

Engineering Investigation of the Bunker Hill Basin 2020-2021

Figures



**San Bernardino Valley
Water Conservation District**

Helping Nature Store Our Water

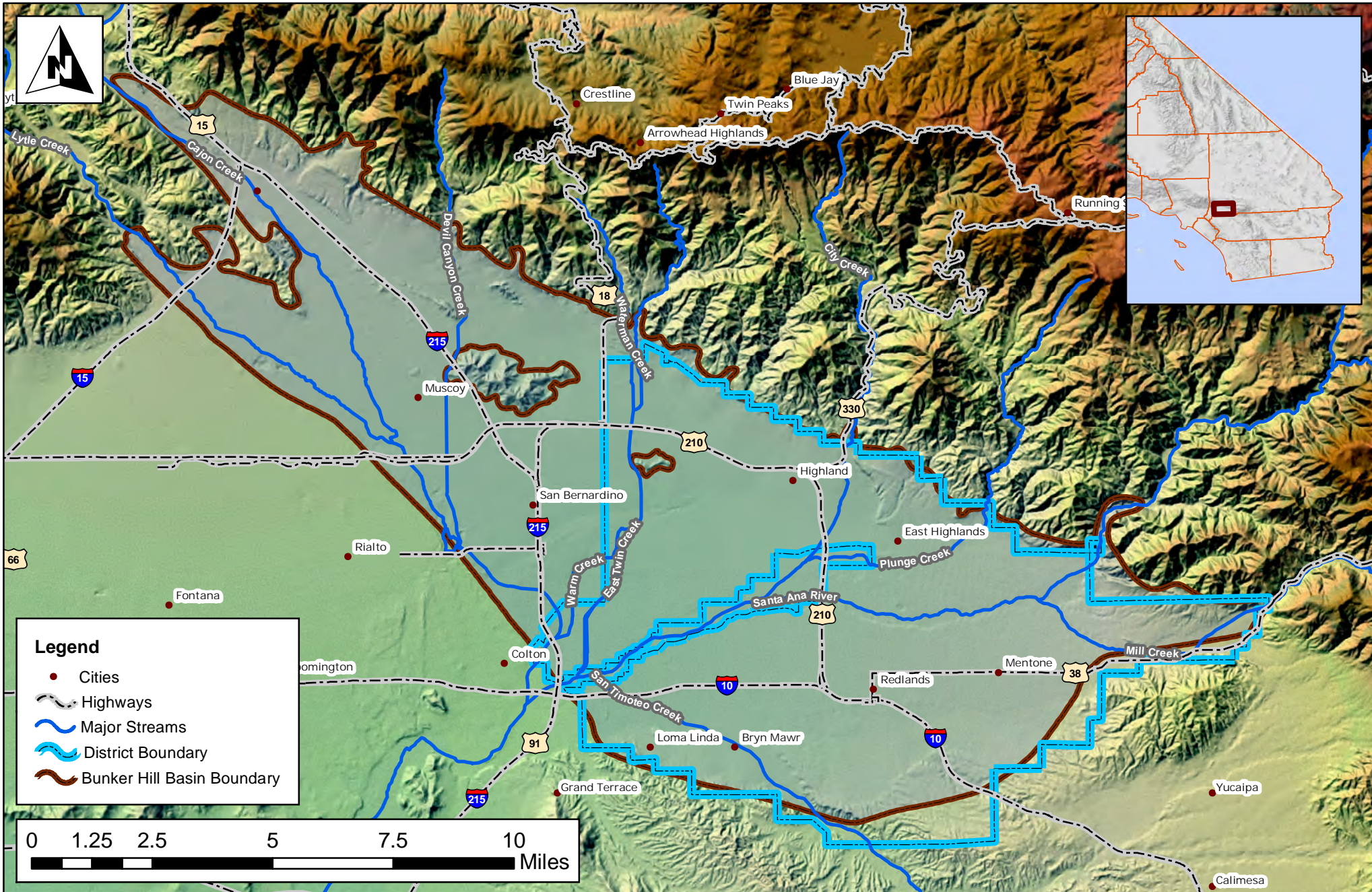
Figure 1: Project Area

Engineering Investigation Report 2022

Coordinate System:
 NAD 1983 StatePlane California V FIPS 0405 Feet
 Projection: Lambert Conformal Conic
 Datum: North American 1983
 Source: SBVWCD, CASIL, SBVMWD
 GIS Contact: K. Scholte
 January 31, 2022



**San Bernardino Valley
 Water Conservation District**
 Helping Nature Store Our Water



Legend

- Cities
- Highways
- Major Streams
- - - District Boundary
- - - Bunker Hill Basin Boundary

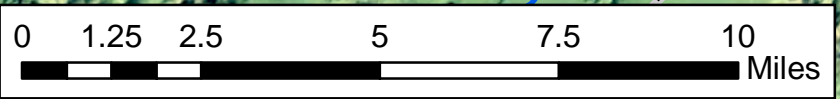


Figure 2: District and Water Agency Boundaries Engineering Investigation Report 2022

Coordinate System:
 NAD 1983 StatePlane California V FIPS 0405 Feet
 Projection: Lambert Conformal Conic
 Datum: North American 1983
 Source: SBVWCD, CASIL, SBVMWD
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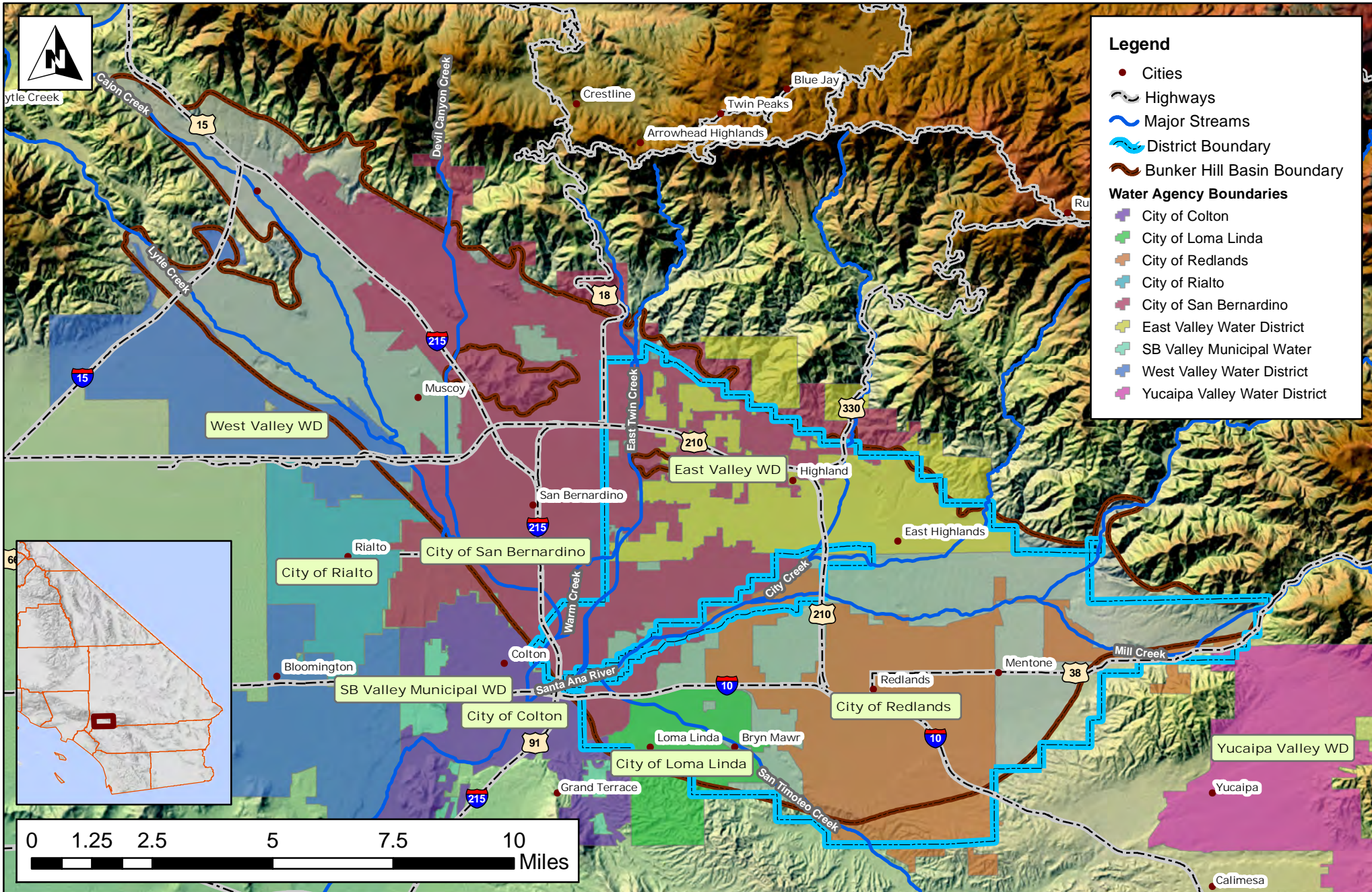


Figure 3: Bunker Hill Sub Basins Engineering Investigation Report 2022

Coordinate System:
NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Source: SBVWCD, CASIL, SBVMWD
GIS Contact: K. Scholte
January 31, 2022

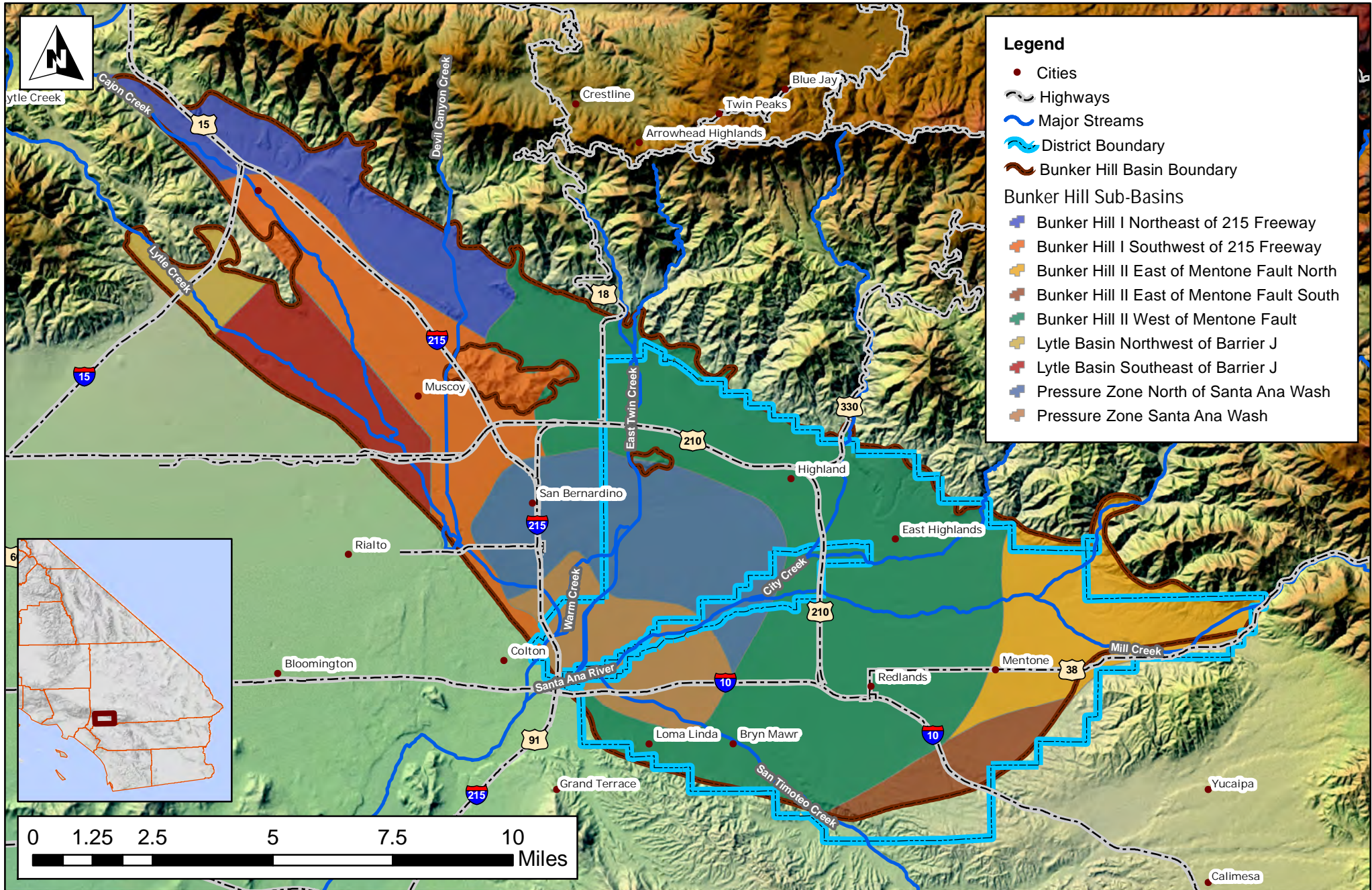


Figure 4: Precipitation Trends and Station Locations October 2020 - September 2021 Engineering Investigation Report 2022

Coordinate System:
NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Source: SBVMWD, CASIL, SBVMWD
GIS Contact: K. Scholte & A. Frey
February 3, 2022

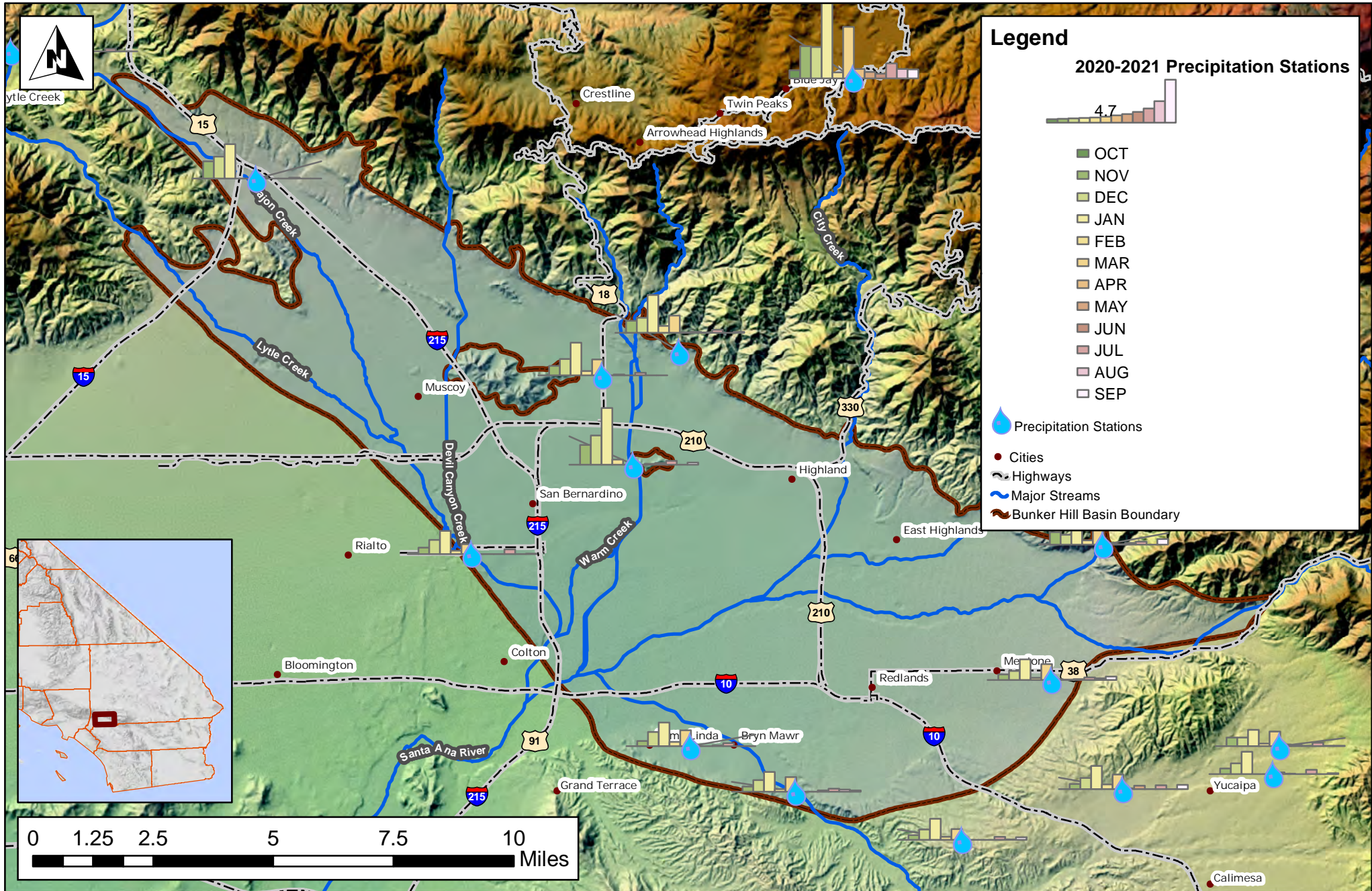


Figure 7: Key Wells (Appendix B Hydrographs) 2020-2021 Engineering Investigation Report 2022

Coordinate System:
NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Source: SBVWCD, CASIL, SBVMWD
GIS Contact: K. Scholte
January 31, 2022

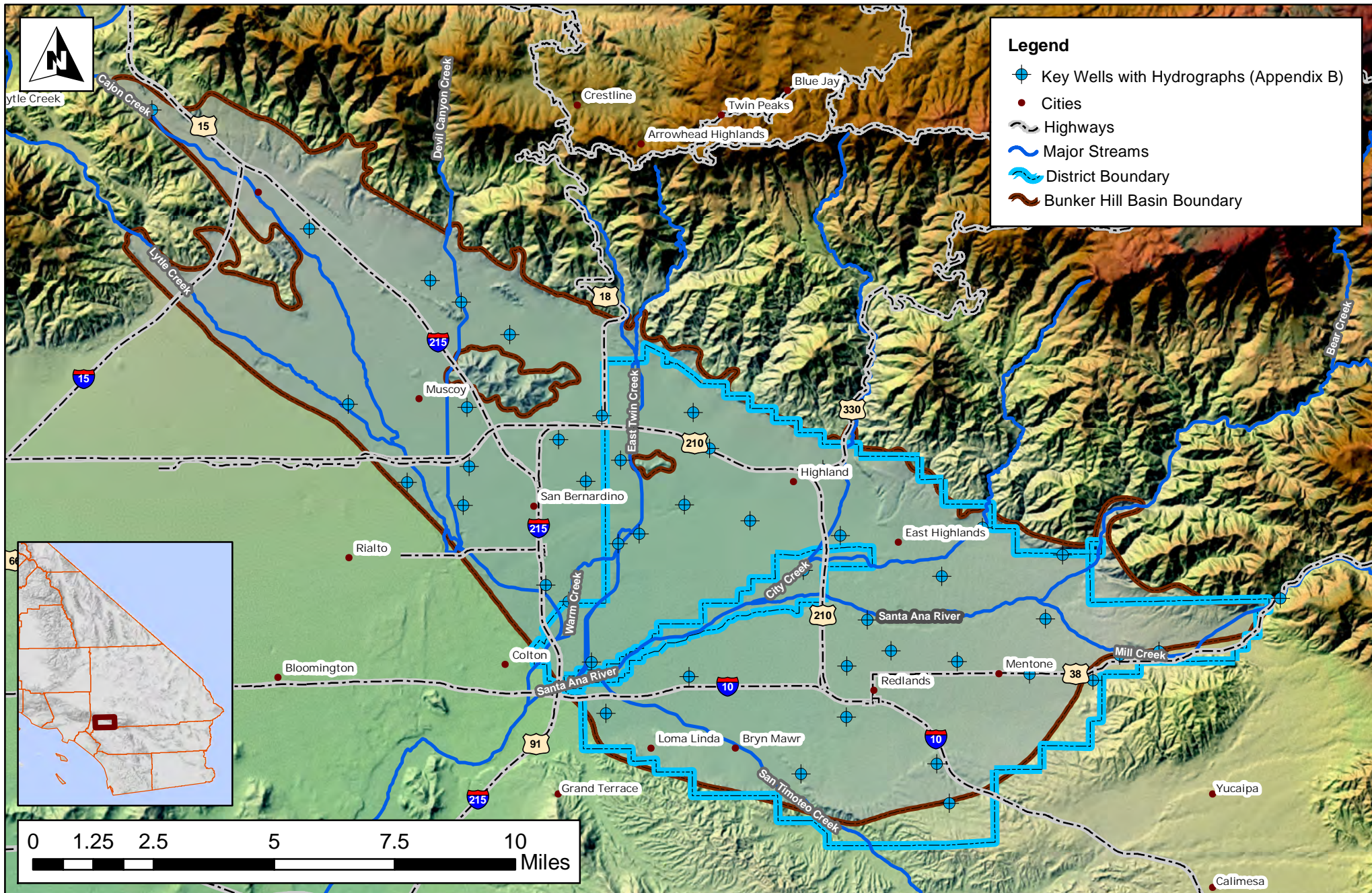
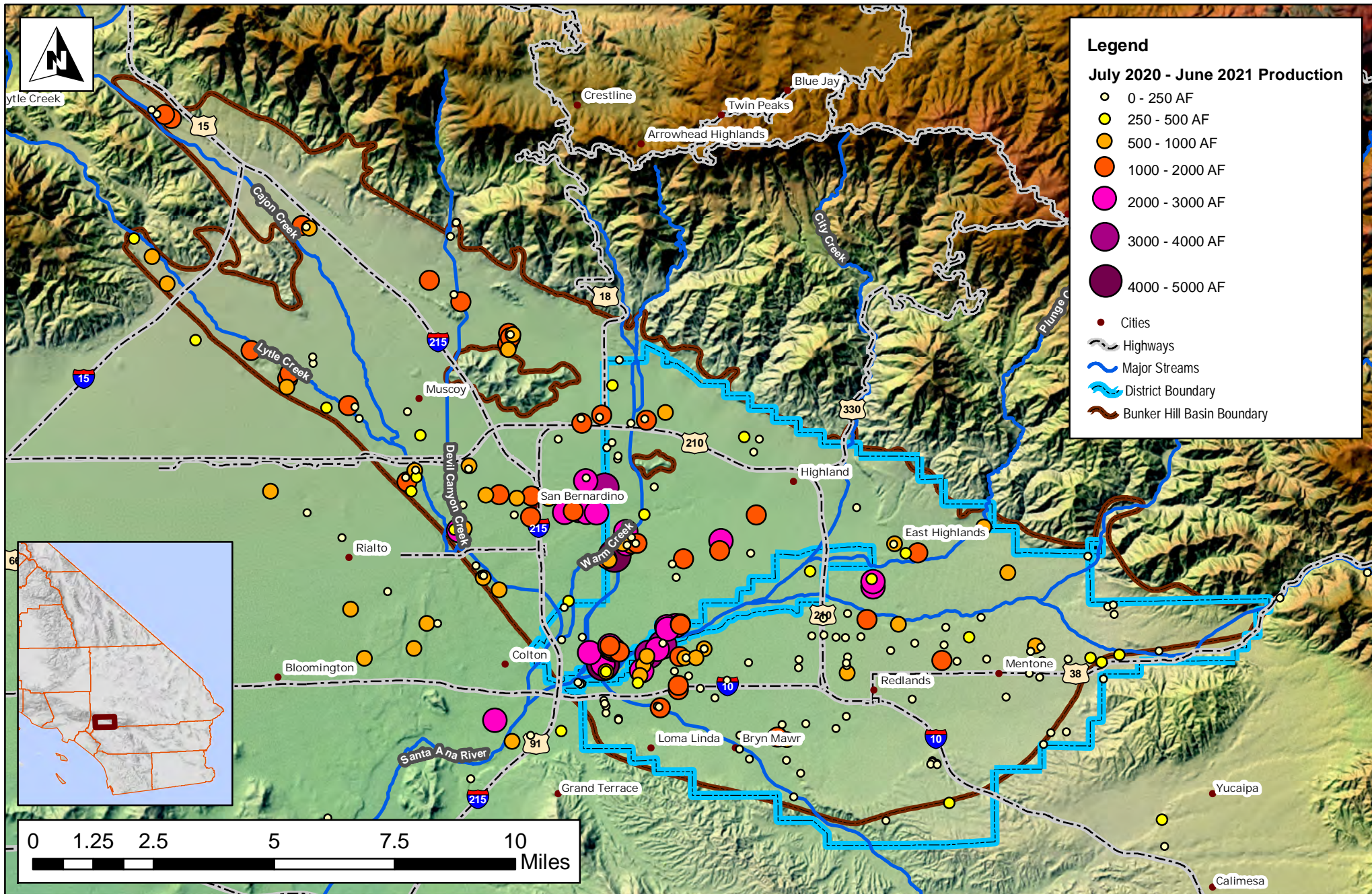


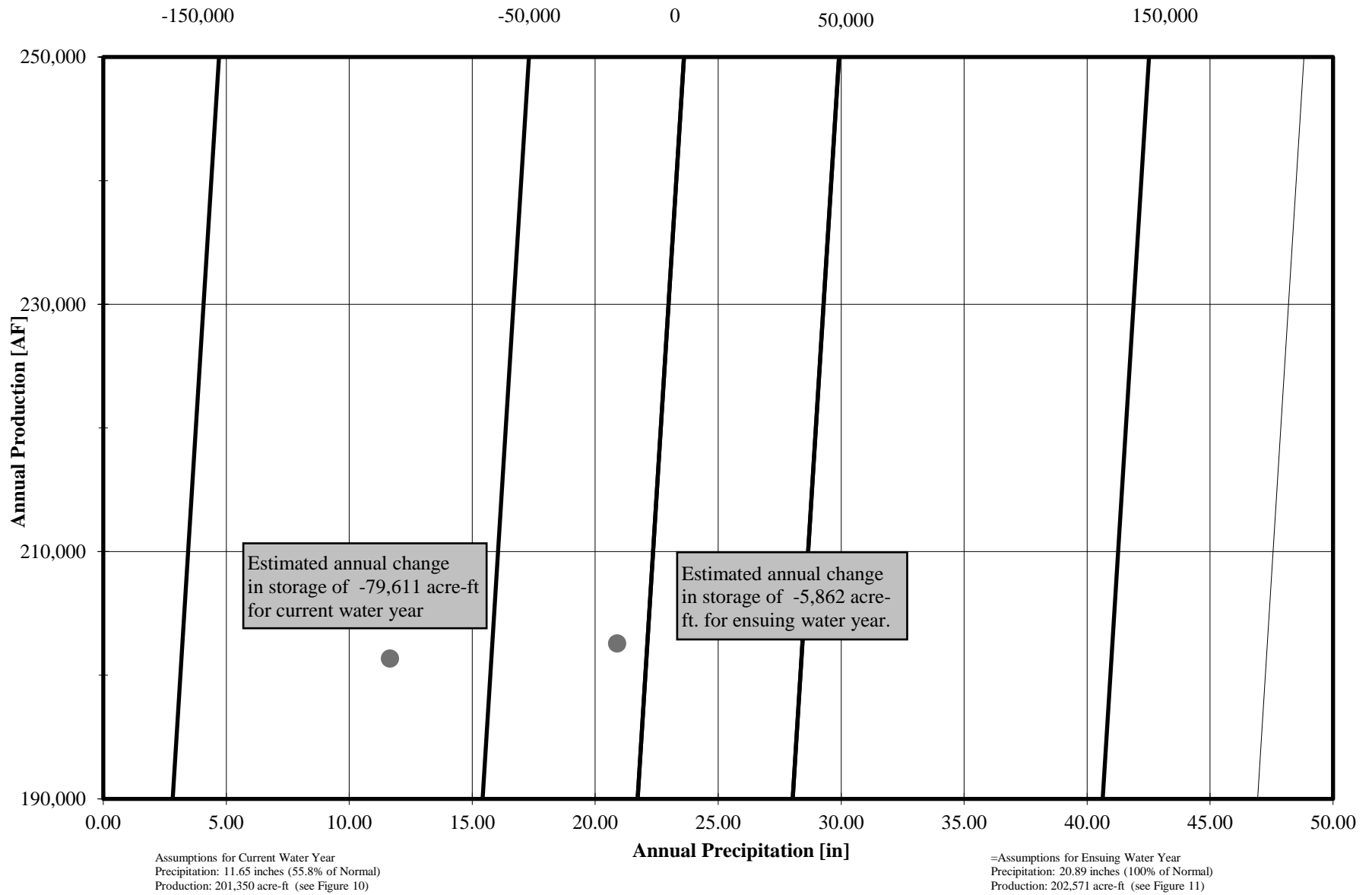
Figure 8: Groundwater Production Bunker Hill Basin Total Well Production for July 2020 - June 2021 Engineering Investigation Report 2022

Coordinate System:
NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Source: SBVWCD, CASIL, SBVMWD
GIS Contact: K. Scholte & A. Frey
February 3, 2022



Prediction Chart for Annual Change in Storage

Current and Ensuing Water Years

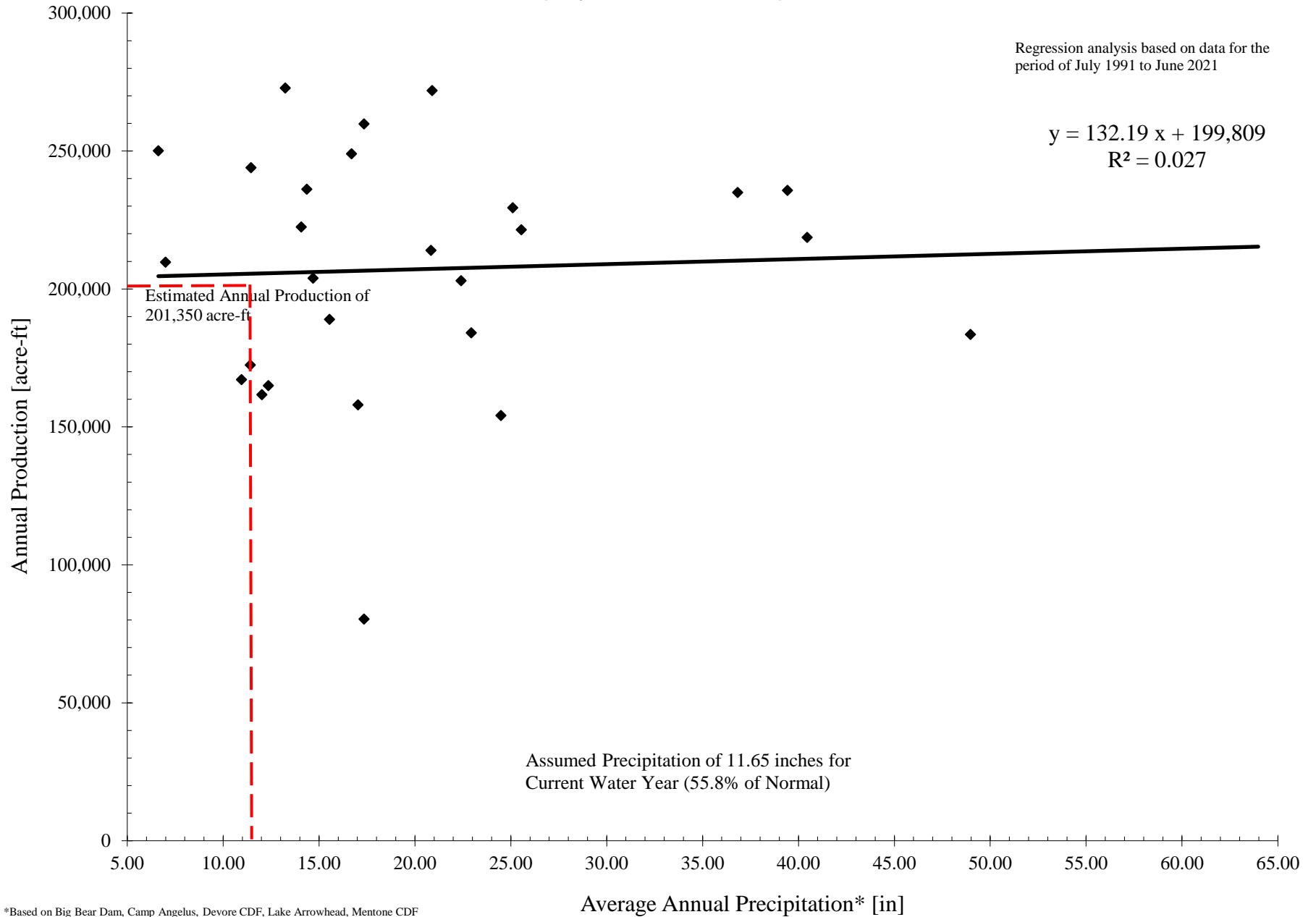


* Based on Big Bear Dam, Camp Angelus, Devore CDF, Lake Arrowhead, Mentone CDF, Redlands Country Club, San Bernardino County Hospital, Santa Ana Powerhouse #3, and Yucaipa CDF.

$$\text{Change in Storage} = -106,334 + 8,026 * \text{Precipitation} - 0.33 * \text{Production} \quad (R^2 = 0.76)$$

Estimate of Production for Current Water Year

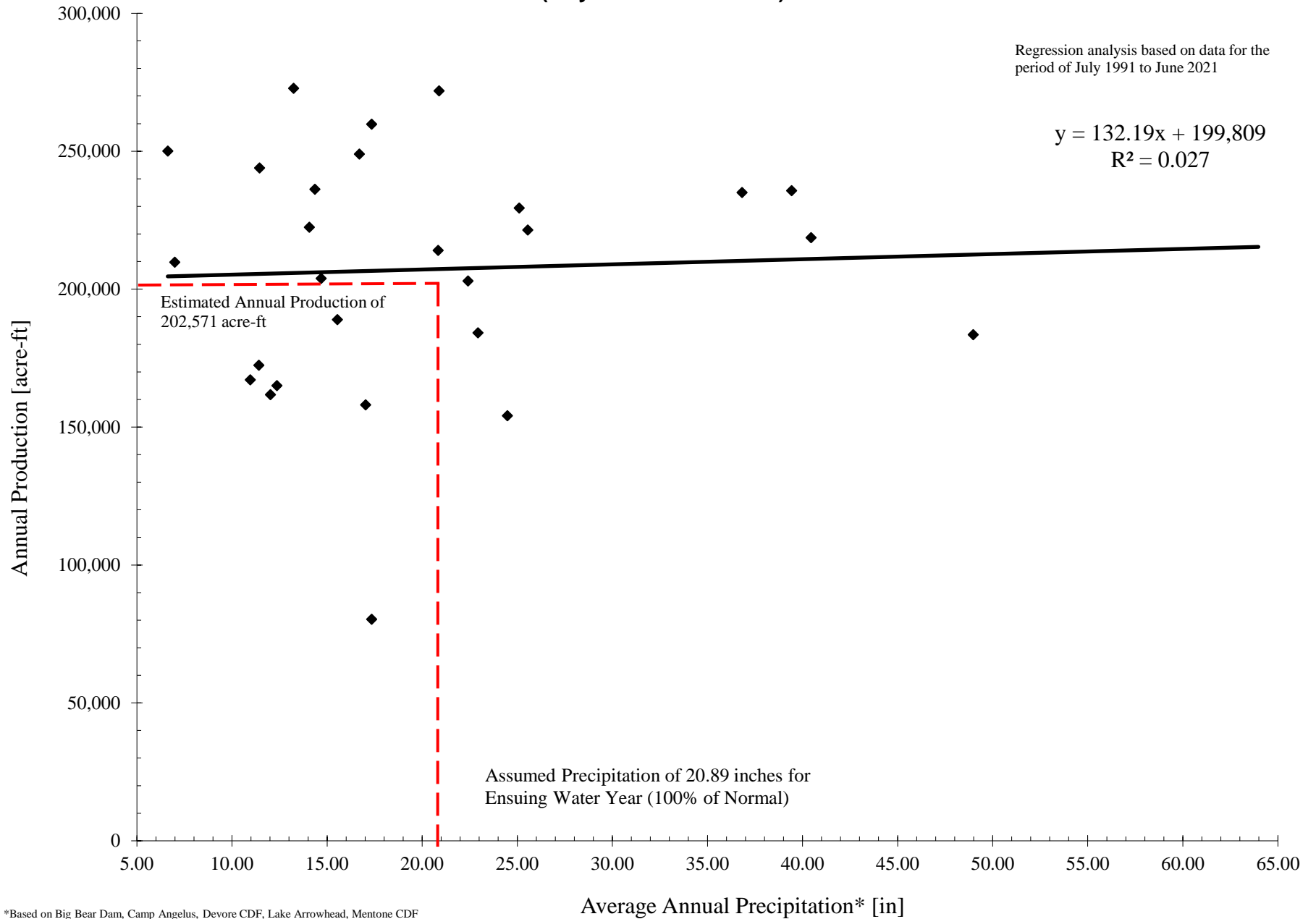
(July 2021 to June 2022)



*Based on Big Bear Dam, Camp Angelus, Devore CDF, Lake Arrowhead, Mentone CDF, Redlands Country Club, San Bernardino County Hospital, Santa Ana Powerhouse #3, and Yucaipa CDF.

Estimate of Production for Ensuing Water Year

(July 2022 to June 2023)



*Based on Big Bear Dam, Camp Angelus, Devore CDF, Lake Arrowhead, Mentone CDF, Redlands Country Club, San Bernardino County Hospital, Santa Ana Powerhouse #3, and Yucaipa CDF.

Engineering Investigation of the Bunker Hill Basin 2020-2021

Tables



**San Bernardino Valley
Water Conservation District**

Helping Nature Store Our Water

Summary of Percentage of Normal Precipitation

1990
to 2021
(Water Year - Oct. to Sept.)

Station	Historic Annual Avg. [in]	1990 -1991 [in]	1991 -1992 [in]	1992 -1993 [in]	1993 -1994 [in]	1994 -1995 [in]	1995 -1996 [in]	1996 -1997 [in]	1997 -1998 [in]	1998 -1999 [in]	1999 -2000 [in]	2000 -2001 [in]	2001 -2002 [in]	2002 -2003 [in]	2003 -2004 [in]	2004 -2005 [in]	2005 -2006 [in]	2006 -2007 [in]	2007 -2008 [in]	2008 -2009 [in]	2009 -2010 [in]	2010 -2011 [in]	2011 -2012 [in]	2012 -2013 [in]	2013 -2014 [in]	2014 -2015 [in]	2015 -2016 [in]	2016 -2017 [in]	2017 -2018 [in]	2018 -2019 [in]	2019 -2020 [in]	2020 -2021 [in]	Each Station 30 Yr. Avg. [in.]
Big Bear City	14.23	16.00	14.58	26.01	10.28	19.41	13.28	11.59	20.64	7.42	5.15	0.01	0.00	0.00	0.00	0.00	0.00	10.21	14.62	19.55	25.33	16.27	10.46	8.54	9.28	11.18	21.09	7.79	23.37	7.73	8.89	10.93	
Big Bear Dam	33.49	32.80	31.90	69.70	27.60	52.40	24.40	18.60	54.30	14.20	20.60	21.40	9.20	38.10	19.60	59.10	26.40	10.30	23.10	19.70	26.00	20.20	10.44	5.19	11.72	20.40	17.32	19.88	31.27	50.19	45.73	20.21	27.48
Camp Angelus	26.06	0.00	28.16	0.00	17.20	46.70	26.00	30.50	55.30	16.10	21.10	21.51	7.70	35.40	13.20	35.20	41.90	0.00	2.70	18.00	18.80	1.70	16.82	9.03	10.62	41.01	11.22	36.29	16.45	45.56	27.92	12.80	21.45
Crafton Hills	13.71	15.38	14.88	28.18	11.26	27.22	9.13	16.67	25.55	7.29	6.40	10.49	2.46	17.57	9.47	31.39	11.45	3.34	13.34	9.90	17.80	24.52	9.57	9.69	6.55	13.06	10.56	19.12	6.27	18.26	17.32	7.81	13.93
Del Rosa Ranger Station	17.33	8.79	24.24	41.39	12.30	27.69	14.21	17.31	37.26	8.30	12.73	16.60	6.09	19.69	13.02	38.55	17.40	8.77	17.80	13.61	22.01	30.84	11.68	2.22	4.54	6.75	6.32	24.37	9.06	27.381	15.87	10.35	17.00
Devore CDF	26.17	21.92	31.50	65.45	19.66	39.77	23.96	33.10	52.69	13.61	8.04	15.52	10.90	35.35	16.44	60.36	24.80	8.86	25.22	16.51	34.12	43.20	17.47	14.5	13.81	18.14	15.29	35.05	12.21	39.471	22.03	8.35	25.72
Fallsvale	31.02	22.50	36.00	71.90	52.00	54.90	22.10	33.80	53.00	16.30	19.20	15.30	6.50	37.50	19.80	59.70	26.90	11.10	29.30	25.00	2.85	29.51	22.90	14.1	26.3	25.58	22.314	47.64	20.77	48.7	39.96	15.39	29.96
Lake Arrowhead	36.52	29.96	43.21	19.27	10.04	62.60	32.70	36.50	72.80	18.10	25.80	28.60	10.70	36.50	22.70	66.40	29.50	13.60	40.40	30.30	46.00	37.76	25.10	21.3	26.7	14.733	24.3	48.81	17.27	50.816	40.3	29.07	32.64
Loma Linda FD	10.75	11.72	12.57	24.27	10.81	21.17	8.65	9.78	22.74	5.12	7.74	6.38	2.45	14.48	8.06	22.59	11.06	3.51	9.64	8.95	13.10	18.24	6.79	6.42	9.06	9.5	7.86	16.13	5.91	17.36	15.17	7.16	11.43
Lytle Creek at Foothill	12.92	15.51	14.91	31.59	9.16	25.51	12.23	13.83	25.84	6.25	9.81	12.12	4.00	13.60	7.16	27.23	11.22	3.84	11.89	8.12	13.03	21.63	6.90	4.51	8.34	10.18	7.04	18.247	4.99	15.32	10.79	6.68	12.63
Lytle Creek Fire Station	22.31	32.07	49.09	87.71	20.50	47.57	24.49	23.10	52.18	11.81	20.40	18.34	4.47	16.96	12.09	44.11	18.92	4.22	21.89	3.32	0.00	28.46	8.18	7.33	8.03	9.07	13.57	31.02	11.902	36.02	24.46	6.77	22.52
Mentone CDF	12.36	14.76	14.57	27.40	11.68	23.25	9.42	15.50	27.09	4.28	9.08	10.16	4.06	15.00	10.38	24.94	11.01	5.41	10.76	9.39	14.96	17.77	7.90	7.33	3.11	0.89	8.57	15.14	5.28	16.22	14.37	7.01	12.15
Oak Glen	23.90	26.92	30.78	57.96	18.76	57.92	20.04	30.39	49.46	11.32	17.12	11.24	6.72	14.28	18.39	34.14	22.58	9.71	27.54	18.11	29.72	36.82	15.13	15.69	14.07	20.54	18.78	16.04	7.44	34.06	23.05	8.88	23.34
Redlands - Roth	11.29	13.34	14.96	25.57	10.06	20.49	8.08	10.77	22.29	6.46	7.41	10.38	3.35	12.18	9.16	24.43	9.52	3.31	9.46	8.91	15.12	17.38	4.34	1.54	2.08	2.72	1.7	14.42	5.43	14.74	13.776	6.63	10.65
Redlands Country Club	12.09	13.95	14.58	26.96	11.90	15.76	0.65	9.03	17.22	6.30	5.68	9.96	3.97	16.45	11.58	29.37	10.30	4.13	11.93	11.35	17.25	22.33	8.84	8.82	6.92	10.37	8.61	16.9	5.53	16.12	6.27	6.23	11.78
San Bernardino CDF	16.47	15.49	21.89	37.35	4.46	20.29	15.77	16.17	34.32	9.30	13.62	16.61	5.29	13.14	11.54	37.28	16.39	6.33	18.91	10.73	20.45	27.94	10.63	7.69	11.3	11.19	10.91	23.3	7.99	23.48	13.65	8.88	16.20
San Bernardino Co. Hospital	15.63	15.60	18.09	34.44	12.40	25.94	11.94	17.80	32.67	8.02	11.09	2.43	3.60	17.06	10.49	29.89	13.20	4.68	12.81	9.96	17.03	21.76	9.58	9.36	10.97	10.97	8.96	19.15	6.67	5.7	13.18	12.84	14.14
Santa Ana Pumphouse #3	16.02	18.54	18.28	36.68	14.00	24.85	11.05	16.60	27.95	7.01	6.78	8.63	3.23	18.24	9.40	27.65	11.78	6.13	10.73	9.75	14.58	20.18	8.62	9.12	7.42	9.57	9.29	16.47	6.762	20.07	14.98	8.62	13.97
Yucaipa CDF	15.09	17.52	19.37	34.60	10.00	14.70	10.89	16.06	24.70	7.63	11.10	9.92	5.66	19.47	11.84	32.70	13.14	6.56	14.67	12.11	18.79	25.09	11.80	5.25	4.45	12.49	11.11	17.18	6.47	20.341	14.7	6.06	14.40
Yucaipa Valley Water District	15.16	16.48	16.80	32.37	11.35	28.54	10.19	16.93	28.60	9.87	9.63	9.65	5.27	19.50	11.10	32.73	12.52	5.53	14.79	10.47	17.68	22.74	10.80	9.6	7.58	12.39	10.31	18.38	6.48	19.73	16.53	5.14	14.83

Percent of Normal	100%	94%	123%	204%	80%	172%	81%	103%	193%	51%	65%	67%	28%	107%	64%	188%	89%	31%	88%	70%	99%	129%	63%	47%	53%	70%	61%	124%	53%	142%	104%	53%	93%
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Total Station Average	19.13
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Source: San Bernardino County Department of Transportation/Flood Control

Change in Groundwater Levels in Key Wells

Fall 2020 to Fall 2021

WCD Code	Recordation Number	State Well Number	Well Name	Owner Or Measuring Agency	2020 Depth To Water (ft)	2021 Depth To Water (ft)	Difference Fall 2020 to Fall 2021
1865	3601675	1N4W25A01S	27	East Valley Water District	190.0	237.0	47.0
1984	3602113	1N3W30N01S	41	East Valley Water District	299.0	336.0	-37.0
1364	3600026	1S3W04J01S	102	East Valley Water District	255.5	255.0	0.5
1401	3600220	1S3W01H01S	142 Mt. Harrison	East Valley Water District		252.0	
1660	3601184	1N3W33F01S	94 Corwin	East Valley Water District	420	409	11.0
1851	3601660	1S3W06H04S	9A	East Valley Water District	231.5	252.0	-20.5
1010	9900021	1S3W09E02S	Tri-City Concrete	East Valley Water District	248.5	250.0	-1.5
2271	3602855	1S4W25D07S	Anderson III	Loma Linda University	253	261	-8.0
1727	3601308	1S2W19K01S	Agate #1	Redlands, City of	108.0	150.0	-42.0
1708	3601283	1S2W22C02S	E. Lugonia #2	Redlands, City of			
1712	3601287	1S2W21B02S	E. Lugonia #3	Redlands, City of	32.0	60.0	-28.0
1714	3601290	1S2W21D01S	E. Lugonia #6	Redlands, City of	62.0	69.0	-7.0
1970	3602065	1S3W32J02S	Lee Well	Redlands, City of			
1706	3601281	1S2W36F01S	Maguet #1	Redlands, City of	24.0	26.0	-2.0
1709	3601284	1S2W21E01S	Maguet #2	Redlands, City of	42.0	53.0	-11.0
1707	3601282	1S1W08H01S	Mill Creek #1	Redlands, City of			
1819	3601586	1S3W15F01S	Orange Street	Redlands, City of	156.0	171.0	-15.0
1591	3600918	2S3W01E01S	Redlands Heights	Redlands, City of	182.0	179.0	3.0
1718	3601294	1S3W35G09S	Well #13	Redlands, City of	63.0	62.0	1.0
1720	3601296	1S3W35H03S	Well #16	Redlands, City of	44.0	43.0	1.0
1722	3601298	1S3W21H01S	Well #32	Redlands, City of	199.0		
1723	3601299	1S4W24K01S	Well #34	Redlands, City of	247.0	236.0	11.0
1964	3602032	1S3W22A02S	Well #35	Redlands, City of	216.0	234.0	-18.0
1725	3601301	1S3W28H01S	Well #41	Redlands, City of			
1702	3601263	1N5W23Q01S	City 1	Rialto, City of	243.0	247.0	-4.0
1668	3601225	1S4W02P02S	Cooley D	Riverside, City of	211.2	232.4	-21.2
1662	3601218	1S4W14P02S	Raub 1	Riverside, City of			
1677	3601234	1S4W27A19S	Stewart 19	Riverside, City of	207.8	194.8	13.0
1744	3601431	1S4W27H01S	Stewart 20	Riverside, City of	192.1	187.6	4.5
1767	3601478	1S4W22B03S	Thorn 10	Riverside, City of			
1683	3601240	1S4W22H04S	Warren 1	Riverside, City of	183.0		
1554	3600787	1S4W23A02S	26-1	Riverside, City Of-Gage Canal	197.0	201.0	-4.0
2291	229101	1S2W07B01S	SBVWCD #1	San Bernardino Valley Water Cons. Dist	220.9		
2290	229001	1S2W07K01S	SBVWCD #2	San Bernardino Valley Water Cons. Dist	174.9	211.6	-36.7
2286	228601	1S3W12J01S	SBVWCD #3	San Bernardino Valley Water Cons. Dist	171.9	225.3	-53.4
2288	228801	1S3W11H01S	SBVWCD #4	San Bernardino Valley Water Cons. Dist	137.7	178.8	-41.1
1525	3600725	1N4W34G01S	17th & Sierra Way #2	San Bernardino, City of			
1517		1N4W32D03S	19th Street No. 1	San Bernardino, City of	377.5	389.3	-11.8
1520	3600720	1N4W27M02S	27th Street Well	San Bernardino, City of	301.4	337.8	-36.4
1519	3600719	1N4W27G01S	30th & Mtn. View	San Bernardino, City of	333.1	336.4	-3.3
1979	3602081	1N4W27B01S	31st & Mtn. View	San Bernardino, City of	338.0	354.5	-16.5
2066	3602422	1S4W02K08S	Antil Well #6	San Bernardino, City of	194.4	195.0	-0.6
2062	3602400	1N4W32N01S	Baseline Well	San Bernardino, City of	388.8	392.8	-4.0
1510	3600710	2N5W19K02S	Cajon Canyon Well	San Bernardino, City of	49.1	81.8	-32.7
1910	3601844	1N5W03H02S	Cajon Well #2	San Bernardino, City of	157.1	188.9	-31.8
2115	3602821	1N5W03A02S	Cajon Well #3	San Bernardino, City of	155.8	196.6	-40.8
2008	3602206	1N4W06H02S	Devil Canyon #3	San Bernardino, City of	22.6	24.2	-1.6
2007	3602205	1N4W06H01S	Devil Canyon #4	San Bernardino, City of	34.0	36.8	-2.8
3139	G363790	1N04W32PS	EPA Extract Well 112	San Bernardino, City of	424.3	426.3	-2.0
1537	3600737	1S4W10N06S	Mill & D	San Bernardino, City of	217.2	220.3	-3.1
1514	3600714	1N4W16E01S	Newmark #1	San Bernardino, City of	229.2	245.2	-16.0
1516	3600716	1N4W16E03S	Newmark #3	San Bernardino, City of	228.9	243.3	-14.4
1647	3601115	1N4W26P03S	Perris Hill #5	San Bernardino, City of	284.9	288.0	-3.1
2448	9900045	1S4W23H	Brier/Gould/Tippecanoe	San Bernardino, City of / shallow wells			
		1S04W22C	Wastewater N MW #1	San Bernardino, City of / shallow wells			
1936	3601944	1N5W23Q01S	2/Lower 7	West Valley Water District	329.0	251.0	78.0
1419	3603769	1N5W25E01S	5A/Lower 5	West Valley Water District	327.0	260.0	67.0
1612	3600997	1N5W36H04S	7/Lord 7	West Valley Water District	400	408	-8.0

Annual Change in Storage for Bunker Hill Basin

Fall 2020 to Fall 2021

Sub-area	[1] Annual Change in Water Level 2020 [ft]	[2] Area [acres]	[3] Storativity (S)	[4] Annual Change in Storage** [acre-ft]
Bunker Hill I - Northeast of 215 Freeway	-14.6	7,795	0.11	-12,560
Bunker Hill I - Southwest of 215 Freeway	-11.2	11,714	0.09	-11,783
Bunker Hill II - West of Mentone Fault	-14.4	35,206	0.06	-30,410
Bunker Hill II - East of Mentone Fault, North	-29.1	8,584	0.13	-32,499
Bunker Hill II - East of Mentone Fault, South	2.7	2,507	0.13	885
Lytle Basin - Northwest of Barrier J	-3.7	1,924	0.13	-917
Lytle Basin - Southeast of Barrier J	-8.2	5,237	0.07	-2,988
Pressure Zone - North of Santa Ana Wash	-4.5	11,920	0.02	-1,064
Pressure Zone - Santa Ana Wash	0.9	6,686	0.02	120

Total = -91,218

[1] Based on average changes in water level within each Sub-area

[2] Estimated using GIS

[3] Based on data from Hardt and Hutchinson (1980).

S, storativity: The amount of water stored or released per unit area of aquifer given unit head change.

[4] = [1] x [2] x [3]

*A positive sign denotes an increase in water level and a negative sign represents a decline in water level.

Accumulated Change in Storage for Bunker Hill Basin

1989 to 2021 (Based on "Zero Year" of 1993)

Year	Accumulated Storage [acre-ft]
1989	-58,000
1990	-170,700
1991	-196,000
1992	-191,000
1993	0
1994	-50,000
1995	41,100
1996	-43,100
1997	-75,500
1998	40,400
1999	-85,700
2000	-131,100
2001	-212,200
2002	-301,500
2003	-338,800
2004	-406,900
2005	-183,100
2006	-245,500
2007	-359,400
2008	-362,000
2009	-397,600
2010	-340,623
2011	-224,603
2012	-314,377
2013	-444,322
2014	-535,877
2015	-583,447
2016	-566,555
2017	-522,930
2018	-570,718
2019	-418,310
2020	-486,185
2021	-577,403

Note: A negative sign indicates a decline in storage and a positive sign represents an increase in storage.

Production for Sub-basins of Bunker Hill Basin

Preceding Water Year (July 2020 to June 2021)

Sub-area	Production July 2020 to June 2021 [acre-ft] ²
Bunker Hill I - Northeast of Interstate 215	5,547
Bunker Hill I - Southwest of Interstate 215	9,000
Bunker Hill II - West of Mentone Fault	30,115
Bunker Hill II - East of Mentone Fault, North	3,571
Bunker Hill II - East of Mentone Fault, South	922
Lytle Basin - Northwest of Barrier J	1,660
Lytle Basin - Southeast of Barrier J	9,351
Pressure Zone - North of Santa Ana Wash	47,162
Pressure Zone - Santa Ana Wash	62,583
Total	169,910

Notes: 188 Wells Used in these Calculations

1 - Refer to Appendix C for Well Values Compiled for Estimate.

2 - Estimated for Water Year July 2020-June 2021 production.

Data Sources: 15 Primary Water Purveyors,
as well as San Bernardino Watermaster, and SBVMWD.

Estimates of Percentage of Normal Precipitation for Previous Water Year

July 2020 to June 2021

	[0]		[1]	[2]	[3]	[4]	[5]	[6]	[7]
	July to June		Season - July to December			Season - January to June			Jul. 2020- Jun. 2021
Station	Historic Average Annual	2020-2021	Historic Average	Sum Jul 2020 to Dec 2021	% of Normal	Historic Average	Sum Jan 2021 to Jun 2021	% of Normal	Water Year % of Normal
	[inches]	[inches]	[inches]	[inches]	[%]	[inches]	[inches]	[%]	[%]
Big Bear Dam	31.38	19.61	10.64	8.10	76%	20.74	11.51	55%	62%
Devore CDF	26.34	8.22	8.41	4.29	51%	17.93	3.93	22%	31%
Camp Angelus	22.51	13.37	7.73	6.24	81%	14.78	7.13	48%	59%
Lake Arrowhead	36.58	27.44	11.84	9.71	82%	24.74	17.73	72%	75%
Mentone CDF	12.40	6.17	3.82	1.67	44%	8.58	4.50	52%	50%
Redlands Country Club	12.09	5.52	3.89	1.69	43%	8.20	3.83	47%	46%
San Bernardino County Hospital	15.37	12.22	4.90	5.30	108%	10.46	8.90	85%	92%
Santa Ana Pumphouse #3	16.17	7.88	5.36	2.71	51%	10.81	5.17	48%	49%
Yucaipa CDF	15.20	5.66	4.94	1.78	36%	10.22	3.88	38%	37%

Avg (in) =	20.89	11.79
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Average =	63.5%
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Average =	51.9%
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2020-21 Average =	55.8%
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[1], [4]: Based on data provided by San Bernardino County Department of Transportation/Flood Control

[3] = (([2] / [1]) x 100

[5] = [0] - [2]

[6] = (([5] / [4]) x 100

[7] = (([2] + [5]) / ([1] + [4])) x 100

Average Annual Change in Storage for Bunker Hill Basin

Fall 2011 to Fall 2021

(The Immediate Past 10 Water Years)

Sub-area	[1] Average Change in 10 Years in Water Level* [ft]	[2] Area [acres]	[3] Storativity (S)	[4] Average Annual Change in Storage** [acre-ft]
Bunker Hill I - Southwest of 215 Freeway	-9.05	11,714	0.09	-9,324
Bunker Hill I - Northeast of 215 Freeway	-6.32	7,795	0.11	-5,415
Bunker Hill II - West of Mentone Fault	-4.65	35,206	0.06	-9,668
Bunker Hill II - East of Mentone Fault	-4.53	11,091	0.13	-6,531
Lytle Basin - Southeast of Barrier J	-1.39	5,237	0.07	-510
Lytle Basin - Northwest of Barrier J	-1.00	1,924	0.13	-251
Pressure Zone - North of Santa Ana Wash	-1.21	11,920	0.02	-290
Pressure Zone - Santa Ana Wash	-4.85	6,686	0.02	-648

Total = -32,637

[1] Based on average annual changes in water level within each Sub-area over last 10 years.

[2] Estimated using GIS.

[3] Based on data from Hardt and Hutchinson (1980).

S storativity: The amount of water stored or released per unit area of aquifer given unit head change.

[4] = [1] x [2] x [3]

*A positive sign is an increase in water level and a negative sign is a decline in water level.

Summary of Surface Distribution Water for Bunker Hill Basin

1993 to 2021

Streamflow Diversions	1993 [acre-ft]	1994 [acre-ft]	1995 [acre-ft]	1996 [acre-ft]	1997 [acre-ft]	1998 [acre-ft]	1999 [acre-ft]	2000 [acre-ft]	2001 [acre-ft]	2002 [acre-ft]	2003 [acre-ft]	2004 [acre-ft]	2005 [acre-ft]	2006 [acre-ft]	2007 [acre-ft]
Lytile Creek															
Fontana Union WC	7,343	12,601	9,893	10,730	7,266	8,626	9,695	4,131	5,829	2,906	3,029	3,774	4,439	12,203	6,516
Mount Vernon WC	1,143	102	0	0	0	0	312	786	778	975	1,442	754	70	250	437
Rialto, City of	193	843	44	1,070	393	896	1,461	NA	1,305	1,143	726	1,707	1,209	1,448	1,160
San Bernardino, City of	520		2,400	2,400	0	0	0	0	0	0	0	580	5	254	483
West Valley Water District	3,696	3,697	3,696	3,686	4,079	3,696	3,408	3,047	3,175	2,573	2,380	4,710	2,079	3,081	NA
Subtotal	12,895	17,243	16,033	17,886	11,738	13,218	14,876	7,964	11,087	7,597	7,577	11,525	7,802	17,236	8,596
Mill Creek															
Redlands, City of	19,086	14,505	9,786	12,250	10,250	11,224	11,951	8,852	9,496	5,867	12,541	10,168	12,574	15,409	9,607
SBVWCD Mill Creek Spreading	21,359	8,522	16,347	3,791	5,576	17,227	2,025	3,868	3,337	352	4,489	3,089	29,138	9,510	1,531
Subtotal	40,445	23,027	26,133	16,041	15,826	28,451	13,976	12,720	12,833	6,219	17,030	13,257	41,712	24,919	11,138
Bunker Hill Creeks															
Arrowhead Water & Power West Twin Crk												50	50	50	50
Arrowhead Water & Power East Twin Crk	16,821	2,225	9,277	3,273	4,451	9,734	2,276	1,420	1,339	616		2,500	1,750	1,700	1,725
Devore Water Company Kimbark Lower Cajon												29	97	80	62
Subtotal	16,821	2,225	9,277	3,273	4,451	9,734	2,276	1,420	1,339	616	0	2,579	1,897	1,830	1,837
Santa Ana River															
Bear Valley Mutual WC	42,079	23,812	30,794	38,252	31,479	36,632	30,245	29,498	26,301	23,458	12,633	11,227	12,516	17,689	11,560
Redlands Water Co					760							588	981	1,044	884
SBVWCD SAR Spreading	41,950	11,427	20,040	13,331	10,361	40,346	6,167	5,085	3,315	1,371	12,330	5,669	27,841	14,476	4,002
Subtotal	84,029	35,239	50,834	51,583	42,600	76,978	36,412	34,583	29,616	24,829	24,963	17,484	41,338	33,209	16,446
Imported Water Spreading															
Sweetwater basin	2,370	2,674	0	96	0	4	0	4,194	1,725	6,559	4,654	2,684	2,420	2,414	5,205
Badger Basin		0	0	0	0	0	0	4	0	0	0	4	0	0	0
Waterman Basin		0	0	0	0	0	0	0	0	3,528	250	0	0	0	39
SBVWCD Santa Ana Basins		1,223	0	0	0	0	0	99	7,153	6,853	2,229	924	2,117	3,782	1,994
SBVWCD Mill Creek Basins									1,462	1,696					0
Subtotal	2,370	3,897	0	96	0	4	0	4,297	10,340	18,636	7,133	3,612	4,537	6,196	7,238

Streamflow Diversions	2008 [acre-ft]	2009 [acre-ft]	2010 [acre-ft]	2011 [acre-ft]	2012 [acre-ft]	2013 [acre-ft]	2014 [acre-ft]	2015 [acre-ft]	2016 [acre-ft]	2017 [acre-ft]	2018 [acre-ft]	2019 [acre-ft]	2020 [acre-ft]	2021 [acre-ft]	Avg. [acre-ft]
Lytile Creek															
Fontana Union WC	6,727	5,776	10,052	18,037	7,656	3,775	3,586	3,407	3,236	3,075	2,921	3,087	5,479	3,813	6,538
Mount Vernon WC	927	1,132	167	685	578	520	468	421	379	341	307	276	276	276	476
Rialto, City of	1,165	1,135	1,000	1,148	1,319	996	1,020	871	1,041	1,206	1,133	950	1,509	1,230	1,047
San Bernardino, City of	498	450	450	0	0	0	0	0	0	0	0	0	1,853	0	353
West Valley Water District	3,369	2,435	3,322	3,382	2,954	2,369	3,810	3,389	1,737	2,516	2,291	5,717	3,851		3,265
Subtotal	12,686	10,928	14,991	23,252	12,507	7,660	8,884	8,088	6,393	7,138	6,652	10,030	12,968	5,319	11,679
Mill Creek															
Redlands, City of	12,332	7,785	10,076	13,492	6,085	7,041	4,657	3,912	4,400	6,121	5,818	5,650	6,045	5,459	9,394
SBVWCD MC	3,810	4,450	8,891	16,185	4,666	1,734	888	1,080	1,057	5,395	1,998	9,324	5,373	2,027	6,794
Subtotal	16,142	12,235	18,967	29,677	10,751	8,775	5,545	4,992	5,457	11,515	7,816	14,974	11,418	7,486	16,189
Bunker Hill Creeks															
Arrowhead Water & Power West Twin Crk	40	40	40	46	46	41	46	46	46	47	47	47	47	47	46
Arrowhead Water & Power East Twin Crk	3	0	0	1,097	1,097	987	889	800	720	648	583	525	472	425	2,405
Devore Water Company Kimbark	68	51	56	78	37	33	62	62	62	62	62	62	62	62	60
Subtotal	111	91	96	1,221	1,180	1,062	997	908	828	757	692	634	581	534	2,512
Santa Ana River															
Bear Valley Mutual WC	13,519	7,303	7,000	14,673	12,583	8,440	5,011	3,900	3,590	6,823	6,189	7,387	11,225	8,277	17,038
Redlands Water Co	625	654	629	739	4,917	2,036	5,201	5,629	6,957	6,059	5,845	5,032	5,796	3,610	3,052
SBVWCD SAR Spreading	17,550	8,456	21,662	36,801	9,073	5,519	1,537	2,982	2,766	20,924	2,618	35,688	18,377	5,194	14,030
Subtotal	31,694	16,413	29,291	52,213	26,573	15,995	11,749	12,511	13,312	33,806	14,651	48,108	35,398	17,081	34,119
Imported Water Spreading															
Sweetwater basin	4,994	3,002	3,983	4,457	6,413	4,514	1,672	4,933	6,286	6,083	1,683	2,819	1,446	0	3,010
Badger Basin	0	0		1,649	2,875	404	0	0	3,429	3,322	466	0	0	0	450
Waterman Basin	9,216	9,368	12,499	10,667	14,089	7,533	0	4,543	12,799	19,108	9,902	22,480	5,316	0	5,048
SBVWCD Santa Ana Basins	56	1,689	14	1,515	603	2	19	61	5,399	22,087	3,608	19,327	0	0	2,884
SBVWCD Mill Creek Basins		1,022	665	711	510	0	0	0	500	3,916	468	10,643	171	0	1,360
Subtotal	14,266	15,081	17,161	18,999	24,490	12,453	1,691	9,537	28,413	54,516	16,127	55,269	6,933	0	12,752

Assumed as average and are provisional data.

Total = 77,251

'21 Total = 30,420

Surface Diversions, comments:

The amount of water for surface distribution for the ensuing water year (October 1, 2020 to September 30, 2021) was estimated based on the average surface for the Santa Ana River, Bunker Hill Creeks, Mill Creek, and Lytle Creek for the period of 1990 to 2021. As shown in Table 8 above, the average surface diversion for the Santa Ana River, Bunker Hill Creek, Mill Creek, and Lytle Creek, including Department of Water Resources purchased water, between 1993 to 2021 was 37,003; 2,512; 17,549; 11,679 acre-feet respectively.