Antelope Creek Groundwater Basin

- Groundwater Basin Number: 5-91
- County: Colusa
- Surface Area: 2,040 acres (3 square miles)

Basin Boundary and Hydrology

The Antelope Creek Groundwater Basin is located east of Black Mountain in Antelope Valley. The basin consists of Quaternary alluvium and is bounded on all sides by Upper Cretaceous marine deposits. Several northeast trending faults may transect the valley (Jennings 1960). The basin is drained to the north by Antelope Creek. Annual precipitation is approximately 18 inches.

Hydrogeologic Information

Hydrologic information was not available for the following:

Water-Bearing Formations

Groundwater Level Trends

Groundwater Storage

Groundwater Budget (Type B)

The estimate of groundwater extraction is based on a 1993 survey conducted by the California Department of Water Resources. The survey included land use and sources of water. Groundwater extraction for municipal/industrial use is estimated to be 2 acre-feet. Deep percolation of applied water is estimated to be 1 acre-foot.

Groundwater Quality

Well Characteristics

	Well yields (gal/min)
Municipal/Irrigation	NKD
	Total depths (ft)
Domestic	NKD
Municipal/Irrigation	NKD

NKD – No known data

Active Monitoring Data

Agency	Parameter	Number of wells /measurement frequency
	Groundwater levels	NKD
	Miscellaneous water quality	NKD

NKD – No Known Data

Basin Management

Groundwater management:	Colusa County adopted a groundwater management ordinance in 1998.
Water agencies	
Public	None
Private	None

Selected References

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Errata

Changes made to the basin description will be noted here.

Funks Creek Groundwater Basin

- Groundwater Basin Number: 5-90
- County: Glenn, Colusa
- Surface Area: 3,000 acres (5 square miles)

Basin Boundary and Hydrology

The Funks Creek Groundwater Basin is located north of Antelope Valley and overlies the boundary of Glenn and Colusa Counties. The basin is north of a series of northeast trending faults and is bounded on all sides by Upper Cretaceous Marine deposits. The basin consists of Quaternary alluvial deposits and is drained to the east by Grapevine Creek and Funks Creek (Jennings 1960). Annual precipitation is approximately 18 inches.

Hydrogeologic Information

Hydrologic information was not available for the following:

Water-Bearing Formations

Groundwater Level Trends

Groundwater Storage

Groundwater Budget

Groundwater Quality

Well Characteristics

	Well yields (gal/min)
Municipal/Irrigation	NKD
	Total depths (ft)
Domestic	NKD
Municipal/Irrigation	NKD

NKD – No known data

Active Monitoring Data

Agency	Parameter	Number of wells /measurement frequency
	Groundwater levels	NKD
	Miscellaneous water quality	NKD

NKD – No Known Data

Basin Management

Groundwater management:	Glenn County adopted a groundwater management ordinance in 2000. Colusa County adopted a groundwater management ordinance in 1998.
Water agencies	
Public	None
Private	None

Selected References

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Planert M, Williams JS. 1995. Ground Water Atlas of the United States, Segment 1, California, Nevada. USGS. HA-730-B.

Errata

Changes made to the basin description will be noted here.

Sacramento Valley Groundwater Basin, Colusa Subbasin

- Groundwater Basin Number: 5-021.52
- County: Colusa, Glenn, Tehama, Yolo
- Surface Area: 918,380 acres (1,434 square miles)

Basin Boundaries and Hydrology

The portion of the Sacramento Valley that comprises the Colusa Subbasin is bounded on the east by the Sacramento River, on the west by the Coast Range and foothills, on the south by Cache Creek, and on the north by Stony Creek. Annual precipitation ranges from 17- to 27-inches with higher precipitation occurring to the west.

Hydrogeologic Information

Water-Bearing Formations

The Colusa Subbasin aquifer system is composed of continental deposits of late Tertiary to Quaternary age. Quaternary deposits include Holocene stream channel and basin deposits and Pleistocene Modesto and Riverbank formations. The Tertiary deposits consist of the Pliocene Tehama Formation and the Tuscan Formation. Except where noted, the following information is taken from USBR (1960).

Holocene Stream Channel Deposits. These deposits consist of unconsolidated gravel, sand, silt, and clay derived from the erosion, reworking, and deposition of adjacent Tehama Formation and Quaternary stream terrace deposits. The thickness varies from 1- to 80-feet (Helley and Harwood 1985). These deposits represent the upper part of the unconfined zone of the aquifer and are moderately-to-highly permeable; however, the thickness and areal extent of the deposits limit the water-bearing capability.

Holocene Basin Deposits. These deposits are the result of sediment-laden floodwaters that rose above natural levees of streams and rivers and spread across low-lying areas. They consist primarily of silts and clays and may be locally interbedded with stream channel deposits along the Sacramento River. Thickness of the unit ranges up to 150 feet. These deposits have low permeability and generally yield low quantities of water to wells. The quality of groundwater produced from basin deposits is often poor.

Pleistocene Modesto and Riverbank Formations. Terrace deposits include the Modesto Formation (deposited between 14,000 and 42,000 years ago) and the Riverbank Formation (deposited between 130,000 and 450,000 years ago). The Modesto deposits consist of moderately to highly permeable gravels, sands, and silts. Thickness of the formation ranges from less than 10 feet to nearly 200 feet across the valley floor (Helley and Harwood 1985). The Riverbank deposits are the older terrace deposits that occur at a higher topographic level and consist of poorly to highly pervious pebble and small cobble gravels interlensed with reddish clay, sand, and silt. Thickness of the formation ranges from less than 1 foot to over 200 feet depending on location. The formation yields moderate quantities of water to domestic and shallow irrigation wells and also provides water to deeper irrigation wells that have multiple zones of perforation. Generally, the thickness of the formation limits the water-bearing capabilities.

Pliocene Tehama Formation. The Tehama Formation is the predominant water-bearing unit within the Colusa Subbasin and reaches a thickness of 2,000 feet (Olmsted and Davis 1961). The formation occurs at depths ranging from a few feet to several hundred feet from the surface. The formation consists of moderately compacted silt, clay, and fine silty sand enclosing lenses of sand and gravel; silt and gravel; and cemented conglomerate. Occasional deep sands and thin gravels constitute a poorly to moderately productive, deep, water-bearing zone.

Pliocene Tuscan Formation. The Tuscan Formation occurs in the northern portion of the subbasin at an approximate depth of 400 feet from the surface and may extend to the west to the Greenwood Anticline east of Interstate Highway 5 (DWR 2000). The formation is composed of a series of volcanic mudflows, tuff breccia, tuffaceous sandstone, and volcanic ash layers. The formation is described as four separate but lithologically similar units, A through D (with Unit A being the oldest), which in some areas are separated by layers of thin tuff or ash units (Helley and Harwood 1985).

Units A, B, and C are found within the subbasin. Unit A is the oldest water-bearing unit of the formation and is characterized by the presence of metamorphic clasts within interbedded lahars, volcanic conglomerate, volcanic sandstone, and siltstone. Unit B is composed of a fairly equal distribution of lahars, tuffaceous sandstone, and conglomerate. Unit C consists of massive mudflow or lahar deposits with some interbedded volcanic conglomerate and sandstone. In the subsurface, these low permeability lahars form thick, confining layers for groundwater contained in the more permeable sediments of Unit B.

Subareas of the Colusa Subbasin

Stony Creek Fan. The Stony Creek Fan occupies the northern extent of the subbasin and extends from Black Butte Reservoir to the City of Willows, northeast from the City of Willows to the Sacramento River, and north beyond the Tehama County line. The geologic units within the fan area include Holocene alluvial deposits, Pleistocene deposits of the Riverbank and Modesto formations, and Pliocene deposits of the Tehama and Tuscan formations.

Holocene alluvial deposits are observed along Stony Creek to the north and along the Sacramento River to the east. Modesto and Riverbank deposits extend to the east along Stony Creek and south and southeast within several ancestral stream channels (DWR 2000). Older alluviated floodplain and channel deposits reach a thickness of 150 feet at Stony Creek and 110 feet along the Sacramento River.

Thick clays of the upper Tehama Formation underlie the intermediate water-bearing zone of the Stony Creek plain at a depth of 300 feet, rising to a minimum depth of 40 feet on the axis of the Willows anticline. Wells installed 4 miles east of Highway 99W intersect occasional Tehama Formation gravels between 225- and 625-foot depths.

Tuscan Units A, B, and C are believed to extend into the Colusa Subbasin north of the City of Willows. The sediments of the Tuscan Formation interfinger with the sediments of the Tehama Formation in the subsurface (Lydon 1969). The degree of hydraulic conductivity between the Tuscan Formation, the Tehama Formation, and the overlying Stony Creek fan deposits has not been established.

Willows-to-Williams Plain. Basin deposits overlie much of the flat alluvial plains in the area between Willows and Williams. Permeabilities of the near-surface soils are extremely low. Riverbank deposits are observed along the western subbasin boundary north of Maxwell. The interstream areas of the westside creeks contain little gravel and are underlain by a poorly pervious, occasionally alkaline, claypan soil. The Tehama Formation contains little gravel and is not an important water-bearing material in this region.

Arbuckle and Dunnigan Plains. Quaternary surface deposits of alluvium, Modesto and Riverbank formations, and basin deposits in the Arbuckle and Dunnigan plains occur east of Hungry Hollow and Dunnigan hills from Williams to Cache Creek. Basin deposits overlie older alluvial deposits. The region north of Arbuckle is alluviated to depths of 20- to 60-feet with moderately to highly permeable sands and gravels from Sand and Cortina creeks. This zone extends east of Highway 99W and, in the College City area, appears to be Sacramento River channel deposits. The area between Salt and Petroleum creeks is composed of poorly to moderately permeable gravels, clayey sands, and silts. Petroleum and Little Buckeye creeks have deposited a thin, moderately to highly permeable sandy gravel and sandy silts over older stream and terrace alluvium.

The area in the vicinity of Zamora is underlain by a homogeneous section of gravels, sands, and interbedded clays to minimum depths of 450 feet. Water producing members range from 25- to 35- percent of total material penetrated. Well production is high within gravel channels.
A poorly to highly productive water-bearing zone consisting of older alluvial deposits and Tehama deposits on the western and southwestern edges of the Arbuckle Plain ranges in depth from 100- to 300-feet. The zone thickens easterly to depths of 400- to 450-feet.

Tehama deposits coarsen in this area and are an important water-bearing unit. The upper 800- to 900-feet contains 10- to 13-percent fine pebble gravel with a well-sorted, fine to medium sand matrix. This portion of the Tehama Formation is highly pervious, loose, and well bedded. The gravel beds range from 5- to 20-feet in thickness and are well confined within a silt and clayey silt section.

Cache Creek Floodplain. Holocene stream channel deposits are observed along the entire extent of Cache Creek (DWR 2000). The Cache Creek area is alluviated with floodplain deposits which are exposed north of the town of Yolo and extend to Knights Landing. The relative proportion of sand and gravel for the depth interval of 20- to 100-feet is approximately 27 percent.

Between depths of 100- to 200-feet the proportion is reduced to 24 percent. The percentage of sand and gravel for deposits extending northward from Cache Creek averages 22 percent for the 20- to 200-foot interval. Farther east the proportion increases to 36 percent for the same depth interval (Olmsted and Davis 1961). Tehama deposits are penetrated in the depth interval of 100- to 200-feet.

Groundwater Level Trends

Review of hydrographs for long-term comparison of spring-spring groundwater levels indicates a slight decline in groundwater levels associated with the 1976-77 and 1987-94 droughts, followed by recovery to pre-drought conditions of the early 1970's and 1980's. Some wells increased in levels beyond the pre-drought conditions of the 1970's during the wet season of the early 1980's. Generally, groundwater level data show an average seasonal fluctuation of approximate 5-feet for normal and dry years. Overall there does not appear to be any increasing or decreasing trends in groundwater levels.

Groundwater Storage

The storage capacity of the subbasin was estimated based on estimates of specific yield for the Sacramento Valley as developed in DWR (1978). Estimates of specific yield, determined on a regional basis, were used to obtain a weighted specific yield conforming to the subbasin boundary. The estimated specific yield for the subbasin is 7.1 percent. The estimated storage capacity to a depth of 200 feet is approximately 13,025,887 acre-feet.

Groundwater Budget (Type B)

Estimates of groundwater extraction for the Colusa Subbasin are based on surveys conducted by the California Department of Water Resources during 1993, 1994, and 1999. Surveys included landuse and sources of water. Estimates of groundwater extraction for agricultural, municipal and industrial, and environmental wetland uses are 310,000, 14,000 and 22,000 acre-feet respectively. Deep percolation from applied water is estimated to be 64,000 acre-feet.

Groundwater Quality

Characterization. Calcium-magnesium bicarbonate and magnesium-calcium bicarbonate are the predominant groundwater types in the subbasin. Calcium bicarbonate waters occur locally from Orland to Artois and near Stony Creek. Mixed character waters for different regions of the subbasin occur as follows: sodium bicarbonate waters from Williams-Colusa south to Grimes; magnesium-sodium bicarbonate or sodium-magnesium bicarbonate waters near Williams-Arbuckle area and locally near Zamora; and magnesium bicarbonate waters locally near Dunnigan. Total dissolved solids (TDS) values range from 120- to 1,220-mg/L, averaging 391 mg/L (DWR unpublished data).

Impairments. High EC, TDS, adjusted sodium absorption ratio (ASAR), nitrate, and manganese impairments occur near Colusa. High TDS and boron occur near Knights Landing. High nitrates occur in Arbuckle, Knights

Landing, and Willows. Localized areas have high manganese, fluoride, magnesium, sodium, iron, ASAR, chloride, TDS, ammonia, and phosphorus.

Water Quality in Public Supply Wells

Constituent Group[1]	Number of wells sampled[2]	Number of wells with a concentration above an MCL[3]
Inorganics – Primary	103	0
Radiological	57	0
Nitrates	109	2
Pesticides	64	0
VOCs and SVOCs	58	0
Inorganics – Secondary	103	18

[1] A description of each member in the constituent groups and a generalized discussion of the relevance of these groups are included in *California's Groundwater – Bulletin 118* by DWR (2003).
[2] Represents distinct number of wells sampled as required under DHS Title 22 program from 1994 through 2000.
[3] Each well reported with a concentration above an MCL was confirmed with a second detection above an MCL. This information is intended as an indicator of the types of activities that cause contamination in a given basin. It represents the water quality at the sample location. It does not indicate the water quality delivered to the consumer. More detailed drinking water quality information can be obtained from the local water purveyor and its annual Consumer Confidence Report.

Well Characteristics

	Well yields (gal/min)	
Municipal/Irrigation	Range 25 – 5,600	Average: 1,967 (109 Well Completion Reports)
	Total depths (ft)	
Domestic	Range: 11 to 870	Average: 155 (2,599 Well Completion Reports)
Municipal/Irrigation	Range 20 to 1340	Average: 368 (1,515 Well Completion Reports)

Active Monitoring Data

Agency	Parameter	Number of wells /measurement frequency
DWR	Groundwater levels	98 wells semi-annually
DWR	Miscellaneous water quality	30 wells biennially
Department of Health Services	Miscellaneous water quality	134

Basin Management

Groundwater management:	Tehama County adopted a groundwater management ordinance in 1994. Glenn County adopted a groundwater management ordinance in 2000. Colusa County adopted a groundwater management ordinance in 1998. Yolo County adopted a groundwater management ordinance in 1996. Reclamation District No. 787 adopted a groundwater management plan in Feb. 1997 and the plan was amended on November 16, 2005.
Water agencies	
Public	Knights Landing WUA, Orland Unit WUA. Cortina Creek FC&WCD, Colusa County FC&WCD, and Yolo County FC&WCD, Artois CSD, Butte City CSD, Hamilton City CSD, NE Willows CSD, Ord CSD, City of Colusa, City of Orland, City of Williams, 4-M WD, Chrome WD, Colusa County WD, Cortina WD, Davis WD, Dunnigan WD, Glenn Valley WD, Glide WD, Holthouse WD, Kanawha WD, La Grande WD,Orland-Artois WD, Princeton WD, Westside WD, and Yolo-Zamora WD, Glenn-Colusa ID, Maxwell ID, Princeton-Cordora-Glenn ID, Provident ID, Maxwell ID, RD 108, RD 478, RD 730, RD 787, RD 1004, RD 2047, Arbuckle PUD, Maxwell PUD
Private	California Water Service Co., Colusa Drain Mutual Water Co., California Water Service Co., Roberts Ditch & Irr. Co. Inc, Willow Creek Mutual Water Co.

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Errata

Updated groundwater management information and added hotlinks to applicable websites. (1/20/06)

Sacramento Valley Groundwater Basin, Red Bluff Subbasin

- Groundwater Basin Number: 5-21.50
- County: Tehama
- Surface Area: 266,750 acres (416 square miles)

Basin Boundaries and Hydrology

The Red Bluff Subbasin is bounded on the west by the Coast Ranges, on the north by the Red Bluff Arch, on the south by Thomes Creek and on the east by the Sacramento River. The Red Bluff Arch is a hydrologic divide between the Redding Basin to the north and the Sacramento Valley. The Red Bluff Subbasin is likely contiguous with the Corning Subbasin at depth. Annual precipitation in the subbasin ranges from 19- to 27-inches with higher precipitation occurring to the north.

Hydrogeologic Information

Water-Bearing Formations

The Red Bluff Subbasin aquifer system is composed of continental deposits of late Tertiary to Quaternary age. The Quaternary deposits include Holocene stream channel deposits and Pleistocene Modesto and Riverbank formations. The Tertiary deposits consist of Pliocene Tehama and Tuscan formations.

Holocene Stream Channel Deposits. These deposits consist of unconsolidated gravel, sand, silt and clay derived from the erosion, reworking, and deposition of adjacent Tehama Formation and Quaternary stream terrace deposits found at or near the surface along stream and river channels. The thickness varies from 1-to 80-feet (Helley and Harwood 1985). This unit represents the upper part of the unconfined zone of the aquifer. Although it is moderately to highly permeable it is not a significant contributor to groundwater because of its limited areal extent.

Pleistocene Modesto Formation. The Modesto Formation (deposited between 14,000 to 42,000 years ago) consists of poorly indurated gravel and cobbles with sand, silt, and clay derived from reworking and deposition of the Tehama and Riverbank formations. The deposit ranges from less than 10 feet to nearly 200 feet across the valley floor (Helley and Harwood 1985). The terrace deposits are observed along Thomes, Elder, and Red Bank Creeks.

Pleistocene Riverbank Formation. The Riverbank Formation (deposited between 130,000 to 450,000 years ago) consists of poorly-to-highly permeable pebble and small cobble gravels interlensed with reddish clay sands and silt. The formation ranges from less than one foot to over 200 feet thick depending on location (Helley and Harwood 1985). Riverbank terrace deposits are observed along Thomes, Pine, Dibble, Reeds, Red Bank, Oat and Elder Creeks.

Pliocene Tehama Formation. The Tehama Formation consists of sediments originating from the Coast Range and Klamath Mountains, and is the primary source of groundwater for the subbasin. The majority of the Tehama Formation consists of fine-grained sediments indicative of deposition under floodplain conditions (McManus 1993). The thickness of coarse-grained beds of sand and gravel, as indicated by drill log data, are typically no more than 5- to 10-feet. The majority of both coarse and fine-grained sediments appears unconsolidated or moderately consolidated. The thickness of the formation is estimated to be up to 1,200 feet north of the City of Corning (DWR 2000).

Pliocene Tuscan Formation. The Tuscan Formation consists of volcanic gravel and tuff-breccia, fine- to coarse-grained volcanic sandstone, conglomerate and tuff, and tuffaceous silt and clay; derived predominantly from andesitic and basaltic sources of the Cascade Range. In the subsurface the Tuscan Formation is found juxtaposed with the Tehama Formation in the axis of the valley near the Sacramento River. Permeability is moderate to high with yields ranging from 100 to 1,000 gpm, excluding areas where beds of the impermeable tuff-breccia exist.

Restrictive Structures

The Red Bluff Arch is a hydrologic divide between the Redding Basin to the north and the Sacramento Valley.

Groundwater Level Trends

Review of hydrographs for long-term comparison of spring-spring groundwater levels indicates a decline of 3- to 7-feet associated with the 1976-77 and 1987-94 droughts, followed by a recovery to pre-drought conditions of the early 1970's and 1980's. Generally, groundwater level data show a seasonal fluctuation ranging from 5- to 10-feet for unconfined, semi-confined, and composite wells. Wells constructed in confined aquifers can fluctuate up to 50 feet. Overall, there does not appear to be any increasing or decreasing trends in the groundwater levels.

Groundwater Storage

The storage capacity of the subbasin was estimated based on estimates of specific yield for the Sacramento Valley as developed in DWR (1978). Estimates of specific yield, determined on a regional basis, were used to obtain a weighted specific yield conforming to the subbasin boundary. The estimated specific yield for the subbasin is 7.9 percent. The estimated storage capacity to a depth of 200 feet is approximately 4,208,851 acre-feet.

Groundwater Budget (Type B)

Estimates of groundwater extraction for the Red Bluff Subbasin are based on a survey conducted by the California Department of Water Resources in 1994. The survey included landuse and sources of water. The estimate of groundwater extraction for agricultural use is estimated to be 81,000 acre-feet. Groundwater extraction for municipal and industrial uses is 8,900 acre-feet. Deep percolation from applied water is estimated to be 20,000 acre-feet.

Groundwater Quality

Characterization. Calcium-magnesium bicarbonate and magnesium-calcium bicarbonate are the predominant groundwater types in the subbasin. Total dissolved solids (TDS) concentrations range from 120- to 500-mg/L and average 207 mg/L (DWR unpublished data).

Impairments. Impairments include high magnesium, TDS, calcium, ASAR, and phosphorus.

Water Quality in Public Supply Wells

Constituent Group[1]	Number of wells sampled[2]	Number of wells with a concentration above an MCL[3]
Inorganics – Primary	41	2
Radiological	33	0
Nitrates	41	0
Pesticides	23	0
VOCs and SVOCs	16	0
Inorganics – Secondary	41	4

[1] A description of each member in the constituent groups and a generalized discussion of the relevance of these groups are included in *California's Groundwater – Bulletin 118* by DWR (2003).
[2] Represents distinct number of wells sampled as required under DHS Title 22 program from 1994 through 2000.
[3] Each well reported with a concentration above an MCL was confirmed with a second detection above an MCL. This information is intended as an indicator of the types of activities that cause contamination in a given basin. It represents the water quality at the sample location. It does not indicate the water quality delivered to the consumer. More detailed drinking water quality information can be obtained from the local water purveyor and its annual Consumer Confidence Report.

Well Characteristics

	Well yields (gal/min)	
Municipal/Irrigation	Range: 50 – 1,200	Average: 363 (4 Well Completion Reports)
	Total depths (ft)	
Domestic	Range: 20 – 780	Average: 197 (3293 Well Completion Reports)
Municipal/Irrigation	Range: 22 – 465	Average: 207 (18 Well Completion Reports)

Active Monitoring Data

Agency	Parameter	Number of wells /measurement frequency
DWR	Groundwater levels	29 wells semi-annually
USBR	Groundwater levels	1 well semi-annually
DWR	Miscellaneous water quality	10 wells biennially
Department of Health Services and cooperators	Miscellaneous water quality	56

Basin Management

Groundwater management:	Tehama County adopted a groundwater management ordinance in 1994. Tehama County adopted a countywide AB 3030 plan in 1996.
Water agencies	
Public	Tehama County Flood Control and Water Conservation District. El Camino ID, Elder Creek WD, Gerber-Los Flores Community Service District, Gerber Water Works Inc., Tehama Ranch M.W.C., Proberta WD, Rawson WD, Thomes Creek WD, City of Red Bluff.
Private	

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Errata

Changes made to the basin description will be noted here.

Sacramento Valley Groundwater Basin
Yolo Subbasin

- Groundwater Basin Number: 5-21.67
- County: Yolo, Solano
- Surface Area: 256,000 acres (400 square miles)

Boundaries & Hydrology

The Yolo Subbasin, located in the southern portion of the Sacramento Valley Basin primarily within Yolo County. It is bounded on the east by the Sacramento River, on the west by the Coast Range, on the north by Cache Creek, and on the south by Putah Creek. The basin is roughly bisected by an anticlinal structure, but otherwise is gently sloping from west to east with elevations ranging from approximately 400 feet at the base of the Coast Range to the west to nearly sea level in the eastern areas. Major cities within the subbasin include Davis, West Sacramento, Winters, and Woodland.

Precipitation averages approximately 20 to 24 inches per year in the western portion of the subbasin, and approximately 18 to 20 inches per year in the eastern portion of the subbasin.

Hydrogeologic Information

Water Bearing Formations

The primary water bearing formations comprising the Yolo subbasin are sedimentary continental deposits of Late Tertiary (Pliocene) to Quaternary (Holocene) age. Fresh water-bearing units include younger alluvium, older alluvium, and the Tehama Formation (Olmstead, 1961 and DWR, 1978). The cumulative thickness of these units ranges from a few hundred feet near the Coast Range on the west to nearly 3000 feet near the eastern margin of the basin. Saline water-bearing sedimentary units underlie the Tehama formation and are generally considered the boundary of fresh water (Berkstresser, 1973).

Younger alluvium includes flood basin deposits and Recent stream channel deposits. Flood basin deposits occur along the eastern margin of the subbasin in the Yolo Flood Basin. They consist primarily of silts and clays, but along the eastern margin of the subbasin may be locally interbedded with stream channel deposits of the Sacramento River. Thickness of the unit ranges from 0 to 150 feet. The flood basin deposits have low permeability and generally yield low quantities of water to wells. The quality of ground water produced from the basin deposits is often poor.

Recent stream channel deposits consist of unconsolidated silt, fine- to medium-grained sand, gravel and occasionally cobbles deposited in and adjacent to active streams in the subbasin. They occur along the Sacramento River, Cache Creek, and Putah Creek. Thickness of the younger alluvium ranges from 0 to 150 feet.

The younger alluvium varies from moderately to highly permeable, but often lies above the saturated zone. Where saturated, the younger alluvium yields significant quantities of water to wells.

Older alluvium consists of loose to moderately compacted silt, silty clay, sand, and gravel deposited in alluvial fans during the Pliocene and Pleistocene. Thickness of the unit ranges from 60 to 130 feet, about one-quarter of which is coarse sand and gravel. Permeability of the older alluvium is highly variable. Wells penetrating sand and gravel lenses of the unit produce between 300 and 1000 gpm. Adjacent to the Sacramento River, wells completed in ancestral Sacramento River stream channel deposits yield up to 4000 gpm. Wells completed in the finer-grained portions of the older alluvium produce between 50 and 150 gpm.

The Tehama Formation is the thickest water-bearing unit underlying the Yolo subbasin, ranging in thickness from 1500 to 2500 feet. Surface exposures of the Tehama Formation are limited mainly to the Coast Range foothills along the western margin of the basin, as well as in the Plainfield Ridge. The Tehama consists of moderately compacted silt, clay, and silty fine sand enclosing lenses of sand and gravel, silt and gravel, and cemented conglomerate. Permeability of the Tehama Formation is variable, but generally less than the younger units. Because of its relatively greater thickness, however, wells completed in the unit can yield up to several thousand gallons per minute.

Underlying the Tehama Formation are brackish to saline water-bearing sedimentary units, including the somewhat brackish sedimentary rocks of volcanic origin (Pliocene to Oligocene?) underlain by marine sedimentary rocks (Oligocene? to Paleocene) which are typically of low permeability and contain connate water (Olmstead, 1961). The upper contact of these units generally coincides with the fresh/saline water boundary. The contact is found near the Coast Range at depths as shallow as a few hundred feet. Near the eastern margin of the basin it reaches depths of nearly 3000 feet.

Subsurface Flow Controls

The geologic structure of the groundwater subbasin is dominated by an anticlinal ridge oriented northwest to southeast, which is expressed at the surface as the Dunnigan Hills and Plainfield Ridge. The anticlinal structure impedes subsurface flow from west to east. Subsurface groundwater outflow sometimes occurs from the Yolo subbasin into the Solano subbasin to the south. Subsurface outflow and inflow may also occur beneath the Sacramento River to the east with the South and North American subbasins. Subsurface groundwater inflow may occur from the west out of the Capay Valley Basin.

Groundwater Level Trends

Groundwater levels are impacted by periods of drought due to increased groundwater pumping and less surface water recharge (e.g. in the late 1970's and early 1990's), but recover quickly in "wet" years. Long term trends do not indicate any significant decline in water levels, with the exception of localized pumping depressions in the vicinity of the Davis, Woodland and Dunnigan/Zamora areas. Past studies (Scott, 1975) have concluded that the

Yolo subbasin is subject to overdraft, however the completion of Indian Valley Reservoir in 1976 provided significant relief in the form of additional available surface water (YCFCWCD, 2000).

Groundwater Storage

Many studies have been conducted to determine the groundwater storage within parts or all of Yolo County. Several of these studies refer to calculations completed by Scott and Scalmanini in their 1975 report, Investigations of Groundwater Resources, Yolo County. Groundwater storage capacity for the entire county for groundwater aquifer depths between 20 and 420 feet was calculated as 14,038,000 acre-feet based on subtotals from six separate study areas. Specific yields were calculated, based on well log information, for three separate depth intervals within six study areas, and ranged from 6.5% to 9.7%.

Groundwater Storage Capacity. From the Scott and Scalmanini calculations it can be roughly estimated that the Yolo Subbasin, (defined in this report as a portion of the county) has a total storage capacity of 6,455,940 acre-feet for depths between 20 and 420 feet (see below).

Table: Storage capacity was calculated based on Scott (1975) as follows:

Groundwater Basin (Scott, 1975)	Area (acres)	Calculated Gross Storage Capacity (Scott, 1975)	Estimated % area within Yolo Subbasin[1]	Estimated Storage Capacity within Yolo Subbasin[1]
Cache Creek	45,800	1,678,100	20%	335,620
Upper Cache-Putah	70,300	2,017,700	100%	2,017,700
Plainfield Ridge	8,800	240,800	100%	240,800
Lower Cache-Putah	97,300	2,876,900	95%	2,733,055
Colusa	95,700	2,709,800	0%	0
Yolo Bypass	129,100	4,514,700	25%	1,128,765
Totals	**447,000**	**14,038,000**		**6,455,940**

[1]Represents the portion of each Groundwater Basin (as defined by Scott, 1975) that is contained within the Yolo Subbasin (as defined by the DWR). Percentages were estimated by DWR staff.

Groundwater in Storage. Groundwater storage between the depths of 20 to 420 feet in 1974 for all of Yolo County was calculated to be 13,208,400 acre-feet (Scott, 1975). Based on the Scott report, groundwater storage within the Yolo Subbasin for 1974 is estimated at 6,074,220 acre-feet (see below).

Table: 1974 groundwater storage calculations based on Scott (1975):

Groundwater Basin (Scott, 1975)	Area (acres)	1974 Calculated Storage (Scott, 1975)	Estimated % area within Yolo Subbasin[1]	Estimated 1974 Storage within Yolo Subbasin[1]
Cache Creek	45,800	1,528,700	20%	305,740
Upper Cache-Putah	70,300	1,921,000	100%	1,921,000
Plainfield Ridge	8,800	189,400	100%	189,400
Lower Cache-Putah	97,300	2,677,400	95%	2,543,530
Colusa	95,700	2,433,700	0%	0
Yolo Bypass	129,100	4,458,200	25%	1,114,550
Totals	**447,000**	**13,208,400**		**6,074,220**

[1]Represents the portion of each Groundwater Basin (as defined by Scott, 1975) that is contained within the Yolo Subbasin (as defined by the DWR). Percentages were estimated by DWR staff.

Groundwater Budget (Type C)

Currently no groundwater budget has been calculated for the Yolo Subbasin (see comments below).

Groundwater Quality

Groundwater found within the subbasin is characterized as a sodium magnesium, calcium magnesium, or magnesium bicarbonate type. The quality is considered good for both agricultural and municipal uses, even though it is hard to very hard overall (generally over 180 mg/l $CaCO_3$). Selenium and boron are found in higher concentrations locally (Evenson, 1985). Total dissolved solids range from a of 107 ppm to 1300 ppm and average 574 ppm, based on Title 22 data obtained from public supply water well samples (DHS, 2000).

Localized impairments include elevated concentrations of boron (as high as 2 to 4 ppm) in groundwater along Cache Creek and in the Cache Creek Settling Basin area, increased levels of selenium present in the groundwater supplies for the City of Davis, and localized areas of nitrate contamination (YCFCWCD 1992) (Evenson, 1985).

Water Quality in Public Supply Wells

Constituent Group[1]	**Number of wells sampled[2]**	**Number of wells with a concentration above an MCL[3]**
Inorganics – Primary	61	3
Radiological	53	0
Nitrates	67	1
Pesticides	59	0
VOCs and SVOCs	59	1
Inorganics – Secondary	61	11

[1] A description of each member in the constituent groups and a generalized discussion of the relevance of these groups are included in *California's Groundwater – Bulletin 118* by DWR (2003).
[2] Represents distinct number of wells sampled as required under DHS Title 22 program from 1994 through 2000.
[3] Each well reported with a concentration above an MCL was confirmed with a second detection above an MCL. This information is intended as an indicator of the types of activities that cause contamination in a given basin. It represents the water quality at the sample location. It does not indicate the water quality delivered to the consumer. More detailed drinking water quality information can be obtained from the local water purveyor and its annual Consumer Confidence Report.

Well Characteristics

	Well yields (gal/min)	
Municipal/Irrigation	Range: 150 – 4000+	Average: 1500 (estimate)
	Total depths (ft) [1]	
Domestic	Range: 40 - 600	Average: 230 (estimate)
Municipal/Irrigation	Range: 50 - 1500	Average: 400 (estimate)

[1]Based on DWR data.

Active Monitoring Data

Agency	Parameter	Number of wells /measurement frequency
DWR	Groundwater Levels	10 semi-annually 4 monthly
YCFC&WCD		92 semi-annually 1 monthly
Sacramento County		1 semi-annually
USBR		12 semi-annually 7 monthly
DHS	Water Quality	133 annually
DWR	Ground Subsidence	1 continuously

Basin Management

Groundwater management:	R.D. 108 adopted AB3030 plan 2/95 R.D. 2035 adopted AB3030 plan 4/95 R.D. 2068 adopted AB3030 plan 1/97 Yolo County Flood Control and Water Conservation District are drafting plan but not pursuant to AB3030 R.D. 900, City of West Sacramento is not drafting AB3030 plan
Water agencies	
Public	Yolo County Flood Control and Water Conservation District City of Woodland, City of Davis, City of West Sacramento
Private	R.D. 108, 900,2035, 2068

Comments:

Although groundwater budgets have been previously calculated for areas overlying the Yolo Subbasin, no groundwater budget has been calculated for the Yolo Subbasin as defined by this report.

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Errata

Changes made to the basin description will be noted here.

5-021.67 SACRAMENTO VALLEY - YOLO

Basin Boundaries

Summary

The Yolo groundwater subbasin is in the southern portion of the Sacramento Valley Basin and includes the majority of Yolo County. The northern, eastern and southern boundaries are predominately defined by the Colusa, Sacramento and Solano County lines, respectively. The subbasin includes the Solano County portion of the University of California at Davis and does not include the Yolo County portions of Colusa County Water District, Reclamation Districts 150, 307, 999, 2068, and 2093. The basin extends to the coast range on the west. The Capay Hills provide a barrier between the main part of the subbasin and Capay Valley, but Capay Valley is interconnected and part of the Yolo subbasin. The subbasin is defined by the 19 segments detailed in the descriptions below.

Segment Descriptions

Segment Label	Segment Type	Description	Ref
1-2	I County	Begins at point (1) and follows the Yolo/Colusa County line to point (2).	{a}
2-3	E Non-Alluvial	Continues from point (2) and generally follows the contact of nonmarine deposits with marine sedimentary rocks of the Great Valley Sequence, around the Capay Hills, to point (3).	{b}
3-4	I County	Continues from point (3) and follows the Yolo/Colusa County line to point (4).	{a}
4-5	I Water Agency	Continues from point (4) and follows the Colusa County Water District boundary to point (5).	{c}
5-6	I County	Continues from point (5) and follows the Yolo/Colusa County line to point (6).	{a}
6-7	I County	Continues from point (6) and follows the Yolo/Sutter County line to point (7).	{a}
7-8	I County	Continues from point (7) and follows the Yolo County line to point (8).	{a}
8-9	I County	Continues from point (8) and follows the Yolo/Sacramento County line to point (9).	{a}
9-10	I Water Agency	Continues from point (9) and follows the Reclamation District 765 boundary to point (10).	{d}
10-11	I Water Agency	Continues from point (10) and follows the Reclamation District 999 boundary to point (11).	{d}
11-12	I County	Continues from point (11) and follows the Yolo/Solano County line to point (12).	{a}
12-13	I Water Agency	Continues from point (12) and follows the boundary of Reclamation District 2093 to point (13).	{d}
13-14	I	Continues from point (13) and follows the Yolo/Solano county line to	{a}

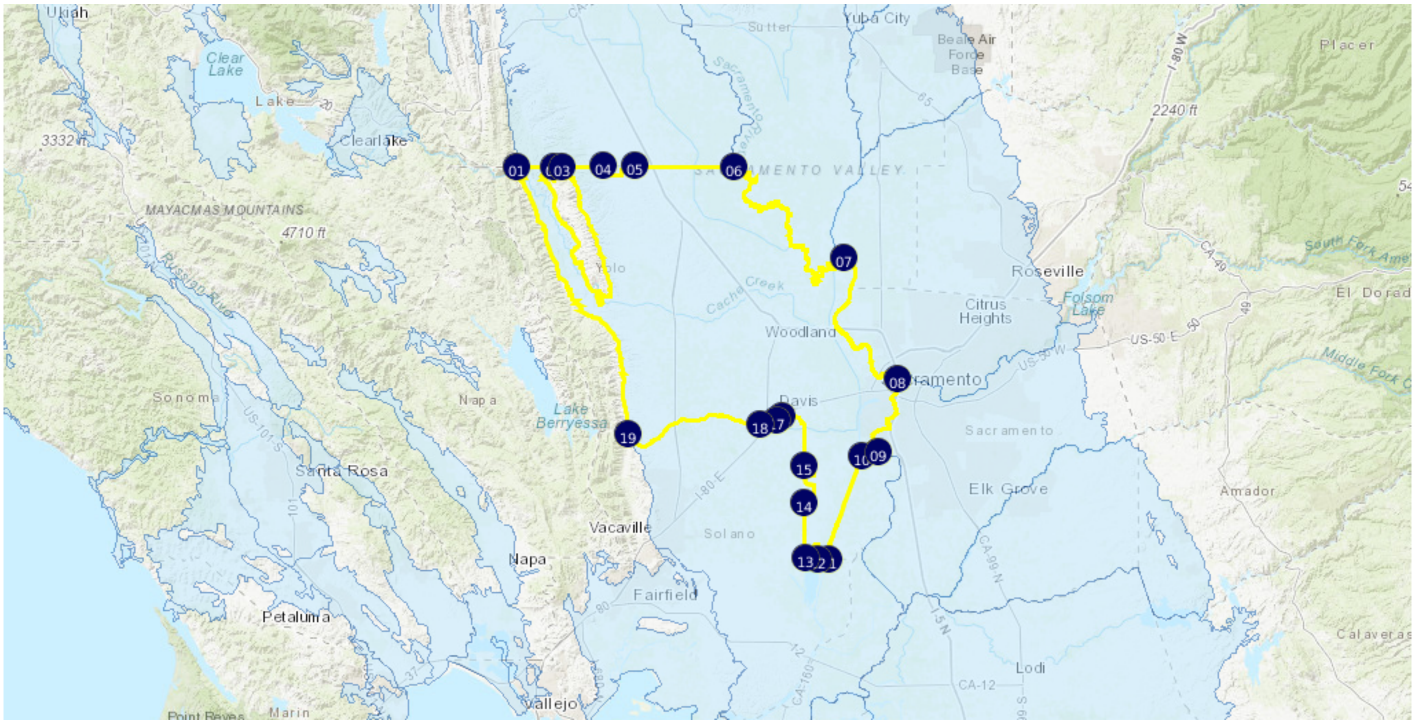
	County	point (14).	
14-15	I Water Agency	Continues from point (14) and follows the boundary of Reclamation District 2068 to point (15).	{d}
15-16	I County	Continues from point (15) and follows the Yolo/Solano County line to point (16).	{a}
16-17	I Transportation	Continues from point (16) and follows US Interstate 80 to point (17).	{e}
17-18	I Water Agency	Continues from point (17) and follows the UC Davis boundary to point (18).	{c}
18-19	I County	Continues from point (18) and follows the Yolo/Solano County line to point (19).	{a}
19-1	E Non-Alluvial	Continues from point (19) and follows the contact of nonmarine deposits with marine sedimentary rocks of the Great Valley Sequence, and ends at point (1).	{b}

Significant Coordinates

Point	**Latitude**	**Longitude**	
1	38.924159504	-122.268372273	
2	38.925373761	-122.194294229	
3	38.925382258	-122.178008696	
4	38.925747874	-122.097112675	
5	38.925931026	-122.032251919	
6	38.924593622	-121.835106407	
7	38.782426125	-121.615152878	
8	38.594075098	-121.507979595	
9	38.480810907	-121.54708919	
10	38.473722298	-121.580924664	
11	38.313876197	-121.644993385	
12	38.314108169	-121.667167823	
13	38.314356996	-121.692188353	
14	38.401378424	-121.693864052	
15	38.459405329	-121.693741856	
16	38.537644069	-121.738506629	
17	38.530613683	-121.749573212	
18	38.523381197	-121.783729869	
19	38.507927249	-122.045258419	

Map

5-021.67 SACRAMENTO VALLEY - YOLO



https://sgma.water.ca.gov/webgis/?appid=160718113212&subbasinid=5-021.67

References

Ref	Citation	Pub Date	Global ID
{a}	California Department of Forestry and Fire Protection (Cal Fire), California Counties and Paired Dataset (cnty15_1).URL: http://frap.fire.ca.gov/data/frapgisdata-subset	2/14/15	2
{b}	California Geological Survey (CGS), Regional Geologic Map No. 2A, Santa Rosa Quadrangle, 1:250,000, D.L. Wagner and E.J. Bortugno.URL: http://www.quake.ca.gov/gmaps/RGM/santarosa/santarosa.html	1982	7
{c}	California Department of Water Resources (DWR), Water Agencies Dataset.URL: https://gis.water.ca.gov/app/bbat/	2016	48
{d}	California Department of Water Resources (DWR), Reclamation Districts Dataset.URL: https://gis.water.ca.gov/app/bbat/	2016	3
{e}	Open Street Maps, Roads and Railroads data.URL: http://www.openstreetmap.org/	9/9/16	47

Footnotes

- I: Internal
- E: External