Energy ALMANAC — The California Energy Commission

California Electrical Energy Generation

California Electrical Energy Generation*
Total Production, by Resource Type
(Gigawatt Hours)

For years 1983 - 1999

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
California Generation plus Net Imports *	246,876	267,399	274,444	280,026	290,211	289,177	298,454	304,823	307,448	299,101	291,310	293,875	302,113	296,569
Total Hydroelectric	42,053	24,988	31,359	36,341	34,490	40,263	48,559	27,105	24,460	29,220	34,327	42,731	27,459	24,098
Large Hydroelectric	N/A	20,691	26,647	30,931	29,589	34,228	41,861	23,071	20,352	24,699	29,145	36,355	23,133	20,754
Small Hydroeletric	N/A	4,297	4,712	5,410	4,901	6,034	6,698	4,034	4,108	4,522	5,182	6,376	4,326	3,343
Nuclear	43,533	33,294	34,353	35,594	30,241	36,155	32,036	35,698	32,482	31,509	32,214	36,666	18,491	17,860
In-State Coal	3,183	4,041	4,275	4,269	4,086	4,283	4,190	4,217	3,977	3,735	3,406	3,120	1,580	1,018
Oil	449	379	87	103	127	148	134	103	92	67	52	36	90	38
Natural Gas **	106,878	116,369	92,752	94,715	105,358	97,110	109,316	120,459	123,036	117,277	109,916	91,276	121,761	120,896
Geothermal	13,456	13,525	13,396	13,329	13,494	13,292	13,093	13,029	12,907	12,907	12,740	12,685	12,733	12,485
Biomass	6,086	5,761	6,196	6,092	6,080	6,076	5,861	5,743	5,927	6,096	5,960	5,986	6,121	6,466
Wind	3,604	3,242	3,546	3,316	4,258	4,084	4,902	5,570	5,724	6,249	6,172	7,598	9,242	12,694
Solar	860	836	851	759	741	660	616	668	733	851	912	1,097	1,834	4,154
Other	0	38	35	108	48	24	34	15	39	20	12	13	14	14
Direct Coal Imports***	23,877	23,699	23,653	23,148	24,504	24,114	14,452	14,417	14,463	13,556	13,119	13,032	9,716	11,824
Other Imports****	2,897	41,227	63,941	62,253	66,785	62,967	65,263	77,799	83,608	77,615	72,481	79,633	93,071	85,022
Total In-State Generation	220,102	202,473	186,851	194,625	198,922	202,096	218,740	212,606	209,377	207,931	205,711	201,210	199,326	199,723
Governmental and Utility-Owned In-State Generation	99,733	67,208	70,484	76,406	71,246	83,213	91,801	83,085	79,345	81,897	86,369	94,169	71,162	68,941
Total Hydroelectric	41,001	21,449	26,395	29,984	28,992	33,210	39,979	23,203	20,676	24,367	28,271	34,437	22,693	20,506
Large Hydroelectric	N/A	18,322	23,198	26,411	25,807	29,301	35,731	20,553	17,991	21,431	24,998	30,432	19,902	18,341
Small Hydroeletric	N/A	3,127	3,197	3,574	3,185	3,910	4,248	2,649	2,684	2,935	3,272	4,006	2,791	2,164
Nuclear	43,533	33,294	34,353	35,594	30,241	36,155	32,036	35,698	32,482	31,509	32,214	36,666	18,491	17,860
In-state Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil	157	123	43	41	51	58	51	53	53	45	35	30	29	28
Natural Gas	13,747	11,344	8,537	9,591	10,814	12,788	18,743	23,142	25,157	25,050	24,954	22,066	28,763	29,394
Geothermal	1,252	996	1,150	1,190	1,140	997	970	975	947	903	846	858	875	817
Biomass	34	0	4	4	6	2	20	12	28	18	38	37	39	20
Wind	7	0	0	0	0	0	0	0	0	0	0	0	0	0
Solar	3	3	2	2	2	2	2	2	3	5	11	73	273	317
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial In-State Generation	120,369	135,265	116,367	118,220	127,676	118,883	126,938	129,521	130,031	126,034	119,341	107,041	128,164	130,782
Total Hydroelectric	1,052	3,539	4,965	6,357	5,498	7,052	8,579	3,902	3,784	4,854	6,057	8,294	4,767	3,592
Large Hydroelectric	N/A	2,369	3,450	4,520	3,782	4,928	6,130	2,517	2,361	3,267	4,147	5,924	3,231	2,413
Small Hydroeletric	N/A	1,170	1,515	1,837	1,716	2,125	2,449	1,384	1,423	1,586	1,910	2,370	1,535	1,179

Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0
In-state Coal	3,183	4,041	4,275	4,269	4,086	4,283	4,190	4,217	3,977	3,735	3,406	3,120	1,580	1,018
Oil	293	256	44	62	76	90	83	51	39	22	17	6	61	11
Natural Gas	93,130	105,025	84,215	85,124	94,544	84,322	90,573	97,317	97,880	92,227	84,962	69,210	92,999	91,502
Geothermal	12,204	12,528	12,246	12,139	12,354	12,295	12,123	12,054	11,960	12,004	11,894	11,826	11,858	11,668
Biomass	6,052	5,761	6,192	6,088	6,074	6,074	5,841	5,731	5,899	6,078	5,922	5,949	6,081	6,446
Wind	3,597	3,242	3,546	3,316	4,258	4,084	4,902	5,570	5,724	6,249	6,172	7,598	9,242	12,694
Solar	857	834	848	757	739	658	614	666	730	846	901	1,024	1,561	3,837
Other	0	38	35	108	48	24	34	15	39	20	12	13	14	14
Energy Exports	N/A	14,854	6,534	6,026	4,825	5,685	5,056	5,586	5,064	4,629	5,054	5,146	4,974	3,281
Pacific Northwest	N/A	5,846	1,020	1,471	1,532	2,061	2,518	2,620	2,242	1,871	1,809	1,133	761	809
Pacific Southwest	N/A	9,007	5,514	4,555	3,292	3,623	2,539	2,966	2,822	2,759	3,245	4,013	4,213	2,472
Energy Imports	N/A	79,780	94,128	91,427	96,113	92,766	84,771	97,802	103,136	95,800	90,653	97,811	107,760	100,127
Pacific Northwest	N/A	12,672	28,206	23,775	22,363	22,347	22,321	27,289	26,201	21,800	26,486	36,352	40,231	35,897
Pacific Southwest	N/A	67,107	65,921	67,652	73,750	70,419	62,450	70,514	76,935	74,000	64,168	61,459	67,529	64,230
Net Energy Imports	26,774	64,926	87,594	85,401	91,289	87,081	79,714	92,217	98,072	91,171	85,599	92,665	102,786	96,846
Pacific Northwest	18,777	6,826	27,186	22,303	20,831	20,286	19,803	24,669	23,959	19,929	24,677	35,219	39,470	35,088
Pacific Southwest	7,997	58,100	60,408	63,097	70,458	66,795	59,911	67,547	74,113	71,241	60,922	57,446	63,317	61,758

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
California Generation plus Net Imports *	199,609	211,900	210,172	211,028	220,371	232,926	238,567	252,355	242,343	245,535	242,026	256,719	256,367	253,621	230,243	244,577	243,077
Total Hydroelectric	59,351	46,880	33,898	44,478	27,140	26,692	32,742	26,092	23,244	22,373	41,595	25,626	51,665	47,883	41,400	48,757	41,627
Large Hydroelectric	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Small Hydroeletric	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nuclear	6,738	13,467	18,911	28,000	32,995	35,481	33,803	36,586	37,167	38,622	36,579	38,828	36,186	39,753	37,267	41,715	40,419
In-State Coal	563	731	865	1,033	1,163	1,791	2,479	3,692	3,050	3,629	2,549	2,655	1,136	2,870	2,276	2,701	3,602
Oil	6,535	2,632	2,790	3,126	2,143	8,158	9,275	4,449	523	107	2,085	1,954	489	693	143	123	55
Natural Gas **	45,486	58,248	69,771	49,260	75,437	74,221	78,916	76,082	75,828	87,032	70,715	95,025	78,378	66,711	74,341	82,052	84,703
Geothermal	7,020	9,272	10,957	13,094	14,083	14,194	15,247	16,038	15,566	16,491	15,770	15,573	14,267	13,539	11,950	12,554	13,251
Biomass	731	1,099	1,171	2,063	2,461	4,092	5,204	6,644	7,312	7,362	5,760	7,173	5,969	5,557	5,701	5,266	5,663
Wind	52	192	655	1,221	1,713	1,824	2,139	2,418	2,669	2,707	2,867	3,293	3,182	3,154	2,739	2,776	3,433
Solar	2	11	33	64	188	315	471	681	719	700	857	798	793	832	810	839	838
Other	0	0	0	6	5	4	4	4	0	2	0	0	0	343	896	230	0
Direct Coal Imports***	17,001	18,080	14,112	17,588	17,544	19,243	17,223	17,710	20,392	28,806	20,358	22,440	16,788	22,590	22,411	22,570	22,802
Other Imports****	56,130	61,288	57,009	51,095	45,499	46,911	41,064	61,959	55,873	37,704	42,892	43,354	47,514	49,696	30,310	24,993	26,685
Governmental and Utility-Owned In-State Generation	121,602	125,533	129,124	127,612	136,518	134,770	137,858	121,599	111,474	124,544	134,280	135,149	132,147	124,573	119,961	121,955	97,688
Total Hydroelectric	59,244	46,687	33,639	44,117	26,727	26,259	32,096	25,612	22,728	22,033	40,440	25,024	50,089	46,660	40,122	47,326	40,593

Large Hydroelectric	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Small Hydroeletric	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nuclear	6,738	13,467	18,911	28,000	32,995	35,481	33,803	36,586	37,167	38,622	36,579	38,828	36,186	39,753	37,267	41,715	40,419
In-state Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil	6,535	2,632	2,790	3,126	2,143	8,158	9,275	4,449	523	107	2,085	1,954	489	693	143	123	55
Natural Gas	42,742	54,168	63,654	40,517	62,222	53,040	52,249	45,262	42,353	54,338	46,738	61,474	39,448	31,856	37,048	27,699	14,995
Geothermal	6,341	8,576	10,122	11,831	12,421	11,827	10,429	9,684	8,700	9,441	8,435	7,842	5,855	5,540	5,302	5,009	1,543
Biomass	0	0	6	8	0	0	0	0	0	0	0	0	65	59	71	80	73
Wind	2	3	0	3	3	0	0	0	0	0	1	26	13	10	6	3	7
Solar	0	0	2	4	2	1	2	2	3	1	3	1	3	2	2	2	3
Other	0	0	0	6	5	4	4	4	0	2	0	0	0	0	0	0	0
Commercial In-State Generation	4,876	6,999	9,927	14,733	20,810	32,002	42,422	51,087	54,604	54,481	44,496	55,776	59,917	56,763	57,561	75,058	95,903
Total Hydroelectric	107	193	259	361	413	433	646	480	516	340	1,155	602	1,576	1,223	1,277	1,430	1,035
Large Hydroelectric	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Small Hydroeletric	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
In-state Coal	563	731	865	1,033	1,163	1,791	2,479	3,692	3,050	3,629	2,549	2,655	1,136	2,870	2,276	2,701	3,602
Oil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas	2,744	4,080	6,117	8,743	13,215	21,181	26,667	30,820	33,475	32,694	23,977	33,550	38,930	34,854	37,292	54,354	69,708
Geothermal	679	696	835	1,263	1,662	2,367	4,818	6,354	6,866	7,050	7,334	7,731	8,412	7,999	6,648	7,546	11,708
Biomass	731	1,099	1,165	2,055	2,461	4,092	5,204	6,644	7,312	7,362	5,760	7,173	5,904	5,498	5,630	5,186	5,590
Wind	50	189	655	1,218	1,710	1,824	2,139	2,418	2,669	2,707	2,867	3,268	3,169	3,144	2,733	2,773	3,426
Solar	2	11	31	60	186	314	469	679	716	699	854	797	790	831	808	837	835
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	343	896	230	0
Energy Exports	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pacific Northwest	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pacific Southwest	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Energy Imports	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pacific Northwest	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pacific Southwest	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Net Energy Imports	73,131	79,368	71,121	51,095	63,043	66,154	58,287	79,669	76,265	66,510	63,250	65,794	64,303	72,285	52,721	47,563	49,487
Pacific Northwest	38,375	41,027	37,146	31,632	24,977	19,893	17,739	31,665	28,819	19,600	15,466	15,315	19,890	29,529	25,204	19,428	26,051
Pacific Southwest	34,756	38,341	33,975	19,463	38,066	46,261	40,548	48,004	47,446	46,910	47,784	50,480	44,412	42,757	27,517	28,136	23,436

* Note: Note: The data in this table is based on corrections and updates as of April 2014.

** Note: Electric generation categories, such as natural gas, are attributed based on the primary fuel of the plant. With the recent addition of biogas contracts being applied to existing natural gas plant supply contracts, the Total System Power table is not intended to be used as a measure of the state's progress toward the large variety of renewable generation and greenhouse gas emission goals. It is intended to be used as a guide only.

*** Note: The Direct Coal Imports category is based on reported ownership shares and contractual arrangements for power purchases by California utilities. Due to legislative

changes required by Assembly Bill 162 (2009) and to simplify the characterization of coal power generation, only Utah's Intermountain Power Project and Nevada's Mohave Generation Station (closed as of 2006) are included in the reported Direct Coal Imports for 1983 through 2012 on this table. A more detailed analysis of the role of coal-based power generation within California is outside the scope of this table. The California Air Resources Board is currently undertaking the task of identifying the fuel source of all imported power into California. When comparing coal and other power imports over time, the best approach is to compare the combined value of Net Energy Imports.

**** Note: In this tabulation, generation located physically out-of-state is included in the energy imports category. The energy imports and exports include all electricity flows in and out of the state as reported by four California Balancing Authorities: California Independent System Operator, Los Angeles Department of Water and Power, Imperial Irrigation District, and Balancing Area of Northern California plus generation at six out-of-state power plants that are within one or more of these Balancing Authorities' control areas but are physically located outside California. These plants include Intermountain Power Plant (coal) in Utah, Mohave Generation Station (coal) in Nevada (now closed), Terra-Gen Dixie Valley plant (geothermal) and Desert Star Plant (natural gas) in Nevada, Termoelectrica de Mexicali Plant and InterGen's La Rosita Plant (natural gas) both of which are in Mexico. Power generated by these plants is not reported by Balancing Authorities as imports, hence their inclusion in this methodology. Finally, imports reported by Balancing Authorities do not include associated fuel source information. Fuel sources for out-of-state power are only reported by load serving entities under Power Source Disclosure and Power Content Label reporting requirements. As presented here, imports are only known for their geographic origin and not their fuel source origin. For a more detailed view of annual imported fuel sources, please refer to Total System Power

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moving water in new directions

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Prepared by:

Primary Author(s):
Dr. Charles Burt, P.E.
Dan J. Howes
Dr. Beau Freeman

Irrigation Training and Research Center (ITRC)
California Polytechnic State University
San Luis Obispo, CA 93407-0730
805.756.2434
www.itrc.org

Contract Number: 500-06-040

Prepared for:

California Energy Commission

Richard Sapudar
Contract Manager

Richard Sapudar
Project Manager

Virginia Lew
Office Manager
Energy Efficiency Research Office

Thom Kelly, Ph.D
Deputy Director
Energy Research & Development Division

Melissa Jones
Executive Director

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Agricultural Water District	First Name	Last Name	Position
Arvin-Edison WSD	Steve	Lewis	Staff Engineer
Banta-Carbona Irrigation District	David	Weisenberger	General Manager
Belridge WSD	Dean	Butler	Electrical Engineer
Berrenda Mesa Water District	Harry	Starkey	Manager
Colusa County Water District	Lee	Emrick	District Manager
Corcoran Irrigation District	Thomas L.	Vernon	Manager
Delano-Earlimart Irrigation District	Dale	Brogan	District Manager
Feather Water District	Dan	Duncan	President
Fresno Irrigation District	Bill	Stretch	Chief Engineer
Glenn-Colusa Irrigation District	Thad	Bettner	General Manager
Imperial Irrigation District	Carlos	Villalon	Water Manager
James Irrigation District	John	Mallyon	District Manager
Lost Hills Water District	Phillip	Nixon	Manager
Meridian Farms Water Co.	Dan	Ruiz	Manager
Natomas Central Mutual Water Co	Fred	Schantz	Assistant General Manager
North Kern WSD	Dana	Munn	Engineer Manager
Orange Cove Irrigation District	John	Roldan	Engineer-Manager
Pacheco Water District	Marcos	Hedrick	Water Master
Panoche Water District	Marcos	Hedrick	Water Master
Princeton-Codora-Glenn ID	Lance	Boyd	District Manager
Provident Irrigation District	Lance	Boyd	District Manager
Reclamation District #108	Lewis	Bair	Manager
San Luis Canal Company	Alejandro	Paolini	Water Conservation Specialist
San Luis Water District	Martin	McIntyre	General Manager
Semitropic WSD	Paul	Oshel	District Engineer
Tea Pot Dome Water District	Keith	Norris	Manager
Tulelake Irrigation District	Gerald	Pyle	Assistant Manager
West Stanislaus Irrigation District	Ron	Roos	Manager
Westlands Water District	Russell	Freeman	Supervisor of Resources
Westside Water District	Mike	Britton	General Manager
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Del Puerto W.D.	Bill Harrison
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Laguna I.D.	Scott Fills
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Lost Hills W.D.	Phillip Nixon
Lower Tule River I.D.	Ken Phelps
Madera I.D.	Dennis Savala
Merced I.D.	Hicham Eltal & Michael Higgins
Modesto I.D.	Joe Lima
North Kern W.S.D.	Dana Munn
North San Joaquin W.C.D.	Ed Stefani & Conrad Weinzheimer
Oakdale I.D.	Kevin King & Tom Laidlaw
Orange Cove I.D.	John Sanders
Orland-Artois W.D.	Chris Drouillard & Emil Cavagnolo
Panoche W.D.	Marcos Hedrick
Patterson W.D.	John Sweigard
Pixley I.D.	Ken Phelps
Reclamation District 108	Lewis Bair
Richvale I.D.	Brad Mattson
Rosedale-Rio Bravo W.S.D.	Hal Crossley & Monique Roberts
San Luis Canal Co.	Alejandro Paolini
San Luis W.D.	Martin Mcintyre
Semitropic W.S.D.	Paul Oshel & Craig Wallace
Shafter-Wasco I.D.	Ron Sutton
Solano I.D.	Paul Lum
South San Joaquin I.D.	Mike Gilton, Sam Bologna, & Cheryl Burke
South Sutter W.D.	Brad Arnold
Southern San Joaquin M.U.D.	William Carlisle
Stockton-East W.D.	John Yoshimura
Sutter Mutual W.C.	Max Sakato
Tulare I.D.	Aaron Fukuda & Wayne Fox
Tulare Lake Basin W.S.D.	Brent Graham & Frank Apgar
Turlock I.D.	Wilt Fryer & Debbie Liebersbach
Westlands W.D.	Russ Freeman
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- Bruce Grant, formerly of Weir-Floway Pumps
- Clark Wilson and Robert Ray of Cornell Pump

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Name	Company	City
Steve Allison	Alsop Roy Pump & Drilling	Salinas
Rod Gossling	Western Oilfield Supply Co.	San Joaquin
Mark Thorton	Salinas Pump Co.	Salinas
Eric Thomas	Preferred Pump	Santa Maria
David Hines	Pacific Irrigation	Bakersfield
John Piercing	Barney Huntington Pump Co.	Fresno
Travis Jackson	Golden State Irrigation Services	Stockton
Wayne Ketcherside	Carter Pump	Wasco
David L. Bradley	Valley Pump & Well	Modesto
Joey Mier	Water Associates	Bakersfield
Frank Morales	M&W Pumps	Santa Maria
Bob Zimmer	Zim Industries	Fresno
Rick Phillips	Hammer CJ Machinery & Pumps	Visalia
James W. Smith	Anderson Pump Co.	Chowchilla
Les Travioli	Alta Pump Co. Inc.	Dinuba
Kurt Sanders	Sanders Pump & Irrigation	Yuba City
Dennis Quindt	Preferred Pump & Equipment	Fresno
Cooper Rossiter	Don Pedro Pumps	Hughson

ITRC takes complete responsibility for any errors in interpretation or presentation of the valuable information that was supplied by these many individuals.

ABSTRACT

Beginning in 2007, the Irrigation Training and Research Center (ITRC) at California Polytechnic State University, San Luis Obispo, contracted with the California Energy Commission's (CEC) Public Interest Energy Research (PIER) Program to undertake a large, multi-tiered study on agricultural water energy efficiency in California. The study was broken into the following research tasks: Task 1: Administrative; Task 2.1: Irrigation district energy survey; Task 2.2: Conversion to groundwater pumping with drip/ micro irrigation systems; Task 2.3: GIS-based water scheduling and software system; Task 3: Irrigation component energy analysis; Task 4: RD&D competitive solicitation; Task 5; Technology transfer. The resulting survey, research, and testing data from these tasks have led to a better understanding of current agricultural operations in California, as well as illuminated new avenues for energy conservation that could have widespread impact on energy efficiency in the state's agricultural industry.

Keywords: California Energy Commission, PIER, energy, irrigation, pump, agriculture, drip irrigation, microirrigation, groundwater, VFD, GIS

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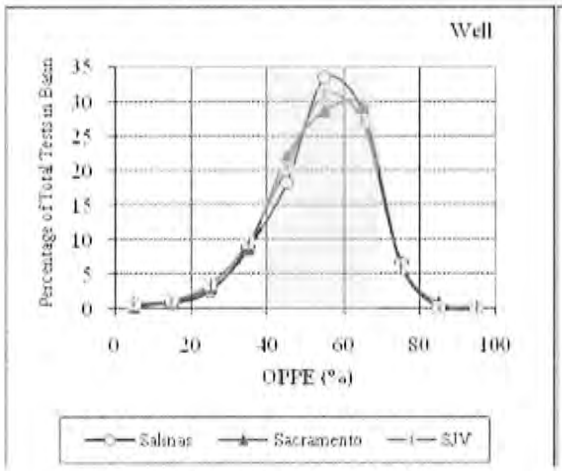
Regional Comparison by Overall Pumping Plant Efficiency (OPPE)

The data for each basin was compared with overall pumping plant efficiency (%) to:

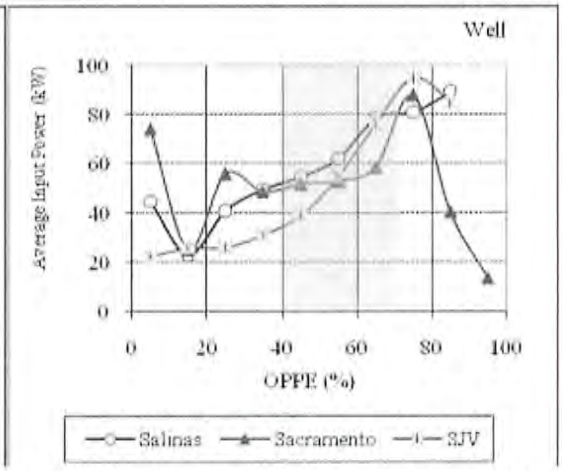
- Test Distribution (Graph 1)
- Average Input Power [kW] (Graph 2)
- Average kWh/AF (weighted by input power) (Graph 3)
- Average Total Dynamic Head (TDH) [ft] (weighted by input power) (Graph 4)
- Average Flow Rate [ft] (weighted by input power) (Graph 5)
- Average Depth to Standing Water Level (SWL) [ft] (weighted by input power) (Graph 6)
- Average Drawdown [ft] (weighted by input power) (Graph 7)
- Average Motor HP (weighted by input power) (Graph 8)

The values are grouped into 10% ranges, with the point at the midpoint of the range (for example, the average value for the 21-30% range is placed at the 25% point). The grayed areas show the ranges where a majority of the values lie.

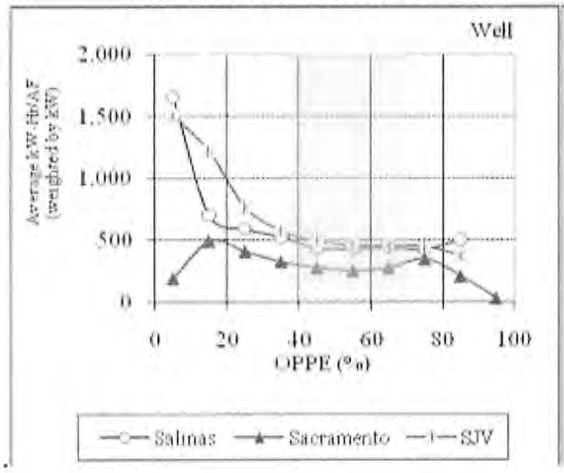
Graph 1: Test distribution.



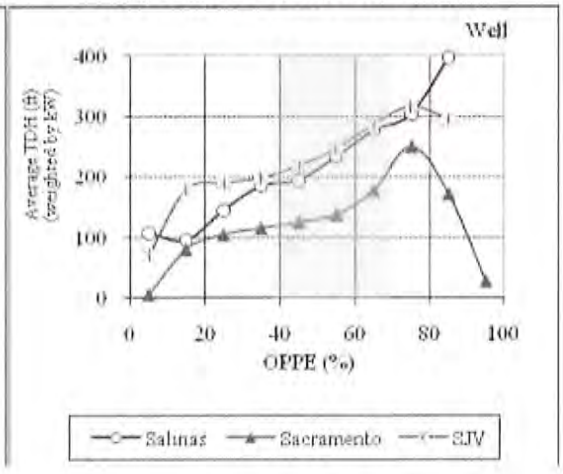
Graph 2: Average input power [kW].



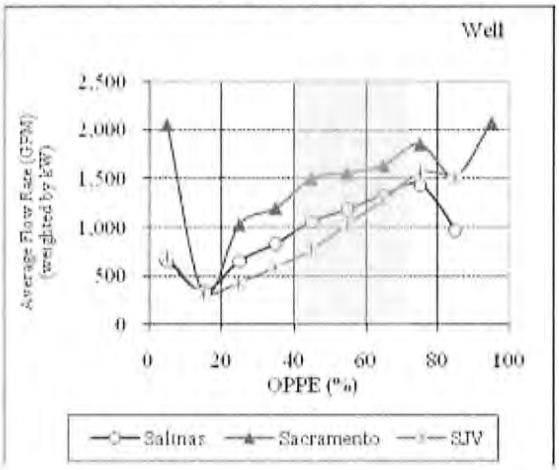
Graph 3: Average kWh/AF (weighted by input power)



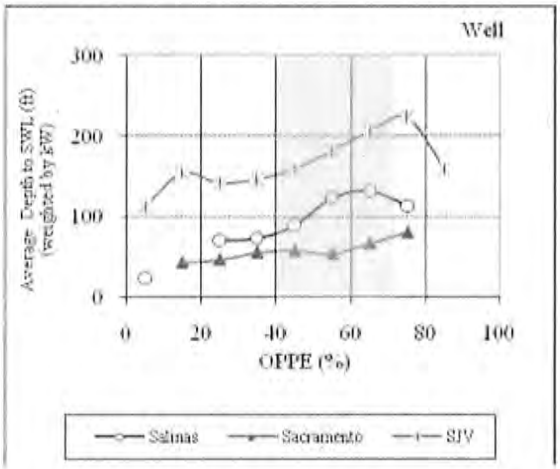
Graph 4: Average total dynamic head (TDG) [ft] (weighted by input power).



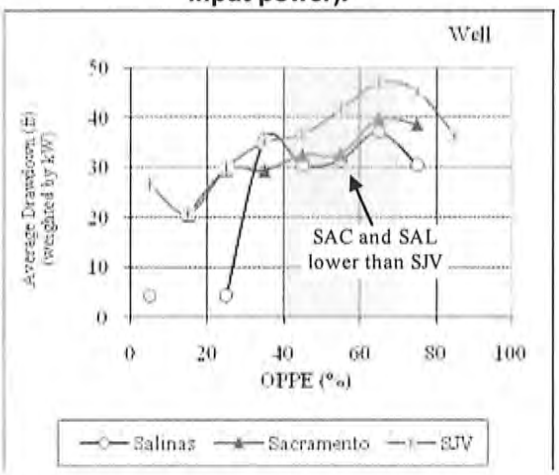
Graph 5: Average flow rate [GPM] (weighted by input power).



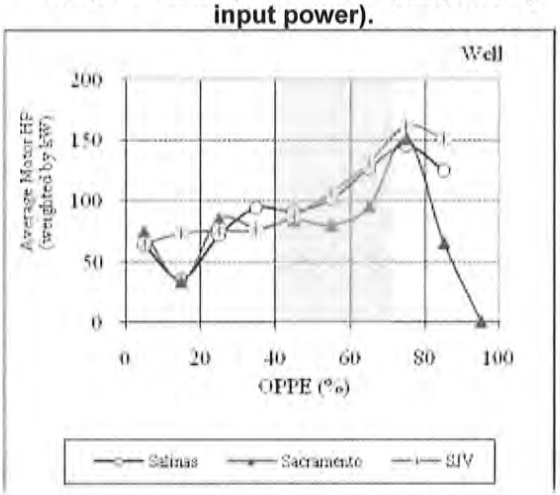
Graph 6: Average depth to standing water level (SWL) [ft] (weighted by input power).



Graph 7: Average drawdown [ft] (weighted by input power).



Graph 8: Average motor HP (weighted by input power).



When comparing the data from the three basins to the overall pumping plant efficiency, some general observations regarding the well pump data can be made:

1. A majority of the well pump tests fall between the 40-70% overall pumping plant efficiency ranges.
2. Across nearly all of the overall pumping plant efficiency ranges, the Sacramento basin's well pump tests have a higher flow rate, and a lower kWh/AF and total dynamic head than the well pump tests in the other basins.
3. The San Joaquin basin's well pump tests had higher average drawdown values than the well pump tests in the other basins.
4. The average depth to the standing water has a lot of variation between basins.

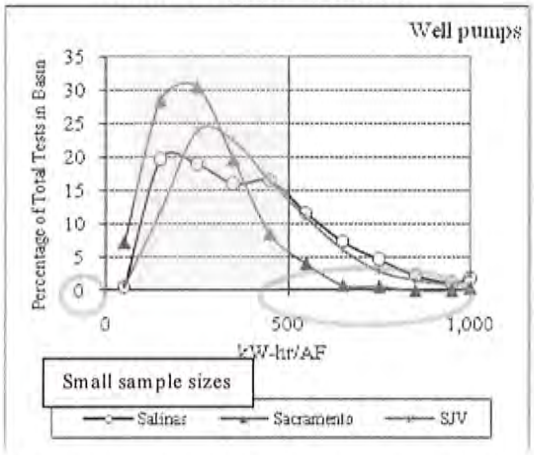
Regional Comparison by Energy Consumption per Volume Pumped

The data for each basin was compared with kWh/ AF to:

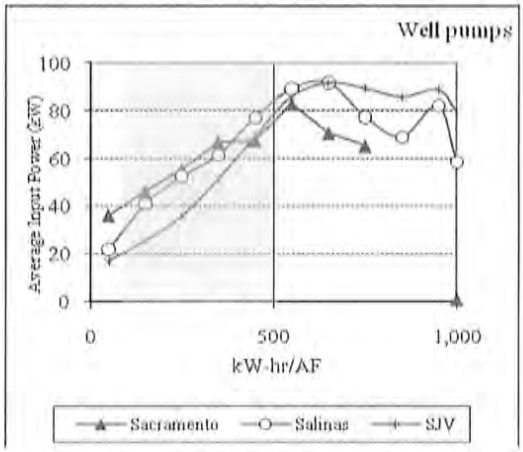
- Test Distribution (Graph 9)
- Average Input Power [kW] (Graph 10)
- Average Total Dynamic Head (TDH) [ft] (weighted by input power) (Graph 11)
- Average Flow Rate [ft] (weighted by input power) (Graph 12)
- Average Depth to Standing Water Level (SWL) [ft] (weighted by input power) (Graph 13)
- Average Drawdown [ft] (weighted by input power) (Graph 14)
- Average Motor HP (weighted by input power) (Graph 15)
- Average Overall Pumping Plant Efficiency (OPPE) [ft] (weighted by input power) (Graph 16)

The values are grouped into ranges of 100 kWh/ AF with the point at the midpoint of the range (for example, the average value for the 201-300 kWh/ AF range is placed at the 250 kWh/ AF point). Each basin had a single data point placed at 1000 kWh/ AF that represents the y-axis average value for all data points greater than 1,000 kWh/ AF. The grayed areas show the ranges where a majority of the values lie.

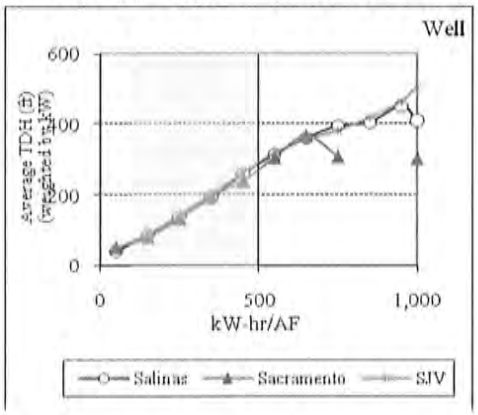
Graph 9: Test distribution.



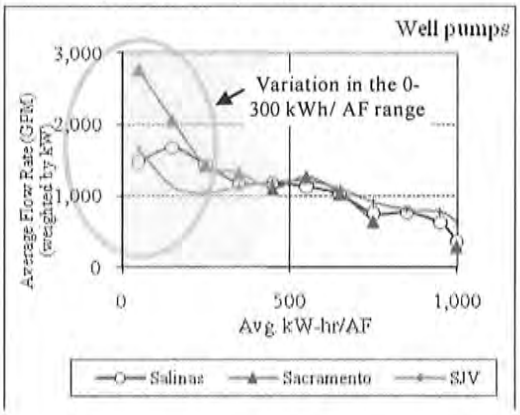
Graph 10: Average input power [kW].



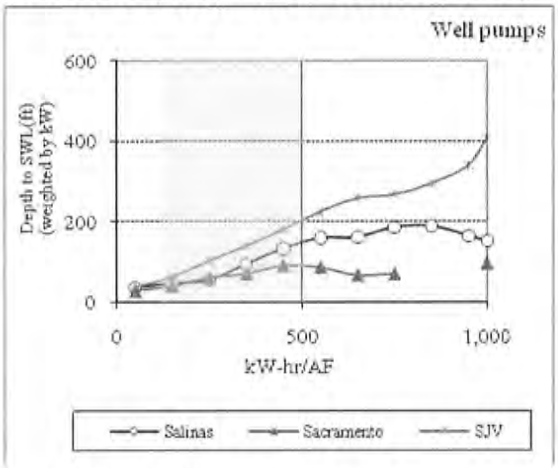
Graph 11: Average total dynamic head (TDH) [ft] (weighted by input power).



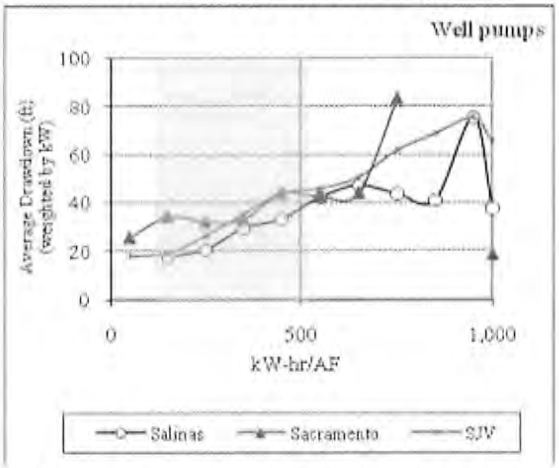
Graph 12: Average flow rate [ft] (weighted by input power).



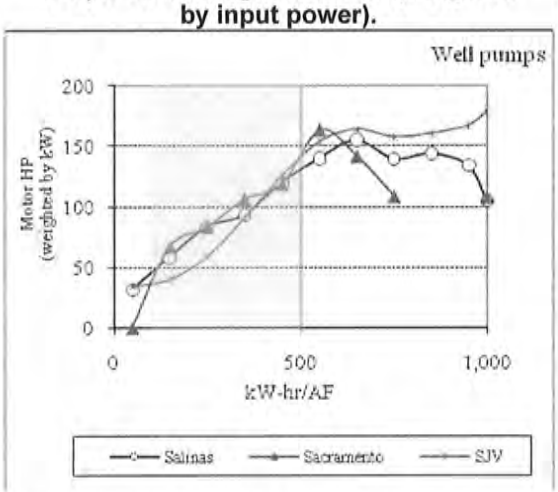
Graph 13: Average depth to standing water level (SWL) [ft] (weighted by input power).



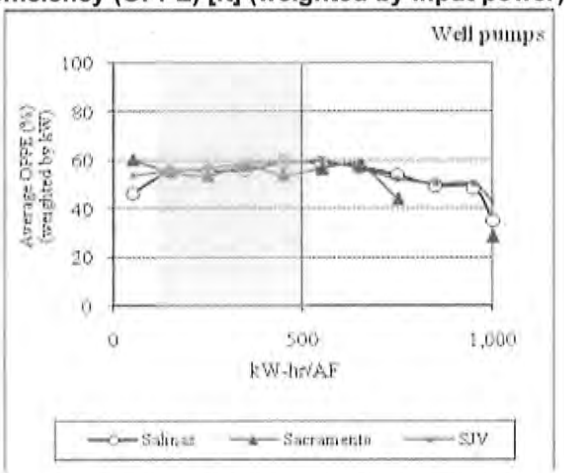
Graph 14: Average drawdown [ft] (weighted by input power).



Graph 15: Average motor HP (weighted by input power).



Graph 16: Average overall pumping plant efficiency (OPPE) [ft] (weighted by input power).



When comparing the data from the three basins to the kWh/ AF, some general observations regarding the well pump data can be made:

1. A majority of the well pump tests fall between 200 and 500 kWh/AF.
2. The Sacramento basin well pump tests differs from the well pump tests in other basins at higher (600+) kWh/AF in all categories. No conclusions are drawn from this data due to the small sample sizes in those ranges.
3. The well pumps tested in the Sacramento and Salinas basins have higher average input power in the 200-500 kWh/AF range than the well pumps in the San Joaquin basin. However, the average input power increases with kWh/ah, and the Salinas and San Joaquin basins have more tests in the higher ranges (400+) than the Sacramento basin. This could explain why the Sacramento and San Joaquin basin-wide averages are nearly equal, and the Salinas basin average is slightly higher.
4. Average regional flow rates vary significantly at low (0-300) kWh/AF, but match well at higher (400+) kWh/AF. Only the Sacramento basin has a significant number of well pump

tests in that range (see Graph 9). These low kWh/AF, high flow rate pumps are probably causing the Sacramento basin tests' average flow rate to be so much higher than the test averages in the other basins

5. The San Joaquin basin's well pump tests do not appear to have a significantly greater drawdown than the other basins (see Graph 14). This can be explained mainly by the distribution of tests. The San Joaquin basin has a significant percent of its tests in the 500-800 kWh/AF range (see Graph 9), and the tests in those ranges have higher drawdown values than the 0-500 kWh/AF ranges and the Salinas basin (which also has a significant percent of its tests in the higher range) and input power (what the average drawdown values are weighted by) than in the 0-500 kWh/AF ranges. This could cause the basin's overall higher value, without making the values in the 200-500 range significantly higher in comparison to the other two basins.
6. The average total dynamic head in each kWh/AF range is almost identical for the three basin averages, even though the average total dynamic head of the Sacramento basin well pump tests was lower than the tests other basins. This is probably due to the fact that the majority of the well pump tests in the Sacramento basin had slightly lower kWh/AF than the well pump tests in the other basins; the lower kWh/AF ranges had lower average total dynamic heads for all basins.
7. The average depth to standing water level increases with the kWh/AF, possibly indicating the effect larger pumps are having on their local water tables.

CALLEGUAS MUNICIPAL WATER DISTRICT

WATER RATE CHARGES

FOR CALENDAR YEARS 2014 & 2015

	Effective January 1,2014	Effective January 1,2015	% Change
MWD Rates			
Tier 1 Supply Rate ($/af)	$148	$160	8.11%
Delta Supply Surcharge - Tier 1 only ($/af)	$0	$0	0.00%
Tier 2 Supply Rate ($/af)	$290	$290	0.00%
System Access Rate ($/af)	$243	$256	5.35%
System Power Rate ($/af)	$161	$125	(22.36%)
Water Stewardship Rate ($/af)	$41	$41	0.00%
Treatment Surcharge ($/af full-service)	$297	$343	15.49%
MWD Combined Rates			
MWD Tier 1	$890	$925	3.93%
MWD Tier 2	$1,032	$1,055	2.23%
CMWD Rates			
O&M Surcharge ($/af)	$58	$60	3.45%
Capital Construction Surcharge ($/af)	$225	$225	0.00%
Total Calleguas	$283	$285	0.71%
Combined Rates			
Tier 1 Rate ($/af)	$1,173	$1,210	3.15%
Tier 2 Rate ($/af)	$1,315	$1,340	1.90%
Temporary Water Rate (per 100 cu ft)	$6.04	$6.15	1.90%
Recycled Water ($/af)	$938	$968	3.20%
Capacity Reservation Charge /cfs	$21,840	$21,840	0.00%

DEFINITIONS:

Tier 1 Supply Rate (Metropolitan) - recovers the of cost of maintaining a reliable amount of supply.

Tier 2 Supply Rate (Metropolitan) - set at Metropolitan's cost of developing additional supply to encourage efficient use of local resources.

System Access Rate (Metropolitan) – recovers a portion of the costs associated with the delivery of supplies.

System Power Rate (Metropolitan) – recovers power costs for pumping supplies to Southern California.

Water Stewardship Rate (Metropolitan) – recovers the cost of Metropolitan's financial commitment to conservation, water recycling, groundwater clean-up and other local resource management programs.

Treatment Surcharge (Metropolitan) – recovers the costs of treating imported water.

Replenishment Water Rate (Metropolitan) - applies to purchases by Member Agencies in accordance with Section 4514 of the Metropolitan Administrative Code.

Readiness-to-Serve Charge (Metropolitan) **-** a fixed charge that recovers the cost of the portion of system capacity that is on standby to provide emergency service and operational flexibility. Based upon a calendar ten year rolling average.

Capacity Charge (Metropolitan) - the capacity charge recovers the cost of providing peak capacity within the distribution system.

Operations and Maintenance Surcharge (Calleguas) - recovers the cost of operating and maintaining system facilities and District administrative functions.

Capital Construction Surcharge (Calleguas) - recovers a portion of the cost of infrastructure expansion to accommodate new demand and increase system reliability.

Capacity Reservation Charge – the capacity charge is levied on the peak week demand on the system between May 1 and September 30, for the prior calendar-year and GSP Water is excluded from peak week calculations.

Readiness to Serve Charge (Calleguas) - a direct pass-through of Metropolitan Readiness to Serve Charge.

2007 Update to the Fox Canyon Groundwater Management Agency Groundwater Management Plan



Prepared by

Fox Canyon Groundwater Management Agency
United Water Conservation District
Calleguas Municipal Water District

May 2007

ACKNOWLEDGEMENTS

This Groundwater Management Plan was prepared by Steven Bachman, with extensive advice and reviews by Fox Canyon Groundwater Management Agency staff (Jeff Pratt, Gerhardt Hubner, Gerard Kapuscik, Christian Laber, David Panaro, and Sheila Lopez) and United Water Conservation District staff (Dana Wisehart, Ken Turner, Dan Detmer, Jim Kentosh, Murray McEachron, Pete Dal Pozzo, and John Dickenson). Lowell Preston (formerly of FCGMA), Curtis Hopkins (for Municipal and Industrial [M&I] providers), Rob Saperstein (for City of Oxnard), John Mathews (for Pleasant Valley County Water District), Tony Emmert (City of Oxnard), Lucia McGovern (City of Camarillo), John Powell (Saticoy Country Club), David Borchard (FCGMA Board Member), and Lawrence (Larry) Fuller provided additional comments and reviews.

EXECUTIVE SUMMARY

The Fox Canyon Groundwater Management Agency (FCGMA) was initially created to manage the groundwater in both overdrafted and potentially seawater-intruded areas within Ventura County. The prime objectives and purposes of the FCGMA are to preserve groundwater resources for agricultural, municipal, and industrial uses in the best interests of the public and for the common benefit of all water users. Protection of water quality and quantity along with maintenance of long-term water supply are included in those goals and objectives.

Initial goals of the FCGMA included balancing water supply and demand in the Upper Aquifer System (UAS) by the year 2000 and in the Lower Aquifer System (LAS) by year 2010. These goals and the FCGMA's basic purpose remain relatively unchanged today. The initial Groundwater Management Plan for the FCGMA was prepared in 1985. This current document is an update to that initial Plan. Since preparation of the initial Plan, significantly more is now known about the occurrence of the seawater intrusion and basin overdraft through focused monitoring programs, studies, and modeling. There has also been a period of time to observe how FCGMA policies and water conservation facilities have improved groundwater conditions.

The goals of this Management Plan are to set specific, measurable management objectives for each basin, identify strategies to reach these goals, and set future FCGMA policy to help implement these strategies. The FCGMA cannot itself build and operate conservation facilities, so the focus of this Plan is both on potential FCGMA policies and on strategies and policies that can assist in implementing conservation projects by other agencies. Thus, the FCGMA acts as a partner with the other agencies in improving conditions in the aquifers within the Agency.

The main focus of the initial Groundwater Management Plan was to contain seawater intrusion in the south Oxnard Plain basin. The combination of FCGMA policies and new water conservation facilities, which included the FCGMA pumping reductions, shifting of pumping from the Upper Aquifer System to the Lower Aquifer System, the construction of the Freeman Diversion, and the operation of the Pumping Trough and Pleasant Valley pipeline systems, has had a significant effect on seawater intrusion in at least a portion of the aquifers. The most significant effect was the reduction of the lobe of seawater in the Upper Aquifer System at Port Hueneme. Monitoring wells drilled into this lobe indicate that seawater intrusion has retreated and is no longer detectable in some areas near Port Hueneme, with groundwater in one well improving from near-seawater back to drinking-quality water.

However, the containment of saline waters is not complete. In the Pleasant Valley and south Oxnard Plain basins, saline waters both from the ocean and from adjacent fine-grained sediments have expanded the area of saline intrusion since 1985. This increase occurred in the Upper Aquifer System near Point Mugu and the Lower Aquifer System in the Port Hueneme and Point Mugu areas. Thus, continuation of current strategies and the implementation of additional strategies are required to fully contain saline intrusion.

Additional water quality problems have also been identified since the original FCGMA Plan was adopted. These include increasing chlorides and other salts in the South Las Posas basin and locally in the Pleasant Valley basin, as well as increased nitrates in the Forebay basin during periods of reduced rainfall and groundwater recharge.

This 2007 Update to the FCGMA Groundwater Management Plan discusses and reviews a number of aspects of groundwater management:

- background information on the groundwater basins;
- history of groundwater extractions within the FCGMA;
- water quality issues, both generally and basin-by-basin,
- basin management objectives to indicate the health of the basin and the efficacy of current and future management strategies;
- the yield of the groundwater basins;
- current management strategies and their effectiveness;
- management strategies under development and their potential effectiveness;
- potential future management strategies and their potential effectiveness; and
- recommended actions to be taken by the FCGMA.

In addition, three appendices include:

- progression of saline intrusion in the Upper and Lower Aquifers;
- description of the Ventura Regional Groundwater Model that was used to evaluate management strategies, as well as details of those evaluations; and
- East Las Posas Basin Management Plan, which deals with issues specific to that basin and that will be adopted as part of this Groundwater Management Plan.

Basin Management Objectives (BMOs) are defined for the basins within the FCGMA in this Plan. The BMOs are measurable groundwater elevation and water quality goals that, if reached, protect the aquifers from further saline intrusion and other water quality problems. The BMOs are set at particular key wells in the groundwater basins. Current groundwater conditions meet the BMO criteria in some, but not all of the basins. They fail to meet BMOs in the Lower Aquifer and portions of the Upper Aquifer in the Oxnard Plain and Pleasant Valley basins, periodically in the Forebay basin, and locally in the Las Posas and Santa Rosa basins. Using the Ventura Regional Groundwater Model to evaluate the effectiveness of management strategies into the future, current management strategies are predicted to meet BMOs for groundwater elevations 51% of the time in the Upper Aquifer and only 5% of the time in the Lower Aquifer[*].

The annual yield of the basins within the FCGMA was calculated to be about 120,000 acre-feet (AF) for the 1985 Groundwater Management Plan. Current pumping within the FCGMA has decreased to something close to that number, however, and BMOs are not being met in key areas – which is consistent with the groundwater model results discussed in the previous paragraph. To recalculate the yield of the basin, groundwater pumping was progressively reduced in the model until BMOs were met on average 50% or more of the time. Pumping would have to be reduced to 100,000 acre-feet per year (AFY) to meet the BMOs, providing that these additional reductions were accomplished largely in the south Oxnard Plain and Pleasant Valley basins.

Because current management strategies are not sufficient to meet BMOs and pumping needs to be reduced to 100,000 AFY, additional management strategies need to be implemented. A series of these additional strategies are proposed in this Plan. Some of these strategies are currently being developed, whereas others would be implemented in the future. For strategies

[*] Percentage is based on the average number of quarters when BMOs are met at each BMO well during the 55-year modeling period of the Ventura Regional Groundwater Model. For an initial target, it is proposed that groundwater elevation BMOs be met at least 50% of the time, thus taking into account that climatic cycles will cause groundwater elevations to rise and fall periodically above and below these objectives.

that were amenable to being evaluated using the Ventura Regional Groundwater Model, the effectiveness in meeting BMOs was calculated.

The following table summarizes the proposed strategies; the strategies are grouped initially by when they could be implemented and secondarily within each time increment by their potential effectiveness in managing the basins and meeting BMOs.

Strategies Currently Under Development

- GREAT Project (recycled water for in-lieu delivery and direct injection)
- South Las Posas Pump/Treat (pump poor quality water and blend/treat it)
- Development Brackish Groundwater, Pleasant Valley (similar to previous, pumping from northern Pleasant Valley basin)
- Non-Export FCGMA Water (water pumped within FCGMA and applied in adjacent areas outside the Agency)
- Continuation of 25% Pump Reduction (continue original Plan strategy of 25% reductions by 2010)
- RiverPark Recharge (additional Santa Clara River recharge)

5-Year Strategies

- 5-Year Update of Plan
- Shift Pumping to UAS (prepare technical basis and policy)
- Protect Recharge (protect current sources of recharge)
- Limit Nitrates in the Forebay (land use, Best Management Practices)
- Recovery of Credits from the Forebay (uniform policy)
- Verification of Extraction Reporting (verify accuracy of reporting)
- Separate Strategies for Each Basin (as needed)
- FCGMA Boundary (adjust slightly to reflect new hydrogeologic understanding)
- Irrigation Efficiency (determine if warrants modifications)
- Additional Storage Projects (to help fill overdrafted basins)
- Penalties Used to Purchase Replacement Water (refill overpumped areas)
- Additional Water Conservation (encourage local agencies)
- Shelf Life for Conservation Credits (limit the long-term accumulation of credits and/or limit number of credits pumped in any one year)

10-Year Strategies

- Additional In-lieu Deliveries to South Oxnard Plain
- Import Additional State Water (for direct or in-lieu recharge)
- Further Destruction of Abandoned or Leaking Wells
- Additional Monitoring Needs (as needed to track saline intrusion or other groundwater issues)

15-Year Strategies

- Barrier Wells in South Oxnard Plain
- Injection of Treated River Water into Overdrafted Basins
- Increase Diversions from Santa Clara River (additional water rights from peak storm flows)
- Shift Pumping to Northwest Oxnard Plain

Greater Than 15-Year Strategies

- Additional Reductions in Pumping Allocations (if strategies are not fully implemented or if they fail to meet BMO targets)

The Ventura Regional Groundwater Model was used to evaluate the effect of individual strategies, as well as the combination of strategies. If all the strategies are implemented as recommended (especially those ranked highest in each time horizon), the model predicts that BMOs for the Upper Aquifer will be met 67% of the time and BMOs for the Lower Aquifer will be met 76% of the time – a major improvement that would likely halt further degradation of groundwater quality.

This management plan calls for a set of actions to implement the recommended strategies. Some of these strategies can be implemented directly by the FCGMA through policy additions or modifications. Other strategies, especially those requiring infrastructure to be built, will be largely the responsibility of other organizations. To ensure that all the strategies are implemented as seamlessly as possible, it is recommended that there be a joint Strategic Planning and Implementation effort with the other agencies that will help implement the strategies in this Plan.

The importance of implementing the strategies in this Plan is illustrated by three potential choices that are available to the FCGMA, organizations, and groundwater pumpers:

- Implementation of recommended strategies in this Plan –resulting in major improvement in overdraft conditions and the potential halt in further degradation of groundwater quality; or
- Most effective strategies not implemented because of cost, lack of cooperation, lack of will – resulting in further FCGMA reductions in pumping allocations. Reductions of an additional 85% of pumping in the south Oxnard Plain and Pleasant Valley basins would be required to meet BMOs; or
- No effective management strategies are implemented and there are no further reductions in pumping allocations – the Lower Aquifer in the south Oxnard Plain and Pleasant Valley basins will degrade until it can no longer be pumped without expensive treatment prior to delivery of the groundwater.

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1.0 INTRODUCTION

The Fox Canyon Groundwater Management Agency (FCGMA) (Figure 1 and Plate 1) is located in Ventura County and encompasses several coastal basins that underlie the cities of Oxnard, Port Hueneme, Camarillo, and Moorpark. The Agency overlies about 118,000 acres (185 sq mi). The FCGMA was initially created to manage the groundwater in both overdrafted and potentially seawater-intruded areas within Ventura County. The prime objectives and purposes of the FCGMA are to preserve groundwater resources for agricultural, municipal, and industrial uses in the best interests of the public and for the common benefit of all water users. Protection of water quality and quantity along with maintenance of long-term water supply are included in those goals and objectives.

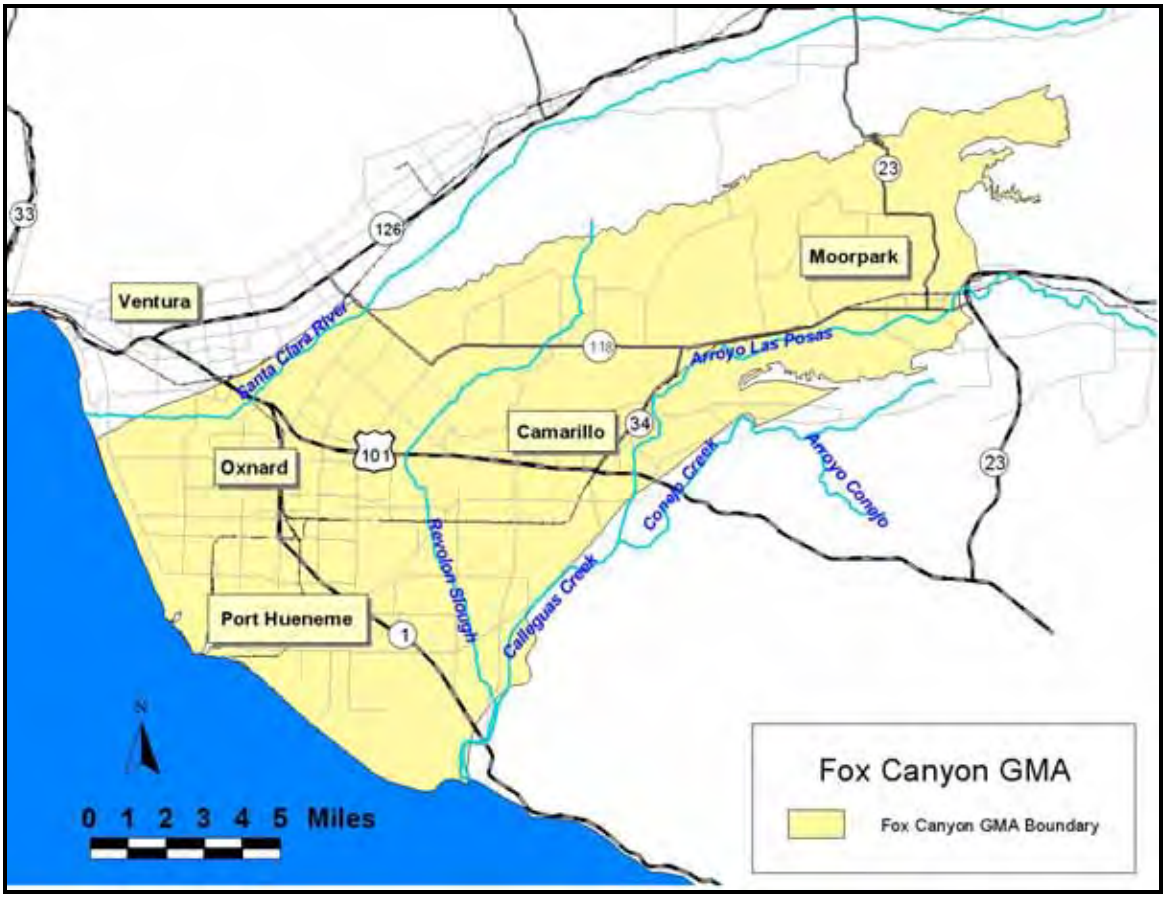


Figure 1. Location map of Fox Canyon Groundwater Management Agency boundary.

The Annotated California Codes Water Appendix, Chapter 121-102 et seq. required the FCGMA to develop, adopt, and implement a plan to control groundwater extractions from the Upper Aquifer System (UAS) to achieve a balanced water supply and demand in the Upper Aquifer System by the year 2000. Additionally, the Water Code required the FCGMA to adopt a Lower Aquifer System (LAS) Management Plan for future extractions from the Lower Aquifer System, including a policy for issuing well permits and a Contingency Plan for seawater intrusion into the Lower Aquifer System. The FCGMA adopted its original Groundwater Management Plan in 1985. The original FCGMA Groundwater Management Plan specified several major items or tasks for accomplishment.

Ventura County Water Purveyors

CALLEGUAS WHOLESALE DISTRICT	
SUPPLIER	WATER COMPANY
Calleguas (CAL-001)	ACADEMY MWC
Calleguas (CAL-002)	ARROYO LAS POSAS MWC
Calleguas (CAL-003)	BALCOLM BIDBY MWA
Calleguas (CAL-004)	BERYLWOOD HEIGHTS MWC
Calleguas (CAL-005)	BRANDEIS-BARDIN MWC
Calleguas (CAL-006)	CONEJO TRAILER PARK
Calleguas (CAL-007)	CALIFORNIA WATER SERVICE COMPANY
Calleguas (CAL-008)	CALIFORNIA AMERICAN WATER COMPANY
Calleguas (CAL-009)	CALLEGUAS MWD
Calleguas (CAL-011)	CAMROSA WATER DISTRICT
Calleguas (CAL-012)	CITY OF CAMARILLO
Calleguas (CAL-013)	CITY OF OXNARD
Calleguas (CAL-014)	CITY OF THOUSAND OAKS
Calleguas (CAL-015)	CRESTVIEW MWC
Calleguas (CAL-016)	DEL NORTE MWC
Calleguas (CAL-017)	EPWORTH MWC
Calleguas (CAL-019)	FOXFIELD RIDING CLUB
Calleguas (CAL-020)	FULLER FALLS MWC
Calleguas (CAL-022)	SUNSHINE RANCH
Calleguas (CAL-023)	LA LOMA RANCH MWC
Calleguas (CAL-024)	LAKE SHERWOOD CSD
Calleguas (CAL-025)	LAS LOMAS WATER SYSTEM
Calleguas (CAL-026)	MESA WATER COMPANY
Calleguas (CAL-027)	OAK PARK WATER SERVICE
Calleguas (CAL-028)	OXNARD UNION HIGH SCHOOL DISTRICT
Calleguas (CAL-029)	PLEASANT VALLEY MWC
Calleguas (CAL-030)	RANCHO CANADA WATER COMPANY
Calleguas (CAL-031)	TOM GRETHER FARMS, Inc.
Calleguas (CAL-035)	GOLDEN STATE WATER CO - Simi Valley
Calleguas (CAL-036)	THERMIC MWC
Calleguas (CAL-038)	VENTURA COUNTY WATERWORKS DISTRICT NO. 1
Calleguas (CAL-039)	VENTURA COUNTY WATERWORKS DISTRICT NO. 8
Calleguas (CAL-040)	VENTURA COUNTY WATERWORKS DISTRICT NO.17
Calleguas (CAL-041)	VENTURA COUNTY WATERWORKS DISTRICT NO.19
Calleguas (CAL-042)	WATERS ROAD USERS GROUP
Calleguas (CAL-044)	ZONE MWC
Calleguas (CAL-179)	BUTLER RANCH MWC
Calleguas (CAL-190)	BALCOM CANYON WATER WELL
Calleguas(CAL-195)	EL CAMPEON RANCH
Calleguas(CAL-196)	COMANCIA RANCH

CASITAS WHOLESALE DISTRICT	
SUPPLIER	WATER COMPANY
Casitas (CAS-046)	CASITAS MWD
Casitas (CAS-047)	CASITAS MWC
Casitas (CAS-048)	CITY OF SAN BUENAVENTURA
Casitas (CAS-049)	DENNISON PARK WATER SYSTEM
Casitas (CAS-051)	GRIDLEY ROAD WATER GROUP*
Casitas (CAS-052)	HERMITAGE MWC
Casitas (CAS-053)	KROTONA INSTITUTE OF THEOSOPHY
Casitas (CAS-054)	MEINERS OAKS CWD
Casitas (CAS-056)	NORTH FORK SPRINGS MWC
Casitas (CAS-057)	OJAI,A
Casitas (CAS-058)	OLD CREEK ROAD MWC
Casitas (CAS-059)	OVIATT WATER ASSOCIATION
Casitas (CAS-060)	RANCHO del CIELO MWC
Casitas (CAS-061)	RANCHO MATILIJA MWC
Casitas (CAS-062)	RINCON WATER AND ROADWORKS
Casitas (CAS-063)	OJAI WATER CONSERVATION DISTRICT
Casitas (CAS-064)	SENIOR CANYON MWC
Casitas (CAS-065)	SHERIFF'S HONOR FARM
Casitas (CAS-066)	SIETE ROBLES MWC
Casitas (CAS-067)	SISAR MWC
Casitas (CAS-068)	GOLDEN STATE WATER CO - Ojai
Casitas (CAS-069)	SULPHUR MOUNTAIN ROAD WATER ASSOCIATION
Casitas (CAS-070)	TICO MWC
Casitas (CAS-071)	TRES CONDADOS
Casitas (CAS-072)	VENTURA RIVER COUNTY WATER DISTRICT
Casitas (CAS-073)	VILLANOVA ROAD WATER WELL ASSOCIATION

UNITED WHOLESALE DISTRICT	
SUPPLIER	WATER COMPANY
United (U-074)	ALISO MWC
United (U-075)	ALTA MWC
United (U-076)	BEEDY STREET WELL
United (U-079)	BROWNSTONE MWC
United (U-080)	CAMARILLO AIRPORT UTILITY ENTERPRISE
United (U-081)	CHANNEL ISLANDS BEACH COMMUNITY SERVICES DISTRICT
United (U-082)	CITY OF FILLMORE
United (U-083)	CITY OF PORT HUENEME
United (U-084)	CLOVERDALE MWC
United (U-086)	COMMUNITY MWC
United (U-087)	CYPRESS MWC
United (U-088)	SUNSHINE TRAILER PARK
United (U-089)	DEMPSEY ROAD MWC
United (U-091)	SEACOAST COOLING
United (U-092)	ELAINS RANCH COMPANY
United (U-093)	EVERGREEN TRAILER PARK
United (U-094)	FARMER'S IRRIGATION COMPANY
United (U-095)	FILLMORE IRRIGATION COMPANY
United (U-096)	FILLMORE WEST MOBILE HOME PARK
United (U-097)	GARDEN ACRES MWC
United (U-099)	GLENVIEW MOBILE HOME PARK
United (U-101)	GOODENOUGH MWC
United (U-102)	HAILWOOD, INC.
United (U-103)	CB SOUTH
United (U-104)	POINSETTIA STOCK FARM
United (U-106)	LAKE PIRU RECREATION AREA
United (U-107)	LIMONEIRA ASSOCIATES
United (U-108)	LINDA VISTA JUNIOR ACADEMY
United (U-109)	MIDDLE ROAD MWC
United (U-110)	MONTALVO MWC
United (U-111)	NAVALAIR MOBILEHOME COURT
United (U-112)	NYELAND ACRES MWC
United (U-113)	OCEAN VIEW MWC
United (U-114)	OCEAN VIEW SCHOOL DISTRICT (LAGUNA VISTA SCHOOL)
United (U-115)	OXNARD LEMON MWC
United (U-118)	PLEASANT VALLEY CWD
United (U-121)	RIO MANOR MWC
United (U-122)	RIO PLAZA WATER COMPANY
United (U-123)	RIO REAL/RIO DEL VALLE SCHOOLS
United (U-126)	SAN CAYETANO MWC
United (U-127)	CITY OF SANTA PAULA
United (U-128)	SAVIERS ROAD MWC
United (U-130)	SILVER WHEEL RANCH MOBILE HOME PARK
United (U-131)	SOUTH MOUNTAIN MWC
United (U-132)	SOUTHSIDE IMPROVEMENT CO
United (U-133)	STORKE MWC
United (U-134)	STRICKLAND MWC
United (U-135)	TEAGUE-McKEVETT CO- LIMONEIRA
United (U-136)	THERMAL BELT MWC
United (U-137)	THOMAS AQUINAS COLLEGE
United (U-138)	TIMBER CANYON MWC
United (U-139)	TOBOCK RANCH MWC
United (U-140)	U.S.N.A.S. - Point Mugu
United (U-141)	U.S.N.C.B.C. - Port Hueneme
United (U-142)	UNITED WCD
United (U-144)	VENTURA COUNTY WATERWORKS DISTRICT NO.16
United (U-145)	G.P. RESOURCES
United (U-146)	VENTURA SCHOOL
United (U-147)	VINEYARD AVENUE ACRES MWC
United (U-148)	THE MUTUAL WATER COMPANY OF VINEYARD AVENUE ESTATES
United (U-149)	VINEYARD MWC
United (U-150)	WARRING WATER SERVICE
United (U-181)	PIRU MWC
United (U-183)	VENTURA COUNTY PROPERTY ADMINISTRATOR
United (U-184)	VENTURA COUNTY DEPT. of AIRPORTS
United (U-185)	HARDSCRABBLE MWC
United (U-186)	SESPE AGRICULTURAL WATER
United (U-187)	GUADALASCA MWC
United (U-191)	SANTA CLARA HIGH SCHOOL
United (U-192)	CITRUS MWC
United (U-200)	LLOYD-BUTLER MWC
United (U-201)	OXNARD MWC
United (U-202)	RANCHO SESPE WORKERS IMPROVEMENT ASSOCIATION
United (U-203)	TOLAND ROAD WATER SYSTEM
United (U-204)	THORNHILL MWC
United (U-205)	SANTA CLARA RESOURCES
United (U-206)	HOUWELING'S NURSERY
United (U-207)	PYRAMID FLOWERS
United (U-208)	SATICOY COUNTRY CLUB
United (U-209)	VUJOVICH RANCH
United (U-210)	BOUQUET MULTIMEDIA

SUPPLIERS WITHOUT WHOLESALE DISTRICT	
SUPPLIER	WATER COMPANY
None (W-152)	ANTELOPE VALLEY - EAST KERN WATER AGENCY
None (W-153)	WILSHIRE BLVD. TEMPLE CAMPS & CONFERENCE CENTER
None (W-154)	CAMP SCHEIDECK LODGE
None (W-155)	CAMP THREE FALLS - BSA
None (W-156)	CASTAIC LAKE WATER AGENCY
None (W-157)	CHANNEL ISLANDS NATIONAL MONUMENT
None (W-158)	CHUCHUPATE CAMPGROUND
None (W-159)	CHUCHUPATE RANGER STATION
None (W-160)	COMPTON HUNTING and FISHING CLUB
None (W-163)	HIDDEN VALLEY MWD
None (W-164)	LAZY J. RANCH
None (W-166)	CIRCLE J RANCH
None (W-168)	NEW CAMP BARTLETT
None (W-170)	OZENA RANGER STATION
None (W-171)	PINE MOUNTAIN INN
None (W-174)	SWEETWATER SPRING RANCH
None (W-178)	YERBA BUENA WATER COMPANY
None (W-182)	U.S. NAVY - San Nicolas Island
None (W-188)	POINT MUGU STATE PARK
None (W-193)	LAKE OF THE WOODS MWC
None (W-194)	OZENA VALLEY SPORTSMANS CLUB

DWR Bulletin 118 Groundwater Basins

1. Las Posas Valley
2. Arroyo Santa Rosa Valley
3. Pleasant Valley
4. Santa Clara River Valley - Santa Paula
5. Santa Clara River Valley - Mound
6. Santa Clara River Valley - Oxnard

Pacific Ocean

N W E S

San Nicolas Island Inset

W-182

W-157

Northern Ventura County Inset

Inventory of Public & Private
Water Purveyors In Ventura County
Figure 3.0

Plate 1

Ventura County Watershed Protection District

Water & Environmental Resources Division
Groundwater Section
800 South Victoria Ave.
Ventura, CA 93009-1600
Ph: (805) 654-2088
Fx: (805) 677-8762

Created: Feb 2006
By: JPD

Legend

DWR Bull. 118 GW Basins
FoxCynGMA-bdy
Roads
Calleguas MWD
Casitas MWD
UWCD
Water Bodies
County Boundary

1:87,500

1 inch equals 3 miles

0 1.5 3 6 Miles

DISCLAIMER: The information contained herein was created by the Ventura County Watershed Protection District solely for its own use. The VCWPD assumes no liability for damages incurred directly or indirectly as a result of errors, omissions or discrepancies.

At the time of the initial Management Plan development in 1984-1985, the primary threat to the aquifers of western Ventura County was seawater intrusion in the Upper Aquifer System. Since that time, a number of studies have identified other water quality problems, including saline intrusion in the Lower Aquifer System (LAS) in the Pleasant Valley basin, and in the Las Posas basin. This update to the groundwater management plan is designed to look at a broader range of problems and to suggest potential solutions to these problems.

Since 1985, there have been a number of studies conducted within the FCGMA, the most comprehensive being the Regional Aquifer System Analysis (or RASA Study) done by the U.S. Geological Survey (USGS) in the late 1980s and 1990s. This study, conducted with the cooperation of local agencies, consisted of drilling monitoring wells with individual casings perforated in selected aquifers or water-bearing zones, constructing a groundwater model, and conducting hydrogeologic studies. Monitoring wells, most constructed along the coastline of the Oxnard Plain, continued to provide critical information on the status of saline intrusion. In addition, a number of more specific or follow-up studies have been conducted by the United Water Conservation District (UWCD) and other agencies. These studies have helped characterized seawater intrusion along the coastline, saline contamination in more inland areas, and nitrate contamination in the Upper Aquifer System. The USGS MODFLOW groundwater model has been used and refined by the groundwater staff at UWCD to test a variety of projects that could help mitigate the water quality problems within the FCGMA.

This 2007 Update to the FCGMA Groundwater Management Plan incorporates all previous work and the specific studies that were undertaken as part of this most-recent planning process. The Plan is organized with the results of past and current studies followed by an evaluation of both current management strategies and potential future management strategies for the FCGMA. Various groundwater management ideas and strategies have been evaluated first by FCGMA staff, and UWCD staff, and then reviewed by Calleguas Municipal Water District (CMWD) management and staff and consultants from the water purveyors within the FCGMA. Extensive public review by stakeholders was also a critical part of the planning process.

Appendix C includes a document entitled, the East Los Posas Basin Management Plan (ELPBMP). The ELPBMP was developed through ongoing discussions between CMWD and the Las Posas Basin Users Group (farm well owners, mutual water companies, and the Ventura County Water Works Districts that supply water to the City of Moorpark and others). The ELPBMP serves as a more detailed sub-basin management planning document grounded in the FCGMA February 23, 1994 approval of CMWD's Application for Injection/Storage Facilities in the North Los Posas Groundwater Basin. (Appendix C - Exhibit A). As such, the ELPBMP particularly addresses the interaction of CMWD's Aquifer Storage and Recovery (ASR) project with other basin pumpers regarding both basin-wide and local effects of the project.

2.0 BACKGROUND OF GROUNDWATER MANAGEMENT AND OVERDRAFT WITHIN THE FCGMA

Although high chloride levels were first documented near Port Hueneme in the 1930s (California Department of Water Resources [DWR], 1954), the conditions for widespread seawater intrusion on the Oxnard Plain were initiated as early as the 1940s, when groundwater levels beneath the southern portion of the Oxnard Plain basin dropped below sea level (see Appendix A). Within 5 to 10 years, chloride concentrations in wells in the Port Hueneme area started to increase rapidly. At that time, seawater had only affected a few wells in the Port Hueneme area, encompassing an area less than one square mile (Appendix A).

Within 20 years, seawater intrusion in the Port Hueneme area had extended as much as 3 miles inland. In some of the affected wells, chloride concentrations were as high as those of seawater (just less than 20,000 mg/L). Appendix A documents the progression of seawater intrusion beneath the southern portion of the Oxnard Plain basin. This seawater intrusion into the Upper Aquifer System was located adjacent to the Hueneme Submarine Canyon that is directly offshore of Port Hueneme (Figure 2). Seawater intrusion also occurred in the Point Mugu area, adjacent to the Mugu Submarine Canyon that extends offshore from Mugu Lagoon. This intrusion in the Point Mugu area first impacted Upper Aquifer System wells in late 1950s (Appendix A).

In the Port Hueneme area, seawater in the Upper Aquifer System reached its farthest point inland in the early 1980s (Appendix A). Following the high rainfall year of 1983, chloride levels began to decrease in many of the Port Hueneme area wells perforated in the UAS. Coupled with pumping allocations and management strategies imposed by the FCGMA, this improving trend in chloride reductions was accelerated in the 1990s, as the Freeman Diversion was completed by UWCD and several wet years occurred, which allowed increased recharge available from the diversion, helping restore aquifer pressures and pushing seawater back toward the coast.

Groundwater levels in the Lower Aquifer System also dropped below sea level in the late 1950s. This Lower Aquifer System intrusion was first detected in wells in the late 1980s (Appendix A). As with the Upper Aquifer System, the intrusion in the Lower Aquifer System spread into the aquifer both near Port Hueneme and at Point Mugu. Further exacerbating the drops in groundwater levels in the LAS was an increase in production in the Lower System – partly in search of better quality water supplies and partly because new or replacement wells were required to be drilled in the LAS as a strategy to lessen pumping in the intruded Upper Aquifer System.

The overpumping of the aquifers that led to seawater intrusion also created land subsidence of up to 2.2 feet in the Pleasant Valley area north and northwest of Mugu Lagoon by the early 1970s as dewatered clay layers between aquifer zones collapsed from reduced hydrostatic pressures. This subsidence is permanent – refilling of the sand and gravel aquifers cannot force water back into the dewatered clay layers.

In the Point Mugu area (Figure 2), chlorides have not lessened over the past two decades. Instead, chloride concentrations continued to increase in the area of Mugu Lagoon, reaching concentrations almost as high as seawater in some wells. The CM1A monitoring well in that area showed an increase in chloride concentrations from several hundred mg/L to 4,600 mg/L in a little more than one decade.

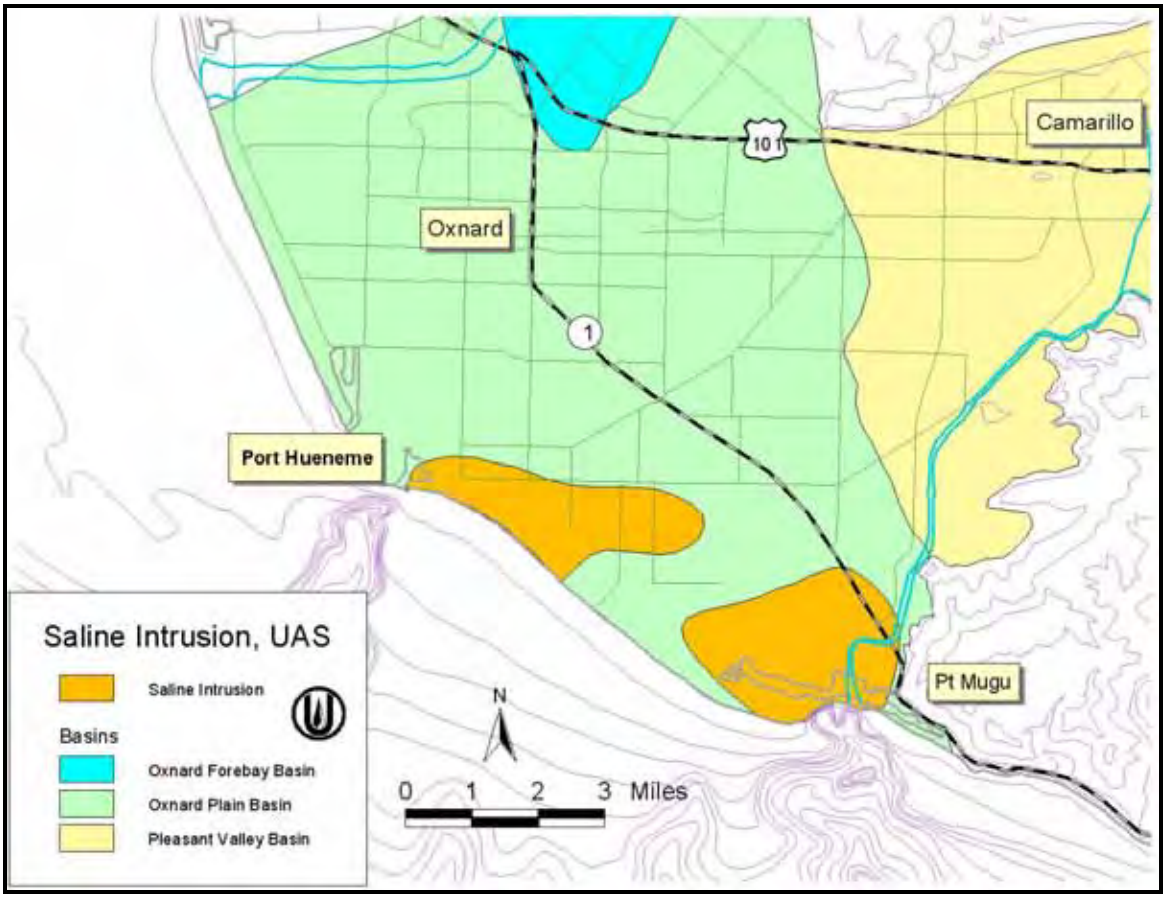


Figure 2. Areas of saline intrusion beneath the Oxnard Plain basin in 2006. The sources of the saline intrusion are discussed in section 5.1.1 *Seawater Intrusion*.

As the USGS began their work in Ventura County in late 1980s, they proposed that the increase in chlorides in the UAS and LAS was caused not just from seawater intrusion but also from the intrusion of saline waters being pulled from surrounding sediments and from deeper depths along fault zones (Izbicki, 1991, 1992; discussed in more detail in section 5.1.1 *Seawater Intrusion*). The cause of this additional saline contamination was the same as for seawater intrusion, that is, very low groundwater levels. This additional saline contamination of groundwater inland from the lobes of seawater intrusion was caused by excessive groundwater pumping and lowered groundwater levels. This finding raised the possibility that saline contamination could occur in inland areas wherever groundwater levels are particularly depressed.

There was some initial concern chloride concentrations measured in some of the producing wells were simply detecting high chloride waters flowing downward from failed well casings. To ensure monitoring results were accurately depicting saline intrusion, a series of monitoring wells were drilled along the coastal portions of the Oxnard Plain. These multiple-completion wells consist of a single well bore containing several smaller-diameter PVC wells completed at varying aquifer depths. These monitoring wells give discrete depth-dependent data from the aquifers and form the basis of much of the current monitoring program.

Several trends in saline intrusion are evident on the south Oxnard Plain. The Port Hueneme lobe of seawater intrusion has decreased considerably in size and chloride concentration in the

Upper Aquifer System. However, Lower Aquifer System chloride concentrations have somewhat increased in this Port Hueneme lobe. In the more southeastern Point Mugu lobe, concentrations of chloride are generally higher than in the past both in the UAS and LAS; the areal extent of the intrusion of seawater is not known with precision. The area affected by saline intrusion from surrounding sediments has increased both in size and in chloride concentration. This increase in size has prompted United Water Conservation District to drill new monitoring wells inboard of this saline intrusion to detect further movement of salts.

Local and State Actions – The increasing seawater intrusion prompted the State Water Resources Control Board to consider adjudication in the early 1980s, with the result that local agencies, working with the State Board, created a series of physical solutions and institutions to tackle the problem. The physical solutions included adding artificial recharge capability for the aquifers and providing additional in-lieu surface water to groundwater pumpers. The institutional solution was the formation of the Fox Canyon Groundwater Management Agency to bring water usage into balance with recharge sources to prevent overdraft conditions.

Formation of the Fox Canyon Groundwater Management Agency – In 1982, State Senate Bill 2995 was approved creating the Fox Canyon Groundwater Management Agency (FCGMA). The agency's activities were defined as "planning, managing, controlling, preserving, and regulating the extraction and use of groundwater within the territory of the agency." That directive also went on to say, "shall not involve itself in activities normally and historically undertaken by its member agencies, such as the construction and operation of dams, spreading grounds, pipelines, flood control facilities, and water distribution facilities, or the wholesale and retail sale of water." This prohibition of water conservation and distribution facilities along with water sales by the FCGMA was clearly meant to delineate the separate powers of the various agencies within the County (see following section).

The FCGMA officially began operations on January 1, 1983 with the County of Ventura contracting to provide staffing and related services to the new agency. In May 1983, Ordinance No. 1 was adopted requiring all wells within the agency to register and begin reporting groundwater extractions. This ordinance also set extraction management fees (at $0.50/AF), becoming the sole source of income to the fledgling agency sans any minor penalty or surcharge fees that would be instituted in later ordinance revisions. Ordinance No. 2 (October 1983) was a short amendment to Ordinance No. 1 establishing semi-annual groundwater extraction reporting to cover the first and second half of each calendar year, with statements due within 30 days following each period.

A groundwater management plan was adopted in 1985 to set goals and to help guide FCGMA policies. In February 1987, Ordinance No. 3 was adopted to require flow meters on all but domestic wells. Ordinance No. 4 (July 1987) soon followed that protected the aquifer outcrop areas in the East and West Las Posas basin (formerly collectively referred to as the North Las Posas basin) and regulated groundwater extractions in the basin via more detailed rules than those in any previous ordinance. The adoption of Ordinance No. 5 in August 1990 completed the first steps for the FCGMA by setting up a system of scheduled extraction reductions, allowing for the use of Historical, Baseline, and Agricultural Efficiency Allocations, and establishing a credit system to encourage cutbacks in pumping, along with a penalty system for overpumping beyond the established annual allocation.

Agencies' responsibilities - Several agencies are responsible for managing water resources in Ventura County. The FCGMA has responsibility for groundwater management planning, managing pumping allocations and credits, and developing policies related to groundwater

extractions and recharge. United Water Conservation District (UWCD) has responsibility for managing groundwater resources in seven basins in the county, including most of the basins within the Fox Canyon Groundwater Management Agency (FCGMA) (Plate 1). UWCD's responsibilities include groundwater and surface water monitoring, constructing and maintaining water conservation and recharge facilities, reporting on groundwater conditions, and groundwater management and planning activities. Groundwater management and planning functions overlap between the FCGMA, UWCD, and other local agencies, with the FCGMA focusing on extractions and policy and UWCD focusing on planning and implementing projects. Calleguas Municipal Water District (CMWD) is responsible for providing State Water to portions of Ventura County and providing water management strategies to ensure a reliable source of water for its customers (Plate 1). The Ventura County Watershed Protection District (VCWPD) is responsible for flood control functions, groundwater/surface water monitoring, and water well permitting. The water purveyors (cities and water districts) decide how much and from where their groundwater supplies are extracted, as well as plan projects that benefit the aquifers. There has been a remarkable amount of cooperation among these organizations in addressing groundwater issues over the last 20+ years.

In practice, groundwater management functions within the boundaries of the FCGMA are performed in the following ways:

1. Groundwater levels and groundwater quality sampling and analysis are conducted by UWCD, VCWPD, and individual water purveyors;
2. Groundwater extraction records are collected by both the FCGMA and UWCD, with the FCGMA maintaining records on extraction allocations and credits;
3. An annual report on groundwater conditions is prepared by UWCD within UWCD boundaries and CMWD prepares reports on groundwater conditions within the West, East, and South Las Posas basins (in conjunction with the Las Posas Basin Users Group;
4. Water purveyors prepare regular plans on current and future water use and supplies (e.g., Urban Water Management Plans);
5. The FCGMA prepares this Groundwater Management Plan to evaluate basin management objectives, strategies, and policies;
6. UWCD and some of the water purveyors construct and operate water conservation facilities; and
7. The VCWPD (and the City of Oxnard within its boundaries) oversees all well drilling, well destruction, and monitoring well requirements and permitting.

The initial Groundwater Management Plan (September 1985) prepared by the FCGMA recommended groundwater pumping be reduced by 25% over a 20-year period to help bring the aquifers into balance or to reach safe yield by year 2010 and to mitigate seawater intrusion by that same target date. This plan was based on groundwater demand projections for the period between 1980 and 2010. Subsequent Board ordinances (Ordinance No. 5) formulated an extraction allocation for all groundwater pumpers within the FCGMA, based on average extractions during the years 1985 to 1989. Starting in 1990, these pumping or “Historical” allocations were to be reduced by 5% every five years, with a planned 25% total reduction by the year 2010.

A program of “Conservation” and “Storage” credits allows well operators to vary their annual pumping in accordance with crop changes and/or annual hydrologic conditions. In addition, agricultural pumpers are allowed the option of using Irrigation Efficiency instead of the allocation/credit program. Agricultural efficiency for individual pumpers (later deemed as

"operators" of one or more wells) is required to be at least 80% or better (20% or less going to leaching, deep percolation, or runoff), when compared to FCGMA allowed water for particular crop water demand based on daily evapotranspiration and precipitation measurements from a series of weather stations installed throughout the FCGMA. A surcharge fee, based on the extraction reporting, was formulated to penalize individual pumping above allowed annual allocations or not meeting the required irrigation efficiency percentage minimum. These penalties have been seldom used since their inception, largely because of widespread cooperation among pumpers to reduce groundwater extractions.

In cooperation with the Watershed Protection District, the FCGMA also helped formulate requirements that new wells be completed in specific aquifers to help control seawater intrusion. A similar cooperative program that utilized Federal 319(h) grant funds coupled with matching local funds helped destroy a number of abandoned wells across the Oxnard Plain which, had the potential to act as conduits allowing inter-aquifer mixing. A total of 49 old abandoned or leaking wells were destroyed under this program.

3.0 GROUNDWATER BASINS & HYDROGEOLOGY

The basins within the FCGMA are part of the Transverse Ranges geologic province, in which the mountain ranges and basins are oriented in an east-west rather than the typical northeast-southwest trend in much of California and the western United States. Active thrust faults border the basins of the Santa Clara River, causing rapid uplift of the adjacent mountains and downdropping of the basins. The alluvial basins are filled with substantial amounts of Tertiary and Quaternary sediments deposited in both marine and terrestrial (non-marine) settings. The basins beneath the Oxnard Plain are filled with sediments deposited on a wide delta complex formed at the terminus of the Santa Clara River and was heavily influenced by alternating episodes of advancing or retreating shallow seas that varied with world-wide sea level changes over many millions of years.

There are seven main or significant groundwater basins within the FCGMA (Figure 3). These groundwater basins have been called by somewhat different names historically; this Plan uses the terminology of the U.S. Geological Survey from their work in the 1990s and early 2000s (e.g., Hanson et al., 2003) because it is the most recent comprehensive study of the basins. These groundwater basins include the Oxnard Plain, the Oxnard Plain Forebay, the Pleasant Valley, the Santa Rosa, and the East, West and South Las Posas basins. These basins generally contain two major aquifer systems, the Upper Aquifer System (UAS) and the Lower Aquifer System (LAS). Separate aquifers locally named within these systems include the Oxnard and Mugu aquifers (UAS) and the Hueneme, Fox Canyon, and Grimes Canyon aquifers (LAS). A shallower, unconfined aquifer is also present locally underlying rivers and creeks. Underlying the Oxnard Plain and Pleasant Valley basins are sand layers of the "semi-perched zone," which may locally contain poor-quality water. This zone extends from the surface to no more than 100 ft in depth. These sands overlie confining clay of the upper Oxnard Aquifer which generally protects the underlying aquifers from contamination from surface land uses. The Semi-perched zone is rarely used for water supply.

The aquifers are comprised of sand and gravel deposited along the ancestral Santa Clara River, within alluvial fans along the flanks of the mountains, or in a coastal plain/delta complex at the terminus of the Santa Clara River and Calleguas Creek. The aquifers are recharged by infiltration of streamflow (primarily the Santa Clara River), artificial recharge of diverted streamflow, mountain-front recharge along the exterior boundary of the basins, direct infiltration of precipitation on the valley floors of the basins and on bedrock outcrops in adjacent mountain

fronts, return flow from agricultural and household irrigation in some areas, and in varying degrees by groundwater underflow from adjacent basins.

LOWER AQUIFER SYSTEM – The Lower Aquifer System (LAS) consists of the Grimes Canyon, Fox Canyon, and Hueneme aquifers (e.g., Figure 6) from the deepest to the shallowest. The LAS is part of the Santa Barbara, San Pedro, and Saugus formations of Plio-Pleistocene age (Hanson et al, 2003). The lowest water-bearing unit of the East Las Posas and Pleasant Valley basins is commonly referred to as the Grimes Canyon aquifer (California Department of Water Resources, 1954; Turner, 1975). The Fox Canyon aquifer underlies all of the groundwater basins beneath the FCGMA, but is most significant in the East and West Las Posas, Pleasant Valley, Oxnard Plain Forebay, and Oxnard Plain basins. The Hueneme aquifer is considered to underlie most coastal areas of the southern Oxnard Plain (Hanson et al, 2003), and is an important source of water in the Oxnard Plain, Pleasant Valley, and the West Las Posas basins.

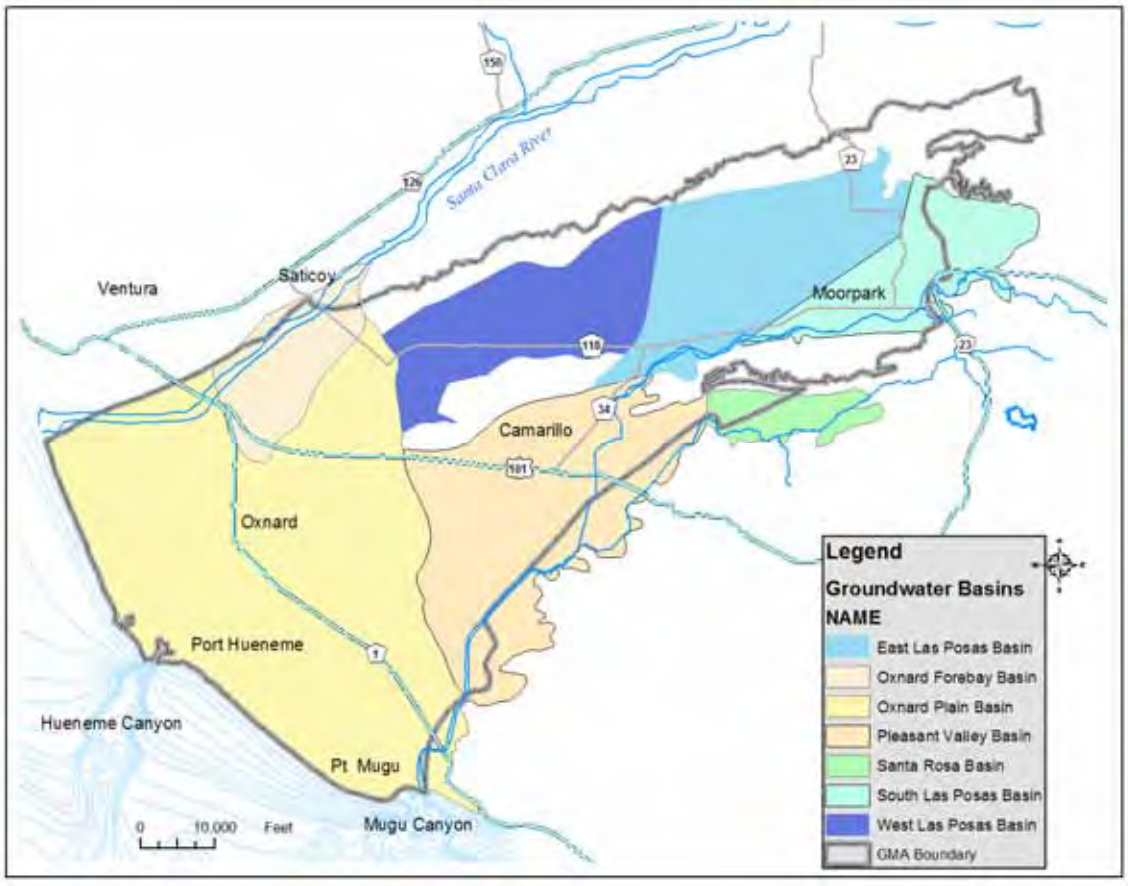


Figure 3. Groundwater basins within the Fox Canyon Groundwater Management Agency.

The aquifers within the LAS are commonly isolated from each other vertically by low-permeability units (silts and clays) and horizontally by regional fault systems. There is active tectonism (faulting and folding) within the area of the FCGMA, caused by compressional and lateral forces as the Transverse Ranges are caught in a vise between the Pacific and North American tectonic plates. As a result, the LAS is folded and tilted in many areas, and has been eroded along an unconformity separating the Upper and Lower aquifer systems.

UPPER AQUIFER SYSTEM – The Upper Aquifer System (UAS) within the FCGMA consists of the Mugu and Oxnard aquifers (Figure 5, Figure 6), from deepest to most shallow, of Late Pleistocene and Holocene age. The UAS rests unconformably on the Lower Aquifer System, with basal conglomerates in many areas (Hanson et al, 2003). In the Oxnard Plain, these coarse-grained basal deposits have been referred to as the Mugu aquifer (Turner, 1975). The Mugu aquifer is generally penetrated at a depth of 255 ft to 425 ft below land surface. The younger Oxnard aquifer is present throughout the Oxnard Plain. The Oxnard aquifer is the primary aquifer used for groundwater supply on the Oxnard Plain. This highly-permeable assemblage of sand and gravel is generally found at a depth of approximately 100 ft to 220 ft below land surface elevation.

OXNARD PLAIN FOREBAY AND OXNARD PLAIN BASINS – Both Upper and Lower aquifers are present in the Oxnard Plain Forebay and Oxnard Plain basins (Figure 4). The Oxnard Plain basin extends several miles offshore beneath the marine shelf, where outer edges of the aquifer are in direct contact with seawater. In areas near Port Hueneme and Point Mugu where submarine canyons extend nearly to the coastline (Figure 2, Figure 7), the fresh-water aquifers are in direct contact with seawater only a short distance offshore.

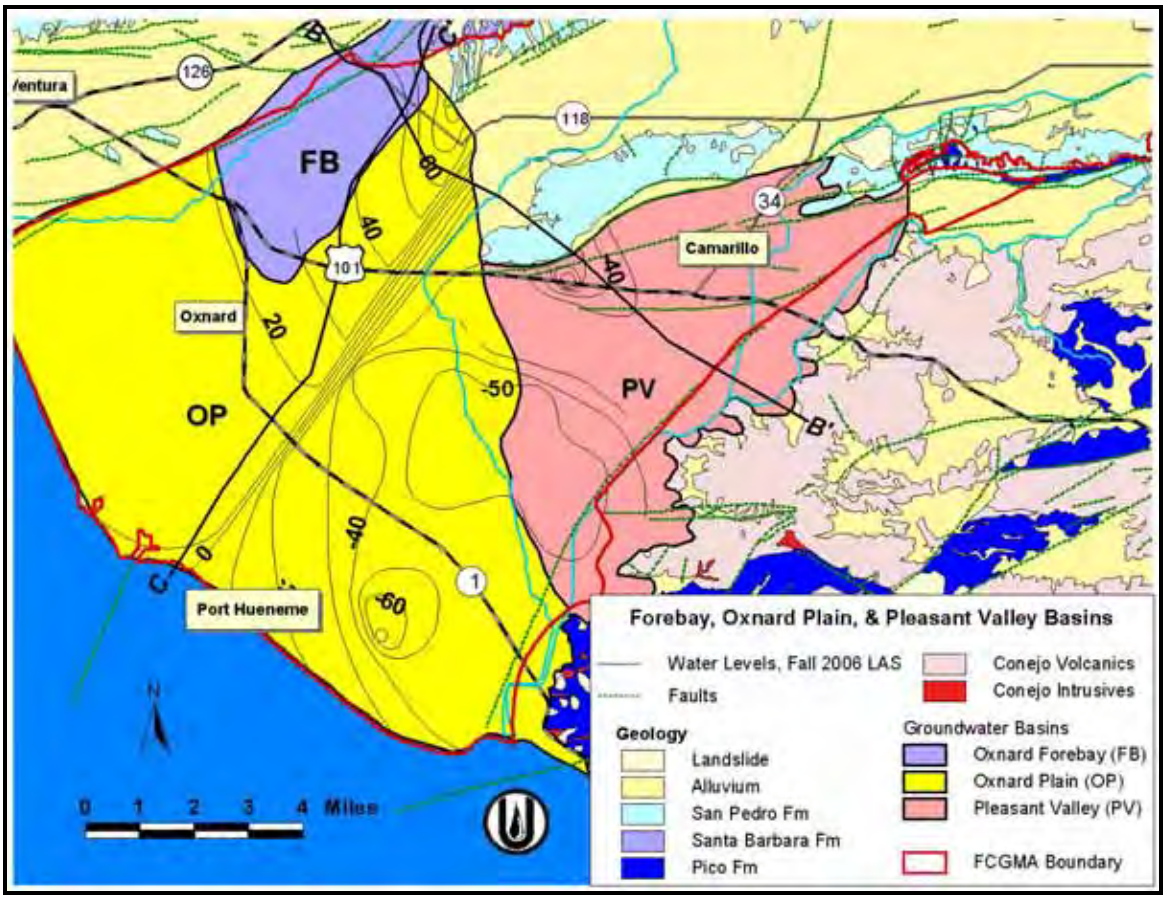


Figure 4. Map of Oxnard Forebay, Oxnard Plain, and Pleasant Valley basins. Contours of Lower Aquifer groundwater elevations in the Fall of 2006 indicate that the south Oxnard Plain and Pleasant Valley basins have significant areas below sea level. The locations of geologic sections B-B' (Figure 5) and C-C' (Figure 6) are indicated on map.

The Oxnard Plain Forebay basin is the main source of recharge to aquifers beneath the Oxnard Plain. The absence of low-permeability confining layers (no continuous clay or silt layers)

between surface recharge sources and the underlying aquifers (sand and gravel layers) in the Forebay basin allows for effective recharge of the basin and subsequent recharge of aquifers further to the south and southwest (e.g., Figure 6). Recharge to the Forebay basin comes from a combination of percolation of Santa Clara River flows, artificial recharge from United's spreading grounds at Saticoy and El Rio, agricultural and household irrigation return flows, percolation of rainfall, and lesser amounts of underflow from adjacent basins. In the area of the Forebay between the El Rio and Saticoy spreading grounds, the Lower Aquifer System has been folded and uplifted and then truncated (eroded away) along its contact with the Upper Aquifer System (Figure 5, Figure 6). In this area, recharge from surface sources may enter both the Upper Aquifer System and the underlying Lower Aquifer System. It is estimated that about 20% of the water recharged to this area reaches the Lower Aquifer System, with the remainder recharging the Upper Aquifer System (Hanson, 1998).

The Oxnard Plain Forebay basin accepts large quantities of recharge water in a single year, and the basin was filled to near-capacity during several recent wet years (UWCD, 2003). High groundwater elevations in the Oxnard Plain Forebay basin increase the hydraulic head (pressure) in the confined aquifers of the Oxnard Plain, raising water levels throughout the Plain and promoting natural offshore flow in coastal areas.

The Oxnard Plain Forebay basin is hydrologically connected with the aquifers of the Oxnard Plain basin (e.g., Figure 6). Thus, the primary recharge to the Oxnard Plain basin is from underflow from the Forebay rather than the deep percolation of water from surface sources on the Plain. When groundwater levels are below sea level along the coastline, there may also be significant recharge by seawater flowing into the aquifers (from the historic discharge areas shown in Figure 7 where the aquifers are exposed on the sea floor). When Lower Aquifer System (LAS) water levels are substantially lower than Upper Aquifer System (UAS) water levels (creating a downward gradient), there may be substantial leakage of UAS water into the LAS both through discontinuities within the silts and clays between aquifers on the Oxnard Plain and as slow vertical percolation directly through the silt and clay material itself. Some amount of downward percolation can also occur via wells that are perforated in both aquifer systems and via compromised (failed or leaking) well casings.

One of the more recent findings associated with groundwater beneath the Oxnard Plain basin is a zone with a steeply-dipping groundwater gradient in the Lower Aquifer System that extends across the Oxnard Plain from just south of Port Hueneme northeastward to the south flank of the Camarillo Hills (Figure 4, just south of section C-C'). This steep gradient is apparently caused by a lower-conductance zone that bisects the Oxnard Plain at the depth of the Lower Aquifer System (e.g., UWCD, 2003). This zone, likely a fault or other structural feature, reduces recharge flowing from the Oxnard Plain Forebay basin to the south Oxnard Plain and Pleasant Valley. This zone may be an extension of the Simi-Santa Rosa fault that extends along the southern flank of the Camarillo Hills. The presence of this subsurface feature that reduces groundwater flow also limits the effectiveness of management strategies that rely on groundwater flowing in the LAS from recharge areas in the Oxnard Plain Forebay basin to the south Oxnard Plain and to Pleasant Valley. This Management Plan proposes specific strategies to overcome this geologic hurdle to recharging the LAS in these southern areas of the FCGMA.

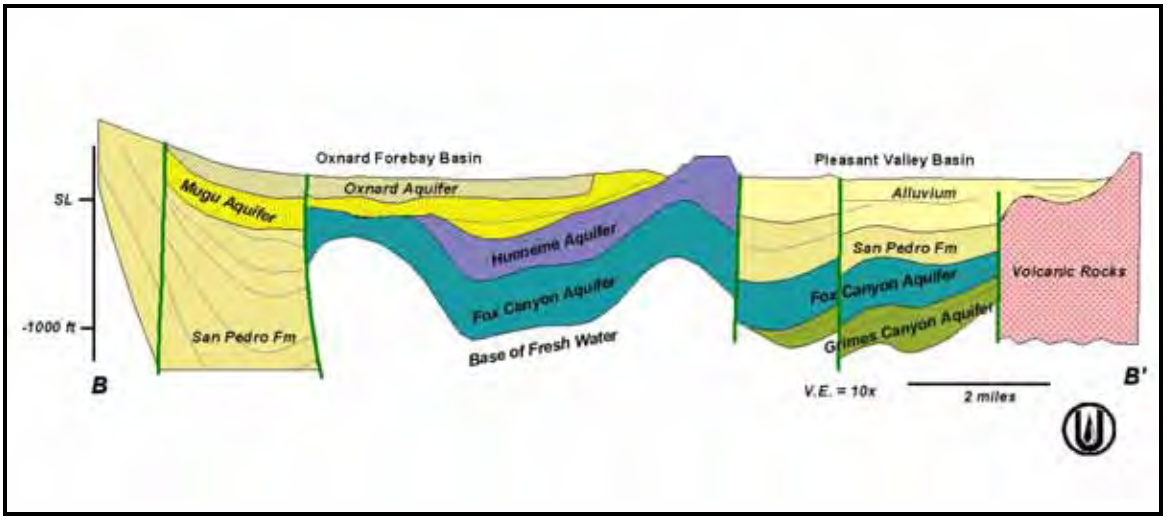


Figure 5. Geologic section B-B'. Simplified from Mukae and Turner (1975). Note ten times vertical exaggeration to accentuate stratigraphic units.

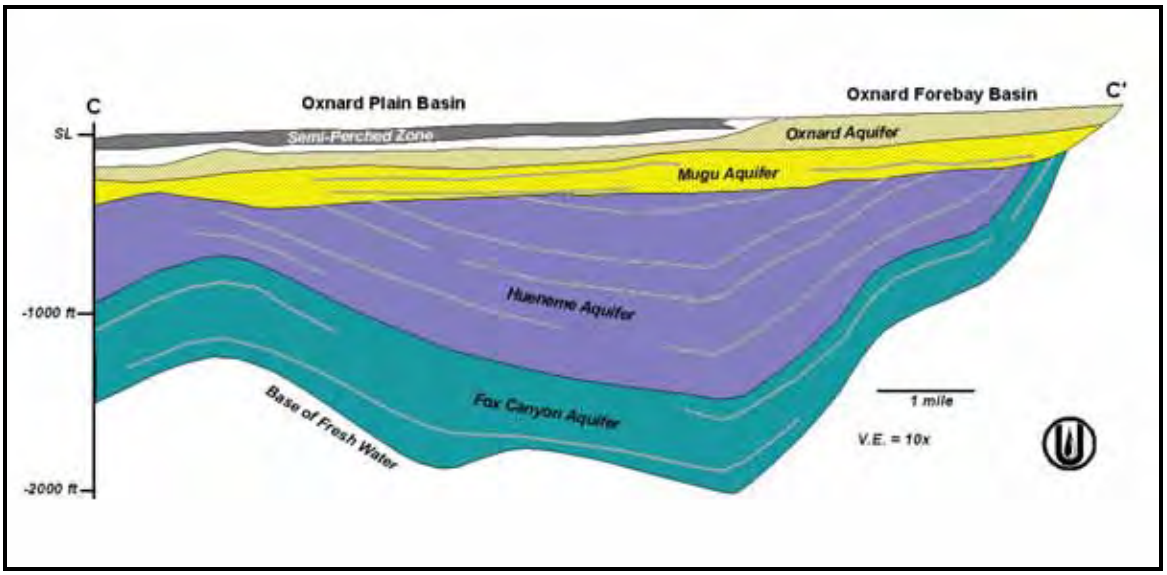


Figure 6. Geologic section C-C'. Simplified from Mukae and Turner (1975). Note ten times vertical exaggeration to accentuate stratigraphic units.

PLEASANT VALLEY BASIN – The Pleasant Valley groundwater basin (Figure 4) has been historically differentiated from the Oxnard Plain basin by a general lack of Upper Aquifer System aquifers (Turner, 1975). However, there may be local water-producing Upper Aquifer System units within the Pleasant Valley basin (Turner, 1975; Hanson et al, 2003). The Pleasant Valley basin is confined by thick fine-grained deposits overlying the aquifers of the basin. The Fox Canyon aquifer is the major water-bearing unit in the basin. Despite the fault barrier to the west, the Lower Aquifer System is in hydrologic continuity with the adjacent southern portion of the Oxnard Plain basin.

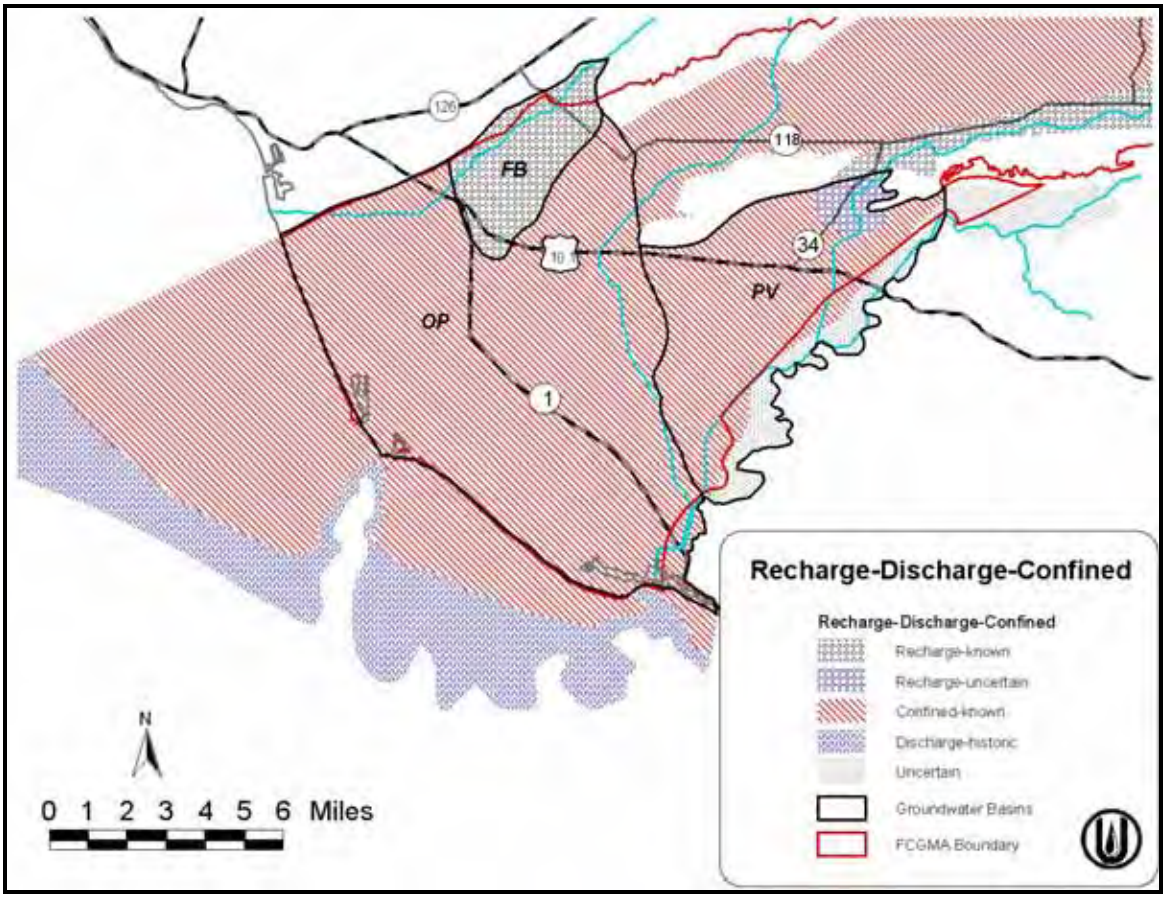


Figure 7. Recharge and discharge areas of coastal aquifers, with confined portions of the aquifers indicated. The offshore discharge area is the location where the aquifers are exposed on the ocean bottom and in submarine canyons. See text for discussion. Basin designations: OP-Oxnard Plain, FB-Oxnard Forebay, PV-Pleasant Valley.

Historically it was assumed that the LAS of the Pleasant Valley Basin was relatively confined and received little overall recharge across the fault that extends from the Camarillo Hills to Port Hueneme. However, since the early 1990s, water levels have begun to rise in the northern adjacent basins. The City of Camarillo has two existing wells in the northeast portion of the Pleasant Valley Basin (hereafter called the Somis Area) and these wells confirm that rising water levels in northern adjacent basins directly impact recharge rates, water quality, and water levels in the Somis Area. The recharge in the Somis Area may be a result of uplift and folding of Lower Aquifer units that allow rapid stream flow percolation. This area is indicated as "Recharge-uncertain" at the north end of the Pleasant Valley basin on Figure 7 to reflect the uncertainty of the extent of this area of recharge. It is recommended that additional monitoring and studies be conducted to determine the dimensions and nature of this apparent recharge area.

The groundwater hydrology of the portion of the Pleasant Valley basin east of the city of Camarillo is not well understood because there are not many wells drilled in the area. Along Calleguas Creek near California State University Channel Islands, water has been produced historically from aquifer depths that are shallower than the typical LAS well, suggesting that water-bearing strata are not limited to the LAS in this area.

It is clear that the eastern and northeastern portions of the Pleasant Valley basin need to be better understood (indicated as "Unknown" along the eastern edge of the Pleasant Valley basin on Figure 7). Past studies have considered the basin as largely confined, with perhaps some perched water along a portion of its eastern edge. The conceptual hydrogeology that was the basis for the Ventura Regional Groundwater Model used the conclusions from these studies. As suggested above, additional monitoring and studies are needed to better determine the hydrogeology of the area, with these results integrated into the groundwater model.

SANTA ROSA BASIN – The Santa Rosa basin (Figure 8) is the smallest basin within the FCGMA. Groundwater levels are heavily influenced by flows in the overlying Conejo Creek; discharges from a wastewater treatment plant and dewatering wells in Thousand Oaks have considerably increased year-round flows in the creek. Aquifers in the basin include a shallow alluvium aquifer and portions of the Lower Aquifer System. The structure of this basin is dominated by the east-trending Santa Rosa syncline that folds the San Pedro and Santa Barbara Formations (CSWRB, 1956). This syncline helps direct groundwater flow in the San Pedro Formation. The Santa Rosa fault zone forms a barrier to groundwater flow into the basin from the north. A sharp change in water level in the western part of the basin may be caused by a roughly north-trending fault that restricts groundwater flow (CDWR, 2003). Elevated nitrate and sulfate have been a problem in the basin.

LAS POSAS BASIN –The Las Posas groundwater basin (Figure 8) is bounded on the south by the Camarillo and Las Posas Hills and on the north by South Mountain and Oak Ridge (CSWRB, 1954). The basin has been variously subdivided into North and South basins (e.g., Turner and Mukae, 1975) or by West, East, and South basins (e.g., Hanson, 1998). The U.S. Geological Survey terminology (Hanson, 1998) is used in this Management Plan. Productive aquifers in this basin include a shallow unconfined aquifer that is most transmissive along the Arroyo Las Posas and a lower confined aquifer system that is considered to be the equivalent of the Lower Aquifer System on the Oxnard Plain (Figure 9).

South Las Posas Basin – This basin is separated from the East Las Posas basin by an east-trending anticline (fold) that affects all but the shallowest alluvium (Figure 9). This fold may affect groundwater flow between the East and South Las Posas basins at some aquifer depths, although recharge from the South Las Posas basin flows readily into the East Las Posas basin at Lower Aquifer System (LAS) depths. To the south, the Springville and Santa Rosa fault zones produce disrupted and tightly folded rocks along the edge of the basin, restricting groundwater flow to the south (CSWRB, 1956). There is a shallow alluvial aquifer that follows the trend of Arroyo Las Posas as it crosses the South Las Posas basin; this shallow aquifer is in hydrologic connection with the underlying LAS and is the main source of recharge to the LAS (indicated as the recharge area along the south edge of the East and South Las Posas basins on Figure 10).

There has been a significant change in average groundwater levels over the past 40 years in the South Las Posas basin, with groundwater levels rising more than 100 ft during this period. The mechanism for this rise in groundwater elevations is the increased recharge from percolation beneath the Arroyo Las Posas as discharges from the Moorpark and Simi Valley wastewater treatment plants and dewatering wells in Simi Valley have increase year-round flow in the arroyo. The entire alluvial aquifer near the arroyo has progressively filled to the elevation of the arroyo, starting in the easternmost portion of the basin in the 1960s and moving westward through the 1990s (Bachman, 2002). Water from the filled alluvial aquifer has percolated downward into the underlying Lower Aquifer System, creating a recharge mound in the Lower

Aquifer System that extends from the arroyo northward into the East Las Posas basin (CH2MHill, 1993; Bachman, 1999).

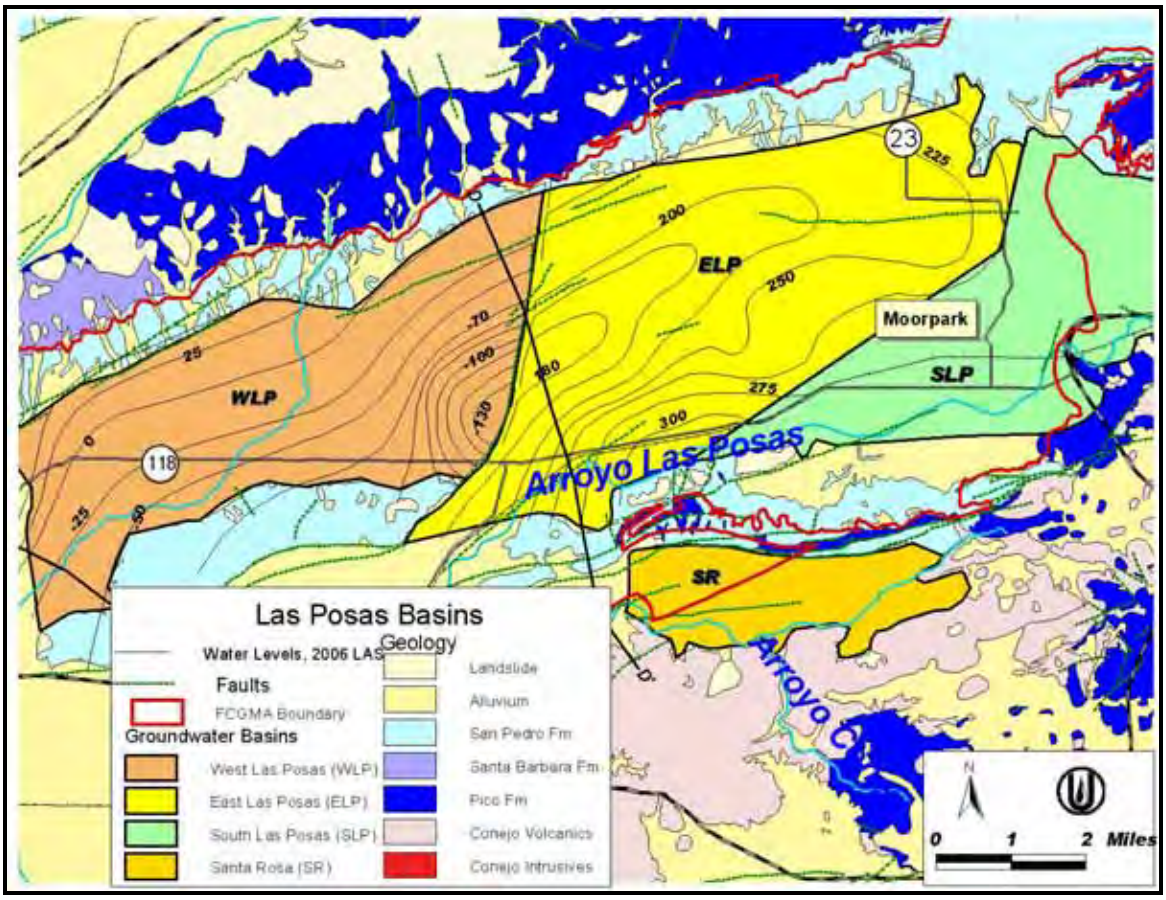


Figure 8. Map of Las Posas and Santa Rosa basins. Contours of Lower Aquifer groundwater elevations in 2006 indicate the recharge mound along Arroyo Las Posas and the change in groundwater elevations across the fault that forms the boundary between the West and East Las Posas basins. The location of geologic section D-D' (Figure 9) is indicated on the map.

Salts (i.e., chloride, sulfate) in the groundwater have increased in the South Las Posas basin and the southwestern portion of the East Las Posas basin as the shallow aquifer filled along Arroyo Las Posas. These salts apparently were leached from the shallow aquifer as groundwater levels reached record highs, saturating sediments that have been unsaturated for the historic period. These salts apparently migrated vertically with percolating groundwater into the LAS and then laterally into the main portion of the East Las Posas basin as the recharge mound developed. Some of this groundwater is unsuitable for irrigation without being blended with better-quality water.

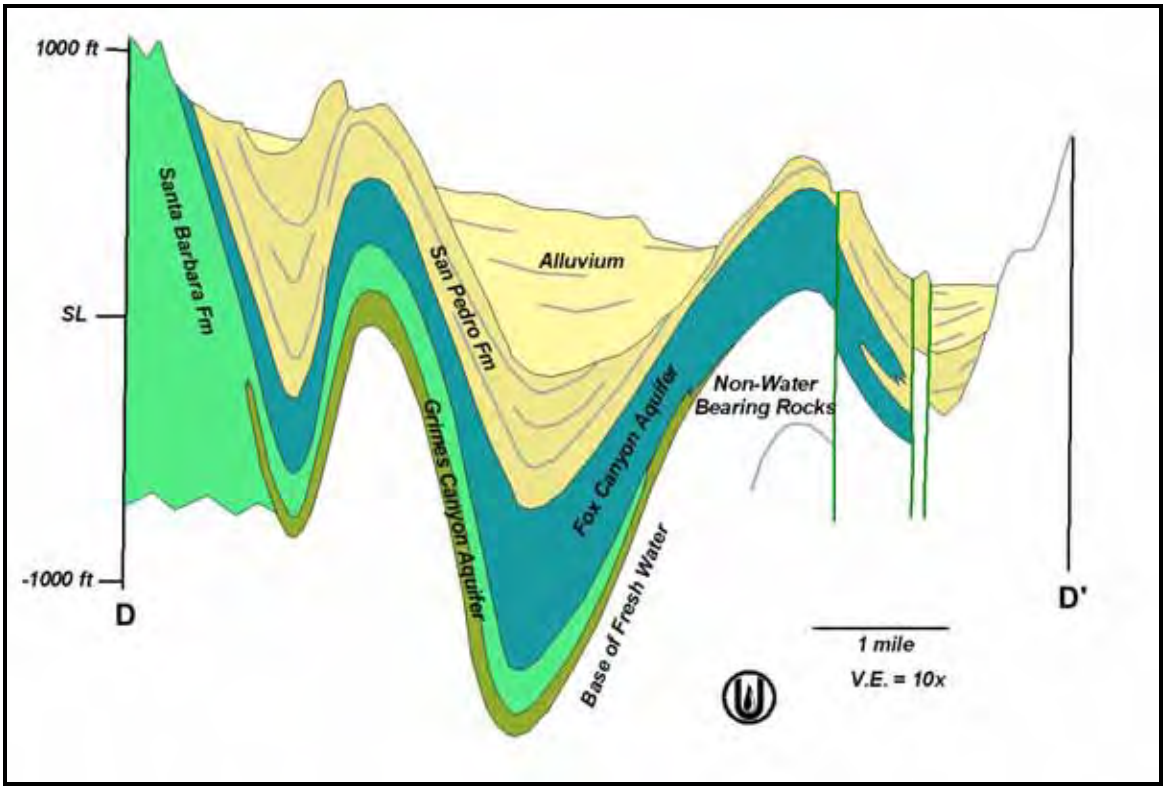


Figure 9. Geologic section D-D'. Simplified from Mukae and Turner (1975). Note ten times vertical exaggeration to accentuate stratigraphic units.

East Las Posas Basin – The East Las Posas basin is separated from the West Las Posas basin by a north-trending unnamed fault running through Somis (CH2MHill, 1993; Hanson, 1998), across which groundwater levels differ by as much as 400 feet (Figure 8). The fault also acts as a barrier to transport of saline waters from the East Las Posas basin to the West Las Posas basin (Bachman, 1999).

The source of recharge to the East Las Posas basin has changed significantly since urban development of the Simi Valley and Moorpark areas over the last 30 years. Prior to this time, recharge was predominantly from rainfall on outcrop areas and from percolation of winter floodwater along the Arroyo Las Posas. Geochemical studies show that groundwater in the central portion of the East Las Posas basin is hundreds to thousands of years old (Izbicki, 1996b), indicating a slow rate of historical recharge along the flanks of the basin. As discussed for the South Las Posas basin, urban development has brought increased discharges of both treated wastewater and shallow groundwater into Arroyo Las Posas, providing a year-round recharge source for the South and East Las Posas basins (CH2MHill, 1993; Bachman, 2002). This increased percolation from the arroyo has created a recharge mound that extends northward into the East Las Posas basin, where groundwater levels have risen by 125 ft to 200 ft during the past 30 years.

Conversely, pumping in the basin has resulted in falling groundwater levels in the eastern portion of the basin, away from the recharge mound. The largest drop in groundwater levels (190 ft) over the period 1973 to 1998 occurred in this region (Bachman, 1999). Groundwater levels have stabilized somewhat across the basin since the late 1990s, at least in part because of the addition of in-lieu and injected recharge by CMWD as part of the Las Posas Basin Aquifer Storage and Recovery (ASR) project.

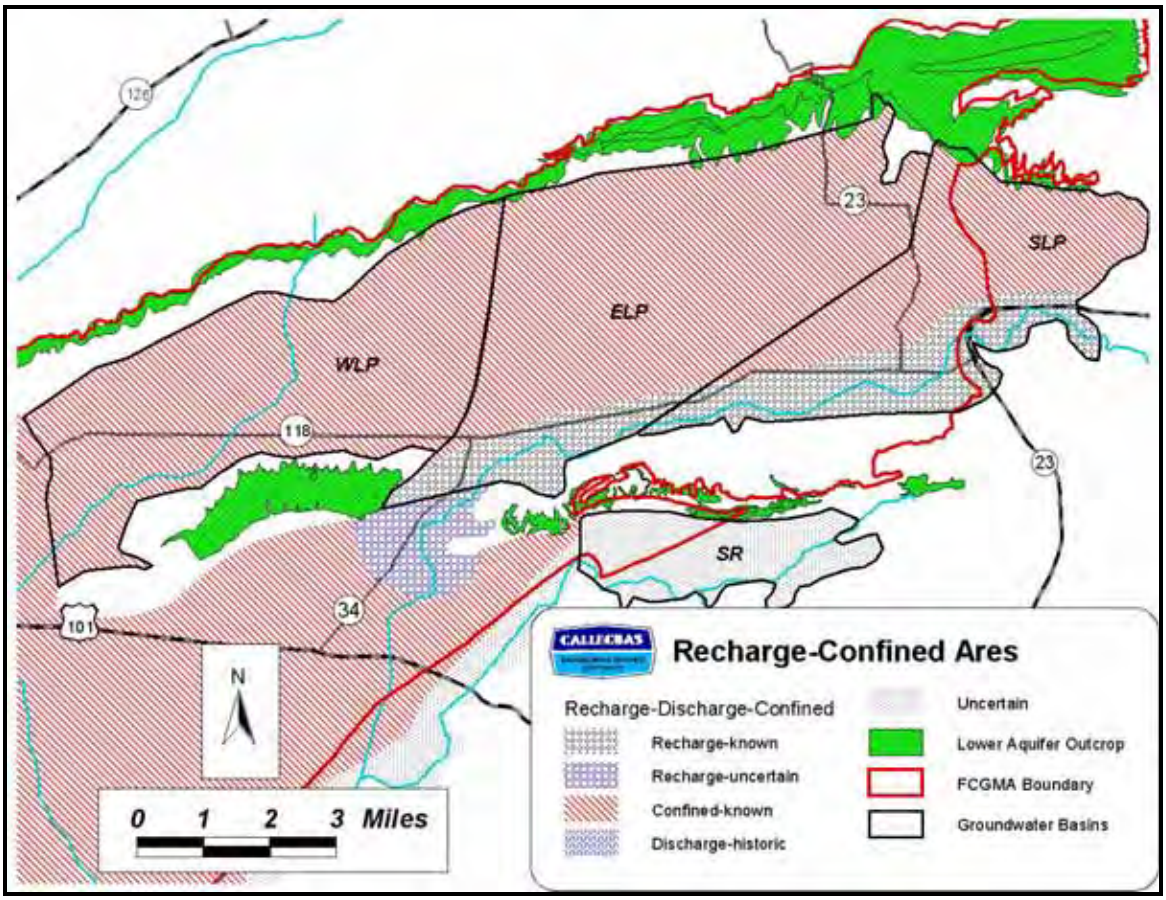


Figure 10. Recharge and discharge areas of Las Posas and Santa Rosa basins, with confined portions of the aquifers indicated. See text for discussion. Basin designations: WLP-West Las Posas, ELP-East Las Posas, SLP-South Las Posas, SR-Santa Rosa.

West Las Posas Basin – The West Las Posas basin (Figure 8) is isolated from the recharge sources of the East and South Las Posas basins by the north-south fault discussed in the previous paragraphs. Instead, the West Las Posas basin is hydrologically connected to the Oxnard Plain basin, with groundwater levels in the western portion of the basin rising and falling with wet and dry climatic cycles of recharge. Groundwater elevation contours are interpreted to extend continuously in the LAS from the Oxnard Plain basin into the West Las Posas basin, suggesting that there is no hydrologic boundary at the western end of the basin. Instead, the western boundary of the basin is defined by surface features – the end of the Las Posas Valley and the beginning of the flat terrain of the Oxnard Plain.

In the eastern portion of the basin, just to the west of the north-trending fault at Somis, a groundwater level trough that was 35 ft below sea level in 1973 had dropped to 150 ft below sea level by 1998 (the trough has since stabilized, with a slight rise in groundwater levels during the last several years). Groundwater elevations slope from their highest point at the western end of the basin to their lowest point at the eastern end of the basin, indicating that recharge water flows from the Oxnard Plain eastward into the basin. There is a flow component from the northern flank of the basin, suggesting that there is also significant mountain-front recharge.

4.0 GROUNDWATER EXTRACTIONS

The FCGMA has collected records of extraction for wells within the Agency for semi-annual periods since 1985. These extraction records are entered into a computer database, and individual wells that reported any pumping between 1985 and 1989 (known as the FCGMA "Base Period") have been assigned Historical Allocations based on those extractions. These extraction records are also used to calculate Conservation Credits and to determine pumping trends within the FCGMA.

Extractions vary from year to year (Figure 11) based largely on the amount (Figure 12) and patterns of rainfall for agricultural uses and the ratio of groundwater to imported water ordered by M&I providers in any year. This year-to-year variation makes it difficult to compare pumping from one year to the next without factoring in these climate and policy variations. However, now that there are historic records available that were gathered over at least a 20-year period, similar climatic years can be compared to determine general trends in pumping. For instance, a comparison of the dry years 1987 and 2002 (the two driest years during the 20-year period, Figure 12) indicates that overall reported pumping declined by about 37,000 acre-feet per year (164,700 to 127,700 AFY) within the Agency. Likewise, comparing average precipitation years 1988 and 2000 (Figure 12) indicates that reported pumping was reduced by 36,800 acre-feet per year (160,500 to 123,700 AFY).

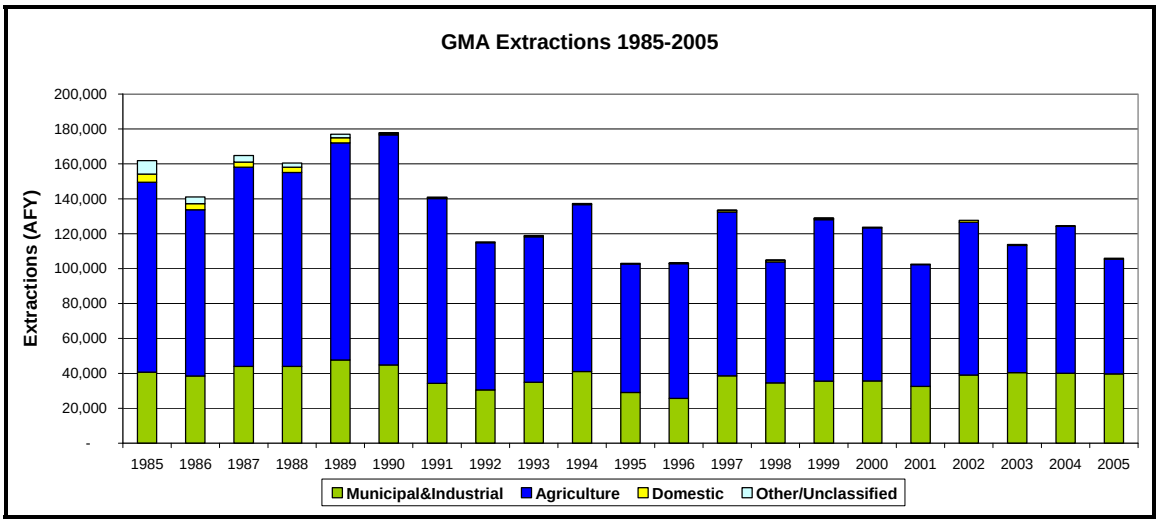


Figure 11. Reported extractions within the FCGMA for years 1985 to 2005.

This apparent decreasing trend in FCGMA pumping occurred in different fashions for agriculture and M&I. Agricultural pumping decreased earliest, following the end of the 1986-1991 drought. This decrease in agricultural pumping has also been documented by UWCD (2002) in a study of agricultural efficiencies within the FCGMA. The increased irrigation efficiency is likely the result of improved irrigation systems such as drip tape and micro sprinklers that were installed within that time frame. A portion of the decrease in agricultural pumping can also be attributed to land conversion to urban uses (see discussion below) and increased yields from the Freeman Diversion and the Conejo Creek project that supplied growers an alternative water source to pumped groundwater.

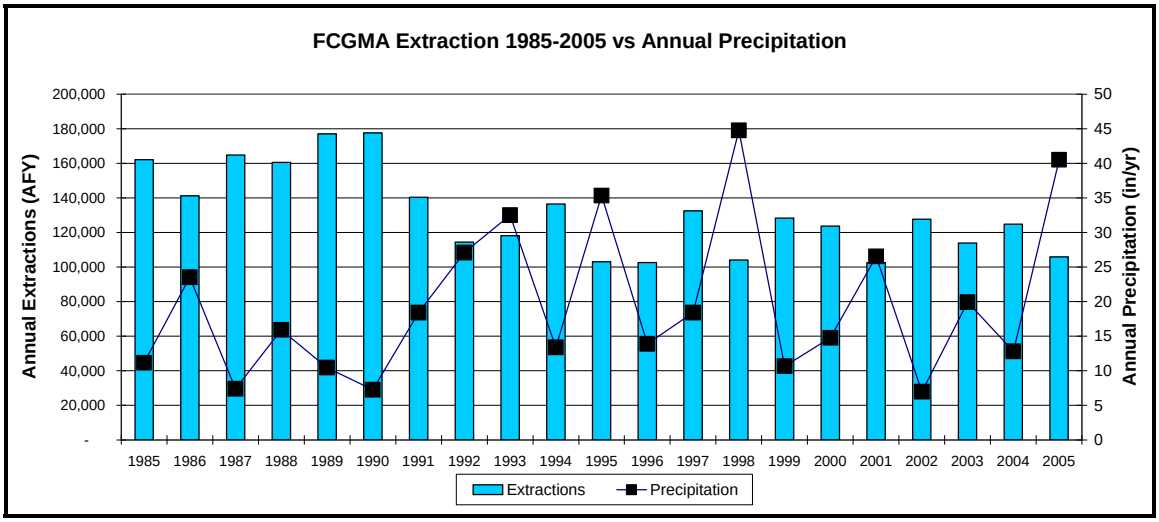


Figure 12. FCGMA extractions plotted against annual precipitation to indicate the general correlation between rainfall and extractions.

Municipal and Industrial (M&I) pumping is somewhat less affected by annual rainfall changes than agricultural irrigation. M&I pumping has been relative flat, with an average of 40,000 AFY pumped during the first decade of FCGMA reported pumping (1985-1994) and an average of 38,300 AFY pumping during the past five years (2001-2005). However, this flat pumping trend occurred as overall urban acreage increased (with an accompanying increase in potential water demand) as agricultural land has converted to urban use. An analysis of changes in land use during the period between aerial photos taken in 1998 and 2002 indicates that about 1,150 acres converted from agriculture to M&I in the Oxnard Plain and Pleasant Valley areas. At the FCGMA conversion rate of two AFY per acre, that represents about 2,300 AFY of new allocation to M&I during this four-year period.

5.0 WATER QUALITY ISSUES

Water quality issues are discussed in two parts: current issues that are evident today and potential future threats that could occur within the basins of the FCGMA if proactive steps are not taken now through management strategies.

5.1 CURRENT WATER QUALITY ISSUES

Seawater intrusion has long been the primary water concern within the FCGMA and was the problem for which the FCGMA was originally formulated to help fix. The intrusion occurs exclusively along the coastline in the Oxnard Plain basin. The U.S. Geological Survey also identified another type of saline intrusion on the Oxnard Plain – salts moving from the surrounding marine clays and older geologic units as pressure in the aquifers is reduced from overpumping. This type of intrusion may also be occurring on a minor scale in the Pleasant Valley basin. Chloride has also become a problem along Arroyo Las Posas, where groundwater from an area in the East and South Las Posas basins must be blended with lower-chloride water to meet irrigation suitability. This problem appears to have migrated downstream, with some of the City of Camarillo's wells now affected.

Chloride is also a problem in the Piru basin near the Los Angeles County line, where high chlorides from discharge of wastewater treatment plants along the Santa Clara River have

degraded the recharge water for the basin. This chloride problem is currently isolated to the Piru basin, although long-term recharge of poorer quality water could eventually move through the groundwater basins along the Santa Clara River and reach the Freeman Diversion.

High nitrate concentrations in groundwater are a localized problem in the Oxnard Plain Forebay and Santa Rosa basins. In and adjacent to the Forebay, nitrates affect drinking water wells of UWCD's Oxnard-Hueneme wellfield, mutual water companies, and the City of Oxnard, particularly during and following dry periods.

5.1.1 Seawater Intrusion

High chloride levels from intrusion of seawater were induced by lowered groundwater levels that formed a distinct pumping trough in the southern Oxnard Plain (Figure 13). In 1989, the U.S. Geological Survey initiated their Regional Aquifer-System Analysis (RASA) study in a cooperative effort with local agencies. As part of this and companion cooperative studies, a series of 14 nested well sites with three or more wells installed at each site, were drilled and completed at specific depths in the Oxnard Plain, Oxnard Plain Forebay, Pleasant Valley, and Las Posas basins (Densmore, 1996). Figure 14 shows the locations of the RASA well sites on the Oxnard Plain.

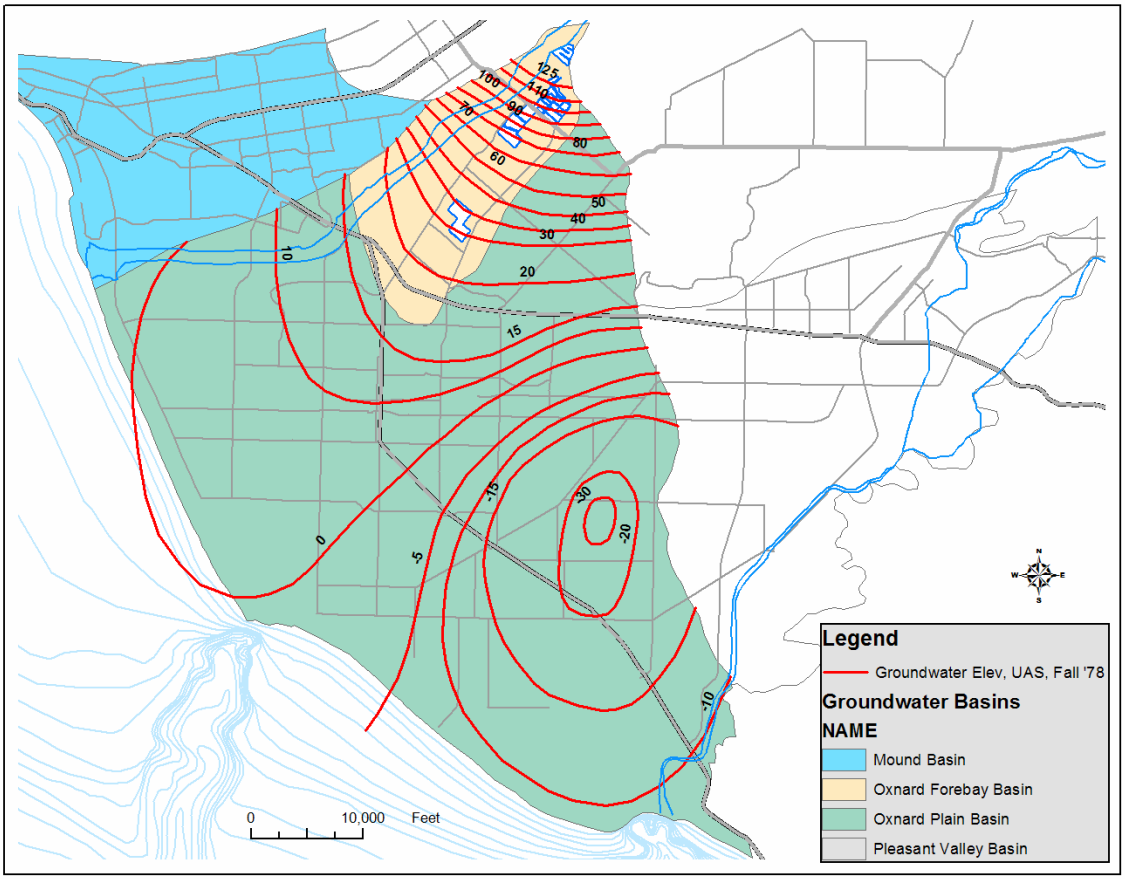


Figure 13. Groundwater elevations in the Upper Aquifer System in Fall 1978, indicating the large pumping trough in the south Oxnard Plain (water levels as much as 30 feet below sea level). This pumping trough, created by overpumping, pulled in seawater from the ocean.

Saline intrusion is recognized in monitoring wells by concentrations of chloride and Total Dissolved Solids (TDS) that are several times higher than the Basin Plan Objectives of 150

mg/L and 1,200 mg/L, respectively. In practice, the leading edge of the intrusion is mapped on the Oxnard Plain as the first occurrence of chloride in excess of 500 mg/L. In some wells that have been intruded, chloride exceeds 10,000 mg/L. The increase in chloride concentration has been rapid in some wells, increasing 1,000s of mg/L in a year or two.

Prior to the RASA study, it was believed an area extending from approximately 3 miles north of Port Hueneme to well SCE (near Highway 1) and south to Point Mugu was intruded by seawater. The installation of a dedicated monitoring network and detailed chemical analysis of water samples from the new wells and other wells yielded new interpretations on the extent of seawater intrusion on the Oxnard Plain. It is now known some areas of the southern Oxnard Plain are not intruded by seawater, but that high chloride readings from older production wells were the result of perched water leaking down failed well casings and contaminating the aquifer (Izbicki, 1992; Izbicki et al., 1995; Izbicki, 1996 a,b). As a partial result of these findings, many of the older wells on the Oxnard Plain have since been destroyed via a cooperative FCGMA-initiated program using Federal 319(h) grant money and matching funds contributed by the City of Oxnard, UWCD, FCGMA, and the County of Ventura. Figure 14 delineates the approximate extent of high-chloride water in the Oxnard aquifer (Upper Aquifer System). Figure 15 delineates the approximate extent of high-chloride water in the Lower Aquifer System.

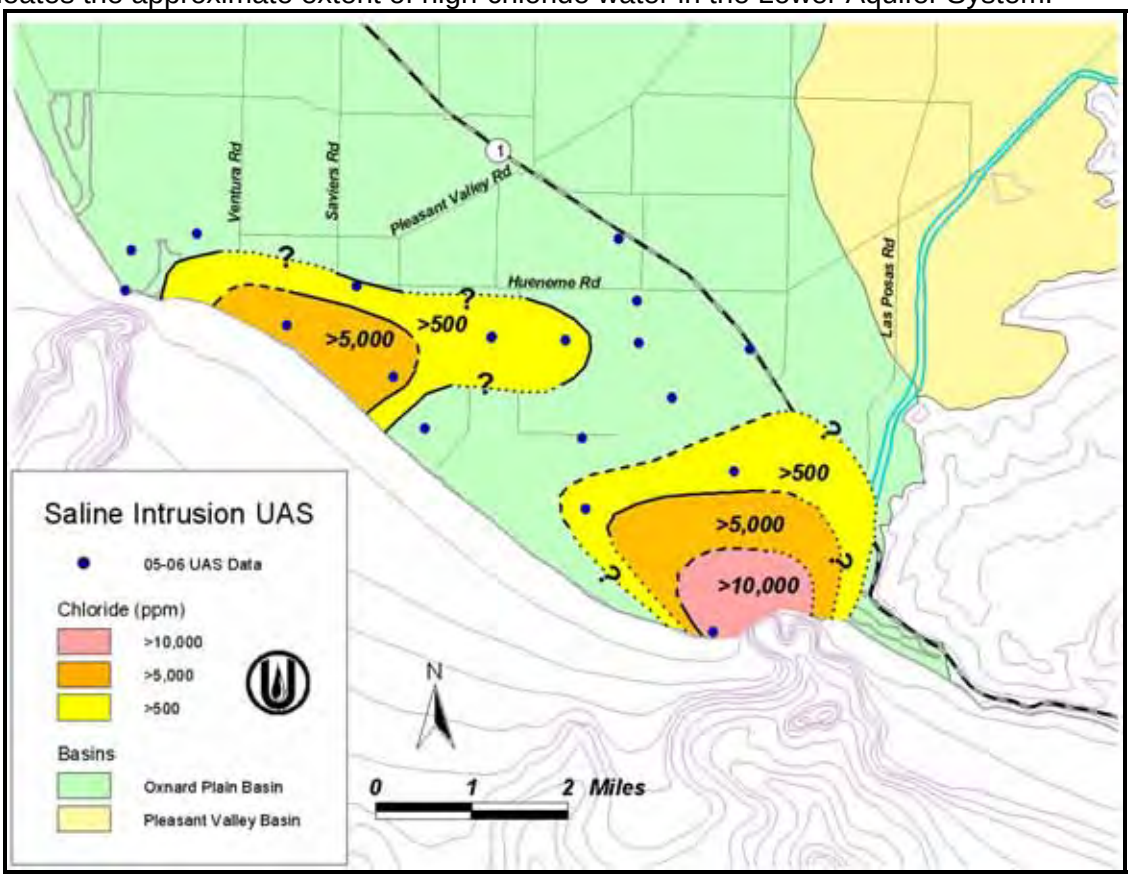


Figure 14. Areas of saline intrusion in the Upper Aquifer System of the Oxnard Plain in 2005-06. Contours of chloride concentrations indicate the maximum extent of the UAS saline intrusion – individual aquifers within the UAS may be less intruded. Contour lines are dashed where inferred and queried where uncertain. Bathymetric contour lines indicate the offshore submarine canyons where the aquifers are eroded along the canyon walls and exposed to seawater.

In addition to drilling and installing the nested monitoring wells, the USGS conducted geophysical surveys to determine the general extent of the high-saline areas (Stamos et al., 1992; Zohdy et al., 1993). This work indicated high-saline areas consisted of two distinct lobes,

with relatively fresh water separating the lobes (Izbicki, 1996a). The lobes identified by the USGS form the basis of the areas of high chloride concentration shown on UWCD maps.

Additional down-hole conductivity surveys by the USGS indicate the edges of the lobes are relatively distinct, with the first saline intrusion occurring in thin individual beds of permeable sand and gravel. As intrusion continues, more individual beds or geologic layers are impacted, resulting in increasing chloride levels within the affected aquifer. Thus, the interpretation of high-chloride areas shown on the maps combine measured concentrations from the monitoring wells, geophysical measurements, and study results about the nature of the intrusion front.

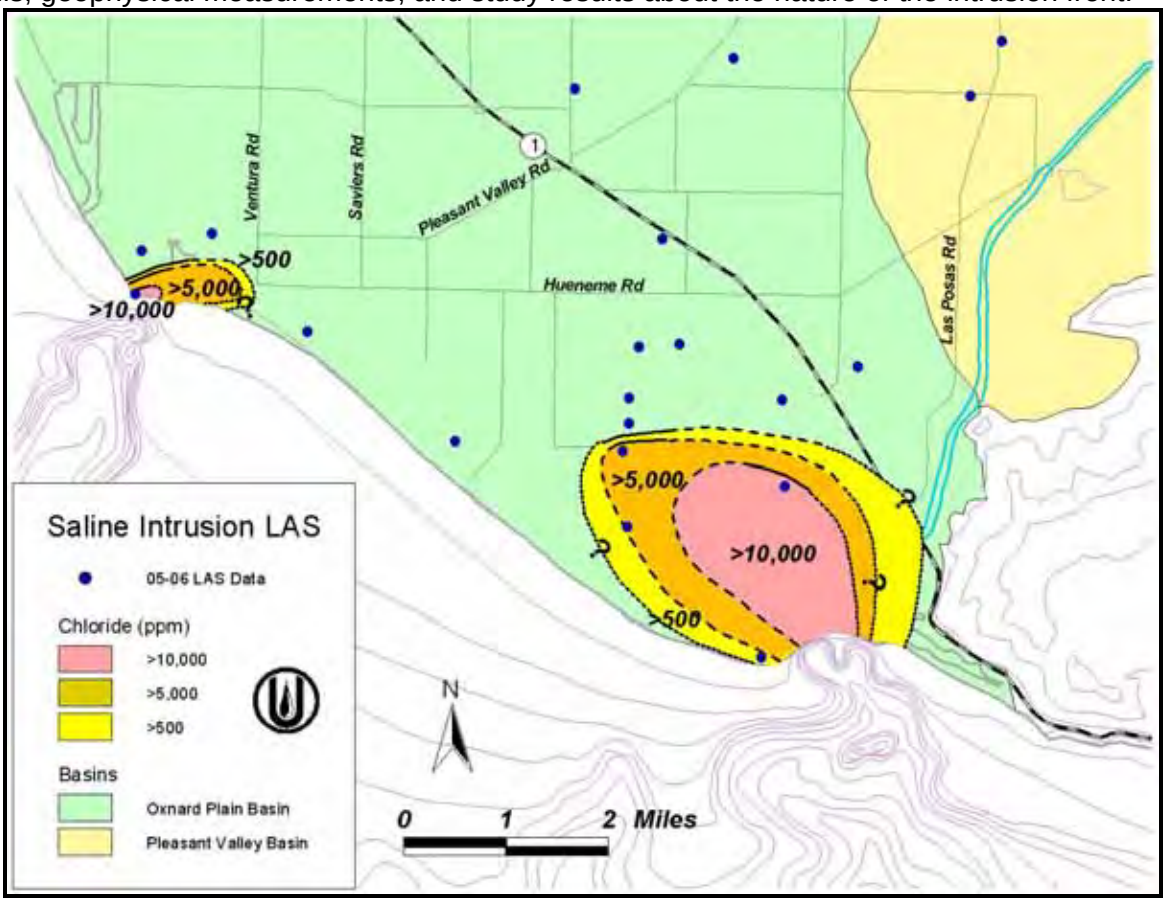


Figure 15. Areas of saline intrusion in the Lower Aquifer System of the Oxnard Plain in 2005-06. Contours of chloride concentrations indicate the maximum extent of the LAS saline intrusion – individual aquifers within the LAS may be less intruded. Contour lines are dashed where inferred and queried where uncertain. Bathymetric contour lines indicate the offshore submarine canyons where the aquifers are eroded along the canyon walls and exposed to seawater.

In addition to monitoring wells and geophysical measurements, isotope studies of groundwater samples from the nested wells indicate that the cause of the elevated chloride levels varies in the Oxnard Plain basin (Izbicki, 1991, 1992). Four major types of chloride degradation were documented:

Lateral Seawater Intrusion - the inland movement of seawater adjacent to the Hueneme and Mugu submarine canyons.

Cross Contamination - the introduction of poor-quality water into the fresh water supply via existing well bores improperly constructed or improperly destroyed, or via corroded casings caused by poor-quality water in the Semi-Perched zone.

Salt-Laden Marine Clays - the dewatering of marine clays, interbedded within the sand and gravel-rich aquifers and containing salts from their marine deposition, yields high concentrations of chloride-enriched water. This dewatering is the result of decreased pressure in the aquifers, caused by regional pumping stresses (excessive groundwater withdrawals).

Lateral Movement of Brines from Tertiary-Age Geological Formations - the lateral movement of saline water from older geologic formations caused by uplift along faults. An example is where older Tertiary rocks are in contact with younger aquifers across a buried fault face near Pt. Mugu.

5.1.2 Saline Intrusion from Surrounding Sediments

A significant portion of the salinity in the aquifers of the Oxnard Plain basin is coming from salts (primarily chloride) pulled from the surrounding sediments, as discussed in the previous section. When this saline intrusion occurs near the coastline, it largely resembles seawater intrusion in concentration and movement in the aquifer, and mitigation measures are similar to those for seawater intrusion (i.e., raising groundwater levels). In more inland areas such as the Pleasant Valley basin, chloride concentrations are generally less, with only a few wells showing any increase in chloride. It is too early to know whether chloride concentrations in the Pleasant Valley basin will escalate to a problem affecting local pumpers.

5.1.3 High Salinity Associated with High Groundwater Levels

Increased salt concentrations (chloride, sulfate, sodium) in aquifers underlying the Arroyo Las Posas in the East Las Posas, South Las Posas, and northern Pleasant Valley basins correspond in time with rising groundwater levels along the arroyo. This rise in groundwater levels has been created by increased recharge as natural streamflow was augmented by the addition of the upstream discharge of treated wastewater and aquifer dewatering projects along the arroyo. The shallow groundwater levels, which are higher than any historic levels, apparently leach salts from the previously unsaturated portions of the aquifer. The problem caused by high groundwater levels in the shallow aquifer has migrated down Arroyo Las Posas across the Las Posas basin and into the northern part of the Pleasant Valley basin, where water levels have risen and salts have increased. Solutions to this salinity problem will likely be based on removing and treating the high-salinity water.

5.1.4 Nitrate in Groundwater

High nitrates in groundwater primarily affect the Oxnard Plain Forebay and Santa Rosa basins. Nitrate is a primary drinking water standard (45 mg/L as NO3), so high nitrate concentrations directly affect the potable water supply. Nitrate is largely introduced into groundwater by man's activities in overlying recharge areas where the nitrate travels directly into the aquifers. Nitrate concentrations typically are a balance between nitrate input and the amount of recharge water available for dilution. Nitrate concentrations commonly increase during dry periods when there is less recharge water for dilution. In groundwater away from recharge areas, nitrates have generally been diluted and are at concentrations well below drinking water standards. An exception to this occurred in the 1990s, when nitrate occurred in City of Oxnard wells in the Oxnard Plain basin, just outside of the Forebay basin. This nitrate may have migrated downward from the Semi-Perched zone through improperly abandoned private wells.

The primary sources of nitrate are septic systems (especially if they are poorly maintained or being used above design capacity) and agricultural fertilizer. These are both being addressed.

As discussed below, septic systems have been prohibited in the Oxnard Plain Forebay basin. In addition, agricultural nitrate, contributed largely from fertilizers, will be monitored in 2006 as part of the Agricultural Irrigated Lands Conditional Waiver program adopted by the Los Angeles Regional Water Quality Control Board. If nitrates are shown to be entering groundwater from agricultural fertilizers through the monitoring program, the waiver requires the implementation of Best Management Practices.

5.2 WATER QUALITY ISSUES BY BASIN

5.2.1 Oxnard Plain Forebay Basin

The primary water quality concern in the Oxnard Plain Forebay basin is nitrate concentrations above the Department of Health Services' Maximum Contaminant Level. Nitrate concentrations in the Upper Aquifer System spike in the Forebay basin during dry periods when there is reduced recharge to the basin. Nitrate concentrations periodically exceed the primary drinking water standard of 45 mg/L (as NO3) in individual wells (Figure 16). Because much of the pumping in the Forebay delivers potable water through the Oxnard-Hueneme (O-H) pipeline (a potable water delivery line that provides groundwater to the cities of Oxnard and Port Hueneme), the drinking water standard is of prime importance. The O-H system has been able to deliver potable water by blending lower-nitrate water and by temporarily shutting down impacted high-nitrate wells.

These nitrates have been attributed to both agricultural activities (fertilizer application) and adjacent septic systems (leach-line effluent discharges). The nitrate problem will continue to be a water quality issue for drinking water wells as long as the sources of nitrate continue to contribute this mineral salt into the groundwater resources. As a result of the high nitrate concentrations, the Regional Water Quality Control Board enacted in 1999 a prohibition on septic systems in portions of the Forebay, with orders that most such disposal systems be eliminated from the Oxnard Plain Forebay basin before 2008. Since that time, disconnecting the nearby El Rio septic tanks and connecting to a sanitary sewer system has been a high priority water quality improvement project for the County.

5.2.2 Oxnard Plain Basin

The significant water quality issue in the Oxnard Plain basin is saline intrusion from both seawater and from surrounding marine sediments. Chloride degradation is directly related to groundwater levels in the basin. The water balance of the Oxnard Plain and the offshore component of the aquifer units is a dynamic balance between groundwater recharge, groundwater extraction, and change in aquifer storage. High groundwater levels in the recharge zone in the Oxnard Plain Forebay basin exert a positive pressure on the confined aquifers of the Oxnard Plain, and water flows from the recharge areas toward the coast (Figure 17). Whereas the pressure exerted by high water levels in the Forebay propagates rapidly through the aquifers, the actual movement of the water itself is slow, at approximately 3 feet per day or less in the Forebay (Izbicki et al, 1992). The pressure (piezometric) surface of the confined aquifer is diminished by the extraction of water from the system. If pressure heads at the coast fall below sea level, the lateral intrusion of seawater will occur. The dewatering of marine clays can occur if heads in the surrounding sediments remain below their historic levels for prolonged periods.

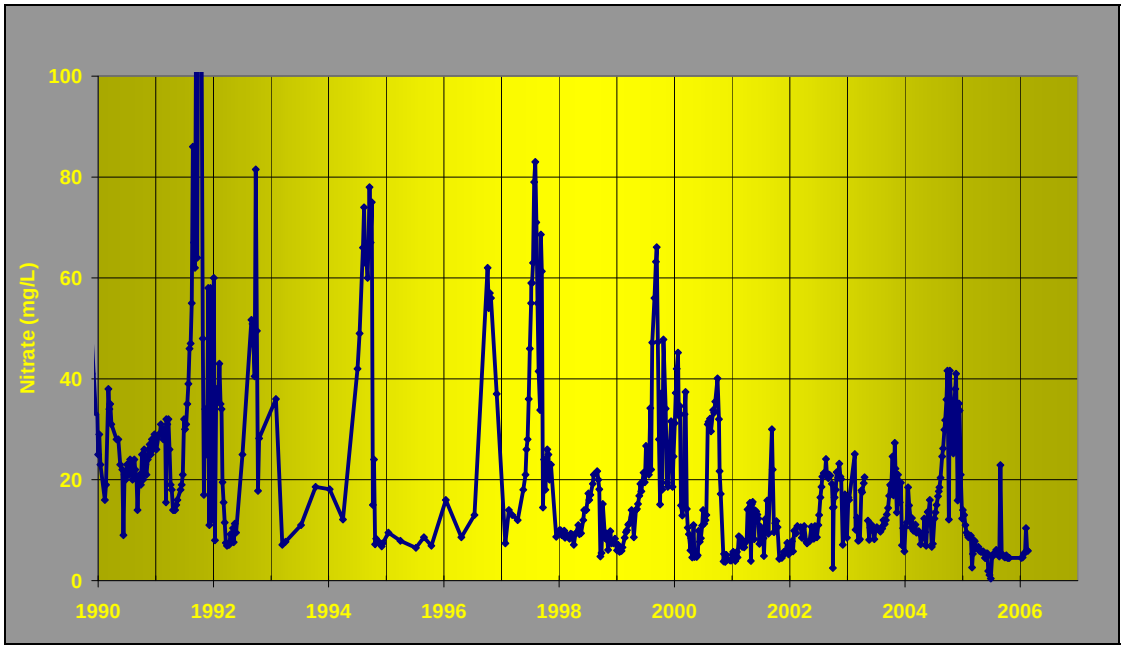


Figure 16. Nitrate concentrations (as NO3) in Oxnard-Hueneme El Rio well #5. Note that nitrate increases during dry portion of year, when nitrate input from overlying land uses is less diluted by low-nitrate recharge water. When nitrate levels are high, this well is either not used or the produced groundwater is diluted with low-nitrate water from other wells in the system.

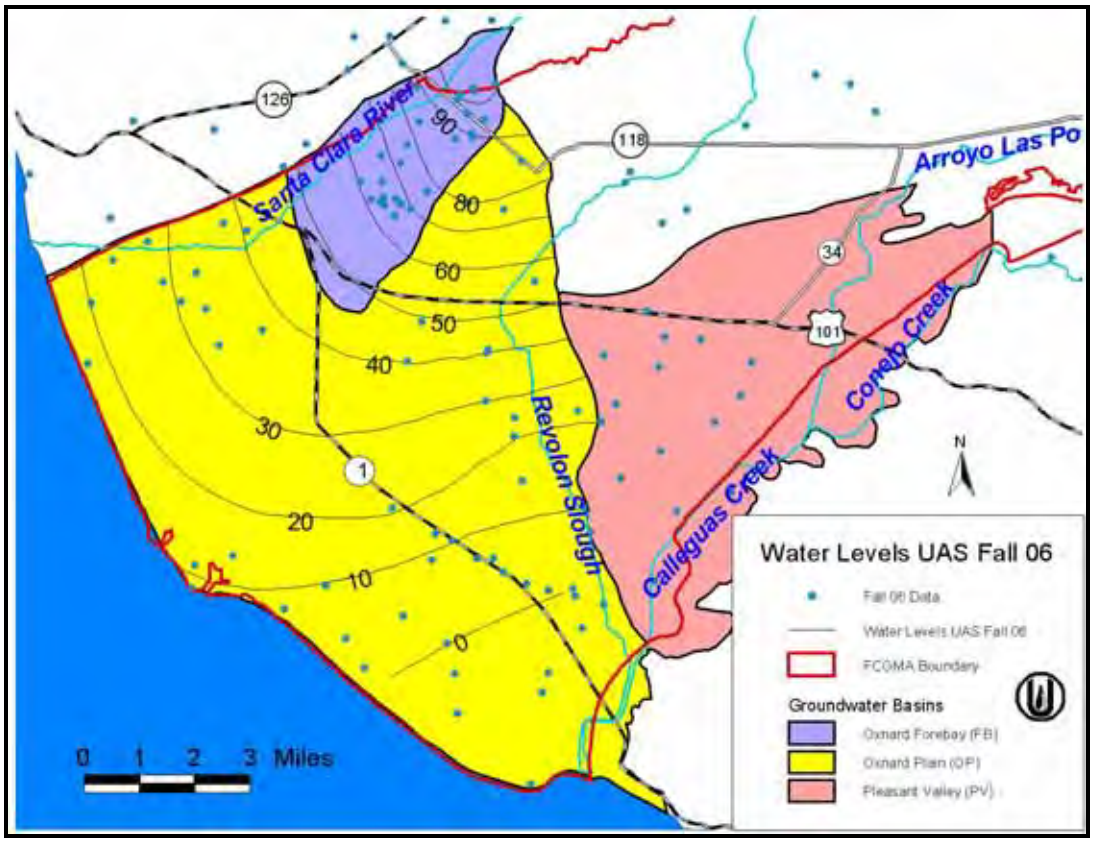


Figure 17. Groundwater elevation contours in the Upper Aquifer System, Fall 2006. Note that southeastern portion of Oxnard Plain remains below sea level (line labeled "zero") and is susceptible to continued seawater intrusion.

Chloride levels in coastal monitoring wells in the Upper Aquifer System show a direct relationship to groundwater levels – with groundwater levels below sea level, chloride levels increased in the early 1990s (e.g., well A1 in Figure 18). However, as the Freeman Diversion on the Santa Clara River began operation in 1991 and a series of wet years followed, the amount of recharge to the former pumping trough area and to the Port Hueneme area increased significantly. This has resulted in a rise in groundwater elevations on the Oxnard Plain and drastic reduction in seawater in some coastal monitoring wells (e.g., well A1 in Figure 18). In fact, the significantly intruded well A1 has returned to its pre-intrusion water quality levels and is currently (2006) within drinking water standards. This may be the first documented instance of such a reversal of seawater intrusion in a coastal basin.

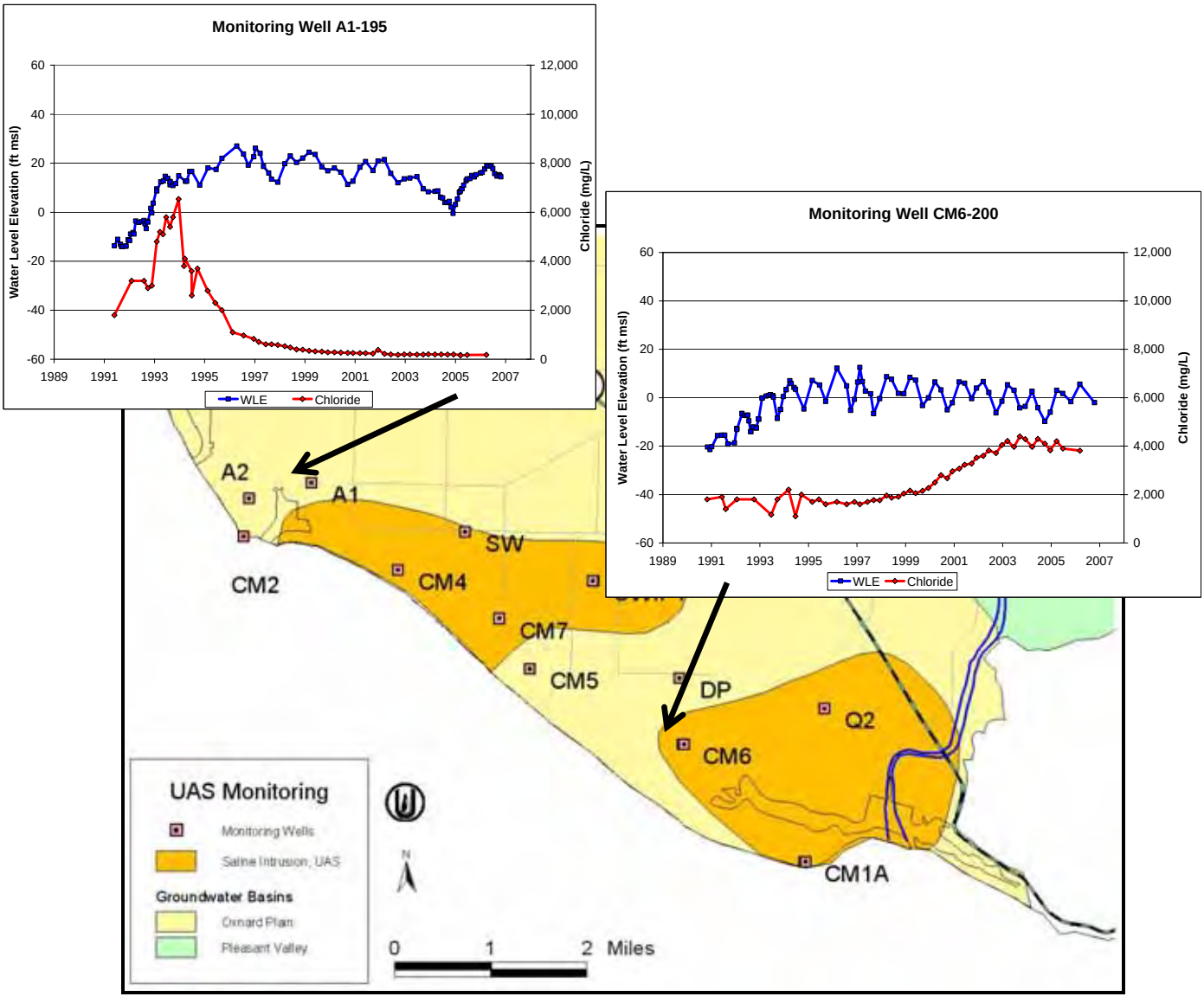


Figure 18. Chloride levels in two Upper Aquifer System coastal monitoring wells. Note that chloride levels have improved to drinking water quality in the A1 well (Port Hueneme lobe), whereas chloride levels continue to increase in the Point Mugu lobe. Uncertainties in exact configuration of saline lobes are indicated in Figure 14.

Despite some encouraging gains, however, the Upper Aquifer System is not completely restored. Although high recharge rates related to the increased flows from the Freeman Diversion have improved water levels and water quality south to Port Hueneme and the higher water levels appear to have eliminated the pumping trough, groundwater levels are still at or below sea level (Figure 17) and water quality continues to degrade in the southern portion of the Oxnard Plain near Point Mugu (e.g., well CM6 in Figure 18). It is likely that the pumping trough situation is similar to the one discussed next for the Lower Aquifer System – namely, that this portion of the Upper Aquifer System may be too far from the recharge areas for direct recharge to be effective, and must rely on artificial or in-lieu (surface water delivered and used in-lieu of pumping groundwater) recharge methods to transport replacement water from the Oxnard Plain Forebay basin or other sources of supply. Groundwater levels in the Lower Aquifer System in the south and southeast Oxnard Plain and central and southern portions of the Pleasant Valley areas have been consistently below sea level since at least the early 1950s (Mann, 1959)(Figure 19). The strategy to switch pumping from the Upper Aquifer to the Lower Aquifer has apparently been at least a portion of the cause for the low water levels and high chlorides that were encountered when the RASA monitoring wells were completed at LAS depths. These high chloride levels occur in several wells at the position of the two Upper Aquifer System seawater lobes (Figure 20).

U.S. Geological Survey studies indicated that the chloride in the LAS occurred not just from seawater intrusion, but also from slow dewatering of the surrounding volcanics and older sediments, as well as chloride-rich marine clays that serve as the aquitard between the Upper and Lower aquifer zones. After the U.S. Geological Survey findings became known and there was the realization the shift in pumping was actually mining LAS groundwater, the County of Ventura took action to change the County Well Ordinance (May 1999) so that only replacement wells or special situations would be allowed to draw water from the LAS; new wells would have to be drilled in the UAS.

The decline in Lower Aquifer System water levels from the late 1980s into the 2000s exacerbated a pumping trough extending from the coastline northeastward to the city of Camarillo (Figure 19). This trough is typically well below sea level, with the deepest portion as much as 180 feet below sea level during the drought of the late 1980s and early 1990s. Despite above-average rainfall in many of the preceding ten years, this pumping trough was still as much as 100 feet below sea level in the fall of 2006 (Figure 19).

Although FCGMA policies and new UWCD recharge facilities built over the last 20 years have significantly improved conditions in the Upper Aquifer System, the Lower Aquifer System continues to experience intrusion by saline waters. This saline intrusion comes both from seawater entering the aquifers along the coastline and from saline waters intruded from surrounding sediments. Any solution to this saline intrusion must include raising water levels in the Lower Aquifer System while concurrently keeping water levels in the Upper Aquifer System at their current elevations. One of the biggest groundwater challenges is to provide either additional recharge or an alternative source of water to the south Oxnard Plain and Pleasant Valley to prevent further water quality degradation in the Lower Aquifer System.

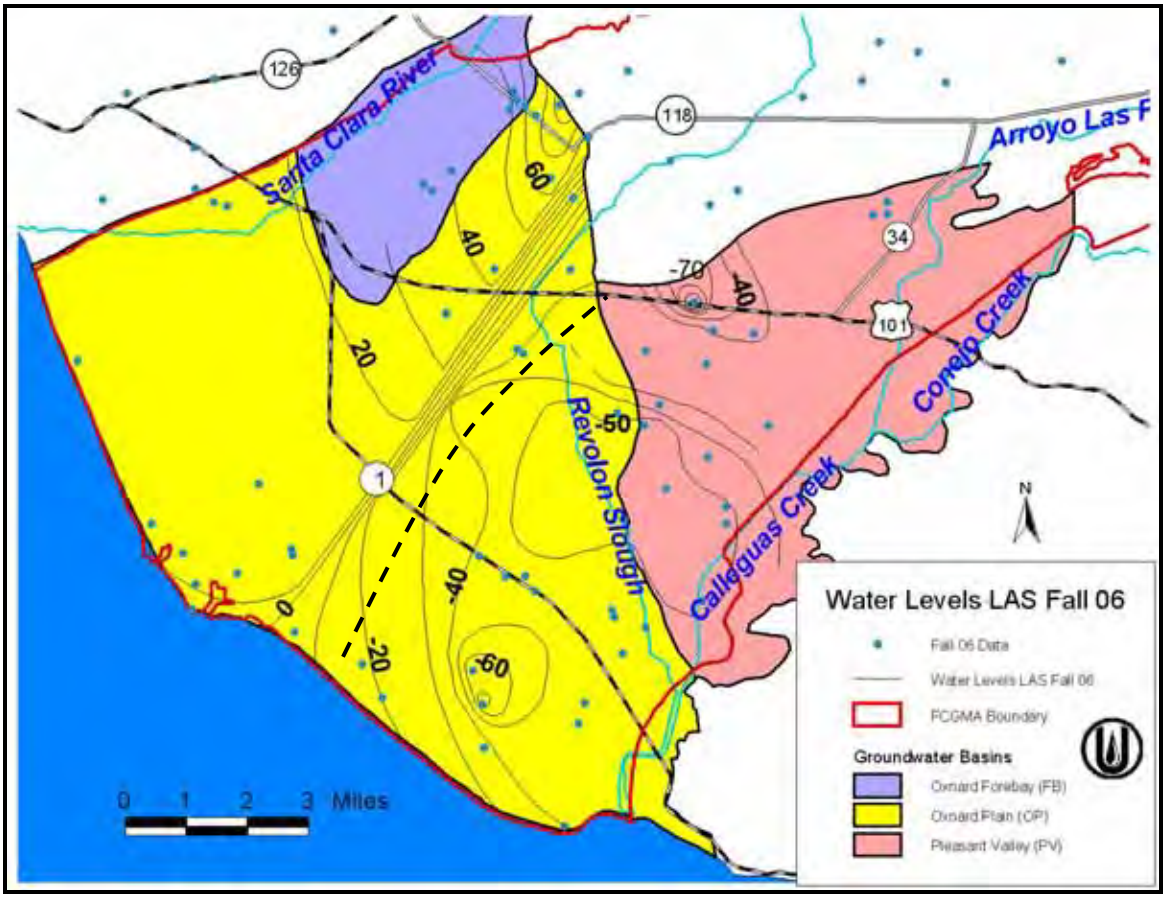


Figure 19. Groundwater elevation contours in the Lower Aquifer System, Fall 2006. Note the distinct series of troughs that extend from the ocean in the south Oxnard Plain northeastward toward Camarillo. These troughs are entirely below sea level. The dashed line indicates the approximate trend of the steep groundwater flow gradients that separate the recharge area in the Forebay from the south Oxnard Plain and Pleasant Valley pumping trough.

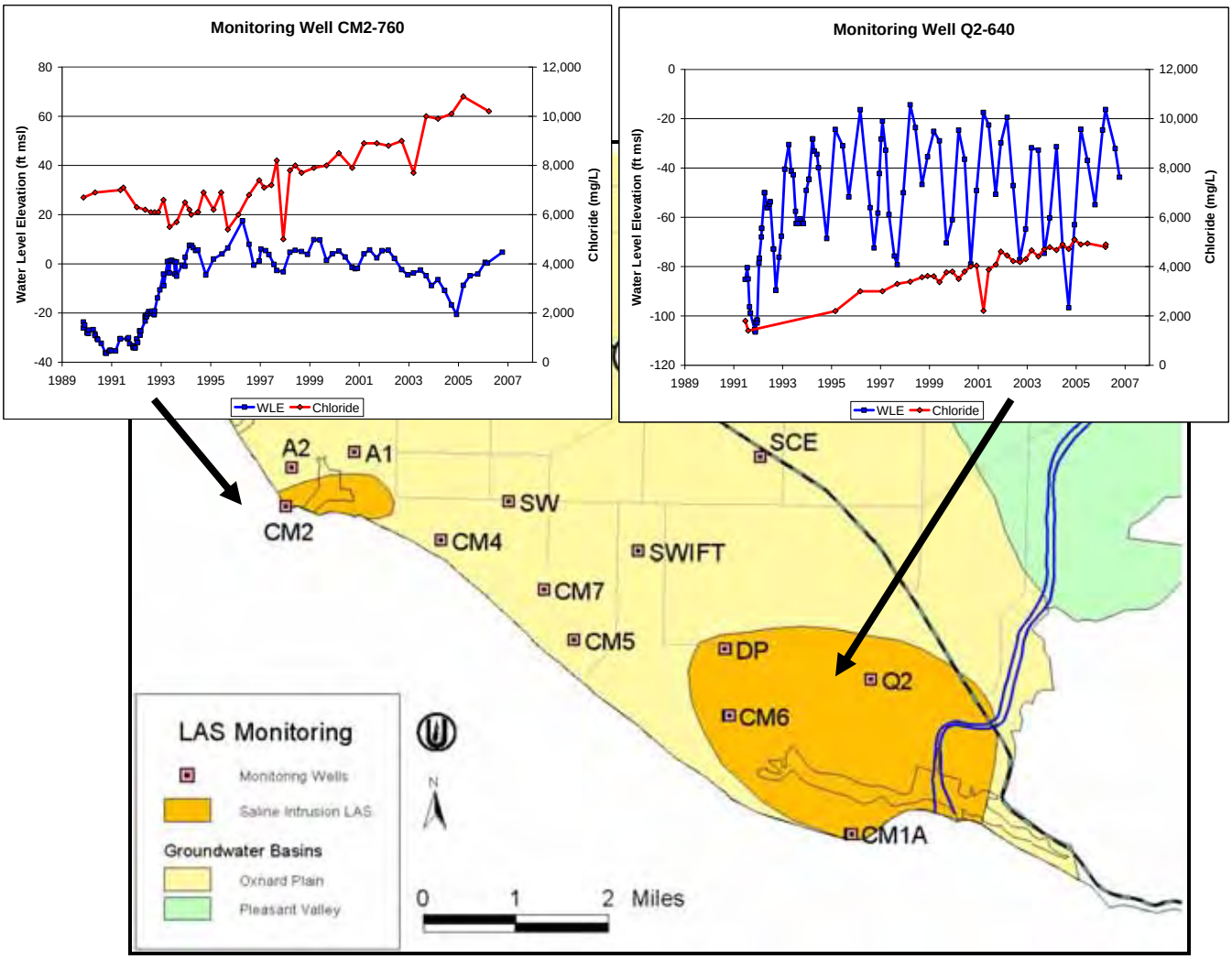


Figure 20. Chloride levels in two Lower Aquifer System coastal monitoring wells. Chloride levels continue to rise in the Point Mugu lobe, requiring new monitoring wells to be drilled inland of current wells to determine the extent of landward movement of high-chloride groundwater. Uncertainties in exact configuration of saline lobes are indicated in Figure 15.

5.2.3 Pleasant Valley Basin

Saline intrusion from surrounding sediments and salinity associated with high groundwater levels are the primary water quality concern in the Pleasant Valley basin. The potential for saline intrusion exists in the depressed groundwater elevations in the Lower Aquifer System of the Pleasant Valley basin (see previous section for discussion of these depressed groundwater levels). The area of depressed groundwater elevations extends from the City of Camarillo to the ocean (Figure 19). Chloride levels within the Pleasant Valley basin are generally less than 150 mg/L, but several wells have shown an increase in chloride. City of Camarillo wells near the Camarillo airport have been affected by the rising chlorides, with one well taken out of service. Increasing chlorides in other wells in the Pleasant Valley basin have recently been shown to have the geochemical signature of “oil-field production water” that underlies the fresh-water bearing aquifers in the basin (Izbicki et al., 2005). This poor-quality water likely was pulled up

along fault zones or other conduits towards the lower pressures of the LAS aquifer that were created by overpumping of the basin.

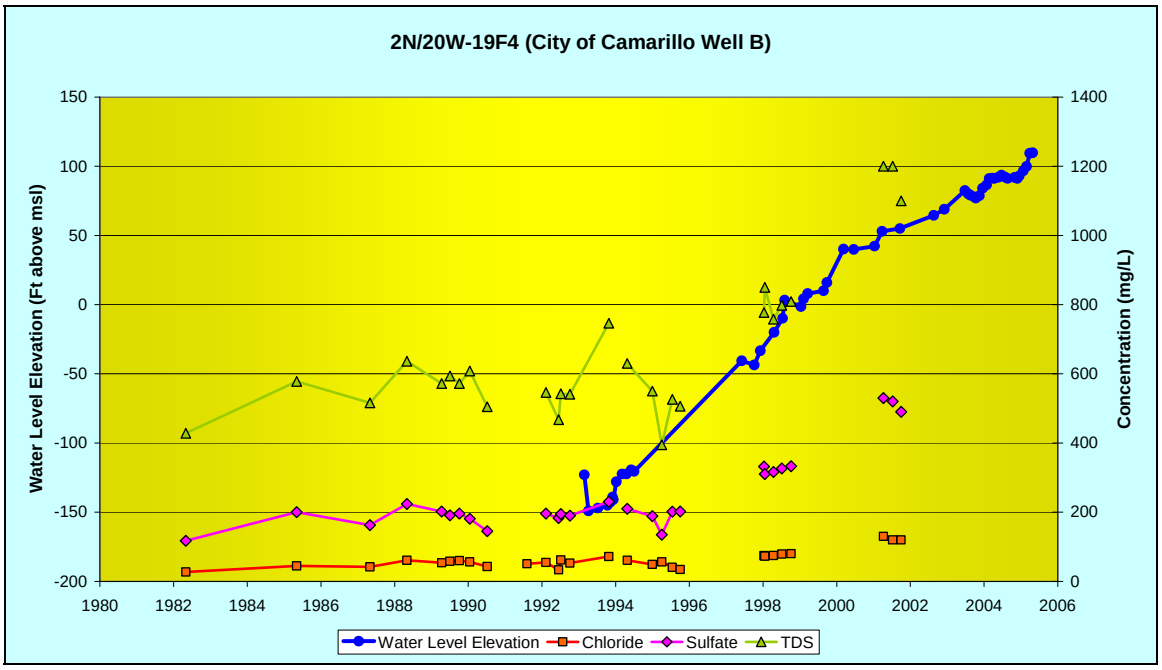


Figure 21. Salts increasing with groundwater elevations, northern Pleasant Valley basin.

Where Arroyo Las Posas crosses into the Pleasant Valley basin in the northern area of the City of Camarillo, the increased flows in the arroyo have raised groundwater levels in the area to historic highs (Figure 21). Coincident with this, water quality has degraded, especially for the constituents sulfate, chloride (Figure 21), iron, and manganese. As in the South Las Posas basin, this higher-salinity water will need to be treated for potable or irrigation use. The City of Camarillo has evaluated the feasibility of treating this poor-quality water, while reducing pumping in the areas of depressed groundwater levels (discussed in section 9.3 *Development of Brackish Groundwater, Pleasant Valley Basin*).

5.2.4 Santa Rosa Basin

The Santa Rosa basin has had long periods where nitrates in some areas were well above drinking water standards (as high as 200 mg/L). Chloride concentrations in the basin are generally between 100 and 150 mg/L, although they have spike locally above 200 mg/L. High chloride concentrations can affect crop production.

5.2.5 West Las Posas Basin

The water quality of the West Las Posas basin currently meets standards for irrigation and drinking water use. Within the pumping depression in the far eastern portion of the basin, samples from two wells have had increased chloride concentrations since 2004. It is not clear if this is the beginning of a trend or if these chlorides were transported into the basin from the shallow aquifer that is generally located along Arroyo Las Posas in the East Las Posas basin (the wells themselves are not along the arroyo).

5.2.6 East Las Posas Basin

Increasing concentrations of salts (chloride, sulfate, sodium) in the portion of the basin along the Arroyo Las Posas continue to be a problem in the East Las Posas basin. Chloride concentrations in the shallow aquifer beneath the arroyo can reach 360 mg/L, whereas chloride concentrations in the surface waters in the arroyo are in the range of 120-180 mg/L (Bachman, 2002). These increased chloride concentrations in the shallow aquifer are associated with historically-high groundwater levels (see discussion in section 5.1.3 *High Salinity Associated with High Groundwater Levels*) that apparently leach salts from previously-unsaturated sediments in the shallow aquifer along the arroyo. The groundwater that contains these chloride-rich salts recharges the Lower Aquifer System by moving downward from the shallow aquifer into the LAS, then northward into the basin. This recharge has formed a chloride-rich recharge mound beneath the Arroyo Las Posas (Figure 22) and northward into the main portion of the East Las Posas basin (Bachman, 2002). Individual wells along the south flank of the basin show a progression of filling of the shallow aquifer, with a coincident increase in chloride concentration (Figure 23). The following section on the South Las Posas basin discusses the age progression of this filling.

5.2.7 South Las Posas Basin

Water quality in the South Las Posas basin is dominated by the movement of salts discussed in the previous section. The filling of the shallow aquifer of the South Las Posas basin progressed from the upstream to the downstream portions of the basin (
Figure 24). With continuing dissolution of salts in the previously-unsaturated sediments, water quality could improve as the salts are expended. Two wells completed in the shallow aquifer beneath the arroyo that have had elevated salts for 20 years have shown a lessening of salinity in the past two years. It is not yet clear if these wells may be a precursor of further salt reduction as salts in the sediments are dissolved and the shallow aquifer begins to reflect the chemistry of surface water in the arroyo (which is higher in chlorides than pre-development conditions, but lower than the groundwater with dissolved salt).

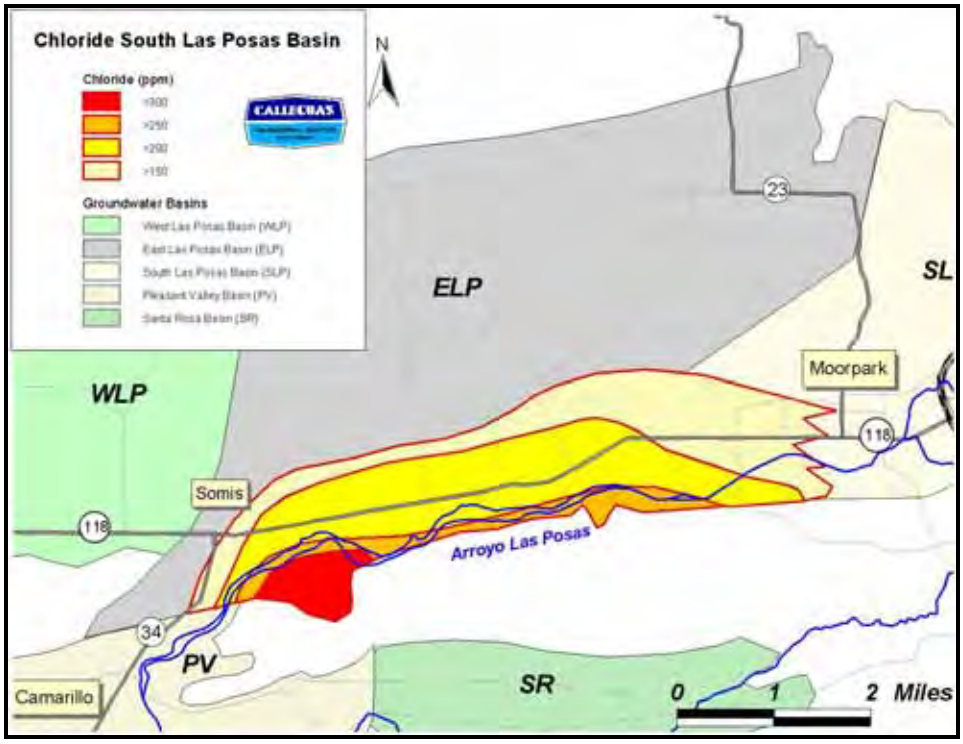


Figure 22. Chloride concentrations (2005-06) in aquifers beneath the Arroyo Las Posas in the East and South Las Posas basins. These concentrations have increased during the last two decades as the shallow aquifer beneath the arroyo has filled to its spill point, caused by increased flow in the arroyo from discharges from dewatering wells and wastewater treatment plants. (Bachman, 2002).

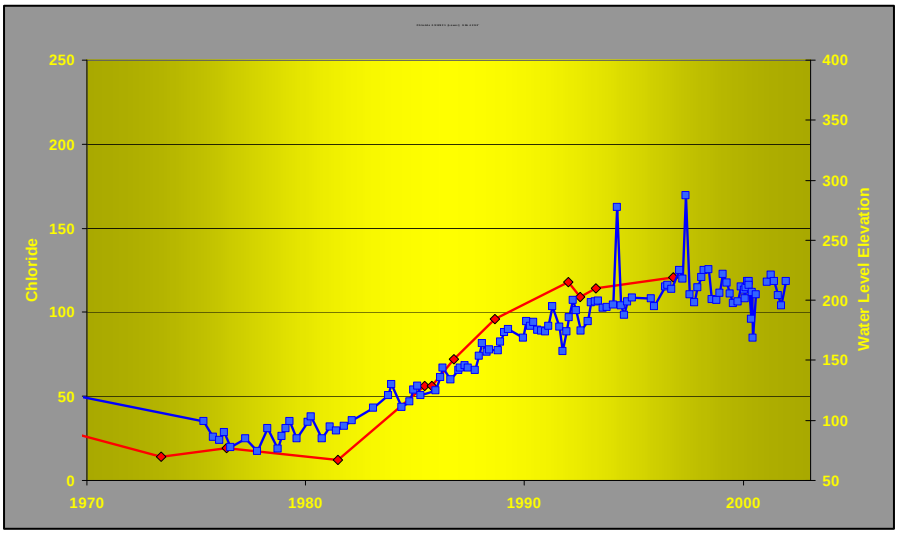


Figure 23. Coincidence of groundwater level rise (blue line with squares) and chloride concentrations (red line with diamonds) in a well in the shallow aquifer along Arroyo Las Posas (Bachman, 2002).

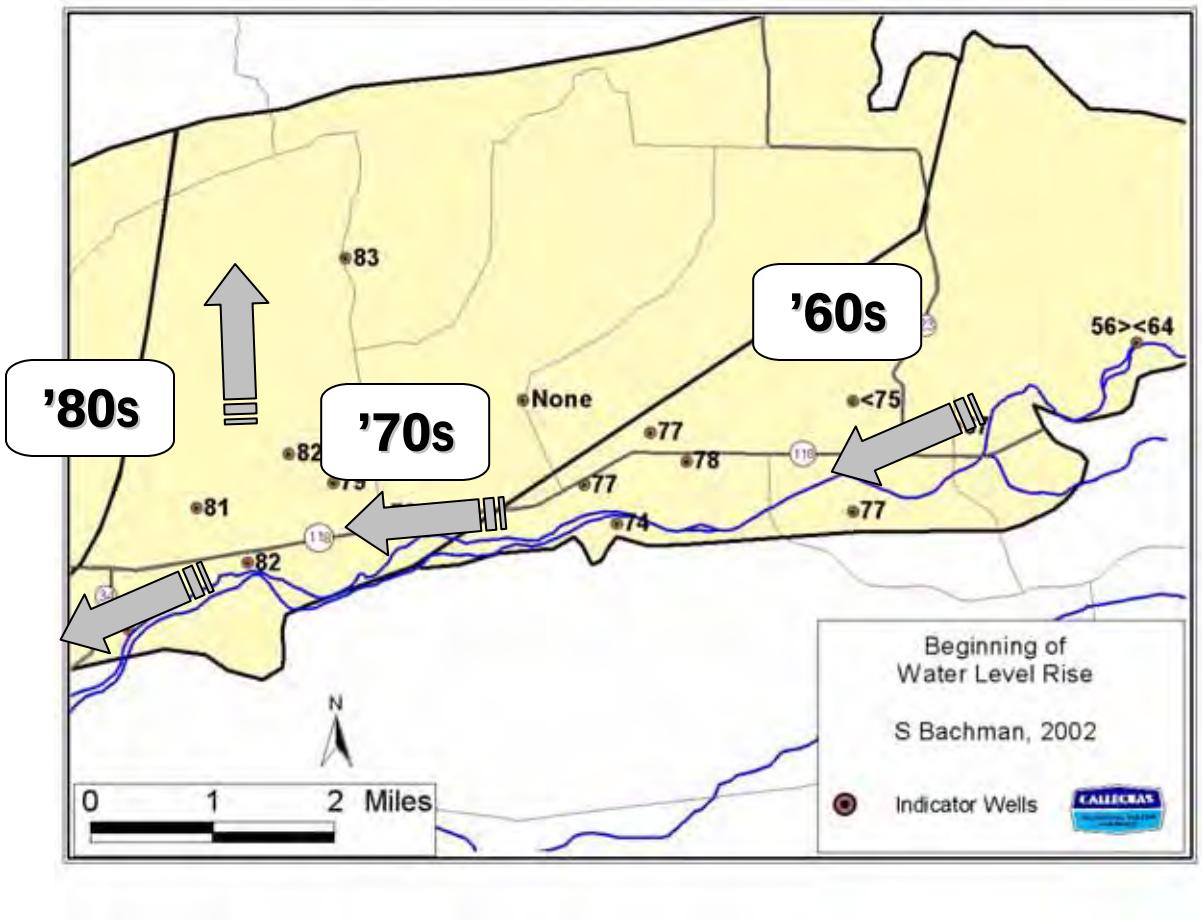


Figure 24. Beginning time of the progressive filling of the shallow aquifer along the Arroyo Las Posas in the South and East Las Posas basins. The number next to each well is the year when groundwater levels started to rise during the filling episode.

5.3 POTENTIAL FUTURE WATER QUALITY THREATS

An area of concern, discussed in the previous section, is potential water quality problems in the Pleasant Valley basin. With groundwater elevations as low as 160 feet below sea level, there exists the potential to pull significant amounts of lower-quality water from surrounding sediments, across or along faults, and from deeper depths (high salinity and/or petroleum-tainted water). Mitigation of these low water levels is important to avoid future water quality problems.

In the northern portion of the Pleasant Valley basin, within the City of Camarillo, increasing chloride concentrations could migrate into the main portion of the basin. However, the details of the hydrogeologic connections from the shallow aquifer to the Lower Aquifer System are still somewhat unclear. Likewise, salt-laden groundwater in proximity to California State University Channel Islands could also migrate from the shallow aquifers to deeper aquifers. This connection is also not well known and the mechanics of transport have yet to be adequately determined, although water level and quality monitoring from wells in the vicinity of the university suggests that the water quality in Lower Aquifer System wells is not affected by poor-quality water in the shallow aquifers. This suggests some barrier to vertical flow between the aquifers in this area.

There are also several other potential water quality concerns within the FCGMA basins. There is a number of leaking underground tanks, some of which have polluted the main aquifers in the basins. Past contamination has been localized and has been addressed through various clean-up operations mandated by the Los Angeles Regional Water Quality Control Board and the Ventura County Environmental Health Department. Water purveyors have become directly involved to ensure rapid cleanup operations in some areas. The FCGMA has lent it support to some of these efforts by water purveyors. There are also possibilities of more-widespread contamination by plumes of such contaminants as perchlorate. Large releases of perchlorate have occurred in the Santa Susana Mountains adjacent to Simi Valley and along the Santa Clara River in Santa Clarita (Los Angeles County). The FCGMA may have to be proactive in the future in ensuring that these and other potential sources do not adversely affect the FCGMA aquifers.

A matter of future water quality concern is the maintenance of current recharge projects that positively affect the Oxnard Plain. Environmental issues in the Santa Clara River and its tributary Piru Creek have the potential for reducing useable water resources – the amount of water available from stored water in Lake Piru and river water at the Freeman Diversion. Since these projects play an integral role in the current FCGMA water management strategies, any loss of yield from these projects would likely reduce some of the gains used in mitigating saline intrusion within the Oxnard Plain.

6.0 BASIN MANAGEMENT OBJECTIVES

6.1 CURRENT OBJECTIVES

Basin Management Objectives (BMOs) are quantitative targets established in a groundwater basin to measure and evaluate the health of the basin. For groundwater basins with seawater intrusion, a critical BMO is maintaining groundwater levels along the coastline to prevent the further intrusion of seawater. In addition, another BMO would be to maintain low concentrations, to the extent possible, of chloride at critical coastal monitoring wells. In inland areas, a BMO would be to ensure groundwater levels prevent conditions that cause groundwater quality degradation. A concurrent BMO would be to maintain concentrations of deleterious chemical constituents in groundwater, such as nitrate and chloride, at or below levels that are harmful to human or animal health or damaging to irrigated crops. Within the FCGMA, several BMOs are appropriate to measure and evaluate the health of the basins. Wells used as monitoring points for the Basin Management Objectives are shown in Figure 25 and described in the following paragraphs.

As part of the BMO attainment process, additional wells may be added to the monitoring process to provide early indications of improving or degrading aquifer conditions at critical locations. An example of such location would be at the north end of the Pleasant Valley Basin where poor quality water from the Las Posas Basin is apparently beginning to enter the Pleasant Valley Basin. This will be an iterative process that will allow the FCGMA to monitor both the current conditions and the relative success of basin management strategies implemented to control water quality in these areas.

6.1.1 Oxnard Plain Basin

The BMO most critical for coastal areas of the FCGMA is the maintenance of groundwater elevations high enough to prevent further seawater intrusion. Because the source of seawater is likely from offshore submarine canyons where the aquifers are truncated and in contact with seawater, coastal aquifers must have groundwater elevations high enough to prevent movement of seawater from the canyons to nearby onshore areas (see discussions in section 5.1.1 *Seawater Intrusion* and section 5.2.2 *Oxnard Plain Basin*). However, seawater is denser than fresh water and the heavier seawater exerts pressure on the fresh water aquifers exposed on the canyon walls – much like water pressure pushes on a diver's mask when the diver descends.

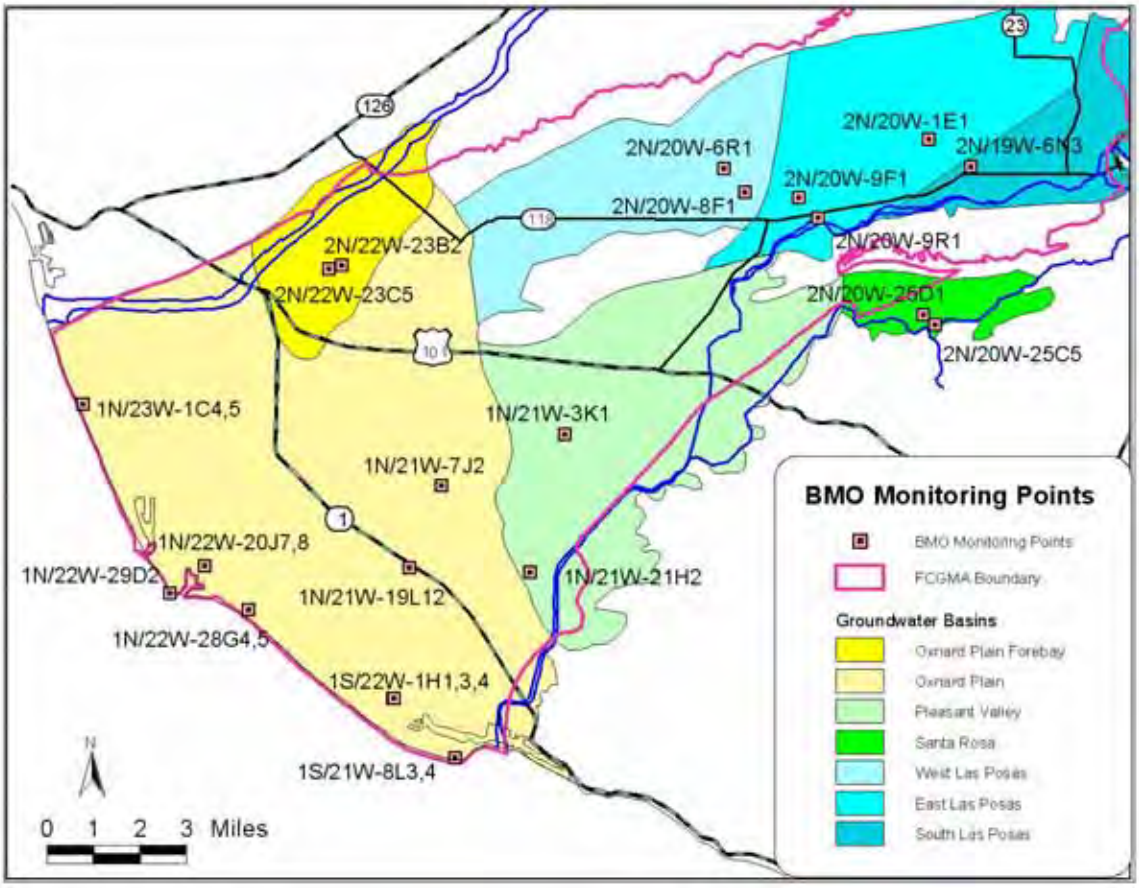


Figure 25. Wells used as monitoring points for Basin Management Objectives.

The pressure differential exerted on the fresh water aquifer depends upon the ocean depth where the aquifer is truncated along the canyon wall – there is the equivalent of 2.5 ft of head (pressure) exerted for every 100 ft of ocean depth. Therefore, an aquifer that is exposed on a submarine canyon wall at 200 ft ocean depth has 5 ft of head exerted on the aquifer by the more-dense seawater. To prevent seawater from intruding from the canyon wall and flowing through the aquifer to the coastline, coastal groundwater elevations must be, on average, at least as high as the head exerted by seawater. Thus, for the example given above, groundwater elevations in monitoring wells at the coastline must average at least 5 ft above sea level to prevent seawater intrusion. The greater ocean depth where the aquifer is exposed to seawater, the higher the average groundwater elevation required to prevent seawater intrusion.

A set of wells was selected to establish the BMOs for the Oxnard Plain basin (Figure 25). Many of these are coastal monitoring wells, completed at different aquifer depths within the Upper (Table 1) and Lower Aquifer Systems (Table 2). There are also several inland wells to detect if a new pumping depression forms in the UAS and if the existing pumping depression in the LAS dissipates. Coastal groundwater elevation objectives were determined using the groundwater elevation and water quality criteria in the preceding paragraph. Inland groundwater elevation objectives were determined such that there is a slight groundwater gradient from the inland areas to the coastline, thereby preventing further landward migration of the existing saline intrusion. The tables list the management objectives for each of the well completions.

The Ventura Regional Groundwater Model suggests that if these groundwater levels are maintained for an adequate period of time, additional saline intrusion will likely be minimized. Water quality objectives for chloride at these wells are also listed in the tables. These objectives follow the Regional Water Quality Control Board's Basin Plan Objective of 150 mg/L for chloride.

Well	*BMO Groundwater Level (msl)*	*Current Level (msl)**	*BMO Chloride (mg/L)*	*Current Chloride (mg/L)*
1N/23W-1C5 (CM3-145, 120-145)	Average 3'	9.2'	<150	41
1N/22W-20J8 (A1-195, 155-195)	Average 4'	14.6'	<150	177
1N/22W-20J7 (A1-320, 280-320)	Average 8'	15.5'	<150	81
1N/22W-28G5 (CM4-200, 180-200)	Average 5'	9.0'	<150	237
1N/22W-28G4 (CM4-275, 255-275)	Average 7'	8.4'	<150	6,536
1N/21W-19L12 (SCE-220, 200-220)	Average 5'	11.3'	<150	67
1S/22W-1H4 (CM6-200, 180-200)	Average 5'	1.8'	<150	4,089
1S/22W-1H3 (CM6-330, 310-330)	Average 8'	-12.5'	<150	1,630
1S/21W-8L4 (CM1A-220, 200-220)	Average 5'	-4.9'	<150	16,917

Table 1. Basin Management Objectives for Upper Aquifer System wells in the Oxnard Plain basin. Well name and perforation depths follow State Well Number.

Well	*BMO Groundwater Level (msl)*	*Current Level (msl)**	*BMO Chloride (mg/L)*	*Current Chloride (mg/L)*
1N/23W-1C4 (CM3-695, 630-695)	Average 17'	15.4'	<150	36
1N/22W-29D2 (CM2-760, 720-760)	Average 19'	0.2'	<150	9,783
1S/22W-1H1 (CM6-550, 490-550)	Average 13'	-33.3'	<150	3,512
1S/21W-8L3 (CM1A-565, 525-565)	Average 14'	-42.3'	<150	4,161
1N/21W-7J2 (PTP #1, 590-1280)	Average 20'	-52.0'	<150	42

Table 2. Basin Management Objectives for Lower Aquifer System wells in the Oxnard Plain basin. Well name and perforation depths follow State Well Number.

6.1.2 Pleasant Valley Basin

In the Pleasant Valley basin, groundwater elevation objectives were calculated to be slightly higher than coastal objectives to prevent landward migration of existing saline intrusion, and to

* Groundwater levels are average for last 10 years; chemical concentrations are average for last 3 years.

minimize vertical groundwater gradients that pull salts from encasing marine clays, from surrounding older marine and volcanic rocks, or from deeper waters within the oil fields of the basin. An additional BMO is to maintain chloride concentrations at or below the Regional Water Quality Control Board's Basin Plan Objective of 150 mg/L. These objectives are indicated in Table 3.

Well	BMO Groundwater Level (msl)	Current Level (msl)*	BMO Chloride (mg/L)	Current Chloride (mg/L)
1N/21W-3K1 (PV #4, 403-1433)	Average 20'	-47.2'	<150	107
1N/21W-21H2 (PV #10, 503-863)	Average 20'	-51.9'	<150	93

Table 3. Basin Management Objectives in the Pleasant Valley basin. Well name and perforation depths follow State Well Number.

6.1.3 Oxnard Plain Forebay Basin

In the Oxnard Plain Forebay basin, nitrate concentrations above drinking water standards have historically been a recurring problem. BMOs in the Forebay basin focus on protection of public drinking water wells (nitrate and TDS) and irrigation suitability (TDS). The management objectives are chosen for wells in the Oxnard-Hueneme wellfield (operated by UWCD) because this is the largest potable water system in the Forebay. The management objectives will maintain nitrate concentrations at one-half or less of the Maximum Contaminant Level for drinking water (45 mg/L of NO3 which is a primary drinking-water standard); at concentrations higher than the BMO of 22.5 mg/L, water purveyors must increase monitoring and reporting to the California Department of Health Services. The TDS objective is set at the Regional Board's Basin Plan Objective of 1,200 mg/L. These BMOs are set at two representative pumping wells (Figure 25) in the O-H Wellfield (Table 4).

Well	BMO Nitrate (as NO_3) (mg/L)	Current Nitrate (mg/L)*	BMO TDS (mg/L)	Current TDS (mg/L)
2N/22W-23B2 (135-277)	<22.5	13	<1200	1044
2N/22W-23C5 (140-310)	<22.5	8	<1200	1010

Table 4. Basin Management Objectives for the Oxnard Plain Forebay basin. Perforation depths follow State Well Number.

6.1.4 Las Posas Basins

In the South and East Las Posas basins, BMOs cannot be linked directly to observed groundwater levels, because the Calleguas MWD aquifer storage project (in-lieu deliveries and direct injection into the aquifer) creates artificially high groundwater levels that are not indicative of the state of the basin. Instead, the proposed East Las Posas Basin Management Plan (Appendix C) contains a method to use groundwater levels along with a computerized groundwater model to monitor the health of the basins.

The recharge mound that is moving northward from the Arroyo Las Posas (Bachman, 2002) has mobilized salts from the shallow aquifer (primarily located along the Arroyo) vertically downward into the Lower Aquifer System and then north into the main portion of the basin. This

* Groundwater levels are average for last 10 years; chemical concentrations are average for last 3 years.

subsurface movement of groundwater occurs because the head (pressure) in the LAS are lower than in the UAS. Therefore, an appropriate BMO for the East and West Las Posas basins is to maintain a chloride concentration that is suitable for agricultural irrigation use (this concentration is well below the standard for drinking water).

Monitoring points for these BMO chloride concentrations (Figure 25) were selected both in the degraded southern portion of the basin, as well as in areas unaffected by the migrating salts. The East and West Las Posas basins' objective for the chlorides is set at 100 mg/L to protect salt-sensitive crops such as avocados and berries (Table 5). It should be noted that salt concentrations, and especially chloride, are already high within the South Las Posas basin. This chloride is caused by groundwater at historically high elevations apparently dissolving salts from sediments that were historically unsaturated (see section 5.1.3 *High Salinity Associated with High Groundwater Levels*). Specific management strategies to address the South Las Posas basin are discussed later in this Plan. The BMOs for chloride and TDS in the South Las Posas basin are set at the average concentration of the surface water in Arroyo Las Posas, which is the concentration that would likely be attained when salts dissolved from sediments are either removed or have migrated elsewhere, and the groundwater then reflects the chemistry of its primary recharge source.

Well	BMO Chloride (mg/L)	Current Chloride (mg/L)[§]	BMO TDS (mg/L)	Current TDS (mg/L)
2N/20W-9F1 (906-1290)(ELP)	<100	164	<500	1,196
2N/20W-9R1 (456-724)(ELP)	<100	187	<500	1,330
2N/20W-1E1 (567-907)(ELP)	<100	28	<500	638
2N/20W-6R1 (1090-1512)(WLP)	<100	12	<600	520
2N/20W-8F1 (752-1406)(WLP)	<100	34	<600	410
2N/19W-6N3 (101-121)(SLP)	<160	150	<1500	1,500

Table 5. Basin Management Objectives for the Las Posas basins. Perforation depths and basin identifier follow State Well Number.

There are also specific water quality criteria for water injected into the East Las Posas basin as part of the Las Posas Basin ASR project. These criteria are included in a letter from the FCGMA to Calleguas MWD dated July 12, 1994 that approved the project as an injection/extraction facility. These criteria include: sodium absorption ratio 1-4 meq/L, TDS 100-800 mg/L, electrical conductivity not to exceed 1100 uMHO, chloride not to exceed 120 mg/L, boron not to exceed 1 mg/L, and nitrate (presumably as NO3) less than 45 mg/L.

6.1.5 Santa Rosa Basin

Basin Management Objectives for the Santa Rosa basin follow the Regional Board's Basin Plan Objectives (Table 6).

[§] Groundwater levels are average for last 10 years, chemical concentrations are average for last 3 years.

Well	BMO Nitrate (mg/L)	Current Nitrate (mg/L)*	BMO Chloride (mg/L)	Current Chloride (mg/L)
2N/20W-25C5 (Unknown)	<45	116	<150	145
2N/20W-25D1 (UAS)	<45	60	<150	78

Table 6. Basin Management Objectives for the Santa Rosa basin. Aquifer designation (if known) follows State Well Number.

6.2 ASSESSMENT OF BASIN MANAGEMENT OBJECTIVES

The parameters for the proposed Basin Management Objectives (BMOs) are currently monitored on a regular frequency throughout the FCGMA, primarily by the VCWPD and UWCD. Along the coastline of the southern portion of the Oxnard Plain basin, BMOs are being met only in a portion of the Upper Aquifer System (see description and discussion of the Oxnard Plain basin in section 3.0 *Groundwater Basins and Hydrogeology*). Within the Lower Aquifer System, BMOs are significantly different than observed measurements. Groundwater levels are well below sea level both near the coastline and in a wide trough that extends into the Pleasant Valley basin beneath the City of Camarillo.

The Ventura Regional Groundwater Model was used to determine the effectiveness of current and future management strategies in meeting BMOs for groundwater levels. These results are reported under each management strategy and are summarized in Table 8 within the sections on management strategies. The model results were compared to the groundwater level goals set in the BMOs for each strategy that was amenable to evaluation by the model. For instance, strategies that involve shifting the place or amount of recharge and/or pumping can be effectively simulated using the model. Strategies that deal exclusively with water quality, such as reductions in nitrate sources, are not amendable to evaluation using the groundwater flow model.

When current management strategies are applied in the model, BMOs for groundwater levels are met or exceeded in 51% of the quarterly time-steps during the 55-year model period for the Upper Aquifer System (meaning that about half of the time groundwater levels are at or above the BMO values and half the time they are below) and only 5% of the time for the Lower Aquifer System. Successful management strategies are those where groundwater levels meet or exceed the BMOs at least half the time – meeting BMOs all the time is a more conservative approach, but requires much larger and more expensive strategies and does not take into account the natural climatic variations in groundwater levels that occurred even before the basin was pumped extensively. When coastal groundwater elevations are below the BMOs during dry periods, seawater could be pulled into the aquifers, but would then be pushed out during wet periods as groundwater levels rose above the BMOs. This has been the experience in the Upper Aquifer near Port Hueneme, where seawater moved inland and then receded with climatic variations in groundwater elevations below and above the BMOs for that area.

BMOs for LAS groundwater elevations are not being met in the Pleasant Valley basin because of this wide trough of depressed groundwater elevations (see map and discussion in section 3.0 *Groundwater Basins and Hydrogeology*). BMOs for chloride concentrations are not currently being met in all portions of the basin, with chlorides increasing in several wells. A study

conducted by UWCD (see following section) indicate some of these chlorides might be pulled from depth with "oil-field production water"[**] that underlies the fresh-water bearing aquifers in the basin (Izbicki et al, 2005). Chloride concentrations are being carefully monitored in the Pleasant Valley basin.

In the Oxnard Plain Forebay basin, BMOs are being met most of the time. However, nitrate concentrations in individual wells in the Oxnard-Hueneme wellfield have periodically been at or above the drinking water standard during drought. Currently, these high nitrates have been evident only during the driest portions of the year when pumping water elevations were at their maximum depth. Both fertilizers from overlying agriculture operations and numerous individual septic tanks are likely contributors to the recurring high nitrate levels in the Forebay, as discussed in the following section. Nitrate problems continue to plague the Santa Rosa basin as well. The high nitrate concentrations in the Santa Rosa basin are also believed to be caused by excessive fertilizer use and numerous individual septic systems.

Two emerging processes could significantly improve source control of nitrate within the FCGMA. Ventura County is in the process of eliminating hundreds of concentrated leach-line septic systems located in the El Rio area of the southern portion of the Oxnard Plain Forebay basin and the northern Oxnard Plain basin; the homes will be connected instead to the adjacent City of Oxnard wastewater system. In addition, the Conditional Discharge Waiver for Irrigated Lands is being put into effect in 2005-2006 by the Los Angeles Regional Water Quality Control Board. This process, with sub-watershed sampling of runoff from agricultural lands, will likely decrease the loading of nitrates from fertilizer through Best Management Practices and education. By 2010, the required monitoring will likely extend to agricultural waters that are percolating to groundwater, in addition to the current emphasis on surface waters.

In the East Las Posas basin, chloride concentrations are higher than the basin management objective in the two wells closest to the Arroyo Las Posas (wells 9F1 and 9R1, Figure 25). Chloride concentrations as high as 273 mg/L have been detected in these wells. Farther into the main portion of the basin, well 1E1 has chloride concentrations of less than 30 mg/L, well below the BMO. In the West Las Posas basin, chloride concentrations remain below the BMO largely because the fault that separates the West and East Las Posas basins appears to be an effective barrier to groundwater flow and the poor-quality water in the East Las Posas basin does not flow into the western basin. Of concern, however, is the recent transient occurrence of higher chlorides in two wells just to the west of the fault. It is not yet known if this is the beginning of wider-spread degradation or if this is caused by periodic overtopping of the fault by poor quality waters in the shallow aquifer along the Arroyo Las Posas.

7.0 YIELD OF THE GROUNDWATER BASINS

7.1 ORIGINAL FCGMA CALCULATION

The approximate yield of all basins within the FCGMA was calculated for the original management plan as approximately 120,000 AFY. This yield was based on a water budget for the year 1980, with estimates of the water balance for every fifth year to 2010. In the year 2010, there were estimated to be extraction rates 25% higher than recharge rates. This calculation is

[**] Izbicki compared the isotopic composition of the sampled groundwater with that of water produced with the oil that was pumped from nearby shallow oil wells.

the origin of the 25% pumping reduction required by the FCGMA. The potential inaccuracies in the assumptions that went into the original balance calculation were not discussed in the previous Management Plan, but they are likely to be relatively high (e.g., Bachman et al, 2005). Note that this yield is not basin-specific, which is discussed in more detail below.

7.2 DEFINITION OF BASIN YIELD

The yield of a basin is the average quantity of water that can be extracted from an aquifer or groundwater basin over a period of time without causing undesirable results. Undesirable results include permanently lowered groundwater levels, subsidence, or degradation of water quality in the aquifer. A basin is in overdraft if the amount of water pumped from the basin exceeds the yield of the basin over a period of time. This does not mean that the same amount of water must be pumped each year – pumping in individual years may vary above or below the yield of the basin during drought or wet years, or as part of basin management plans. If water management in the basin changes, the yield of the basin may change.

The term “safe yield” is often used in judicial proceedings for basin yield; it is determined by technical professionals and subsequently interpreted by courts to define the legal rights to extract groundwater in a basin (further discussion in Bachman et al, 2005). Outside of judicial proceedings, terms such as “perennial yield” are commonly used for basin yield. For the purpose of this Management Plan, the term “yield” is synonymous with “perennial yield” which follows the definition in the previous paragraph.

7.3 METHOD OF CALCULATING BASIN YIELD

To evaluate whether falling groundwater levels are likely to cause an undesirable result (i.e., whether the basin is presently in overdraft), a basin’s water levels are evaluated over at least one complete hydrologic cycle to establish a trend. Since hydrologic conditions vary throughout each year and over long periods of time spanning multiple years, conditions must be analyzed over a long period (generally several decades) to accurately determine if the yield has been exceeded such that overdraft is present. If the trend suggests a continual drop in water levels over time, even after wet year conditions, then undesirable results are likely to eventually occur and the basin is considered to be in a state of overdraft.

Methods to determine basin yield include (e.g., Bachman et al, 2005):

- Hydrologic balance,
- Change in groundwater levels over an average hydrologic base period,
- Zero net groundwater level fluctuation,
- The correlation between groundwater levels and extractions,
- Change of storage vs. extractions,
- Calculation of groundwater inflow,
- Groundwater modeling,
- Annual retained inflow and change in groundwater levels,
- Pumping trough in a coastal aquifer (basin yield is exceeded if pumping trough at the ocean creates conditions for seawater intrusion).

The yield calculation for the 1985 FCGMA Management Plan used the hydrologic balance method – summing up all the water inputs and outputs to determine how much could be extracted from the basins. The calculation was not done over a period of wet and dry years, which is the current standard. The basin yield for this Management Plan was calculated using

the groundwater modeling method. This method integrates aspects of some of the other methods:

- A hydrologic balance is calculated in the model;
- One of the model outputs is a change in groundwater levels over an average hydrologic base period; and
- A pumping trough in a coastal aquifer is one of the criteria to determine if the basin yield has been exceeded.

The groundwater model technique is more rigorous than the 1985 hydrologic balance calculation because the calculation of a water budget depends upon inputs and outputs (Table 7) to the groundwater basins which can be difficult to estimate independently. The groundwater model also has similar inputs and outputs, but the groundwater model is calibrated to match actual measured groundwater levels over a long period of wet and dry years. This calibration of the groundwater model lessens some of the potential errors in a water budget calculation.

Model Parameter	*Input*	*Output*
Aquifer geometry	Yes	
Recharge, discharge areas	Yes	
Aquifer properties (e.g., transmissivity, storage coefficient)	Yes	
Boundary conditions at edge of model	Yes	
Faults	Yes	
Rainfall percolation	Yes	
Streamflow	Yes	
Recharge from adjacent bedrock	Yes	
Irrigation return flow	Yes	
Artificial recharge	Yes	
Pumping	Yes	
Groundwater elevations	For calibration	Yes
Groundwater flow from one area to another (horizontal & vertical)		Yes

Table 7. Inputs and outputs from groundwater flow model (Ventura Regional Groundwater Model).

The groundwater model used was constructed by the U.S. Geological Survey as part of their RASA study (Hanson et al, 2003), which has since been updated and upgraded by UWCD. The groundwater model is described in more detail in Appendix B. The model was also used to test the efficacy of various management strategies. The base period used for the model runs was 1944 to 1998, which encompasses several wet and dry cycles; this period was also used as a base period in the Santa Paula basin and Santa Maria basin adjudications during the last decade. The base period is only used in the model to simulate the natural hydrology over the 55-year period – modern and future man-made inputs and outputs such as water facilities, pumping, and artificial recharge are added to the model to determine both the current state of the basin and the future state of the basin with new management strategies applied.

There is little doubt that the coastal basins within the FCGMA have exceeded their yield and been in overdraft for several decades. The over-arching undesirable result of lowered groundwater levels has been seawater and other saline intrusion. A key aspect of the modeling was to determine the basin yield such that these undesirable results caused by lowered groundwater levels were eliminated.

Basins within the FCGMA that do not abut the coastline and do not themselves have saline intrusion cannot be evaluated directly for this undesirable result. The 1985 FCGMA Management Plan handled this by treating all the basins of the FCGMA as a common pool – an action in one of the basins would also affect the other basins – so pumping in one basin affects groundwater levels in adjacent basins. There is ample evidence that this proposition continues to be correct, with potentially two exceptions (East and South Las Posas basins). The Oxnard Plain Forebay, Pleasant Valley, West Las Posas, and Santa Rosa basins are all hydrologically connected to the coastal basins, evidenced by the continuity of groundwater elevation contours across their boundaries. The East and South Las Posas basins appear to be hydrologically disconnected within the subsurface from the other basins, separated from adjacent basins by either the north-south fault between the East and West Las Posas basins or a structural discontinuity between the basins and the northern Pleasant Valley basin at LAS depths. Thus, in this Management Plan, the East and South Las Posas basins are combined in determining basin yield and the remaining basins are combined for the same purpose. An example of this combination is the Oxnard Plain Forebay basin – although the basin regularly fills during wet periods, it is so directly connected to the Oxnard Plain basin (there are no hydrologic barriers preventing flow between the basins) that it is not considered separately in determining basin yield.

To determine the yield of the two sets of basins, groundwater levels calculated by the groundwater model for the 55-year forward model period were then compared to the section 6.0 *Basin Management Objectives* in the various basins to determine how close the modeled groundwater levels were to the objective groundwater levels. Because the model simulates conditions over several wet and dry climatic cycles, average modeled groundwater levels were compared to the objectives. The following section summarizes the results of these comparisons.

The basin yield calculation was accomplished in several steps:

1) The groundwater model was run in its 55-year forward model configuration (see Appendix B) with current management strategies included. If modeled groundwater levels were at or higher than Basin Management Objectives for more than half of the time, then undesirable effects such as seawater intrusion were less likely to occur and the basins were considered to be operated within their yield. If not, then the basins were considered to be operating in excess of their yield.

2) Groundwater extractions in the basins were either increased or decreased by stepwise amounts to determine the amount of pumping that would meet the criteria of modeled groundwater levels being at or above BMOs for more than half of the time, but not exceed, BMOs. Extraction were modified in two ways: a) changes were made proportionately to all wells in the basins within the FCGMA, and b) changes were made only in portions of the basins that were tailored to prevent undesirable effects (e.g., extractions were reduced in the south Oxnard Plain and Pleasant Valley only).

3) As an additional calculation, all of the management strategies in this Management Plan were combined in one model scenario to simulate whether Basin Management Objectives can be met when all the strategies were applied – in other words, can these objectives be met with the tools that may be available.

7.4 BASIN YIELD

When current strategies were applied in the Base Case groundwater model run (see Appendix B), groundwater levels in the Upper Aquifer System met or exceeded BMOs 51% of the time and in the Lower Aquifer System 5% of the time. These results are consistent with observed groundwater conditions today, where groundwater levels are close to BMOs in the Upper Aquifer (and seawater is largely being held back) and significantly below BMOs in the Lower Aquifer. Thus, both the model results and observed groundwater levels indicate that the basins within the FCGMA are not being operated within their yield under the current pumping patterns and management strategies – lowered groundwater levels create undesirable effects such as saline intrusion.

To determine basin yield, pumping was then reduced step-wise in the forward model until BMOs were met at least half the time during the model simulation. As indicated above, two methods of pumping reductions were used – GMA-wide and targeted only to the south Oxnard Plain and Pleasant Valley basins. The results of these model runs are shown in Figure 26.

Figure 26 indicates that when progressively greater pumping reductions are applied to all wells within the FCGMA, Lower Aquifer BMOs are attained at least 50% of the time when FCGMA pumping is reduced to about 65,000 AFY – about half of current average pumping. When the reductions are limited to the south Oxnard Plain and Pleasant Valley basins, overall FCGMA pumping is reduced to about 100,000 AFY to attain the same Lower Aquifer BMO goals. Because the significant lowering of groundwater levels has occurred in the south Oxnard Plain and Pleasant Valley areas, it is appropriate that this is where pumping reductions should occur, as they have through historic in-lieu water deliveries. Thus, 100,000 AFY appears to be an appropriate number for basin yield.

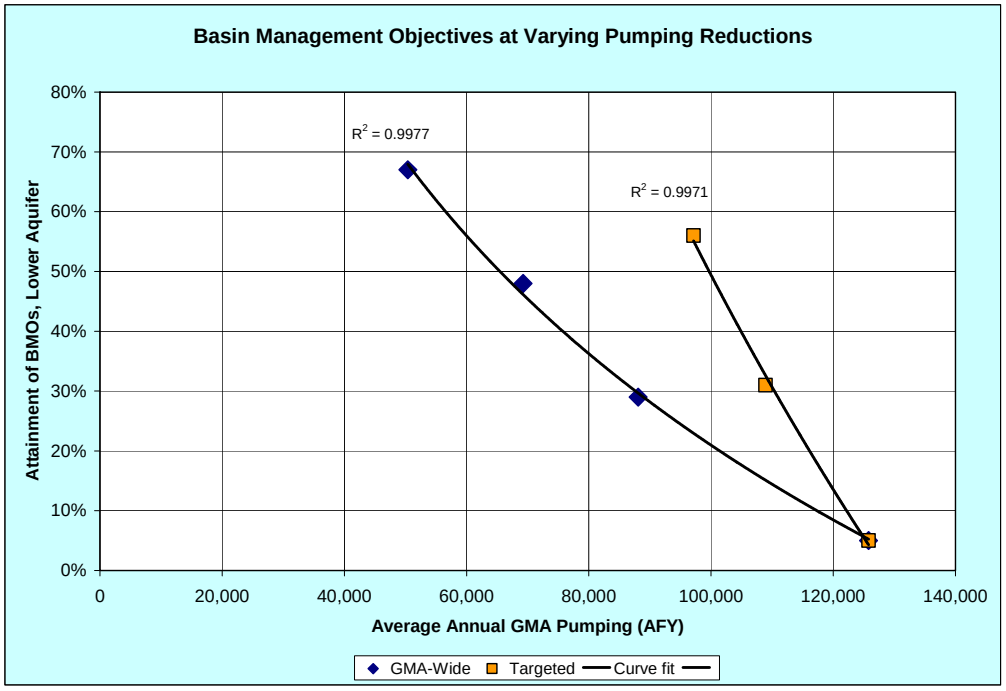


Figure 26. Groundwater model results from progressively reducing FCGMA pumping both agency-wide (diamond symbol) and targeted to the south Oxnard Plain and Pleasant Valley basins (square symbol). Results are indicated as percent of time that BMOs are met or exceeded in the Lower Aquifer System. R^2 values are indicated for the two curve fits.

There are three caveats to this calculation of basin yield:

1) Overall pumping in the south Oxnard Plain and Pleasant Valley areas was reduced by about 25,000 AFY (an 85% reduction). There are several approaches to achieve this reduction, with replacing the pumping with in-lieu deliveries being the primary historic method that is also favored in the management strategies discussed in this Plan.

2) The yield of the basins is not a forever-fixed number, but depends upon the projects in the basin – increasing the amount of recharge in the basins also increases the yield of the basins. Therefore, the yield of the basins must be recalculated periodically as new projects become operational and conjunctive use is increased.

3) When Lower Aquifer BMOs are attained 50% of the time, there should be no net movement of seawater within the aquifers. However, during dry periods there would be onshore gradients and during wet periods there would be offshore gradients. Thus, seawater may move landward during the dry periods and be pushed back during wet periods (which has been evident over the past 15 years at coastal Port Hueneme). To create conditions such that seawater could never move landward, the Lower Aquifer goals would have to be met nearly 100% of the time – an unrealistic goal that would require very large pumping reductions and create conditions where large quantities of fresh water were flowing to the ocean almost all the time. The 50% attainment of BMOs should be considered as an initial target level, but should be revisited as that goal is approached to ensure that it is sufficiently protective of the aquifers. If water quality problems continue as the 50% attainment level is approached, an increase in the attainment level should then be considered. Thus, the basin yield of 100,000 AFY that is tied to the 50% attainment level may have to be adjusted in the future.

An additional basin yield task was to apply all the future management strategies into one simulation of the model to determine whether Basin Management Objectives could be met if these strategies were in place. After applying the management strategies discussed in section 9.0 *Management Strategies Under Development* and section 10.0 *Potential Future Management Strategies*, the groundwater modeling indicates that Upper Aquifer BMOs could be met 67% of the time and Lower Aquifer BMOs could be met 76% of the time. Thus, application of the management strategies in this Plan apparently can solve the overdraft within the FCGMA.

8.0 CURRENT GROUNDWATER MANAGEMENT STRATEGIES

This Plan evaluated three types of management strategies for effectiveness: 1) currently implemented management strategies; 2) strategies under development where some action has already been taken to design and implement those strategies; and 3) potential future management strategies. Current strategies were evaluated by measuring their effect on changing groundwater levels and improving groundwater quality. Proposed and future strategies were evaluated using the Ventura County Regional Groundwater Model (an empirical computer simulation of groundwater flow described in Appendix B).

Several management strategies were adopted as part of the original 1985 FCGMA Management Plan. In addition, several other strategies were also implemented in the ensuing period since 1985. The previously-adopted 1985 FCGMA management strategies are discussed first, followed by the additional strategies. The effectiveness of these management strategies is then evaluated in the following discussion.

8.1 DESCRIPTION OF 1985 FCGMA MANAGEMENT PLAN STRATEGIES

The original 1985 FCGMA Management Plan specified several management strategies that would be implemented. These included the following general strategies.

8.1.1 Limitation of Groundwater Extractions

The most visible of the FCGMA strategies was the phased reduction in pumping within the FCGMA, implemented under FCGMA Ordinance No. 5 (now Chapter 5 within Ordinance No. 8.1). This strategy called for a 25% pumping reduction over a 20-year period via phased 5% incremental cutbacks to Historical Allocations every 5 years. As part of this strategy, pumping allocations, conservation credits, and agricultural irrigation efficiency allowances were implemented. To allow inherent flexibility, the Ordinance provides for Historical Allocation adjustments of no more than two acre feet per acre when land use changes from farming to municipal/industrial. A Baseline Allocation of one acre foot per acre was established for lands without allocations or lands that were developed after the baseline period ended in 1989 and were dependent upon groundwater. In addition, an Efficiency Allocation that allows farmers sufficient allocation to grow different crops as long as they remain at least 80% efficient (less than 20% of irrigation water runs off, leaches, or goes to deep percolation). Baseline and Efficiency allocations are exempt from the mandatory 25% reductions. To discourage overpumping, the FCGMA Ordinance imposes an extraction surcharge on all water pumped in excess of the annual allocation. The penalty initially ranged from $50/AF to $200/AF under a four-tiered system; however, that system was modified in favor of a single flat rate that was adjusted upward to $725/AF.

Ordinance No. 5, now part of Ordinance No. 8.1, also has a provision for establishing Conservation Credits by extracting less groundwater than the Historical Allocation. Conservation Credits can be used to avoid paying penalties when extractions exceed the allocation. A second type of credit, Injection or Storage, may be established and applied to future extractions when foreign water is injected or percolated into the aquifer. Conservation credits are allowed to accumulate with no restrictions, allowing some pumpers to accumulate credits for tens of thousands of acre-feet of water.

The required phased 5% reductions occurred in 1992, 1995, and 2000 for a current reduction of 15% of allocation for pumpers using their Historical Allocation. The planned additional 5% reduction for 2005 has been delayed per a request from M&I well owners who have asked for a re-evaluation of the effectiveness of such reductions as part of formulating this Management Plan.

8.1.2 Encourage Both Wastewater Reclamation and Water Conservation

The Ventura County Planning Department prepared a “Water Conservation Management Plan” which recommended various voluntary measures that could be employed to conserve water. Many farmers, individual households, and cities have adopted voluntary agricultural and urban water conservation programs. For several years, in the late 1980s and early 1990s, the County Planning Department designated Planner positions as “Water Conservation Coordinators.” This program no longer has funding, but the water conservation program created material that continues to be distributed to schools and the public.

A Countywide Wastewater Reuse Study, prepared in 1981, identified wastewater reuse opportunities in the Las Posas Valley from either the Simi Valley Wastewater Treatment Plant or the Moorpark Wastewater Treatment Plant, and identified an opportunity to use recycled

wastewater from the Thousand Oaks/Hill Canyon Wastewater Treatment Plant for irrigation on the Oxnard Plain. Since that report, the Moorpark Wastewater Treatment plant has upgraded to tertiary disinfection and a portion of the recycled water is supplied for irrigation to nearby golf courses. The Thousand Oaks/Hill Canyon project (now known as the Conejo Creek Diversion project) has been in operation for several years; it is discussed in the following section. In addition, the City of Oxnard's proposed recycled water project is discussed in section 9.1 GREAT Project (Recycled Water).

8.1.3 Operation of the Oxnard Plain Seawater Intrusion Abatement Project (UWCD's Pumping Trough Pipeline, Lower Aquifer System Wells, Freeman Diversion) –

The Pumping Trough Pipeline (PTP) was constructed in 1986 to convey diverted Santa Clara River water to agricultural pumpers on the Oxnard Plain, thus reducing the amount of groundwater extractions in areas susceptible to seawater intrusion (Figure 27). When river water is not available, five Lower Aquifer System wells pump water into the pipeline. The Freeman Diversion (1991), which replaced the former use of temporary diversion dikes in the Santa Clara River with a permanent concrete structure, now allows for diversion of river storm flows throughout the winter rainy season. As a side benefit, the Freeman Diversion helped stabilize the riverbed after years of degradation caused by in-stream gravel mining. The permanent Freeman Diversion increased the yield of the Seawater Intrusion Control Project by about 6,000 AFY over the previous means of temporary diversion.

8.1.4 Operating Criteria for the Oxnard Plain –

The combination of FCGMA policies and water conservation facilities have effectively moved pumping away from the coastline and from the Upper Aquifer System to the Lower Aquifer System. The switch in aquifer pumping is discussed in the next FCGMA strategy. The effectiveness of these criteria is discussed in section 8.3 Effectiveness To-Date of Current Management Strategies.

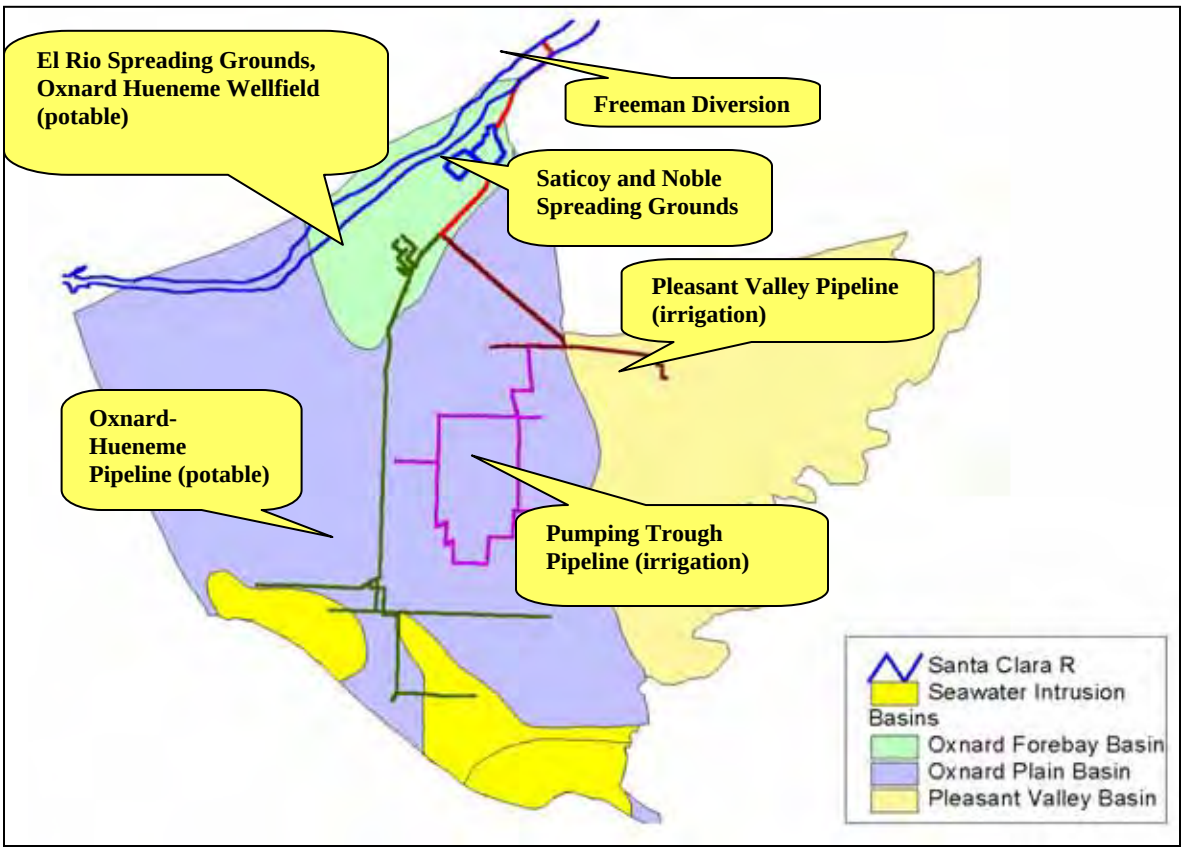


Figure 27. Elements of the Seawater Intrusion Control Project on the Oxnard Plain.

8.1.5 Construction/Modification Restrictions on Upper Aquifer System Water Wells –

In areas where they could cause overdraft or seawater intrusion in the Oxnard Plain basin, the County adopted a well ordinance that prohibited new wells in the Upper Aquifer System in the Oxnard Plain basin, instead requiring new and replacement wells to be drilled in the Lower Aquifer System. The effectiveness of this strategy is discussed in section 8.3 *Effectiveness To-Date of Current Management Strategies*.

This policy has now been shifted. A new policy for areas where pumping could cause overdraft or seawater intrusion in the Oxnard Plain basin (especially in what are called Sealing Zones 1 and 2 where multiple aquifer layers exist) was adopted by the County. This new well ordinance, adopted in 1998, prohibited new wells in the LAS beneath the Oxnard Plain, instead requiring new and replacement wells to be drilled into the more-easily replenished UAS. This shift in pumping was effected by a change in the County Well Ordinance to institute a complete reversal in which aquifers are targeted for production based on findings from the U.S. Geological Survey RASA study and observations from the network of monitoring wells. Since the County Well Ordinance was revised in 1998, only replacement wells or situations with no other water supply option available may tap into the LAS beneath the Oxnard Plain.

8.1.6 Annual Groundwater Monitoring Program

The FCGMA and UWCD participated with the USGS in installing (circa 1990) a series of multiple-completion nested monitoring wells along coastal areas of the Oxnard Plain basin and

in a few inland areas. These wells allow measurement of groundwater levels and sampling of water quality at two to six discrete aquifer depths at each well site. These wells, in addition to a wide range of productions wells, are now being monitored at regular intervals by VCWPD and UWCD. The VCWPD findings are entered into a database and published as supporting data in various reports on water quality, groundwater basins, or special subject or area studies. UWCD enters its monitoring data into a database that is then augmented by monitoring data from VCWPD and California Department of Health Services (public supply wells). UWCD conducts an annual evaluation of all the monitoring results in its database and prepares an annual report that is available on UWCD's website (www.unitedwater.org).

8.1.7 Contingency Plan for LAS Seawater Intrusion

Although it was hoped that such a plan would never be needed, the FCGMA staff developed an as-yet-unfinished and informal contingency plan that consists of a list of possible measures that could be instituted to address intrusion of seawater into the LAS. The list items were only to be offered to the FCGMA Board as possible countermeasures in the event of a severe water quality decline in a significant number of LAS wells. This list included suggestions such as managing the intruded basin in a separate management scheme, further reductions in LAS well Historical Allocations, possible groundwater use restrictions by maximum volume per acre served (in the case of irrigated lands or per resident or dwelling unit in the case of urbanized areas), a complete ban on all future LAS wells regardless of need or circumstance, monetary or other potential incentives to encourage LAS well owners to destroy wells in favor of other possible water sources, and other such means of LAS management.

8.1.8 North (now called East and West) Las Posas Basin Pumping Restrictions

The FCGMA adopted Ordinance No. 4 (now Chapter 4 within Ordinance 8) that prohibits expansion of water use outside the Las Posas Basins and/or the Agency boundary, especially on the sensitive Aquifer Outcrop Zone or Expansion Area. The Aquifer Outcrop Zone is that land or geographic area where the Fox Canyon and/or Grimes Canyon aquifers reach the ground surface and are exposed as outcrops. Ordinance 4 restricts or precludes use of any harmful land uses in this zone (such as impervious surfaces, septic systems, pesticides, fertilizers, or groundwater withdrawals), because this area acts as a direct conduit to the usable aquifer water stored at depth. The Expansion Area was defined as that portion of land from the crest of the hill or 1.5 miles beyond the Agency boundary (northernmost extension of the Aquifer Outcrop) that drains into the Agency. Because groundwater quality protection and prevention of volume exports are the prime subjects of these laws, the Expansion Area was officially designated as an official Sphere of Influence zone by the Ventura LAFCO (Local Area Formation Commission). No wells, no additional agriculture, and only very limited single family home development is allowed in these areas, and only under special restrictions and circumstances.

8.1.9 Monitor FCGMA Groundwater Extractions to Ensure That They Do Not Exceed Adopted Projections for That Basin

The FCGMA requires semi-annual reporting of extractions from pumpers within the Agency as part of the measures instituted within Ordinance No. 5 (now Ordinance No. 8). These data are entered into a database maintained by the FCGMA. Individual operator annual extractions are compared against allowed allocations or irrigation efficiency at the end of each calendar year to determine whether well operators are within their allowed pumping. As discussed under the first

strategy on limitations of groundwater pumping, penalties are assessed for overpumping, and credits are posted for conservation or storage.

8.1.10 Implementation of Drilling and Pumping Restrictions

This strategy is discussed as part of several of the strategies above and is supported by the County Well Ordinance and the cooperation of water districts and well owners.

8.1.11 Metering of Groundwater Extractions

As part of the original Ordinance No. 5, extractions must be reported to the FCGMA on a semi-annual basis. Ordinance No. 3 (now Chapter 3 within Ordinance No. 8) required water flow meters to be installed at owners' expense on all groundwater pumps except domestic users on one acre or less. Not all pumpers have installed meters or use their meter readings to report extractions. Resolution 2006-1 requires periodic accuracy calibration of every water flow meter by independent testing agents. This Resolution also tightened requirements and imposed restrictions on well extraction reporting in addition to adding more strict penalties for non-compliance.

8.2 DESCRIPTION OF OTHER CURRENT STRATEGIES

There are several other groundwater management strategies that have been implemented within the FCGMA area that were not foreseen when the original management plan was formulated some 20 years ago. These include:

8.2.1 Fox Canyon Outcrop Expansion Area

A buffer zone ("Expansion Area") along the outcrops of the Fox and Grimes Canyon aquifers, which are adjacent to and outside of the FCGMA boundaries, was established in 1997. This zone was established to protect any land uses on the outcrop or within the Agency that might adversely affect groundwater recharge, groundwater extractions, or water quality.

8.2.2 Noble Spreading Basins

The Noble Spreading Basins (1995), across Los Angeles Avenue opposite UWCD's Saticoy Spreading Grounds, were constructed to store and recharge additional Santa Clara River water diverted at the upstream Freeman Diversion, particularly during wet periods. These relatively shallow basins were reclaimed gravel pits purchased by UWCD and reconfigured as water spreading basins. Water placed in the facility recharges both the Upper Aquifer System and the Lower Aquifer System. The ten-year average for the facility is 6,000 AFY, with individual years varying from 0 AF to 17,800 AF.

8.2.3 Las Posas Basin ASR Project

The FCGMA in 1994 approved Calleguas MWD's Las Posas Basin Aquifer Storage and Recovery (ASR) project as an Injection/Storage Facility. This allowed Calleguas MWD to receive Storage Credits for water recharged as part of the project. Conditions of the approval included registration of the injection/extraction wells, monthly reporting of injection/extraction volumes, water quality requirements for injected water, a limit on the amount of water in storage (300,000 AF), required points of extraction, a limitation to use the stored water only within Ventura County, periodic review of injection/extraction effects, and an agreement to halt operations if any conditions are not met. As of 2006, Calleguas MWD has stored over 60,000

AF of water through in-lieu deliveries to basin pumpers and direct injection. Although most extractions have been for testing and maintenance purposes, full-scale extractions occurred during January 2007 to supply customers during a scheduled maintenance shut-down of the supply line bringing State Water to Calleguas MWD.

8.2.4 Conejo Creek Diversion Project

The Conejo Creek Diversion Project (2002), constructed by Camrosa Water District just south of where Highway 101 crosses Conejo Creek, diverts flows from the creek and delivers the water to Pleasant Valley County Water District to meet local irrigation demands within the overdrafted Pleasant Valley basin. The water diverted from the creek is a combination of natural stream flow and recycled water released into the creek from wastewater treatment plants upstream. This diverted water replaces Lower Aquifer System pumping in the Pleasant Valley basin. The contractual amount of water from the diversion is 3,000 AFY (if available), although an average of 5,300 AFY has been diverted in the first four years of operations. These diversions may increase temporarily, but are likely to decrease over the next 20 years as the recycled water is used elsewhere by Camrosa Water District customers.

8.2.5 Supplemental M&I Water Program

The Supplemental M&I Water Program is operated through the Oxnard-Hueneme (O-H) Pipeline system. The joint UWCD-Calleguas MWD project uses FCGMA credits earned by Pleasant Valley County Water District from the Conejo Creek Diversion Project to supplement O-H water supply. This project effectively shifts Lower Aquifer System pumping in the Pleasant Valley basin to Upper Aquifer System pumping in the Oxnard Plain Forebay basin. The program is capped at 4,000 AFY and is only implemented in years when groundwater levels in the Forebay are sufficiently high to prevent harm to other Forebay pumpers. The program effectively reimburses Calleguas MWD for their investments in the Conejo Creek project, a precedent that may allow similar types of projects in the future.

8.2.6 Saticoy Wellfield

The UWCD Saticoy Wellfield (2005) was constructed adjacent to the UWCD Saticoy Spreading Grounds to pump shallow water from the recharge mound underlying the spreading grounds in wet years and deliver the water to users along United's existing agricultural pipeline system (Pleasant Valley and PTP pipelines). This pumping from the Oxnard Plain Forebay basin decreases the recharge mound, allowing more spreading and groundwater recharge from the basins during wet periods. The water produced by the pumping in the Forebay replaces LAS groundwater pumping along the Pumping Trough Pipeline (PTP) and Pleasant Valley (PV) Pipelines.

8.2.7 Importation of State Water

The County of Ventura holds a State Water allocation of 20,000 AFY administered by the California Department of Water Resources (DWR). This allocation is divided among UWCD, the City of Ventura, Port Hueneme Water Agency (as a sub-allocation of UWCD's portion), and Casitas MWD. UWCD uses its allocation to supplement recharge to the aquifers along the Santa Clara River within Ventura County. UWCD's 3,150 AFY allocation (UWCD's allocation was 5,000 AFY, but the Port Hueneme Water Agency acquired 1,850 AFY of the allocation) is ordered from DWR during normal and dry years for delivery to Lake Piru via stream releases from the DWR-operated Lake Pyramid downstream along Piru Creek. This State Water is then released from Lake Piru as part of UWCD's normal conservation release in the late summer and fall. As this water flows down Piru Creek and the Santa Clara River, a portion of it percolates into the groundwater basins along the river (Piru, Fillmore, and Santa Paula) and a portion reaches the Freeman Diversion for recharge to the Oxnard Plain.

This recharge is not credited by the FCGMA to UWCD directly, but based on many years of study, measurement, and computer modeling, the portion of the DWR purchased water that ultimately reaches the Freeman Diversion is credited as new or foreign water. The credits are placed in a UWCD-held trust fund that may be used in the future to solve common FCGMA management issues that are beneficial to the aquifers within the Agency. The Port Hueneme Water Agency's 1,850 AFY is delivered via Calleguas MWD's conveyance facilities. Except for 2,000 AF imported in 2002, no other portion of the 20,000 AFY entitlement has ever been imported to Ventura County, although annual capital costs continue to be paid to DWR to maintain this Allocation. Additional importation of State Water is discussed in section 10.0 *Potential Future Management Strategies*.

8.2.8 Additional Groundwater Monitoring

As saline intrusion has encroached further inland beneath the south Oxnard Plain, saline waters have moved eastward of the existing monitoring well network in some areas. In 2006, UWCD will install two additional nested monitoring well sites north of Mugu Lagoon, with funds obtained from a Department of Water Resources grant. These monitoring wells will be incorporated into the monitoring network and sampling protocol for the existing dedicated monitoring wells.

8.2.9 Calibration of Groundwater Extraction Meters

Resolution 2006-1 was adopted by the FCGMA Board that will phase-in a flow meter calibration and inspection program over three years. After the phase-in, each meter will be required to be checked at 3-year intervals.

8.3 EFFECTIVENESS TO-DATE OF CURRENT MANAGEMENT STRATEGIES

The management strategies applied over the past 20 years to combat seawater intrusion have resulted in significant changes in water levels and in water quality indicators in the FCGMA aquifers. Conditions in the Upper Aquifer System (UAS) have improved with groundwater elevations increasing to, or exceeding, acceptable levels and chloride-impacted water decreasing in both concentration and geographic extent in most areas. However, water quality conditions in the Lower Aquifer System (LAS) have worsened over this same time period. Specifically, LAS groundwater elevations in the southern portion of the Pleasant Valley Basin and southern Oxnard Plain Basin have decreased and remained well below sea level and salinity has increased in both concentration and geographic extent. This has occurred for two reasons. First, the combined UAS and LAS extraction in this area has exceeded levels the resource can support. Second, policies adding recharge to the UAS and switching pumping from the UAS to the LAS have relieved the stress on the Upper Aquifer but increased the stress on the Lower Aquifer.

The FCGMA policy of reduced pumping has had positive effects in all the aquifers. For pumpers using their Historical Allocation under Ordinance No. 5, there has been a pumping reduction in excess of the 15% currently required by the FCGMA. There have been only isolated incidents of pumping in excess of allocation, reflecting both the general acceptance of the pumping reductions and the stiff monetary penalty for overpumping. For agricultural pumpers using an Irrigation Efficiency calculation, pumping reductions have been even more dramatic. In a study using the FCGMA weather stations to calculate daily crop water demand, Agency-wide irrigation efficiency (measured by less reported water use compared to FCGMA-computed crop water demand) improved by about 30% during the first several years of the FCGMA pumping reductions (UWCD, 2002). The increased efficiency is consistent with the decreased extractions reported to the FCGMA over the last decade (see section 4.0

Groundwater Extractions). Widespread acceptance and installation of drip tape, micro sprinklers, mini sprinklers, leak repairs, computer controlled watering cycles, farm-operated weather stations to assist with irrigation frequency and duration, various ground-based moisture sensors and lysimeters, farmer and irrigation crew education, and a shift away from wasteful furrow irrigation or high volume sprinkler heads, along with reduction of tailwater losses have all contributed to the reduction in groundwater use.

One of the key hydrogeologic findings over the last 10 years indicated that a zone of lower conductivity (such as a fault or some other deformation) extends from the Camarillo Hills to Port Hueneme (aligned with the known location of the Simi-Santa Rosa fault in the Camarillo Hills) limiting the amount of recharge that can flow from the Oxnard Plain Forebay basin into the south Oxnard Plain and Pleasant Valley areas. This zone appears to be limited to the Lower Aquifer System, with no evidence that the lower conductivity zone extends upward into the Upper Aquifer System. In these areas of the LAS, extractions far exceed recharge, resulting in groundwater levels that have fallen to well below sea level from the ocean inland to the City of Camarillo. Three current projects recharge these critically overdrafted areas: diverted Santa Clara River water is delivered via the Pleasant Valley and Pumping Trough pipelines and diverted Conejo Creek water is delivered via the Conejo Creek project. These three projects deliver in-lieu recharge to the south Oxnard Plain and Pleasant Valley basins (the delivered surface water is used for irrigation in-lieu of pumping groundwater).

However, the Pumping Trough Pipeline (PTP) operated by UWCD provides mixed effects in reducing pumping in the Lower Aquifer System. The diverted Santa Clara River supplies delivered to PTP customers in-lieu of pumping groundwater have unambiguous benefits in helping to eliminate the pumping trough in the Upper Aquifer System and helping eliminate overdraft in the Lower Aquifer System. But the PTP project also has five LAS wells that provide irrigation water to customers along the pipeline when there are insufficient supplies in the Santa Clara River available for diversion and delivery. These wells were completed in the LAS because at the time the LAS was in better shape than the UAS. Since the UAS has substantially recovered from overpumping but the LAS has been severely depleted, these five LAS wells are no longer optimally-located; they now pump from the flank of the large pumping depression in the LAS of the south Oxnard Plain and Pleasant Valley basins. Thus, one of the previously-assumed solutions to reduce groundwater extractions within the pumping trough of the UAS has created new problems in the LAS. Some of this LAS pumping for the PTP project is being replaced by UAS pumping from the UWCD Saticoy Wellfield (located in the Oxnard Plain Forebay basin); this strategy should be maximized in the future.

One of the FCGMA strategies historically underutilized is the substitution of recycled water for groundwater pumping. The Conejo Creek project has begun the process of using recycled water which originates in the City of Thousand Oaks. Other recycled projects are not yet operational (e.g., see later discussion of the City of Oxnard's GREAT project).

The Ventura Regional Groundwater Model was used to test the future effectiveness of current projects to reduce the overdraft in the FCGMA basins. This analysis assumes that hydrological conditions of the past 50 years are similar to future conditions, that projects continue to be implemented as designed, and that FCGMA reported pumping is relatively accurate. This modeling indicates that when all current projects that implement the FCGMA Management Plan are operational, there will still be an overdraft in the basins within the Agency. With only current strategies in place, BMOs for groundwater levels would be met 51% of the time in the Upper Aquifer and 5% of the time in the Lower Aquifer (see Appendix B). This analysis is derived from the model Base Case, which uses reported pumping over the past 10 years as the basis for

modeled extractions. If actual pumping was higher than reported, then the model would have to be recalibrated to reflect this. A sensitivity analysis was conducted to examine the effect of understated pumping in the model (Appendix B, section A2.2.2 *Sensitivity Analysis – Understatement of Reported Extractions*), which indicated that if agricultural pumping was understated by 15% (caused by poorly-calibrated meters or inaccuracies in other reporting methods), results from the current model could be up to 15 feet too high in the Lower Aquifer (the aquifers would be in worse shape than modeling suggested). If the model was recalibrated to reflect this understatement of pumping, these results would be corrected.

It is clear both from the modeling results and from the observation that BMOs are not being met in many areas, and that additional management strategies and projects must be initiated to alleviate this continued overdraft. The following sections address this need.

9.0 MANAGEMENT STRATEGIES UNDER DEVELOPMENT

There are several projects at various stages of development that will further reduce water supply and water quality problems within the FCGMA. Some of these projects follow the original management strategies of the Agency, whereas others deal with issues not contemplated in the original management plan. The strategies are presented in the order of their impact on the aquifer (high impact strategies are discussed first), with projects under development discussed in this section and future strategies discussed in the following section. The ranking of both strategies under development and future strategies that were amenable to testing with the groundwater model is indicated in Table 8. For strategies that could not be directly evaluated with the groundwater model (because there was no change in the place or amount of recharge or pumping), other ranking factors are discussed with each strategy.

Strategy	*UAS ΔWL*	*Meet UAS BMOs*	*LAS ΔWL*	*Meet LAS BMOs*
Current Strategies		**51%**		**5%**
Barrier Wells	+11’	63%	+46’	48%
GREAT Project	-1’	51%	+38’	36%
Injection River Water	+1’	53%	+7’	11%
Shift Pumping UAS	-1’	50%	+8’	9%
Increase River Diversions	+3’	54%	+3’	8%
Addtl Recharge S Oxnard	+1’	53%	+4’	7%
Continue 25% Reduction	+1’	53%	+2’	7%
Import State Water	+2’	54%	+1’	7%
RiverPark Recharge	<1’	52%	<1’	6%
Shift Pumping NW Oxnard	<1’	51%	<1’	5%
All Strategies	**+15’**	**67%**	**100’**	**76%**

Table 8. Ranked results of groundwater modeling of management strategies amenable to evaluation with the groundwater model. The table indicates the average change in groundwater levels expected in each aquifer at the wells for which there is a BMO for each strategy. The table also indicates the average amount of time that groundwater levels were at or above BMOs for each aquifer (see discussion of this technique in section 6.0*Basin Management Objectives*).

9.1 GREAT PROJECT (RECYCLED WATER)

The GREAT (Groundwater Recovery Enhancement and Treatment) project is ranked highest of the projects under development because of its effectiveness in reducing Lower Aquifer overdraft (see Table 8). However, the most effective portion of the project would occur at 10 to 15 years from now, when all components of the project are scheduled to be in place.

9.1.1 Description

The project is being designed and implemented by the City of Oxnard. The project has three major components: 1) a new regional groundwater desalination facility; 2) a recycled water system to deliver water to M&I non-potable water uses within the City of Oxnard, to deliver water to agricultural users in the Pleasant Valley area, and to inject water as a barrier to seawater intrusion; and 3) conveyance of desalination backwash concentrates through a brine line to either the City's existing ocean outfall or the Ormond Beach area for coastal wetland restoration. Potable water supplies for the City would then be pumped from the Forebay by utilizing FCGMA credits earned from both direct recharge (barrier wells) and in-lieu recharge (M&I non-potable and agricultural deliveries). This Forebay supply could be pumped from existing Oxnard-Hueneme system UAS wells, existing City wells, and/or new City wells. The FCGMA would have to approve recharge and pumping facilities, as well as implement policies discussed later in this section.

The project will be constructed in phases, with project yield ramping up over time from around 5,000 AFY to more than 21,000 AFY. Actual timing of construction will depend upon projected growth in water demand and funding. This project implements the strategy of pumping groundwater from areas of the aquifer readily recharged and reducing pumping in areas of the aquifer that are more difficult to recharge. In addition to offsetting existing potable water demands with recycled water supplies, this is accomplished by supplying in-lieu and injected recharge to the Pleasant Valley basin and south Oxnard Plain areas where it is needed most. A similar amount of water would be pumped from the Oxnard Plain Forebay basin. This strategy moves a considerable amount of extractions from areas that are overpumped to the easily-recharged Oxnard Plain Forebay basin.

Because M&I non-potable and agricultural demand is lower in the winter and recycled water cannot be effectively utilized during that time, a direct recharge component is necessary to accommodate the winter quantities of recycled water. A configuration of injection wells along Highway 1 and Hueneme Road was examined using the Ventura Regional Groundwater Model; this conceptual configuration is discussed in the EIR for the GREAT Project (City of Oxnard, 2005). Injecting water during only a portion of the year is less effective than with full-time injection; the addition of supplemental waters to use for injection is discussed as another strategy of this management plan.

Two FCGMA policy issues need to be addressed relative to the GREAT project. The FCGMA has allowed a one-for-one earning of storage credits – one acre-foot of stored water equals one acre-foot of storage credits – that has been applied to such projects as Calleguas MWD's Las Posas ASR project. When water is injected into a groundwater barrier to contain saline intrusion, however, some of the injected water will likely be tainted by the saline waters. The policy question then becomes whether the entire injected water should earn one-for-one storage credits; this is largely a policy decision rather than a technical decision.

The other FCGMA policy issue relates to pumping the storage credits from the Oxnard Plain Forebay basin. Moving the location of pumping to the Forebay is beneficial to the Pleasant Valley and Oxnard Plain basins, providing that the added pumping stress in the Forebay can be accommodated. For other strategies that involve pumping in the Forebay (e.g., Saticoy Wellfield, Supplemental M&I Water Program), there is a caveat that pumping not occur when groundwater levels have dropped below a threshold that applies to the use of water from the Freeman Diversion as a grant condition from the State Water Resources Control Board (available Forebay storage of 80,000 AF, using two index wells). Such a caveat is also appropriate for the GREAT project. The City of Oxnard can accommodate such an operational requirement by shifting its pumping to wells in the Oxnard Plain just outside of the Forebay when groundwater levels are low in the Forebay. The FCGMA should implement a general policy for all projects that shift pumping from overdrafted areas to the Forebay.

In addition, there are water quality concerns with injection of recycled water. The GREAT project will be performing a Title 22 analysis to permit this injection, which is administered by the Los Angeles Regional Water Quality Control Board with input from the California Department of Health Services. Water quality monitoring will be required by the permit; the FCGMA should review any proposed monitoring and comment to the Regional Board as needed.

9.1.2 Potential Effectiveness

This planned GREAT project would implement one of the strategies likely to be successful in restoring groundwater levels in the Pleasant Valley and Oxnard Plain basins. As part of the EIR for this project, the Regional Groundwater Model was used to test the effects of the project. The project was tested both at the lower initial yield and at full implementation. The effectiveness of the project must be judged by balancing raising Lower Aquifer System water levels in the Pleasant Valley basin and south Oxnard Plain areas against lowering water levels in the Oxnard Plain Forebay basin. The groundwater model indicated water levels in the LAS beneath the southern Oxnard Plain basin and the Pleasant Valley basin would rise by as much as 70 feet, whereas UAS water levels in the Forebay basin would only drop by about 5 feet during wet periods and 20 feet during dry periods. Thus, the project will have to carefully balance the positive and negative effects on water levels. Potential mitigation of lowered water levels in the Forebay include inducing more recharge from existing facilities and from potential increased diversion rights at the Freeman Diversion. The results of the groundwater modeling suggest that BMOs for groundwater levels would be met 51% of the time in the Upper Aquifer (compared to 51% with current management strategies) and 36% of the time in the Lower Aquifer (compared to 5% with current management strategies) with full construction of the GREAT project.

If current recharge is reduced in the Forebay because of required fish flows or other reasons, then the Forebay basin may not be able to accommodate increased pumping, particularly in dryer periods. The City of Oxnard will conduct a monitoring program as part of the GREAT project to measure effects of the project. It would be prudent for the FCGMA to have a written agreement on operation of the GREAT project to ensure long-term operation of the project would continue to meet Agency strategies.

9.2 SOUTH LAS POSAS BASIN PUMP/TREAT

This management strategy is ranked high because it is in a mature stage of design and the problem that it aims to help solve is an ongoing problem for the Las Posas basin that needs a rapid solution to prevent further water quality degradation.

9.2.1 Description

As discussed in section 5.1.3 *High Salinity Associated with High Groundwater Levels*, high groundwater levels in the South Las Posas basin have apparently dissolved salts from the unsaturated portions of the shallow aquifer and created a mound of water more saline than ambient groundwater. One potential mitigation measure would be to pump the saline groundwater from the shallow aquifer, creating space in the aquifer thus allowing less-saline winter storm water to percolate into the aquifer. Under the current conditions, the majority of these winter flows now bypass the recharge areas because there is no available storage in the shallow aquifer. If implemented, this strategy would involve the pumped saline water being blended with low-chloride water and/or desalinated before delivery to customers.

Ventura County Waterworks Districts #1 (Moorpark) and #19 (Somis) are working with the Calleguas MWD to design and fund such a pilot project in the South Las Posas basin. The pumping associated with such a project would be in excess of current FCGMA allocations and would require approval of the FCGMA Board prior to implementation. Under FCGMA Resolution 2003-03, the Board indicated that upon its review and approval, it may change or alter an allocation for pumping from the South Las Posas basin to accommodate a responsible entity that submits a plan to render this groundwater usable. A general FCGMA policy for these types of projects in the future is discussed in section 11.3 *Recommended Additions to FCGMA Policies.*

9.2.2 Potential Effectiveness

The effectiveness of this particular strategy can be evaluated using two criteria. The first is the overall reduction in salts in the South Las Posas basin because higher-salinity groundwater is extracted and treated, removing salts from the system. The improvement in water quality in the basin would depend upon the amount of groundwater extracted and the amount of water recharged versus the ability of the aquifer or other sources to contribute additional dissolved salts. Another measurement of effectiveness would be the efficacy of drawing down the shallow groundwater to create space for recharge of better quality rain water. Greater drawdown could create conditions more favorable to recharge thus allowing more “fresh water” into the basin. It could also create space for addition salt-impacted waters. Thus, there are several factors that control the effectiveness of removing salts by pumping and treating the groundwater.

It is not possible at this time to adequately combine the factors to determine overall potential changes in water quality, although it is likely that dissolved salts removed during extraction and treatment would remove at least a portion of the salt load in the basin. Further analysis of nature and extent of the of the salts, quantification of the salt inputs (for example, mass balance), and evaluation of potential removal efficacy may be necessary to estimate the potential success of this strategy.

9.3 DEVELOPMENT OF BRACKISH GROUNDWATER, PLEASANT VALLEY BASIN

This strategy is also highly ranked because it can be implemented relatively quickly, may prevent water quality degradation in the northern Pleasant Valley basin, and would reduce pumping in the middle of the largest pumping depression in the Pleasant Valley basin.

9.3.1 Description

There are additional areas along Calleguas Creek besides the South Las Posas basin where groundwater has elevated salinity. Base flow from the Arroyo Las Posas has migrated completely across the South and East Las Posas basins and into the northernmost Pleasant Valley basin, providing a source of recharge to this portion of the Pleasant Valley basin. However, this recharge water has created water quality problems for groundwater pumpers. There are additional areas along Calleguas Creek besides the South Las Posas basin where groundwater has elevated salinity. Base flow from the Arroyo Las Posas has migrated completely across the South and East Las Posas basins and into the northernmost Pleasant Valley basin, providing a source of recharge to this portion of the Pleasant Valley basin. However, this recharge water has created water quality problems for groundwater pumpers. City of Camarillo wells in this area have experienced increased salts as groundwater levels have risen over the last decade (Figure 21), similar to the condition described in section 9.2 *South Las Posas Basin Pump/Treat*.

It is not yet clear if this recharge water from the Arroyo Las Posas will create a mound of poorer-quality groundwater that would move out into the main portion of the Pleasant Valley basin under recharge conditions. This would depend upon how well-connected the recharge area is to the main portion of the LAS in the Pleasant Valley basin. The City of Camarillo is considering a strategy to move some of its current pumping from the area of the LAS pumping depression in the central portion of the Pleasant Valley basin to the northern portion of the basin where rise in poorer-quality groundwater is being observed. Under this plan, the poorer-quality water would be extracted and desalinated in a similar manner to the South Las Posas basin project.

The City of Camarillo has assessed the feasibility of constructing a Groundwater Treatment Facility that would be located in the Somis Gap area of the Pleasant Valley Basin (Black and Veatch, 2005). The study determined the project to be technically feasible and would allow Camarillo to halt pumping from an area of the LAS with depressed groundwater levels and instead pump in an area of rising groundwater levels.

Camrosa Water District is considering another type of project that potentially develops the use of brackish groundwater. In an area of the eastern portion of the Pleasant Valley basin near California State University, Channel Islands along Calleguas Creek, Camrosa has been studying the possibility of extracting poor-quality Upper Aquifer(?) water, treating it, and putting it in their delivery system. This water, some of which was used historically, has risen to relatively high levels. Water quality monitoring in the adjacent main portion of the Pleasant Valley basin indicates that this poorer-quality water may not be migrating into the Lower Aquifer of the Pleasant Valley basin. Thus, there is the possibility this water could be pumped without lessening the supply to the Pleasant Valley basin. Some of this area is outside the FCGMA boundary.

Previously, both the potential Camarillo and Camrosa projects would have to be pumped using existing allocations if the well was within the FCGMA boundary. However, as FCGMA policy has evolved over time, pumping of poorer quality groundwater without an allocation has been evaluated on a case-by-case basis. A coordinated effort between the FCGMA and proponents of such projects in the Pleasant Valley basin should be undertaken to determine whether these projects are within this policy. Also, a feasibility analysis of these projects may be necessary to determine the potential net effects to the area and evaluate whether additional pumping would improve or degrade current water quality conditions. This FCGMA policy issue is discussed in more detail in Section 11.3 *Recommended Additions to FCGMA Policies.*

9.3.2 Potential Effectiveness

Pumping and removing salts from groundwater is an effective means of reducing the salt load in a watershed. If the areas from which the salts are removed are hydrologically connected to the main portions of the groundwater basins within the FCGMA, then this removal of salts could also have a positive impact. If the pumping of this poorer-quality groundwater does not affect the main groundwater basins, then these projects would have a neutral effect on the main groundwater basins while increasing the supply of available water. However, if these projects reduce the recharge to the FCGMA groundwater basins without also providing a significant benefit to water quality in these basins, than the projects could have a negative impact on the groundwater basins within the Agency. Any such projects would require monitoring of both water levels and water quality to determine their effect on adjacent areas of the basin.

The potential City of Camarillo project also has an element of moving existing pumping from the area of the Pleasant Valley basin near the Camarillo airport, which has the most-depressed groundwater levels, to an area more favorable for recharge along Arroyo Las Posas. The portion of the potential project related to the pumping reduction was tested using the Ventura Regional Groundwater Model (see Appendix B). Model results indicate that the worst portion of the pumping depression would be decreased considerably in size, leaving a smaller depression in the southern Pleasant Valley basin. The other element of the project, increasing pumping along the Arroyo Las Posas, cannot yet be tested effectively with the model. The model does not now capture the hydrogeology of the northernmost portion of the Pleasant Valley basin – a recharge area of the basin near Somis that is now apparent from monitoring data needs to be better understood and integrated into the model.

9.4 NON-EXPORT OF FCGMA WATER

This strategy is important in preventing additional un-authorized pumping within FCGMA basins, where additional strategies are required to mitigate current pumping. The strategy can also be implemented rather rapidly through FCGMA actions.

9.4.1 Description

Current policies and ordinances limit the use of groundwater produced from within the FCGMA to only those areas within the boundaries of the Agency with only rare exceptions. In 1997, original or prior historical uses outside the FCGMA boundary that were not known in 1985 were allowed through grandfathering of these uses. Since 1997, however, recent aerial photo analysis of new developments and additional crops grown near the FCGMA boundary indicate that there is a “fringe” of crops or additional lands being irrigated outside the boundary that are apparently being irrigated by groundwater produced from within the FCGMA. In most cases, these crops are contiguous across the FCGMA boundary from inside the boundary to outside the boundary; in some cases, the crops are grown on a parcel that spans the boundary. Some of these crops may have been planted in earlier years, but air photo analyses indicate that a portion of the crops have been planted in the last several years.

When the FCGMA was formed, it was envisioned that some undeveloped acreage within the FCGMA would be developed in the future and would create a new water use. A baseline allocation of one acre-feet per acre of water was to be allocated to any newly-developed lands. However, this baseline allocation was only for land within the FCGMA boundaries. If groundwater produced from inside the FCGMA boundaries was used on adjacent hillsides outside of the FCGMA boundary, this new irrigation would provide considerable extra draft on

the groundwater basins. This additional draft on the aquifers is counter to all the FCGMA policies aimed at reducing pumping in the overdrafted aquifers.

Preventing this additional draft on the aquifers is clearly a high priority of this management plan. It appears that current ordinances and policies of the FCGMA may be sufficient to deal with its export issue, but this should be reviewed. What is needed is a regular procedure to both educate pumpers of the export policy and to identify areas where this policy has been violated. It is recommended that the FCGMA developed such a procedure and determine how to address past and current violations of this policy.

9.4.2 Potential Effectiveness

Preventing additional draft on the groundwater basins of the FCGMA is equivalent in effectiveness to pumping reductions. Many of the areas where water is exported across the FCGMA boundary are adjacent to the Pleasant Valley and Las Posas basins where lowered groundwater levels are particularly apparent. Therefore, much of this additional draft on the groundwater basins is occurring in the areas of the aquifer that can least sustain them. This fact increases the effectiveness of preventing these water exports.

9.5 CONTINUATION OF 25% PUMPING REDUCTION

This strategy is already in place, but is being reviewed by the FCGMA Board.

9.5.1 Description

Current FCGMA management strategies include the 25% reduction in pumping allocation that was called for in the original management plan. This management strategy is to continue the planned reductions as they were originality intended -- the planned reduction to 20% of allocation occurring during 2007 (delayed from 2005) and the 25% reduction occurring according to the 2010 schedule. These reductions were to stay in force until the FCGMA basins are no longer in overdraft and there is sufficient water for recharge to compensate for the increased pumping created when the restrictions are removed.

9.5.2 Potential Effectiveness

The original 25% pumping reduction has had the effect of reducing both M&I pumping and agricultural pumping (see section 8.3 *Effectiveness To-Date of Current Management Strategies*). The effect of continuing the phased reductions to the full 25% reduction was modeled using the Ventura Regional Groundwater Model. This model scenario assumed that pumping reductions beyond the current 15% reduction were applied only to M&I pumping; it was assumed that any agricultural wells currently using their reduced pumping allocation for FCGMA reporting would simply shift to an efficiency calculation, rather than further reduce pumping. The results of the modeling suggest that these additional pumping reductions, which amount to 3,800 acre-feet per year throughout the FCGMA, would raise groundwater levels in the Upper Aquifer System by a little over one foot at the Port Hueneme coastline and raise Lower Aquifer System groundwater levels by an average of a little over two feet. BMOs for groundwater levels would be met 53% of the time in the Upper Aquifer (compared to 51% with current management strategies) and 7% of the time in the Lower Aquifer (compared to 5% with current management strategies).

9.6 RIVERPARK RECHARGE PITS

This strategy is being implemented through a Joint Powers Agreement between the City of Oxnard and United Water Conservation District.

9.6.1 Description

Decades of relatively unrestricted deep gravel mining beginning in the 1950s created a series of large open pits (formerly owned by S.P. Milling) along the Santa Clara River within the Oxnard Plain Forebay basin that are now unused and expose groundwater in the pits to evaporation and potential contamination. As part of an agreement between the City of Oxnard, a developer (RiverPark), the FCGMA, County of Ventura, and UWCD, these pits are being stabilized and urban surface drainage is being diverted away from the pits. If all the work on the pits is accomplished appropriately, the plan is to have UWCD operate the pits as a recharge and storage facility. UWCD would build a water conveyance system that would allow flood flows diverted at the Freeman Diversion to be transported to the RiverPark pits for recharge. These facilities would allow increased diversions of the Santa Clara River; silt-laden river water could be diverted and recharged, water that now must be bypassed and which flows to the ocean following large rainstorms.

Use of the RiverPark pits serves two purposes for the aquifer. First, the facilities will allow additional recharge to the aquifers from silty water that is now bypassed at the Freeman Diversion. Second, the project moves a portion of the Forebay recharge further down-gradient in the basin, away from the recharge mound that forms in the upgradient portions of the Forebay basin beneath the UWCD Saticoy Spreading Grounds. Thus, more recharge water will infiltrate into the Forebay during wet years, a time when a recharge mound builds in the upgradient portion of the basin and reduces recharge rates in existing spreading facilities. No FCGMA policy changes would be required to implement this project.

9.6.2 Potential Effectiveness

UWCD has analyzed the effectiveness of the RiverPark recharge project by combining UWCD's surface water model with the Ventura Regional Groundwater Model. This modeling suggests the yield of the project could be as much as 4,000 AFY (combined with a higher diversion rate at the Freeman Diversion), with the annual yield ranging from 400 AF in dry years to 11,500 AF in wet years. This additional recharge in the Forebay will raise water levels in the basin, which helps pressurize the greater Oxnard Plain. In addition, higher water levels in the Forebay basin will help mitigate the effects of other projects described in this management plan that rely on increased pumping in the Forebay.

The results of the groundwater modeling suggest that BMOs for groundwater levels would be met 52% of the time in the Upper Aquifer (compared to 51% with current management strategies) and 6% of the time in the Lower Aquifer (compared to 5% with current management strategies).

10.0 POTENTIAL FUTURE MANAGEMENT STRATEGIES

Groundwater modeling indicates that additional management strategies are required to eliminate overdraft in both Upper Aquifer and Lower Aquifer System aquifers and to prevent further seawater intrusion along the coastline and saline intrusion in more inland areas. A variety of potential future strategies are ranked below, with those that are the most effective and

can be implemented the soonest discussed first. Because of the large number of strategies, they are separated into those that can be implemented within 5 years, 10 years, 15 years, and greater than 15 years.

10.1 5-YEAR STRATEGIES

The following strategies that can be implemented within five years are ranked by order of effectiveness and/or importance.

10.1.1 5-Year Update of FCGMA Management Plan

10.1.1.1 Description

It is recommended that this Plan be updated every five years. This update should include a status of how the BMOs are being met, effectiveness of strategies that have been implemented, status of other recommended strategies, and recommendations for any additional management strategies.

10.1.1.2 Potential Effectiveness

Updating the Plan every five years will be an effective milestone for the FCGMA to evaluate and re-evaluate its course of action. This will keep the FCGMA's goals and its successes and failures front and center where they belong.

10.1.2 A Plan To Shift Some Pumping Back to Upper Aquifer System

10.1.2.1 Description

One of the initial groundwater management strategies for the FCGMA was to shift pumping to the Lower Aquifer System from the Upper Aquifer System to relieve pumping stresses that created a pumping trough in the UAS on the Oxnard Plain basin. This was accomplished by requiring new and replacement wells to be drilled in the LAS. Now that it is clear that the LAS cannot accommodate all this new pumping, it would be prudent to move some of the LAS pumping back to the UAS. However, this must be done very carefully to prevent a shift that would again create problems in the UAS.

A shift in pumping back to the UAS has already been initiated through County well permitting requirements. However, this shift cannot be uniformly enforced across the basins within the FCGMA. A detailed plan must be formulated that takes into account local recharge sources, hydrologic connection between portions of the basin, and current/future in-lieu recharge projects. This should be accomplished through use of the Ventura Regional Groundwater Model in fine-tuning the details of this plan, with the FCGMA, VCWPD, and UWCD working together.

10.1.2.2 Potential Effectiveness

By shifting pumping from the LAS to the UAS in areas where the Lower Aquifer System is not readily recharged could substantially raise groundwater levels in critical areas of the basins. This strategy only works, however, if the increased UAS pumping can be accommodated by the shift in pumping. For this reason, a sophisticated tool such as the Ventura Regional Groundwater Model is required to predict where and how much pumping should be shifted.

For an indication of how this strategy might work, 5,000 AFY of Lower Aquifer pumping was moved to the Upper Aquifer in the triangular area of the south Oxnard Plain from the Port

Hueneme zone of low conductance (fault?) to the western edge of the Pleasant Valley basin. The results of the groundwater modeling suggest that BMOs for groundwater levels would be met 50% of the time in the Upper Aquifer (compared to 51% with current management strategies) and 9% of the time in the Lower Aquifer (compared to 5% with current management strategies) – raising Lower Aquifer water levels at BMO wells an average of 8 feet (Table 8).

10.1.3 Protect Current Sources of Recharge

10.1.3.1 Description

Protecting current sources of recharge to the FCGMA basins is particularly important as we face additional groundwater management problems. Maintaining Santa Clara River flows and water quality has been a focus for Ventura County over the past decade. The County of Ventura and UWCD went to court in the late 1990s to ensure that increasing land development and water use in the Santa Clarita area of Los Angeles County did not jeopardize Santa Clara River flows across the County line into Ventura County. More recently, local water agencies and especially the farming community have expressed concerned about rising chlorides from waste water discharges coming from Los Angeles County. It is very important to the FCGMA to continue to protect this important source of groundwater recharge through support of local agencies who deal directly with these issues.

On Calleguas Creek, where a portion of the flow originates from discharges produced by wastewater treatment plants, downstream users have come to rely on the increased flows in the Creek for recharge. Agreements on wastewater discharges flowing down Arroyo Santa Rosa resulted in the Conejo Creek project. Similar flows along the Arroyo Las Posas provide recharge to the Las Posas basins and the northern Pleasant Valley basin. The Arroyo Las Posas flows are augmented by discharges from the Simi Valley and Moorpark wastewater treatment plants and from dewatering of shallow groundwater in western Simi Valley. Similar to the Santa Clara River, maintenance of these flows is necessary to recharge the downstream groundwater basins. As such, the quantitative effects of shallow groundwater extraction in the Las Posas and northern Pleasant Valley Basins may need to be evaluated for the potential impacts to downstream surface water flows.

10.1.3.2 Potential Effectiveness

The current sources of recharge to the groundwater basins within the FCGMA are essential not only in maintaining current management strategies but also in implementing future strategies. Without protecting current recharge sources, the overdraft within the FCGMA could increase and negate some of the benefits realized by projects and strategies that have been very successful to date. Therefore, this strategy is one of the most effective in reducing overdraft, and is an essential FCGMA strategy.

10.1.4 Limitation on Nitrate Sources in Portions of the Oxnard Plain Forebay Basin

10.1.4.1 Description

High nitrate concentrations are present in groundwater in portions of the Oxnard Plain Forebay basin (see section 5.1.4 *Nitrate in Groundwater*). The source of a portion of this nitrate is from fertilizer use on overlying crops. A thick vadose zone (unsaturated zone) between the crops and the groundwater table allows natural processes to degrade some of the nitrate before it percolates with irrigation waters down to groundwater. Gravel pits within the Forebay were generally mined to five feet above historic groundwater levels, with reclamation plan restrictions

on growing high-nitrate use crops within the mined pits where the vadose zone is so limited. As reclamation is completed, however, there are no longer crop restrictions. Thus, high-nitrate crops could be grown in these former gravel basins with a limited vadose zone.

The FCGMA should take a leading role in preventing further nitrate contamination in the Forebay. The FCGMA should work with land use planners and the Regional Water Quality Control Board to ensure that high-nitrate crops are not grown in areas with a limited vadose zone caused by gravel mining.

10.1.4.2 Potential Effectiveness

Limiting sources of nitrate is the most effective method of reducing nitrate in groundwater. Because nitrate is a primary drinking water contaminant that can cause serious adverse health effects and because the Forebay is a primary source of drinking water for consumers across the Oxnard Plain, limiting sources of nitrate should be a high priority for the FCGMA.

10.1.5 Policy on Recovery of Credits from Oxnard Plain Forebay Basin

10.1.5.1 Description

There are several management strategies that involve increased pumping in the Oxnard Plain Forebay basin to either supply water to overdrafted areas (e.g., Saticoy Wellfield) or to recover FCGMA credits earned by reducing pumping in overdrafted areas (e.g., Supplemental M&I Water Program, GREAT project). Using the Forebay in such a manner is definitely beneficial to both the Pleasant Valley and Oxnard Plain basins – however, it must be done in a manner such that the added pumping stress in the Forebay can be accommodated. For the Saticoy Wellfield and the Supplemental M&I Program, there is a caveat that pumping not occur when groundwater levels have dropped below a certain threshold. This threshold is the same as the grant condition applied to the use of water from the Freeman Diversion by the State Water Resources Control Board – that there is no more than 80,000 AF of available storage in the Forebay. In practice, this means that the average of combined groundwater levels of two index wells in the Forebay be above a certain level.

To assure a uniform policy, the FCGMA should implement a general policy for all projects that use FCGMA credits to shift pumping from overdrafted areas to the Forebay. It is recommended that this policy follow the State Board criteria discussed above and delineated in Table 9, or equivalent criteria if these wells are not available in the future. In addition, pumping using these credits should not adversely impact other pumpers in the basin. How these adverse impacts are defined will depend upon the specifics of each project and will have to be detailed when individual projects are approved by the FCGMA. It is also recommended that the FCGMA establish a policy for prioritizing the types of projects that can use transferred credits to pump in the Forebay. This will be especially important if there is more demand for these transfer projects than the Forebay can accommodate.

Wells Used	*Groundwater Elevations*
2N/22W-12R1 ***2N/22W-22R1***	>17 ft above msl for combined groundwater elevations

Table 9. Criteria for using Credits for extraction in the Oxnard Plain Forebay basin.

10.1.5.2 Potential Effectiveness

Shifting pumping from an impacted area to the Forebay through the use of FCGMA credits is a very effective strategy, providing that this pumping doesn't adversely impact the Forebay. Using the criteria outlined in the previous paragraph, Forebay impacts can be avoided or mitigated.

10.1.6 Verification of Extraction Reporting

10.1.6.1 Description

Meters are required to be installed on all but domestic wells by Chapter 3 of Ordinance 8, although not all pumpers have installed meters or use their meters for reporting extractions. In addition, all extractions are self-reported and the accuracy of FCGMA extraction records relies on correct self-reporting. To ensure the accuracy of extraction records, which are used by the FCGMA and others to determine the changing pumping stress on the aquifers in the FCGMA, it is recommended that the FCGMA make periodic random checks on a small number of meters annually to ensure that meters are correctly installed and that the extractions reported by pumpers to the FCGMA correctly reflect actual meter readings.

10.1.6.2 Potential Effectiveness

The accuracy of FCGMA reporting records is important for extraction trends, determination of credits and efficiency, and overall compliance with pumping reductions. It is essential that all pumpers believe that everyone is "playing by the rules" and a verification procedure could help ensure that pumpers continue to believe that everyone is in this together.

10.1.7 Separate Management Strategies for Some Basins

10.1.7.1 Description

The initial FCGMA Management Plan treated all the FCGMA basins the same in that the same rules applied to all basins. We now know more about how these basins are interconnected and whether some of the basins have unique circumstances. For example, we know that the East Las Posas basin is largely hydraulically disconnected from both the West Las Posas basin and the northern Pleasant Valley basin. However, these basins also share some common elements; for instance, the East Las Posas basin and northern Pleasant Valley basin share a common recharge source, the Arroyo Las Posas. One element common to all the FCGMA basins is that they are overdrafted. Current FCGMA management strategies such as pumping reductions are thus appropriate to all the basins.

The FCGMA has considered localized management strategies. In the South Las Posas basin, for instance, a project to pump and treat poor-quality water without an allocation has been considered by the FCGMA Board. The strategy of moving pumping away from coastal areas applies largely to the Oxnard plain basin.

New strategies in this Management Plan are also applied to specific situations in each basin. The Management Plan for the East Las Posas basin, included as Appendix C, addresses issues specific to the operation of Calleguas' ASR project. This plan is adopted as part of the overall FCGMA Management Plan and the FCGMA Board will consider how its elements will be integrated into FCGMA ordinances. Likewise, the strategies for potentially pumping shallow groundwater along Calleguas Creek are also specific to the Pleasant Valley basin. The basin management objectives of this plan are also specific to each basin.

The FCGMA-wide strategy of pumping reductions across all FCGMA basins engenders the most discussion of whether this is appropriate in all cases. As discussed in section 9.5 *Continuation of 25% Pumping Reduction*, these reductions are appropriate across all FCGMA basins as long as there is overdraft in all basins. It would be appropriate, however, to re-evaluate any future additional pumping reductions by examining each basin separately.

10.1.7.2 Potential Effectiveness

The current strategy of allowing specific policies to address individual basin problems is the most effective means of addressing the overdraft and water quality problems within the FCGMA.

10.1.8 FCGMA Boundary

10.1.8.1 Description

The FCGMA boundary is defined as the outer edge of Fox Canyon Aquifer. In most areas, this outer edge is either the outcrop of the Fox Canyon Aquifer (such as along the north and east flanks of the Las Posas basin) or is the point where the Fox Canyon Aquifer onlaps older rocks (such as along the east side of the Pleasant Valley basin). However, along the western boundary of the FCGMA, it is defined as the western edge of the Oxnard Plain Forebay and Oxnard Plain basins (west of which the Fox Canyon Aquifer is not identified). Thus, this western boundary is also the boundary between the Oxnard Plain and Mound basins or the Oxnard Plain Forebay and Santa Paula basins.

Recent work done as part of the Santa Paula Basin Stipulated Judgment has moved the southern boundary of the Santa Paula basin farther north to coincide with the current known location of the Oak Ridge fault. This boundary of the Santa Paula basin was agreed to by experts working for the parties in the Santa Paula Basin Stipulated Judgment, including UWCD, the city of San Buenaventura, and the Santa Paula Basin Pumpers Association. In addition, UWCD groundwater staff have carefully monitored groundwater elevations in wells on both sides of this Santa Paula basin boundary and have confirmed that groundwater elevations south of the adjudicated basin boundary respond to recharge operations in the Oxnard Plain Forebay basin, whereas groundwater elevations to the north of the boundary do not. In addition, there is a significant discontinuity in groundwater elevations from one side of this boundary to the other.

The practical effect of this change in the Santa Paula basin boundary is that there is now a small region between the old and new boundary of the Santa Paula basin (Figure 28) that is not managed under either the Santa Paula Basin Stipulated Judgment or FCGMA rules and regulations. Because this area is in hydrologic continuity with the remainder of the Oxnard Plain Forebay basin, it would be appropriate to move the FCGMA boundary slightly north and east to coincide with the reinterpreted boundary of the Santa Paula basin and to reflect the reality of the continuity of this area with the Oxnard Plain Forebay basin. It is recommended that the FCGMA consider making this boundary change based on the technical information available.

10.1.8.2 Potential Effectiveness

By allowing a strip of land to be unmanaged through either the Santa Paula Stipulated Judgment or the FCGMA, it is possible to site wells on this strip of land and directly benefit from the significant recharge that takes place in the Oxnard Plain Forebay basin, meanwhile adversely affecting downgradient portions of the aquifers that rely on this recharge to repel seawater intrusion. By bringing this area into the FCGMA, wells sited in a strip of land will appropriately be subject to FCGMA extraction allocations and other management strategies. If the land described here is not brought into the FCGMA, it could invite unmanaged pumping that would adversely affect the basins within the FCGMA.

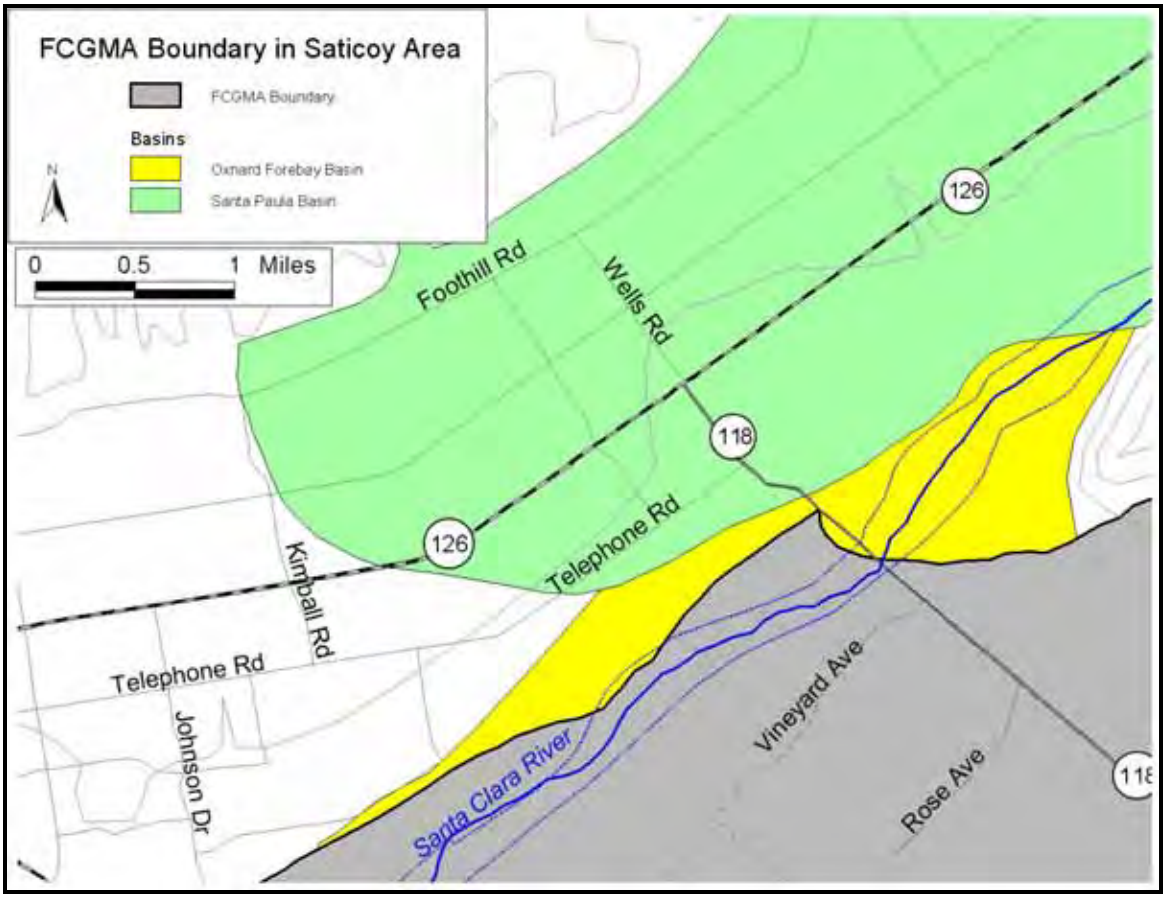


Figure 28. Area southeast of Santa Paula basin where FCGMA boundary is not coincident with current basin boundaries. The yellow area represents the portion of the Oxnard Forebay basin which is currently outside of the FCGMA.

10.1.9 Irrigation Efficiency Calculations

10.1.9.1 Description

Current FCGMA policies allow agricultural pumpers to meet a crop efficiency standard for their irrigation as an alternative to the Historical or Baseline allocation and credit program. This option is called the Irrigation Efficiency allocation. FCGMA efficiency calculations are based on daily information from a set of weather information gathering stations maintained across the FCGMA. Water demand for an index crop (cool season grass) is calculated daily. A crop factor is then applied to this index water demand to adjust the required water demand downward for four major categories of crops grown within the FCGMA. The final step in calculating crop irrigation efficiency is to adjust for 80% irrigation efficiency by taking the annual allowed water demand for each of the four major crop types and allowing an extra 20% water use for salt leaching and irrigation-system inefficiencies. The Irrigation Efficiency allocation was intentionally designed to make it possible for growers to sustain profitable agriculture within the FCGMA, but at the same time raise awareness of water conservation. The FCGMA should review the effectiveness of the efficiency allocation periodically to ensure that it being equitably applied.

In practice, Irrigation Efficiencies that pumpers report to the FCGMA are as a rule quite high – 100% to as much as 300% (water use as little as one third of estimated demand). This

suggests the method of calculating Irrigation Efficiency may not be appropriate. Improving the method would not affect the vast majority of pumpers who now report high efficiencies. However, it may identify any pumpers who are not using irrigation water efficiently by making it more difficult for them to reach the minimum required efficiency. It is recommended that the FCGMA Board consider a strategy to examine the method of calculating Irrigation Efficiency. Topics to consider might include adjusting crop demand for more specific crops, re-examining the 80% efficiency requirement, and ensuring that acreages reported be actual irrigated acreage rather than total owned acreage.

10.1.9.2 Potential Effectiveness

It is not clear exactly what amount of reduction in agricultural pumping would occur by adjusting the Irrigation Efficiency calculation. As documented elsewhere in this Management Plan, agricultural pumping reported to the FCGMA has been reduced by as much as 30% since the FCGMA pumping restrictions were initiated. Thus, most agricultural pumpers have apparently increased their irrigation efficiency substantially over the last 15 years. As discussed above, the vast majority of those efficient pumpers are unlikely to be affected by any changes in the Irrigation Efficiency calculation. However, changes in the efficiency calculation might affect those pumpers who have not already improved their irrigation efficiency.

10.1.10 Additional Storage Projects in Overdrafted Basins

10.1.10.1 Description

Aquifer Storage and Recovery (ASR) projects, such as the Las Posas Basin ASR project, provide benefits to an overdrafted basin because water stored in the basin raises groundwater levels above what they would be without the project. The water is not permanently devoted to the basin, but is removed from time to time, generally during periods of water shortage in droughts or emergencies. In practice, the water generally remains in storage for multiple years and is not completely removed during extraction periods. Thus, there is a long-term benefit to the basin. Such projects need to be carefully designed so that neither recharge nor recovery adversely affects other users in the basin. The recovery periods generally cause a significant decline in water levels in the vicinity of the ASR wellfield, especially if the ASR is operated in a confined aquifer setting.

ASR projects are most effective in areas where groundwater levels have been substantially lowered by overdrafting and where the physical properties of the in-situ geologic formation are amenable to both efficient injection and efficient extraction. Within the FCGMA, the Pleasant Valley and south Oxnard Plain areas are both candidates for ASR projects under current conditions because groundwater elevations are continuously below sea level due to overpumping and the geologic formations in these areas have relatively high permeability and transmissivity (e.g., Densmore, 1996; Hanson et al., 2003). To make this strategy effective, saline intrusion currently evident in the south Oxnard Plain would need to be hydrologically isolated from any ASR project to protect the stored water from degradation and to prevent additional intrusion of saline waters during extraction of the stored water. An ASR project could potentially be paired with a barrier well project (discussed in section 10.3.1 *Barrier Wells in South Oxnard Plain*).

The available storage space in the Pleasant Valley and southern Oxnard Plain basins has not been rigorously calculated. The amount of water that has been extracted from coastal areas in excess of recharge has been calculate as about one million acre-feet since the 1950s (UWCD, 2006), with permanent loss of aquifer storage capability from resulting subsidence of about 200,000 AF. The remaining 800,000 AF of potential storage space in the aquifer has been

partially refilled by intruded seawater, but there remains a large amount of potential aquifer storage space available.

10.1.10.2 Potential Effectiveness

Storage projects can be effective in restoring groundwater levels in overdrafted basins. However, the restoration only occurs during the period when water is stored in the basin. For many storage projects, the period of storage can be many years and not all the stored water may be removed during the extraction phase of the project – in that case, there is a long-term positive effect on the basin.

There are two issues that must be addressed with any storage project to ensure that the project does not adversely impact a basin: 1) the storage project must not interfere with recharge to the basin by creating groundwater levels so high that there is rejected natural and artificial recharge; and 2) extraction of stored water must not adversely affect the basin and other pumpers by pulling in poor-quality water, dewatering clays and creating subsidence, or creating large cones of depression around project extraction wells that prevent nearby pumpers from using their wells efficiently. Mitigation of such potential impacts may be feasible. Higher groundwater levels from storage projects may also mask continuing overdraft in a basin, so it is essential to continually determine what the basin condition would be without the storage project. Such safeguards are part of the East Las Posas Basin Management Plan (Appendix C) with regards to the Las Posas Basin ASR project.

10.1.11 Penalties Used to Purchase Replacement Water

10.1.11.1 Description

The FCGMA charges a penalty to pumpers for extracting more water than is allowed under the various allocations (Historical, Baseline, Irrigation Efficiency). Up to 2006, this has not generated significant revenue because few pumpers have exceeded their allocation. There may be circumstances in the future, however, where this may not be true. The increased groundwater use caused by the over-pumping could be offset by using the fees generated by penalties to purchase replacement water for the extracted groundwater. This is a strategy used by the Orange County Water District, where the penalty is called a Basin Assessment Fee. The FCGMA has several options to obtain additional water, including purchasing unused portions of Ventura County's State Water Allocation, paying M&I users to increase their imported/groundwater blend, and purchase of water through a variety of programs from the State or others such as turn-back pool water, Dry-Year Purchase Program, and other programs. This water could be delivered through either conveyance down the Santa Clara River or Calleguas MWD's pipeline, depending upon how the water was purchased and used.

10.1.11.2 Potential Effectiveness

A FCGMA policy to purchase water to replace over-pumped groundwater would have a direct effect on the aquifers. If the replacement was done judiciously, more water could be purchased than was originally pumped and/or the water could be used for recharge particularly stressed areas such as the southern Oxnard Plain basin or the Pleasant Valley basin. Thus, the replacement water could actually improve groundwater conditions.

10.1.12 Additional Water Conservation

10.1.12.1 Description

There is a growing move to require the use of recycled water to replace non-potable uses in new developments in California. The FCGMA could encourage local cities and other planning agencies to require a dual plumbing system (where it meets plumbing code) in new developments where it is practical to deliver recycled water of suitable quality. The FCGMA could make this policy known to the permitting agencies through both a resolution sent to these organizations and by commenting on this issue when reviewing EIRs and other planning documents. This policy would be consistent with the requirements in some areas within the Agency, such as the County policy that requires all new golf courses to use 100% reclaimed water and the City of Camarillo that requires dual plumbing systems in new larger developments.

Another water conservation strategy is to require maximum feasible infiltration of stormwater within a new development (Low Impact Development). This strategy is only effective when the development overlies a recharge area for the aquifer. When a development overlies perched water or sealing clay near the surface, the infiltrated water does not benefit the aquifers.

10.1.12.2 Potential Effectiveness

The effectiveness of this policy in reducing pumping depends upon the amount of groundwater that would otherwise be pumped from groundwater and delivered to the project. Many water purveyors within the FCGMA serve a blend of groundwater and imported water, so the pumping savings would be in the groundwater component. The savings would also depend upon the amount of non-potable water needs or uses within these projects. Where there is substantial landscaping in a new project, for example, the savings in potable water would be more substantial. In developments that require a dual plumbing system, there have been estimated savings of 30% to 40% in potable water use just from outdoor landscaping.

As discussed above, the effectiveness of maximizing recharge of stormwater can be variable. When a development is located in a basin such as the Oxnard Plain Forebay, percolation of rain is an important component of recharge and should be protected. In areas where percolated surface water does not reach the aquifers, the strategy is not effective.

10.1.13 Shelf Life for Conservation Credits

10.1.13.1 Description

The initial 1985 FCGMA Management Plan set the policy that when a well operator pumped less than his allocation in any particular year, Conservation Credits were awarded for the unpumped portion of the allocation. The theory behind the Conservation Credit policy was that pumping would vary between wet and dry years; credits would be earned during wet years when pumping was reduced and the credits would then be used during the dry years when above-average pumping was required. With this scheme, pumping credits would theoretically zero-out at the end of each wet-dry cycle. However, no process was put in place to assure that large numbers of Conservation Credits were not accumulated beyond the end at each wet-dry cycle. The practical result of this policy is large numbers of Conservation Credits continue to accrue to some well owners – as many as tens of thousands of acre-feet of Conservation Credits have accrued to some organizations with multiple wells.

The current method of accumulating Conservation Credits with no expiration date has effectively left a large theoretical pumping debt on the aquifers (equivalent to several years of pumping at current extraction rates). This large debt complicates evaluation of the health of the basin because current groundwater conditions do not reflect this unused pumping debt. This is no different than judging a company's financial condition without considering monetary debt.

To bring FCGMA policy into line with the purpose for which credits were originally intended, several approaches are available. Perhaps the most important approach could be to have a limit on the annual use of these credits so that the aquifers would not be overly stressed in any single year. Another approach could be similar to that used in the adjacent Santa Paula basin, where the Stipulated Judgment from the basin adjudication allows unpumped allocations to be accumulated, but unlike in the FCGMA, any unpumped allocations for a single year expire after seven years. In this manner, accumulated debt is restricted to unpumped allocations earned within any single wet-dry cycle.

If unused credits were to expire after a period of time, the strategy would have to reflect a reasonable management strategy that takes into account the needs of pumpers, which vary by water use. For agricultural pumpers, credits are accrued for both future drought conditions and cropping changes. M&I pumpers may have accrued credits by substituting more-expensive imported water to provide a drought or emergency buffer. To ensure that any change in credit policy reflects these varying management strategies, the FCGMA should consider forming a committee (similar to the one that proposed the policy on calibration of meters) to study the issue and make recommendations on any policy changes. There are two issues that would need to be addressed – the shelf life on credits to be earned in the future and the fate of credits earned in the past.

This policy is not appropriate for Storage Credits, where water is stored for both dry periods and for emergencies such as earthquakes or levee failures in the Sacramento Delta. No change is recommended for Storage Credits.

10.1.13.2 Potential Effectiveness

The current policy for Conservation Credits allowing continuing accumulation makes it difficult to determine the current health of the basin – especially when the current pumping debt is equivalent to about three years' total pumping within the FCGMA. Modifying the FCGMA policy to expire older credits would allow a more accurate view of the health of the basin and would prevent a large pumping debt from accumulating. The effect a changed policy would have on future extractions within the FCGMA is not clear. On one hand, credit holders might be encouraged to pump credits prior to their expiration. This might effectively increase FCGMA pumping over its current levels, because some of these credits are currently being accumulated instead of being pumped. Alternatively, under the current policy of accumulating credits, many years-worth of accumulated credits could be pumped in a single dry year far exceeding any annual recharge, adversely impacting the groundwater basins through pulling in poor-quality waters and/or causing irreversible basin subsidence.

10.2 10-YEAR STRATEGIES

The following strategies that can be implemented within ten years are ranked by order of effectiveness and/or importance.

10.2.1 Additional In-Lieu Recharge to South Oxnard Plain

10.2.1.1 Description

One of the most effective management strategies in reducing overdraft is to supply water directly to overdrafted areas. This in-lieu strategy has been very effective in the Upper Aquifer System, where Santa Clara River water delivered through the Pumping Trough Pipeline has helped to alleviate the pumping trough that has been present for several decades beneath the south Oxnard Plain. Because the Lower Aquifer System now has its own pumping trough beneath the same area, extending the Pumping Trough Pipeline and/or bringing in water from other sources to the south Oxnard Plain would likely be equally as effective.

There are several options available to implement this strategy. UWCD could extend the Pumping Trough Pipeline to supply water to pumpers who are south of the current pipeline. The source of this water would likely be a combination of diverted Santa Clara River water and groundwater pumped from the Saticoy Wellfield located in the Oxnard Plain Forebay basin. UWCD has investigated such a project in the past, but costs were prohibitive. Another method of bringing water to the area would be to use Calleguas MWD's regional brine line (under construction in 2006) to bring recycled or other water from upstream areas, providing this water was of sufficient irrigation suitability. A third option would be to use water from Oxnard's GREAT project either for direct delivery to pumpers or for injection into the Lower Aquifer System. Any water delivered through an in-lieu program to this area should be eligible for credits. If there is any transfer of pumping back to the Oxnard Plain Forebay basin as part of a project using this strategy, then the considerations discussed in section 10.1.5 *Policy on Recovery of Credits from Oxnard Plain Forebay Basin* would be applicable.

10.2.1.2 Potential Effectiveness

Reducing pumping and/or injecting water into the aquifer in areas just inland of seawater intrusion can be a very effective strategy. Simulations of the Ventura Regional Groundwater Model that implement this management strategy have been shown to be effective in reducing the overdraft. For example, when 3,000 AFY of additional water are delivered or injected in the south Oxnard Plain, groundwater levels in the Lower Aquifer System rise by an average of 7 feet. The results of the groundwater modeling suggest that BMOs for groundwater levels would be met 53% of the time in the Upper Aquifer (compared to 51% with current management strategies) and 7% of the time in the Lower Aquifer (compared to 5% with current management strategies).

10.2.2 Import Additional State Water

10.2.2.1 Description

As part of a joint integrated water management plan, UWCD and Calleguas MWD are considering expansion of State Water importation by obtaining additional amounts of Ventura County's State Water allocation on a year-by-year basis when it is not used by other Ventura County agencies. This additional water would likely be delivered to Lake Piru and released as part of UWCD's conservation release to benefit the Oxnard Plain. Currently, State Water is released from Lake Piru by UWCD as part of its conveyance of stored storm water to downstream basins. Typically, a portion of the released water percolates into basins upstream from the Freeman Diversions and the remainder of the water is diverted for recharge (direct and in-lieu). How this additional State Water is used and accounted for will likely depend upon how it is financed.

10.2.2.2 Potential Effectiveness

The effectiveness of new water importation depends upon how the water is recharged to the aquifers or delivered. If this imported water could be delivered to FCGMA pumpers in-lieu of pumping groundwater, then there would be a direct benefit to the aquifers from reduced pumping proportional to the amount of imported water. If, instead, this water was extracted by pumpers and substituted for a like amount of the imported water that would they would otherwise have delivered by Calleguas MWD, then the effects of the importation would be neutral. Thus, the ultimate fate of this additional imported water would govern the effectiveness of the strategy.

The Ventura Regional Groundwater Model was used to test the effectiveness of importing additional State Water. For the model scenario, the water was imported through Lake Piru, released with UWCD's annual conservation release down the Santa Clara River, diverted at the Freeman Diversion, and recharged in the Oxnard Plain Forebay basin. For the model simulation, it was assumed that 10,000 AFY of additional State Water were purchased in dry and average years. The results of the groundwater modeling suggest that Upper Aquifer groundwater levels in the Forebay basin would rise by an average of 6 feet. BMOs for groundwater levels would be met 54% of the time in the Upper Aquifer (compared to 51% with current management strategies) and 7% of the time in the Lower Aquifer (compared to 5% with current management strategies).

10.2.3 Further Destruction of Abandoned or Leaking Wells

10.2.3.1 Description

With grant support, the FCGMA destroyed 49 abandoned or leaking wells that were considered by the FCGMA and UWCD to have the highest potential for cross-contamination from perched waters into the main aquifers within the FCGMA (cost and feasibility were also considered in ranking the wells for destruction). There remains a long list of additional wells that also have the potential for cross contamination of the aquifers. The FCGMA should give a priority to finding additional funds to continue this effort of well destruction.

10.2.3.2 Potential Effectiveness

Destroying abandoned or leaking wells is very effective in preventing cross contamination of aquifers within the FCGMA. In the Oxnard Plain and Pleasant Valley basins, perched waters have a much higher head (elevation) than underlying aquifers, so the conditions for cross contamination are widespread. Although there are documented cases of this cross contamination occurring, it is not known how widespread this has actually occurred.

10.2.4 Additional Monitoring Needs

10.2.4.1 Description

The current groundwater monitoring program has worked well in tracking saline intrusion beneath the Oxnard Plain. This monitoring network, along with a few other monitoring wells, were installed around 1990 by the US Geological Survey with financing provided by local agencies. Since the initial installation of the monitoring network, the continuing monitoring of these wells has been conducted by UWCD, VCWPD, and the City of San Buenaventura. As the saline intrusion on the south Oxnard Plain has moved inland, UWCD has sited and will drill two new multiple-completion monitoring wells inland of the saline intrusion. This increased monitoring program will adequately track water level and water quality trends on the south Oxnard Plain for the next several years.

In the Pleasant Valley basin, additional monitoring wells might be required if chloride levels continue to increase. The location of these potential monitoring wells would depend upon where the chloride increases occur. In the Las Posas basins, most of the existing monitoring utilizes existing production or injection wells. As part of the East Las Posas Basin Management Plan (Appendix C), new monitoring wells would provide information on the effects of the Calleguas Aquifer Storage and Recovery (ASR) project. Any such monitoring wells would likely be drilled by the Calleguas Municipal Water District. Monitoring of these wells would likely become a part of the overall Calleguas ASR monitoring program.

As more management strategies rely on increased pumping in the Oxnard Plain Forebay basin, increased monitoring will be required to ensure Forebay pumpers are not adversely affected or that pumping does not create additional groundwater problems. Increased monitoring in the Forebay has already been planned during operation of the UWCD Saticoy Wellfield. Additional monitoring should be required by the FCGMA for other projects where pumping will be shifted to the Forebay basin. An example is the GREAT project, where a substantial amount of pumping may be shifted to the Forebay; environmental documentation for the project proposes such increased monitoring. The exact monitoring required for any Forebay pumping that uses a transfer of credits should be appropriate to the location of increased pumping. At a minimum, this monitoring should include collection of monthly groundwater levels and quarterly water quality samples (to include constituents of concern such as nitrate and TDS) should include both Forebay monitoring and monitoring between the Forebay and the coast to determine potential effects in coastal groundwater levels.

10.2.4.2 Potential Effectiveness

Monitoring by itself does not solve the overdraft problem, but it is essential in determining the effectiveness of the other management strategies. In particular, monitoring provides the continuing evaluation of whether basin management objectives are being met, and often serves to increase the understanding of the dynamics of the multiple aquifer systems identified within the FCGMA.

10.3 15-YEAR STRATEGIES

The following strategies that can be implemented within 15 years are ranked by order of effectiveness and/or importance.

10.3.1 Barrier Wells in South Oxnard Plain

10.3.1.1 Description

Seawater barrier wells are used extensively in Los Angeles and Orange counties as a means of controlling seawater intrusion. A barrier project injects water along a series of wells creating a mound of recharge water as protection against seawater moving inland. Barrier wells are both expensive and complex, with costs of maintaining a barrier several times higher than for typical facilities in Ventura County such as the Freeman Diversion, spreading ponds, and distribution pipelines. In Los Angeles and Orange counties, there is a significant component of recycled water in the injected water. Thus, special health regulations govern this type of injection and are a necessary component of plans and facilities. In Ventura County, an attempt to construct a seawater barrier in the late 1970s and 1980s by the California Department of Water Resources in the Port Hueneme area was not particularly successful. Since that attempt, barrier wells were not seriously considered again because lower-cost options were identified.

We now know portions of the aquifer on the south Oxnard Plain are very difficult to recharge. In particular, the Lower Aquifer System of the south Oxnard Plain has been largely unaffected by spreading operations in the Oxnard Plain Forebay basin because this recharge is partially impeded from flowing into the areas of depressed groundwater levels by a fault or other structural barrier (see discussion in section 3.0 *Groundwater Basins and Hydrogeology – Oxnard Plain Basin*). The City of Oxnard GREAT project has evaluated barrier wells in the south Oxnard Plain as a method of delivering recycled water during winter months when agricultural irrigation demand is low. It may be prudent to consider expanding winter injection to more seasons of the year to create a full-time barrier. Additional source water for this full-time barrier would need to be identified.

A difficulty with barrier wells is that the injected water must be of very high quality to prevent clogging of the well screens. Thus, the source water for the injection would likely be a combination of highly-treated recycled water and potable water. The expense of building, maintaining, and providing water to a full-time barrier project currently makes such a project for Ventura County a lower priority. If other projects to supply in-lieu water to the south Oxnard Plain fail to prevent the increasing intrusion of saline waters or if a full-time barrier was considered as an add-on to injection wells already built through the GREAT project, then a full-time barrier project might be economically feasible.

As discussed in section 9.1 *GREAT Project (Recycled Water)*, FCGMA credits for recharge in a barrier project might be less than 1:1 because the recharged water might mix with contaminated saline groundwater. Likewise, if these credits are used for extraction from the Oxnard Plain Forebay basin, these extractions would have to follow uniform procedures addressed in section 10.1.5 *Policy on Recovery of Credits from Oxnard Plain Forebay Basin.*

10.3.1.2 Potential Effectiveness

Barrier wells could be very effective in preventing saline intrusion from moving further inland. Simulations of the Ventura Regional Groundwater Model indicate a barrier project with injection rates of 21,000 AFY into the Lower Aquifer System would raise Lower Aquifer water levels an average of 46 feet at the BMO wells, with an average groundwater elevation at the barrier of 28 ft msl. The rate of injection that was tested in the model was chosen to match the winter injection rate of the GREAT project at full planned implementation.

The groundwater modeling suggests that BMOs for groundwater levels would be met 63% of the time in the Upper Aquifer (compared to 51% with current management strategies) and 48% of the time in the Lower Aquifer (compared to 5% with current management strategies. The barrier project is the most effective strategy modeled in meeting BMOs (Table 8). However, the barrier would not prevent saline intrusion in areas inland of the barrier within the LAS groundwater depression in the Pleasant Valley basin; the only prevention for saline intrusion within the groundwater depression would be to raise groundwater levels within the depression.

10.3.2 Injection of Treated River Water into Overdrafted Basins

10.3.2.1 Description

A management strategy that is commonly suggested is taking diversions from the Santa Clara River when there is abundant river flow and injecting it into the aquifers that have depressed water levels. However, raw river water could not be injected without treatment that would bring the water to at least drinking water quality to prevent well clogging and potential health concerns; the cost of this treatment was generally considered to be prohibitive when compared

to other management strategies. This assumption may no longer be correct, as treatment costs become more affordable when compared to alternatives.

Much of the infrastructure to convey water from the Freeman Diversion to Pleasant Valley and the south Oxnard Plain already exists. The costs of the injection would be building a treatment facility, installing injection wells, and operating the treatment plant.

This injection would logically operate during periods when there is more water in the Santa Clara River than recharge facilities can accommodate. These conditions occur following rainstorms during many average precipitation years and can occur for extended periods (several months) during heavy precipitation years. The additional diversions could be conveyed to Pleasant Valley and the South Oxnard Plain via the existing Pleasant Valley and PTP pipelines. The raw water would then be treated and injected. Unlike aquifer storage and recovery (ASR) projects, the water would be placed in the aquifer for recharge purposes and would not be extracted at a later time as part of the project.

10.3.2.2 Potential Effectiveness

Besides reducing groundwater pumping in areas of lowered groundwater levels, providing direct recharge to affected aquifers is the most effective method of reducing pumping stresses and overdraft.

Injection of treated river water could be very effective in raising groundwater levels in the pumping depression in the south Oxnard Plain and Pleasant Valley basins. Simulations of the Ventura Regional Groundwater Model indicate an injection project with rates into the Lower Aquifer System of 1,500 AFY during dry years to 5,000 AFY during wet years would raise Lower Aquifer water levels an average of as much as 13 feet at the BMO wells in the area of injection.

The groundwater modeling suggests that BMOs for groundwater levels would be met 53% of the time in the Upper Aquifer (compared to 51% with current management strategies) and 11% of the time in the Lower Aquifer (compared to 5% with current management strategies.

10.3.3 Increase Diversions from Santa Clara River

10.3.3.1 Description

The Freeman Diversion was designed to divert more river water than current diversions. However, the current water right for the Freeman Diversion permitted by the State Water Resources Control Board is only 375 cfs (cubic feet per second) because other conveyance facilities downstream of the Freeman Diversion were not designed for the higher flow rate. If these conveyance facilities were modified and additional spreading facilities were constructed to physically handle the additional volume of water, a right to a higher diversion rate could be beneficial during periods of high flow in the river. Any higher diversion procedure would have to be designed so that there was sufficient water available for environmental uses. In order to increase diversions at the Freeman Diversion, a modified water right would have to be obtained from the State Water Resources Control Board and appropriate State and Federal agencies would have to be consulted. UWCD is studying options for such an expansion.

10.3.3.2 Potential Effectiveness

The Santa Clara River remains the primary recharge source for the Oxnard Plain basin and supplies significant recharge to the Pleasant Valley basin. It is clear that increased recharge since the Freeman Diversion was constructed has had a major positive impact in reducing seawater intrusion in the Upper Aquifer System. Likewise, many other strategies of this

Management Plan rely on substituting pumping in areas of poor recharge to pumping in the Oxnard Plain Forebay basin, which is easily recharged by water diverted from the Santa Clara River. Additional diversions and recharge to the Forebay basin, therefore, are necessary to make other management strategies possible.

UWCD's River Routing Model was used to predict the amount of additional diversions that were possible from peak winter storm flows at the Freeman Diversion, within the current 1,000 cfs flow capacity limitation of key portions of the conveyance system. The model, which uses daily flow data, predicted that additional potential diversions ranged from an average of 3,000 AFY during dry years to an average of 43,000 AFY in wet years. This additional water was largely recharged in hypothetical recharge facilities in the RiverPark and Ferro mining pits.

The Ventura Regional Groundwater Model simulations suggest that the additional diversions have several beneficial effects. The additional recharge from the diversions raise groundwater levels in the Upper Aquifer of the Oxnard Plain Forebay basin by more than 10 ft, allowing the Forebay to fully fill during wet years and lessening the impact of the dry-year pumping envisioned in other strategies in this Plan. At Upper and Lower Aquifer wells with BMOs, average groundwater levels would increase by about 3 ft. BMOs for groundwater levels would be met 54% of the time in the Upper Aquifer (compared to 51% with current management strategies) and 8% of the time in the Lower Aquifer (compared to 5% with current management strategies.

10.3.4 Shift Pumping to Northwest Oxnard Plain

10.3.4.1 Description

The northwest Oxnard Plain, in the area south of the Santa Clara River, has historically had groundwater elevations that have rarely gone below sea level. There are also no submarine canyons offshore of the northwest Oxnard Plain, eliminating a short-circuit route for seawater intrusion to reach coastal aquifers. Groundwater gradients in the Upper Aquifer System indicate that some of the water recharged to the UAS in the Forebay likely flows offshore in the coastal northwest Oxnard Plain basin. Thus, this portion of the aquifer might sustain some increased pumping without negative consequences. The amount of pumping that could be shifted to this area would depend upon the configuration of the pumping wells and the volume of pumping.

10.3.4.2 Potential Effectiveness

If pumping is shifted from areas that are difficult to recharge, such as the LAS in the southern portion of the Oxnard Plain basin and in the Pleasant Valley basin, to areas that are more-easily recharged, the effect is beneficial to the aquifers. Simulations of the Ventura Regional Groundwater Model indicate that with a shift of pumping of 2,000 AFY from near the edge of the Oxnard Plain Forebay basin to the northwest Oxnard Plain basin, groundwater levels improve less than a foot at wells with BMOs, but drop less than a foot in the northwest Oxnard Plain. Because the current groundwater levels in the Upper Aquifer of the northwest Oxnard Plain are more than 6 ft above their BMO, a more substantial shift in pumping could be accommodated, with a like amount of improvement in other areas of the coastal basins.

10.4 GREATER THAN 15-YEAR STRATEGIES

The following strategies that would be implemented later than 15 years are ranked by order of effectiveness and/or importance.

10.4.1 Additional Reductions in Pumping Allocations

10.4.1.1 Description

After other feasible strategies for reducing the overdraft within the FCGMA are considered, pumping reductions beyond the 25% may have to be examined. As discussed below, any further pumping reductions may not be necessary if most of the strategies discussed in this Plan are implemented. These strategies are likely to be expensive, however, so the FCGMA should retain as a further strategy additional pumping reductions if the means are not found to implement the strategies. Any additional required reductions should be effected using the current system of allocations and efficiencies. If this step is necessary, it would be prudent to revisit whether agricultural efficiency should be tightened up or continue to be used, or whether all pumpers should use the allocation/credit method of reporting. If significant portions of the strategies recommended in this Plan are not implemented, consideration should be given to applying further pumping reductions only in areas where groundwater levels are particularly depressed. For instance, as part of the evaluation of basin yield (section 7.0 *Yield of the Groundwater Basins*), a further reduction of 85% in pumping in the south Oxnard Plain and Pleasant Valley basins allowed groundwater elevations to meet Basin Management Objectives.

10.4.1.2 Potential Effectiveness

The necessity of any further pumping reductions was evaluated using the Ventura Regional Groundwater Model. This modeling suggested that with all strategies implemented, BMOs for groundwater levels would be met 67% of the time in the Upper Aquifer (compared to 51% with current management strategies) and 76% of the time in the Lower Aquifer (compared to 5% with current management strategies. Section 7.0 *Yield of the Groundwater Basins* discusses the issue of how often BMOs should be met to be protective of the basins in the FCGMA. The above numbers suggest that implementation of all the management strategies would vastly improve the health of the basins. Actual future observations of basin conditions, particularly the fate of sweater intrusion, will determine whether these strategies truly protect the basins. The modeling does suggest that further reductions in FCGMA extractions would not be warranted until the effect of the other management strategies can be observed or unless may of the strategies are not implemented because of financial or other reasons. However, implementation of a significant number of the strategies recommended in this Plan would be necessary to avoid further pumping reductions.

11.0 ACTION PLAN TO ATTAIN BASIN MANAGEMENT OBJECTIVES

11.1 PLANNING/IMPLEMENTATION ACTIONS

11.1.1 Strategic Planning

Many of the management strategies in this plan involve considerable cooperation among agencies within the FCGMA and come at considerable cost. The FCGMA is the common element among these agencies and is the appropriate forum in which to discuss the management strategies. Although many of the actual projects that would implement the management strategies would be built and managed by individual agencies within the FCGMA, the cost of the projects is likely to be spread to a wider group. Projects that have the most advantageous cost/benefit ratios would likely be supported by this wider group.

The FCGMA should initiate the discussion of how all the strategies fit together with current and future project of individual agencies. The topics to be covered could include:

1) Cost/benefit analyses of management strategies;

2) Cooperative efforts needed;

3) Methods to finance the projects;

4) Actions to implement the projects.

Parts of the analyses needed for the discussion have already been generated through agency's master planning efforts either within agencies or as larger cooperative efforts, and these plans cold be used as the starting point in these discussions.

11.1.2 Implementation

As a follow-up to the strategic planning effort, the FCGMA should take the results of the strategic planning and facilitate their implementation. The main focus of this effort would be to assist in cooperative efforts to implement the FCGMA management strategies.

11.2 RECOMMENDED CHANGES TO EXISTING FCGMA POLICIES

11.2.1 Continuation of 25% Pumping Reduction

Groundwater modeling of extending the phased FCGMA pumping reductions to their conclusion at 25% reductions indicated that this policy results in modest improvements at BMO indicator wells. Despite these modest improvements, it is necessary to continue this policy because the modeling also indicated that it will take the combination of all of the strategies recommended in this Plan to reach BMO goals – although individual strategies may not make large contributions, the sum of these strategies is the key to solving the overdraft problem. It is recommended that the FCGMA Board implement the delayed reduction to 20% before the end of 2007 and implement the reduction to 25% on the 2010 scheduled date.

11.2.2 Credits to be Transferred to Forebay Basin

Current water conservation facilities and FCGMA policies encourage reduced pumping in areas of seawater intrusion or overdrafted areas by moving those pumping stresses to areas that are more readily recharged. Examples of these projects are the Oxnard-Hueneme Pipeline system, the Pumping Trough Pipeline, and the Pleasant Valley Pipeline. A more recent transfer is for credits accrued by the Conejo Creek project to be used for extractions from the Oxnard Plain Forebay basin as part of the Supplemental M&I Water Program. The program has criteria to prevent adverse impacts from this increased pumping in the Forebay, including a restriction on pumping when groundwater elevations in key wells in the Forebay are below pre-determined levels.

The FCGMA should establish a policy for future credit transfers to the Forebay. This policy should include both criteria to ensure that projects do not harm the Forebay and to prioritize future projects if there is more demand for these transfers than the Forebay can accommodate. The Conejo Creek-Supplemental M&I Water projects serve as a good model for future projects that would provide in-lieu recharge or injection through wells in overdrafted areas and then recover that water from the Forebay or other areas that are readily recharged. Any such pumping using FCGMA credits should be able to demonstrate that a plan for increased pumping would not adversely impact the basin pumped. The FCGMA should encourage these types of projects, as long as there is a net benefit to the aquifers and the pumping does not adversely

affect that basin. Specific criteria that the FCGMA could use for future projects are discussed in section 10.1.5 *Policy on Recovery of Credits from Oxnard Plain Forebay Basin*.

11.2.3 Shift Some Pumping from Lower Aquifer System to Upper Aquifer System

A shift in pumping back to the UAS has already been initiated through County well permitting requirements. However, this shift should not be uniformly enforced across the basins within the FCGMA. A detailed plan must be formulated that takes into account local recharge sources, hydrologic connection between portions of the basin, and current/future in-lieu recharge projects. This should be accomplished through use of the Ventura Regional Groundwater Model in fine-tuning the details of this plan, with the FCGMA, VCWPD, and UWCD working together.

11.2.4 Irrigation Efficiency Calculation

As discussed in section 10.1.9 *Irrigation Efficiency Calculations*, the irrigation efficiency calculation should be revisited to ensure that the methodology gives appropriate results. The FCGMA Board should convene a committee of experts and stakeholders to examine the efficiency methodology. This committee would incorporate current methods of determining crop demand, including recommending updated weather station technology if necessary. The purpose of this exercise is to ensure that the efficiency calculations submitted to the FCGMA by agricultural irrigators are accurate. Any changes to the methodology should focus on improving actual irrigation efficiency by pumpers and ensuring pumpers reporting actual groundwater use against their allocation are on the same “level field” as those using irrigation efficiency.

The committee would also review whether 80% irrigation efficiency is appropriate to current farm management methods or whether this efficiency percentage should be changed. The committee should be convened within six months of adoption of this Management Plan. Recommendations of the committee would be presented to the FCGMA for possible modification of current ordinances.

11.2.5 Additional Monitoring

Additional monitoring may be required by the FCGMA when certain management strategies are implemented. For instance, projects that rely upon new pumping from the Forebay basin, as a result of water delivery to areas that are not as readily recharged such as the south Oxnard Plain, may require additional monitoring to ensure that other Forebay pumpers are not adversely impacted. It is recommended that this additional monitoring be a condition of approval for applying pumping credits to the Forebay when they are earned elsewhere within the FCGMA.

Additional monitoring is also required as part of the East Las Posas Basin Management Plan (Attachment C). This additional monitoring is incorporated in the FCGMA Management Plan by reference.

In addition, monitoring should also be required for projects in the future that pump poor-quality water without an allocation along Calleguas Creek. This monitoring would focus on detecting both improvements in water quality in the pumped area and un-anticipated changes in water levels or water quality in adjacent portions of the FCGMA aquifers.

11.2.6 Use Penalties to Purchase Replacement Water

The FCGMA charges a penalty to pumpers for extracting more water than is allowed under the various allocations (Historical, Baseline, Irrigation Efficiency). The increased groundwater use caused by the over-pumping could be offset by using the fees generated by penalties to purchase replacement water for the extracted groundwater. The FCGMA has several options to obtain additional water, including purchasing unused portions of Ventura County's State Water Allocation, paying M&I users to increase their imported/groundwater blend, and purchase of water through a variety of programs from the State or others such as turn-back pool water, Dry-Year Purchase Program, and other programs. This water could be delivered through either conveyance down the Santa Clara River or Calleguas MWD's pipeline, depending upon how the water was purchased and used.

11.3 RECOMMENDED ADDITIONS TO FCGMA POLICIES

11.3.1 5-Year Update of FCGMA Management Plan

It is recommended that this Plan be updated every five years. This update should include a status of how the BMOs are being met, effectiveness of strategies that have been implemented, status of other recommended strategies, and recommendations for any additional management strategies.

11.3.2 Separate Management Plans for Some Basins

All of the basins within the FCGMA are managed under an umbrella of this Management Plan. However, there are circumstances in some of the basins that require additional management policies, such as in the East Las Posas basin. It is recommended that the FCGMA Board adopt the East Las Posas Management Plan (Appendix C) by resolution. In addition, the policies on pumping and treating poorer quality groundwater without an allocation should be incorporated into FCGMA policy by adopting this overall FCGMA Management Plan.

It is recommended that no changes be made to current FCGMA pumping reductions that treat all the FCGMA basins the same. It would be appropriate to revisit this policy in the future if basin management objectives have been achieved in a particular basin; the FCGMA Board might consider whether it is appropriate to continue with additional pumping reductions.

11.3.3 Adoption of Basin Management Objectives

The basin management objectives recommended in this Management Plan should be adopted by resolution by the FCGMA Board. As additional information becomes known about individual groundwater basins, it may be appropriate to modify the recommended objectives and/or to add additional objectives.

11.3.4 Extractions of Poor-Quality Water Without an Allocation

There are additional areas along Calleguas Creek besides the South Las Posas basin where groundwater has elevated salinity. Base flow from the Arroyo Las Posas has migrated completely across the South and East Las Posas basins and into the northernmost Pleasant Valley basin, providing a source of new recharge to this portion of the Pleasant Valley basin. However, this new recharge water has created water quality problems for groundwater pumpers. City of Camarillo wells in this area have experienced increased salts as groundwater

levels have risen over the last decade, similar to what has already happened in the South and East Las Posas basins.

Extraction of this groundwater is an appropriate groundwater management strategy providing that either: 1) extracting the groundwater improves the overall water quality in the basin without also causing overpumping of the basin or 2) extracting the groundwater provides a new water supply outside of those currently allocated by the FCGMA. If these conditions are not met, then the extractions should be debited against an existing allocation. In the South Las Posas basin, for example, pumping and treating the shallow groundwater would both improve the water quality and not reduce supplies to the basin (better quality stormwater that now bypasses the basin would then have the ability to infiltrate and replace the pumped water). Alternatively, if shallow groundwater along Calleguas Creek was not hydraulically connected to the main portion of the basin, and pumping that groundwater would have no effect on groundwater in the main basin, then pumping this groundwater could provide a new supply of water. This lack of hydrologic connection would have to be demonstrated using standard geologic techniques. These techniques would include analysis of groundwater levels, water quality parameters, well logs, age-dating, geochemical analyses, or other techniques.

11.3.5 Barrier Wells

As discussed in section 10.3.1 *Barrier Wells in South Oxnard Plain*, construction of injection barrier wells near the coastline to prevent landward migration of saline intrusion is one management strategy. Under current FCGMA policy, any project in the future that has barrier wells as a project component would need FCGMA approval to earn extraction credits that could be used to pump a like amount of groundwater elsewhere within the FCGMA. As discussed in section 10.1.5 *Policy on Recovery of Credits from Oxnard Plain Forebay Basin*, there may be issues related to the pump-back. It is recommended that any such FCGMA approval be contingent upon analysis of the potential effectiveness of the barrier in the improving water quality, analysis showing that pumping credits earned by injection that are used elsewhere does not adversely affect the pumped area, and a monitoring program to measure the effects of both the barrier wells and the extraction wells.

11.3.6 Protecting Recharge Supplies

Because of the importance of preserving current recharge sources for the aquifers and potentially adding additional recharge, the FCGMA adopts a policy that protects these recharge sources. Although the FCGMA cannot determine water rights, it will use its influence with other agencies to ensure protection of the recharge sources. FCGMA actions might include writing letters of support, discussing the issues with other agencies, and testifying at hearings related to these recharge sources.

11.3.7 Nitrate Sources in Oxnard Plain Forebay Basin

It is recommended that the FCGMA develop a policy to limit high-nitrate crops in reclaimed gravel basins where there is little or no vadose zone for degradation of the nitrate before it reaches groundwater. The particulars of this issue are discussed in section 10.1.4 *Limitation on Nitrate Sources in Portions of the Oxnard Plain Forebay Basin*.

11.3.8 Additional Conservation Measures

It is recommended that the FCGMA Board adopt a policy encouraging all planning agencies within the FCGMA to require dual plumbing in new developments where treated wastewater is

feasible for use. As part of this policy, the FCGMA should work with planners to incorporate these policies into general plans and other appropriate planning documents.

11.3.9 Verification Procedure for Extraction Reporting

It is recommended that the FCGMA establish a verification procedure to ensure that self-reporting of extractions by pumpers to the FCGMA is accurate. This procedure could be as simple as an annual random inspection of a few meters to ensure that the meter is installed and that the readings that are reported to the FCGMA agree with the meter readings.

11.3.10 Consideration of Further Pumping Reductions

If most of the effective strategies recommended in this Plan are not implemented because of cost, lack of cooperation, lack of will, or some other factor, the FCGMA should consider further pumping reductions. The actual reductions required would depend upon how the basins have responded to the strategies that have been implemented, and the required reductions could be determined using the groundwater model at that time.

12.0 SUMMARY OF FCGMA MANAGEMENT STRATEGIES

FCGMA management strategies are separated into three categories – current, in development, and future. Each strategy has a short description. For a full discussion of each strategy, refer to the earlier three sections on management strategies. Some of these strategies related directly to FCGMA ordinances and other actions. Many of these strategies are carried out by agencies other than the FCGMA, but FCGMA policies either encourage these projects or make them possible through the credit program.

12.1 CURRENT STRATEGIES

Includes those within the original 1985 FCGMA Management Plan and those that have been developed since that time:

- Limitation of Groundwater Extractions – 25% phased reduction in pumping, including 80% agricultural efficiency.
- Encourage Both Wastewater Reclamation and Water Conservation – Encouraged use of recycled water and water conservation techniques.
- Operation of the Oxnard Plain Seawater Intrusion Control Project (UWCD's Pumping Trough Pipeline, Lower Aquifer System Wells, Freeman Diversion) – Encourage UWCD projects.
- Annual Groundwater Monitoring Program – Conducted by VCWPD and UWCD.
- East and West Las Posas Basin Pumping Restrictions – Restricted water use outside La Posas basin and FCGMA boundary.
- Monitor FCGMA Groundwater Extractions – Program of reporting extractions to FCGMA.
- Implementation of Drilling and Pumping Restrictions – Various policies for aquifers used for water production and for well completions.

- Metering of Groundwater Extractions – Required meters on all except domestic wells.
- Fox Canyon Outcrop Expansion Area – Grandfathered some historic areas where groundwater pumped from within the FCGMA is delivered outside of Agency boundaries.
- Noble Spreading Basins – Encouraged expanding UWCD historical artificial recharge areas.
- Las Posas Basin ASR Project – Set criteria for Aquifer Storage and Recovery project in Las Posas basin.
- Conejo Creek Diversion Project – Allowed credits for diversion and delivery of water to pumpers in-lieu of their pumping groundwater.
- Supplemental M&I Water Program – Allowed credits earned in Pleasant Valley basin to be pumped from Oxnard Plain Forebay basin which is more easily recharged.
- Saticoy Wellfield – Groundwater pumped by UWCD from Oxnard Plain Forebay basin is delivered to pumpers in Oxnard Plain and Pleasant Valley basins in lieu of pumping local groundwater.
- Importation of State Water – Credits earned by UWCD for importing State Water for recharge are put in a special account to help solve management problems in the future.
- Calibration of Groundwater Extraction Meters – Meters on wells will now be re-calibrated every three years.

12.2 STRATEGIES UNDER DEVELOPMENT

Includes strategies in which planning and design of projects is currently taking place:

- RiverPark Recharge Pits – Encourage additional recharge facilities in Forebay.
- GREAT Project (Recycled Water) – Credits earned from in-lieu deliveries and injection of recycled can be pumped from Forebay.
- South Las Posas Basin Pump/Treat – Poor quality water can be pumped and treated without using credits.
- Development of Brackish Groundwater, Pleasant Valley Basin – Poor quality water may be able to be pumped and treated without using credits.
- Non-Export of FCGMA Water – Enforce current restrictions on water export; determine procedure for periodic evaluation of whether there are new water exports.

12.3 FUTURE STRATEGIES – 5 YEARS

Includes strategies that could be implemented within the first 5 years (ranked in order of effectiveness):

- 5-Year Update of FCGMA Management Plan – Regular updating of plan, report on BMOs and progress

- Plan to Shift Some Pumping Back to Upper Aquifer System – Shift some new wells back to UAS, with area and number to be determined jointly with UWCD using Ventura Regional Groundwater Model.
- Protect Current Sources of Recharge – Use FCGMA influence with regulatory agencies to ensure that sources of recharge such as the Santa Clara River are not degraded or unduly dedicated to non-recharge uses.
- Limitation on Nitrate Sources in Portions of the Oxnard Plain Forebay Basin – Limit high-nitrate crops in reclaimed gravel basins in Forebay where a vadose zone is either very thin or missing.
- Policy on Recovery of Credits from Oxnard Plain Forebay Basin – Adopt a recommended policy for transfer of credits for pumping in the Oxnard Plain Forebay basin.
- Verification of Extraction Reporting – Annually check a few random wells for meter use and accurate reporting of meter readings.
- Separate Management Strategies for Some Basins – Adopt East Las Posas Basin Management Plan.
- FCGMA Boundary – Adjust FCGMA boundary to conform to Oak Ridge fault and boundary with Santa Paula Basin Adjudication.
- Irrigation Efficiency Calculations – Consider modifying calculations for Irrigation Efficiency Allocation.
- Additional Storage Projects in Overdrafted Basins – Consider storage projects in Pleasant Valley and perhaps southern Oxnard Plain basins, ensuring that the storage does not interfere with current groundwater uses or recharge to the basin.
- Penalties Used to Purchase Replacement Water – Use penalties for pumping beyond allocation to purchase water for recharge to the aquifers.
- Additional Water Conservation – Encourage agencies and cities to require dual plumbing in new developments, where possible, to replace groundwater use with recycled water.
- Shelf Life for Conservation Credits – Allow Conservation Credits to expire after a wet-dry cycle to bring credit policy in line with goals of this program.

12.4 FUTURE STRATEGIES – 10 YEARS

Includes strategies that could be implemented within 5 to 10 years (ranked in order of effectiveness):

- Additional In-Lieu Recharge to South Oxnard Plain – Deliver additional water to southern Oxnard Plain to offset pumping.
- Import Additional State Water – Import and recharge more of Ventura County's State Water Allocation.

- Further Destruction of Abandoned or Leaking Wells – Seek grant funding to reinstate program of destroying abandoned or leaking wells that pose a risk of cross contamination of FCGMA aquifers.
- Additional Monitoring Needs – Support UWCD and VCWPD in determining additional monitoring needs as contamination threats evolve.

12.5 FUTURE STRATEGIES – 10 TO 15 YEARS

Includes strategies that could be implemented within 10 to 15 years (ranked in order of effectiveness):

- Barrier Wells in South Oxnard Plain – Develop a policy for credits for water injected in barrier wells.
- Injection of Treated River Water into Overdrafted Basins – Treat diverted river water to drinking water quality and recharge it through injection in Oxnard Plain and Pleasant Valley basin.
- Increase Diversions from Santa Clara River– Increase diversions of high-volume storm flows for recharge.
- Shift Pumping to Northwest Oxnard Plain – Shift some pumping to the more easily recharged northwestern Oxnard Plain.

12.6 FUTURE STRATEGIES – GREATER THAN 15 YEARS

Includes strategies that could be implemented more than 15 years from now (ranked in order of effectiveness):

- Additional Reductions in Pumping Allocations – As a last resort if the other strategies fail to meet Basin Management Objectives, consider reducing allocations beyond the required 25% reduction. Also consider focusing these reductions in the south Oxnard Plain and Pleasant Valley basins where groundwater levels are particularly depressed.

13.0 REFERENCES

Bachman, S.B., 1999. *Las Posas basin groundwater elevations and water quality*, Joint report to Calleguas Municipal Water District and United Water Conservation District, 35p.

Bachman, S.B., 2002. *Water quality in the East and South Las Posas basin – problems and solutions*, Report to Calleguas Municipal Water District, 25p.

Bachman, S.B., Hauge, C., McGlothlin, R., Neese, K., Parker, T., Saracino, A., Slater, S., 2005. *California groundwater management*, California Groundwater Resources Association, 270p.

Black and Veatch, Inc., 2005. City of Camarillo Groundwater Treatment Facility Feasibility Study, August.

California Department of Water Resources, 1954. *Seawater intrusion: Oxnard Plain of Ventura County*: Bulletin No. 63-1, 59p.

California Department of Water Resources, 1971. *Seawater intrusion: aquitards in the coastal ground water basin of Oxnard Plain, Ventura County*: California Department of Water Resources Bulletin 63-4, 567p.

California Department of Water Resources, 1973. *Seawater intrusion lowers Salinas Valley*, California Department of Water Resources San Joaquin District Technical Report, 42p.

California Department of Water Resources, 2003. *California's Groundwater,* Bulletin 118, http://www.groundwater.water.ca.gov/bulletin118/index.cfm.

California State Water Resources Board (CSWRB), 1956. *Ventura County Investigation*, Bulletin 12, 2 volumes.

CH2MHill, 1993. Technical memorandum hydrogeology and three-dimensional groundwater flow model of the Las Posas basin, Ventura County, California, Report to Metropolitan Water District of Southern California, 58 p.

City of Oxnard, 2005, Environmental Impact Report for GREAT Project, 180 p.

Densmore, J.N., 1996. *Lithologic and ground-water data for monitoring wells in the Santa Clara-Calleguas ground-water basin, Ventura County, California, 1989-95*: U.S. Geological Survey Open-File Report 96-120, 179p.

ETIC Engineering, 2003. *Task 2 Technical Memorandum: Documentation of the Updated Santa Clara-Calleguas Groundwater Flow Mode*l, 14p. January.

Hanson, R.T., 1998. *Draft Simulation of Groundwater/Surface-Water Flow in the Santa Clara-Calleguas Basin, Ventura County, California*, U.S. Geological Survey, Unpublished Water Resources Investigations Report.

Hanson, R.T., Martin, Peter, Koczot, K.M., 2003. *Simulation of ground-water/surface-water flow in the Santa Clara-Calleguas ground-water basin, Ventura County, California*, U.S. Geological Survey, USGS Water Resources Investigations Report 02-4136.

Izbicki, J.A., 1991. *Chloride sources in a California coastal aquifer*: American Society of Civil Engineers, 1991 Symposium on Ground Water in the Pacific Rim, Honolulu, Hawaii, July 22-26, 1991, Proceedings, p.71-77.

Izbicki, J.A., 1992. *Sources of chloride in ground water of the Oxnard Plain, California*, in Prince K.R. and Johnson, A.I., eds., Regional aquifer systems of the United States—Aquifers of the Far West: American Water Resources Association Monograph Series, no.16, p.5-14.

Izbicki, J.A., Michel, R.L., and P. Martin, 1992. *Tritium and carbon-14 as tracers of ground-water recharge*: Irrigation & Drainage Session Proceedings/Water Forum '92, ASCE, Baltimore, MD, p.122-127.

Izbicki, J.A., P. Martin, Densmore, J.N. and Clark, D.A., 1995. *Water-quality data for the Santa Clara-Calleguas hydrologic unit, Ventura County, California, October 1989 through December 1993*: U.S. Geological Survey Open-File Report 95-315, 124p.

Izbicki, J.A., 1996a, *Seawater Intrusion in a Coastal California Aquifer,* United States Geologic Survey Fact Sheet 125-96.

Izbicki, J.A., 1996b. *Source, Movement, and Age of Ground Water in a Coastal California Aquifer,* United States Geologic Survey Fact Sheet 126-96.

Izbicki, J.A., Christensen, A.H., Newhouse, M.W., and Aiken, G.R., 2005. *Inorganic, isotopic, and organic composition of high-chloride water from wells in a coastal southern California aquifer*, Applied Geochemistry 20, p.1496-1517.

Mann, J.F., Jr., 1959, *A plan for ground water management, United Water Conservation District*: Report to United Water Conservation District, 120p.

Mukae, M.M. and Turner, J.M., 1975. Ventura County water resources management study – geologic formations, structures and history in the Santa Clara-Calleguas area, *in* Compilation of Technical Information Records for the Ventura County Cooperative Investigation: California Department of Water Resources, v.1.

Stamos, C.L., Predmore, S.K., and Zohdy, A.A.R., 1992. *Use of D-C resistivity to map saline ground water*: American Society of Civil Engineers National Conference, Water Forum 1992, Baltimore, Maryland, August 2-6, 1992, Proceedings, p.80-85.

Turner, J.M., 1975. *Aquifer delineation in the Oxnard-Calleguas area, Ventura County*, *in* Compilation of Technical Information Records for the Ventura County Cooperative Investigation: California Department of Water Resources, 28p.

Turner, J.M., and Mukae, M.M., 1975. *Ventura County Water Resources Management Study - Effective Base of Fresh Water Reservoir in the Oxnard-Calleguas Area*, Ventura County Department of Public Works Flood Control District, 14p.

United Water Conservation District, 1998. *Nitrate study of El Rio area Phase I*: Report to United Water Conservation District, 17p.

United Water Conservation District, 2001. *Conjunctive use alternatives for overdraft reduction in the Oxnard Plain and Pleasant Valley*: Report to United Water Conservation District, 36p.

United Water Conservation District, 2002. *Agricultural efficiency*, Presentation to UWCD and Association of Water Agencies of Ventura County.

United Water Conservation District, 2003. *Coastal Saline Intrusion*, Report to United Water Conservation District, 32p.

United Water Conservation District, 2006a. *Annual Groundwater Conditions Report*, 19p.

United Water Conservation District, 2006b. *Update of the Ventura Regional Groundwater Model*.

U.S. Bureau of Reclamation, 1975. *Ventura County water management project working document*, Sacramento, CA, 211p.

Ventura County Public Works Agency, 1985. *Task 86-3 Groundwater management plan for the Fox Canyon Groundwater Management Agency*.

Ventura County Watershed Protection District, 2006. *Inventory of Public and Private Water Purveyors of Ventura County*, County of Ventura, California, 342 p.

Zohdy A.A.R., Martin, Peter, and Bisdorf, B.J., 1993. *A study of seawater intrusion using direct-current soundings in the southeastern part of the Oxnard Plain, California*: U.S. Geological Survey Open-File Report 93-524, 138p.

A 1.0 APPENDIX A - PROGRESSION OF SEAWATER INTRUSION BENEATH THE SOUTH OXNARD PLAIN

Although seawater intrusion under the Oxnard Plain has been studied over several decades, the details of the intrusion have not been analyzed until recently when United Water Conservation District (UWCD) entered all historic data on water levels, water quality, and well construction into digital databases and GIS coverages so the entire data set could be analyzed systematically. This new analysis uses all this digital information to construct a series of maps depicting groundwater levels and chloride concentrations in wells within the south Oxnard Plain from as far back as 1920. The analysis used 5-year time slices in both the Lower Aquifer System and Upper Aquifer System to determine when groundwater levels first dropped below sea level, when chloride levels first increased as a result of the landward gradient caused by these lowered groundwater levels, and the progression of saline water since that time.

Saline intrusion is recognized in monitoring wells by concentrations of chloride and Total Dissolved Solids (TDS) that are several times higher than the Basin Plan Objectives of 150 mg/L and 1,200 mg/L, respectively. In practice, the leading edge of the intrusion is mapped on the Oxnard Plain as the first occurrence of chloride in excess of 500 mg/L., which is used in the following set of maps.

Groundwater levels first dropped below sea level in the period 1945-49 in the Upper Aquifer System (Figure 34), although groundwater levels were scarce at the coastline for some years prior to that time. In the following 5-year time slice of 1950-54 (Figure 35), groundwater levels dropped below sea level across much of the south Oxnard Plain, and chlorides increased to as much as 1,925 mg/L at the Port Hueneme coastline. Thus, the apparent time lag between groundwater dropping below sea level and the encroachment of seawater was somewhere in the range of 5 to 10 years. In the following 5-year time slice of 1955-59, chlorides increased rapidly in coastal wells, reaching as high as 27,350 mg/L (Figure 36).

Although a few sampled wells may have had corroded casings that allowed poorer-quality perched water to flow into the well, most of the early chloride readings were taken from pumping wells with a smaller chance of significant cross-contamination during sampling (groundwater flowing into pumping wells would likely come mostly from screened intervals in the well). Outliers of wells with poorer quality water were not considered in the interpretation of the areas of saline intrusion to minimize random instances of cross-contamination; it was only concentrations of wells with poor quality water that were considered as significant. Within the first 20 years of intrusion, higher chloride levels were evident up to 3 miles inland from the area of initial intrusion, an intrusion rate of about 800 feet per year. This rate of intrusion is similar to rates calculated for seawater intrusion in the Salinas groundwater basin (e.g., CDWR, 1973).

The intrusion of the Upper Aquifer System in the Port Hueneme area was temporarily arrested during the mid 1980s following a wet climatic cycle (e.g., Figure 42). As the new FCGMA policies, the Freeman Diversion, and the PTP Pipeline came online, chloride levels in the Port Hueneme saline lobe in the Upper Aquifer System continued to decrease, with chloride concentrations in some wells near the coastline returning to drinking-water quality. However, chloride levels remain high in smaller lobes centered around both Port Hueneme Harbor and Mugu Lagoon (Figure 44). Unfortunately, some of the saline water intruded around Port Hueneme did not exit via the canyon when high water levels return. Unquantified amounts of saline water were transported to the southeast along the coast by the prevailing (non-drought period) groundwater gradient.

Intrusion in the Lower Aquifer System lagged considerably in time behind the Upper Aquifer System. Groundwater levels near the coastline first went below sea level in the 1955-59 time period (Figure 48), but high chlorides were not detected until the 1985-89 time period at Port Hueneme and the 1990-94 time period near Point Mugu (Figure 52, Figure 53), some 30 years later. This time lag is partially caused by the longer travel time for seawater intruded from the Lower Aquifer System outcrops along the offshore Hueneme Submarine Canyon walls and partially the result of the lack of monitoring points right at the coastline until the USGS monitoring wells were drilled in the late 1980s and early 1990s. As discussed in section 5.0 *Water Quality Issues*, the U.S. Geological Survey interpretation is that the majority of the saline intrusion in the Lower Aquifer System near Point Mugu is saline water being pulled from surrounding sediments rather than from the ocean itself (see Figure 56).

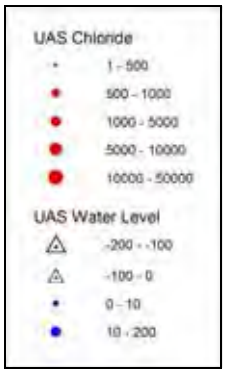


Figure 29. Legend for Figure 30 to Figure 44 for Upper Aquifer System time slices. Chloride concentrations are in mg/L, water level is elevation above or below mean sea level. All maps are oriented with north to the top of the page. Area of map coincides with location map in Figure 2 in section 2.0 *Background of Groundwater Management and Overdraft Within the FCGMA.*

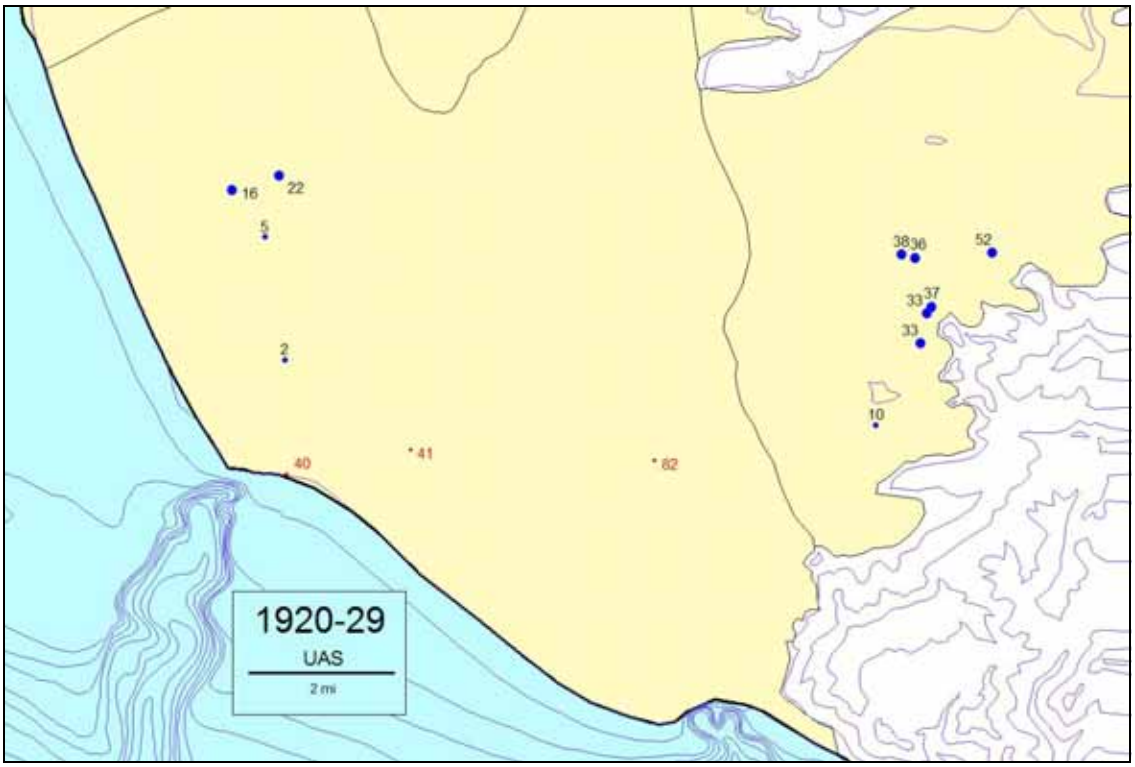


Figure 30. Upper Aquifer System groundwater levels and chloride levels, 1920 to 1929. Legend is shown in Figure 29. Line in title block is two miles in length.

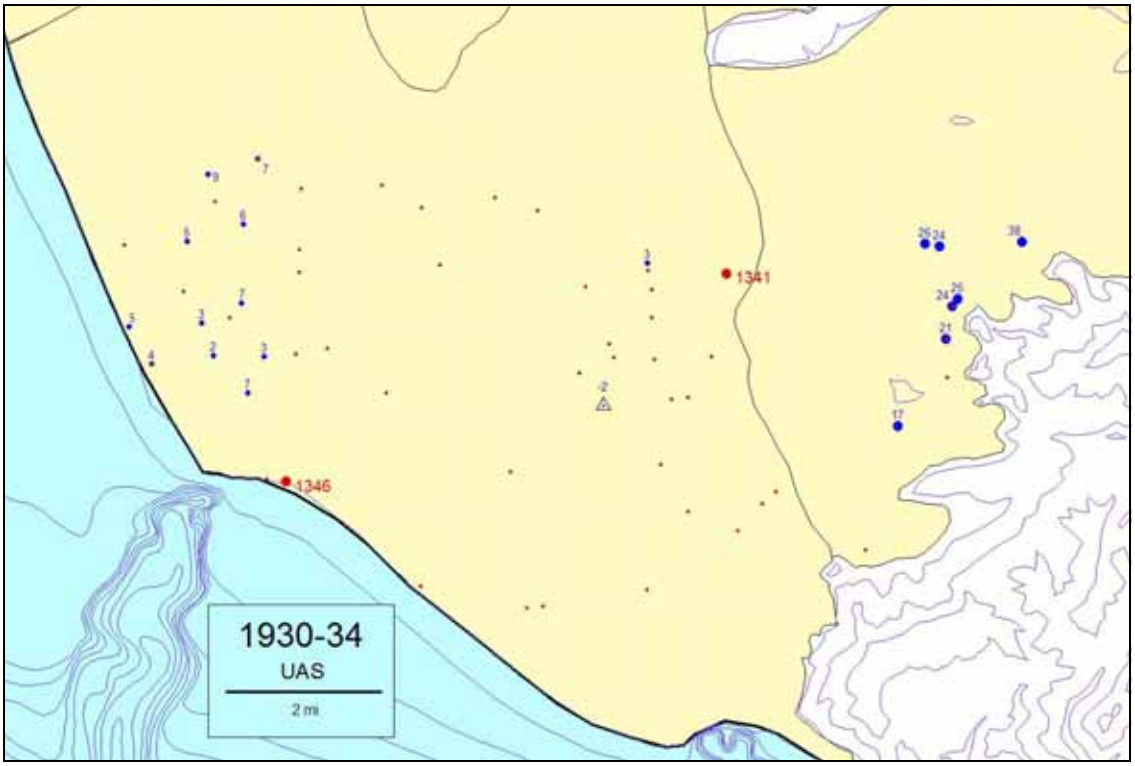


Figure 31. Upper Aquifer System groundwater levels and chloride levels, 1930 to 1934. Legend is shown in Figure 29. Line in title block is two miles in length.

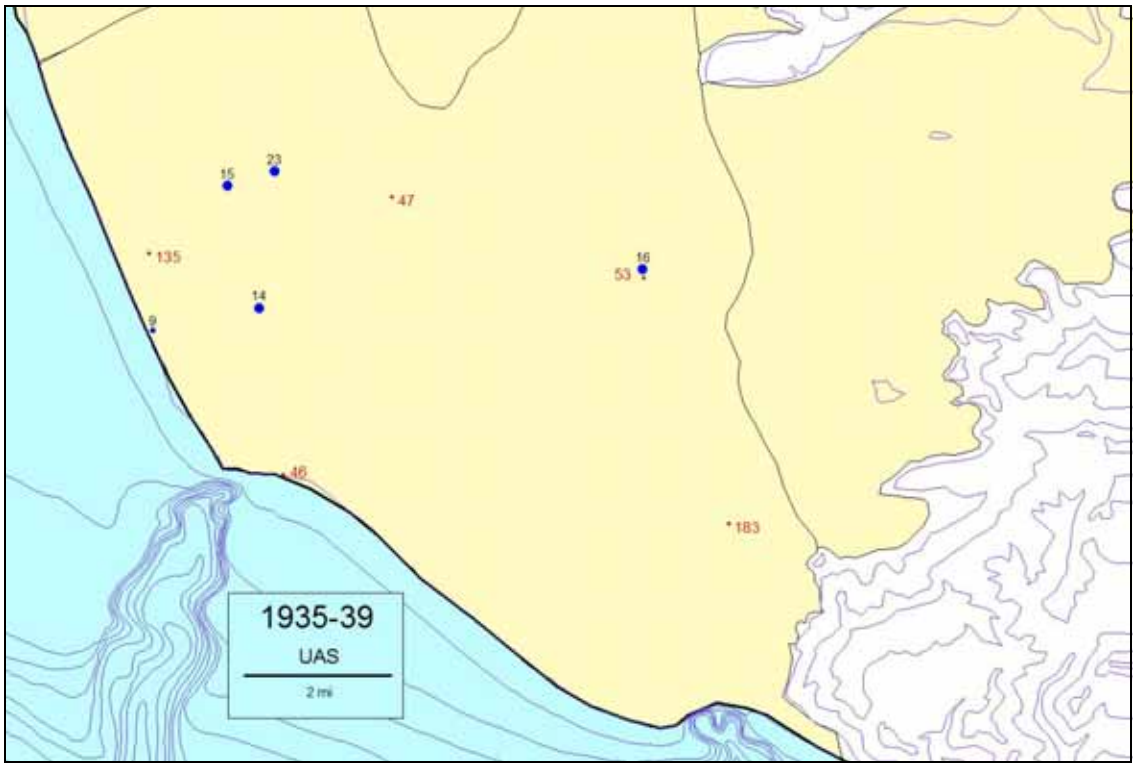


Figure 32. Upper Aquifer System groundwater levels and chloride levels, 1935 to 1939. Legend is shown in Figure 29. Line in title block is two miles in length.

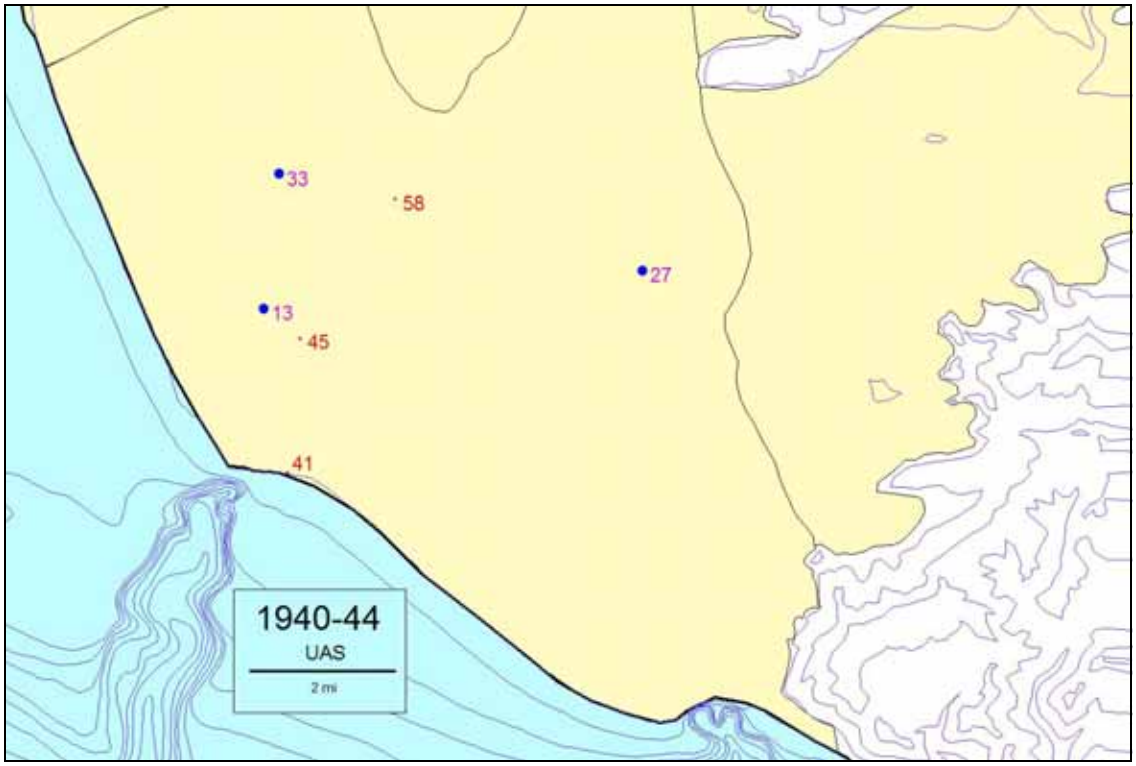


Figure 33. Upper Aquifer System groundwater levels and chloride levels, 1940 to 1944. Legend is shown in Figure 29. Line in title block is two miles in length.

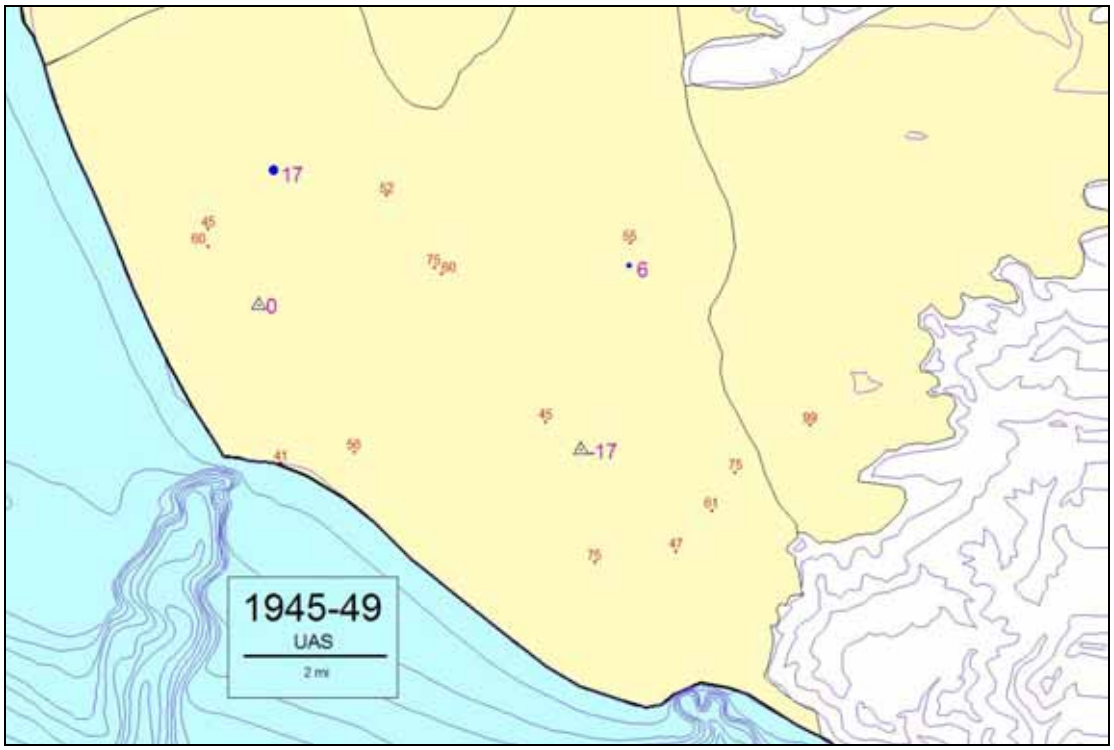


Figure 34. Upper Aquifer System groundwater levels and chloride levels, 1945 to 1949. Legend is shown in Figure 29. Line in title block is two miles in length.

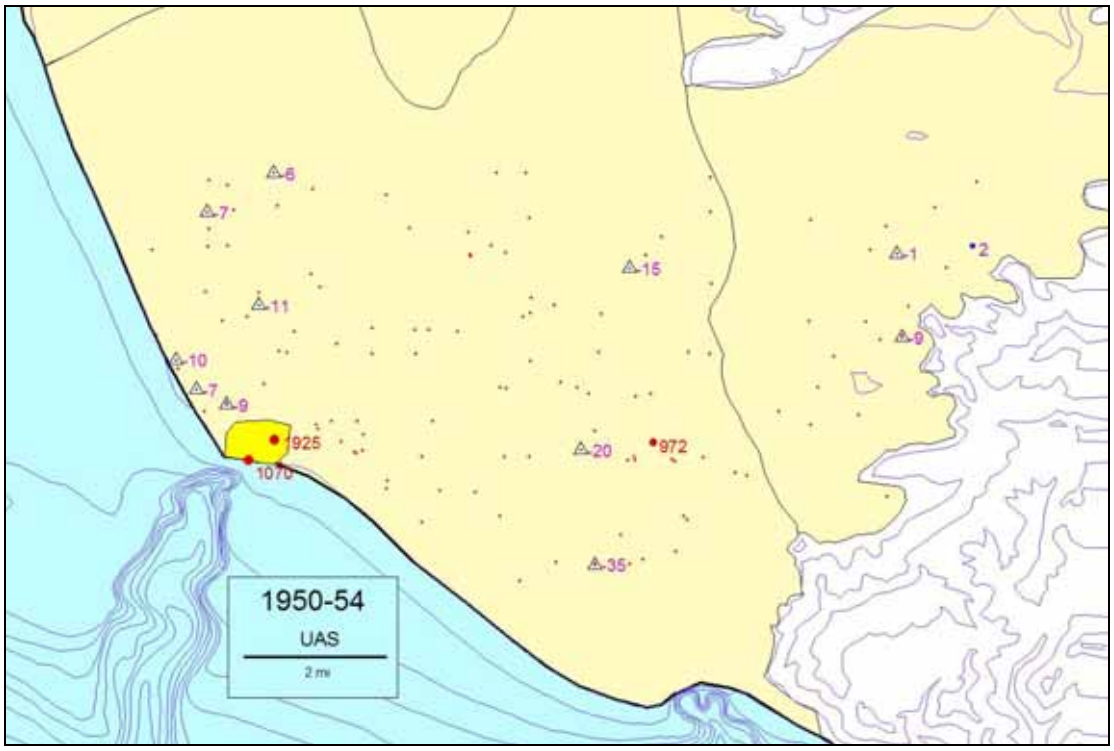


Figure 35. Upper Aquifer System groundwater levels and chloride levels, 1950 to 1954. Legend is shown in Figure 29. Bright yellow area is intruded by seawater near Hueneme Submarine Canyon. Line in title block is two miles in length.

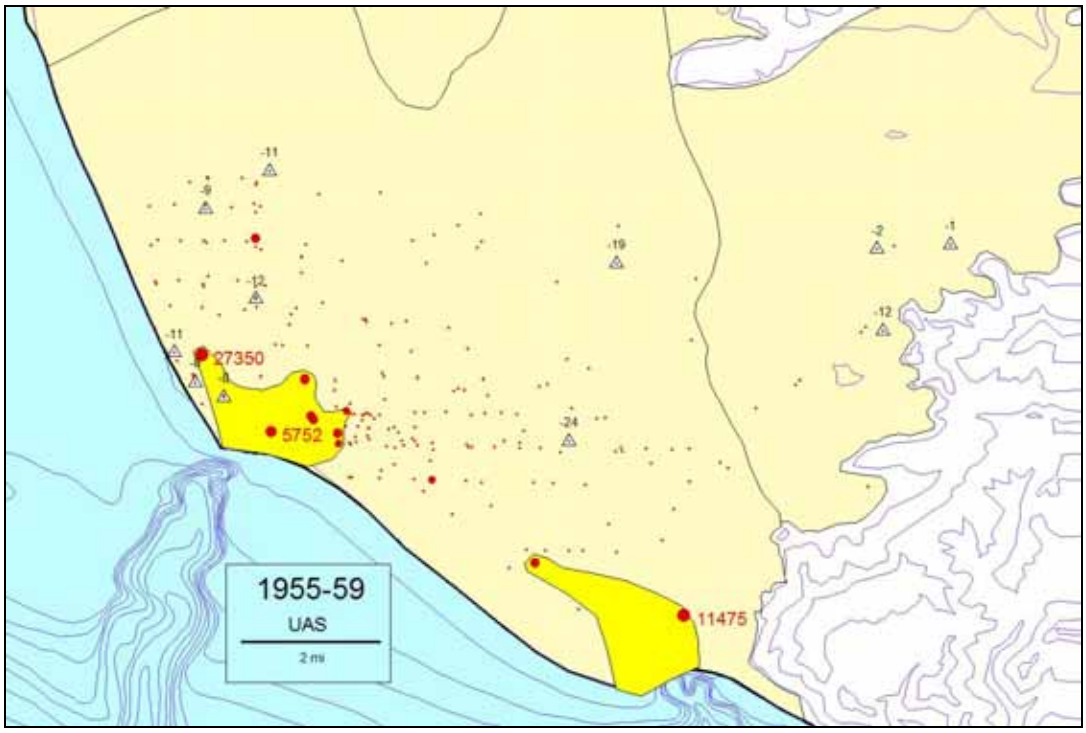


Figure 36. Upper Aquifer System groundwater levels and chloride levels, 1955 to 1959. Legend is shown in Figure 29. Bright yellow areas are intruded by saline waters. Line in title block is two miles in length.

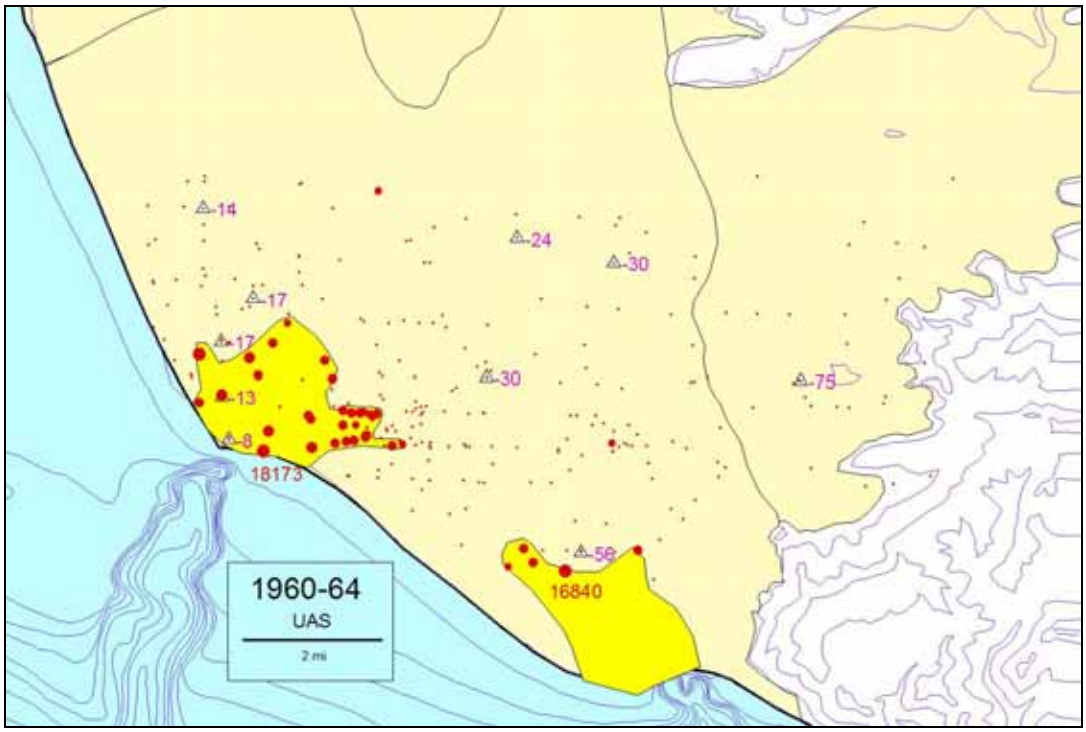


Figure 37. Upper Aquifer System groundwater levels and chloride levels, 1960 to 1964. Legend is shown in Figure 29. Bright yellow areas are intruded by saline waters. Line in title block is two miles in length.

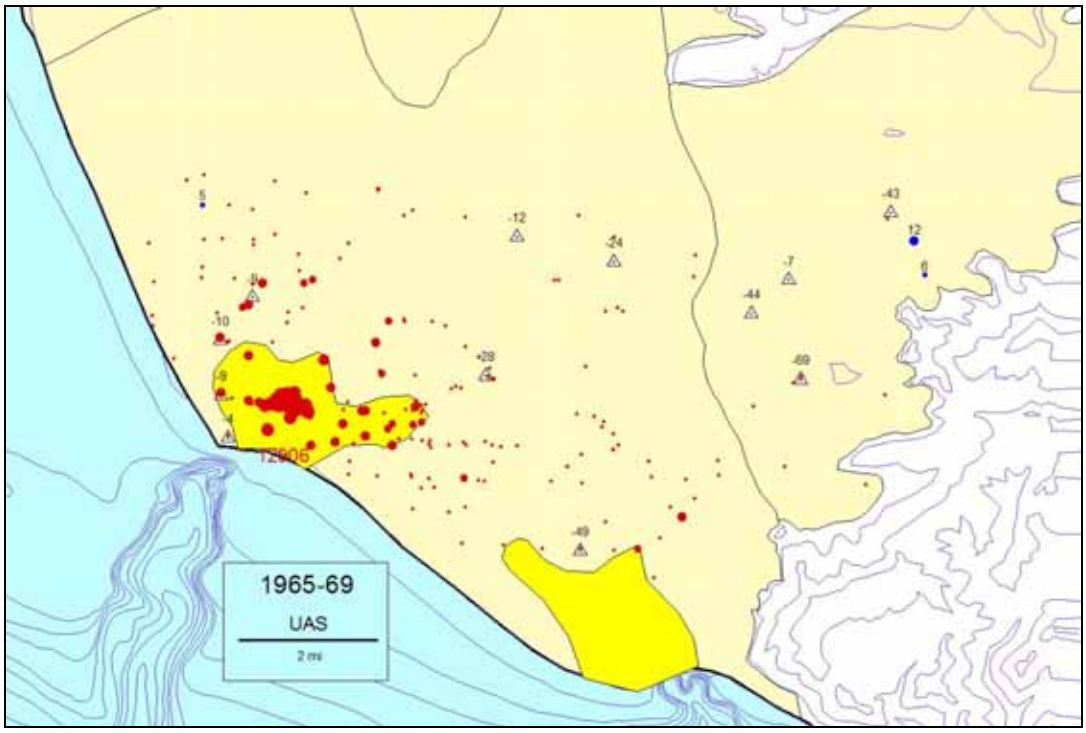


Figure 38. Upper Aquifer System groundwater levels and chloride levels, 1965 to 1969. Legend is shown in Figure 29. Bright yellow areas are intruded by saline waters. Line in title block is two miles in length.

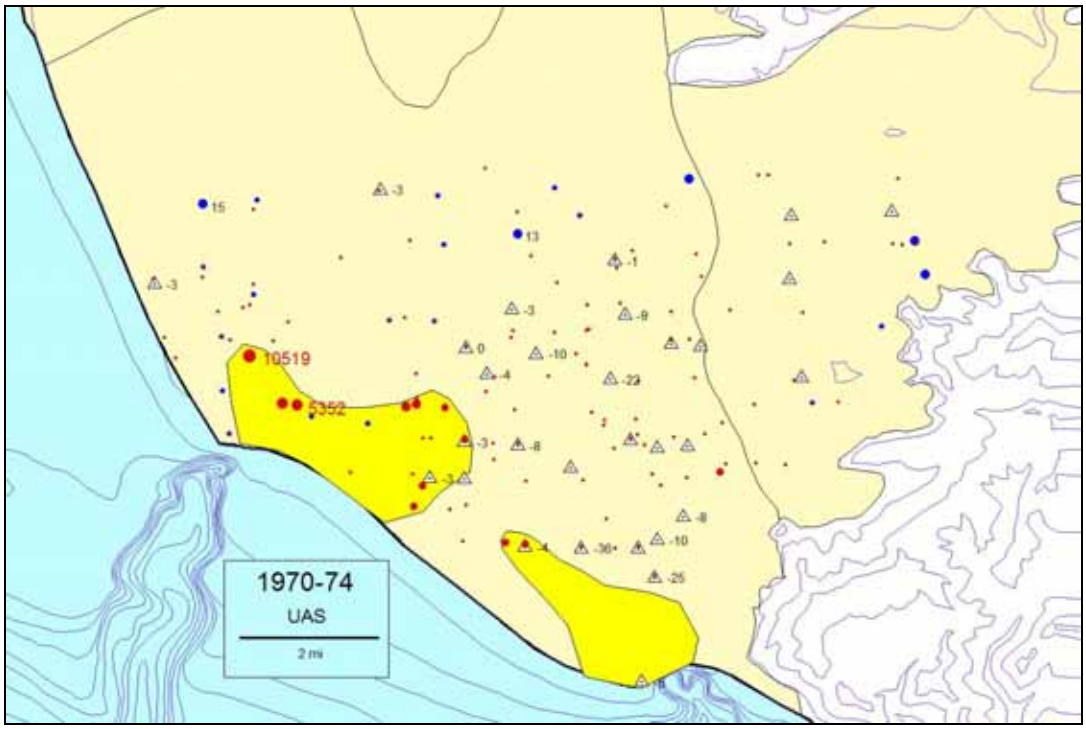


Figure 39. Upper Aquifer System groundwater levels and chloride levels, 1970 to 1974. Legend is shown in Figure 29. Bright yellow areas are intruded by saline waters. Line in title block is two miles in length.

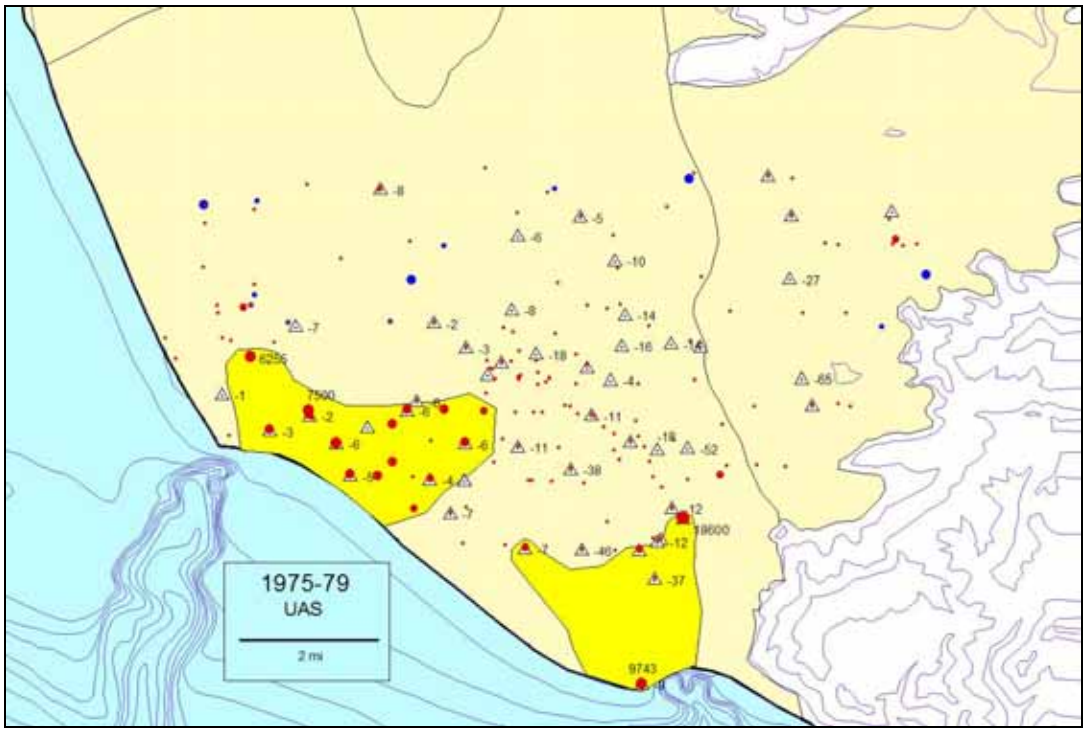


Figure 40. Upper Aquifer System groundwater levels and chloride levels, 1975 to 1979. Legend is shown in Figure 29. Bright yellow areas are intruded by saline waters. Line in title block is two miles in length.

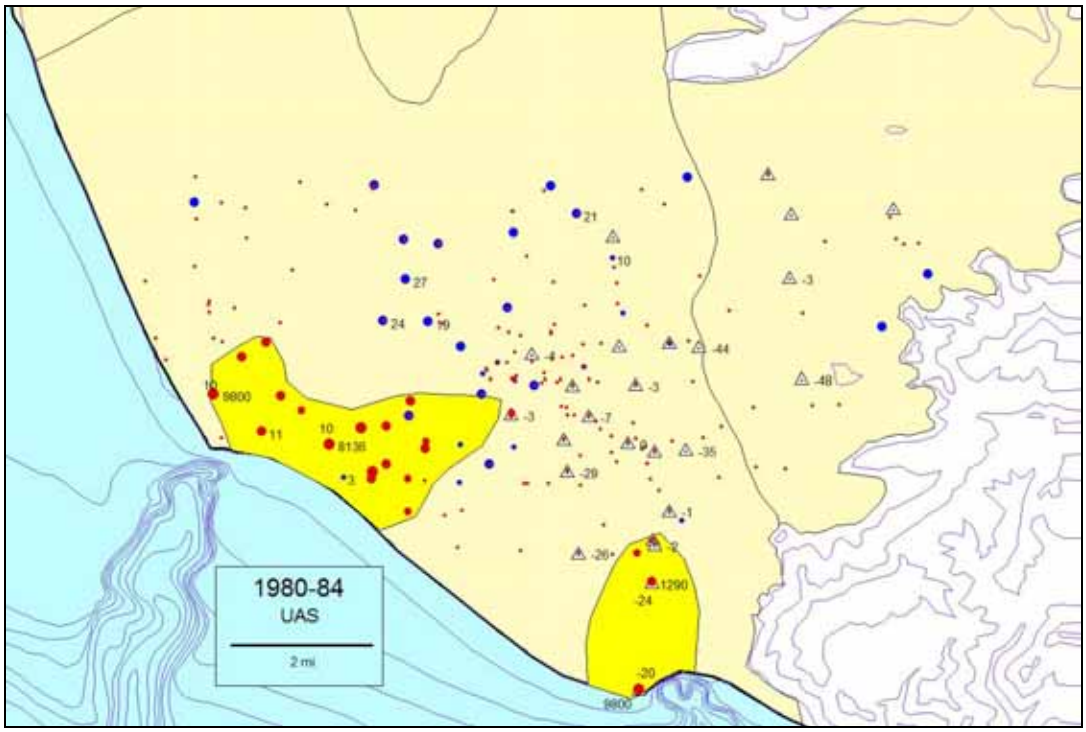


Figure 41. Upper Aquifer System groundwater levels and chloride levels, 1980 to 1984. Legend is shown in Figure 29. Bright yellow areas are intruded by saline waters. Line in title block is two miles in length.

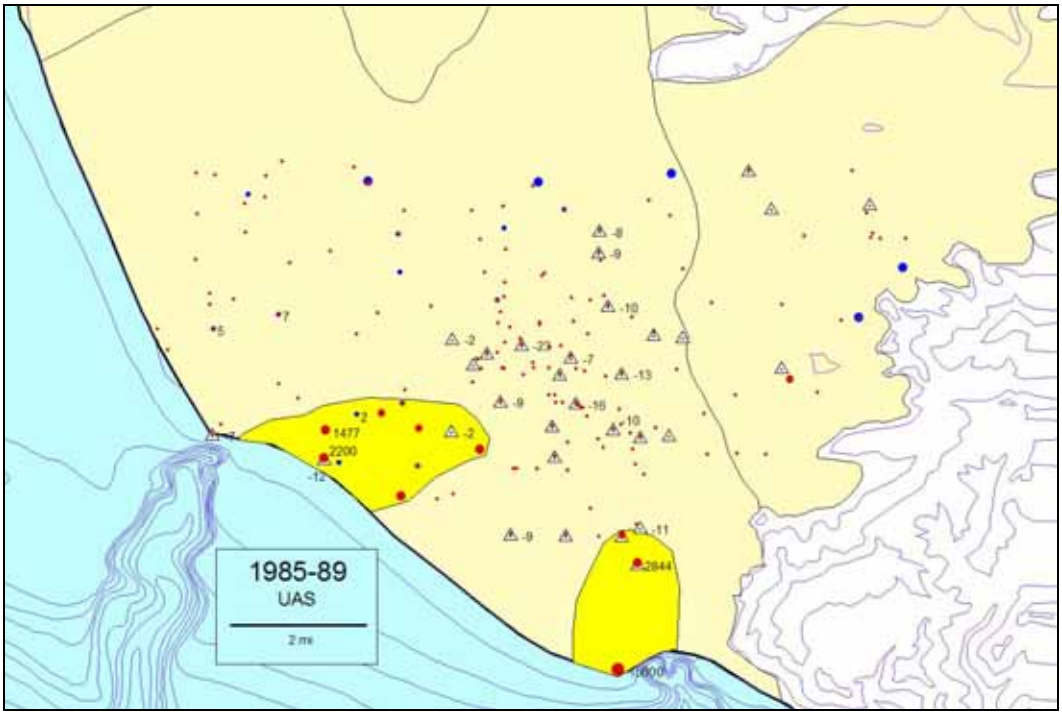


Figure 42. Upper Aquifer System groundwater levels and chloride levels, 1985 to 1989. Legend is shown in Figure 29. Bright yellow areas are intruded by saline waters. Line in title block is two miles in length.

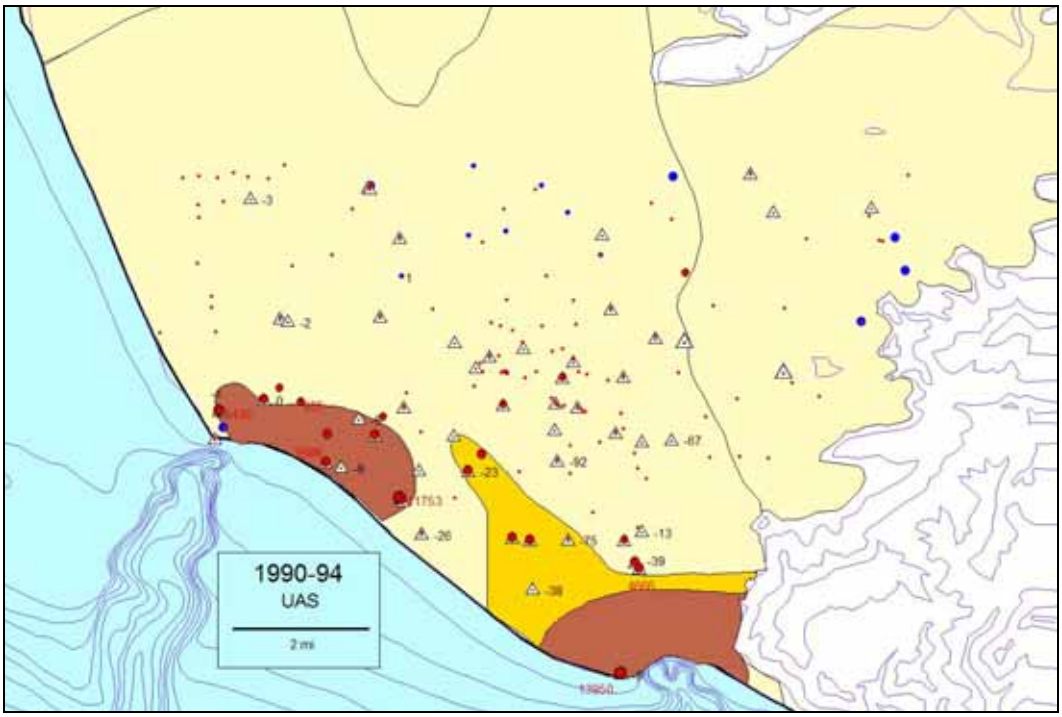


Figure 43. Upper Aquifer System groundwater levels and chloride levels, 1990 to 1994. Legend is shown in Figure 29. Source of saline intruded areas: reddish brown is from seawater; yellow-orange is from sediments. Line in title block is two miles in length.

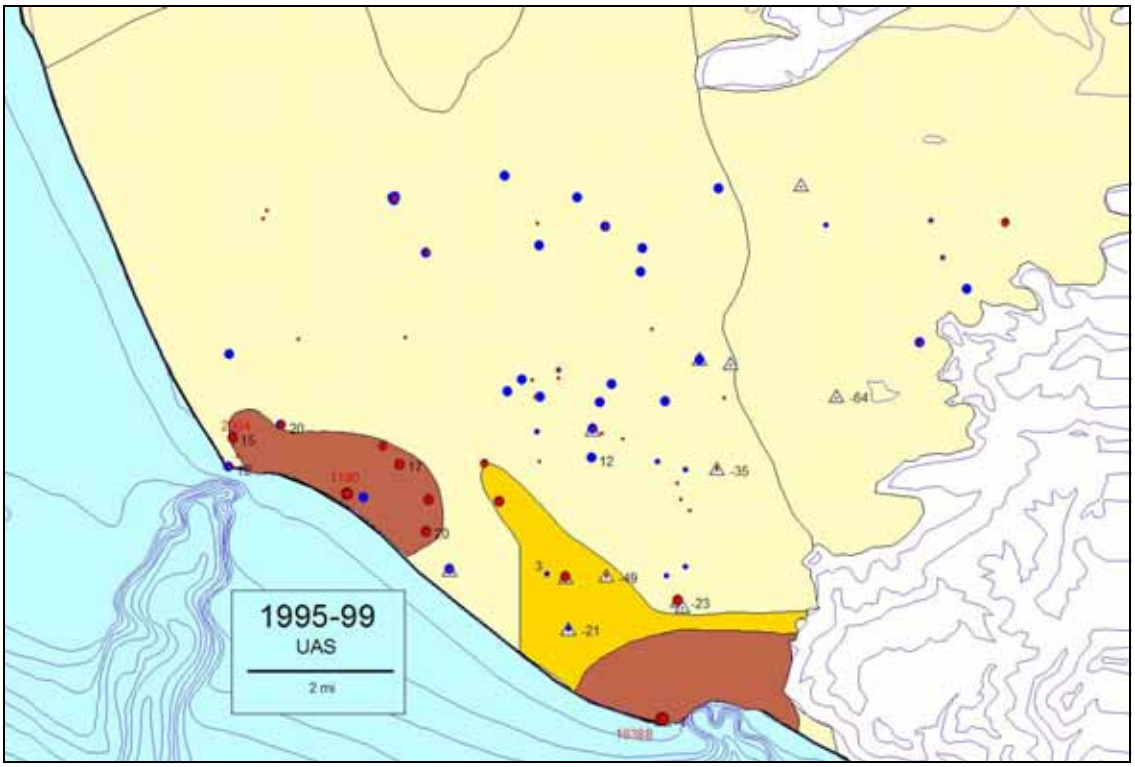


Figure 44 Upper Aquifer System groundwater levels and chloride levels, 1995 to 1999. Legend is shown in Figure 29. Source of saline intruded areas: reddish brown is from seawater; yellow-orange is from sediments. Line in title block is two miles in length.

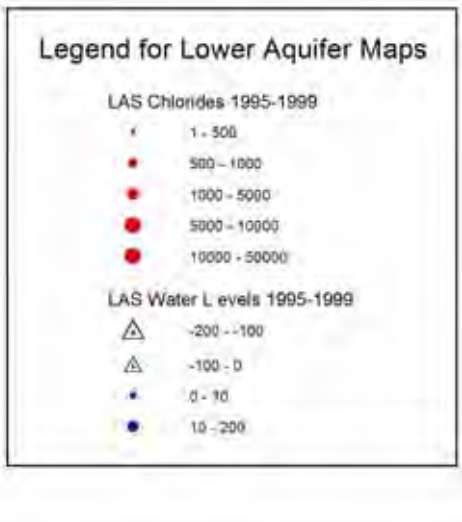


Figure 45. Legend for Figure 46 to Figure 56 for Lower Aquifer System time slices. Chloride concentrations are in mg/L, water level is elevation above or below mean sea level. All maps are

oriented with north to the top of the page. Area of map coincides with location map in Figure 2 in section 2.0 *Background of Groundwater Management and Overdraft Within the FCGMA*.

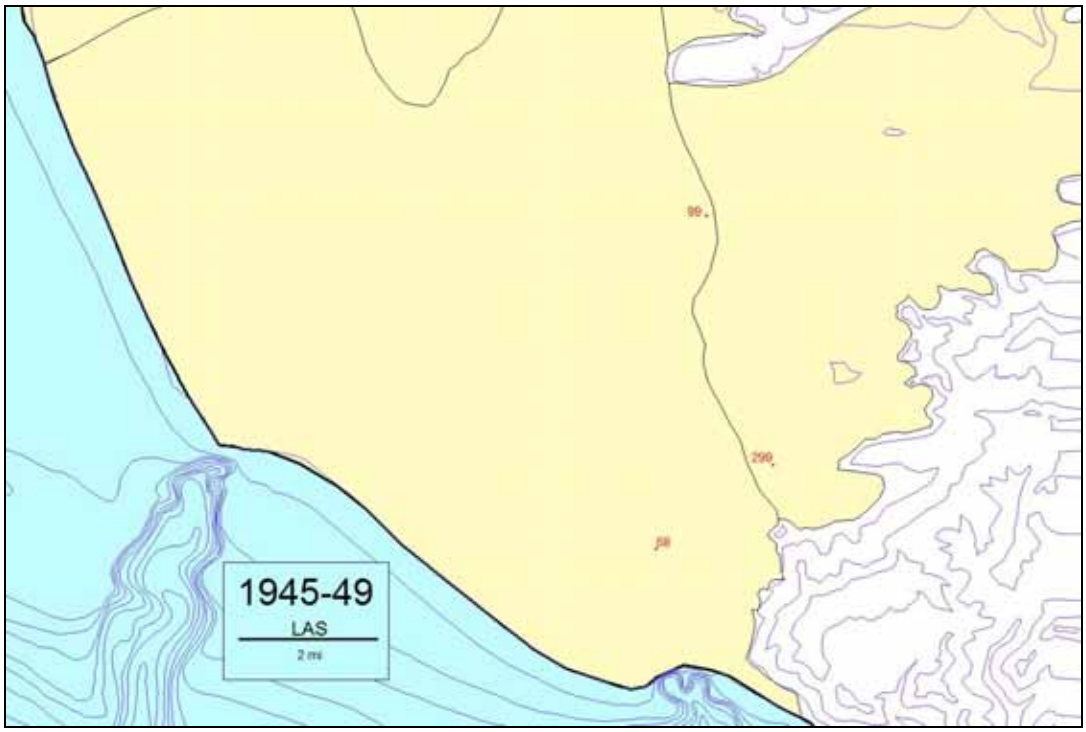


Figure 46. Lower Aquifer System groundwater levels and chloride levels, 1945 to 1949. Legend is shown in Figure 45. Line in title block is two miles in length.

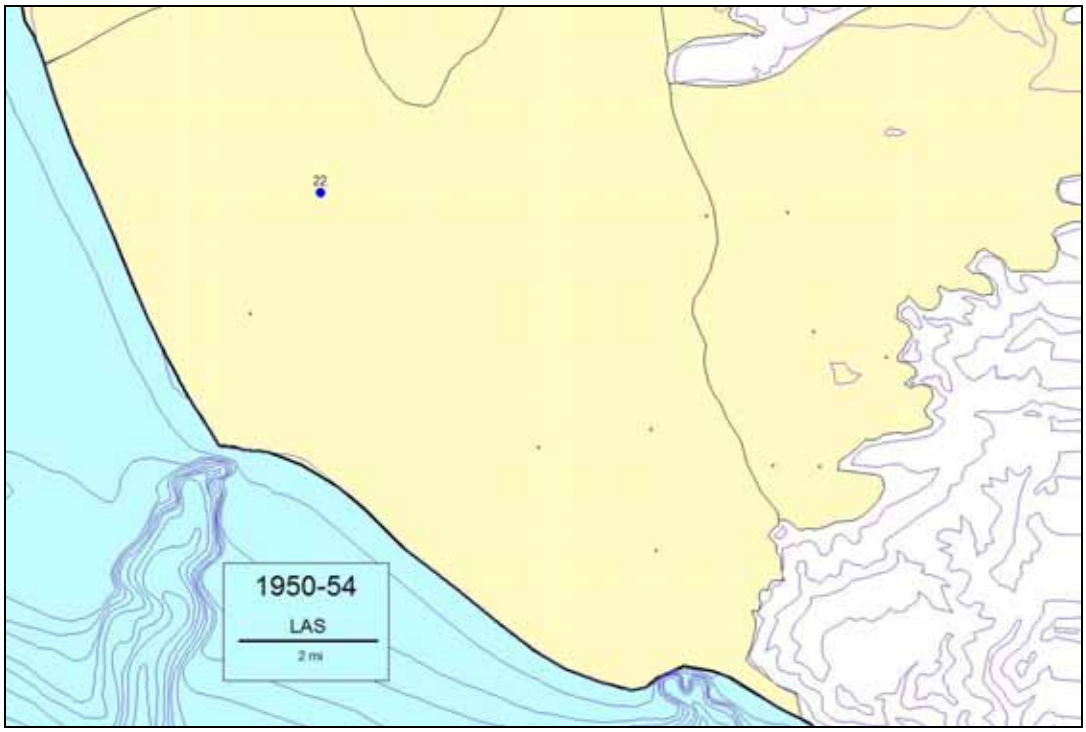


Figure 47. Lower Aquifer System groundwater levels and chloride levels, 1950 to 1954. Legend is shown in Figure 45. Line in title block is two miles in length.

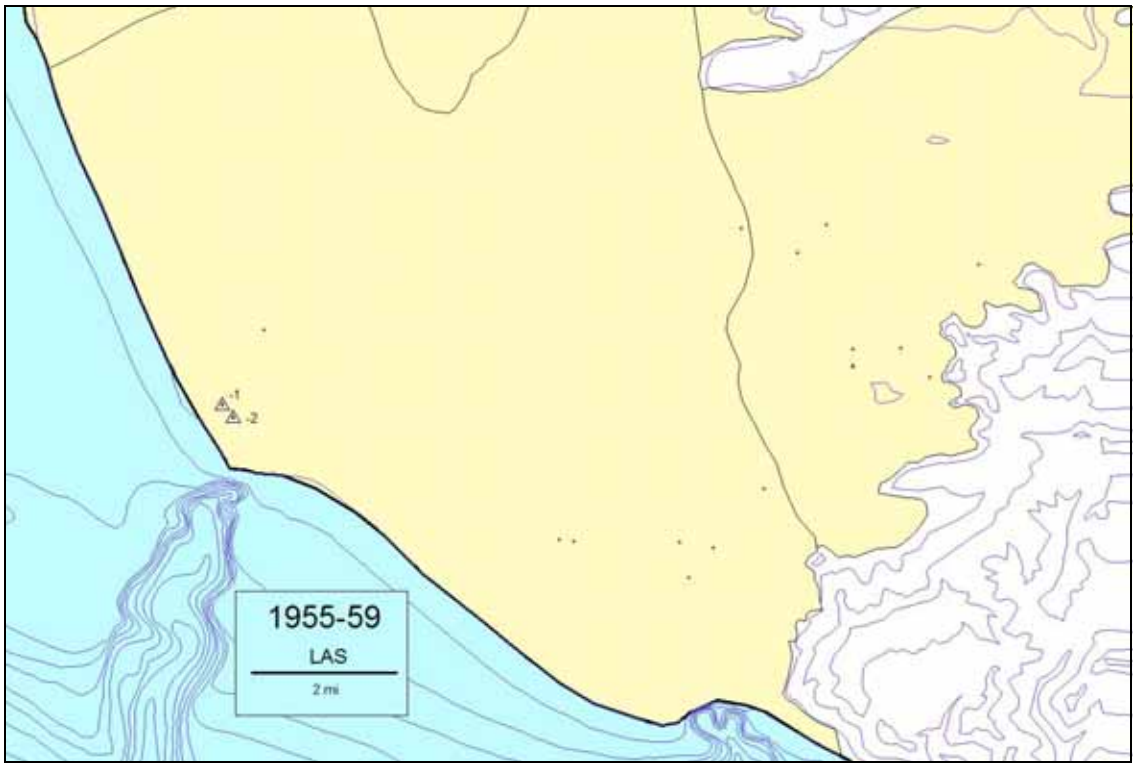


Figure 48. Lower Aquifer System groundwater levels and chloride levels, 1955 to 1959. Legend is shown in Figure 45. Line in title block is two miles in length.

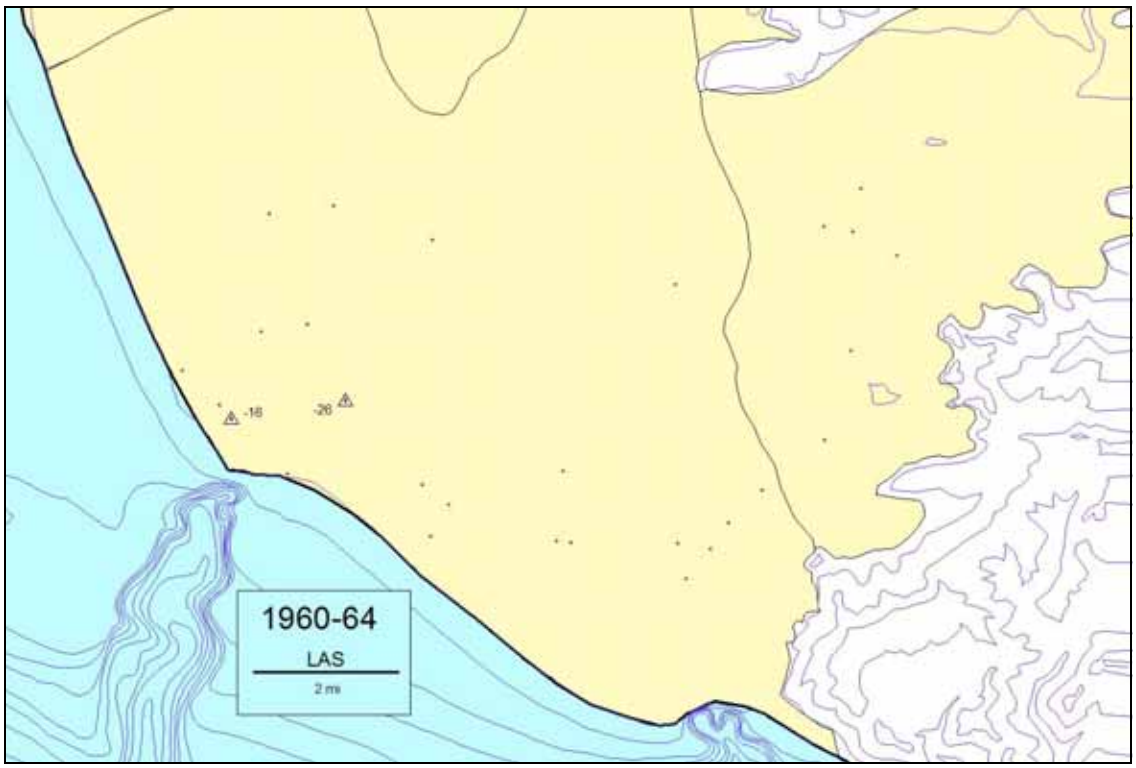


Figure 49. Lower Aquifer System groundwater levels and chloride levels, 1960 to 1964. Legend is shown in Figure 45. Line in title block is two miles in length.

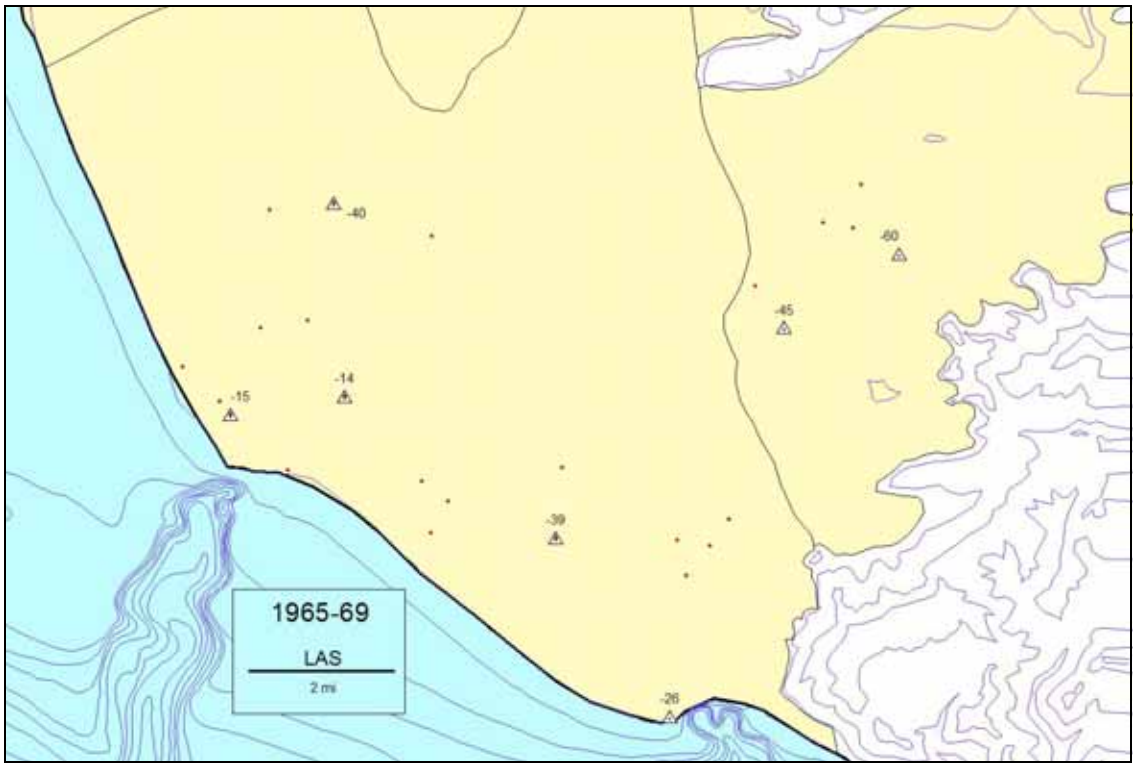


Figure 50. Lower Aquifer System groundwater levels and chloride levels, 1965 to 1969. Legend is shown in Figure 45. Line in title block is two miles in length.

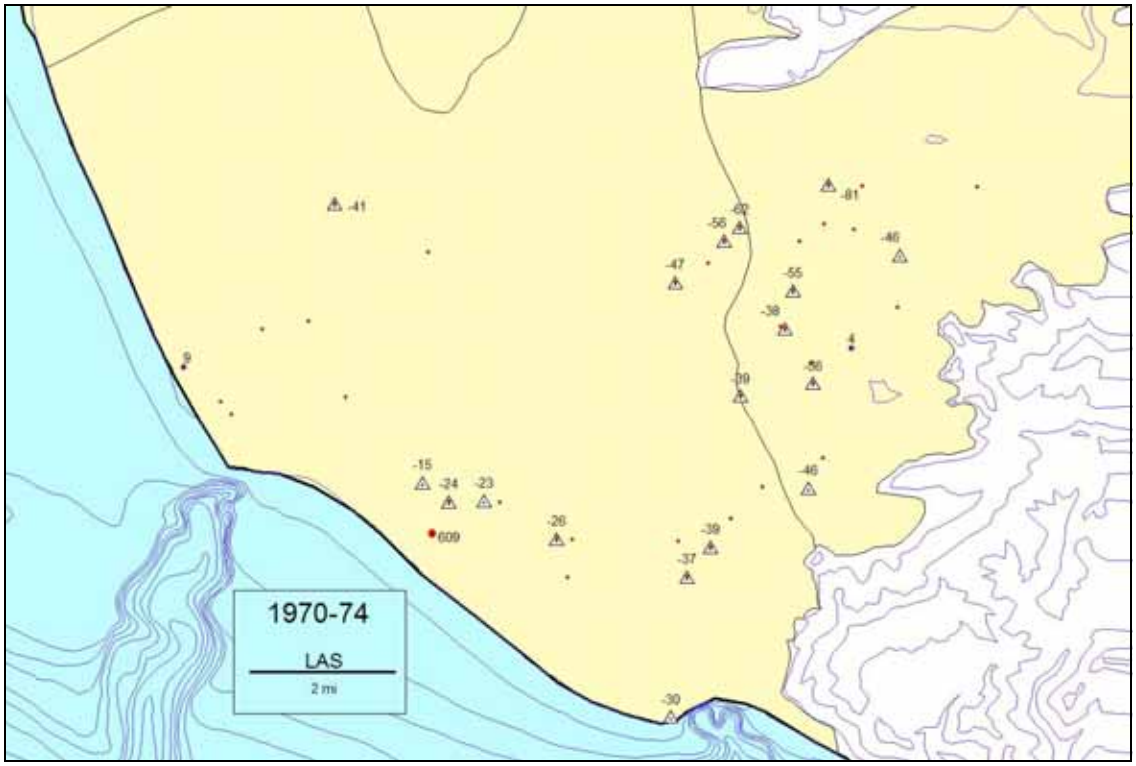


Figure 51. Lower Aquifer System groundwater levels and chloride levels, 1970 to 1974. Legend is shown in Figure 45. Line in title block is two miles in length.

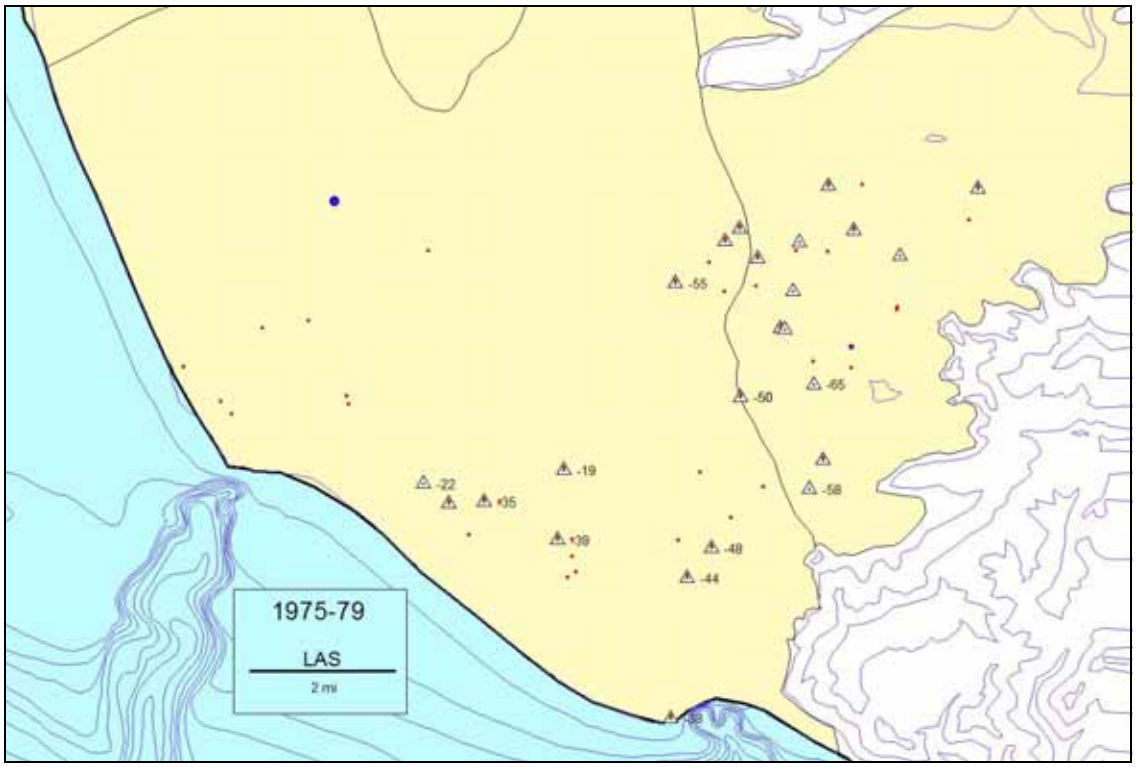


Figure 52. Lower Aquifer System groundwater levels and chloride levels, 1975 to 1979. Legend is shown in Figure 45. Line in title block is two miles in length.

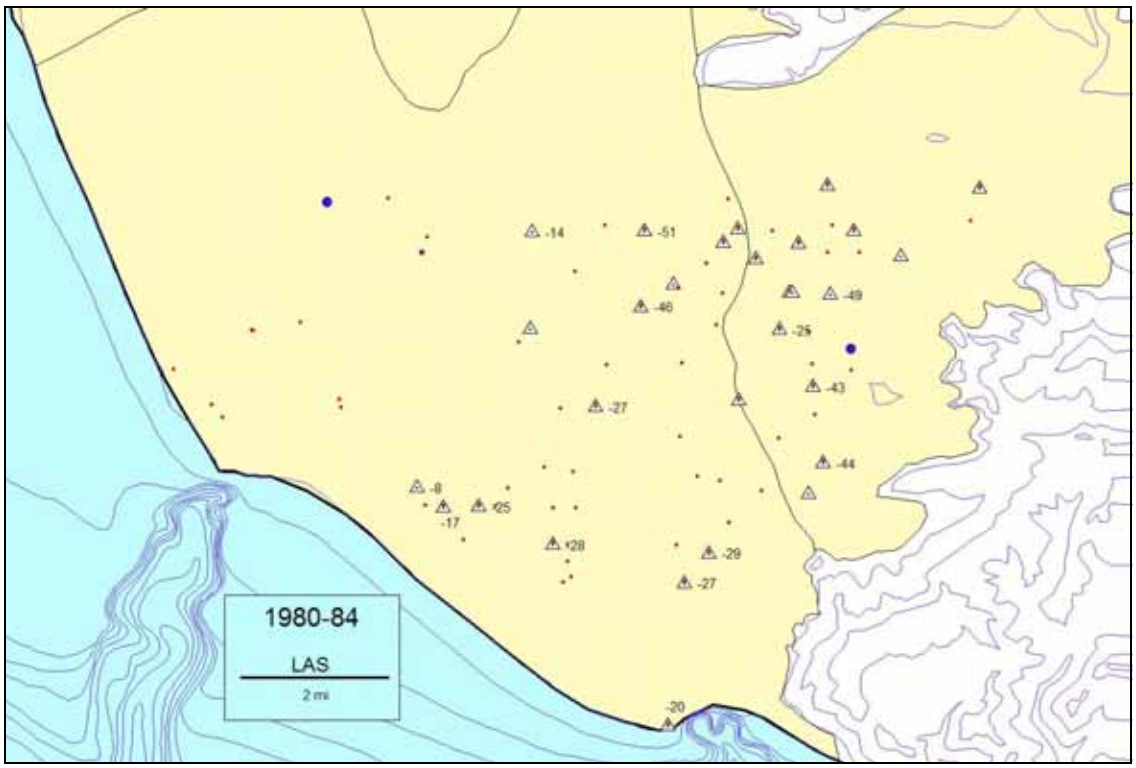


Figure 53. Lower Aquifer System groundwater levels and chloride levels, 1980 to 1984. Legend is shown in Figure 45. Line in title block is two miles in length.

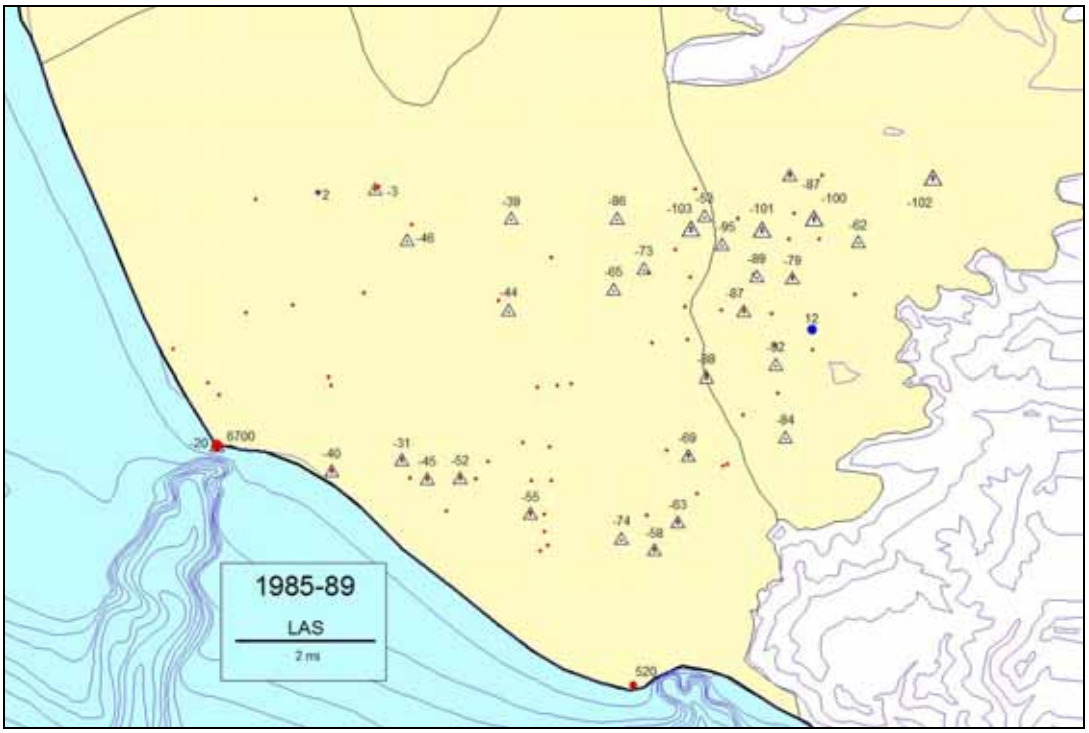


Figure 54. Lower Aquifer System groundwater levels and chloride levels, 1985 to 1989. Legend is shown in Figure 45. Note start of seawater intrusion (red dot) at head of Hueneme Submarine Canyon. Line in title block is two miles in length.

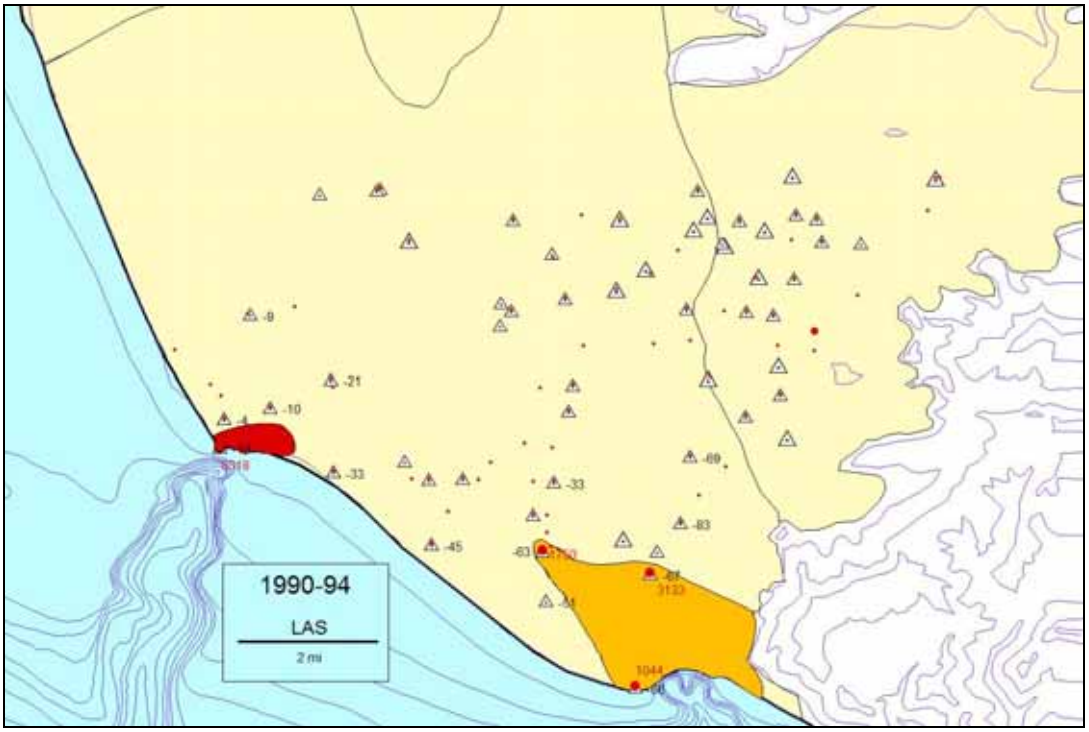


Figure 55. Lower Aquifer System groundwater levels and chloride levels, 1990 to 1994. Legend is shown in Figure 45. Source of saline intruded areas: reddish brown is from seawater; yellow-orange is from sediments. Line in title block is two miles in length.

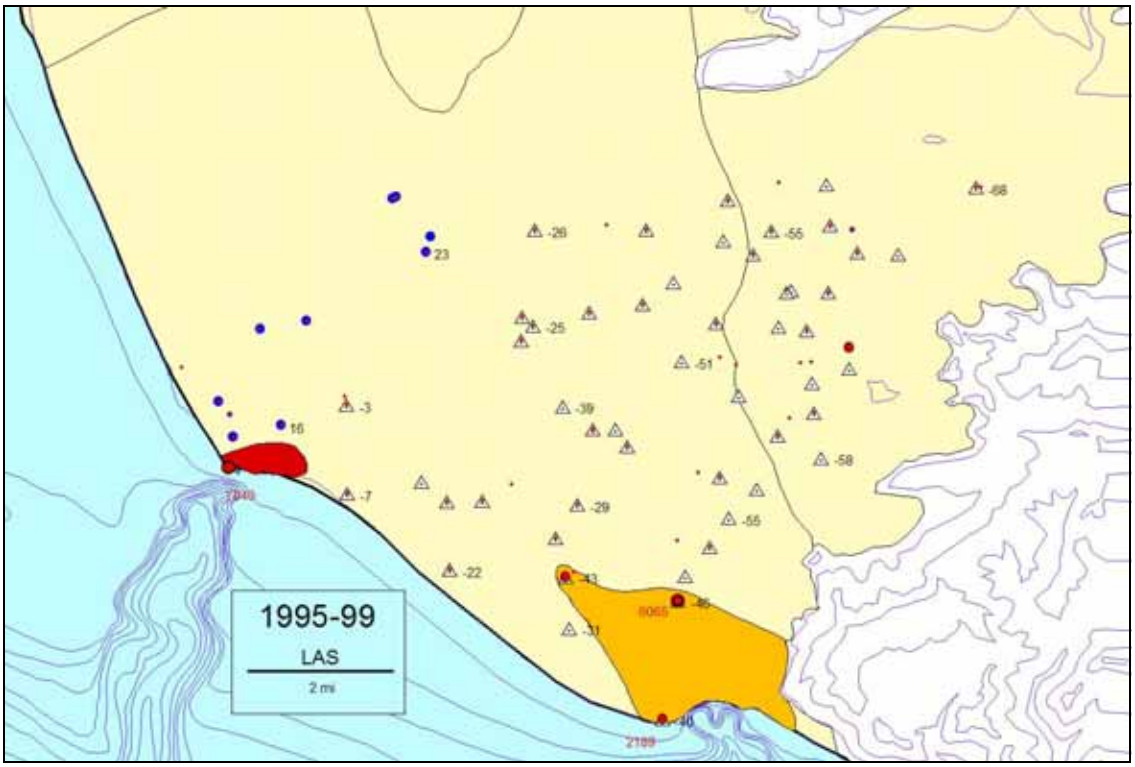


Figure 56. Lower Aquifer System groundwater levels and chloride levels, 1995 to 1999. Legend is shown in Figure 45. Source of saline intruded areas: reddish brown is from seawater; yellow-orange is from sediments. Line in title block is two miles in length.

A2.0 APPENDIX B. - VENTURA REGIONAL GROUNDWATER MODEL

A2.1 INTRODUCTION

The Ventura Regional Groundwater Model is a tool developed to evaluate multifaceted conjunctive use groundwater management projects designed to alleviate seawater intrusion, overdraft, land subsidence and other problems. These projects include in-lieu use of surface water, shifts in pumping and waste water effluent recycling.

The regional groundwater flow model was originally developed by the U.S. Geological Survey (Hanson et al., 2003) as part of the Regional Aquifer Systems Analysis (RASA), jointly funded by United Water Conservation District and Ventura County Water Resources.

The model is a finite difference numerical model which uses the MODFLOW code. The USGS developed an historical model from 1891 to 1993 and a forward model based on 1970 to 1993 hydrology. The original 2 layer model (Upper Aquifer System and Lower

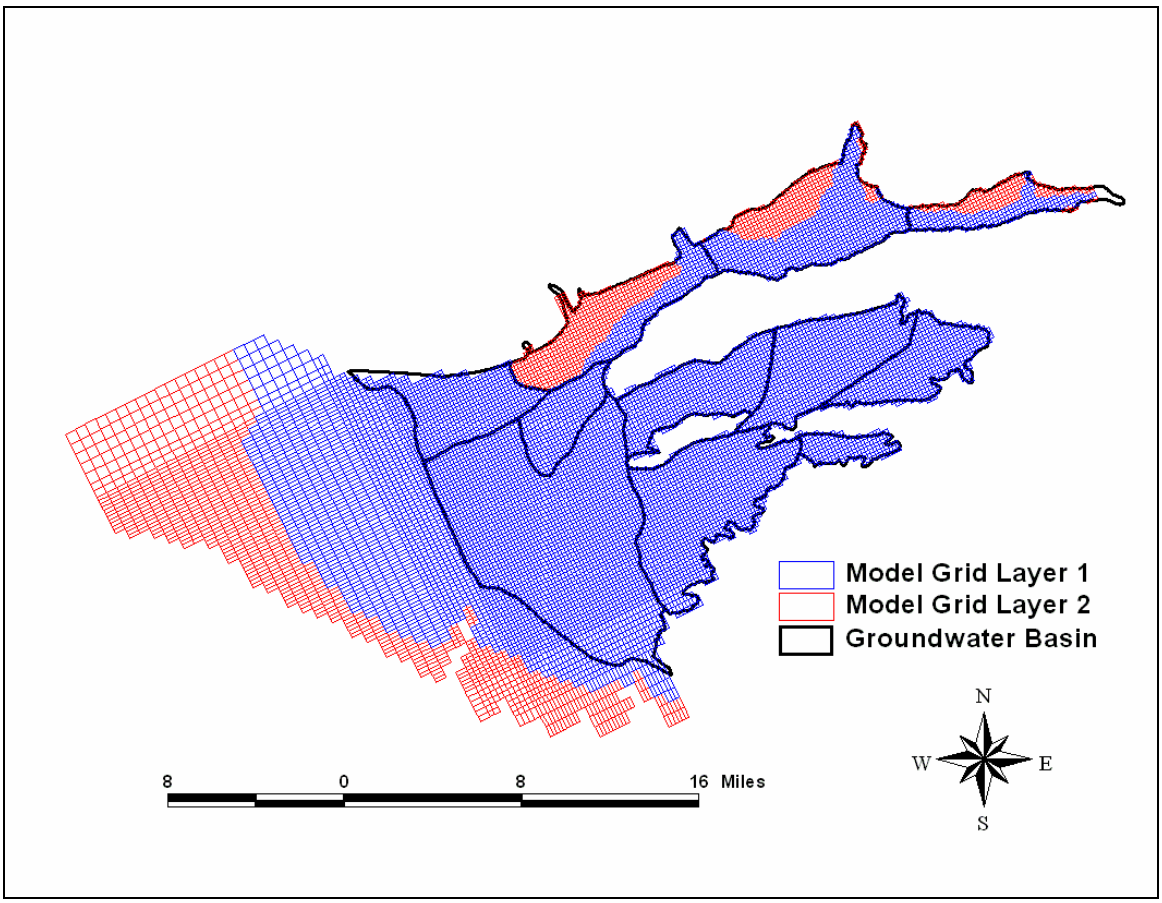


Figure 57. Updated model grid for Ventura Regional Groundwater Model.

Aquifer System) consists of a grid that contains 60 rows and 110 columns for a total of 6,600 cells (Figure 57). Within each cell a groundwater level can be computed. Volume amounts of flow can be computed from cell to cell, basin to basin and from layer to layer. The groundwater

basins within the model include Piru, Fillmore, Santa Paula, Mound, Oxnard Plain Forebay, Oxnard Plain, Pleasant Valley, East Las Posas, West Las Posas, South Las Posas, and Santa Rosa.

Water resource inputs to the model include stream flow, artificial recharge, onshore flow, effluent recharge, recharge on permeable mountain front outcrops, rainfall infiltration on the valley floor, and groundwater storage within the permeable sand and gravel aquifers. Water resource outputs include offshore flow and pumping.

The United Water Conservation District has recently modified the groundwater model. The modifications include the following:

- Model was put on user friendly *Groundwater Vistas* platform. This eliminates having to run the model in DOS.
- Refinement of cell size from 1/2 mile x 1/2 mile to 1/6 mile x 1/6 mile for the alluvial basins. This, for example, enables the artificial recharge water to more accurately be input to the appropriate area instead of overlapping into the river.
- Reduction in grid size. In the original USGS model only 28% of the grid cells are active. In the modified model 47% of grid cells are active (ETIC, 2003).
- Extension of the historical and forward model to include 1994 to 2000 hydrology.
- Addition of a zone of lower hydraulic conductivity in the Lower Aquifer System extending in a linear trend from the Camarillo Hills anti-cline to Port Hueneme. This is to simulate the maximum uplift and truncation of the more permeable upper portion of the Lower Aquifer System along this linear trend.
- Addition of an additional layer in the upper basins of Piru, Fillmore, and Santa Paula to better simulate the more permeable alluvium along the Santa Clara River, Sespe Creek, Santa Paula Creek and Piru Creek.
- Recalibration of the Forebay and Oxnard Plain portions of the model over the period 1983 to 1998 to reflect the increased diversions and recharge that have occurred in this area since the USGS originally calibrated the model (UWCD, 2006b).
- Expansion of the forward model period to a full 55 years that reflect the climate and hydrology of the years 1944 to 1998. This period is a commonly-used base period because it starts and ends in very wet years, spans several wet and dry cycles, and represents zero cumulative departure for rainfall across the period.

The regional groundwater flow model has been used in the following projects and analyses:

- Oxnard Plain LAS and UAS overdraft analysis – UWCD (2001)
- GREAT Project EIR – UWCD and City of Oxnard
- Las Posas Basin ASR project operations – Calleguas MWD
- City of Fillmore water supply planning – UWCD and City of Fillmore
- Pleasant Valley AB303 grant study – UWCD
- Fox Canyon Groundwater Management Agency Groundwater Management Plan – UWCD and FCGMA

A2.2 MODELING FOR THE FCGMA GROUNDWATER MANAGEMENT PLAN

The Ventura Regional Groundwater Model was used to evaluate all FCGMA management strategies that change the water budget within the FCGMA – that is, all projects that have recharge and/or groundwater pumping components. The model is a groundwater flow model, not a chemical transport model, so water quality changes could not be directly tested. However,

water quality changes could be inferred from the groundwater flows and groundwater elevations in cases such as seawater intrusion – we know how high groundwater elevations need to be at the coastline to prevent seawater from intruding into the aquifers.

The method of evaluation of management strategies was straightforward:

1) First, the forward model was used to determine conditions in the aquifer using only existing strategies and facilities (Base Case).

2) Each strategy was independently added to the Base Case and was run through the forward model (one model run for each strategy). A final model simulation combined all the strategies to determine if together they could solve the overdraft conditions. For ease of evaluation, it was assumed that the new strategy was in place at the beginning of the model period and remained in place for the entire model period.

3) Groundwater elevation results for all the time steps within the forward model were extracted for each of the wells for which there are water-level BMOs. Water levels at the BMO wells were compared between the Base Case and the individual management strategy to determine the effect of the strategy in meeting water-level BMOs.

A2.2.1 Base Case

The Base Case included strategies and facilities currently in place. Although the hydrology of the 55 years of the forward model is based on historical data, several other model inputs are different than they were during the historic period. For instance, the Freeman Diversion allows greater diversions now than were possible before it was constructed; these additional diversions are factored into the forward model. Likewise, groundwater extractions have been reduced during the past 15 years and the forward model must reflect these changes. To calculate the correct extractions for the forward model, the 55-year period was divided into dry, average, and wet years depending upon historical rainfall and stream flow for each model year. There were roughly equal numbers of dry, average, and wet years in the model. Representative data for dry, average, and wet years were used to approximate pumping during the model period; the representative pumping included only the previous 15 years since FCGMA pumping has been reduced and was adjusted to reflect the current 15% FCGMA pumping reduction. The average pumping over the 55-year period of the forward model was calculated to be equivalent to the actual average pumping of the past 15 years (adjusted for FCGMA pumping reductions).

The Base Case does not include potential future changes in pumping or recharge – it represents today's social, economic, and water use conditions, but tests the status quo over a range of hydrologic conditions. In this manner, various groundwater management strategies can be modeled and compared to the Base Case with no other changing conditions to complicate the comparison. Additional model simulations could factor in such changes as potential land use conversion (e.g., agriculture to urban), but it is appropriate to have these model simulations separate from the Base Case.

The Base Case is the starting point for each of the management strategies that were evaluated with the model. Each simulation discussed below simply adds the new management strategy to the Base Case for comparison. The only exception is the Combined Strategies simulation, where all the modeled strategies are combined in a single simulation.

Base Case Evaluation	Upper Aquifer	Lower Aquifer
BMO Avg (ft msl)	5.3	17.6
Base Case		
Avg (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%

Table 10. Results of Base Case groundwater model simulation. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

A2.2.2 Sensitivity Analysis – Understatement of Reported Extractions

Concerns have been voiced that pumping reported to the FCGMA may be understated by agricultural irrigators because of either poorly-calibrated water meters or inaccuracies in using other reporting methods. To test the effect of understated pumping on modeling results, the Base Case was modified to increase agricultural pumping by 15% during all hydrologic conditions (i.e., wet, average, and dry model years). This modified simulation yielded lower groundwater levels, as would be expected (Table 11).

Pumping Sensitivity Analysis	Upper Aquifer	Lower Aquifer
Change in Avg BMO Water Levels (ft)	-7.3	-15.0
Change in % of Time Above BMO	-9%	-3%

Table 11. Change in model results for the Base Case if actual agricultural pumping was increased by 15%. The negative changes indicate that groundwater levels would be lower at BMO wells and the percentage of time that groundwater levels were above BMOs would be less.

The sensitivity analysis indicates that the Base Case modeling results may be overestimating future groundwater levels. However, if the model was recalibrated in the future to correct for any understatement of pumping, it is likely that the results would not look much different than the present Base Case. This would happen because if pumping was increased over the calibration period, then this pumping must be balanced by additional recharge that has not been accounted for. If the re-calibrated model has more recharge, then the increased pumping that would be added to the Base Case would potentially be offset by this increased recharge.

The main conclusion to be drawn from the sensitivity analysis is that the current management strategies for the basin may not be as effective as modeled, but not by any amount that would change conclusions of this Plan. More management strategies are still required, and because most of the modeling effort compares one strategy against another (a comparative rather than an absolute analysis), errors will be relatively small. However, if the meter calibration effort planned by the FCGMA proves that there is indeed understating of pumping, the model should be recalibrated to ensure that errors are marginalized.

A2.2.3 Continuation of 25% Pumping Reduction

This simulation compares attainment of BMOs between current 15% pumping reduction and full 25% pumping reduction. The 15% pumping reduction is the Base Case for the model. Thus, an additional 10% pumping reduction is applied for this comparison simulation. This reduction is applied only to M&I wells because agricultural wells have already taken actions that have reduced pumping in excess of 25% and it is unlikely that any additional steps in changing

irrigation methods will be undertaken before the 2010 date for full implementation of the 25% pumping reductions. .

Pumping for each M&I well in the model is reduced by an additional 10% for the complete model period. This results in 3,800 AFY of reduced pumping across the FCGMA.

The results of this simulation are indicated in Table 12.

25% Reduction Evaluation	*Upper Aquifer*	*Lower Aquifer*
BMO Avg Level (ft msl)	5.3	17.6
Base Case		
Avg Level (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%
25% Pumping Reduction		
Avg Level (ft msl)	4.9	-37.8
Improve from Base Case (ft)	1.2	2.2
% of Time Above BMO	53%	7%

Table 12. Results of groundwater model simulation for the continuation of the 25% FCGMA pumping reduction. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

A2.2.4 RiverPark Recharge Pits

Compares attainment of BMOs between current recharge operations (Base Case) and the addition of the RiverPark Recharge pits. Using UWCD's daily river routing model, available storm flow that is not already diverted by the Freeman Diversion is diverted to the RiverPark Recharge Pits for percolation and recharge. This additional recharge is generally only available during the winter and spring of wetter years when river flow exceeds UWCD's current recharge capabilities. The amount of recharge water applied in any one quarter to the model for the RiverPark pits is calculated in daily increments through the river routing model, and takes into account both water availability and recharge capacity in the pits. The extra recharge varies from an average of 400 AFY in dry years to an average of 11,500 AFY during wet years.

The results of this simulation are indicated in Table 13.

RiverPark Recharge Evaluation	*Upper Aquifer*	*Lower Aquifer*
BMO Avg Level (ft msl)	5.3	17.6
Base Case		
Avg Level (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%
RiverPark Recharge		
Avg Level (ft msl)	3.7	-40.0
Improve from Base Case (ft)	<0.1	<0.1
% of Time Above BMO	52%	6%

Table 13. Results of groundwater model simulation for the RiverPark Recharge project. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

A2.2.5 GREAT Project

This simulation compares attainment of BMOs between current basin operations (Base Case) and the addition of the GREAT project. This simulation was performed in two parts to reflect the two phases of the project that were evaluated in the City of Oxnard's EIR for the project. Although the project phases are in reality scheduled sequentially, the model simulates each phase separately to determine the effectiveness of each. For model purposes, Phase I includes 5,000 AFY of reclaimed water, with one fourth of the water being injected in the Ocean view area of the south Oxnard Plain during the first quarter of each year when agricultural demand is low, and three fourths of the water delivered to agricultural irrigators within the PTP service area in-lieu of pumping their own wells. The City of Oxnard then retrieves the 5,000 AFY of injection/in-lieu recharge (as storage credits) equally from UWCD's O-H well field in the Oxnard Plain Forebay and the City's Water Yard wells located just outside the Forebay.

The Phase II model simulation includes 21,000 AFY of reclaimed water delivered in the same proportions between direct injection and in-lieu deliveries. However, the area receiving reclaimed water for irrigation is expanded to include the Pleasant Valley County Water District delivery area. In addition, the winter injection is accomplished through a series of barrier wells located along Highway 1 and Hueneme Road. The City of Oxnard then retrieves one-third of the 21,000 AFY of injection/in-lieu recharge (as storage credits) from UWCD's O-H well field in the Oxnard Plain Forebay and two-thirds from the City's own wells located just outside the Forebay.

Phase I Results: The results of this simulation are indicated in Table 1. The 8-foot improvement in Lower Aquifer groundwater levels at BMO wells is partially offset by the drop of less than one foot in Upper Aquifer BMO wells. The average drop in groundwater levels in the Oxnard Plain Forebay basin resulting from the extraction of the FCGMA credits is 2 to 3 feet.

GREAT Project Phase I Evaluation	*Upper Aquifer*	*Lower Aquifer*
BMO Avg Level (ft msl)	5.3	17.6
Base Case		
Avg Level (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%
GREAT Project Phase I		
Avg Level (ft msl)	3.4	-31.9
Improve from Base Case (ft)	-0.3	8.1
% of Time Above BMO	51%	9%

Table 1. Results of groundwater model simulation for Phase I of the GREAT project at full capacity. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

Phase II Results: The results of this simulation are indicated in Table 15. The 38-foot improvement in Lower Aquifer groundwater levels at BMO wells is partially offset by the one-foot drop in Upper Aquifer BMO wells. The average drop in groundwater levels in the Oxnard Plain Forebay basin resulting from the extraction of the FCGMA credits is 6 to 11 feet.

GREAT Project Phase II Evaluation	Upper Aquifer	Lower Aquifer
BMO Avg Level (ft msl)	5.3	17.6
Base Case		
Avg Level (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%
GREAT Project Phase II		
Avg Level (ft msl)	2.6	-1.5
Improve from Base Case (ft)	-1.1	38.5
% of Time Above BMO	51%	36%

Table 15. Results of groundwater model simulation for Phase II of the GREAT project at full capacity. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

A2.2.6 Shift Some Pumping From LAS to UAS

This simulation compares attainment of BMOs between current basin operations (Base Case) and the shifting of some pumping from the Lower Aquifer back to the Upper Aquifer in critical areas. For purposes of the model scenario, pumping is shifted only in the area of the Oxnard Plain basin where Lower Aquifer groundwater levels are well below sea level (southwest of the zone of low conductance that extends from the Camarillo Hills to Port Hueneme). Actual FCGMA policy might vary from this, but the model run demonstrates the effect of this policy change in a discrete area. In the simulation, 5,000 AFY of Lower Aquifer System pumping is moved to nearby Upper Aquifer System wells (or new UAS wells if necessary). There is no shift in pumping in areas where UAS water quality is not suitable for irrigation.

The results of this simulation are indicated in Table 16.

LAS to UAS Evaluation	Upper Aquifer	Lower Aquifer
BMO Avg Level (ft msl)	5.3	17.6
Base Case		
Avg Level (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%
LAS to UAS Shift		
Avg Level (ft msl)	2.6	-31.8
Improve from Base Case (ft)	-1.1	8.2
% of Time Above BMO	50%	9%

Table 16. Results of groundwater model simulation for shifting 5,000 AFY of pumping from the Lower to the Upper Aquifer in the south Oxnard Plain basin. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

A2.2.7 Import Additional State Water

This scenario compares attainment of BMOs between current basin operations (Base Case) and the purchase and recharge of additional State Water. For the purposes of this model simulation, an additional 10,000 AF of State Water is purchased during average and dry years, delivered to Lake Piru, and then released down the Santa Clara River as part of UWCD's

normal conservation release. The portion of this water that is likely to reach the Freeman Diversion, as calculated separately using UWCD's daily river routing model, is then diverted at the Freeman Diversion and recharged in UWCD's spreading ponds in the Oxnard Plain Forebay basin.

The results of this simulation are indicated in Table 17. Average groundwater levels in the Oxnard Plain Forebay basin would be 4 to 6 ft higher than the Base Case, providing mitigation for other strategies that have a component of pumping additional groundwater from the Forebay.

Import State Water Evaluation	*Upper Aquifer*	*Lower Aquifer*
BMO Avg Level (ft msl)	5.3	17.6
Base Case		
Avg Level (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%
Import SWP		
Avg Level (ft msl)	5.5	-38.7
Improve from Base Case (ft)	1.8	1.3
% of Time Above BMO	54%	7%

Table 17. Results of groundwater model simulation of importing additional State Water. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

A2.2.8 Increase Diversions from Santa Clara River

This simulation compares attainment of BMOs between current basin operations (Base Case) and increasing recharge from the Santa Clara River during periods of high storm flow. For purposes of this model simulation, it is assumed that the diversion rate and license of the Freeman Diversion is increased to 1,000 cfs from its current 375 cfs. Thus, during times of high flow, up to 1,000 cfs could be diverted. These additional diversions are recharged at UWCD's facilities according to their unused capacity, as determined by UWCD's daily river routing model. For purposes of the model scenario, it is assumed that the RiverPark recharge facility is available and that the Ferro gravel pit has been converted to use for recharge and storage.

The results of this simulation are indicated in Table 18. Average groundwater levels in the Oxnard Plain Forebay basin would be 6 ft higher than the Base Case, providing mitigation for other strategies that have a component of pumping additional groundwater from the Forebay.

Increase Diversions Evaluation	*Upper Aquifer*	*Lower Aquifer*
BMO Avg Level (ft msl)	5.3	17.6
Base Case		
Avg Level (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%
Increase Diversions		
Avg Level (ft msl)	6.4	-37.4
Improve from Base Case (ft)	2.7	2.6
% of Time Above BMO	54%	8%

Table 18. Results of groundwater model simulation for increasing diversions from the Santa Clara River. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

A2.2.9 Additional In-Lieu Deliveries to South Oxnard Plain

This model scenario compares attainment of BMOs between current basin operations (Base Case) and the delivery of additional in-lieu recharge water to the south Oxnard Plain. For purposes of this model simulation, it is assumed that there are 3,000 AFY of in-lieu water available for delivery to irrigation irrigators in the area south of the end of the PTP Pipeline. This in-lieu water delivery is adjusted for changes in quarterly agricultural demand.

The results of this simulation are indicated in Table 19.

In-Lieu S Oxnard Plain Evaluation	*Upper Aquifer*	*Lower Aquifer*
BMO Avg Level (ft msl)	5.3	17.6
Base Case		
Avg Level (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%
In-Lieu S Oxnard Plain		
Avg Level (ft msl)	4.9	-35.9
Improve from Base Case (ft)	1.2	4.1
% of Time Above BMO	53%	7%

Table 19. Results of groundwater model simulation of delivering additional in-lieu water to pumpers on the southern Oxnard Plain basin. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

A2.2.10 Shift Some Pumping to Northwest Oxnard Plain

This simulation compares attainment of BMOs between current basin operations (Base Case) and shifting some pumping to the northwest Oxnard Plain from areas less easily recharged. For this model simulation, it is assumed that 2,000 AFY of M&I pumping is moved from the portion of the Oxnard Plain near the Forebay basin to the northwest Oxnard Plain. This pumping is shifted from the City of Oxnard's Water Yard and Blending Station to the area within 2 miles of the ocean along Gonzalez Rd.

The results of this simulation are indicated in Table 20.

Shift NW Oxnard Plain Evaluation	*Upper Aquifer*	*Lower Aquifer*
BMO Avg Level (ft msl)	5.3	17.6
Base Case		
Avg Level (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%
Shift NW Oxnard Plain		
Avg Level (ft msl)	3.9	-39.7
Improve from Base Case (ft)	0.2	0.3
% of Time Above BMO	51%	5%

Table 20. Results of groundwater model simulation of shifting some pumping to the northwestern portion of the Oxnard Plain basin. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

A2.2.11 Injection of Treated River Water in Overdrafted Basins

This model scenario compares attainment of BMOs between current basin operations (Base Case) and the injection of treated river water into the south Oxnard Plain and Pleasant Valley areas when there are unused river diversions either during the wet portion of the year or during extended times during very wet years. The rate of injection was varied from 1,500 AFY during dry years to 5,000 AFY during wet years. For purposes of this simulation, it is assumed that the injection sites are located both within the PTP system and the Pleasant Valley CWD service area along the deepest portion of LAS pumping depression.

The results of this simulation are indicated in Table 21.

Injecting River Water Evaluation	*Upper Aquifer*	*Lower Aquifer*
BMO Avg Level (ft msl)	5.3	17.6
Base Case		
Avg Level (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%
Injecting River Water		
Avg Level (ft msl)	5.0	-32.6
Improve from Base Case (ft)	1.3	7.4
% of Time Above BMO	53%	11%

Table 21. Results of groundwater model simulation of injecting treated river water in the south Oxnard Plain and Pleasant Valley areas. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

A2.2.12 Switch Location of City of Camarillo Pumping

To test the effectiveness of moving pumping from near the Camarillo airport to an area along the Arroyo Las Posas (see section 9.3 *Development of Brackish Groundwater, Pleasant Valley Basin*), the pumping from the airport well was eliminated for the model simulation. Model results indicate that the worst portion of the pumping depression would be decreased considerably in size, leaving a smaller depression in the southern Pleasant Valley basin (Figure 58).

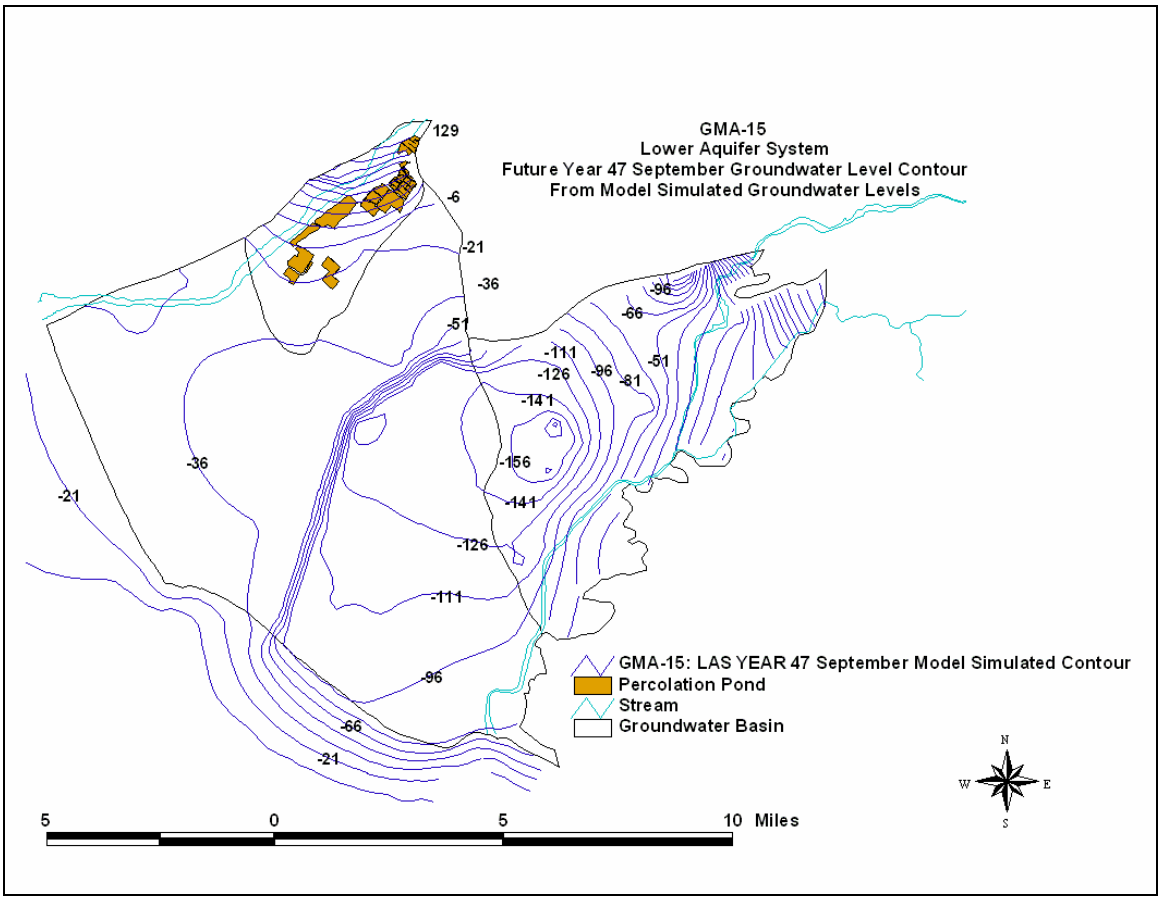


Figure 58. Simulated groundwater elevations for the LAS during the model year corresponding to the 1990 drought year, when the pumping trough beneath Pleasant Valley and the south Oxnard Plain was most pronounced. The elimination of pumping from the City's airport well decreased the size of the northern portion of the pumping depression.

A2.2.13 Full-Time Barrier Wells in South Oxnard Plain

This simulation compares attainment of BMOs between current basin operations (Base Case) and the use of barrier wells in the south Oxnard Plain to build a recharge mound that prevents coastal chloride contamination from moving further inland. The effectiveness of barrier wells was partially tested for the GREAT project. This simulation assumes that there is water available during the entire year for injection – the actual water available would likely be a combination of recycled water and other water sources. To dovetail with the GREAT simulation's winter-only injection scenario, the water available for injection in the barrier wells was modeled at 21,000 AFY, which was injected at a constant rate throughout the year. The barrier wells used in the simulation are identical to the locations of the GREAT Phase II barrier wells along Highway 1 and Hueneme Road.

The results of this simulation are indicated in Table 22.

Barrier Wells Evaluation	Upper Aquifer	Lower Aquifer
BMO Avg Level (ft msl)	5.3	17.6
Base Case		
Avg Level (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%
Barrier Wells		
Avg Level (ft msl)	15.2	6.5
Improve from Base Case (ft)	11.5	46.5
% of Time Above BMO	63%	48%

Table 22. Results of groundwater model simulation for a barrier well project in the south Oxnard Plain. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

A2.2.14 Combined Management Strategies

The management strategies used in the previous simulations were combined in a single model run to determine their overall combined effect in reaching BMOs. This model simulation is an indicator of whether additional management strategies are needed beyond those in this Plan.

The results of this simulation are indicated in Table 23. The most important result is that the combined management strategies allow BMOs to be met 67% of the time in the Upper Aquifer and 76% of the time in the Lower Aquifer. This result suggests that if all the management strategies in the Plan are implemented, the basin would be relatively safe from saline intrusion (see discussion in section 7.0 *Yield of the Groundwater Basins* on level of attainment of BMOs).

Combined Strategies Evaluation	Upper Aquifer	Lower Aquifer
BMO Avg Level (ft msl)	5.3	17.6
Base Case		
Avg Level (ft msl)	3.7	-40.0
% of Time Above BMO	51%	5%
Combined Strategies		
Avg Level (ft msl)	18.4	59.8
Improve from Base Case (ft)	14.7	99.8
% of Time Above BMO	67%	76%

Table 23. Results of groundwater model simulation of implementing the combination of all the management strategies evaluated using the groundwater model. Groundwater elevations are averages for Upper and Lower Aquifer wells for which there is a groundwater elevation BMO. Also indicated is the percentage of time (weekly time steps) that groundwater elevations were above the BMO elevation for each BMO well.

A3.0 APPENDIX C. EAST LAS POSAS BASIN MANAGEMENT PLAN

During the February 23, 1994 meeting, the Board of Directors of the FCGMA conditionally approved CMWD's Application for the Injection/Storage Facilities in the North Los Posas Basin. (**Note:** The reference to the North Las Posas Basin stems from the FCGMA original Groundwater Management Plan adopted in 1985. The current correct reference is the East Las Posas Basin).

This approval was conditioned upon several factors including but not limited to: (1) a maximum of 20 injection/storage wells registered with the FCGMA; (2) well injection/extraction schedule determined by availability of water and needs of CMWD's customers; (3) continuous injection period well testing and monthly reporting of acre-feet injected/extracted from wells along with water quality analysis for selected constituents to the FCGMA by CMWD; (4) maximum storage limit of 300,000 acre-feet without further approval of the FCGMA; (5) extraction/injection points shall be coterminous, or in proximate vicinity and coordinated with the FCGMA; (6) water stored in such facilities shall be used in Ventura County; (7) CMWD periodic review of the effects of the injection on surrounding basins to ensure no detrimental effect; (8) CMWD shall have an affirmative obligation to mitigate any detrimental effects found; and (9) FCGMA approval standards for the injection/storage wells shall be mandatory. These conditions were memorialized in a July 12, 1994 letter from Lowell Preston, Ph.D., Agency Coordinator, to Eric Berg, Administrator, CMWD (See Appendix C - Exhibit A).

Subsequently to FCGMA's above mentioned approval, CMWD engaged in several years of discussions about groundwater issues in the Las Posas basin with members of the East Las Posas Basin Users Group (the Group) and individual pumpers. This informal Group, which meets every second month, discusses both basin-wide groundwater issues and potential issues related to Calleguas' Las Posas Basin ASR project.

As a result of those discussions, CMWD and the Group developed the East Los Posas Basin Management Plan (ELPBMP). The ELPBMP, which outlines a monitoring program for the injection/storage wells, establishes action levels, sets stakeholder responsibilities for operation of the ASR project by CMWD, and provides for a dispute resolution mechanism between the parties, attempts to manage the ASR project in such a way as to minimize problems and maximize the beneficial use of groundwater within the East Las Posas Basin..

The ELPBMP is attached to the FCGMA Management Plan as Appendix C. It is understood by the parties that the East Las Posas Basin Management Plan will be reviewed and updated regularly as conditions warrant it.

The Plan begins on the following page.

EAST LAS POSAS BASIN MANAGEMENT PLAN

THIS MANAGEMENT PLAN FOR THE EAST LAS POSAS BASIN (the "Plan"**)** is effective as of _____, 2006, and is created with reference to the following recitals of fact, understandings and intentions:

RECITALS

A. Calleguas Municipal Water District ("Calleguas") operates an Aquifer Storage and Recovery Project ("ASR") for the benefit of its urban, industrial and agricultural water delivery customers in the Las Posas Basin ("Basin") in Ventura County, California.

B. The Basin is identified as a groundwater subsystem within the boundaries of the Fox Canyon Groundwater Management Agency ("GMA").

C. The ASR project stores potable water in the aquifers of the Basin for use during emergencies and drought periods.

D. The Las Posas Basin Pumpers extract groundwater from the Basin for beneficial uses that include agricultural, domestic, urban and industrial uses. The "Las Posas Basin Pumpers" includes members of the Las Posas Basin Users Group and all other persons or entities extracting groundwater from the East Las Posas Basin (within the boundaries of the GMA).

E. Calleguas and the Las Posas Basin Pumpers desire to manage the groundwater basin such that the ASR project and the Las Posas Basin Pumpers' beneficial uses co-exist to the benefit of all.

F. Calleguas has previously entered into an agreement with the GMA for operation of the ASR project ("Calleguas-GMA Agreement"). A copy of the Calleguas-GMA Agreement is attached hereto as Exhibit "A" and incorporated herein by reference. The Calleguas-GMA Agreement describes the general principles within which the ASR project will operate.

G. Pursuant to the Calleguas-GMA Agreement, stored water is credited to the ASR project when Calleguas either injects potable water into the aquifer through wells or when water is delivered by or through Calleguas to the Las Posas Basin Pumpers in lieu of pumping groundwater. The storage credit pursuant to the Calleguas-GMA Agreement remains in the Basin until the stored water is extracted.

H. Calleguas and the Las Posas Basin Pumpers desire to have the GMA incorporate the terms of this Plan into the updated GMA plan.

NOW, THEREFORE, in consideration of the mutual benefits, covenants and promises set forth herein, the Management Plan for the East Las Posas Basin is as follows:

1. Monitoring Program. Calleguas will maintain a monitoring program to track changes in groundwater levels and groundwater quality in the Basin. This monitoring program will consist of two parts: (1) a set of four representative key wells spaced throughout the Basin

("baseline key wells") will monitor the overall health of the Basin (Exhibit "B" and identified by State Well number); and (2) a set of monitoring and producing wells on parcels within or adjacent to the ASR project ("local vicinity wells") will monitor the effects of the ASR injection and pumping on the Basin (Exhibit "C").

2. Report of Results of Monitoring Program. Calleguas will report results of the monitoring program described in paragraph 1 above in writing to the Las Posas Basin Pumpers at least every six (6) months during noticed meetings of the Las Posas Basin Users Group. In addition, Calleguas will prepare a written report on ASR activities, monitoring results and the state of the Basin annually, and that report will also be made available to the Las Posas Basin Users Group.

3. Extractions and Storage Credits. Calleguas covenants and promises that it will only extract water consistent with the Calleguas-GMA Agreement and in an amount which does not exceed Calleguas' storage credits in the Basin, as they may exist at any time. Calleguas will apply for storage credits from the GMA annually based on the amount of water injected and in lieu water delivered that year; the GMA will maintain the storage credit balance for the ASR project and will give written notice to the Las Posas Basin Users Group of the amount of those credits annually and provide a report directly to the Las Posas Basin Users Group every six months as to the amount of storage and extractions which have occurred.

4. Operation of ASR Project. Calleguas will operate the ASR project in a manner that does not adversely affect the Basin by creating, by way of example only, chronic declining water levels, increased levels of TDS or chlorides, significant increased pumping lifts, or saline intrusion. It is acknowledged that all currently available information indicates that the Basin may be in overdraft. Although it is not projected that the ASR project will alleviate the overdraft, Calleguas will make a good faith effort to assist the Las Posas Basin Pumpers in reducing the overdraft. Additionally, it is recognized that there is a mound of high-chloride, high-TDS water migrating into the Basin from beneath the Arroyo Las Posas. Calleguas will assist in mitigating this water quality problem by facilitating projects that will pump this poor-quality water, treat it for agricultural and drinking water use and discharge the resulting brine into a regional brine line. To keep Las Posas Basin Pumpers informed of ASR operations, Calleguas will provide a summary sheet of injections and extractions relating to ASR operations at every Las Posas Basin Users Group meeting (held approximately every two months, but no less than 4 times a year). This summary will discuss, among other things, all injection, extraction and in-lieu activities for the two months prior to the meeting. This summary will also be provided to the GMA.

5. Groundwater Levels. Calleguas will operate the ASR project in a manner which will not significantly impact Las Posas Basin Pumpers' ability to use groundwater from the Basin. Impacts will be measured on two levels – basin-wide and local. Basin-wide impacts will be measured using the four baseline key wells. Local impacts will be measured using the local vicinity wells.

Basin-Wide Effects: In order to establish groundwater levels that would exist without the ASR project ("baseline"), the USGS Santa Clara-Calleguas MODFLOW groundwater flow model, as updated by United Water Conservation District and Calleguas, will be used in conjunction with the four baseline key wells. The baseline will be established by running the groundwater model every two years using all available actual pumping and hydrologic data for the period, but excluding any ASR injection/extraction operations or water deliveries in-lieu of injection. The first run of the model for purposes of this Plan will be as follows: The modeled "no ASR project" groundwater levels determined as of September 1, 2006, at the four baseline key

wells would establish the baseline for the two-year period. If actual measured water levels fall below the baseline in any of the baseline key wells during the applicable two-year period, then the cause of the groundwater level decline below the baseline will be investigated by Calleguas within 45 days of Calleguas learning of the measured water level falling below the baseline. If the water level drop below baseline is determined to be caused by ASR operations, then Calleguas will present a written plan to the Las Posas Basin Pumpers to mitigate the excess drawdown. That written plan will be presented by Calleguas to the Las Posas Basin Users Group no later than 120 days after Calleguas learns that measured water levels are below baseline.

Local Effects: In the vicinity of the ASR injection/extraction wells, it is recognized that groundwater levels will fluctuate depending upon rates of injection/extraction and proximity to the wells. Nearby wells will see groundwater levels rise and pumping lifts decrease during and following injections of stored water. During extractions of stored water, groundwater levels in the vicinity of the extraction may decrease below levels normally seen in nearby wells, with this pumping effect dissipating when extraction is terminated. Calleguas will use all reasonable efforts to insure that nearby wells can continue to be pumped during this extraction period; if lowered water levels create operational problems such as the inability to pump groundwater because groundwater levels are below pump bowls or the pump breaks suction in any nearby well, Calleguas will attempt to assist well owners in mitigating the problem. Such mitigation measures may include, among other things, providing in-lieu water to well owners at prevailing rates.

6. Disputes. If any dispute arises over the effects of the ASR program and this Plan, the specifics of the dispute will first be presented within 45 days of the dispute arising to an advisory group of members of the Las Posas Basin Users Group numbering not less than 5. If the dispute is not resolved within 45 days after submittal to the advisory group, the dispute shall be presented to Calleguas in writing. Calleguas will then, within 45 days of receiving written notice of the dispute, investigate the issues in the dispute, including performing any hydrogeologic investigation where appropriate. The disputing party will not unreasonably withhold access to historic groundwater data known to the party or access to wells for monitoring. Calleguas will, within 120 days, give a written reply to the disputing party which will include results of any hydrogeologic investigation. In the event that the party is not satisfied by this procedure, the disputing party can deliver a copy of the written dispute to the GMA. If the GMA does not resolve the problem to the satisfaction of the disputing party within 120 days of the delivery of a copy of the written dispute to the GMA, then the disputing party can take whatever legal action it deems appropriate.

7. Term. This Plan shall remain in effect so long as the Calleguas-GMA Agreement remains in effect.

8. Existing Water Rights Unaffected. This Plan and the ASR project shall in no way affect or alter existing water rights in the Basin or grant new or additional water rights to Calleguas or the Las Posas Basin Pumpers (other than the specific rights of injection and extraction granted herein). All injections or extractions are done with the knowledge and consent of the Las Posas Basin Pumpers and under no circumstances will any injections or extractions or pumping under this Plan ripen into a claim for prescriptive or superior rights.

9. Condition of Basin. This Plan is made with the express understanding and assumption that the Basin is of such condition that any water injected by Calleguas into the Basin will remain in the Basin until extracted by Calleguas (or by other pumpers). If this

understanding/assumption is determined to be incorrect or determined to be substantially called into question, then **either** Calleguas or the Las Posas Basin Pumpers may immediately proceed to dispute resolution as set forth in Section 6 above.

END OF PLAN

A3.1 **EXHIBIT "A"**

FOX CANYON GROUNDWATER MANAGEMENT AGENCY

BOARD OF DIRECTORS
John E. Maulhardt, Chair
John K. Flynn
Sam McIntyre
James Daniels
Michael Conroy

AGENCY COORDINATOR
Lowell Preston, Ph.D.

July 12, 1994

Eric Berg, Projects Administrator
Calleguas Municipal Water District
2100 Olsen Road
Thousand Oaks, CA 91360-6800

SUBJECT: BOARD APPROVAL OF CMWD APPLICATION FOR INJECTION/STORAGE FACILITIES IN NORTH LAS POSAS GROUNDWATER BASIN

Dear Mr. Berg:

At the Board of Directors meeting on February 23, 1994, the Board approved the CMWD application for injection/storage facilities in the North Las Posas Basin. The approval of this application, as provided for under Ordinance 5.3, was subject to the conditions that follow. These conditions include several changes and additions requested by the Board of Directors.

NORTH LAS POSAS BASIN
INJECTION/STORAGE FACILITIES CONDITIONS

1. ***The identification, size, depth, well logs and location of wells used for injection/extraction will be registered with the GMA. A maximum of twenty (20) wells all to be permitted by the County of Ventura, Public Works Agency, and registered with the GMA.***

2. ***Calleguas will inject/extract on a schedule determined by availability of water to inject and the needs of their customers. The number of acre-feet injected/extracted from each well shall be reported to the GMA monthly. The monthly report shall also include a water quality analysis for the injected water that covers and conforms to the limits listed for the following items:***

a.	*Sodium Adsorption Ratio (SAR) calculated in meq/l as* $SAR=NA/((CA + Mg)/2)^{.5}$	*≥1≤4*	
b.	*Total Dissolved Solids (TDS)* *Electrical conductivity (EC)*	*≥100≤800* *≤1100*	*mg/l* *uMHO*
c.	*Chloride (Cl)*	*≤120*	*mg/l*
d.	*Boron* (H_3Bo_3)	*≤1*	*mg/l*
e.	*Nitrates*	*<45*	*mg/l*

(NOTE: **These limits are based on University of California research. Should the University reverse these limits, the recommended changes will be incorporated into these conditions.)**

800 South Victoria Avenue, Ventura, CA 93009
(805) 654-2088 FAX:(805) 654-3952

Testing shall be conducted monthly during periods of continuous injection, prior to beginning an injection of more than one hundred (100) acre-feet (but no more frequently than monthly), and as frequently as necessary when a change in water quality is suspected or known to exist.

3. *The total water in storage at any one time shall not exceed three hundred thousand (300,000) acre-feet (AF) unless approved by the GMA Board of Directors.*

4. *The point of extraction shall be the same as the point of injection or in the near vicinity. Extraction from points other than that of injection may be desirable and shall be coordinated with, and approved by the GMA.*

5. *Water stored by the facility shall be used in Ventura County.*

6. *Calleguas shall periodically review the effects of the injection on surrounding basins to ensure no detrimental effects result from the injection alone or in combination with natural recharge. Should negative effects exist, Calleguas shall take action to mitigate those effects caused by the injection program.*

7. *Should the injected water or conditions deviate from these standards, injection will stop, or not be started until the condition has been corrected.*

If you have any questions regarding this Agency's approval of your project facilities, please call Rick Farnsworth at 654-2327 or myself at 648-9204.

Very truly yours,

Lowell Preston, Ph.D.
Agency Coordinator

RF:vg

JGG/berg

A3.2 EXHIBIT "B"

Key wells will be used to monitor the overall health of the basin (Figure B-1). These wells, which have a long historic monitoring record of groundwater levels, include State Well Numbers 2N/20W-8F1, 2N/20W-9F1, 3N/20W-34G1, and 3N/19W-29K4.

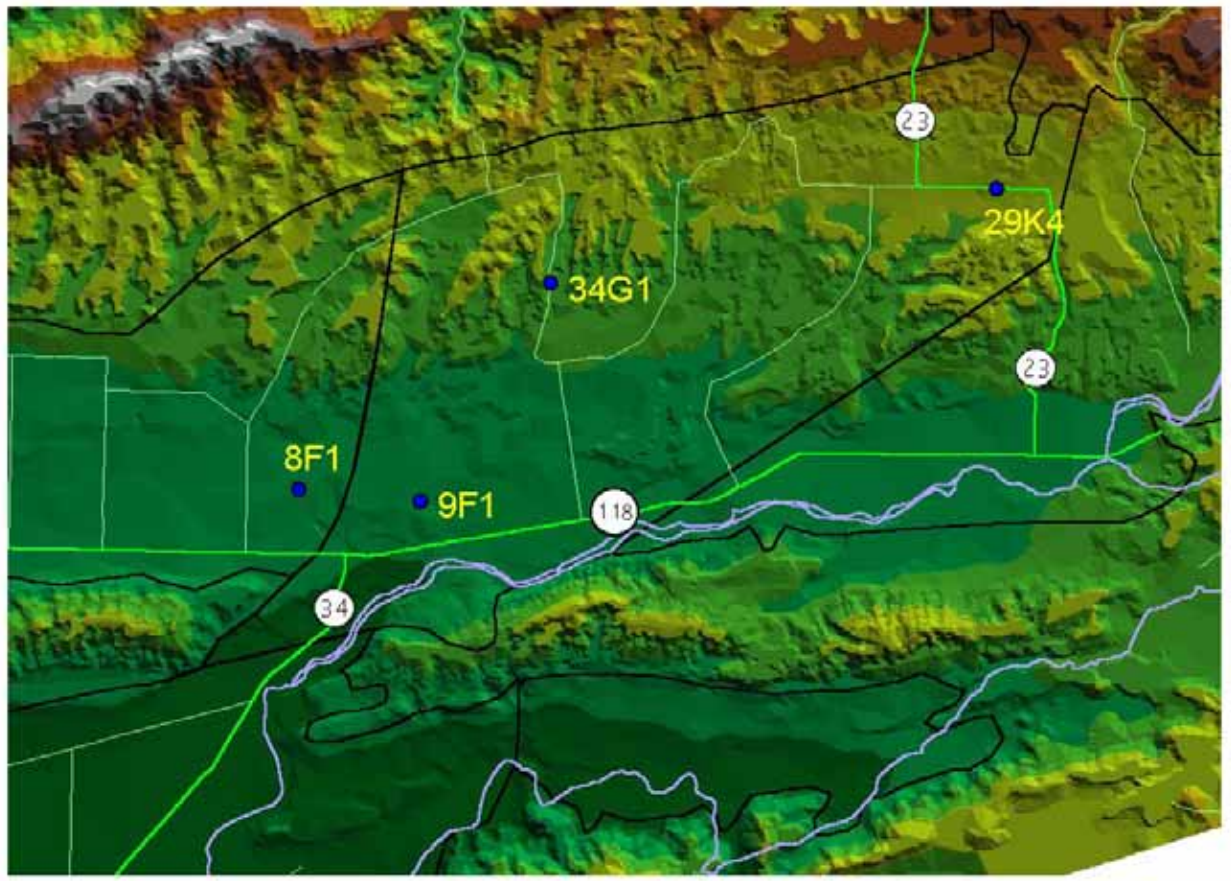


Figure B-1. Key wells in the Las Posas basin.

A3.3 EXHIBIT "C"

Calleguas Municipal Water District will monitor the effects of its Las Posas Basin ASR project using both its ASR wells and additional monitoring points surrounding the ASR project (Figure C-1). These additional monitoring points will consist of existing production wells or, where necessary to complete the area 1 coverage, new monitoring well(s) installed by Calleguas MWD.

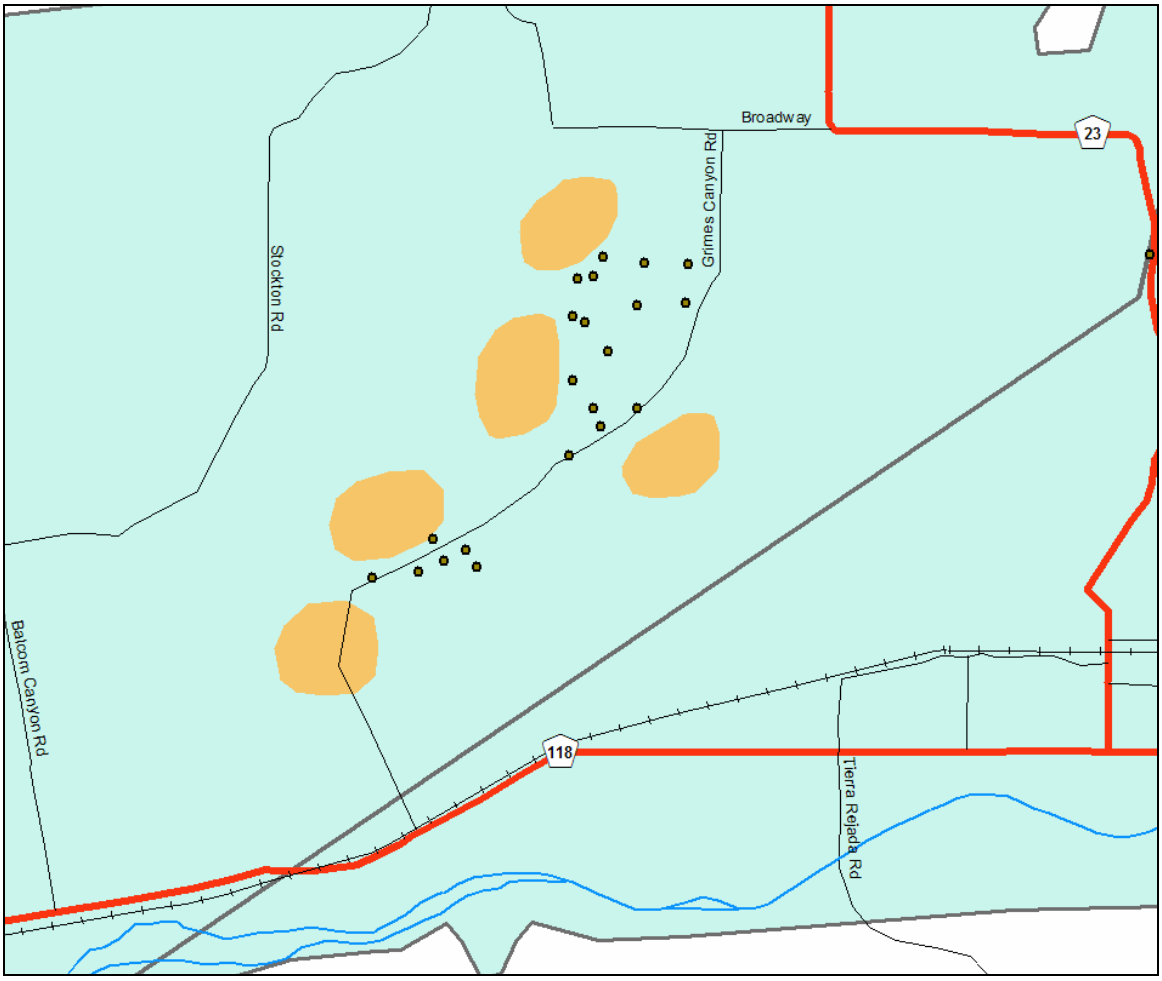


Figure C-1. Locations (indicated by orange circular areas) of monitoring to track the effects of ASR injection and pumping. Dots represent Calleguas MWD ASR wells.

A4.0 APPENDIX D. RESPONSE TO PUBLIC COMMENTS ON THE FCGMA GROUNDWATER MANAGEMENT PLAN

The development of the final FCGMA Groundwater Management Plan involved the release of three separate written drafts between June 2006 and February 2007, presenting the Plan at three public workshops over the same time period, and presenting the Final Plan at a special meeting for the Agency's Board of Directors in March 2007. The Agency accepted public comments throughout the Plan development process.

This section is a compilation of the written public comments to the Plan submitted to the Agency between June 2006 and April 2007. The first part contains a verbatim transcription of each comment and a specific Agency response to each comment. The second part contains a reproduction of the original public comment document.

FCGMA responses to written comments submitted on behalf of the City of Oxnard, City of Camarillo, and Crestview Mutual Water Company (Crestview) by:
Robert J. Saperstein
HATCH & PARENT
A Law Corporation
Santa Barbara, CA

1. ***Oxnard, Camarillo, and Crestview's Comment:*** *GMA Board attendance at the workshops. While we understand the time commitment is extensive, this update to the Management Plan is very important. It will guide GMA policy and decision-making for years to come. We are not sure how the GMA Board can obtain adequate familiarity with all the issues and the constituents' concerns without some attendance at the workshops. No board members attended the first workshop.*

Response to Oxnard, Camarillo, and Crestview's Comment #1: This issue was subsequently resolved by the Board member attendance at subsequent workshops and the Special Groundwater Management Plan Workshop held on March 9, 2007. Four Directors and two Alternate Directors were in attendance at this Workshop. Minutes for this meeting have been included in this Appendix (D) to the Groundwater Management Plan.

2. ***Oxnard, Camarillo, and Crestview's Comment: Executive Summary****. This Section is written as part introduction and part summary. An Executive Summary is normally drafted when the remainder of the document is complete. Given the length and technical nature of the material, the Executive Summary will be the most important Section of the Plan. It may be the only portion of the document many individuals read. It should summarize the purpose, issues and recommendations, once all of the technical work is complete.*

Response to Oxnard, Camarillo, and Crestview's Comment #2: Taking this suggestion, the Executive Summary was put on hold until the final draft. The final version now includes an Executive Summary

3. ***Oxnard, Camarillo, and Crestview's Comment: Acknowledgements*****.** *Throughout the document, there is repetitive recognition of United and Calleguas as the two entities who contribute to the GMA. This recognition is limited almost exclusively to these two entities. Either this self-congratulatory language should be eliminated, or there should be proper acknowledgement of the work of all the individuals and agencies who have and continue to contribute to the GMA's success.*

Response to Oxnard, Camarillo, and Crestview's Comment #3: The final Fox Canyon Groundwater Management Plan (Plan) acknowledges the contributions many contributors including members of the three sponsoring agencies (Fox Canyon Groundwater Management Agency, United Water Conservation District, Calleguas Municipal Water District) as well as six other stakeholders who provided written comments, reviews, or provided other material input to the completion of the plan. Any other omission of other individual who provided contributions to the completion of the FCGMP is the result of simple oversight.

4. ***Oxnard, Camarillo, and Crestview's Comment:*** *Modeling. There needs to be a distinct Section that better describes the model details used for the technical analysis. This Section need not be long, but it should include mention of the software, construction, assumptions and details of the model construct. It ought to give enough information for the technically capable reader to understand its basics.*

Response to Oxnard, Camarillo, and Crestview's Comment #4: There is now a considerable discussion of the modeling approach, assumptions, limitations, and modeling

results included as Appendix B of the final FCGMP. While not an exhaustive technical discussion of model development and results, it provides a thorough and meaningful summary of the model approach and its use in the development and analysis of various policies developed in the Plan.

5. Oxnard, Camarillo, and Crestview's Comment: Organization and Redundancy. *There is tremendous redundancy in the report. Perhaps with different organization, it could be slimmed down significantly. You might describe the water quality and quantity issues generally applicable to all areas, along with the general concept of basin management objectives. Then discuss all the issues comprehensively, separated for each basin or in some cases regions with multiple basins. As an alternative, some of the nonessential background and detailed technical information might be moved to appendices.*

Response to Oxnard, Camarillo, and Crestview's Comment #5: The final Plan has been reorganized and indexed to limit redundancies and improve the organizational structure. Due to the interrelated nature and technical complexity of many of the water quality, water quantity, and public policy issues, some redundancy is necessary to provide the appropriate context for specific topics.

6. Oxnard, Camarillo, and Crestview's Comment: Management Strategies: Organization. *In a fashion, the Management Plan is really several separate management plans. Perhaps it should be organized by basin for the three content subjects: strategies under development, future strategies and actions to attain BMO's. There may need to be one more general Section that addresses those strategies that cross basin boundaries. You may be able to combine all the basin specific discussions in one Section for each basin. A couple different organizational approaches might be tested, with the goal of, reducing redundancy and volume of text.*

Response to Oxnard, Camarillo, and Crestview's Comment #6: See the response to Oxnard, Camarillo, and Crestview's Comment #5.

7. Oxnard, Camarillo, and Crestview's Comment: Specific strategy: Forebay priorities*. The potential over-reliance on the Forebay under certain conditions is acknowledged in the document. However, there is no mention of the importance, from a policy perspective, to establish some hierarchy for use of the Forebay. There will be increasing reliance on the Forebay. To the extent access to the Forebay may be limited under certain conditions; the GMA board must consider limiting certain uses before others.*

Response to Oxnard, Camarillo, and Crestview's Comment #7: As implied by Oxnard, Camarillo, and Crestview's Comment #7, the Plan acknowledges that the Oxnard Plain Forebay Basin represents one of the most significant sources of subsurface storage and recharge within the FCGMA. Specific groundwater management strategies directly involving the use of the Oxnard Plain Forebay Basin have been addressed in Sections 10.1.4, 10.1.5, 10.1.7. Other policy recommendations are addressed in Sections 11.2.2, 11.3.6, and 11.3.7. Through its discussion in these Sections as well as its implicit inclusion other strategies, the Plan acknowledges the significance and challenge of prioritizing use of the Oxnard Plain Forebay Basin. The Oxnard Plain Forebay Basin will remain a source of significant consideration and focus in the development of effective future strategies.

8. Oxnard, Camarillo, and Crestview's Comment: Specific strategy: Transfers across basins. *There is no direct mention that transfers (of allocation or credits) from challenged areas to areas of abundance may be the simplest method of mitigating problems. This has been a policy not favored in the past. However, this is an appropriate time to reconsider this*

question, particularly if the technical analysis suggests that a surgical approach is required to solve certain problem areas.

Response to Oxnard, Camarillo, and Crestview's Comment #8: Allocation or Credit transfers are now discussed in relation to several strategies that would physically move water from one basin to another, particularly moving credits to the Forebay Groundwater Basin. In addition, many of the listed potential water management strategies move river water or reclaimed water across basins to be used for either in-lieu deliveries that replace groundwater pumping, or for direct groundwater recharge. The fundamental concept of localized management strategies is also discussed in Section 10.1.7.

9. Oxnard, Camarillo, and Crestview's Comment: Specific strategy: Ag recycled water use*. The draft Plan acknowledges (assumes) that larger volumes of recycled water will be available for Ag use in the future. The assumption is correct that highly purified recycled water will be available and recycled water use could be a very efficient method of solving several regional problems. However, there is some resistance in the Ag community to take direct use of recycled water. The resistance is not over the quality of the recycled water, but over the required reporting to distributors and product buyers that the crop was grown with recycled water. As long as there is the Ag industry perception that recycled water use may harm the user's competitiveness, recycled water will not be widely accepted. The Board may be able to help influence certain industry groups to alter the current reporting requirements that create these problems for individual users.*

Response to Oxnard, Camarillo, and Crestview's Comment #9: The comment is noted.

10. Oxnard, Camarillo, and Crestview's Comment: Analytic Methodology. *There appears to be no intent to model the expected (inevitable) conversion of Ag use to M&I use over the period of the modeling run. Without this detail, the modeling exercise may provide very misleading results. For example, there are several significant Ag to M&I projects that are in the planning stages located in the south Oxnard Plain area, nearby the City's wastewater treatment plant and the military bases. The result of these conversions will be a shift in groundwater use from wells in a highly sensitive area, to City and United wells located far from the coast (and imported water). If the model does not take into account these expected transitions, it will predict a materially different future than that which will occur. In this fashion, the modeling results may be very misleading.*

Response to Oxnard, Camarillo, and Crestview's Comment #10: The groundwater modeling purposely kept land use constant through the forward model period to analyze the quantitative effect of different groundwater management strategies (such as 5% reduction of historical allocation or implementation of an injection barrier). A typical model-based quantitative analysis, including the Ventura Regional Groundwater Model (VRGM), alters only one variable at a time to determine its effect on the entire system. Often, if more than one variable is changed, (e.g., adding a management strategy plus changing land use), the quantitative effect of either variables is obscured. The effect of changing land-use was not one of the variables examined in this analysis; however, adding such a scenario would be instructive. As part of the Plan implementation process, this may be one of the recommendations to the Technical Analysis Group (TAG).

11. Oxnard, Camarillo, and Crestview's Comment: Water Quality. *It is somewhat troubling that the cornerstone of the Plan is the setting of Basin Management Objectives, some of which are water quality objectives. However, the model has no capability to predict water quality changes. Thus, we need to be very careful in how we set and monitor compliance with the Basin Management Objectives.*

Response to Oxnard, Camarillo, and Crestview's Comment #11: It is true that the groundwater model cannot directly predict water quality changes, although there is some capacity to determine the effects of seawater intrusion in coastal areas. In these areas, controlling seawater through management of groundwater elevations is a priority goal and key component of the management plan, and is addressed in Sections 9.1, 10.2.1, and 10.3.1. In other areas, the BMOs are the Regional Board's Basin Plan Groundwater Objectives Other water quality objectives and are discussed in Section 6.1, 9.2, 9.3, 10.1.3, and 10.1.4. In the Forebay basin, nitrate BMO's are set at the Department of Health Services notification level for drinking water. As part of the Plan implementation process, this may be one of the recommendations to the Technical Analysis Group (TAG).

12. Oxnard, Camarillo, and Crestview's Comment: Periodic update. *Either as a component of the Plan, or as a Board measure in adopting the Plan, there should be a built in requirement to update the Plan no less than every 5 years. This should not be so difficult if the model proves to be as useful a tool as is expected.*

Response to Oxnard, Camarillo, and Crestview's Comment #12: This recommendation for periodic reviews and updates are now a strategy and action item in the Plan and is discussed in Section 11.1.3.

13a. Oxnard, Camarillo, and Crestview's Comment: Pg. 12. There is no such thing as "in-lieu"' credits. Ordinance 8 only defines storage and conservation credits. There are special credit transfer agreements/programs the GMA has approved that amount to "in-lieu" transfer of credits, but the term has no meaning in Ordinance 8.

Response to Oxnard, Camarillo, and Crestview's Comment #13a: The reference to "In-Lieu" credits have been eliminated or corrected and the term in-lieu is only used to refer to imported, surface, or reclaimed water that could be used instead of extracted groundwater.

13b. Oxnard, Camarillo, and Crestview's Comment: *Ordinance 8 requires Ag to demonstrate 80% efficiency, based on the individual crops grown. The Plan does not propose tightening the efficiency percentage as a potential method of reducing water use. Also, the current reporting requirements are not clear in requiring that the efficiency calculation is to be based on irrigated acreage, not total owned property. In some cases, the irrigated acreage may be materially smaller than the property footprint. In that circumstance, the user gets a substantial benefit in reporting efficiency based on the property footprint instead of the irrigated acreage.*

Response to Oxnard, Camarillo, and Crestview's Comment #13b: As indicated in Section 11.2.4, an examination of the irrigation efficiency allocation will be undertaken as part of the implementation of the Plan.

13c. Oxnard, Camarillo, and Crestview's Comment: Pgs. 13, 16. *There is no mention of M&I return flows as a source of recharge.*

Response to Oxnard, Camarillo, and Crestview's Comment #13c: Return flows have been added as a nominal potential recharge source, with the caveat this only occurs in some areas. In fact, return flows can only reach the main FCGMA aquifers in a few areas where there is hydrologic continuity between surface uses and these aquifers – elsewhere, it is intercepted by impermeable layers and/or perched aquifers.

13d. Oxnard, Camarillo, and Crestview's Comment: *Two different definitions of basin yield are used and overdraft is not defined.*

Response to Oxnard, Camarillo, and Crestview's Comment #13d: Section 7.0 of the final Plan addresses the concept of Yield of Groundwater Basins, its calculation, and the associated assumptions.

***13e. Oxnard, Camarillo, and Crestview's Comment**: The discussion of the decreasing trend of extractions is incomplete and therefore misleading. As to the Ag side: (1) there is no quantification of the reduction of Ag pumping resulting from reduced acreage in production over the past two decades, and (2) there is no recognition that the initial period against which we are measuring reduced usage was a very dry period. During dry periods, Ag groundwater use tends to be greatest. Since those early years, we have been in a generally wet period. Thus, we would expect a natural reduction in Ag groundwater use simply based on the historical hydrology*.

As to the M&I side, there is no quantification of the increase in municipal demand as a result of conversion of Ag use to M&I use. There is no discussion of the relative efficiencies of use of water prior to the imposition of the cutback goals. The implication of the current discussion in the Plan is that Ag has done more than its share and M&I has not. There is insufficient information or analysis for this conclusion or implication. This discussion should either be made complete and correct, or eliminated, especially if policy decisions might be influenced by it.

Response to Oxnard, Camarillo, and Crestview's Comment #13e: The language has been changed to eliminate any implication that M&I has not done its share of water conservation or planned reductions in overall groundwater extractions. An example of ag to urban conversion was also added. The discussion of reduction in pumping does not simply compare the dry years of the base period to the wet years following that period to document reductions in pumping. Instead, extraction in like years were compared (dry to dry, wet to wet), with the comparison included in the discussion of overall FCGMA annual extractions and any changes over time. Therefore, the language on FCGMA pumping reductions remains in the Plan.

***13f. Oxnard, Camarillo, and Crestview's Comment: Pg.29.** The discussion of increasing salt concentrations in the Las Posas basins is somewhat conclusory and incomplete. It might help to actually provide the POTW discharge water quality for TDS and chlorides, so that it would be more clear to the reader that the problem is, in fact, generating from aquifer conditions, not discharge water quality.*

Response to Oxnard, Camarillo, and Crestview's Comment #13f: Language was added to point out that chloride concentrations of surface waters (including POTW discharges) were considerably lower than those of the affected aquifer. While it is true that the problem was not generated by the quality of the discharge water, the problem appears to have been created by the increased quantity of discharge water (POTW's plus Simi Valley Groundwater Basin dewatering and increased urban runoff throughout the watershed). The higher stream flows created by these discharges have apparently filled the shallow aquifer above historic levels, which may be dissolving salts in the previously unsaturated portion of the shallow aquifer. The Plan references a report done for Calleguas MWD for a more-detailed discussion of this water quality problem.

F**CGMA responses to written comments submitted on behalf of the City of Oxnard by:**
Anthony Emmert
Water Resources Manager
City of Oxnard, California

1. Oxnard's Comment: *At the last workshop on the draft Plan, the group discussed the potential that incorrect assumptions about the quantity of groundwater production could result in erroneous outcomes from the model. Indeed, there is substantial anecdotal evidence that groundwater production reporting may be materially incorrect because of inaccurate meters or other faulty reporting mechanisms. For this reason, we recommend that the model be run to assume a band of uncertainty relating to the quantity of groundwater production within FCGMA. Such sensitivity analysis will help verify the integrity of the model results.*

Response to Oxnard's Comment #1: A sensitivity analysis was added to the discussion of model results in Appendix B of the final Plan. Following implementation of the meter calibration program scheduled to begin in mid-2007, it would be prudent to revisit this issue to ensure the model is calibrated with the most accurate extraction data.

2. Oxnard's Comment*: As a related matter, the FCGMA will pursue an aggressive review of meter calibrations over the next several years. However, this process is not scheduled to start until 2007 and it will take three years to complete the first cycle. We recommend that the model be periodically rerun and updated with this new, more accurate production data when it becomes available. In the interim, we recommend that FCGMA staff review suspect accounts and perform a preliminary audit of groundwater production reporting to determine the scope of potential discrepancies*.

Response to Oxnard's Comment #2: Periodic reviews and updates to both the VRGM and the Plan are now a strategy and action item in the Plan (Section 11.3.1). More frequent changes or additions to the Management Plan and/or changes to the model could be performed at the Board's discretion, although additional funding may need to be obtained for such efforts.

The final Plan contains a discussion of verification of extraction reporting as a management strategy as well as a proposed procedure for verification. Verification of extraction reporting coupled with revised model inputs represents a fundamental step to enhancing the accuracy and effectiveness of the model. Both are addressed in the final Plan.
FCGMA staff has, and continues to, work diligently on an ongoing basis to identify, research, and, to the extent practical, correct extraction reporting anomalies. Fundamentally, the current system relies on the honesty, forthrightness, and diligence of individual well operators. Given that the Agency has limited resources, the FCGMA will need to continue to rely on self-monitoring reports from the operators, education efforts highlighting the need for accurate reporting, and the contributions of its member agencies to enable it to capture the most accurate data available.

3. Oxnard's Comment: *The Draft Plan sets forth several potential future management strategies that should be further explored for their potential effectiveness in addressing seawater intrusion and other adverse hydrogeologic conditions. We recommend that the next draft of the Plan prioritize these potential future strategies in terms of their potential effectiveness. We further recommend that the FCGMA develop procedure to apply a cost/benefit analysis to determine which of the prioritized strategies should be implemented.*

Response to Oxnard's Comment #3: The final Plan (October 2006) prioritizes groundwater management strategies as suggested. At the March 2007 special Groundwater

Management Plan Workshop, the FCGMA staff introduced a proposed implementation approach that involves both technical and strategic advisory groups that would work together to evaluate each of the groundwater management strategies on both a technical and a cost/benefit basis. These groups will subsequently provide recommendations to the Board.

4. Oxnard's Comment: *As a general matter, we also encourage the FCGMA to consider more dynamic use of aquifers with dewatered storage space as a potential resource for future conjunctive use programs. Other basins, such as the Chino and Orange County basins, are currently planning and using available dewatered storage space for local and regional conjunctive use programs that yield better water supply reliability and financial benefits to support other necessary basin management programs. The FCGMA could pursue similar programs. There are numerous hydrogeologic and policy matters that must be resolved to implement a large scale groundwater storage program. Still, we recommend that the Plan include additional and more detailed discussion of potential opportunities for active conjunctive use programs within the FCGMA area.*

Response to Oxnard's Comment #4: The final Plan includes several strategies that utilize existing aquifer space for storage including the Oxnard Plain Forebay Basin (Sections 9.6.6, 10.1.5, 10.2.2), the South and East Las Posas Basins (Sections 9.2, 10.1.7, and 10.1.10) and the Pleasant Valley Basin (Sections 9.3, 10.1.7, and 10.1.10) In addition, the use of recycled water for injection is discussed in Section 9.1. Ultimately, the technical and cost/benefit of each of these strategies will have to be evaluated by the advisory group(s) and recommended to the Board for implementation.

FCGMA responses to written comments submitted on behalf of Pleasant Valley County Water District (PVCWD) by:

Mr. John Mathews
Arnold, Bluel, Mathews, & Zirbel, Attorney's at Law, LLP
Oxnard, CA
Legal Counsel for Pleasant Valley County Water District
Camarillo, CA

1. ***PVCWD's Comment:*** *Under the section "Groundwater Extractions", in the third paragraph it refers to increased agricultural efficiencies. We believe that somewhere in this paragraph reference should be made to the fact that extractions from the groundwater may have also decreased because increased yields from the Freeman diversion and the Conejo Creek project.*

Response to PVCWD's Comment #1: A sentence has been added as suggested.

2. ***PVCWD's Comment****: On page 43, in the section entitled "Assessment of Basin Management Objectives", in the second paragraph it refers to Basin Management Objectives (BMO's) for groundwater levels in the Pleasant Valley basin. In table 3, it makes reference to Basin Management Objectives in the Pleasant Valley area, but does not set forth what the current levels are, it would be helpful to state the groundwater BMO's.*

Response to PVCWD's Comment #2: Current levels have been added to all the BMO tables.

3. ***PVCWD's Comment:*** *On page 48, under the Section "Contingency Plan for LAS Seawater Intrusion", it states that the GMA staff has developed a contingency plan to address the intrusion of seawater into the LAS. It would be helpful if drafts of that Contingency Plan could be made available for public review.*

Response to PVCWD's Comment #3: As stated in the final Plan (Section 8.1), no formalized Contingency Plan for LAS Seawater Intrusion exists. The original FCGMA Groundwater Management Plan completed in September 1985 contained a list of countermeasures that could be employed either temporarily or for longer periods of time to offset an extreme and threatening loss of fresh water resources. Some of the schemes listed, such as a complete ban on all future LAS wells, forced urban and farm water conservation, or monetary incentives to encourage destruction of LAS wells, have limited feasibility at the present time. Others such as implementing voluntary conservation measures, changing the County Well Ordinance to limit new LAS wells, and additional monitoring efforts either proposed in the current plan or already under development.

4. ***PVCWD's Comment****: On page 50, under the Section "Conejo Creek Diversion Project", the last sentence references that over the "net 20 years" that the yield of the diversion might decrease. There obviously is a spelling error there in that the word "net" should be "next". Furthermore, input should be sought from Camrosa Water District to determine whether or not their proposed plans will in fact reduce yield to Pleasant Valley. In discussions with Richard Hajas, it is our understanding that Camrosa's intent is to continue to provide current levels of diverted water to Pleasant Valley and in fact yields may be increased.*

Response to PVCWD's Comment #4: The typo has been corrected. The information in this Section was based on a conversation with Camrosa staff, who emphasized that yields of the Conejo Creek diversion project may not always be available to PVCWD.

5. PVCWD's Comment: *Under the Section "Great Project (Recycled Water)", the first paragraph makes reference to the delivery of recycled water to the Pleasant Valley area. PVCWD has continued to express their concerns to the City of Oxnard about the suitability of the recycled water for agricultural use. In particular, Pleasant Valley is concerned about the "stigma" that recycled water has in the market place. Many growers are now required to provide information on the source of their irrigation water. In the event that recycled water is used, the agricultural produce is often downgraded.*

Also, Pleasant Valley has concern about the injection of recycled water into the LAS. Injection into the LAS is discussed on pages 65 and 66 (June 2006 Draft Plan). Because the LAS is the only groundwater source for the PVCWD, Pleasant Valley will closely scrutinize any injection of recycled water into the LAS. We feel that a better alternative to injection would be the transportation of the recycled water to the spreading grounds. This would enhance recharge and remove concerns relative to injection.

Response to PVCWD's Comment #5: The use of reclaimed water, as well as most or all of the proposed strategies will need to be analyzed for both technical feasibility and cost/benefit considerations prior to implementation. At that time, the proposed alternative, as well as other alternatives, will be considered. Indeed, the purpose of the advisory groups proposed by the FCGMA Staff at the March 2007 Special Groundwater Management Plan Workshop is to evaluate both the Plan-proposed and alternative groundwater management strategies.

With respect to the specifics of your proposal, the alternative to injection suggested above has two major drawbacks:

1) Reclaimed water recharged in the spreading grounds is not as quantitatively effective or efficient in recharging the Lower Aquifer on a unit for unit basis as using the water in place of extracted groundwater or injecting water directly into the areas with lowered groundwater levels; specifically, the south Oxnard Plain and Pleasant Valley basins; and

2) Reclaimed water delivered via pipeline to the spreading grounds would trigger a host of California Department of Health Services (DHS) requirements, including a zone surrounding the spreading grounds where no groundwater could be pumped for potable use. The DHS requirements for the spreading grounds with piped reclaimed water could significantly alter United Water's operations of the spreading grounds. Any directly injected recycled water would be subject to existing or future DHS stringent water quality standards for domestic consumption, which are very stringent.

6. PVCWD's Comment*: Under the Section "Non-Export of FCGMA Water", the last paragraph on that page states "It appears that current ordinances and policies of the FCGMA are sufficient to deal with its export issue." In light of recent issues, the ordinances of the GMA should be reviewed again to make sure that they are adequate to address the export issues. In particular, the enforcement provisions relating to export of "GMA" water should be closely reviewed.*

Response to PVCWD's Comment #6: A discussion about reviewing the sufficiency of current ordinances and policies was added to the Plan in Section 10.1.8.

7. PVCWD's Comment*: Under the Section "Increase Diversions from Santa Clara River, Potential Effectiveness". the first sentence states "The Santa Clara River remains a primary recharge source for the Oxnard Plain and Pleasant Valley basins." Based upon our understandings of various studies, it is a little misleading to suggest that the Pleasant Valley*

basin gets much recharge from the Santa Clara River. Although there may be some recharge, even that is disputed, it is clear that the amount of recharge is minimal at best.

Response to PVCWD's Comment #7: PVCWD's comment has merit and the corresponding text has been amended to indicate there is some uncertainty with regards to the quantitative contribution of the Santa Clara River to the southern portion of the Oxnard Plain Pressure Basin and the Pleasant Valley Basin. However, the Santa Clara River likely provides significant recharge to the northern Oxnard Plain Pressure Basin. It is probably not accurate to portray the recharge going to Pleasant Valley from the Santa Clara River as "minimal at best." Although recharge to this basin is hampered by the zone of lower conductivity (fault?) that separates it from the Santa Clara River, there is still recharge moving across the zone. The river also alleviates the need for some recharge through the pipeline delivery of surface water as a replacement for extracted groundwater.

***8. PVCWD's Comment**: Under the section "Shelf Life for Conservation Credits", it is Pleasant Valley's opinion that at the present time there is no need for "sunsetting" of conservation credits. While conservation credits have been built up by not only Pleasant Valley, but other entities, it was the very purpose of allowing for conservation credits so that the credits could be retained and used for future needs. Pleasant Valley sees no present need to "sunset" the conservation credits. Credits would only be used when there was inadequate surface water from the Freeman Diversion and the Conejo Creek Project, and pumping from our wells were insufficient to meet our needs. Putting a shelf life on credits seems to suggest that Pleasant Valley would utilize their credits to over-pump and waste water.*

It is also our opinion that putting a shelf life on credits, will also remove incentives to look for creative water solutions. For example, much of the impetus for Pleasant Valley to participate in the Conejo Creek Project, was the fact that credits would be generated.

Response to PVCWD's Comment #8: Your comments are noted. Currently, there are no restrictions on the use of conservation credits, thus there is significant potential for over-use of the groundwater resource through the conservation credit program. The "sunsetting proposal" has been one of several proposals advanced by FCGMA stakeholders to mitigate the potentially negative consequences of the current credit program. Ultimately, current program will need to be evaluated in the context of the groundwater conditions and other groundwater management strategies to determine its potential benefit/consequences.

FCGMA responses to written comments submitted on behalf of Saticoy Country Club (SCC) by:
Mr. John Powell, Water Committee Representative
Saticoy Country Club

1. ***SCC's Comment:*** *Continuation of 25% Pumping Reduction. SCC supports all efforts to bring the basins into safe yield and we not only have committed to reduce our overall pumping but we also have committed significant capital resources to increase our efficiencies. As briefly described above we have made a significant efficiency effort already through our infrastructure alterations and water management practices and will continue that effort in the future. As such it is our opinion that to continue the phased reductions to the full 25% reduction (with possible further reductions) only to M&I users is unfair and that the Draft Management Plan Update should either include provisions to reward increases in efficiencies by M&I users and/or to implement additional productive measures to also reduce agricultural pumping. Agricultural users consume far more of the resource and it is completely unfair to place the burden of balancing the basin on the M&I users.*

Response to SCC's Comment #1: Your comments and continuing conservation efforts are very much appreciated. As a point of clarification, the proposed further reductions in groundwater extraction under historical allocation are **not** limited to M & I Operators as suggested by your comment. Other extraction reduction strategies included in the final Plan include a change to the Irrigation Efficiency Calculation (Section 10.1.9) and Additional Water Conservation strategies (Section 10.1.12). A generic discussion of M&I and agricultural conservation efforts has been added the final Plan (Section 4.0).
One of the somewhat surprising conclusions that resulted from the many computer modeling scenarios was that implementation of the remaining two 5% scheduled reductions in Historical Allocations would not eliminate the overuse of groundwater resources within the FCGMA. Thus, reduction of allocation will have to be considered in conjunction with other groundwater management strategies. Ultimately, the responsibility for efficient and effective groundwater use falls on all of the FCGMA stakeholders.

2. ***SCC's Comment: Shelf Life for Conservation Credits.*** *We understand the potential concerns of accumulating Conservation Credits with no expiration date and that this accumulation effectively has left a large theoretical pumping debt on the aquifers. Sunset provisions may be warranted in many cases. Our initial concerns with this proposed provision alteration is how it may impact different size users and also the potential for removal of credits earned through our continued efficiency improvements.*

Response to SCC's Comment #2: As noted in a response to similar comments, there are no restrictions on the use of conservation credits, thus there is significant potential for over-use of the groundwater resource through the conservation credit program. The "sunsetting proposal" has been one of several proposals advanced by FCGMA stakeholders to mitigate the potentially negative consequences of the current credit program. As part of the implementation of the Plan, both the quantitative contribution and cost/benefit of all groundwater management strategies will be evaluated as part of the development process.

FCGMA responses to written comments submitted on behalf of the City of Camarillo (Camarillo) by:

Ms. Lucia McGovern, Deputy Public Works Director
City of Camarillo

1. ***Camarillo's Comment:*** *Page 58* (of the June 2006 Draft Plan Draft Plan) *indicates the following, "the City of Camarillo is considering a strategy to move some of its current pumping from the area of the LAS pumping depression beneath Pleasant Valley to this area of poorer-quality rising groundwater. Under this plan, the poorer-quality water would be extracted and desalted in a similar manner to the South Las Posas Basin project approved by the FCGMA."*

   Recommended Action: Consider replacing this text with the following, "The City of Camarillo has assessed the feasibility of constructing a Groundwater Treatment Facility that would be located in the Somis Gap area of the Pleasant Valley Basin (Black & Veatch, August 2005). The study determined the project to be technically feasible and would allow Camarillo to halt pumping from an area of the LAS with depressed groundwater levels and instead pump in an area of rising groundwater levels. This plan is similar in nature to the South Las Posas Basin project, which was previously approved by the FCGMA Board and consistent with policy to move pumping to areas of known substantial recharge (i.e., Oxnard Forebay) which will create more storage space for future recharge events. The City of Camarillo proposes to coordinate pumping strategies between various stakeholders in the neighboring sub-basins in order maintain replenishment of the Pleasant Valley Basin."

Response to Camarillo's Comment #1: Some of this language has been added to the final Plan. Parenthetically, moving pumping away from Camarillo's airport wells has been simulated using the Ventura Regional Groundwater Model, with results discussed in Appendix B of the revised report and included in the discussion of this particular management strategy.

As a point of clarification, the Board **has not**, in fact, approved any plan for pumping without allocation in the South Las Posas Basin, although the Board has addressed the potential for consideration of such a plan. Specifically, Resolution 2003-03 states that "an allocation for pumping from the South Las Posas Basin may be changed or altered to accommodate a responsible entity that submits **a plan** to render this groundwater usable"[*] To date, no specific plan has been approved through ordinance or resolution by the Board.

2. ***Camarillo's Comment****: The majority of the discussion on page 58 focuses on the development of brackish groundwater in the LAS of the Pleasant Valley Basin by means of Camarillo's Groundwater Treatment Facility project. However, the third paragraph awkwardly mixes in a brief discussion of an alternate subject in an area of the Pleasant Valley Basin that is far away from the observed recharge in the Forebay.*

   Recommended Action: Please elaborate on the significance of this paragraph to Camarillo's Groundwater Treatment Facility Project or relocate this paragraph to an alternate location to maintain the continuity of the discussion regarding Camarillo's Groundwater Treatment Facility project which is in the Forebay.

[*] FCGMA, 2003. Item 4: Minutes of the October 22, 2003 Board Meeting *in: Full Agenda for the December 17, 2003 FCGMA Board Meeting.*

Response to Camarillo's Comment #2: The paragraph has been revised to reflect this comment, however we cannot agree with Camarillo's use of the term "Forebay" when discussing a possible unconfined area near the town of Somis at the northeastern corner of the Pleasant Valley Basin. There is at present, no comprehensive and conclusive evidence to support the concept that this area acts like a "Forebay" from a hydrogeologic standpoint. Further, the use of this term could be misleading when used in context with the rest of the FCGMA Management Plan where "Forebay" refers to the Oxnard Plain Forebay Groundwater Basin adjacent to the northern end of the Oxnard Plain Pressure Groundwater Basin.

3. ***Camarillo's Comment:*** *Page 17 (June 2006 Draft Plan) provides the following description of the Pleasant Valley Basin, "Despite the fault barrier to the west, the LAS is in hydrologic continuity with the adjacent southern portion of the Oxnard Plain Basin, which is the primary recharge source for the Pleasant Valley Basin."*
Two paragraphs later, the following is stated, "At the northeast edge of the Pleasant Valley basin, where Arroyo Las Posas flows cross the basin boundary, increased flows in the arroyo have apparently percolated directly into the LAS, significantly raising groundwater levels in City of Camarillo wells. This recharge suggests that this portion of the Pleasant Valley Basin is unconfined, contrary to current understanding of the basin. "
Recommended Action: Consider the following definition of the Pleasant Valley Basin and explanation of recharge sources for this basin:
Historically it was assumed that the LAS of the Pleasant Valley Basin was relatively confined and received little overall recharge. This assumption was based on the understanding that the primary recharge source for this basin was from the adjacent Oxnard Plain Basin to the south and recharge potential between these basins was low due to the low permeability of the Pleasant Valley Basin aquifer in this region, as well as the presence of a fault barrier in the lower portions of the Oxnard Plain. However, since the early 1990s, water levels have begun to rise in the northern adjacent basins. The City of Camarillo has two existing wells in .the northeast portion of the Pleasant Valley Basin (hereafter called the Somis Area) and these wells confirm that rising water levels in northern adjacent basins directly impact recharge rates, water quality, and water levels in the Somis Area.
The recharge in the Somis Area (Pleasant Valley Forebay) may be a result of the Saugus Formation being folded upward and subsequently eroding away in the Somis gap area covering the underlying bedrock with a predominantly sandy alluvial layer that allows rapid stream flow percolation. If this theory is correct, it is also likely true that the primary source of recharge for the Pleasant Valley Basin prior to the decline of the water levels in the adjacent northern basins was a forebay in the Pleasant Valley Basin and this primary recharge source is again prevalent due to the recent rise in water levels in the northern basins. It is recommended that additional monitoring and studies be conducted to determine if this theory is correct."
Figure 1 illustrates the conceptual location of the Pleasant Valley Forebay.

Response to Camarillo's Comment #3: Much of this suggested language has been included in the final Plan (Section 3.0). Section 3.0 significantly revises the text to indicate the degree of uncertainty in this area with respect recharge and hydrogeology. There is agreement that the northern portion of the Pleasant Valley basin south of Somis needs to be better understood and there is significant recharge occurring in this area of the basin. The details of how this recharge impacts the main portion of the Pleasant Valley basin needs further evaluation, with the result of the study integrated into the conceptual geology of the Ventura Regional Groundwater Model.
The term "Pleasant Valley Forebay" is not used for the reasons cited in the response to the previous Camarillo's Comment #2.

4. ***Camarillo's Comment****: Page 58 (June 2006 Draft Plan) indicates the following, "Base flow from the Arroyo Las Posas has migrated completely across the South and East Las Posas Basins and into the northernmost Pleasant Valley Basin, providing a source of new recharge to this portion of the Pleasant Valley Basin. Coordination in pumping strategies between the sub-basins is recommended in order to avoid negatively impacting groundwater levels in the Fox Canyon Groundwater Basin." As stated in Camarillo's Comment #3, this may not be a "new" source of recharge but instead reestablishing of an old source of recharge to the Pleasant Valley Basin.*

   Recommended Action: Consider revising the text to indicate that the Somis Gap was potentially the primary recharge source for the Pleasant Valley Basin prior to pumping activities in the northern adjacent basins.

Response to Camarillo's Comment #4: See our response to Camarillo's Comment #3 above. Section 3.0 significantly revises the text to indicate the degree of uncertainty in this area with respect recharge and hydrogeology.

5. ***Camarillo's Comment:*** *The Draft GMP does not segregate the Pleasant Valley Basin into sub-basins, it only describes the basin as a whole. Furthermore, the last sentence of the second paragraph of page 17 (June 2006 Draft Plan) indicates a lack of current understanding of this basin.*

   Recommended Action: Please elaborate on the current understanding of the Pleasant Valley Basin and clarify how the basin is currently handled in the model. It is also recommended that the authors consider sub-dividing the Pleasant Valley Basin into sub-basins (Pleasant Valley Forebay and Pleasant Valley Basin) to assist in evaluating the different potential recharge sources for the basin.

Response to Camarillo's Comment #5: See responses to the previous two Camarillo's Comments.

6. ***Camarillo's Comment****: The second paragraph on page 33 (June 2006 Draft Plan) indicates groundwater levels in the LAS have consistently been below sea level in the Pleasant Valley Basin. This is not true across the entire basin.*

   Recommended Action: Clarify that water levels in the southern portion of Pleasant Valley Basin have historically been below sea level since the 1950's. However, water levels in the northeastern portion of the basin near the Somis gap have historically been above sea level and continue to rise along with levels in the adjacent northern basins.

Response to Camarillo's Comment #6: The text has been amended appropriately in the final Plan.

7. ***Camarillo's Comment****: The last sentence of the second paragraph on page 29 (June 2006 Draft Plan) states that: "It is too early to know whether chlorides in the Pleasant Valley Basin will escalate to a problem affecting local pumpers." This sentence is restated in the third sentence of the second paragraph on page 35. In both places it should be noted that two City of Camarillo wells (Wells A and B) have already been impacted by a rise in chlorides, which has prompted the City to discontinue use of Well A and to blend water from Well B with higher quality imported water to meet drinking water standards.*

   Recommended Action: Revise the referenced sentences to indicate that chloride levels in the southern portion of the basin have risen marginally from rising water levels, but due to limited data, the marginal rise of chloride levels could be much higher. However, as shown on Figure 14 of the draft GMP, sulfate and TDS levels in the northern portion of the Pleasant Valley Basin have been rising steadily and have already exceeded secondary drinking water standards. Available data also indicate that concentrations of iron and manganese are also

rising in response to basin recharge and have risen to levels that impair M&I uses.

Response to Camarillo's Comment #7: The text has been amended appropriately in the final Plan.

8. ***Camarillo's Comment****: Page 35 (June 2006 Draft Plan) provides discussion on increasing sulfate and chloride levels in the northern Pleasant Valley Basin and indicates water treatment will be needed for potable or irrigation use.*
   Recommended Action: Consider expanding the discussion to include the following text: "Camarillo has evaluated the feasibility of constructing a Groundwater Treatment Facility that would intercept a portion of the poorer water quality surge and remove salts from the aquifer system. This would help protect the water quality in the southern portion of the basin and preserve higher quality water for use by other pumpers in areas of major overdraft. Furthermore, by utilizing the water from the Groundwater Treatment Facility, Camarillo could curtail or eliminate pumping operations in the southern portion of the Pleasant Valley Basin, which would promote recovery of the depressed water table in that region. Further details of the project are provided in the Section titled, Development of Brackish Groundwater, Pleasant Valley Basin."

Response to Camarillo's Comment #8: Appropriate language has been added to Section 5.2.3 and Section 9.3 of the final Plan. Based on the data and analyses available at this time, it is not known whether a groundwater treatment facility in the northern half of the Pleasant Valley basin would necessarily help to protect water quality in the southern portion of the basin. There is also significant potential for increased pumping associated with a treatment facility to worsen water quality in the southern portion of the Pleasant Valley Basin. Given that there is limited study and data on the area and no quantitative analysis regarding such a system, any statements regarding its success or failure are speculative.

9. ***Camarillo's Comment***: *The second sentence of the last paragraph on page 43 (June 2006 Draft Plan) indicates, "Basin Management Objectives (BMO's) for chloride concentrations in the Pleasant Valley Basin are currently being met, although chlorides are rising slowly in a few wells in the basin."*
   There are a number of wells that indicate that the BMO's are not being met. For example, County data indicate that well 01N/21W-01B04 screened from 820 to 1,150 feet has chloride greater than 200 mg/l, well 01N/21W-03C01 is screened from 956 to 1,216 feet has chloride greater than 260 mg/l, and well 01N/21W-01D02 is screened from 107 to 437 feet with chloride greater than 450 mg/l.
   Recommended Action: Consider revising the statement to indicate that BMO's are not currently being met throughout the entire Pleasant Valley Basin.

Response to Camarillo's Comment #9: The text has been amended appropriately in Section 6.2 of the final Plan.

10. ***Camarillo's Comment****: The first sentence of the last paragraph on page 58·(June 2006 Draft Plan) indicates, "Under current FCGMA policy, City of Camarillo pumping of poor-quality groundwater along Calleguas Creek would have to be pumped using existing allocations if the well was within the FCGMA boundary." The City of Camarillo understands that current FCGMA policy has evolved over time and has previously allowed unrestricted pumping of poorer quality shallow groundwater, with the semi-perched zone in the Oxnard Plain and the South Las Posas along the Arroyo being two examples.*
    Recommended Action: .Consider revising the last paragraph of page 58·(June 2006 Draft Plan) to say: "Previously, City of Camarillo pumping of poor-quality groundwater along Calleguas Creek would have to be pumped using existing allocations since the wells are within the FCGMA boundary. However, as FCGMA policy has evolved over time,

unrestricted pumping of poorer quality shallow groundwater has been allowed. For the Camarillo Project, a coordinated effort between the FCGMA and City of Camarillo should be undertaken to define the potential benefits of operating the City of Camarillo Groundwater Treatment Facility. Extractions of poor-quality water without allocations are discussed in more detail in the Section titled "Recommended Additions to FCGMA Policies."

Response to Camarillo's Comment #10: This comment is addressed in Section 9.3 of the final Plan. A formal written policy that includes criteria for these types of projects is recommended as an addition to FCGMA policies.

With regard to other as aspects of this comment, there are two points of clarification. First, no actual pumping of poor-quality shallow groundwater has been authorizes by the FCGMA to date without an existing allocation. Resolution No. 98-1 provides for construction dewatering without an established allocation since such work is typically short-lived and occurs in the shallow subsurface. Resolution No. 99-3 allowed for unrestricted pumping of "mounded groundwater" within the Oxnard Plain Forebay Basin without an allocation, but only under very specific terms and conditions that to date, have never been met or authorized. Second, the Board **has not**, in fact, approved any plan for pumping without allocation in the South Las Posas Basin although the Board is willing to consider the submittal of a plan. Specifically, Resolution No 2003-03 states that "an allocation for pumping from the South Las Posas Basin may be changed or altered to accommodate a responsible entity that submits a plan to render this groundwater usable"[*] To date, no specific plan has been approved through ordinance or resolution by the Board.

11. Camarillo's Comment*: The last 3 paragraphs on page 23 (June 2006 Draft Plan) discuss groundwater extraction reduction. The numbers presented in the second paragraph in this Section indicates that the total reduction in pumping is about 22 to 23 percent. The next paragraph indicates that the largest decrease in pumping is from agricultural uses, while the last paragraph indicates that the first phase of the FCGMA enforced pumping reductions of 15 percent resulted in the reduction of 8,300 acre-feet of pumping by the M&I users. However, the discussion on the reduced pumping does not appear to reflect the transfer of allocation from agricultural uses to M&I service, or the fact that while some M&I providers are using all their allocation, others have been conserving them for conjunctive use with other sources. We believe that the apparent 15 percent reduction in pumping is somewhat coincidental and that the overall M&I allocation for groundwater use has increased substantially due to land use conversion.*

Recommended Action: This discussion should compare the changes in acreage irrigated and M&I acreage served over the same time period that pumping reduction has occurred. This may also be the place to discuss the likelihood that under recording meters, or agricultural wells with no meters at all, may be contributing to the apparent reduction in reported agricultural pumping.

Response to Camarillo's Comment #11: The discussion of groundwater extraction has been expanded significantly and is located in Section 4.0 of the final Plan. The issue of potential under-reporting of groundwater extractions is addressed in Section 10.1.6 and Section 11.3.9 of the final Plan. In addition, an additional modeling scenario was performed to address potential under-reporting of groundwater extractions. A discussion of the results is provided in Section A.2.2.2 of Appendix B.

[*] FCGMA, 2003. Item 4: Minutes of the October 22, 2003 Board Meeting *in: Full Agenda for the December 17, 2003 FCGMA Board Meeting.*

***12. Camarillo's Comment**: The second paragraph of page 52 (June 2006 Draft Plan) implies that there is a universal acceptance of the pumping reductions and the stiff penalty for over pumping. The City of Camarillo doesn't agree that there is a universal acceptance of the pumping reductions. It is the City's view, as well as other M&I users, that the reduction is not equitable and recommends that the efficiency policy be reviewed in conjunction with production meter testing activities.*

Recommended Action: Consider revising the text to indicate there may be general acceptance of the pumping reduction policies but not universal agreement. The reduction policies should consider equal distribution in sharing the burden in resolving water level deficits in the basins.

Response to Camarillo's Comment #12: The language has been revised to reflect general, but not universal, acceptance of mandated or scheduled Historical allocation reductions.

***13. Camarillo's Comment**: The third paragraph on page 59 (June 2006 Draft Plan) states that the baseline allocation is two acre-feet per acre. The City of Camarillo understands that the two acre-feet per acre may have been the historical allocation, not the baseline allocation. Baseline allocation is only one acre-foot of water per acre, and should be considered when analyzing the baseline allocation policies.*

Response to Camarillo's Comment #13: The baseline allocation number as stated has been corrected to one acre-foot per acre as provided by Section 5.6.1.1 of FCGMA Ordinance No. 8.1.

***14. Camarillo's Comment:** Page 63 (June 2006 Draft Plan) provides a discussion on the potential effectiveness of importing additional state water. Further clarification of this paragraph would be very helpful in understanding this potential strategy.*

Response to Camarillo's Comment #14: A discussion of the potential effectiveness of importing California State Water is provided in Section 10.2.2 of the final Plan. The potential effects of importing California State Water was also addressed as a model scenario using the VRGM and is discussed in Section A.2.2.7 of Appendix B.

***15. Camarillo's Comment:** Page 73 (June 2006 Draft Plan) provides a discussion on penalties used to purchase replacement water. It should be noted that a large percentage of overpumping is by agricultural users who have the ability to escape penalties by switching to irrigation efficiency and consequently the revenue from these fees has historically been very little. Therefore, using this revenue to purchase replenishment water may be of little benefit to the basins.*

Response to Camarillo's Comment #15: The comment is noted.

***16. Camarillo's Comment:** Page 79 (June 2006 Draft Plan) includes a Section on "Extractions of Poor-Quality Water Without an Allocation", which would be an addition to current FCGMA policy. The City of Camarillo supports such a strategy that allows projects that would benefit the overall aquifer system. The City of Camarillo would like to see this policy implemented and would appreciate the opportunity to review the draft policy.*

Response to Camarillo's Comment #16: Please see the response to Camarillo's Comment #10 above.

***17. Camarillo's Comment:** FCGMA has reduced pumping and approved projects that provide some benefit to some portion of aquifers within the agency boundaries. However, this does not promote the implementation of projects in critical areas of the basin that are just outside of agency boundaries. Before implementing the next stage of pumping reductions on M&I users, the City of Camarillo recommends that the FCGMA evaluate larger picture projects*

that could help solve groundwater impacts in the most critical areas and potentially provide solutions in-lieu of additional pumping reductions. Further pumping reductions could possibly be avoided if the current basin by basin management approach was revised and strategies were implemented based on the principal that downstream basins are impacted by upstream uses and that the impact is therefore created by both agricultural and M&I users who pump from all basins.

FCGMA could consider implementing a "mitigation fee" of approximately $10/AF that would be paid by all groundwater users in the FCGMA. This strategy would allow funding for agencies like UWCD, Oxnard, or Calleguas MWD to develop projects that would effectively improve the conditions of the basins as a whole by moving water to over pumped areas within FCGMA boundaries. This approach would help prevent basin by basin management which could inordinately impact users in downstream basins, like the City of Camarillo.

Response to Camarillo's Comment #17: Section 11.1 of the final Plan proposes that there be a dialog on strategic planning within the water community that would discuss specific projects and project proposals. FCGMA staff has proposed a Plan implementation strategy that not only provides for, but encourages, significant stakeholder contribution and input. There are some inherent limitations to the influence of the FCGMA. The enabling legislation for the FCGMA limits its ability to influence projects and conditions outside its boundary. The opportunity to expend FCGMA funds outside its boundary is also limited.

18. Camarillo's Comment: *The City of Camarillo is under the impression that there is a quantifiable amount of groundwater being exported outside the FCGMA boundary from Pleasant Valley and Las Posas Basins. The City of Camarillo would recommend that FCGMA pursue controlling the exportation of groundwater before additional pumping reductions are approved.*

Response to Camarillo's Comment #18: The exportation of groundwater outside the FCGMA boundary is addressed in Section 9.4.

19. Camarillo's Comment: *The Draft GMP indicates that FCGMA is considering expiring accumulated groundwater credits. It should be noted that M&I users conjunctively balance surface water and imported supplies with local groundwater thereby conserving groundwater for use when surface and imported supply is not available. Therefore, setting a time limit on credits works against this water supply management philosophy. Credit reduction is an issue that should be reviewed separately for M&I uses and agricultural uses. Similar to implementing 25 percent pumping reductions, credit reductions would only impact M&I agencies who conduct long-term planning, since agricultural users could go on efficiency allocation and would not be impacted by a loss of credits. M&I users do not have this option.*

In regards to agricultural credits, please note that UWCD surface water deliveries have in part allowed accumulation of credits by agricultural users that receive surface water for irrigation. Those who funded the Freeman Diversion have in part funded the accumulation of these credits when surface deliveries were annually increased. The credit reduction strategy is believed to be of very little benefit to the overall basins but would have a significant impact to M&I users. If there is a desire to eliminate the perceived "groundwater debt", agricultural credit reduction should be the first consideration.

Pages 71 and 72 (June 2006 Draft Plan) state that there are tens of thousands of acre-feet of accrued conservation credits. The credits that the City of Camarillo has accrued came at a high cost, when we purchase more expensive imported water. Poor quality groundwater has forced the City of Camarillo to blend groundwater with imported supplies, subsequently accruing groundwater credits. The City of Camarillo intends to retain its credits until such time they are needed to meet demands during a drought. Even though credits cannot be

sold, they have a value to M&I users that is equal to the over pumping surcharge. FCGMA should reconsider the proposed strategy of expiring/reducing M&I groundwater credits.

Response to Camarillo's Comment #19: The issue of M&I accrual of credits as well as the "shelf-life" for conservations credits is discussed in extensive detail in Section 10.1.13 of the final Plan.

20. Camarillo's Comment: *Page 73 discusses proper filling and capping of abandoned or leaking wells and states that FCGMA helps with the costs associated with well abandonment. The owner of the land that the well is on should be responsible for costs associated with destruction of well(s).*

Response to Camarillo's Comment #20: It is true the owner of the land is responsible for well destruction. Historically, the City of Oxnard, United Water, and the FCGMA have each provided funding to destroy wells for a variety of reasons including urgency, difficult access, threats to water supply, and inability to find former owners. The Ventura County Watershed Protection District - Groundwater Section has pursued the destruction of 40 to 50 abandoned wells per year over the last several years at the property owner's expense without FCGMA financial assistance.

21. Camarillo's Comment*: Page 75 (June 2006 Draft Plan) provides a discussion of additional reductions in pumping allocations. It is recommended that further reductions not be implemented until after the meter testing effort is complete. Perhaps FCGMA should require an initial testing of all meters within one year. This would be very beneficial to the modeling effort because the model will only be as accurate as the information used to develop it.*

Response to Camarillo's Comment #21: The groundwater management strategy of reducing extraction allocations is discussed in extensive detail in Sections 9.5, 10.4.1, 11.2.1, 11.3.10, and Appendix Section A.2.2.3 of the final Plan. The verification of extraction reporting is discussed in detail in Sections, 10.1.6, 11.3.9, and in Appendix Section A.2.2.2. Many different and independent analyses performed over the last four years as well as years of historic documentation demonstrate nearly all of the aquifers of the FCGMA are in a state of overdraft. Two FCGMA Staff reports prepared since October 2006, the *FCGMA 2005 Annual Report*, the output of the VRGM (Appendix B to the final Plan), and the UWCD's *2003 Coastal Saline Intrusion Report, Oxnard Plain Ventura County, California* universally identify extraction of groundwater beyond a level the resource can support as the sole reason for depressed groundwater elevations, seawater intrusion, and water quality degradation throughout the FCGMA. Thus, there is an urgent need to implement strategies that both limit use of the resource and provide additional sources of acceptable recharge. While the increased accuracy of extraction reporting may indirectly contribute to better management of the groundwater resource, the overwhelming body of data and analysis supports the conclusion the resource as whole is over-allocated and overused. Delaying the implementation of any strategy that either reduces overuse of the resource or limits the acquisition of additional recharge does not serve either the FCGMA or its stakeholders. Nevertheless, further extraction reduction will be considered in conjunction with other management strategies described in the Plan with the overarching purpose of comprehensively managing the groundwater resource.

FCGMA responses to written comments provided by:
Mr. Lawrence (Larry) Fuller
Land Owner/Well Operator in the FCGMA
Somis, CA

1. ***Fuller's Comment:*** *Examining the FCGMA Management Plan in light of the case CITY OF BARSTOW et al, v. MOJAVE WATER AGENCY (21 August 2000), I believe this case clarifies the California Supreme Court's position on water rights. It is my understanding that the FCGMA used the "equitable" (physical) concept for allocation pumping to all of the Fox Canyon aquifer pumpers. This method of allocation is clearly a violation of the law, if I understand the ruling cited above. The three levels of priority, as stated in the case law, are 1st priority Overlying Owners, 2nd in priority are Appropriators, and 3rd are Exporters. Thus, while the rights of all overlying owners in a groundwater basin are correlative, and subject to cutbacks when the basin is overdrafted, overlying rights are superior to appropriative rights. It is my request that the FCGMA Board of Directors NOT make any further pumping reductions until these legal issues can be resolved. Small water users, Co-ops, and small M&I agricultural systems are not addressed specifically in the Management Plan. In addition, the FCGMA Board has no small operation representative to ensure that their interests and concerns will be heard.*

Response to Fuller's Comment #1: The history and responsibilities of the FCGMA are summarized in Section 2.0 of the final Plan.

The Agency was created by the State Legislature in 1982 [AB 2995] and granted with certain powers and authority to manage groundwater resources. Included in its enabling legislation (now codified as California Water Code Appendix Chapter 121) is the directive to develop, adopt, and implement a plan to control groundwater extractions (Sect 601). It was also granted the power to "Control extractions by regulating, limiting, or suspending extractions form extraction facilities…" [Ch. 121 Sect. 701 (b)]; and the power to "Impose reasonable operating regulations on extraction facilities…"[Ch. 121 Sect. 701(c)]. SB 747 (1991) amended AB 2995 and authorized the FCGMA Board to establish extraction allocations and levy charges for groundwater extraction. Neither the final Plan nor the FCGMA Ordinance No. 8.1 address the issue of water rights, which is beyond the scope of the FCGMA.

The final Plan was prepared to address the future management of the groundwater resource with respect to the needs of all of the FCGMA stakeholders, regardless of size. Since the operational impacts of larger users have a greater impact on the common resource, some priority has necessarily been placed on strategies that effect large-scale extraction or recharge operations. However, almost all of the proposed groundwater management strategies either directly or indirectly affect all users.

With respect to the comment regarding representation, two of the five FCGMA Board positions are established to represent agricultural operators and small water districts.

2. ***Fuller's Comment:*** *According to my understanding, the Calleguas Municipal Water District (CMWD) has been allowed to acquire Fox Canyon aquifer prescriptive pumping rights. The Board has already allowed the injection wells to be drilled and injection of imported water is progressing. It is imperative that CMWD be restricted in writing that they will not be allowed to extract water outside of their injection field.*

Response to Fuller's Comment #2: A discussion of the Las Posas Basin ASR project as well as other proposed aquifer storage projects, a preliminary set of proposed conditions is provided in Section 9.1 and Section 10.1.10 of the final Plan. Specific aspects of the East Las Posas Basin ASR (formerly Identified as the North Las Posas Basin ASR) are provided in Appendix Section A.3.1 of the final Plan.

The FCGMA has no authority in either its enabling legislation or through its Ordinance code to grant prescriptive rights. When the FCGMA Board authorized and approved the East Las Posas Aquifer Storage and Recovery Project (or ASR Program) proposed by CMWD back in February 1994, certain restrictions were placed on both the operational limitations and the water quality alterations that could result. A written list of conditions was attached to the general injection permit authorized by the FCGMA that included but were not limited to volume reporting, monthly water quality reports, water quality restrictions for both imported water and extracted water, total storage limitations, vicinity groundwater conditions reporting requirements, as well as other standards and condition-dependent response actions (Appendix Section A.3.1 of the final Plan). A copy of these standards or conditions is available and included in an official policy sheet entitled "GMA Adoption of Water Quality Standards."

3. Fuller's Comment: *A gallon for gallon or acre-foot for acre-foot of water injected for water extracted allowance associated with the CMWD ASR field should take into account the wetting factor of the dry sands and the drift factor of the water moving through the aquifer. Fluid losses can be substantial due to wetting of a dry formation and losses via underflow out of the basin or injection area. The FCGMA should not be providing free water to CMWD.*

Response to Fuller's Comment #3: The comment regarding the equity of credits for injected water compared to extracted water is addressed in Section 9.1 and Section 10.1.10 of the final Plan. This is one of the many issues to be considered as part of implementation of all FCGMA groundwater management strategies.

4. Fuller's Comment: *The court cases cited should be discussed in detail and rights of prescription should be examined as they might apply or effect FCGMA ordinances, processes or procedures especially in light of recent rulings by the court.*

Response to Fuller's Comment #4: The Agency Counsel, supplied to the FCGMA under contract with the County of Ventura, reviews and provides legal counsel to the Staff and the Board for all decisions, Ordinances, and resolutions with respect to County, State, and Federal Codes. Historically, the Agency has also contracted external legal services to provide advice on both policy and legal issues.

Folder: GMP
Comments Received

21 East Carrillo Street
Santa Barbara, CA 93101
Telephone: (805) 963-7000
Fax: (805) 965-4333

HATCH & PARENT
A Law Corporation

Robert J. Saperstein
(805) 882-1417
RSaperstein@HatchParent.com

June 22, 2006

Via Electronic Mail



Fox Canyon Groundwater Management Agency
c/o Dr. Steve Bachman
800 South Victoria Avenue, L#1600
Ventura, CA 93009

Re: Comments on Draft Groundwater Management Plan

Dear Steve:

These comments are provided on behalf of the cities of Oxnard and Camarillo, and Crestview Mutual Water Company. Many members of the GMA's M&I Providers Group have also reviewed these comments, but given the short time available, this letter has not been endorsed by any entities other than those listed above.

The M&I Providers group is committed to working with all the interested parties in ensuring that the final, updated GMA Groundwater Management Plan is well-done. The product must be comprehensive, technically well-grounded, and accessible to all the various GMA constituents. This is not a simple task.

GMA staff is also aware that the M&I Provider's Group has hired Curtis Hopkins to provide a peer review of the Management Plan. Curtis and Steve Bachman have already discussed ways in which they might collaborate in making the product meet all our expectations.

The first rough draft presented on June 12, 2006, provides an excellent starting point. Given that this initial draft does not contain the results of the modeling work, these comments are purposely general. When the modeling effort yields results, and the Management Plan is then crafted with more specific recommendations, more specific comments will be provided.

The M&I Providers Group also wanted to express its appreciation for the first workshop conducted on June 15, 2006. It is clear that Steve and the GMA staff have a good plan to ensure that the GMA constituents who chose to be involved will have ample opportunity to influence the content of the plan.

Fox Canyon Groundwater Management Agency
June 22, 2006
Page 2

In no particular order of importance, please consider the following observations and comments regarding the first draft of the Management Plan and the process in getting it completed:

1. GMA Board attendance at the workshops. While we understand the time commitment is extensive, this update to the Management Plan is very important. It will guide GMA policy and decision-making for years to come. We are not sure how the GMA Board can obtain adequate familiarity with all the issues and the constituents' concerns without some attendance at the workshops. No board members attended the first workshop.

2. Executive Summary. This section is written as part introduction and part summary. An Executive Summary is normally drafted when the remainder of the document is complete. Given the length and technical nature of the material, the Executive Summary will be the most important section of the Plan. It may be the only portion of the document many individuals read. It should summarize the purpose, issues and recommendations, once all of the technical work is complete.

3. Acknowledgements. Throughout the document, there is repetitive recognition of United and Calleguas as the two entities who contribute to the GMA. This recognition is limited almost exclusively to these two entities. Either this self-congratulatory language should be eliminated, or there should be proper acknowledgement of the work of all the individuals and agencies who have and continue to contribute to the GMA's success.

4. Modeling. There needs to be a distinct section that better describes the model details used for the technical analysis. This section need not be long, but it should include mention of the software, construction, assumptions and details of the model construct. It ought to give enough information for the technically capable reader to understand its basics.

5. Organization and Redundancy. There is tremendous redundancy in the report. Perhaps with different organization, it could be slimmed down significantly. You might describe the water quality and quantity issues generally applicable to all areas, along with the general concept of basin management objectives. Then discuss all the issues comprehensively, separated for each basin or in some cases regions with multiple basins. As an alternative, some of the nonessential background and detailed technical information might be moved to appendices.

6. Management Strategies: Organization. In a fashion, the Management Plan is really several separate management plans. Perhaps it should be organized by basin for the three content subjects: strategies under development, future strategies and actions to attain BMO's. There may need to be one more general section that addresses those strategies that cross basin boundaries. You may be able to combine all the basin specific discussions in one section for each basin. A couple different organizational approaches might be tested, with the goal of reducing redundancy and volume of text.

7. Specific strategy: Forebay priorities. The potential over-reliance on the Forebay under certain conditions is acknowledged in the document. However, there is no mention of the importance, from a policy perspective, to establish some hierarchy for use of the Forebay. There will be increasing reliance on the Forebay. To the extent access to the Forebay may be limited under certain conditions; the GMA board must consider limiting certain uses before others.

8. Specific strategy: Transfers across basins. There is no direct mention that transfers (of allocation or credits) from challenged areas to areas of abundance may be the simplest method of mitigating problems. This has been a policy not favored in the past. However, this is an appropriate time to reconsider this question, particularly if the technical analysis suggests that a surgical approach is required to solve certain problem areas.

9. Specific strategy: Ag recycled water use. The draft Plan acknowledges (assumes) that larger volumes of recycled water will be available for Ag use in the future. The assumption is correct that highly purified recycled water will be available and recycled water use could be a very efficient method of solving several regional problems. However, there is some resistance in the Ag community to take direct use of recycled water. The resistance is not over the quality of the recycled water, but over the required reporting to distributors and product buyers that the crop was grown with recycled water. As long as there is the Ag industry perception that recycled water use may harm the user's competitiveness, recycled water will not be widely accepted. The Board may be able to help influence certain industry groups to alter the current reporting requirements that create these problems for individual users.

10. Analytic methodology. There appears to be no intent to model the expected (inevitable) conversion of Ag use to M&I use over the period of the modeling run. Without this detail, the modeling exercise may provide very misleading results. For example, there are several significant Ag to M&I projects that are in the planning stages located in the south Oxnard Plain area, nearby the City's wastewater treatment plant and the military bases. The result of these conversions will be a shift in groundwater use from wells in a highly sensitive area, to City and United wells located far from the coast (and imported water). If the model does not take into account these expected transitions, it will predict a materially different future than that which will occur. In this fashion, the modeling results may be very misleading.

11. Water quality. It is somewhat troubling that the cornerstone of the Plan is the setting of Basin Management Objectives, some of which are water quality objectives. However, the model has no capability to predict water quality changes. Thus, we need to be very careful in how we set and monitor compliance with the Basin Management Objectives.

12. Periodic update. Either as a component of the Plan, or as a Board measure in adopting the Plan, there should be a built in requirement to update the Plan no less than every 5 years. This should not be so difficult if the model proves to be as useful a tool as is expected.

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June 22, 2006
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13. A few detail comments (there are several other nits in the document that we assume will be fixed in future drafts):

a. Pg. 12. There is no such thing as "in-lieu" credits. Ordinance 8 only defines storage and conservation credits. There are special credit transfer agreements/programs the GMA has approved that amount to "in-lieu" transfer of credits, but the term has no meaning in Ordinance 8.

b. Pg. 12. Ordinance 8 requires Ag to demonstrate 80% efficiency, based on the individual crops grown. The Plan does not propose tightening the efficiency percentage as a potential method of reducing water use. Also, the current reporting requirements are not clear in requiring that the efficiency calculation is to be based on irrigated acreage, not total owned property. In some cases, the irrigated acreage may be materially smaller than the property footprint. In that circumstance, the user gets a substantial benefit in reporting efficiency based on the property footprint instead of the irrigated acreage.

c. Pgs. 13, 16. There is no mention of M&I return flows as a source of recharge.

d. Pg. 20. Two different definitions of basin yield are used and overdraft is not defined.

e. Pg. 23. The discussion of the decreasing trend of extractions is incomplete and therefore misleading. As to the Ag side: (1) there is no quantification of the reduction of Ag pumping resulting from reduced acreage in production over the past two decades, and (2) there is no recognition that the initial period against which we are measuring reduced usage was a very dry period. During dry periods, Ag groundwater use tends to be greatest. Since those early years, we have been in a generally wet period. Thus, we would expect a natural reduction in Ag groundwater use simply based on the historical hydrology.

As to the M&I side, there is no quantification of the increase in municipal demand as a result of conversion of Ag use to M&I use. There is no discussion of the relative efficiencies of use of water prior to the imposition of the cutback goals. The implication of the current discussion in the Plan is that Ag has done more than its share and M&I has not. There is insufficient information or analysis for this conclusion or implication. This discussion should either be made complete and correct, or eliminated, especially if policy decisions might be influenced by it.

f. Pg. 29. The discussion of increasing salt concentrations in the Las Posas basins is somewhat conclusory and incomplete. It might help to actually provide the POTW discharge water quality for TDS and chlorides, so that it would be more clear to the reader that the problem is, in fact, generating from aquifer conditions, not discharge water quality.

The M&I Provider's Group and Curtis Hopkins will continue to be very actively involved in finalizing the Plan. We appreciate the Board's instructions to develop the Plan in an open and interactive environment. Thank you for your consideration of these comments and those that are certain to follow.

Best Regards,

Robert J. Saperstein
For HATCH & PARENT
A Law Corporation

ROB:olr

cc: Board of Directors of Fox Canyon Groundwater Management Agency
Jeff Pratt
David Panaro
M&I Provider's Group

SB 395545 v1:006670.0041

PUBLIC WORKS DEPARTMENT
Water Division
251 South Hayes Avenue • Oxnard, CA 93030-6058
(805) 385-8136 • Fax (805) 385-8137



16 August 2006

Transmitted Via Electronic Mail

Fox Canyon Groundwater Management Agency
c/o Dr. Steve Bachman
800 South Victoria Avenue, L#1600
Ventura CA 93009

Subject: Additional Interim Comments on Draft Groundwater Management Plan

Dear Dr. Bachman:

This letter sets forth additional interim general comments on the Draft Fox Canyon Groundwater Management Agency ("FCGMA") Groundwater Management Plan ("Plan") and the current planning process by the City of Oxnard. A draft of this letter and the substantive comments herein were also discussed at the Municipal & Industrial ("M&I") Providers Group meeting on 15 August 2006. Those in attendance expressed their general support for the recommendations set forth below. We will provide more specific comments when the results of the basin model become available. We understand that the modeling results will be available by the end of this month, and that the draft Plan will be amended to include specific recommendations based upon the results. The M&I Provider's Group and its consultant, Hopkins Groundwater Consultants, will need sufficient time to review the model results and the revised draft Plan when available, so that we can provide meaningful comments.

As an interim effort, we are submitting these additional comments to supplement the comments provided by the City of Oxnard and others by letter, dated 22 June 2006. Our additional interim comments are as follows:

1. At the last workshop on the draft Plan, the group discussed the potential that incorrect assumptions about the quantity of groundwater production could result in erroneous outcomes from the model. Indeed, there is substantial anecdotal evidence that groundwater production reporting may be materially incorrect because of inaccurate meters or other faulty reporting mechanisms. For this reason, we recommend that the model be run to assume a band of uncertainty relating to the quantity of groundwater production within FCGMA. Such sensitivity analysis will help verify the integrity of the model results.

2. As a related matter, the FCGMA will pursue an aggressive review of meter calibrations over the next several years. However, this process is not scheduled to start until 2007 and it will take three years to complete the first cycle. We recommend that the model be periodically rerun and updated with this new, more accurate production data when it becomes available. In the interim, we recommend that FCGMA staff review suspect accounts and perform a preliminary audit of groundwater production reporting to determine the scope of potential discrepancies.

3. The Draft Plan sets forth several potential future management strategies that should be further explored for their potential effectiveness in addressing seawater intrusion and other adverse hydrogeologic conditions. We recommend that the next draft of the Plan prioritize these potential future strategies in terms of their potential effectiveness. We further recommend that the FCGMA develop procedure to apply a cost/benefit analysis to determine which of the prioritized strategies should be implemented.

4. As a general matter, we also encourage the FCGMA to consider more dynamic use of aquifers with dewatered storage space as a potential resource for future conjunctive use programs. Other basins, such as the Chino and Orange County basins, are currently planning and using available dewatered storage space for local and regional conjunctive use programs that yield better water supply reliability and financial benefits to support other necessary basin management programs. The FCGMA could pursue similar programs. There are numerous hydrogeologic and policy matters that must be resolved to implement a large scale groundwater storage program. Still, we recommend that the Plan include additional and more detailed discussion of potential opportunities for active conjunctive use programs within the FCGMA area.

We look forward to viewing the model results and the next iteration of the draft Plan so that we may provide more specific comments. As we noted in our prior letter, we appreciate the open and interactive environment in which this planning effort is being conducted. Thank you for your consideration of these additional interim comments.

Sincerely,

Anthony A. Emmert
Water Resources Manager

cc: Board of Directors, Fox Canyon Groundwater Management Agency
Jeff Pratt
Gerhardt Hubner
David Panaro
M & I Providers Group

ARNOLD, BLEUEL, LAROCHELLE, MATHEWS & ZIRBEL, LLP
ATTORNEYS AT LAW

ATTORNEYS

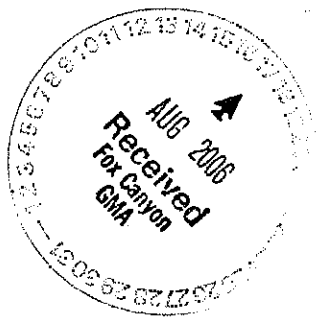
GARY D. ARNOLD
BARTLEY S. BLEUEL
DENNIS LAROCHELLE
JOHN M. MATHEWS
MARK A. ZIRBEL
DENNIS P. McNULTY
KENDALL A. VAN CONAS
AMBER A. EISENBREY
PETER D. LEMMON

OF COUNSEL
SUSAN L. McCARTHY

300 ESPLANADE DRIVE, SUITE 2100
OXNARD, CALIFORNIA 93036
TELEPHONE: 805.988.9886
FAX: 805.988.1937
www.atozlaw.com

WRITER'S E-MAIL
jmathews@atozlaw.com

August 16, 2006



Mr. David Pantaro
Fox Canyon Groundwater
Management Agency
800 S. Victoria Avenue
Ventura, CA 93009

Re: Draft Goundwater Management Plan

Dear David:

Pleasant Valley County Water District ("PVCWD") has reviewed the Fox Canyon Groundwater Management Agency (GMA) Draft Groundwater Management Plan. The staff of the GMA and their consultants are to be congratulated on their efforts in drafting this comprehensive document. We continue to believe that the best way to address our groundwater issues in Ventura County is the consensus building approach that the GMA has always embraced. In our review we have several initial comments. Our comments are made sequentially based upon the GMA draft.

1. On page 23, under the section "*Groundwater Extractions*", in the third paragraph it refers to increased agricultural efficiencies. We believe that somewhere in this paragraph reference should be made to the fact that extractions from the groundwater may have also decreased because increased yields from the Freeman diversion and the Conejo Creek project.

2. On page 43, in the section entitled "*Assessment of Basin Management Objectives*", in the second paragraph it refers to BMOs for groundwater levels in the Pleasant Valley basin. In table 3, it makes reference to Basin Management Objectives in the Pleasant Valley area, but does not set forth what the current levels are, it would be helpful to state the groundwater BMOs.

3. On page 48, under the section "*Contingency Plan for LAS Seawater Intrusion*", it states that the GMA staff has developed a contingency plan to address the intrusion of seawater into the LAS. It would be helpful if drafts of that Contingency Plan could be made available for public review.

Mr. David Panaro
Fox Canyon Groundwater
Management Agency
Re: Draft Goundwater Management Plan
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4. On page 50, under the section "*Conejo Creek Diversion Project*", the last sentence references that over the "net 20 years" that the yield of the diversion might decrease. There obviously is a spelling error there in that the word "net" should be "next". Furthermore, input should be sought from Camrosa Water District to determine whether or not their proposed plans will in fact reduce yield to Pleasant Valley. In discussions with Richard Hajas. it is our understanding that Camrosa's intent is to continue to provide current levels of diverted water to Pleasant Valley and in fact yields may be increased.

5. On page 55, under the section "*Great Project (Recycled Water)*", the first paragraph makes reference to the delivery of recycled water to the Pleasant Valley area. Pleasant Valley has continued to express their coneerns to the City of Oxnard about the suitability of the reeycled water for agricultural use. In particular, Pleasant Valley is concerned about the "stigma" that recycled water has in the market place. Many growers are now required to provide information on the source of their irrigation water. In the event that recycled water is used, the agricultural produce is often downgraded.

   Also, Pleasant Valley has concern about the injection of recycled water into the LAS. Injection into the LAS is discussed on pages 65 and 66. Beeause the LAS is the only groundwater source for the Pleasant Valley County Water District, Pleasant Valley will closely scrutinize any injeetion of recycled water into the LAS.

   We feel that a better alternative to injection would be the transportation of the recycled water to the spreading grounds. This would enhance recharge and remove concerns relative to injection.

6. On page 59, under the section "*Non-Export of FCGMA Water*", the last paragraph on that page states "It appears that current ordinances and policies of the FCGMA are sufficient to deal with its export issue." In light of recent issues, the ordinances of the GMA should be reviewed again to make sure that they are adequate to address the export issues. In particular, the enforcement provisions relating to export of "GMA" water should be closely reviewed.

7. On page 63, under the section "*Increase Diversions from Santa Clara River. Potential Effectiveness*", the first sentence states "The Santa Clara River remains a primary recharge source for the Oxnard Plain and Pleasant Valley basins." Based upon our understandings of various studies, it is a little misleading to suggest that the Pleasant Valley basin gets much recharge from the Santa Clara River. Although there may be some recharge, even that is disputed, it is clear that the amount of recharge is minimal at best.

Mr. David Panaro
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8. Beginning on page 71, under the section "*Shelf Life for Conservation Credits*", it is Pleasant Valley's opinion that at the present time there is no need for "sunsetting" of conservation credits. While conservation credits have been built up by not only Pleasant Valley, but other entities, it was the very purpose of allowing for conservation credits so that the credits could be retained and used for future needs. Pleasant Valley sees no present need to "sunset" the conservation credits. Credits would only be used when there was inadequate surface water from the Freeman Diversion and the Conejo Creek Project, and pumping from our wells were insufficient to meet our needs. Putting a shelf life on credits seems to suggest that Pleasant Valley would utilize their credits to over pump and waste water.

   It is also our opinion that putting a shelf life on credits, will also remove incentives to look for creative water solutions. For example, much of the impetus for Pleasant Valley to participate in the Conejo Creek Project, was the fact that credits would be generated.

We appreciate the opportunity to provide our comments concerning the draft, and look forward to the further development of the plan.

Very truly yours,

ARNOLD, BLEUEL, LAROCHELLE,
MATHEWS & ZIRBEL, LLP

John M. Mathews

JMM/ksvk
cc: PVCWD
S:\USER\SHARE\P\PVCWD\Correspondence\Panero 8-16-06.wpd



August 17, 2006

Fox Canyon Ground Water Management Agency
Ventura County Government Center Administration Building
800 South Victoria Avenue
Ventura, California 93009-1600

Attention: Mr. Lynn E. Maulhardt, Chair

Subject: Comments on the Public Review Draft Updated Management Plan dated June, 2006

Dear Mr. Maulhardt:

Saticoy Country Club (SCC) has a vested interest in the proposed changes to the current Fox Canyon Groundwater Management Agency Management Plan (Management Plan Update) but we have not been able to complete our comments in time for the August 21, 2006 deadline for comments. While this letter presents our early thoughts on several issues in the draft Management Plan Update, we intend to continue our effort to prepare comments. Our goal is to have our completed comments shortly after the next FCGMA Groundwater Management Plan Workshop on August 31, 2006. With this schedule we trust our comments will be considered for incorporation in the Final Management Plan Update.

SCC has significantly reduced our water usage through a reduction in irrigated acreage and increased our efficiencies through infrastructure improvements and our water management practices including the following:

- Hired a golf architect to provide a plan to reduce our irrigated acreage from about 117 acres to 95 acres.
- Implemented the 95 acre plan.
- Hired a landscape architect to prepare a drought resistant landscape plan.
- We are in the process implementing the landscape plan.
- Converted many sprinkler heads to more efficient one half head models along the edges of the fairways.
- Rewired each of our sprinkler heads and installed new sprinkler controls for improved individual run time controls.
- We have on-going turf grass studies for additional efficiency improvement.
- A complete irrigation system upgrade evaluation is planned within the next few years.

For the draft Management Plan Update we have identified two areas so far that warrant comments. Those are:

Continuation Of 25% Pumping Reduction

SCC supports all efforts to bring the basins into safe yield and we not only have committed to reduce our overall pumping but we also have committed significant capital resources to increase our efficiencies. As briefly described above we have made a significant efficiency effort already through our infrastructure alterations and water management practices and will continue that effort in the future. As such it is our opinion that to continue the phased reductions to the full 25% reduction (with possible further reductions) only to M&I users is unfair and that the Draft Management Plan Update should either include provisions to reward increases in efficiencies by M&I users and/or to implement additional productive measures to also reduce agricultural pumping.

SATICOY COUNTRY CLUB

4450 NORTH CLUBHOUSE DRIVE
SOMIS, CALIFORNIA 93066
(805) 485-4956
FAX (805) 647-1158

Agricultural users consume far more of the resource and it is completely unfair to place the burden of balancing the basin on the M&I users.

Shelf Life For Conservation Credits

We understand the potential concerns of accumulating Conservation Credits with no expiration date and that this accumulation effectively has left a large theoretical pumping debt on the aquifers. Sunset provisions may be warranted in many cases. Our initial concerns with this proposed provision alteration is how it may impact different size users and also the potential for removal of credits earned through our continued efficiency improvements.

We look forward to discussions on both of these issues in the workshops.

Sincerely,

John R. Powell. RG, CEG
For the Water Committee

City of Camarillo

601 Carmen Drive • P.O. Box 248 • Camarillo, CA 93011-024

Public Works
(805) 388-5380

August 25, 2006

Mr. Jeff Pratt, P.E.
Executive Officer
Fox Canyon Groundwater Management Agency
800 South Victoria Avenue
Ventura, CA 93009

Subject: Comments to Fox Canyon Groundwater Management Agency Draft Groundwater Management Plan (June 2006)

Dear Jeff,

The City of Camarillo, and its consultants, Black & Veatch and Hopkins Groundwater Consultants, Inc., have reviewed the June 2006 Draft Groundwater Management Plan (Draft GMP) prepared by your agency, and attended two Agency workshops. Based on these interactions, we offer the following comments and recommended actions.

Comments Regarding Development of Brackish Groundwater

The Draft GMP provides discussion in several locations regarding the potential feasibility of the development of the brackish groundwater supply in the northern portion of the Pleasant Valley Basin. The following comments are in regards to this subject.

1. Comment: Page 58 indicates the following, *"the City of Camarillo is considering a strategy to move some of its current pumping from the area of the LAS pumping depression beneath Pleasant Valley to this area of poorer-quality rising groundwater. Under this plan, the poorer-quality water would be extracted and desalted in a similar manner to the South Las Posas Basin project approved by the FCGMA."*

   Recommended Action: Consider replacing this text with the following, *"The City of Camarillo has assessed the feasibility of constructing a Groundwater Treatment Facility that*

would be located in the Somis Gap area of the Pleasant Valley Basin (Black & Veatch, August 2005). The study determined the project to be technically feasible and would allow Camarillo to halt pumping from an area of the LAS with depressed groundwater levels and instead pump in an area of rising groundwater levels. This plan is similar in nature to the South Las Posas Basin project, which was previously approved by the FCGMA Board and consistent with policy to move pumping to areas of known substantial recharge (i.e., Oxnard Forebay) which will create more storage space for future recharge events. The City of Camarillo proposes to coordinate pumping strategies between various stakeholders in the neighboring sub-basins in order maintain replenishment of the Pleasant Valley Basin."

2. Comment: The majority of the discussion on page 58 focuses on the development of brackish groundwater in the LAS of the Pleasant Valley Basin by means of Camarillo's Groundwater Treatment Facility project. However, the third paragraph awkwardly mixes in a brief discussion of an alternate subject in an area of the Pleasant Valley Basin that is far away from the observed recharge in the forebay.

   Recommended Action: Please elaborate on the significance of this paragraph to Camarillo's Groundwater Treatment Facility Project or relocate this paragraph to an alternate location to maintain the continuity of the discussion regarding Camarillo's Groundwater Treatment Facility project which is in the forebay.

3. Comment: Page 17 provides the following description of the Pleasant Valley Basin, *"Despite the fault barrier to the west, the LAS is in hydrologic continuity with the adjacent southern portion of the Oxnard Plain Basin, which is the primary recharge source for the Pleasant Valley Basin."*

   Two paragraphs later, the following is stated, *"At the northeast edge of the Pleasant Valley basin, where Arroyo Las Posas flows cross the basin boundary, increased flows in the arroyo have apparently percolated directly into the LAS, significantly raising groundwater levels in City of Camarillo wells. This recharge suggests that this portion of the Pleasant Valley Basin is unconfined, contrary to current understanding of the basin."*

   Recommended Action: Consider the following definition of the Pleasant Valley Basin and explanation of recharge sources for this basin:

   "Historically it was assumed that the LAS of the Pleasant Valley Basin was relatively confined and received little overall recharge. This assumption was based on the understanding that the primary recharge source for this basin was from the adjacent Oxnard Plain Basin to the south and recharge potential between these basins was low due to the low permeability of the Pleasant Valley Basin aquifer in this region, as well as the presence of a fault barrier in the lower portions of the Oxnard Plain. However, since the early 1990's, water levels have begun to rise in the northern adjacent basins. The City of Camarillo has two existing wells in the northeast portion of the Pleasant Valley Basin (hereafter called the Somis Area) and these wells confirm that rising water levels in northern adjacent basins directly impact recharge rates, water quality, and water levels in the Somis Area.

The recharge in the Somis Area (Pleasant Valley Forebay) may be a result of the Saugus Formation being folded upward and subsequently eroding away in the Somis gap area covering the underlying bedrock with a predominantly sandy alluvial layer that allows rapid stream flow percolation. If this theory is correct, it is also likely true that the primary source of recharge for the Pleasant Valley Basin prior to the decline of the water levels in the adjacent northern basins was a forebay in the Pleasant Valley Basin and this primary recharge source is again prevalent due to the recent rise in water levels in the northern basins. It is recommended that additional monitoring and studies be conducted to determine if this theory is correct."

Figure 1 illustrates the conceptual location of the Pleasant Valley Forebay.

4. Comment: Page 58 indicates the following, *"Base flow from the Arroyo Las Posas has migrated completely across the South and East Las Posas Basins and into the northernmost Pleasant Valley Basin, providing a source of new recharge to this portion of the Pleasant Valley Basin. Coordination in pumping strategies between the sub-basins is recommended in order to avoid negatively impacting groundwater levels in the Fox Canyon Groundwater Basin."* As stated in Comment #3, this may not be a "new" source of recharge but instead reestablishing of an old source of recharge to the Pleasant Valley Basin.

   Recommended Action: Consider revising the text to indicate that the Somis Gap was potentially the primary recharge source for the Pleasant Valley Basin prior to pumping activities in the northern adjacent basins.

5. Comment: The Draft GMP does not segregate the Pleasant Valley Basin into sub-basins, it only describes the basin as a whole. Furthermore, the last sentence of the second paragraph of page 17 indicates a lack of current understanding of this basin.

   Recommended Action: Please elaborate on the current understanding of the Pleasant Valley Basin and clarify how the basin is currently handled in the model. It is also recommended that the authors consider sub-dividing the Pleasant Valley Basin into sub-basins (Pleasant Valley Forebay and Pleasant Valley Basin) to assist in evaluating the different potential recharge sources for the basin.

6. Comment: The second paragraph on page 33 indicates groundwater levels in the LAS have consistently been below sea level in the Pleasant Valley Basin. This is not true across the entire basin.

   Recommended Action: Clarify that water levels in the southern portion of Pleasant Valley Basin have historically been below sea level since the 1950's. However, water levels in the northeastern portion of the basin near the Somis gap have historically been above sea level and continue to rise along with levels in the adjacent northern basins.

7. Comment: The last sentence of the second paragraph on page 29 states that: *"It is too early to know whether chlorides in the Pleasant Valley Basin will escalate to a problem affecting local pumpers."* This sentence is restated in the third sentence of the second paragraph on page 35. In both places it should be noted that two City of Camarillo wells (Wells A and B) have already been impacted by a rise in chlorides, which has prompted the City to discontinue use of Well A and to blend water from Well B with higher quality imported water to meet drinking water standards.

   Recommended Action: Revise the referenced sentences to indicate that chloride levels in the southern portion of the basin have risen marginally from rising water levels, but due to limited data, the marginal rise of chloride levels could be much higher. However, as shown on Figure 14 of the draft GMP, sulfate and TDS levels in the northern portion of the Pleasant Valley Basin have been rising steadily and have already exceeded secondary drinking water standards. Available data also indicate that concentrations of iron and manganese are also rising in response to basin recharge and have risen to levels that impair M&I uses.

8. Comment: Page 35 provides discussion on increasing sulfate and chloride levels in the northern Pleasant Valley Basin and indicates water treatment will be needed for potable or irrigation use.

   Recommended Action: Consider expanding the discussion to include the following text: *"Camarillo has evaluated the feasibility of constructing a Groundwater Treatment Facility that would intercept a portion of the poorer water quality surge and remove salts from the aquifer system. This would help protect the water quality in the southern portion of the basin and preserve higher quality water for use by other pumpers in areas of major overdraft. Furthermore, by utilizing the water from the Groundwater Treatment Facility, Camarillo could curtail or eliminate pumping operations in the southern portion of the Pleasant Valley Basin, which would promote recovery of the depressed water table in that region. Further details of the project are provided in the section titled, Development of Brackish Groundwater, Pleasant Valley Basin."*

9. Comment: The second sentence of the last paragraph on page 43 indicates, *"Basin Management Objectives (BMOs) for chloride concentrations in the Pleasant Valley Basin are currently being met, although chlorides are rising slowly in a few wells in the basin."*

   There are a number of wells that indicate that the BMOs are not being met. For example, County data indicate that 1N/21W-1B04 screened 820 to 1150 feet has chloride greater than 200 mg/l, 1N/21W-3C01 screened 956 to 1216 feet has chloride greater than 260 mg/l, and 1N/21W-1D02 screened 107 to 437 feet has chloride greater than 450 mg/l.

   Recommended Action: Consider revising the statement to indicate that BMOs are not currently being met throughout the entire Pleasant Valley Basin.

10. Comment: The first sentence of the last paragraph on page 58 indicates, *"Under current FCGMA policy, City of Camarillo pumping of poor-quality groundwater along Calleguas*

Creek would have to be pumped using existing allocations if the well was within the FCGMA boundary." The City of Camarillo understands that current FCGMA policy has evolved over time and has previously allowed unrestricted pumping of poorer quality shallow groundwater, with the semi-perched zone in the Oxnard Plain and the South Las Posas along the Arroyo being two examples.

Recommended Action: Consider revising the last paragraph of page 58 to say: *"Previously, City of Camarillo pumping of poor-quality groundwater along Calleguas Creek would have to be pumped using existing allocations since the wells are within the FCGMA boundary. However, as FCGMA policy has evolved over time, unrestricted pumping of poorer quality shallow groundwater has been allowed. For the Camarillo Project, a coordinated effort between the FCGMA and City of Camarillo should be undertaken to define the potential benefits of operating the City of Camarillo Groundwater Treatment Facility. Extractions of poor-quality water without allocations are discussed in more detail in the section titled "Recommended Additions to FCGMA Policies."*

Comments Regarding Further Pumping Reduction Strategies

The Draft GMP includes discussions on the continuation of 25 percent pumping reductions. The M&I users are impacted by reduction strategies while agricultural users are impacted by irrigation efficiency strategies. The actual benefit of the 25 percent pumping reduction is limited because the M&I component of groundwater use (about 30 percent) is significantly less than agricultural uses (about 70 percent) as illustrated in Figures 4 and 5 of the GMP. As a result, this strategy will only ensure a minor reduction in the overall pumping, which will be from the M&I users. This conserved amount could easily be negated by inefficient agricultural practices. Therefore, it is recommended that the 25 percent (or greater) reduction strategies should be reviewed in conjunction with agricultural efficiency calculations. In addition, FCGMA should consider more restrictive crop efficiencies and consider a replenishment fee to be paid by all users.

Specific comments related to pumping reduction strategies are:

11. Comment: The last 3 paragraphs on page 23 discuss groundwater extraction reduction. The numbers presented in the second paragraph in this section indicates that the total reduction in pumping is about 22 to 23 percent. The next paragraph indicates that the largest decrease in pumping is from agricultural uses, while the last paragraph indicates that the first phase of the FCGMA enforced pumping reductions of 15 percent resulted in the reduction of 8,300 acre-feet of pumping by the M&I users. However, the discussion on the reduced pumping does not appear to reflect the transfer of allocation from agricultural uses to M&I service, or the fact that while some M&I providers are using all their allocation, others have been conserving them for conjunctive use with other sources. We believe that the apparent 15 percent reduction in pumping is somewhat coincidental and that the overall M&I allocation for groundwater use has increased substantially due to land use conversion.

Recommended Action: This discussion should compare the changes in acreage irrigated and

M&I acreage served over the same time period that pumping reduction has occurred. This may also be the place to discuss the likelihood that under recording meters, or agricultural wells with no meters at all, may be contributing to the apparent reduction in reported agricultural pumping.

12. Comment: The second paragraph of page 52 implies that there is a universal acceptance of the pumping reductions and the stiff penalty for over pumping. The City of Camarillo doesn't agree that there is a universal acceptance of the pumping reductions. It is the City's view, as well as other M&I users, that the reduction is not equitable and recommends that the efficiency policy be reviewed in conjunction with production meter testing activities.

    Recommended Action: Consider revising the text to indicate there may be general acceptance of the pumping reduction policies but not universal agreement. The reduction policies should consider equal distribution in sharing the burden in resolving water level deficits in the basins..

General Comments on the Draft GMP

The following comments and recommendations are more general in nature:

13. The third paragraph on page 59 states that the baseline allocation is two acre-feet per acre. The City of Camarillo understands that the two acre-feet per acre may have been the historical allocation, not the baseline allocation. Baseline allocation is only one acre-foot of water per acre, and should be considered when analyzing the baseline allocation policies.

14. Page 63 provides a discussion on the potential effectiveness of importing additional state water. Further clarification of this paragraph would be very helpful in understanding this potential strategy.

15. Page 73 provides a discussion on penalties used to purchase replacement water. It should be noted that a large percentage of overpumping is by agricultural users who have the ability to escape penalties by switching to irrigation efficiency and consequently the revenue from these fees has historically been very little. Therefore, using this revenue to purchase replenishment water may be of little benefit to the basins.

16. Page 79 includes a section on *"Extractions of Poor-Quality Water Without An Allocation"*, which would be an addition to current FCGMA policy. The City of Camarillo supports such a strategy that allows projects that would benefit the overall aquifer system. The City of Camarillo would like to see this policy implemented and would appreciate the opportunity to review and comment on the draft policy.

17. FCGMA has reduced pumping and approved projects that provide some benefit to some portion of aquifers within the agency boundaries. However, this does not promote the implementation of projects in critical areas of the basin that are just outside of agency boundaries.

Before implementing the next stage of pumping reductions on M&I users, the City of Camarillo recommends that the FCGMA evaluate larger picture projects that could help solve groundwater impacts in the most critical areas and potentially provide solutions in-lieu of additional pumping reductions.

Further pumping reductions could possibly be avoided if the current basin by basin management approach was revised and strategies were implemented based on the principal that downstream basins are impacted by upstream uses and that the impact is therefore created by both agricultural and M&I users who pump from all basins.

FCGMA could consider implementing a "mitigation fee" of approximately $10/AF that would be paid by all groundwater users in the FCGMA. This strategy would allow funding for agencies like UWCD, Oxnard, or Calleguas MWD to develop projects that would effectively improve the conditions of the basins as a whole by moving water to over pumped areas within FCGMA boundaries. This approach would help prevent basin by basin management which could inordinately impact users in downstream basins, like the City of Camarillo.

18. The City of Camarillo is under the impression that there is a quantifiable amount of groundwater being exported outside the FCGMA boundary from Pleasant Valley and Las Posas Basins. The City of Camarillo would recommend that FCGMA pursue controlling the exportation of groundwater before additional pumping reductions are approved.

19. The Draft GMP indicates that FCGMA is considering expiring accumulated groundwater credits. It should be noted that M&I users conjunctively balance surface water and imported supplies with local groundwater thereby conserving groundwater for use when surface and imported supply is not available. Therefore, setting a time limit on credits works against this water supply management philosophy.

    Credit reduction is an issue that should be reviewed separately for M&I uses and agricultural uses. Similar to implementing 25 percent pumping reductions, credit reductions would only impact M&I agencies who conduct long-term planning, since agricultural users could go on efficiency allocation and would not be impacted by a loss of credits. M&I users do not have this option.

    In regards to agricultural credits, please note that UWCD surface water deliveries have in part allowed accumulation of credits by agricultural users that receive surface water for irrigation. Those who funded the Freeman Diversion have in part funded the accumulation of these credits when surface deliveries were annually increased.

    The credit reduction strategy is believed to be of very little benefit to the overall basins but would have a significant impact to M&I users. If there is a desire to eliminate the perceived "groundwater debt", agricultural credit reduction should be the first consideration.

Pages 71 and 72 state that there are tens of thousands of acre-feet of accrued conservation credits. The credits that the City of Camarillo has accrued came at a high cost, when we purchase more expensive imported water. Poor quality groundwater has forced the City of Camarillo to blend groundwater with imported supplies, subsequently accruing groundwater credits. The City of Camarillo intends to retain its credits until such time they are needed to meet demands during a drought. Even though credits cannot be sold, they have a value to M&I users that is equal to the over pumping surcharge.

FCGMA should reconsider the proposed strategy of expiring/reducing M&I groundwater credits .

20. Page 73 discusses proper filling and capping of abandoned or leaking wells and states that FCGMA helps with the costs associated with well abandonment. The owner of the land that the well is on should be responsible for costs associated with destruction of well(s).

21. Page 75 provides a discussion of additional reductions in pumping allocations. It is recommended that further reductions not be implemented until after the meter testing effort is complete. Perhaps FCGMA should require an initial testing of all meters within one year. This would be very beneficial to the modeling effort because the model will only be as accurate as the information used to develop it.

The City of Camarillo requests the opportunity to provide additional comments once the groundwater modeling effort for the GMP is available for review. The City believes it would be valuable if the GMP provided more quantifiable measures regarding water level deficits and anticipated impacts each FCGMA strategy would contribute towards reducing those deficits. However, the City recognizes that those quantifiable measures would much easier to identify once the modeling results are available.

Please contact me at (805) 388-5334 if you have any questions or need additional information.

Very truly yours,

City of Camarillo

Lucia McGovern
Deputy Director of Public Works

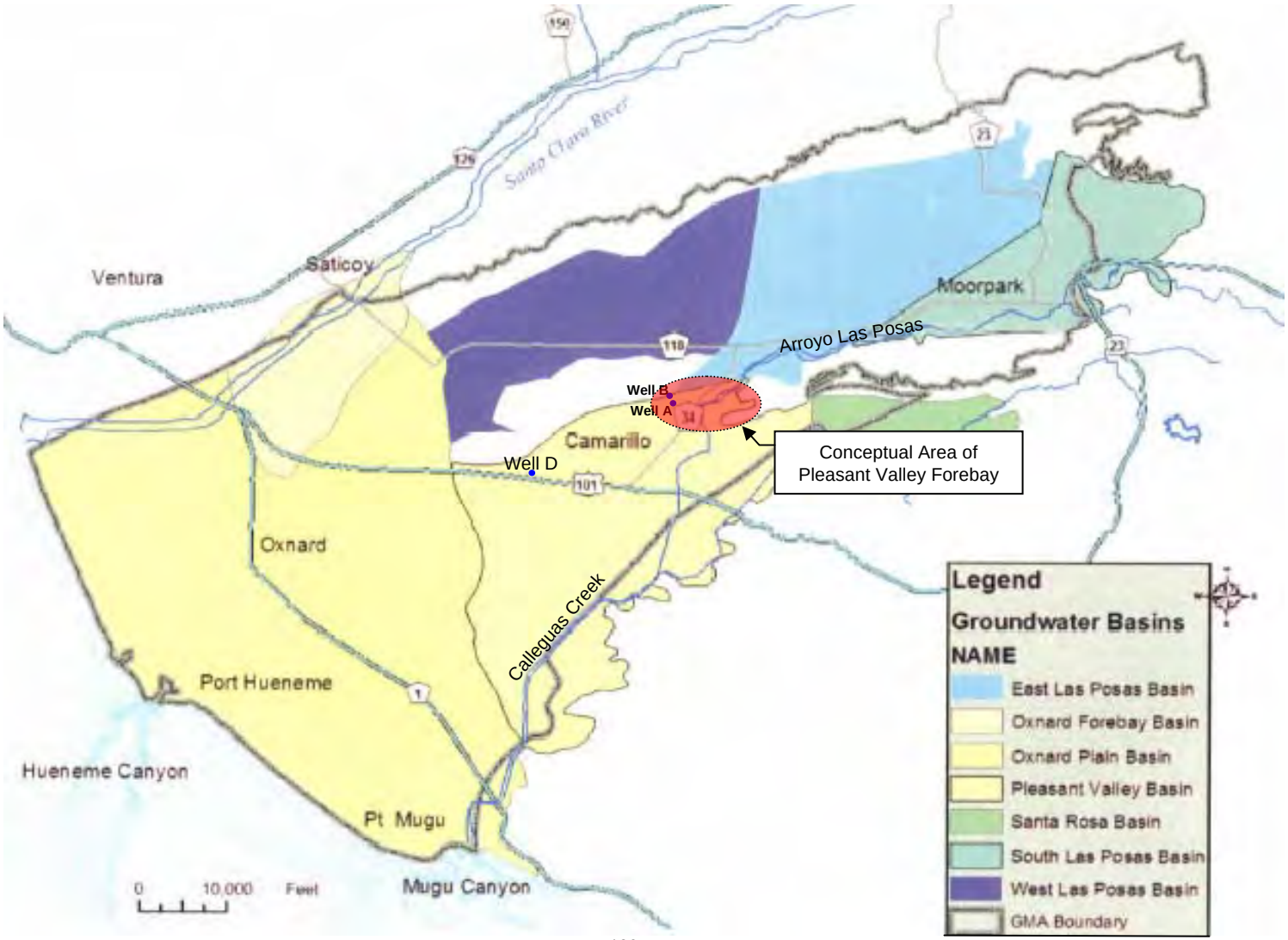
Attachment – Figure of Pleasant Valley Forebay

City of Camarillo Comments on June 2006 Draft GMP
August 25, 2006

cc:
Tom Smith – City of Camarillo
Curtis Hopkins – Hopkins Consultants
Randy Krueger – Black & Veatch
Tony Emmert – City of Oxnard
Jim Kentosh – UCWD
Jim Passanisi – City of Ventura
Carrie Mattingly – City of Port Hueneme
Steve Bachman, PhD – UCWD
Don Kendall, PhD – Calleguas MWD

Figure 1

Pleasant Valley Forebay Map





Lawrence (Larry) Fuller
7935 Dusty Lane
Somis, CA 93066
805-386 –4086

September 26, 2006

Fox Canyon Groundwater Management Agency
800 S. Victoria Ave.
Ventura, CA 93009

Attn: David Panaro, Jeff Pratt & Steve Bachman

Subj: Comments and concerns on the FCGWMA Management Plan.

Hi David,

I told you that I would put in writing some of my thoughts and concerns expressed in the 1st workshop. My research has led me to look at the management plan in the light of the State of California water case law especially the case CITY OF BARSTOW et al., v. MOJAVE WATER AGENCY (S071728) 21 August 2000. This case clarifies the Supreme Court of California's position on water rights. A summery of the Courts decisions can be found in Downey Brand Attorneys LLP document titled California Water Law & Policy Reporter- October 2000.

It is my understanding that the FCGWMA used the "equitable" (physical) concept for allocating pumping to all of the Fox Canyon aquifer pumpers. This method of allocation is clearly a violation of the law, if I understand the California Supreme Court ruling cited above. The three levels of priority, as stated in the case law, are 1st Priority Overlying Owners, 2nd in priority are appropriators and 3rd are exporters (water transferred out of the immediate pumping area).

The clearest statement of this fact is found on page 29 starting with line 3. "We repeat the guiding principle: 'Under California law, "[p]roper overlying use,... is paramount, and the right of an **appropriator**, being limited to the amount of **surplus**, must yield to that of the overlying owner in the event of a shortage unless the appropriator has gained prescriptive rights through the taking of nonsurplus waters." [Citation.]' (*Hi-Desert County Water Dist. V. Blue Skies Country Club, Inc., supra*, 23 Cal.App.4th 1723-1731, Thus, while the rights of all overlying owners in a ground water basin are correlative, and subject to cutbacks when the basin is over drafted, **overlying rights are superior to appropriative rights.** Here, the trial court did not attempt to determine the priority of water rights, and merely allocated pumping rights based on prior production. This approach elevates the rights of appropriators and those producing without any claim of right to the same status as the rights of riparins and overlying owners. The trial court erred in doing so."

It is my request that the FCGWMA board of directors DO NOT make any further pumping reductions until these legal issues can be resolved. The case law sited states that only the Court has the right to restrict our pumping. A little caution now could prevent law suits caused by not following the law. (page 54,61) The original allocation system did not take into consideration efficient use of water and therefore it was/is flawed. **The allocation should also consider the number of water sources available to a given property.** Some properties have water available via pipelines from major water suppliers while many properties are dependent on their wells as the only source of water. Small users, Coops and small M &I/Agriculture systems are not addressed specifically in Management Plan. In addition to this the FCGWMA board has no small operation representative on the board to insure that their interests and concerns will be heard.

Another issue that I talked about in the workshop was the FCGWMA's Board approval of CMWD application for injection/storage facilities in North Las Posas Groundwater Basin.

According to my understanding this letter opens the door for CMWD to acquire Fox Canyon Aquifer **prescriptive** pumping rights. The Board has already allowed the injection wells to be drilled and injection of imported water is progressing. It is imperative that CMWD be restricted **IN WRITING** that they will not be allowed to extract water outside of their injection field. The Board can not by letter change the California water laws regarding prescriptive water rights that can and will be developed if pumping is allowed outside of the injection site boundaries. See page two paragraph 4. end of 1st sentence....**OR IN THE NEAR VICINITY**. What constitutes "near"? One mile, five miles? It is a known fact that CMWD wants to pump Fox Canyon water to blend with their imported water. Overlying owner priority rights will be affected if this issue is not addressed before any extraction is started out side their injection field.

Another problem area with CMWD that was discussed, concerned the One for One or gallon for gallon of water pumped to be extracted. When I addressed this issue your engineer made light of my comments concerning both the wetting factor of the dry sands and the drift factor of the water moving through the aquifer. I have friends that are very knowledgeable in the field of both hydrology and geology. They state that anyone who knows anything about the Fox Canyon aquifer knows about the drift out through Hueneme Canyon and the losses of fluid due to wetting of a dry formation. I can only assume that CMWD is injecting into an area that is dry—water does not compress. David this is right down your alley. I know with your training you can do the calculations for both the wetting and the transfer function even if your engineer can't. The FCGWMA should not be providing free water to CMWD.

The Court case sited discussed in detail the effect of allowing a right by prescription to be developed. Please look into all of the FCGWM ordinances in the light of the rulings by the Court.

Sincerely,

Larry Fuller

Encl: Copies for Mr. Jeff Pratt
Mr. Steve Bachman

GROUNDWATER AND SURFACE WATER CONDITIONS REPORT - 2013

United Water Conservation District
Open-File Report 2014-02



PREPARED BY

GROUNDWATER RESOURCES DEPARTMENT
MAY 2014

UWCD OFR 2014-02

GROUNDWATER AND SURFACE WATER CONDITIONS REPORT - 2013

United Water Conservation District
Open-File Report 2014-02

Groundwater Resources Department
May 2014

THIS REPORT IS PRELIMINARY AND IS SUBJECT TO MODIFICATION BASED UPON FUTURE ANALYSIS AND EVALUATION

Cover Photo: Sunrise at El Rio Spreading Grounds. By John Carman.

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GROUNDWATER AND SURFACE WATER CONDITIONS REPORT - 2013

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EXECUTIVE SUMMARY / ABSTRACT

United Water Conservation District is a public agency that encompasses nearly 213,000 acres of central and southern Ventura County. The District covers the downstream (Ventura County) portion of the valley of the Santa Clara River, as well as the Oxnard Plain. The District serves as the steward for managing the surface water and groundwater resources within all or portions of eight groundwater basins. This report includes data and records from the 2013 calendar year, including basic information and discussion on the operation of the District's facilities, weather and hydrologic information, groundwater levels and available storage within the basins, and the quality of surface water and groundwater.

Major water resource issues and concerns are the driving impetus for the District's projects and programs. Projects and programs are implemented to manage, mitigate, or eliminate those issues or concerns that threaten the water resources. Those issues and concerns include, but are certainly not limited to, groundwater overdraft and the intrusion of saline water in the Oxnard Plain and Pleasant Valley basins, the gradual, long-term declining water levels in the Santa Paula Basin, water quality of the Oxnard Forebay basin and the Piru basin, and concerns related to the management of the Piru and Fillmore basin water resources.

To address those issues and concerns, United implements a wide variety of activities. Some of the activities are District-wide, for example: water levels are monitored in an extensive network of water wells thorough the District and a significant number of these wells are sampled as a part of a water quality monitoring program. In addition, stream gauging is performed periodically to quantify surface water volumes and flow rates under various hydrologic conditions. These data are important to United's habitat conservation efforts and the facilitation of fish passage at the Vern Freeman Diversion, as well as optimizing various District operations (e.g., annual conservation release, diversion of water to recharge basins or for use in-lieu of groundwater pumping by agricultural operations on the Oxnard Plain and in Pleasant Valley basin). Currently, the largest District-wide project underway by the groundwater department is the update of the Ventura County Regional Groundwater Flow Model. This is a multi-year, multi-faceted project that requires the expertise of several groundwater science specialties and relies on the District's long record of water-level, water quality, and stream gauging data. When completed, the groundwater flow model will be a primary evaluative tool for various proposed water management scenarios and will assist stakeholders with enhancing the sustainability and reliability of local water resources.

Issue-specific projects are also implemented by United to assist local stakeholders in the management of local water resources (e.g., AB3030 Piru/Fillmore Groundwater Management Plan, analyses of groundwater conditions in the Santa Paula basin as a part of the Technical Advisory Committee) or the pursuit of grant funds (e.g., Local Groundwater Assistance Program grants from CA Department of Water Resources, Fox Canyon Groundwater Management Agency Groundwater

Supply Enhancement Assistance Program) to help defray the costs of some of the groundwater projects.

The benefits of the surface water and groundwater projects and programs operated by United are shared by the many groundwater pumping entities in the District and those who receive those waters. Many of the benefits are in the background and not readily recognized or apparent to individual water users, however, the positive impacts of the District's activities are significant to the agricultural, municipal, and industrial economies of Ventura County.

1 INTRODUCTION AND BACKGROUND

United Water Conservation District (also "United" or "District") is a public agency that encompasses nearly 213,000 acres of central and southern Ventura County. The District covers the downstream (Ventura County) portion of the valley of the Santa Clara River, as well as the Oxnard Plain. The District serves as a steward for managing the surface water and groundwater resources for all or portions of eight interconnected groundwater subbasins (Figure 1-1). It is governed by a seven-person board of directors elected by division, and receives revenue from property taxes, groundwater extraction (pump) charges, recreation fees, and water delivery charges. The developed areas of the District are a mix of agriculture and urban areas, with prime agricultural land supporting high-dollar crops such as avocados, berries, row crops, tomatoes, lemons, oranges, flowers, ornamental nursery stock and sod. Approximately 370,000 people live within the District boundaries, including those living in the cities of Oxnard, Port Hueneme, Santa Paula, Fillmore and eastern Ventura.

The District is authorized under its principal act (California Water Code Section 74000 et seq) to exercise multiple powers. These powers include the authority to conduct water resource investigations, acquire water rights, build facilities to store and recharge water, construct wells and pipelines for water deliveries, commence actions involving water rights and water use, prevent interference with or diminution of stream/river flows and their associated natural subterranean supply of water, and to acquire and operate recreational facilities in connection with dams, reservoirs or other District works.

This report includes general information about the District's mission and detailed data on the operation of the District's facilities, weather and hydrologic information for calendar year 2013, including discussion regarding groundwater levels and storage within the basins, and the quality of the surface water and groundwater. Recent and current studies and investigations conducted by the District's Groundwater Department are also detailed. This report updates information presented in a similar report detailing District conditions in 2011 (UWCD, 2012d), and some discussion is devoted to contrasting the wet-year conditions of 2011 to the dry-year conditions of 2013.

1.1 UWCD MISSION STATEMENT AND GOALS

The District's mission statement is:

United Water Conservation District shall manage, protect, conserve, and enhance the water resources of the Santa Clara River, its tributaries and associated aquifers, in the most cost-effective and environmentally balanced manner.

In order to accomplish this mission, United Water Conservation District follows these guiding principles:

- Construct, operate, and maintain facilities needed now and in the future to put local and imported water resources to optimum beneficial use;
- Deliver safe and reliable drinking water that meets current and future health standards to cities and urban areas;
- Provide an adequate and economical water supply to support a viable and productive agricultural sector;
- Fight overdraft and seawater intrusion and enhance the water quality of the aquifers through the use of District programs;
- Monitor water conditions to detect and guard against problems and to report those conditions to the public;
- Seek opportunities to develop cooperative programs with other agencies in order to maximize use of District resources and promote mutually beneficial projects;
- Acquire and operate high-quality public recreational facilities that are financially self-supporting;
- Balance District operations with environmental needs to maximize use of the region's water resources; and
- Conduct District affairs in a business-like manner that promotes safe investment policy, sound financial audits and the utmost in professional and financial integrity.

The District recognizes that many of the projects and activities required to implement these guiding principles have long timelines for development and initiation, and the positive impacts of these projects and activities may be realized over many years. This is consistent with the District's mission to provide for the long-term health of the water resources within the District. To fulfill its mission, the District retains technical experts in the fields of engineering, hydrogeology, surface water hydrology, environmental science, ecology, and regulatory compliance, as well as administrative personnel with specialties in accounting and finance.

1.2 UWCD HISTORY

The original founding organization for United Water Conservation District was called the Santa Clara River Protective Association. It was formed in 1925 to protect the runoff of the Santa Clara River from being appropriated and exported outside the watershed. The Santa Clara Water Conservation District was formed in 1927 to further the goals of the Association by protecting water rights and conserving the waters of the Santa Clara River and its tributaries. The District began a systematic program of groundwater recharge in 1928, primarily through constructing spreading grounds along the Santa Clara River. Sand dikes were constructed on the Santa Clara River near Saticoy to divert river water into spreading grounds in nearby upland areas.

As groundwater overdraft and seawater intrusion on the Oxnard Plain were recognized in the 1940s, it was clear that the District did not have the financial ability to raise money to construct the facilities necessary to combat the problem. With the help of the City of Oxnard, a new district was organized in 1950 under the Water Conservation District Law of 1931. The new district was called United Water Conservation District for its unification of urban and agricultural concerns. Substantial bond measures were approved by the constituents of the District, allowing United to construct a number of water conservation projects, including:

- Santa Felicia Dam (1955) to capture and store winter runoff on Piru Creek to release in controlled amounts during the dry season. The 200-foot high dam can currently store about 82,300 acre-feet (AF) in Lake Piru. The reservoir is located downstream of a State Water Project reservoir, enabling the District to receive Northern California water via flows down middle Piru Creek without the construction of expensive delivery pipelines;
- A pipeline to new spreading grounds at El Rio; and
- Municipal wells at the El Rio spreading grounds to produce water for the Oxnard-Hueneme (O-H) pipeline (1954) that supplies drinking water to the cities of Oxnard and Port Hueneme, a number of mutual water companies, and the two Navy bases at the coast. The O-H system supplies water from the Oxnard Forebay basin (the recharge area for the Oxnard Plain basin), rather than pumping individual wells in coastal areas of the Oxnard Plain that could accelerate seawater intrusion.

Following increasing intrusion of seawater from the 1950s to the 1980s, United Water built several new facilities to increase recharge to the aquifers and to decrease groundwater pumping in areas affected by the intrusion. These facilities provide both direct present benefit, and long-term benefits, to the groundwater aquifers and to the groundwater extractors in the District. In 1958 a pipeline was completed to deliver diverted surface water to Pleasant Valley County Water District, which serves agricultural water to the Pleasant Valley basin. The Pumping Trough Pipeline (PTP) was constructed in 1986 to convey diverted river water to agricultural pumpers on the Oxnard Plain, thus reducing the amount of groundwater pumping in critical areas. The Freeman Diversion (1991) replaced the temporary diversion dikes in the Santa Clara River with a permanent concrete structure, allowing diversion of storm flows throughout the winter. A major additional benefit of the Freeman Diversion was the stabilization of riverbed elevations upstream of the facility, correcting the long-term incision of the river related to decades of in-channel gravel mining in the Saticoy vicinity.

Following the construction of the Freeman Diversion, the Noble spreading basins (1995) were constructed to store and recharge additional water diverted from the river, particularly during wet periods. The Saticoy well field was constructed in 2003 to pump down the groundwater mound that develops beneath the Saticoy spreading grounds during periods of heavy spreading. In late 2009 United acquired the Ferro and Rose basins, former mining pits located in the Oxnard Forebay that will be used for future groundwater recharge activities. United intends to construct facilities to convey Santa Clara River water diverted at the Freeman Diversion to these basins. Both the City of

Oxnard and the City of Ventura have recently studied the feasibility of piping recycled municipal wastewater to United's recharge basins in the Oxnard Forebay as a way to replenish the groundwater basins from which they extract water. United anticipated that the City of Ventura might desire to move recycled water to the District's recharge basins (or alternatively, potable water from the Forebay to east Ventura) in the future and arranged for "pipe hangers" to be added to the Highway 118 bridge over the Santa Clara River during its reconstruction in 1993.

1.3 UWCD ORGANIZATION

The District is governed by a seven-person board of directors elected by division, and receives revenue from property taxes, groundwater extraction (pump) charges, recreation fees, and water delivery charges. The District currently employs about 50 full-time staff. Management, professional staff and administrative staff work out of the District's headquarters in Santa Paula. Operations staff are based at field offices located at Lake Piru, Saticoy and El Rio.

1.4 UWCD OPERATIONS AND FACILITIES

United Water Conservation District operates a series of water conservation facilities from the tributaries of the Santa Clara River to the Oxnard Plain and Pleasant Valley (Figure 1-1). These facilities store winter runoff for later release during the dry season, divert water from the Santa Clara River, recharge the aquifers through the natural river channel and off-channel spreading basins, and deliver surface water and groundwater to cities and growers so that groundwater pumping is reduced in critically overdrafted areas.

1.4.1 SANTA FELICIA DAM AND LAKE PIRU

Santa Felicia Dam was constructed in 1955 for the conservation of runoff on Piru Creek. The main function of the dam is to retain the high flows in Piru Creek during the winter and spring months, and release the stored water in the fall when the basins of the Santa Clara River valley and the facilities that receive water from the Freeman Diversion have the capability to receive the most benefit from the release. The current capacity of the Lake Piru is 82,300 AF (See Figure 1.4-1 for storage history). The operational minimum pool is set at 20,000 AF of storage to help prevent the accumulation of sediment around the outlet works for Santa Felicia Dam.

1.4.2 PIRU DIVERSION AND SPREADING GROUNDS

The Piru Diversion is operated to divert surface water into the Piru Spreading Grounds for groundwater recharge. The diversion is located on the western bank of lower Piru Creek just south of the old Center Street Bridge in the town of Piru. Part of the diversion dam is built under the two roadway bridges crossing lower Piru Creek at Center Street.

The existing diversion consists of an earthen berm that extends out across the river channel, a sluice channel that can accommodate approximately 200 cubic feet per second (cfs), and a diversion structure with a trash rack and four 24-inch inlets leading to a 48-inch diversion pipe that conveys diverted water to the spreading grounds. The structure lacks a fish screen and is not in compliance with National Marine Fisheries Service (NMFS) standards for diverting water in a stream that could possibly contain endangered southern California steelhead. The diversion will not be put back into operation until an incidental take permit has been issued.

1.4.3 FREEMAN DIVERSION AND SATICOY SPREADING GROUNDS

The Freeman Diversion is located on the Santa Clara River about 10 miles upstream from its mouth at the Pacific Ocean. The concrete diversion structure was completed in 1991 and replaced the previous diversion method of building temporary sand and gravel diversion dikes, levees, and canals. The prior method of diverting water from the Santa Clara River near Saticoy had been in practice since the 1920s. The Freeman Diversion facility replaced the former method of building temporary sand and gravel diversion dikes, levees, and canals along the Santa Clara River near Saticoy. With each high flow in the river the dikes were washed out, eliminating the ability to divert water until construction crews were able to work in the riverbed with bulldozers to restore the diversion levees. Construction of the Freeman Diversion has increased the conservation of flood flows by extending the time each year when flows can be diverted and not discharged to the ocean. The current facility consists of the following structures: diversion structure, fish passage facilities, headworks, canal, flocculation building, and desilting basin. The diversion is operated to redirect surface water from the Santa Clara River to United's recharge basins located in Saticoy, El Rio and the Noble Basins for the purpose of recharging the aquifers underlying the Oxnard Forebay and Oxnard Plain. The remainder of the diverted water is delivered directly to agricultural users to satisfy irrigation demand "in lieu" of the users pumping groundwater. These deliveries are designed to reduce groundwater pumping in areas where overdraft conditions and related water quality issues exist, such as where aquifers are most susceptible to saline water intrusion and the upwelling of saline waters. Water releases from Lake Piru and a portion of the natural runoff from the Santa Clara River are diverted by the Freeman Diversion.

1.4.4 EL RIO FACILITY AND SPREADING GROUNDS

The El Rio Spreading Grounds are located at the terminus of the El Rio branch of the main supply line, approximately two miles southwest of the Saticoy spreading grounds. Surface water diverted from the Santa Clara River is distributed to a series of ponds totaling approximately 80 acres for the purpose of groundwater recharge. .

1.4.5 MUNICIPAL WATER DELIVERIES

United built the Oxnard-Hueneme (O-H) system in 1954 to move municipal groundwater extraction on the Oxnard Plain away from coastal areas subject to seawater intrusion. The well field for the O-

H system surrounds the El Rio recharge basins, and water produced by the well field is a blend of recharge water that has filtered down through the aquifer, and water drawn laterally from surrounding areas. The El Rio well field includes both upper and lower aquifer wells, allowing a blending of sources for water quality purposes. In practice, the Lower Aquifer System (LAS) wells are rarely used, as they are primarily used as alternative wells when others have high nitrate concentrations.

The California Department of Health Services requires the publication of an annual water quality summary of water delivered by the O-H system. The 2013 Consumer Confidence Report for the O-H water delivery system is included in Appendix A. The O-H delivery system is operated as an enterprise fund; water rates are set and approved by the users to support operation and improvements to the system without subsidies from United's other rate payers. Major customers include the City of Oxnard, the Port Hueneme Water Agency, and a number of mutual water companies in the southern Oxnard Forebay and on the Oxnard Plain.

1.4.6 AGRICULTURAL WATER DELIVERIES

Water deliveries for agricultural purposes are achieved through two systems, the Pumping Trough Pipeline (PTP) System and the Pleasant Valley Delivery System. These systems are discussed separately in the following two subsections. See Figure 1-1 for locations.

1.4.6.1 PTP DELIVERY SYSTEM

The Pumping Trough Pipeline (PTP) delivery system was designed to serve surface water from the Santa Clara River to a portion of the Oxnard Plain where the Upper Aquifer System (UAS) was determined to be in severe overdraft. Five Lower Aquifer System wells were constructed along the pipeline to balance pipeline pressures and provide additional water to the system when surface water supplies are incapable of meeting demand. Like the O-H System, the PTP delivery system is operated as an enterprise fund. The four UAS wells of the Saticoy well field, completed in 2004, can also provide groundwater to the agricultural pipelines when groundwater elevations are high near the Saticoy Spreading Grounds.

1.4.6.2 PLEASANT VALLEY DELIVERY SYSTEM

Water diverted from the Santa Clara River is delivered to the Pleasant Valley County Water District (PVCWD) via the Pleasant Valley Pipeline. The pipeline terminates at the Pleasant Valley Reservoir, located east of the Camarillo Airport near the City of Camarillo. PVCWD operates the reservoir and eleven LAS wells in the western Pleasant Valley basin, supplying water to agricultural customers via a delivery system linking the wells and the reservoir. The delivery of diverted river water to PVCWD offsets pumping of irrigation wells in the area. United is obligated by contract to supply, on an annual basis, 12.22 percent of the water diverted at the Freeman Diversion to

PVCWD. Since 2002 PVCWD has also received surface water from the Conejo Creek Diversion, operated by Camrosa Water District.

1.5 GROUNDWATER ISSUES AND CONCERNS

United's core mission is to manage, conserve and protect the water resources that exist within the District boundaries. United operates Santa Felicia Dam and maintains contractual arrangements with a number of upstream agencies to store or convey surface runoff to the lower portions of the Santa Clara River watershed. United does not regulate the use of groundwater within the District, but operates a number of facilities intended to maximize the conjunctive use of surface water and groundwater resources. Aside from United's annual State Water imports of up to 3,150 acre-feet, the Ventura County portion of the Santa Clara River valley is wholly dependent on local water resources for irrigation and potable supply, an uncommon arrangement in southern California where most areas regularly import large quantities of water. Significant quantities of State Water are however purchased by the cities of Oxnard and Camarillo for urban use on the Oxnard Plain.

Despite long-term efforts to import more water to the District and optimize the use of local resources, water deficits exist in a number of areas throughout the District. In some places the depletion of groundwater reserves has simply resulted in lowered water tables. In other places significant water quality problems developed in response to conditions of overdraft. In some areas water quality problems are related to land use practices, or exist naturally.

Listed below are summaries of several of the water supply and water quality issues that exist within United's district boundaries. In some cases United's involvement includes groundwater recharge or water delivery to actively address issues related to overdraft. In other cases United has conducted or sponsored research in order to better define existing problems and help identify potential physical projects or management strategies to mitigate the problem. United management and staff are knowledgeable concerning groundwater management practices and have expertise in conducting monitoring programs and with applying various methods for evaluating basin conditions (e.g., Bachman et al, 2005). United's water management activities go well beyond the storage, distribution and deliberate recharge of water within the watershed of the Santa Clara River.

1.5.1 OVERDRAFT CONDITIONS

Although high chloride concentrations in groundwater were first documented near Port Hueneme in the 1930s (California Department of Water Resources [DWR], 1954), the conditions for widespread seawater intrusion in the Upper Aquifer System (UAS) on the Oxnard Plain were initiated as early as the 1940s, when groundwater levels beneath the southern portion of the Oxnard Plain basin dropped below sea level (FCGMA, 2007). Within 5 to 10 years, chloride concentrations in wells in the Port Hueneme area started to increase rapidly. At that time, seawater had only affected a few wells in the Port Hueneme area, encompassing an area less than one square mile. Overdraft conditions generally persisted in the UAS on the Oxnard Plain through the late 1970s, when several

years of above-average rainfall increased recharge to the basin and pumping demands began to shift to the Lower Aquifer System (LAS), allowing some recovery in the UAS. The aquifers of the UAS were severely depleted again during the drought of the late 1980s. The construction of the Freeman Diversion in 1991 coincided with the start of an extended wet period, and artesian conditions were common following wet winters in 1995, 1998 and 2005. Rainfall has been scarce since the winter of 2011, and many UAS wells on the southern Oxnard Plain currently have water levels below sea level.

Overdraft conditions were recognized in the Lower Aquifer System (LAS) in the late 1980s after the impairment of water quality in the Upper Aquifer System led to the implementation of a Fox Canyon Groundwater Management Agency (FCGMA) strategy to require new or replacement wells to be drilled into the LAS to lessen pumping on the UAS. The overdraft conditions in the LAS now persist in the southern and eastern portions of the Oxnard plain, and in much of the adjacent Pleasant Valley groundwater basin. Land subsidence related to groundwater overdraft has not been thoroughly investigated on the Oxnard Plain, but one estimate suggests up to 2.6 feet of permanent land subsidence (Hanson et al, 2003).

Overdraft conditions in the Oxnard Plain and Forebay groundwater basins continue today with the annual overdraft amount estimated to be about 20,000 to 25,000 ac-ft/yr (UWCD, 2014).

1.5.2 SALINE WATER INTRUSION

High chloride levels were first detected on the Oxnard Plain in the vicinity of the Hueneme and Mugu submarine canyons in the early 1930s (CA DWR, 1971) and became a serious concern in the 1950s. Early monitoring programs used only existing production wells and abandoned wells as monitoring points; sampling of these wells indicated that there was a widespread area of elevated chloride concentrations in the Hueneme to Mugu areas. In 1989, the U.S. Geological Survey initiated their Regional Aquifer-System Analysis (RASA) study and cooperative studies with United Water Conservation District on the Santa Clara-Calleguas groundwater basin. As part of those studies, a series of 14 nested well sites, with three or more wells installed at each site, were drilled and completed at specific depths in the Oxnard Plain basin (Densmore, 1996).

Figure 1.5-1 shows the locations of the RASA well sites on the Oxnard Plain. Prior to the RASA study, it was believed that an area of the UAS extending from approximately Channel Islands Blvd. (2 miles north of Port Hueneme) and across to the area near Hwy 1 and Nauman Road, then south to include the area underlying Point Mugu Navy base was intruded by seawater. The installation of a dedicated monitoring network and detailed chemical analysis of water samples from the new wells and other wells yielded new interpretations on the extent of seawater intrusion on the Oxnard Plain. It is now known that some areas of the southern Oxnard Plain are not intruded by seawater, and that high chloride readings from older production wells were the result of perched water leaking down failed well casings and contaminating the aquifer (Izbicki, 1992; Stamos and others, 1992;

Izbicki and others, 1995; U.S. Geological Survey, 1996). Maps presented in this report delineate the approximate extent of high-chloride water at various depths on the Oxnard Plain (Section 4.3.6).

In addition to drilling the monitoring wells, the USGS conducted geophysical surveys to determine the general extent of the high-saline areas (Stamos and others, 1992; Zohdy and others, 1993). This work indicated that the high-saline areas consisted of two distinct lobes, with relatively fresh water separating the lobes (U.S. Geological Survey, 1996). These areas were resurveyed in 2010 by United (UWCD, 2012a). The lobes originally identified by the USGS form the basis of the areas of high chloride concentration shown on the maps in this report. Additional down-hole conductivity surveys by the USGS (also resurveyed recently by United) indicate that the edges of the lobes are relatively distinct, with the first saline intrusion occurring in thin individual beds of permeable sand and gravel. As intrusion continues, more individual beds are impacted, resulting in increasing chloride levels. Thus, the interpretation of high-chloride areas shown on Figure 1.5-1 and other enclosed maps combine measured concentrations from the monitoring wells, geophysical measurements, and study results about the nature of the intrusion front.

In addition, isotope studies of samples from the nested wells indicate that the cause of the elevated chloride levels varies on the Oxnard Plain (Izbicki, 1991; Izbicki, 1992; Izbicki et al, 2005a). Four major types of chloride degradation have been documented:

Lateral Seawater Intrusion - the inland movement of seawater adjacent to the Hueneme and Mugu submarine canyons;

Cross Contamination - the introduction of poor-quality water into the fresh water supply via existing wellbores that were improperly constructed, improperly destroyed, or have been corroded by poor-quality water in the Semi-Perched zone;

Salt-Laden Marine Clays - the dewatering of marine clays, interbedded within the sand and gravel-rich aquifers, yields high concentrations of chloride-enriched water. This dewatering is associated with aquifer compaction and land subsidence resulting from decreased pressure in the aquifers, caused by regional pumping stresses (also see Section 1.5.4); and

Lateral Movement of Brines from Tertiary formations - the lateral movement of saline water from older geologic formations that have been uplifted by faulting. The lateral movement occurs across a buried fault face near Pt. Mugu where Tertiary rocks are in contact with the younger aquifers (also see Section 1.5.4).

Chloride degradation from each of the processes identified above is directly related to water levels in the basin. The water balance of the Oxnard Plain and the offshore component of the aquifer units is a dynamic relationship between groundwater recharge, groundwater extraction and change in aquifer storage. The primary source of groundwater recharge for the Oxnard Plain groundwater basin is the unconfined northeastern portion of this basin, known as the Oxnard Forebay (and formerly the Montalvo Basin or Montalvo Forebay). High water levels in the Forebay exert a positive pressure on the confined aquifers of the Oxnard Plain, and water flows from the recharge areas toward the coast (Figure 4.3-22). While the pressure exerted by high water levels in the

Forebay propagates rapidly through the aquifers, the actual movement of water is very slow, approximately 3 feet per day or less in the Forebay (Izbicki et al, 1992). The pressure (piezometric) surface of the confined aquifer is diminished by the extraction of water from the system. If pressure heads at the coast fall below sea level, the lateral intrusion of seawater will occur, resulting in aquifers being recharged with seawater due to landward pressure gradients. The dewatering of marine clays will occur if heads in the surrounding sediments remain below their historic levels for prolonged periods, allowing formerly immobile salts to be expelled into surrounding aquifer material. The slow compaction of these clays also contributes to land subsidence.

1.5.3 DECLINING WATER LEVELS

In addition to the overdraft conditions in the coastal basins discussed in previous sections, long-term declining water levels have been observed in the Santa Paula Basin. Groundwater elevations in many of the wells (43 of 57 wells) in both the eastern and western portions of the Santa Paula basin failed to fully recover to 1998 levels after near-record precipitation in 2005. This observation is consistent with an observed long-term, gradual decline in basin groundwater elevations (Santa Paula Basin Technical Advisory Committee, 2011).

An evaluation of the spatial and temporal distribution of groundwater pumping in the basin (UWCD, 2011) concluded that no significant changes in pumping locations occurred over a 30-year study period (1980 to 2009) and that water level fluctuations observed from 1980 to 2009 in the Santa Paula Basin cannot be attributed solely to spatial or temporal variations in pumping. The Santa Paula Basin Technical Advisory Committee has initiated several specialty studies (Section 2.1.3) to provide additional data on the possible hydrologic cause(s) of the observed decline in groundwater elevations.

In 2003, a basin study titled "Investigation of Santa Paula Basin Yield" by experts from the City of Ventura, Santa Paula Basin Pumpers Association and United Water Conservation District suggested that the yield of the basin is probably near the historic average pumping amount (Santa Paula Basin Experts Group, 2003). There is now interest in conducting a more detailed study on the hydrogeology and yield of the basin, as well as identifying approaches to increasing the yield of the basin.

In March 1996, as a result of legal action relating to declining groundwater levels in the Santa Paula Basin during the 1984 to 1991 drought and the City of Ventura's stated intention to increase pumping from the basin, the Superior Court of the State of California for the County of Ventura approved a Stipulated Judgment for Santa Paula Basin (*United Water Conservation District vs. City of San Buenaventura,* original judgment March 7, 1996, amended judgment August 24, 2010). The Stipulated Judgment established pumping allocations for each basin pumper. Representatives from United, the Santa Paula Basin Pumpers Association and the City of Ventura submit an annual report detailing basin issues and conditions to the Court.

1.5.4 UPWELLING SALINE WATER

The upwelling of saline waters has been documented in a number of production wells in the Pleasant Valley basin. Advancements in the tools used in sampling pumping production wells has allowed for the documentation of flow and water quality profiles in long-screen production wells (Izbicki et al, 2005a, 2005b). Data from some area wells indicate that poor water quality at the wellhead results from saline water entering the well from specific aquifer zones. High chloride concentrations most commonly observed in the deepest portion of a well may be indicative of brines migrating from deeper zones towards a water level depression (low pressure area) created by long-term overpumping. This upwelling of brines is another form of saline intrusion, and like the compaction of marine clays, occurrence is not limited to coastal areas (Izbicki, 1992). An increase in the number of LAS wells recording increases in chloride concentrations suggest areas impacted by brine intrusion are increasing, most notably in the Pleasant Valley basin.

1.5.5 EXPORTATION OF GROUNDWATER

As agricultural land value continues to increase throughout the District, and as continued urbanization removes farmland from the valley floor, the development of the hillside lands located near a reliable supply of water is also expanding. In many cases the hillside properties will not support a productive well, and water is supplied to the property from a nearby groundwater basin or established surface water diversion. Both water supply options result in the increased use of existing water resources. Most basins within the District lack clear policy or regulation regarding the "export" of water from the basin floor to surrounding uplands, or from one basin to another, although numerous area ranches have employed such arrangements for many years.

The AB3030 Groundwater Management Council for the Piru and Fillmore groundwater basins has had difficulty finalizing a proposed export policy for these basins. Some council members are concerned about increased pumping from the basins, while others feel the energy costs associated with lifting water to hillside orchards will limit the amount of hillside development. A new well exporting large quantities of water from the Fillmore basin to users in the Santa Paula basin has also complicated the development of an export policy.

1.5.6 NITRATE IN FOREBAY GROUNDWATER BASIN

The Oxnard Forebay is vulnerable to nitrate contamination for some of the same reasons the basin is valued for water resource projects. The coarse alluvial sediments common to the area allow the rapid vertical transport of water from the near-surface to the water table. During wet periods, the regional water table is often only tens of feet below the land surface in the Forebay. Nitrate is highly soluble and very mobile, making it susceptible to leaching from soils and transport to groundwater. Public supply wells in some areas of the Oxnard Forebay periodically exceed the California Department of Public Health's maximum contamination level (MCL) for nitrate, which is 45 mg/l nitrate (or 10 mg/l nitrate as N). Exceedence of this MCL can result in methemoglobinemia

("blue baby syndrome") a condition where ingested nitrogen interferes with the blood's ability to carry oxygen. Infants less than three months of age are most sensitive to this condition (Canter, 1997). United has conducted a series of studies to determine the extent of nitrate concentrations and the possible causes of this contamination. The Santa Clara River, which provides much of the natural and artificial recharge to the Forebay, is consistently low in nitrate (averaging 7 mg/l nitrate, UWCD, 1996a). Nitrate loading to the groundwater is principally related to land uses within the Forebay, with the most significant sources being agricultural fertilizers and septic systems. United's groundwater recharge activities in the Oxnard Forebay introduce large volumes of low-nitrate water to the groundwater flow system, providing a water quality benefit to both local wells and wells located greater distances down-gradient from the recharge facilities.

Nitrate levels in the El Rio area have fluctuated widely through time, with highest nitrate levels commonly observed during and following drought periods, and relatively low nitrate levels are often recorded during wet periods (UWCD, 1998). Nitrate levels tend to stay relatively low during wet periods when low-nitrate Santa Clara River water is spread by United in the El Rio recharge basins and natural recharge to the basin is abundant. However, when there is not sufficient river water to spread at El Rio, nitrate levels in the O-H wells sometimes rise, particularly in the northeastern portion of the spreading grounds. Blending with water from other O-H wells with low nitrate concentrations keeps nitrate concentrations in delivered water within the health standard for potable supply.

During the drought of the late 1980s and early 1990s, nitrate peaks increased in intensity. Following previous droughts, nitrate concentrations in the wells generally decreased to low levels during the intervening wet years. However, following the 1980s to 1990s drought, nitrate levels in a series of wells even increased during the dry season of wet or average precipitation years when flow in the Santa Clara River was low and United was not recharging water at El Rio. The distribution of nitrate both laterally and with depth is difficult to document with certainty, but the sampling of monitoring wells installed over the past decade has shown that the highest nitrate concentrations are often recorded in the shallowest portions of the aquifer (UWCD, 2008). Whereas the large-scale groundwater flow patterns within the Upper Aquifer System of the Forebay are believed to be fairly well understood, the individual flow paths of small volumes of water are often complex. This complexity of flow paths, unknown travel times, and an imprecise knowledge of nitrogen inputs often limits what can be concluded about nitrate provenance from the basic chemical analyses common to many routine groundwater monitoring programs.

In response to long-term concerns about water quality in the Oxnard Forebay and down-gradient areas, and a regulatory order issued by the Los Angeles Regional Water Quality Control Board, areas of high-density septic systems in the greater El Rio area have been converted to sanitary sewers. More than 1,400 properties were connected to sewer between the years 2005 and 2011, with project costs totaling $35 million. The County of Ventura managed the eleven phases of this successful project. Ongoing programs also exist to promote efficient irrigation and fertilizer practices among area growers. These educational programs are conducted regularly by the

University of California Cooperative Extension, the Ventura County Farm Bureau and various agricultural product suppliers or manufacturers. Despite these programs to reduce nitrate loading to groundwater, a number of wells in the Forebay recorded nitrate concentrations above the MCL in 2013.

1.6 SURFACE WATER ISSUES AND CONCERNS

Complex and variable interactions between surface water and groundwater flow systems exist within the valley of the Santa Clara River. Along the length of the Santa Clara River there are several areas where flow in the river commonly percolates entirely, resulting in dry reaches of the riverbed. Surface flow resumes some distance downstream as "rising groundwater" and discharges flow to the river, usually near a boundary of one of the groundwater basins in the valley. Flow from tributary streams sometimes reaches the confluence with the river, while at other times stream flow percolates to groundwater upstream of the main river channel.

Given the complex dynamics related to the gaining and losing reaches of the Santa Clara River and its major tributaries, management activities for both water resources and environmental protection are more complicated than might be imagined. Flows in the river are naturally variable both seasonally and annually, but dry reaches are common in all but the wettest of years. These variables often complicate permitting requirements and management efforts to maintain various river habitats. In addition, water quality issues generally require consideration of the interaction of surface water and groundwater, as do efforts to convey stored surface water to points lower in the watershed via natural stream channels.

1.6.1 SANTA CLARA RIVERBED STABILIZATION

The construction of the Vern Freeman Diversion structure accomplished two primary objectives for the District: creating a diversion structure highly resistant to storm damage, and stabilizing the elevation from which surface water is diverted from the river. Following extensive mining of aggregate from the channel of the Santa Clara River in the Forebay area, riverbed elevations near Saticoy had dropped by about twenty feet by the late 1980s. Scour associated with large flow events in the river allowed the riverbed degradation to propagate ever farther upstream, and United was repeatedly required to move its Saticoy diversion location farther upstream. The completed structure has prevented further down-cutting of the river upstream of the facility as expected, and some recovery of channel elevations between Santa Paula Creek and the Freeman Diversion has been documented (Stillwater Sciences, 2007). Since completion in 1991 the elevation of the Freeman diversion point has been stable at 162 feet, and the facility has enabled the diversion of river flow soon after large storm events (Figure 1.6-1).

When the Freeman Diversion was constructed, the riverbed elevation upstream of the structure was elevated about ten feet, and materials excavated during construction were used to raise floodplain elevations in an area extending approximately 2,000 feet upstream of the facility. The dam

structure extends about 90 feet in the subsurface and rests on a bench of low-permeability Pico Formation. While the facility was not intended to pond surface water, it does act as a dam in the subsurface. Groundwater elevations at an upstream location near the diversion structure vary little from the crest elevation of 162 feet, as groundwater moving through shallow river alluvium stages up behind the Freeman structure. Construction of the Freeman Diversion has benefited groundwater elevations in the Santa Paula basin, as the earlier incision of the river that was lowering the discharge elevation for shallow groundwater in the basin was arrested and partially restored in the area upstream of the diversion structure (Santa Paula Basin Experts Group, 2003).

1.6.2 INCREASED CHLORIDE CONCENTRATION IN THE SANTA CLARA RIVER

The watershed of the Santa Clara River is one of the largest in southern California, draining over 1,600 square miles in Los Angeles and Ventura Counties. The Piru groundwater basin underlies the Santa Clara River just west of the LA-Ventura County line, and the nature of the river channel is such that much of the time the entire flow of the river emanating from upstream areas infiltrates to groundwater in the eastern portions of the Piru basin. Water quality in the river has suffered periodically due to land use practices in Los Angeles County, and water quality impacts have been shown to persist in the groundwater of the Piru basin for many years after corrections have been made to restore quality in surface water.

In the 1950s and 1960s brines from oil production in the greater Newhall area were discharged to the Santa Clara River, and very high chloride and TDS concentrations were recorded during this period. These practices ceased in the early 1970s following the passage of the federal Clean Water Act, but residual degradation of groundwater quality was noted when water quality objectives were formulated by the Regional Water Quality Control Board years later (UWCD, 2006). Another episode of chloride contamination has occurred more recently and is associated with wastewater discharges from the City of Santa Clarita. Beginning in 1999, rapid urban growth and the increasing popularity of self-regenerating water softeners resulted in increased flow and rising chloride concentrations in the Santa Clara River at the Los Angeles County line. A clear trend of increasing chlorides continued until late 2004, when recorded chloride concentrations in the river peaked around 150 mg/l. Wells in the eastern Piru basin responded rapidly to the changes in the quality of the recharge water to the basin, and a group of concerned growers and other Ventura County interests repeatedly requested to the Regional Board to take action to regulate the chloride discharges which exceeded regulatory limits and advisory thresholds for agricultural use (100 mg/l).

Following several years of study and a successful groundwater modeling effort to predict the impacts of various discharge scenarios on downstream areas, a compromise solution emerged that was endorsed by most area stakeholders and approved by the Regional Board in fall 2008. The approved project was to allow chloride discharges as high as 117 mg/l to the Santa Clara River, and to construct a series of extraction wells, desalting facility and pipeline to convey blended water across the dry reach of the Piru basin. The local (Santa Clarita) board of the Sanitation Districts of

Los Angeles County refused to authorize the rate increases necessary to implement the approved project. In 2011 the Sanitation Districts, with support from Castaic Lake Water Agency, began work to modify the former project and eventually proposed several new dilution alternatives to mitigate future chloride impacts in the Piru basin. The extended implementation periods and lack of meaningful salt exports in the new proposals failed to gain support among Ventura County interests, and in summer 2013 the Sanitation Districts announced they would pursue a project that would attain treatment plant chloride discharges of 100 mg/l to the Santa Clara River. The proposed reverse osmosis treatment process would reduce discharge to the river by about 7,000 acre-feet per year, but chloride concentrations will be reduced to levels acceptable to agricultural users. It will likely take several years to permit, design and built the proposed salt removal facilities.

In the meantime, the successful removal of most water softeners from Santa Clarita and lower chloride concentrations in imported State Water has resulted in wastewater chloride concentrations below the peak concentrations seen in the mid-2000s. The chloride plume associated with the worst of the past discharges continues to migrate with groundwater flow across the Piru basin, and now extends past the midpoint of the basin.

1.6.3 WATER FOR ENVIRONMENTAL INITIATIVES

United's operation of the Freeman Diversion includes bypass flows to maintain migration corridors for southern California steelhead and habitats downstream of the facility. Operations of the Freeman Diversion are included in a Multiple Species Habitat Conservation Plan (MSHCP) that is under development as part of the federal permitting requirements triggered by the presence of listed and endangered species. United expects to submit a first complete draft of the MSHCP in the spring of 2015.

1.6.3.1 SANTA FELICIA DAM ENVIRONMENTAL FLOWS.

The original water rights license for Santa Felicia Dam requires a minimum release of 5 cfs or natural inflow, whichever is less. Due to the conditions in United's Federal Energy Regulatory Commission (FERC) license which were adopted in 2011, the bypass flows have now been changed to a minimum of 7 cfs with conditions which require higher flows to maintain downstream habitat when the monthly cumulative precipitation is above the historic average measured at County Station 160, located at the guard station entering Lake Piru. Release migration flows of 200 cfs have been implemented for fisheries migration in Piru Creek when the Santa Clara River has elevated flows due to storm runoff and surface flows in the river are continuous from Piru Creek to the Santa Clara River estuary near Ventura Harbor. The trigger to initiate migration releases occurs when the USGS gaging station on the Santa Clara River above Piru measures over 200 cfs at 8:00 am and is expected to stay above 200 cfs through the following day. Migration flows are to continue as long as flows at the county line are over 200 cfs.

The National Marine Fisheries Service has required that United evaluate the feasibility of both the upstream and downstream passage of southern California steelhead over Santa Felicia dam. United has convened a panel of fish passage experts to evaluate the range of facilities that might be required to allow fish passage over the 200-foot-high dam.

1.6.3.2 HABITAT CONSERVATION PLAN

The Freeman Diversion currently provides bypass flows for the upstream and downstream migration of the endangered southern California steelhead. State Water Rights Permit 18908 allows United to divert its license amounts as long as 40 cfs is provided through the fish ladder for 48 hours after the total river flow subsides below 415 cfs. These migration flow requirements are limited to storms that occur between February 15th and April 31st of each year. As part of the MSHCP development, United remains in consultation with National Marine Fisheries Service and is currently operating the bypass flows to better meet the needs of the species for migration between the ocean and the Freeman Diversion. The bypass flows currently being released are based on the "2009 and 2010 bypass flow operation plan." The 2009 plan addresses the bypass flows for upstream migration (adult steelhead) and the 2010 plan focuses on the bypass flows provided for downstream migration (smolts or juvenile steelhead). The plans are fairly complicated due to the widely varying river conditions on a given year. Section 2.2.7.4 discusses the actual bypass flows implemented recently along with an associated yield loss.

2 PROJECTS AND INITIATIVES

Figure 2.1-1 is a matrix introducing United's current projects underway by the Groundwater Department and the issues those projects address. The projects vary in scope and application. The groundwater and surface water projects are discussed in the following sections of this report.

2.1 GROUNDWATER

Section 2.1 introduces the groundwater projects that have been conducted by United. These consist of a wide range of projects which are discussed separately in the following sub-sections of this report. These are the same projects introduced in Figure 2.1-1.

2.1.1 UPDATE REGIONAL GROUNDWATER FLOW MODEL

The Ventura Regional Groundwater Model (VRGWM) is a numerical modeling tool being developed to evaluate multifaceted conjunctive use, water recycling, and water conservation projects designed to alleviate seawater intrusion, overdraft, land subsidence, and other problems. A calibrated

groundwater flow model allows the prediction of benefits or impacts associated with either specific water supply projects (such as well fields, water deliveries, recharge projects, reservoir releases, etc.) or regional changes within the model domain (changing irrigation demands, changing rainfall patterns, extended drought, etc.). Both United and the FCGMA have relied upon existing versions of the VRGWM for planning and groundwater management activities.

The VRGWM was originally developed by the U.S. Geological Survey as part of the Regional Aquifer Systems Analysis (RASA) in the late 1980s and early 1990s. Local financial support for the RASA study was contributed by United, Calleguas Municipal Water District, and the Fox Canyon Groundwater Management Agency. The VRGWM by the USGS simulates regional groundwater flow in the Piru, Fillmore, Santa Paula, Mound, and Oxnard subbasins of the Santa Clara River Valley Basin, and the Pleasant Valley Basin, Arroyo Santa Rosa Valley Basin, and Las Posas Valley Basin in the Calleguas Creek watershed. The original MODFLOW model used a finite-difference grid consisting of 60 rows and 100 columns for a total of 3,354 active cells with constant nodal spacing of 2,640 feet. The model used two layers to simulate regional groundwater flow in the region's Upper Aquifer System and Lower Aquifer System.

Since completion of the original model by the USGS in 1996, UWCD has completed several modifications to the VRGWM to improve its predictive capabilities and better address project-specific questions:

- Model Grid Size Reduction – Reduced cell size from 1/2 mile to 1/6 mile for improved accuracy;
- Model Layer Addition – Added a third model layer to simulate groundwater flow and groundwater-surface water interactions in the shallow alluvial units in the Piru, Fillmore, and Santa Paula subbasins;
- Conceptual Model Updates – Added/modified groundwater flow barriers and hydrogeologic properties;
- Expanded Calibration Period - Added 1994 to 2000 hydrology;
- Model Recalibration – Recalibrated the Oxnard Basin through 1998 to better reflect the new conjunctive use projects built after USGS originally calibrated the model; and
- Improved Predictive Simulations – Expanded the forward model (predictive tool) period to a full 55 years that reflect the climate and hydrology of the years 1944 through 1998.

The revised MODFLOW model used a finite-difference grid consisting of 114 rows and 229 columns for a total of over 24,000 active cells with nodal spacing of approximately 900 feet throughout most of the model domain. The model used 3 layers to simulate regional groundwater flow in the Upper Aquifer System, Lower Aquifer System, and shallow alluvial aquifers.

While the existing VRGWM (the revised MODFLOW model) has been successfully used in this capacity for more than a decade, the model needs to be updated in order to answer the increasingly

complex and detailed questions with which water managers are now faced. As environmental stewardship, climate change, drought preparedness, and recycled water have become integral aspects of groundwater management, the level of analysis required to support such planning has become increasingly more detailed in both time and space, as compared to the early 1990s when the model was developed. In its current form, the VRGWM is not fully capable of evaluating the complex issues Ventura County water managers are faced with today or expect to confront in future years.

Grant funds were used to partially fund the overhaul of the VRGWM. United's staff decided that it is more efficient to develop a completely new groundwater model instead of revising the existing VRGWM as more detailed data only available in recent years will enable United's staff to further divide Upper Aquifer System and Lower Aquifer System into seven aquifers. The new VRGWM development is divided into two geographic areas that will be completed in two separate but linked project phases. The first phase includes the Oxnard Forebay, Oxnard Plain, Mound and Pleasant Valley basins. The second phase will include other basins such as Piru, Fillmore, and Santa Paula. Each project phase has three tasks: (1) Develop Basin Conceptual Model; (2) Develop Groundwater Flow Model; and (3) Calibrate Groundwater Flow Model. The original grant funding was to facilitate completion of Tasks 1 and 2 of the first project phase, which was completed in February 2014. The remaining VRGWM development tasks will be funded via other sources including United's resources. The third task of the first project phase (Calibrate Groundwater Flow Model) is estimated to complete in fall 2014.

Task 1: Develop Basin Conceptual Model

The basin conceptual model provides the basis for developing the numerical groundwater flow model. The goal of Task 1 is to update the basin conceptual model for the Oxnard Forebay and Plain with improved geologic understanding so a new more-detailed groundwater flow model can be constructed. The existing VRGWM is based on a conceptual model that uses an aquifer system framework where multiple aquifers are grouped into upper and lower systems. This approach ignores difference in water levels and properties between the aquifers in each system, which are significant in many areas. As groundwater management issues become more complex, the need for aquifer-specific answers increases. Thus, a key objective of Task 1 is to expand the basin conceptual model to include aquifer-specific data.

Updating the basin conceptual model is a two-step process – data collection and data analysis. Data collection includes identifying and compiling available geological data. United has focused on subsurface data contained in water, oil, and gas well logs. District staff have identified available geophysical logs and prioritized the logs for digitization. The digitized logs were georeferenced and input into GIS for analysis. United's hydrogeologists thereafter identified and correlated regional hydrogeologic units (aquifers and aquitards); constructed geologic cross-sections; and identified regional facie changes that affect the occurrence and movement of groundwater within the hydrogeologic units. Geologic maps and studies were also reviewed to identify geologic structures (faults and folds) that are potential or partial barriers to groundwater flow. United's staff has

developed a 3-dimensional (3-D) geologic model covering Oxnard Forebay, Oxnard Plain, and Mound basins for developing the numerical groundwater flow model (Task 2).

Task 2: Develop Groundwater Flow Model

The goal of Task 2 is to develop the numerical model architecture and initial inputs that will be used for calibration. The model is constructed using USGS's Modular Three-Dimensional Ground Water Flow Model code (MODFLOW) and the commercial pre-processing package Groundwater Vistas offered by Environmental Simulations, Inc. Groundwater model development is further divided into a two-step process that includes: (1) grid design and (2) model setup.

(1) Grid Design

United's groundwater staff has constructed a finite-difference grid for the model domain based on the 3-D geologic model prepared in Task 1. The 3-D geologic model identifies seven aquifers (Semi-perched aquifer, Oxnard aquifer, Mugu aquifer, Hueneme aquifer, Upper Fox Canyon aquifer, Basal Fox Canyon aquifer, and Grimes Canyon aquifer). A seven-layer numerical groundwater flow model has been developed corresponding to the seven geologic aquifers.

(2) Model Setup

In numerical model setup groundwater stresses and boundary conditions are implemented to simulate artificial conditions of groundwater flow. The stresses include the natural recharge from precipitation, artificial recharge from spreading grounds, and groundwater extraction by wells. United's operations records were used to calculate the recharge rate at the spreading grounds. The pumping records from UWCD and FCGMA were collected, reviewed and incorporated in the model. The boundary conditions include no flow or fluxes along the edge of model domain. The geological faults were identified and may be implemented as barriers, conduits or no flow depending upon the evidence of groundwater data. The new VRGWM is a transient flow model with simulation period from 1985 to 2012 with monthly time step.

Task 3: Calibrate Groundwater Flow Model

The groundwater model needs to go through a calibration process in order to provide credible simulation results. The calibration of groundwater model is accomplished by adjusting input parameters and modifying model conditions so that the simulated water levels closely approximate observed water levels. The groundwater elevation measurements from wells within groundwater model domain were collected and reviewed. Seasonal changes in water levels will be used as primary targets for model calibration. By adjusting the input parameters including hydraulic conductivity, specific yield, and storage coefficient, the calibrated groundwater flow model is expected to mimic the long-term trends and seasonal fluctuations of recorded groundwater levels

from 1985 through 2012. During the calibration exercise, the available aquifer pumping test data and literature review will provide guidance in determining the optimal input parameters. Where possible, UWCD will also seek opportunities to perform aquifer tests or collect other field data that will help quantify the hydraulic properties of aquifers and flow barriers.

Following the successful calibration of the groundwater flow model, the model can be utilized to evaluate specific water supply projects or broader pumping or precipitation changes within the watershed. The evaluation of individual projects requires the construction of model input files that define changes in pumping or recharge associated with the project under consideration. Model scenarios that include the new water project are typically compared to a "base case" scenario that characterizes how the basin or basins operate without the new project. United anticipates that the new calibrated VRGWM will be used to assist cities or management agencies such as the FCGMA in evaluating large and/or complex water supply or water management proposals.

2.1.2 AB3030 GROUNDWATER MANAGEMENT PLAN UPDATE

An update to the AB3030 Groundwater Management Plan (GMP), which is currently in draft form, is a cooperative effort of United Water, the City of Fillmore, and water companies/pumpers in the Piru and Fillmore Groundwater basins (Piru/Fillmore Groundwater Management Council, 2011). The original 1996 GMP was formulated with input gained from public information meetings and hearings. The draft GMP is an update of the original 1996 Plan (Piru/Fillmore Groundwater Planning Council, 1996).

The GMP uses the groundwater management plan authority contained in California Water Code Section 10750 et seq. initially enacted in 1992 through Assembly Bill 3030. An initial 1995 Memorandum of Understanding (MOU) between United, the City of Fillmore, and the water companies/pumpers, was incorporated in the plan and established the GMP as a cooperative groundwater management plan for the basins. The MOU outlines the roles of the various parties in implementing the Plan (M.O.U., 1995). The Piru and Fillmore subbasins are considered part of the Ventura Central Basin which is subject to critical conditions of overdraft (California Department of Water Resources, 1980).

United, as the lead agency, has formally adopted the GMP, which was formulated to ensure local control of groundwater management. It is the intent of the GMP to foster local control in as many aspects of the management of the basins as possible. The draft GMP update includes numeric Basin Management Objectives (BMO) for groundwater levels, groundwater quality, and surface water quality. Water Code Section 10753.7 now requires the inclusion of BMOs in a GMP for any local agency seeking state funds administered by the California Department of Water Resources for the construction of groundwater projects or groundwater quality projects. In addition the update includes a formal groundwater export policy which was a requirement of the original GMP. For various reasons, adoption of the updated plan has not yet occurred.

2.1.3 SANTA PAULA BASIN SPECIALTY STUDIES

In March 1996, the Superior Court of the State of California for the County of Ventura approved a stipulated Judgment for the Santa Paula Basin. (*United Water Conservation District vs. City of San Buenaventura etc, Ventura County Superior Court Case No. CIV115611,* Judgement entered March 7, 1996, and amended August 24, 2010) [hereinafter "Judgment"]). The Judgment recognized that all of the parties have an interest in the Santa Paula Basin, and in the proper management and protection of both the quantity and quality of this important groundwater supply. The basin is a significant water resource in the County of Ventura. Members of the Santa Paula Basin Pumpers Association and the City of San Buenaventura exercise rights to pump water from the basin for reasonable and beneficial uses. The United Water Conservation District does not produce water from the basin, but the basin is located within its boundaries and the District is authorized to engage in groundwater management activities and to commence actions to protect the water supplies which are of common benefit to the lands within the District or its inhabitants.

In 2010 the Judgment was amended to join various groundwater pumpers that were not previously joined as parties to the adjudication, and to clarify certain provisions pertaining to shortage conditions, the responsibilities of the Santa Paula Basin Pumpers Association and groundwater production by its members, and water rights transfer procedures.

The Judgment provides for the creation of a Technical Advisory Committee (TAC). The committee is charged with establishing a program to monitor conditions in the basin, including, but not necessarily limited to, verification of future pumping amounts; measurements of groundwater levels; estimates of inflow to and outflow from the basin; increases and decreases in groundwater storage; analyses of groundwater quality; studies relative to the basin; development of programs for its conjunctive use and operation; and other information useful in developing a management plan for the basin. The Judgment also authorizes the TAC to consider and attempt to agree on the safe yield of the basin.

The Judgment among other things requires the TAC to monitor and annually report individual and cumulative groundwater production from the basin. The Judgment further specifically provides that *"United Water Conservation District shall have the primary responsibility for collecting, collating, and verifying the data required under the monitoring program, and shall present the results thereof in annual reports to the Technical Advisory Committee."* The United Water Conservation District submits draft annual reports to the Santa Paula Basin TAC members for review, comment, and approval.

The 2008 Annual Report, filed with the Court in 2010, noted that the TAC has observed a long-term, but gradual, decline in basin groundwater elevations. The Annual Report stated that the TAC would over the following 12-24 months seek to determine the cause of the long-term gradual decline in the groundwater elevations, and formulate remedial actions to reverse the problem should it persist (United Water Conservation District, 2009).

In 2011 the Santa Paula Basin TAC created a Santa Paula Basin Working Group to investigate the cause of the long-term gradual decline in groundwater elevations. The Working Group consists of technical experts from the United Water Conservation District, the Santa Paula Basin Pumpers Association and the City of San Buenaventura. The Working Group has initiated a series of studies that will address the cause of the long-term gradual decline in groundwater elevations.

In August 2011, the TAC issued a list of ten work items which were evaluations and studies to be completed for the Santa Paula Basin. These items are listed below:

- Investigation of Hydrologic Base Period.
- Investigation of groundwater and surface water inflow at Fillmore-Santa Paula Basins boundary.
- Evaluate groundwater confinement and differentiate measured wells by aquifer.
- Evaluate water level trends in both confined and unconfined parts of the Santa Paula Basin.
- Identify crop change over time.
- Investigation of groundwater storage change.
- Evaluate historical changes to the Santa Paula Creek channel and potential effects on basin recharge.
- Refine and finalize spatial and temporal Pumping Trends Report (UWCD, 2011b).
- Compilation of Santa Clara River infiltration data (UWCD, 2013c).
- Compilation of Santa Paula Creek infiltration data (UWCD, 2013d).

Some of these studies have now been completed and will likely serve as supporting documents for a new effort to determine the safe yield of the Santa Paula basin. There is concern among some parties that pumping allocations defined in the Stipulated Judgment exceed the safe yield of the basin. TAC members have agreed to hire a technical consultant to assess the safe yield of the basin. A concurrent study will examine approaches to increasing the operational yield of the basin. If the yield study determines the current pumping allocation cannot be supported by the basin, pumpers may have the opportunity to fund projects to increase the operational yield of the basin rather than reducing the pumping allocations of individual parties. It is anticipated that both the safe yield and yield augmentation studies will be completed in the fall of 2014.

2.1.4 DISTRICT-WIDE GROUNDWATER LEVEL MONITORING

United monitors groundwater elevations in all or portions of eight groundwater basins within the District boundaries. The regular monitoring of a large number of wells in the multiple aquifers throughout the District is necessary to adequately define the regional influences of groundwater extractions as well as natural and artificial groundwater recharge to the basins. Measurements are collected from both active production wells and dedicated monitoring wells. "Nests" of monitoring

wells exist in some locations, allowing determination of heads in various aquifer units, and vertical gradients between aquifer zones at these locations.

In excess of 3,000 water level measurements were collected by District staff in 2013, on either a monthly, bimonthly, quarterly or semi-annual basis. The semi-annual runs are the most extensive runs and are scheduled to document annual high groundwater conditions in the spring and annual low groundwater conditions in the fall. The locations of wells measured by United at various frequencies are shown by basin in Figure 2.1-2. The locations of wells with groundwater elevation measurements are represented in various figures in Section 4 of this report.

Beginning in 2009, United has increased its efforts to instrument additional wells in each groundwater basin with pressure transducers ("transducers"). These units consist of a compact pressure transducer and data logger, and are commonly suspended in a well by a special cable that allows records to be retrieved without removing the device from the well. The transducers are programmed to record water levels at frequent time intervals, allowing the acquisition of data sets that would be impossible or impractical to collect by hand. The automated collection of head measurements are very useful in evaluating transient events, such as tidal influences, the area of influence surrounding pumping wells, and water table responses to both natural and artificial recharge events. As of fall 2013, approximately 109 pressure transducers were deployed throughout the District (Figure 2.1-2).

Groundwater conditions in the Oxnard Forebay tend to be more dynamic than in other basins within the District. Groundwater mounding associated with recharge to the basin variously occurs beneath United's spreading grounds and the channel of the Santa Clara River. United has transducers in 30 Forebay wells. Analysis of these records has lead to a much better understanding of groundwater storage within the basin, and how groundwater levels affect the percolation of river flows in the upstream portions of the Forebay.

In the Santa Paula basin, a more extensive groundwater elevation monitoring effort was initiated in 1998 and is continuing. The monthly, bimonthly and semi-annual monitoring of wells is conducted to assist technical work in progress to determine the perennial yield of the basin, and related to a March 1996 Court Settlement regarding pumping in the basin. The use of pressure transducers was expanded beginning in 2011, and 21 basin wells are now instrumented with transducers. Several of these transducers were purchased by the Santa Paula Basin Pumpers Association and the City of Ventura.

Beginning in the spring of 1999 the number of Upper and Lower Aquifer System wells monitored in the Oxnard Forebay, Oxnard Plain, Pleasant Valley and Mound basins was increased substantially. The increased frequency and distribution of groundwater elevation data in the coastal basins is intended to better define areas of groundwater abundance and deficit, and how these conditions relate to groundwater recharge and extraction in the basins, and geologic features within and between the basins. The implementation of an extensive semi-annual (spring and fall) water level measurement program in these basins is also intended to define the extremes of water levels

throughout the year. Pressure transducers are useful for determining seasonal high and low groundwater elevations and United currently has transducers in 22 Oxnard Plain wells.

A number of other Ventura County agencies routinely measure and record groundwater elevations in their wells, most commonly on a monthly or quarterly basis. Most cities and the larger mutual water companies measure water levels in their wells, often under both static and pumping conditions. Water levels are also routinely measured in monitoring wells at a number of environmental sites, such as landfills, large scale contaminant sites, or wastewater percolation ponds. United obtains water level records from these various sources and archives the records in a central database.

The Groundwater Section of the Water and Environmental Resources Division of the Ventura County Watershed Protection District also maintains a long-term groundwater elevation monitoring program (VCWPD, 2014). As with United's monitoring program, the lengthy water levels records now associated with many of the wells in the County's program are valuable records for assessing long-term changes in water levels within area basins. United and the County of Ventura regularly exchange groundwater elevation records. The County of Ventura in turn reports groundwater elevation records to the California Department of Water Resources (DWR) as part of the California Statewide Groundwater Elevation Monitoring (CASGEM) program. This reporting program was authorized by the Legislature in 2009 as part of bill SBX7 6, and encourages local agencies to develop monitoring programs that adequately characterize groundwater conditions in their areas and regularly report the records to DWR for archiving and improved public accessibility.

2.1.5 DISTRICT-WIDE WATER QUALITY SAMPLING

United's water quality monitoring program integrates the District's sampling with sampling conducted by a variety of other organizations. Together, this monitoring serves the following varied purposes:

- For purveyors' wells, monitoring of a variety of regulated constituents ensures that groundwater is safe for potable use, and ensures taste and odor are within established guidelines.
- The saltwater intrusion monitoring network tracks the migration of saline water by direct seawater intrusion and the movement of chloride from clay layers between the aquifers. The network monitors the full series of aquifers from the Oxnard to the Grimes Canyon aquifer.
- Monitoring of wells allows documentation of both abrupt and long-term changes in water quality.

United staff samples numerous monitoring and production wells on a regular basis in order to evaluate the quality of groundwater within the District. Monitoring programs sometimes focus on specific areas within the District, typically for a specific type of degradation or improvement of water

quality. In addition to United's regular sampling programs, water quality data are routinely acquired from other sources, most notably the California Department of Public Health (DPH) and the County of Ventura's Groundwater Section. Other sources of information include the California Department of Water Resources, cities, consultant reports and technical studies, landfill operators and individual well owners.

United routinely samples production wells and dedicated monitoring wells throughout the District, but monitoring is performed with increased frequency and density in two critical areas. One such area is the Oxnard Forebay basin, where United operates its main groundwater recharge facilities and the well field supplying the Oxnard-Hueneme potable water system. The monitoring serves to document both typical conditions and the variability of groundwater quality in areas of groundwater recharge and areas of groundwater production near specific land uses. Another area of frequent monitoring is the coastal area near and between the Hueneme and Mugu submarine canyons. Elevated chloride levels from the intrusion of saline waters continue to be a concern in this area, especially in the area surrounding the naval base at Point Mugu. Over the past decade there has been a renewed interest in documenting the changing chloride conditions in the Piru basin. Water quality monitoring has increased in that basin, with much of the increased sampling of production wells being performed by the Groundwater Section of the Ventura County Watershed Protection District. Changing water quality conditions are also a concern in the Pleasant Valley basin.

When water is delivered to the public, the California Department of Public Health enforces minimum monitoring requirements to assure that delivered water is free of chemical and biological contaminants. Testing requirements vary depending on the number of people served by the system and a system's vulnerability to contamination, as determined by the DPH. United regularly collects samples from the wells supplying the O-H potable water system, with sampling frequency exceeding the minimum DPH requirements. Water purveyors throughout California are required to report results of all water analyses to the DPH, and United regularly obtains these water quality records from the DPH for integration into United's water quality database.

United's groundwater staff regularly collects water quality samples from approximately 150 monitoring wells located throughout the District. Nearly all of these wells are PVC wells with a diameter of two inches. A portable submersible sampling pump is lowered into the well in order to purge the well prior to collecting a sample. Alternatively, an air compressor and long air line are used to purge other wells, where compressed air is released in the well below the water surface and water is "air lifted" as the air expands and rises to the surface. Most of the monitoring wells have a short screened interval, allowing the collection of water from a limited section of the aquifer. Many monitoring wells were installed as a "nest" or cluster of wells in a single borehole, allowing the collection of piezometric head and water quality samples from multiple depths at the same location. United measures field parameters during sampling, but all water quality analyses are performed by a commercial laboratory.

United also monitors a number of private domestic and irrigation wells throughout the District as part of its regional monitoring programs. The sampling of production wells spares the expense of

drilling new monitoring wells, and provides examples of water quality pumped by groundwater users. However, the long screen intervals common to most production wells often draws water from multiple water-bearing zones, which can mask poor quality water that may source from specific aquifer zones. The Groundwater Section of the Ventura County Watershed Protection District also conducts annual sampling of a number of production wells in Ventura County, commonly in the fall of the year. The County sampled over 174 wells in 2013, 92 of which were in located within United's district boundaries. This sampling complements the sampling performed by United and significantly contributes to the water quality sample coverage for several local basins.

The distribution of wells sampled by United is shown in Figure 2.1-3. As shown in the map, the Oxnard Forebay and the coastal areas of the southern Oxnard Plain have the highest density of monitoring wells. Production wells belonging to private parties and monitored by United are concentrated around the Oxnard Forebay and in the basins of the Santa Clara River Valley. The figure includes a table showing the number of wells monitored in each basin.

Special water quality studies are occasionally conducted within Ventura County. One significant recent study was the Groundwater Ambient Monitoring and Assessment (GAMA) program, conducted by the United States Geological Survey (USGS) in cooperation with the CA State Water Resources Control Board. This project sampled a number of "representative" wells throughout the Santa Clara River valley and the Oxnard Plain in order to assess the quality of local groundwaters commonly used for public supply. Many wells were sampled in spring 2007 for a broad suite of compounds at very low concentrations in order to document both the character of natural waters and the nature of contamination where it exists. While the identities of the wells sampled remain confidential, results from this sampling effort allowed characterization of groundwater in the study area. Contamination related to human activities was found to be relatively uncommon, and associated with shallow wells screens and younger waters when present. Older and deeper groundwater in some areas has somewhat elevated mineral content, and may have elevated iron and manganese concentrations related to reducing groundwater conditions (Burton el al, 2011). The geologic setting and nature of the area's aquifers are largely responsible for the high mineral content in the water, resulting in some aesthetic issues but not health concerns.

2.1.6 SALINE WATER INTRUSION MAPPING

The intrusion of saline waters remains the principal water quality threat to the groundwater resources of the Oxnard Plain and the Pleasant Valley basin. As described in Section 1.5.2, the movement of brines into fresh aquifer units remains a concern as long-term overdraft conditions persist in these basins, and chloride impacts are no longer limited to the coastal areas adjacent the Hueneme and Mugu submarine canyons. Water with elevated chloride concentration is not suitable for either potable use or for irrigation water. In recent years United has conducted several investigations to better define the extent of saline water in the coastal basins. Some of the subprojects of this effort include:

- Seismic reflection survey on south Oxnard Plain – this subproject focused on meso-scale geologic structures/features that were postulated to impact groundwater movement on the south Oxnard Plain (UWCD, 2011a);
- Time domain electromagnetic survey in the Port Hueneme and Point Mugu areas – this subproject was designed to reassess the areal extent of saline water intrusion and compare it to the USGS data from the early 1990s (UWCD, 2012a);
- Borehole electrical conductivity surveys in existing piezometers in the Port Hueneme and Point Mugu areas - conductivity profiling in existing wells/piezometers was performed to determine if the saline waters have begun to impact strata other than the screened intervals of the wells (data from the conductivity profiling is currently being evaluated and findings have yet to be published);
- Collection of flow profile data and discrete-depth water quality samples - conducting flow profiling, depth-specific sampling with water quality analyses, and mass balance calculations is proposed for existing production wells to identify changes in salinity near impacted areas surrounding Mugu and Hueneme canyons that may be masked in high-capacity/long-screen wells; and
- A feasibility study is currently underway to evaluate the technical and economic viability of using groundwater of a quality degraded by sea water as source water for a brackish water treatment facility that would create irrigation-quality water for growers in overdrafted areas.

To date, two of these subprojects have been completed and results are contained in the respective Open-File Reports.

2.1.6.1 COLLECTION OF FLOW PROFILE DATA AND DISCRETE-DEPTH WATER QUALITY SAMPLES

This proposed subproject includes conducting flow profiling, depth-specific sampling with water quality analyses, and mass balance calculations on production wells to identify salinity changes for Mugu and Hueneme saline water impact areas that may be masked in a high capacity well. United Water proposes to field verify the TDEM geophysical results by performing production profiles and discrete-depth water quality sampling from existing production wells located near the leading edge of the saline zones identified by the TDEM survey. Production profiles (also called flowmeter surveys) are performed on wells to determine the distribution of water entering the perforated intervals. The results of a production profile are often presented as gallons/minute (gpm) per ft of perforated interval or percentage of the total flow per perforated interval.

Inflow rates to a production well can be measured and typically the flow rates are not equal along the length of the perforations. By identifying the proportional flow rates, discrete-depth water samples can be collected from each flow interval and mass balance calculations can be used to determine the water chemistry in the aquifer surrounding the inflow zones. These techniques are in use by many water districts and the USGS to better understand the impact well hydraulics have on water quality sampling and evaluate variations in groundwater geochemistry with depth. For our study, we propose to use this technique to look for production intervals within existing wells that have elevated chloride values and determine the depths at which the well has been impacted by saline waters. Funding for this subproject has been included in United's budget for the 2013-14 fiscal year.

In 2002 United sponsored a similar study for a number of high-capacity production wells in the Pleasant Valley Basin. Researchers from the USGS performed flow profiling and collected water quality samples at specific depths within the screened interval of the wells under pumping conditions. The work demonstrated that deeper portions of these wells generally produced little water but tended to have higher chloride concentrations (Izbicki et al, 2005a and Izbicki et al, 2005b). This study was proposed by United and funded by DWR through an AB303 local groundwater assistance grant.

2.1.6.2 BRACKISH WATER DESALTING FACILITY

United has hired an engineering firm to perform a feasibility study for a proposal to pump brackish water from impacted aquifers along the coastal area of the southern Oxnard Plain. Production wells distributed throughout the greater project area would supply poor-quality groundwater to a plant site where reverse-osmosis membranes would purify the water. Brine generated by the treatment process would be discharged to the nearby Salinity Management Pipeline. Product water would be sold to growers who want desire pure water for the production of high-value crops such as berries.

Production wells feeding the desalting facility would extract brackish groundwater resulting from past episodes of seawater intrusion during times of drought. Fresh plumes of seawater intrusion are likely developing in the current drought conditions as water levels in UAS wells near Port Hueneme have dropped below sea level. In the early years of operation the supply wells will be managed to remove existing salts from the aquifers. In later years extractions may act as a hydraulic control that could help mitigate the landward migration of groundwater impacted by saline intrusion. Potential impacts of the proposed operation of the facility will be modeled as part of the permitting and approval process for the project, should it be deemed feasible and economical.

2.1.7 FOREBAY AQUIFER DELINEATION/MAPPING USING SURFACE GEOPHYSICS

Reconnaissance-level time domain surveys performed by UWCD in 2010 identified previously unrecognized geologic conditions (e.g., faults, thick clay sequences) underlying several of the District's recharge basins. Previous investigations (e.g., Daniel B. Stephens & Associates, 2008) depict the presence of clay units (aquitards) in the Oxnard Forebay, but the lateral continuity and presence/absence of faulting were not addressed. The Oxnard Forebay is a critical component of the region's water supply system and is envisioned as a location for expansion of future groundwater pumping and the potential introduction of recycled water for aquifer recharge. As the groundwater resource utilization in the Forebay intensifies, a more refined understanding of the hydrogeologic conditions is needed to facilitate optimization of this resource.

Following the initial time domain electromagnetic (TDEM) survey in the Forebay, United purchased TDEM equipment and conducted additional surveys. In fall 2011 and summer 2012 an additional 139 soundings were made throughout the Forebay basin. These readings allowed the identification

of several areas of anomalous resistivity in the subsurface, suggesting areas of higher and lower permeability. The TDEM readings identified some fault traces in the subsurface and generally confirmed the existing mapping of the Forebay boundary where shallow confining layers become prevalent (UWCD, 2013a). The Fox Canyon Groundwater Management Agency (FCGMA) provided funding for this surface geophysical survey with a grant from their *Groundwater Supply Enhancement Assistance Program (GSEAP)*.

In 2013 the TDEM surveys were expanded into adjacent areas in the western Santa Paula basin and the eastern Mound basin. United Water field crews have enjoyed extensive cooperation from land owners who have readily provided access to their property. Survey sites are limited to open spaces and agricultural areas as overhead power lines and buried metallic objects interfere with the electrical fields that allow the mapping of subsurface properties.

2.2 SURFACE WATER

The interaction of surface water and groundwater is complex and dynamic in the valley of the Santa Clara River. Surface water flows are often highly variable both between years and seasonally within single years. The water quality of stream flow also commonly varies throughout the year, with mineral content typically increasing as flows decrease. United's interest in surface water flows has historically centered on the Santa Clara River near Saticoy, where water is diverted from the river and routed to various facilities for either groundwater recharge or direct use as irrigation water. Because of various regulatory requirements imposed upon the District by the federal government, United has recently devoted more effort to the study and characterization of flow in the river and its major tributaries in order to better understand aquatic habitat within the lower watershed of the Santa Clara River. Of particular interest are seasonal migration opportunities for the endangered Southern California Steelhead and how United's activities affect flows in Piru Creek and the Santa Clara River.

2.2.1 STREAM FLOW

Flows in the Santa Clara Watershed are recorded by United, United States Geological Survey (USGS) and the Ventura County Watershed Protection District (VCWPD). Flows in the main stem of the Santa Clara River are recorded by the USGS at the Los Angeles/ Ventura County line (funded by United) and by the VCWPD downstream at Victoria Bridge near Oxnard. United also records continuous flows diverted at the Freeman Diversion. All of the major tributaries are monitored coming into the Ventura County portion of the watershed. United Water funds the USGS to monitor the flows above and below Lake Piru. The VCWPD funds the USGS to record Sespe and Santa Paula Creek while the VCWPD records Hopper and Pole Creek.

Additionally, manual discharge measurements are made in locations that are not at a continuous gauging location. These data provides the information needed to estimate benefits to each basin

during the conservation/State Water release, discharge/percolation rates of each basin, and adjustment of environmental flows.

2.2.2 WATER QUALITY

United maintains a water quality monitoring program and samples from a number of locations (Figure 4.2-4) either seasonally, monthly or every two weeks. Sampling sites are generally located near groundwater basin boundaries or on major tributaries near their confluence with the Santa Clara River. Sampling of tributaries and the upstream reaches of the Santa Clara River assure that waters are acceptable for natural groundwater recharge. Sampling is conducted on a quarterly basis and consists of either a full general mineral suite or several key constituents. Water temperature and pH is documented at the time of sample collection. Sampling is conducted more frequently along the Santa Clara River near the Los Angeles County line (monthly) and at the Freeman Diversion (every two weeks).

Beginning in January 1999, United has sampled the Santa Clara River at Blue Cut near the Los Angeles County line each month. This monitoring is intended to improve understanding of how urbanization and community water supply decisions in the Santa Clarita area affect the quality and quantity of water flowing into Ventura County. From the late 1990s through 2003 discharges from the Valencia Water Reclamation Plant increased steadily in both volume and chloride concentration, with chloride concentrations exceeding 200 mg/l at the end of this period. Discharge rates continued to increase for several more years before diminishing slightly. Chloride concentrations in the discharges have fallen to levels common to the early 1990s (Figure 4.3-6), the result of lower chloride levels in State Water Project imports and a successful ban of self-regenerating water softeners in area homes.

Water quality monitoring of the river water diverted at the Freeman Diversion is performed every two weeks to confirm that the water is acceptable for use in both aquifer recharge and for irrigation deliveries. The mineral content of water in the river at this location exhibits a strong negative correlation with flow, where higher flows are less mineralized. Nitrate concentrations are routinely low in the river and do not show a strong correlation with flow. The County of Ventura maintains and operates composite sampling device at the Freeman, and samples storm flow and dry weather base flows several times per year. These samples are analyzed for a broad suite of organic contaminants and metals as part of a storm water quality program required by the Los Angeles Regional Water Quality Control Board.

In recent years both the City of Fillmore and the City of Santa Paula have eliminated discharges of treated wastewater to the Santa Clara River upstream of the Freeman Diversion. Santa Paula's new treatment plant came on-line in 2010 and utilizes percolation basins for wastewater disposal. Fillmore completed a new plant in 2009 and now distributes reclaimed water to both percolation basins near the plant site and a network of subsurface irrigation systems constructed in parks and school fields throughout the city.

2.2.3 SANTA FELICIA DAM CONSERVATION RELEASES

United's conservation releases are designed to replenish the Piru, Fillmore and Santa Paula Basins by direct percolation from the Santa Clara River. The remaining portion of the release is diverted at the Freeman Diversion and is either spread for percolation into the Forebay, or is sent to agricultural users in the Oxnard Plain or Pleasant Valley Basins via the surface water delivery system. The conservation release can be adjusted in quantity (duration and magnitude) and timing to optimize benefits within the district. The quantity in most years is limited by the supply from the wet season runoff and, to a lesser degree, the amount of State Water purchased. Lake Piru maintains a minimum pool of 20,000 AF of storage that is designed to keep the sediment deposits in the lake away from the outlet works. Releases beyond this point are only done when State Water released from Pyramid Lake is expected to fill the lake back to the minimum pool shortly after the conservation release.

The following factors are considered when deciding on how much of the stored water is to be released:

- Provide enough storage capacity in Lake Piru to minimize the chances of spilling in the following year;
- Meet the needs of the downstream basins;
- Meet the needs of the agricultural surface water deliveries to the Pleasant Valley and the Pumping Trough (PTP) pipeline systems;
- Meet the flows from the FERC Santa Felicia Water Release Plan in Piru Creek for the Southern California Steelhead;
- Maintain a minimum pool of 20,000 AF of storage in Lake Piru
- Hold over enough water in the lake in case the following year is a dry year.

In 2011 the volume of water released from SFD was 31,700 AF leaving 46,100 AF in the lake. The additional stored water was left due to the favorable groundwater conditions in the downstream basins and for the potential benefit to the basins if the following year was dry. This was prudent planning by United, as 2012 was a dry year.

In 2012 approximately 35,100 AF was released, which brought the lake storage to below minimal pool at 17,000 AF. This release was made knowing that 3,150 AF of inflow from State Water releases from Pyramid Lake would fill Lake Piru back up to minimum pool. The release in 2012 was a larger than normal release for a dry year due to the 24,500 AF of additional natural runoff stored from 2011 and the state water purchased from 2011 and 2012 totaling 5,670 AF (see accounting below for state water). Without the additional stored water from 2011 and the state water the release would have been less than 5,000 AF due to the minimal natural runoff from the dry year.

In 2013, the natural runoff that flowed into the lake totaled less than the mandated environmental bypass flows and evaporation from the lake. As a result the stored water in the lake was 17,000 AF (3,000 AF below minimum pool) without a conservation release. The basic hydrology for the past 3 years of inflows, outflows and storage in Lake Piru is shown in Figure 2.2-1.

Of the 31,700 AF released from Santa Felicia Dam in 2011, approximately 15,700 AF (50%) of the water directly percolated into the Piru and Fillmore basins (Upper basins). The remaining 16,000 AF either percolated into the Santa Paula basin or was diverted at the Freeman Diversion for groundwater recharge or surface water deliveries. In 2012, due to drier hydrologic conditions, more of the release water percolated into the Piru and Fillmore basins (estimated at approximately 22,200 AF (63%)). Figure 2.2-2 shows the response of the groundwater levels in the Piru Basin to the conservation releases in the recent past. Due to no release in 2013, water levels in the Piru basin continue to drop in the basin as seen in the Figure 2.2-2. As of December of 2013 water levels had dropped over 60 feet since the conservation release of 2011.

Table 2-1 shows estimates of the distribution of percolated flows in each basin during United's conservation releases since 1999. Both 2011 and 2012 releases were slightly more than the 16 year average of the releases in terms of total quantity of the release. The lowest volume released in the fifteen years prior to 2013 was in the dry year of 2004 at 12,200 AF. The last time prior to 2013 that there was no conservation release was during the drought in 1990. Figure 2.2-3 shows the 2012 conservation release and the associated direct benefit to each basin. Flow measurements were made near the Piru and Fillmore basin boundary to calculate the amount of water that percolated into the Piru Basin, and measurements were also made at Willard Rd. for the Fillmore/ Santa Paula basin boundary to calculate what percolated in the Fillmore Basin. The remaining discharge measured at Willard Rd. either benefits the Santa Paula Basin or is diverted at the Freeman Diversion ("Lower Basins" in following tables). Several surface water diversions exist in the Santa Paula basin, making it difficult to measure recharge to this basin. In 2010 and 2011 a detailed study was done in the Santa Clara River overlying the Santa Paula Basin. The study found that there was percolation in this reach and that the percolation was greater when groundwater levels in the alluvial aquifer were lower. (UWCD 2103c)

Table 2-1 Benefits of the SFD Conservation Release due to direct percolation

Year	Total Conservation Released from SFD AF	Direct Deliveries in AF. of SFD Release to:			
		Piru Basin	Fillmore Basin	Lower Basins (groundwater recharge)	Surface water Deliveries PTP and PV
1999	22,800	5,700	3,500	11,200	2,400
2000	47,200	13,800	6,100	24,150	3,150
2001	47,400	14,000	2,900	28,300	2,200
2002	20,200	8,000	5,100	6,530	570
2003	29,000	21,000	3,500	3,600	900
2004	12,200	8,000	2,150	1,600	550
2005	9,100	na	na	4,500**	0
2005	23,400	na	na	17,200**	150
2006	30,900	na	na	17,200**	1,600
2007	40,700	15,900	6,300	12,200	6,400
2008	44,400	15,400	5,700	17,400	5,800
2009	26,700	13,200	4,700	5,200	3,000
2010	33,000	14,500	4,800	10,700	3,200
2011	**31,700**	**12,400**	**3,300**	**14,100**	**1,600**
2012	**35,200**	**13,600**	**8,600**	**9,300**	**3,700**
2013	**0**	**0**	**0**	**0**	**0**
Average	28,369	11,962	4,358	11,449	2,201
16 yr. Total	453,900	155,500	56,650	183,180	35,220

*2005 had two conservation releases. Portion of the release includes spill water when the lake was full

** measured at the Freeman Diversion

2.2.4 IMPORTATION OF STATE WATER

Ventura County has a 20,000 AF allocation for State Water. United Water's share of the allocation is 5,000 AF. Port Hueneme Water agency uses 1,850 AF of the original 5,000 AF and takes delivery directly through Calleguas MWD. Up to 3,150 AF of water is permitted to be released from Pyramid Lake and sent to Lake Piru through the natural water course of Piru Creek. United may receive this water from November 1st through the end of February of each year. When available deliveries by DWR are less than United's full allocation, United has occasionally purchased a portion of either the City of Ventura's or Casitas Municipal Water District (CMWD) allocation to

maximize the deliveries to the county. The purchase of the additional water along with United's State Water cannot exceed the conveyance limit of 3,150 AF in Piru Creek without additional environmental work to evaluate whether larger releases would not cause problems for endangered species in middle Piru Creek.

Typically, United's conservation release will end before the State Water has arrived in Lake Piru. In order to release the state water that year, United will continue the release below the lake's minimum pool to the volume of State Water that was purchased, knowing that the delivery of state water will fill the lake back to the minimum pool by the end of November. The State Water allows the conservation release to be extended a few extra days due to the extra volume of water. The volume of water that percolates into each basin on the extended days of the release is considered to be the direct benefit to each basin.

In 2011 the State Water Project made available 80% of water allocations held by subscribers to the system. United received its 80% (2,520 AF) by a release from Pyramid Lake in November and December of 2011. Due to the wetter than normal conditions United chose to store the State Water in Lake Piru until 2012 so that it could be delivered at the end of the conservation release along with the State Water purchased for 2012.

In 2012 the State Water Project made available 60% of the State Water allocations at the time of ordering the water. This gave United 1,890 AF of its total allocation of 3,150 AF. In order to increase its state water deliveries, United purchased 1,260 AF from CMWD to reach its full permitted amount it can convey down Piru Creek from Lake Pyramid.

The State Water component of United's 2012 conservation release consisted of 2,520 AF from 2011, 1,890 AF from United's 2012 allocation and 1,260 AF purchased from CMWD for a total of 5,670 AF. Discharge measurements at the basin boundaries showed that 3,900 AF (69%) of the released water passed the Piru and Fillmore basins to percolate into the Santa Paula Basin or be diverted at the Freeman Diversion for groundwater recharge or surface deliveries to the PV and PTP pipelines. The remaining 31% recharged the upper basins.

In 2013 the State Water Project made available 40% of its allocations. This gave United 1,102.5 AF of its total allocation of 3,150 AF. This time United attempted to purchase the difference between its conveyances limit of 3,150 AF and its potential delivery of 1,102.5 AF; however only an additional 1,140 AF of State Water from the City of Ventura was made available. This gave United and total of 2,242.5 AF that was delivered to Lake Piru in November of 2013. Due to the low lake levels a conservation release was not done this year, so the State Water remains in the lake until a future conservation release.

Table 2-2 is a summary of all the State Water purchased by United Water along with the direct benefits to each basin from percolation. Detailed stream flow measurements are taken near the basin boundaries throughout the releases to determine where the State Water is percolating.

Table 2-2 Summary of State Water Release from Santa Felicia Dam

	Summary of State Water Released From Santa Felicia Dam in 1991-2013 (Values in AF)				
Year State Water Purchased	From Santa Felicia Dam	Release to Upper Basins (Fillmore and Piru)	Releases to the Lower Basins (Santa Paula and Coastal Basins)	Delivered to PV. And PTP	Recharge To Lower Basins
1991	4,836	3,603	1,233	0	1,233
1992	988	84	904	0	904
2000	2,200	406	1,794	69	1,725
2002	3,150	1,455	1,695	192	1,503
2003	3,150	2,041	1,109	70	1,039
2004	4,047.5	3,348	700	228	472
2007	1,890	844	1,046	116	930
2008	1,980	673	1,307	306	1,001
2009	3,150	1,045	2,105	724	1,381
2010	3,150	917	2,233	559	1,674
2011	2,520*				
2012	3,150+2,520	1,770	3,900	1,097	2,803
2013	2,242**				
Total	34,212	16,186	18,026	3,361	14,665

* Released in 2012 conservation release

** Remains in the Lake at the time of the publication of this document

The benefit to groundwater levels in the Piru Basin of the conservation release along with the State Water released can be seen in Figure 2.2-2. Since November of 2007 a transducer has been recording water levels in a monitoring well near the Santa Clara River in the Piru Basin. The graph shows the immediate rise in water levels in a well during the releases (shown in red). Because the well is approximately 600 feet from the flow in the river, a groundwater mound will build rapidly when the release starts and dissipate a little more slowly at the end of the release. Water levels are always considerably higher following the release compared to the projected trends of water levels before the release.

2.2.5 PIRU DIVERSION EVALUATION

The Piru Diversion has historically been operated to divert surface water into United's nearby spreading grounds for groundwater recharge, however, this facility has not been operated since September of 2008. The diversion is located on the west bank of lower Piru Creek just south of the

old Center Street Bridge in the town of Piru. Part of the diversion dam is built under the two roadway bridges crossing lower Piru Creek at Center Street.

The existing diversion consists of an earthen berm that extends out across the river channel, a sluice channel that can accommodate approximately 200 cfs, and a diversion structure with a trash rack and four 24-inch inlets leading to a 48-inch diversion pipe that conveys diverted water to the 44- acre spreading grounds.

The structure is not in compliance with National Marine Fisheries Service standards for diverting water in a stream that is considered by NMFS to constitute anadromous waters for Southern California steelhead. The diversion will not be put back into operation until the appropriate permits has been issued and the facility has been retrofitted.

2.2.6 FEDERAL ENERGY AND REGULATORY COMMISSION (FERC) LICENSED FLOWS IMPLEMENTATION

The original water rights license for Santa Felicia Dam requires a minimum release of 5 cfs or natural inflow, whichever is less. Due to the conditions in a new FERC license which was adopted in 2011, the bypass flows have now been changed to a minimum of 7 cfs. License conditions now require higher flows to maintain downstream habitat when the monthly cumulative precipitation is above the historic average measured at County Station 160, located at the guard station entering Lake Piru. Release migration flow requirements of 200 cfs are also in the license for fisheries migration in Piru Creek when the Santa Clara River has elevated flows due to storm runoff, and surface flows in the river are continuous from Piru Creek to the Santa Clara River estuary near Ventura Harbor. The trigger to initiate migration releases occurs when the USGS gauging station on the Santa Clara River near the Los Angeles County line measures over 200 cfs at 8:00 am and is expected to stay above 200 cfs through the following day. Migration flows are to continue as long as flows at the county line are over 200 cfs.

Based on recommendations from NMFS, FERC has also imposed license conditions on the rate at which United may decrease flows when ending conservation releases or environmental flows. Release ramping rates are to be adjusted so that water depths in Piru Creek never decreases more than two inches per hour. As an example ramping down the conservation release in fall 2011 took five days and a minimum of 25 adjustments to go from 300 cfs down to 7 cfs.

The FERC bypass flow plan was not adopted until late May 2011. In order to be in compliance with the new license requirements, a wet year habitat flow of a minimum of nine cfs was implemented on May 27, 2011 and maintained until October 1st. After October 1st minimum flows were decreased to 7 cfs until the appropriate triggers are met to change the flows.

Due to the below average rainfall in 2012 and 2013 the habitat flow trigger was never met so the minimum bypass flow of 7 cfs was maintained as the appropriate bypass flows. Additionally, the storm runoff, as measured at the USGS gage, on the Santa Clara River near the county line never

met the trigger for the migration flows. Therefore no migration flows were released from Lake Piru. All of the additional water that was released from SFD for the habitat flows (7 cfs instead or 5 cfs or less) either percolated into the Piru basin or was used by downstream diverters.

2.2.7 SANTA CLARA RIVER FLOW DIVERSIONS

The Freeman Diversion diverted 92,600 AF from the Santa Clara River in 2011. This represents about 150% of the historical average diversions since 1955. In wet years such as 2011 various operational strategies were implemented to assure maximum yield at the diversion. Such strategies included limiting turbidity turn-outs, shifting the locations of spread water to reduce mounding near the river, alternating ponds to insure the maximum possible percolation rates, and implementing new SCADA controls to optimize canal levels. Some of these strategies are discussed below.

High flows in the river are normally associated with high turbidity. When the storm hydrograph is near its peak, diversions stop so that the sediment-laden water is not diverted. A recently implemented, more aggressive schedule to divert more turbid water allowed the facility to divert 2,000 to 3,000 acre feet more than it would have in prior years. This more aggressive turn-in procedure increases the use of the desilting basin, resulting in the need for more frequent cleanouts of accumulated sediment.

United's aggressive wet season spreading at Saticoy and the Noble Basin in 2011 increased water levels in the surrounding area to a point where groundwater from spreading in the Saticoy and Noble basins was discharging back to the river near the Highway 118 Bridge. Rising groundwater in this area reached around 50 cfs of discharge in the river in the month of April. The spreading ponds further away from the river were used to limit the amount of discharge back to the river. The discharging water is in large part due to the degradation in the riverbed near the Highway 118 Bridge. The riverbed is currently about 20 feet lower than it was in the early 1950's, resulting in a larger elevation differential between the ponds and the river. A portion of the discharging water will percolate downstream of the discharge point. The balance of the discharging river that breached the Forebay becomes part of the environmental flows that are required to maintain downstream passage for the Southern California Steelhead.

Nearly 72,000 AF were spread for groundwater recharge at United's three recharge facilities in 2011. El Rio recharged nearly half of the water, with Saticoy and the Noble Basins making up the other half (Figure 2.2-4). The remaining 20,600 AF went to surface water deliveries.

The dry years of 2012 and 2013, in contrast to the wet year of 2011, diverted only 37,000 AF and 10,200 AF, respectively, at the Freeman Diversion. The operational strategy of preferentially sending water to the ponds furthest away from the river when groundwater mounding and discharge occurs at the Saticoy and Noble Recharge basins was not applicable in the dry years of 2012 and 2013. The strategy in these years was focused on sending water preferentially to the El Rio spreading grounds to help alleviate the elevated nitrates concentrations observed in some of United's El Rio O-H well field Upper Aquifer wells. These elevated nitrates are commonly

associated with the lower water levels that occur during dry periods. This strategy has been used effectively during past dry periods.

In 2012, approximately 20,800 AF were spread at United's three facilities, with El Rio receiving 78% (16,300 AF) and the remaining water spread at Saticoy and the Noble Pit. Combined agricultural surface water deliveries to the Pumping Trough pipeline (PTP), Pleasant Valley pipeline and the Lloyd-Butler diversion totaled to 16,200 AF.

In 2013 dry conditions were more severe than 2012, with only 4,000 AF spread at United's three facilities. 2,380 AF (60%) were spread at El Rio and the remaining water spread at Saticoy and the Noble Pit. The water spread at Saticoy and the Noble Pit was due to the recently adopted practice of turning in sediment-laden river water immediately after a storm. This water is preferentially spread at the Noble Basin because of the possibility of the sediment carried past the desilting basin clogging the ponds over time. Combined agricultural surface water deliveries to the Pumping Trough pipeline (PTP), Pleasant Valley pipeline and the Lloyd-Butler diversion totaled only 6,520 AF.

As a result of the small volume of water recharged to the Saticoy and Noble recharge basins in 2012 and 2013, groundwater levels did not mound to the surface at the recharge basins as they did in 2011, and as a result water did not discharge back into the Santa Clara River near the Highway 118 Bridge.

2.2.7.1 EL RIO RECHARGE BASIN

Recharge to El Rio in the wet year of 2011 exceeded the 59-year average in all months except for August. The total volume recharged was approximately 160% of average. El Rio becomes the preferred facility to recharge when mounding of water and discharge back to the river at the other facilities occurs. Due to the active O-H well field surrounding the El Rio facility, percolation rates are not reduced by groundwater mounding to the surface near the recharge basins.

Recharge to El Rio in 2012 was 69% of the 59-year average, while recharge in to El Rio in 2013 was 10% of the 59-year average. In 2012 and 2013 El Rio was the preferred facility for recharge because the water was needed to help alleviate elevated nitrates in some of the O-H well field upper aquifer wells.

Table 2-3 Recharge to El Rio for calendar years 2011, 2012 and 2013

Recharge to El Rio AF				
	2011 Year	2012 Year	2013 Year	average since 1955
Jan	3,776	1,968	1,036	2,651
Feb	3,617	1,525	1,028	3,061
Mar	5,283	1,295	317	3,383
Apr	6,070	3,610	0	2,678
May	2,188	1,198	0	1,986
Jun	2,594	20	0	1,018
Jul	1,459	0	0	842
Aug	224	0	0	1,106
Sep	2,283	725	0	1,562
Oct	4,370	3,964	0	1,744
Nov	3,520	85	0	1,523
Dec	2,461	1,903	0	2,134
Totals	37,845	16,293	2,381	23,688

2.2.7.2 NOBLE RECHARGE BASIN

The Noble Basin is normally the last of United's Forebay facilities to be used for groundwater recharge. It is difficult to maintain the ponds during the wet season due to greater pond water depths and proximity to shallow groundwater. During 2011, water was spread to this basin for a portion of four months during the natural runoff period, and two months during the conservation release. The spreading at this facility in 2011, at 10,679 AF, was nearly double the annual average since it was built in 1994.

In 2012 and 2013 the Noble basin was scarcely utilized, recharging 538 AF and 263 AF respectively. This limited amount of recharge to the Noble basin is typical for dry years when the El Rio and Saticoy Recharge basins are also underutilized.

Table 2-4 Recharge to the Noble Basin for calendar years 2011, 2012 and 2013

Recharge to Noble Basin AF				
	2011	2012	2013	average since 1994
Jan	766	197	263	271
Feb	2,507	0	0	723
Mar	2,259	97	0	1,150
Apr	4,305	244	0	1,252
May	0	0	0	549
Jun	0	0	0	389
Jul	0	0	0	188
Aug	0	0	0	97
Sep	0	0	0	135
Oct	137	0	0	145
Nov	705	0	0	151
Dec	0	0	0	166
Totals	10,679	538	263	5,216

2.2.7.3 SATICOY RECHARGE BASINS

The Saticoy facilities recharged 23,400 AF in 2011, which is about average for the 58-year period since construction of Lake Piru. As mentioned above, mounding occurred under the ponds and some recharged water was flowed back out to the river near the Highway 118 Bridge. Priority was given to the El Rio facility and the ponds furthest away from the river at this time in an attempt to decrease the amount of groundwater going back to the river.

In the dry years of 2012 and 2013, in contrast to the wet year of 2011, a much lower volume of water was recharged at Saticoy. In 2012 the Saticoy facility recharged 3,985 AF or 17% of the 59 year average. In 2013, a drier year than 2012, the Saticoy facility recharged only 1,395 AF or 6% of the 59-year average.

The lower volume of water recharged at Saticoy in 2012 and 2013 was due to the lower volumes of water in the Santa Clara River available for diversions at the Freeman Diversion. It was also was due to the prioritizing of both recharge to the El Rio facilities and the deliveries of surface water to the Pumping Trough and Pleasant Valley agricultural pipelines.

In 2012 and 2013 groundwater mounding did not reach the surface of the recharge basins at the Saticoy facility, and recharged water did not flow back to the river as it did in 2011.

Table 2-5 Recharge to Saticoy for calendar years 2011, 2012 and 2013

Recharge to Saticoy AF				
	2011	2012	2013	Average since 1955
Jan	7,608	30	436	2,155
Feb	1,946	0	159	2,419
Mar	2,208	0	158	3,247
Apr	4,478	318	235	2,975
May	265	0	222	2,297
Jun	164	0	67	1,411
Jul	0	559	117	1,200
Aug	0	308	0	1,045
Sep	816	345	0	1,409
Oct	5,041	2,364	0	1,935
Nov	909	0	0	1,248
Dec	0	61	0	1,635
Totals	23,435	3,985	1,395	22,977

2.2.7.4 ENVIRONMENTAL BYPASS FLOWS AT THE FREEMAN DIVERSION

The Freeman Diversion is operated to provide bypass flows for the upstream and downstream migration of the endangered southern California steelhead. State Water Rights Permit 18908 allows United to divert up to 375 cfs as long as 40 cfs is provided through the fish ladder for 48 hours after total river flow subsides below 415 cfs. These migration flow requirements are limited to storms that occur between February 15th and April 31st of each year, and are not to exceed an average annual loss of diversion of 500 AF. As part of the MSHCP development, United remains in consultation with National Marine Fisheries Service (NMFS) and is currently maintaining bypass flows to better meet the needs of the species for migration between the ocean and the Freeman Diversion. The current bypass flows are detailed in the 2009 and 2010 Freeman Diversion bypass flow plans. The flows are designed to increase the magnitude and extend the duration of the flows for upstream migration and to provide volitional passage for smolts to the estuary when conditions are favorable. While achieving the goals set forth for the migration of steelhead, diversions have been reduced since they have been implemented. United started implementing the bypass flow plans as detailed in the 2009 and 2010 plans in 2010 through 2011. The following is a summary of the operations in relation to the diversions for those years.

In 2010 four migration storms triggered the newly adopted bypass flows for upstream migration, allowing the ladder to run from late January to mid-March. United could have diverted an estimated 22,500 AF additional if the original water permit flow plan was implemented. A portion of the additional bypass flows percolated downstream in the riverbed overlaying the Forebay. The net

loss of water to the basins for the 2010 migration season was estimated at 15,300 AF when considering percolation in the Forebay.

In 2011, three storms provided sustained flow in the Santa Clara River and allowed for the fish ladder to be in operation nearly continuously from February 19th to June 8th, 2011. An estimated 2,400 to 3,000 AF of water was used for fish migration flows that otherwise would have been used for groundwater recharge. However the losses could have been substantially more if United had the physical capabilities of diverting its full water right. Due to the high turbidity in the river and the mounding of the water, potential diversions allowed in the water license were rejected back to the river.

In 2012 there were three small storms that created only 8 days of targeted bypass flows. In the largest of the storms, two adult steelhead were observed ascending the fish ladder. In 2013 an estimated 2,700 AF was directed past the diversion although being a dry year much of this water percolated further downstream in the Forebay. The net estimated loss to the groundwater basins for 2012 was 1,000 AF.

In 2013 no storms produced enough runoff to initiate the bypass flows therefore all water during the year was diverted. The diversion was operated in compliance with the State Board water license, but migration requirements were not triggered.

Table 2-6 summarizes the loss in potential diversions and the total loss to groundwater basins with consideration of the additional percolation created downstream of the diversion. These bypass flows have only been implemented since 2010. Before 2010 different bypass flow regimes were implemented in accordance with the ongoing consultation with NMFS.

Table 2-6

Year	Loss in Potential Diversions due to additional bypass flows AF	Loss in Total recharge to Forebay AF
2010	22,500	15,300
2011	3,000	less than 1,000
2012	2,700	1,000
2013	0	0

2.2.8 PTP DELIVERY SYSTEM

The Pumping Trough Pipeline (PTP) delivers a combination of surface water diverted at the Freeman Diversion, Saticoy well field water, PTP Wells 1-5 and some water from OH wells 12 and 13 to help meet the demands on the pipeline. The total deliveries by the district to the system was nearly the same in recent years with (8,470 AF in 2011), (8,350 AF in 2012) and (8,610 AF in 2013).

In 2011 surface water diverted at the Freeman Diversion supplied nearly 90% of the demand on the PTP system. Flows were augmented by the Saticoy Well Field during the summer months and early in the rain season when the river flows were inadequate to meet demand. The peak demand on the PTP occurs in October during the establishment period for the strawberry crop. The conservation release from Lake Piru coincided with the peak demands to help reduce the amount of groundwater pumping in this area that would otherwise occur.

In 2012 the summer base flows in the river remained high, so about 75% of the demand was met by the surface water deliveries. The Saticoy well field and the PTP wells were used in the summer to help meet demands. Like in 2011, the conservation release from Lake Piru benefited the system during the peak demands in October.

In 2013 surface flows had diminished by March to a point where both the PTP wells and the Saticoy Well field were needed to augment flows. By September the Saticoy Well field was unable to produce any water because water levels had fallen to a point where the wells could no longer be operated. This put a larger burden on the PTP wells. By April of 2013 the district realized that it would not be able to meet peak demands during the month of October because of the lack of a conservation release from Lake Piru to help meet the demands. As a result the district asked the PTP customers to use their own wells, if able, during this peak demand period. In addition, the district used the OH wells 12 and 13 to help augment the flows to the PTP. As a result demands were met through the month of October due to the additional sources of water. The situation could have worsened if a Santa Ana wind event had occurred during the peak of the establishment period, driving up the demands on the system. In 2013 nearly two-thirds of the demands were met by groundwater pumping from the district's three different sources.

Figure 2.2-5 shows the percent of source water used for the PTP deliveries from 2011 through 2013.

2.2.9 PLEASANT VALLEY COUNTY WATER DISTRICT DELIVERIES

Supply to the Pleasant Valley County Water District (PVCWD) varies from year to year depending on the Freeman Diversion surface water supply. In 2011 when there was substantial surface water in the Santa Clara River the district was able to send over 12,000 AF of surface water augmented with a small amount from the Saticoy Well field. By 2013 when surface water was very limited for diversions the district was only able to deliver a little over 3,000 AF. Figure 2.2-6 shows the yearly total of deliveries to PVCWD. The graph differentiates the two different source of water delivered (surface water diversions and the Saticoy well field). Below is a table showing the total amount delivered in each year, along with the percent of total diversions. As mentioned in section 1.4.6.2, the district is required to deliver a minimum of 12.22 % of the total diversions to PVCWD on an annual basis.

Table 2-7. Percent of Freeman diversions delivered to PVCWD

	Total delivered to PVCWD AF	Percent of Total Diversions
2011	12,300	13.30%
2012	9,670	23.10%
2013	3,060	30.00%

2.2.10 SATICOY WELL FIELD USAGE AND CREDIT SYSTEM BALANCE

In conjunction with the conservation releases from Santa Felicia Dam, United temporarily stores water beneath the Saticoy Spreading Ground for later pumping and delivery to the overdrafted areas of the Pleasant Valley and Oxnard Plain basins. United constructed the Saticoy well field in 2004, allowing the pumping of mounded groundwater for delivery to the PV and PTP systems. The Fox Canyon Groundwater Management Agency thereafter adopted a resolution that created a pump- back storage program of the Saticoy spreading system and its well field usage. Recharged water from a Lake Piru conservation release can be pumped back from Saticoy for a period of two years. At the end of the two years the storage credits expire. Below is a table showing the history of the credit/ balance of this system. To date an additional 33,400 AF have been stored during the conservation releases at Saticoy, with a total of 11,616 AF extracted for deliveries to the PV and PTP irrigation delivery systems. The credit system does not include State Water. As of October of 2013, water levels at the well field have fallen below the pumps, so the wells are currently not being used. The credit system would still allow the extraction of 1,552 AF for 2014, although due to no release in 2013 and no release anticipated in 2014, the two-year credit system will have expired all credits until a release of suitable size stores additional water beneath the Saticoy Spreading Grounds.

Table 2-8 Credit system for the Saticoy Well Field

	Start of the year			End of the year	
Calendar Year	First year Storage*	Second year Storage	Total extractions to Surface water deliveries	Remaining second year Storage to expire	Remaining First year Storage
2007	7,846	0	1,753	0	6,093
2008	4,711	6,093	3,845	2,248	4,711
2009	8,715	4,711	2,455	2,256	8,715
2010	2,414	8,715	759	7,956	2,414
2011	2,221	2,414	737	1,677	2,221
2012	5,974	2,221	1,590	631	5,974
2013	1,552	5,974	477	5,497	1,552
2014	0	1,552			
* Water stored in the prior year's conservation release.					

2.2.11 CASTAIC LAKE FLOODFLOW RELEASE

United is the lead member of a water conservation agreement between the California Department of Water Resources and the Downstream Water Users (DWU). The DWUs consist of United, Los Angeles County, Newhall Land and Farming, and Valencia Water District. The program is designed to hold back flood flows in Castaic Lake and release them at a later date in a manner that allows the flows to percolate in the basins downstream of the dam, benefiting the DWU's. United takes the lead role for the DWUs in requesting the storage and releases, and by monitoring the associated release to make sure that the flows are benefiting the basins. In 2011 approximately 11,000 AF of captured flood flows were released. Most of the released water percolated into the Piru Basin with some of it making it to the Fillmore Basin. Figure 2.2-7 shows the water level increase in a key well in Piru Basin during the release. Figure 2.2-8 shows the inflows/outflows from Castaic Lake in 2011. Due to the dry conditions in 2012 and 2013, no flood flows were retained for a later controlled release.

2.2.12 BOUQUET RESERVOIR RELEASES

United has an agreement with the Los Angeles Department of Water and Power (LADWP) that provides for the release of flow from Bouquet Reservoir to recharge the aquifers of the Santa Clara River Valley to the extent that they were recharged from the Bouquet Canyon watershed prior to construction of the reservoir. The agreement stipulates that LADWP release between 2,100 and 2,194 acre feet per year. This quantity is based on historical annual inflows to the reservoir. The

agreement requires a continual release of 5 cfs between April 1st and September 30th; and 1 cfs between October 1st and March 31st of each year.

The prescribed flows were interrupted following an extreme weather event in 2005 that raised the streambed elevation and pushed it toward Bouquet Canyon Road. In several locations the stream is higher than the road and on occasion stream flows have entered the road, posing a threat to public safety. When water is observed on the road, flows from Bouquet Reservoir are reduced. To complicate matters, this area of Bouquet Creek is designated critical habitat for unarmored three-spine stickleback, and flow changes require special consideration for this species. United has been participating in the stakeholders meetings to ensure that the deficit of water will eventually be released. As of November 2013 the total deficit of releases has reached 5,540 AF.

3 HYDROGEOLOGY OF DISTRICT

United Water Conservation District overlies all or portions of eight groundwater basins in central and southern Ventura County. The geologic setting of the basins, the regional aquifers, and some characteristics of each basin are discussed in this section. Discussion related to 2013 conditions in the various basins are included in Chapter 4 of this report.

3.1 GEOLOGIC SETTING

The groundwater basins within United's district boundaries are part of the Transverse Ranges geologic province where the mountain ranges and basins are oriented east-west rather than the typical northwest-southeast trend of much of California. The geology associated with the Transverse Ranges is primarily east-to-west trending folds and faulting (fold axes trend east-west). This configuration creates the elongate mountains and valleys that dominate Santa Barbara County and Ventura County.

The boundaries of United Water Conservation District are located within the more regional Ventura Basin, which is an elongate east to west trending structurally complex syncline within the Transverse Range province (Yeats, et. al., 1981). The seven sub-basins of the Ventura Basin that underlie the District are the Piru, Fillmore, Santa Paula, Mound, Oxnard Forebay, Oxnard Plain, and Pleasant Valley basins (Figure 1-1). The western portion of the West Las Posas Basin also falls within the District boundary. All the sub-basins are share hydrologic connection (CA DWR, 1980; Hanson et al, 2003), and the common vernacular is to use the shorter term "basins" rather than sub-basins.

The Santa Clara River Valley occupies the Ventura Basin, which is one of the major sedimentary basins in the geomorphic province. The total stratigraphic thickness of upper Cretaceous, Tertiary,

and Quaternary strata exceeds 55,000 feet (Sylvester and Brown, 1988). Only the uppermost portions of these deposits, however, contain fresh water.

Active thrust/reverse faults border the basins of the Santa Clara River Valley, contributing to the uplift of the adjacent mountains and down-dropping of the basins. The Piru, Fillmore, and Santa Paula basins are bounded by the Oak Ridge fault to the south and the San Cayetano fault system to the north. The Oxnard Plain and Mound basins extend across the offshore marine shelf to the shelf/slope break (the edge of the shelf).

The basins are filled with substantial amounts of Tertiary and Quaternary sediments that were deposited in both marine and terrestrial settings. The basins on the coast, including the Mound basin, are filled with recent sediments deposited on a wide delta complex that formed at the terminus of the Santa Clara River. Figure 3.1-1 shows the local formations which form the mountain ranges, surface/subsurface geology, and the major faulting in relation to the eight sub-basins within United's district boundary.

3.2 AQUIFERS

Most of the coastal basins within United Water Conservation District have a shallow perched aquifer zone, and the aquifers of all the basins can be classified as part of an Upper Aquifer System (UAS) and Lower Aquifer System (LAS) (e.g., Turner, 1975; Mukae and Turner, 1975). The UAS consists of the Oxnard and Mugu aquifers. The LAS consists of the Hueneme, Fox Canyon and Grimes Canyon aquifers. The aquifers contain gravel and sand deposited along the ancestral Santa Clara River, from alluvial fans along the flanks of the mountains, from a coastal plain/delta complex at the terminus of the Santa Clara River, and marine deposits from transgressional seas. The aquifers are recharged by infiltration of streamflow (primarily the Santa Clara River), artificial recharge of diverted streamflow, mountain-front recharge along the exterior boundary of the basins, direct infiltration of precipitation on the valley floors of the basins and on bedrock outcrops in adjacent mountain fronts, the percolation of reclaimed water from sanitary sewers and irrigation return flow in some agricultural areas.

Figure 3.2-1 is a schematic of the UAS and LAS showing their subsurface sequence. The figure also shows general depths in feet. However, more recent work with geophysical logs has suggested that some of the aquifers are actually deeper than originally thought and indicated on this schematic. Also note that the clay layers (aquitards) shown in the UAS are inter-fingering and in some places discontinuous.

3.2.1 PERCHED/SEMI-PERCHED

On the Oxnard Plain, the uppermost silt and clay deposits of the Oxnard aquifer are overlain by sand layers of the "semi-perched zone," which generally contains poor-quality water. This zone extends from the surface to no more than 100 ft in depth. The confining clay of the upper Oxnard

aquifer generally protects the underlying aquifers from contamination from surface land uses. Deep percolation of rainfall and irrigation return flows are the major components of recharge to the semi-perched aquifer. Although difficult to quantify, there is likely some vertical leakage of water between this semi-perched aquifer and underlying confined aquifer units. The semi-perched zone is rarely used for water supply on the Oxnard Plain.

3.2.2 UPPER SYSTEM

The Upper Aquifer System (UAS) consists of the Oxnard and Mugu aquifers. These aquifers are characterized by recent alluvium (Oxnard aquifer) of Holocene age and older alluvium (Mugu aquifer) of late Pleistocene age. The Oxnard aquifer rests unconformably on the Mugu aquifer. A clay layer commonly occurs between the two aquifers.

Recent river channel deposits comprise the uppermost water-bearing units along portions of the Santa Clara River basins. These deposits are generally up to 100 ft in thickness. In the Santa Paula basin, water level records from nested monitoring wells indicate that this upper alluvial aquifer is somewhat isolated from the underlying aquifers of the San Pedro formation. The alluvial unit, from which there is considerable water production in the Santa Clara River basins, may be time-equivalent to portions of the UAS on the Oxnard Plain, but has not been assigned to the UAS in the literature.

3.2.2.1 OXNARD

The Oxnard aquifer materials generally consist of lagoonal, beach, river, floodplain and alluvial fan deposits (Turner, 1975). The Oxnard aquifer is present throughout the Oxnard Plain and other basins. The Oxnard aquifer is the primary aquifer used for groundwater supply on the Oxnard Plain. This highly-permeable assemblage of sand and gravel is generally found at a depth of approximately 100 ft to 250 ft below land surface elevation.

3.2.2.2 MUGU

The Mugu aquifer materials generally consist of lagoonal, beach, river, floodplain, alluvial fan terrace and marine terrace deposits. The Mugu aquifer rests unconformably on the LAS. Basal conglomerates occur in many areas (Hanson et al, 2003). In the Oxnard Plain, these coarse-grained basal deposits comprise the Mugu aquifer (Turner, 1975). The Mugu aquifer is generally penetrated at a depth of 255 ft to 500 ft below land surface.

3.2.3 LOWER SYSTEM

The Lower Aquifer System (LAS) consists of the Grimes Canyon, Fox Canyon, and Hueneme aquifers (Figure 3.2-1). The LAS is part of the Santa Barbara, San Pedro, and Saugus formations of Plio-Pleistocene age (Mukae and Turner, 1975).

In any of the basins, the aquifers of the LAS may be isolated from each other vertically by low-permeability units and horizontally by regional fault systems. The LAS is folded and tilted in many areas, and has been eroded along an unconformity that separates the Upper and Lower Aquifer Systems.

3.2.3.1 HUENEME

The Hueneme aquifer is considered to underlie the Oxnard Plain basin (Hanson et al, 2003). The Hueneme aquifer materials generally consist of terrestrial fluvial sediments, and marine clays and sands. In the basins along the Santa Clara River, the deeper aquifer system is generally considered to be the San Pedro Formation (Mann, 1959) or the time-equivalent Saugus Formation, although the U.S. Geological Survey considers this deeper aquifer to be equivalent to the Hueneme aquifer (Hanson et al, 2003).

3.2.3.2 FOX CANYON

The Fox Canyon aquifer underlies the Las Posas, Pleasant Valley, Oxnard Forebay and Oxnard Plain basins. The Fox Canyon aquifer materials generally consist of marine shallow regressive sands and some clays. The Fox Canyon aquifer is the lower unit in the San Pedro formation. This same unit also extends north into the Mound basin, but the character of the sediments change to more finely-bedded deposits (UWCD, 2012).

3.2.3.3 GRIMES

The lowest water-bearing unit of the East Las Posas and Pleasant Valley basins is commonly referred to as the Grimes Canyon aquifer (CA DWR, 1954; Turner, 1975). The Grimes Canyon aquifer materials generally consist of marine shallow regressive sands.

3.3 GROUNDWATER BASINS

The groundwater basins within the District vary in their water production and ability to be recharged rapidly. The groundwater basins detailed here are really sub-basins of the larger basin of the Santa Clara River Valley (CA DWR, 2003). Hydraulic connection exists between all basins within the District boundaries. The Fillmore basin receives recharge as underflow from the Piru basin, and the Santa Paula basin receives significant recharge from the Fillmore basin. Often, a component of the flow between basins occurs as surface water around the sub-basin boundaries. The Mound basin receives recharge from the Santa Paula basin as well as from the Oxnard Plain and Oxnard Forebay basins, although head differentials across the western Santa Paula basin boundary are greater than those between the other sub-basins of the Santa Clara River valley. The Oxnard Forebay basin is widely recognized as the primary recharge area for aquifers in the Oxnard Plain. Many of the confining clays present in the aquifer systems of the Oxnard Plain are absent or discontinuous in the Oxnard Forebay basin, creating a window for recharge to other down-gradient

aquifers. High groundwater elevations in and near the Oxnard Forebay promote groundwater flow to the nearby Mound and West Las Posas basins. The Pleasant Valley basin is more distant from the Oxnard Forebay and receives less direct benefit from United's recharge operations, but pipelines have been constructed to convey irrigation water directly to water users in Pleasant Valley and on the southern Oxnard Plain.

3.3.1 PIRU

The Piru basin consists of recent and older alluvium underlain by San Pedro (Saugus) Formation. The recent and older alluvium is made up of coarse sand and gravel that are present to a depth of approximately 60 to 80 feet throughout the basin. The San Pedro Formation consists of permeable sand and gravel and extends to a depth of approximately 8,000 feet. Two faults bound the Piru basin, the Oak Ridge fault to the south and the San Cayetano fault to the north (UWCD, 1996b).

Groundwater flow in the alluvium of the Piru basin tends to be westerly, parallel to the river channel. Similarly, the flow gradient in the San Pedro Formation is westerly with a small north/south component as the groundwater moves parallel to the axis of the syncline that forms the basin. The basin is considered to be an unconfined groundwater basin. The Santa Clara River and Piru Creek are major sources of recharge to the Piru basin, with minor sources from smaller streams, from outcrops to the north of the basin, and from percolation of rainfall. United occasionally operates the Piru Spreading Grounds, a 44-acre recharge basin which diverts water from Piru Creek for groundwater recharge. The Piru basin readily accepts large volumes of recharge as surface water percolates to groundwater in the channel of the river. During United's conservation releases from Lake Piru a significant percentage of flow infiltrates through the river channel and serves to recharge the Piru basin.

Under low-flow conditions (up to approximately 100 cfs), all of the surface flow of the Santa Clara River coming from Los Angeles County commonly infiltrates into the Piru basin above the confluence of Piru Creek, so that there is no continuity of river flow across the basin. Continuous surface flow may extend the length of the basin following large winter storms, during large releases from Castaic Lake, and in the winter and early spring of exceptionally wet years. A lengthy "dry gap" of approximately five miles commonly exists in the central portion of the Piru basin, extending from the point of complete percolation of surface water east of Piru Creek to areas near the downstream end of the basin. During United's conservation releases flows ranging from 100-200 cfs are often required to establish surface flow between Piru Creek and the west end of the basin. In the area west of Hopper Creek groundwater flow is constricted as the basin narrows and shallow groundwater intersects the river channel. This "rising groundwater" contributes or restores surface flow in the river near the west end of the basin. When groundwater levels in the Piru basin are high, the area of rising groundwater extends farther east than in drier times, and the total flow of the discharge to surface water is greater. At the lower end of the Piru basin, a significant amount of groundwater flows into the Fillmore basin as underflow (Mann, 1959).

The channel of the Santa Clara River stays along the basin's southern edge over the length of the basin, likely secured in that position by the alluvial fans of Piru and Hopper Creeks entering the basin from the north. Chloride impacts associated with wastewater discharges sourcing from Los Angeles County over the past decade are now observed in wells along the northern portions of the middle of the basin. The northerly extent of these chloride impacts suggests the primary groundwater flow paths down the basin are north of the modern river channel. Groundwater flow paths are likely influenced by both geologic structure within the basin and the extraction of groundwater in the northern portions of the basin.

3.3.2 FILLMORE

The Fillmore basin consists of varying alluvial deposits resting on the San Pedro Formation. The younger alluvial deposits comprise recent sands and gravels of the Santa Clara River and Sespe Creek in the southern and eastern parts of the basin. Southward-sloping alluvial fan material forms the Sespe uplands in the north-central portion of the basin, and alluvial fan material of the Pole Creek Fan underlies the City of Fillmore (UWCD, 1996b). Alluvial thickness varies from about 60 to 120 ft. The San Pedro Formation, folded into an east-west syncline, underlies most of the Fillmore basin. Along the main axis of the syncline, the San Pedro Formation reaches a depth of 8,430 feet. At the western basin boundary, the San Pedro Formation extends to a depth of 5,000 to 6,000 feet.

The groundwater flow gradient in the Fillmore basin generally creates an east-to-west movement of groundwater through the alluvium. Groundwater that infiltrates from Sespe Creek generally flows towards the southwest. In the San Pedro Formation, the movement of groundwater is believed to be southerly beneath the Sespe fan, changing to westerly near the axis of the syncline. The basin is considered an unconfined groundwater basin. The Santa Clara River and Sespe Creek are two major sources of recharge to the Fillmore basin, as is underflow from Piru basin. As with the Piru basin to the east, the Fillmore basin readily recharges in years of abundant rainfall and streamflow.

The Fillmore basin narrows at the downstream end, resulting in an extensive area of rising groundwater and gaining flow in the Santa Clara River. Extensive wetlands exist in this area, and are easily visible on aerial photographs. Groundwater underflow into the Santa Paula basin is likely significant, although some suggest surface flow related to rising groundwater comprises a larger component of the discharge from the basin (Mann, 1959).

3.3.3 SANTA PAULA

The Santa Paula Basin is located along the Santa Clara River, extending from approximately Kimball Road and the town of Saticoy in the west to Santa Paula Creek in the east. The basin is bounded by the Sulphur Mountain foothills on the north and South Mountain on the south. The basin is elongated in a northeast-southwest direction, about 10 miles long and as much as 3.5 miles wide. The surface area of the basin is approximately 13,000 acres, and ranges in elevation from 130 feet above sea level near Saticoy to 270 feet above sea level near the City of Santa Paula.

Ongoing uplift along the Oak Ridge and other faults has created a deep basin, with Plio-Pleistocene deposits exceeding 10,000 feet in thickness.

The principal fresh water-bearing strata of the Santa Paula Basin are the Pleistocene San Pedro Formation, Pleistocene river deposits of the ancient Santa Clara River, alluvial fan deposits shed from the uplifted mountain blocks, and recent river and stream sediments deposited locally along the Santa Clara River and its tributaries. These water-bearing sediments are underlain by relatively impermeable Pliocene and older units. The sediments of the basin have been warped into a syncline that is oriented in a northeast-southwest direction along the center of the basin. To the east, the Santa Paula Basin has hydraulic connection with the Fillmore Basin. To the south, the Oak Ridge fault forms a partial barrier to groundwater movement. To the north, the portion of the aquifer represented by the San Pedro Formation is exposed in an outcrop along the Sulphur Mountain foothills. The Santa Paula basin borders the Oxnard Forebay and Mound basins on the west. The western boundary of the Santa Paula Basin is more complex, with local uplift and faults mapped by some investigators. Although there is general agreement that there is some hydraulic connection between Santa Paula Basin and the Mound Basin, the degree of connection is uncertain.

Long-term records of groundwater elevations within the Santa Paula basin demonstrate that the basin has a more muted recharge response to wet years than the Piru and Fillmore basins to the east. Much of the recharge likely occurs in the eastern portion of the basin (Santa Paula Basin Experts Group, 2003). Groundwater levels in many wells in the central and western portions of the basin show significant seasonal variability (UWCD, 2013b), suggesting some degree of confinement. During high rainfall years, monitor wells in the southern portion of the basin near the Freeman Diversion, and historically some other wells near Saticoy, have shown artesian flow. The complex subsurface geology in the western portion of the basin complicates interpretations of groundwater flow in this area.

3.3.4 MOUND

The principal fresh water-bearing strata of the Mound basin are the upper units of the San Pedro Formation and overlying Pleistocene deposits that are interpreted to be correlative with the Mugu aquifer of the Oxnard Plain basin. There is an upper confining layer of Pleistocene clay approximately 300 feet in thickness. The basin extends several miles into the offshore.

The sediments of the basin have been warped into a syncline that is oriented in an east-west direction that roughly follows Highway 126. Structural disruption along the Oak Ridge fault in the southern portion of the basin has resulted in considerable uplift and erosion of the San Pedro and younger sediments. This disruption is the cause of the topographic "mounds" near the intersection of Victoria Avenue and U.S. 101, for which the basin is named. The Montalvo anticline has traditionally been used to define the southern extent of the basin. These structural features generally offset only the deeper LAS units of the adjacent Oxnard Plain. The deposits of the Upper Aquifer System overlie the faults and folds along the southern margins of the basin, but the

character of the deposits change as they extend to the north, becoming more finely bedded and fine-grained (UWCD, 2012b).

The limited number of wells in the Mound basin, especially in the northern half of the basin, complicates efforts to ascertain the primary sources of recharge to the basin. There likely is some component of recharge from precipitation falling on aquifer units that outcrop in the hills along the northern margin of the Mound basin (Figure 3.1-1), but no wells exist to provide evidence of this occurrence. There is general agreement that the basin benefits from recharge from the Oxnard Forebay and Oxnard Plain to the south, especially during periods of high water level on the Plain (GTC, 1972; Fugro, 1996; UWCD 2012b). The hydrogeologic boundaries of the Mound basin are not coincident with the structural boundaries of the basin, so there is hydrologic connection between the Mound basin and adjoining groundwater basins (UWCD, 2012b). The amount of recharge from the Santa Paula basin to the east is also unclear, but high heads in some wells in the eastern Mound basin suggests some degree of connection and recharge. Mann (1959) suggested that there is little underflow from the Santa Paula basin to the Mound basin, although more recent studies suggest it may be significant (Fugro, 1996; UWCD, 2012b).

Groundwater flow in the Mound basin is generally to the west and southwest with modest to weak gradients, especially in times of drought. The poor distribution and limited number of wells with water level records complicates efforts to contour groundwater elevations in the basin. During periods of drought and increased pumping, a pumping trough forms along the southern portion of the basin that significantly modifies groundwater gradients.

3.3.5 OXNARD FOREBAY

Both UAS and LAS aquifers are present in the Oxnard Forebay and Oxnard Plain basins. The Oxnard Forebay maintains direct hydraulic connection with confined aquifers of the Oxnard Plain basin, which extends several miles offshore beneath the marine shelf where outer edges of the aquifer are in direct contact with seawater. In areas near Port Hueneme and Pt. Mugu where submarine canyons extend nearly to the coastline, the fresh-water aquifers may be in direct contact with seawater a short distance offshore.

The Forebay is the main source of recharge to the Oxnard Plain basin. Recharge to the Forebay benefits other coastal basins (Mound, West Las Posas, Pleasant Valley) but a majority of the water recharged to the Forebay flows downgradient to the confined aquifers of the Oxnard Plain. The shallow sediments of the basin are dominated by coarse alluvial deposits of the ancestral Santa Clara River. The absence of low-permeability confining layers between surface recharge sources and the underlying aquifers in the Forebay allow rapid groundwater recharge in the Forebay. The recharge to the Forebay comes from percolation of Santa Clara River flows, artificial recharge from United's spreading basins, irrigation return flows, percolation of rainfall, and likely lesser amounts of underflow from the Santa Paula basin and mountain-front recharge from the nose of South Mountain. In the area of the Forebay between the El Rio and Saticoy spreading grounds, the LAS

has been uplifted and truncated along its contact with the UAS. In this area recharge from surface sources may enter both the UAS and the underlying LAS. The U.S. Geological Survey estimates that about 20% of the water recharged to this area reaches the LAS, with the remainder recharging the UAS. In some areas of the Forebay significant clays are present among the deposits of the LAS.

3.3.6 OXNARD PLAIN

The Oxnard Forebay is hydraulically connected with the aquifers of the Oxnard Plain basin, which is overlain by an extensive confining clay layer. Thus, the primary recharge to the Oxnard Plain basin is from underflow from the Forebay rather than the deep percolation of water from surface sources on the Plain. Natural and artificial recharge to the Forebay serves to raise groundwater elevations in this up-gradient area of the groundwater flow system for the Oxnard Plain. Changes in the volume of groundwater in storage in the Forebay changes the hydrostatic pressure in the confined aquifers extending from the margins of the Forebay to the coastal and offshore portions of these continuous aquifer units. High water levels in the Forebay are desirable, as they are required to maintain offshore pressure gradients from the Forebay to coastal areas. While the physical movement of groundwater out of the Forebay is fairly slow, the pressure response in the confined aquifers distant from the Forebay responds more rapidly to significant recharge events in the Forebay. When groundwater levels are below sea level along the coastline, there can be significant recharge by seawater flowing into the aquifers.

Vertical gradients also commonly exist between aquifer units on the Oxnard Plain, resulting in some degree of water movement through low-permeability units that occur between most of the major aquifers. When LAS water levels are substantially lower than UAS water levels (creating a downward gradient), there may be substantial leakage of UAS water into the LAS through the various aquitards that separate the aquifer units. Likewise, a downward pressure gradient can exist between the Semi-perched aquifer and the Oxnard aquifer when heads in the shallow confined Oxnard aquifer are lowered (either regionally by drought conditions or locally by pumping wells). The movement of poor quality water from the semi-perched zone to the Oxnard aquifer has been documented in some locations, with abandoned or improperly constructed wells being a notable pathway for this downward flow (Izbicki, 1992; Stamos et al, 1992).

The highly-permeable deposits of the UAS are relatively flat lying across approximately the upper 400 feet of the Oxnard Plain. In the northern Oxnard Plain heads are often similar in the Oxnard and Mugu aquifers, but heads in the Mugu aquifer are considerably deeper in the greater area surrounding Mugu Lagoon. Deposits of the LAS are generally finer-grained and have been deformed by folding and faulting in many areas. An uneven distribution of pumping, along with structural and stratigraphic changes within the deposits of the LAS result in varied heads among the deep wells across the Oxnard Plain and Pleasant Valley.

3.3.7 PLEASANT VALLEY

The Pleasant Valley basin is bounded to the south by the Santa Monica Mountains, to the north by the Camarillo Hills, and to the west by the Oxnard Plain. The Bailey fault runs along the base of the Santa Monica Mountains, and the Camarillo fault along the Camarillo Hills to the north.

The Pleasant Valley basin is differentiated from the Oxnard Plain basin by a general lack of productive UAS aquifers (Turner, 1975). The UAS is composed of alluvial deposits about 400 feet thick. In Pleasant Valley much of the UAS is fine grained and not extensively pumped for water supply (Turner, 1975; Hanson et al, 2003). UAS deposits in the Pleasant Valley basin are comprised of sediments sourcing from the Calleguas Creek watershed, a much smaller drainage than that of the Santa Clara River which deposited the UAS deposits on the Oxnard Plain.

The LAS is composed of the Hueneme, Fox Canyon, and Grimes Canyon aquifers to a depth of about 1,400 feet. The Hueneme aquifer is composed of alternating layers of sand and finer grained deposits. The Fox Canyon and Grimes Canyon aquifers are composed of thick sequences of relatively uniform marine sand. The Fox Canyon aquifer is the major water-bearing unit in the basin.

In Pleasant Valley the LAS is surrounded and underlain by partly consolidated marine deposits and volcanic rocks. Marine deposits are present in the Camarillo Hills and in the western edge of the Santa Monica Mountains near the coast. As a result of faulting and uplift of the underlying marine deposits near Mugu Lagoon the LAS is not hydraulically connected to the Pacific Ocean in this area (Izbicki, 1996a; Hanson et al., 2003). Volcanic rocks consisting of basalts, submarine volcanic flows, and debris flows are present in the Santa Monica Mountains along the southern edge of the valley (Weber et al., 1976). The underlying marine deposits and volcanic rocks both contain high-chloride water.

Under predevelopment conditions groundwater movement in the UAS and LAS was likely from recharge areas in the eastern part of Pleasant Valley toward the Oxnard Plain to the southwest. The LAS in Pleasant Valley appears to be fairly isolated from sources of recharge, and the time since recharge of the ground water ranges from 3,000 to more than 6,000 years before present (Izbicki, 1996b). Groundwater age increases with depth and water within deeper aquifers has contacted aquifer material longer, reacting to a greater extent with these materials than water in overlying aquifers. Over the past two decades water levels in two wells in northern Pleasant Valley have recovered more than 250 feet. The re-establishment of surface flow in Arroyo Las Posas that subsequently percolates at the northern margin of the basin is now recognized as a source of recharge to the basin. The degree to which this large recharge mound serves to recharge the central portion of the basin is not well established. The City of Camarillo is proposing construction of a large-scale desalter to treat and utilize this water which tends to be more mineralized than the older water native to the basin.

High-chloride concentrations are present in water from wells throughout Pleasant Valley, especially along the southern edge of the valley near the Bailey Fault. Wells yielding high-chloride water in this area may have been drilled too deep and directly penetrate deposits having high-chloride water, or brines may have invaded deep freshwater aquifers from surrounding and underlying deposits as a result of pumping. Regardless of the source, changing hydraulic pressure as water levels within the Lower Aquifer System decline as a result of pumping wells, especially during dry periods, may increase chloride concentrations in water produced from deeper wells if the proportion of high-chloride water yielded to the well from underlying deposits increases (Izbicki et al., 2005a). Chloride concentrations in water from deep wells in the Pleasant Valley basin tend to increase during dry periods when ground-water pumping increases. Conversely, chloride concentrations generally decrease during wetter periods when alternative sources of irrigation water are available from surface supplies and groundwater pumping decreases. In addition to water from surrounding and underlying rocks, irrigation return flow also may contribute to high chloride concentrations in deep wells that are partly screened in the Upper Aquifer System. More recently, groundwater recharge from Arroyo Las Posas in the northern portion of the basin has been recognized as an additional source of salt in the basin.

3.3.8 LAS POSAS

The West Las Posas basin lies adjacent the northeast Oxnard Plain in the area south of South Mountain and north of the Camarillo Hills. The basins generally consists of a broad alluvial plain sloping to the south, and is drained by Beardsley Wash which flows west around the Camarillo Hills. Only the western portion of the West Las Posas basin lies within United's District boundary. Tree crops are the dominant land use in this agricultural area. Much of this area is served by groundwater imports from the Oxnard Plain, but some agricultural pumping is reported from deep wells near Beardsley Wash and other wells along the South Mountain foothills.

Most groundwater production in the West Las Posas basin is from deposits of the San Pedro Formation. Beneath most of the Las Posas Valley, the upper San Pedro Formation consists of low permeability sediments with lenses of permeable sediments which are age-equivalent to Hueneme Aquifer on Oxnard Plain (DWR, 1975). The permeable lenses form isolated, yet, locally important water sources. The water-bearing zones in the upper San Pedro Formation are not well connected. Some recharge to the deeper Fox Canyon aquifer may source from downward leakage from the upper San Pedro Formation. Many wells in the Las Posas Basin are perforated in the Fox Canyon aquifer, making it the principal water-bearing unit (Mukae, 1988). The Fox Canyon aquifer is exposed almost continuously along the southern flank of South Mountain. South of the outcrop, beds of the Fox Canyon aquifer dip below the valley and are folded into a series of anticlines and synclines. Groundwater in the Fox Canyon aquifer exists under confined conditions beneath the valley and unconfined conditions at the valley margins where the aquifer is folded upward and exposed at the surface. Much of the groundwater recharge to the western portion of the West Las Posas basin is believed to source from the Oxnard Plain. Minor amounts of recharge are derived likely from infiltration of precipitation and runoff in the outcrop areas.

4 ANNUAL HYDROLOGIC CONDITIONS

This section details the range of hydrologic conditions observed throughout United's district boundaries in the year 2013. While the emphasis is placed on surface water and groundwater conditions over the past year, some discussion is devoted to the comparison of recent conditions to conditions documented in the historical record. Rainfall totals were well below normal in both 2012 and 2013, and significant storms have not visited the region since March 2011. The basins of the district have responded to these unusually dry conditions.

4.1 PRECIPITATION AND EVAPOTRANSPIRATION

United participates in data collection in partnership with the Ventura County Watershed Protection District's three rainfall gages, two of which are also evaporation stations. The VCWPD maintains approximately 125 gages around the county (Figure 4.1-1). United's gages are located at the field offices in Saticoy, El Rio, and at the guard station at the Lake Piru. United also maintains records from the gage at the office in Santa Paula for its own use. United's monitoring stations showed that precipitation was about 136% of normal for the 2011 water year, with December and March accounting for 65% of the rainfall. Lake Piru recorded 28.48 inches of rainfall, approximately 8.6 inches more that the average received at that location, and in the top 20% in terms of rainfall totals for this station. In contrast, 2013 precipitation was about 38% of normal within the district with an average rainfall of just 6.6 inches across the district. The rainfall measured at the Santa Paula site for 2013 represents the second driest year measured since 1890. Table 4-1 and Figure 4.1-2 show the precipitation across the districts monitoring sites for 2011 through 2013.

Table 4-1 Monthly Precipitation for water years 2011-2013

Rainfall at UWCD Stations (Inches)			
WY	El Rio #239	Lake Piru # 160	Santa Paula # 245
2011	19.41	28.48	23.79
2012	9.7	13.07	10.18
2013	5.7	7.55	6.53

4.2 SURFACE WATER

The Santa Clara River Watershed is extensively monitored by multiple agencies for rainfall, daily stream discharge and flood flows. Data for many of the monitoring sites goes back to the early 1900s giving a long period of record for comparison purposes. The year 2011 overall would fall in the normal to wet category in terms of both precipitation and run-off. Below is a brief discussion of how 2011 compares to the historical record. Daily and monthly data for all the sites discussed can be obtained on-line at websites maintained by the USGS and VCWPD.

4.2.1 SANTA CLARA RIVER SYSTEM

The Santa Clara River is the largest river system in southern California remaining in a relatively natural state. The headwaters start on the northern slopes of the San Gabriel Mountains and the river flows approximately 84 miles to an estuary and river mouth at the Pacific Ocean near Ventura Harbor on the northern Oxnard Plain. The major tributaries include Castaic Creek and San Francisquito Creek in Los Angeles County, and Sespe, Piru and Santa Paula creeks in Ventura County. While the Los Angeles portion of the watershed accounts for 40% of the total area, it only produces about 20% of the total river flow, with dry-season base flows sustained by discharges from wastewater treatment plants and rising groundwater from the Eastern groundwater basin. As mentioned in other sections of this report, even though 2011 was wetter than most years, large sections of the main stem of the Santa Clara River remained dry for most of the year.

4.2.1.1 FLOW IN THE SANTA CLARA RIVER WATERSHED

Surface water flows in the Santa Clara River system were well above normal for the 2011 calendar year. The season started out wet with an early storm in December 2010. The storm peaked Sespe flows over 3,000 cfs a couple of times before runoff subsided in late February. Two smaller storms were then followed by a large March storm where the Sespe's peak flow exceeded 35,000 cfs. Flows in the Sespe were over 1,000 cfs for the next 10 days. In contrast to 2012 and 2013, the maximum runoff measured at the Sespe gage was 2,300 cfs for 2012 and just 77cfs for 2013. Base flows in these years went down to 2-3 cfs measured at the gage.

The USGS station 111090000, Santa Clara River near Piru, measures the entire contribution from Los Angeles County's portion of the watershed that flows into Ventura County. This station recorded a peak flow of nearly 9,000 cfs in the March storm. Flows subsided to a little over 300 cfs within a couple of days after the peak. A large release from Castaic Lake in the month of April brought the average flow up to 11,000 AF that month. In contrast peak flows for 2012 reached 1,520 cfs and 893 cfs in 2013. Due to the effluent dominating the low flows, all years experienced base flows as low as 10 -12 cfs during the summer months.

Table 4-2 Total Discharge for various stream flow stations

USGS/VCWPD Stream flow Stations	2011	2012	2013
	AF	AF	AF
Santa Clara River Near Piru USGS Sta. 11109000	69,813	31,582	23,271
Piru Creek Above Santa Felicia Dam USGS Sta. 11109600	69,885	13,081	6,605
Piru Creek Below Santa Felicia Dam USGS Sta. 1110900	41,989	39,893	22,765
Sespe Near Fillmore USGS Sta. 1111300	158,271	15,104	4,307
Santa Paula Creek VCWPD 709	32,811	4,408	1,164

Table 4-2 shows the annual water year runoff for the monitoring sites above the Freeman Diversion. The Sespe, Piru Creek above Santa Felicia Dam and Santa Paula Creek in general represent the natural runoff produced by rainfall. Because Pyramid above Lake Piru has adopted an inflow = outflow flow regime this gage can be included as a more natural flow regime. Both the Piru Creek below Santa Felicia Dam and The Santa Clara River Near Piru sites represent a more regulated stream flow with SFD on Piru Creek and the Los Angeles County effluent discharge upstream of the other site. As a result of the more regulated flows the dry year of 2013 has less of an effect on the flows when compared to the more natural watersheds. In 2013 the natural watersheds produced a total of 261,000 AF of runoff in 2011 and only 12,000 AF of runoff in 2013. The dry year of 2013 represents only 5% of the total runoff produced in 2011. In contrast the regulated flows in Piru and the County Line dry year represents 33% of the total runoff produced in 2011. Figure 4.2-1 shows the discharge measured at the above mentioned USGS sites for 2011 through 2013.

4.2.1.2 WATER QUALITY

United maintains a surface water quality monitoring program and collects samples from a number locations at frequencies ranging from quarterly to every two weeks. Sampling sites are generally located on the Santa Clara River near groundwater basin boundaries and at the major tributaries near the confluence with the river. Additional water quality sampling sites include the Santa Clara River at the Freeman Diversion and the weir where surface water arrives at United's El Rio recharge basins. Sample analysis commonly consists of either a full inorganic general mineral suite or several key constituents such as TDS, chloride and nitrate. This surface water quality monitoring provides documentation of variations in surface water quality and information on the quality of water that is recharging the groundwater basins of the District. Sampling is conducted every three months at most of the sites, but more frequently at some key locations (Santa Clara River: every month near County Line and every two weeks at Freeman Diversion).

Water quality at the various sampling sites throughout the District tends to vary seasonally, with the lowest annual mineral concentrations commonly recorded in the winter and spring when flow is

higher. Results from United's 2013 surface water sampling are shown on Figures 4.2-2 and 4.2-3, where the annual recorded maximum concentrations of chloride and TDS, respectively, are displayed over the annual minimum values. The range in values is from four seasonal samples at most locations, so the true range in quality in the water bodies is likely greater than what is documented. In 2013 several sites had dry channel conditions at the time of scheduled sampling, so less than four annual samples were collected at those locations. With the dry conditions in the watershed this year, the mineral content of surface waters tended to be higher at some locations. At locations when rising groundwater is a primary component of surface flow, dry season water quality tends to be fairly stable year-to-year.

Water quality in Piru Creek is influenced by Pyramid Lake located higher in the Piru Creek watershed, which receives large volumes of water from the State Water Project. Water in middle Piru Creek is a blend of State Water and local runoff from the upper Piru Creek watershed. When chloride concentrations in State Water are high, the chloride in middle Piru Creek (below Pyramid dam) and Lake Piru can be much higher than what would occur naturally. In 2013 the maximum-recorded chloride in Lake Piru was 63 mg/l. Chloride concentrations as high as 135 mg/l were recorded flowing into the lake, but the 2013 flows associated with these high chloride concentrations were minor.

Chloride concentrations in the Santa Clara River near the Los Angeles County line are also influenced by chloride in imported State Water, as Castaic Lake Water Agency delivers State Water to water retailers in the greater Santa Clarita area. Nearly 50% of the chloride load in wastewater discharges is from the chloride load in delivered water (LACSD, 2008). Additional chloride loading occurs during beneficial use of the delivered water, but loading has been significantly reduced in recent years as the Los Angeles County Sanitation District has managed a successful campaign to remove thousands of self-regenerating water softeners from the community. The Sanitation Districts are trying to satisfy regulatory requirements for the quality of their effluent, but the approach to be taken is not yet clear as community residents have resisted funding a chloride TMDL proposed by the Sanitation Districts and approved by the Los Angeles Regional Water Quality Control Board in December 2008.

Over the past few decades chloride concentrations in the Santa Clara River have varied considerably near the Los Angeles County line as water quality at this location is heavily influenced by discharges from the Valencia Water Reclamation Plant. From the late 1990s through 2003 the discharges from the Valencia plant increased steadily in both volume and chloride, with chloride concentrations exceeding 200 mg/l near the end of this period. Since 2003 chloride concentrations in the discharges have fallen somewhat: however, chloride in the river commonly exceeds the 100 mg/l surface water objective during months without significant rainfall (Figure 4.2-4). The lower chloride concentrations in the Santa Clara River in recent years are largely related to lower chloride in wastewater discharges from the Valencia WRP (Figure 4.3-4). This is likely the result of lower chloride levels in State Water Project imports and a successful ban of self-regenerating water softeners in City of Santa Clarita area homes. Prior to 1970 the discharge of oilfield brines

significantly impaired water quality in the river at this location, but flows associated with this poor water quality were likely minor.

Beginning in January 1999, United has sampled the Santa Clara River near the Los Angeles County line each month for chloride and other analytes. Sampling in 2013 documented chloride concentrations ranging from 112 to 135 mg/l. Chloride concentrations in the water released from Lake Piru ranged from 61 to 63 mg/l over the same time period (Figure 4.2-2).

Sespe Creek at times has high chloride concentrations, historically and in recent years. Low chloride concentrations are also commonly measured in the runoff from the Sespe watershed, and the source of chloride has not been determined.

In recent years both the City of Fillmore and the City of Santa Paula have eliminated discharges of treated wastewater to the Santa Clara River. Santa Paula's new treatment plant came on line in 2010 and now utilizes percolation basins for wastewater disposal. Fillmore completed a new plant in 2009 and now distributes reclaimed water to both percolation basins near the plant site and a network of subsurface irrigation systems constructed in parks and school fields throughout the City. The City of Fillmore has banned installation of self-regenerating water softeners as part of its efforts to reduce chloride loading to the watershed. There are now no Ventura County water reclamation plants discharging flow to the Santa Clara River. Continuous river flow from Los Angeles County line to the Freeman Diversion is uncommon, but when there is connection, flows are usually high in the lower watershed and the recycled water component sourcing from Los Angeles County is very minor. The maximum-recorded chloride concentration in the Santa Clara River at Freeman Diversion in 2013 was 140 mg/l (Figure 4.2-2). In the summer and fall of 2013 when chloride in the Santa Clara River was recorded at concentrations greater than 100 mg/l, flow in the river was approximately one cfs or less.

United frequently monitors water quality in the Santa Clara River at the Freeman Diversion, the point where water is diverted from the river for either direct deliveries to agricultural users or groundwater recharge in the Oxnard Forebay. Samples are collected at the Freeman Diversion approximately every two weeks to confirm that the water is acceptable for use in both aquifer recharge and for irrigation deliveries. The TDS and chloride content of water in the river at this location exhibits a strong negative correlation with flow, with higher flows being less mineralized (Figure 4.2-5 and Figure 4.2-6). Under dry watershed conditions groundwater discharge (rising water) from the Fillmore basin comprises a large portion of the river flow at the Freeman Diversion. Under wetter conditions tributary flow, most notably from Sespe and Santa Paula Creeks, contribute flow to the lower river and improves water quality compared to low-flow conditions. High river flows resulting from the direct runoff of precipitation commonly has the lowest dissolved mineral content, as does the recession limb of hydrographs from large flow events (Figure 4.2-5). United commonly diverts large volumes of water from the river for groundwater recharge during these periods of high flow and good water quality. Recorded TDS concentrations at the Freeman Diversion ranged from 1110 to 1570 mg/l in 2013 (Figure 4.2-3). As with chloride concentrations at this location, poor

quality is associated with low flows in the river, and this water is generally used for irrigation deliveries rather than groundwater recharge.

Nitrate concentrations in the Santa Clara River at Freeman Diversion show some negative correlation with flow but concentrations are routinely low in the river during both high and low flows (Figure 4.2-6). A weak seasonal signature has been observed, with nitrate concentrations rising slightly in the fall (UWCD, 2008). For the 27 samples collected at Freeman Diversion in 2013 the maximum-recorded nitrate concentration was 7.7 mg/l, well below the CA DPH health standard of 45 mg/l.

The County of Ventura maintains and operates composite sampling device at the Freeman Diversion, and samples storm flow and dry weather base flows several times per year. These samples are analyzed for a broad suite of organic contaminants and metals as part of a storm water quality program required by the Los Angeles Regional Water Quality Control Board. Detections of organic contaminants such as pesticides are uncommon and generally of low concentration (VCWPD, 2010)

4.2.2 CALLEGUAS CREEK

United does not actively gage or sample surface water in the Calleguas Creek watershed. Much of the monitoring activity in the Calleguas Creek watershed is currently associated with the Salts TMDL under development for the watershed.

4.3 GROUNDWATER

Groundwater is utilized extensively for municipal and agricultural use throughout the boundaries of United Water Conservation District, as imported water supplies are unavailable over much of this area. United has a responsibility to monitor conditions in the basins throughout the District so that the basins are understood and managed as needed. Many small water supply projects are completed without United's direct involvement, but proponents of most large water projects engage United's support in some way (e.g., data sets, technical support, financial assistance, etc.).

The following sections detail 2013 basin conditions within the eight groundwater subbasins which fall wholly or partially within United's District boundaries. Groundwater elevations have fallen considerably in a number of areas since 2011, the last year with significant local rainfall. In 2013 rainfall and streamflow were well below average, which limited the amount of recharge to the basins. For the first time since 1990 there was no conservation release from Lake Piru. Some discussion in the following section is devoted to comparing current conditions to past periods of abundant rainfall or drought, or periods pre-dating some major water supply projects within the District.

4.3.1 PIRU BASIN

The unconfined Piru basin has the capacity to rapidly accept water from the channel of the Santa Clara River and tributary streams. Groundwater in storage within the basin is slowly discharged to the downstream Fillmore basin, so in some ways the Piru basin acts as a "forebay" to downstream groundwater basins in the Santa Clara River Valley. Surface water flow resulting from the discharge of rising groundwater at the west end of the basin is greater when groundwater elevations are higher in the downstream portions of the basin. Groundwater elevations remain above historic lows, but over the past decade chloride impacts sourcing from Los Angeles County have migrated down past the midpoint of the basin.

4.3.1.1 WATER LEVELS

Historical groundwater elevations for United's Piru basin key well, located northwest of the confluence of Piru Creek and the Santa Clara River are shown on the hydrograph in Figure 4.3-1. The historical record for this well shows that groundwater elevations in the Piru basin fluctuate dramatically, and that the basin is capable of rapid recovery of water levels following periods of drought. Water level recovery at this location is largely related to channel recharge associated with high and prolonged flow in the Santa Clara River and in Piru Creek, such as that which occurs during reservoir releases or large winter storms.

The basin fills in wet years such as 1998 and 2005, as shown by the flat-topping of groundwater elevations at 620 feet (Figure 4.3-1). The winter of 2011 was moderately wet but the basin did not fill to historical highs. Water levels in this key well recovered by about 13 feet in response to United's fall 2012 conservation release, but have fallen continuously since that time. Water levels in this well have fallen 80 feet since the spring of 2011, to a level within 20 feet of the level recorded in the drought conditions of 1991.

Piru basin groundwater levels have benefited from the recharge of recycled water discharged to the Santa Clara River by water reclamation plants in Los Angeles County. Historically the Santa Clara River has maintained perennial flow in the vicinity of Blue Cut and the County line, with the flow sustained by groundwater discharge from the Eastern groundwater basin. The City of Santa Clarita began importing State Water in 1980, and steady growth in that community resulted in steady increases in wastewater discharges until recent years, when discharge has diminished slightly. United's fall conservation releases from Lake Piru provide an additional source of recharge to the basin. Release volumes vary year-to-year, and variable channel conditions affect the percentage of the released water that percolates in the Piru basin. Recharge through the channel of Hopper Creek is likely another source of significant recharge during wet years. Reclaimed water from the community of Piru is distributed to recharge ponds near the confluence of Hopper Creek and the Santa Clara River.

Groundwater elevation contours were interpreted from measured groundwater elevation highs from the spring of 2013 and groundwater elevation lows from the fall of 2013, and are shown in Figures

4.3-2 and 4.3-3 respectively. Groundwater flow is consistently from east to west, roughly following the land surface gradient of the river channel. In the eastern portion of the Piru basin, groundwater flow paths angle north towards areas of groundwater pumping north of the Santa Clara River. Depths to water are greater along the northern portions of the basin where alluvial fan deposits elevate the land surface.

The tight contours shown in the eastern Piru basin, just west of United's District boundary, indicate that this eastern portion of the basin is an area of significant recharge. This is the area where surface water sourcing from the Santa Clara River watershed in Los Angeles County infiltrates to groundwater and the river often goes dry. Spring 2013 measured groundwater elevations were approximately 30 feet higher than in the fall in this area.

Groundwater rises near the constriction at the downstream west end of the basin, contributing flow to the Santa Clara River. Groundwater elevations near the constriction at the west end of the basin are historically more stable than those in the central and eastern portions of the basin. Recorded groundwater elevations were about the same in this area in spring and fall of 2013. Near Hopper Creek, water levels were about 20 feet lower in the fall than they were in the spring. The contours also show groundwater flow from the Piru basin to the Fillmore basin to the west.

4.3.1.2 GROUNDWATER EXTRACTIONS

Reported groundwater extractions from 107 active wells in the Piru Basin totaled 12,800 acre-feet for the 2013 calendar year. This is about 420 acre-feet more than the historical average for the period 1980 to 2013, the period of available records. A portion of the Piru basin extends east of United's District boundary and any pumping from this portion of the basin is not reported to United. The historical annual extractions for the Piru basin are shown in the histogram in Figure 4.3-4. Only a small percentage of groundwater pumping in the Piru basin is for municipal and industrial use, consistent with agriculture being the dominant land use within the basin.

Figure 4.3-5 is a map showing reported groundwater extractions from individual wells in the Piru Basin for the 2013 calendar year. Pumping magnitude is indicated by dot size and color. Agriculture is the predominant land use within the Piru basin, and pumping is shown to be distributed throughout the basin. Few active wells exist along the southeastern margin of the basin, and some crops here are irrigated with water piped in from other areas. Two private mutual water companies operate within the basin. The Piru Mutual Water Company diverts water from Piru Creek for agricultural use in the north-central portion of the basin, and Warring Water Company pumps water primarily for domestic use in the town of Piru.

In some canyon and upland areas, orchards are irrigated with groundwater pumped from lower areas of the basin and lifted to higher elevations. Additional development of hillside areas surrounding the alluvial basin floor results in increased groundwater demand on the basin. Over the past decade a large number of orange orchards have been removed and replaced by row crops or box tree nurseries.

The primary losses of groundwater from the Piru basin are the result of discharge of groundwater to the Santa Clara River at the western boundary of the basin, the subsurface outflow of groundwater at the western boundary of the basin and extraction of groundwater by wells.

4.3.1.3 WATER QUALITY

Over the past fifteen years the main water quality concern in the Piru basin has been impacts associated with high chloride concentrations in the Santa Clara River flows sourcing from Los Angeles County. Discharge from the Valencia Water Reclamation Plant located next to the river at Interstate 5 significantly influences the flow and water quality of this reach of the river, which normally percolates completely in the eastern Piru basin (UWCD, 2006; CH2M Hill, 2006). The chloride concentration of plant discharges began to increase in the late 1990s and peaked at over 210 mg/l in 2003 (Figure 4.3-6). The chloride plume associated with these discharges has made a steady advance with groundwater flow down the Piru basin. The extent of chloride impacts now reaches Hopper Creek in the western third of the basin (Figure 4.3-7). Irrigation of salt-sensitive crops such as strawberries and avocado with water over 100 mg/l chloride is generally not recommended, and growers in Ventura County remain concerned about the westward progression of these impacts. More recently, chloride concentrations in Los Angeles County wastewater discharges are improving, the result of a successful campaign to remove self-regenerating water softeners from Santa Clarita residences and lower chloride concentrations in imported State Water Project deliveries. The Sanitation Districts of Los Angeles County have recently indicated their intention to construct a desalter and maintain chloride concentrations of less than 100 mg/l in their discharges. In the western portion of the basin chloride concentrations are generally less than 70 mg/l, indicative of background levels within the basin (DWR, 1989).

The Piru basin generally does not have problems with nitrate contamination, and samples collected in 2013 show only two wells exceeding the MCL of 45 mg/l. Many wells record TDS concentrations of 1,200 mg/l or less, but some wells near Highway 126 west of Hopper Creek record TDS concentrations approaching twice this value (VCWPD, 2014). Water quality of the Piru basin is characterized more thoroughly in the revised Groundwater Management Plan for the Piru and Fillmore basins (Piru/Fillmore Groundwater Management Council, 2011).

4.3.2 FILLMORE BASIN

The City of Fillmore overlies the northeast portion of the Fillmore basin, and relies entirely on groundwater for water supply. Sespe Creek is the largest tributary to the Santa Clara River and enters the Fillmore basin from the north. Sespe Creek is an important source of recharge to the basin, providing high-quality water from a largely undeveloped watershed draining the southern slopes of the Pine Mountain complex in the Los Padres National Forest. Groundwater supports extensive acreage of agriculture in the basin, ranging from row crops and nursery stock near the valley floor to citrus and avocado plantings at both low and high elevations. Groundwater discharge to the downstream Santa Paula basin is thought to be significant, and the extensive wetlands near

this basin boundary are supported by rising groundwater. This groundwater discharge to the Santa Clara River in this vicinity commonly sustains surface flow downstream in the Santa Paula basin.

4.3.2.1 WATER LEVELS

Many water levels in the Fillmore basin behave in a manner similar to the Piru basin. Water levels from a key well in the Bardsdale area shows that water levels rise to a threshold elevation in significant wet years, as evidenced by the flat topping of groundwater elevations in 1998 and 2005 (Figure 4.3-8). In this vicinity south of the confluence of Sespe Creek and the Santa Clara River, groundwater elevations do not fluctuate as dramatically as those in the Piru basin.

Groundwater elevations at United's key well for the basin show that in 2011, a moderately wet year, the basin did not fill completely. In 2013 the recorded high groundwater elevation at United's key well was approximately six feet lower that the 2005 recorded high groundwater elevation, and approximately 23 feet higher than the recorded low groundwater elevation during the 1987 to 1991 drought.

Fillmore basin groundwater levels benefit from increased discharge from the Piru basin as that basin has sustained fairly high water levels in recent decades. The Fillmore basin also benefits from United's fall conservation release from Lake Piru which helps stabilize groundwater elevations. The unconfined Fillmore basin receives most of its recharge from the Santa Clara River and Sespe Creek. The upland areas in the northern portion of the basin likely receive relatively more recharge from direct precipitation and mountain front recharge.

Groundwater elevation contours are shown for spring and fall 2013 in Figures 4.3-2 and 4.3-3. Groundwater flow is predominantly east-to-west in the area of the Santa Clara River alluvium. In the Pole Creek fan area underlying the City of Fillmore, groundwater flow is generally westerly, but also is interpreted to trend northerly towards the City's active wells. Well control in the Sespe Upland area is relatively poor, but groundwater flow here is thought to be predominantly north-to-south. Along the valley floor groundwater gradients are quite uniform and are similar for the spring and fall of 2013. Groundwater flow converges near the west end of the basin where the groundwater flow aligns with the orientation of the river valley. Groundwater elevations in wells located in the Sespe Upland area and in the Pole Creek fan area of the basin generally exhibit more variability than wells along the valley floor.

The relatively tight contours shown in the eastern Fillmore Basin near the basin boundary reflect a steeper gradient as groundwater moves from the constriction of the Piru narrows and moves into the basin. In this area surface water commonly infiltrates to groundwater, resulting in diminished surface flow and a greater component of flow as groundwater. As in Piru basin, groundwater is forced to the surface near the downstream end of the Fillmore basin as geologic structure constricts the main aquifer units of the Fillmore basin. In this area groundwater elevations are more stable than elsewhere in the basin. At this discharge area of the basin contouring shows that spring and

fall 2013 groundwater elevations are approximately the same (Figures 4.3-2 and 4.3-3). Extensive wetlands in this area are clearly visible on aerial imagery.

4.3.2.2 GROUNDWATER EXTRACTIONS

Reported groundwater extractions from 287 wells in the Fillmore Basin totaled approximately 50,400 acre-feet for the 2013 calendar year. This is 6,100 acre-feet more than the historical average from 1980 to 2013. The historical annual extractions for the Fillmore basin are shown in the histogram in Figure 4.3-9. Recently and historically, agriculture has been the predominant user of groundwater in the basin.

Figure 4.3-5 is a map depicting reported groundwater extractions from individual wells in the Fillmore Basin for the 2013 calendar year. This graphic shows that: 1) the City of Fillmore pumps from three wells located in the north Pole Creek fan area near Sespe Creek and no longer pumps from wells located near the Santa Clara River; 2) there are numerous wells in the Bardsdale area pumping small volumes of water, as there is no mutual water company distributing potable water in this area; 3) there are few active wells in the Sespe Upland area and most active wells are located at lower elevations; and 4) Groundwater extractions from wells at the Fillmore Fish Hatchery located at the eastern boundary of the basin accounts for a significant portion of the groundwater extractions of the basin. In 2013 Fillmore Fish Hatchery wells reported pumping of 7,500 acre-feet (15% of the total groundwater extractions from the basin). In 2012 Farmers Irrigation Company constructed a new well near the western boundary of the Fillmore basin. This well pumped 4,400 AF in 2013, supplying irrigation water to growers in the Santa Paula basin.

Twelve mutual water companies operate in the Fillmore Basin, serving water primarily for irrigated agriculture. Fillmore Irrigation operates a surface water diversion on Sespe Creek, supplying water to nearby agricultural lands. Several water companies operate wells near the valley floor and pump water to higher elevation where groundwater is not as plentiful. Plantings in Timber Canyon and many areas of the Sespe Uplands are served by such arrangements. In recent years many orange orchards at lower elevations have been removed and replaced by row crops or box tree nurseries. Plantings of citrus and avocado remain the primary agricultural land use at higher elevations.

Discharge of groundwater to the Santa Clara River at the western boundary of the basin, subsurface outflow of groundwater to the Santa Paula Basin and extraction of groundwater by wells are the three primary losses of groundwater from the basin. The extensive wetlands and stands of *Arundo donax* (an invasive giant cane) at the west end of basin likely transpire large volumes of water. By some estimates *Arundo donax* may transpire up to six times the amount of water as native vegetation (CA Invasive Plant Council, 2011).

4.3.2.3 WATER QUALITY

The Fillmore basin is not known for having any pervasive water quality problems. TDS concentrations can be somewhat elevated in some locations, as in other groundwater basins along

the Santa Clara River Valley. The City of Fillmore no longer uses wells near the Santa Clara River, favoring locations near Sespe Creek where TDS tends to be lower. Naturally-occurring boron sourcing from the Sespe watershed, however, is sometimes a concern for citrus growers and the City of Fillmore. Deeper aquifer units may have elevated concentrations of iron and manganese, a common occurrence throughout Ventura County.

Chloride concentrations from samples collected in 2013 are shown on Figure 4.3-7. Recorded chloride concentrations exceeding 80 mg/l are uncommon, and the highest concentrations are observed along the southern edge of the basin. Concentrations in the 40s and 50s in the downstream/discharge portion of the basin are likely indicative of background chloride concentrations in the basin. While elevated chloride concentrations are sometimes observed in surface water in Sespe Creek, wells near the channel of Sespe Creek record chloride levels common to the rest of the basin.

4.3.3 SANTA PAULA BASIN

Groundwater storage in the Santa Paula basin is generally less dynamic than in surrounding basins, as recharge appears to be limited by confined aquifer conditions in some portions of the basin. Pumping in the Santa Paula basin is managed by a stipulated Judgment which assigns pumping allocations to each basin pumper that restricts the amount or groundwater each pumper can extract (on a seven-year rolling average). The City of Santa Paula occupies the eastern portion of the basin and relies entirely on groundwater for its water supply. Extensive water delivery systems have long existed in the basin, delivering water to agricultural users areas of the basin with poor water quality or areas that are not readily recharged.

4.3.3.1 WATER LEVELS

Long-term records of groundwater elevations in the Santa Paula Basin indicate that water levels do not recover as readily as in the Piru and Fillmore basins. The channel of the Santa Clara River is located south of the Oakridge fault in the central portion of the basin, and overlies older sedimentary units of low permeability. The basin likely receives significant recharge as underflow from the Fillmore basin. Recent gauging of surface water flows at various locations along Santa Paula Creek and the Santa Clara River suggests the amount of recharge the basin receives from these sources, at least during low-flow conditions, is limited. An extensive flood control project on lower Santa Paula Creek, completed in the late 1990s, may have negatively affected the amount of recharge derived from the watershed of Santa Paula Creek.

Historical groundwater elevations dating from 1923 to present are shown in a hydrograph for United's key well for the basin (Figure 4.3-10). The well is located near Peck Road and Highway 126 in the eastern portion of the basin. In contrast to the key wells from the Piru and Fillmore basins, this Santa Paula basin well shows a long-term decline in water levels. The hydrograph shows that the recorded high groundwater elevation for 2011 was approximately 8 feet lower than

the recorded high groundwater elevation in 1998. The low water level measured in fall 2013 was within 5.5 feet of the February 1991 historic low for this well.

Evaluation of the key well hydrograph and other the hydrographs for other wells located throughout the basin show that water levels in many of the wells (43 of 57 wells) in both the eastern and western portions of the Santa Paula basin failed to fully recover to 1998 levels after near-record precipitation in 2005. This lack of complete recovery is consistent with an observed long-term, gradual decline in basin groundwater elevations (UWCD, 2009; Santa Paula Basin Technical Advisory Committee, 2011).

Figure 4.3-11 and Figure 4.3-12 show groundwater elevation contours in the Santa Paula Basin for spring and fall 2011, respectively. The spring contours represent the annual basin high groundwater elevations and the fall contours represent the annual basin low groundwater elevations. The difference between the spring high groundwater elevations and the fall low groundwater elevations is approximately 10 feet throughout the basin.

The contours show a general east-to-west flow direction with groundwater underflow from the Fillmore basin to the Santa Paula Basin and groundwater underflow from the Santa Paula Basin to the Mound basin. The relatively tight contours just west of the Santa Paula-Fillmore boundary show an area of recharge to the basin. The complex subsurface geology related to extensive faulting in the most western portion of the basin complicates the interpretation of groundwater flow in this area.

4.3.3.2 GROUNDWATER EXTRACTIONS

A histogram of reported basin pumping from 1980 to 2013 is shown in Figure 4.3-13. In recent years municipal pumping has accounted for more than 20% of the total pumping from the basin. The total reported groundwater extractions from 129 active wells in the Santa Paula Basin totaled nearly 26,700 acre-feet for the 2013 calendar year. A new Farmers Irrigation Company well located in the Fillmore basin immediately east of the Santa Paula basin Settlement Boundary pumped an additional 4,400 AF for delivery to the western Santa Paula basin. A 2003 basin study titled "Investigation of Santa Paula Basin Yield" was conducted by experts from the City of Ventura, Santa Paula Basin Pumpers Association and United. The study suggested that the yield of Santa Paula basin is probably near the historic average pumping of about 26,000 acre-feet per year. Additional study of the safe yield of the Santa Paula basin is planned, as modest declines in water levels have been observed in recent years when annual extractions have averaged about 26,000 acre-feet per year.

Figure 4.3-14 is a map showing groundwater extractions by wells in the Santa Paula Basin in year 2013. The map shows significant pumping within the Santa Paula city limits and near the Fillmore basin boundary. Numerous wells report pumping in agricultural areas in the central portion of the basin. Few active wells exist north, west and south of this vicinity. In the western third of the basin,

significant pumping is reported south of Highway 126 and west of Ellsworth Barranca, and in the area north of Highway 126 and west of Brown Barranca.

Several private irrigation companies are active in the Santa Paula basin, operating wells and delivery pipelines that distribute large quantities of water around the basin. Farmers Irrigation Company pumps groundwater primarily from the eastern portion of the basin and distributes the water by pipeline for agricultural use in areas of the central and western basin. Also affiliated with Farmers Irrigation Company are Canyon Irrigation Company and Thermal Belt Mutual Water Company. Canyon Irrigation operates the Harvey Diversion on Santa Paula Creek, and some wells in the eastern basin, delivering water to agriculture in the area of Santa Paula Canyon. Thermal Belt Mutual pumps groundwater from the east basin for pipeline distribution for agriculture in the Foothill Road area and upland area of the north central basin. Alta Mutual Water Company extracts water from the Saticoy area in the west basin, and delivers water primarily to agricultural areas north of Telegraph Road. These extensive water delivery systems were largely established to deliver water to areas of the Santa Paula basin having poor quality groundwater. In the canyons and foothills along the northern flank of the basin, both well production and water quality are generally poor.

4.3.3.3 WATER QUALITY

Water quality is fairly variable throughout the Santa Paula basin, but water quality is generally worse in the western portion of the basin. The maximum recorded TDS concentrations for Santa Paula basin wells in calendar year 2013 are shown in Figure 4.3-15, with the highest concentrations recorded in the west. In these wells sulfate is commonly a large contributor to TDS. Deeper wells in the basin tend to have elevated iron and manganese concentrations, and both the City of Santa Paula and City of Ventura operate treatment facilities to reduce these constituents in delivered municipal water. Recorded nitrate concentrations from wells within the basin are generally low, but two irrigation wells recorded nitrate concentrations slightly over the MCL of 45 mg/l in 2013.

United conducts groundwater quality monitoring at the two nested monitoring well sites in the Santa Paula Basin, and in several production wells in the basin. Mineral concentrations are observed to vary with groundwater elevation in some wells. More thorough characterizations of groundwater quality in the Santa Paula basin can be found in other publications (DWR, 1989; Santa Paula Basin TAC, 2011).

4.3.4 MOUND BASIN

The Mound Basin is located in the westerly portion of the District and has experienced over time a progression of groundwater use that was historically dominated by agriculture, followed by a period of time when municipal and industrial pumping was dominant, and most recently a return to greater pumping by agriculture than by municipal and industrial users. The City of Ventura overlies much of the Mound basin, although some areas of agricultural land use remain.

4.3.4.1 WATER LEVELS

Historical groundwater levels for a key monitoring well in the Mound Basin are shown in Figure 4.3-16. Measured water levels have varied over about a 90-foot range over the period of record for this well, located in the eastern portion of the basin near Kimball Road. An extended period of low water levels was recorded in the late 1980s and early 1990s when water levels declined to below sea level. Water levels recovered in the 1990s and generally have remained more than 15 feet above sea level over the past decade, except when falling below sea level in 2004.

Recharge of the aquifers in this basin comes from multiple sources such as direct precipitation, mountain-front recharge, and subsurface flow from adjoining basins (e.g., Santa Paula, Oxnard Forebay, and Oxnard Plain). Recharge from the Oxnard Forebay and Oxnard Plain is thought to be significant, most notably during periods of high water levels in these adjacent basins (GTC, 1972; UWCD, 2012b). The aquifers utilized for groundwater production are confined.

Groundwater elevation records exist for nearly 60 active and historic wells located within the Mound Basin. A number of important wells have water levels dating to the late 1920s, allowing an evaluation of long-term water level trends within the basin. However, the distribution of wells is heavily skewed towards the southern half of the basin, with relatively few wells existing north of Telephone Road. In the western portion of the basin wells are concentrated along Olivas Park Drive and near the railroad tracks south of Highway 101. This poor distribution of active and historic wells complicates the assessment of potential mountain-front recharge to the basin from the north. The southern and eastern boundaries of the basin are defined by structural features, and water level records from adjacent areas help assess the nature of the basin boundaries in these areas. Water level trends for many wells within the basin are similar, with evidence of recharge from adjacent basins to the east and south (UWCD, 2012b). The main groundwater flow pattern is down the axis of the basin from east-to-west. The slope of the potentiometric surface within the basin is quite flat during dry periods and the gradient increases somewhat following periods of above-average rainfall. During dry periods, groundwater elevations in many wells fall below sea level.

The contouring of past water level conditions is complicated at times by sparse data. Available groundwater elevation data for the spring and fall of 2013 are presented in Figures 4.3-17 and 4.3-18. Increased collection of water level records is recommended in this basin to better define groundwater gradients between this basin and adjacent basins. The recent installation of monitoring wells north of the Santa Clara River near the northwestern margin of the Forebay should be helpful in better defining the flow of groundwater from the Oxnard Forebay to areas north of the Montalvo anticline (see Section 2.1.8). Relatively few wells, however, exist along the southeastern portion of the Mound basin, an area of sparse well records and known structural complexity.

4.3.4.2 GROUNDWATER EXTRACTIONS

The City of Ventura is the major municipal and industrial groundwater pumper in the Mound basin, with its wells concentrated in the area near the Ventura County Government Center. Agricultural pumping was historically the majority use of groundwater in the Mound Basin, but municipal and industrial use exceeded or approximately equaled agricultural use for the period 1999 through about 2006 (Figure 4.3-19). Municipal pumping peaked in 2003 and declined fairly steadily through 2011. Since the mid-1980s agricultural pumping has averaged nearly 4,100 acre-feet per year with a peak annual production of 5,850 acre-feet recorded in 1990. Over the past two years municipal pumping has increased again, and reported pumping in 2013 totaled 7,000 AF, equally divided between agriculture and urban use.

4.3.4.3 WATER QUALITY

While the quality of the groundwater produced by most wells within the Mound Basin is suitable for municipal and agricultural uses, the basin is not known for the high quality of its groundwater. Water quality is variable between wells, and many records indicate somewhat elevated concentrations of TDS, sulfate, hardness and other analytes. Water quality appears to be relatively stable among many of the Mound basin wells having long-term water quality records, although some municipal production wells (e.g., Victoria 1 and 2) in the central portion of the basin have been experiencing declining water quality (i.e., increasing TDS values) that currently reach about 1,800 mg/L. Available records from wells nearest the coast do not show evidence of saline intrusion.

A map showing recorded TDS concentrations in Mound basin wells from 2013 is shown as Figure 4.3-20. The map plots TDS (by summation) from production well samples collected by the Groundwater Section of the Ventura County Watershed Protection District, as well as TDS (by total filterable residue) as sampled by United Water and the City of Ventura. TDS in the production wells ranged from 1,050 to nearly 3,000 mg/l. Sulfate commonly contributes roughly half the TDS in these samples, and water quality results are often variable among nearby wells.

Records from existing monitoring wells within the basin reveal very poor quality water at depths up to several hundred feet in the central portion of the basin. Water from these wells is thought to be connate or perched waters that are not utilized for groundwater supply. The three 2013 samples recording TDS greater than 3,000 mg/l are from monitoring wells with screened intervals shallower than 510 feet below the land surface.

4.3.5 OXNARD FOREBAY

The Oxnard Forebay basin is an area of critical importance to the water resources of the Oxnard Plain. This is the unconfined portion of the Oxnard Plain where units of low permeability are generally absent or discontinuous, allowing water to percolate deep into the ground and recharge

the aquifers which extend from the Forebay to the Oxnard Plain. The basin readily accepts large volumes of recharge water in wet years when abundant surface water is available for recharge. A time series of estimated changes in available groundwater storage within the Forebay is shown in Figure 4.3-21. The graphic shows that storage in the basin can change rapidly. In the dry conditions that have prevailed since spring 2011, groundwater storage in the Forebay has fallen by about 87,500 AF.

Coarse gravel deposits deposited by high flows of the ancestral Santa Clara River are common in the Oxnard Forebay. These gravels have historically been extensively mined, both within the river channel and in nearby upland areas. The high permeability of these coarse alluvial deposits also comprise an ideal substrate for groundwater recharge. Groundwater recharge occurs naturally where water percolates through the bed of the Santa Clara River, and in upland areas near the river where United distributes diverted river water to a series of recharge basins. United's recharge activities are sometimes termed "artificial recharge" because the activities augment the recharge that would naturally occur in this area. The term "managed aquifer recharge" has become more popular in recent years.

Groundwater recharge to the Forebay serves to raise groundwater elevations in this up-gradient area of the groundwater flow system for the Oxnard Plain. High water levels in the Forebay increase the hydrostatic pressure in the confined aquifers extending from the margins of the Forebay to the coastal and offshore portions of these continuous aquifer units. While the physical movement of groundwater out of the Forebay is fairly slow, the pressure response in the confined aquifers distant from the Forebay responds more rapidly to significant recharge events in the Forebay. During wet climatic years the Forebay has the ability to quickly accept large volumes of water, allowing storage of surface water that otherwise would be lost from the watershed. Water stored in the Forebay slowly bleeds out to the outlying areas, flowing naturally from areas of high elevation to areas of lower elevation on the Oxnard Plain and near the coast, which serves to raise or sustain groundwater elevations in wells in down-gradient areas. Groundwater extraction by wells, both in the Forebay and in the confined aquifers of the Oxnard Plain, hastens the decline of Forebay water levels as water is removed from the system. Under drought conditions, groundwater elevations in the Forebay may approach sea level, resulting in flattened groundwater gradients and only minor groundwater flow out of the Forebay. These conditions now exist for the first time since completion of the Freeman Diversion in 1991. While there have been very wet years in the past where groundwater storage in the Forebay has recovered greatly, United's ability to divert and recharge water is now more constrained by regulatory requirements relating to fish migration opportunities. Significant recovery of groundwater storage in the Forebay can still be expected in future wet years, but the degree of recovery may well be less than what has been observed in the past.

4.3.5.1 WATER LEVELS

Groundwater elevation contours for the Upper Aquifer System (UAS) in the spring of 2013 are shown in Figure 4.3-22. Less than 100 AF of water was recharged through United's Saticoy Spreading Grounds in early 2013, as diversions from the Santa Clara River were minor and available surface water was delivered elsewhere. Recorded groundwater elevations at the northern portion of the Forebay were only 50 feet above sea level in spring 2013. Despite a lack of significant recharge activities, a flatter but familiar pattern of groundwater flow radiating from the up-gradient portion of the Forebay to surrounding areas is readily apparent. Groundwater elevations near the southern boundary of the Forebay were less than 25 feet above sea level in spring 2013.

Figure 4.3-23 displays UAS groundwater elevation contours for the Oxnard Forebay and Plain in fall 2013. Groundwater elevations near the Saticoy Spreading Grounds remain about 50 feet above sea level, but elevations fall quickly to less than 10 feet near the midpoint of the basin. A pumping depression associated with the O-H well field at the El Rio Spreading Grounds is apparent, where water levels are below sea level. With low water levels around the perimeter of the Forebay there is the potential for shallow groundwater of the semi-perched zone on the Oxnard Plain to drain into the Forebay. This reverse flow out of this semi-perched zone would be difficult to document without additional wells, but there is some concern about the potential water quality impacts to the Oxnard aquifer.

Historical water level hydrographs from selected wells in the Forebay are shown in Figure 4.3-24. UAS water levels in the Forebay fluctuate by as much as 100 feet, with groundwater elevations dropping below sea level in drought periods and recovering during wet periods. Historic highs were recorded in a number of wells in recent years, following a number of consecutive wet years and the expansion of United's recharge facilities. Extremely dry conditions in the Santa Clara River watershed since spring 2011 have resulted in significant declines among some key wells in the Forebay: in less than three years the water level in United's key well near the Saticoy Spreading Grounds has fallen more than 90 feet and another well in the down-gradient portion of the basin has fallen more than 50 feet.

4.3.5.2 GROUNDWATER EXTRACTIONS

Reported 2013 groundwater extractions from the Forebay totaled nearly 23,500 acre-feet. Figure 4.3-25 shows reported extractions for the basin since 1980. The 2013 reported pumping from the Forebay was less than the average annual extraction rate of 25,000 AF. Pumping from the Forebay is often more variable than in other basins within the District, resulting the variable amount of groundwater pumping for delivery to the Oxnard Plain and Pleasant Valley basins. United's O-H well field is the largest pumping center in the basin, delivering water to coastal areas as part of a management strategy to move pumping away from coastal areas vulnerable to saline intrusion. The City of Oxnard is the largest O-H customer. The City's other two sources of water are their own wells on the Oxnard Plain and State Water imported by and purchased from Calleguas Municipal Water District.

In the 2013 calendar year only 2,400 AF were spread for groundwater recharge at the El Rio Spreading grounds (in contrast to 2011 when some 37,800 AF of water was diverted for recharge at El Rio). Over this same period 12,850 AF was pumped from UAS wells at El Rio for deliveries to the O-H system. In most years United recharges more water at El Rio than is pumped for delivery to O-H customers.

The distribution of UAS pumping for calendar year 2013 is shown in Figure 4.3-26. Significant pumping is apparent surrounding the El Rio Spreading Grounds, where municipal pumping in the basin is centered. The majority of the pumping in the up-gradient areas of the Forebay is for irrigation purposes, including the pumping on the south side of United's Saticoy Spreading Grounds. Wells screened in units of the Lower Aquifer System are relatively uncommon in the Oxnard Forebay, and 2013 pumping from LAS wells is shown in Figure 4.3-27.

4.3.5.3 WATER QUALITY

Water quality records from Forebay basin wells near the Santa Clara River and United's recharge facilities show that groundwater quality in these areas is generally similar to that of the Santa Clara River. The most recharge from the river takes place when flows are high, when water quality in the river is best. Some characterization of Santa Clara River water quality is included in Section 4.2 of this report. During the dry season when river flows are lower and mineral content is generally higher, much of the diverted surface water is blended with well water and used for irrigation in areas served by the PTP and Pleasant Valley pipelines.

Occasional high nitrate concentrations in UAS wells has historically been the water quality issue causing concern in the Forebay. A definitive evaluation of sources of nitrate and flow paths to area wells has proven difficult, but septic systems and fertilizer from irrigated agriculture are commonly believed to be major contributors of nitrate to the groundwater flow system (UWCD, 1998). The highest nitrate concentrations are often observed during drought periods, when nitrogen inputs continue but the diluting influence of natural and artificial recharge is reduced. High nitrate has also been documented in wells as water levels rise following periods of drought, as nitrogen stored in the vadose zones is mobilized as sediments become saturated by a rising water table. Installation of additional monitoring wells in the Forebay has contributed to the understanding that the highest nitrate concentrations are often observed in the shallowest wells (UWCD, 2008). Once high-nitrate water enters the groundwater flow system its movement is likely very complex. An incomplete understanding of nitrate inputs to the Forebay basin and the complexity of water movement in the unsaturated and saturated zones of the subsurface make predictions of future nitrate impacts to area wells impractical.

Maximum-recorded nitrate concentrations from wells in the Forebay and northern Oxnard Plain in 2011 are shown in Figure 4.3-28. With dry conditions prevailing in both 2012 and 2013, nitrate concentrations have increased in a number of production and monitoring wells in the Forebay. Five of the nine active O-H (UAS) wells recorded annual-maximum nitrate concentrations over the health standard. Other public supply wells in the El Rio community recorded high nitrate concentrations,

but purchased water from the O-H system so as to not deliver water which exceeded the MCL for nitrate. Near United's Saticoy Spreading Grounds UAS nitrate concentrations ranged from four to nine mg/l, values that match the range of nitrate concentrations recorded for diverted Santa Clara River water spread nearby.

A major effort to sewer the El Rio community was recently completed, significantly reducing nitrate loading in this areas of shallow unconfined groundwater. Residents and regulators are hopeful that significant nitrate impacts will be avoided in future droughts, but a cautionary statement from a recent UC Davis report on nitrate contamination is repeated here as a reminder that flow paths to production wells are often not well understood, and may be longer and more complex than many might imagine: "Travel times of nitrate from source to wells range from a few years to decades in domestic wells, and from years to many decades and even centuries in deeper production wells. This means that nitrate source reduction actions made today may not affect sources of drinking water for years to many decades" (Harter and Lund, 2012).

4.3.6 OXNARD PLAIN BASIN

Early newspaper accounts suggest that the confined aquifers of the Oxnard Plain were first drilled for water supply wells in the early 1870s. Artesian conditions existed on the Oxnard Plain at this time, and the well installations that received press coverage were wells providing impressive flow at the land surface without a pump in the well. Artesian conditions are believed to have persisted through the late 1800s. The town of Oxnard was established in 1897, and in 1899 a large sugar beet processing facility began operations. The large water demands associated with irrigation of beets and other crops on the Oxnard Plain, along with the growing population and industrial uses, lowered the pressure in the Oxnard aquifer. By the turn of the century widespread artesian conditions were generally absent, requiring wells to be fitted with pumps to lift water from elevations below the land surface (Freeman, 1968).

Over the approximately 110 years since the initial depressuring of the Oxnard Aquifer in the late 1800s, artesian conditions have periodically returned to the Oxnard Plain during wet climatic cycles. Documentation of water levels in the aquifers of the Oxnard Plain are sparse until the early 1930s, but artesian conditions were documented in Oxnard City well #9 in the winters of 1917, 1919, 1922 and 1923 (CA Division of Water Rights, 1928). The early 1940s was a wet period, and widespread artesian conditions likely existed at that time. The year 1945 marked the beginning of a long dry period during which water levels fell across the plain and problems with saline intrusion intensified in coastal areas. These alarming developments at a time of urban and economic growth in Ventura County prompted significant investments in water resource projects, including the O-H well field at El Rio and a pipeline delivery system to urban areas on the coastal plain. In subsequent years pumping patterns continued to change as the City of Oxnard grew. The city once had water supply wells distributed throughout its service area, but now pumping is centralized in two primary well fields. As farmland around the city margins has converted to urban areas, pumping has generally been transferred to the City of Oxnard's main well field in the northern Oxnard Plain. Much of the

population growth in the cities of Oxnard and Port Hueneme has been supported by State Water Project supplies, imported and delivered by Calleguas Municipal Water District.

Widespread artesian conditions were again present on the Oxnard Plain in the late 1990s following the completion of the Freeman Diversion and high precipitation totals in 1993, 1995 and 1998. More recently, artesian conditions periodically existed in coastal areas surrounding Port Hueneme, and are more common in UAS wells than in wells with deeper screened intervals. Near Point Mugu in the southernmost portion of the Oxnard Plain, water levels have remained below sea level for decades in both the UAS and LAS.

Following a period of drought in the 1970s and expansion of the areas impacted by saline intrusion, the Fox Canyon Groundwater Management Agency (FCGMA) was established in 1982 as a local agency with regulatory authority to bring overdraft conditions under control in southern Ventura County. The agency has successfully implemented a number of mandatory cutbacks for production from public supply wells, and agricultural pumpers are required to demonstrate the use of efficient irrigation practices. One early strategy was a shift of pumping from the Upper Aquifer System to the Lower Aquifer System on the Oxnard Plain. This shift in pumping resulted in improved conditions in the UAS but considerable overdraft of deeper aquifers. An update to the FCGMA's management plan was completed in 2007, and describes a number of projects and strategies that might be employed to bring pumping in the Oxnard Plain, Pleasant Valley and Las Posas basins into balance with recharge to the aquifers of these highly-developed basins (FCGMA, 2007).

The primary water quality concern on the Oxnard Plain is water quality degradation associated with the intrusion of saline waters. The direct lateral intrusion of seawater remains the primary threat in coastal areas, with the near-shore submarine canyons at Port Hueneme and Point Mugu exposing aquifer beds to the sea. The vertical movement of deep brines and shallow water of poor quality has also been documented. This movement of poor-quality groundwater is also related to overdraft conditions, but is not limited to coastal areas. Nitrate problems have been documented periodically in specific Oxnard Plain wells. In some cases this nitrate problem is likely related to the downward movement of poor-quality water, in other locations it may be related to nitrate contamination sourcing from the Oxnard Forebay (UWCD, 2008).

4.3.6.1 WATER LEVELS

As discussed in the groundwater basin descriptions of the Oxnard Forebay and Oxnard Plain, large volumes of groundwater flow from the Oxnard Forebay to the Oxnard Plain. Contouring of recorded UAS water levels from wells shows that groundwater flows radially from recharge areas in the Forebay to surrounding areas (Figures 4.3-22 and 4.3-23). Recharge from the Forebay serves to raise or sustain water levels in wells on the Oxnard Plain, countering the decline in groundwater elevations resulting from groundwater extractions. When water levels are high across the basin groundwater may flow past the coastline to the offshore extension of the aquifers of the plain, or exit the system at near-shore canyons as discharge to the sea.

Precipitation totals for the 2012-13 water year were only about a third of average. Only about six inches of rain was measured in Santa Paula, and no single day recorded rainfall greater than one inch. The lack of any significant storm event resulted in very low flows in the Santa Clara River throughout the year, limiting the amount of water available for artificial recharge in the Forebay. Recorded high water levels on the Oxnard Plain in spring 2013 were similar to those measured in fall 2012.

Selected hydrographs for UAS wells on the Oxnard Plain are shown in Figure 4.3-29. It is typical for water levels in the confined aquifers of the Oxnard Plain to exhibit a distinct annual signature, with increased pumping stresses and reduced recharge in the summer and fall resulting in water level declines of ten feet or more, followed by some degree of recovery the following winter and spring. The absence of notable recharge to the basin in winter 2013 resulted in a continuous water level decline in most wells over the past two years. Fall 2013 water levels are below sea level in all the well hydrographs shown in Figure 4.3-29. Contours of fall 2013 water levels across the basin are shown in Figure 4.3-24. The zero elevation (sea level) contour is mapped in an arc extending northeast from Port Hueneme to an area north of Fifth Street near downtown Oxnard. Approximately half the area of the Oxnard Plain is below sea level, including an area in the northeastern portion of the basin.. In the southern Oxnard Plain groundwater elevations in Oxnard aquifer wells in some areas are more than 20 feet below sea level. In the area south of Hueneme Road, piezometric heads in the Mugu aquifer of the UAS are commonly at least 20 feet lower than those in the Oxnard aquifer.

Groundwater elevations from Lower Aquifer System wells are contoured for the spring and fall of 2013 for the Oxnard Forebay, Oxnard Plain and Pleasant Valley basins (Figures 4.3-30 and 4.3-31). In the spring of 2013 a pumping depression centered near the Oxnard Plain/ Pleasant Valley basin was clearly visible. By fall 2013 the depression is much deeper and broader. Groundwater elevations in the central plain south of the Camarillo Hill are more than 130 feet below sea level, and 80 feet below sea level at the coast near the Mugu submarine canyon. Available records suggest that only small portions of the basin near the recharge areas (northern Oxnard Forebay, northern Pleasant Valley) remain above sea level.

These contours show a revised interpretation for LAS groundwater flow in the central and western Oxnard Plain. Evaluation of well construction, interpretation of geophysical well logs and construction of stratigraphic cross-sections for the area indicate that a number of wells in the Oxnard Forebay and north Oxnard Plain, utilized in the past for LAS contours, and previously classified as LAS wells, are likely influenced by higher heads in the UAS. Some of these wells may be screened in both the LAS and UAS. South of a certain point these "shallow LAS" wells are absent, and wells are screened much deeper due to structural and stratigraphic changes in the subsurface. The inclusion of the "shallow LAS" wells in earlier contouring resulted in a steep break in groundwater elevations that was thought to be indicative of a structural barrier to groundwater flow. The newer interpretation of LAS groundwater elevations functionally expands the pumping depression seen along the eastern Oxnard Plain and western portions of the Pleasant Valley basin

north into the Forebay. LAS groundwater elevations above sea level near the Saticoy Spreading Grounds, however, indicates that the LAS pumping depression does not extend north to this area of the Forebay. Water level records and associated contouring shows that in the aquifers of the LAS, groundwater flows from the Oxnard Forebay to the large pumping depression in the eastern Oxnard Plain and the Pleasant Valley basin.

Also notable in this interpretation (of deeper LAS wells) is higher LAS heads along the coast in the western Oxnard Plain than in most other areas of the basin. Maps showing LAS pumping locations within the basin (next section) are consistent with the contouring. The LAS contouring presented here is somewhat preliminary and subject to modification in the future as work on the hydrogeology in this area is ongoing.

In the northwestern Oxnard Plain, LAS groundwater flow is likely from the Oxnard Forebay towards the coast. Few LAS wells exist in this area (Figure 4.3-27), as recharge to the Oxnard Forebay is very effective in sustaining groundwater elevations in this area (UWCD, 2010). LAS wells near Victoria Avenue and the northern boundary of the Oxnard Plain record groundwater elevations similar to nearby UAS wells (UWCD, 2010). The exclusion of "shallow LAS" groundwater elevations from Figures 4.3-30 and 4.3-31 provides an incomplete representation of LAS heads in the northwestern Oxnard Plain.

Historical water level records from selected LAS wells on the Oxnard Plain are shown on Figure 4.3-32. Periods of drought (notably ~1989-1991) are clearly evident in some of the wells, with measured water level declines exceeding 100 feet in some wells. Annual water level fluctuations of greater than thirty feet are common in the confined conditions of the LAS. As shown in the figure, the LAS hydrographs show fall 2013 water levels at more than 100 feet below sea level in Pleasant Valley and in the east-central Oxnard Plain. Water levels in wells near the coast are more muted, as recharge by seawater prevents heads from falling as low as they do in inland areas.

While the occurrence of land subsidence is not well documented in Pleasant Valley and on the Oxnard Plain, concern about increased subsidence is justified as water levels in the LAS approach historic lows.

4.3.6.2 GROUNDWATER EXTRACTIONS

The groundwater resources of the Oxnard Plain are heavily utilized to support overlying land uses. The area is famous for its highly productive agriculture, supporting year-round production of a wide variety of agricultural products. Groundwater supports much of the agriculture on the Oxnard Plain, but surface water is available in some areas. The area also supports an extensive urban population. The Cities of Oxnard and Ventura maintain active wells on the Oxnard Plain, but also rely on other sources of water. The City of Port Hueneme and other coastal communities generally maintain wells in reserve status and import water from inland areas given their location near the coast and vulnerabilities with respect to seawater intrusion.

The distribution of reported UAS pumping shown in Figure 4.3-26 is typical of pumping patterns in recent years. The City of Oxnard operates several wells at its main well field near Third Street and Oxnard Blvd., and at a smaller facility some distance to the northeast. Aside from these locations UAS pumping is uncommon in the urban areas of the Oxnard Plain. Agricultural interests pump extensively from the UAS in the northwest Oxnard Plain, as well as in the northeastern portion of the basin near the Oxnard Forebay. Additional pumping is scattered across the central Plain east of the City of Oxnard, where a number of wells reporting minor pumping are small domestic wells. Few UAS wells are active south of Hueneme Road on the southern Oxnard Plain.

The distribution of LAS pumping on the Oxnard Plain is concentrated in the eastern half of the basin, as shown in Figure 4.3-27. Near the basin boundary in the northwestern Oxnard Plain the City of Ventura operates two wells at the Ventura Municipal Golf Course, and exports water for municipal use in the Mound basin. LAS extractions are common for irrigation in the northeastern Oxnard Plain, as they are in the east-central portion of the basin. South of Hueneme Road LAS aquifers are pumped extensively for irrigation, in contrast to the UAS which is pumped very little in this area. Also notable is the near-absence of LAS pumping in the northwest portion of the basin.

A histogram of historical extractions from the Oxnard Plain are shown in Figure 4.3-33. Reported pumping for agricultural and municipal uses were greater in 2013 than in any year since 1990. The percentage of agricultural pumping is typically slightly greater in dry years, as less of the irrigation demand for various crops is satisfied by rainfall.

Some 60,900 acre-feet of pumping reported on the Oxnard Plain in 2013, about 10,000 AF more than was reported in 2011 and 2012. In the years 1985-1990, annual extractions totaling more than 70,000 AF were not uncommon. The Freeman Diversion was completed in 1991, which improved the quantity and reliability of surface water delivered to the Oxnard Plain. Municipal and Industrial (M&I) pumping has been subject to cutbacks mandated by the FCGMA, beginning with 5% in 1992 and currently at 25%. Municipal pumping has not actually been reduced by this amount: pumping allocations have been transferred to the Cities of Oxnard and Camarillo, as these cities have expanded into agricultural areas. As noted in earlier sections, large volumes of potable water are imported from both the Oxnard Forebay and from northern California, so the extraction totals represented in Figure 4.3-33 are less than the total demand for agricultural and M&I water in the area.

4.3.6.3 WATER QUALITY

Seawater intrusion was first recognized on the Oxnard Plain in the 1930s and since that time this issue has dominated water quality concerns in southern Ventura County (CA DWR, 1971; FCGMA, 2007). In areas not impacted by saline intrusion, groundwater quality is somewhat variable among wells but generally is adequate for most agricultural and municipal/industrial uses. Water in the confined aquifers of the Oxnard Plain tends to be somewhat mineralized due the marine deposition of many of the aquifers (TDS, sulfate, iron, manganese), but contamination by organic

contaminants is uncommon (Burton et al, 2011). Nuisance concentrations of iron and manganese are most commonly associated with LAS wells where reducing conditions are present.

In the northern portion of the Oxnard Plain samples for some wells in 2013 show elevated concentrations of nitrate. The provenance of the high nitrate detected in these wells is generally difficult to determine, but high and variable concentrations are likely related to the downward leakage of near-surface waters (Izbicki, 1992, Zohdy et al, 1993). On the southern Oxnard Plain nitrate concentrations in wells are not commonly detected, and the rare detects are likely related to damaged or improperly constructed wells.

Recorded chloride concentrations across the central Oxnard Plain were consistently low in 2013, as shown in Figure 3.4-34. These values are similar to native chloride concentrations in the basins of the Santa Clara River Valley. South of Hueneme Road some wells record chloride concentrations of greater than 16,000 mg/l, concentrations similar to seawater.

4.3.6.3.1 SALINE INTRUSION

Since the 1930s the southern Oxnard Plain in Ventura County has been subject to seawater intrusion. The Oxnard, Mugu, Fox Canyon, and Grimes Canyon aquifers are believed to be geologically vulnerable, to varying degrees, to seawater intrusion by their exposure in offshore outcrop in the walls of submarine canyons and along the broader offshore shelf. Concerns related to the expansion of intruded areas in the 1970s and 1980s helped motivate local funding for cooperative studies with the U.S. Geological Survey.

In 1989 the U.S. Geological Survey initiated the Regional Aquifer-System Analysis (RASA) study in the Santa Clara-Calleguas groundwater basin. As part of this project a series of fourteen nested monitoring well sites were installed in coastal areas. Extensive sampling was conducted, and a number of advanced analytical techniques were used to provide a much better understanding of the nature and extent of saline intrusion on the Oxnard Plain. The USGS studies concluded that some areas classified as seawater intrusion in the past were in fact subject to increased chloride concentrations from connate saline water squeezed from fine-grained sediments within and separating the aquifers (Izbicki, 1992). The USGS mapped areas of high salinity in the major aquifer units of the southern Oxnard Plain, and classified sources of salinity as either seawater intrusion or saline intrusion from local sediments. A major product of the RASA study for the Santa Clara-Calleguas study area was a calibrated groundwater flow model. A solute transport component of the model was proposed in the scoping of the study, but this component was later abandoned after initial efforts proved unsuccessful.

United continues to sample the network of monitoring wells on the southern Oxnard Plain. In all of the recent samples from the southern Oxnard Plain, calcium or sodium are the dominant cations. Among samples not affected by high salinity, sulfate and bicarbonate are the dominant anions. For most samples impacted by saline waters, sodium and chloride are the dominant ions (UWCD, 2007). Major ion analysis is helpful in determining chemical conditions and changes over time, but

not necessarily the source of brine causing water quality degradation. Researchers from the USGS have advanced methods for determining whether high chloride is sourcing from direct seawater intrusion or rather from deep or stranded brines (Izbicki, 1992 and Izbicki et al, 2005a). The minor ions iodide and bromide, along with the trace elements boron and barium, are useful indicators for delineating the source of brines impacting fresh aquifers. Analysis of minor ion concentrations and trace element ratios from coastal monitoring wells suggest that some wells are impacted by the recent intrusion of seawater via the near-shore submarine canyons at Port Hueneme and Point Mugu. Other wells are likely impacted by inland brines, such as those expelled from buried fine-grained marine deposits. Clays within these deposits compact over time in response to regional pumping stresses, allowing the brines to enter adjacent permeable beds within the aquifer system (UWCD, 2007).

Over the past decade the sampling of coastal monitoring wells has indicated that near Port Hueneme chloride conditions have generally improved as heads in most aquifers have remained near or above sea level. United's sampling of wells and contouring of groundwater elevations in this area suggest the chloride plumes associated with past periods of drought are now migrating southeast towards the Mugu area, most notably in the UAS (UWCD, 2004). Figure 4.3-35 displays chloride records for selected UAS monitoring wells in coastal areas of the southern Oxnard Plain. The figure shows well A1-195 located north of Port Hueneme has totally recovered from chloride impacts in the early 1990s. The chloride plume shown east of Hueneme Harbor likely extended north from Hueneme Canyon during the drought (chloride spike in well A1-195), and since that time the plume has slowly shifted towards the southeast (groundwater flow is perpendicular to the groundwater elevation contours shown on Figure 4.3-23). Within the plume of displaced seawater, samples from well CM4-275 remain above 6,000 mg/l, and chloride continues to rise in well CM7-190 some 20 years after the drought ended. In the Mugu area, however, saline groundwater would likely flow out from the groundwater basin if a significant seaward groundwater gradient could be maintained, but such conditions have not existed for many years. In inland areas surrounding Mugu Lagoon aquifers of the UAS remain impaired by high chloride. One well in the western portion of this area has shown some improvement in recent years, but chloride is still over 2,000 mg/l (Figure 4.3-35). Other UAS wells show continued degradation by either brines or direct intrusion of seawater (UWCD, 2007). With depressed water levels in the basin, another period of active seawater intrusion is now underway. While seawater is believed to be entering the aquifers of the UAS in the areas surrounding Hueneme and Mugu Canyons, high chloride concentrations from this new episode of seawater intrusion has not yet reached the coastal monitoring wells.

Selected chloride time series for Lower Aquifer System monitoring wells on the southern Oxnard Plain are shown in Figure 4.3-36. Near Hueneme Canyon few wells show chloride impacts, but well CM2-760 shows increasing chloride at concentrations greater than 10,000 mg/l. In the greater Mugu area chloride degradation is severe in a number of wells, and chloride is trending upwards in many wells. Degradation by brines continues unabated in LAS monitoring wells at the Q2 well site, located about two miles north of Mugu Canyon. Degradation in these wells is related to chronically depressed water levels in the area, allowing brines to migrate into the aquifers from surrounding

sediments or deeper zones hosting poor-quality groundwater (UWCD, 2007). These trends are expected to continue as water levels remain severely depressed in the LAS in both coastal and inland areas.

Given the chronic groundwater depression existing north and northeast of the Mugu area, basin managers wish to better understand the extent of existing chloride impacts and the potential for further degradation. While additional monitoring wells allow the ability to sample discrete zones within an aquifer and identify vertical head gradients, expansion of the network of monitoring wells is fairly expensive. In recent years United has conducted geophysical studies to gain some information on chloride conditions in areas where wells are not available.

In 2010 United conducted a Time Domain Electromagnetic (TDEM) geophysical survey on the southern Oxnard Plain to assess the lateral extent of saline water intrusion over four different depth ranges (UWCD, 2012a). The survey was designed to replicate a study performed by the USGS in the early 1990s, conducted as part of the RASA project (Zohdy et al, 1993). United's field survey area was approximately 35 square miles and extended along the coast between Port Hueneme and Point Mugu (approximately 7 miles) and inland for approximately 5 miles. One hundred twenty five soundings were collected throughout the study area and the data were forward and inverse modeled for each sounding. The model data were used to construct resistivity maps, at four depth ranges typical of the UAS and LAS.

United's TDEM investigation was successful at delineating earth resistivity values that are typical of saline and brackish water in both the Upper and Lower Aquifer Systems. Resistivities typical of saline water occurred along the coast and extended farther inland near Point Mugu with brackish water inferred at various locations inland. An image of contoured resistivity values at depths approximating the lower portions of the UAS are shown in Figure 4.3-37. A second image of contoured resistivity values for the shallower portions of the LAS are shown in Figure 4.3-38. Groundwater salinity estimates from the TDEM surveys generally correlated well samples from areas monitoring wells. The work suggested that geologic features such as paleochannels may affect groundwater flow and the migration of chloride, particularly in deposits of the UAS (UWCD, 2012a).

Local water managers share a common desire to better understand the extent of saline water impacts on the southern Oxnard Plain and how rapidly it might be migrating toward pumping depressions that exist within the basin . There are relative few monitoring wells in the coastal areas of the southern Oxnard Plain and the extent of saline impacts is not precisely known, but it is well understood that elimination of groundwater overdraft conditions will largely mitigate the worsening of chloride impacts on the southern Oxnard Plain. Prevention of additional water quality degradation is a common goal for all stakeholders as degraded aquifers can negatively affect land values. Restoration of degraded aquifers is also a difficult and expensive prospect, especially in areas already suffering from groundwater overdraft. United recently retained an engineering firm to study the feasibility and expense of desalting brackish groundwater in coastal areas and delivering the treated water to growers on the Oxnard Plain.

4.3.7 PLEASANT VALLEY BASIN

The Pleasant Valley basin lies adjacent and east of the Oxnard Plain, occupying the area south of the Camarillo Hills. The entire area of the basin falls within the Calleguas Creek watershed. Aquifers of the Upper Aquifer System are poorly developed in this basin and dominated by fine-grained deposits. This change in UAS deposits forms the basis for the basin boundary with the Oxnard Plain. Aquifers of the Lower Aquifer System are continuous with areas to the west on the Oxnard Plain. The City of Camarillo occupies the northern portion of the basin and operates public supply wells located outside of United's boundaries. Agriculture is the predominant land use in the remainder of the basin, where the Pleasant Valley County Water District (PVCWD) operates an extensive water delivery system. United has delivered surface water from the Santa Clara River to PVCWD since 1958. Completion of the Conejo Creek Diversion in 2002 brought additional surface water to the Pleasant Valley area.

4.3.7.1 WATER LEVELS

Most wells in the Pleasant Valley basin area are completed in units of the Lower Aquifer System. Some wells are perforated in coarse basal units of the UAS, but pumping and water level measurements from UAS wells are uncommon as the UAS in the Pleasant Valley basin is predominantly comprised of fine-grained sediments (UWCD, 2003). United does not attempt to contour UAS water levels in the Pleasant Valley basin.

Groundwater elevation hydrographs for selected LAS wells are shown in Figure 4.3-39. The LAS well located in the northeast corner of the Pleasant Valley basin near Las Posas Road and Lewis Road recorded groundwater elevations approximately 140 feet below sea level in the early 1990s. Since the early 1990s water levels in this well have increased dramatically, reaching levels of about 140 feet above sea-level in 2011. This recovery is related to increased surface water flow in Arroyo Las Posas and the associated groundwater recharge in the northern portion of the basin. Since the 1990s flow in the Arroyo Las Posas has increased dramatically, largely due to population growth in upstream areas and related water imports and wastewater discharges (LPUG, 2011). This recharge in recent years has lead to the recognition that the basin is unconfined in this area and may be considered a forebay area for the Pleasant Valley basin (Hopkins, 2008). Some recovery in this well is likely related to the relatively wet period the area has experienced since the drought period ending in 1991. The degree to which this recharge has influenced water levels in the central portion of the basin remains a topic worthy of further study.

The groundwater elevation hydrograph for the LAS well located at the intersection of Las Posas Road and Pleasant Valley Road shows a clear decline during the drought conditions of the late 1980s, with water levels reaching approximately 180 feet below sea level in 1991. Since that time, with the onset of a relatively wet period, groundwater elevations increased steadily except for a slight decline during a dry period from 2002 to 2004. From 2005 through 2011 groundwater elevations remained below sea level but higher than the water levels recorded in the late 1980s and

early 1990s. This recovery is likely related to the utilization of surface water diverted from Conejo Creek and delivered to agricultural users in the basin. Camrosa Water District constructed the Conejo Creek Diversion in 2002 and has negotiated agreements to provide water to Pleasant Valley County Water District (PVCWD), a major supplier of agricultural water in the Pleasant Valley basin. From 2004 to 2011, diversions from Conejo Creek have averaged approximately 5,600 acre-feet per year. Use of this water for irrigation has reduced pumping demands on the basin. Despite the general water level recovery in this well over the past twenty years, records from fall 2013 show levels have fallen to about 90 feet below sea level.

The groundwater elevation hydrograph for a well in the southern Pleasant Valley area, located along Laguna Road, shows a 1991 drought groundwater elevation of 174 feet below sea level. Since 1993, groundwater levels have returned to pre-drought levels and annual high water levels have remained fairly stable. Annual variability in groundwater elevation appears to be greater following the drought, which could be the influence of a nearby well. Unlike some wells in the northern portion of the basin, spring high water levels recorded in this well are not appreciably higher than they were in the 1980s. The highest recorded groundwater elevation for this well is approximately twenty feet below sea level.

Groundwater elevation contours for LAS wells measured in spring and fall 2013 are shown in Figures 4.3-30 and 4.3-31. The spring LAS contours on the maps show the significant pumping depression that exists in western Pleasant Valley and the eastern Oxnard Plain, where groundwater elevations are well below sea level over a broad area. The fall map shows a pumping depression over several square miles with groundwater elevations more than 120 feet below sea level. The severely depressed water levels in the basin promote the upwelling of brines from deeper formations, the compaction of both aquifers and aquitards, and land subsidence.

The contours for both spring and fall indicate groundwater flow from the west Oxnard Plain and from the Oxnard Forebay to the north. A steep groundwater gradient likely exists between the main pumping depression and the recharge area along Calleguas Creek in the northern part of the basin, but this area is not contoured due to sparse well control and the unknown influence of faulting in the northern basin.

4.3.7.2 GROUNDWATER EXTRACTIONS

Maps showing reported groundwater pumping from LAS wells in the Pleasant Valley basin and on the Oxnard Plain are shown in Figure 4.3-27. The northern and eastern portions of the basin fall outside of United's district boundary, and pumping in those areas is not shown on figures in this report. Pumping from the LAS within United's district boundaries is concentrated along the western portion of the basin, and aligns with the areas where water levels are deepest in the basin. Pumping of the UAS is limited, and skewed towards the eastern portion of the basin (Figure 4.3-26). A majority of the UAS wells report minor pumping and are likely used for domestic supply.

Reported Pleasant Valley basin pumping for the area within United's boundaries is shown in Figure 4.3-40. In 2013 pumping was the greatest since 1991, totaling 18,700 AF. Pumping from the Pleasant Valley basin is fairly variable, in large part due to the significant surface water deliveries that are possible during years of above-average precipitation.

4.3.7.3 WATER QUALITY

The map showing the maximum groundwater chloride concentrations recorded in 2013 is shown as Figure 4.3-34. Samples from wells in the Pleasant Valley basin are distinctly higher than those from the Oxnard Plain to the west (except for the intruded areas near the coast). Many wells in the Pleasant Valley Basin had chloride concentrations well over 100 mg/l, a common advisory chloride level for sensitive agricultural crops. A number of the samples are from wells operated by Pleasant Valley County Water District, which blends well water with surface water diverted from Conejo Creek and the Santa Clara River before delivery to areas growers.

During the RASA study in the early 1990s USGS investigators recognized high chloride in some Pleasant Valley basin wells. Innovative sampling techniques were employed to profile flow and chloride concentrations in deep production wells. It was recognized that the highest chloride and TDS concentrations were commonly sourcing from the deepest portions of these deep LAS wells, and that these zones contributed little water to the well. In 2001 United sought and was awarded an AB303 grant from the California Department of Water Resources to study the nature of the inland saline intrusion problem in the Pleasant Valley basin (UWCD, 2003). A major part of this study was depth dependent sampling and flow profiling of eight deep production wells in the basin. The USGS was contracted to perform this work, which included chemical analysis of major ions and trace elements as well as specific isotopes and chemical tracers. The report concluded that chloride increased with pumping during past period of drought, and that increased delivery of surface water to the area of the Pleasant Valley Basin pumping depression would help groundwater levels recover and likely decrease chloride concentrations in water produced from deep wells in the basin.

In 2005 the USGS published technical papers detailing the results of their sampling of Pleasant Valley wells, which included depth-dependent groundwater sampling, flow profiling, and analysis of isotopic and chemical tracers (Izbicki et al, 2005a; Izbicki et al, 2005b). The results detailed by the USGS included that: 1) high chlorides were entering wells from various sources at different depths; 2) concentrations of chlorides in the upper portion of some wells influenced by irrigation return flow were as high as 220 mg/L; 3) concentrations of chlorides in wells with depths greater than 1400 feet were as high as 500 mg/L and had the chemical and isotopic composition trending toward oil field production water in the area; 4) higher chloride concentrations occurred in deep wells near faults that bound the valley such as the Camarillo fault in the north basin and the Bailey Fault on the south side of the basin; and 5) chlorides increase with increased pumping during droughts.

A recommendation by the USGS was that sealing off the low-yield and poor-quality lower portions of some deep wells would act to improve water quality in many production wells without sacrificing

appreciable yield. The 2013 chloride concentrations shown in Figure 4.3-34 suggests that a majority of the wells in the basin are impacted by elevated chloride concentrations. These impacts are likely to continue as chronic overdraft conditions persist in the basin and deep brines migrate upward in response to the hydraulic gradients produced by over-pumping. Figure 4.3-41 displays maximum chloride concentrations from calendar year 1990, a year when extensive sampling was conducted by the USGS as part of the RASA study. In this drought year few wells recorded chloride less than 100 mg/l. Comparison of chloride records from 1990 to 2013 reveals that recent samples from a number of wells record higher chloride now than they did in a past period of drought.

Recharge water sourcing from Arroyo Las Posas in the northern portion of the Pleasant Valley basin is another significant chloride input to the basin. Chloride loading associated with this recharge is currently under evaluation as part of a proposed desalter project for this area. The effort is being lead by the City of Camarillo. Calleguas MWD has constructed an ocean outfall and brine line ("Salinity Management Pipeline") to inland areas along Calleguas Creek. This pipeline is a tremendous development for the region, as a number of desalters are expected to be built to improve the quality of water delivered to both municipal and agricultural users.

4.3.8 WEST LAS POSAS BASIN

The West Las Posas basin is the western-most of a series of three subbasins that are referred to collectively as the Las Posas basin. The other subbasins of the Las Posas basin are the East Las Posas basin and South Las Posas basin. The West Las Posas basin is bounded to the north by South Mountain, to the south by the Camarillo Hills, to the west by the Oxnard Plain and to the east by the East Las Posas basin. Only approximately the western one-third of the West Las Posas basin is included within the boundaries of United Water Conservation District (Figure 1-1).

The Los Posas Basin Users Group (LPUG) is currently in the process of formulating a Basin Specific Groundwater Management Plan for the Las Posas Basin. The portion of the basin within the District, however, is excluded from the Plan. Del Norte Mutual Water Company made a formal request of the LPUG to be excluded from the current Las Posas basin plan on the basis of groundwater conditions, groundwater source, and political jurisdiction. LPUG agreed that the District's portion of the Las Posas basin does not have to be managed under the Las Posas basin plan, because groundwater users pay pump charges for groundwater recharge and management activities conducted by United (LPUG, 2011). Although the United portion of the West Las Posas basin will not be managed by the LPUG plan, it will be monitored because it is hydraulically connected to the remainder of the West Las Posas subbasin.

4.3.8.1 WATER LEVELS

Groundwater levels have been monitored for nearly a century in the Las Posas Valley. Groundwater elevations in the West Las Posas Basin are monitored by UWCD and Ventura County

Watershed Protection District (VCWPD) with private entities also providing data. Fewer wells are monitored in this basin than for most other basins within the District.

In the West Las Posas basin, piezometric heads range from approximately 100 feet below mean sea level (msl) near the Central Las Posas fault to approximately 50 feet above msl near the Oxnard Plain, indicating a general northwest to southeast flow direction (LPUG, 2011). The flow pattern in the West Las Posas basin suggests the aquifer is receiving inflow from the Oxnard Plain and recharge along the northern flank of the valley. Groundwater moves across the subbasin toward an area of focused pumping near Bradley Road where there has been a long history of depressed water levels (LPUG, 2011).

4.3.8.2 GROUNDWATER EXTRACTIONS

During calendar year 2013, a reported 4,000 acre-feet of groundwater were pumped from the portion of West Las Posas basin that lies within United's boundaries. The areal distribution of pumping in the UAS and LAS in 2013 is shown in Figures 4.3-26 and 4.3-27. Reported groundwater extraction from the basin has generally been increasing in recent years (Figure 4.3-42). The Del Norte Water Company pumps water from its well yard located near Highway 118 and Santa Clara Avenue on the Oxnard Plain, and delivers this water for agricultural use in northern portions of the West Las Posas Basin within United's District boundary. In 2013 Del Norte pumped and exported nearly 3,000 acre-feet from the Oxnard Plain to the West Las Posas Basin.

4.3.8.3 WATER QUALITY

Water quality samples from wells in the West Las Posas basin indicate groundwater quality is generally adequate for agricultural and municipal use, however, localized exceedances of the MCL for TDS, nitrates, and sulfates have been reported.

Ventura County Watershed Protection District (2014) reports that for the average TDS among the ten wells sampled in 2013 was 874 mg/l, and two wells had nitrate concentrations above the MCL for nitrate. Groundwater with this degree of mineralization is common throughout United's service area. In the West Las Posas basin TDS and chloride concentrations tend to be higher in the northern and western portions of this basin compared to other areas, suggesting that mountain front recharge along the southern flank of South Mountain and inflow from the Oxnard Plain Basin are the sources of higher TDS and chloride concentrations (LPUG, 2011).

5 SUMMARY

With two years of below-average rainfall in 2012 and 2013, the basins within United's service area are showing signs of stress. Groundwater elevations have fallen in all basins, and water levels across much of the coastal plain are now below sea level. A renewed period of active saline intrusion is now underway. Water quality problems associated with reduced rainfall and recharge are also apparent in some inland areas where nitrate, chloride and TDS concentrations are causing problems for some users of groundwater. Groundwater conditions are expected to deteriorate further over the summer and fall of 2014. Dry weather is expected for these months and there will not be a conservation release from Lake Piru in fall 2014. Much of United's current infrastructure is designed to maximize the use of surface water from the watershed of the Santa Clara River, but these projects are of limited use when the river is dry. Even when wet conditions do return to the area, the recovery of groundwater storage in the coastal basins is expected to be slower than it was in 1991-1995. United's ability to divert water at the Freeman Diversion is likely to be less than in prior years due to regulatory constraints associated with endangered species issues, and multiple wet years may not occur again following this period of drought.

United Water continues to evaluate various strategies to best manage and protect the surface and groundwater resources within the District. Current and on-going considerations include: the characterization of groundwater conditions, the most-efficient use of existing infrastructure and the need for additional or modified facilities, current and future water demands, current and anticipated water quality issues, and effective utilization of existing allocations of imported State Water Project water. United Water's goal is to identify the best use of local water resources and infrastructure, and to work with other agencies to implement these strategies, while honoring a coherent strategy and set of priorities that guides all future infrastructure and water management decisions.

The District's groundwater and surface water projects and programs are keyed to the issues and concerns that impact or potentially impact the water resources of the region. These issues and concerns evolve over time and United Water strives to adjust, modify, or devise new projects or programs in response to changing water resource challenges. Many of the projects and programs undertaken by United Water have long-term implementation schedules (e.g., District-wide groundwater level measurements, conservation releases), however, these types of efforts provide the critical data needed to make sound water resource management decisions that provide for the maintenance of reliable, sustainable, local water resources for the benefit of both agricultural and municipal and industrial water users in central and southern Ventura County. United is encouraged by the desalters and advanced water treatment plants that are either planned or under construction in the region, and it hopeful that these facilities will serve to lessen long-term demands on the groundwater basins.

6 REFERENCES

Bachman S., Hauge, C., McGlothlin, R., Neese, K., Parker, T., Saracino, A ., and Slater, S., 2005, California groundwater management 2nd Ed., Groundwater Resources Association of California, 272 p.

Burton, C.A., Montrella, Joseph, Landon, M.K., and Belitz, Kenneth, 2011, Status and understanding of groundwater quality in the Santa Clara River Valley, 2007—California GAMA Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2011–5052, 86 p.

California Department of Water Resources, 2003, California's groundwater, Bulletin 118 update 2003, dated October 2003, 222 p.

California Department of Water Resources, 1989, Update of Basin Plan for Piru, Sespe, and Santa Paula Hydrologic Areas: Final Project Report dated June 1989.

California Department of Water Resources, 1980, Ground water basins in California: California Department of Water Resources Bulletin 118-80, 73p.

California Department of Water Resources, 1975, Compilation of Technical Information Records for the Ventura County Cooperative Investigation: California Department of Water Resources, Volume 1.

California Department of Water Resources, 1971, Seawater intrusion: aquitards in the coastal ground water basin of Oxnard Plain, Ventura County: California Department of Water Resources Bulletin 63-4, 567p.

California Department of Water Resources, 1954, Seawater intrusion: Oxnard Plain of Ventura County: Bulletin No. 63-1, 59p.

California Division of Water Rights, 1928, Ventura County Investigation, 228p.

California Invasive Plant Council, 2011, Jason Giessow, Dendra Inc. (Chapters 2, 4.2, 5.2, 6-10), Jason Casanova, Los Angeles and San Gabriel Rivers Watershed Council (Chapters 3, 5.2), Rene Lecler, Robert MacArthur, Norwest Hydraulic Consultants (Chapter 5.1), Genie Fleming, Consultant (Chapter 4.1), Jesse Giessow (Else), Dendra Inc. (Chapter 1), *Arundo donax* (giant reed): Distribution and Impact Report, dated March 2011.

CH2M HILL, 2006, Final report: Task 2A – Conceptual model development East and Piru subbasins; Upper Santa Clara River chloride TMDL collaborative process, dated October 2006, 326p.

Canter, Larry W., 1997, Nitrates in Groundwater, CRC Press, Inc, Boca Raton, 263 p.

Carollo Engineers, 2010, City of Ventura Recycled Water Market Study Phase 1 Report, engineering report prepared for the City of Ventura.

Daniel B. Stephens & Associates Inc., 2008, Final draft report: Oxnard Forebay deep pit recharge study, prepared for United Water Conservation District, dated May 30, 2008.

Densmore, J.N., 1996, Lithologic and ground-water data for monitoring wells in the Santa Clara-Calleguas ground-water basin, Ventura County, California, 1989-95: U.S. Geological Survey Open-File Report 96-120, 179p.

Freeman, V.M., 1968, People-land-water: Santa Clara River Valley and Oxnard Plain, Ventura County , California, Lorrin L. Morrison, 1968, 227p.

Fox Canyon Groundwater Management Agency, 2007, 2007 Update to the Fox Canyon Groundwater Management Agency Groundwater Management Plan dated May 2007.

Fugro West, Inc., 1996, Calendar Year 1995 Annual Report, Mound Ground Water Basin, Ventura County, California. A summary of hydrologic conditions, prepared for the City of Ventura, 21 p.

Geotechnical Consultants, Inc., 1972, Hydrogeologic Investigation of the Mound Ground Water Basin for the City of San Buenaventura, California. Draft hydrogeologic investigation.

Hanson, R.T., Martin, P. and Koczot, K.M., 2003, Simulation of Ground-Water/Surface-Water Flow in the Santa Clara –Calleguas Ground-Water Basin, Ventura County, California, U.S. Geological Survey, Water-Resources Investigations Report 02-4136, 157p.

Harter T. and Lund J.R., 2012, Assessing nitrate in California's drinking water, with a focus on the Tulare Lake Basin and Salinas Valley groundwater; report for the State Water Resources Control Board to the legislature; Groundwater Nitrate Project, Implementation of Senate Bill X2 1, Center for Watershed Sciences, University of California Davis , dated January 2012.

Hopkins Groundwater Consultants, Inc., 2008, Preliminary Hydrological Study, Northeast Pleasant Valley Basin Surface Water and Groundwater Study, Somis, California, unpublished consultants report prepared for Calleguas Municipal Water District dated July 2008.

Izbicki, J.A., Christensen, Allen H., Newhouse, Mark W., Smith, and Aiken, George R., 2005a, Inorganic, isotopic, and organic composition of high-chloride water from wells in a coastal southern California, Applied Geochemistry, V. 20, no. 8, 1496-1517p.

Izbicki, J.A., Christensen, Allen H., Newhouse, Mark W., Smith, Gregory A., and Hanson, Randall T., 2005b, Temporal Changes in the Vertical Distribution of Flow and Chloride in Deep Wells, Ground Water: Journal of the Scientists and Engineers Division of National Ground Water Association, V. 43, no. 4, 531-544p.

Izbicki, J.A., 1996a, Seawater intrusion in a coastal California aquifer, U.S. Geological Survey, Fact Sheet 125-96, 4p.

Izbicki, J.A., 1996b, Source movement and age of groundwater in a coastal California aquifer, U.S. Geological Survey, Fact Sheet 126-96, 4p.

Izbicki, J.A., Martin, Peter, Densmore, J.N., Clark, D.A., 1995, Water-quality data for the Santa Clara-Calleguas Hydrologic Unit, Ventura County, California, October 1989 through December 1993: U.S. Geological Survey Open-File Report 95-315, 125p.

Izbicki, J.A., Michel, R.L., and Martin, Peter, 1992, ^{3}H and ^{14}C as Tracers of Groundwater Recharge, in Engman, Ted, Saving a threatened resource—In Search of Solutions: American Society of Civil Engineers, IR Division/ASCE, 122-127p.

Izbicki, J.A., 1992, Sources of chloride in ground water of the Oxnard Plain, California, in Prince K.R. and Johnson, A.I., eds., Regional aquifer systems of the United States—Aquifers of the Far West: American Water Resources Association Monograph Series, no.16, 5-14p.

Izbicki, J.A., 1991, Chloride sources in a California coastal aquifer: American Society of Civil Engineers, 1991 Symposium on Ground Water in the Pacific Rim, Honolulu, Hawaii, July 22-26, 1991, Proceedings, 71-77p.

Las Posas Users Group, 2011, PRELIMINARY DRAFT Las Posas Basin-Specific Groundwater Management Plan dated September 2011.

Mann, J.F., Jr., 1959, A plan for ground water management, United Water Conservation District: Report to United Water Conservation District, 120p.

Mukae, Mike, 1988, General geology and groundwater occurrence within Calleguas Municipal Water District service area. Progress Report No. 9. Prepared for Metropolitan Water District of Southern California.

Mukae, M., and Turner, J., 1975, Ventura County Water Resources Management Study, Geologic Formations, Structures and History in the Santa Clara-Calleguas Area, in Compilation of Technical Information Records for the Ventura County Cooperative Investigation: California Department of Water Resources, 28 p.

M.O.U., 1995, Memorandum of Understanding regarding groundwater basin management in the Fillmore/Piru Groundwater basins.

Piru/Fillmore Groundwater Management Council, 2011, Draft 2011 Piru/Fillmore Basins AB 3030 Groundwater Management Plan.

Piru/Fillmore Groundwater Planning Council, 1996, AB 3030 Groundwater Management Plan for Piru/Fillmore Basins, 30p.

Predmore, Steven K., 1993, Use Of A Geographic Information System to Identify Abandoned Wells: U.S. Geological Survey Open-File Report 93-147.

Sanitation Districts of Los Angeles County, 2008, 2008 Chloride Source Identification/Reduction, Pollution Prevention, and Public Outreach Plan.

Santa Paula Basin Technical Advisory Committee, 2011, Combined 2009 and 2010 Santa Paula Basin Annual Report, United Water Conservation District Professional Paper 2011-001 dated October 2011.

Santa Paula Basin Experts Group, 2003 Investigation of Santa Paula Basin Yield *prepared for* Santa Paula Basin Technical Advisory Committee dated July 2003.

Stamos, C.L., Predmore, S.K., and Zohdy, A.A.R., 1992, Use of D-C resistivity to map saline ground water: American Society of Civil Engineers National Conference, Water Forum 1992, Baltimore, Maryland, August 2-6, 1992, Proceedings, 80-85p.

Stillwater Sciences, 2007, Santa Clara River Parkway Floodplain Restoration Feasibility Study: Assessment of Geomorphic Processes for the Santa Clara River Watershed, Ventura and Los Angeles Counties, California. Prepared by Stillwater Sciences for the California Coastal Conservancy.

Sylvester, A.G., and Brown, G.C., 1988, Santa Barbara and Ventura Basins; Tectonics, Structure, Sedimentation, Oilfields along an East-West Transect: Coast Geological Society Guidebook 64, Ventura, California, 167 p.

Turner, J.M., 1975, Aquifer delineation in the Oxnard-Calleguas area, Ventura County, in Compilation of Technical Information Records for the Ventura County Cooperative Investigation: California Department of Water Resources, 45 p.

United States Geological Survey, 1996, Seawater intrusion in a coastal California aquifer, Fact Sheet 125-96, 4p.

United Water Conservation District, 2013a, Aquifer Delineation within the Oxnard Forebay Groundwater basin using Surface Geophysics, United Water Conservation District Open-File Report 2013-06.

United Water Conservation District, 2013b, Santa Paula Basin Groundwater Elevation Trend Assessment, United Water Conservation District Open-File Report 2013-03.

United Water Conservation District, 2013c, Percolation of Santa Clara River Flow Within The Santa Paula Basin, United Water Conservation District Open-File Report 2013-01

United Water Conservation District, 2013d, Santa Paula Creek Percolation: An Update, United Water Conservation District Open-File Report 2013-02.

United Water Conservation District, 2012a, Oxnard Plain Time Domain Electromagnetic Study for Saline Intrusion, United Water Conservation District Open-File Report 2012-003.

United Water Conservation District, 2012b, Hydrogeologic Assessment of the Mound Basin, United Water Conservation District Open-File Report 2012-001.

United Water Conservation District, 2012c, Annual Investigation and Report of Groundwater Conditions within United Water Conservation District dated March 2012.

United Water Conservation District, 2012d, Groundwater and Surface Water Conditions Report - 2011, United Water Conservation District Open-File Report 2012-02.

United Water Conservation District, 2011a, High Resolution Seismic Reflection Survey of the Oxnard Plain Basin, United Water Conservation District Open-File Report 2011-004.

United Water Conservation District, 2011b, Santa Paula Basin Pumping Trend Effects and Assessment, United Water Conservation District Open-File Report 2010-003.

United Water Conservation District, 2010, History of the Zone C Settlement Agreement, and Discussion of Groundwater Elevation Records In and Around this Zone, technical memo to files.

United Water Conservation District, 2009, Santa Paula Basin 2008 Annual Report prepared for Santa Paula Basin Technical Advisory Committee.

United Water Conservation District, 2008, Nitrate Observations in the Oxnard Forebay and Vicinity, 1995-2006.

United Water Conservation District, 2007, Mugu Seawater/Saline Monitoring Program, Report to California Department of Water Resources, dated April 2007.

United Water Conservation District, 2006, Chloride in the Piru Basin, Steven Bachman and Daniel Detmer, April 2006.

United Water Conservation District, 2004, 2003 Coastal Saline Intrusion Report, Oxnard Plain Ventura County, California dated August 2004.

United Water Conservation District, 2003, Inland Saline Intrusion Assessment Project report submitted to the California Department of Water Resources dated June 2003.

United Water Conservation District, 1998, Nitrate study of El Rio area Phase I: nitrates through time, areas of occurrence, 17p.

United Water Conservation District, 1996a, Water quality of the Santa Clara River and the Montalvo and Oxnard Plain groundwater basins, 53p.

United Water Conservation District, 1996b, Santa Clara River watershed sanitary survey, 115p.

United Water Conservation District vs. City of San Buenaventura, March 7, 1996, Judgment; Superior Court of the State of California for the County of Ventura, Case No. 115611, amended August 24, 2010.

Ventura County Watershed Protection District, Water and Environmental Resources. (2014). 2013 Groundwater Section Annual Report.

Ventura County Watershed Protection District, Water and Environmental Resources. (2010). NPDES Permit No. CAS004002: Ventura County Municipal Separate Storm Sewer System Permit, Order No. R4-2010-0108.

Weber, F.H., Kiessling, E.W., Sprotte, E.C., Johnson, J.A., Sherburne, R.W., and Cleveland, G.B., 1976, Seismic hazards study of Ventura County, California: California Department of Conservation, California Division of Mines and Geology Open-File Report 76-5, 396 p., pls. 3A and 3B.

Yeats, R.S., Clark, M.N., Keller, E.A., and Rockwell, T.K., 1981, Active Fault Hazard in Southern California: Ground Rupture Versus Seismic Shaking: Geol. Soc. America Bull, Part 1, v. 92, 189-196p.

Zohdy A.A.R., Martin, Peter, and Bisdorf, B.J., 1993, A study of seawater intrusion using direct-current soundings in the southeastern part of the Oxnard Plain, California: U.S. Geological Survey Open-File Report 93-524, 138p.

7 FIGURES AND TABLES

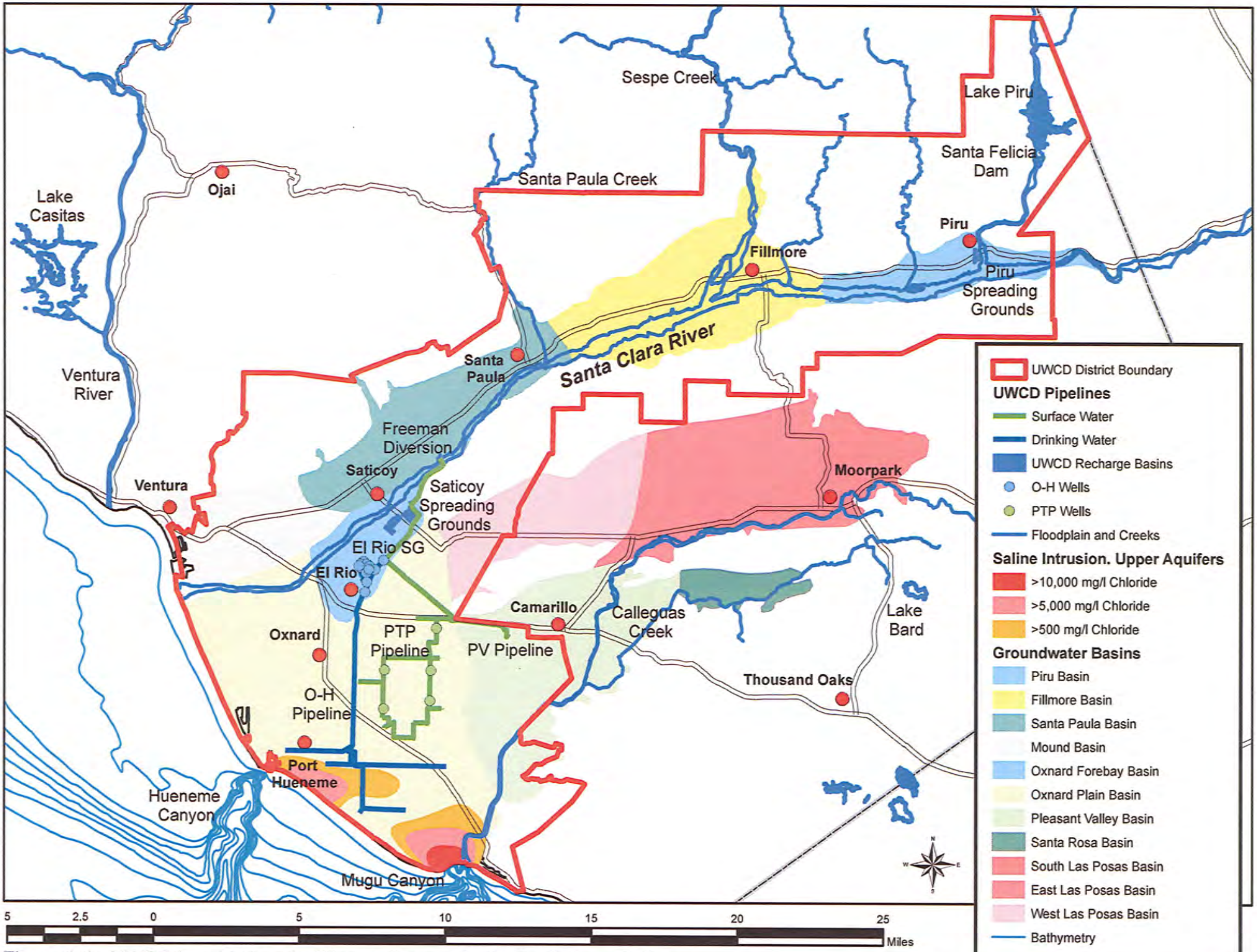


Figure 1-1. UWCD boundaries, facilities and groundwater basin boundaries

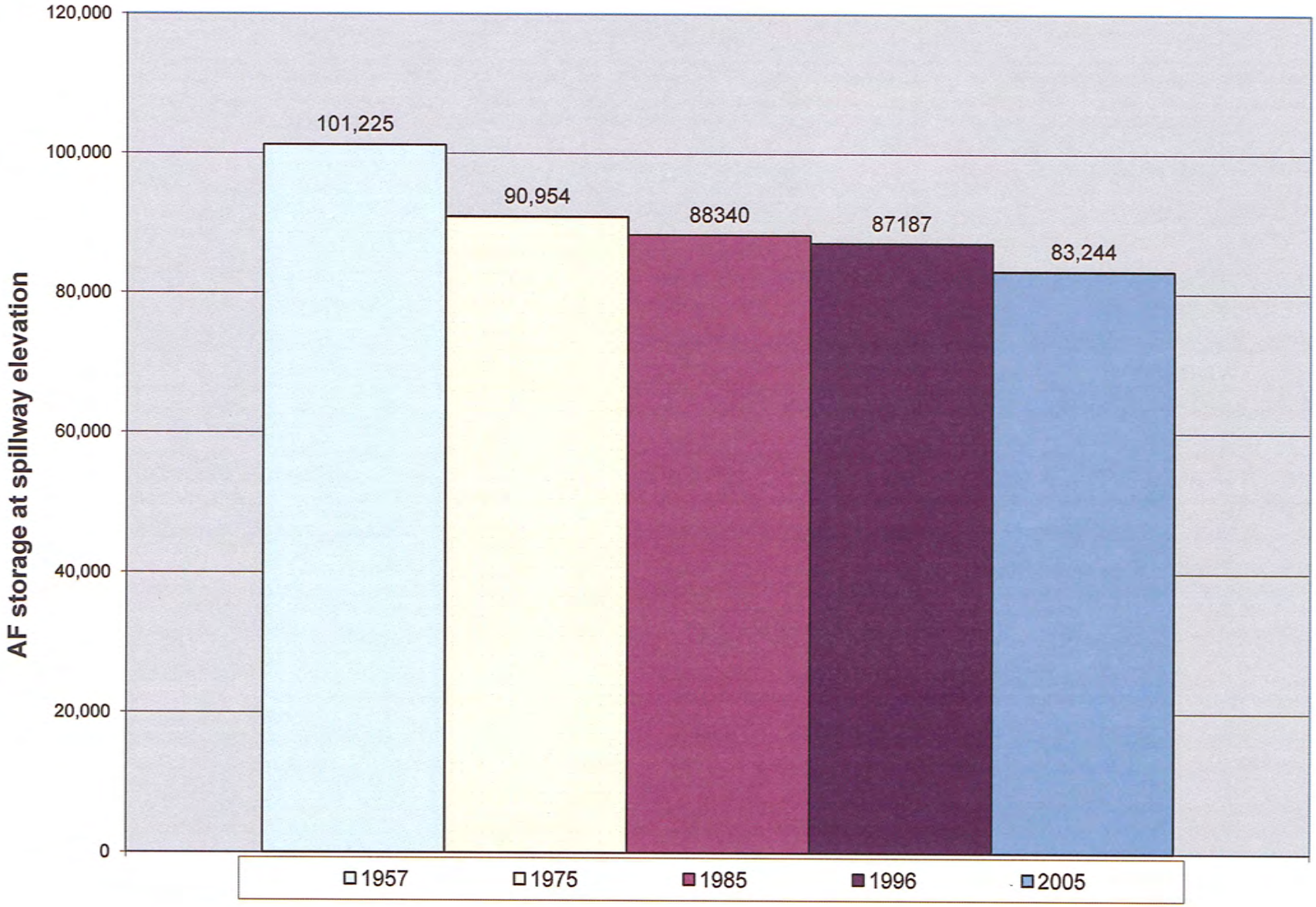


Figure 1.4-1. Silt surveys showing historic storage capacity in Lake Piru

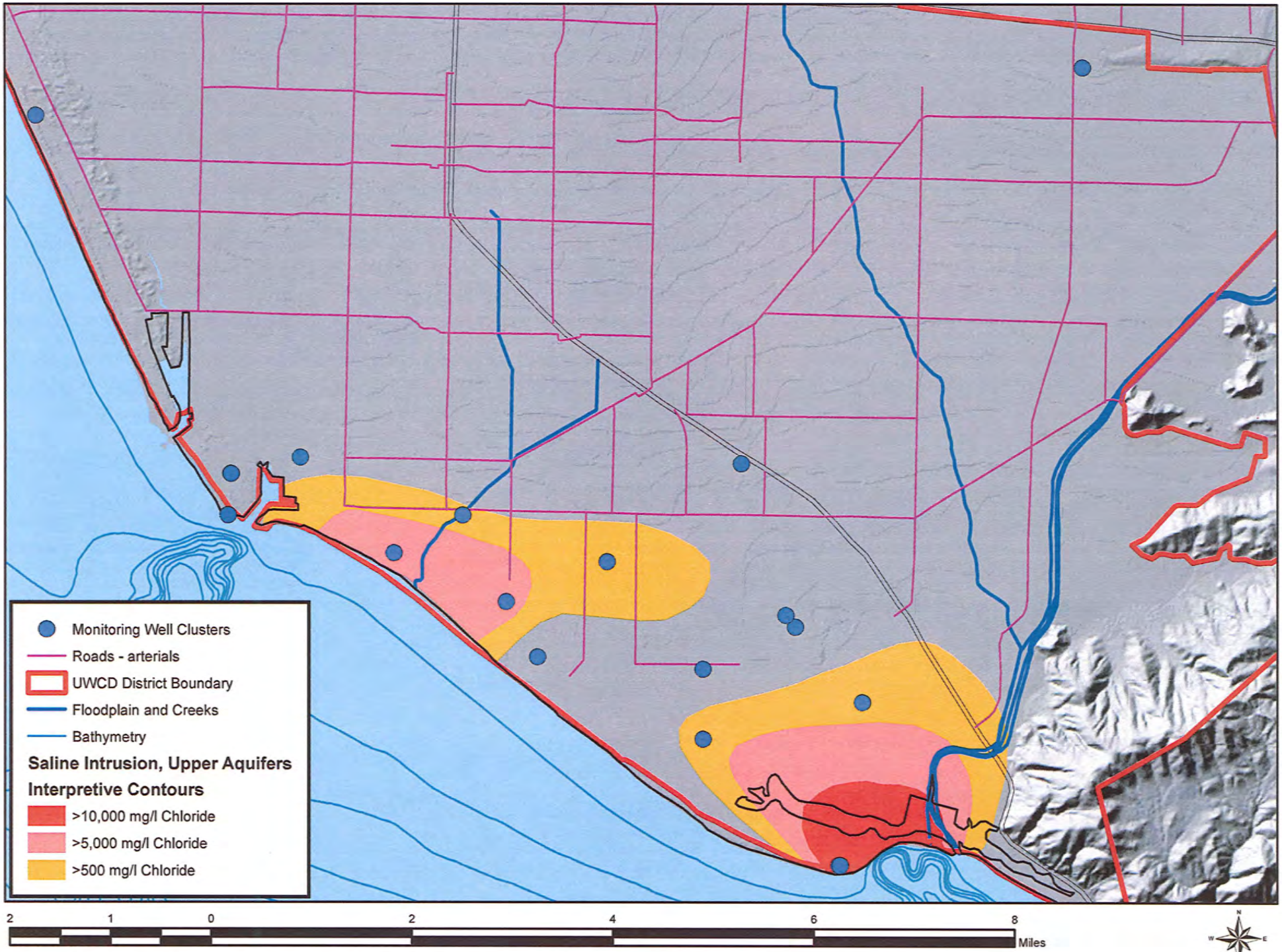


Figure 1.5-1. Locations of RASA coastal monitoring well clusters

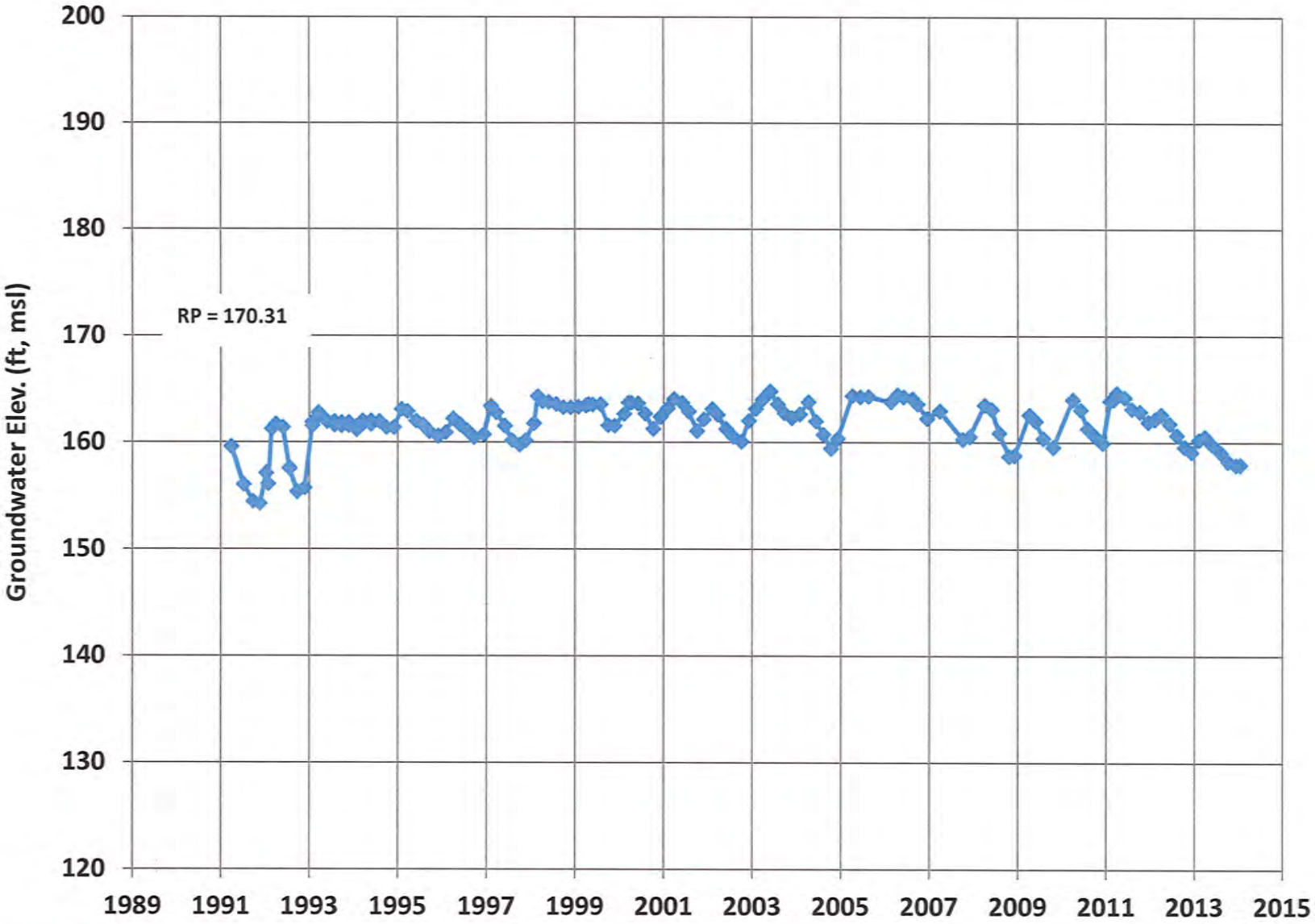


Figure 1.6-1. Groundwater elevations near the Freeman Diversion

Project	Overdraft Conditions	Declining Water Levels	Groundwater Exports	Saline Water Intrusion	Upwelling Saline Water	Riverbed Stabilization	Biological Opinion-SFD	Biological Opinion-VFD	VFD Operation	Aquifer Mapping	Recharge Optimization	Water Quality Degradation
Update Regional GW Flow Model	X	X	X	X	X	X				X	X	X
AB3030 Piru/Fillmore GW Management Plan Update			X								X	X
Santa Paula Basin TAC and Specialty Studies		X	X			X			X	X	X	
District-Wide GW Level Measurements / Piezometers	X	X	X	X	X	X	X	X	X		X	X
District-Wide Water Quality Sampling & Analyses	X	X	X	X	X						X	X
District-Wide Stream Gauging	X	X				X	X	X	X		X	X
Surface Geophysical Studies (Seismic Reflection, TDEM)	X	X		X						X	X	
SCR/Forebay Piezometer Installation		X					X	X	X		X	
Brackish Water Treatment Feasibility Study	X	X		X	X						X	

Figure 2.1-1. Groundwater issues and concerns versus projects

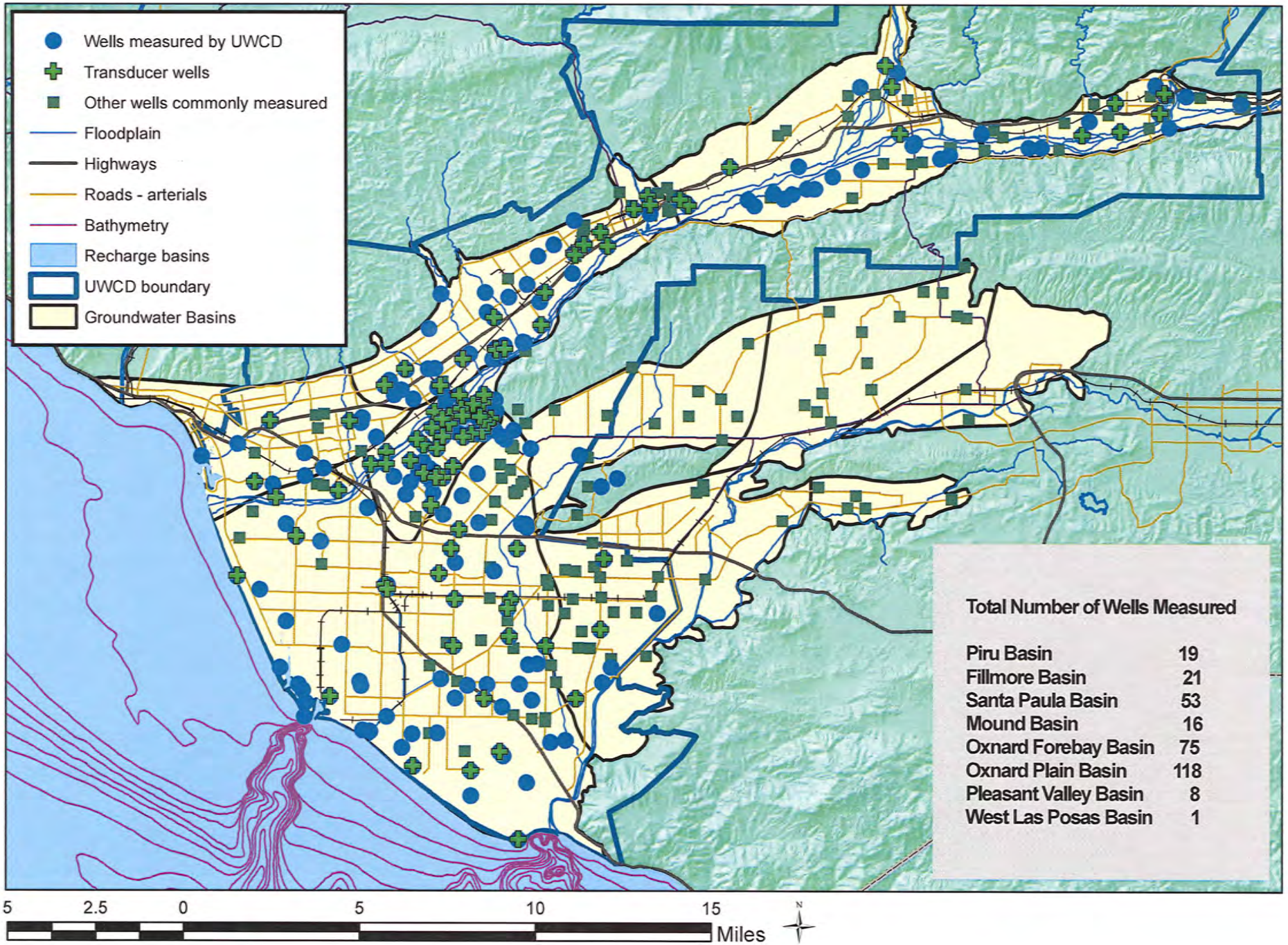


Figure 2.1-2 Wells monitored by United for water levels

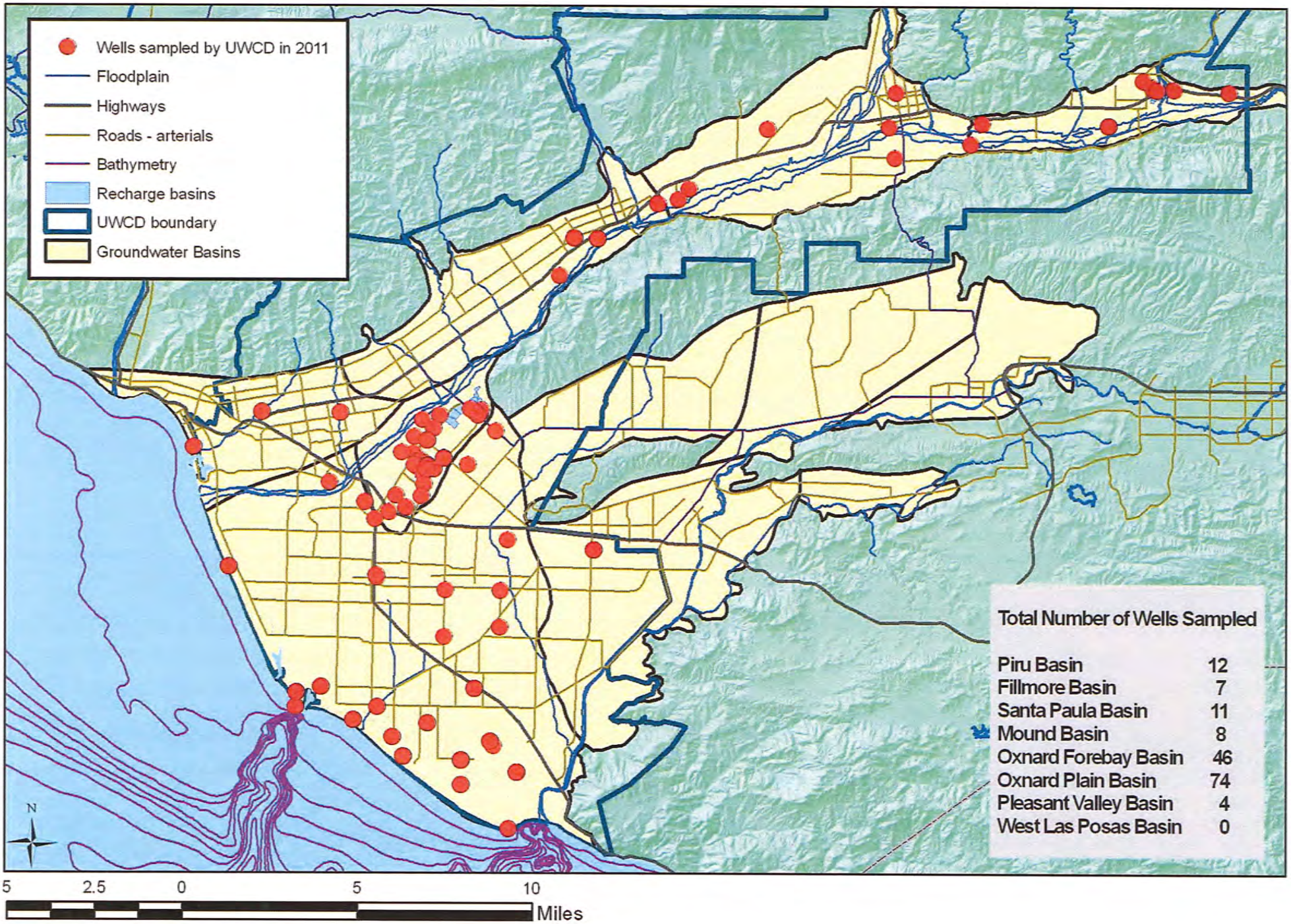


Figure 2.1-3. Wells sampled by United for water quality

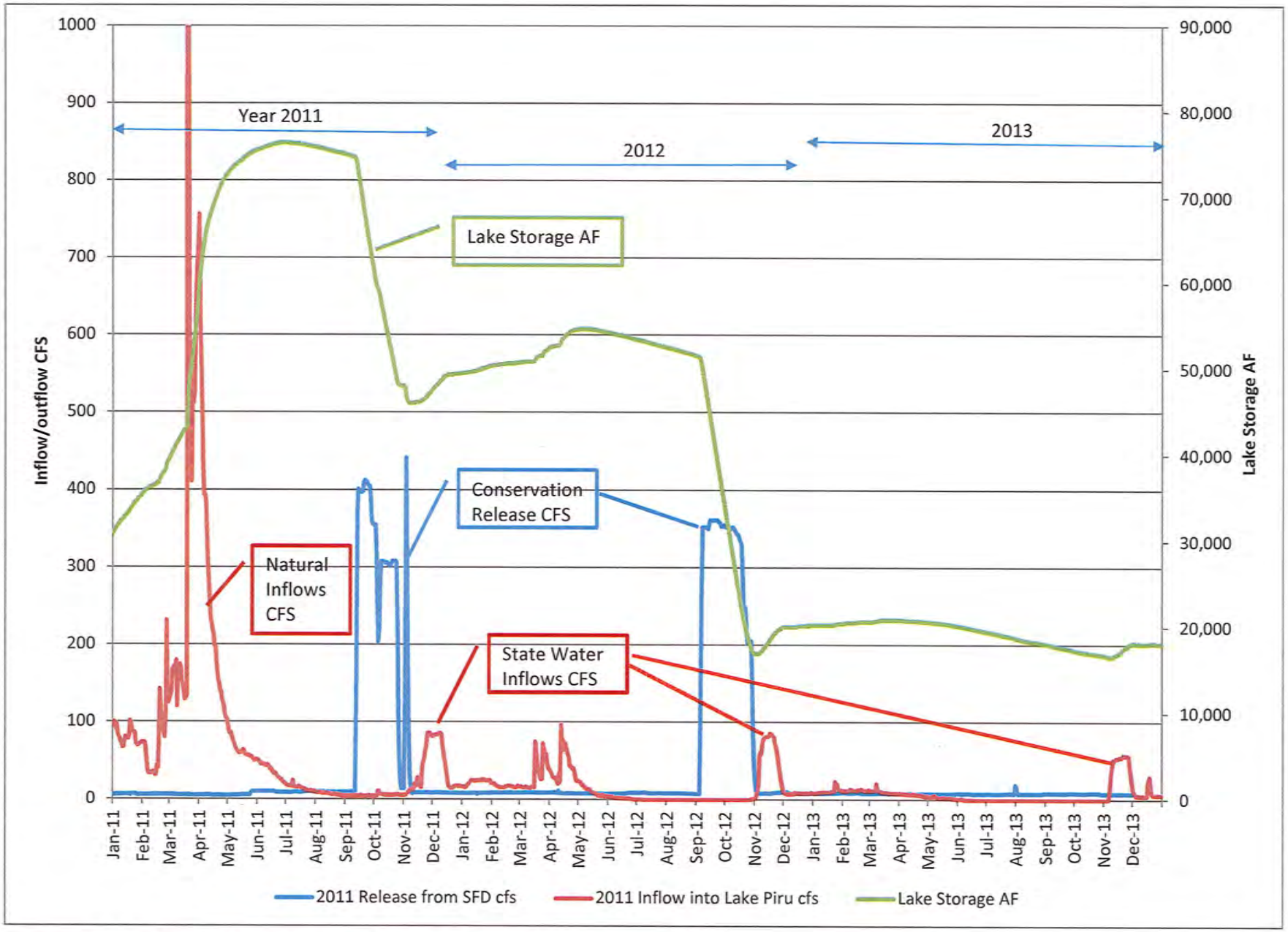


Figure 2.2-1. Basic Hydrology at Lake Piru from 2011 through 2013

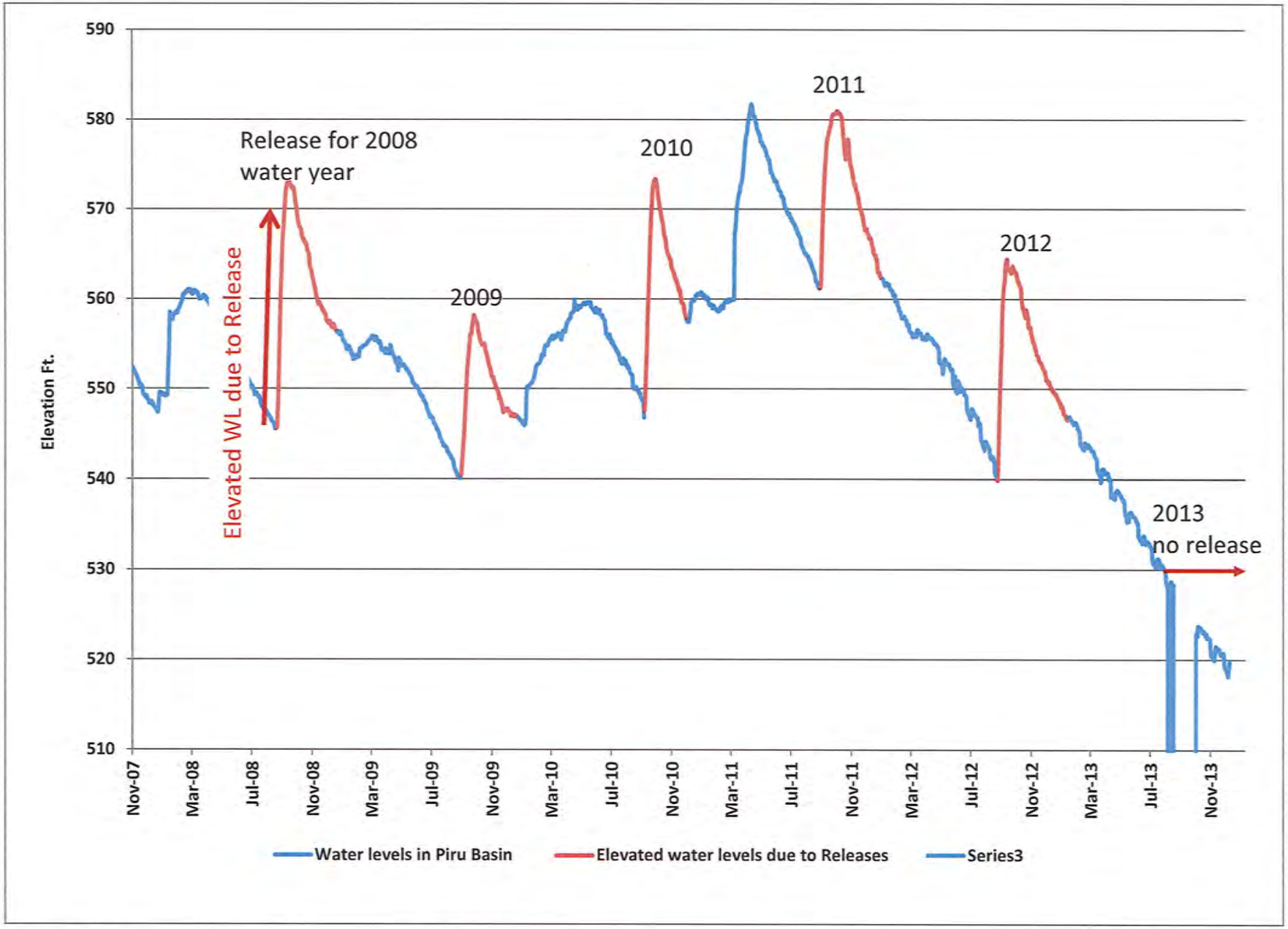


Figure 2.2-2. Groundwater response in the Piru basin from the conservation release at SFD (well 04N18W31D07S & -D04S)

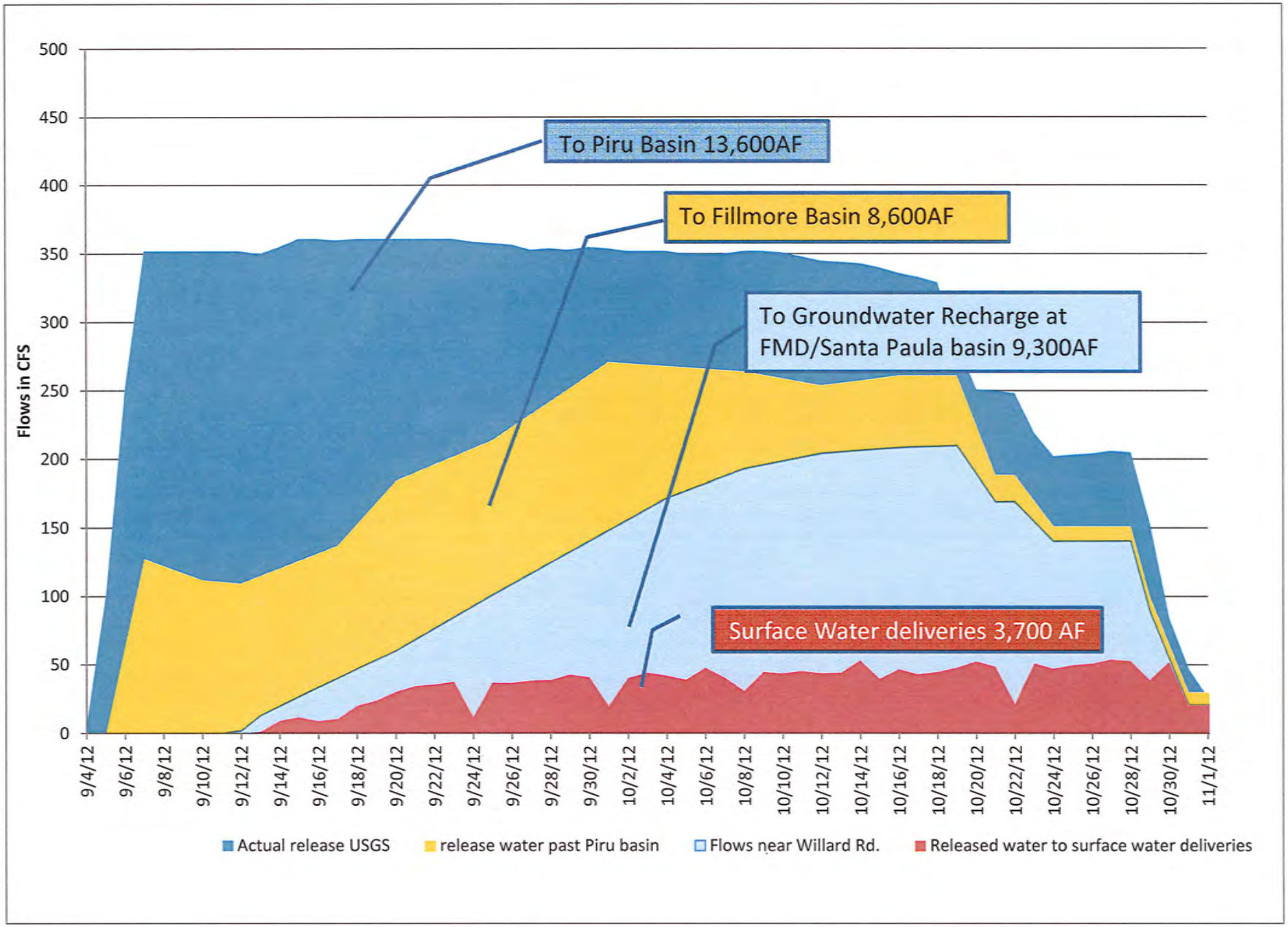


Figure 2.2-3. Benefits of the direct percolation of the 2012 Lake Piru conservation release (35,200 AF)

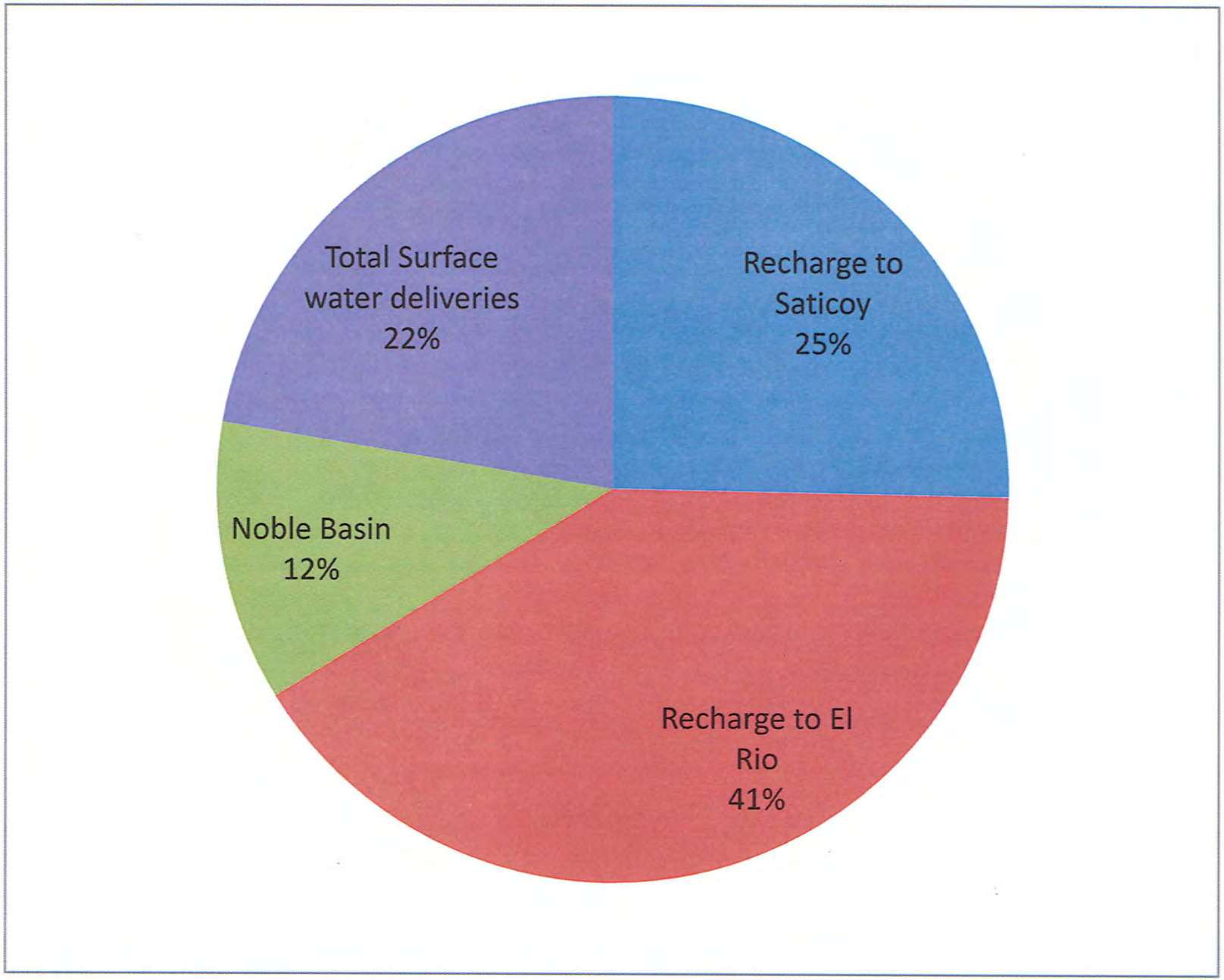


Figure 2.2-4. Distribution of water diverted at Freeman Diversion, 2011

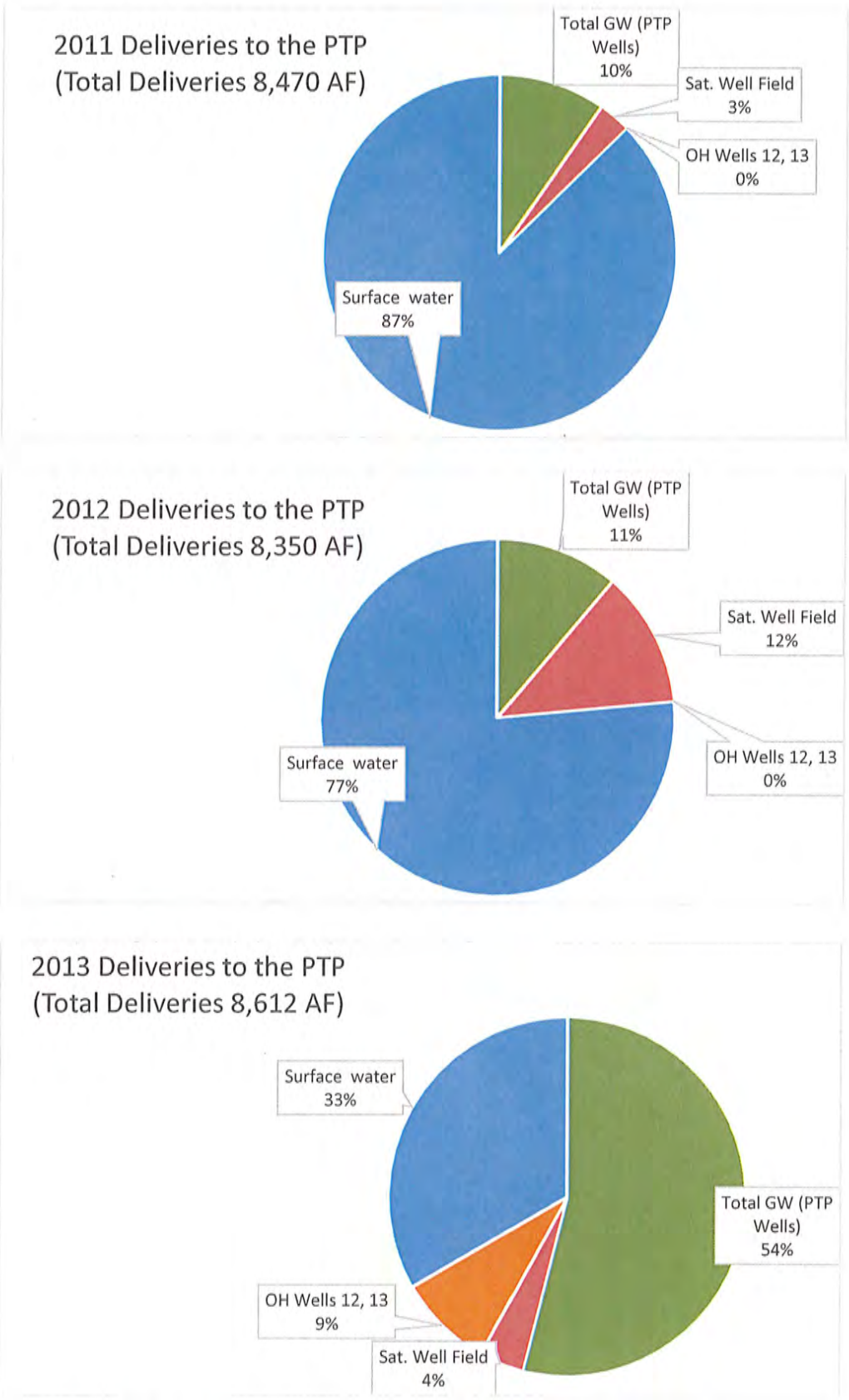


Figure 2.2-5. Source water of the PTP deliveries

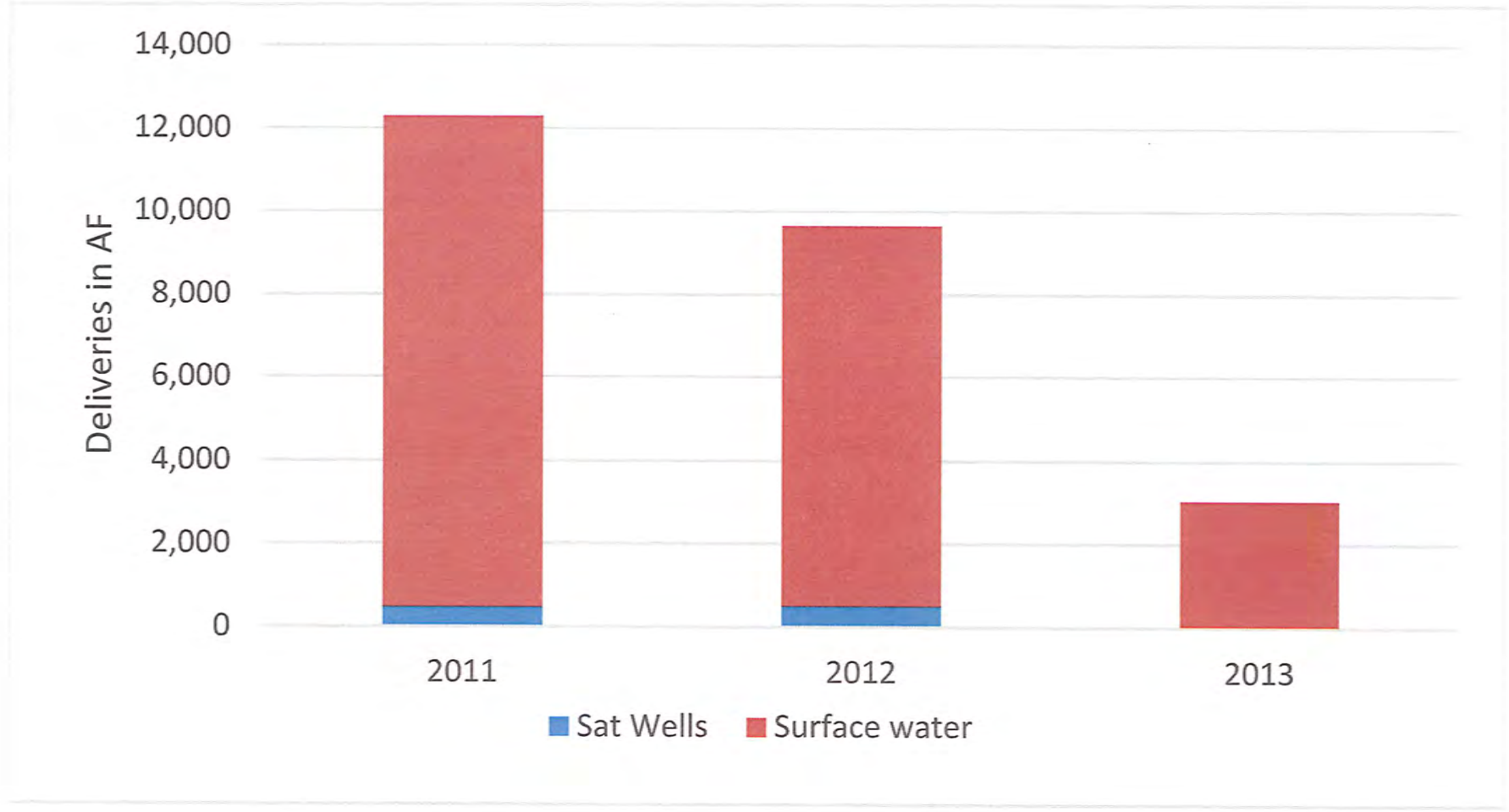


Figure 2.2-6. Source water of the Pleasant Valley County Water District deliveries

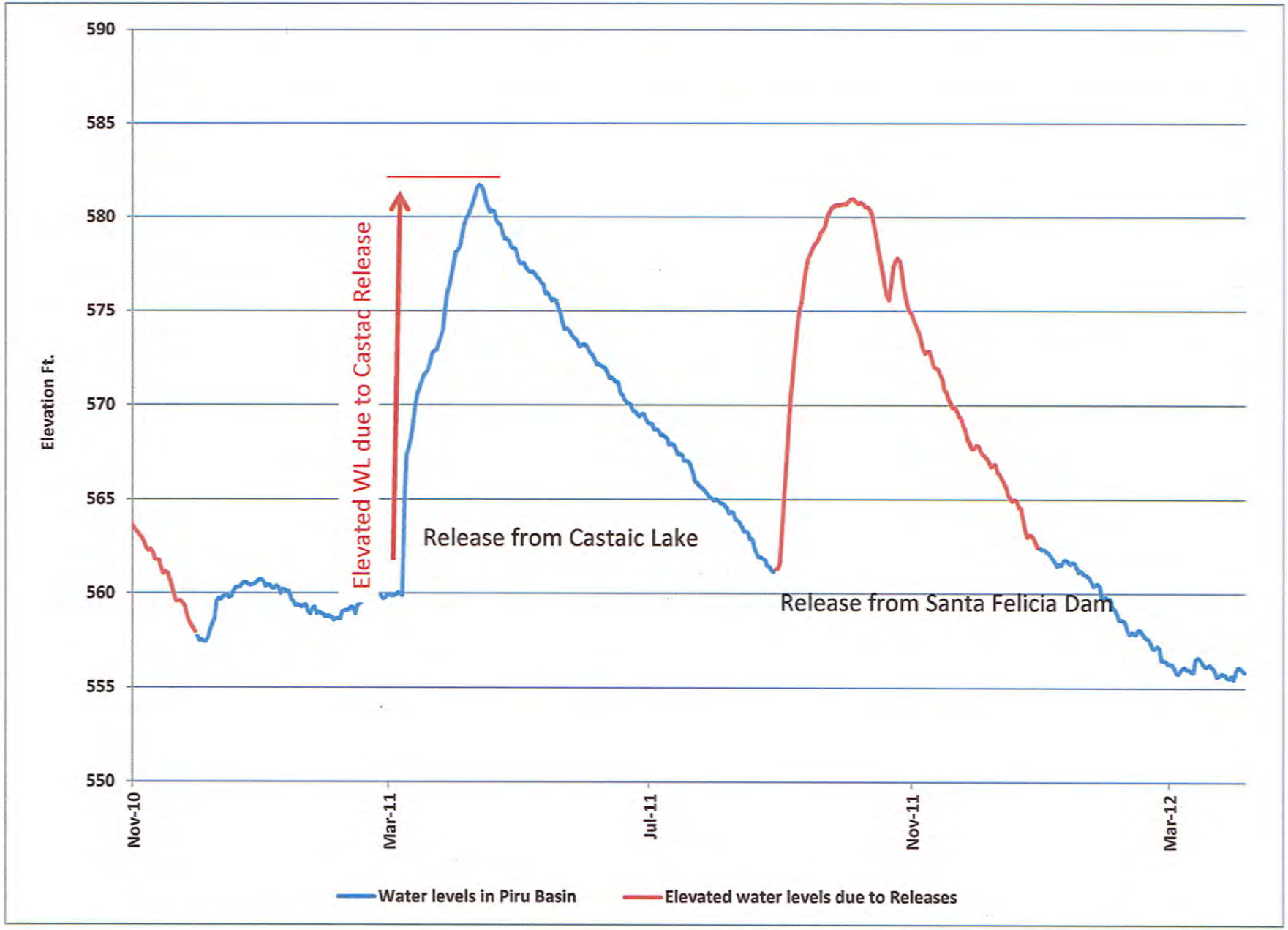


Figure 2.2-7. Groundwater response in the Piru basin to Castaic Lake floodflow release (well 04N18W31D07S)

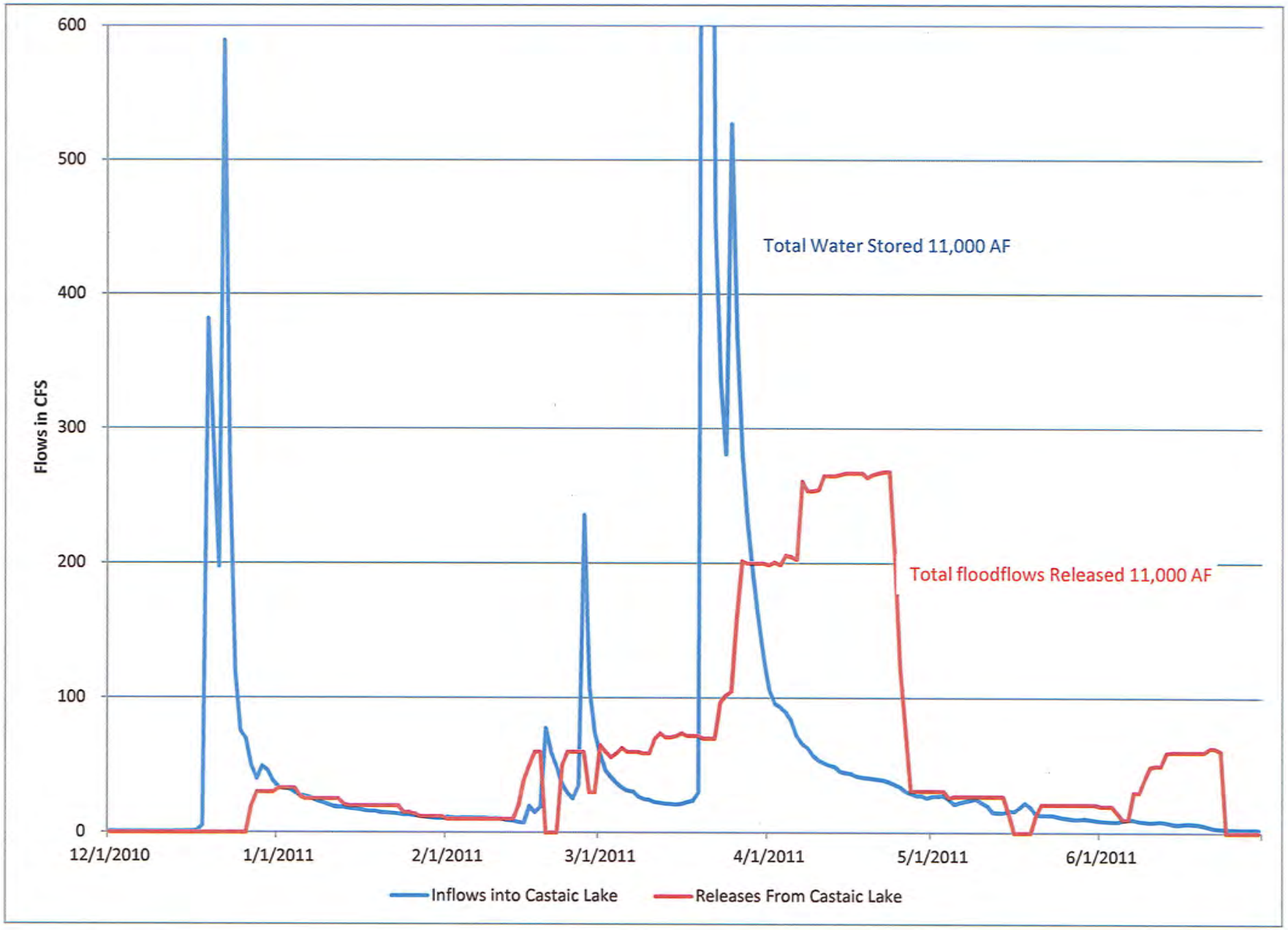


Figure 2.2-8. Conservation release from Castaic Lake for downstream water users

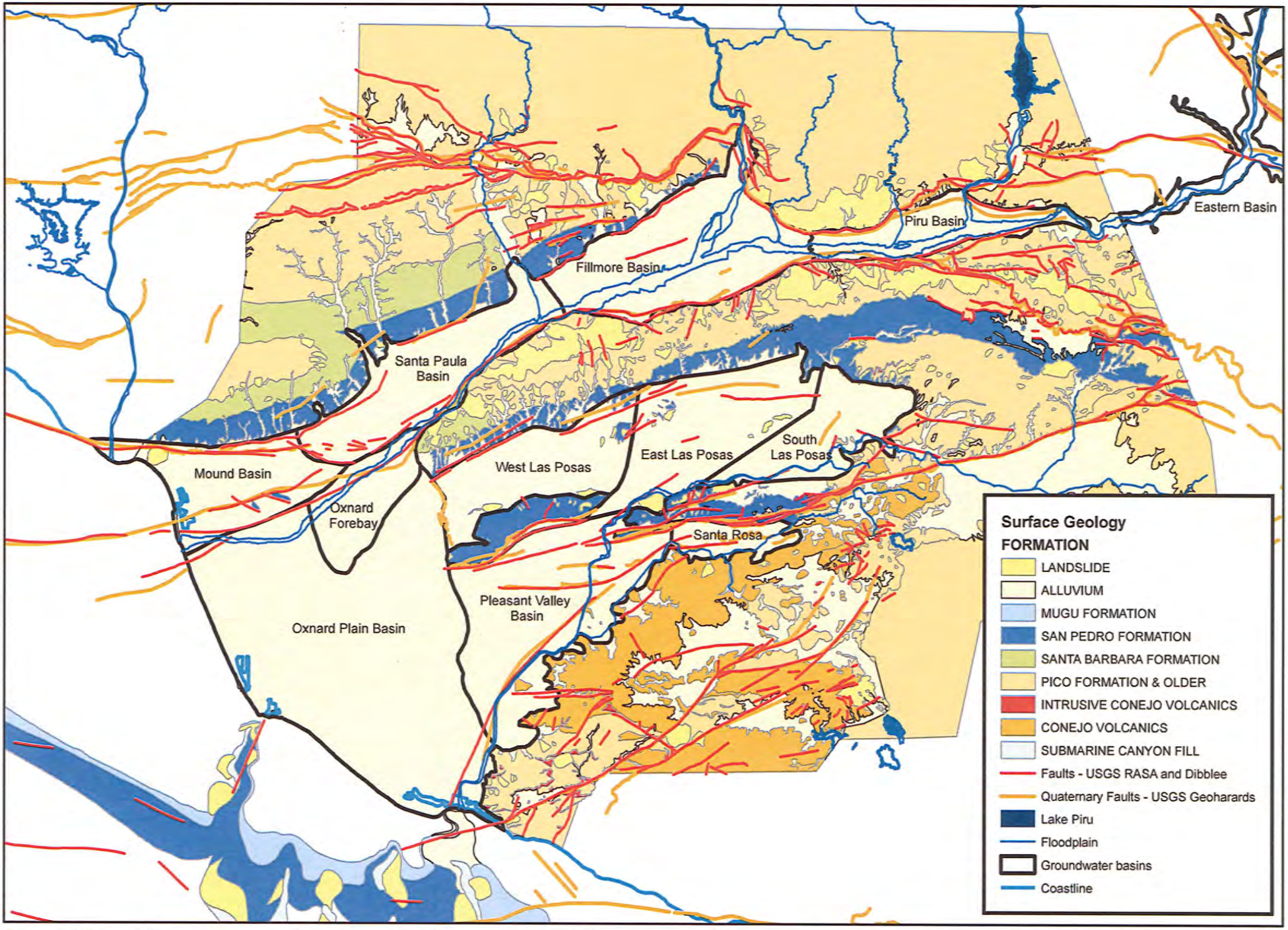


Figure 3.1-1. Surface geology and faults

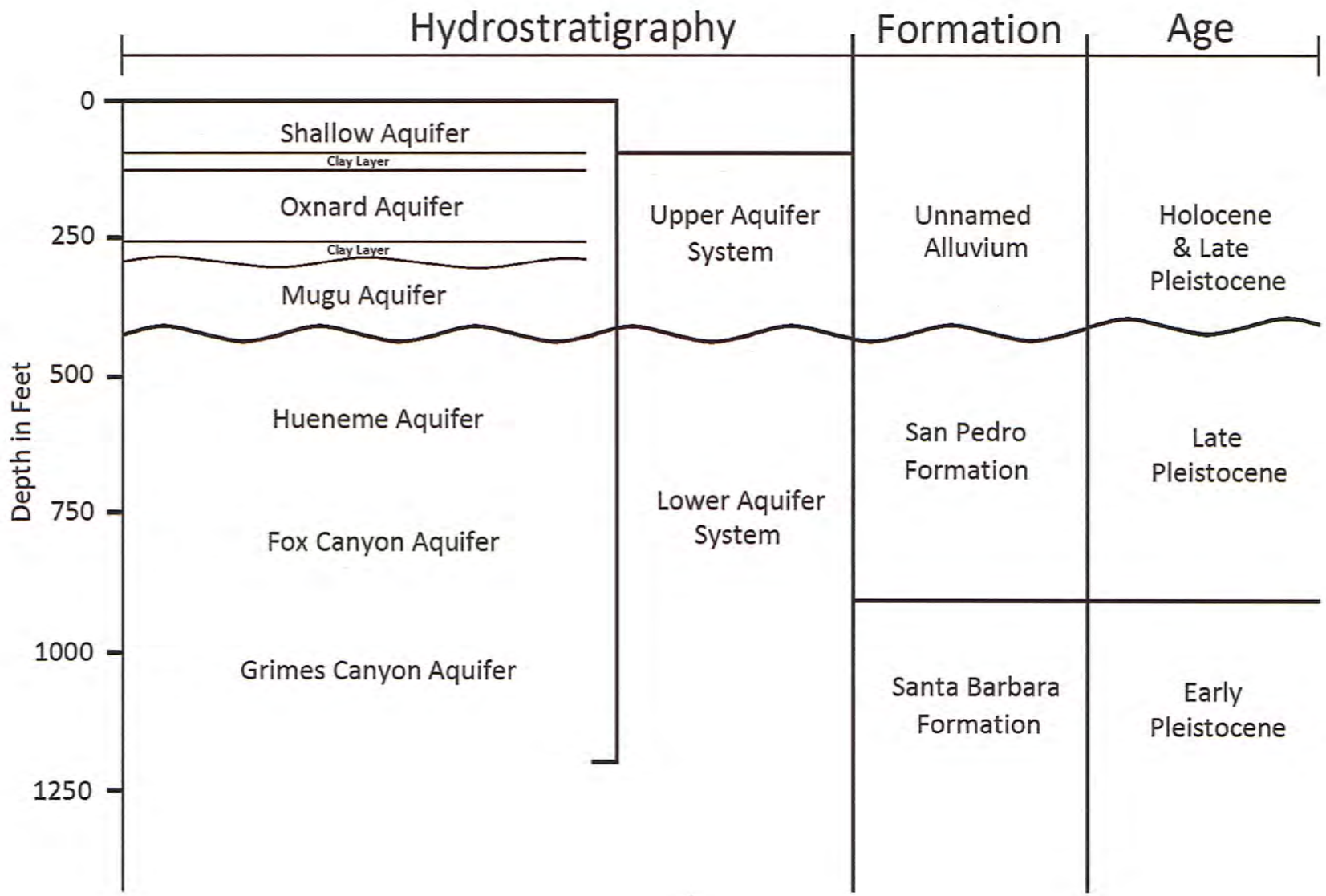


Figure 3.2-1. Schematic of UAS and LAS aquifer systems

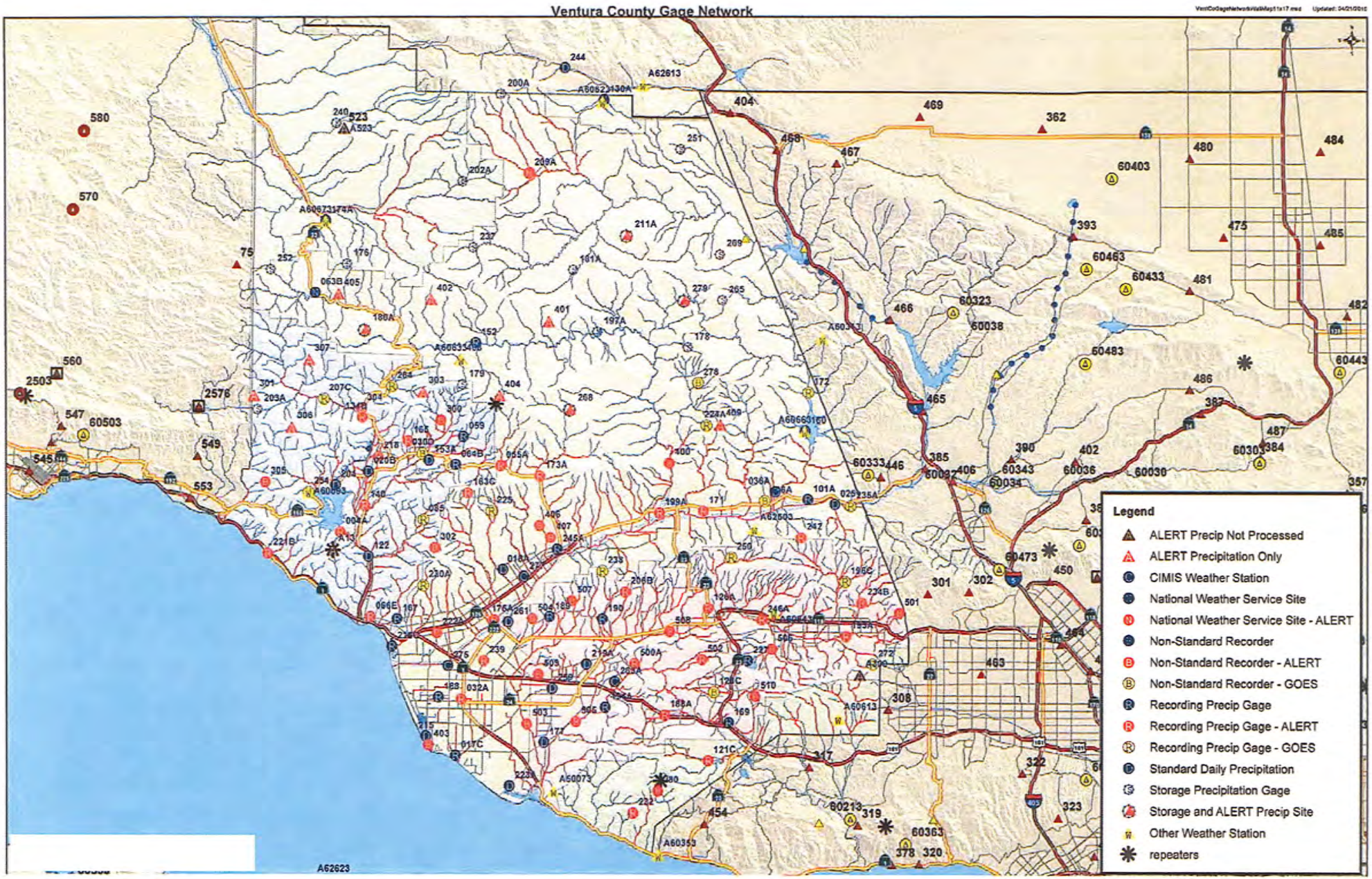
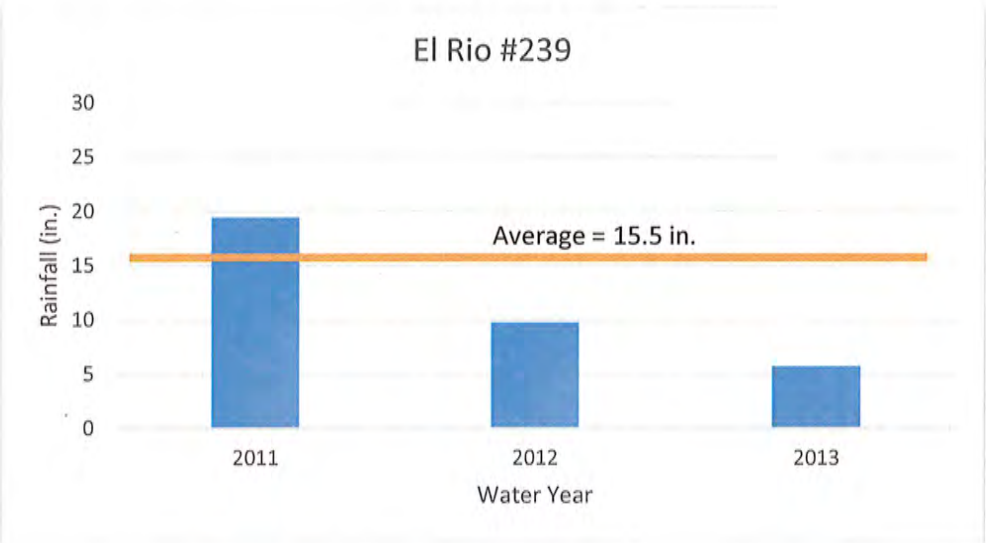
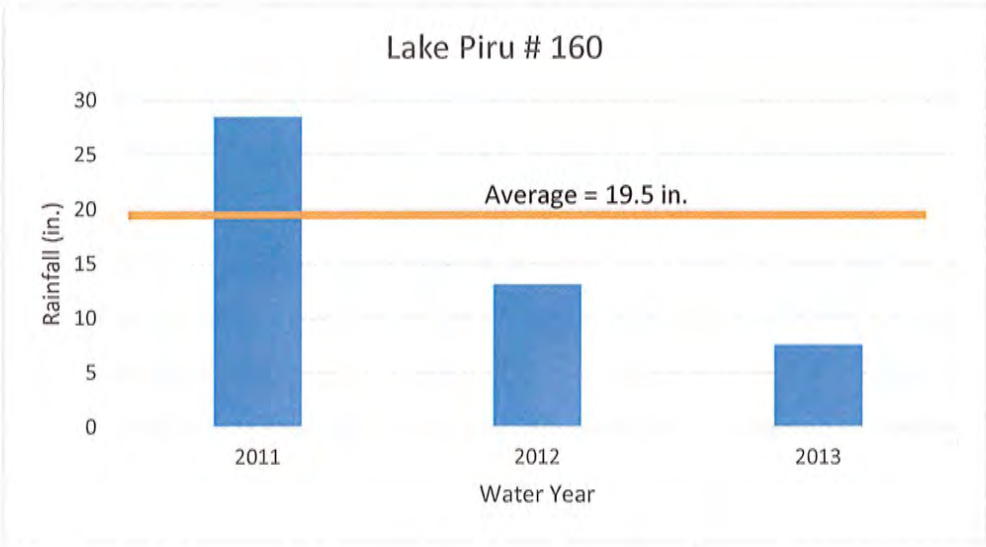


Figure 4.1-1. Regional rainfall gages





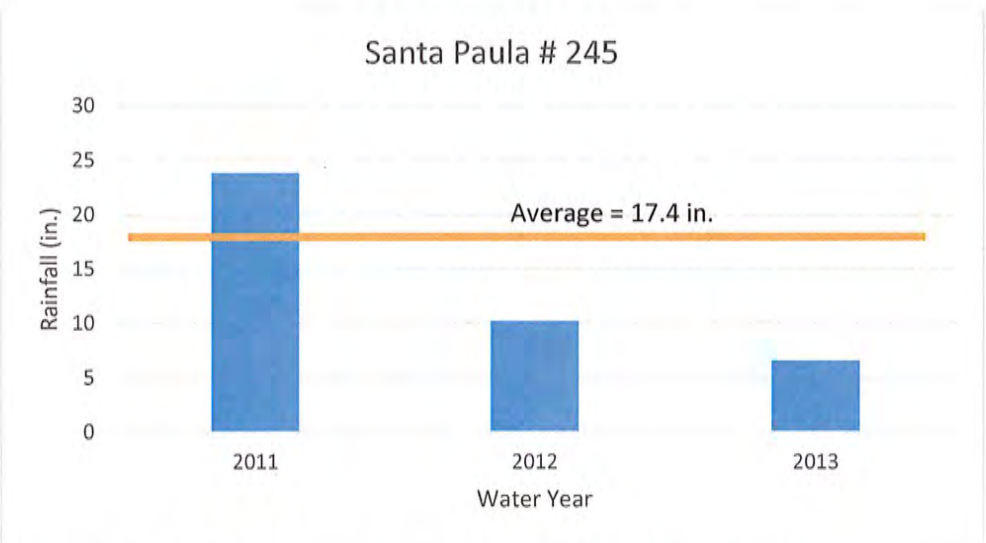


Figure 4.1-2. Rainfall at the District's three rainfall gages

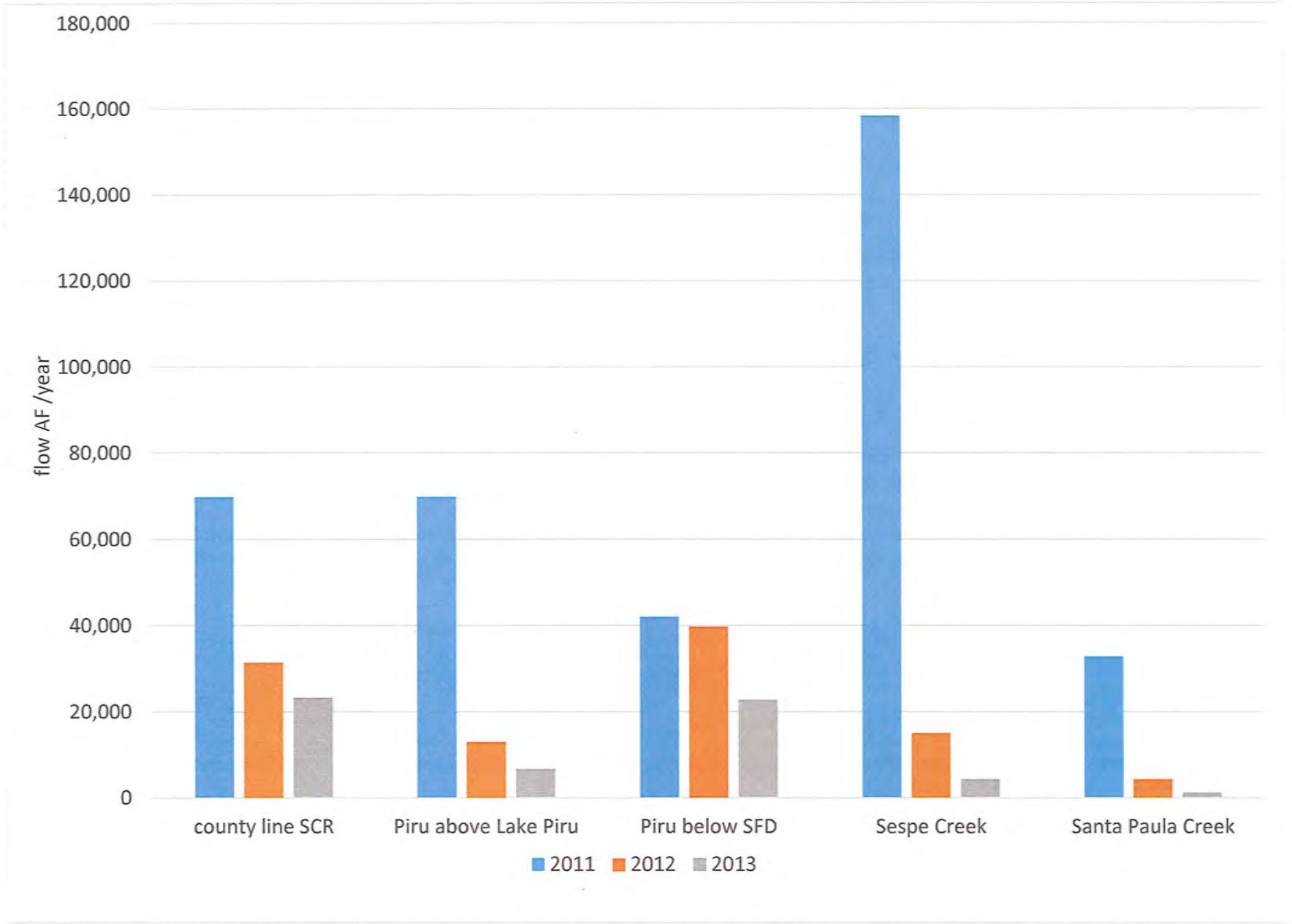


Figure 4.2-1. Total discharge measured at the USGS station (water year)

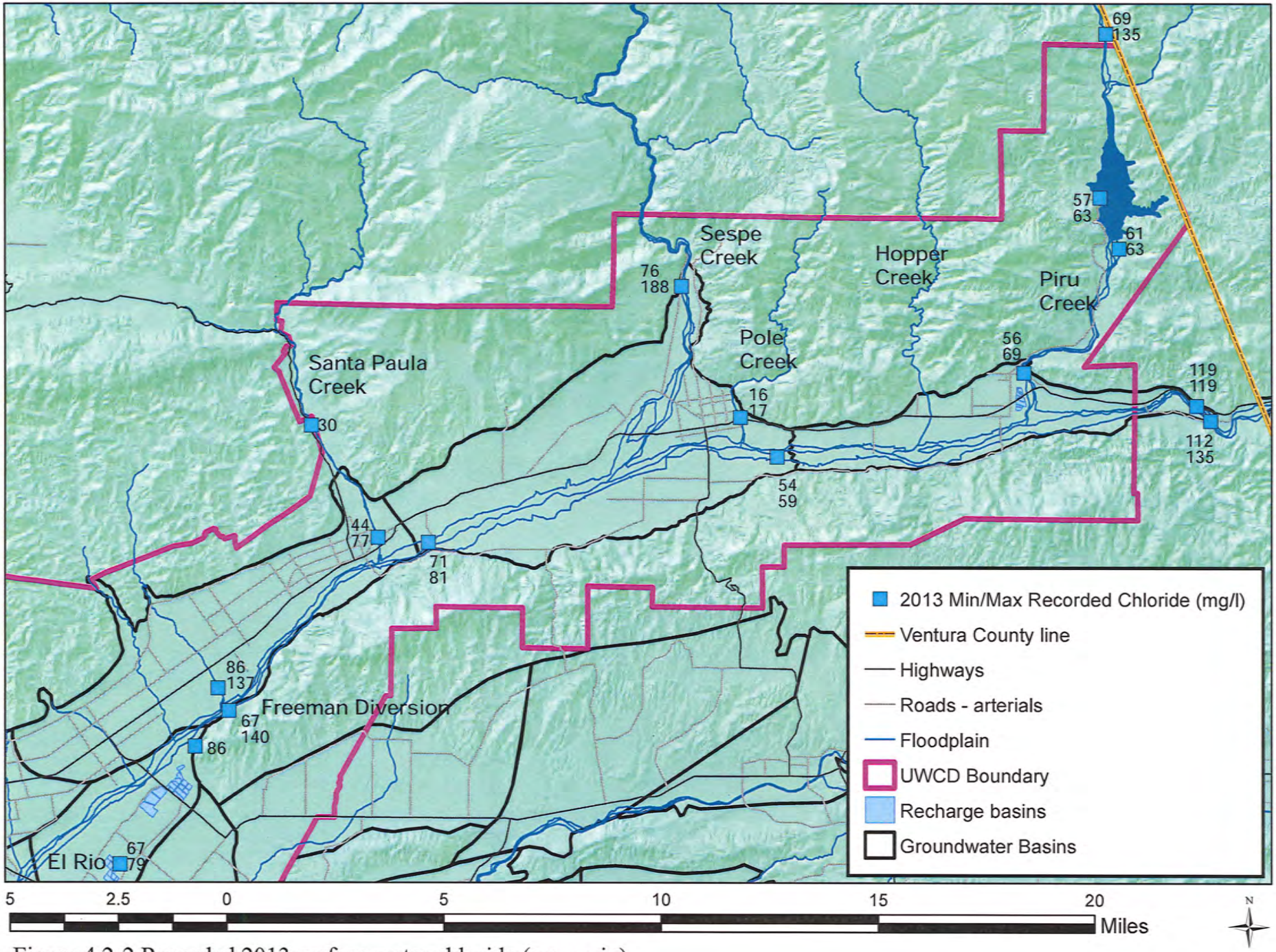


Figure 4.2-2 Recorded 2013 surface water chloride (max-min)

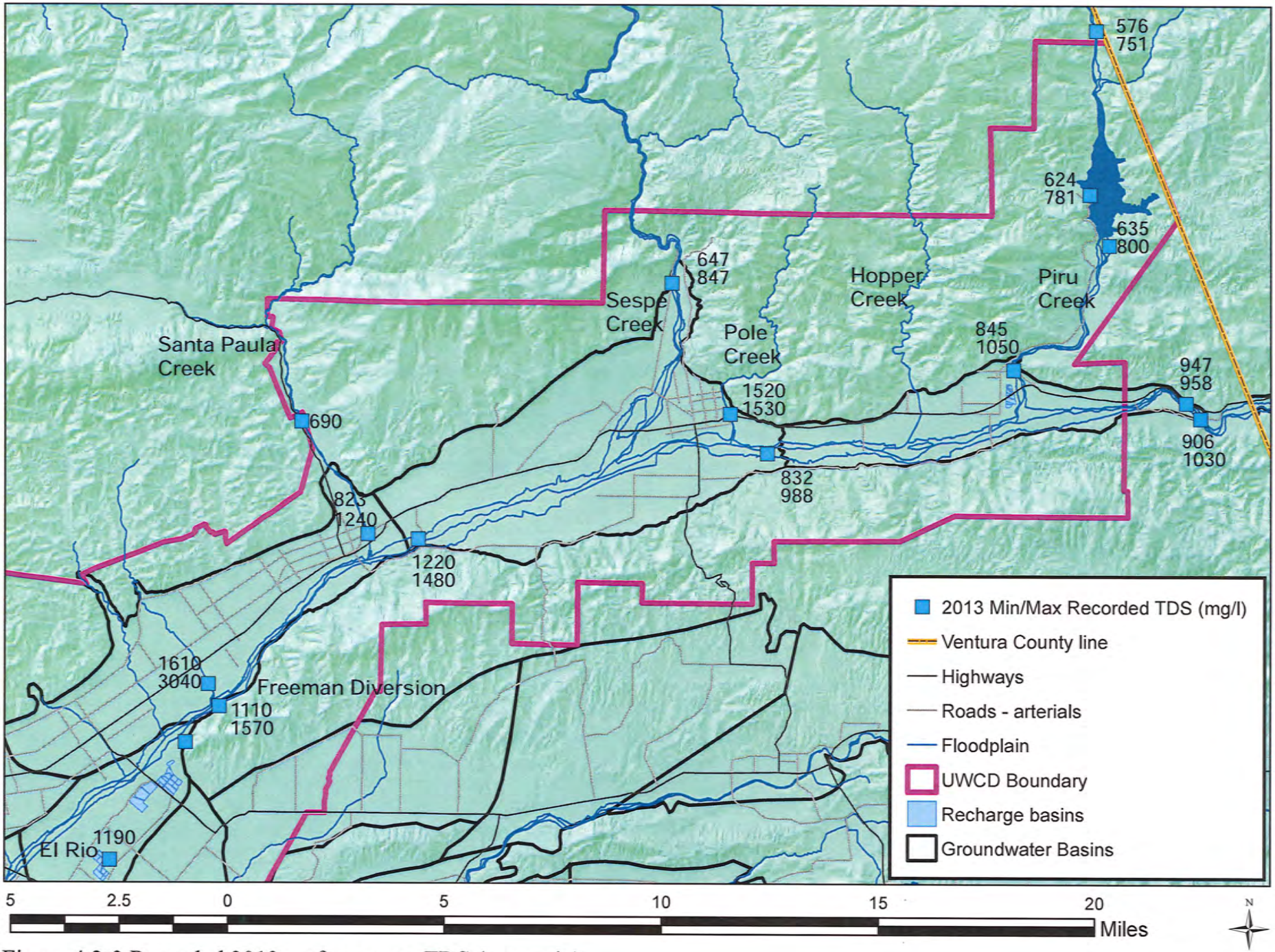


Figure 4.2-3 Recorded 2013 surface water TDS (max-min)

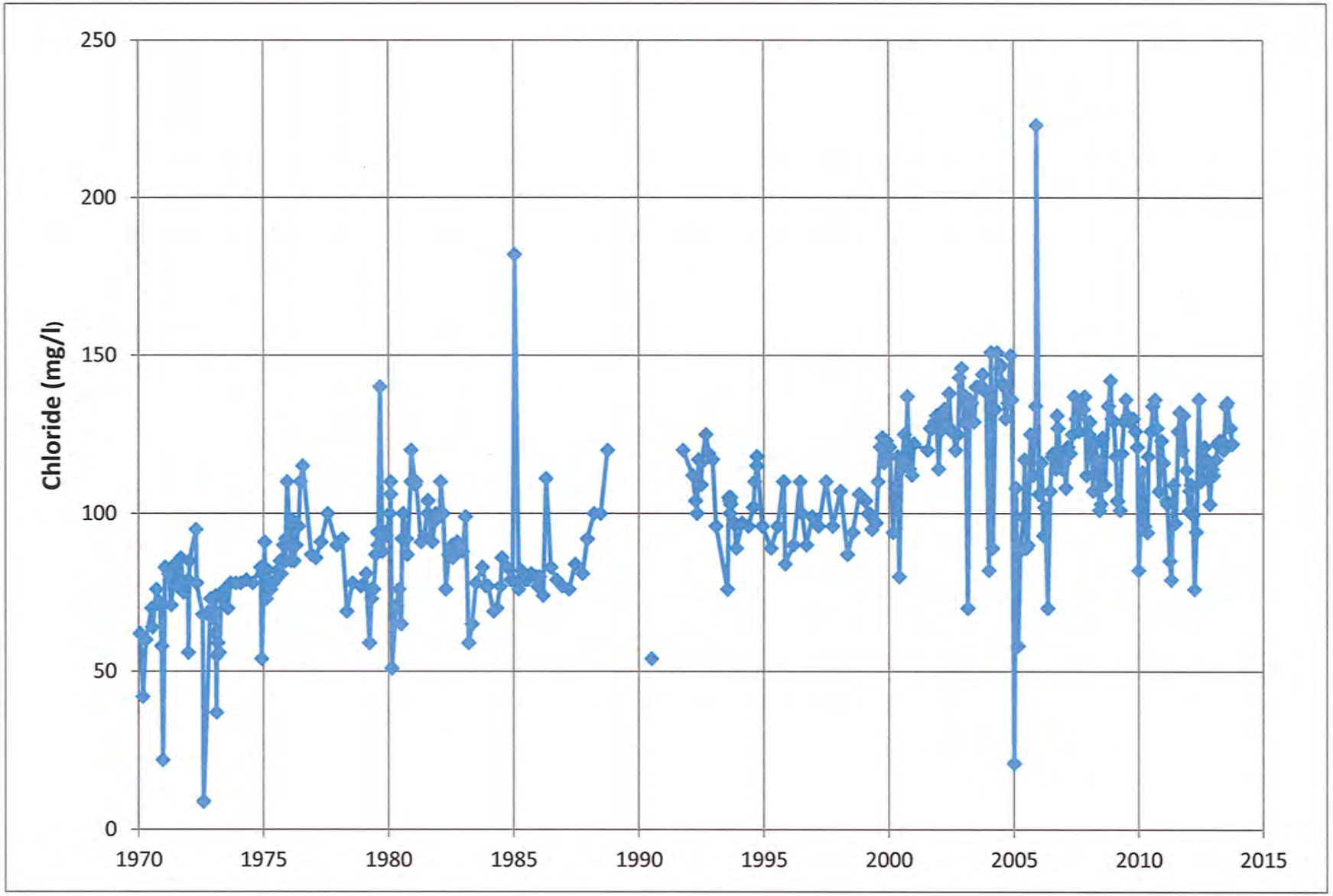


Figure 4.2-4. Historical chloride concentrations in the Santa Clara River near the Ventura-Los Angeles County line

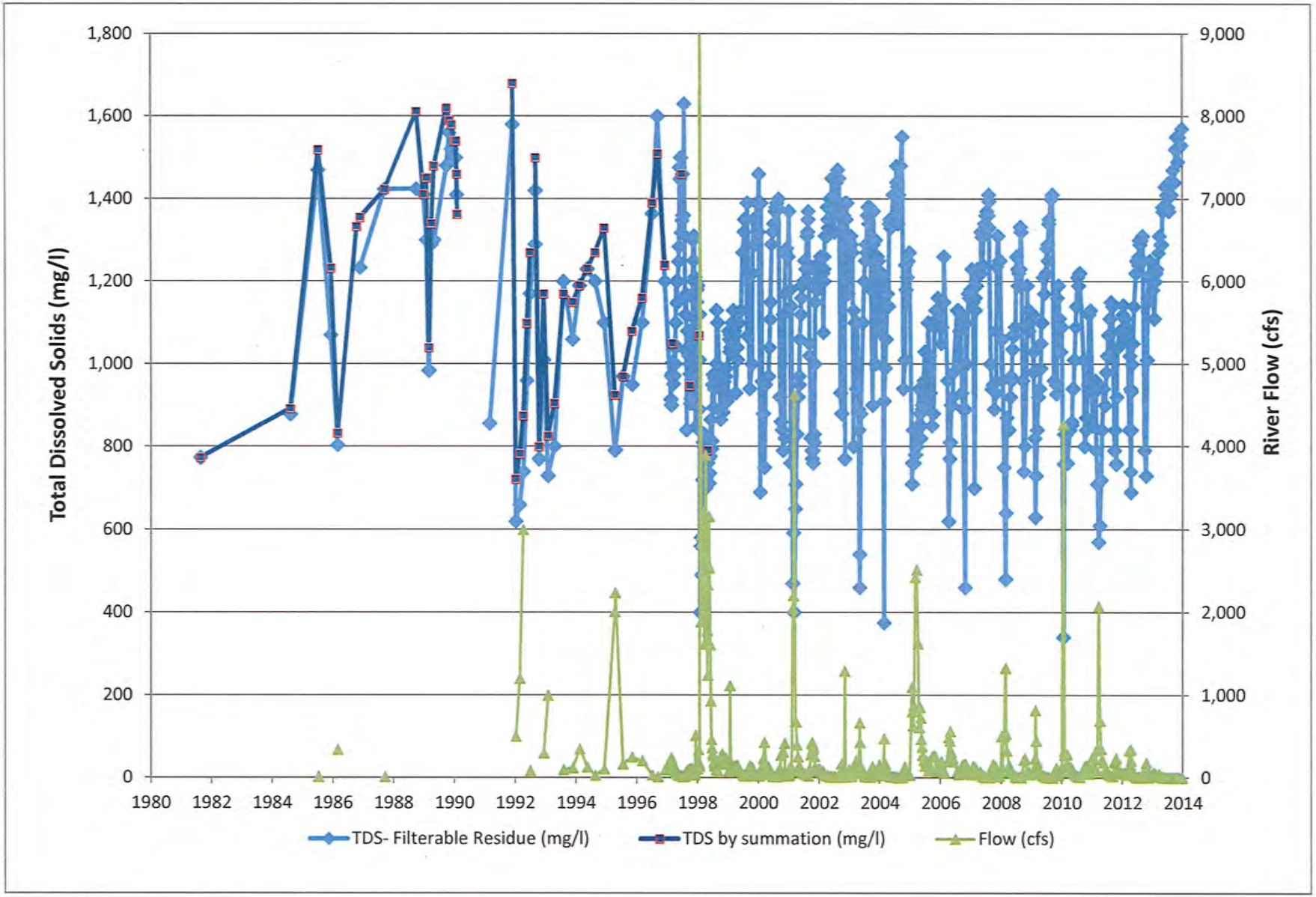


Figure 4.2-5. Historical TDS concentrations in the Santa Clara River at the Freeman Diversion

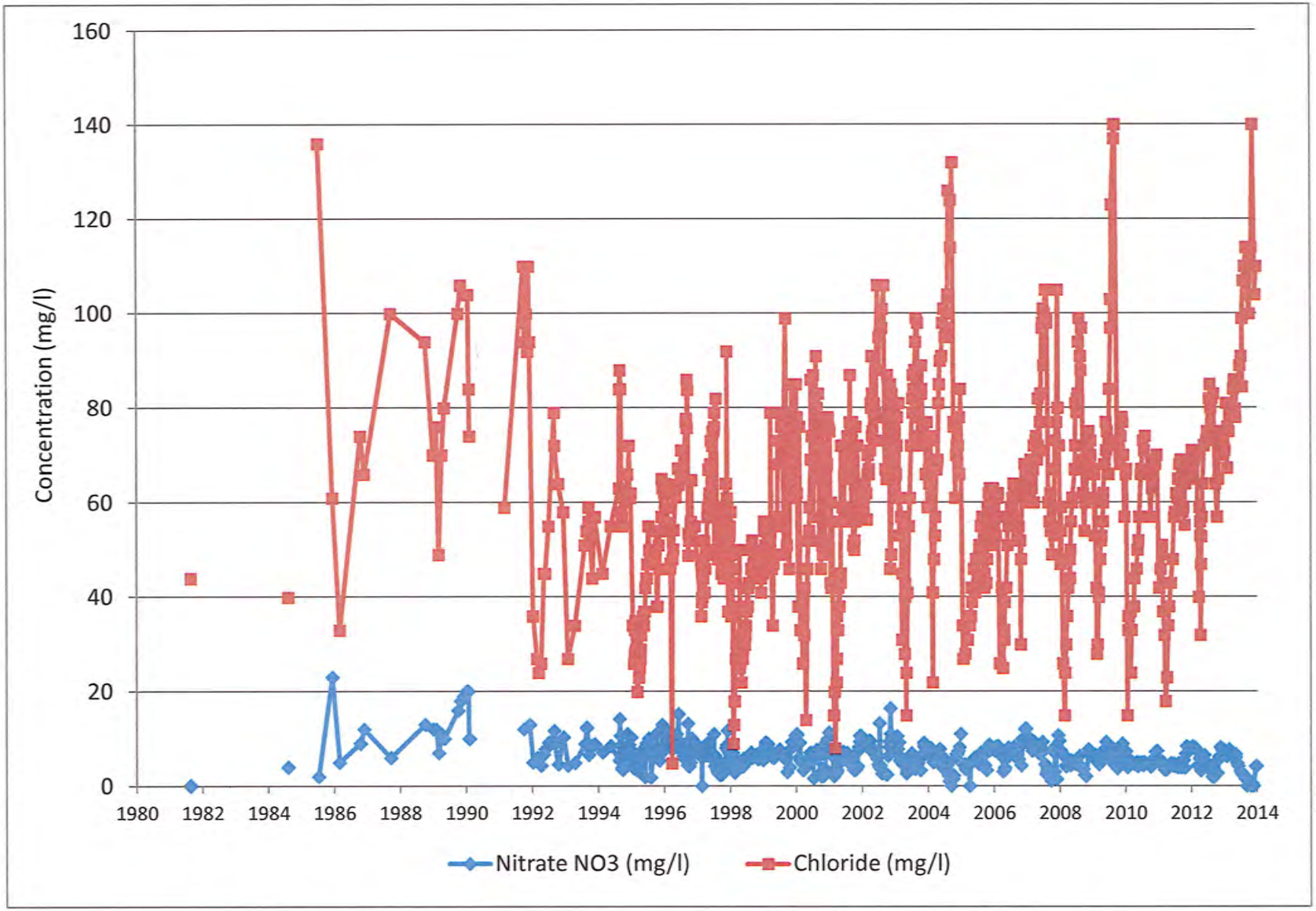


Figure 4.2-6. Historical chloride concentrations in the Santa Clara River at the Freeman Diversion

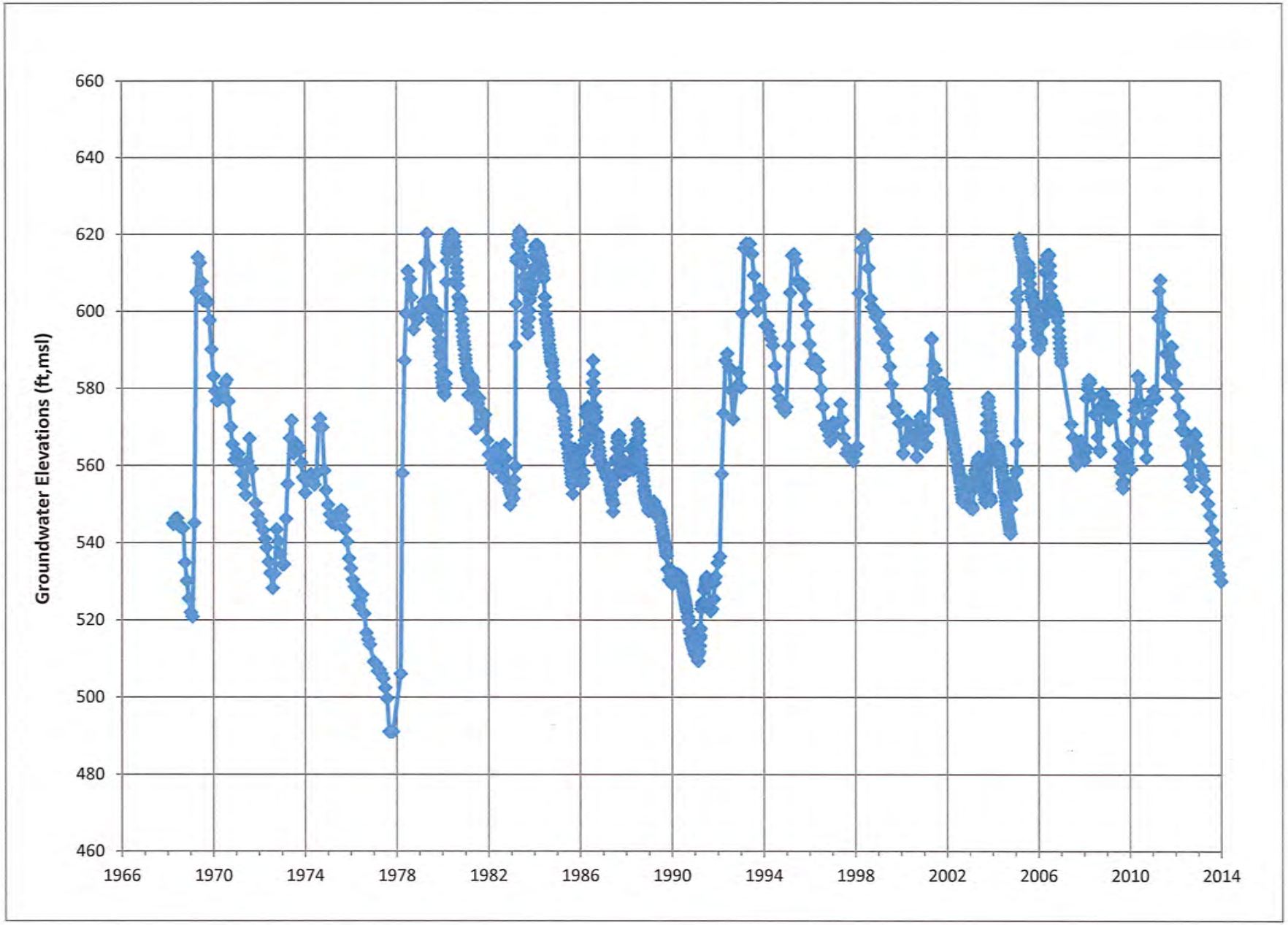


Figure 4.3-1. Historical groundwater elevations in Piru basin key well

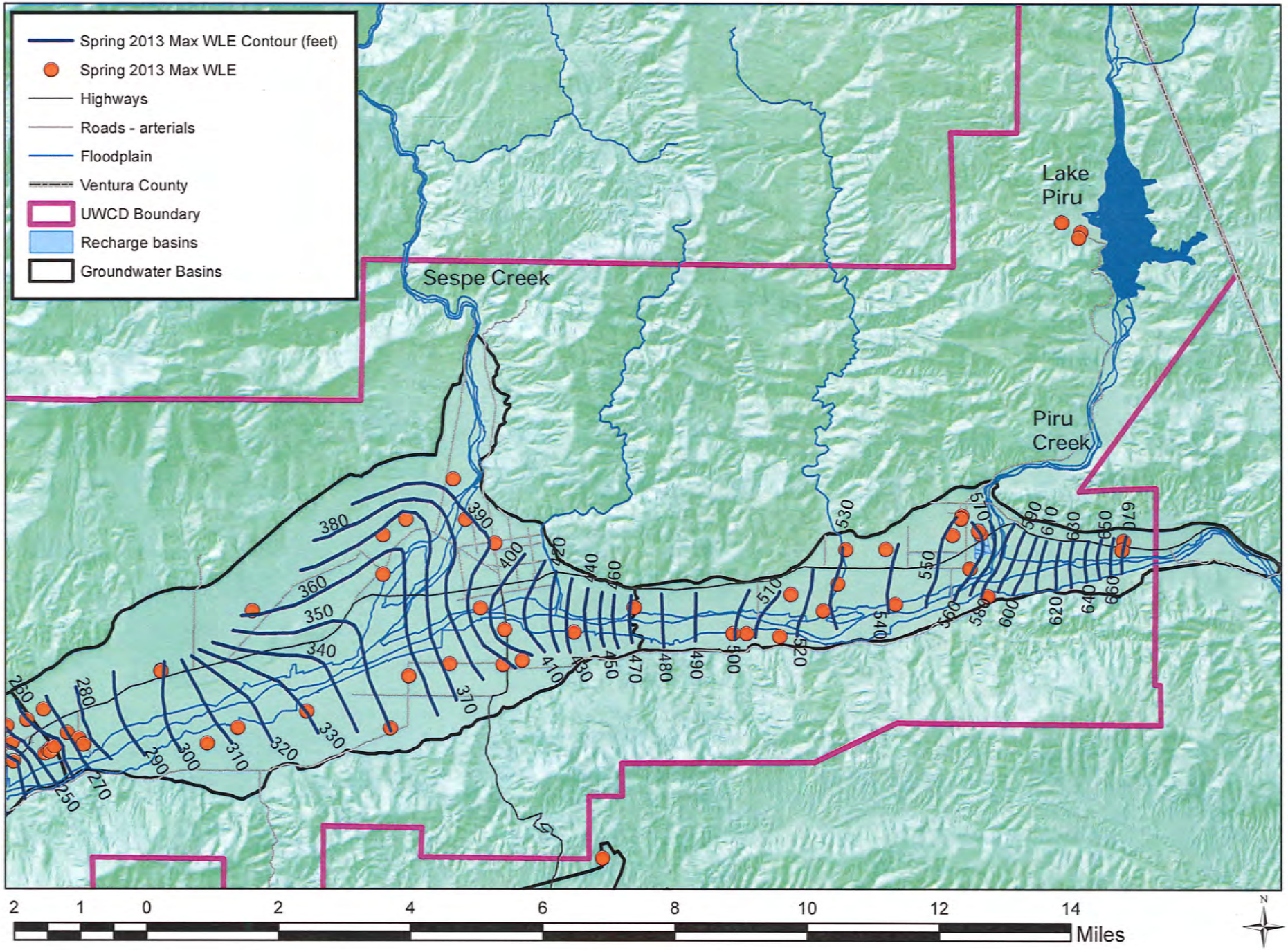


Figure 4.3-2. Piru and Fillmore basin groundwater elevations, spring 2013

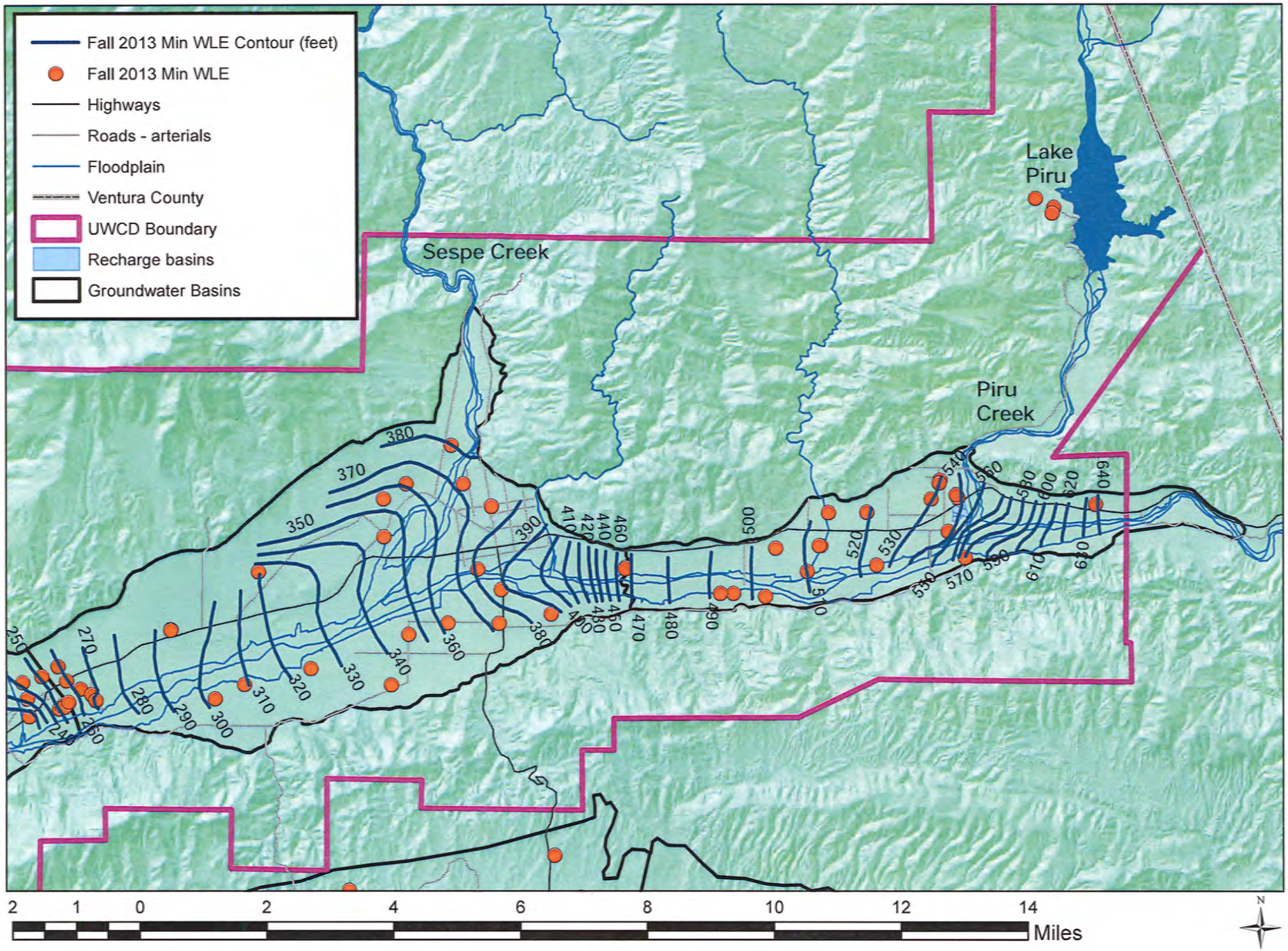


Figure 4.3-3. Piru and Fillmore basin groundwater elevations, fall 2013

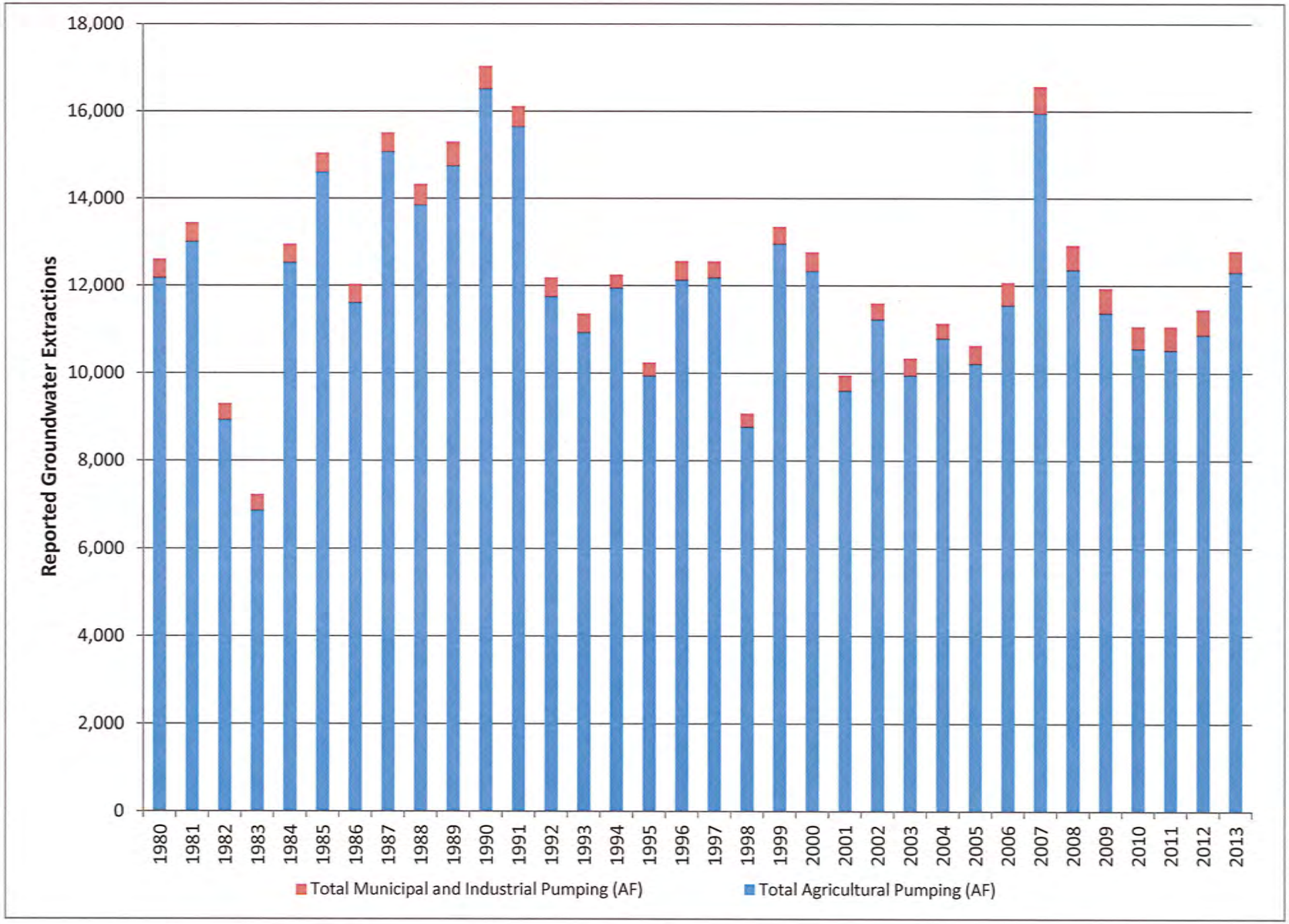


Figure 4.3-4. Historical reported groundwater extractions for the Piru basin

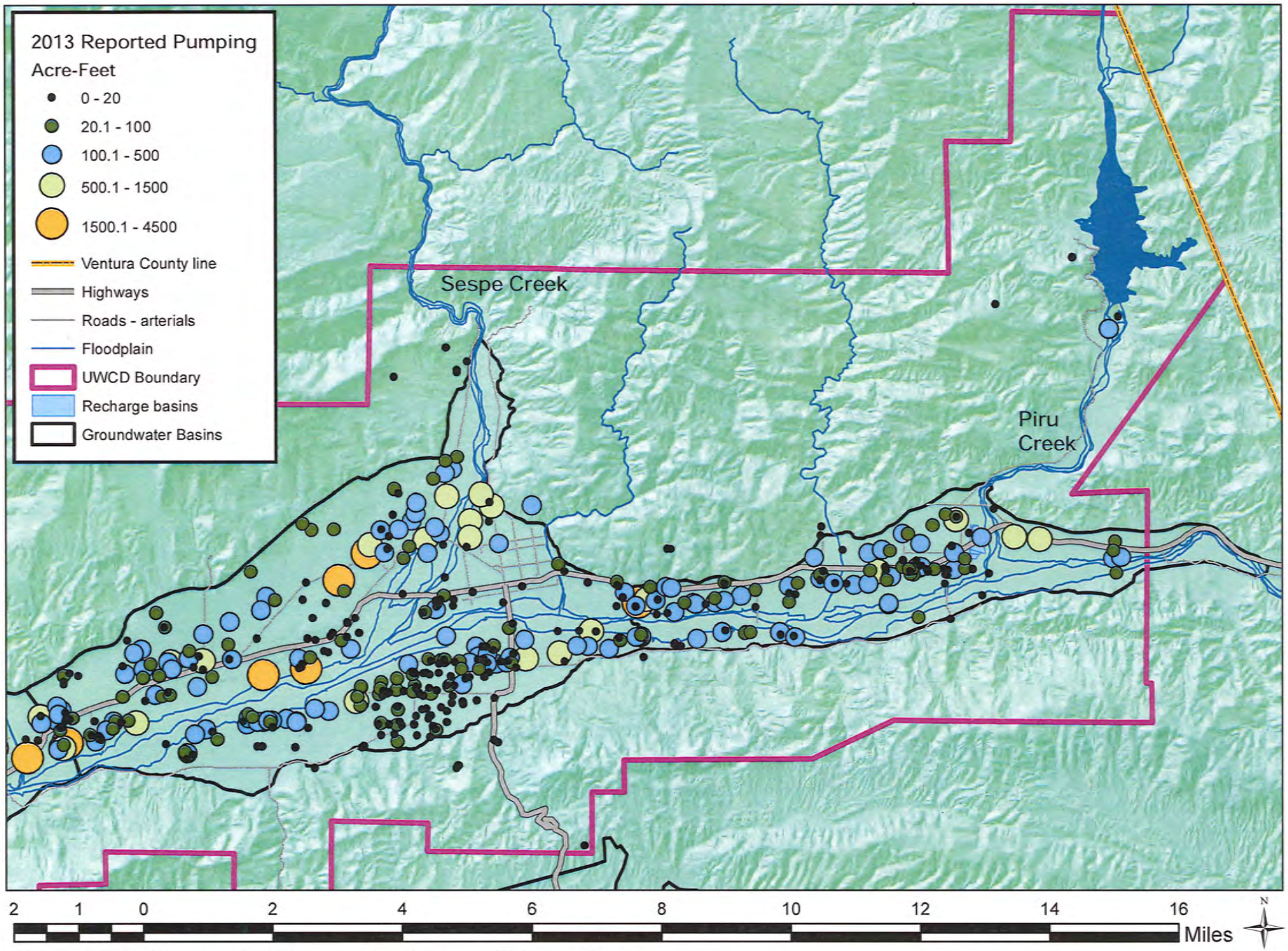


Figure 4.3-5. Reported 2013 pumping, Piru and Fillmore basins

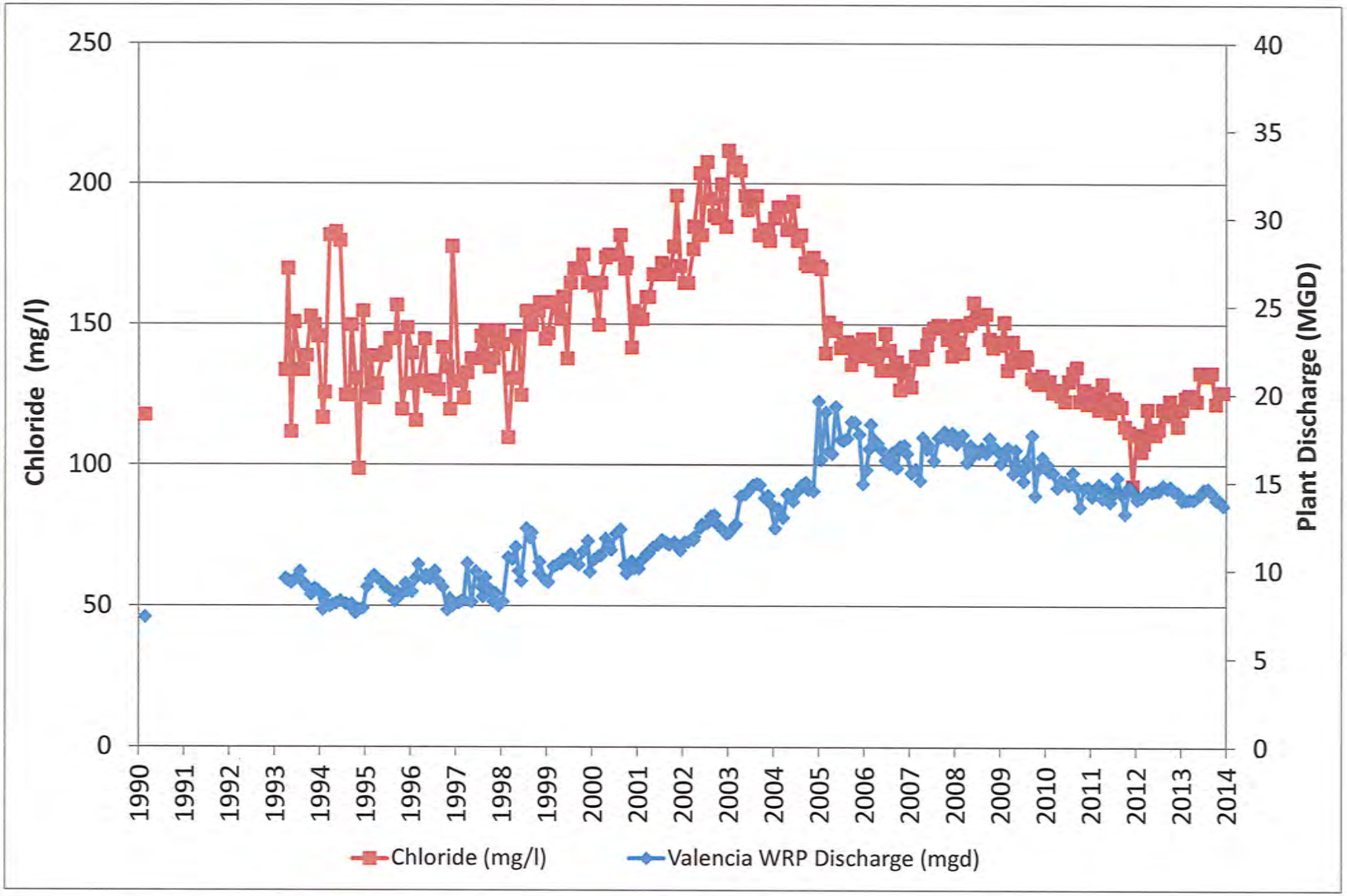


Figure 4.3-6. Historical chloride and discharge volumes at Valencia WRP

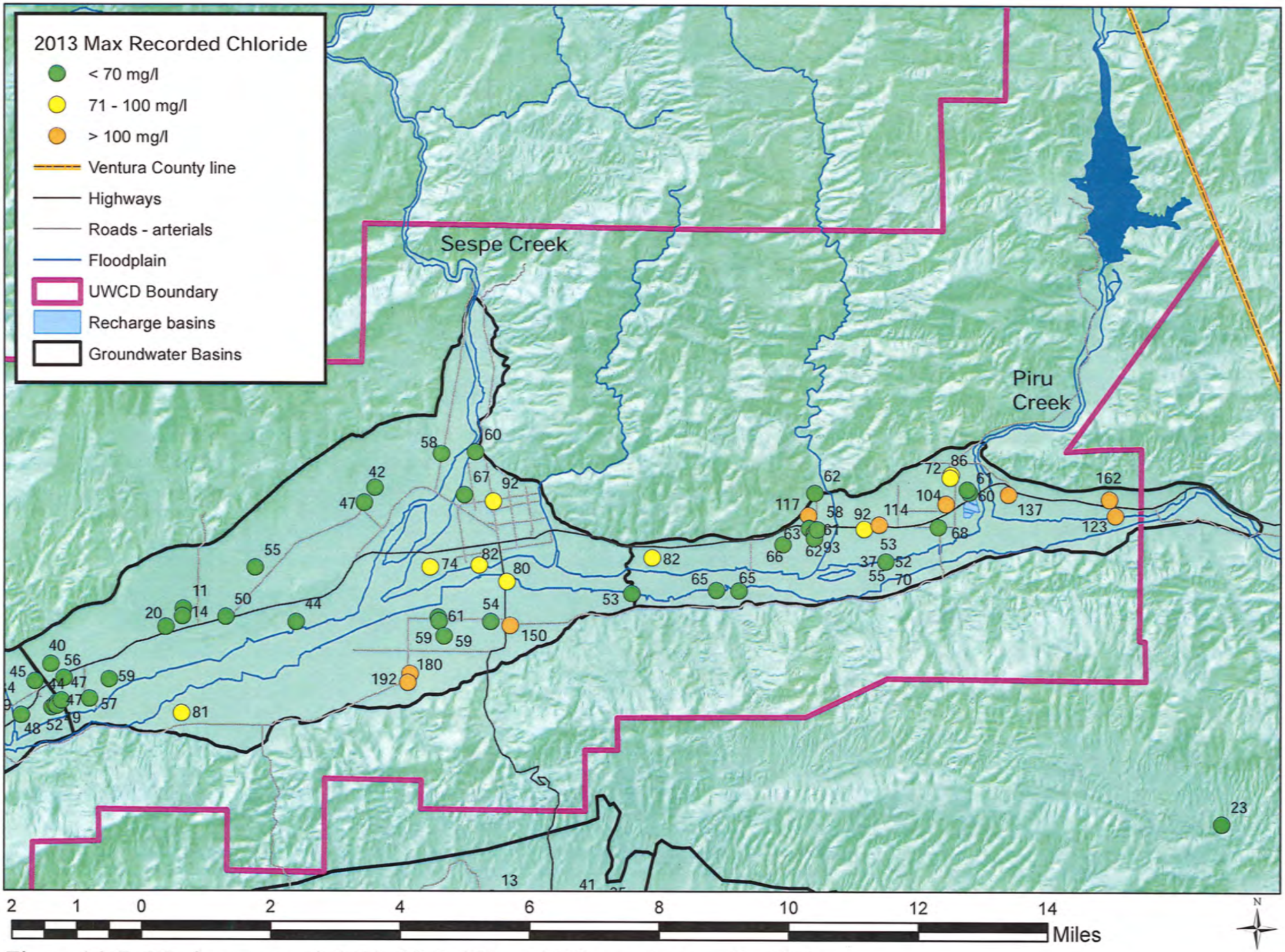


Figure 4.3-7. Maximum recorded chloride in Piru and Fillmore basin wells, 2013

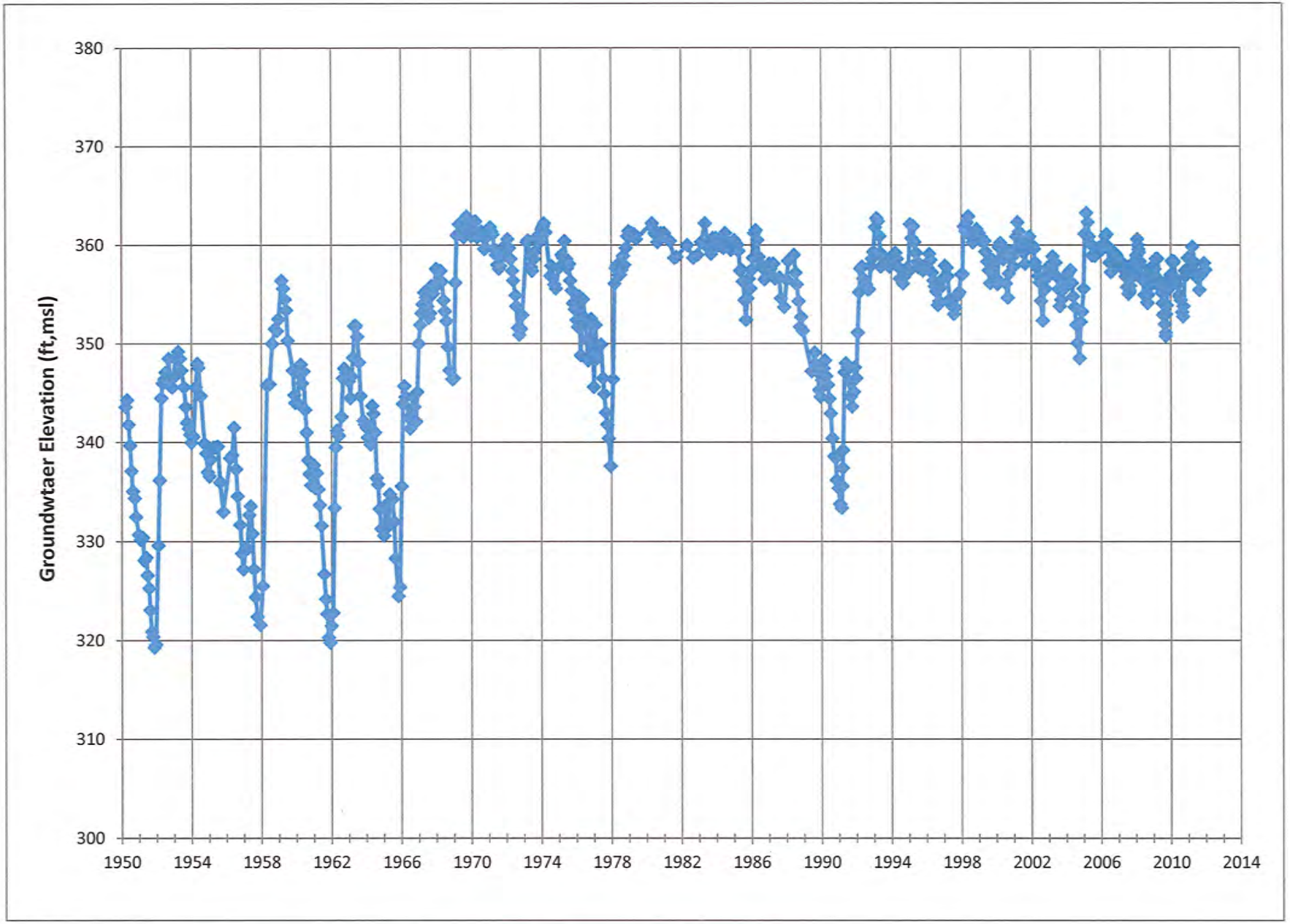


Figure 4.3-8. Historical groundwater elevations in Fillmore basin key well

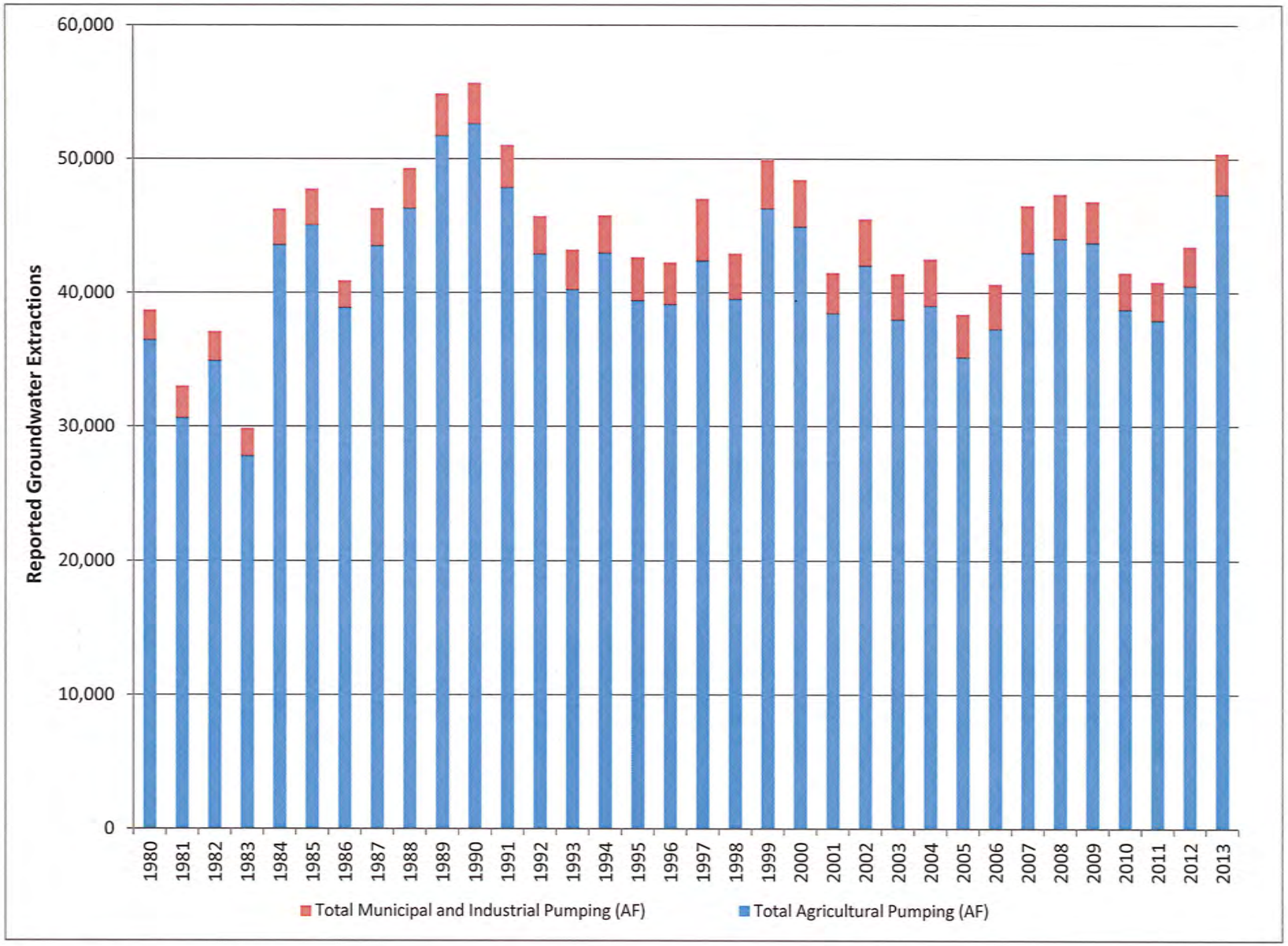


Figure 4.3-9. Historical reported groundwater extractions for the Fillmore basin

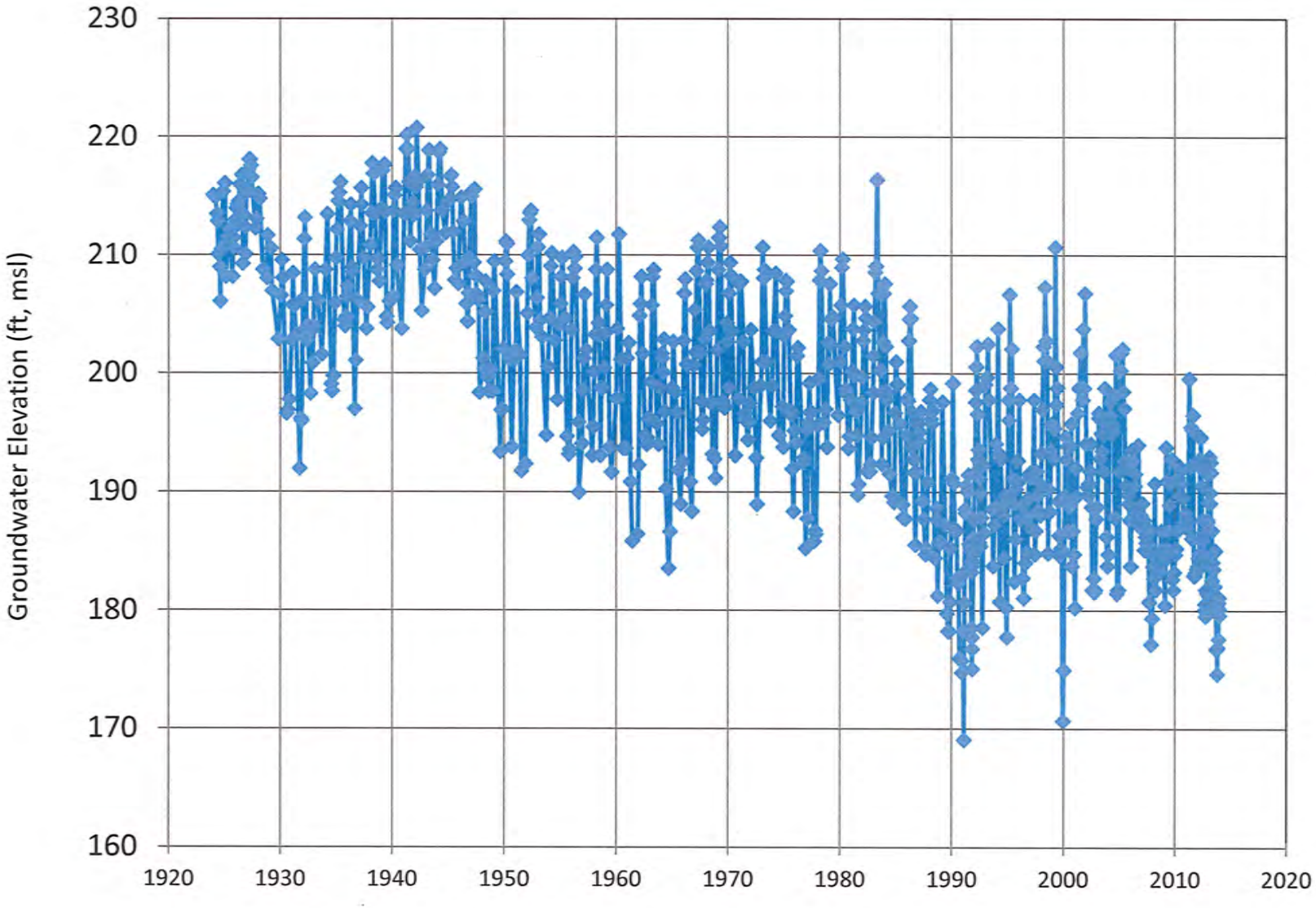


Figure 4.3-10. Historical groundwater elevations in Santa Paula basin key well

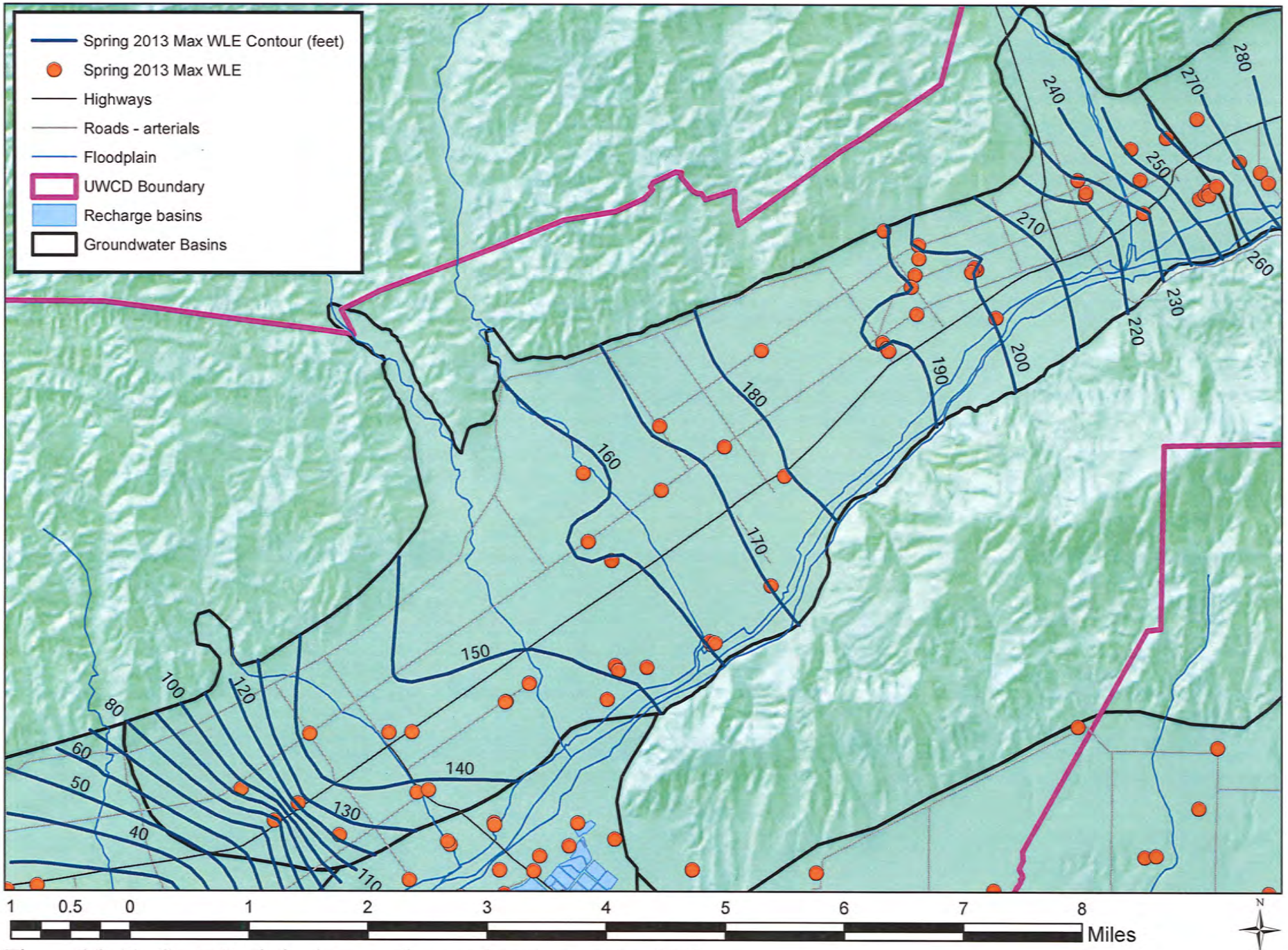


Figure 4.3-11. Santa Paula basin groundwater elevations, spring 2013

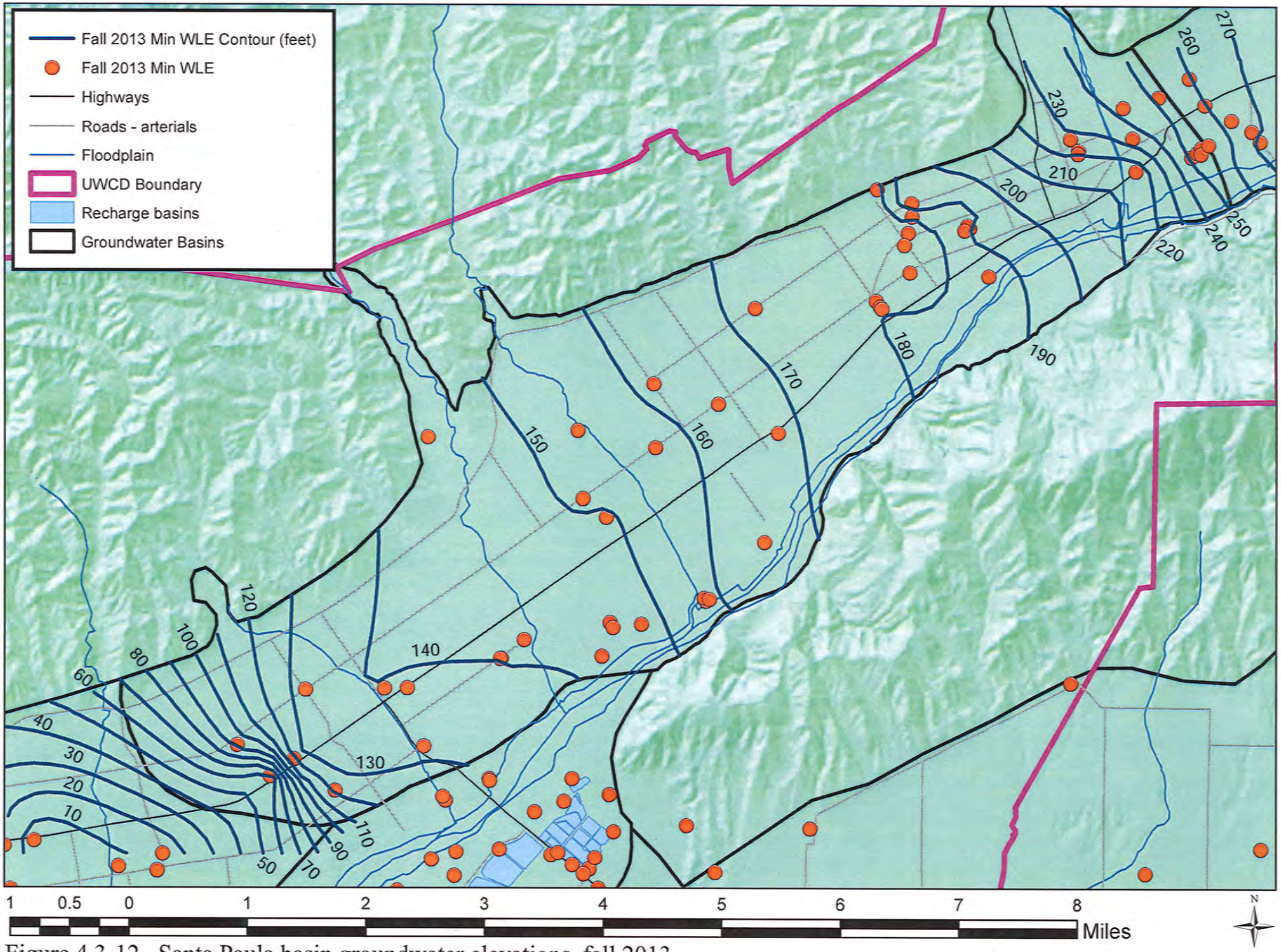


Figure 4.3-12. Santa Paula basin groundwater elevations, fall 2013

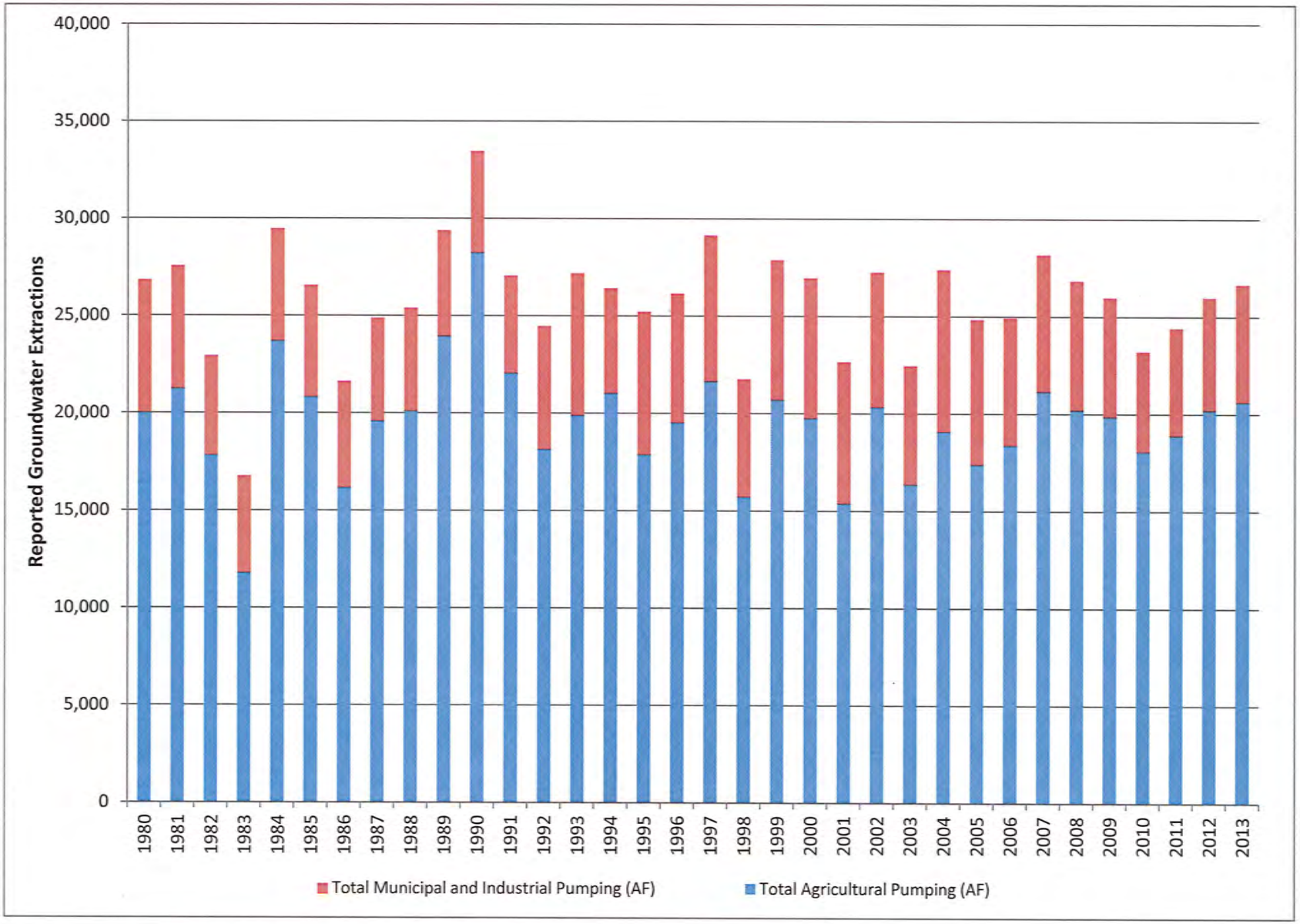


Figure 4.3-13. Historical reported groundwater extractions for the Santa Paula basin

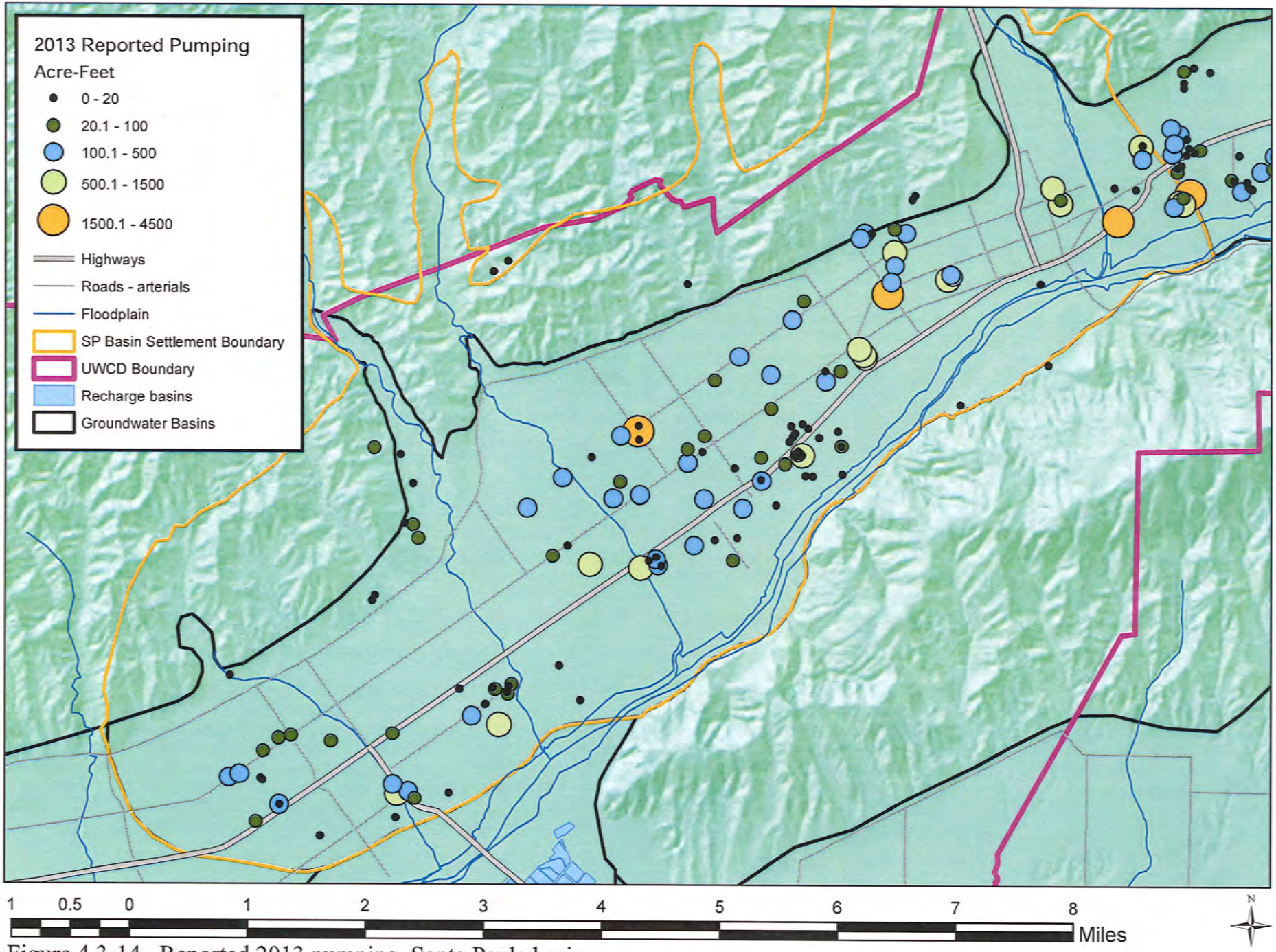


Figure 4.3-14. Reported 2013 pumping, Santa Paula basin

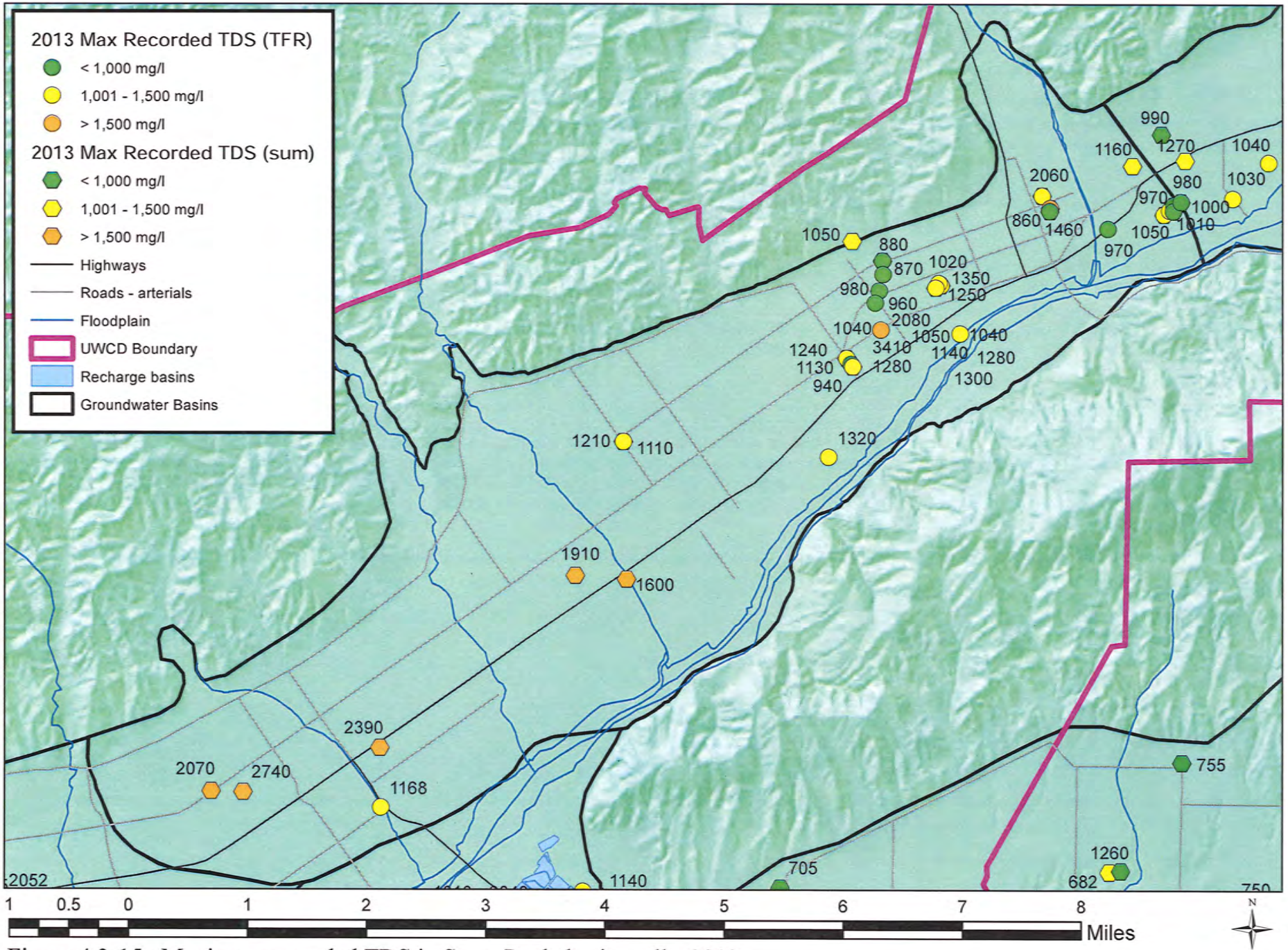


Figure 4.3-15. Maximum recorded TDS in Santa Paula basin wells, 2013

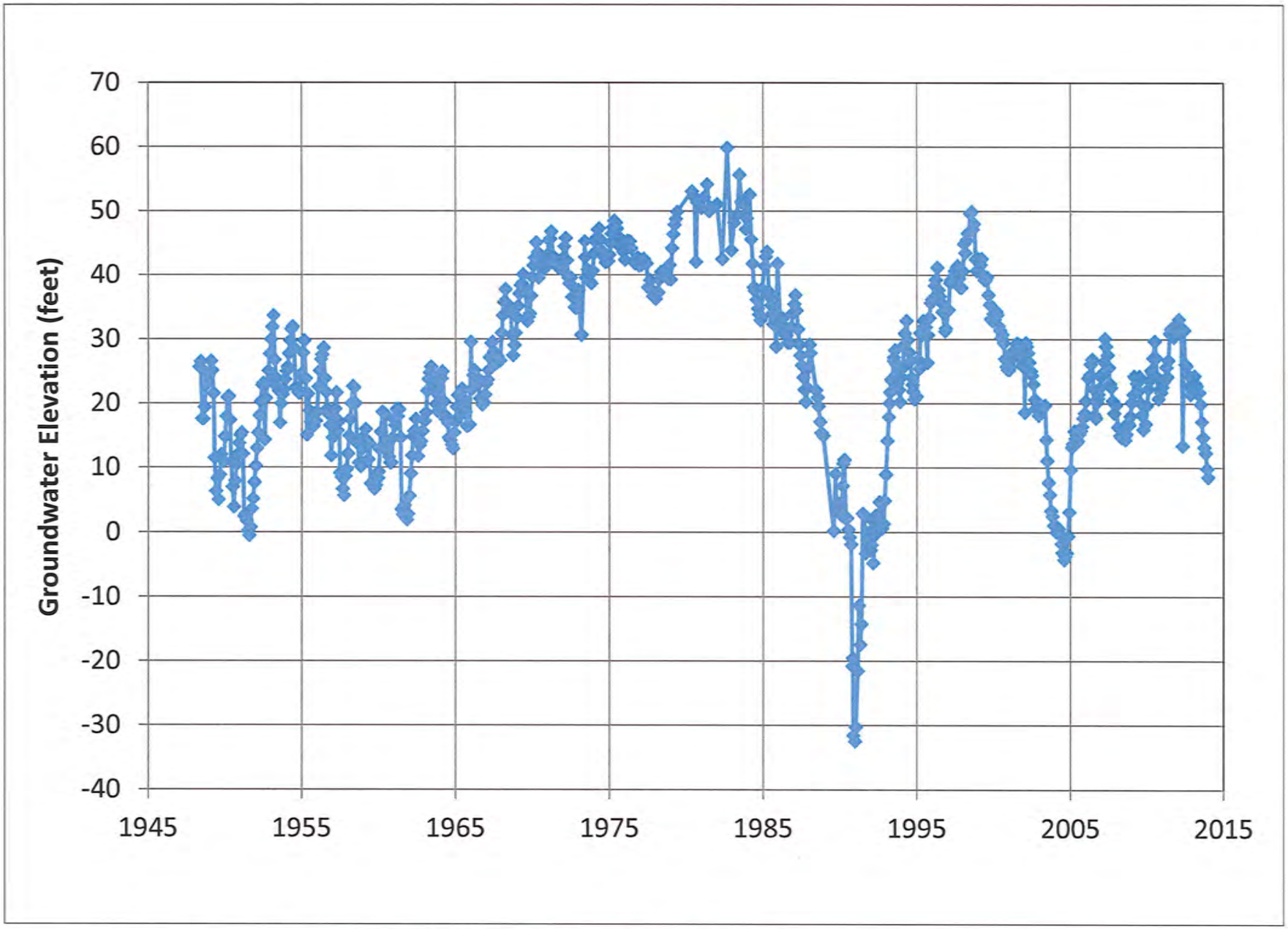


Figure 4.3-16. Historical groundwater elevations in Mound basin key well

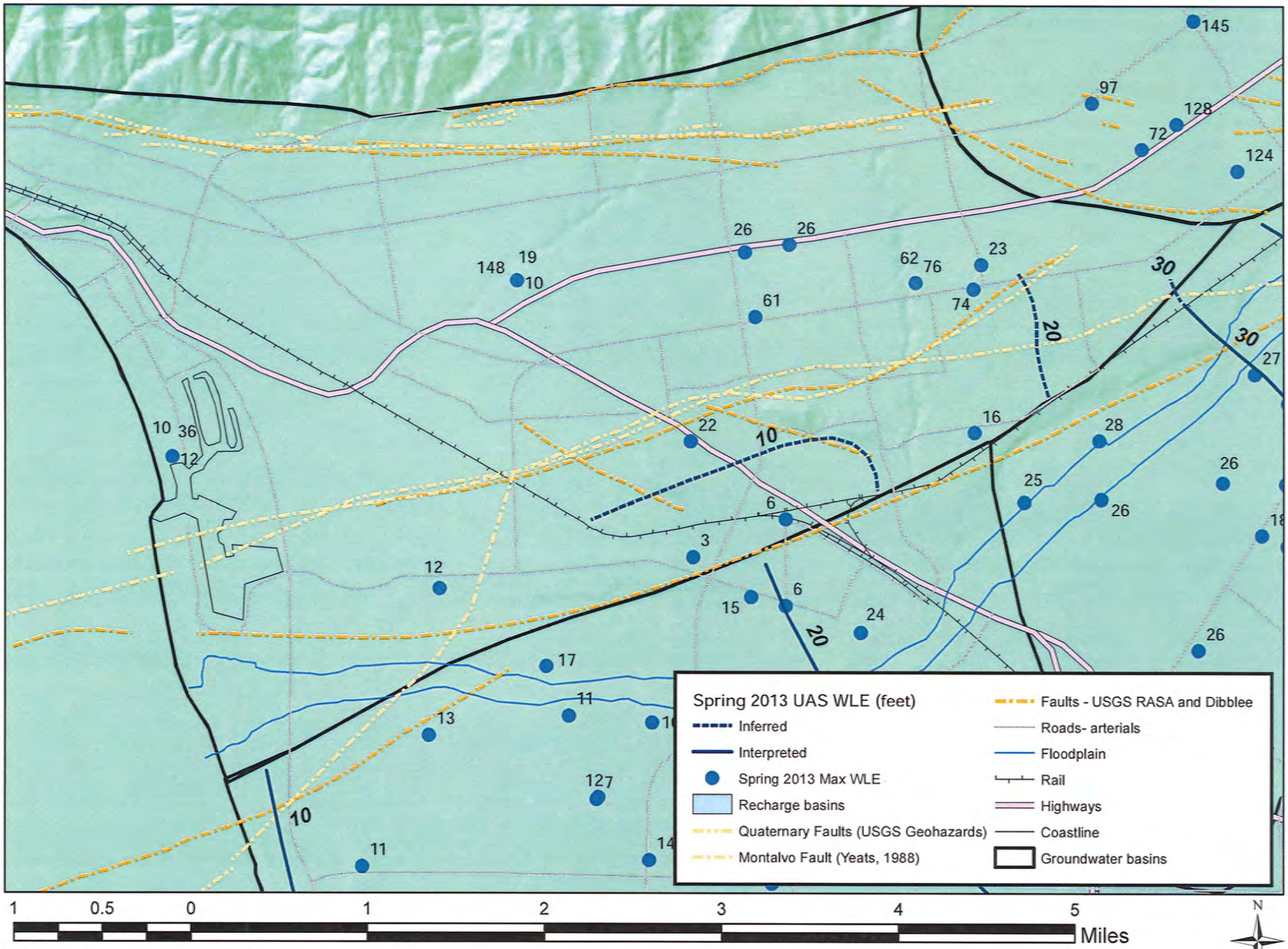


Figure 4.3-17. Mound basin groundwater elevations, spring 2013

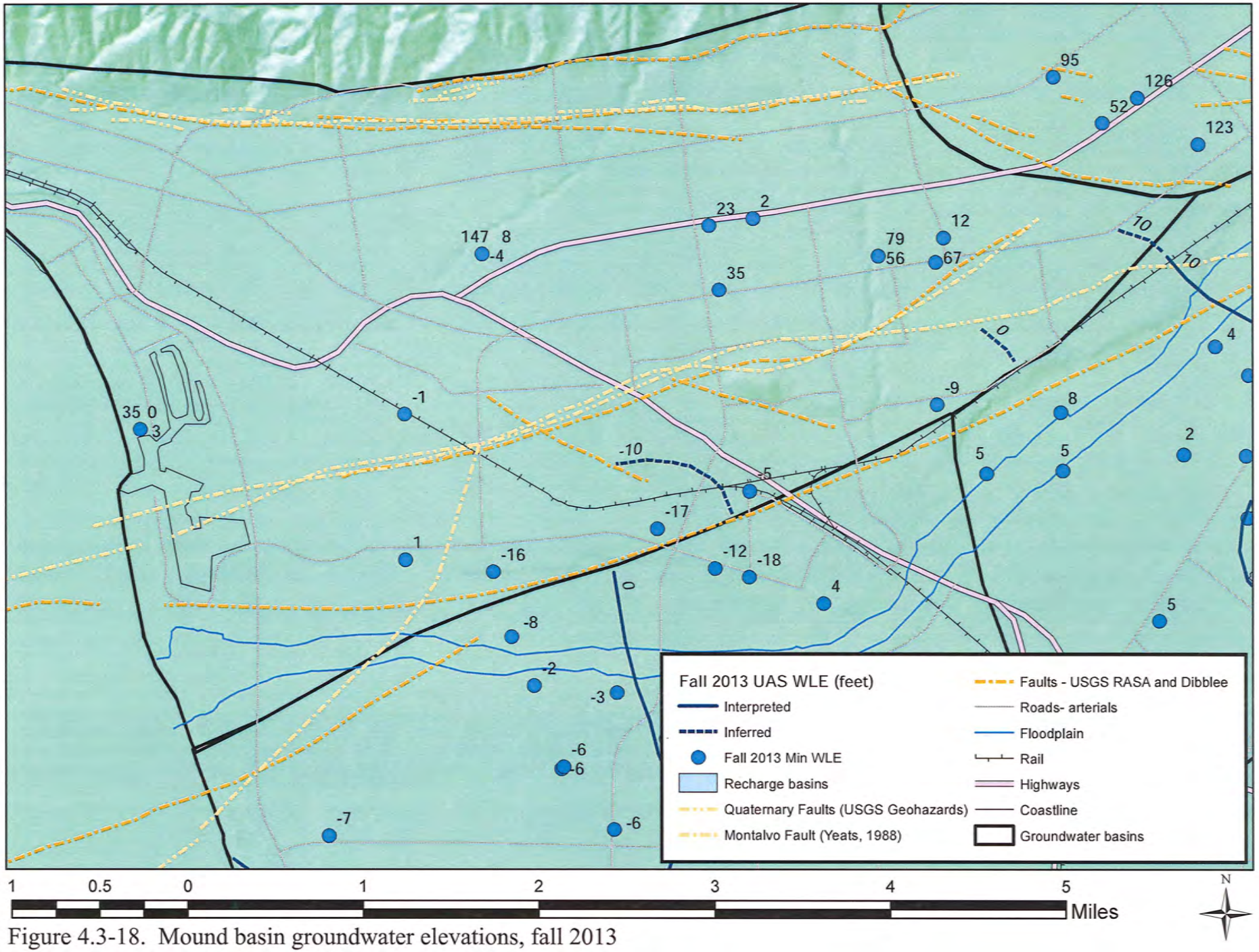


Figure 4.3-18. Mound basin groundwater elevations, fall 2013

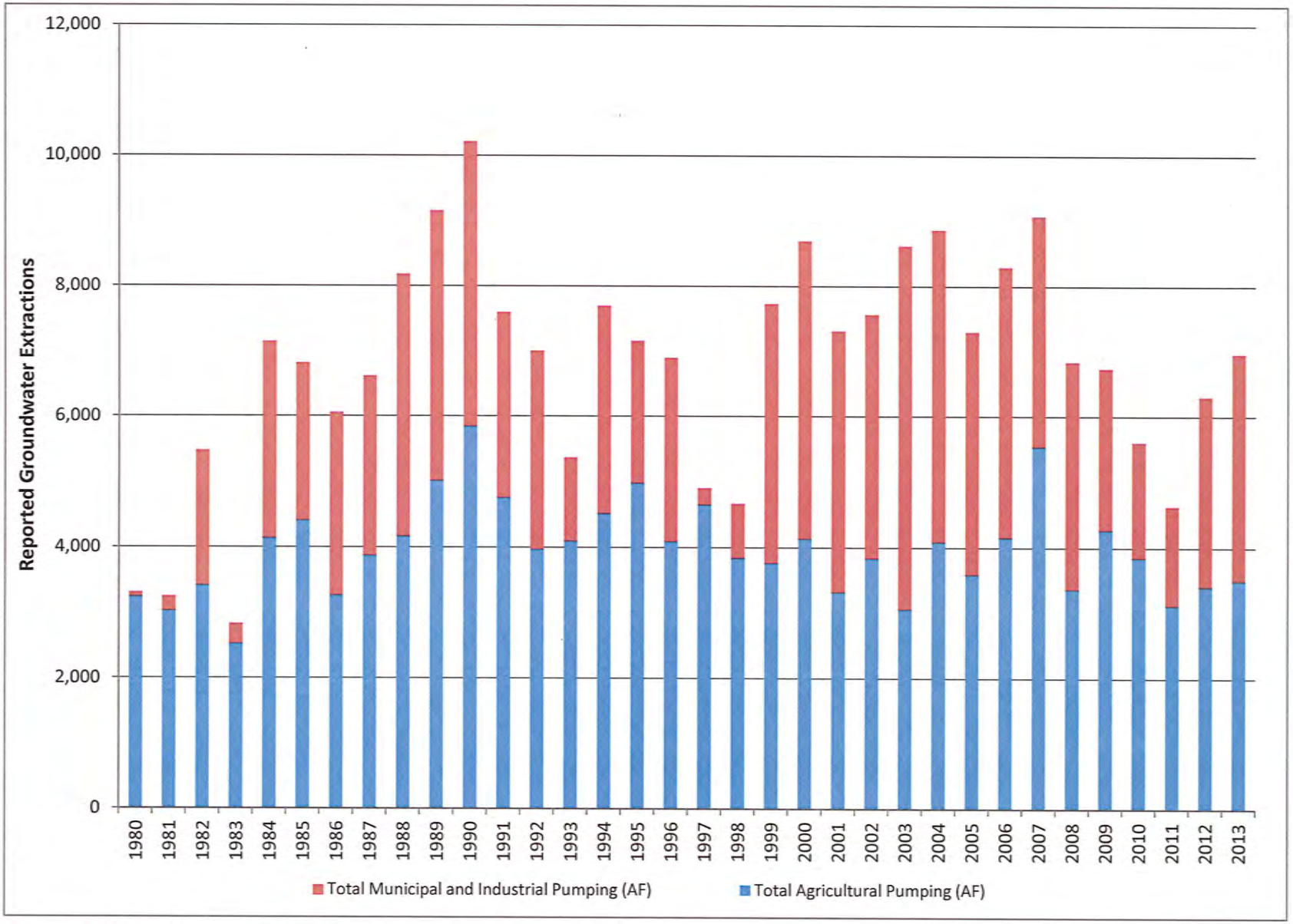


Figure 4.3-19. Historical reported groundwater extractions for the Mound basin

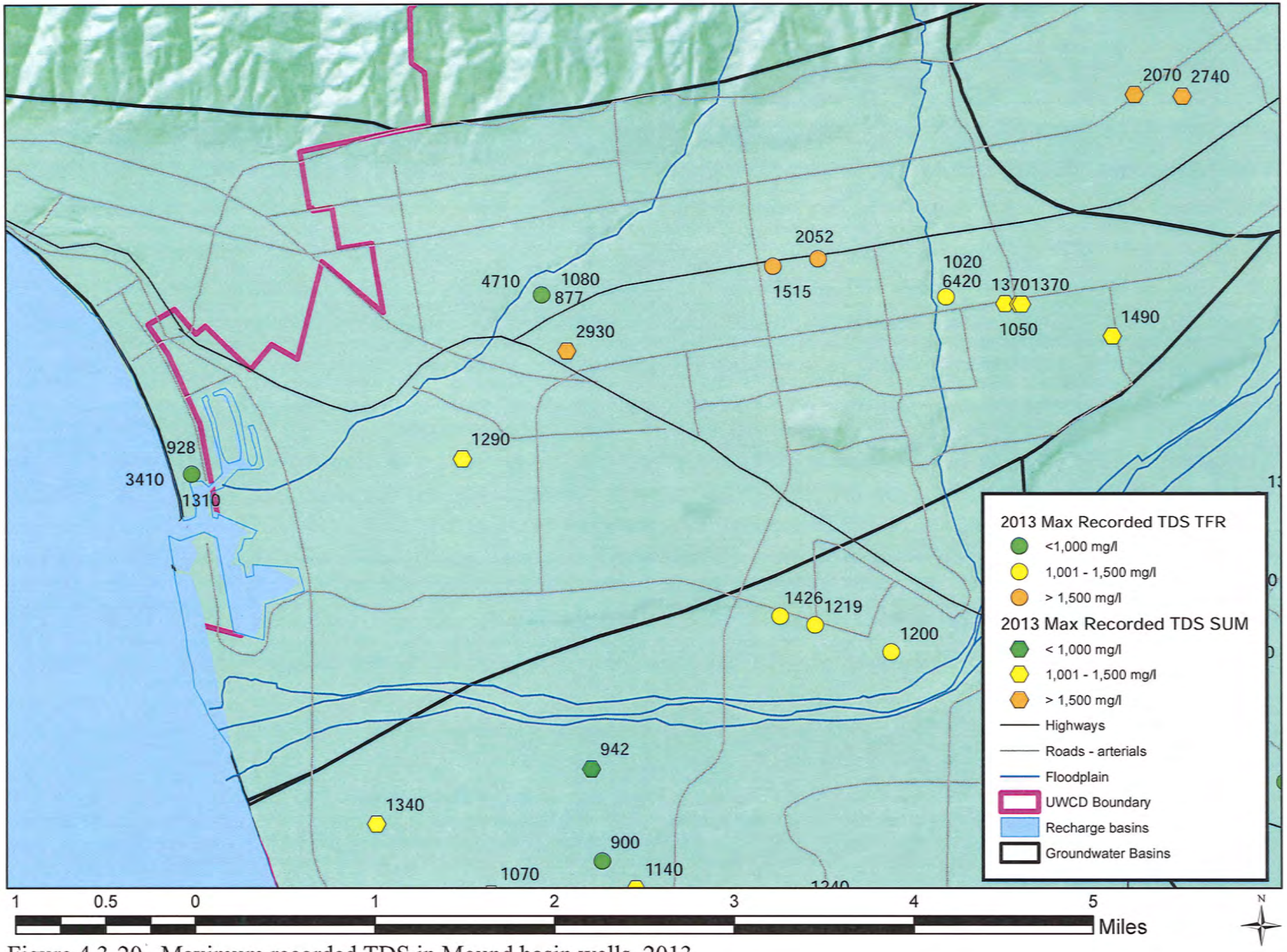


Figure 4.3-20. Maximum recorded TDS in Mound basin wells, 2013

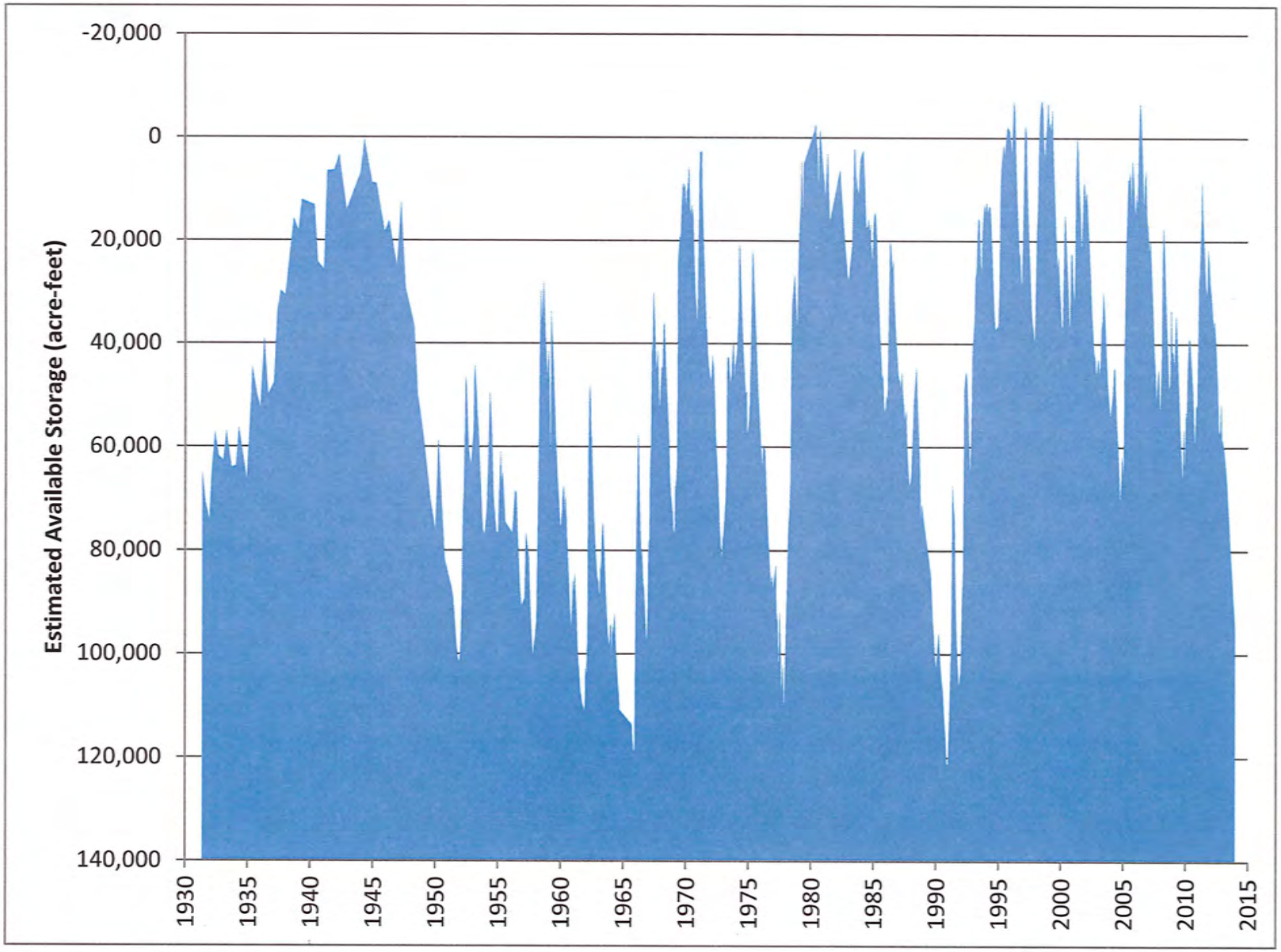


Figure 4.3-21. Historical estimates of available groundwater storage, Oxnard Forebay basin

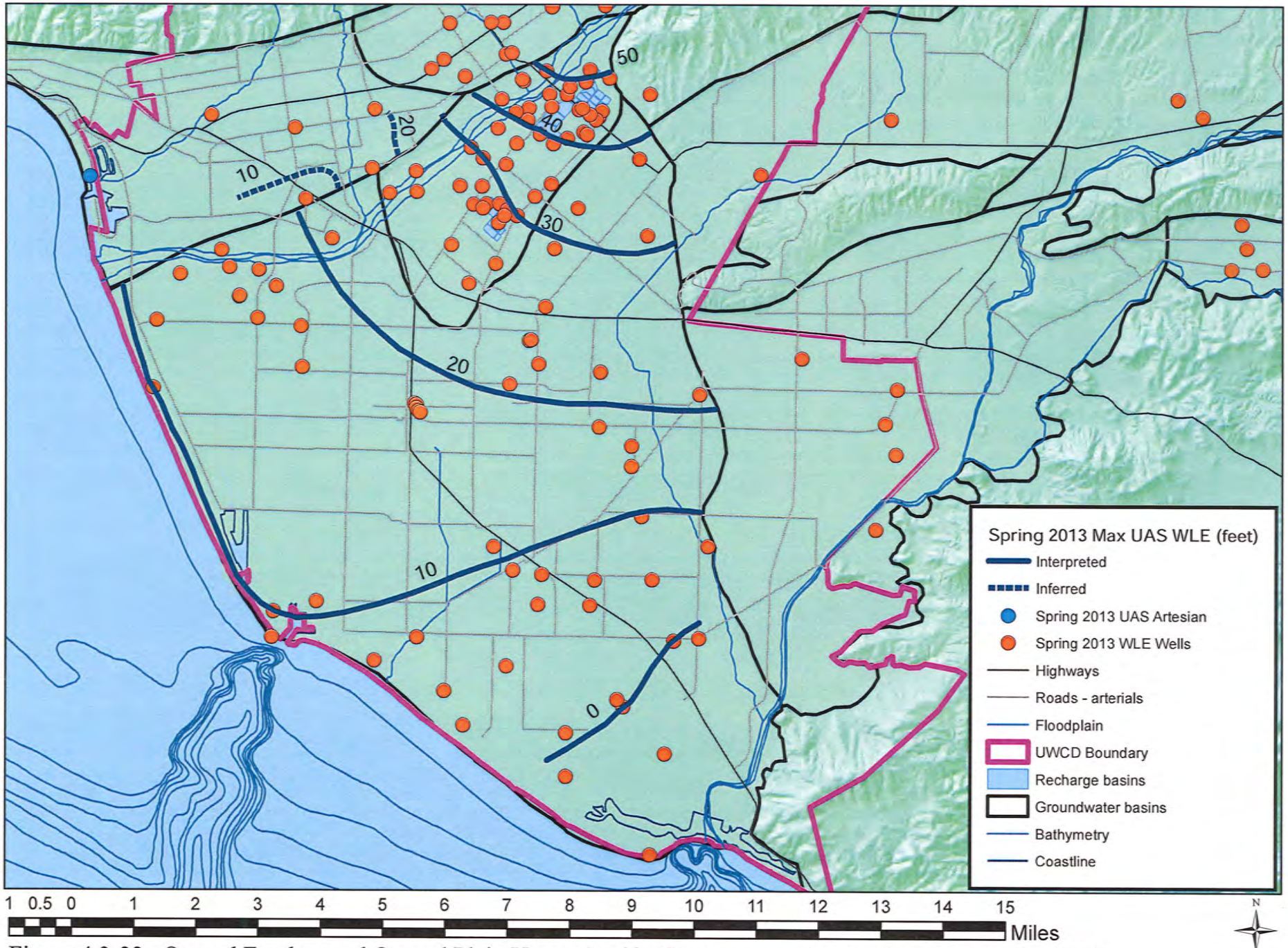


Figure 4.3-22. Oxnard Forebay and Oxnard Plain Upper Aquifer System groundwater elevations, spring 2013

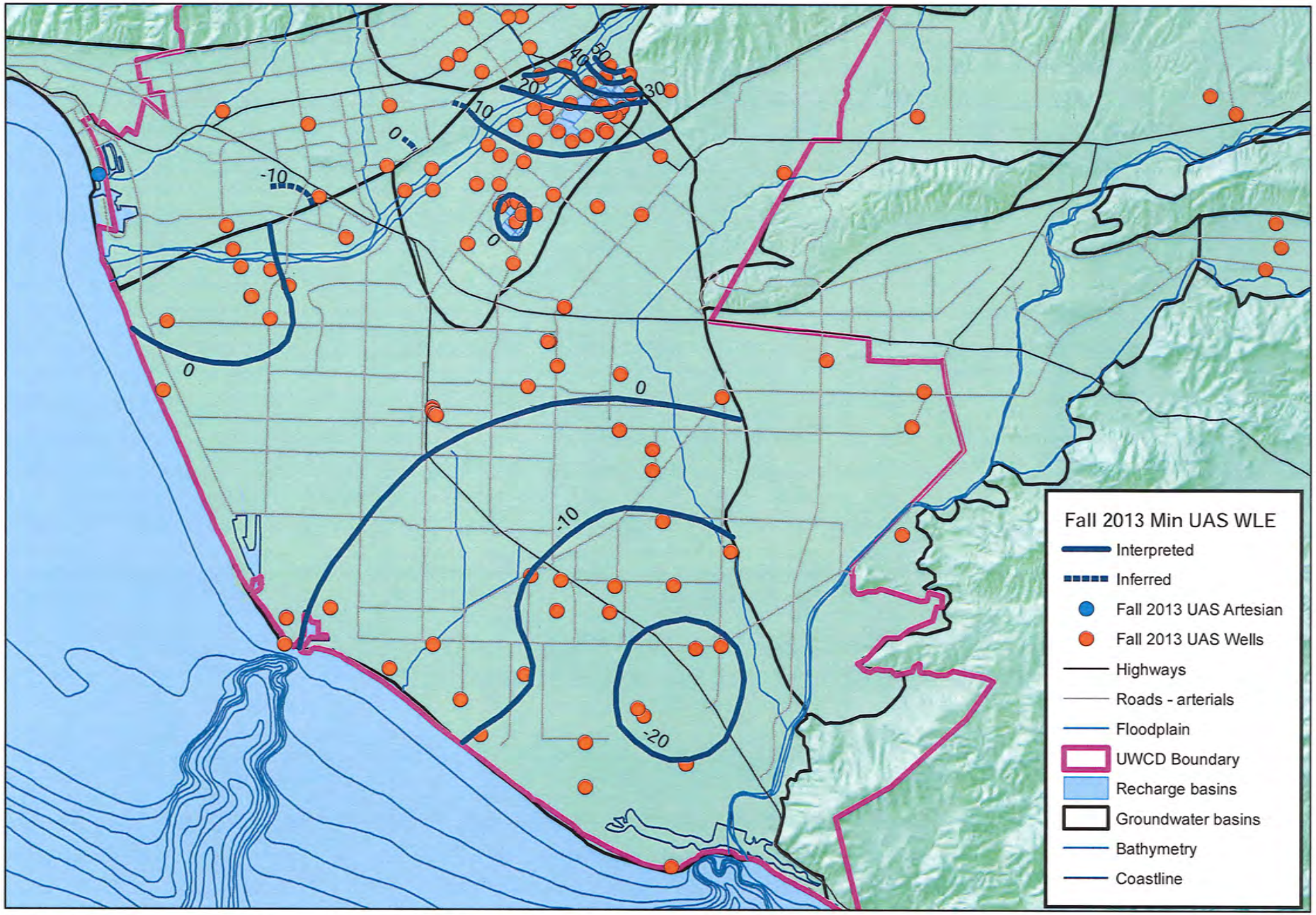


Figure 4.3-23. Oxnard Forebay and Oxnard Plain Upper Aquifer System groundwater elevations, fall 2013

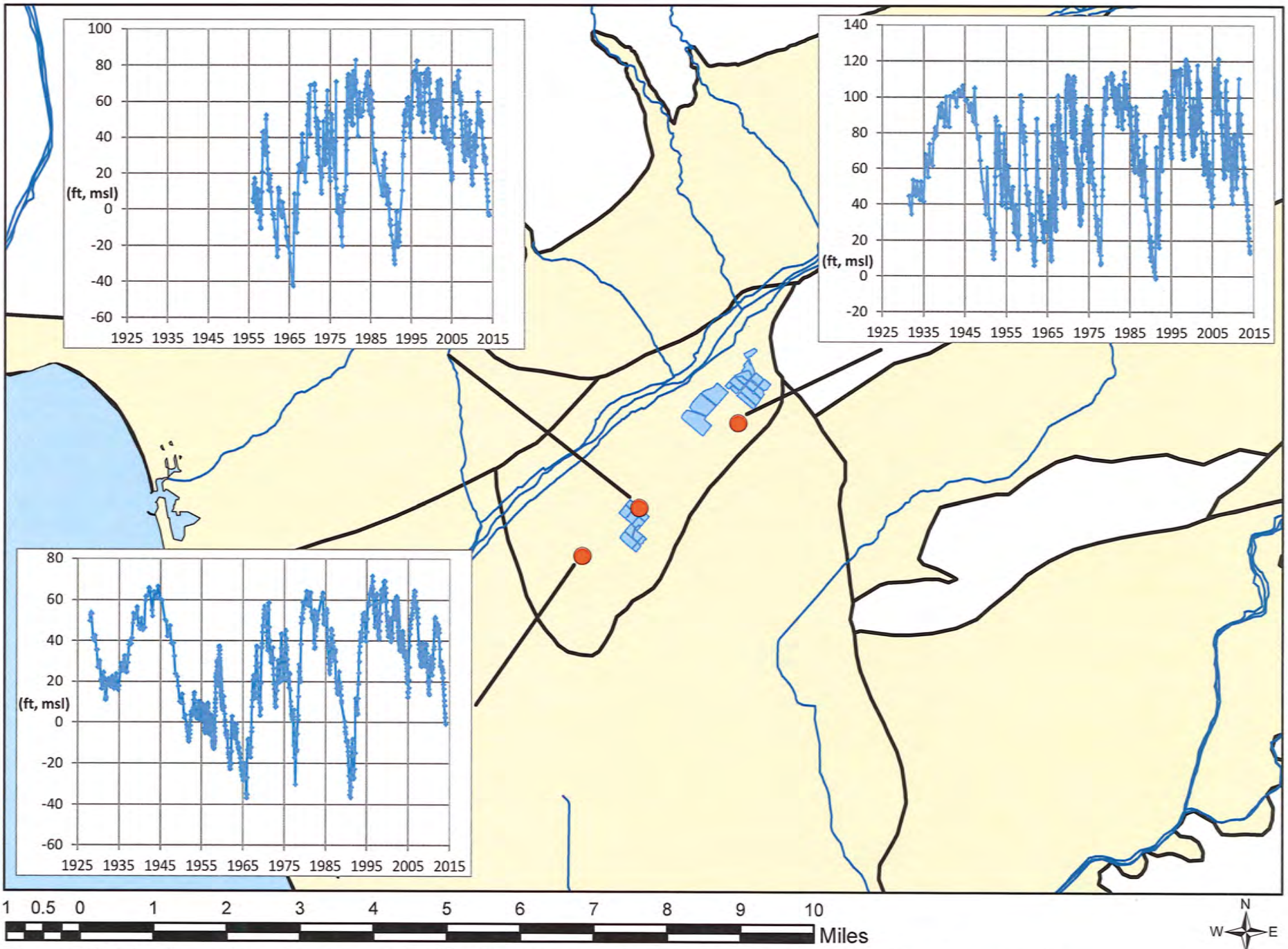


Figure 4.3-24. Oxnard Forebay Upper Aquifer System groundwater elevation hydrographs, selected wells

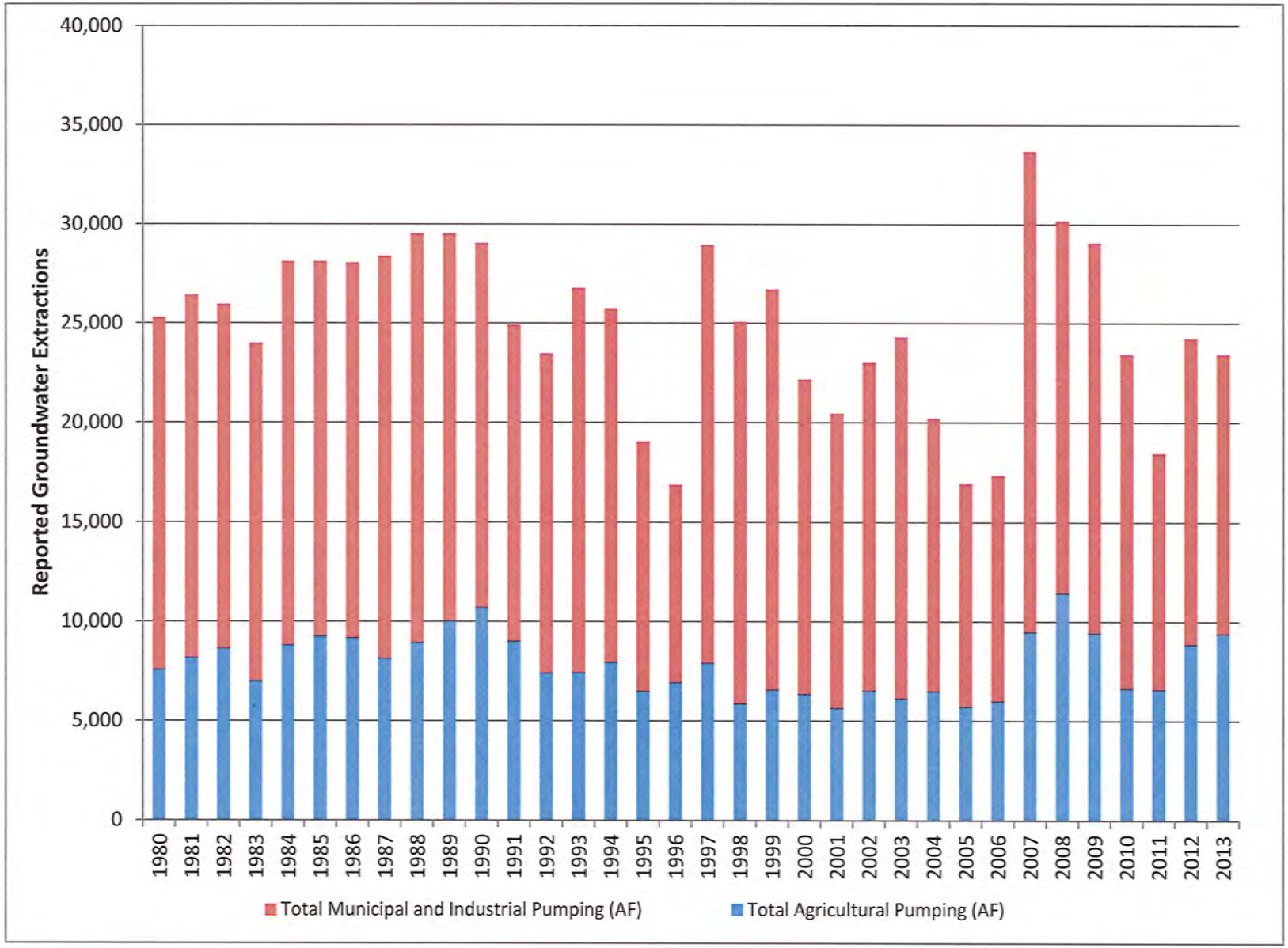


Figure 4.3-25. Historical reported groundwater extractions for the Oxnard Forebay

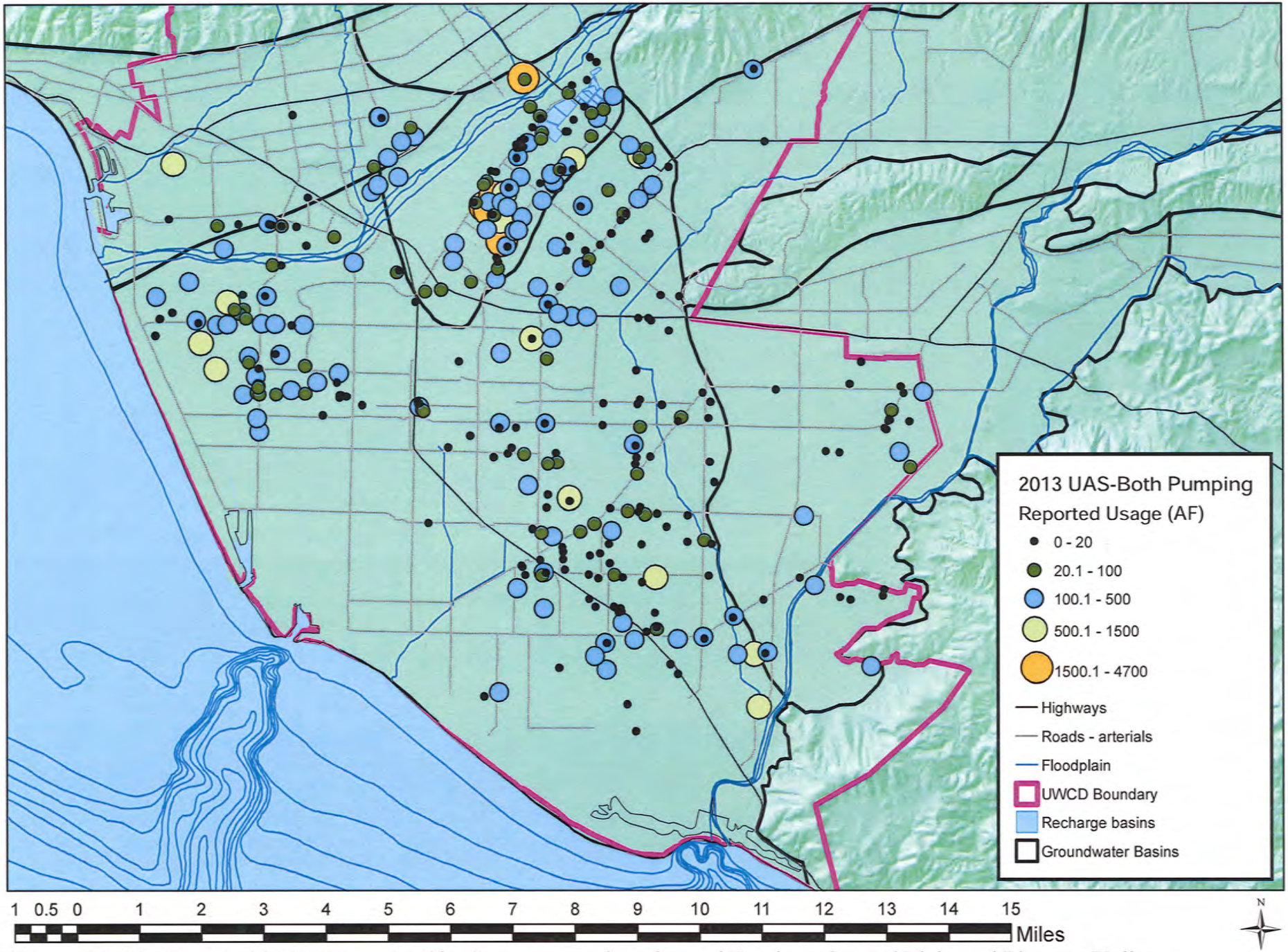


Figure 4.3-26. Reported 2013 Upper Aquifer System pumping, Oxnard Forebay, Oxnard Plain and Pleasant Valley

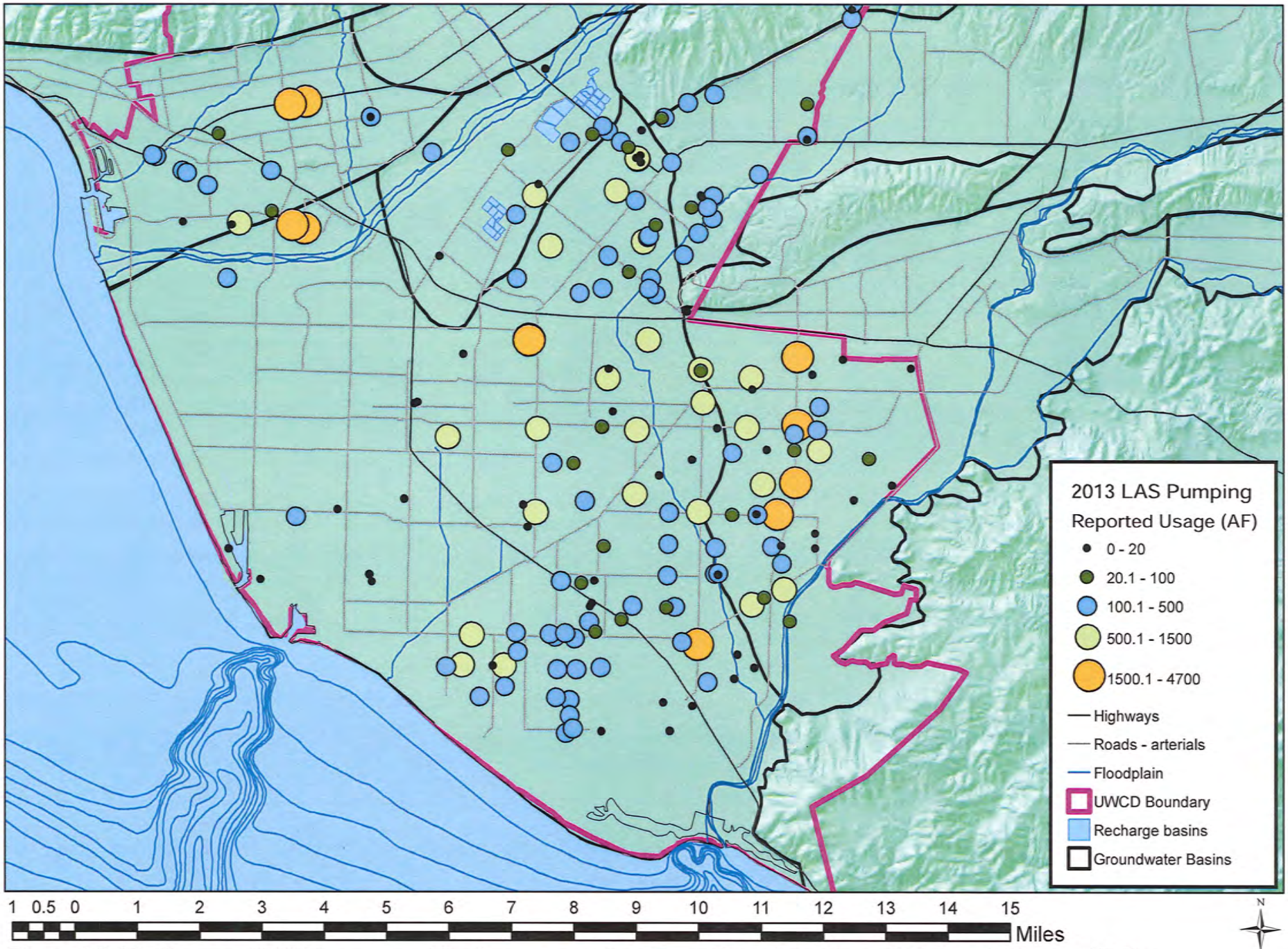


Figure 4.3-27. Reported 2013 Lower Aquifer System pumping, Oxnard Forebay, Oxnard Plain and Pleasant Valley

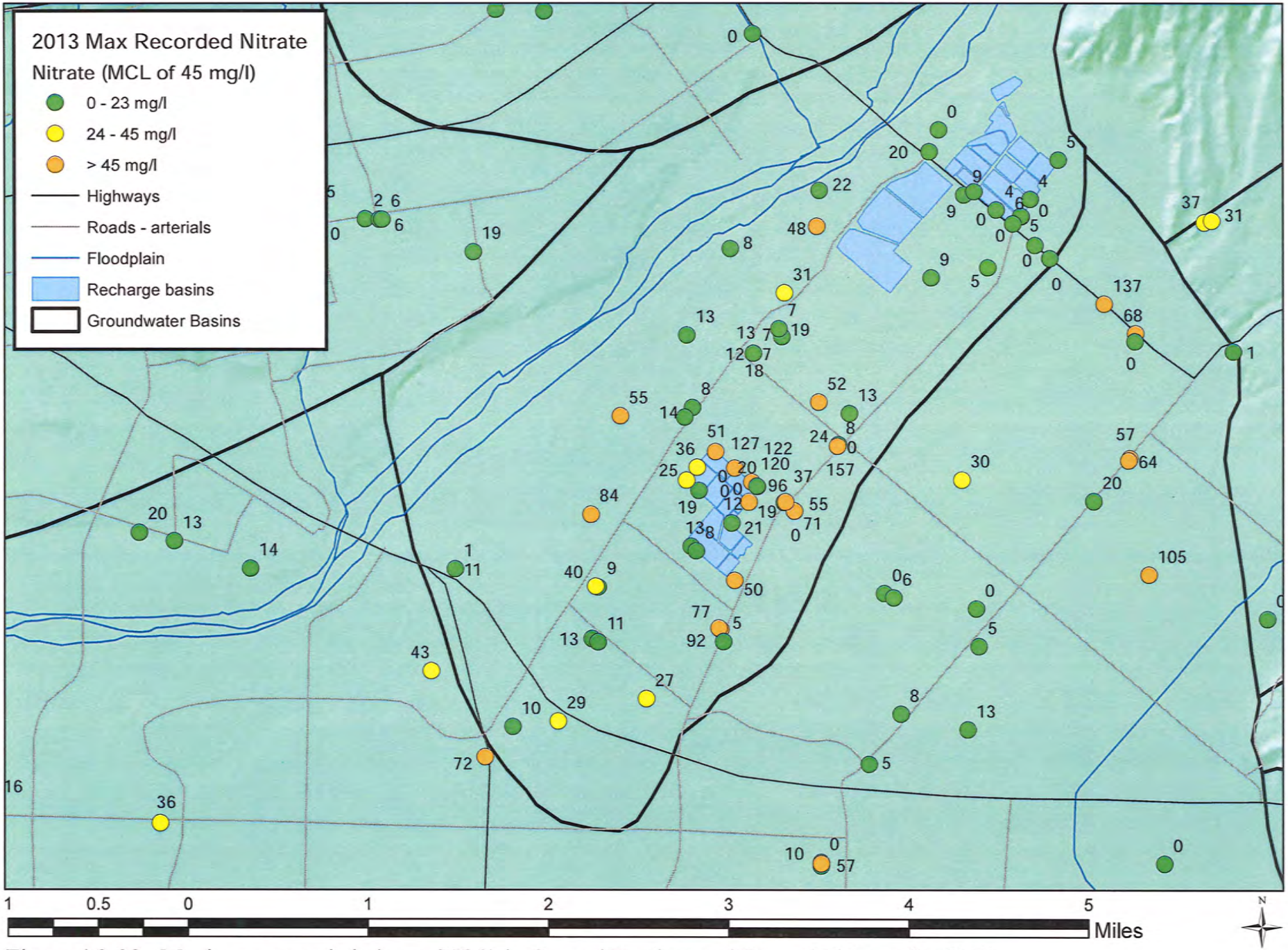


Figure 4.3-28. Maximum recorded nitrate (NO3) in Oxnard Forebay and Oxnard Plain wells, 2013

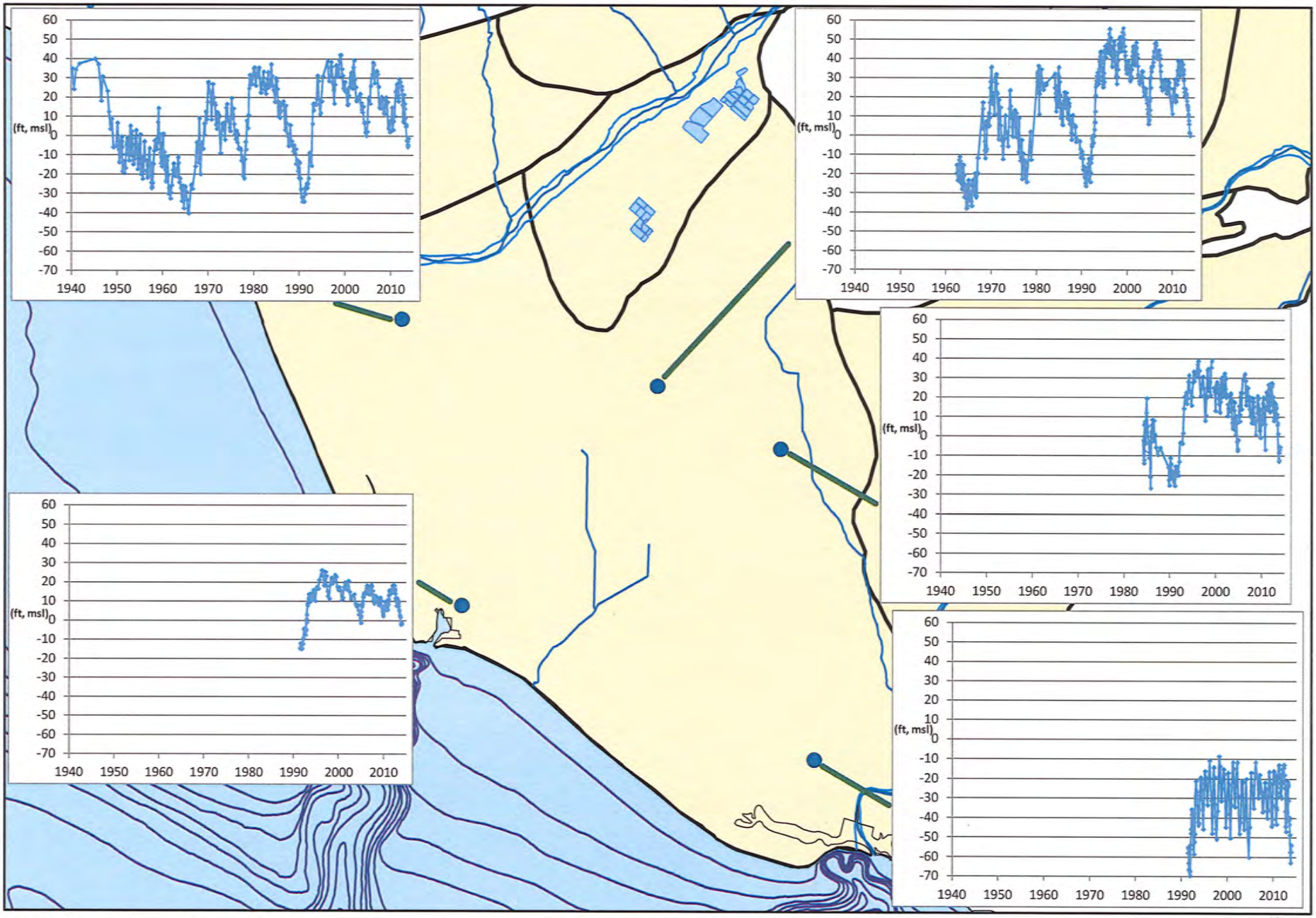


Figure 4.3-29. Oxnard Plain Upper Aquifer System groundwater elevation hydrographs, selected wells

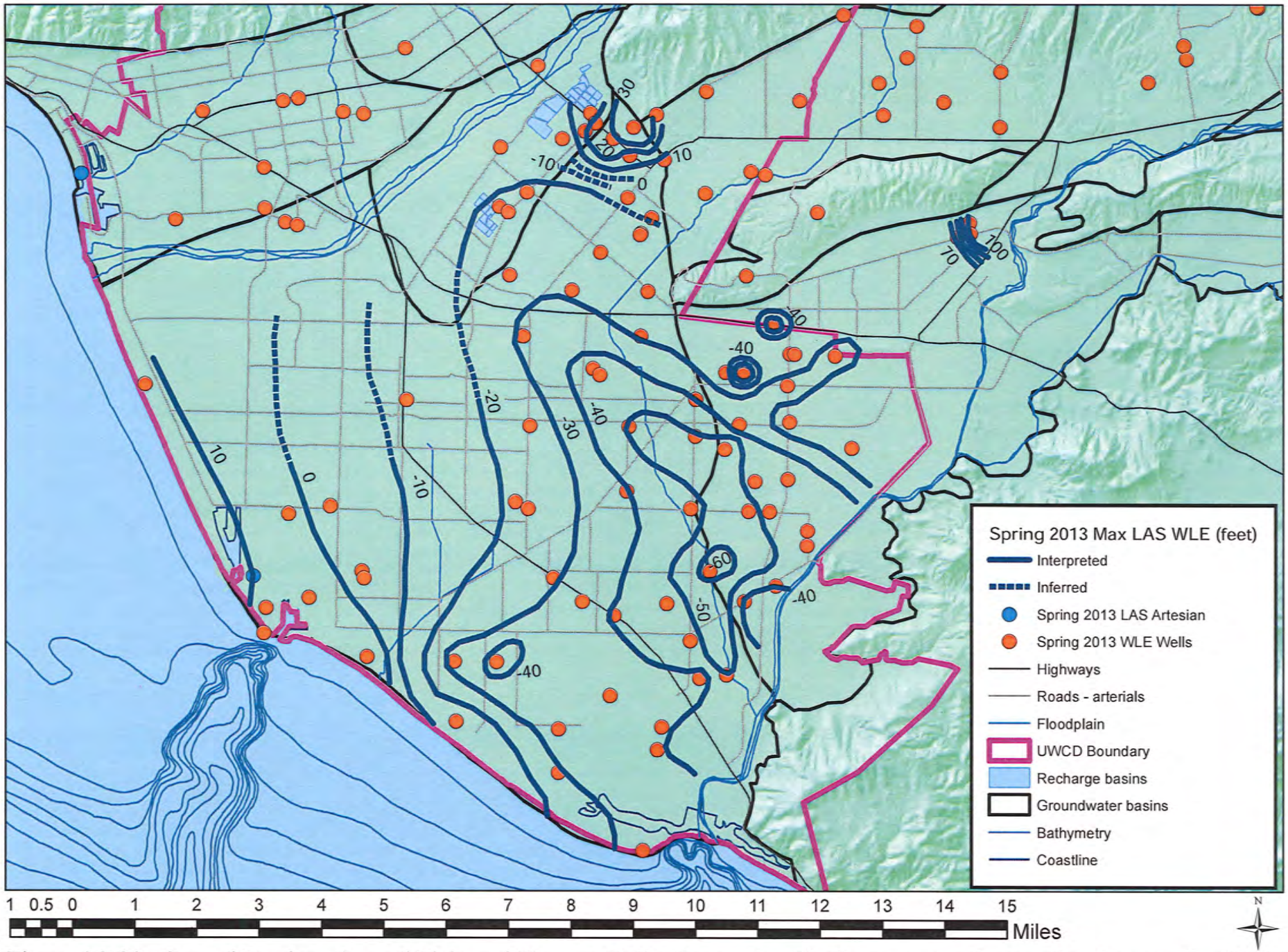


Figure 4.3-30. Oxnard Forebay, Oxnard Plain and Pleasant Valley Lower Aquifer System groundwater elevations, spring 2013

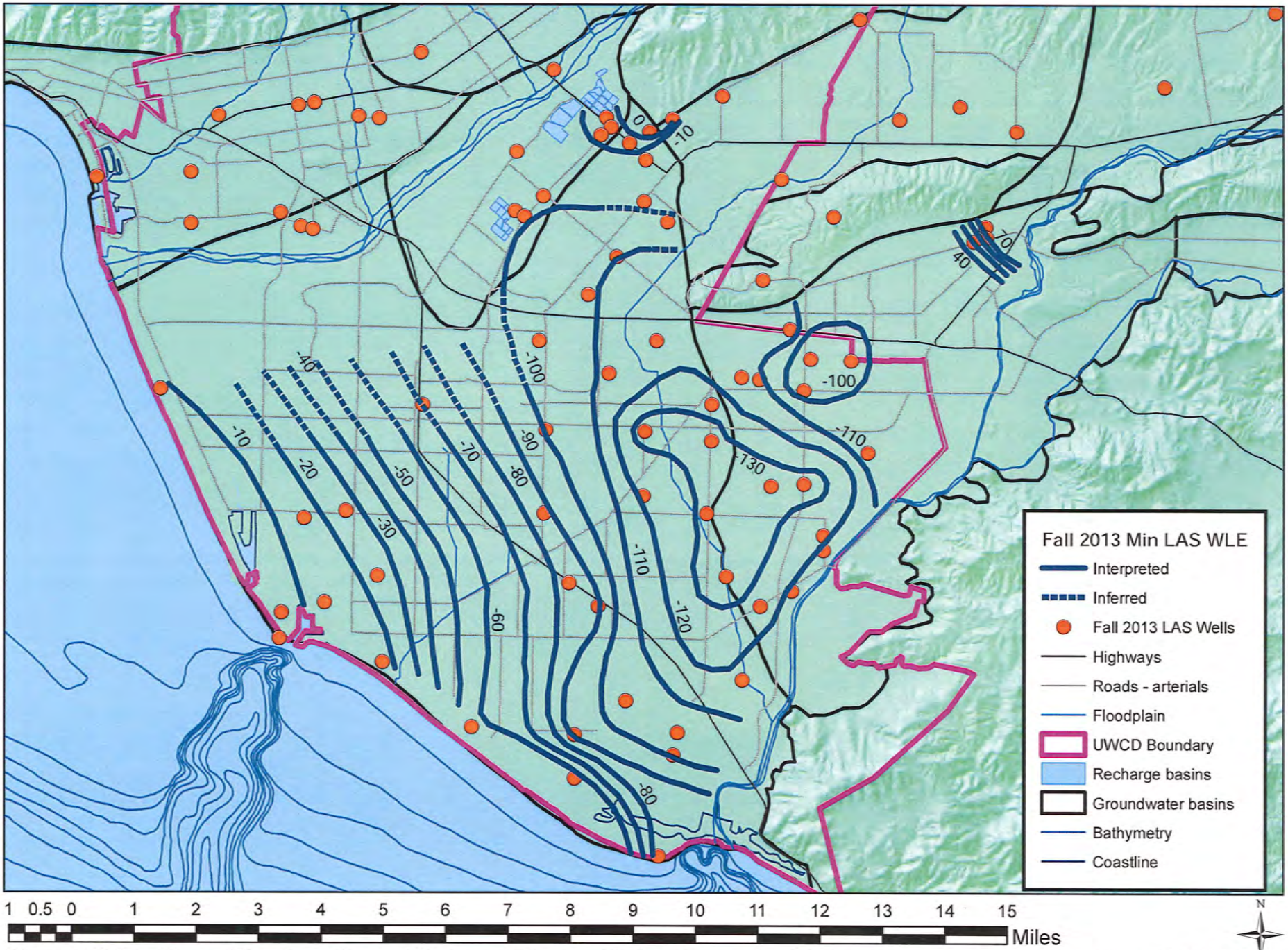


Figure 4.3-31. Oxnard Forebay, Oxnard Plain and Pleasant Valley Lower Aquifer System groundwater elevations, fall 2013

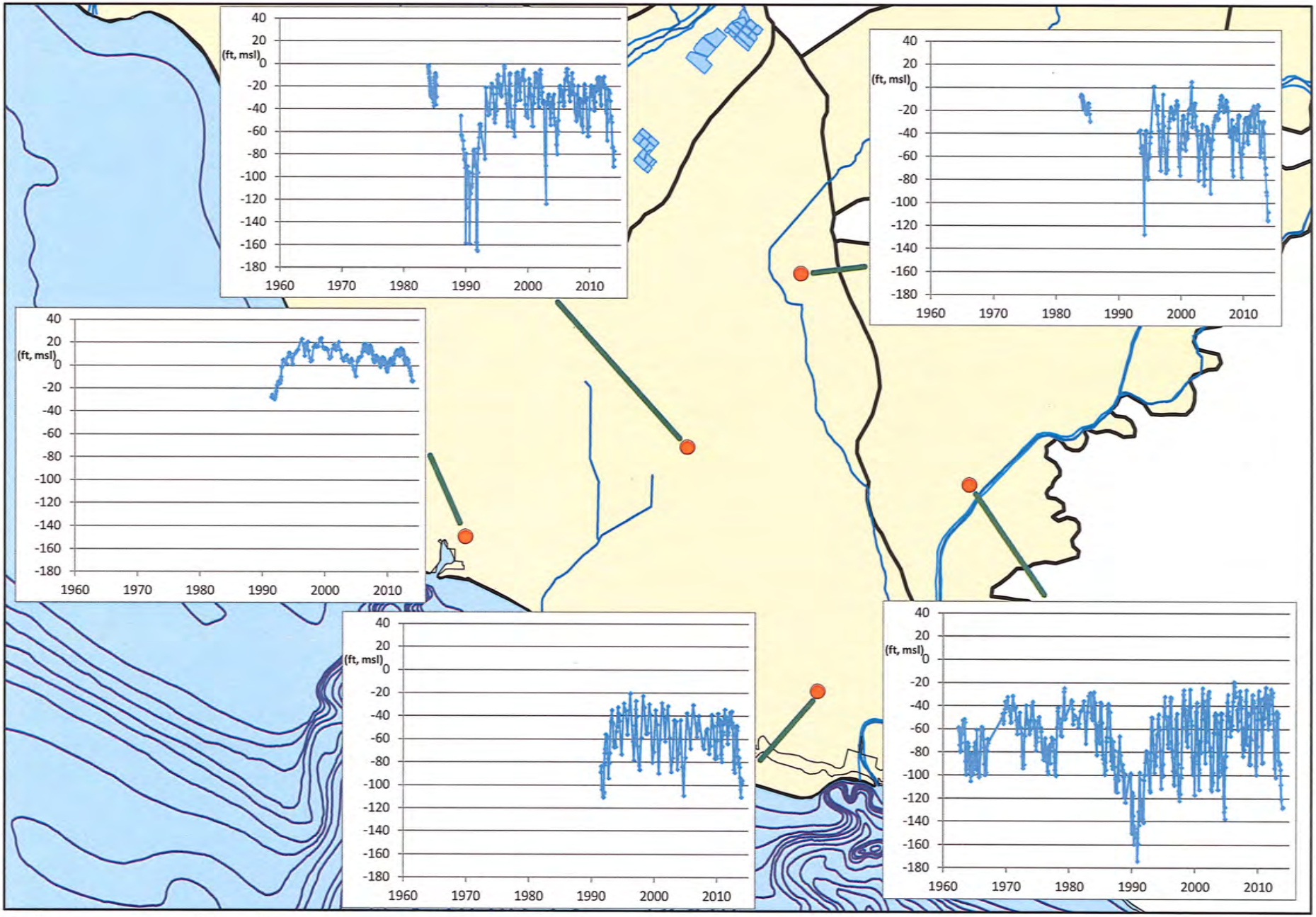


Figure 4.3-32. Oxnard Plain Lower Aquifer System groundwater elevation hydrographs, selected wells

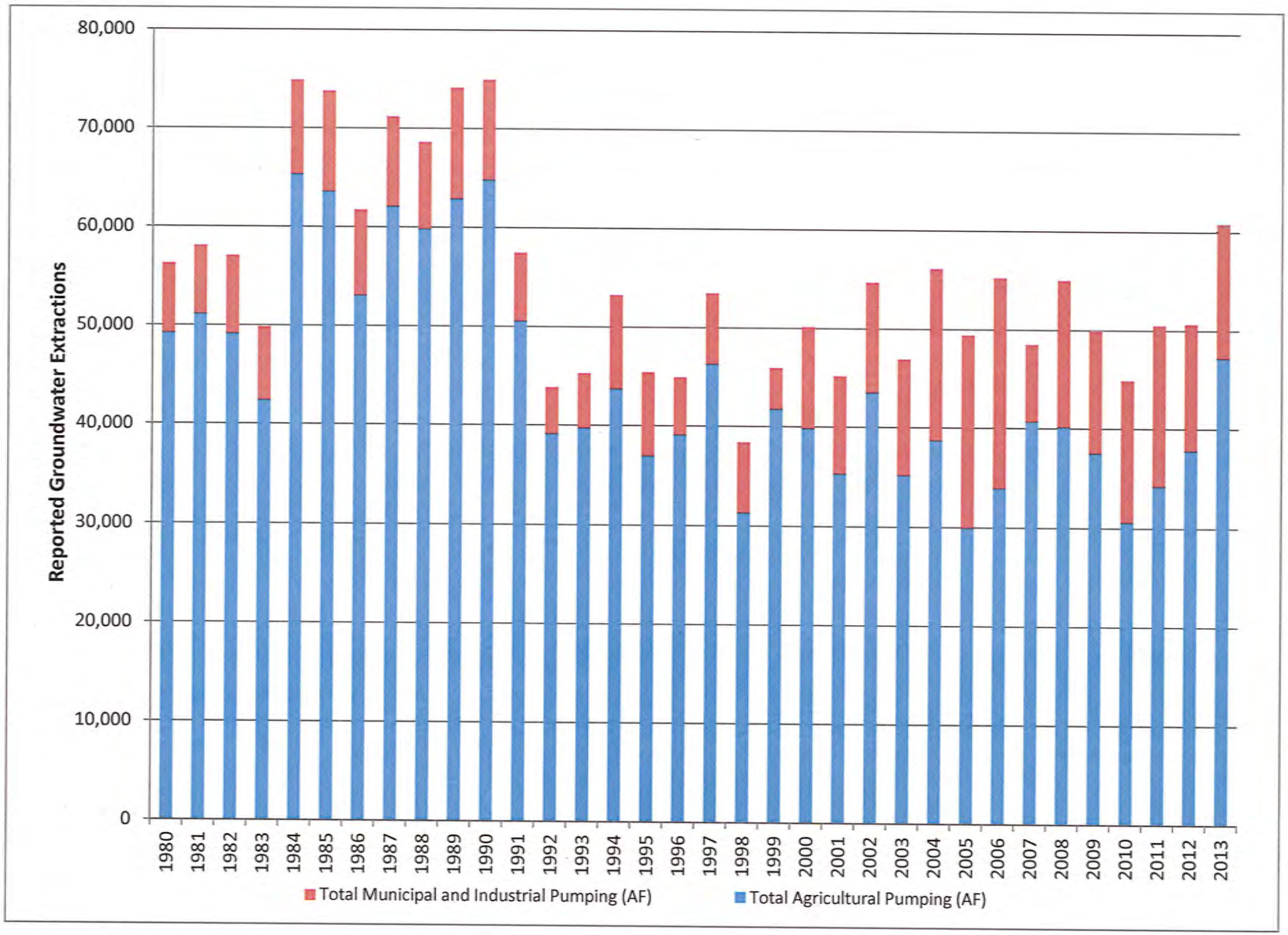


Figure 4.3-33. Historical reported groundwater extractions for the Oxnard Plain

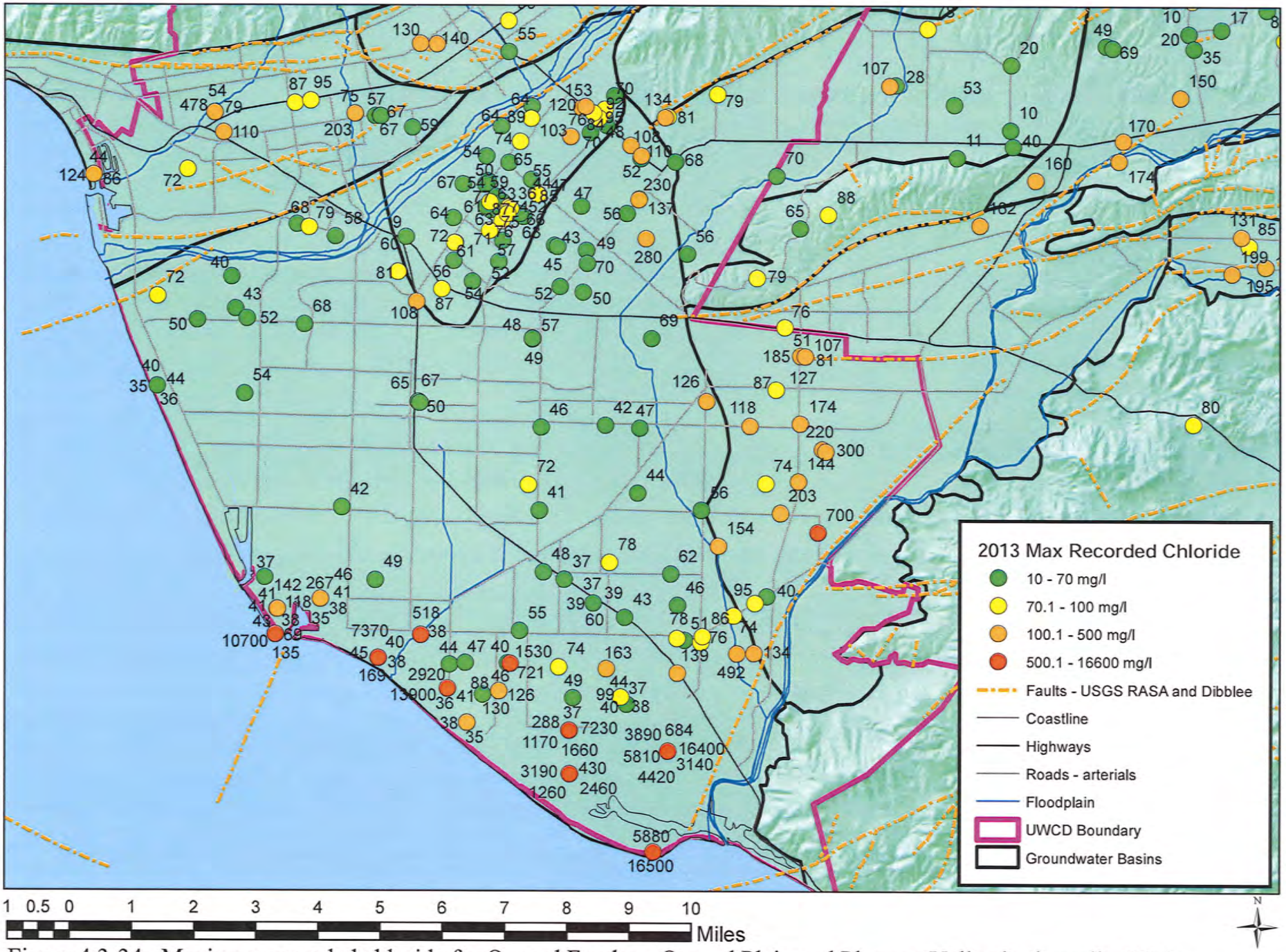


Figure 4.3-34. Maximum recorded chloride for Oxnard Forebay, Oxnard Plain and Pleasant Valley basin wells, 2013

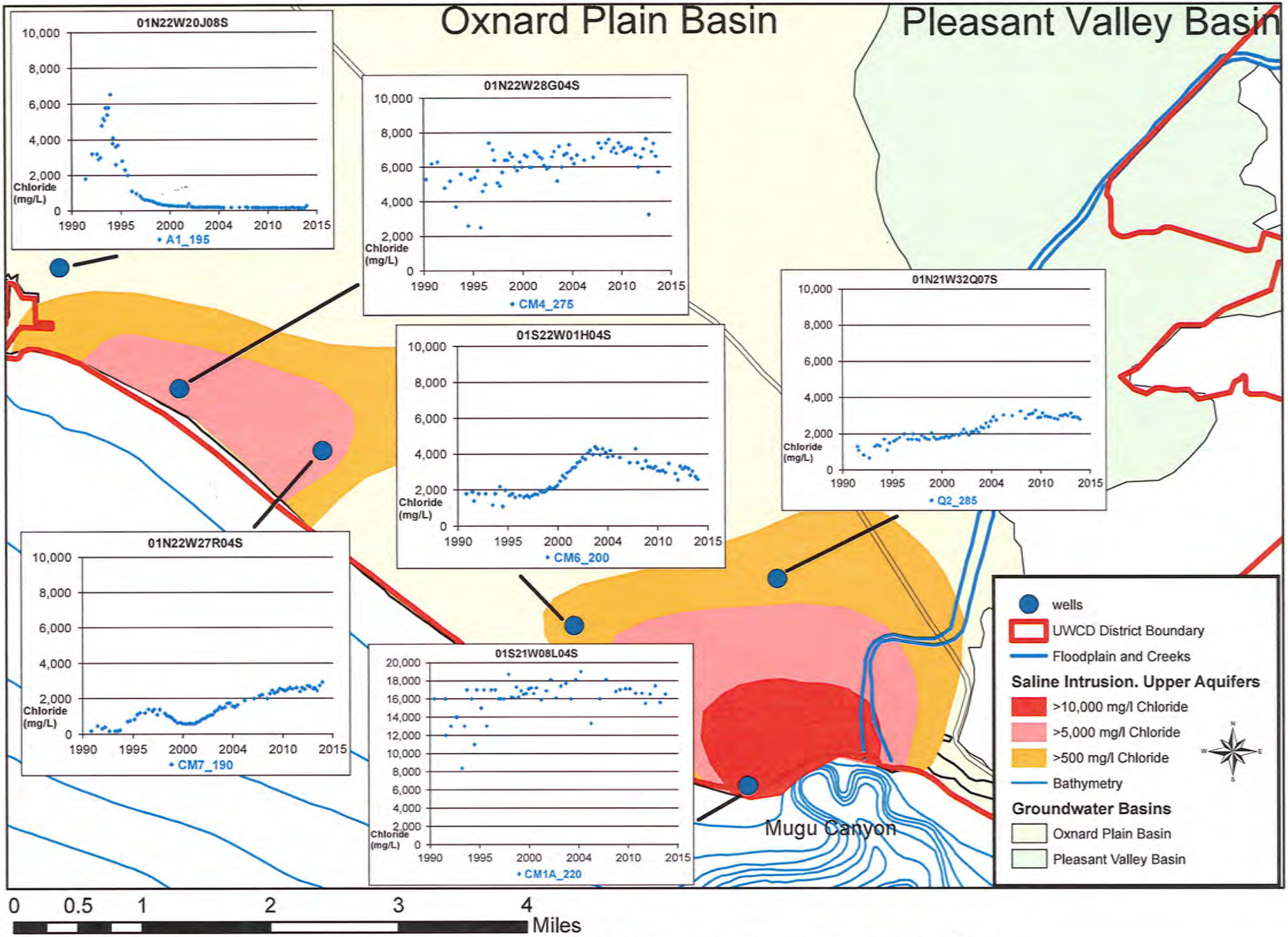


Figure 4.3-35. Chloride time series for selected Upper Aquifer System wells, southern Oxnard Plain

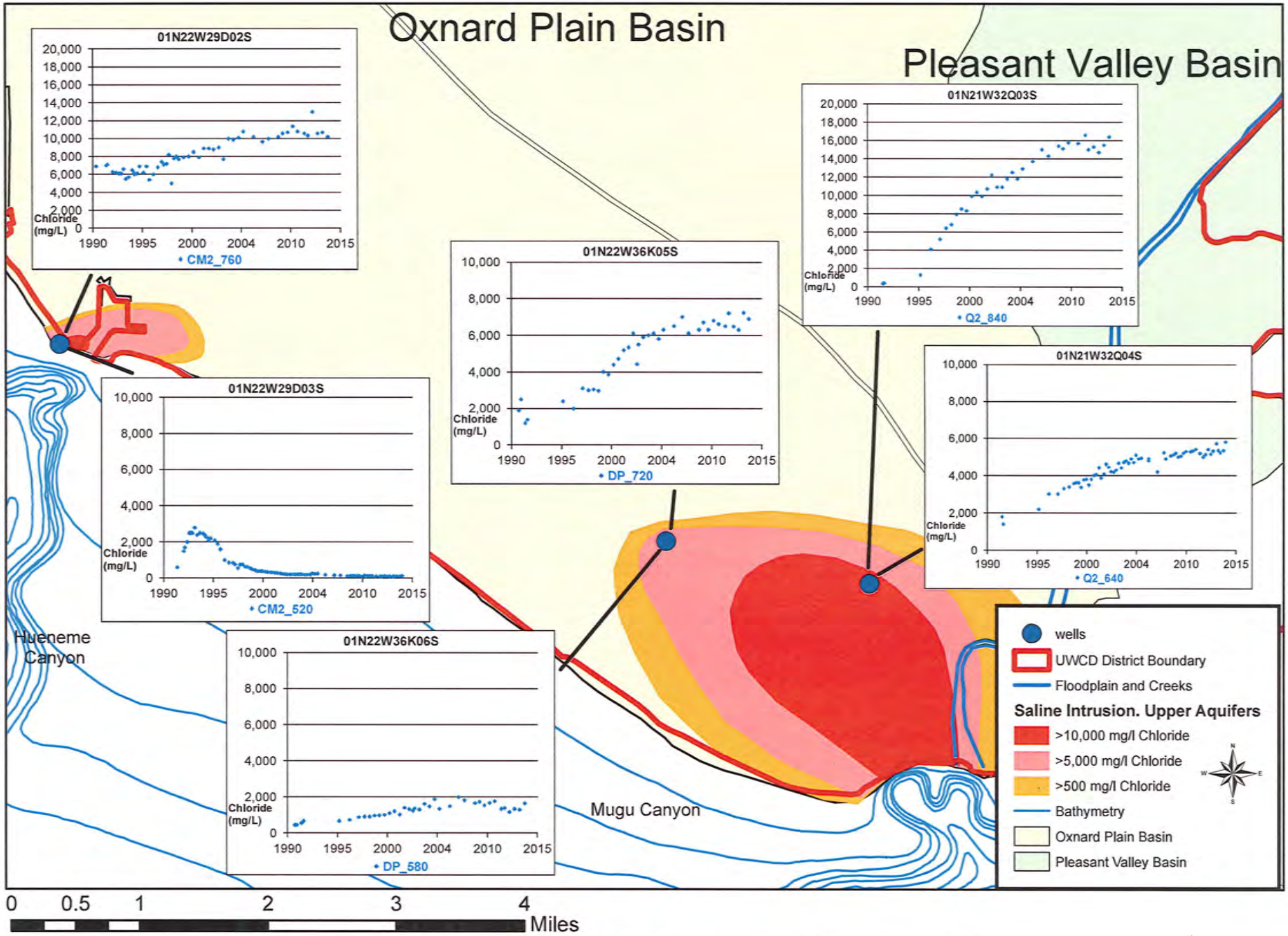


Figure 4.3-36. Chloride time series for selected Lower Aquifer System wells, southern Oxnard Plain

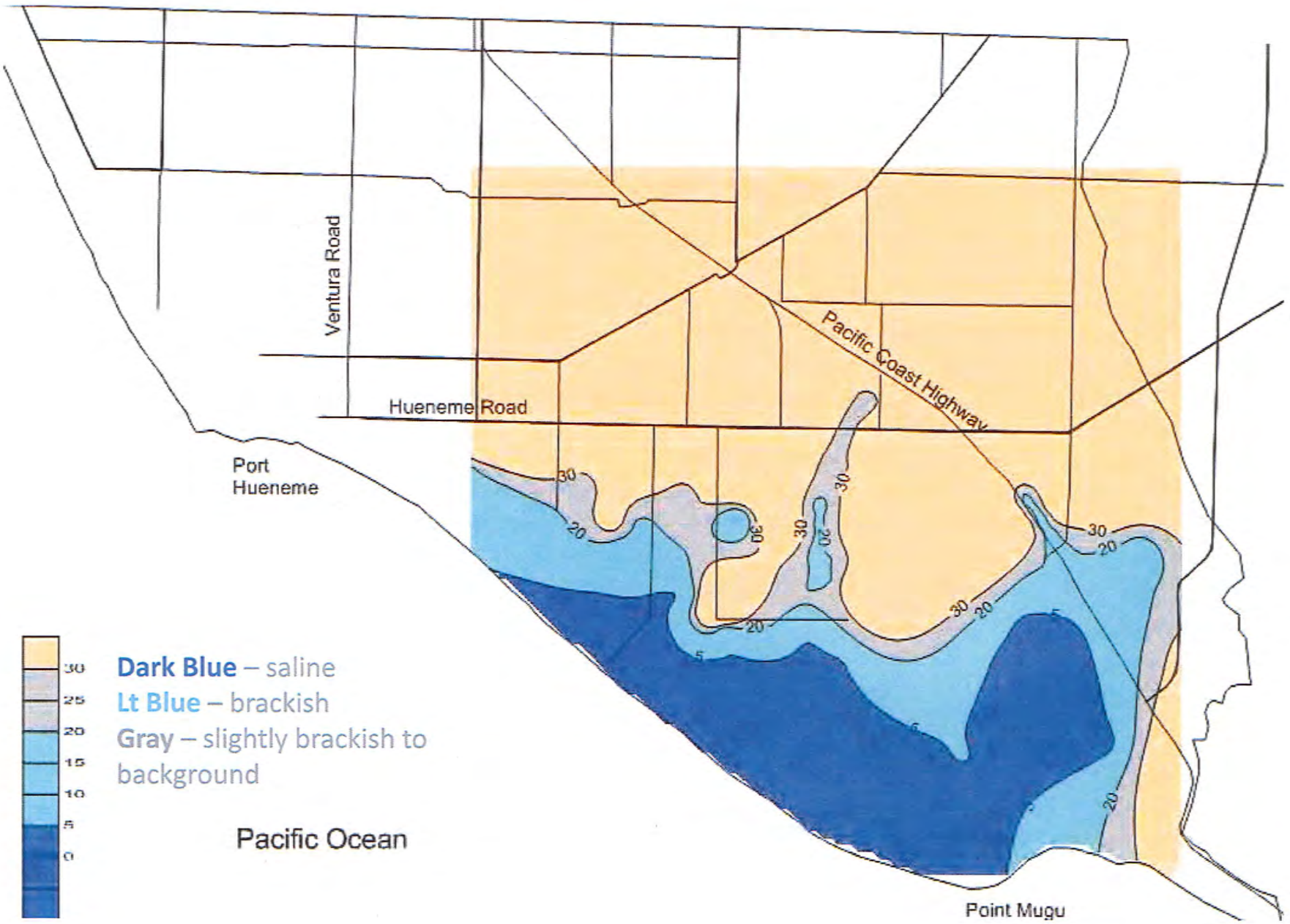


Figure 4.3-37. Geophysical survey (TDEM) of deep Upper Aquifer System (UAS) salinity, southern Oxnard Plain

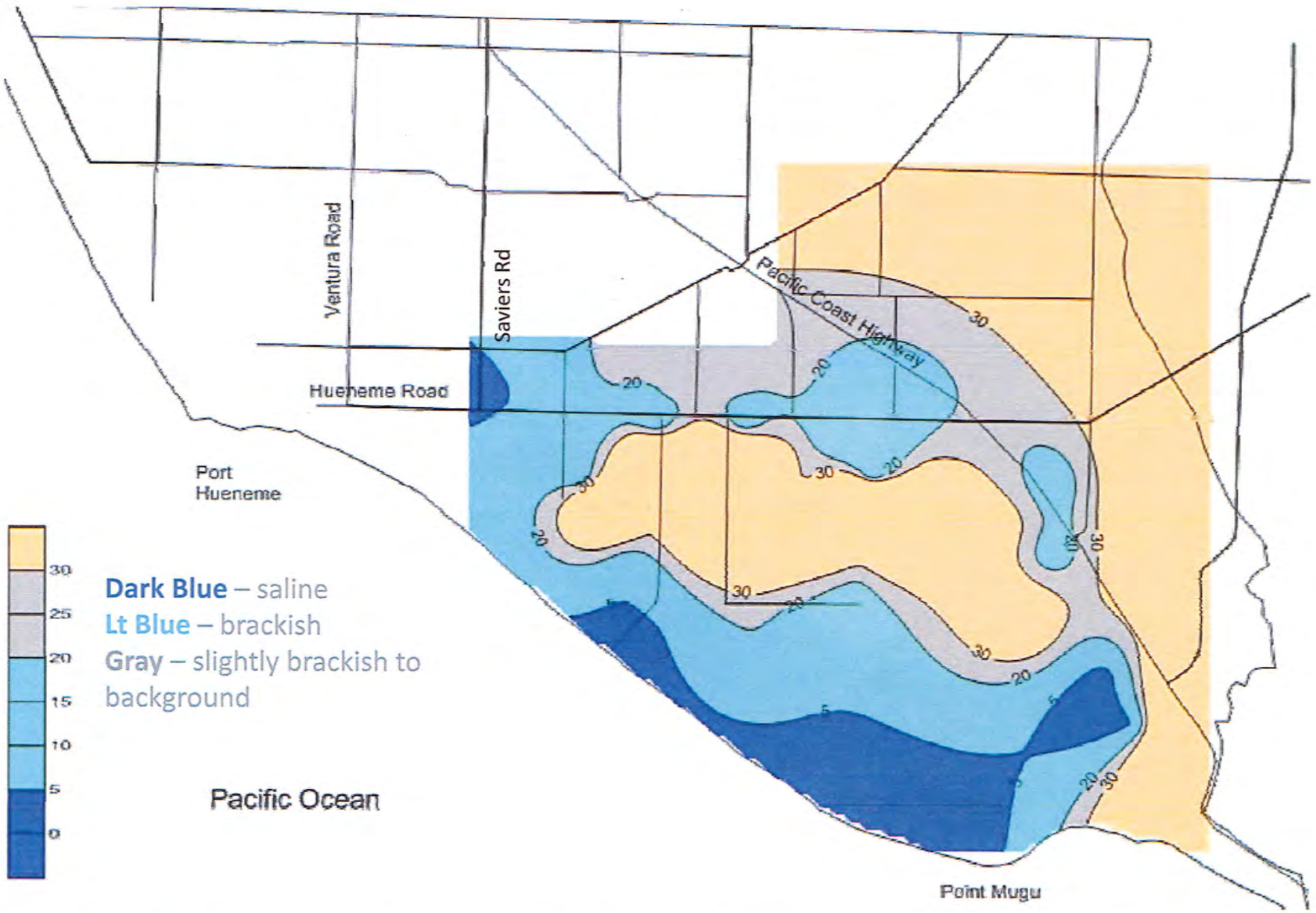


Figure 4.3-38. Geophysical survey (TDEM) of shallow Lower Aquifer System (LAS) salinity, southern Oxnard Plain

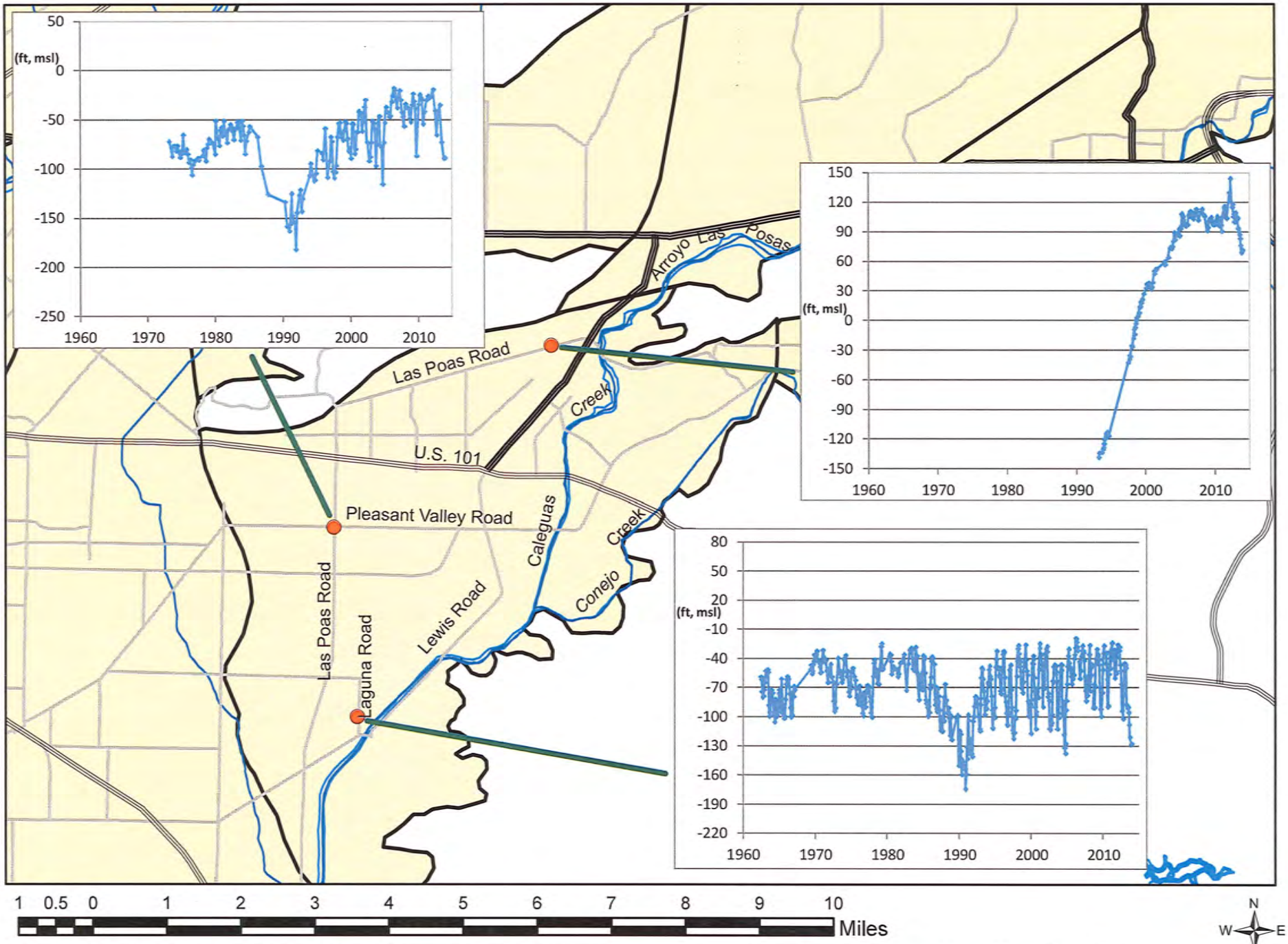


Figure 4.3-39. Pleasant Valley basin Lower Aquifer System groundwater elevation hydrographs, selected wells

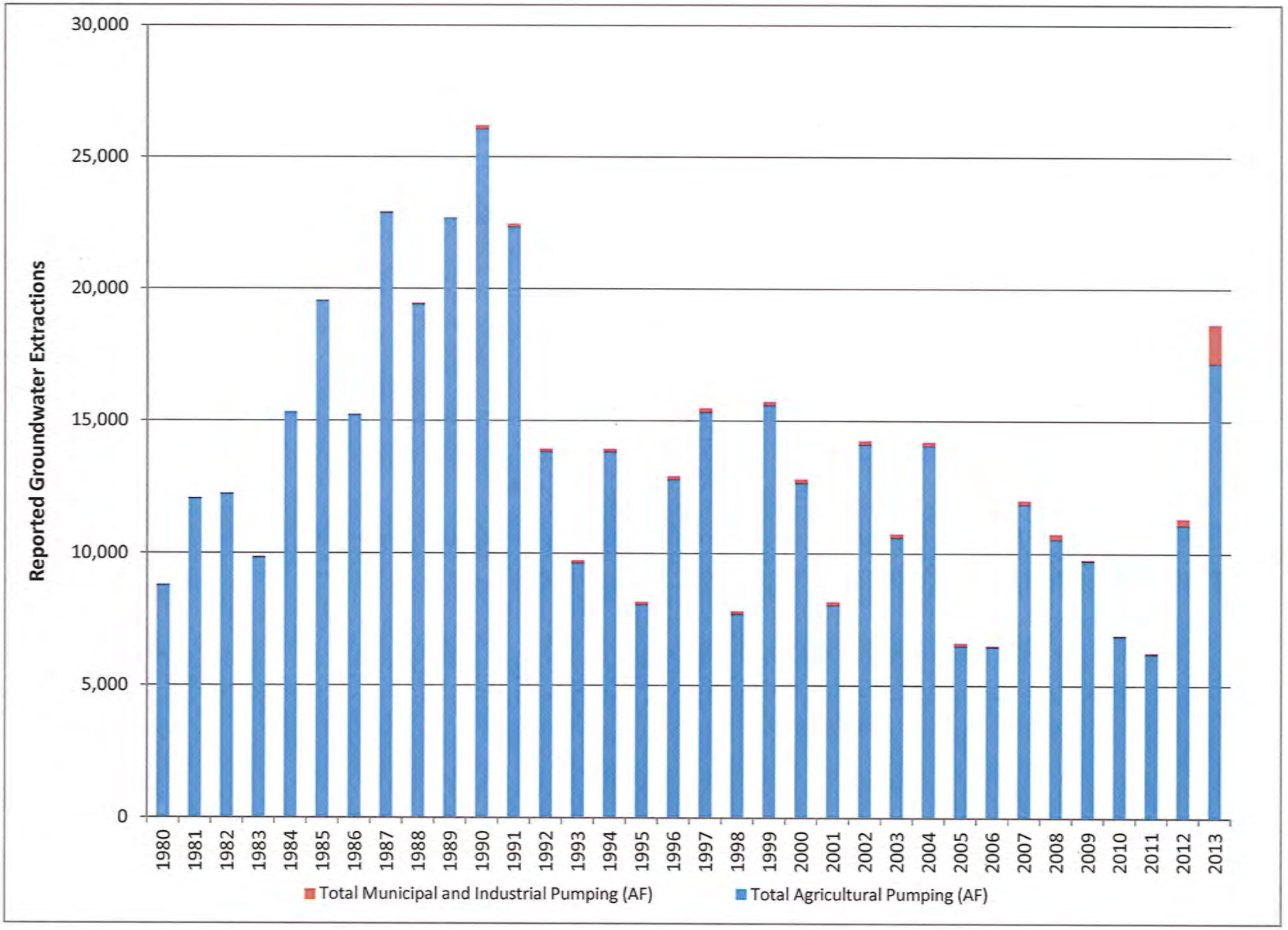


Figure 4.3-40. Historical reported groundwater extractions for Pleasant Valley basin

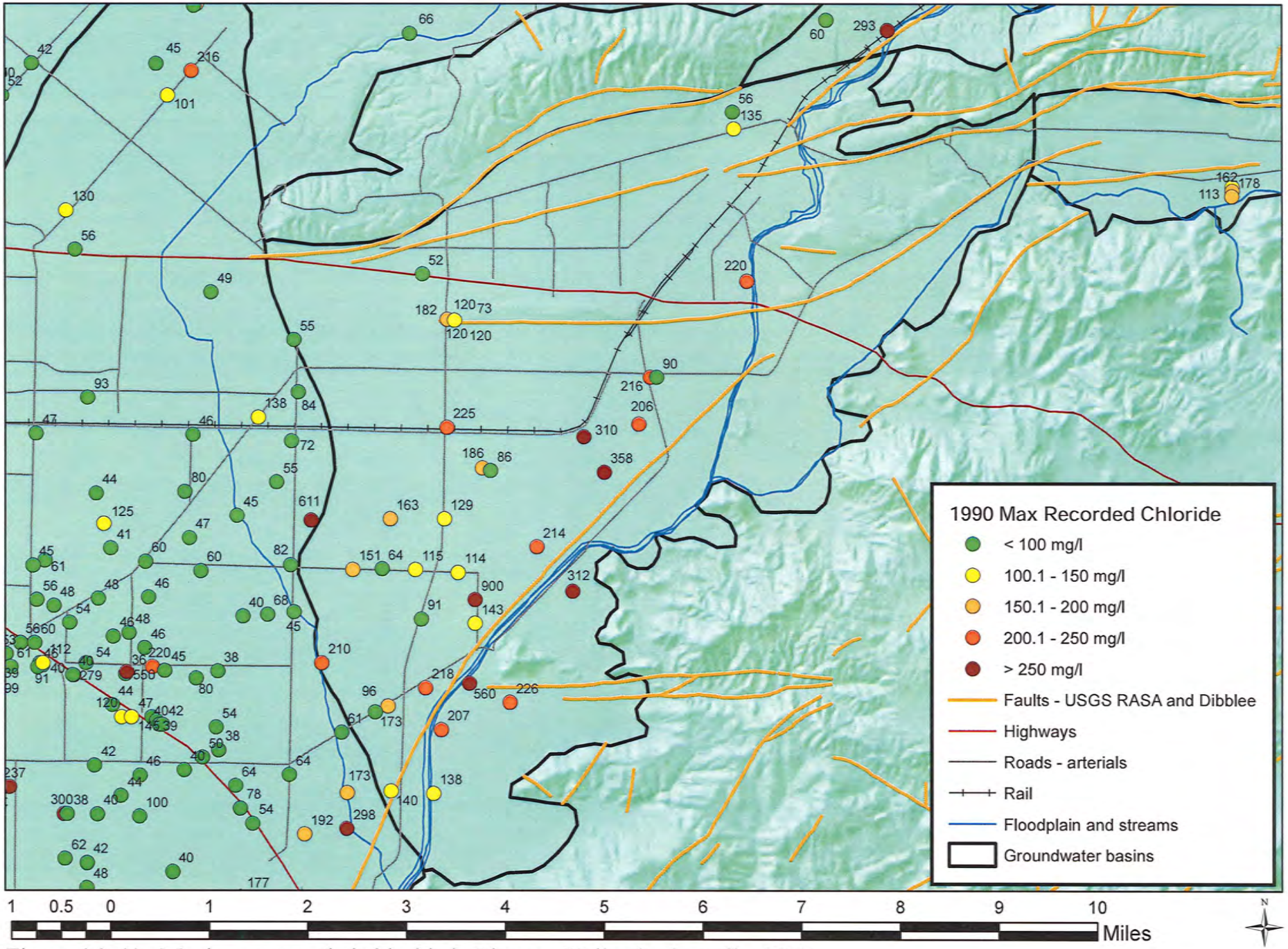


Figure 4.3-41. Maximum recorded chloride in Pleasant Valley basin wells, 1990

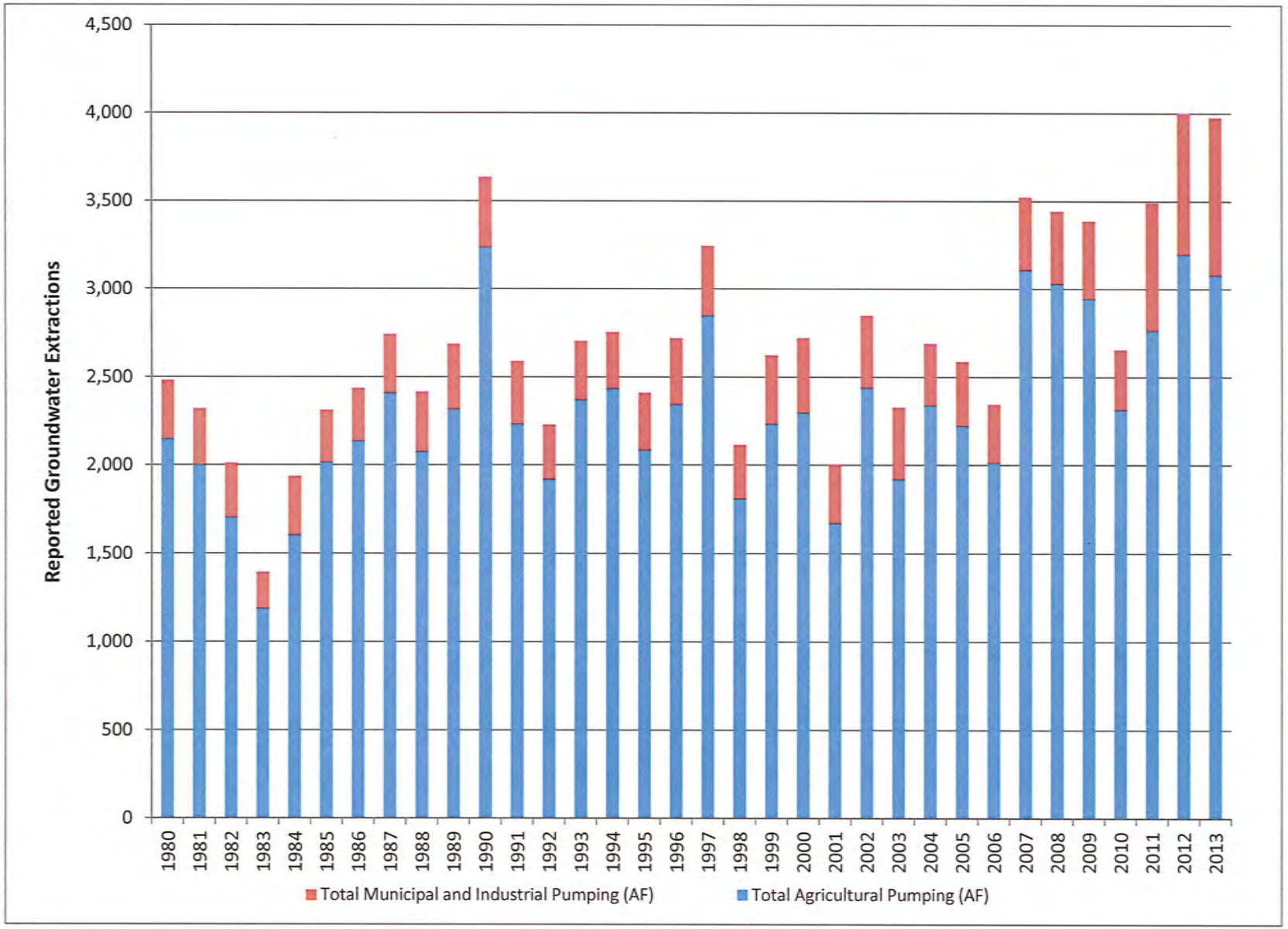


Figure 4.3-42. Historical reported groundwater extractions for West Las Posas basin

8 APPENDIX A. 2013 CONSUMER CONFIDENCE REPORT, O-H SYSTEM

United Water Conservation District

Oxnard-Hueneme Water Delivery System

2013 Consumer Confidence Report



Testing and Results

Last year we conducted thousands of tests for over 180 chemicals and contaminants that could be found in your drinking water. We did not detect any contaminants that would make the water unsafe to drink. This report highlights the quality of water we delivered to our customers last year. Included are details about where your water comes from, what it contains, and how it compares to State standards. For more information about your water, please call our Operations & Maintenance Manager, Mike Ellis at (805) 485-5114.

Public Meetings

Our monthly Board meetings are usually held on the second Wednesday of every month at 1:00 PM in our board room at our "Irv Wilde Headquarters" located at 106 North 8th Street in Santa Paula. Our meetings are open to the public and we would welcome your questions and comments.

About Your Water Supply

United Water's Oxnard-Hueneme Delivery System supplies about 15,000 acre-feet of water per year to several agencies in the Oxnard Plain, including the cities of Oxnard and Port Hueneme, two Naval bases, and several smaller water companies. Those agencies supply our water to over 222,000 people, most of it treated or blended with other supplies. Our water source is 100% local groundwater, pumped from wells near El Rio, north of Oxnard. Water from those wells has its origin in the mountains and valleys of the 1,600 square mile Santa Clara River watershed. The wells are in an aquifer called the Oxnard Forebay. Our water is naturally high in minerals that affect its taste, but is safe to drink. Our groundwater is considered to be "under the influence of surface water," which means we do extensive monitoring of turbidity and other parameters to meet health regulations.

United Water Conservation District
106 North 8th Street
Santa Paula, CA 93060
805/525-4431 Fax 805/525-2661
www.unitedwater.org

Water produced by our wells is naturally filtered through the ground. We use chlorine as a disinfectant to kill bacteria, parasites, and viruses. Then we add chloramines to provide a long-lasting disinfection residual to keep the water safe until it reaches our customers. Due to the longer-lasting residual of chloramines, owners of pet fish must treat their tap water before putting it into aquariums or ponds.

Types of Potential Contamination

In general, sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves, naturally-occurring minerals and, in some cases, radioactive material can pick up substances resulting from the presence of animals or from human activity. Contaminants that may be present in source water include:

Microbial contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.

Inorganic contaminants, such as salts and metals, which can be naturally-occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming

Organic chemical contamination, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, agricultural application, and septic systems.

Pesticides and herbicides, which may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses.

Radioactive contaminants, which can be naturally-occurring or be the result of oil and gas production and mining activities.

In order to ensure that tap is safe to drink USEPA and the California Department of Public Health prescribes regulations that limit the amount of certain contaminants in public drinking water. We treat our water to meet these health regulations. The Department's regulations also establish limits for contaminants in bottled water, which must provide the same protection for public health. Scientists and health experts are continually studying the effects of various chemicals in drinking water to make sure the public water supply is safe.

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the USEPA's Safe Drinking Water Hotline (1-800-426-4791).

Definitions

Public Health Goal (PHG): The level of a contaminant in drinking water below which there is no known or expected risk to health. PHGs are set by the California Environmental Protection Agency.

Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs are set by the U.S. Environmental Protection Agency.

Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. Primary MCLs are set as close to the PHGs (or MCLGs) as is economically and technologically feasible. Secondary MCLs are set to protect to odor, taste and appearance of drinking water.

Primary Drinking Water Standard (PDWS): MCLs for contaminants that affect health along with their monitoring and reporting requirements, and water treatment requirements.

Maximum Residual Disinfectant Level (MRDL): The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

Maximum Residual Disinfectant Level Goal (MRDLG): The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLG's do not reflect the benefits of the use of disinfectants to control microbial contaminants.

Treatment Technique (TT): A required process intended to reduce the level of a contaminant in drinking water.

Detection Limit for Reporting (DLR): The level above which a chemical is to be reported.

NA: Not applicable

ppm: parts per million, or milligrams per litre

ppb: parts per billion, or micrograms per litre

ND: none detected

pCi/L: picocuries per litre (a measure of radioactivity)

µS/cm: a measure of electric conductivity

Turbidity

Turbidity is a measure of the cloudiness of the water. We monitor it because it is a good indicator of the effectiveness of our water treatment. Turbidity is measured in units called NTUs. We achieved 100% compliance with turbidity standards in 2013.

Contaminants Detected in 2013

Contaminant	Units	State MCL [MRDL]	PHG (MCLG) [MRDLG]	Avg	Range	Sample Date	Violation	Typical Sources in Drinking Water
Microbiological Contaminants								
Total Coliform bacteria	Absence/ Presence/ 100ml	Systems that collect <40 samples/month: no more than 1 positive sample	(0)	Absent	Absent	2013	No	Naturally present in the environment.
Fecal Coliform bacteria and *E.coli*	Absence/ Presence/ 100ml	A routine and repeat sample are total coliform positive, and one of these is fecal or *E.coli positive*	(0)	Absent	Absent	2013	No	Human and animal fecal waste.
Delivered water turbidity	NTU	TT	NA	0.11	0.07-0.25	2013	No	Well corrosion byproducts. Microscopic soil particles.
Radioactivity Contaminants								
Gross Alpha	pCi/L	15	(0)	6.34	2.59-8.41	2013	No	Erosion of natural deposits.
Radon	pCi/L	NA	NA	370.25	319-412	2013	No	Decay of natural deposits.
Inorganic Contaminants								
Arsenic	ppb	10	0.004	4	3-5	2013	No	Erosion of natural deposits.
Fluoride	ppm	2.0	1	0.55	0.5-0.6	2013	No	Erosion of natural deposits.
Nitrate (as NO3)	ppm	45	45	17.5	9.9-27.1	2013	No	Runoff and leaching from fertilizer use; leaching from septic tanks and sewage; erosion of natural
Selenium	ppb	50	30	15.0	10-20	2013	No	Erosion of natural deposits. Discharge from mines, runoff from
Disinfection								
Chloramine Residual (as Cl2)	ppm	[4.0]	[4]	1.93	1.35-2.40	2013	No	Drinking water disinfectant added for treatment.
Disinfection By-Products								
Haloacetic Acids	ppb	60	NA	4.38	ND-7	2013	No	By-product of drinking water disinfection.
Total Trihalomethanes	ppb	80	NA	22.9	13-31.9	2013	No	By-product of drinking water disinfection.
Disinfection By-Product								
Total Organic Carbon (TOC)	ppb	TT	NA	1.33	0.8-2.1	2013	No	Various natural and man-made sources.
Secondary Standards								
Chloride	ppm	500	NA	61.5	61-62	2013	No	Leaching from natural mineral
Sodium	ppm	NA	NA	96	96-96	2013	No	Leaching from natural mineral
Specific Conductance	µS/cm	1600	NA	1412.5	1360-1470	2013	No	Runoff/leaching from natural deposits.
Sulfate	ppm	500	NA	499.2	440-580	2013	No	Runoff/leaching from natural de-
Total Dissolved Solids, TDS	ppm	1,000	NA	1012.5	960-1060	2013	No	Runoff/leaching from natural de-
Total Hardness	ppm	N/A	NA	591.5	574-609	2013	No	Leaching from natural mineral
Unregulated Contaminants								
Boron*	ppb	NA	NA	600	600-600	2013	No	Erosion of natural deposits.

* The notification level for Boron is 1 ppm. There currently is no Maximum Contaminant Level for Boron hovever, the babies of some pregnant women who drink water containing boron in excess of the notification level may have an increased risk of developmental effects, based on studies in laboratory animals.

Water Quality Data

The table on page 3 lists all of the drinking water contaminants that we detected during the 2013 calendar year. The presence of these contaminants in the water does not indicate that the water poses a health risk. In addition to the contaminants on the table, we tested for many other chemicals which were not detected at significant levels. Please call us if you would like a copy of the complete list of chemicals we tested for and the test results.

Total Dissolved Solids and Sulfate

Total Dissolved Solids, or TDS, is a measure of the total mineral content of the water. TDS and sulfate are secondary standards related to the taste of the water, and water exceeding the MCL is generally safe for human consumption. Our water exceeds the secondary standards for TDS and sulfate because of naturally occurring minerals in the water.

Source Water Assessment

United Water completed a Source Water Assessment for its drinking water wells in October 2001. The current report is available for public review at our office in Santa Paula. The assessment provides a survey of potential sources of contamination of the groundwater that supplies our wells. Activities that constitute the highest risk to our water are the following: petroleum storage tanks and fueling operations, septic systems, and animal feed lots that are no longer in use. The most recent update for the Surface Water Sanitary Survey was completed in January of 2011 and was submitted to the Department of Health Services.

Cryptosporidium

Cryptosporidium is a microbial pathogen found in surface water throughout the U.S. Although filtration removes Cryptosporidium, the most commonly-used filtration methods cannot guarantee 100 percent removal. Our monitoring indicates the presence of these organisms in our source water and/or finished water. Current test methods do not allow us to determine if the organisms are dead or if they are capable of causing disease. Ingestion of Cryptosporidium may cause cryptosporidiosis, an abdominal infection. Symptoms of infection include nausea, diarrhea, and abdominal cramps. Most healthy individuals can overcome the disease within a few weeks. However, immuno-compromised people are at greater risk of developing life-threatening illness. We encourage immuno-compromised individuals to consult with their doctor regarding appropriate precautions to take to avoid infection. Cryptosporidium must be digested to cause disease, and it may be spread through means other than drinking water.

Radon

Radon is a radioactive gas that you cannot see, taste or smell. It is found throughout the U.S. Radon can move up through the ground and into a home through cracks and holes in the foundation. Radon can build up to high levels in all types of homes. Radon can also get into indoor air when released from tap water from showering, washing dishes and other household activities. Compared to radon entering the home through soil, radon entering the home through tap water will be a small source of radon in indoor air. Radon is a known human carcinogen. Breathing air containing radon can lead to lung cancer. Drinking water containing radon may also cause increased risk of stomach cancer. If you are concerned about radon in your home, you may test the air in your home. There are simple ways to fix a radon problem that are not too costly. For additional information, call the National Safety Council's Radon Hotline (800-SOS-RADON).

About Nitrate

Nitrate in drinking water at levels above 45 ppm is a health risk for infants of less than six months of age. High nitrate levels in drinking water can interfere with the capacity of the infant's blood to carry oxygen, resulting in a serious illness. Symptoms include shortness of breath and blueness of the skin. High nitrate levels may also affect the ability of the blood to carry oxygen in some individuals, such as pregnant women and those with certain specific enzyme deficiencies. Nitrate levels may rise quickly because of rainfall or agricultural activity and groundwater movement. If you are caring for an infant, or are pregnant, you should ask advice from your doctor, or choose to use bottled water for drinking and for mixing formula and juice for your baby.

Immuno-compromised Persons

Some people may be more vulnerable to contaminants in drinking water than the general population. Immune-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly and infants, can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. USEPA/Centers for Disease Control (CDC) guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants are available from the Safe Drinking Water Hotline (1-800-426-4791).

Security of your Water

We have completed a Vulnerability Assessment of our OH water facilities. This work, funded by an EPA grant, has improved the security and safety of our water supply.

Hablamos Español

Para información en español llámenos al (805) 525-4431.

Ventura County's Agricultural Future:

Challenges and Opportunities

May, 2008

Authors:

Ken Kambara, Ph.D.
Dan Hamilton, Ph.D.
Kirk Lesh, MBA, MA
Chuck Maxey, Ph.D.
Bill Watkins, Ph.D.
Susan Weaver, MA

models: the WIB report,
VCCA Indicators
AFA standards - the 3-legged
approach (sections aimed at
growers, policy makers, consumers

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Section II: Envisioning Change

What if the economic threats became so insurmountable that agriculture in the County largely disappeared? We explore this possibility in Section II and conclude that the demographic and economic effects would be substantial and destructive. We then explore four alternative scenarios making different, but plausible assumptions about changes in factors that affect agriculture including land use policies, immigration policies and trade. With each scenario we explore, over time, the economic, demographic, and social outcomes of the scenario. We provide time paths for farmed acres, crop value, farm proprietors, farm employment and farm real wages.

Based on these assessments, we conclude the following: The most likely path is the current one; agriculture will slowly disappear in Ventura County. SOAR initiatives have done very little to slow the rate of decline. A disruption to the supply of cheap labor would have serious, negative consequences for the industry. Creating a level playing field with foreign imports will improve agriculture's future viability. Whether that is possible as a practical (or political) matter is another question.

We also explore the potential of non-traditional, "alternative" approaches to both agricultural production and market relationships. Undoubtedly, changes in public preferences are creating opportunities for organic farming, and "sustainable" and "community based" approaches. Some Ventura County farmers have found successful niches in these developing circumstances. More will develop over time. Individually and collectively, growers may find successful adaptation opportunities. So too will some large-scale players; in some cases, "alternative" crops and "sustainable" practices will become the tools of large concentrated and vertically integrated organizations.

Section III: Strategic Marketing Options

Here we provide a complete analysis of existing and possible marketing strategies, including organizational structure, distribution channels, and branding. It examines the constraints on Ventura County growers. It also explores, in a very detailed way, three strategic plans available to Ventura County growers and their implications: Low-Cost, Differentiation, and Focus.

Section III examines the role of marketing in Ventura County agriculture. The perspectives of both traditional and alternative agriculture are described, as well as how there are fewer and fewer middle-scale farms due to economic forces at work. The global business environment is shaping agriculture's future in Ventura County. Within this scenario of increased global competition, industry consolidation, and pressures to maximize returns giving increasing costs, marketing strategies are offered to blueprint options. In order to stay competitive, Ventura County agriculture must effectively coordinate production with marketing, in order to deliver value given relatively high input costs.

INTRODUCTION

As we make our way through the first decade of the 21st century, many ask whether California agriculture can maintain its economic viability. There is broad agreement that California agriculture is highly productive and efficient. But there is also agreement that California agriculture faces serious issues and challenges related to the globalization of markets, competition for land and water, increases in factor costs, changes in governmental policies and regulations, and changes in technology and consumer preferences. [1]

While not a true microcosm of the larger California agricultural industry, Ventura County agriculture is also diverse, has a strong history of adaptation and change, and faces serious challenges. Ventura County's agricultural sector faces virtually all of the challenges confronting California agriculture in general, yet it must deal with some unique issues as well. The threats to Ventura County agriculture are serious, and the stakes are high.

Agriculture is integral to Ventura County's economy. The County's agricultural production sector employs more than 20,000 workers, with many more working in support businesses. The value of crops produced in the County approaches $1.3 billion. Ventura ranks 10th among California farm counties, and its annual farm sales are equivalent to those for the entire state of Utah.[2] (This figure represents the value of the crops only and does not account for the economic impact of the supporting businesses.) Of course, the impact of crop production on the County's economy is substantially larger that the crop value alone, as we show later in this report. This means that the threats to agriculture's ongoing economic viability should be of concern to all County residents, not just to those in the agriculture community. Any substantial decline in agriculture would have widespread effects across Ventura County.

Responding to changing conditions is not new to those in agriculture in California, or in Ventura County. Some point to this long history of adaptation and innovation by California agriculturalists as a basis for optimism.[3] While observations about sustained and successful adaptation to changing market conditions over the decades may appear reassuring, these accounts do not provide any specific road map for ways to deal with the challenges emerging today and tomorrow.

What those in agriculture need are an objective consideration of the factors that will influence agriculture's future, a focused discussion of the options open to it, and a reasoned assessment of which options might work best under different sets of conditions.

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[1] Siebert, Jerry (ed.), *California Agriculture: Dimensions and Issues*, Giannini Foundation (2004). http://are.berkeley.edu/extension/giannini.html or http://giannini.ucop.edu/calag.htm

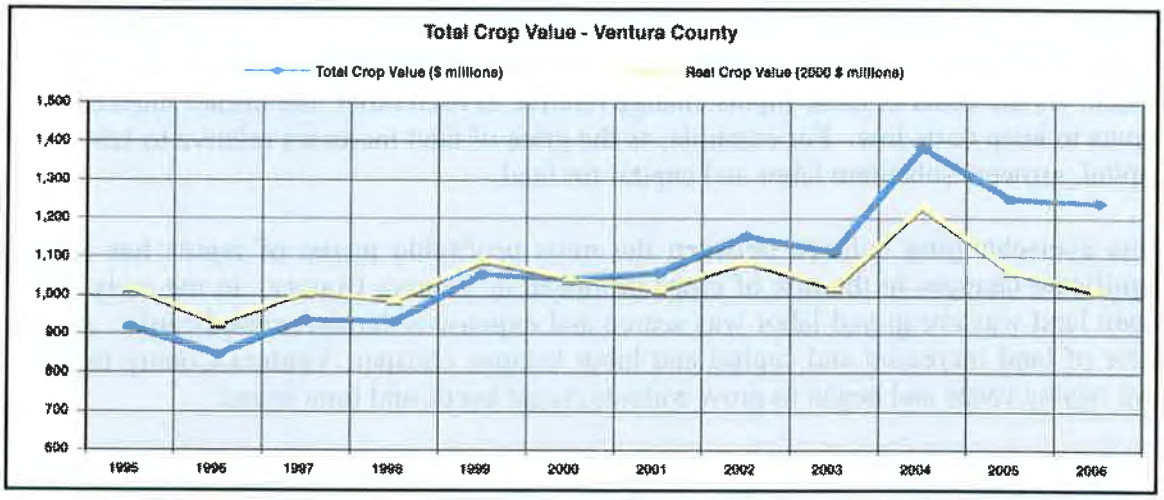
[2] Martin, Philip, Michael Fix and J, Edward Taylor, *The New Rural Poverty*, The Urban Institute Press, Washington D. C., 2006.

[3] For example, see Blank, Steven C., "Is this California agriculture's last century?" *California Agriculture*, Perspective: July-August 2000. pp. 23-25.

- Total proprietor income was $148 million.
- Agricultural crop production provided almost 23,000 jobs. On average, these jobs provided annual earnings of $22,668.

These figures indicate that Ventura County agriculture is a substantial economic presence. Analysis of related trends, however, suggests some bases for serious concern. Examining the trends in each of these metrics of agriculture for period 1995-2006 tells an interesting story.

Crop Value Over the past dozen years, the total value of crops produced in Ventura County has increased. When controlled for inflation (using 2000 dollars), however, the real value of the crops looks much more flat or stagnant. In fact, when using constant dollars, the total value of tbe crop in 2006 was slightly less than that in 1995. Over these twelve years, the annual compound growth rate was -0.06 percent.



In addition, the total value of agricultural production as a share of the County's total economic output is falling, declining from about 5.5 percent of County GCP in 1995 to about 4.4 percent in 2006. While we expect this number to remain roughly constant in the short run, it is likely to continue to decline in the longer term.

A more promising trend is that agricultural producers have become more productive over the study period. Between 1995 and 2006, the total number of harvested acres in the County declined by 837 (about 8 percent). From the year with the highest number of harvested acres (1998), the decline to 2006 is about 14 percent. At the same time, the average crop value per acre increased. In nominal terms, crop value per acre increased from $8,691 in 1995 to $12,850 in 2006. In real terms, average crop value per acre rose $838 (about 9.5 percent). This increase is because growers, responding to rising land values, have switched to more capital-intensive and labor-intensive crops.

As land continued to increase in price while labor continued to decrease in price, the composition of local crops changed once again. Oranges, lemons, and avocados replaced walnuts, sugar beets and lima beans. These new crops were labor intensive, reflecting the changing cost structure.

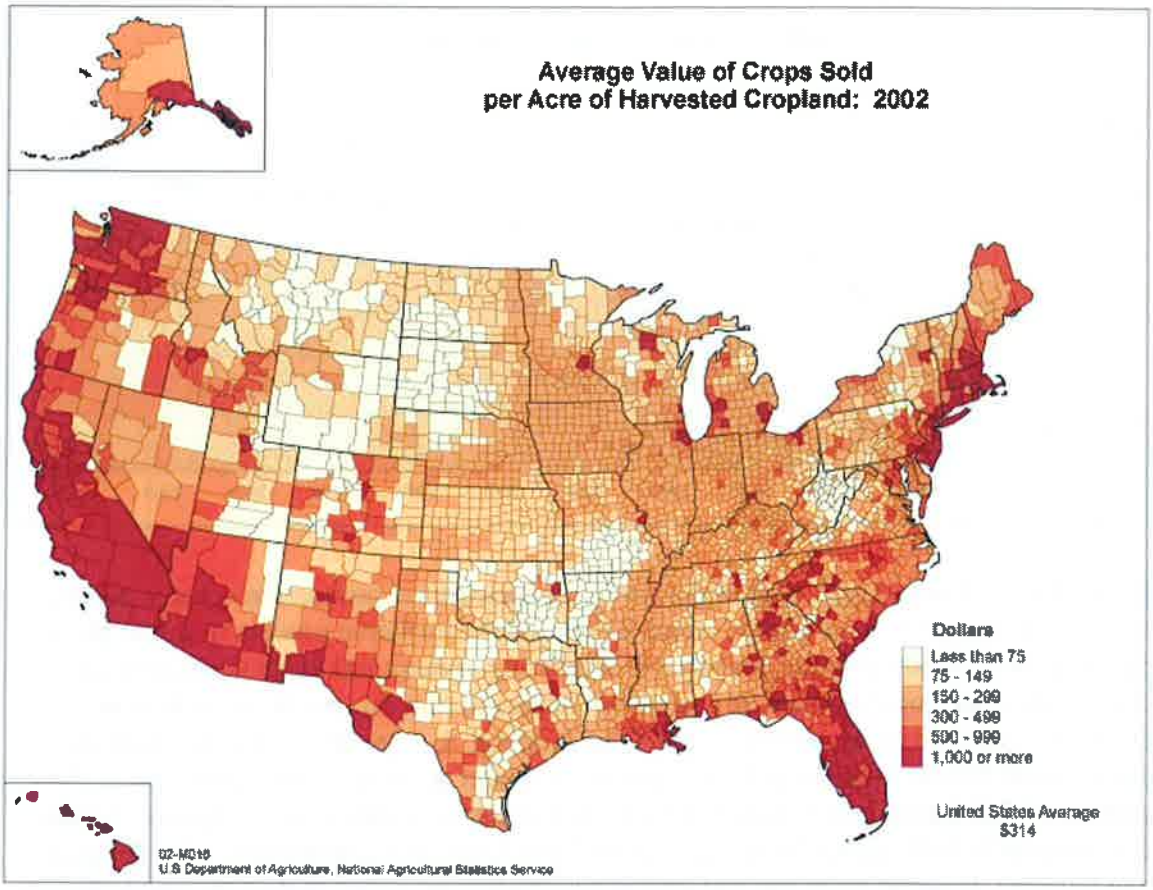
In the past fifteen years, we have witnessed yet another change in crops. Population growth increased the demand for land, which caused the price of land to increase. At the same time, a cheap and abundant source of labor entered the area. As a result, land became more expensive relative to labor: strawberries, raspberries, and nurseries increasingly became the crops of choice for Ventura County growers.

Acreage Changes in Selected Crops 1991-2006

Crop	1991	2006	Change
Avocados	12,926	16,417	3,491
Lemons	23,630	19,100	-4,530
Oranges (Navel)	1,300	455	-845
Oranges (Valencia)	14,355	4,377	-9,978
Total Tree	52,211	40,349	-11,862
Raspberries		1,492	1,492
Strawberries	4,435	11,936	7,501
Total Berries	4,435	13,428	8,993
Beans (all)	4,391	2,724	-1,667
Broccoli	4,457	1,140	-3,317
Cabbage	2,503	2,768	265
Celery	10,528	11,917	1,389
Lettuce	7,368	2,530	-4,838
Onions (all)		595	595
Peppers	1,429	2,483	1,054
Spinach	1,669	1,256	-413
Tomatoes	2,464	1,741	-723
Total Row	34,809	27,154	-7,655
Total Acres	91,455	80,931	-10,524

In 1991, oranges were grown on 15,655 acres in Ventura County. By 2006, however, fewer than 5,000 acres were devoted to orange production. This represents a total loss of nearly 11,000 acres. While not as dramatic, the acreage devoted to lemons has also decreased. From 1991 to 2006, approximately 4,500 acres were taken out of lemon production.

While orange and lemon production were decreasing, strawberry and raspberry production were increasing. From 1991 to 2006 strawberry acreage increased from 4,435 to 11,936. This is nearly a three-fold increase. Raspberry acreage has increased from 268 to 1,492 since the fruit's introduction in 2002. In five years, raspberry acreage has increased five-fold.



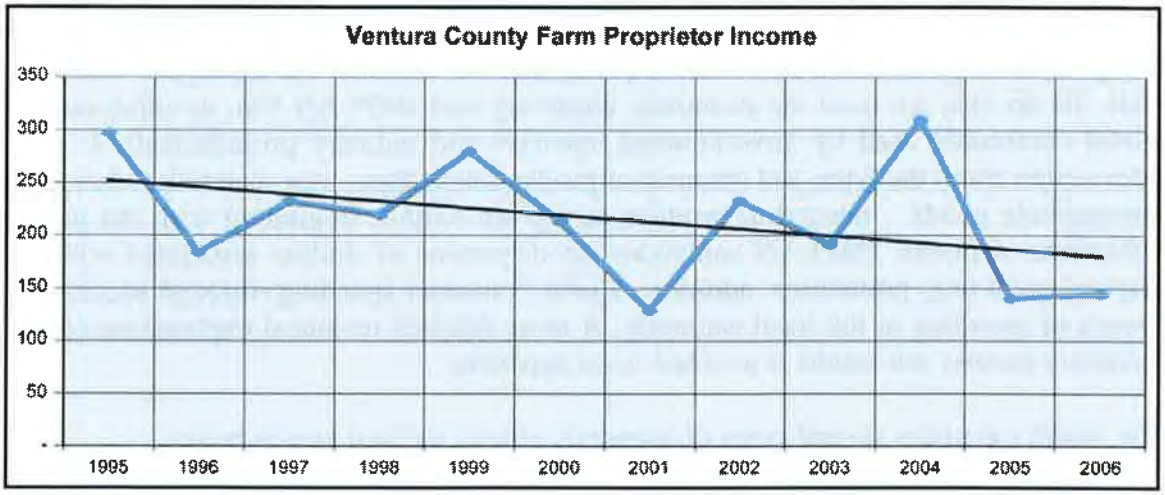
Employment and Earnings One byproduct of the move to more labor-intensive crops has been an increase in the number of jobs associated with farming. Official estimates suggest that the number of workers employed in Ventura County agricultural production increased from about 17,000 in 1995 to just under 23,000 in 2006, a labor force increase of about a third.

In nominal terms, agricultural wages have also risen, increasing from average annual earnings in 1995 of $16,217 to $22,668 in 2006. When adjusted for inflation, however, these increases are much more modest, growing from $17,982 in 1995 to $18,479 in 2006, an increase of less than 3 percent over the entire period.

Ventura County Land Values									
	Row Crops		Lemons		Oranges		Avocados		Median
Year	Low	High	Low	High	Low	High	Low	High	Home Price
1992	$18,000	$22,000	$18,000	$28,000	$18,000	$20,000	$12,000	$24,000	$222,510
1993	$16,000	$20,000	$20,000	$26,000	$16,000	$26,000	$12,000	$24,000	$211,800
1994	$22,000	$25,000	$20,000	$40,000	$14,000	$28,000	$12,000	$29,000	$205,640
1995	$18,000	$35,000	$20,000	$28,000	$12,000	$20,000	$12,000	$25,000	$199,990
1996	$19,000	$33,000	$20,000	$25,500	$12,000	$18,000	$12,000	$25,000	$205,720
1997	$20,000	$30,000	$20,000	$25,000	$11,000	$18,000	$12,000	$25,000	$219,300
1998	$25,000	$35,000	$20,000	$25,000	$11,000	$15,000	$15,000	$25,000	$233,770
1999	$30,000	$33,000	$20,000	$25,000	$11,000	$15,000	$15,000	$25,000	$254,950
2000	$31,500	$49,000	$25,000	$30,000	$11,000	$15,000	$15,000	$25,000	$285,080
2001	$30,000	$49,000	$24,000	$34,500	$10,000	$14,000	$17,000	$28,000	$322,560
2002	$29,000	$49,000	$24,000	$34,500	$12,000	$16,000	$20,000	$32,000	$372,400
2003	$32,000	$53,000	$18,000	$45,000	$17,000	$25,000	$20,000	$35,000	$482,520
2004	$40,000	$65,000	$20,000	$36,000	$19,000	$35,000	$20,000	$34,000	$599,280
2005	$45,000	$75,000	$20,000	$55,000	$19,000	$51,000	$25,000	$47,000	$688,870
Growth Rate (a)	7.7%	9.2%	0.8%	4.9%	1.2%	6.9%	5.4%	4.9%	8.4%

(a) Compound annual growth rate
Source: California Chapter of the American Society of Farm Managers and Rural Appraisers Trends in Agricultural Land and Lease Values Report
http://www.calasfmra.com/

Farm Proprietors While the local farmworker force has increased rather substantially in size since 1995, the number of farm proprietors has declined. In 2006, there were about 200 fewer farmers in Ventura County than there were in 1995, perhaps echoing the decline in total harvested acres.



There has also been a dramatic decrease in farm proprietor income. In 1995, total farm proprietor income in the County was about $298 million. By 2006, this had shrunk to about $146 million. On average, income to the 1995 proprietor was $115,325; in 2006, it was $62,344. The chart above shows the year-to-year volatility in farm income that is characteristic of agriculture; the trend line demonstrates the steady march toward lower incomes that area farmers have experienced over the past 12 years. *This trend, in a nutshell, is the threat to the future viability of Ventura County agriculture*. Farmers have

- **Induced Impacts**: These are estimates of activity attributable to the consumption spending of employees of firms that are directly or indirectly affected by the expenditures related to the project being studied. An example of this would be the increased spending by a farmer's household made possible by the extra business gained from increased sales or profitability.

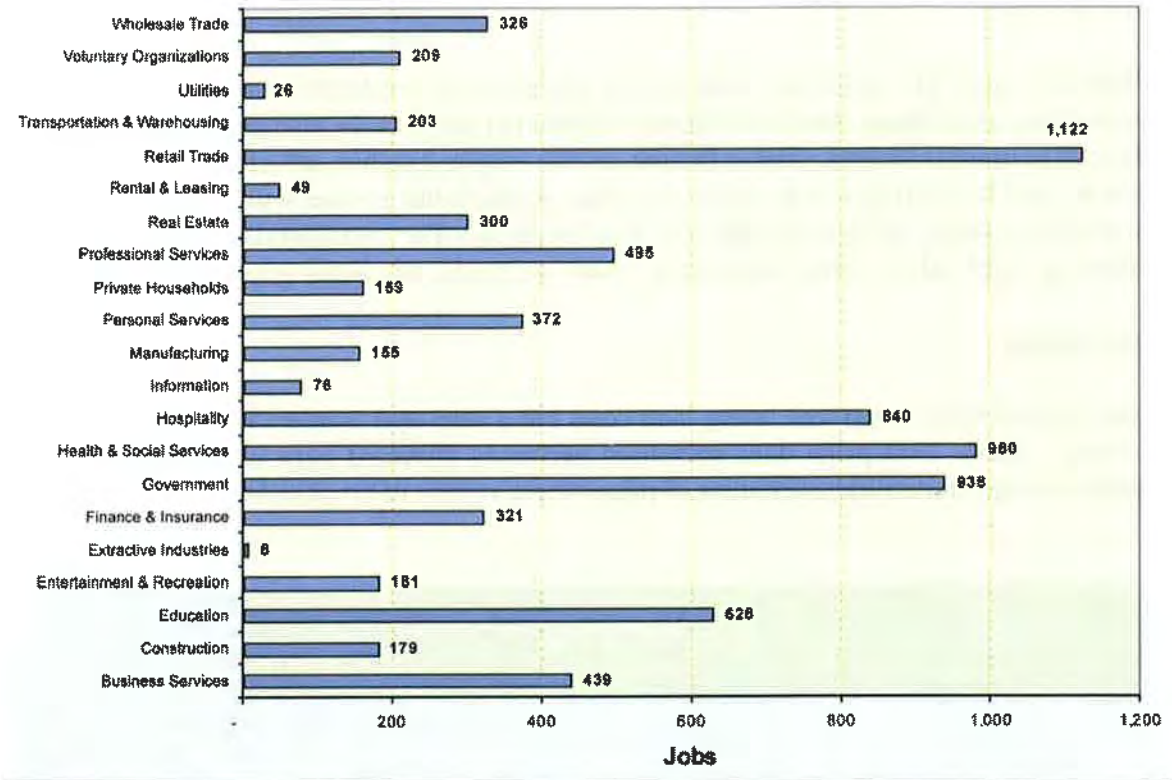
Impacts to Gross County Output

Agricultural output was reported as approximately $1.255 billion in 2005. For our analysis, we must disaggregate the production number. Therefore, we estimated the distribution of output as follows: $1.149 billion in direct impacts, $102.9 million indirect impacts and $3.2 million in induced impacts for a total agricultural output value of $1.255 billion. The distribution reflects the fact that agricultural production creates local demand for its products. For example, the production of nursery stock and cut flowers both supports and stimulates businesses that wholesale and retail these products and thus creates what is called indirect demand. Similarly, induced local demand is created when agricultural workers (those who work in industries that supply farmers and ranchers, or those who use agricultural products as inputs) spend their wages in local stores, farmer's markets, and roadside stands.

Based on the direct impacts associated with agriculture, the estimated output multiplier is 1.86, which is to say that for every dollar of direct impact due to agriculture, another $0.86 of output is generated by the indirect and induced effects.

The economic activity directly related to agricultural production also spurs indirect and induced activity throughout the County economy. In addition to the $106.1 million in indirect and induced activity generated in its own sector, the direct impact of agriculture ($1.149 billion) is responsible for generating another $878 million of output, distributed among the other sectors of the economy. In total, $2.133 billion dollars of the 2005 gross County output can be traced to the direct, indirect, and induced effects of agricultural production.

Jobs Created Across Other Industries by Agricultural Production



Impacts to Indirect Business Tax Receipts

Indirect business taxes, as calculated by IMPLAN, include sales, excise, motor vehicle licenses, and "other taxes associated with the operation of industry." In 2005, the indirect business taxes estimated to have derived from the economic activity instigated by agricultural production totaled $75.6 million. Of this amount, $23.6 million was generated by agriculture alone. The remaining $52 million was generated by the indirect and induced activity in other industries.

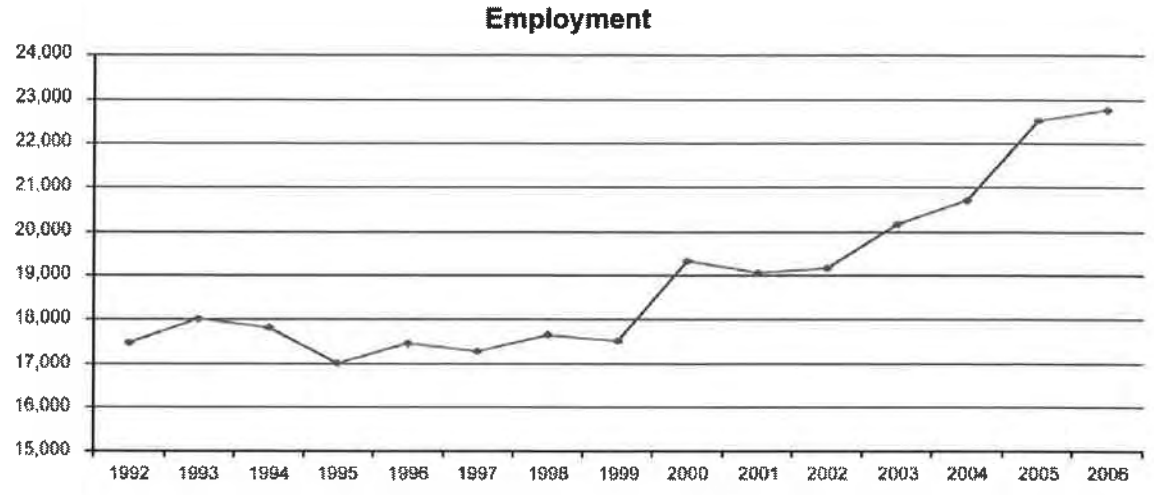
Overall Impact

Ventura County's agricultural production is an important element in the County's overall economy. In 2005, farming produced crop values of $1.25 billion and provided 23,000 jobs. The indirect effects of this economic engine produced $878 million in other sectors of the County's economy, added another 8,000 jobs, and generated additional tax revenues of $75.6 million to the government. Clearly, the future of agriculture in the County should be everyone's concern.

THREATS TO AGRICULTURAL PRODUCTION

Since the beginning of farming, growers have had to face a myriad of natural threats to the physical production of a "good crop," including the vagaries of weather, fire, pests,

Labor



Perhaps the most serious threat to Ventura County agriculture is a potential labor shortage. We noted earlier that even while the total number of harvested acres in the County has been in modest decline, the number of agricultural productions jobs has been steadily increasing. As farmers have continued to shift to higher-value crops, their need for additional labor has continued to increase. This demand for more workers will continue, at least in the short run.

Immigrants hold the vast majority of Ventura County farm jobs, and many of them are undocumented. Most farmworkers in Ventura County were born in Mexico; the newest arrivals are often Mixtec-speaking indigenous peoples from Oaxaca (Martin, 2006). Exact counts of workers, their origins, and their immigration statutes are difficult to come by. One recent study of 13 California counties, including Ventura, gathered information from interviews with about 2,300 farmworkers. The profile data reported in this study suggest the following:

- Ninety-five percent of California agricultural workers were born outside the U. S.; 91 percent in Mexico.
- Ninety-nine percent classify themselves as Hispanic; 20 percent identify themselves as "indigenous peoples."
- On average, they have been in the United States 11.1 years. Twenty-two percent have been in the United States two years or less.
- Ten percent are United States citizens; 33 percent have green cards, and 57 percent are unauthorized. Of the newcomers, 99 percent are unauthorized.

The high proportion of undocumented workers in the fields makes the agricultural industry especially vulnerable. Immigration policies that would actively seek to export those here illegally (or, indeed, enforce existing policies) would wreak swift and substantial damage to the agriculture industry. We will consider the specifics of immigration policy questions in a later section of this report.

The current primary bio-fuel is corn. As demand for corn increases, we would expect to see marginal land come into production. We would also expect growers to switch to corn from other crops. Because of the decreasing supply of the crops that growers move out of, prices of other agricultural products will increase. Ultimately, this will tend to increase all growers' profits.

Methyl Bromide A specific example of pesticide regulation is the controversy around the use of methyl hromide. In 1992, the Montreal Protocol, an international treaty created in 1987 to protect the world's ozone layer, identified methyl bromide as an ozone-depleting substance. Methyl bromide was to be phased out by 2005. However, Critical Use Exemptions (CUE) have routinely been granted since 2005[5].

According to the California Strawberry Commission, the statewide use of methyl bromide has decreased from 195 pounds per acre in 1992 to 130 pounds per acre in 2003. The use of alternative fumigants has increased from 84 pounds per acre in 1992 to 156 pounds per acre in 2003. Furthermore, 35 percent of California's 33,000 acres of strawberry fields no longer use any methyl hromide. While this is certainly a step in the right direction, full phaseout has yet to occur.

Year	Methyl Bromide (lbs.)	Strawberry Acreage	Pounds per Acre
1998	1,658,591	5,776	287
1999	2,069,710	6,352	326
2000	1,728,695	7,591	228
2001	1,461,787	7,777	188
2002	1,430,386	8,582	167
2003	1,561,145	8,794	178
2004	1,438,890	10,349	139

Source: Central Coast Environmental Health Project

Ventura County strawberry growers have also scaled back their use of methyl bromide. In 1998 County growers used 287 pounds of methyl bromide per acre. By 2004 that number had declined to 139 pounds per acre. In seven years, Ventura County strawberry growers have reduced their use of methyl bromide by 51.6 percent. In fact, while total County strawberry acres have almost doubled since 1998, total methyl bromide usage has declined.

Completely phasing out methyl hromide in Ventura County could have severe repercussions, since it is the preferred fumigant for strawberry growers. Lacking suitable alternatives, many growers face reduced and, hence, less profitable production. While some alternatives do exist, it will be difficult and costly for growers to switch fumigants.

While a formal economic impact study has not been done, there is some data regarding the negative impacts of VOC regulation in Ventura County. A 2007 report by the Air

[5] California Strawberry Commission: http://www.calstrawberry.com/research/mbromide.asp

relatively rare, incidences of food poisoning are often magnified and kept in the news. The impact on growers in general, and Ventura County growers in particular, is that resultant regulations and buyer policies increase costs.

Growers have responded by investing in equipment to monitor the entire workflow of a crop. For example, strawberry containers are bar coded at the time of harvest. The bar code contains information on the harvest date, picker, and field. In addition, less technical solutions have also been implemented. It is not uncommon to find workers' using plastic gloves while handling fresh produce. Hand sanitizers are also used. The containers are attached to the tractors and are always available to employees.

While these changes have improved food safety, it is not clear that the benefits justify the costs. It is clear, though, that it increases costs, which may generate increased costs to the consumer and/or reduced profits to the grower.

Agricultural and Urban Interface

People have a romantic view of agriculture. People imagine lush fields, a sea of color, and the aroma of fresh fruit and vegetables. When people live next to a cultivated field, however, they often find the reality is not quite so romantic.

Living next to a cultivated field means living next to a dust generator. On very cold nights, the wind machines sound exactly like helicopters (loud helicopters). Pesticides must be applied. Sometimes the fields emit noxious odors. At times, lots of truck traffic is generated. These trucks are noisy, and they create a lot of dust.

When people experience the inconveniences of living next to a field, they often try to eliminate those inconveniences. This may result in regulatory change, such as a requirement to eliminate or reduce pesticide usage. It may mean regulation to limit the times or method a pesticide can be applied. Restrictions may also be placed on the hours of noise-generating activities.

As Ventura County has grown, the boundary between agricultural and urban land has blurred. It is not uncommon to find farms in the midst of housing developments, or even next to schools. As urban development inched closer to agricultural land, conflicts inevitably arose.

The most contentious arguments concern the use of pesticides and fumigants. Residents cite the health problems associated with these chemicals. Farmers point to the importance of these products in the growing cycle. As the debate rages on, the question becomes what can be done in both the short and long run to solve this problem for all parties?

In the short run, farmers bear the burden and cost of reducing potential exposure. Expensive application methods are used to limit potential exposure to these chemicals.

Opportunities

Where there are threats, there are also opportunities. For agriculture, new and evolving technologies have often been the source of continued or enhanced economic viability. As is the case in most industries, technology plays an ever-increasing role in agriculture. While it does not receive the attention so noticeable in other industries, agriculture technology has greatly improved productivity.

Technology has had its greatest impact in plant science. Today's crops are more productive, resistant to pests and fungi, and resilient to cold weather. A prime example is the new Albion strawberry, developed by researchers at the University of California, Davis.

The Albion is the successor to the Diamante. According the University of California, the Albion is "quite resistant to Verticillium wilt and Phytophthora crown, and relatively resistant to Anthracnose crown rot. When treated properly, it has tolerance to two-spotted spidermites equal to or greater than the Diamante. When treated with appropriate planting regimes, Albion has similar fruit size and produces equal or greater individual plant yields than Diamante".[10]

The Albion's resistance to various fungi and pests and greater yield has caught the attention of growers. In 2006, approximately 2,795 acres in California were planted with the Albion strawberry. A year later 9,993 acres were planted with the Albion. The Diamante strawberry, on the other hand, went from 6,023 acres in 2006 to 890 acres in 2007. In one year, acreage planted with Albion strawberries increased 250 percent while acreage planted with Diamante strawberries decreased 85 percent.[11] Despite these pluses, the Albion variety has limits in Ventura County where "short day" varietals may provide better profitability than "day neutral" types.

Technology has also had a tremendous impact in an area we call field operations. New tools for planting, watering, and harvesting crops have been developed. Perhaps the most interesting example of this is the mechanical chili harvester. Using the harvester, a farmer can harvest seven acres a day with minimal labor. Prior to the mechanical harvester, it took forty to fifty workers to harvest seven acres.[12]

While the mechanical chili harvester will not help local farmers, technology has led to advancements used by local growers. Drip irrigation is used to reduce water costs. As the water is essentially injected directly where it is needed, less is lost to evaporation or watering of weeds. Improvements in harvesting have led to greater efficiency. Celery can now be picked, cleaned, and packaged in the field.

Finally, technology has created new fumigants and pesticides. Of great interest to local farmers are new alternatives to methyl bromide. Approximately $200 million has been

[10] University of California: http://www.ucop.com/ott/strawberry/Albion.htm
[11] Farm Credit West Appraisal Services.
[12] Santa Maria Times 12/24/2007.

Appendix

Appendix A

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assumed by the study, the sectors in which these events occurred, and the structure of the economy in Ventura County at the time the data used to construct the model were collected).[4]

It should be noted that changes in the structure of the economies of Ventura County and the state of California since 2004 are not captured by the model but might affect the estimates of output, job creation, labor compensation, and tax receipts attributable to agricultural spending in 2005; hence all figures calculated here should be considered approximate.

Impacts to Gross County Output

Agricultural output was reported as approximately $1.255 billion in 2005. For our analysis, we must disaggregate the production number. Therefore, we estimated the distribution of output as follows: $1.149 billion in direct impacts, $102.9 million indirect impacts, and $3.2 million in induced impacts—a total agricultural output value of $1.255 billion. The distribution reflects the fact that agricultural production creates local demand for its products. For example, the production of nursery stock and cut flowers both supports and stimulates businesses that wholesale and retail these products and thus creates what is called indirect demand. Similarly, induced local demand is created when agricultural workers (those who work in industries that supply farmers and ranchers, or those who use agricultural products as inputs) spend their wages in local stores, farmer's markets, and roadside stands.

Based on the direct impacts associated with agriculture, the estimated output multiplier is 1.86, which is to say that for every dollar of direct impact due to agriculture, another $0.86 of output is generated by the indirect and induced effects.

The economic activity directly related to agricultural production also spurs indirect and induced activity throughout the County economy. As seen in Exhibit 2, in addition to the $106.1 million in indirect and induced activity generated in its own sector, the direct impact of agriculture ($1.149 billion) is responsible for generating another $878.1 million of output, distributed among the other sectors of the economy. In total, $2.133 billion dollars of the 2005 gross County output can be traced to the direct, indirect, and induced effects of agricultural production. This represents about 4.2 percent of the total $50.3 billion gross County output in 2005. Based on the direct impacts associated with agriculture, the estimated output multiplier is 1.86, which is to say that for every dollar of direct impact due to agriculture, another $0.86 of output is generated by the indirect and induced effects.

As shown in Exhibit 3, the impacts are distributed among all sectors of the economy. Those in which output was most affected were Private Households ($93.1 million), Government ($90.0 million), Retail ($81.7 million), and Health and Social Services ($80.8 million).

[4] The type and quality of data used will also affect the analysis. Those analyses done with the benefit of highly detailed survey information are generally more accurate than those which rely on estimates.

Proprietor Income

Agricultural production in 2005 generated an estimated $361.4 million in proprietor income in 2005. An additional $40.8 million was generated for proprietors by the indirect and induced effects (Table 10).

Exhibit 1: Value of 2005 Ventura County Agricultural Output

Type of Agricultural Product	Value in 2005 dollars
Fruits and nuts	652.8
Vegetables	330.3
Nursery stock	213.7
Cut flowers	51.7
Field crops	1.9
Livestock and poultry	2.1
Apiary	0.5
Timber	0.1
Sustainable agriculture	2.0
Total	**1,255.1**

Source: Ventura County Crop Report 2006

Exhibit 2: Output Impact Agricultural Production, 2005
(Stated in millions of Year 2005 dollars)

Aggregated Sector	Direct	Indirect	Induced	Total
Agriculture	1,149.0	102.9	3.2	1,255.1
Business Services	-	4.5	26.6	31.2
Construction	-	2.2	17.6	19.8
Education	-	0.0	27.9	28.0
Entertainment & Recreation	-	0.3	8.3	8.6
Extractive Industries	-	0.9	1.6	2.5
Finance & Insurance	-	11.7	57.4	69.1
Government	-	3.6	86.4	90.0
Health & Social Services	-	0.0	80.8	80.8
Hospitality	-	0.9	42.5	43.4
Information	-	3.0	19.1	22.1
Manufacturing	-	6.7	44.7	51.3
Personal Services	-	3.8	26.8	30.6
Private Households	-	-	93.1	93.1
Professional Services	-	7.7	46.1	53.8
Real Estate	-	25.1	30.8	55.9
Rental & Leasing	-	1.9	4.5	6.4
Retail Trade	-	1.8	79.9	81.7
Transportation & Warehousing	-	7.5	12.7	20.2
Utilities	-	2.8	9.2	12.0
Voluntary Organizations	-	0.5	8.5	9.1
Wholesale Trade	-	27.3	41.3	68.6
Total	**1,149.0**	**215.2**	**769.0**	**2,133.1**

Totals may not sum exactly due to rounding.
Source: IMPLAN Pro®

Exhibit 4: Employment Impact, 2005

Aggregated Sector	Direct	Indirect	Induced	Total
Agriculture	20,273	3,368	65	23,706
Business Services	-	61	378	439
Construction	-	20	159	179
Education	-	1	627	628
Entertainment & Recreation	-	6	176	181
Extractive Industries	-	2	4	6
Finance & Insurance	-	50	271	321
Government	-	18	920	938
Health & Social Services	-	0	980	980
Hospitality	-	15	824	840
Information	-	9	67	76
Manufacturing	-	20	135	155
Personal Services	-	34	338	372
Private Households	-	-	159	159
Professional Services	-	70	425	495
Real Estate	-	135	165	300
Rental & Leasing	-	7	41	49
Retail Trade	-	26	1,097	1,122
Transportation & Warehousing	-	72	131	203
Utilities	-	8	18	26
Voluntary Organizations	-	20	189	209
Wholesale Trade	-	130	196	326
Total	**20,273**	**4,072**	**7,366**	**31,710**

Totals may not sum exactly due to rounding.
Source: IMPLAN Pro®

Exhibit 6: Labor Income Impact, 2005
(Stated in millions of 2005 dollars)

Aggregated Sector	Direct	Indirect	Induced	Total
Agriculture	742.4	90.4	2.1	834.9
Business Services	-	2.1	12.8	14.9
Construction	-	1.0	8.4	9.5
Education	-	0.0	20.9	20.9
Entertainment & Recreation	-	0.1	3.4	3.5
Extractive Industries	-	0.2	0.3	0.5
Finance & Insurance	-	4.3	21.5	25.8
Government	-	1.3	75.3	76.6
Health & Social Services	-	0.0	44.7	44.7
Hospitality	-	0.3	14.7	15.0
Information	-	0.7	4.7	5.4
Manufacturing	-	1.2	9.0	10.2
Personal Services	-	1.3	9.4	10.7
Private Households	-	-	1.6	1.6
Professional Services	-	3.7	24.0	27.7
Real Estate	-	4.4	5.3	9.7
Rental & Leasing	-	0.4	1.4	1.8
Retail Trade	-	0.7	33.0	33.7
Transportation & Warehousing	-	3.7	6.3	9.9
Utilities	-	0.6	1.5	2.1
Voluntary Organizations	-	0.5	4.6	5.1
Wholesale Trade	-	10.3	15.5	25.8
Total	**742.4**	**127.2**	**320.3**	**1,189.9**

Totals may not sum exactly due to rounding.
Source: IMPLAN Pro®

Exhibit 9: Employee Compensation Impact, 2005
(Stated in millions of 2005 dollars)

Aggregated Sector	Direct	Indirect	Induced	Total
Agriculture	398.2	74.1	1.1	473.5
Business Services	-	1.9	11.4	13.3
Construction	-	0.8	6.5	7.3
Education	-	0.0	20.7	20.7
Entertainment & Recreation	-	0.1	3.0	3.0
Extractive Industries	-	0.1	0.2	0.4
Finance & Insurance	-	4.1	19.2	23.3
Government	-	1.3	75.3	76.6
Health & Social Services	-	0.0	37.3	37.3
Hospitality	-	0.3	13.9	14.2
Information	-	0.7	4.3	4.9
Manufacturing	-	1.1	8.4	9.5
Personal Services	-	0.9	6.5	7.4
Private Households	-	-	1.6	1.6
Professional Services	-	2.8	17.6	20.4
Real Estate	-	1.6	1.9	3.5
Rental & Leasing	-	0.4	1.4	1.8
Retail Trade	-	0.6	28.3	28.9
Transportation & Warehousing	-	3.2	5.4	8.6
Utilities	-	0.6	1.5	2.1
Voluntary Organizations	-	0.5	4.6	5.1
Wholesale Trade	-	9.8	14.7	24.5
Total	**398.2**	**104.7**	**284.8**	**787.8**

Totals may not sum exactly due to rounding.
Source: IMPLAN Pro®

Exhibit 11: Estimated Indirect Business Tax Receipts, 2005

Aggregated Sector	Direct	Indirect	Induced	Total
Agriculture	22.3	1.2	0.1	23.6
Business Services	-	0.1	0.4	0.5
Construction	-	0.0	0.1	0.1
Education	-	0.0	0.1	0.1
Entertainment & Recreation	-	0.0	0.6	0.6
Extractive Industries	-	0.1	0.1	0.2
Finance & Insurance	-	0.5	2.2	2.7
Government	-	0.0	0.0	0.0
Health & Social Services	-	0.0	0.6	0.6
Hospitality	-	0.1	2.5	2.6
Information	-	0.2	1.0	1.2
Manufacturing	-	0.0	0.3	0.3
Personal Services	-	0.2	1.7	1.9
Private Households	-	-	10.6	10.6
Professional Services	-	0.1	0.5	0.6
Real Estate	-	2.9	3.6	6.5
Rental & Leasing	-	0.0	0.1	0.1
Retail Trade	-	0.3	11.3	11.6
Transportation & Warehousing	-	0.1	0.3	0.4
Utilities	-	0.3	0.9	1.2
Voluntary Organizations	-	0.0	0.0	0.0
Wholesale Trade	-	4.2	6.4	10.6
Total	**22.3**	**10.3**	**43.4**	**75.6**

Totals may not sum exactly due to rounding.
Source: IMPLAN Pro®

	Current Production (Acres)	Meet County Demand	Change from Current	Meet Demand for 5 Million	Change from Current
Current High Production Crops					
Avocados	17,545	292	(17,253)	2,011	(15,534)
Celery	11,030	56	(10,974)	385	(10,645)
Corn	677	7,064	6,387	1,688	1,011
Lemons	23,865	1,091	(22,744)	864	(23,001)
Melons	149	1,453	1,304	8,675	7,371
Misc. Vegetables	1,895	15	(1,880)	20	(1,875)
Oranges	6,070	226	(5,844)	5,520	(550)
Peppers	1,647	116	(1,531)	745	(902)
Strawberries	8,794	98	(8,696)	516	(8,278)
Tomatoes	167	201	34	640	473
Totals	71,839	10,612	(61,237)	21,064	(51,930)
Not Currently High Production Crops in Ventura County	Current Production (Tons)	Meet County Demand	Change from Current	Meet Demand for 5 Million	Change from Current
Alfalfa	-	25,363	25,363	10,138	10,138
Apples	-	15,718	15,718	87,379	87,379
Grain	-	59,157	59,157	28,464	28,464
Misc. Subtropicals	-	54,050	54,050	15,336	15,336
Potatoes	-	50,265	50,265	853	853
Sugar Beets	-	24,032	24,032	113491	113,491
Totals	-	228,585	228,585	255,661	255,661

Source: Mike Mertens and Howard Silverman, "Landscape Production Analysis for Ventura County: A Preliminary Summary for the Ag Futures Allliance and Ag Innovation Network," May 2007, ecotrust.(Acres were calculated using crop yields derived from authors data)

State of California
California Regional Water Quality Control Board, Los Angeles Region

RESOLUTION NO. R12-011
December 6, 2012

Amendment to the Water Quality Control Plan for the Los Angeles Region to Incorporate a Total Maximum Daily Load for Algae, Eutrophic Conditions, and Nutrients in Ventura River, including the Estuary, and its Tributaries

WHEREAS, the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) finds that:

1. The Federal Clean Water Act (CWA) requires the Regional Board to establish water quality standards for each waterbody within its region. Water quality standards include beneficial uses, water quality objectives that are established at levels sufficient to protect those beneficial uses, and an antidegradation policy to prevent degrading waters. Waterbodies that do not meet water quality standards are considered impaired.

2. Section 303(d)(1) of the CWA requires each state to identify the waters within its boundaries that do not meet water quality standards. Those waters are placed on the state's "303(d) List" or "Impaired Waters List". For each listed water, the state is required to establish the Total Maximum Daily Load (TMDL) of each pollutant impairing the water quality standards in that waterbody. Both the identification of impaired waters and TMDLs established for those waters must be submitted to the United States Environmental Protection Agency (U.S. EPA) for approval pursuant to CWA section 303(d)(2).

3. A consent decree between U.S. EPA, Heal the Bay, and Santa Monica BayKeeper was approved on March 22, 1999, which resolved litigation between those parties relating to the pace of TMDL development in the Los Angeles Region. The consent decree directs the U.S. EPA to ensure that TMDLs for all 1998-listed impaired waters in the Los Angeles Region be established within 13 years of the consent decree. The consent decree combined waterbody pollutant combinations in the Los Angeles Region into 92 TMDL analytical units. In accordance with the consent decree, the Algae, Eutrophic Conditions, and Nutrients TMDL for Ventura River (including the Estuary and its Tributaries) addresses the listing for algae, eutrophic conditions, nitrogen, and low dissolved oxygen in Ventura River Estuary, Ventura River Reaches 1 and 2, San Antonio Creek and Cañada Larga (Analytical Unit 88). In 2010, the consent decree was modified to include an extension for Analytical Unit 88 until March 2013. Based on the consent decree schedule, TMDLs addressing these listings must be approved or established by U.S. EPA by March 2013.

4. The elements of a TMDL are described in sections 130.2 and 130.7 of Title 40 of the Code of Federal Regulation (40 CFR) and section 303(d)(1), subdivisions (C) and (D), of the CWA, as well as in U.S. EPA guidance documents (Report No. EPA/440/4-91/001). A TMDL is defined as the sum of the individual waste load allocations for point sources, load allocations for non-point sources, and natural background. (40 CFR § 130.2.) TMDLs must be set at levels necessary to attain and maintain the applicable narrative and numeric water quality standards with seasonal variations and a margin of safety that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. (40 CFR § 130.7(c)(1).) Section 130.7 of Title 40 of the Code of Federal Regulations also dictates that TMDLs shall take into account critical conditions for stream flow, loading, and water quality parameters. TMDLs typically include one or more numeric "targets"; i.e., numerical translations of the existing water quality standards that represent attainment of those standards, contemplating the TMDL elements described above. Since a TMDL must represent the "total" load, TMDLs must account for all sources of the relevant pollutants, irrespective of whether the pollutant is discharged to impaired or unimpaired upstream reaches.

5. Neither TMDLs nor their targets or other components are water quality objectives, and thus their establishment does not implicate California Water Code section 13241. Rather, under California law, TMDLs are programs to implement existing standards (including objectives), and are thus established pursuant to California Water Code section 13242. Moreover, TMDLs do not create new bases for direct enforcement against dischargers apart from the existing water quality standards they translate. Like most other parts of the Water Quality Control Plan for the Los Angeles Region (Basin Plan), TMDLs are not generally self-implementing. The targets merely establish the bases through which load allocations (LAs) and waste load allocations (WLAs) are calculated. The LAs and WLAs may be implemented in any manner consistent with the Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options, adopted by the State Water Resources Control Board (State Board) on June 16, 2005 (Resolution No. 2005-0050). Federal regulations also require that National Pollutant Discharge Elimination System (NPDES) permits be consistent with the assumptions and requirements of available WLAs. (40 CFR § 122.44(d)(vii)(B).)

6. As envisioned by California Water Code section 13242, the TMDL contains a "description of surveillance to be undertaken to determine compliance with objectives." The Compliance Monitoring element of the TMDL recognizes that monitoring will be necessary to assess the progress of pollutant load reductions and improvements in water quality in the Ventura River Watershed. The TMDL establishes the types of data and information that will be necessary to obtain. The Regional Board's Executive Officer will ensure that appropriate entities develop and submit monitoring programs and technical reports necessary to achieve the purposes of the TMDL. The Executive Officer will determine the scope of these

programs and reports, taking into account any legal requirements, including this TMDL, and if necessary issue appropriate orders to appropriate entities.

7. Upon establishment of TMDLs by the State or U.S. EPA, the State is required to incorporate, or reference, the TMDLs into the State Water Quality Management Plan. (40 CFR §§ 130.6(c)(1), 130.7.) The Basin Plan and applicable statewide plans serve as the State Water Quality Management Plans governing the watersheds under the jurisdiction of the Los Angeles Regional Board. Attachment A to this resolution contains the language to be incorporated into the Basin Plan for this TMDL.

8. The Ventura River watershed is located in the northwestern portion of Ventura County with a small portion in the southeastern portion of Santa Barbara County. The watershed is characterized by rugged mountains in the upper basins transitioning to less steep areas and valleys. The watershed drains an area of about 220 square miles with an elevation ranging from 6,000 feet to sea level. Major tributaries to the river, include Matilija Creek, North Fork Matilija Creek, San Antonio Creek, Coyote Creek, and Cañada Larga. The river starts at the confluence of Matilija Creek and North Fork Matilija Creek and flows for about 16 miles in a southern direction to the estuary and Pacific Ocean. The river has intermittent direct discharges to the ocean; longshore transport of sand can cause a sand bar to form at the mouth of the estuary in the late summer and early fall obstructing flow.

9. In addition to natural variations in flow, flow regimes in the Ventura River have been altered to support water supply. Lake Casitas and Matilija Reservoir are the two reservoirs within the watershed. Perennial flow occurs from the headwaters to the Robles Diversion Dam, located about two miles downstream from the Matilija Dam. The flow downstream of the Robles Diversion Dam to the confluence with San Antonio Creek is intermittent, particularly during the dry summer months. Flow in the river is disrupted at Foster Park due to subsurface diversions and groundwater extraction. However, the river flow below Foster Park to the estuary increases due to effluent discharges from the Ojai Valley Wastewater Treatment Plant.

10. Eighty-five percent of the land use in the Ventura River watershed is classified as open space and with approximately half of the watershed located within the Los Padres National Forest. Approximately 4.5 percent of the watershed consists of agricultural land with the developed area being small compared to the open space and agriculture. The cities of Ojai and Ventura are the largest urban areas in the watershed and the communities of Casitas Springs, Foster Park, Oak View, Valley Vista, Mira Monte, Meiners Oaks, Upper Ojai, and Live Oak Acres are within the unincorporated Ventura County.

11. The Regional Board's goal in establishing the TMDL for algae, eutrophic conditions, and nutrients in the Ventura River Watershed is to protect the water

contact recreation (REC-1) and non-contact water recreation (REC-2) beneficial uses, as well as uses associated with habitat preservation and protection as applicable including: warm fresh water habitat (WARM), cold fresh water habitat (COLD), estuarine habitat (EST), wetland habitat (WET), marine habitat (MAR), wildlife habitat (WILD), rare, threatened, or endarngered species (RARE), migration of aquatic organisms (MIGR), and spawning, reproduction, and/or early development (SPWN).

12. Regional Board staff have prepared a detailed technical document that analyzes and describes the specific necessity and rationale for the development of this TMDL. The technical document entitled "Algae, Eutrophic Conditions, and Nutrients Total Maximum Daily Loads for Ventura River and its Tributaries" is an integral part of this Regional Board action and was reviewed, considered, and accepted by the Regional Board before acting. Further, the technical document provides the detailed factual basis and analysis supporting the problem statement, numeric targets (interpretation of the narrative and numeric water quality objectives used to calculate the waste load and load allocations), source analysis, linkage analysis, waste load allocations (for point sources), load allocations (for non-point sources), margin of safety, and seasonal variations and critical conditions of this TMDL.

13. On December 6, 2012, prior to the Regional Board's action on this resolution, a public hearing was conducted on this TMDL. Notice of the hearing was published in accordance with the requirements of California Water Code section 13244. This notice was published in the Ventura County Star on July 20, 2012.

14. The public has had a reasonable opportunity to participate in the review of this TMDL. A draft of the TMDL was released for public comment on July 20, 2012; a Notice of Hearing was published and circulated 45 days preceding Regional Board action. The draft of the TMDL was also made available on the Regional Board's website. Regional Board staff responded to oral and written comments received from the public; and the Regional Board held a public hearing on December 6, 2012 to consider adoption of the TMDL.

15. In amending the Basin Plan to establish this TMDL, the Regional Board considered the requirements set forth in sections 13240 and 13242 of the California Water Code.

16. Because the TMDL implements existing narrative and numeric water quality objectives (i.e., water quality objectives in the Basin Plan), the Regional Board (along with the State Board) has determined that adopting a TMDL does not require the Regional Board to consider the factors of California Water Code section 13241. The consideration of the California Water Code section 13241 factors, by section 13241's express terms, only applies "in establishing water quality objectives." Here, the Regional Board is not establishing water quality objectives, but as required by section 303(d)(1)(C) of the Clean Water Act is

adopting a TMDL that will implement the previously established objectives that have not been achieved. In making this determination, the Regional Board has considered and relied upon a legal memorandum from the Office of Chief Counsel to the State Board's basin planning staff detailing why TMDLs cannot be considered water quality objectives. (See Memorandum from Staff Counsel Michael J. Levy, Office of Chief Counsel, to Ken Harris and Paul Lillebo, Division of Water Quality: *The Distinction Between a TMDL's Numeric Targets and Water Quality Standards*, dated June 12, 2002.)

17. While the Regional Board is not required to consider the factors of California Water Code section 13241, it nonetheless has developed and received significant information pertaining to the California Water Code section 13241 factors and has considered that information in developing and adopting this TMDL. Section 13241, at a minimum, requires that water quality objectives ensure reasonable protection of beneficial uses. The designated beneficial uses in the Ventura River Watershed include aquatic life habitat uses, water contact recreation, and non-water contact recreation, navigation, ground water recharge, agricultural supply, municipal and domestic supply, and industrial service supply. The estuary has the designated use of navigation, commericial and sport fishing, and shellfish harvesting. In addition upstream reaches along with the listed tributaries are also designated for industrial service supply. The past, present and probable future beneficial uses of water have been considered in that the Ventura River Watershed is designated for a number of beneficial uses in the Basin Plan.

18. The environmental characteristics of the watershed are spelled out at length in the Basin Plan and in the technical documents supporting this Basin Plan amendment, and have been considered in developing this TMDL. Water quality conditions that reasonably could be achieved through the coordinated control of all factors that affect water quality in the area have been considered. This TMDL provides several compliance options, including improved nitrification-dentrification at the WWTP, structural best management practices (BMPs) such as constructed wetlands, biofiltration, agricultural BMPs and source reduction BMPs, as well as non-structural BMPs and alternatives such as pollution prevention, inspection and proper servicing of onsite waste treatment systems, and outreach and education. These options provide flexibility for responsible parties to reduce nutrient loading to the river, its tributaries, and the estuary. Attainment of the water quality standards through the compliance options is a reasonably achievable water quality condition for the watershed. However, to the extent that there would be any conflict between the consideration of the factor in California Water Code section 13241(c), if the consideration were required, and the Clean Water Act, the Clean Water Act would prevail.

19. Economic considerations were considered throughout the development of the TMDL. Some of these economic considerations arise in the context of Public Resources Code section 21159 and are equally applicable here. The implementation program for this TMDL recognizes the economic limitations on

achieving immediate compliance and allows a flexible implementation schedule of 6 to 12 years to meet the load and waste load allocations, depending on the source. The need for housing within the region has been considered, but this TMDL is unlikely to affect housing needs. Whatever housing impacts could materialize are ameliorated by the flexible nature of this TMDL and the 6- to 12-year implementation schedule.

20. The amendment is consistent with the State Antidegradation Policy (State Board Resolution No. 68-16), and the federal Antidegradation Policy (40 CFR § 131.12), in that it does not allow degradation of water quality, but requires restoration of water quality and attainment of water quality standards.

21. Pursuant to Public Resources Code section 21080.5, the Resources Agency has approved the Regional Boards' basin planning process as a "certified regulatory program" that adequately satisfies the California Environmental Quality Act (CEQA) (Public Resources Code, § 21000 *et seq.*) requirements for preparing environmental documents. (14 Cal. Code Regs. § 15251(g); 23 Cal. Code Regs. § 3782). The Regional Board staff has prepared "substitute environmental documents" for this project that contain the required environmental documentation under the State Board's CEQA regulations. (23 Cal. Code Regs. § 3775-3781.) The project itself is the establishment of a TMDL for algae, eutrophic conditions, and nutrients in the Ventura River Watershed. While the Regional Board has no discretion to not establish a TMDL (the TMDL is required by federal law), the Board does exercise discretion in assigning waste load allocations and load allocations, determining the program of implementation, and setting various milestones in achieving the water quality standards. The CEQA checklist and other portions of the substitute environmental documents contain significant analysis and numerous findings related to impacts and mitigation measures.

22. A CEQA Scoping meeting was conducted on May 30, 2012 at the Ventura City Hall Community Meeting Room to solicit input from the public and interested stakeholders in determining the appropriate scope, content, and implementation options of the proposed TMDL. At the meeting, staff presented the regulatory background, description of the project, location of the project, project purpose, and potential implementation alternatives. Staff received input from members of the regulated community, the Ventura River Watershed Council, the environmental community, and other stakeholders regarding reasonably foreseeable methods of compliance, reasonably foreseeable environmental impacts of the methods of compliance, reasonably foreseeable mitigation measures, reasonably foreseeable alternative means of compliance, and alternatives to the project. This meeting fulfilled the requirements under CEQA. (Public Resources Code § 21083.9; 23 Cal. Code Regs. § 3775.5). A notice of the CEQA Scoping meeting was sent to interested parties on May 16, 2012.

23. In preparing the substitute environmental documents, the Regional Board has considered the requirements of Public Resources Code section 21159 and section 15187 of Title 14 of the California Code of Regulations, and intends those documents to serve as a tier 1 environmental review. This analysis is not intended to be an exhaustive analysis of every conceivable impact, but an analysis of the reasonably foreseeable consequences of the adoption of this regulation, from a programmatic perspective. The "Lead" agencies for tier 2 projects will assure compliance with project-level CEQA analysis of this programmatic project. Project level impacts will need to be considered in any subsequent environmental analysis performed by other public agencies, pursuant to Public Resources Code section 21159.2.

24. The reasonably foreseeable methods of compliance for this TMDL include improved nitrification-denitrification at the WWTP; structural BMPs including constructed wetlands, alum injection systems, and biofiltration systems; agricultural BMPs including filter strips, improved irrigation efficiency, manure management, and grazing management; an anaerobic biodigester; onsite wastewater treatment system upgrades; and watershed-wide implementation, including riparian buffer strips and stream bank stabilization. Foreseeable methods of compliance also include non-structural BMPs, such as onsite wastewater treatment system inspections and servicing, manure management plans, illicit discharge ordinances and preventation plans, and outreach and education.

25. Consistent with the Regional Board's substantive obligations under CEQA, the substitute environmental documents do not engage in speculation or conjecture. The substitute environmental docuemnts only consider the reasonably foreseeable environmental impacts, including those relating to the reasonably foreseeable methods of compliance, reasonably foreseeable feasible mitigation measures to reduce those impacts, and the reasonably foreseeable alternative means of compliance, which would avoid or reduce the identified impacts.

26. The proposed Basin Plan amendment could have a potentially significant adverse effect on the environment. However, there are feasible alternatives, feasible mitigation measures, or both, that if employed, would substantially lessen the potentially significant adverse impacts identified in the substitute environmental documents. Such alternatives or mitigation measures are within the responsibility and jurisdiction of other public agencies, and not the Regional Board. California Water Code section 13360 precludes the Regional Board from specifying the design, location, type of construction, or particular manner in which responsible parties comply with Regional Board orders. When the parties responsible for implementing this TMDL determine how they will proceed, the parties responsible for those parts of the project can and should incorporate such alternatives and mitigation into any subsequent projects or project approvals. These feasible alternatives and mitigation measures are described in more detail

elsewhere in the substitute environmental documents. (14 Cal. Code Regs. § 15091(a)(2).)

27. The substitute environmental documents for this TMDL, and in particular the Environmental Checklist and staff's responses to comments, identify broad mitigation approaches that should be considered at the project level.

28. To the extent significant adverse environmental effects could occur, the Regional Board has balanced the economic, legal, social, technological, and other benefits of the TMDL against the unavoidable environmental risks and finds that specific economic, legal, social, technological, and other benefits of the TMDL outweigh the unavoidable adverse environmental effects, such that those effects are considered acceptable. The basis for this finding is set forth in the substitute environmental documents. (14 Cal. Code Regs. § 15093.)

29. The regulatory action meets the "Necessity" standard of the Administrative Procedures Act. (Gov. Code, section 11353(b).) As specified above, federal law and regulations require that TMDLs be incorporated, or referenced, in the state's water quality management plan. The Regional Board's Basin Plan is the Regional Board's component of the water quality management plan, and the Basin Plan is how the Regional Board takes quasi-legislative planning actions. Moreover, the TMDL is a program of implementation for existing water quality objectives and is, therefore, appropriately a component of the Basin Plan under Water Code section 13242. The necessity of developing a TMDL is established in the TMDL staff report, the section 303(d) list, and the data contained in the administrative record documenting the algae, eutrophic conditions, nitrogen, and low dissolved oxygen impairments in the Ventura River Watershed.

30. The Basin Plan amendment incorporating a TMDL and implementation schedule for algae, eutrophic conditions, and nutrients in the Ventura River Watershed must be submitted for review and approval by the State Board, the State Office of Administrative Law (OAL), and pursuant to CWA section 303(d) and/or 303(c) (as appropriate) by the U.S. EPA. The Basin Plan amendment will become effective upon approval by U.S. EPA. Once effective, a Notice of Decision will be filed with the Resources Agency.

31. If during the State Board's approval process, Regional Board staff, the State Board or State Board staff, or OAL determine that minor, non-substantive modifications to the language of the amendment are needed for clarity or consistency, the Executive Officer should make such changes consistent with the Regional Board's intent in adopting this TMDL, and should inform the Regional Board of any such changes.

32. Considering the record as a whole, this Basin Plan amendment is expected to result in an effect, either individually or cumulatively, on wildlife resources.

THEREFORE, be it resolved that pursuant to sections 13240 and 13242 of the California Water Code, the Regional Board hereby amends the Basin Plan as follows:

1. The Regional Board hereby approves and adopts the CEQA substitute environmental documentation, which was prepared in accordance with Public Resources Code section 21159 and section 15187 of Title 14 of the California Code of Regulations, and directs the Executive Officer to sign the environmental checklist.

2. Pursuant to sections 13240 and 13242 of the California Water Code, the Regional Board, after considering the entire record including oral testimony at the hearing, hereby adopts the amendments to Chapter 7 of the Water Quality Control Plan for the Los Angeles Region, as set forth in Attachment A hereto, to incorporate the elements and implementation schedule of the Algae, Eutrophic Conditions, and Nutrients Total Maximum Daily Loads for Ventura River, including the Estuary, and its Tributaries.

3. The Executive Officer is directed to forward copies of the Basin Plan amendment to the State Board in accordance with the requirements of section 13245 of the California Water Code.

4. The Regional Board requests that the State Board approve the Basin Plan amendment in accordance with the requirements of sections 13245 and 13246 of the California Water Code and forward it to the OAL for review and approval and finally, for review and approval pursuant to CWA sections 303(d) and/or 303(c), as appropriate, to the U.S. EPA.

5. If during the State Board's approval process, Regional Board staff, the State Board or State Board staff, or OAL determine that minor, non-substantive modifications to the language of the amendment are needed for clarity or consistency, the Executive Officer is authorized to make such changes, and shall inform the Regional Board of any such changes.

6. The Executive Officer is authorized to request a "No Effect Determination" from the Department of Fish and Game, and/or transmit payment of the applicable fee as may be required to the Department of Fish and Game.

I, Samuel Unger, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of a resolution adopted by the California Regional Water Quality Control Board, Los Angeles Region, on Decmber 6, 2012.

Samuel Unger

Samuel Unger, P.E.
Executive Officer

12-18-12
Date

Amendment to the Water Quality Control Plan – Los Angeles Region

to Incorporate the

Total Maximum Daily Load for Algae, Eutrophic Conditions, and Nutrients In the Ventura River and its Tributaries

Adopted by the California Regional Water Quality Control Board, Los Angeles Region on **December 6, 2012.**

Amendments:

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Add:

Chapter 7. Total Maximum Daily Loads (TMDLs)

7-35 Ventura River and Tributaries Algae, Eutrophic Conditions, and Nutrients TMDL

List of Figures, Tables, and Inserts
Add:

Chapter 7. Total Maximum Daily Loads (TMDLs)
Tables

7-35 Ventura River and Tributaries Algae, Eutrophic Conditions, and Nutrients TMDL
7-35.1. Ventura River and Tributaries Algae, Eutrophic Conditions, and Nutrients TMDL - Elements
7-35.2. Ventura River and Tributaries Algae, Eutrophic Conditions, and Nutrients TMDL - Implementation Schedule

Chapter 7. Total Maximum Daily Loads (TMDLs) Summaries
Add:
7-35 Ventura River and Tributaries Algae, Eutrophic Conditions, and Nutrients TMDL

This TMDL was adopted by:

The Regional Water Quality Control Board on December 6, 2012**.**

This TMDL was approved by:

The State Water Resources Control Board on February 19, 2013
The Office of Administrative Law on June 4, 2013
The U.S. Environmental Protection Agency on June 28, 2013

This TMDL is effective on June 28, 2013

The elements of the TMDL are presented in Table 7-35.1 and the Implementation Plan in Table 7-35.2.

Table 7-35.1. Ventura River and Tributaries Algae, Eutrophic Conditions, and Nutrients TMDL: Elements

TMDL Element	Regulatory Provisions
Problem Statement	The Ventura River Estuary and Reaches 1 and 2 are on the Clean Water Act (CWA) section 303(d) list as impaired for algae and eutrophic conditions. San Antonio Creek and Cañada Larga are on the CWA section 303(d) list as impaired for nitrogen and dissolved oxygen, respectively. Recent data confirm these impairments and demonstrate additional impairments for low dissolved oxygen in the Estuary, San Antonio Creek, and Reaches 1-4. The algae and nutrient-related impairments are caused by excessive loading of nutrients, particularly nitrogen and phosphorus, to Ventura River and its tributaries. The water quality impairments due to eutrophication and increased nutrient loading occur during the dry season when algae growth primarily occurs. For purposes related to this TMDL, the dry season is defined as occurring from May 1 to September 30. The water quality objectives used to assess impairment for this TMDL are the narrative water quality objective for biostimulatory substances and the numeric water quality objectives for dissolved oxygen (DO) and pH contained in Chapter 3. Nutrient loading and the resulting ecological responses in the Ventura River, including the Estuary, and its tributaries result in impairments of beneficial uses associated with recreation activities (water contact and non-contact) and aquatic life (warm and cold freshwater habitat; estuarine and wetland habitat; rare, threatened or endangered species; migration of aquatic organisms; spawning, reproduction, and/or early development). The most sensitive beneficial use is the cold water aquatic habitat use and the associated migratory and spawning and early development uses. The Ventura River and its tributaries are home to the Southern California Steelhead, which is an endangered species.

<table>
<tr><th>TMDL Element</th><th>Regulatory Provisions</th></tr>
<tr><td>Numeric Targets</td><td>The DO and pH numeric targets are set equal to their numeric water quality objectives in Chapter 3 of the Basin Plan. The numeric targets for algal and phytoplankton biomass and percent cover are established as a numeric interpretation of the water quality condition that will demonstrate attainment of the narrative water quality objective for biostimulatory substances contained in Chapter 3.

Numeric targets to interpret narrative water quality objectives are based on the California Nutrient Numeric Endpoints (NNE) approach, developed by USEPA Region 9 and the State and Regional Water Quality Control Boards.
<table>
<tr><th>Indicator</th><th>Numeric Target</th><th>Water body</th></tr>
<tr><td>Total Algal Biomass</td><td>150 mg/m^2 chlorophyll a as seasonal average</td><td>Ventura River and Tributaries</td></tr>
<tr><td>Macroalgal Cover (attached & unattached)</td><td>$\leq$ 30 percent as seasonal average</td><td>Ventura River and Tributaries</td></tr>
<tr><td>Phytoplankton Biomass</td><td>20 µg/L chlorophyll a as seasonal average</td><td>Estuary (shallow subtidal area)</td></tr>
<tr><td>Macroalgal Cover</td><td>$\leq$ 15 percent as seasonal average</td><td>Estuary (intertidal and shallow subtidal areas)</td></tr>
<tr><td>Dissolved Oxygen</td><td>$\geq$ 7 mg/L as a daily minimum</td><td>Ventura River, Tributaries and Estuary</td></tr>
<tr><td>pH</td><td>6.5 – 8.5 (instantaneous value)</td><td>Ventura River, Tributaries, and Estuary</td></tr>
<tr><td colspan="3">Biomass and percent cover indicator targets apply during the dry season when algae growth primarily occurs. The seasonal averaging period for algal biomass and percent cover is the dry season of May 1 to September 30. River indicators are averaged over a sampling reach as required by the SWAMP monitoring protocol Bioassessment SOP 02. Estuary macroalgal cover is measured using 3 transects and evaluating percent cover at 10 random points along each transect. Results are reported as a transect average. See methods used in the Bight ’08 Estuarine Eutrophication Assessment (McLaughlin K et al. Southern California Bight 2008 Regional Monitoring Program: Estuarine Eutrophication Assessment. Southern California Coastal Water Research Project. Costa Mesa, CA).</td></tr>
</table>
</td></tr>
<tr><td>Source Analysis</td><td>The source analysis is an estimate of the amount of TN and TP entering the river from point and nonpoint sources based on available information such as discharge nutrient concentration data, land use data, rainfall-runoff models, studies, and literature reviews.

<u>Point sources:</u>

Stormwater runoff discharged via the municipal separate storm sewer system (MS4) contributes a large percentage of the nutrients to the Ventura River and its tributaries (21.3% in dry weather and 28.3% in wet weather). The Ojai Valley waste water treatment plant (WWTP) contributes a large portion of nutrient loading in dry weather (37.6%) but a smaller portion in wet weather (1.7%).

<u>Nonpoint sources:</u>

Horses/livestock and agricultural land uses contribute significant loading in both dry weather (33.5%) and wet weather (36.1%). Open space loading is a</td></tr>
</table>

TMDL Element	Regulatory Provisions
	significant source of nutrients in wet weather (19.1%) and a smaller source of nutrients in dry weather (7.6%). Septic systems are estimated to contribute 4.7% of the annual nutrient load. Groundwater discharge and direct atmospheric deposition to the water surface are responsible for a small portion of the annual load (1.3% and 0.2%, respectively).
Linkage Analysis	The critical condition is the dry season and the linkage analysis for both the Ventura River and Estuary is for dry-weather conditions. Basing the linkage analysis on *dry-weather* conditions is a conservative approach to assessing conditions in the *dry season*. Nutrients are loaded from the watershed to the Ventura River and Estuary in both dry and wet weather, but the nutrients loaded in the dry season are predominately responsible for the algae, eutrophic conditions, and nutrient impairments in the Ventura River and Estuary. <u>Linkage analysis for the river</u> The linkage analysis for the river is based on the River and Stream Water Quality Model (QUAL2K). QUAL2K predicts the nutrient concentrations and algal biomass in the various reaches of the Ventura River based on an estimate of watershed-based loading. The results of the model are used to determine allowable in-stream nutrient concentrations to meet algal biomass targets and to evaluate various source reduction scenarios to set dry-weather load and waste load allocations. <u>Linkage analysis for the Estuary</u> The linkage analysis for the Estuary is based on two lines of evidence that establish the relationship between nutrient loading to the Estuary and the resulting nutrient concentrations and algal biomass in the Estuary. The first approach uses the NNE BATHTUB spreadsheet modeling tool to establish the linkage between nutrient loading to the Estuary and the predicted water quality response, assuming that the open water portion of the Estuary, formed by the closing of the berm in the late summer and early fall, acts like a freshwater reservoir. The second approach uses empirical relationships between nutrient loading and algal biomass (peak macroalgae biomass and annual average chlorophyll a) in estuaries developed as part of a 2008 Southern California Bight Regional Monitoring Program study. Both approaches predict that the current nutrient loading to the Estuary will attain the phytoplankton numeric target. Moreover, the watershed loading reductions required to protect the river will reduce nutrient concentrations delivered to the Estuary and ensure attainment of numeric targets and protection of beneficial uses.

<table>
<tr><th>TMDL Element</th><th>Regulatory Provisions</th></tr>
<tr><td>Allocations</td><td>
Waste load allocations (WLAs) and load allocations (LAs) addressing point and nonpoint sources of nutrients are assigned to discharges to the Ventura River watershed. Because the critical condition for this TMDL is dry weather, and it is the dry-weather loading that results in water quality impairments, the allocations are primarily focused on dry-weather nutrient loading reductions. However, wet-weather WLAs and LAs are assigned as well.

<u>Dry-weather Allocations</u>

The dry-weather WLAs for Ojai Valley WWTP are expressed as seasonal loads. The TN WLA is expressed as a summer dry-weather load based on an estimated 153 summer dry-weather days and a winter dry-weather load based on an estimated 178 winter dry-weather days. The TP WLA is expressed as a dry-weather load based on an estimated 331 dry-weather days. Dry-weather WLAs for the Ojai Valley WWTP are as follows:

<table>
<tr><th>Summer Dry-Weather TN WLA (lb/season)</th><th>Winter Dry-Weather TN WLA (lb/season)</th><th>Dry-Weather TP WLA (lb/season)</th></tr>
<tr><td>8,044</td><td>12,477</td><td>5,799</td></tr>
</table>

At the TMDL reconsideration, the Ojai Valley WWTP allocation may be revised (i.e. increased) if the Ojai WWTP has accepted additional flows from other watershed sources such as septic systems in order to achieve the TMDL. The Ojai WWTP will document and report annually the number, flow and TN load from watershed sources for the Regional Board to consider as part of the TMDL reconsideration.

Dry-weather WLAs for Ventura County MS4 and Caltrans are expressed as daily loads based on an estimated 331 dry-weather days per year. Dry-weather WLAs for Ventura County MS4 and Caltrans are as follows:

<table>
<tr><th>Source Type</th><th>Dry-Weather WLA (lb/day)</th><th>Dry-Weather TP WLA (lb/day)</th></tr>
<tr><td>Dry-weather WLAs for Ventura MS4</td><td>28</td><td>0.5</td></tr>
<tr><td>Dry-weather WLAs for Caltrans</td><td>1.1</td><td>0.11</td></tr>
</table>

The dry-weather WLAs for the general industrial and construction stormwater permittees are equal to the in-stream nutrient concentrations required to meet algal biomass numeric targets. Dry-weather WLAs for general industrial and construction stormwater permittees are as follows:

<table>
<tr><th>Permittee</th><th>TN (mg/L)</th><th>TP (mg/L)</th></tr>
<tr><td>General Industrial Stormwater Permittees</td><td>1.15</td><td>0.115</td></tr>
<tr><td>General Construction Stormwater Permittees</td><td>1.15</td><td>0.115</td></tr>
<tr><td colspan="3">Applied as an annual dry-weather average.</td></tr>
</table>
</td></tr>
</table>

TMDL Element	Regulatory Provisions
	Dry-weather LAs for Agriculture are expressed as daily loads based on an estimated 331 dry-weather days per year as follows:

Source Type	Dry-Weather TN LA (lb/day)	Dry-Weather TP LA (lb/day)
Agriculture	16	0.12

Dry-weather LAs for Horse facilities and intensive livestock operations are expressed as daily loads based on an estimated 331 dry-weather days per year as follows:

Source Type	Dry-Weather TN LA (lb/day)	Dry-Weather TP LA (lb/day)
Horse facilities/Intensive Livestock	0.6	0.14

The dry-weather LA for grazing activities is equal to a 10% percent reduction of the existing TN and TP load. The existing load will be quantified as part of management plans required to implement the TMDL.

Dry- and Wet-weather LAs for OWTS

LAs for OWTS are equal to 7,478 pounds TN per year based on a required 50% reduction in loading. The LAs apply in dry and wet weather. No LAs are assigned to OWTS for TP.

Dry- and Wet-weather WLAs for Other NPDES permittees

Dry-weather WLAs for other NPDES permittees are equal to the in-stream nutrient concentrations required to meet algal biomass numeric targets of 1.15 mg/L TN and 0.115 mg/L TP. Wet-weather allocations are set to attain site-specific nitrogen water quality objectives from Table 3-8. There are no site-specific objectives for Reach 1 or the Estuary, nor are there any "Other NPDES permittees" that discharge to Reach 1 or the Estuary. Thus, there are no wet-weather WLAs assigned to Other NPDES permittees for Reach 1 or the Estuary.

Wet-weather Allocations

Wet-weather allocations for stormwater, agriculture, and horse/livestock sources are set to attain site-specific water quality objectives from Table 3-8 of the Basin Plan, provided in the table below. There are no site-specific objectives for Reach 1 or the Estuary. For Reach 1 and the Estuary, Wet-weather WLAs for stormwater sources are equal to existing water quality in stormwater discharges (maximum TN = 7.4 mg/L) and LAs for agriculture and horse/livestock sources are equal to water quality benchmarks of 10 mg/L nitrate-N + nitrite-N in the Agriculture Waiver.

<table>
<tr><th>TMDL Element</th><th>Regulatory Provisions</th></tr>
<tr><td></td><td>
Wet-weather allocations for stormwater, agriculture, and horse/livestock sources are as follows:
<table>
<tr><th>Reach</th><th>Nitrate-N + Nitrite-N (mg/L)</th></tr>
<tr><td>Estuary</td><td>*</td></tr>
<tr><td>Reach 1</td><td>*</td></tr>
<tr><td>Reach 2</td><td>10</td></tr>
<tr><td>Cañada Larga</td><td>10</td></tr>
<tr><td>Reach 3</td><td>5</td></tr>
<tr><td>San Antonio Creek</td><td>5</td></tr>
<tr><td>Reach 4</td><td>5</td></tr>
<tr><td>Reach 5</td><td>5</td></tr>
</table>
*WLAs for stormwater are equal to 7.4 mg/ L TN and LAs for agriculture and horse/livestock sources are equal to 10 mg/L nitrate-N + nitrite-N.

Wet-weather WLAs for the Ojai Valley WWTP are based on existing performance of the facility. Existing performance was calculated as the 90th percentile of the last 12 years of effluent data.

Wet-weather WLAs for Ojai Valley WWTP
<table>
<tr><th>TN (mg/L)</th><th>TP (mg/L)</th></tr>
<tr><td>7.6</td><td>2.6</td></tr>
</table>
</td></tr>
<tr><td>Margin of Safety</td><td>The sources of uncertainty in this TMDL are related to the selection of the algal biomass target, the relationship between nutrient concentrations and algal biomass in freshwater river systems and estuaries, the estimate of watershed-based nutrient loading, and the model-predicted water quality conditions in the receiving water. These areas of uncertainty are addressed with both an implicit margin of safety that includes conservative assumptions made when estimating watershed-based nutrient loading and the assignment of dry-weather allocations to address a dry-season impairment, and an explicit margin of safety calculated as the difference between the model-predicted maximum concentration in-stream after implementation of reduction scenarios and the desired in-stream concentrations. The explicit margin of safety was calculated as seven percent.</td></tr>
<tr><td>Seasonal Variations and Critical Conditions</td><td>This TMDL addresses impairments that are causing exceedances of the biostimulatory substances water quality objective during the dry season, when algae growth primarily occurs, in the Ventura River, the Estuary and its tributaries. The critical condition is the dry season. Nutrients are loaded from the watershed to the Ventura River and its tributaries, and the Estuary in both dry and wet weather, but the nutrients loaded in the dry season are predominately responsible for the algae, eutrophic conditions, and nutrient impairments. Nutrient</td></tr>
</table>

TMDL Element	Regulatory Provisions
	concentrations present in the river during the winter months are sufficient to support algal growth; however, cofactors in the winter, such as greater flow and lower temperatures, mitigate algal growth in the winter. Also, the typical seasonal succession of primary producers generally shifts in the winter to be dominated by aquatic plants. The watershed nutrient wet-weather loads are generally delivered directly to the ocean and thus do not contribute to exceedance of the biostimulatory substances objective in the river or Estuary, which occurs during the dry season when algae growth primarily occurs. Nonetheless, to protect water quality year-round, wet-weather WLAs and LAs are assigned to meet water quality objectives and/or maintain existing discharge quality.
Monitoring	The TMDL monitoring program consists of three components: 1) receiving water monitoring, 2) discharge monitoring, and 3) optional special studies. All monitoring requirements may be included in subsequent permits or other orders and are subject to Executive Officer approval. <u>Receiving Water Monitoring</u> Responsible parties (Ojai Valley Sanitary District, Ventura County Watershed Protection District, Ventura County, City of Ojai, City of Ventura, Caltrans, and agricultural dischargers) are responsible for developing and implementing a comprehensive monitoring plan to assess numeric target attainment and measure in-stream nutrient concentrations. Responsible parties are encouraged to work together to submit a joint watershed wide plan. Ten years from the effective date of the TMDL, horse intensive livestock, and grazing activities shall participate in the implementation of the watershed-wide monitoring plan or submit their own plan. The monitoring plan should outline a program to sample for algal biomass, algal percent cover, nutrients (total and dissolved), *in situ* water quality parameters (dissolved oxygen, pH, temperature, electrical conductivity), and flow for the river and estuary. Monitoring should include visual observations documenting whether the Estuary is open or closed. The monitoring procedures/methods, analysis, and quality assurance shall be SWAMP comparable, where appropriate. The sampling frequency and locations must be adequate to assess beneficial use condition and attainment of applicable water quality objectives. At a minimum, for algal biomass and percent cover, the monitoring frequency shall be once per month in the dry season (May 1st to September 30th). After two years, if a significant difference between monthly algal biomass measurements is not observed, algal biomass monitoring may be reduced to three times per dry season, during the months of May, July, and September. DO and pH shall be measured continuously for two week periods on a quarterly basis. Continuous monitoring of DO and pH shall occur during the months of May and September in the 2nd and 3rd quarters. . All other parameters shall be monitored monthly. River indicators shall be averaged over a sampling reach as described in the SWAMP monitoring protocol - Bioassessment SOP 02. Estuary macroalgal cover is measured using three transects and evaluating percent cover at 10 random points along each transect. Results are reported as a transect average. See methods used in the Bight '08 Estuarine Eutrophication Assessment

TMDL Element	Regulatory Provisions
	(McLaughlin K et al. Southern California Bight 2008 Regional Monitoring Program: Estuarine Eutrophication Assessment. Southern California Coastal Water Research Project. Costa Mesa, CA). Existing receiving water monitoring conducted under other programs can be leveraged to assist in meeting these monitoring requirements. Responsible parties may build upon existing monitoring programs in the Ventura River watershed when developing the receiving water quality monitoring plan for this TMDL. Receiving water monitoring requirements shall be incorporated into the permit, waste discharge requirements (WDRs), or waiver for each responsible party upon issuance, renewal, or modification. The responsible parties may continue to coordinate a watershed-wide monitoring program to meet this requirement in order to fulfill individual permit, WDR, or waiver requirements. Receiving water monitoring shall continue beyond the final implementation date of the TMDL unless the Executive Officer approves a reduction or elimination of such monitoring. <u>Discharge Monitoring</u> Discharge monitoring will assess attainment of the WLAs and LAs. Discharge monitoring shall be required by regulatory mechanisms used to implement the WLAs and LAs. The monitoring to determine compliance with WLAs and LAs shall be conducted as specified in the Implementation Plan in the following section. The monitoring procedures/methods, analysis, and quality assurance shall be Surface Water Ambient Monitoring Program (SWAMP) comparable, where appropriate, and are subject to Executive Officer Approval. <u>Special Studies</u> Responsible parties within the watershed may conduct optional special studies designed to refine WLAs, LAs, and/or numeric targets. The results of special studies and monitoring may be used to revise numeric targets and allocations, if supported, when the TMDL is reconsidered. The following are potential special studies. ▪ Build upon the algal biomass and total nitrogen relationship established in the 2008 UCSB Study (UCSB, 2009) and collect data to support the establishment of reach-specific relationships. ▪ Confirm the conclusion that an algal biomass target of 150 mg/m^2 is fully protective of aquatic life and minimizes the risk of low DO events. ▪ Collect additional source assessment information and model input data to refine model-predicted relationships between watershed loading and in-stream nutrient concentrations. ▪ Investigate the influence of OWTS on surface water quality. ▪ Collect data to support development of an estuary model, which takes into account tidal influence, the dynamics of macroalgae and phytoplankton growth, residence time, and breaching conditions.

<table>
<tr><th>TMDL Element</th><th>Regulatory Provisions</th></tr>
<tr><td>Implementation Plan</td><td>
<u>WLA Implementation</u>

The regulatory mechanisms used to implement the WLAs include the Ojai Valley WWTP NPDES permit, the Ventura County MS4 permit, the Caltrans MS4 permit, the general industrial storm water permits, the general construction storm water permits, and other NPDES permits. Effluent limits consistent with the assumptions and requirements of the WLAs shall be incorporated into each permit, following the effective date of this TMDL, at the time of permit issuance, modification, or renewal.

<u>Ojai Valley WWTP</u>

The dry-weather TN WLAs for the Ojai WWTP shall be incorporated into the permit as seasonal numeric effluent limitations. The summer effluent limitation shall be equal to the summer dry-weather WLA of 8,044 lbs/season (May 1 to September 30). Compliance with the summer effluent limitation shall be determined by calculating the sum of the products of the average monthly TN concentration, a conversion factor, and the daily flow for each dry-weather day, over the summer season. The winter dry-weather WLA and wet-weather WLA shall be combined into a single concentration-based winter season effluent limitation, calculated as the weighted average of 4 mg/L (the allowable winter dry-weather concentration) and 7.6 (the allowable wet-weather concentration), based on the assumption that there are 178 winter dry-weather days and 34 wet-weather days in a year. The resulting concentration of 4.6 mg/L shall be expressed as a monthly effluent limitation from October 1 to April 30. This calculation is consistent with the assumptions and requirements of the winter dry-weather and wet-weather WLAs.

For TP, compliance with the dry-weather WLA-based effluent limitation shall be determined by calculating the sum of the products of the monthly average TP concentration and the daily flow for each dry-weather day, over an annual period. Wet-weather days shall be excluded from the dry-weather WLA compliance determination. The wet-weather TP WLAs shall be incorporated as effluent limitations, expressed as a daily maximum concentration, to be assessed at a minimum with monthly sampling during months when rain occurs.

Ojai WWTP shall achieve compliance with wet-weather TP WLAs upon incorporation into the permit and shall achieve compliance with dry-weather TP WLAs, winter season TN limits, and summer season TN limits within 10 years of the effective date of the TMDL. Ojai Valley WWTP shall have interim WLAs based on current plant performance.

Ojai Valley WWTP interim dry-weather WLAs (monthly average)
<table>
<tr><th>TN (mg/L)</th><th>TP (mg/L)</th></tr>
<tr><td>7.6</td><td>2.6</td></tr>
</table>
</td></tr>
</table>

TMDL Element	Regulatory Provisions
	Ventura County MS4 and Caltrans The WLAs for the Ventura County MS4 permittees and Caltrans shall be incorporated into the permits as numeric water quality-based effluent limitations. Permittees may be deemed in compliance with water-quality based effluent limitations if they demonstrate that (1) there are no violations of the water quality-based effluent limitation at the Permittee's applicable MS4 outfall(s); or (2) there is no direct or indirect discharge from the Permittee's MS4 to the receiving water during the time period subject to the water quality-based effluent limitation. Wet-weather numeric effluent limitations shall be expressed as event mean concentrations and shall apply immediately upon issuance, modification, or renewal of the permits. Compliance with wet-weather WLAs shall be assessed at a minimum with two wet-weather sampling events per year. If permittees provide a quantitative demonstration that watershed control measures and BMPs will achieve wet-weather water quality-based effluent limitations, then compliance with wet-weather water quality-based effluent limitations can be determined by implementing those actions, subject to Executive Officer approval. Dry-weather numeric effluent limitations shall be assessed at a minimum with quarterly sampling and shall be attained within 6 years of the effective date of the TMDL. Compliance will only be assessed on the day of sampling. Dry-weather sampling may occur 72 hours after a storm event. Consistent with the assumptions of the dry-weather waste load allocations, compliance with water quality-based effluent limitations may be demonstrated with area-weighted effluent limitations. Area-weighted effluent limitations shall be 0.0025 lb/day/acre TN and 4.7×10^{-5} lb/acre/day TP for the Ventura County MS4, and 0.0042 lb/acre/day TN and 4.2×10^{-4} lb/acre/day TP for Caltrans, derived by dividing the daily loads by the total land use area in the watershed covered by their respective permits (11,085 acres for the Ventura County MS4 and 251 acres for Caltrans, excluding the Coyote Creek subwatershed). Ventura County MS4 permittees and Caltrans shall provide an implementation plan to the Regional Board outlining how they intend to achieve compliance with the WLAs. The report shall include implementation methods and a quantitative analysis of the expected water quality outcomes of the implementation methods, an implementation schedule, proposed interim milestones, and compliance points. The report shall provide reasonable assurance that implementation methods will be sufficient to achieve the WLAs. General Industrial and Construction Stormwater Permittees The dry- and wet-weather WLAs for the general and industrial stormwater permittees shall apply immediately upon permit issuance, modification, or renewal and shall be incorporated into permits as numeric water quality-based effluent limitations. Wet-weather effluent limitations shall be expressed as event mean concentrations and dry-weather effluent limitations shall be expressed as instantaneous maximums. Compliance with wet-weather WLAs shall be assessed

TMDL Element	Regulatory Provisions
	at a minimum with one wet-weather sampling event. Compliance with dry-weather WLAs shall be assessed at a minimum by averaging the results of two grab samples. Other NPDES Permittees The dry- and wet-weather WLAs for other NPDES permittees shall apply immediately upon permit issuance, modification, or renewal of applicable permits and shall be incorporated into permits as numeric effluent limitations. Wet-weather effluent limitations shall be expressed as event mean concentrations and dry-weather effluent limitations shall be expressed as instantaneous maximums. Compliance with wet-weather WLAs shall be assessed at a minimum with one wet-weather sampling event. Compliance with dry-weather WLAs shall be assessed at a minimum with two grab samples. LA Implementation The regulatory mechanisms that will be used to implement the LAs include Basin Plan discharge prohibitions, WDRs, and waivers of WDRs. Agricultural Discharges The LAs for irrigated agricultural lands shall be implemented through the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands or other appropriate Regional Board order. Agricultural lands shall achieve compliance with dry- and wet-weather LAs within 6 years of the effective date of the TMDL. To implement the LAs in this TMDL, the monitoring program shall be revised to add representative sites in the lower watershed to monitor runoff from other crop types. In addition, VCAILG shall work with the Regional Board staff to relocate monitoring sites in the upper watershed to better assess potential dry-weather runoff from agriculture. The existing monitoring program for the Agriculture Waiver requires two dry-weather and two wet-weather sampling events. In order to implement the dry-weather LAs, dry-weather sampling may occur 72 hours after a storm event. The revised monitoring program shall be subject to approval by the Executive Officer. To assist in implementation of LAs, area-weighted benchmarks can be applied; if used, they shall be 0.008 lb/day/acre TN and 6.3×10^{-5} lb/acre/day TP, derived by dividing the daily loads by the total agriculture area in the watershed (1971 acres, excluding orchards and the Coyote Creek subwatershed). Order No. 2010-0186 states, “It is expected that source control management practices, such as improved irrigation efficiency and fertilizer management, employed by Dischargers to attain surface Water Quality Benchmarks will reduce loading to groundwater as well.” To implement this TMDL, the VCAILG water quality management plan shall specify that all growers in the Ventura River watershed shall implement nutrient-related source control BMPs. If the LAs are

TMDL Element	Regulatory Provisions
	implemented in another Regional Board order in the future, then that order shall require growers in the Ventura River watershed to implement nutrient-related source control BMPs. The estimated costs for BMPs to control agricultural discharges such as filter strips, mulching, improved irrigation efficiency, nutrient management, manure management, and grazing management are approximately $1031 per acre, $808 per acre, $1784 per acre, $55 per acre-year, $4,500 (average cost of manure bunker), and $1,356 (average cost of a typical watering facility), respectively. Potential sources of financing for these implementation alternatives, such as Clean Water Act section 319(h) grant funding, are discussed in Chapter 4. As discussed in Chapter 4, the U.S. Department of Agriculture Soil Conservation Service and the Resource Conservation Districts provide information on, and assistance in, implementing BMPs. <u>OWTS</u> The LAs for OWTS shall be implemented through discharge prohibitions, WDRs, or waivers of WDRs. Commercial and multifamily OWTS are currently regulated by the Regional Board through WDRs. Single family residential OWTS are currently regulated by the City of Ojai, the City of Ventura, and the County of Ventura, as specified in memorandums of understanding (MOUs) with the Regional Board, in order to implement a waiver of WDRs for single family residential OWTS adopted by the Regional Board in 2004. The MOUs require the Regional Board to evaluate the local agency every five years to ensure their municipal plumbing code and OWTS program is substantially equivalent to any statewide standards adopted pursuant to California Water Code sections 13290 and 13291. The State Water Resources Control Board (State Board) Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems (OWTS Policy) was adopted by the State Board to comply with California Water Code sections 13290 and 13291 on June 19, 2012. The OWTS Policy must be approved by the Office of Administrative Law before it becomes final and in effect. The OWTS in the Ventura River watershed fall under Tier 3 of the OWTS policy and this TMDL establishes the Advanced Protection Management Program for the watershed. The geographic area for the Advanced Protection Management Programs to implement this TMDL shall initially be the entire Ventura River watershed. The Regional Board will work with local agencies to determine which existing OWTS or areas of OWTS are contributing to the overall loading from OWTS to the Ventura River and its tributaries. Areas found not to be contributing to the overall loading may be removed from the Advanced Protection Management Program as approved in a Local Agency Management Program. Existing OWTS are required to be upgraded or modified to enhance their nitrogen removal or meet other requirements of the Advanced Protection Management Program if it is determined they are contributing to the impairment, and are subsequently covered under approved special provisions of a Local Agency

TMDL Element	Regulatory Provisions
	Management Program, or the Regional Board issues subsequent orders requiring upgrades or modifications. Existing OWTS will remain regulated by existing MOUs and future Local Agency Management Programs until the above determination is made and subsequent upgrades are required. New or replacement OWTS installations, as defined by the OWTS Policy upon its becoming effective, that are within the Advanced Protection Management Program area, shall meet the supplemental treatment requirements for nitrogen per Tier 3 of the OWTS Policy. The Regional Board will evaluate the existing MOUs and any future submittal of a Local Agency Management Program under the OWTS Policy with the City of Ventura, the City of Ojai, and the County of Ventura to determine if their OWTS programs need to be updated to reflect the OWTS Policy, or if additional changes are needed to implement the LAs. OWTS dischargers shall achieve compliance with dry- and wet-weather LAs within 10 years of the effective date of the TMDL. <u>Horse and Intensive Livestock Activities</u> The LAs for horse and intensive livestock activities shall be regulated by WDRs, waivers of WDRs, or other regulatory mechanisms in accordance with the Nonpoint Source Implementation and Enforcement Policy (NPS Policy). The Regional Board will determine which horse and intensive livestock activities shall be subject to the WDRs, waivers of WDRs or other regulatory mechanisms during their development based on factors that may include, but are not limited to, type of operation, density of animals, and risk to water quality. Horse and intensive livestock activities shall be required to develop management plans for Executive Officer approval and implement management measures identified in management plans to attain LAs. Compliance with LAs will be demonstrated with monitoring approved by the Executive Officer of the Regional Board through the monitoring program developed as part of the waiver, WDR, or other regulatory mechanism. Monitoring may consist of documentation of BMP implementation, and may include water quality monitoring as needed. Horse and intensive livestock activities shall achieve compliance with dry- and wet-weather LAs within 10 years of the effective date of the TMDL. <u>Grazing Activities</u> The LAs for grazing activities shall be regulated by WDRs, waivers of WDRs, or other regulatory mechanisms in accordance with the NPS Policy. Because the dry-weather load from grazing activities has not been quantified as of the effective date of this TMDL, and dry-weather LAs are based on a 10% reduction of existing dry-weather load, grazing activities shall be required to either conduct monitoring or utilize other acceptable data or studies as approved by the Executive Officer to determine baseline dry-weather pollutant load caused by grazing activities, unless the Regional Board has already quantified the existing dry-weather pollutant load. In addition, grazing activities may conduct baseline

TMDL Element	Regulatory Provisions
	monitoring to confirm wet-weather pollutant loading. Baseline monitoring shall be required by WDRs, waivers of WDRs, or other regulatory mechanism, if necessary. Baseline monitoring may consist of water quality monitoring of sites impacted by grazing and compared to water quality monitoring from unimpacted natural background sites. If it is determined that there are no water quality impacts due to dry- and/or wet-weather pollutant loading from grazing in the Ventura River watershed, then the TMDL may be revised to adjust the source assessment and allocation scenario when the TMDL is reconsidered. If it is determined that there are water quality impacts due to dry- and/or wet-weather pollutant loading from grazing in the Ventura River watershed, then grazing activities shall develop management plans for approval by the Executive Officer and implement management measures identified in management plans to attain LAs. Compliance with LAs will be demonstrated with monitoring approved by the Executive Officer of the Regional Board through the monitoring program developed as part of the waiver, WDR, or other regulatory mechanism. Monitoring may consist of documentation of no discharge due to BMP implementation, and may include water quality monitoring during conditions under which discharge may occur, including wet weather. Grazing activities shall achieve compliance with dry- and wet-weather LAs within 10 years of the effective date of the TMDL.

Table 7-35.2. Ventura River, Ventura River Estuary, and Tributaries Algae, Eutrophic Conditions and Nutrients TMDL: Implementation Schedule

Task	Due Date
Submit results of optional special studies	4 years after effective date of TMDL
Reconsider TMDL to revise numeric targets and allocations if supported by special studies or other changes in the watershed.	5 years after effective date of TMDL
Ojai Valley Sanitary District	
Wet-weather and interim dry-weather WLAs apply	Effective date of TMDL
Submit receiving water monitoring plan to assess numeric target attainment and measure in-stream nutrient concentrations	1 year after effective date of TMDL
Initiate receiving water monitoring plan	90 days after approval of monitoring plan
Discharge monitoring plan incorporated into permit	Upon permit adoption, renewal, or modification
Dry-weather WLA apply	No later than 12 years after effective date of TMDL*
Ventura County MS4 Permittees and Caltrans	
Wet-weather WLAs apply	Effective date of TMDL
Discharge monitoring plan incorporated into permit	Upon permit adoption, renewal, or modification
Submit monitoring plan to assess numeric target attainment and measure in-stream nutrient concentrations.	1 year after effective date of TMDL
Initiate receiving water monitoring plan	90 days after approval of monitoring plan
Submit implementation plan to achieve compliance with the WLAs. The plan shall include implementation methods, an implementation schedule, proposed interim milestones, and compliance points.	2 years after effective date of TMDL
Dry-weather WLAs apply	6 years after effective date of TMDL
General Industrial and Construction Stormwater Permittees	
Wet-weather and dry-weather WLAs apply	Effective date of TMDL
Discharge monitoring plan incorporated into permit	Upon permit adoption, renewal, or modification
Other NPDES Permittees	
Wet-weather and dry-weather WLAs apply	Effective date of TMDL
Discharge monitoring plan incorporated into permit	Upon permit adoption, renewal, or modification

Task	Due Date
Agricultural Discharges	
Discharge monitoring plan incorporated into Agriculture Waiver or other order or waiver	Upon adoption, renewal, or modification
Submit monitoring plan to assess numeric target attainment and measure in-stream nutrient concentrations.	1 year after effective date of TMDL
Initiate receiving water monitoring plan	90 days after approval of monitoring plan
Wet-weather and dry-weather LAs apply	6 years after effective date of TMDL
Onsite Waste Water Treatment Systems	
Regional Board staff and Ventura County will work to determine areas of OWTS to be included in an Advanced Protection Management Program area and a plan for a 50 percent reduction of loading from OWTS in these areas	3 years from the effective date of the TMDL
Wet-weather and dry-weather LAs apply	10 years after effective date of TMDL
Horse/ Intensive Livestock Activities	
Discharge monitoring plan submitted as part of waiver, WDR, or other regulatory mechanism requirement or in response to Regional Board order	5 years after effective date of TMDL
Conduct receiving water monitoring to assess numeric target attainment and measure in-stream nutrient concentrations	10 years after effective date of TMDL
Wet-weather and dry-weather LAs apply	10 years after effective date of TMDL
Grazing Activities	
Baseline monitoring plan or acceptable existing data or studies to determine baseline dry-weather pollutant load submitted as part of waiver or WDR requirement or in response to Regional Board order, unless the Regional Board has quantified the existing pollutant load	2 years after effective date of TMDL
Results of baseline monitoring submitted, if necessary	18 months after approval of baseline monitoring plan
Discharge monitoring plan submitted as part of waiver, WDR, or other regulatory mechanism requirement or in response to Regional Board order	5 years after effective date of TMDL
Conduct receiving water monitoring to assess numeric target attainment and measure in-stream nutrient concentrations	10 years after effective date of TMDL
Wet-weather and dry-weather LAs apply	10 years after effective date of TMDL

* If TMDL reconsideration results in more stringent WLAs, then the implementation schedule for OVSD may be extended, if necessary, by only the amount of time required to upgrade treatment processes to meet the more stringent WLAs.

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

ORDER NO. R4-2010-0186

CONDITIONAL WAIVER OF WASTE DISCHARGE REQUIREMENTS FOR DISCHARGES FROM IRRIGATED LANDS WITHIN THE LOS ANGELES REGION

The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) finds:

PURPOSE OF ORDER

1. For the reasons set forth below, the Regional Board concludes that it is in the public interest to establish a Conditional Waiver for Discharges from Irrigated Agriculture Lands. (Conditional Waiver or Qrder). The conditions established in this Order are intended to ensure that discharges from irrigated agriculture lands are managed such that they do not degrade water quality or impair beneficial uses of waters of the state within the Los Angeles Region. This Qrder regulates discharges from irrigated agriculture lands in a manner that is intended to attain Water Quality Benchmarks by requiring the quantitative assessment of the water quality impacts of discharges and, when necessary to attain Water Quality Benchmarks, the implementation of management practices.

2. The Los Angeles Region has approximately 100,000 acres of agriculture under irrigation and approximately 2,500 operations that are, or may be, discharging waste from irrigated agriculture lands to waters of the state..

3. Regional water quality data from the Surface Water Ambient Monitoring Program (SWAMP), the Calleguas Creek Watershed Management Plan Surface Water Monitoring Program, the Stormwater Monitoring Program of the Ventura County Watershed Protection District, the Los Angeles County Stormwater Monitoring Program, and other monitoring programs, identify waters of the state as having water quality impairments that appear attributable to or influenced by discharges of waste from irrigated agriculture land.

4. Annual monitoring reports, submitted during the first term of the conditional waiver of waste discharge requirements adopted by Qrder No. R4-2005-0080, have documented water quality that exceeds Water Quality Benchmarks and that could cause or contribute to water quality impairments. Water Quality Benchmark exceedances have been documented in every monitored watershed within the Los Angeles Region. Two categories of wastes frequently reported in agricultural discharges that impair waters of the state in the Los Angeles Region are pesticides and biostimulatory substances.

5. The 2008 Federal Clean Water Act Section 303(d) list of impaired water bodies in the Los Angeles Region identifies agriculture as a potential source of pollutants that impair beneficial uses of some waters within the Region and threaten the quality of the waters of the state.

As authorized by Water Code section 13269, this Order adopts a conditional waiver of waste discharge requirements for discharges from irrigated agriculture lands that requires persons who obtain coverage under the waiver to, in part, (1) prepare monitoring plans, conduct monitoring, and report annually on monitoring results, including the identification of Water Quality Benchmark exceedances; (2) develop, as required, a water quality management plan (WQMP), which identifies management practices that will address Water Quality Benchmark exceedances; (3) implement the WQMP and management practices to attain Water Quality Benchmarks; and (4) assess the effectiveness of implemented agricultural management practices in attaining Water Quality Benchmarks and, when necessary to attain Water Quality Benchmarks, identify, implement, or upgrade management practices.

6. This Order sets forth conditions that apply to discharges of waste from irrigated agriculture lands. This conditional waiver of waste discharge requirements constitutes the Los Angeles Region Irrigated Lands Regulatory Program.

DEFINITIONS

7. "Discharger" means the owner and/or operator of irrigated agriculture lands that discharge, have the potential to discharge, or propose to discharge waste that could directly or indirectly affect the quality of waters of the state.

8. A "Discharger Group" is any group of dischargers and/or organizations that forms to comply with this Order. Discharger Groups can be, but are not limited to, organizations formed on a geographic basis or formed with other factors in common, such as commodities.

9. "Discharges" are discharges from irrigated agriculture lands, including surface discharges (also known as irrigation return flows or tailwater), subsurface discharges through drainage systems that lower the water table below irrigated agriculture lands (also known as tile drains), discharges to groundwater, and stormwater runoff flowing from irrigated agriculture lands.

10. "Hobby Growing/Gardening" activities include growing crops for personal use (includes moderate fundraising and minor secondary incomes from sales at direct marketing locations only) and consumption only. Furthermore:

- The crop is not sold, including but not limited to (1) an industry cooperative, (2) harvest crew/company, or (3) a direct marketing location, except in the case of moderate funding or minor secondary incomes.

- The property owner/operator does not hold a current Operator Identification Number/Permit Number for pesticide use reporting.

- The federal Department of Treasury Internal Revenue Service form 1040 Schedule F Profit or Loss from Farming is not used to file federal taxes.

11. "Irrigated Agriculture Lands" means lands where water is applied for producing crops and, for the purpose of this Order, includes, but is not limited to, lands planted for row, vineyard, pasture, field and tree crops, nurseries, nursery stock production, wholesale nurseries, and greenhouse operations with permeable floors, which are not subject to waste discharge requirements, including Municipal Separate Storm Sewer System (MS4) or other National Pollutant Discharge Elimination System (NPDES) permits.

12. "New Discharges" are defined as irrigated agriculture operations that did not commence the discharge of stormwater and/or irrigation water at a particular site prior to October 7, 2010.

13. "Waste" includes sewage and any and all other waste substances, liquid, solid, gaseous, or radioactive, associated with human habitation, or of human or animal origin, or from any producing, manufacturing, or processing operation, including waste placed within containers of whatever nature prior to, and for purposes of, disposal (Cal. Wat. Code § 13050 (d)).

14. "Water Quality Benchmark" means a requirement established by the Regional Board Basin Plan (including discharge prohibitions and narrative or numeric water quality objectives), a requirement established by an applicable Statewide plan or policy, criteria established by USEPA (including those in the California Toxics Rule and the applicable portions of the National Toxics Rule), and load allocations established pursuant to a total maximum daily load (TMDL) (whether established in the Basin Plan or other lawful means). Water Quality Benchmarks for Discharges from Irrigated Agricultural Lands are identified in Appendices 2 and 3 of this Order.

15. "Waters of the State" means any surface water or groundwater, including saline waters, within the boundaries of the state. (Cal. Wat. Code § 13050(e))

16. Unless otherwise specified above, all other terms used in this Order shall have the same definition as that set forth in California Water Code Division 7.

LEGAL AND REGULATORY CONSIDERATIONS

17. Water Code section 13260(a)(1) requires that any person discharging waste or proposing to discharge waste within the Regional Board's jurisdiction that could affect the quality of the waters of the state, shall file a Report of Waste Discharge (ROWD) with the Regional Board. The Regional Board may, in its discretion, issue Waste Discharge Requirements (WDRs) pursuant to Water Code section 13263(a). Water Code section 13269 authorizes the Regional Board to conditionally waive the provisions of Water Code sections 13260(a)(1) and 13263(a).

18. Water Code section 13269 requires that any waiver of ROWDs and/or WDRs ("Conditional Waiver") must (i) be consistent with any applicable water quality control plans; (ii) be "in the public interest;" (iii) contain conditions; (iv) not exceed five years in duration, but may be renewed in five-year increments; and (v) include monitoring provisions. In addition, Water Code section 13269(a)(4)(A) authorizes the State Water Resources Control Board (State Board) to adopt annual fees for recipients of waivers.

Water Code section 13269(e) mandates that the regional water boards shall require compliance with the conditions of a waiver of waste discharge requirements.

19. All requirements for monitoring and reporting are established in this Order pursuant to Water Code sections 13267 and 13269. These monitoring and reporting requirements are necessary to evaluate the following: (1) compliance with the terms and conditions of this Conditional Waiver of waste discharge requirements for discharges from irrigated agriculture lands; ((2) the effectiveness of any measures or actions taken pursuant to this Order (including water quality management plans); and (3) whether revisions to this Conditional Waiver and/or additional regulatory programs or enforcement actions are warranted.

20. Failure to submit a report in accordance with schedules established by this Order, Monitoring and Reporting Requirements (Appendix 1) approved by the Regional Board Executive Officer, or failure to submit a report of sufficient technical quality to be acceptable to the Executive Officer, or failure to comply with the conditions of the waiver, may subject a Discharger to enforcement action pursuant to section 13268 and/or 13350 of the Water Code and/or the requirement to submit a ROWD.

21. The Basin Plan designates beneficial uses, establishes water quality objectives, contains implementation plans and policies for protecting waters of the region, and references the plans and policies adopted by the State Water Board.

22. This Conditional Waiver is consistent with State and Regional Board water quality control plans because it requires compliance with water quality objectives, prohibitions, and TMDLs set forth in the Regional Board Basin Plan and pertinent state water quality control plans and policies and federal water quality criteria, and it requires protection of the beneficial uses of the waters of the state within the Los Angeles Region.

23. Beneficial uses designated for groundwater and surface water in the Basin Plan include:

- Municipal and Domestic Supply
- Agricultural Supply
- Industrial Process Supply
- Industrial Service Supply
- Groundwater Recharge
- Freshwater Replenishment
- Navigation
- Hydropower Generation
- Water Contact Recreation
- Non-contact Water Recreation
- Commercial and Sport Fishing
- Aquaculture
- Water Freshwater Habitat
- Cold Freshwater Habitat
- Inland Saline Water Habitat
- Marine Habitat
- Estuarine Habitat
- Wetland Habitat
- Wildlife Habitat
- Preservation of Biological Habitat
- Rare, Threatened, or Endangered Species
- Migration of Aquatic Organisms
- Spawning, Reproduction, and Early Development
- Shellfish Harvesting

24. Agricultural activities can generate wastes such as sediment, pesticides, nutrients, and oxygen-demanding organic matter that, upon discharge to a water of the state, can degrade water quality and impair beneficial uses. Section F - Water Quality Benchmarks and Appendices 2 and 3 of this Order identify specific water quality objectives, prohibitions, and load allocations and water quality criteria, which will be used to assess the effect of irrigated agriculture discharges on water quality and to determine if management practices implemented to comply with the terms and conditions of the Conditional Waiver are effective.

25. The intent of this Order is to establish a regulatory program for irrigated agricultural lands that requires Dischargers to attain Water Quality Benchmarks through a process that quantitatively assesses the in-stream water quality impacts of discharges and, when necessary to attain Water Quality Benchmarks, requires Dischargers to implement effective management practices. Where a Discharger is determined to be causing or contributing to exceedances of Water Quality Benchmarks, this Order requires the Discharger or Discharger Group to identify and implement or upgrade management practices to attain the Water Quality Benchmarks.

26. The State Water Board has adopted the "Plan for California's Nonpoint Source Pollution Control Program" (Nonpoint Source Program Plan) dated January 2000 and the "Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program" (Nonpoint Source Implementation and Enforcement Policy) dated May 2004. The purpose of the Nonpoint Source Program Plan is to improve the State's ability to effectively manage nonpoint source pollution and conform to the requirements of the federal Clean Water Act and the federal Coastal Zone Management Act. The Nonpoint Source Implementation and Enforcement Policy explains the authorities used to implement and enforce the Nonpoint Source Program Plan and describes three options for addressing nonpoint source pollution: (1) waste discharge requirements, (2) conditional waivers of waste discharge requirements, and (3) discharge prohibitions. The policy also describes implementation programs to prevent and/or reduce nonpoint source pollution including antidegradation requirements, management practices, time schedules, feedback to Regional Board to evaluate the program progress, and appropriate Board actions to correct program deficiencies, if necessary.

27. This Order is consistent with the provisions of State Water Board Resolution No. 68-16 (Statement of Policy with respect to Maintaining High Quality of Waters in California). Regional boards, in regulating the discharge of waste, must maintain high quality waters of the state unless it is demonstrated that any degradation will be consistent with the maximum benefit to the people of the State, will not unreasonably affect beneficial uses, and will not result in water quality worse than that described in a regional board's policies. This Order, appendices, and attachments require a Discharger who obtains coverage under the Conditional Waiver to protect beneficial uses, and prevent nuisance by implementing monitoring and reporting programs and management practices to attain Water Quality Benchmarks. This Order does not authorize further degradation of waters of the state. Further, this Order is likely to improve the quality of existing waters by establishing conditions on discharges from irrigated agriculture lands, and including monitoring of such discharges that is designed to determine compliance with the conditions.

28. USEPA promulgated the California Toxics Rule (CTR) on May 18, 2000.[1] The CTR contains water quality criteria that, when combined with beneficial use designations in regional boards' basin plans, constitute enforceable water quality standards for priority toxic pollutants in California surface waters. The CTR contains numeric water quality criteria (i.e., objectives) that implement the narrative toxicity objective in the Basin Plan, such that compliance with CTR criteria is consistent with the Basin Plan. The State Water Board adopted the "Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California" (known as the State Implementation Policy or SIP), which contains guidance on implementation of the CTR. The SIP states that implementation of the CTR for agricultural nonpoint sources of pollution shall be consistent with the State's Nonpoint Source Management Plan. Adoption of this Order is consistent with the State's Nonpoint Source Management Plan.

29. Water Code section 13141 states that prior to implementation of any agricultural water quality control program, an estimate of the total cost of such a program and potential sources of financing must be indicated in any regional water quality control plan. The Regional Board is not required to adopt a basin plan amendment to issue an order pursuant to Water Code section 13269. However, to assist the Regional Board in generally considering the economic impacts of this action, the Regional Board has considered the estimated costs (set forth in the Review of Conditional Waiver Order R4-2005-0080) to Dischargers to implement this agricultural water quality control program in order to protect water quality consistent with section 13141 of the California Water Code. The Regional Board has identified potential sources of funding in the Basin Plan, Chapter 4.

30. In California, the Department of Pesticide Regulations (DPR), State Water Board and the Regional Water Boards have mandates and authorities related to pesticides and water quality. In order to promote cooperation to protect water quality from the adverse effects of pesticides, DPR and the State Water Board signed a Management Agency Agreement (MAA) in 1997. The MAA, and its companion document, "The California Pesticide Management Plan for Water Quality," strives to coordinate interaction, facilitate communication, promote problem solving, and ultimately assure the protection of water quality. The intent of this Order is to support and implement the MAA.

31. This Order does not authorize any act which results in the taking of a threatened or endangered species or any act which is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish & Game Code section 2050 to 2097) or the federal Endangered Species Act (16 U.S.C.A. section 1531 to 1544).

32. The TMDLs listed in the table below assign load allocations to agricultural Dischargers. All TMDLs listed in the table have an interim and/or final load allocations compliance deadline during the term of this waiver. The TMDL load allocations will be

[1] 40 CFR 131.38. Minor, non-substantive typographical corrections were made to the CTR by the USEPA on February 13, 2001.

implemented through this Order as Water Quality Benchmarks. The interim and final numeric TMDL load allocations are presented in Appendix 3.

Table 1 Effective TMDLs with load allocations assigned to irrigated agriculture, listed by pollutant category

Pesticides and PCBs
Calleguas Creek Watershed and Mugu Lagoon Organochlorine Pesticides, PCBs, and Siltation TMDL (Resolution No. R05-010)
Calleguas Creek Watershed and Mugu Lagoon Toxicity, Chlorpyrifos, and Diazinon TMDL (Resolution No. R05-009)
Nutrients
Santa Clara River Nitrogen Compounds TMDL (Resolution No. R03-011)
Calleguas Creek Watershed Nitrogen Compounds and Related Effects TMDL (Resolution No. R08-009)
Malibu Creek Watershed Nutrients TMDL (U.S. EPA-established TMDL)
Trash
Ventura River Estuary Trash TMDL (Resolution No. R07-008)
Revolon Slough and Beardsley Wash Trash TMDL (Resolution No. R07-007)
Metals
Calleguas Creek Watershed and Mugu Lagoon Metals and Selenium TMDL (Resolution No. R06-012)
Salts
Calleguas Creek Watershed Boron, Chloride, Sulfate, and TDS (Salts) TMDL (Resolution No. R07-016)
Upper Santa Clara River Chloride TMDL, Revisions (Resolution No. R08-012)

33. The Santa Clara River Estuary is identified on the 1998, 2002 and 2006 Clean Water Act Section 303(d) list of impaired water bodies as impaired due to Chem A and toxaphene in fish tissue. Approved 303(d) listings require the development of a TMDL in most cases. Regional Board Staff have prepared a detailed technical document that provides the factual basis and analysis supporting a TMDL for toxaphene in fish tissue in the Santa Clara River Estuary, including a problem statement, numeric targets, source analysis, linkage analysis, load allocations, a margin of safety, and a consideration of seasonal variations and critical conditions. Based on the source analysis, the Regional Board finds that the implementation of the TMDL for toxaphene in fish tissue can effectively focus on source control and reduction of sediment loading from irrigated agriculture dischargers in the TMDL subwatershed area. According to the "Water Quality Control Policy for Addressing Impaired Waters" (State Water Board Resolution 2005-0050), "[i]f the solution to an impairment can be implemented with a single vote of the regional board, it may be implemented by that vote ... there is no legal requirement to first adopt the plan [TMDL] through a basin plan amendment. The plan [TMDL] may be adopted directly in that single regulatory action" (p. 5). The Regional Board finds, based on the technical documentation, that a single regulatory action through the Conditional Waiver can be used to implement this TMDL. This Order contains additional requirements for water, sediment, and fish tissue monitoring

for toxaphene, chlordane, and dieldrin in the Santa Clara River Estuary and its subwatershed. In addition, this Order incorporates the toxaphene load allocation for sediment and the toxaphene numeric target for fish tissue as Water Quality Benchmarks (Appendix 3). Based on these requirements and other requirements in this Order, the Conditional Waiver will implement the Santa Clara River Estuary toxaphene TMDL.

RATIONALE FOR CONDITIONAL WAIVER OF WASTE DISCHARGE REQUIREMENTS FOR DISCHARGES FROM IRRIGATED LANDS

34. Discharges from irrigated agriculture lands can and/or do contain wastes, as defined in Water Code section 13050 that could affect the quality of the waters of the state. The discharge of tailwater, wastewater and/or stormwater from irrigated lands occurs to both surface and ground water. Such wastes include earthen materials, including soil, silt, sand, clay, and rock; inorganic materials (such as metals, salts, boron, selenium, potassium, nitrogen, etc.); organic materials (such as organic pesticides) that enter or threaten to enter into waters of the state. This Order does not authorize the discharge of hazardous waste or human wastes. Discharges of such waste to waters of the state are prohibited unless regulated by waste discharge requirements.

35. Irrigated agriculture discharges can impact groundwater quality. A review of groundwater quality data in the Los Angeles Region reveals that groundwater is contaminated with pollutants, such as nitrate, contained in irrigated agriculture discharges. Data obtained from the State's Groundwater Ambient Monitoring and Assessment (GAMA) program, the Department of Water Resources (DWR) Bulletin 118, and the Ventura County Watershed Protection District groundwater monitoring program demonstrate that groundwater basins underlying areas with irrigated agriculture lands contain levels of nitrate that exceed water quality objectives, including state drinking water standards. Recent studies on the effects of irrigated land discharges on groundwater quality funded by the State Water Board showed that nitrate applied to irrigated agriculture lands is not completely taken up in the root zone of crops and can percolate to groundwater (Modifying Agricultural Practices, Nutrients, and Pesticides, Calleguas Creek and Santa Clara River. United Water Conservation District, August 31, 2007, SWRCB Grant No. 04-073-554-1). The studies did not quantify the loading of nitrate from irrigated agriculture lands to groundwater, but they provide evidence that irrigated agricultural practices are a potential source of groundwater pollution in the Los Angeles Region. It is expected that source control management practices, such as improved irrigation efficiency and fertilizer management, employed by Dischargers to attain surface Water Quality Benchmarks will reduce loading to groundwater as well. The number of existing groundwater wells in the Los Angeles Region is adequate to assess broad changes in groundwater quality as a result of implementation of management practices under the Conditional Waiver. Therefore, it is not necessary to require additional groundwater monitoring or requirements in the Conditional Waiver adopted by this Order.

36. The goal of this Order is to improve and protect water quality and attain water quality objectives in waters of the state by providing a program to regulate and manage discharges from irrigated lands that cause or contribute to conditions of pollution or

nuisance as defined in Section 13050 of the Water Code or that cause or contribute to exceedances of applicable Water Quality Benchmarks.

37. The Monitoring and Reporting Requirements of this Order satisfy section 13269 of the California Water Code. Under Appendix 1, an Individual Discharger and/or Discharger Group subject to this Order is required to monitor locations where discharges from irrigated lands enter waters of the state, as approved by the Executive Officer. If results from the monitoring programs indicate that applicable Water Quality Benchmarks are exceeded, the individual and/or group is required to submit a WQMP, as described Appendix 1. The WQMP requires improved management practices and additional monitoring, if necessary, to achieve and document compliance with Water Quality Benchmarks.

38. The adoption of this Order is in the public interest because, in part: (1) it was adopted in compliance with Water Code sections 13260, 13263, 13267, and 13269 and other applicable law, (2) it includes conditions that are intended to reduce and prevent pollution and nuisance and protect the beneficial uses of the waters of the state, (3) it requires compliance with State and Regional Board's water quality control plans, (4) it implements the Nonpoint Source Implementation and Enforcement Policy, (5) it provides for an efficient and effective use of limited staff resources given the magnitude and number of waste discharges from irrigated lands, and (6) it provides reasonable flexibility for the Dischargers who seek coverage under the Conditional Waiver by providing them with the option of complying with the Water Code through participation in Discharger Groups or as individuals.

39. The requirements of the Conditional Waiver adopted by Order No. R4-2005-0080 have thus far resulted in extensive water quality monitoring, ongoing grower education and outreach, and implementation of numerous new and/or improved management practices. These activities represent significant strides toward the improvement and protection of water quality. At this time, the Regional Board finds the continuation of similar activities and requirements under this Order an appropriate approach for regulation of discharges of waste from irrigated agriculture lands. The Regional Board may consider reasonable and appropriate bases for the adoption of individual or general WDRs, where necessary, in the future.

40. Where other federal, State, and local agencies have a regulatory role for activities or pollution addressed by the conditions of this Order, the Regional Board will work cooperatively with the other agencies in order to effectively regulate discharges from irrigated lands.

41. The Regional Board may consider adoption of waste discharge requirements to regulate discharges from irrigated lands that do not meet the requirements for participation in the Conditional Wavier as described herein.

SCOPE AND DESCRIPTION OF CONDITIONAL WAIVER OF WASTE DISCHARGE REQUIREMENTS FOR DISCHARGES FROM IRRIGATED AGRICULTURE LANDS

42. This Order applies to discharges of waste from irrigated agriculture lands to waters of the state.

43. This Order does not apply to discharges that are subject to the NPDES permit program under the federal Clean Water Act and does not relieve discharges of the obligation to apply for an NPDES permit if required. This Order does not apply to discharges of waste that are regulated under another conditional waiver, or regulated by individual or general waste discharge requirements.

44. This Order applies to return flows from irrigated agriculture because such discharges are excluded from coverage under the NPDES permit program (40 CFR § 122.2).

45. This Order does not preempt or supersede the authority of municipalities, flood control agencies, agricultural commissioners, pesticide regulators or other agencies to prohibit, restrict, or control discharges of waste subject to their jurisdiction.

46. This Order does not apply to confined animal operations, parks, golf courses, cemeteries, and recreational fields. These are regulated under other regulatory programs and permits.

47. This Order does not apply to hobby growing and or gardening.

48. This action to waive the requirement to submit ROWDs and to waive the issuance of waste discharge requirements for discharges from irrigated lands: (a) is conditional, (b) may be terminated at any time, (c) does not permit an illegal activity, (d) does not preclude the need for permits that may be required by other State or local government agencies, and (e) does not preclude the Regional Board or Executive Officer from taking other actions authorized by the Water Code, including requiring additional technical reports or administering enforcement remedies (including civil liability).

49. The Regional Board will periodically evaluate whether the Conditional Waiver is adequate to restore and/or protect water quality and beneficial uses. The evaluation will include a consideration of the character of the discharges covered by this Order, the effect of those discharges on waters of the state, and the effectiveness of any management practices that were implemented to address impairments of waters of the state.

50. The Regional Board recognizes that the overall effectiveness of this Order is based on a myriad of factors. When assessing the effectiveness of this Order, the Regional Board will consider the monitoring and reporting results, the effectiveness of management practices in reducing or eliminating discharges of waste and meeting Water Quality Benchmarks, changes in water quality, and other factors, including, without limitation, the level of participation and cooperation of Dischargers.

51. The conditions of this Order require the identification and implementation of targeted actions that will lead to achieving Water Quality Benchmarks, including implementation

or upgrading management practices. When results from the required monitoring program indicate that a Water Quality Benchmark is exceeded, an Individual Discharger or Discharger Group shall submit a WQMP for approval by the Executive Officer. The WQMP shall include specific, targeted steps with milestones to attain Water Quality Benchmarks through the use of best management practices. The guidelines for developing a WQMP are presented in Appendix 1.

52. Irrigated lands dischargers shall comply with the conditions of this Order by (1) submitting a Notice of Intent (NOI) to comply with this Order, or participating in a Discharger Group that submits an NOI to comply with this Order, (2) performing individual or group monitoring, (3) submitting annual monitoring reports, and (4) developing and implementing a WQMP, if necessary, to reduce or eliminate waste discharges to surface waters. Monitoring requirements shall be designed to support the development and implementation of this Order, including but not limited to, verifying the adequacy and effectiveness of the conditions. In establishing monitoring requirements, the Regional Board may consider the volume, duration, frequency, and constituents of the discharge; the extent and type of existing monitoring activities; including, but not limited to, existing watershed-based, compliance, and effectiveness monitoring efforts; the size of the project area; and other relevant factors (Water Code section 13269(a)(2)). Existing monitoring activities may include monitoring requirements established under TMDLs.

53. The primary objective of the WQMP is to identify and construct or implement targeted management practices to reduce or eliminate waste discharges from irrigated agriculture lands to the waters of the state in order to achieve water quality objectives. To support this objective, the WQMP is also designed to (1) assess the impacts of waste discharges from irrigated lands to surface waters, including an evaluation of compliance with narrative and numeric water quality objectives and, where applicable, load allocations and federal water quality criteria to determine where additional implementation of management practices is necessary to improve and/or protect water quality and implement those practices; (2) determine waste concentration and load in these discharges to surface waters; (3) identify likely waste constituent sources; (4) document the degree of implementation of management practices to reduce discharge of specific wastes that impact water quality; and (5) determine the effectiveness of management practices and strategies to reduce discharges of waste that impact water quality.

54. A Discharger Group or an individual Discharger may apply for coverage under the Conditional Waiver as specified in this Order. The Discharger Group or Individual Discharger must submit a complete NOI to comply with the conditions of the Conditional Waiver. The NOI submitted by Dischargers shall contain information required by this Order. Requirements for the NOI are presented in Section A of this Order.

55. Individual Dischargers and Discharger Groups shall develop a Monitoring and Reporting Plan (MRP) to assess the impacts of waste discharges from irrigated agriculture lands on the waters of the state and, where necessary, to assess the sources of wastes and track progress in reducing the amount of waste discharged that affects the quality of the waters of the state and their beneficial uses and causes

nuisance conditions. Monitoring and Reporting Requirements are described in Appendix 1. All Dischargers subject to the requirements of this Order will be required to comply with the monitoring requirements in Appendix 1.

56. Upon submittal of complete and approved enrollment documents (NOI and MRP), the individual Discharger or Discharger Group will be considered enrolled under the Conditional Waiver and the Executive Officer will issue a Notice of Applicability (NOA).

57. The formation, operation, and funding of Discharger Groups are the responsibilities of the local entities and/or individual Dischargers who are represented by the Discharger Group.

58. A Discharger Group collects and maintains enrollment information, financial records, monitoring data, and fulfills the reporting requirements on behalf of a specific set of Dischargers. Discharger Groups must manage and comply with the Monitoring and Reporting Requirements in Appendix 1.

59. The Regional Board may review this Order at any time and may modify or terminate the Conditional Waiver for Individual Dischargers, individual members of a Discharger Group, or an entire Discharger Group, as appropriate.

60. Pursuant to Water Code section 13263(g), discharge of waste to waters of the state is a privilege, not a right, and adoption of this Order establishing a Conditional Waiver, and the receipt of an NOA from the Executive Officer, does not create a vested right to continue the discharge.

61. The Regional Board has notified interested agencies and persons of its intent to adopt a Conditional Waiver as described in this Order, and has provided them with an opportunity to submit written comments and recommendations regarding the tentative requirements. This notice complied with the requirements of Government Code section 11125.

62. The Regional Board, in a public meeting, heard and considered all comments pertaining to the discharges to be regulated under this Order and to the tentative requirements of the Conditional Waiver.

63. Pursuant to Water Code section 13320, any aggrieved party may seek review of this Order by filing a petition with the State Water Board. A petition must be sent to the State Water Resources Control Board, P.O. Box 100, Sacramento, California 95812, within 30 days of adoption of this Order.

64. As specified in California Code of Regulations, title 23, section 2511(a), discharges covered by the Conditional Waiver established by this Order are exempt from the provisions of title 23 of the California Code of Regulations, Division. 3, Chapter 15, Discharge of Hazardous Waste to Land.

CALIFORNIA ENVIRONMENTAL QUALITY ACT

65. The Regional Board is the lead agency for this project under the California Environmental Quality Act (CEQA) (Public Resources Code section 21000 et seq.) The Regional Board finds that the adoption of this Order to renew a waiver of waste discharge requirements for discharges from irrigated lands is categorically exempt from CEQA review as an existing facility. The action to renew a conditional waiver is intended to protect, maintain, and improve water quality. The waiver renewal sets forth similar conditions as those required by Order No, R4-2005-0080, including the requirement to implement management practices to protect and restore water quality and monitoring to ensure that such practices are effective, and thus does not require additional CEQA review. To the extent that this Order includes requirements for additional management practices beyond those required by R4-2005-0080 in order to meet load allocations established by TMDLs, the substitute environmental documents for the TMDLs have considered the reasonably foreseeable environmental impacts of the management practices, the reasonably foreseeable feasible mitigation measures, and the reasonably foreseeable alternative means of compliance, which would avoid, eliminate, or reduce the identified impacts.

IT IS HEREBY ORDERED that:

In order to meet the provisions contained in Division 7 of the Water Code and regulations adopted there under, and those of the Regional Board's Basin Plan, the Regional Board hereby waives waste discharge requirements for discharges of wastes from irrigated agriculture lands provided that the Discharger satisfies all conditions and requirements of this Conditional Waiver.

A. ELIGIBILITY

1. Existing and future discharges from irrigated agriculture lands to waters of the state are potentially eligible for coverage under this Order.

2. Dischargers eligible under this Order bear the responsibility of complying with the provisions and conditions contained in this Order and others related thereto.

3. Dischargers eligible under this Order shall comply with the terms and conditions of the Conditional Waiver and take action to improve and protect waters of the State.

Individual Dischargers

Individual Dischargers eligible for coverage under this Order shall:

4. File a Notice of Intent (NOI) within six months after this Conditional Waiver is adopted by the Regional Board that provides Individual Discharger information, billing address, site information, water supply, type of discharge, facility information (including type and volume of crops; type, quantity and frequency of pesticide

applications; irrigation schedule; and management practices in place to mitigate waste loadings). The Individual NOI form is provided in Appendix 4.

5. Submit a Monitoring and Reporting Plan (MRP) in accordance with the Monitoring and Reporting Requirements in Appendix 1 and attach it to the NOI. The purpose of the Monitoring and Reporting Requirements is to assess the impacts of waste discharges on waters of the state, evaluate the effectiveness of management practices, and, where necessary, to track progress in reducing the amount of waste discharged that affects the quality of the waters of the state and their beneficial uses.

6. Provide any additional information that the Executive Officer deems necessary to evaluate the discharge.

7. After the required documents are reviewed and approved by the Executive Officer, the Executive Officer will issue a Notice of Applicability (NOA).

8. Upon receipt of an NOA, Individual Dischargers shall implement the approved MRP in accordance with the requirements of Appendix 1.

9. Within two years of issuance of the NOA, the Discharger shall complete 8 hours of educational training on water quality impairments related to agriculture discharges, regulatory requirements, and management practices that control waste discharges.

10. One year after issuance of an NOA and annually thereafter the Individual Discharger shall submit an annual monitoring report in accordance with the Monitoring and Reporting Requirements in Appendix 1.

11. Each Individual Discharger shall pay a fee to the State Water Resources Control Board in compliance with the fee schedule contained in Title 23 California Code of Regulations.

Discharger Groups

Discharger Groups eligible for coverage under this Order shall:

12. File an NOI within six months after this Order is adopted by the Regional Board. The NOI shall include a participant list that identifies the Dischargers participating in the group. The participant list shall include: (1) assessor parcel number, 2) parcel owner and operator name, (3) parcel size, (4) parcel watershed, and (5) parcel owner and operator mailing address. The NOI shall also include the billing address for the Group; general site information for group participants; and descriptions of water supplies used by group participants, types of discharges, types of crops, types of pesticides and application practices, irrigation practices, and other management practices.

13. Submit an MRP in accordance with the Monitoring and Reporting Requirements in Appendix 1 and attach it to the NOI. The purpose of the Monitoring and Reporting Requirements is to assess the impacts of waste discharges from irrigated lands on waters of the state, evaluate the effectiveness of management practices and, where necessary, to track progress in reducing the amount of waste discharged that affects the quality of the waters of the state and their beneficial uses.

14. Submit a Bacteria Special Study in accordance with the requirements in Appendix 1.

15. Provide any additional information that the Executive Officer deems necessary to evaluate the discharge.

16. After the required documents are reviewed and approved by the Executive Officer, the Executive Officer will issue an NOA.

17. Upon receipt of an NOA Discharger Groups shall implement the approved MRP in accordance with the requirements of Appendix 1.

18. Within two years of issuance of the NOA, all Dischargers within the Discharger Group shall complete 8 hours of educational training on water quality impairments related to agriculture discharges, regulatory requirements, and management practices that control waste discharges.

19. One year after issuance of an NOA and annually thereafter the Discharger Group shall submit an annual monitoring report in accordance with the Monitoring and Reporting Requirements in Appendix 1.

20. Each Discharger Group shall pay a fee to the State Water Resources Control Board in compliance with the fee schedule contained in Title 23 California Code of Regulations.

B. AUTHORIZATION

1. To be authorized to discharge under this Order, an Individual Discharger or Discharger Group must submit an NOI and other required documents in accordance with Section A and Appendix 1 of this Order.

2. Upon receipt of the application, the Executive Officer shall (1) determine the applicability of this Order to the Individual Discharger or individuals within a Discharger Group, (2) notify the Individual Discharger or Discharger Group that the discharge is or is not authorized under the terms and conditions of this Order, and (3) approve or require modifications to documents submitted to comply with the Monitoring and Reporting Requirements (Appendix 1).

3. For new discharges, the discharge shall not commence until receipt of the Executive Officer's NOA under this Order.

C. DISCHARGE PROHIBITIONS

1. The discharge of wastes from irrigated lands that are not authorized by this Conditional Waiver or other Order authorized by the Regional Board is prohibited.

2. Wastes discharged from irrigated lands shall be limited to agricultural wastewater only; no residential, municipal, industrial, hazardous or commercial wastes shall be discharged from the agricultural property.

3. Except in conformance with the conditions of this Order, the discharge of wastes containing any substance in concentrations toxic to human, animal, plant or aquatic life is prohibited.

4. The discharge of pollutants subject to Clean Water Act section 310, 402, or 404 is not authorized by this Order.

D. GENERAL PROVISIONS

1. Dischargers shall comply with applicable Water Quality Benchmarks. Dischargers shall demonstrate compliance with Water Quality Benchmarks according to Section E, provisions 1, 2, and 3.

2. Dischargers may not discharge any waste not specifically regulated by this Order except in compliance with the Water Code.

3. An Individual Discharger shall maintain, for inspection by Regional Board staff, the NOI, an MRP (as required by Appendix 1), records of pesticide and fertilizer application information as required by other regulatory programs, and a WQMP, if monitoring results have documented Water Quality Benchmark exceedances.

4. Participants in a Discharger Group shall maintain, for inspection by the Regional Board staff, proof of participation in a Discharger Group, contact information for the Discharger Group, individual pesticide and fertilizer application information as required by other regulatory programs, and a Discharger Group WQMP, if monitoring results have documented Water Quality Benchmark exceedances.

    a. To the extent authorized by, and in accordance with, Water Code section 13267, the Regional Board is authorized to inspect upon reasonable notice private property owned or occupied by any Discharger for the purpose of determining compliance with the provisions of this Order. Except in emergency situations that pose a threat to public health, safety and property, no authorized official of the Regional Board may enter private property owned or occupied by a Discharger except upon consent of the owner or possessor of the facilities or, if consent is withheld, with a warrant issued pursuant to Civil Code section 1822.50. In the course of a duly authorized inspection, the Regional Board may (a) upon reasonable notice enter upon the Discharger's premises where a regulated operation or activity is located or conducted or where records must be kept under conditions of this Order; (b) inspect or photograph any operation or activity

(including monitoring and control equipment) pertinent to this Order, (c) have access to and copy any records pertinent to this Order; (d) sample or monitor to determine compliance with this Order, or as otherwise authorized by the Water Code, any substances or parameters; and (e) without notice enter upon the discharger's premises in the event of an emergency affecting the public health or safety.

5. This Order does not relieve the Discharger from responsibility to obtain other necessary local, State, and federal permits to construct facilities necessary for compliance with this Order, nor does this Order prevent imposition of additional standards, requirements, or conditions by any other regulatory agency.

6. The Discharger shall furnish, within a reasonable time not to exceed 30 days, any information the Regional Board may request to determine whether cause exists for modifying, revoking and reissuing, or terminating the Discharger's coverage under this Order. The Discharger shall also furnish to the Regional Board, upon request, copies of records required to be kept by this Order.

7. After notice, coverage of an Individual Discharger or participant of a Discharger Group under this Order may be terminated or modified for cause by the Executive Officer, including but not limited to the following:

   a. Violation of any term or condition contained in this Order;

   b. Obtaining this Order by misrepresentation or failure to disclose all relevant facts; or

   c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

8. The filing of a request by the Discharger for an Order modification, revocation and issuance, termination, or a notification of planned changes or anticipated noncompliance does not stay any condition of this Order.

9. This Order does not convey any property rights of any sort or any exclusive privileges. The requirements prescribed herein do not authorize the commission of any act causing injury to persons or property, do not protect the discharger from liability under federal, State or local laws, nor do they create a vested right for the discharger to continue the waste discharge (Water Code section 13263(g)).

E. SPECIFIC PROVISIONS

1. Individual Dischargers and Discharger Groups shall submit the results of water quality monitoring to the Regional Board every year in accordance with the Monitoring and Reporting Requirements in Appendix 1.

2. If the monitoring results demonstrate an exceedance of a Water Quality Benchmark, including load allocations, then the Individual Discharger or

Discharger Group shall, in accordance with an approved WQMP, implement targeted management practices intended to attain Water Quality Benchmarks.

3. Individual Dischargers and Discharger Groups shall submit a WQMP within six months after submittal of the annual monitoring report. Requirements for a WQMP are set forth in the Monitoring and Reporting Requirements, Appendix 1. The WQMP shall be revised annually based on the results of continued water quality monitoring. Dischargers shall continue to implement the existing WQMP required by Order No. R4-2005-0080 until the WQMP required by this Order is submitted and approved by the Executive Officer.

4. All Dischargers shall conduct monitoring required pursuant to established TMDLs, as described in Appendix 1.

5. All Dischargers shall obtain a minimum of 8 hours of educational training within two years of receiving an NOA. Training shall focus on water quality impairments from agriculture discharges, regulatory requirements, and management practices to reduce or eliminate discharges of waste to waters of the state. At least one hour of the educational training shall focus on requirements of, and compliance with, this regulatory program. Documentation of participation in educational training is required. All educational training programs must be approved by the Executive Officer in order to provide accredited hours.

F. WATER QUALITY BENCHMARKS

1. Water Quality Benchmarks for discharges from irrigated land are identified in Appendix 2 and 3.

2. Pursuant to the Basin Plan, there shall be no individual pesticide or combination of pesticides present in the discharge in the concentrations that adversely affect beneficial uses. Waters (surface water and groundwater) designated for use as domestic or municipal supply (MUN) shall not contain concentrations of pesticide in excess of the limiting concentrations specified in Table 6444-A of Section 6444 (Organic Chemicals) of Title 22 of the California Code of Regulations.

3. Discharges from irrigated lands that result in an exceedance of a Water Quality Benchmark shall be subject to a WQMP as required by this Order. Specific requirements for developing and implementing a WQMP are contained in the Monitoring and Reporting Requirements, Appendix 1.

G. SCHEDULE

1. Existing Individual Dischargers or Discharger Groups seeking to discharge under this Order shall submit an NOI and MRP (Appendix 1) within six months after adoption of this Order.

2. New Dischargers shall file a complete NOI at least 45 days before commencement of the discharge.

3. The table below presents the schedule of tasks for Dischargers enrolling under this Conditional Waiver

Task	Responsible Party	Due Date
Submit NOI and MRP	Each Individual Discharger or Discharger Group	6 months after adoption of Conditional Waiver
Annual Monitoring Report	Each Individual Discharger or Discharger Group	Within 12 months after issuance of NOA and annually thereafter
WQMP, if necessary	Each Individual Discharger or Discharger Group	6 months after submittal of annual monitoring report if necessary, and annually thereafter, if necessary

H. COMPLIANCE AND ENFORCEMENT

1. Individual Dischargers and participants of a Discharger Group are the responsible parties for meeting the conditions of this Order. Failure by a Discharger to maintain compliance with conditions of this Order may result in enforcement actions including imposition of civil liability under Water Code 13268 or 13350, and/or withdrawal of the Conditional Waiver and issuance of waste discharge requirements by the Regional Board (Water Code sections 13261, 13263, 13265, 13268, 13300, 13301, 13304, 13340, 13350).

2. Under the terms of this Order, both owners and operators of irrigated lands have responsibility for compliance with the conditions of this Order. Many management practices will be operational in nature and under the direct control of the operator, while structural practices which remain in place through changes in leaseholders will more likely be the responsibility of the landowner. In the event that the Regional Board undertakes enforcement action, the owner and the operator may be held accountable. Owners and operators may consider delineating these responsibilities in lease agreements; however both the owner and operator will retain full legal responsibility for complying with all provisions of this Order.

3. The conditions of this Order require the identification and implementation of targeted actions to attain Water Quality Benchmarks. To satisfy the conditions of this Order, an Individual Discharger or Discharger Group must submit technical reports and conduct required monitoring programs. In addition to the foregoing, a Discharger must, where necessary to attain Water Quality Benchmarks, implement management practices, evaluate the effectiveness of those practices, and, refine and/or supplement those practices to improve their effectiveness, as necessary to

attain Water Ouality Benchmarks, and protect the beneficial uses of waters of the state.

4. If a Discharger fails to meet the requirements and conditions of this Order, the Executive Officer may, upon providing the Discharger with reasonable notice and an opportunity to submit information and be heard, terminate the Discharger's coverage under this Conditional Waiver.

5. Individual Dischargers and members of a Discharger Group in compliance with the conditions of this Order will not be required to file ROWDs or be subject to WDRs during the term of this Conditional Waiver.

6. This Order and Conditional Waiver shall become effective on October 7, 2010 and expire on October 7, 2015, except for enforcement purposes, unless rescinded, renewed, or extended by the Regional Board.

I. TERMINATION

21. The Los Angeles Regional Board may review this Order at any time and may modify or terminate the Conditional Waiver in its entirety. Upon providing a Discharger or Discharger Group with reasonable notice and opportunity to be heard, the Executive Officer may terminate applicability of the Conditional Waiver with respect to that Individual Discharger or Discharger Group.

22. The Los Angeles Regional Board may reopen this Order at the time the State Water Resources Control Board adopts a policy for Whole Effluent Toxicity Assessment and Control and modify the Monitoring and Reporting Requirements (Appendix 1) pertaining to toxicity monitoring and Toxicity Identification Evaluation (TIE).

23. The Los Angeles Regional Board may reopen this Order to incorporate any new or revised TMDL load allocations (assigned to irrigated agriculture discharges) that become effective during the term of this Order.

24. If an Individual Discharger or individual participant in a Discharger Group wishes to terminate coverage under this Order, the Discharger shall submit a complete Notice of Termination (NOT), Appendix 5. Termination from coverage will occur on the date specified in the NOT, unless otherwise specified. All discharges shall cease before the date of termination, and any discharges on or after that date shall be considered in violation of the California Water Code, unless the discharge is regulated by another conditional waiver or other waste discharge requirements.

25. Administrators of a Discharger Group shall notify the Regional Board of an individual's failure to participate in the group efforts. The Discharger Group shall not be responsible or liable for individual compliance with the terms of this Order or the Water Code in general. The Discharger Group shall only be responsible for conveying information related to an individual's participation in the Group, and not for determining if the individual is in compliance with the terms of this Order. The

Discharger Group shall provide at least 30 days notice to individual participants before informing the Regional Board of the individual's failure to participate, which may result in the Regional Board issuing a NOT to the participant. Termination from coverage will occur on the date specified in the NOT, unless otherwise specified. All discharges shall cease before the date of termination, and any discharges on or after that date shall be considered in violation of the California Water Code, unless the discharge is regulated by another conditional waiver or waste discharge requirements.

26. In the event that the Regional Board issues an individual order with more specific requirements to a Discharger, the applicability of this Order to that Discharger is automatically terminated, except for enforcement purposes, on the effective date of the individual order.

I, Samuel Unger, Executive Officer, do hereby certify that the foregoing is a full, true and correct copy of an Order adopted by the California Regional Water Quality Control Board, Los Angeles Region, on October 7, 2010.

Samuel Unger, PE
Executive Officer

CALIFORNIA REGIONAL WATER OUALITY CONTROL BOARD
LOS ANGELES REGION

APPENDIX 1

MONITORING AND REPORTING REOUIREMENTS

UNDER

ORDER NO. R4-2010-0186

CONDITIONAL WAIVER OF WASTE DISCHARGE REOUIREMENTS
FOR
DISCHARGES FROM IRRIGATED LANDS

These Monitoring and Reporting Requirements are issued by the Regional Water Quality Control Board, Los Angeles Region (Regional Board) pursuant to Water Code sections 13267 and 13269. As conditioned by the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Conditional Waiver), Order No. R4-2010-0186 (Order No. R4-2010-0186), Individual Dischargers and Discharger Groups (Dischargers) shall develop a Monitoring and Reporting Plan (MRP) to (1) assess the impacts of waste discharges from irrigated lands, and where necessary, (2) assess the source(s) of wastes, evaluate the effectiveness of management practices, and track progress in reducing the amount of waste discharged that affects the quality of the waters of the State and their beneficial uses and causes nuisance conditions. In order to support the Conditional Waiver program, the monitoring requirements must be able to detect long-term trends over time, assess areas where Water Quality Benchmarks, as defined in the Order, are not attained, and conduct follow-up investigations to better characterize problems areas. The Monitoring and Reporting Requirements presented in this document describe the minimum MRP requirements for compliance with Order No. R4-2010-0186. The Executive Officer of the Regional Board may revise these Monitoring and Reporting Requirements based on site-specific conditions for an Individual Discharger or Discharger Group.

The MRP has three basic purposes:

1. to monitor the discharge of wastes in irrigation return flows, tile drains, stormwater, and waters of the state and identify waste sources;
2. where discharges of waste cause or contribute to exceedances of Water Quality Benchmarks or cause pollution or nuisance, to submit a Water Quality Management Plan (WQMP) to implement targeted management practices to reduce or eliminate the discharges of waste; and
3. report results and other required information on an annual basis.

Dischargers shall prepare and submit to the Regional Board for review and approval by the Regional Board Executive Officer an MRP that meets the minimum requirements of this Order, including sites to be monitored, frequency of monitoring, constituents to be monitored, documentation of monitoring protocols, and sufficient information about the irrigated agriculture lands to demonstrate that the proposed MRP adequately documents water quality and waste discharges to waters of the state.

As required, Dischargers shall submit a Water Quality Management Plan (WQMP), if a Water Quality Benchmark[1] is exceeded. WQMPs shall contain the necessary information to (1) assess the impacts of waste discharges from irrigated lands to surface waters, (2) quantify and identify waste sources, (3) identify and implement new and/or revised management practices to reduce or eliminate discharges of waste that cause or contribute to exceedances of Water Quality Benchmarks, (4) document the implementation and maintenance of management practices, and (5) document attainment of Water Quality Benchmarks.

1 MONITORING AND REPORTING PLAN

Dischargers shall submit an MRP to the Regional Board for Executive Officer approval six months after adoption of Order No. R4-2010-0186. Specifications in these monitoring requirements are subject to periodic revisions. Monitoring requirements may be modified or revised by the Executive Officer based on review of monitoring data submitted pursuant to this Qrder.

Other Regional Board programs (e.g. TMDLs) may contain requirements similar to the monitoring requirements for Discharger Groups or Individual Dischargers. If such requirements are in place in another regulatory program, the Executive Officer may modify the monitoring tasks of Dischargers to coordinate between Regional Board Programs.

The sections below outline the requirements for the MRP.

Monitoring Sites

Waters of the state receiving discharges from irrigated lands shall be monitored per monitoring plans approved by the Executive Officer. The number and location of monitoring sites must be based on specific watershed characteristics and be supported by scientific rationale and a detailed discussion of drainage characteristics. Several criteria should be used to identify waterbodies and locations for monitoring. These include, but are not limited to the following:

- waterbodies that are on or proposed for the 303(d) list of impaired waterbodies
- waterbodies that have documented beneficial use impairments due to waste discharges associated with agriculture
- size and complexity of watershed
- watershed hydrology
- size of waterbodies
- flow of waterbodies

[1] Water Quality Benchmark means a requirement established by the Regional Board Basin Plan (including discharge prohibitions and narrative or numeric water quality objectives), a requirement established by an applicable Statewide plan or policy, criteria established by USEPA (including those in the California Toxics Rule and the applicable portions of the National Toxics Rule), and load allocations established pursuant to a total maximum daily load (TMDL) (whether established in the Basin Plan or other lawful means). Water Quality Benchmarks for Discharges from Irrigated Agricultural Lands are identified in Appendices 2 and 3 of Order R4-2010-0186.

- previous or existing monitoring locations
- proximity to agriculture operations
- safe all-weather access locations

The MRP shall describe the general drainage area (e.g. land use, crop type, and cultivation practices, which may affect water quality) of each sampling site and provide GPS coordinates for each site. A topographic map that shows the proposed monitoring site(s), the agricultural land with crop type, and potentially affected waters of the state shall also be included as a part of the MRP.

More than one site may be located on tributaries, if required to distinguish and assess agriculturally-sourced inputs from those of other land uses. Dischargers shall sample no more than 50 feet downstream from the location where the discharge(s) enters the receiving water, to the extent feasible; otherwise, sampling shall occur at the nearest feasible downstream location. The number of discharge locations shall be considered when selecting the number and location of sampling sites required.

Monitoring Frequency and Seasonality

The frequency of monitoring shall be, each year, twice during the dry season and twice during the wet season. Toxicity shall be monitored during one wet season event and the second dry-season sampling event each year. Based on a review of annual monitoring reports, the Executive Officer may increase or decrease the frequency of monitoring. Factors that may inform the Executive Officer's evaluation of the monitoring frequency include, but are not limited to, the exceedances or attainment of applicable Water Quality Benchmarks and the effectiveness of any management measures as a result of WQMP implementation.

Monitoring shall be conducted during the dry season and wet season. The dry season is from May 15 to October 15. The wet season is from October 15 to May 15. The wet-season samples shall be collected within 24 hours of a storm with greater than 0.5 inch rain as measured by the nearest National Weather Service rain gauge, to the extent practicable. Practical constraints on wet season sampling events include but are not limited to 1) lab closures on weekends and holidays, 2) sample holding times, and 3) safety of monitoring team. The first wet-season samples shall be collected affer the first storm of the year. The first dry-season samples will be collected after the majority of growers in a subwatershed have applied pesticides or fertilizers and during the period where irrigation is required.

Monitoring Constituents

Monitoring is required for all constituents list in Table 1. Owners/Operators of irrigated agriculture lands discharging to the subwatersheds listed in Table 2 must monitor for the additional constituents specified in the table.

The MRP shall include chronic toxicity testing to evaluate compliance with the narrative toxicity objective in the Basin Plan. Chronic toxicity testing shall be conducted for three test species: *Pimephales promelas* (fathead minnow), *Ceriodaphnia dubia* (water flea) and *Selenastrum capricornutum* (green algae). Once one toxicity sample has been

collected and analyzed in the first year, the Discharger shall select the most sensitive species for subsequent toxicity monitoring. In addition to the three species toxicity screening, the MRP plan may propose the most relevant species for toxicity testing based on pesticide usage, sample nutrient concentrations, and site conditions for consideration by the Executive Officer. If sampling sites are located in tidally influenced areas, alternative species may be selected for toxicity testing, subject to Executive Officer approval.

The results of toxicity testing will be used to trigger further investigations to determine the cause of observed toxicity. If toxicity tests indicate the presence of significant toxicity in the sample, Toxicity Identification Evaluation (TIE) procedures shall be initiated to investigate the cause of toxicity. For the purposes of triggering a TIE, significant toxicity is defined as at least 50% mortality. This threshold is consistent with the approach recommended in guidance published by US EPA for conducting TIEs (US EPA, 1996b). During the field collection of samples an adequate volume of water to conduct both toxicity tests and TIEs should be collected from each monitoring site.

Table 1. List of constituents to be monitored Regionwide

Constituent	Units
Flow	CFS (Ft^3/Sec)
pH	pH units
Temperature	^0F
Dissolved Oxygen	mg/L
Turbidity	NTU
Total Dissolved Solids	mg/L
Total Suspended Solids	mg/L
Hardness (as $CaCO_3$)	mg/L
Chloride	mg/L
Ammonia	mg/L
Nitrate-Nitrogen	mg/L
Phosphate	mg/L
Sulfate	mg/L
Total Copper	µg/L
Organophosphate Suite[2]	µg/L
Organochlorine Suite[3]	µg/L
Toxaphene	µg/L
Pyrethroids	µg/L
Toxicity	TU_c[4]
Trash	Observations

[2] Oragnophosphate Suite: Bolstar, Chlorpyrifos, Demeton, Diazinon, Dichlorvos, Dimethoate, Disulfoton, Ethoprop, Fenchlorophos, Fensulfothion, Fenthion, Malathion, Merphos, Methyl Parathion, Mevinphos, Phorate, Tetrachlorvinphos, Tokuthion, Trichloronate

[3] Organochlorine Suite: 2,4' – DDD, 2,4' – DDE, 2,4'DDT, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Aldrin, BHC-alpha, BHC-beta, BHC-delta, BHC-gamma, Chlordane-alpha, Chlordane-gamma, Dieldrin, Endosulfan sufate, Endosulfan-I, Endosulfan-II, Endrin, Endrin Aldehyde, Endrin Ketone

[4] Chronic Toxic Unit is the reciprocal of the sample concentration that causes no observable effects on the test organism by the end of a chronic toxicity test.

Table 2. List of constituents to be monitored in specific subwatersheds based on TMDL requirements

Subwatershed	Constituent	Units
Calleguas Creek - Reach 2 Revolon Slough Mugu Lagoon	Nickel	µg/L
Calleguas Creek - Reach 2 Revolon Slough Mugu Lagoon	Selenium	µg/L
Calleguas Creek - Reach 2 Revolon Slough Mugu Lagoon	Mercury	µg/L
Mugu Lagoon Calleguas Creek Revolon Slough Arroyo Las Posas Arroyo Simi Conejo Creek	In Sediment: PCBs Chlordane Dieldrin Toxaphene 4,4 DDD 4,4 DDE 4,4 DDT	ng/g
Simi Revolon Slough	Boron	mg/L
Channel Islands Harbor	Bacteria	MPN/100 mL
Santa Clara River Estuary	In Fish Tissue: Chlordane Dieldrin Toxaphene	µg/kg
	In Water: Chlordane Dieldrin Toxaphene	µg/L
	In Suspended Sediment[1]: Chlordane Dieldrin Toxaphene	µg/kg

[1] Santa Clara River Estuary monitoring for constituents in suspended sediment is only required during wet weather events.

If other Regional Board programs (e.g. TMDLs) are used to monitor the constituents in Table 2 the results of that monitoring must be reported in the Annual Monitoring Report required in Section 3 of this document.

Santa Clara River Watershed Toxaphene Monitoring

The SCR Estuary is identified on the 1998, 2002 and 2006 Clean Water Act (CWA) 303(d) list of impaired water bodies as impaired due to toxaphene and a TMDL is

required for this waterbody-pollutant combination. This TMDL is being adopted and implemented through requirements contained in this Conditional Waiver.

In addition to the requirements for all Dischargers covered by the Conditional Waiver, owners/operators of irrigated lands discharging to the Santa Clara River Estuary and the Santa Clara River Reaches 1 and 2 shall conduct monitoring and implement BMPs, as necessary, to address the toxaphene impairment and assess chlordane and dieldrin concentrations in the Santa Clara River Estuary. Monitoring and analyses for measuring toxaphene, chlordane, and dieldrin in water, sediment, and fish tissue shall be proposed in the Discharger's MRP for review and approval by the Executive Officer.

Monitoring will be conducted at one representative agricultural drain that discharges to the river between Victoria Boulevard and Harbor Boulevard, and one representative agricultural drain that discharges to the river above Victoria Boulevard and below the Freeman Diversion. Water quality samples shall be analyzed for total suspended solids, toxaphene, chlordane, and dieldrin. Water quality samples shall be collected from two wet weather events and two dry weather events a year. Water samples shall be filtered and the filter residue (i.e. filtered sediment) shall be analyzed for toxaphene, chlordane, and dieldrin. Filtered sediment samples shall be collected from two wet weather events a year.

Fish tissue shall be collected in the Estuary. The minimum frequency for fish tissue analysis shall be every three years. Fish tissue samples shall be analyzed for toxaphene, chlordane, and dieldrin.

Methods and Quality Assurance Project Plan

A discussion of monitoring event preparation and field protocols for sample collection and sample handling (including chain of custody requirements) shall be included in the MRP. Additionally, the MRP shall present the quality control (QC) samples that will be collected in conjunction with environmental samples to verify data quality. All samples shall be collected utilizing field techniques consistent with the State Water Resources Control Board's (State Water Board) Surface Water Ambient Monitoring Program (SWAMP). Moreover, all monitoring instruments and devices used by the Discharger for the prescribed field monitoring and sample collection shall be properly maintained and calibrated to ensure proper working condition and continued accuracy.

Dischargers shall submit a Quality Assurance Project Plan (QAPP) for Executive Officer approval six months after adoption of the Conditional Waiver. The QAPP shall describe the quality assurance requirements for the MRP. The QAPP will ensure that data are collected and analyzed consistent with State and Regional Board monitoring programs and are of high quality. The QAPP shall be consistent with the SWAMP QAPP. As such, the Discharger's QAPP shall include at least the following four sections (1) Project Management, (2) Data Generation and Acquisition, (3) Assessment and Oversight, and (4) Data Validation and Usability. A QAPP template is available through the SWAMP website.

The QAPP shall include the location of sample site(s) and the sampling schedule. The QAPP shall include data quality objectives including, but not limited to the following:

- Representativeness
- Comparability
- Accuracy
- Precision
- Recovery
- Reporting limits
- Completeness

The analytical methods, including method detection limits and reporting limits shall be presented in the QAPP. In general, the method detection limits shall be at or below applicable Water Quality Benchmarks. However, several of the constituents of concern have Water Quality Benchmarks that are lower than the readily available detection limits. As analytical methods and detection limits continue to improve (i.e., development of lower detection limits) and become more environmentally relevant, Dischargers shall incorporate new method detection limits in the MRP and QAPP. In the meantime, the detection limits for these constituents shall be set at levels achievable by professional analytical labs, subject to Executive Officer approval.

A laboratory that is certified by the Department of Health Services shall conduct all laboratory analysis according to standard methodologies (e.g. USEPA methods and/or Standard Methods for the Examination of Water and Wastewater). Laboratory analytical methods must be included as an appendix of the QAPP. All data will be submitted in both electronic and written tabular formats to the Regional Board. These formats will be specified by the Executive Officer. The QAPP shall include the laboratory's Standard Operating Procedures (SOPs).

Toxicity testing shall be conducted in accordance with USEPA *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms* (EPA-821-R-02-013) and *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms, Third Edition* (EPA-821-R-02-014), as appropriate. Additionally, toxicity testing will be implemented in accordance with State Water Board and Regional Board plans, policies and guidance at the time that toxicity monitoring is conducted. The Regional Board may review Order No. R4-2010-0186 at the time the State Water Resources Control Board adopts a policy for Whole Effluent Toxicity Assessment and Control and modify the Monitoring and Reporting Requirements pertaining to toxicity monitoring and TIE. Toxicity testing shall be implemented as a trigger for initiation of the TIE process as outlined in USEPA's *Understanding and Accounting for Method Variability in Whole Effluent Toxicity Applications Under the National Pollutant Discharge Elimination System Program* (2000) and *Clarifications Regarding Toxicity Reduction and Identification Evaluations in the National Pollutant Discharge Elimination System Program* (March 27, 2001).

The fish collection and analysis shall be conducted in accordance with the USEPA *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 1 Fish Sampling and Analysis* (EPA 823-B-00-0007) or updates.

2 WATER QUALITY MANAGEMENT PLAN

If water quality monitoring data, collected as described above, indicate exceedances of applicable Water Quality Benchmarks, the Dischargers shall develop a WQMP and, upon approval of and in accordance with said WQMP, implement targeted management practices intended to attain Water Quality Benchmarks. Dischargers shall submit a WQMP within six months after the submittal of the annual monitoring report. The WQMP shall outline specific steps with milestones that work to attainment of Water Quality Benchmarks through the use of management practices. Management practices must be designed and implemented to reduce or eliminate waste discharges to surface waters and groundwater in order to achieve Water Quality Benchmarks. Management practices may include those recommended by organizations such as Natural Resources Conservation Service and University of California Cooperative Extension. The WQMP is subject to Executive Officer approval. In order to address high priority water quality problems, the Executive Officer may require additional monitoring.

Elements of the Water Quality Management Plan

The elements of the WQMP shall include:

Assessment of Existing Conditions

- A summary review of monitoring objectives and sample locations including GPS coordinates and maps.
- An assessment of the impacts of waste discharges from irrigated lands to waters of the State, including a summary of Water Quality Benchmark exceedances.
- Determination of pollutant loading from irrigated agricultural land, where practicable.
- Identification of likely waste sources, review of possible correlations between sampling conditions (e.g., time and weather), seasonal growing activities, and water quality results.
- Follow-up monitoring, which may include edge of field monitoring, as needed, to improve understanding of the nature and source of wastes and/or to document attainment of Water Quality Benchmarks. Follow-up monitoring may be proposed as a revision to the MRP. Edge of field monitoring, conducted as part of follow-up monitoring, is at the discretion of the discharger.
- A description and documentation of existing management practices, including the degree and location of implementation.
- A review of existing management practice maintenance.

Proposed Onsite and/or Subwatershed Modifications

- Identification of priority areas for management practice implementation, follow-up monitoring, and focused outreach and education. Information, such as the severity of water quality problems, existence of TMDL load allocations, and availability of other data sources to inform decision-making, should be considered when identifying priority areas.

- Description and general location of management practices (new or revised) which will be implemented to address water quality impairments. Proposed management practices shall be based on a quantitative assessment of practice performance and expected attainment of Water Quality Benchmarks. Proposed management practices shall consider the protection of both surface and groundwater quality. For example, source control management practices, such as improved irrigation efficiency and nutrient management protect both surface water and groundwater.

- Explanation of the management practice selection process and how the new or revised management practices implemented will address Water Quality Benchmark exceedances.

- A time-certain schedule and strategy for the implementation of new and/or revised management practices.

- Pesticide use evaluation assessment should include the timing of pesticide applications, the application rates, the amounts of pesticide applied, and the points of application. Compare changes in pesticide concentrations at specific monitoring sites to pesticide use patterns for land areas upstream. This comparison may demonstrate how a change in pesticide use patterns could impact water quality. Changing pesticide use patterns is a management practice and may be included in a WQMP.

- Tracking of management practice implementation and maintenance. Compile information on the type of management practices that are being used, the degree and locations of implementation in the area, and the effectiveness of the practices in protecting waters of the state. Data should be collected in several broad areas: (1) fertilizer and pesticide application and post-application practices, (2) management practices to address other wastes (salt, sediment, nitrogen, etc.), and (3) operational practices. If more effective management practices are available and practicable, a time-specific plan to change management practices shall be included.

- An approach to determine the effectiveness of management practices at reducing waste discharge and protecting water quality. This may

require follow-up monitoring. As the program develops, revisions to the WQMP should document effective management

- An evaluation of compliance with Water Quality Benchmarks to determine if implementation of additional or upgraded management practices are necessary to improve and/or protect water quality. Alternatively, provide technical documentation of natural, historical, or existing conditions that are causing noncompliance.

3 Bacteria Special Study

Dischargers shall conduct a Bacteria Special Study to characterize potential discharges of bacteria from irrigated agriculture lands. Within one year of adoption of Order R4-2010-0186 dischargers shall submit a Bacteria Special Study workplan for Executive Officer approval. The workplan must be technically adequate to assess the quality of irrigated agriculture discharges with respect to bacteria. The workplan shall specify representative monitoring locations and frequency to accurately characterize wet- and dry-weather discharges and allow comparison to bacteria water quality objectives. The length of the special study shall be no less than two years.

4 REPORTING REQUIREMENTS

Pursuant to Water Code Section 13267 and 13269, the following Reports are required to be submitted to the Regional Board by the deadlines identified below.

Monitoring and Reporting Plan
DUE: 6 months after Conditional Waiver adoption

The MRP must include the components of the monitoring and reporting requirements as stated in this document. The MRP for receiving waters shall include the following elements:

1. Title page and Table of Contents
2. Description of the Individual Discharger or Discharger Group
3. Summary of Discharger Group membership and setting, including characteristics relevant to the monitoring
4. Summary of the historical data and/or on-going monitoring at each monitoring site
5. Monitoring periods and sites with GPS coordinates
6. Maps showing property boundaries, land use, topography, waters of the state, crop types, and any other features which may affect water quality
7. Summary of current pesticide use practices (including top 5 pesticides applied by volume and 5 most frequently applied pesticides).
8. Monitoring constituents and frequency of sampling to include all constituents in Table 1 and 2
9. A QAPP consistent with the requirements described in Section 1
10. Documentation of monitoring protocols including sample collection and handling methods

11. Individual or Discharger Group contact information
12. Preliminary monitoring data, after QA/QC has been conducted, shall be submitted to the Regional Board in electronic format within 90 days of a monitoring event. Preliminary data will not be considered final until it is submitted as part of the annual monitoring report. Preliminary data will not be used to formally assess attainment of Water Quality Benchmarks.

Annual Monitoring Report
Due: Annually beginning 1 year after issuance of NOA

The Annual Monitoring Report (AMR) shall be prepared after monitoring events have been completed and shall include a review of the results of the data collected and data evaluation. The AMR shall include the following components:

1. Title page
2. Table of contents
3. Description/Summary of Individual or Discharger Group membership and setting
4. Updated membership list, submitted electronically
5. Monitoring objectives
6. Sampling site descriptions, including photographs
7. Location map of sampling sites including GPS coordinates of sampling sites
8. Parameters monitored and frequency
9. Sampling and analytical methods used, submitted in a tabular format
10. Tabulated results of analyses
11. Data interpretation including assessment of compliance and/or noncompliance with Water Quality Benchmarks
12. Results of toxicity exceedances and results of TIE, clearly identified in the report as a separate section
13. Copy of chain of custody, submitted electronically
14. Associated laboratory and field quality control samples results
15. Summary of precision and accuracy
16. Quality control data interpretation, including assessment of data quality objectives
17. If Water Quality Benchmarks are not attained as demonstrated by monitoring, the AMR shall include a statement of intent to prepare a WQMP within six months to address all benchmark exceedances.

18. Documentation that education requirements have been fulfilled by the Individual Discharger or each member of a Discharger Group
19. Conclusions and recommendations

Dischargers eligible under this Qrder bear the responsibility to inform the Regional Board, maintain records, and submit regular reports detailing the types of discharges, monitoring results for required constituents, participants in the Group, the type of management practices implemented (including changes in pesticides applied), how those measures have changed water quality, and other basic information that the Executive Officer may determine is required. Copies of all field documentation and

laboratory original data must be included in the annual monitoring report as attachments. The annual monitoring report should also provide a characterization of the field conditions during each sampling event, including a description of the weather, rainfall, temperature, photographs, stream flow, color of the water, odor, crop type, cultivation practices and pesticide, fertilizer or sediment control measures, which may affect water quality, and other relevant information that can help in data interpretation.

Monitoring and analyses event records shall include the following information: (1) date and time of sampling, (2) sample location (GPS coordinates), (3) individual(s) who performed the sampling or measurements, (4) date(s) analyses were performed, (5) laboratory and/or individual(s) who performed the analyses, (6) the analytical techniques or method used, and (7) the results of such analyses.

The monitoring data will be submitted in a format consistent with SWAMP reporting requirements, both electronically and in written tabular form.

Water Quality Management Plan
Due: Annually 6 months after first AMR with exceedances

The WQMP shall be prepared if monitoring results document the exceedances of Water Quality Benchmarks. The required elements of a WQMP are presented in Section 3 of this document.

Other Reporting Requirements

1. A transmittal letter shall accompany each report. This letter shall include a brief discussion of any violations of the Conditional Waiver that were found during the reporting period or outline implementation of actions to be taken under a WQMP. The transmittal letter shall be signed and shall contain a penalty of perjury statement by the Individual Discharger, Discharger Group, or the Discharger Group's authorized agent. This statement shall state:

   "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for knowingly submitting false information, including the possibility of fine and imprisonment for perjury."

2. If Dischargers monitor any constituent (at locations established in the MRP), for the purposes of evaluating compliance with the provisions of this Qrder, more frequently than required by the Conditional Waiver, the discharger shall submit the monitoring results to the Regional Board.

3. The Dischargers shall retain records of all monitoring information including all calibration and maintenance records, copies of all reports required by this Order, and records of all data used to complete the application for this Order.

4. Records shall be maintained for a minimum of five years from the date of the sample, measurement, or report. This period may be extended during the course of any unresolved enforcement action, including, but not limited to, litigation regarding this discharge, or when requested by the Executive Officer.

5. Each monitoring report must affirm in writing that "All analyses were conducted at a laboratory certified for such analyses by the California Department of Health Services, and in accordance with current USEPA guideline procedures, or as specified in this Monitoring Program."

6. If there is no discharge during any reporting period, the report shall so state. The Discharger shall submit an annual report to the Regional Board within one year of the date of Notice of Applicability and at the same date each year thereafter. Monitoring reports must be provided in electronic format to be specified by the Executive Officer, and a paper copy must be provided and addressed to the Regional Board, Attention: Irrigated Lands Regulatory Program.

7. Records and reports submitted to the Regional Board are public documents and shall be made available for inspection during normal business hours at the Regional Board office.

CONDITIONAL WAIVER OF WASTE DISCHARGE REQUIREMENTS
FOR DISCHARGES FROM IRRIGATED LANDS
ORDER NO. R4-2010 – 0186

APPENDIX 2
STANDARD WATER QUALITY BENCHMARKS

Constituent	Units	Water Quality Benchmark
Temperature	^{0}F	(a)[1]
pH	pH units	(a)[1]
Dissolved Oxygen (DO)	mg/L	(a)[1]
Turbidity	NTU	(a)[1]
Trash	NA	(a)[1]
Total Suspended Solids	mg/L	(a)[1]
Total Dissolved Solids	mg/L	(a)[1]
Chloride	mg/L	(a)[1]
Nitrate-Nitrogen	mg/L	(a)[1]
Ammonia-Nitrogen	mg/L	(a)[1]
Sulfate	mg/L	(a)[1]
Copper[2]	µg/L	$CCC = 0.960e^{[(0.8545(\ln(\text{hardness}) + (-1.702)]}$
Chlordane[2]	µg/L	0.00059
4,4'-DDT[2]	µg/L	0.00059
4,4'-DDD[2]	µg/L	0.00084
DDE[2]	µg/L	0.00059
Dieldrin[2]	µg/L	0.00014
Toxaphene[2]	µg/L	0.00075
Chlorpyrifos[3]	µg/L	0.025
Diazinon[3]	µg/L	0.10
Toxicity[4]	TU_c	1.0

(a)[1] Water Quality Benchmarks shall be based on the surface water and groundwater basin objectives currently contained in the Water Quality Control Plan Los Angeles Region (Basin Plan) or other applicable water quality standards established for the Los Angeles Region.

[2] The Water Quality Benchmarks are based on the CTR criteria.

[3] The Water Quality Benchmarks are based on the targets developed in the Calleguas Creek Watershed and Mugu Lagoon Toxicity, Chlorpyrifos, and Diazinon TMDL (Resolution No. R05-009).

[4] TU_c or Toxic Unit-Chronic is the reciprocal of the effluent concentration that causes no observable effects (i.e., no mortality) on the test organisms by the end of a chronic toxicity test.

CONDITIONAL WAIVER OF WASTE DISCHARGE REQUIREMENTS
FOR DISCHARGES FROM IRRIGATED LANDS
ORDER NO. R4-2010 – 0186

APPENDIX 3

WATER QUALITY BENCHMARKS BASED UPON TMDL LOAD ALLOCATIONS

(Load allocations that apply after the term of the waiver are shaded in grey)

Calleguas Creek Watershed and Mugu Lagoon OC Pesticides & PCBs TMDL — **Compliance Date**

Compliance with interim and final sediment based load allocations (LAs) is measured as an in-stream annual average at the base of each subwatershed.

Interim Sediment LAs (ng/g)

Constituent	Subwatershed					
	Mugu Lagoon[1]	Calleguas Creek	Revolon Slough	Arroyo Las Posas	Arroyo Simi	Conejo Creek
Chlordane	25.0	17.0	48.0	3.3	3.3	3.4
4,4-DDD	69.0	66.0	400.0	290.0	14.0	5.3
4,4- DDE	300.0	470.0	1,600.0	950.0	170.0	20.0
4,4-DDT	39.0	110.0	690.0	670.0	25.0	2.0
Dieldrin	19.0	3.0	5.7	1.1	1.1	3.0
PCBs	180.0	3,800.0	7,600.0	25,700.0	25,700.0	3,800.0
Toxaphene	22,900.0	260.0	790.0	230.0	230.0	260.0

March 24, 2006

[1]The Mugu Lagoon subwatershed includes Duck Pond/Agricultural Drain/Mugu/Oxnard Drain #2.

Final Sediment LAs (ng/g)

Constituent	Subwatershed					
	Mugu Lagoon[1]	Calleguas Creek	Revolon Slough	Arroyo Las Posas	Arroyo Simi	Conejo Creek
Chlordane	3.3	3.3	0.9	3.3	3.3	3.3
4,4-DDD	2.0	2.0	2.0	2.0	2.0	2.0
4,4- DDE	2.2	1.4	1.4	1.4	1.4	1.4
4,4-DDT	0.3	0.3	0.3	0.3	0.3	0.3
Dieldrin	4.3	0.2	0.1	0.2	0.2	0.2
PCBs	180.0	120.0	130.0	120.0	120.0	120.0
Toxaphene	360.0	0.6	1.0	0.6	0.6	0.6

March 24, 2026

[1] The Mugu Lagoon subwatershed includes Duck Pond/Agricultural Drain/Mugu/Oxnard Drain #2.

Siltation LAs

2,704 tons/yr reduction in sediment yield to Mugu Lagoon. The baseline from which the load reduction will be evaluated will be determined by a special study of this TMDL. The results of this special study are due March 24, 2014.

March 24, 2015

<table>
<tr><th>Calleguas Creek Watershed and Mugu Lagoon Toxicity, Chlorpyrifos, and Diazinon TMDL</th><th>Compliance Date</th></tr>
<tr><td>Interim Chlorpyrifos Load Allocations (ug/L) apply watershed-wide
<table><tr><th>Acute (1hour)</th><th>Chronic (4 day)</th></tr><tr><td>2.57</td><td>0.810</td></tr></table>
Interim Diazinon Load Allocations (ug/L) apply watershed-wide
<table><tr><th>Acute (1hour)</th><th>Chronic (4 day)</th></tr><tr><td>0.278</td><td>0.138</td></tr></table></td><td>March 24, 2006</td></tr>
<tr><td>A load allocation of 1.0 TUc applies watershed-wide.</td><td>March 24, 2006</td></tr>
<tr><td>Final Chlorpyrifos Load Allocations (ug/L)
<table><tr><th>Subwatershed</th><th>Acute & Chronic</th></tr><tr><td>Arroyo Simi</td><td>0.014</td></tr><tr><td>Las Posas</td><td>0.014</td></tr><tr><td>Conejo</td><td>0.014</td></tr><tr><td>Calleguas</td><td>0.0133</td></tr><tr><td>Revolon</td><td>0.0133</td></tr><tr><td>Mugu Lagoon</td><td>0.014</td></tr></table>
Final Diazinon Load Allocations (ug/L) apply watershed-wide
<table><tr><th>Acute & Chronic</th></tr><tr><td>0.1</td></tr></table></td><td>March 24, 2016</td></tr>
</table>

<table>
<tr><th>Calleguas Creek Watershed Boron, Chloride, Sulfate and TDS (Salts) TMDL</th><th>Compliance Date</th></tr>
<tr><td>Interim Dry Weather Load Allocations
<table><tr><th>Constituent</th><th>Interim Limit (mg/L)</th></tr><tr><td>Boron Total</td><td>1.8</td></tr><tr><td>Chloride Total</td><td>230</td></tr><tr><td>Sulfate Total</td><td>1962</td></tr><tr><td>TDS Total</td><td>3995</td></tr></table></td><td>Dec. 2, 2008</td></tr>
</table>

<table>
<tr><th>Calleguas Creek Watershed Boron, Chloride, Sulfate and TDS (Salts) TMDL</th><th>Compliance Date</th></tr>
<tr><td>Interim dry weather load allocations are measured as in-stream monthly averages at the based of each subwatershed, except for chloride which is measured as an instantaneous maximum.

Dry weather LAs apply when flow rates are below the 86th percentile and there was no measurable precipitation in the previous 24 hour period.

The 86th percentile flow rate shall be calculated based on flow in the hydrologic year (Oct. 1st – Sept. 30th) that the sample was collected.</td><td></td></tr>
<tr><td>Final Dry Weather Load Allocations

<table><tr><th>Subwatershed</th><th>Boron Allocation (lb/day)</th><th>Chloride Allocation (lb/day)</th><th>TDS Allocation (lb/day)</th><th>Sulfate Allocation (lb/day)</th></tr><tr><td>Simi</td><td>641</td><td>3,631</td><td>1,068</td><td>4</td></tr><tr><td>Las Posas</td><td>2,109</td><td>11,952</td><td>3,515</td><td>N/A</td></tr><tr><td>Conejo</td><td>743</td><td>4,212</td><td>1,239</td><td>N/A</td></tr><tr><td>Camarillo</td><td>59</td><td>336</td><td>99</td><td>N/A</td></tr><tr><td>Pleasant Valley</td><td>305</td><td>1,730</td><td>509</td><td>N/A</td></tr><tr><td>Revolon</td><td>7,238</td><td>41,015</td><td>12,063</td><td>48</td></tr></table>
Dry weather LAs apply in the receiving water at the base of each subwatershed when flow rates are below the 86th percentile and there was no measurable precipitation in the previous 24 hour period.

The 86th percentile flow rate shall be calculated based on flow in the hydrologic year (Oct. 1st – Sept. 30th) that the sample was collected.</td><td>Dec. 23, 2023</td></tr>
</table>

<table>
<tr><th>Calleguas Creek Watershed and Mugu Lagoon Metals and Selenium TMDL</th><th>Compliance Date</th></tr>
<tr><td>
Interim Load Allocations for total recoverable metals
<table>
<tr><th rowspan="2">Constituent</th><th colspan="3">Calleguas and Conejo Creek</th></tr>
<tr><th>Dry Daily Maximum (ug/L)</th><th>Dry Monthly Average (ug/L)</th><th>Wet Daily Maximum (ug/L)</th></tr>
<tr><td>Copper</td><td>24</td><td>19</td><td>1390</td></tr>
<tr><td>Nickel</td><td>43</td><td>42</td><td>--</td></tr>
<tr><td>Selenium</td><td>--</td><td>--</td><td>--</td></tr>
</table>
<table>
<tr><th rowspan="2">Constituent</th><th colspan="3">Revolon Slough</th></tr>
<tr><th>Dry Daily Maximum (ug/L)</th><th>Dry Monthly Average (ug/L)</th><th>Wet Daily Maximum (ug/L)</th></tr>
<tr><td>Copper</td><td>24</td><td>19</td><td>1390</td></tr>
<tr><td>Nickel</td><td>43</td><td>42</td><td>--</td></tr>
<tr><td>Selenium</td><td>6.7 (c)</td><td>6 (c)</td><td>--</td></tr>
</table>
c – Attainment of interim limits will be evaluated in consideration of background loading data, if available.

Dry weather LAs apply to days when flows in the stream are less than the 86th percentile flow rate for each subwatershed. Wet weather LAs apply to days when flows in the stream exceed the 86th percentile flow rate for each subwatershed.

The 86th percentile flow rate shall be calculated based on flow in the hydrologic year (Oct. 1st – Sept. 30th) that the sample was collected.
</td><td>March 26, 2007</td></tr>
<tr><td>
Interim Load allocations for Mercury in Suspended Sediment (lbs/year)
<table>
<tr><th>Flow Range million gallons/year</th><th>Calleguas Creek</th><th>Revolon Slough</th></tr>
<tr><td>0-15,000</td><td>3.9</td><td>2</td></tr>
<tr><td>15,000-25,000</td><td>12.6</td><td>4.8</td></tr>
<tr><td>Above 25,000</td><td>77.5</td><td>12.2</td></tr>
</table>
Interim load allocations are measured in-stream at the based of Revolon Slough and Calleguas Creek.
</td><td>March 26, 2007</td></tr>
</table>

Calleguas Creek Watershed and Mugu Lagoon Metals and Selenium TMDL	Compliance Date

Dry Weather - Final Load allocations (lbs/day) for total recoverable metals

Constituent	Calleguas Creek		
	Low Flow	Avg. Flow	Elevated Flow
Copper*	0.07 x (WER – 0.03)	0.12 x (WER – 0.02)	0.31 x (WER – 0.05)
Nickel	0.420	0.260	0.970
Selenium	--	--	--

* If site-specific WERs are approved by the Regional Board, TMDL load allocations shall be implemented in accordance with the approved WERs using the equations set forth above.

Calleguas Creek	
Flow Category	Flow Rate (cfs)
Low	0 - 5
Average	5 - 21
Elevated	21 - 30

Constituent	Revolon Slough		
	Low Flow	Avg. Flow	Elevated Flow
Copper*	0.07 x (WER – 0.03)	0.14 x (WER – 0.07)	0.35 x (WER – 0.07)
Nickel	0.390	0.690	1.600
Selenium	0.008	0.007	0.018

* If site-specific WERs are approved by the Regional Board, TMDL load allocations shall be implemented in accordance with the approved WERs using the equations set forth above.

Revolon Slough	
Flow Category	Flow Rate (cfs)
Low	0 - 10
Average	10 - 17
Elevated	17 - 22

Wet Weather Final Load Allocations (lbs/day) for total recoverable metals

Constituent	Calleguas Creek	Revolon Slough
Copper*	$(0.00017 \times Q^2 \times 0.01 \times Q - 0.05) \times WER - 0.02$	$(0.00123 \times Q^2 + 0.0034 \times Q) \times WER$
Nickel	$0.014 \times Q^2 + 0.82 \times Q$	$0.027 \times Q^2 + 0.47 \times Q$
Selenium	--	$0.1 \times Q^2 + 1.8 \times Q$

* If site-specific WERs are approved by the Regional Board, TMDL load allocations shall be implemented in accordance with the approved WERs using the equations set forth above.
Q = Daily storm volume

March 26, 2022

<table>
<tr><th>Calleguas Creek Watershed and Mugu Lagoon Metals and Selenium TMDL</th><th>Compliance Date</th></tr>
<tr><td>Final Load allocations for Mercury in Suspended Sediment (lbs/year)
<table><tr><th></th><th>Calleguas Creek</th><th>Revolon Slough</th></tr><tr><th>Flow Range MGY</th><th>Agriculture</th><th>Agriculture</th></tr><tr><td>0-15,000</td><td>0.5</td><td>0.2</td></tr><tr><td>15,000-25,000</td><td>1.9</td><td>0.8</td></tr><tr><td>Above 25,000</td><td>11.2</td><td>2.2</td></tr></table>
Final load allocations are measured in-stream at the based of Revolon Slough and Calleguas Creek.</td><td>March 26, 2022</td></tr>
</table>

<table>
<tr><th>Calleguas Creek Nitrogen Compounds and Related Effects TMDL</th><th>Compliance Date</th></tr>
<tr><td><table><tr><th>Nitrate-N + Nitrite-N (mg/L)</th></tr><tr><td>9.0</td></tr></table></td><td>July 16, 2010</td></tr>
</table>

<table>
<tr><th>Revolon Slough and Beardsley Wash Trash TMDL</th><th>Compliance Date</th></tr>
<tr><td>LAs are zero trash. Dischargers may achieve compliance with the LAs by implementing a minimum frequency of assessment and collection/best management practice (MFAC/BMP) program. By March 6, 2010, agricultural dischargers must demonstrate full compliance and attainment of the zero trash target's requirement that trash is not accumulating in deleterious amounts between the required trash assessment and collection events.</td><td>March 6, 2010</td></tr>
</table>

Upper Santa Clara River Chloride TMDL, Revisions	Compliance Date

Reach	Chloride Conditional LA (mg/L)
6	150 (12 month average)
	230 (daily maximum)
5	150 (12 month average)
	230 (daily maximum)
4B	117 (3 month average)
	230 (daily maximum)

These are conditional LAs and shall apply only when chloride load reductions and/or chloride export projects are in operation by the Santa Clarita Valley Sanitation District according to the implementation section in Table 7-6.1 of Attachment A to Resolution No. R4-2008-012. If these conditions are not met, LAs are based on existing water quality objectives 100mg/L.

April 6, 2010

Santa Clara River Nitrogen Compounds TMDL	Compliance Date

Reach	NH_3-N + NO_2-N + NO_3-N (mg-N/L)
7	8.5
Mint Canyon Reach 1 Wheeler Canyon/Todd Barranca Brown Barranca/Long Canyon Other Santa Clara River Reaches	10

March 23, 2004

Malibu Creek Watershed Nutrients TMDL	Compliance Date

Season	Total Nitrogen (lbs/day)	Total Phosphorus (lbs/day)
Summer (April 15 – November 15)	3	0.2

Season	Nitrogen (mg/L) (nitrate-N + nitrite-N)
Winter (November 16 – April 14)	8

March 21, 2003

Ventura River Estuary Trash TMDL	Compliance Date
LAs are zero trash. Dischargers may achieve compliance with the LAs by implementing a minimum frequency of assessment and collection/best management practice (MFAC/BMP) program. By March 6, 2010, agricultural dischargers must demonstrate full compliance and attainment of the zero trash target's requirement that trash is not accumulating in deleterious amounts between the required trash assessment and collection events.	March 6, 2010

The Santa Clara River Estuary Toxaphene TMDL				Compliance Date
Reach		**Toxaphene Fish Tissue Target**	**Toxaphene Allocation for Concentration in Suspended Sediment**	October 7, 2010
Santa Clara River Estuary		6.1 (µg/kg)	0.1 (µg/kg)	
Within ten years of the compliance date, toxaphene concentrations in fish tissue shall be attenuating such that it appears that numeric targets will be achieved within 15 years.				

Ordered by: Samuel Unger

Samuel Unger, PE
Executive Officer

Nov. 19, 2010
Date

State of California
California Regional Water Quality Control Board, Los Angeles Region

RESOLUTION NO. R4-2008-009
September 11, 2008

Amendment to the Water Quality Control Plan for the Los Angeles Region through revision of the Waste Load Allocations for the Calleguas Creek Watershed Nitrogen Compounds and Related Effects Total Maximum Daily Load

WHEREAS, the California Regional Water Quality Control Board, Los Angeles Region, finds that:

1. The Federal Clean Water Act (CWA) requires the California Regional Water Quality Control Board, Los Angles Region (Regional Board) to establish water quality standards for each water body within its region. Water quality standards include beneficial uses, water quality objectives that are established at levels sufficient to protect those beneficial uses, and an antidegradation policy to prevent degrading waters. Water bodies that do not meet water quality standards are considered impaired.

2. CWA section 303(d)(1) requires each state to identify the waters within its boundaries that do not meet water quality standards. Those waters are placed on the state's "303(d) List" or "Impaired Waters List". For each listed water, the state is required to establish the Total Maximum Daily Load (TMDL) of each pollutant impairing the water quality standards in that waterbody. Both the identification of impaired waters and TMDLs established for those water must be submitted to the United States Environmental Protection Agency (U.S. EPA) for approval pursuant to CWA section 303(d)(2). For all waters that are not identified as impaired, the states are nevertheless required to create TMDLs pursuant to CWA section 303(d)(3), however TMDLs pursuant to subdivision (d)(3) do not require U.S. EPA approval.

3. The elements of a TMDL are described in 40 CFR 130.2 and 130.7 and section 303(d) of the CWA, as well as in U.S. EPA guidance documents (e.g., U.S. EPA, 1991). A TMDL is defined as "the sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background" (40 CFR 130.2). Regulations further stipulate that TMDLs must be set at "levels necessary to attain and maintain the applicable narrative and numeric water quality standards with seasonal variations and a margin of safety that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality" (40 CFR 130.7(c)(1)). The regulations in 40 CFR 130.7 also state that TMDLs shall take into account critical conditions for stream flow, loading and water quality parameters.

4. Upon establishment of TMDLs by the State or U.S. EPA, the State is required to incorporate the TMDLs along with appropriate implementation measures into the State Water Quality Management Plan (40 CFR 130.6(c)(1), 130.7). The Basin Plan and applicable statewide plans serve as the State Water Quality Management Plans governing the watersheds under the jurisdiction of the Regional Board.

5. A consent decree between U.S. EPA, Heal the Bay, Inc. and BayKeeper, Inc. was approved on March 22, 1999, which resolved litigation between those parties relating to the pace of TMDL development. The court order directs the U.S. EPA to ensure that TMDLs for all 1998-listed impaired waters be established within 13 years of the consent decree. The consent decree combined water body pollutant combinations in the Los Angeles Region into 92 TMDL analytical units. Waterbodies impaired by eutrophia, algae, ammonia, and odor in Calleguas Creek watershed were scheduled in the Consent Decree as analytical unit 1. The TMDL for eutrophia, algae, ammonia and odor, Resolution No. 02-017, was adopted by the Regional Board on October 24, 2002.

6. The Calleguas Creek Watershed is located in southeast Ventura County, California, and in a small portion of western Los Angeles County, and drains an area of approximately 343 square miles from the Santa Susana Pass in the east, to Mugu Lagoon in the southwest. Current land use is approximately 26 percent agriculture, 24 percent urban, and 50 percent open space.

7. The Regional Board's goal in establishing the above-mentioned TMDL was to maintain the warm water fish and wildlife habitat (WARM, WILD) and groundwater recharge (GWR) beneficial uses of Calleguas Creek as established in the Basin Plan. Nitrogen compounds at high concentration may stimulate the production of excessive algae mats which have been observed in certain reaches of Calleguas Creek and can result in eutrophic conditions characterized by low dissolved oxygen concentrations which is harmful to aquatic life. Additionally, ammonia is known to cause toxicity to aquatic organisms.

8. At a public meeting on October 24, 2002, the Regional Board adopted an amendment to the Basin Plan to include a TMDL for Nitrogen Compounds and Related Effects in the Calleguas Creek watershed. The Calleguas Creek ~~Nutrient~~ Nitrogen Compounds and Related Effects TMDL included concentration based maximum daily effluent limits (MDEL), average monthly effluent limits (AMEL), and mass based daily waste load allocations (WLAs) for ammonia for publicly owned treatment works (POTWs) including Hill Canyon Wastewater Treatment Plant (WTP), Simi Valley Water Quality Control Facility (WQCF), Moorpark Wastewater Treatment Plant (WTP), Camarillo Water Reclamation Plant (WRP), and Camrosa Water Reclamation Facility (WRF).

9. The Regional Board considered the entire record, including the California Environmental Quality Act (CEQA) documentation, written and oral comments received from the public, and the Regional Board staff's response to the written

comments. The Basin Plan amendment to incorporate the TMDL for ~~Nutrient~~ Nitrogen Compounds and Related Effects for Calleguas Creek, Resolution 02-017, was adopted by Regional Board on October 24, 2002. Resolution 02-017 assigned waste load allocations (WLAs) to major publicly owned treatment works (POTWs).

10. The TMDL for ~~Nutrient~~ Nitrogen Compounds and Related Effects for Calleguas Creek, Resolution No. 02-017 was approved by the State Water Resources Control Board (State Board) on March 19, 2003, the Office of Administrative Law (OAL) on June 5, 2003, and the U.S. EPA on June 20, 2003. The TMDL for ~~Nutrient~~ Nitrogen Compounds and Related Effects for Calleguas Creek, Resolution No. 02-017 is effective on July 16, 2003.

11. The National Pollutant Discharge Elimination System (NPDES) permits for the Hill Canyon WTP, Simi Valley WQCF, Moorpark WTP, Camarillo WRP, and Camrosa WRF will be under consideration in the near future for renewal by the Regional Board. The Calleguas Creek Nitrogen Compounds and Related Effects TMDL waste load allocations will be incorporated into the permits in conformance with the Clean Water Act and related federal regulations.

12. In preparing the NPDES permit renewals, Regional Board identified a typographical error in the mass based daily WLAs for ammonia in the Calleguas Creek Nitrogen Compounds and Related Effects TMDL. Translating a concentration–based limit into a mass based daily limit requires multiplying the concentration-based limit by the flow rate. The mass based daily WLAs for ammonia, however, were incorrectly calculated as the product of the daily flow rate and the average monthly effluent limits (AMEL), rather than the daily flow rate and the maximum daily effluent limits (MDEL).

13. When the original TMDL was adopted (2002) the practice at that time was to calculate the flow rate of a POTW and include it in the basin plan a static factor. Current practice, however, recognizes that POTW flow rates are dynamic. As a result, current mass-based limits that are incorporated into the basin plan will often be expressed as an equation that includes Q, or the flow rate, as one of its factors. The use of the POTW effluent flow rate to calculate mass based WLAs is consistent with other TMDLs recently approved by U.S. EPA.

14. This Basin Plan Amendment corrects the mass based daily WLAs for ammonia to be based upon the MDEL, and updates the WLAs to be consistent with the current practice of recognizing that flow is variable. The mass based WLAs for ammonia are corrected to be based on the maximum daily effluent limit, MDEL and the actual POTW effluent flow rate at the time the monitoring is conducted.

15. The mass based WLAs for ammonia in the Calleguas Creek Nitrogen Compounds and Related Effects TMDL include a 10% explicit margin of safety to account for uncertainty concerning the relationships between WLAs and attainment of the

water quality standards addressing algae and other listed stressors associated with nutrient loads.

16. The amendment is consistent with the State Antidegradation Policy (State Board Resolution No. 68-16), in that the revisions of the WLAs for the Calleguas Creek ~~creek Nutrients~~ Nitrogen Compounds and Related Effects TMDL do not include revisions to WQOs, and provide mass reduction to meet water quality objectives. Likewise, the amendment is consistent with the federal Antidegradation Policy (40 CFR 131.12).

17. The proposed amendment results does not alter the environmental analysis that was previously completed for the Calleguas Creek Nitrogen Compounds and Related Effects TMDL because correction of the mass based WLAs for ammonia will not result in different implementation actions than those previously analyzed for the Calleguas Creek Nitrogen Compounds and Related Effects TMDL, or different effects upon the environment. The environmentally significant WLA remains the MDEL, which is the technically derived ceiling to the amount of ammonia that can and should be authorized. Correcting the mass-based daily limit to be consistent with the MDEL, as originally intended, has no potential to result in a change in the physical environment. As such, this amendment is both consistent with the prior CEQA documentation, and is itself not a "project" within the meaning of CEQA.

18. The public has had a reasonable opportunity to participate in the review of the revision to the Waste Load Allocations of the Basin Plan amendment, Resolution 02-017. A draft of the TMDL revisions was released for public comment on July 1, 2008; a Notice of Hearing was published and circulated 45 days preceding Board action; Regional Board staff responded to oral and written comments received from the public; and the Regional Board held a public hearing on September 11, 2008 to consider adoption of the revision to the Waste Load Allocations of the Basin Plan Amendment, Resolution 02-017. The revised WLAs are proposed in Attachment A to this resolution.

19. The regulatory action meets the "Necessity" standard of the Administrative Procedures Act, Government Code, section 11353, subdivision (b).

20. The Basin Plan amendment incorporating a revision for the Waste Load Allocation section in the Calleguas Creek ~~Nutrient~~ Nitrogen Compounds and Related Effects TMDL must be submitted for review and approval by the State Board, the OAL, and the U.S. EPA. The Basin Plan amendment will become effective upon approval by OAL and U.S. EPA. A Notice of Decision will be filed following these approvals.

THEREFORE, be it resolved that pursuant to Section 13240 and 13242 of the Water Code, the Regional Board bereby amends the Basin Plan as follows:

1. Pursuant to sections 13240 and 13242 of the California Water Code, the Regional Board, after considering the entire record, including oral testimony at the hearing, hereby adopts the amendment to Chapter 7 of the Water Quality Control Plan for the Los Angeles Region to incorporate the revisions of the Waste Load Allocation in the Calleguas Creek Watershed Nitrogen Compounds and Related Effects TMDL, Table 7-7.1 Calleguas Creek Nitrogen Compounds and Related Effects TMDL: Elements, and the corresponding reference to Chapter 5, as set forth in Attachment A hereto.

2. The Executive Officer is directed to forward copies of the Basin Plan amendment to the State Board in accordance with the requirements of section 13245 of the California Water Code.

3. The Regional Board requests that the State Board approves the Basin Plan amendment in accordance with the requirements of sections 13245 and 13246 of the California Water Code and forward it to the OAL and the U.S. EPA.

4. If during its approval process Regional Board staff, State Board or OAL determines that minor, non-substantive corrections to the language of the amendment are needed for clarity, or for consistency, the Executive Officer may make such changes, and shall inform the Board of any such changes.

5. The Executive Officer is authorized to request a "No Effect Determination" from the Department of Fish and Game, or transmit a payment of applicable as maybe required to the Department of Fish and Game.

I, Tracy J. Egoscue, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of a resolution adopted by the California Regional Water Quality Control Board, Los Angeles Region, on September 11, 2008.

Original signed by
Tracy J. Egoscue
Executive Officer

09/25/08
Date

Attachment A to Resolution No. R4-2008-009

Revision of the Waste Load Allocation of the

Calleguas Creek Watershed Nitrogen Compounds and Related Effects TMDL

Adopted by the California Regional Water Quality Control Board, Los Angeles Region on September 11, 2008.

Amendments

Table of Contents

Chapter 7. Total Maximum Daily Loads (TMDLs)

7-7 Calleguas Creek Nitrogen Compounds and Related Effects TMDL

List of Figures, Tables, and Inserts

Chapter 7. Total Maximum Daily Loads (TMDLs)
Tables

7-7 Calleguas Creek Nitrogen Compounds and Related Effects TMDL
7-7.1. Calleguas Creek Nitrogen Compounds and Related Effects TMDL: Elements
7-7.2. Calleguas Creek Nitrogen Compounds and Related Effects TMDL: Implementation Schedule

Chapter 7. Total Maximum Daily Loads (TMDLs)
Calleguas Creek Nitrogen Compounds and Related Effects TMDL

This TMDL was adopted by: The Regional Water Quality Control Board on October 24, 2002.
This TMDL was approved by: The State Water Resources Control Board on March 19, 2003.
This TMDL was approved by: The Office of Administrative Law on June 5, 2003.
This TMDL was approved by: The U.S. Environmental Protection Agency on June 20, 2003.
This TMDL was revised and adopted by: The Regional Water Quality Control Board on September 11, 2008.
This TMDL was re-approved by: The State Water Resources Control Board on [Insert date].
This TMDL was re-approved by: The Office of Administrative Law on [Insert date].
This TMDL was re-approved by: The U.S. Environmental Protection Agency on [Insert date].
This TMDL is effective on July 16, 2003

The elements of the TMDL are presented in Table 7-7.1 and the Implementation Plan in Table 7-7.2

Table 7-7.1. Calleguas Creek Nitrogen Compounds and Related Effects TMDL: Elements

<table>
<tr><th>Element</th><th>Calleguas Creek Nitrogen Compound and Related Effects</th></tr>
<tr><td>Problem Statement</td><td>Elevated nitrogen concentrations (ammonia, nitrite and nitrate) are causing impairments of the warm water fish and wildlife habitat, and groundwater recharge beneficial uses of Calleguas Creek. Nitrite and nitrate contribute to eutrophic effects such as low dissolved oxygen and algae growth. Ammonia contributes to toxicity.</td></tr>
<tr><td>Numeric Target (Interpretation of the numeric water quality objective, used to calculate the load allocations)</td><td>Numeric targets for this TMDL are listed as follows:

1. Total Ammonia as Nitrogen (NH_3-N)

<table>
<tr><th></th><th>Reach</th><th>NH_3-N concentration (mg/L)
One-hour average</th><th>Thirty-day average</th></tr>
<tr><td>*</td><td>Mugu Lagoon</td><td>8.1</td><td>2.9</td></tr>
<tr><td>*</td><td>Calleguas Creek, South</td><td>5.5</td><td>2.4</td></tr>
<tr><td>*</td><td>Calleguas Creek, North</td><td>8.4</td><td>3.0</td></tr>
<tr><td>*</td><td>Revlon Slough</td><td>5.7</td><td>2.9</td></tr>
<tr><td>*</td><td>Beardsley Channel</td><td>5.7</td><td>2.9</td></tr>
<tr><td>*</td><td>Arroyo Las Posas</td><td>8.1</td><td>2.6</td></tr>
<tr><td>*</td><td>Arroyo Simi</td><td>4.7</td><td>2.4</td></tr>
<tr><td>*</td><td>Tapo Canyon</td><td>3.9</td><td>1.9</td></tr>
<tr><td>*</td><td>Conejo Creek (Confluence with Calleguas Creek to Santa Rosa Rd.)</td><td>9.5</td><td>3.5</td></tr>
<tr><td>*</td><td>Conejo Creek (Santa Rosa Road to Thousand Oaks City Limit)</td><td>8.4</td><td>3.4</td></tr>
<tr><td>*</td><td>Conejo Creek, Hill Canyon Reach</td><td>8.4</td><td>3.1</td></tr>
<tr><td>*</td><td>Conejo Creek, North Fork</td><td>3.2</td><td>1.7</td></tr>
<tr><td>*</td><td>Arroyo Conejo (South Fork Conejo Creek)</td><td>5.1</td><td>3.4</td></tr>
<tr><td>*</td><td>Arroyo Santa Rosa</td><td>5.7</td><td>2.4</td></tr>
</table>

2. Nitrate and nitrite as nitrogen (NO_3-N and NO_2-N)

<table>
<tr><th></th><th>Constituent</th><th>Concentration (mg/L)</th></tr>
<tr><td>*</td><td>NO_3-N</td><td>10</td></tr>
<tr><td>*</td><td>NO_2-N</td><td>1</td></tr>
<tr><td>*</td><td>NO_3-N + NO_2-N</td><td>10</td></tr>
</table>

Numeric targets to address narrative objectives required to protect warm freshwater and wildlife habitat are intended to implement the narrative objectives and may be revised based on the results of monitoring and special studies conducted pursuant to the implementation plan.</td></tr>
</table>

<table>
<tr><td>Source Analysis</td><td>The principal sources of nitrogen into Calleguas Creek are discharges from the POTWs in the watershed and runoff from agricultural activities in the watershed.</td></tr>
<tr><td>Linkage Analysis</td><td>Linkage between nitrogen sources and the in-stream water quality was established through a mass continuity model based on an evaluation of recent hydrodynamic and water quality data.</td></tr>
<tr><td>Waste Load Allocations (for point sources)</td><td>The waste load allocations (WLAs) are as follows:
<table>
<tr><th rowspan="2">POTWs</th><th colspan="3">NH_3-N</th><th>NO_3-N (mg/L)</th><th>NO_2-N (mg/L)</th><th>NO_3-N + NO_2-N (mg/L)</th></tr>
<tr><th>MDEL[1] (mg/L)</th><th>AMEL[2] (mg/L)</th><th>Daily WLA[3] (lbs/day)</th></tr>
<tr><td>Hill Canyon WTP[4]</td><td>5.6</td><td>3.1</td><td>5.1xQ</td><td>9.0</td><td>0.9</td><td>9.0</td></tr>
<tr><td>Simi Valley WQCF[5]</td><td>3.3</td><td>2.4</td><td>2.9xQ</td><td>9.0</td><td>0.9</td><td>9.0</td></tr>
<tr><td>Moorpark WTP</td><td>6.4</td><td>2.6</td><td>5.7xQ</td><td>9.0</td><td>0.9</td><td>9.0</td></tr>
<tr><td>Camarillo WRP[6]</td><td>7.8</td><td>3.5</td><td>7.0xQ</td><td>9.0</td><td>0.9</td><td>9.0</td></tr>
<tr><td>Camrosa WRF[7]</td><td>7.2</td><td>3.0</td><td>6.5xQ</td><td>9.0</td><td>0.9</td><td>9.0</td></tr>
</table></td></tr>
<tr><td>Load Allocation (for non point sources)</td><td>The source analysis indicates that agricultural discharge is the major non-point source of oxidized nitrogen to Calleguas Creek and its tributaries. This source is particularly significant in Revolon Slough and other agricultural drains in the lower Calleguas watershed where there are no point sources of ammonia and oxidized nitrogen. Load allocations for non-point sources are:
<table>
<tr><th>Nonpoint Source</th><th>NO_3-N + NO_2-N (mg/L)</th></tr>
<tr><td>Agriculture</td><td>9.0</td></tr>
<tr><td>Other Nonpoint Source</td><td>9.0</td></tr>
</table></td></tr>
<tr><td>Implementation</td><td>1. Refer to Table 7-7.2
2. Several of the POTWs in the Calleguas Creek watershed will require additional time to meet the nitrogen (NO_3-N, NO_2-N, and NO_3-N + NO_2-N) waste load allocations. To allow time to meet the nitrogen waste load allocations, interim limits will be allowed for a period of four years from the effective date of the TMDL during which the POTWs will be required to meet the effluent limit for NO_3-N + NO_2-N only. Effluent limits for the individual compounds NO_3-N and NO_2-N are not required during the interim period.</td></tr>
</table>

[1] Maximum daily effluent limitation

[2] Average monthly effluent limitation

[3] Q represents the POTW effluent flow at the time the water quality measurement is collected and a conversion factor to lb/day based on the units of measurement for the effluent flow.

[4] Wastewater Treatment Plant

[5] Water Quality Control Facility

[6] Water Reclamation Plant

[7] Water Reclamation Facility

	Interim Limits for NO_3-N + NO_2-N* *POTWs* — *Monthly Average (mg/L)* — *Daily Maximum (mg/L)* • Hill Canyon WTP 36.03 38.32 • Simi Valley WQCF 31.60 32.17 • Moorpark WTP 31.5 32.01 • Camarillo WRP 36.23 37.75 *The monthly average and daily maximum interim limits are based on the 95th and 99th percentiles of effluent performance data reported in the Calleguas Creek Characterization Study 3. The waste load allocations for ammonia will be applicable on the effective date of the TMDL. Interim limits for ammonia will be applicable for no more than 2 years starting from October 24, 2002 for POTWs that are not able to achieve immediate compliance with the assigned waste load allocations. The interim limits for ammonia may be established at the discretion of the Regional Board when a POTW's NPDES permit is reissued.
Margin of Safety	An implicit margin of safety is incorporated through conservative model assumptions and statistical analysis. In addition, an explicit margin of safety is incorporated by reserving 10% of the load, calculated on a concentration basis, from allocation to POTW effluent sources.
Seasonal Variations and Critical Conditions	A low flow critical condition is identified for this TMDL based on a review of flow data for the past twenty years. This flow condition was identified because less assimilative capacity is available to dilute effluent discharge.

Table 7-7.2. Implementation Schedule

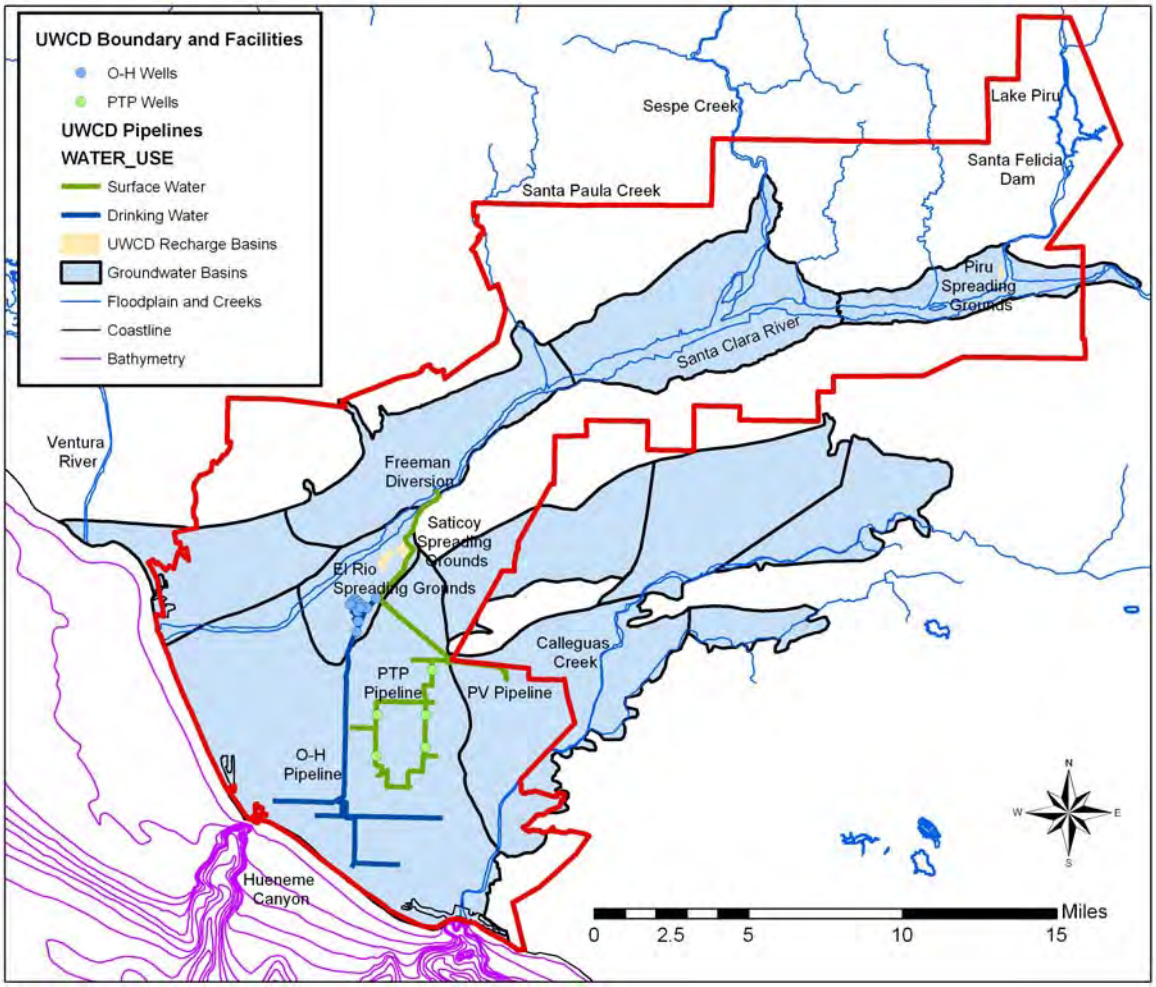
IMPLEMENTATION TASKS, MILESTONES AND PROVISIONS*		COMPLETION DATE
1.	WLA for ammonia apply to POTWs.	Effective Date of TMDL
2.	Interim Limits for NO_3-N + NO_2-N apply to POTWs.	
3.	Formation of Nonpoint Source BMP Evaluation Committee.	
4.	Submittal of Non point Source Monitoring Workplan by Calleguas Creek Watershed Management Plan – Water Resources/Water Quality (CCWMP) Subcommittee. This monitoring is to evaluate nutrient loadings associated with agricultural drainage and other nonpoint sources. The monitoring program will include both dry and wet weather discharges from agricultural, urban and open space sources. In addition, groundwater discharge to Calleguas Creek will also be analyzed for nutrients to determine the magnitude of these loading and the need for load allocations. A key objective of these special studies will be to determine the effectiveness of agricultural BMPs in reducing nutrient loadings. Consequently, flow and analytical data for nutrients will be required to estimate loadings from nonpoint sources.	1 year after Effective Date of TMDL
5.	Submittal of Watershed Monitoring Workplan by CCWMP Subcommittee. In addition to the analytical parameters and flow data requirements, the watershed monitoring program will establish sampling locations from which representative samples can be obtained, including all listed tributaries. Monitoring results will be compared to the numeric instream targets identified in this TMDL to determine the effectiveness of the TMDL. Data on the extent and distribution of algal mats, scum and odors will be included in the	

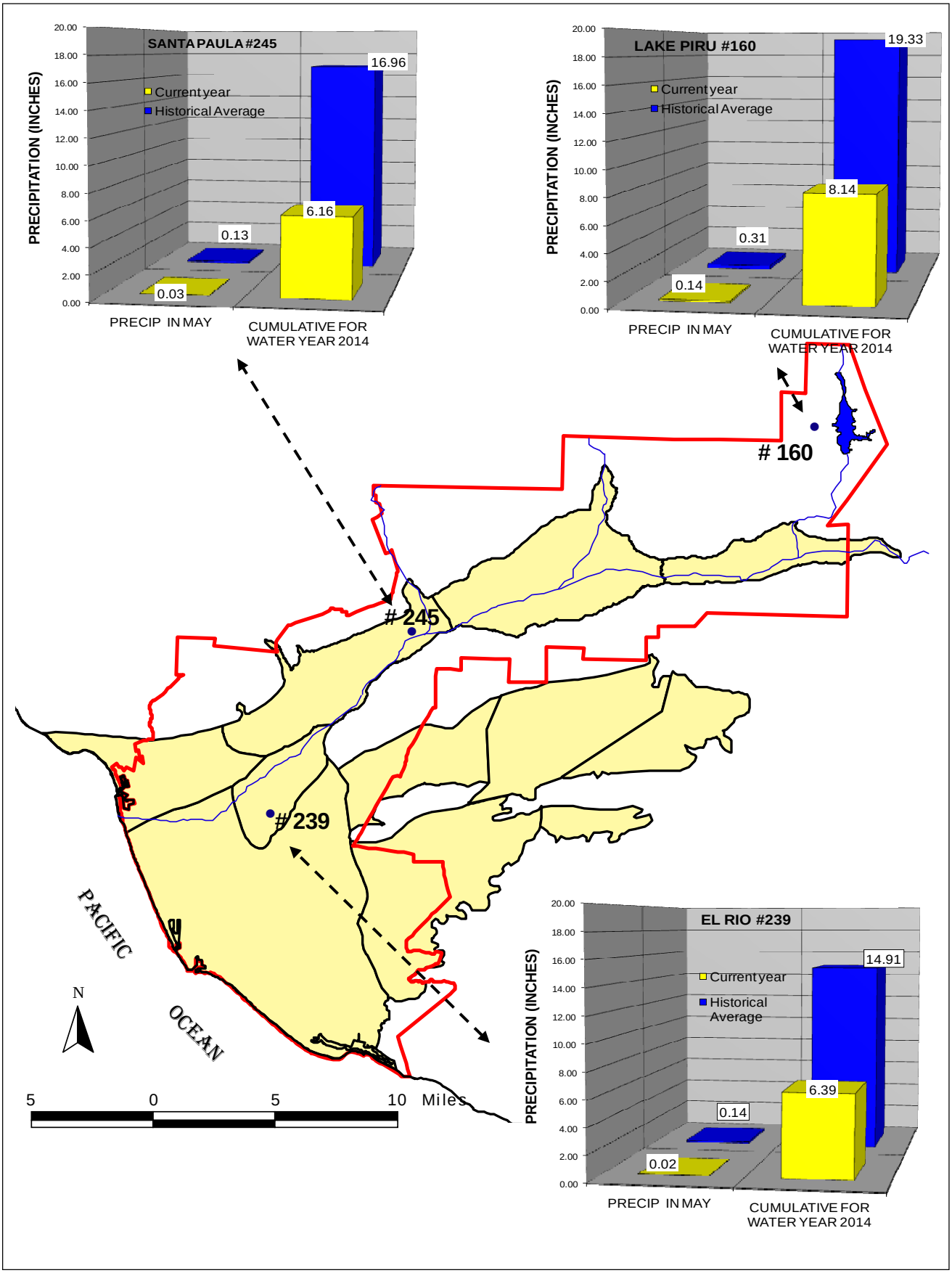
* The CCWMP Subcommittee has offered to complete tasks 4 through 9 and 11. In the event the CCWMP Subcommittee fails to timely complete these tasks, the Regional Board will consider whether to amend this Implementation Plan to assign tasks to responsible dischargers in the regulatory approach. The Regional Board also reserves its right to take any other appropriate actions including, but not limited to, exercising its authorities under Water Code section 13267.

	IMPLEMENTATION TASKS, MILESTONES AND PROVISIONS*	COMPLETION DATE
	watershed monitoring program. The data will be used to provide further verification of the model and refine the TMDL to address nutrient effects as appropriate.	
6.	Submittal of Special Studies Workplan by CCWMP Subcommittee. These special studies include: Monitoring of minor point sources for nutrients to confirm assumptions that the loadings from these sources are minor; Monitoring of greenhouse discharges and runoff to assess loadings from these sources; Monitoring of groundwater extraction and discharges in the Arroyo Santa Rosa subwatershed and other areas that may add significant nutrient loadings to Calleguas Creek; and Additional studies of the type and extent of algae impairment in Calleguas Creek and Mugu Lagoon.	
7.	Complete Special Studies for minor sources, greenhouses, and groundwater loadings.	3 years after Effective Date of TMDL
8.	Completion of ammonia Water Effect Ratio (WER) studies.	
9.	Complete planning and preparation for construction of TMDL remedies to reduce non-point source nitrogen loads.	
10.	Interim Limits for NO_3-N + NO_2-N expire and WLAs for NO_3-N, NO_2-N, NO_3-N + NO_2-N apply to POTWs.	4 years after Effective Date of TMDL
11.	Complete Special Studies for algae impairments of Calleguas Creek, its tributaries and Mugu Lagoon.	5 years after Effective Date of TMDL
12.	Regional Board consideration of revised water quality objectives for nitrogen compounds based on monitoring data, special studies, and ammonia WER, if appropriate.	6 years after Effective Date of TMDL
13.	Final achievement of ammonia and oxidized nitrogen standards.	7 years after Effective Date of TMDL

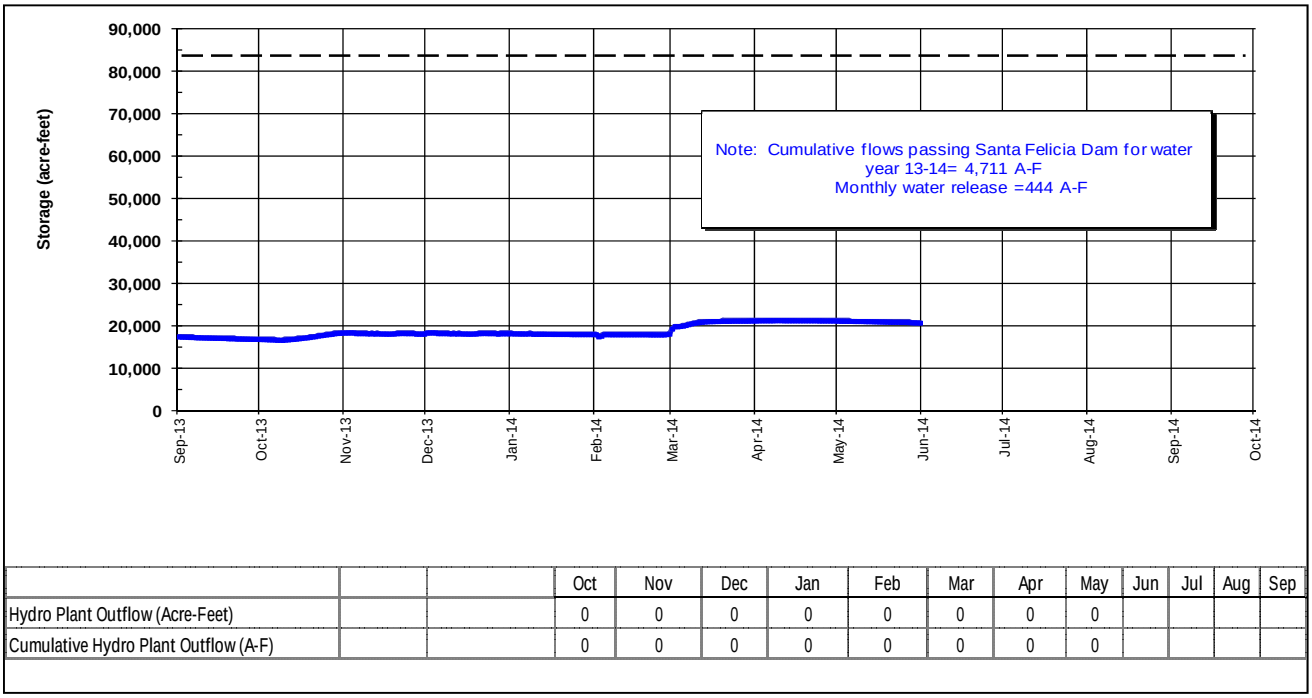
United Water Conservation District
May 2014 Hydrologic Conditions Report
2014 Water Year

June 4, 2014



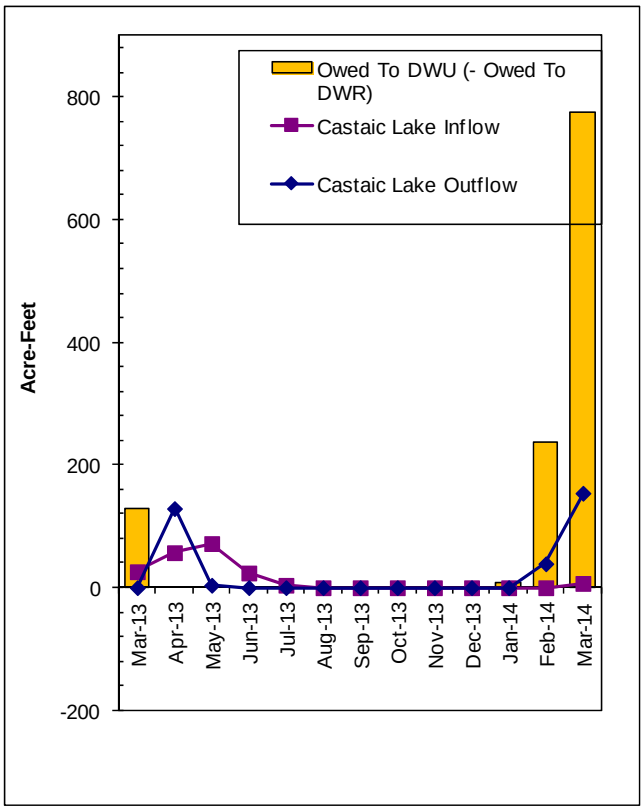


District-wide percent of normal precipitation = 40%

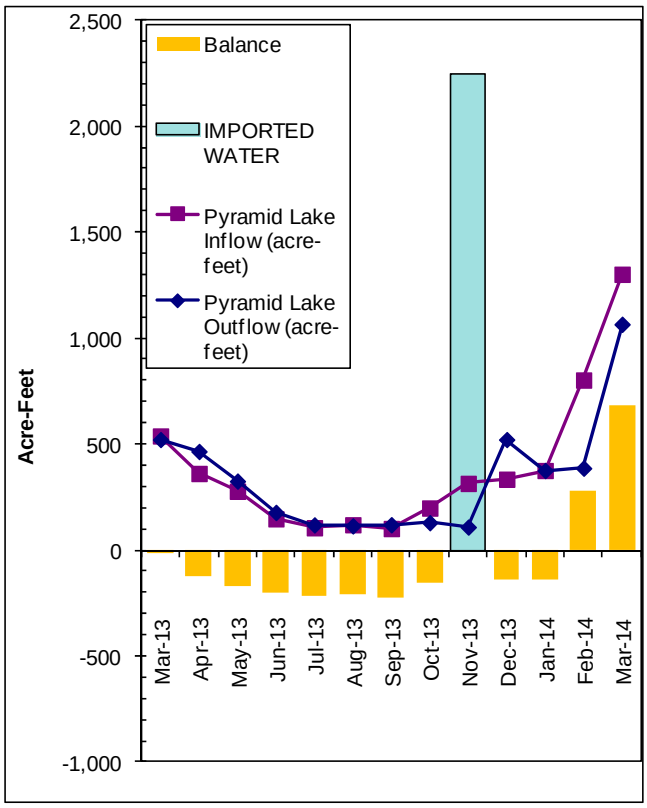


			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Hydro Plant Outflow (Acre-Feet)			0	0	0	0	0	0	0	0				
Cumulative Hydro Plant Outflow (A-F)			0	0	0	0	0	0	0	0				

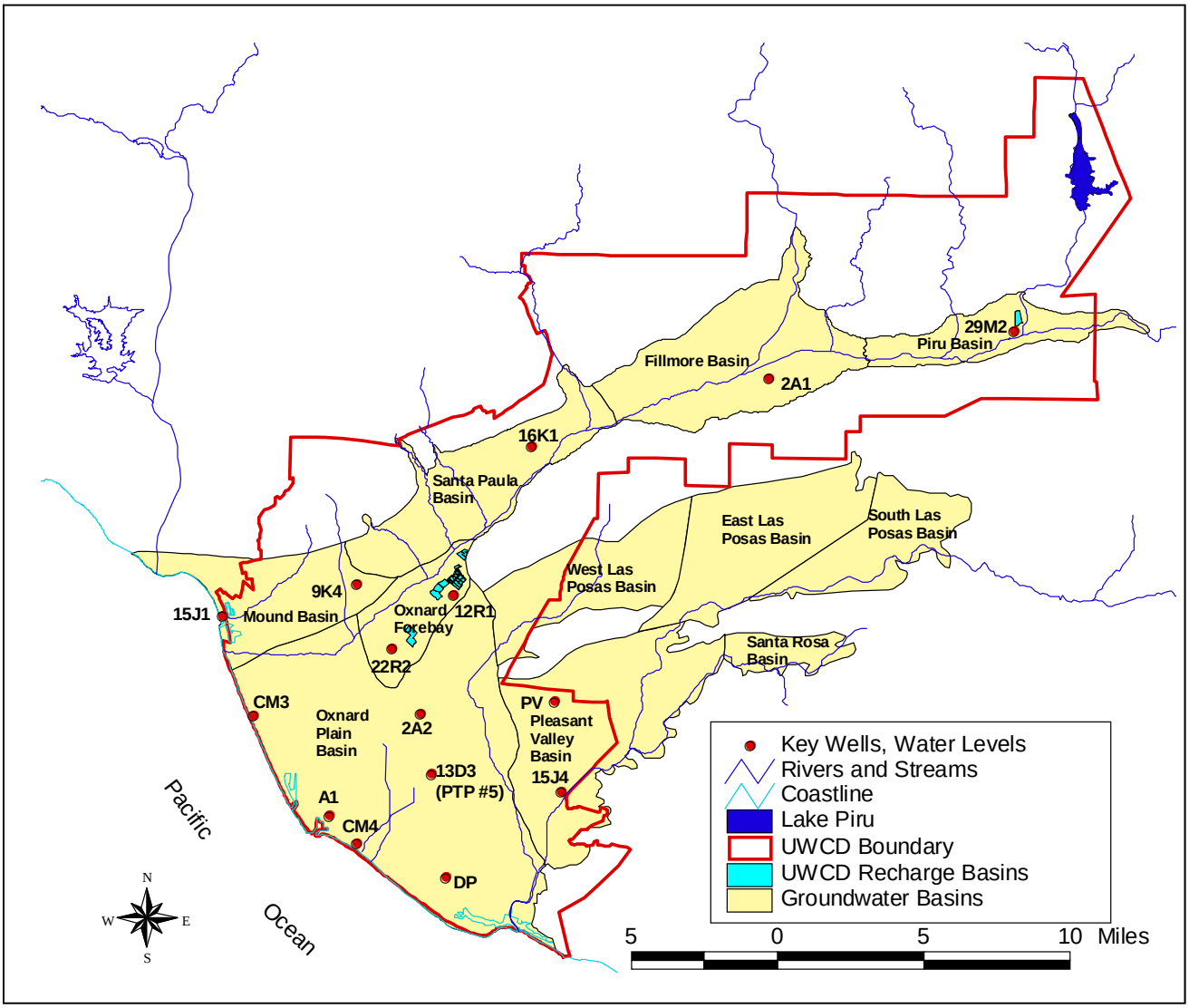
Lake Piru storage and outflow



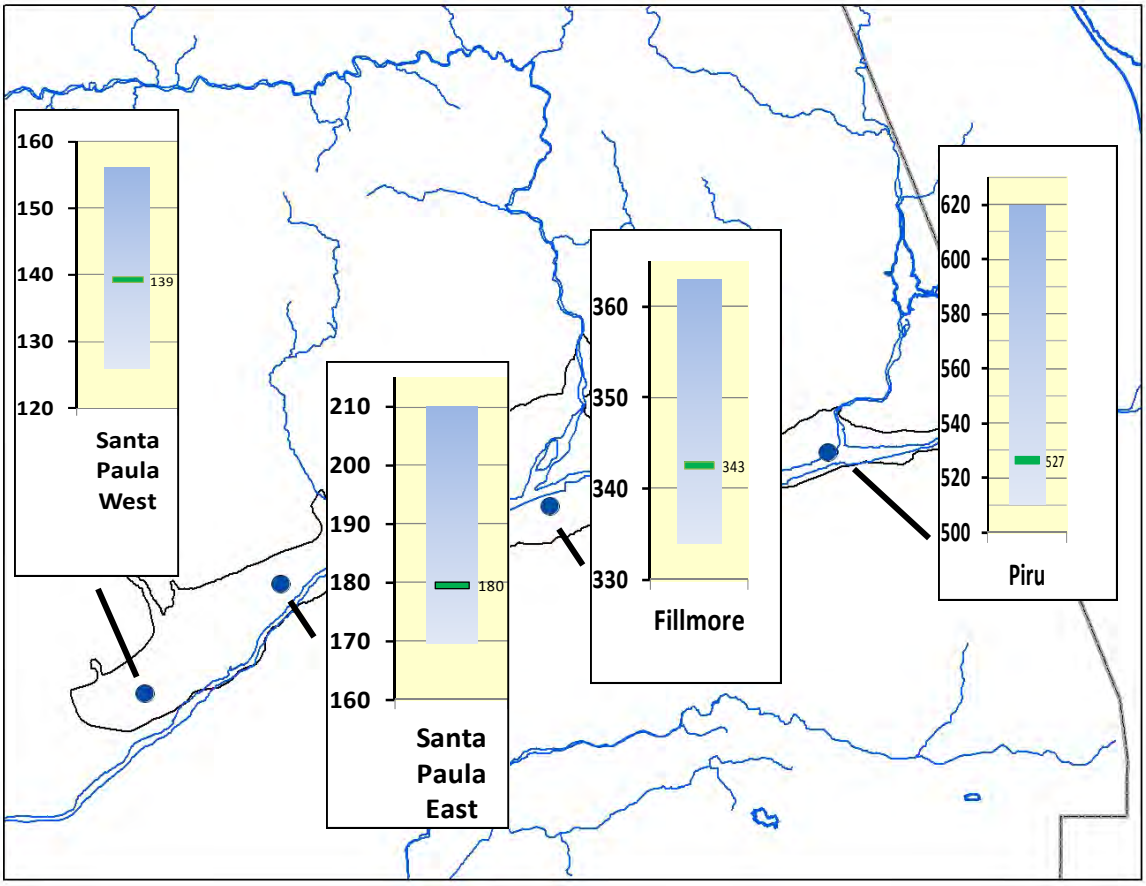
Castaic Lake releases to downstream users



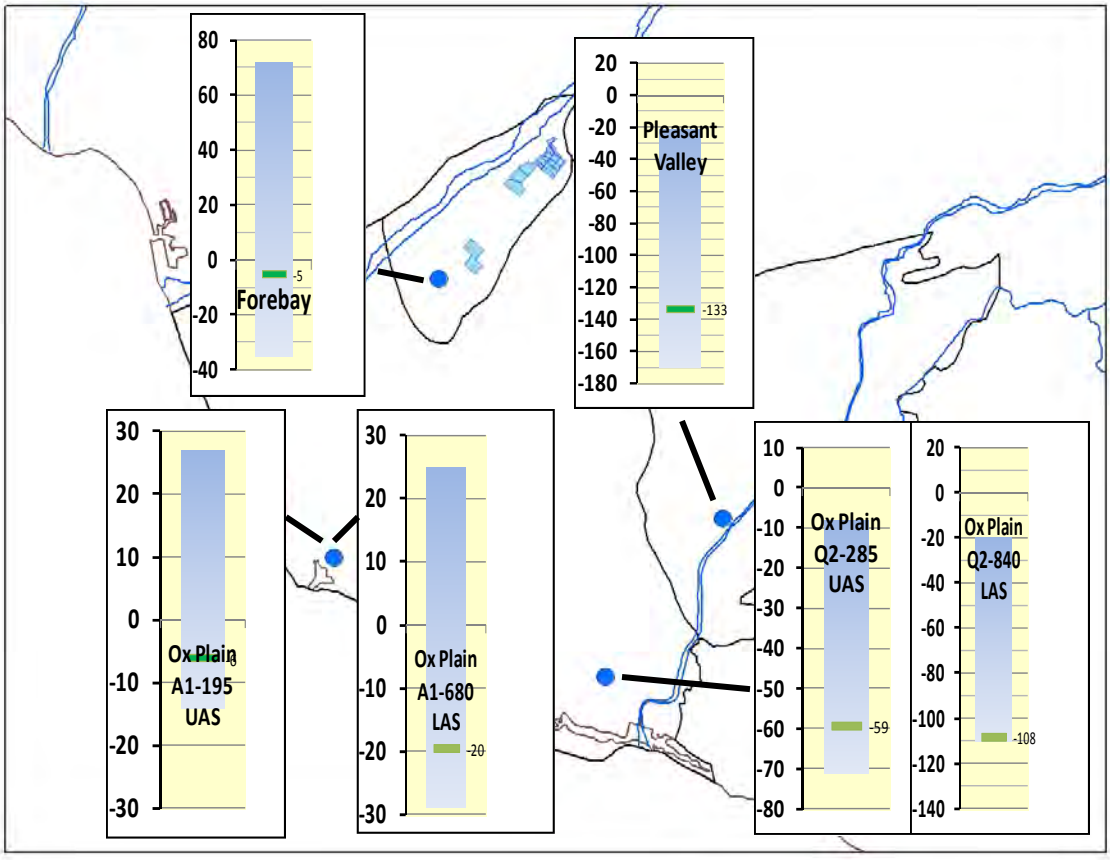
Pyramid Lake releases to UWCD

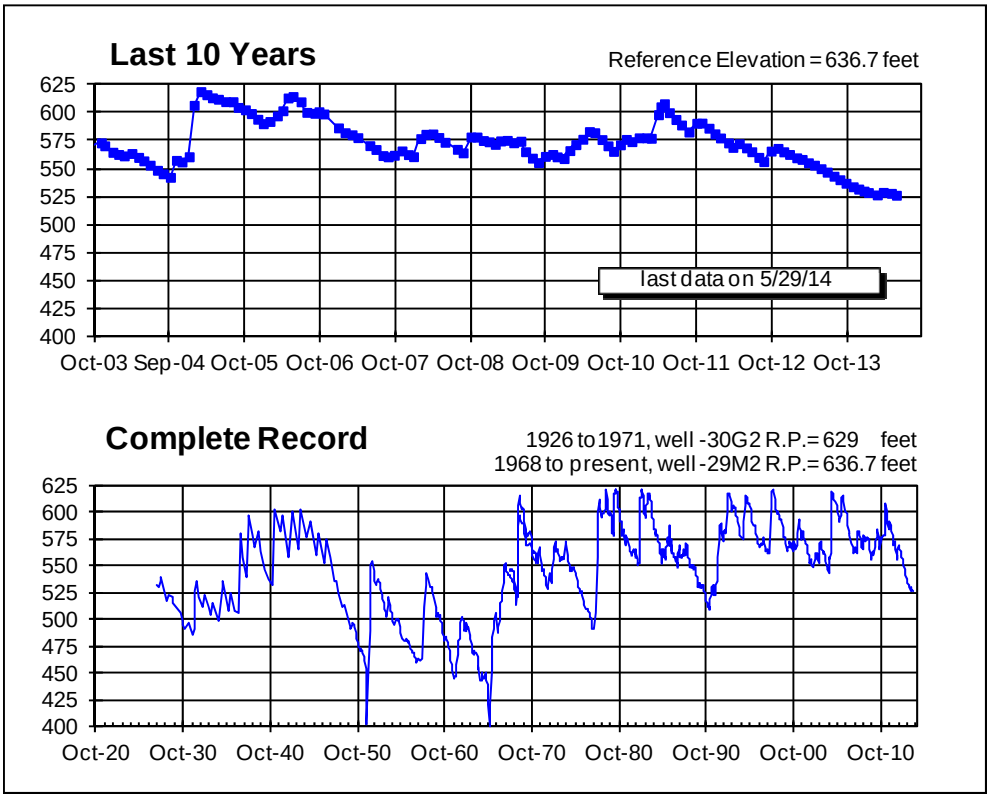


Locations of key wells, monthly groundwater elevation monitoring

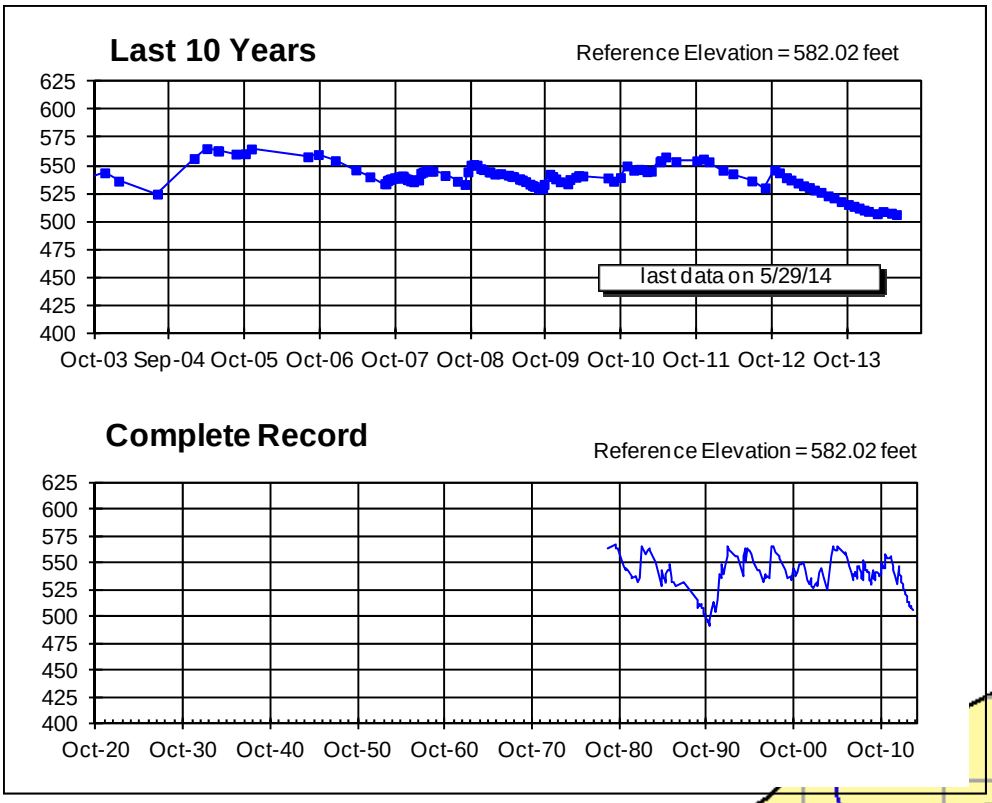


Recent water level elevations, compared to high-low range since 1990

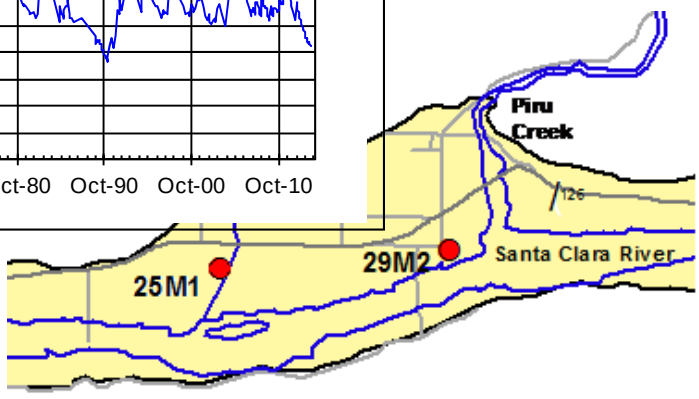


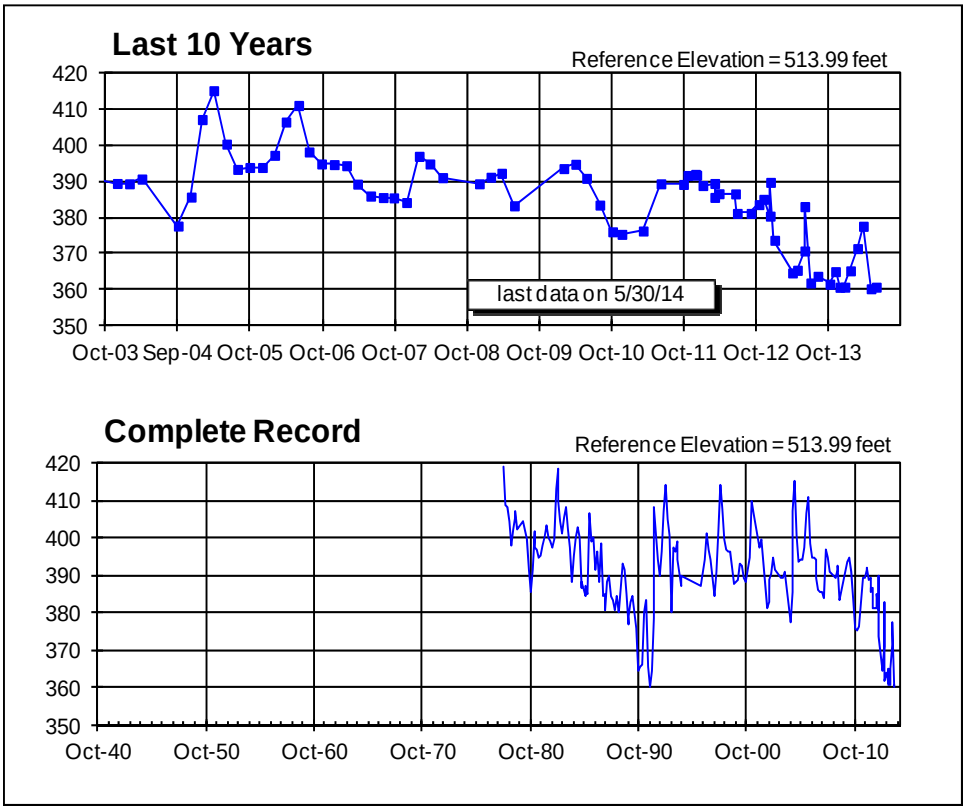


Historic groundwater elevation records, well 04N18W29M02S, Piru basin

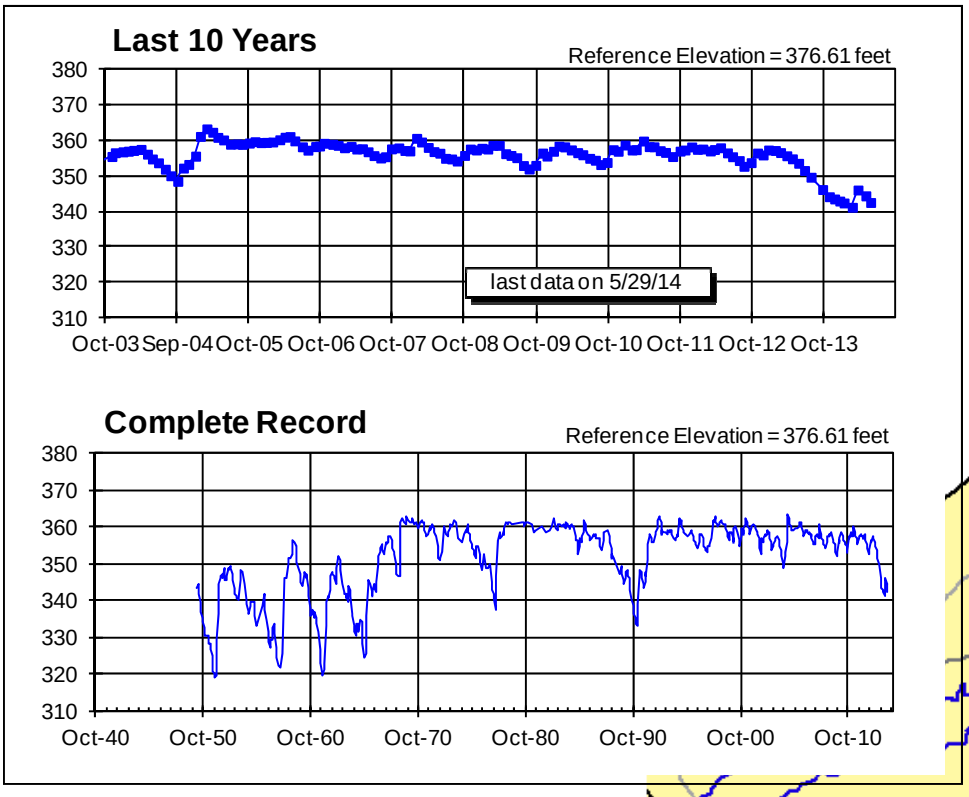


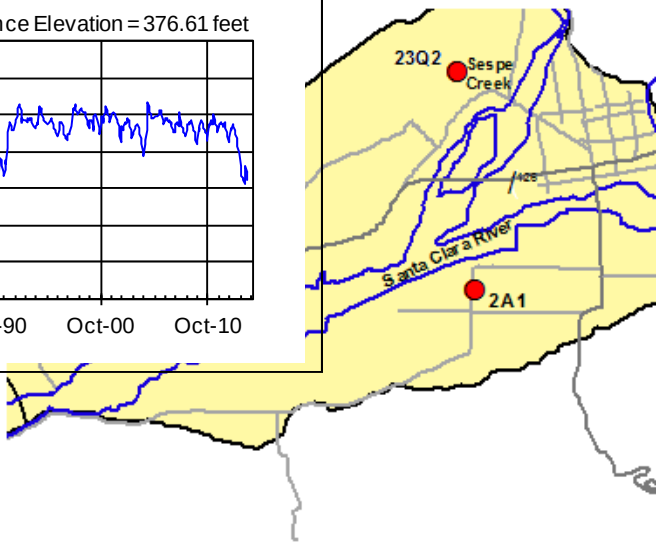
Historic groundwater elevation records, well 04N19W25M01S, Piru basin



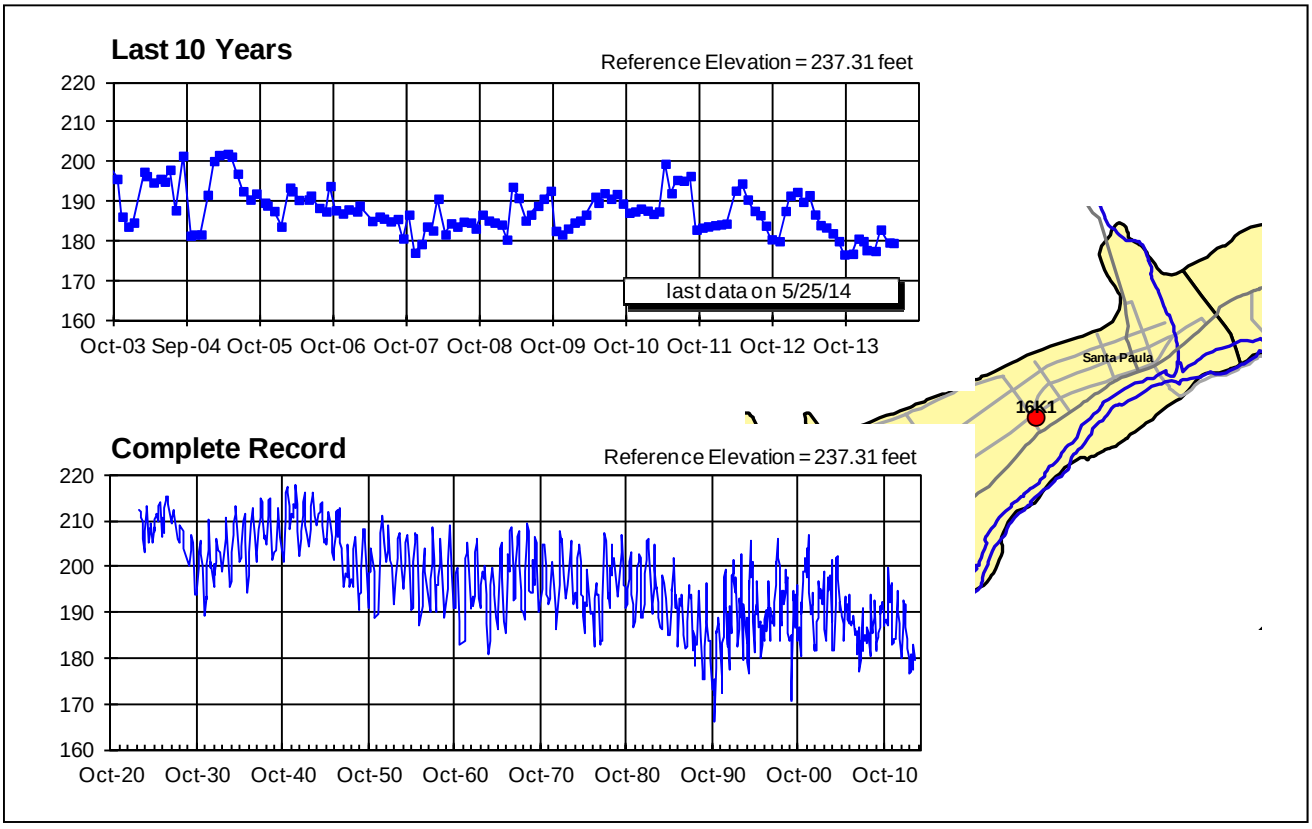


Historic groundwater elevation records, well 04N20W23Q02S, Fillmore basin

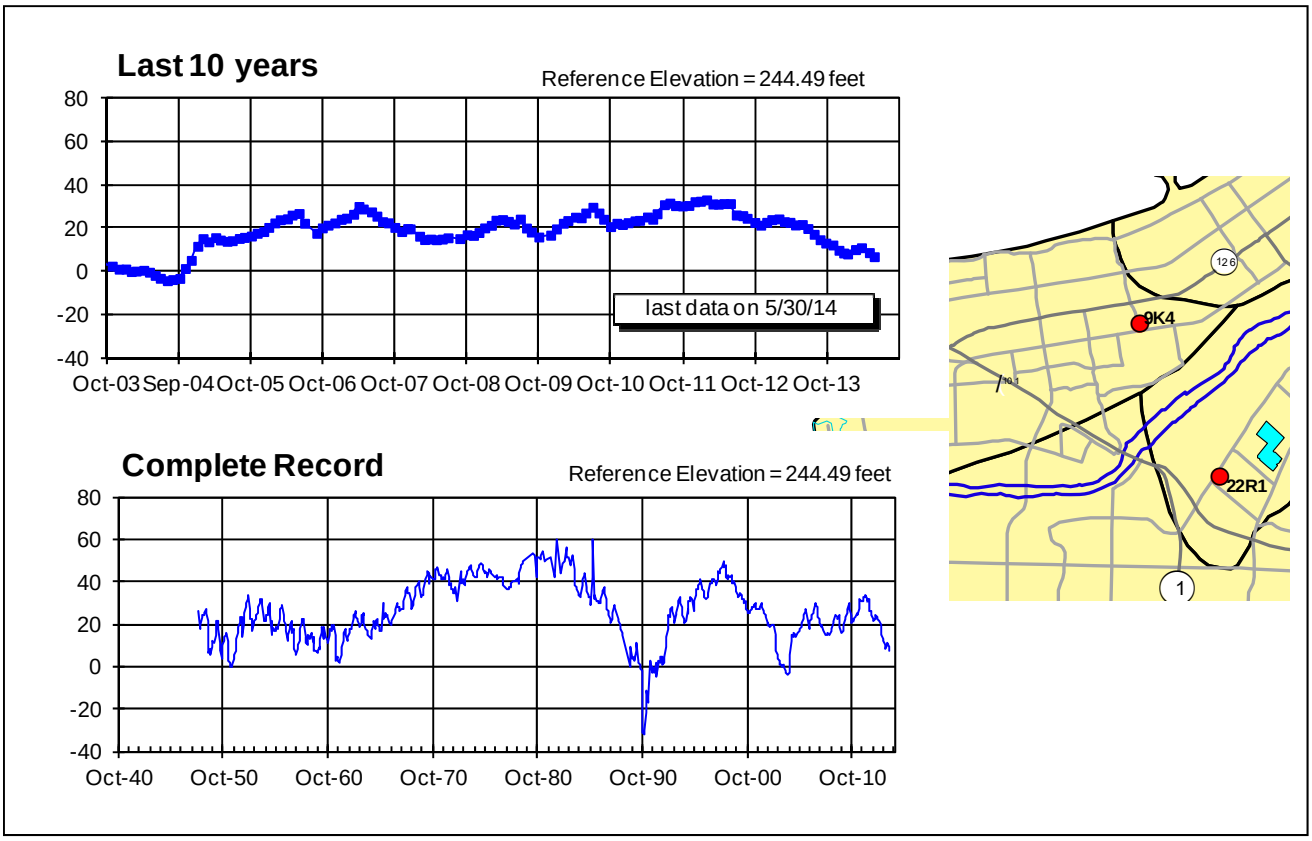




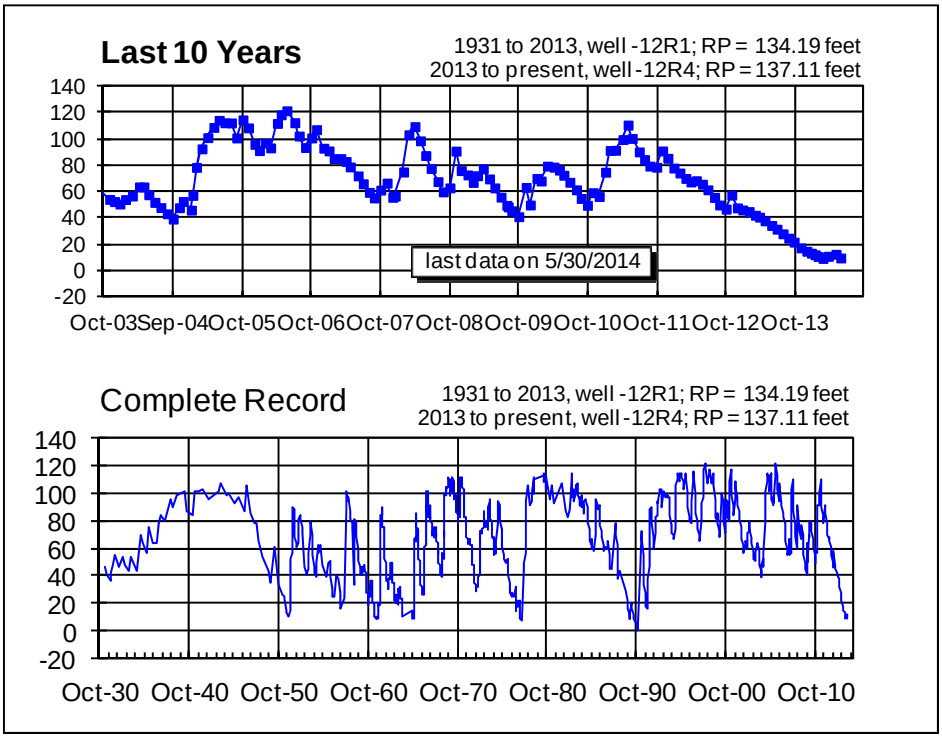
Historic groundwater elevation records, well 03N20W02A01S, Fillmore basin



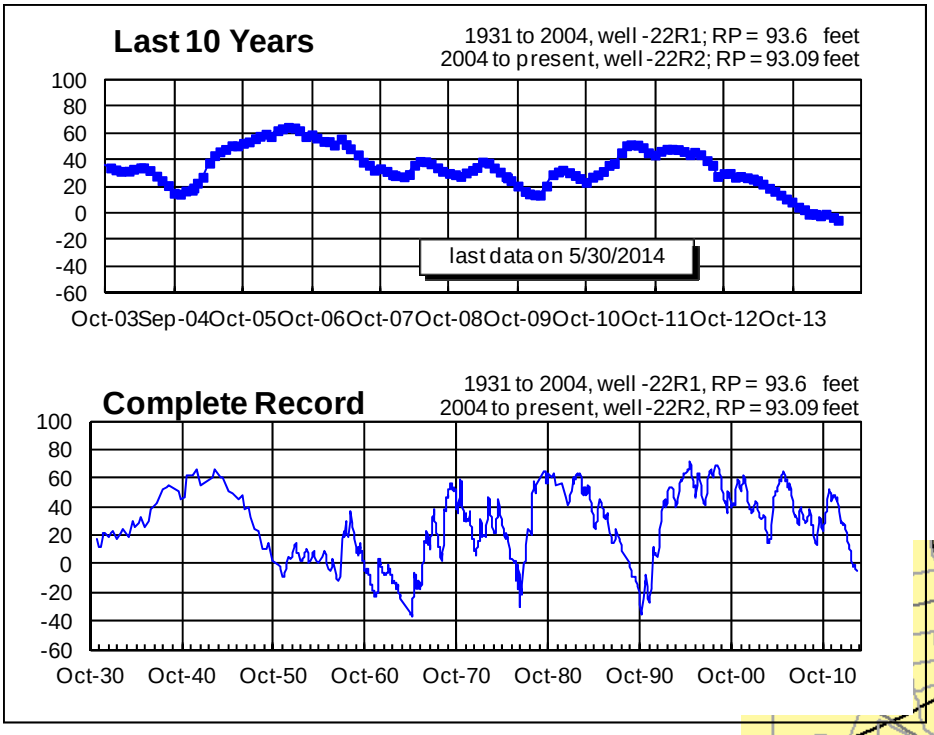
Historic groundwater elevation records, well 03N21W16K01S, Santa Paula basin

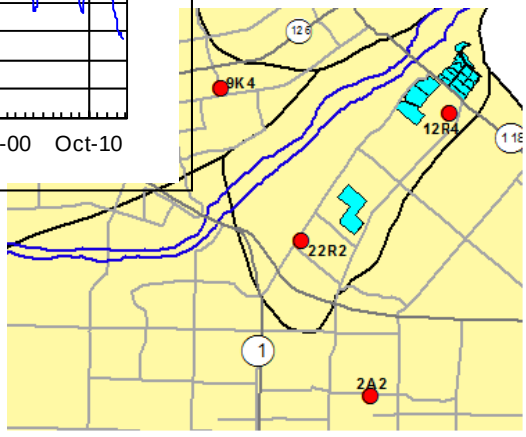


Historic groundwater elevation records, well 02N22W09K04S, Mound basin

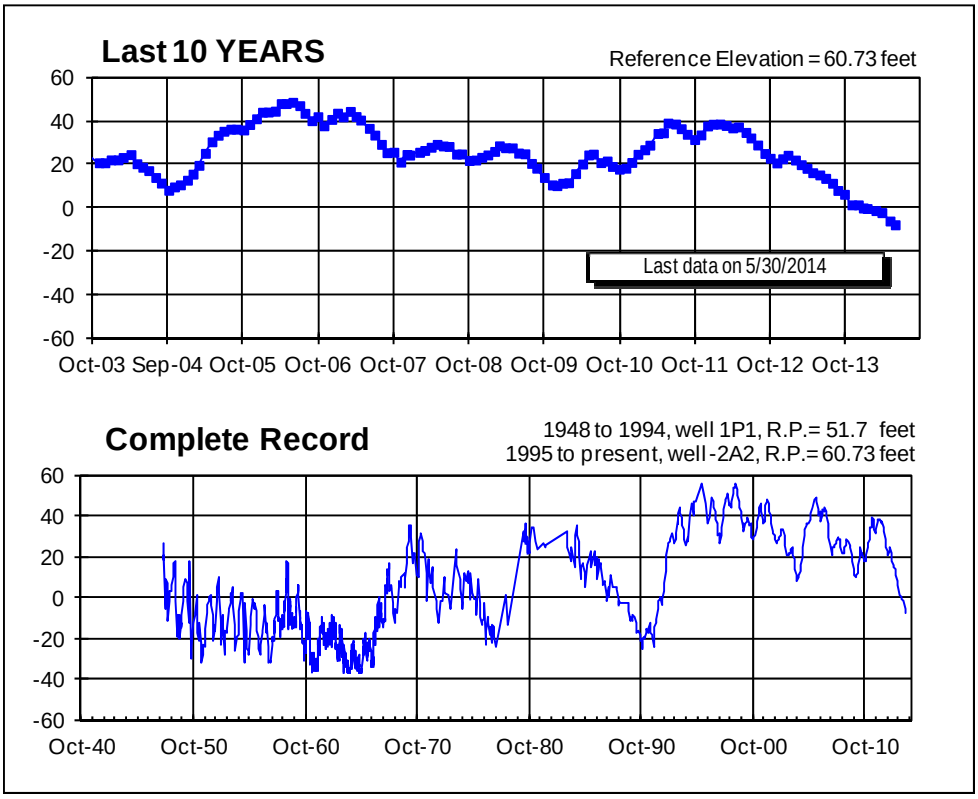


Historic groundwater elevation records, well 02N22W12R04S, Oxnard Forebay basin

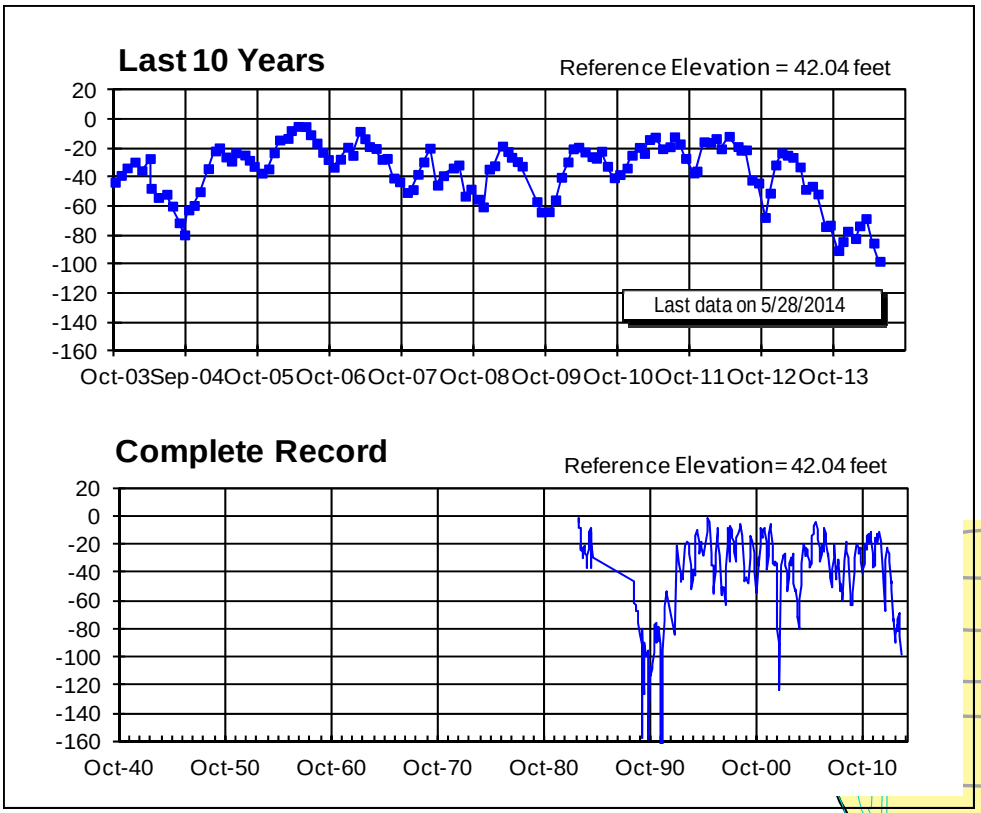


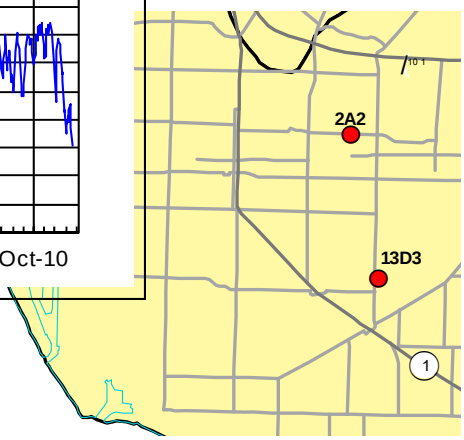


Historic groundwater elevation records, well 02N22W22R02S, Oxnard Forebay

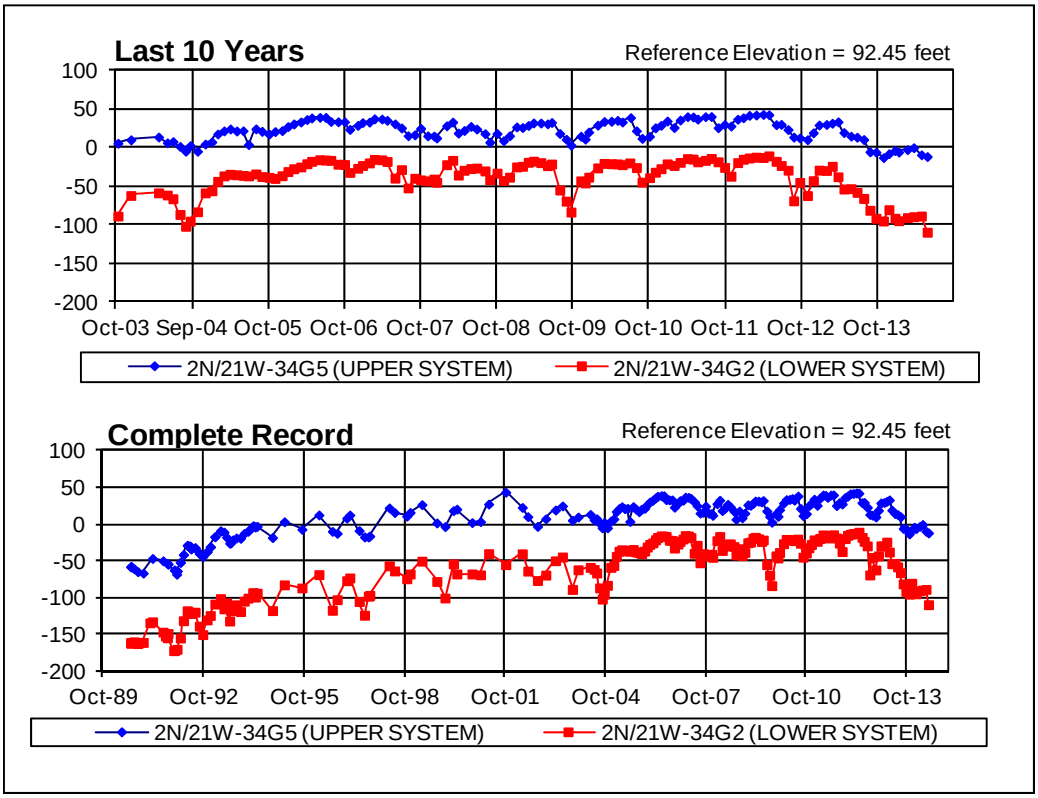


Historic groundwater elevation records, UAS well 01N22W02A02S, Oxnard Plain

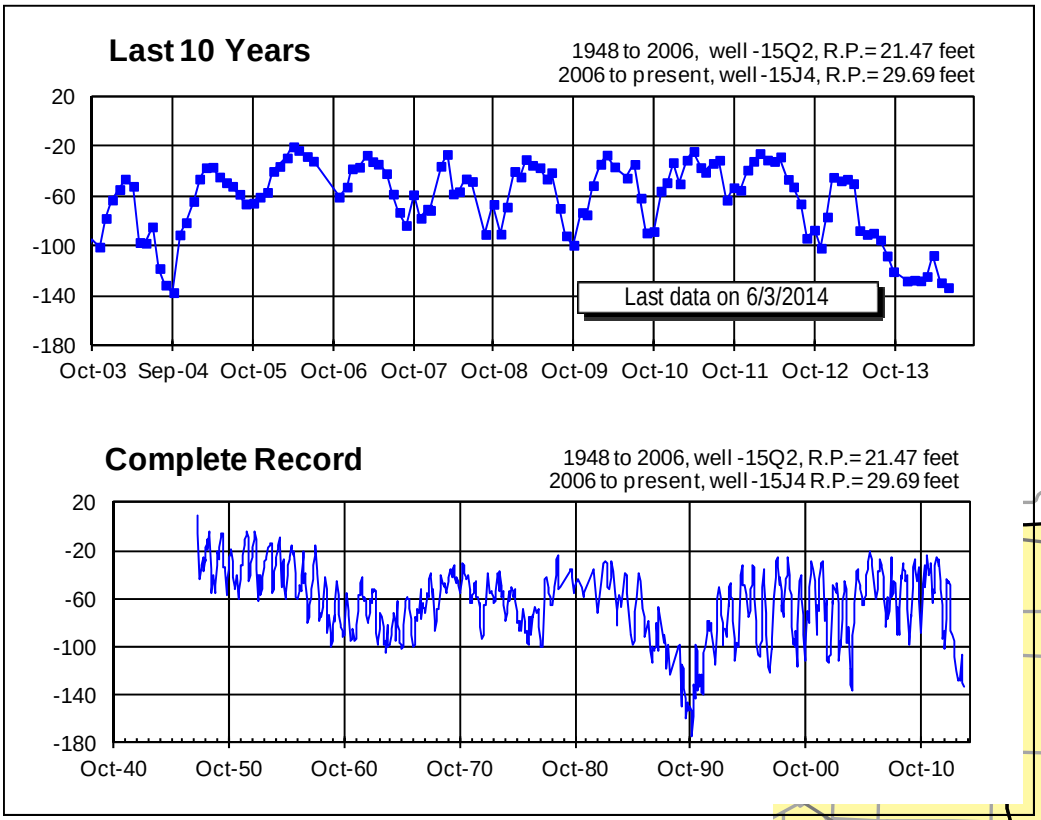


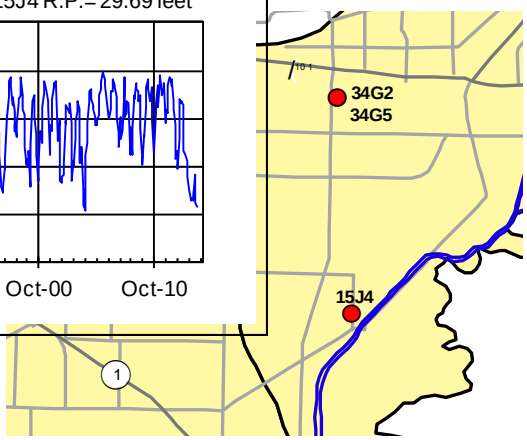


Historic groundwater elevation records, Lower Aquifer System well 01N22W13D03S(PTP #5), Oxnard Plain

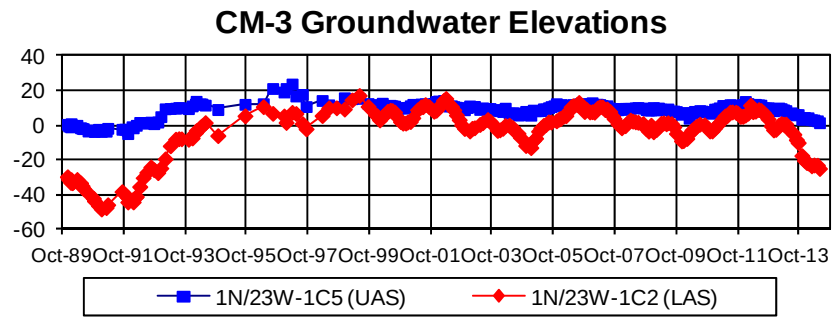


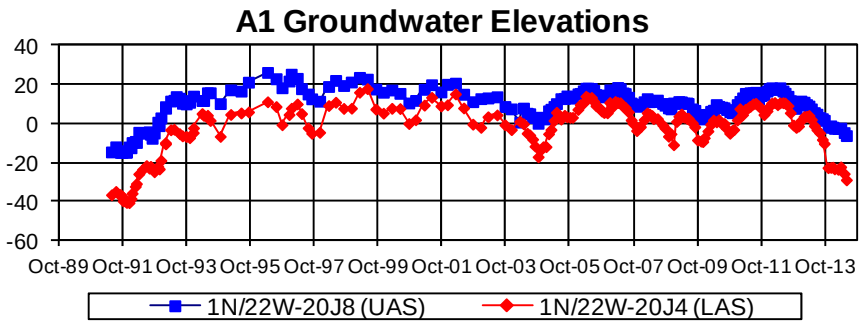
Historic groundwater elevation records, Upper and Lower Aquifer Systems, PV nested monitor well, Pleasant Valley basin

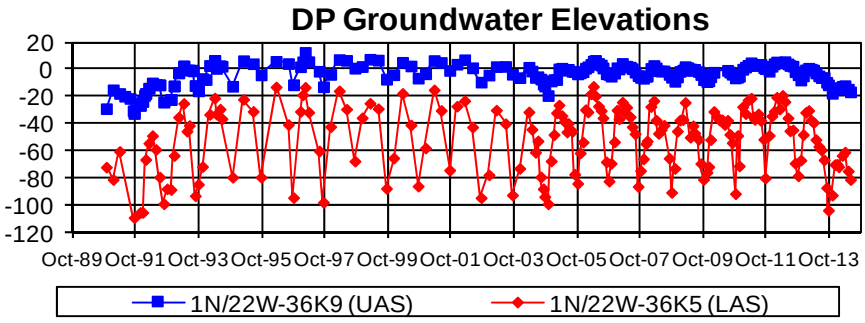


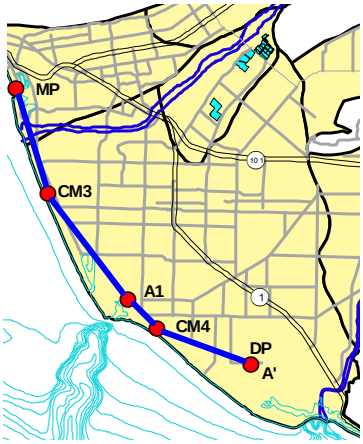


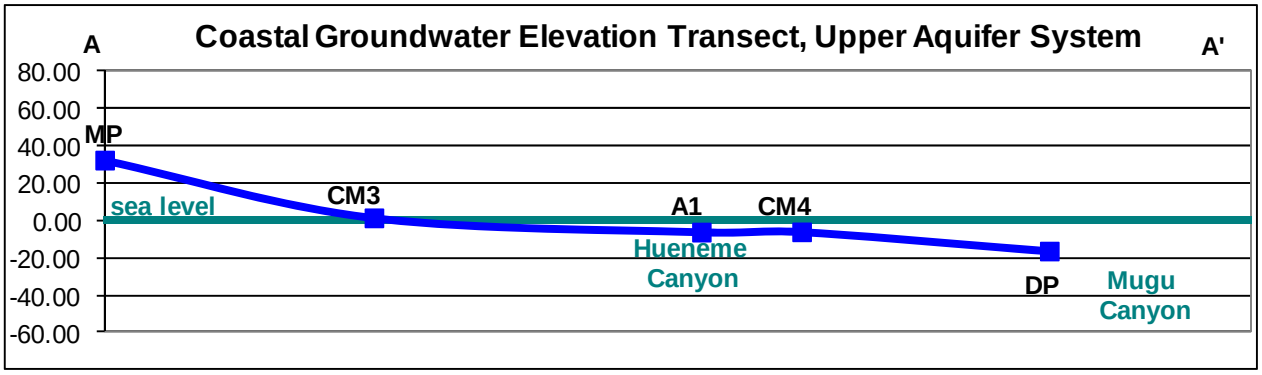
Historic groundwater elevation records,
LAS well 01N21W15J04S, Pleasant Valley basin

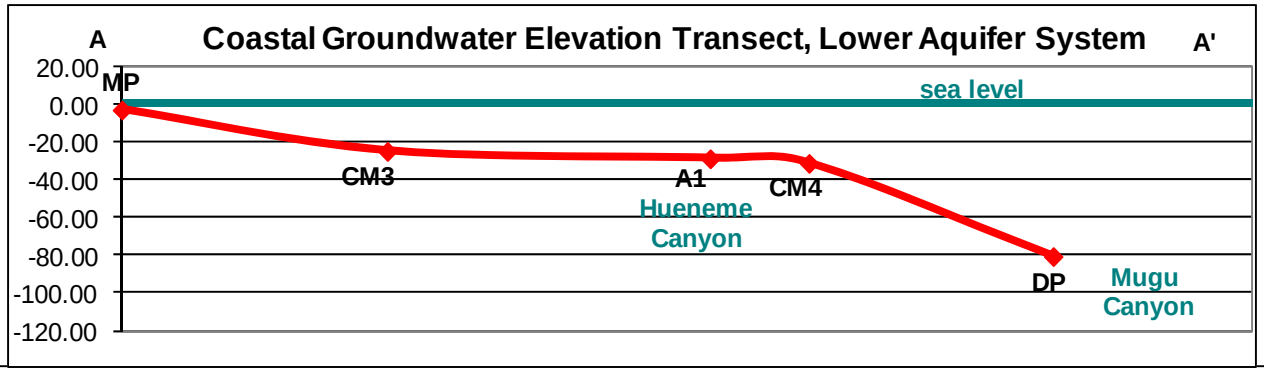












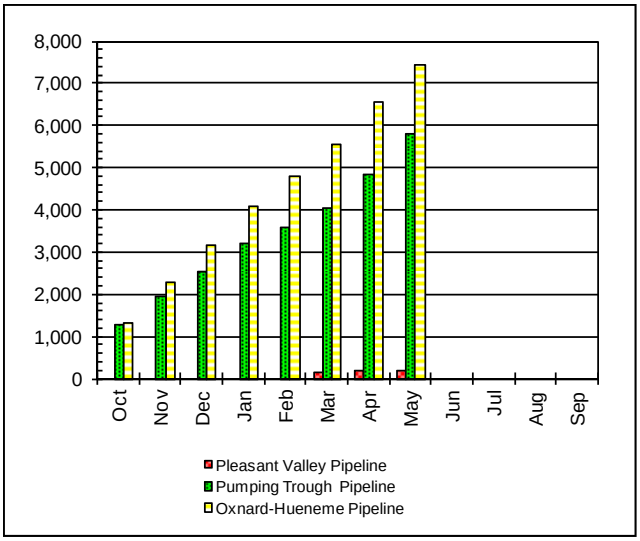
Coastal groundwater elevation transect, recent conditions

Monthly Water Deliveries - 2013-2014 Water Year (acre-feet)												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
PV Pipeline incl. c cust. (surface water)	0.0	0.0	0.0	0.0	0.0	161.2	38.0	1.9				
PV Pipeline inc. C cust.(saticoy well field and 12+13)	43.8	10.2	9.0	11.7	0.0	0.0	0.0	0.0				
Total to Pleasant Valley Pipeline	43.8	10.2	9.0	11.7	0.0	161.2	38.0	0.0				
Saticoy Well Field *(inc. OH-12, OH-13)	477.4	246.7	214.3	145.1	0.0	0.0	0.0	0.0				
PTP (surface water)	0.0	0.0	0.0	0.0	0.0	15.9	6.0	0.0				
PTP (groundwater)	844.1	408.3	404.5	514.2	378.9	465.9	789.8	947.9				
PTP (Saticoy well field & OH.)	433.6	256.5	204.5	133.4	0.0	0.0	0.0	0.0				
Total PTP	1,277.7	664.8	609.0	647.6	378.9	481.8	795.8	947.9				
O-H Pipeline (groundwater)	1,321.9	969.6	873.3	919.5	698.9	768.9	987.1	902.4				
Total Surface Water Delivery (PTP & PV)	0.0	0.0	0.0	0.0	0.0	177.1	44.0	1.9				
Total Groundwater Delivery (OH & PTP & SW & OH 12-13)	2,643.4	1,624.6	1,492.1	1,578.8	1,077.8	1,234.8	1,776.9	1,850.3				
Total Delivery, Surface Water & GW	2,643.4	1,624.6	1,492.1	1,578.8	1,077.8	1,411.9	1,820.9	1,852.2				

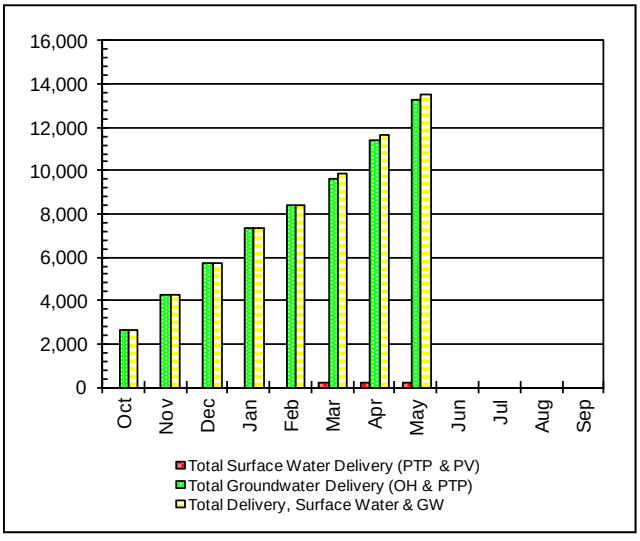
Monthly water deliveries, 2013-2014 water year, in acre-feet

Cumulative Water Deliveries - 2013-2014 Water Year (acre-feet)												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
PV Pipeline (surface water)	0.0	0.0	0.0	0.0	0.0	161.2	199.2	201.1				
PV Pipeline (saticoy well field)	43.8	54.0	63.0	74.7	74.7	74.7	74.7	74.7				
Total to Pleasant Valley Pipeline	43.8	54.0	63.0	74.7	74.7	235.9	273.9	273.9				
Saticoy Well Field *(inc. OH-12, OH-13)	477.4	724.1	938.4	1,083.5	1,083.5	1,083.5	1,083.5	1,083.5				
PTP (surface water)	0.0	0.0	0.0	0.0	0.0	15.9	21.9	21.9				
PTP (groundwater)	844.1	1,252.4	1,656.9	2,171.1	2,550.0	3,015.9	3,805.6	4,753.5				
PTP (Saticoy well field)	433.6	690.1	894.6	1,028.0	1,028.0	1,028.0	1,028.0	1,028.0				
Total PTP	1,277.7	1,942.5	2,551.5	3,199.1	3,578.0	4,059.8	4,855.5	5,803.4				
O-H Pipeline (groundwater)	1,321.9	2,291.5	3,164.8	4,084.3	4,783.2	5,552.1	6,539.2	7,441.6				
Total Surface Water Delivery (PTP & PV)	0.0	0.0	0.0	0.0	0.0	177.1	221.1	223.0				
Total Groundwater Delivery (OH & PTP)	2,643.4	4,268.0	5,760.1	7,338.8	8,416.6	9,651.4	11,428.3	13,278.6				
Total Delivery, Surface Water & GW	2,643.4	4,268.0	5,760.1	7,338.8	8,416.6	9,828.5	11,649.4	13,501.6				

Cumulative water deliveries, 2013-2014 water year, in acre-feet



Cumulative deliveries by system



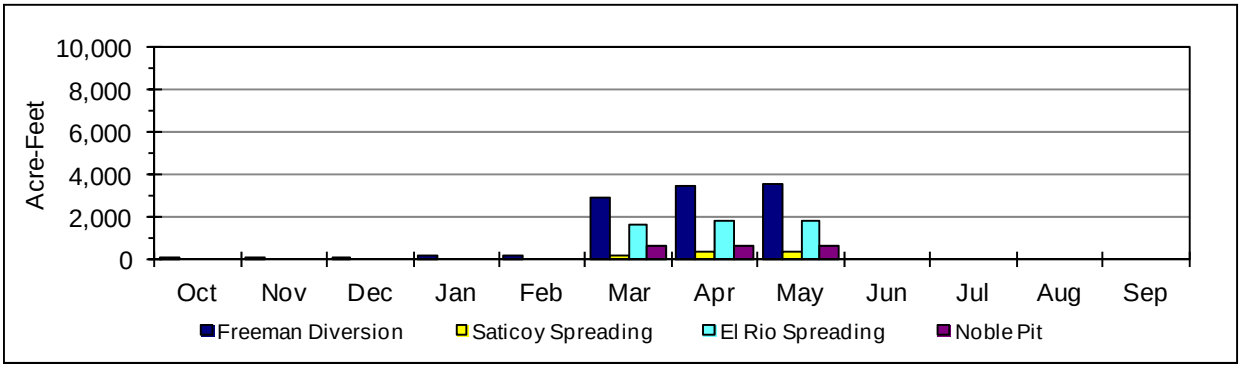
Cumulative deliveries by source/type

Month	Piru Spreading	Freeman Diversion	Saticoy Spreading	El Rio Spreading	Noble Pit
Oct	0	35	0	0	0
Nov	0	54	0	0	0
Dec	0	7	0	0	0
Jan	0	29	0	0	0
Feb	0	67	0	0	0
Mar	0	2,748	135	1,588	578
Apr	0	518	185	218	0
May	0	112	67	0	0
Jun					
Jul					
Aug					
Sep					

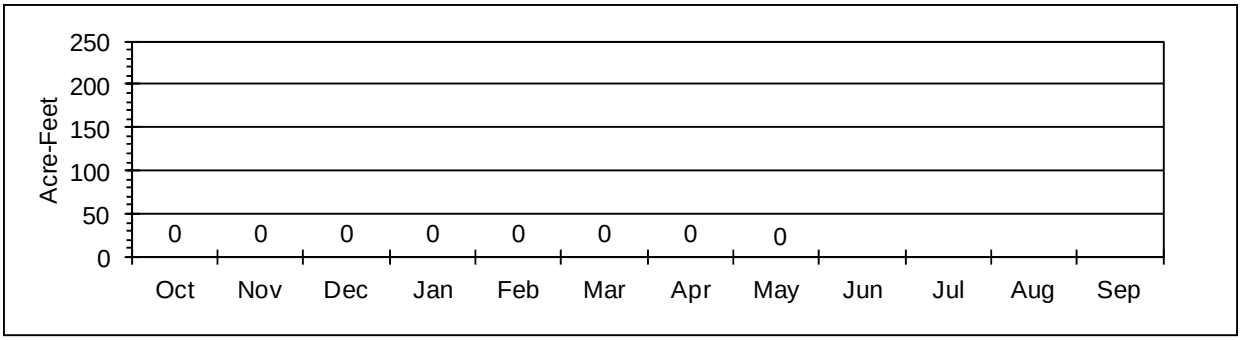
Monthly diversion and recharge totals by facility, 2013-2014, in acre-feet

Month	Piru Spreading	Freeman Diversion	Saticoy Spreading	El Rio Spreading	Noble Pit
Oct	0	35	0	0	0
Nov	0	88	0	0	0
Dec	0	95	0	0	0
Jan	0	125	0	0	0
Feb	0	191	0	0	0
Mar	0	2,939	135	1,588	578
Apr	0	3,457	320	1,806	578
May	0	3,569	387	1,806	578
Jun					
Jul					
Aug					
Sep					

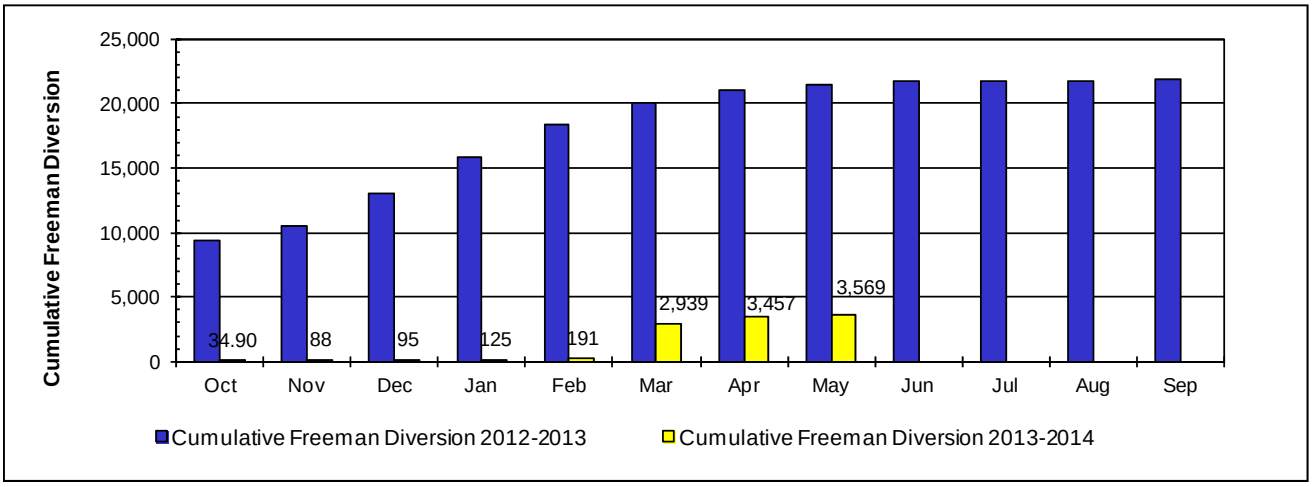
Cumulative diversion and recharge totals by facility, 2013-2014, in acre-feet



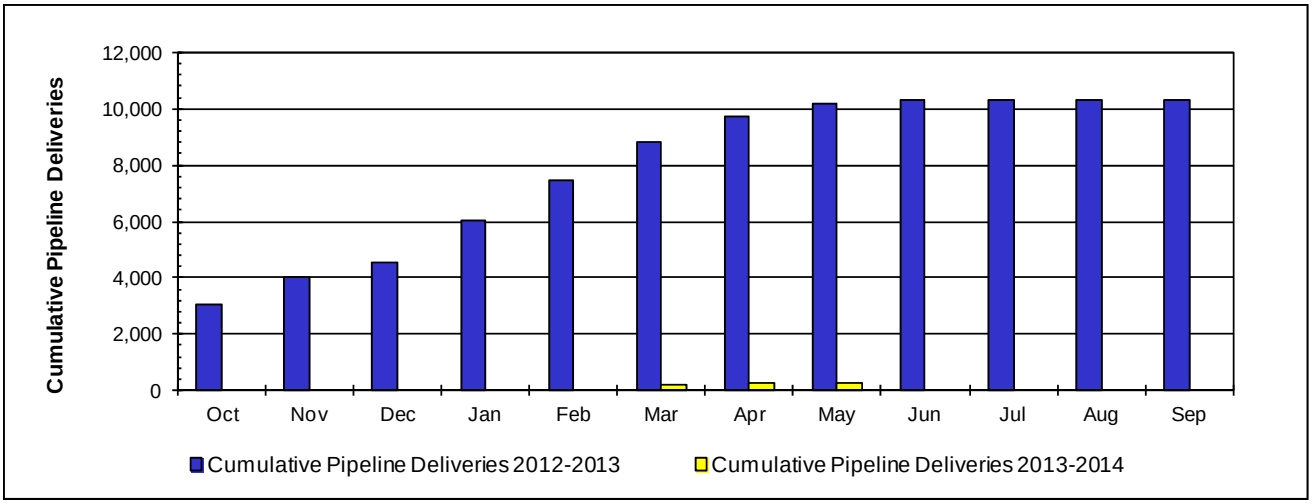
Cumulative diversion at Freeman, and distribution to recharge facilities, in acre-feet



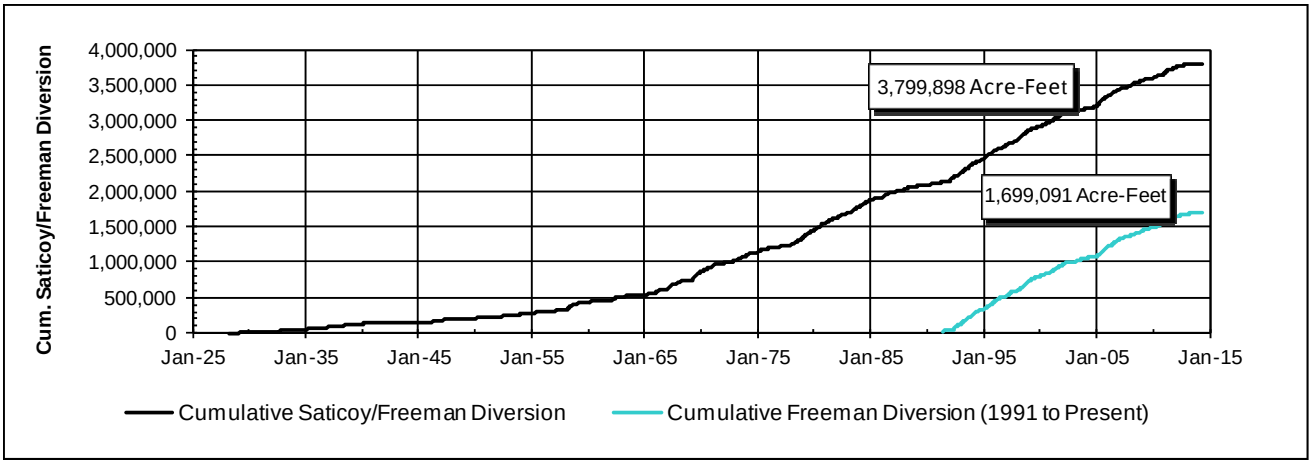
Cumulative diversions to Piru Spreading Grounds, 2013-2014, in acre-feet



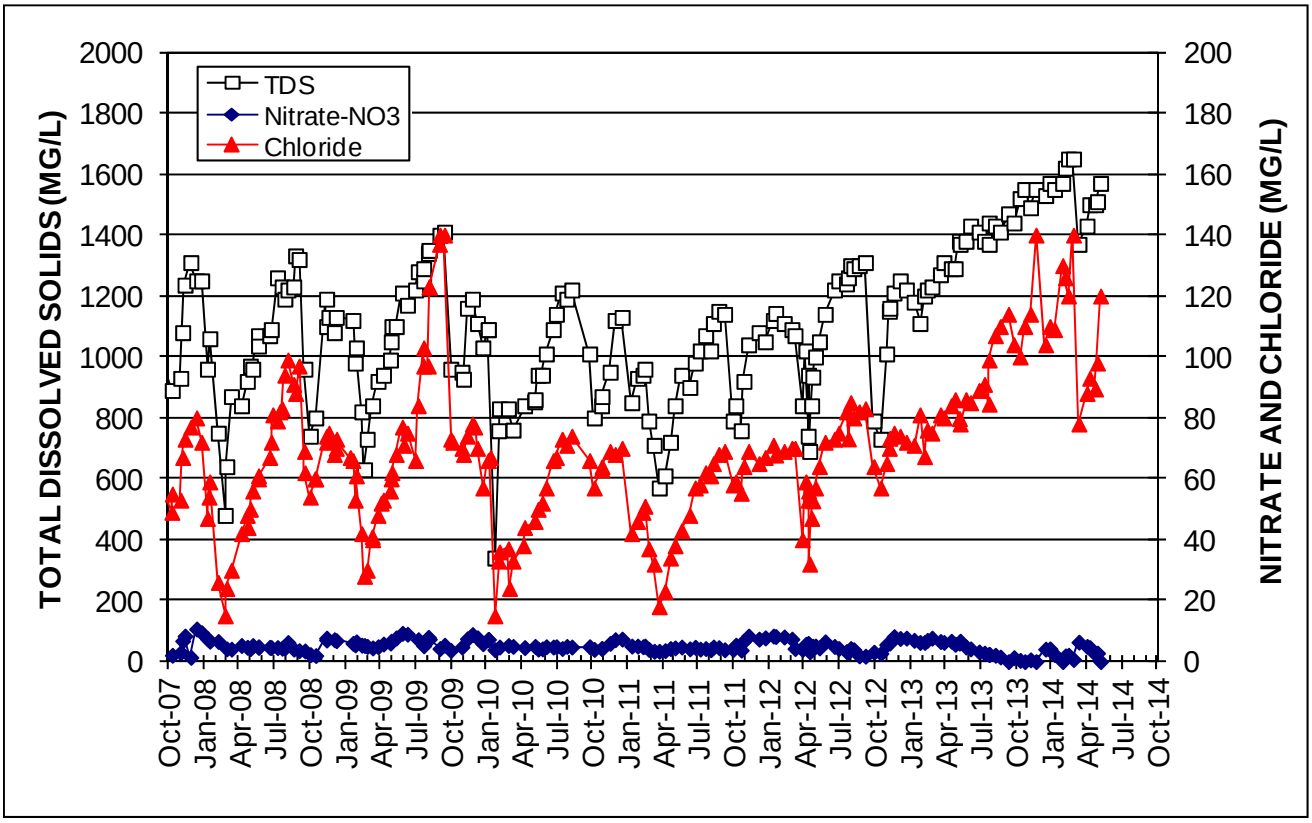
Cumulative 2013-2014 diversion at Freeman, compared to prior water year



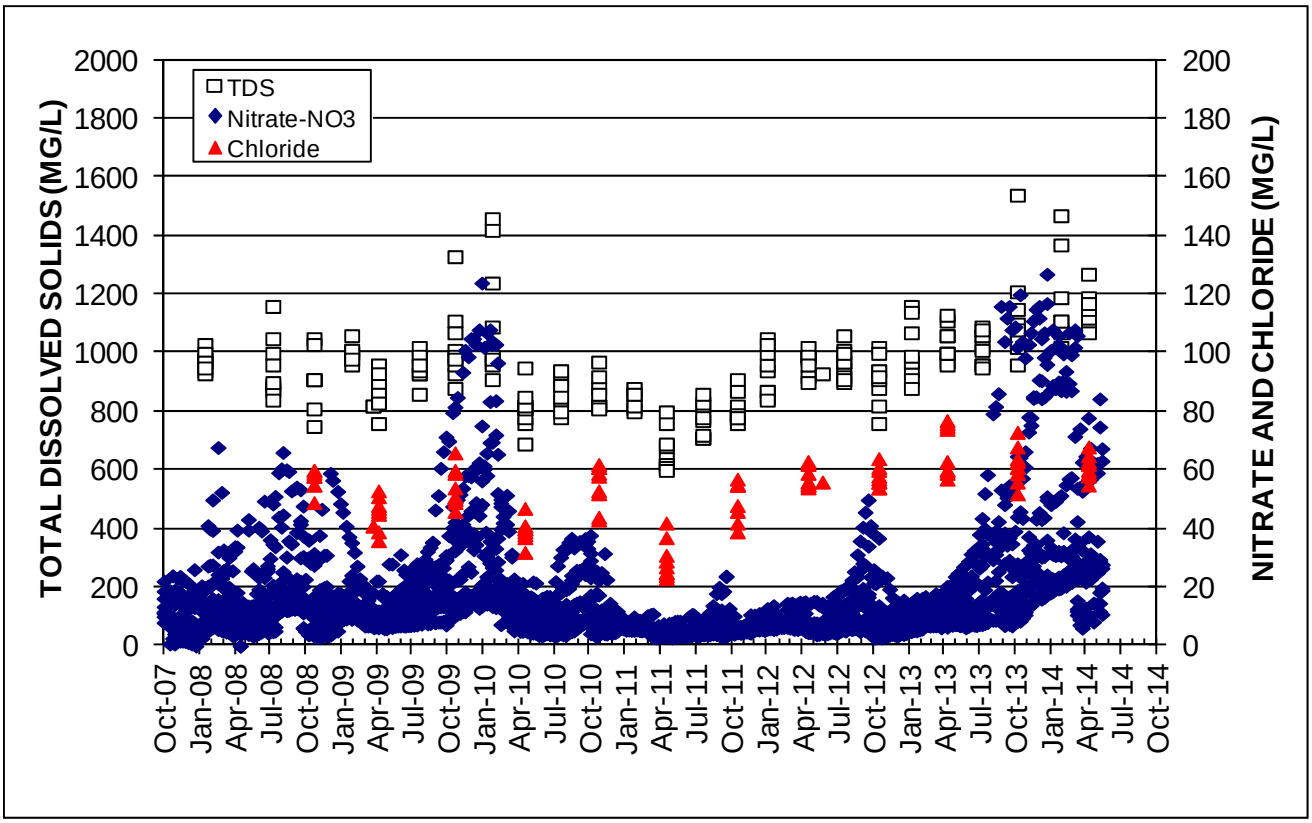
Cumulative 2013-2014 pipeline deliveries (surface water deliveries), compared to prior water year



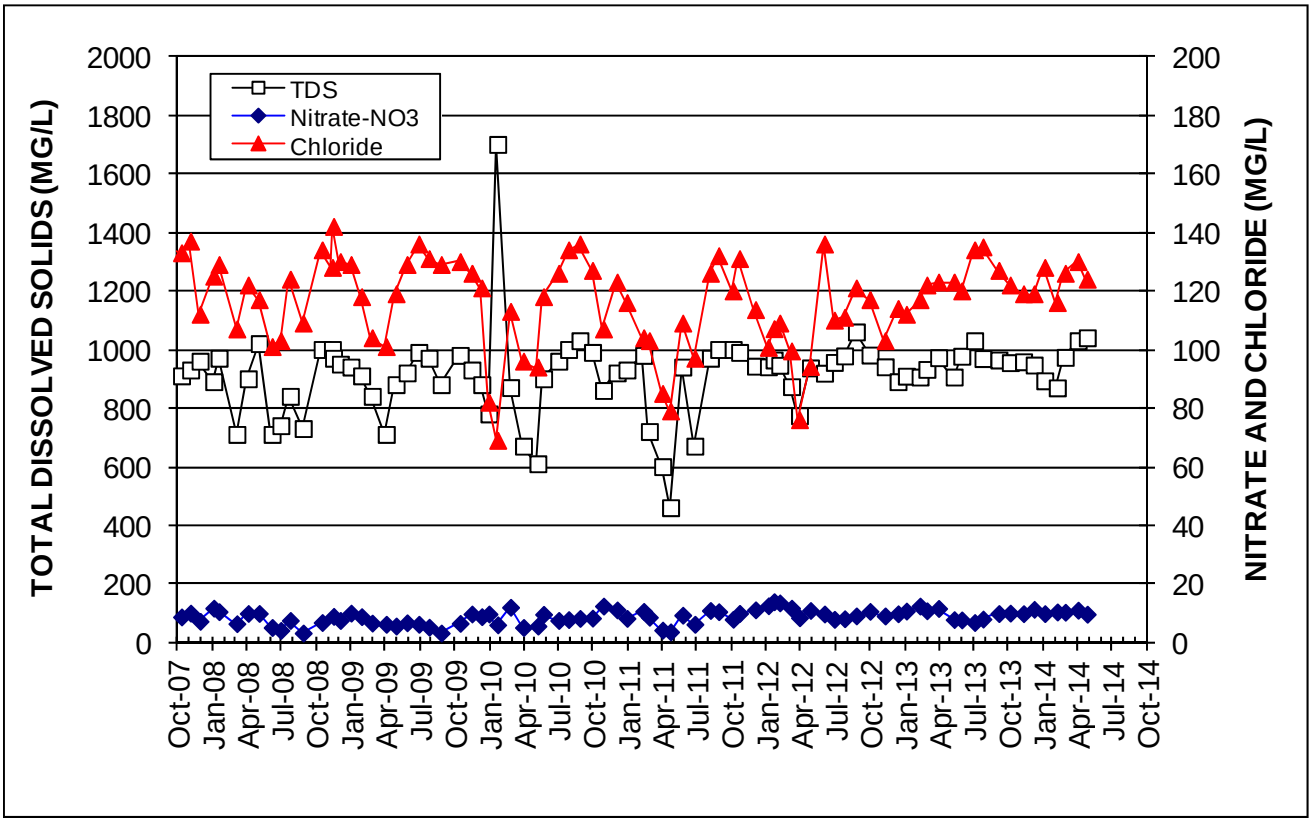
Cumulative diversion at Saticoy and Freeman diversion, in acre-feet



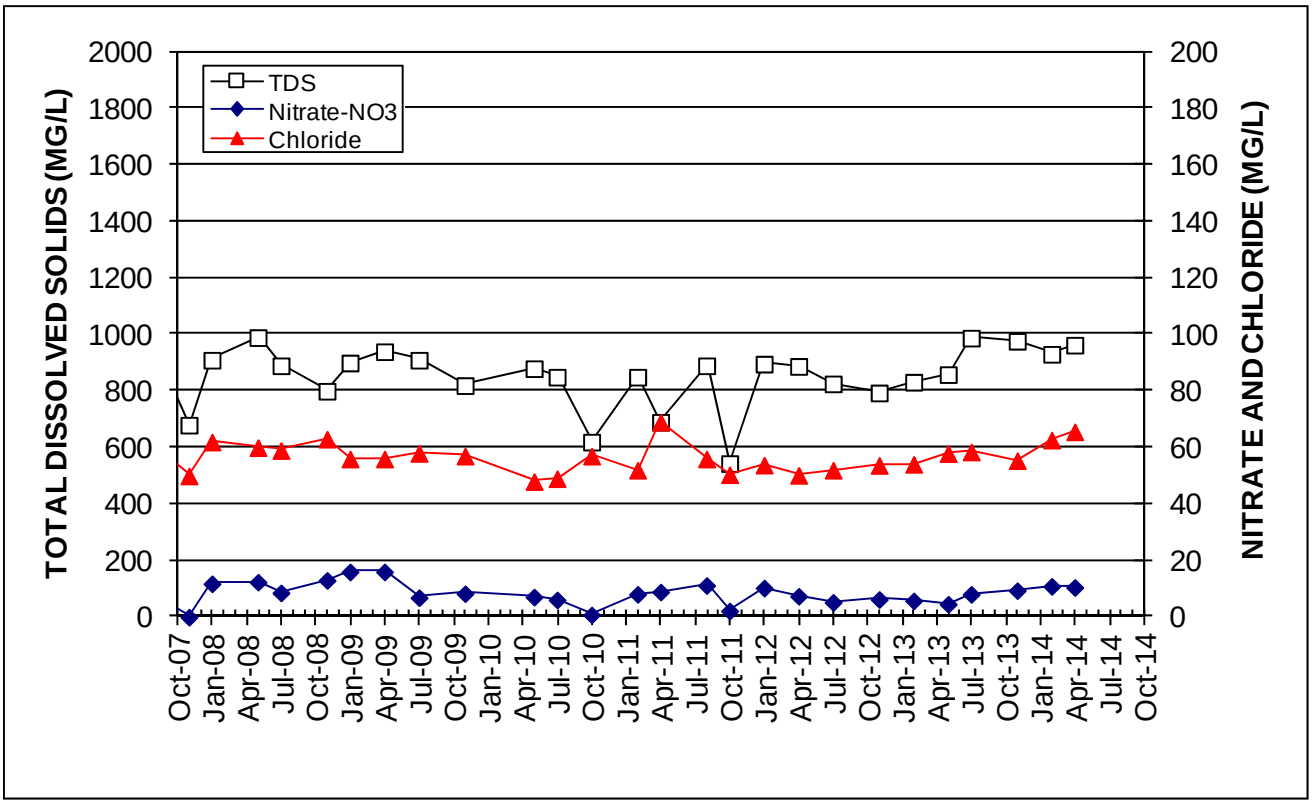
Santa Clara River water quality at Freeman Diversion



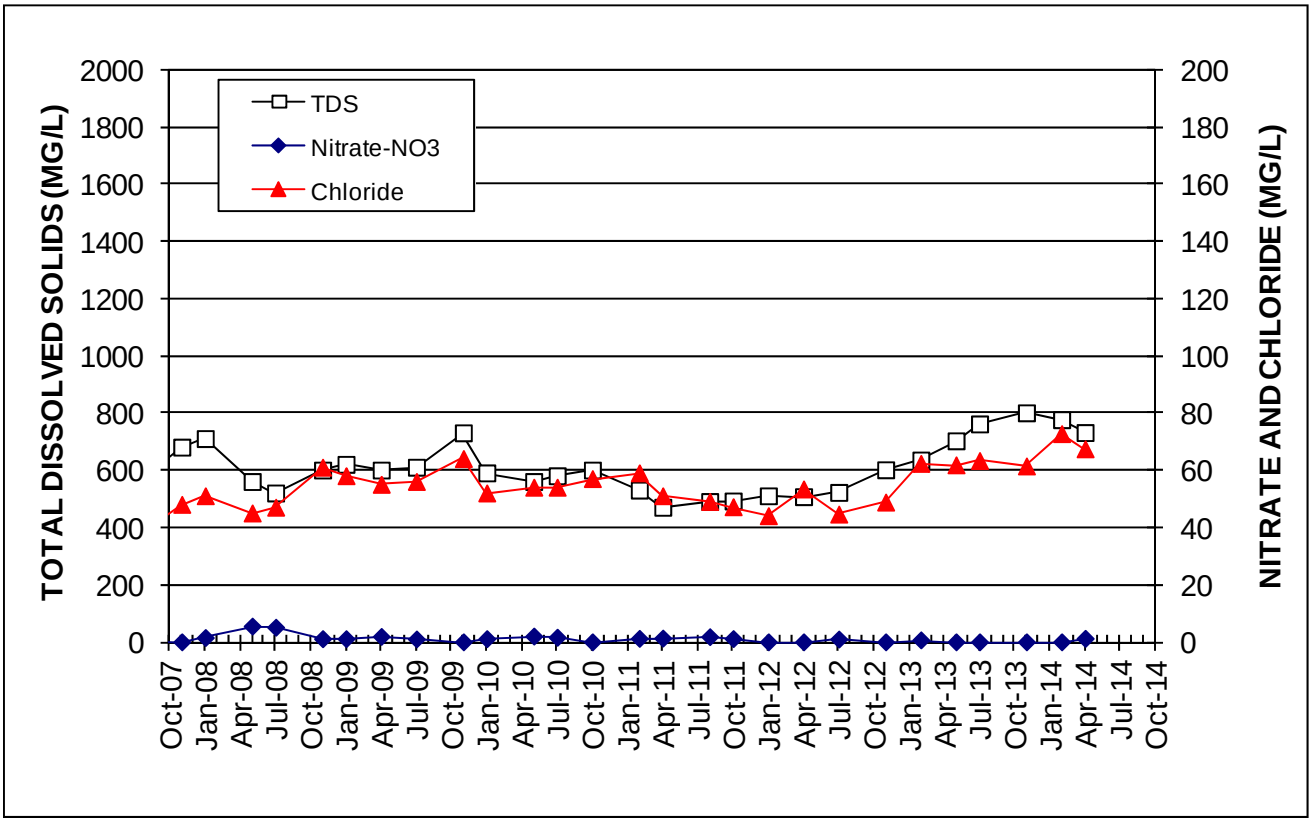
Water quality of Upper Aquifer System wells, El Rio well field



Santa Clara River water quality near Los Angeles/Ventura County line

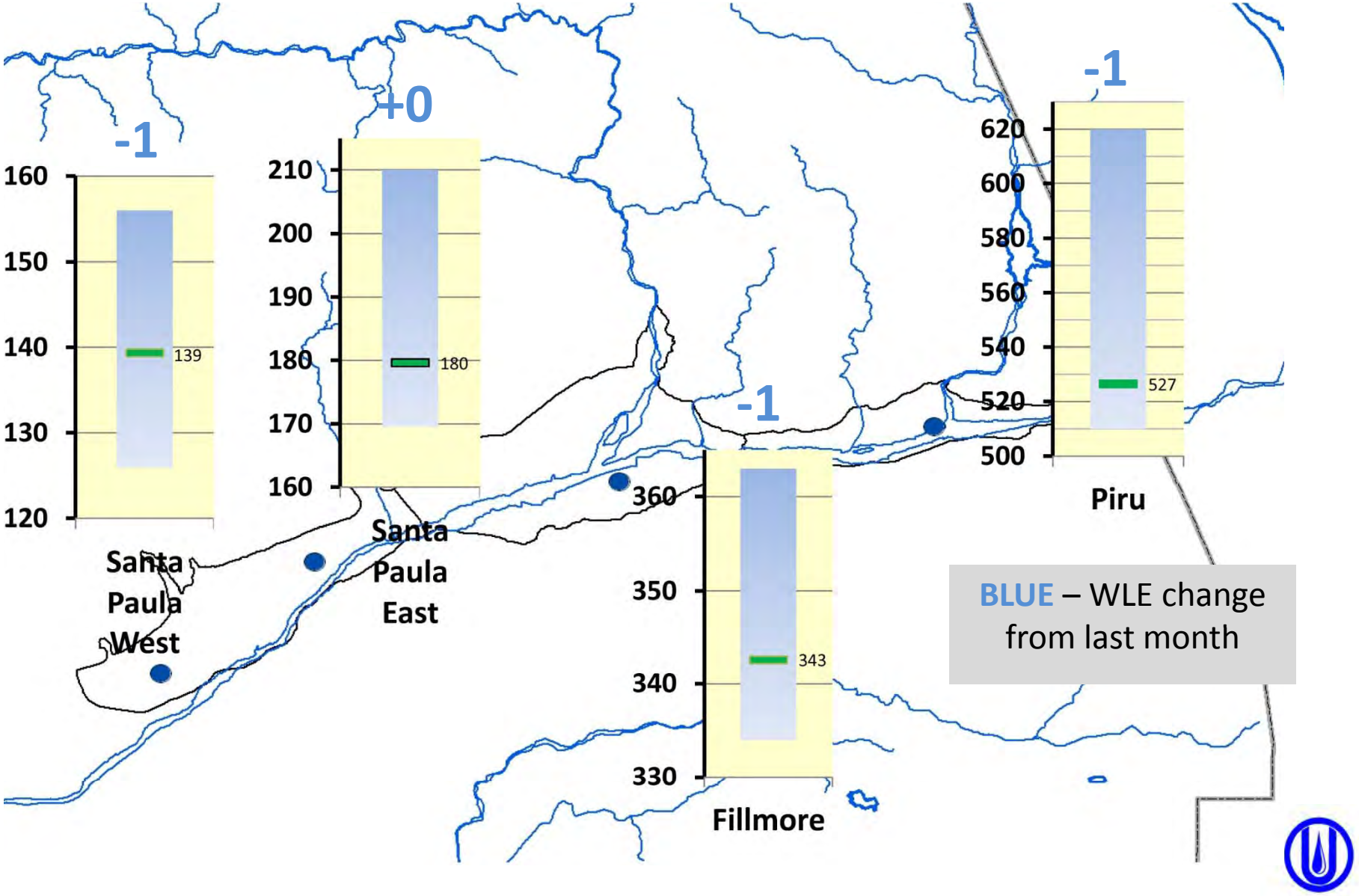


Santa Clara River water quality near Fillmore Fish Hatchery

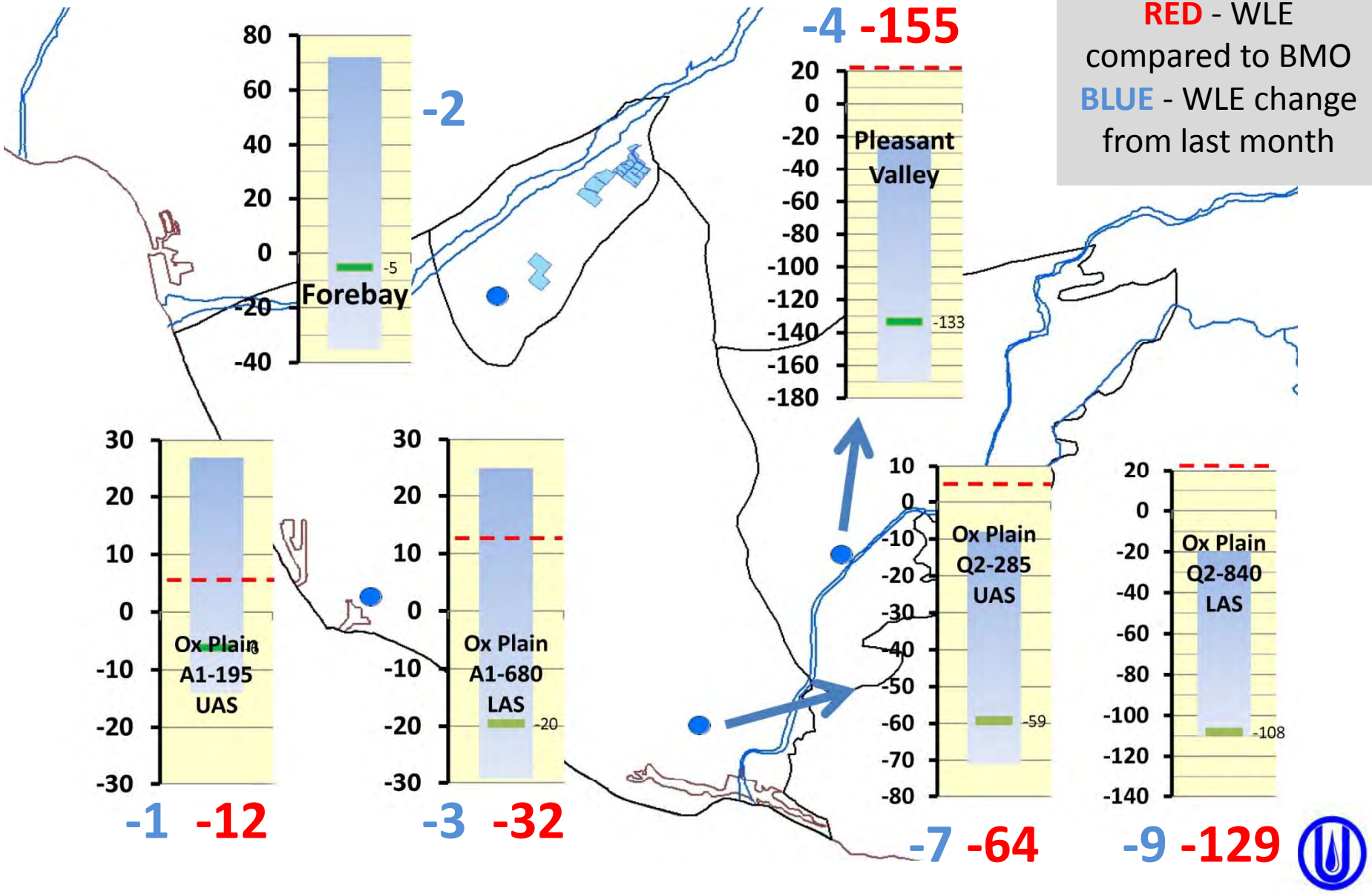


Piru Creek water quality below Santa Felicia Dam

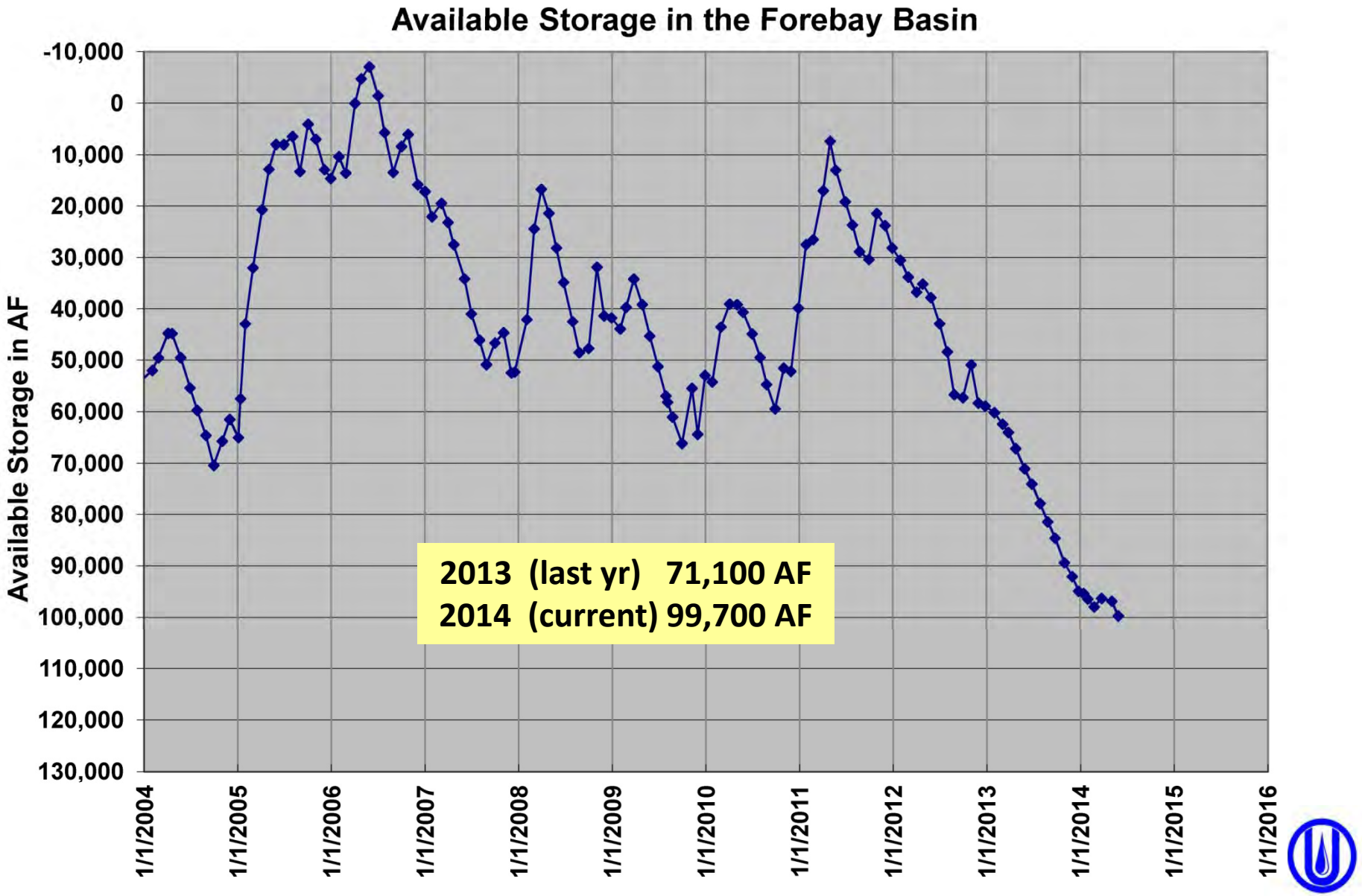
United Water Conservation District



United Water Conservation District



United Water Conservation District



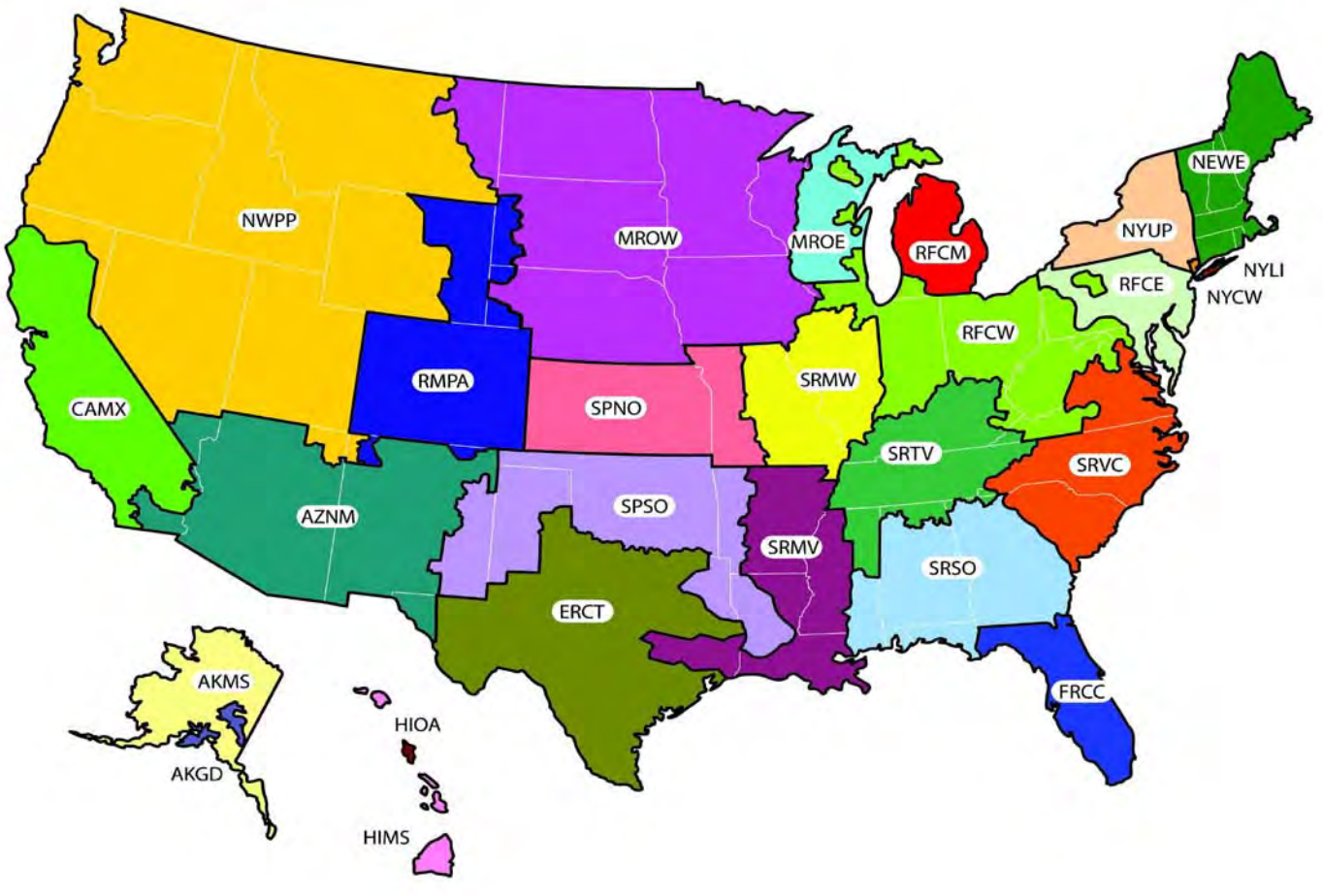
eGRID 9th edition Version 1.0
Year 2010 Summary Tables

(created February 2014)

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Year 2010 eGRID Subregion Emissions - Greenhouse Gases

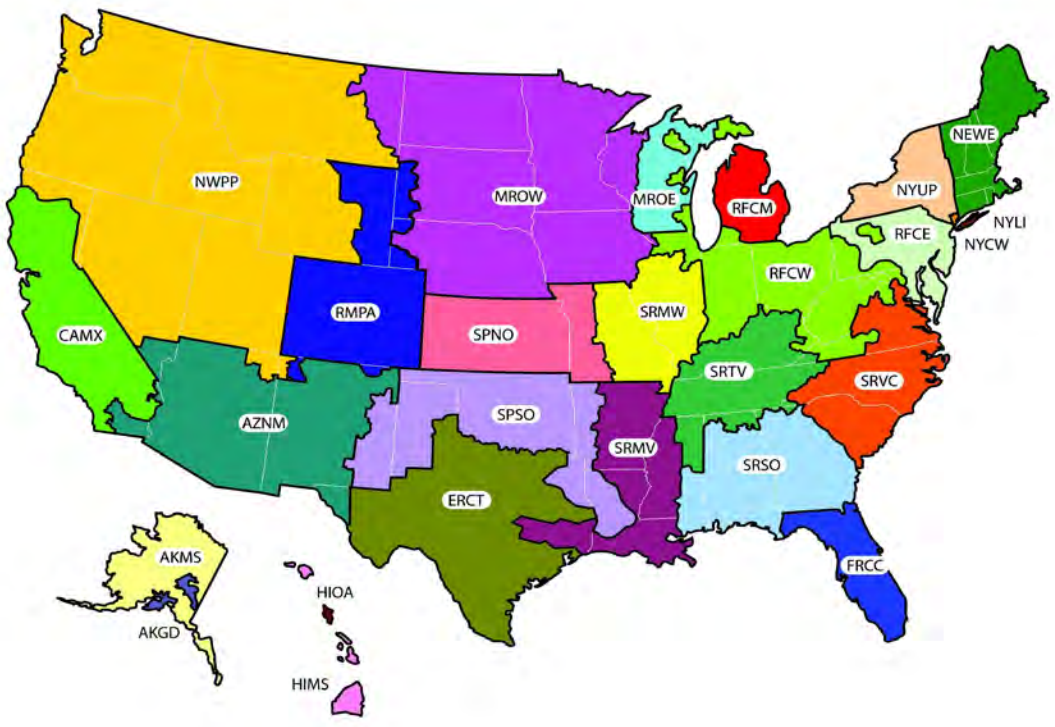
eGRID subregion acronym	eGRID subregion name	Carbon dioxide (CO_2)		Methane (CH_4)		Nitrous oxide (N_2O)		Carbon dioxide equivalent (CO_2e)	
		Emissions (tons)	Total output emission rate (lb/MWh)	Emissions (lbs)	Total output emission rate (lb/GWh)	Emissions (lbs)	Total output emission rate (lb/GWh)	Emissions (tons)	Total output emission rate (lb/MWh)
AKGD	ASCC Alaska Grid	3,350,817.0	1,256.87	139,035.5	26.08	38,279.9	7.18	3,358,210.3	1,259.64
AKMS	ASCC Miscellaneous	317,398.6	448.57	26,527.0	18.74	5,208.6	3.68	318,484.5	450.10
AZNM	WECC Southwest	104,967,483.8	1,177.61	3,424,005.1	19.21	2,802,975.8	15.72	105,437,897.1	1,182.89
CAMX	WECC California	64,799,260.4	610.82	6,044,809.1	28.49	1,278,773.3	6.03	65,060,940.8	613.28
ERCT	ERCOT All	210,366,837.2	1,218.17	5,820,108.3	16.85	4,859,884.0	14.07	211,181,230.4	1,222.88
FRCC	FRCC All	130,376,587.7	1,196.71	8,478,102.7	38.91	2,995,217.6	13.75	130,929,866.5	1,201.79
HIMS	HICC Miscellaneous	1,963,642.7	1,330.16	218,438.7	73.98	40,985.9	13.88	1,972,289.1	1,336.02
HIOA	HICC Oahu	6,393,027.4	1,621.86	782,825.4	99.30	176,679.8	22.41	6,428,632.4	1,630.90
MROE	MRO East	26,009,237.7	1,610.80	784,331.9	24.29	888,770.5	27.52	26,155,232.6	1,619.84
MROW	MRO West	156,444,752.4	1,536.36	5,809,874.5	28.53	5,354,351.3	26.29	157,335,680.5	1,545.11
NEWE	NPCC New England	46,905,984.7	722.07	9,322,707.0	71.76	1,685,853.4	12.98	47,265,180.4	727.60
NWPP	WECC Northwest	112,891,853.5	842.58	4,300,901.6	16.05	3,502,980.9	13.07	113,479,975.1	846.97
NYCW	NPCC NYC/Westchester	12,733,660.7	622.42	974,161.1	23.81	114,582.6	2.80	12,761,649.6	623.78
NYLI	NPCC Long Island	8,115,858.7	1,336.11	989,929.6	81.49	124,943.6	10.28	8,145,619.2	1,341.01
NYUP	NPCC Upstate NY	24,165,154.6	545.79	1,443,157.6	16.30	641,283.5	7.24	24,279,706.7	548.37
RFCE	RFC East	137,558,868.7	1,001.72	7,434,984.1	27.07	4,210,267.5	15.33	138,289,527.5	1,007.04
RFCM	RFC Michigan	74,602,328.8	1,629.38	2,789,651.5	30.46	2,457,844.2	26.84	75,012,586.0	1,638.34
RFCW	RFC West	449,994,271.4	1,503.47	10,897,168.6	18.20	14,813,680.5	24.75	452,404,812.2	1,511.52
RMPA	WECC Rockies	61,839,528.9	1,896.74	1,477,560.7	22.66	1,904,448.4	29.21	62,150,232.8	1,906.27
SPNO	SPP North	62,457,258.2	1,799.45	1,444,401.4	20.81	1,986,994.1	28.62	62,780,408.5	1,808.76
SPSO	SPP South	117,325,297.0	1,580.60	3,444,187.9	23.20	3,095,469.5	20.85	117,841,258.7	1,587.55
SRMV	SERC Mississippi Valley	90,967,299.2	1,029.82	3,650,522.7	20.66	1,900,187.0	10.76	91,300,158.7	1,033.58
SRMW	SERC Midwest	123,042,911.4	1,810.83	2,783,643.6	20.48	4,019,051.2	29.57	123,695,092.6	1,820.43
SRSO	SERC South	183,236,856.9	1,354.09	6,176,437.4	22.82	5,653,138.2	20.89	184,177,945.9	1,361.05
SRTV	SERC Tennessee Valley	163,960,526.8	1,389.20	4,177,202.5	17.70	5,290,412.2	22.41	164,824,401.3	1,396.52
SRVC	SERC Virginia/Carolina	167,452,188.6	1,073.65	6,766,296.6	21.69	5,502,582.8	17.64	168,376,135.0	1,079.57
U.S.		**2,542,238,893.0**	**1,232.35**	**99,600,972.2**	**24.14**	**75,344,845.9**	**18.26**	**2,554,963,154.4**	**1,238.52**



This is a representational map; many of the boundaries shown on this map are approximate because they are based on companies, not on strictly geographical boundaries.

Year 2010 eGRID Subregion Emissions - Criteria Pollutants

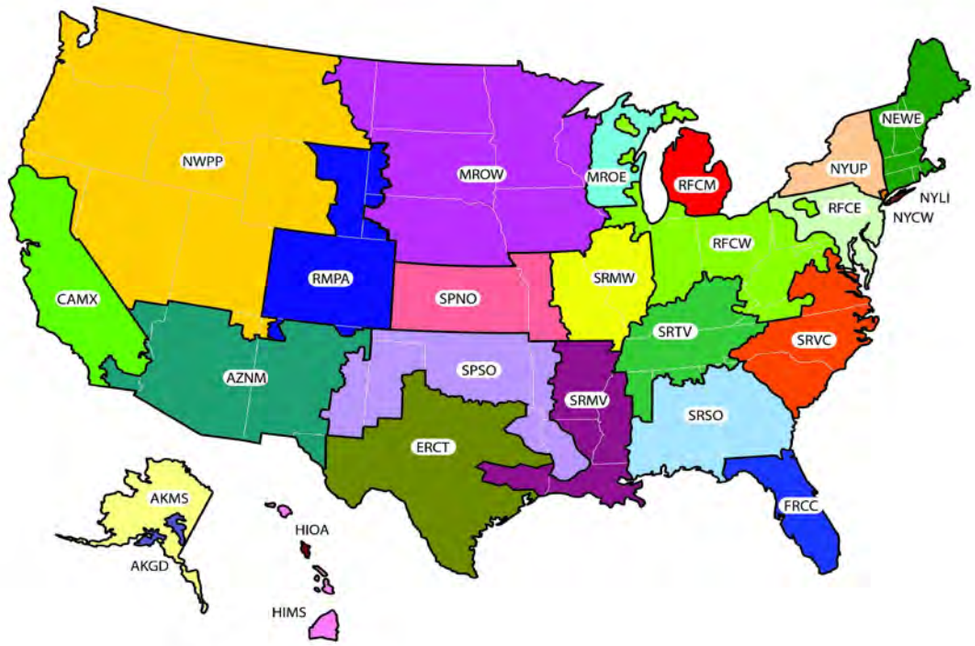
eGRID subregion acronym	eGRID subregion name	Nitrogen oxides (NO_x)				Sulfur dioxide (SO_2)	
		Emissions (tons)	Total output emission rate (lb/MWh)	Ozone season emissions (tons)	Ozone season total output emission rate (lb/MWh)	Emissions (tons)	Total output emission rate (lb/MWh)
AKGD	ASCC Alaska Grid	6,747.78	2.5310	2,483.95	2.4531	1,218.16	0.4569
AKMS	ASCC Miscellaneous	4,190.35	5.9221	1,283.02	4.8215	119.64	0.1691
AZNM	WECC Southwest	126,803.83	1.4226	56,734.05	1.3558	54,384.88	0.6101
CAMX	WECC California	42,935.54	0.4047	18,951.31	0.3980	18,114.85	0.1708
ERCT	ERCOT All	112,686.33	0.6525	53,116.56	0.6318	388,236.16	2.2482
FRCC	FRCC All	77,861.56	0.7147	36,505.33	0.7058	154,674.97	1.4197
HIMS	HICC Miscellaneous	8,265.74	5.5992	3,655.16	5.6423	5,555.84	3.7635
HIOA	HICC Oahu	9,822.55	2.4919	3,473.29	2.0489	15,846.99	4.0203
MROE	MRO East	22,388.78	1.3866	9,773.05	1.3457	84,527.18	5.2349
MROW	MRO West	202,395.91	1.9876	83,125.52	1.9047	386,476.47	3.7954
NEWE	NPCC New England	33,872.13	0.5214	13,062.90	0.4453	91,903.02	1.4148
NWPP	WECC Northwest	136,341.44	1.0176	54,279.01	0.9348	134,623.44	1.0048
NYCW	NPCC NYC/Westchester	5,507.03	0.2692	3,174.62	0.3203	1,895.26	0.0926
NYLI	NPCC Long Island	5,739.65	0.9449	3,186.08	1.0224	3,346.78	0.5510
NYUP	NPCC Upstate NY	18,704.86	0.4225	8,393.89	0.4287	49,396.12	1.1156
RFCE	RFC East	118,630.07	0.8639	54,277.28	0.8714	293,625.57	2.1382
RFCM	RFC Michigan	76,828.93	1.6780	33,224.72	1.5480	240,734.60	5.2579
RFCW	RFC West	416,995.47	1.3932	180,238.54	1.3824	1,489,089.68	4.9752
RMPA	WECC Rockies	78,970.58	2.4222	32,666.01	2.3263	61,109.45	1.8743
SPNO	SPP North	66,593.95	1.9186	29,964.11	1.8933	88,544.89	2.5511
SPSO	SPP South	136,008.22	1.8323	64,420.86	1.7981	236,116.02	3.1809
SRMV	SERC Mississippi Valley	118,153.08	1.3376	59,670.07	1.4449	127,939.31	1.4484
SRMW	SERC Midwest	71,474.29	1.0519	31,153.17	1.0524	335,167.04	4.9327
SRSO	SERC South	150,786.79	1.1143	66,651.11	1.0437	484,599.01	3.5811
SRTV	SERC Tennessee Valley	134,430.67	1.1390	58,229.66	1.1400	387,669.47	3.2846
SRVC	SERC Virginia/Carolina	124,727.96	0.7997	57,608.45	0.8113	317,964.62	2.0387
U.S.		**2,307,863.49**	**1.1187**	**1,019,301.72**	**1.0885**	**5,452,879.41**	**2.6433**



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Year 2010 eGRID Subregion Output Emission Rates - Greenhouse Gases

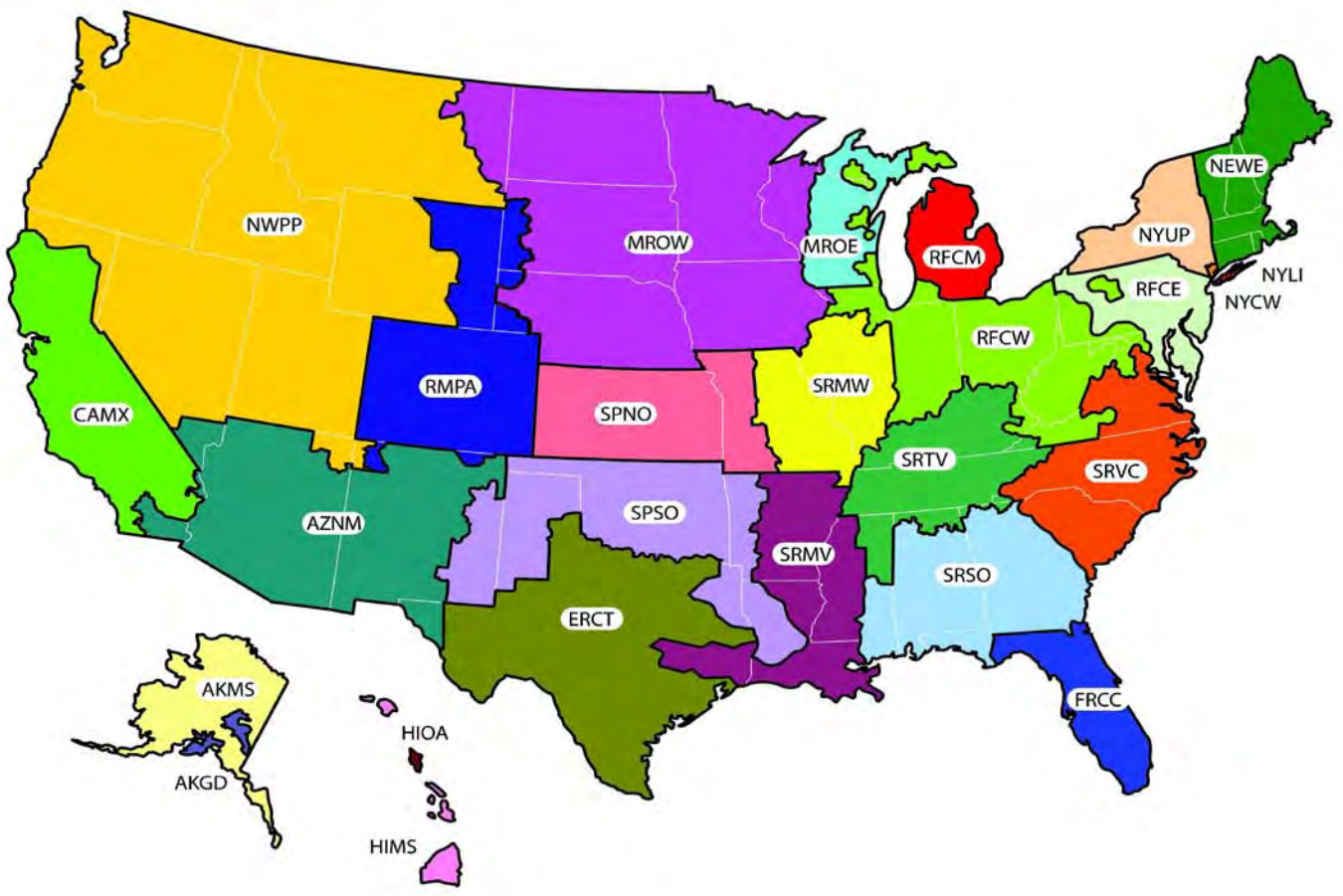
eGRID subregion acronym	eGRID subregion name	Total output emission rates			Fossil fuel output emission rate	Non-baseload output emission rates		
		CO_2 (lb/MWh)	CH_4 (lb/GWh)	N_2O (lb/GWh)	CO_2 (lb/MWh)	CO_2 (lb/MWh)	CH_4 (lb/GWh)	N_2O (lb/GWh)
AKGD	ASCC Alaska Grid	1,256.87	26.08	7.18	1,377.76	1,387.37	34.05	6.93
AKMS	ASCC Miscellaneous	448.57	18.74	3.68	1,413.40	1,427.76	59.97	11.80
AZNM	WECC Southwest	1,177.61	19.21	15.72	1,613.24	1,210.44	21.88	9.86
CAMX	WECC California	610.82	28.49	6.03	1,014.49	932.82	35.91	4.55
ERCT	ERCOT All	1,218.17	16.85	14.07	1,508.72	1,181.70	20.12	7.63
FRCC	FRCC All	1,196.71	38.91	13.75	1,342.00	1,277.42	38.73	10.83
HIMS	HICC Miscellaneous	1,330.16	73.98	13.88	1,712.90	1,690.72	104.05	19.12
HIOA	HICC Oahu	1,621.86	99.30	22.41	1,596.89	1,588.23	119.48	20.10
MROE	MRO East	1,610.80	24.29	27.52	2,120.96	1,755.66	31.53	27.99
MROW	MRO West	1,536.36	28.53	26.29	2,225.15	2,054.55	59.86	35.53
NEWE	NPCC New England	722.07	71.76	12.98	1,115.40	1,106.82	61.55	12.07
NWPP	WECC Northwest	842.58	16.05	13.07	1,819.02	1,340.34	41.38	17.84
NYCW	NPCC NYC/Westchester	622.42	23.81	2.80	1,004.41	1,131.63	23.58	2.44
NYLI	NPCC Long Island	1,336.11	81.49	10.28	1,269.76	1,445.94	34.03	3.91
NYUP	NPCC Upstate NY	545.79	16.30	7.24	1,384.41	1,253.77	36.83	13.67
RFCE	RFC East	1,001.72	27.07	15.33	1,695.25	1,562.72	35.93	20.02
RFCM	RFC Michigan	1,629.38	30.46	26.84	1,966.47	1,744.52	32.31	26.00
RFCW	RFC West	1,503.47	18.20	24.75	2,040.18	1,982.87	24.50	31.07
RMPA	WECC Rockies	1,896.74	22.66	29.21	2,103.57	1,808.03	24.56	22.89
SPNO	SPP North	1,799.45	20.81	28.62	2,218.66	1,951.83	25.15	26.90
SPSO	SPP South	1,580.60	23.20	20.85	1,762.16	1,436.29	27.94	12.10
SRMV	SERC Mississippi Valley	1,029.82	20.66	10.76	1,433.94	1,222.40	27.71	6.63
SRMW	SERC Midwest	1,810.83	20.48	29.57	2,124.43	1,964.98	23.93	29.65
SRSO	SERC South	1,354.09	22.82	20.89	1,754.16	1,574.37	26.52	21.49
SRTV	SERC Tennessee Valley	1,389.20	17.70	22.41	1,977.32	1,873.83	24.99	28.88
SRVC	SERC Virginia/Carolina	1,073.65	21.69	17.64	1,835.13	1,624.71	36.42	23.06
U.S.		**1,232.35**	**24.14**	**18.26**	**1,745.14**	**1,520.20**	**31.27**	**18.34**



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Year 2010 eGRID Subregion Output Emission Rates - Criteria Pollutants

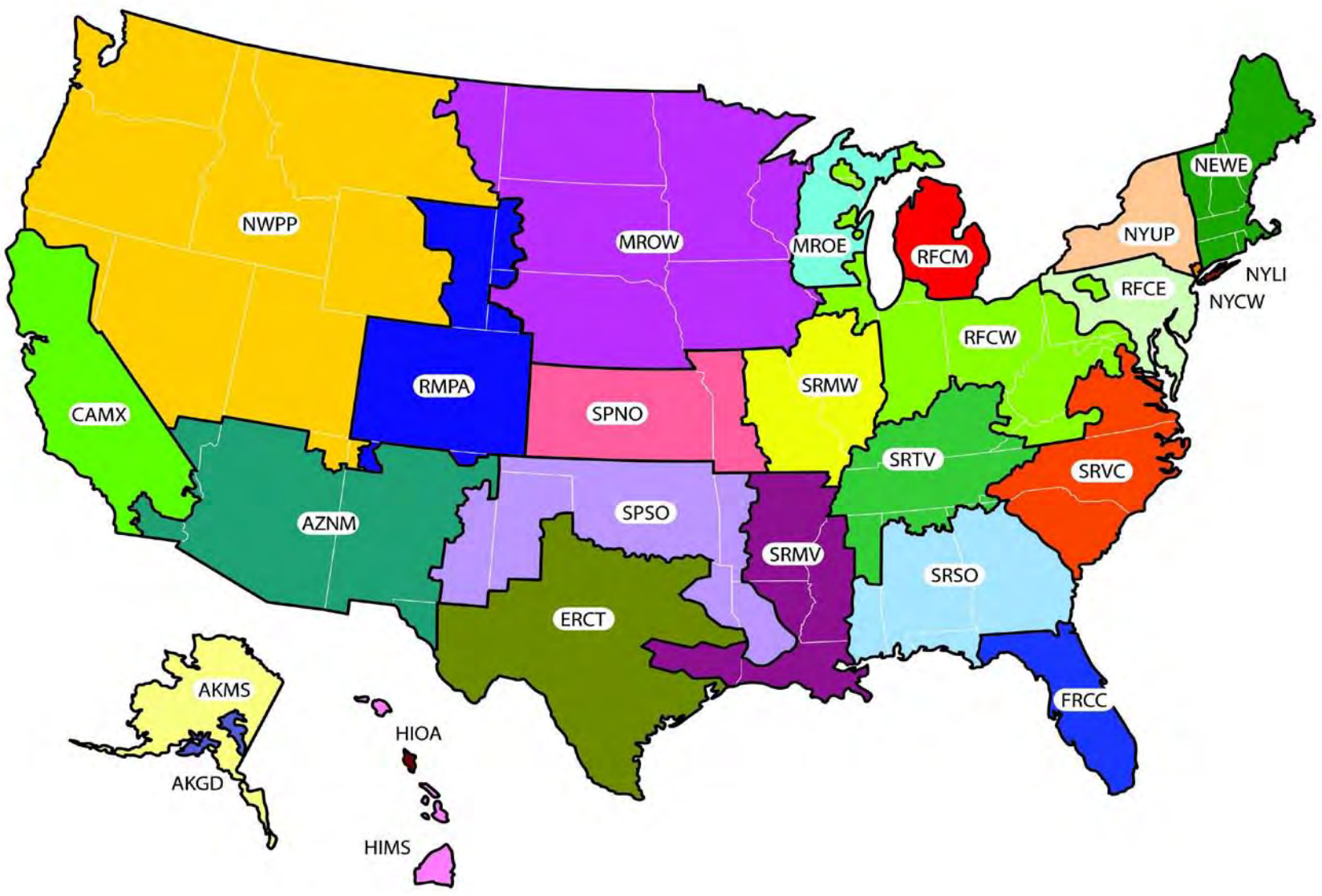
eGRID subregion acronym	eGRID subregion name	Total output emission rates			Fossil fuel output emission rates			Non-baseload output emission rates		
		NO_x (lb/MWh)	Ozone season NO_x (lb/MWh)	SO_2 (lb/MWh)	NO_x (lb/MWh)	Ozone season NO_x (lb/MWh)	SO_2 (lb/MWh)	NO_x (lb/MWh)	Ozone season NO_x (lb/MWh)	SO_2 (lb/MWh)
AKGD	ASCC Alaska Grid	2.5310	2.4531	0.4569	2.7745	2.7521	0.5009	3.0246	2.8092	0.3259
AKMS	ASCC Miscellaneous	5.9221	4.8215	0.1691	18.6600	18.1551	0.5328	19.8413	19.0429	0.5650
AZNM	WECC Southwest	1.4226	1.3558	0.6101	1.9411	1.8081	0.8258	0.9297	1.0420	0.3530
CAMX	WECC California	0.4047	0.3980	0.1708	0.6281	0.7057	0.2692	0.2297	0.2411	0.0353
ERCT	ERCOT All	0.6525	0.6318	2.2482	0.8081	0.7579	2.7844	0.4978	0.6096	0.6151
FRCC	FRCC All	0.7147	0.7058	1.4197	0.7297	0.7218	1.3664	0.9144	1.0966	1.6357
HIMS	HICC Miscellaneous	5.5992	5.6423	3.7635	7.1599	7.5503	4.8125	10.0149	10.2218	4.6127
HIOA	HICC Oahu	2.4919	2.0489	4.0203	2.1156	2.1299	4.0004	3.0144	2.5090	3.0473
MROE	MRO East	1.3866	1.3457	5.2349	1.7560	1.6704	6.7674	2.0548	1.8436	5.7894
MROW	MRO West	1.9876	1.9047	3.7954	2.8218	2.6886	5.4912	2.8321	2.5897	5.4565
NEWE	NPCC New England	0.5214	0.4453	1.4148	0.4811	0.4586	2.1040	0.6342	0.7031	1.4931
NWPP	WECC Northwest	1.0176	0.9348	1.0048	2.1644	2.1853	2.1380	1.3986	1.2181	1.0904
NYCW	NPCC NYC/Westchester	0.2692	0.3203	0.0926	0.3712	0.4364	0.0551	0.6647	1.0352	0.1156
NYLI	NPCC Long Island	0.9449	1.0224	0.5510	0.8396	0.9442	0.4555	1.0904	1.4493	0.6610
NYUP	NPCC Upstate NY	0.4225	0.4287	1.1156	1.0072	0.9434	2.8092	0.8264	1.0011	2.3687
RFCE	RFC East	0.8639	0.8714	2.1382	1.4340	1.3786	3.6029	1.3913	1.7091	3.8673
RFCM	RFC Michigan	1.6780	1.5480	5.2579	1.9799	1.8406	6.3198	1.8329	1.7387	6.1011
RFCW	RFC West	1.3932	1.3824	4.9752	1.8841	1.8503	6.7425	2.0632	2.0945	8.0711
RMPA	WECC Rockies	2.4222	2.3263	1.8743	2.6863	2.6180	2.0787	2.0440	1.9649	1.5854
SPNO	SPP North	1.9186	1.8933	2.5511	2.3656	2.3119	3.1454	2.2149	2.3211	3.3784
SPSO	SPP South	1.8323	1.7981	3.1809	2.0274	1.9639	3.5117	1.7566	2.0256	1.9672
SRMV	SERC Mississippi Valley	1.3376	1.4449	1.4484	1.8094	1.8819	1.8602	1.5096	1.8411	0.5643
SRMW	SERC Midwest	1.0519	1.0524	4.9327	1.2341	1.2222	5.7869	1.2024	1.1874	5.5356
SRSO	SERC South	1.1143	1.0437	3.5811	1.3853	1.2723	4.5101	1.6404	1.6834	5.6683
SRTV	SERC Tennessee Valley	1.1390	1.1400	3.2846	1.6093	1.5641	4.6351	1.5843	1.6606	4.8449
SRVC	SERC Virginia/Carolina	0.7997	0.8113	2.0387	1.2994	1.2772	3.3959	1.3915	1.5785	4.3637
U.S.		**1.1187**	**1.0885**	**2.6433**	**1.5479**	**1.4877**	**3.7004**	**1.3930**	**1.5101**	**3.4026**



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Year 2010 eGRID Subregion Resource Mix

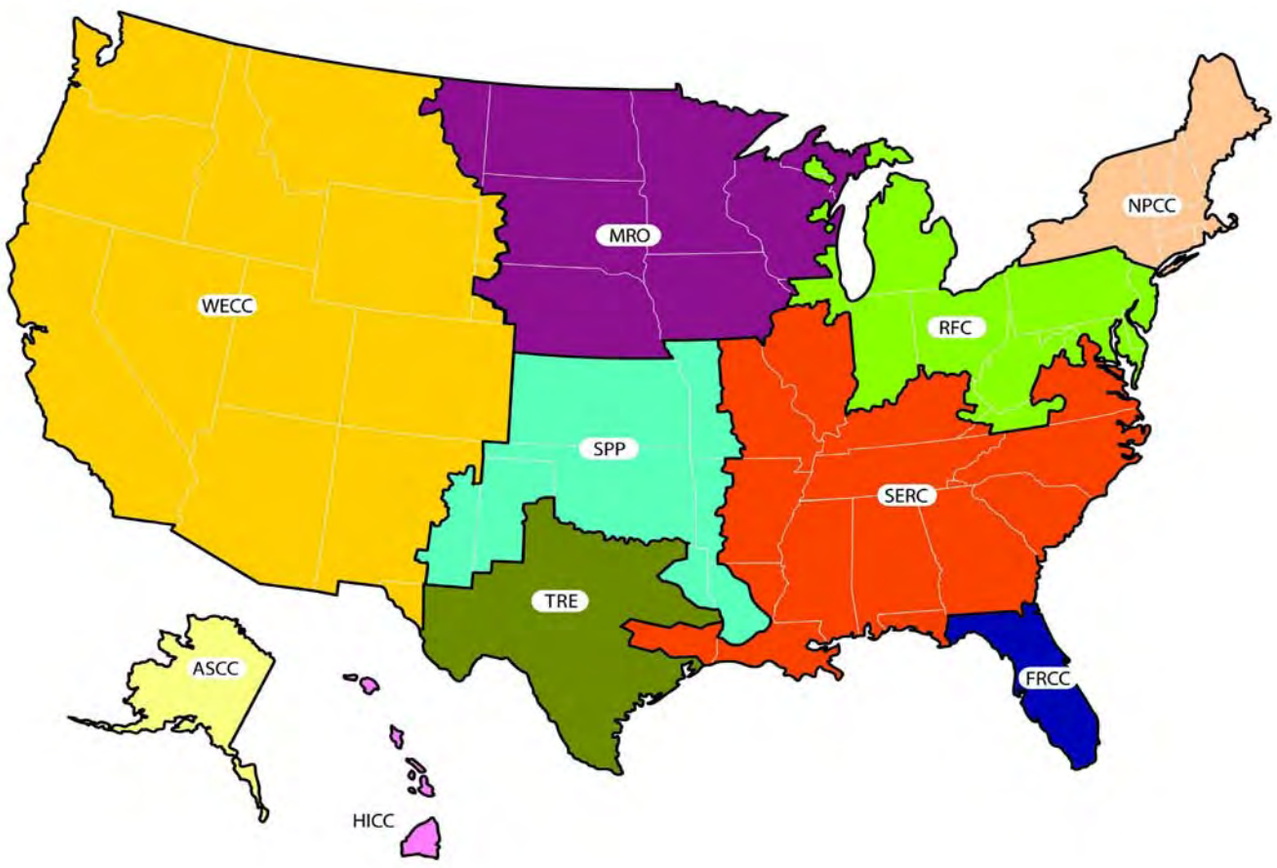
eGRID subregion acronym	eGRID subregion name	Nameplate capacity (MW)	Net Generation (MWh)	Generation resource mix (percent)										
				Coal	Oil	Gas	Other fossil	Biomass	Hydro	Nuclear	Wind	Solar	Geo-thermal	Other unknown/ purchased fuel
AKGD	ASCC Alaska Grid	1,522.2	5,332,020.2	11.6362	10.1930	69.3962	0.0000	0.0000	8.7746	0.0000	0.0000	0.0000	0.0000	0.0000
AKMS	ASCC Miscellaneous	713.2	1,415,158.2	0.0000	27.7721	3.5193	0.0000	0.4455	67.3723	0.0000	0.8909	0.0000	0.0000	0.0000
AZNM	WECC Southwest	49,321.6	178,271,415.3	39.4515	0.0661	33.4001	0.0056	0.3422	6.1810	17.5014	0.6862	0.1295	2.2366	0.0000
CAMX	WECC California	75,066.4	212,172,138.5	7.1466	1.1510	50.4490	0.2316	2.6248	15.1942	15.1767	3.0538	0.3564	4.3187	0.2970
ERCT	ERCOT All	100,595.3	345,382,525.6	34.8356	0.7898	44.9525	0.1266	0.1306	0.2040	11.9680	6.8938	0.0024	0.0000	0.0968
FRCC	FRCC All	64,862.9	217,890,866.6	24.3846	4.1835	57.3321	0.6049	1.6658	0.0815	10.9853	0.0000	0.0369	0.0000	0.7254
HIMS	HICC Miscellaneous	895.3	2,952,481.9	1.6723	69.1861	0.0000	7.4198	3.6384	2.3852	0.0000	8.8441	0.0599	6.7941	0.0000
HIOA	HICC Oahu	1,925.6	7,883,554.0	18.9780	76.9519	0.0000	1.9673	2.1028	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MROE	MRO East	8,897.0	32,293,505.5	69.4580	2.1436	4.0010	0.0783	3.2994	3.3210	15.4528	2.1402	0.0000	0.0000	0.1058
MROW	MRO West	55,325.0	203,656,312.3	65.2593	0.1544	3.1566	0.1293	1.2099	5.8722	14.2313	9.8081	0.0000	0.0000	0.1789
NEWE	NPCC New England	36,485.3	129,920,243.4	10.8375	0.8196	45.2791	1.5167	5.6102	5.9300	29.5263	0.4698	0.0000	0.0000	0.0101
NWPP	WECC Northwest	69,721.0	267,967,318.0	31.3015	0.3279	14.3386	0.1423	1.2372	43.5510	3.4486	4.8371	0.0000	0.6973	0.1179
NYCW	NPCC NYC/Westchester	13,906.9	40,916,871.9	0.0000	1.2934	57.3676	0.4697	0.5234	0.0000	39.8873	0.4585	0.0000	0.0000	0.0000
NYLI	NPCC Long Island	6,000.4	12,148,487.3	0.0000	6.9312	85.4961	3.5635	4.0093	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NYUP	NPCC Upstate NY	25,067.6	88,551,618.2	15.3388	0.8398	22.2004	0.3017	1.6451	28.1600	28.8520	2.6622	0.0000	0.0000	0.0000
RFCE	RFC East	74,350.1	274,646,405.8	35.2745	0.5476	20.6192	0.6873	1.2794	1.0071	39.9059	0.6687	0.0104	0.0000	0.0000
RFCM	RFC Michigan	29,590.2	91,571,321.5	68.0216	0.3973	13.2495	0.6553	1.8774	0.0000	15.1705	0.6284	0.0000	0.0000	0.0000
RFCW	RFC West	147,391.4	598,607,320.8	68.5984	0.3959	4.1640	0.4478	0.4818	0.6593	23.7740	1.4141	0.0042	0.0000	0.0606
RMPA	WECC Rockies	18,178.1	65,206,132.2	72.9959	0.0427	17.1257	0.0000	0.0923	3.9125	0.0000	5.6469	0.0770	0.0000	0.1070
SPNO	SPP North	21,261.8	69,418,232.2	72.8397	0.2706	7.9546	0.0394	0.0792	0.1460	13.7654	4.9051	0.0000	0.0000	0.0000
SPSO	SPP South	44,883.8	148,456,365.7	52.1508	1.2466	35.9421	0.2062	1.4223	4.4055	0.0000	4.6265	0.0000	0.0000	0.0000
SRMV	SERC Mississippi Valley	50,942.3	176,667,075.4	22.9107	1.1187	46.9265	1.0137	1.8933	1.3544	24.5124	0.0000	0.0000	0.0000	0.2703
SRMW	SERC Midwest	33,454.6	135,896,937.1	80.9052	0.0814	4.0123	0.0576	0.1064	1.0568	12.9569	0.6540	0.0000	0.0000	0.1695
SRSO	SERC South	71,782.9	270,641,138.1	52.3701	0.3031	24.6072	0.1211	2.6539	2.6959	17.2486	0.0000	0.0000	0.0000	0.0000
SRTV	SERC Tennessee Valley	62,065.4	236,050,232.4	58.7899	1.0760	10.4018	0.0144	0.8583	6.5970	22.2454	0.0172	0.0000	0.0000	0.0000
SRVC	SERC Virginia/Carolina	80,849.7	311,931,345.0	45.7303	0.5484	11.7297	0.1706	1.9584	1.4920	38.2454	0.0000	0.0036	0.0000	0.1215
U.S.		**1,145,056.0**	**4,125,847,023.5**	**44.7748**	**1.0174**	**23.9686**	**0.3498**	**1.3571**	**6.1730**	**19.5589**	**2.2864**	**0.0290**	**0.3689**	**0.1162**



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Year 2010 NERC Region Emissions

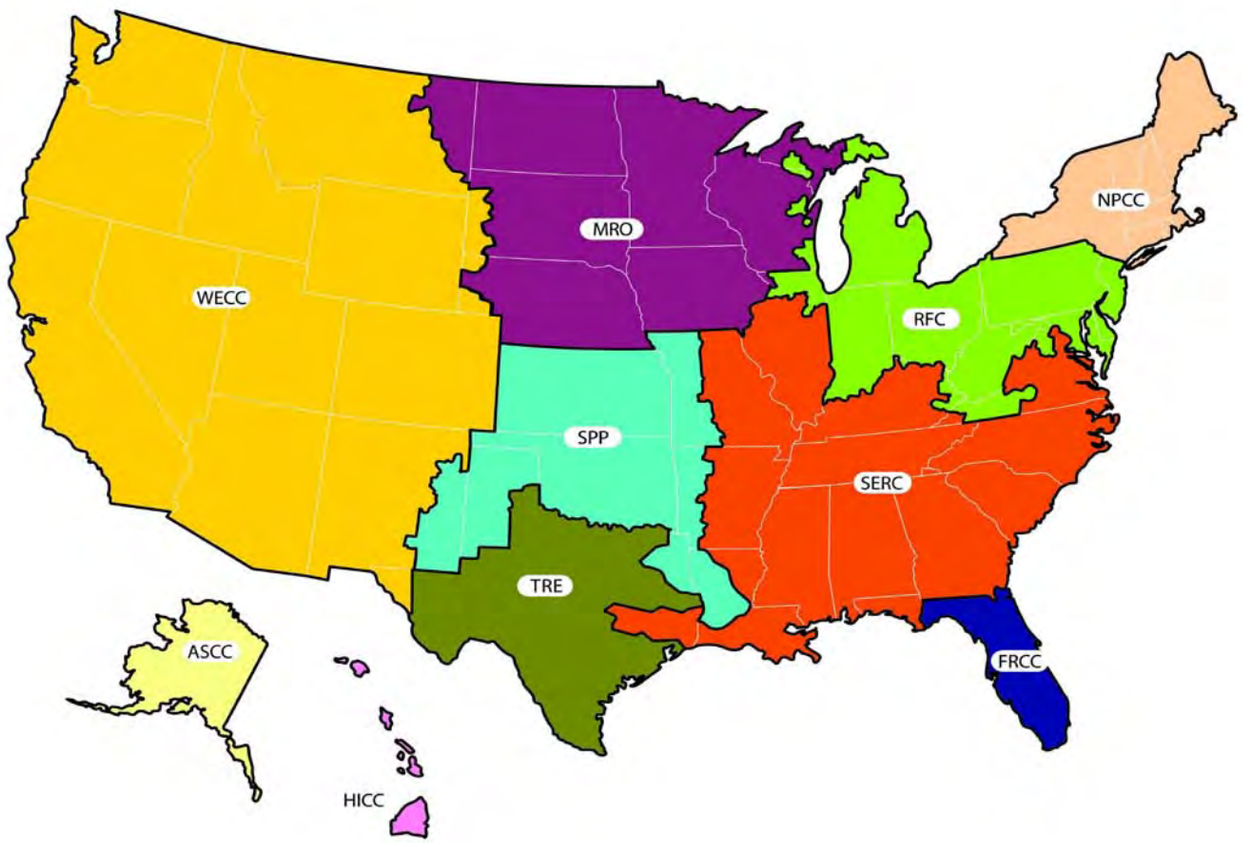
NERC region acronym	NERC region name	Nitrogen oxides (NO_x)				Sulfur dioxide (SO_2)		Carbon dioxide (CO_2)		Methane (CH_4)		Nitrous oxide (N_2O)	
		Emissions (tons)	Total output emission rate (lb/MWh)	Ozone season emissions (tons)	Ozone season total output emission rate (lb/MWh)	Emissions (tons)	Total output emission rate (lb/MWh)	Emissions (tons)	Total output emission rate (lb/MWh)	Emissions (lbs)	Total output emission rate (lb/GWh)	Emissions (lbs)	total output emission rate (lb/GWh)
ASCC	Alaska Systems Coordinating Council	10,938.14	3.2423	3,766.96	2.9460	1,337.80	0.3966	3,668,215.6	1,087.33	165,562.5	24.54	43,488.4	6.45
FRCC	Florida Reliability Coordinating Council	77,861.56	0.7147	36,505.33	0.7058	154,674.97	1.4197	130,376,587.7	1,196.71	8,478,102.7	38.91	2,995,217.6	13.75
HICC	Hawaiian Islands Coordinating Council	18,088.29	3.3385	7,128.45	3.0424	21,402.83	3.9503	8,356,670.1	1,542.39	1,001,264.1	92.40	217,665.6	20.09
MRO	Midwest Reliability Organization	224,784.69	1.9054	92,898.57	1.8249	471,003.65	3.9924	182,453,990.1	1,546.55	6,594,206.4	27.95	6,243,121.8	26.46
NPCC	Northeast Power Coordinating Council	63,823.66	0.4701	27,817.49	0.4491	146,541.18	1.0793	91,920,658.6	677.04	12,729,955.3	46.88	2,566,663.1	9.45
RFC	Reliability First Corporation	612,454.47	1.2696	267,740.55	1.2503	2,023,449.85	4.1944	662,155,468.9	1,372.59	21,121,804.2	21.89	21,481,792.2	22.27
SERC	SERC Reliability Corporation	599,572.79	1.0601	273,312.46	1.0641	1,653,339.44	2.9232	728,659,782.9	1,288.31	23,554,102.9	20.82	22,365,371.3	19.77
SPP	Southwest Power Pool	202,602.16	1.8598	94,384.98	1.8273	324,660.92	2.9803	179,782,555.2	1,650.33	4,888,589.3	22.44	5,082,463.6	23.33
TRE	Texas Regional Entity	112,686.33	0.6525	53,116.56	0.6318	388,236.16	2.2482	210,366,837.2	1,218.17	5,820,108.3	16.85	4,859,884.0	14.07
WECC	Western Electricity Coordinating Council	385,051.39	1.0642	162,630.38	1.0066	268,232.62	0.7414	344,498,126.7	952.16	15,247,276.5	21.07	9,489,178.4	13.11
U.S.		**2,307,863.49**	**1.1187**	**1,019,301.72**	**1.0885**	**5,452,879.41**	**2.6433**	**2,542,238,893.0**	**1,232.35**	**99,600,972.2**	**24.14**	**75,344,845.9**	**18.26**



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Year 2010 NERC Region Output Emission Rates

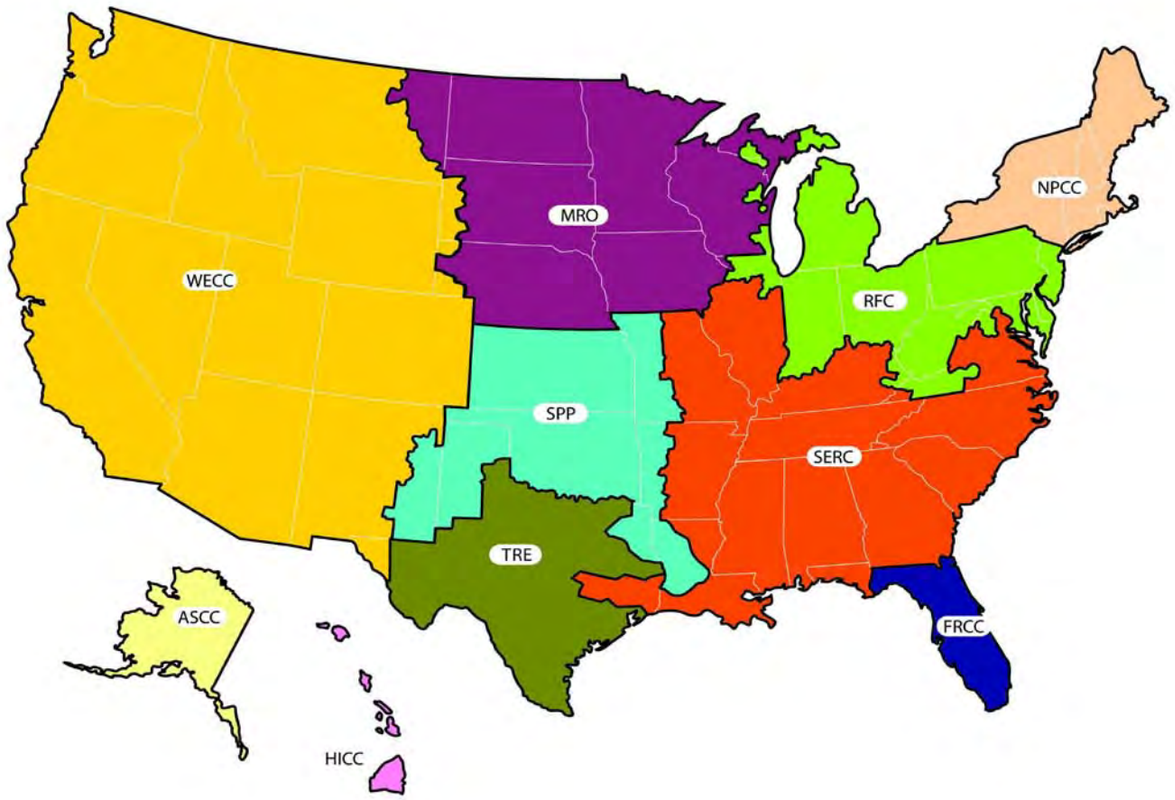
NERC region acronym	NERC region name	Total output emission rates						Fossil fuel output emission rates				Non-baseload output emission rates					
		NO_x (lb/MWh)	Ozone season NO_x (lb/MWh)	SO_2 (lb/MWh)	CO_2 (lb/MWh)	CH_4 (lb/GWh)	N_2O (lb/GWh)	NO_x (lb/MWh)	Ozone season NO_x (lb/MWh)	SO_2 (lb/MWh)	CO_2 (lb/MWh)	NO_x (lb/MWh)	Ozone season NO_x (lb/MWh)	SO2 (lb/MWh)	CO2 (lb/MWh)	CH4 (lb/GWh)	N2O (lb/GWh)
ASCC	Alaska Systems Coordinating Council	3.2423	2.9460	0.3966	1,087.33	24.54	6.45	4.1173	3.8706	0.5036	1,380.77	6.9664	5.4081	0.3820	1,396.84	40.13	8.07
FRCC	Florida Reliability Coordinating Council	0.7147	0.7058	1.4197	1,196.71	38.91	13.75	0.7297	0.7218	1.3664	1,342.00	0.9144	1.0966	1.6357	1,277.42	38.73	10.83
HICC	Hawaiian Islands Coordinating Council	3.3385	3.0424	3.9503	1,542.39	92.40	20.09	3.2744	3.3516	4.1870	1,623.54	5.1001	4.8970	3.5137	1,618.77	114.89	19.81
MRO	Midwest Reliability Organization	1.9054	1.8249	3.9924	1,546.55	27.95	26.46	2.6634	2.5294	5.6808	2,209.67	2.7289	2.4894	5.5007	2,014.87	56.10	34.53
NPCC	Northeast Power Coordinating Council	0.4701	0.4491	1.0793	677.04	46.88	9.45	0.6155	0.6063	1.8000	1,172.71	0.7317	0.9133	1.3935	1,180.62	46.59	10.05
RFC	Reliability First Corporation	1.2696	1.2503	4.1944	1,372.59	21.89	22.27	1.7906	1.7338	5.9677	1,952.00	1.8552	1.9460	6.7014	1,840.57	28.55	27.48
SERC	SERC Reliability Corporation	1.0601	1.0641	2.9232	1,288.31	20.82	19.77	1.4578	1.4253	4.0491	1,822.04	1.5089	1.6445	4.1395	1,612.56	28.47	21.13
SPP	Southwest Power Pool	1.8598	1.8273	2.9803	1,650.33	22.44	23.33	2.1280	2.0630	3.4028	1,897.95	1.8588	2.0957	2.2821	1,551.33	27.31	15.40
TRE	Texas Regional Entity	0.6525	0.6318	2.2482	1,218.17	16.85	14.07	0.8081	0.7579	2.7844	1,508.72	0.4978	0.6096	0.6151	1,181.70	20.12	7.63
WECC	Western Electricity Coordinating Council	1.0642	1.0066	0.7414	952.16	21.07	13.11	1.7282	1.7233	1.2051	1,565.73	0.9287	0.9372	0.5462	1,217.45	30.76	11.30
U.S.		**1.1187**	**1.0885**	**2.6433**	**1,232.35**	**24.14**	**18.26**	**1.5479**	**1.4877**	**3.7004**	**1,745.14**	**1.3930**	**1.5101**	**3.4026**	**1,520.20**	**31.27**	**18.34**



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Year 2010 NERC Region Resource Mix

NERC region acronym	NERC region name	Nameplate capacity (MW)	Net Generation (MWh)	Generation resource mix (percent)										
				Coal	Oil	Gas	Other fossil	Biomass	Hydro	Nuclear	Wind	Solar	Geo-thermal	Other unknown/ purchased fuel
ASCC	Alaska Systems Coordinating Council	2,235.4	6,747,178.4	9.1956	13.8801	55.5791	0.0000	0.0934	21.0649	0.0000	0.1868	0.0000	0.0000	0.0000
FRCC	Florida Reliability Coordinating Council	64,862.9	217,890,866.6	24.3846	4.1835	57.3321	0.6049	1.6658	0.0815	10.9853	0.0000	0.0369	0.0000	0.7254
HICC	Hawaiian Islands Coordinating Council	2,820.9	10,836,036.0	14.2627	74.8360	0.0000	3.4529	2.5212	0.6499	0.0000	2.4097	0.0163	1.8512	0.0000
MRO	Midwest Reliability Organization	64,222.0	235,949,817.8	65.8340	0.4266	3.2722	0.1223	1.4959	5.5230	14.3985	8.7586	0.0000	0.0000	0.1689
NPCC	Northeast Power Coordinating Council	81,460.2	271,537,220.9	10.1875	1.1710	41.3737	1.0543	3.4790	12.0206	29.5467	1.1621	0.0000	0.0000	0.0048
RFC	Reliability First Corporation	251,331.7	964,825,048.1	59.0980	0.4394	9.7183	0.5361	0.8424	0.6365	27.5585	1.1277	0.0056	0.0000	0.0376
SERC	SERC Reliability Corporation	299,094.9	1,131,186,728.1	50.7060	0.6328	19.1034	0.2443	1.6626	2.7715	24.7002	0.0822	0.0010	0.0000	0.0961
SPP	Southwest Power Pool	66,145.6	217,874,597.9	58.7426	0.9356	27.0248	0.1531	0.9944	3.0483	4.3859	4.7153	0.0000	0.0000	0.0000
TRE	Texas Regional Entity	100,595.3	345,382,525.6	34.8356	0.7898	44.9525	0.1266	0.1306	0.2040	11.9680	6.8938	0.0024	0.0000	0.0968
WECC	Western Electricity Coordinating Council	212,287.1	723,617,004.1	29.9840	0.4790	29.8737	0.1220	1.3204	22.4581	10.0387	3.3646	0.1436	2.0755	0.1404
U.S.		**1,145,056.0**	**4,125,847,023.5**	**44.7748**	**1.0174**	**23.9686**	**0.3498**	**1.3571**	**6.1730**	**19.5589**	**2.2864**	**0.0290**	**0.3689**	**0.1162**



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Year 2010 eGRID 9th edition Grid Gross Loss (%)

Region	Grid Gross Loss (%)
Eastern	5.82
Western	6.84
ERCOT	7.12
Alaska	6.89
Hawaii	7.38
U.S.	**6.18**

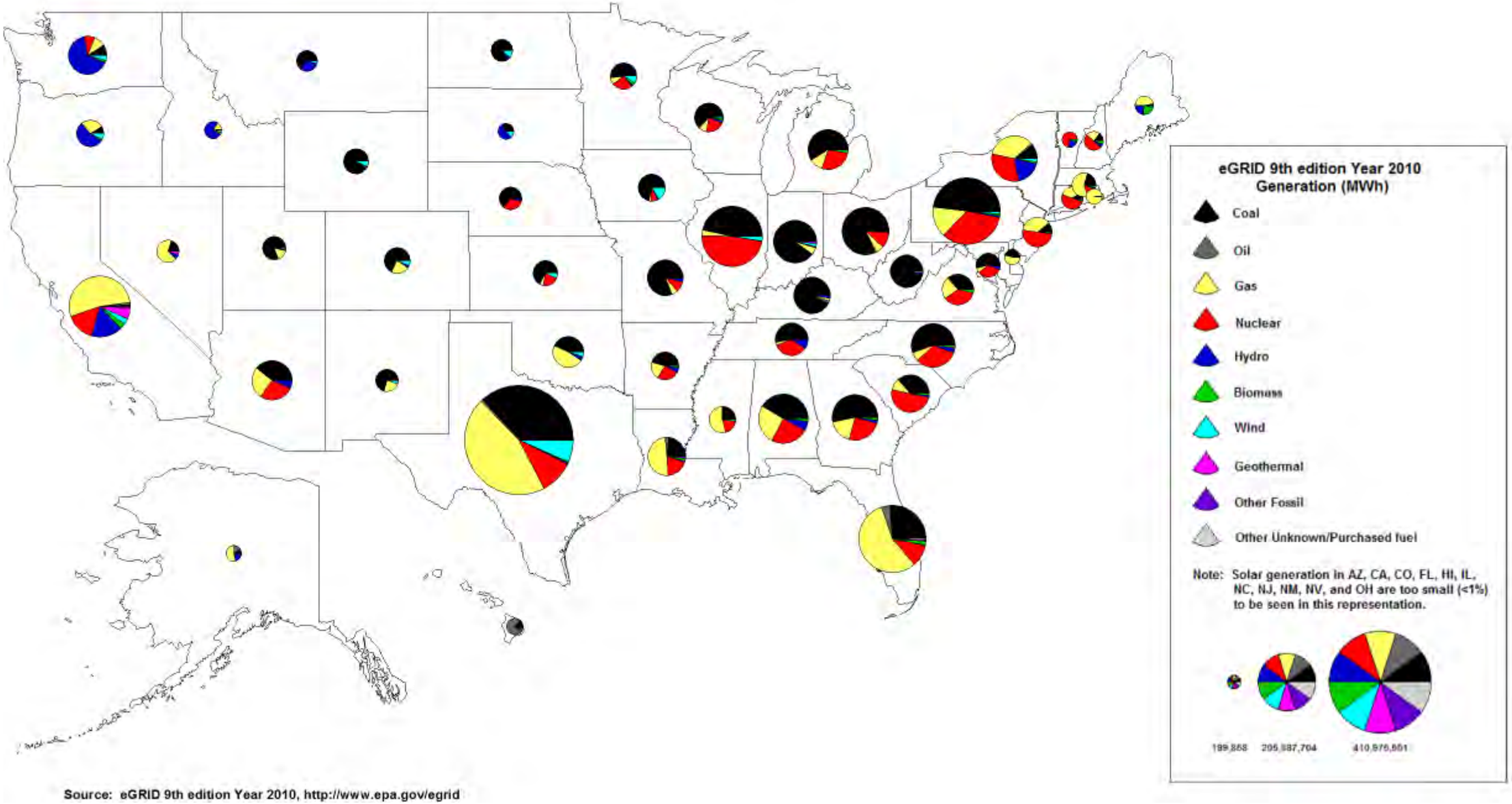
Year 2010 State Emissions and Input Emission Rates

State	Nitrogen oxides (NO_x)				Sulfur dioxide (SO_2)		Carbon dioxide (CO_2)		Methane (CH_4)	Nitrous oxide (N_2O)	Carbon dioxide equivalent (CO_2e)
	Emissions (tons)	Input emission rate (lb/MMBtu)	Ozone season emissions (tons)	Ozone season Input emission rate (lb/MMBtu)	Emissions (tons)	Input emission rate (lb/MMBtu)	Emissions (tons)	Input emission rate (lb/MMBtu)	Emissions (lbs)	Emissions (lbs)	Emissions (tons)
AK	10,938.14	0.4031	3,766.96	0.3708	1,337.80	0.0493	3,668,215.6	135.20	165,562.5	43,488.4	3,676,694.7
AL	66,622.21	0.1358	28,823.32	0.1241	209,590.23	0.4274	85,715,048.6	174.77	2,993,903.1	2,540,640.2	86,140,283.8
AR	39,423.06	0.1960	18,971.25	0.1873	70,842.77	0.3522	36,164,186.1	179.82	1,244,587.7	1,119,887.4	36,350,836.8
AZ	61,480.17	0.1787	27,179.65	0.1641	37,021.35	0.1076	61,050,565.5	177.49	1,724,431.1	1,686,270.6	61,330,044.0
CA	17,579.95	0.0383	7,473.64	0.0409	13,726.92	0.0299	52,220,430.3	113.66	6,272,224.6	903,490.5	52,426,329.7
CO	59,701.07	0.2463	25,364.24	0.2394	48,893.16	0.2017	46,144,407.7	190.34	1,129,077.5	1,383,861.1	46,370,761.5
CT	6,107.73	0.0855	3,047.11	0.0862	5,463.70	0.0765	10,253,243.4	143.51	1,984,006.9	340,003.9	10,326,776.1
DC	381.82	0.2738	356.54	0.2732	889.58	0.6378	226,368.4	162.30	19,464.6	3,894.0	227,176.4
DE	4,551.24	0.1665	2,372.17	0.1524	15,107.28	0.5527	4,326,901.8	158.31	127,536.4	116,018.8	4,346,223.9
FL	92,384.69	0.1012	42,104.05	0.0949	175,571.78	0.1922	140,801,771.3	154.17	8,944,921.3	3,337,706.8	141,413,037.6
GA	64,109.32	0.1341	28,211.81	0.1204	236,463.00	0.4946	88,428,450.5	184.97	2,724,620.9	2,797,085.9	88,890,607.4
HI	18,088.29	0.3640	7,128.45	0.3371	21,402.83	0.4307	8,356,670.1	168.16	1,001,264.1	217,665.6	8,400,921.6
IA	46,871.57	0.2073	19,913.17	0.2025	113,880.84	0.5036	46,718,005.7	206.61	1,070,014.1	1,536,928.7	46,967,464.8
ID	733.98	0.0886	262.63	0.0828	1,267.85	0.1530	793,345.7	95.77	146,715.0	27,701.4	799,180.0
IL	81,514.56	0.1543	30,192.93	0.1319	232,967.64	0.4409	107,988,153.3	204.37	2,476,797.1	3,497,646.7	108,556,294.9
IN	123,751.71	0.1995	53,881.14	0.1955	419,876.66	0.6768	125,300,699.5	201.96	2,945,056.5	4,115,309.6	125,969,495.6
KS	49,566.37	0.2519	22,754.87	0.2496	45,257.35	0.2300	39,853,473.1	202.57	914,404.8	1,279,980.3	40,061,471.3
KY	92,165.97	0.1840	39,223.15	0.1808	272,033.30	0.5432	101,776,482.9	203.24	2,368,627.8	3,428,294.9	102,332,739.2
LA	81,650.26	0.2125	40,702.71	0.2152	112,313.06	0.2923	58,043,121.0	151.09	2,413,780.1	1,197,371.3	58,254,058.3
MA	16,206.00	0.1036	5,264.39	0.0692	43,043.41	0.2752	22,829,787.4	145.94	2,909,216.0	631,688.1	22,958,245.8
MD	21,731.66	0.1434	10,473.72	0.1390	34,508.33	0.2277	29,435,319.8	194.20	1,476,599.3	1,012,842.9	29,607,814.8
ME	4,676.07	0.0942	1,694.85	0.0735	4,892.91	0.0986	4,110,254.7	82.79	2,415,898.5	346,206.6	4,189,283.7
MI	84,762.09	0.2075	36,639.52	0.1941	253,278.56	0.6201	78,302,919.0	191.71	3,137,100.8	2,626,947.8	78,743,035.5
MN	38,030.18	0.2056	15,865.27	0.1883	46,864.13	0.2533	34,938,226.7	188.84	2,607,814.6	1,323,661.7	35,170,776.4
MO	62,419.34	0.1515	27,479.55	0.1504	248,739.78	0.6036	84,647,824.2	205.39	1,920,562.8	2,747,571.4	85,093,863.7
MS	30,663.49	0.1521	16,469.41	0.1577	56,675.49	0.2811	30,615,271.3	151.86	1,127,202.4	663,138.6	30,729,893.4
MT	23,004.30	0.2171	8,930.98	0.2160	31,607.98	0.2983	22,228,592.4	209.78	493,021.9	736,585.4	22,347,939.8
NC	54,538.31	0.1374	24,744.90	0.1327	123,403.67	0.3108	76,432,458.8	192.50	2,332,576.7	2,550,615.2	76,852,296.2
ND	55,465.94	0.3550	21,831.90	0.3414	125,576.20	0.8038	33,931,163.2	217.19	731,527.3	1,090,089.2	34,107,808.1
NE	38,001.58	0.2964	15,947.19	0.2911	65,002.36	0.5070	26,646,390.3	207.84	594,805.1	880,411.6	26,789,099.5
NH	5,882.45	0.1247	2,624.83	0.1206	38,441.83	0.8151	6,178,537.5	131.01	1,452,810.8	297,656.3	6,239,928.7
NJ	10,857.95	0.0782	5,725.25	0.0817	17,100.88	0.1231	20,279,670.9	146.04	1,487,132.6	412,036.0	20,359,151.3
NM	60,817.45	0.3473	27,366.27	0.3416	16,576.43	0.0947	32,828,620.2	187.49	814,428.3	966,457.8	32,986,972.7
NV	13,716.25	0.1075	6,137.02	0.1037	8,068.82	0.0632	18,532,489.6	145.27	593,046.7	307,689.7	18,586,408.5
NY	29,682.22	0.0966	14,636.21	0.0928	54,626.86	0.1777	43,255,846.7	140.72	3,338,932.5	873,966.3	43,426,370.3
OH	110,770.95	0.1769	49,991.05	0.1757	595,525.49	0.9509	126,605,522.9	202.16	3,157,858.3	4,178,568.0	127,286,358.5
OK	76,560.04	0.2368	37,249.09	0.2284	90,317.68	0.2793	53,474,671.9	165.39	1,547,352.0	1,268,905.7	53,687,599.5
OR	10,761.32	0.1326	3,590.32	0.1330	15,973.27	0.1968	11,112,587.0	136.91	873,122.3	240,968.9	11,159,105.0
PA	136,940.19	0.1908	59,947.76	0.1860	420,696.93	0.5863	134,692,699.6	187.71	5,549,904.2	4,304,606.4	135,418,187.6
RI	673.13	0.0220	298.74	0.0205	28.71	0.0009	3,524,651.0	115.42	138,535.3	13,966.9	3,528,270.5
SC	31,229.71	0.1258	14,842.03	0.1242	106,152.84	0.4276	45,600,605.9	183.69	1,584,510.2	1,487,071.1	45,847,739.3
SD	12,897.43	0.6825	4,861.77	0.6546	12,844.12	0.6797	3,895,860.1	206.17	88,106.8	126,620.9	3,916,411.4
TN	32,659.61	0.1403	15,119.87	0.1416	122,116.65	0.5248	46,817,471.5	201.18	1,187,033.8	1,573,736.7	47,073,864.5
TX	156,493.51	0.0999	73,211.95	0.0951	463,923.55	0.2962	261,563,593.8	167.00	7,431,309.4	6,079,946.8	262,584,014.3
UT	63,268.33	0.3191	27,853.95	0.3171	26,054.71	0.1314	38,664,161.7	194.99	931,731.4	1,233,200.5	38,865,090.9
VA	40,080.56	0.1773	18,711.11	0.1682	96,676.48	0.4276	37,871,435.6	167.50	2,704,342.2	1,216,140.6	38,088,333.0
VT	326.75	0.1021	132.97	0.0965	32.46	0.0101	9,510.7	2.97	422,239.5	56,331.7	22,675.6
WA	14,444.51	0.1466	5,355.06	0.1377	4,131.33	0.0419	15,516,229.8	157.43	1,250,091.0	512,209.0	15,608,748.1
WI	36,012.24	0.1408	15,745.28	0.1368	117,717.52	0.4602	50,101,006.6	195.86	1,731,707.7	1,675,594.5	50,378,906.7
WV	53,129.94	0.1385	24,189.26	0.1454	110,445.10	0.2880	79,503,716.3	207.29	1,784,259.2	2,671,080.7	79,936,468.5
WY	63,537.87	0.2639	24,640.46	0.2546	67,927.83	0.2821	50,262,255.0	208.75	1,119,196.7	1,665,087.0	50,532,095.1
U.S.	**2,307,863.49**	**0.1616**	**1,019,301.72**	**0.1549**	**5,452,879.41**	**0.3864**	**2,542,238,893.0**	**182.21**	**99,600,972.2**	**75,344,845.9**	**2,554,963,154.4**

Year 2010 State Resource Mix

State	Nameplate capacity (MW)	Net Generation (MWh)	Generation resource mix (percent)										
			Coal	Oil	Gas	Other fossil	Biomass	Hydro	Nuclear	Wind	Solar	Geo-thermal	Other unknown/ purchased fuel
AK	2,235.4	6,747,178.4	9.1956	13.8801	55.5791	0.0000	0.0934	21.0649	0.0000	0.1868	0.0000	0.0000	0.0000
AL	35,263.2	152,150,512.1	41.4395	0.1314	25.7870	0.1837	1.8013	5.7208	24.9364	0.0000	0.0000	0.0000	0.0000
AR	17,085.5	60,994,581.5	46.1556	0.0741	20.4413	0.0466	2.6549	5.9980	24.6295	0.0000	0.0000	0.0000	0.0000
AZ	29,616.6	111,750,756.6	39.0546	0.0594	26.5555	0.0000	0.1637	6.1129	27.9192	0.1207	0.0139	0.0000	0.0000
CA	73,142.4	204,267,352.5	1.0282	1.1935	52.7141	0.2427	2.9521	16.2824	15.7640	2.9758	0.3702	6.1684	0.3085
CO	15,668.2	50,759,105.5	68.0849	0.0344	21.8716	0.0000	0.1186	2.8714	0.0000	6.8005	0.0813	0.0000	0.1374
CT	8,916.7	33,349,623.3	7.8094	1.2262	35.1716	2.2348	2.0925	1.1999	50.2264	0.0000	0.0000	0.0000	0.0392
DC	850.0	199,858.0	0.0000	100.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DE	3,486.5	5,627,645.0	45.6385	0.9968	50.9091	0.0000	2.4103	0.0000	0.0000	0.0454	0.0000	0.0000	0.0000
FL	67,640.2	229,267,216.5	26.1256	3.9865	56.1774	0.5867	1.8817	0.0774	10.4402	0.0000	0.0351	0.0000	0.6894
GA	39,656.6	137,576,941.3	53.2779	0.4656	17.3608	0.0115	2.3131	2.2124	24.3588	0.0000	0.0000	0.0000	0.0000
HI	2,820.9	10,836,036.0	14.2627	74.8360	0.0000	3.4529	2.5212	0.6499	0.0000	2.4097	0.0163	1.8512	0.0000
IA	15,927.1	57,506,610.6	71.7882	0.2683	2.2818	0.0274	0.3032	1.6488	7.7394	15.9430	0.0000	0.0000	0.0000
ID	4,002.5	12,024,564.1	0.7341	0.0000	14.0482	0.0000	4.1700	76.1295	0.0000	3.6654	0.0000	0.5975	0.6547
IL	50,253.8	201,353,080.0	46.4912	0.1032	2.8432	0.0658	0.3329	0.0589	47.7716	2.2119	0.0070	0.0000	0.1144
IN	31,562.2	125,224,661.1	89.7393	0.3617	5.1707	1.4890	0.2478	0.3623	0.0000	2.3397	0.0000	0.0000	0.2895
KS	13,440.3	47,923,760.2	67.8266	0.2151	4.7728	0.0000	0.1133	0.0276	19.9394	7.1052	0.0000	0.0000	0.0000
KY	25,137.3	98,240,668.7	92.6845	2.3258	1.8998	0.0157	0.4478	2.6265	0.0000	0.0000	0.0000	0.0000	0.0000
LA	30,928.2	103,722,692.1	23.0651	3.1631	50.3090	1.5839	2.3792	1.0690	17.9704	0.0000	0.0000	0.0000	0.4604
MA	15,372.5	42,991,075.5	19.3200	0.6879	59.9465	1.9270	2.7749	1.5335	13.7652	0.0431	0.0019	0.0000	0.0000
MD	13,609.8	43,607,183.5	54.2759	0.7394	6.6434	1.1578	1.2655	3.8237	32.0909	0.0034	0.0000	0.0000	0.0000
ME	4,583.5	17,018,659.6	0.5123	1.6000	49.2025	1.9722	21.3903	22.3894	0.0000	2.9332	0.0000	0.0000	0.0000
MI	32,940.8	111,551,371.3	58.8109	0.3425	10.9808	0.5746	2.2069	0.2044	26.5569	0.3230	0.0000	0.0000	0.0000
MN	16,797.4	53,637,617.5	52.3561	0.0580	8.0929	0.4231	3.4167	1.5668	25.1280	8.8727	0.0000	0.0000	0.0857
MO	23,723.8	92,312,563.4	81.2969	0.1364	5.0875	0.0350	0.0673	2.6291	9.7452	1.0026	0.0000	0.0000	0.0000
MS	17,077.3	54,486,051.7	25.0137	0.1496	54.3613	0.0150	2.7608	0.0000	17.6985	0.0000	0.0000	0.0000	0.0000
MT	6,142.4	29,727,586.6	62.5703	1.3805	0.3042	0.0000	0.0000	31.6698	0.0000	3.1292	0.0000	0.0000	0.9460
NC	30,835.8	129,430,192.8	55.5907	0.2263	6.7996	0.0219	1.6007	3.9830	31.4761	0.0000	0.0088	0.0000	0.2929
ND	6,514.1	34,709,793.9	82.0000	0.2125	0.0471	0.0000	0.0357	5.8834	0.0000	11.7140	0.0000	0.0000	0.1073
NE	8,624.6	36,630,006.2	63.7804	0.0842	1.0238	0.0000	0.1952	3.5868	30.1784	1.1511	0.0000	0.0000	0.0000
NH	4,493.0	22,195,912.0	13.8883	0.3229	24.1704	0.2756	5.1913	6.6570	49.1534	0.3410	0.0000	0.0000	0.0000
NJ	20,911.1	65,682,493.6	9.7450	0.6590	37.8120	0.7832	1.1891	0.0000	49.7604	0.0192	0.0320	0.0000	0.0000
NM	8,965.7	36,294,249.0	70.5836	0.1272	23.5808	0.0000	0.0377	0.5979	0.0000	5.0481	0.0246	0.0000	0.0000
NV	13,491.4	35,146,247.7	19.9091	0.0317	67.3989	0.0161	0.0000	6.1381	0.0000	0.0000	0.6172	5.8889	0.0000
NY	43,853.7	136,910,481.4	9.9209	1.4644	35.7281	0.6517	1.5762	18.2181	30.5817	1.8589	0.0000	0.0000	0.0000
OH	36,946.0	143,596,345.0	82.0550	1.0045	4.9642	0.1849	0.4698	0.2988	11.0064	0.0088	0.0076	0.0000	0.0000
OK	23,690.3	72,318,205.6	43.5231	0.0250	47.0271	0.0000	0.4866	3.6725	0.0000	5.2657	0.0000	0.0000	0.0000
OR	14,955.8	55,126,999.1	7.4853	0.0062	28.3911	0.0748	1.5282	55.4035	0.0000	7.1109	0.0000	0.0000	0.0000
PA	49,858.6	229,751,956.0	48.0385	0.2921	14.6759	0.5641	1.0372	0.7070	33.8749	0.8070	0.0033	0.0000	0.0000
RI	2,020.5	7,738,719.0	0.0000	0.1507	97.9914	0.0000	1.7697	0.0479	0.0000	0.0404	0.0000	0.0000	0.0000
SC	25,867.1	104,153,132.7	36.1690	0.1831	10.4915	0.0587	1.7984	1.3843	49.9150	0.0000	0.0000	0.0000	0.0000
SD	3,741.8	10,049,636.1	32.8197	0.0609	1.3404	0.0000	0.0000	52.1293	0.0000	13.6497	0.0000	0.0000	0.0000
TN	23,487.9	81,937,881.8	53.2967	0.2647	2.7952	0.0196	1.1557	8.5646	33.8540	0.0495	0.0000	0.0000	0.0000
TX	117,753.5	410,983,759.8	36.5398	0.7642	45.3293	0.2100	0.3516	0.3070	10.0576	6.3570	0.0020	0.0000	0.0813
UT	7,860.7	42,249,354.6	80.6101	0.2049	15.2793	0.0106	0.1326	1.6462	0.0000	1.0596	0.0000	0.6555	0.4011
VA	25,926.1	72,966,456.0	34.8917	1.7719	23.2972	0.6067	3.0029	0.0131	36.4166	0.0000	0.0000	0.0000	0.0000
VT	1,097.2	6,619,990.0	0.0000	0.0681	0.0571	0.0000	7.0762	20.3458	72.2429	0.2098	0.0000	0.0000	0.0000
WA	30,907.4	103,277,990.5	8.2563	0.3142	9.9089	0.0648	1.8083	66.1726	8.9478	4.5270	0.0000	0.0000	0.0000
WI	19,767.9	64,314,067.1	62.4571	1.1169	8.5469	0.0469	2.1529	3.2837	20.6501	1.6924	0.0000	0.0000	0.0531
WV	17,225.5	80,788,947.2	96.7305	0.1913	0.1728	0.0504	0.0000	1.6925	0.0000	1.1625	0.0000	0.0000	0.0000
WY	8,379.2	48,119,253.8	89.3333	0.1385	0.9538	0.5581	0.0000	2.1278	0.0000	6.7474	0.0000	0.0000	0.1410
U.S.	**1,145,056.0**	**4,125,847,023.5**	**44.7748**	**1.0174**	**23.9686**	**0.3498**	**1.3571**	**6.1730**	**19.5589**	**2.2864**	**0.0290**	**0.3689**	**0.1162**

Year 2010 Generation by Fuel Type



Source: eGRID 9th edition Year 2010, http://www.epa.gov/egrid

To: Los Angeles Regional Water Quality Control Board

Jenny Newman, Grant Manager

320 West 4th Street, Suite 200

Los Angeles, CA 90013

Proposition 84 Agricultural Water Quality Grant Program

Final Report

Reporting Period: July, 2011 - March, 2014

Grant Agreement No: 10-417-554

Project Name: Mobile Irrigation Laboratory (MIL)

Grantee Name: The Ventura County Resource Conservation District

Project Manager: Marty Melvin, Executive Officer

Project Director Signature:  **Date:** 3/1/14

Funding for this project has been provided in full or in part through an agreement with the State Water Resources Control Board and the U.S. Environmental Protection Agency under Proposition 84 the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006. The contents of this document do not necessarily reflect the views and policies of the State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. (Gov. Code § 7550, 40 CFR § 31.20)

Grant Agreement Number: 10-417-554

Project Name: Mobile Irrigation Lab (MIL)

Grantee Name: Ventura County Resource Conservation District

I certify that the Mobile Irrigation Lab (MIL) project is complete in accordance with the signed grant agreement and Project Assessment and Evaluation Plan. Post-Evaluation Technical Assistance and BMP Implementation results of the MIL Cost-share component of the project are documented in the Final Project Report. I certify under penalty of law that this document and any attachment was prepared by me or under my direction in accordance with the terms and conditions of each Grant Agreement Exhibit. Based on my inquiry of the persons or persons who manage the project or those directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. All information submitted in this document and all attachments conform to and are in accordance with the state and federal laws and I so here certify with my signature. I am aware that there are significant penalties for submitting false or misleading information.

Project Director _____

Martin Melvin, Executive Officer

Date 3/1/14

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Proposition 84 MIL Final Report

a. The goal of the Mobile Irrigation Lab (MIL) was to work with landowners and farmers to improve water quality by limiting irrigation runoff and decreasing nutrient leaching, energy use, and water use. The program has proven effective because of the non-regulatory nature of the Ventura County Resource Conservation District (VCRCD). The program ensures a complimentary evaluation and site specific best management recommendations which include on-farm enhancements that help improve the health of watersheds in Ventura County.

All growers who request an irrigation evaluation must fill out an application which requires general, personal, and property information and which permits VCRCD staff on the property to perform an evaluation. Trained technicians arrive at a site prepared with pre-evaluation questions which inquire about farm acreage, size of blocks, type of crop, type and age of irrigation system, and water source. One technician tests water pressure and field flow rates as the other records the data. Number and locations for testing are determined by the size of property and amount of risers within the irrigation block. GPS points are gathered to correspond location with data collected.

The VCRCD has two primary and two secondary technical staff who perform irrigation evaluations at orchards, nurseries, and row crops primarily throughout the unincorporated areas of Ventura County. During these evaluations, efficiency of irrigation systems were assessed by testing distribution uniformity, application rates, and nitrogen levels of water used on property. Based on results from the evaluation, recommendations were made for utilization of Best Management Practices (BMPs) that assist in nutrient and runoff management, installation of new hardware, and implementation of improvements. Effectiveness of BMPs are identified through grower reassessments and follow-up evaluations.

The purpose of the Mobile Irrigation Lab was to assist growers with evaluations and technical assistance in order to help them improve the efficiency of their water systems. The implemented recommendations improved nutrient management and increased efficiency of agricultural water use. Efficiency efforts include reducing on-farm application rates, thereby reducing the amount of runoff entering local waters. This facilitates compliance with the Los Angeles Regional Water Quality Control Board's *Conditional Waiver of Waste Discharge Requirements from Irrigated Lands within the Los Angeles Region.*

All growers evaluated were presented with a flyer which describes the MIL cost-share program. Growers were encouraged to enter the program which offers reimbursement for irrigation hardware improvements and labor costs associated with implementation. The project offered and utilized $129,000 in funds which enabled growers to implement efficiencies with the improvement of irrigation hardware. The cost-share program has proven to be effective in improving distribution uniformity, reducing water use on individual properties, and reducing runoff into the waterways.

Partners involved include the Farm Bureau of Ventura County, Ventura County Agricultural Irrigated Lands Group, University of California Cooperative Extension, RCD, LA Regional Water

Quality Control Board, Casitas Municipal Water, Camrosa Water, Calleguas Municipal Water, United Water District, and Ventura County Water Works.

b. Maps of locations and GPS points from cost-share re-evaluations have been accounted for in monthly invoices and are provided in Appendix A for reference. These locations identify BMPs which have been implemented on cost-share participant properties. These BMPs are identified in the National Resource Conservation Service (NRCS) Field Office Technical Guide (FOTG) as Conservation Practice Codes identified in Appendix B.

A summary of improvement in Distribution Uniformity (DU) and estimated irrigation need reduction by each grower who participated in the MIL cost-share program is provided in Appendix C. The calculation used to determine estimated water reduction uses an average number for the type of crop in acre-foot per acre per year. Those are: Citrus- 2.1, Avocado- 2.2, and Cabbage- 1. That number is divided by first and final DU numbers. The number from the final DU calculation is subtracted from first DU calculation. That sum is multiplied by number of acres and that product represents the estimated irrigation needs reduction in acre foot per year. Example: Babtiste Ranch- (assuming 2.1 acre-ft/acre/year water use) is as follows: (2.1/0.82) - (2.1/0.87) = 0.147 (*23.46 ac) = 3.45 acre-ft/year reduction. Reduction in water use is expected to lead to reduction of runoff.

c. The MIL has been successful in assisting growers in improving water efficiency by implementing BMPs, developing improved irrigation strategies, and establishing nutrient management practices. The VCRCD performed irrigation evaluations at orchards, row crops, and nurseries throughout the Calleguas Creek, Santa Clara River, and Ventura River Watersheds. 58 irrigation evaluations were performed in 2012 and 75 evaluations in 2013. This exceeds the requirement of the grant which requires a minimum of 48 evaluations per year with a goal of 80 per year. A list of all participants of the MIL program are listed in Appendix D. The VCRCD has met the goals identified in the Project Assessment and Evaluation Plan (PAEP). The description of benefits, successes, and shortcomings of Project Performance are as follows.

Goal: Increase water use efficiency in Ventura County irrigated agricultural operations (e.g. row crops, orchards, and/or nursery operations) and improve water quality from agricultural tail water/runoff.

Post-evaluation reports were prepared and contain a number for Low Quarter Distribution Uniformity, (lqDU), which is determined by the calculation: Low Quarter Average (ml) /Total Average (ml). The target lqDU is 0.85. General and site-specific recommendations of management measures as well as an introduction to the cost-share program are made during every visit. The irrigation technicians recommend irrigating with the correct amount of water at the optimum time. The prevention of excessive irrigation limits or eliminates the potential for erosion and transportation of pesticides and nutrients which have potential to flow to surface and groundwater. The logical assumption is that irrigation efficiency leads to no water passing the root zone. Proposed improvements to increase efficiency included the use of soil moisture sensor systems to determine irrigation needs, and the installation of pressure regulators and

pressure compensating emitters to offset variation in lateral pressures. Documented management measures were implemented at 14 locations where re-evaluations were performed for cost-share participants. Growers in the cost-share program have updated irrigation hardware and improved DU.

Goal: Maximize nutrient usage efficiency and reduce agriculture's contribution of nutrients, pesticides, and other pollutants to impaired water bodies in Ventura County.

At every evaluation a Nitrate Quick Test was conducted to determine nitrate levels in parts per million (PPM) from irrigation water used on the property. The use of mulch was recommended to contain moisture in the ground. Proper placement of emitters was suggested so that water does not hit tree trunks, but that they are located between adjacent trees in order to irrigate root zones and prevent Phytophthora, which causes root rot. Recommendations also included monitoring the amount and depth of soil moisture to prevent leaching by using a soil moisture sensor system, which is NRCS Practice Code # 449. Location where this BMP was implemented at cost-share locations is indicated in Appendix B. Reduction in fertilizer is also suggested if necessary.

Goal: Increase understanding of water quality issues and effective management practices and expand the implementation of these practices by growers.

The VCRCD participated in continual outreach by hosting two educational events in coordination with VCAILG where over 200 growers attended. VCRCD attended various grower meetings and events where over 500 growers were informed of the MIL program. Involvement in monthly meetings ensured over 2,000 watershed stakeholders were informed about the MIL program and services provided. To advertise MIL services, posters were created and displayed at several locations which include the Farm Bureau, the Ag Comissioners office, United Water District, Casitas Water District, Camrosa Water District and the Calleguas Municipal Water District as well as businesses which sell irrigation hardware and fertilizer throughout the county. The number of posters displayed throughout Ventura County exceeded the grant requirement of 10 locations.

Goal: Contribute to the achievement of TMDL and Conditional Waiver water quality objectives for agriculture in Ventura County.

VCRCD works closely with Farm Bureau of Ventura County to identify and reach growers who could benefit from MIL services. The Farm Bureau administers the program Ventura County Agricultural Irrigated Lands Group (VGAILG) which was formed in 2006 to allow Ventura County growers and landowners to act as a single discharger group in order to comply with the Conditional Waiver which requires Ag producers to control runoff. Monitoring reports have been documented since 2007. In 2010 there were 15 monitoring sites in the Calleguas and Oxnard Coastal Watersheds, 8 in the Santa Clara River Watershed, and 2 in Ventura River Watershed. However, the 2012 monitoring report only included data for 9 sites for Calleguas and Oxnard Coastal and 7 for Santa Clara. General water quality constituents, along with

nutrients and pesticides were sampled. Samples were taken during wet and dry weather events. The majority of samples in both reports consist of wet weather samples because during dry weather, no water was present at monitoring sites. All monitoring sites are located at the end of tributaries and agricultural drainage into local surface waters.

In order to assess documented changes based on monitoring, VCAILGs 2010 monitoring report was compared to the most recent 2012 report. 2012 samples indicate a slight decrease in constituents during wet events compared to 2010 samples. However, concentrations of constituents, including turbidity and pesticides, mimicked water flow rate. Data from monitoring reports do not demonstrate any flow pattern that can be compared for either dry or wet events. Reasons for this may include differences in quantity of rainfall or irrigation timing at the time of sampling. Results from both reports demonstrate that Calleguas Creek and Oxnard Coastal Watersheds consistently show benchmark exceedances for DDT constituents in wet weather events. Reasons for these exceedances include the long half-life of DDT compounds and low water solubility. In a rain event, these legacy pesticides are carried to surface water on sediments through runoff. The majority of constituents sampled in dry events were not detected, present in very low concentrations, or not sampled because the site was dry. Ventura River Watershed sites revealed no benchmark exceedances.

d. The MIL program has been successful because of the relationship VCRCD has established with growers over decades. Initial irrigation evaluations suggest established BMPs were being implemented in order to prevent nutrient loss, increase irrigation efficiency, and reduce water use. Growers are interested in conserving water, saving money, and being in compliance with the Conditional Waiver. There has been great interest in the cost-share program which provides an incentive for improving irrigation efficiency. With the assurance of a new grant, the MIL will continue to provide irrigation evaluations and seamlessly rollover current cost-share applicants who are approved for reimbursement for improvements made to their current systems. An obstacle which has presented itself as a result of the drought, is that of water availability. Water availability and use is dictated by local water agencies. Timing and allocation of water use for irrigation is limited to growers who are utilizing this resource as efficiently as they are allowed. Moving forward with less available water, VCRCD can work with local water agencies to assist with ideas for improved methods of water use and transport.

e. Extensive and ongoing outreach has been conducted since the grant agreement was signed in October 2011. VCRCD staff hand out flyers, make announcements, and have personal conversations about the services offered by MIL. Thousands of growers and Watershed Stakeholders have been reached through monthly meetings for the following groups: The Watersheds Coalition of Ventura County, Ventura River Watershed Committee, Ventura County Water Use Efficiency Group, Farm Bureau of Ventura County, Santa Clara River Watershed Committee, Association of Water Agencies, Calleguas Creek Steering committee, and the TGIF Ag BBQ. Greater outreach efforts include, the RCDs Annual Award Luncheon and Annual Ag Appreciation Luncheon where connections are made with hundreds of people in one day. There are also several workshops and training seminars offered by the VCRCD and VCAILG to

educate growers on irrigation and nutrient management strategies. Outreach efforts will seamlessly continue with added momentum from the accomplishments achieved thus far.

f. The projected cost of this program is $825,000.00. As of November 30, 2013, the total cost of the program was $707,808.39, with $513,446.40 in funds provided by the grant and $194,361.99 in matching funds. The grant funds were spent on personnel costs to administer and perform the tasks of the program and to provide cost share for producers to install best management practices related to their irrigation systems on their farms. To date, match funds in the amount of $194,361.99 have been contributed to the program from other sources, $95,700.50 was contributed by the Resource Conservation District, and an additional $98,661.49 has been contributed by producers during the installation of their irrigation system improvements. We have leveraged the Mobile Irrigation Efficiency Laboratory Program to secure additional funding to continue the important work of this program. In late 2013, we were notified that we had been awarded a grant from the Department of Water Resources in the amount of $915,000.00 to continue the work of this program. Additional funding will continue to be sought to extend the work after the completion of the Department of Water Resources grant if deemed necessary.

g. With the assurance of funding from the Department of Water Resources (DWR), MIL will continue to perform irrigation evaluations for growers in Ventura County. This service will continue to assist growers in complying with the Conditional Waiver. Under this grant agreement, priorities include improvement of irrigation systems and on-farm water and nutrient management. VCRCD also plans to extend its Stormwater program which is currently funded by the Ventura County Watershed Protection District. Under this program, the VCRCD provides complimentary site visits to horse properties where they identify possible sources of runoff and make recommendations of BMPs that minimize contaminated runoff from property. This work is focused to address TMDLs for the Ventura River and Malibu Creek.

h. Photos of implemented BMPs from follow-up evaluations are provided in Appendix E.

i. The list of items which have been submitted monthly as outlined in the Table of Items for Review is provided in Appendix F.

j. Examples of grower DU and Re-DU reports are provided in Appendix G.

List of Appendices

Appendix A - Locations of Implemented BMPs

Appendix B - Cost-Share Participant Location and BMP Implementation

Appendix C - Cost-Share Participant DU Improvement

Appendix D – Master list of MIL Program Participants

Appendix E - Photos of Implemented BMPs

Appendix F - Table of Items for Review

Appendix G - Examples of Grower DU and Re-DU Reports

Appendix A: Locations of Implemented BMPs

Borchard Babtiste Ranch

Address: 4990 Bradley Road, Somis CA 93066

APN: 110017064



Appendix A: Locations of Implemented BMPs

Borchard DBJ Ranch

Address: 4250 Bradley Road, Somis CA 93066

APN: 110016002



Appendix A: Locations of Implemented BMPs

Bowler

Address: 4399 Hitch Boulevard, Moorpark CA 93021

APN: 163003116

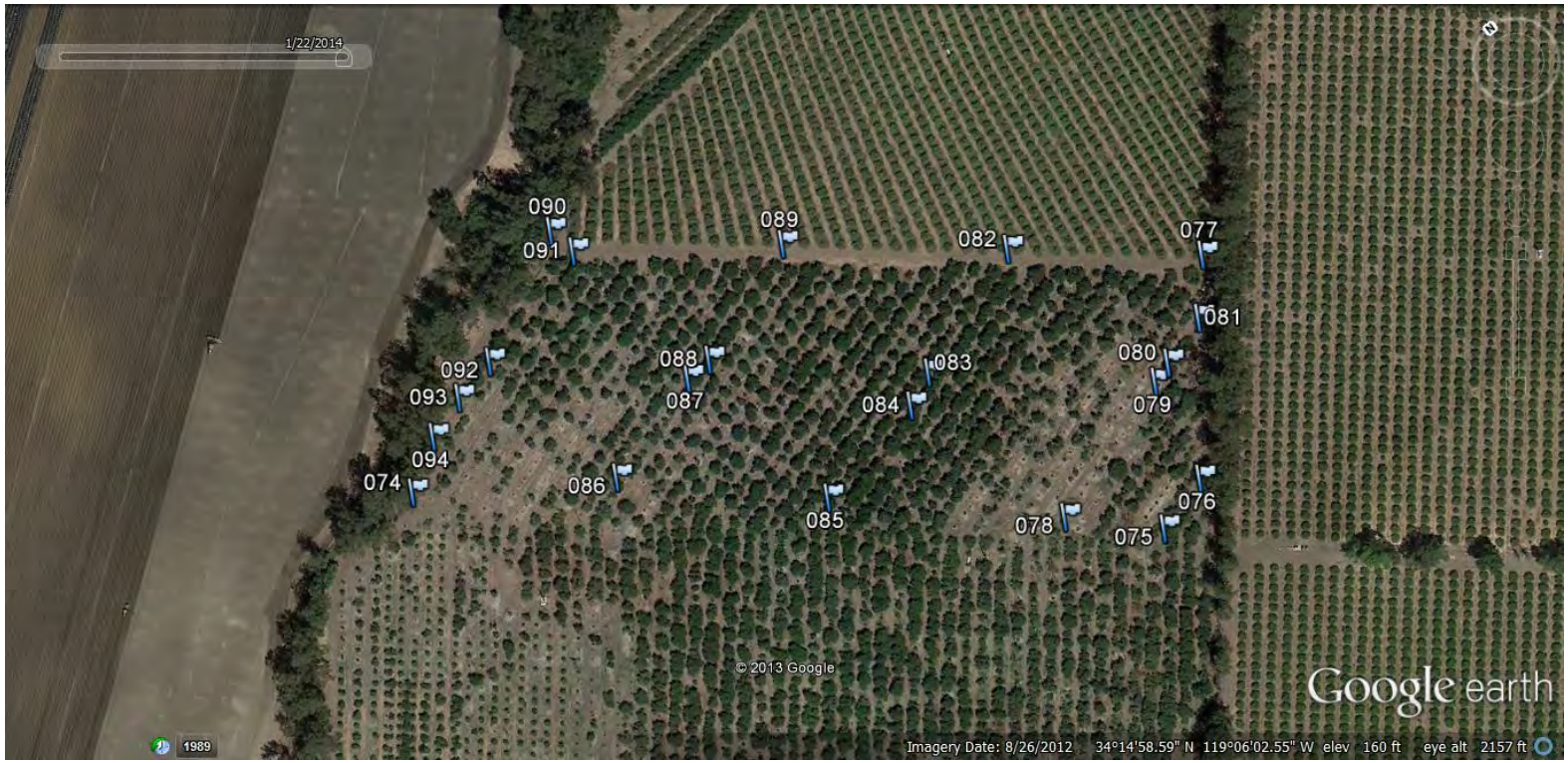


Appendix A: Locations of Implemented BMPs

Broome

Address: 3111 Wright Road, Camarillo CA 93010

APN: 109005013



Appendix A: Locations of Implemented BMPs

Hobson

Address: 19134 E. Telegraph Road, Santa Paula CA 93060

APN: 046012202



Appendix A: Locations of Implemented BMPs

Ikeda

Address: 10735 W. Los Angeles Avenue, Moorpark CA 93201

APN: 503006029



Appendix A: Locations of Implemented BMPs

Nichols

Address: 5501 Elizabeth Road, Santa Paula CA 93060

APN: 064027022

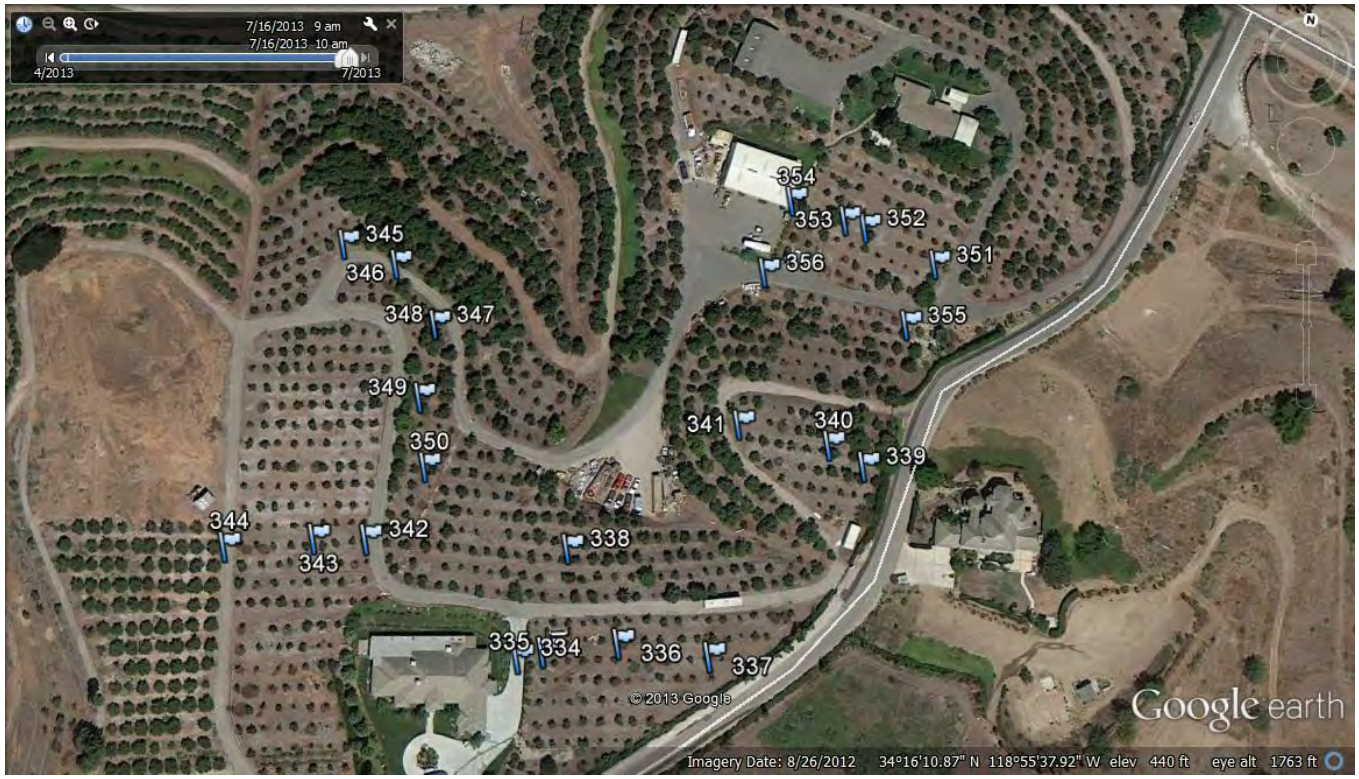


Appendix A: Locations of Implemented BMPs

Penman

Address: 4287 Ventavo Drive, Moorpark CA 93021

APN: 163020001



Appendix A: Locations of Implemented BMPs

Pereira

Address: 664 Laguna Road, Oxnard CA 93033

APN: 230007205



Appendix A: Locations of Implemented BMPs

Romero

Address: 620 Hall Road, Santa Paula CA 93060

APN: 041016032



Appendix A: Locations of Implemented BMPs

Sevin

Address: 800 Stockton Road, Somis CA 93066

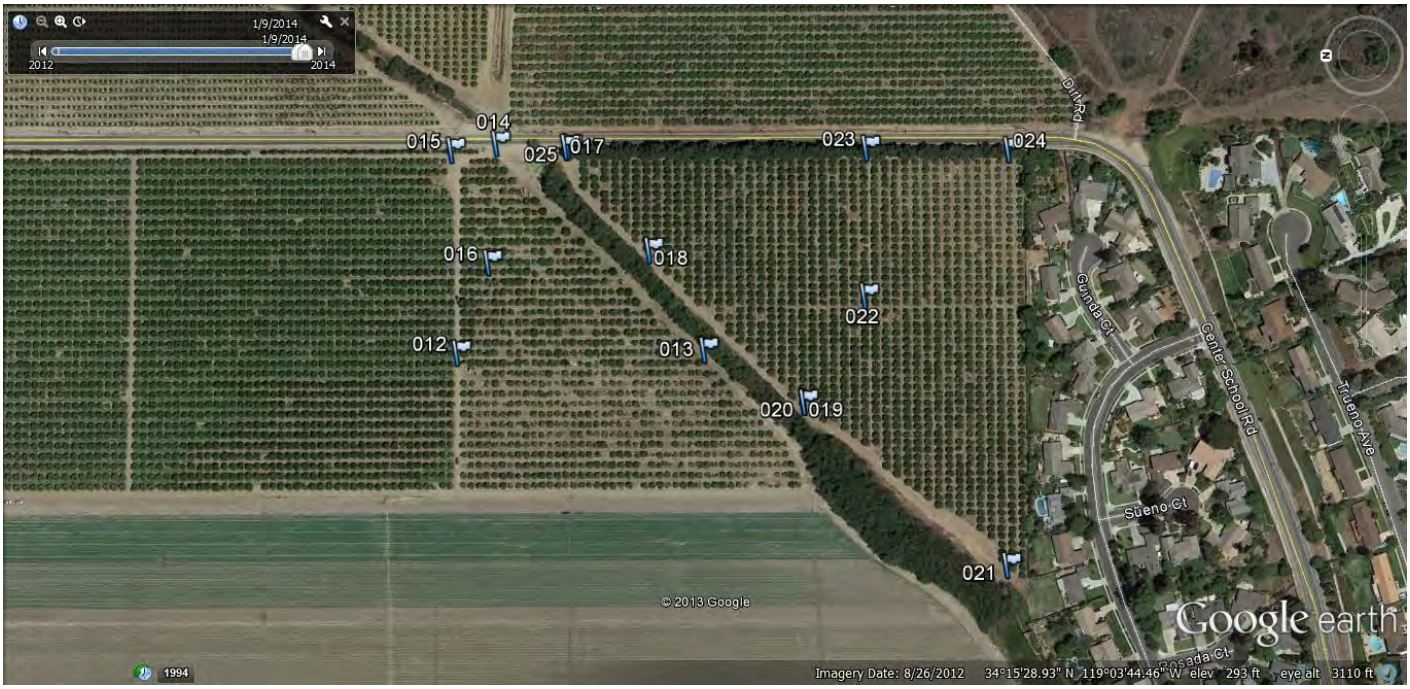
APN: 503004004



Thille

Address: 512 E. Los Angeles Avenue, Somis CA 93066

APN: 109006108 & 109006115



Appendix A: Locations of Implemented BMPs

Waters

Address: 4896 Balcom Canyon Road, Somis CA 93066

APN: 503004027



Appendix A: Locations of Implemented BMPs

White

Address: 4106 Thatcher Road, Ojai CA 93023

APN: 029002023



Appendix B - Cost-Share Participant Location and BMP Implementation

NRCS Conservation Practice Codes

Irrigation system-micro-irrigation #441- A micro-irrigation system, also known as drip or trickle irrigation, is used for distribution of water directly to the plant root zone by means of surface or subsurface applicators.

Irrigation system-surface and subsurface #443- A system in which all necessary earthwork, multi-outlet pipelines, and water-control structures have been installed for distribution of water by surface means, such as furrows, borders, and contour levees, or by subsurface means through water table control.

Irrigation water management #449- Determining and controlling the rate, amount and timing of irrigation water in planned and efficient manner.

Grower	Property Address	GPS Points	Implemented BMPs	APN
Borchard Babtiste Ranch	4990 Bradley Road, Somis	44-61	#443	110017064
Borchard DJB Ranch	4250 Bradley Road, Somis	145-159	#443	110016002
Bowler	4399 Hitch Boulevard, Moorpark	324-333	#441 #449	163003116
Broome	3111 Wright Road, Ventura	74-94	#441	109005013
Hobson	19134 E. Telegraph Road, Santa Paula	33-48	#443	046012202
Ikeda	10735 W. Los Angeles Avenue, Moorpark	20-32	#449 #443 #441	503006029
Nichols	5501 Elizabeth Road, Ventura	33-43	#441 #443	064027022
Penman	4287 Ventavo Drive, Moorpark	334-356	#441 #443 #449	163020001
Pereira	664 Laguna Road, Oxnard	79-90	#449	230007205
Romero	620 Hall Road, Santa Paula	367-383	#441 #443	041016032
Servin	800 Stockton Road, Somis	34-53	# 443 #441 #449	503004004
Thille	512 E. Los Angeles Avenue, Somis	12-25	#441 #443	109006108 & 109006115
Waters	4896 Balcom Canyon Road, Somis	26-51	#449	503004027
White	4106 Thatcher Road, Ojai	291-303	#441 #443	029002023

Appendix C: Cost-Share Participant DU Improvement

Grower	Acreage	Crop	First DU	Final DU	Estimated water use reduction in acre-ft/year
Borchard Babtiste Ranch	23	Lemon	0.82	0.87	3.45
Borchard DJB Ranch	12	Lemon	0.84	0.89	0.7
Bowler	12	Avocado	0.66	0.75	4.6
Broome	20	Avocado	0.68	0.98	19.8
Hobson	34	Lemon Avocado	0.10	0.91	9.3
Ikeda	16	Avocado	0.82	0.91	3.75
Nichols	23	Avocado	0.65	0.94	24
Penman	15	Avocado	0.68	0.79	6.5
Pereira	250	Cabbage	0.81	0.85	14.5
Romero	16	Avocado	0.61	0.93	8.2
Servin	8.5	Lemon	0.74	0.95	5.3
Thille	40.4	Lemon	0.35	0.97	155
Waters	20.9	Lemon	0.63	0.85	18
White	10	Orange Tangerine	0.76	0.92	4.8

Appendix D: Master list of MIL Program Participants

#	Date	Grower	Watershed	Orchard/Nursery/ RowCrop	acres	Plot #	# Blocks	DU	F/U?	DU post-F/U	Nitrate Test (mg/l)	notes
	10/12/11	West Coast Nurseries	Santa Clara River	Nursery	2			0.90	No	n/a	none given	
	10/20/11	Luddington	Calleguas Creek	Orchard	10			0.87	No	n/a	none given	
	10/26/11	Cornejo Ranch	Santa Clara River	Orchard	50	1		0.89	No	n/a	50	
	10/27/11	Cornejo Ranch	Santa Clara River	Orchard		2		0.80	No	n/a	50	
	10/24/11	MVP Properties LP	Santa Clara River	Orchard	7.6			0.72	No	n/a	none given	not reported in October progress report, included in Nov progress report
	11/1/11	Linda Haque	Ventura River	Orchard	15	1		0.80	No	n/a	< 10	
	11/3/11	Linda Haque	Ventura River	Orchard		2		0.88	No	n/a	> 10	
	3/8/12	Ken Ikeda	Calleguas Creek	Orchard	10 0f 24	1	3				<10	Potable Water
	3/13/12	Jesus Lopez	Calleguas Creek	Orchard	3.5 of 14.5	1	4	0.50			<10	Reclaimed Water (District17)
	4/2/12	Darrell Jones	Ventura River	Orchard	3.5	2	6	0.81			<10	Potable Water
	4/4/12	Skyline Nursery	Oxnard Coastal	Nursery	35.0			0.75			<10	Well Water
	5/15/12	Ken Ikeda	Calleguas Creek	Orchard	8 of 24	2	4	0.73			<10	Potable Water
	5/16/12	MVP Properties LP	Santa Clara River	Orchard	10			0.70			>50	Well Water
	5/17/12	Eyal Gordon	Calleguas Creek	Orchard							<25	Reclaimed Water
	5/22/12	Dick Marshall	Santa Clara River	Orchard	14			0.87			<25	Well Water
	5/30/12	Ken Ikeda	Calleguas Creek	Orchard							<10	Potable Water
	5/31/12	Mario Vina	Santa Clara River	Orchard	3.9			0.82			25 ppm	Santa Paula Municipal Water
												: Cancelled and postponed
	6/5/12	Dick Marshall	Santa Clara River	Lemon Orchard	8			0.78			< 25	Farmers Irrigation
	6/6/12	Ken Ikeda	Calleguas Creek	Avocado Orchard	8			0.82			< 10	Potable Water
	6/7/12	Eyal Gorden	Calleguas Creek	Avocado Orchard	5			0.84			< 25	Reclaimed Water
	6/12/12	Dean Hobson	Santa Clara River	Lemon Orchard	13.75			0.10			< 25	Well Water
	6/13/12	Darrel Jones	Ventura River	Avocado Orchard	3.5			0.80			< 10	Potable Water
	6/19/12	Ron White	Ventura River	Orange Orchard				0.76			< 10	Well Water and Casitas Water
	6/20/12	Camille King	Calleguas Creek	Lemon Orchard	3			0.54			> 25 < 50	Camrosa Water
	6/21/12	Jim Steinberg	Santa Clara River	Avocado Orchard								Well Water
	6/26/12	Ron White	Ventura River	Orange Orchard	3			0.95			<10	Well Water
	6/27/12	Cole Epstein	Ventura River	Avocado	35			1.00				Well Water
	6/28/12	Rugger Pulmer	Santa Clara River	Lemon								
												:Cancelled and Postponed
	7/10/12	Ron White	Ventura River	Orange Orchard	10			0.89			<10	Potable Water (Casitas Water)
	7/12/12	Ron White	Ventura River	Orange Orchard	10			0.89			<10	"Casitas" Water
	7/17/12	MVP Properties LP	Santa Clara River	Avocado Orchard	3			0.91			<100	"United" Water
	7/18/12	MVP Properties LP	Santa Clara River	Avocado Orchard								
	7/19/12	Ted Bowler	Calleguas Creek	Avocado Orchard	3			0.66			<100	Well Water
	7/24/12	Tom Crocker	Calleguas Creek	Avocado Orchard	2.5			0.00			< 10	Ag water "Calleguas"
	7/25/12	MVP Properties LP	Santa Clara River	Avocado/Orange	10			0.59			< 50	"United " water
	7/26/12	Ted Bowler	Calleguas Creek	Avocado Orchard	3			0.62			< 100	Well Water
	7/31/12	Tom Crocker	Calleguas Creek	Lemon Orchard	2.5			0.47			< 10	Ag water "Calleguas"
												:Cancelled and Postponed
	8/1/12	Jim Steinberg	Santa Clara River	Avocado	31			0.92			25> <50	Well Water
	8/1/12	Jim Steinberg	Santa Clara River	Avocado				0.83			25> <50	Well Water
	8/3/12	Roger Palmer	Santa Clara River	Avocado	15.5		2	0.92			10> <25	Well Water
	8/3/12	Roger Palmer	Santa Clara River	Orange				0.84			10> <25	Well Water
	8/7/12	Tom Crocker	Calleguas Creek	Lemon	2.5			0.01			<10	Ag water "Calleguas"

Appendix D: Master list of MIL Program Participants

#	Date	Grower	Watershed	Orchard/Nursery/ RowCrop	acres	Plot #	# Blocks	DU	F/U?	DU post-F/U	Nitrate Test (mg/l)	notes
	8/8/12	Tom Crocker	Calleguas Creek	Avocado	2.5			0.00			<10	Ag water "Calleguas"
	8/14/12	Kim Penman	Calleguas Creek	Avocado	13			0.79			25> <50	city and well water
	8/15/12	Mrs. Spar	Calleguas Creek	Avocado	6.25			0.87			<10	Camrosa water
cxl	8/16/12	Ted Bowler	Calleguas Creek	Avocado								
	8/20 12	Kim Penman	Calleguas Creek	Avocado				0.83			<10	city water
	8/20/12	Kim Penman	Calleguas Creek	Avocado				0.77			<10	city water
	8/20/12	Kim Penman	Calleguas Creek	Avocado				0.68			<10	city water
	8/21/12	Kim Penman	Calleguas Creek	Avocado				0.80			<10	city water
	8/21/12	Kim Penman	Calleguas Creek	Avocado				0.72			<10	city water
	8/22/12	Ted Bowler	Calleguas Creek	Avocado	3		5	0.79			<100	well water
	8/23/12	Cornejo Ranch	Santa Clara River	Orange	17.5			0.73			25> <50	well water
	8/27/12	Performance Nursery	Calleguas Creek	Potted Plants	2500sq/ft			0.76			<10	well water
	8/27/12	Performance Nursery	Calleguas Creek	Potted Plants	2500sq/ft			0.66			<10	well water
	8/29/12	Jim Steinberg	Santa Clara River	Orange	8.5			0.82			25> <50	well water
	8/30/12	Jim Steinberg	Santa Clara River	Orange	8.5			0.81			25> <50	well water
	8/31/12	Performance Nursery	Calleguas Creek	Potted Plants	10000sq/ft			0.66			<10	well water
				:Cancelled evaluation that Turned into BMP.								
	9/4/12	Charles Vanoni	Calleguas Creek									
	9/5/12	Charles Vanoni	Calleguas Creek	lemon	11			0.76			25> <50	well water
	9/6/12	Charles Vanoni	Calleguas Creek	Avocado	6			0.83			25> <50	well water
	9/11/12	Cornejo Ranch	Santa Clara River	orange	17.5			0.85			25> <50	well water
	9/12/12	Jim Steinberg	Santa Clara River	Tangerine	8			0.87			25> <50	well water
	9/18/12	Ted bowler	Calleguas Creek	Avocado	3			0.78			50> <100	well water
	9/19/12	Jim Steinberg	Santa Clara River	Avocado	12			0.80			25> <50	well water
	9/24/12	Ron Nicholes	Santa Clara River	Avocado	20			0.65			10> <25	well water
	9/25/12	Charles Vanoni	Calleguas Creek	Avocado	12			0.88			25> <50	well water
	9/27/12	Steve Murata	Calleguas Creek									
				:Cancelled and Postponed								
	10/4/12	Ralph DeVane	Calleguas Creek	Avocado	7.5			0.00			10> <25	well water
	10/10/12	Kirby Yale	Calleguas Creek	Avocado	8			0.77			<10	District 11
	10/17/12	Dave Borchard	Calleguas Creek	Lemon								
	10/18/12	Dave Borchard	Calleguas Creek	Lemon	12			0.93			<10	District 11
	10/22/12	Ron Nicholes	Santa Clara River	Avocado	10			0.79				
	10/23/12	Dave Borchard	Calleguas Creek	Lemon								
	10/23/12	Dave Borchard	Calleguas Creek	Lemon	23			0.82			<10	
	10/25/12	Ralph DeVane	Calleguas Creek	Avocado								
				:Cancelled and Postponed								
	11/1/12	Steven Murata	Calleguas Creek	Lemon	24		Block# 2	0.73			<10	well water
	11/12/12	Dave Borchard	Calleguas Creek	Lemon	10		Block2and F	0.88			<10	well water
	11/14/12	Dave Borchard	Calleguas Creek	Avocado	10.5		Block D	0.87			25> <50	well water
	12/19/12	Daryl Smith	Calleguas Creek	Lemon	3.5			0.70			25> <50	well water
	12/20/12	Daryl Smith	Calleguas Creek	Avocado	3.5			0.56			25> <50	well water

Appendix D: Master list of MIL Program Participants

#	Date	Grower	Watershed	Orchard/Nursery/ RowCrop	acres	Plot #	# Blocks	DU	F/U?	DU post-F/U	Nitrate Test (mg/l)	notes	
	2/26/13	Audrey Morine	Calleguas Creek	Lemon		7						lines needed walking and repair	
	2/27/13	Audrey Morine	Calleguas Creek	Lemon		7		0.67			< 10	return to finish eval	
	3/4/13	Mark Mooring	Ventura River	Olive		14							
	3/11/13	Tony Lunna											
	3/12/13	Audrey Morin	Calleguas Creek	Lemon 1st		7		0.80			< 10	district water	
	3/12/13	Audrey Morin	Calleguas Creek	Lemon 2nd				0.74			< 10	district water	
	3/19/13	Paul Romero	Santa Clara River	Avocado		7		0.93			< 25	well water	
	3/21/13	Mark Mooring	Ventura River	Olive		14					< 10	well water	
	3/25/13	EdMcFadden	Sanata Clara River										
	3/26/13	Ken Neary	Ventura River	Avocado		3.5		0.58			< 10	Senior Canyon water Dist.	
	3/27/13	Dan Spykerman	Calleguas Creek	Avocado		20							
												:Cancelled and Postponed	
												Postponed due to system malfunction	
	4/1/13	Ed McFadden	Santa Clara River										
	4/2/13	Deanna Kubit	Calleguas Creek	Avocado		20		0.69			< 10	waterworks district	
	4/3/13	Mark Mooring	Ventura River	Olive		14		0.78			< 10	well water	
	4/4/13	Dan Spykerman	Calleguas Creek	Mandarin		20		0.83			< 10		
	4/8/13	Bill Miller	Calleguas Creek	Lemon		15		0.58			< 100	well water	
	4/9/13	Dan Spykerman	Calleguas Creek	Mandarin				0.75			< 10		
	4/10/13	Bill Miller	Calleguas Creek	Avocado/Lemon				0.68			< 100	well water	
	4/11/13	Arts Ranch	Santa Clara River	Strawberry		3		0.63			< 10		
	4/16/13	Seacoast Farms	Calleguas Creek	Lemon		33		0.80			50< <100	well water	
	4/16/13	Seacoast Farms	Calleguas Creek	Lemon				0.79			50< <100	well water	
	4/17/13	Rachel Munzig	Ventura River	Orange									
	4/18/13	Rio Farms	Santa Clara River	Celery		15		0.81			< 10	municipal water	
	4/22/13	Alexandra Vorbeck	Calleguas Creek	Avocado		13		0.49			100< <250	Palo Verde (Ag water)	
	4/24/13	Arlin True	Santa Clara River	Avocado		8.5		0.49			10< <25	Farmers(Ag water)	
	4/25/13	Richard Burns	Calleguas Creek	Avocado		32		0.73			< 10	municipal water	
	4/26/13	Roger D. Clow	Santa Clara River	Avocado		16		0.68			< 10	well water	
	4/29/13	Mary Albee	Calleguas Creek	Avocado		3.5		0.88			< 10	municipal water	
												:Postponed evaluation that Turned into BMP.	
												:Cancelled and Postponed	
	5/1/13	Mary Albee	Calleguas Creek	Avocado				0.88			<10	municipal water	
	5/2/13	John Tull											
	5/8/13	Vincent Sevin	Calleguas Creek					0.74			50< >100	Ag water	
	5/9/13	John Tull	Calleguas Creek	Avocado									
	5/10/13	Roger Clow											
	5/14/13	Ken Ikeda	Calleguas Creek	Avocado				0.91			<10	Potable water	Re- eval. For the cost share
	5/15/13	Ron Nichols	Santa Clara River	Avocado				0.94			10< >25	well water	Re- eval. For the cost share
	5/16/13	Richard Burns											
	5/17/13	Audry Morin	Calleguas Creek										<< post eval for the purpose of report review >>
	5/21/13	Dave Borchard	Calleguas Creek	Lemon				0.87			<10		

Appendix D: Master list of MIL Program Participants

#	Date	Grower	Watershed	Orchard/Nursery/ RowCrop	acres	Plot #	# Blocks	DU	F/U?	DU post-F/U	Nitrate Test (mg/l)	notes
	5/22/13	Richard Burns	Calleguas Creek	Avocado	4			0.63			<10	
	5/29/13	Bill Miller										

:Cancelled and Postponed
:Landowner did not show up at the site to turn the system on.
:Did not have use for our sevices.

	6/1/13	Rolloing Greenhills										
	6/3/13	Ron Nichols	Santa Clara River	Lemon	16			0.56			< 10	well water
	6/4/13	Jane Waters	Calleguas Creek	Lemon	25			0.63			< 10	well water
	6/5/13	Dave Borchard										
	6/6/13	Jane Waters (Donlon Ranch)	Calleguas Creek	Blue Berry	15			0.96			< 10	well water
	6/7/13	Roger Clow	Santa Clara River	Lemon								
	6/11/13	David Pommer	Calleguas Creek	Lemon								Furrow Irrigation
	6/12/13	Bill Newman	Calleguas Creek	Avocado	2			0.70			< 10	Crestview Muyal Water Co.6
	6/13/13	Ludmila Vlach	Calleguas Creek	Avocado	20			0.27			< 10	Water Sanitation Dept.
	6/18/13	Bill Miller	Calleguas Creek	Avo. & Lemon	15-Jan			0.83			< 100	well water
	6/19/13	Sam Rustomji	Calleguas Creek	Avocado	3/4			0.92			< 10	Camrosa Water Dist.
	6/20/13	Harvey Corr	Calleguas Creek	Avocado	3			0.81			< 10	Camrosa Water Dist. & well water
	6/24/13	Rancho Guadacasca	Santa Clara River	Avocado	30			0.70			< 10	well & District water Ag water
	6/24/13	Rancho Guadacasca	Santa Clara River	Lemon				0.84			< 10	well & District water Ag water
	6/25/13	Regenerative Earth llc (Loren Luyendyk)	Ventura River	Avocado	25			0.73			< 10	Casitas Mun. Water Dist.
	6/26/13	Nunes Vegetables Inc (Walter Rutledge)	Santa Clara River	Peppers	27.5			0.76			< 10	well water
	6/27/13	Stony Grove LLc (Loren Luyendyk)			20			0.73			25< <50	well & Casitas M.W.D.

:Cancelled or Postponed
:insufficient data, need to go back .

	7/2/13	Simon Patterson										
	7/3/13	Simon Patterson										
	7/2/13	Ron White	Ventura River	Orange Orchard	10			0.92			<10	Casitas water
	7/3/13	Alden Broome	Calleguas Creek	Lemon/Avocado	111			0.68			10> >25	well water
	7/9/13	Performance Nursery	Calleguas Creek	Container				0.63			< 10	City water
	7/11/13	Ted Bowler	Calleguas Creek	Avocado	3			0.75			10> >25	County Ag water
	7/12/13	Robert Delara(1st)	Santa Clara	Citrus	40			0.90			10> >25	County Ag water
	7/12/13	Robert Delara(2nd)	Santa Clara	Citrus				0.86			10> >25	
	7/16/13	Kim Penman	Calleguas Creek	Avocado	20			0.79			25< <50	City and well water
	7/16/13	Jim Gill	Calleguas Creek	Beans	50			0.63			< 10	District water
	7/18/13	Pacific Sod										
	7/19/13	Roger Clow	Sanat Clara River	Lemon	20			0.82			< 10	Well water
	7/19/13	Roger Clow	Santa Clara River	Avocado				0.77			< 10	Well water
	7/24/13	Craig Underwood	Calleguas Creek	Avocado	11			0.73			50< 100	Well water
	7/25/13	Richard French	Calleguas Creek	Lemon	11.8			0.92			10< <25	Berylwood Hights
	7/29/13	Deann Hobson	Santa Clara River	Lemon	13.75			0.91			10< 25	Well water

:Cancelled or Postponed
:insufficient data, need to go back .
:Re-Evaluation

Appendix D: Master list of MIL Program Participants

#	Date	Grower	Watershed	Orchard/Nursery/ RowCrop	acres	Plot #	# Blocks	DU	F/U?	DU post-F/U	Nitrate Test (mg/l)	notes
	8/1/13	David Borchard	Calleguas Creek	Lemon	44			0.89			10< <25	WELL WATER
	8/6/13	Vern Haller										
	8/6/13	Simon Patterson	Ventura River	Avocado	17.1			0.68			< 10	Casitas water
	8/7/13	Pacific Sod	Calleguas Creek	Turf	200			0.75			10< <25	PleasantValley CountyWaterDistrict
	8/14/13	Harvey Corr	Calleguas Creek	Avocado	3.5			0.58			< 10	Camrosa water
	8/15/13	Ludmila Vlach	Calleguas Creek	Avocado	20			0.22			< 10	Water Sanitation Dept.
	8/21/13	Charlette Brandes	Calleguas Creek	Avocado	1.2			0.78			< 10	W & S Dept.County of Ventura
	8/27/13	Vern Haller	Santa Clara River	Avocado	8.5			0.75			25< <50	Well water
					294.3			0.66				
							:Cancelled or Postponed					
							:Re-Evaluation					
1st Eval	9/9/13	Charles Blanc	Calleguas Creek	Lemon	12.5			0.85			< 10	Well water
2nd Eval	9/9/13	Charles Blanc	Calleguas Creek	Avocado	12.5			0.70			< 10	Well water
	9/10/13	Muranaka Farm Inc.										
Pre-Eval	9/13/13	Muranaka Farm Inc.	Calleguas Creek	Row Crop								
	9/16/13	Charles Blanc	Calleguas Creek	Lemon	12.5			0.80			< 10	Well water
	9/18/13	Muranaka Farm Inc.	Calleguas Creek	Organic row crop	500			0.77			< 10	Well water
	9/23/13	Muranaka Farm Inc.										
	9/24/13	Fairview Orchard (Sean Jenkins)	Ventura River	Avocado/Lemon	12.5			0.60			< 10	Casitas
	9/25/13	Muranaka Farm Inc.	Calleguas Creek	Cilantro(row crop)	500			0.75			50 < <100	Well water
	9/30/13	Muranaka Farm Inc.						0.75				
					1050			5.22	0.75			
							:Cancelled or Postponed					
	10/2/13	Muranaka Farm Inc.										
	10/4/13	Muranaka Farm Inc.										
	10/8/13	Muranaka Farm Inc.	Calleguas Creek	Row Crop	500			0.62			50< <100	Well water
	10/23/13	Ludmila Vlach	Calleguas Creek	Avocado	20			0.67			< 10	Water Sanitation Dept.
	10/24/13	Ludmila Vlach										
					520			0.65				
	11/1/13	Otto & Sons Nursery										
	11/4/13	Otto & Sons Nursery	Santa Clara River	Valencia Orange	22			0.74			25< <50	Well water (United Water)
	11/6/13	CE&D Mabry Family L.P.	Calleguas Creek	Lemon & Avocado	47			0.84				Well water & District
	11/7/13	Reimer Petit Ranch	Santa Clara River	Valencia Orange	17			0.68			50< <100	Well water
	11/22/13	Otto & Sons Nursery	Santa Clara River	Valencia Orange	22			0.78			10< <25	Well water (United Water)
					108			0.76				
							:Cancelled or Postponed					
	12/11/13	Reimer Petit Ranch	Santa Clara River	Navel Orange	72			0.76			25< <50	Well water
	12/16/13	Vincent servin	Calleguas Creek	Lemon	9			0.95			0< <10	Ag water
	12/20/13	Dorkas (Pommer)	Calleguas Creek	Lemon	40			.00(Furrow irrigation)			10< <25	Well water (Zone Mutual Water Co.)
							:Re-Evaluation					
							:insufficient data, need to go back .					

Appendix D: Master list of MIL Program Participants

#	Date	Grower	Watershed	Orchard/Nursery/ RowCrop	acres	Plot #	# Blocks	DU	F/U?	DU post-F/U	Nitrate Test (mg/l)	notes
	1/9/14	Dorcas Thille	Calleguas Creek	lemon	40			0.97			10< <25	Zone Water Co.
	1/15/14	Jane Waters (Donlon Ranch)	Calleguas Creek	lemon	21			0.85			0< <10	Well
	1/16/14	Ron Oba (Dos Hijos Ranch)	Santa Clara River	Avocado	23			0.27			10< <25	Thermal Belt Mutual Water
	1/22/14	Alden Broome	Calleguas Creek	Lemon/Avocado	111			0.98			0< <10	Well water
					195			0.77				
							: Re-Evaluation					

Borchard Babtiste Ranch

Address: 4990 Bradley Road, Somis. BMP #443

Under and above ground work to bring more water to enhance pressure required to irrigate more efficiently.

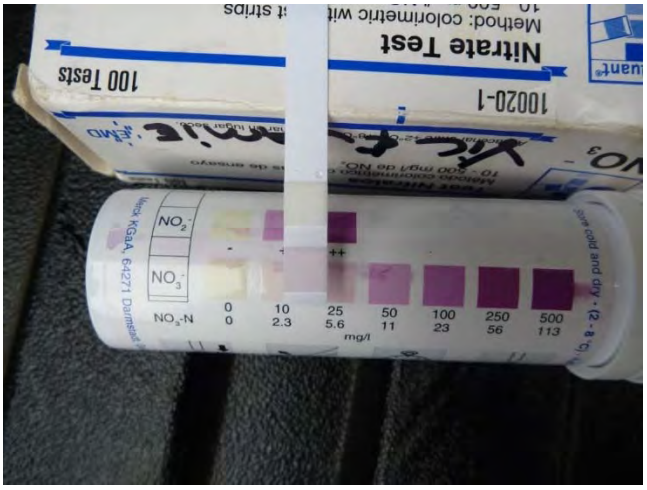




Borchard DBJ Ranch

Address: 4250 Bradley Road, Somis. BMP # 443

New inline pressure compensating disk used to regulate flow of water emitted.



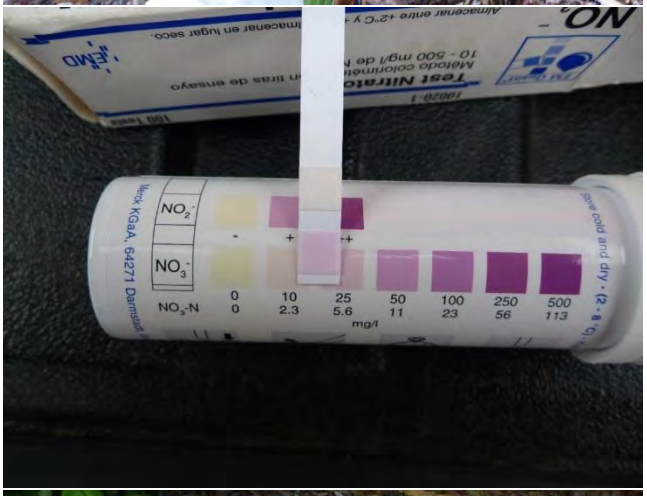


Bowler

Address: 4399 Hitch Boulevard, Moorpark. BMPs #441 #449

New laterals, hoses, and emitters for flow control and irrigation efficiency. Use of soil moisture sensors.








S-6a
S-6b













Broome

Address: 3111 Wright Road, Camarillo. BMP #441

New hoses and emitters for flow control and irrigation efficiency.








AGRIFIM





Hobson

Address: 19134 E. Telegraph Road, Santa Paula. BMP #443

New hoses and emitters for flow control and irrigation efficiency.













Ikeda

Address: 10735 W. Los Angeles Avenue, Moorpark. BMPs #441 #443 #449

New piping, hoses, emitters, and pressure regulators for flow control and irrigation efficiency. Use of soil moisture sensors.



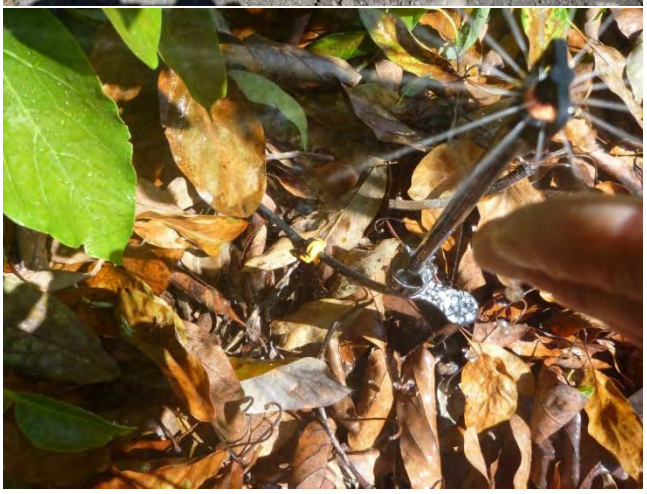


















Nichols

Address: 5501 Elizabeth Road, Santa Paula. BMPs #441 #443

New emitters and pressure regulators for flow control and irrigation efficiency.

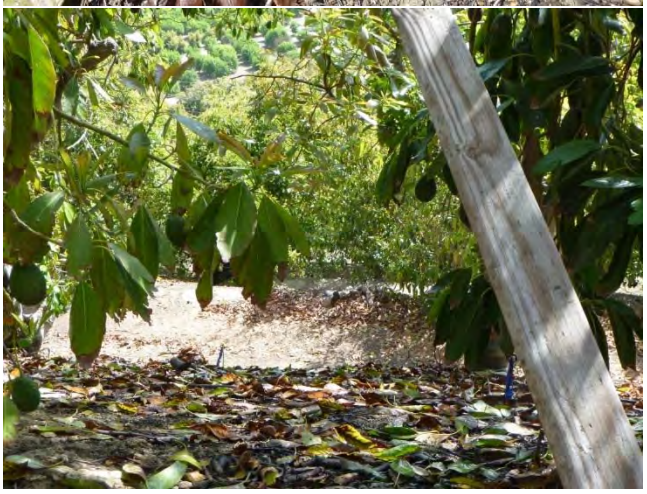












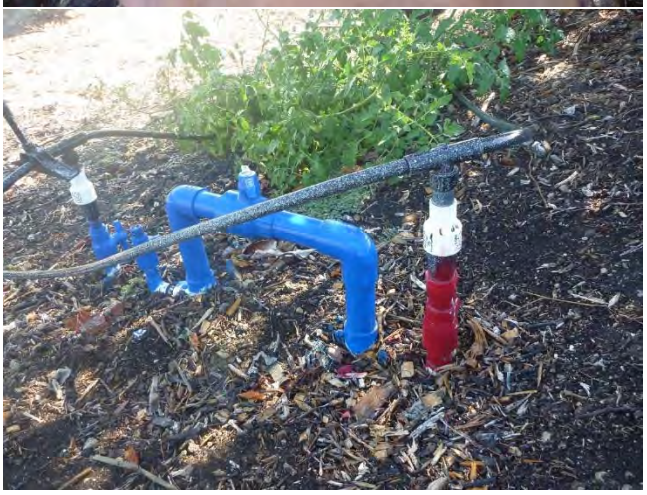
Penman

Address: 4287 Ventavo Drive, Moorpark. BMPs #441 #443 #449

New piping, hoses, and emitters for flow control and irrigation efficiency. Use of soil moisture testing.











Pereira

Address: 664 Laguna Road, Oxnard. BMP #449

Use of soil moisture sensors.





Romero

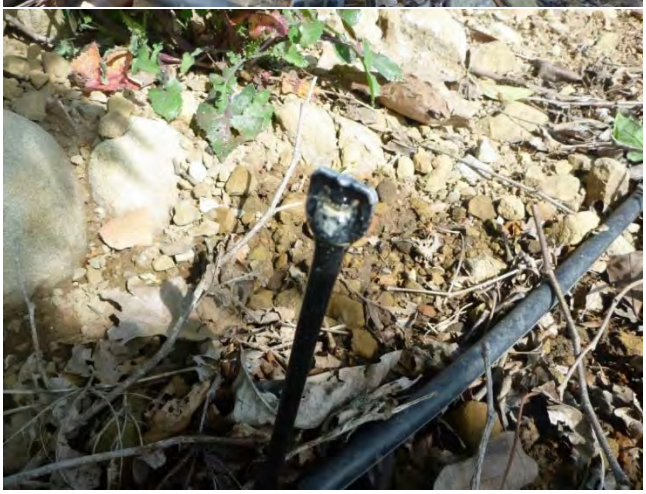
Address: 620 Hall Road, Santa Paula. BMPs #441 #443

New pressure regulators, hoses, and emitters for flow control and irrigation efficiency.













Servin

Address: 800 Stockton Road, Somis. BMPs #441 #443 #449

New pressure regulators, hoses, and emitters for flow control and irrigation efficiency. Use of soil moisture sensors.









Thille

Address: 512 E. Los Angeles Avenue, Somis. BMPs #441 #443

Converted entire system from furrow to drip irrigation.















Waters

Address: 4896 Balcom Canyon Road, Somis. BMP #449

Installation of soil moisture sensor system.

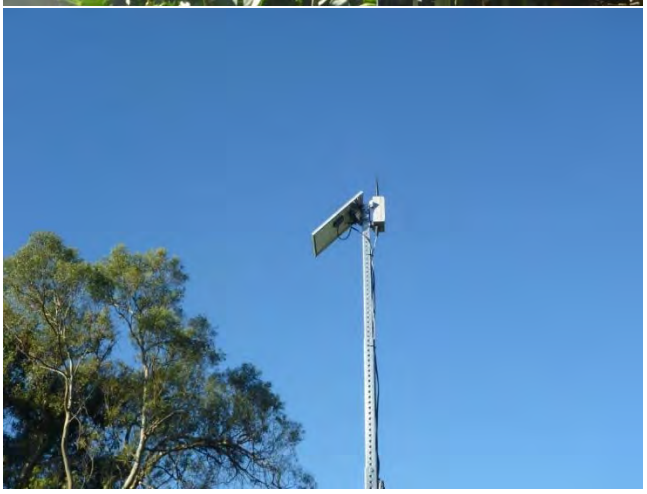
















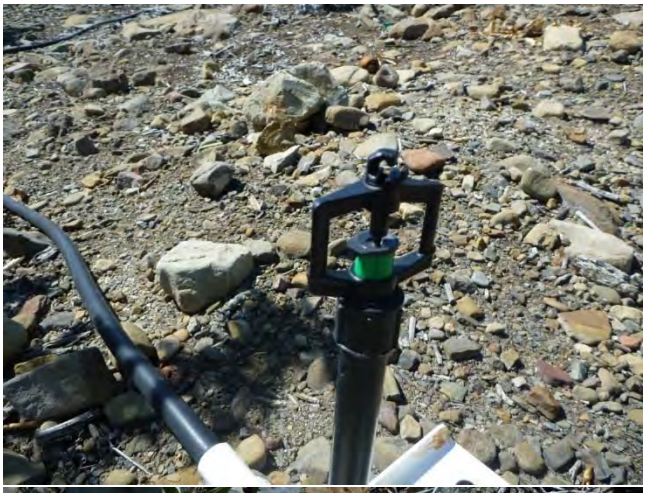
White

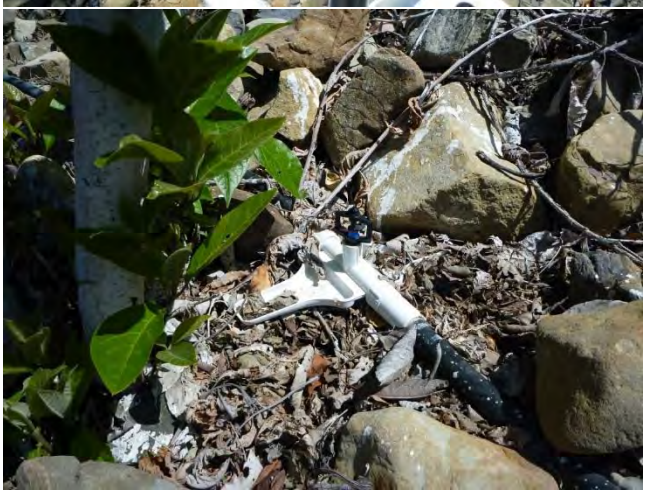
Address: 4106 Thatcher Road, Ojai. BMPs #441 #443

New hoses and emitters for flow control and irrigation efficiency.









Appendix F: Table of Items for Review

Date	Submitted Items for Review
October 2011	EXHIBIT A.A TASK 3a Monitoring and Reporting Plan (MRP) TASK 4 Quality Assurance Project Plan (QAPP) TASK 6 Landowner Agreements EXHIBIT A.B TASK 1 Outreach and Advertising (documentation of outreach efforts) TASK 4.2 Lists of Growers Evaluated
November 2011	EXHIBIT A.A TASK 6 Landowner Agreements EXHIBIT A.B TASK 1 Outreach and Advertising (documentation of outreach efforts) TASK 2.2 TAC Agenda and Sign-In Sheet TASK 3.2 Intended Use Plan TASK 4.2 Lists of Growers Evaluated TASK 5.1 BMP Cost Share Plan
December 2011	EXHIBIT A.B TASK 1 Outreach and Advertising (documentation of outreach efforts) TASK 4.2 Lists of Growers Evaluated & Summary of Evaluation Results TASK 5.1 BMP Cost Share Plan
January 2012	EXHIBIT A. TASK A.5 Draft Notice of Exemption TASK B.1 Outreach and Advertising (documentation of outreach efforts) TASK B.5.1 Draft BMP Cost Share Plan

Appendix F: Table of Items for Review

February 2012	EXHIBIT A. TASK A.5 Notice of Exemption TASK B.1 Outreach and Advertising (documentation of outreach efforts)
March 2012	EXHIBIT A. TASK B.1 Outreach and Advertising (documentation of outreach efforts) EXHIBIT B TASK B1.1 Meeting announcement materials from external meetings TASK B2.2 MIL TAC Sign In Sheet
April 2012	EXHIBIT A. TASK B.1 Outreach and Advertising (documentation of outreach efforts) EXHIBIT B TASK B1.1 Meeting announcement materials from external meetings
May 2012	EXHIBIT A. TASK B.1 Outreach and Advertising (documentation of outreach efforts) TASK B.3.4 List of Trained & Qualified Staff TASK B.5.1 Cost Share Plan (advertising flyer)
June 2012	EXHIBIT A. TASK B1 Outreach and Advertising (documentation of outreach efforts) TASK B2.2 MIL TAC Sign In Sheet
July 2012	EXHIBIT A. TASK B1 Outreach and Advertising (documentation of outreach efforts)

Appendix F: Table of Items for Review

August 2012	EXHIBIT A. TASK B1 Outreach and Advertising (documentation of outreach efforts) TASK B4.2 Copy of Post Evaluation Report
September 2012	EXHIBIT A. TASK B1 Outreach and Advertising (documentation of outreach efforts) TASK B5.1 Root Zone Monitoring Flyer
October 2012	EXHIBIT A. TASK B1 Outreach and Advertising (documentation of outreach efforts)
January 2013	EXHIBIT A. TASK B1.1 Meeting announcement materials from external meetings
February 2013	EXHIBIT A. TASK B1 Outreach Calendar TASK B1.1 Meeting Material Announcement (VCAILG Educational Event Agenda) TASK B3.2 List of equipment used in the MIL
March 2013	EXHIBIT A. TASK B1 Outreach Calendar
April 2013	EXHIBIT A. TASK B1 Outreach Calendar
May 2013	EXHIBIT A. TASK B1 Outreach Calendar TASK B Outreach – Ag Appreciation BBQ Banner
June 2013	EXHIBIT A.

Appendix F: Table of Items for Review

	TASK B1 Outreach Calendar TASK B Presentation to the Ventura River Watershed Council
July 2013	EXHIBIT A. TASK B1 Outreach Calendar
August 2013	EXHIBIT A. TASK B1 Outreach Calendar
September 2013	EXHIBIT A. TASK B1 Outreach Calendar MIL TAC Meeting Agenda MIL TAC Meeting Sign in Sheet
October 2013	EXHIBIT A. TASK B1 Outreach Calendar MIL TAC Meeting Agenda MIL TAC Meeting Sign in Sheet
November 2013	EXHIBIT A. TASK B1 Outreach Calendar
December 2013	EXHIBIT A. TASK B1 Outreach Calendar



VENTURA COUNTY RESOURCE CONSERVATION DISTRICT
MOBILE IRRIGATION EFFICIENCY PROGRAM

COVER PAGE

RON NICHOLS
PO Box 7360
Ventura CA 93006

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- Block Map
- Emission/Flow Data
- Pressure Data
- Infiltration Diagram

Section 2: (Upper Tier, Blocks 13 & 14) Irrigation Evaluation (October 22, 2012) 5 pages
- Summary and Recommendations
- GPS Map
- Emission/Flow Data
- Pressure Data
- Infiltration Diagram

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- VCRCD MIL Cost-Share Program Application
- CMWD Purveyor List
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- FSA Guaranteed Lender List

Ventura County Resource Conservation District

Low Volume Irrigation System Evaluation

Ranch;	Ron Nichols	Date;	September 24, 2012
Location;	Elizabeth Rd. Ventura	Job #;	
Block #;	see GPS map (points 85-106)	Contact;	Ron Nichols
# Manifold ;	1	Phone #	901-1652
Crop and Spacing;	Avocado		

Summary of Uniformity Findings;

lq **DU** = 0.65

target **l**ow **q**uarter **D**istribution **U**niformity is 0.85 or better !

Emitter Emission Uniformity %	71.29%
Estimated Average Flow/Emitter (in/hr)	0.114
Estimated Average Flow/Emitter (in/24hr)	2.747

Conclusions and Recommendations;

Pressure Variations;

The three main reasons for pressure variation are,

1. Irrigation sets are not matching pump capacities.

a. Irrigation set demand in gpm exceeds the pump capability, resulting in low pressures — yes

:Refer to GPS map points 86 @9psi , 87 @13psi,89@1psi,and 102@10psi.

2. Irrigation lines are undersized relative to total water flow. — no

3. Elevation changes are causing gain/loss in PSI. — yes

Emitter Variations;

1. Multiple emitter flow rates are installed. — yes

:Refer to CALC SHT of this report!

2. Manufacture variability may be an issue. — yes

3. Emitter plugging is causing uniformity problems. — no

Water Quality related issues;

1. Plugging due to; — no

Calcium deposits
Bacterial
Physical

2. Quick Nitrate Test; — 10> <25 ppm NO_3

Potential Water Savings; :Refer to the last section of this report for important cost share information!

To "save" water or increase the D.U. either under irrigate, or shut it off.
For best quality and yield bring the irrigation system up to par, and manage the system to provide the correct amount of water at the optimum timing !!!

Recommendations: Soil moisture sensor. More often flushing of line-ends. New hardware including pressure-compensating emitters, or pressure regulators at each riser , and 3/4" or 7/8' lateral hose.

Low Volume Irrigation System Evaluation Results;

Ranch Name;	Ron Nichols	Date;	September 24, 2012
Location;	Elizabeth Rd. Ventura	Job #;	
Block #;	see GPS map (points 85-106)	Contact;	Ron Nichols
# Manifold ;	1	Phone #'s	901-1652
Crop and Spacing;	Avocado		

Emitter Catch Data;

Poly Hose Line #	Emitter (ml)	Flow (gph)	Emitter (ml)	Flow (gph)	Emitter (ml)	Flow (gph)	Emitter (ml)	Flow (gph)	Emitter (ml)
Manifold # 1	500	**15.85**	600	**19.02**		**0.00**		**0.00**	
Poly side 1		*first C-1*		*first C-2*		*first C-3*		*first C-4*	
Manifold # 1		**0.00**		**0.00**		**0.00**		**0.00**	550
Poly side 1		*mid #1 C-1*		*mid #1 C-2*		*mid #1 C-3*		*mid #1 C-4*	
Manifold # 1		**0.00**	390	**12.36**		**0.00**	450	**14.27**	
Poly side 1		*mid #2 C-1*		*mid #2 C-2*		*mid #2 C-3*		*mid #2 C-4*	
Manifold # 1	775	**24.57**		**0.00**	500	**15.85**		**0.00**	440
Poly side 1		*mid #3 C-1*		*mid #3 C-2*		*mid #3 C-3*		*mid #3 C-4*	
Manifold # 1	370	**11.73**	430	**13.63**		**0.00**	340	**10.78**	130
Poly side 1		*Terminal C-1*		*Terminal C-2*		*Terminal C-3*		*Terminal C-4*	
Manifold # 1	455	**14.43**	515	**16.33**	305	**9.67**	245	**7.77**	
Poly side 2		*first C-1*		*first C-2*		*first C-3*		*first C-4*	
Manifold # 1		**0.00**		**0.00**		**0.00**	470	**14.90**	560
Poly side 2		*mid #1 C-1*		*mid #1 C-2*		*mid #1 C-3*		*mid #1 C-4*	
Manifold #1		**0.00**		**0.00**	490	**15.54**		**0.00**	
Poly side 2		*mid #2 C-1*		*mid #2 C-2*		*mid #2 C-3*		*mid #2 C-4*	
Manifold # 1		**0.00**	480	**15.22**		**0.00**	620	**19.66**	
Poly side 2		*mid #3 C-1*		*mid #3 C-2*		*mid #3 C-3*		*mid #3 C-4*	
Manifold # 1	465	**14.74**		**0.00**	405	**12.84**		**0.00**	370
Poly side 2		*Terminal C-1*		*Terminal C-2*		*Terminal C-3*		*Terminal C-4*	
Catch time in seconds	*30*								

Low Volume Emitter Emission Uniformity Results;

Number of Catches	**24**
#LQ Catches	**6**
LQ Average Catch(ml)	**293.3333333**
Average Catch (ml)	**452.292**
Ave. Flow Rate (gph)	**14.339**
Emitters/Plant	1
Wetted Area Ft. (Dia.)	16.000
Wetted Area Ft^2	**200.960**
Est. Applied in./hr	**0.114**
Est. Applied in./24hr	**2.747**

lqDU (low quarter Distribution Uniformity) 0.65

Coefficient of Variation (CvU) = (1-Std Dev / Ave of Catches) x 100%

71.289% 2

:Blue Fan-jet
:GreenFan-jet
:Black Olsen
:Purple Fan-jet
:Netaffim

Flow (gph)					
0.00	500	600			
first C-5					
17.44					550
mid #1 C-5					
0.00		390		450	
mid #2 C-5					
13.95	775		500		440
mid #3 C-5					
4.12	370	430		340	130
Terminal C-5					
0.00	455	515	305	245	
first C-5					
17.75				470	560
mid #1 C-5					
0.00			490		
mid #2 C-5					
0.00		480		620	
mid #3 C-5					
11.73	465		405		370
Terminal C-5					

#1	130		
#2	245		
#3	305		
#4	340		
#5	370		
#6	370		
#7		390	
#8		405	
#9		430	
#10		440	
#11		450	
#12		455	
#13		465	
#14		470	
#15		480	

2

Pressure Test Results;			
Manifold #1			
	First Line psi's		
Ploy Side 1	Riser	Ploy Side 2	
35.5	24	10	
48%		**-58%**	% variation
	Middle #1		
Ploy Side 1	Riser	Ploy Side 2	
20	23.5	24	
-15%	**-2%**	**2%**	% variation
	Middle #2		
Ploy Side 1	Riser	Ploy Side 2	
21	21.5	0.5	
-2%	**-10%**	**-98%**	% variation
	Middle #3		
Ploy Side 1	Riser	Ploy Side 2	
21	19.5	20.5	
8%	**-19%**	**5%**	% variation
	Terminal		
Ploy Side 1	Riser	Ploy Side 2	
9	13	1	
-31%	**-46%**	**-92%**	% variation

	Additional line		
Ploy Side 1	Riser	Ploy Side 2	
18.5	17.5	16.5	
6%	**-27%**	**-6%**	% variation

Ranch Name;	Ron Nichols
Block #;	S map (points 85-106)
Manifold #	1

C's = catches in gph

First Line		Poly Side 1					First	Line		Poly Side 2					First Line
Side 1 psi=	C-5	C-4	C-3=	C-2=	C-1=		Riser psi=	**24**	C-1=	C-2=	C 3=	C-4	C-5		Side 2 psi=
35.5	**0.00**	**0.00**	**0.00**	**19.02**	**15.85**				**14.43**	**16.33**	**9.67**	**7.77**	**0.00**		**10**

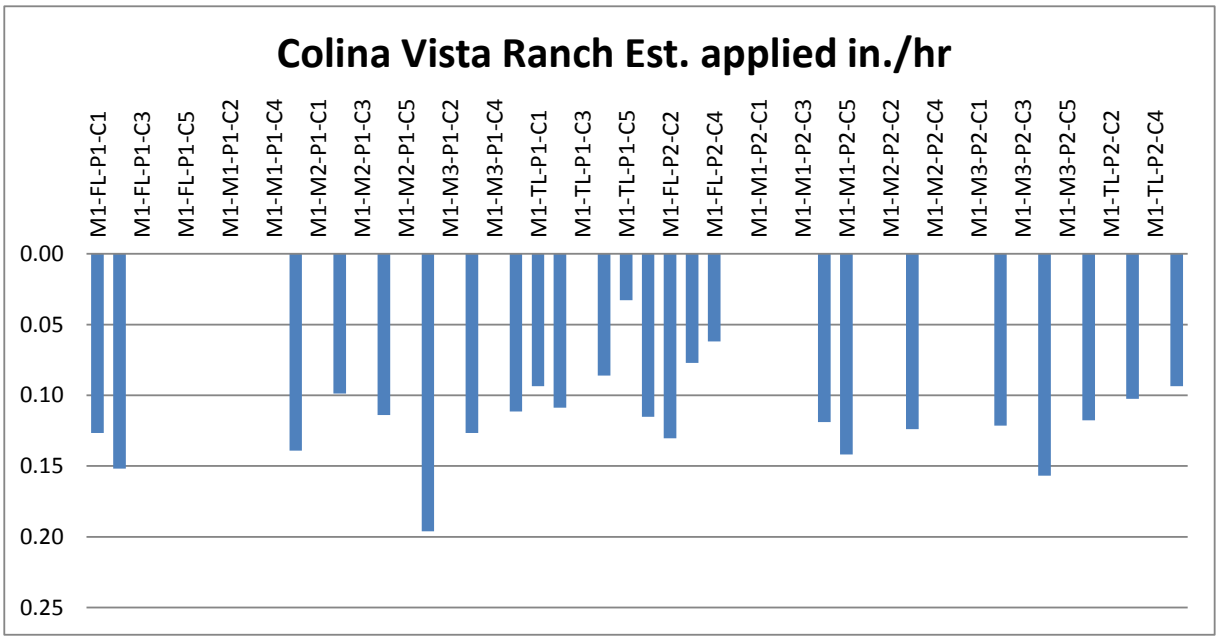
Middle #1		Poly Side 1					Middle	#1		Poly Side 2					Middle #1
Side 1 psi=	C-5	C-4	C-3=	C-2=	C-1=		Riser psi=	**23.5**	C-1=	C-2=	C 3=	C-4	C-5		Side 2 psi=
20	**17.44**	**0.00**	**0.00**	**0.00**	**0.00**				**0.00**	**0.00**	**0.00**	**14.90**	**17.75**		**24**

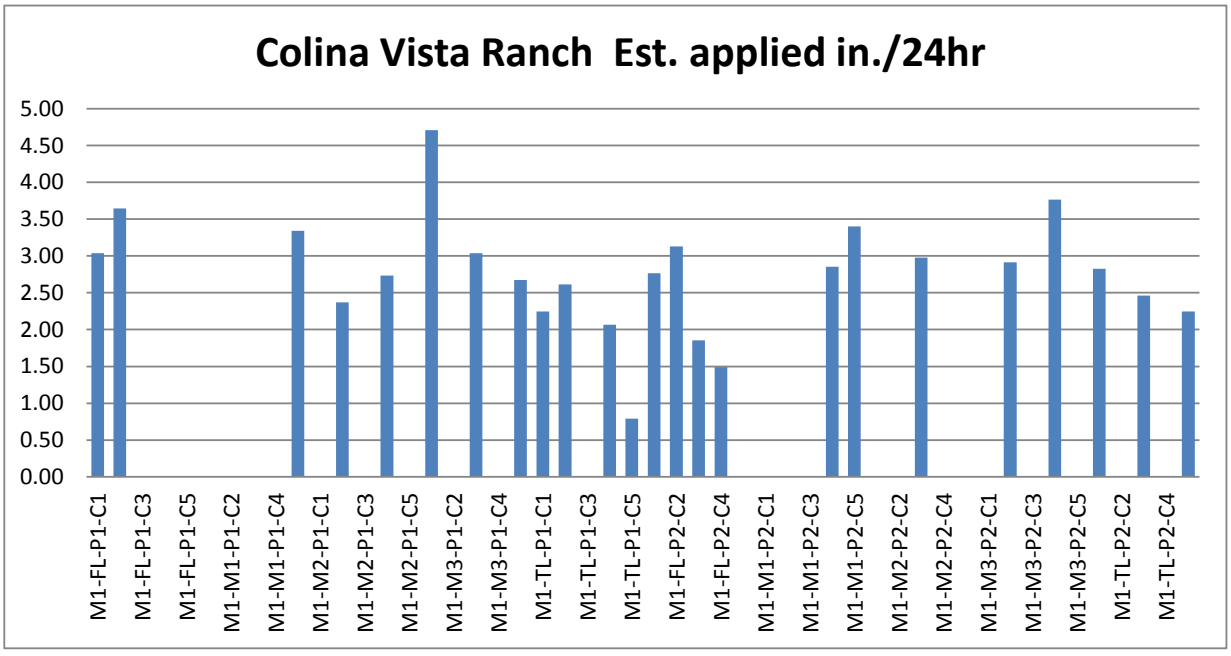
Middle #2		Poly Side 1					Middle	#2		Poly Side 2					Middle #2
Side 1 psi=	C-5	C-4	C-3=	C-2=	C-1=		Riser psi=	**21.5**	C-1=	C-2=	C 3=	C-4	C-5		Side 2 psi=
21	**0.00**	**14.27**	**0.00**	**12.36**	**0.00**				**0.00**	**0.00**	**15.54**	**0.00**	**0.00**		**0.5**

Middle #3		Poly Side 1					Middle	#3		Poly Side 2					Middle #3
Side 1 psi=	C-5	C-4	C-3=	C-2=	C-1=		Riser psi=	**19.5**	C-1=	C-2=	C 3=	C-4	C-5		Side 2 psi=
21	**13.95**	**0.00**	**15.85**	**0.00**	**24.57**				**0.00**	**15.22**	**0.00**	**19.66**	**0.00**		**20.5**

Terminal Line		Poly Side 1					Terminal	Line		Poly Side 2					Terminal Line
Side 1 psi=	C-5	C-4	C-3=	C-2=	C-1=		Riser psi=	**13**	C-1=	C-2=	C 3=	C-4	C-5		Side 2 psi=
9	**4.12**	**10.78**	**0.00**	**13.63**	**11.73**				**14.74**	**0.00**	**12.84**	**0.00**	**11.73**		**1**

Emitter Location	Test Ranch Est. applied in./	Test Ranch Est. applied in./24hr
M1-FL-P1-C1	0.13	3.04
M1-FL-P1-C2	0.15	3.64
M1-FL-P1-C3	0.00	0.00
M1-FL-P1-C4	0.00	0.00
M1-FL-P1-C5	0.00	0.00
M1-M1-P1-C1	0.00	0.00
M1-M1-P1-C2	0.00	0.00
M1-M1-P1-C3	0.00	0.00
M1-M1-P1-C4	0.00	0.00
M1-M1-P1-C5	0.14	3.34
M1-M2-P1-C1	0.00	0.00
M1-M2-P1-C2	0.10	2.37
M1-M2-P1-C3	0.00	0.00
M1-M2-P1-C4	0.11	2.73
M1-M2-P1-C5	0.00	0.00
M1-M3-P1-C1	0.20	4.71
M1-M3-P1-C2	0.00	0.00
M1-M3-P1-C3	0.13	3.04
M1-M3-P1-C4	0.00	0.00
M1-M3-P1-C5	0.11	2.67
M1-TL-P1-C1	0.09	2.25
M1-TL-P1-C2	0.11	2.61
M1-TL-P1-C3	0.00	0.00
M1-TL-P1-C4	0.09	2.07
M1-TL-P1-C5	0.03	0.79
M1-FL-P2-C1	0.12	2.76
M1-FL-P2-C2	0.13	3.13
M1-FL-P2-C3	0.08	1.85
M1-FL-P2-C4	0.06	1.49
M1-FL-P2-C5	0.00	0.00
M1-M1-P2-C1	0.00	0.00
M1-M1-P2-C2	0.00	0.00
M1-M1-P2-C3	0.00	0.00
M1-M1-P2-C4	0.12	2.85
M1-M1-P2-C5	0.14	3.40
M1-M2-P2-C1	0.00	0.00
M1-M2-P2-C2	0.00	0.00
M1-M2-P2-C3	0.12	2.98
M1-M2-P2-C4	0.00	0.00
M1-M2-P2-C5	0.00	0.00
M1-M3-P2-C1	0.00	0.00
M1-M3-P2-C2	0.12	2.92
M1-M3-P2-C3	0.00	0.00
M1-M3-P2-C4	0.16	3.77
M1-M3-P2-C5	0.00	0.00
M1-TL-P2-C1	0.12	2.82
M1-TL-P2-C2	0.00	0.00
M1-TL-P2-C3	0.10	2.46
M1-TL-P2-C4	0.00	0.00
M1-TL-P2-C5	0.09	2.25


Colina Vista Ranch Est. applied in./hr
M1-FL-P1-C1
M1-FL-P1-C3
M1-FL-P1-C5
M1-M1-P1-C2
M1-M1-P1-C4
M1-M2-P1-C1
M1-M2-P1-C3
M1-M2-P1-C5
M1-M3-P1-C2
M1-M3-P1-C4
M1-TL-P1-C1
M1-TL-P1-C3
M1-TL-P1-C5
M1-FL-P2-C2
M1-FL-P2-C4
M1-M1-P2-C1
M1-M1-P2-C3
M1-M1-P2-C5
M1-M2-P2-C2
M1-M2-P2-C4
M1-M3-P2-C1
M1-M3-P2-C3
M1-M3-P2-C5
M1-TL-P2-C2
M1-TL-P2-C4
0.00
0.05
0.10
0.15
0.20
0.25


Colina Vista Ranch Est. applied in./24hr
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
M1-FL-P1-C1
M1-FL-P1-C3
M1-FL-P1-C5
M1-M1-P1-C2
M1-M1-P1-C4
M1-M2-P1-C1
M1-M2-P1-C3
M1-M2-P1-C5
M1-M3-P1-C2
M1-M3-P1-C4
M1-TL-P1-C1
M1-TL-P1-C3
M1-TL-P1-C5
M1-FL-P2-C2
M1-FL-P2-C4
M1-M1-P2-C1
M1-M1-P2-C3
M1-M1-P2-C5
M1-M2-P2-C2
M1-M2-P2-C4
M1-M3-P2-C1
M1-M3-P2-C3
M1-M3-P2-C5
M1-TL-P2-C2
M1-TL-P2-C4

PHYTOPHTHORA ROOT AND CROWN ROT IN THE GARDEN

Integrated Pest Management for Home Gardeners and Landscape Professionals

Several species of soilborne pathogens in the genus *Phytophthora* cause crown and root rot diseases of herbaceous and woody plants. Almost all fruit and nut trees, as well as most ornamental trees and shrubs (including many California natives), can develop Phytophthora rot if soil around the base of the plant remains wet for prolonged periods, or when planted too deeply (Fig. 1). Tomatoes, peppers, eggplant, and other vegetable crops can also be affected by Phytophthora rot. In trees and shrubs, the pathogen kills plants by growing from the roots up through the root crown and into the lower trunk, where it kills the inner bark and causes a browning of the outer layer of sapwood. In many of these crops, different species of *Phytophthora* are involved. Losses to *Phytophthora* are minimized by providing good soil drainage and selecting the most tolerant rootstocks or varieties available. In general, *Phytophthora* requires warm, moist soils in order to cause disease. Another species of *Phytophthora*, *Phytophthora ramorum*, causes sudden oak death, which has very different symptoms and management than the species discussed here. See *Pest Note: Sudden Oak Death in California*, available online at http://www.ipm.ucdavis.edu.

SYMPTOMS

The leaves of plants affected by Phytophthora rot appear drought stressed. Trees or plants often wilt and die rapidly with the first warm weather of the season. Leaves may turn dull green, yellow, or in some cases red or purplish. Often, only plants in the most poorly drained area of the field or garden are affected. *Phytophthora* infections typically kill young trees, because their root systems and crown areas are small compared to those of mature trees.

Symptoms may develop first on one branch or stem then spread to the rest of a tree or plant. Trees may decline over a period of years before finally dying or they may be killed in a single season. Slow decline occurs when the roots are attacked; rapid decline occurs when the crown or basal stem is attacked and girdled, the damage completely encircling the stem in a single season.

Symptoms on roots and crowns may vary somewhat depending on the species of *Phytophthora* involved, the plant being attacked, the resistance of the plant variety, and soil moisture and temperature. In general, trees affected by *Phytophthora* develop darkened areas in the bark around the crown and upper roots. Gum or dark sap may ooze from the margins of the diseased trunk area. If bark tissue is carefully cut away, reddish brown streaks or zones can be seen in the inner bark and outer layer of wood. No mycelium (slender filaments of a fungus body) is visible in between the bark and wood in trees affected by *Phytophthora*, distinguishing this disease from Armillaria root rot, which is caused by a true fungus.

When tomatoes and eggplants are affected by Phytophthora root rot, roots of all sizes develop water-soaked spots that dry out and turn a chocolate brown as the disease becomes advanced. Early infections, caused by *Phytophthora* and other pathogens that cause damping-off diseases, kill seedlings. For more information on damping-off diseases, see Suggested Reading, *Pest Notes: Damping-Off Diseases in the Garden*. Later infections reduce plant vigor and may cause collapse and death of the plant. If you cut infected tap roots in cross section, you will see

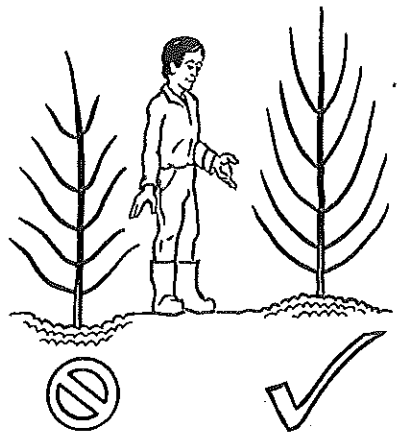


Figure 1. Avoid planting in a hole or a low-lying area, except when planting in sandy soils.

that the stele (central core of conducting tissue) is brownish above the rot lesions. Stele discoloration may extend into the lower stem.

BIOLOGY

Phytophthora species are soil-inhabiting pathogens that are favored by wet conditions. Although previously considered fungi, *Phytophthora* species are now considered to be in a separate classification called oomycetes. Species of *Phytophthora* produce resting spores that survive for years in moist soil in the absence of a suitable host. However, if the soil is completely dried out, these spores are less likely to survive for more than a few months. When a host is nearby and free water (water in soil pore spaces) is present in the soil, resting spores germinate to produce motile spores that can directly penetrate roots, branches, or crowns as long as free water is present. Wounds are not required for infection. Resting spores, decaying host tissue in the soil, and active cankers (disease-infected dead, sunken lesions in plant parts) can all be

sources for new infections. The pathogen can be spread in splashing rain or irrigation water, in surface irrigation, and runoff water, and by movement of contaminated soil, equipment, or plant parts. Flooded and saturated soil favors the spread of *Phytophthora* to healthy plants.

Some *Phytophthora* species are favored by warm weather, some by cool weather. Root rot of avocado, citrus, and tomato are favored by warm conditions, developing most extensively in late spring and early summer. Decay of crown, trunk, and branches of other tree species are favored by cool, wet conditions. These decays develop most rapidly in late fall and early spring.

MANAGEMENT

The most important factor in reducing the threat of Phytophthora rot is good water management (Fig. 2). Avoid prolonged saturation of the soil or standing water around the base of trees or other susceptible plants. Irrigate only as much and as often as necessary; in an orchard, keep track of the soil moisture around each tree and water only when necessary. If you irrigate trees with sprinklers, use low-angle sprinkler heads and splitters to avoid wetting the trunk and lower branches. If using a drip system, place the emitters at least a foot away from the trunk. Avoid planting susceptible species on poorly drained or shallow soils. Water stress and/or salinity make some plant species more susceptible to infection when wetted subsequently by irrigation or rains.

For all vegetable and orchard plants, provide good soil drainage. Good soil drainage is best provided before planting. Drainage should be plentiful to the rooting depth of the plants, generally 3 to 6 feet for trees, 2 to 4 feet for shrubs, and 1 to 2 feet for bedding plants. During favorable weather you do not want the roots and crown of a plant to remain wet for the 4 to 8 hours that are required for *Phytophthora* to infect the plant.

Provide adequate drainage by breaking through soil compaction and hardpan. In poorly drained soils, or in an area where you know *Phytophthora* is present, consider planting trees and shrubs on mounds. The mounds should be 8 to 10 inches high. Planting depth after settling should be no deeper than as received from the nursery, with the upper roots near the soil level and the graft union well above the soil line. Do not install irrigated turf around the base of trees, remove all weeds, and do not water the crown area directly. Never cover the graft union with soil or mulch. If you are not sure where the graft union is, ask someone at the nursery to show you and mark it. Raised beds provide good drainage in vegetable garden situations also. Group plants according to their irrigation needs. Separate those needing frequent, light irrigations, such as potatoes and strawberries, from those needing infrequent, deep irrigations, such as tomatoes and melons.

At the first signs of aboveground symptoms, examine the tree at the soil line for crown rot. Carefully cut away bark that looks affected. If crown rot is present, trees can sometimes be saved by removing soil from the base of the tree down to the top of the main roots and allowing the crown tissue to dry out.

Sanitation

It may be possible to slow the spread of *Phytophthora* within an orchard by avoiding movement of infested soil, water, and plant parts from an area where Phytophthora rot has developed. Surface and subsurface drainage water and anything that can move moist soil can carry the pathogen to a new area, including boots, car tires, and tools. If the physical setting allows drainage water to flow from infested to uninfected areas within the garden during wet weather, consider putting in drains to channel the water away from healthy plants.

Selection of planting stock

Plant only certified nursery stock from a reputable source, and choose the most resistant rootstocks or varieties available for your area. Less susceptible

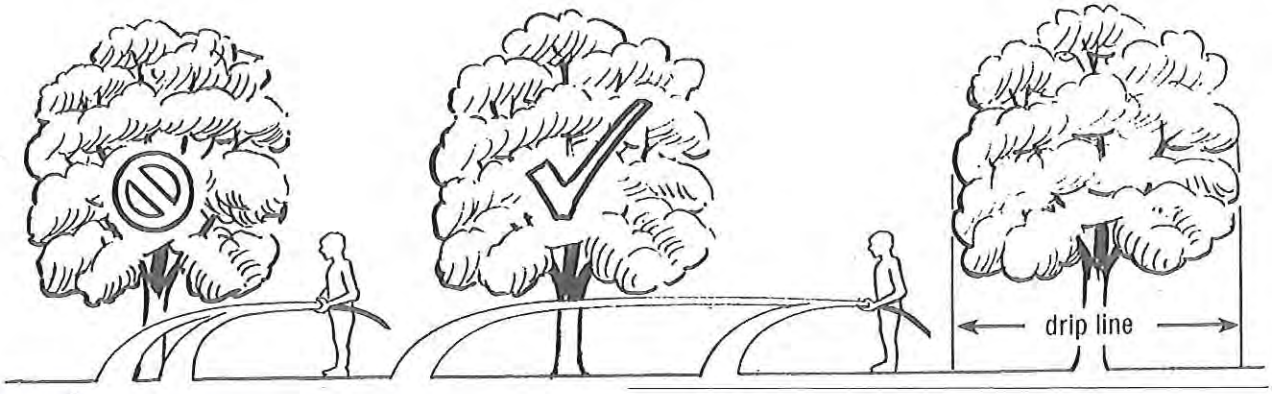


Figure. 2. Do not water established trees and shrubs near their trunks, as this promotes root and crown disease. Water plants when needed around the drip line and beyond. Adjust sprinklers or install deflectors to prevent wetting of trunk bases. Move drip emitters away from the base of the trunk after plants are established.

rootstocks or varieties are available for almonds and stone fruit, apples, cauliflower, and strawberries. Carefully select individual plants that are free of symptoms and/or that come from healthy lots of material.

Rotation

If tomatoes have been affected by *Phytophthora* root rot, avoid planting tomatoes or other susceptible plants such as eggplant or peppers in the same soil for at least one or two seasons. Plant a resistant crop such as corn instead, or leave the soil unplanted and do not irrigate, but keep it well worked to allow the soil to dry as deeply as possible. Different species of *Phytophthora* attack beans and cole crops, so these plants can be substituted as well. Consult a nursery or farm advisor for possible alternatives in your area.

Chemical control

The most effective way of preventing Phytophthora rot diseases is to provide good drainage and to practice good water management. Along with the appropriate cultural controls, the fungicide fosetyl-al (Aliette) may be used on a number of ornamental plant species to help prevent *Phytophthora* infections. When applied as a foliar spray it is absorbed by foliage and moves into roots. However, do not rely on fungicide applications alone to control root and crown rot diseases.

SUGGESTED READING

Pest Notes: Damping-Off Diseases in the Garden. Aug. 2006. Perry, E. J. Oakland: Univ. Calif. Div. Agric. Nat. Res. Publ. 74132 UC Statewide IPM Program. Also available online at http://www.ipm.ucdavis.edu.

Pests of the Garden and Small Farm: A Grower's Guide to Using Less Pesticide. 1998. Flint, M. L. Oakland: Univ. Calif. Agric. Nat. Res. Publication 3332.

Pests of Landscape Trees and Shrubs. 2004. Dreistadt, S. H. Oakland: Univ. Calif. Div. Agric. Nat. Res. Publ. 3359. ❖

For more information contact the University of California Cooperative Extension in your county. See your telephone directory for addresses and phone numbers.

AUTHOR: E. J. Perry, UC Cooperative Extension, Stanislaus Co.
TECHNICAL EDITOR: M. L. Flint
COORDINATION & PRODUCTION: P. N. Galin
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UC PEER REVIEWED

This publication has been anonymously peer reviewed for technical accuracy by University of California scientists and other qualified professionals. This review process was managed by the ANR Associate Editor for Pest Management.

To simplify information, trade names of products have been used. No endorsement of named products is intended, nor is criticism implied of similar products that are not mentioned.

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WARNING ON THE USE OF CHEMICALS

Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in the original labeled containers in a locked cabinet or shed, away from food or feeds, and out of the reach of children, unauthorized persons, pets, and livestock.

Confine chemicals to the property being treated. Avoid drift onto neighboring properties, especially gardens containing fruits or vegetables ready to be picked.

Do not place containers containing pesticide in the trash or pour pesticides down sink or toilet. Either use the pesticide according to the label or take unwanted pesticides to a Household Hazardous Waste Collection site. Contact your county agricultural commissioner for additional information on safe container disposal and for the location of the Household Hazardous Waste Collection site nearest you. Dispose of empty containers by following label directions. Never reuse or burn the containers or dispose of them in such a manner that they may contaminate water supplies or natural waterways.

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WATERMARK DIGITAL METER

IRROMETER®



The WATERMARK Meter is a hand held device designed for reading WATERMARK sensors in the field. The digital readout displays the sensors' soil moisture status in centibars (cb) or kilopascals (kPa) of soil water tension. This value represents the energy a plant's root system uses to draw water from the soil. Whereas higher tension values indicate dryer soil, lower tension values indicate wetter soil. The meter's replaceable cable assembly has spring loaded clips for attaching to sensor leads. Users only need one meter to read any number of WATERMARK sensors. The meter comes in its own nylon case, padded and zippered for safe keeping when not in use.

Features:

- ***Large LCD display is easy to see in sunlight***
- ***Touch pad operating panel is simple to use and has a self test function***
- ***Quick release cable assembly is field changeable***
- ***Adjustable for soil temperature variations***

WATERMARK Digital Meter

Specifications –

COMPATIBILITY: The WATERMARK meter is designed to read WATERMARK sensors exclusively

POWER REQUIREMENTS: Self powered 9 VDC internal battery

MATERIALS: ABS plastic case with touchpad controls (tactile switches)

DIMENSIONS:

HEIGHT: 4.750 in. (121 mm) [5.25 in. (140 mm) including cable recepticle]

WIDTH: 2.75 in. (70 mm)

DEPTH: 1.0 in. (25 mm)

CABLE: 50 OHM coaxial cable [24 in. (.6 m)] with bayonet type connection (BNC) on the meter end and two alligator clips on the sensor end

DISPLAY: 0–199 cb (kPa) of soil water tension

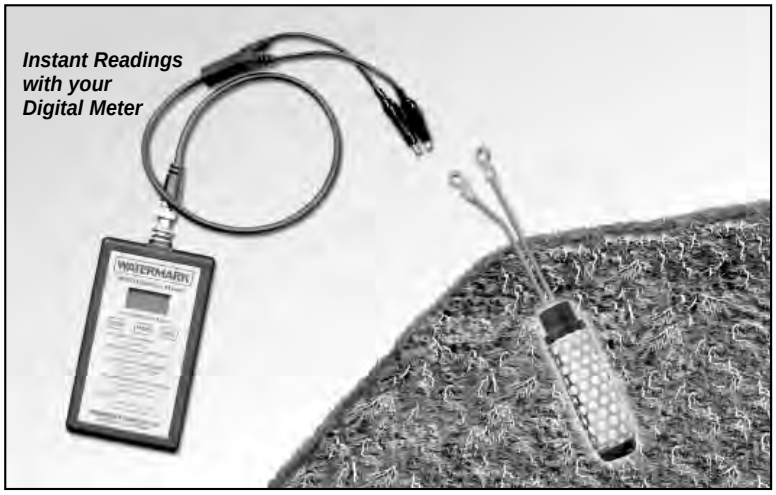
WARRANTY: One year

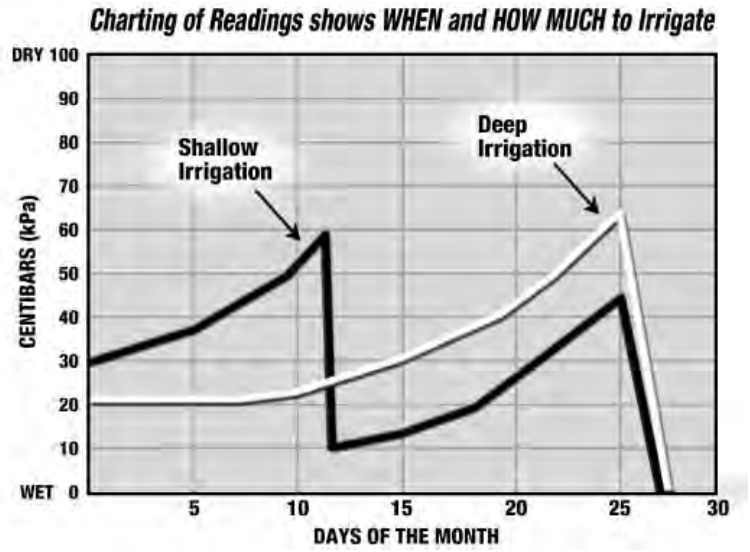
ORDERING INFORMATION: **Catalog #30-KTCD-NL — WATERMARK Digital Meter**, cable assembly and instructions in a zippered case.

OPERATING PRINCIPLE: The WATERMARK meter is designed to read all WATERMARK soil moisture sensors exclusvely. These sensors have an output of 500–30,000 ohms of electrical resistance which is non-linear. The meter uses a solid-state alternating current resistance bridge meter for reading the sensors and converts the resistance value into centibars (cb) or kilopascals (kPa) of soil water tenson. The reading is displayed on an LCD screen [range 0–199 cb (kPa)]. Soil temperature values can be input by the user to compensate for their effect on sensor reading.

SPECIFICATION INFORMATION: The soil moisture monitoring system shall incorporate Granular Matrix Sensors (GMS) to measure soil water tension. The sensors shall use a digital meter to read sensor values. The meter shall have a soil temperature compensation feature and self test functions on its tactile keypad. The meter shall be the model #30-KTCD-NL WATERMARK digital meter as manufactured by the IRROMETER Company, Inc. of Riverside, California.

WATERMARK DIGITAL METER





This illustration shows how the WATERMARK meter can be used to improve irrigation scheduling efficiency. Starting in the lower left quadrant of the chart, it appears that for the first nine days of the month the sensor readings indicate normal drying of the soil. At the ten day mark the soil water tension for the shallow sensor (black line) starts to spike to approximately 60 cb (kPa) which prompts the user to initiate an irrigation cycle. This has an immediate impact on the shallow sensor as indicated by the drop to 10 cb (kPa) which may be close to field capacity (depending on soil type). Notice that the deep sensor (white line) saw little impact from the irrigation event because it was short in duration. This was planned by the irrigator to apply water to the shallow roots only and not reach the deeper portion of the root zone. On the twenty-fifth day both sensor readings peaked prompting the irrigator to run a longer duration irrigation cycle which was significantly more effective based on the steep drop of the sensor reading at both depths. The WATERMARK sensors and meter provide a very effective method of monitoring soil moisture trends and can help growers make informed scheduling decisions.

WATERMARK

IRROMETER®
THE IRROMETER COMPANY, INC.
P.O. Box 2424, Riverside, CA 92516
(951) 689-1701 PHONE
(951) 689-3706 FAX
www.IRROMETER.com
sales@IRROMETER.com

Irrigation Association™ Bronze Member

LITHO U.S.A. (5/10) #407

Soil Map—Ventura Area, California
(Ron Nichols Rancho Colina Vista)
Appendix G: Example of Grower DU



Appendix G: Example of Grower DU
Soil Map–Ventura Area, California
(Ron Nichols Rancho Colina Vista)

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:5,430 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Ventura Area, California
Survey Area Data: Version 6, Jan 3, 2008

Date(s) aerial images were photographed: 6/7/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Ventura Area, California (CA674)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
MoA	Mocho loam, 0 to 2 percent slopes	1.8	2.2%
MoC	Mocho loam, 2 to 9 percent slopes	0.7	0.9%
SvF2	Soper gravelly loam, 30 to 50 percent slopes, eroded	79.0	96.8%
SxC	Sorrento silty clay loam, 2 to 9 percent slopes	0.1	0.1%
Totals for Area of Interest		**81.6**	**100.0%**

Cost-Share and Financial Assistance Information

Enclosed Literature Briefs:

VCRCD MIL Cost-Share Program
VCRCD MIL Cost-Share Program Application
CMWD Purveyor List
USDA NRCS EQIP Program
USDA FSA Guaranteed Loan Program

The Ventura County Resource Conservation District (VCRCD) offers a free agricultural irrigation system efficiency evaluation through the Mobile Irrigation Lab (MIL) program. The purpose of the MIL program is to determine the distribution uniformity of irrigation systems and offer guidance to enhance irrigation efficiency.

In addition to this free service, the VCRCD also provides financial incentives through the MIL cost share program to defray the cost of implementing water conservation practices. As a complement to the MIL cost share program, growers within Ventura County may qualify for cost-share assistance from local water agencies throughout the Calleguas Municipal Water District (CMWD) service area.

Landowners within environmentally sensitive watersheds may also qualify for financial or technical services provided by the Natural Resources Conservation Service (NRCS) through their Environmental Quality Incentives Program (EQIP). Landowners looking for capital to finance projects may benefit from the Guaranteed Loan Program offered by the Farm Service Agency (FSA).

To facilitate a better understanding of these programs, their services, and their respective eligibility requirements, the VCRCD has compiled and enclosed literature briefs for these programs. These enclosures are meant to help landowners better understand their water conservation service and incentive options so they are equipped to adopt the practices recommended by the VCRCD.

For additional information, please contact representatives of the respective programs or contact VCRCD at 805-764-5130.

MOBILE IRRIGATION LABORATORY (MIL) COST SHARE PROGRAM

ASSISTING AGRICULTURAL OPERATIONS WITH IRRIGATION SYSTEM IMPROVEMENTS

This Program is intended to promote Best Management Practice (BMP) implementation for irrigation and nutrient management. Eligible participants include owners and operators of nursery, row crops, and orchard operations.



As funding allows, upon review of applicants' expenditures, applicants will be reimbursed for:

- 50% of eligible equipment costs, up to $1,500, for agricultural operations < 100 acres
- 50% of eligible equipment costs, up to $5,000, for agricultural operations ≥ 100 acres
- Additional 25% coverage of eligible equipment costs, up to $1,000, with increase in irrigation efficiency
- Additional 25% coverage of eligible equipment costs, up to $1,000, with reduction in water usage



Types of Qualifying Equipment:

- Tensiometers
- Atmometers
- Pressure compensating emitters and filters
- Soil moisture sensors
- Salinity sensors
- Drip and micro irrigation systems
- Valves
- Emitters/nozzles
- Irrigation Controllers
- Other equipment as approved by the RCD

(not to include consultant fees or leased equipment)

RESOURCE CONSERVATION DISTRICTS

Contact Vic Akundzadeh at the RCD for a FREE irrigation evaluation and for more details on how to apply for cost share funding:

Resource Conservation District
3380 Somis Rd
Somis, CA 93066
office: 805-764-5136
mobile: 805-216-3641

Water Boards

Contact Information

Name:

Company Name:

Phone (work): (mobile):

Email:

Property Information

Location Address:

Mailing Address:

Total Acreage: Total Irrigated Acreage:

Number of Irrigated Blocks: Water Source(s):

Irrigation System (e.g. drip, microsprinkler):

Indicate the following information for each irrigated block:

Block Name or ID	Acreage	Crop	DU (Value or N/A)

Signature: _____ Date: _____

Block Description

Block Name/ID:

Summary Text of Improvements:

Project Start Date: Project End Date:

Source(s) of Cost Estimates:

Parts List and Cost Estimates:

Part	Unit Cost	Quantity	Total Cost

Parts Cost Estimate	
Labor Cost Estimate	
Tax Estimate	
Project Cost Estimate	

Signature: _____ Date: _____

If you are within the service area of the following water purveyors, you may qualify for cost-share funds through an agricultural water conservation program. Please contact either the Resource Conservation District or the agencies listed below for more information.

Calleguas Municipal Water District (CMWD) Member Agencies

American Water Works (California American Water Co.)
Berylwood Heights Mutual Water Company
Brandeis Mutual Water Company
Butler Ranch
California Water Service Company
Camrosa Water District
City of Camarillo Water Division
City of Oxnard
City of Simi Valley Water Works District #8
City of Thousand Oaks Utilities Department
Crestview Water Company
Golden State Water
Oak Park Water Service
Pleasant Valley Mutual Water Company
Solano Verde Mutual Water Company
Ventura County Waterworks Districts 1, 19
Zone Mutual Water Company

Contact Information

Camrosa Water District
7385 Santa Rosa Road
Attn: Donnie Alexander
Camarillo CA 93023
Phone: 805.482.8514

County of Ventura Water and Sanitation Department
PO Box 250
Attn: Bill Lykins
Moorpark CA 93020
Phone: 805.378.3011

Resource Conservation District
PO Box 147
Somis CA 93066
Phone: 805.764.5130

Free Water Quality Farm Plans Available

- NRCS staff will conduct field visits with land owners to develop a farm water quality plan which involves:
  - Inventory resources, identify any concerns issues or problems, determine landowner objectives
  - Formulate and evaluate alternatives and objectives
  - Identify any potential Red-Flags for water quality

Irrigation Water Management/ Nutrient Management

- **Free irrigation evaluations from the Ventura RCD (805) 386-4489 x 113**
- Irrigation: Making improvements in irrigation systems and irrigation water management not only saves water, but can save nutrients and reduce erosion/groundwater pollution
- **Micro or drip irrigation**, water applications directed more towards root zone
- **Irrigation water management:** using available technologies for scheduling irrigations according to plant needs and controlling volumes and frequencies of applications
- **Irrigation Reservoir:** Part of a water conservation system to store water until it is needed to meet crop water requirements

Environmental Quality Incentives Program (EQIP) $$$$ Funding applications taken year round!

A voluntary program to provide agricultural producers technical and financial assistance to promote agricultural production and environmental quality as compatible goals, optimize environmental benefits, help producers meet environmental requirements

- An incentive program to address resource concerns related to soil, water, air, energy and other resource issues on private land
- **Partnership Approach:** Since the Dust Bowl of the 1930's, NRCS has worked through conservation districts and others throughout the U.S. to help landowners, local governments and community groups conserve natural resources on private lands

To contact our office:

USDA-NRCS
3380 Somis Road
Somis, CA 93066
805-386-4489 x101 or x109
http://www.ca.nrcs.usda.gov

Ventura / Santa Barbara / San Luis Obispo Counties
USDA - Farm Service Agency
Guaranteed Lender's List

Farm Credit West
https://www.farmcreditwest.com/
2031 Knoll Drive, **Ventura**, CA 93003
805-477-1020 ventura.ca@farmcreditwest.com
OR
1178 Tama Lane, **Santa Maria**, CA 93455
805-922-7991 santamaria.ca@farmcreditwest.com
OR
175 Cow Meadow Place, **Paso Robles**, CA 93446
805-434-3665 - templeton.ca@farmcreditwest.com

Nebraska State Bank
http://www.fsaloans.net/nsb/
PO Box 260 Oshkosh, NE 69154
308-772-3234 or Toll free: 800-733-1229
Blake Howsden - bhowsden@fsaloans.net
Randy Stanczyk - rstanczyk@fsaloans.net

Bank of America
https://www.bankofamerica.com
2060 S Broadway
Santa Maria, CA 93454 - 805-349-2329

Heritage Oaks Bank
http://www.heritageoaksbank.com/
Main Office - 545 Twelfth Street
Paso Robles, CA 93446 - 805-369-5206
OR
1255 East Grand Avenue
Arroyo Grande, CA 93420 - 805-489-5260
loans@heritageoaksbank.com

AgriCap Financial Corporation
http://www.agricap.com/
350 S. Figueroa Street, Suite 501
Los Angeles, CA 90071 – 213-687-8200
OR
99 Pacific Street, Suite 155D
Monterey, CA 93940 – 831-221-5108 or
213-542-5232 or sales@agricap.com

Cal Coastal Rural Development
http://www.calcoastal.org/
910 E. Stowell Road, Suite 105
Santa Maria, CA 93454 805-349-0798
Clay Appleton – clay_appleton@calcoastal.org
OR
221 Main Street, Suite 301
Salinas, CA 93901 831-424-1099
Jose Guerra – jose_guerra@calcoastal.org

American Perspective Bank
http://www.americanperspectivebank.com
2646 Santa Maria Way, Suite 101
Santa Maria, CA 93455 805-354-7800
OR
4051 Broad Street - Suite 140
San Luis Obispo, CA 93401 805-547-2800
OR
720 10th Street
Paso Robles, CA 93446
Office: 805-226-5300 - cell: 805-835-1955
Greg Chilina - greg.chilina@americanperspectivebank.com

Community West Bank
2615 S Miller Street – Ste 110
Santa Maria, CA 93455 - 805-938-1690
Ruth Moran – rmoran@communitywestbank.com
Steve Rosso – srosso@communitywestbank.com

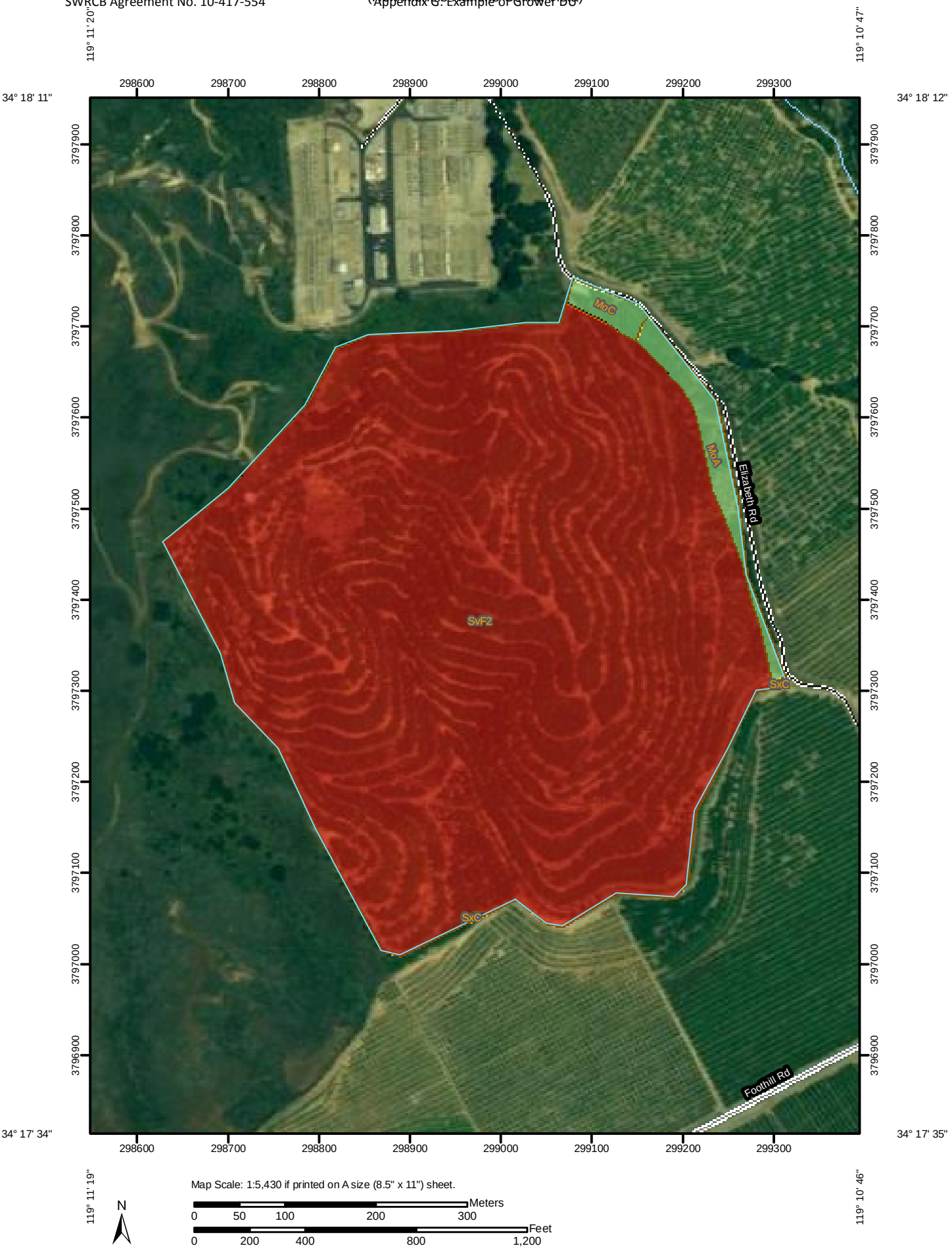
Santa Cruz County Bank
http://www.sccountybank.com
720 Front Street
Santa Cruz, CA 95060 831-457-5003

California FarmLink
http://www.californiafarmlink.org
2360 Professional Drive, Suite C
Santa Rosa, CA 95403 707-528-2920
info@californiafarmlink.org

American Farm Mortgage Company Inc
http://www.afmc-loans.com
8901 Greeneway Commons Place, Suite 200
Louisville, KY 40220 502-964-2111
Toll free: 800-876-2362
Patrick Hamilton

Peoples State Bank of Newton
http://www.psbnewton.com
100 West Washington (PO Box 328)
Newton, IL 62448
618-783-2321 or Toll free: 800-669-0341
Brian Bohnhoff or Ben Goebel

Available Water Capacity—Ventura Area, California
(Ron Nichols Rancho Colina Vista)



Appendix G: Example of Grower DU
Available Water Capacity–Ventura Area, California
(Ron Nichols Rancho Colina Vista)

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Soil Ratings
- <= 0.14
- > 0.14 AND <= 0.17
- > 0.17 AND <= 0.18
- Not rated or not available

Political Features
- Cities

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

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Available Water Capacity

Available Water Capacity— Summary by Map Unit — Ventura Area, California (CA674)				
Map unit symbol	**Map unit name**	**Rating (centimeters per centimeter)**	**Acres in AOI**	**Percent of AOI**
MoA	Mocho loam, 0 to 2 percent slopes	0.17	1.8	2.2%
MoC	Mocho loam, 2 to 9 percent slopes	0.17	0.7	0.9%
SvF2	Soper gravelly loam, 30 to 50 percent slopes, eroded	0.14	79.0	96.8%
SxC	Sorrento silty clay loam, 2 to 9 percent slopes	0.18	0.1	0.1%
Totals for Area of Interest			**81.6**	**100.0%**

Description

Available water capacity (AWC) refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in centimeters of water per centimeter of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure, with corrections for salinity and rock fragments. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. It is not an estimate of the quantity of water actually available to plants at any given time.

Available water supply (AWS) is computed as AWC times the thickness of the soil. For example, if AWC is 0.15 cm/cm, the available water supply for 25 centimeters of soil would be 0.15 x 25, or 3.75 centimeters of water.

For each soil layer, AWC is recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters per centimeter

Aggregation Method: Dominant Component

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Interpret Nulls as Zero: No

Layer Options: Depth Range

Top Depth: 12

Bottom Depth: 36

Units of Measure: Inches



VENTURA COUNTY RESOURCE CONSERVATION DISTRICT
MOBILE IRRIGATION EFFICIENCY PROGRAM

RONALD NICHOLS
PO Box 7360
Ventura CA 93006

RESOURCE CONSERVATION DISTRICT
Ventura County

Mike Mobley, President
Victor Contreras, Secretary/Treasurer
Kevin Cannon, Director
Mike Richardson, Director
Chris DeVan, Director
Mark Mooring, Director
Steve Murata, Director
Doug Nelson, Director
Bud Sloan, Director
Marty Melvin, Executive Officer

August 21, 2013

Mr. Nichols,

Please note that this irrigation evaluation report is being provided to you because of your participation in the Ventura County Resource Conservation District's Mobile Irrigation Laboratory Cost Share Program.

The purpose of this program is to support the implementation of irrigation and nutrient best management practices by reimbursing growers for capital costs incurred by irrigation system improvements. Funding for these improvements is provided by a Proposition 84 Agricultural Water Quality Grant which is administered by the Los Angeles Regional Water Quality Control Board (RWQCB).

Our records indicate that you have applied for reimbursement and this report serves to document the improvements you've implemented. Please take a moment to review this information along with the reimbursement amount you are allowed. Be advised that this reimbursement amount is contingent upon final approval by the RWQCB.

If you have any questions concerning the information contained within this report, please contact Jamie Whiteford by phone (805.764.5132) or email (jamie.k.whiteford@gmail.com).

On behalf of the Ventura County Resource Conservation District, I would like to thank you for your participation in the Mobile Irrigation Laboratory Cost Share Program.

Jamie Whiteford
Irrigation Technician
Ventura County Resource Conservation District
805-764-5132
jamie.k.whiteford@gmail.com

NICHOLS

Cost Description	Reimbursed Costs	Nonreimbursed Costs: Labor	Nonreimbursed Costs: Fees	Nonreimbursed Costs: Taxes	Line Item Subtotals
Cost Share Applicant Cost	$0.00	$696.00	$0.00	$0.00	$696.00
Invoice 16172	$31.70	$0.00	$0.00	$0.79	$32.49
Invoice 16254	$5.22	$0.00	$0.00	$0.13	$5.35
Invoice S1759247.001	$7.41	$0.00	$0.00	$0.15	$7.56
Invoice S1755929.001	$69.71	$0.00	$0.00	$1.39	$71.10
Invoice S1755980.001	$7.33	$0.00	$0.00	$0.15	$7.48
Invoice S1755929.002	$79.26	$0.00	$0.00	$1.59	$80.85
Invoice 16554	$9,734.69	$0.00	$0.00	$194.69	$9,929.38
Installation of Improvements	$0.00	$6,150.74	$0.00	$0.00	$6,150.74
Cost Subtotals	$9,935.32	$6,846.74	$0.00	$198.89	

Reimbursed Cost Total **$9,935.32** *$7,045.63* *Nonreimbursed Cost Total*

Project Cost Total $16,980.95

Summary of Irrigation Enhancements

· Applicant implemented majority of recommended irrigation best management practices
· Irrigation system Distribution Uniformity improved from 0.65 to 0.94
· New emitters reduce water use by 60% **per tree**, from to 14.3 GPH to 5.8 GPH
· Irrigation frequency changed from 10 days to 14 days, eliminating 10 irrigation events annually
· Irrigation needs monitored by hand probe

Ventura County Resource Conservation District

Low Volume Irrigation System Evaluation

Ranch;	Ron Nichols (Rancho Colina Vista) Final Eval	Date;	May 15, 2013
Location;	Elizabeth Rd Ventura	VCAILG#	2136
Block #;	see GPS map points (33 - 43)	Contact;	Ron Nichols
# Manifold ;	1	Phone #	805-901-1650
Crop and Spacing;	Avocado 18' X 22'		

Summary of Uniformity Findings;

lq **DU** = 0.94

target **l**ow **q**uarter **D**istribution **U**niformity is 0.85 or better !

Emitter Emission Uniformity %	95.42%
Estimated Average Flow/Emitter (in/hr)	0.036
Estimated Average Flow/Emitter (in/24hr)	0.875

Conclusions and Recommendations;

Pressure Variations;

The three main reasons for pressure variation are,

1. Irrigation sets are not matching pump capacities. — no

a. Irrigation set demand in gpm exceeds the pump capability, resulting in low pressures

b. Irrigation set demand in gpm are less than the pump potential, resulting in high pressures.

2. Irrigation lines are undersized relative to total water flow. — no

:3/4" OR 7/8" line .

3. Elevation changes are causing gain/loss in PSI. — small %

Emitter Variations;

1. Multiple emitter flow rates are installed. — no

2. Manufacture variability may be an issue. — small %

3. Emitter plugging is causing uniformity problems. — no

Water Quality related issues;

1. Plugging due to; — no

Calcium deposits
Bacterial
Physical

2. Quick nitrate test ; — 10 - 25 ppm NO_3

Potential Water Savings; :Refer to the last section of this report for important cost share information!

Recommendations: · Install soil moisture meter for irrigation scheduling.

To "save" water or increase the D.U. either under irrigate, or shut it off.
For best quality and yield bring the irrigation system up to par, and manage the system to provide the correct amount of water at the optimum timing !!!

Low Volume Irrigation System Evaluation Results;

Ranch Name;	Ron Nichols (Rancho Colina Vista) Final Eval	Date;	May 15, 2013
Location;	Elizabeth Rd Ventura	VCAILG#	2136
Block #;	see GPS map points (33 - 43)	Contact;	Ron Nichols
# Manifold ;	1	Phone #'s	805-901-1650
Crop and Spacing;	Avocado 18' X 22'		

Emitter Catch Data;

Poly Hose Line #	Emitter (ml)	Flow (gph)	Emitter (ml)	Flow (gph)	Emitter (ml)	Flow (gph)	Emitter (ml)	Flow (gph)	Emitter (ml)
Manifold # 1		**0.00**	180	**5.71**	185	**5.87**	190	**6.02**	
Poly side 1		*first C-1*		*first C-2*		*first C-3*		*first C-4*	
Manifold # 1		**0.00**		**0.00**		**0.00**		**0.00**	
Poly side 1		*mid #1 C-1*		*mid #1 C-2*		*mid #1 C-3*		*mid #1 C-4*	
Manifold # 1		**0.00**	160	**5.07**	175	**5.55**	175	**5.55**	
Poly side 1		*mid #2 C-1*		*mid #2 C-2*		*mid #2 C-3*		*mid #2 C-4*	
Manifold # 1		**0.00**		**0.00**		**0.00**		**0.00**	
Poly side 1		*mid #3 C-1*		*mid #3 C-2*		*mid #3 C-3*		*mid #3 C-4*	
Manifold # 1		**0.00**	190	**6.02**	185	**5.87**	195	**6.18**	
Poly side 1		*Terminal C-1*		*Terminal C-2*		*Terminal C-3*		*Terminal C-4*	
Manifold # 1	180	**5.71**		**0.00**	185	**5.87**		**0.00**	190
Poly side 2		*first C-1*		*first C-2*		*first C-3*		*first C-4*	
Manifold # 1		**0.00**		**0.00**		**0.00**		**0.00**	
Poly side 2		*mid #1 C-1*		*mid #1 C-2*		*mid #1 C-3*		*mid #1 C-4*	
Manifold #1		**0.00**	170	**5.39**	180	**5.71**	190	**6.02**	
Poly side 2		*mid #2 C-1*		*mid #2 C-2*		*mid #2 C-3*		*mid #2 C-4*	
Manifold # 1		**0.00**		**0.00**		**0.00**		**0.00**	
Poly side 2		*mid #3 C-1*		*mid #3 C-2*		*mid #3 C-3*		*mid #3 C-4*	
Manifold # 1	190	**6.02**	185	**5.87**	180	**5.71**	185	**5.87**	175
Poly side 2		*Terminal C-1*		*Terminal C-2*		*Terminal C-3*		*Terminal C-4*	
Catch time in seconds	*30*								

Low Volume Emitter Emission Uniformity Results;

Number of Catches	**20**
#LQ Catches	**5**
LQ Average Catch(ml)	**171**
Average Catch (ml)	**182.250**
Ave. Flow Rate (gph)	**5.778**
Emitters/Plant	1
Wetted Area Ft. (Dia.)	18.000
Wetted Area Ft^2	**254.340**
Est. Applied in./hr	**0.036**
Est. Applied in./24hr	**0.875**

lqDU (low quarter Distribution Uniformity) 0.94

Coefficient of Variation (CvU) = (1-Std Dev / Ave of Catches) x 100%

95.420% 2

[ ] :Presure compensating Netafim .

Flow (gph)					
0.00		180	185	190	
first C-5					
0.00					
mid #1 C-5					
0.00		160	175	175	
mid #2 C-5					
0.00					
mid #3 C-5					
0.00		190	185	195	
Terminal C-5					
6.02	180		185		190
first C-5					
0.00					
mid #1 C-5					
0.00		170	180	190	
mid #2 C-5					
0.00					
mid #3 C-5					
5.55	190	185	180	185	175
Terminal C-5					

#1	160	
#2	170	
#3	175	
#4	175	
#5	175	
#6		180
#7		180
#8		180
#9		180
#10		185
#11		185
#12		185
#13		185
#14		185
#15		190

Pressure Test Results;			
Manifold #1			
	First Line psi's		
Ploy Side 1	Riser	Ploy Side 2	
31.5	31.5	33	
0%		**5%**	% variation
	Middle #1		
Ploy Side 1	Riser	Ploy Side 2	
#DIV/0!	**-100%**	**#DIV/0!**	% variation
	Middle #2		
Ploy Side 1	Riser	Ploy Side 2	
17	21	21	
-19%	**-33%**	**0%**	% variation
	Middle #3		
Ploy Side 1	Riser	Ploy Side 2	
#DIV/0!	**-100%**	**#DIV/0!**	% variation
	Terminal		
Ploy Side 1	Riser	Ploy Side 2	
26.5	31.5	30.5	
-16%	**0%**	**-3%**	% variation

Ranch Name;	Ron Nichols (Rancho Colina Vista) Final Eval
Block #;	5 map points (33 - 43)
Manifold #	1

C's = catches in gph

First Line		Poly Side 1				First	Line		Poly Side 2				First Line
Side 1 psi=	C-5	C-4	C-3=	C-2=	C-1=	Riser psi=	**31.5**	C-1=	C-2=	C 3=	C-4	C-5	Side 2 psi=
31.5	**0.00**	**6.02**	**5.87**	**5.71**	**0.00**			**5.71**	**0.00**	**5.87**	**0.00**	**6.02**	**33**

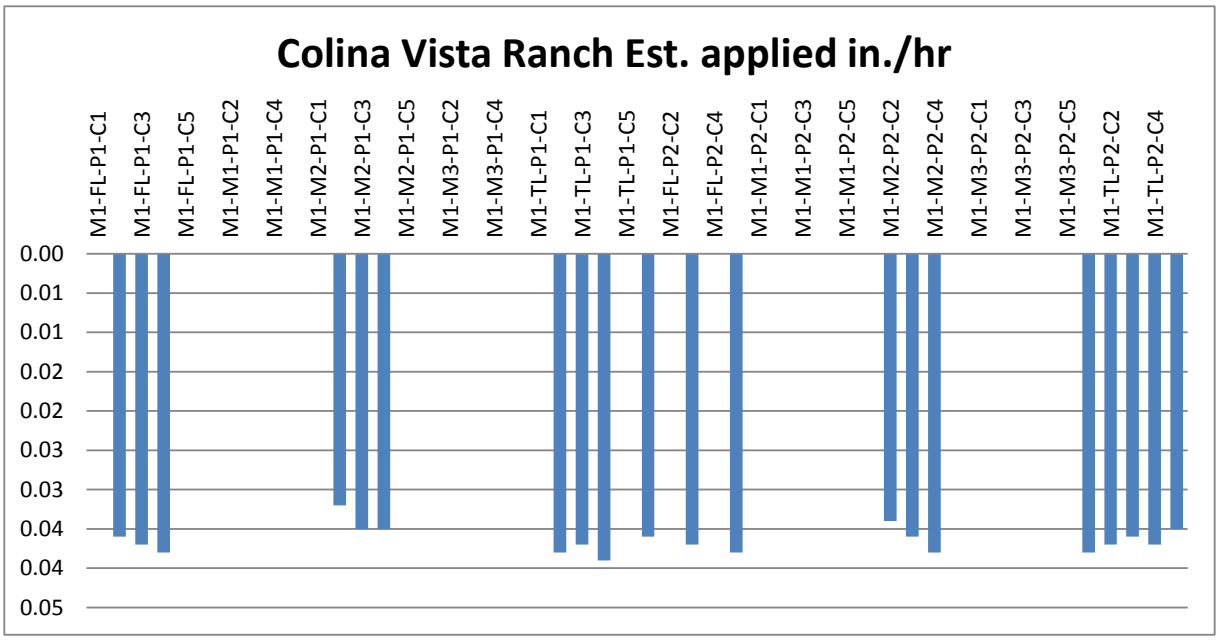
Middle #1		Poly Side 1				Middle	#1		Poly Side 2				Middle #1
Side 1 psi=	C-5	C-4	C-3=	C-2=	C-1=	Riser psi=	**0**	C-1=	C-2=	C 3=	C-4	C-5	Side 2 psi=
0	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0**

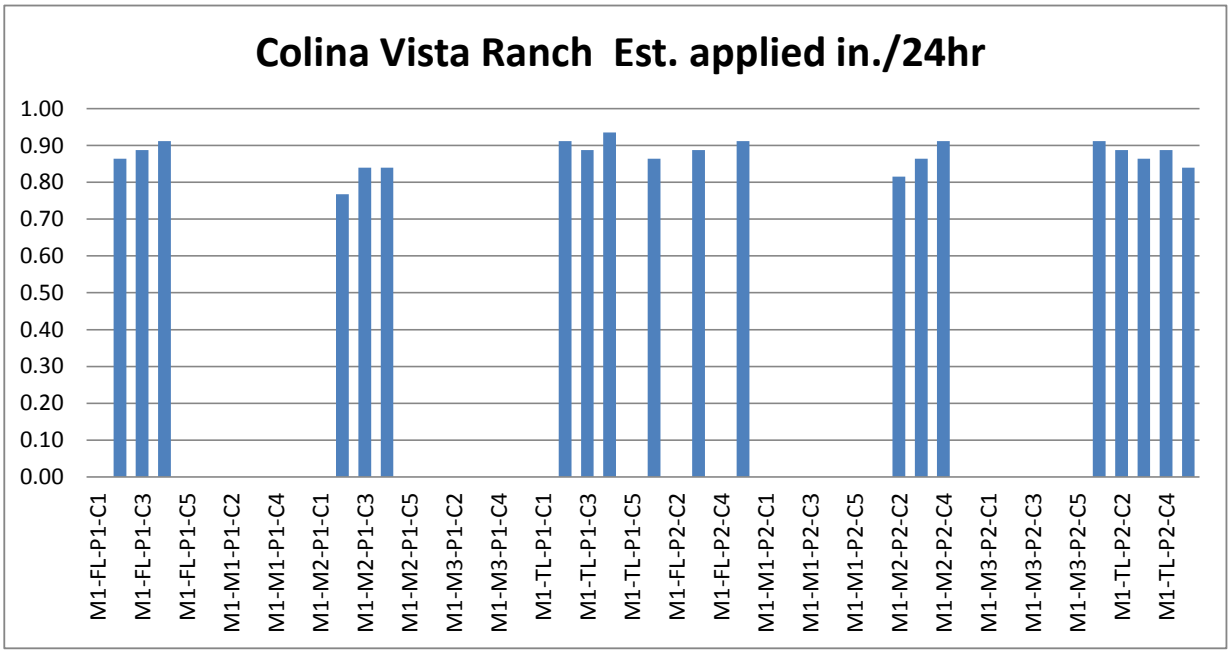
Middle #2		Poly Side 1				Middle	#2		Poly Side 2				Middle #2
Side 1 psi=	C-5	C-4	C-3=	C-2=	C-1=	Riser psi=	**21**	C-1=	C-2=	C 3=	C-4	C-5	Side 2 psi=
17	**0.00**	**5.55**	**5.55**	**5.07**	**0.00**			**0.00**	**5.39**	**5.71**	**6.02**	**0.00**	**21**

Middle #3		Poly Side 1				Middle	#3		Poly Side 2				Middle #3
Side 1 psi=	C-5	C-4	C-3=	C-2=	C-1=	Riser psi=	**0**	C-1=	C-2=	C 3=	C-4	C-5	Side 2 psi=
0	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0**

Terminal Line		Poly Side 1				Terminal	Line		Poly Side 2				Terminal Line
Side 1 psi=	C-5	C-4	C-3=	C-2=	C-1=	Riser psi=	**31.5**	C-1=	C-2=	C 3=	C-4	C-5	Side 2 psi=
27	**0.00**	**6.18**	**5.87**	**6.02**	**0.00**			**6.02**	**5.87**	**5.71**	**5.87**	**5.55**	**30.5**

Emitter Location	Test Ranch Est. applied in./	Test Ranch Est. applied in./24hr
M1-FL-P1-C1	0.00	0.00
M1-FL-P1-C2	0.04	0.86
M1-FL-P1-C3	0.04	0.89
M1-FL-P1-C4	0.04	0.91
M1-FL-P1-C5	0.00	0.00
M1-M1-P1-C1	0.00	0.00
M1-M1-P1-C2	0.00	0.00
M1-M1-P1-C3	0.00	0.00
M1-M1-P1-C4	0.00	0.00
M1-M1-P1-C5	0.00	0.00
M1-M2-P1-C1	0.00	0.00
M1-M2-P1-C2	0.03	0.77
M1-M2-P1-C3	0.03	0.84
M1-M2-P1-C4	0.03	0.84
M1-M2-P1-C5	0.00	0.00
M1-M3-P1-C1	0.00	0.00
M1-M3-P1-C2	0.00	0.00
M1-M3-P1-C3	0.00	0.00
M1-M3-P1-C4	0.00	0.00
M1-M3-P1-C5	0.00	0.00
M1-TL-P1-C1	0.00	0.00
M1-TL-P1-C2	0.04	0.91
M1-TL-P1-C3	0.04	0.89
M1-TL-P1-C4	0.04	0.94
M1-TL-P1-C5	0.00	0.00
M1-FL-P2-C1	0.04	0.86
M1-FL-P2-C2	0.00	0.00
M1-FL-P2-C3	0.04	0.89
M1-FL-P2-C4	0.00	0.00
M1-FL-P2-C5	0.04	0.91
M1-M1-P2-C1	0.00	0.00
M1-M1-P2-C2	0.00	0.00
M1-M1-P2-C3	0.00	0.00
M1-M1-P2-C4	0.00	0.00
M1-M1-P2-C5	0.00	0.00
M1-M2-P2-C1	0.00	0.00
M1-M2-P2-C2	0.03	0.82
M1-M2-P2-C3	0.04	0.86
M1-M2-P2-C4	0.04	0.91
M1-M2-P2-C5	0.00	0.00
M1-M3-P2-C1	0.00	0.00
M1-M3-P2-C2	0.00	0.00
M1-M3-P2-C3	0.00	0.00
M1-M3-P2-C4	0.00	0.00
M1-M3-P2-C5	0.00	0.00
M1-TL-P2-C1	0.04	0.91
M1-TL-P2-C2	0.04	0.89
M1-TL-P2-C3	0.04	0.86
M1-TL-P2-C4	0.04	0.89
M1-TL-P2-C5	0.03	0.84


Colina Vista Ranch Est. applied in./hr
M1-FL-P1-C1
M1-FL-P1-C3
M1-FL-P1-C5
M1-M1-P1-C2
M1-M1-P1-C4
M1-M2-P1-C1
M1-M2-P1-C3
M1-M2-P1-C5
M1-M3-P1-C2
M1-M3-P1-C4
M1-TL-P1-C1
M1-TL-P1-C3
M1-TL-P1-C5
M1-FL-P2-C2
M1-FL-P2-C4
M1-M1-P2-C1
M1-M1-P2-C3
M1-M1-P2-C5
M1-M2-P2-C2
M1-M2-P2-C4
M1-M3-P2-C1
M1-M3-P2-C3
M1-M3-P2-C5
M1-TL-P2-C2
M1-TL-P2-C4
0.00
0.01
0.01
0.02
0.02
0.03
0.03
0.04
0.04
0.05


Colina Vista Ranch Est. applied in./24hr
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
M1-FL-P1-C1
M1-FL-P1-C3
M1-FL-P1-C5
M1-M1-P1-C2
M1-M1-P1-C4
M1-M2-P1-C1
M1-M2-P1-C3
M1-M2-P1-C5
M1-M3-P1-C2
M1-M3-P1-C4
M1-TL-P1-C1
M1-TL-P1-C3
M1-TL-P1-C5
M1-FL-P2-C2
M1-FL-P2-C4
M1-M1-P2-C1
M1-M1-P2-C3
M1-M1-P2-C5
M1-M2-P2-C2
M1-M2-P2-C4
M1-M3-P2-C1
M1-M3-P2-C3
M1-M3-P2-C5
M1-TL-P2-C2
M1-TL-P2-C4


5/15/2013
Elizabeth Rd
041
042
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© 2013 Google
Google earth
Imagery Date: 8/26/2012 34°17'58.20" N 119°10'58.01" W elev 581 ft eye alt 2366 ft

Mobile Irrigation Lab (MIL) 2014

Overview

The purpose of the Mobile Irrigation Lab (MIL) is to evaluate the irrigation efficiency of agricultural operations and recommend improvements that will correct inefficiencies. The goal of the MIL program is to protect environmental quality by offering growers practical water management options. To accomplish this, MIL staff tailor comprehensive irrigation reports for growers incorporating both irrigation system measurements and field observations. Since the first evaluation in 2008, MIL staff have performed approximately 200 irrigation evaluations covering nearly 3,000 acres in Ventura County (Figure 1).

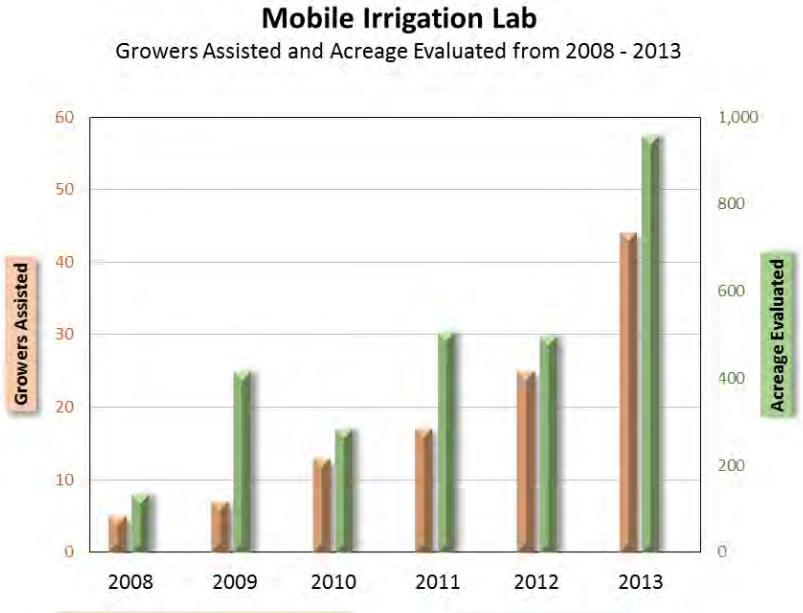
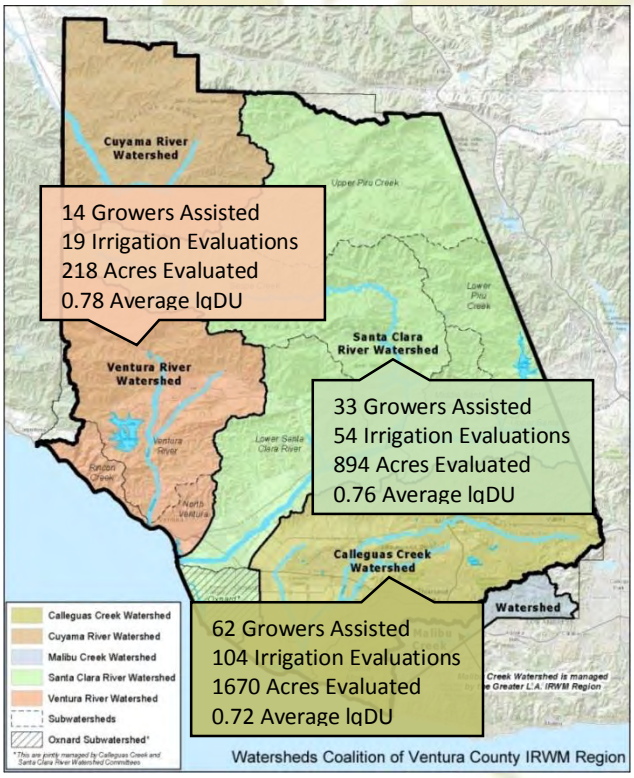


Figure 1: Graph illustrating the steady growth of the MIL program as measured by growers assisted and acreage evaluated.

Figure 2: Ventura County watershed map illustrating the distribution of MIL evaluations and system analysis data.



Results

The MIL program has grown steadily since its start in 2008, both in terms of growers assisted, numbers of irrigation evaluations, and acreage evaluated. As of 2013, the majority of analyzes have occurred within the Calleguas Creek Watershed, reflecting the large degree of environmental impacts within this area (Figure 2).

Using the Low-Quarter Distribution Uniformity (lqDU) protocol developed by Irrigation Training and Research Center (ITRC) faculty at Cal Poly SLO, MIL staff have determined that the average lqDU of irrigation systems within Ventura County watersheds range from 0.72 - 0.76, reflecting inefficiencies of 28% - 24%.

A comparison of the average Ventura County watershed lqDU value (0.76) to the industry standard (0.85) indicates that if growers were to follow MIL staff recommendations, they could reduce their water consumption by 4 inches per acre, or a cumulative sum of about 800 acre-feet (AF) (Figure 3). Extrapolating this value throughout the county indicates that over 26,000 AF of irrigation water is recoverable.

RESOURCE CONSERVATION DISTRICT
Ventura County
PO Box 147
3380 Somis Road
Somis CA 93066

www.conserveventura.org
805-764-5130

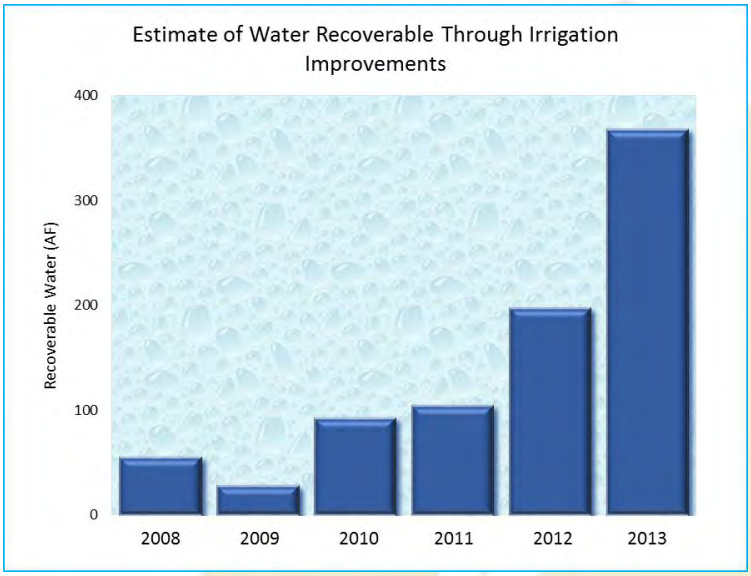


Figure 3: An estimate of the amount of water that could have been recovered each year had irrigation system improvements been implemented by irrigators.

Inefficient irrigation practices and overwatering …
… leach nutrients and degrade water quality.
… increase fossil fuel use and greenhouse gas emissions.
… degrade soil quality and enhance soil erosion.
… degrade aquatic habitat and reduce water reserves.

Table 1: A short list of the environmental impacts associated with inefficient water-use practices and overwatering.

NRCS Code	Best Management Practice
311	Alley Cropping
340	Cover crop
441	Irrigation system, micro irrigation
442	Sprinkler system
443	Irrigation System, Surface and subsurface
449	Irrigation water management
590	Nutrient Management

Table 2: A compilation of relevant BMP's reviewed and discussed with growers as part of the MIL program irrigation analysis procedure.

A review of projects where MIL recommendations were implemented indicate this estimate of recoverable water is conservative. Following improvements, the average lqDU for these systems exceeded industry standards (0.90 versus 0.85), reducing water consumption an average of 6 inches per acre (versus 4 inches per acre).

Discussion

Inefficient irrigation practices have numerous environmental impacts (Table 1). Because of this, irrigation evaluations are often required by local, regional, and state-wide environmental agencies. These numerous impacts imply that quantifying the benefits of the MIL program by water savings alone underestimates the program's value.

To address these larger impacts, MIL staff also survey and review crop, soil, nutrient, and pesticide Best Management Practices (BMP's) with growers. A partial list of BMPs recommended for water conservation and nutrient management is provided in Table 2.

Interestingly, the average lqDU values of evaluated irrigation systems has fallen in the later two years of the program implying that growers with deficiency's are actively seeking help through the MIL program. It is very likely this is due to the development of a MIL cost-share component which provides financial assistance to growers who implement improvements.

Conclusion

The MIL program has achieved success because of the relationship the Resource Conservation District (RCD) has cultivated with both growers and regulators.

For Ventura County to remedy its recurring water issues, continued support of the MIL program and further investments in irrigation efficiencies through grower incentives should be a component of any broader water management plan.

RESOURCE CONSERVATION DISTRICT
Ventura County
PO Box 147
3380 Somis Road
Somis CA 93066

www.conserveventura.org
805-764-5130

VENTURA COUNTY'S

Crop & Livestock Report

CHANGING TASTES

2012







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14 Sustainable Agriculture
15 Trends in Agriculture
16 History of Crops

Thank You to all of our past and present staff members who helped put this report together. Without your tireless work and devotion to your jobs, none of this would be possible.

Thomas E. Dimock
Senior Agricultural Inspector Biologist
Retired after 25 years of service

In Memoriam
Louis A. Ortali
Senior Agricultural Inspector Biologist
12/31/2012

Photo Credits: Front Cover: *Man Hauling Sugar Beets*, property of The Museum of Ventura County (top); *Lemon Processing* by Dexter McDonald (middle); *Farmers' Market Berries* by Jamie Mastright (bottom).
Back Cover: *Top Ten Crops* by Jamie Mastright.

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Henry S. Gonzales

CHIEF DEPUTY AGRICULTURAL COMMISSIONER
Rudy Martel

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Clifford Ball, Linda Bellamy, Michael Bellamy, Andrew DuBridge, Gary Graves, Rex Hense, Lance Hermann, Eli Hernandez, Francisco Hernandez, Bernard Makuaole, Barbara Miller, Ruben Ortega, Connie Ratner, Ingus Richters, John Salfen, Ed Toves

STUDENT WORKER III
Abel Ayala, Brittnee Carter, Allisen Hansen, Andres Hernandez, Joel Hernandez, Miguel Munguia, Teddi Nichols, Jose Ruiz, Desiree Teran, Israel Vasquez

GRAPHIC DESIGN & PRINTING
GSA Business Support/Graphics

Office of Agricultural Commissioner | Henry S. Gonzales
Chief Deputy - Rudy Martel

P.O. Box 3937 | 669 County Square Drive, Ventura, CA 93003
T: (805) 477-1620 | F: (805) 477-1615

July 30, 2013



Karen Ross, Secretary
California Department of Food & Agriculture
and
The Honorable Board of Supervisors of Ventura County
Steve Bennett, 1st District,
Linda Parks, 2nd District
Kathy Long, 3rd District
Peter C. Foy, 4th District, Chair
John C. Zaragoza, 5th District

Pursuant to Section 2279 of the California Food and Agricultural Code, I am pleased to submit the 2012 Ventura County Agricultural Report. The estimated gross value for Ventura County agriculture for calendar year 2012 is $1,963,798,000. This represents a 1.6% increase over 2011.

Strawberries again are the leading crop in the County, with a total value of $691,303,000. This 11% increase over 2011 is attributed to more acres planted and increased production. Lemons climbed back to second place with a strong rebound from 2011 reflected in a value of $201,820,000. This 15% gain in total value is due to an increase in per ton value, even with a reduction in acreage and production. Although raspberries had a 1% increase in total value to $187,277,000, the greater surge by lemons moved raspberries down in ranking to third. This increase is ascribed to increases in acreage and production. Nursery stock remained in fourth place, even with a 14% increase in total value of $186,351,000. This increase is primarily due to increases in acreage and value, and possibly reflects the improving housing sector. Celery remained in fifth place, even with a decrease in total value of $134,258,000. This decrease of 13% is due to decreases in per ton value and production. Avocados had another up year moving from seventh to sixth place with a 10% increase to $113,315,000. The large increase is due to a correction of missed acreage in 2011, and additional increases in acreage and production in 2012. Tomatoes dropped in rank from sixth to seventh place, with a decrease of 24% to $75,819,000. The reduction in tomatoes is due to fewer acres planted, less production, and a considerable decrease in per ton value. Peppers moved up from ninth to eighth place due to a 16% increase in total value to $48,395,000. An increase in acres planted and per acre production is credited with the rise. Cut flowers moved down a spot from eighth to ninth place, reflecting a 10% decrease to $46,829,000. This decrease is due to a decline in per item value. Moving into the top 10 for the first time and possibly reflecting changes in consumer tastes is cilantro at $23,438,000. An overall increase of 30%, due primarily to per ton value and an increase in per acre production, negated a decrease in acreage.

Always worth keeping in mind is that this report reflects gross values only and does not represent the net return to farmers or the multiplier effect on the surrounding economy.

Special thanks go to Kerry DuFrain for compiling the data in this report and to industry members that provided her with their individual information. Special recognition goes to Korinne Bell, for the overall production of this report and to Matt Kreiger for the graphic design and layout.

Respectfully submitted,

Henry S. Gonzales
Agricultural Commissioner
County of Ventura

– Serving Ventura County since 1895 –

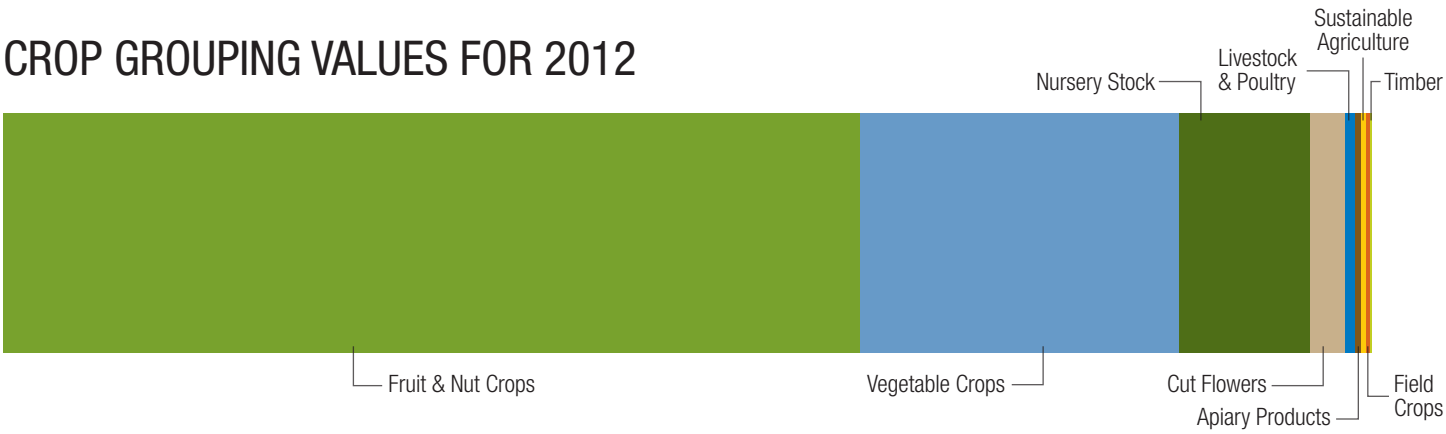


Recapitulation & Index 2011 - 2012

CROP GROUPING	YEAR	VALUE[1]
1. Fruit & Nut Crops	2012 2011	$1,254,592,000 $1,124,860,000
2. Vegetable Crops	2012 2011	$460,280,000 $490,233,000
3. Nursery Stock[2]	2012 2011	$186,351,000 $163,793,000
4. Cut Flowers	2012 2011	$46,829,000 $52,217,000
5. Livestock & Poultry	2012 2011	$6,872,000 $6,075,000
6. Apiary Products	2012 2011	$3,326,000 $2,385,000
7. Sustainable Agriculture	2012 2011	$3,045,000 $3,000,000
8. Field Crops	2012 2011	$2,491,000 $1,684,000
9. Timber	2012 2011	$12,000 $13,000
GRAND TOTAL*	**2012** 2011	**$1,963,798,000** $1,844,260,000

** Ventura County has approximately 96,340 acres of irrigated cropland* [1] *Figures are rounded off to nearest $1,000* [2] *Includes Cut Christmas Trees*

CROP GROUPING VALUES FOR 2012



Five Year Comparison

	2008	2009	2010	2011	2012
Fruit & Nut Crops	$823,464,000	$867,759,000	$1,085,677,000	$1,124,860,000	$1,254,592,000
Vegetable Crops	$427,742,000	$ 509,248,000	$ 533,473,000	$ 490,233,000	$460,280,000
Livestock & Poultry Products	$6,853,000	$7,494,000	$6,161,000	$6,075,000	$6,872,000
Apiary Products	$463,000	$698,000	$1,505,000	$2,385,000	$3,326,000
Nursery Stock	$298,690,000	$191,300,000	$180,057,000	$163,793,000	$186,351,000
Cut Flowers	$51,297,000	$42,763,000	$47,348,000	$52,217,000	$46,829,000
Field Crops	$2,580,000	$2,313,000	$2,463,000	$1,684,000	$2,491,000
Timber	$10,000	$9,000	$14,000	$13,000	$12,000
Sustainable Agriculture	$2,148,000	$2,273,000	$2,453,000	$3,000,000	$3,045,000
GRAND TOTAL	**$1,613,247,000**	**$1,623,857,000**	**$1,859,151,000**	**$1,844,260,000**	**$1,963,798,000**

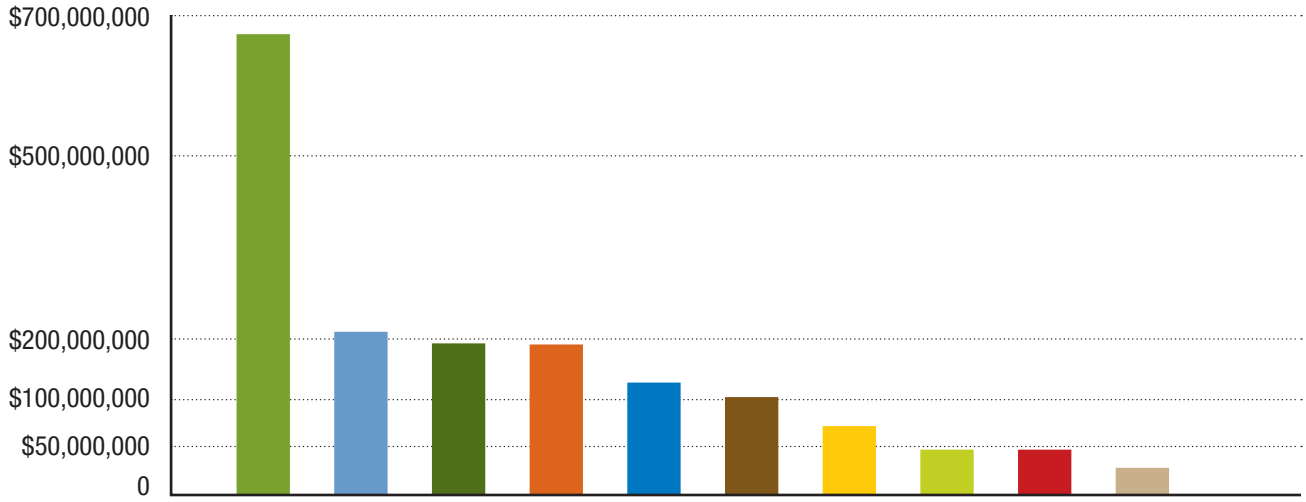
Certified Farmers' Markets (CFM's)

Certified Farmers' Markets (CFM's) are located throughout the state of California. CFM's supply produce such as fruits, nuts, vegetables, honey and eggs, from the grower directly to the consumer. CFM's provide an alternative method of sale for growers and exempts them from certain federal and state packaging and labeling requirements. CFM's gives consumers the opportunity to meet the farmers and producers and learn about how the commodities are produced. Only commodities produced by the grower can be sold at a CFM. Growers participating at the markets must obtain a Certified Producer's Certificate (CPC) from the county in which they produce their commodities. An inspector from the local County Agricultural Commissioner's Office will certify that the producer is growing what they intend to sell at the CFM and issue the CPC. In Ventura County, there are a total of 13 registered CFM's. Ventura County Agricultural Inspectors also perform routine inspections of CFM's to ensure the public is receiving fresh, locally grown produce and that farmers are only selling what they have produced.



Ten Leading Crops for 2012

RANK	CROP	VALUE
1st	Strawberries	$691,303,000
2nd	Lemons	$201,820,000
3rd	Raspberries	$187,277,000
4th	Nursery Stock	$186,351,000
5th	Celery	$134,258,000
6th	Avocados	$113,315,000
7th	Tomatoes	$75,819,000
8th	Peppers	$48,395,000
9th	Cut Flowers	$46,829,000
10th	Cilantro	$23,438,000



Other Million Dollar Crops

CROP/PRODUCT	VALUE
Kale	$21,185,000
Greens	$20,768,000
Valencia Oranges	$17,327,000
Cabbage	$15,636,000
Lettuce	$14,634,000
Blueberries	$13,818,000
Vegetable Transplants*	$12,221,000
Spinach	$11,595,000
Mandarins	$10,328,000
Cucumber	$9,524,000

CROP/PRODUCT	VALUE
Oriental Vegetables	$9,010,000
Beans (all)	$8,038,000
Broccoli	$7,573,000
Parsley	$7,181,000
Livestock	$6,872,000
Radishes	$4,456,000
Orchids*	$3,592,000
Beets	$3,541,000
Poinsettia*	$2,586,000
Onions (all)	$1,256,000

** Included in Nursery Stock total above*





ACREAGE, PRODUCTION AND VALUES | 2011-2012

Fruit & Nut Crops

		PRODUCTION				VALUE	
Crop	Year	Acreage	Per Acre	Total	Unit	Per Unit	Total
Avocados[3]	2012	19,284	3.40	65,451	tons	$1,731.30	$113,315,000
	2011	16,777	1.72	28,732	tons	$3,196.75	$91,849,000
Blueberries[4]	2012	526	3.05	1,603	tons	$8,620.09	$13,818,000
	2011	458	12.31	1,426	tons	$6,586.74	$9,395,000
Grapefruit	2012	104	12.31	1,280	tons	$518.75	$664,000
	2011	130	11.50	1,495	tons	$381.28	$570,000
Lemons	2012	15,562	19.41	302,083	tons	$668.10	$201,820,000
	2011	15,876	19.84	314,863	tons	$555.60	$174,937,000
Mandarins & Tangelos	2012	1,348	7.07	9,531	tons	$1,083.62	$10,328,000
	2011	1,080	4.89	5,281	tons	$956.07	$5,049,000
Oranges (Navel)	2012	451	16.26	7,333	tons	$389.20	$2,854,000
	2011	452	16.38	7,403	tons	$359.86	$2,664,000
Oranges (Valencia)	2012	3,004	14.02	42,106	tons	$411.51	$17,327,000
	2011	3,246	14.85	48,177	tons	$398.49	$19,198,000
Raspberries	2012	3,076	11.17	34,346	tons	$5,452.66	$187,277,000
	2011	2,981	8.95	26,673	tons	$6,950.85	$185,400,000
Strawberries - Total	2012	11,419	30.91	352,961	tons	$1,958.58	$691,303,000
	2011	11,230	28.28	317,584	tons	$1,969.59	$625,509,000
Fresh	2012	---	---	257,704	tons	$2,425.85	$625,151,000
	2011			219,145	tons	$2,540.89	$556,823,000
Processed	2012	---	---	95,257	tons	$694.45	$66,152,000
	2011			98,439	tons	$697.76	$68,686,000
Misc. Fruits & Nuts[5]	2012	914	---	---	tons	---	$15,886,000
	2011	1,387			tons		$19,684,000
TOTAL	**2012**	**55,688**					**$1,254,592,000**
	2011	53,159					$1,124,860,000

[3] The increase in Avocado figures reflected in the 2012 crop report actually spanned a two year period. Information changes concerning out-of-county packers was missed by the county agricultural department and the Avocado figures for 2011 were under-reported. This includes the total acres harvested, the total avocado production in tons, and the total crop value. The 2011 harvested acres should have shown an increase of approximately 2,000 acres over the number of acres in 2010.

[4] Listed as a single commodity for the first time, enters top 30 crops

[5] MISC. FRUITS AND NUTS include Apples, Apricots, Asian Pears, Bushberries, Cherimoya, Grapes, Guavas, Kiwi, Limes, Olives, Persimmons, Macadamias, Walnuts; and miscellaneous citrus, deciduous, and subtropical fruit.



Vegetable Crops

ACREAGE, PRODUCTION AND VALUES | 2011-2012

		PRODUCTION				VALUE	
Crop	Year	Acreage	Per Acre	Total	Unit	Per Unit	Total
Beans Green & Dry Limas, Green Snap	2012	3,450	2.29	7,896	tons	$1,017.98	$8,038,000
	2011	2,257	2.67	6,022	tons	$1,087.02	$6,546,000
Beets	2012	439	3.14	1,376	tons	$2,573.40	$3,541,000
	2011	513	9.81	5,030	tons	$675.75	$3,399,000
Broccoli Fresh & Processed	2012	1,607	9.17	14,738	tons	$513.84	$7,573,000
	2011	890	4.79	4,259	tons	$747.36	$3,183,000
Cabbage	2012	3,111	20.18	62,783	tons	$249.05	$15,636,000
	2011	3,225	25.44	82,014	tons	$236.83	$19,423,000
Carrots	2012	170	30.54	5,191	tons	$178.19	$925,000
	2011	362	22.07	7,987	tons	$509.58	$4,070,000
Celery	2012	10,598	37.53	397,717	tons	$337.57	$134,258,000
	2011	10,581	37.61	397,903	tons	$388.50	$154,584,000
Cilantro	2012	3,397	8.38	28,463	tons	$823.46	$23,438,000
	2011	4,234	8.13	34,399	tons	$522.90	$17,987,000
Cucumbers[6]	2012	67	153.03	10,253	tons	$928.90	$9,524,000
	2011	147	61.04	8,972	tons	$1,156.49	$10,376,000
Greens[7]	2012	1,265	8.28	10,479	tons	$1,981.87	$20,768,000
	2011	1,237	11.92	14,735	tons	$1,405.98	$20,717,000
Kale	2012	677	13.42	9,084	tons	$2,332.12	$21,185,000
	2011	460	15.89	7,308	tons	$1,510.13	$11,036,000
Lettuce - Total	2012	1,994	13.10	26,126	tons	$560.13	$14,634,000
	2011	1,432	10.14	14,518	tons	$794.19	$11,530,000
Head	2012	196	13.72	2,688	tons	$726.56	$1,953,000
	2011	116	19.79	2,295	tons	$373.43	$857,000
Leaf	2012	916	10.95	10,028	tons	$694.66	$6,966,000
	2011	958	9.91	9,493	tons	$931.43	$8,842,000
Romaine	2012	882	15.26	13,410	tons	$426.18	$5,715,000
	2011	358	7.63	2,730	tons	$670.70	$1,831,000
Onions Green & Dry	2012	183	5.12	937	tons	$1,340.45	$1,256,000
	2011	236	7.37	1,738	tons	$755.47	$1,313,000

[6] *Includes hydroponics*

[7] *Includes: chard, collard, mustard, turnip and watercress.*

Crop	Year	PRODUCTION Acreage	Per Acre	Total	Unit	VALUE Per Unit	Total
Oriental Vegetables	2012	999	8.22	8,206	ton	$1,097.98	$9,010,000
	2011	926	8.45	7,823	ton	$845.59	$6,615,000
Parsley	2012	301	18.90	5,689	ton	$1,262.26	$7,181,000
	2011	357	16.21	5,784	ton	$1,619.65	$9,368,000
Peppers Bell & Chili	2012	3,146	28.01	88,116	ton	$549.22	$48,395,000
	2011	2,634	26.28	69,203	ton	$602.59	$41,701,000
Pumpkin	2012	116	12.23	1,418	ton	$273.63	$388,000
	2011	128	13.24	1,694	ton	$194.81	$330,000
Radishes	2012	597	12.12	7,234	ton	$615.98	$4,456,000
	2011	824	13.03	10,733	ton	$534.52	$5,737,000
Spinach	2012	1,548	7.72	11,945	ton	$970.70	$11,595,000
	2011	1,519	6.21	9,430	ton	$1,103.93	$10,410,000
Sweet Corn	2012	134	7.05	945	ton	$376.72	$356,000
	2011	242	7.84	1,897	ton	$176.07	$334,000
Tomatoes[8]	2012	1,734	48.43	83,978	ton	$902.84	$75,819,000
	2011	1,755	51.59	90,540	ton	$1,098.61	$99,468,000
Vegetables, Misc.[9] Field, Indoor & Processed	2012	1,322	---	---	---	---	$42,304,000
	2011	1,341					$52,106,000
TOTAL	**2012**	**36,855**					**$460,280,000**
	2011	35,300					$490,233,000

[8] *Includes hydroponics*

[9] *Includes: artichokes, arugula, asparagus, baby vegetables, cauliflower, eggplant, endive, garlic, gourds, herbs, kohlrabi, leeks, melons, mushrooms, peas, radicchio, sprouts, squash, tomatillos, and turnips.*

Community Gardens

Community Gardens are a growing trend not only in Ventura County, but throughout the country. As yards in urban areas continue to shrink, people are continuing to find different outlets for their need and desire for gardening. Community Gardens are a shared plot of land, usually in urban locations, where a group of members from the community grow food and plants for their own personal use. The plots are rented or loaned to the groups. The gardens are usually managed and controlled by unpaid volunteers. These gardens are a great way for people to connect with their surroundings and feel a sense of community while producing fresh, healthy fruits and vegetables.



Sustainability & Changing Consumer Tastes



Consumer tastes are changing and in order to be sustainable, agriculture in Ventura County is changing with it.

Agriculture is an almost 2 billion dollar industry that has shaped and defined Ventura County since the mid 1800's. Although the existence of the agricultural industry has been a mainstay, the face of agriculture itself has changed greatly in the last two centuries. Ventura County started out as a dry land farming county. In the late 1800's, crops such as lima beans, sugar beets, walnuts and apricots were prevalent. 100 years ago, citrus dominated the landscape. Railways and shipping portals in our cities were designed to accommodate this massive sector of the industry. Citrus was "king" in this county for a century, but in 2011, Oranges fell out of the top ten completely after teetering on the edge for several years. For the past decade, strawberries have taken the number one spot in value, with a nearly half-million dollar edge over the other leading crops in Ventura County.

Agriculture in Ventura County is as rich and diverse as the people who call it home. It is not just the iconic citrus trees, or the lush, green strawberry fields. Agriculture in Ventura County is rangeland for cattle, hoop houses for berries, and greenhouses for nursery or tomatoes and cucumbers that literally grow overnight! Agriculture in Ventura County can be hydroponic, biodynamic, organic, and conventional. Agriculture can be all of these things but one thing it has to be is sustainable; sustainable both economically for the farmer, and sustainable for the environment which supports it.



There are a number of factors that impact the sustainability of agriculture in Ventura County. Availability of resources such as land, water and labor can determine not only what types of crops, but how they are grown. The depth of topsoil in the Oxnard plain makes it some of the most valuable and productive farm land in the world. The range of microclimates in this county enables farmers to grow a huge variety of fruits and vegetables year-round. Due to land values, it is also one of the most expensive places to farm. The past decade of farming has shown that berries are one of the few crops that can keep up with the rising costs of resources. However, due to years of compounding drought, farmers on the Oxnard plain were told they will be receiving approximately half the water in 2013 that they received last year during a critical time in the lifecycles of their berry plants. In addition to the drought, California is experiencing a major shortage in skilled agricultural labor. In 2012, many crops in Ventura County were incompletely harvested due to this shortage. A lack of these available resources has a severe impact on the economic sustainability of this industry.

Another major impact on agriculture in Ventura County is the introduction of invasive species such as the Asian Citrus Psyllid. This tiny insect can spread a lethal disease (Huanglongbing) that has decimated the citrus industry in Florida. The pest has arrived in Ventura County, and the disease has been found right at our back door, in neighboring Los Angeles County. Another invasive pest known as the Glassy Winged Sharpshooter has already infested our county. This insect spreads a deadly disease known as Pierce's Disease which kills grapevines. Traditionally in counties where land values are high, wine grapes were a comparable alternative to berries. With the Glassy Winged Sharpshooter, wine grapes will not be an option in our county. The presence of invasive species has an impact on the success and sustainability of crops.



The less obvious of impacts to the sustainability of agriculture in Ventura County is the industry's ability to adapt to changing consumer tastes. In 2011, greens replaced oranges by entering the top ten crops of highest value in Ventura County. This increase in value can attributed in part, to a more health-conscious society. In recent years, a lot of press has been devoted to praising the nutritional advantages of leafy green vegetables including chard, collards and mustard greens. Berries have steadily been on the rise in value for the past decade. Similarly, this increase can be attributed to an aging Baby Boomer population in search of antioxidant-rich foods. However, health crazes are not the only factor. Oranges, which recently fell out of the top ten for example, have not suddenly become less healthy. In 2012, cilantro entered the top ten crops in value for the first time in history. Consumer tastes are changing and in order to be sustainable, agriculture in Ventura County is changing with it.

The effect of changing consumer tastes and the sustainability of agriculture is not limited to changes in the choices of commodities grown. Changes are also being made in how these crops are grown and marketed. Farmers are constantly seeking new and different ways to make their product more accessible to consumers. In addition to traditional Packers, Coolers and Shippers, Ventura County has seen an increase in the amount of Certified Farmer's Markets (CFM's), Farm Stands, and Community Supported Agriculture (CSA's) within the last decade. Venues such as these have allowed farmers in Ventura County the opportunity to sell their product directly to consumers in search of fresh, local produce. A health-seeking consumer public has also created a rise in the number of Registered Organic Farms. Municipalities and non-profit organizations are allowing residents to participate in producing fresh, healthy food through avenues such as Community Gardens. More and more farmers are incorporating Agritourism into their operations to show the public how their food is produced.



No one understands the importance of sustainability better than the farmer. Farmers' lives are deeply connected to the land and what it produces. Farmers are continuously making decisions which impact their future; they understand that by being good stewards of the land they are ensuring the future of agriculture for generations to come. The agricultural industry has responded to the demands created by changes in consumer tastes and will continue to do so in order to keep agriculture sustainable in Ventura County. By keeping ourselves and our children informed on what it means to eat fresh, healthy, local produce, we can help support the economic sustainability of this industry.

Nursery Stock PRODUCTION & VALUES | 2011 - 2012

Item	Year	Production	PRODUCTION AREA Greenhouse Sq Ft	PRODUCTION AREA Field Access	Per Unit	Total
Nursery Stock	2012 2011	--- ---	7,001,236 6,128,111	3,194 2,922	--- ---	$186,351,000 $163,793,000
Fruit & Nut Trees	2012 2011	861,556 Trees 1,018,057 Trees	--- 41,520	269 121	$15.78 $16.39	$13,595,000 $16,681,000
Potted Plants	2012 2011	3,279,526 Pots 2,947,725 Pots	3,539,255 2,882,389	23 15	$4.22 $3.82	$13,837,000 $11,245,000
Propagative Material	2012 2011	41,047,998 Cuttings 50,939,254 Cuttings	644,155 610,804	16 4	$0.22 $0.15	$8,788,000 $7,312,000
Herbaceous Perennials	2012 2011	3,897,226 Containers 2,759,691 Containers	41,700 83,526	130 203	$2.91 $4.25	$11,355,000 $11,720,000
Woody Ornamentals[10]	2012 2011	5,257,814 Tree/Shrubs 5,092,880 Tree/Shrubs	326,460 711,900	1,638 1,455	$14.60 $13.39	$76,777,000 $68,177,000
Bedding Plants, Ground Cover & Turf	2012 2011	21,914,879 Flats 21,079,877 Flats	1,006,732 611,720	1,086 1,093	$2.25 $1.88	$49,382,000 $39,619,000
Vegetable Transplants	2012 2011	3,849,783 Flats 3,836,037 Flats	1,442,934 1,186,252	32 31	$3.28 $2.36	$12,617,000 $9,039,000
TOTAL	**2012** 2011					**$186,351,000** $163,793,000

[10] *Includes cut Christmas Trees*

Community Supported Agriculture (CSA)

Community Supported Agriculture (CSA) is a growing trend involving partnerships between growers and their consumers. CSA's allow members of the community to purchase a "share" of produce from a local participating farmer. Farmers and consumers share the risks and benefits of producing the crop. Members pay a subscription at the beginning of the growing season for a share of the anticipated harvest. During harvest, members receive boxes of local, fresh, and seasonal produce grown directly from the farmer. CSA's are a great educational experience for all ages and allow for diversity in produce options. There are many online databases developed as a guide to help members of each community contact participating farmers. Currently, the state is working on establishing regulatory authority and governance of CSA's.





PRODUCTION AND VALUES | 2011-2012

Cut Flowers

Crop	Year	Acres	Production	Unit	Per Unit	Total Value
Flower Blooms & Stems	2012	26	13,465,491	blooms	---	$4,101,000
	2011	25	15,025,251	blooms	---	$4,443,000
Cut Greens & Dried Flowers	2012	86	441,816	bunches	---	$1,229,000
	2011	106	1,376,025	bunches	---	$1,963,000
Flower Bunches - Total	2012	737	14,119,176	bunches	---	$41,499,000
	2011	717	15,254,590	bunches	---	$45,811,000
Statice, Lace, Aster & Gypsophila	2012	88	1,994,572	bunches	$1.91	$3,798,000
	2011	73	1,253,381	bunches	$2.79	$3,497,000
Chrysanthemums & Sunflowers	2012	76	3,054,502	bunches	$1.92	$5,918,000
	2011	78	3,469,654	bunches	$1.41	$4,894,000
Lilies & Irises	2012	79	4,331,620	bunches	$4.04	$17,504,000
	2011	94	4,290,745	bunches	$4.60	$19,723,000
Lisianthus	2012	32	437,730	bunches	$4.20	$1,839,000
	2011	37	556,965	bunches	$3.88	$2,162,000
Delphinium, Larkspur, Stock & Snapdragons	2012	242	2,622,094	bunches	$2.71	$7,115,000
	2011	296	3,786,821	bunches	$2.57	$9,721,000
Miscellaneous	2012	220	1,678,658	bunches	$3.17	$5,325,000
	2011	139	1,897,024	bunches	$3.07	$5,814,000
TOTAL	**2012**	**849**				**$46,829,000**
	2011	848				$52,217,000

Field Crops

ACREAGE, PRODUCTION AND VALUES | 2011-2012

Crop	Year	Acreage	Total
Alfalfa & Pasture	2012	97,058	$1,290,000
Irrigated & Non-Irrigated	2011	93,113	$1,071,000
Grain[11], Hay & Vegetable Seed	2012	1,080	$1,201,000
	2011	759	$613,000
TOTAL	**2012**		**$2,491,000**
	2011		$1,684,000

[11] *Includes green barley*

Livestock & Poultry

PRODUCTION AND VALUES | 2011-2012

				Value	
Item	**Year**	**Production**	**Unit**	**Per Unit**	**Total**
Livestock	2012	16,268	cwt	$114.77	$1,867,000
Cattle, Hogs & Sheep	2011	16,474	cwt	$115.34	$1,900,000
Poultry	2012	---	---	---	$4,914,000
Chickens & Eggs	2011	---	---	---	$4,087,000
Other Livestock	2012	---	---	---	$91,000
Alpaca & Squab	2011	---	---	---	$88,000
TOTAL	**2012**				**$6,872,000**
	2011				$6,075,000

Organic Farming

Ventura County currently has a total of 88 registered organic growers. There are a total of 5,202 acres in Organic production in Ventura County. Organic farming is defined by the United States Department of Agriculture (USDA) as, "A production system that is managed to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity." The federal Organic Foods Production Act of 1990 and the California Organic Products Act of 2003 set forward guidelines and standards which must be followed by any grower, handler, processor, wholesaler, or retailer who wish to sell or advertise their product as "Organic". Producers and handlers interested in working with organic commodities must register with the California State Organic Program, and if gross sales exceed $5,000, certification from a third party is required. Registration is initiated with the County Agricultural Commissioner's Office. Our office performs routine inspections of Organic produce at Certified Farmer's Markets, audits of records for Organic producers, processors and handlers, as well as inspections of Organic production sites.



Apiary Products

				Value	
Item	Year	Production	Unit	Per Unit	Total
Honey	2012 2011	767,570 518,887	lbs lbs	$2.17 $1.49	$1,664,000 $774,000
Beeswax & Pollen[12]	2012 2011	9,090 17,115	lbs lbs	$2.97 $3.56	$27,000 $61,000
Pollination Use	2012 2011	--- ---	--- ---	--- ---	$1,635,000 $1,550,000
TOTAL	**2012** 2011				**$3,326,000** $2,385,000

12 Beeswax only

Timber

Crop	Year	Total
Timber	2012 2011	$12,000 $13,000
TOTAL	**2012** 2011	**$12,000** $13,000

Farm Stands

Farm Stands can be found throughout the county and provide a wide variety of commodities, including locally grown produce. Farm Stands can operate seasonally or year-round. Most stands are located directly adjacent to production fields, others operate as retail establishments. Farm Stands offer a venue of marketing for local growers and individuals involved in the agricultural industry. The Ventura County Agricultural Commissioner's Office performs routine standardization inspections at the various stands. Our office is looking for proper container labeling, use of containers as well as proof of ownership of produce. Currently in Ventura County, there are over 50 Farm Stands.



Sustainable Agriculture

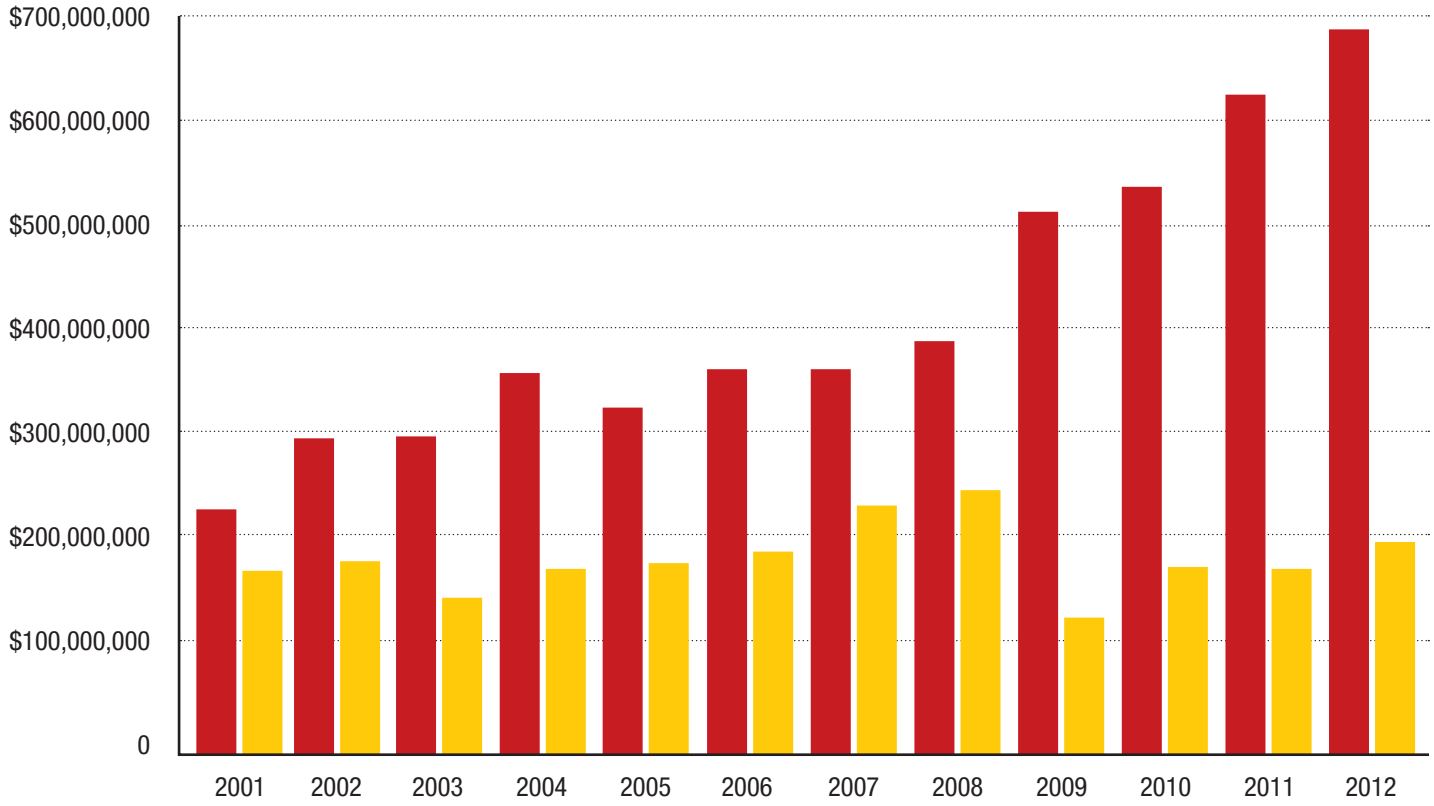
Item	Pest	Agent	Scope of Program
Biological Control Commercial Insectaries	Red and black scale, Mealybug, snails, various aphids, mites and flies	Aphytus melinus, Cryptolemus, Decollate snails, various predators, parasitic wasps and nematodes	Estimate 995,791,651 beneficials, released on 250 ranches. Valued at $3,000,000
Colonization of Beneficial Organisms	---	---	---
Manure	---	9,500 tons	Valued at $45,000
TOTAL			**$3,045,000**
Pest Eradications	Dalmation Toadflax Scotch Thistle Spotted Knapweed Euphorbia terracina	Mechanical/Digging Mechanical/Digging Mechanical/Digging Mechanical/Digging	1 Site 1 Site 1 Site 1 Site
Pest Exclusion	Various Gypsy Moth Various	<u>Incoming Shipments</u> Postal/UPS/Fed Express (Parcels) Truck/Air Freight Household Goods (Inspections) Swap Meets/Ethnic Markets/Mobile Venders	 8,442 623 61 Total: 9,126 26

Organic Farming

Crops	Year	# of Registered Growers	Acres
	2012 2011	88 90	
Vegetables & Herbs	2012 2011		1,755 2,524
Fruits & Nuts	2012 2011		3,431 3,214
Field Crops	2012 2011		2 2
Flowers/Nursery Stock	2012 2011		14 11
TOTAL ACREAGE	**2012** 2011		**5,202** 5,751

STRAWBERRIES VS. LEMONS

In 2001, Strawberries took over lemons as the number one crop in value in Ventura County.



Agritourism

Agritourism is on the rise in Ventura County, as farmers seek alternative ways to increase and diversify the economic productivity of their farms and ranches. The main goal of Agritourism is to attract and bring the community onto the farms or ranches. Agritourism allows the public to witness how their food and fiber is produced. Agritourism in Ventura County can range from educational seminars,"U-Picks", harvest festivals, tastings, pumpkin patches, plant mazes, petting zoos, farm tours, guest ranches, and agricultural venues for weddings and special events.



History of Crops

TOP TEN FOR EACH YEAR

1922	
Ranking	**Crop**
1	Beans
2	Lemons
3	Walnuts
4	Apricots
5	Valencia Oranges
6	Sugar Beets
7	Navel Oranges
8	Hay
9	Grain
10	Misc. Citrus

1932	
Ranking	**Crop**
1	Lemons
2	Valencia Oranges
3	Walnuts
4	Beans
5	Sugar Beets
6	Misc. Vegetables
7	Navel Oranges
8	Hay
9	Apricots
10	Citrus Nursery Stock

1942	
Ranking	**Crop**
1	Lemons
2	Valencia Oranges
3	Beans
4	Walnuts
5	Misc. Vegetables
6	Livestock
7	Dairy Products
8	Hay
9	Navel Oranges
10	Poultry Products



1952	
Ranking	**Crop**
1	Lemons
2	Valencia Oranges
3	Beans
4	Misc. Vegetables
5	Walnuts
6	Livestock
7	Poultry Products
8	Dairy Products
9	Navel Oranges
10	Grain

1962	
Ranking	**Crop**
1	Lemons
2	Valencia Oranges
3	Livestock & Poultry
4	Tomatoes
5	Celery
6	Lettuce
7	Green Beans
8	Dairy Products
9	Lima Beans
10	Navel Oranges

1972	
Ranking	**Crop**
1	Lemons
2	Livestock, Poultry & Dairy
3	Celery
4	Tomatoes
5	Strawberries
6	Valencia Oranges
7	Lettuce
8	Avocados
9	Misc. Vegetables
10	Lima Beans

1982	
Ranking	**Crop**
1	Lemons
2	Celery
3	Poultry and Dairy
4	Strawberries
5	Valencia Oranges
6	Seed
7	Nursery Stock
8	Lettuce
9	Avocados
10	Broccoli

1992	
Ranking	**Crop**
1	Lemons
2	Strawberries
3	Celery
4	Nursery Stock
5	Valencia Oranges
6	Avocados
7	Lettuce
8	Cut Flowers
9	Broccoli
10	Cabbage



2002	
Ranking	**Crop**
1	Strawberries
2	Lemons
3	Nursery Stock
4	Celery
5	Avocados
6	Cut Flowers
7	Tomatoes
8	Peppers
9	Valencia Oranges
10	Raspberries

2012	
Ranking	**Crop**
1	Strawberries
2	Lemons
3	Raspberries
4	Nursery Stock
5	Celery
6	Avocados
7	Tomatoes
8	Peppers
9	Cut Flowers
10	Cilantro

DEPUTY AGRICULTURAL COMMISSIONER

Kerry L. DuFrain

Kerry DuFrain will retire from the Ventura County Agricultural Commissioner's Office in August of 2013, after dutifully serving the county since 1984. Kerry graduated from Cal Poly Pomona with a Bachelor of Science degree in Agricultural Biology. She began her career with the department as an insect trapper and worked her way to Deputy Agricultural Commissioner in 1992. Since that time she has managed several programs including: Pest Detection, Direct Marketing, Fruit, Nut, & Vegetable Standardization, Organics, Nursery & Seed and Pierces Disease Control [also known as the GWSS]. In addition to her extensive work in these programs, Kerry has been responsible for the compilation of the annual crop report for the last 23 years. Kerry acknowledges two life-changing experiences in her career with the department as having experienced the med fly outbreak in the mid 90's and participating in the two-year CA Agricultural Leadership Program. Throughout her career, Kerry has been known for her ability to relate to people. She used those skills to build effective relationships with colleagues, growers and members of the industry. She went out of her way to find something positive or encouraging to say to her coworkers each day. Kerry's expertise in programs and institutional knowledge of the department will be greatly missed. With sincerest thanks for her many years of service, the Ventura County Agricultural Commissioner's Office would like to wish Kerry well in her much-deserved retirement.



Kerry DuFrain featured with her supervisor, Glen Hackworth earlier in her career with the department.

Coolers, Packers, Shippers

Ventura County is home to more than 2,400 farms, according to the 2007 Census of Agriculture. Commercial coolers, packers and shippers are an integral part of the produce industry supply chain. Approximately 85% of Ventura County's agricultural products are not produced for local consumption. 65% of the commodities produced in Ventura County are exported to foreign countries. The ability to export products is essential to the viability of Ventura County's almost 2 billion dollar agricultural industry. Coolers, Packers, and Shippers are designed to handle each commodity's different postharvest requirements. Coolers are large scale facilities which temporarily receive and cool product directly from the field. These facilities help not only large commercial growers, but also small farming operations by allowing farmers access to distributors and continuing the movement of their product through the supply chain. Packers sort, clean and package the commodity, preparing it for resale. Shippers transport commodities to various wholesale and retail outlets. The Ventura County Agricultural Commissioner's Office performs routine inspections of Coolers, Packers and Shippers, checking for proper container labeling, proper use of containers and proof of ownership of produce. Inspectors also certify local commodities for export shipments, both foreign and domestic. Upon completion of an inspection, Phytosanitary Certificates can be issued, attesting to the products' cleanliness from pests and diseases and to other various requirements of foreign countries.





Office of Agricultural Commissioner | 669 County Square Drive | Ventura, CA 93003
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