Appendix 2-K

Detailed Water Budget Details

Red Bluff Subbasin

Sustainable Groundwater Management Act

Groundwater Sustainability Plan Appendix 2K - Water Budget

September 2021

DRAFT

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LIST OF ACRONYMS & ABBREVIATIONS

af	Acre-feet
AN	Above normal Sacramento Valley water year type
AWMP	Agricultural Water Management Plan
BMP	Best Management Practice
BN	Below normal Sacramento Valley water year type
C	Critical (dry) Sacramento Valley water year type
CCR	California Code of Regulations
D	Dry Sacramento Valley water year type
DWR	Department of Water Resources
ET	Evapotranspiration
GMP	Groundwater Management Plan
GSP	Groundwater Sustainability Plan
GWS	Groundwater System
SWS	Surface Water System
taf	Thousand acre-feet
Tehama IHM	Tehama Integrated Hydrologic Model
UWMP	Urban Water Management Plan
W	Wet Sacramento Valley water year type
WMP	Water Management Plan

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1 DETAILED HISTORICAL WATER BUDGET

1.1 Surface Water System Water Budget Results

1.1.1 Inflows

1.1.1.1 Surface Water Inflow by Water Source Type

Per the GSP Regulations, surface inflows must be reported by water source type. According to the Regulations (23 CCR § 351(ak)):

> *"Water source type" represents the source from which water is derived to meet the applied beneficial uses, including groundwater, recycled water, reused water, and surface water sources identified as Central Valley Project, the State Water Project, the Colorado River Project, local supplies, and local imported supplies.*

Major surface water inflows to the Red Bluff Subbasin are summarized below according to water source type.

1.1.1.1.1 *Local Supplies*

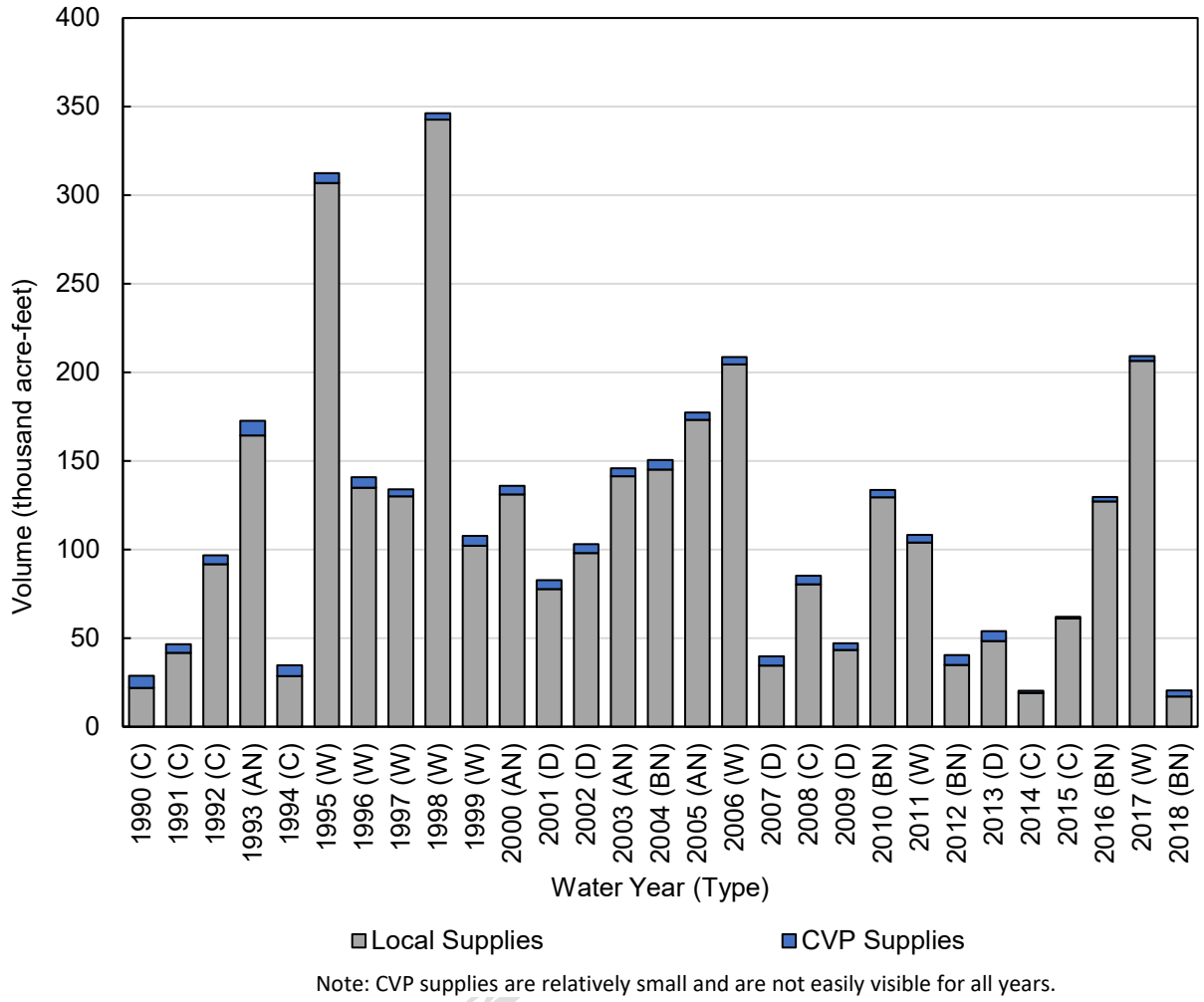
Local supply inflows to the Red Bluff Subbasin predominantly include runoff from upgradient small watersheds adjacent to the Subbasin and surface inflows along Red Bank Creek and Elder Creek. A portion of these local supplies are diverted by local water rights users for beneficial use within the Subbasin.

1.1.1.1.2 *Central Valley Project*

Central Valley Project (CVP) inflows to the Red Bluff Subbasin include surface water delivered along the Corning Canal to Proberta Water District and the portions of Thomes Creek Water District that overlie the Red Bluff Subbasin.

1.1.1.1.3 *Summary of Surface Inflows*

The annual volume of surface water inflows is summarized by water source type in **Figure 1** and **Table 1**. Between 1990 and 2018, total surface inflows from all sources averaged approximately 120 thousand acre-feet (taf) per year. Of this total, local supplies averaged approximately 110 taf per year, while CVP supplies averaged 5 taf per year.



Note: CVP supplies are relatively small and are not easily visible for all years.

Figure 1. Red Bluff Subbasin Historical Surface Water Inflows, by Water Source Type

Table 1. Red Bluff Subbasin Historical Surface Water Inflows, by Water Source Type

Water Year (Type)		CVP Supplies	Local Supplies	Total
1990 (C)		6,900	22,000	29,000
1991 (C)		4,900	42,000	47,000
1992 (C)		5,000	92,000	97,000
1993 (AN)		8,400	160,000	170,000
1994 (C)		6,200	29,000	35,000
1995 (W)		5,600	310,000	310,000
1996 (W)		5,900	130,000	140,000
1997 (W)		4,000	130,000	130,000
1998 (W)		3,600	340,000	350,000
1999 (W)		5,500	100,000	110,000
2000 (AN)		5,000	130,000	140,000
2001 (D)		5,000	78,000	83,000
2002 (D)		5,100	98,000	100,000
2003 (AN)		4,500	140,000	150,000
2004 (BN)		5,400	150,000	150,000
2005 (AN)		4,100	170,000	180,000
2006 (W)		4,200	200,000	210,000
2007 (D)		5,400	34,000	40,000
2008 (C)		4,800	80,000	85,000
2009 (D)		3,800	43,000	47,000
2010 (BN)		4,100	130,000	130,000
2011 (W)		4,500	100,000	110,000
2012 (BN)		5,700	35,000	41,000
2013 (D)		5,700	48,000	54,000
2014 (C)		1,300	19,000	20,000
2015 (C)		930	61,000	62,000
2016 (BN)		2,500	130,000	130,000
2017 (W)		2,700	210,000	210,000
2018 (BN)		3,400	17,000	20,000
Average (1990-2018)		4,600	110,000	120,000
1990-2018	W	4,500	190,000	200,000
	AN	5,500	150,000	160,000
	BN	4,200	91,000	95,000
	D	5,000	60,000	65,000
	C	4,300	49,000	53,000

1.1.1.2 Precipitation

Precipitation estimates for the Red Bluff Subbasin are provided in **Figure 2** and **Table 2**. Total precipitation is highly variable between years in the study area, ranging from approximately 420 taf (18.5 inches) during average critically dry years to 780 taf (34.5 inches) during average wet years.

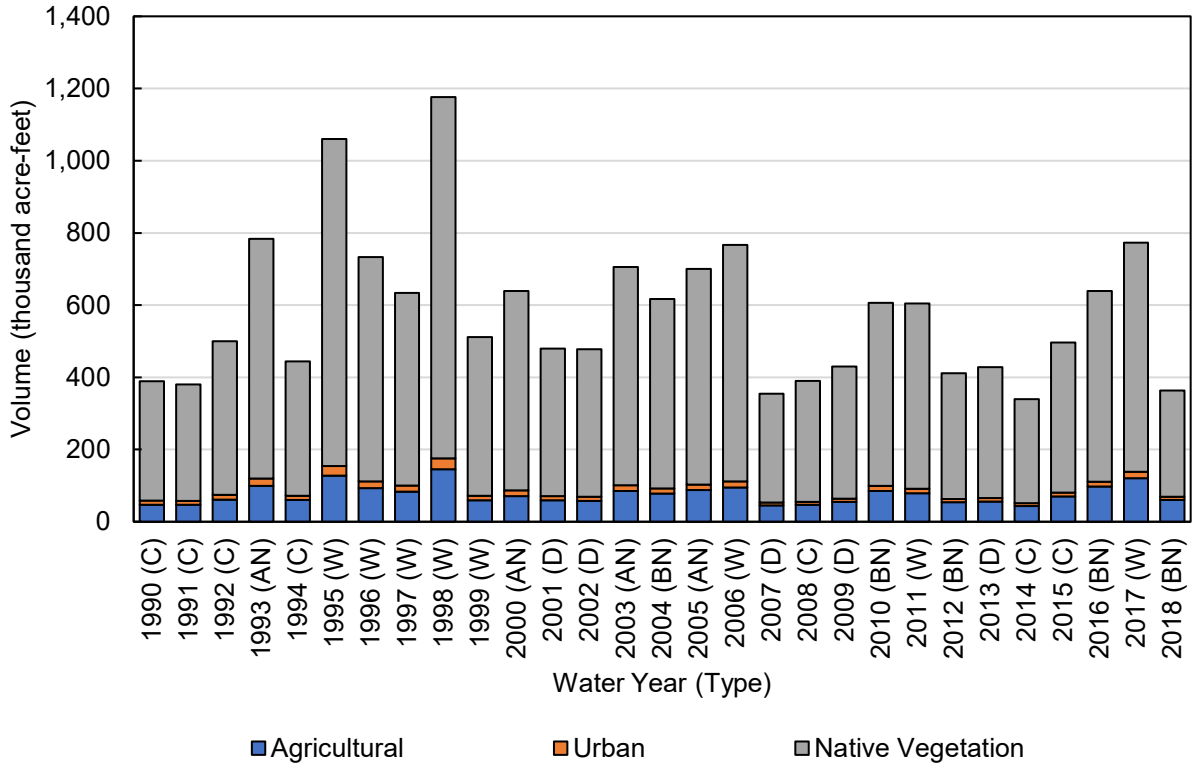


Figure 2. Red Bluff Subbasin Historical Precipitation, by Water Use Sector

Table 2. Red Bluff Subbasin Historical Precipitation, by Water Use Sector (acre-feet)

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
1990 (C)		48,000	11,000	330,000	390,000
1991 (C)		47,000	10,000	320,000	380,000
1992 (C)		62,000	13,000	430,000	500,000
1993 (AN)		99,000	21,000	660,000	780,000
1994 (C)		60,000	12,000	370,000	440,000
1995 (W)		130,000	27,000	910,000	1,100,000
1996 (W)		93,000	19,000	620,000	730,000
1997 (W)		83,000	17,000	530,000	630,000
1998 (W)		150,000	30,000	1,000,000	1,200,000
1999 (W)		59,000	13,000	440,000	510,000
2000 (AN)		71,000	16,000	550,000	640,000
2001 (D)		59,000	12,000	410,000	480,000
2002 (D)		58,000	11,000	410,000	480,000
2003 (AN)		86,000	16,000	600,000	710,000
2004 (BN)		78,000	14,000	520,000	620,000
2005 (AN)		88,000	15,000	600,000	700,000
2006 (W)		95,000	17,000	660,000	770,000
2007 (D)		45,000	8,000	300,000	350,000
2008 (C)		47,000	8,100	330,000	390,000
2009 (D)		55,000	9,500	370,000	430,000
2010 (BN)		85,000	14,000	510,000	610,000
2011 (W)		79,000	12,000	510,000	600,000
2012 (BN)		54,000	9,200	350,000	410,000
2013 (D)		56,000	9,100	360,000	430,000
2014 (C)		44,000	7,300	290,000	340,000
2015 (C)		70,000	11,000	420,000	500,000
2016 (BN)		97,000	14,000	530,000	640,000
2017 (W)		120,000	17,000	640,000	770,000
2018 (BN)		61,000	8,300	290,000	360,000
Average (1990-2018)		75,000	14,000	490,000	580,000
1990-2018	W	100,000	19,000	660,000	780,000
	AN	86,000	17,000	600,000	710,000
	BN	75,000	12,000	440,000	530,000
	D	55,000	9,900	370,000	430,000
	C	54,000	10,000	360,000	420,000

1.1.1.3 Groundwater Extraction by Water Use Sector

Total groundwater extraction in the Red Bluff Subbasin represents a combination of groundwater pumping to support agricultural and urban water demands, including rural residential use, and groundwater uptake by crops, urban vegetation, and native vegetation.

Estimates of groundwater pumping by water use sector are provided in **Figure 3** and **Table 3**. Virtually all groundwater pumping in the Red Bluff Subbasin is used to meet agricultural demand, averaging 80 taf per year. Groundwater pumping for urban use is approximately 5 taf per year. The total groundwater extraction varies from about 66 taf in above-normal years to 89 taf in critically dry years based on variability in surface water supplies, precipitation, and crop water demand.

When groundwater is near the land surface, groundwater uptake can also be a source of supply for vegetation. Estimates of groundwater uptake by vegetation are provided in **Figure 4** and **Table 4**. The majority of groundwater uptake is consumed directly by agricultural crops and native vegetation, totaling 4.9 taf and 4.7 taf per year, on average.

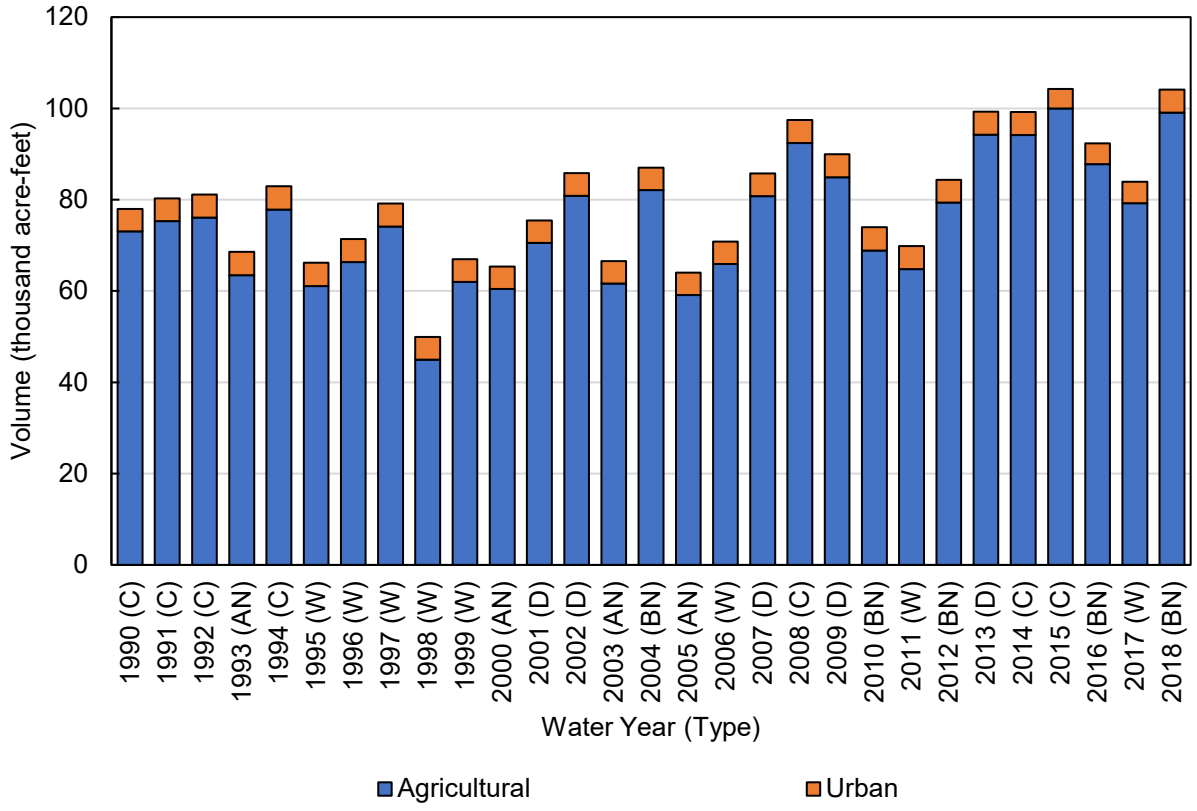


Figure 3. Red Bluff Subbasin Historical Groundwater Pumping, by Water Use Sector

Table 3. Red Bluff Subbasin Historical Groundwater Pumping, by Water Use Sector (acre-feet)

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
1990 (C)		73,000	5,000	0	78,000
1991 (C)		75,000	5,000	0	80,000
1992 (C)		76,000	5,100	0	81,000
1993 (AN)		63,000	5,100	0	69,000
1994 (C)		78,000	5,100	0	83,000
1995 (W)		61,000	5,100	0	66,000
1996 (W)		66,000	5,100	0	71,000
1997 (W)		74,000	5,100	0	79,000
1998 (W)		45,000	5,000	0	50,000
1999 (W)		62,000	5,000	0	67,000
2000 (AN)		60,000	4,900	0	65,000
2001 (D)		71,000	4,900	0	75,000
2002 (D)		81,000	4,900	0	86,000
2003 (AN)		62,000	4,900	0	67,000
2004 (BN)		82,000	4,900	0	87,000
2005 (AN)		59,000	4,900	0	64,000
2006 (W)		66,000	4,900	0	71,000
2007 (D)		81,000	5,000	0	86,000
2008 (C)		92,000	5,000	0	97,000
2009 (D)		85,000	5,000	0	90,000
2010 (BN)		69,000	5,100	0	74,000
2011 (W)		65,000	5,100	0	70,000
2012 (BN)		79,000	5,000	0	84,000
2013 (D)		94,000	5,100	0	99,000
2014 (C)		94,000	5,100	0	99,000
2015 (C)		100,000	4,300	0	100,000
2016 (BN)		88,000	4,500	0	92,000
2017 (W)		79,000	4,700	0	84,000
2018 (BN)		99,000	5,100	0	100,000
Average (1990-2018)		75,000	5,000	0	80,000
1990-2018	W	65,000	5,000	0	70,000
	AN	61,000	5,000	0	66,000
	BN	83,000	4,900	0	88,000
	D	82,000	5,000	0	87,000
	C	84,000	4,900	0	89,000

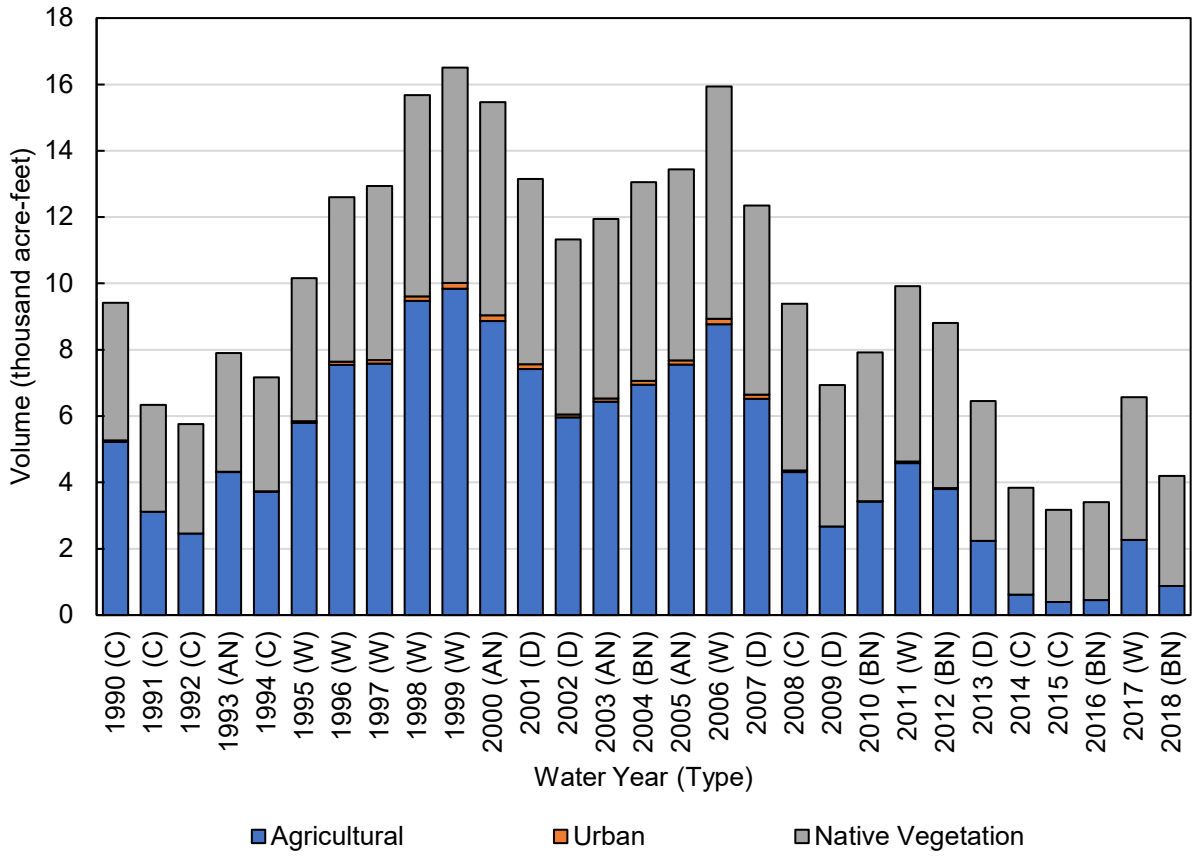


Figure 4. Red Bluff Subbasin Historical Groundwater Uptake, by Water Use Sector

Table 4. Red Bluff Subbasin Historical Groundwater Uptake, by Water Use Sector (acre-feet)

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
1990 (C)		5,200	50	4,200	9,400
1991 (C)		3,100	0	3,200	6,300
1992 (C)		2,500	0	3,300	5,800
1993 (AN)		4,300	10	3,600	7,900
1994 (C)		3,700	10	3,400	7,200
1995 (W)		5,800	50	4,300	10,000
1996 (W)		7,500	100	5,000	13,000
1997 (W)		7,600	110	5,300	13,000
1998 (W)		9,500	140	6,100	16,000
1999 (W)		9,800	170	6,500	17,000
2000 (AN)		8,900	170	6,400	15,000
2001 (D)		7,400	140	5,600	13,000
2002 (D)		6,000	90	5,300	11,000
2003 (AN)		6,400	100	5,400	12,000
2004 (BN)		7,000	110	6,000	13,000
2005 (AN)		7,600	130	5,800	13,000
2006 (W)		8,800	160	7,000	16,000
2007 (D)		6,500	130	5,700	12,000
2008 (C)		4,300	50	5,000	9,400
2009 (D)		2,700	0	4,300	6,900
2010 (BN)		3,400	10	4,500	7,900
2011 (W)		4,600	50	5,300	9,900
2012 (BN)		3,800	30	5,000	8,800
2013 (D)		2,200	0	4,200	6,500
2014 (C)		620	0	3,200	3,800
2015 (C)		390	0	2,800	3,200
2016 (BN)		450	0	3,000	3,400
2017 (W)		2,300	0	4,300	6,600
2018 (BN)		880	0	3,300	4,200
Average (1990-2018)		4,900	60	4,700	9,700
1990-2018	W	7,000	100	5,500	13,000
	AN	6,800	100	5,300	12,000
	BN	3,100	30	4,400	7,500
	D	5,000	70	5,000	10,000
	C	2,800	20	3,600	6,400

1.1.1.4 Groundwater Discharge to Surface Waterways

Groundwater discharge to surface water, as described herein, represents a gain, or increase of flow, in waterways that traverse or flow along the boundary of the Red Bluff Subbasin. Groundwater discharge in the Red Bluff Subbasin is calculated from the Tehama IHM as the net groundwater outflow to water reaches (i.e., groundwater discharge) in excess of groundwater inflows from waterway reaches (i.e., seepage). The total volume of estimated groundwater discharge to surface water is summarized in **Figure 5** and **Table 5**, averaging approximately 39 taf per year.

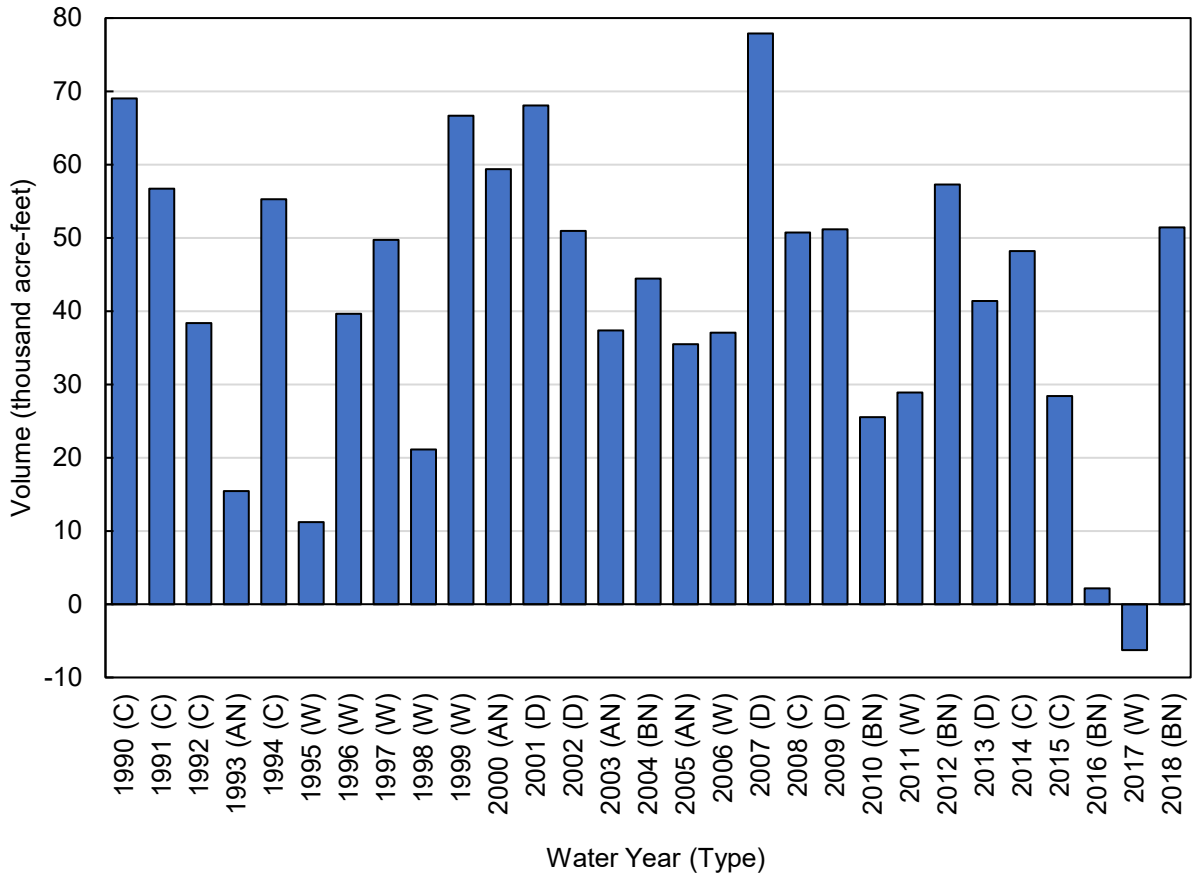


Figure 5. Red Bluff Subbasin Historical Groundwater Discharge to Surface Water

Table 5. Red Bluff Subbasin Historical Groundwater Discharge to Surface Water (acre-feet)

Water Year (Type)		Groundwater Discharge to Surface Water
1990 (C)		-67,000
1991 (C)		-55,000
1992 (C)		-36,000
1993 (AN)		-13,000
1994 (C)		-53,000
1995 (W)		-8,300
1996 (W)		-37,000
1997 (W)		-47,000
1998 (W)		-18,000
1999 (W)		-64,000
2000 (AN)		-57,000
2001 (D)		-66,000
2002 (D)		-48,000
2003 (AN)		-35,000
2004 (BN)		-41,000
2005 (AN)		-33,000
2006 (W)		-34,000
2007 (D)		-76,000
2008 (C)		-48,000
2009 (D)		-49,000
2010 (BN)		-23,000
2011 (W)		-26,000
2012 (BN)		-55,000
2013 (D)		-39,000
2014 (C)		-47,000
2015 (C)		-27,000
2016 (BN)		82
2017 (W)		8,800
2018 (BN)		-49,000
Average (1990-2018)		-39,000
1990-2018	W	-28,000
	AN	-27,000
	BN	-28,000
	D	-56,000
	C	-48,000

1.1.2 Outflows

1.1.2.1 Evapotranspiration by Water Use Sector

Evapotranspiration (ET) by water use sector is reported in **Figure 6** through **Figure 9**, and **Table 6** through **Table 9**. First, total ET is reported, followed by ET from applied water (ET of water actively applied from surface water deliveries or groundwater pumping), ET of groundwater uptake (ET of shallow water extracted directly by vegetation), and ET from precipitation (ET of water supplied through rainfall).

Total ET varies between years, with the lowest observed in 1991, at approximately 340 taf, and greatest in 2005, at approximately 470 taf. Agricultural ET tends to increase slightly in drier years due to increased climatic demand, while the ET of native vegetation typically decreases due to reduced water supply.

ET of applied water occurs primarily from agricultural land, averaging about 48 taf in above-normal and wet years and about 67 taf in years classified as below normal, dry, or critical. Urban ET of applied water is lower and relatively constant between years, averaging less than 1.6 taf per year. Native vegetation and agricultural crops in the Red Bluff Subbasin also directly consume shallow groundwater to meet a portion of their consumptive use requirements. ET of groundwater uptake by native vegetation and agricultural crops and totals 4.2 and 2.5 taf per year, on average.

ET of precipitation generally follows the pattern of precipitation, with higher volumes occurring in wet years when more precipitation occurs. Across all water use sectors, ET of precipitation in the Red Bluff Subbasin averages about 380 taf in wet and above-normal years and 320 taf in dry and critical water years. Much of the total ET of precipitation results from the large acreage of native vegetation in the Red Bluff Subbasin, though significant volumes result from agricultural and urban areas as well.

Evaporation from rivers, streams, and canals in the Red Bluff Subbasin is reported in **Figure 10** and **Table 10**. The total volume is relatively small and constant between years, averaging less than 0.7 taf per year. Evaporation from upgradient small watersheds is minimal, and is also not considered to substantially contribute to the subbasin SWS water budget.

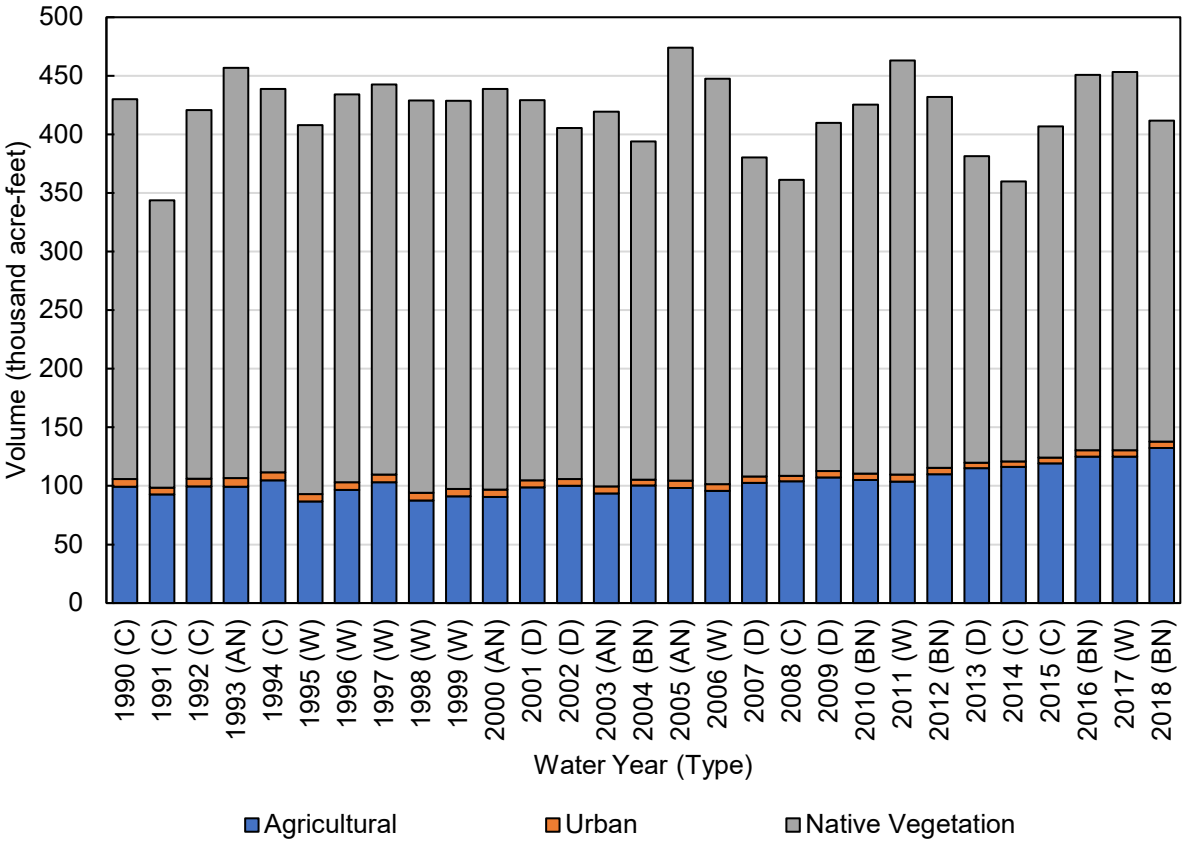


Figure 6. Red Bluff Subbasin Historical Total Evapotranspiration, (acre-feet)

Table 6. Red Bluff Subbasin Historical Total Evapotranspiration, by Water Use Sector (acre-feet)

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
1990 (C)		99,000	6,700	320,000	430,000
1991 (C)		93,000	5,700	250,000	340,000
1992 (C)		100,000	6,600	310,000	420,000
1993 (AN)		99,000	7,200	350,000	460,000
1994 (C)		100,000	7,000	330,000	440,000
1995 (W)		87,000	6,300	310,000	410,000
1996 (W)		97,000	6,500	330,000	430,000
1997 (W)		100,000	6,700	330,000	440,000
1998 (W)		87,000	6,600	340,000	430,000
1999 (W)		91,000	6,100	330,000	430,000
2000 (AN)		91,000	6,300	340,000	440,000
2001 (D)		99,000	6,000	320,000	430,000
2002 (D)		100,000	5,600	300,000	410,000
2003 (AN)		94,000	5,800	320,000	420,000
2004 (BN)		100,000	5,000	290,000	390,000
2005 (AN)		98,000	6,200	370,000	470,000
2006 (W)		96,000	5,600	350,000	450,000
2007 (D)		100,000	5,300	270,000	380,000
2008 (C)		100,000	4,600	250,000	360,000
2009 (D)		110,000	5,500	300,000	410,000
2010 (BN)		100,000	5,600	310,000	430,000
2011 (W)		100,000	5,900	350,000	460,000
2012 (BN)		110,000	5,700	320,000	430,000
2013 (D)		120,000	4,700	260,000	380,000
2014 (C)		120,000	4,700	240,000	360,000
2015 (C)		120,000	4,700	280,000	410,000
2016 (BN)		120,000	5,500	320,000	450,000
2017 (W)		120,000	5,400	320,000	450,000
2018 (BN)		130,000	5,400	270,000	410,000
Average (1990-2018)		100,000	5,800	310,000	420,000
1990-2018	W	99,000	6,100	330,000	440,000
	AN	95,000	6,400	350,000	450,000
	BN	110,000	5,400	300,000	420,000
	D	100,000	5,400	290,000	400,000
	C	110,000	5,700	280,000	390,000

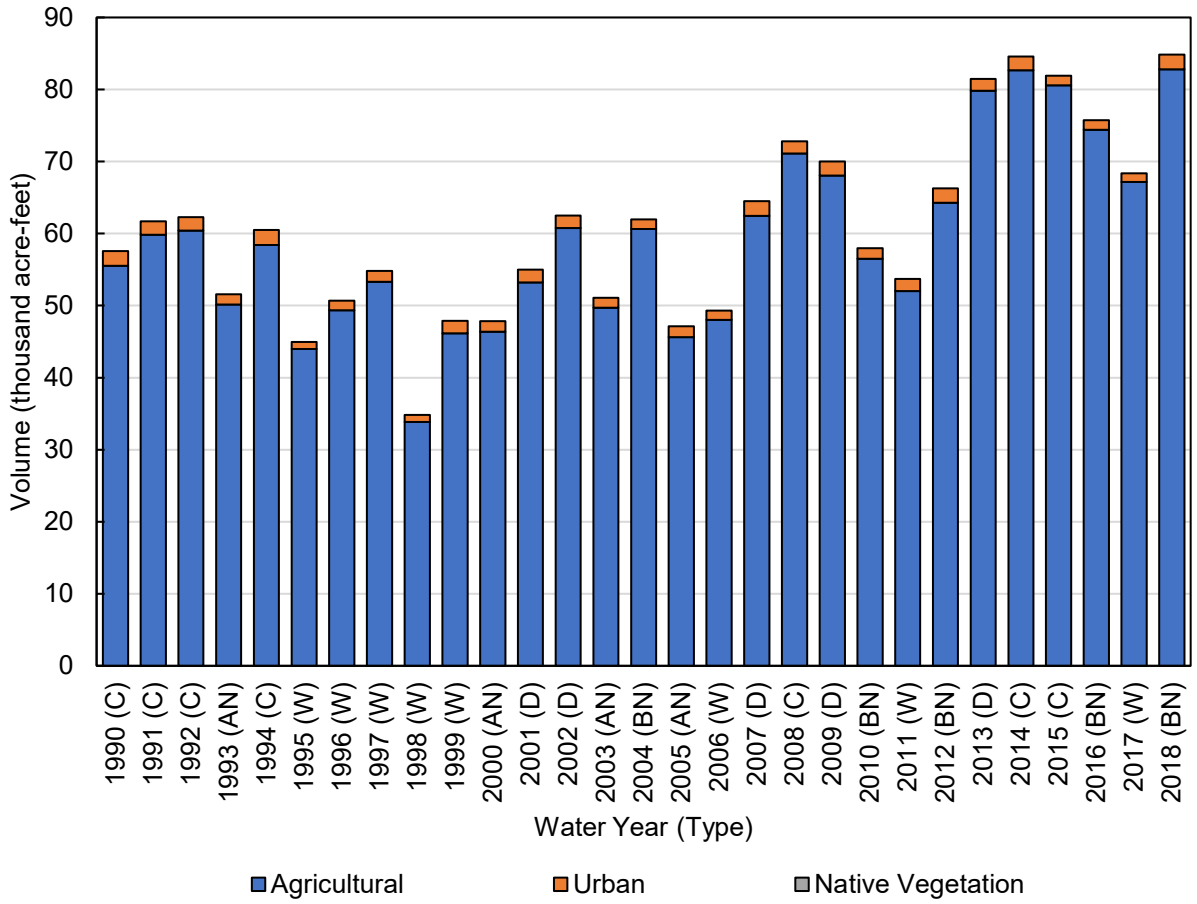


Figure 7. Red Bluff Subbasin Historical Evapotranspiration of Applied Water, by Water Use Sector

Table 7. Red Bluff Subbasin Historical Evapotranspiration of Applied Water, by Water Use Sector (acre-feet)

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
1990 (C)		56,000	2,100	0	58,000
1991 (C)		60,000	1,900	0	62,000
1992 (C)		60,000	1,900	0	62,000
1993 (AN)		50,000	1,400	0	52,000
1994 (C)		58,000	2,100	0	60,000
1995 (W)		44,000	1,000	0	45,000
1996 (W)		49,000	1,400	0	51,000
1997 (W)		53,000	1,500	0	55,000
1998 (W)		34,000	940	0	35,000
1999 (W)		46,000	1,700	0	48,000
2000 (AN)		46,000	1,500	0	48,000
2001 (D)		53,000	1,800	0	55,000
2002 (D)		61,000	1,700	0	62,000
2003 (AN)		50,000	1,400	0	51,000
2004 (BN)		61,000	1,300	0	62,000
2005 (AN)		46,000	1,500	0	47,000
2006 (W)		48,000	1,300	0	49,000
2007 (D)		62,000	2,000	0	64,000
2008 (C)		71,000	1,700	0	73,000
2009 (D)		68,000	1,900	0	70,000
2010 (BN)		56,000	1,500	0	58,000
2011 (W)		52,000	1,700	0	54,000
2012 (BN)		64,000	2,000	0	66,000
2013 (D)		80,000	1,700	0	81,000
2014 (C)		83,000	1,900	0	85,000
2015 (C)		81,000	1,400	0	82,000
2016 (BN)		74,000	1,400	0	76,000
2017 (W)		67,000	1,200	0	68,000
2018 (BN)		83,000	2,000	0	85,000
Average (1990-2018)		59,000	1,600	0	61,000
1990-2018	W	49,000	1,300	0	51,000
	AN	48,000	1,500	0	49,000
	BN	68,000	1,600	0	69,000
	D	65,000	1,800	0	67,000
	C	67,000	1,800	0	69,000

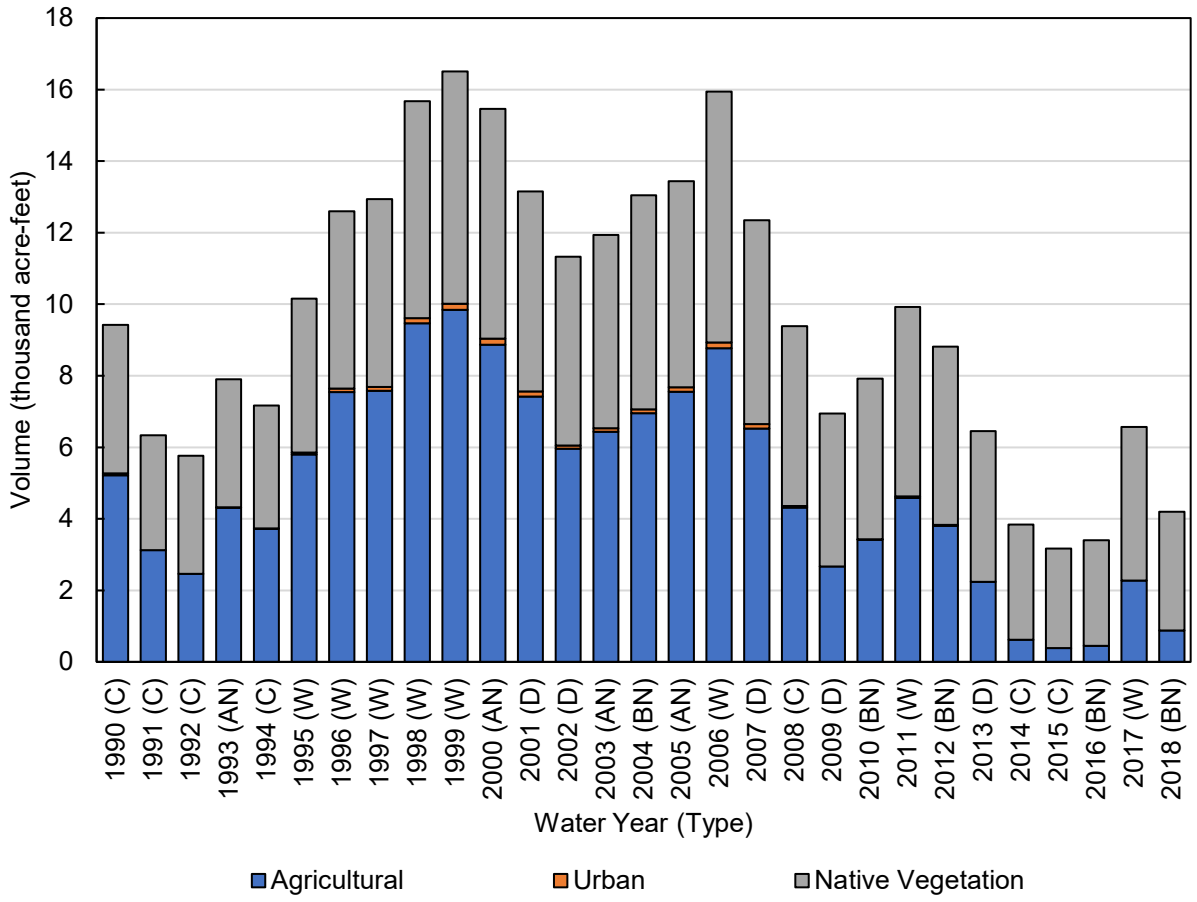


Figure 8. Red Bluff Subbasin Historical Evapotranspiration of Groundwater Uptake, by Water Use Sector

Table 8. Red Bluff Subbasin Historical Evapotranspiration of Groundwater Uptake, by Water Use Sector (acre-feet)

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
1990 (C)		5,200	50	4,200	9,400
1991 (C)		3,100	0	3,200	6,300
1992 (C)		2,500	0	3,300	5,800
1993 (AN)		4,300	10	3,600	7,900
1994 (C)		3,700	10	3,400	7,200
1995 (W)		5,800	50	4,300	10,000
1996 (W)		7,500	100	5,000	13,000
1997 (W)		7,600	110	5,300	13,000
1998 (W)		9,500	140	6,100	16,000
1999 (W)		9,800	170	6,500	17,000
2000 (AN)		8,900	170	6,400	15,000
2001 (D)		7,400	140	5,600	13,000
2002 (D)		6,000	90	5,300	11,000
2003 (AN)		6,400	100	5,400	12,000
2004 (BN)		7,000	110	6,000	13,000
2005 (AN)		7,600	130	5,800	13,000
2006 (W)		8,800	160	7,000	16,000
2007 (D)		6,500	130	5,700	12,000
2008 (C)		4,300	50	5,000	9,400
2009 (D)		2,700	0	4,300	6,900
2010 (BN)		3,400	10	4,500	7,900
2011 (W)		4,600	50	5,300	9,900
2012 (BN)		3,800	30	5,000	8,800
2013 (D)		2,200	0	4,200	6,500
2014 (C)		620	0	3,200	3,800
2015 (C)		390	0	2,800	3,200
2016 (BN)		450	0	3,000	3,400
2017 (W)		2,300	0	4,300	6,600
2018 (BN)		880	0	3,300	4,200
Average (1990-2018)		2,100	0	4,200	6,300
1990-2018	W	7,000	100	5,500	13,000
	AN	6,800	100	5,300	12,000
	BN	3,100	30	4,400	7,500
	D	5,000	70	5,000	10,000
	C	2,800	20	3,600	6,400

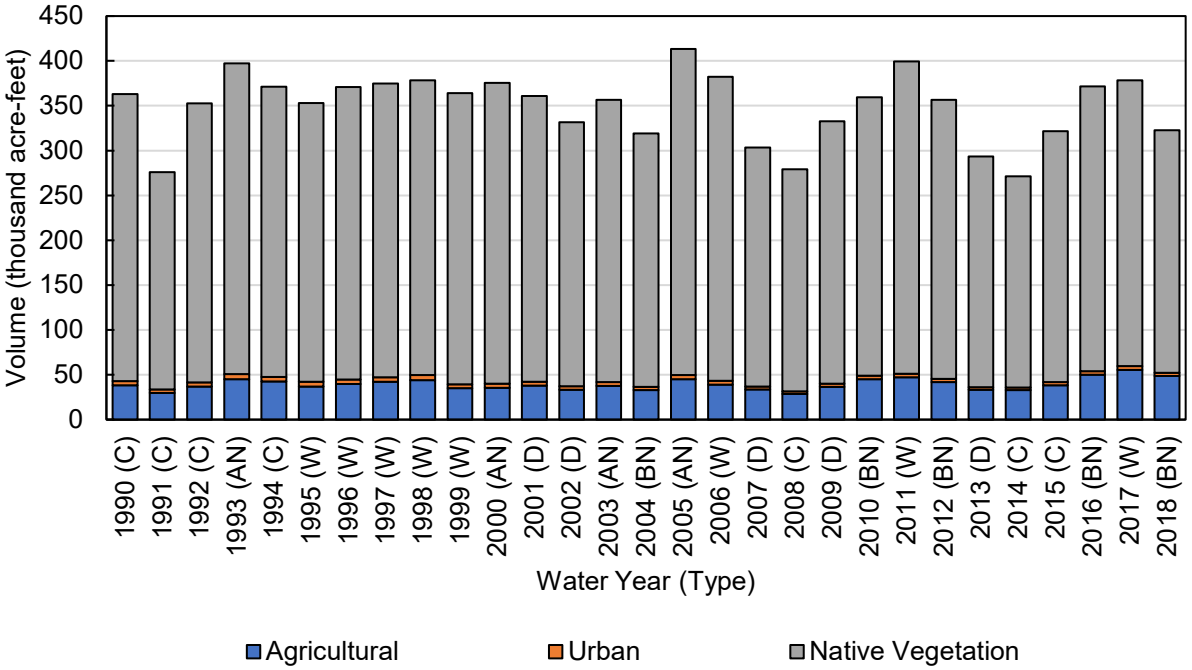


Figure 9. Red Bluff Subbasin Historical Evapotranspiration of Precipitation, by Water Use Sector

Table 9. Red Bluff Subbasin Historical Evapotranspiration of Precipitation, by Water Use Sector (acre-feet)

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
1990 (C)		38,000	4,600	320,000	360,000
1991 (C)		30,000	3,800	240,000	280,000
1992 (C)		37,000	4,700	310,000	350,000
1993 (AN)		45,000	5,800	350,000	400,000
1994 (C)		43,000	4,900	320,000	370,000
1995 (W)		37,000	5,300	310,000	350,000
1996 (W)		40,000	5,000	330,000	370,000
1997 (W)		42,000	5,000	330,000	370,000
1998 (W)		44,000	5,500	330,000	380,000
1999 (W)		35,000	4,200	320,000	360,000
2000 (AN)		35,000	4,700	340,000	380,000
2001 (D)		38,000	4,100	320,000	360,000
2002 (D)		33,000	3,800	290,000	330,000
2003 (AN)		38,000	4,300	310,000	360,000
2004 (BN)		33,000	3,600	280,000	320,000
2005 (AN)		45,000	4,600	360,000	410,000
2006 (W)		39,000	4,200	340,000	380,000
2007 (D)		34,000	3,200	270,000	300,000
2008 (C)		29,000	2,800	250,000	280,000
2009 (D)		36,000	3,600	290,000	330,000
2010 (BN)		45,000	4,100	310,000	360,000
2011 (W)		47,000	4,100	350,000	400,000
2012 (BN)		42,000	3,600	310,000	360,000
2013 (D)		33,000	3,000	260,000	290,000
2014 (C)		33,000	2,800	240,000	270,000
2015 (C)		38,000	3,300	280,000	320,000
2016 (BN)		50,000	4,200	320,000	370,000
2017 (W)		56,000	4,300	320,000	380,000
2018 (BN)		49,000	3,300	270,000	320,000
Average (1990-2018)		39,000	4,200	310,000	350,000
1990-2018	W	42,000	4,700	330,000	380,000
	AN	41,000	4,800	340,000	390,000
	BN	44,000	3,800	300,000	350,000
	D	35,000	3,500	290,000	320,000
	C	35,000	3,900	280,000	320,000

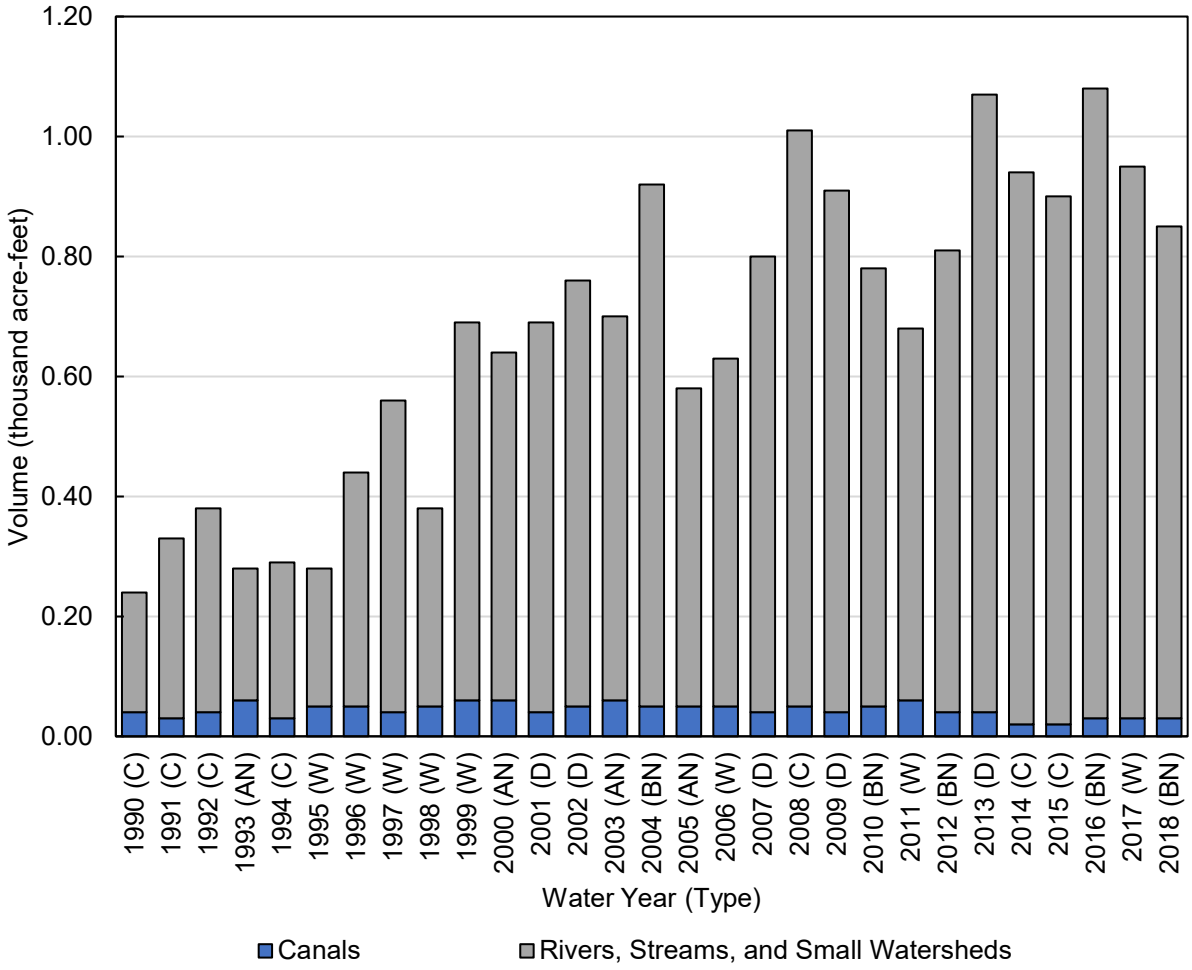


Figure 10. Red Bluff Subbasin Historical Evaporation of Surface Water Sources

Table 10. Red Bluff Subbasin Historical Evaporation of Surface Water Sources, by Water Use Sector (acre-feet)

Water Year (Type)		Canals	Rivers, Streams, and Small Watersheds[1]	Total
1990 (C)		40	200	240
1991 (C)		30	300	330
1992 (C)		40	340	380
1993 (AN)		60	220	280
1994 (C)		30	260	290
1995 (W)		50	230	280
1996 (W)		50	390	440
1997 (W)		40	520	560
1998 (W)		50	330	380
1999 (W)		60	630	690
2000 (AN)		60	580	640
2001 (D)		40	650	690
2002 (D)		50	710	760
2003 (AN)		60	640	700
2004 (BN)		50	870	920
2005 (AN)		50	530	580
2006 (W)		50	580	630
2007 (D)		40	760	800
2008 (C)		50	960	1,000
2009 (D)		40	870	910
2010 (BN)		50	730	780
2011 (W)		60	620	680
2012 (BN)		40	770	810
2013 (D)		40	1,000	1,100
2014 (C)		20	920	940
2015 (C)		20	880	900
2016 (BN)		30	1,100	1,100
2017 (W)		30	920	950
2018 (BN)		30	820	850
Average (1990-2018)		40	630	670
1990-2018	W	50	530	580
	AN	60	490	550
	BN	40	850	890
	D	40	800	850
	C	30	550	580

[1] Includes ET of riparian vegetation along rivers and streams.

1.1.2.2 Surface Water Outflow by Water Source Type

Surface water outflows from the Red Bluff Subbasin are summarized in **Figure 11** and **Table 11** by water source type. In the Red Bluff Subbasin, local supply outflows primarily include outflows of runoff, tailwater, and net drainage from land surfaces, in addition to runoff from small watersheds and stream outflows to the Sacramento River. Local supply outflows average approximately 300 taf per year, and range from 100 taf or less in certain dry years up to 970 taf in 1998. Other surface water outflows that leave the subbasin include outflow of groundwater discharge to the Sacramento River, Red Bank Creek, and Elder Creek. This water travels along each respective waterway as part of the flow in the river or creek.

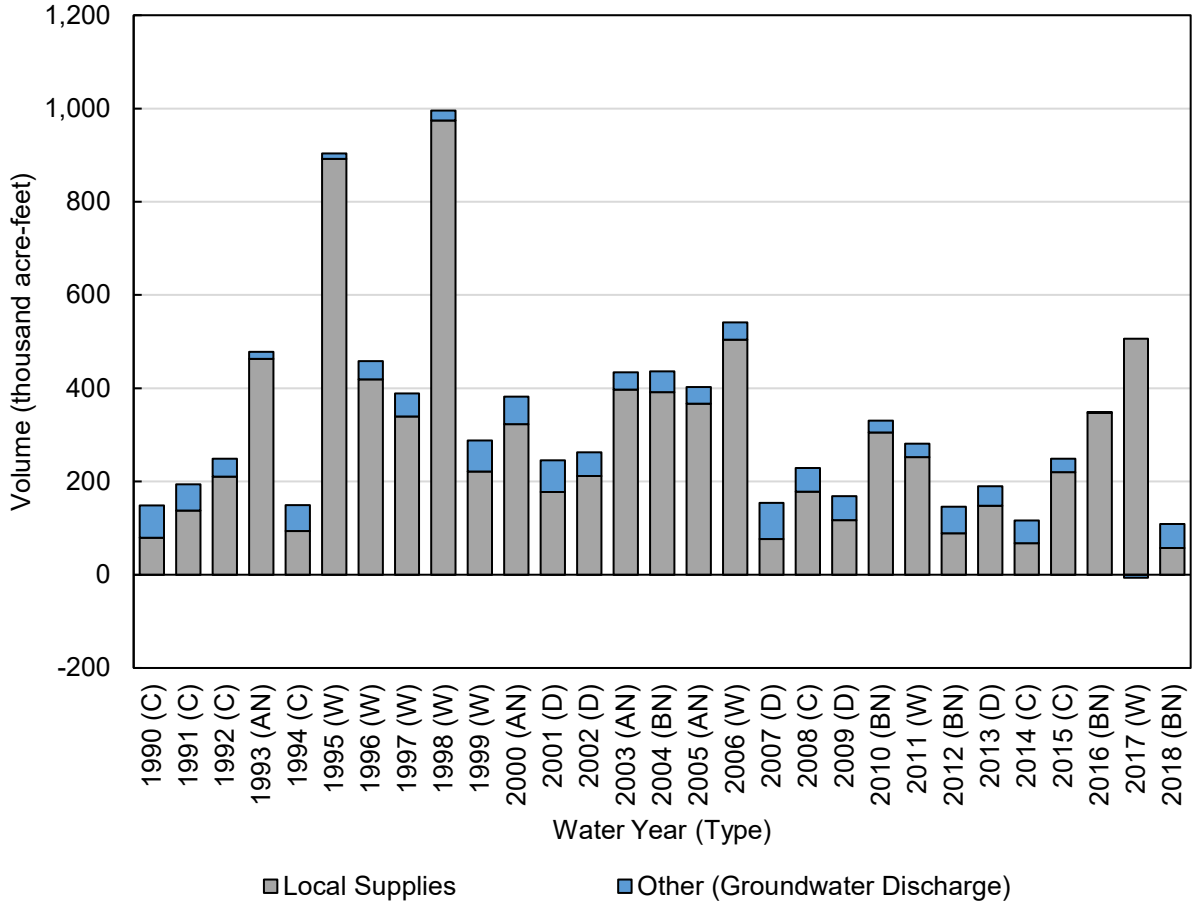


Figure 11. Red Bluff Subbasin Historical Surface Water Outflows, by Water Source Type

Table 11. Red Bluff Subbasin Historical Surface Water Outflows, by Water Source Type (acre-feet)

Water Year (Type)		CVP Supplies	Local Supplies	Other (Groundwater Discharge)	Total
1990 (C)		0	80,000	69,000	150,000
1991 (C)		0	140,000	57,000	190,000
1992 (C)		0	210,000	38,000	250,000
1993 (AN)		0	460,000	15,000	480,000
1994 (C)		0	94,000	55,000	150,000
1995 (W)		0	890,000	11,000	900,000
1996 (W)		0	420,000	40,000	460,000
1997 (W)		0	340,000	50,000	390,000
1998 (W)		0	970,000	21,000	1,000,000
1999 (W)		0	220,000	67,000	290,000
2000 (AN)		0	320,000	59,000	380,000
2001 (D)		0	180,000	68,000	250,000
2002 (D)		0	210,000	51,000	260,000
2003 (AN)		0	400,000	37,000	430,000
2004 (BN)		0	390,000	44,000	440,000
2005 (AN)		0	370,000	35,000	400,000
2006 (W)		0	500,000	37,000	540,000
2007 (D)		0	76,000	78,000	150,000
2008 (C)		0	180,000	51,000	230,000
2009 (D)		0	120,000	51,000	170,000
2010 (BN)		0	300,000	26,000	330,000
2011 (W)		0	250,000	29,000	280,000
2012 (BN)		0	89,000	57,000	150,000
2013 (D)		0	150,000	41,000	190,000
2014 (C)		0	68,000	48,000	120,000
2015 (C)		0	220,000	28,000	250,000
2016 (BN)		0	350,000	2,200	350,000
2017 (W)		0	510,000	-6,300	500,000
2018 (BN)		0	57,000	51,000	110,000
Average (1990-2018)		0	300,000	42,000	340,000
1990-2018	W	0	510,000	31,000	540,000
	AN	0	390,000	37,000	420,000
	BN	0	240,000	36,000	270,000
	D	0	150,000	58,000	200,000
	C	0	140,000	50,000	190,000

1.1.2.3 Deep Percolation of Applied Water

Estimated deep percolation of applied water (equal to infiltration of applied water in 23 CCR § 354.18(b)(2)) is summarized in **Figure 12** and **Table 12** by water use sector. Deep percolation of applied water is dominated by agricultural irrigation and varies between years, following the pattern of surface water diversions and deliveries to irrigated lands.

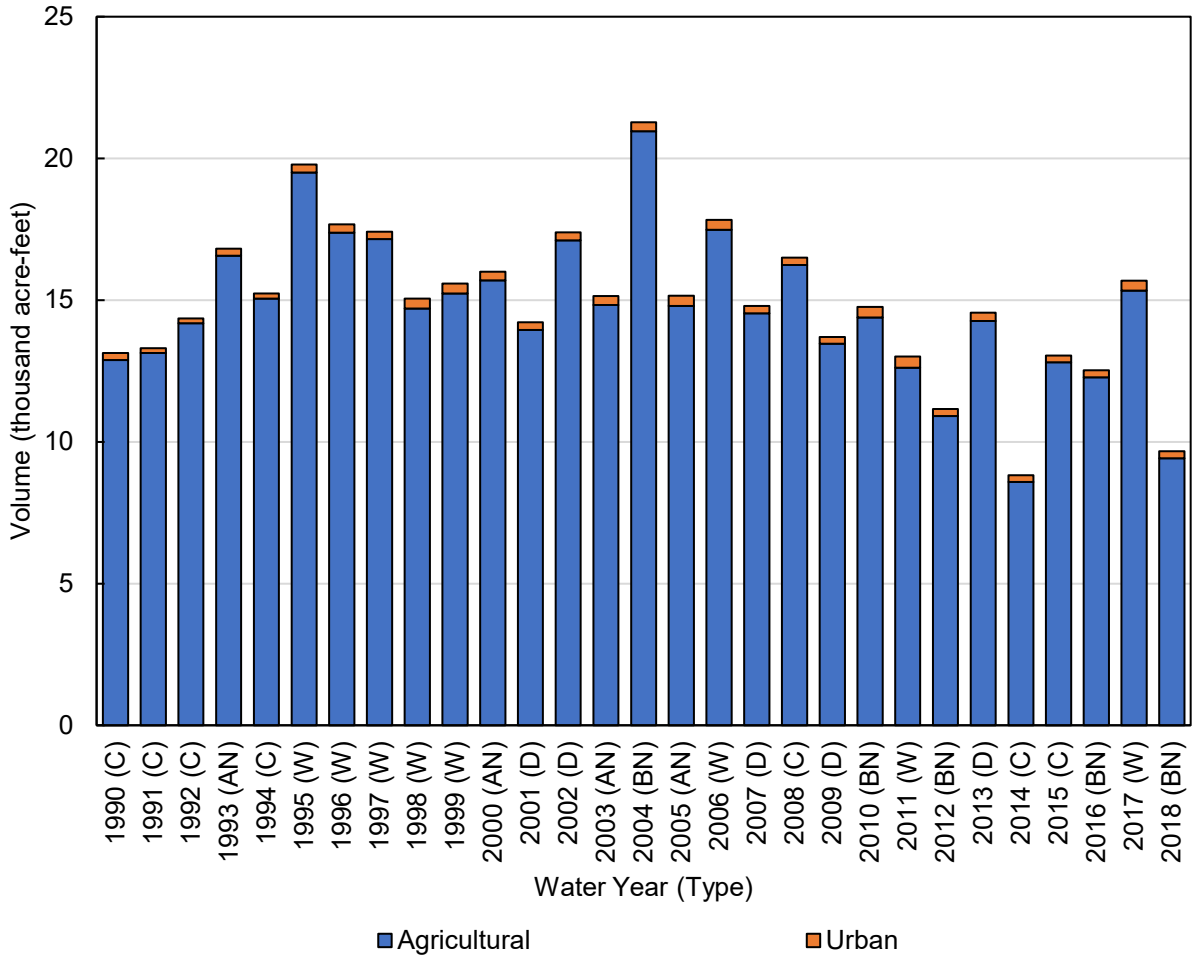


Figure 12. Red Bluff Subbasin Historical Deep Percolation of Applied Water, by Water Use Sector

Table 12. Red Bluff Subbasin Historical Deep Percolation of Applied Water, by Water Use Sector (acre-feet)

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
1990 (C)		13,000	250	0	13,000
1991 (C)		13,000	160	0	13,000
1992 (C)		14,000	180	0	14,000
1993 (AN)		17,000	250	0	17,000
1994 (C)		15,000	190	0	15,000
1995 (W)		20,000	280	0	20,000
1996 (W)		17,000	290	0	18,000
1997 (W)		17,000	260	0	17,000
1998 (W)		15,000	340	0	15,000
1999 (W)		15,000	340	0	16,000
2000 (AN)		16,000	300	0	16,000
2001 (D)		14,000	270	0	14,000
2002 (D)		17,000	280	0	17,000
2003 (AN)		15,000	320	0	15,000
2004 (BN)		21,000	310	0	21,000
2005 (AN)		15,000	360	0	15,000
2006 (W)		17,000	350	0	18,000
2007 (D)		15,000	260	0	15,000
2008 (C)		16,000	260	0	17,000
2009 (D)		13,000	240	0	14,000
2010 (BN)		14,000	370	0	15,000
2011 (W)		13,000	390	0	13,000
2012 (BN)		11,000	250	0	11,000
2013 (D)		14,000	300	0	15,000
2014 (C)		8,600	230	0	8,800
2015 (C)		13,000	230	0	13,000
2016 (BN)		12,000	240	0	13,000
2017 (W)		15,000	350	0	16,000
2018 (BN)		9,400	250	0	9,700
Average (1990-2018)		15,000	280	0	15,000
1990-2018	W	16,000	330	0	17,000
	AN	15,000	310	0	16,000
	BN	14,000	280	0	14,000
	D	15,000	270	0	15,000
	C	13,000	210	0	13,000

1.1.2.4 Deep Percolation of Precipitation

Estimated deep percolation of precipitation (equal to infiltration of precipitation in 23 CCR § 354.18(b)(2)) is provided in and **Table 13** and **Figure 13** by water use sector. Deep percolation of precipitation to the GWS is highly variable from year to year due to variation in the timing and amount of precipitation, ranging from less than 20 taf annually during some critical and dry years to about 150 taf in 1998.

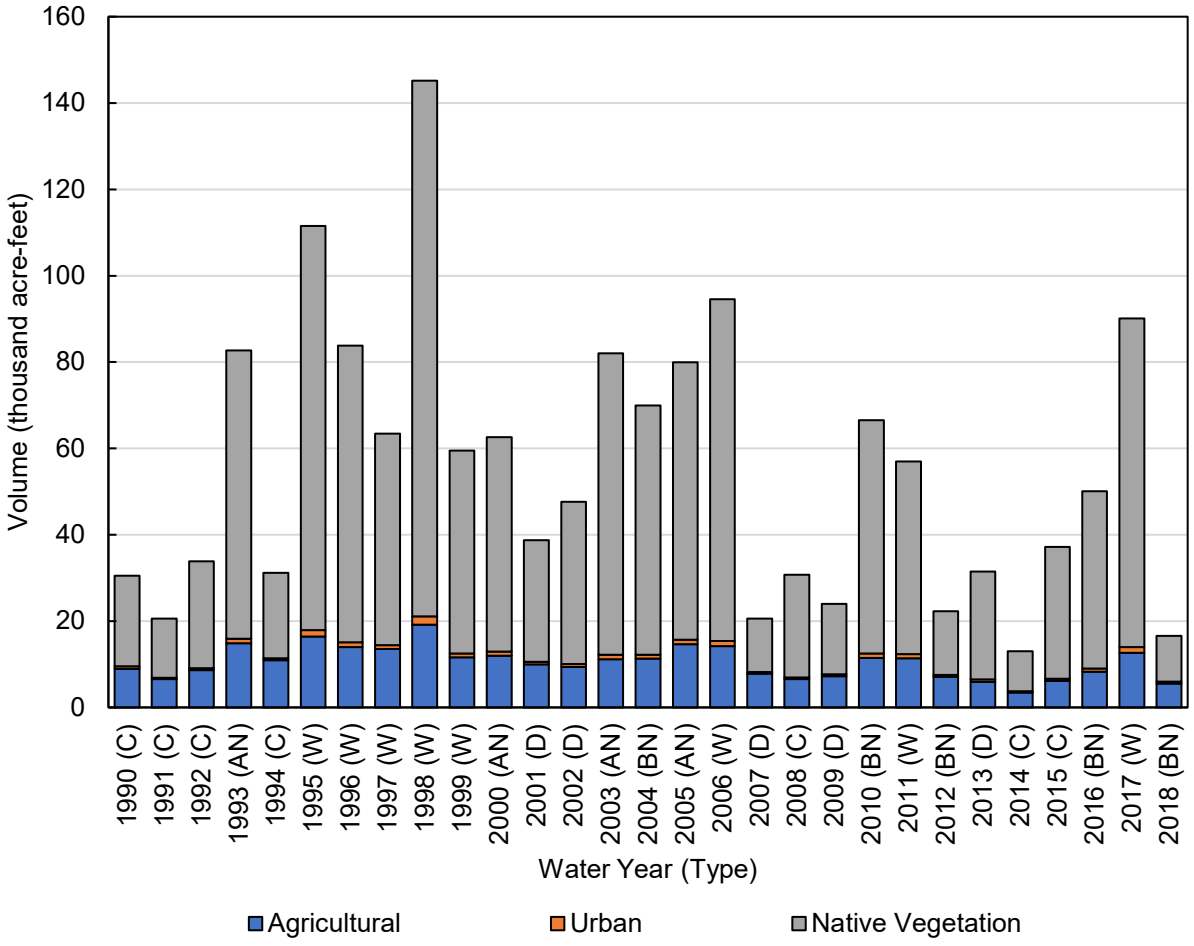


Figure 13. Red Bluff Subbasin Historical Deep Percolation of Precipitation, by Water Use Sector

Table 13. Red Bluff Subbasin Historical Deep Percolation of Precipitation, by Water Use Sector (acre-feet)

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
1990 (C)		8,900	570	21,000	31,000
1991 (C)		6,500	330	14,000	21,000
1992 (C)		8,600	450	25,000	34,000
1993 (AN)		15,000	1,000	67,000	83,000
1994 (C)		11,000	440	20,000	31,000
1995 (W)		16,000	1,500	94,000	110,000
1996 (W)		14,000	1,100	69,000	84,000
1997 (W)		14,000	860	49,000	63,000
1998 (W)		19,000	2,000	120,000	150,000
1999 (W)		12,000	840	47,000	59,000
2000 (AN)		12,000	950	50,000	63,000
2001 (D)		10,000	630	28,000	39,000
2002 (D)		9,400	620	38,000	48,000
2003 (AN)		11,000	1,000	70,000	82,000
2004 (BN)		11,000	850	58,000	70,000
2005 (AN)		15,000	1,100	64,000	80,000
2006 (W)		14,000	1,200	79,000	95,000
2007 (D)		7,800	400	12,000	21,000
2008 (C)		6,500	420	24,000	31,000
2009 (D)		7,200	460	16,000	24,000
2010 (BN)		11,000	1,000	54,000	67,000
2011 (W)		11,000	950	45,000	57,000
2012 (BN)		7,100	460	15,000	22,000
2013 (D)		5,900	540	25,000	31,000
2014 (C)		3,400	330	9,300	13,000
2015 (C)		6,100	570	31,000	37,000
2016 (BN)		8,300	730	41,000	50,000
2017 (W)		13,000	1,300	76,000	90,000
2018 (BN)		5,500	420	11,000	17,000
Average (1990-2018)		10,000	790	44,000	55,000
1990-2018	W	14,000	1,200	73,000	88,000
	AN	13,000	1,000	63,000	77,000
	BN	8,700	690	36,000	45,000
	D	8,100	530	24,000	32,000
	C	7,300	440	20,000	28,000

1.1.2.5 Infiltration of Surface Water

Estimated infiltration of surface water (seepage) by water source is provided in **Figure 14** and **Table 14.** Seepage in the Red Bluff Subbasin comes from the Tehama-Colusa Canal and Corning Canal that traverse the subbasin, as well as conveyance of supply delivered to water districts. The total seepage from all canals and diversions is less than 1 taf per year, on average. Runoff from upgradient small watersheds also contributes seepage to the Red Bluff Subbasin. The total seepage from rivers, streams and small water sheds average about 1.5 taf per year.

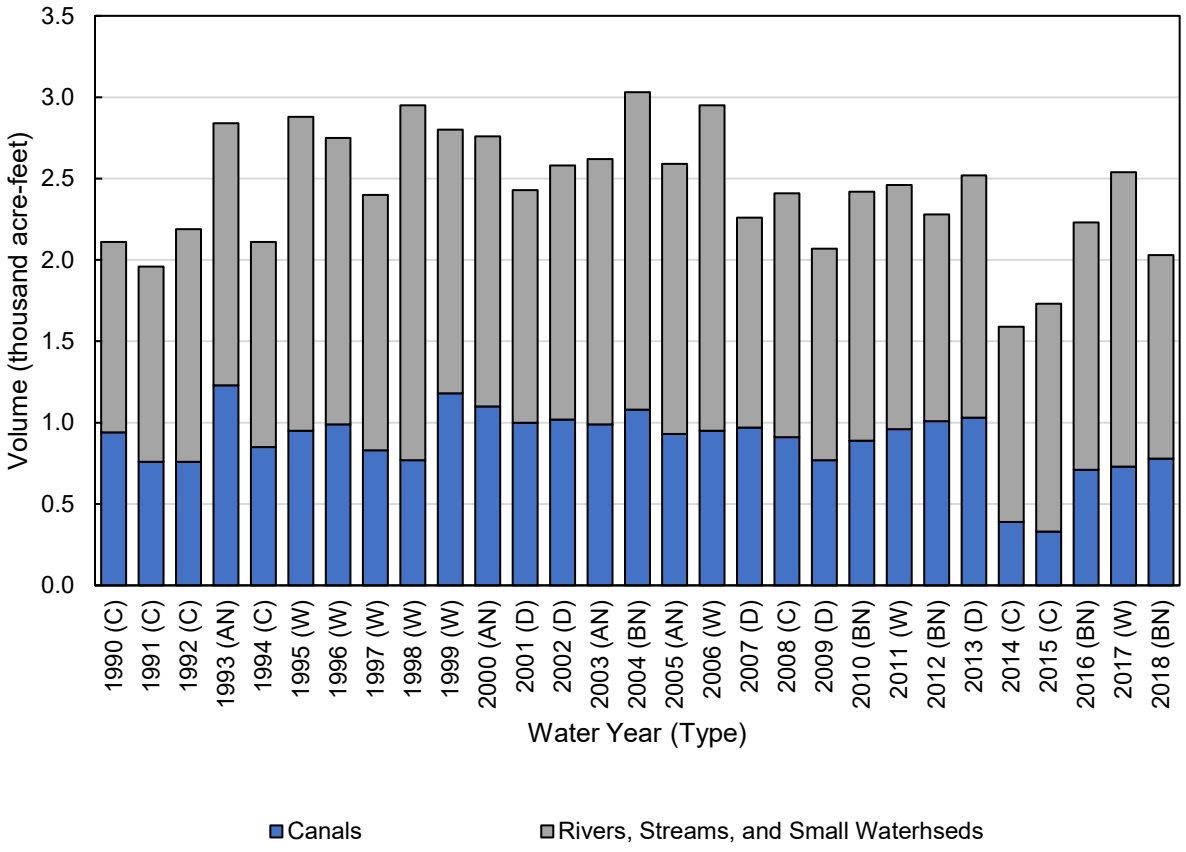


Figure 14. Red Bluff Subbasin Historical Infiltration of Surface Water, by Water Use Sector

Table 14. Red Bluff Subbasin Historical Infiltration of Surface Water, by Water Use Sector (acre-feet)

Water Year (Type)		Canals	Rivers, Streams, and Small Watersheds	Total
1990 (C)		940	1,200	2,100
1991 (C)		760	1,200	2,000
1992 (C)		760	1,400	2,200
1993 (AN)		1,200	1,600	2,800
1994 (C)		850	1,300	2,100
1995 (W)		950	1,900	2,900
1996 (W)		990	1,800	2,800
1997 (W)		830	1,600	2,400
1998 (W)		770	2,200	3,000
1999 (W)		1,200	1,600	2,800
2000 (AN)		1,100	1,700	2,800
2001 (D)		1,000	1,400	2,400
2002 (D)		1,000	1,600	2,600
2003 (AN)		990	1,600	2,600
2004 (BN)		1,100	2,000	3,000
2005 (AN)		930	1,700	2,600
2006 (W)		950	2,000	3,000
2007 (D)		970	1,300	2,300
2008 (C)		910	1,500	2,400
2009 (D)		770	1,300	2,100
2010 (BN)		890	1,500	2,400
2011 (W)		960	1,500	2,500
2012 (BN)		1,000	1,300	2,300
2013 (D)		1,000	1,500	2,500
2014 (C)		390	1,200	1,600
2015 (C)		330	1,400	1,700
2016 (BN)		710	1,500	2,200
2017 (W)		730	1,800	2,500
2018 (BN)		780	1,300	2,000
Average (1990-2018)		890	1,500	2,400
1990-2018	W	920	1,800	2,700
	AN	1,100	1,600	2,700
	BN	890	1,500	2,400
	D	960	1,400	2,400
	C	710	1,300	2,000

1.1.3 Change in Root Zone Storage

Estimates of change in root zone storage are provided in Figure 15 and Table 15. Inter-annual changes in storage within the SWS consist primarily of root zone soil moisture storage changes, are relatively small, and tend to average near zero over many years.

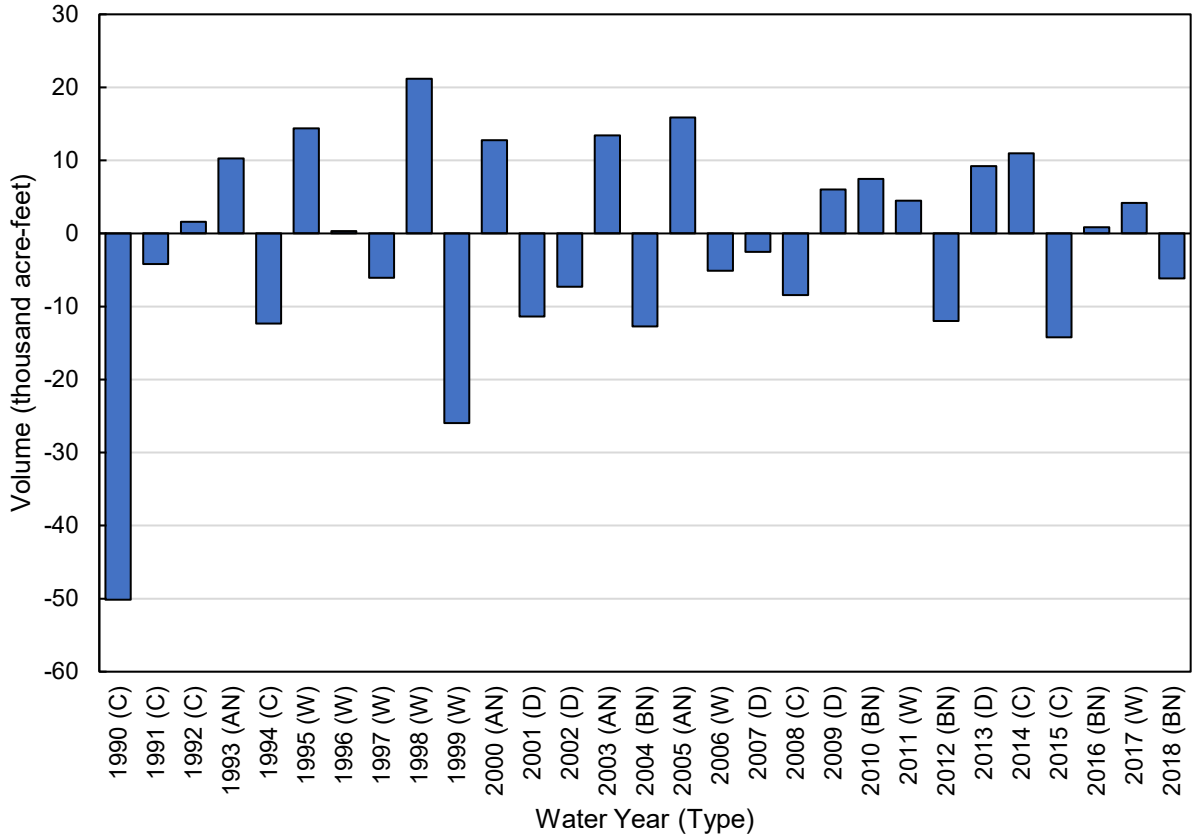


Figure 15. Red Bluff Subbasin Historical Change in Root Zone Storage

Table 15. Red Bluff Subbasin Historical Change in Root Zone Storage (acre-feet)

Water Year (Type)		Change in Root Zone Storage
1990 (C)		-50,000
1991 (C)		-4,200
1992 (C)		1,600
1993 (AN)		10,000
1994 (C)		-12,000
1995 (W)		14,000
1996 (W)		310
1997 (W)		-6,100
1998 (W)		21,000
1999 (W)		-26,000
2000 (AN)		13,000
2001 (D)		-11,000
2002 (D)		-7,300
2003 (AN)		13,000
2004 (BN)		-13,000
2005 (AN)		16,000
2006 (W)		-5,100
2007 (D)		-2,500
2008 (C)		-8,400
2009 (D)		6,000
2010 (BN)		7,500
2011 (W)		4,500
2012 (BN)		-12,000
2013 (D)		9,200
2014 (C)		11,000
2015 (C)		-14,000
2016 (BN)		830
2017 (W)		4,200
2018 (BN)		-6,100
Average (1990-2018)		-1,600
1990-2018	W	930
	AN	13,000
	BN	-4,500
	D	-1,200
	C	-11,000

1.1.4 Net Recharge from Surface Water System

Net recharge from the SWS is a useful metric that equates only the impacts of the SWS on recharge and extraction from the GWS, providing valuable insight to the combined effects of land surface processes on the underlying GWS. Net recharge from the SWS is calculated as the total groundwater recharge minus the total groundwater extraction and uptake. When calculated for the historical water budget, average net recharge from the SWS represents the average surplus (when positive) or shortage (when negative) of recharge that has resulted from historical cropping, land use practices, and average hydrologic conditions, when comparing groundwater extractions with deep percolation and infiltration from the SWS to the GWS. Net recharge does not include groundwater discharges to surface water and is not a full accounting of all exchanges occurring between the SWS and GWS. Although net recharge is a useful water balance metric, groundwater sustainability is not defined by the balance of net recharge from the SWS. Other important factors must be considered in the complete assessment of groundwater sustainability, including but not limited to subsurface groundwater flows and groundwater discharge to surface water.

Annual values for net recharge from the SWS over the historical water budget period are presented below for the Red Bluff Subbasin. **Figure 16** and **Table 16** show the average net recharge from the SWS over 1990-2018 based on the historical water budget results. Historically, the average net recharge in the Red Bluff Subbasin was approximately -17 taf per year between 1990-2018, indicating net outflows from the GWS to the SWS during the historical water budget period. As illustrated on the cumulative net recharge plot in **Figure 16**, this results in a cumulative net negative recharge (i.e., net discharge from the GWS to the SWS) of about 500 taf over the 29-year historical water budget period. Although this means there has historically been less recharge from the SWS to the GWS than extractions and discharges from the GWS to the SWS, this alone does not necessarily mean that groundwater storage is decreasing or that the Subbasin groundwater system has been unsustainable. The complete Subbasin water budget, including the GWS water budget results, provide an indication of whether total groundwater inflows and outflows are in balance.

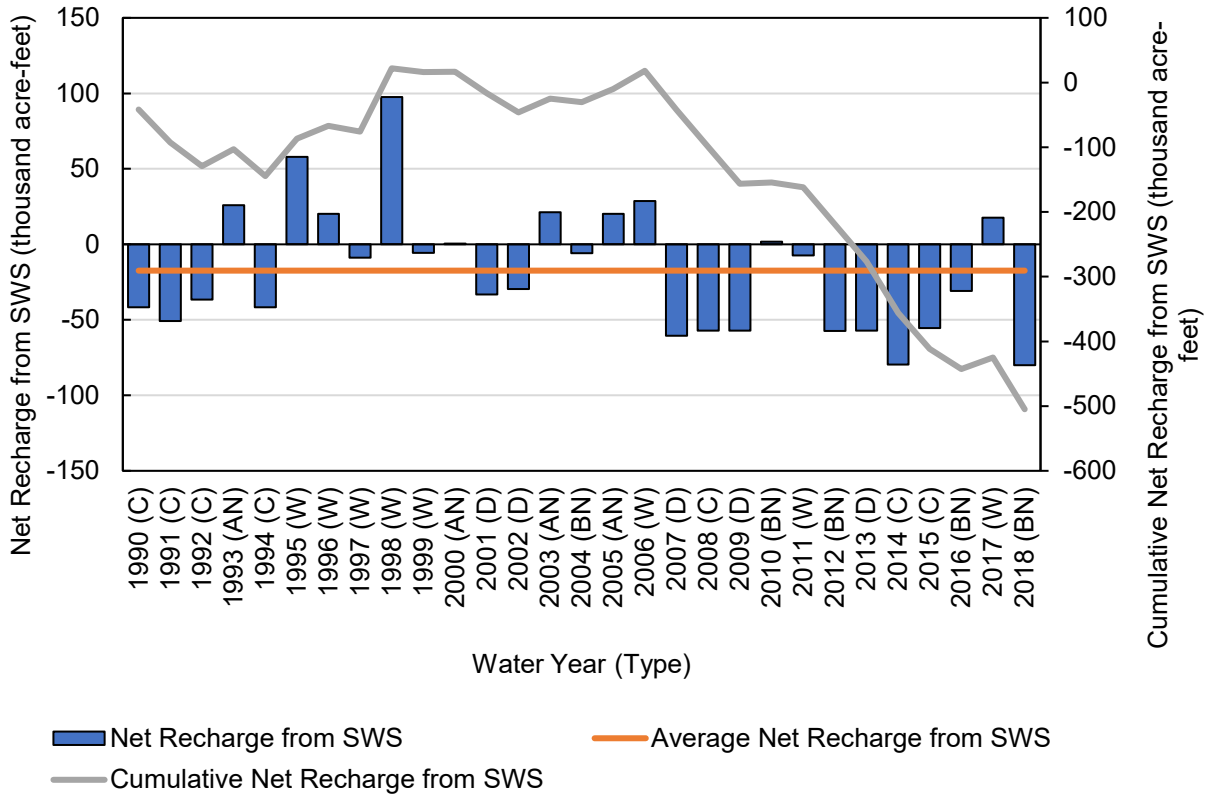


Figure 16. Red Bluff Subbasin Historical Net Recharge Overview

Table 16. Red Bluff Subbasin Historical Water Budget: Average Net Recharge from SWS, by Water Year Type (acre-feet)

Year Type	Number of Years	Deep Perc. of Applied Water (a)	Deep Perc. of Precipitation (b)	Infil. of Surface Water (c)	Groundwater Extraction/ Uptake (d)	Net Recharge from SWS (a+b+c-d)
W	8	17,000	88,000	2,700	82,000	25,000
AN	4	16,000	77,000	2,700	78,000	17,000
BN	5	14,000	45,000	2,400	96,000	-34,000
D	5	15,000	32,000	2,400	97,000	-48,000
C	7	13,000	28,000	2,000	95,000	-52,000
Annual Average (1990-2018)	29	15,000	55,000	2,400	90,000	-17,000

1.2 Groundwater System Water Budget Results

Historical water budget results for different components of the GWS are presented in the sections below. Inflows and outflows from the GWS that occur through exchanges with the SWS are discussed in the SWS water budget results, although these components are also noted in the sections below relating to the GWS water budget. In contrast to the SWS water budget, many of the GWS water budget components change in flow direction over time representing inflows during some periods and outflows during other periods, depending on Subbasin conditions. The GWS water budget results are presented with net inflows indicated by positive values and net outflows as negative values.

1.2.1 Lateral Subsurface Groundwater Flows

Subsurface groundwater flows to and from the Red Bluff Subbasin occur between the Bowman Subbasin to the north, the Bend, Antelope, and Los Molinos Subbasins to the east, and the Corning Subbasin to the south. Some subsurface groundwater flows also occur between the South Battle Creek Subbasin which borders the Red Bluff Subbasin to the northeast. Additional subsurface groundwater inflows occur from the upland foothill (small watershed) areas adjoining the Red Bluff Subbasin to the west.

1.2.1.1 Lateral Subsurface Flows to/from Adjacent Subbasins

Historical lateral subsurface flows occurring from and to adjacent subbasin are summarized in **Figure 17** and **Table 17**. The total historical net subsurface flows to and from all adjacent subbasins averages about 48 taf per year occurring as inflow to the Red Bluff Subbasin. The largest historical subsurface flows occur across the boundary with the Bowman with somewhat less subsurface flow occurring across the boundaries with the Corning, Antelope and Bend Subbasins, although these flows are still considerable. Much smaller flows occur across the boundaries with the Los Molinos and South Battle Creek Subbasins.

Historical subsurface flows with the Bowman Subbasin consistently average about 120 taf occurring as inflows to the Red Bluff Subbasin. This makes up most of the subsurface inflows occurring to the Red Bluff Subbasin. Annual subsurface flows from Red Bluff Subbasin to Corning, Antelope and Bend Subbasins (negative values) average about 28, 25 and 18 taf, respectively. The magnitudes of the subsurface outflows from Red Bluff Subbasin to the Corning and Bend Subbasins are relatively consistent from year to year; however, the year-to-year variability in the outflows to the Antelope Subbasin are somewhat greater. Historical subsurface flows across the boundary with Los Molinos Subbasin generally occur as smaller volumes of outflows to the Los Molinos Subbasin, although the magnitude of flows across this boundary do vary, including the occurrence of a net inflow from Los Molinos Subbasin in 2014 and 2018. The long-term average over the historical water budget period is a net outflow of about 2.2 taf per year from Red Bluff Subbasin to Los Molinos Subbasin (negative value). A small amount of subsurface inflow also occurs across the boundary with the South Battle Creek Subbasin totaling about 1.5 taf per year on average.

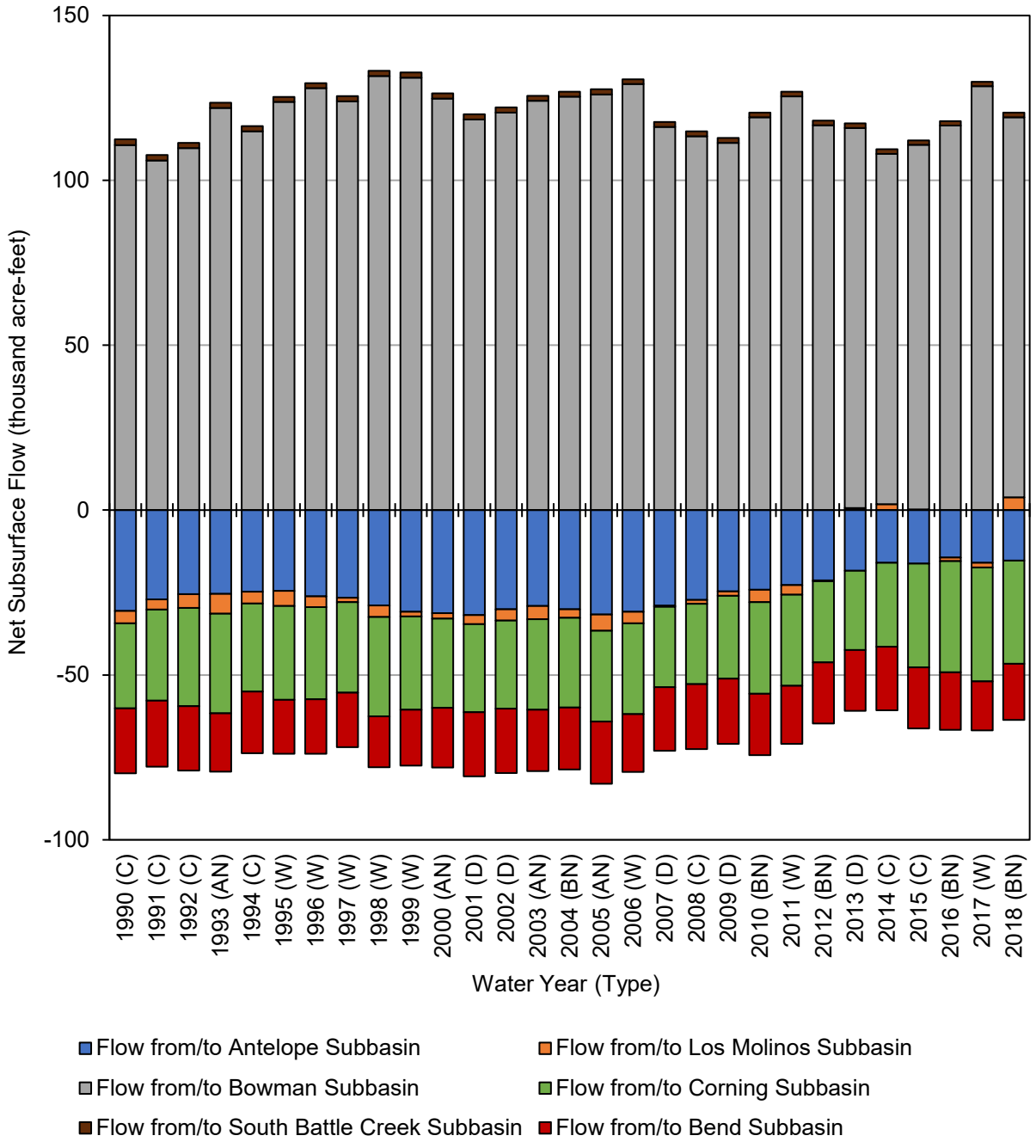


Figure 17. Red Bluff Subbasin Historical Lateral Subsurface Groundwater Flows to/from Adjacent Subbasins

Table 17. Red Bluff Subbasin Historical Lateral Subsurface Groundwater Flows Between Adjacent Subbasins (net flows as acre-feet)

Water Year (Type)		Antelope	Los Molinos	Bowman	Corning	S. Battle Creek	Bend	Total
1990 (C)		-31,000	-3,800	110,000	-26,000	1,700	-20,000	33,000
1991 (C)		-27,000	-3,000	110,000	-28,000	1,700	-20,000	30,000
1992 (C)		-26,000	-4,100	110,000	-30,000	1,600	-20,000	32,000
1993 (AN)		-25,000	-6,000	120,000	-30,000	1,600	-18,000	44,000
1994 (C)		-25,000	-3,500	110,000	-27,000	1,600	-19,000	43,000
1995 (W)		-25,000	-4,600	120,000	-28,000	1,500	-16,000	51,000
1996 (W)		-26,000	-3,200	130,000	-28,000	1,500	-17,000	56,000
1997 (W)		-27,000	-1,400	120,000	-27,000	1,500	-17,000	54,000
1998 (W)		-29,000	-3,600	130,000	-30,000	1,500	-15,000	55,000
1999 (W)		-31,000	-1,400	130,000	-28,000	1,600	-17,000	55,000
2000 (AN)		-31,000	-1,700	120,000	-27,000	1,600	-18,000	48,000
2001 (D)		-32,000	-2,800	120,000	-27,000	1,600	-19,000	39,000
2002 (D)		-30,000	-3,400	120,000	-27,000	1,600	-20,000	42,000
2003 (AN)		-29,000	-4,000	120,000	-27,000	1,500	-19,000	46,000
2004 (BN)		-30,000	-2,600	130,000	-27,000	1,500	-19,000	48,000
2005 (AN)		-32,000	-4,900	130,000	-28,000	1,500	-19,000	45,000
2006 (W)		-31,000	-3,500	130,000	-28,000	1,500	-18,000	51,000
2007 (D)		-29,000	-260	120,000	-24,000	1,500	-19,000	45,000
2008 (C)		-27,000	-1,200	110,000	-24,000	1,500	-20,000	42,000
2009 (D)		-25,000	-1,300	110,000	-25,000	1,500	-20,000	42,000
2010 (BN)		-24,000	-3,700	120,000	-28,000	1,400	-19,000	46,000
2011 (W)		-23,000	-2,900	130,000	-28,000	1,400	-18,000	56,000
2012 (BN)		-21,000	-240	120,000	-25,000	1,400	-19,000	53,000
2013 (D)		-18,000	660	120,000	-24,000	1,400	-18,000	56,000
2014 (C)		-16,000	1,800	110,000	-25,000	1,400	-19,000	49,000
2015 (C)		-16,000	180	110,000	-31,000	1,400	-19,000	46,000
2016 (BN)		-14,000	-1,100	120,000	-34,000	1,300	-17,000	51,000
2017 (W)		-16,000	-1,500	130,000	-35,000	1,300	-15,000	63,000
2018 (BN)		-15,000	3,900	120,000	-31,000	1,400	-17,000	57,000
Average (1990-2018)		-25,000	-2,200	120,000	-28,000	1,500	-18,000	48,000
1990-2018	W	-26,000	-2,800	130,000	-29,000	1,500	-16,000	55,000
	AN	-29,000	-5,000	120,000	-28,000	1,500	-18,000	45,000
	BN	-20,000	-810	120,000	-30,000	1,400	-18,000	51,000
	D	-27,000	-1,400	120,000	-25,000	1,500	-19,000	45,000
	C	-24,000	-2,000	110,000	-27,000	1,600	-19,000	39,000

Note: positive values represent net inflows to Red Bluff Subbasin, negative values represent net outflows from Red Bluff Subbasin.

1.2.1.2 Lateral Subsurface Flows from Upland Areas (Small Watersheds)

Historical lateral subsurface inflows occurring from upland or foothill areas (small watersheds outside of the Central Valley Floor) to the west of the Red Bluff Subbasin are summarized in **Figure 18** and **Table 16**. This component does not include surface water inflows to the Red Bluff Subbasin which are discussed as part of the SWS water budget. The average historical subsurface inflow from the upland areas is about 1.1 taf per year and varies only very minimally from year to year. The volume of subsurface inflows from upland areas is small relative to the net subsurface inflows occurring between adjacent subbasins.

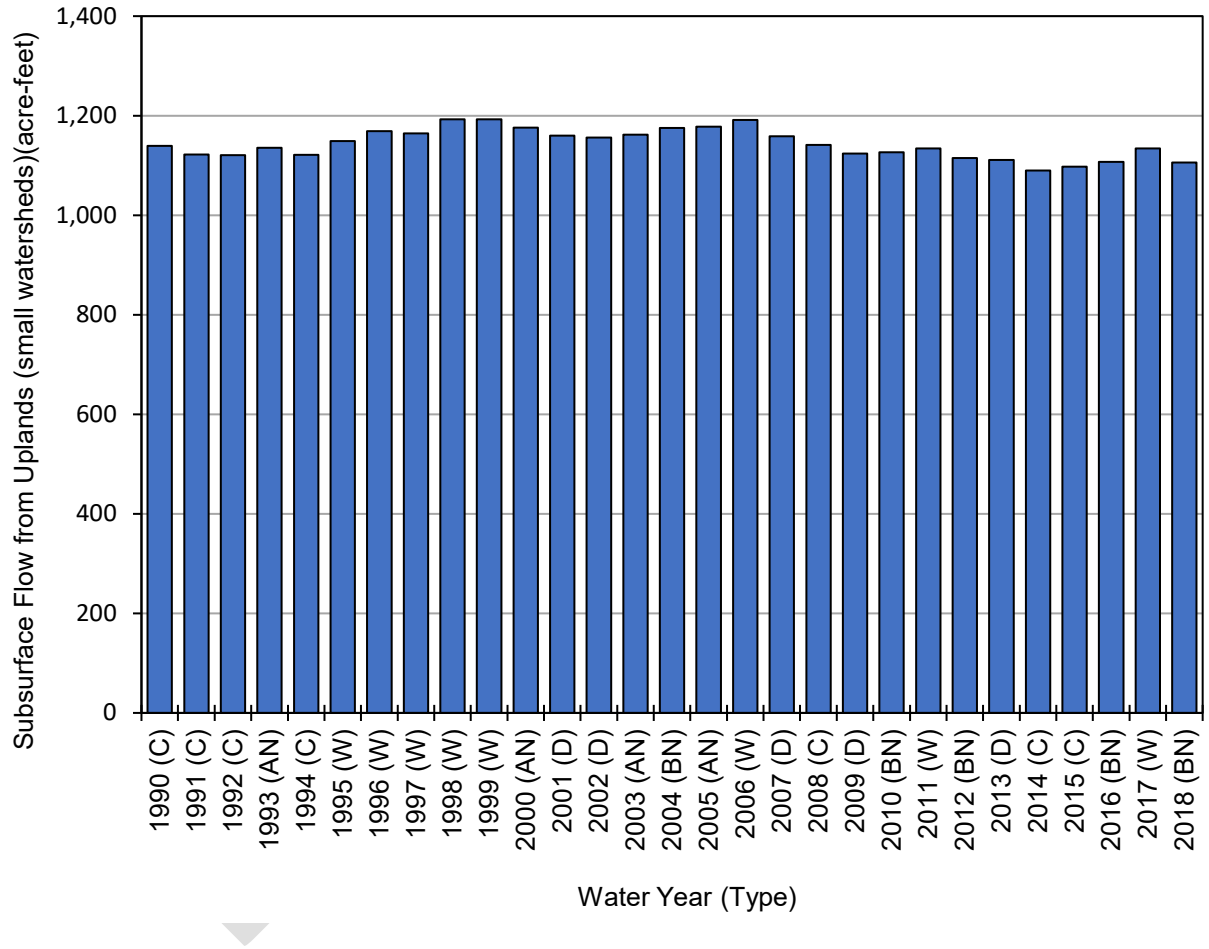


Figure 18. Red Bluff Subbasin Historical Subsurface Groundwater Inflows from Upland Areas

Table 18. Red Bluff Subbasin Historical Subsurface Groundwater Inflows from Adjacent Uplands (small watersheds) (acre-feet)

Water Year (Type)		Subsurface Inflow from Uplands
1990 (C)		1,100
1991 (C)		1,100
1992 (C)		1,100
1993 (AN)		1,100
1994 (C)		1,100
1995 (W)		1,100
1996 (W)		1,200
1997 (W)		1,200
1998 (W)		1,200
1999 (W)		1,200
2000 (AN)		1,200
2001 (D)		1,200
2002 (D)		1,200
2003 (AN)		1,200
2004 (BN)		1,200
2005 (AN)		1,200
2006 (W)		1,200
2007 (D)		1,200
2008 (C)		1,100
2009 (D)		1,100
2010 (BN)		1,100
2011 (W)		1,100
2012 (BN)		1,100
2013 (D)		1,100
2014 (C)		1,100
2015 (C)		1,100
2016 (BN)		1,100
2017 (W)		1,100
2018 (BN)		1,100
Average (1990-2018)		1,100
1990-2018	W	1,200
	AN	1,200
	BN	1,100
	D	1,100
	C	1,100

1.2.2 Deep Percolation From the SWS

Deep percolation from the SWS includes infiltration of water below the root zone (deep percolation) from precipitation and applied water. These two water budget components are summarized in the SWS water budget as outflows to the SWS and are presented as aggregated deep percolation inflows to the GWS in **Figure 19** and **Table 19**. The average annual deep percolation from the SWS over the historical water budget period is approximately 70 taf per year. Greater volumes of deep percolation occur during wetter years when infiltration of precipitation is higher.

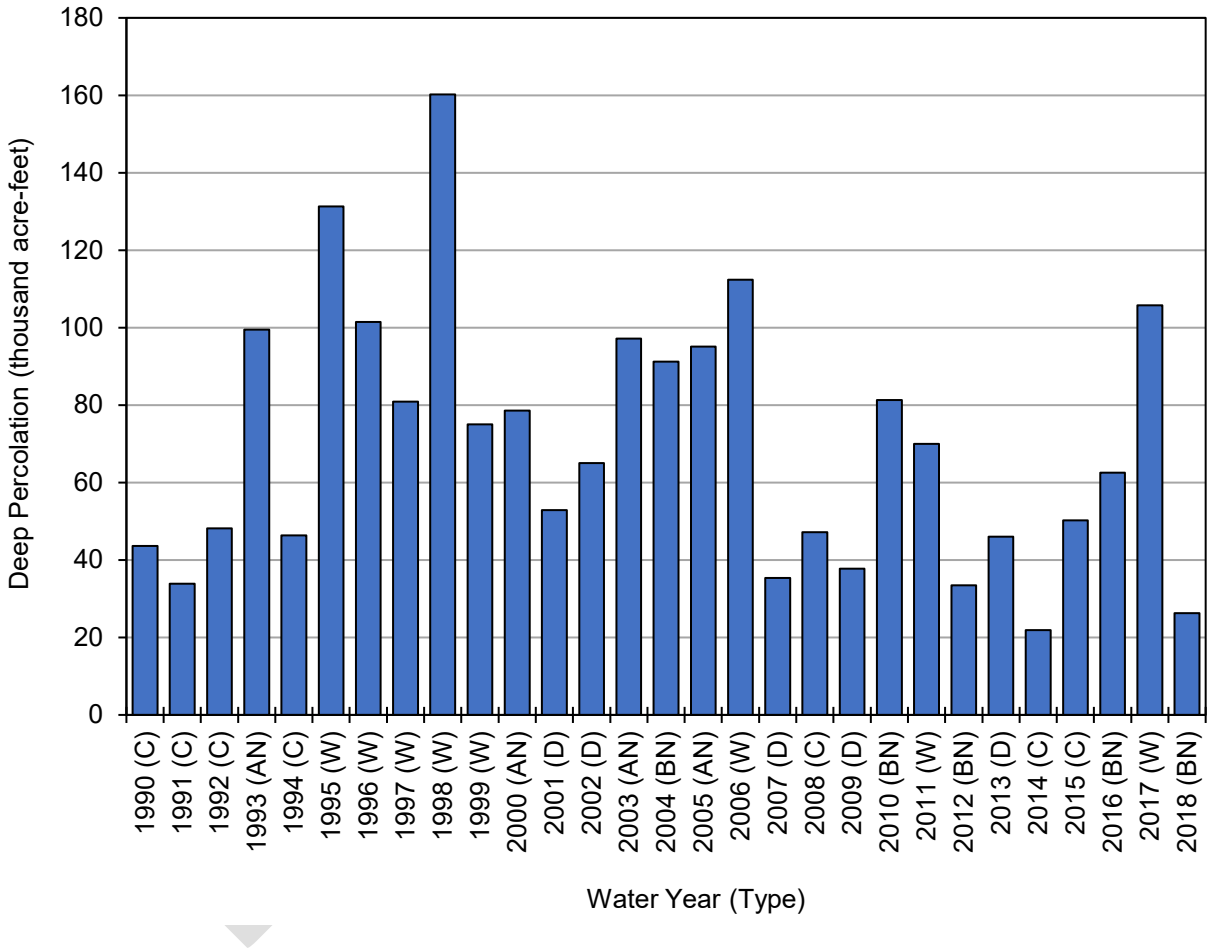


Figure 19. Red Bluff Subbasin Historical Deep Percolation from the SWS

Table 19. Red Bluff Subbasin Historical Deep Percolation from the SWS (acre-feet)

Water Year (Type)		Deep Percolation from the SWS
1990 (C)		44,000
1991 (C)		34,000
1992 (C)		48,000
1993 (AN)		100,000
1994 (C)		46,000
1995 (W)		130,000
1996 (W)		100,000
1997 (W)		81,000
1998 (W)		160,000
1999 (W)		75,000
2000 (AN)		79,000
2001 (D)		53,000
2002 (D)		65,000
2003 (AN)		97,000
2004 (BN)		91,000
2005 (AN)		95,000
2006 (W)		110,000
2007 (D)		35,000
2008 (C)		47,000
2009 (D)		38,000
2010 (BN)		81,000
2011 (W)		70,000
2012 (BN)		33,000
2013 (D)		46,000
2014 (C)		22,000
2015 (C)		50,000
2016 (BN)		63,000
2017 (W)		110,000
2018 (BN)		26,000
Average (1990-2018)		70,000
1990-2018	W	100,000
	AN	97,000
	BN	60,000
	D	47,000
	C	42,000

1.2.3 Net Stream Seepage/Groundwater Discharge to Surface Water

The flow of water between the GWS and SWS through seepage of water from streams and canals and groundwater discharging into streams is discussed as part of the SWS water budget. These components are combined for presentation in the GWS water budget as a net volume of stream seepage (**Figure 20** and **Table 20**). Positive total net seepage values represent a net inflow of water from the SWS to the GWS via stream and canal seepage indicating that the overall volume of stream seepage is greater than the volume of any groundwater discharging into surface waterways. Negative net seepage values represent a net outflow of groundwater from the GWS to the SWS through groundwater discharge to surface water. When net seepage is negative, it means that more groundwater is discharging into the surface waterways than is seeping from surface waterways into the GWS.

In the Red Bluff Subbasin, the historical annual net seepage values are always highly negative with an average annual net stream seepage value of -49 taf per year indicating that groundwater discharge is providing considerable flow to the surface waterways. The annual net stream seepage values tend to be more negative in dry years and less negative in wet years corresponding with more net groundwater discharge to surface water in drier years and less groundwater discharge in wetter years.

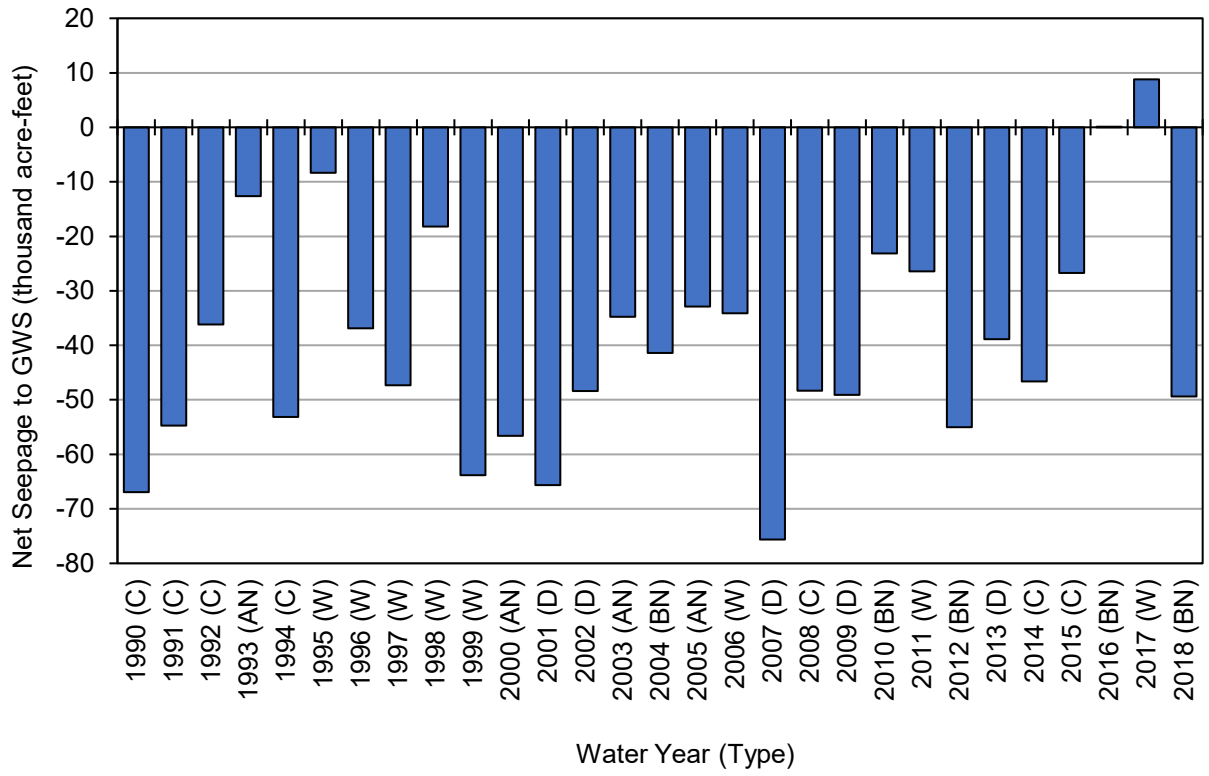


Figure 20. Red Bluff Subbasin Historical Net Stream Seepage to GWS/Discharge to Surface Water

Table 20. Red Bluff Subbasin Historical Net Stream Seepage (net flows as acre-feet)

Water Year (Type)		Total Net Seepage from Surface Waterways and Canals
1990 (C)		-67,000
1991 (C)		-55,000
1992 (C)		-36,000
1993 (AN)		-13,000
1994 (C)		-53,000
1995 (W)		-8,300
1996 (W)		-37,000
1997 (W)		-47,000
1998 (W)		-18,000
1999 (W)		-64,000
2000 (AN)		-57,000
2001 (D)		-66,000
2002 (D)		-48,000
2003 (AN)		-35,000
2004 (BN)		-41,000
2005 (AN)		-33,000
2006 (W)		-34,000
2007 (D)		-76,000
2008 (C)		-48,000
2009 (D)		-49,000
2010 (BN)		-23,000
2011 (W)		-26,000
2012 (BN)		-55,000
2013 (D)		-39,000
2014 (C)		-47,000
2015 (C)		-27,000
2016 (BN)		82
2017 (W)		8,800
2018 (BN)		-49,000
Average (1990-2018)		-39,000
1990-2018	W	-28,000
	AN	-27,000
	BN	-28,000
	D	-56,000
	C	-48,000

Note: negative values indicate net groundwater discharge to surface water

1.2.4 Groundwater Extraction

Groundwater extractions are exchanges that occur between the GWS and the SWS. Groundwater extraction from the GWS occurs through groundwater pumping to meet water demands for urban and agricultural needs and also through groundwater (root water) uptake by plants directly from shallow groundwater during times and at locations of sufficiently shallow groundwater conditions. Historical groundwater extractions are summarized in **Figure 21** and **Table 21** and also presented and discussed in the SWS water budget sections. Total groundwater extractions over the historical water budget period average about -90 taf per year. Overall, groundwater pumping represents a larger fraction (nearly eight times) of the groundwater extractions than groundwater uptake. Groundwater pumping averaged about -80 taf over the historical period and groundwater uptake averaged about -9.7 taf. In wetter periods, groundwater uptake increases and groundwater pumping decreases. Accordingly, during drier periods groundwater pumping increases and water uptake by plants from shallow groundwater decreases in response to the higher water demands for irrigation and other uses and the greater depths to groundwater that also tend to occur during dry periods.

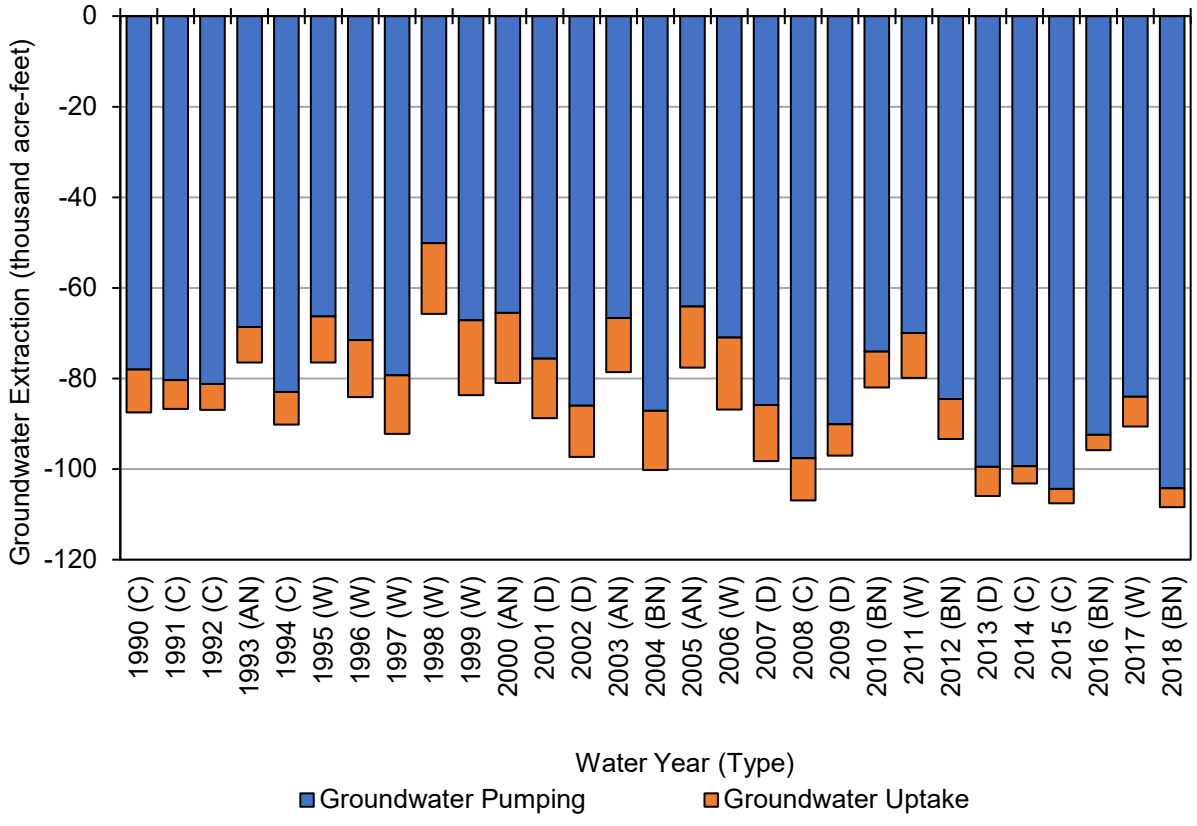


Figure 21. Red Bluff Subbasin Historical Groundwater Extractions

Table 21. Red Bluff Subbasin Historical Groundwater Extractions (acre-feet)

Water Year (Type)		Groundwater Pumping	Groundwater (Root Water) Uptake	Total Extractions
1990 (C)		-78,000	-9,400	-87,000
1991 (C)		-80,000	-6,300	-87,000
1992 (C)		-81,000	-5,800	-87,000
1993 (AN)		-69,000	-7,900	-77,000
1994 (C)		-83,000	-7,200	-90,000
1995 (W)		-66,000	-10,000	-76,000
1996 (W)		-72,000	-13,000	-84,000
1997 (W)		-79,000	-13,000	-92,000
1998 (W)		-50,000	-16,000	-66,000
1999 (W)		-67,000	-17,000	-84,000
2000 (AN)		-66,000	-15,000	-81,000
2001 (D)		-76,000	-13,000	-89,000
2002 (D)		-86,000	-11,000	-97,000
2003 (AN)		-67,000	-12,000	-79,000
2004 (BN)		-87,000	-13,000	-100,000
2005 (AN)		-64,000	-13,000	-78,000
2006 (W)		-71,000	-16,000	-87,000
2007 (D)		-86,000	-12,000	-98,000
2008 (C)		-98,000	-9,400	-110,000
2009 (D)		-90,000	-6,900	-97,000
2010 (BN)		-74,000	-7,900	-82,000
2011 (W)		-70,000	-9,900	-80,000
2012 (BN)		-85,000	-8,800	-93,000
2013 (D)		-99,000	-6,500	-110,000
2014 (C)		-99,000	-3,800	-100,000
2015 (C)		-100,000	-3,200	-110,000
2016 (BN)		-92,000	-3,400	-96,000
2017 (W)		-84,000	-6,600	-91,000
2018 (BN)		-100,000	-4,200	-110,000
Average (1990-2018)		-80,000	-9,700	-90,000
1990-2018	W	-70,000	-13,000	-82,000
	AN	-66,000	-11,000	-78,000
	BN	-89,000	-6,800	-96,000
	D	-87,000	-10,000	-97,000
	C	-89,000	-6,400	-96,000

1.2.5 Vertical Subsurface Flows within the Groundwater System

Vertical subsurface flows within the GWS occur between the Upper and Lower Aquifers and represent an internal flow of water within the GWS. These exchanges between the principal aquifers do not directly affect the total volume of groundwater in storage, but do highlight the net vertical movement of water within the GWS. Historical vertical flows between the Upper Aquifer and Lower Aquifer are summarized in **Figure 22** and **Table 22** and show consistent net overall upward vertical flow from the Lower Aquifer to the Upper Aquifer. On average, vertical flows from the Lower Aquifer to the Upper Aquifer total about 41 taf per year over the historical water budget period. There is considerable year-to-year variability in the magnitude of these flows, which appear to correlate with water year conditions, although they are always in an upward direction. The magnitude of upward flows are generally greatest during drier years and decrease during wet periods. The net upward vertical flow between the two principal aquifers in the Subbasin is consistent with the large groundwater outflows (e.g., groundwater extractions, groundwater discharge to SWS) that occur from the Upper Aquifer in the Subbasin that result in upward movement of groundwater from the Lower Aquifer.

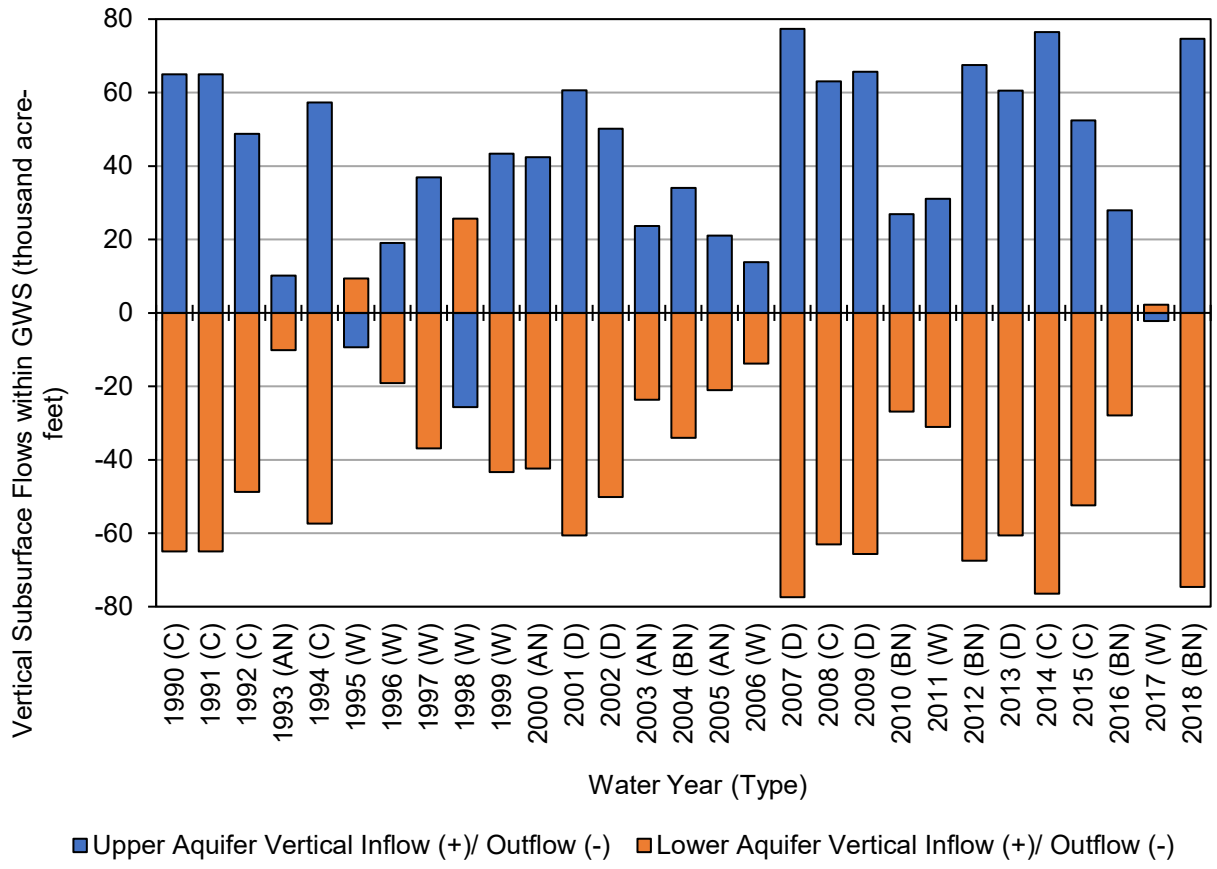


Figure 22. Red Bluff Subbasin Historical Vertical Subsurface Flow within the GWS

Table 22. Red Bluff Subbasin Historical Vertical Subsurface Flows within the GWS (acre-feet)

Water Year (Type)		Upper Aquifer to (-) / from (+) Lower Aquifer
1990 (C)		65,000
1991 (C)		65,000
1992 (C)		49,000
1993 (AN)		10,000
1994 (C)		57,000
1995 (W)		-9,400
1996 (W)		19,000
1997 (W)		37,000
1998 (W)		-26,000
1999 (W)		43,000
2000 (AN)		42,000
2001 (D)		61,000
2002 (D)		50,000
2003 (AN)		24,000
2004 (BN)		34,000
2005 (AN)		21,000
2006 (W)		14,000
2007 (D)		77,000
2008 (C)		63,000
2009 (D)		66,000
2010 (BN)		27,000
2011 (W)		31,000
2012 (BN)		67,000
2013 (D)		61,000
2014 (C)		76,000
2015 (C)		52,000
2016 (BN)		28,000
2017 (W)		-2,200
2018 (BN)		75,000
Average (1990-2018)		41,000
1990-2018	W	13,000
	AN	24,000
	BN	46,000
	D	63,000
	C	61,000

1.2.6 Change in Groundwater Storage

Historical change in groundwater storage values for the Red Bluff Subbasin are summarized in **Figure 23** and **Figure 24,** and **Table 23**. Values for total change in storage in the GWS and cumulative change in storage over the historical water budget period are presented in conjunction with the volumes of groundwater storage change within each of the two principal aquifers present in the Subbasin. Over the 29-year historical period, the average total annual change in groundwater storage is about -11 taf per year, representing a decrease in groundwater storage. The corresponding cumulative total change in storage over the historical period is about -310 taf. The annual change in storage numbers generally reflect the effects of the water year type with increase in storage occurring during wetter years and decreases in storage occurring during dry years. Within the GWS, the magnitudes of average annual changes in storage are higher in the Lower Aquifer (average -7.1 taf per year) compared to the Upper Aquifer (average -3.5 taf per year).

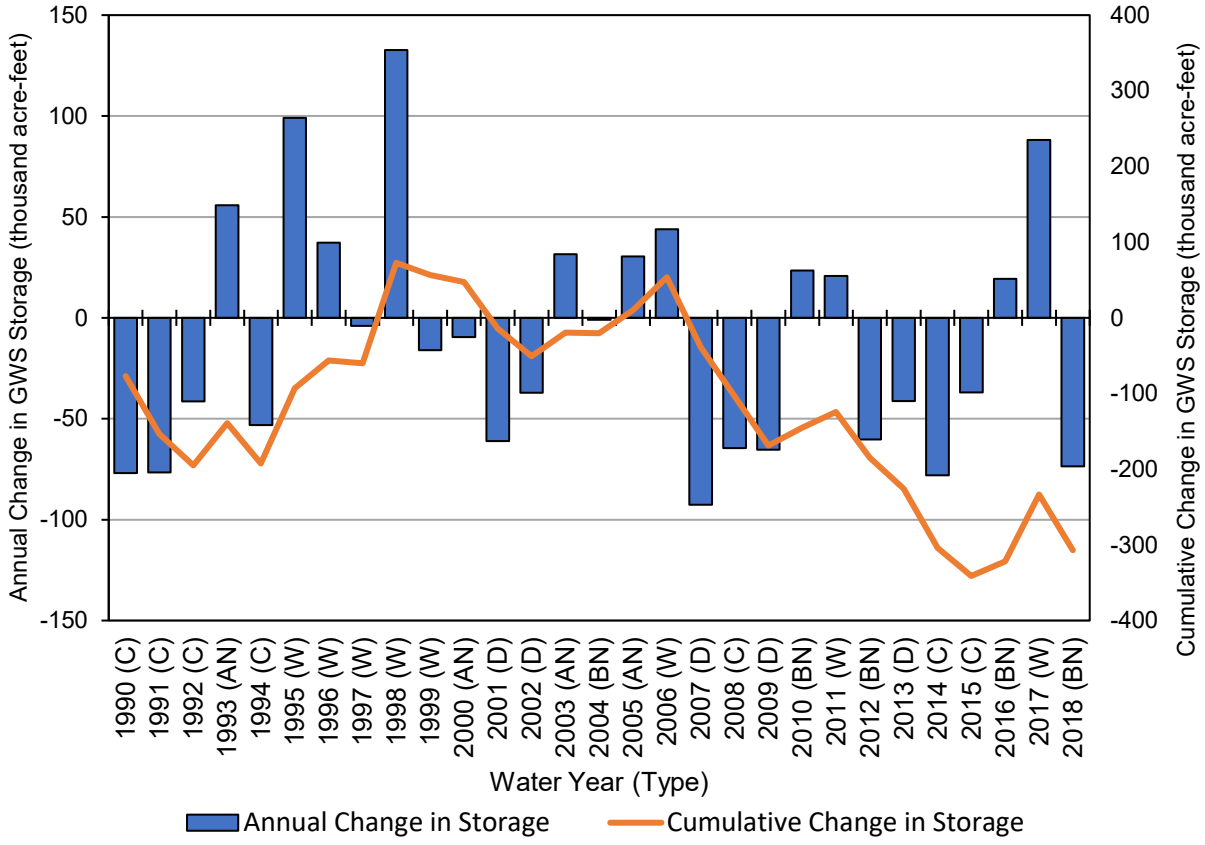


Figure 23. Red Bluff Subbasin Historical Total Change in Storage within the GWS

Table 23. Red Bluff Subbasin Historical Change in Groundwater Storage (acre-feet)

Water Year (Type)		Upper Aquifer	Lower Aquifer	Total Annual Change	Total Cumulative Change
1990 (C)		-32,000	-45,000	-77,000	-77,000
1991 (C)		-29,000	-48,000	-77,000	-150,000
1992 (C)		-13,000	-28,000	-41,000	-200,000
1993 (AN)		33,000	22,000	56,000	-140,000
1994 (C)		-24,000	-29,000	-53,000	-190,000
1995 (W)		51,000	48,000	99,000	-93,000
1996 (W)		14,000	23,000	37,000	-56,000
1997 (W)		-5,100	1,100	-3,900	-60,000
1998 (W)		61,000	71,000	130,000	73,000
1999 (W)		-17,000	880	-16,000	57,000
2000 (AN)		-4,500	-5,000	-9,500	47,000
2001 (D)		-29,000	-32,000	-61,000	-14,000
2002 (D)		-17,000	-20,000	-37,000	-51,000
2003 (AN)		18,000	14,000	31,000	-20,000
2004 (BN)		-2,000	1,000	-1,000	-21,000
2005 (AN)		15,000	15,000	30,000	9,900
2006 (W)		18,000	26,000	44,000	54,000
2007 (D)		-45,000	-48,000	-93,000	-39,000
2008 (C)		-28,000	-37,000	-65,000	-100,000
2009 (D)		-25,000	-40,000	-65,000	-170,000
2010 (BN)		18,000	5,800	23,000	-150,000
2011 (W)		11,000	10,000	21,000	-120,000
2012 (BN)		-28,000	-32,000	-60,000	-180,000
2013 (D)		-17,000	-24,000	-41,000	-230,000
2014 (C)		-32,000	-46,000	-78,000	-300,000
2015 (C)		-13,000	-24,000	-37,000	-340,000
2016 (BN)		13,000	6,000	19,000	-320,000
2017 (W)		40,000	48,000	88,000	-230,000
2018 (BN)		-34,000	-40,000	-74,000	-310,000
Average (1990-2018)		-3,500	-7,100	-11,000	
1990-2018	W	22,000	29,000	50,000	
	AN	15,000	12,000	27,000	
	BN	-6,600	-12,000	-18,000	
	D	-27,000	-33,000	-59,000	
	C	-24,000	-37,000	-61,000	

Note: positive values indicate increases in groundwater storage, negative values indicate decreases in groundwater storage.

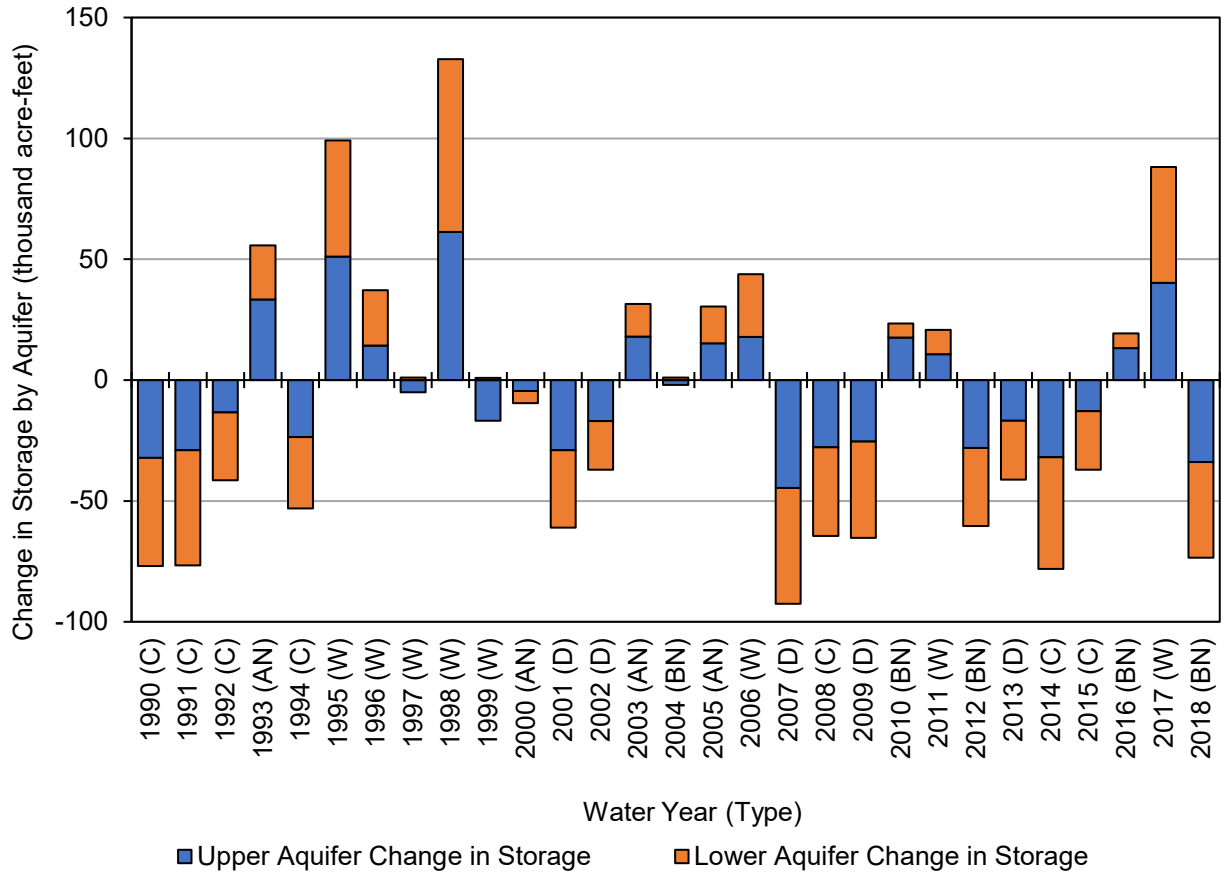


Figure 24. Red Bluff Subbasin Historical Change in Groundwater Storage by Aquifer

2 DETAILED PROJECTED (CURRENT LAND USE) WATER BUDGET

This section presents the results of the Projected (Current Land Use) scenario. The Current Land Use scenario assumes constant land use conditions based on 2018 conditions.

2.1 Surface Water System Water Budget Results

2.1.1 Inflows

2.1.1.1 Surface Water Inflow by Water Source Type

The projected annual volume of surface water inflows is summarized by water source type in **Figure 25** and **Table 24**. Over the projected (current land use) period, surface water inflows average about 120 taf per year. Virtually, all inflows of the SWS are local supplies. The CVP supplies are very small and average about 5 taf per year, on average.

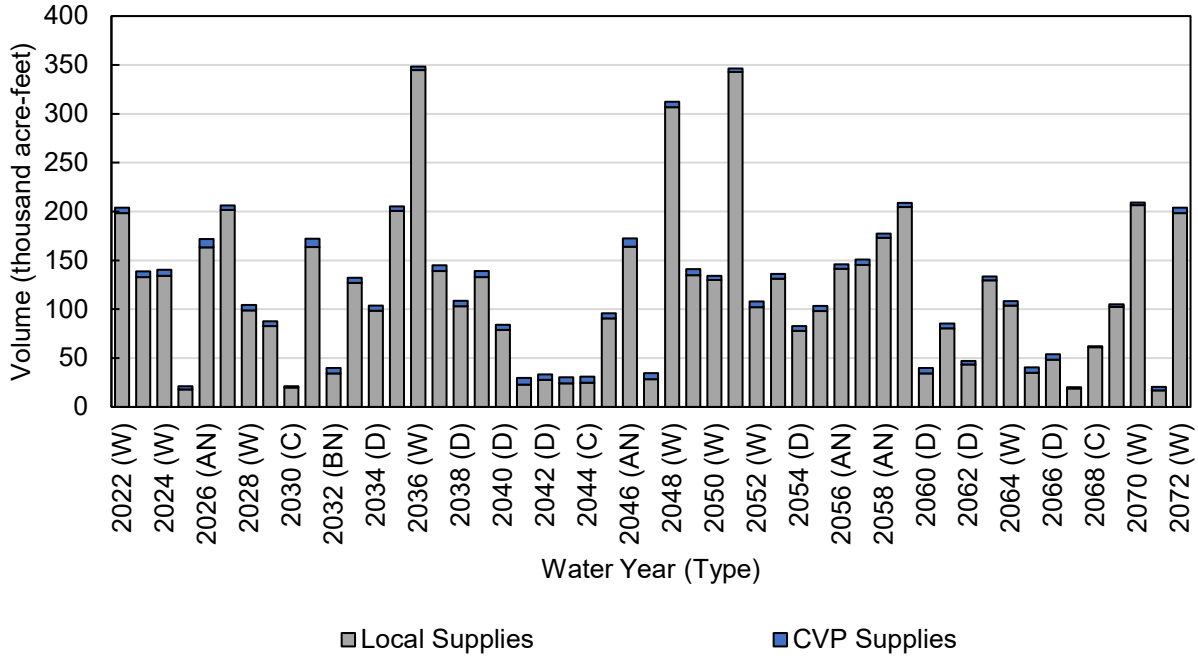


Figure 25. Red Bluff Subbasin Projected (Current Land Use) Surface Water Inflows, by Water Source Type

Table 24. Red Bluff Subbasin Projected (Current Land Use) Surface Water Inflows, by Water Source Type (acre-feet)

Water Year (Type)	CVP Supplies	Local Supplies	Total
2022 (W)	5,600	200,000	200,000
2023 (W)	6,100	130,000	140,000
2024 (W)	6,100	130,000	140,000
2025 (BN)	3,400	18,000	21,000
2026 (AN)	8,400	160,000	170,000
2027 (W)	4,400	200,000	210,000
2028 (W)	5,700	99,000	100,000
2029 (C)	4,800	83,000	88,000
2030 (C)	1,400	20,000	21,000
2031 (AN)	8,600	160,000	170,000
2032 (BN)	5,700	34,000	40,000
2033 (AN)	5,200	130,000	130,000
2034 (D)	5,300	98,000	100,000
2035 (W)	4,400	200,000	210,000
2036 (W)	3,600	340,000	350,000
2037 (W)	6,100	140,000	150,000
2038 (D)	5,300	100,000	110,000
2039 (W)	6,100	130,000	140,000
2040 (D)	5,100	79,000	84,000
2041 (C)	7,100	23,000	30,000
2042 (D)	5,400	28,000	33,000
2043 (C)	6,200	24,000	30,000
2044 (C)	6,200	25,000	31,000
2045 (C)	5,000	91,000	96,000
2046 (AN)	8,400	160,000	170,000
2047 (C)	6,200	28,000	35,000
2048 (W)	5,800	310,000	310,000
2049 (W)	6,100	130,000	140,000
2050 (W)	4,100	130,000	130,000
2051 (W)	3,600	340,000	350,000
2052 (W)	5,700	100,000	110,000
2053 (AN)	5,200	130,000	140,000
2054 (D)	5,100	78,000	83,000
2055 (D)	5,300	98,000	100,000
2056 (AN)	4,700	140,000	150,000

2057 (BN)		5,700	150,000	150,000
2058 (AN)		4,100	170,000	180,000
2059 (W)		4,400	200,000	210,000
2060 (D)		5,400	34,000	40,000
2061 (C)		4,900	80,000	85,000
2062 (D)		3,800	43,000	47,000
2063 (BN)		4,100	130,000	130,000
2064 (W)		4,500	100,000	110,000
2065 (BN)		5,700	35,000	40,000
2066 (D)		5,500	48,000	54,000
2067 (C)		1,400	19,000	20,000
2068 (C)		930	61,000	62,000
2069 (BN)		2,500	100,000	100,000
2070 (W)		2,600	210,000	210,000
2071 (BN)		3,400	17,000	20,000
2072 (W)		5,500	200,000	200,000
Average (2022-2072)		5,000	120,000	120,000
2022-2072	W	5,000	180,000	190,000
	AN	6,400	150,000	160,000
	BN	4,300	69,000	73,000
	D	5,100	68,000	73,000
	C	4,400	45,000	50,000

2.1.1.2 Precipitation

Precipitation estimates for the Red Bluff Subbasin are provided in **Figure 26** and **Table 25**. Total precipitation is highly variable between years in the study area, ranging from approximately 420 taf (18.5 inches) during average critically dry years to 790 taf (34.8 inches) during average wet years.

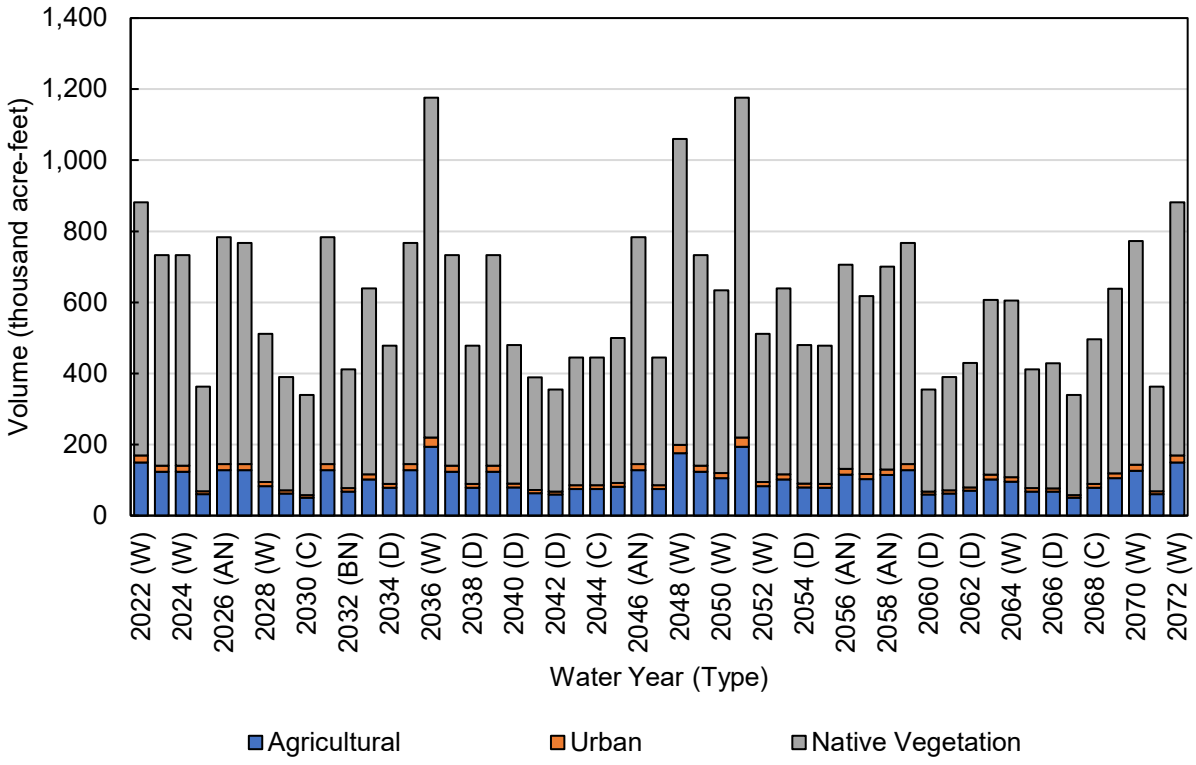


Figure 26. Red Bluff Subbasin Projected (Current Land Use) Precipitation, by Water Use Sector

Table 25. Red Bluff Subbasin Projected (Current Land Use) Precipitation, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (BN)	150,000	20,000	710,000	880,000
2023 (W)	120,000	17,000	590,000	730,000
2024 (W)	120,000	17,000	590,000	730,000
2025 (W)	61,000	8,200	290,000	360,000
2026 (BN)	130,000	17,000	640,000	780,000
2027 (AN)	130,000	17,000	620,000	770,000
2028 (W)	83,000	11,000	420,000	510,000
2029 (W)	63,000	8,300	320,000	390,000
2030 (C)	50,000	7,300	280,000	340,000
2031 (C)	130,000	17,000	640,000	780,000
2032 (AN)	68,000	9,100	330,000	410,000
2033 (BN)	100,000	15,000	520,000	640,000
2034 (AN)	78,000	11,000	390,000	480,000
2035 (D)	130,000	17,000	620,000	770,000
2036 (W)	190,000	26,000	960,000	1,200,000
2037 (W)	120,000	17,000	590,000	730,000
2038 (W)	78,000	11,000	390,000	480,000
2039 (D)	120,000	17,000	590,000	730,000
2040 (W)	79,000	11,000	390,000	480,000
2041 (D)	63,000	9,000	320,000	390,000
2042 (C)	59,000	8,200	290,000	350,000
2043 (D)	75,000	10,000	360,000	440,000
2044 (C)	75,000	10,000	360,000	440,000
2045 (C)	81,000	11,000	410,000	500,000
2046 (C)	130,000	17,000	640,000	780,000
2047 (AN)	75,000	10,000	360,000	440,000
2048 (C)	180,000	24,000	860,000	1,100,000
2049 (W)	120,000	17,000	590,000	730,000
2050 (W)	110,000	15,000	510,000	630,000
2051 (W)	190,000	26,000	960,000	1,200,000
2052 (W)	83,000	11,000	420,000	510,000
2053 (W)	100,000	15,000	520,000	640,000
2054 (AN)	79,000	11,000	390,000	480,000
2055 (D)	78,000	11,000	390,000	480,000
2056 (D)	120,000	16,000	570,000	710,000
2057 (AN)	100,000	14,000	500,000	620,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (BN)		110,000	15,000	570,000	700,000
2059 (AN)		130,000	17,000	620,000	770,000
2060 (W)		59,000	8,200	290,000	350,000
2061 (D)		63,000	8,300	320,000	390,000
2062 (C)		70,000	9,500	350,000	430,000
2063 (D)		100,000	14,000	490,000	610,000
2064 (BN)		96,000	12,000	500,000	600,000
2065 (W)		68,000	9,100	330,000	410,000
2066 (BN)		67,000	9,100	350,000	430,000
2067 (D)		50,000	7,300	280,000	340,000
2068 (C)		78,000	11,000	410,000	500,000
2069 (C)		110,000	14,000	520,000	640,000
2070 (BN)		130,000	17,000	630,000	770,000
2071 (W)		61,000	8,200	290,000	360,000
2072 (W)		150,000	20,000	710,000	880,000
Average (2022-2072)		99,000	13,000	490,000	600,000
2022-2072	W	130,000	18,000	640,000	790,000
	AN	120,000	16,000	590,000	720,000
	BN	81,000	11,000	400,000	490,000
	D	72,000	9,800	360,000	440,000
	C	67,000	9,200	340,000	420,000

2.1.1.3 Groundwater Extraction by Water Use Sector

Total groundwater extraction in the Red Bluff Subbasin represents a combination of groundwater pumping to support agricultural and urban water demands, including rural residential use, and groundwater uptake by crops, urban vegetation, and native vegetation.

Estimates of groundwater pumping by water use sector are provided in **Figure 27** and **Table 26**. Virtually all groundwater pumping in the Red Bluff Subbasin is used to meet agricultural demand, averaging 80 taf per year. Groundwater pumping for urban use is approximately 5.5 taf per year. The total groundwater extraction varies from about 82 taf in above-normal years to 110 taf in critically dry years based on variability in surface water supplies, precipitation, and crop water demand.

When groundwater is near the land surface, groundwater uptake can also be a source of supply for vegetation. Estimates of groundwater uptake by vegetation are provided in **Figure 28** and **Table 27**. The majority of groundwater uptake is consumed directly by native vegetation and agricultural crops, totaling 4.0 taf and 2.4 taf per year, on average.

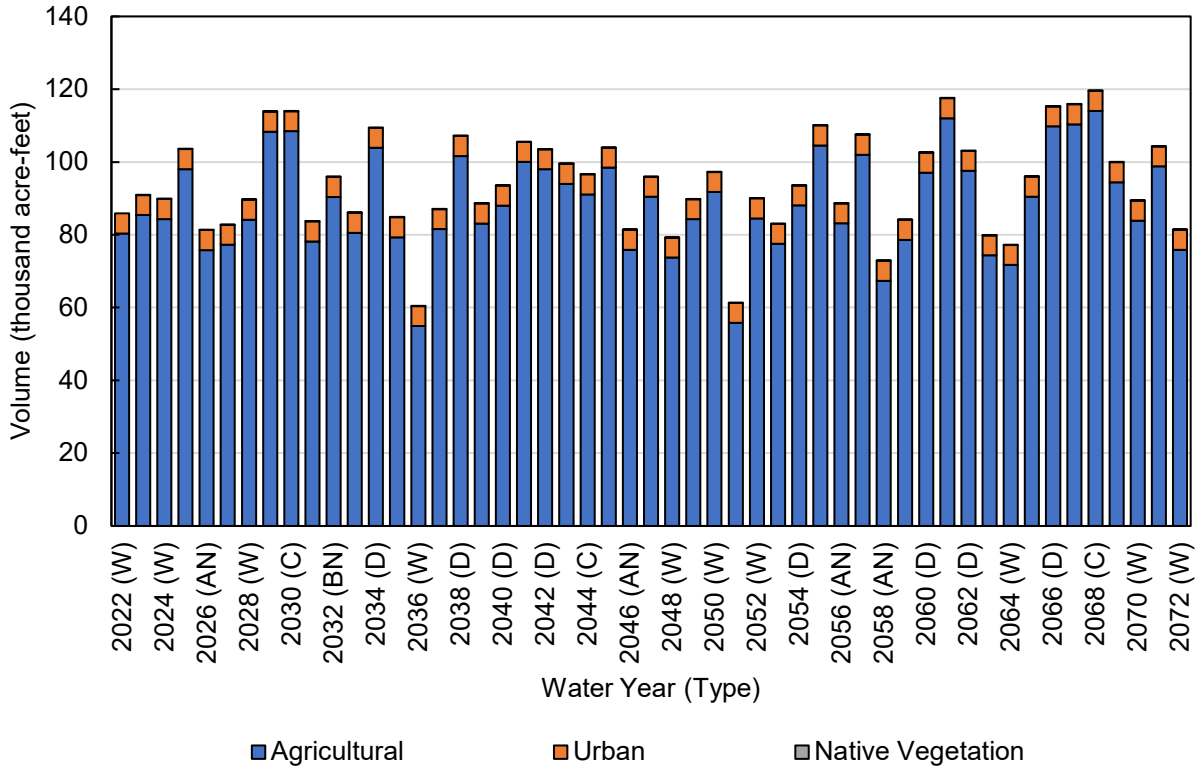


Figure 27. Red Bluff Subbasin Projected (Current Land Use) Groundwater Pumping, by Water Use Sector

Table 26. Red Bluff Subbasin Projected (Current Land Use) Groundwater Pumping, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (BN)	80,000	5,500	0	86,000
2023 (W)	85,000	5,500	0	91,000
2024 (W)	84,000	5,500	0	90,000
2025 (W)	98,000	5,500	0	100,000
2026 (BN)	76,000	5,500	0	81,000
2027 (AN)	77,000	5,500	0	83,000
2028 (W)	84,000	5,500	0	90,000
2029 (W)	110,000	5,500	0	110,000
2030 (C)	110,000	5,500	0	110,000
2031 (C)	78,000	5,500	0	84,000
2032 (AN)	90,000	5,500	0	96,000
2033 (BN)	81,000	5,500	0	86,000
2034 (AN)	100,000	5,500	0	110,000
2035 (D)	79,000	5,500	0	85,000
2036 (W)	55,000	5,500	0	60,000
2037 (W)	82,000	5,500	0	87,000
2038 (W)	100,000	5,500	0	110,000
2039 (D)	83,000	5,500	0	89,000
2040 (W)	88,000	5,500	0	94,000
2041 (D)	100,000	5,500	0	110,000
2042 (C)	98,000	5,500	0	100,000
2043 (D)	94,000	5,500	0	100,000
2044 (C)	91,000	5,500	0	97,000
2045 (C)	98,000	5,500	0	100,000
2046 (C)	76,000	5,500	0	81,000
2047 (AN)	90,000	5,500	0	96,000
2048 (C)	74,000	5,500	0	79,000
2049 (W)	84,000	5,500	0	90,000
2050 (W)	92,000	5,500	0	97,000
2051 (W)	56,000	5,500	0	61,000
2052 (W)	85,000	5,500	0	90,000
2053 (W)	78,000	5,500	0	83,000
2054 (AN)	88,000	5,500	0	94,000
2055 (D)	100,000	5,500	0	110,000
2056 (D)	83,000	5,500	0	89,000
2057 (AN)	100,000	5,500	0	110,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (BN)		67,000	5,500	0	73,000
2059 (AN)		79,000	5,500	0	84,000
2060 (W)		97,000	5,500	0	100,000
2061 (D)		110,000	5,500	0	120,000
2062 (C)		98,000	5,500	0	100,000
2063 (D)		74,000	5,500	0	80,000
2064 (BN)		72,000	5,500	0	77,000
2065 (W)		90,000	5,500	0	96,000
2066 (BN)		110,000	5,500	0	120,000
2067 (D)		110,000	5,500	0	120,000
2068 (C)		110,000	5,500	0	120,000
2069 (C)		94,000	5,500	0	100,000
2070 (BN)		84,000	5,500	0	89,000
2071 (W)		99,000	5,500	0	100,000
2072 (W)		76,000	5,500	0	81,000
Average (2022-2072)		89,000	5,500	0	94,000
2022-2072	W	78,000	5,500	0	84,000
	AN	77,000	5,500	0	82,000
	BN	93,000	5,500	0	98,000
	D	99,000	5,500	0	100,000
	C	100,000	5,500	0	110,000

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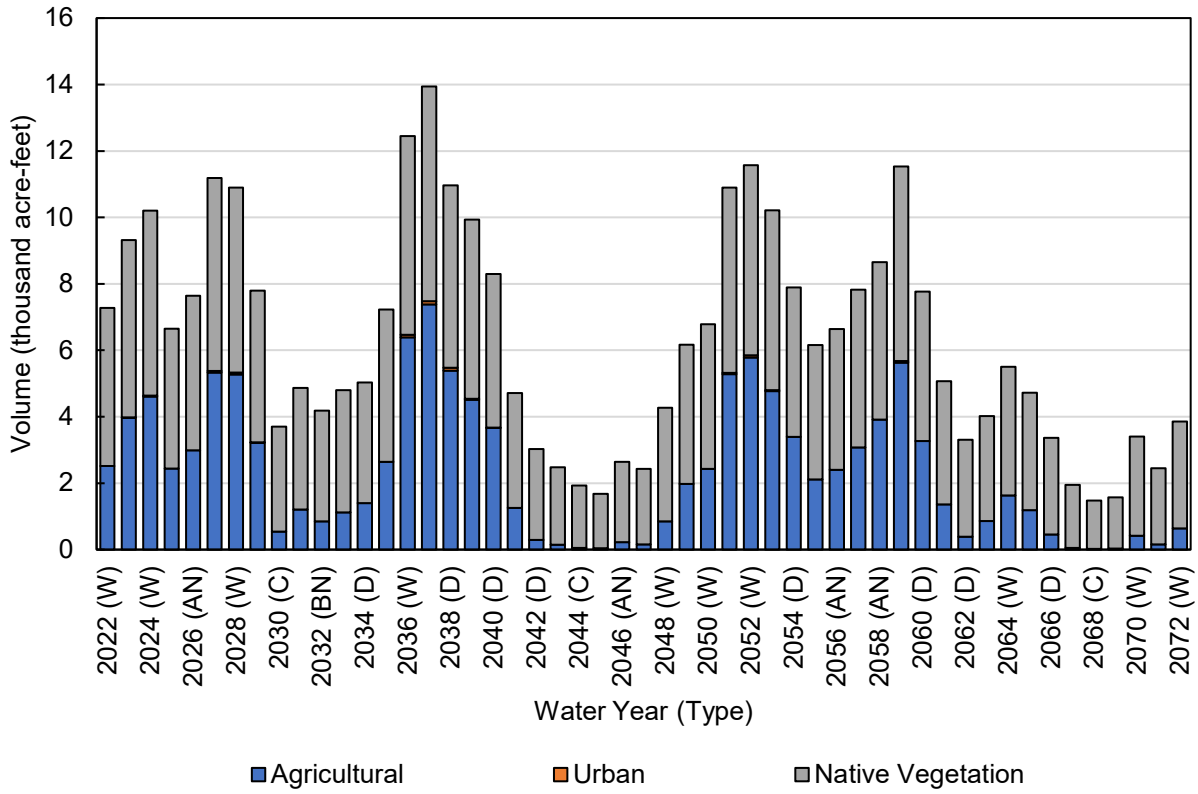

Figure 28. Red Bluff Subbasin Projected (Current Land Use) Groundwater Uptake, by Water Use Sector

Table 27. Red Bluff Subbasin Projected (Current Land Use) Groundwater Uptake, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (BN)	2,500	0	4,800	7,300
2023 (W)	4,000	10	5,300	9,300
2024 (W)	4,600	30	5,600	10,000
2025 (W)	2,400	0	4,200	6,700
2026 (BN)	3,000	0	4,700	7,600
2027 (AN)	5,300	50	5,800	11,000
2028 (W)	5,300	60	5,600	11,000
2029 (W)	3,200	10	4,600	7,800
2030 (C)	540	0	3,200	3,700
2031 (C)	1,200	0	3,700	4,900
2032 (AN)	850	0	3,300	4,200
2033 (BN)	1,100	0	3,700	4,800
2034 (AN)	1,400	0	3,600	5,000
2035 (D)	2,600	0	4,600	7,200
2036 (W)	6,400	80	6,000	12,000
2037 (W)	7,400	100	6,500	14,000
2038 (W)	5,400	80	5,500	11,000
2039 (D)	4,500	30	5,400	9,900
2040 (W)	3,700	10	4,600	8,300
2041 (D)	1,300	0	3,500	4,700
2042 (C)	290	0	2,700	3,000
2043 (D)	150	0	2,300	2,500
2044 (C)	50	0	1,900	1,900
2045 (C)	40	0	1,600	1,700
2046 (C)	220	0	2,400	2,600
2047 (AN)	160	0	2,300	2,400
2048 (C)	850	0	3,400	4,300
2049 (W)	2,000	0	4,200	6,200
2050 (W)	2,400	0	4,400	6,800
2051 (W)	5,300	40	5,600	11,000
2052 (W)	5,800	70	5,700	12,000
2053 (W)	4,800	30	5,400	10,000
2054 (AN)	3,400	0	4,500	7,900
2055 (D)	2,100	0	4,100	6,200
2056 (D)	2,400	0	4,200	6,600
2057 (AN)	3,100	0	4,700	7,800

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (BN)		3,900	0	4,700	8,700
2059 (AN)		5,600	50	5,900	12,000
2060 (W)		3,300	0	4,500	7,800
2061 (D)		1,400	0	3,700	5,100
2062 (C)		390	0	2,900	3,300
2063 (D)		860	0	3,200	4,000
2064 (BN)		1,600	0	3,900	5,500
2065 (W)		1,200	0	3,500	4,700
2066 (BN)		460	0	2,900	3,400
2067 (D)		50	0	1,900	2,000
2068 (C)		20	0	1,500	1,500
2069 (C)		30	0	1,500	1,600
2070 (BN)		420	0	3,000	3,400
2071 (W)		160	0	2,300	2,500
2072 (W)		640	0	3,200	3,900
Average (2022-2072)		2,400	10	4,000	6,300
2022-2072	W	3,700	30	4,900	8,700
	AN	2,400	0	4,100	6,500
	BN	1,200	0	3,300	4,500
	D	2,300	10	3,900	6,200
	C	690	0	2,600	3,300

2.1.1.4 Groundwater Discharge to Surface Waterways

Groundwater discharge to surface water, as described herein, represents a gain, or increase of flow, in waterways that traverse or flow along the boundary of the Red Bluff Subbasin. Groundwater discharge in the Red Bluff Subbasin is calculated from the Tehama IHM as the net groundwater outflow to water reaches (i.e., groundwater discharge) in excess of groundwater inflows from waterway reaches (i.e., seepage). The total volume of estimated groundwater discharge to surface water is summarized in **Figure 29** and **Table 28**, averaging approximately 26 taf per year.

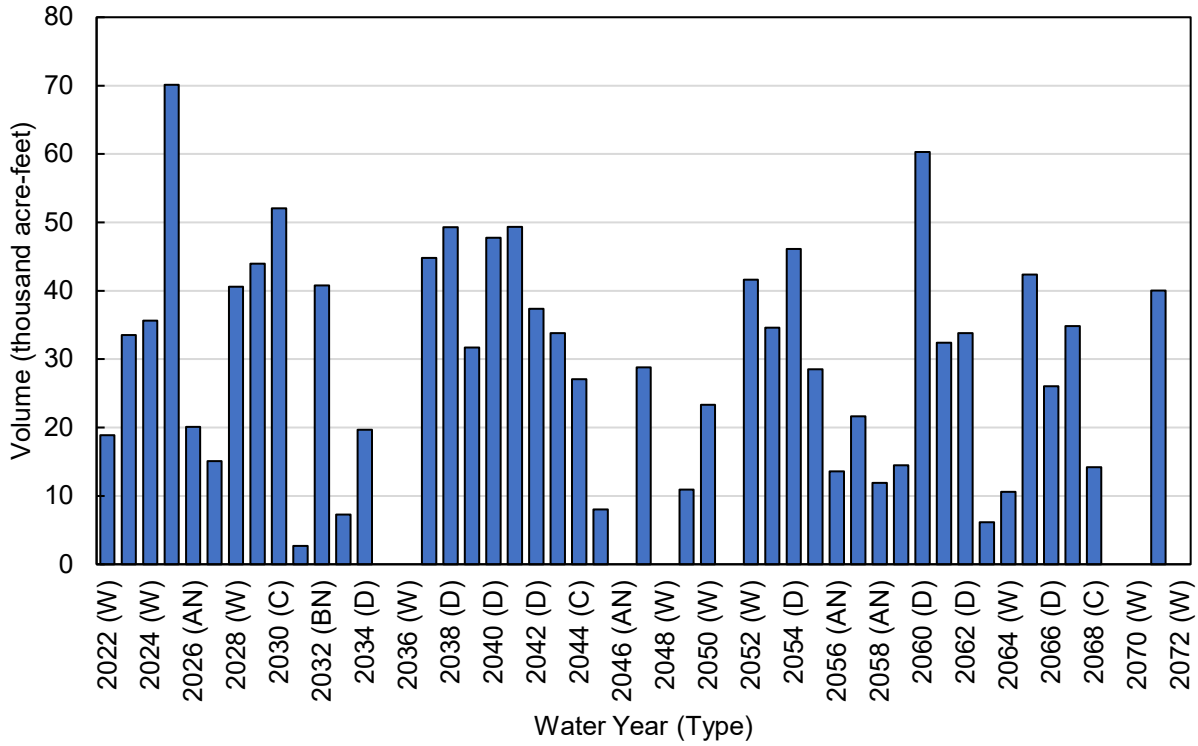

Figure 29. Red Bluff Subbasin Projected (Current Land Use) Groundwater Discharge to Surface Water

Table 28. Red Bluff Subbasin Projected (Current Land Use) Groundwater Discharge to Surface Water (acre-feet)

Water Year (Type)	Groundwater Discharge to Surface Water
2022 (BN)	19,000
2023 (W)	34,000
2024 (W)	36,000
2025 (W)	70,000
2026 (BN)	20,000
2027 (AN)	15,000
2028 (W)	41,000
2029 (W)	44,000
2030 (C)	52,000
2031 (C)	2,700
2032 (AN)	41,000
2033 (BN)	7,300
2034 (AN)	20,000
2035 (D)	0
2036 (W)	0
2037 (W)	45,000
2038 (W)	49,000
2039 (D)	32,000
2040 (W)	48,000
2041 (D)	49,000
2042 (C)	37,000
2043 (D)	34,000
2044 (C)	27,000
2045 (C)	8,000
2046 (C)	0
2047 (AN)	29,000
2048 (C)	0
2049 (W)	11,000
2050 (W)	23,000
2051 (W)	0
2052 (W)	42,000
2053 (W)	35,000
2054 (AN)	46,000
2055 (D)	29,000
2056 (D)	14,000
2057 (AN)	22,000

Water Year (Type)		Groundwater Discharge to Surface Water
2058 (BN)		12,000
2059 (AN)		14,000
2060 (W)		60,000
2061 (D)		32,000
2062 (C)		34,000
2063 (D)		6,100
2064 (BN)		11,000
2065 (W)		42,000
2066 (BN)		26,000
2067 (D)		35,000
2068 (C)		14,000
2069 (C)		0
2070 (BN)		0
2071 (W)		40,000
2072 (W)		0
Average (2022-2072)		26,000
2022-2072	W	18,000
	AN	13,000
	BN	32,000
	D	39,000
	C	32,000

2.1.2 Outflows

2.1.2.1 Evapotranspiration by Water Use Sector

Evapotranspiration (ET) by water use sector is reported in **Figure 30** through **Figure 33**, and **Table 29** through **Table 32**. First, total ET is reported, followed by ET from applied water (ET of water actively applied from surface water deliveries or groundwater pumping), ET of groundwater uptake (ET of shallow water extracted directly by vegetation), and ET from precipitation (ET of water supplied through rainfall).

Total ET varies between years, with a projected average of 440 taf per year. Agricultural ET tends to increase slightly in drier years due to increased climatic demand, while the ET of native vegetation typically decreases due to reduced water supply. ET of applied water occurs primarily from agricultural land, averaging about 70 taf in above-normal and wet years and about 86 taf in years classified as below normal, dry, or critical. Urban ET of applied water is lower and relatively constant between years, averaging less than 1.7 taf per year. Native vegetation and agricultural crops in the Red Bluff Subbasin also directly consume shallow groundwater to meet a portion of their consumptive use requirements. ET of

groundwater uptake by native vegetation and agricultural crops and totals 4.0 and 2.4 taf per year, on average.

ET of precipitation generally follows the pattern of precipitation, with higher volumes occurring in wet years when more precipitation occurs. Across all water use sectors, ET of precipitation in the Red Bluff Subbasin averages about 380 taf in wet and above-normal years and 320 taf in dry and critical water years. Much of the total ET of precipitation results from the large acreage of native vegetation in the Red Bluff Subbasin, though significant volumes result from agricultural and urban areas as well.

Evaporation from rivers, streams, and canals in the Red Bluff Subbasin is reported in **Figure 34** and **Table 33**. The total volume is relatively small and constant between years, averaging about 0.9 taf per year. Evaporation from upgradient small watersheds is minimal, and is also not considered to substantially contribute to the subbasin SWS water budget.

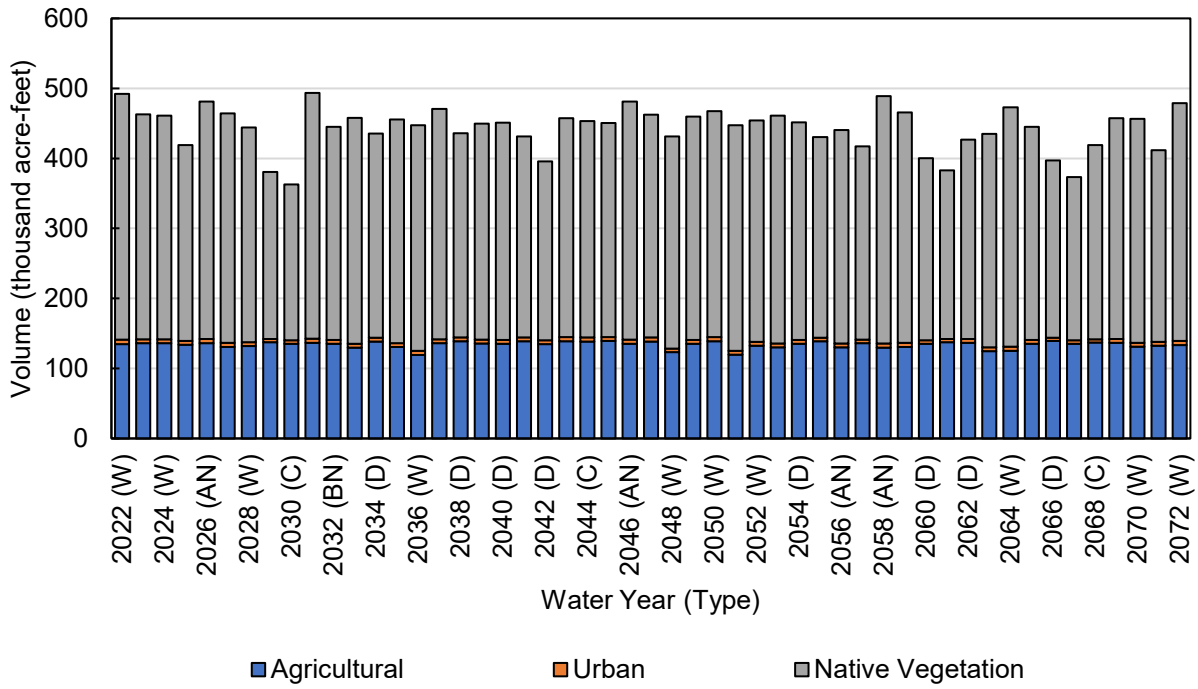

Figure 30. Red Bluff Subbasin Projected (Current Land Use) Total Evapotranspiration, (acre-feet)

Table 29. Red Bluff Subbasin Projected (Current Land Use) Total Evapotranspiration, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	130,000	6,100	350,000	490,000
2023 (W)	140,000	5,700	320,000	460,000
2024 (W)	140,000	5,600	320,000	460,000
2025 (BN)	130,000	5,300	280,000	420,000
2026 (AN)	140,000	6,000	340,000	480,000
2027 (W)	130,000	5,600	330,000	460,000
2028 (W)	130,000	5,400	310,000	440,000
2029 (C)	140,000	4,500	240,000	380,000
2030 (C)	140,000	4,700	220,000	360,000
2031 (AN)	140,000	6,200	350,000	490,000
2032 (BN)	140,000	5,600	300,000	450,000
2033 (AN)	130,000	5,700	320,000	460,000
2034 (D)	140,000	5,200	290,000	440,000
2035 (W)	130,000	5,600	320,000	460,000
2036 (W)	120,000	5,700	320,000	450,000
2037 (W)	140,000	5,600	330,000	470,000
2038 (D)	140,000	5,300	290,000	440,000
2039 (W)	140,000	5,600	310,000	450,000
2040 (D)	140,000	5,500	310,000	450,000
2041 (C)	140,000	5,500	290,000	430,000
2042 (D)	130,000	5,300	260,000	400,000
2043 (C)	140,000	5,900	310,000	460,000
2044 (C)	140,000	5,900	310,000	450,000
2045 (C)	140,000	5,600	310,000	450,000
2046 (AN)	140,000	6,000	340,000	480,000
2047 (C)	140,000	5,900	320,000	460,000
2048 (W)	120,000	5,300	300,000	430,000
2049 (W)	140,000	5,600	320,000	460,000
2050 (W)	140,000	5,700	320,000	470,000
2051 (W)	120,000	5,700	320,000	450,000
2052 (W)	130,000	5,400	320,000	450,000
2053 (AN)	130,000	5,700	330,000	460,000
2054 (D)	140,000	5,500	310,000	450,000
2055 (D)	140,000	5,200	290,000	430,000
2056 (AN)	130,000	5,500	310,000	440,000
2057 (BN)	140,000	4,900	280,000	420,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		130,000	6,200	350,000	490,000
2059 (W)		130,000	5,600	330,000	470,000
2060 (D)		140,000	5,300	260,000	400,000
2061 (C)		140,000	4,600	240,000	380,000
2062 (D)		140,000	5,500	290,000	430,000
2063 (BN)		120,000	5,500	300,000	440,000
2064 (W)		130,000	5,800	340,000	470,000
2065 (BN)		140,000	5,600	300,000	450,000
2066 (D)		140,000	4,700	250,000	400,000
2067 (C)		140,000	4,800	230,000	370,000
2068 (C)		140,000	4,900	280,000	420,000
2069 (BN)		140,000	5,700	320,000	460,000
2070 (W)		130,000	5,500	320,000	460,000
2071 (BN)		130,000	5,300	270,000	410,000
2072 (W)		130,000	6,000	340,000	480,000
Average (2022-2072)		130,000	5,500	300,000	440,000
2022 - 2072	W	130,000	5,600	320,000	460,000
	AN	130,000	5,900	330,000	470,000
	BN	130,000	5,400	290,000	430,000
	D	140,000	5,300	280,000	430,000
	C	140,000	5,200	270,000	420,000

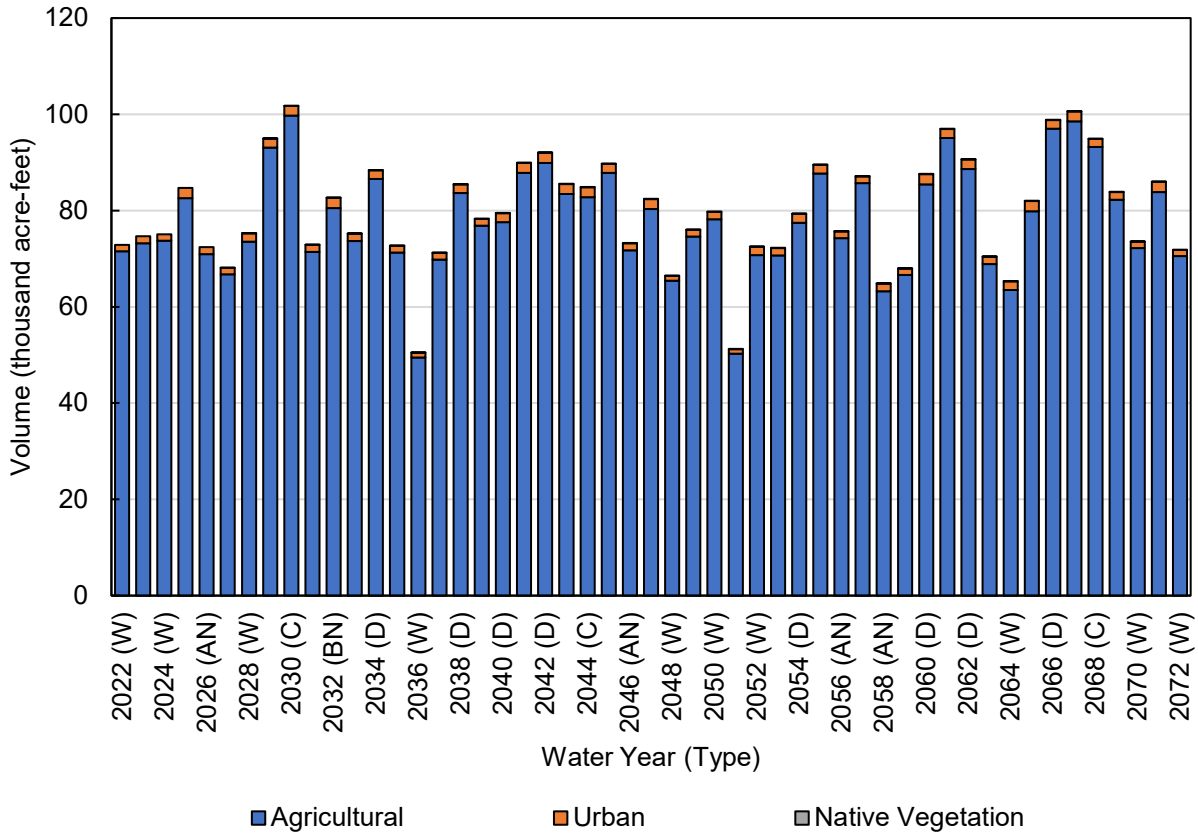

Figure 31. Red Bluff Subbasin Projected (Current Land Use) Evapotranspiration of Applied Water, by Water Use Sector

Table 30. Red Bluff Subbasin Projected (Current Land Use) Evapotranspiration of Applied Water, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	72,000	1,300	0	73,000
2023 (W)	73,000	1,400	0	75,000
2024 (W)	74,000	1,400	0	75,000
2025 (BN)	83,000	2,100	0	85,000
2026 (AN)	71,000	1,500	0	72,000
2027 (W)	67,000	1,400	0	68,000
2028 (W)	74,000	1,800	0	75,000
2029 (C)	93,000	1,800	0	95,000
2030 (C)	100,000	2,000	0	100,000
2031 (AN)	71,000	1,500	0	73,000
2032 (BN)	81,000	2,100	0	83,000
2033 (AN)	74,000	1,600	0	75,000
2034 (D)	87,000	1,800	0	88,000
2035 (W)	71,000	1,400	0	73,000
2036 (W)	49,000	980	0	50,000
2037 (W)	70,000	1,400	0	71,000
2038 (D)	84,000	1,800	0	85,000
2039 (W)	77,000	1,400	0	78,000
2040 (D)	78,000	1,900	0	79,000
2041 (C)	88,000	2,100	0	90,000
2042 (D)	90,000	2,100	0	92,000
2043 (C)	83,000	2,100	0	86,000
2044 (C)	83,000	2,100	0	85,000
2045 (C)	88,000	1,900	0	90,000
2046 (AN)	72,000	1,400	0	73,000
2047 (C)	80,000	2,100	0	82,000
2048 (W)	65,000	1,000	0	66,000
2049 (W)	75,000	1,400	0	76,000
2050 (W)	78,000	1,600	0	80,000
2051 (W)	50,000	980	0	51,000
2052 (W)	71,000	1,800	0	73,000
2053 (AN)	71,000	1,600	0	72,000
2054 (D)	77,000	1,900	0	79,000
2055 (D)	88,000	1,800	0	90,000
2056 (AN)	74,000	1,400	0	76,000
2057 (BN)	86,000	1,400	0	87,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		63,000	1,600	0	65,000
2059 (W)		67,000	1,400	0	68,000
2060 (D)		85,000	2,100	0	88,000
2061 (C)		95,000	1,800	0	97,000
2062 (D)		89,000	2,000	0	91,000
2063 (BN)		69,000	1,600	0	70,000
2064 (W)		64,000	1,800	0	65,000
2065 (BN)		80,000	2,100	0	82,000
2066 (D)		97,000	1,800	0	99,000
2067 (C)		99,000	2,000	0	100,000
2068 (C)		93,000	1,700	0	95,000
2069 (BN)		82,000	1,600	0	84,000
2070 (W)		72,000	1,300	0	74,000
2071 (BN)		84,000	2,100	0	86,000
2072 (W)		71,000	1,300	0	72,000
Average (2022-2072)		78,000	1,700	0	80,000
2022 - 2072	W	69,000	1,400	0	70,000
	AN	71,000	1,500	0	72,000
	BN	81,000	1,900	0	82,000
	D	86,000	1,900	0	88,000
	C	90,000	2,000	0	92,000

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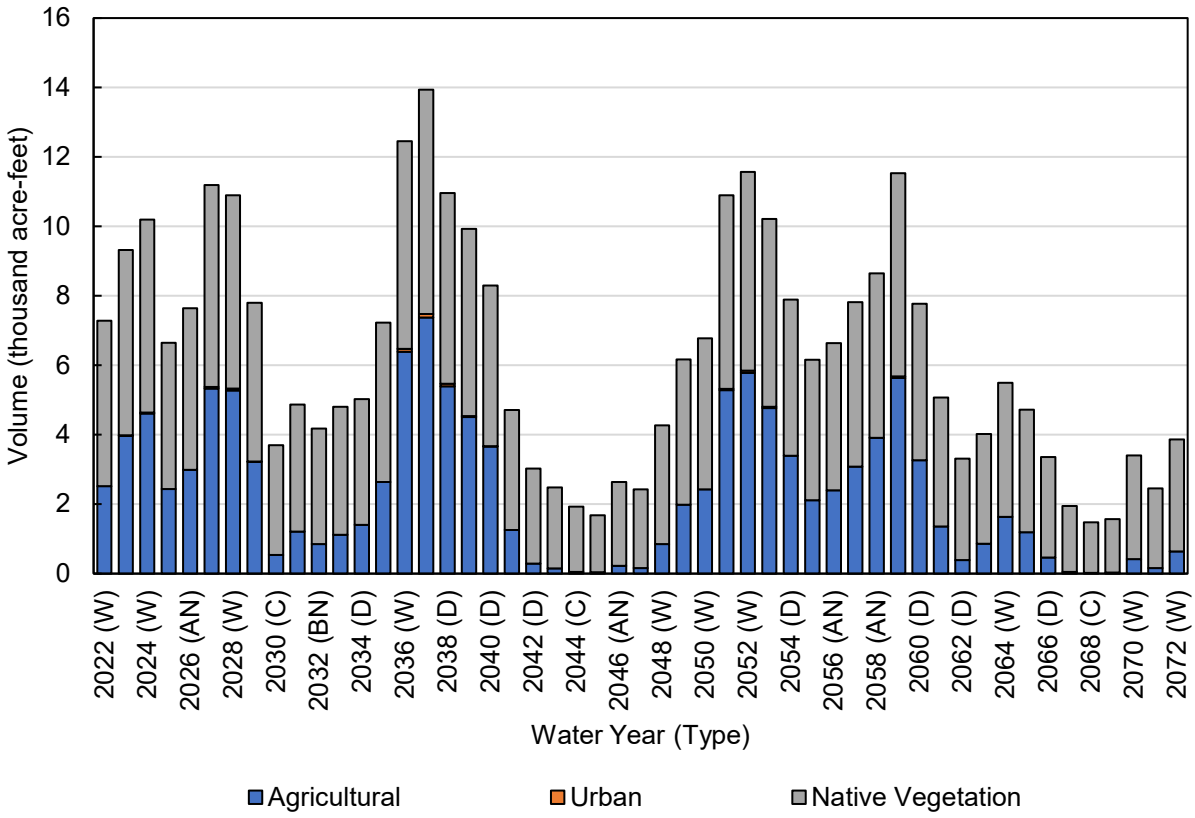

Figure 32. Red Bluff Subbasin Projected (Current Land Use) Evapotranspiration of Groundwater Uptake, by Water Use Sector

Table 31. Red Bluff Subbasin Projected (Current Land Use) Evapotranspiration of Groundwater Uptake, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	2,500	0	4,800	7,300
2023 (W)	4,000	10	5,300	9,300
2024 (W)	4,600	30	5,600	10,000
2025 (BN)	2,400	0	4,200	6,700
2026 (AN)	3,000	0	4,700	7,600
2027 (W)	5,300	50	5,800	11,000
2028 (W)	5,300	60	5,600	11,000
2029 (C)	3,200	10	4,600	7,800
2030 (C)	540	0	3,200	3,700
2031 (AN)	1,200	0	3,700	4,900
2032 (BN)	850	0	3,300	4,200
2033 (AN)	1,100	0	3,700	4,800
2034 (D)	1,400	0	3,600	5,000
2035 (W)	2,600	0	4,600	7,200
2036 (W)	6,400	80	6,000	12,000
2037 (W)	7,400	100	6,500	14,000
2038 (D)	5,400	80	5,500	11,000
2039 (W)	4,500	30	5,400	9,900
2040 (D)	3,700	10	4,600	8,300
2041 (C)	1,300	0	3,500	4,700
2042 (D)	290	0	2,700	3,000
2043 (C)	150	0	2,300	2,500
2044 (C)	50	0	1,900	1,900
2045 (C)	40	0	1,600	1,700
2046 (AN)	220	0	2,400	2,600
2047 (C)	160	0	2,300	2,400
2048 (W)	850	0	3,400	4,300
2049 (W)	2,000	0	4,200	6,200
2050 (W)	2,400	0	4,400	6,800
2051 (W)	5,300	40	5,600	11,000
2052 (W)	5,800	70	5,700	12,000
2053 (AN)	4,800	30	5,400	10,000
2054 (D)	3,400	0	4,500	7,900
2055 (D)	2,100	0	4,100	6,200
2056 (AN)	2,400	0	4,200	6,600
2057 (BN)	3,100	0	4,700	7,800

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		3,900	0	4,700	8,700
2059 (W)		5,600	50	5,900	12,000
2060 (D)		3,300	0	4,500	7,800
2061 (C)		1,400	0	3,700	5,100
2062 (D)		390	0	2,900	3,300
2063 (BN)		860	0	3,200	4,000
2064 (W)		1,600	0	3,900	5,500
2065 (BN)		1,200	0	3,500	4,700
2066 (D)		460	0	2,900	3,400
2067 (C)		50	0	1,900	2,000
2068 (C)		20	0	1,500	1,500
2069 (BN)		30	0	1,500	1,600
2070 (W)		420	0	3,000	3,400
2071 (BN)		160	0	2,300	2,500
2072 (W)		640	0	3,200	3,900
Average (2022-2072)		2,400	10	4,000	6,300
2022 - 2072	W	3,700	30	4,900	8,700
	AN	2,400	0	4,100	6,500
	BN	1,200	0	3,300	4,500
	D	2,300	10	3,900	6,200
	C	690	0	2,600	3,300

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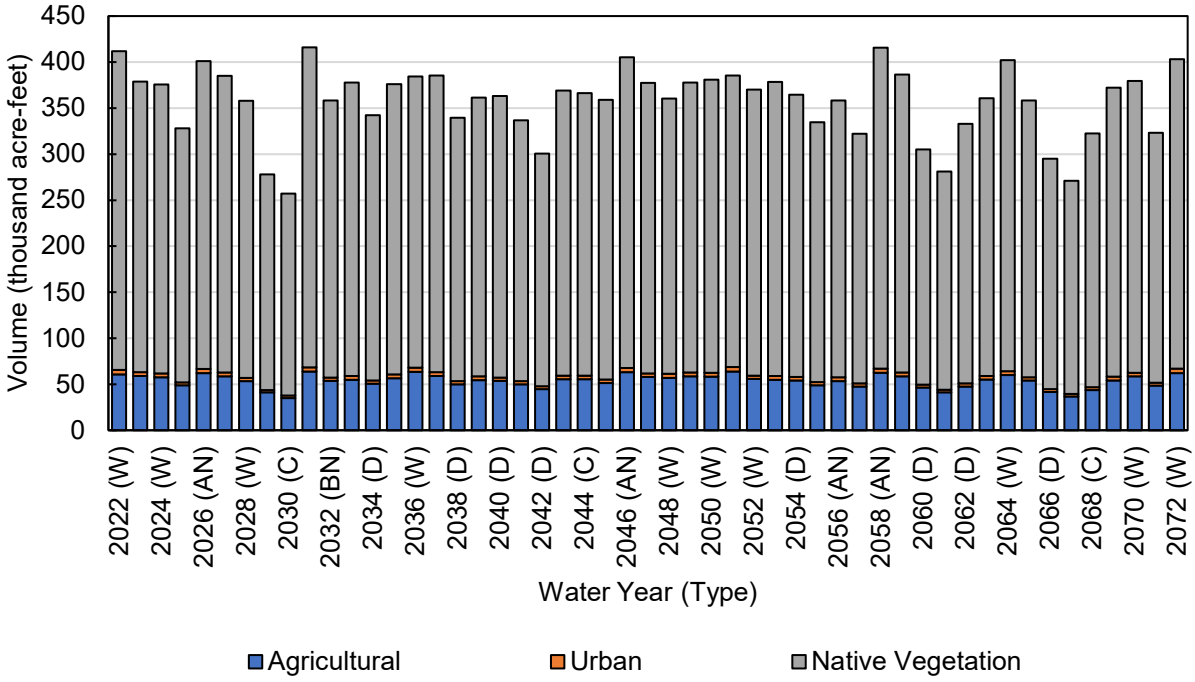

Figure 33. Red Bluff Subbasin Projected (Current Land Use) Evapotranspiration of Precipitation, by Water Use Sector

Table 32. Red Bluff Subbasin Projected (Current Land Use) Evapotranspiration of Precipitation, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	61,000	4,800	350,000	410,000
2023 (W)	59,000	4,200	320,000	380,000
2024 (W)	58,000	4,200	310,000	380,000
2025 (BN)	49,000	3,200	280,000	330,000
2026 (AN)	62,000	4,600	330,000	400,000
2027 (W)	59,000	4,200	320,000	390,000
2028 (W)	53,000	3,600	300,000	360,000
2029 (C)	41,000	2,700	230,000	280,000
2030 (C)	35,000	2,700	220,000	260,000
2031 (AN)	64,000	4,700	350,000	420,000
2032 (BN)	54,000	3,500	300,000	360,000
2033 (AN)	55,000	4,100	320,000	380,000
2034 (D)	51,000	3,400	290,000	340,000
2035 (W)	57,000	4,200	320,000	380,000
2036 (W)	64,000	4,600	320,000	380,000
2037 (W)	59,000	4,100	320,000	390,000
2038 (D)	50,000	3,400	290,000	340,000
2039 (W)	54,000	4,200	300,000	360,000
2040 (D)	54,000	3,700	310,000	360,000
2041 (C)	50,000	3,500	280,000	340,000
2042 (D)	45,000	3,200	250,000	300,000
2043 (C)	55,000	3,900	310,000	370,000
2044 (C)	55,000	3,800	310,000	370,000
2045 (C)	51,000	3,800	300,000	360,000
2046 (AN)	63,000	4,600	340,000	410,000
2047 (C)	58,000	3,800	320,000	380,000
2048 (W)	57,000	4,300	300,000	360,000
2049 (W)	59,000	4,200	310,000	380,000
2050 (W)	58,000	4,200	320,000	380,000
2051 (W)	64,000	4,700	320,000	390,000
2052 (W)	56,000	3,600	310,000	370,000
2053 (AN)	55,000	4,100	320,000	380,000
2054 (D)	54,000	3,700	310,000	360,000
2055 (D)	49,000	3,400	280,000	330,000
2056 (AN)	53,000	4,100	300,000	360,000
2057 (BN)	48,000	3,500	270,000	320,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		62,000	4,600	350,000	420,000
2059 (W)		59,000	4,200	320,000	390,000
2060 (D)		46,000	3,200	260,000	310,000
2061 (C)		41,000	2,800	240,000	280,000
2062 (D)		47,000	3,500	280,000	330,000
2063 (BN)		55,000	3,900	300,000	360,000
2064 (W)		60,000	4,000	340,000	400,000
2065 (BN)		54,000	3,500	300,000	360,000
2066 (D)		42,000	2,900	250,000	290,000
2067 (C)		37,000	2,700	230,000	270,000
2068 (C)		44,000	3,300	280,000	320,000
2069 (BN)		54,000	4,100	310,000	370,000
2070 (W)		58,000	4,100	320,000	380,000
2071 (BN)		49,000	3,200	270,000	320,000
2072 (W)		62,000	4,700	340,000	400,000
Average (2022-2072)		54,000	3,800	300,000	360,000
2022 - 2072	W	59,000	4,200	320,000	380,000
	AN	59,000	4,400	330,000	390,000
	BN	52,000	3,600	290,000	350,000
	D	49,000	3,400	280,000	330,000
	C	47,000	3,300	270,000	320,000

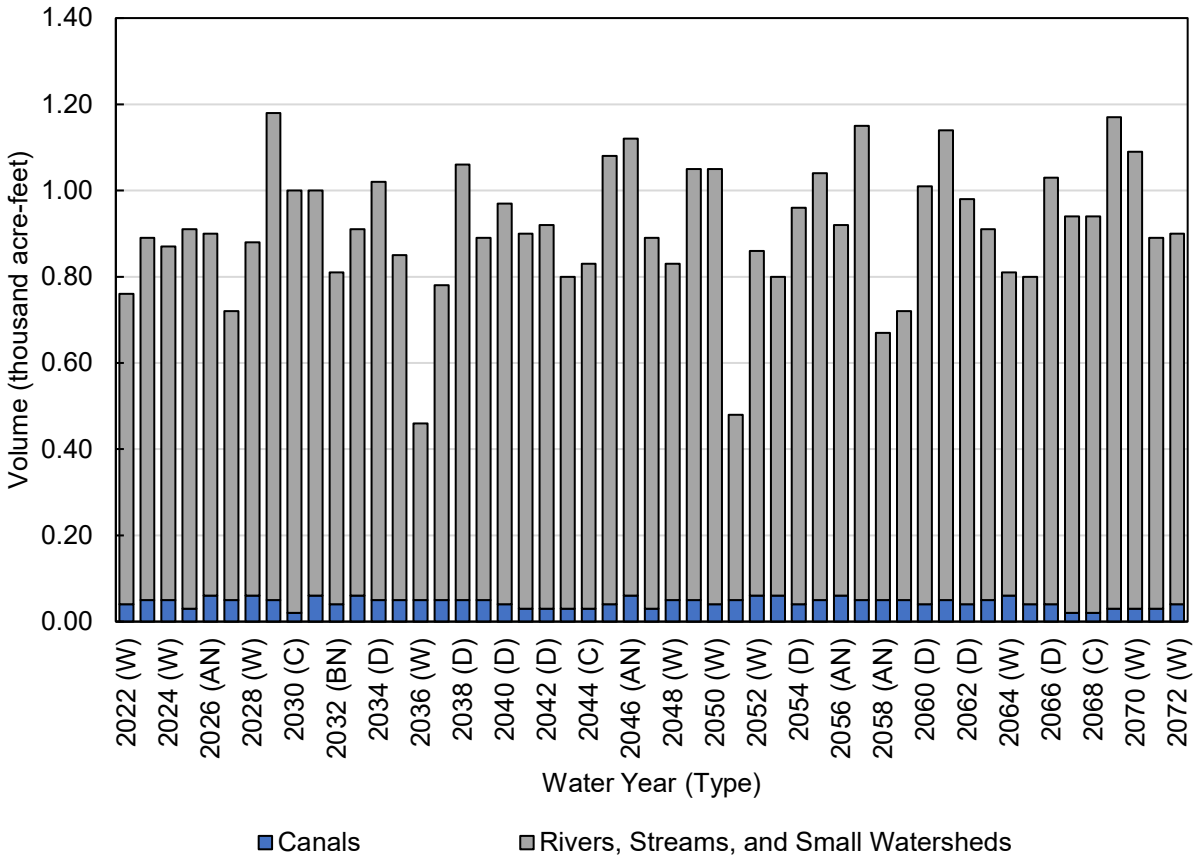

Figure 34. Red Bluff Subbasin Projected (Current Land Use) Evaporation of Surface Water Sources

Table 33. Red Bluff Subbasin Projected (Current Land Use) Evaporation of Surface Water Sources, by Water Use Sector (acre-feet)

Water Year (Type)	Canals	Rivers, Streams, and Small Watersheds[1]	Total
2022 (W)	40	720	760
2023 (W)	50	840	890
2024 (W)	50	820	870
2025 (BN)	30	880	910
2026 (AN)	60	840	900
2027 (W)	50	670	720
2028 (W)	60	820	880
2029 (C)	50	1,100	1,200
2030 (C)	20	980	1,000
2031 (AN)	60	940	1,000
2032 (BN)	40	770	810
2033 (AN)	60	850	910
2034 (D)	50	970	1,000
2035 (W)	50	800	850
2036 (W)	50	410	460
2037 (W)	50	730	780
2038 (D)	50	1,000	1,100
2039 (W)	50	840	890
2040 (D)	40	930	970
2041 (C)	30	870	900
2042 (D)	30	890	920
2043 (C)	30	770	800
2044 (C)	30	800	830
2045 (C)	40	1,000	1,100
2046 (AN)	60	1,100	1,100
2047 (C)	30	860	890
2048 (W)	50	780	830
2049 (W)	50	1,000	1,100
2050 (W)	40	1,000	1,100
2051 (W)	50	430	480
2052 (W)	60	800	860
2053 (AN)	60	740	800
2054 (D)	40	920	960
2055 (D)	50	990	1,000
2056 (AN)	60	860	920
2057 (BN)	50	1,100	1,200
2058 (AN)	50	620	670

Water Year (Type)		Canals	Rivers, Streams, and Small Watersheds[1]	Total
2059 (W)		50	670	720
2060 (D)		40	970	1,000
2061 (C)		50	1,100	1,100
2062 (D)		40	940	980
2063 (BN)		50	860	910
2064 (W)		60	750	810
2065 (BN)		40	760	800
2066 (D)		40	990	1,000
2067 (C)		20	920	940
2068 (C)		20	920	940
2069 (BN)		30	1,100	1,200
2070 (W)		30	1,100	1,100
2071 (BN)		30	860	890
2072 (W)		40	860	900
Average (2022-2072)		40	870	910
2022 - 2072	W	50	780	830
	AN	60	840	900
	BN	40	910	950
	D	40	960	1,000
	C	30	940	970

[1] Includes ET of riparian vegetation along rivers and streams.

2.1.2.2 Surface Water Outflow by Water Source Type

Surface water outflows from the Red Bluff Subbasin are summarized in **Figure 35** and **Table 34** by water source type. In the Red Bluff Subbasin, local supply outflows primarily include outflows of runoff, tailwater, and net drainage from land surfaces, in addition to runoff from small watersheds and stream outflows to the Sacramento River. Local supply outflows average approximately 310 taf per year, and range from 120 taf or less in critically dry years up to 500 taf in wet years. Other surface water outflows that leave the subbasin include outflow of groundwater discharge to the Sacramento River, Red Bank Creek, and Elder Creek. This water travels along each respective waterway as part of the flow in the river or creek.

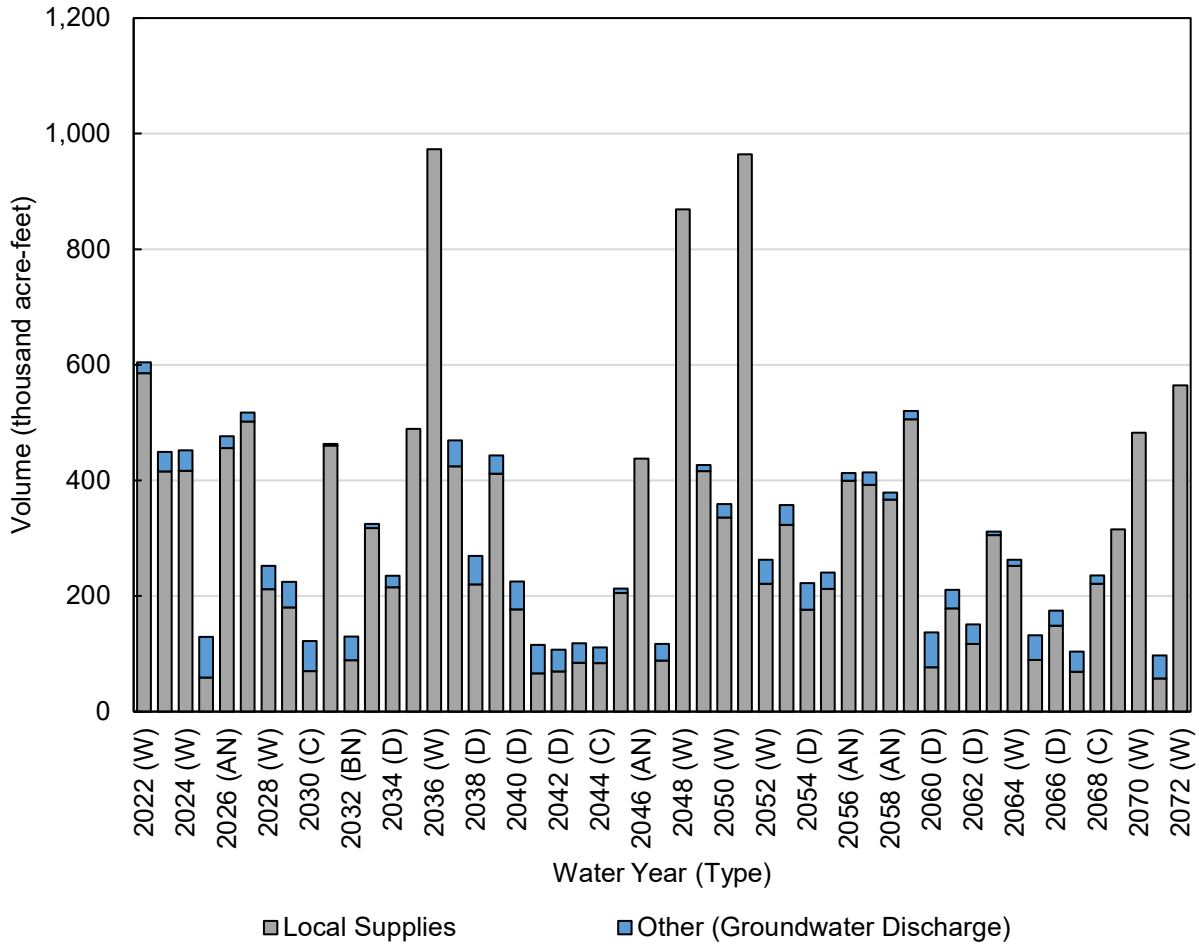

Figure 35. Red Bluff Subbasin Projected (Current Land Use) Surface Water Outflows, by Water Source Type

Table 34. Red Bluff Subbasin Projected (Current Land Use) Surface Water Outflows, by Water Source Type (acre-feet)

Water Year (Type)	CVP Supplies	Local Supplies	Other (Groundwater Discharge)	Total
2022 (W)	0	590,000	19,000	600,000
2023 (W)	0	420,000	34,000	450,000
2024 (W)	0	420,000	36,000	450,000
2025 (BN)	0	59,000	70,000	130,000
2026 (AN)	0	460,000	20,000	480,000
2027 (W)	0	500,000	15,000	520,000
2028 (W)	0	210,000	41,000	250,000
2029 (C)	0	180,000	44,000	220,000
2030 (C)	0	70,000	52,000	120,000
2031 (AN)	0	460,000	2,700	460,000
2032 (BN)	0	89,000	41,000	130,000
2033 (AN)	0	320,000	7,300	320,000
2034 (D)	0	220,000	20,000	240,000
2035 (W)	0	490,000	0	490,000
2036 (W)	0	970,000	0	970,000
2037 (W)	0	420,000	45,000	470,000
2038 (D)	0	220,000	49,000	270,000
2039 (W)	0	410,000	32,000	440,000
2040 (D)	0	180,000	48,000	220,000
2041 (C)	0	66,000	49,000	120,000
2042 (D)	0	70,000	37,000	110,000
2043 (C)	0	85,000	34,000	120,000
2044 (C)	0	84,000	27,000	110,000
2045 (C)	0	200,000	8,000	210,000
2046 (AN)	0	440,000	0	440,000
2047 (C)	0	88,000	29,000	120,000
2048 (W)	0	870,000	0	870,000
2049 (W)	0	420,000	11,000	430,000
2050 (W)	0	340,000	23,000	360,000
2051 (W)	0	960,000	0	960,000
2052 (W)	0	220,000	42,000	260,000
2053 (AN)	0	320,000	35,000	360,000
2054 (D)	0	180,000	46,000	220,000
2055 (D)	0	210,000	29,000	240,000
2056 (AN)	0	400,000	14,000	410,000

Water Year (Type)		CVP Supplies	Local Supplies	Other (Groundwater Discharge)	Total
2057 (BN)		0	390,000	22,000	410,000
2058 (AN)		0	370,000	12,000	380,000
2059 (W)		0	510,000	14,000	520,000
2060 (D)		0	77,000	60,000	140,000
2061 (C)		0	180,000	32,000	210,000
2062 (D)		0	120,000	34,000	150,000
2063 (BN)		0	310,000	6,100	310,000
2064 (W)		0	250,000	11,000	260,000
2065 (BN)		0	90,000	42,000	130,000
2066 (D)		0	150,000	26,000	170,000
2067 (C)		0	69,000	35,000	100,000
2068 (C)		0	220,000	14,000	240,000
2069 (BN)		0	320,000	0	320,000
2070 (W)		0	480,000	0	480,000
2071 (BN)		0	57,000	40,000	97,000
2072 (W)		0	560,000	0	560,000
Average (2022-2072)		0	310,000	26,000	330,000
2022 - 2072	W	0	500,000	18,000	520,000
	AN	0	390,000	13,000	410,000
	BN	0	190,000	32,000	220,000
	D	0	160,000	39,000	200,000
	C	0	120,000	32,000	160,000

2.1.2.3 Deep Percolation of Applied Water

Estimated deep percolation of applied water (equal to infiltration of applied water in 23 CCR § 354.18(b)(2)) is summarized in **Figure 36** and **Table 35** by water use sector. Deep percolation of applied water is about 13 taf on average, and dominated by agricultural irrigation and varies between years, following the pattern of surface water diversions and deliveries to irrigated lands.

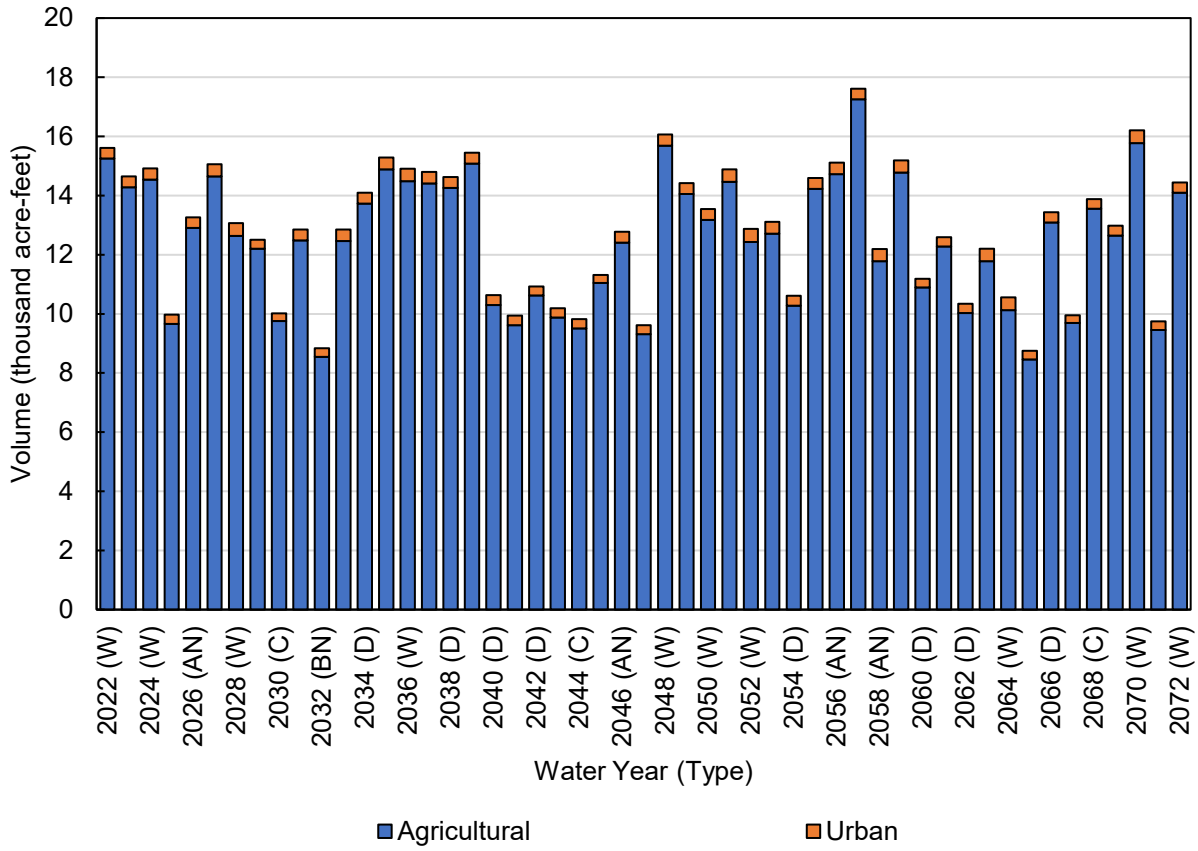

Figure 36. Red Bluff Subbasin Projected (Current Land Use) Deep Percolation of Applied Water, by Water Use Sector

Table 35. Red Bluff Subbasin Projected (Current Land Use) Deep Percolation of Applied Water, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	15,000	360	0	16,000
2023 (W)	14,000	370	0	15,000
2024 (W)	15,000	380	0	15,000
2025 (BN)	9,700	310	0	10,000
2026 (AN)	13,000	360	0	13,000
2027 (W)	15,000	410	0	15,000
2028 (W)	13,000	430	0	13,000
2029 (C)	12,000	300	0	13,000
2030 (C)	9,800	260	0	10,000
2031 (AN)	12,000	370	0	13,000
2032 (BN)	8,600	290	0	8,800
2033 (AN)	12,000	390	0	13,000
2034 (D)	14,000	360	0	14,000
2035 (W)	15,000	400	0	15,000
2036 (W)	14,000	430	0	15,000
2037 (W)	14,000	390	0	15,000
2038 (D)	14,000	370	0	15,000
2039 (W)	15,000	370	0	15,000
2040 (D)	10,000	330	0	11,000
2041 (C)	9,600	320	0	9,900
2042 (D)	11,000	300	0	11,000
2043 (C)	9,900	310	0	10,000
2044 (C)	9,500	310	0	9,800
2045 (C)	11,000	280	0	11,000
2046 (AN)	12,000	360	0	13,000
2047 (C)	9,300	310	0	9,600
2048 (W)	16,000	370	0	16,000
2049 (W)	14,000	370	0	14,000
2050 (W)	13,000	360	0	14,000
2051 (W)	14,000	430	0	15,000
2052 (W)	12,000	440	0	13,000
2053 (AN)	13,000	400	0	13,000
2054 (D)	10,000	330	0	11,000
2055 (D)	14,000	360	0	15,000
2056 (AN)	15,000	390	0	15,000
2057 (BN)	17,000	360	0	18,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		12,000	410	0	12,000
2059 (W)		15,000	410	0	15,000
2060 (D)		11,000	300	0	11,000
2061 (C)		12,000	310	0	13,000
2062 (D)		10,000	310	0	10,000
2063 (BN)		12,000	420	0	12,000
2064 (W)		10,000	430	0	11,000
2065 (BN)		8,500	290	0	8,800
2066 (D)		13,000	350	0	13,000
2067 (C)		9,700	260	0	10,000
2068 (C)		14,000	330	0	14,000
2069 (BN)		13,000	330	0	13,000
2070 (W)		16,000	430	0	16,000
2071 (BN)		9,500	300	0	9,800
2072 (W)		14,000	350	0	14,000
Average (2022-2072)		12,000	360	0	13,000
2022 - 2072	W	14,000	400	0	15,000
	AN	13,000	380	0	13,000
	BN	11,000	330	0	11,000
	D	12,000	330	0	12,000
	C	11,000	300	0	11,000

2.1.2.4 Deep Percolation of Precipitation

Estimated deep percolation of precipitation (equal to infiltration of precipitation in 23 CCR § 354.18(b)(2)) is provided in and **Figure 37** and **Table 36** by water use sector. Deep percolation of precipitation to the GWS is highly variable from year to year due to variation in the timing and amount of precipitation, ranging from about 24 taf per year during critical dry years to about 82 taf per year during wet years on average.

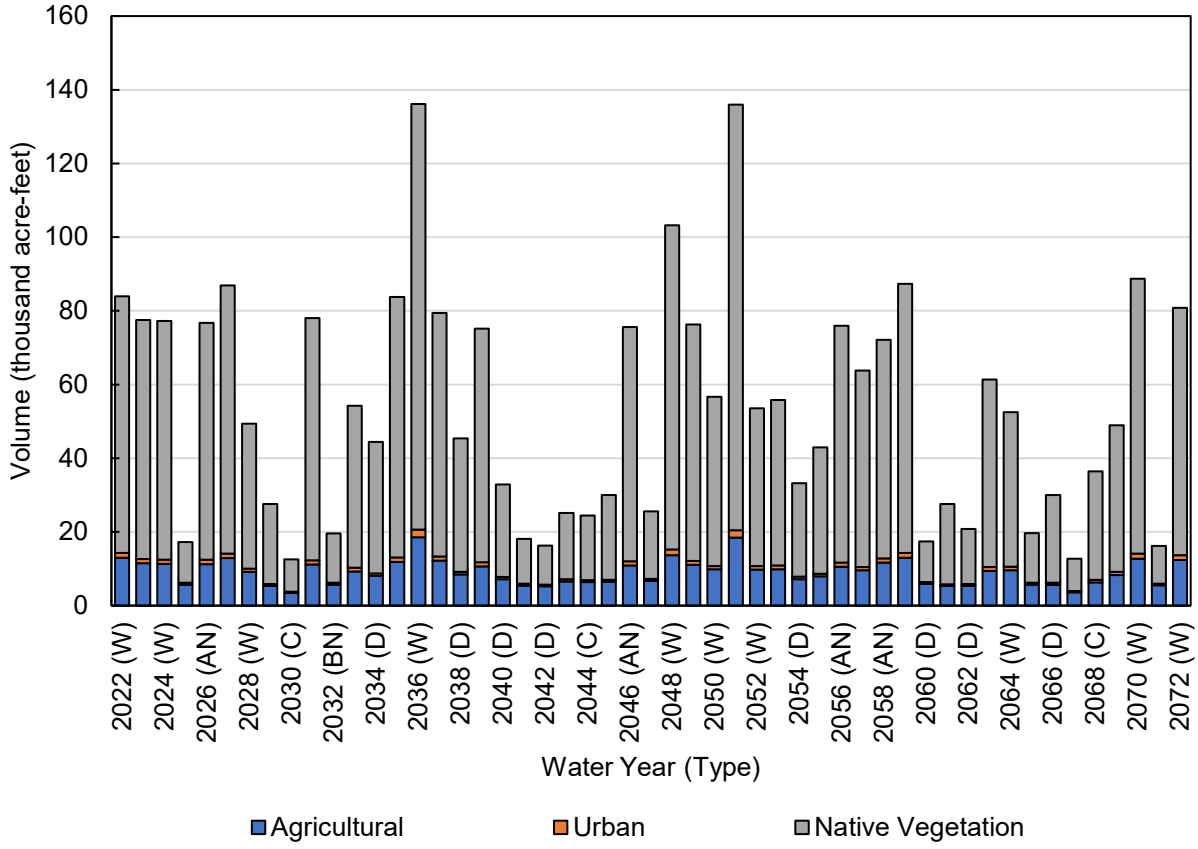

Figure 37. Red Bluff Subbasin Projected (Current Land Use) Deep Percolation of Precipitation, by Water Use Sector

Table 36. Red Bluff Subbasin Projected (Current Land Use) Deep Percolation of Precipitation, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	13,000	1,300	70,000	84,000
2023 (W)	11,000	1,100	65,000	78,000
2024 (W)	11,000	1,100	65,000	77,000
2025 (BN)	5,700	460	11,000	17,000
2026 (AN)	11,000	1,200	64,000	77,000
2027 (W)	13,000	1,300	73,000	87,000
2028 (W)	9,200	880	39,000	49,000
2029 (C)	5,400	460	22,000	28,000
2030 (C)	3,400	340	8,800	13,000
2031 (AN)	11,000	1,200	66,000	78,000
2032 (BN)	5,700	480	13,000	20,000
2033 (AN)	9,300	1,000	44,000	54,000
2034 (D)	8,000	690	36,000	44,000
2035 (W)	12,000	1,200	71,000	84,000
2036 (W)	19,000	2,000	120,000	140,000
2037 (W)	12,000	1,200	66,000	79,000
2038 (D)	8,500	700	36,000	45,000
2039 (W)	11,000	1,100	63,000	75,000
2040 (D)	7,100	660	25,000	33,000
2041 (C)	5,500	520	12,000	18,000
2042 (D)	5,300	450	11,000	16,000
2043 (C)	6,600	580	18,000	25,000
2044 (C)	6,400	570	18,000	24,000
2045 (C)	6,500	550	23,000	30,000
2046 (AN)	11,000	1,200	64,000	76,000
2047 (C)	6,700	570	18,000	26,000
2048 (W)	14,000	1,600	88,000	100,000
2049 (W)	11,000	1,100	64,000	76,000
2050 (W)	9,800	950	46,000	57,000
2051 (W)	18,000	2,000	120,000	140,000
2052 (W)	9,800	890	43,000	54,000
2053 (AN)	9,800	1,100	45,000	56,000
2054 (D)	7,200	660	25,000	33,000
2055 (D)	7,900	680	34,000	43,000
2056 (AN)	11,000	1,100	64,000	76,000
2057 (BN)	9,600	920	53,000	64,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		12,000	1,200	59,000	72,000
2059 (W)		13,000	1,300	73,000	87,000
2060 (D)		5,900	450	11,000	17,000
2061 (C)		5,300	460	22,000	28,000
2062 (D)		5,400	530	15,000	21,000
2063 (BN)		9,400	1,100	51,000	61,000
2064 (W)		9,600	970	42,000	52,000
2065 (BN)		5,700	480	13,000	20,000
2066 (D)		5,600	570	24,000	30,000
2067 (C)		3,600	350	8,800	13,000
2068 (C)		6,300	640	29,000	36,000
2069 (BN)		8,300	860	40,000	49,000
2070 (W)		13,000	1,300	75,000	89,000
2071 (BN)		5,500	450	10,000	16,000
2072 (W)		12,000	1,300	67,000	81,000
Average (2022-2072)		9,100	890	44,000	54,000
2022 - 2072	W	12,000	1,300	69,000	82,000
	AN	11,000	1,100	58,000	70,000
	BN	7,100	670	27,000	35,000
	D	6,800	600	24,000	31,000
	C	5,600	500	18,000	24,000

2.1.2.5 Infiltration of Surface Water

Estimated infiltration of surface water (seepage) by water source is provided in **Figure 38** and **Table 37.** Seepage in the Red Bluff Subbasin comes from the Tehama-Colusa Canal and Corning Canal that traverse the subbasin, as well as conveyance of supply delivered to water districts. The total seepage from all canals and diversions is less than 1 taf per year, on average. Runoff from upgradient small watersheds also contributes seepage to the Red Bluff Subbasin. The total seepage from rivers, streams and small water sheds average about 4.5 taf per year.

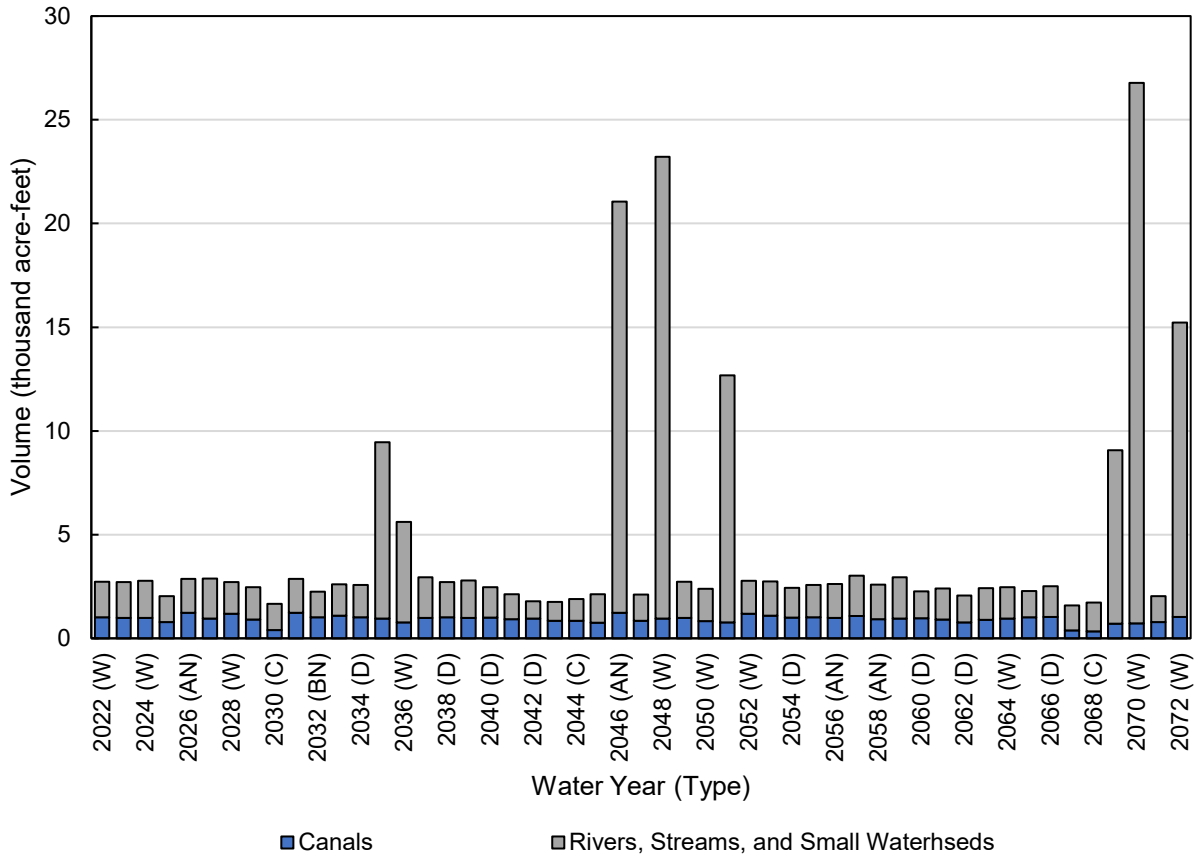

Figure 38. Red Bluff Subbasin Projected (Current Land Use) Infiltration of Surface Water, by Water Use Sector

Table 37. Red Bluff Subbasin Projected (Current Land Use) Infiltration of Surface Water, by Water Use Sector (acre-feet)

Water Year (Type)	Canals	Rivers, Streams, and Small Watersheds	Total
2022 (W)	1,000	1,700	2,700
2023 (W)	990	1,700	2,700
2024 (W)	990	1,800	2,800
2025 (BN)	780	1,300	2,000
2026 (AN)	1,200	1,600	2,900
2027 (W)	950	1,900	2,900
2028 (W)	1,200	1,500	2,700
2029 (C)	910	1,600	2,500
2030 (C)	400	1,300	1,700
2031 (AN)	1,200	1,600	2,900
2032 (BN)	1,000	1,200	2,300
2033 (AN)	1,100	1,500	2,600
2034 (D)	1,000	1,600	2,600
2035 (W)	950	8,500	9,500
2036 (W)	770	4,900	5,600
2037 (W)	990	2,000	2,900
2038 (D)	1,000	1,700	2,700
2039 (W)	990	1,800	2,800
2040 (D)	1,000	1,500	2,500
2041 (C)	930	1,200	2,100
2042 (D)	960	830	1,800
2043 (C)	840	920	1,800
2044 (C)	840	1,100	1,900
2045 (C)	760	1,400	2,100
2046 (AN)	1,200	20,000	21,000
2047 (C)	850	1,300	2,100
2048 (W)	950	22,000	23,000
2049 (W)	990	1,700	2,700
2050 (W)	830	1,600	2,400
2051 (W)	770	12,000	13,000
2052 (W)	1,200	1,600	2,800
2053 (AN)	1,100	1,700	2,800
2054 (D)	1,000	1,400	2,400
2055 (D)	1,000	1,600	2,600
2056 (AN)	990	1,600	2,600
2057 (BN)	1,100	1,900	3,000

Water Year (Type)		Canals	Rivers, Streams, and Small Watersheds	Total
2058 (AN)		930	1,700	2,600
2059 (W)		950	2,000	3,000
2060 (D)		970	1,300	2,300
2061 (C)		910	1,500	2,400
2062 (D)		770	1,300	2,100
2063 (BN)		890	1,500	2,400
2064 (W)		960	1,500	2,500
2065 (BN)		1,000	1,300	2,300
2066 (D)		1,000	1,500	2,500
2067 (C)		390	1,200	1,600
2068 (C)		330	1,400	1,700
2069 (BN)		710	8,400	9,100
2070 (W)		730	26,000	27,000
2071 (BN)		780	1,300	2,000
2072 (W)		1,000	14,000	15,000
Average (2022-2072)		930	3,500	4,500
2022 - 2072	W	960	6,000	7,000
	AN	1,100	4,200	5,300
	BN	890	2,400	3,300
	D	980	1,400	2,400
	C	720	1,300	2,000

2.1.3 Change in Root Zone Storage

Estimates of change in root zone storage are provided in **Figure 39** and **Table 38**. Inter-annual changes in storage within the SWS consist primarily of root zone soil moisture storage changes, are relatively small, and tend to average near zero over many years.

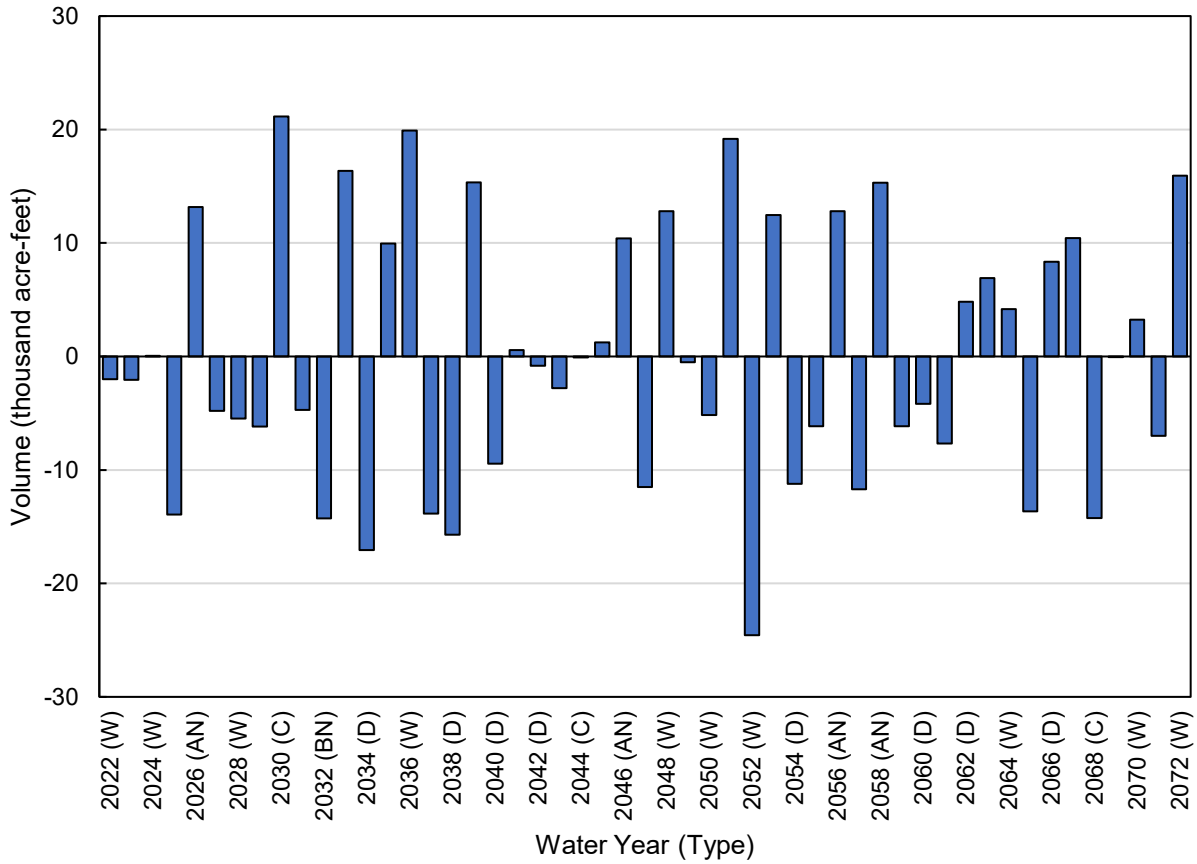

Figure 39. Red Bluff Subbasin Projected (Current Land Use) Change in Root Zone Storage

Table 38. Red Bluff Subbasin Projected (Current Land Use) Change in Root Zone Storage (acre-feet)

Water Year (Type)	Change in Root Zone Storage
2022 (W)	-2,000
2023 (W)	-2,100
2024 (W)	60
2025 (BN)	-14,000
2026 (AN)	13,000
2027 (W)	-4,800
2028 (W)	-5,500
2029 (C)	-6,200
2030 (C)	21,000
2031 (AN)	-4,700
2032 (BN)	-14,000
2033 (AN)	16,000
2034 (D)	-17,000
2035 (W)	10,000
2036 (W)	20,000
2037 (W)	-14,000
2038 (D)	-16,000
2039 (W)	15,000
2040 (D)	-9,500
2041 (C)	570
2042 (D)	-830
2043 (C)	-2,800
2044 (C)	-80
2045 (C)	1,200
2046 (AN)	10,000
2047 (C)	-12,000
2048 (W)	13,000
2049 (W)	-510
2050 (W)	-5,200
2051 (W)	19,000
2052 (W)	-25,000
2053 (AN)	12,000
2054 (D)	-11,000
2055 (D)	-6,100
2056 (AN)	13,000
2057 (BN)	-12,000

Water Year (Type)		Change in Root Zone Storage
2058 (AN)		15,000
2059 (W)		-6,100
2060 (D)		-4,200
2061 (C)		-7,700
2062 (D)		4,800
2063 (BN)		6,900
2064 (W)		4,200
2065 (BN)		-14,000
2066 (D)		8,400
2067 (C)		10,000
2068 (C)		-14,000
2069 (BN)		-60
2070 (W)		3,300
2071 (BN)		-7,000
2072 (W)		16,000
Average (2022-2072)		-50
2022 - 2072	W	2,000
	AN	11,000
	BN	-7,700
	D	-5,700
	C	-910

2.1.4 Net Recharge from Surface Water System

Net recharge from the SWS is a useful metric that equates only the impacts of the SWS on recharge and extraction from the GWS, providing valuable insight to the combined effects of land surface processes on the underlying GWS. Net recharge from the SWS is calculated as the total groundwater recharge minus the total groundwater extraction and uptake. When calculated for the projected (current land use) water budget, average net recharge from the SWS represents the average surplus (when positive) or shortage (when negative) of recharge that has resulted from projected cropping, land use practices, and average hydrologic conditions, when comparing groundwater extractions with deep percolation and infiltration from the SWS to the GWS. Net recharge does not include groundwater discharges to surface water and is not a full accounting of all exchanges occurring between the SWS and GWS. Although net recharge is a useful water balance metric, groundwater sustainability is not defined by the balance of net recharge from the SWS. Other important factors must be considered in the complete assessment of groundwater sustainability, including but not limited to subsurface groundwater flows and groundwater discharge to surface water.

Annual values for net recharge from the SWS over the projected (current land use) water budget period are presented below for the Red Bluff Subbasin. **Figure 40** and **Table 39** show the average net recharge from the SWS over 2022-2072 based on the projected (current land use) water budget results. Under current land use conditions, the average net recharge in the Red Bluff Subbasin was projected as approximately -29 taf per year between 2022-2072, indicating net outflows from the GWS to the SWS during the projected (current land use) water budget period. As illustrated on the cumulative net recharge plot in **Figure 40**, this results in a cumulative net negative recharge (i.e., net discharge from the GWS to the SWS) of about 1.5 taf over the 51-year projected (current land use) water budget period. Although this means there is projected to be more recharge from the SWS to the GWS than extractions and discharges from the GWS to the SWS, this alone does not necessarily mean that groundwater storage is decreasing or that the Subbasin groundwater system has been unsustainable. The complete Subbasin water budget, including the GWS water budget results, provide an indication of whether total groundwater inflows and outflows are in balance.

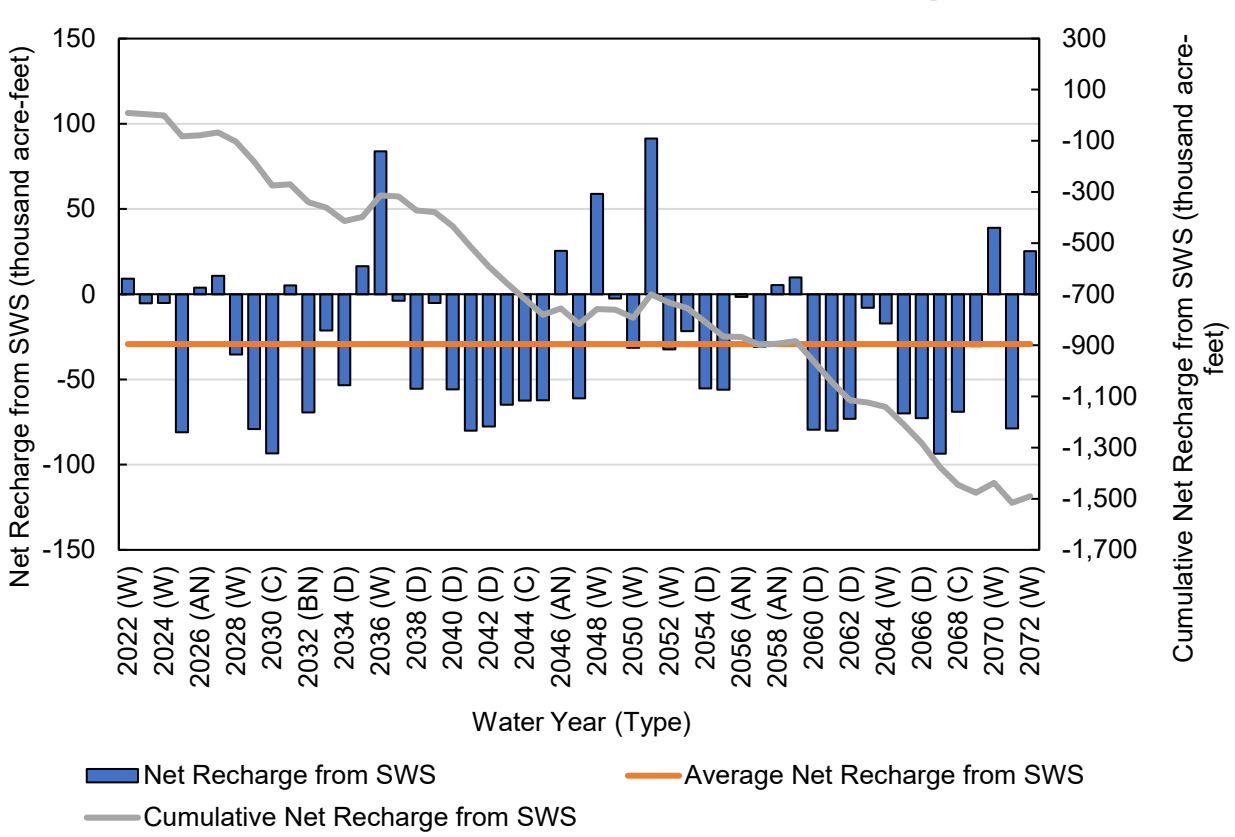

Figure 40. Red Bluff Subbasin Projected (Current Land Use) Net Recharge Overview

Table 39. Red Bluff Subbasin Projected (Current Land Use) Water Budget: Average Net Recharge from SWS, by Water Year Type (acre-feet)

Year Type	Number of Years	Deep Perc. of Applied Water (a)	Deep Perc. of Precipitation (b)	Infil. of Surface Water (c)	Groundwater Extraction/ Uptake (d)	Net Recharge from SWS (a+b+c-d)
W	18	15,000	82,000	7,000	93,000	11,000
AN	7	13,000	70,000	5,300	89,000	-640
BN	7	11,000	35,000	3,300	100,000	-53,000
D	9	12,000	31,000	2,400	110,000	-64,000
C	10	11,000	24,000	2,000	110,000	-75,000
Annual Average (2022 - 2072)	51	13,000	54,000	4,500	100,000	-29,000

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2.2 Groundwater System Water Budget Results

Projected (current land use) water budget results for different components of the GWS are presented in the sections below. Inflows and outflows from the GWS that occur through exchanges with the SWS are discussed in the SWS water budget results, although these components are also noted in the sections below relating to the GWS water budget. In contrast to the SWS water budget, many of the GWS water budget components change in flow direction over time representing inflows during some periods and outflows during other periods, depending on Subbasin conditions. The GWS water budget results are presented with net inflows indicated by positive values and net outflows as negative values.

2.2.1 Lateral Subsurface Groundwater Flows

Subsurface groundwater flows to and from the Red Bluff Subbasin occur between the Bowman Subbasin to the north, the Bend, Antelope, and Los Molinos Subbasins to the east, and the Corning Subbasin to the south. Some subsurface groundwater flows also occur between the South Battle Creek Subbasin which borders the Red Bluff Subbasin to the northeast. Additional subsurface groundwater inflows occur from the upland foothill (small watershed) areas adjoining the Red Bluff Subbasin to the west.

2.2.1.1 Lateral Subsurface Flows to/from Adjacent Subbasins

Projected (current land use) lateral subsurface flows occurring from and to adjacent subbasin are summarized in **Figure41** and **Table 40**. The total Projected (current land use) net subsurface flows to and from all adjacent subbasins averages about 52 taf per year occurring as inflow to the Red Bluff Subbasin. The largest projected (current land use) subsurface flows occur across the boundary with the Bowman with somewhat less subsurface flow occurring across the boundaries with the Corning, Antelope and Bend Subbasins, although these flows are still considerable. Much smaller flows occur across the boundaries with the Los Molinos and South Battle Creek Subbasins.

Projected (current land use) subsurface flows with the Bowman Subbasin consistently average about 120 taf occurring as inflows to the Red Bluff Subbasin. This makes up most of the subsurface inflows occurring to the Red Bluff Subbasin. Annual subsurface flows from Red Bluff Subbasin to Corning, Antelope and Bend Subbasins (negative values) average about 36, 15 and 17 taf, respectively. The magnitudes of the subsurface outflows from Red Bluff Subbasin to the Corning and Bend Subbasins are relatively consistent from year to year; however, the year-to-year variability in the outflows to the Antelope Subbasin are somewhat greater. Projected (current land use) subsurface flows across the boundary with Los Molinos Subbasin generally occur as smaller volumes of outflows to the Los Molinos Subbasin, although the magnitude of flows across this boundary do vary, including the occurrence of a net inflow from Los Molinos Subbasin in some years. The average over the projected (current land use) water budget period is a net outflow of about 0.9 taf per year from Red Bluff Subbasin to Los Molinos Subbasin (negative value). A small amount of subsurface inflow also occurs across the boundary with the South Battle Creek Subbasin totaling about 1.5 taf per year on average.

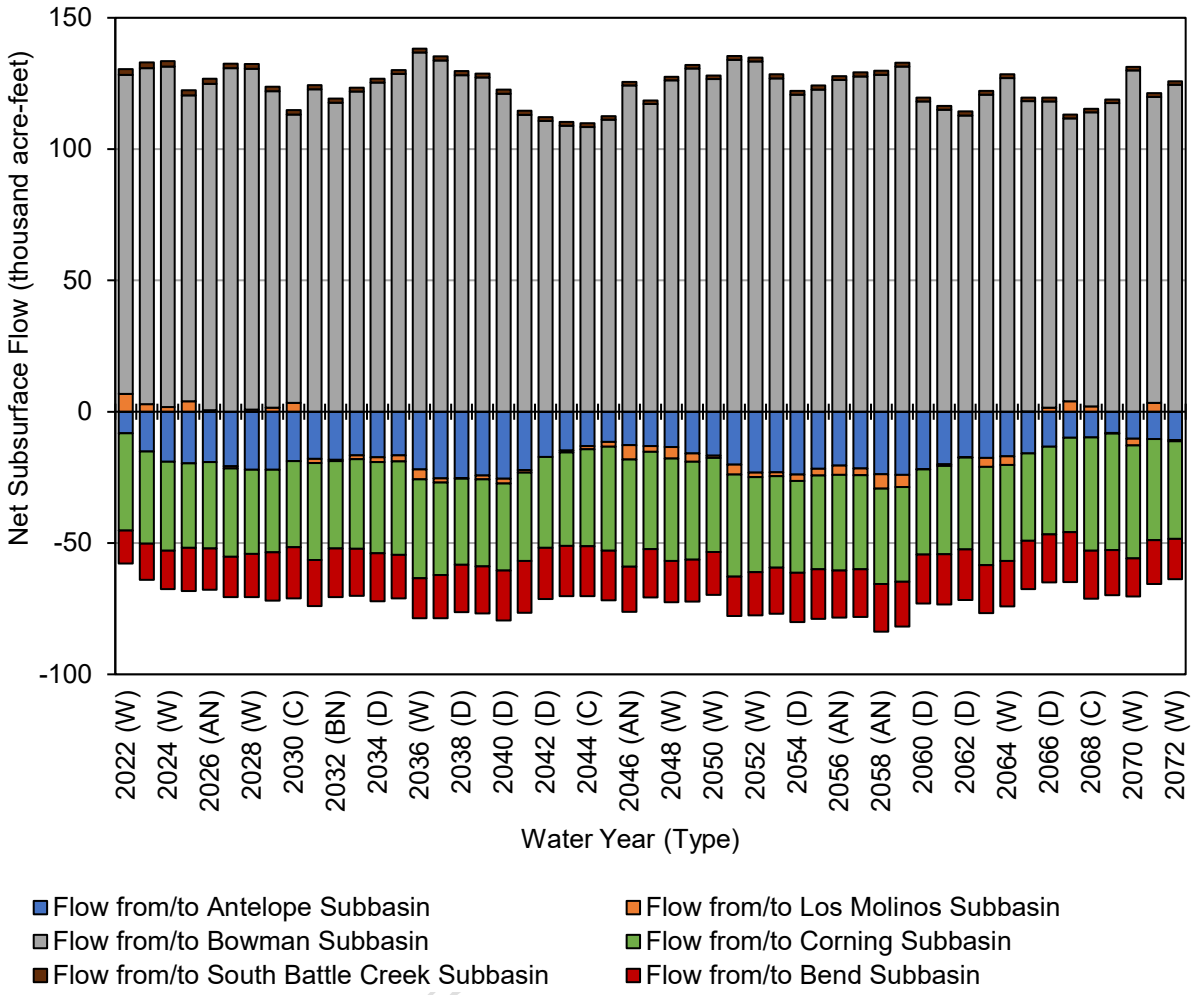

Figure 41. Red Bluff Subbasin Projected (Current Land Use) Lateral Subsurface Groundwater Flows to/from Adjacent Subbasins

Table 40. Red Bluff Subbasin Projected (Current Land Use) Lateral Subsurface Groundwater Flows Between Adjacent Subbasins (net flows as acre-feet)

Water Year (Type)	Antelope	Los Molinos	Bowman	Corning	S. Battle Creek	Bend	Total
2022 (W)	-8,200	6,700	120,000	-37,000	2,200	-13,000	73,000
2023 (W)	-15,000	2,900	130,000	-35,000	2,100	-14,000	69,000
2024 (W)	-19,000	1,800	130,000	-34,000	2,000	-15,000	66,000
2025 (BN)	-20,000	4,000	120,000	-32,000	1,900	-16,000	54,000
2026 (AN)	-19,000	610	120,000	-33,000	1,800	-16,000	59,000
2027 (W)	-21,000	-820	130,000	-34,000	1,800	-15,000	62,000
2028 (W)	-22,000	760	130,000	-32,000	1,700	-17,000	62,000
2029 (C)	-22,000	1,500	120,000	-31,000	1,700	-18,000	52,000
2030 (C)	-19,000	3,300	110,000	-33,000	1,700	-20,000	44,000
2031 (AN)	-18,000	-1,600	120,000	-37,000	1,600	-17,000	50,000
2032 (BN)	-18,000	-510	120,000	-33,000	1,600	-19,000	49,000
2033 (AN)	-17,000	-1,500	120,000	-34,000	1,500	-18,000	53,000
2034 (D)	-17,000	-1,800	130,000	-35,000	1,500	-18,000	55,000
2035 (W)	-17,000	-2,300	130,000	-36,000	1,400	-17,000	59,000
2036 (W)	-22,000	-3,700	140,000	-38,000	1,400	-15,000	60,000
2037 (W)	-25,000	-1,500	130,000	-35,000	1,500	-16,000	57,000
2038 (D)	-25,000	-270	130,000	-33,000	1,600	-18,000	53,000
2039 (W)	-24,000	-1,400	130,000	-33,000	1,600	-18,000	52,000
2040 (D)	-25,000	-1,900	120,000	-33,000	1,600	-19,000	43,000
2041 (C)	-22,000	-960	110,000	-34,000	1,500	-20,000	38,000
2042 (D)	-17,000	5	110,000	-35,000	1,500	-19,000	41,000
2043 (C)	-15,000	-710	110,000	-36,000	1,400	-19,000	40,000
2044 (C)	-13,000	-1,200	110,000	-37,000	1,400	-19,000	40,000
2045 (C)	-11,000	-1,900	110,000	-40,000	1,400	-19,000	41,000
2046 (AN)	-13,000	-5,400	120,000	-41,000	1,300	-17,000	49,000
2047 (C)	-13,000	-2,200	120,000	-37,000	1,300	-18,000	48,000
2048 (W)	-13,000	-4,400	130,000	-39,000	1,300	-16,000	55,000
2049 (W)	-16,000	-3,300	130,000	-37,000	1,400	-16,000	60,000
2050 (W)	-17,000	-850	130,000	-36,000	1,400	-16,000	58,000
2051 (W)	-20,000	-3,800	130,000	-39,000	1,400	-15,000	58,000
2052 (W)	-23,000	-1,800	130,000	-36,000	1,500	-16,000	57,000
2053 (AN)	-23,000	-1,500	130,000	-35,000	1,500	-18,000	52,000
2054 (D)	-24,000	-2,500	120,000	-35,000	1,600	-19,000	42,000
2055 (D)	-22,000	-2,600	120,000	-36,000	1,500	-19,000	45,000
2056 (AN)	-21,000	-3,500	130,000	-36,000	1,500	-18,000	49,000
2057 (BN)	-22,000	-2,500	130,000	-36,000	1,500	-18,000	51,000
2058 (AN)	-24,000	-5,400	130,000	-36,000	1,500	-18,000	46,000
2059 (W)	-24,000	-4,600	130,000	-36,000	1,500	-17,000	51,000

Water Year (Type)		Antelope	Los Molinos	Bowman	Corning	S. Battle Creek	Bend	Total
2060 (D)		-22,000	-110	120,000	-32,000	1,500	-19,000	47,000
2061 (C)		-20,000	-680	110,000	-34,000	1,500	-19,000	43,000
2062 (D)		-17,000	-120	110,000	-35,000	1,500	-19,000	43,000
2063 (BN)		-18,000	-3,500	120,000	-37,000	1,400	-18,000	45,000
2064 (W)		-17,000	-3,300	130,000	-37,000	1,400	-17,000	54,000
2065 (BN)		-16,000	57	120,000	-33,000	1,400	-18,000	52,000
2066 (D)		-13,000	1,500	120,000	-33,000	1,400	-18,000	55,000
2067 (C)		-9,900	4,000	110,000	-36,000	1,400	-19,000	48,000
2068 (C)		-9,800	2,000	110,000	-43,000	1,400	-18,000	44,000
2069 (BN)		-8,000	-280	120,000	-44,000	1,300	-17,000	49,000
2070 (W)		-10,000	-2,600	130,000	-43,000	1,300	-14,000	61,000
2071 (BN)		-10,000	3,400	120,000	-38,000	1,400	-17,000	56,000
2072 (W)		-11,000	-480	120,000	-37,000	1,400	-15,000	62,000
Average (2022-2072)		-18,000	-880	120,000	-36,000	1,500	-17,000	52,000
2022 - 2072	W	-18,000	-1,300	130,000	-36,000	1,600	-16,000	60,000
	AN	-19,000	-2,600	120,000	-36,000	1,500	-17,000	51,000
	BN	-16,000	100	120,000	-36,000	1,500	-18,000	51,000
	D	-20,000	-870	120,000	-34,000	1,500	-19,000	47,000
	C	-16,000	320	110,000	-36,000	1,500	-19,000	44,000

Note: positive values represent net inflows to Red Bluff Subbasin, negative values represent net outflows from Red Bluff Subbasin.

2.2.1.2 Lateral Subsurface Flows from Upland Areas (Small Watersheds)

Projected (current land use) lateral subsurface inflows occurring from upland or foothill areas (small watersheds outside of the Central Valley Floor) to the west of the Red Bluff Subbasin are summarized in **Figure 42** and **Table 41**. This component does not include surface water inflows to the Red Bluff Subbasin which are discussed as part of the SWS water budget. The average projected (current land use) subsurface inflow from the upland areas is about 1.1 taf per year and varies only very minimally from year to year. The volume of subsurface inflows from upland areas is small relative to the net subsurface inflows occurring between adjacent subbasins.

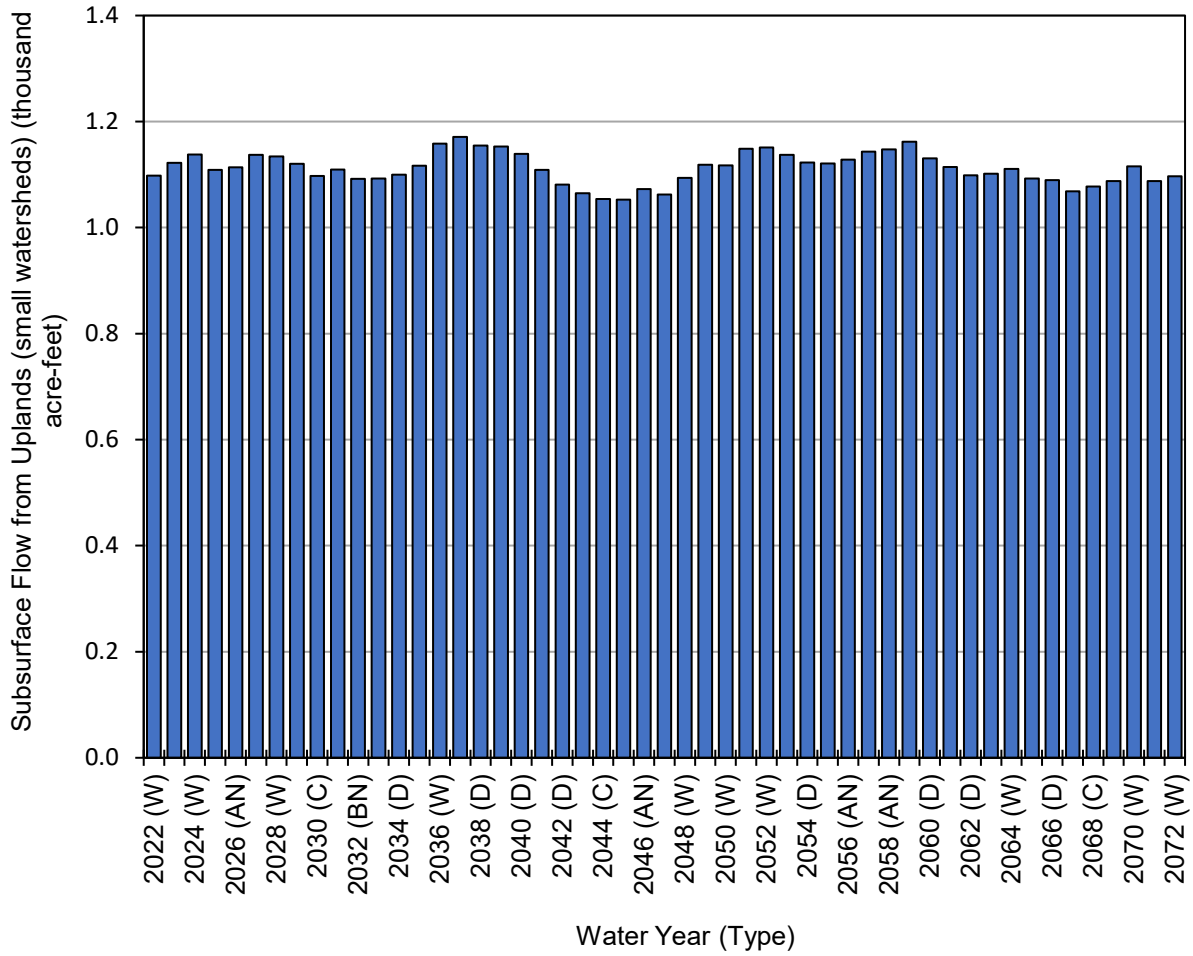

Figure 42. Red Bluff Subbasin Projected (Current Land Use) Subsurface Groundwater Inflows from Upland Areas

Table 41. Red Bluff Subbasin Projected (Current Land Use) Subsurface Groundwater Inflows from Adjacent Uplands (small watersheds) (acre-feet)

Water Year (Type)	Subsurface Inflow from Uplands
2022 (W)	1,100
2023 (W)	1,100
2024 (W)	1,100
2025 (BN)	1,100
2026 (AN)	1,100
2027 (W)	1,100
2028 (W)	1,100
2029 (C)	1,100
2030 (C)	1,100
2031 (AN)	1,100
2032 (BN)	1,100
2033 (AN)	1,100
2034 (D)	1,100
2035 (W)	1,100
2036 (W)	1,200
2037 (W)	1,200
2038 (D)	1,200
2039 (W)	1,200
2040 (D)	1,100
2041 (C)	1,100
2042 (D)	1,100
2043 (C)	1,100
2044 (C)	1,100
2045 (C)	1,100
2046 (AN)	1,100
2047 (C)	1,100
2048 (W)	1,100
2049 (W)	1,100
2050 (W)	1,100
2051 (W)	1,100
2052 (W)	1,200
2053 (AN)	1,100
2054 (D)	1,100
2055 (D)	1,100
2056 (AN)	1,100
2057 (BN)	1,100
2058 (AN)	1,100
2059 (W)	1,200

Water Year (Type)		Subsurface Inflow from Uplands
2060 (D)		1,100
2061 (C)		1,100
2062 (D)		1,100
2063 (BN)		1,100
2064 (W)		1,100
2065 (BN)		1,100
2066 (D)		1,100
2067 (C)		1,100
2068 (C)		1,100
2069 (BN)		1,100
2070 (W)		1,100
2071 (BN)		1,100
2072 (W)		1,100
Average (2022-2072)		1,100
2022 - 2072	W	1,100
	AN	1,100
	BN	1,100
	D	1,100
	C	1,100

2.2.2 Deep Percolation From the SWS

Deep percolation from the SWS includes infiltration of water below the root zone (deep percolation) from precipitation and applied water. These two water budget components are summarized in the SWS water budget as outflows to the SWS and are presented as aggregated deep percolation inflows to the GWS in **Figure 43** and **Table 42**. The average annual deep percolation from the SWS over the projected (current land use) water budget period is approximately 68 taf per year. Greater volumes of deep percolation occur during wetter years when infiltration of precipitation is higher.

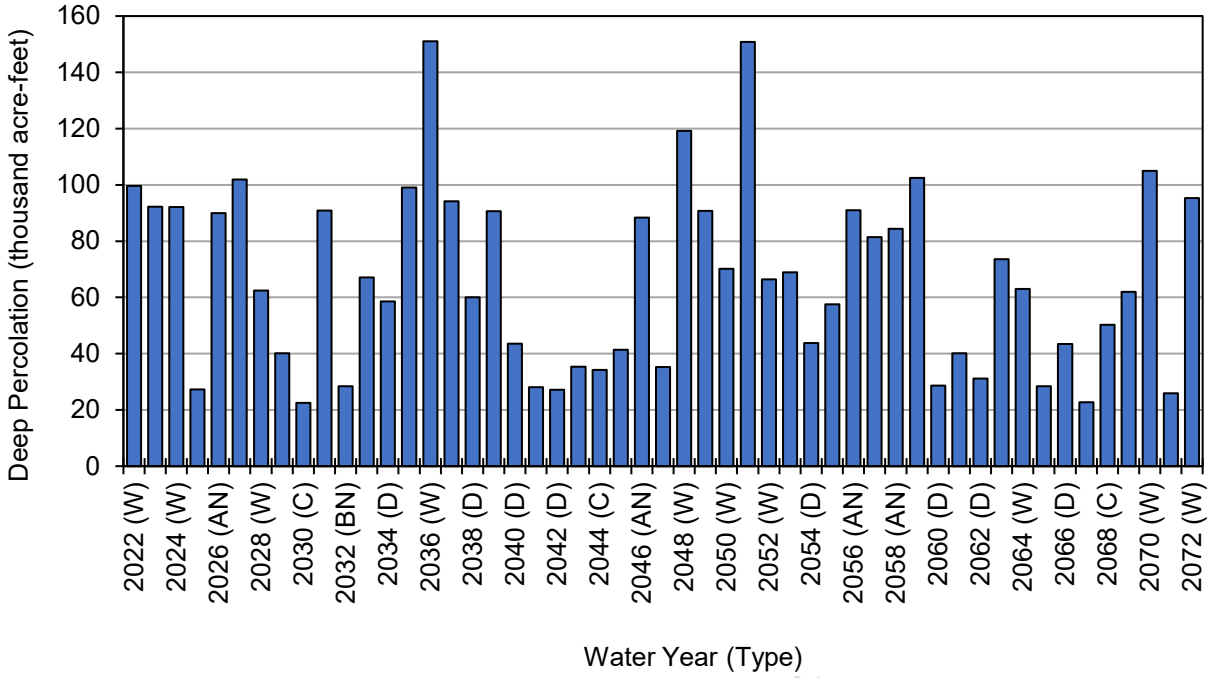

Figure 43. Red Bluff Subbasin Projected (Current Land Use) Deep Percolation

Table 42. Red Bluff Subbasin Projected (Current Land Use) Deep Percolation from the SWS (acre-feet)

Water Year (Type)	Deep Percolation from the SWS
2022 (W)	100,000
2023 (W)	92,000
2024 (W)	92,000
2025 (BN)	31,000
2026 (AN)	89,000
2027 (W)	100,000
2028 (W)	64,000
2029 (C)	43,000
2030 (C)	25,000
2031 (AN)	90,000
2032 (BN)	31,000
2033 (AN)	68,000
2034 (D)	61,000
2035 (W)	99,000
2036 (W)	150,000
2037 (W)	94,000
2038 (D)	63,000
2039 (W)	90,000
2040 (D)	45,000
2041 (C)	31,000
2042 (D)	31,000
2043 (C)	38,000
2044 (C)	37,000
2045 (C)	44,000
2046 (AN)	88,000
2047 (C)	37,000
2048 (W)	120,000
2049 (W)	90,000
2050 (W)	72,000
2051 (W)	150,000
2052 (W)	68,000
2053 (AN)	70,000
2054 (D)	45,000
2055 (D)	60,000
2056 (AN)	91,000
2057 (BN)	84,000
2058 (AN)	85,000
2059 (W)	100,000

Water Year (Type)		Deep Percolation from the SWS
2060 (D)		32,000
2061 (C)		43,000
2062 (D)		34,000
2063 (BN)		74,000
2064 (W)		65,000
2065 (BN)		31,000
2066 (D)		47,000
2067 (C)		26,000
2068 (C)		54,000
2069 (BN)		64,000
2070 (W)		110,000
2071 (BN)		30,000
2072 (W)		95,000
Average (2022-2072)		68,000
2022 - 2072	W	97,000
	AN	83,000
	BN	49,000
	D	46,000
	C	38,000

2.2.3 Net Stream Seepage/Groundwater Discharge to Surface Water

The flow of water between the GWS and SWS through seepage of water from streams and canals and groundwater discharging into streams is discussed as part of the SWS water budget. These components are combined for presentation in the GWS water budget as a net volume of stream seepage (**Figure 44** and **Table 43**). Positive total net seepage values represent a net inflow of water from the SWS to the GWS via stream and canal seepage indicating that the overall volume of stream seepage is greater than the volume of any groundwater discharging into surface waterways. Negative net seepage values represent a net outflow of groundwater from the GWS to the SWS through groundwater discharge to surface water. When net seepage is negative, it means that more groundwater is discharging into the surface waterways than is seeping from surface waterways into the GWS.

In the Red Bluff Subbasin, the projected (current land use) annual net seepage values are highly negative in most years with an average annual net stream seepage value of -21 taf per year indicating that groundwater discharge is providing considerable flow to the surface waterways. The annual net stream seepage values tend to be more negative in dry years and less negative in wet years corresponding with more net groundwater discharge to surface water in drier years and less groundwater discharge in wetter years.

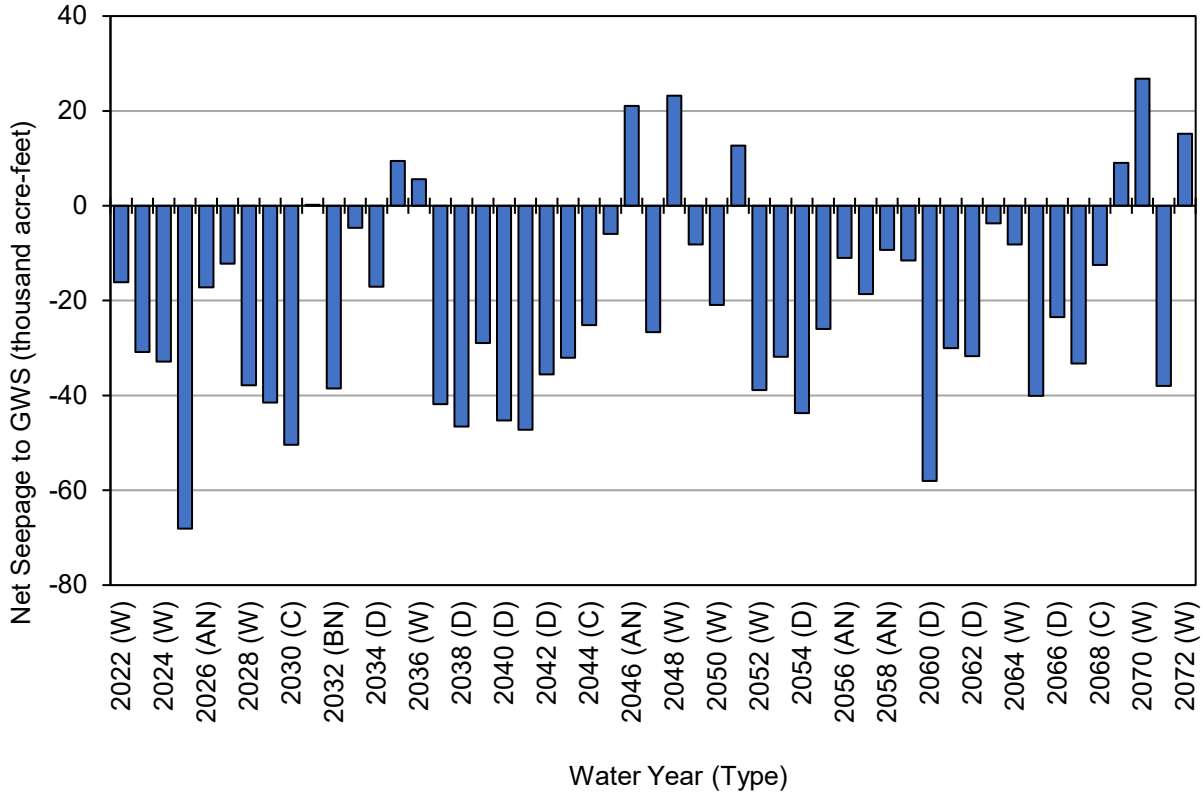

Figure 44. Red Bluff Subbasin Projected (Current Land Use) Net Stream Seepage to GWS/Discharge to Surface Water

Table 43. Red Bluff Subbasin Projected (Current Land Use) Net Stream Seepage (net flows as acre-feet)

Water Year (Type)	Total Net Seepage from Surface Waterways and Canals
2022 (W)	-16,000
2023 (W)	-31,000
2024 (W)	-33,000
2025 (BN)	-68,000
2026 (AN)	-17,000
2027 (W)	-12,000
2028 (W)	-38,000
2029 (C)	-42,000
2030 (C)	-50,000
2031 (AN)	170
2032 (BN)	-39,000
2033 (AN)	-4,700
2034 (D)	-17,000
2035 (W)	9,500
2036 (W)	5,600
2037 (W)	-42,000
2038 (D)	-47,000
2039 (W)	-29,000
2040 (D)	-45,000
2041 (C)	-47,000
2042 (D)	-36,000
2043 (C)	-32,000
2044 (C)	-25,000
2045 (C)	-5,900
2046 (AN)	21,000
2047 (C)	-27,000
2048 (W)	23,000
2049 (W)	-8,200
2050 (W)	-21,000
2051 (W)	13,000
2052 (W)	-39,000
2053 (AN)	-32,000
2054 (D)	-44,000
2055 (D)	-26,000
2056 (AN)	-11,000
2057 (BN)	-19,000
2058 (AN)	-9,300
2059 (W)	-12,000

Water Year (Type)		Total Net Seepage from Surface Waterways and Canals
2060 (D)		-58,000
2061 (C)		-30,000
2062 (D)		-32,000
2063 (BN)		-3,700
2064 (W)		-8,100
2065 (BN)		-40,000
2066 (D)		-24,000
2067 (C)		-33,000
2068 (C)		-12,000
2069 (BN)		9,100
2070 (W)		27,000
2071 (BN)		-38,000
2072 (W)		15,000
Average (2022-2072)		-21,000
2022 - 2072	W	-11,000
	AN	-7,500
	BN	-28,000
	D	-36,000
	C	-30,000

Note: negative values indicate net groundwater discharge to surface water

2.2.4 Groundwater Extraction

Groundwater extractions are exchanges that occur between the GWS and the SWS. Groundwater extraction from the GWS occurs through groundwater pumping to meet water demands for urban and agricultural needs and also through groundwater (root water) uptake by plants directly from shallow groundwater during times and at locations of sufficiently shallow groundwater conditions. Projected (current land use) groundwater extractions are summarized in **Figure 45** and **Table 44** and also presented and discussed in the SWS water budget sections. Total groundwater extractions over the projected (current land use) water budget period average about -100 taf per year. Overall, groundwater pumping represents a larger fraction of the groundwater extractions than groundwater uptake. Groundwater pumping averaged about -94 taf over the projected (current land use) period and groundwater uptake averaged about -6.3 taf. In wetter periods, groundwater uptake increases and groundwater pumping decreases. Accordingly, during drier periods groundwater pumping increases and water uptake by plants from shallow groundwater decreases in response to the higher water demands for irrigation and other uses and the greater depths to groundwater that also tend to occur during dry periods.

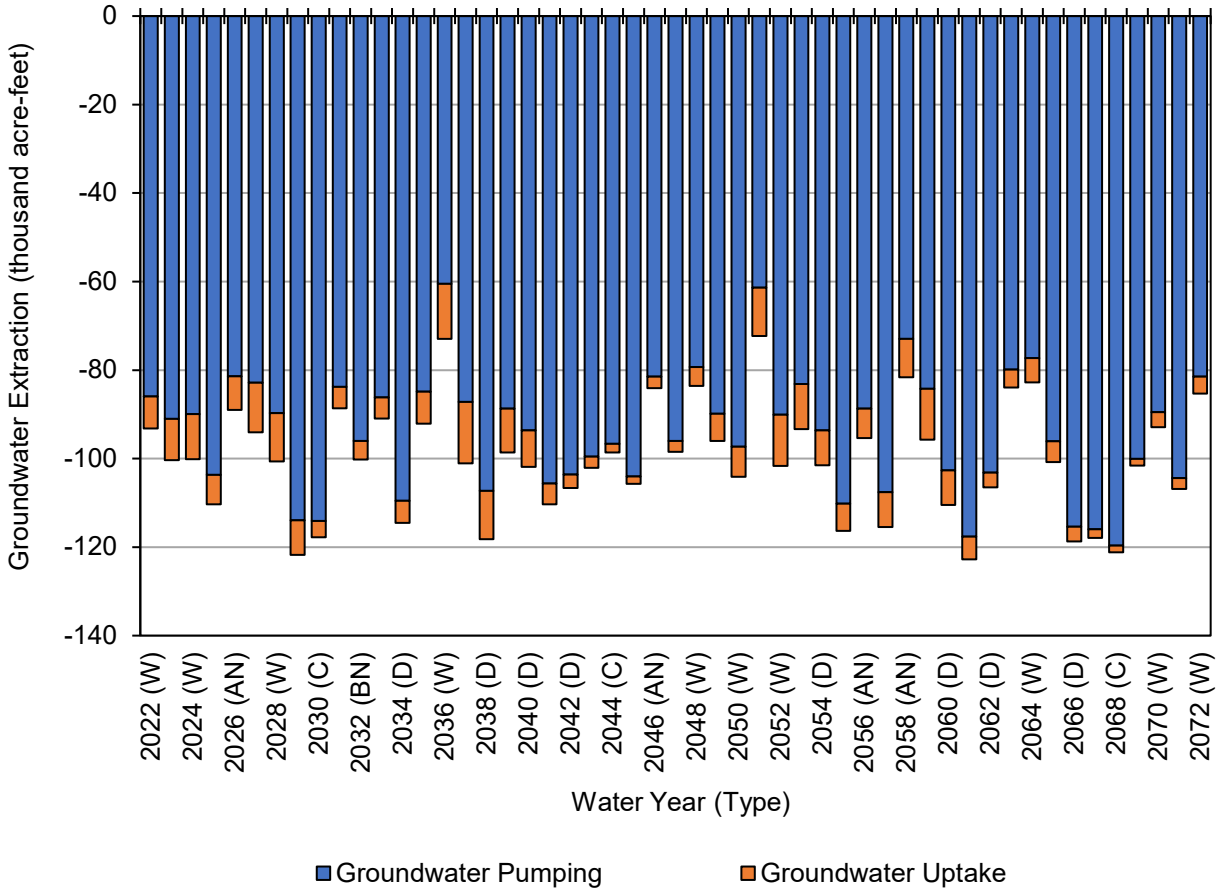

Figure 45. Red Bluff Subbasin Projected (Current Land Use) Groundwater Extractions

Table 44. Red Bluff Subbasin Projected (Current Land Use) Groundwater Extractions (acre-feet)

Water Year (Type)	Groundwater Pumping	Groundwater (Root Water) Uptake	Total Extractions
2022 (W)	-86,000	-7,300	-93,000
2023 (W)	-91,000	-9,300	-100,000
2024 (W)	-90,000	-10,000	-100,000
2025 (BN)	-100,000	-6,700	-110,000
2026 (AN)	-81,000	-7,600	-89,000
2027 (W)	-83,000	-11,000	-94,000
2028 (W)	-90,000	-11,000	-100,000
2029 (C)	-110,000	-7,800	-120,000
2030 (C)	-110,000	-3,700	-120,000
2031 (AN)	-84,000	-4,900	-89,000
2032 (BN)	-96,000	-4,200	-100,000
2033 (AN)	-86,000	-4,800	-91,000
2034 (D)	-110,000	-5,000	-110,000
2035 (W)	-85,000	-7,200	-92,000
2036 (W)	-60,000	-12,000	-73,000
2037 (W)	-87,000	-14,000	-100,000
2038 (D)	-110,000	-11,000	-120,000
2039 (W)	-89,000	-9,900	-99,000
2040 (D)	-94,000	-8,300	-100,000
2041 (C)	-110,000	-4,700	-110,000
2042 (D)	-100,000	-3,000	-110,000
2043 (C)	-100,000	-2,500	-100,000
2044 (C)	-97,000	-1,900	-99,000
2045 (C)	-100,000	-1,700	-110,000
2046 (AN)	-81,000	-2,600	-84,000
2047 (C)	-96,000	-2,400	-98,000
2048 (W)	-79,000	-4,300	-84,000
2049 (W)	-90,000	-6,200	-96,000
2050 (W)	-97,000	-6,800	-100,000
2051 (W)	-61,000	-11,000	-72,000
2052 (W)	-90,000	-12,000	-100,000
2053 (AN)	-83,000	-10,000	-93,000
2054 (D)	-94,000	-7,900	-100,000
2055 (D)	-110,000	-6,200	-120,000
2056 (AN)	-89,000	-6,600	-95,000
2057 (BN)	-110,000	-7,800	-120,000
2058 (AN)	-73,000	-8,700	-82,000

Water Year (Type)		Groundwater Pumping	Groundwater (Root Water) Uptake	Total Extractions
2059 (W)		-84,000	-12,000	-96,000
2060 (D)		-100,000	-7,800	-110,000
2061 (C)		-120,000	-5,100	-120,000
2062 (D)		-100,000	-3,300	-110,000
2063 (BN)		-80,000	-4,000	-84,000
2064 (W)		-77,000	-5,500	-83,000
2065 (BN)		-96,000	-4,700	-100,000
2066 (D)		-120,000	-3,400	-120,000
2067 (C)		-120,000	-1,900	-120,000
2068 (C)		-120,000	-1,500	-120,000
2069 (BN)		-100,000	-1,600	-100,000
2070 (W)		-89,000	-3,400	-93,000
2071 (BN)		-100,000	-2,400	-110,000
2072 (W)		-81,000	-3,900	-85,000
Average (2022-2072)		-94,000	-6,300	-100,000
2022 - 2072	W	-84,000	-8,700	-93,000
	AN	-83,000	-6,500	-89,000
	BN	-98,000	-4,500	-100,000
	D	-100,000	-6,200	-110,000
	C	-110,000	-3,300	-110,000

2.2.5 Vertical Subsurface Flows within the Groundwater System

Vertical subsurface flows within the GWS occur between the Upper and Lower Aquifers and represent an internal flow of water within the GWS. These exchanges between the principal aquifers do not directly affect the total volume of groundwater in storage, but do highlight the net vertical movement of water within the GWS. Projected (current land use) vertical flows between the Upper Aquifer and Lower Aquifer are summarized in **Figure 46** and **Table 45** and show consistent net overall upward vertical flow from the Lower Aquifer to the Upper Aquifer. On average, vertical flows from the Lower Aquifer to the Upper Aquifer total about 35 taf per year over the projected (current land use) water budget period. There is considerable year-to-year variability in the magnitude of these flows, which appear to correlate with water year conditions, although they are mostly in an upward direction except in few wet years. The magnitude of upward flows are generally greatest during drier years and decrease during wet periods. The net upward vertical flow between the two principal aquifers in the Subbasin is consistent with the large groundwater outflows (e.g., groundwater extractions, groundwater discharge to SWS) that occur from the Upper Aquifer in the Subbasin that result in upward movement of groundwater from the Lower Aquifer.

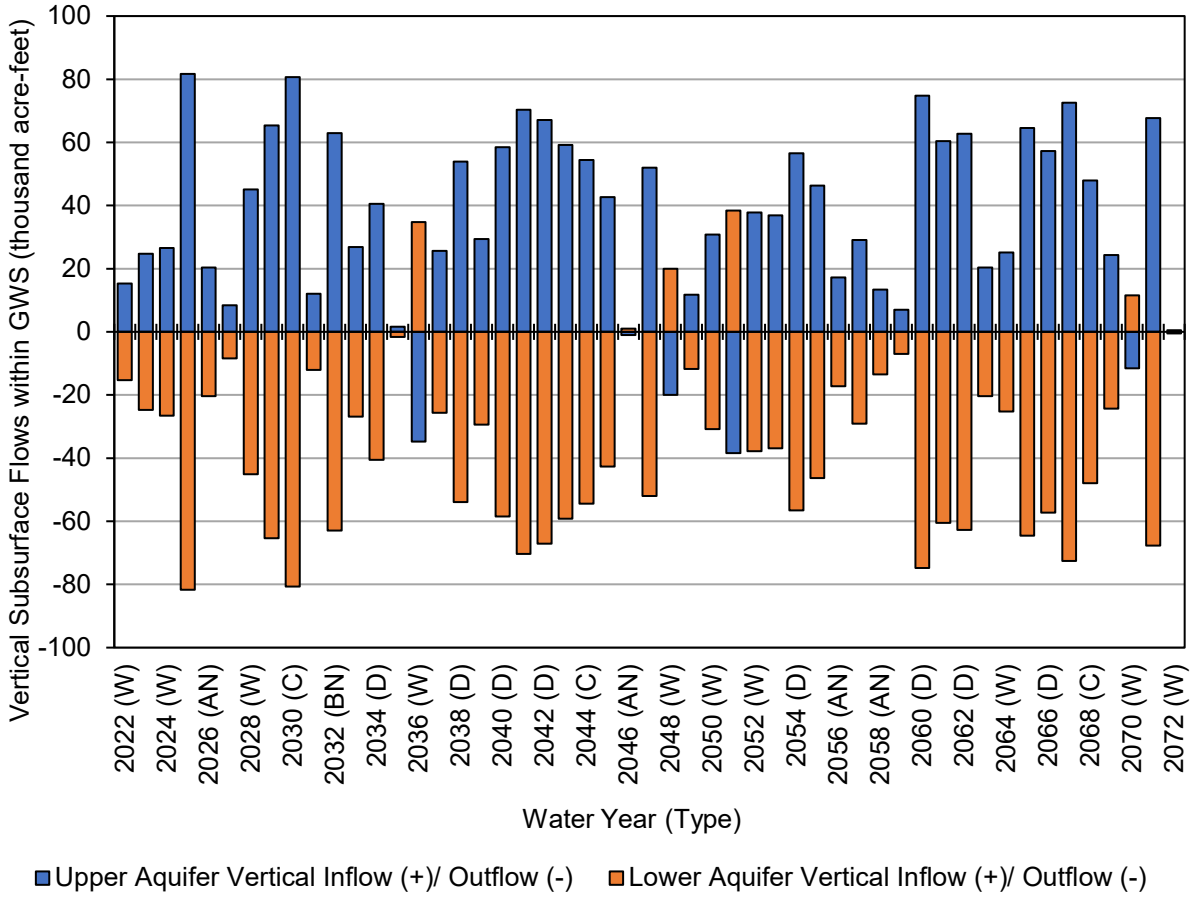

Figure 46. Red Bluff Subbasin Projected (Current Land Use) Vertical Subsurface Flow within the GWS

Table 45. Red Bluff Subbasin Projected (Current Land Use) Vertical Subsurface Flows within the GWS (acre-feet)

Water Year (Type)	Upper Aquifer to (-) / from (+) Lower Aquifer
2022 (W)	15,000
2023 (W)	25,000
2024 (W)	27,000
2025 (BN)	82,000
2026 (AN)	20,000
2027 (W)	8,400
2028 (W)	45,000
2029 (C)	65,000
2030 (C)	81,000
2031 (AN)	12,000
2032 (BN)	63,000
2033 (AN)	27,000
2034 (D)	41,000
2035 (W)	1,600
2036 (W)	-35,000
2037 (W)	26,000
2038 (D)	54,000
2039 (W)	29,000
2040 (D)	59,000
2041 (C)	70,000
2042 (D)	67,000
2043 (C)	59,000
2044 (C)	54,000
2045 (C)	43,000
2046 (AN)	-990
2047 (C)	52,000
2048 (W)	-20,000
2049 (W)	12,000
2050 (W)	31,000
2051 (W)	-38,000
2052 (W)	38,000
2053 (AN)	37,000
2054 (D)	57,000
2055 (D)	46,000
2056 (AN)	17,000
2057 (BN)	29,000
2058 (AN)	13,000
2059 (W)	7,000

Water Year (Type)		Upper Aquifer to (-) / from (+) Lower Aquifer
2060 (D)		75,000
2061 (C)		60,000
2062 (D)		63,000
2063 (BN)		20,000
2064 (W)		25,000
2065 (BN)		65,000
2066 (D)		57,000
2067 (C)		73,000
2068 (C)		48,000
2069 (BN)		24,000
2070 (W)		-12,000
2071 (BN)		68,000
2072 (W)		-540
Average (2022-2072)		35,000
2022 - 2072	W	10,000
	AN	18,000
	BN	50000
	D	58000
	C	61000

2.2.6 Change in Groundwater Storage

Projected (current land use) change in groundwater storage values for the Red Bluff Subbasin are summarized in **Figure 47** and **Figure 48**, and **Table 46**. Over the projected (current land use) period, the average total annual change in groundwater storage is about -1.8 taf per year, representing a decrease in groundwater storage. The corresponding cumulative total change in storage over the projected (current land use) period is about -94 taf. The annual change in storage numbers generally reflect the effects of the water year type with increase in storage occurring during wetter years and decreases in storage occurring during dry years.

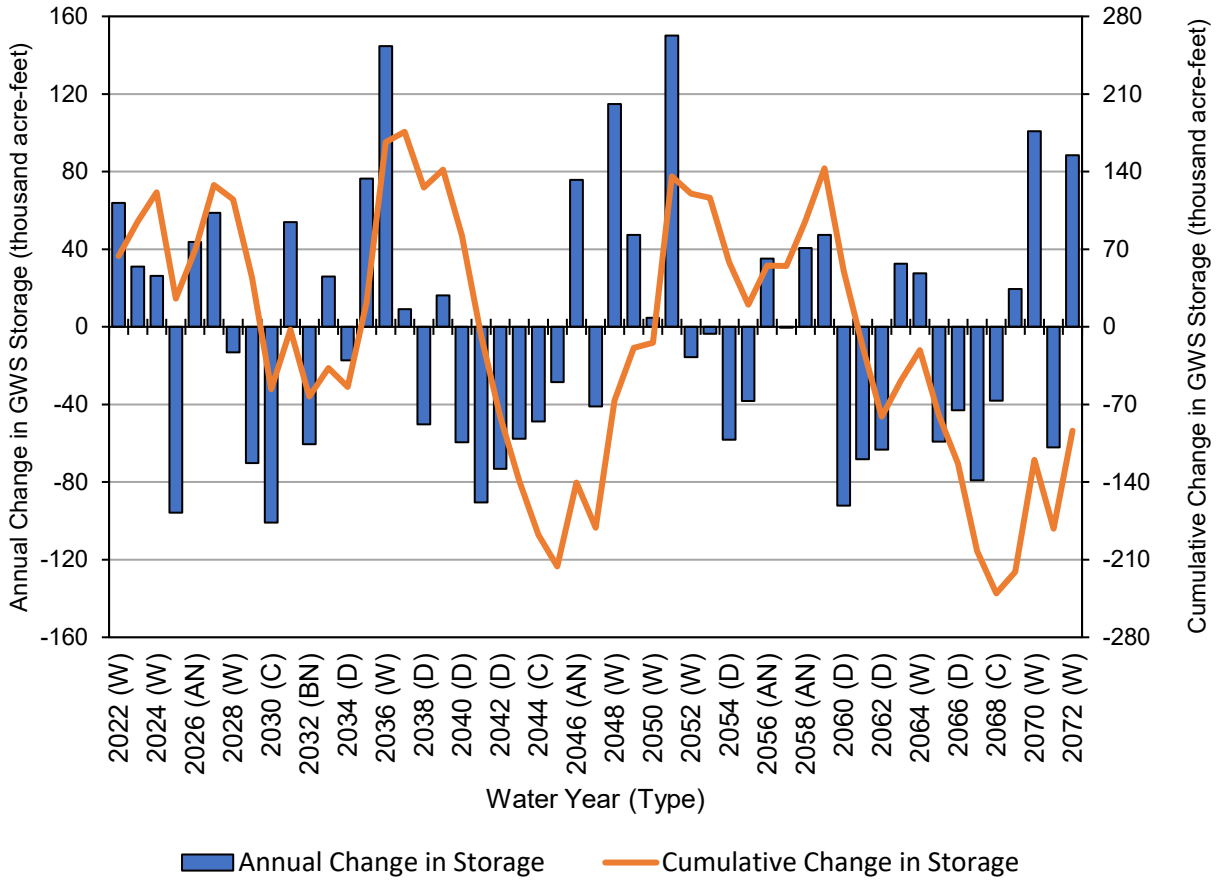

Figure 47. Red Bluff Subbasin Projected (Current Land Use) Projected (Current Land Use) Total Change in Storage within the GWS

Table 46. Red Bluff Subbasin Projected (Current Land Use) Change in Groundwater Storage (acre-feet)

Water Year (Type)	Upper Aquifer	Lower Aquifer	Total Annual Change	Total Cumulative Change
2022 (BN)	30,000	34,000	64,000	64,000
2023 (W)	9,300	22,000	31,000	95,000
2024 (W)	7,900	18,000	26,000	120,000
2025 (W)	-46,000	-50,000	-96,000	25,000
2026 (BN)	23,000	21,000	44,000	69,000
2027 (AN)	24,000	35,000	59,000	130,000
2028 (W)	-11,000	-2,600	-13,000	110,000
2029 (W)	-34,000	-36,000	-70,000	45,000
2030 (C)	-41,000	-60,000	-100,000	-56,000
2031 (C)	31,000	23,000	54,000	-2,400
2032 (AN)	-28,000	-33,000	-61,000	-63,000
2033 (BN)	17,000	9,300	26,000	-37,000
2034 (AN)	-11,000	-6,600	-17,000	-54,000
2035 (D)	37,000	40,000	76,000	22,000
2036 (W)	62,000	82,000	140,000	170,000
2037 (W)	-4,500	14,000	9,200	180,000
2038 (W)	-29,000	-21,000	-50,000	130,000
2039 (D)	11,000	5,200	16,000	140,000
2040 (W)	-27,000	-32,000	-59,000	82,000
2041 (D)	-39,000	-51,000	-90,000	-8,100
2042 (C)	-27,000	-47,000	-73,000	-81,000
2043 (D)	-20,000	-38,000	-58,000	-140,000
2044 (C)	-17,000	-32,000	-49,000	-190,000
2045 (C)	-9,200	-19,000	-28,000	-220,000
2046 (C)	39,000	37,000	76,000	-140,000
2047 (AN)	-19,000	-22,000	-41,000	-180,000
2048 (C)	55,000	60,000	110,000	-66,000
2049 (W)	17,000	31,000	47,000	-19,000
2050 (W)	-3,100	7,700	4,600	-14,000
2051 (W)	66,000	84,000	150,000	140,000
2052 (W)	-18,000	2,600	-16,000	120,000
2053 (W)	-2,000	-1,600	-3,600	120,000
2054 (AN)	-27,000	-31,000	-58,000	58,000
2055 (D)	-18,000	-21,000	-38,000	20,000
2056 (D)	19,000	16,000	35,000	55,000
2057 (AN)	-2,000	1,700	-380	55,000
2058 (BN)	20,000	21,000	41,000	95,000

Water Year (Type)		Upper Aquifer	Lower Aquifer	Total Annual Change	Total Cumulative Change
2059 (AN)		19,000	29,000	47,000	140,000
2060 (W)		-43,000	-49,000	-92,000	51,000
2061 (D)		-30,000	-39,000	-68,000	-18,000
2062 (C)		-24,000	-39,000	-63,000	-81,000
2063 (D)		21,000	11,000	32,000	-48,000
2064 (BN)		13,000	14,000	28,000	-21,000
2065 (W)		-28,000	-32,000	-59,000	-80,000
2066 (BN)		-17,000	-26,000	-43,000	-120,000
2067 (D)		-31,000	-48,000	-79,000	-200,000
2068 (C)		-13,000	-25,000	-38,000	-240,000
2069 (C)		13,000	6,600	20,000	-220,000
2070 (BN)		45,000	55,000	100,000	-120,000
2071 (W)		-29,000	-33,000	-62,000	-180,000
2072 (W)		43,000	46,000	88,000	-94,000
Average (2022-2072)		-510	-1,300	-1,800	
2022-2072	W	22,000	32,000	54,000	
	AN	21,000	18,000	39,000	
	BN	-14,000	-18,000	-32,000	
	D	-25,000	-30,000	-55,000	
	C	-25,000	-37,000	-62,000	

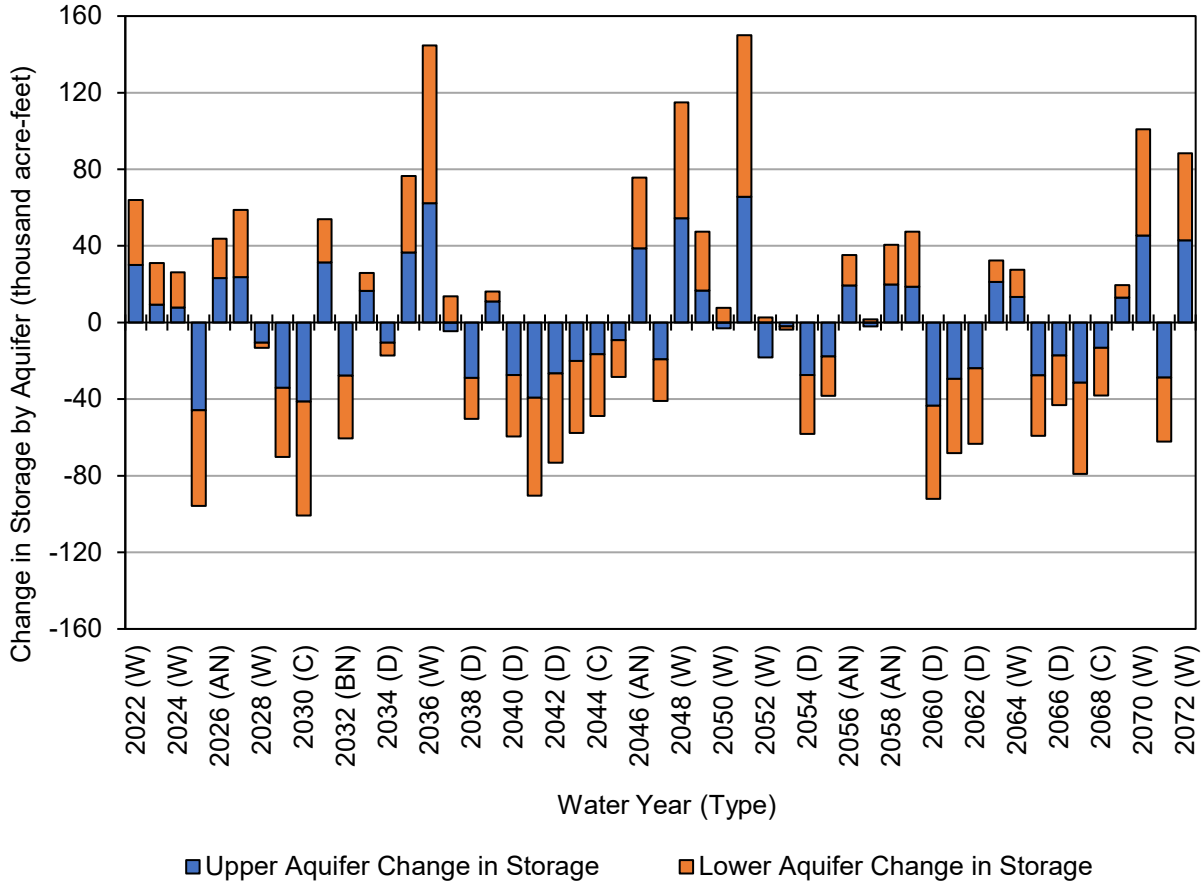

Figure 48. Red Bluff Subbasin Projected (Current Land Use) Change in Groundwater Storage by Aquifer

3 DETAILED PROJECTED (FUTURE LAND USE) WATER BUDGET

This section presents the results of the Projected (Future Land Use) scenario. The Future Land Use scenario assumes constant land use conditions based on assumed projected development within the Red Bluff Subbasin.

3.3 Surface Water System Water Budget Results

3.3.1 Inflows

3.3.1.1 Surface Water Inflow by Water Source Type

The projected annual volume of surface water inflows is summarized by water source type in **Figure 49** and **Table 47**. Over the projected (future land use) period, surface water inflows average about 120 taf per year. Virtually, all inflows of the SWS are local supplies. The CVP supplies are very small and average about 5 taf per year, on average.

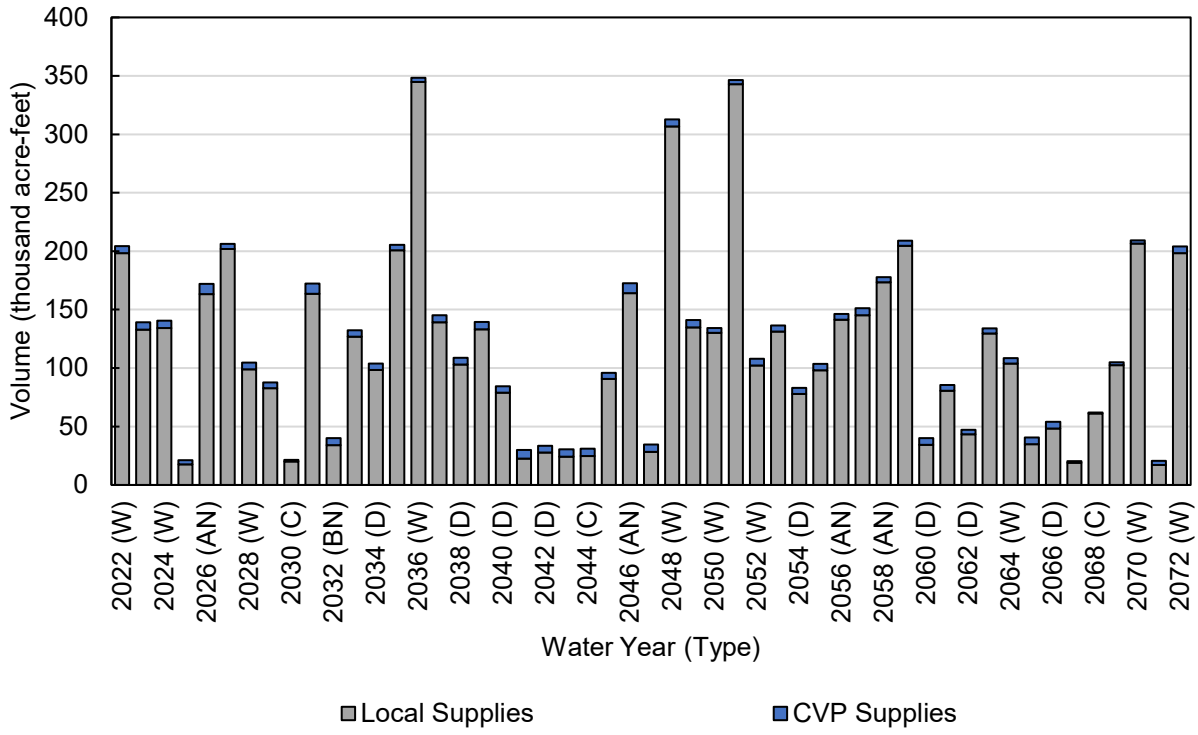

Figure 49. Red Bluff Subbasin Projected (Future Land Use) Surface Water Inflows, by Water Source Type

Table 47. Red Bluff Subbasin Projected (Future Land Use) Surface Water Inflows, by Water Source Type (acre-feet)

Water Year (Type)	CVP Supplies	Local Supplies	Total
2022 (W)	5,800	200,000	200,000
2023 (W)	6,300	130,000	140,000
2024 (W)	6,200	130,000	140,000
2025 (BN)	3,500	18,000	21,000
2026 (AN)	8,600	160,000	170,000
2027 (W)	4,400	200,000	210,000
2028 (W)	5,800	99,000	100,000
2029 (C)	4,900	83,000	88,000
2030 (C)	1,400	20,000	21,000
2031 (AN)	8,700	160,000	170,000
2032 (BN)	5,800	34,000	40,000
2033 (AN)	5,400	130,000	130,000
2034 (D)	5,400	98,000	100,000
2035 (W)	4,500	200,000	210,000
2036 (W)	3,700	340,000	350,000
2037 (W)	6,200	140,000	150,000
2038 (D)	5,500	100,000	110,000
2039 (W)	6,200	130,000	140,000
2040 (D)	5,400	79,000	84,000
2041 (C)	7,400	23,000	30,000
2042 (D)	5,600	28,000	33,000
2043 (C)	6,400	24,000	31,000
2044 (C)	6,300	25,000	31,000
2045 (C)	5,100	91,000	96,000
2046 (AN)	8,600	160,000	170,000
2047 (C)	6,300	28,000	35,000
2048 (W)	5,900	310,000	310,000
2049 (W)	6,200	130,000	140,000
2050 (W)	4,200	130,000	130,000
2051 (W)	3,700	340,000	350,000
2052 (W)	5,800	100,000	110,000
2053 (AN)	5,400	130,000	140,000
2054 (D)	5,400	78,000	83,000
2055 (D)	5,500	98,000	100,000
2056 (AN)	4,900	140,000	150,000

Water Year (Type)		CVP Supplies	Local Supplies	Total
2057 (BN)		5,900	150,000	150,000
2058 (AN)		4,400	170,000	180,000
2059 (W)		4,500	200,000	210,000
2060 (D)		5,600	34,000	40,000
2061 (C)		5,000	81,000	86,000
2062 (D)		3,900	43,000	47,000
2063 (BN)		4,300	130,000	130,000
2064 (W)		4,700	100,000	110,000
2065 (BN)		5,800	35,000	41,000
2066 (D)		5,700	48,000	54,000
2067 (C)		1,400	19,000	20,000
2068 (C)		950	61,000	62,000
2069 (BN)		2,500	100,000	110,000
2070 (W)		2,700	210,000	210,000
2071 (BN)		3,400	17,000	21,000
2072 (W)		5,700	200,000	200,000
Average (2022-2072)		5,200	120,000	120,000
2022-2072	W	5,200	180,000	190,000
	AN	6,500	150,000	160,000
	BN	4,500	69,000	73,000
	D	5,300	68,000	73,000
	C	4,500	45,000	50,000

3.3.1.2 Precipitation

Precipitation estimates for the Red Bluff Subbasin are provided in **Figure 50** and **Table 48**. Total precipitation is highly variable between years in the study area, ranging from approximately 420 taf (18.5 inches) during average critically dry years to 790 taf (34.8 inches) during average wet years.

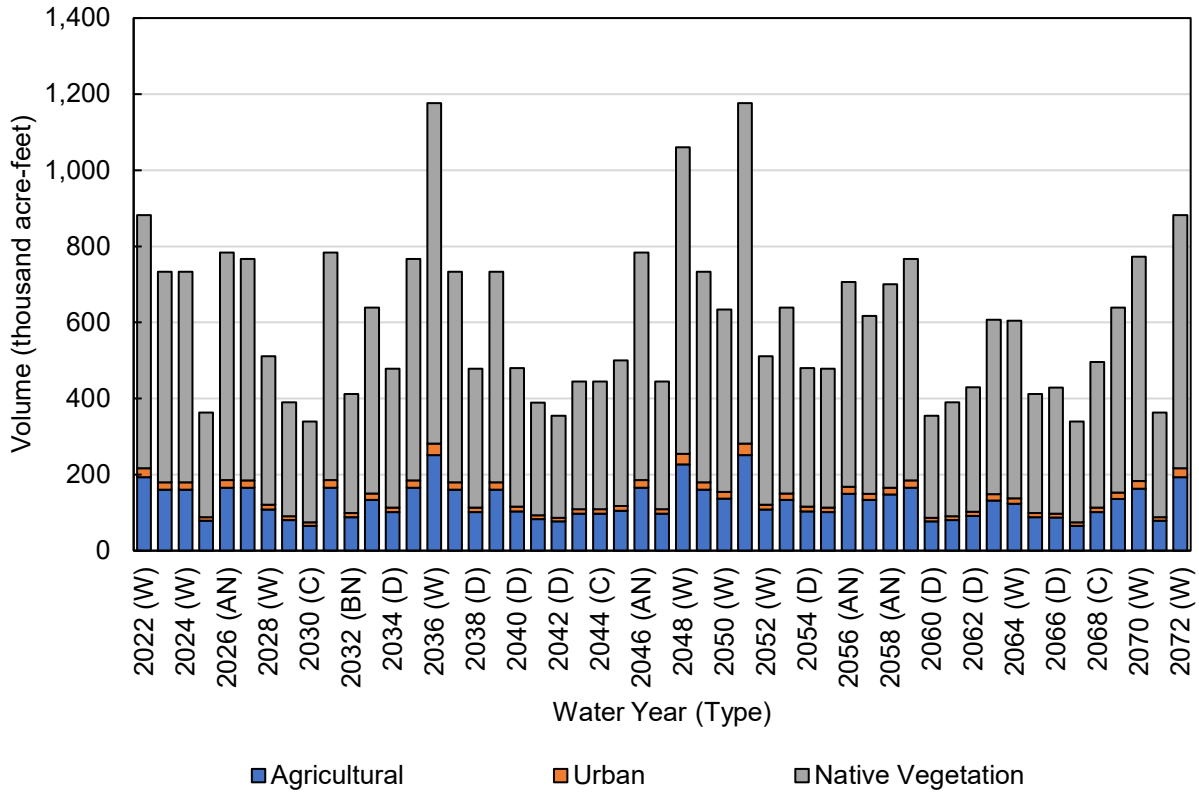

Figure 50. Red Bluff Subbasin Projected (Future Land Use) Precipitation, by Water Use Sector

Table 48. Red Bluff Subbasin Projected (Future Land Use) Precipitation, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (BN)	190,000	23,000	670,000	880,000
2023 (W)	160,000	19,000	550,000	730,000
2024 (W)	160,000	19,000	550,000	730,000
2025 (W)	78,000	9,600	280,000	360,000
2026 (BN)	170,000	20,000	600,000	780,000
2027 (AN)	170,000	20,000	580,000	770,000
2028 (W)	110,000	13,000	390,000	510,000
2029 (W)	81,000	9,700	300,000	390,000
2030 (C)	66,000	8,600	270,000	340,000
2031 (C)	170,000	20,000	600,000	780,000
2032 (AN)	88,000	11,000	310,000	410,000
2033 (BN)	130,000	17,000	490,000	640,000
2034 (AN)	100,000	12,000	360,000	480,000
2035 (D)	170,000	20,000	580,000	770,000
2036 (W)	250,000	31,000	890,000	1,200,000
2037 (W)	160,000	19,000	550,000	730,000
2038 (W)	100,000	12,000	360,000	480,000
2039 (D)	160,000	19,000	550,000	730,000
2040 (W)	100,000	13,000	360,000	480,000
2041 (D)	83,000	11,000	300,000	390,000
2042 (C)	77,000	9,600	270,000	350,000
2043 (D)	98,000	12,000	340,000	440,000
2044 (C)	98,000	12,000	340,000	440,000
2045 (C)	100,000	13,000	380,000	500,000
2046 (C)	170,000	20,000	600,000	780,000
2047 (AN)	98,000	12,000	340,000	440,000
2048 (C)	230,000	28,000	810,000	1,100,000
2049 (W)	160,000	19,000	550,000	730,000
2050 (W)	140,000	17,000	480,000	630,000
2051 (W)	250,000	31,000	890,000	1,200,000
2052 (W)	110,000	13,000	390,000	510,000
2053 (W)	130,000	17,000	490,000	640,000
2054 (AN)	100,000	13,000	360,000	480,000
2055 (D)	100,000	12,000	360,000	480,000
2056 (D)	150,000	18,000	540,000	710,000
2057 (AN)	130,000	16,000	470,000	620,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (BN)		150,000	18,000	530,000	700,000
2059 (AN)		170,000	20,000	580,000	770,000
2060 (W)		77,000	9,600	270,000	350,000
2061 (D)		81,000	9,700	300,000	390,000
2062 (C)		91,000	11,000	330,000	430,000
2063 (D)		130,000	16,000	460,000	610,000
2064 (BN)		120,000	15,000	470,000	600,000
2065 (W)		88,000	11,000	310,000	410,000
2066 (BN)		87,000	11,000	330,000	430,000
2067 (D)		66,000	8,600	270,000	340,000
2068 (C)		100,000	13,000	380,000	500,000
2069 (C)		140,000	16,000	490,000	640,000
2070 (BN)		160,000	20,000	590,000	770,000
2071 (W)		78,000	9,600	280,000	360,000
2072 (W)		190,000	23,000	670,000	880,000
Average (2022-2072)		130,000	16,000	460,000	600,000
2022-2072	W	170,000	21,000	600,000	790,000
	AN	150,000	19,000	550,000	720,000
	BN	100,000	13,000	370,000	490,000
	D	94,000	11,000	340,000	440,000
	C	87,000	11,000	320,000	420,000

3.3.1.3 Groundwater Extraction by Water Use Sector

Total groundwater extraction in the Red Bluff Subbasin represents a combination of groundwater pumping to support agricultural and urban water demands, including rural residential use, and groundwater uptake by crops, urban vegetation, and native vegetation.

Estimates of groundwater pumping by water use sector are provided in **Figure 51** and **Table 49**. Virtually all groundwater pumping in the Red Bluff Subbasin is used to meet agricultural demand, averaging 120 taf per year. Groundwater pumping for urban use is approximately 5.9 taf per year. The total groundwater extraction varies from about 110 taf in above-normal years to 150 taf in critically dry years based on variability in surface water supplies, precipitation, and crop water demand.

When groundwater is near the land surface, groundwater uptake can also be a source of supply for vegetation. Estimates of groundwater uptake by vegetation are provided in **Figure 52** and **Table 50**. The majority of groundwater uptake is consumed directly by native vegetation and agricultural crops, totaling 3.4 taf and 1.5 taf per year, on average.

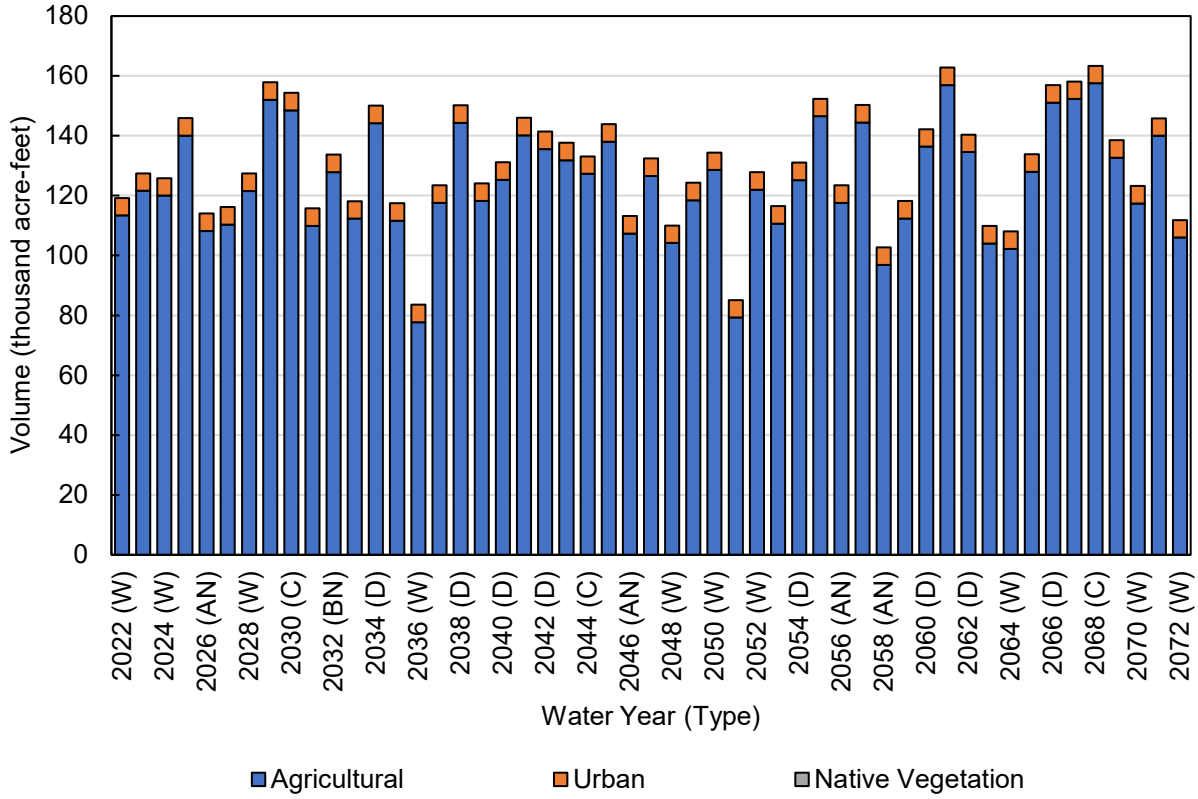

Figure 51. Red Bluff Subbasin Projected (Future Land Use) Groundwater Pumping, by Water Use Sector

Table 49. Red Bluff Subbasin Projected (Future Land Use) Groundwater Pumping, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (BN)	110,000	5,900	0	120,000
2023 (W)	120,000	5,900	0	130,000
2024 (W)	120,000	5,900	0	130,000
2025 (W)	140,000	5,900	0	150,000
2026 (BN)	110,000	5,900	0	110,000
2027 (AN)	110,000	5,900	0	120,000
2028 (W)	120,000	5,900	0	130,000
2029 (W)	150,000	5,900	0	160,000
2030 (C)	150,000	5,900	0	150,000
2031 (C)	110,000	5,900	0	120,000
2032 (AN)	130,000	5,900	0	130,000
2033 (BN)	110,000	5,900	0	120,000
2034 (AN)	140,000	5,900	0	150,000
2035 (D)	110,000	5,900	0	120,000
2036 (W)	78,000	5,900	0	84,000
2037 (W)	120,000	5,900	0	120,000
2038 (W)	140,000	5,900	0	150,000
2039 (D)	120,000	5,900	0	120,000
2040 (W)	130,000	5,900	0	130,000
2041 (D)	140,000	5,900	0	150,000
2042 (C)	140,000	5,800	0	140,000
2043 (D)	130,000	5,800	0	140,000
2044 (C)	130,000	5,800	0	130,000
2045 (C)	140,000	5,800	0	140,000
2046 (C)	110,000	5,900	0	110,000
2047 (AN)	130,000	5,800	0	130,000
2048 (C)	100,000	5,900	0	110,000
2049 (W)	120,000	5,900	0	120,000
2050 (W)	130,000	5,900	0	130,000
2051 (W)	79,000	5,900	0	85,000
2052 (W)	120,000	5,900	0	130,000
2053 (W)	110,000	5,900	0	120,000
2054 (AN)	130,000	5,900	0	130,000
2055 (D)	150,000	5,900	0	150,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2056 (D)		120,000	5,900	0	120,000
2057 (AN)		140,000	5,900	0	150,000
2058 (BN)		97,000	5,900	0	100,000
2059 (AN)		110,000	5,900	0	120,000
2060 (W)		140,000	5,900	0	140,000
2061 (D)		160,000	5,900	0	160,000
2062 (C)		130,000	5,900	0	140,000
2063 (D)		100,000	5,900	0	110,000
2064 (BN)		100,000	5,900	0	110,000
2065 (W)		130,000	5,900	0	130,000
2066 (BN)		150,000	5,800	0	160,000
2067 (D)		150,000	5,800	0	160,000
2068 (C)		160,000	5,800	0	160,000
2069 (C)		130,000	5,800	0	140,000
2070 (BN)		120,000	5,900	0	120,000
2071 (W)		140,000	5,800	0	150,000
2072 (W)		110,000	5,900	0	110,000
Average (2022-2072)		120,000	5,900	0	130,000
2022-2072	W	110,000	5,900	0	120,000
	AN	110,000	5,900	0	110,000
	BN	130,000	5,900	0	140,000
	D	140,000	5,900	0	140,000
	C	140,000	5,800	0	150,000

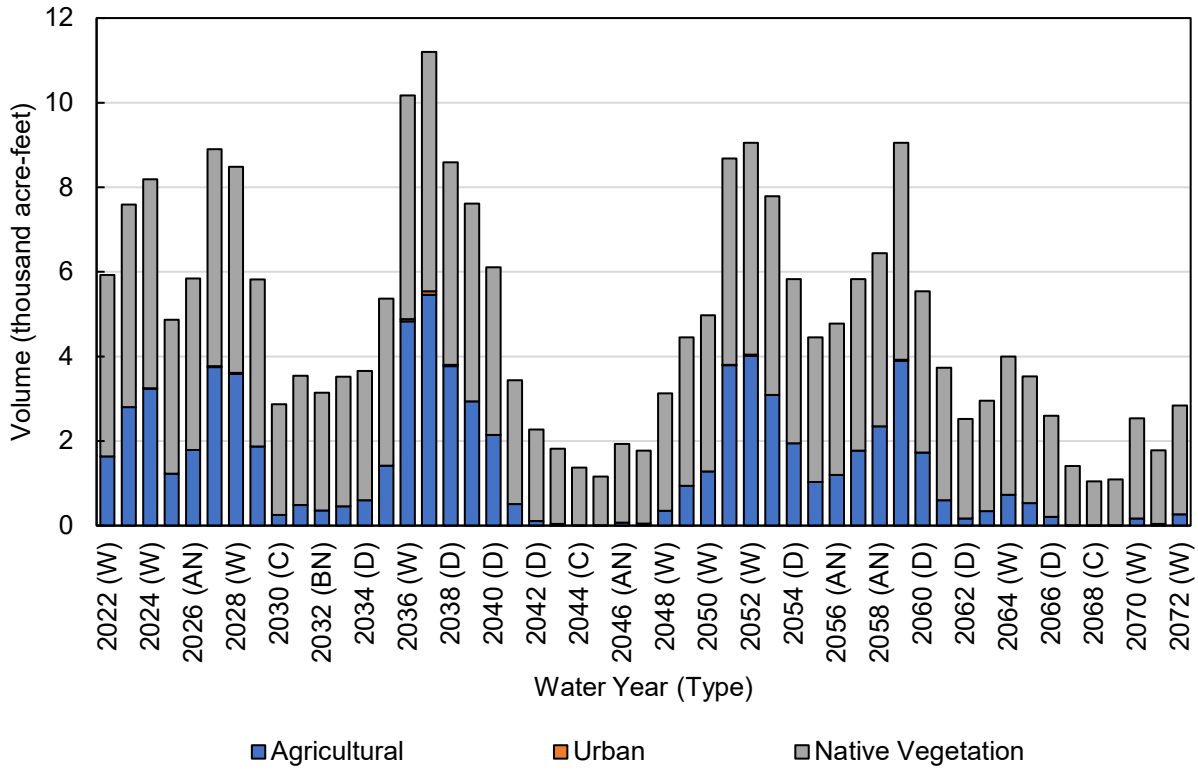

Figure 52. Red Bluff Subbasin Projected (Future Land Use) Groundwater Uptake,by Water Use Sector

Table 50. Red Bluff Subbasin Projected (Future Land Use) Groundwater Uptake, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (BN)	1,600	0	4,300	5,900
2023 (W)	2,800	0	4,800	7,600
2024 (W)	3,200	10	4,900	8,200
2025 (W)	1,200	0	3,600	4,900
2026 (BN)	1,800	0	4,100	5,800
2027 (AN)	3,800	20	5,100	8,900
2028 (W)	3,600	20	4,900	8,500
2029 (W)	1,900	0	4,000	5,800
2030 (C)	250	0	2,600	2,900
2031 (C)	490	0	3,100	3,500
2032 (AN)	360	0	2,800	3,100
2033 (BN)	460	0	3,100	3,500
2034 (AN)	600	0	3,100	3,700
2035 (D)	1,400	0	4,000	5,400
2036 (W)	4,800	50	5,300	10,000
2037 (W)	5,500	80	5,700	11,000
2038 (W)	3,800	30	4,800	8,600
2039 (D)	2,900	0	4,700	7,600
2040 (W)	2,100	0	4,000	6,100
2041 (D)	510	0	2,900	3,400
2042 (C)	110	0	2,200	2,300
2043 (D)	40	0	1,800	1,800
2044 (C)	10	0	1,400	1,400
2045 (C)	10	0	1,200	1,200
2046 (C)	70	0	1,900	1,900
2047 (AN)	50	0	1,700	1,800
2048 (C)	350	0	2,800	3,100
2049 (W)	940	0	3,500	4,500
2050 (W)	1,300	0	3,700	5,000
2051 (W)	3,800	10	4,900	8,700
2052 (W)	4,000	30	5,000	9,100
2053 (W)	3,100	0	4,700	7,800
2054 (AN)	2,000	0	3,900	5,800
2055 (D)	1,000	0	3,400	4,500

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2056 (D)		1,200	0	3,600	4,800
2057 (AN)		1,800	0	4,100	5,800
2058 (BN)		2,400	0	4,100	6,400
2059 (AN)		3,900	20	5,100	9,100
2060 (W)		1,700	0	3,800	5,500
2061 (D)		600	0	3,100	3,700
2062 (C)		170	0	2,400	2,500
2063 (D)		340	0	2,600	3,000
2064 (BN)		730	0	3,300	4,000
2065 (W)		530	0	3,000	3,500
2066 (BN)		210	0	2,400	2,600
2067 (D)		10	0	1,400	1,400
2068 (C)		10	0	1,000	1,100
2069 (C)		10	0	1,100	1,100
2070 (BN)		170	0	2,400	2,500
2071 (W)		40	0	1,700	1,800
2072 (W)		270	0	2,600	2,800
Average (2022-2072)		1,500	10	3,400	4,800
2022-2072	W	2,500	10	4,300	6,800
	AN	1,400	0	3,500	4,800
	BN	610	0	2,700	3,300
	D	1,300	0	3,300	4,600
	C	340	0	2,100	2,400

3.3.1.4 Groundwater Discharge to Surface Waterways

Groundwater discharge to surface water, as described herein, represents a gain, or increase of flow, in waterways that traverse or flow along the boundary of the Red Bluff Subbasin. Groundwater discharge in the Red Bluff Subbasin is calculated from the Tehama IHM as the net groundwater outflow to water reaches (i.e., groundwater discharge) in excess of groundwater inflows from waterway reaches (i.e., seepage). The total volume of estimated groundwater discharge to surface water is summarized in **Figure 53** and **Table 51**, averaging approximately 16 taf per year.

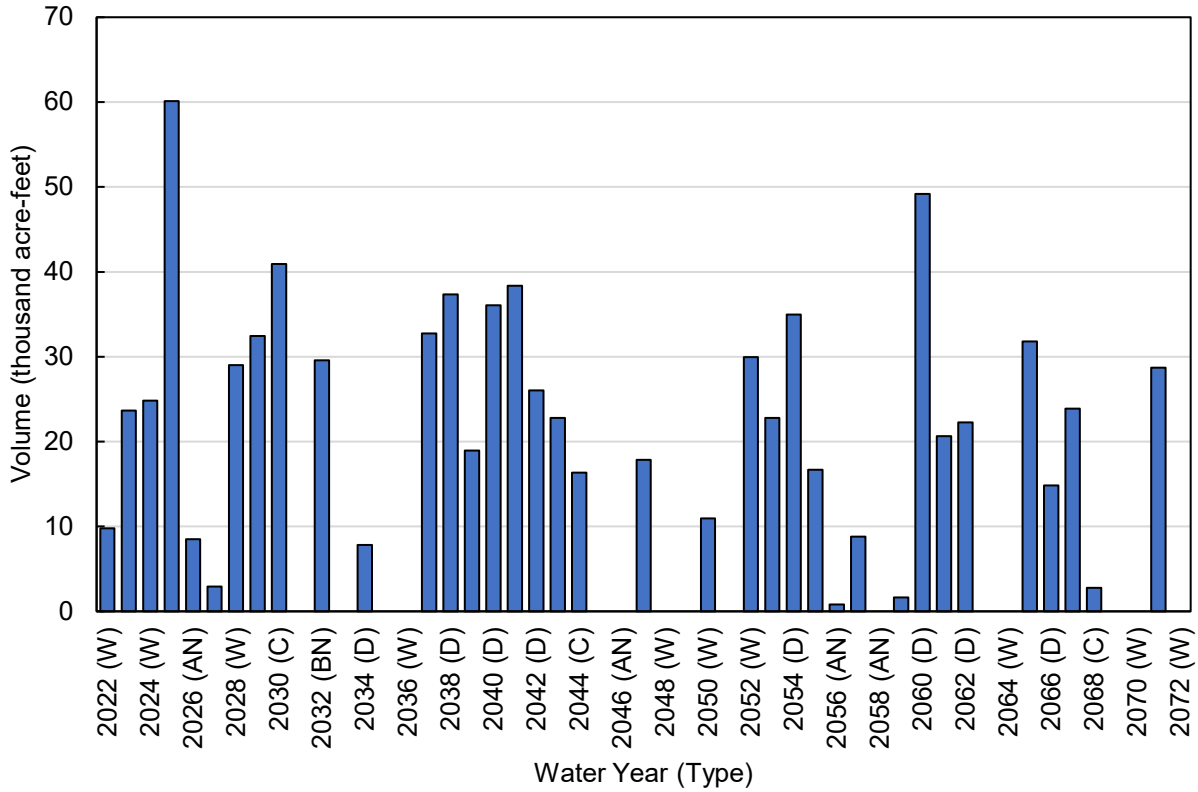

Figure 53. Red Bluff Subbasin Projected (Future Land Use) Groundwater Discharge to Surface Water

Table 51. Red Bluff Subbasin Projected (Future Land Use) Groundwater Discharge to Surface Water (acre-feet)

Water Year (Type)	Groundwater Discharge to Surface Water
2022 (BN)	9,800
2023 (W)	24,000
2024 (W)	25,000
2025 (W)	60,000
2026 (BN)	8,500
2027 (AN)	2,900
2028 (W)	29,000
2029 (W)	32,000
2030 (C)	41,000
2031 (C)	0
2032 (AN)	30,000
2033 (BN)	0
2034 (AN)	7,800
2035 (D)	0
2036 (W)	0
2037 (W)	33,000
2038 (W)	37,000
2039 (D)	19,000
2040 (W)	36,000
2041 (D)	38,000
2042 (C)	26,000
2043 (D)	23,000
2044 (C)	16,000
2045 (C)	0
2046 (C)	0
2047 (AN)	18,000
2048 (C)	0
2049 (W)	0
2050 (W)	11,000
2051 (W)	0
2052 (W)	30,000
2053 (W)	23,000
2054 (AN)	35,000
2055 (D)	17,000
2056 (D)	810
2057 (AN)	8,800

Water Year (Type)		Groundwater Discharge to Surface Water
2058 (BN)		0
2059 (AN)		1,700
2060 (W)		49,000
2061 (D)		21,000
2062 (C)		22,000
2063 (D)		0
2064 (BN)		0
2065 (W)		32,000
2066 (BN)		15,000
2067 (D)		24,000
2068 (C)		2,800
2069 (C)		0
2070 (BN)		0
2071 (W)		29,000
2072 (W)		0
Average (2022-2072)		16,000
2022-2072	W	10,000
	AN	4,600
	BN	23,000
	D	27,000
	C	22,000

3.3.2 Outflows

3.3.2.1 Evapotranspiration by Water Use Sector

Evapotranspiration (ET) by water use sector is reported in **Figure 54** through **Figure 57,** and **Table 52** through **Table 55**. First, total ET is reported, followed by ET from applied water (ET of water actively applied from surface water deliveries or groundwater pumping), ET of groundwater uptake (ET of shallow water extracted directly by vegetation), and ET from precipitation (ET of water supplied through rainfall).

Total ET varies between years, with a projected average of 470 taf per year. Agricultural ET tends to increase slightly in drier years due to increased climatic demand, while the ET of native vegetation typically decreases due to reduced water supply. ET of applied water occurs primarily from agricultural land, averaging about 99 taf in above-normal and wet years and about 120 taf in years classified as below normal, dry, or critical. Native vegetation and agricultural crops in the Red Bluff Subbasin also directly consume shallow groundwater to meet a portion of their consumptive use requirements. ET of groundwater uptake by native vegetation and agricultural crops and totals 3.4 and 1.5 taf per year, on average. Urban ET of applied water is consistently very low and negligible.

ET of precipitation generally follows the pattern of precipitation, with higher volumes occurring in wet years when more precipitation occurs. Across all water use sectors, ET of precipitation in the Red Bluff Subbasin averages about 380 taf in wet and above-normal years and 330 taf in dry and critical water years. Much of the total ET of precipitation results from the large acreage of native vegetation in the Red Bluff Subbasin, though significant volumes result from agricultural and urban areas as well.

Evaporation from rivers, streams, and canals in the Red Bluff Subbasin is reported in **Figure 58** and **Table 56**. The total volume is relatively small and constant between years, averaging slightly less than 1.0 taf per year. Evaporation from upgradient small watersheds is minimal, and is also not considered to substantially contribute to the subbasin SWS water budget.

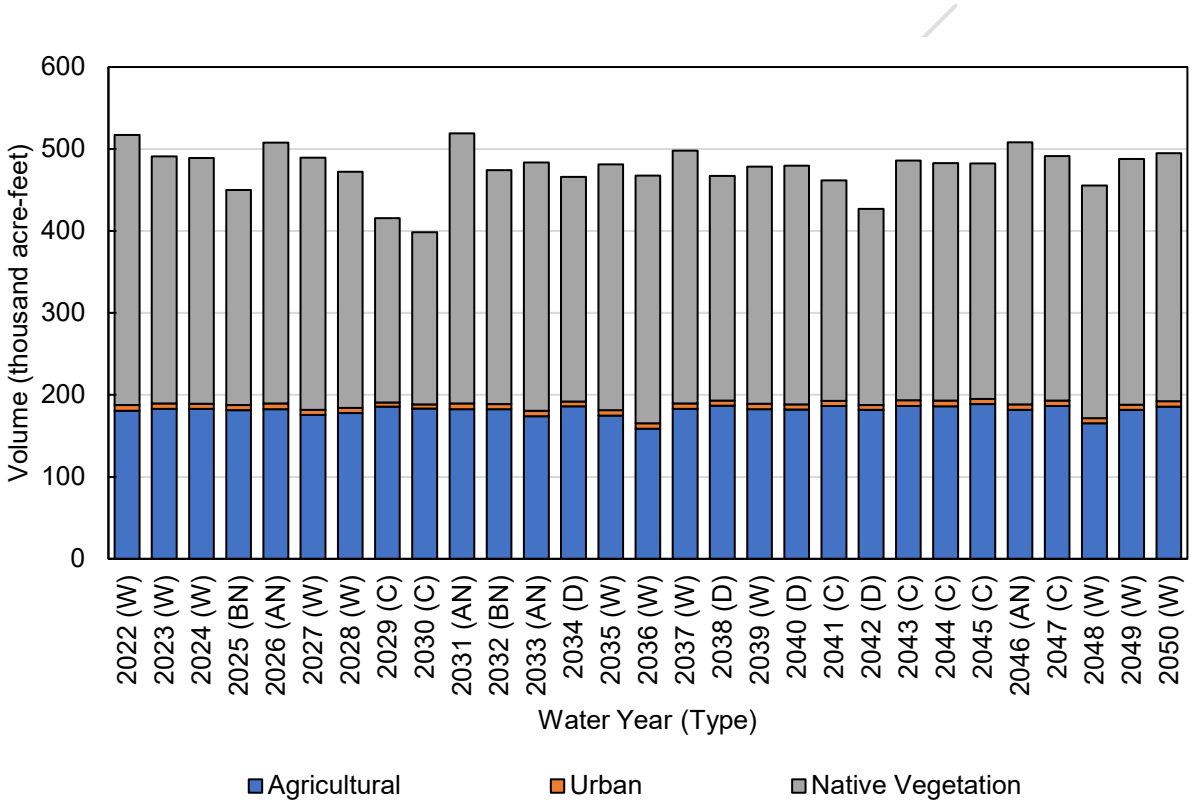

Figure 54. Red Bluff Subbasin Projected (Future Land Use) Total Evapotranspiration, (acre-feet)

Table 52. Red Bluff Subbasin Projected (Future Land Use) Total Evapotranspiration, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	180,000	7,100	330,000	520,000
2023 (W)	180,000	6,500	300,000	490,000
2024 (W)	180,000	6,500	300,000	490,000
2025 (BN)	180,000	6,100	260,000	450,000
2026 (AN)	180,000	7,000	320,000	510,000
2027 (W)	180,000	6,500	310,000	490,000
2028 (W)	180,000	6,200	290,000	470,000
2029 (C)	190,000	5,200	220,000	420,000
2030 (C)	180,000	5,300	210,000	400,000
2031 (AN)	180,000	7,100	330,000	520,000
2032 (BN)	180,000	6,500	290,000	470,000
2033 (AN)	170,000	6,600	300,000	480,000
2034 (D)	190,000	6,000	270,000	470,000
2035 (W)	170,000	6,500	300,000	480,000
2036 (W)	160,000	6,600	300,000	470,000
2037 (W)	180,000	6,500	310,000	500,000
2038 (D)	190,000	6,000	270,000	470,000
2039 (W)	180,000	6,400	290,000	480,000
2040 (D)	180,000	6,300	290,000	480,000
2041 (C)	190,000	6,400	270,000	460,000
2042 (D)	180,000	6,100	240,000	430,000
2043 (C)	190,000	6,900	290,000	490,000
2044 (C)	190,000	6,800	290,000	480,000
2045 (C)	190,000	6,500	290,000	480,000
2046 (AN)	180,000	7,000	320,000	510,000
2047 (C)	190,000	6,800	300,000	490,000
2048 (W)	170,000	6,200	280,000	460,000
2049 (W)	180,000	6,400	300,000	490,000
2050 (W)	190,000	6,600	300,000	490,000
2051 (W)	160,000	6,600	300,000	470,000
2052 (W)	180,000	6,200	300,000	480,000
2053 (AN)	180,000	6,600	310,000	490,000
2054 (D)	180,000	6,300	290,000	480,000
2055 (D)	190,000	6,000	270,000	460,000
2056 (AN)	170,000	6,400	290,000	470,000
2057 (BN)	180,000	5,600	260,000	450,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		170,000	7,200	330,000	510,000
2059 (W)		180,000	6,500	310,000	490,000
2060 (D)		180,000	6,100	240,000	430,000
2061 (C)		190,000	5,200	230,000	420,000
2062 (D)		180,000	6,300	270,000	460,000
2063 (BN)		170,000	6,300	290,000	460,000
2064 (W)		170,000	6,800	320,000	500,000
2065 (BN)		180,000	6,500	290,000	470,000
2066 (D)		190,000	5,400	240,000	430,000
2067 (C)		180,000	5,400	220,000	410,000
2068 (C)		190,000	5,700	260,000	450,000
2069 (BN)		180,000	6,600	300,000	490,000
2070 (W)		180,000	6,300	300,000	480,000
2071 (BN)		180,000	6,200	260,000	440,000
2072 (W)		180,000	6,900	320,000	500,000
Average (2022-2072)		180,000	6,300	290,000	470,000
2022 - 2072	W	180,000	6,500	300,000	490,000
	AN	180,000	6,800	310,000	500,000
	BN	180,000	6,300	280,000	460,000
	D	180,000	6,000	270,000	460,000
	C	190,000	6,000	260,000	450,000

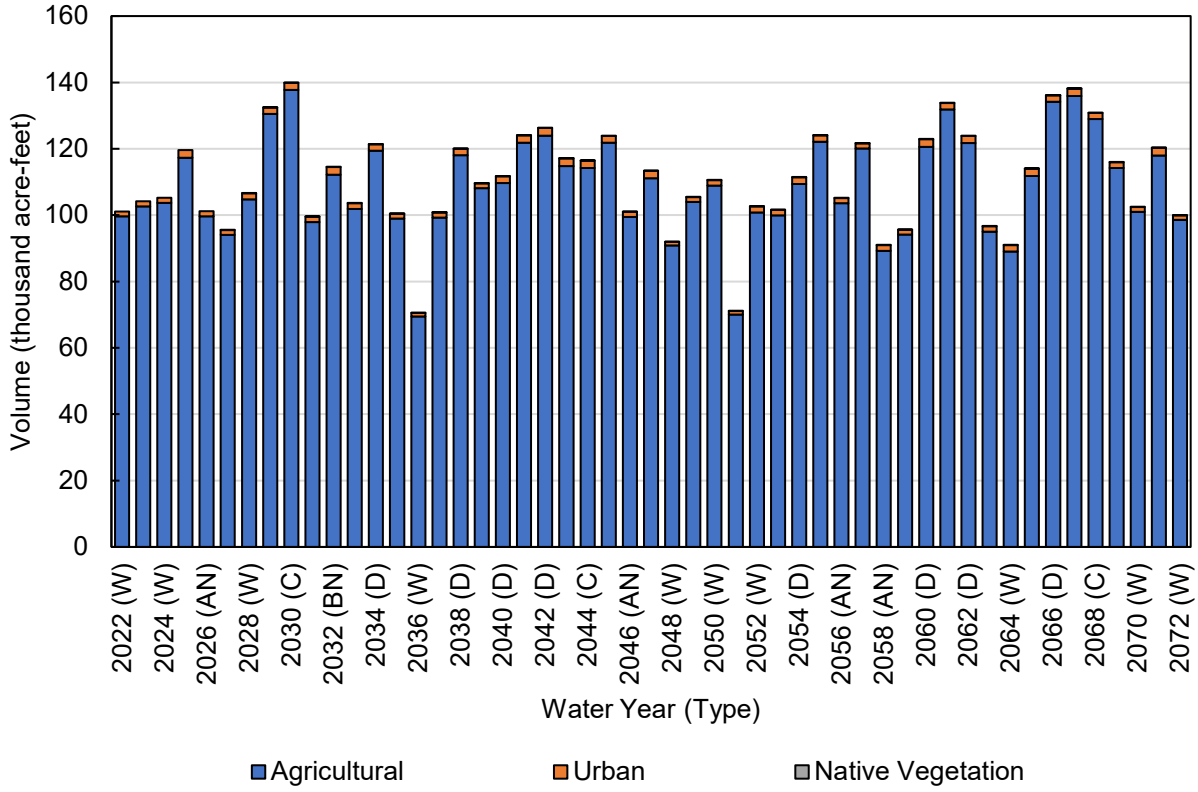

Figure 55. Red Bluff Subbasin Projected (Future Land Use) Evapotranspiration of Applied Water, by Water Use Sector

Table 53. Red Bluff Subbasin Projected (Future Land Use) Evapotranspiration of Applied Water, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	100,000	1,400	0	100,000
2023 (W)	100,000	1,500	0	100,000
2024 (W)	100,000	1,500	0	110,000
2025 (BN)	120,000	2,300	0	120,000
2026 (AN)	100,000	1,600	0	100,000
2027 (W)	94,000	1,500	0	95,000
2028 (W)	100,000	1,900	0	110,000
2029 (C)	130,000	2,000	0	130,000
2030 (C)	140,000	2,200	0	140,000
2031 (AN)	98,000	1,600	0	100,000
2032 (BN)	110,000	2,300	0	110,000
2033 (AN)	100,000	1,700	0	100,000
2034 (D)	120,000	1,900	0	120,000
2035 (W)	99,000	1,500	0	100,000
2036 (W)	69,000	1,100	0	71,000
2037 (W)	99,000	1,500	0	100,000
2038 (D)	120,000	1,900	0	120,000
2039 (W)	110,000	1,500	0	110,000
2040 (D)	110,000	2,000	0	110,000
2041 (C)	120,000	2,300	0	120,000
2042 (D)	120,000	2,300	0	130,000
2043 (C)	110,000	2,300	0	120,000
2044 (C)	110,000	2,200	0	120,000
2045 (C)	120,000	2,000	0	120,000
2046 (AN)	99,000	1,600	0	100,000
2047 (C)	110,000	2,300	0	110,000
2048 (W)	91,000	1,100	0	92,000
2049 (W)	100,000	1,500	0	110,000
2050 (W)	110,000	1,700	0	110,000
2051 (W)	70,000	1,100	0	71,000
2052 (W)	100,000	1,900	0	100,000
2053 (AN)	100,000	1,700	0	100,000
2054 (D)	110,000	2,000	0	110,000
2055 (D)	120,000	1,900	0	120,000
2056 (AN)	100,000	1,600	0	110,000
2057 (BN)	120,000	1,500	0	120,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		89,000	1,800	0	91,000
2059 (W)		94,000	1,500	0	96,000
2060 (D)		120,000	2,300	0	120,000
2061 (C)		130,000	2,000	0	130,000
2062 (D)		120,000	2,200	0	120,000
2063 (BN)		95,000	1,700	0	97,000
2064 (W)		89,000	1,900	0	91,000
2065 (BN)		110,000	2,300	0	110,000
2066 (D)		130,000	1,900	0	140,000
2067 (C)		140,000	2,200	0	140,000
2068 (C)		130,000	1,800	0	130,000
2069 (BN)		110,000	1,700	0	120,000
2070 (W)		100,000	1,400	0	100,000
2071 (BN)		120,000	2,300	0	120,000
2072 (W)		99,000	1,400	0	100,000
Average (2022-2072)		110,000	1,800	0	110,000
2022 - 2072	W	97,000	1,500	0	98,000
	AN	99,000	1,600	0	100,000
	BN	110,000	2,000	0	110,000
	D	120,000	2,100	0	120,000
	C	120,000	2,100	0	130,000

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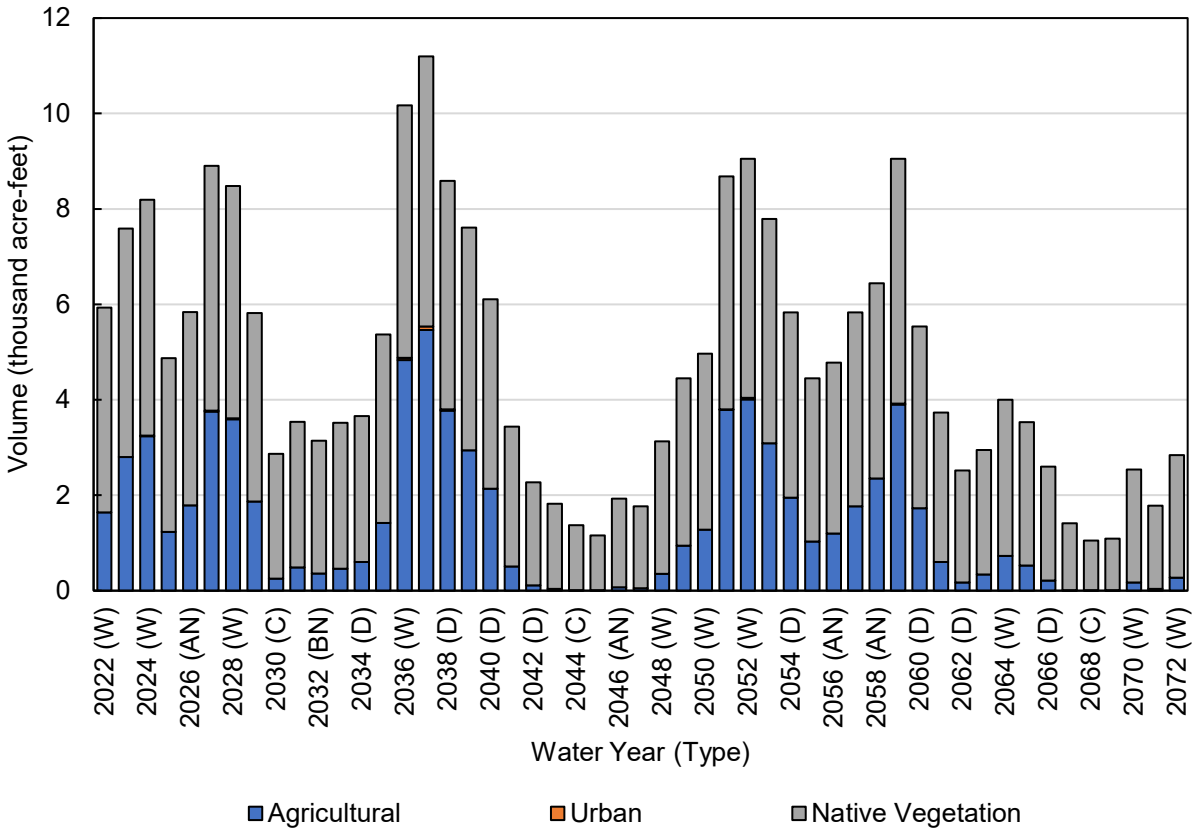

Figure 56. Red Bluff Subbasin Projected (Future Land Use) Evapotranspiration of Groundwater Uptake, by Water Use Sector

Table 54. Red Bluff Subbasin Projected (Future Land Use) Evapotranspiration of Groundwater Uptake, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	1,600	0	4,300	5,900
2023 (W)	2,800	0	4,800	7,600
2024 (W)	3,200	10	4,900	8,200
2025 (BN)	1,200	0	3,600	4,900
2026 (AN)	1,800	0	4,100	5,800
2027 (W)	3,800	20	5,100	8,900
2028 (W)	3,600	20	4,900	8,500
2029 (C)	1,900	0	4,000	5,800
2030 (C)	250	0	2,600	2,900
2031 (AN)	490	0	3,100	3,500
2032 (BN)	360	0	2,800	3,100
2033 (AN)	460	0	3,100	3,500
2034 (D)	600	0	3,100	3,700
2035 (W)	1,400	0	4,000	5,400
2036 (W)	4,800	50	5,300	10,000
2037 (W)	5,500	80	5,700	11,000
2038 (D)	3,800	30	4,800	8,600
2039 (W)	2,900	0	4,700	7,600
2040 (D)	2,100	0	4,000	6,100
2041 (C)	510	0	2,900	3,400
2042 (D)	110	0	2,200	2,300
2043 (C)	40	0	1,800	1,800
2044 (C)	10	0	1,400	1,400
2045 (C)	10	0	1,200	1,200
2046 (AN)	70	0	1,900	1,900
2047 (C)	50	0	1,700	1,800
2048 (W)	350	0	2,800	3,100
2049 (W)	940	0	3,500	4,500
2050 (W)	1,300	0	3,700	5,000
2051 (W)	3,800	10	4,900	8,700
2052 (W)	4,000	30	5,000	9,100
2053 (AN)	3,100	0	4,700	7,800
2054 (D)	2,000	0	3,900	5,800
2055 (D)	1,000	0	3,400	4,500
2056 (AN)	1,200	0	3,600	4,800
2057 (BN)	1,800	0	4,100	5,800

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		2,400	0	4,100	6,400
2059 (W)		3,900	20	5,100	9,100
2060 (D)		1,700	0	3,800	5,500
2061 (C)		600	0	3,100	3,700
2062 (D)		170	0	2,400	2,500
2063 (BN)		340	0	2,600	3,000
2064 (W)		730	0	3,300	4,000
2065 (BN)		530	0	3,000	3,500
2066 (D)		210	0	2,400	2,600
2067 (C)		10	0	1,400	1,400
2068 (C)		10	0	1,000	1,100
2069 (BN)		10	0	1,100	1,100
2070 (W)		170	0	2,400	2,500
2071 (BN)		40	0	1,700	1,800
2072 (W)		270	0	2,600	2,800
Average (2022-2072)		1,500	10	3,400	4,800
2022 - 2072	W	2,500	10	4,300	6,800
	AN	1,400	0	3,500	4,800
	BN	610	0	2,700	3,300
	D	1,300	0	3,300	4,600
	C	340	0	2,100	2,400

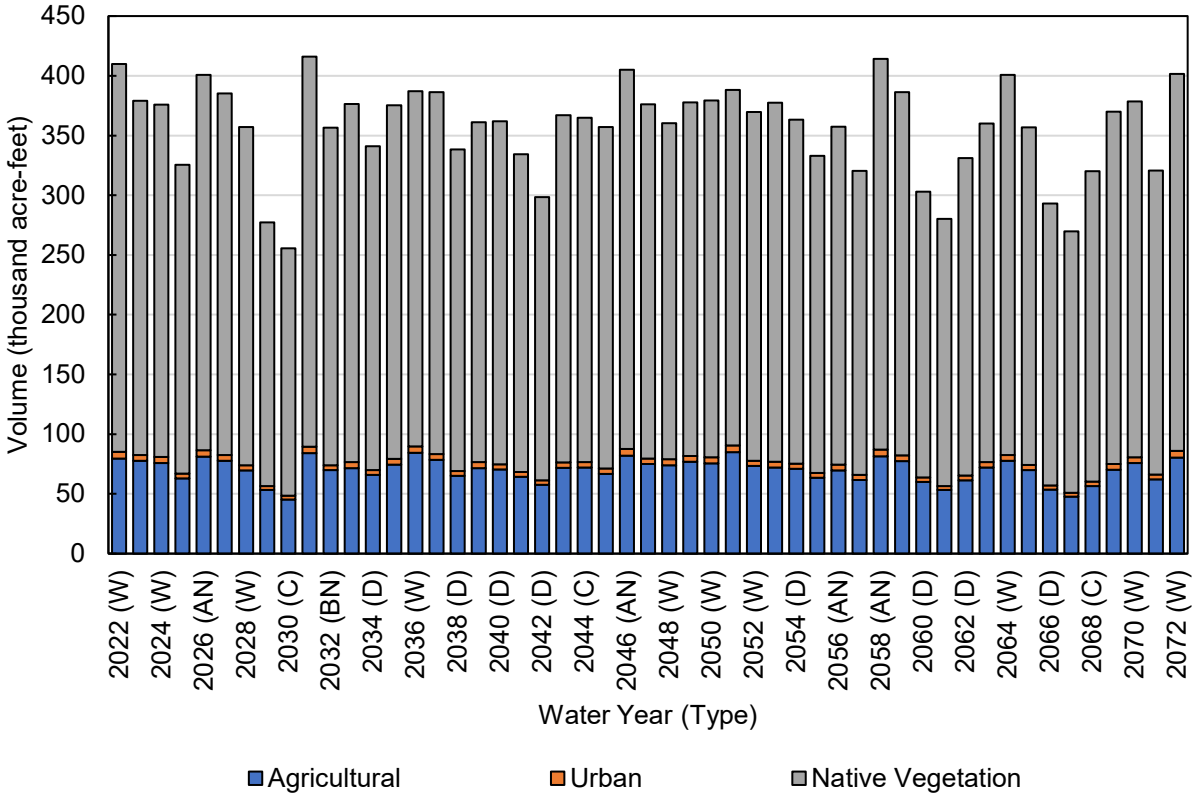

Figure 57. Red Bluff Subbasin Projected (Future Land Use) Evapotranspiration of Precipitation, by Water Use Sector

Table 55. Red Bluff Subbasin Projected (Future Land Use) Evapotranspiration of Precipitation, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	79,000	5,700	320,000	410,000
2023 (W)	78,000	5,000	300,000	380,000
2024 (W)	76,000	5,000	290,000	380,000
2025 (BN)	63,000	3,800	260,000	330,000
2026 (AN)	81,000	5,400	310,000	400,000
2027 (W)	78,000	5,000	300,000	390,000
2028 (W)	70,000	4,300	280,000	360,000
2029 (C)	53,000	3,200	220,000	280,000
2030 (C)	45,000	3,200	210,000	260,000
2031 (AN)	84,000	5,500	330,000	420,000
2032 (BN)	70,000	4,200	280,000	360,000
2033 (AN)	72,000	4,900	300,000	380,000
2034 (D)	66,000	4,000	270,000	340,000
2035 (W)	74,000	5,000	300,000	380,000
2036 (W)	84,000	5,500	300,000	390,000
2037 (W)	78,000	4,900	300,000	390,000
2038 (D)	65,000	4,000	270,000	340,000
2039 (W)	72,000	4,900	280,000	360,000
2040 (D)	70,000	4,300	290,000	360,000
2041 (C)	64,000	4,100	270,000	330,000
2042 (D)	58,000	3,800	240,000	300,000
2043 (C)	72,000	4,600	290,000	370,000
2044 (C)	72,000	4,600	290,000	360,000
2045 (C)	67,000	4,400	290,000	360,000
2046 (AN)	82,000	5,400	320,000	410,000
2047 (C)	75,000	4,600	300,000	380,000
2048 (W)	74,000	5,100	280,000	360,000
2049 (W)	77,000	4,900	300,000	380,000
2050 (W)	76,000	4,900	300,000	380,000
2051 (W)	85,000	5,500	300,000	390,000
2052 (W)	73,000	4,300	290,000	370,000
2053 (AN)	72,000	4,900	300,000	380,000
2054 (D)	71,000	4,300	290,000	360,000
2055 (D)	64,000	4,000	270,000	330,000
2056 (AN)	70,000	4,800	280,000	360,000
2057 (BN)	62,000	4,100	250,000	320,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		82,000	5,400	330,000	410,000
2059 (W)		77,000	5,000	300,000	390,000
2060 (D)		60,000	3,800	240,000	300,000
2061 (C)		53,000	3,300	220,000	280,000
2062 (D)		61,000	4,100	270,000	330,000
2063 (BN)		72,000	4,700	280,000	360,000
2064 (W)		78,000	4,800	320,000	400,000
2065 (BN)		70,000	4,200	280,000	360,000
2066 (D)		54,000	3,500	240,000	290,000
2067 (C)		48,000	3,200	220,000	270,000
2068 (C)		56,000	3,900	260,000	320,000
2069 (BN)		70,000	4,900	300,000	370,000
2070 (W)		76,000	4,900	300,000	380,000
2071 (BN)		62,000	3,800	250,000	320,000
2072 (W)		80,000	5,500	320,000	400,000
Average (2022-2072)		70,000	4,500	280,000	360,000
2022 - 2072	W	77,000	5,000	300,000	380,000
	AN	77,000	5,200	310,000	390,000
	BN	67,000	4,200	270,000	340,000
	D	63,000	4,000	260,000	330,000
	C	61,000	3,900	260,000	320,000

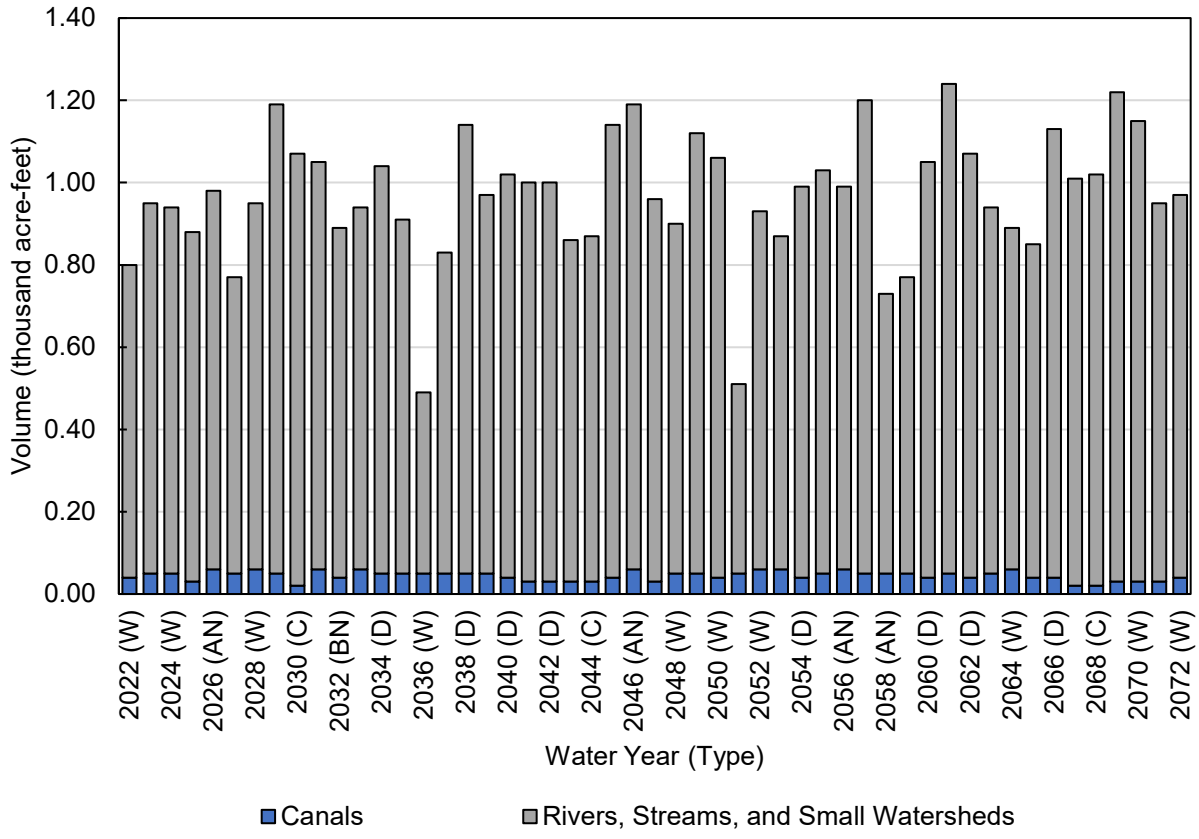

Figure 58. Red Bluff Subbasin Projected (Future Land Use) Evaporation of Surface Water Sources

Table 56. Red Bluff Subbasin Projected (Future Land Use) Evaporation of Surface Water Sources, by Water Use Sector (acre-feet)

Water Year (Type)	Canals	Rivers, Streams, and Small Watersheds[1]	Total
2022 (W)	40	760	800
2023 (W)	50	900	950
2024 (W)	50	890	940
2025 (BN)	30	850	880
2026 (AN)	60	920	980
2027 (W)	50	720	770
2028 (W)	60	890	950
2029 (C)	50	1,100	1,200
2030 (C)	20	1,100	1,100
2031 (AN)	60	990	1,100
2032 (BN)	40	850	890
2033 (AN)	60	880	940
2034 (D)	50	990	1,000
2035 (W)	50	860	910
2036 (W)	50	440	490
2037 (W)	50	780	830
2038 (D)	50	1,100	1,100
2039 (W)	50	920	970
2040 (D)	40	980	1,000
2041 (C)	30	970	1,000
2042 (D)	30	970	1,000
2043 (C)	30	830	860
2044 (C)	30	840	870
2045 (C)	40	1,100	1,100
2046 (AN)	60	1,100	1,200
2047 (C)	30	930	960
2048 (W)	50	850	900
2049 (W)	50	1,100	1,100
2050 (W)	40	1,000	1,100
2051 (W)	50	460	510
2052 (W)	60	870	930
2053 (AN)	60	810	870
2054 (D)	40	950	990
2055 (D)	50	980	1,000
2056 (AN)	60	930	990
2057 (BN)	50	1,200	1,200
2058 (AN)	50	680	730

Water Year (Type)		Canals	Rivers, Streams, and Small Watersheds[1]	Total
2059 (W)		50	720	770
2060 (D)		40	1,000	1,100
2061 (C)		50	1,200	1,200
2062 (D)		40	1,000	1,100
2063 (BN)		50	890	940
2064 (W)		60	830	890
2065 (BN)		40	810	850
2066 (D)		40	1,100	1,100
2067 (C)		20	990	1,000
2068 (C)		20	1,000	1,000
2069 (BN)		30	1,200	1,200
2070 (W)		30	1,100	1,200
2071 (BN)		30	920	950
2072 (W)		40	930	970
Average (2022-2072)		40	920	970
2022 - 2072	W	50	840	880
	AN	60	910	960
	BN	40	950	990
	D	40	1,000	1,100
	C	30	1,000	1,000

[1] Includes ET of riparian vegetation along rivers and streams.

3.3.2.2 Surface Water Outflow by Water Source Type

Surface water outflows from the Red Bluff Subbasin are summarized in **Figure 59** and **Table 57** by water source type. In the Red Bluff Subbasin, local supply outflows primarily include outflows of runoff, tailwater, and net drainage from land surfaces, in addition to runoff from small watersheds and stream outflows to the Sacramento River. Local supply outflows average approximately 330 taf per year, and range from 150 taf in critically dry years up to 510 taf in wet years. Other surface water outflows that leave the subbasin include outflow of groundwater discharge to the Sacramento River, Red Bank Creek, and Elder Creek. This water travels along each respective waterway as part of the flow in the river or creek.

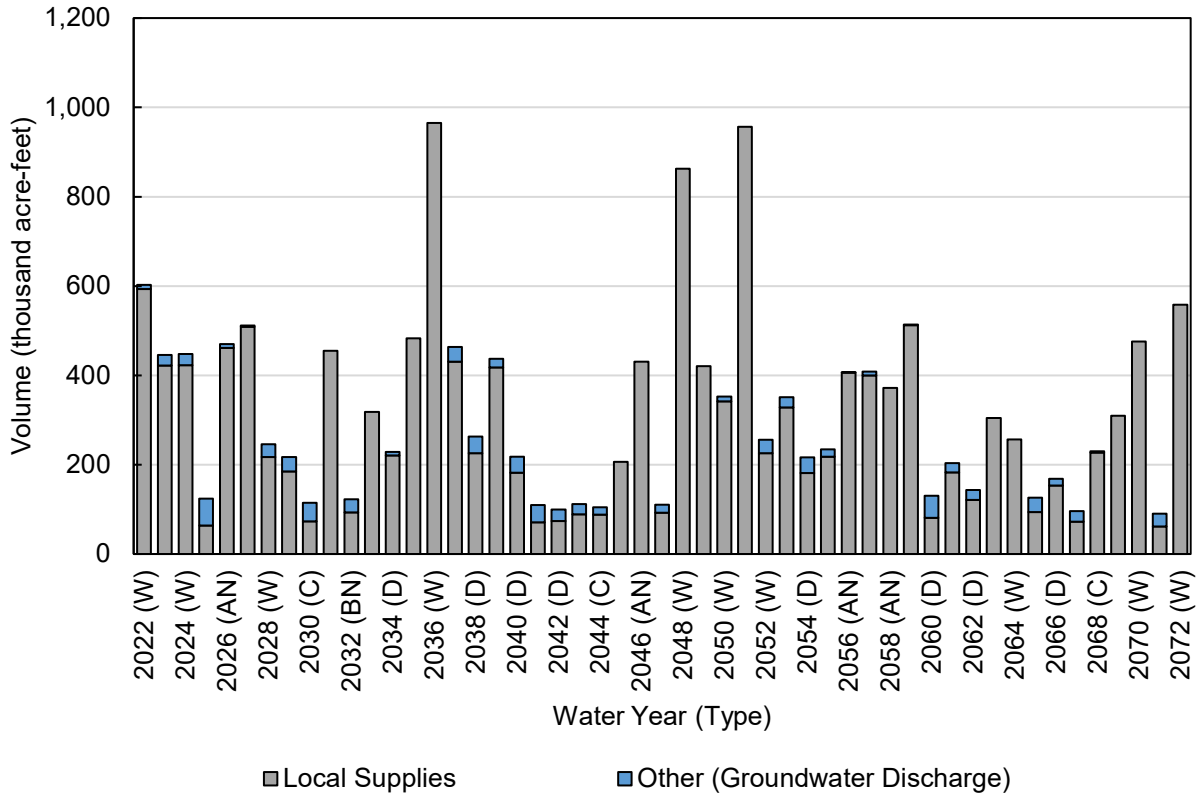

Figure 59. Red Bluff Subbasin Projected (Future Land Use) Surface Water Outflows, by Water Source Type

Table 57. Red Bluff Subbasin Projected (Future Land Use) Surface Water Outflows, by Water Source Type (acre-feet)

Water Year (Type)	CVP Supplies	Local Supplies	Other (Groundwater Discharge)	Total
2022 (W)	0	590,000	9,800	600,000
2023 (W)	0	420,000	24,000	450,000
2024 (W)	0	420,000	25,000	450,000
2025 (BN)	0	64,000	60,000	120,000
2026 (AN)	0	460,000	8,500	470,000
2027 (W)	0	510,000	2,900	510,000
2028 (W)	0	220,000	29,000	250,000
2029 (C)	0	180,000	32,000	220,000
2030 (C)	0	73,000	41,000	110,000
2031 (AN)	0	460,000	0	460,000
2032 (BN)	0	93,000	30,000	120,000
2033 (AN)	0	320,000	0	320,000
2034 (D)	0	220,000	7,800	230,000
2035 (W)	0	480,000	0	480,000
2036 (W)	0	970,000	0	970,000
2037 (W)	0	430,000	33,000	460,000
2038 (D)	0	230,000	37,000	260,000
2039 (W)	0	420,000	19,000	440,000
2040 (D)	0	180,000	36,000	220,000
2041 (C)	0	71,000	38,000	110,000
2042 (D)	0	74,000	26,000	100,000
2043 (C)	0	89,000	23,000	110,000
2044 (C)	0	88,000	16,000	100,000
2045 (C)	0	210,000	0	210,000
2046 (AN)	0	430,000	0	430,000
2047 (C)	0	92,000	18,000	110,000
2048 (W)	0	860,000	0	860,000
2049 (W)	0	420,000	0	420,000
2050 (W)	0	340,000	11,000	350,000
2051 (W)	0	960,000	0	960,000
2052 (W)	0	230,000	30,000	260,000
2053 (AN)	0	330,000	23,000	350,000
2054 (D)	0	180,000	35,000	220,000
2055 (D)	0	220,000	17,000	230,000
2056 (AN)	0	410,000	810	410,000

Water Year (Type)		CVP Supplies	Local Supplies	Other (Groundwater Discharge)	Total
2057 (BN)		0	400,000	8,800	410,000
2058 (AN)		0	370,000	0	370,000
2059 (W)		0	510,000	1,700	510,000
2060 (D)		0	81,000	49,000	130,000
2061 (C)		0	180,000	21,000	200,000
2062 (D)		0	120,000	22,000	140,000
2063 (BN)		0	300,000	0	300,000
2064 (W)		0	260,000	0	260,000
2065 (BN)		0	94,000	32,000	130,000
2066 (D)		0	150,000	15,000	170,000
2067 (C)		0	72,000	24,000	96,000
2068 (C)		0	230,000	2,800	230,000
2069 (BN)		0	310,000	0	310,000
2070 (W)		0	480,000	0	480,000
2071 (BN)		0	62,000	29,000	90,000
2072 (W)		0	560,000	0	560,000
Average (2022-2072)		0	310,000	16,000	330,000
2022 - 2072	W	0	500,000	10,000	510,000
	AN	0	400,000	4,600	400,000
	BN	0	190,000	23,000	210,000
	D	0	160,000	27,000	190,000
	C	0	130,000	22,000	150,000

3.3.2.3 Deep Percolation of Applied Water

Estimated deep percolation of applied water (equal to infiltration of applied water in 23 CCR § 354.18(b)(2)) is summarized in **Figure 60** and **Table 58** by water use sector. Deep percolation of applied water is about 17 taf on average, and dominated by agricultural irrigation and varies between years, following the pattern of surface water diversions and deliveries to irrigated lands.

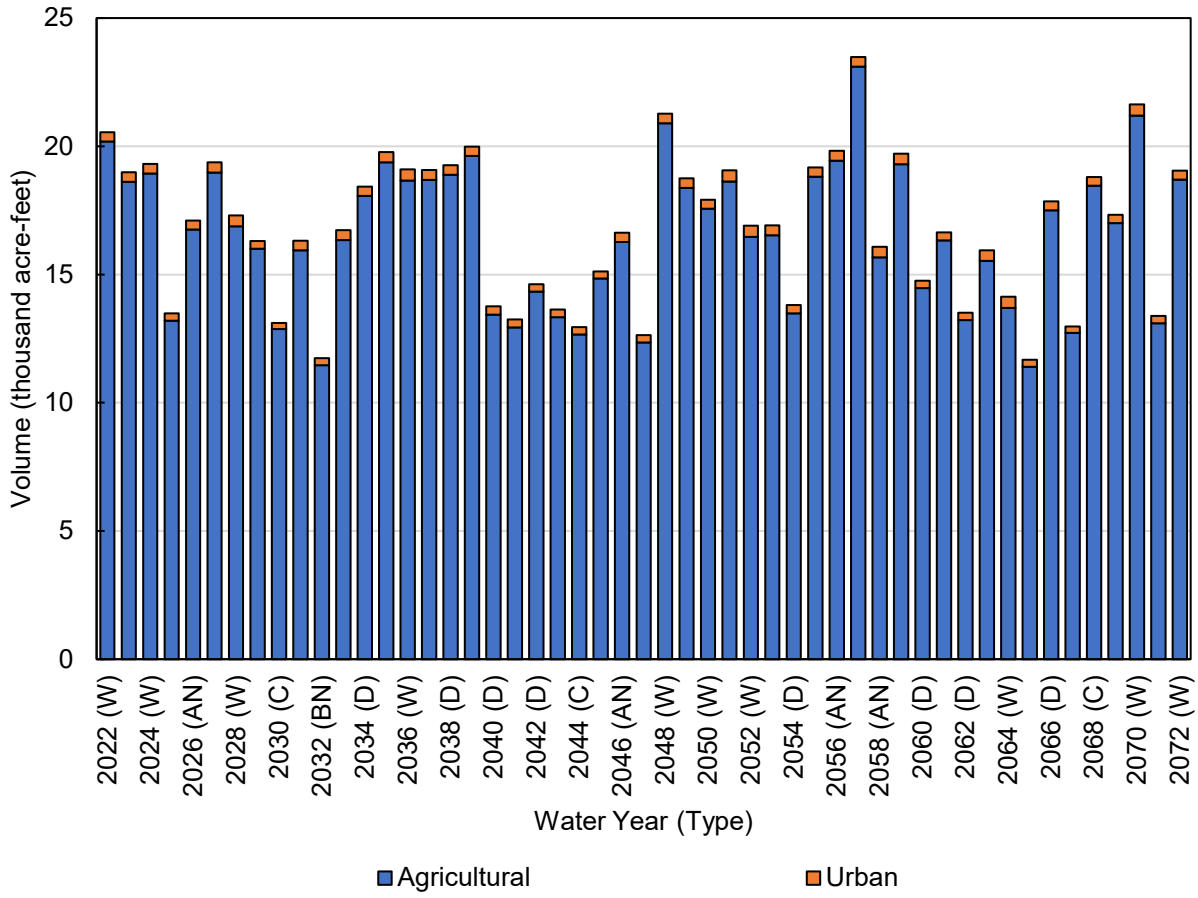

Figure 60. Red Bluff Subbasin Projected (Future Land Use) Deep Percolation of Applied Water, by Water Use Sector

Table 58. Red Bluff Subbasin Projected (Future Land Use) Deep Percolation of Applied Water, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	20,000	360	0	21,000
2023 (W)	19,000	380	0	19,000
2024 (W)	19,000	370	0	19,000
2025 (BN)	13,000	290	0	13,000
2026 (AN)	17,000	360	0	17,000
2027 (W)	19,000	400	0	19,000
2028 (W)	17,000	430	0	17,000
2029 (C)	16,000	300	0	16,000
2030 (C)	13,000	240	0	13,000
2031 (AN)	16,000	370	0	16,000
2032 (BN)	11,000	280	0	12,000
2033 (AN)	16,000	390	0	17,000
2034 (D)	18,000	360	0	18,000
2035 (W)	19,000	400	0	20,000
2036 (W)	19,000	430	0	19,000
2037 (W)	19,000	390	0	19,000
2038 (D)	19,000	370	0	19,000
2039 (W)	20,000	370	0	20,000
2040 (D)	13,000	330	0	14,000
2041 (C)	13,000	310	0	13,000
2042 (D)	14,000	290	0	15,000
2043 (C)	13,000	300	0	14,000
2044 (C)	13,000	290	0	13,000
2045 (C)	15,000	270	0	15,000
2046 (AN)	16,000	360	0	17,000
2047 (C)	12,000	290	0	13,000
2048 (W)	21,000	370	0	21,000
2049 (W)	18,000	370	0	19,000
2050 (W)	18,000	360	0	18,000
2051 (W)	19,000	430	0	19,000
2052 (W)	16,000	430	0	17,000
2053 (AN)	17,000	390	0	17,000
2054 (D)	13,000	330	0	14,000
2055 (D)	19,000	360	0	19,000
2056 (AN)	19,000	390	0	20,000
2057 (BN)	23,000	370	0	23,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		16,000	410	0	16,000
2059 (W)		19,000	410	0	20,000
2060 (D)		14,000	290	0	15,000
2061 (C)		16,000	310	0	17,000
2062 (D)		13,000	290	0	14,000
2063 (BN)		16,000	420	0	16,000
2064 (W)		14,000	430	0	14,000
2065 (BN)		11,000	280	0	12,000
2066 (D)		18,000	350	0	18,000
2067 (C)		13,000	250	0	13,000
2068 (C)		18,000	330	0	19,000
2069 (BN)		17,000	330	0	17,000
2070 (W)		21,000	440	0	22,000
2071 (BN)		13,000	290	0	13,000
2072 (W)		19,000	350	0	19,000
Average (2022-2072)		17,000	350	0	17,000
2022 - 2072	W	19,000	400	0	19,000
	AN	17,000	380	0	17,000
	BN	15,000	320	0	15,000
	D	16,000	330	0	16,000
	C	14,000	290	0	15,000

3.3.2.4 Deep Percolation of Precipitation

Estimated deep percolation of precipitation (equal to infiltration of precipitation in 23 CCR § 354.18(b)(2)) is provided in and **Figure 61** and **Table 59** by water use sector. Deep percolation of precipitation to the GWS is highly variable from year to year due to variation in the timing and amount of precipitation, ranging from about 23 taf per year during critical dry years to about 78 taf per year during wet years on average.

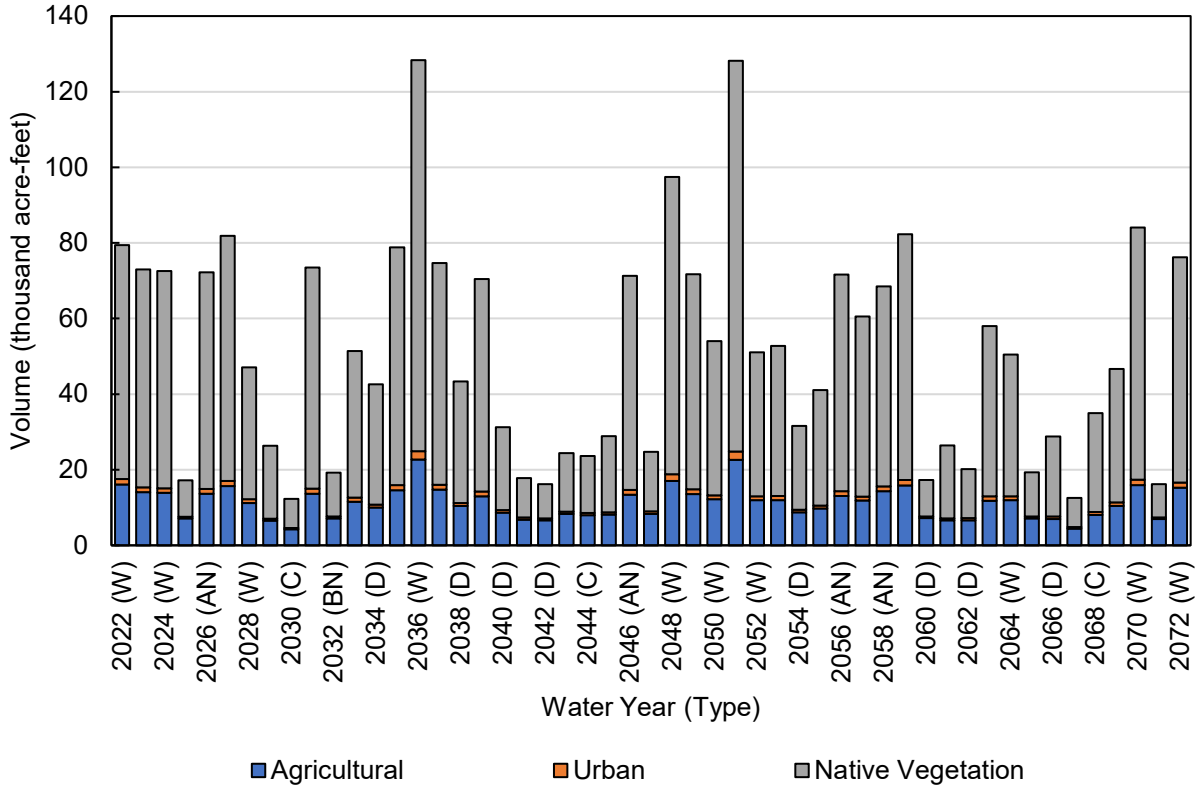

Figure 61. Red Bluff Subbasin Projected (Future Land Use) Deep Percolation of Precipitation, by Water Use Sector

Table 59. Red Bluff Subbasin Projected (Future Land Use) Deep Percolation of Precipitation, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	16,000	1,400	62,000	79,000
2023 (W)	14,000	1,300	58,000	73,000
2024 (W)	14,000	1,200	57,000	73,000
2025 (BN)	7,100	470	9,600	17,000
2026 (AN)	14,000	1,300	57,000	72,000
2027 (W)	16,000	1,400	65,000	82,000
2028 (W)	11,000	960	35,000	47,000
2029 (C)	6,600	500	19,000	26,000
2030 (C)	4,200	360	7,700	12,000
2031 (AN)	14,000	1,300	59,000	74,000
2032 (BN)	7,100	510	12,000	19,000
2033 (AN)	11,000	1,100	39,000	51,000
2034 (D)	10,000	760	32,000	43,000
2035 (W)	15,000	1,400	63,000	79,000
2036 (W)	23,000	2,300	100,000	130,000
2037 (W)	15,000	1,300	59,000	75,000
2038 (D)	10,000	760	32,000	43,000
2039 (W)	13,000	1,200	56,000	70,000
2040 (D)	8,600	710	22,000	31,000
2041 (C)	6,800	550	10,000	18,000
2042 (D)	6,700	470	9,100	16,000
2043 (C)	8,300	610	15,000	24,000
2044 (C)	8,000	590	15,000	24,000
2045 (C)	8,100	580	20,000	29,000
2046 (AN)	13,000	1,300	57,000	71,000
2047 (C)	8,400	600	16,000	25,000
2048 (W)	17,000	1,700	79,000	97,000
2049 (W)	14,000	1,200	57,000	72,000
2050 (W)	12,000	1,000	41,000	54,000
2051 (W)	23,000	2,300	100,000	130,000
2052 (W)	12,000	970	38,000	51,000
2053 (AN)	12,000	1,100	40,000	53,000
2054 (D)	8,700	710	22,000	32,000
2055 (D)	9,800	760	31,000	41,000
2056 (AN)	13,000	1,200	57,000	72,000
2057 (BN)	12,000	1,000	48,000	61,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		14,000	1,300	53,000	68,000
2059 (W)		16,000	1,400	65,000	82,000
2060 (D)		7,200	470	9,600	17,000
2061 (C)		6,600	510	19,000	26,000
2062 (D)		6,700	560	13,000	20,000
2063 (BN)		12,000	1,200	45,000	58,000
2064 (W)		12,000	1,100	37,000	50,000
2065 (BN)		7,100	510	12,000	19,000
2066 (D)		7,000	630	21,000	29,000
2067 (C)		4,500	370	7,700	13,000
2068 (C)		8,100	710	26,000	35,000
2069 (BN)		10,000	930	35,000	47,000
2070 (W)		16,000	1,500	67,000	84,000
2071 (BN)		6,900	470	8,800	16,000
2072 (W)		15,000	1,400	60,000	76,000
Average (2022-2072)		11,000	980	39,000	51,000
2022 - 2072	W	15,000	1,400	61,000	78,000
	AN	13,000	1,200	52,000	66,000
	BN	8,900	730	24,000	34,000
	D	8,300	650	21,000	30,000
	C	7,000	540	16,000	23,000

3.3.2.5 Infiltration of Surface Water

Estimated infiltration of surface water (seepage) by water source is provided in **Figure 62** and **Table 60.** Seepage in the Red Bluff Subbasin comes from the Tehama-Colusa Canal and Corning Canal that traverse the subbasin, as well as conveyance of supply delivered to water districts. The total seepage from all canals and diversions is less than 1 taf per year, on average. Runoff from upgradient small watersheds also contributes seepage to the Red Bluff Subbasin. The total seepage from rivers, streams and small water sheds average about 6.1 taf per year.

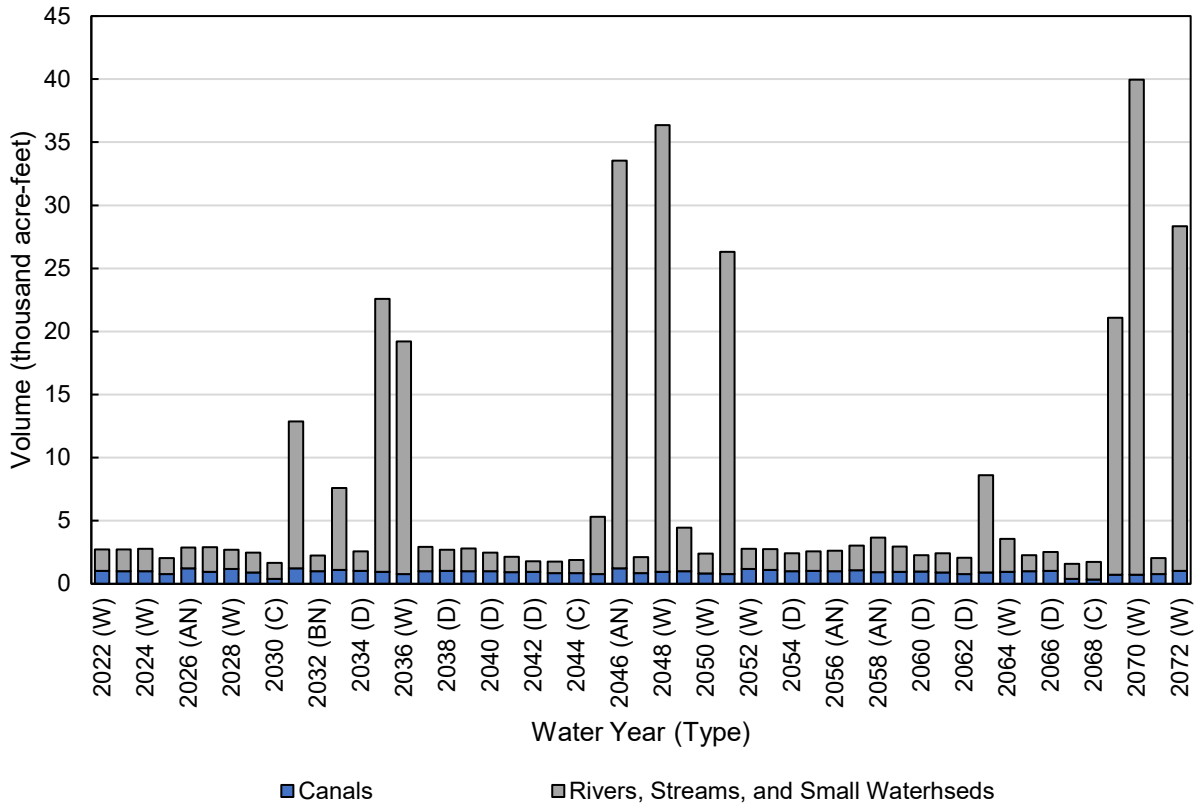

Figure 62. Red Bluff Subbasin Projected (Future Land Use) Infiltration of Surface Water, by Water Use Sector

Table 60. Red Bluff Subbasin Projected (Future Land Use) Infiltration of Surface Water, by Water Use Sector (acre-feet)

Water Year (Type)	Canals	Rivers, Streams, and Small Watersheds	Total
2022 (W)	1,000	1,700	2,700
2023 (W)	990	1,700	2,700
2024 (W)	990	1,800	2,800
2025 (BN)	780	1,300	2,000
2026 (AN)	1,200	1,600	2,900
2027 (W)	950	1,900	2,900
2028 (W)	1,200	1,500	2,700
2029 (C)	910	1,600	2,500
2030 (C)	400	1,300	1,700
2031 (AN)	1,200	12,000	13,000
2032 (BN)	1,000	1,200	2,300
2033 (AN)	1,100	6,500	7,600
2034 (D)	1,000	1,600	2,600
2035 (W)	950	22,000	23,000
2036 (W)	770	18,000	19,000
2037 (W)	990	2,000	2,900
2038 (D)	1,000	1,700	2,700
2039 (W)	990	1,800	2,800
2040 (D)	1,000	1,500	2,500
2041 (C)	930	1,200	2,100
2042 (D)	960	830	1,800
2043 (C)	840	920	1,800
2044 (C)	840	1,100	1,900
2045 (C)	760	4,500	5,300
2046 (AN)	1,200	32,000	34,000
2047 (C)	850	1,300	2,100
2048 (W)	950	35,000	36,000
2049 (W)	990	3,500	4,400
2050 (W)	830	1,600	2,400
2051 (W)	770	26,000	26,000
2052 (W)	1,200	1,600	2,800
2053 (AN)	1,100	1,700	2,800
2054 (D)	1,000	1,400	2,400
2055 (D)	1,000	1,600	2,600
2056 (AN)	990	1,600	2,600
2057 (BN)	1,100	1,900	3,000

Water Year (Type)		Canals	Rivers, Streams, and Small Watersheds	Total
2058 (AN)		930	2,700	3,700
2059 (W)		950	2,000	3,000
2060 (D)		970	1,300	2,300
2061 (C)		910	1,500	2,400
2062 (D)		770	1,300	2,100
2063 (BN)		890	7,700	8,600
2064 (W)		960	2,600	3,600
2065 (BN)		1,000	1,300	2,300
2066 (D)		1,000	1,500	2,500
2067 (C)		390	1,200	1,600
2068 (C)		330	1,400	1,700
2069 (BN)		710	20,000	21,000
2070 (W)		730	39,000	40,000
2071 (BN)		780	1,300	2,000
2072 (W)		1,000	27,000	28,000
Average (2022-2072)		930	6,100	7,100
2022 - 2072	W	960	11,000	12,000
	AN	1,100	8,300	9,400
	BN	890	5,000	5,900
	D	980	1,400	2,400
	C	720	1,600	2,300

3.3.3 Change in Root Zone Storage

Estimates of change in root zone storage are provided in **Figure 63** and **Table 61**. Inter-annual changes in storage within the SWS consist primarily of root zone soil moisture storage changes, are relatively small, and tend to average near zero over many years.

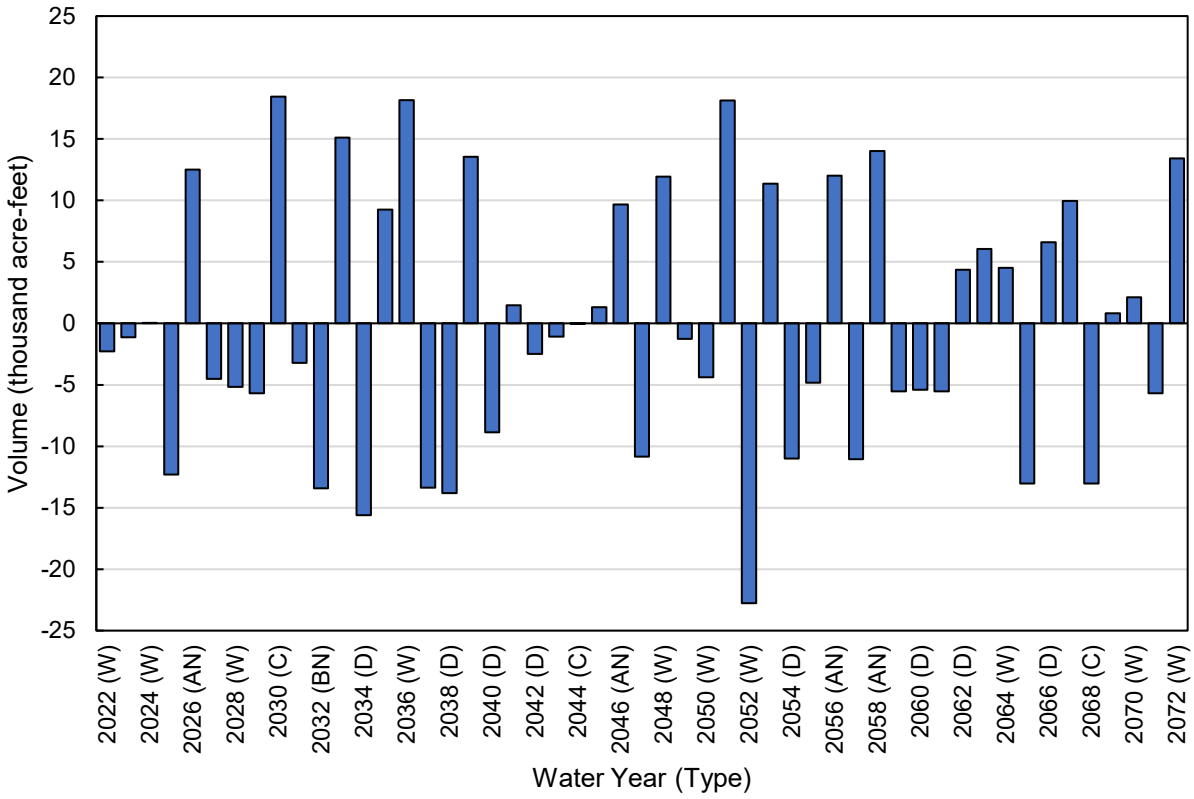

Figure 63. Red Bluff Subbasin Projected (Future Land Use) Change in Root Zone Storage

Table 61. Red Bluff Subbasin Projected (Future Land Use) Change in Root Zone Storage (acre-feet)

Water Year (Type)	Change in Root Zone Storage
2022 (W)	-2,300
2023 (W)	-1,100
2024 (W)	20
2025 (BN)	-12,000
2026 (AN)	13,000
2027 (W)	-4,500
2028 (W)	-5,200
2029 (C)	-5,700
2030 (C)	18,000
2031 (AN)	-3,200
2032 (BN)	-13,000
2033 (AN)	15,000
2034 (D)	-16,000
2035 (W)	9,300
2036 (W)	18,000
2037 (W)	-13,000
2038 (D)	-14,000
2039 (W)	14,000
2040 (D)	-8,900
2041 (C)	1,500
2042 (D)	-2,500
2043 (C)	-1,100
2044 (C)	-40
2045 (C)	1,300
2046 (AN)	9,700
2047 (C)	-11,000
2048 (W)	12,000
2049 (W)	-1,300
2050 (W)	-4,400
2051 (W)	18,000
2052 (W)	-23,000
2053 (AN)	11,000
2054 (D)	-11,000
2055 (D)	-4,800
2056 (AN)	12,000
2057 (BN)	-11,000

Water Year (Type)		Change in Root Zone Storage
2058 (AN)		14,000
2059 (W)		-5,500
2060 (D)		-5,400
2061 (C)		-5,500
2062 (D)		4,400
2063 (BN)		6,100
2064 (W)		4,500
2065 (BN)		-13,000
2066 (D)		6,600
2067 (C)		10,000
2068 (C)		-13,000
2069 (BN)		820
2070 (W)		2,100
2071 (BN)		-5,700
2072 (W)		13,000
Average (2022-2072)		-50
2022 - 2072	W	1,700
	AN	10,000
	BN	-7,000
	D	-5,700
	C	-500

3.3.4 Net Recharge from Surface Water System

Net recharge from the SWS is a useful metric that equates only the impacts of the SWS on recharge and extraction from the GWS, providing valuable insight to the combined effects of land surface processes on the underlying GWS. Net recharge from the SWS is calculated as the total groundwater recharge minus the total groundwater extraction and uptake. When calculated for the projected (future land use) water budget, average net recharge from the SWS represents the average surplus (when positive) or shortage (when negative) of recharge that has resulted from projected cropping, land use practices, and average hydrologic conditions, when comparing groundwater extractions with deep percolation and infiltration from the SWS to the GWS. Net recharge does not include groundwater discharges to surface water and is not a full accounting of all exchanges occurring between the SWS and GWS. Although net recharge is a useful water balance metric, groundwater sustainability is not defined by the balance of net recharge from the SWS. Other important factors must be considered in the complete assessment of groundwater sustainability, including but not limited to subsurface groundwater flows and groundwater discharge to surface water.

Annual values for net recharge from the SWS over the projected (future land use) water budget period are presented below for the Red Bluff Subbasin. **Figure 64** and **Table 62** show the average net recharge from the SWS over 2022-2072 based on the projected (future land use) water budget results. Under future land use conditions, the average net recharge in the Red Bluff Subbasin was projected as approximately -60 taf per year between 2022-2072, indicating net outflows from the GWS to the SWS during the projected (future land use) water budget period. As illustrated on the cumulative net recharge plot in **Figure 64**, this results in a cumulative net negative recharge (i.e., net discharge from the GWS to the SWS) of about 1.2 taf over the 51-year projected (future land use) water budget period. Although this means there is projected to be more recharge from the SWS to the GWS than extractions and discharges from the GWS to the SWS, this alone does not necessarily mean that groundwater storage is decreasing or that the Subbasin groundwater system has been unsustainable. The complete Subbasin water budget, including the GWS water budget results, provide an indication of whether total groundwater inflows and outflows are in balance.

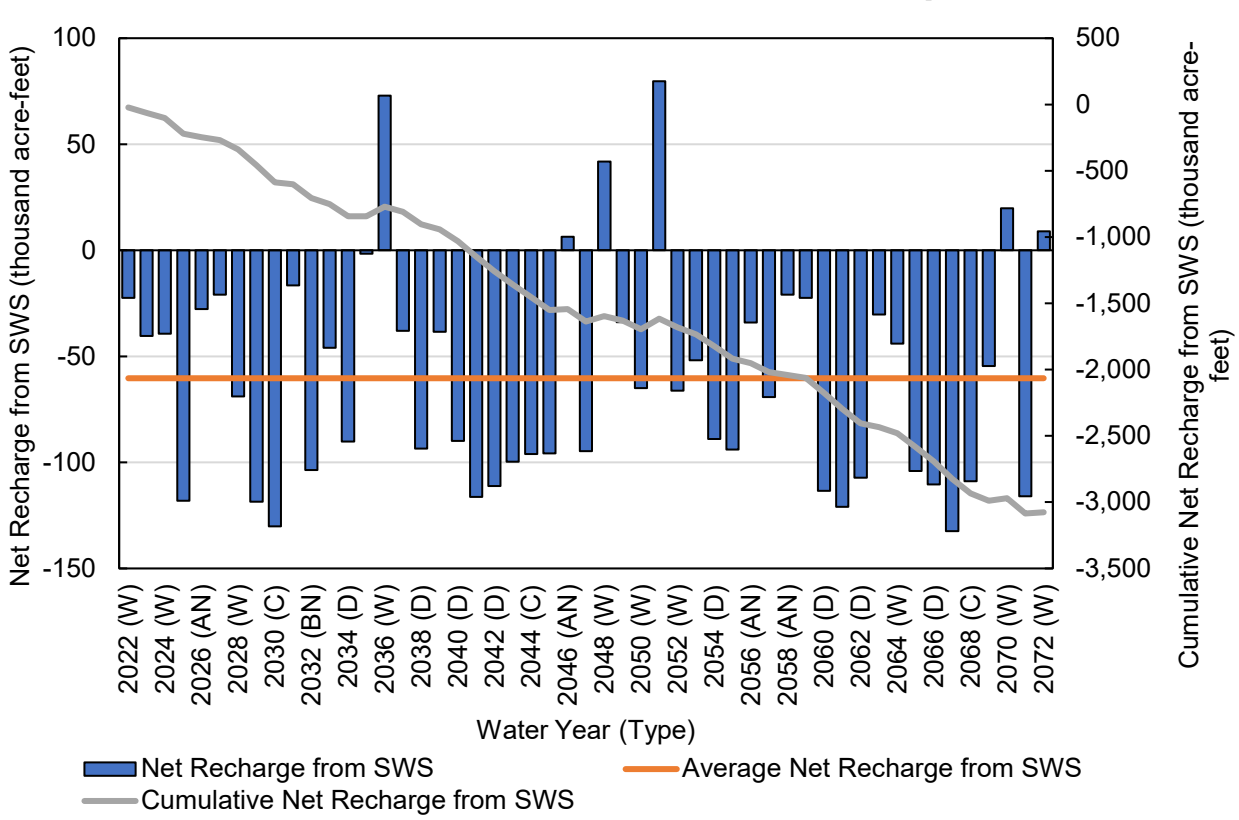

Figure 64. Red Bluff Subbasin Projected (Future Land Use) Net Recharge Overview

Table 62. Red Bluff Subbasin Projected (Future Land Use) Water Budget: Average Net Recharge from SWS, by Water Year Type (acre-feet)

Year Type	Number of Years	Deep Perc. of Applied Water (a)	Deep Perc. of Precipitation (b)	Infil. of Surface Water (c)	Groundwater Extraction/ Uptake (d)	Net Recharge from SWS (a+b+c-d)
W	18	19,000	78,000	12,000	120,000	-15,000
AN	7	17,000	66,000	9,400	120,000	-27,000
BN	7	15,000	34,000	5,900	140,000	-85,000
D	9	16,000	30,000	2,400	150,000	-100,000
C	10	15,000	23,000	2,300	150,000	-110,000
Annual Average (2022 - 2072)	51	17,000	51,000	7,100	140,000	-60,000

3.4 Groundwater System Water Budget Results

Projected (future land use) water budget results for different components of the GWS are presented in the sections below. Inflows and outflows from the GWS that occur through exchanges with the SWS are discussed in the SWS water budget results, although these components are also noted in the sections below relating to the GWS water budget. In contrast to the SWS water budget, many of the GWS water budget components change in flow direction over time representing inflows during some periods and outflows during other periods, depending on Subbasin conditions. The GWS water budget results are presented with net inflows indicated by positive values and net outflows as negative values.

3.4.1 Lateral Subsurface Groundwater Flows

Subsurface groundwater flows to and from the Red Bluff Subbasin occur between the Bowman Subbasin to the north, the Bend, Antelope, and Los Molinos Subbasins to the east, and the Corning Subbasin to the south. Some subsurface groundwater flows also occur between the South Battle Creek Subbasin which borders the Red Bluff Subbasin to the northeast. Additional subsurface groundwater inflows occur from the upland foothill (small watershed) areas adjoining the Red Bluff Subbasin to the west.

3.4.1.1 Lateral Subsurface Flows to/from Adjacent Subbasins

Projected (future land use) lateral subsurface flows occurring from and to adjacent subbasin are summarized in **Figure 65** and **Table 63**. The total Projected (future land use) net subsurface flows to and from all adjacent subbasins averages about 73 taf per year occurring as inflow to the Red Bluff Subbasin. The largest projected (future land use) subsurface flows occur across the boundary with the Bowman with somewhat less subsurface flow occurring across the boundaries with the Corning, Antelope and Bend Subbasins, although these flows are still considerable. Much smaller flows occur across the boundaries with the Los Molinos and South Battle Creek Subbasins.

Projected (future land use) subsurface flows with the Bowman Subbasin consistently average about 130 taf occurring as inflows to the Red Bluff Subbasin. This makes up most of the subsurface inflows occurring to the Red Bluff Subbasin. Annual subsurface flows from Red Bluff Subbasin to Corning, Bend and Antelope Subbasins (negative values) average about 32, 16 and 8 taf, respectively. The magnitudes of the subsurface outflows from Red Bluff Subbasin to the Corning and Bend Subbasins are relatively consistent from year to year. Projected (future land use) subsurface flows across the boundary with Los Molinos Subbasin generally occur as smaller volumes of inflows to the Red Bluff Subbasin (about 2.0 taf per year on average over the projected period), although the magnitude of flows across this boundary do vary, including the occurrence of a net outflow to the Los Molinos Subbasin in some years. A small amount of subsurface inflow also occurs across the boundary with the South Battle Creek Subbasin totaling about 1.5 taf per year on average.

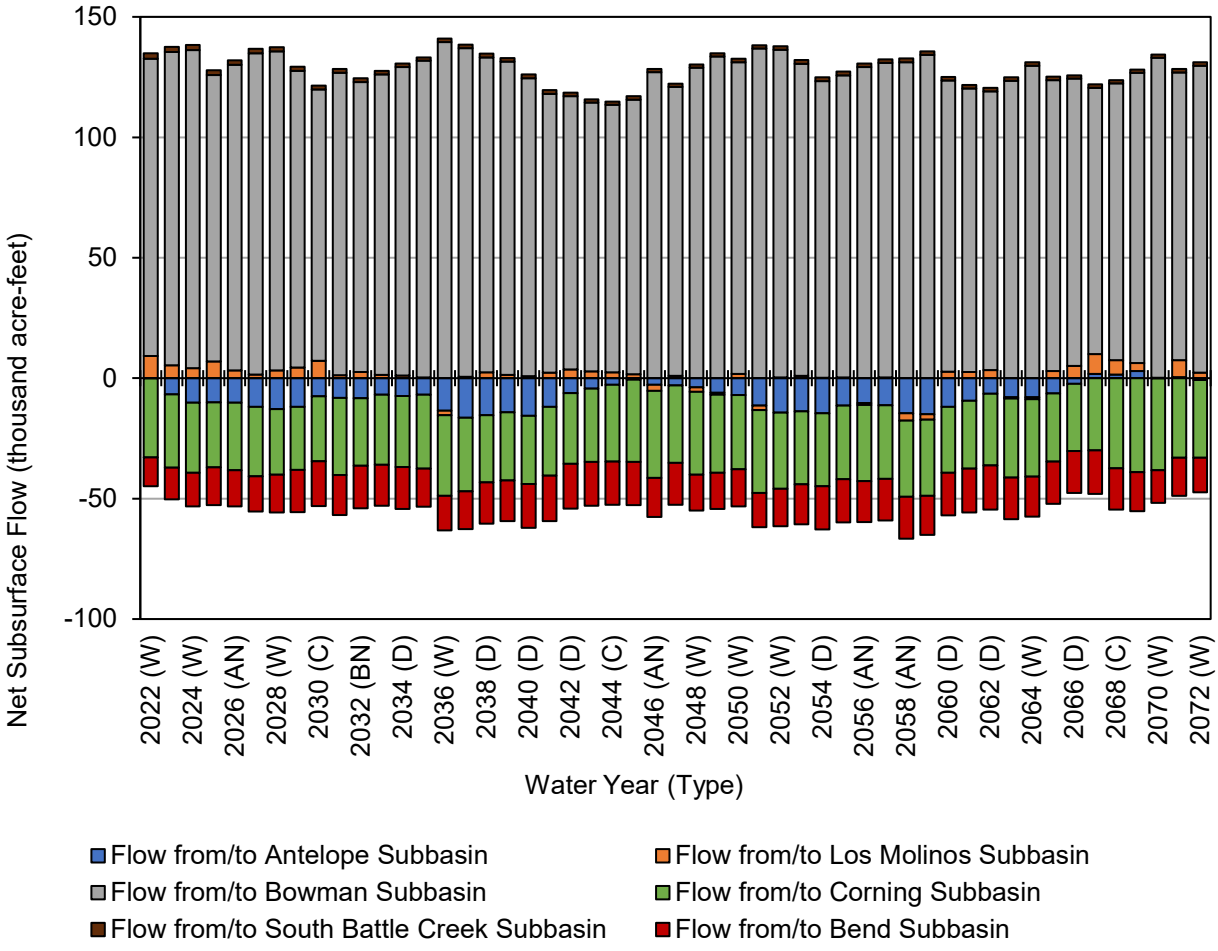

Figure 65. Red Bluff Subbasin Projected (Future Land Use) Lateral Subsurface Groundwater Flows to/from Adjacent Subbasins

Table 63. Red Bluff Subbasin Projected (Future Land Use) Lateral Subsurface Groundwater Flows Between Adjacent Subbasins (net flows as acre-feet)

Water Year (Type)	Antelope	Los Molinos	Bowman	Corning	S. Battle Creek	Bend	Total
2022 (W)	-88	9,200	120,000	-33,000	2,200	-12,000	90,000
2023 (W)	-6,700	5,300	130,000	-30,000	2,100	-13,000	87,000
2024 (W)	-10,000	4,200	130,000	-29,000	2,000	-14,000	85,000
2025 (BN)	-10,000	6,900	120,000	-27,000	2,000	-16,000	75,000
2026 (AN)	-10,000	3,200	130,000	-28,000	1,900	-15,000	79,000
2027 (W)	-12,000	1,500	130,000	-29,000	1,800	-15,000	81,000
2028 (W)	-13,000	3,200	130,000	-27,000	1,700	-16,000	82,000
2029 (C)	-12,000	4,400	120,000	-26,000	1,700	-18,000	74,000
2030 (C)	-7,500	7,200	110,000	-27,000	1,700	-19,000	68,000
2031 (AN)	-8,200	1,200	130,000	-32,000	1,600	-17,000	72,000
2032 (BN)	-8,300	2,600	120,000	-28,000	1,600	-18,000	70,000
2033 (AN)	-6,900	1,400	120,000	-29,000	1,500	-17,000	75,000
2034 (D)	-7,400	1,100	130,000	-29,000	1,500	-17,000	76,000
2035 (W)	-6,900	240	130,000	-31,000	1,400	-16,000	80,000
2036 (W)	-14,000	-1,800	140,000	-33,000	1,500	-14,000	78,000
2037 (W)	-16,000	630	140,000	-31,000	1,500	-16,000	76,000
2038 (D)	-15,000	2,400	130,000	-28,000	1,600	-17,000	74,000
2039 (W)	-14,000	1,300	130,000	-28,000	1,600	-17,000	74,000
2040 (D)	-16,000	830	120,000	-28,000	1,600	-18,000	64,000
2041 (C)	-12,000	2,300	120,000	-29,000	1,500	-19,000	60,000
2042 (D)	-6,200	3,600	110,000	-29,000	1,500	-19,000	64,000
2043 (C)	-4,300	2,800	110,000	-30,000	1,400	-18,000	63,000
2044 (C)	-2,700	2,400	110,000	-32,000	1,400	-18,000	62,000
2045 (C)	-590	1,700	110,000	-34,000	1,400	-18,000	64,000
2046 (AN)	-2,800	-2,600	130,000	-36,000	1,300	-16,000	71,000
2047 (C)	-3,000	970	120,000	-32,000	1,300	-17,000	70,000
2048 (W)	-3,800	-1,900	130,000	-34,000	1,300	-15,000	75,000
2049 (W)	-6,100	-770	130,000	-32,000	1,400	-15,000	81,000
2050 (W)	-6,900	1,700	130,000	-31,000	1,400	-15,000	79,000
2051 (W)	-11,000	-1,800	140,000	-34,000	1,400	-14,000	76,000
2052 (W)	-14,000	350	140,000	-32,000	1,500	-16,000	76,000
2053 (AN)	-14,000	940	130,000	-30,000	1,500	-17,000	71,000
2054 (D)	-15,000	180	120,000	-30,000	1,600	-18,000	62,000
2055 (D)	-11,000	330	130,000	-31,000	1,500	-18,000	67,000
2056 (AN)	-10,000	-800	130,000	-32,000	1,500	-17,000	71,000
2057 (BN)	-11,000	270	130,000	-31,000	1,500	-17,000	73,000
2058 (AN)	-15,000	-3,100	130,000	-32,000	1,500	-17,000	66,000
2059 (W)	-15,000	-2,300	130,000	-32,000	1,500	-16,000	71,000

Water Year (Type)		Antelope	Los Molinos	Bowman	Corning	S. Battle Creek	Bend	Total
2060 (D)		-12,000	2,800	120,000	-27,000	1,500	-18,000	68,000
2061 (C)		-9,400	2,500	120,000	-28,000	1,500	-18,000	66,000
2062 (D)		-6,500	3,400	120,000	-30,000	1,500	-18,000	66,000
2063 (BN)		-7,900	-620	120,000	-33,000	1,400	-17,000	66,000
2064 (W)		-7,900	-840	130,000	-32,000	1,400	-17,000	74,000
2065 (BN)		-6,400	3,000	120,000	-28,000	1,400	-18,000	73,000
2066 (D)		-2,400	5,000	120,000	-28,000	1,400	-17,000	78,000
2067 (C)		1,800	8,200	110,000	-30,000	1,400	-18,000	74,000
2068 (C)		1,500	6,000	110,000	-37,000	1,400	-17,000	69,000
2069 (BN)		3,000	3,200	120,000	-39,000	1,400	-16,000	73,000
2070 (W)		-83	230	130,000	-38,000	1,300	-14,000	83,000
2071 (BN)		500	7,000	120,000	-33,000	1,400	-16,000	80,000
2072 (W)		-710	2,400	130,000	-32,000	1,400	-14,000	84,000
Average (2022-2072)		-8,000	2,000	130,000	-31,000	1,500	-16,000	73,000
2022 - 2072	W	-8,800	1,200	130,000	-32,000	1,600	-15,000	80,000
	AN	-9,500	44	130,000	-31,000	1,500	-17,000	72,000
	BN	-5,800	3,200	120,000	-31,000	1,500	-17,000	73,000
	D	-10,000	2,200	120,000	-29,000	1,500	-18,000	69,000
	C	-4,800	3,900	120,000	-31,000	1,500	-18,000	67,000

Note: positive values represent net inflows to Red Bluff Subbasin, negative values represent net outflows from Red Bluff Subbasin.

3.4.1.2 Lateral Subsurface Flows from Upland Areas (Small Watersheds)

Projected (future land use) lateral subsurface inflows occurring from upland or foothill areas (small watersheds outside of the Central Valley Floor) to the west of the Red Bluff Subbasin are summarized in **Figure 66** and **Table 64**. This component does not include surface water inflows to the Red Bluff Subbasin which are discussed as part of the SWS water budget. The average projected (future land use) subsurface inflow from the upland areas is about 1.1 taf per year and varies only very minimally from year to year. The volume of subsurface inflows from upland areas is small relative to the net subsurface inflows occurring between adjacent subbasins.

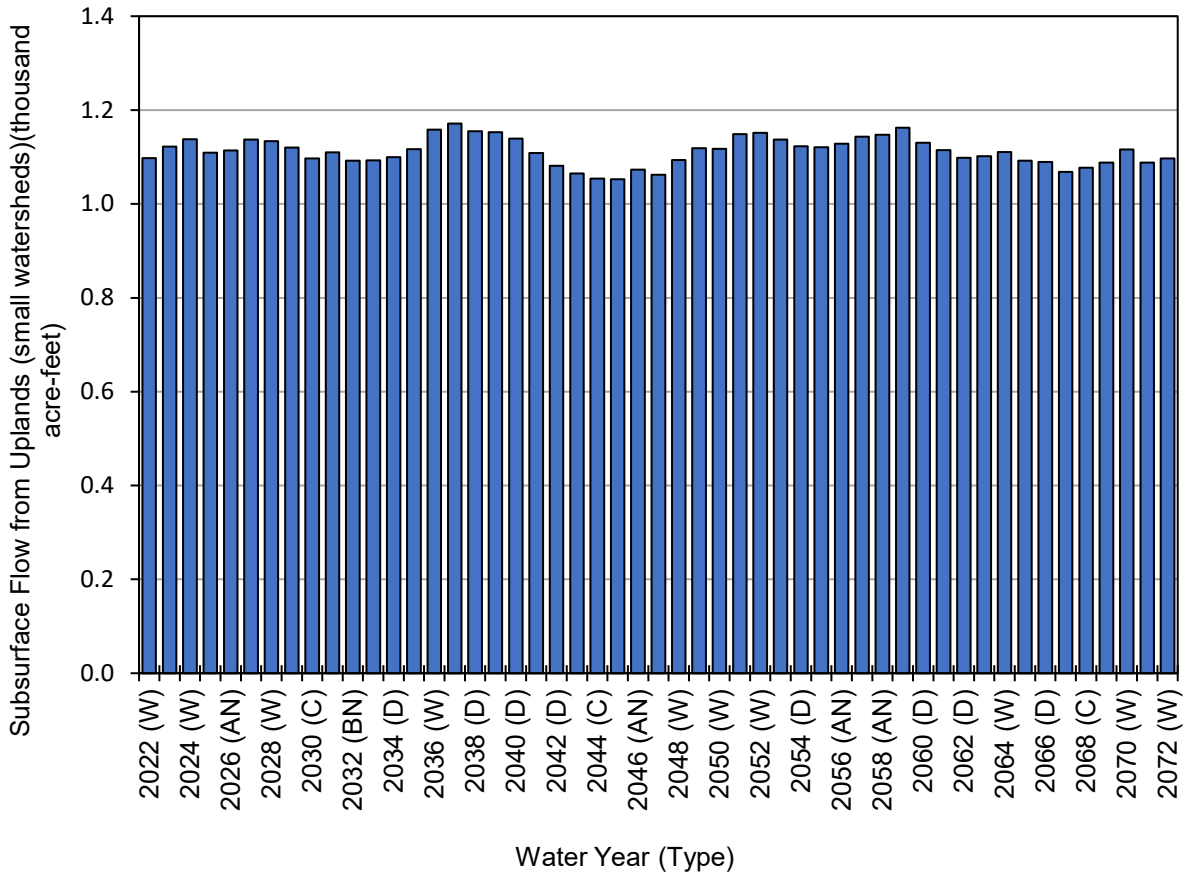

Figure 66. Red Bluff Subbasin Projected (Future Land Use) Subsurface Groundwater Inflows from Upland Areas

Table 64. Red Bluff Subbasin Projected (Future Land Use) Subsurface Groundwater Inflows from Adjacent Uplands (small watersheds) (acre-feet)

Water Year (Type)	Subsurface Inflow from Uplands
2022 (W)	1,100
2023 (W)	1,100
2024 (W)	1,100
2025 (BN)	1,100
2026 (AN)	1,100
2027 (W)	1,100
2028 (W)	1,100
2029 (C)	1,100
2030 (C)	1,100
2031 (AN)	1,100
2032 (BN)	1,100
2033 (AN)	1,100
2034 (D)	1,100
2035 (W)	1,100
2036 (W)	1,200
2037 (W)	1,200
2038 (D)	1,200
2039 (W)	1,200
2040 (D)	1,100
2041 (C)	1,100
2042 (D)	1,100
2043 (C)	1,100
2044 (C)	1,100
2045 (C)	1,100
2046 (AN)	1,100
2047 (C)	1,100
2048 (W)	1,100
2049 (W)	1,100
2050 (W)	1,100
2051 (W)	1,100
2052 (W)	1,200
2053 (AN)	1,100
2054 (D)	1,100
2055 (D)	1,100
2056 (AN)	1,100
2057 (BN)	1,100
2058 (AN)	1,100
2059 (W)	1,200

Water Year (Type)		Subsurface Inflow from Uplands
2060 (D)		1,100
2061 (C)		1,100
2062 (D)		1,100
2063 (BN)		1,100
2064 (W)		1,100
2065 (BN)		1,100
2066 (D)		1,100
2067 (C)		1,100
2068 (C)		1,100
2069 (BN)		1,100
2070 (W)		1,100
2071 (BN)		1,100
2072 (W)		1,100
Average (2022-2072)		1,100
2022 - 2072	W	1,100
	AN	1,100
	BN	1,100
	D	1,100
	C	1,100

3.4.2 Deep Percolation From the SWS

Deep percolation from the SWS includes infiltration of water below the root zone (deep percolation) from precipitation and applied water. These two water budget components are summarized in the SWS water budget as outflows to the SWS and are presented as aggregated deep percolation inflows to the GWS in **Figure 67** and **Table 65**. The average annual deep percolation from the SWS over the projected (future land use) water budget period is approximately 68 taf per year. Greater volumes of deep percolation occur during wetter years when infiltration of precipitation is higher.

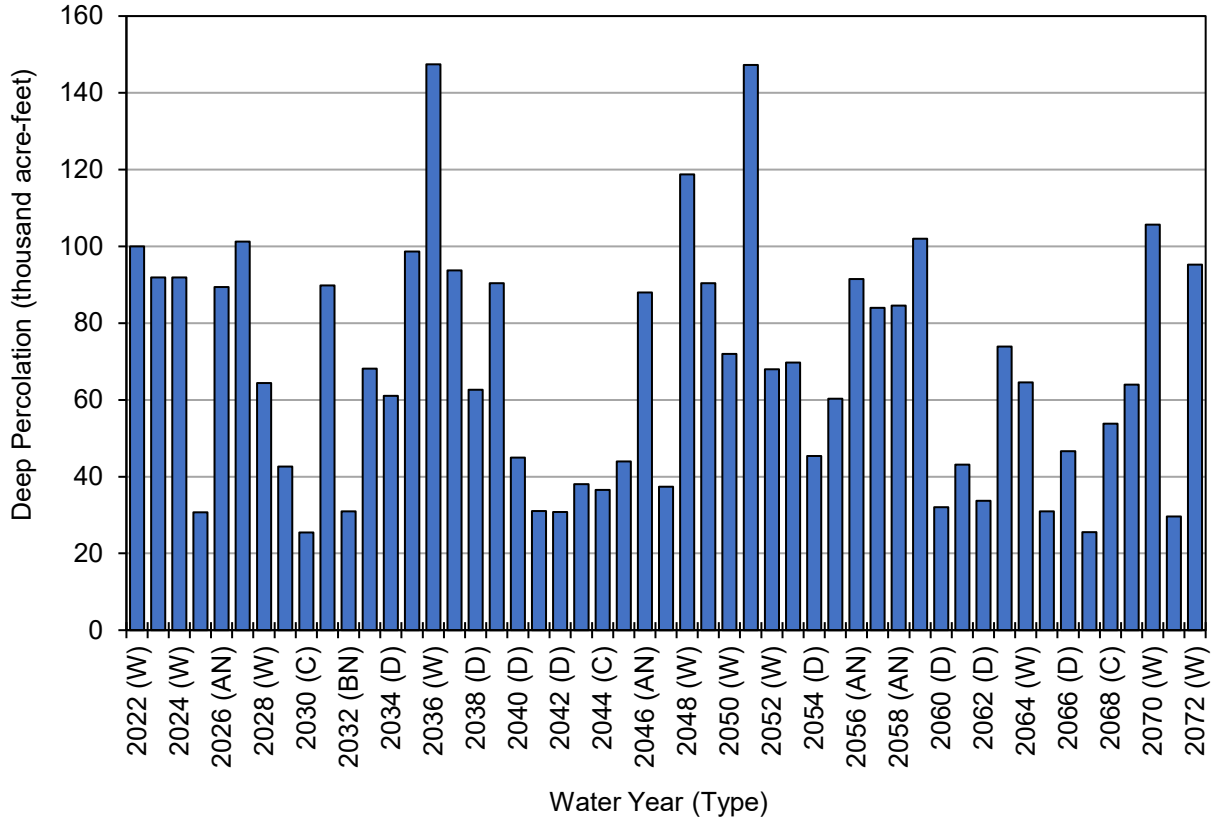

Figure 67. Red Bluff Subbasin Projected (Future Land Use) Deep Percolation

Table 65. Red Bluff Subbasin Projected (Future Land Use) Deep Percolation from the SWS (acre-feet)

Water Year (Type)	Deep Percolation from the SWS
2022 (W)	100,000
2023 (W)	92,000
2024 (W)	92,000
2025 (BN)	31,000
2026 (AN)	89,000
2027 (W)	100,000
2028 (W)	64,000
2029 (C)	43,000
2030 (C)	25,000
2031 (AN)	90,000
2032 (BN)	31,000
2033 (AN)	68,000
2034 (D)	61,000
2035 (W)	99,000
2036 (W)	150,000
2037 (W)	94,000
2038 (D)	63,000
2039 (W)	90,000
2040 (D)	45,000
2041 (C)	31,000
2042 (D)	31,000
2043 (C)	38,000
2044 (C)	37,000
2045 (C)	44,000
2046 (AN)	88,000
2047 (C)	37,000
2048 (W)	120,000
2049 (W)	90,000
2050 (W)	72,000
2051 (W)	150,000
2052 (W)	68,000
2053 (AN)	70,000
2054 (D)	45,000
2055 (D)	60,000
2056 (AN)	91,000
2057 (BN)	84,000
2058 (AN)	85,000
2059 (W)	100,000

Water Year (Type)		Deep Percolation from the SWS
2060 (D)		32,000
2061 (C)		43,000
2062 (D)		34,000
2063 (BN)		74,000
2064 (W)		65,000
2065 (BN)		31,000
2066 (D)		47,000
2067 (C)		26,000
2068 (C)		54,000
2069 (BN)		64,000
2070 (W)		110,000
2071 (BN)		30,000
2072 (W)		95,000
Average (2022-2072)		68,000
2022 - 2072	W	97,000
	AN	83,000
	BN	49,000
	D	46,000
	C	38,000

3.4.3 Net Stream Seepage/Groundwater Discharge to Surface Water

The flow of water between the GWS and SWS through seepage of water from streams and canals and groundwater discharging into streams is discussed as part of the SWS water budget. These components are combined for presentation in the GWS water budget as a net volume of stream seepage (**Figure 68** and **Table 66**). Positive total net seepage values represent a net inflow of water from the SWS to the GWS via stream and canal seepage indicating that the overall volume of stream seepage is greater than the volume of any groundwater discharging into surface waterways. Negative net seepage values represent a net outflow of groundwater from the GWS to the SWS through groundwater discharge to surface water. When net seepage is negative, it means that more groundwater is discharging into the surface waterways than is seeping from surface waterways into the GWS.

In the Red Bluff Subbasin, the projected (future land use) annual net seepage values are highly negative in most years with an average annual net stream seepage value of -9.3 taf per year indicating that groundwater discharge is providing considerable flow to the surface waterways. The annual net stream seepage values tend to be more negative in dry years and less negative in wet years corresponding with more net groundwater discharge to surface water in drier years and less groundwater discharge in wetter years.

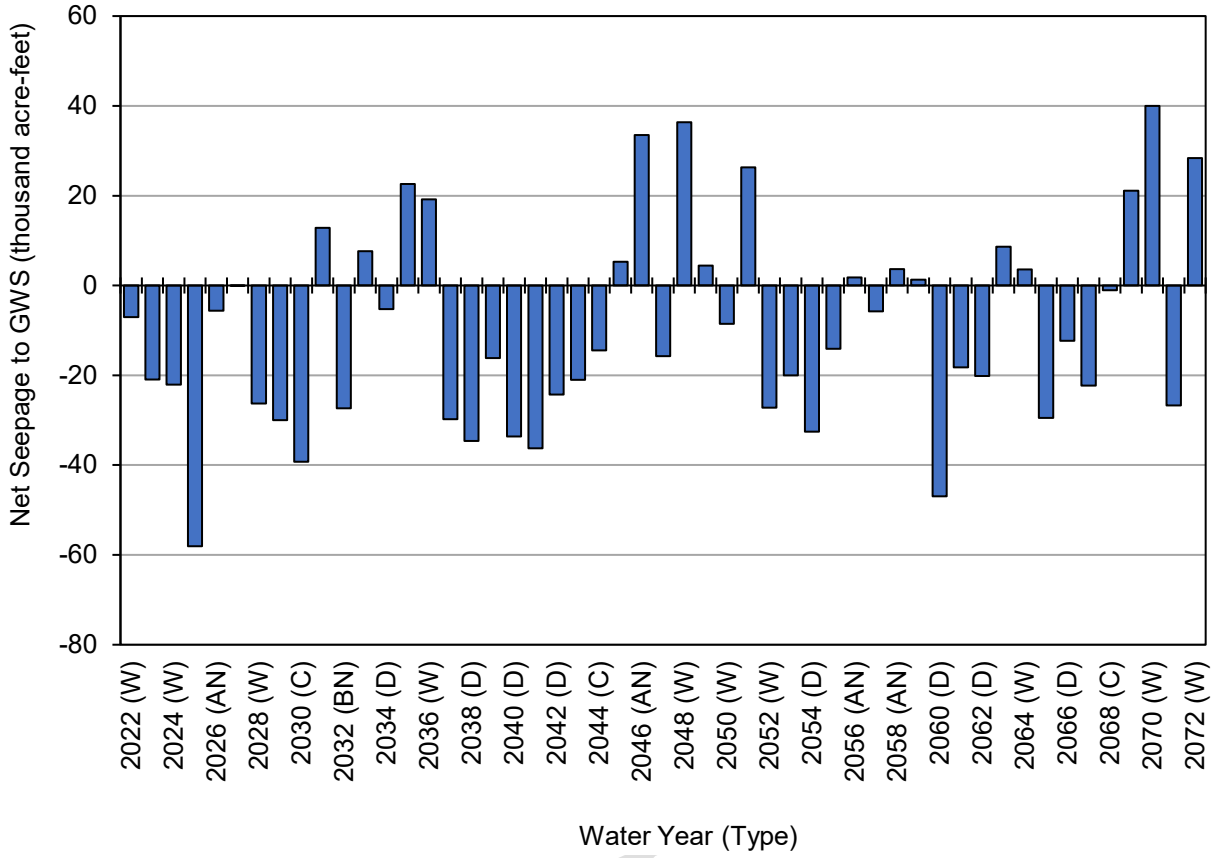

Figure 68. Red Bluff Subbasin Projected (Future Land Use) Net Stream Seepage to GWS/Discharge to Surface Water

Table 66. Red Bluff Subbasin Projected (Future Land Use) Net Stream Seepage (net flows as acre-feet)

Water Year (Type)	Total Net Seepage from Surface Waterways and Canals
2022 (W)	-7,000
2023 (W)	-21,000
2024 (W)	-22,000
2025 (BN)	-58,000
2026 (AN)	-5,600
2027 (W)	-47
2028 (W)	-26,000
2029 (C)	-30,000
2030 (C)	-39,000
2031 (AN)	13,000
2032 (BN)	-27,000
2033 (AN)	7,600
2034 (D)	-5,300
2035 (W)	23,000
2036 (W)	19,000
2037 (W)	-30,000
2038 (D)	-35,000
2039 (W)	-16,000
2040 (D)	-34,000
2041 (C)	-36,000
2042 (D)	-24,000
2043 (C)	-21,000
2044 (C)	-14,000
2045 (C)	5,300
2046 (AN)	34,000
2047 (C)	-16,000
2048 (W)	36,000
2049 (W)	4,400
2050 (W)	-8,600
2051 (W)	26,000
2052 (W)	-27,000
2053 (AN)	-20,000
2054 (D)	-33,000
2055 (D)	-14,000
2056 (AN)	1,800
2057 (BN)	-5,800
2058 (AN)	3,700
2059 (W)	1,300

Water Year (Type)		Total Net Seepage from Surface Waterways and Canals
2060 (D)		-47,000
2061 (C)		-18,000
2062 (D)		-20,000
2063 (BN)		8,600
2064 (W)		3,600
2065 (BN)		-30,000
2066 (D)		-12,000
2067 (C)		-22,000
2068 (C)		-1,000
2069 (BN)		21,000
2070 (W)		40,000
2071 (BN)		-27,000
2072 (W)		28,000
Average (2022-2072)		-9,300
2022 - 2072	W	1,300
	AN	4,800
	BN	-17,000
	D	-25,000
	C	-19,000

Note: negative values indicate net groundwater discharge to surface water

3.4.4 Groundwater Extraction

Groundwater extractions are exchanges that occur between the GWS and the SWS. Groundwater extraction from the GWS occurs through groundwater pumping to meet water demands for urban and agricultural needs and also through groundwater (root water) uptake by plants directly from shallow groundwater during times and at locations of sufficiently shallow groundwater conditions. Projected (future land use) groundwater extractions are summarized in **Figure 69** and **Table 67** and also presented and discussed in the SWS water budget sections. Total groundwater extractions over the projected (future land use) water budget period average about -140 taf per year. Overall, groundwater pumping represents a larger fraction of the groundwater extractions than groundwater uptake. Groundwater pumping averaged about -130 taf over the projected (future land use) period and groundwater uptake averaged about -4.8 taf. In wetter periods, groundwater uptake increases and groundwater pumping decreases. Accordingly, during drier periods groundwater pumping increases and water uptake by plants from shallow groundwater decreases in response to the higher water demands for irrigation and other uses and the greater depths to groundwater that also tend to occur during dry periods.

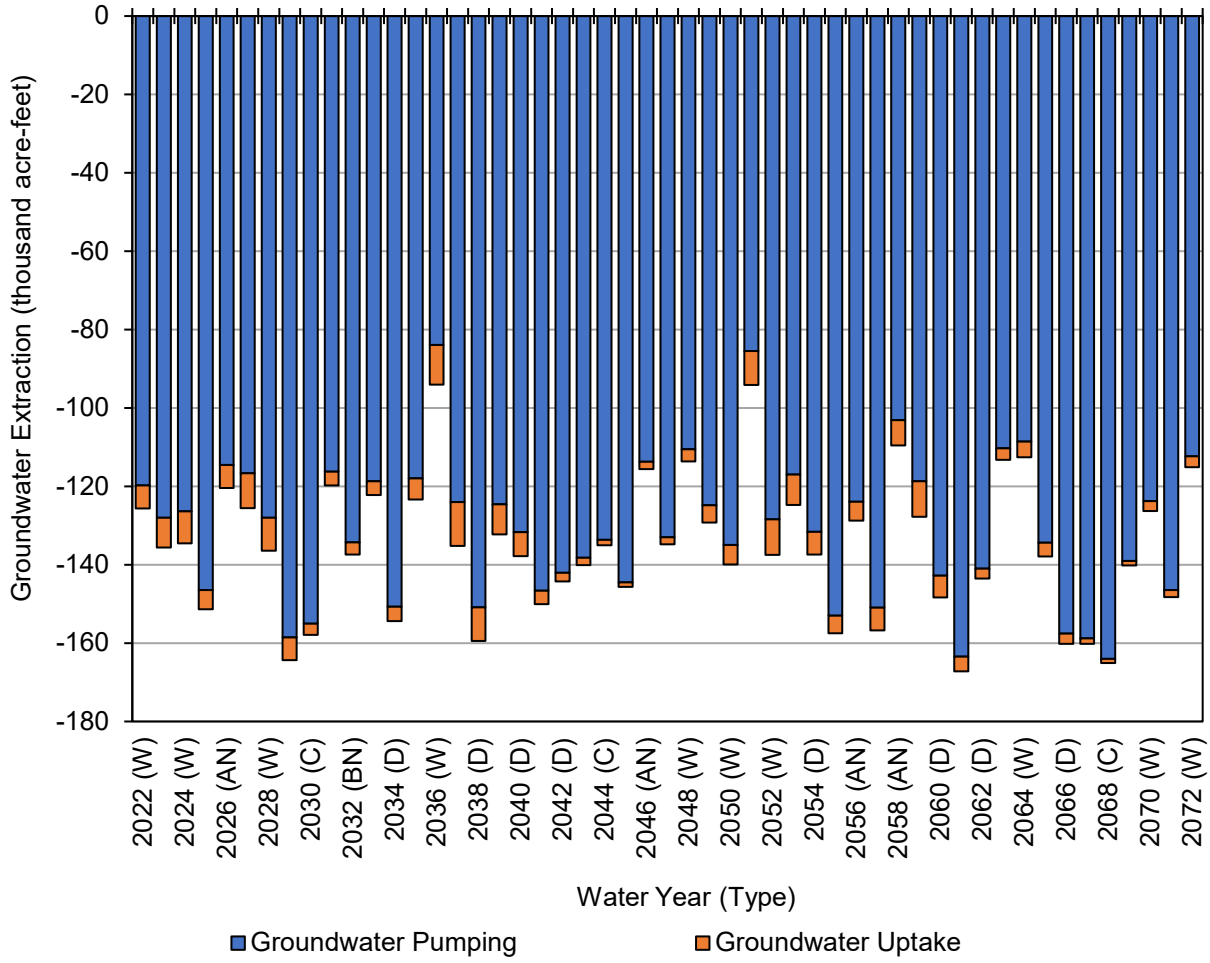

Figure 69. Red Bluff Subbasin Projected (Future Land Use) Groundwater Extractions

Table 67. Red Bluff Subbasin Projected (Future Land Use) Groundwater Extractions (acre-feet)

Water Year (Type)	Groundwater Pumping	Groundwater (Root Water) Uptake	Total Extractions
2022 (W)	-120,000	-5,900	-130,000
2023 (W)	-130,000	-7,600	-140,000
2024 (W)	-130,000	-8,200	-130,000
2025 (BN)	-150,000	-4,900	-150,000
2026 (AN)	-110,000	-5,800	-120,000
2027 (W)	-120,000	-8,900	-130,000
2028 (W)	-130,000	-8,500	-140,000
2029 (C)	-160,000	-5,800	-160,000
2030 (C)	-160,000	-2,900	-160,000
2031 (AN)	-120,000	-3,500	-120,000
2032 (BN)	-130,000	-3,100	-140,000
2033 (AN)	-120,000	-3,500	-120,000
2034 (D)	-150,000	-3,700	-150,000
2035 (W)	-120,000	-5,400	-120,000
2036 (W)	-84,000	-10,000	-94,000
2037 (W)	-120,000	-11,000	-140,000
2038 (D)	-150,000	-8,600	-160,000
2039 (W)	-120,000	-7,600	-130,000
2040 (D)	-130,000	-6,100	-140,000
2041 (C)	-150,000	-3,400	-150,000
2042 (D)	-140,000	-2,300	-140,000
2043 (C)	-140,000	-1,800	-140,000
2044 (C)	-130,000	-1,400	-140,000
2045 (C)	-140,000	-1,200	-150,000
2046 (AN)	-110,000	-1,900	-120,000
2047 (C)	-130,000	-1,800	-130,000
2048 (W)	-110,000	-3,100	-110,000
2049 (W)	-120,000	-4,400	-130,000
2050 (W)	-130,000	-5,000	-140,000
2051 (W)	-85,000	-8,700	-94,000
2052 (W)	-130,000	-9,000	-140,000
2053 (AN)	-120,000	-7,800	-120,000
2054 (D)	-130,000	-5,800	-140,000
2055 (D)	-150,000	-4,500	-160,000
2056 (AN)	-120,000	-4,800	-130,000
2057 (BN)	-150,000	-5,800	-160,000
2058 (AN)	-100,000	-6,400	-110,000

Water Year (Type)		Groundwater Pumping	Groundwater (Root Water) Uptake	Total Extractions
2059 (W)		-120,000	-9,000	-130,000
2060 (D)		-140,000	-5,500	-150,000
2061 (C)		-160,000	-3,700	-170,000
2062 (D)		-140,000	-2,500	-140,000
2063 (BN)		-110,000	-2,900	-110,000
2064 (W)		-110,000	-4,000	-110,000
2065 (BN)		-130,000	-3,500	-140,000
2066 (D)		-160,000	-2,600	-160,000
2067 (C)		-160,000	-1,400	-160,000
2068 (C)		-160,000	-1,000	-170,000
2069 (BN)		-140,000	-1,100	-140,000
2070 (W)		-120,000	-2,500	-130,000
2071 (BN)		-150,000	-1,800	-150,000
2072 (W)		-110,000	-2,800	-120,000
Average (2022-2072)		-130,000	-4,800	-140,000
2022 - 2072	W	-120,000	-6,800	-120,000
	AN	-120,000	-4,800	-120,000
	BN	-140,000	-3,300	-140,000
	D	-140,000	-4,600	-150,000
	C	-150,000	-2,400	-150,000

3.4.5 Vertical Subsurface Flows within the Groundwater System

Vertical subsurface flows within the GWS occur between the Upper and Lower Aquifers and represent an internal flow of water within the GWS. These exchanges between the principal aquifers do not directly affect the total volume of groundwater in storage, but do highlight the net vertical movement of water within the GWS. Projected (future land use) vertical flows between the Upper Aquifer and Lower Aquifer are summarized in **Figure 70 and Table 68** and show consistent net overall upward vertical flow from the Lower Aquifer to the Upper Aquifer. On average, vertical flows from the Lower Aquifer to the Upper Aquifer total about 48 taf per year over the projected (future land use) water budget period. There is considerable year-to-year variability in the magnitude of these flows, which appear to correlate with water year conditions, although they are mostly in an upward direction except in few wet years. The magnitude of upward flows are generally greatest during drier years and decrease during wet periods. The net upward vertical flow between the two principal aquifers in the Subbasin is consistent with the large groundwater outflows (e.g., groundwater extractions, groundwater discharge to SWS) that occur from the Upper Aquifer in the Subbasin that result in upward movement of groundwater from the Lower Aquifer.

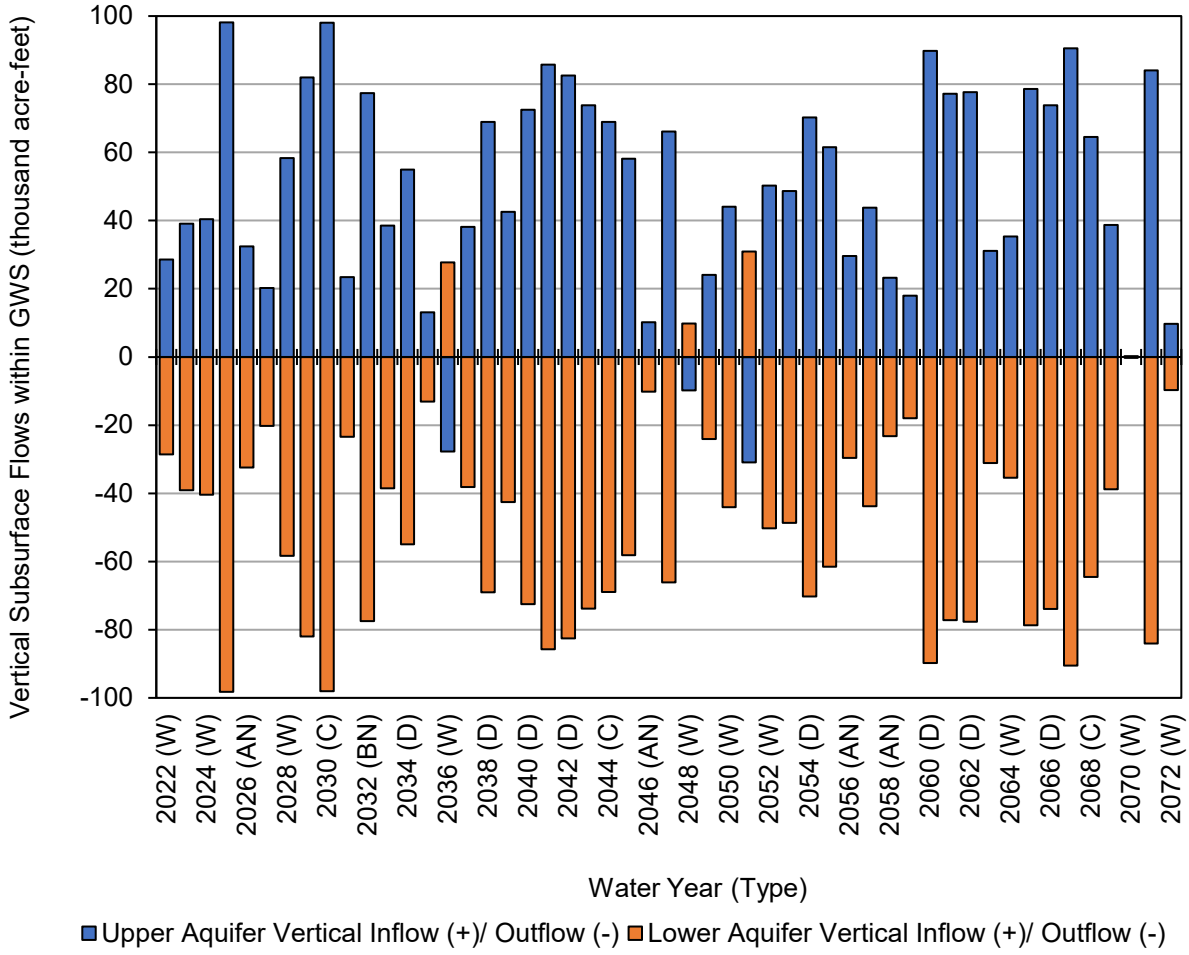

Figure 70. Red Bluff Subbasin Projected (Future Land Use) Vertical Subsurface Flow within the GWS

Table 68. Red Bluff Subbasin Projected (Future Land Use) Vertical Subsurface Flows within the GWS (acre-feet)

Water Year (Type)	Upper Aquifer to (-) / from (+) Lower Aquifer
2022 (W)	29,000
2023 (W)	39,000
2024 (W)	40,000
2025 (BN)	98,000
2026 (AN)	32,000
2027 (W)	20,000
2028 (W)	58,000
2029 (C)	82,000
2030 (C)	98,000
2031 (AN)	23,000
2032 (BN)	77,000
2033 (AN)	39,000
2034 (D)	55,000
2035 (W)	13,000
2036 (W)	-28,000
2037 (W)	38,000
2038 (D)	69,000
2039 (W)	43,000
2040 (D)	73,000
2041 (C)	86,000
2042 (D)	83,000
2043 (C)	74,000
2044 (C)	69,000
2045 (C)	58,000
2046 (AN)	10,000
2047 (C)	66,000
2048 (W)	-9,800
2049 (W)	24,000
2050 (W)	44,000
2051 (W)	-31,000
2052 (W)	50,000
2053 (AN)	49,000
2054 (D)	70,000
2055 (D)	62,000
2056 (AN)	30,000
2057 (BN)	44,000
2058 (AN)	23,000
2059 (W)	18,000

Water Year (Type)		Upper Aquifer to (-) / from (+) Lower Aquifer
2060 (D)		90,000
2061 (C)		77,000
2062 (D)		78,000
2063 (BN)		31,000
2064 (W)		35,000
2065 (BN)		79,000
2066 (D)		74,000
2067 (C)		91,000
2068 (C)		65,000
2069 (BN)		39,000
2070 (W)		-210
2071 (BN)		84,000
2072 (W)		9,700
Average (2022-2072)		48,000
2022 - 2072	W	22,000
	AN	29,000
	BN	65,000
	D	72,000
	C	77,000

3.4.6 Change in Groundwater Storage

Projected (future land use) change in groundwater storage values for the Red Bluff Subbasin are summarized in **Figure 71** and **Figure 72**, and **Table 69**. Over the projected (future land use) period, the average total annual change in groundwater storage is about -2.9 taf per year, representing a decrease in groundwater storage. The corresponding cumulative total change in storage over the projected (future land use) period is about -150 taf. The annual change in storage numbers generally reflect the effects of the water year type with increase in storage occurring during wetter years and decreases in storage occurring during dry years.

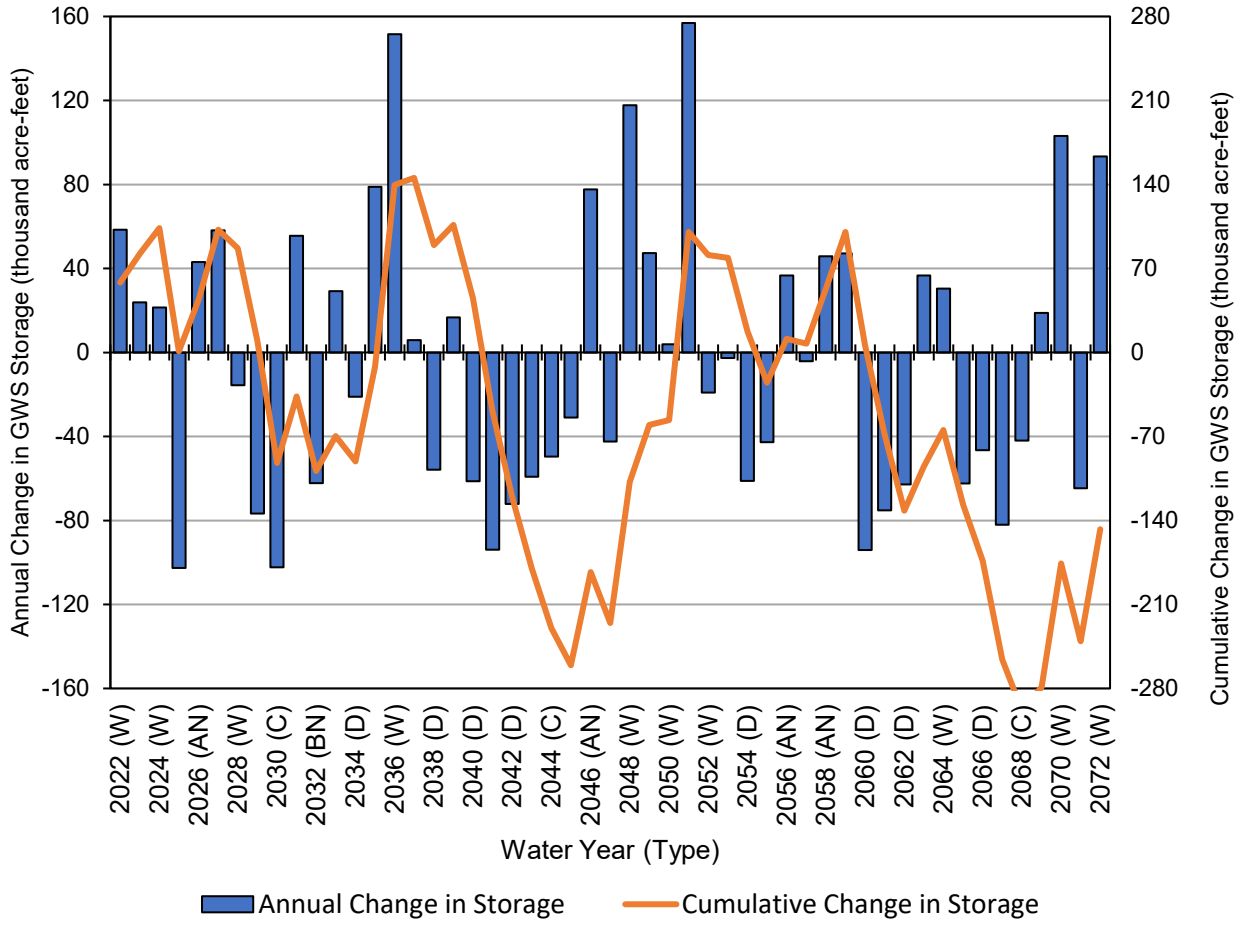

Figure 71. Red Bluff Subbasin Projected (Future Land Use) Projected (Future Land Use) Total Change in Storage within the GWS

Table 69. Red Bluff Subbasin Projected (Future Land Use) Change in Groundwater Storage (acre-feet)

Water Year (Type)	Upper Aquifer	Lower Aquifer	Total Annual Change	Total Cumulative Change
2022 (BN)	28,000	30,000	58,000	58,000
2023 (W)	6,100	18,000	24,000	82,000
2024 (W)	6,100	15,000	21,000	100,000
2025 (W)	-47,000	-55,000	-100,000	1,000
2026 (BN)	23,000	20,000	43,000	44,000
2027 (AN)	23,000	35,000	58,000	100,000
2028 (W)	-11,000	-4,500	-16,000	87,000
2029 (W)	-36,000	-41,000	-77,000	10,000
2030 (C)	-40,000	-62,000	-100,000	-92,000
2031 (C)	31,000	24,000	56,000	-37,000
2032 (AN)	-28,000	-34,000	-62,000	-99,000
2033 (BN)	18,000	11,000	29,000	-70,000
2034 (AN)	-13,000	-8,400	-21,000	-91,000
2035 (D)	37,000	41,000	79,000	-12,000
2036 (W)	65,000	87,000	150,000	140,000
2037 (W)	-6,200	12,000	5,900	150,000
2038 (W)	-31,000	-25,000	-56,000	90,000
2039 (D)	12,000	4,900	17,000	110,000
2040 (W)	-27,000	-34,000	-61,000	45,000
2041 (D)	-40,000	-54,000	-94,000	-49,000
2042 (C)	-25,000	-48,000	-72,000	-120,000
2043 (D)	-21,000	-39,000	-59,000	-180,000
2044 (C)	-16,000	-33,000	-50,000	-230,000
2045 (C)	-10,000	-21,000	-31,000	-260,000
2046 (C)	38,000	39,000	78,000	-180,000
2047 (AN)	-20,000	-23,000	-42,000	-230,000
2048 (C)	55,000	63,000	120,000	-110,000
2049 (W)	16,000	31,000	47,000	-60,000
2050 (W)	-3,200	7,200	4,000	-56,000
2051 (W)	68,000	89,000	160,000	100,000
2052 (W)	-20,000	800	-19,000	81,000
2053 (W)	-890	-1,700	-2,600	79,000
2054 (AN)	-28,000	-33,000	-61,000	18,000
2055 (D)	-19,000	-23,000	-43,000	-25,000
2056 (D)	20,000	17,000	37,000	11,000
2057 (AN)	-3,800	-380	-4,100	7,200
2058 (BN)	23,000	23,000	46,000	53,000

Water Year (Type)		Upper Aquifer	Lower Aquifer	Total Annual Change	Total Cumulative Change
2059 (AN)		18,000	29,000	47,000	100,000
2060 (W)		-43,000	-51,000	-94,000	6,300
2061 (D)		-33,000	-43,000	-75,000	-69,000
2062 (C)		-23,000	-40,000	-63,000	-130,000
2063 (D)		23,000	14,000	37,000	-95,000
2064 (BN)		14,000	16,000	30,000	-65,000
2065 (W)		-29,000	-33,000	-62,000	-130,000
2066 (BN)		-18,000	-29,000	-47,000	-170,000
2067 (D)		-31,000	-51,000	-82,000	-260,000
2068 (C)		-15,000	-27,000	-42,000	-300,000
2069 (C)		12,000	6,400	19,000	-280,000
2070 (BN)		46,000	57,000	100,000	-180,000
2071 (W)		-29,000	-36,000	-65,000	-240,000
2072 (W)		44,000	49,000	93,000	-150,000
Average (2022-2072)		-740	-2,100	-2,900	
2022-2072	W	22,000	32,000	54,000	
	AN	22,000	19,000	41,000	
	BN	-15,000	-20,000	-34,000	
	D	-25,000	-32,000	-58,000	
	C	-26,000	-39,000	-65,000	

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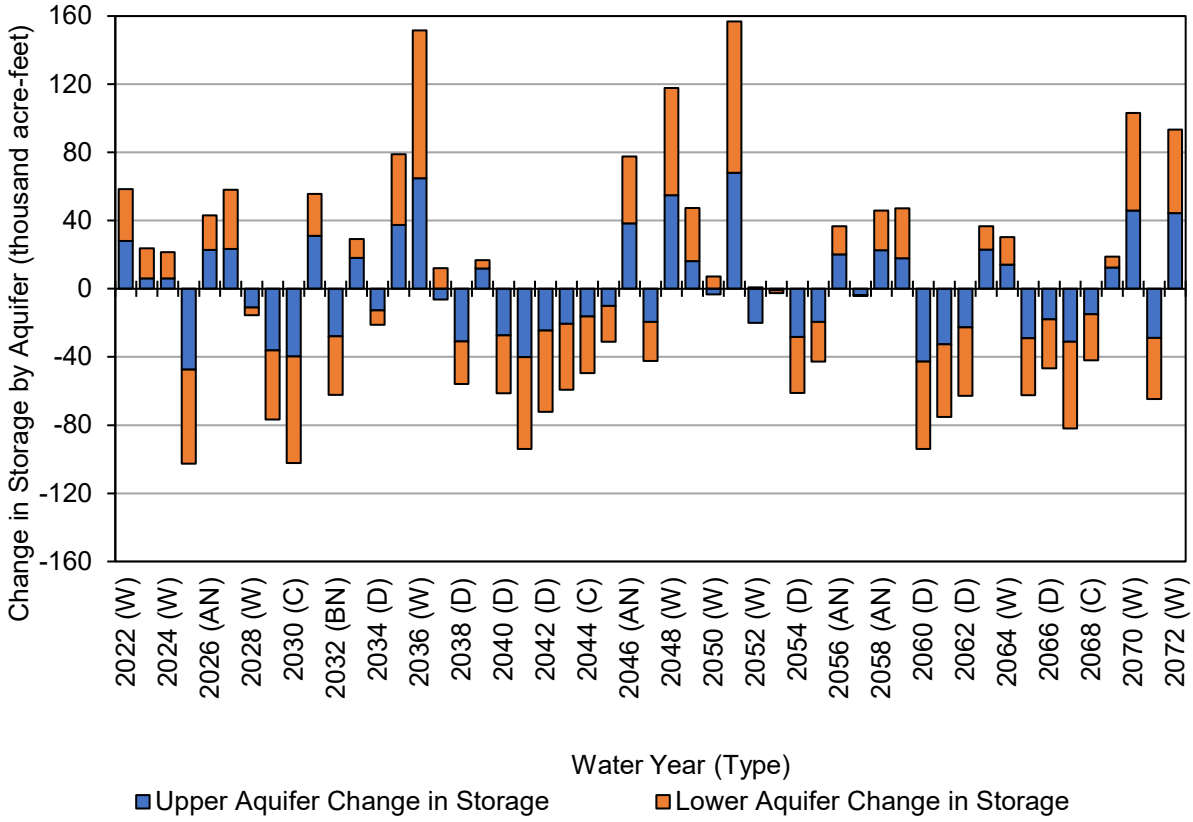

Figure 72. Red Bluff Subbasin Projected (Future Land Use) Change in Groundwater Storage by Aquifer

4 DETAILED PROJECTED (FUTURE LAND USE WITH CLIMATE CHANGE) WATER BUDGET

This section presents the results of the Projected (Future Land Use with Climate Change) scenario. This scenario assumes constant land use conditions based on assumed projected development within the Red Bluff Subbasin and the DWR climate change guidance for the 2070 central tendencies.

4.3 Surface Water System Water Budget Results

4.3.1 Inflows

4.3.1.1 Surface Water Inflow by Water Source Type

The projected annual volume of surface water inflows is summarized by water source type in **Figure 73** and **Table 70**. Over the projected (future land use with climate change) period, surface water inflows average about 140 taf per year. Virtually, all inflows of the SWS are local supplies. The CVP supplies are very small and average about 5 taf per year, on average.

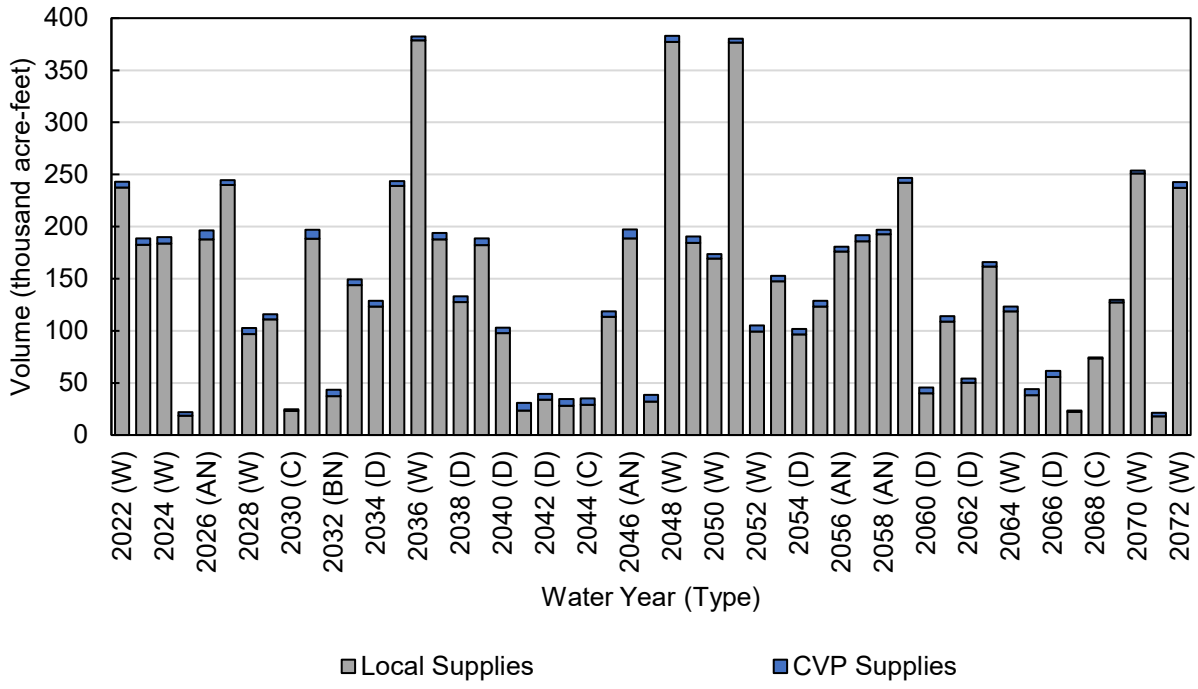

Figure 73. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Surface Water Inflows, by Water Source Type

Table 70. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Surface Water Inflows, by Water Source Type (acre-feet)

Water Year (Type)	CVP Supplies	Local Supplies	Total
2022 (W)	5,800	240,000	240,000
2023 (W)	6,300	180,000	190,000
2024 (W)	6,200	180,000	190,000
2025 (BN)	3,500	19,000	22,000
2026 (AN)	8,500	190,000	200,000
2027 (W)	4,600	240,000	240,000
2028 (W)	5,900	97,000	100,000
2029 (C)	5,000	110,000	120,000
2030 (C)	1,400	23,000	25,000
2031 (AN)	8,600	190,000	200,000
2032 (BN)	5,900	37,000	43,000
2033 (AN)	5,400	140,000	150,000
2034 (D)	5,500	120,000	130,000
2035 (W)	4,600	240,000	240,000
2036 (W)	3,700	380,000	380,000
2037 (W)	6,200	190,000	190,000
2038 (D)	5,500	130,000	130,000
2039 (W)	6,300	180,000	190,000
2040 (D)	5,300	98,000	100,000
2041 (C)	7,300	24,000	31,000
2042 (D)	5,600	34,000	39,000
2043 (C)	6,400	28,000	35,000
2044 (C)	6,300	29,000	35,000
2045 (C)	5,200	110,000	120,000
2046 (AN)	8,600	190,000	200,000
2047 (C)	6,400	32,000	38,000
2048 (W)	5,900	380,000	380,000
2049 (W)	6,300	180,000	190,000
2050 (W)	4,100	170,000	170,000
2051 (W)	3,700	380,000	380,000
2052 (W)	5,800	99,000	110,000
2053 (AN)	5,400	150,000	150,000
2054 (D)	5,300	97,000	100,000
2055 (D)	5,500	120,000	130,000
2056 (AN)	4,900	180,000	180,000

Water Year (Type)		CVP Supplies	Local Supplies	Total
2057 (BN)		5,900	190,000	190,000
2058 (AN)		4,400	190,000	200,000
2059 (W)		4,500	240,000	250,000
2060 (D)		5,600	40,000	46,000
2061 (C)		5,000	110,000	110,000
2062 (D)		3,900	50,000	54,000
2063 (BN)		4,200	160,000	170,000
2064 (W)		4,700	120,000	120,000
2065 (BN)		5,800	38,000	44,000
2066 (D)		5,700	56,000	61,000
2067 (C)		1,400	22,000	24,000
2068 (C)		950	73,000	74,000
2069 (BN)		2,500	130,000	130,000
2070 (W)		2,700	250,000	250,000
2071 (BN)		3,500	18,000	21,000
2072 (W)		5,800	240,000	240,000
Average (2022-2072)		5,200	140,000	140,000
2022-2072	W	5,200	220,000	230,000
	AN	6,500	170,000	180,000
	BN	4,500	84,000	88,000
	D	5,300	83,000	89,000
	C	4,500	56,000	61,000

4.3.1.2 Precipitation

Precipitation estimates for the Red Bluff Subbasin are provided in **Figure 74** and **Table 71**. Total precipitation is highly variable between years in the study area, ranging from approximately 440 taf (18.5 inches) during average critically dry years to 840 taf (37.0 inches) during average wet years.

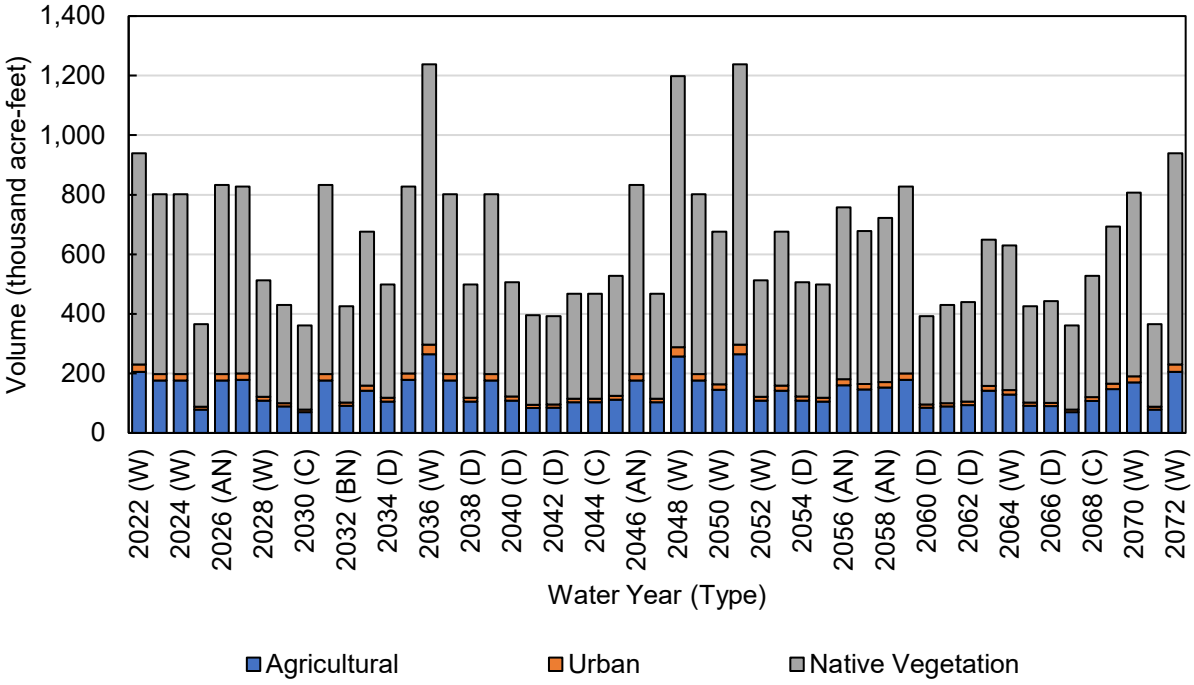

Figure 74. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Precipitation, by Water Use Sector

Table 71. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Precipitation, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (BN)	210,000	25,000	710,000	940,000
2023 (W)	180,000	21,000	600,000	800,000
2024 (W)	180,000	21,000	600,000	800,000
2025 (W)	79,000	9,600	280,000	360,000
2026 (BN)	180,000	22,000	640,000	830,000
2027 (AN)	180,000	22,000	630,000	830,000
2028 (W)	110,000	13,000	390,000	510,000
2029 (W)	89,000	11,000	330,000	430,000
2030 (C)	70,000	9,100	280,000	360,000
2031 (C)	180,000	22,000	640,000	830,000
2032 (AN)	91,000	11,000	320,000	430,000
2033 (BN)	140,000	18,000	520,000	680,000
2034 (AN)	110,000	13,000	380,000	500,000
2035 (D)	180,000	22,000	630,000	830,000
2036 (W)	260,000	32,000	940,000	1,200,000
2037 (W)	180,000	21,000	600,000	800,000
2038 (W)	110,000	13,000	380,000	500,000
2039 (D)	180,000	21,000	600,000	800,000
2040 (W)	110,000	13,000	380,000	510,000
2041 (D)	84,000	11,000	300,000	400,000
2042 (C)	85,000	11,000	300,000	390,000
2043 (D)	100,000	13,000	350,000	470,000
2044 (C)	100,000	13,000	350,000	470,000
2045 (C)	110,000	14,000	400,000	530,000
2046 (C)	180,000	22,000	640,000	830,000
2047 (AN)	100,000	13,000	350,000	470,000
2048 (C)	260,000	31,000	910,000	1,200,000
2049 (W)	180,000	21,000	600,000	800,000
2050 (W)	150,000	18,000	510,000	680,000
2051 (W)	260,000	32,000	940,000	1,200,000
2052 (W)	110,000	13,000	390,000	510,000
2053 (W)	140,000	18,000	520,000	680,000
2054 (AN)	110,000	13,000	380,000	510,000
2055 (D)	110,000	13,000	380,000	500,000
2056 (D)	160,000	20,000	580,000	760,000
2057 (AN)	150,000	18,000	510,000	680,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (BN)		150,000	19,000	550,000	720,000
2059 (AN)		180,000	22,000	630,000	830,000
2060 (W)		85,000	11,000	300,000	390,000
2061 (D)		89,000	11,000	330,000	430,000
2062 (C)		94,000	11,000	330,000	440,000
2063 (D)		140,000	17,000	490,000	650,000
2064 (BN)		130,000	15,000	490,000	630,000
2065 (W)		91,000	11,000	320,000	430,000
2066 (BN)		90,000	11,000	340,000	440,000
2067 (D)		70,000	9,100	280,000	360,000
2068 (C)		110,000	13,000	410,000	530,000
2069 (C)		150,000	18,000	530,000	690,000
2070 (BN)		170,000	21,000	620,000	810,000
2071 (W)		79,000	9,600	280,000	360,000
2072 (W)		210,000	25,000	710,000	940,000
Average (2022-2072)		140,000	17,000	490,000	640,000
2022-2072	W	180,000	22,000	640,000	840,000
	AN	160,000	20,000	580,000	760,000
	BN	110,000	13,000	390,000	510,000
	D	99,000	12,000	350,000	460,000
	C	93,000	11,000	340,000	440,000

4.3.1.3 Groundwater Extraction by Water Use Sector

Total groundwater extraction in the Red Bluff Subbasin represents a combination of groundwater pumping to support agricultural and urban water demands, including rural residential use, and groundwater uptake by crops, urban vegetation, and native vegetation.

Estimates of groundwater pumping by water use sector are provided in **Figure 75** and **Table 72**. Virtually all groundwater pumping in the Red Bluff Subbasin is used to meet agricultural demand, averaging 140 taf per year. Groundwater pumping for urban use is approximately 5.9 taf per year. The total groundwater extraction varies from about 130 taf in wet years to 160 taf in critically dry years based on variability in surface water supplies, precipitation, and crop water demand. When groundwater is near the land surface, groundwater uptake can also be a source of supply for vegetation. Estimates of groundwater uptake by vegetation are provided in **Figure 76** and **Table 73**. The majority of groundwater uptake is consumed directly by native vegetation and agricultural crops, totaling 3.1 taf and 1.0 taf per year, on average.

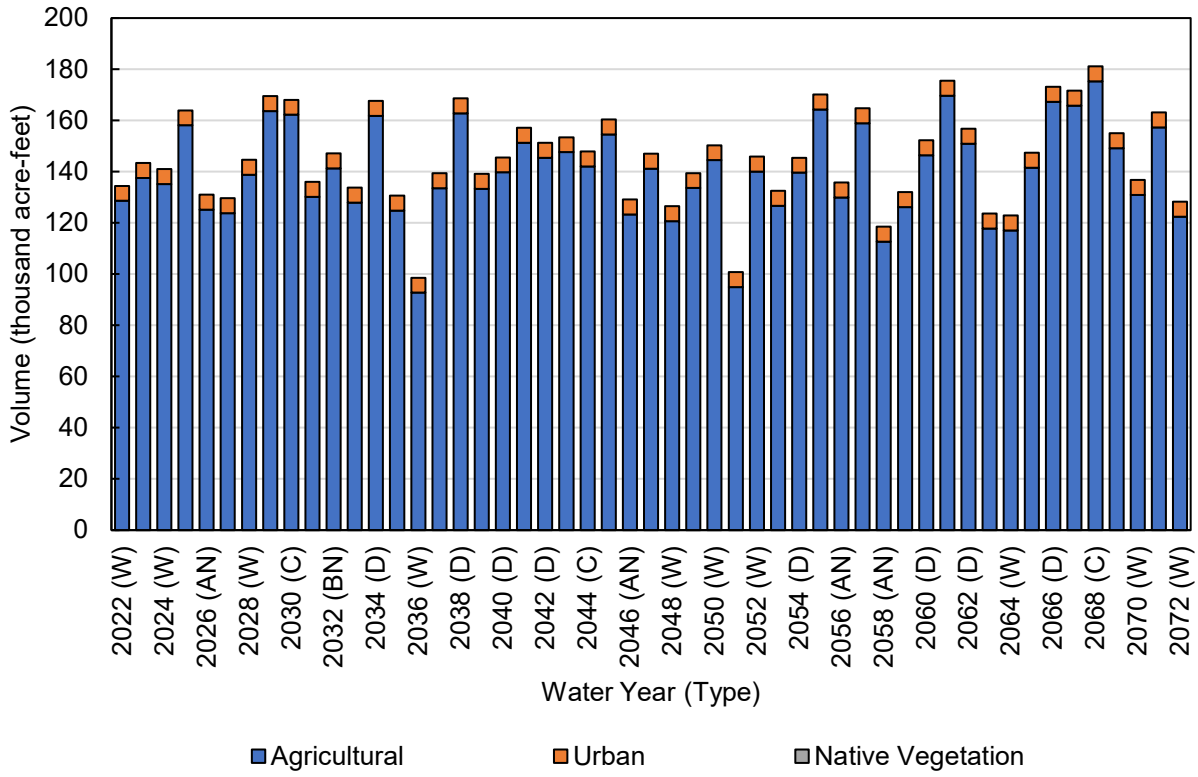

Figure 75. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Groundwater Pumping, by Water Use Sector

Table 72. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Groundwater Pumping, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (BN)	130,000	5,900	0	130,000
2023 (W)	140,000	5,900	0	140,000
2024 (W)	140,000	5,900	0	140,000
2025 (W)	160,000	5,900	0	160,000
2026 (BN)	130,000	5,900	0	130,000
2027 (AN)	120,000	5,900	0	130,000
2028 (W)	140,000	5,900	0	140,000
2029 (W)	160,000	5,900	0	170,000
2030 (C)	160,000	5,800	0	170,000
2031 (C)	130,000	5,900	0	140,000
2032 (AN)	140,000	5,800	0	150,000
2033 (BN)	130,000	5,900	0	130,000
2034 (AN)	160,000	5,800	0	170,000
2035 (D)	120,000	5,900	0	130,000
2036 (W)	93,000	5,900	0	99,000
2037 (W)	130,000	5,900	0	140,000
2038 (W)	160,000	5,900	0	170,000
2039 (D)	130,000	5,900	0	140,000
2040 (W)	140,000	5,900	0	150,000
2041 (D)	150,000	5,900	0	160,000
2042 (C)	150,000	5,800	0	150,000
2043 (D)	150,000	5,800	0	150,000
2044 (C)	140,000	5,800	0	150,000
2045 (C)	150,000	5,800	0	160,000
2046 (C)	120,000	5,900	0	130,000
2047 (AN)	140,000	5,800	0	150,000
2048 (C)	120,000	5,900	0	130,000
2049 (W)	130,000	5,900	0	140,000
2050 (W)	140,000	5,900	0	150,000
2051 (W)	95,000	5,900	0	100,000
2052 (W)	140,000	5,900	0	150,000
2053 (W)	130,000	5,900	0	130,000
2054 (AN)	140,000	5,900	0	150,000
2055 (D)	160,000	5,900	0	170,000
2056 (D)	130,000	5,900	0	140,000
2057 (AN)	160,000	5,900	0	160,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (BN)		110,000	5,900	0	120,000
2059 (AN)		130,000	5,900	0	130,000
2060 (W)		150,000	5,900	0	150,000
2061 (D)		170,000	5,900	0	180,000
2062 (C)		150,000	5,800	0	160,000
2063 (D)		120,000	5,900	0	120,000
2064 (BN)		120,000	5,900	0	120,000
2065 (W)		140,000	5,800	0	150,000
2066 (BN)		170,000	5,800	0	170,000
2067 (D)		170,000	5,800	0	170,000
2068 (C)		180,000	5,800	0	180,000
2069 (C)		150,000	5,800	0	160,000
2070 (BN)		130,000	5,900	0	140,000
2071 (W)		160,000	5,800	0	160,000
2072 (W)		120,000	5,900	0	130,000
Average (2022-2072)		140,000	5,900	0	150,000
2022-2072	W	130,000	5,900	0	130,000
	AN	130,000	5,900	0	130,000
	BN	150,000	5,800	0	150,000
	D	150,000	5,900	0	160,000
	C	160,000	5,800	0	160,000

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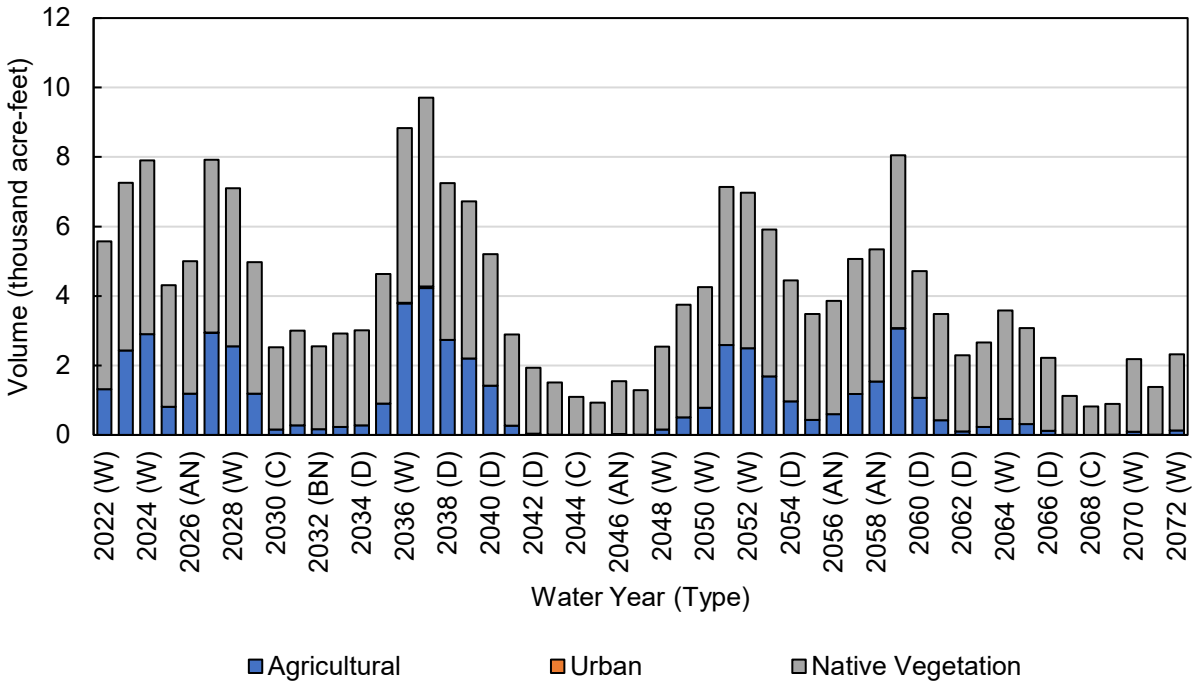

Figure 76. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Groundwater Uptake, by Water Use Sector

Table 73. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Groundwater Uptake, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (BN)	1,300	0	4,300	5,600
2023 (W)	2,400	0	4,800	7,300
2024 (W)	2,900	0	5,000	7,900
2025 (W)	810	0	3,500	4,300
2026 (BN)	1,200	0	3,800	5,000
2027 (AN)	2,900	10	5,000	7,900
2028 (W)	2,600	0	4,600	7,100
2029 (W)	1,200	0	3,800	5,000
2030 (C)	160	0	2,400	2,500
2031 (C)	280	0	2,700	3,000
2032 (AN)	170	0	2,400	2,600
2033 (BN)	230	0	2,700	2,900
2034 (AN)	280	0	2,700	3,000
2035 (D)	900	0	3,700	4,600
2036 (W)	3,800	10	5,000	8,800
2037 (W)	4,200	40	5,400	9,700
2038 (W)	2,700	0	4,500	7,300
2039 (D)	2,200	0	4,500	6,700
2040 (W)	1,400	0	3,800	5,200
2041 (D)	270	0	2,600	2,900
2042 (C)	40	0	1,900	1,900
2043 (D)	10	0	1,500	1,500
2044 (C)	10	0	1,100	1,100
2045 (C)	10	0	920	930
2046 (C)	30	0	1,500	1,600
2047 (AN)	10	0	1,300	1,300
2048 (C)	160	0	2,400	2,500
2049 (W)	510	0	3,200	3,800
2050 (W)	780	0	3,500	4,300
2051 (W)	2,600	0	4,600	7,100
2052 (W)	2,500	0	4,500	7,000
2053 (W)	1,700	0	4,200	5,900
2054 (AN)	970	0	3,500	4,500
2055 (D)	430	0	3,100	3,500
2056 (D)	600	0	3,300	3,900
2057 (AN)	1,200	0	3,900	5,100

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (BN)		1,500	0	3,800	5,300
2059 (AN)		3,100	10	5,000	8,100
2060 (W)		1,100	0	3,700	4,700
2061 (D)		420	0	3,100	3,500
2062 (C)		100	0	2,200	2,300
2063 (D)		230	0	2,400	2,700
2064 (BN)		460	0	3,100	3,600
2065 (W)		310	0	2,800	3,100
2066 (BN)		120	0	2,100	2,200
2067 (D)		10	0	1,100	1,100
2068 (C)		0	0	820	820
2069 (C)		10	0	880	890
2070 (BN)		90	0	2,100	2,200
2071 (W)		10	0	1,400	1,400
2072 (W)		130	0	2,200	2,300
Average (2022-2072)		1,000	0	3,100	4,100
2022-2072	W	1,900	0	4,100	5,900
	AN	790	0	3,200	3,900
	BN	390	0	2,500	2,900
	D	800	0	3,000	3,800
	C	210	0	1,900	2,100

4.3.1.4 Groundwater Discharge to Surface Waterways

Groundwater discharge to surface water, as described herein, represents a gain, or increase of flow, in waterways that traverse or flow along the boundary of the Red Bluff Subbasin. Groundwater discharge in the Red Bluff Subbasin is calculated from the Tehama IHM as the net groundwater outflow to water reaches (i.e., groundwater discharge) in excess of groundwater inflows from waterway reaches (i.e., seepage). The total volume of estimated groundwater discharge to surface water is summarized in **Figure 77** and **Table 74**, averaging approximately 10 taf per year.

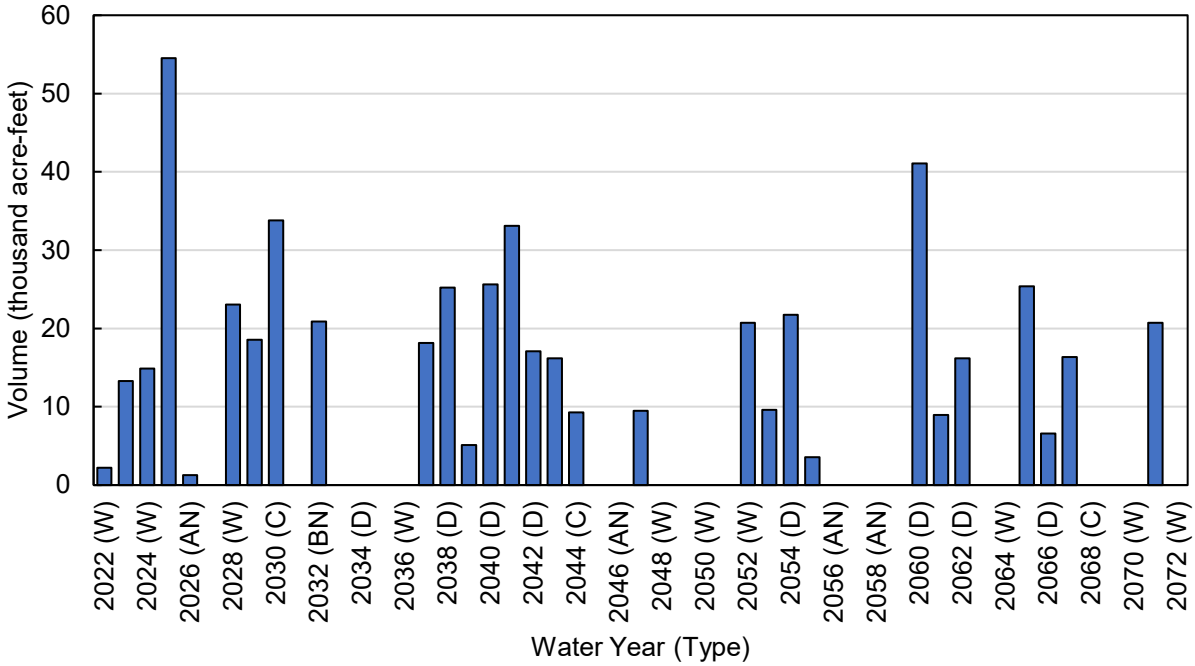

Figure 77. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Groundwater Discharge to Surface Water

Table 74. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Groundwater Discharge to Surface Water (acre-feet)

Water Year (Type)	Groundwater Discharge to Surface Water
2022 (BN)	2,200
2023 (W)	13,000
2024 (W)	15,000
2025 (W)	55,000
2026 (BN)	1,300
2027 (AN)	0
2028 (W)	23,000
2029 (W)	19,000
2030 (C)	34,000
2031 (C)	0
2032 (AN)	21,000
2033 (BN)	0
2034 (AN)	0
2035 (D)	0
2036 (W)	0
2037 (W)	18,000
2038 (W)	25,000
2039 (D)	5,100
2040 (W)	26,000
2041 (D)	33,000
2042 (C)	17,000
2043 (D)	16,000
2044 (C)	9,300
2045 (C)	0
2046 (C)	0
2047 (AN)	9,500
2048 (C)	0
2049 (W)	0
2050 (W)	0
2051 (W)	0
2052 (W)	21,000
2053 (W)	9,600
2054 (AN)	22,000
2055 (D)	3,600
2056 (D)	0
2057 (AN)	0

Water Year (Type)		Groundwater Discharge to Surface Water
2058 (BN)		0
2059 (AN)		0
2060 (W)		41,000
2061 (D)		8,900
2062 (C)		16,000
2063 (D)		0
2064 (BN)		0
2065 (W)		25,000
2066 (BN)		6,600
2067 (D)		16,000
2068 (C)		0
2069 (C)		0
2070 (BN)		0
2071 (W)		21,000
2072 (W)		0
Average (2022-2072)		10,000
2022-2072	W	5,400
	AN	1,600
	BN	17,000
	D	17,000
	C	15,000

4.3.2 Outflows

4.3.2.1 Evapotranspiration by Water Use Sector

Evapotranspiration (ET) by water use sector is reported in **Figure 78** through **Figure 81,** and **Table 75** through **Table 78**. First, total ET is reported, followed by ET from applied water (ET of water actively applied from surface water deliveries or groundwater pumping), ET of groundwater uptake (ET of shallow water extracted directly by vegetation), and ET from precipitation (ET of water supplied through rainfall).

Total ET varies between years, with a projected average of 490 taf per year. Agricultural ET tends to increase slightly in drier years due to increased climatic demand, while the ET of native vegetation typically decreases due to reduced water supply. ET of applied water occurs primarily from agricultural land, averaging about 110 taf in wet years and about 140 taf in years classified as dry or critical. Native vegetation and agricultural crops in the Red Bluff Subbasin also directly consume shallow groundwater to meet a portion of their consumptive use requirements. ET of groundwater uptake by native vegetation and agricultural crops and totals 3.1 and 1.0 taf per year, on average. Urban ET of applied water is consistently very low and negligible.

ET of precipitation generally follows the pattern of precipitation, with higher volumes occurring in wet years when more precipitation occurs. Across all water use sectors, ET of precipitation in the Red Bluff Subbasin averages about 390 taf in wet and above-normal years and 340 taf in dry and critical water years. Much of the total ET of precipitation results from the large acreage of native vegetation in the Red Bluff Subbasin, though significant volumes result from agricultural and urban areas as well.

Evaporation from rivers, streams, and canals in the Red Bluff Subbasin is reported in **Figure 82** and **Table 79**. The total volume is relatively small and constant between years, averaging approximately 1.1 taf per year. Evaporation from upgradient small watersheds is minimal, and is also not considered to substantially contribute to the subbasin SWS water budget.

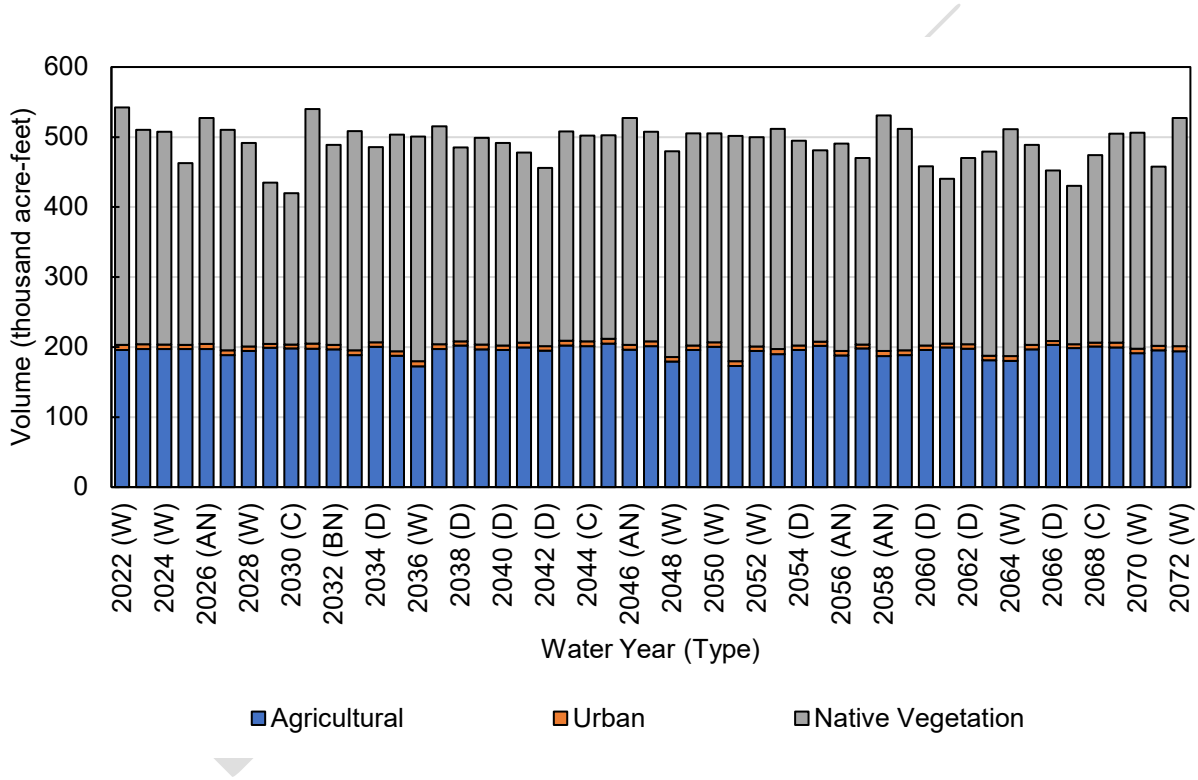

Figure 78. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Total Evapotranspiration, (acre-feet)

Table 75. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Total Evapotranspiration, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	200,000	7,300	340,000	540,000
2023 (W)	200,000	6,700	310,000	510,000
2024 (W)	200,000	6,600	300,000	510,000
2025 (BN)	200,000	6,200	260,000	460,000
2026 (AN)	200,000	7,100	320,000	530,000
2027 (W)	190,000	6,800	320,000	510,000
2028 (W)	190,000	6,300	290,000	490,000
2029 (C)	200,000	5,300	230,000	440,000
2030 (C)	200,000	5,400	220,000	420,000
2031 (AN)	200,000	7,300	340,000	540,000
2032 (BN)	200,000	6,600	290,000	490,000
2033 (AN)	190,000	6,900	310,000	510,000
2034 (D)	200,000	6,100	280,000	490,000
2035 (W)	190,000	6,700	310,000	500,000
2036 (W)	170,000	6,900	320,000	500,000
2037 (W)	200,000	6,600	310,000	520,000
2038 (D)	200,000	6,100	280,000	490,000
2039 (W)	200,000	6,600	300,000	500,000
2040 (D)	200,000	6,400	290,000	490,000
2041 (C)	200,000	6,700	270,000	480,000
2042 (D)	190,000	6,400	250,000	460,000
2043 (C)	200,000	7,000	300,000	510,000
2044 (C)	200,000	7,000	290,000	500,000
2045 (C)	210,000	6,600	290,000	500,000
2046 (AN)	200,000	7,100	320,000	530,000
2047 (C)	200,000	7,000	300,000	510,000
2048 (W)	180,000	6,400	290,000	480,000
2049 (W)	200,000	6,600	300,000	510,000
2050 (W)	200,000	6,700	300,000	510,000
2051 (W)	170,000	7,000	320,000	500,000
2052 (W)	190,000	6,300	300,000	500,000
2053 (AN)	190,000	6,900	310,000	510,000
2054 (D)	200,000	6,500	290,000	490,000
2055 (D)	200,000	6,100	270,000	480,000
2056 (AN)	190,000	6,600	300,000	490,000
2057 (BN)	200,000	5,800	270,000	470,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		190,000	7,400	340,000	530,000
2059 (W)		190,000	6,800	320,000	510,000
2060 (D)		200,000	6,400	260,000	460,000
2061 (C)		200,000	5,400	240,000	440,000
2062 (D)		200,000	6,400	270,000	470,000
2063 (BN)		180,000	6,500	290,000	480,000
2064 (W)		180,000	6,900	320,000	510,000
2065 (BN)		200,000	6,600	290,000	490,000
2066 (D)		200,000	5,500	240,000	450,000
2067 (C)		200,000	5,600	230,000	430,000
2068 (C)		200,000	5,800	270,000	470,000
2069 (BN)		200,000	6,700	300,000	510,000
2070 (W)		190,000	6,600	310,000	510,000
2071 (BN)		200,000	6,200	260,000	460,000
2072 (W)		190,000	7,200	330,000	530,000
Average (2022-2072)		190,000	6,500	290,000	490,000
2022 - 2072	W	190,000	6,700	310,000	510,000
	AN	190,000	7,100	320,000	520,000
	BN	190,000	6,400	280,000	480,000
	D	200,000	6,200	270,000	470,000
	C	200,000	6,200	260,000	470,000

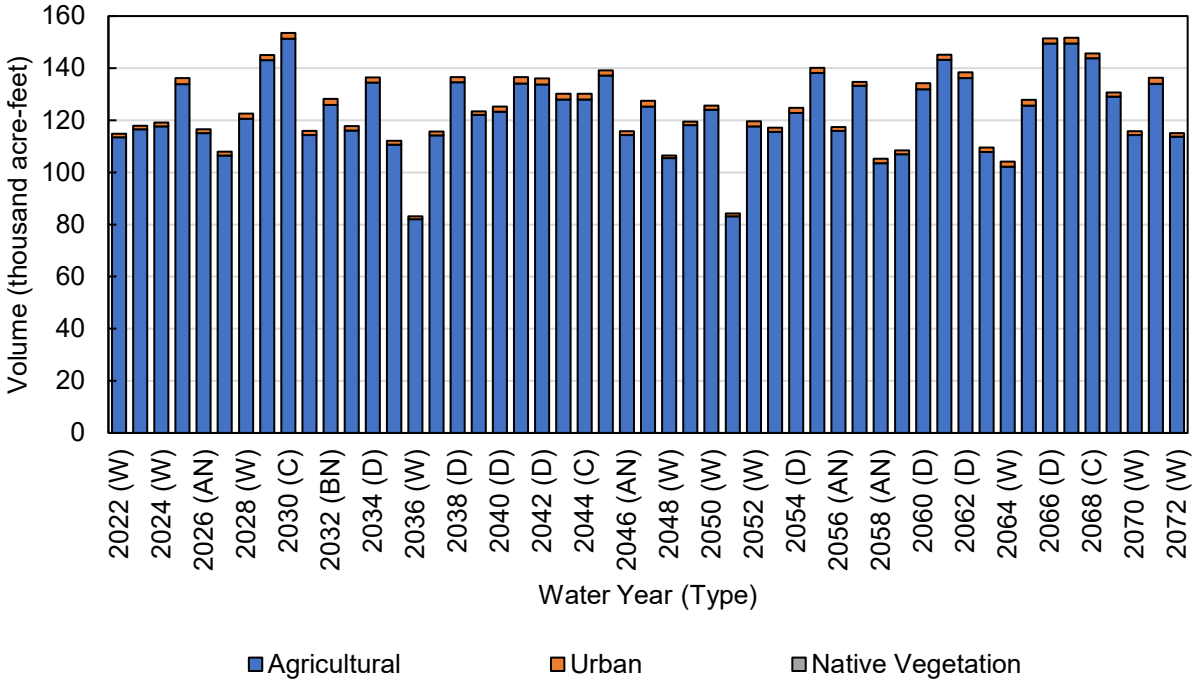

Figure 79. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Evapotranspiration of Applied Water, by Water Use Sector

Table 76. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Evapotranspiration of Applied Water, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	110,000	1,400	0	110,000
2023 (W)	120,000	1,400	0	120,000
2024 (W)	120,000	1,400	0	120,000
2025 (BN)	130,000	2,400	0	140,000
2026 (AN)	120,000	1,500	0	120,000
2027 (W)	110,000	1,400	0	110,000
2028 (W)	120,000	1,900	0	120,000
2029 (C)	140,000	1,900	0	150,000
2030 (C)	150,000	2,100	0	150,000
2031 (AN)	110,000	1,600	0	120,000
2032 (BN)	130,000	2,300	0	130,000
2033 (AN)	120,000	1,700	0	120,000
2034 (D)	130,000	1,900	0	140,000
2035 (W)	110,000	1,400	0	110,000
2036 (W)	82,000	1,100	0	83,000
2037 (W)	110,000	1,400	0	120,000
2038 (D)	130,000	1,900	0	140,000
2039 (W)	120,000	1,400	0	120,000
2040 (D)	120,000	2,000	0	130,000
2041 (C)	130,000	2,400	0	140,000
2042 (D)	130,000	2,300	0	140,000
2043 (C)	130,000	2,200	0	130,000
2044 (C)	130,000	2,200	0	130,000
2045 (C)	140,000	2,000	0	140,000
2046 (AN)	110,000	1,500	0	120,000
2047 (C)	130,000	2,200	0	130,000
2048 (W)	110,000	1,000	0	110,000
2049 (W)	120,000	1,400	0	120,000
2050 (W)	120,000	1,600	0	130,000
2051 (W)	83,000	1,100	0	84,000
2052 (W)	120,000	1,900	0	120,000
2053 (AN)	120,000	1,700	0	120,000
2054 (D)	120,000	2,000	0	120,000
2055 (D)	140,000	1,900	0	140,000
2056 (AN)	120,000	1,500	0	120,000
2057 (BN)	130,000	1,400	0	130,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		100,000	1,800	0	110,000
2059 (W)		110,000	1,400	0	110,000
2060 (D)		130,000	2,300	0	130,000
2061 (C)		140,000	1,900	0	150,000
2062 (D)		140,000	2,200	0	140,000
2063 (BN)		110,000	1,700	0	110,000
2064 (W)		100,000	1,900	0	100,000
2065 (BN)		130,000	2,300	0	130,000
2066 (D)		150,000	1,900	0	150,000
2067 (C)		150,000	2,200	0	150,000
2068 (C)		140,000	1,800	0	150,000
2069 (BN)		130,000	1,700	0	130,000
2070 (W)		110,000	1,500	0	120,000
2071 (BN)		130,000	2,400	0	140,000
2072 (W)		110,000	1,400	0	120,000
Average (2022-2072)		120,000	1,800	0	120,000
2022 - 2072	W	110,000	1,500	0	110,000
	AN	110,000	1,600	0	120,000
	BN	130,000	2,000	0	130,000
	D	130,000	2,000	0	140,000
	C	140,000	2,100	0	140,000

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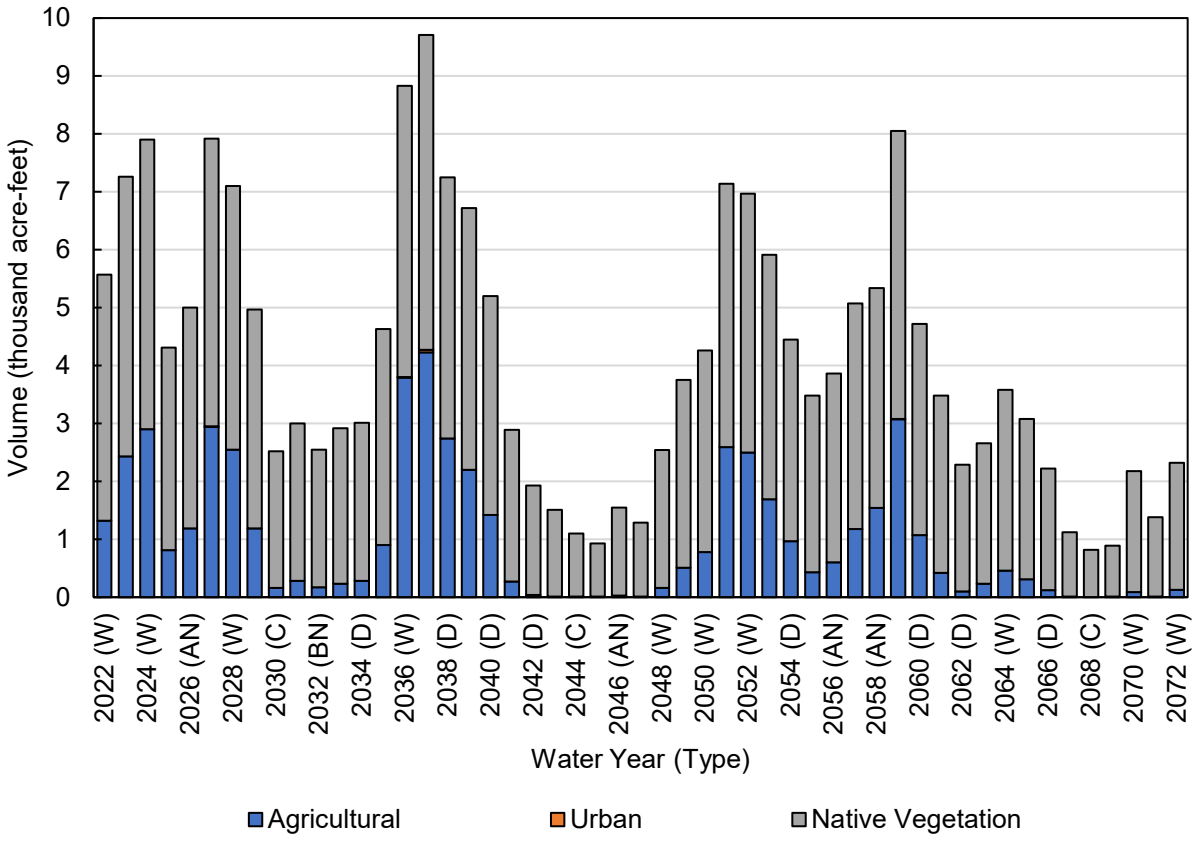

Figure 80. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Evapotranspiration of Groundwater Uptake, by Water Use Sector

Table 77. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Evapotranspiration of Groundwater Uptake, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	1,300	0	4,300	5,600
2023 (W)	2,400	0	4,800	7,300
2024 (W)	2,900	0	5,000	7,900
2025 (BN)	810	0	3,500	4,300
2026 (AN)	1,200	0	3,800	5,000
2027 (W)	2,900	10	5,000	7,900
2028 (W)	2,600	0	4,600	7,100
2029 (C)	1,200	0	3,800	5,000
2030 (C)	160	0	2,400	2,500
2031 (AN)	280	0	2,700	3,000
2032 (BN)	170	0	2,400	2,600
2033 (AN)	230	0	2,700	2,900
2034 (D)	280	0	2,700	3,000
2035 (W)	900	0	3,700	4,600
2036 (W)	3,800	10	5,000	8,800
2037 (W)	4,200	40	5,400	9,700
2038 (D)	2,700	0	4,500	7,300
2039 (W)	2,200	0	4,500	6,700
2040 (D)	1,400	0	3,800	5,200
2041 (C)	270	0	2,600	2,900
2042 (D)	40	0	1,900	1,900
2043 (C)	10	0	1,500	1,500
2044 (C)	10	0	1,100	1,100
2045 (C)	10	0	920	930
2046 (AN)	30	0	1,500	1,600
2047 (C)	10	0	1,300	1,300
2048 (W)	160	0	2,400	2,500
2049 (W)	510	0	3,200	3,800
2050 (W)	780	0	3,500	4,300
2051 (W)	2,600	0	4,600	7,100
2052 (W)	2,500	0	4,500	7,000
2053 (AN)	1,700	0	4,200	5,900
2054 (D)	970	0	3,500	4,500
2055 (D)	430	0	3,100	3,500
2056 (AN)	600	0	3,300	3,900
2057 (BN)	1,200	0	3,900	5,100

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		1,500	0	3,800	5,300
2059 (W)		3,100	10	5,000	8,100
2060 (D)		1,100	0	3,700	4,700
2061 (C)		420	0	3,100	3,500
2062 (D)		100	0	2,200	2,300
2063 (BN)		230	0	2,400	2,700
2064 (W)		460	0	3,100	3,600
2065 (BN)		310	0	2,800	3,100
2066 (D)		120	0	2,100	2,200
2067 (C)		10	0	1,100	1,100
2068 (C)		0	0	820	820
2069 (BN)		10	0	880	890
2070 (W)		90	0	2,100	2,200
2071 (BN)		10	0	1,400	1,400
2072 (W)		130	0	2,200	2,300
Average (2022-2072)		1,000	0	3,100	4,100
2022 - 2072	W	1,900	0	4,100	5,900
	AN	790	0	3,200	3,900
	BN	390	0	2,500	2,900
	D	800	0	3,000	3,800
	C	210	0	1,900	2,100

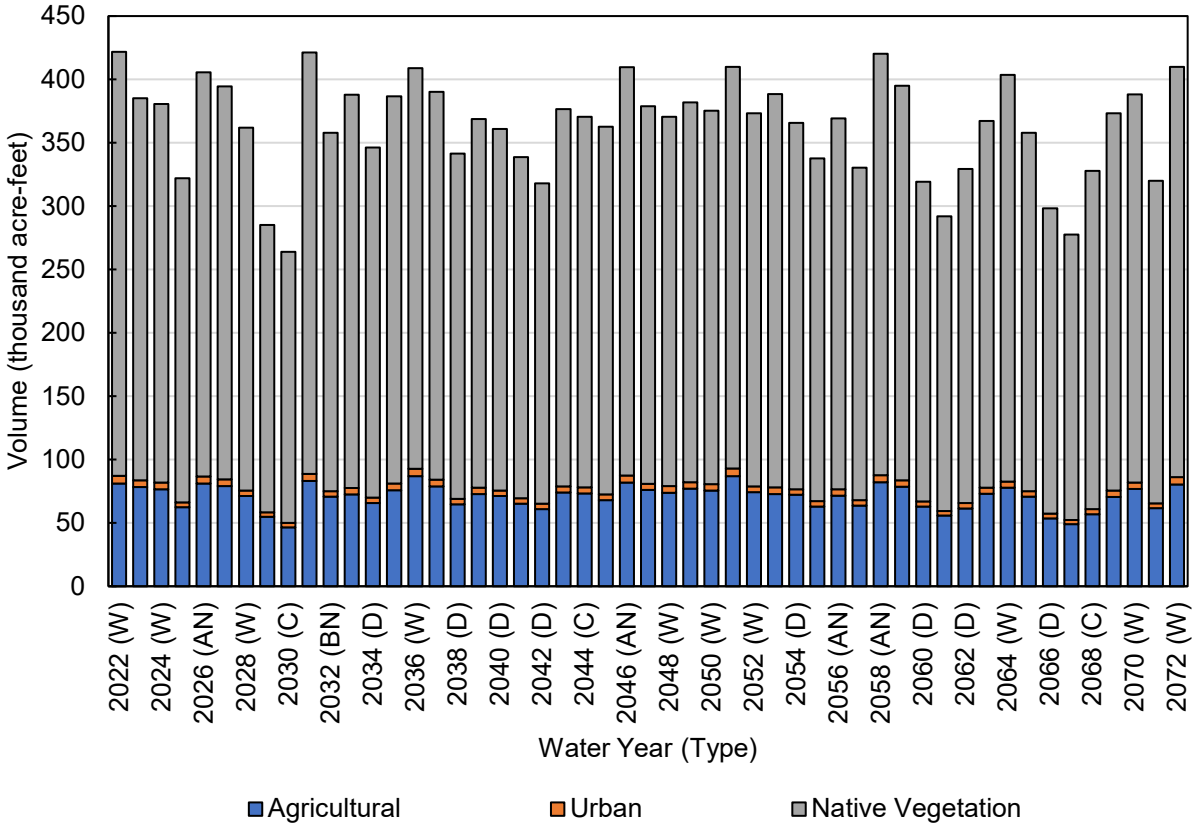

Figure 81. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Evapotranspiration of Precipitation, by Water Use Sector

Table 78. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Evapotranspiration of Precipitation, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	81,000	5,900	330,000	420,000
2023 (W)	78,000	5,300	300,000	390,000
2024 (W)	77,000	5,200	300,000	380,000
2025 (BN)	62,000	3,900	260,000	320,000
2026 (AN)	81,000	5,600	320,000	410,000
2027 (W)	79,000	5,300	310,000	390,000
2028 (W)	71,000	4,400	290,000	360,000
2029 (C)	55,000	3,500	230,000	290,000
2030 (C)	47,000	3,300	210,000	260,000
2031 (AN)	83,000	5,700	330,000	420,000
2032 (BN)	71,000	4,300	280,000	360,000
2033 (AN)	72,000	5,200	310,000	390,000
2034 (D)	66,000	4,200	280,000	350,000
2035 (W)	76,000	5,300	310,000	390,000
2036 (W)	87,000	5,900	320,000	410,000
2037 (W)	79,000	5,200	310,000	390,000
2038 (D)	65,000	4,200	270,000	340,000
2039 (W)	73,000	5,200	290,000	370,000
2040 (D)	71,000	4,500	290,000	360,000
2041 (C)	65,000	4,300	270,000	340,000
2042 (D)	61,000	4,100	250,000	320,000
2043 (C)	74,000	4,800	300,000	380,000
2044 (C)	73,000	4,800	290,000	370,000
2045 (C)	68,000	4,600	290,000	360,000
2046 (AN)	82,000	5,600	320,000	410,000
2047 (C)	76,000	4,800	300,000	380,000
2048 (W)	74,000	5,400	290,000	370,000
2049 (W)	77,000	5,200	300,000	380,000
2050 (W)	75,000	5,000	290,000	380,000
2051 (W)	87,000	5,900	320,000	410,000
2052 (W)	74,000	4,400	290,000	370,000
2053 (AN)	73,000	5,200	310,000	390,000
2054 (D)	72,000	4,500	290,000	370,000
2055 (D)	63,000	4,200	270,000	340,000
2056 (AN)	71,000	5,100	290,000	370,000
2057 (BN)	64,000	4,400	260,000	330,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		82,000	5,600	330,000	420,000
2059 (W)		78,000	5,300	310,000	400,000
2060 (D)		63,000	4,100	250,000	320,000
2061 (C)		56,000	3,500	230,000	290,000
2062 (D)		61,000	4,200	260,000	330,000
2063 (BN)		73,000	4,900	290,000	370,000
2064 (W)		78,000	5,000	320,000	400,000
2065 (BN)		71,000	4,300	280,000	360,000
2066 (D)		54,000	3,600	240,000	300,000
2067 (C)		49,000	3,400	230,000	280,000
2068 (C)		57,000	4,000	270,000	330,000
2069 (BN)		70,000	5,000	300,000	370,000
2070 (W)		77,000	5,100	310,000	390,000
2071 (BN)		62,000	3,900	250,000	320,000
2072 (W)		80,000	5,800	320,000	410,000
Average (2022-2072)		71,000	4,700	290,000	360,000
2022 - 2072	W	78,000	5,300	310,000	390,000
	AN	78,000	5,400	320,000	400,000
	BN	67,000	4,400	280,000	350,000
	D	64,000	4,200	270,000	340,000
	C	62,000	4,100	260,000	330,000

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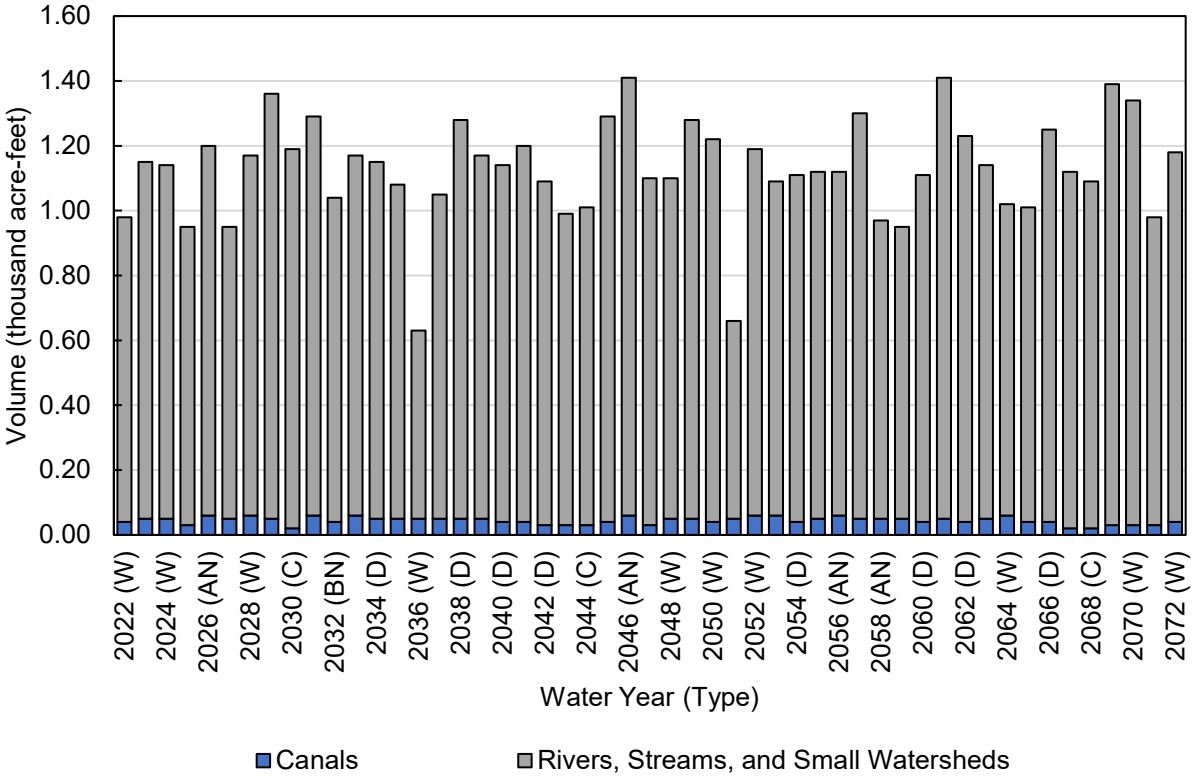

Figure 82. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Evaporation of Surface Water Sources

Table 79. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Evaporation of Surface Water Sources, by Water Use Sector (acre-feet)

Water Year (Type)	Canals	Rivers, Streams, and Small Watersheds[1]	Total
2022 (W)	40	940	980
2023 (W)	50	1,100	1,200
2024 (W)	50	1,100	1,100
2025 (BN)	30	920	950
2026 (AN)	60	1,100	1,200
2027 (W)	50	900	950
2028 (W)	60	1,100	1,200
2029 (C)	50	1,300	1,400
2030 (C)	20	1,200	1,200
2031 (AN)	60	1,200	1,300
2032 (BN)	40	1,000	1,000
2033 (AN)	60	1,100	1,200
2034 (D)	50	1,100	1,200
2035 (W)	50	1,000	1,100
2036 (W)	50	580	630
2037 (W)	50	1,000	1,100
2038 (D)	50	1,200	1,300
2039 (W)	50	1,100	1,200
2040 (D)	40	1,100	1,100
2041 (C)	40	1,200	1,200
2042 (D)	30	1,100	1,100
2043 (C)	30	960	990
2044 (C)	30	980	1,000
2045 (C)	40	1,300	1,300
2046 (AN)	60	1,400	1,400
2047 (C)	30	1,100	1,100
2048 (W)	50	1,100	1,100
2049 (W)	50	1,200	1,300
2050 (W)	40	1,200	1,200
2051 (W)	50	610	660
2052 (W)	60	1,100	1,200
2053 (AN)	60	1,000	1,100
2054 (D)	40	1,100	1,100
2055 (D)	50	1,100	1,100
2056 (AN)	60	1,100	1,100
2057 (BN)	50	1,300	1,300
2058 (AN)	50	920	970

Water Year (Type)		Canals	Rivers, Streams, and Small Watersheds[1]	Total
2059 (W)		50	900	950
2060 (D)		40	1,100	1,100
2061 (C)		50	1,400	1,400
2062 (D)		40	1,200	1,200
2063 (BN)		50	1,100	1,100
2064 (W)		60	960	1,000
2065 (BN)		40	970	1,000
2066 (D)		40	1,200	1,300
2067 (C)		20	1,100	1,100
2068 (C)		20	1,100	1,100
2069 (BN)		30	1,400	1,400
2070 (W)		30	1,300	1,300
2071 (BN)		30	950	980
2072 (W)		40	1,100	1,200
Average (2022-2072)		40	1,100	1,100
2022 - 2072	W	50	1,000	1,100
	AN	60	1,100	1,200
	BN	40	1,100	1,100
	D	40	1,100	1,200
	C	30	1,100	1,200

[1] Includes ET of riparian vegetation along rivers and streams.

4.3.2.2 Surface Water Outflow by Water Source Type

Surface water outflows from the Red Bluff Subbasin are summarized in **Figure 83** and **Table 80** by water source type. In the Red Bluff Subbasin, local supply outflows primarily include outflows of runoff, tailwater, and net drainage from land surfaces, in addition to runoff from small watersheds and stream outflows to the Sacramento River. Local supply outflows average approximately 370 taf per year, and range from 170 taf in critically dry years up to 590 taf in wet years. Other surface water outflows that leave the subbasin include outflow of groundwater discharge to the Sacramento River, Red Bank Creek, and Elder Creek. This water travels along each respective waterway as part of the flow in the river or creek.

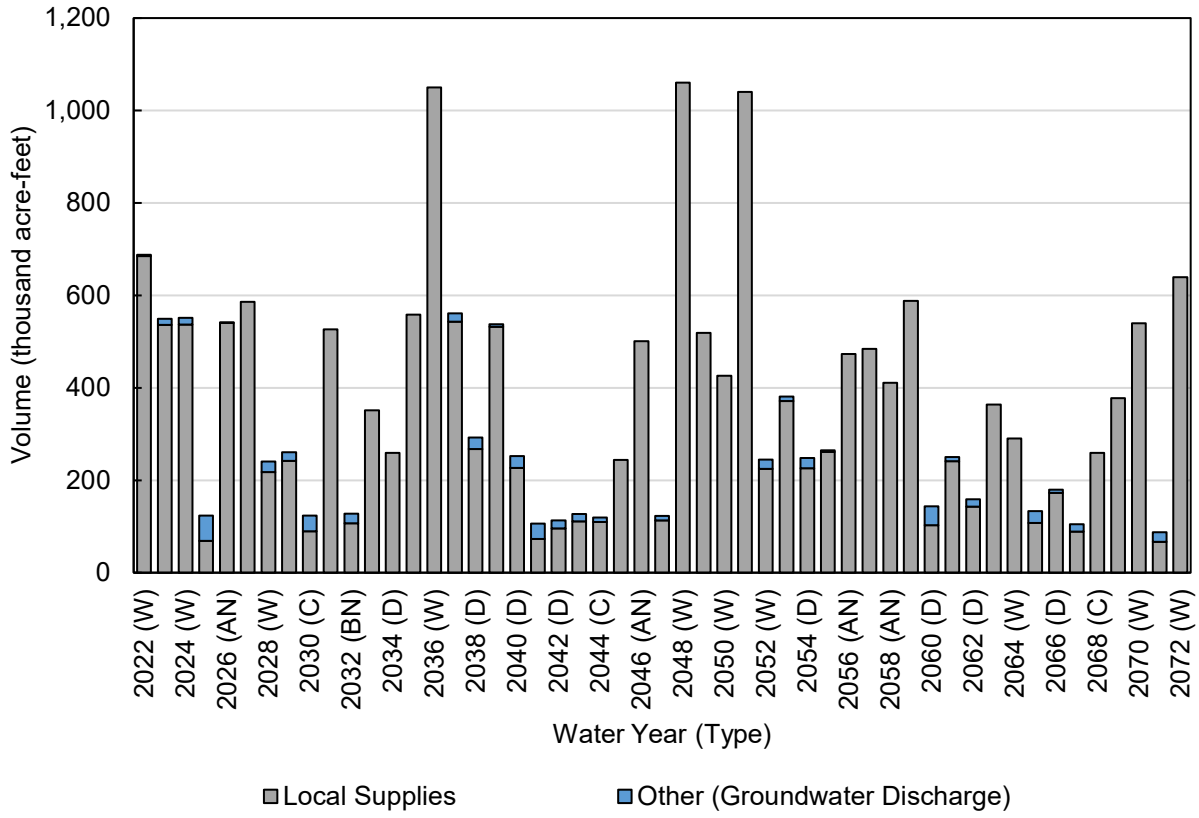

Figure 83. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Surface Water Outflows, by Water Source Type

Table 80. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Surface Water Outflows, by Water Source Type (acre-feet)

Water Year (Type)	CVP Supplies	Local Supplies	Other (Groundwater Discharge)	Total
2022 (W)	0	690,000	2,200	690,000
2023 (W)	0	540,000	13,000	550,000
2024 (W)	0	540,000	15,000	550,000
2025 (BN)	0	69,000	55,000	120,000
2026 (AN)	0	540,000	1,300	540,000
2027 (W)	0	590,000	0	590,000
2028 (W)	0	220,000	23,000	240,000
2029 (C)	0	240,000	19,000	260,000
2030 (C)	0	90,000	34,000	120,000
2031 (AN)	0	530,000	0	530,000
2032 (BN)	0	110,000	21,000	130,000
2033 (AN)	0	350,000	0	350,000
2034 (D)	0	260,000	0	260,000
2035 (W)	0	560,000	0	560,000
2036 (W)	0	1,000,000	0	1,000,000
2037 (W)	0	540,000	18,000	560,000
2038 (D)	0	270,000	25,000	290,000
2039 (W)	0	530,000	5,100	540,000
2040 (D)	0	230,000	26,000	250,000
2041 (C)	0	73,000	33,000	110,000
2042 (D)	0	96,000	17,000	110,000
2043 (C)	0	110,000	16,000	130,000
2044 (C)	0	110,000	9,300	120,000
2045 (C)	0	240,000	0	240,000
2046 (AN)	0	500,000	0	500,000
2047 (C)	0	110,000	9,500	120,000
2048 (W)	0	1,100,000	0	1,100,000
2049 (W)	0	520,000	0	520,000
2050 (W)	0	430,000	0	430,000
2051 (W)	0	1,000,000	0	1,000,000
2052 (W)	0	220,000	21,000	250,000
2053 (AN)	0	370,000	9,600	380,000
2054 (D)	0	230,000	22,000	250,000
2055 (D)	0	260,000	3,600	270,000
2056 (AN)	0	470,000	0	470,000

Water Year (Type)		CVP Supplies	Local Supplies	Other (Groundwater Discharge)	Total
2057 (BN)		0	480,000	0	480,000
2058 (AN)		0	410,000	0	410,000
2059 (W)		0	590,000	0	590,000
2060 (D)		0	100,000	41,000	140,000
2061 (C)		0	240,000	8,900	250,000
2062 (D)		0	140,000	16,000	160,000
2063 (BN)		0	360,000	0	360,000
2064 (W)		0	290,000	0	290,000
2065 (BN)		0	110,000	25,000	130,000
2066 (D)		0	170,000	6,600	180,000
2067 (C)		0	89,000	16,000	110,000
2068 (C)		0	260,000	0	260,000
2069 (BN)		0	380,000	0	380,000
2070 (W)		0	540,000	0	540,000
2071 (BN)		0	67,000	21,000	87,000
2072 (W)		0	640,000	0	640,000
Average (2022-2072)		0	370,000	10,000	380,000
2022 - 2072	W	0	590,000	5,400	590,000
	AN	0	450,000	1,600	460,000
	BN	0	230,000	17,000	240,000
	D	0	190,000	17,000	210,000
	C	0	160,000	15,000	170,000

4.3.2.3 Deep Percolation of Applied Water

Estimated deep percolation of applied water (equal to infiltration of applied water in 23 CCR § 354.18(b)(2)) is summarized in **Figure 84** and **Table 81** by water use sector. Deep percolation of applied water is about 17 taf on average, and dominated by agricultural irrigation and varies between years, following the pattern of surface water diversions and deliveries to irrigated lands.

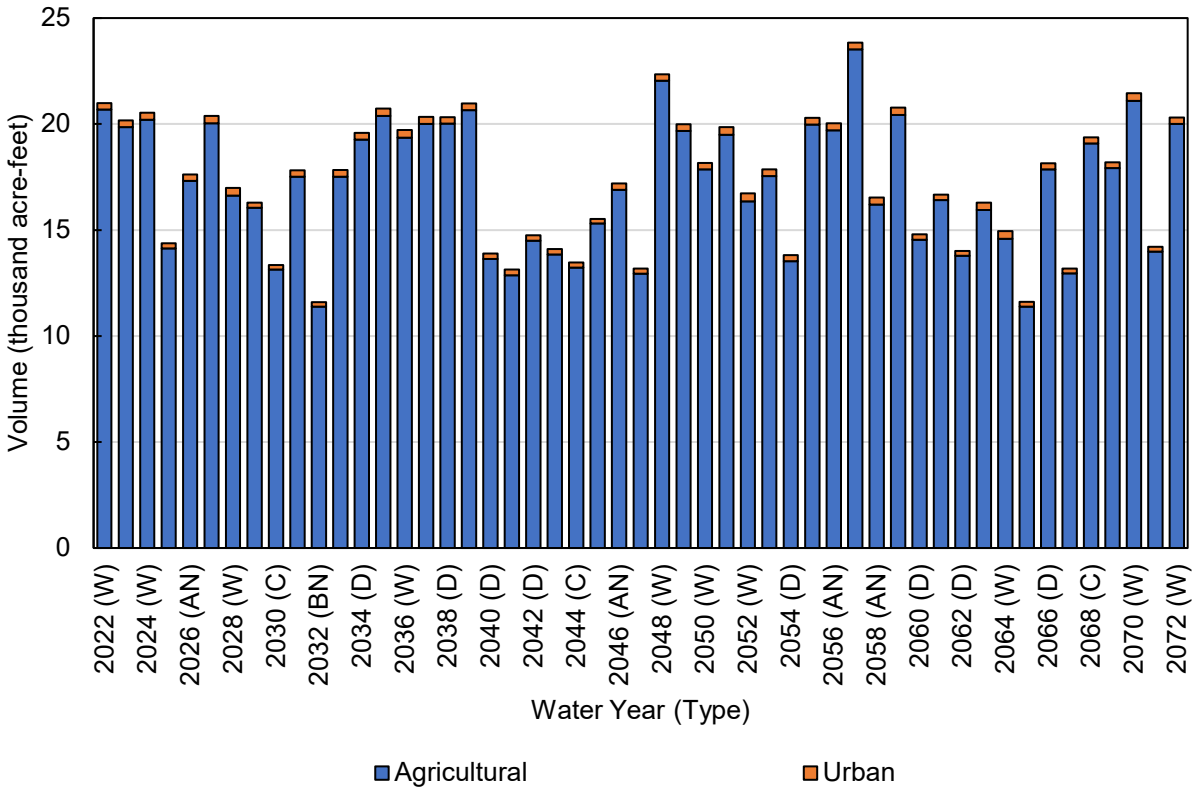

Figure 84. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Deep Percolation of Applied Water, by Water Use Sector

Table 81. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Deep Percolation of Applied Water, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	21,000	300	0	21,000
2023 (W)	20,000	320	0	20,000
2024 (W)	20,000	320	0	21,000
2025 (BN)	14,000	240	0	14,000
2026 (AN)	17,000	300	0	18,000
2027 (W)	20,000	350	0	20,000
2028 (W)	17,000	360	0	17,000
2029 (C)	16,000	250	0	16,000
2030 (C)	13,000	210	0	13,000
2031 (AN)	18,000	300	0	18,000
2032 (BN)	11,000	220	0	12,000
2033 (AN)	18,000	330	0	18,000
2034 (D)	19,000	320	0	20,000
2035 (W)	20,000	340	0	21,000
2036 (W)	19,000	360	0	20,000
2037 (W)	20,000	330	0	20,000
2038 (D)	20,000	310	0	20,000
2039 (W)	21,000	320	0	21,000
2040 (D)	14,000	270	0	14,000
2041 (C)	13,000	270	0	13,000
2042 (D)	15,000	260	0	15,000
2043 (C)	14,000	250	0	14,000
2044 (C)	13,000	240	0	13,000
2045 (C)	15,000	210	0	16,000
2046 (AN)	17,000	300	0	17,000
2047 (C)	13,000	240	0	13,000
2048 (W)	22,000	290	0	22,000
2049 (W)	20,000	320	0	20,000
2050 (W)	18,000	300	0	18,000
2051 (W)	19,000	360	0	20,000
2052 (W)	16,000	370	0	17,000
2053 (AN)	18,000	330	0	18,000
2054 (D)	14,000	280	0	14,000
2055 (D)	20,000	310	0	20,000
2056 (AN)	20,000	330	0	20,000
2057 (BN)	24,000	320	0	24,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		16,000	340	0	17,000
2059 (W)		20,000	350	0	21,000
2060 (D)		15,000	260	0	15,000
2061 (C)		16,000	260	0	17,000
2062 (D)		14,000	230	0	14,000
2063 (BN)		16,000	350	0	16,000
2064 (W)		15,000	370	0	15,000
2065 (BN)		11,000	220	0	12,000
2066 (D)		18,000	290	0	18,000
2067 (C)		13,000	220	0	13,000
2068 (C)		19,000	280	0	19,000
2069 (BN)		18,000	280	0	18,000
2070 (W)		21,000	370	0	21,000
2071 (BN)		14,000	230	0	14,000
2072 (W)		20,000	300	0	20,000
Average (2022-2072)		17,000	300	0	17,000
2022 - 2072	W	19,000	340	0	20,000
	AN	18,000	320	0	18,000
	BN	15,000	270	0	16,000
	D	16,000	280	0	17,000
	C	15,000	240	0	15,000

4.3.2.4 Deep Percolation of Precipitation

Estimated deep percolation of precipitation (equal to infiltration of precipitation in 23 CCR § 354.18(b)(2)) is provided in and **Figure 85** and **Table 82** by water use sector. Deep percolation of precipitation to the GWS is highly variable from year to year due to variation in the timing and amount of precipitation, ranging from about 23 taf per year during critical dry years to about 74 taf per year during wet years on average.

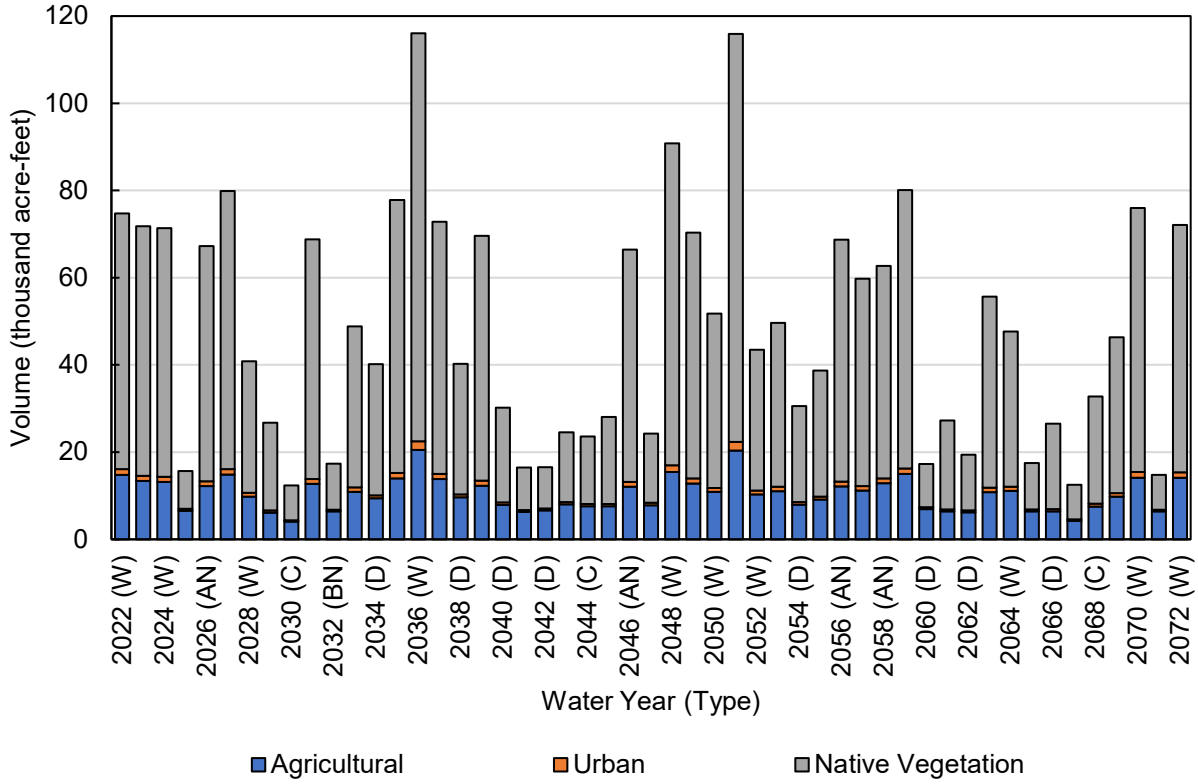

Figure 85. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Deep Percolation of Precipitation, by Water Use Sector

Table 82. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Deep Percolation of Precipitation, by Water Use Sector (acre-feet)

Water Year (Type)	Agricultural	Urban	Native Vegetation	Total
2022 (W)	15,000	1,300	59,000	75,000
2023 (W)	13,000	1,200	57,000	72,000
2024 (W)	13,000	1,200	57,000	71,000
2025 (BN)	6,600	390	8,700	16,000
2026 (AN)	12,000	1,100	54,000	67,000
2027 (W)	15,000	1,300	64,000	80,000
2028 (W)	9,800	820	30,000	41,000
2029 (C)	6,200	460	20,000	27,000
2030 (C)	4,100	330	8,000	12,000
2031 (AN)	13,000	1,100	55,000	69,000
2032 (BN)	6,400	420	11,000	17,000
2033 (AN)	11,000	1,000	37,000	49,000
2034 (D)	9,400	690	30,000	40,000
2035 (W)	14,000	1,300	63,000	78,000
2036 (W)	21,000	2,000	94,000	120,000
2037 (W)	14,000	1,200	58,000	73,000
2038 (D)	9,600	690	30,000	40,000
2039 (W)	12,000	1,200	56,000	70,000
2040 (D)	7,900	630	22,000	30,000
2041 (C)	6,300	490	9,800	17,000
2042 (D)	6,600	460	9,500	17,000
2043 (C)	8,000	530	16,000	25,000
2044 (C)	7,600	510	16,000	24,000
2045 (C)	7,600	500	20,000	28,000
2046 (AN)	12,000	1,100	53,000	66,000
2047 (C)	7,900	520	16,000	24,000
2048 (W)	15,000	1,600	74,000	91,000
2049 (W)	13,000	1,200	56,000	70,000
2050 (W)	11,000	930	40,000	52,000
2051 (W)	20,000	2,000	94,000	120,000
2052 (W)	10,000	830	32,000	44,000
2053 (AN)	11,000	1,000	38,000	50,000
2054 (D)	8,000	630	22,000	31,000
2055 (D)	9,100	680	29,000	39,000
2056 (AN)	12,000	1,100	55,000	69,000
2057 (BN)	11,000	980	48,000	60,000

Water Year (Type)		Agricultural	Urban	Native Vegetation	Total
2058 (AN)		13,000	1,100	49,000	63,000
2059 (W)		15,000	1,300	64,000	80,000
2060 (D)		6,900	460	9,900	17,000
2061 (C)		6,400	480	20,000	27,000
2062 (D)		6,200	460	13,000	19,000
2063 (BN)		11,000	1,000	44,000	56,000
2064 (W)		11,000	950	36,000	48,000
2065 (BN)		6,400	420	11,000	18,000
2066 (D)		6,400	550	20,000	27,000
2067 (C)		4,200	340	7,900	12,000
2068 (C)		7,500	640	25,000	33,000
2069 (BN)		9,800	840	36,000	46,000
2070 (W)		14,000	1,300	61,000	76,000
2071 (BN)		6,400	380	8,000	15,000
2072 (W)		14,000	1,300	57,000	72,000
Average (2022-2072)		10,000	880	37,000	48,000
2022 - 2072	W	14,000	1,300	58,000	74,000
	AN	12,000	1,100	49,000	62,000
	BN	8,200	640	24,000	32,000
	D	7,800	580	20,000	29,000
	C	6,600	480	16,000	23,000

4.3.2.5 Infiltration of Surface Water

Estimated infiltration of surface water (seepage) by water source is provided in **Figure 86** and **Table 83**. Seepage in the Red Bluff Subbasin comes from the Tehama-Colusa Canal and Corning Canal that traverse the subbasin, as well as conveyance of supply delivered to water districts. The total seepage from all canals and diversions is less than 1 taf per year, on average. Runoff from upgradient small watersheds also contributes seepage to the Red Bluff Subbasin. The total seepage from rivers, streams and small water sheds average about 11 taf per year.

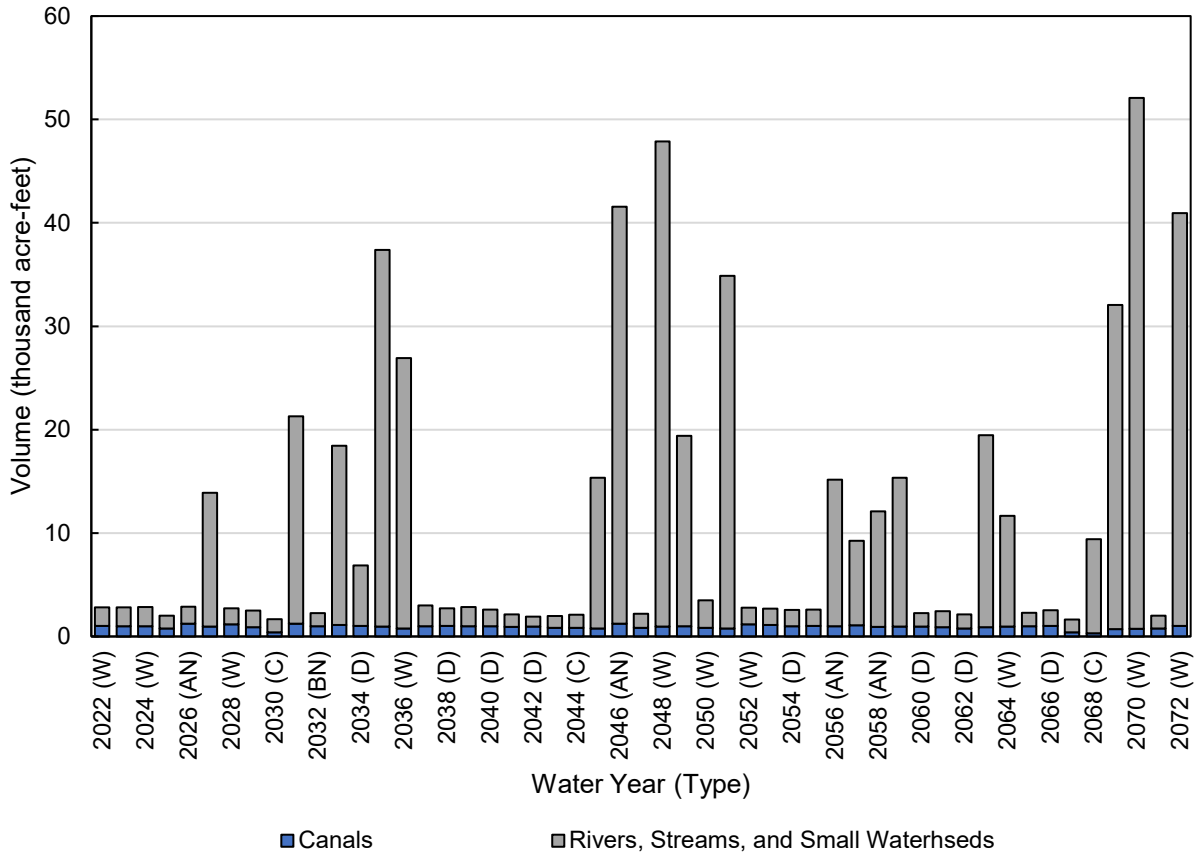

Figure 86. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Infiltration of Surface Water, by Water Use Sector

Table 83. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Infiltration of Surface Water, by Water Use Sector (acre-feet)

Water Year (Type)	Canals	Rivers, Streams, and Small Watersheds	Total
2022 (W)	1,000	1,800	2,800
2023 (W)	990	1,800	2,800
2024 (W)	990	1,900	2,900
2025 (BN)	780	1,200	2,000
2026 (AN)	1,200	1,600	2,900
2027 (W)	950	13,000	14,000
2028 (W)	1,200	1,600	2,700
2029 (C)	910	1,600	2,500
2030 (C)	390	1,300	1,700
2031 (AN)	1,200	20,000	21,000
2032 (BN)	1,000	1,300	2,300
2033 (AN)	1,100	17,000	18,000
2034 (D)	1,000	5,900	6,900
2035 (W)	950	36,000	37,000
2036 (W)	770	26,000	27,000
2037 (W)	990	2,000	3,000
2038 (D)	1,000	1,700	2,700
2039 (W)	990	1,900	2,900
2040 (D)	1,000	1,600	2,600
2041 (C)	930	1,200	2,100
2042 (D)	970	940	1,900
2043 (C)	850	1,100	2,000
2044 (C)	850	1,300	2,100
2045 (C)	760	15,000	15,000
2046 (AN)	1,200	40,000	42,000
2047 (C)	850	1,400	2,200
2048 (W)	950	47,000	48,000
2049 (W)	990	18,000	19,000
2050 (W)	830	2,700	3,500
2051 (W)	770	34,000	35,000
2052 (W)	1,200	1,600	2,800
2053 (AN)	1,100	1,600	2,700
2054 (D)	1,000	1,600	2,600
2055 (D)	1,000	1,600	2,600
2056 (AN)	990	14,000	15,000
2057 (BN)	1,100	8,200	9,200

Water Year (Type)		Canals	Rivers, Streams, and Small Watersheds	Total
2058 (AN)		930	11,000	12,000
2059 (W)		950	14,000	15,000
2060 (D)		970	1,300	2,300
2061 (C)		910	1,600	2,500
2062 (D)		770	1,400	2,200
2063 (BN)		890	19,000	19,000
2064 (W)		960	11,000	12,000
2065 (BN)		1,000	1,300	2,300
2066 (D)		1,000	1,500	2,500
2067 (C)		390	1,200	1,600
2068 (C)		320	9,100	9,400
2069 (BN)		710	31,000	32,000
2070 (W)		730	51,000	52,000
2071 (BN)		780	1,200	2,000
2072 (W)		1,000	40,000	41,000
Average (2022-2072)		930	10,000	11,000
2022 - 2072	W	960	17,000	18,000
	AN	1,100	15,000	16,000
	BN	890	9,000	9,900
	D	980	1,900	2,900
	C	720	3,400	4,200

4.3.3 Change in Root Zone Storage

Estimates of change in root zone storage are provided in **Figure 87** and **Table 84**. Inter-annual changes in storage within the SWS consist primarily of root zone soil moisture storage changes, are relatively small, and tend to average near zero over many years.

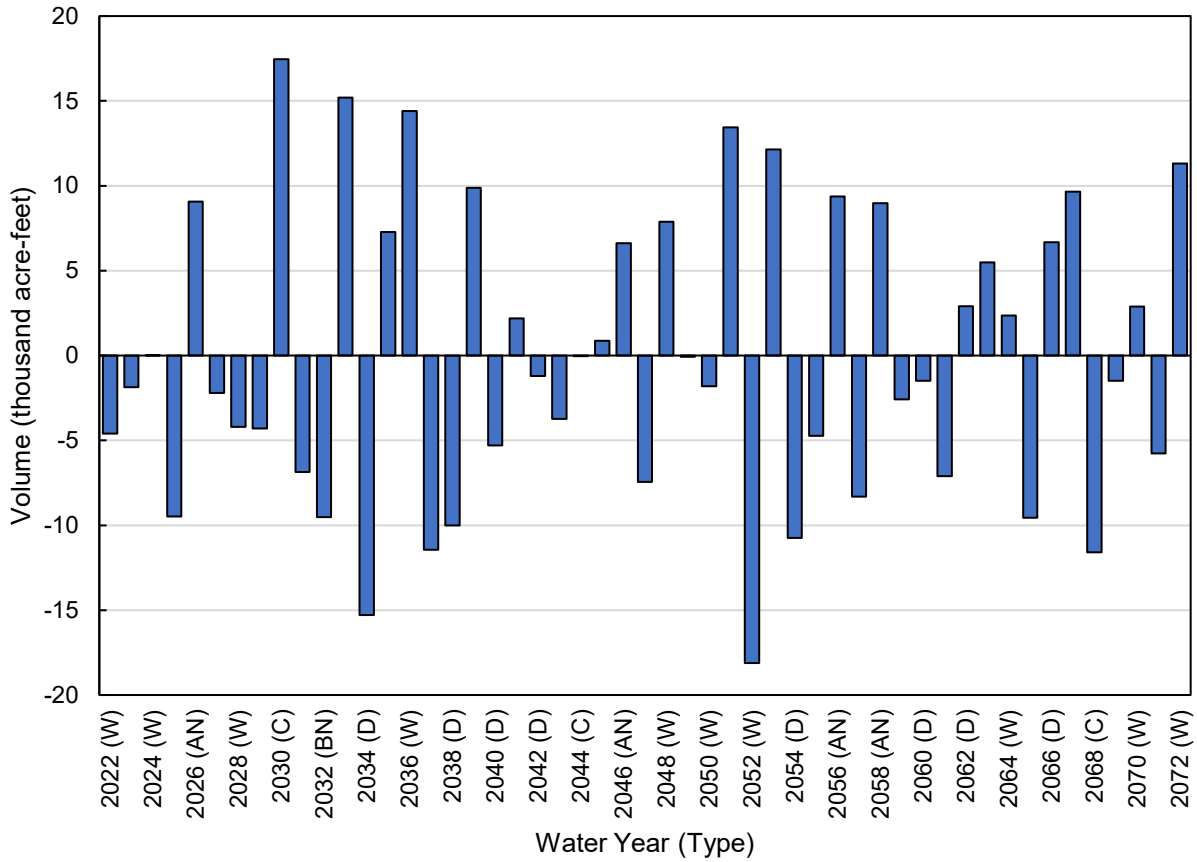

Figure 87. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Change in Root Zone Storage

Table 84. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Change in Root Zone Storage (acre-feet)

Water Year (Type)	Change in Root Zone Storage
2022 (W)	-4,600
2023 (W)	-1,900
2024 (W)	10
2025 (BN)	-9,500
2026 (AN)	9,100
2027 (W)	-2,200
2028 (W)	-4,200
2029 (C)	-4,300
2030 (C)	17,000
2031 (AN)	-6,900
2032 (BN)	-9,500
2033 (AN)	15,000
2034 (D)	-15,000
2035 (W)	7,300
2036 (W)	14,000
2037 (W)	-11,000
2038 (D)	-10,000
2039 (W)	9,900
2040 (D)	-5,300
2041 (C)	2,200
2042 (D)	-1,200
2043 (C)	-3,700
2044 (C)	-30
2045 (C)	860
2046 (AN)	6,600
2047 (C)	-7,400
2048 (W)	7,900
2049 (W)	-70
2050 (W)	-1,800
2051 (W)	13,000
2052 (W)	-18,000
2053 (AN)	12,000
2054 (D)	-11,000
2055 (D)	-4,700
2056 (AN)	9,400
2057 (BN)	-8,300

Water Year (Type)		Change in Root Zone Storage
2058 (AN)		9,000
2059 (W)		-2,600
2060 (D)		-1,500
2061 (C)		-7,100
2062 (D)		2,900
2063 (BN)		5,500
2064 (W)		2,400
2065 (BN)		-9,600
2066 (D)		6,700
2067 (C)		9,700
2068 (C)		-12,000
2069 (BN)		-1,500
2070 (W)		2,900
2071 (BN)		-5,800
2072 (W)		11,000
Average (2022-2072)		-90
2022 - 2072	W	1,300
	AN	7,800
	BN	-5,500
	D	-4,400
	C	-400

4.3.4 Net Recharge from Surface Water System

Net recharge from the SWS is a useful metric that equates only the impacts of the SWS on recharge and extraction from the GWS, providing valuable insight to the combined effects of land surface processes on the underlying GWS. Net recharge from the SWS is calculated as the total groundwater recharge minus the total groundwater extraction and uptake. When calculated for the projected (future land use with climate change) water budget, average net recharge from the SWS represents the average surplus (when positive) or shortage (when negative) of recharge that has resulted from projected cropping, land use practices, and average hydrologic conditions, when comparing groundwater extractions with deep percolation and infiltration from the SWS to the GWS. Net recharge does not include groundwater discharges to surface water and is not a full accounting of all exchanges occurring between the SWS and GWS. Although net recharge is a useful water balance metric, groundwater sustainability is not defined by the balance of net recharge from the SWS. Other important factors must be considered in the complete assessment of groundwater sustainability, including but not limited to subsurface groundwater flows and groundwater discharge to surface water.

Annual values for net recharge from the SWS over the projected (future land use with climate change) water budget period are presented below for the Red Bluff Subbasin. **Figure 88** and **Table 85** show the average net recharge from the SWS over 2022-2072 based on the projected (future land use with climate change) water budget results. Under future land use with climate change conditions, the average net recharge in the Red Bluff Subbasin was projected as approximately -73 taf per year between 2022-2072, indicating net outflows from the GWS to the SWS during the projected (future land use with climate change) water budget period. As illustrated on the cumulative net recharge plot in **Figure 88**, this results in a cumulative net negative recharge (i.e., net discharge from the GWS to the SWS) of about 3.7 taf over the 51-year projected (future land use with climate change) water budget period. Although this means there is projected to be more recharge from the SWS to the GWS than extractions and discharges from the GWS to the SWS, this alone does not necessarily mean that groundwater storage is decreasing or that the Subbasin groundwater system has been unsustainable. The complete Subbasin water budget, including the GWS water budget results, provide an indication of whether total groundwater inflows and outflows are in balance.

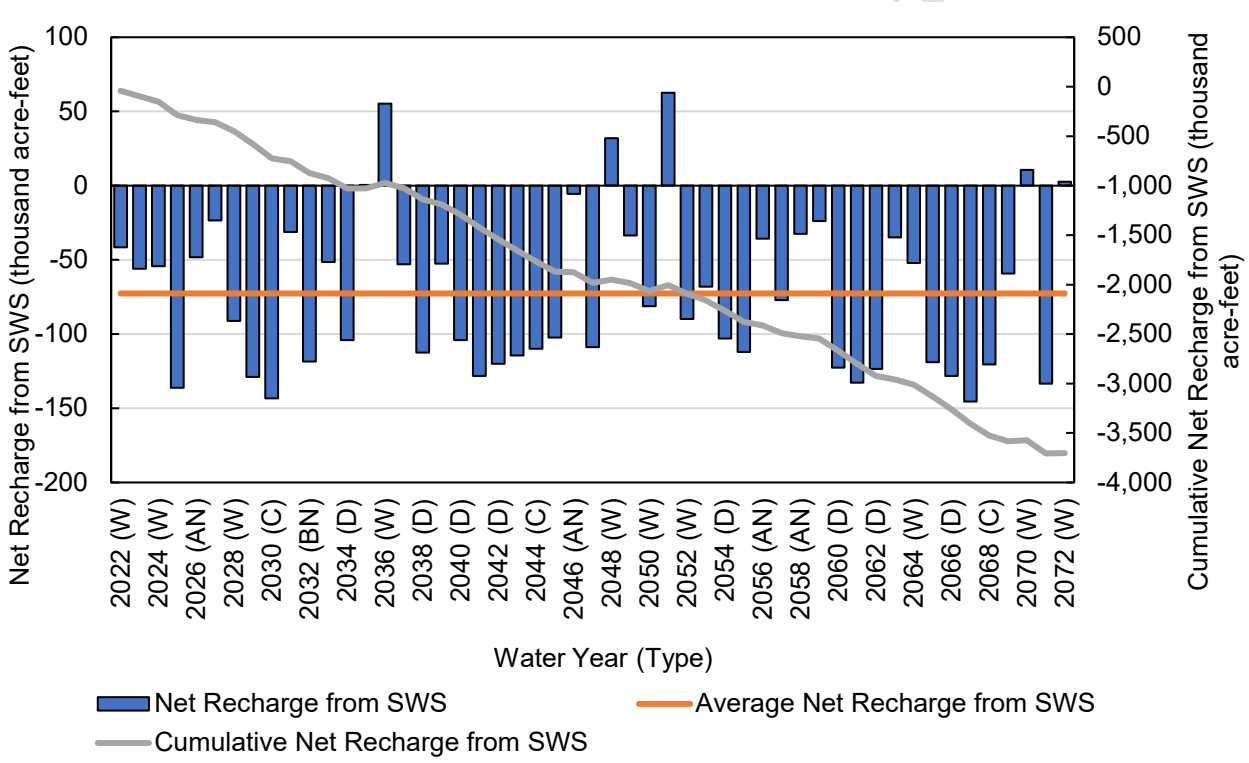

Figure 88. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Net Recharge Overview

Table 85. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Water Budget: Average Net Recharge from SWS, by Water Year Type (acre-feet)

Year Type	Number of Years	Deep Perc. of Applied Water (a)	Deep Perc. of Precipitation (b)	Infil. of Surface Water (c)	Groundwater Extraction/ Uptake (d)	Net Recharge from SWS (a+b+c-d)
W	18	20,000	74,000	18,000	140,000	-27,000
AN	7	18,000	62,000	16,000	130,000	-39,000
BN	7	16,000	32,000	9,900	160,000	-97,000
D	9	17,000	29,000	2,900	160,000	-110,000
C	10	15,000	23,000	4,200	170,000	-120,000
Annual Average (2022 - 2072)	51	17,000	48,000	11,000	150,000	-73,000

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4.4 Groundwater System Water Budget Results

Projected (future land use with climate change) water budget results for different components of the GWS are presented in the sections below. Inflows and outflows from the GWS that occur through exchanges with the SWS are discussed in the SWS water budget results, although these components are also noted in the sections below relating to the GWS water budget. In contrast to the SWS water budget, many of the GWS water budget components change in flow direction over time representing inflows during some periods and outflows during other periods, depending on Subbasin conditions. The GWS water budget results are presented with net inflows indicated by positive values and net outflows as negative values.

4.4.1 Lateral Subsurface Groundwater Flows

Subsurface groundwater flows to and from the Red Bluff Subbasin occur between the Bowman Subbasin to the north, the Bend, Antelope, and Los Molinos Subbasins to the east, and the Corning Subbasin to the south. Some subsurface groundwater flows also occur between the South Battle Creek Subbasin which borders the Red Bluff Subbasin to the northeast. Additional subsurface groundwater inflows occur from the upland foothill (small watershed) areas adjoining the Red Bluff Subbasin to the west.

4.4.1.1 Lateral Subsurface Flows to/from Adjacent Subbasins

Projected (future land use with climate change) lateral subsurface flows occurring from and to adjacent subbasin are summarized in **Figure 89** and **Table 86**. The total Projected (future land use with climate change) net subsurface flows to and from all adjacent subbasins averages about 79 taf per year occurring as inflow to the Red Bluff Subbasin. The largest projected (future land use with climate change) subsurface flows occur across the boundary with the Bowman with somewhat less subsurface flow occurring across the boundaries with the Corning, Bend, Los Molinos and Antelope Subbasins, although these flows are still considerable. Much smaller flows occur across the boundary with the South Battle Creek Subbasin.

Projected (future land use with climate change) subsurface flows with the Bowman Subbasin consistently average about 120 taf occurring as inflows to the Red Bluff Subbasin. This makes up most of the subsurface inflows occurring to the Red Bluff Subbasin. Annual subsurface flows from Red Bluff Subbasin to Corning, Bend, and Antelope Subbasins (negative values) average about 31, 16, and 4.1 taf respectively. The magnitudes of the subsurface outflows from Red Bluff Subbasin to the Corning and Bend Subbasins are relatively consistent from year to year. Projected (future land use with climate change) subsurface flows across the boundary with Los Molinos Subbasin generally occur as smaller volumes of inflows to the Red Bluff Subbasin (about 4.2 taf per year on average over the projected period), although the magnitude of flows across this boundary do vary, including the occurrence of a net outflow to the Los Molinos Subbasin in some years. A small amount of subsurface inflow also occurs across the boundary with the South Battle Creek Subbasin totaling about 1.6 taf per year on average.

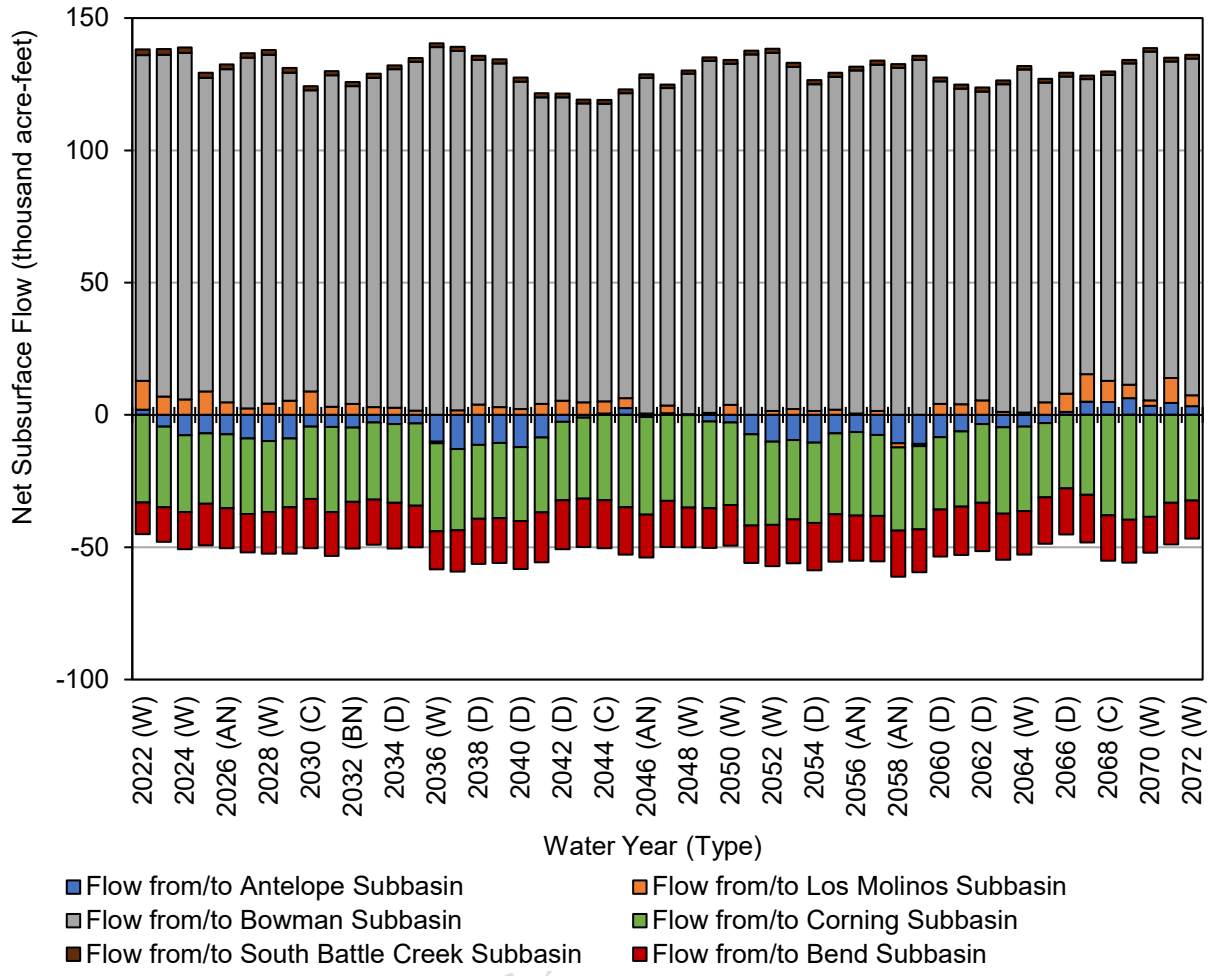

Figure 89. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Lateral Subsurface Groundwater Flows to/from Adjacent Subbasins

Table 86. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Lateral Subsurface Groundwater Flows Between Adjacent Subbasins (net flows as acre-feet)

Water Year (Type)	Antelope	Los Molinos	Bowman	Corning	S. Battle Creek	Bend	Total
2022 (W)	2,000	11,000	120,000	-33,000	2,200	-12,000	93,000
2023 (W)	-4,400	6,900	130,000	-31,000	2,100	-13,000	90,000
2024 (W)	-7,600	5,800	130,000	-29,000	2,000	-14,000	88,000
2025 (BN)	-6,900	8,900	120,000	-27,000	2,000	-16,000	80,000
2026 (AN)	-7,400	4,800	130,000	-28,000	1,900	-15,000	82,000
2027 (W)	-8,900	2,500	130,000	-29,000	1,800	-15,000	85,000
2028 (W)	-9,800	4,300	130,000	-27,000	1,700	-16,000	85,000
2029 (C)	-8,800	5,400	120,000	-26,000	1,700	-18,000	79,000
2030 (C)	-4,500	8,900	110,000	-27,000	1,700	-19,000	74,000
2031 (AN)	-4,600	3,100	130,000	-32,000	1,600	-17,000	77,000
2032 (BN)	-4,800	4,200	120,000	-28,000	1,600	-18,000	75,000
2033 (AN)	-2,900	3,000	120,000	-29,000	1,500	-17,000	80,000
2034 (D)	-3,400	2,700	130,000	-30,000	1,500	-17,000	82,000
2035 (W)	-3,200	1,600	130,000	-31,000	1,400	-16,000	85,000
2036 (W)	-10,000	-610	140,000	-33,000	1,500	-14,000	82,000
2037 (W)	-13,000	1,800	140,000	-31,000	1,500	-16,000	80,000
2038 (D)	-11,000	3,900	130,000	-28,000	1,600	-17,000	79,000
2039 (W)	-11,000	3,000	130,000	-28,000	1,600	-17,000	78,000
2040 (D)	-12,000	2,300	120,000	-28,000	1,600	-18,000	69,000
2041 (C)	-8,500	4,200	120,000	-28,000	1,500	-19,000	66,000
2042 (D)	-2,700	5,400	110,000	-30,000	1,500	-19,000	71,000
2043 (C)	-1,000	4,800	110,000	-31,000	1,400	-18,000	69,000
2044 (C)	550	4,600	110,000	-32,000	1,400	-18,000	69,000
2045 (C)	2,600	3,700	120,000	-35,000	1,400	-18,000	70,000
2046 (AN)	590	-830	130,000	-37,000	1,300	-16,000	75,000
2047 (C)	620	3,000	120,000	-32,000	1,300	-17,000	75,000
2048 (W)	250	-110	130,000	-35,000	1,300	-15,000	80,000
2049 (W)	-2,400	760	130,000	-33,000	1,400	-15,000	85,000
2050 (W)	-2,900	3,800	130,000	-31,000	1,400	-15,000	85,000
2051 (W)	-7,300	17	140,000	-34,000	1,400	-14,000	82,000
2052 (W)	-10,000	1,500	140,000	-31,000	1,500	-16,000	81,000
2053 (AN)	-9,500	2,200	130,000	-30,000	1,500	-17,000	77,000
2054 (D)	-10,000	1,500	120,000	-30,000	1,600	-18,000	68,000
2055 (D)	-6,900	2,000	130,000	-31,000	1,500	-18,000	74,000
2056 (AN)	-6,500	570	130,000	-32,000	1,500	-17,000	77,000
2057 (BN)	-7,500	1,500	130,000	-31,000	1,500	-17,000	79,000
2058 (AN)	-11,000	-1,600	130,000	-32,000	1,500	-17,000	72,000
2059 (W)	-11,000	-810	130,000	-31,000	1,500	-16,000	76,000

Water Year (Type)		Antelope	Los Molinos	Bowman	Corning	S. Battle Creek	Bend	Total
2060 (D)		-8,400	4,200	120,000	-27,000	1,500	-18,000	74,000
2061 (C)		-6,200	4,000	120,000	-29,000	1,500	-18,000	72,000
2062 (D)		-3,400	5,500	120,000	-30,000	1,500	-18,000	72,000
2063 (BN)		-4,600	1,200	120,000	-33,000	1,400	-17,000	72,000
2064 (W)		-4,400	960	130,000	-32,000	1,400	-17,000	79,000
2065 (BN)		-3,000	4,800	120,000	-28,000	1,400	-18,000	78,000
2066 (D)		1,100	6,900	120,000	-28,000	1,400	-17,000	84,000
2067 (C)		5,100	10,000	110,000	-30,000	1,400	-18,000	80,000
2068 (C)		5,000	7,900	120,000	-38,000	1,400	-17,000	75,000
2069 (BN)		6,400	5,000	120,000	-40,000	1,400	-16,000	78,000
2070 (W)		3,400	2,100	130,000	-38,000	1,300	-14,000	87,000
2071 (BN)		4,500	9,500	120,000	-33,000	1,400	-16,000	86,000
2072 (W)		3,300	4,200	130,000	-32,000	1,400	-14,000	89,000
Average (2022-2072)		-4,100	4,200	120,000	-31,000	1,600	-16,000	79,000
2022 - 2072	W	-5,400	2,700	130,000	-32,000	1,600	-15,000	84,000
	AN	-5,800	1,600	130,000	-31,000	1,500	-17,000	77,000
	BN	-2,300	5,000	120,000	-31,000	1,500	-17,000	78,000
	D	-6,400	3,800	120,000	-29,000	1,500	-18,000	75,000
	C	-1,500	5,700	120,000	-31,000	1,500	-18,000	73,000

Note: positive values represent net inflows to Red Bluff Subbasin, negative values represent net outflows from Red Bluff Subbasin.

4.4.1.2 Lateral Subsurface Flows from Upland Areas (Small Watersheds)

Projected (future land use with climate change) lateral subsurface inflows occurring from upland or foothill areas (small watersheds outside of the Central Valley Floor) to the west of the Red Bluff Subbasin are summarized in **Figure 90** and **Table 87**. This component does not include surface water inflows to the Red Bluff Subbasin which are discussed as part of the SWS water budget. The average projected (future land use with climate change) subsurface inflow from the upland areas is about 1.1 taf per year and varies only very minimally from year to year. The volume of subsurface inflows from upland areas is small relative to the net subsurface inflows occurring between adjacent subbasins.

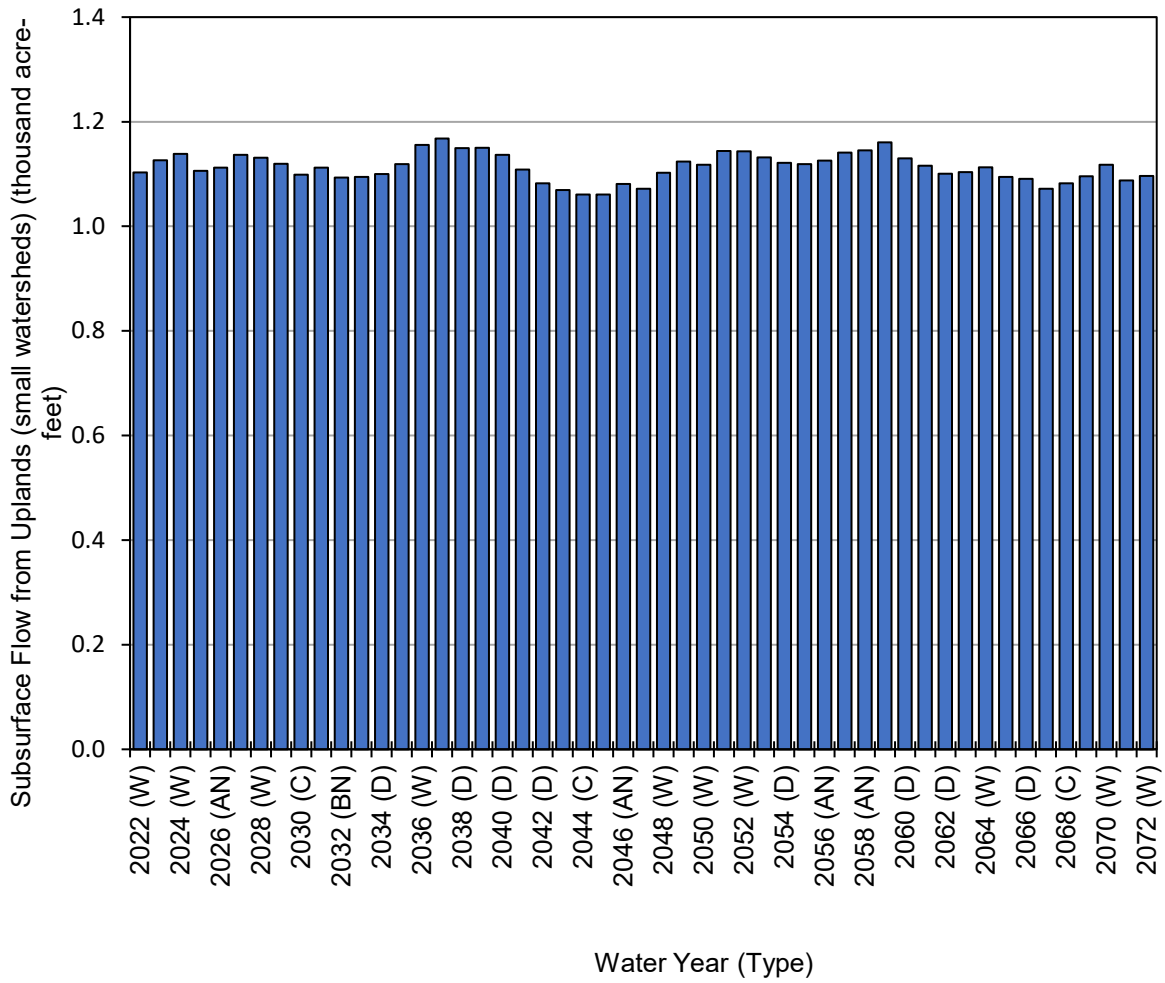

Figure 90. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Subsurface Groundwater Inflows from Upland Areas

Table 87. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Subsurface Groundwater Inflows from Adjacent Uplands (small watersheds) (acre-feet)

Water Year (Type)	Subsurface Inflow from Uplands
2022 (W)	1,100
2023 (W)	1,100
2024 (W)	1,100
2025 (BN)	1,100
2026 (AN)	1,100
2027 (W)	1,100
2028 (W)	1,100
2029 (C)	1,100
2030 (C)	1,100
2031 (AN)	1,100
2032 (BN)	1,100
2033 (AN)	1,100
2034 (D)	1,100
2035 (W)	1,100
2036 (W)	1,200
2037 (W)	1,200
2038 (D)	1,100
2039 (W)	1,100
2040 (D)	1,100
2041 (C)	1,100
2042 (D)	1,100
2043 (C)	1,100
2044 (C)	1,100
2045 (C)	1,100
2046 (AN)	1,100
2047 (C)	1,100
2048 (W)	1,100
2049 (W)	1,100
2050 (W)	1,100
2051 (W)	1,100
2052 (W)	1,100
2053 (AN)	1,100
2054 (D)	1,100
2055 (D)	1,100
2056 (AN)	1,100
2057 (BN)	1,100
2058 (AN)	1,100
2059 (W)	1,200

Water Year (Type)		Subsurface Inflow from Uplands
2060 (D)		1,100
2061 (C)		1,100
2062 (D)		1,100
2063 (BN)		1,100
2064 (W)		1,100
2065 (BN)		1,100
2066 (D)		1,100
2067 (C)		1,100
2068 (C)		1,100
2069 (BN)		1,100
2070 (W)		1,100
2071 (BN)		1,100
2072 (W)		1,100
Average (2022-2072)		1,100
2022 - 2072	W	1,100
	AN	1,100
	BN	1,100
	D	1,100
	C	1,100

4.4.2 Deep Percolation From the SWS

Deep percolation from the SWS includes infiltration of water below the root zone (deep percolation) from precipitation and applied water. These two water budget components are summarized in the SWS water budget as outflows to the SWS and are presented as aggregated deep percolation inflows to the GWS in **Figure 91** and **Table 88**. The average annual deep percolation from the SWS over the projected (future land use with climate change) water budget period is approximately 64 taf per year. Greater volumes of deep percolation occur during wetter years when infiltration of precipitation is higher.

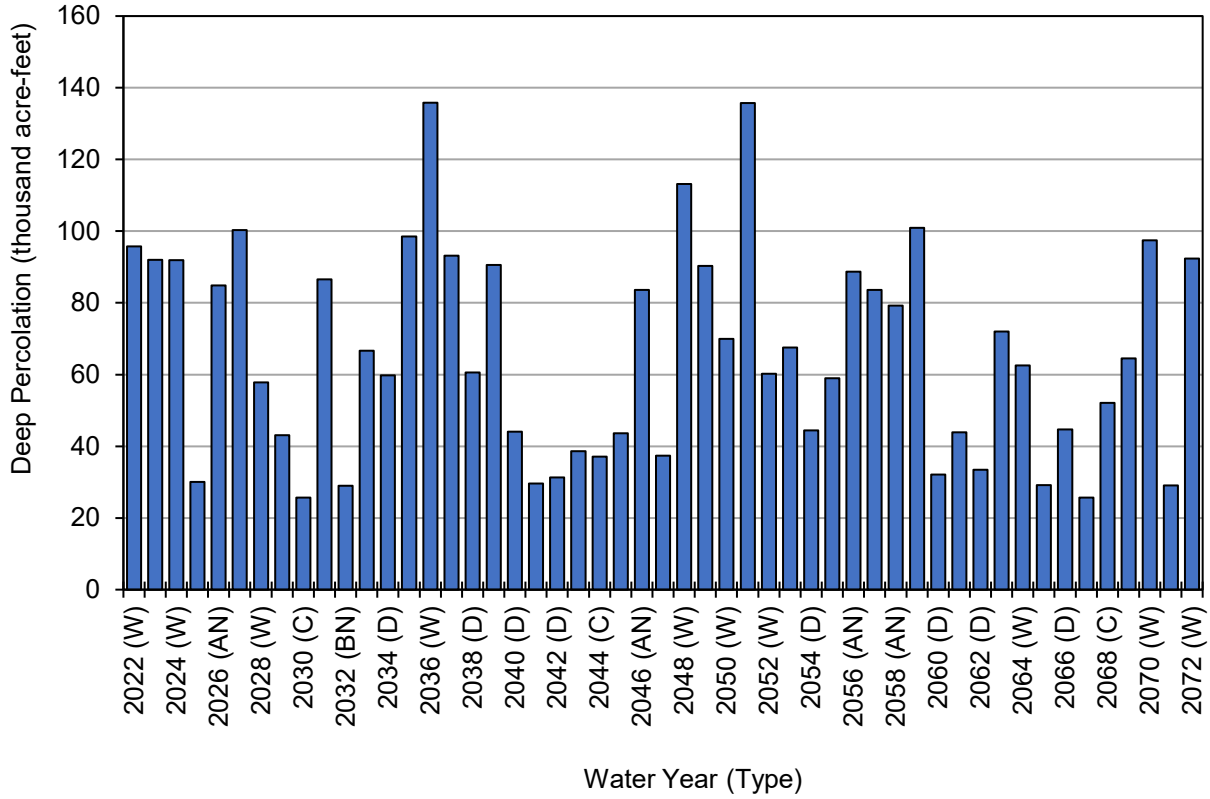

Figure 91. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Deep Percolation

Table 88. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Deep Percolation from the SWS (acre-feet)

Water Year (Type)	Deep Percolation from the SWS
2022 (W)	96,000
2023 (W)	92,000
2024 (W)	92,000
2025 (BN)	30,000
2026 (AN)	85,000
2027 (W)	100,000
2028 (W)	58,000
2029 (C)	43,000
2030 (C)	26,000
2031 (AN)	87,000
2032 (BN)	29,000
2033 (AN)	67,000
2034 (D)	60,000
2035 (W)	99,000
2036 (W)	140,000
2037 (W)	93,000
2038 (D)	61,000
2039 (W)	91,000
2040 (D)	44,000
2041 (C)	30,000
2042 (D)	31,000
2043 (C)	39,000
2044 (C)	37,000
2045 (C)	44,000
2046 (AN)	84,000
2047 (C)	37,000
2048 (W)	110,000
2049 (W)	90,000
2050 (W)	70,000
2051 (W)	140,000
2052 (W)	60,000
2053 (AN)	68,000
2054 (D)	44,000
2055 (D)	59,000
2056 (AN)	89,000
2057 (BN)	84,000
2058 (AN)	79,000
2059 (W)	100,000

Water Year (Type)		Deep Percolation from the SWS
2060 (D)		32,000
2061 (C)		44,000
2062 (D)		33,000
2063 (BN)		72,000
2064 (W)		63,000
2065 (BN)		29,000
2066 (D)		45,000
2067 (C)		26,000
2068 (C)		52,000
2069 (BN)		65,000
2070 (W)		97,000
2071 (BN)		29,000
2072 (W)		92,000
Average (2022-2072)		64,000
2022 - 2072	W	93,000
	AN	80,000
	BN	48,000
	D	45,000
	C	38,000

4.4.3 Net Stream Seepage/Groundwater Discharge to Surface Water

The flow of water between the GWS and SWS through seepage of water from streams and canals and groundwater discharging into streams is discussed as part of the SWS water budget. These components are combined for presentation in the GWS water budget as a net volume of stream seepage (**Figure 92** and **Table 89**). Positive total net seepage values represent a net inflow of water from the SWS to the GWS via stream and canal seepage indicating that the overall volume of stream seepage is greater than the volume of any groundwater discharging into surface waterways. Negative net seepage values represent a net outflow of groundwater from the GWS to the SWS through groundwater discharge to surface water. When net seepage is negative, it means that more groundwater is discharging into the surface waterways than is seeping from surface waterways into the GWS.

In the Red Bluff Subbasin, the projected (future land use with climate change) annual net seepage values are highly variable between years with an average annual net stream seepage value of -2.7 taf per year indicating that groundwater discharge is providing considerable flow to the surface waterways. The annual net stream seepage values tend to be more negative in dry years and positive in above normal and wet years corresponding with net groundwater discharge to surface water in drier years and net seepage of surface water to groundwater in wetter years.

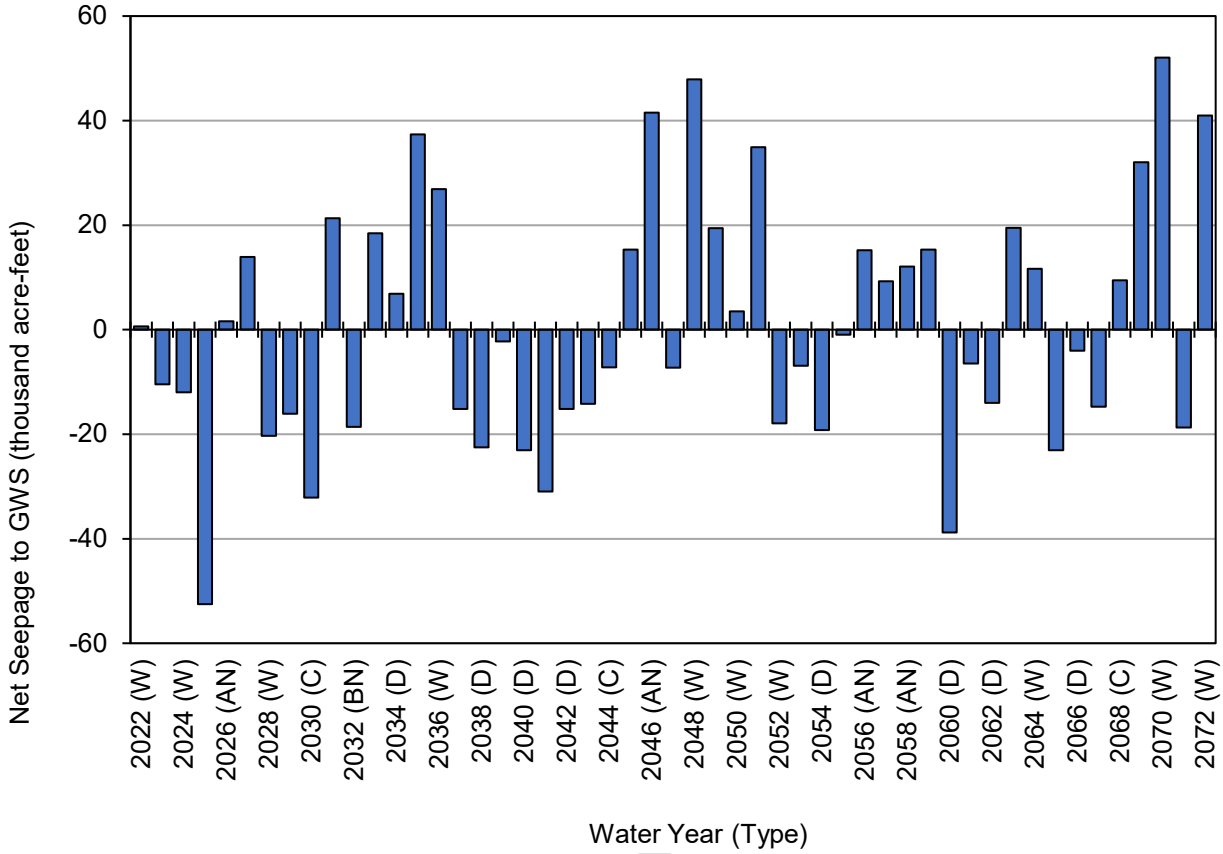

Figure 92. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Net Stream Seepage to GWS/Discharge to Surface Water

Table 89. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Net Stream Seepage (net flows as acre-feet)

Water Year (Type)	Total Net Seepage from Surface Waterways and Canals
2022 (W)	600
2023 (W)	-10,000
2024 (W)	-12,000
2025 (BN)	-53,000
2026 (AN)	1,600
2027 (W)	14,000
2028 (W)	-20,000
2029 (C)	-16,000
2030 (C)	-32,000
2031 (AN)	21,000
2032 (BN)	-19,000
2033 (AN)	18,000
2034 (D)	6,900
2035 (W)	37,000
2036 (W)	27,000
2037 (W)	-15,000
2038 (D)	-23,000
2039 (W)	-2,200
2040 (D)	-23,000
2041 (C)	-31,000
2042 (D)	-15,000
2043 (C)	-14,000
2044 (C)	-7,200
2045 (C)	15,000
2046 (AN)	42,000
2047 (C)	-7,300
2048 (W)	48,000
2049 (W)	19,000
2050 (W)	3,500
2051 (W)	35,000
2052 (W)	-18,000
2053 (AN)	-6,900
2054 (D)	-19,000
2055 (D)	-960
2056 (AN)	15,000
2057 (BN)	9,200
2058 (AN)	12,000
2059 (W)	15,000

Water Year (Type)		Total Net Seepage from Surface Waterways and Canals
2060 (D)		-39,000
2061 (C)		-6,500
2062 (D)		-14,000
2063 (BN)		19,000
2064 (W)		12,000
2065 (BN)		-23,000
2066 (D)		-4,100
2067 (C)		-15,000
2068 (C)		9,400
2069 (BN)		32,000
2070 (W)		52,000
2071 (BN)		-19,000
2072 (W)		41,000
Average (2022-2072)		-2,700
2022 - 2072	W	13,000
	AN	15,000
	BN	-7,400
	D	-15,000
	C	-10,000

Note: negative values indicate net groundwater discharge to surface water

4.4.4 Groundwater Extraction

Groundwater extractions are exchanges that occur between the GWS and the SWS. Groundwater extraction from the GWS occurs through groundwater pumping to meet water demands for urban and agricultural needs and also through groundwater (root water) uptake by plants directly from shallow groundwater during times and at locations of sufficiently shallow groundwater conditions. Projected (future land use with climate change) groundwater extractions are summarized in **Figure 93** and **Table 90** and also presented and discussed in the SWS water budget sections. Total groundwater extractions over the projected (future land use with climate change) water budget period average about -150 taf per year. Overall, groundwater pumping represents a larger fraction of the groundwater extractions than groundwater uptake. Groundwater pumping averaged about -150 taf over the projected (future land use with climate change) period and groundwater uptake averaged about -4.2 taf. In wetter periods, groundwater uptake increases and groundwater pumping decreases. Accordingly, during drier periods groundwater pumping increases and water uptake by plants from shallow groundwater decreases in response to the higher water demands for irrigation and other uses and the greater depths to groundwater that also tend to occur during dry periods.

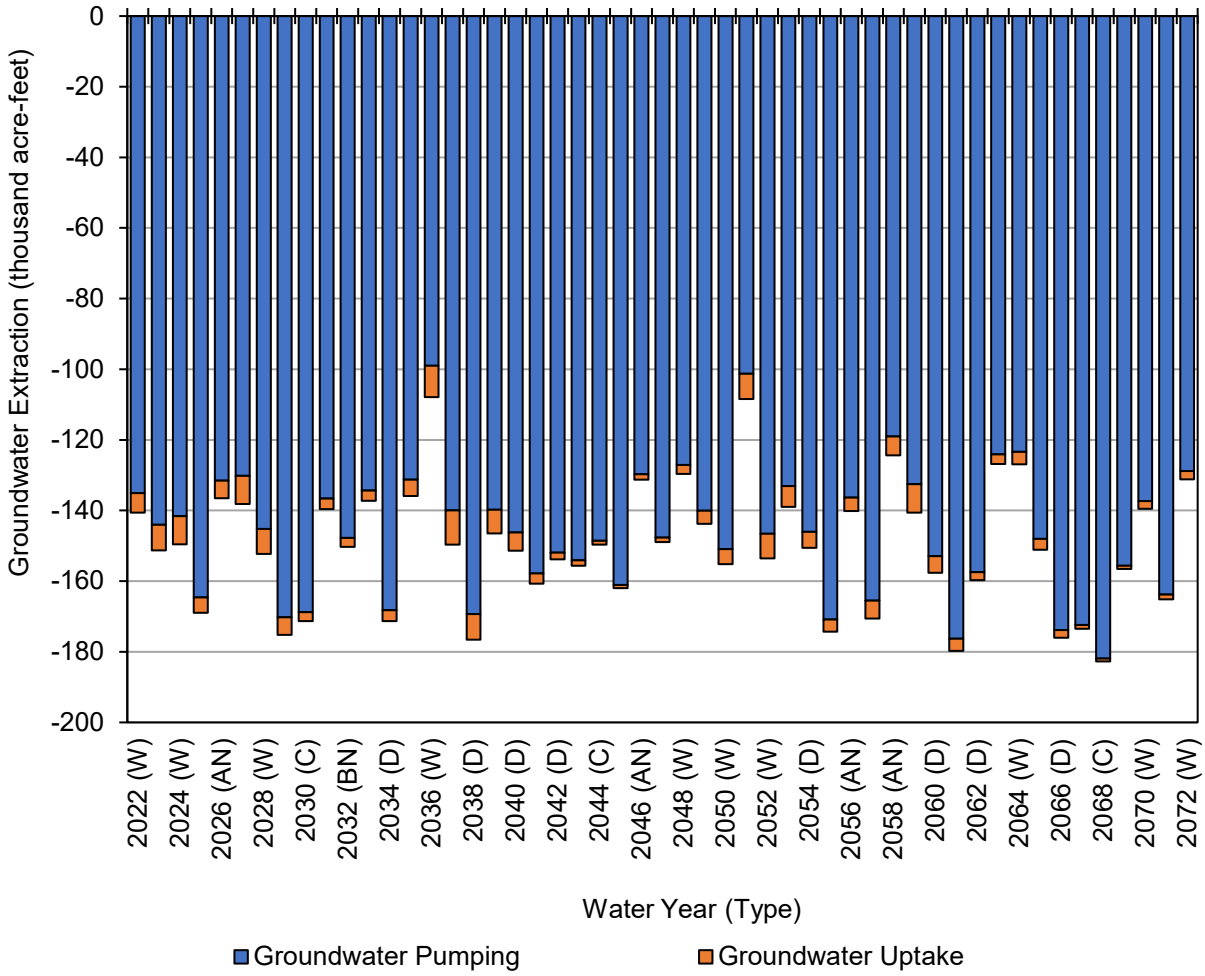

Figure 93. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Groundwater Extractions

Table 90. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Groundwater Extractions (acre-feet)

Water Year (Type)	Groundwater Pumping	Groundwater (Root Water) Uptake	Total Extractions
2022 (W)	-140,000	-5,600	-140,000
2023 (W)	-140,000	-7,300	-150,000
2024 (W)	-140,000	-7,900	-150,000
2025 (BN)	-160,000	-4,300	-170,000
2026 (AN)	-130,000	-5,000	-140,000
2027 (W)	-130,000	-7,900	-140,000
2028 (W)	-150,000	-7,100	-150,000
2029 (C)	-170,000	-5,000	-180,000
2030 (C)	-170,000	-2,500	-170,000
2031 (AN)	-140,000	-3,000	-140,000
2032 (BN)	-150,000	-2,500	-150,000
2033 (AN)	-130,000	-2,900	-140,000
2034 (D)	-170,000	-3,000	-170,000
2035 (W)	-130,000	-4,600	-140,000
2036 (W)	-99,000	-8,800	-110,000
2037 (W)	-140,000	-9,700	-150,000
2038 (D)	-170,000	-7,200	-180,000
2039 (W)	-140,000	-6,700	-150,000
2040 (D)	-150,000	-5,200	-150,000
2041 (C)	-160,000	-2,900	-160,000
2042 (D)	-150,000	-1,900	-150,000
2043 (C)	-150,000	-1,500	-160,000
2044 (C)	-150,000	-1,100	-150,000
2045 (C)	-160,000	-930	-160,000
2046 (AN)	-130,000	-1,600	-130,000
2047 (C)	-150,000	-1,300	-150,000
2048 (W)	-130,000	-2,500	-130,000
2049 (W)	-140,000	-3,800	-140,000
2050 (W)	-150,000	-4,300	-160,000
2051 (W)	-100,000	-7,100	-110,000
2052 (W)	-150,000	-7,000	-150,000
2053 (AN)	-130,000	-5,900	-140,000
2054 (D)	-150,000	-4,500	-150,000
2055 (D)	-170,000	-3,500	-170,000
2056 (AN)	-140,000	-3,900	-140,000
2057 (BN)	-170,000	-5,100	-170,000
2058 (AN)	-120,000	-5,300	-120,000

Water Year (Type)		Groundwater Pumping	Groundwater (Root Water) Uptake	Total Extractions
2059 (W)		-130,000	-8,000	-140,000
2060 (D)		-150,000	-4,700	-160,000
2061 (C)		-180,000	-3,500	-180,000
2062 (D)		-160,000	-2,300	-160,000
2063 (BN)		-120,000	-2,700	-130,000
2064 (W)		-120,000	-3,600	-130,000
2065 (BN)		-150,000	-3,100	-150,000
2066 (D)		-170,000	-2,200	-180,000
2067 (C)		-170,000	-1,100	-170,000
2068 (C)		-180,000	-830	-180,000
2069 (BN)		-160,000	-890	-160,000
2070 (W)		-140,000	-2,200	-140,000
2071 (BN)		-160,000	-1,400	-170,000
2072 (W)		-130,000	-2,300	-130,000
Average (2022-2072)		-150,000	-4,200	-150,000
2022 - 2072	W	-130,000	-5,900	-140,000
	AN	-130,000	-3,900	-140,000
	BN	-150,000	-2,800	-160,000
	D	-160,000	-3,800	-160,000
	C	-160,000	-2,100	-170,000

4.4.5 Vertical Subsurface Flows within the Groundwater System

Vertical subsurface flows within the GWS occur between the Upper and Lower Aquifers and represent an internal flow of water within the GWS. These exchanges between the principal aquifers do not directly affect the total volume of groundwater in storage, but do highlight the net vertical movement of water within the GWS. Projected (future land use with climate change) vertical flows between the Upper Aquifer and Lower Aquifer are summarized in **Figure 94** and **Table 91** and show consistent net overall upward vertical flow from the Lower Aquifer to the Upper Aquifer. On average, vertical flows from the Lower Aquifer to the Upper Aquifer total about 51 taf per year over the projected (future land use with climate change) water budget period. There is considerable year-to-year variability in the magnitude of these flows, which appear to correlate with water year conditions, although they are mostly in an upward direction except in few wet years. The magnitude of upward flows are generally greatest during drier years and decrease during wet periods. The net upward vertical flow between the two principal aquifers in the Subbasin is consistent with the large groundwater outflows (e.g., groundwater extractions, groundwater discharge to SWS) that occur from the Upper Aquifer in the Subbasin that result in upward movement of groundwater from the Lower Aquifer.

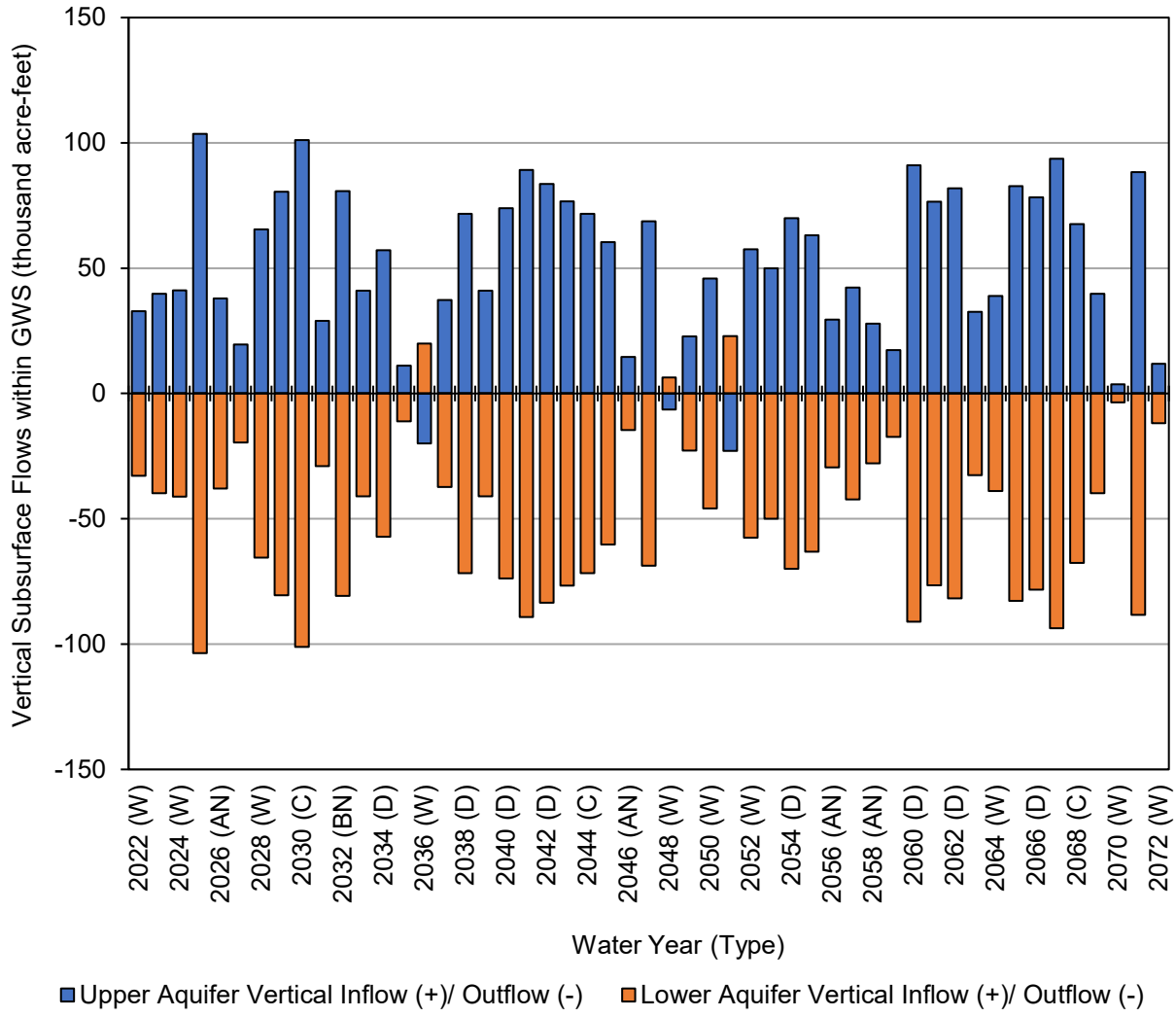

Figure 94. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Vertical Subsurface Flow within the GWS

Table 91. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Vertical Subsurface Flows within the GWS (acre-feet)

Water Year (Type)	Upper Aquifer to (-) / from (+) Lower Aquifer
2022 (W)	33,000
2023 (W)	40,000
2024 (W)	41,000
2025 (BN)	100,000
2026 (AN)	38,000
2027 (W)	20,000
2028 (W)	66,000
2029 (C)	81,000
2030 (C)	100,000
2031 (AN)	29,000
2032 (BN)	81,000
2033 (AN)	41,000
2034 (D)	57,000
2035 (W)	11,000
2036 (W)	-20,000
2037 (W)	37,000
2038 (D)	72,000
2039 (W)	41,000
2040 (D)	74,000
2041 (C)	89,000
2042 (D)	84,000
2043 (C)	77,000
2044 (C)	72,000
2045 (C)	60,000
2046 (AN)	15,000
2047 (C)	69,000
2048 (W)	-6,500
2049 (W)	23,000
2050 (W)	46,000
2051 (W)	-23,000
2052 (W)	58,000
2053 (AN)	50,000
2054 (D)	70,000
2055 (D)	63,000
2056 (AN)	29,000
2057 (BN)	42,000
2058 (AN)	28,000
2059 (W)	17,000

Water Year (Type)		Upper Aquifer to (-) / from (+) Lower Aquifer
2060 (D)		91,000
2061 (C)		77,000
2062 (D)		82,000
2063 (BN)		33,000
2064 (W)		39,000
2065 (BN)		83,000
2066 (D)		78,000
2067 (C)		94,000
2068 (C)		68,000
2069 (BN)		40,000
2070 (W)		3,600
2071 (BN)		88,000
2072 (W)		12,000
Average (2022-2072)		51,000
2022 - 2072	W	24,000
	AN	33,000
	BN	67,000
	D	75,000
	C	79,000

4.4.6 Change in Groundwater Storage

Projected (future land use with climate change) change in groundwater storage values for the Red Bluff Subbasin are summarized in **Figure 95** and **Figure 96,** and **Table 92**. Over the projected (future land use with climate change) period, the average total annual change in groundwater storage is about -4.0 taf per year, representing a decrease in groundwater storage. The corresponding cumulative total change in storage over the projected (future land use with climate change) period is about -210 taf. The annual change in storage numbers generally reflect the effects of the water year type with increase in storage occurring during wetter years and decreases in storage occurring during dry years.

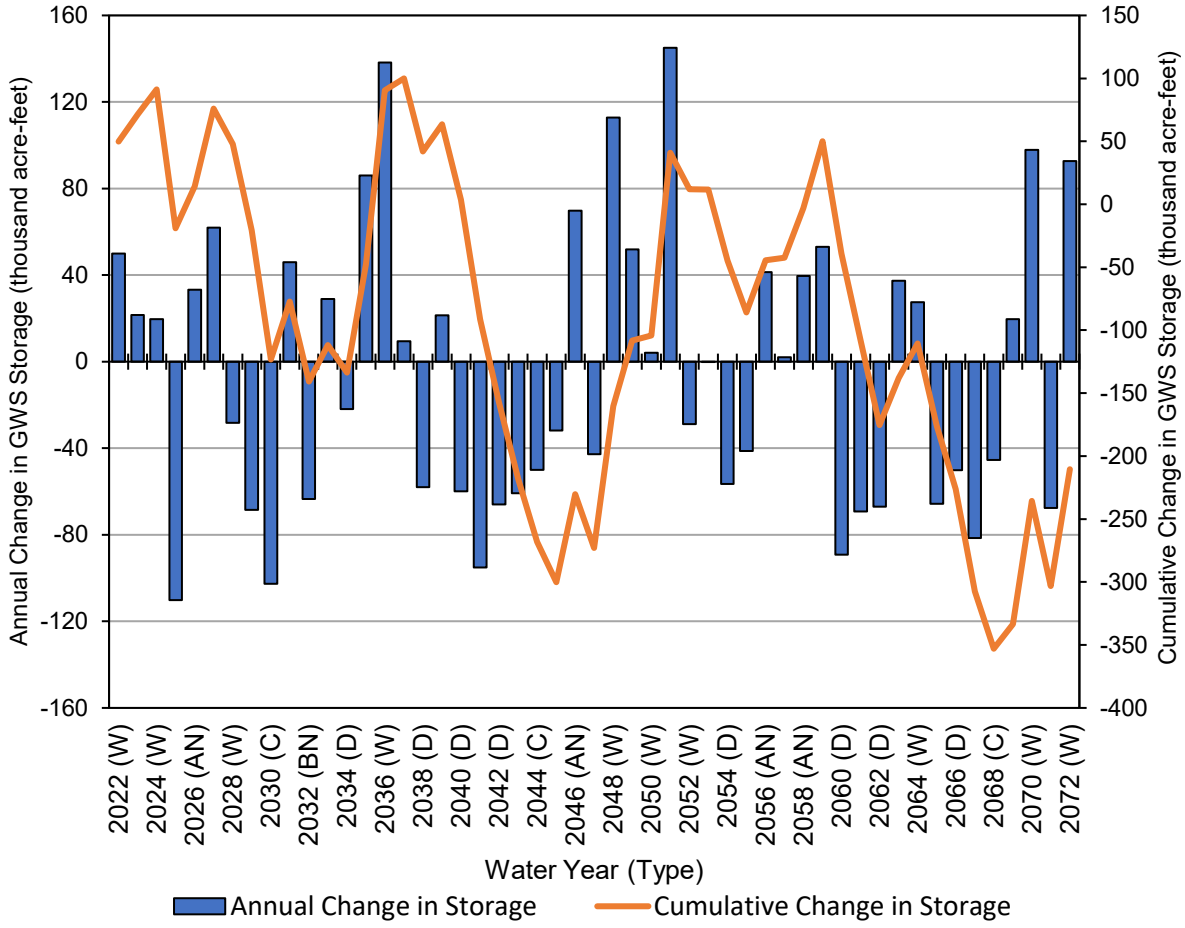

Figure 95. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Projected (Future Land Use with Climate Change) Total Change in Storage within the GWS

Table 92. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Change in Groundwater Storage (acre-feet)

Water Year (Type)	Upper Aquifer	Lowe Aquifer	Total Annual Change	Total Cumulative Change
2022 (BN)	24,000	26,000	50,000	50,000
2023 (W)	5,400	17,000	22,000	72,000
2024 (W)	5,800	15,000	20,000	91,000
2025 (W)	-50,000	-59,000	-110,000	-19,000
2026 (BN)	18,000	15,000	33,000	14,000
2027 (AN)	26,000	36,000	62,000	76,000
2028 (W)	-16,000	-11,000	-28,000	48,000
2029 (W)	-31,000	-36,000	-68,000	-21,000
2030 (C)	-40,000	-63,000	-100,000	-120,000
2031 (C)	26,000	20,000	46,000	-77,000
2032 (AN)	-28,000	-36,000	-64,000	-140,000
2033 (BN)	19,000	11,000	29,000	-110,000
2034 (AN)	-13,000	-8,600	-22,000	-130,000
2035 (D)	41,000	46,000	86,000	-48,000
2036 (W)	59,000	80,000	140,000	91,000
2037 (W)	-3,900	14,000	9,500	100,000
2038 (W)	-31,000	-26,000	-58,000	42,000
2039 (D)	14,000	8,200	21,000	64,000
2040 (W)	-26,000	-33,000	-60,000	3,600
2041 (D)	-40,000	-54,000	-95,000	-92,000
2042 (C)	-21,000	-45,000	-66,000	-160,000
2043 (D)	-22,000	-38,000	-61,000	-220,000
2044 (C)	-16,000	-33,000	-50,000	-270,000
2045 (C)	-11,000	-21,000	-32,000	-300,000
2046 (C)	34,000	36,000	70,000	-230,000
2047 (AN)	-19,000	-24,000	-43,000	-270,000
2048 (C)	52,000	61,000	110,000	-160,000
2049 (W)	19,000	34,000	52,000	-110,000
2050 (W)	-2,800	7,700	4,100	-100,000
2051 (W)	63,000	83,000	150,000	41,000
2052 (W)	-23,000	-5,500	-29,000	12,000
2053 (W)	1,100	-930	-180	12,000
2054 (AN)	-26,000	-30,000	-56,000	-45,000
2055 (D)	-19,000	-22,000	-41,000	-86,000
2056 (D)	22,000	20,000	41,000	-45,000
2057 (AN)	-1,000	3,800	2,000	-43,000
2058 (BN)	19,000	21,000	40,000	-3,000

Water Year (Type)		Upper Aquifer	Lowe Aquifer	Total Annual Change	Total Cumulative Change
2059 (AN)		21,000	33,000	53,000	50,000
2060 (W)		-40,000	-49,000	-89,000	-39,000
2061 (D)		-30,000	-38,000	-69,000	-110,000
2062 (C)		-25,000	-42,000	-67,000	-180,000
2063 (D)		23,000	15,000	37,000	-140,000
2064 (BN)		13,000	15,000	28,000	-110,000
2065 (W)		-30,000	-35,000	-66,000	-180,000
2066 (BN)		-19,000	-31,000	-50,000	-230,000
2067 (D)		-30,000	-51,000	-81,000	-310,000
2068 (C)		-17,000	-29,000	-45,000	-350,000
2069 (C)		13,000	7,400	20,000	-330,000
2070 (BN)		44,000	54,000	98,000	-240,000
2071 (W)		-30,000	-38,000	-68,000	-300,000
2072 (W)		44,000	49,000	93,000	-210,000
Average (2022-2072)		-1,000	-3,000	-4,000	
2022-2072	W	21,000	31,000	52,000	
	AN	20,000	17,000	37,000	
	BN	-15,000	-20,000	-35,000	
	D	-24,000	-32,000	-57,000	
	C	-26,000	-39,000	-65,000	

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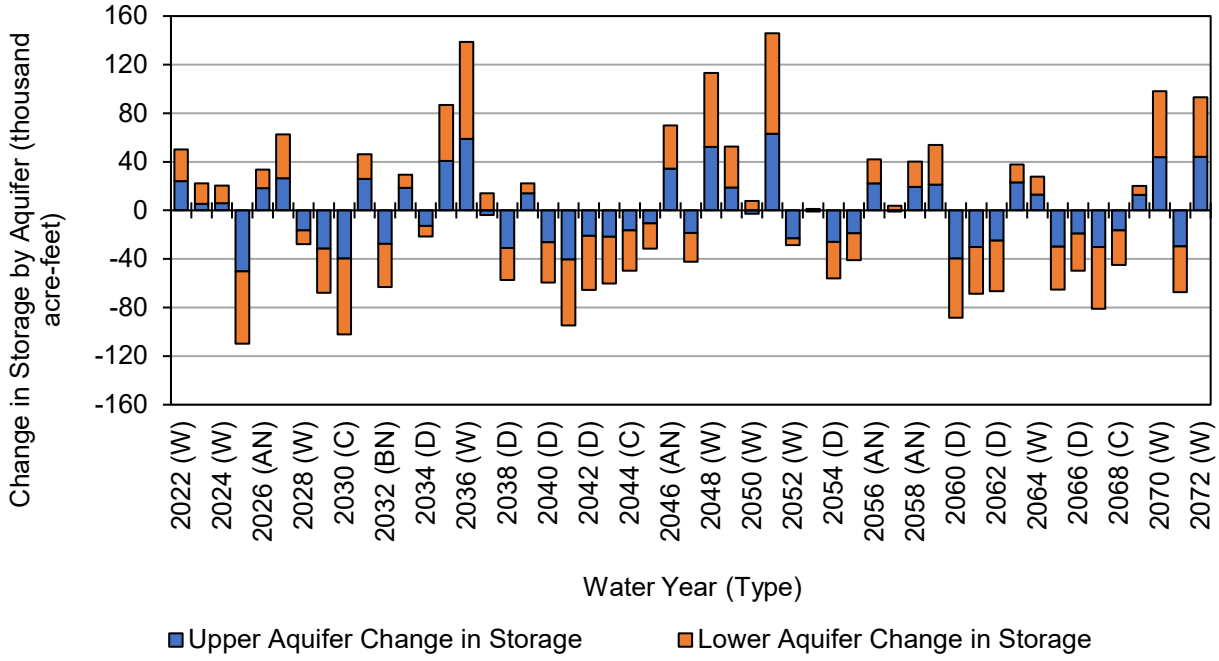

Figure 96. Red Bluff Subbasin Projected (Future Land Use with Climate Change) Change in Groundwater Storage by Aquifer