah	1	2
Sacramento (P501)	2	5
Sacramento (P504)	4	7
Stony	4	9
Thomes	1	3
Trinity	2	5
Yuba	12	23
Total	**92**	**194**

To facilitate calibration and analysis, the model was divided into seven regions (Table 5-4).One subwatershed is included in two regions because of a transfer between regions.

Table 5-4. Model Regions

Model Region	Subwatersheds
Shasta	Clear, McCloud, Pit, Sacramento (01, 02), Trinity
Westside	Cache, Cottonwood, Elder, Putah, Stony, Thomes
Northeast Streams (NEStreams)	Antelope, Battle, Bear, Big Chico, Butte, Cow, Deer, Feather (06),* Little Chico, Mill, Paynes, Sacramento (96, 97, 98, 99)
Feather	Feather, Dry of Yuba
CABY	Cosumnes (all but 99), American, Bear, Yuba
Eastside	Calaveras, Cosumnes (99), Dry, Jackson, Littlejohns, Mokelumne
Delta	Delta, Marsh

*The Feather_06 subwatershed was included in both the Northeast Streams and Feather regions in order to model a trans-basin transfer.

Zonal statistics were performed to produce tables of the average elevation of each catchment, using the **reclassified elevation shapefiles**. The tables were joined to the **catchments** shapefile, and the average elevation data added.

5.1.5 Land Cover

Land cover data are National Land Cover Database (NLCD) 2011. Most NLCD classes correspond to a single WEAP class, with the exception of low-, medium-, and high-intensity developed land. Low-intensity developed land is subdivided in WEAP to include a residential landscape class so that the user can control the portion of residential lots that is pervious, thus allowing for a more accurate simulation of runoff from these areas. Similarly, portions of medium- and high-intensity area are designated as commercial-industrial landscape. Proportions of low-, medium-, and high intensity developed land are stored in *Other\Urban Outdoor\SAC\Area Factors*.

The NLCD 2011 raster for the coterminous United States was clipped to the Sacramento Basin with a 100 m buffer with “Maintain Clipping Extent” unchecked to disallow resampling. This was output to a **land-use tif**. Raster-to-Polygon converted the tif to a polygon layer, which was then clipped to the upper watersheds extent, with “simplify polygons” unchecked. WEAP level 1 and 2 fields were added to facilitate calculation of areas for the land-use classes used as input in WEAP (Table 5-5).

The catchment-NLCD intersections were dissolved on the WEAP1 and catchment fields, resulting in one polygon per catchment–land use combination in seven **simplified NLCD** files. Land use areas by catchment were exported and used in Excel lookup tables to produce area formulas (for low-, medium-, and high intensity urban; and residential and commercial/industrial landscape) and raw areas (for all other land use categories) for import into WEAP in square miles. Areas were rounded to three decimal places; this resulted in “0” values for land uses that covered less than approximately 1300m^2. This data processing can be reviewed in the **catchment land use** file.

Table 5-5. National Land Cover Database Land Use Classes and Corresponding WEAP Classes

Gridcode	NLCD 2006	WEAP 1	WEAP_2
21	Developed, Open Space	OpenSpace	Urban
22	Developed, Low Intensity	Low Int Res Landscape*	
23	Developed, Medium Intensity	Med Int	
		CommInd Landscape*	
24	Developed, High Intensity	Hi Int	
82	Cultivated Crops	Cultivated	Irrigated
81	Pasture/Hay	Pasture	
12	Perennial Ice/Snow	Barren	Non Irrigated
31	Barren Land		
41	Deciduous Forest	Forest	
42	Evergreen Forest		
43	Mixed Forest		
11	Open Water	Open Water	
52	Shrub/Scrub	Non Forest	
71	Grassland/Herbaceous		
90	Woody Wetlands		
95	Emergent Herbaceous Wetlands		

*Commercial/Industrial Landscape and Residential Landscape are calculated as percentages of Low-, Medium-, and High Intensity Developed and are not assigned to specific pixels in the data files.

5.2 Upper Watershed Parameters

All values with the exception of Initial Z1 and Initial Z2 can be reviewed in the **upper watershed parameterization** file. During calibration of the upper watershed scaling factors were created to adjust hydraulic parameters on a sub watershed scale such that all parameters for catchments contributing to a specific calibration point have the same value. The mapping of these groupings of catchments to calibration points is provided in the **upper watershed expressions** file.

5.2.1 Climate

5.2.1.1 *Precipitation, Temperature, Humidity, Wind*

Similar to the approach taken for the valley floor catchments (described in Section 4.3), the Livneh et al. (2013) **climate dataset** was used to provide spatially interpolated *temperature*, *precipitation*, and *wind* inputs. The following steps were followed:

1. The **Livneh grid** was intersected with the **catchments**.
2. A VBA macro in **upper watershed processor** was used to calculate the area weighted average of the maximum and minimum daily temperature, precipitation, and wind speed for all **Livneh grid** cells that intersected each catchment. This differed from the approach taken on the valley floor. It was assumed that an area weighted average would give a more representative value of the climate data for each catchment since the catchments cover up to 500 m of elevation and there is a strong gradient in precipitation and temperature as a function of elevation. This dataset was converted into monthly average data since the upper watershed hydrological calculations are performed on a monthly time step.
3. An average monthly relative humidity data timeseries was derived from a long term climatological average at Blue Canyon and applied to all catchments.

4. Data from steps 2 and 3 were combined to create the **WEAP Input Data**.

The wind data in the Livneh et al. (2013) dataset are provided as wind speed at 10 m above the ground. This dataset was modified to represent wind speed at 2 m above the ground using the following relationship (Neitsch et al., 2005):

$$wind_2 = wind_{10} * (2/10)^{0.2} \qquad \text{Equation 5-1}$$

where:

$wind_2$ is the wind speed at 2 m above the ground;
$wind_{10}$ is the wind speed at 10 m above the ground.

5.2.1.2 *Cloudiness Fraction*

No data were input for the *Cloudiness Fraction*. It was assumed that errors introduced by this assumption are minimal since there is little cloudiness during the period of highest ET (Apr – Oct).

5.2.1.3 *Latitude*

Centroids were calculated in ArcGIS for all catchments. Latitudes were calculated for these points in decimal degrees in WGS1984 UTM Zone 11 N. **Latitudes** were rounded to three decimal places and imported into WEAP.

5.2.1.4 *Freezing Point and Melting Point*

Freezing and melting points are regionally calibrated values. The regions are defined and further discussed in Section 7.4.1.1 of Chapter 7 on Other Assumptions.

5.2.1.5 *Albedo*

Default WEAP values were used for *Albedo Upper Bound* (0.25) and *Albedo Lower Bound* (0.15), No value was set for *Albedo*, resulting in WEAP calculating this value based on snow accumulation.

5.2.1.6 *Initial Snow*

No initial snow data were entered. The model runs begin with the assumption that no snow is on the ground.

5.2.1.7 *Snow Accumulation Gauge*

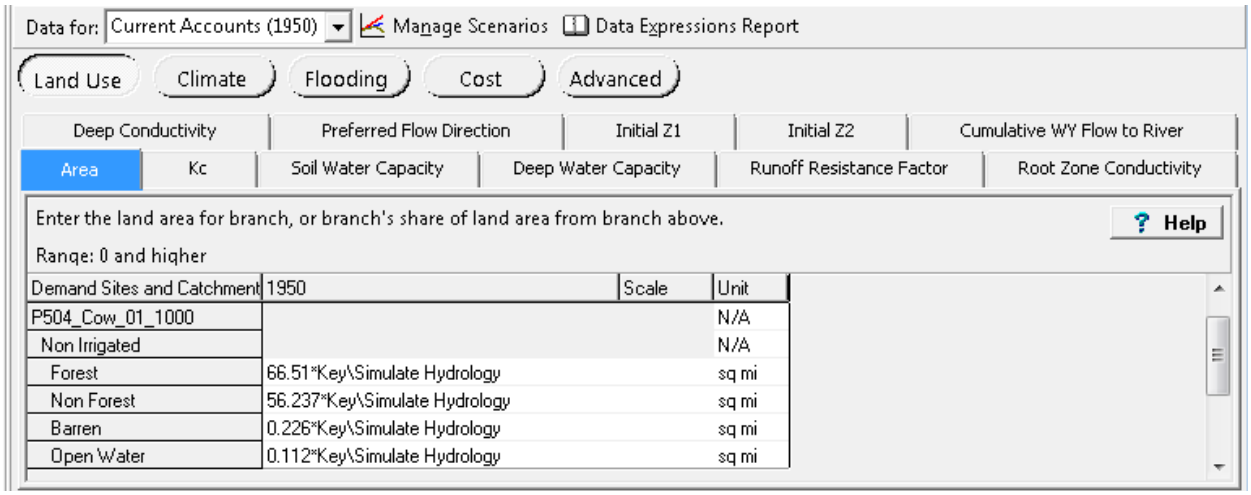
Snow water equivalent data were downloaded from DWR's CDEC (www.cdec.water.ca.gov). Snow gauge locations were spatially joined with the catchments layer so that the elevation of the snow gauge could be compared with the average elevation of the catchment it falls in. Only stations within 100 m of the average elevation of their respective catchment were considered. If more than one station met the elevation criterion, the one with more complete data was chosen to represent the catchment.

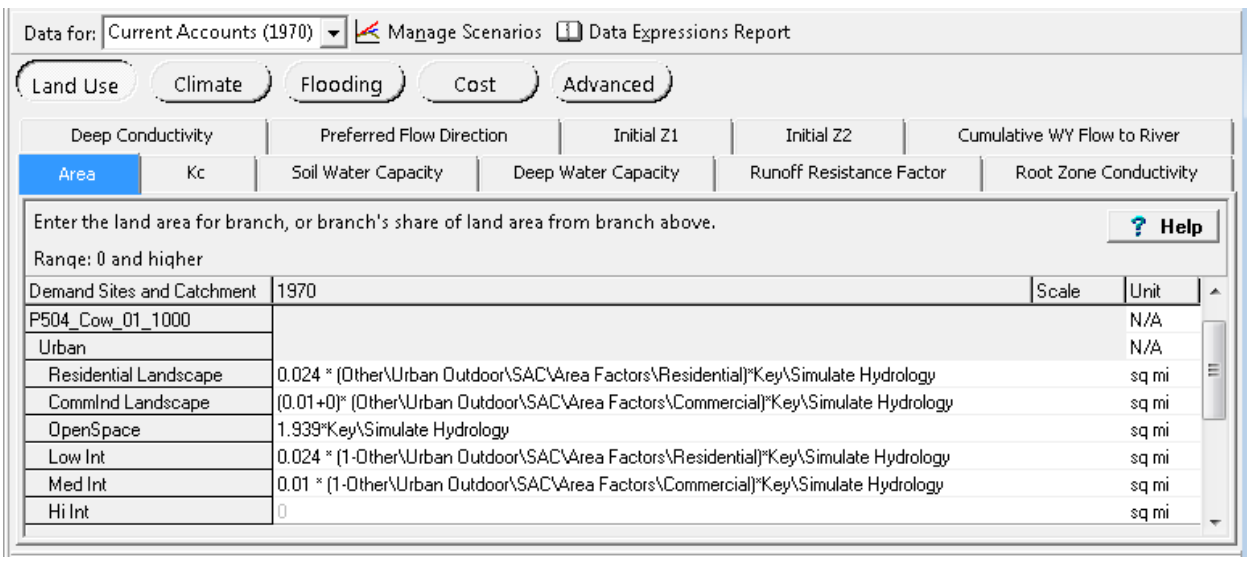
Adjusted snow equivalent data were used as available; raw data were used for dates lacking adjusted data. Data from a total of 26 snow gauges were entered. However, the data were not used during calibration as it was found the 500-meter elevation bands represent too large a range of elevation to have meaningful comparisons between observed and simulated snow accumulation.

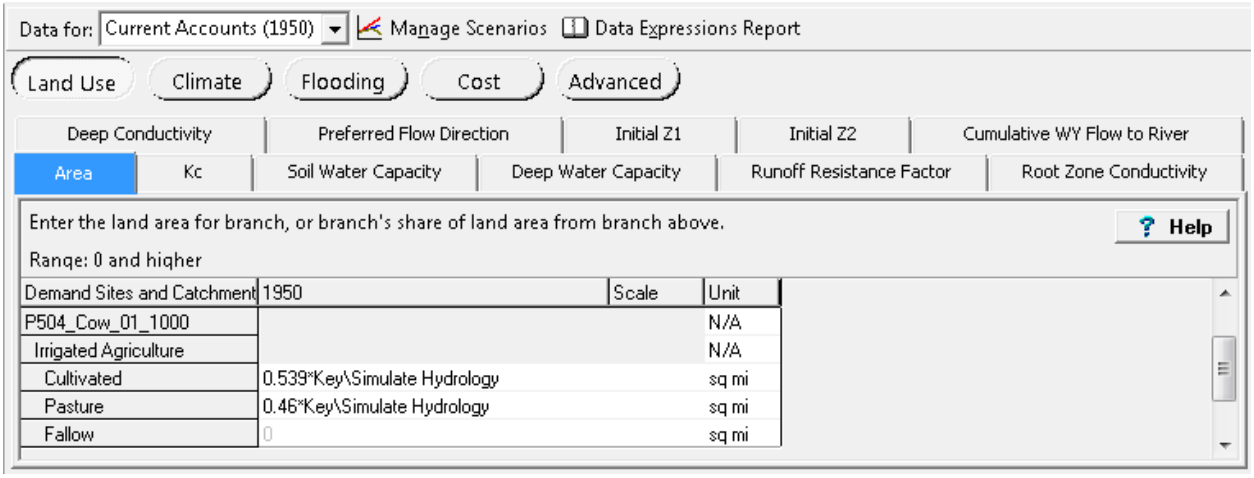
5.2.2 Land Use

5.2.2.1 *Area*

Land-use areas for upper watershed catchments were calculated based on the procedure outlined in Section 5.1.5. All area values from the GIS analysis can be found in **catchment land use**. Each area expression has the additional multiplier **Key\Simulate Hydrology* which sets the area value to zero if the DWR inflow timeseries are being used (see Section 9.4).

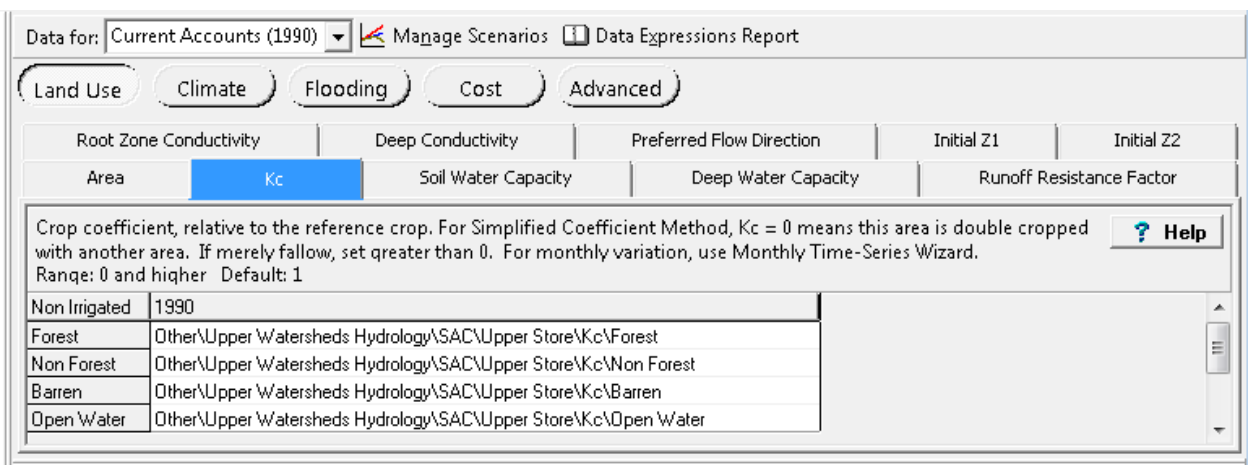


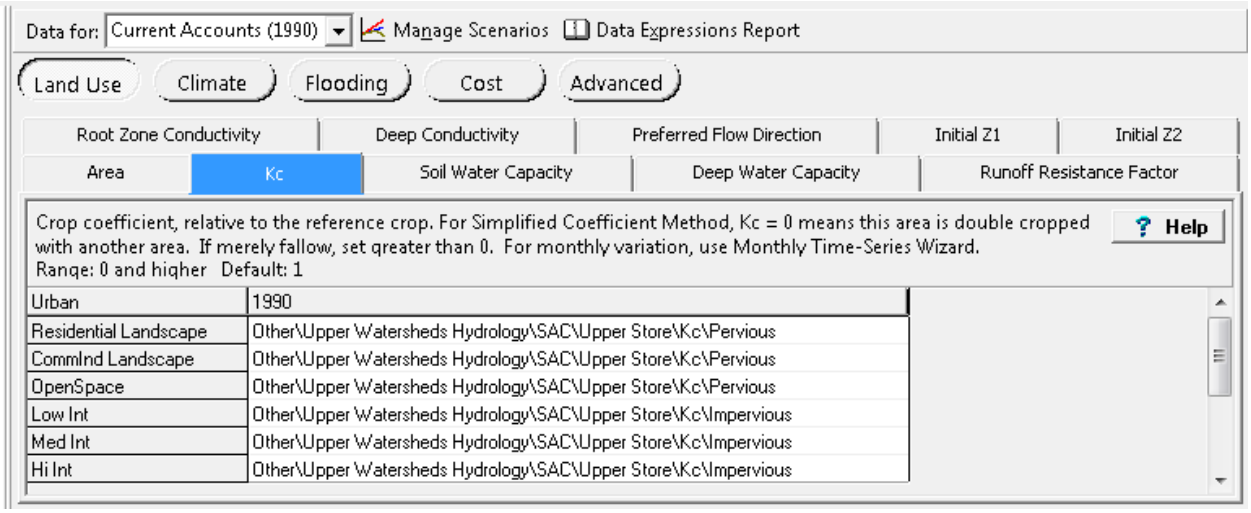


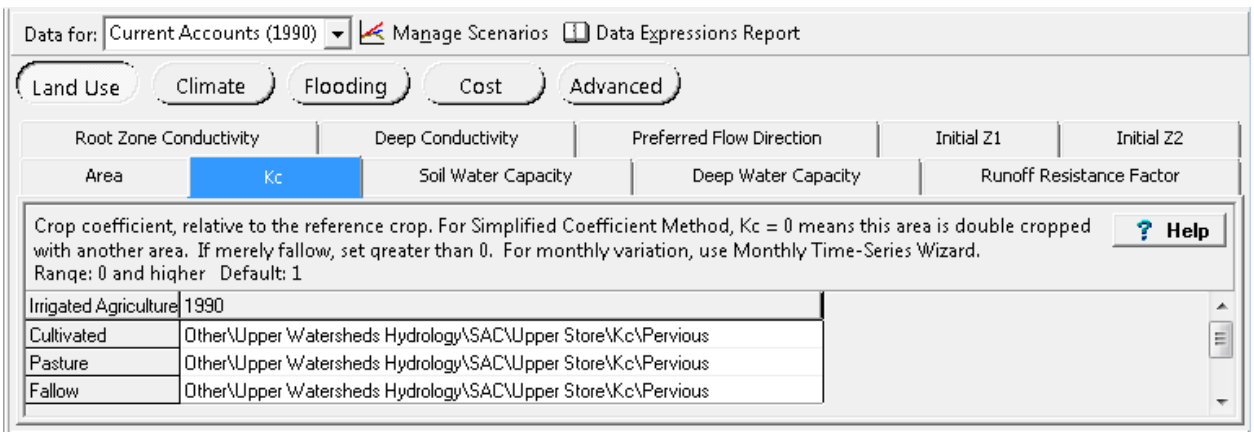


5.2.2.2 *Kc*

The crop coefficient (Kc) is used to scale the potential ET (ETo) calculated by WEAP to a level appropriate for the particular land cover type of interest. In SacWAM, land use–specific values from the CVPA model were used. These values range from 0.7 for impervious land classes to 1.2 for forested areas. In SacWAM, these values do not vary in time. See **upper watershed parameterization** and **upper watershed expressions** for details.

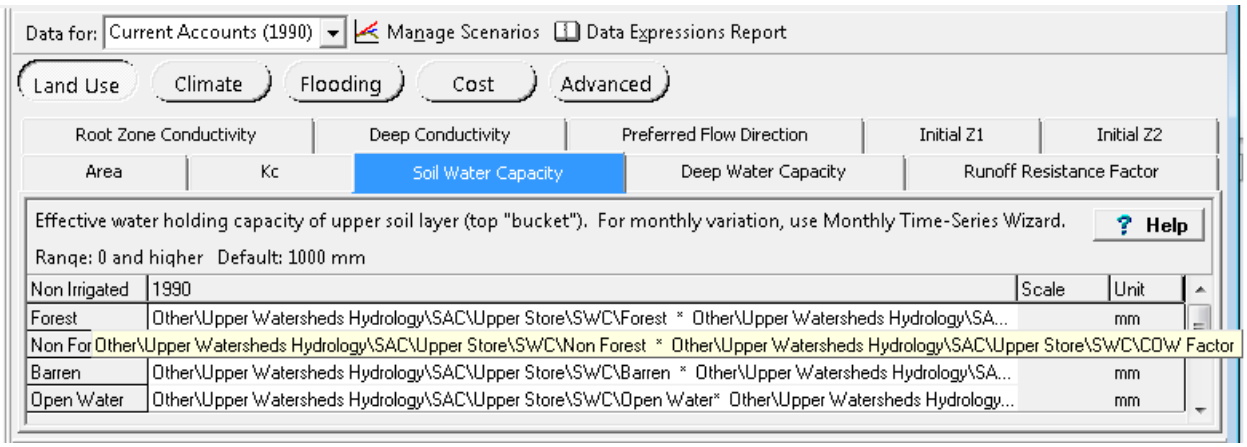


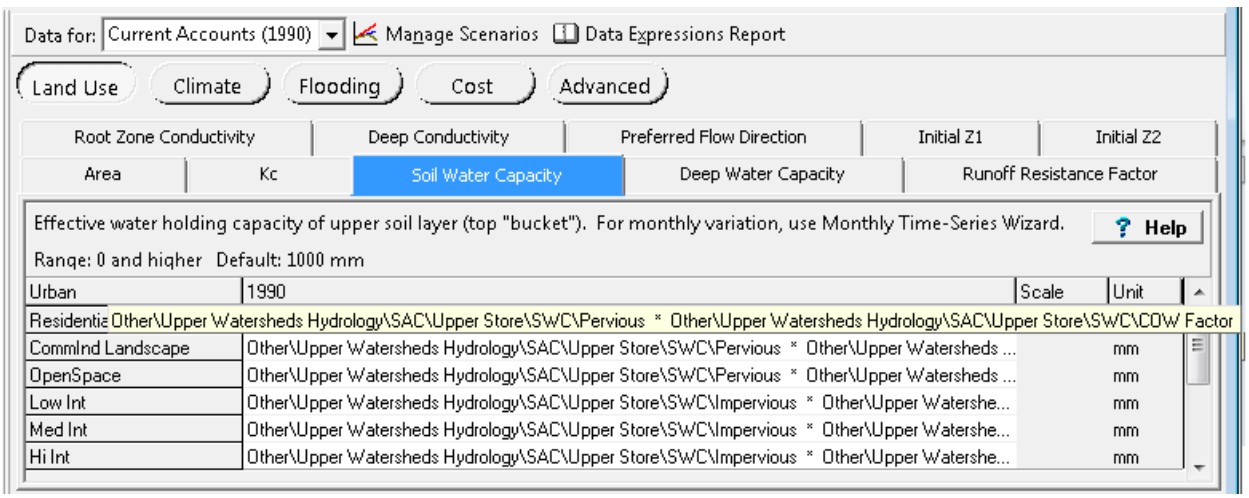


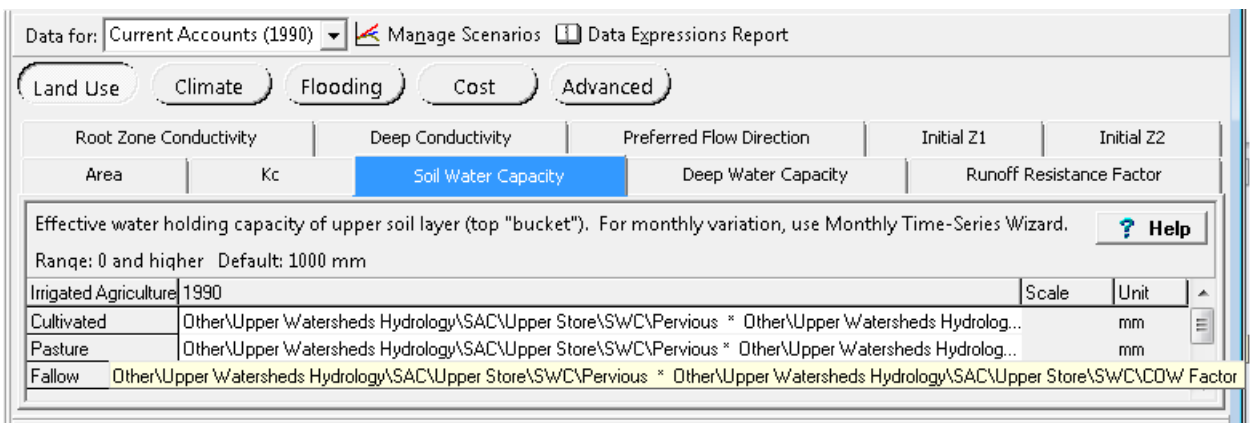


5.2.2.3 *Soil Water Capacity*

The soil water capacity is the maximum amount of water that can be stored in the upper compartment of the Soil Moisture Model. This is effectively the root zone soil water capacity. Soil water capacity was specified through two parameters—a land use–specific value multiplied by a subwatershed-specific multiplier. The land use–specific parameter was taken from the CVPA model. During calibration of SacWAM, subwatershed scaling factors were utilized to scale the soil water capacity values for all catchments that contribute to a specific flow calibration point. The scaling factors are located in *Other Assumptions\Upper Watershed Hydrology\SAC\Upper Store\SWC*. See **upper watershed parameterization** and **upper watershed expressions** for details.

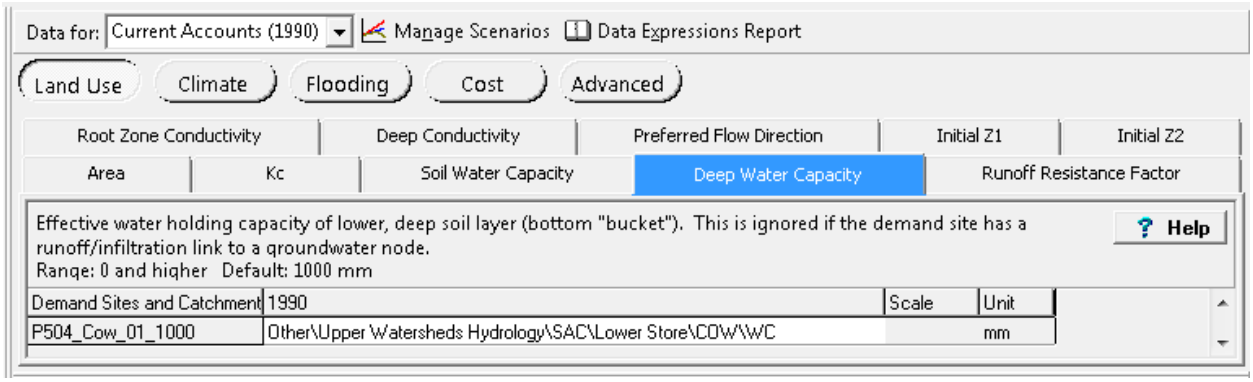






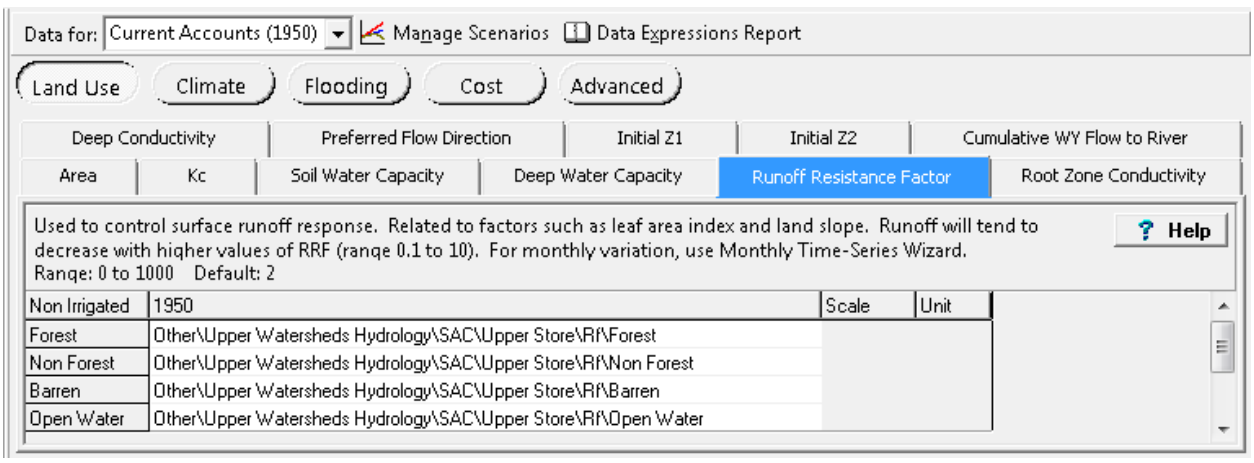
5.2.2.4 *Deep Water Capacity*

The deep water capacity is the maximum amount of water that can be stored in the second compartment of the Soil Moisture Model. Deep water capacity (WC) was initially given a value of 1000 mm for all catchments. During calibration of the baseflow portion of the hydrograph for some sub watersheds it was necessary to alter the value. These values are located in *Other Assumptions\Upper Watershed Hydrology\SAC\Lower Store* under the parameter name WC. All values are provided in **upper watershed parameterization**.



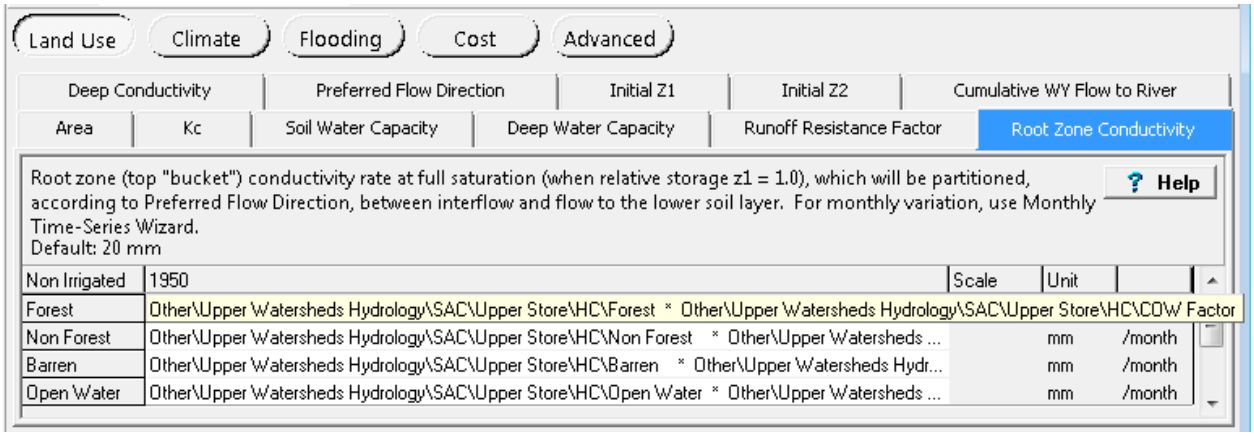
5.2.2.5 *Runoff Resistance Factor*

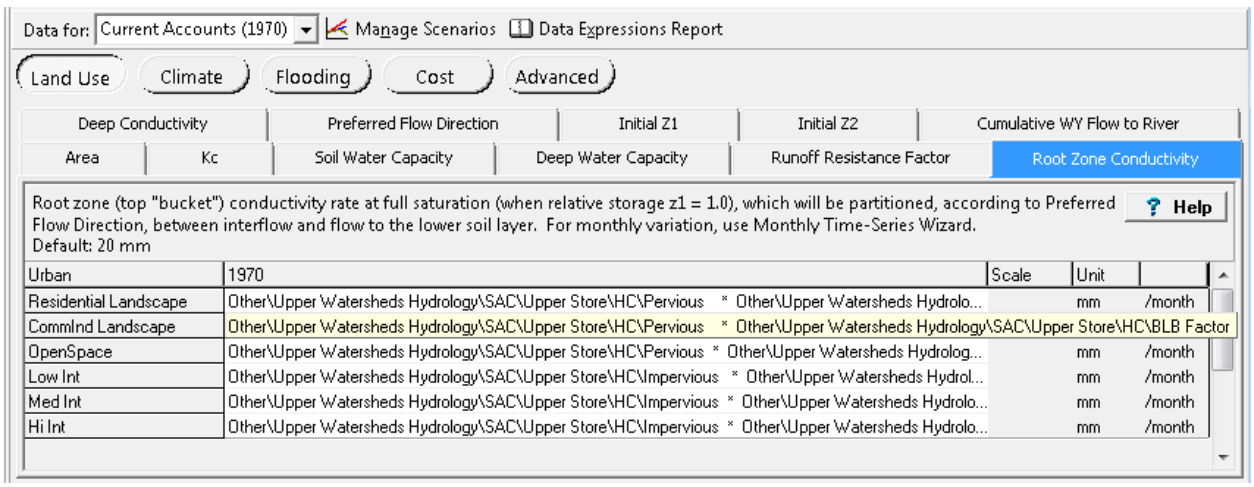
The runoff resistance factor reduces the rapidity of surface runoff thereby increasing the potential for water to infiltrate into the soil. In SacWAM, the runoff resistance factor (Rf) is based on land use class with smaller values for more pervious land cover types such as barren soil and impervious surfaces in urban areas. Higher values were assigned to areas with denser vegetation cover such as forests and pervious surfaces in urban areas. These values are located in *Other Assumptions\Upper Watershed Hydrology\SAC\Upper Store\Rf.* All values are provided in the **upper watershed parameterization** file.

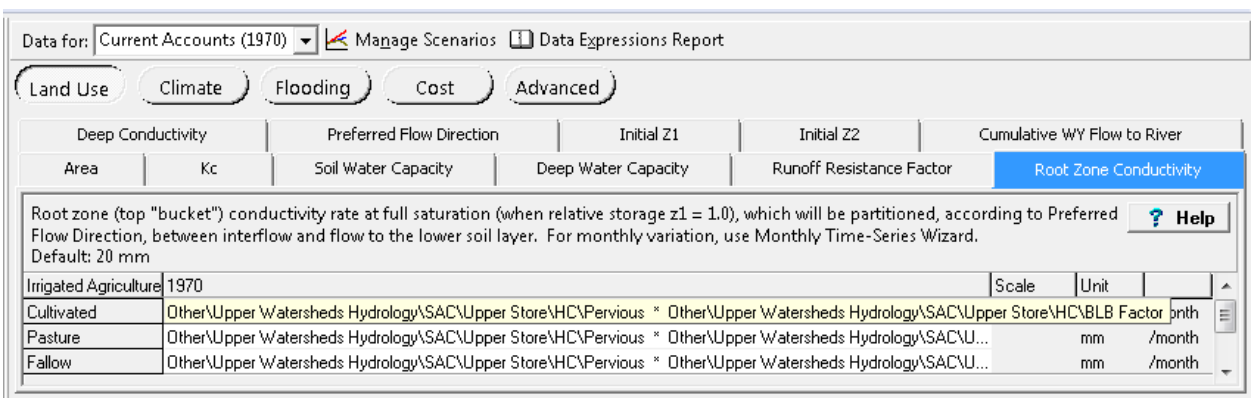


5.2.2.6 *Root Zone Conductivity*

The root zone conductivity specifies the hydraulic conductivity in the root zone. Root zone conductivity (HC) is specified through two parameters—a land use–specific value multiplied by a sub watershed-specific multiplier. The land use–specific parameters were obtained from the CVPA model. During calibration these values were modified on a subwatershed basis. These values are located in *Other Assumptions\Upper Watershed Hydrology\SAC\Upper Store\HC.* See **upper watershed parameterization** and **upper watershed expressions** for details.

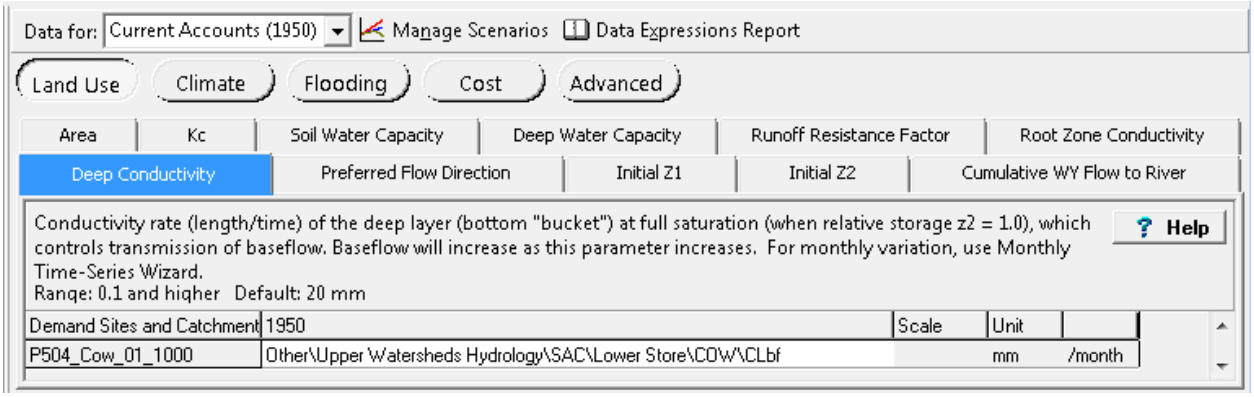






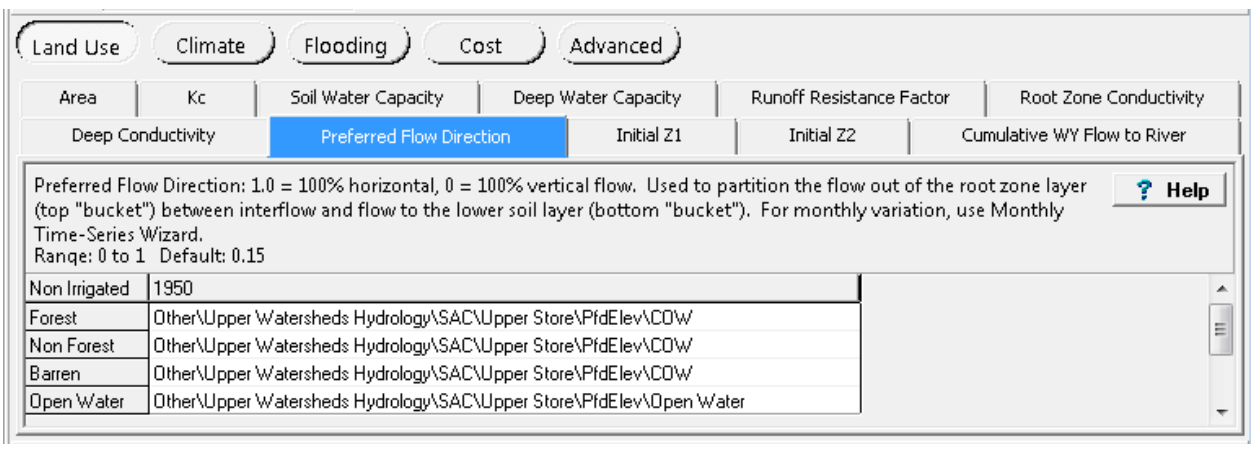
5.2.2.7 *Deep Conductivity*

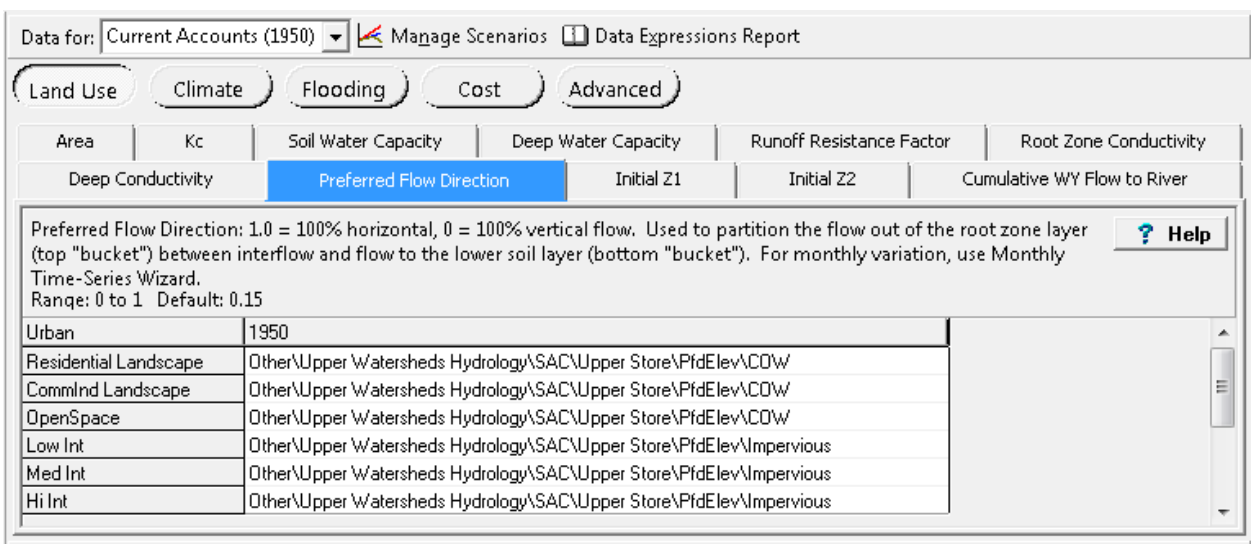
The deep conductivity parameter specifies the conductivity of the second, deep, compartment of the Soil Moisture Model. This parameter was initially set to a value of 500 mm/month, similar the CVPA. During calibration it was adjusted on a sub watershed basis. These values are located in *Other Assumptions\Upper Watershed Hydrology\SAC\Lower Store* under the parameter name CLbf. See **upper watershed parameterization** and **upper watershed expressions** for details.

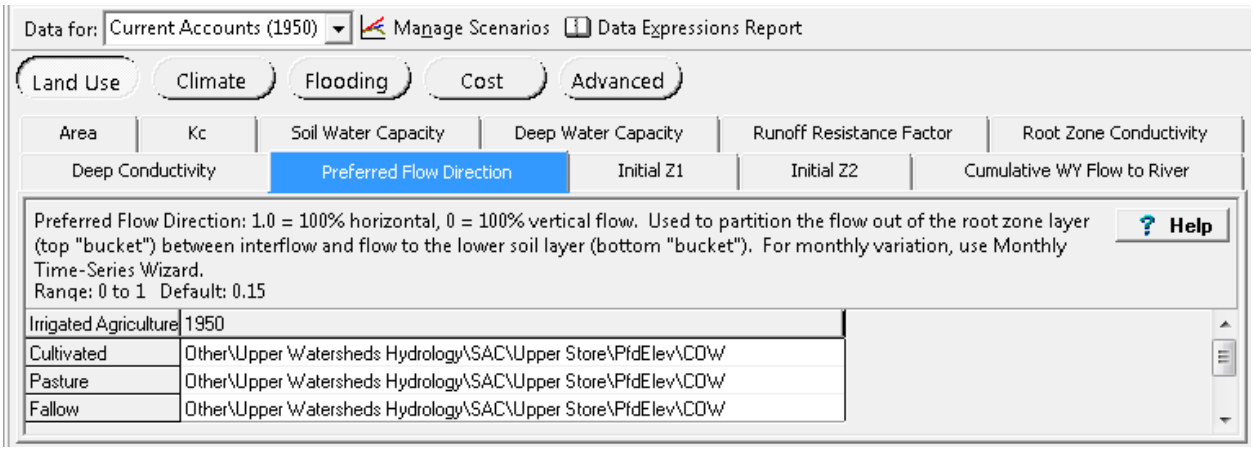


5.2.2.8 *Preferred Flow Direction*

The preferred flow direction is used to specify the division of flow from the root zone into interflow or deep percolation into the second compartment. Initially, land-use specific values were obtained from the CVPA model. During calibration it was adjusted on a sub watershed basis. These values are located in *Other Assumptions\Upper Watershed Hydrology\SAC\PfdElev.* See **upper watershed parameterization** and **upper watershed expressions** for details.

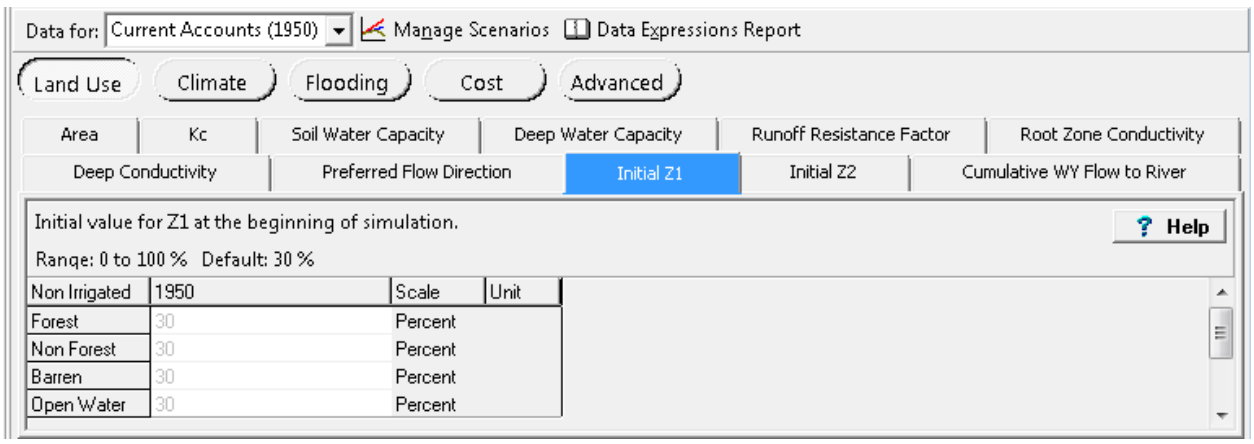






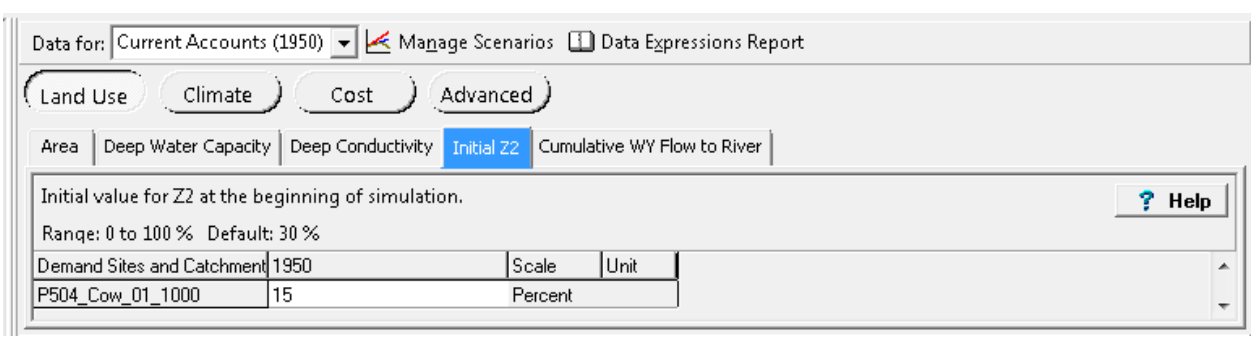
5.2.2.9 *Initial Z1*

The initial Z1 value is the initial soil moisture condition for the top compartment in the Soil Moisture Model. The default value for initial Z1 is 30%.



5.2.2.10 *Initial Z2*

The initial Z2 value is the initial soil moisture condition for the top compartment in the Soil Moisture Model. The value for initial Z2 has been set to 15%.



5.3 Data Directory

Table 5-6 provides location information in the SacWAM data directory for the datasets referenced in Chapter 5.

Table 5-6. File Location Information for Upper Watersheds Demand Sites and Catchments

Referenced Name	File Name(s)	File Location
catchment analysis	Catchments.xlsx	Data\Demand_Sites_and_Catchments\Upper_Watershed_Catchments
catchment land use	NLCD_all.xlsx	Data\Demand_Sites_and_Catchments\Upper_Watershed_Catchments
catchments	Catchments_final	GIS\Boundaries
climate dataset	*Individual files by coordinates*	Livneh Data
flow accumulation	nhdplusfac18b, nhdplusfac18c	GIS\Hydrology
flow direction grid	nhdplusfdr18b, nhdplusfdr18c	GIS\Hydrology
latitudes	catchment_and_DU_latitudes.xlsx	Data\Demand_Sites_and_Catchments
land-use tif	2011_SacWAM.tif	GIS\Landuse
Livneh grid	Livneh_Grid_Coords_UTM11.shp	GIS\Climate
NEDsnapshot	elev_cm_18b, elev_cm_18c	GIS\Elevation
pour point grid	upws_pts_grd	GIS\Hydrology
pour points	upws_ppts	GIS\Hydrology
reclassified elevation grid	ned_m_18b, ned_m_18c	GIS\Elevation
reclassified elevation shapefile	ned_m_upws	GIS\Elevation
simplified NLCD	NLCD_[*Region*]_Dissolve	GIS\Landuse
upper watershed expressions	UpperWShed_Expressions.xlsx	Data\Demand_Sites_and_Catchments\Upper_Watershed_Catchments
upper watershed parameterization	Upper_ws_parameterization.xlsx	Data\Other_Assumptions\Upper_Watersheds
upper watershed processor	UpperWShed_Livneh_Data_Processor.xlsm	Data\Demand_Sites_and_Catchments\Climate\Upper Watersheds
upper watershed rasters	upws_18b, upws_18c, losvaq	GIS\Boundaries
upper watersheds	Upws_final	GIS\Boundaries
WEAP input data	*Individual files by catchment*	Data\Demand_Sites_and_Catchments\Climate\WEAP Input Data