Table 3-9
Releases from Castaic Lagoon to Castaic Creek (1980-2019)
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Cal Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	1,998	1,692	2,686	3,767	1,243	2,919	406	55	20	0	0	0	**14,786**
1981	0	935	2,702	512	190	154	48	0	0	0	0	0	**4,541**
1982	0	0	923	3,846	1,702	0	0	0	0	0	0	242	**6,713**
1983	178	53,378	6,804	2,456	0	0	0	0	0	0	235	2,080	**65,131**
1984	1,781	987	1,743	1,957	209	0	0	0	0	0	0	0	**6,677**
1985	169	124	162	173	75	161	306	222	243	228	141	615	**2,619**
1986	1,387	450	219	1,268	990	163	112	9	42	72	101	132	**4,945**
1987	147	141	101	282	26	3	0	0	0	38	212	121	**1,071**
1988	548	718	992	519	1,078	108	204	6	0	7	20	83	**4,283**
1989	121	126	150	256	163	6	0	0	0	0	0	0	**822**
1990	60	117	165	165	21	4	0	0	0	0	0	0	**532**
1991	30	102	0	235	210	227	330	282	239	212	319	89	**2,275**
1992	187	12,174	766	3,232	853	307	210	137	195	129	135	0	**18,325**
1993	180	140	13,139	3,211	2,149	875	589	616	1,083	168	96	431	**22,677**
1994	396	53	7	3,069	1,572	58	152	136	117	228	164	128	**6,080**
1995	155	57	62	92	105	1,758	2,197	2,116	0	74	113	144	**6,873**
1996	0	78	4,961	795	118	109	256	148	161	98	62	0	**6,786**
1997	62	30	8,800	963	70	118	149	150	145	194	137	465	**11,283**
1998	1,248	19,573	10,778	4,596	7,592	47	1,525	591	619	426	772	1,050	**48,817**
1999	736	775	50	3,277	1,284	269	119	116	120	193	106	178	**7,223**
2000	0	660	855	0	2,087	3,484	0	0	0	0	0	0	**7,086**
2001	0	389	1,218	867	221	0	0	0	0	0	0	0	**2,695**
2002	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2003	0	0	0	2,286	418	315	0	0	0	0	0	0	**3,019**
2004	0	59	1,004	0	0	0	0	0	0	0	0	60	**1,123**
2005	32,391	37,514	12,993	3,613	2,891	90	1,657	32	0	0	0	0	**91,181**
2006	1,403	2,185	2,648	5,906	3,395	2,307	0	0	0	0	0	0	**17,844**
2007	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2008	0	1,543	1,377	80	220	3,087	1,441	2,831	0	0	0	0	**10,579**
2009	0	571	1,027	954	0	0	0	0	0	0	0	0	**2,552**
2010	0	0	4,155	5,192	838	0	0	0	0	0	0	0	**10,185**
2011	572	1,180	5,562	12,049	1,165	1,719	0	0	0	0	0	0	**22,247**
2012	0	0	150	553	6	0	0	0	0	0	0	0	**709**
2013	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2014	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2015	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2016	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2017	0	3,261	355	1,639	2,357	7,606	4,363	0	0	0	0	0	**19,581**
2018	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2019	0	666	4,453	8,662	5,184	266	0	0	0	0	0	0	**19,231**

Notes

All values are in units of acre-feet.

Cal = calendar

Table 3-10
Releases from Bouquet Reservoir to Bouquet Creek (1980-2019)
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Cal Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	60.77	37.90	23.94	295.81	309.36	297.59	297.08	369.51	356.40	62.61	59.99	61.99	**2,232.95**
1981	61.99	55.99	60.77	402.14	514.98	299.38	308.74	307.51	297.59	54.63	68.90	62.61	**2,495.24**
1982	63.84	59.88	65.68	291.65	310.58	297.59	308.74	308.74	298.78	57.70	60.59	65.06	**2,188.83**
1983	63.84	57.66	63.84	204.34	336.36	326.70	332.07	331.45	299.38	69.97	67.72	65.06	**2,218.37**
1984	60.77	58.57	62.61	297.59	310.58	299.38	307.51	307.51	300.56	62.61	59.99	60.77	**2,188.45**
1985	60.77	55.99	61.99	297.59	309.36	298.78	309.36	308.74	307.69	65.06	62.96	66.90	**2,205.21**
1986	63.84	57.10	62.61	298.78	307.51	300.56	309.36	309.36	303.53	70.59	63.56	62.61	**2,209.40**
1987	66.90	61.54	70.59	300.56	310.58	297.59	311.20	308.74	301.75	65.06	62.96	63.84	**2,221.32**
1988	65.06	57.99	62.61	303.53	317.33	304.72	310.58	310.58	302.35	61.99	61.78	62.61	**2,221.14**
1989	65.06	58.77	61.99	298.78	313.65	301.75	309.36	311.20	299.38	97.59	63.56	62.61	**2,243.70**
1990	68.75	57.66	65.06	304.72	312.42	298.78	310.58	313.65	298.78	66.90	65.93	65.06	**2,228.31**
1991	65.68	58.77	68.75	303.53	314.27	304.72	310.58	312.42	304.72	70.59	63.56	66.90	**2,244.49**
1992	65.06	60.87	65.06	295.81	306.29	297.59	304.44	301.38	289.87	58.92	59.99	60.77	**2,166.06**
1993	60.15	57.10	60.15	289.87	305.67	291.65	311.20	307.51	301.75	62.61	59.99	62.61	**2,170.28**
1994	57.08	57.10	58.92	271.46	307.51	293.44	305.67	298.92	296.41	93.91	60.59	63.84	**2,164.85**
1995	60.15	53.78	60.15	294.62	305.67	297.59	305.67	308.74	296.41	68.75	58.81	61.99	**2,172.34**
1996	63.84	56.85	62.61	297.59	306.29	299.38	305.67	306.29	297.59	60.77	58.81	1.23	**2,116.90**
1997	60.77	54.89	65.06	296.41	306.29	296.41	306.29	304.44	296.41	81.02	60.59	62.61	**2,191.17**
1998	62.61	57.10	62.61	127.71	307.51	296.41	304.44	305.67	298.78	243.68	57.62	60.15	**2,184.30**
1999	61.99	55.99	60.77	293.44	307.51	296.41	305.67	305.67	294.62	67.52	60.59	61.99	**2,172.18**
2000	61.99	57.99	70.59	282.15	306.29	298.78	307.51	305.67	294.62	66.90	57.02	60.15	**2,169.68**
2001	60.77	57.10	65.06	292.84	318.56	287.50	306.29	305.67	295.81	63.84	60.59	62.61	**2,176.63**
2002	61.99	55.99	62.61	294.62	307.51	296.41	306.29	306.29	253.64	58.92	57.62	60.77	**2,122.66**
2003	58.92	54.89	65.06	296.41	306.29	296.41	306.29	306.29	292.84	60.77	58.81	60.77	**2,163.72**
2004	60.77	56.85	60.77	284.53	306.29	296.41	306.29	306.29	296.41	67.08	179.45	243.20	**2,464.31**
2005	21.62	26.87	1.03	55.68	65.91	61.89	114.46	62.96	60.96	60.89	58.89	62.96	**654.13**
2006	62.96	52.81	60.89	99.02	124.60	123.83	120.48	126.66	118.54	77.14	60.96	62.96	**1,090.86**
2007	62.96	56.96	62.96	111.34	126.66	122.66	124.60	126.66	122.66	126.66	122.66	103.04	**1,269.83**
2008	62.96	58.96	62.96	117.53	126.66	122.66	126.66	126.66	122.66	126.66	163.49	70.49	**1,288.37**
2009	63.38	59.88	86.65	289.32	316.38	306.73	316.62	306.90	297.00	306.50	297.99	64.35	**2,711.70**
2010	86.33	55.44	102.56	206.12	266.11	288.09	306.90	306.90	297.00	306.90	297.00	119.45	**2,638.81**
2011	60.83	98.88	60.98	202.36	302.98	298.62	306.90	306.90	278.78	302.33	160.78	65.06	**2,445.40**
2012	61.38	57.42	61.38	142.54	93.08	162.08	122.76	124.98	115.41	61.38	52.15	61.38	**1,115.95**
2013	61.38	122.32	184.14	64.39	46.33	44.06	69.93	61.38	55.72	36.04	36.29	29.22	**811.21**
2014	13.35	26.47	30.69	30.29	93.87	89.10	101.55	78.94	71.85	72.97	59.40	50.31	**718.80**
2015	42.97	38.81	55.78	61.93	61.38	59.40	69.91	73.66	58.59	49.10	48.13	29.54	**649.20**
2016	30.69	48.91	61.38	65.76	79.79	77.22	79.79	82.82	65.12	92.07	89.42	61.38	**834.35**
2017	61.38	55.44	61.38	59.40	61.38	66.69	113.30	122.76	118.80	122.76	84.39	92.07	**1,019.74**
2018	92.07	92.07	89.10	92.07	89.10	115.26	122.76	122.56	118.40	122.36	96.36	92.07	**1,244.19**
2019	92.07	92.07	58.51	65.68	90.64	106.84	122.76	122.56	122.76	122.76	122.76	122.76	**1,242.17**

Notes

All values are in units of acre-feet.

Cal = calendar

Table 3-11
Annual Groundwater Pumping Volumes from the Alluvial Aquifer
Development of a Numerical Groundwater Flow Model for theSanta Clara River Valley East Groundwater Subbasin

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NWD	Castaic1	244	257	253	189	251	274	295	450	520	478	444	561	515	458	496	401	385	535	166	426
	Castaic2	124	48	0	0	0	0	380	535	324	678	0	0	0	477	518	380	327	268	257	331
	Castaic3	0	108	136	172	240	301	0	0	324	0	660	532	488	0	0	0	0	0	0	0
	Castaic4	0	0	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	95	57	6
	Castaic 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Castaic 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pinetree1	346	326	355	242	148	273	8	0	2	152	0	47	16	247	154	79	64	89	227	403
	Pinetree2	58	84	209	112	154	113	206	309	351	348	31	0	283	326	218	165	70	0	0	0
	Pinetree3	398	527	225	432	753	655	719	756	758	672	801	724	682	450	607	595	624	812	716	505
	Pinetree4	0	0	0	0	3	28	234	77	4	0	0	0	10	19	232	55	333	510	338	5
	Pinetree5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCWD	Clark	303	228	131	137	194	200	208	342	248	301	407	542	662	635	572	662	1,027	873	697	878
	Guida	1,058	795	457	477	677	698	221	569	158	530	676	801	978	895	942	744	1,252	1,479	1,274	1,556
	Honby	594	447	257	268	381	392	193	391	462	216	930	893	731	1,393	476	553	352	814	532	1,162
	Lost Canyon 2	1,083	814	468	489	693	714	765	923	787	588	601	404	465	692	669	773	678	792	757	946
	Lost Canyon 2A	0	0	0	0	0	0	0	0	0	0	293	832	1,284	1,080	1,383	1,230	1,370	1,055	973	890
	Methodist	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mitchell 5A	1,189	893	515	537	761	785	444	582	485	435	264	3	474	663	564	610	598	633	482	913
	Mitchell 5b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	N.Oaks Central	488	367	211	220	313	322	304	361	153	329	525	704	701	1,403	1,313	965	851	870	1,490	1,682
	N.Oaks East	601	451	260	271	385	396	863	972	776	914	454	194	588	1,233	1,473	1,295	900	1,033	1,407	695
	N.Oaks West	643	483	278	290	412	424	874	465	842	413	275	78	634	866	972	795	663	952	934	1,894
	Sand Canyon	721	542	312	325	461	477	514	466	498	1,115	458	49	661	918	781	842	1,211	1,533	1,622	1,629
	SantaClara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sierra	2,787	2,086	1,202	1,255	1,780	1,834	856	220	459	730	772	719	1,050	1,413	1,433	1,092	1,034	597	814	1,158
	Stadium	0	0	0	0	0	0	167	291	211	214	328	374	60	825	418	656	509	637	444	338
	Valley Center	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VWD	D	289	269	164	163	240	41	0	305	588	614	510	680	239	173	494	403	454	1,134	1,209	921
	E15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I	214	200	122	121	177	181	95	0	91	132	73	108	1	0	1	0	0	0	0	0
	K2	0	0	0	0	0	0	0	0	0	0	0	982	1,134	1,708	2,089	1,155	1,305	1,076	1,489	1,420
	L2	9	8	5	5	7	91	0	0	0	0	0	838	526	996	1,236	818	961	308	190	532
	N	1,475	1,376	840	833	1,223	1,093	1,472	1,420	1,473	1,177	792	976	697	66	0	24	263	808	768	1,036
	N3	0	0	0	0	0	0	0	0	0	0	0	10	999	1,536	29	943	1,325	1,034	1,093	1,057
	N4	5	5	3	3	4	65	0	0	0	0	0	847	248	133	911	1,329	1,328	1,185	772	894
	N7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	N8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Q2	440	411	251	248	367	461	838	893	512	1,483	1,398	1,783	335	548	1,348	1,126	1,385	1,462	1,655	1,288
	S6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T2	621	580	354	351	515	704	894	913	1,007	1,030	643	662	379	0	3	280	733	837	941	726
	T4	160	150	91	91	133	54	167	0	0	0	0	163	687	3	1	975	1,258	804	523	892
	T7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	U3	1,476	1,378	841	834	1,225	1,278	1,033	638	323	823	1,254	1,199	369	1	2	765	987	851	560	702
	U4	1,306	1,220	744	738	1,084	665	668	606	696	567	551	584	42	3	2	7	742	789	529	828
	U6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W6	0	0	0	0	0	0	0	146	145	0	0	217	260	204	224	365	615	493	355	416
	W9	0	0	0	0	0	0	0	0	0	0	11	902	699	444	507	508	1,077	915	627	1,111
	W10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3-11
Annual Groundwater Pumping Volumes from the Alluvial Aquifer
Development of a Numerical Groundwater Flow Model for theSanta Clara River Valley East Groundwater Subbasin

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
NLF	161	317	370	271	223	314	220	170	0	0	0	120	82	401	753	791	0	0	0	0	123
	B10	0	0	0	0	0	0	0	0	0	0	0	291	1,225	452	1,406	894	1,045	930	1,244	1,155
	B11	186	217	159	133	184	138	60	0	0	127	445	311	0	136	51	127	151	30	250	212
	B5	1,218	1,423	1,041	858	1,208	772	1,178	1,002	1,481	1,928	1,893	1,880	860	989	1,950	1,921	1,649	1,756	1,273	1,748
	B6	858	1,002	733	604	850	543	946	788	165	96	137	263	615	283	808	1,359	1,421	1,602	1,572	2,133
	B7	0	0	0	0	0	0	60	0	0	127	0	0	400	180	581	373	56	286	176	444
	B14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	723	845	618	510	717	575	660	387	418	557	338	226	756	1,024	417	1,324	715	1,126	598	716
	C3	196	229	168	138	195	140	254	63	130	71	134	48	197	259	582	333	397	355	378	619
	C4	260	304	222	183	258	196	137	25	30	7	213	225	166	12	108	150	293	483	609	819
	C5	459	536	392	323	455	359	328	191	198	154	147	250	428	414	394	472	676	894	628	685
	C6	203	237	174	143	201	166	161	103	117	77	59	123	0	0	0	360	229	226	128	154
	C7	575	671	491	405	570	354	195	192	318	337	339	220	427	279	625	778	582	779	779	1,167
	C8	0	0	0	0	0	0	0	0	0	0	0	0	126	254	166	199	458	432	179	236
	C9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	E	2,067	2,416	1,767	1,457	2,051	3,342	1,842	1,180	812	624	965	498	1,325	1,513	1,022	1,366	2,542	1,949	1,522	2,506
	E2	174	203	149	123	173	138	103	0	0	251	1,284	830	560	584	555	115	669	525	426	138
	E3	0	0	0	0	0	0	0	0	0	0	0	0	0	15	138	0	0	0	0	0
	E4	1,011	1,181	864	712	1,003	639	716	83	566	392	553	284	376	16	0	381	140	339	80	281
	E5	0	0	0	0	0	0	0	0	0	0	0	0	65	274	0	142	514	598	42	0
	E7	0	0	0	0	0	0	0	0	0	0	0	0	116	80	105	88	79	2	0	0
	E9	96	113	82	68	96	78	117	288	476	411	339	596	252	187	435	319	12	142	170	42
	G45	324	378	277	228	321	179	153	98	123	99	143	146	165	82	144	137	159	180	144	231
	Q	441	515	377	311	438	159	360	382	312	185	15	0	0	0	0	0	0	0	0	0
	R	0	0	0	0	0	0	0	205	0	0	0	0	0	0	0	0	0	0	0	0
	R2	159	186	136	112	158	71	104	47	0	0	0	87	0	0	0	0	0	0	0	0
	S2	293	342	250	206	290	95	0	958	0	0	503	0	0	0	0	0	0	0	0	276
	S3	655	765	560	461	649	327	124	0	0	0	29	37	52	99	87	109	97	55	10	3
	Topco 1	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0
	W4	303	354	259	213	300	138	60	1	0	300	157	252	1	0	36	5	128	29	20	3
	W5	553	646	472	389	548	191	315	205	308	192	0	175	0	0	0	0	0	0	0	21
	X3	260	304	222	183	258	508	244	314	497	308	412	215	350	135	205	222	8	108	22	112
Robinson Ranch	—	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PDC	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,229	1,376	772	1,104	1,204	1,352	760	614	1,229	1,131
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	137	137	137	137	137	137	137	137	137	137	91	102	57	82	89	100	56	46	91	84
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	680	762	427	612	666	748	421	340	680	627
	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3-11
Annual Groundwater Pumping Volumes from the Alluvial Aquifer
Development of a Numerical Groundwater Flow Model for theSanta Clara River Valley East Groundwater Subbasin

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Total (NWD)	1,170	1,350	1,178	1,147	1,549	1,644	1,842	2,127	2,283	2,367	1,936	1,864	1,994	1,977	2,225	1,675	1,803	2,309	1,761	1,676
	Total (SCWD)	9,467	7,106	4,091	4,269	6,057	6,242	5,409	5,582	5,079	5,785	5,983	5,593	8,288	12,016	10,996	10,217	10,445	11,268	11,426	13,741
	Total (VWD)	5,995	5,597	3,415	3,387	4,975	4,633	5,167	4,921	4,835	5,826	5,232	9,951	6,615	5,815	6,847	8,698	12,433	11,696	10,711	11,823
	Total (All Purveyors)	**16,632**	**14,053**	**8,684**	**8,803**	**12,581**	**12,519**	**12,418**	**12,630**	**12,197**	**13,978**	**13,151**	**17,408**	**16,897**	**19,808**	**20,068**	**20,590**	**24,681**	**25,273**	**23,898**	**27,240**
	Total (NLF)	11,331	13,237	9,684	7,983	11,237	9,328	8,287	6,512	5,951	6,243	8,225	7,039	8,938	8,020	10,606	11,174	12,020	12,826	10,250	13,824
	Total (Robinson Ranch)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total (PDC)	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	2,000	2,240	1,256	1,798	1,959	2,200	1,237	1,000	2,000	1,842
	Total (Domestic)	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
	Total (Private and Domestic)	**14,831**	**16,737**	**13,184**	**11,483**	**14,737**	**12,828**	**11,787**	**10,012**	**9,451**	**9,743**	**10,725**	**9,779**	**10,694**	**10,318**	**13,065**	**13,874**	**13,757**	**14,326**	**12,750**	**16,166**
	Total Alluvial Aquifer Pumping	**31,463**	**30,790**	**21,868**	**20,286**	**27,318**	**25,347**	**24,205**	**22,642**	**21,648**	**23,721**	**23,876**	**27,187**	**27,591**	**30,126**	**33,133**	**34,464**	**38,438**	**39,599**	**36,648**	**43,406**

Note
All pumping volumes are listed in acre-feet (AF) and are from records maintained by SCV Water and its retail divisions.

Abbreviations
NLF= Newhall Land & Farming Company
NWD = Newhall County Water Division of SCV Water
PDC = Pitchess Detention Center (formerly known as Wayside Honor Rancho)
— = not available
SCV Water = Santa Clarita Valley Water Agency
SCWD = Santa Clarita Water Division of SCV Water
VWD = Valencia Water Division of SCV Water

Table 3-11
Annual Groundwater Pumping Volumes from the Alluvial Aquifer
Development of a Numerical Groundwater Flow Model for theSanta Clara River Valley East Groundwater Subbasin

Owner	Well Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NWD	Castaic1	118	345	385	561	456	360	557	392	596	347	320	464	424	87	340	214	0	32	421	379
	Castaic2	289	166	0	123	403	288	310	162	66	21	30	138	224	199	172	78	73	225	197	173
	Castaic3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Castaic4	7	100	47	56	80	66	198	38	0	0	0	0	0	0	0	0	0	0	0	0
	Castaic 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Castaic 7	0	0	0	0	0	0	0	0	498	965	1043	1046	890	680	871	839	553	518	108	492
	Pinetree1	245	164	0	0	0	131	242	343	197	181	151	186	173	53	0	0	0	0	0	0
	Pinetree2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pinetree3	494	566	544	525	643	336	427	473	257	306	299	475	395	119	0	0	0	0	0	0
	Pinetree4	355	300	5	0	0	208	415	399	103	40	0	122	0	0	0	0	0	0	0	0
	Pinetree5	0	0	0	0	0	0	0	0	0	0	480	785	525	267	0	0	0	5	2	0
SCWD	Clark	747	696	782	712	728	694	777	795	770	572	707	521	486	400	242	470	373	56	255	333
	Guida	853	1,047	1,320	1,230	1,432	1,487	1,479	1,384	1147	858	1095	962	971	974	781	613	405	237	347	405
	Honby	815	721	696	874	707	1,289	886	1,291	1314	1173	965	695	596	500	21	72	38	20	19	16
	Lost Canyon 2	708	741	730	644	785	853	837	802	1197	1015	666	848	739	674	570	69	0	12	12	203
	Lost Canyon 2A	998	1,034	905	593	756	738	799	554	609	567	268	583	611	460	160	314	287	104	387	534
	Methodist	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mitchell 5A	439	407	293	19	54	1,158	1,996	1,728	545	263	253	462	514	171	91	10	27	17	47	0
	Mitchell 5b	0	0	0	0	0	0	0	0	752	365	253	506	711	215	17	0	0	3	97	4
	N.Oaks Central	1,145	822	1,646	1,641	669	1,700	1,024	14	1232	849	746	801	710	724	406	3	69	37	20	70
	N.Oaks East	1,483	1,234	448	485	595	941	987	1,028	735	958	677	471	487	436	260	0	111	35	31	48
	N.Oaks West	1,663	898	1,123	31	858	904	1,143	30	1168	975	661	739	778	534	530	397	113	27	31	0
	Sand Canyon	1,317	930	705	195	562	1,260	1,557	1,408	1029	891	896	1009	995	733	331	548	251	85	332	621
	SantaClara	0	0	0	0	0	0	0	0	0	1116	1392	946	695	302	104	484	337	1	27	56
	Sierra	640	846	87	0	0	1,384	1,671	1,652	1381	446	806	616	1107	80	57	563	562	52	313	215
	Stadium	721	565	778	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Valley Center	0	0	0	0	0	0	0	0	0	29	1222	1036	792	1059	650	1054	912	221	547	257
VWD	D	880	646	772	687	833	1,178	1,048	870	680	559	1096	925	675	850	1087	1122	978	454	752	155
	E15	0	0	0	0	0	0	838	1,263	771	714	1095	822	1239	852	1676	1186	924	669	619	180
	I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	K2	861	669	954	364	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	L2	494	349	490	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	N	935	591	700	622	587	282	1,053	849	1281	933	315	683	403	955	1266	1175	837	724	948	437
	N3	778	226	857	255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	N4	710	458	909	248	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	N7	0	0	0	0	0	0	0	486	1326	1488	1538	876	1100	1299	1875	1342	1356	677	1340	649
	N8	0	0	0	0	0	0	0	539	958	1299	1306	1234	900	1086	1776	1352	1273	684	1165	546
	Q2	1,387	923	1,167	1,451	1,096	404	1,280	1,116	1711	1090	1409	1456	1238	1223	1264	1102	1177	798	1100	157
	S6	515	1,489	1,311	2,135	2,302	1,695	1,579	1,751	1812	1127	930	1078	1445	1836	2558	2127	2080	1370	1350	324
	S7	111	564	419	1,095	471	186	766	675	622	100	76	291	241	224	862	499	255	226	503	151
	S8	79	327	190	409	153	2,095	437	422	577	117	96	229	254	245	868	423	262	225	558	143
	T2	984	700	696	1,014	822	724	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T4	625	690	831	799	747	823	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T7	0	0	0	0	0	0	0	0	566	879	822	741	642	469	365	44	36	63	91	148
	U3	1,126	956	572	823	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	U4	1,073	942	796	934	625	1,049	750	790	1008	824	474	658	719	462	818	62	43	48	63	71
	U6	0	0	0	0	0	0	636	1,323	540	566	818	638	816	819	918	73	67	81	102	128
	W6	445	182	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W9	1,176	806	939	764	566	995	951	931	564	1210	535	867	1165	558	831	657	39	59	214	642
	W10	0	0	0	36	1,537	1,674	990	1,244	1113	1131	1618	1517	1474	1402	1745	1299	970	988	1384	999
	W11	0	0	0	0	123	1,123	1,556	881	794	422	926	760	459	484	1171	1142	835	671	648	513

Table 3-11
Annual Groundwater Pumping Volumes from the Alluvial Aquifer
Development of a Numerical Groundwater Flow Model for theSanta Clara River Valley East Groundwater Subbasin

Owner	Well Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
NLF	161	328	496	485	2,021	1,834	986	1,069	645	27	572	194	84	349	528	451	337	795	631	655	640
	B10	1,446	1,240	534	344	589	592	466	140	0	0	0	0	0	0	0	0	0	0	0	0
	B11	87	205	232	271	338	81	30	34	87	109	79	125	113	91	144	143	133	159	181	130
	B5	2,008	1,680	2,280	1,582	2,166	2,129	2,673	1,730	1394	1647	1782	1595	1048	1242	575	653	1130	755	873	723
	B6	870	1,312	2,175	1,766	1,356	1,090	1,216	834	1065	985	704	1053	785	746	573	762	729	459	476	725
	B7	461	474	584	402	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B14	0	0	0	0	0	0	239	1,125	614	879	831	868	1063	1247	585	394	1415	1279	711	901
	B15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	841	658
	B16	0	0	0	0	0	0	0	0	0	708	1198	1113	1474	1329	961	791	790	760	713	777
	B20	0	0	0	0	0	0	347	483	552	392	281	312	343	280	432	427	388	371	373	78
	C	1,034	1,319	1,720	1,373	1,202	1,091	1,197	817	717	1588	1585	1195	1203	1339	857	951	903	168	678	450
	C3	441	93	192	186	59	0	124	362	127	85	67	60	88	141	98	184	143	55	0	169
	C4	1,078	1,028	809	764	274	0	358	663	609	341	160	211	295	523	383	286	489	529	441	636
	C5	605	680	850	622	649	864	896	1,027	1034	36	378	465	576	550	428	829	571	4031	3336	1973
	C6	164	231	241	108	119	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C7	503	741	866	443	369	366	336	905	0	0	0	0	0	0	0	0	0	0	0	0
	C8	241	286	593	408	390	316	463	192	42	671	196	169	227	133	75	0	0	0	0	0
	C9	0	0	0	0	0	0	0	0	1	1	6	3	4	6	0	0	0	0	0	0
	C10	0	0	0	0	0	0	0	0	1622	1350	1738	2118	1982	2186	2387	1889	2073	60	3	832
	C11	0	0	0	0	0	0	271	355	540	1010	997	945	1513	1342	978	751	1211	1091	414	789
	C12	0	0	0	0	0	0	0	0	0	0	0	0	76	131	115	293	308	0	536	309
	E	1,854	1,700	17	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	E2	125	141	55	14	676	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	E3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	E4	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	E5	47	172	679	537	284	157	92	17	0	0	0	0	0	0	0	0	0	0	0	0
	E7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	E9	38	238	814	47	609	842	992	42	0	0	0	0	0	0	0	0	0	0	0	0
	G45	197	291	283	60	0	26	690	597	760	687	576	7	157	277	220	178	198	0	0	0
	Q	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S2	237	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Topco 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W4	0	46	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W5	17	276	104	23	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0
	X3	10	12	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Robinson Ranch	—	720	724	563	431	571	633	869	588	600	597	457	513	590	561	369	223	213	76	95	117
PDC	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	472	0	627	677	388	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	1,010	1,000	1,000	1,000	2,000	2,000	2,000	2,000	763	2000	851	614	713	725	870	450	541	530	655	578
	11	0	0	0	0	0	0	0	0	425	0	606	740	282	0	0	0	0	0	0	0
	15	75	74	72	173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17	559	530	530	1,100	1,105	842	1,026	85	1423	1432	979	734	917	1027	897	923	659	616	505	521
	18	0	0	0	0	0	0	0	0	423	0	383	461	422	557	315	395	417	484	451	461
	1A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3-11
Annual Groundwater Pumping Volumes from the Alluvial Aquifer
Development of a Numerical Groundwater Flow Model for theSanta Clara River Valley East Groundwater Subbasin

Owner	Well Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	Total (NWD)	1,508	1,641	981	1,265	1,582	1,389	2,149	1,807	1,717	1,860	2,323	3,216	2,631	1,405	1,383	1,131	626	780	728	1,044
	Total (SCWD)	11,529	9,941	9,513	6,424	7,146	12,408	13,156	10,686	11,879	10,077	10,607	10,195	10,192	7,262	4,220	4,597	3,485	907	2,465	2,762
	Total (VWD)	12,179	10,518	11,603	11,707	9,862	12,228	11,884	13,140	14,323	12,459	13,054	12,775	12,770	12,764	19,080	13,605	11,132	7,737	10,837	5,243
	Total (All Purveyors)	**25,216**	**22,100**	**22,097**	**19,396**	**18,590**	**26,025**	**27,189**	**25,633**	**27,919**	**24,396**	**25,984**	**26,186**	**25,593**	**21,431**	**24,683**	**19,333**	**15,243**	**9,424**	**14,030**	**9,049**
	Total (NLF)	11,857	12,661	13,514	10,999	10,991	8,648	11,477	9,968	9,191	11,061	10,772	10,323	11,296	12,091	9,262	8,868	11,276	10,348	10,231	9,790
	Total (Robinson Ranch)	720	724	563	431	571	633	869	588	600	597	457	513	590	561	369	223	213	76	95	117
	Total (PDC)	1,644	1,604	1,602	2,273	3,105	2,842	3,026	2,085	3,506	3,432	3,446	3,226	2,722	2,309	2,082	1,768	1,617	1,630	1,611	1,560
	Total (Domestic)	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
	Total (Private and Domestic)	**14,721**	**15,489**	**16,179**	**14,203**	**15,167**	**12,623**	**15,872**	**13,141**	**13,797**	**15,590**	**15,175**	**14,562**	**15,108**	**15,461**	**12,213**	**11,359**	**13,606**	**12,554**	**12,437**	**11,967**
	Total Alluvial Aquifer Pumping	**39,937**	**37,589**	**38,276**	**33,599**	**33,757**	**38,648**	**43,061**	**38,774**	**41,716**	**39,986**	**41,159**	**40,748**	**40,701**	**36,892**	**36,896**	**30,692**	**28,849**	**21,978**	**26,467**	**21,016**

Note
All pumping volumes are listed in acre-feet (AF) and are from records maintained by SCV Water and its retail divisions.

Abbreviations
NLF= Newhall Land & Farming Company
NWD = Newhall County Water Division of SCV Water
PDC = Pitchess Detention Center (formerly known as Wayside Honor Rancho)
— = not available
SCV Water = Santa Clarita Valley Water Agency
SCWD = Santa Clarita Water Division of SCV Water
VWD = Valencia Water Division of SCV Water

Table 3-12

Annual Groundwater Pumping from the Saugus Formation

Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
LACWWD36	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NWD	4	440	449	319	385	315	369	222	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	404	396	350	348	355	384	271	260	332	242	242	274	180	268	321	364	332	288	280	172
	9	0	0	0	0	119	227	115	138	1	0	5	1	1	0	4	1	1	0	1	0
	10	790	906	1,287	1,300	1,007	997	731	888	613	453	644	343	351	61	0	1	0	0	2	0
	11	729	870	716	754	1,159	1,278	2,209	2,371	1,265	1,280	1,252	1,034	428	730	614	522	353	81	14	0
	12	0	0	0	0	0	0	0	0	1,830	2,713	2,603	3,342	2,807	1,956	1,918	2,264	2,140	1,798	1,909	1,155
	13	0	0	0	0	0	0	0	0	0	0	0	0	1,393	2,053	2,246	1,623	2,045	3,001	2,351	1,295
NLF	156	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	266	445	426	479
SCWD	Saugus1	0	0	0	0	0	0	0	0	31	0	0	1,690	437	1,226	1,333	0	410	451	0	0
	Saugus2	0	0	0	0	0	0	0	0	32	0	40	3,091	2,476	1,675	2,530	1,726	1,766	617	0	0
VWD	157	635	604	529	239	387	314	581	483	1,223	1,146	635	1,005	570	436	616	403	46	80	0	0
	159	0	0	0	0	0	0	0	0	0	0	3	63	65	74	147	68	3	0	0	0
	160	1,571	1,725	869	806	1,087	1,126	1,336	1,401	1,581	1,848	1,378	1,805	1,026	1,359	1,431	1,038	753	949	556	604
	201	0	0	0	0	0	0	0	0	0	57	2,039	2,249	1,170	752	845	530	71	35	16	11
	205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	206		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	207	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (LACWWD36)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total (NWD)		**2,363**	**2,621**	**2,672**	**2,787**	**2,955**	**3,255**	**3,548**	**3,657**	**4,041**	**4,688**	**4,746**	**4,994**	**5,160**	**5,068**	**5,103**	**4,775**	**4,871**	**5,168**	**4,557**	**2,622**
Total (SCWD)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**63**	**0**	**40**	**4,781**	**2,913**	**2,901**	**3,863**	**1,726**	**2,176**	**1,068**	**0**	**0**
SCWD Pumping to Municipal Supply System		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*63*	*0*	*40*	*4,781*	*2,913*	*2,901*	*3,863*	*1,726*	*2,176*	*1,068*	*0*	*0*
SCWD Pumping to NPDES Discharge		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total (VWD)		**2,206**	**2,329**	**1,398**	**1,045**	**1,474**	**1,440**	**1,917**	**1,884**	**2,804**	**3,051**	**4,055**	**5,122**	**2,831**	**2,621**	**3,039**	**2,039**	**873**	**1,064**	**572**	**615**
VWD Pumping to Municipal Supply System		*1,644*	*1,808*	*897*	*611*	*854*	*885*	*1,427*	*1,305*	*2,300*	*2,529*	*3,516*	*4,642*	*2,385*	*2,182*	*2,565*	*1,586*	*326*	*516*	*149*	*106*
VWD Pumping to Golf Course Uses		*562*	*521*	*501*	*434*	*620*	*555*	*490*	*579*	*504*	*522*	*539*	*480*	*446*	*439*	*474*	*453*	*547*	*548*	*423*	*509*
VWD Pumping to NPDES Discharge		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
VWD Other Non-System Pumping		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total (All Purveyors)		**4,569**	**4,950**	**4,070**	**3,832**	**4,429**	**4,695**	**5,465**	**5,541**	**6,908**	**7,739**	**8,841**	**14,897**	**10,904**	**10,590**	**12,005**	**8,540**	**7,920**	**7,300**	**5,129**	**3,237**
Pumping to Municipal Supply System		*4,007*	*4,429*	*3,569*	*3,398*	*3,809*	*4,140*	*4,975*	*4,962*	*6,404*	*7,217*	*8,302*	*14,417*	*10,458*	*10,151*	*11,531*	*8,087*	*7,373*	*6,752*	*4,706*	*2,728*
Pumping to Golf Course Uses		*562*	*521*	*501*	*434*	*620*	*555*	*490*	*579*	*504*	*522*	*539*	*480*	*446*	*439*	*474*	*453*	*547*	*548*	*423*	*509*
Pumping to NPDES Discharge		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total (NLF)		**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**266**	**445**	**426**	**479**
Total Saugus Formation Pumping		**4,589**	**4,970**	**4,090**	**3,852**	**4,449**	**4,715**	**5,485**	**5,561**	**6,928**	**7,759**	**8,861**	**14,917**	**10,924**	**10,610**	**12,025**	**8,560**	**8,186**	**7,745**	**5,555**	**3,716**

Note

All pumping volumes are listed in acre-feet (AF) and are from records maintained by SCV Water and its retail divisions.

Abbreviations

LACWD36 = Los Angeles County Waterworks District 36
NPDES = National Pollutant Discharge Elimination System
NLF= Newhall Land & Farming Company
SCV Water = Santa Clarita Valley Water Agency
NWD = Newhall County Water Division of SCV Water
SCWD = Santa Clarita Water Division of SCV Water
VWD = Valencia Water Division of SCV Water

GSI Water Solutions, Inc.

Table 3-12

Annual Groundwater Pumping from the Saugus Formation

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Owner	Well Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
LACWWD36	19	0	0	0	0	0	0	0	0	0	0	0	0	794	811	1,238	973	1,046	1,093	1,204	972
NWD	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	1,767	1,242	1,758	1,013	1,833	1,878	2,305	1,397	2,188	1,906	2,223	2,326	2,130	2,475	2,532	1,710	2,028	802	117	1,112
	13	419	1,190	1,637	1,500	1,906	1,557	1,118	2,294	2,006	1,962	1,950	2,063	1,951	1,360	1,317	1,987	1,815	721	1,762	1,552
NLF	156	374	300	211	122	268	6	934	971	330	379	366	344	0	0	0	0	0	0	0	0
SCWD	Saugus1	0	0	0	0	0	0	0	0	0	0	909	1,617	1,807	1,478	813	1,726	1,715	1,345	1,609	1,658
	Saugus2	0	0	0	0	0	0	0	0	0	0	733	1,317	1,149	1,630	1,690	1,235	1,692	1,648	1,310	1,528
VWD	157	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	159	0	91	0	30	9	25	1	40	22	26	32	15	7	15	8	183	225	232	27	9
	160	1,124	1,189	936	863	1,527	844	583	681	741	955	945	532	592	693	680	552	546	664	621	554
	201	295	128	495	168	148	299	396	133	106	135	49	0	0	0	0	0	0	0	1,931	1,156
	205	101	0	123	511	813	1,478	613	772	562	716	728	70	5	0	0	0	0	0	0	3
	206	0	0	0	0	0	366	1,362	1,397	963	1,599	1,799	181	191	274	1,193	889	1,326	656	1,331	716
	207	0	0	0	0	0	0	0	0	0	0	0	0	93	302	1,130	2,025	1,446	702	1,493	940
Total (LACWWD36)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**794**	**811**	**1,238**	**973**	**1,046**	**1,093**	**1,204**	**972**
Total (NWD)		**2,186**	**2,432**	**3,395**	**2,513**	**3,739**	**3,435**	**3,423**	**3,691**	**4,194**	**3,868**	**4,173**	**4,389**	**4,081**	**3,835**	**3,849**	**3,697**	**3,843**	**1,523**	**1,879**	**2,664**
Total (SCWD)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1,642**	**2,934**	**2,956**	**3,108**	**2,503**	**2,961**	**3,407**	**2,993**	**2,919**	**3,186**
SCWD Pumping to Municipal Supply System		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1,642*	*2,784*	*2,956*	*3,108*	*2,503*	*2,961*	*3,407*	*2,993*	*2,919*	*3,186*
SCWD Pumping to NPDES Discharge		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*150*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total (VWD)		**1,520**	**1,408**	**1,554**	**1,572**	**2,497**	**3,012**	**2,955**	**3,023**	**2,394**	**3,431**	**3,553**	**798**	**888**	**1,284**	**3,011**	**3,649**	**3,543**	**2,254**	**5,403**	**3,378**
VWD Pumping to Municipal Supply System		*1,007*	*835*	*965*	*1,068*	*1,962*	*2,513*	*2,449*	*2,367*	*1,771*	*2,836*	*2,995*	*265*	*302*	*594*	*2,339*	*2,929*	*2,789*	*1,370*	*2,838*	*1,667*
VWD Pumping to Golf Course Uses		*513*	*573*	*589*	*504*	*535*	*499*	*506*	*656*	*623*	*595*	*558*	*533*	*586*	*690*	*672*	*720*	*754*	*884*	*634*	*543*
VWD Pumping to NPDES Discharge		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1,931*	*1,156*
VWD Other Non-System Pumping		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*3*
Total (All Purveyors)		**3,706**	**3,840**	**4,949**	**4,085**	**6,236**	**6,447**	**6,378**	**6,714**	**6,588**	**7,299**	**9,368**	**8,121**	**8,719**	**9,038**	**10,601**	**11,280**	**11,839**	**7,863**	**11,405**	**10,200**
Pumping to Municipal Supply System		*3,193*	*3,267*	*4,360*	*3,581*	*5,701*	*5,948*	*5,872*	*6,058*	*5,965*	*6,704*	*8,810*	*7,438*	*8,133*	*8,348*	*9,929*	*10,560*	*11,085*	*6,979*	*8,840*	*8,501*
Pumping to Golf Course Uses		*513*	*573*	*589*	*504*	*535*	*499*	*506*	*656*	*623*	*595*	*558*	*533*	*586*	*690*	*672*	*720*	*754*	*884*	*634*	*543*
Pumping to NPDES Discharge		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*150*	*0*	*0*	*0*	*0*	*0*	*0*	*1,931*	*1,156*
Total (NLF)		**374**	**300**	**211**	**122**	**268**	**6**	**934**	**971**	**330**	**379**	**366**	**344**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Saugus Formation Pumping		**4,080**	**4,140**	**5,160**	**4,207**	**6,504**	**6,453**	**7,312**	**7,685**	**6,918**	**7,678**	**9,734**	**8,465**	**8,719**	**9,038**	**10,601**	**11,280**	**11,839**	**7,863**	**11,405**	**10,200**

Note

All pumping volumes are listed in acre-feet (AF) and are from records maintained by SCV Water and its retail divisions.

Abbreviations

LACWD36 = Los Angeles County Waterworks District 36

NPDES = National Pollutant Discharge Elimination System

NLF= Newhall Land & Farming Company

SCV Water = Santa Clarita Valley Water Agency

NWD = Newhall County Water Division of SCV Water

SCWD = Santa Clarita Water Division of SCV Water

VWD = Valencia Water Division of SCV Water

GSI Water Solutions, Inc.

Table 3-13
Distribution of Pumping by Month for Agricultural and Urban Production Wells
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Month	% of Annual Water Use (Agricultural)	% of Annual Water Use (Urban)	% of May-Oct Water Use (Urban)
January	3.8%	6.3%	
February	5.0%	6.0%	
March	6.6%	6.7%	
April	9.1%	8.1%	
May	10.6%	9.1%	15.2%
June	11.4%	9.7%	16.2%
July	14.1%	10.8%	18.1%
August	12.9%	11.3%	18.9%
September	10.2%	10.2%	17.1%
October	7.5%	8.7%	14.5%
November	5.0%	7.0%	
December	3.8%	6.1%	
Total	**100.0%**	**100.0%**	**100.0%**

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Table 3-14
Hydraulic Conductivity Zones Used in the Numerical Model
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Old Zone Number	Horizontal Hydraulic Conductivity (ft/day)	Vertical Hydraulic Conductivity (ft/day)	Vertical Hydraulic Conductivity (cm/sec)
1	0.1	0.01	3.5E-06
2	0.2	0.002	7.1E-07
3	0.3	0.01	3.5E-06
4	0.3	0.015	5.3E-06
5	0.4	0.04	1.4E-05
6	1	0.002	7.1E-07
7	1	0.01	3.5E-06
8	1	0.01	3.5E-06
9	1	0.02	7.1E-06
10	1	0.1	3.5E-05
11	2	0.02	7.1E-06
12	2	0.2	7.1E-05
13	2	0.2	7.1E-05
14	2	1	3.5E-04
15	4	0.002	7.1E-07
16	5	0.5	1.8E-04
17	5	1	3.5E-04
18	6.5	0.3	1.1E-04
19	6.5	0.325	1.1E-04
20	10	0.02	7.1E-06
21	20	0.01	3.5E-06
22	30	0.01	3.5E-06
23	30	0.3	1.1E-04
24	50	1	3.5E-04
25	75	7.5	2.6E-03
26	75	7.5	2.6E-03
27	100	1	3.5E-04
28	100	1	3.5E-04
29	100	5	1.8E-03
30	175	1	3.5E-04
31	250	10	3.5E-03
32	250	25	8.8E-03
33	250	25	8.8E-03
34	250	25	8.8E-03
35	300	1	3.5E-04
36	300	15	5.3E-03
37	375	37.5	1.3E-02
38	400	15	5.3E-03
39	600	60	2.1E-02
40	700	45	1.6E-02
41	700	70	2.5E-02
42	800	15	5.3E-03
43	1,000	35	1.2E-02
44	1,200	12	4.2E-03
45	1,200	120	4.2E-02
46	1,200	120	4.2E-02
47	1,200	120	4.2E-02
48	1,200	120	4.2E-02
49	1,400	15	5.3E-03
50	1,400	35	1.2E-02
51	1,500	150	5.3E-02

Note

ft/day = feet or foot per day   cm/sec = centimeters per second

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Table 3-15
Test Results and Hydraulic Conductivity Estimates for Wells with High Specific Capacity in the Alluvial Aquifer
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Owner	Well Name	Alluvial Subarea	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=80%)	T (ft^2/day) (E=60%)	Known or Estimated Depth to Top of Screen (ft)	Estimated Depth to Bottom of Alluvium (ft)	Estimated Depth to Static Water (ft)	Estimated Saturated Thickness (ft)	Reported Typical Saturated Thickness of Alluvium (ft)	Selected Saturated Thickness (ft)	Kh (ft/day) (E=80%)	Kh (ft/day) (E=60%)
Along the Santa Clara River																			
NLF	B5	Below Valencia WRP	3/28/2000	2357	6	392.8	6	4.2	3	98,463	131,283	30	100	10.8	89	110	90	1,090	1,460
VWD	N4	Below Saugus WRP	11/21/1991	1510	5.5	274.5	5.5	3.85	2.75	68,808	91,745	76	175	44	131	170	130	530	710
SCWD	Stadium	Above Saugus WRP	3/19/1974	1046	2.8	373.6	2.8	1.96	1.4	93,650	124,866	33	130	25	105	115	105	890	1,190
VWD	U3	Above Saugus WRP	8/15/1973	1997	4.7	424.9	4.7	3.29	2.35	106,509	142,012	39	133	27.6	105	115	105	1,010	1,350
VWD	U4	Above Saugus WRP	8/13/1973	2679	8	334.9	8	5.6	4	83,949	111,932	30	130	---	---	115	105	800	1,070
SCWD	N. Oaks Central	At and Above Mint Canyon	9/17/1998	1450	4.8	302.1	4.8	3.36	2.4	75,727	100,969	50	117	28.6	88	90	90	840	1,120
SCWD	Sand Canyon	At and Above Mint Canyon	9/1/1979	825	2.6	317.3	2.6	1.82	1.3	79,537	106,049	60	130	14	116	90	115	690	920
SCWD	Sierra	At and Above Mint Canyon	3/15/1983	1950	5.5	354.5	5.5	3.85	2.75	88,862	118,483	60	120	21	99	90	100	890	1,180
In Tributary Valleys																			
NLF	R2	Bouquet Canyon	10/29/1947	1680	6.4	262.5	6.4	4.48	3.2	65,800	87,734	40	140	---	---	90	90	730	970
SCWD	Clark	Bouquet Canyon	6/6/1972	814	4	203.5	4	2.8	2	51,011	68,015	56	96	---	---	90	90	570	760
SCWD	Guida	Bouquet Canyon	9/1/1979	990	3.6	275	3.6	2.52	1.8	68,934	91,912	20	95	37	58	90	80	860	1,150
NLF	E	Castaic Valley	4/10/1984	1726	7.8	221.3	7.8	5.46	3.9	55,473	73,964	12	93	17.3	76	105	100	550	740
NLF	E2	Castaic Valley	6/5/1996	1473	5.8	254	5.8	4.06	2.9	63,670	84,893	30	105	17.3	88	105	100	640	850

Notes

The reported typical saturated thicknesses are based on examining values reported by RCS (2002; see Table 4.4) for wet vs. normal vs. dry years (1945, 1965, 1985, and 2000).

E = well efficiency
ft = feet or foot
ft/day = feet per day
ft^2/day = square feet per day
gpm/ft = gallons per minute per foot
gpm/ft = gallons per minute per foot
Kh = horizontal hydraulic conductivity
NLF= Newhall Land & Farming Company
SCWD = Santa Clarita Water Division
T = transmissivity, which is calculated as 1,500 times the specific capacity per the method recommended by Driscoll (1986) for unconfined aquifers.
VWD = Valencia Water Division
WRP = water reclamation plant

Table 3-16
Summary of Selected Tests and Estimated Parameter Values for the Saugus Formation
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Well Owner-Name	Model Layers for Open Interval	Test Date	Type of Test	Pumping or Injection Rates (gpm)	Length of Test (minutes)	Well Monitored (Distance from Pumping / Injection Well)	Specific Capacity (gpm/ft)[a]	T (gpd/ft)	T (ft^2/day)	Thickness of Producing Zones[b]	Open Interval Length (ft)	K (ft/day)	Storativity
NWD-7	3, 4, 5	3/4/1987	Drawdown	341	1,440	NWD-7	3.1	26,400	3,530	1,000	454	7.8	
		3/5/1987	Recovery		1,500	NWD-7		23,300	3,110	feet	454	6.9	
NWD-9	2, 3	3/17/1987	Drawdown	256	1,460	NWD-9	1.9	3,700	490	400 to 600	363	1.3	
		3/17/1987	Recovery		1,500	NWD-9		3,000	400	feet	363	1.1	
NWD-10	4, 5	3/11/1987	Drawdown	364	1,440	NWD-10	8.3	28,500	3,810	1,000 to 1,100	764	5.0	
		3/11/1987	Drawdown	364	1,440	NWD-12 (160 feet)		57,700	7,710	feet	764	10.1	9.10E-04
		3/11/1987	Recovery		1,480	NWD-10		38,400	5,130		764	6.7	
		3/11/1987	Recovery		1,490	NWD-12 (160 feet)		61,500	8,220		764	10.8	7.60E-04
VWD-160	4, 5, 6	3/24/1987	Drawdown	2,562	720	VWD-160	49.8	163,000	21,790	1,200 to 1,400	1,050	20.8	
		3/24/1987	Recovery		850	VWD-160		182,000	24,330	feet	1,050	23.2	
VWD-201	3, 4, 5, 6	10/1/2000	Pumping	2,439	14,440 / 2,880	VWD-201	30	65,100	8,700	1,000 to 1,200	1,130	7.7	5.75E-04
		10/1/2000	Pumping + Recovery	2,439	14,440 / 2,880	VWD-157 (1,900 feet)		44,230	5,910	feet	1,130	5.2	1.17E-03
		10/1/2000	Pumping + Recovery	2,439	14,440 / 2,880	VWD-205M (2,360 feet)		57,210	7,650		1,130	6.8	8.49E-04
		10/1/2000	Pumping + Recovery	2,439	14,440 / 2,880	VWD-205 (2,400 feet)		47,890	6,400		1,130	5.7	6.75E-04
VWD-205	4, 5, 6	7/1/2000	Injection + Recovery	500-800-1,100	30,240 / 12,960	VWD-205M (40 feet)	12.2	41,370	5,530	1,000 to 1,200	1,110	5.0	8.88E-04
		7/2/2000	Injection + Recovery	500-800-1,100	30,240 / 12,960	VWD-201 (2,400 feet)		50,450	6,740	feet	1,110	6.1	7.56E-04
		7/3/2000	Injection + Recovery	500-800-1,100	30,240 / 12,960	VWD-157 (4,100 feet)		54,880	7,340		1,110	6.6	6.45E-04
		8/1/2000	Pumping	2,273	12,960 / 14,440	VWD-205	18.7						
		8/1/2000	Pumping + Recovery	2,273	12,960 / 14,440	VWD-205M (40 feet)	18.7	78,910	10,550		1,110	9.5	9.48E-04
		8/2/2000	Pumping + Recovery	2,273	12,960 / 14,440	VWD-201 (2,400 feet)		76,410	10,220		1,110	9.2	1.37E-03
		8/3/2000	Pumping + Recovery	2,273	12,960 / 14,440	VWD-157 (4,100 feet)		65,880	8,810		1,110	7.9	1.36E-03
SCWD-Saugus1	3, 4, 5, 6	7/1/1988	Pumping	2,941	1,440	SCWD-Saugus1	30.2	69,300	9,260	1,200 to 1,400	1,130	8.2	
		7/1/1988	Recovery	2,941	480	SCWD-Saugus1		59,700	7,980	feet	1,130	7.1	
SCWD-Saugus2	3, 4, 5, 6	9/1/1988	Pumping	2,531	2,880	SCWD-Saugus2	24.1	53,500	7,150	1,200 to 1,400	1,101	6.5	
		9/1/1988	Recovery	2,531	1,320	SCWD-Saugus2		55,700	7,450	feet	1,101	6.8	
		9/1/1988	Pumping	2,531	2,880	SCWD-Saugus1		71,500	9,560		1,101	8.7	3.60E-04
		9/1/1988	Recovery	2,531	1,320	SCWD-Saugus1		60,200	8,050		1,101	7.3	

Notes

Data source: RCS, 2002. The estimated hydraulic conductivity (K) values are calculated by GSI Water Solutions.

[a]Galllons per minute per foot of drawdown
ft/day = feet per day
gpd/ft = gallons per day per foot
gpm = gallons per minute
K = hydraulic conductivity
SCV Water = Santa Clarita Valley Water Agency
SCWD = Santa Clarita Water Division of SCV Water

[b]From Plate 3.2 in RCS, 2002.
ft^2/day = square feet per day
gpd/ft = gallons per day per foot
gpm/ft^2= gallons per minute per square foot
T = transmissivity
NWD = Newhall Water Division of SCV Water
VWD = Valencia Water Division of SCV Water

Table 4-1
Production Wells Used for Calibration of the Regional Model
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

Well Owner-Well Name	Year Drilled	Status in 2019	Data Use for Model Calibration Process	Easting (feet)[1]	Northing (feet)[1]	Measuring Point Elevation (feet NAVD88)	Well Depth (feet bgs)	Depth to Top of Open Interval (feet bgs)	Depth to Base of Open Interval (feet bgs)	Type of Open Interval
Alluvial Aquifer Below Valencia WRP										
NLF-B7	1946	Active	Hydrographs & Statistics	6364397	1974200	901.6	102	18	88	Knife Cut
NLF-B10	1956	Active	Hydrographs & Statistics	6364235	1974541	901.4	142	30	130	Knife Cut
NLF-B11	---	Active	Hydrographs & Statistics	6362161	1971971	890	160	---	---	---
NLF-B14	2006	Active	Hydrographs & Statistics	6364610	1974815	904	250	60	235	Screen
NLF-B16	2005	Active	Hydrographs & Statistics	6364235	1974541	901	160	50	135	Screen
NLF-C4	1939	Active	Hydrographs & Statistics	6371437	1976775	953	148	25	120	Knife Cut
NLF-C10	2007	Active	Hydrographs & Statistics	6371677	1977813	958	200	70	170	Screen
NLF-G3	---	Inactive	Hydrographs & Statistics	6377122	1981837	1002	190	90	160	Screen
NLF-G45	---	Inactive	Statistics	6381356	1982222	1029	140	40	140	Knife Cut
NLF-X3	1954	Inactive	Hydrographs & Statistics	6378422	1983172	1014	161	75	145	Knife Cut
VWD-E17	2005	Inactive	Hydrographs & Statistics	6372981	1979707	983	150	80	120	Screen
Alluvial Aquifer Below Saugus WRP										
VWD-I	1945	Inactive	Hydrographs & Statistics	6388567	1981657	1089	165	30	165	---
VWD-N	1936	Active	Hydrographs & Statistics	6395527	1976081	1131.56	237	76	237	Knife Cut
VWD-N7	2004	Active	Hydrographs & Statistics	6395551	1976309	1131.61	175	120	175	Screen
VWD-N8	2004	Active	Statistics	6396002	1976313	1133.31	175	120	175	Screen
VWC-Q2	1954	Active	Hydrographs & Statistics	6399032	1977459	1158	170	76	126	Knife Cut
VWD-S6	1999	Active	Statistics	6393030	1978313	1127.16	195	130	195	Screen (Louvers)
VWD-S7	1999	Active	Statistics	6394379	1977732	1128.64	190	130	190	Screen (Louvers)
VWD-S8	1999	Active	Hydrographs & Statistics	6395968	1977596	1143.36	195	130	195	Screen (Louvers)
Alluvial Aquifer Above Saugus WRP										
SCWD-Stadium	1946	Destroyed	Statistics	6402385	1974713	1197	130	33	130	Knife Cut
VWD-T2	1952	Destroyed	Statistics	6403623	1975127	1201	150	50	138	Knife Cut
VWD-T4	1953	Destroyed	Hydrographs & Statistics	6403350	1975164	1194	150	50	135	Knife Cut
VWD-T7	2008	Active	Hydrographs & Statistics	6403920	1975210	1211.08	140	80	115	Screen (Louvers)
VWD-U3	1950	Destroyed	Statistics	6409838	1976455	1263	142	39	133	---
VWD-U4	1944	Active	Hydrographs & Statistics	6407736	1975507	1242.8	135	30	130	Knife Cut
VWD-U6	2004	Active	Hydrographs & Statistics	6405885	1974975	1230.6	175	100	145	Screen (Louvers)
SCWD-Honby	1959	Active	Hydrographs & Statistics	6411408	1977202	1290	202	50	202	Screen
SCWD-Santa Clara	2009	Active	Hydrographs & Statistics	6412073	1977514	1289	160	90	135	Screen (Louvers)
SCWD-Valley Center	2009	Active	Hydrographs & Statistics	6409117	1976637	1262	133	90	125	Screen (Louvers)
Alluvial Aquifer At and Above Mint Canyon										
SCWD-North Oaks West	1940	Active	Hydrographs & Statistics	6421187	1972857	1400	117	78	117	Knife Cut
SCWD-NorthOaks Central	1965	Active	Hydrographs & Statistics	6421383	1972922	1400	140	50	140	Screen
SCWD-NorthOaks East	1940	Active	Hydrographs & Statistics	6421651	1972936	1400	140	76	138	Knife Cut
SCWD-Sierra	1973	Active	Hydrographs & Statistics	6423745	1973272	1430	175	60	150	Screen
SCWD-Mitchell-5A	1976	Active	Hydrographs & Statistics	6430168	1974420	1500	135	76	246	Screen
SCWD-Mitchell-5B	2001	Active	Hydrographs & Statistics	6430168	1974420	1500	145	80	115	Screen
SCWD-Sand Canyon	1973	Active	Hydrographs & Statistics	6432953	1975589	1520	140	60	140	Screen
SCWD-Lost Canyon 2	1965	Active	Hydrographs & Statistics	6433582	1975573	1520	125	125	125	Open Bottom
SCWD-Lost Canyon 2A	1989	Active	Hydrographs & Statistics	6433492	1975620	1520	126	95	125	Screen
NWD-Pinetree1	1966	Active	Hydrographs & Statistics	6439862	1978092	1602.5	210	50	210	Knife Cut
NWD-Pinetree2	1952	Destroyed	Hydrographs & Statistics	6438464	1978022	1592	132	70	130	---
NWD-Pinetree3	1969	Active	Hydrographs & Statistics	6436407	1977772	1570.5	135	50	135	Screen (Louvers)
NWD-Pinetree4	1975	Active	Hydrographs & Statistics	6435493	1977619	1562	185	110	185	Screen (Louvers)
NWD-Pinetree5	2009	Active	Hydrographs & Statistics	6438464	1978022	1592	160	70	130	Screen (Louvers)
Alluvial Aquifer in Castaic Valley										
NLF-C6	1939	Active	Hydrographs & Statistics	6371835	1978154	967	103	26	93	Knife Cut
NLF-E	1937	Inactive	Hydrographs & Statistics	6376155	1987015	1027	---	12	93	Knife Cut
NLF-E4	1940	Active	Statistics	6374844	1982371	994	142	50	136	Knife Cut
VWD-D	1950	Active	Hydrographs & Statistics	6375668	1987267	1035.62	142	60	136	Knife Cut
VWD-E14	2005	Inactive	Hydrographs & Statistics	6376184	1982733	1000	---	75	115	---
VWD-E15	2005	Active	Hydrographs & Statistics	6377260	1983738	1022.96	---	90	135	---
VWD-E16	2005	Inactive	Hydrographs & Statistics	6375816	1982320	996	---	80	145	---
NWD-Castaic1	1966	Active	Hydrographs & Statistics	6376482	2000975	1129	142	74	140	Louvre and Perf
NWD-Castaic2	1951	Active	Hydrographs & Statistics	6376420	2002313	1135	140	55	140	---
NWD-Castaic3	1961	Inactive	Hydrographs & Statistics	6376475	2002309	1135	135	55	135	---
NWD-Castaic4	1987	Inactive	Hydrographs & Statistics	6377087	2001454	1129	165	59.5	165	Knife Cut
NWD-Castaic6	2008	Inactive	Hydrographs & Statistics	6376020	2002730	1146	142	---	120	Screen
NWD-Castaic7	2008	Active	Hydrographs & Statistics	6376007	2002291	1149	150	80	125	Screen
Alluvial Aquifer in San Francisquito Canyon										
NLF-W5	---	Inactive	Hydrographs & Statistics	6393674	1985976	1156.5	---	20	116	---
VWD-W6	1952	Destroyed	Hydrographs & Statistics	6393801	1985449	1155	158	90	153	Knife Cut
VWD-W9	1990	Active	Statistics	6393191	1986829	1174.99	130	70	130	Screen
VWD-W10	1999	Active	Hydrographs & Statistics	6392133	1981322	1130.28	160	120	160	Screen (Louvers)
VWD-W11	2004	Active	Hydrographs & Statistics	6395175	1990192	1208.25	155	110	155	Screen (Louvers)
Alluvial Aquifer in Bouquet Canyon										
SCWD-Clark	1946	Active	Hydrographs & Statistics	6405894	1983061	1260	115	20	115	Knife Cut
SCWD-Guida	1960	Active	Hydrographs & Statistics	6411663	1988666	1350	123	56	123	Screen
Saugus Formation										
LACWWD36-19	2012	Active	Hydrographs & Statistics	6368049	1992202	1410	---	400	2100	---
NWD-7	1954	Inactive	Hydrographs & Statistics	6401264	1962732	1250	994	520	974	Knife Cut
NWD-9	1958	Inactive	Hydrographs & Statistics	6404122	1956997	1358	675	311	674	Screen (Louvers)
NWD-10	1961	Inactive	Hydrographs & Statistics	6399388	1965803	1204	1555	780	1544	Screen (Louvers)
NWD-11	1973	Active	Hydrographs & Statistics	6399004	1968019	1188	1136	200	1075	Screen (Louvers)
NWD-12	1985	Active	Hydrographs & Statistics	6399282	1965920	1204	1340	485	1280	Screen (Louvers)
NWD-13	1990	Active	Hydrographs & Statistics	6399098	1967327	1194	1300	420	830	Screen
SCWD-Saugus1	1988	Inactive	Hydrographs & Statistics	6397847	1973452	1165.5	1640	490	1620	Screen
SCWD-Saugus2	1988	Inactive	Hydrographs & Statistics	6398514	1972540	1170	1612	510	1590	Screen
VWD-157	1962	Destroyed	Hydrographs & Statistics	6395696	1974099	1148	2008	586	2008	Vertical Slots
VWD-159	---	Active	Hydrographs & Statistics	6390972	1962392	1291.2	---	662	1900	---
VWD-160	1964	Active	Hydrographs & Statistics	6388950	1976191	1102.1	2000	950	2000	Screen (Louvers)
VWD-201	1989	Active	Hydrographs & Statistics	6394125	1973032	1151.7	1690	540	1670	Screen (Louvers)
VWD-205	2000	Active	Hydrographs & Statistics	6391703	1973191	1148.5	---	820	1930	---
VWD-206	2005	Active	Hydrographs & Statistics	6379895	1979309	1058.6	---	490	2040	---
VWD-207	2011	Active	Hydrographs & Statistics	6379936	1978292	1035.7	---	507	1199	---

Notes

[1]Coordinates are listed in California State Plane, NAD83 Datum, Zone V.
-- = No data available.
bgs = below ground surface
MSL = mean sea level
NAVD88 = North American Vertical Datum of 1988

SCV Water = Santa Clarita Valley Water Agency
NWD = Newhall Water Division of SCV Water
SCWD = Santa Clarita Water Division of SCV Water
VWD = Valencia Water Division of SCV Water
WRP = water reclamation plant

Table 4-2

Observation Wells Used for Calibration of the Regional Model

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Well Owner-Well Name	Year Drilled	Status in 2019	Data Use for Model Calibration Process	Easting (feet)[a]	Northing (feet)[a]	Measuring Point Elevation (feet MSL)	Well Depth (feet bgs)	Depth to Top of Open Interval (feet bgs)	Depth to Base of Open Interval (feet bgs)	Type of Open Interval
Alluvial Aquifer										
AL-12A	2004	Active	Hydrographs & Statistics	6397974	1973448	1165.63	80	60	80	Screen
LACFCD-7177B	1949?	Active	Hydrographs & Statistics	6434745	1976476	1542	---	---	---	---
LACFCD-7197D	---	Active	Hydrographs & Statistics	6438052	1977798	1582	---	---	---	---
Saugus Formation										
DW-1A	2012	Active	Hydrographs	6393492	1975565	1127.61	805	780	800	Screen
DW-1B	2012	Active	Hydrographs & Statistics	6393492	1975565	1127.54	1010	985	1005	Screen
DW-1C	2012	Active	Hydrographs	6393492	1975565	1127.43	1205	1180	1200	Screen
DW-2	2012	Active	Hydrographs & Statistics	6390584	1976140	1114.99	945	920	940	Screen
Library-A	2015	Active	Hydrographs & Statistics	6395727	1974050	1151.70	647	622	642	Screen
Library-B	2015	Active	Hydrographs	6395727	1974050	1151.66	747	722	742	Screen
Library-C	2015	Active	Hydrographs	6395727	1974050	1151.66	857	832	852	Screen
Mall-A	2015	Active	Hydrographs & Statistics	6392905	1973370	1147.98	810	785	805	Screen
Mall-B	2015	Active	Hydrographs	6392905	1973370	1147.92	910	885	905	Screen
Mall-C	2015	Active	Hydrographs	6392905	1973370	1147.92	1095	1070	1090	Screen
MP1-02	2002	Active	Hydrographs	6398350	1973445	1180.13	1570	391	401	Screen
MP1-03	2002	Active	Hydrographs	6399862	1970763	1180.13	1570	532	542	Screen
MP1-06	2002	Active	Hydrographs	6399862	1970763	1180.13	1570	983	993	Screen
MP1-08	2002	Active	Hydrographs & Statistics	6399862	1970763	1180.13	1570	1224	1234	Screen
MP1-10	2002	Active	Hydrographs	6399862	1970763	1180.13	1570	1540	1550	Screen
MP2-1	2002	Active	Hydrographs	6405080	1969044	1429.81	1255	323	333	Screen
MP2-2	2002	Active	Hydrographs	6405080	1969044	1429.81	1255	529	539	Screen
MP2-3	2002	Active	Hydrographs	6405080	1969044	1429.81	1255	599	609	Screen
MP2-4	2002	Active	Hydrographs	6405080	1969044	1429.81	1255	769	779	Screen
MP2-5	2002	Active	Hydrographs	6405080	1969044	1429.81	1255	1090	1100	Screen
MP2-6	2002	Active	Hydrographs	6405080	1969044	1429.81	1255	1225	1235	Screen
MP5-1	2003	Active	Hydrographs	6395394	1976084	1132.03	990	409	419	Screen
MP5-2	2003	Active	Hydrographs	6395394	1976084	1132.03	990	565	575	Screen
MP5-3	2003	Active	Hydrographs & Statistics	6395394	1976084	1132.03	990	790	800	Screen
MP5-4	2003	Active	Hydrographs	6395394	1976084	1132.03	990	960	970	Screen
SG1-HSU1	2004	Active	Hydrographs	6398001	1973438	1165.60	285	265	285	Screen
SG1-HSU3a	2009	Active	Hydrographs & Statistics	6398364	1973452	1165.64	520	495	515	Screen
SG1-HSU3c	2006	Active	Hydrographs & Statistics	6398370	1973434	1165.39	745	720	740	Screen

Table 4-3
Calibration Statistics Using All Target Wells
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Residual Statistics	Alluvial Aquifer	Saugus Formation	Both Aquifers Combined
Groundwater Elevations			
Mean	7.1	23.0	11.2
Absolute Mean	15.4	33.7	20.1
Standard Deviation	19.4	42.9	28.3
Range of Measured Values	719.3	407.5	719.3
Scaled Absolute Mean	1.0%	5.7%	1.6%
Scaled Standard Deviation	2.7%	10.5%	3.9%
Minimum Observed Value	-61.7	-64.5	-64.5
Maximum Observed Value	71.1	156.0	156.0
Data Count	15,073	5,244	20,317
Well Count	65	24	89
Groundwater Elevation Changes			
Mean	-9.7	2.4	-6.5
Absolute Mean	15.4	22.9	17.1
Standard Deviation	22.5	37.8	27.8
Range of Measured Values	184.0	327.1	327.1
Scaled Absolute Mean	5.2%	0.7%	2.0%
Scaled Standard Deviation	12.2%	11.6%	8.5%
Minimum Residual	-95.0	-102.1	-102.1
Maximum Residual	65.3	123.1	123.1
Data Count	15,073	5,244	20,317
Well Count	65	24	89

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Table 4-4

Calibration Statistics with and without Saugus Wells on the Model's Periphery

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

	Saugus Formation		Both Aquifers	
Residual Statistics	**With All Saugus Wells**	**Without Five Peripheral Saugus Wells**	**With All Saugus Wells**	**Without Five Peripheral Saugus Wells**
Groundwater Elevations				
Mean	23.0	2.7	11.2	6.3
Absolute Mean	33.7	14.1	20.1	15.2
Standard Deviation	42.9	18.0	28.3	19.2
Range of Measured Values	407.5	229.5	719.3	719.3
Scaled Absolute Mean	5.7%	1.2%	1.6%	0.9%
Scaled Standard Deviation	10.5%	7.8%	3.9%	2.7%
Minimum Observed Value	-64.5	-64.5	-64.5	-64.5
Maximum Observed Value	156.0	114.3	156.0	114.3
Data Count	5,244	3,331	20,317	18,404
Well Count	24	19	89	84
Groundwater Elevation Changes				
Mean	2.4	-12.8	-6.5	-10.2
Absolute Mean	22.9	27.6	17.1	15.7
Standard Deviation	37.8	27.3	27.8	23.5
Range of Measured Values	327.1	287.0	327.1	287.0
Scaled Absolute Mean	0.7%	4.5%	2.0%	3.6%
Scaled Standard Deviation	11.6%	9.5%	8.5%	8.2%
Minimum Residual	-102.1	-102.1	-102.1	-102.1
Maximum Residual	123.1	90.4	123.1	90.4
Data Count	5,244	3,331	20,317	18,404
Well Count	24	19	89	84

FIGURES

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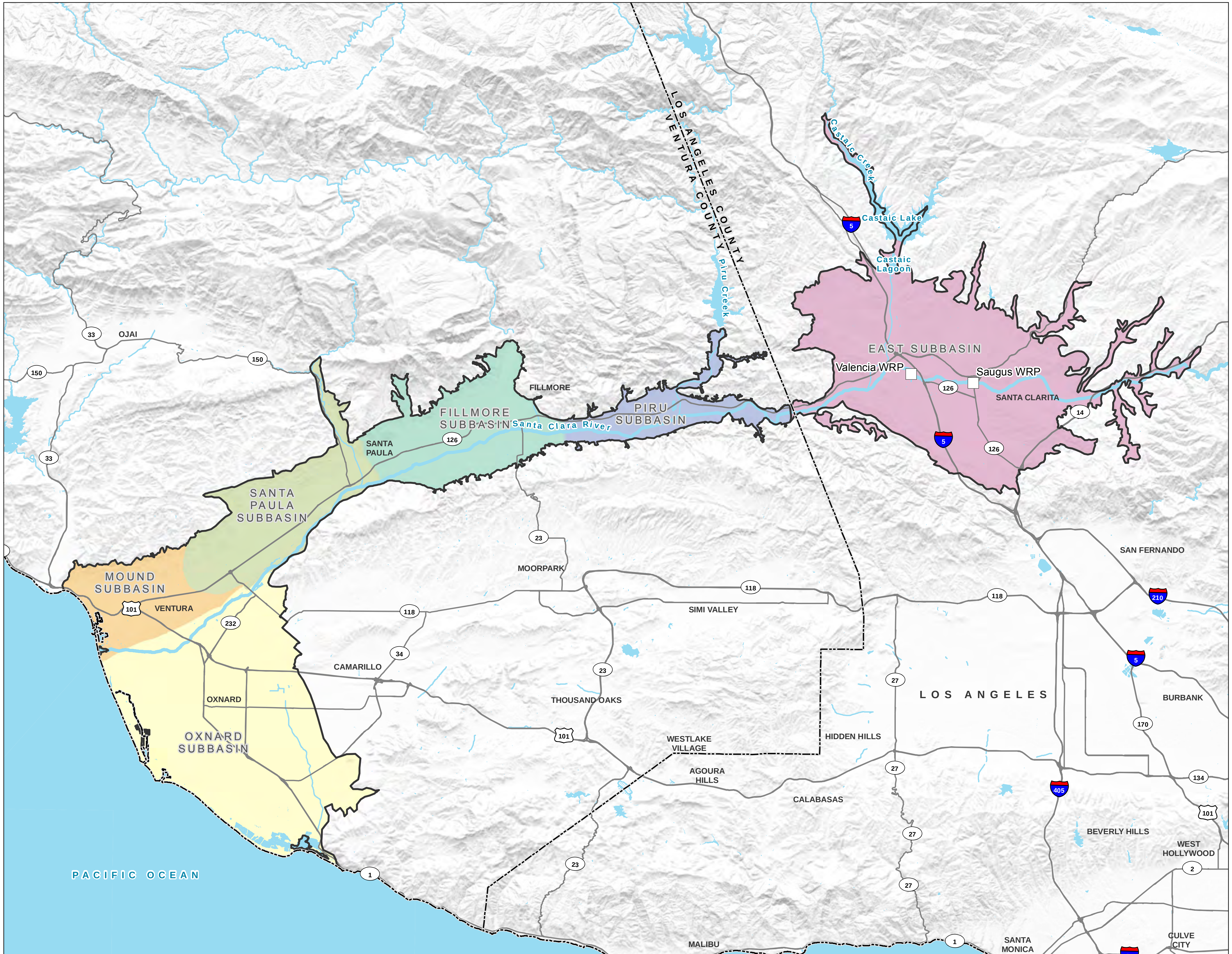

FIGURE 1-1

Santa Clara River Valley Groundwater Basin and Subbasins

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Water Reclamation Plant (WRP)
- Santa Clara River Valley Groundwater Basin

Santa Clara River Valley Subbasins

- Santa Clara River Valley East
- Piru
- Fillmore
- Santa Paula
- Mound
- Oxnard

All Other Features

- County Boundary
- Major Road
- Watercourse
- Waterbody

N

0 12,500 25,000 37,500
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure1_1_BasinLocation.mxd, abarry

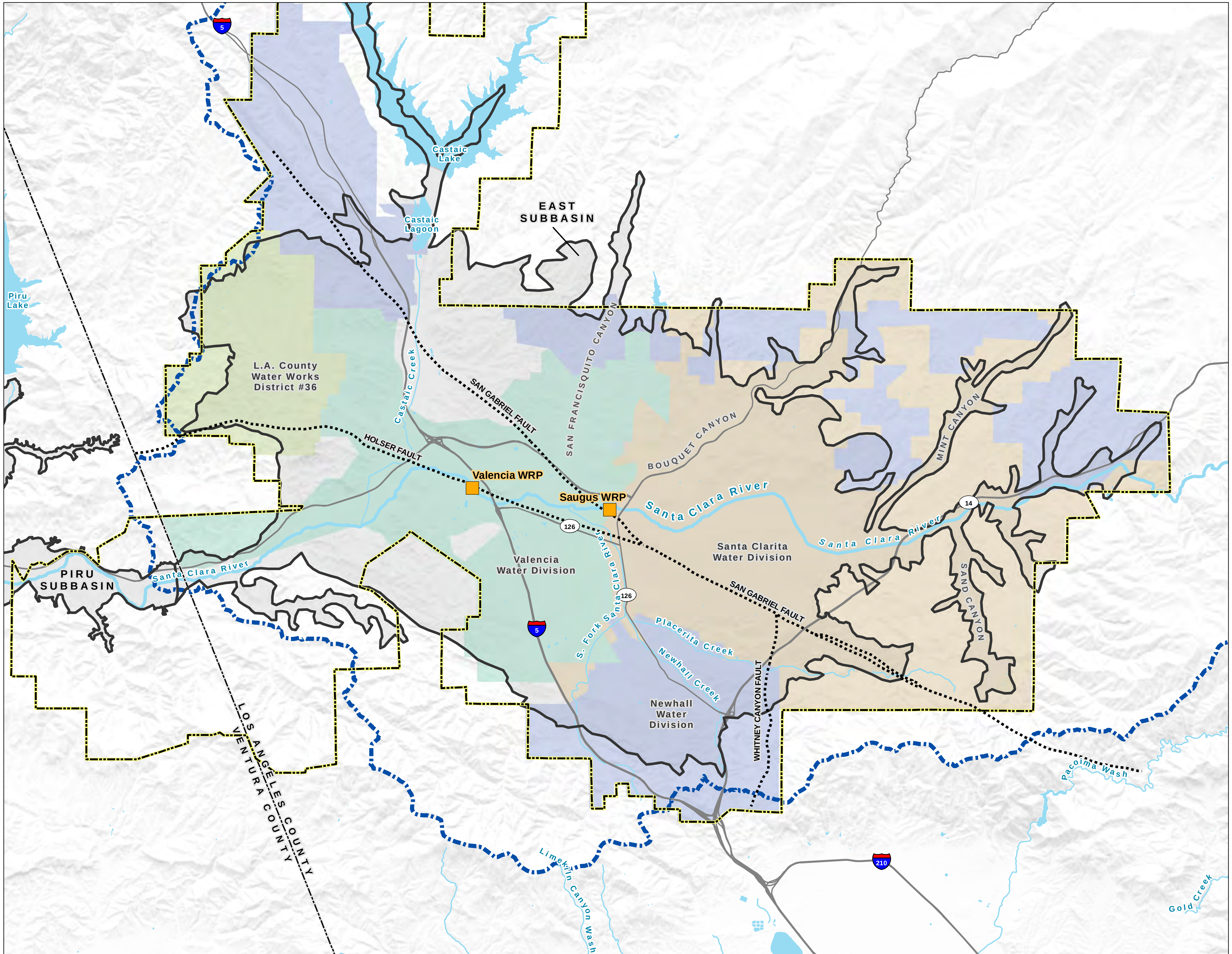

FIGURE 1-2

Service Areas for SCV Water and Water Retailers

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Water Reclamation Plant (WRP)

SCV Water Divisions

- L.A. County Water Works District #36
- Newhall Water Division
- Santa Clarita Water Division
- Valencia Water Division

All Other Features

- Service Area Boundary for SCV Water
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary
- Major Road
- Watercourse
- Waterbody

NOTES

SCV Water: Santa Clarita Valley Water Agency
WRP: Water Reclamation Plant

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

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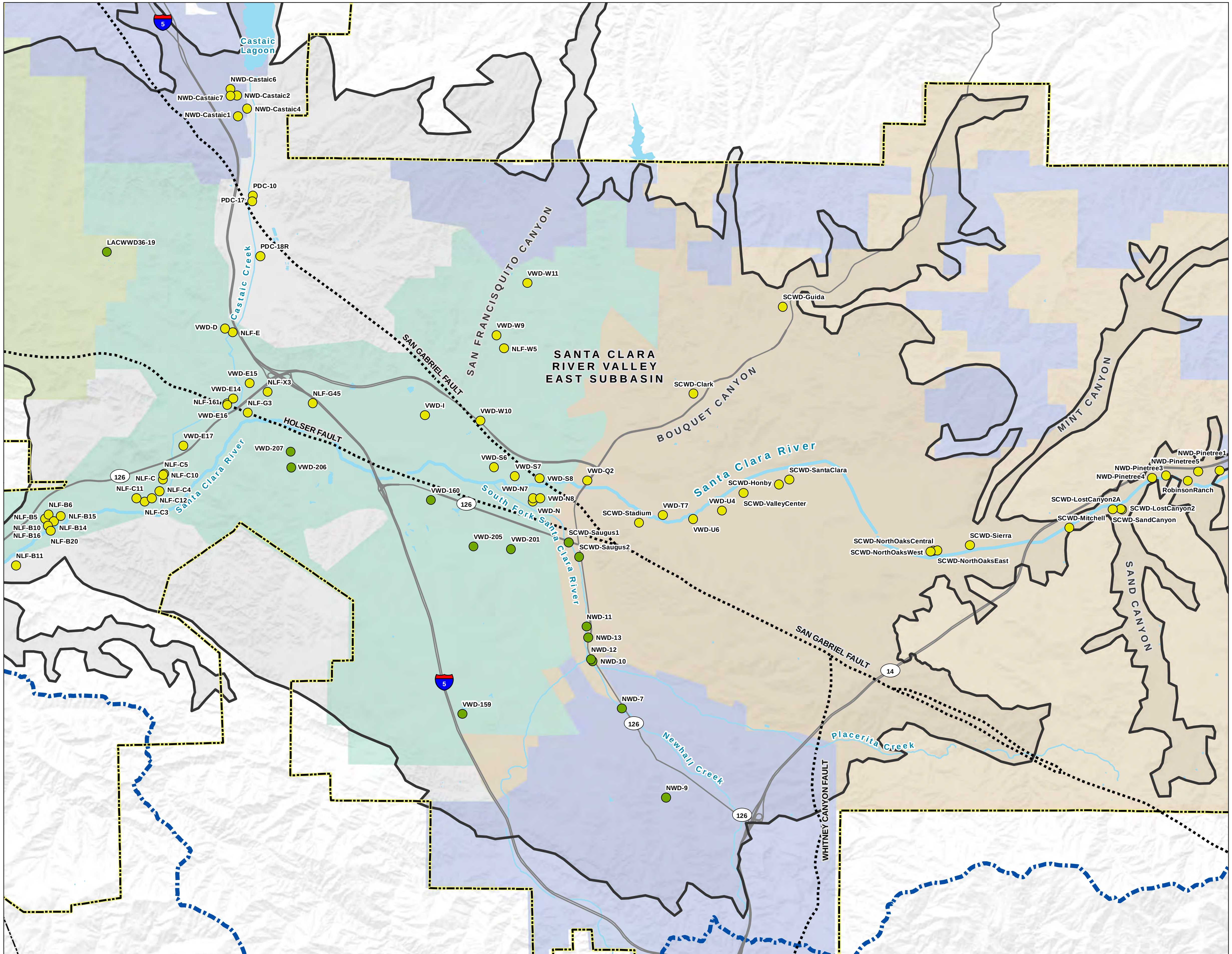
FIGURE 1-3

2019 Production Well Locations

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

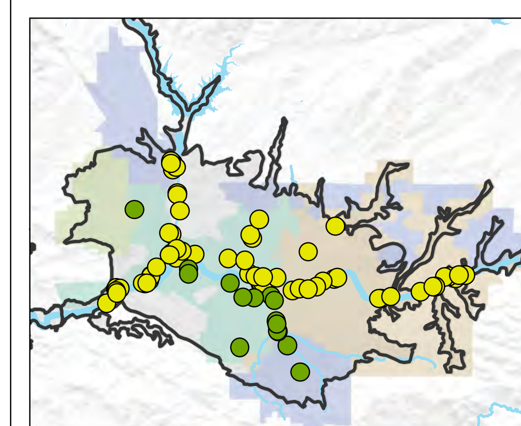


LEGEND

- Alluvial Aquifer Production Well
- Saugus Formation Production Well

All Other Features

- Santa Clara River Valley Groundwater Basin
- Watershed Boundary
- Service Area Boundary for SCV Water
- County Boundary
- Major Road
- Watercourse
- Waterbody



NOTE

SCV Water: Santa Clarita Valley Water Agency

N

0 3,100 6,200 9,300

Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

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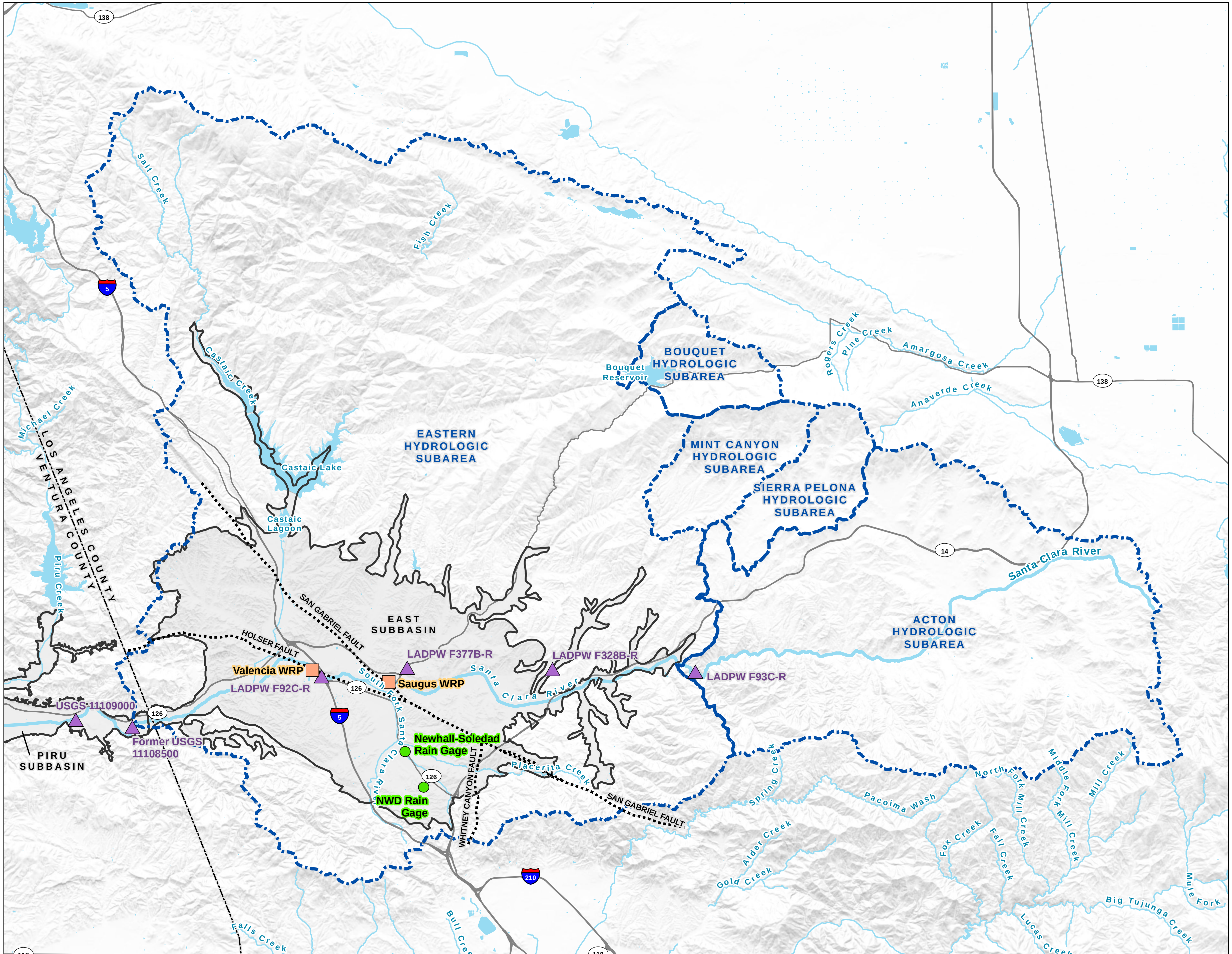
Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure1_3_Production_Well_Locations_2019.mxd, abarry

FIGURE 1-4

Watershed Boundaries for Upper Santa Clara River Hydrologic Area and Subareas

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Rain Gage
- Stream Gage
- Water Reclamation Plant (WRP)
- Santa Clara River Valley Groundwater Basin
- Upper Santa Clara River Hydrologic Subbarea

All Other Features

- Major Road
- Watercourse
- Waterbody

NOTES

DWR: Department of Water Resources
LADPW: Los Angeles County Department of Public Works
NWD: Newhall Water Division
USGS: U.S. Geological Survey

N

0 9,000 18,000 27,000
Feet

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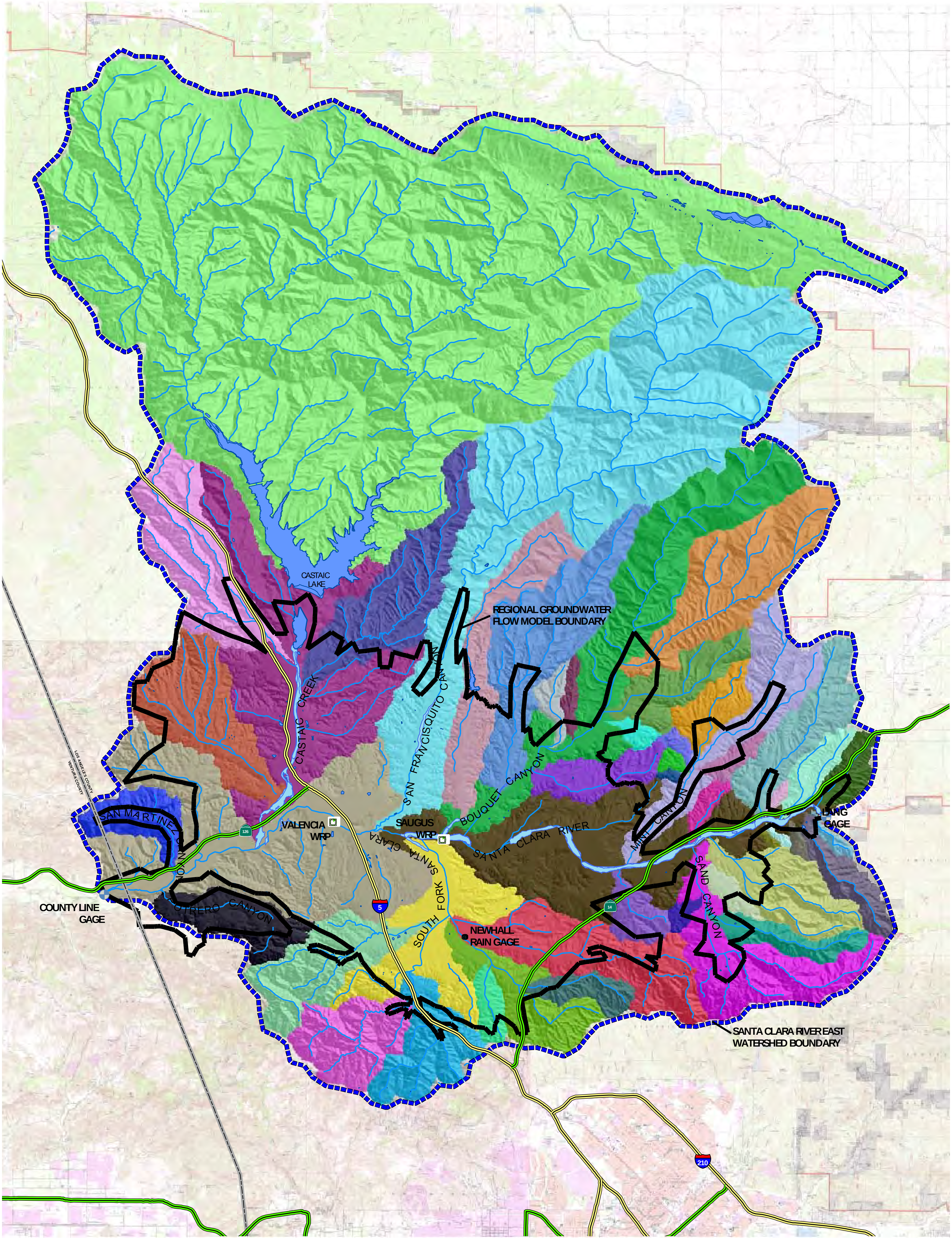
Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure1_4_Watershed_Boundaries.mxd, abarry



LEGEND

Hydrography

Lake

Stream

Stream Gage

Major Road

Interstate

State Highway

Data Sources: CH2M HILL, 2004

N

0 2.5 5

Miles

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FIGURE 1-5

Contributing Watersheds to the Santa Clara River Valley East Groundwater Subbasin

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report

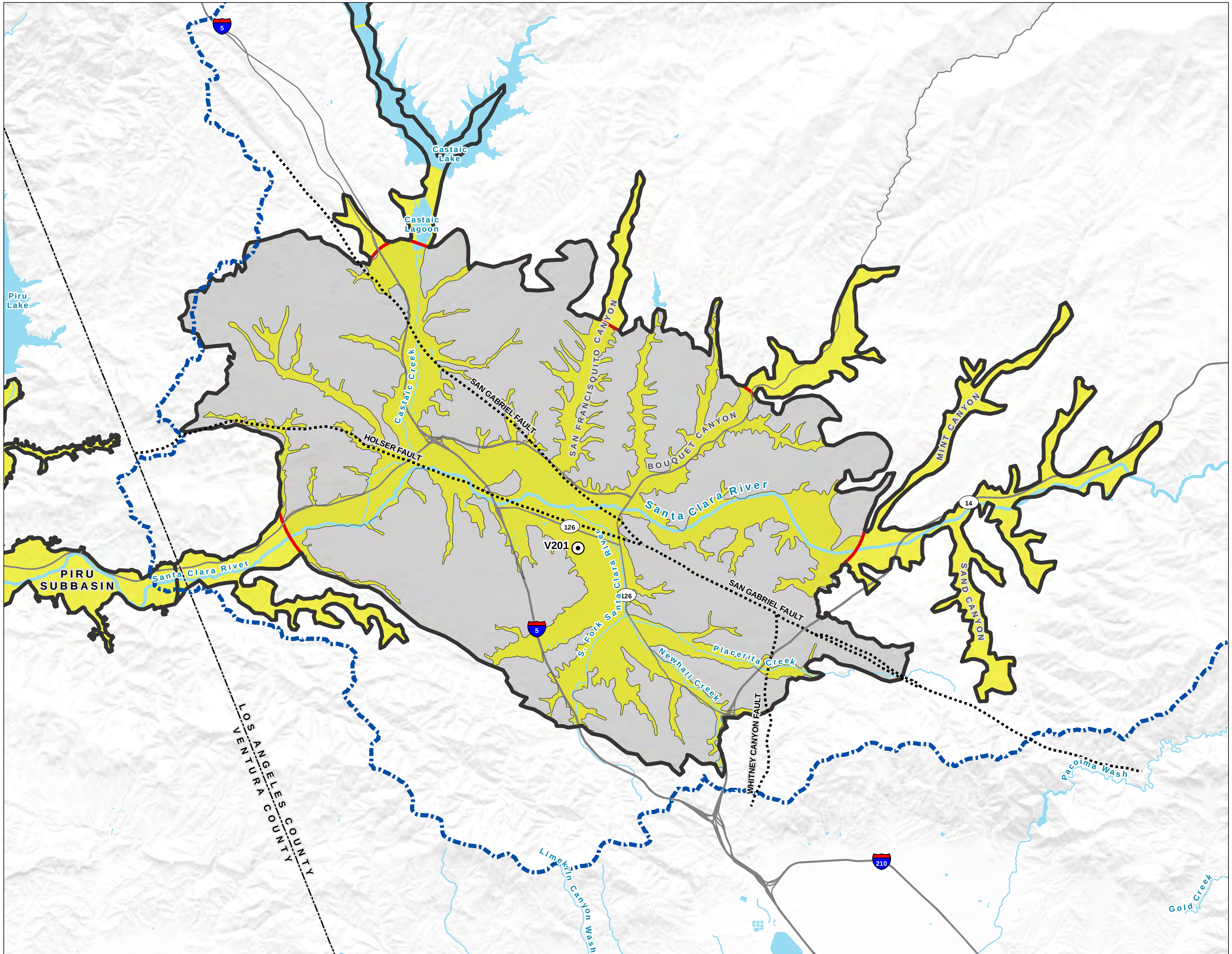


FIGURE 1-6

Areal Extent of Alluvial Aquifer and Saugus Formation

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Well
- Alluvial Aquifer
- Saugus Formation
- Outer Margin of Saugus Formation at Locations Beneath the Alluvial Aquifer
- DWR Bulletin 118 Boundary for Santa Clara River Valley East Groundwater Subbasin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

NOTE

DWR: California Department of Water Resources

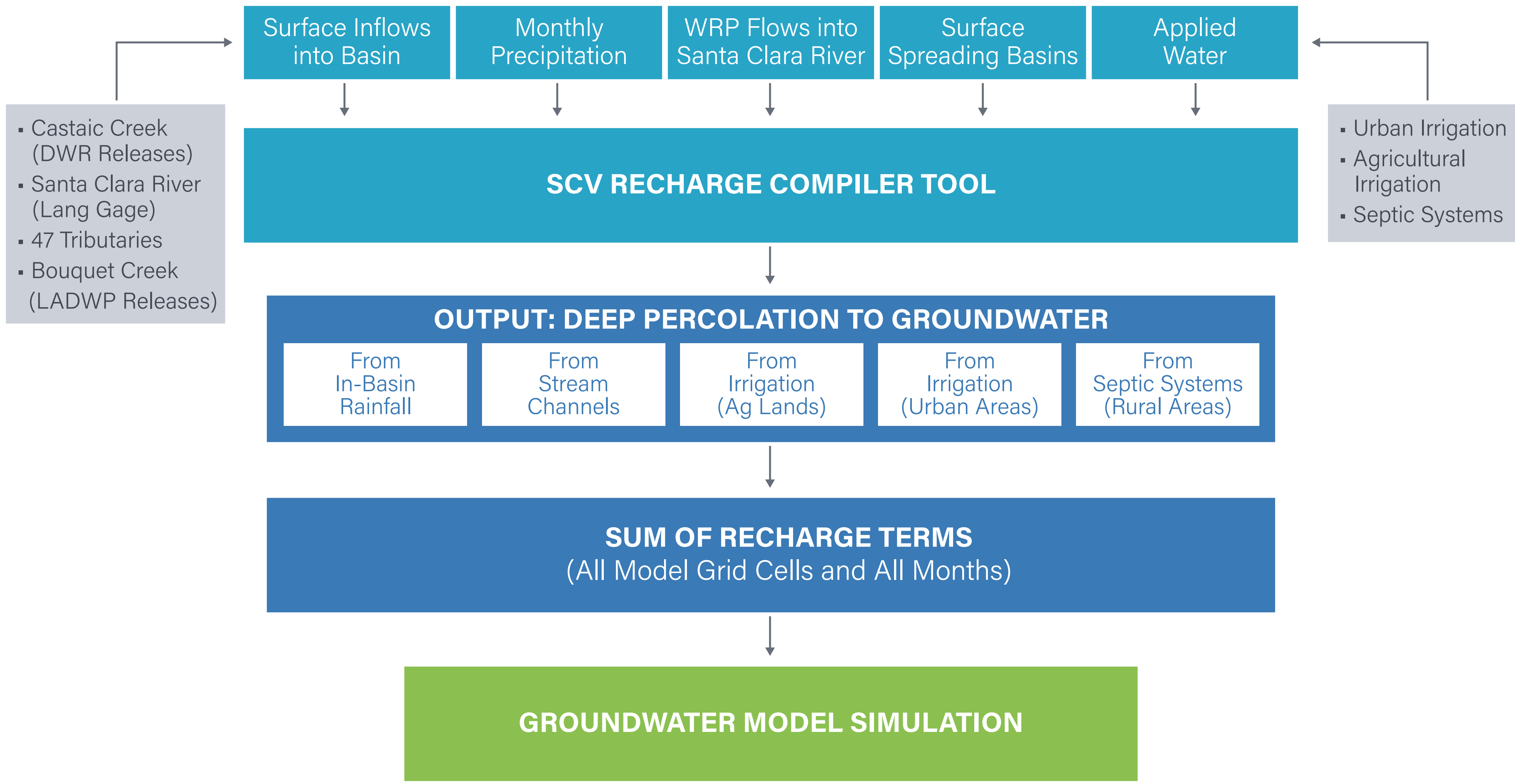
N

0 5,000 10,000 15,000
Feet

GSI Water Solutions, Inc.

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure1-6_Areal_Extent_Alluvium_Saugus.mxd, abarry



NOTES

Ag:	agricultural
DWR:	California Department of Water Resources
LADWP:	Los Angeles Department of Water and Power
SCV:	Santa Clarita Valley
WRP:	water reclamation plant

FIGURE 2-1

Hydrologic Processes Implemented in the SCV Recharge Compiler

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

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\\PDX\GIS_Files\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report

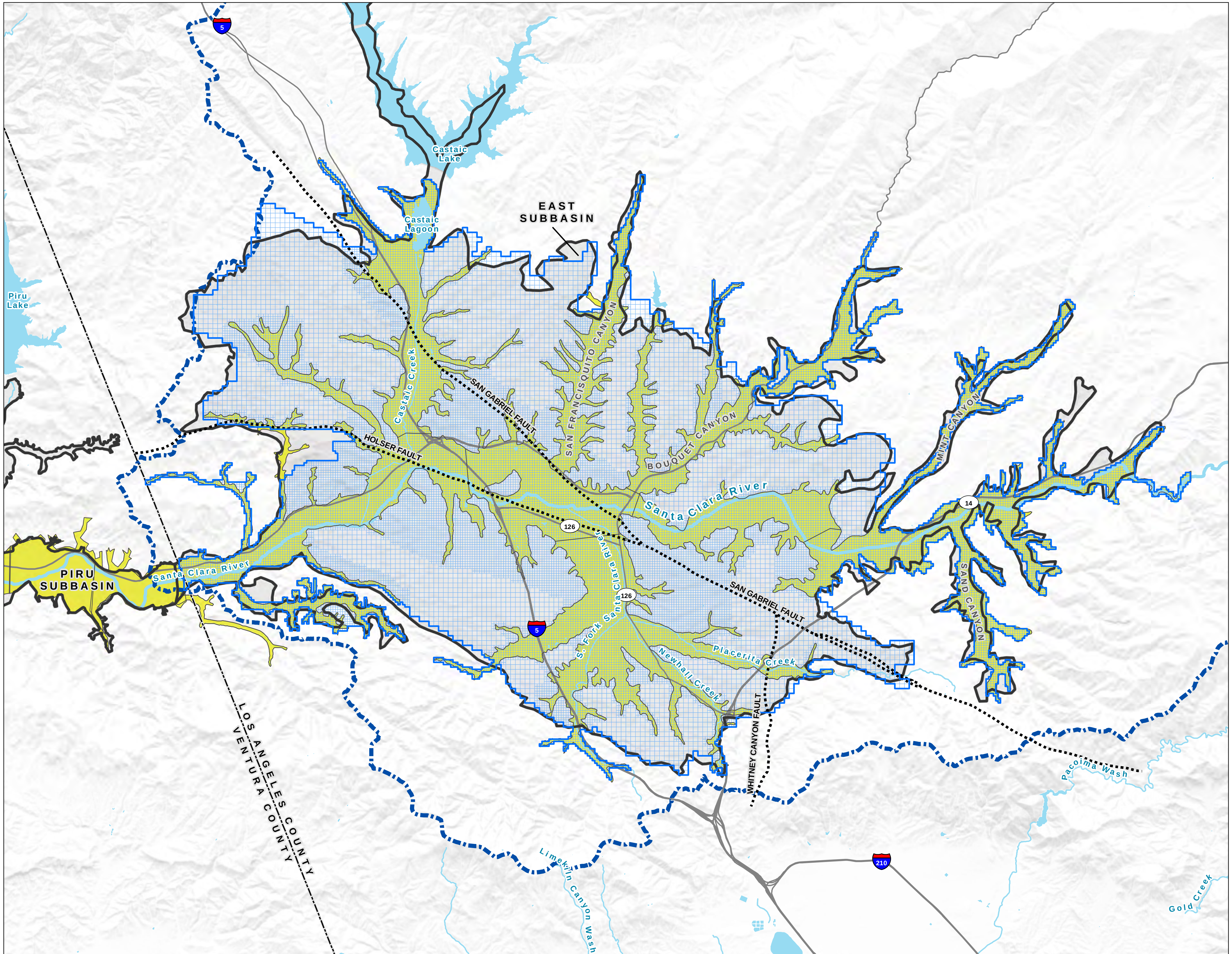

FIGURE 3-1

Spatial Extent of Model Grid in Model Layer 1

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 1
- Model Grid
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

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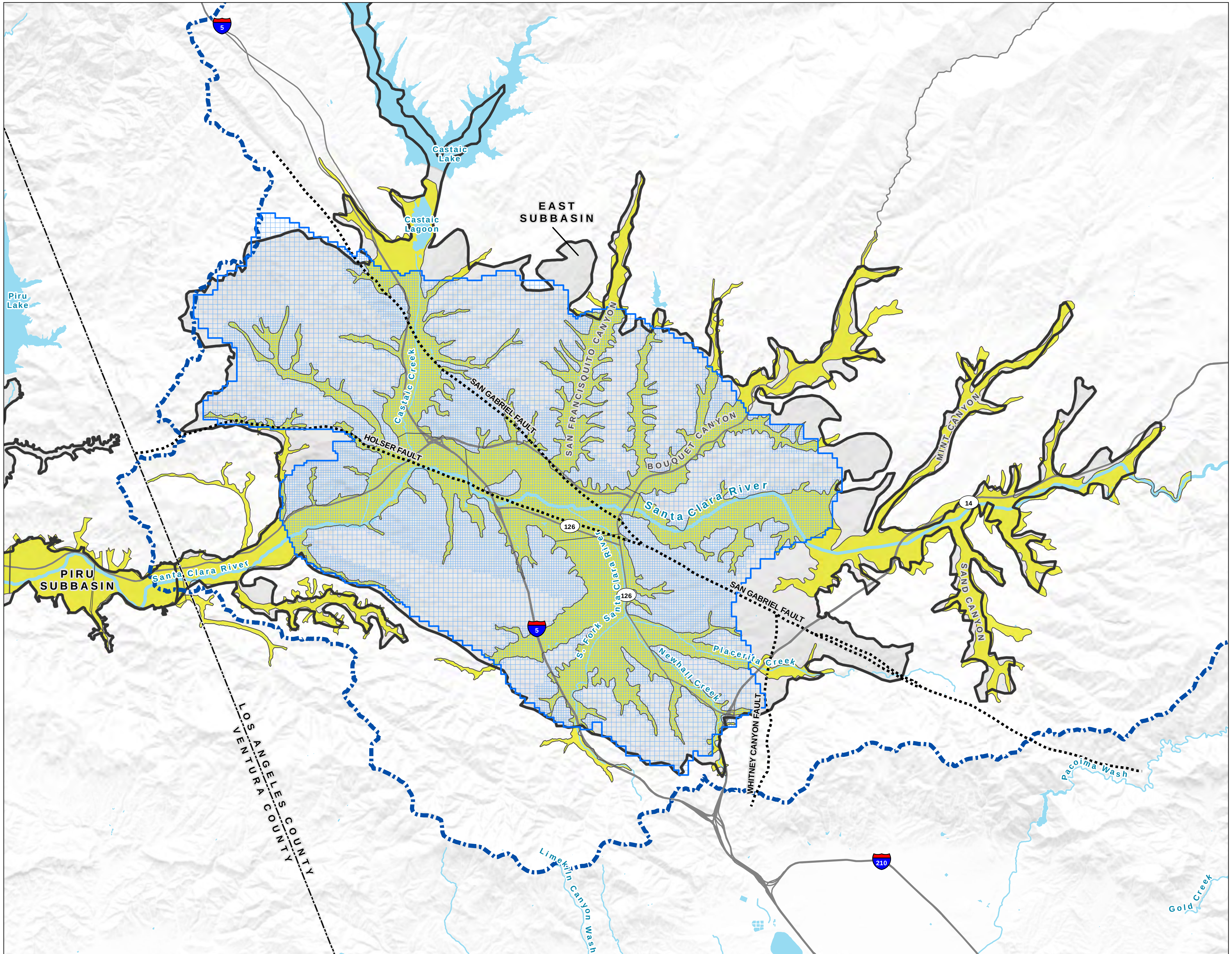


FIGURE 3-2

Spatial Extent of Model Grid in Model Layer 2

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 2
- Model Grid
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

GSI Water Solutions, Inc.

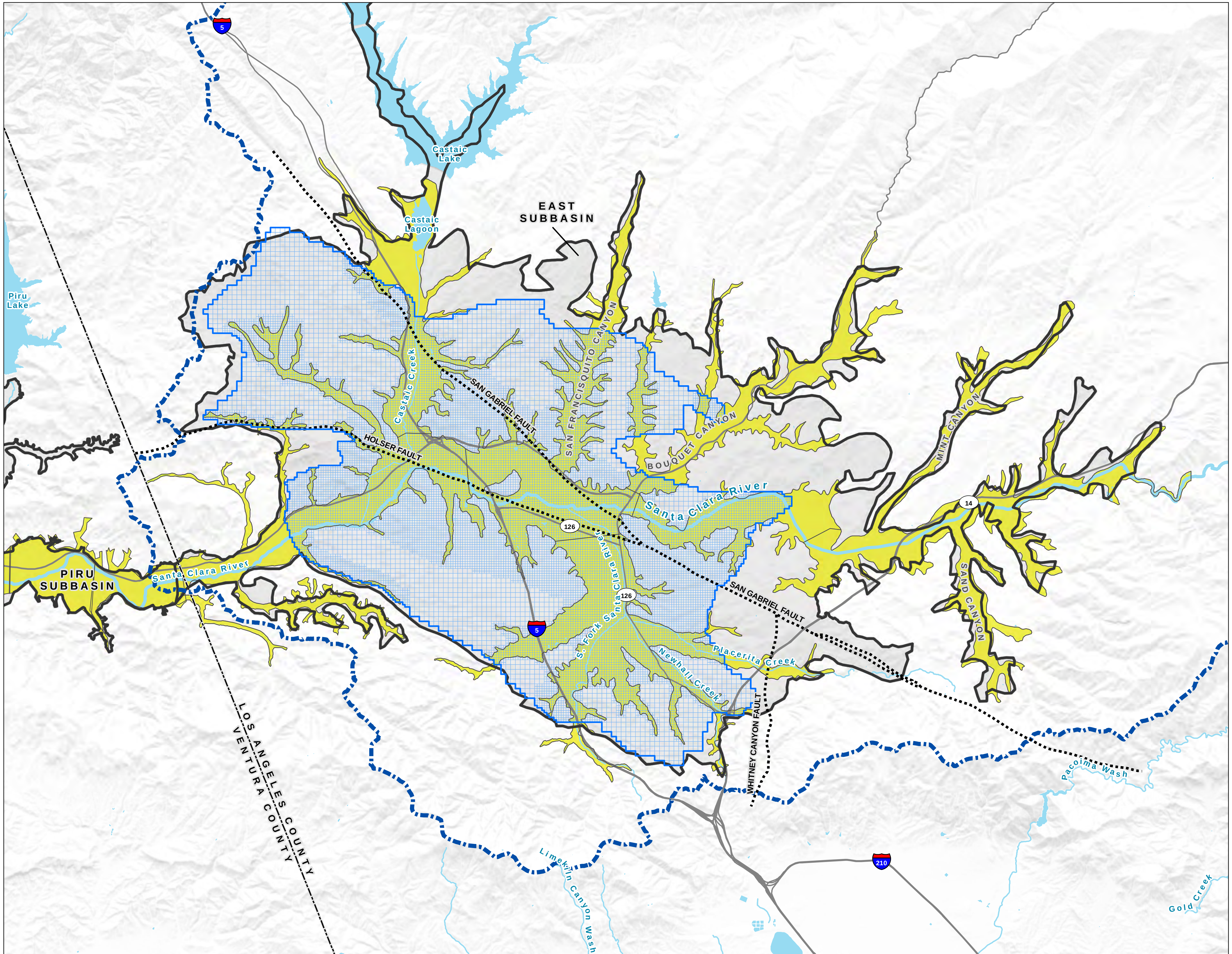
Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_2_Spatial_Extent_of_Model_Grid_Model_Layer_2.mxd, abarry

FIGURE 3-3

Spatial Extent of Model Grid in Model Layer 3

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Model Grid Outline Layer 3
- Model Grid
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000 Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

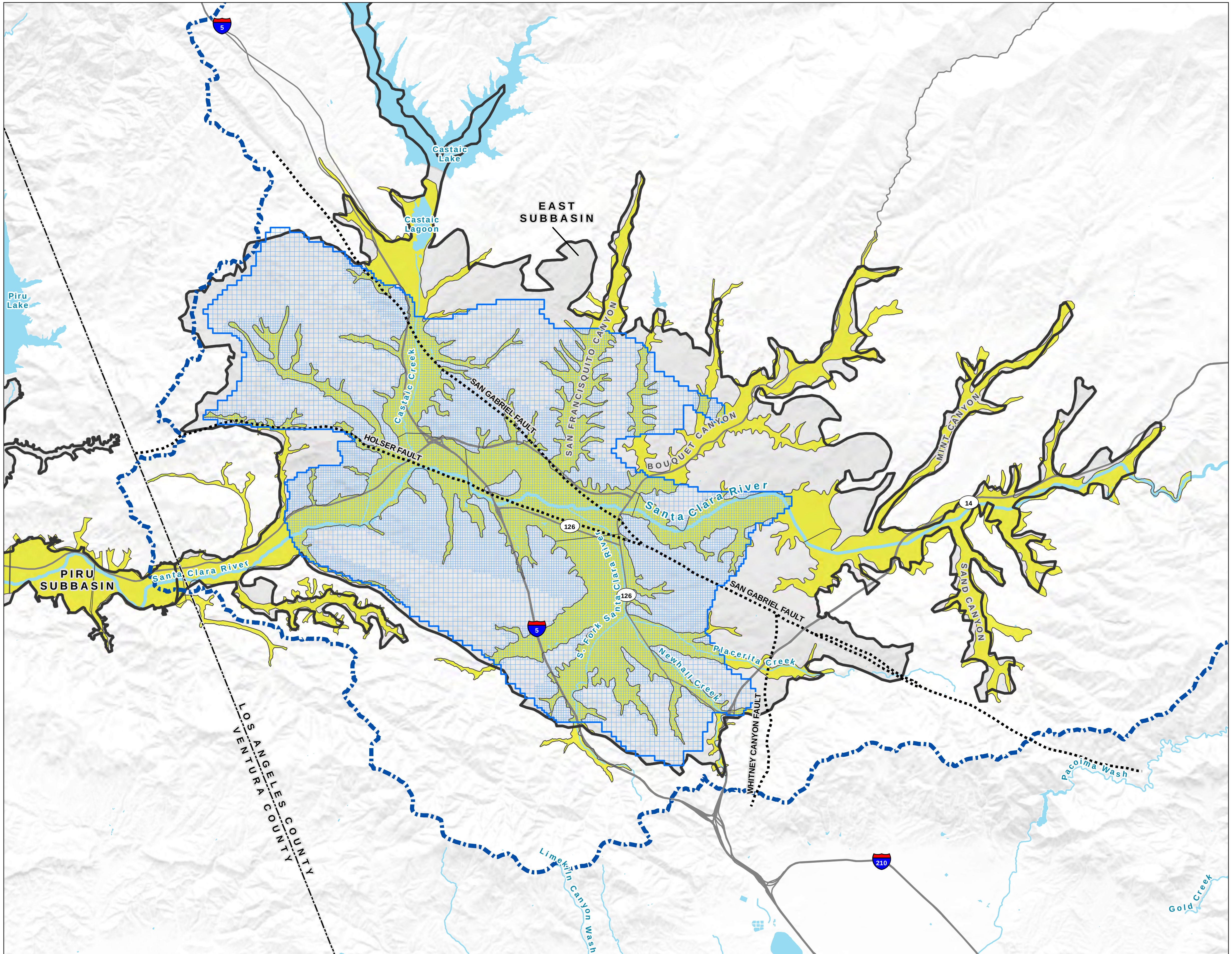
GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_3_Spatial_Extent_of_Model_Grid_Model_Layer_3.mxd, abarry

FIGURE 3-4

Spatial Extent of Model Grid in Model Layer 4

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Model Grid Outline Layer 4
- Model Grid
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

GSI Water Solutions, Inc.

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_4_Spatial_Extent_of_Model_Grid_Model_Layer_4.mxd, abarry

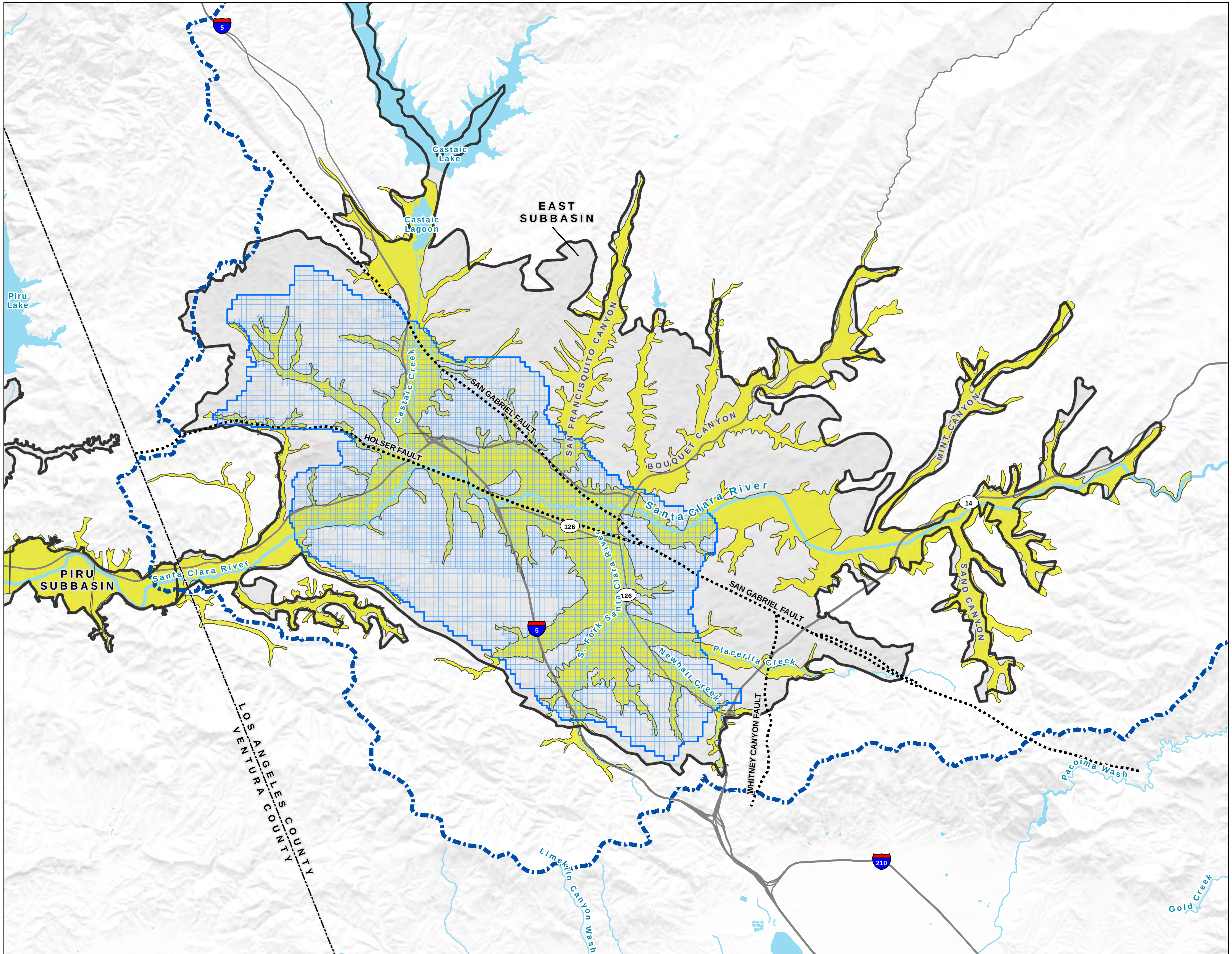


FIGURE 3-5

Spatial Extent of Model Grid in Model Layer 5

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 5
- Model Grid
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

GSI Water Solutions, Inc.

Date: December 9, 2021
Data Sources: USGS, DNR Bulletin 118

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_5_Spatial_Extent_of_Model_Grid_Model_Layer_5.mxd, abarry

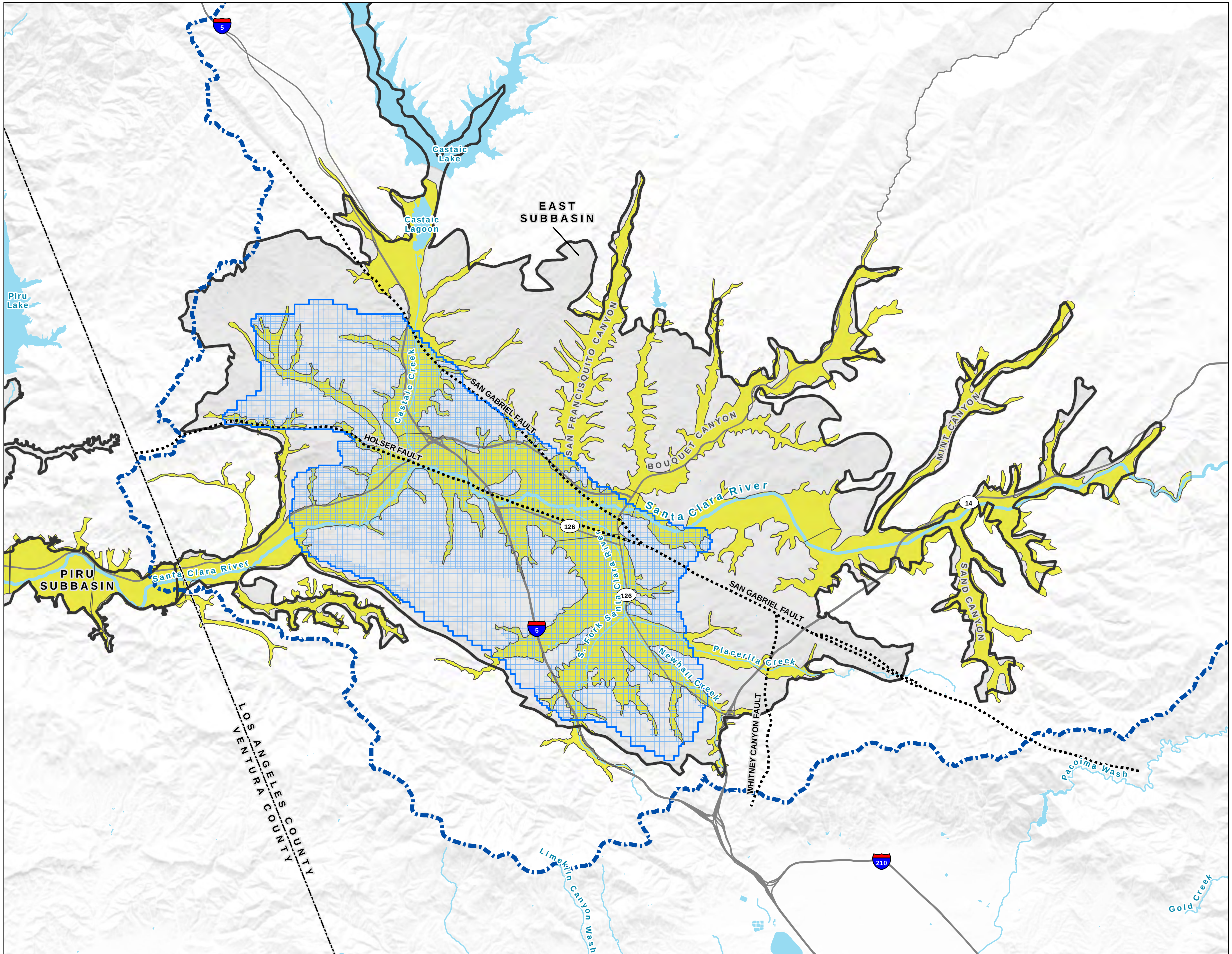


FIGURE 3-6

Spatial Extent of Model Grid in Model Layer 6

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 6
- Model Grid
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DNR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_6_Spatial_Extent_of_Model_Grid_Model_Layer_6.mxd, abarry

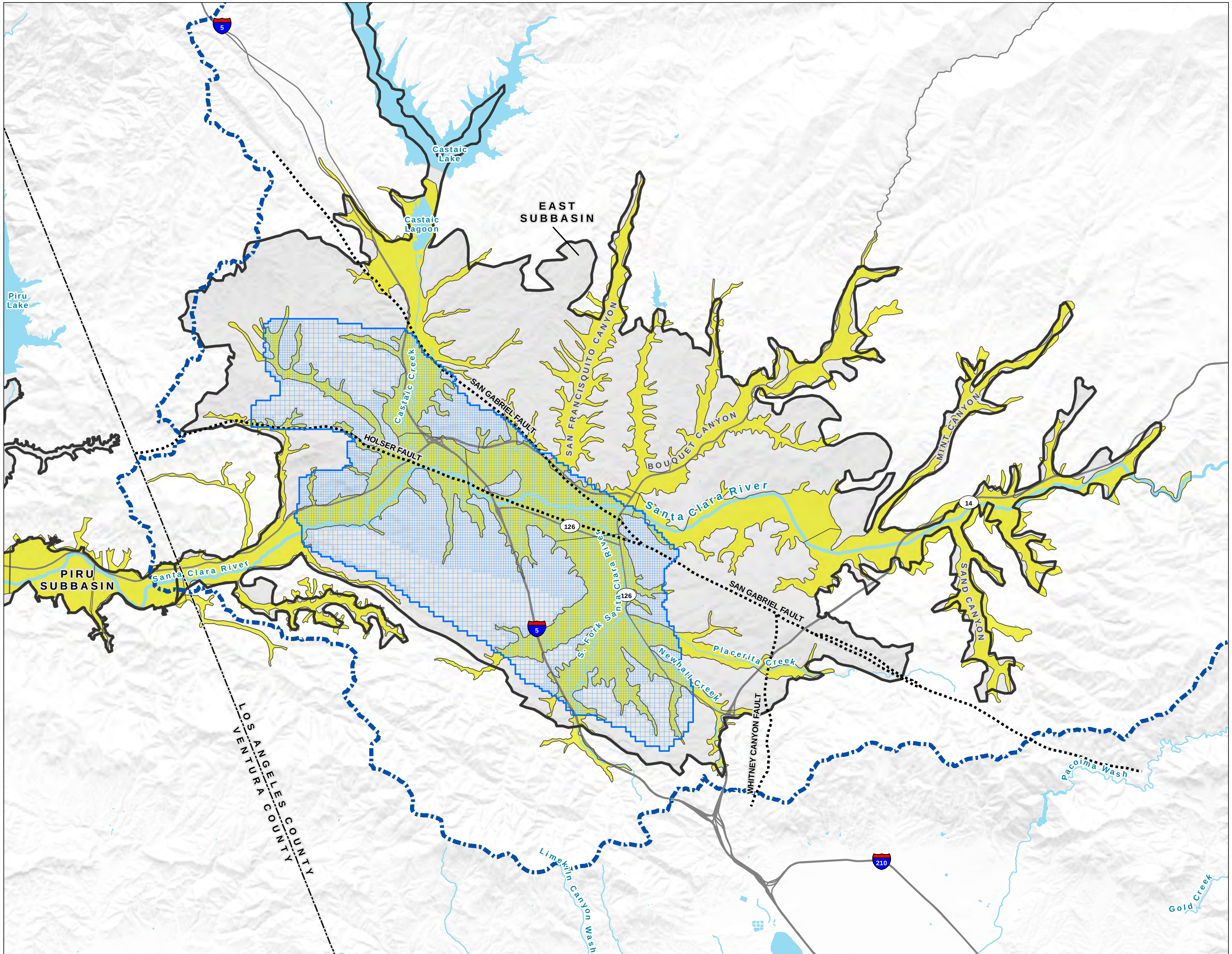


FIGURE 3-7

Spatial Extent of Model Grid in Model Layer 7

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 7
- Model Grid
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_7_Spatial_Extent_of_Model_Grid_Model_Layer_7.mxd, abarry

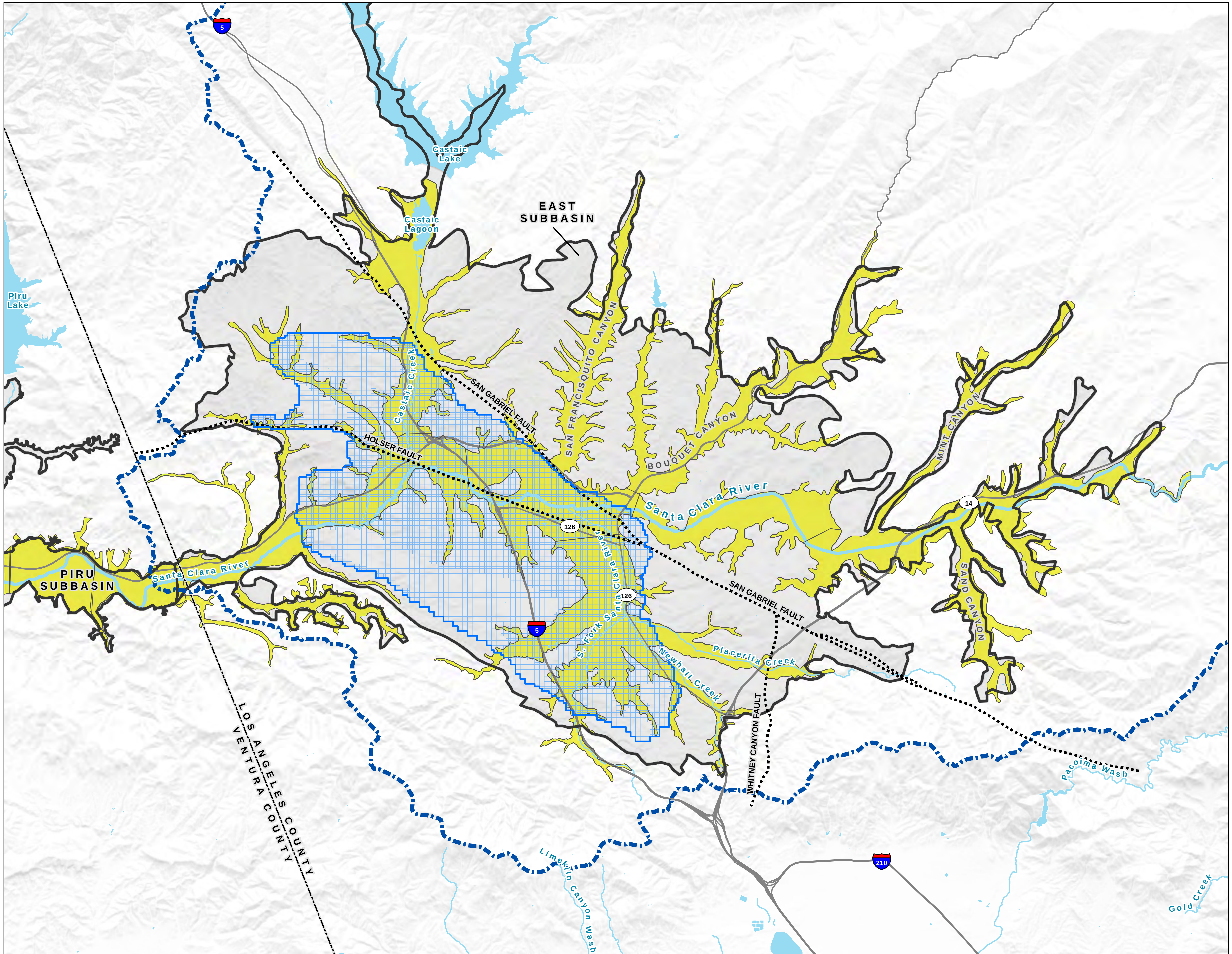


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FIGURE 3-8

Spatial Extent of Model Grid in Model Layer 8

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 8
- Model Grid
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

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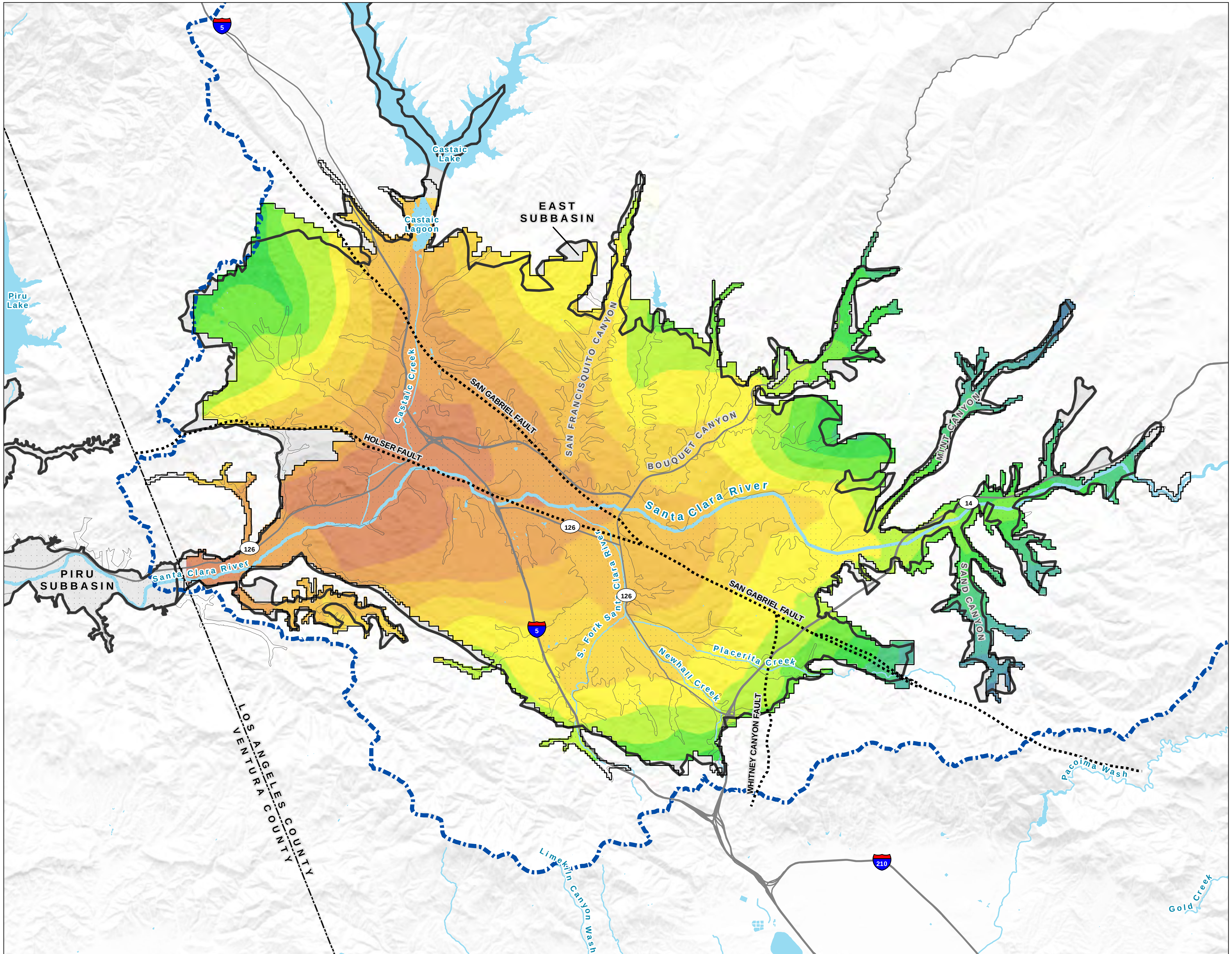
FIGURE 3-9

Bottom Elevation of Model Grid in Model Layer 1

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Model Grid Outline Layer 1
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Bottom Elevation Flood Intervals (feet)

- < 800
- 800 - 900
- 900 - 1,000
- 1,000 - 1,100
- 1,100 - 1,200
- 1,200 - 1,300
- 1,300 - 1,400
- 1,400 - 1,500
- 1,500 - 1,600
- 1,600 - 1,700
- 1,700 - 1,800
- 1,800 - 1,900
- 1,900 - 2,000
- > 2,000

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

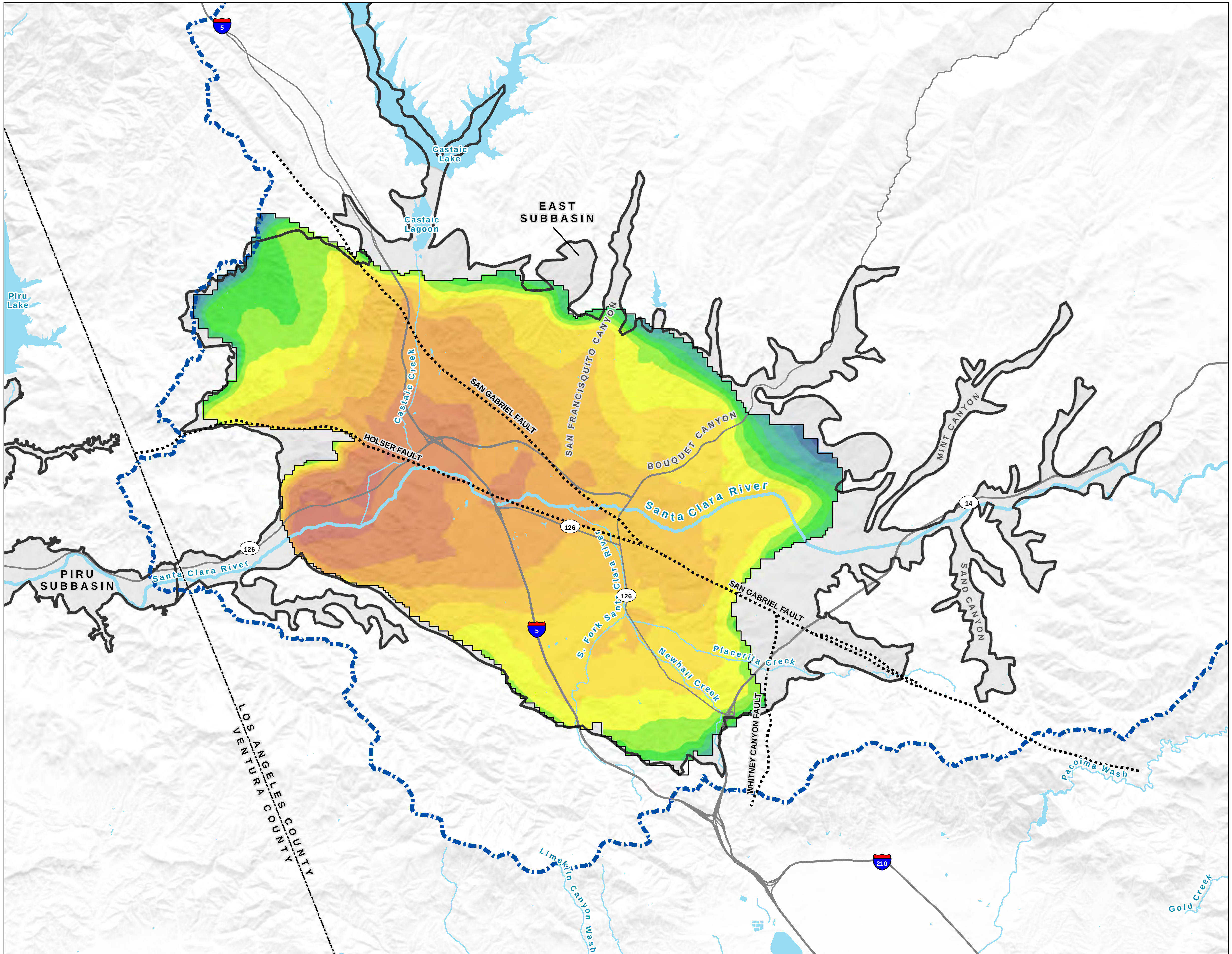


FIGURE 3-10

Bottom Elevation of Model Grid in Model Layer 2

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 2
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Bottom Elevation Flood Intervals (feet)

- < 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- 900 - 1,000
- 1,000 - 1,100
- 1,100 - 1,200
- 1,200 - 1,300
- 1,300 - 1,400
- 1,400 - 1,500
- > 1,500

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_10_Bottom_Elevation_of_Model_Grid_Model_Layer_2.mxd, abarry

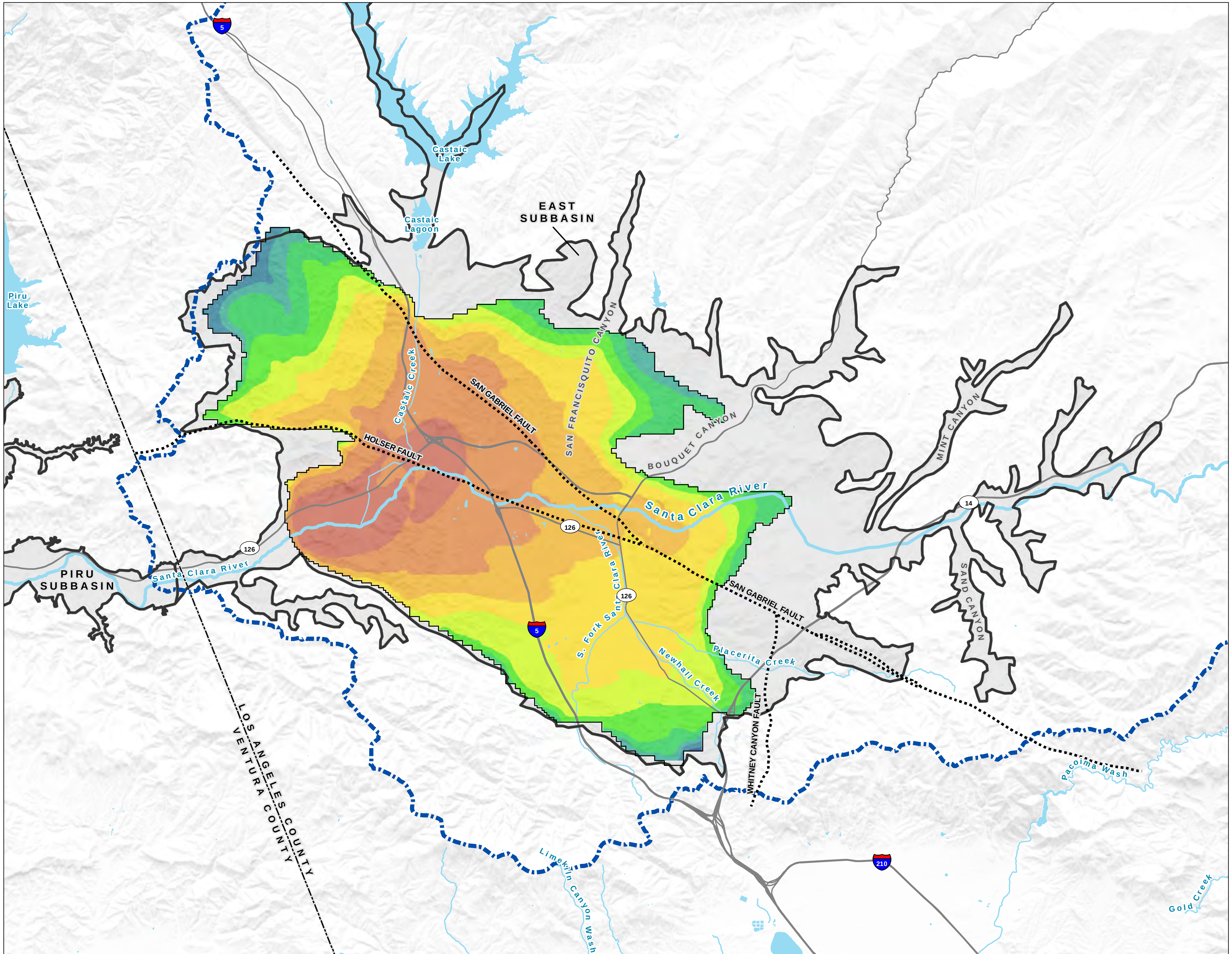


FIGURE 3-11

Bottom Elevation of Model Grid in Model Layer 3

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

Model Grid Outline Layer 3

Santa Clara River Valley Groundwater Basin

Watershed Boundary

Bottom Elevation Flood Intervals (feet)

- < 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- 900 - 1,000
- > 1,000

All Other Features

Major Road

Watercourse

Waterbody

N

0 5,000 10,000 15,000

Feet

GSI Water Solutions, Inc.

Date: December 9, 2021

Data Sources: USGS, DWR Bulletin 118

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_11_Bottom_Elevation_of_Model_Grid_Model_Layer_3.mxd, abarry

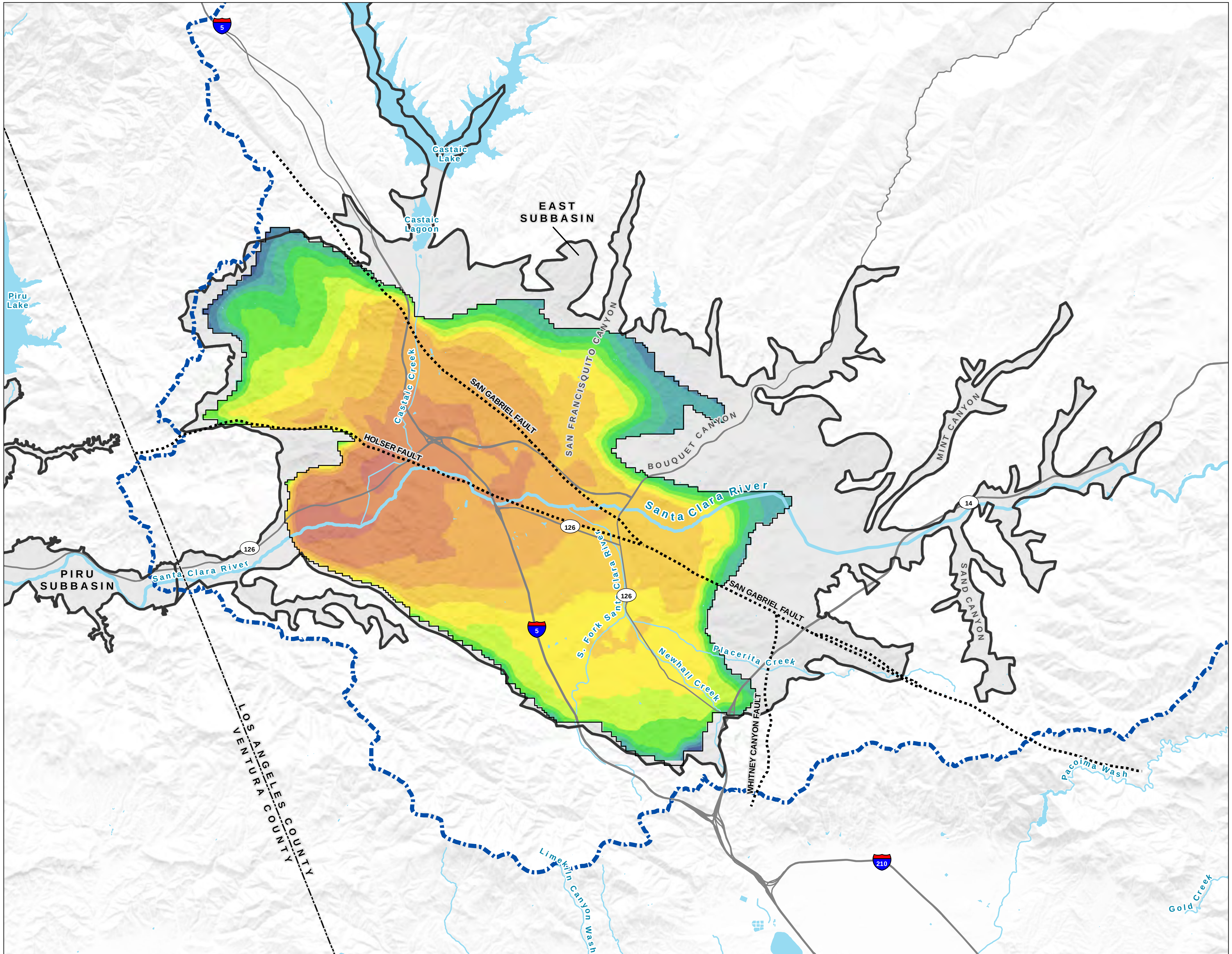


FIGURE 3-12

Bottom Elevation of Model Grid in Model Layer 4

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 4
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Bottom Elevation Flood Intervals (feet)

- < -100
- -100 - 0
- 0 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- > 900

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

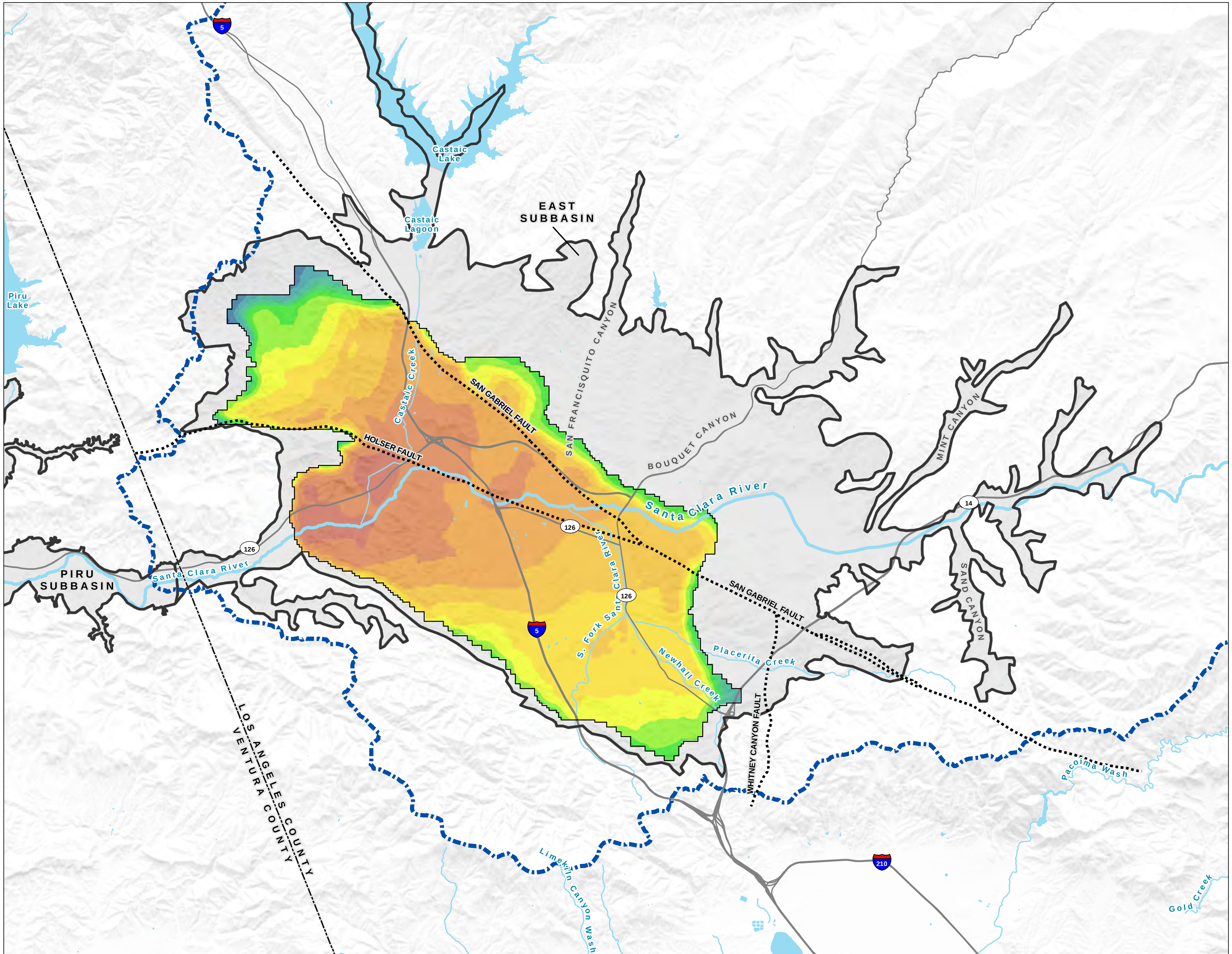


FIGURE 3-13

Bottom Elevation of Model Grid in Model Layer 5

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 5
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Bottom Elevation Flood Intervals (feet)

- < -600
- -600 - -500
- -500 - -400
- -400 - -300
- -300 - -200
- -100 - -100
- -100 - 0
- 0 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- > 500

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

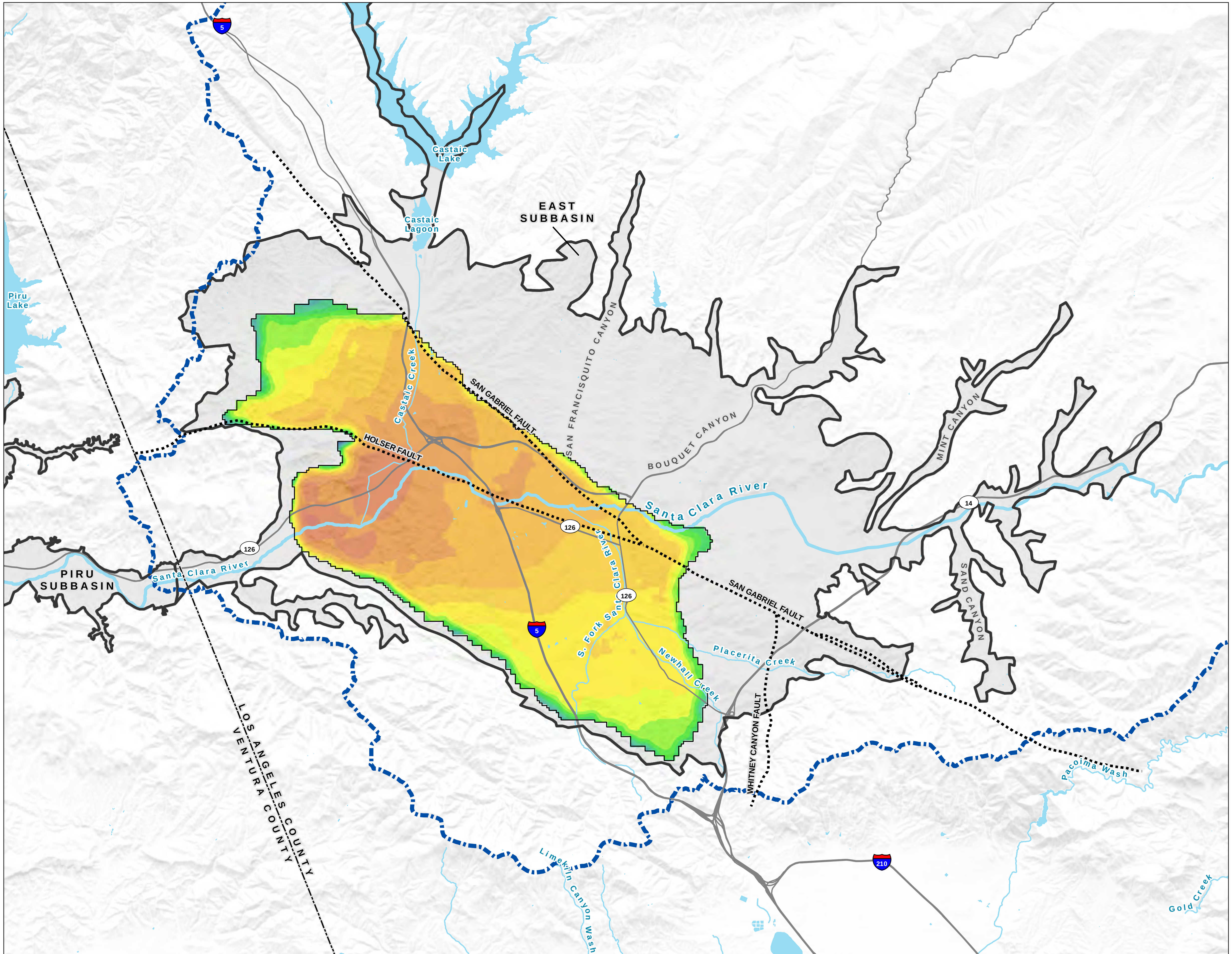


FIGURE 3-14

Bottom Elevation of Model Grid in Model Layer 6

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 6
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Bottom Elevation Flood Intervals (feet)

- < -1,200
- -1,200 - -1,100
- -1,100 - -1,000
- -1,000 - -900
- -900 - -800
- -800 - -700
- -700 - -600
- -600 - -500
- -500 - -400
- -400 - -300
- -300 - -200
- -200 - -100
- -100 - 0
- 0 - 100
- > 100

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_14_Bottom_Elevation_of_Model_Grid_Model_Layer_6.mxd, abarry

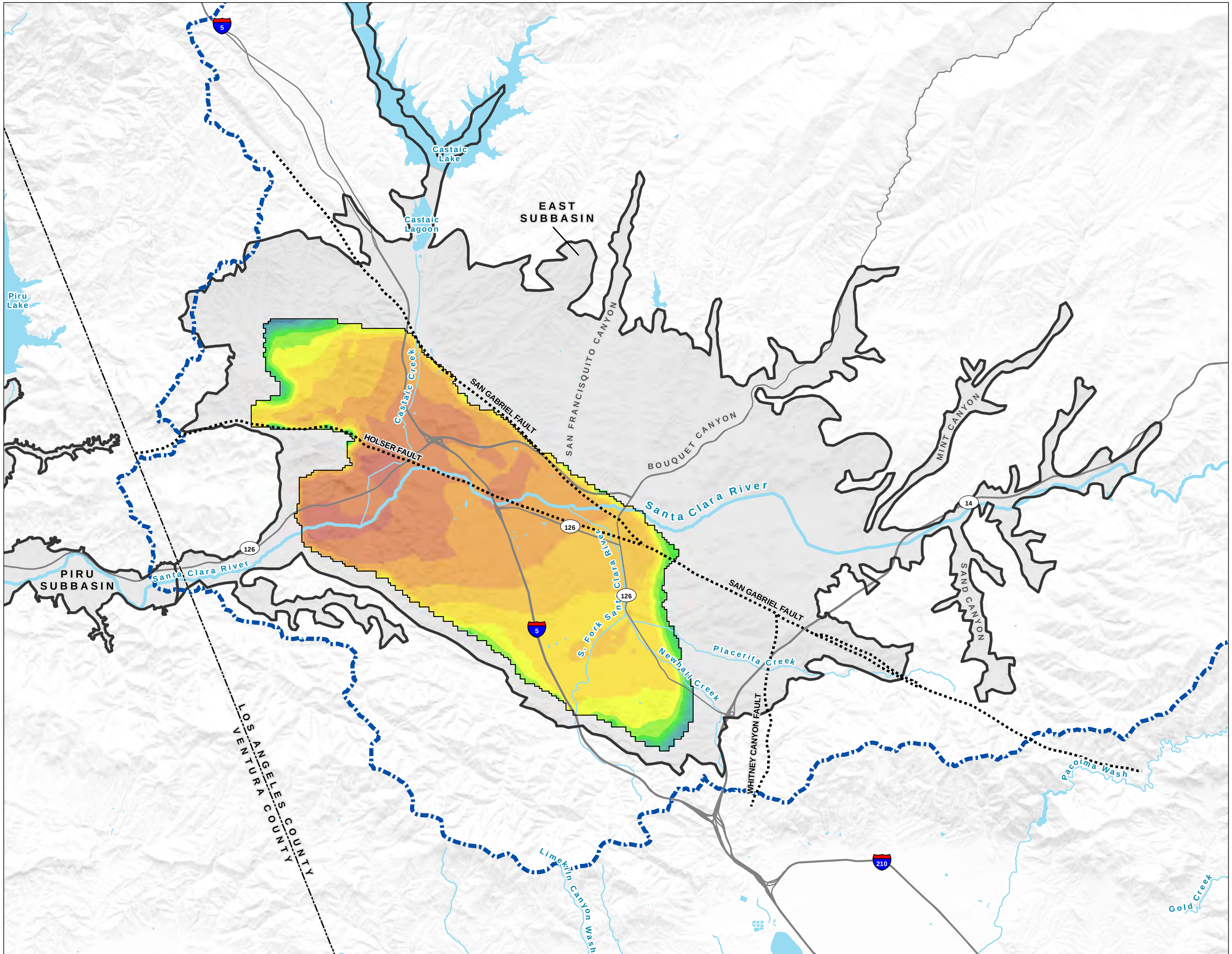


FIGURE 3-15

Bottom Elevation of Model Grid in Model Layer 7

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 7
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Bottom Elevation Flood Intervals (feet)

- < -1,600
- -1,600 - -1,500
- -1,500 - -1,400
- -1,400 - -1,300
- -1,300 - -1,200
- -1,200 - -1,100
- -1,100 - -1,000
- -1,000 - -900
- -900 - -800
- -800 - -700
- -700 - -600
- -600 - -500
- > -500

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

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Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_15_Bottom_Elevation_of_Model_Grid_Model_Layer_7.mxd, abarry

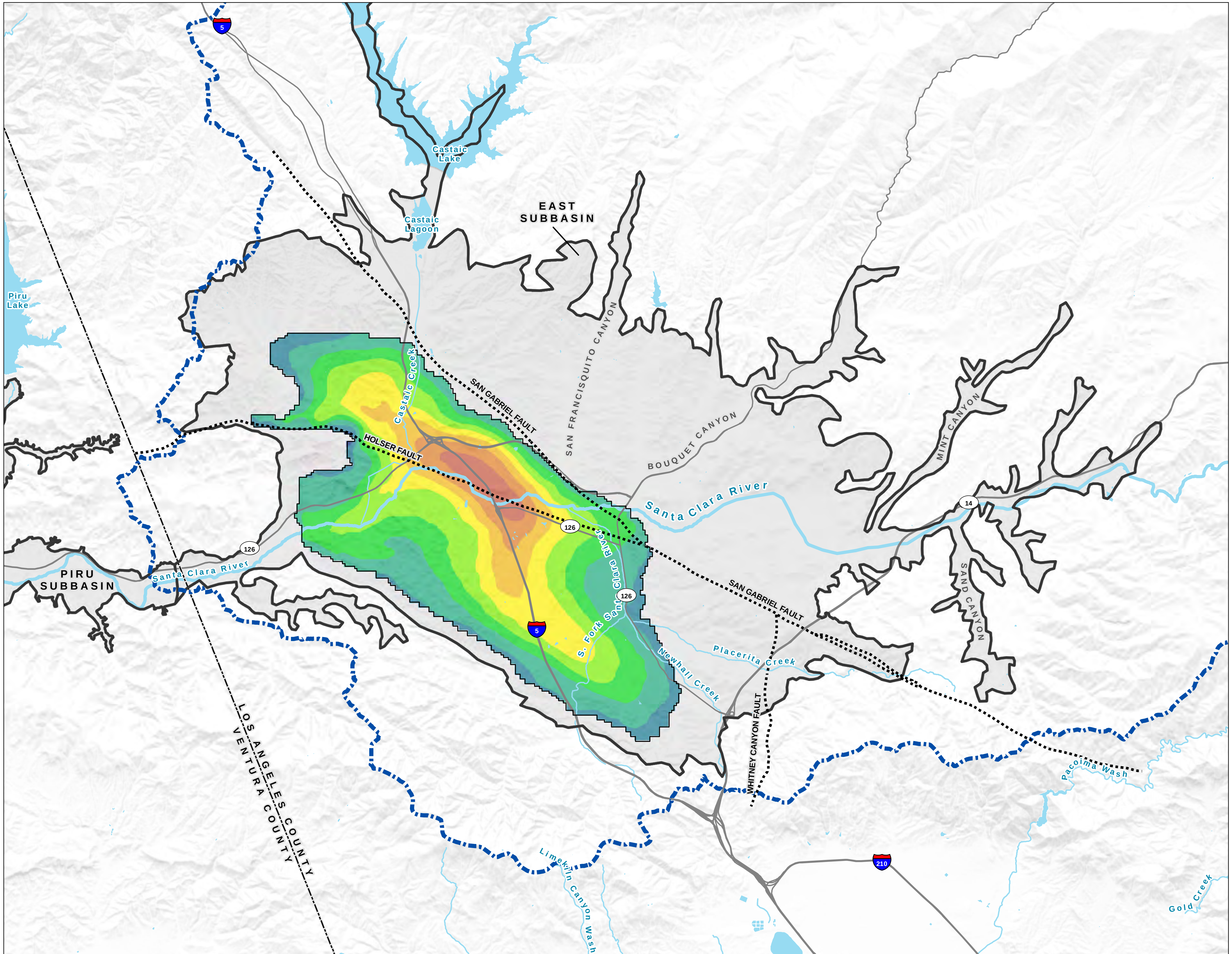


FIGURE 3-16

Bottom Elevation of Model Grid in Model Layer 8

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 8
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Bottom Elevation Flood Intervals (feet)

- < -4,500
- -4,500 - -4,000
- -4,000 - -3,500
- -3,500 - -3,000
- -3,000 - -2,500
- -2,500 - -2,000
- -2,000 - -1,500
- -1,500 - -1,000
- > -1,000

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

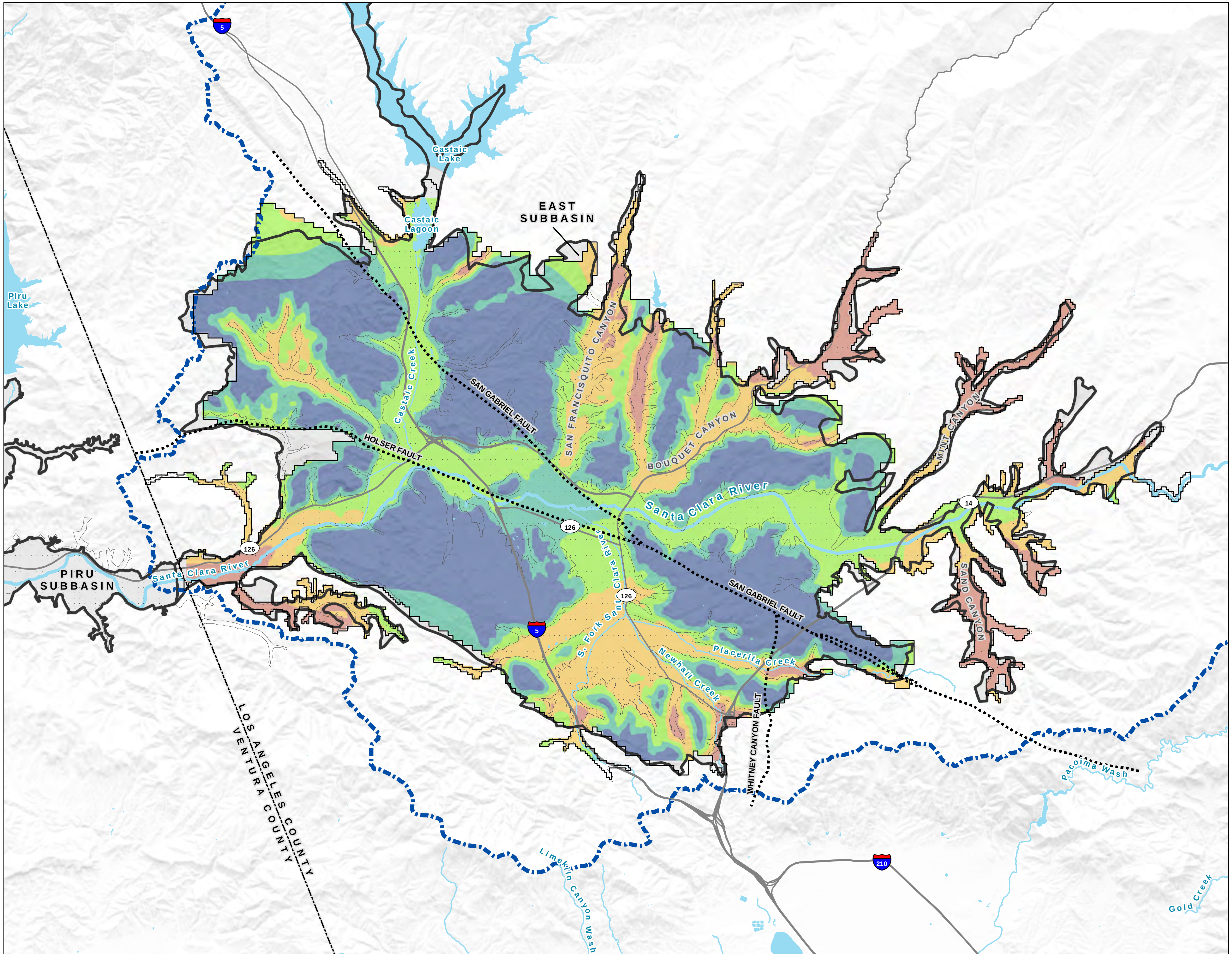
Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

FIGURE 3-17

Thickness of Model Layer 1

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Model Grid Outline Layer 1
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Model Thickness Flood Intervals (feet)

- Up to 75
- 76 - 125
- 126 - 175
- 176 - 225
- > 225

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

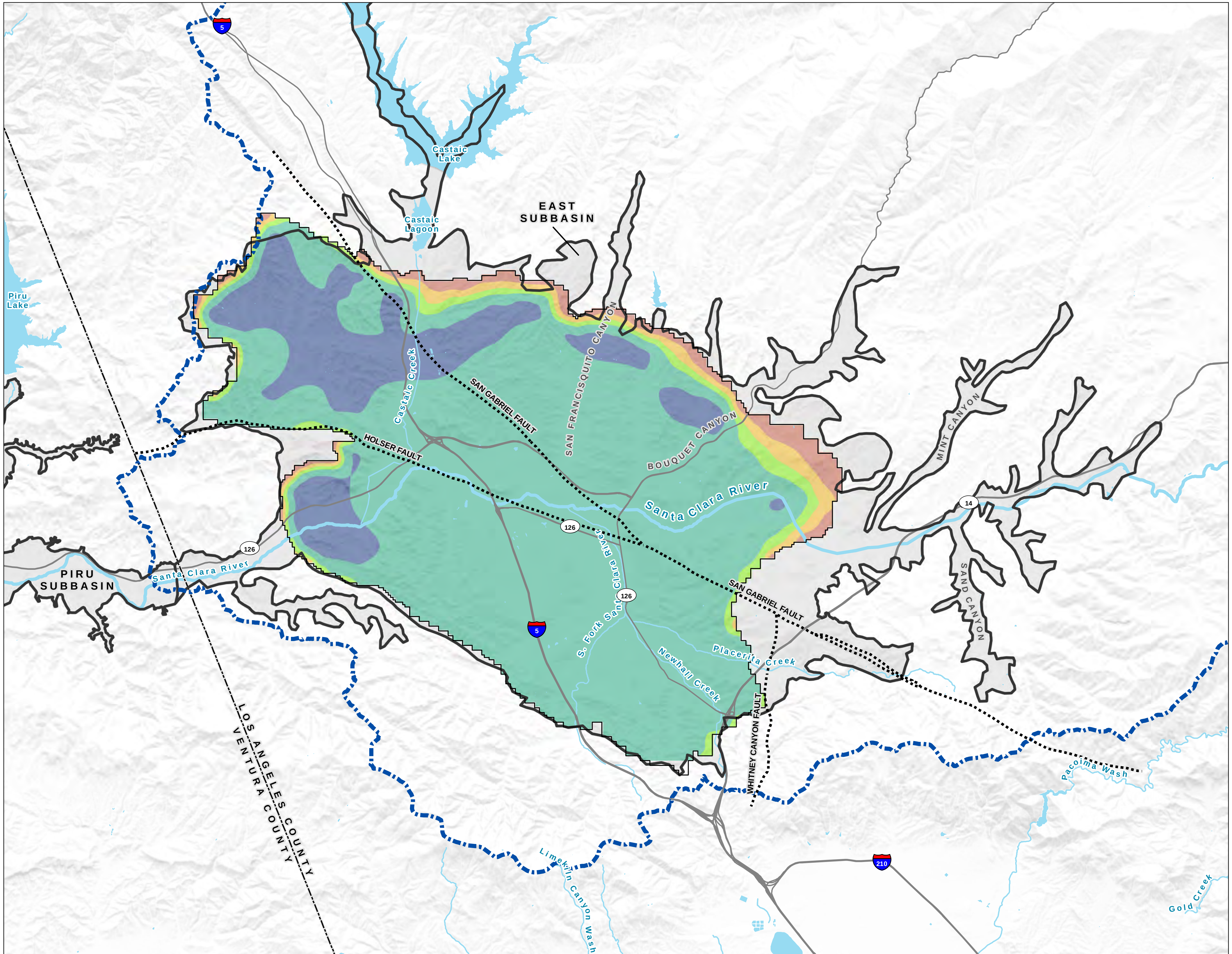
GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_17_Thickness_of_Model_Layer_1.mxd, abarry

FIGURE 3-18

Thickness of Model Layer 2

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

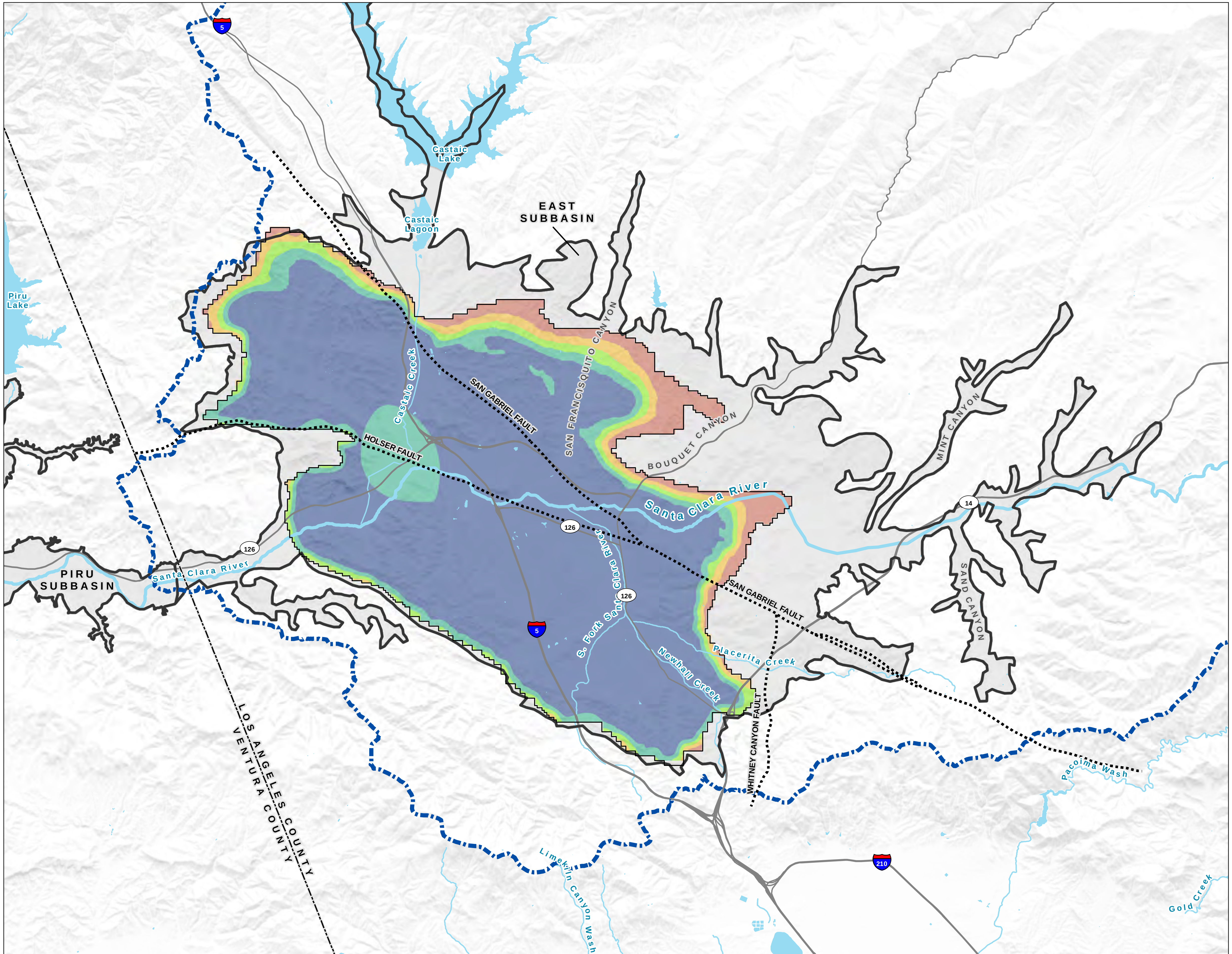


FIGURE 3-19

Thickness of Model Layer 3

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

Model Grid Outline Layer 3

Santa Clara River Valley Groundwater Basin

Watershed Boundary

Model Thickness Flood Intervals (feet)

- Up to 75
- 75 - 125
- 125 - 175
- 175 - 225
- 225 - 275

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000

Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

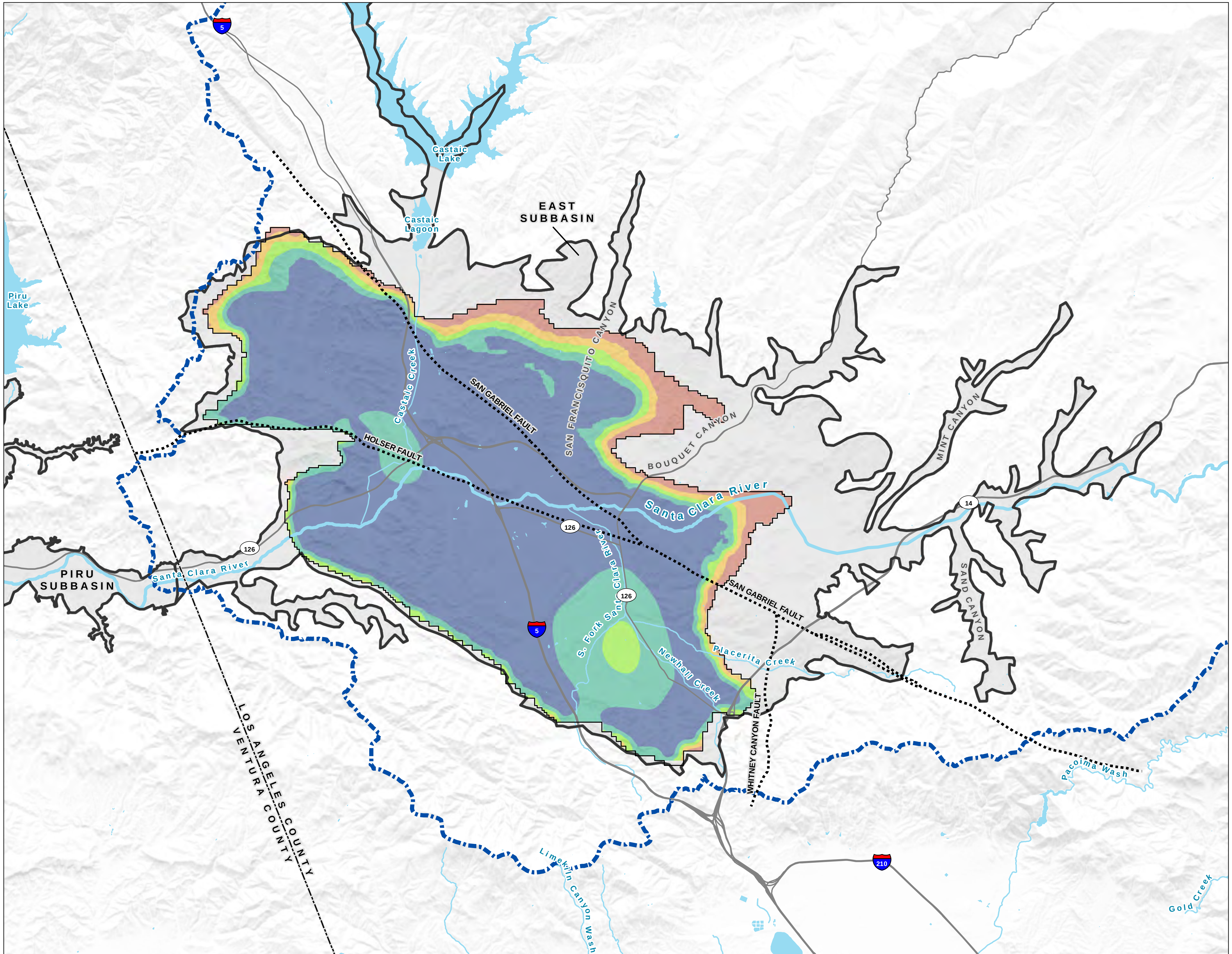
GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_19_Thickness_of_Model_Layer_3.mxd, abarry

FIGURE 3-20

Thickness of Model Layer 4

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Model Grid Outline Layer 4
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Model Thickness Flood Intervals (feet)

- Up to 75
- 75 - 125
- 125 - 175
- 175 - 225
- 225 - 275

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_20_Thickness_of_Model_Layer_4.mxd, abarry

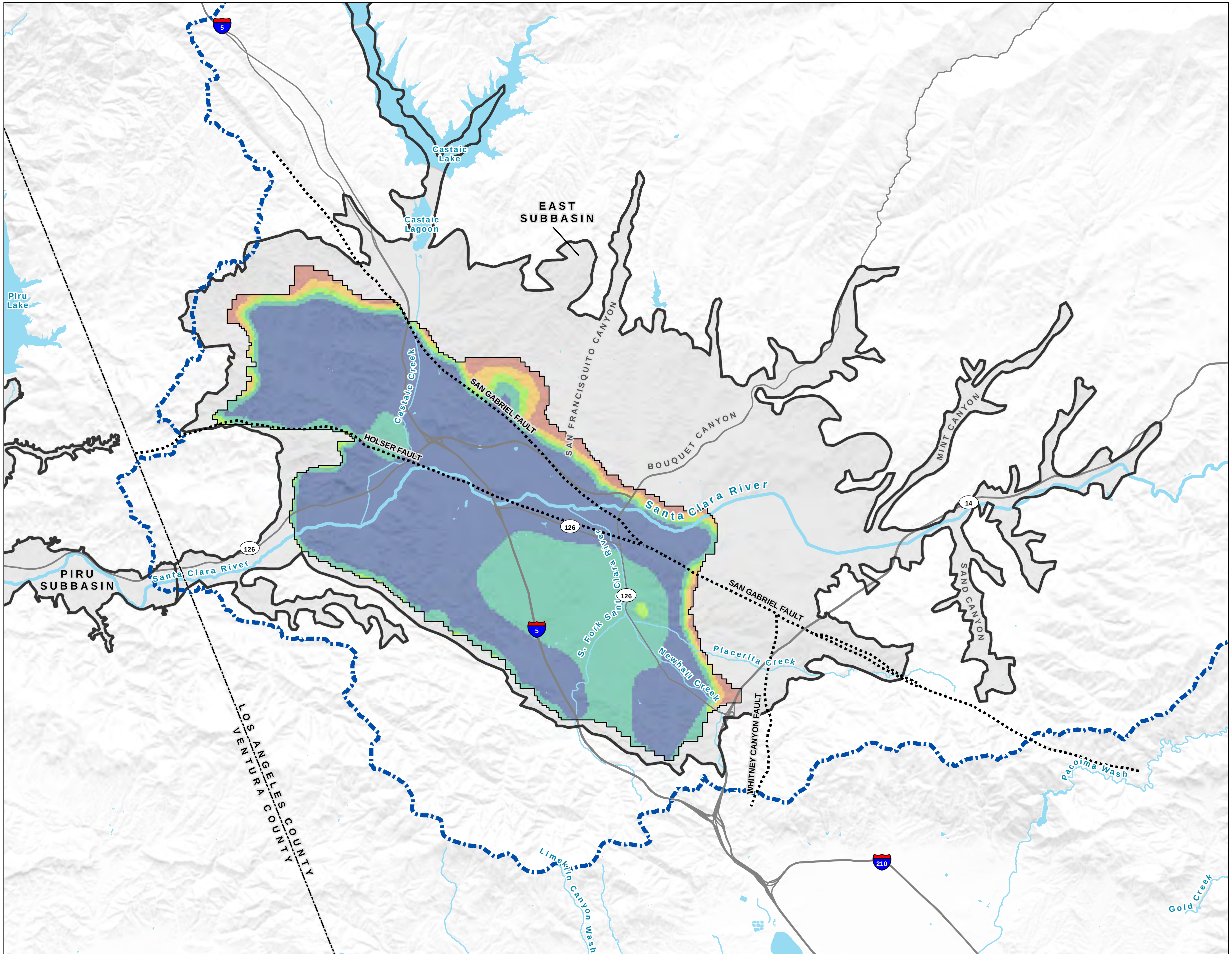


FIGURE 3-21

Thickness of Model Layer 5

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 5
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Model Thickness Flood Intervals (feet)

- Up to 150
- 150 - 250
- 250 - 350
- 350 - 450
- 450 - 550

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

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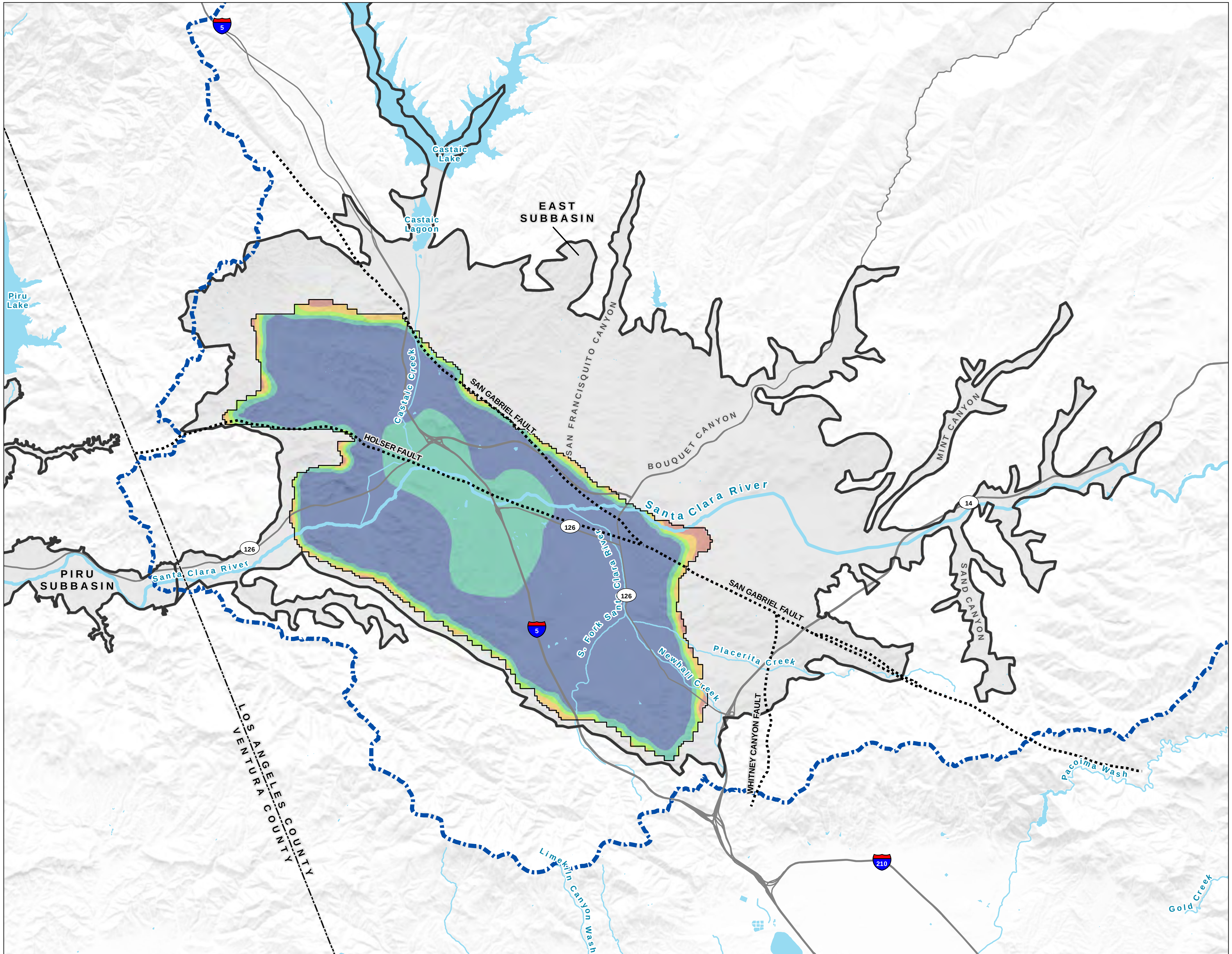
FIGURE 3-22

Thickness of Model Layer 6

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Model Grid Outline Layer 6
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Model Thickness Flood Intervals (feet)

- Up to 150
- 150 - 250
- 250 - 350
- 350 - 450
- 450 - 550

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

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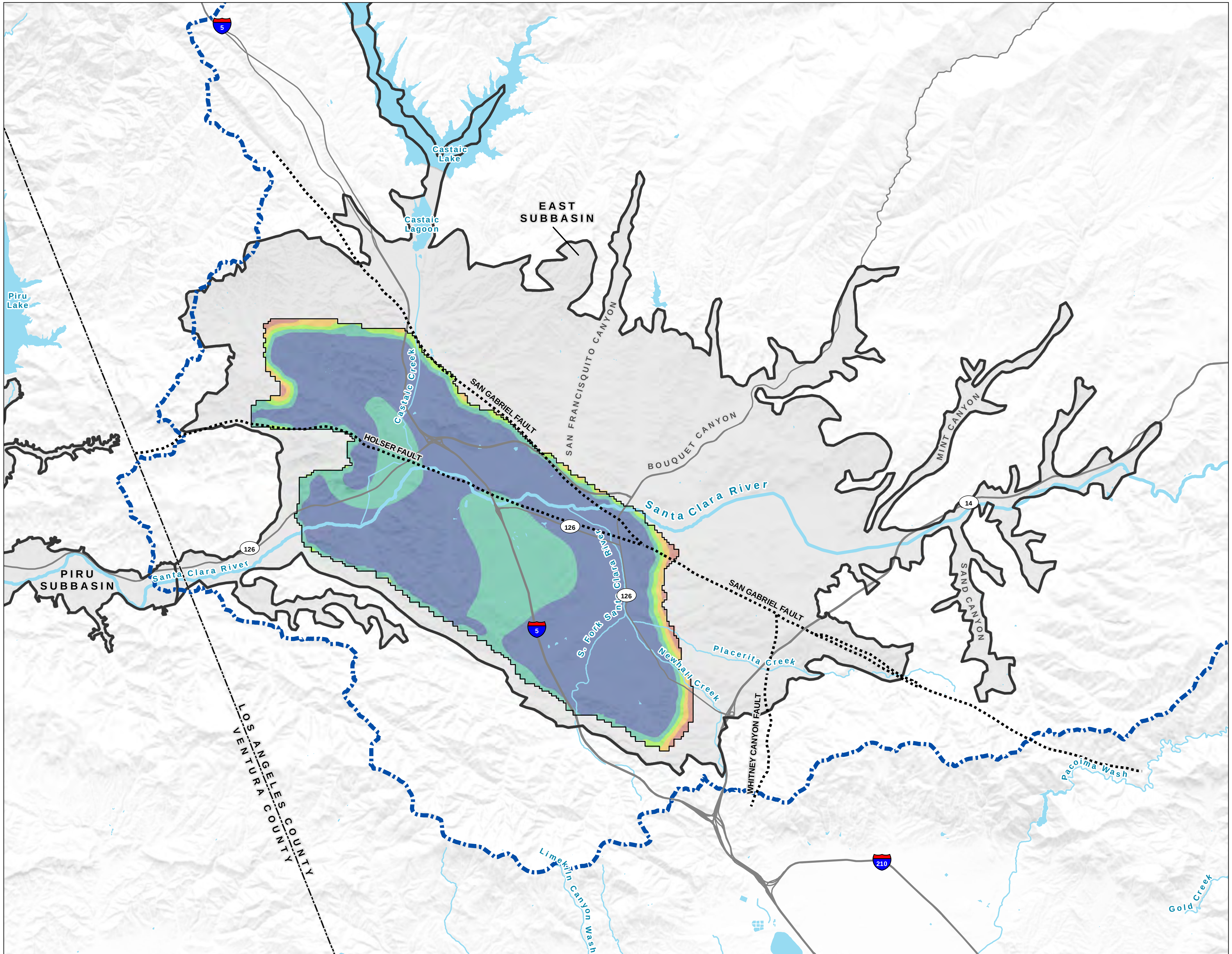
FIGURE 3-23

Thickness of Model Layer 7

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Model Grid Outline Layer 7
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Model Thickness Flood Intervals (feet)

- Up to 150
- 150 - 250
- 250 - 350
- 350 - 450
- 450 - 550

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

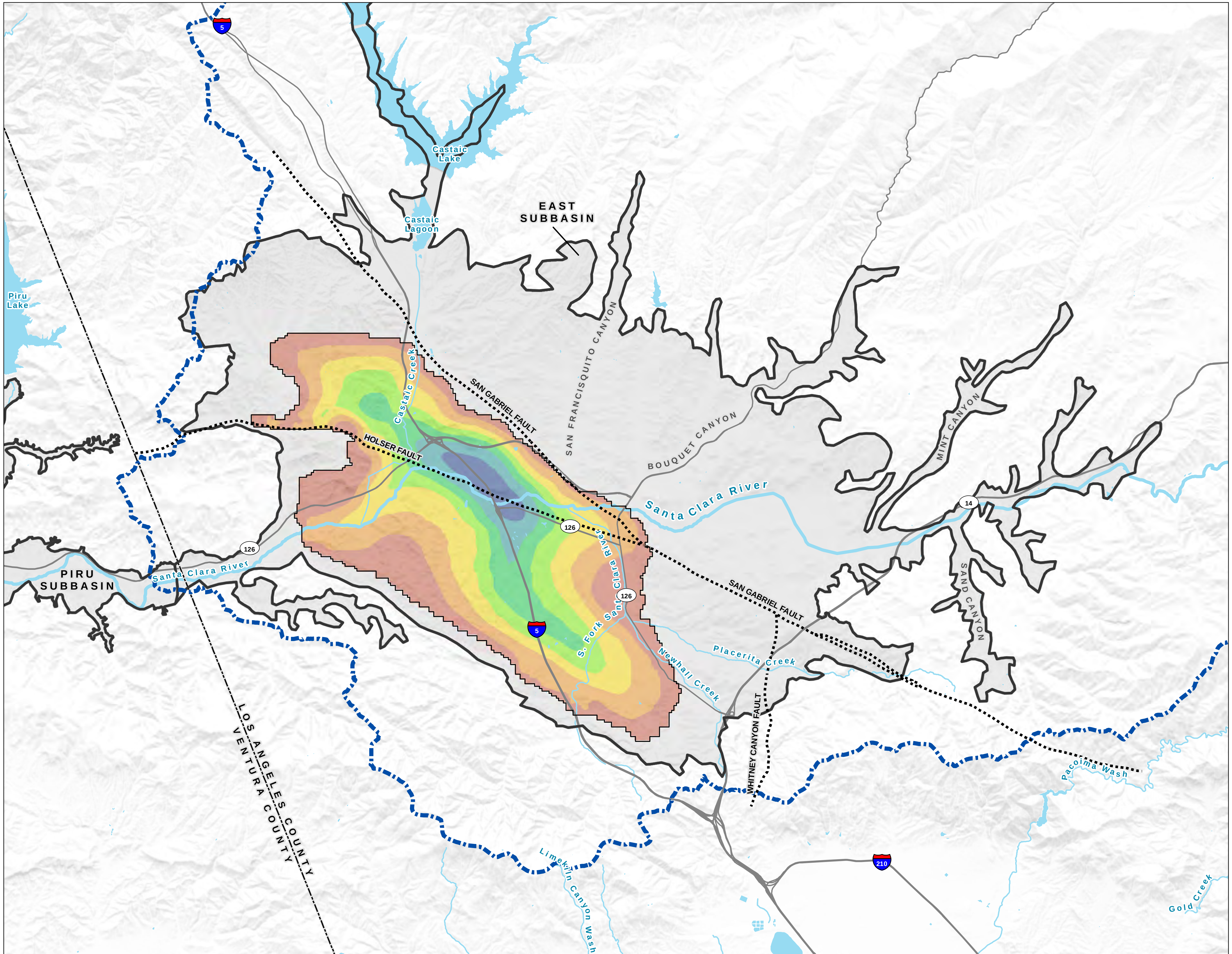
GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_23_Thickness_of_Model_Layer_7.mxd, abarry

FIGURE 3-24

Thickness of Model Layer 8

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Model Grid Outline Layer 8
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Model Thickness Flood Interval (feet)

- 0 - 500
- 500 - 1,000
- 1,000 - 1,500
- 1,500 - 2,000
- 2,000 - 2,500
- 2,500 - 3,000
- 3,000 - 3,200

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

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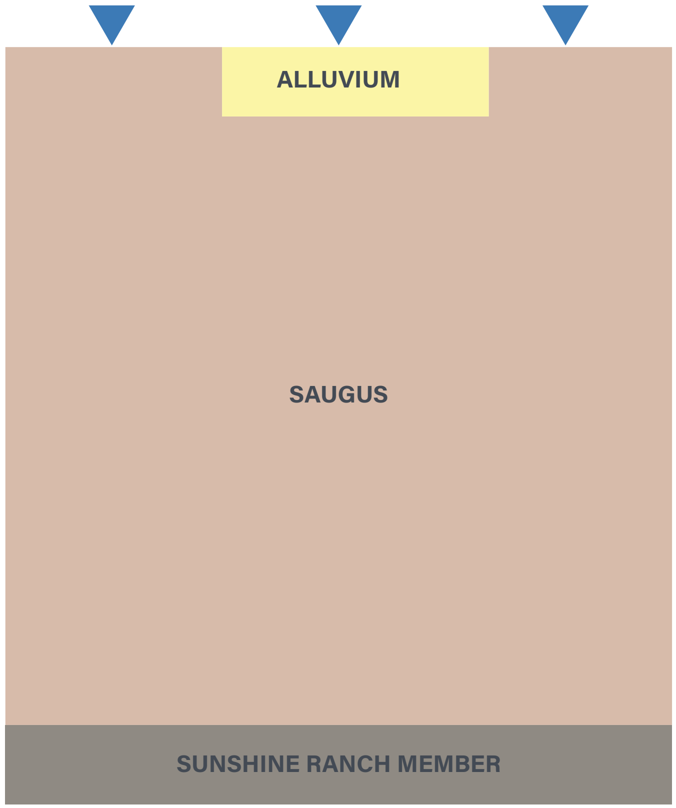
Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_24_Thickness_of_Model_Layer_8.mxd, abarry

FIGURE 3-25

Schematic Diagram of Model Layer Design and Aquifer Systems

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

STRATIGRAPHY



MODEL LAYER NUMBER	TYPICAL THICKNESS (FEET)
1	500
2	
3	250
4	250
5	500
6	500
7	500
8	Variable

NOTE

The blue triangles represent the long-term water table surface in model layer 1.

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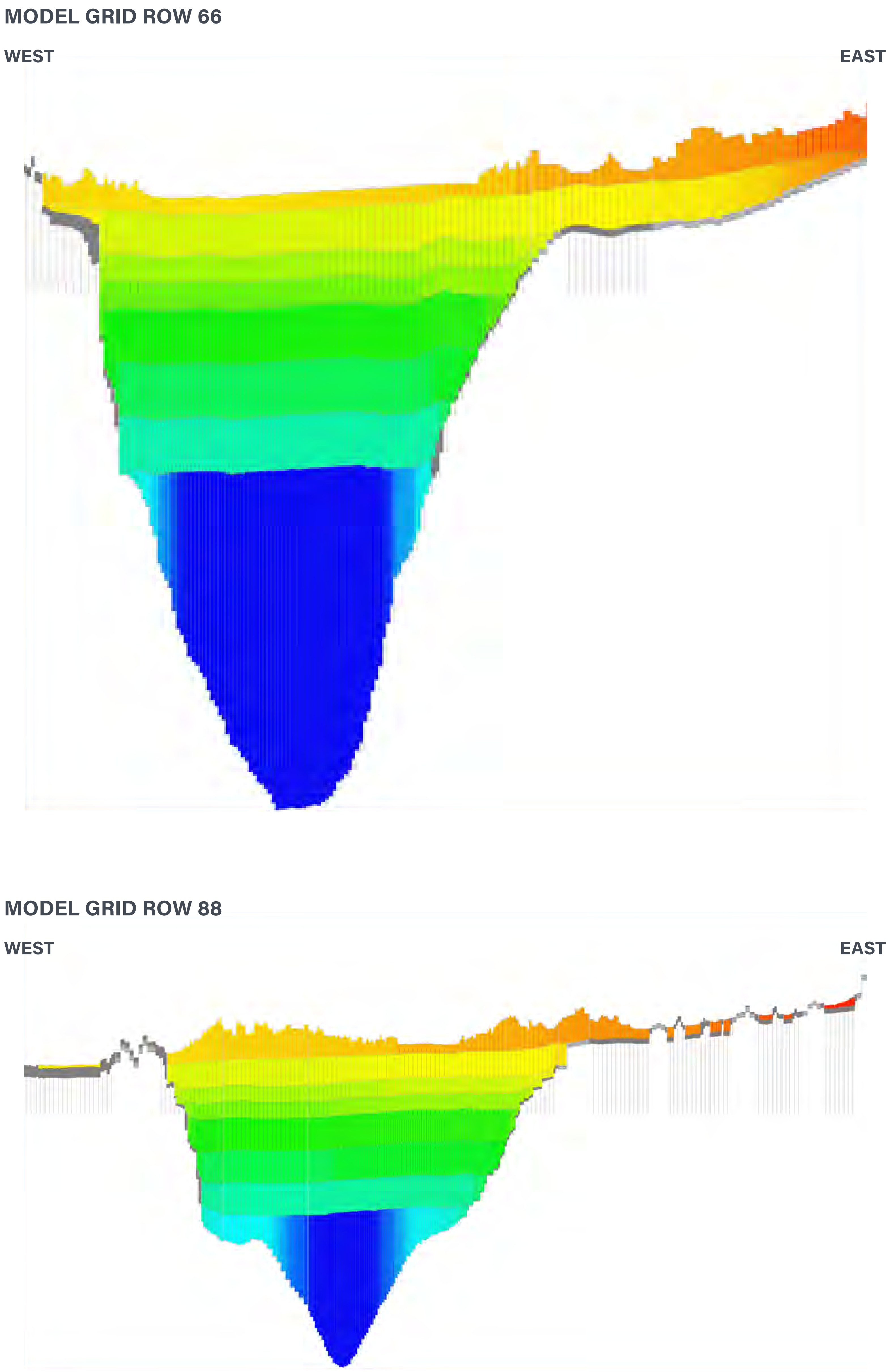

FIGURE 3-26

West-to-East Schematic Cross-Sectional View Along Model Grid Rows 66 and 88

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

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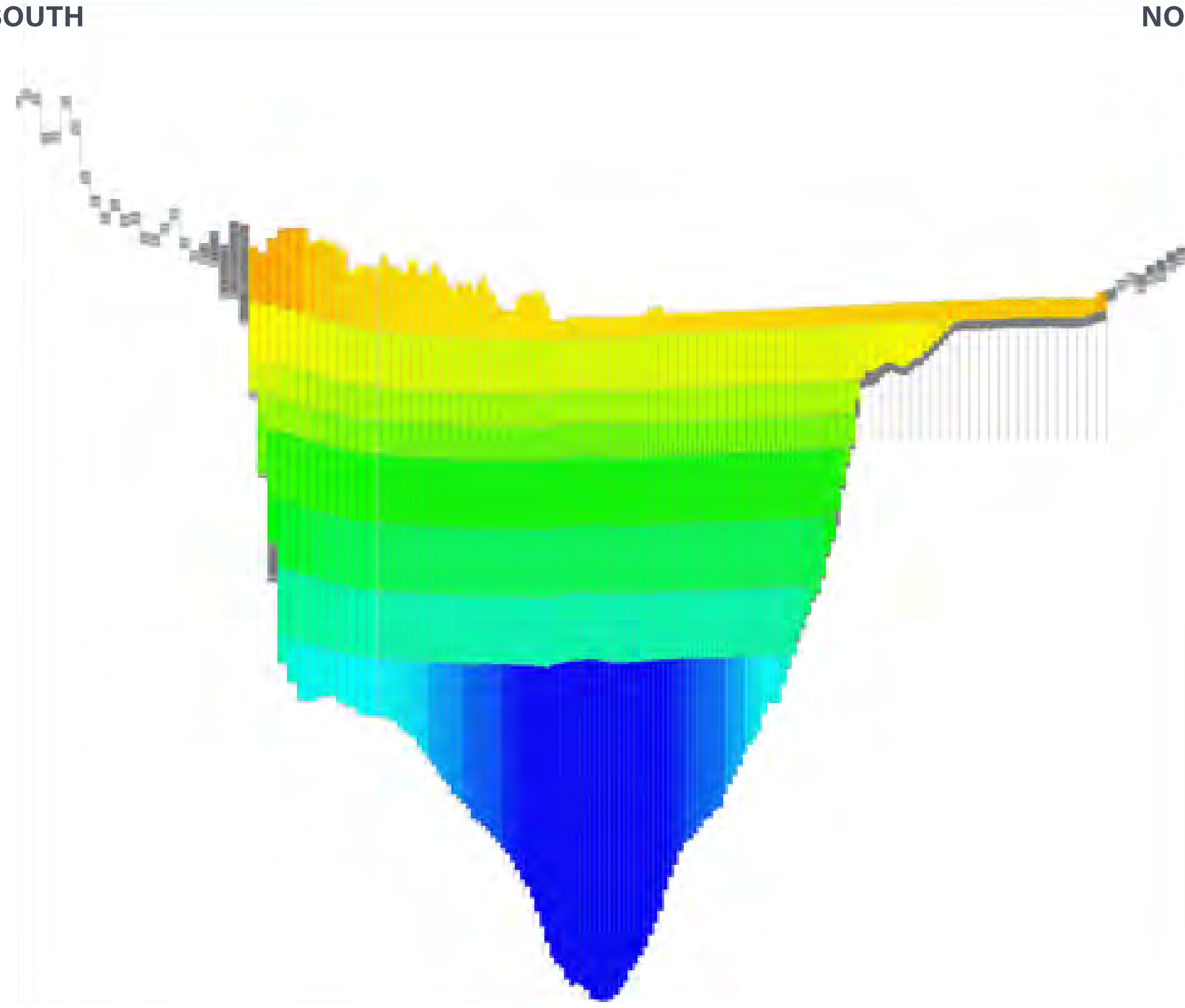
MODEL GRID COLUMN 162

SOUTH NORTH



MODEL GRID COLUMN 205

SOUTH NORTH

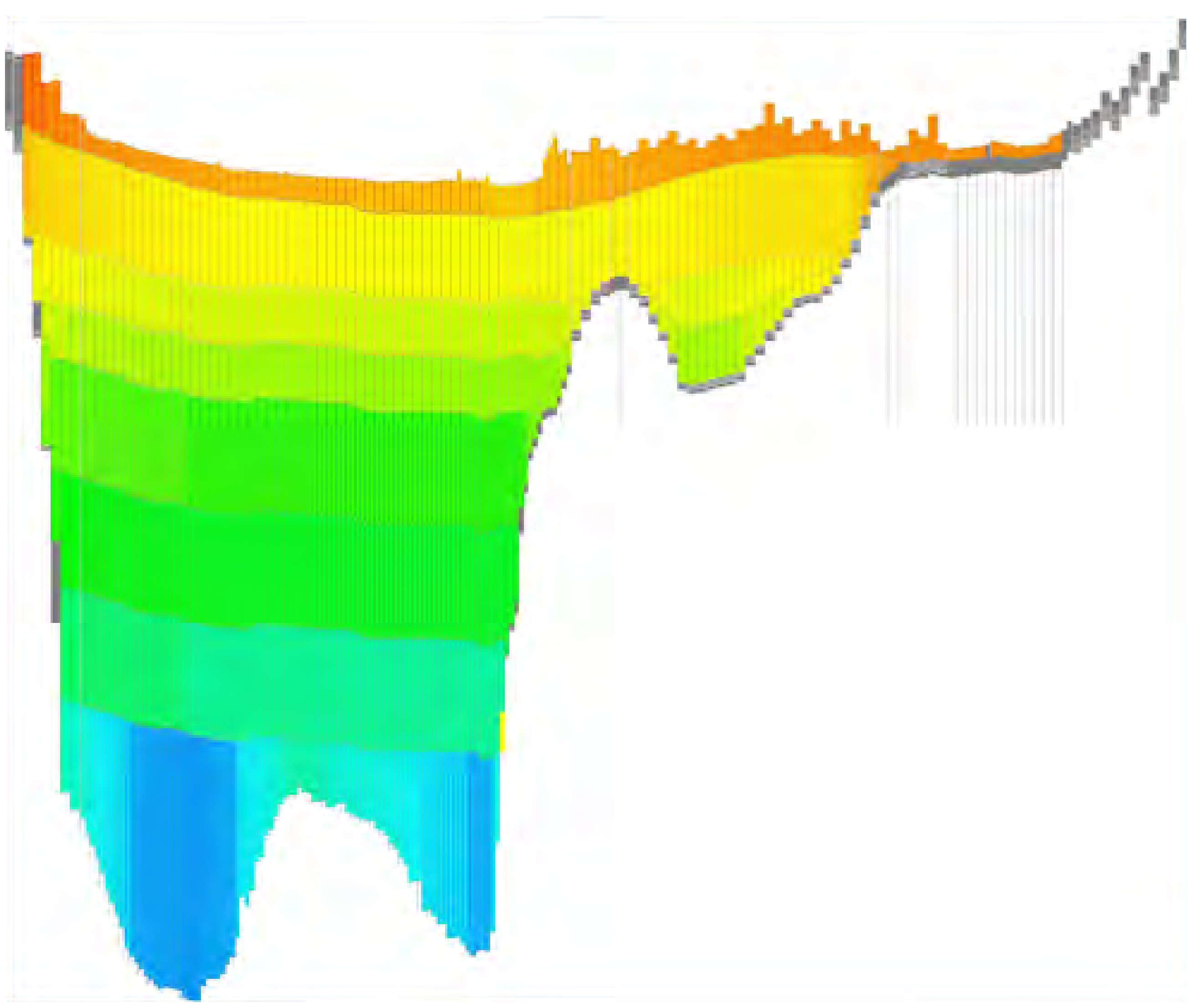


FIGURE 3-27

South-to-North Schematic Cross-Sectional View Along Model Grid Columns 162 and 205

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

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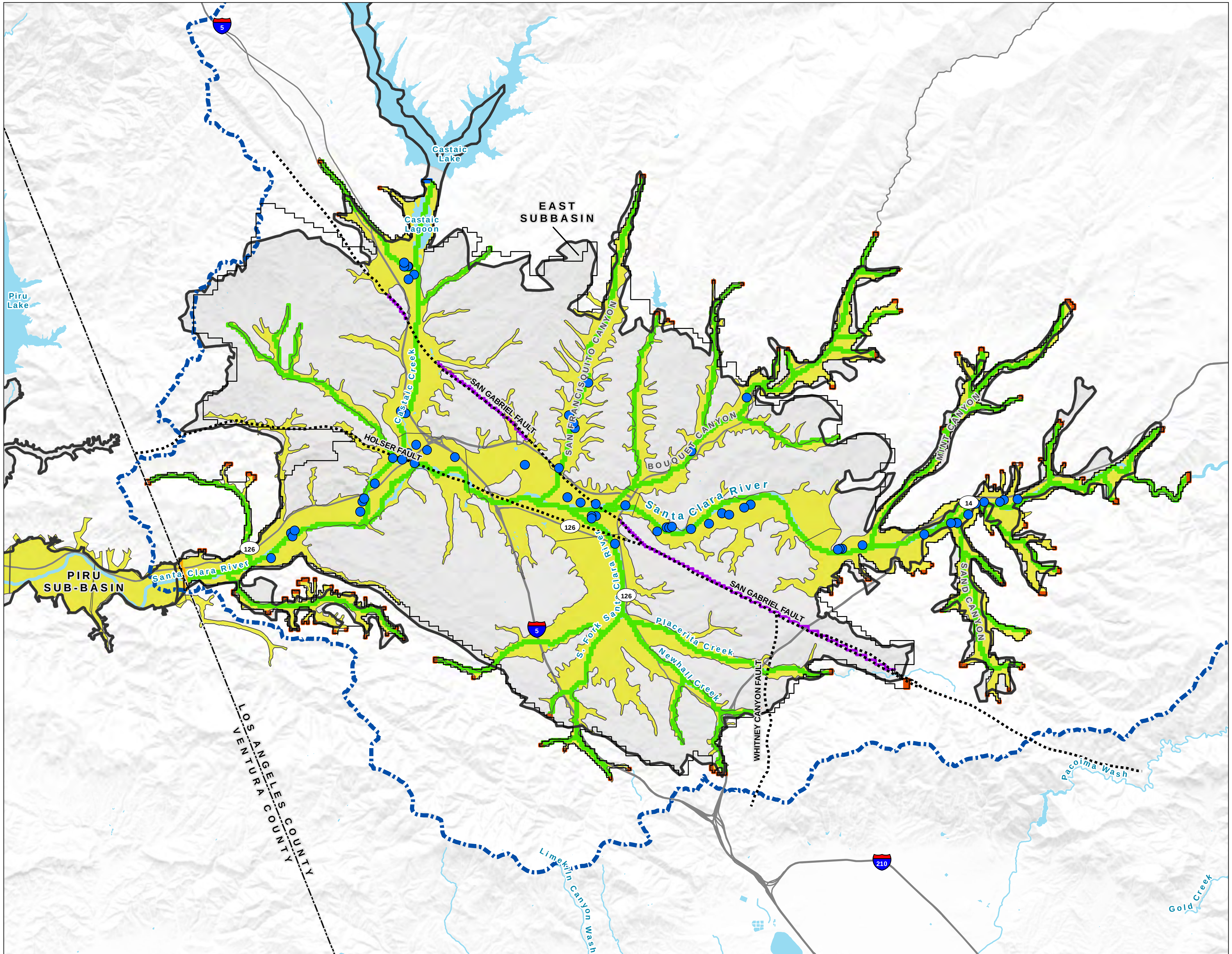

FIGURE 3-28

Boundary Conditions for the Alluvial Aquifer

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Production Well in Alluvial Aquifer
- Model Grid Outline Layer 1
- HFB = Horizontal Flow Barrier package in MODFLOW-USG (for faults)
- CHD = Constant-Head package in MODFLOW-USG (at County Line)
- GHB = General-Head Boundary package in MODFLOW-USG (for subsurface inflows at basin boundaries)
- SFR = Streamflow-Routing package in MODFLOW-USG (for Santa Clara River and its tributaries)
- Well package in MODFLOW-USG (for production wells and specified inflow at Castaic Dam)
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

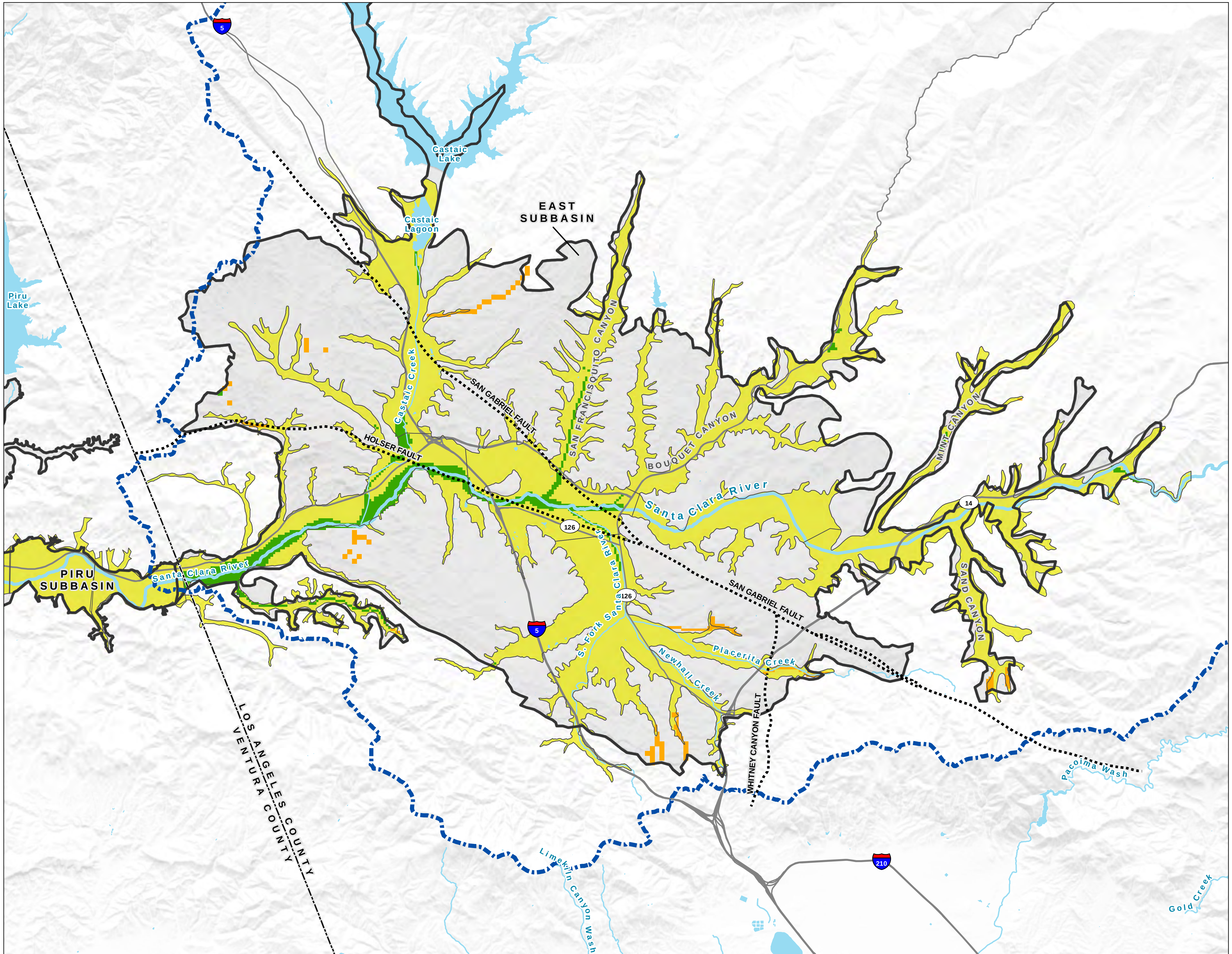

FIGURE 3-29

Phreatophyte Locations in the Model Grid

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Phreatophyte Locations

- Riparian Mixed Hardwood
- Coast Live Oak Woodland

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000 Feet

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Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_29_Phreatophyte_Locations_in_the_Model_Grid.mxd, abarry

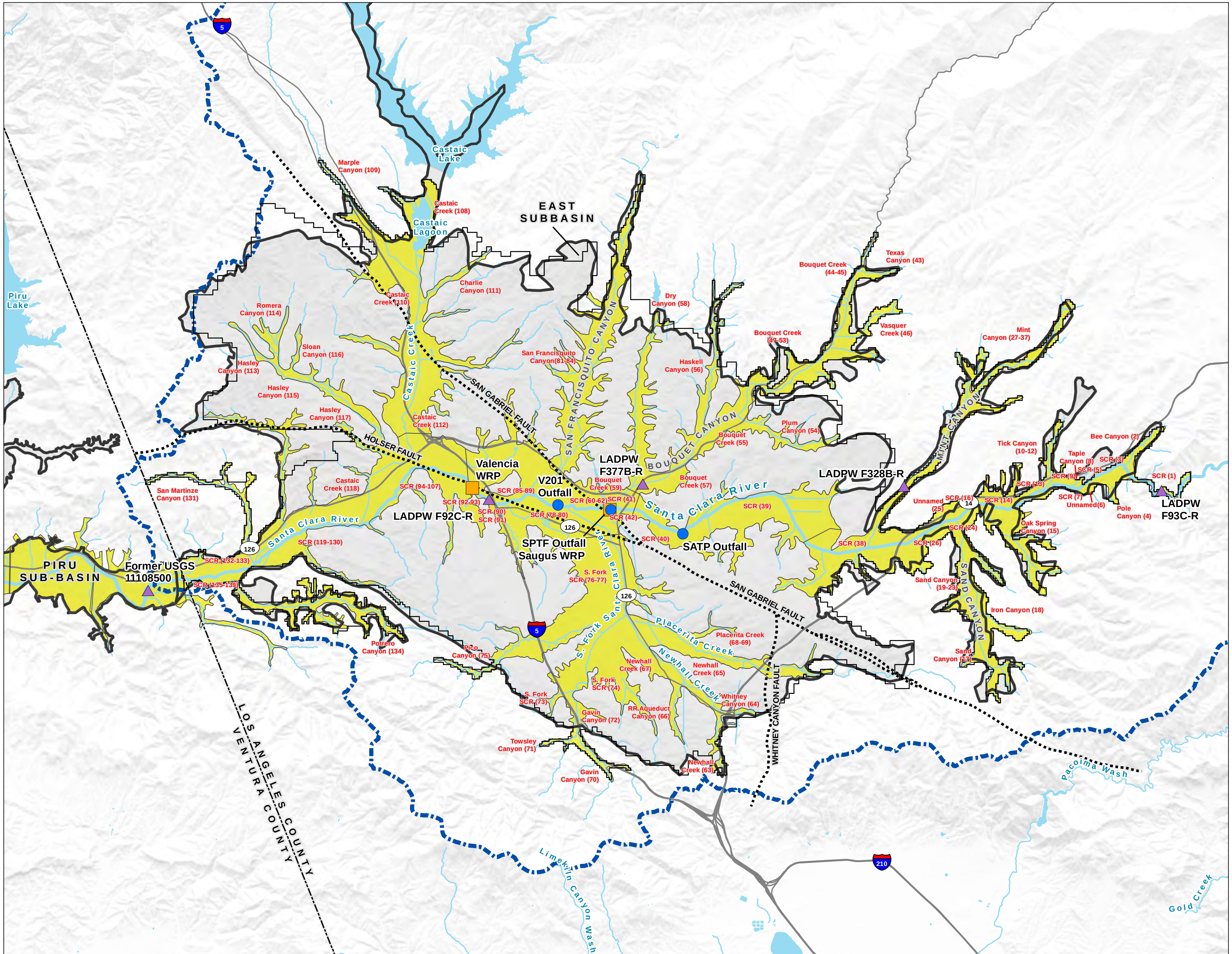

FIGURE 3-30

Definition of Stream Segments in Streamflow Routing Package

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Outfall
- Stream Gage
- Water Reclamation Plant (WRP)
- Model Grid Outline Layer 1
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse: Stream Name (Segment Number)
- Waterbody

NOTES

DWR: Department of Water Resources
LADPW: Los Angeles County Department of Public Works
SATP: Saugus Aquifer Treatment Plant
SCR: Santa Clara River
SPTF: Saugus Perchlorate Treatment Facility
USGS: U.S. Geological Survey

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

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Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_30_Definition_of_Stream_Segs_Streamflow_Routing_Package.mxd, abarry

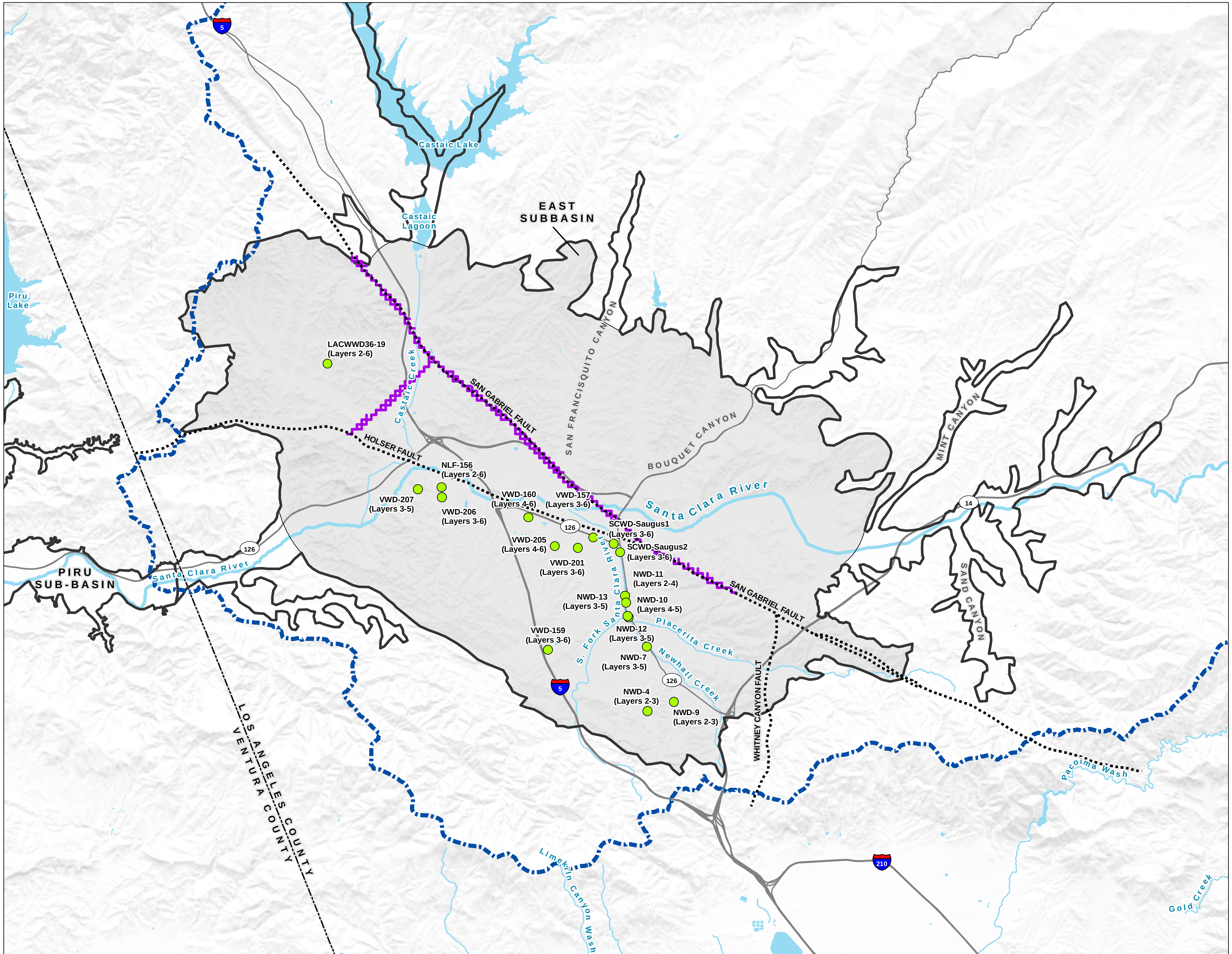

FIGURE 3-31

Boundary Conditions for the Saugus Formation

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- CLN = Connected Linear Network package in MODFLOW-USG
- HFB = Horizontal Flow Barrier package in MODFLOW-USG
- Saugus Formation
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

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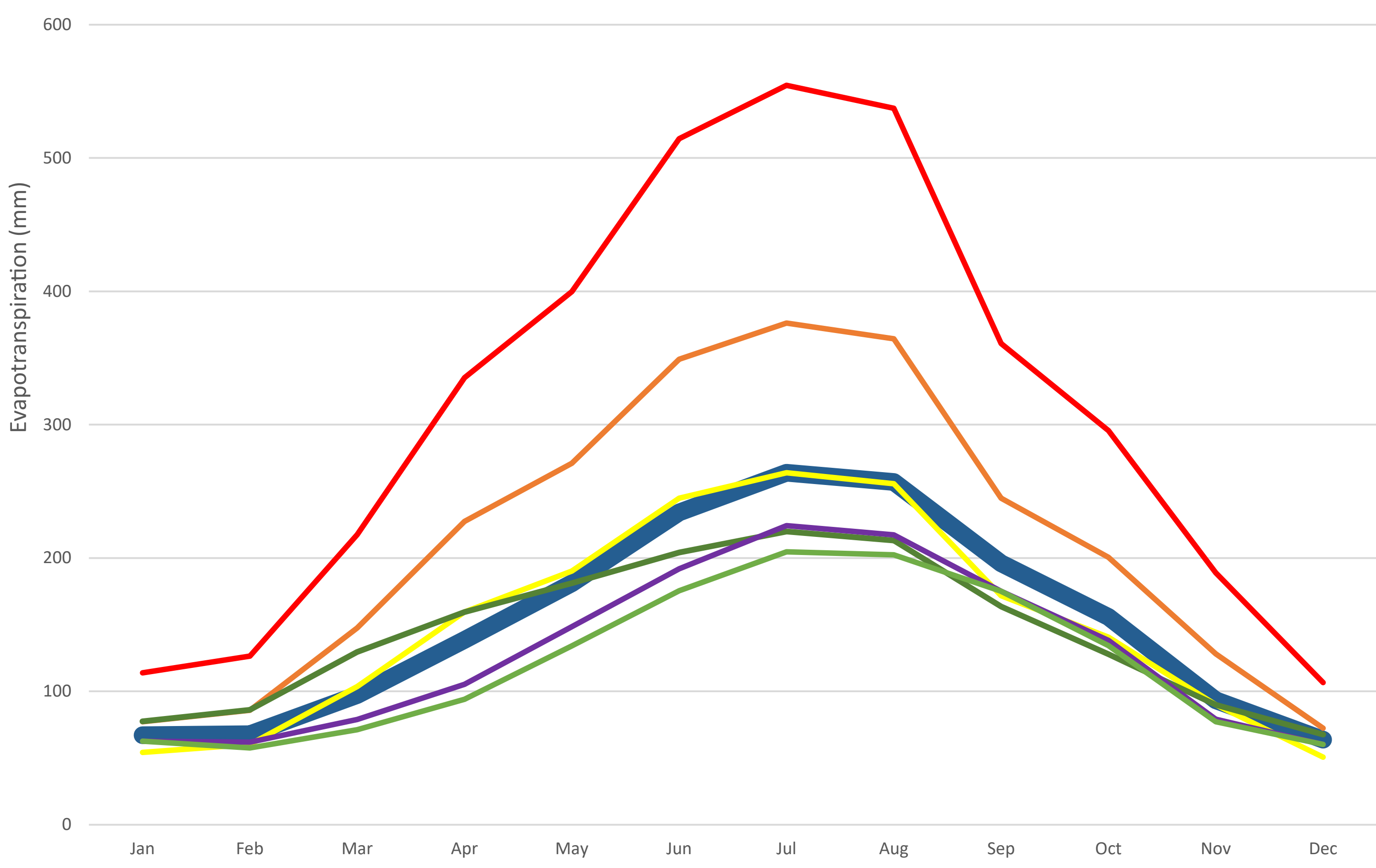

FIGURE 3-32

Evapotranspiration Demand Curves for Native and Nonnative Species

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Amalgam of 30% *Arundo*, 40% cottonwood, 30% willow
- Estimated *Arundo* (median of TNC values)
- Reference surface (grass)
- Large-stand willow
- Estimated *Arundo* (mean of TNC values)
- Large-stand permanent wetland
- Large-stand cottonwood

NOTE
TNC: The Nature Conservancy

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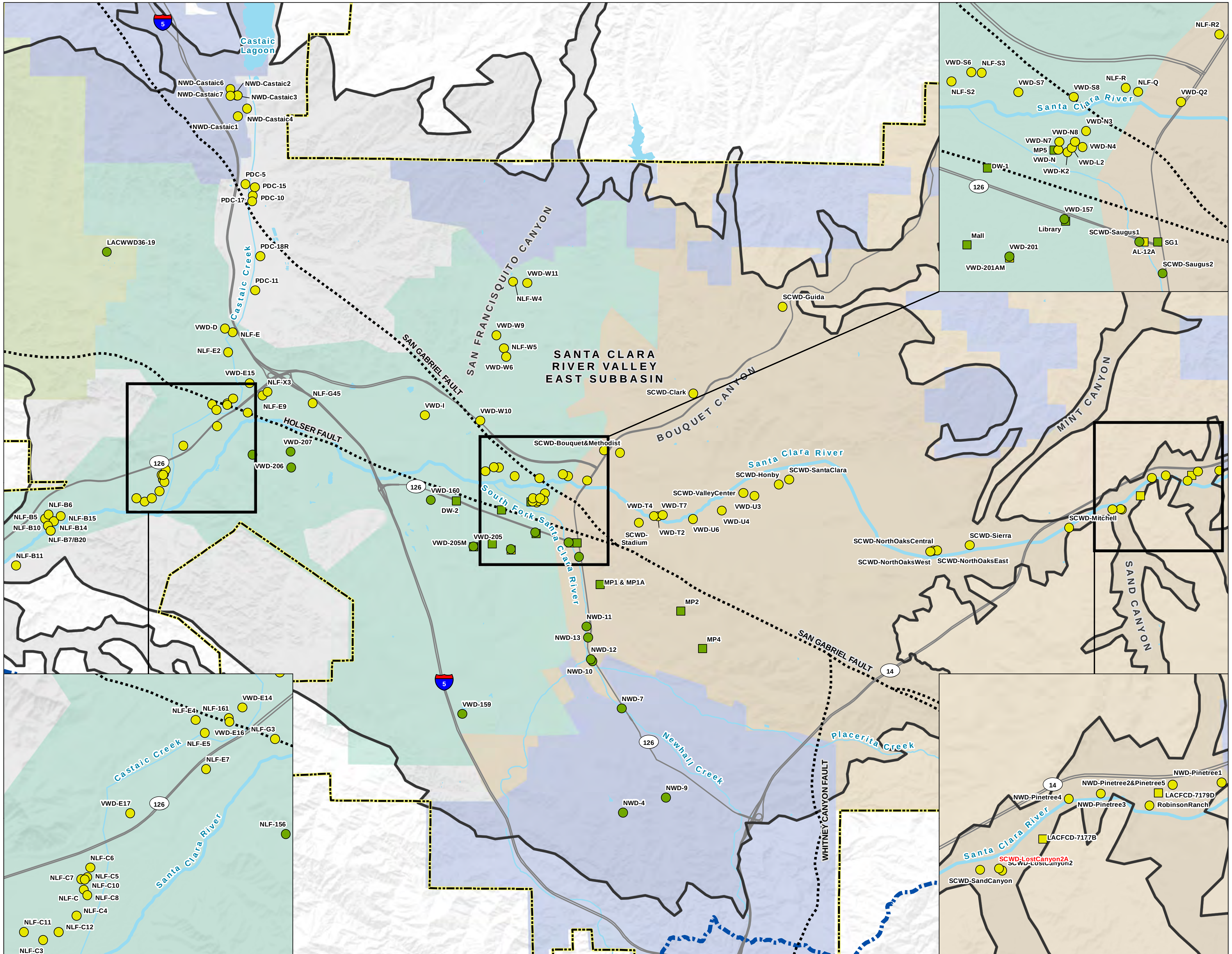


FIGURE 3-33

Locations of Active Production Wells and Select Observation Wells Wells from 1980 through 2019

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

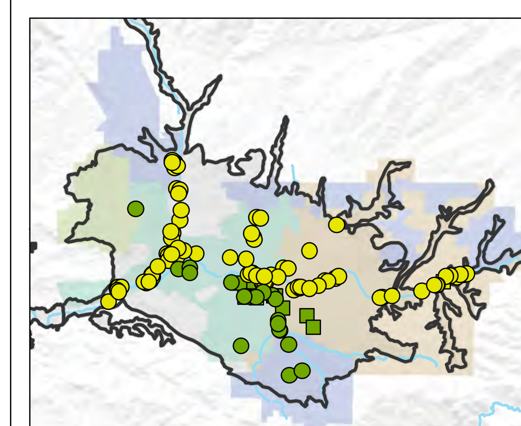
LEGEND

Aquifer, Type of Well

- Alluvial, Observation Well
- Alluvial, Production Well
- Saugus Formation, Observation Well
- Saugus Formation, Production Well

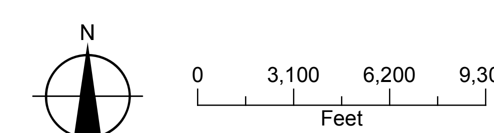
All Other Features

- Santa Clara River Valley Groundwater Basin
- Watershed Boundary
- Service Area Boundary for SCV Water
- Major Road
- Watercourse
- Waterbody



NOTE

SCV Water: Santa Clarita Valley Water Agency



Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

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Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_33_Locations_of_Active_Prod_Wells_and_Select_Obs_1980_2019.mxd, abarry

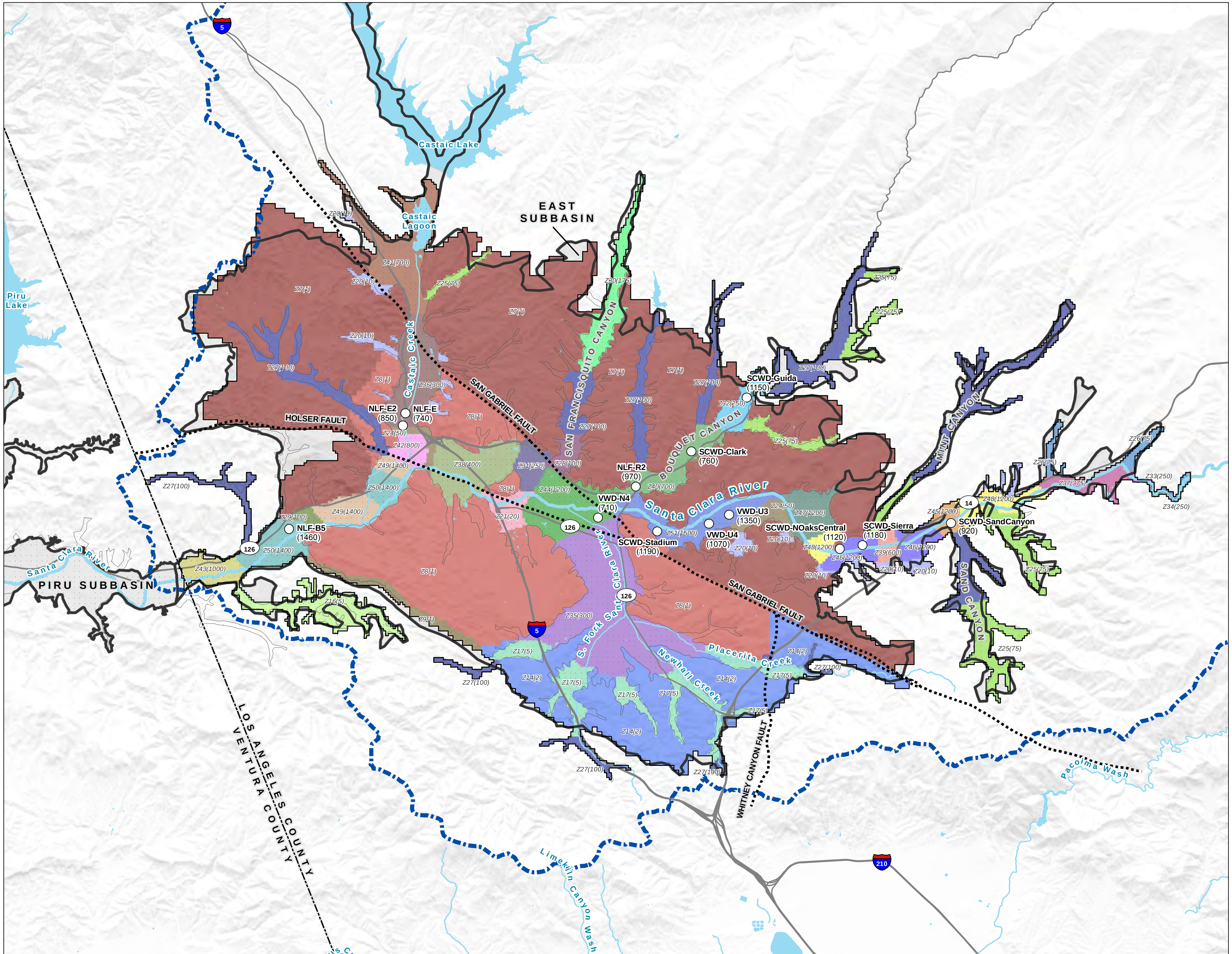

FIGURE 3-34

Hydraulic Conductivity Zones in Model Layer 1

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Alluvial Aquifer Production Well (Hydraulic Conductivity)
- Model Grid Outline Layer 1
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

NOTES

1. Z25 (75) represents "Zone Number (Hydraulic Conductivity)".
2. Hydrologic Conductivity is measured in units of feet/day.

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_34_Hydraulic_Conductivity_Zones_Layer1.mxd, abarry

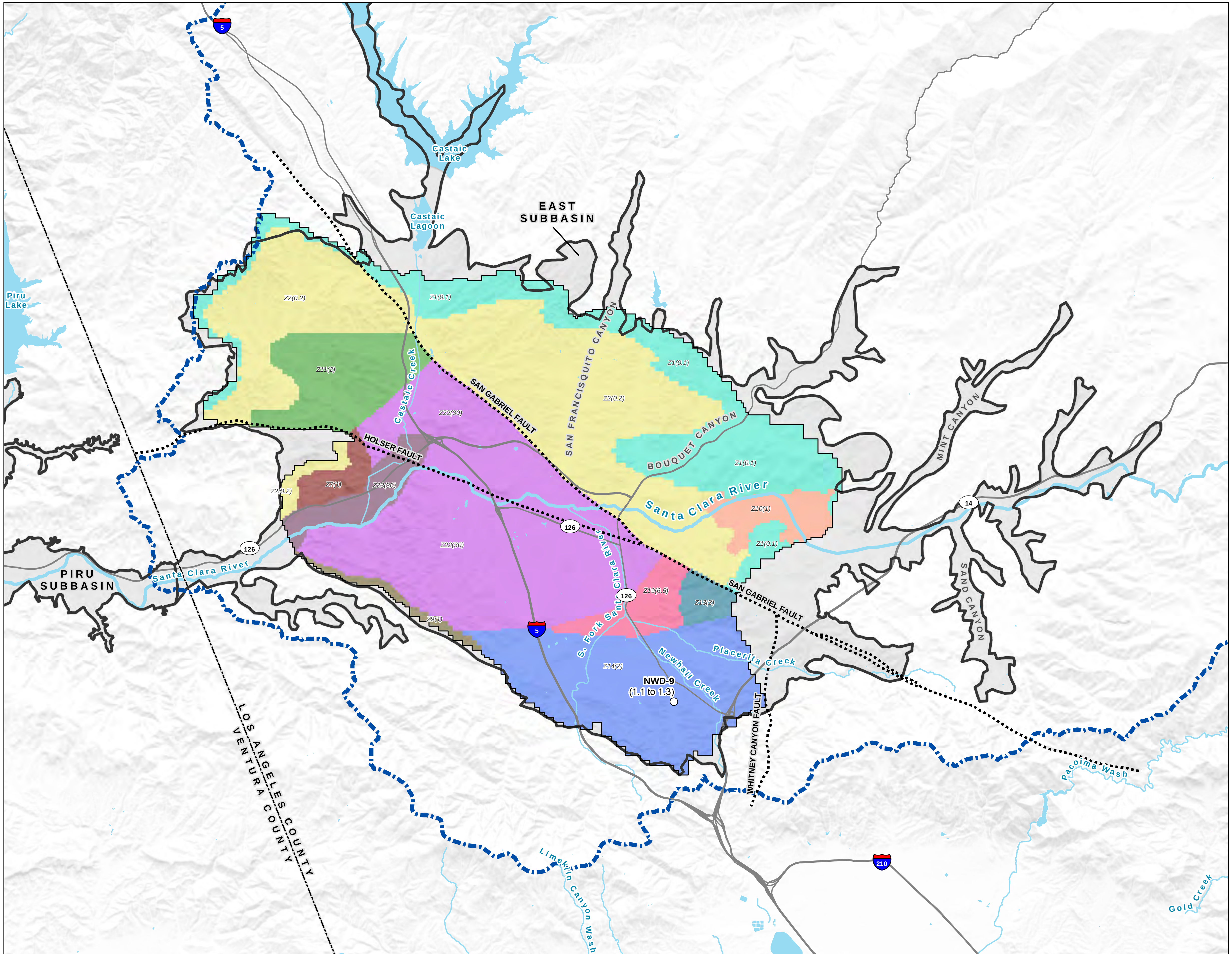

FIGURE 3-35

Hydraulic Conductivity Zones in Model Layer 2

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Saugus Formation Production Well (Hydraulic Conductivity)
- Model Grid Outline Layer 2
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

NOTES

1. Z25 (75) represents "Zone Number (Hydraulic Conductivity)".
2. Hydrologic Conductivity is measured in units of feet/day.

N

0 5,000 10,000 15,000
Feet

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Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_35_Hydraulic_Conductivity_Zones_Layer2.mxd, abarry

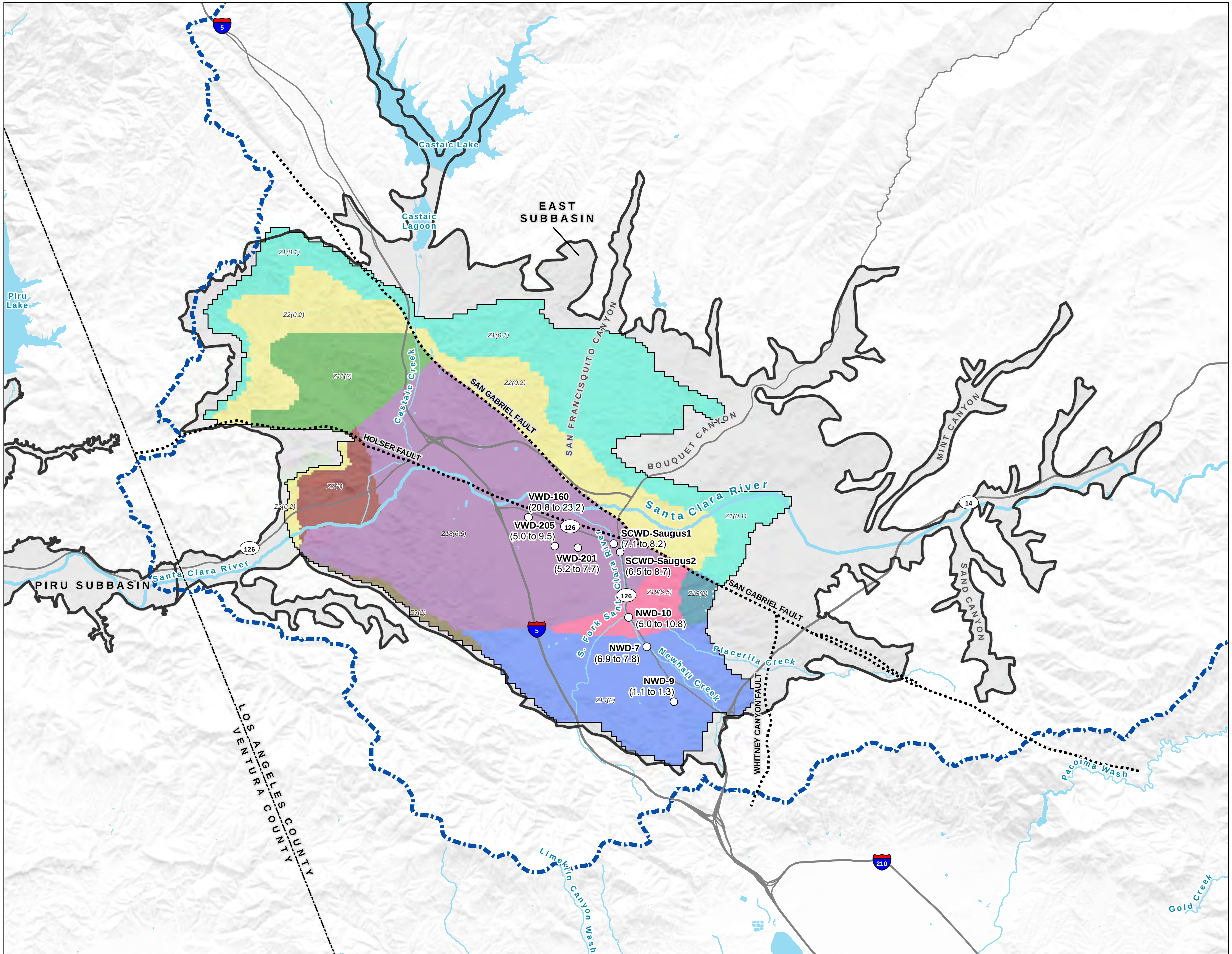

FIGURE 3-36

Hydraulic Conductivity Zones in Model Layers 3 and 4

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Saugus Formation Production Well (Hydraulic Conductivity)
- Model Grid Outline Layer 3
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

NOTES

1. Z25 (75) represents "Zone Number (Hydraulic Conductivity)".
2. Hydrologic Conductivity is measured in units of feet/day.

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

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Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_36_Hydraulic_Conductivity_Zones_Layer3and4.mxd, abarry

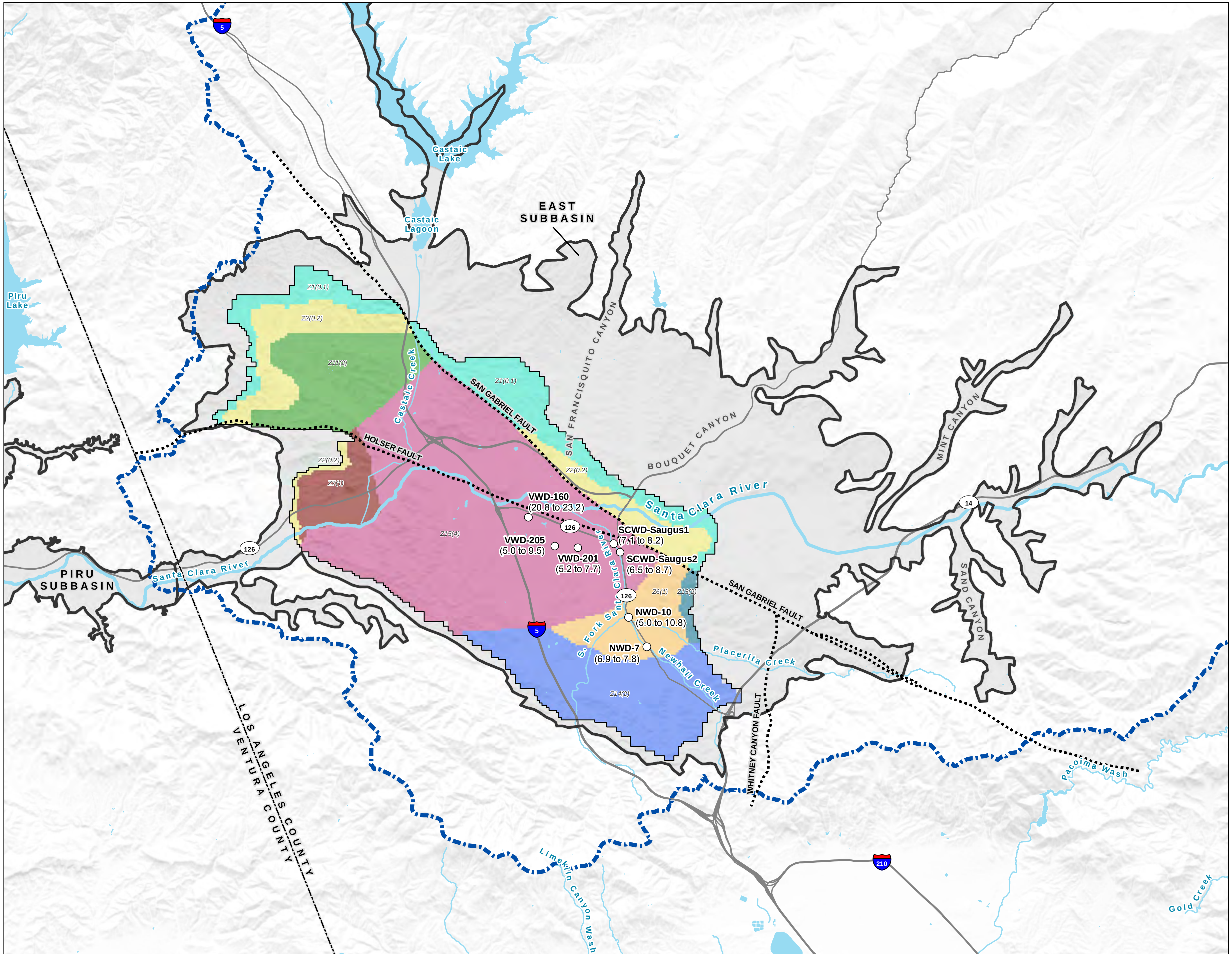


FIGURE 3-37

Hydraulic Conductivity Zones in Model Layer 5

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Saugus Formation Production Well (Hydraulic Conductivity)
- Model Grid Outline Layer 5
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

NOTES

1. Z25 (75) represents "Zone Number (Hydraulic Conductivity)".
2. Hydrologic Conductivity is measured in units of feet/day.

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_37_Hydraulic_Conductivity_Zones_Layer5.mxd, abarry

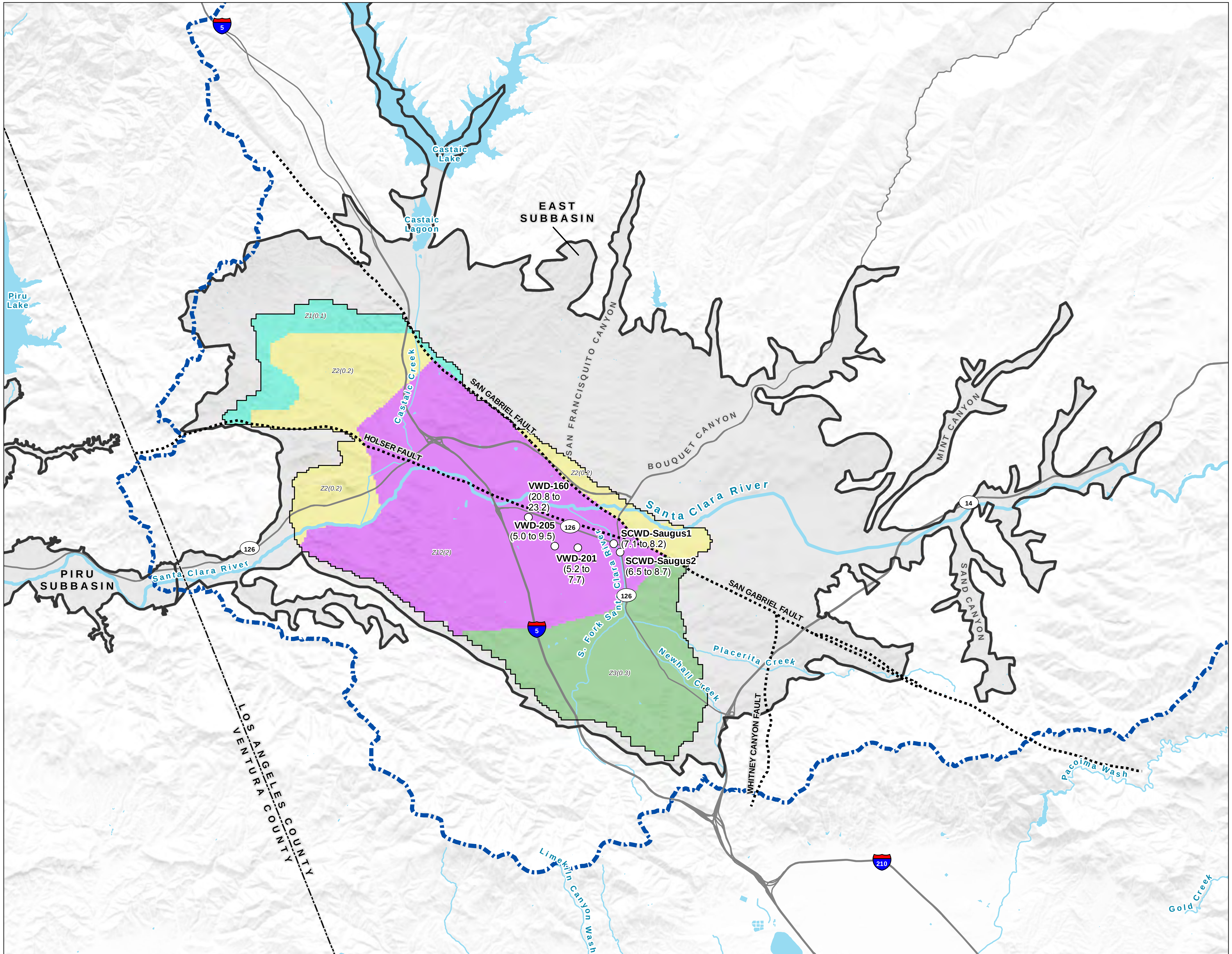


FIGURE 3-38

Hydraulic Conductivity Zones in Model Layer 6

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Saugus Formation Production Well (Hydraulic Conductivity)
- Model Grid Outline Layer 6
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

NOTES

1. Z25 (75) represents "Zone Number (Hydraulic Conductivity)".
2. Hydrologic Conductivity is measured in units of feet/day.

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_38_Hydraulic_Conductivity_Zones_Layer6.mxd, abarry

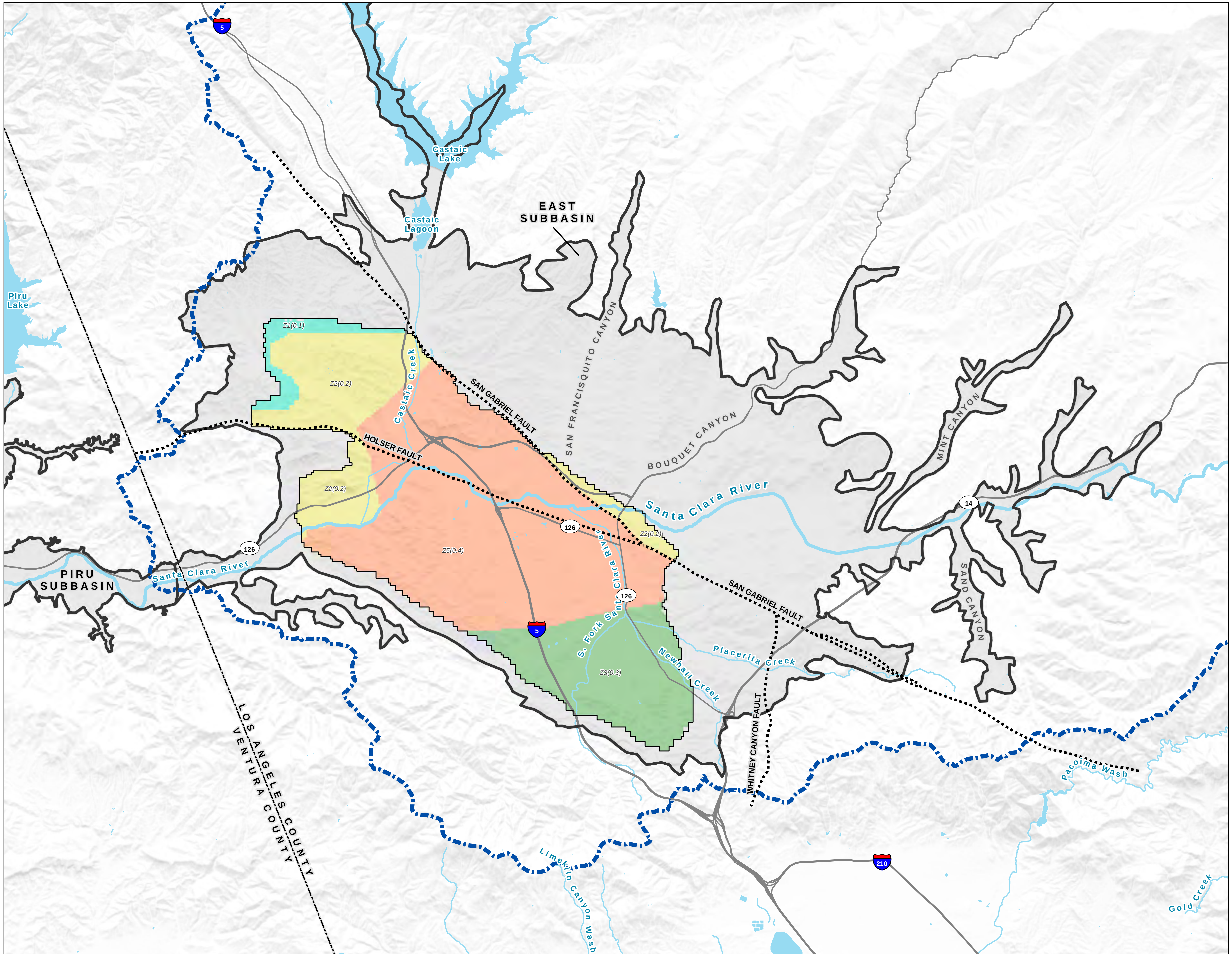


FIGURE 3-39

Hydraulic Conductivity Zones in Model Layer 7

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 7
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

NOTES

1. Z25 (75) represents "Zone Number (Hydraulic Conductivity)".
2. Hydrologic Conductivity is measured in units of feet/day.

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_39_Hydraulic_Conductivity_Zones_Layer7.mxd, abarry

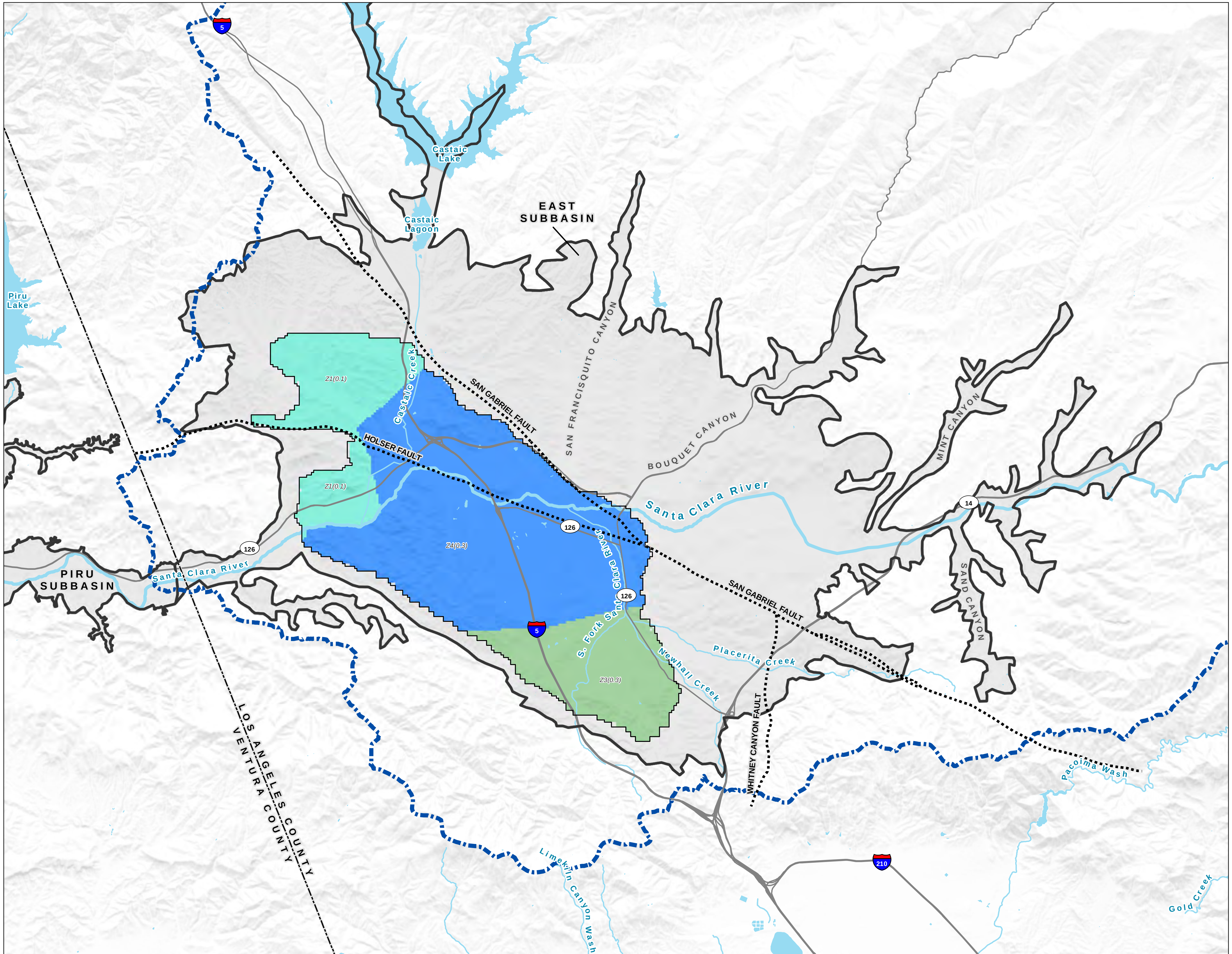


FIGURE 3-40

Hydraulic Conductivity Zones in Model Layer 8

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 8
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

NOTES

1. Z25 (75) represents "Zone Number (Hydraulic Conductivity)".
2. Hydrologic Conductivity is measured in units of feet/day.

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_40_Hydraulic_Conductivity_Zones_Layer8.mxd, abarry

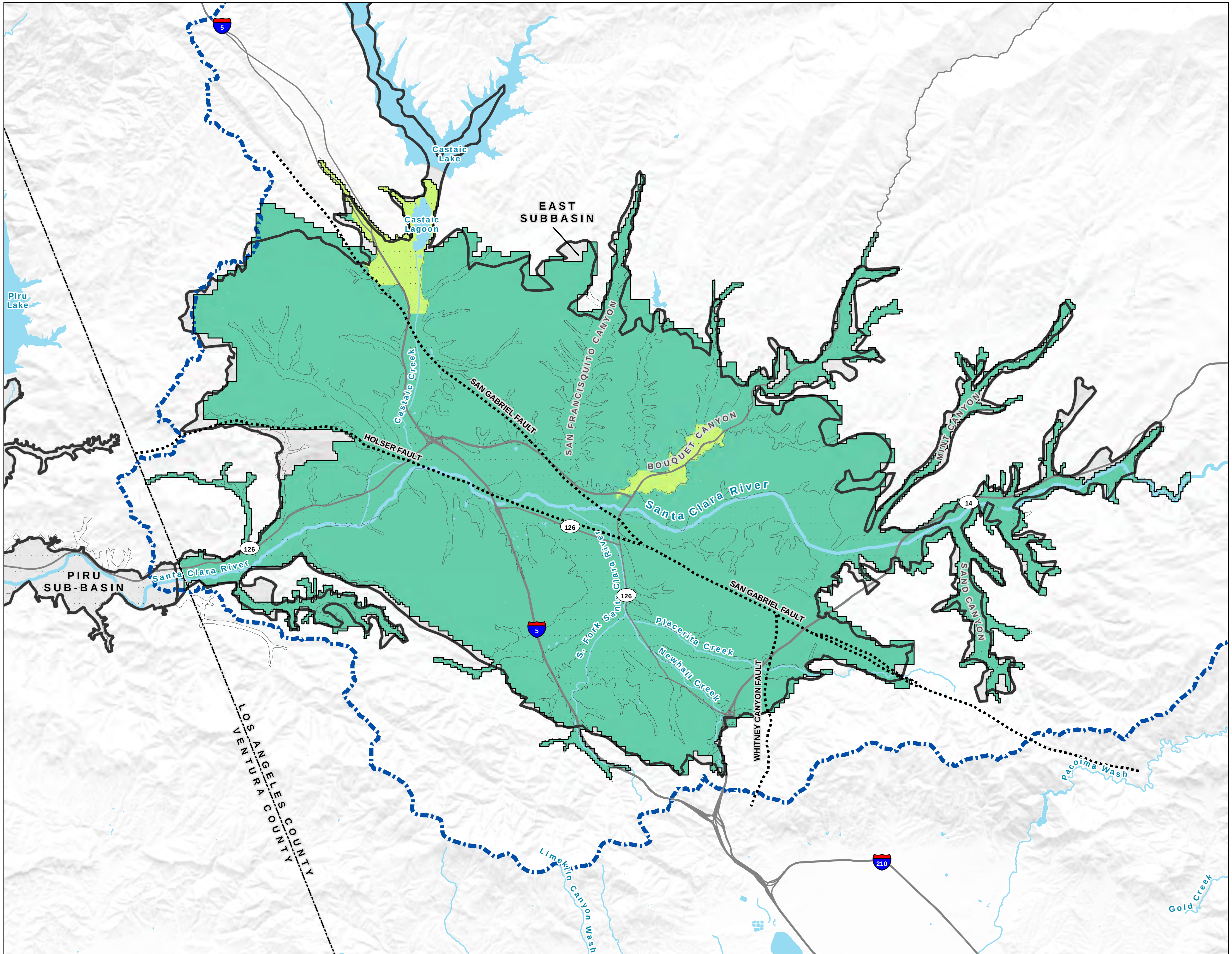


FIGURE 3-41

Specific Yield in Model Layer 1

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

Model Grid Outline Layer 1

Alluvial Aquifer

Specific Yield (unitless)

0.1

0.2

All Other Features

Santa Clara River Valley Groundwater Basin

Watershed Boundary

Major Road

Watercourse

Waterbody

N

0 5,000 10,000 15,000

Feet

Date: December 9, 2021

Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure3_41_Specific_Yield_Model_Layer_1.mxd, abarry

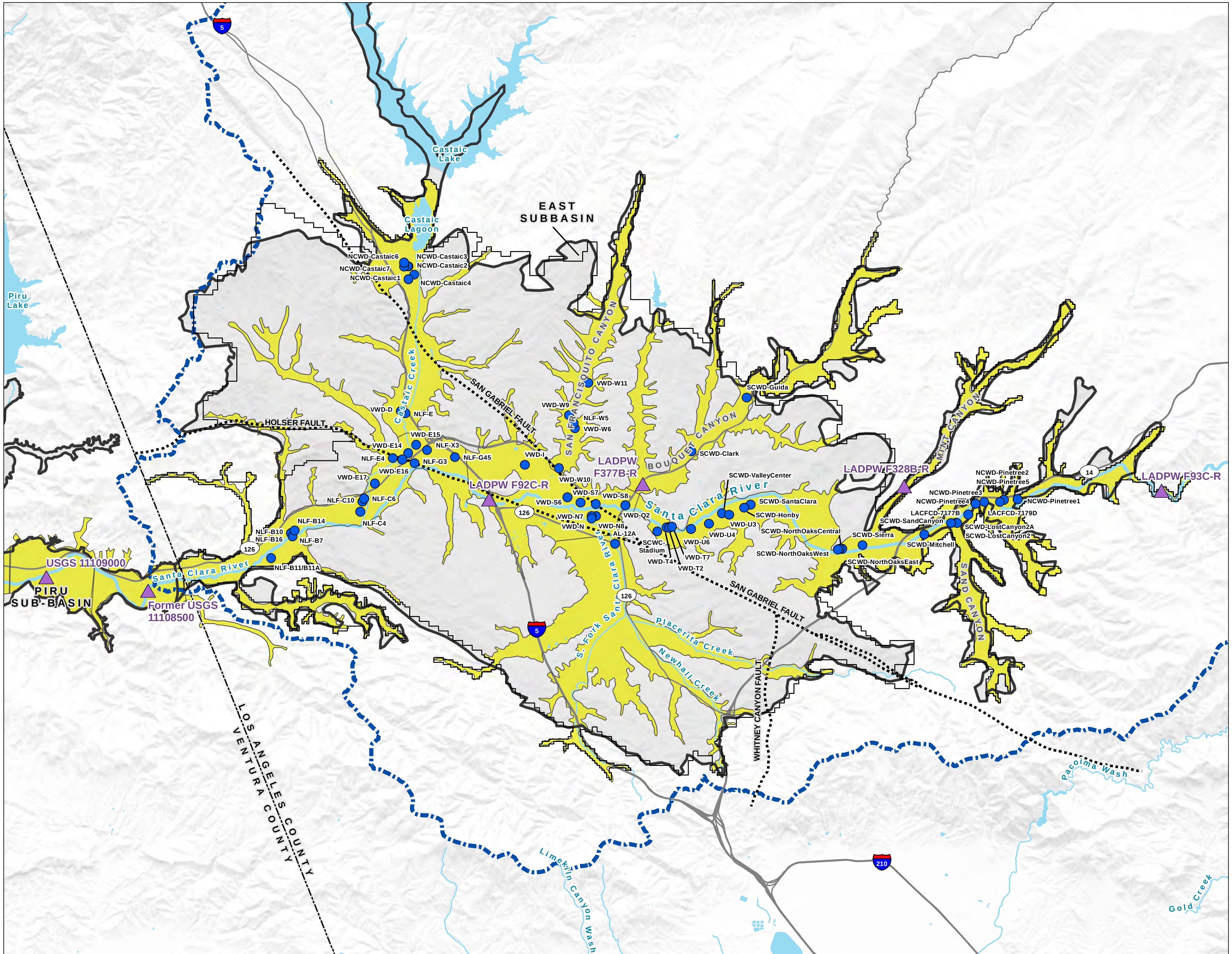


FIGURE 4-1

Calibration Data Locations in the Alluvial Aquifer

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Calibration Well
- Stream Gage
- Model Grid Outline Layer 1
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

NOTES

DWR: Department of Water Resources
LADPW: Los Angeles County Department of Public Works
USGS: U.S. Geological Survey

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

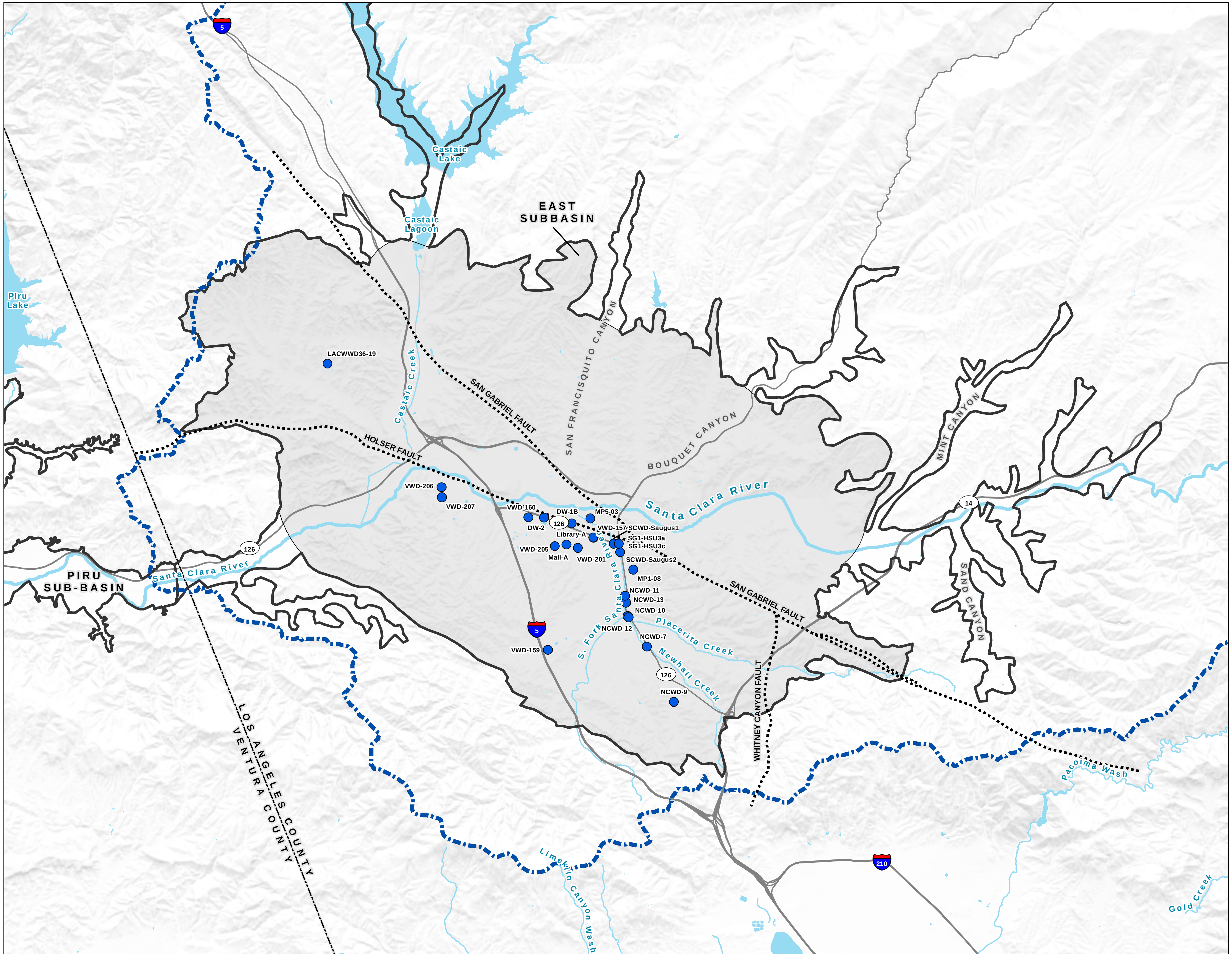
GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure4_1_Calibration_Data_Locs_Alluvial_Aquifer.mxd, abarry

FIGURE 4-2

Calibration Data Locations in the Saugus Formation

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Calibration Well
- Saugus Formation
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

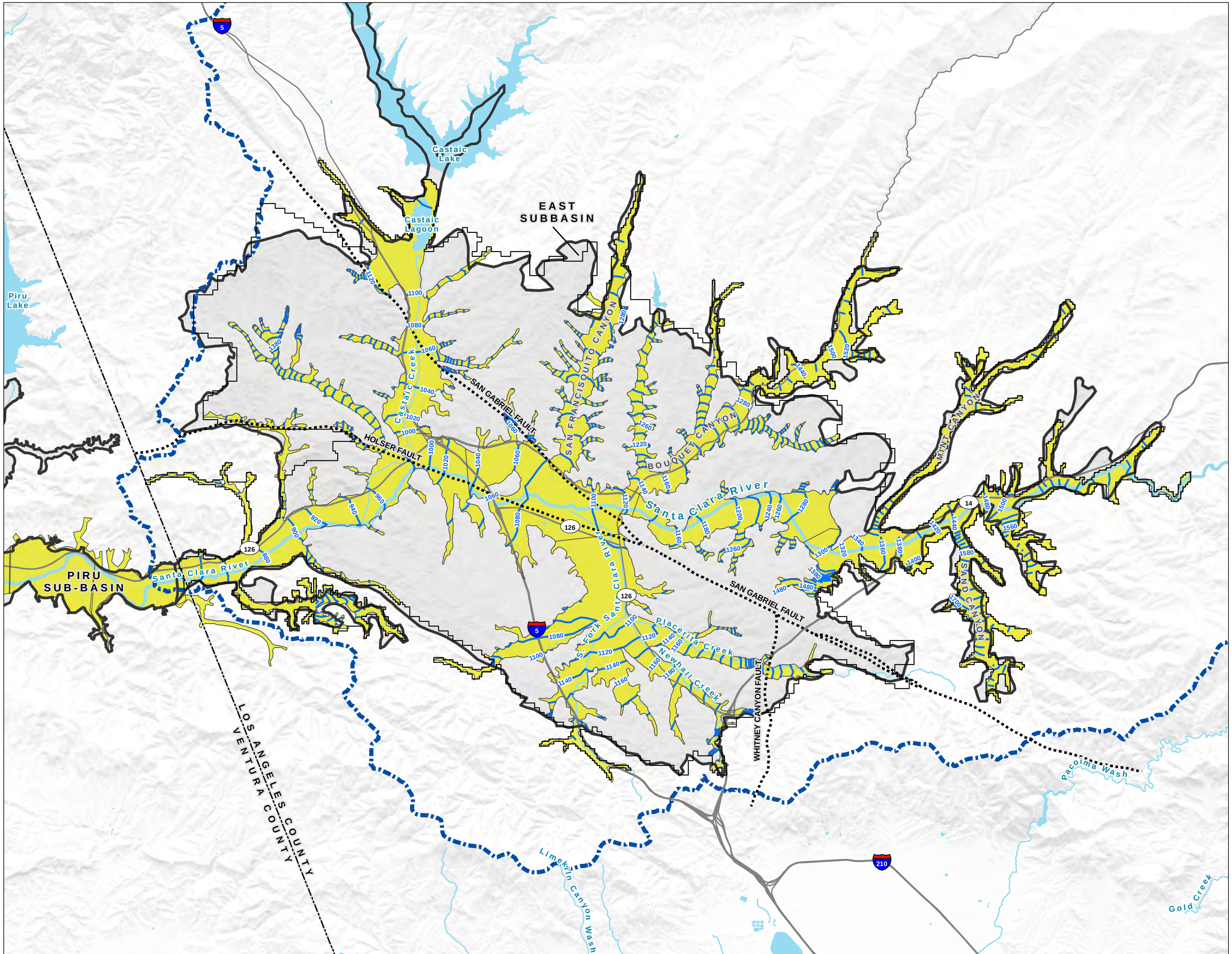


FIGURE 4-3

Spring 2000 Simulated Groundwater Elevation Contours for the Alluvial Aquifer in Model Layer 1

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Groundwater Elevation Contour (feet), Contour Interval: 20 feet
- Model Grid Outline Layer 1
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure4_3_Spring2000_Simulated_GW_Contours_Layer1.mxd, abarry

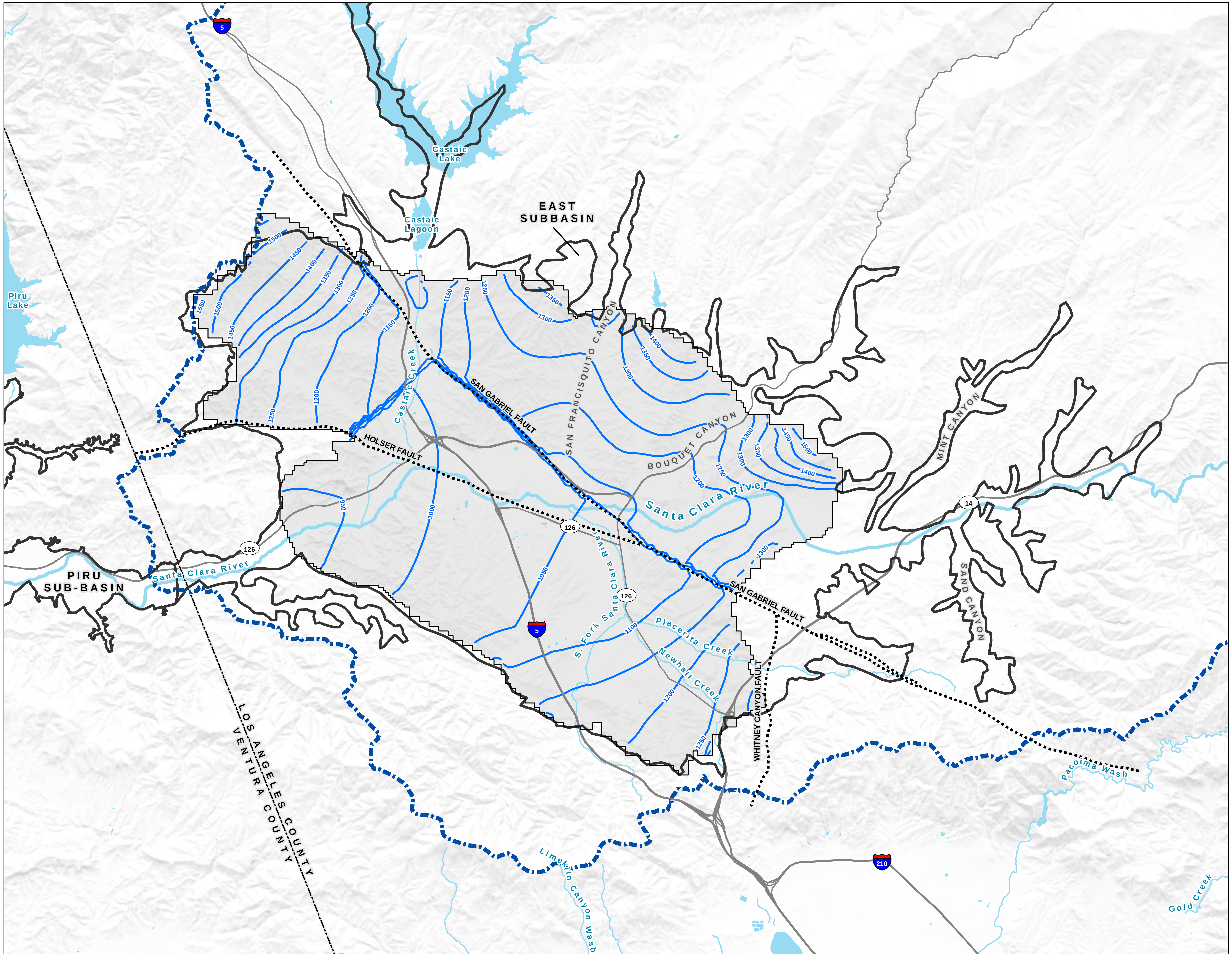


FIGURE 4-4

Fall 2000 Simulated Groundwater Elevation Contours in Model Layer 2

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Groundwater Elevation Contour (feet), Contour interval: 50 feet
- Model Grid Area Layer 2
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

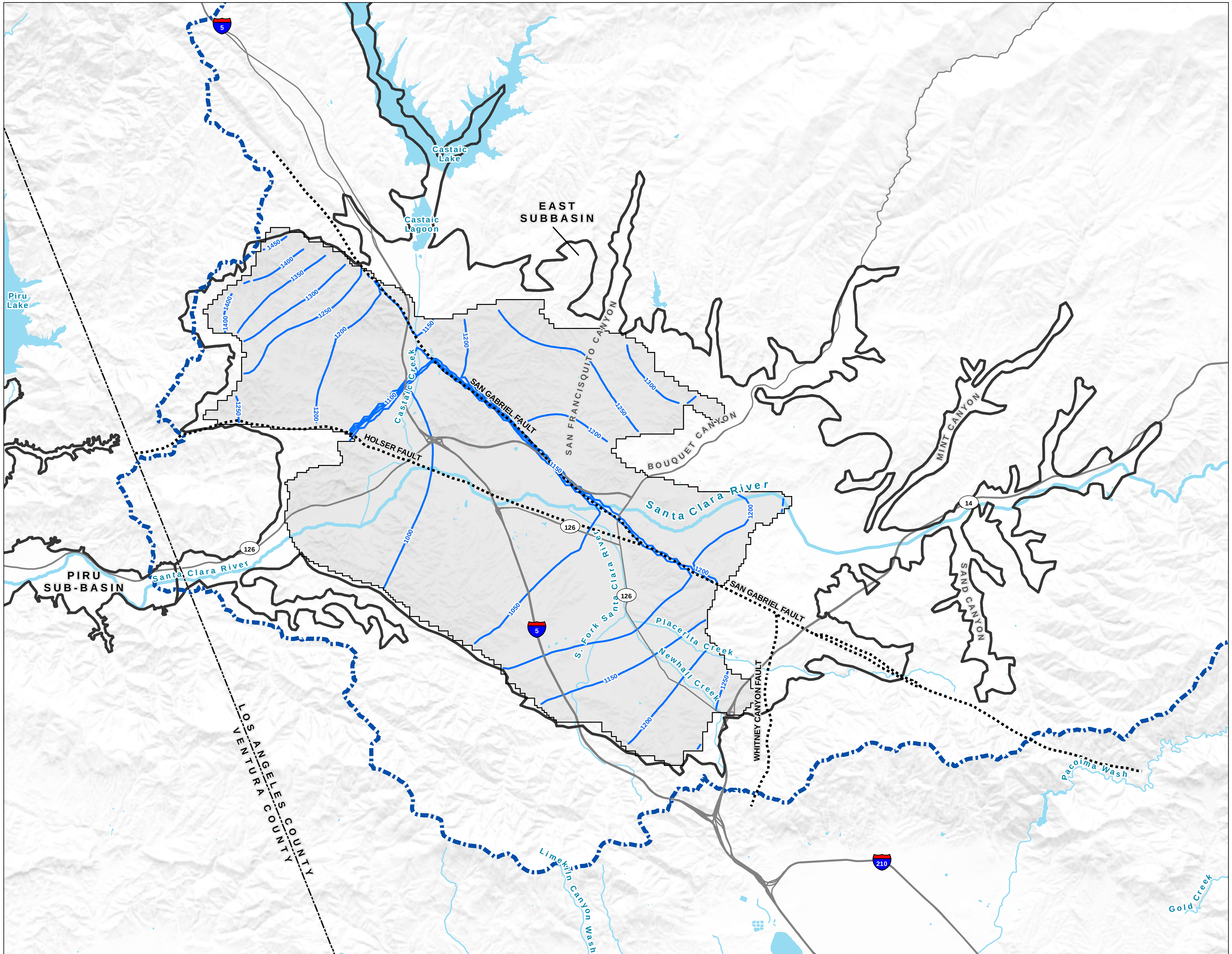
GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure4_4_Fall2000_Simulated_GW_Contours_Layer2.mxd, abarry

FIGURE 4-5

Fall 2000 Simulated Groundwater Elevation Contours in Model Layer 3

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Groundwater Elevation Contour (feet), Contour interval: 50 feet
- Model Grid Area Layer 3
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure4_5_Fall2000_Simulated_GW_Contours_Layer3.mxd, abarry

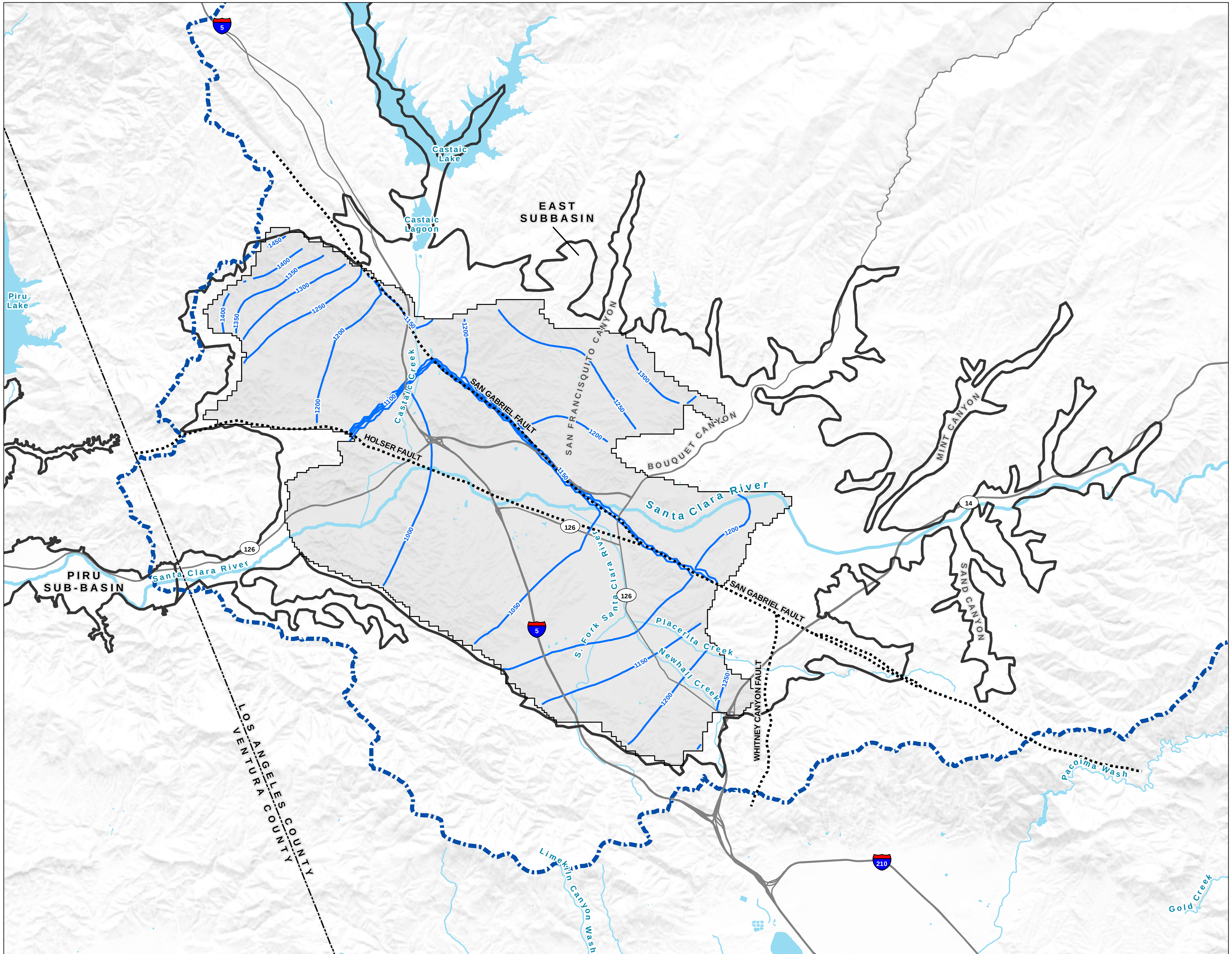


FIGURE 4-6

Fall 2000 Simulated Groundwater Elevation Contours in Model Layer 4

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Groundwater Elevation Contour (feet), Contour interval: 50 feet
- Model Grid Area Layer 4
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure4_6_Fall2000_Simulated_GW_Contours_Layer4.mxd, abarry

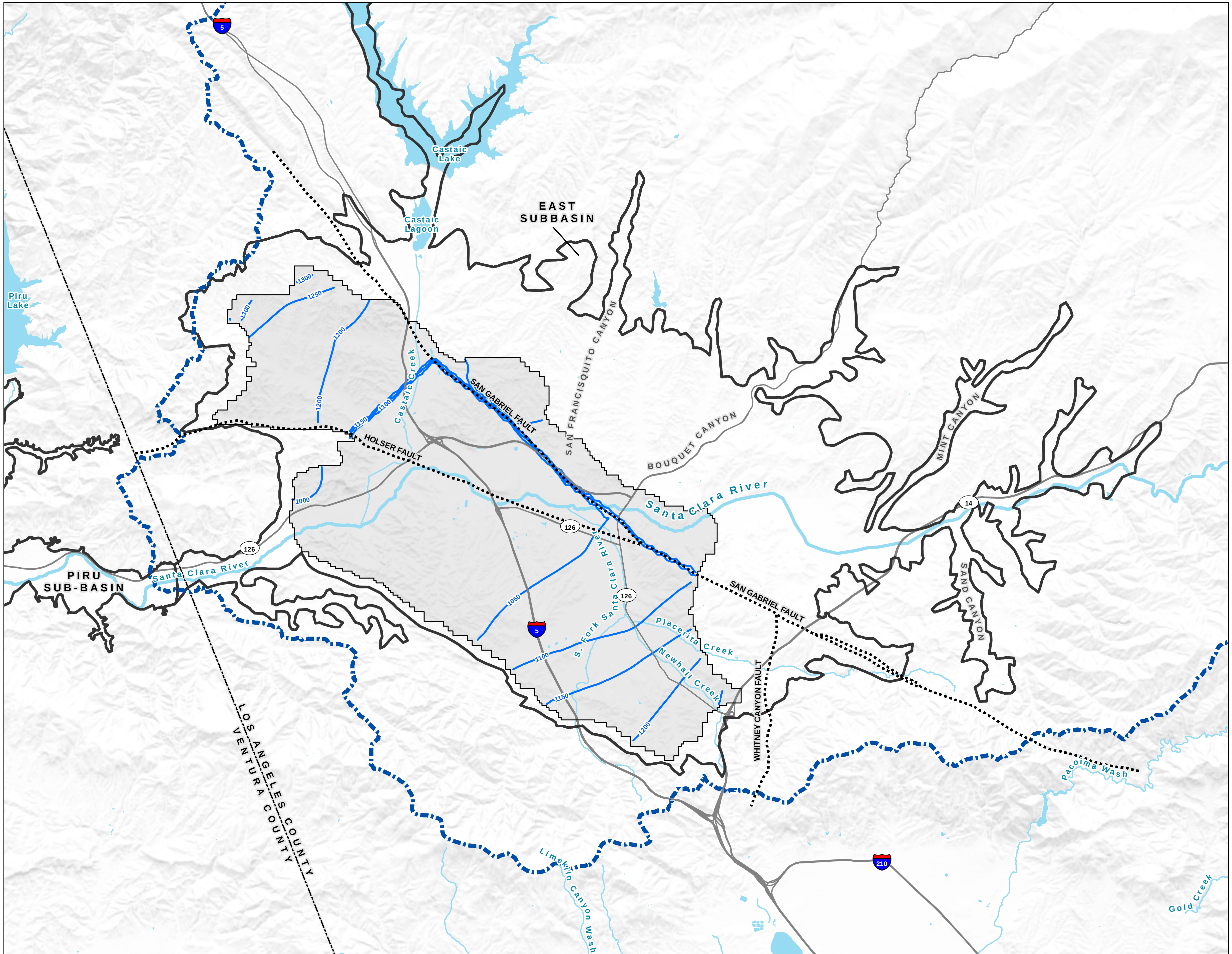


FIGURE 4-7

Fall 2000 Simulated Groundwater Elevation Contours in Model Layer 5

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Groundwater Elevation Contour (feet), Contour interval: 50 feet
- Model Grid Area Layer 5
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

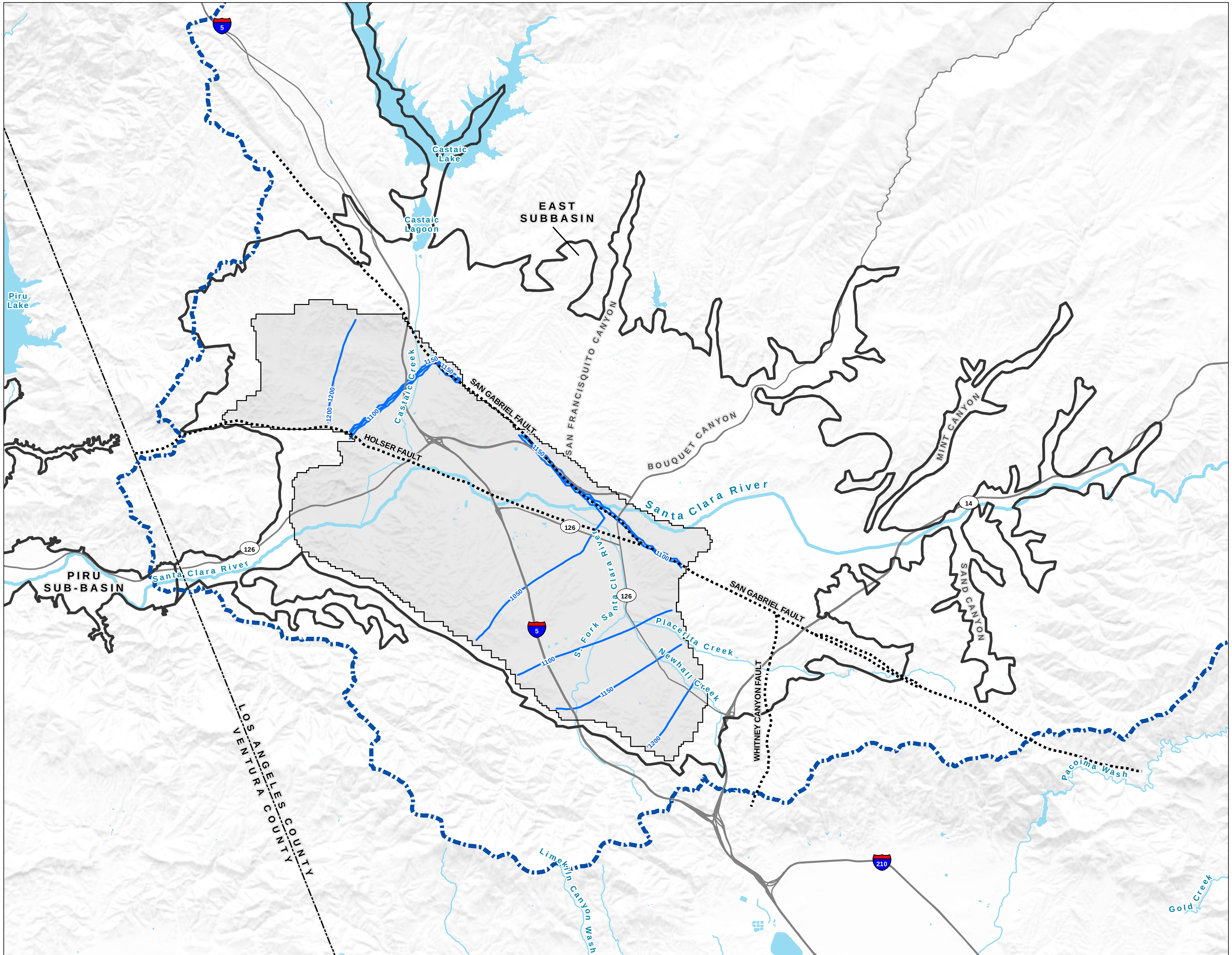
GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure4_7_Fall2000_Simulated_GW_Contours_Layer5.mxd, abarry

FIGURE 4-8

Fall 2000 Simulated Groundwater Elevation Contours in Model Layer 6

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Groundwater Elevation Contour (feet), Contour interval: 50 feet
- Model Grid Area Layer 6
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

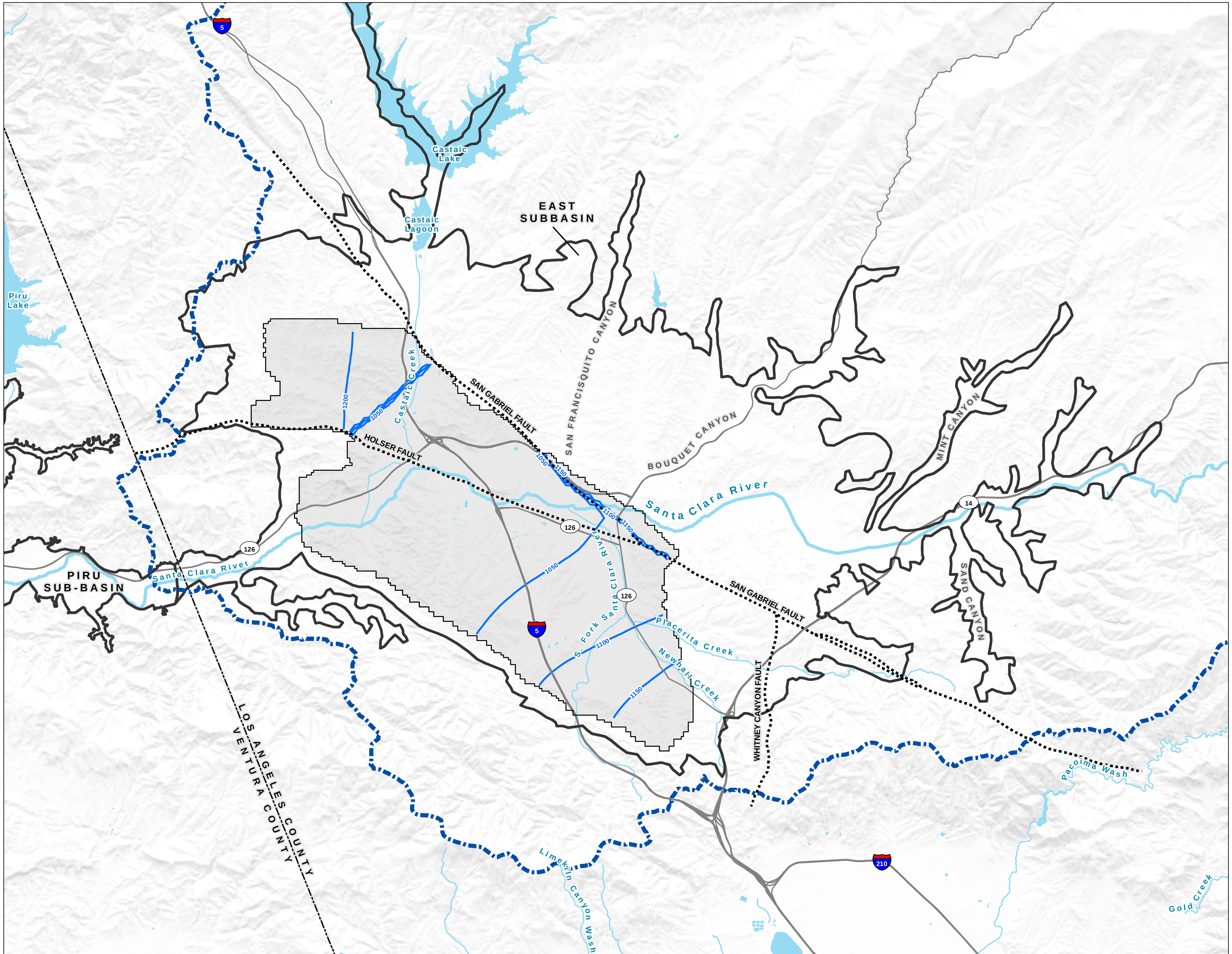


FIGURE 4-9

Fall 2000 Simulated Groundwater Elevation Contours in Model Layer 7

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Groundwater Elevation Contour (feet), Contour interval: 50 feet
- Model Grid Area Layer 7
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

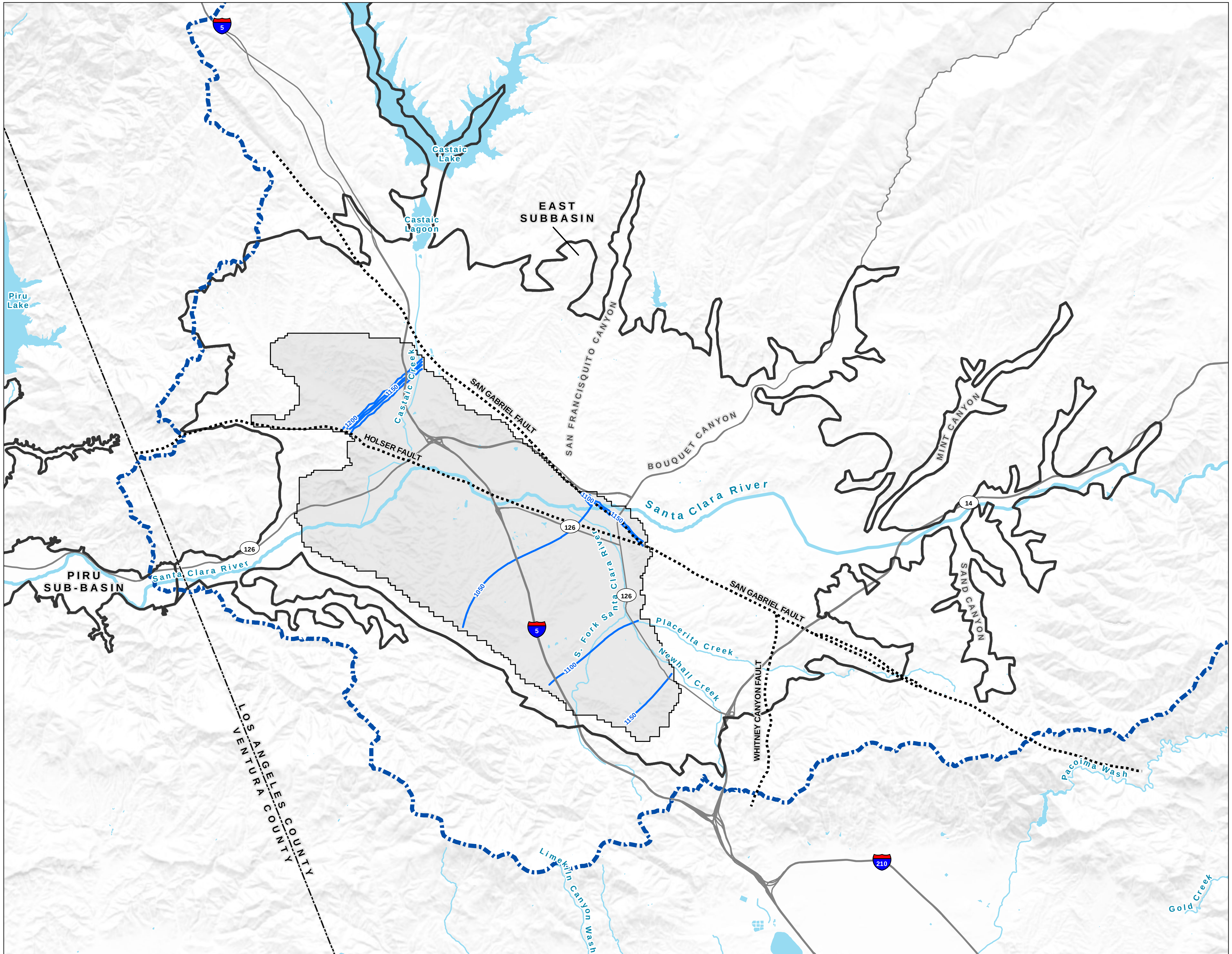
GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure4_9_Fall2000_Simulated_GW_Contours_Layer7.mxd, abarry

FIGURE 4-10

Fall 2000 Simulated Groundwater Elevation Contours in Model Layer 8

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Groundwater Elevation Contour (feet), Contour interval: 50 feet
- Model Grid Area Layer 8
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- Major Road
- Watercourse
- Waterbody

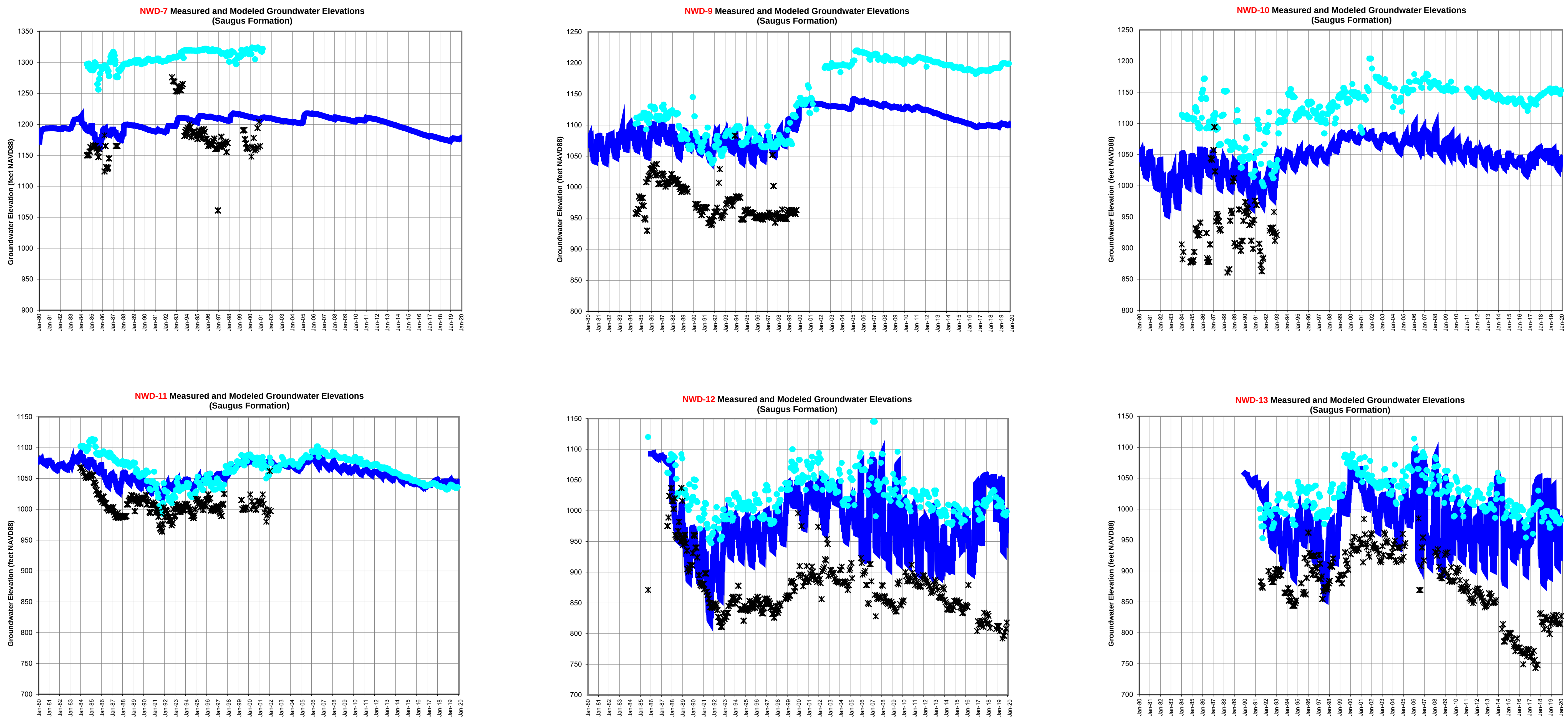
N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure4_10_Fall2000_Simulated_GW_Contours_Layer8.mxd, abarry



LEGEND

- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation

NOTE

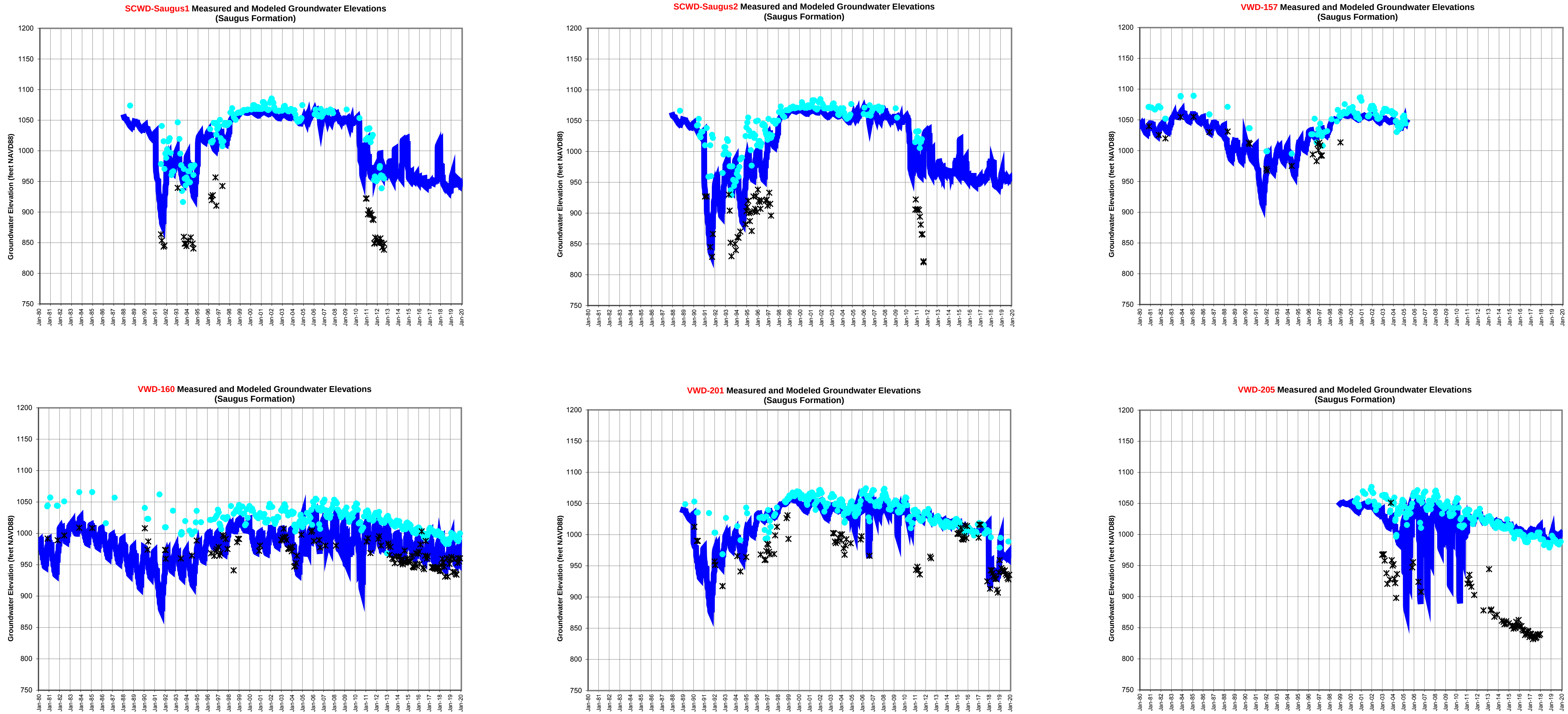
NWD: Newhall Water Division

FIGURE 4-11

Simulated and Measured Saugus Formation Hydrographs, 1980-2019
(NWD Production Wells Along S. Fork Santa Clara River)

Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.



LEGEND

- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation

FIGURE 4-12

Simulated and Measured Saugus Formation Hydrographs, 1980-2019
(SCWD and VWD Production Wells Near S. Fork Santa Clara River)

Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

NOTES
SCWD; Santa Clarita Water Division
VWD: Valencia Water Division

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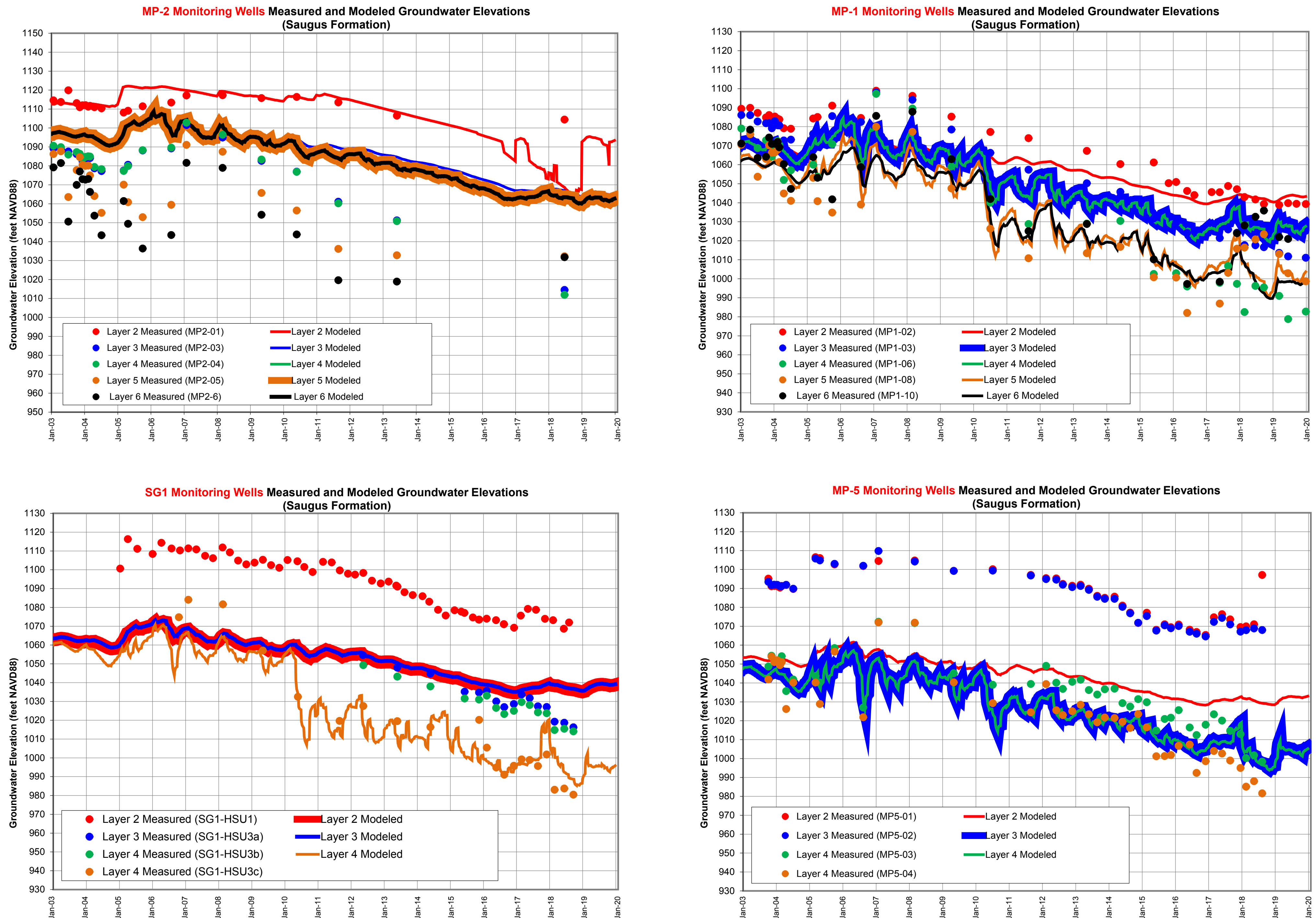

FIGURE 4-13a

Simulated and Measured Saugus Formation Hydrographs, 1980-2019
(Observation Wells Near and West of S. Fork Santa Clara River)

Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

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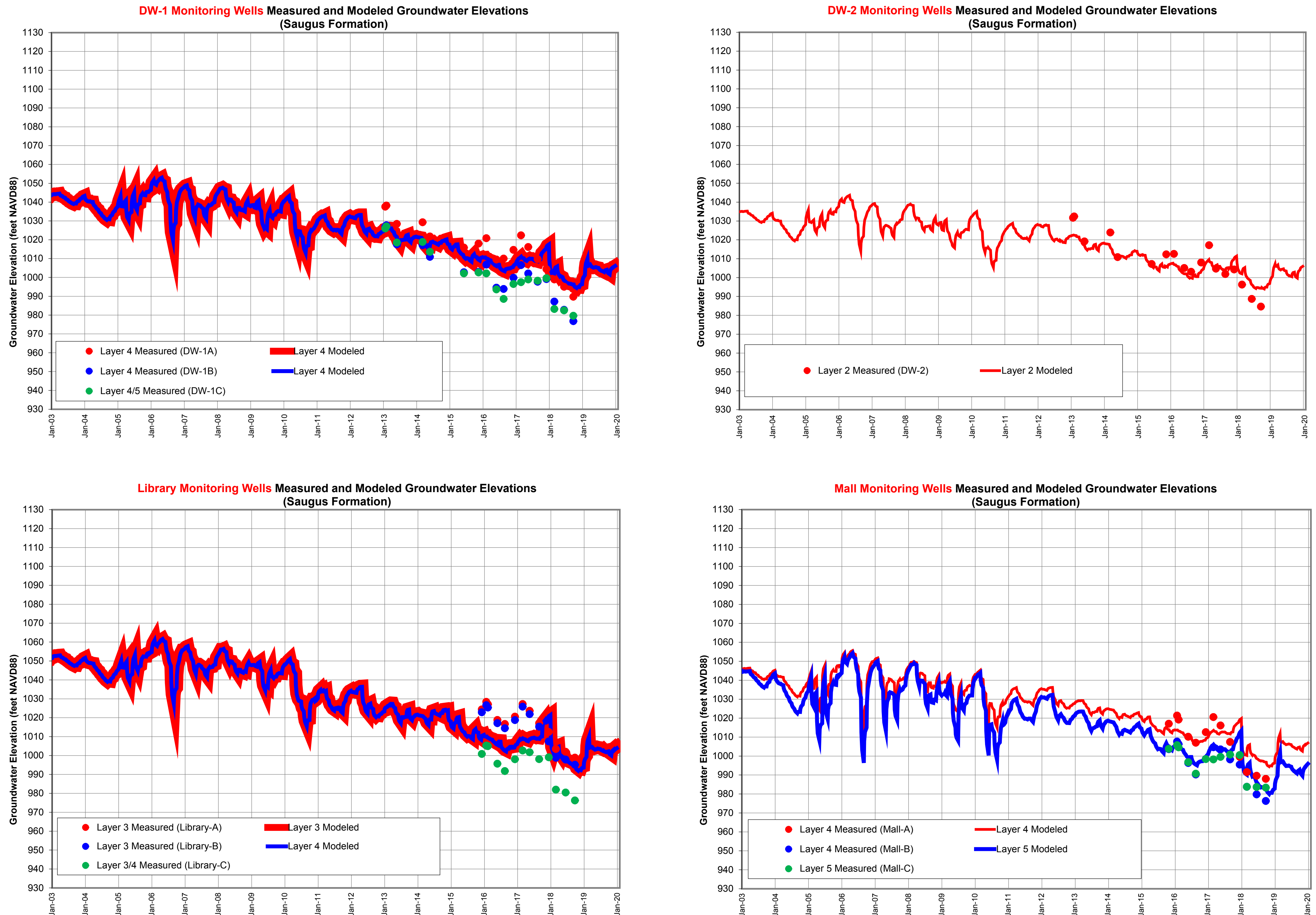

FIGURE 4-13b

Simulated and Measured Saugus Formation Hydrographs, 1980-2019
(Observation Wells Near and West of S. Fork Santa Clara River)
Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

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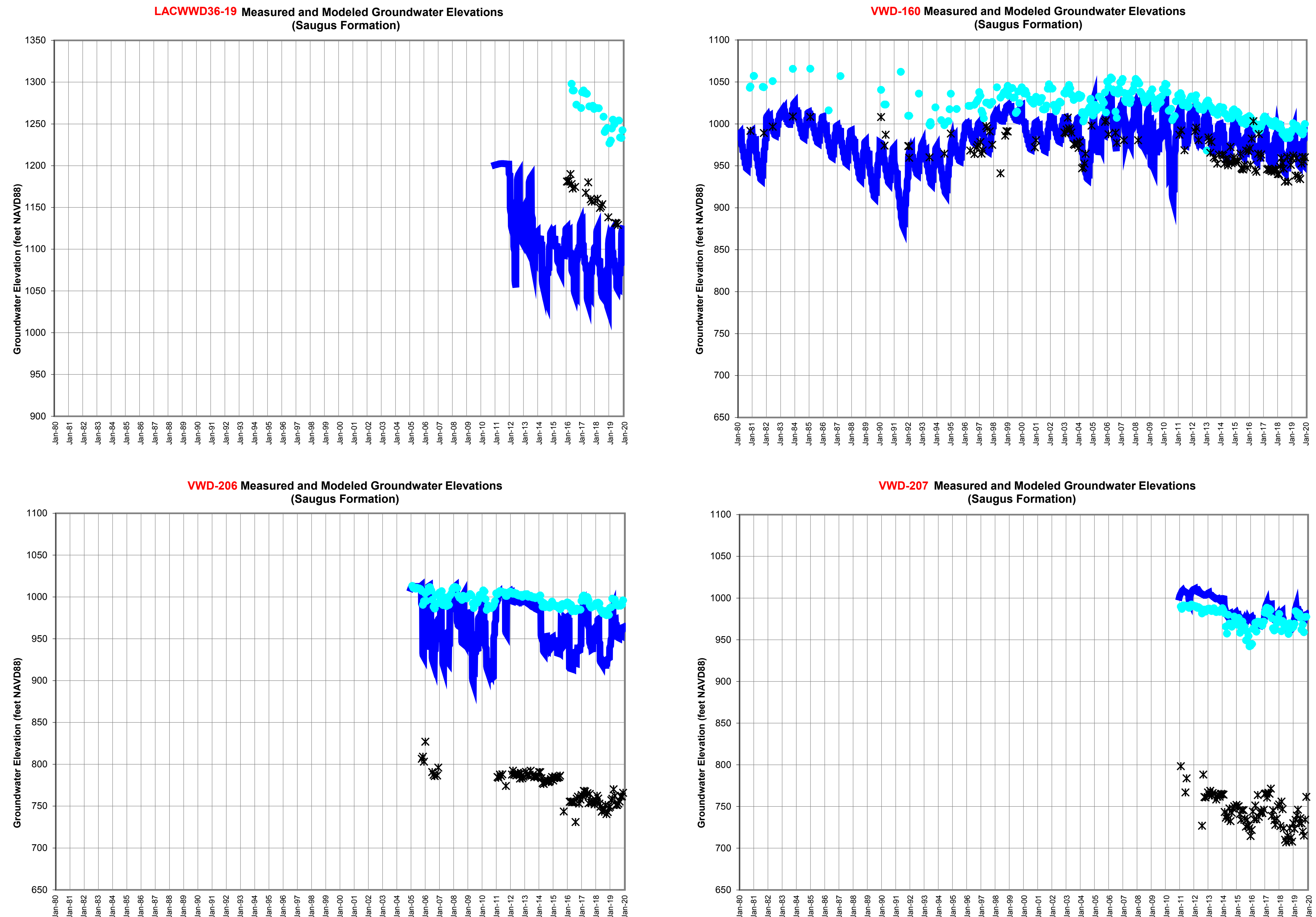


LEGEND

- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation

NOTES

LACWWD: Los Angeles County Waterworks District
VWD: Valencia Water Division

FIGURE 4-14

Simulated and Measured Saugus Formation Hydrographs, 1980-2019
(Production Wells in the Western Portion of the Saugus Formation)

Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

\\PDX\GIS_Files\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report

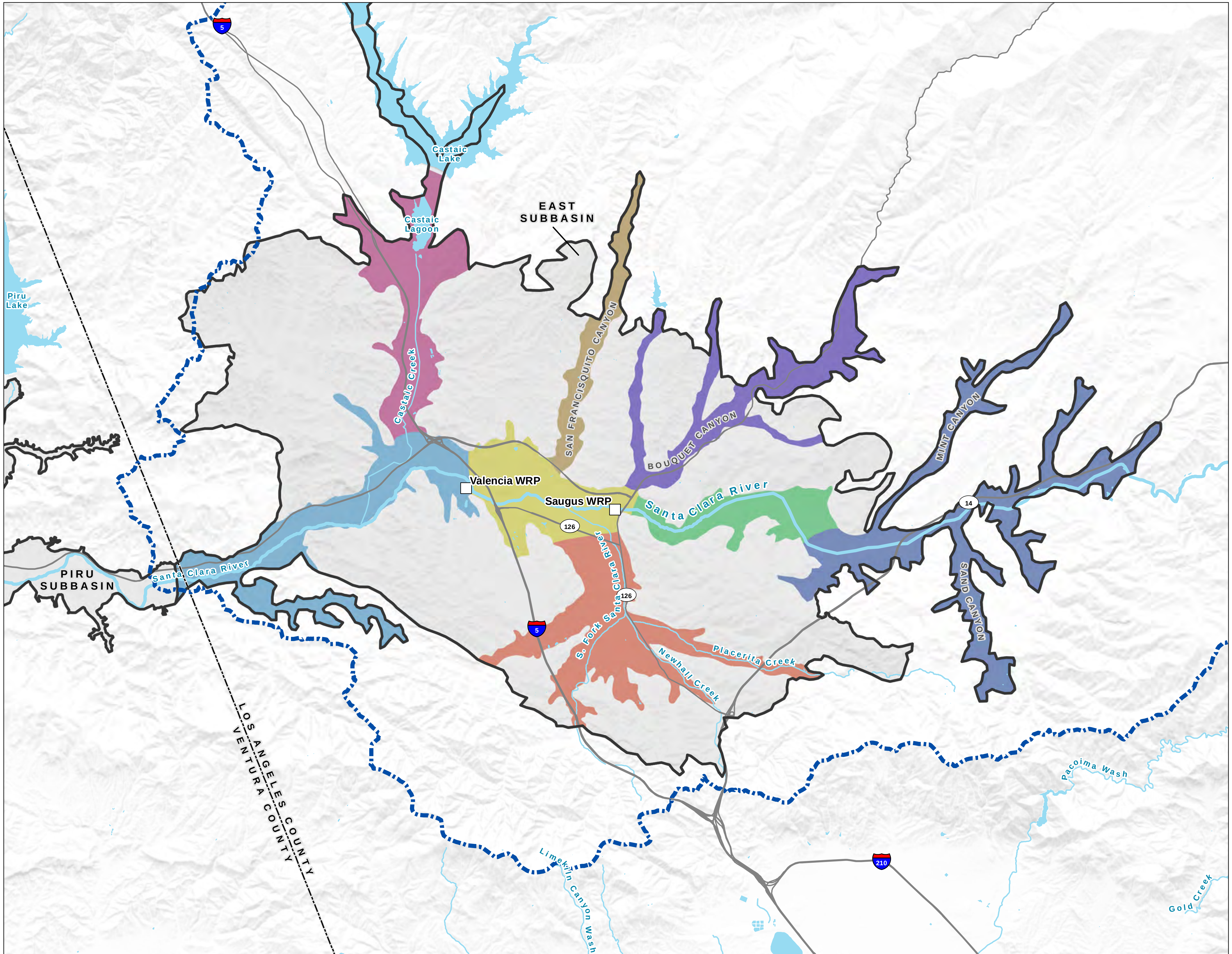


FIGURE 4-15

Alluvial Aquifer Subareas

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Water Reclamation Plant (WRP)
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Alluvial Aquifer Subareas

- Above Saugus WRP
- Below Saugus WRP
- Below Valencia WRP
- Bouquet Canyon
- Castaic Valley
- Mint Canyon
- San Francisquito Canyon
- South Fork Area

All Other Features

- Major Road
- Watercourse
- Waterbody

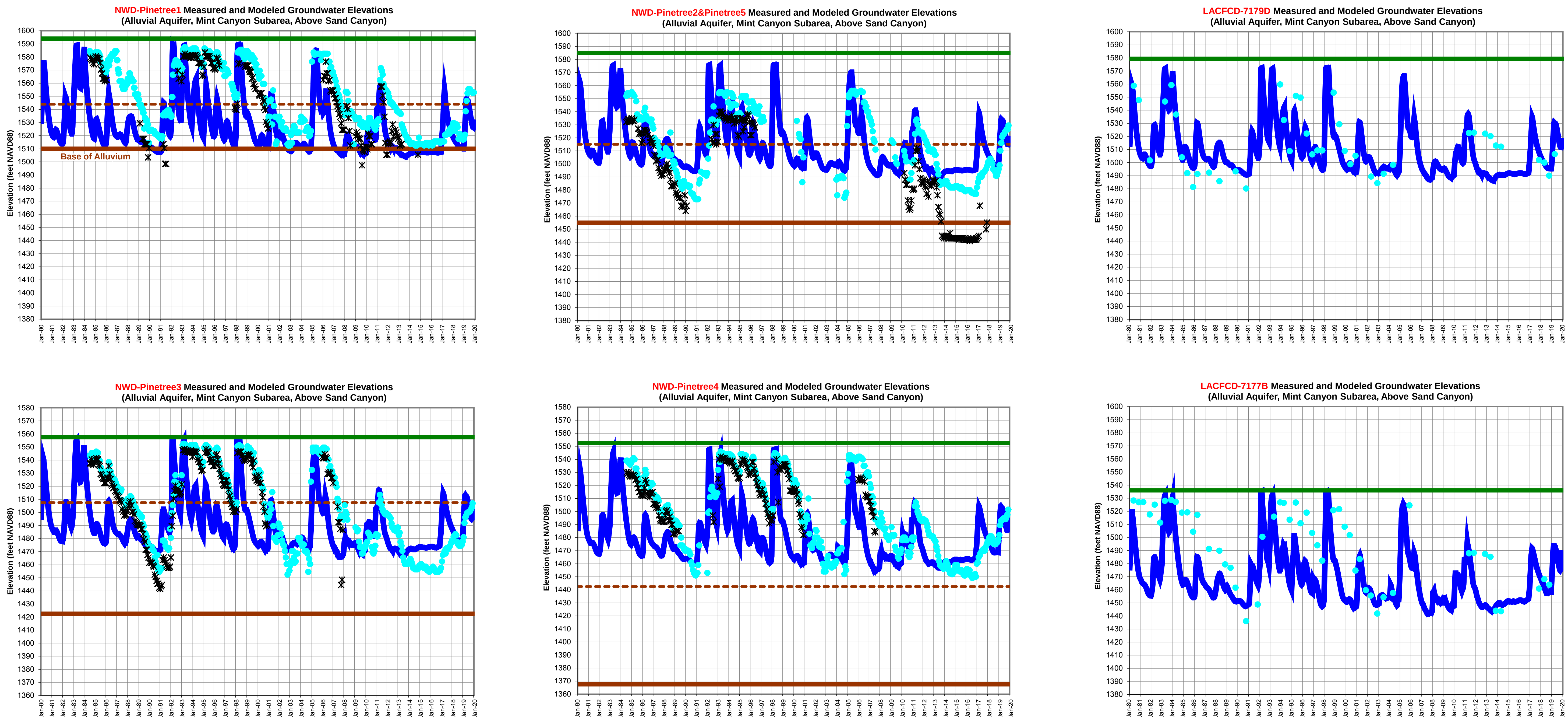
N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118, LSCE (2019)

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\Figure4_15_Alluvial_Aquifer_Subareas.mxd, abarry



LEGEND

- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation
- Ground Surface
- Top of Screen/Slots
- Bottom of Screen/Slots

FIGURE 4-16

Simulated and Measured Alluvial Aquifer Hydrographs, 1980-2019
(Mint Canyon Subarea, Above Sand Canyon)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

NOTES

LACFCD: Los Angeles County Flood Control Division
NWD: Newhall Water Division

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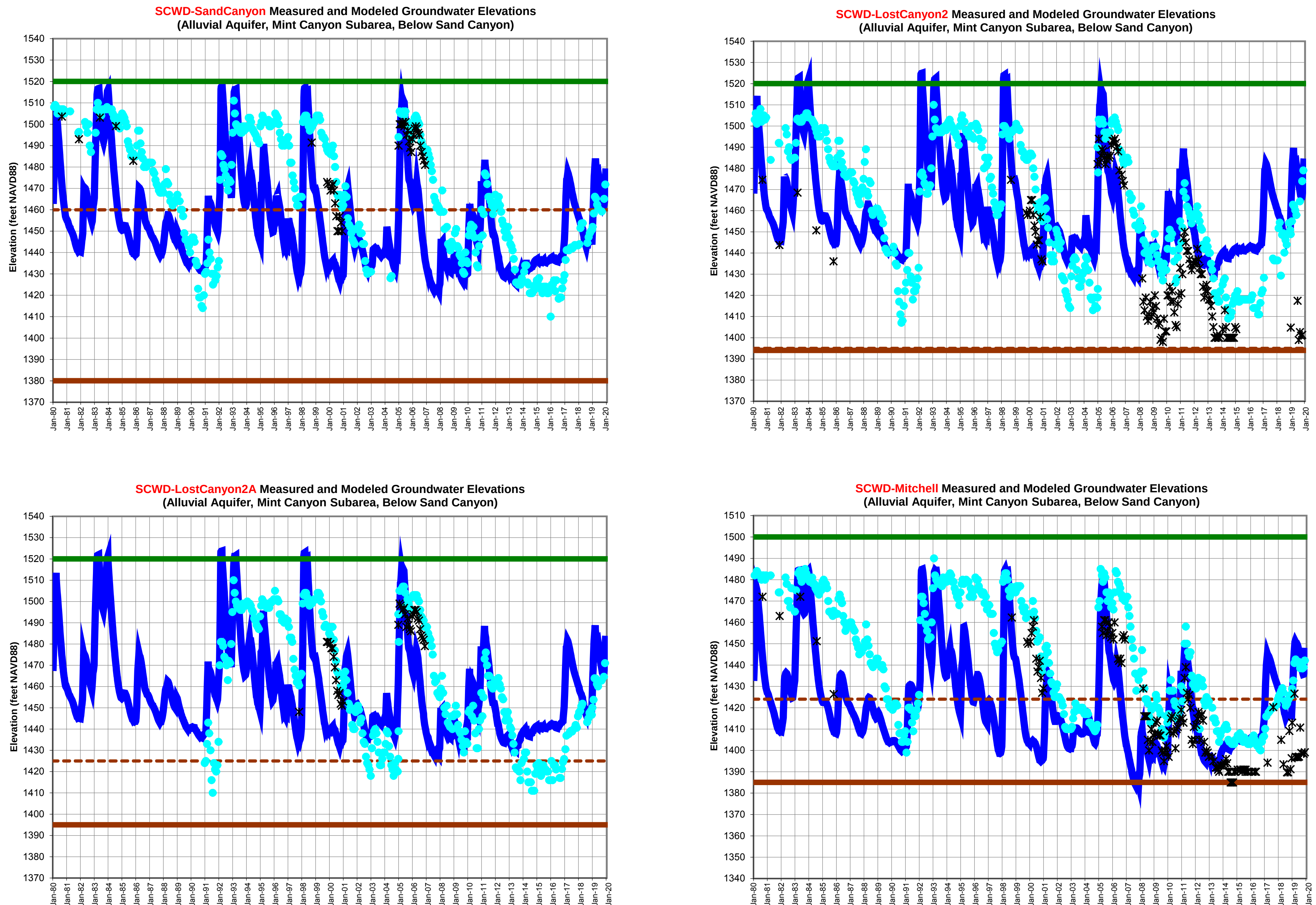

LEGEND

- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation
- Ground Surface
- Top of Screen/Slots
- Bottom of Screen/Slots

FIGURE 4-17

Simulated and Measured Alluvial Aquifer Hydrographs, 1980-2019
(Mint Canyon Subarea, Below Sand Canyon)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

NOTE

SCWD: Santa Clarita Water Division

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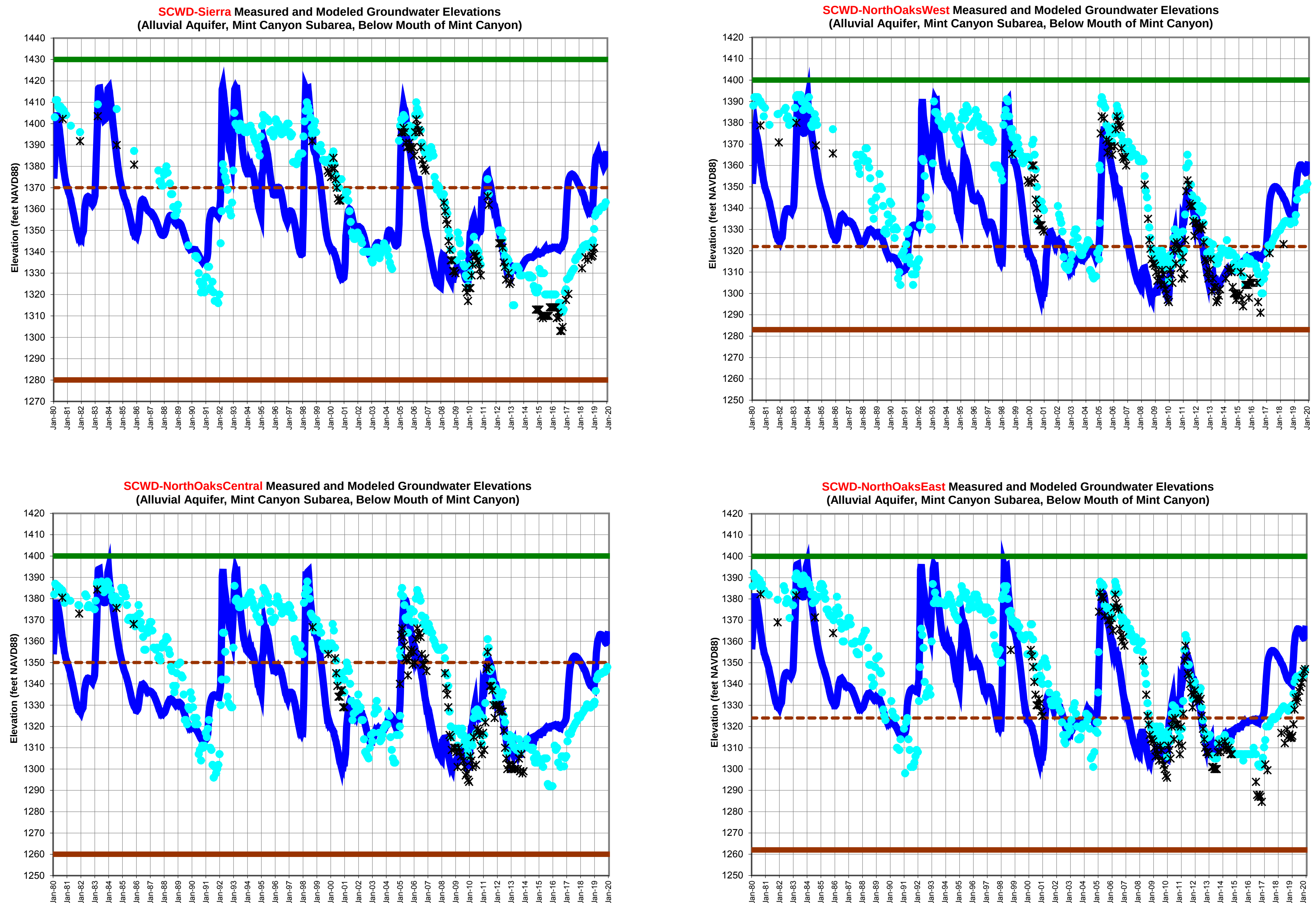

LEGEND

- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation
- Ground Surface
- Top of Screen/Slots
- Bottom of Screen/Slots

NOTE

SCWD: Santa Clarita Water Division

FIGURE 4-18

Simulated and Measured Alluvial Aquifer Hydrographs, 1980-2019
(Mint Canyon Subarea, Below the Mouth of Mint Canyon)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

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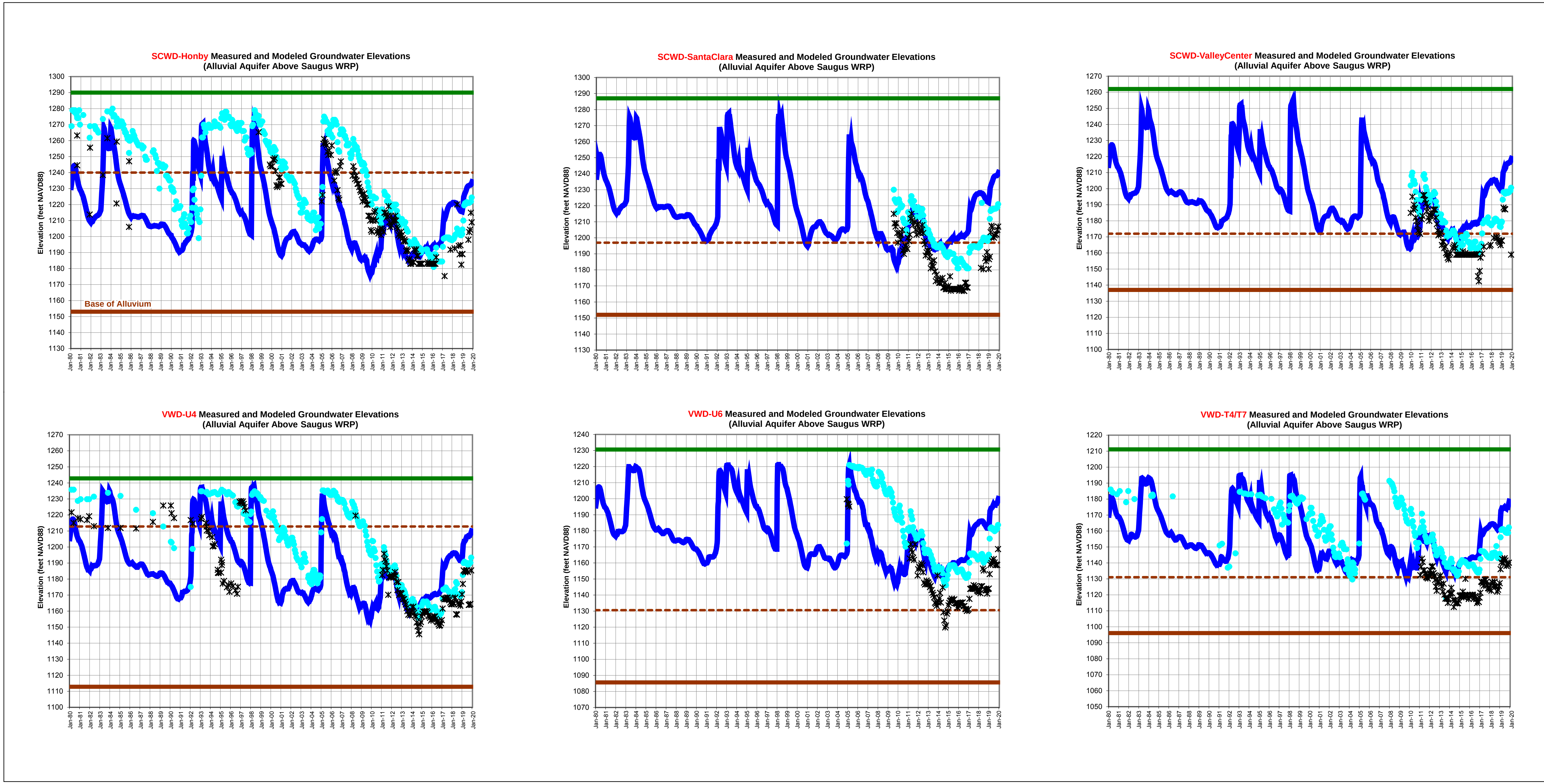

LEGEND

- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation
- Ground Surface
- Top of Screen/Slots
- Bottom of Screen/Slots

FIGURE 4-19

Simulated and Measured Alluvial Aquifer Hydrographs, 1980-2019
(Above Saugus Water Reclamation Plant)

Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

NOTES

SCWD; Santa Clarita Water Division
VWD: Valencia Water Division
WRP: Water Reclamation Plant

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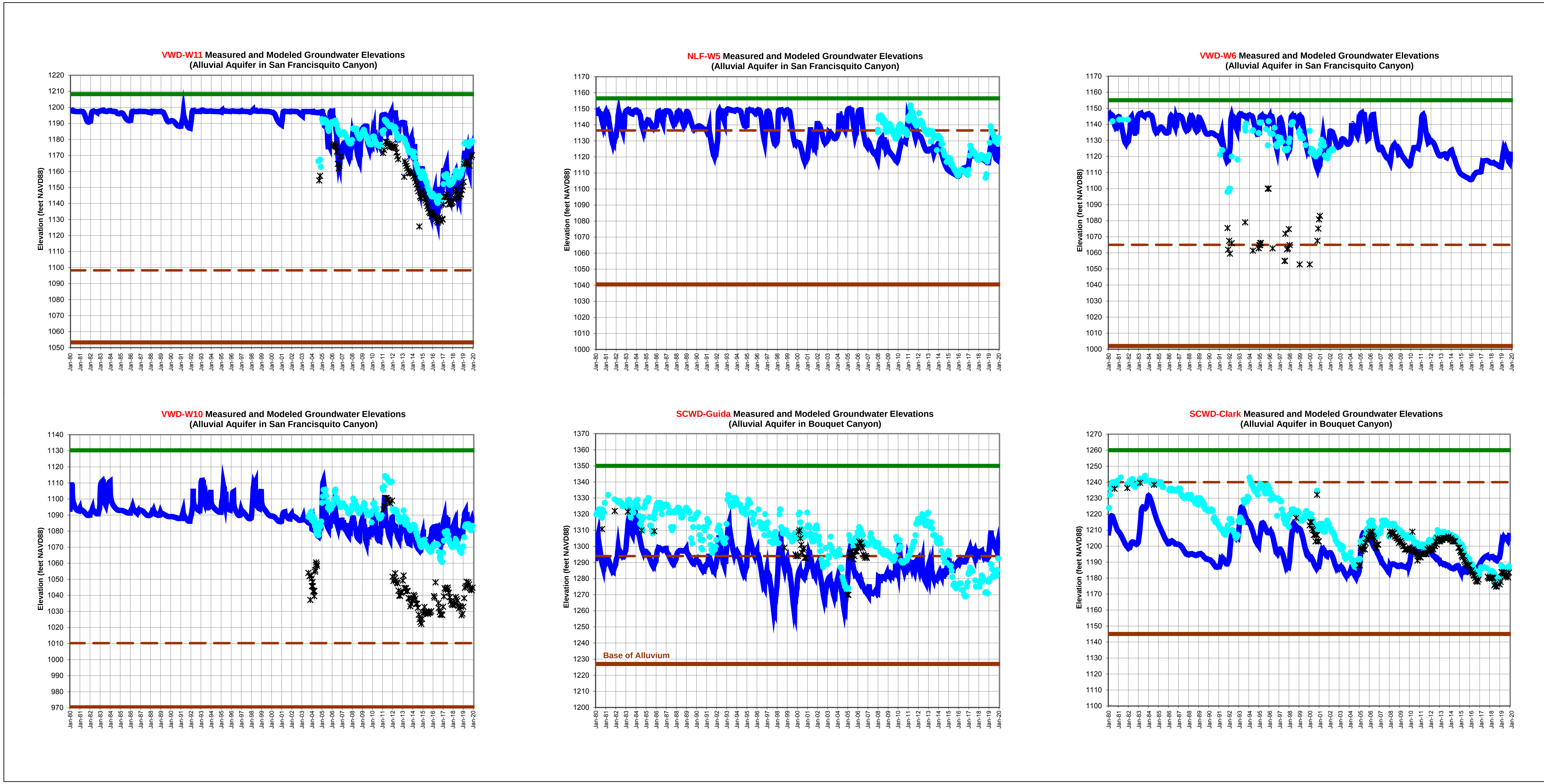

LEGEND

- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation
- Ground Surface
- Top of Screen/Slots
- Bottom of Screen/Slots

FIGURE 4-20

Simulated and Measured Alluvial Aquifer Hydrographs, 1980-2019 (San Francisquito Canyon and Mint Canyon)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

NOTES

SCWD: Santa Clarita Water Division
VWD: Valencia Water Division

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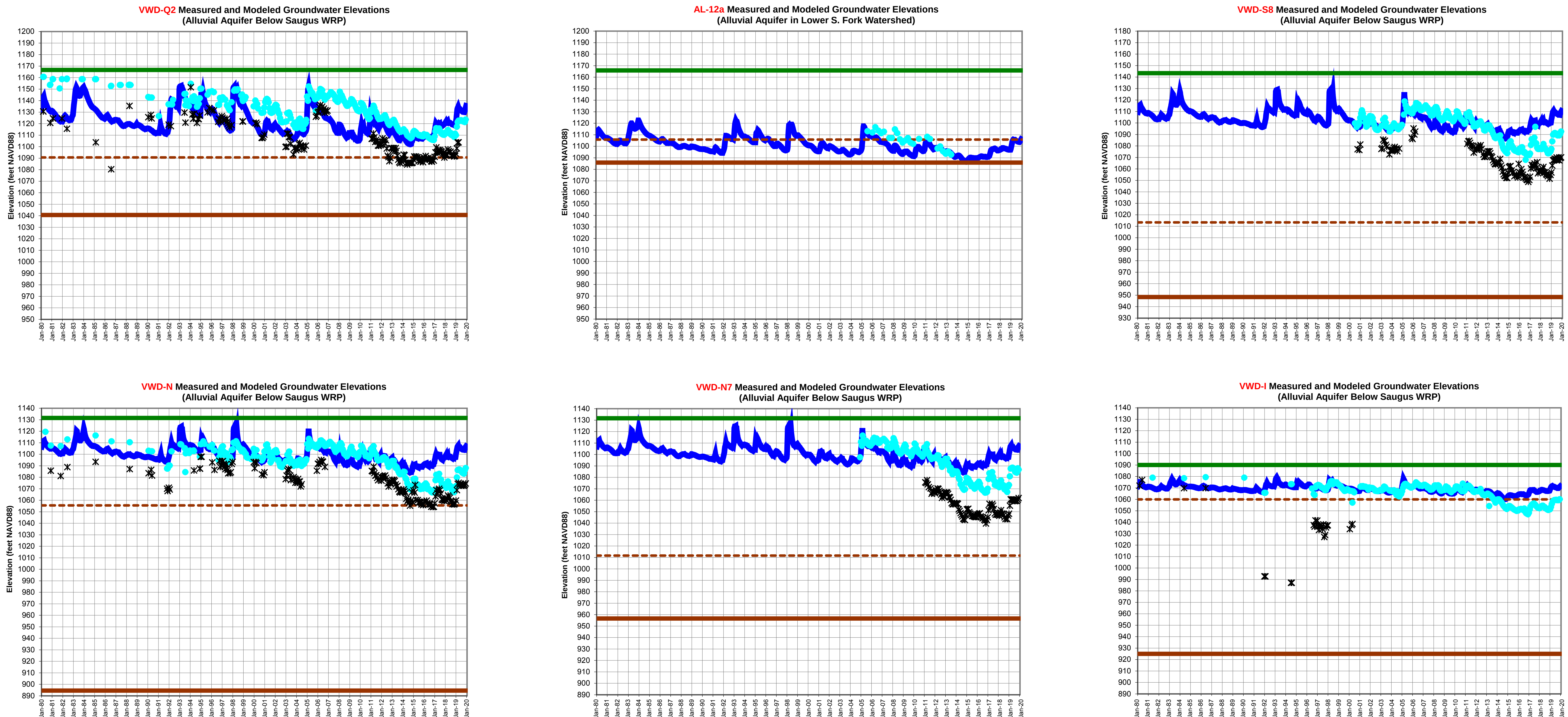

LEGEND

- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation
- Ground Surface
- Top of Screen/Slots
- Bottom of Screen/Slots

FIGURE 4-21

Simulated and Measured Alluvial Aquifer Hydrographs, 1980-2019 (Below Saugus Water Reclamation Plant)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

NOTES

VWD: Valencia Water Division
WRP: Water Reclamation Plant

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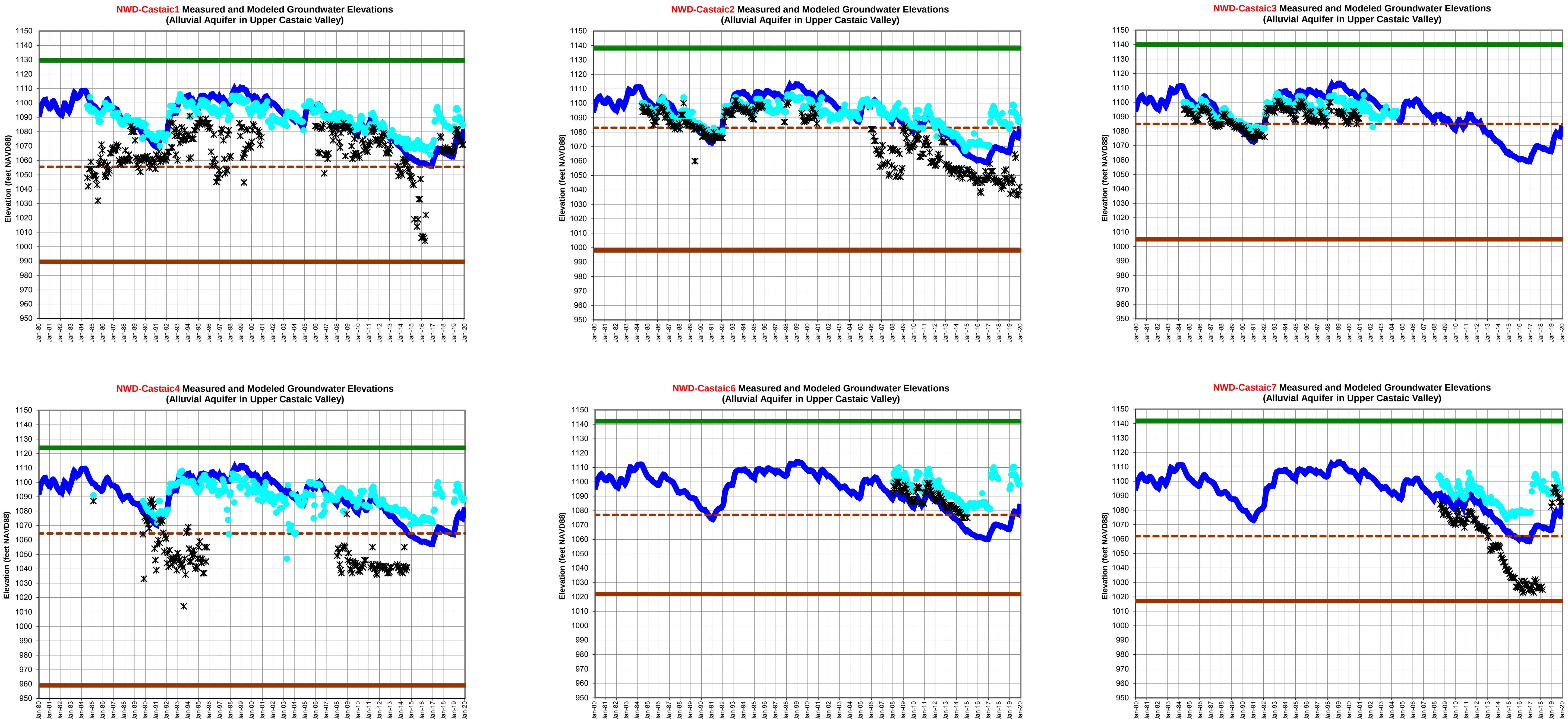

LEGEND

- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation
- Ground Surface
- Top of Screen/Slots
- Bottom of Screen/Slots

FIGURE 4-22

Simulated and Measured Alluvial Aquifer Hydrographs, 1980-2019 (Upper Castaic Valley)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

NOTE

NWD: Newhall Water Division

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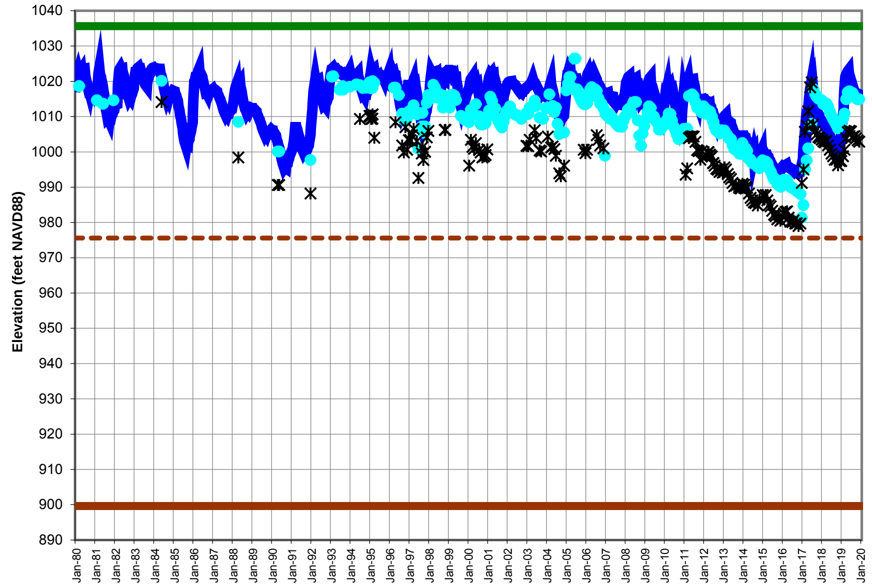
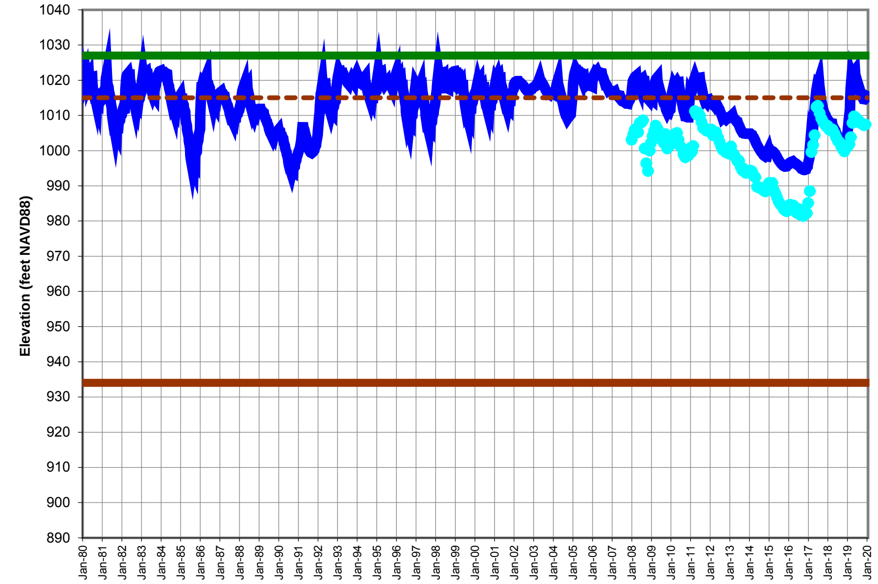
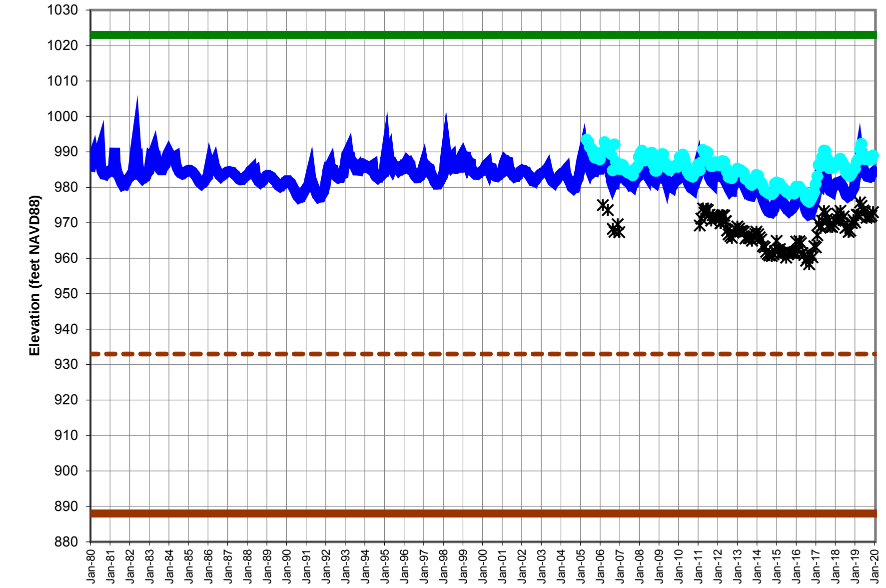
VWD-D Measured and Modeled Groundwater Elevations
(Alluvial Aquifer in Lower Castaic Valley)



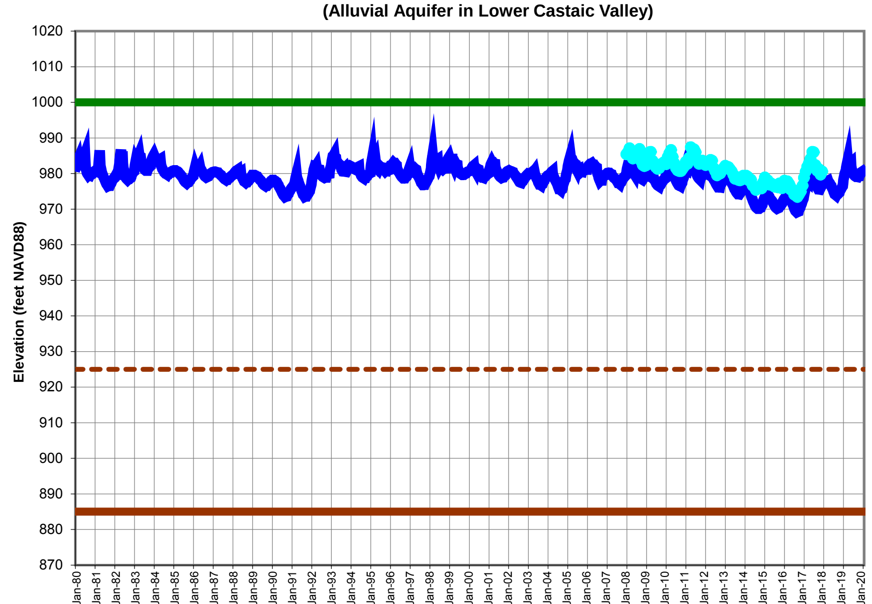
NLF-E Measured and Modeled Groundwater Elevations
(Alluvial Aquifer in Lower Castaic Valley)



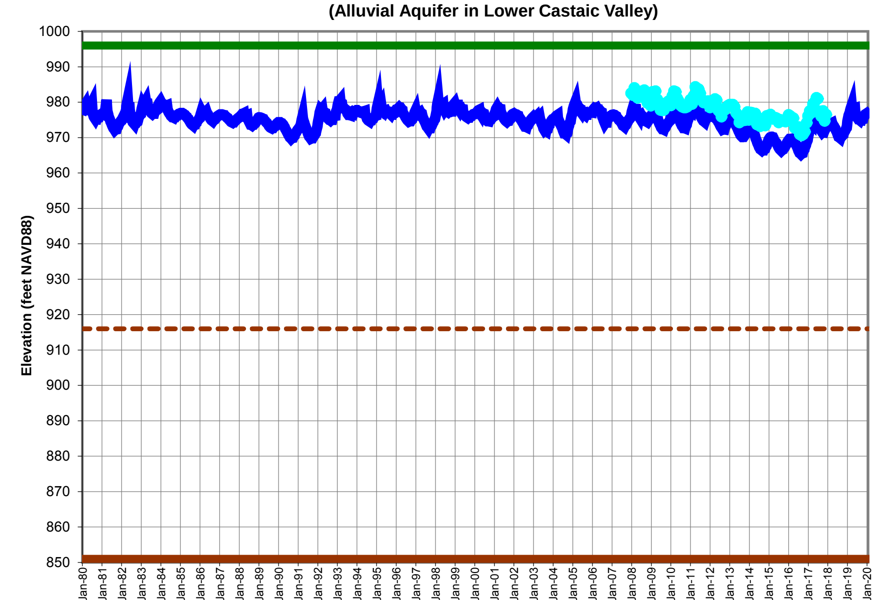
VWD-E15 Measured and Modeled Groundwater Elevations
(Alluvial Aquifer in Lower Castaic Valley)



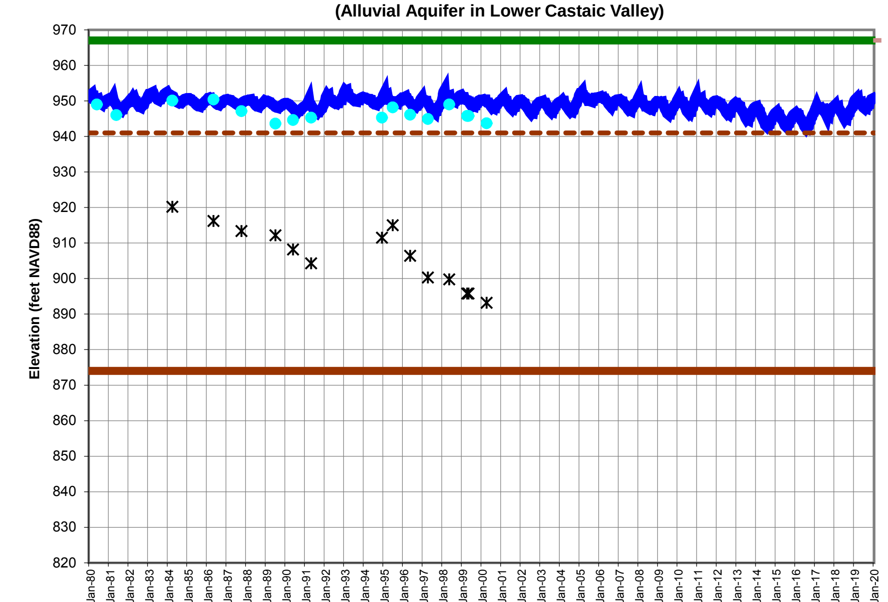
VWD-E14 Measured and Modeled Groundwater Elevations
(Alluvial Aquifer in Lower Castaic Valley)



VWD-E16 Measured and Modeled Groundwater Elevations
(Alluvial Aquifer in Lower Castaic Valley)



NLF-C6 Measured and Modeled Groundwater Elevations
(Alluvial Aquifer in Lower Castaic Valley)



LEGEND

- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation
- Ground Surface
- Top of Screen/Slots
- Bottom of Screen/Slots

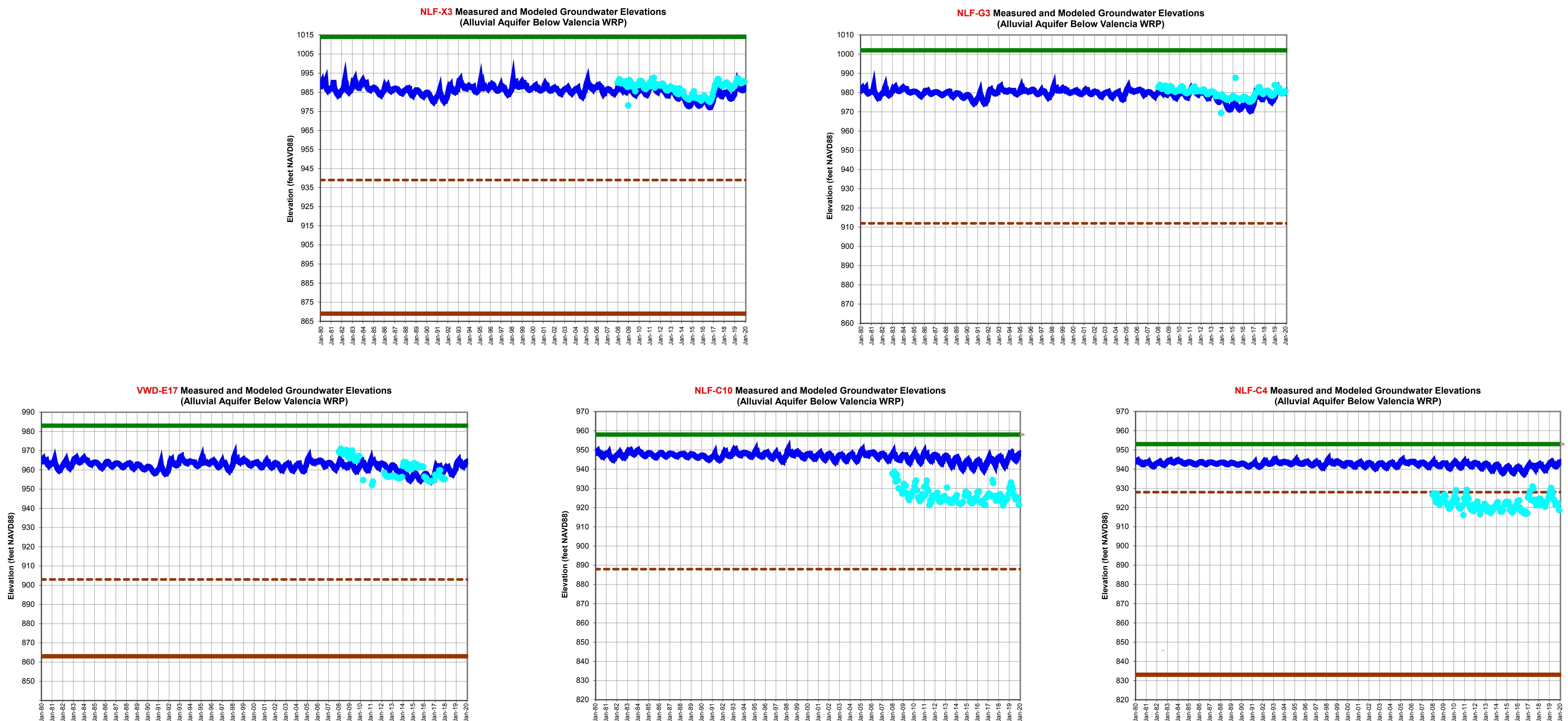
NOTE
VWD: Valencia Water Division

FIGURE 4-23

Simulated and Measured Alluvial Aquifer Hydrographs, 1980-2019 (Lower Castaic Valley)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.



LEGEND

- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation
- Ground Surface
- Top of Screen/Slots
- Bottom of Screen/Slots

FIGURE 4-24

Simulated and Measured Alluvial Aquifer Hydrographs, 1980-2019
(Below Valencia Water Reclamation Plant, At and East of Castaic Valley)

Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

NOTES

VWD: Valencia Water Division
WRP: Water Reclamation Plant

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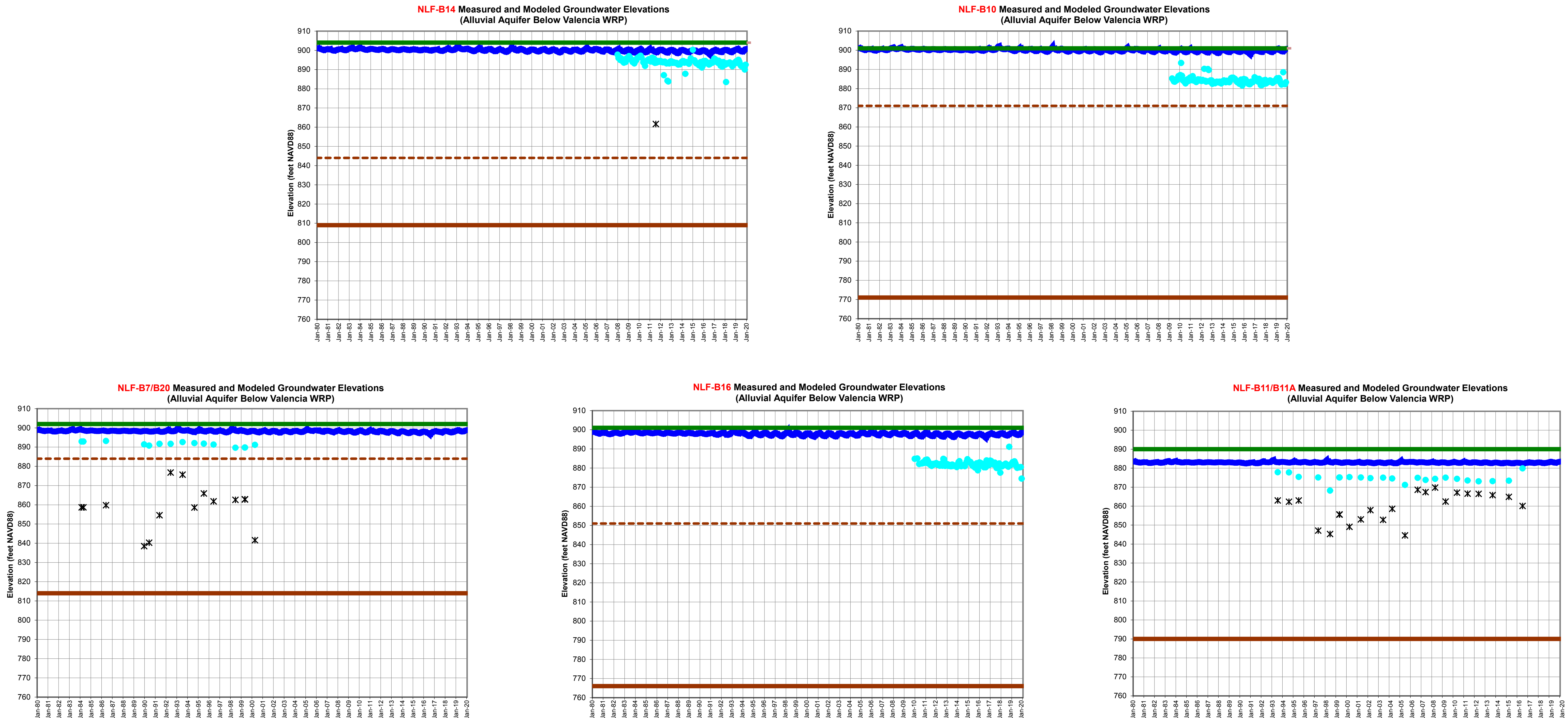


LEGEND

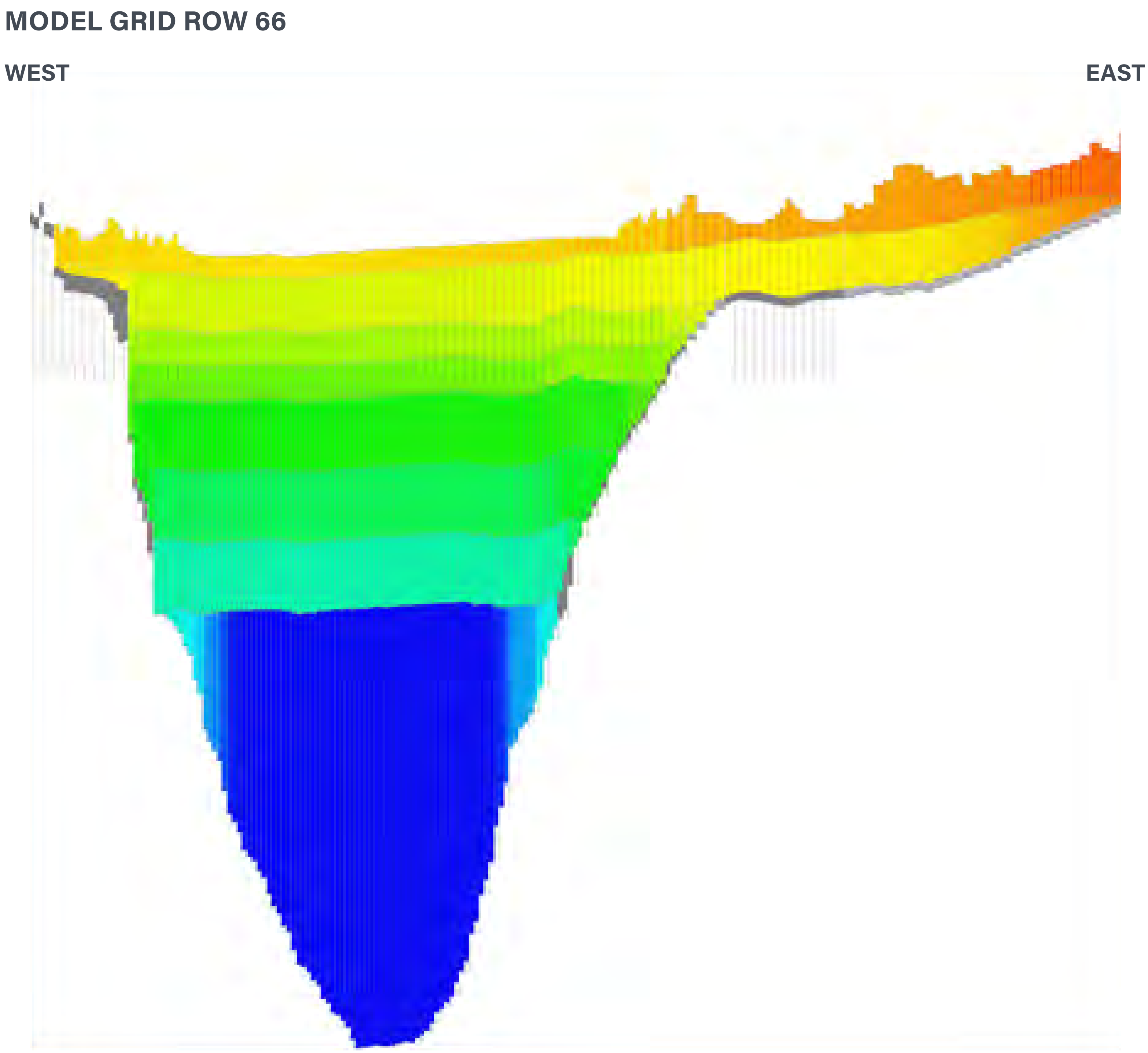
- Measured Static Elevation
- Measured Pumping Elevation
- Simulated Elevation
- Ground Surface
- Top of Screen/Slots
- Bottom of Screen/Slots

FIGURE 4-25

Simulated and Measured Alluvial Aquifer Hydrographs, 1980-2019
(Below Valencia Water Reclamation Plant, At and East of Castaic Valley)
Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

NOTES
VWD: Valencia Water Division
WRP: Water Reclamation Plant



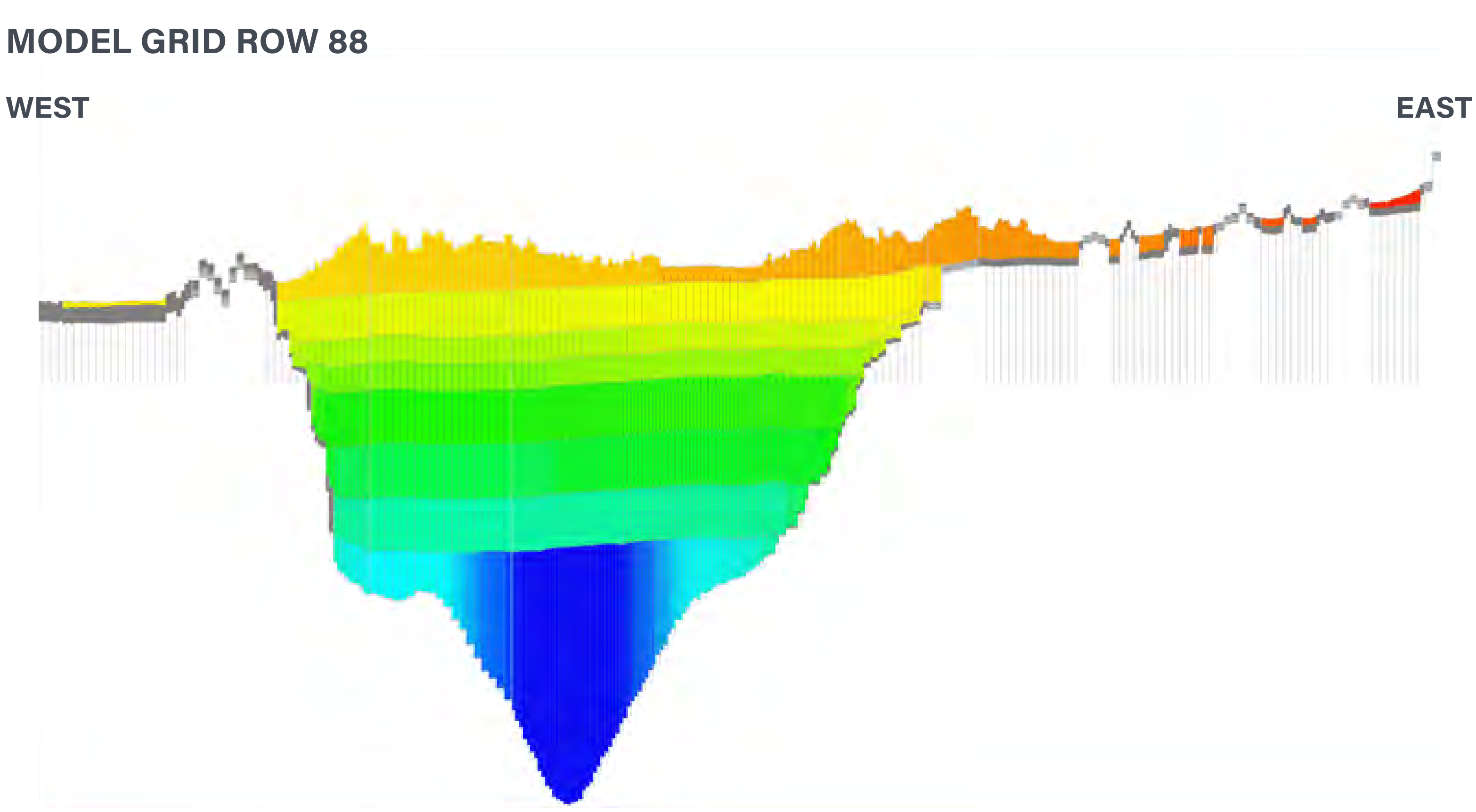


FIGURE 3-26

West-to-East Schematic Cross-Sectional View Along Model Grid Rows 66 and 88

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

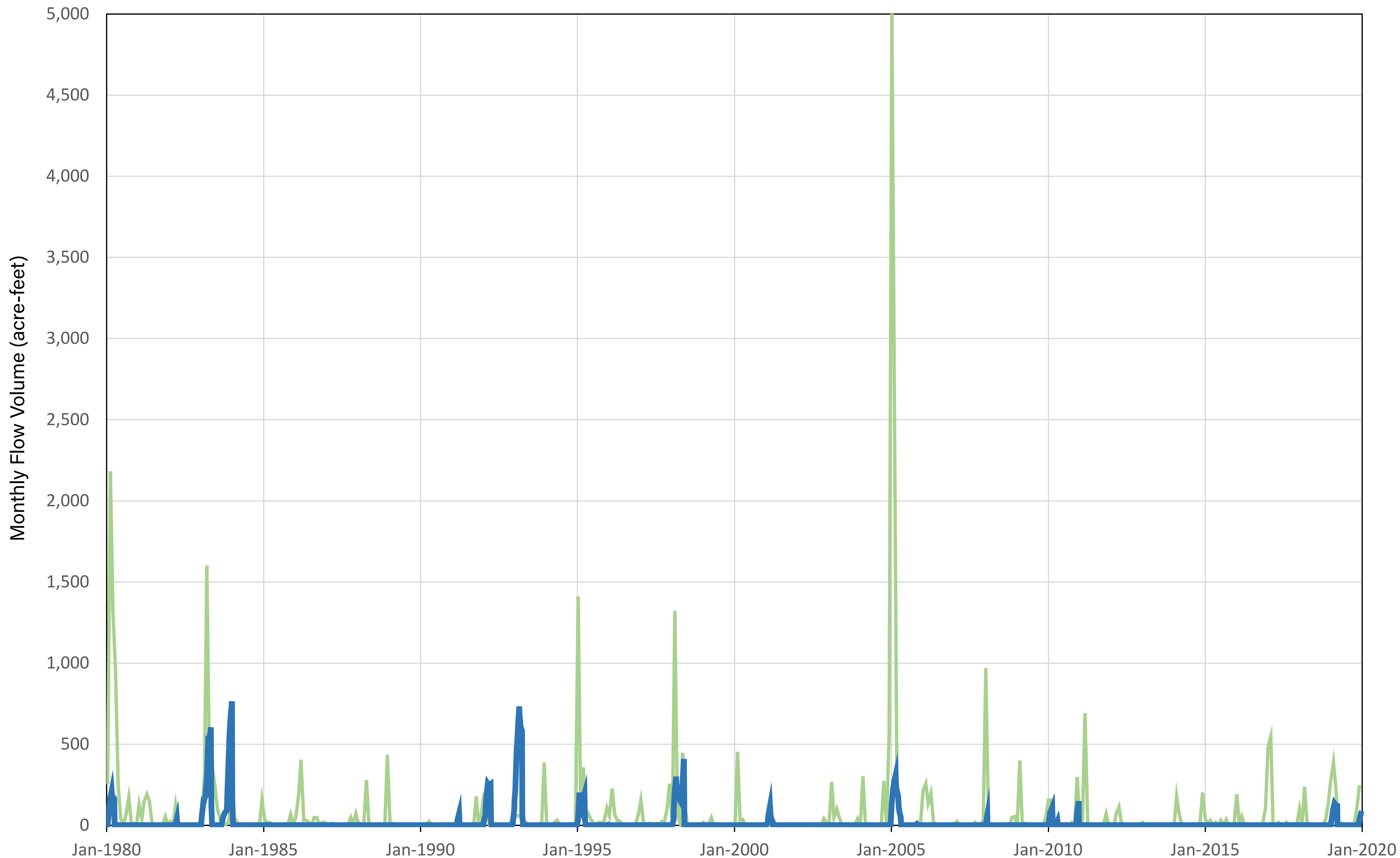


FIGURE 4-27

Modeled Flow Volumes in Bouquet Creek at Bouquet Canyon Road (LADPW Stream Gage 377B-R)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Measured at LADPW Stream Gage 377B-R
- Modeled

NOTE

LADPW: Los Angeles County Department of Public Works

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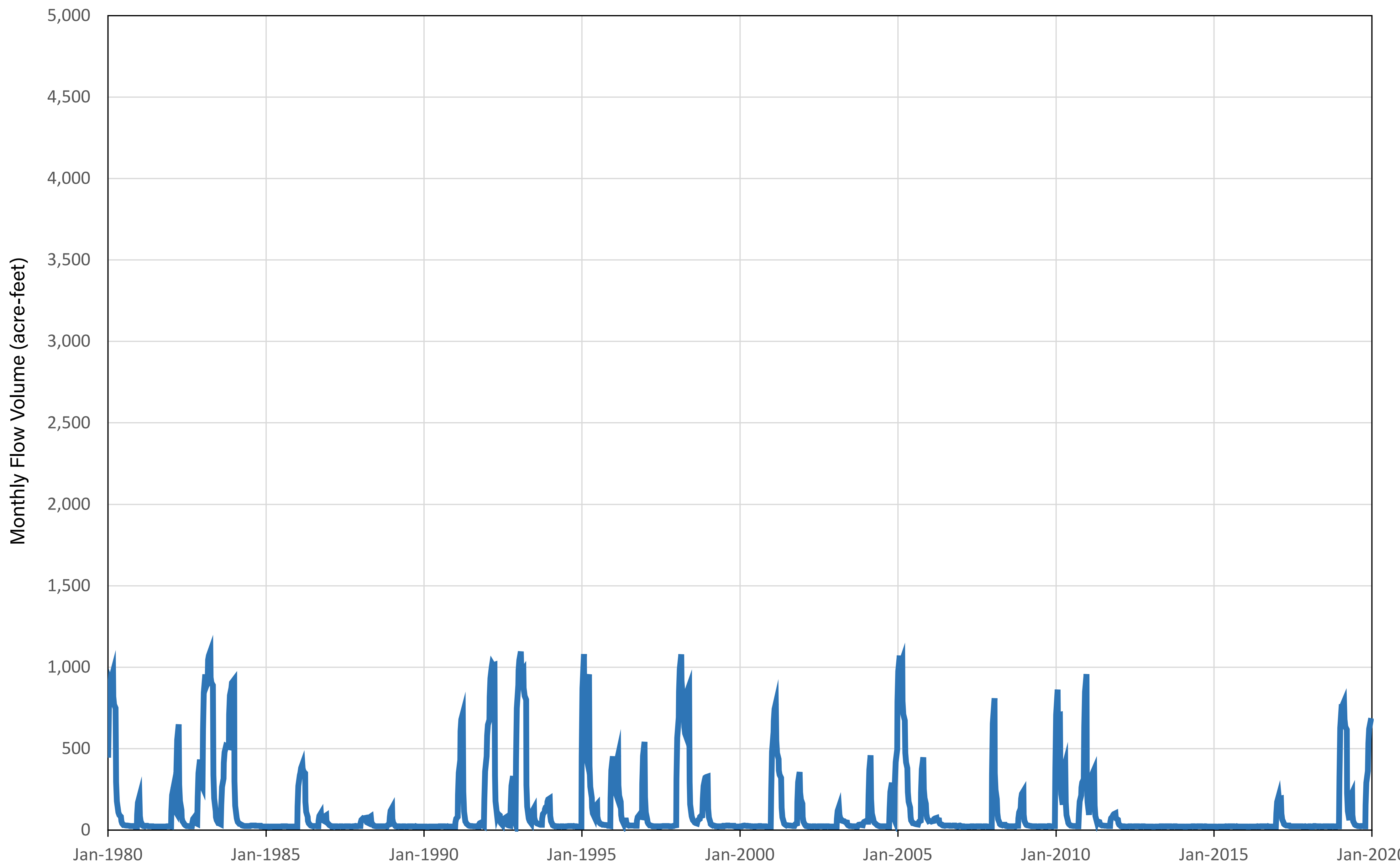

FIGURE 4-28

Modeled Flow Volumes in South Fork Santa Clara River at Its Mouth

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

Modeled

NOTE

LADPW: Los Angeles County Department of Public Works

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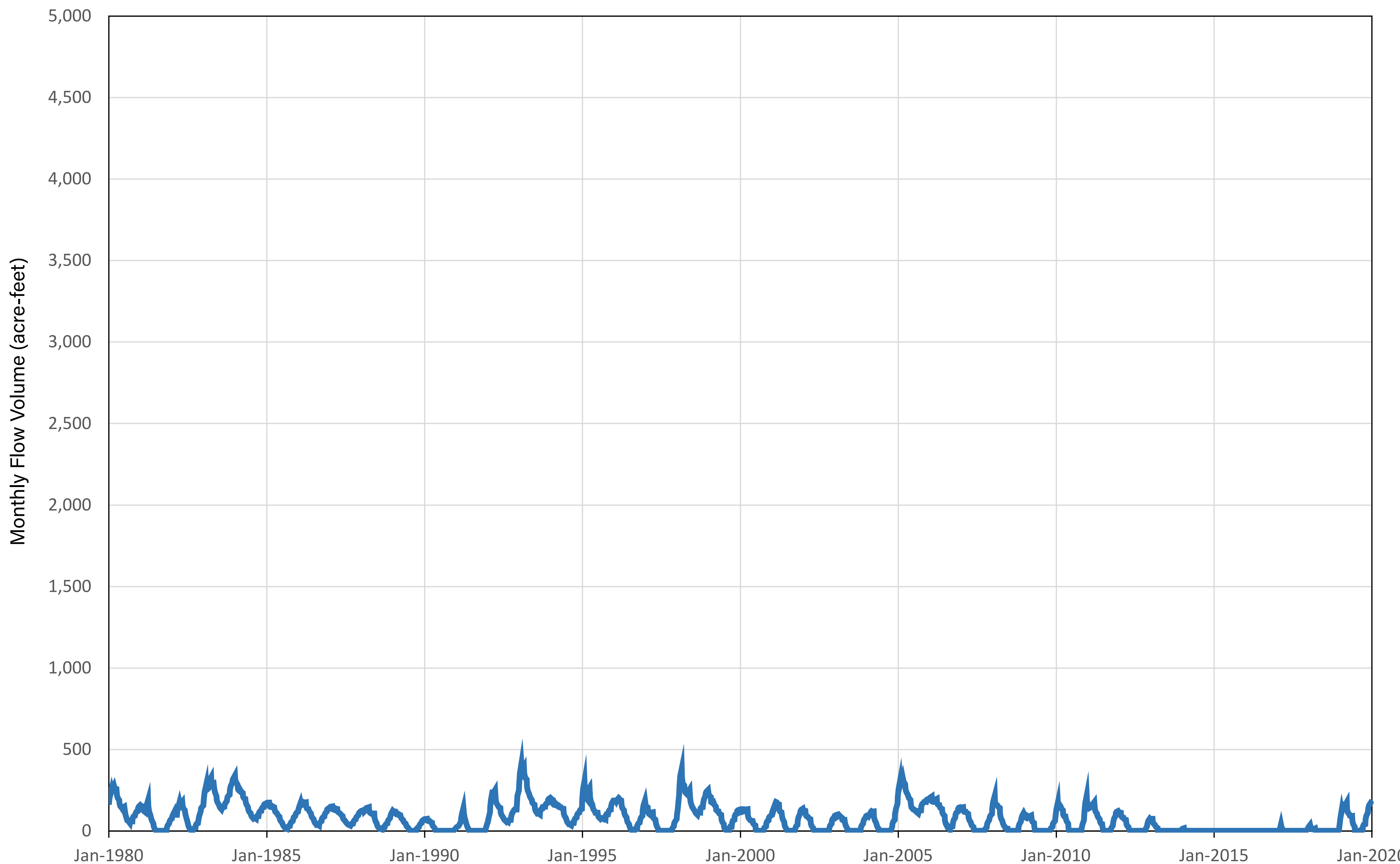

FIGURE 4-29

Modeled Flow Volumes in Castaic Creek at Its Mouth

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

Modeled

GSI Water Solutions, Inc.

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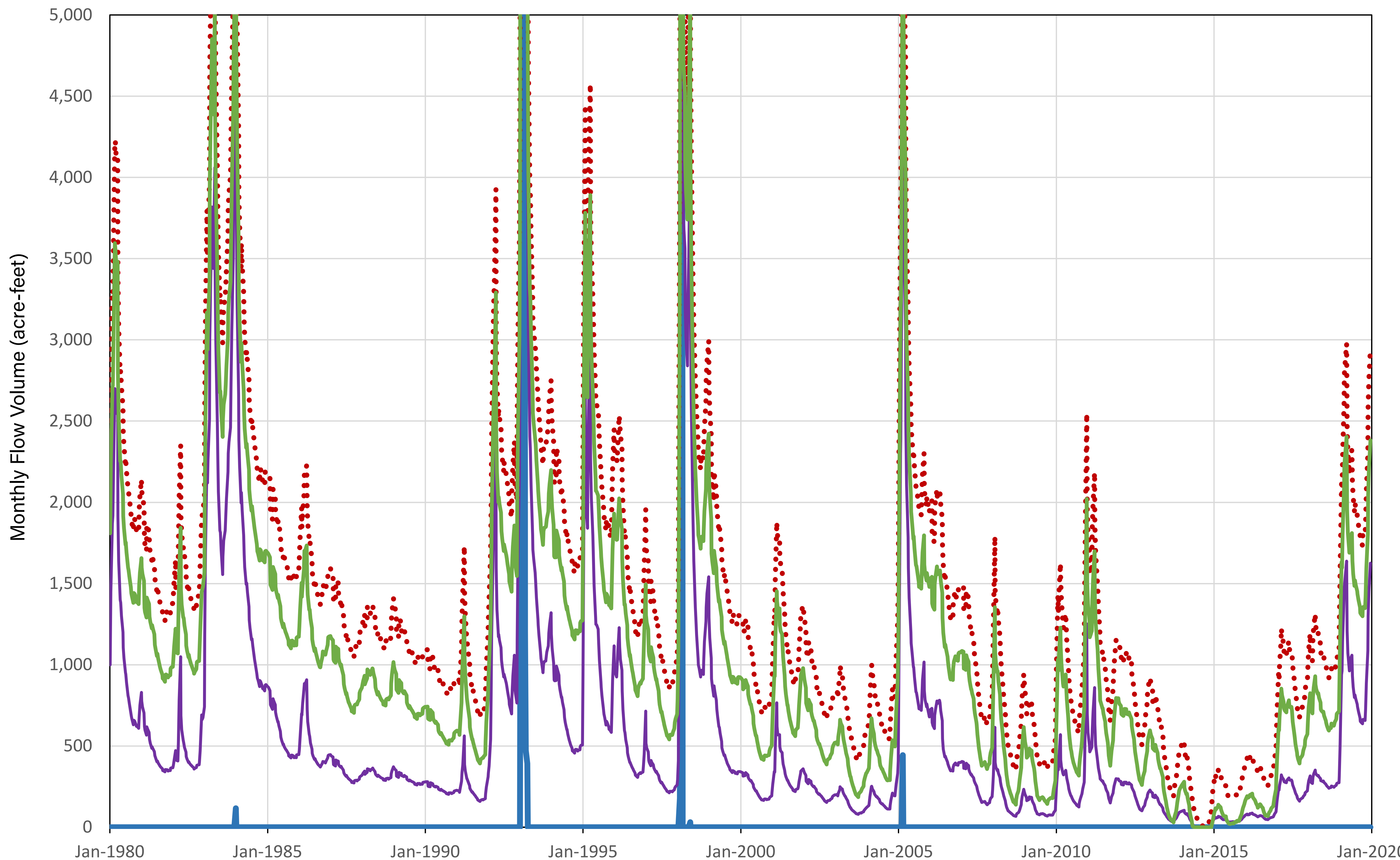

FIGURE 4-30

Modeled Flow Volumes in Santa Clara River From Bouquet Canyon to Valencia WRP

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- At Bouquet Canyon
- At San Francisquito Canyon
- At I-5 Bridge
- Above Valencia WRP

NOTE

WRP: Water Reclamation Plant

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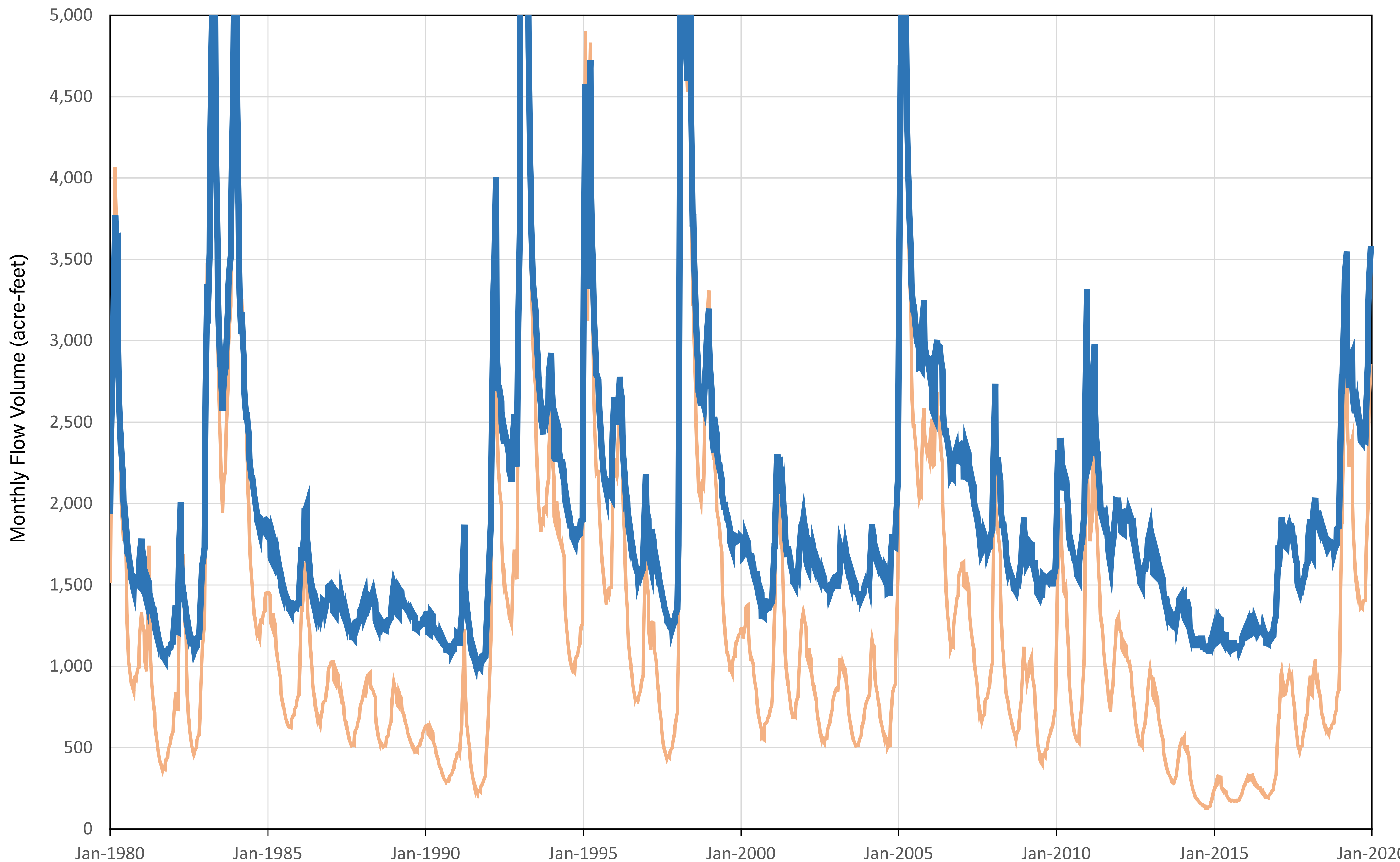

FIGURE 4-31

Modeled Flow Volumes in Santa Clara River From Valencia WRP Outfall to Castaic Creek

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

At Castaic Creek

Immediately Below Valencia WRP

NOTE

WRP: Water Reclamation Plant

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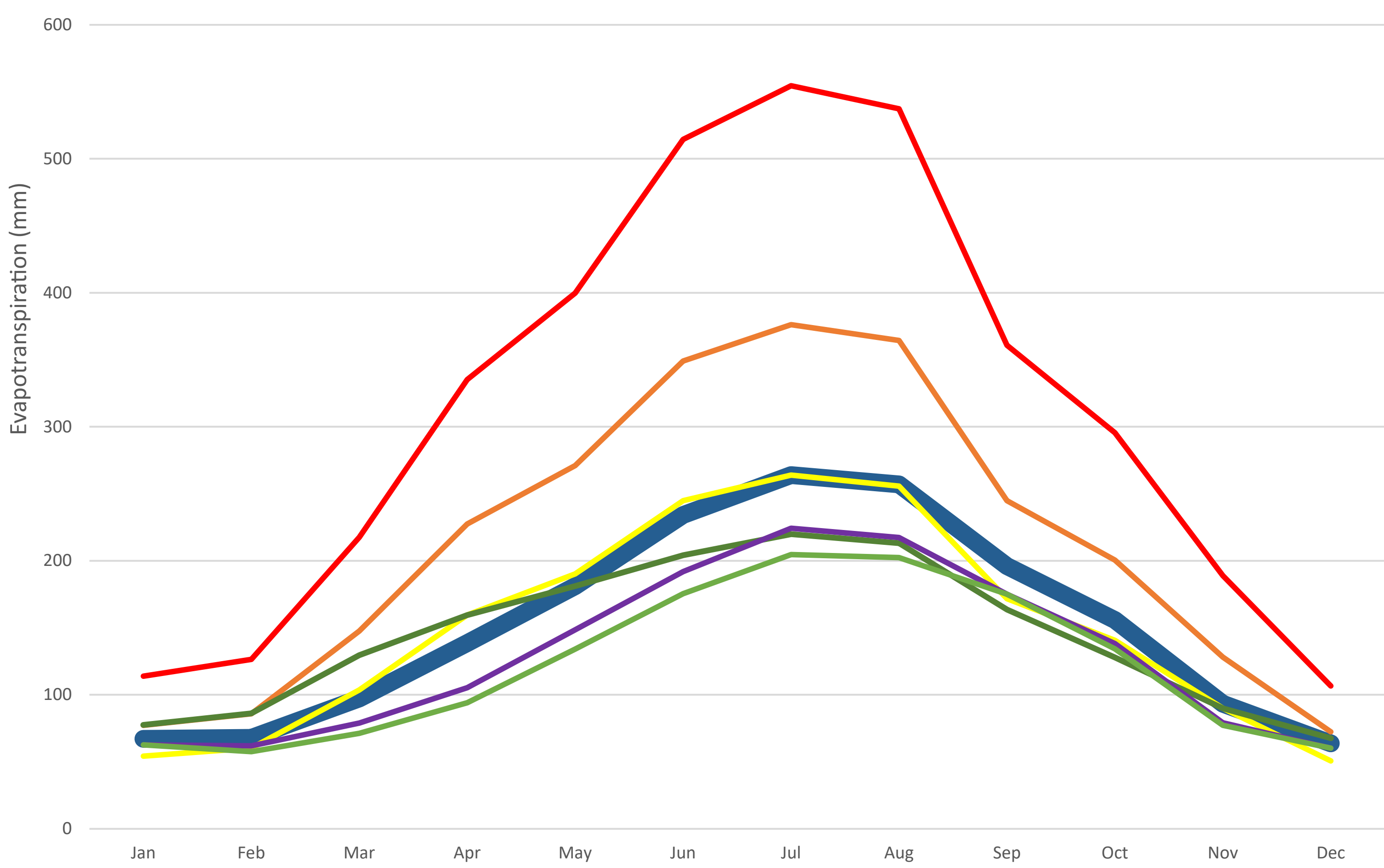

FIGURE 3-32

Evapotranspiration Demand Curves for Native and Nonnative Species

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Amalgam of 30% *Arundo*, 40% cottonwood, 30% willow
- Estimated *Arundo* (median of TNC values)
- Reference surface (grass)
- Large-stand willow
- Estimated *Arundo* (mean of TNC values)
- Large-stand permanent wetland
- Large-stand cottonwood

NOTE

TNC: The Nature Conservancy

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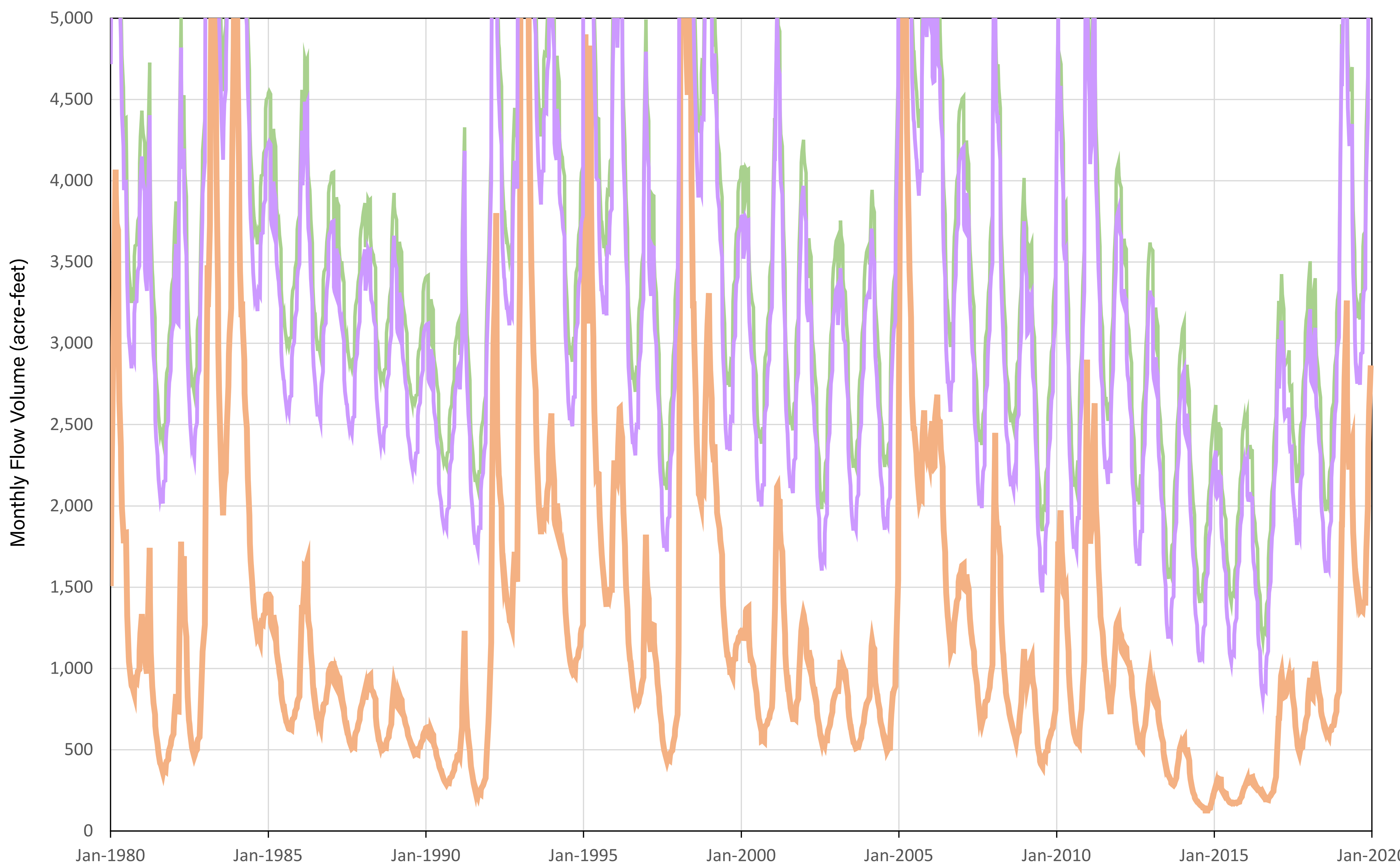

FIGURE 4-33

Modeled Flow Volumes in Santa Clara River From Castaic Creek to Basin Boundary

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

At Castaic Creek

A Potrero Canyon

At Basin Boundary

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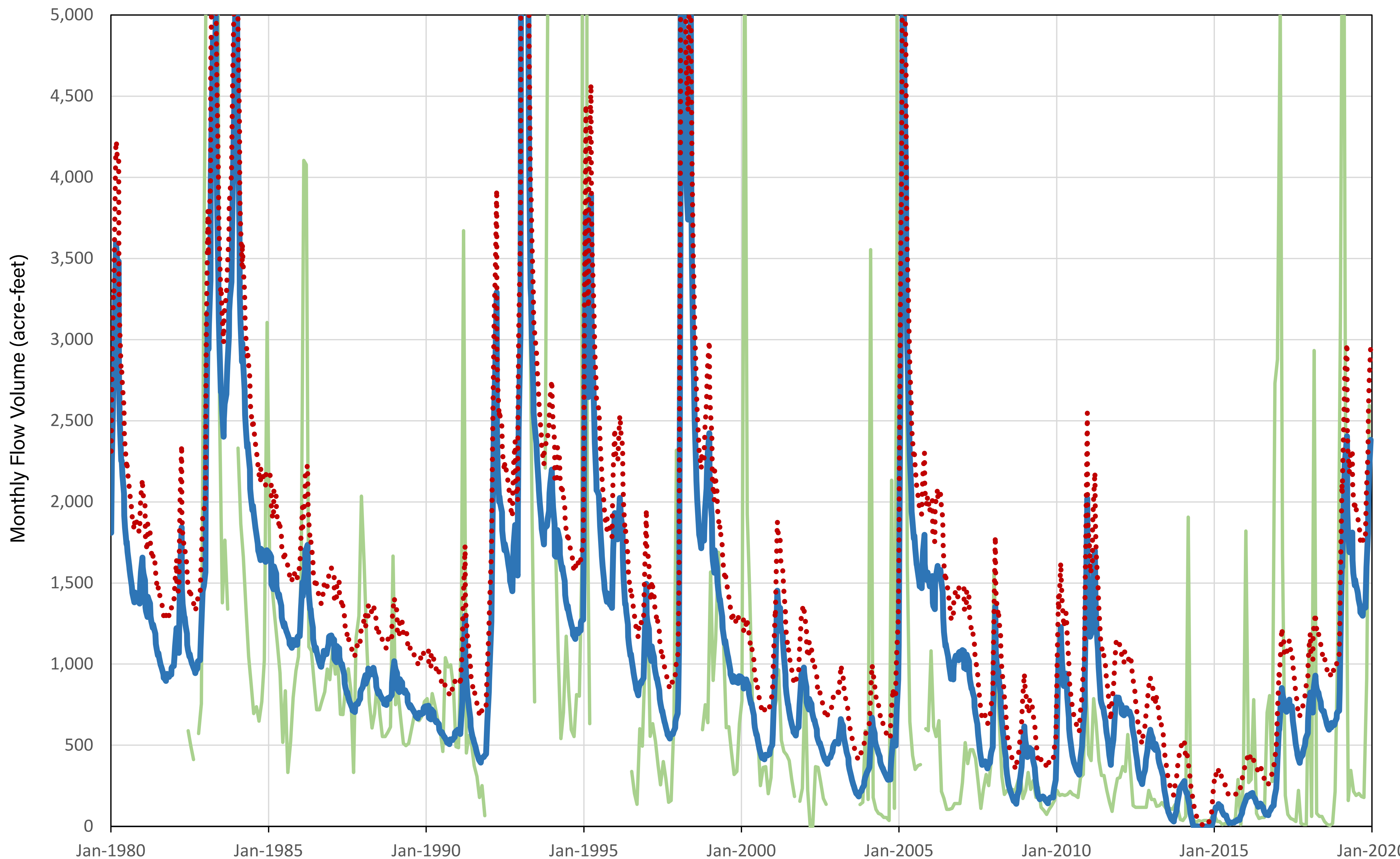

FIGURE 4-34

Modeled Flow Volumes in Santa Clara River At I-5 Bridge and Immediately Upstream of the Valencia WRP Outfall

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Measured at Old Road Bridge (LADPW Stream Gage F92C-R)
- Modeled Above Valencia WRP Outfall
- Modeled At I-5 Bridge

NOTES

LADPW: Los Angeles County Department of Public Works

WRP: Water Reclamation Plant

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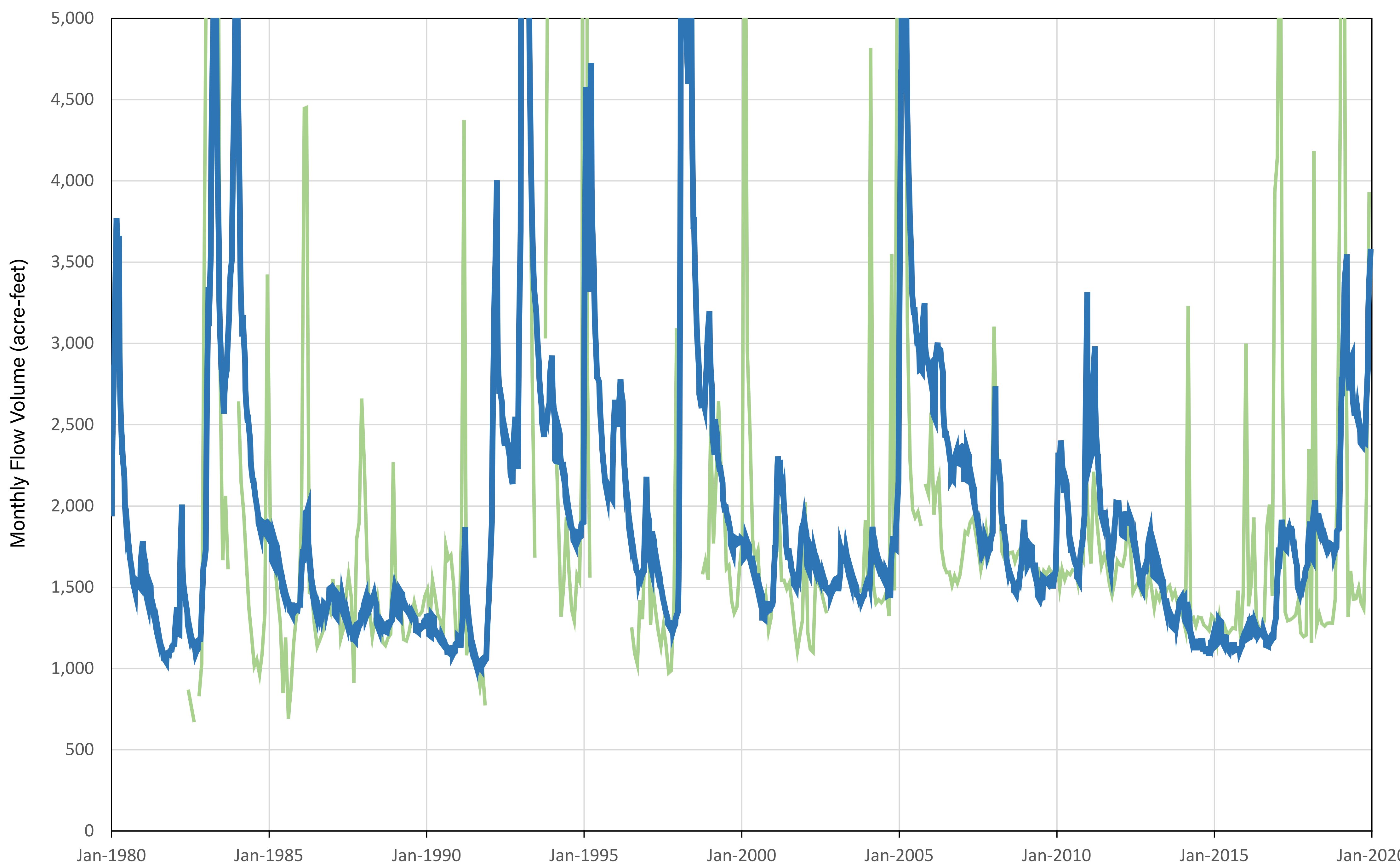

FIGURE 4-35

Modeled Flow Volumes in Santa Clara River Immediately Downstream of the Valencia WRP Outfall

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

Valencia WRP Discharges and Measured at Old Road Bridge (LADPW Stream Gage F92C-R)

Modeled Flow

NOTES

LADPW: Los Angeles County Department of Public Works

WRP: Water Reclamation Plant

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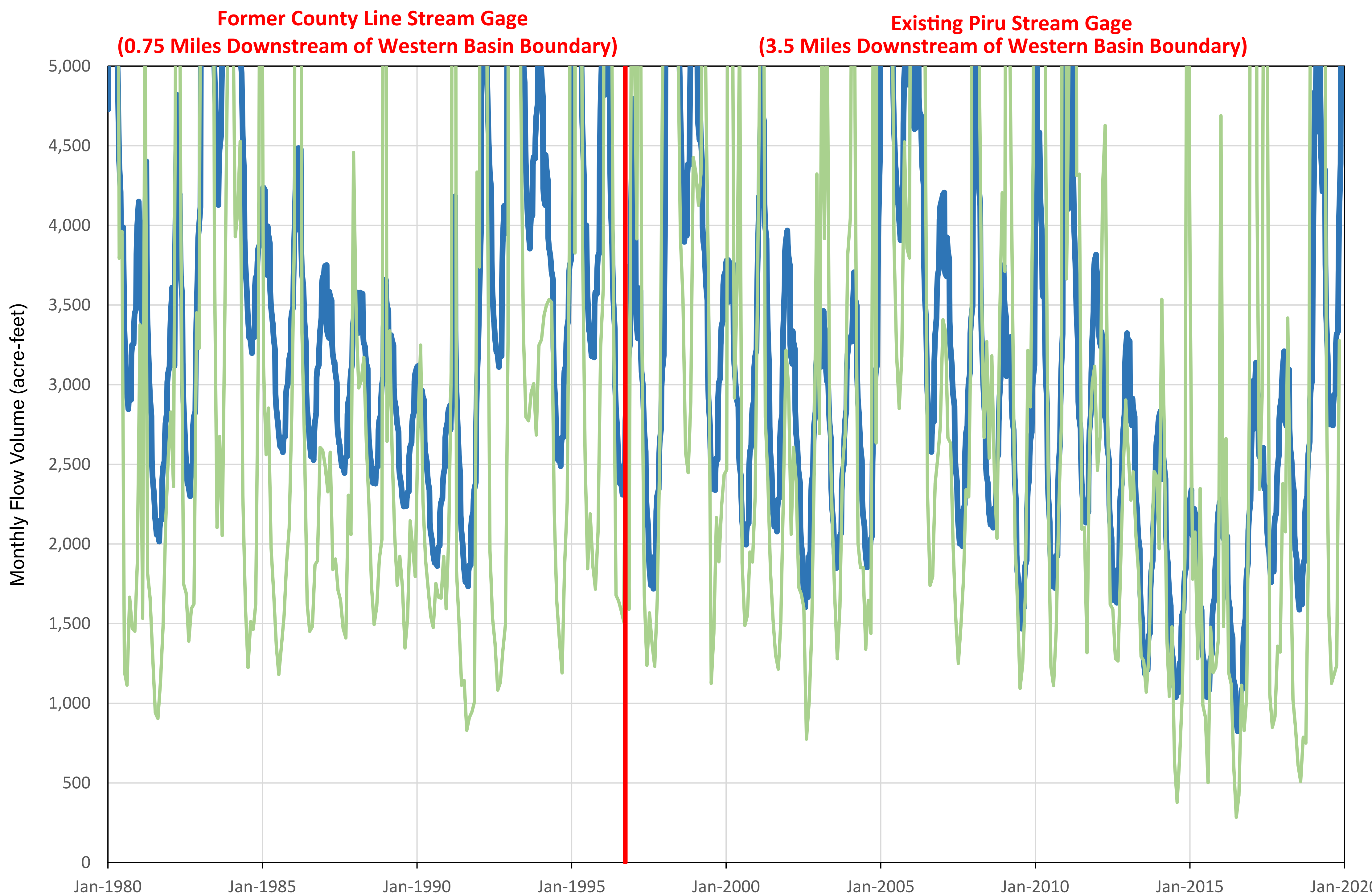

FIGURE 4-36

Modeled Flow Volumes in Santa Clara River at the Western Basin Boundary vs. Gaged Flows Downstream

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Modeled Flow at Western Basin Boundary
- Measured Flow at County Line/ Piru Stream Gages

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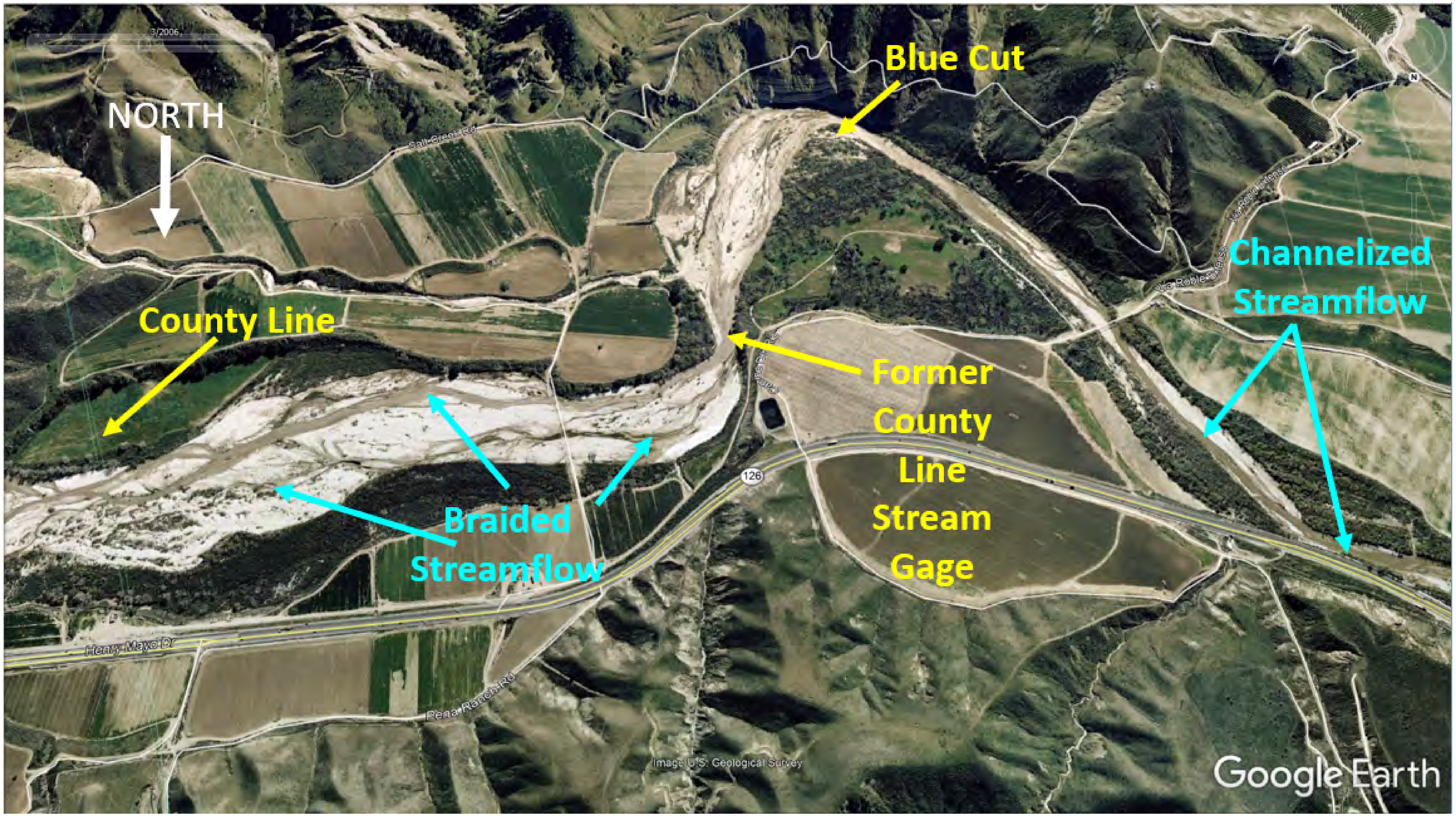

FIGURE 4-37

Santa Clara River Streambed and Streamflow Conditions in 2006 (View from County Line through Blue Cut)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

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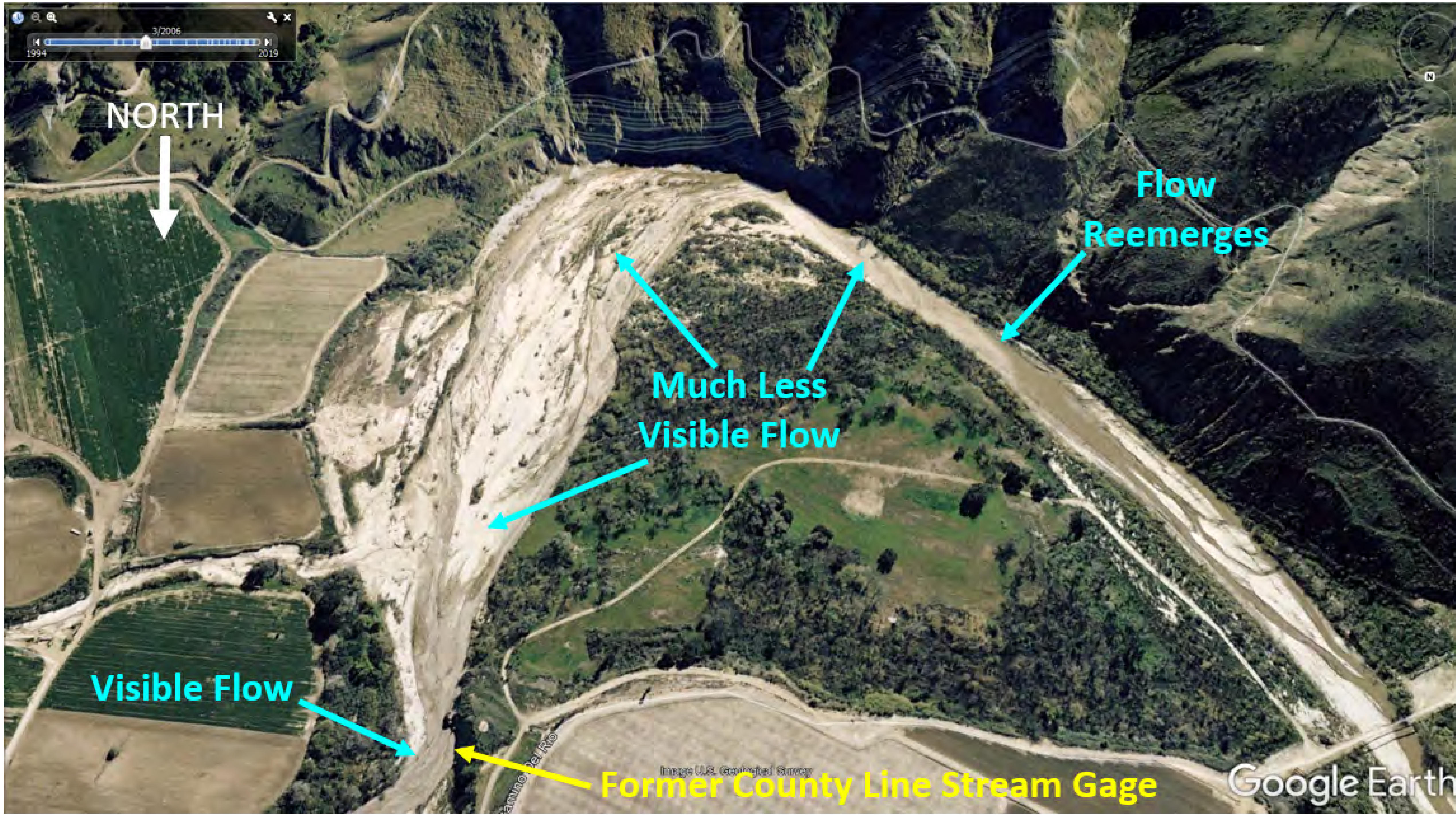

FIGURE 4-38

Santa Clara River Streambed and Streamflow Conditions in 2006 (View through Blue Cut Horseshoe Bend)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

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FIGURE 4-39

Santa Clara River Streambed and Streamflow Conditions in 2006 (View at South End of Blue Cut Horseshoe Bend)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

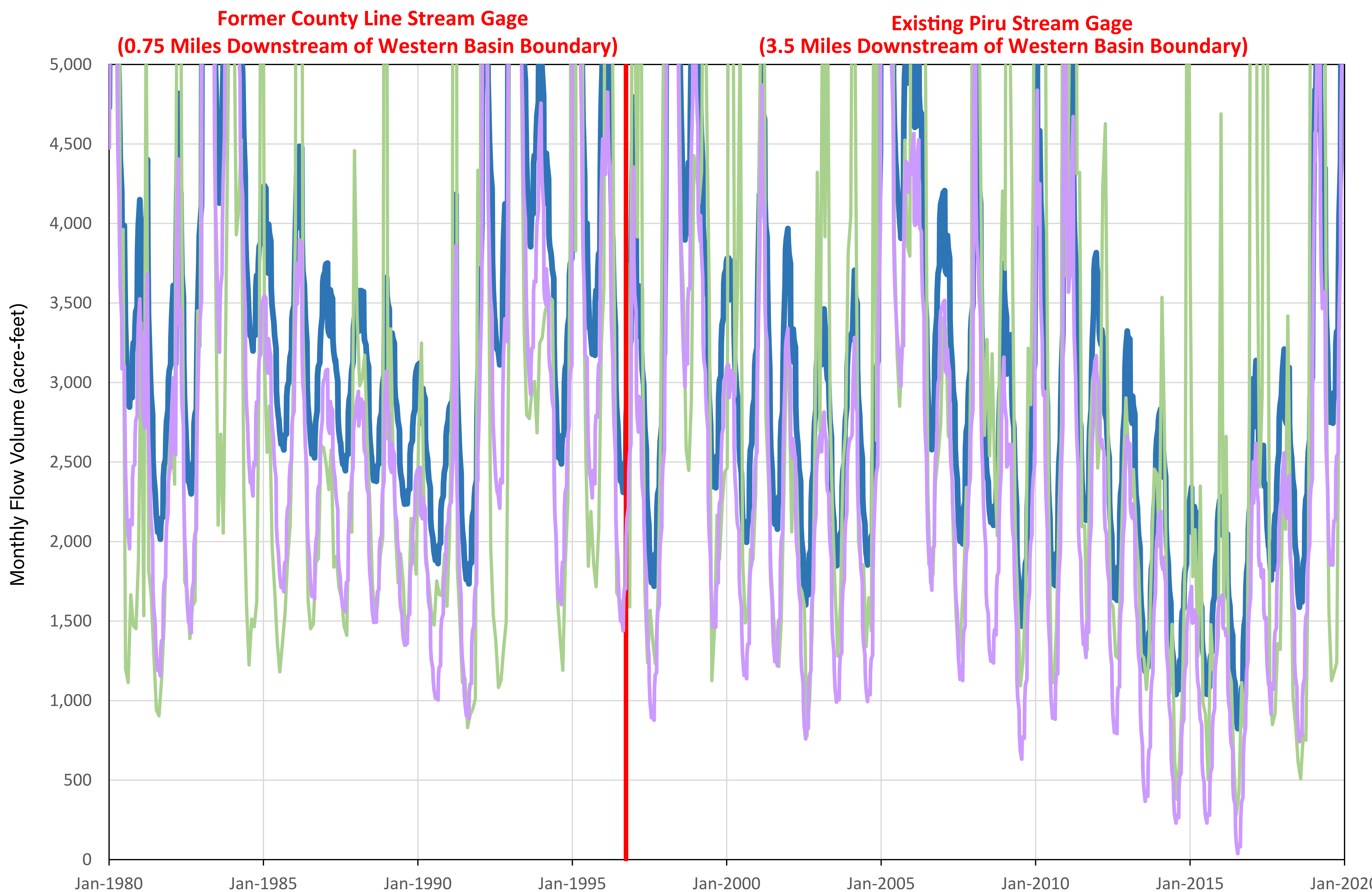

FIGURE 4-40

Comparison of Simulated and Measured Non-Storm Streamflows At and Beyond the Western Basin Boundary

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Modeled Flow at Western Basin Boundary
- Measured Flow at County Line/ Piru Stream Gages
- Modeled Flow at Former County Line Gage Site

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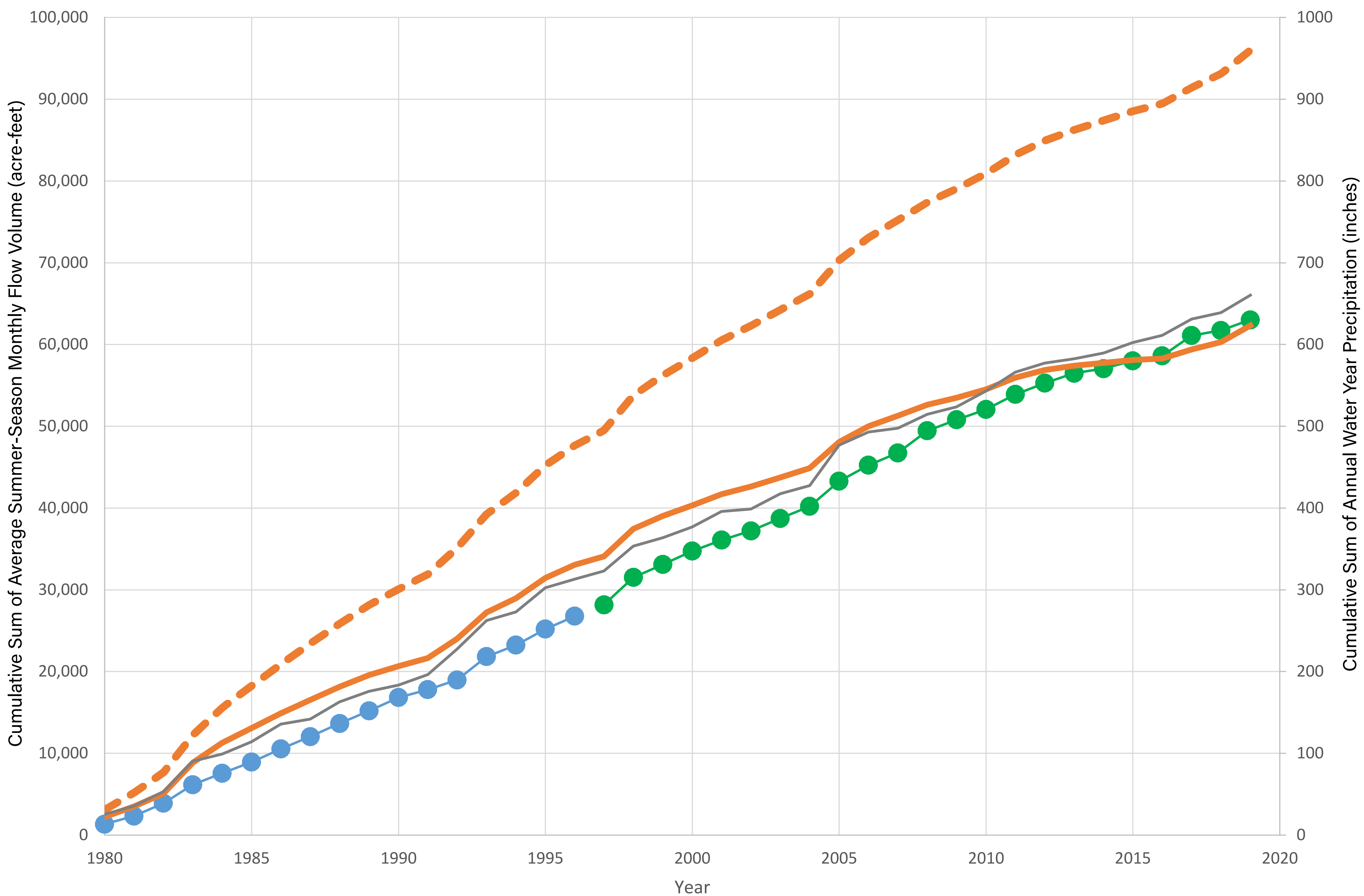


FIGURE 4-41

Comparison of Simulated and Measured Cumulative Streamflow Volumes for the Summer-Season At and Beyond the Western Basin Boundary

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

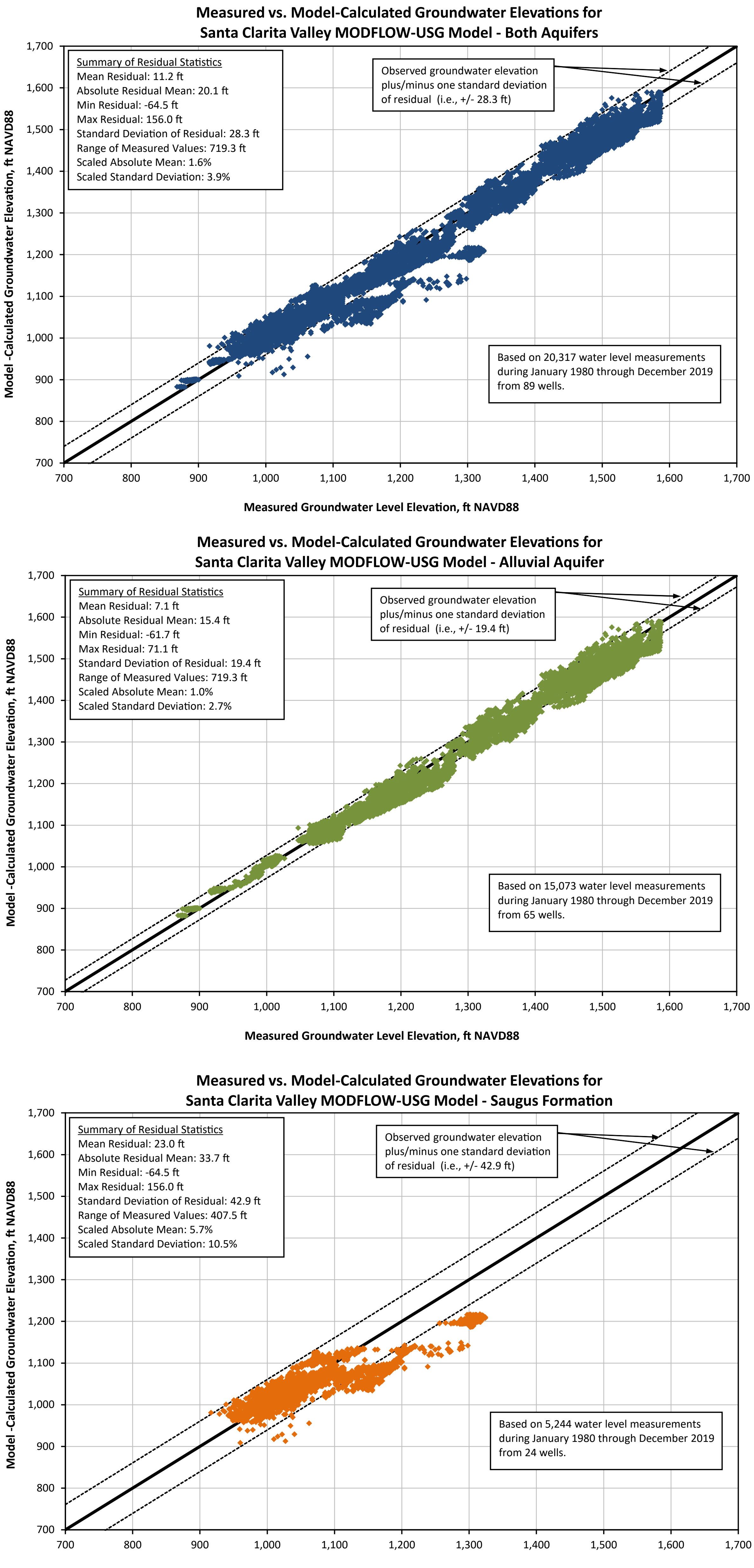
LEGEND

- Measured Flow Volume at County Line Stream Gage
- Measured Flow Volume at Piru Stream Gage
- Modeled Flow Volume (At Western Basin Boundary)
- Modeled Flow Volume (At County Line)
- Cumulative Annual Precipitation at Newhall-Soledad

NOTE

WRP: Water Reclamation Plant

GSI Water Solutions, Inc.



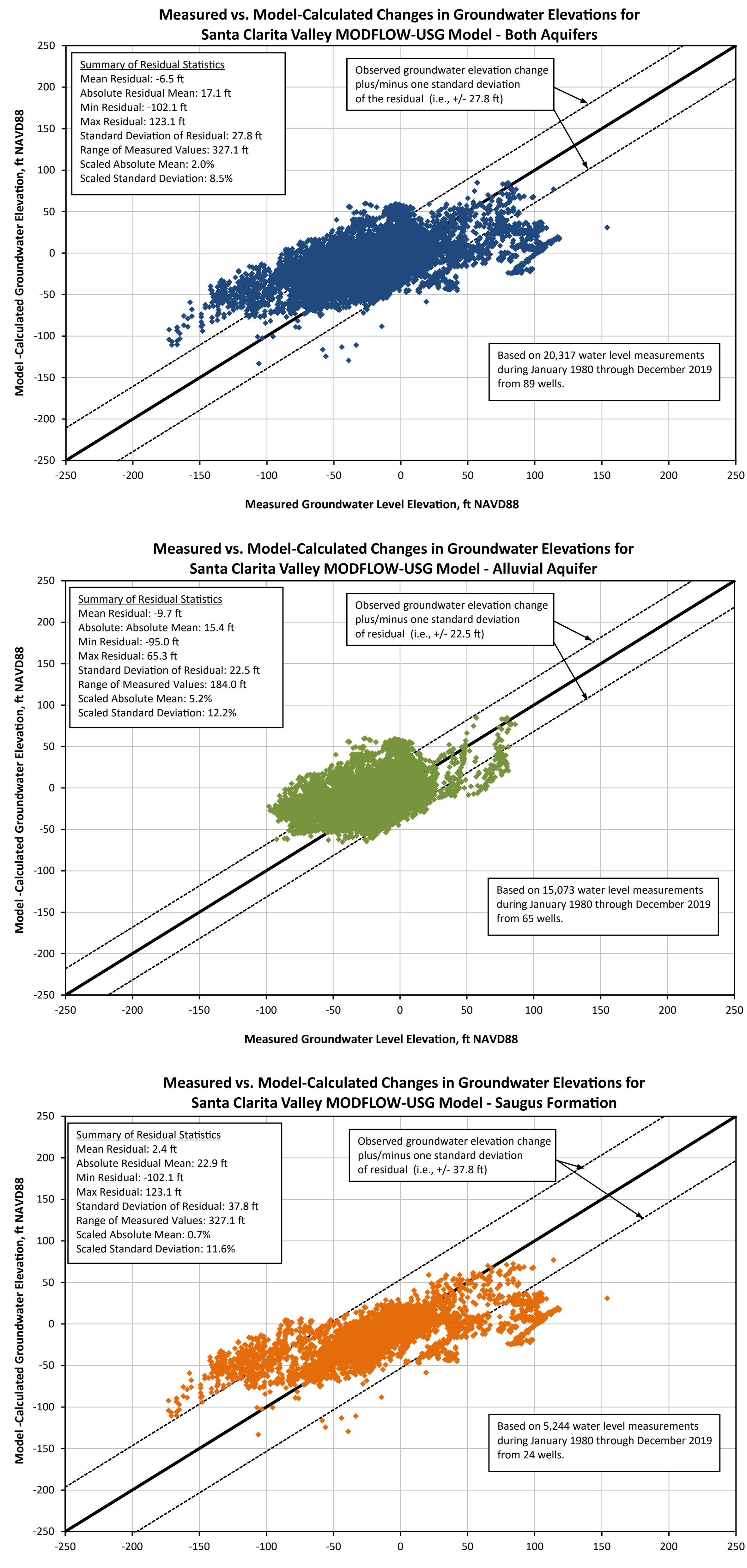
NOTE

Common modeling practice is to consider a good fit between historical and model-generated data if the relative error is below 10% (Spitz and Moreno, 1996).

FIGURE 4-42

Scatterplots of Groundwater Elevation Residuals

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



NOTE
Common modeling practice is to consider a good fit between historical and model-generated data if the relative error is below 10% (Spitz and Moreno, 1996).

FIGURE 4-43

Scatterplots of Groundwater Elevation Change Residuals

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

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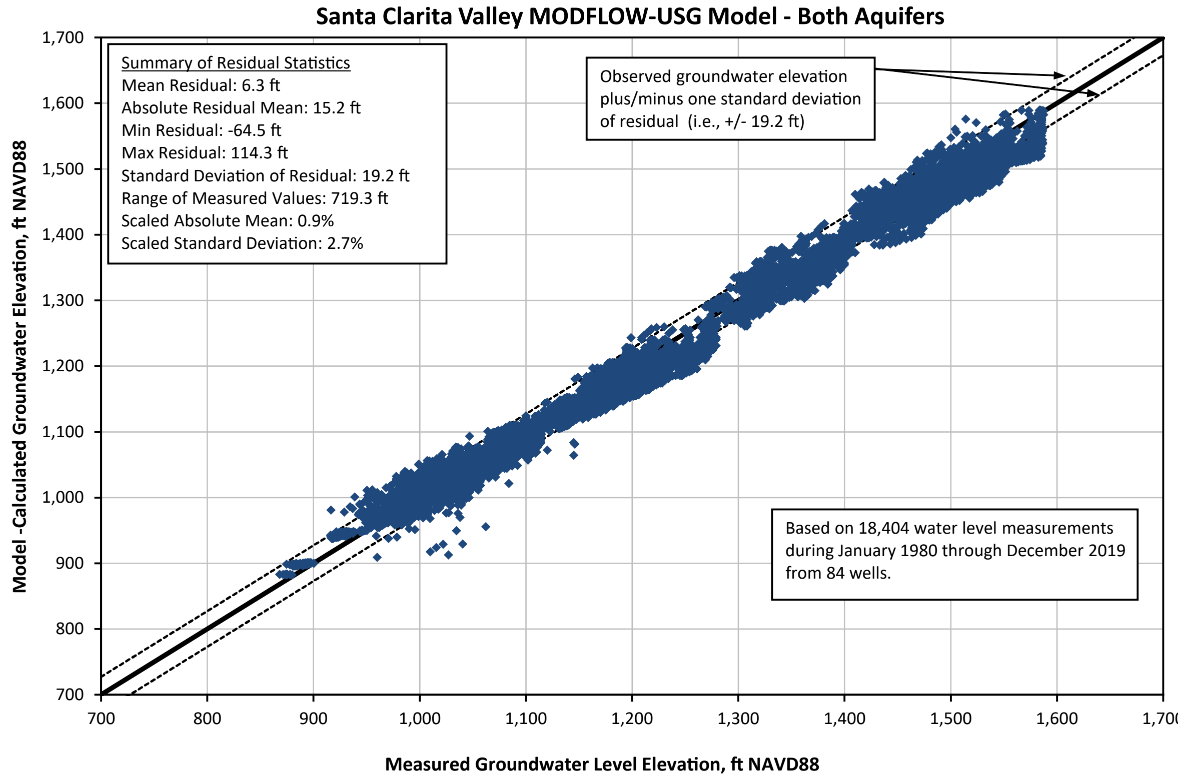
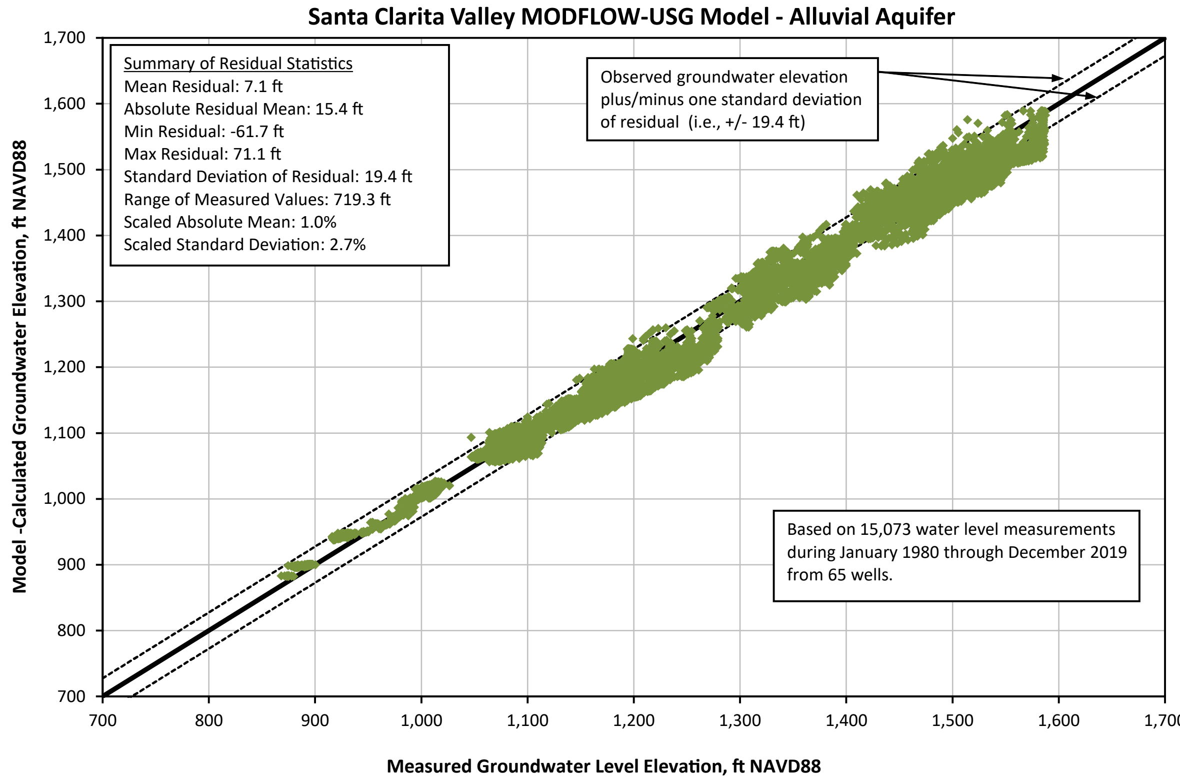
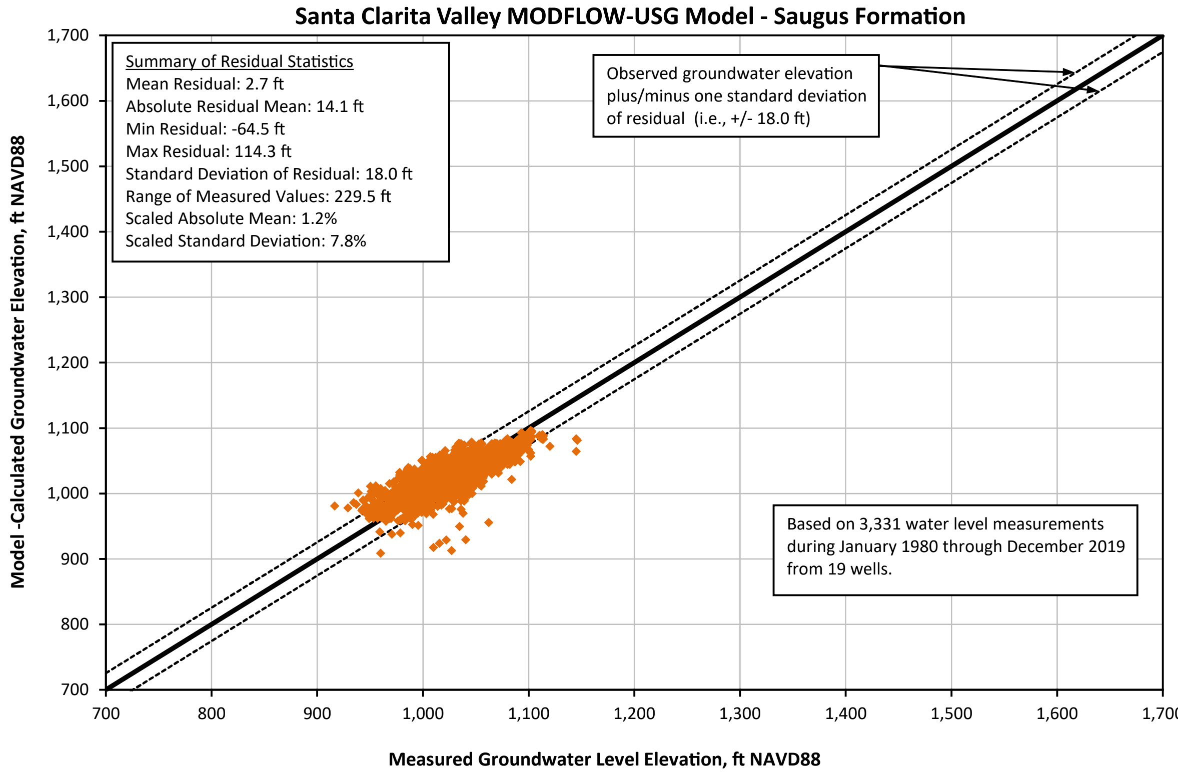
Measured vs. Model-Calculated Groundwater Elevations for Santa Clarita Valley MODFLOW-USG Model - Both Aquifers



Measured vs. Model-Calculated Groundwater Elevations for Santa Clarita Valley MODFLOW-USG Model - Alluvial Aquifer



Measured vs. Model-Calculated Groundwater Elevations for Santa Clarita Valley MODFLOW-USG Model - Saugus Formation



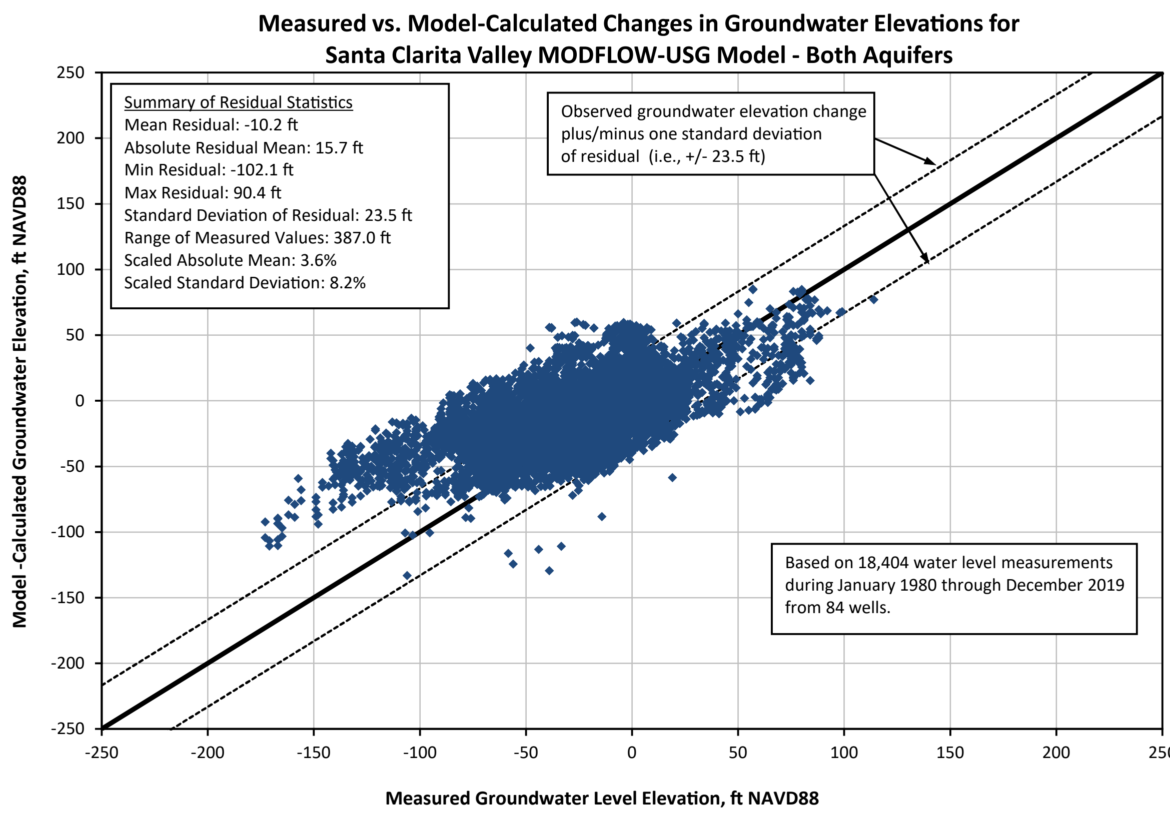
NOTE
Common modeling practice is to consider a good fit between historical and model-generated data if the relative error is below 10% (Spitz and Moreno, 1996).

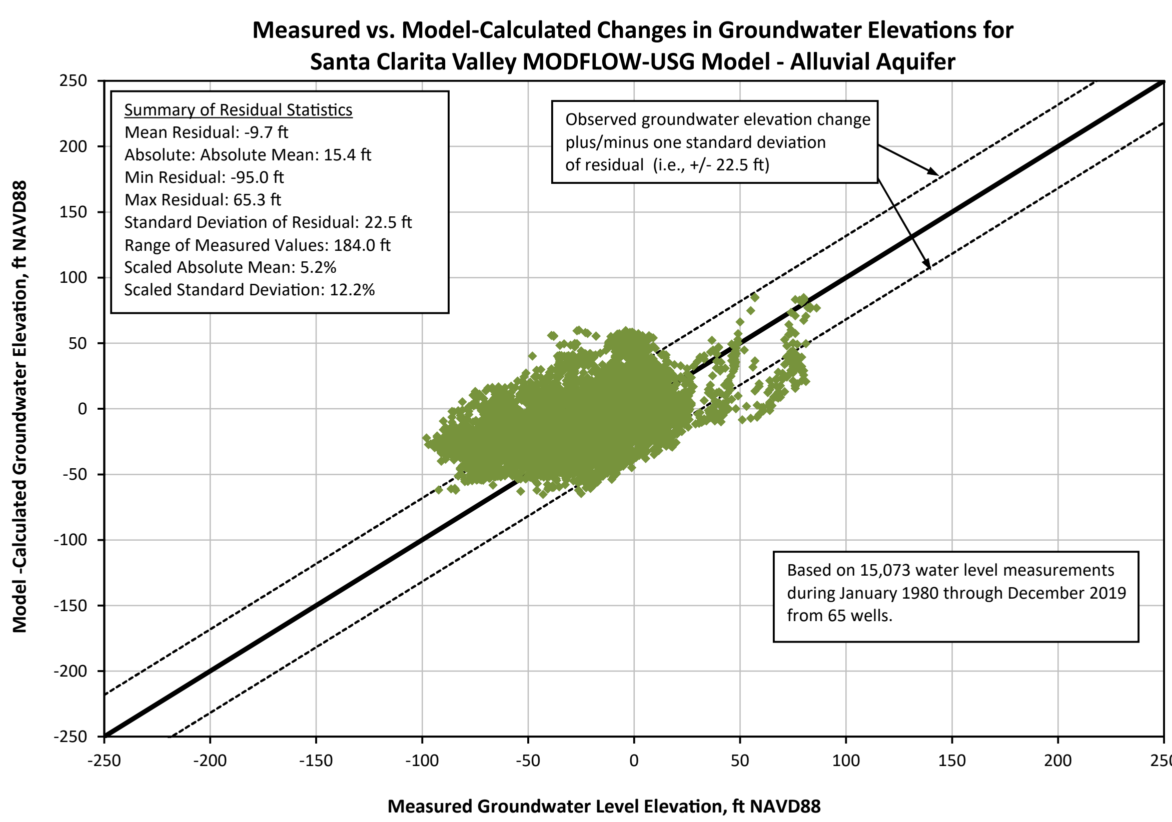
FIGURE 4-44

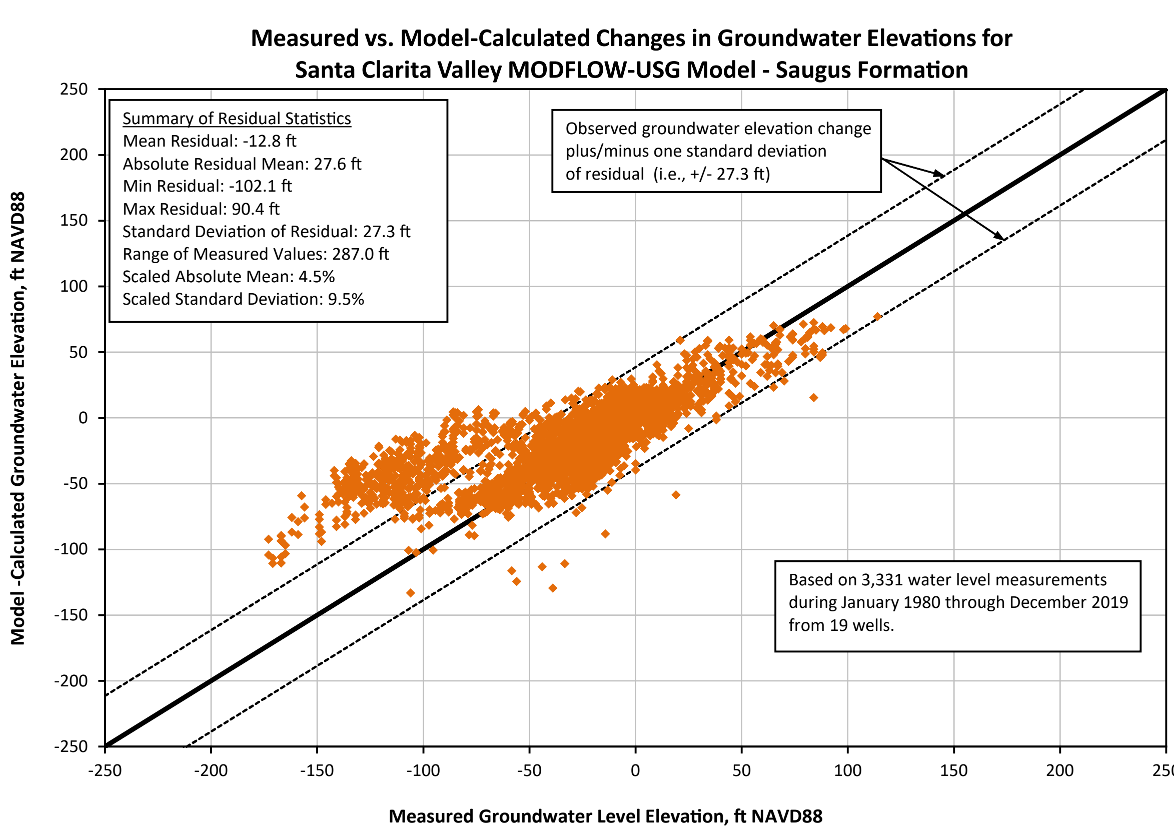
Scatterplots of Groundwater Elevation Residuals Without Peripheral Saugus Wells

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.







NOTE
Common modeling practice is to consider a good fit between historical and model-generated data if the relative error is below 10% (Spitz and Moreno, 1996).

FIGURE 4-45

Scatterplots of Groundwater Elevation Change Residuals Without Peripheral Saugus Wells

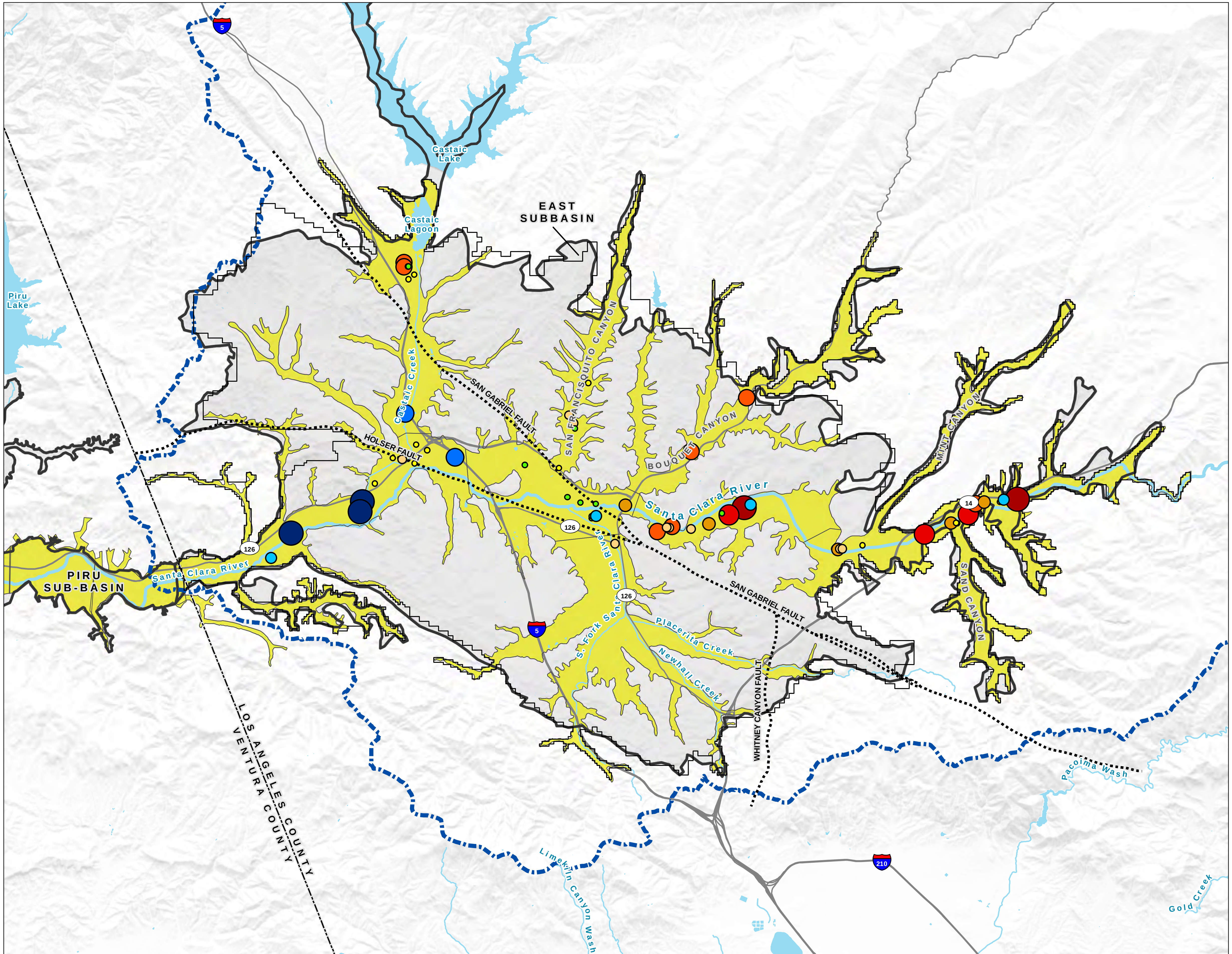
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

FIGURE 4-46

Mean Residuals for Groundwater Elevation in the Alluvial Aquifer

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Model Grid Outline Layer 1
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Groundwater Elevation Mean Residuals (ft)

- -20.0 -15.10
- -15.09 - -10.10
- -10.09 - -5.10
- -5.09 - 0.00
- 0.00 - 5.00
- 5.01 - 10.00
- 10.01 - 15.00
- 15.01 - 20.00
- 20.01 - 25.00
- 25.01 - 30.00

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

GSI Water Solutions, Inc.

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

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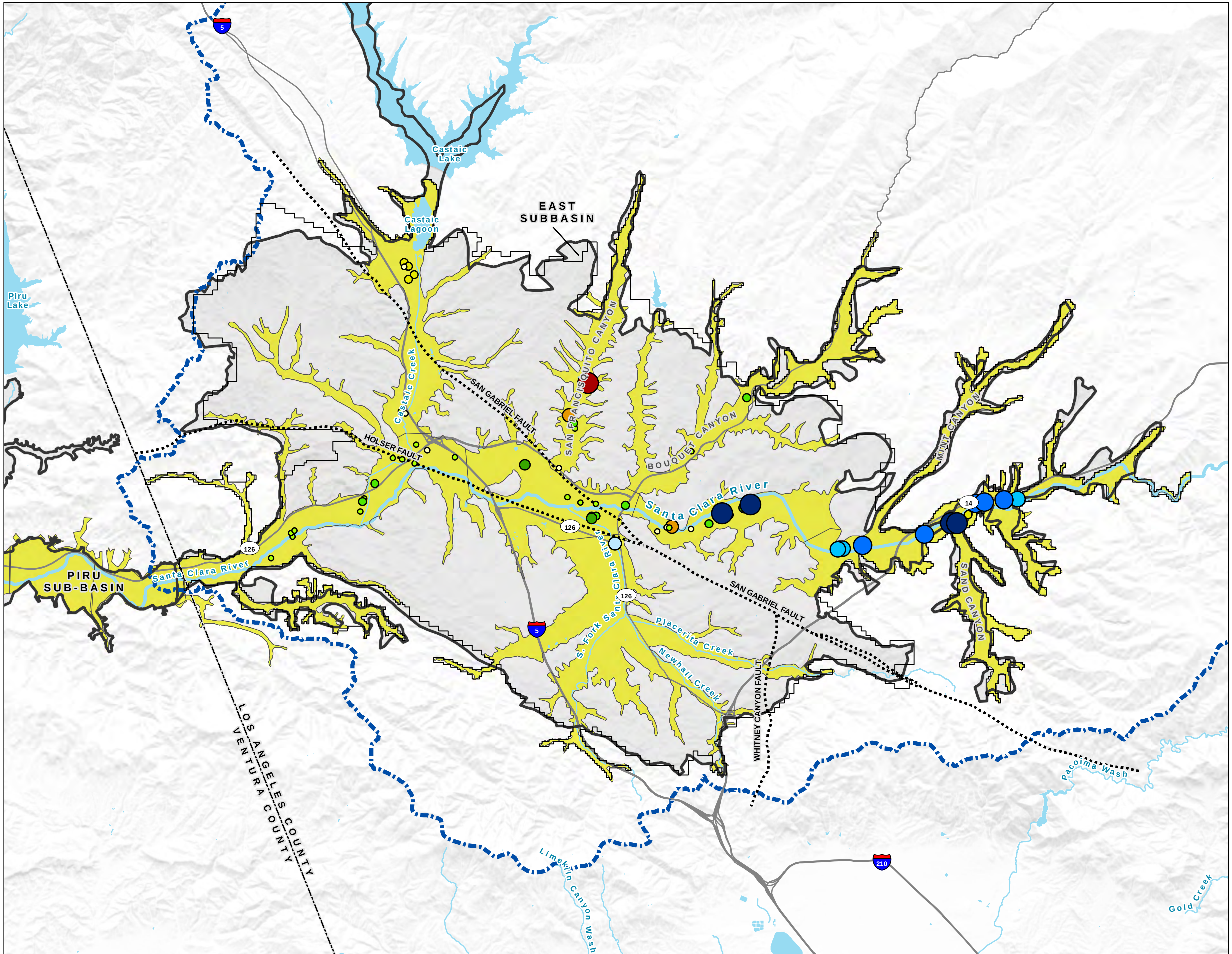

FIGURE 4-47

Mean Residuals for Groundwater Elevation Change in the Alluvial Aquifer

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline Layer 1
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Change in Groundwater Elevation Mean Residuals (ft)

- -48.6 - -30.0
- -29.9 - -25.1
- -25.0 - -20.1
- -20.0 - -15.1
- -15.0 - -10.1
- -10.0 - -5.1
- -5.0 - 0.0
- 0.30 - 5.00
- 5.01 - 10.00
- 10.01 - 15.00
- 15.01 - 20.00
- 20.01 - 25.00
- 25.01 - 30.00
- 30.01 - 31.10

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

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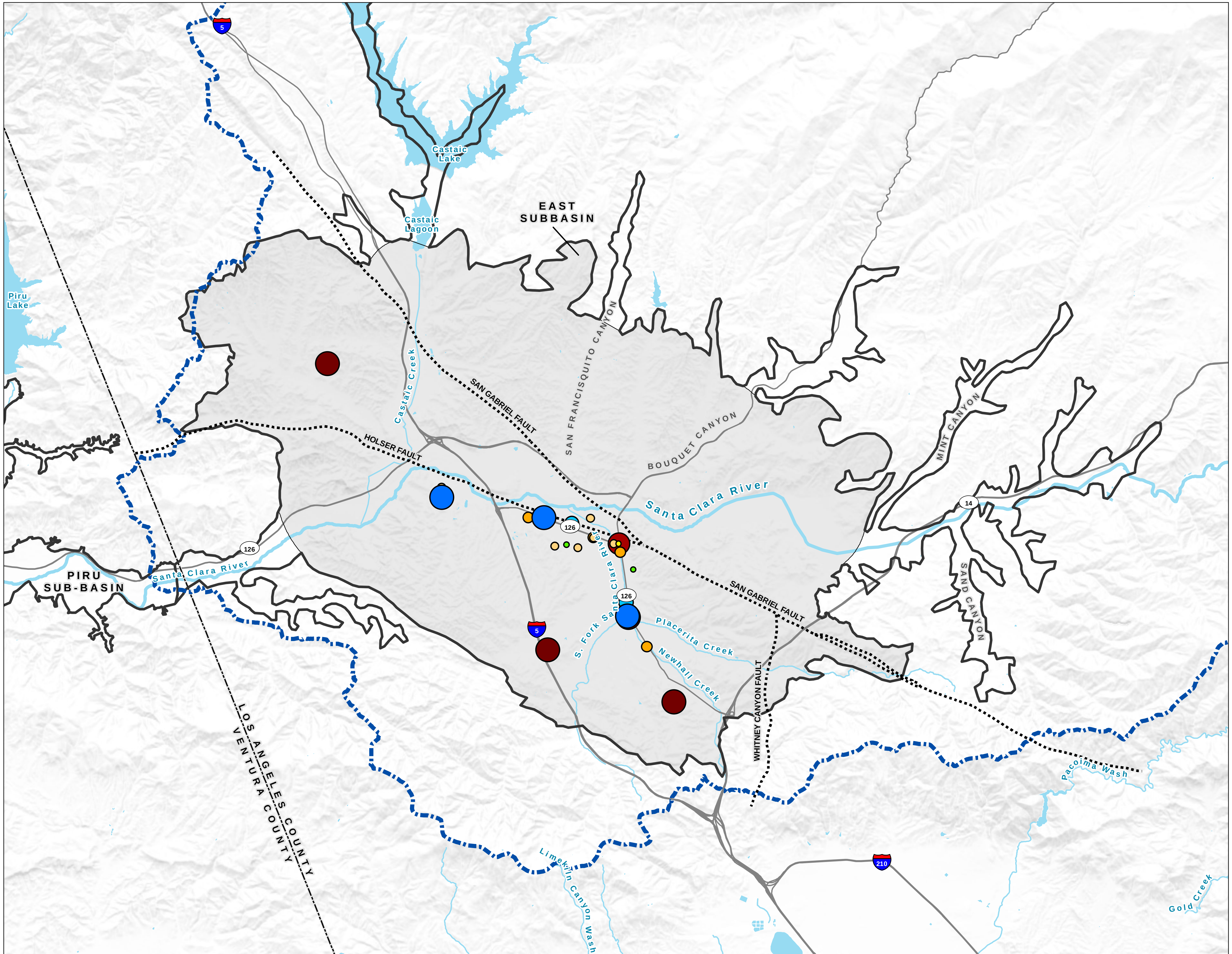

FIGURE 4-48

Mean Residuals for Groundwater Elevation in the Saugus Formation

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Saugus Formation
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Groundwater Elevation Mean Residuals (ft)

- -14.5 - -10.0
- -9.9 - -5.0
- -4.9 - 0.0
- 3.7 - 5.0
- 5.1 - 10.0
- 10.1 - 15.0
- 15.1 - 20.0
- 20.1 - 25.0
- 25.1 - 30.0
- 30.1 - 50.0
- 50.1 - 129.9

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

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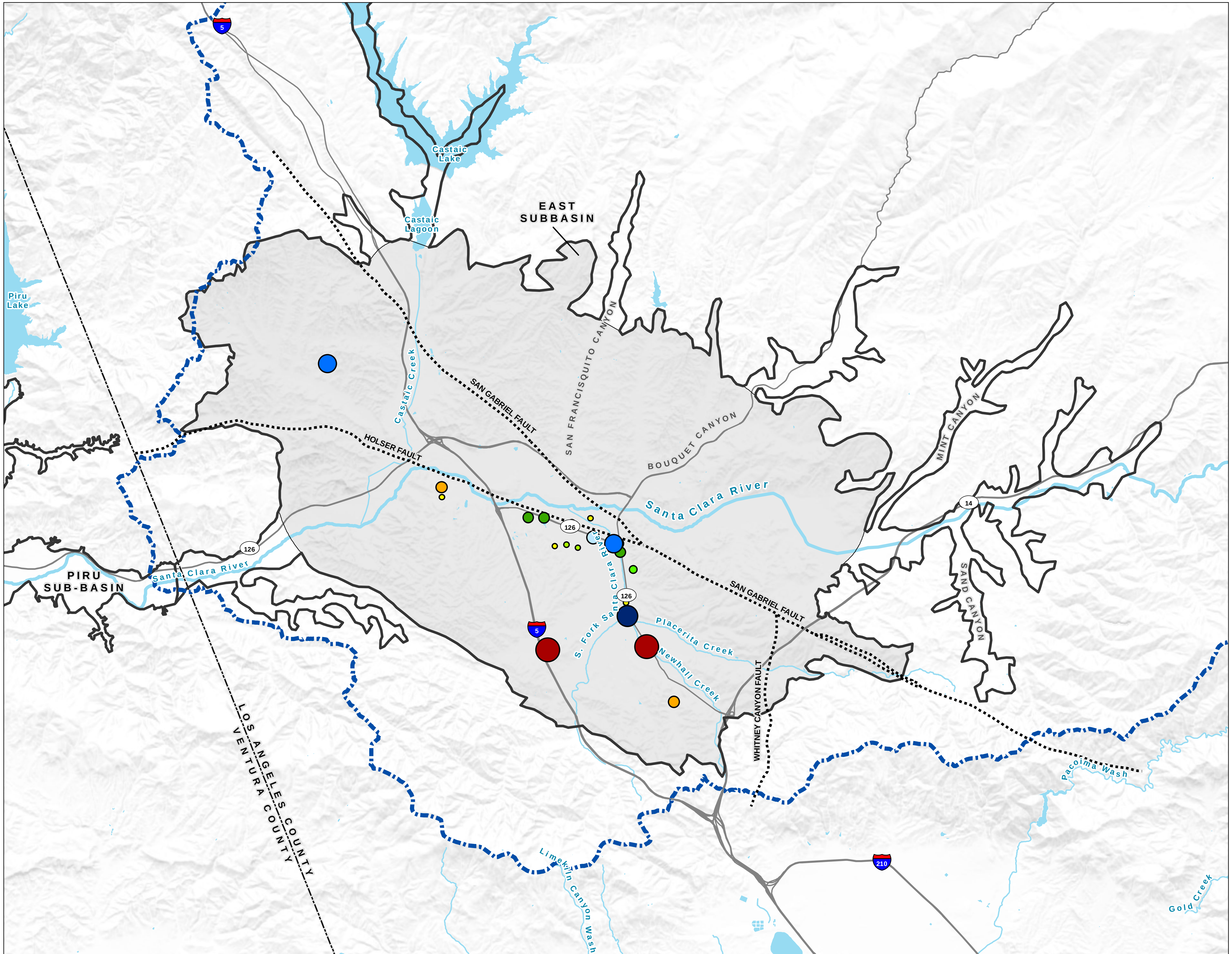
FIGURE 4-49

Mean Residuals for Groundwater Elevation Change in the Saugus Formation

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin



LEGEND

- Saugus Formation
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

Change in Groundwater Elevation Mean Residuals (ft)

- -62.2 - -30.0
- -29.9 - -25.1
- -25.0 - -20.1
- -20.0 - -15.1
- -15.0 - -10.1
- -10.0 - -5.1
- -5.0 - 0.0
- 0.9 - 5.0
- 5.1 - 10.1
- 10.2 - 15.1
- 15.2 - 20.1
- 20.2 - 25.1
- 25.2 - 30.0
- 30.1 - 69.5

All Other Features

- Major Road
- Watercourse
- Waterbody

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

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Appendix A. Summary of Physical Setting and Hydrogeology for the East Subbasin

December 2021

Prepared by:
GSI Water Solutions, Inc.
5855 Capistrano Avenue, Suite C, Atascadero, CA 93422

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Contents

Figures

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Abbreviations and Acronyms

°F	degrees Fahrenheit
amsl	above mean sea level
ASR	aquifer storage and recovery
basin	groundwater basin
county line	Los Angeles/Ventura County Line
DWR	California Department of Water Resources
East Subbasin	Santa Clara River Valley East Groundwater Subbasin
ft	foot or feet
ft/day	foot per day
ft^2/day	square feet per day
gpd/ft	gallons per day per foot
I-5	Interstate 5
LSCE	Luhdorff and Scalmanini Consulting Engineers
NWD	Newhall Water Division
RCS	Richard C. Slade & Associates
SCV Water	Santa Clarita Valley Water Agency
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
VWD	Valencia Water Division

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SECTION 1: **Introduction**

Following are summary-level discussions of the physical setting of the Santa Clara River Valley East Groundwater Subbasin (East Subbasin; Section 2), its climate (Section 3), its geology (Section 4); a summary of groundwater occurrence and the mechanisms by which groundwater recharge and discharge occur (Section 5); and a list of references cited in this appendix (Section 6). See Richard C. Slade & Associates (RCS; 2021) and Luhdorff and Scalmanini Consulting Engineers (LSCE; 2021) for more detailed discussions of the hydrogeologic conceptual model for the East Subbasin.

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SECTION 2: **Basin Setting**

The East Subbasin lies within the relatively flat-lying Santa Clarita Valley and portions of the surrounding hills and mountains. This groundwater basin (basin) extends from approximately the Los Angeles/Ventura County Line (county line) on the west to the community of Lang on the east, and from the southern end of Castaic Lake on the north to the intersection of the Golden State Freeway (Interstate 5 [I-5]) and the Antelope Valley Freeway (State Highway 14) on the south. The mountains that surround this groundwater basin and the Santa Clarita Valley itself include the Santa Susana and San Gabriel Mountains to the south and the Sierra Pelona and Leibre-Sawmill Mountains to the north. Elevations range from about 800 feet (ft) on the valley floor to about 6,500 ft above mean sea level (amsl) in the San Gabriel Mountains. The headwaters of the Santa Clara River are at an elevation of about 3,200 ft amsl at the topographic divide separating the Upper Santa Clara River Hydrologic Area from the Mojave Desert.

Before the 1960s, the predominant land use in the Santa Clarita Valley was agricultural, with much of the valley undeveloped. Urbanization began gradually in the 1960s, with a rapid increase beginning in the late 1970s and early 1980s and continuing to the present. Accompanying the rapid population increase has been a gradual change in valley land use patterns, from largely agricultural to urban and suburban developments. Nevertheless, a considerable portion of the hills and low mountains bordering the main river valley remain in a natural, undeveloped condition, as shown on the accompanying land use map (see Figure A-1). See Sections 1.4.1 and 3.1 of GSI (2021) for further details about historical land and water uses in the East Subbasin.

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SECTION 3: **Climate**

The Santa Clarita Valley has a semi-arid Mediterranean-type climate, characterized by long, dry summers and relatively short, wet winters. Temperatures in the Santa Clarita Valley range from a maximum of approximately 100 to 110 degrees Fahrenheit (°F) during the summer to a minimum of 20°F to 30°F in the winter. Mean monthly temperatures range between approximately 77°F in the summer and 48°F in the winter.

In the community of Newhall, rainfall data have been recorded at the Newhall-Soledad gage (Fire Station #73) since 1883 and at the office of the Newhall Water Division (NWD) of the Santa Clarita Valley Water Agency (SCV Water) since 1979. At the Newhall-Soledad gage, the average annual precipitation during the past 9 decades (1930 through 2019) was 17.36 inches per year on a calendar-year basis and 17.29 inches per year on a water-year basis. At the NWD gage, the average annual precipitation from 1979 through 2019 was 21.31 inches on a calendar-year basis and 21.28 inches per year on a water-year basis. Annual rainfall is highly variable from year to year as shown in Figures A-2 and A-3, ranging from as little as 3.75 inches in water year 2013 at the Newhall-Soledad gage to about 52.5 inches in water year 2005 at the NWD gage. Approximately 80 percent of the annual precipitation in the Santa Clarita Valley falls between November and March. Most of the precipitation comes from winter storms that last a few days and are separated by relatively long periods of dry weather.

Rainfall varies across the basin according to elevation differences and the locations of surrounding mountain ranges. As shown in Figure A-3, the NWD gage has shown on average about 17 percent higher rainfall than the Newhall-Soledad gage, in part because of its closer proximity to the San Gabriel Mountains (which form the southern margin of the valley). The spatial variability in rainfall (expressed as contour lines of equal precipitation; i.e., rainfall isohyets) shows that average rainfall is notably higher (exceeding 25 inches/year on average) in the highest elevations of the watershed—areas that contribute surface water runoff that moves into, and then partially or wholly recharges, the groundwater basin (see Figure A-4).

Figure A-5 is a rainfall cumulative departure curve, which shows how much the rainfall from one year to the next departed from the 1930–2019 average annual rainfall at the Newhall-Soledad rain gage and from the 1979–2019 average annual rainfall at the NWD gage. A downward slope of the curve indicates the presence of prevailing dry conditions (one or more years of below-normal rainfall), while an upward slope of the curve indicates the presence of prevailing wet conditions (one or more years of above-normal rainfall). The cumulative departure curves show that prevailing dry conditions occurred from water years 1947 through 1964, 1987 through 1991, 1998 through 2004, and 2012 through 2018. Prevailing wet conditions occurred from water years 1937 through 1944, 1966 through 1969, and 1978 through 1983. Afterwards, noteworthy single wet years occurred in 1992, 1995, 1998, and 2005.

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SECTION 4: **Geology**

The geology of the East Subbasin has been described and mapped in detail by RCS (1986, 1988, 2002) and Dibblee (1991, 1992, 1993, 1996a, 1996b, 1996c, 1997a, 1997b, and 1997c). An updated discussion has been prepared by RCS (2021) to provide the hydrogeologic conceptual model for the Groundwater Sustainability Plan. Figure A-6 shows a geologic map of the Santa Clarita Valley. The local groundwater basin is underlain and laterally bounded by non-water-bearing bedrock units that are Miocene, Oligocene, and pre-Tertiary in geologic age. The Saugus Formation, which is of Pliocene and Pleistocene age, overlies these rocks within much of the local groundwater basin, except where the Saugus Formation is absent at the far western and eastern ends of the basin and in the upper reaches of some of the canyons. In these areas, the bedrock units are overlain by a blanket of unconsolidated alluvium of Quaternary geologic age, which comprises the Alluvial Aquifer.

In some areas where the alluvium is absent, the Saugus Formation is overlain by scattered outcrops of Quaternary-age terrace deposits, including in upland areas near the San Gabriel Fault. Here and elsewhere, the terrace deposits do not contain significant water resources because they typically are situated at elevations above the regional water table.

The Saugus Formation contains lenticular and interfingered beds of poorly consolidated to well-consolidated sandstone, conglomerate, and siltstone that are at least 7,500 ft thick in the deepest part of the basin. These terrestrial sediments were deposited in stream channels, floodplains, and alluvial fans by the ancestral drainage system in the valley. In the ancestral drainage system, the locations of the primary stream channels changed throughout the approximately 3 million-year period of deposition of the Saugus Formation. Prior interpretations of geophysical electric log data indicate that the coarse-grained channel deposits (the primary water-bearing strata) are thicker and more numerous in some locations than in others. Although the Saugus Formation displays a considerable amount of lateral variability in lithology and grain size, some thicker stratigraphic packages can be traced through portions of the basin, as have been mapped by RCS (1988 and 2002) and CH2M HILL (2005).

The deepest and oldest portion of the Saugus Formation (the Sunshine Ranch Member) was deposited in a marine environment and consists of fine-grained, low-permeability siltstone and sandstone. The Sunshine Ranch Member has a maximum thickness of approximately 3,500 ft in the central part of the basin. It is present at or near the ground surface at the margins of the Santa Clarita Valley. Geophysical (electric) logging indicates that the groundwater in much of the Sunshine Ranch Member may be somewhat brackish in quality and is generally not useful for municipal water supply purposes.

Faulting and folding of the rocks in the region have caused the sedimentary rocks, including the Saugus Formation, to form a bowl-shaped structure on a regional, basin-wide scale. The Saugus Formation dips generally toward the center of the “bowl,” mimicking the dip of the bedrock units that underlie the Saugus Formation. However, certain features create structural imperfections in this bowl. Most notable are (1) Round Mountain, which is a localized knob of Saugus Formation sediments along the northern bank of the Santa Clara River just east of I-5; (2) the southeast-northwest-trending San Gabriel Fault; and (3) the east-west trending Holser Fault. The San Gabriel Fault is a northeast-dipping reverse fault with vertical displacement of the Saugus Formation of as much as 2,600 ft (RCS, 1988). The Saugus Formation is thickest south of the fault, and this is the area where all Saugus Formation municipal water supply wells are located. North of the San Gabriel Fault, the Saugus Formation is composed primarily of the older, fine-grained Sunshine Ranch member and has not been targeted for groundwater supply development. The Holser Fault is a spur off of the San Gabriel Fault. The Holser Fault shows vertical displacement of the Saugus Formation on the order of 100 to 200 ft. Another spur fault (the Whitney Canyon Fault) extends south from the San Gabriel Fault in the southeastern corner of the valley.

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SECTION 5: **Groundwater Occurrence, Recharge, and Discharge**

5.1 Groundwater Occurrence in the Alluvium

Groundwater is present in the alluvial valley occupied by the Santa Clara River and also in each tributary. Development of agricultural and municipal groundwater supplies from the alluvium (in the Alluvial Aquifer) has occurred primarily along the Santa Clara River and Castaic Creek, and also in the lower reaches of Bouquet Canyon and San Francisquito Canyon. Smaller amounts of water supply—primarily by individual domestic wells—have been developed elsewhere in the alluvium. The alluvial valley occupied by the South Fork Santa Clara River contains only a thin saturated zone and hence has not been the target of groundwater supply development.

Available groundwater elevation data and aquifer test data indicate that the Alluvial Aquifer is unconfined (i.e., is under water table conditions). Transmissivity values are estimated to range from 4,700 square feet per day (ft^2/day), or 35,000 gallons per day per foot (gpd/ft), to more than 100,000 ft^2/day, or 750,000 gpd/ft (CH2M HILL, 2004a). The specific yield of the Alluvial Aquifer has been estimated in past studies to range from about 0.09 to 0.16 (RCS, 1986 and 2002; CH2M HILL, 2004a). Based on interpretations of aquifer tests, specific capacity tests, and groundwater model calibration results, the hydraulic conductivity of the Alluvial Aquifer is estimated to range from 250 to 1,500 ft per day (ft/day) in the alluvial valley occupied by the Santa Clara River, and 75 to 700 ft/day in the alluvium that occupies the various tributary valleys.

5.2 Groundwater Occurrence in the Saugus Formation

As described by RCS (1988, 2002, 2021), Saugus Formation groundwater is present under unconfined conditions in the shallowest water-bearing zones where the Alluvial Aquifer is absent, and under semi-confined and confined conditions elsewhere. Available aquifer test data from Saugus Formation wells located near the center of the valley (where the Saugus is thickest) indicate that groundwater in the Saugus Formation is strongly confined (under pressure) in this area. Where the Saugus Formation crops out away from the center of the valley, the uppermost saturated zones are partially unconfined because the permeable beds are folded upward near the margin of the aquifer. In the highlands, the Saugus Formation beds are exposed at the ground surface, and in the valley, the top of the Saugus Formation is in contact with the Alluvial Aquifer wherever the alluvium is present.

The 1988 and 2002 hydrogeologic studies by RCS concluded that the Saugus Formation is discretely layered, with groundwater production occurring from discrete sand and gravel zones that exist throughout much of the total thickness of the formation. RCS also concluded that (1) it is hydrogeologically feasible to develop additional groundwater supplies from the Saugus Formation as long as wells are properly sited and constructed, and (2) the groundwater-yielding capability of the Saugus Formation likely is limited north and east of the San Gabriel fault compared with areas lying south of the fault (where all Saugus groundwater development has occurred to date). These findings later were supported by the U.S. Army Corps of Engineers (USACE) conceptual hydrogeologic evaluation (CH2M HILL, 2005) in the central portion of the East Subbasin, adjacent to the Whittaker Bermite property (which lies just east of the lower reaches of the South Fork Santa Clara River). The CH2M HILL (2005) study noted three particular findings regarding groundwater occurrence that complement the geologic conceptual model in this general area:

1. Further indications (from water level data) that the San Gabriel Fault is a barrier to groundwater flow.
2. An indication (from aquifer testing) that the Holser Fault likely is not a barrier to groundwater flow.
3. The identification of eight distinct hydrostratigraphic units within the Saugus Formation, based on the lithological characteristics of the Saugus Formation at and in the immediate vicinity of the Whittaker Bermite property.

The definition of hydrostratigraphic units near the Whittaker Bermite property reflects the presence of alternating sequences of coarse and fine-grained beds within the Saugus Formation. The coarse-grained units are relatively thick and are identified as the SI, SIII, SV, SVII, and SVIII units, while the fine-grained beds are relatively thin in comparison and are designated as the SII, SIV, and SVI units (CH2M HILL, 2005). A schematic depiction of these units is illustrated in Figure A-7. More recently, the SIII unit has been further subdivided on the Whittaker Bermite property into the coarse-grained SIIIA and SIIIC subunits, and the intervening fine-grained SIIIB subunit.

As shown in a hydrostratigraphic cross section prepared by CH2M HILL (2005; see Figure A-8), the eight major hydrostratigraphic units have been traced lithologically from the Whittaker Bermite property westward to SCWD's Saugus 1 and Saugus 2 production wells, and also to Valencia Water Division's (VWD's) production wells VWD-201 and VWD-205. These wells are all open to the SIII, SV, and SVII coarse-grained units, which are the primary water-producing zones. Although these hydrostratigraphic units are traceable across the area shown in Figure A-8, inspections of geophysical logs and spinner flow profile surveys indicate that the distinctions in the hydraulic properties of the fine-grained versus the coarse-grained units likely are not as strong west of the Whittaker Bermite property as is the case on that property. Specifically, LSCE (2013) found that the lithological definitions of the SIIIA, SIIIB, and SIIIC subunits are not as distinctly pronounced near these production wells as they are on the Whittaker Bermite property, but that some distinction between the SIII unit and the underlying SV unit could be made based on spinner testing results at existing production well VWD-201 and former production well VWD-157.

RCS (1988 and 2002) estimated that transmissivity values in the Saugus Formation range from about 400 to 25,000 ft^2/day (3,000 to 180,000 gpd/ft), but are typically between 5,500 and 11,000 ft^2/day (between 40,000 and 80,000 gpd/ft). Those studies estimated that storativity values are on the order of 10^{-3} to 10^{-4}. These aquifer parameter values have been estimated from well performance tests and from an aquifer storage and recovery (ASR) pump test and study conducted in the Saugus Formation (RCS, 2001 and 2002). Analyses of the ASR test data, including numerical model calibration runs, indicated that the bulk hydraulic conductivity of the Saugus Formation at wells VWD-201 and VWD-205 is approximately 6.5 ft/day (CH2M HILL, 2004a). In the numerical model, the hydraulic conductivity of the Saugus Formation in the primary target area for groundwater development (the area south of the San Gabriel Fault) is represented as gradually decreasing with depth, from values of 6.5 to 30 ft/day in the upper hydrostratigraphic units to values of 0.1 to 4 ft/day in deeper hydrostratigraphic units.

5.3 Groundwater Recharge and Discharge

Figure A-9 is a schematic cross-sectional representation of the geologic structure and groundwater flow patterns in the Santa Clarita Valley, including the predominant recharge and discharge mechanisms for the two principal aquifer systems that are present in the East Subbasin (the Alluvial Aquifer and the Saugus Formation). Groundwater recharge and discharge processes for the two principal aquifers are as follows:

- **Alluvial Aquifer.** Groundwater elevation data indicate that the direction of groundwater flow in the Alluvial Aquifer is towards the alluvial corridor containing the Santa Clara River, and east-to-west within that corridor. The specific recharge and discharge mechanisms for the Alluvial Aquifer are as follows:
  - Recharge occurs as (1) seepage of rainfall over the alluvium, (2) stormwater flows in the Santa Clara River, (3) seepage of controlled releases in two tributaries (Castaic Creek and Bouquet Creek), (4) seepage of point-source discharges of water from the Saugus and Valencia water reclamation plants and from permitted discharges from groundwater treatment systems, (5) subsurface inflows in alluvial streams entering the East Subbasin, (6) land-applied water for agricultural and urban irrigation, and (7) septic system percolation.

  - Discharge occurs as (1) groundwater pumping, (2) discharges to streams (primarily in the perennial reach of the Santa Clara River, which extends westward from the mouth of San Francisquito Canyon), and (3) evapotranspiration by phreatophytes (withdrawals of groundwater by riparian plant communities located along the Santa Clara River and the lower reaches of Castaic Creek and San Francisquito Canyon), and (4) subsurface outflow at the western basin boundary.

- **Saugus Formation.** Groundwater elevation data indicate that the direction of groundwater flow is toward the center of the valley from the highlands, and that Saugus Formation groundwater flows toward the western end of the Santa Clara Valley where it discharges naturally into the Alluvial Aquifer. The specific recharge and discharge mechanisms for the Saugus Formation are as follows:
  - Recharge occurs in the form of (1) infiltration of precipitation in the exposed portions of the Saugus Formation in the highlands surrounding the valley, (2) seepage from the Alluvial Aquifer along the Santa Clara River and its tributaries, particularly in the central portion of the Santa Clarita Valley (including along the South Fork Santa Clara River), (3) land-applied water for agricultural and urban irrigation, and (4) septic system percolation.
  - Discharge from the Saugus Formation occurs in part as groundwater pumping from wells that are completed to depths of as much as 2,000 ft. Discharge from the Saugus Formation also occurs at the west end of the valley, west of I-5, where water level data and geochemical data indicate that Saugus Formation groundwater naturally discharges to the Alluvial Aquifer. The Saugus Formation is not present at Blue Cut, which is approximately 3 miles downstream of the Saugus/Pico Formation contact and about 1 mile downstream of the county line; consequently, the Saugus Formation does not discharge directly to the Santa Clara River.

See GSI (2021) for details regarding the historical water budget in the East Subbasin.

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SECTION 6: **References**

CH2M HILL. 2004a. *Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration.* Prepared for the Upper Basin Water Purveyors (Castaic Lake Water Agency, Santa Clarita Water Division of CLWA, Newhall County Water District, and Valencia Water Company). April 2004.

CH2M HILL. 2004b. *Final Report: Analysis of Perchlorate Containment in Groundwater Near the Whittaker-Bermite Property.* Presented in Support of the 97-005 Permit Application. Prepared for the Upper Basin Water Purveyors (Castaic Lake Water Agency, Newhall County Water District, Santa Clarita Water Division of CLWA, and Valencia Water Company). December 2004.

CH2M HILL. 2005. *Eastern Santa Clara Subbasin Groundwater Study, Santa Clarita, California: Conceptual Hydrogeology Technical Memorandum.* Prepared for the U.S. Army Corps of Engineers (USACE), Los Angeles District, Southern Pacific Division. January 19, 2005.

Dibblee, T.W. Jr. 1991. *Geologic Map of the San Fernando and North ½ Van Nuys Quadrangles, Los Angeles County, California.* Dibblee Geology Center Map #DF-33. Scale 1:24,000.

Dibblee, T.W. Jr. 1991. *Geologic Map of the Oat Mountain and Canoga Park (North ½) Quadrangles, Los Angeles County, California.* Dibblee Geology Center Map #DF-36. Scale 1:24,000.

Dibblee, T.W. Jr. 1993. *Geologic Map of the Val Verde Quadrangle, Los Angeles County, California.* Dibblee Geology Center Map #DF-50. Scale 1:24,000.

Dibblee, T.W. Jr. 1996a. *Geologic Map of the Newhall Quadrangle, Los Angeles County, California.* Dibblee Geology Center Map #DF-56. Scale 1:24,000.

Dibblee, T.W. Jr. 1996b. *Geologic Map of the Mint Canyon Quadrangle, Los Angeles County, California.* Dibblee Geology Center Map #DF-57. Scale 1:24,000.

Dibblee, T.W. Jr. 1996b. *Geologic Map of the Aqua Dulce Quadrangle, Los Angeles County, California.* Dibblee Geology Center Map #DF-58. Scale 1:24,000.

Dibblee, T.W. Jr. 1997a. *Geologic Map of the Whitaker Peak Quadrangle, Los Angeles County, California.* Dibblee Geology Center Map #DF-62. Scale 1:24,000.

Dibblee, T.W. Jr. 1997b. *Geologic Map of the Warm Springs Mtn Quadrangle, Los Angeles County, California.* Dibblee Geology Center Map #DF-64. Scale 1:24,000.

Dibblee, T.W. Jr. 1997c. *Geologic Map of the Green Valley Quadrangle, Los Angeles County, California.* Dibblee Geology Center Map #DF-65. Scale 1:24,000.

GSI. 2021. *Water Budget Development for the Santa Clara River Valley Groundwater Basin, East Subbasin.* Prepared for Santa Clarita Valley Water Agency by GSI Water Solutions. In Progress.

LSCE. 2013. *Task 1 Historical Data Analysis, Restoration of Valencia Water Company Well V201, Santa Clarita Valley California.* Draft Technical Memorandum prepared for Keith Abercrombie, Valencia Water Company. Prepared by Luhdorff and Scalmanini Consulting Engineers (LSCE). December 2013.

LSCE. 2021. *Hydrogeologic Conceptual Model: Groundwater Conditions in the Santa Clara River Valley Groundwater Basin, East Subbasin.* Technical Memorandum to Jeff Barry/GSI Water Solutions, from Will Halligan, PG and Andrew Francis/Luhdorff & Scalmanini Consulting Engineers (LSCE). In Progress.

RCS. 1986. *Hydrogeologic Investigation: Perennial Yield and Artificial Recharge Potential of the Alluvial Sediments in the Santa Clarita Valley of Los Angeles County, California.* December 1986. Richard C. Slade and Associates, LLC (RCS).

RCS. 1988. *Hydrogeologic Assessment of the Saugus Formation in the Santa Clarita Valley of Los Angeles County, California.* February 1988. Richard C. Slade and Associates, LLC (RCS).

RCS. 2001. *Assessment of the Hydrogeologic Feasibility of Aquifer Storage and Recovery, Saugus Formation, Santa Clarita Valley, California.* Richard C. Slade and Associates, LLC (RCS). February 2001.

RCS. 2002. *2001 Update Report: Hydrogeologic Conditions in the Alluvial and Saugus Formation Aquifer Systems.* Prepared for Santa Clarita Valley Water Purveyors. July 2002. Richard C. Slade and Associates, LLC (RCS).

RCS. 2021. *Hydrogeologic Conceptual Model: Geologic Framework and Principal Aquifers, Santa Clara River Valley Groundwater Basin, East Subbasin Groundwater Sustainability Plan (Santa Clarita Valley Groundwater Sustainability Agency).* Technical Memorandum prepared for GSI Water Solutions by Richard C. Slade & Associates LLC (RCS). In Progress.

FIGURES

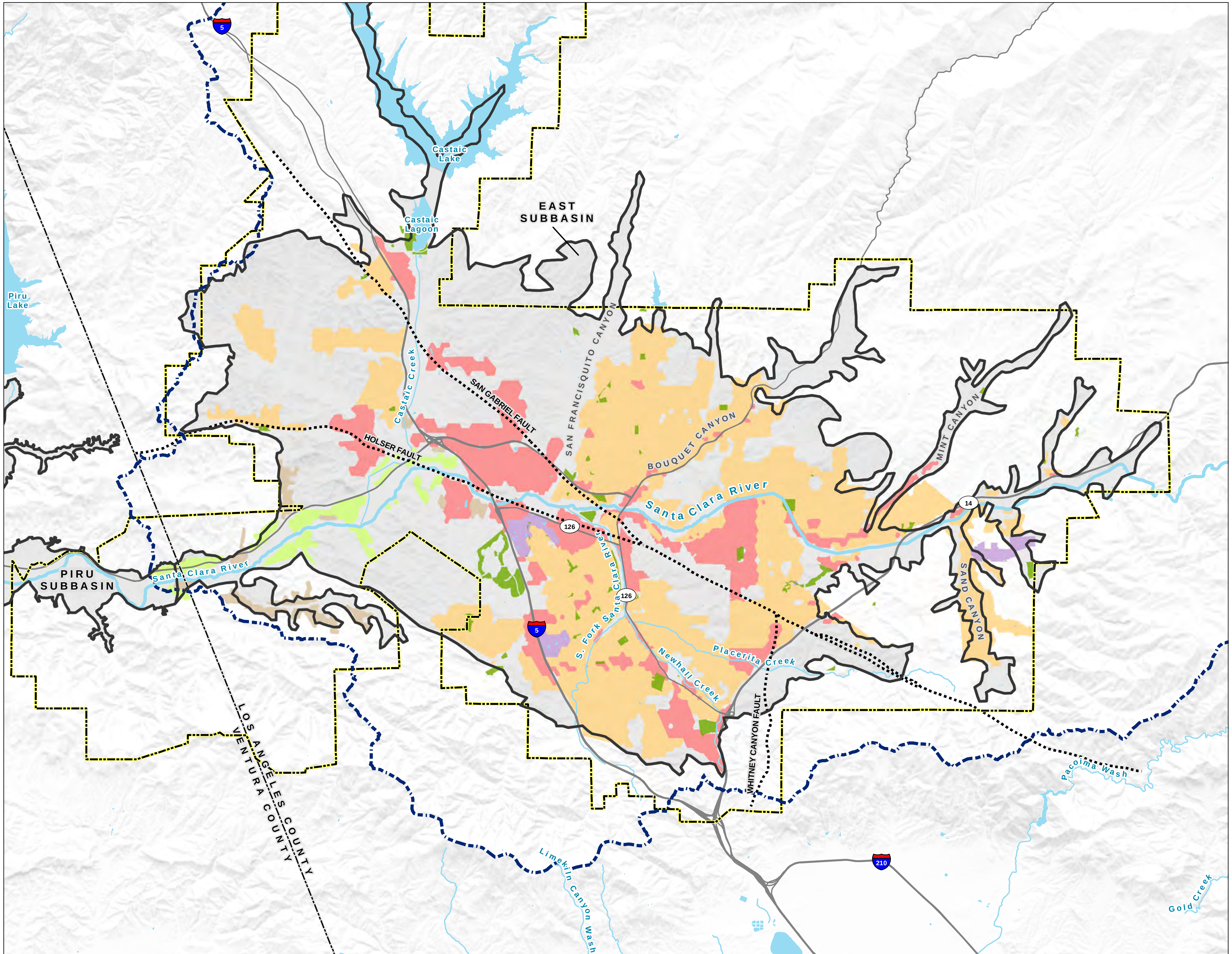

FIGURE A-1

2014 Land Use

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Santa Clara River Valley Groundwater Basin
- Watershed Boundary
- Service Boundary Area for SCV Water

Land Use

- Agriculture (Dryland)
- Agriculture (Irrigated)
- Park
- Golf Course
- Commercial
- Residential

All Other Features

- Major Road
- Watercourse
- Waterbody

NOTE

SCV Water: Santa Clarita Valley Water Agency

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, Southern California Association of Governments (2008), LA County and City of Santa Clarita (2012), DWR Bulletin 118

GSI Water Solutions, Inc.

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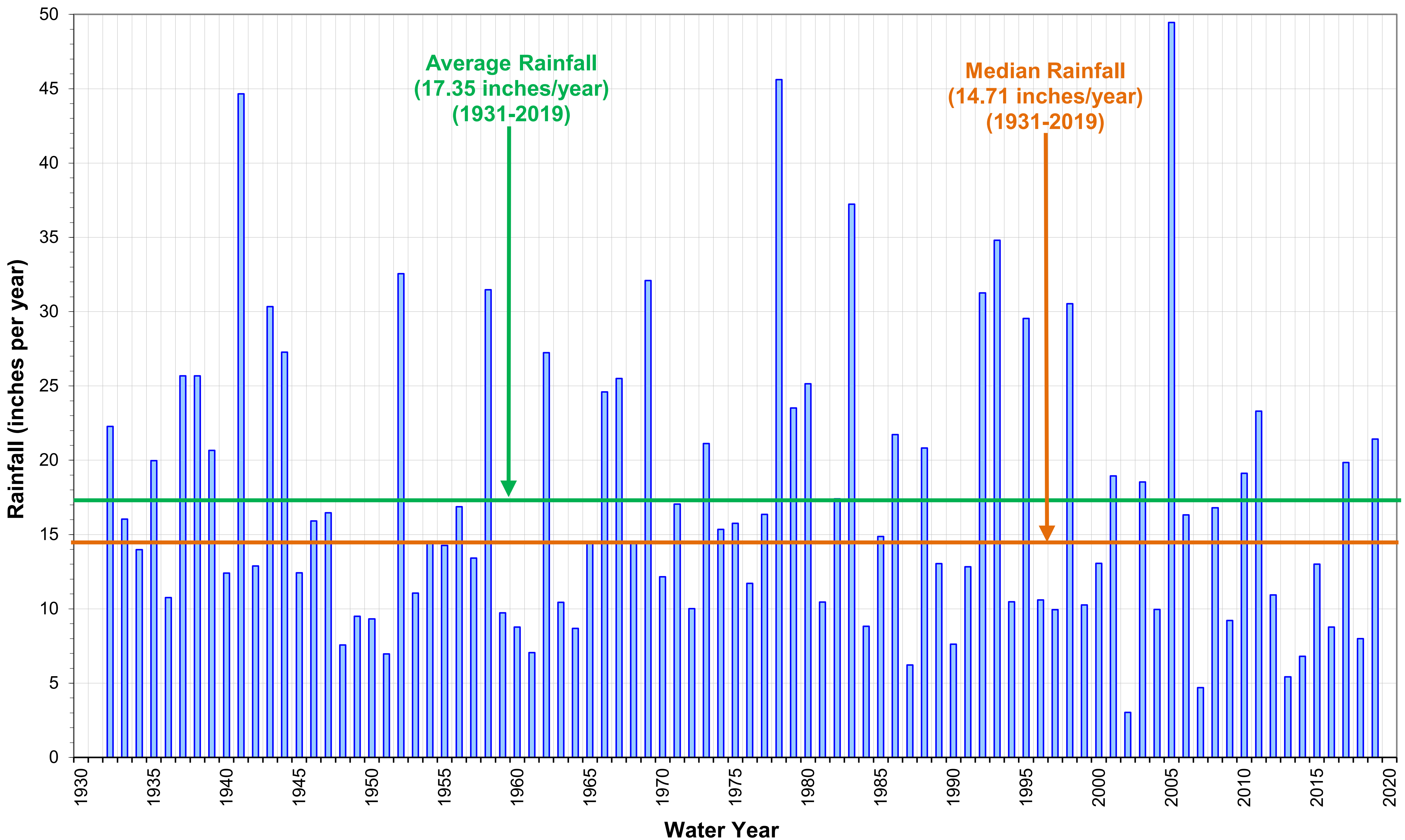

FIGURE A-2

Water-Year Rainfall at the Newhall-Soledad (Newhall Fire Station #73) Rain Gage

Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

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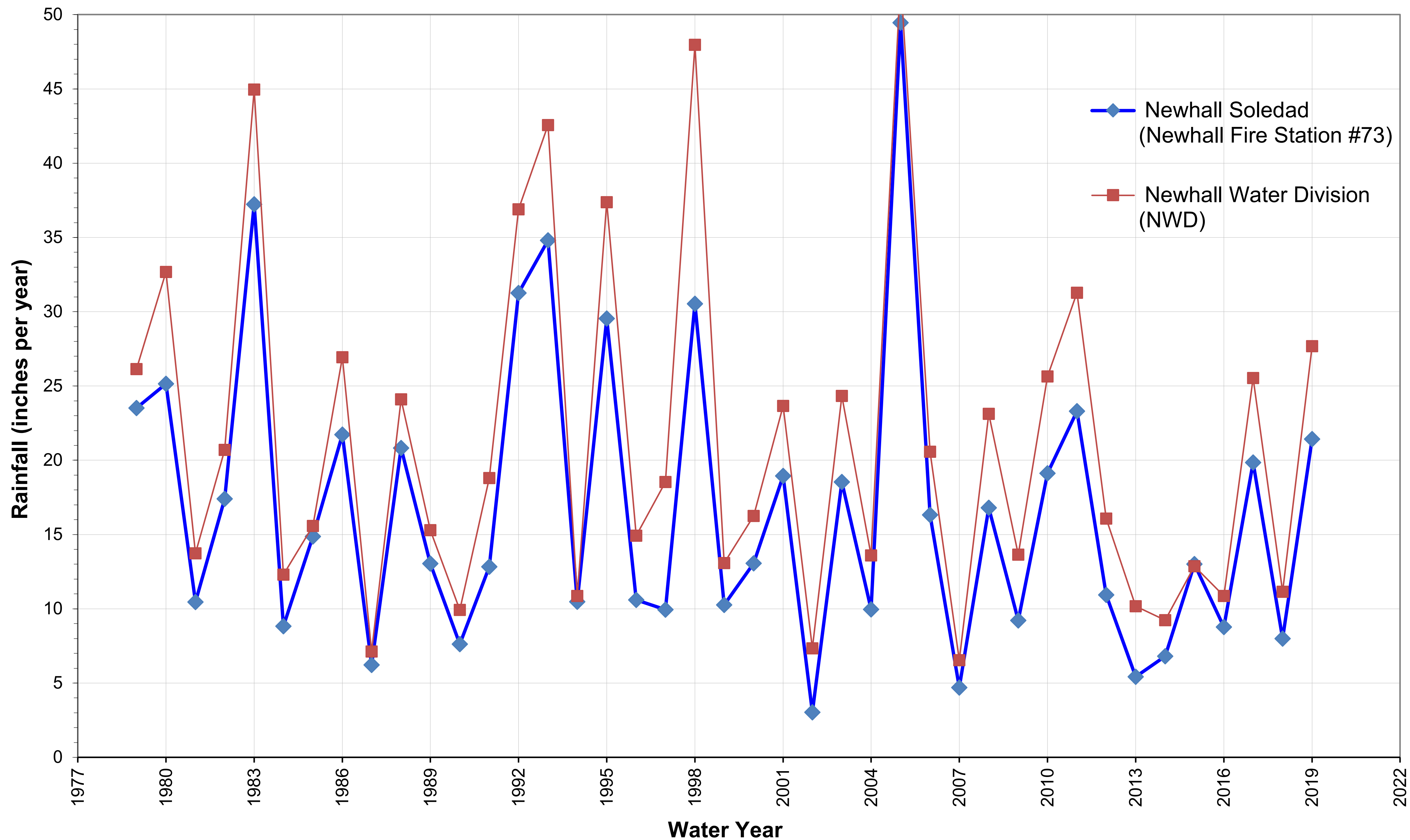

FIGURE A-3

Water-Year Rainfall Comparison: Newhall-Soledad (Newhall Fire Station #73) and Newhall Water Division (NWD) Rain Gages

Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

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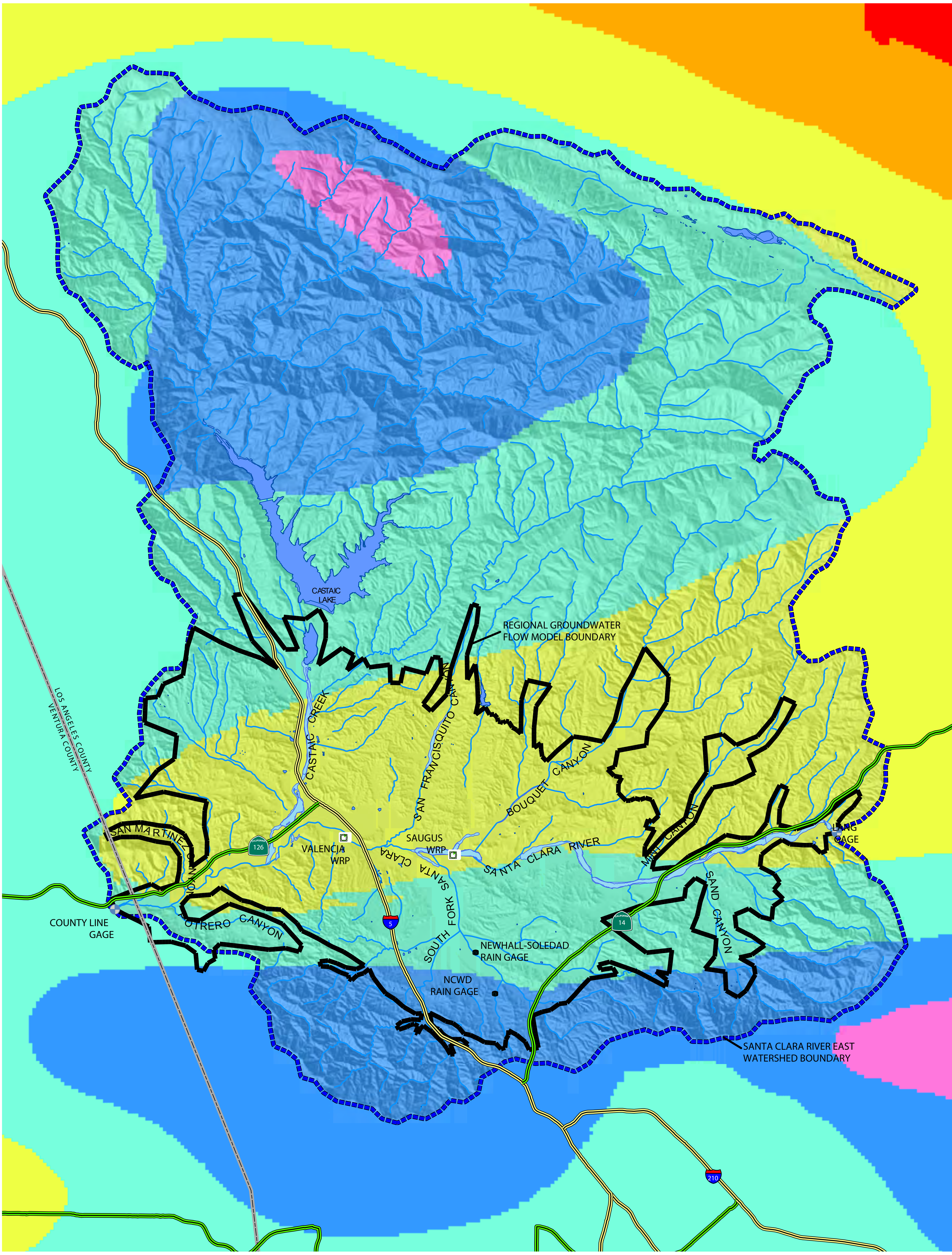

LEGEND

Hydrography

- Lake
- Stream
- Stream Gage

Major Road

- Interstate
- State Highway

Annual Precipitation (inches)

- <5
- 5 to 10
- 10 to 15
- 15 to 20
- 20 to 25
- 25 to 30

N

0 2.5 5

Miles

GSI Water Solutions, Inc.

Data Sources: CH2M HILL, 2004a

FIGURE A-4

Isohyetal Map Showing Average Annual Precipitation Pattern from 1900 to 1960

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

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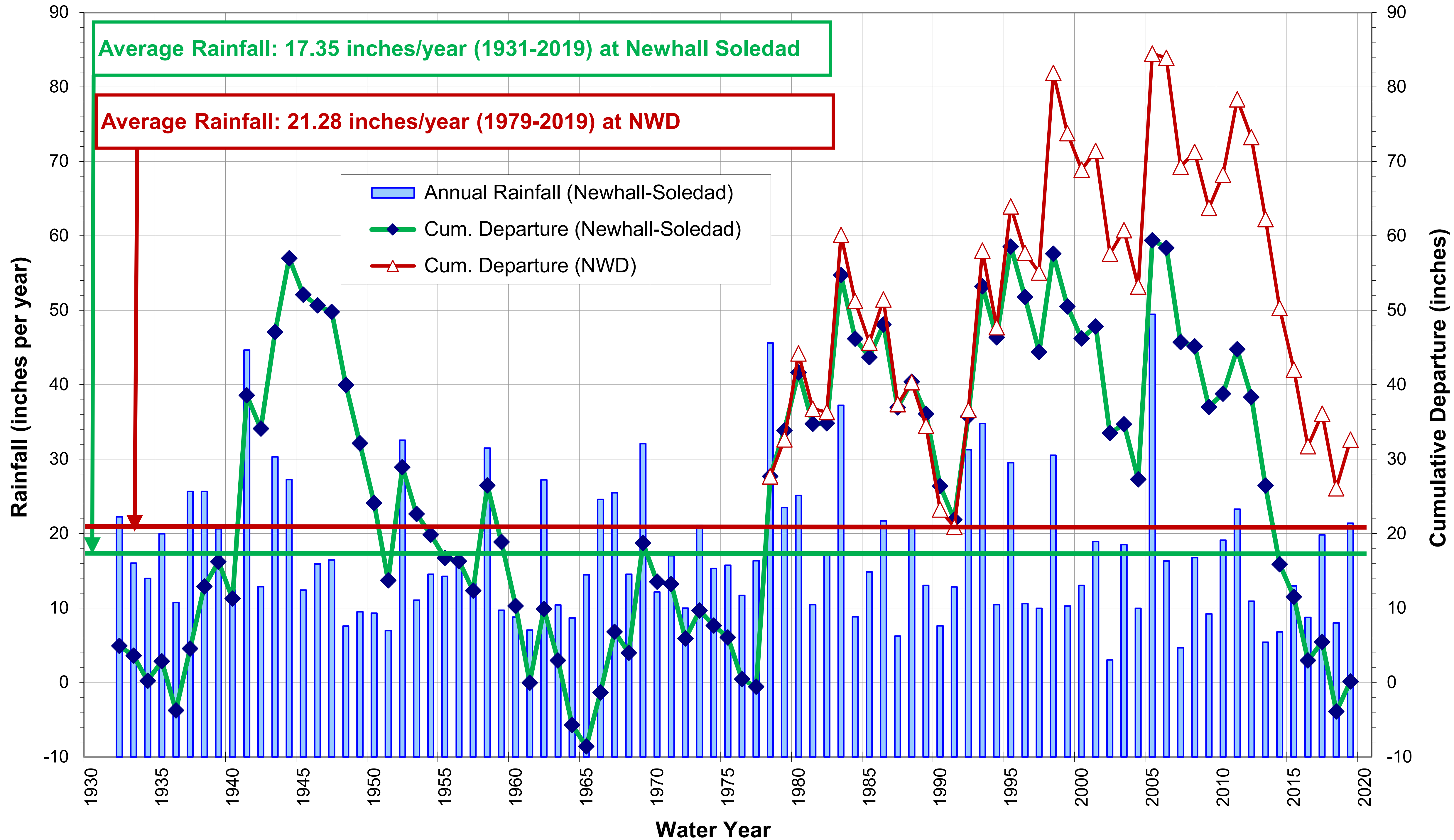

FIGURE A-5

Water-Year Rainfall and Cumulative Departure from Average Rainfall at the Newhall-Soledad (Newhall Fire Station #73) and Newhall Water Division (NWD) Rain Gages

Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

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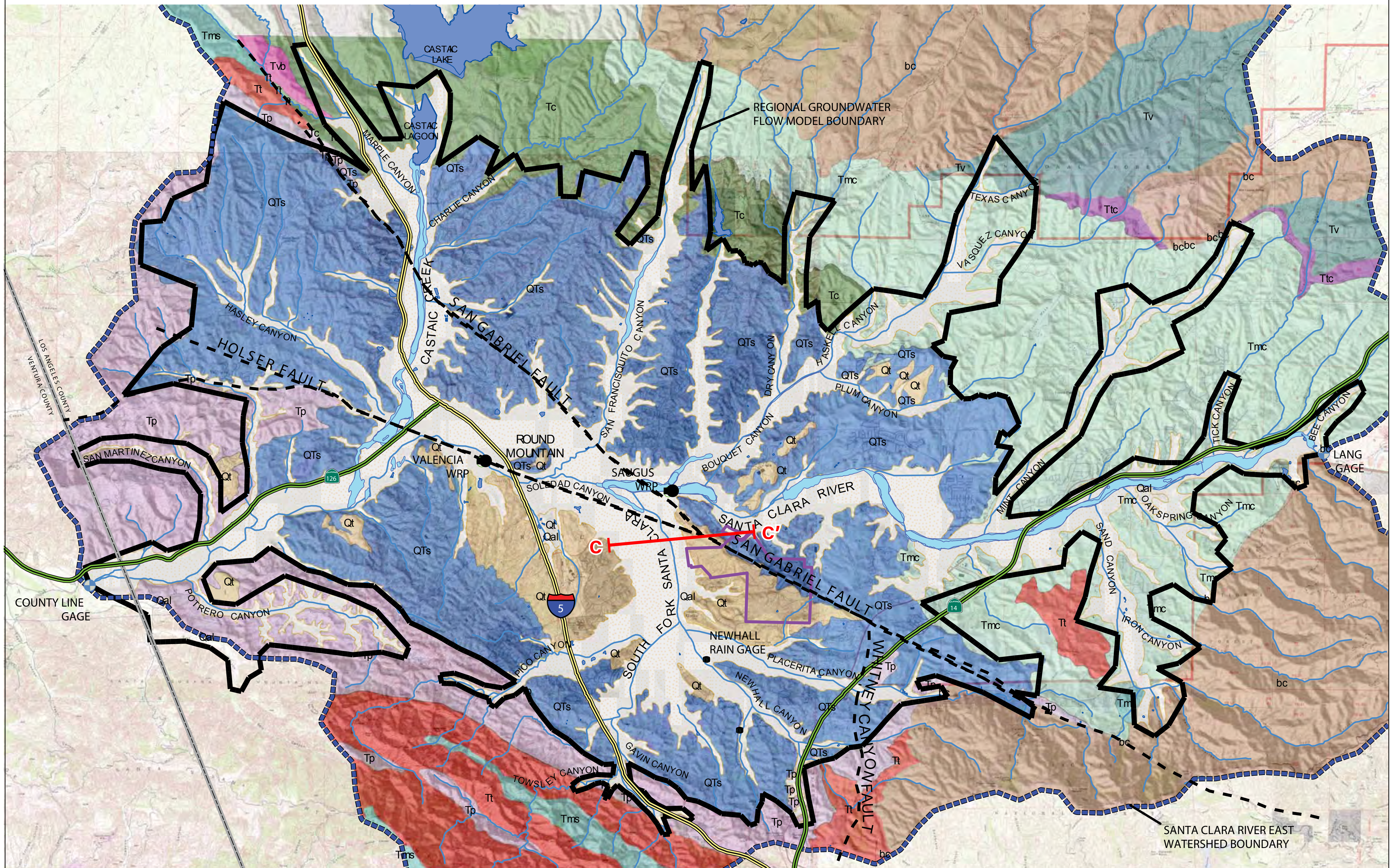


FIGURE A-6

Basin Geologic Map

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

Cross Section Line

Geology

- Undifferentiated Alluvium (Qal)
- Terrace Deposits (Qt)
- Saugus Formation (Qts)
- Pico Formation (Tp)
- Towsley Formation (Tt)
- Modelo Formation (Tms)
- Castaic Formation (Tc)
- Violin Breccia (Tvb)
- Mint Canyon Formation (Tmc)
- Tick Canyon Formation (Ttc)
- Vasquez Formation (Tv)
- Undifferentiated Basement Complex (Bc)

Hydrography

- Lake
- Stream
- Stream Gage

Major Road

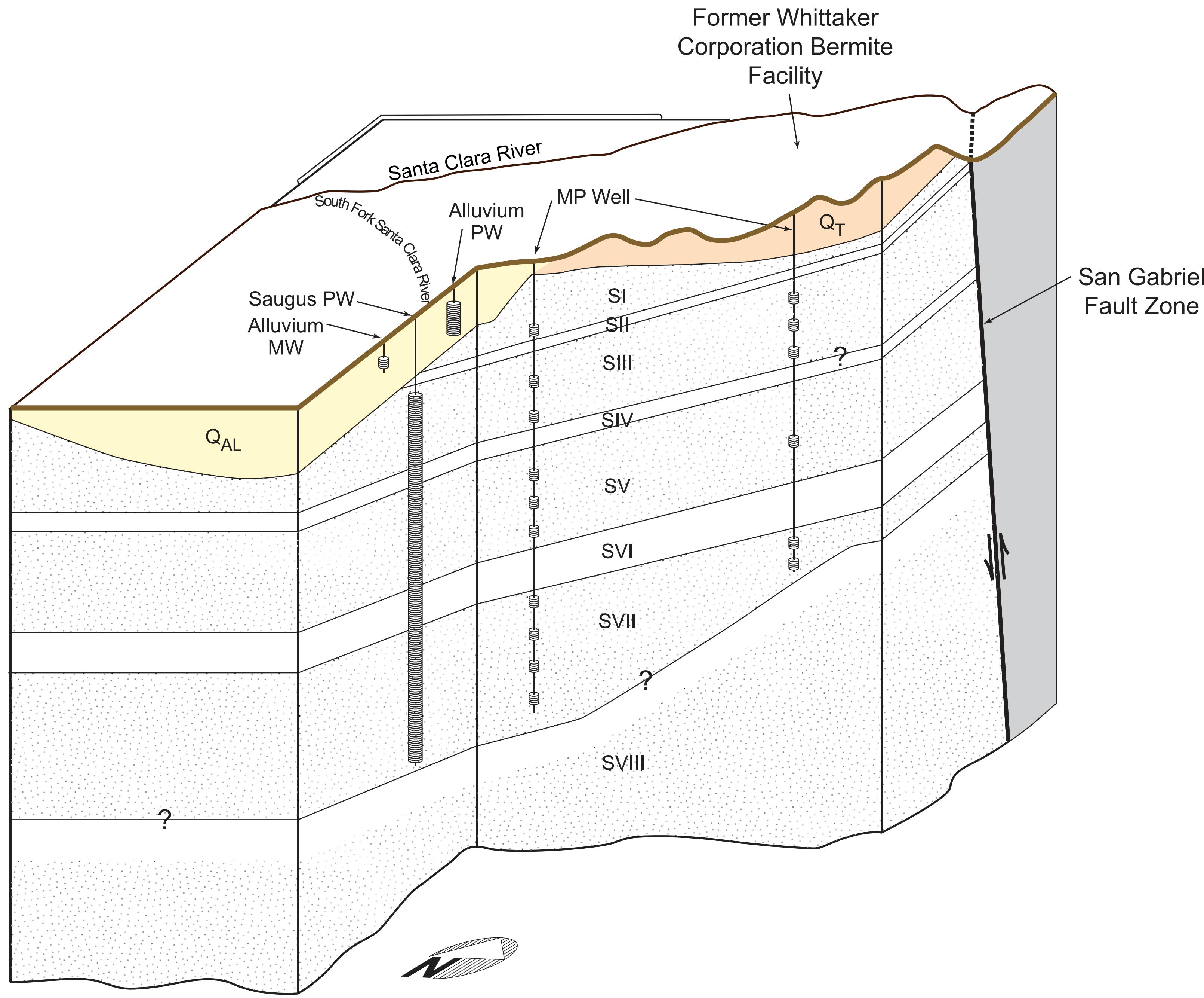
- Interstate
- State Highway
- Whittaker-bermite Property Boundary

N

0 4,500 9,000
Feet

Data Sources:
CH2M HILL (2004a and 2004b)

GSI Water Solutions, Inc.



LEGEND

- Quaternary Alluvium (Q_{AL})
- Quaternary Terrace Deposits (Q_T)

Saugus Formation

- Predominantly Fine-Grained
- Predominantly Coarse-Grained
- Undifferentiated Saugus Formation

- Production Well Screen Interval
- Monitoring Well Screen Interval
- Fault

SIII Saugus Formation Hydrostratigraphic Unit #3
PW = Production Well
MW = Monitoring Well
MP = Multiport

Data Sources: CH2M HILL (2005)

FIGURE A-7

Schematic Diagram of Detailed Hydrostratigraphy near the Whittaker Bermite Property

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

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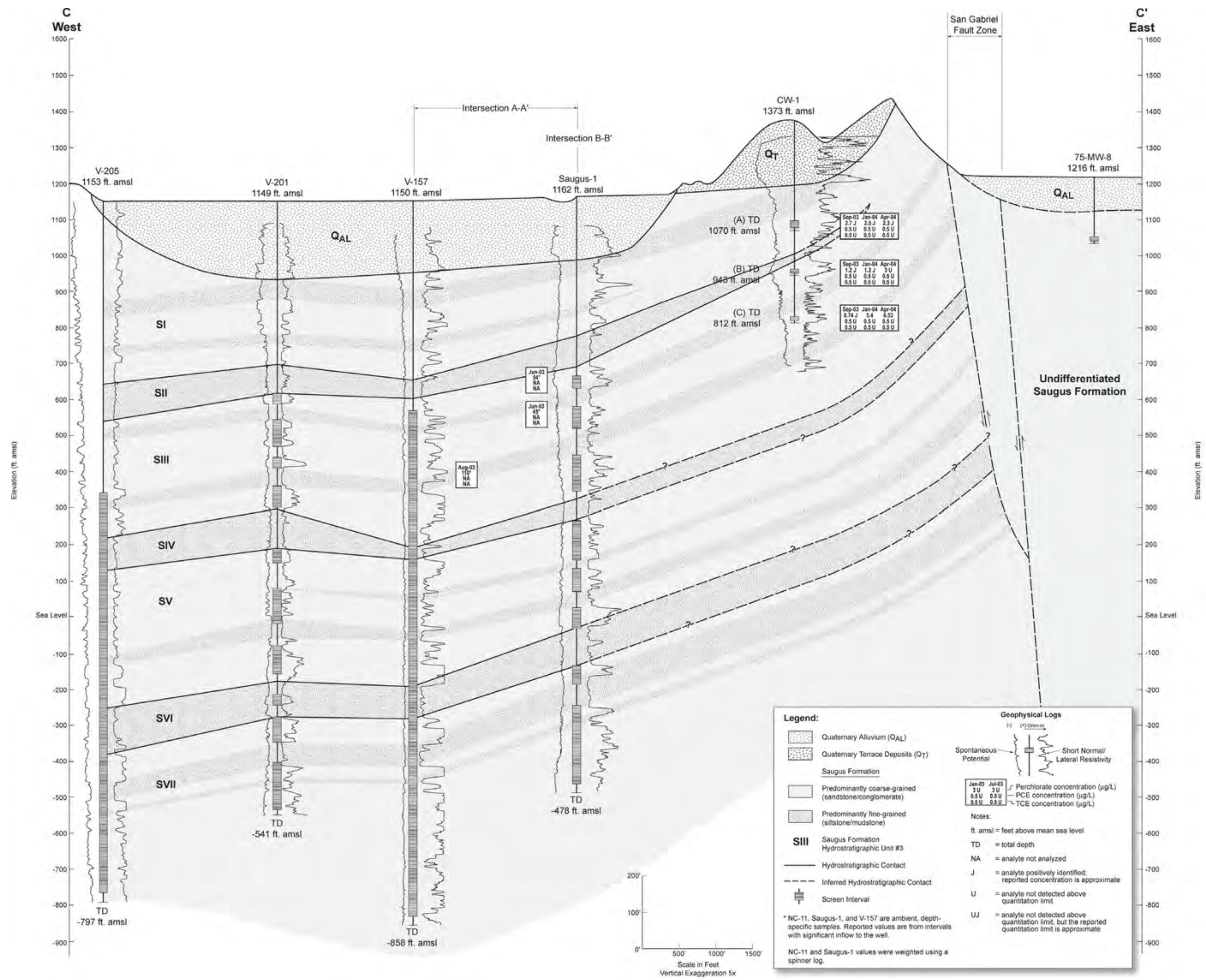

FIGURE A-8

West-East Hydrogeologic Cross-Section Showing Detailed Hydrostratigraphy near the Whittaker Bermite Property

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Data Sources: CH2M HILL (2005)

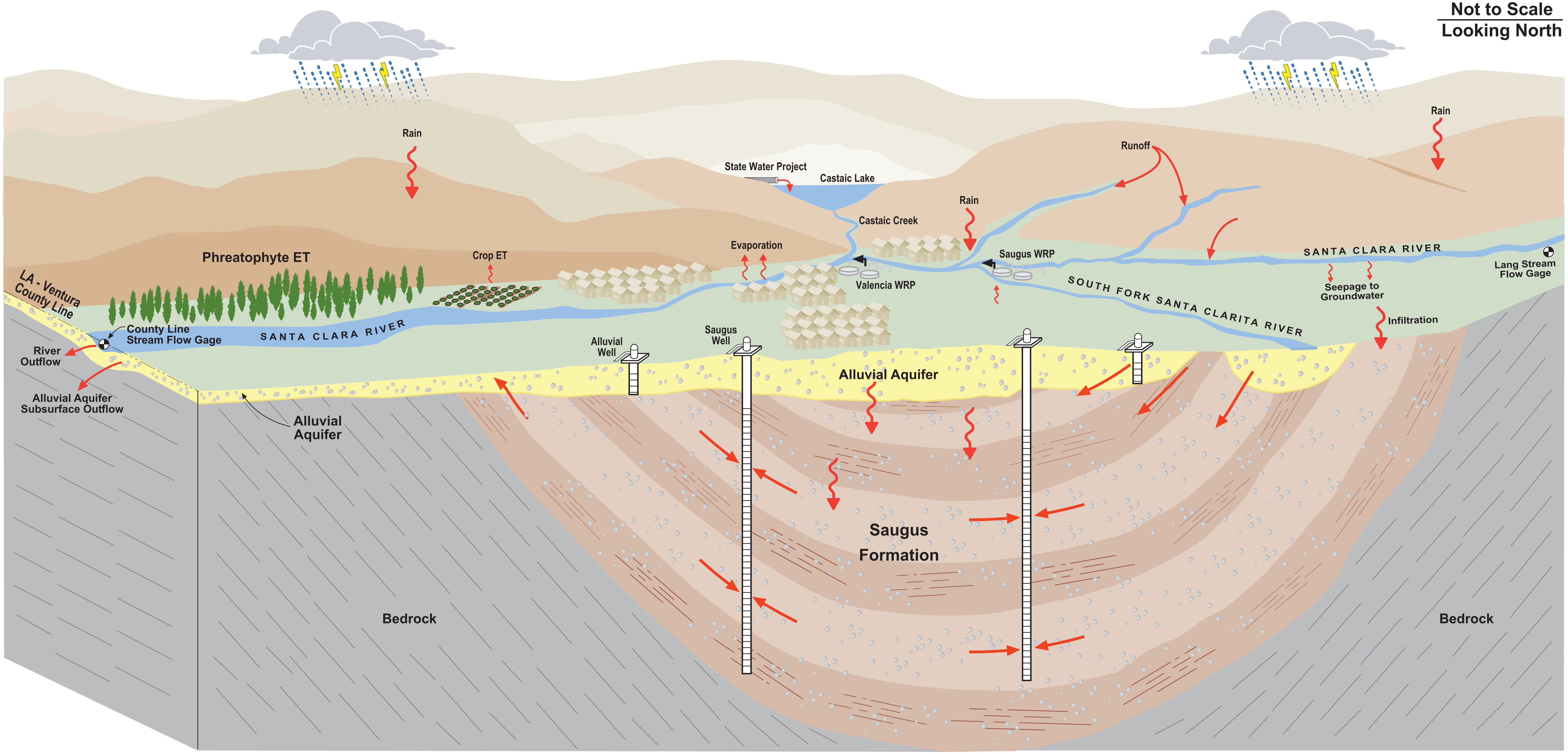

FIGURE A-9

Schematic Diagram of Santa Clarita Valley Geologic Structure and Hydrologic Processes

Development of a Numerical Groundwater Flow Model for the
Santa Clara River Valley East Groundwater Subbasin

NOTES
ET: Evapotranspiration
LA: Los Angeles
WRP: Water Reclamation Plant

Data Sources: CH2M HILL (2004a and 2004b)

GSI Water Solutions, Inc.

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Appendix B. SCV Recharge Compiler

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Prepared by:
GSI Water Solutions, Inc.
5855 Capistrano Avenue, Suite C, Atascadero, CA 93422

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Abbreviations and Acronyms

AFY	acre-feet per year
AF/day	acre-feet per day
cfs/mile	cubic feet per second per stream mile
DWR	California Department of Water Resources
East Subbasin	Santa Clara River Valley East Groundwater Subbasin
ET	evapotranspiration
ft/day	feet per day
ft/yr	feet per year
GHB	general-head boundary
GIS	geographic information system
gpdpc	gallon per day per capita
HGL	HydroGeoLogic, Inc.
in/yr	inch per year
LADWP	Los Angeles Department of Water and Power
NLF	Newhall Land and Farming Company
NWD	Newhall Water Division
RCH	Recharge package
SCV	Santa Clarita Valley
SFR	Stream-Flow Routing package
SWP	State Water Project
USGS	U.S. Geological Survey
UWCD	United Water Conservation District
WRP	water reclamation plant

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SECTION 1: **Introduction**

The time-varying rate of groundwater recharge is an important hydrologic term that is specified in (i.e., serves as input to) the numerical groundwater flow model for the Santa Clara River Valley East Groundwater Subbasin (East Subbasin). Groundwater recharge is specified on a monthly basis for each and every grid cell in the model's upper layer. Groundwater recharge rates are estimated using precipitation records, streamflow records, watershed maps, topographic maps, aerial photography, land use maps, and water use and water discharge records. Recharge rates to groundwater are calculated and compiled into the time-dependent, spatially varying recharge rates that are required by the MODFLOW-USG numerical groundwater flow model of the East Subbasin, using a detailed tool that was written in the Visual Basic Editor in Microsoft Excel. This tool—named the Santa Clarita Valley (SCV) Recharge Compiler—is designed specifically for the MODFLOW-USG groundwater model of the East Subbasin. The SCV Recharge Compiler assembles the multiple sources of recharge at any given location (and any given point in time) into a single recharge value for input to the Recharge (RCH) package of MODFLOW-USG at that location and at that particular time during the model simulation.

Further details about the SCV Recharge Compiler and its use in groundwater model simulations are presented in this appendix. Specific topics include the following:

1. A list of the sources of recharge that are evaluated by the SCV Recharge Compiler (Section 2)
2. The design of the SCV Recharge Compiler (Section 3)
3. Detailed discussions of the calculations of the magnitudes of each surface water source and its associated infiltration rate to groundwater (Section 4)
4. A list of references cited in this appendix (Section 5)

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SECTION 2: **Sources of Recharge**

The sources of recharge to the groundwater system in the Santa Clarita Valley are the following:

1. Infiltration of precipitation falling directly within the geographic boundaries of the East Subbasin, which is defined from precipitation data.
2. Infiltration of stormwater and anthropogenic discharges into the ephemeral reach of the Santa Clara River and into its tributaries. These sources are:
    a. Surface water runoff emanating from portions of the Upper Santa Clara River Hydrologic Area that are located outside of (upstream of) the boundary of the East Subbasin
    b. Santa Clara River flows that enter the East Subbasin from the east
    c. Water released from Castaic Lagoon into Castaic Creek by the California Department of Water Resources (DWR)
    d. Water released from Bouquet Reservoir into Bouquet Creek by the Los Angeles Department of Water and Power (LADWP)
3. Infiltration of water that is used for agricultural irrigation within the East Subbasin. This source of water consists exclusively of groundwater pumping from the Alluvial Aquifer.
4. Infiltration of applied water for urban and industrial outdoor uses and for irrigating golf courses. Sources of urban and golf course irrigation water are groundwater pumping from the Alluvial Aquifer and the Saugus Formation, and importation of water from the State Water Project (SWP) and other sources of imported water.
5. Infiltration from septic systems in rural and semi-urbanized portions of the valley that are served by public water supplies but not served by sanitary sewers.

For simulations of historical basin conditions, the SCV Recharge Compiler relies on (1) watershed mapping and historical records from rain gages and stream gages to quantify natural sources of recharge and (2) land and water use records for anthropogenic sources of recharge. For predictive simulations, the input values for the SCV Recharge Compiler are programmed in a manner that allows the user to test different future conditions that could involve different cycles and magnitudes of rainfall, changes to upstream reservoir operations, changes in land use, and changes in irrigation demands.

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SECTION 3: **Design of the SCV Recharge Compiler**

At every model grid cell in the upper layer of the numerical model, the SCV Recharge Compiler estimates groundwater recharge rates using the following basic steps:

1. For precipitation falling directly within the basin boundary, local rain gage data are coupled with a nonlinear rainfall-runoff relationship to define the amount of rainfall that percolates past the root zone and becomes deep percolation to the water table (i.e., groundwater recharge).
2. For each stream:
    a. The monthly and annual volumes of water entering the groundwater basin from each natural and anthropogenic water source at the margin of, or upstream of, the groundwater basin boundary are estimated in the case of natural flows and specified from historical records in the case of anthropogenic flows.
    b. The combined flow (which consists of storm flow and, in some tributaries, anthropogenic flow) is routed in the downstream direction while calculating the monthly volume of water that leaks through the streambed to the underlying water table (using an assigned streambed leakage rate at each model grid cell representing the stream). At each time during the simulation period, the infiltration volume through the streambed within any model grid cell is not allowed to exceed the amount of water that is present in the stream at that location.
3. For agricultural irrigation, data on crop coverage, crop type, crop water requirements (i.e., evapotranspiration [ET] demands), and groundwater pumping are used to estimate the amount of water that is applied on agricultural lands and the amount that returns back to groundwater as deep percolation beneath the root zone and any tile drain systems.
4. For urban irrigation, land-use coverage maps, urban water use volumes, and urban flows of indoor water into local water reclamation plants (WRPs) are used to estimate the amount of water that is land-applied and that returns back to groundwater as deep percolation beneath the root zone.
5. For septic systems, census tract maps and infiltration estimates that were developed for the groundwater basin's Salt Nutrient Management Plan (GSSI, 2016; GSI, 2014) are used to quantify and spatially distribute this source of recharge to the basin's groundwater system.

A critical aspect of the SCV Recharge Compiler's design is its role of defining groundwater recharge from stormwater flows in the Santa Clara River and its tributaries. As discussed in Sections 3.1 and 3.3.8 of the numerical modeling report, a decision was made during the model grid design process to use the RCH package, rather than the Stream-Flow Routing (SFR7) package, to simulate streambed infiltration of stormwater in the ephemeral reach of the Santa Clara River and in its tributaries. This decision was made because in-channel hydraulic calculations for ephemeral and perennial streams (using SFR7) are of interest only during non-storm periods, and particularly during the summer months, as well as throughout years of low rainfall. Accordingly, the use of the SCV Recharge Compiler and the use of a 250-foot cell spacing in the numerical model provides sufficient channel width for in-channel hydraulic calculations to be made during non-storm periods, thereby eliminating the need for larger grid cells that would be required if SFR7 were to be used to calculate high streamflow rates during storm runoff periods.

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SECTION 4: **Calculation Methodology for Each Water Source**

Following are discussions of the data and methods that are used in the SCV Recharge Compiler to estimate source water volumes and the amount of infiltration from each of these sources during each month of the simulation period. These discussions focus on the historical period of January 2018 through December 2019, which is the time period that was used to calibrate the regional groundwater flow model.

4.1 Recharge from Precipitation

As precipitation falls onto the land surface or onto a body of water, it follows three natural pathways:

1. **Evapotranspiration (ET).** This is the process by which water passes from a liquid to a vapor state via direct evaporation from the ground surface and shallow soil, and via transpiration by plants (crops, urban landscaping, and native vegetation).
2. **Surface water runoff.** This water occurs as overland flow or water flowing in a stream.
3. **Infiltration.** This is the process by which water moves from the land surface downward through the upper soil layers. This process of infiltration increases the soil moisture content. If the soil moisture content reaches its field capacity, then any additional infiltration that takes place displaces water in the vadose zone and migrates to the water table as groundwater recharge (deep percolation of precipitation). For the sake of clarity, references to “infiltration” in the rest of Appendix B will be synonymous with “deep percolation of precipitation.”

In order to estimate the amount of groundwater recharge occurring from precipitation, an understanding of the spatial pattern of precipitation must first be developed. In order to estimate the total volume of precipitation that falls onto the watershed, one would ideally like to have long-term precipitation data from several active rain gages located with fairly consistent spacing throughout the watershed. However, due to the expense and maintenance required to operate a rain gage, such an extensive network of rain gages is typically not available for an extended period in most watersheds, as is the case for the Santa Clarita Valley.

Accordingly, historical rates of recharge from precipitation within the model domain are defined using data collected at a rain gage with a long history of continuous records (the Newhall Water Division [NWD] rain gage), an isohyet map of rainfall throughout the watershed for the period of 1900 to 1960; and a power-function equation developed by Turner (1986) that describes the relationship between annual rainfall and annual groundwater recharge within the valley. These are described below.

4.1.1 Precipitation Data

The SCV Recharge Compiler uses precipitation data from the NWD rain gage, which is located at the NWD office south of Newhall Creek, approximately 1.3 miles south of the Newhall-Soledad (Newhall Fire Station #73) rain gage. Appendix A of this report discusses and plots the historical data from both rain gages. Monthly and annual values of rainfall at this gage for calendar years 1980 through 2019 are presented in Table B-1.

Because data from a single rain gage are not ideal for estimating the total volume of precipitation that falls within the entire watershed area, an isohyet map of California was used to translate the monthly precipitation at the NWD gage to monthly rainfall values throughout the watershed. See Figure A-4 in Appendix A of this report for a view of the isohyetal contours, which represent average annual rainfall within the local watershed (the Eastern Hydrologic Subarea of the Upper Santa Clara River Hydrologic Area) during the period 1900 through 1960. These isohyetal contours were obtained in 2003 during construction of the original model of the groundwater basin; as described in the documentation report for that model (see Appendix C of CH2M HILL, 2004), these isohyetal contours were provided by DWR using statewide data compiled by the National Weather Service, the U.S. Geological Survey (USGS), DWR, the California Geologic Survey (formerly the California Division of Mines and Geology), and county and/or local agencies in some locations. The isohyetal contours were draped over the model grid cells using geographic information system (GIS) methods, and the contour value at the NWD gage (20.50 inches) was then compared with the recorded value during a given month at the NWD gage to determine the percentage difference and thereby provide a factor for scaling up and down the isohyetal surface during each month of the simulation period. For example, in 1980, annual precipitation at the NWD rain gage was 31.95 inches, resulting in a scaling factor for that year of 1.559 (31.95 inches divided by 20.50 inches). In 1980, this scaling factor was applied to the isohyetal values at all model grid cells to estimate the spatial distribution of rainfall within the groundwater basin boundary. The magnitudes of the scaling factors for each calendar year in the historical calibration model are shown in Table B-1.

4.1.2 Precipitation Infiltration within the Groundwater Basin Boundary

Annual precipitation volumes arising from precipitation within the boundaries of the groundwater basin were estimated from annual precipitation data using a variation of a method described by Turner (1986). Turner empirically derived a power-function equation that describes the average state-wide relationship between annual rainfall and ET rates, based on the measured yields from 68 different watersheds throughout California. Rainfall that does not go to ET is available for surface water runoff and infiltration to groundwater. During large storm events, some of this water leaves the basin before it has a chance to infiltrate to groundwater. However, during smaller storm events, precipitation that is not consumed by ET eventually infiltrates to groundwater within the groundwater basin. On an annual basis, the amount of water (measured in inches) that infiltrates as a function of the annual precipitation volume (in inches) is defined by the following equation (Turner, 1986):

$$\text{Infiltration} = \text{Precipitation} - 2.32*(\text{Precipitation})^{0.66} \qquad \textbf{(Equation B-1)}$$

Equation B-1 is plotted on Figure B-1 for a range of annual precipitation values expressed in units of inches. Because this expression was empirically derived based on a best-fit to data from 68 watersheds throughout California, it is not necessarily representative of the conditions in an individual watershed. Therefore, the two power-function coefficients were adjusted during the process of calibrating the numerical groundwater flow model for the East Subbasin. The calibration process for the numerical model resulted in the following set of power-function coefficients for the East Subbasin:

$$\text{Infiltration} = \text{Precipitation} - 5.00(\text{Precipitation})^{0.41} \qquad \textbf{(Equation B-2)}$$

As shown in Figure B-1, outside of stream channels, this relationship results in no recharge arising from precipitation until annual rainfall at the NWD gage exceeds 15 inches. This relationship for the East Subbasin simulates below-normal rainfall as being unlikely to promote substantive amounts of deep percolation (groundwater recharge), because of insufficient water percolating past the root zone and past the shallow soil depths where direct evaporation from soil can occur during the warmest months. In contrast, deep percolation occurs once annual rainfall exceeds 15 inches, with the volume of deep percolation per inch of extra annual rainfall increasing as soil moisture deficits are met and more of the shallow rainfall infiltration can percolate deeper into the soil, compared with being taken up by plants or evaporated from shallow soil.

The SCV Recharge Compiler applies Equation B-2 to the annual precipitation-adjusted isohyetal values to estimate the annual rate of infiltration at each cell in the numerical model grid at any point in time. Based on the percentage of annual precipitation that falls during a given month at the NWD rain gage, the annual volumes of precipitation recharge are converted into monthly rates for every cell in the uppermost layer of the numerical model.

4.2 Stormwater Flows and Recharge from Streams

For each month of the simulation, the SCV Recharge Compiler calculates the amounts of stormwater flow and groundwater recharge in streams, plus the amount of flow and groundwater recharge arising from controlled releases to Castaic Creek and Bouquet Creek from impoundments on those streams.

For the Santa Clara River, the volume of streamflow in historical simulations is defined from measured and estimated streamflow data at the Lang Gage (see Table B-2). For Castaic Creek, the monthly volumes of historical controlled releases were obtained from DWR operations records for Castaic Lake and Castaic Lagoon (see Table B-3). For Bouquet Creek, the monthly volumes of historical controlled releases were obtained from LADWP operations records for Bouquet Reservoir (see Table B-4). For the remaining Santa Clara River tributaries, streamflow volumes were defined by using the methods described in Section 4.1 to quantify the relationship between rainfall, ET, and the subsequent yield of stormwater from the portion of each watershed lying upstream of the groundwater basin boundary. Following are discussions of the volumes of these water sources and the methods used to determine infiltration rates in streambeds, based on the magnitude of flow in each stream and the streambed characteristics.

4.2.1 Surface Water Generation in Sub-Watersheds Upstream of the Groundwater Basin Boundary

In order for the numerical groundwater model to account for the water budget for the entire watershed, a method was developed to estimate the monthly availability of surface water runoff from the portion of each area that comprises the contributing watershed for a tributary entering the groundwater basin. To do this, GIS software was used in 2003 (during development of the original numerical model; see CH2M HILL, 2004) that provides specific input data to the SCV Recharge Compiler as follows:

1. First, the GIS software was used to delineate the geographic extent of each tributary's watershed, with each of these areas comprising a "sub-watershed" within the Eastern Hydrologic Subbasin of the Upper Santa Clara River Hydrologic Area. This mapping was conducted using a 30-meter digital elevation model data obtained from the USGS. Figure B-2 depicts the extents of these sub-watersheds. The extents of the sub-watersheds were important to delineate because precipitation rates vary spatially as described previously (and as shown in Figure B-1); therefore, at any given time, each sub-watershed receives different magnitudes of precipitation, and yields different quantities of surface water runoff into the groundwater basin.
2. Once the selected sub-watersheds were delineated, the spatial areas were computed by GIS software for the entire sub-watershed and for the portion of the sub-watershed lying outside the groundwater basin boundary. The GIS software also computed the mean of the 1900 to 1960 precipitation (isohyet) distribution within each sub-watershed. The areas and the 1900 to 1960 mean average precipitation values for each of the 49 identified sub-watersheds are listed in Table B-5.[1] The 1900–1960 average precipitation for a given sub-watershed was then multiplied by the precipitation adjustment factors described in Section 4.1 for each calendar year to estimate the average magnitude of precipitation that fell within the sub-watershed during that calendar year.

In the SCV Recharge Compiler, Equation B-2 is applied to the adjusted annual precipitation values for each sub-watershed to estimate the annual volume of surface water runoff throughout the simulation period (which, for model calibration, is January 1980 through December 2019). This provides an estimate of the

[1] The 49 sub-watersheds include (1) the natural contributing watershed to lower and upper Castaic Creek (even though Castaic Dam captures those flows) and (2) the ephemeral and perennial reaches of the Santa Clara River. Excluding these four water bodies, 45 contributing watersheds lie outside the groundwater basin boundary.

annual volume of water from sub-watersheds that is then available as potential groundwater recharge within the stream reach that lies within the numerical model domain (i.e., within the groundwater basin boundary). In any given year, these annual estimates are converted to monthly estimates by multiplying them by the monthly percentage of annual precipitation observed at the NWD rain gage during that year.

4.2.2 Santa Clara River Streamflow at the Eastern Model Boundary

The eastern end of the groundwater flow model lies slightly upstream of the groundwater basin boundary, at the location of the Lang Station streamflow monitoring gage (see Figure B-2). Streamflow has been measured at this gage by the USGS and Los Angeles County since 1949, but its operation has been intermittent and long periods exist for which the record includes only sporadic readings or has multiple years of no readings. CH2M HILL and HydroGeoLogic, Inc. (HGL; 2006) used precipitation records to estimate the monthly streamflow volumes at this gage using regression techniques for the period 1980 through 2005; these volumes are incorporated into the SCV Recharge Compiler. After 2005, the streamflow rates used by the SCV Recharge Compiler are from rainfall-streamflow regression calculations for 2006 and 2007, and field data measurements after 2007.

4.2.3 Releases from Castaic Lake/Castaic Lagoon

Castaic Creek occasionally receives surface water releases from Castaic Lagoon (i.e., Castaic Lake). Table B-3 lists the historical monthly releases into Castaic Creek from January 1980 through December 2019, as reported by DWR's Southern Field Division Water Operations office in its monthly operations tables for the complex comprising Pyramid Lake, the Elderberry Forebay, Castaic Lake, and Castaic Lagoon. These flows consist primarily of releases of stormwater flows generated in the contributing watershed to Castaic Lake; additionally, releases of impounded State Water Project water periodically occur for the purpose of delivering water to the United Water Conservation District (UWCD) in Ventura County.

4.2.4 Releases from Bouquet Reservoir

Table B-4 lists the historical monthly releases into Bouquet Creek from January 1980 through December 2019. Under a 1978 agreement between LADWP and UWCD,[2] LADWP is required to release into Bouquet Creek approximately 2,200 acre-feet per year (AFY) of water impounded behind Bouquet Dam. The dam was constructed to regulate and store Owens Valley Aqueduct water for use by LADWP, and it impounds stormwater generated in the portion of Bouquet Canyon upstream of the dam. The 1978 agreement, which replaced an earlier agreement from 1932, specifies that releases should occur year-round in the amounts of 2 acre-feet per day (AF/day) from October 1 through March 31, and 10 AF/day from April 1 through September 30. Assuming no adjustments or shutoffs occur, this equates to an annual release volume of 2,194 acre-feet. However, major storm events in early 2005 significantly altered the Bouquet Canyon streambed, requiring since that time that LADWP's releases be reduced to avoid overflow of the creek onto Bouquet Canyon Road. The area (including the streambed) is going through an extensive restoration at this time, after which it is expected that the releases can return to the rates and volumes specified under the 1978 agreement.

Based on aerial imagery and the results of the model calibration process, it is estimated that only a small fraction of these releases enters the basin as surface flow (assumed to be 5 percent for modeling purposes). A portion of these releases may also enter as subsurface flow, which is implicitly accounted for by using

[2] Agreement No. 10162 between Department of Water and Power of the City of Los Angeles and United Water Conservation District. March 9, 1978.

general-head boundaries (GHBs) to allow subsurface flow from outside the basin boundary to enter the basin in the thin alluvial veneer present in this area.

4.2.5 Calculation of Stream Leakage to Groundwater

As was described for the original finite-element groundwater model of the East Subbasin (CH2M HILL, 2004), a method was developed to determine the rates and locations of infiltration from streambeds to the underlying Alluvial Aquifer. This method relies on defining a stream connectivity and ranking system and defining the streambed infiltration capacity in each stream.

4.2.5.1 Stream Connectivity and Ranking System

As shown in Figure B-3, the streambed infiltration calculations make use of a stream ranking convention as follows:

1. Santa Clara River (1st-order stream)
2. All modeled streams that merge with the Santa Clara River (2nd-order streams)
3. All modeled streams that merge with the 2nd-order streams (3rd-order streams)
4. All modeled streams that merge with the 3rd-order streams (4th-order streams)
5. All modeled streams that merge with the 4th-order streams (5th-order streams)

The SCV Recharge Compiler processes the assignment of stream leakage, beginning with the highest ranking (furthest upstream) stream nodes and progressing sequentially downstream to the lowest ranking stream nodes for each sub-watershed. This ensures a correct accounting of available stream leakage throughout the stream network in the model domain. Within a given stream, the connectivity relationships between each model grid node/grid cell in that stream were established by ordering the model's stream node numbers from upgradient nodes to downgradient nodes. Additionally, the last stream node of a given stream was assigned a "next node number," which indicates the nearest node for the next downstream (lower ranking) stream that can receive any surface flows that might remain in the higher-ranking stream. This "next node number" attribute allows the SCV Recharge Compiler to simulate continued surface water infiltration in the lower ranking streams as long as the total volume of available recharge water is not consumed in upstream reaches of the simulated stream.

4.2.5.2 Streambed Infiltration Capacity at Each Node

A streambed infiltration capacity value is specified for each stream node in the SCV Recharge Compiler. The streambed infiltration capacity is the maximum volume of water that can infiltrate through streambed sediments, assuming a sufficient volume of water in the stream. The streambed infiltration capacity is programmed into the SCV Recharge Compiler in units of cubic feet per second per stream mile (cfs/mile) and is a function of streambed sediment permeability and the wetted width of the stream at any given time. The streambed infiltration capacity averages 4 cfs/mile along the ephemeral reach of the Santa Clara River (which extends upstream from the mouth of San Francisquito Canyon) and averages between 0.6 and 3.75 cfs/mile in the tributaries to the Santa Clara River.

Because the MODFLOW-USG numerical groundwater flow model (the RCH package) requires input in units of feet per day (ft/day), the SCV Recharge Compiler divides its computed volumetric groundwater recharge rate (in cubic feet per day) by the size (in square feet) of the model grid cells where streams are present (62,500 square feet, based on the 250-foot by 250-foot cell sizes), resulting in a deep percolation rate that is in units of ft/day and is calculated based on the amount of streamflow that is present in a given model grid cell and the size of the grid cell. In terms of the infiltration capacity of an individual grid cell, if the wetted channel width is 25 feet (a reasonable estimate of the typical width of ephemeral streams except during the highest rainfall events), then the cfs/mile streambed infiltration capacity values described above are equivalent to infiltration capacities of approximately 2.5 ft/day along the ephemeral reach of the Santa Clara River and between 0.4 and 2.3 ft/day in the tributaries to the Santa Clara River.[3]

Historical groundwater level records indicate that groundwater levels respond quickly to stormwater flow events in the Santa Clara River and its tributaries, particularly after large “episodic” storm events as occur periodically during El Niño years. Accordingly, in the SCV Recharge Compiler, stream leakage to groundwater is assumed to be a nearly instantaneous process, with the water table being recharged in the same month that a given stormwater flow event occurs.

4.3 Recharge from Agricultural Irrigation

Agricultural irrigation occurs on lands owned and operated by the Newhall Land and Farming Company (NLF), a subsidiary of Five Point Holdings, LLC. Shortly before development of the original groundwater model for the East Subbasin (CH2M HILL, 2004), NLF reported irrigated acreages, crop types, and water use volumes for five calendar years (1996 through 2000) as part of its water resources analysis planning for the future Newhall Ranch development (see Appendix 2.5m in Impact Sciences, 2001). These data indicated that approximately 877 acres were irrigated at that time for agricultural purposes, with approximately 90 percent of these lands overlying the Alluvial Aquifer and the remaining 10 percent overlying terrace deposits. These lands are used primarily to grow row crops.

As part of developing the original groundwater model, a review was conducted of the records from NLF and the water use requirements for each crop type (as listed in the California Irrigation Management Information System), for the purpose of estimating the amount of applied irrigation water during this 5-year period that was not consumed by the crops and was potentially available to infiltrate to groundwater beneath irrigated agricultural lands. Figure B-4 shows the analysis, which compares crop water use requirements with applied water volumes and identifies the difference as being equal to the infiltration volume to groundwater. For the period 1996 through 2000, Figure B-4 shows the following:

1. The average applied water volume was 7,038 AFY.
2. The average amount of water that was not consumptively used by the crops was 2,583 AFY, which is approximately 37 percent of the applied water volume.
3. Over the 877-acre area, the equivalent average rate of water application beyond the crop’s water requirement was 2.9 AF/acre/yr (which is equivalent to 2.9 feet per year [ft/yr])

Table B-6 shows the corresponding rates of application beyond crop water needs for each year, based on records of actual agricultural water use each year. The rate of 2.9 ft/yr corresponds to the 7,038 AFY average water use during 1996 through 2000. A higher rate would be expected during years of higher water use, and a lower rate would be expected during years of reduced water use over this 877-acre area. Over-application is necessary to flush salts from the soil and maintain target soil moisture levels. Only a portion of this 2.9 ft/yr over-application volume will seep downward past the root zone and directly recharge the underlying Alluvial Aquifer. The SCV Recharge Compiler assumes that 1.96 ft/yr (2/3 of the over-applied water) can infiltrate to the underlying water table.

[3] As shown in Table 3-5 of the main report, the Stream-Flow Routing (SFR) package in the regional groundwater flow model uses hydraulic conductivity values of 25 ft/day in many ephemeral streams, with values no lower than 0.5 ft/day. Those values are generally higher than the streambed infiltration capacities that are used in the SCV Recharge Compiler. The use of higher values in the SFR package is intentional and is designed to avoid unduly limiting seepage from groundwater back into stream channels at times and places where such seepage might occur.

The 250-foot spacing of the model grid over the Alluvial Aquifer results in modest over-estimation of the acreage within the model (1,292.76 acres) compared with the actual irrigated acreage (877 acres). The ratio of the actual area of irrigated agriculture to the model grid-cell area (0.6784) is an adjustment factor that is applied to the 1.96 ft/yr rate so as to provide a rate (1.357 ft/yr, or 16.28 inches per year [in/yr]) that produces the proper volume of infiltration over the grid cells that are designated in the numerical model as containing irrigated agricultural lands. The effect of this adjustment is shown in Table B-6.

The source of agricultural irrigation water primarily has been groundwater pumping from the Alluvial Aquifer, with some limited pumping occurring from one Saugus Formation well (NLF-156) prior to 2008 (when this well was taken out of service). As the Newhall Ranch development is constructed, the currently irrigated lands no longer will be irrigated because their water source will be used as part of the water supply for this community. Therefore, under future full build-out conditions for Newhall Ranch, no agricultural irrigation recharge will occur within the area simulated by the regional groundwater model.

4.4 Recharge from Urban Irrigation

As derived by CH2M HILL (2004), the long-term infiltration rates of applied irrigation water in urban areas are defined in the SCV Recharge Compiler to be 1.0 in/yr for industrial and retail lands, 2.2 in/yr for residential developments and parks, and 4.6 in/yr for golf courses. Since then, an additional separate rate has been defined for schools and recreational facilities (ranging from 3.4 to 4.6 in/yr). These rates are applied during each year (and each month) of the simulation period, but are varied in simulations of historical conditions to reflect changes in urban water use volumes from year to year. The area over which these rates are applied in the historical simulations is defined from land use data provided to the local water purveyors by the City of Santa Clarita in 2013 when an update was occurring to the original finite-element model (GSI and LSCE, 2013). Following are discussions of how these rates have been derived for residential and commercial/industrial areas (Section 4.4.1), for golf courses (Section 4.4.2), and for schools and recreational facilities (Section 4.4.3).

4.4.1 Infiltration of Urban Irrigation Water (Residential, Commercial/Industrial)

A significant portion of water that is used outdoors goes to plant uptake and direct evaporation, and a smaller portion infiltrates to the underlying aquifer system. The magnitude of infiltration was estimated during the development of the original finite-element groundwater model of the basin (CH2M HILL, 2004), using water use and land use data that were available for developed areas within the Santa Clarita Valley at the time.

The average annual urban water demand was approximately 49,000 AFY from 1994 through 1998. On a long-term basis, outdoor water use in urbanized areas was approximately 65 percent of the total annual water demand, as indicated by records of total water demands and WRP flows for the period 1980 through 1999 (see Table B-7). Within urbanized areas that contain industrial and retail land uses, the outdoor water use was estimated to be approximately 30 percent of the total water use. For residential and commercial/industrial land uses, it was assumed that 10 percent of the applied water could potentially recharge groundwater, which means that a total of 90 percent of the applied water goes to ET demands and surface runoff.

During the development of the original finite-element groundwater model of the basin (CH2M HILL, 2004), aerial photographs of the valley taken in 1999 were used to identify land uses in developed areas, and GIS was used to determine the acreage of each land use type. Table B-8 summarizes the derivation of estimated values of infiltration for urban irrigation water from land use data and from water use data reported as of 1999 (LSCE, 2000). Table B-8 shows the average annual water use volumes, the land use acreage, and the calculated depths of annual infiltration to groundwater as were developed for the original finite-element groundwater model. As shown in the table, infiltration of urban irrigation water was estimated to be approximately 1 in/yr for retail and industrial land uses, and 2.2 in/yr for suburban residential land uses. These values are thought to be reasonable estimates of more recent long-term average infiltration rates from residential and commercial/industrial lands and accordingly were used as direct specified input to the SCV Recharge Compiler and were not varied during groundwater flow model calibration.

During development of the original finite-element model, an attempt was made to vary over time the locations at which urban applied water was specified in the model, given that the amount of urbanization in the basin was changing significantly during the 1980s and 1990s (which were the calibration period for the original finite-element model). However, electronic records of historical land use data were unavailable. Consequently, to ensure that the total infiltration volume in urbanized areas reflected the increase in development and water use that occurred throughout the 1980s and 1990s, infiltration was applied to the 1999 urbanized area, but at rates that were adjusted upward or downward in a given year according to the difference between water uses in that year and in 1999 (CH2M HILL, 2004). This process of adjusting the infiltration rates for the urbanized area was carried forward through the year 2019 during development of the new regional model. Tables B-9 and B-10 show the actual rates that were applied to the 1999 urbanized area (in suburban residential areas and commercial/industrial areas, respectively) to account for the gradual increase in water use from 1980 through 1999 and the changes in water use after 1999.

4.4.2 Infiltration of Urban Irrigation Water Beneath Golf Courses

This infiltration term was developed for the original finite-element model using golf course irrigation data from 1994 through 1998, which indicated that golf courses in the valley used approximately 500 AFY of water on average. The majority of this water is used for irrigation purposes.

During the development of the original finite-element model, the amount of deep percolation to groundwater resulting from golf course irrigation was estimated to be 30 percent of applied water, which is three times higher than the assumed rate of 10 percent for residential and commercial/industrial areas. This estimate was based on information suggesting that golf courses irrigate beyond the water demand requirements of grassy areas to maintain the quality of the greens. As shown in Table B-8, this resulted in an estimated annual average infiltration rate of 4.6 in/yr. This rate is used throughout the entire historical calibration period (January 1980 through December 2019) in the new regional model.

4.4.3 Infiltration of Urban Irrigation Water Beneath Schools and Recreational Facilities

A rate of 4.6 in/yr is used for schools and recreational facilities under historical conditions. For simulation of future conditions, this rate should be considered to be lower to reflect that current state water conservation standards now require lower irrigation rates on landscapes not being irrigated with recycled water. An infiltration rate of 3.4 in/yr is recommended, which is midway between the rates for residential areas (2.2 in/yr) and golf courses (4.6 in/yr). The rate of 3.4 in/yr for schools and recreational facilities is based on the logic that these facilities will keep their recreational fields in good condition, but not require the high rates of irrigation that are applied to golf courses (particularly the professional tour golf courses that are present in Santa Clarita). Urban parks could use rates of between 2.2 in/yr and 3.4 in/yr, or even as much as 4.6 in/yr, with the choice of the rate based on considerations of the park type and setting; specifically, a small park built in a residential development and with few or no athletic fields would use less water than a larger park where athletic facilities are more prevalent or are the dominant feature of the park.

4.5 Recharge from Septic Systems

Infiltration from septic systems was defined for residential developments that are served by public water supplies, but not sanitary storm sewers. In these developments, the onsite treatment of wastewater (via septic systems) represents an importation of water into the residential development with subsequent recharge to groundwater from the septic systems.

The locations of these areas were obtained in 2013 during development of the Salt Nutrient Management Plan for the East Subbasin (GSSI, 2016; GSI, 2014). See Figure B-5. Census tract maps developed by Los Angeles County (using data from the 2010 census; see Los Angeles County, 2010) were coupled with sewer infrastructure information provided by the City of Santa Clarita, Los Angeles County Sanitation District, and the Los Angeles Department of Public Works. Personal communications with these agencies determined that areas beyond the sewered system were likely to be on a septic system.

The rates of septic system discharges were defined from a USGS study (USGS, 2003) and from Bouwer (1978), which estimates that residential and commercial land use septic systems seep as much as 70 gallons per day per capita (gpdpc) and 1,000 gallons per day per acre, respectively. Two other studies (Systech, 2002; and KJC et al., 2011) estimate household septic uses to occur at rates of 75 gpdpc and 77 gpdpc, respectively. Based upon a population of approximately 29,343 living in unsewered areas (as determined from the census data for areas outside sewered areas), and based on an average 74 gpdpc of flow into septic systems[4], the recharge from septic systems was estimated to be 2,432 AFY.

Although some of the areas contributing this volume of recharge do not lie directly over the aquifer, they are in close proximity. Consequently, to account for their potential to load salt into the groundwater system, the full 2,432 AFY volume of recharge is distributed evenly over the 888 model grid cells where septic systems are present within the groundwater basin boundary, so that the full volume of 2,432 AFY is loaded to the aquifer. The 888 model grid cells cover an area of 76,125,000 ft^2, which equals 1,747.5 acres. Accordingly, the loading rate from septic systems in each of the 888 grid cells where these systems are present is 1.39 ft per year, which is equivalent to 16.7 inches per year.

[4] This is the average of 70 gpd/person (USGS, 2003), 75 gpd/person (Systech, 2002), and 77 gpd/person (KJC and others, 2011).

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SECTION 5: **References**

Bouwer, Herman. 1978. *Groundwater Hydrology.* McGraw-Hill Series in Water Resources and Environmental Engineering. McGraw-Hill, New York. 480 p.

CH2M HILL. 2004. *Regional Groundwater Flow Model for the Santa Clarita Valley: Model Development and Calibration.* Prepared for the Upper Basin Water Purveyors (Castaic Lake Water Agency, Santa Clarita Water Division of CLWA, Newhall County Water District, and Valencia Water Company). April 2004.

CH2M HILL and HGL. 2006. *Final Report: Task 2A – Conceptual Model Development, East and Piru Subbasins, Upper Santa Clara River Chloride TMDL Collaborative Process.* Prepared for Sanitation Districts of Los Angeles County and the Los Angeles Regional Water Quality Control Board. Prepared by CH2M HILL and HydroGeoLogic, Inc. (HGL). October 2006.

GSI and LSCE. 2013. *Calibration Update of the Purveyors' Regional Groundwater Flow Model through 2011 (Santa Clarita Valley, California).* Draft Technical Memorandum to Keith Abercrombie, Valencia Water Company, and Jim Leserman, Castaic Lake Water Agency. Prepared by GSI Water Solutions (GSI) and Luhdorff and Scalmanini Consulting Engineers (LSCE). December 16, 2013.

GSI. 2014. *Development of Groundwater Budget Terms for the Santa Clara River Valley East Subbasin Salt and Nutrient Management Plan (Santa Clarita Valley, CA).* Draft Technical Memorandum to Brian Villalobos/Geoscience Support Services, Inc., and Jeff Ford/Castaic Lake Water Agency. Prepared by John Porcello and Jeff Barry, GSI Water Solutions (GSI). December 5, 2014.

GSSI. 2016. *Final Salt and Nutrient Management Plan, Santa Clara River Valley East Subbasin.* Prepared for Castaic Lake Water Agency and Santa Clara River Valley East Subbasin Salt and Nutrient Management Plan Task Force by Geoscience Support Services, Inc. (GSSI). Volumes 1 and 2. December 8, 2016.

Impact Sciences, Inc. 2001. *Newhall Ranch Draft Additional Analysis.* Prepared for the Newhall Ranch Company. April 2001.

KJC, N. Clemm, LSCE, and Stacy Miller Public Affairs. 2011. *2010 Urban Water Management Plan.* Prepared for Castaic Lake Water Agency (CLWA), CLWA Santa Clarita Water Division, Newhall County Water District, Valencia Water Company, and Los Angeles County Waterworks District No. 36 by Kennedy/Jenks Consultants (KJC), Nancy Clemm, Luhdorff & Scalmanini Consulting Engineers (LSCE), and Stacy Miller Public Affairs. June 2011.

Los Angeles County. 2010. *2010 Census – Census Tract Reference Map: Los Angeles County, CA.* Maps created by Geography Division. Map numbers 205006037007 and 205006037008. December 1, 2010.

LSCE. 2000. *Santa Clarita Valley Water Report 1999.* Prepared for the Castaic Lake Water Agency, Los Angeles County Waterworks District No. 36, Newhall County Water District, and Valencia Water Company. Luhdorff and Scalmanini Consulting Engineers (LSCE). April 2000.

Systech, 2002. *Final Task 1 Report for the Santa Clara Nutrient TMDL Analysis, Source Identification and Characterization.* Prepared by Systech Engineering for the Los Angeles Regional Water Quality Control Board, Los Angeles, California.

Turner, K.M. 1986. *Water Loss from Forest and Range Lands in California.* In Proceedings of the Chaparral Ecosystems Research Meetings and Field Conference, Santa Barbara, California, May 16-17, 1986, J. Devries (Editor). Water Resources Center, Report 62, University of California, Davis, California, pp. 63–66.

USGS. 2003. *Evaluation of Source and Transport of High Nitrate Concentrations in Groundwater, Warren Subbasin, California*. Water-Resources Investigations Report 03-4009. Prepared by the U.S. Geological Survey.

TABLES

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Table B-1

Monthly and Annual Precipitation at the Newhall Water Division (NWD) Rain Gage (1980-2019)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Calendar Year	Precipitation (inches)													Scaling Factor for Isohyetal Contour Map	Calendar Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual		
1980	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	**31.95**	**1.559**	**1980**
1981	4.76	1.66	5.50	0.46	0.00	0.00	0.00	0.00	0.00	0.58	3.62	0.22	**16.80**	**0.820**	**1981**
1982	3.33	1.21	9.50	1.09	0.13	0.00	0.00	0.00	1.02	0.25	5.34	2.95	**24.82**	**1.211**	**1982**
1983	8.67	6.85	13.07	4.61	0.20	0.00	0.00	1.17	1.85	1.74	5.04	5.13	**48.33**	**2.358**	**1983**
1984	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.00	0.05	0.16	3.87	8.13	**12.55**	**0.612**	**1984**
1985	0.78	1.20	1.04	0.14	0.07	0.00	0.06	0.00	0.12	0.54	5.11	0.70	**9.76**	**0.476**	**1985**
1986	5.84	6.65	5.39	0.88	0.00	0.00	0.05	0.00	1.78	0.68	1.55	0.24	**23.06**	**1.125**	**1986**
1987	2.10	0.61	1.69	0.14	0.00	0.00	0.09	0.02	0.00	3.47	3.84	4.80	**16.76**	**0.818**	**1987**
1988	3.27	3.39	1.16	3.98	0.09	0.00	0.00	0.00	0.10	0.00	0.92	7.14	**20.05**	**0.978**	**1988**
1989	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	**8.47**	**0.413**	**1989**
1990	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	**9.34**	**0.456**	**1990**
1991	1.11	5.72	11.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	5.95	**24.61**	**1.200**	**1991**
1992	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	**39.24**	**1.914**	**1992**
1993	17.11	11.73	4.27	0.00	0.00	0.65	0.00	0.00	0.00	0.57	0.75	1.00	**36.08**	**1.760**	**1993**
1994	0.48	5.31	2.33	0.42	0.00	0.00	0.00	0.00	0.00	0.78	0.71	1.94	**11.97**	**0.584**	**1994**
1995	21.98	1.93	8.30	0.72	0.26	0.76	0.00	0.00	0.00	0.00	0.00	2.33	**36.28**	**1.770**	**1995**
1996	2.97	6.73	2.08	0.13	0.68	0.00	0.00	0.00	0.00	1.30	1.06	8.70	**23.65**	**1.154**	**1996**
1997	6.67	0.23	0.00	0.00	0.00	0.00	0.05	0.00	0.53	0.00	3.73	6.72	**17.93**	**0.875**	**1997**
1998	3.49	22.00	3.98	2.28	5.50	0.06	0.00	0.00	0.21	0.33	1.36	1.39	**40.60**	**1.980**	**1998**
1999	2.08	0.65	3.00	3.78	0.00	0.48	0.00	0.00	0.01	0.00	0.00	0.05	**10.05**	**0.490**	**1999**
2000	1.21	9.43	3.15	2.10	0.00	0.00	0.00	0.31	0.00	1.13	0.00	0.00	**17.33**	**0.845**	**2000**
2001	5.84	10.76	3.38	2.56	0.00	0.00	0.00	0.00	0.00	0.22	3.18	1.30	**27.24**	**1.329**	**2001**
2002	1.55	0.51	0.38	0.05	0.12	0.01	0.00	0.00	0.02	0.00	3.01	5.85	**11.50**	**0.561**	**2002**
2003	0.00	9.03	2.38	2.35	1.70	0.00	0.02	0.00	0.00	1.10	0.63	2.57	**19.78**	**0.965**	**2003**
2004	0.65	8.07	0.37	0.20	0.00	0.00	0.00	0.00	0.00	4.79	0.64	8.54	**23.26**	**1.135**	**2004**
2005	17.06	16.69	2.70	1.42	0.45	0.00	0.00	0.00	0.17	1.91	0.59	0.14	**41.13**	**2.006**	**2005**
2006	3.27	3.78	5.68	4.22	0.99	0.00	0.00	0.00	0.00	0.42	0.05	0.83	**19.24**	**0.939**	**2006**
2007	1.66	1.38	0.17	0.71	0.00	0.00	0.00	0.00	1.32	0.25	0.50	2.67	**8.66**	**0.422**	**2007**
2008	17.54	1.82	0.10	0.07	0.17	0.00	0.00	0.00	0.00	0.09	1.78	3.01	**24.58**	**1.199**	**2008**
2009	0.69	6.78	1.18	0.07	0.01	0.03	0.00	0.00	0.00	4.04	0.08	4.28	**17.16**	**0.837**	**2009**
2010	9.13	4.96	0.69	2.40	0.07	0.00	0.00	0.00	0.00	1.34	1.87	11.97	**32.43**	**1.582**	**2010**
2011	0.96	5.36	8.86	0.12	0.74	0.04	0.01	0.00	0.00	1.97	2.50	1.19	**21.75**	**1.061**	**2011**
2012	1.23	0.13	4.99	4.02	0.01	0.00	0.00	0.01	0.02	0.15	2.20	1.54	**14.30**	**0.698**	**2012**
2013	1.94	0.42	1.21	0.00	0.74	0.00	0.08	0.00	0.00	0.11	1.41	0.37	**6.28**	**0.306**	**2013**
2014	0.06	5.26	1.64	0.31	0.00	0.00	0.02	0.05	0.00	0.32	0.64	6.16	**14.46**	**0.705**	**2014**
2015	1.44	0.74	1.09	0.16	0.66	0.01	0.87	0.00	0.78	0.17	0.21	0.49	**6.62**	**0.323**	**2015**
2016	6.07	0.69	2.75	0.37	0.09	0.01	0.00	0.02	0.00	0.43	1.49	3.44	**15.36**	**0.749**	**2016**
2017	10.30	8.98	0.33	0.09	0.26	0.00	0.01	0.07	0.13	0.00	0.06	0.01	**20.24**	**0.987**	**2017**
2018	3.18	0.35	7.50	0.02	0.01	0.00	0.00	0.00	0.02	0.52	1.87	2.77	**16.24**	**0.792**	**2018**
2019	8.08	8.56	4.15	0.09	1.60	0.01	0.00	0.00	0.03	0.01	2.61	5.12	**30.26**	**1.476**	**2019**

Note: The scaling factor in any given year equals the annual precipitation for that year divided by 20.50 inches, which is the value of 1900-1960 precipitation shown on the isohyetal contour map.

Table B-2

Streamflow at the Lang Station Stream Gage at the Eastern End of the East Subbasin (1980-2019)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Cal Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	1,310	7,446	1,213	568	218	78	6	0	0	0	36	48	**10,923**
1981	157	416	528	388	154	81	20	3	5	159	218	444	**2,573**
1982	465	836	718	573	151	109	16	38	75	364	530	838	**4,713**
1983	967	16,566	5,593	1,251	472	227	306	375	438	248	382	304	**27,129**
1984	246	65	68	25	4	4	0	9	17	102	647	830	**2,017**
1985	686	271	234	94	37	26	4	20	59	257	314	418	**2,420**
1986	604	929	810	484	186	80	29	23	35	113	169	259	**3,721**
1987	267	311	222	180	100	71	22	19	289	519	637	556	**3,193**
1988	553	431	449	393	278	94	74	35	12	74	94	77	**2,564**
1989	15	273	345	286	57	57	6	63	102	94	34	18	**1,350**
1990	5	0	0	9	12	10	11	14	10	29	38	147	**285**
1991	297	955	1,028	766	175	163	38	20	49	73	276	547	**4,387**
1992	573	645	562	474	132	98	17	5	108	144	498	1,446	**4,702**
1993	14,704	5,335	1,194	530	239	110	54	10	64	118	228	1,016	**23,602**
1994	1,483	13,753	1,431	1,119	431	236	81	15	43	103	193	176	**19,064**
1995	110	31	19	2	0	0	0	0	0	0	27	189	**378**
1996	666	896	730	314	151	46	7	0	0	85	252	502	**3,649**
1997	505	345	140	85	33	5	4	50	66	239	566	808	**2,846**
1998	18,991	8,543	3,838	963	667	347	81	91	70	146	199	311	**34,247**
1999	249	217	230	250	200	107	80	46	52	54	31	80	**1,596**
2000	302	458	511	333	214	57	55	41	68	71	65	255	**2,430**
2001	800	1,058	858	417	219	67	27	9	34	152	267	315	**4,223**
2002	235	46	0	0	0	0	0	0	0	0	0	0	**281**
2003	0	404	226	349	109	0	0	0	0	0	0	0	**1,088**
2004	0	30	0	0	0	0	0	0	0	25	0	1,513	**1,568**
2005	13,750	11,074	6,300	2,426	1,484	738	334	122	78	384	328	0	**37,018**
2006	632	532	770	1,390	575	102	0	0	0	0	0	0	**4,000**
2007	5	344	178	118	0	0	0	0	0	20	46	38	**749**
2008	214	447	348	172	0	0	2	0	0	0	0	0	**1,182**
2009	0	43	80	36	0	0	0	0	0	0	0	0	**159**
2010	50	166	253	256	217	118	0	0	0	128	339	490	**2,016**
2011	304	397	908	814	728	332	26	0	0	0	0	0	**3,508**
2012	24	104	241	642	83	0	0	0	0	0	0	0	**1,094**
2013	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2014	0	101	113	0	0	0	0	0	0	0	0	35	**249**
2015	0	0	0	0	0	0	22	0	8	0	0	0	**30**
2016	21	0	1	0	0	0	0	0	0	0	0	1,462	**1,484**
2017	4,478	2,567	1,851	124	68	0	0	0	0	0	0	0	**9,089**
2018	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2019	0	1,645	689	345	307	116	0	0	0	0	0	13	**3,116**

Note: All values are in units of acre-feet.

Table B-3

Releases from Castaic Lagoon to Castaic Creek (1980-2019)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Cal Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	1,998	1,692	2,686	3,767	1,243	2,919	406	55	20	0	0	0	**14,786**
1981	0	935	2,702	512	190	154	48	0	0	0	0	0	**4,541**
1982	0	0	923	3,846	1,702	0	0	0	0	0	0	242	**6,713**
1983	178	53,378	6,804	2,456	0	0	0	0	0	0	235	2,080	**65,131**
1984	1,781	987	1,743	1,957	209	0	0	0	0	0	0	0	**6,677**
1985	169	124	162	173	75	161	306	222	243	228	141	615	**2,619**
1986	1,387	450	219	1,268	990	163	112	9	42	72	101	132	**4,945**
1987	147	141	101	282	26	3	0	0	0	38	212	121	**1,071**
1988	548	718	992	519	1,078	108	204	6	0	7	20	83	**4,283**
1989	121	126	150	256	163	6	0	0	0	0	0	0	**822**
1990	60	117	165	165	21	4	0	0	0	0	0	0	**532**
1991	30	102	0	235	210	227	330	282	239	212	319	89	**2,275**
1992	187	12,174	766	3,232	853	307	210	137	195	129	135	0	**18,325**
1993	180	140	13,139	3,211	2,149	875	589	616	1,083	168	96	431	**22,677**
1994	396	53	7	3,069	1,572	58	152	136	117	228	164	128	**6,080**
1995	155	57	62	92	105	1,758	2,197	2,116	0	74	113	144	**6,873**
1996	0	78	4,961	795	118	109	256	148	161	98	62	0	**6,786**
1997	62	30	8,800	963	70	118	149	150	145	194	137	465	**11,283**
1998	1,248	19,573	10,778	4,596	7,592	47	1,525	591	619	426	772	1,050	**48,817**
1999	736	775	50	3,277	1,284	269	119	116	120	193	106	178	**7,223**
2000	0	660	855	0	2,087	3,484	0	0	0	0	0	0	**7,086**
2001	0	389	1,218	867	221	0	0	0	0	0	0	0	**2,695**
2002	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2003	0	0	0	2,286	418	315	0	0	0	0	0	0	**3,019**
2004	0	59	1,004	0	0	0	0	0	0	0	0	60	**1,123**
2005	32,391	37,514	12,993	3,613	2,891	90	1,657	32	0	0	0	0	**91,181**
2006	1,403	2,185	2,648	5,906	3,395	2,307	0	0	0	0	0	0	**17,844**
2007	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2008	0	1,543	1,377	80	220	3,087	1,441	2,831	0	0	0	0	**10,579**
2009	0	571	1,027	954	0	0	0	0	0	0	0	0	**2,552**
2010	0	0	4,155	5,192	838	0	0	0	0	0	0	0	**10,185**
2011	572	1,180	5,562	12,049	1,165	1,719	0	0	0	0	0	0	**22,247**
2012	0	0	150	553	6	0	0	0	0	0	0	0	**709**
2013	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2014	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2015	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2016	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2017	0	3,261	355	1,639	2,357	7,606	4,363	0	0	0	0	0	**19,581**
2018	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2019	0	666	4,453	8,662	5,184	266	0	0	0	0	0	0	**19,231**

Notes

All values are in units of acre-feet.

Cal = calendar

Table B-4

Releases from Bouquet Reservoir to Bouquet Creek (1980-2019)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Cal Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	60.77	37.90	23.94	295.81	309.36	297.59	297.08	369.51	356.40	62.61	59.99	61.99	**2,232.95**
1981	61.99	55.99	60.77	402.14	514.98	299.38	308.74	307.51	297.59	54.63	68.90	62.61	**2,495.24**
1982	63.84	59.88	65.68	291.65	310.58	297.59	308.74	308.74	298.78	57.70	60.59	65.06	**2,188.83**
1983	63.84	57.66	63.84	204.34	336.36	326.70	332.07	331.45	299.38	69.97	67.72	65.06	**2,218.37**
1984	60.77	58.57	62.61	297.59	310.58	299.38	307.51	307.51	300.56	62.61	59.99	60.77	**2,188.45**
1985	60.77	55.99	61.99	297.59	309.36	298.78	309.36	308.74	307.69	65.06	62.96	66.90	**2,205.21**
1986	63.84	57.10	62.61	298.78	307.51	300.56	309.36	309.36	303.53	70.59	63.56	62.61	**2,209.40**
1987	66.90	61.54	70.59	300.56	310.58	297.59	311.20	308.74	301.75	65.06	62.96	63.84	**2,221.32**
1988	65.06	57.99	62.61	303.53	317.33	304.72	310.58	310.58	302.35	61.99	61.78	62.61	**2,221.14**
1989	65.06	58.77	61.99	298.78	313.65	301.75	309.36	311.20	299.38	97.59	63.56	62.61	**2,243.70**
1990	68.75	57.66	65.06	304.72	312.42	298.78	310.58	313.65	298.78	66.90	65.93	65.06	**2,228.31**
1991	65.68	58.77	68.75	303.53	314.27	304.72	310.58	312.42	304.72	70.59	63.56	66.90	**2,244.49**
1992	65.06	60.87	65.06	295.81	306.29	297.59	304.44	301.38	289.87	58.92	59.99	60.77	**2,166.06**
1993	60.15	57.10	60.15	289.87	305.67	291.65	311.20	307.51	301.75	62.61	59.99	62.61	**2,170.28**
1994	57.08	57.10	58.92	271.46	307.51	293.44	305.67	298.92	296.41	93.91	60.59	63.84	**2,164.85**
1995	60.15	53.78	60.15	294.62	305.67	297.59	305.67	308.74	296.41	68.75	58.81	61.99	**2,172.34**
1996	63.84	56.85	62.61	297.59	306.29	299.38	305.67	306.29	297.59	60.77	58.81	1.23	**2,116.90**
1997	60.77	54.89	65.06	296.41	306.29	296.41	306.29	304.44	296.41	81.02	60.59	62.61	**2,191.17**
1998	62.61	57.10	62.61	127.71	307.51	296.41	304.44	305.67	298.78	243.68	57.62	60.15	**2,184.30**
1999	61.99	55.99	60.77	293.44	307.51	296.41	305.67	305.67	294.62	67.52	60.59	61.99	**2,172.18**
2000	61.99	57.99	70.59	282.15	306.29	298.78	307.51	305.67	294.62	66.90	57.02	60.15	**2,169.68**
2001	60.77	57.10	65.06	292.84	318.56	287.50	306.29	305.67	295.81	63.84	60.59	62.61	**2,176.63**
2002	61.99	55.99	62.61	294.62	307.51	296.41	306.29	306.29	253.64	58.92	57.62	60.77	**2,122.66**
2003	58.92	54.89	65.06	296.41	306.29	296.41	306.29	306.29	292.84	60.77	58.81	60.77	**2,163.72**
2004	60.77	56.85	60.77	284.53	306.29	296.41	306.29	306.29	296.41	67.08	179.45	243.20	**2,464.31**
2005	21.62	26.87	1.03	55.68	65.91	61.89	114.46	62.96	60.96	60.89	58.89	62.96	**654.13**
2006	62.96	52.81	60.89	99.02	124.60	123.83	120.48	126.66	118.54	77.14	60.96	62.96	**1,090.86**
2007	62.96	56.96	62.96	111.34	126.66	122.66	124.60	126.66	122.66	126.66	122.66	103.04	**1,269.83**
2008	62.96	58.96	62.96	117.53	126.66	122.66	126.66	126.66	122.66	126.66	163.49	70.49	**1,288.37**
2009	63.38	59.88	86.65	289.32	316.38	306.73	316.62	306.90	297.00	306.50	297.99	64.35	**2,711.70**
2010	86.33	55.44	102.56	206.12	266.11	288.09	306.90	306.90	297.00	306.90	297.00	119.45	**2,638.81**
2011	60.83	98.88	60.98	202.36	302.98	298.62	306.90	306.90	278.78	302.33	160.78	65.06	**2,445.40**
2012	61.38	57.42	61.38	142.54	93.08	162.08	122.76	124.98	115.41	61.38	52.15	61.38	**1,115.95**
2013	61.38	122.32	184.14	64.39	46.33	44.06	69.93	61.38	55.72	36.04	36.29	29.22	**811.21**
2014	13.35	26.47	30.69	30.29	93.87	89.10	101.55	78.94	71.85	72.97	59.40	50.31	**718.80**
2015	42.97	38.81	55.78	61.93	61.38	59.40	69.91	73.66	58.59	49.10	48.13	29.54	**649.20**
2016	30.69	48.91	61.38	65.76	79.79	77.22	79.79	82.82	65.12	92.07	89.42	61.38	**834.35**
2017	61.38	55.44	61.38	59.40	61.38	66.69	113.30	122.76	118.80	122.76	84.39	92.07	**1,019.74**
2018	92.07	92.07	89.10	92.07	89.10	115.26	122.76	122.56	118.40	122.36	96.36	92.07	**1,244.19**
2019	92.07	92.07	58.51	65.68	90.64	106.84	122.76	122.56	122.76	122.76	122.76	122.76	**1,242.17**

Notes

All values are in units of acre-feet.

Cal = calendar

Table B-5
Spatial Areas and Means of 1900 to 1960 Precipitation for Subwatersheds
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Canyon/Stream	Subwatershed Area (acres)	Contributing Area to Regional Model (acres)	Mean of Precipitation 1900 to 1960 within Each Contributing Area (in/yr)
Bee Canyon	1,163.38	970.06	11.41
Bouquet Canyon	11,995.90	9,100.66	14.09
Bouquet Canyon Tributary 1	409.84	291.36	12.81
Bouquet Canyon Tributary 2	683.75	577.67	13.25
Bouquet Canyon Tributary 3	459.20	393.53	13.18
Lower Castaic Creek	13,109.20	4,205.12	14.73
Upper Castaic Creek	98,417.60	98,417.60	19.62
Charlie Canyon	6,323.41	5,418.33	15.55
Dry Canyon	4,883.13	2,900.08	14.20
Gavin Canyon	3,608.62	2,913.39	21.32
Haskell Canyon	7,608.26	5,976.49	14.01
Hasley Canyon	5,609.59	385.96	14.25
Iron Canyon	1,734.63	1,401.94	18.92
Marple Canyon	6,031.13	4,980.94	17.09
Mint Canyon	5,711.30	4,155.07	12.45
Mint Canyon Tributary 1	615.56	367.82	12.14
Mint Canyon Tributary 2	1,697.89	1,438.90	12.22
Mint Canyon Tributary 3	304.45	296.87	12.61
Mint Canyon Tributary 4	234.88	231.90	12.93
Mint Canyon Tributary 5	118.01	114.80	13.01
Newhall Canyon	3,191.67	1,625.11	18.98
Oak Spring Canyon	3,628.60	2,721.91	16.21
Pico Canyon	4,404.42	2,853.93	19.47
Placerita Canyon	6,117.92	2,490.47	18.20
Plum Canyon	2,085.00	753.09	13.25
Pole Canyon	1,744.04	1,614.78	15.95
Potrero Canyon	2,865.18	1,074.76	15.88
Railroad Aqueduct Canyon	865.82	198.83	20.27
San Francisquito Canyon	31,388.60	26,878.10	16.51

Table B-5
Spatial Areas and Means of 1900 to 1960 Precipitation for Subwatersheds
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Canyon/Stream	Subwatershed Area (acres)	Contributing Area to Regional Model (acres)	Mean of Precipitation 1900 to 1960 within Each Contributing Area (in/yr)
San Martinez Canyon	2,117.60	1,384.49	13.67
Sand Canyon	5,489.51	4,191.58	19.39
Sand Canyon Road Tributary	554.03	508.56	13.12
Sand Canyon Tributary 1	644.26	251.41	15.97
Sand Canyon Tributary 2	338.66	221.79	16.99
Santa Clara River East	12,696.90	2,562.57	14.16
Santa Clara River West	17,105.90	3,169.86	13.76
Santa Clara River Tributary 1	1,278.18	927.13	16.97
Santa Clara River Tributary 2	277.82	264.96	13.64
Santa Clara River Tributary 3	219.50	189.19	13.65
Santa Clara River Tributary 4	101.25	91.84	13.54
Santa Clara River Tributary 5	114.80	106.31	13.44
South Fork Santa Clara River	5,491.11	655.74	17.62
Tapie Canyon	1,260.27	1,235.25	11.39
Texas Canyon	6,956.88	6,659.55	13.59
Tick Canyon	3,662.58	3,428.16	11.57
Tick Canyon Tributary	175.19	154.75	12.09
Towsley Canyon	3,681.64	3,606.56	21.43
Vasquer Canyon	2,743.26	2,151.81	12.66
Whitney Canyon	1,321.58	1,104.38	18.95
Area Totals	**293,241.89**	**217,615.36**	

Note

in/yr = inches per year

Table B-6

Estimated Irrigation Infiltration Rates for Agricultural Lands (1980-2019)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Year	Recorded Agricultural Groundwater Pumping Volume (AF/yr)[a]	Estimated LA County Agricultural Applied Water Volume (AF/yr)[b]	Infiltration Rate (ft/yr)[c]	Infiltration Rate (in/yr)[d]	Infiltration Rate for Modeled Acreage (ft/yr)[e]	Infiltration Rate for Modeled Acreage (in/yr)[e]	Percentage of 1996 through 2000 Average[f]
1980	11,351	---	1.77	21.24	1.20	14.41	90%
1981	13,257	---	2.07	24.84	1.40	16.85	106%
1982	9,704	---	1.51	18.12	1.02	12.29	77%
1983	8,003	---	1.25	15.00	0.85	10.18	64%
1984	11,257	---	1.76	21.12	1.19	14.33	90%
1985	9,348	---	1.46	17.52	0.99	11.89	75%
1986	8,307	---	1.30	15.60	0.88	10.58	66%
1987	6,532	---	1.02	12.24	0.69	8.30	52%
1988	5,971	---	0.93	11.16	0.63	7.57	47%
1989	6,263	---	0.98	11.76	0.66	7.98	50%
1990	8,245	---	1.29	15.48	0.88	10.50	66%
1991	7,059	---	1.10	13.20	0.75	8.95	56%
1992	8,958	---	1.40	16.80	0.95	11.40	72%
1993	8,040	---	1.25	15.00	0.85	10.18	64%
1994	10,626	---	1.66	19.92	1.13	13.51	85%
1995	11,194	---	1.75	21.00	1.19	14.25	89%
1996	12,286	6,728	2.13	25.56	1.44	17.34	109%
1997	13,271	7,528	2.00	24.00	1.36	16.28	102%
1998	10,676	5,980	1.80	21.60	1.22	14.65	92%
1999	14,303	7,479	1.93	23.16	1.31	15.71	99%
2000	12,231	7,476	1.93	23.16	1.31	15.71	99%
Average (1996 through 2000)	**12,553**	**7,038**	**1.96**	**23.50**	**1.33**	**15.94**	**100%**
2001	12,961	---	2.02	24.24	1.37	16.44	103%
2002	13,725	---	2.14	25.68	1.45	17.42	109%
2003	11,121	---	1.73	20.76	1.17	14.08	88%
2004	11,259	---	1.76	21.12	1.19	14.33	90%
2005	8,654	---	1.35	16.20	0.92	10.99	69%
2006	12,411	---	1.94	23.28	1.32	15.79	99%
2007	10,939	---	1.71	20.52	1.16	13.92	87%
2008	9,521	---	1.49	17.88	1.01	12.13	76%
2009	11,440	---	1.78	21.36	1.21	14.49	91%
2010	11,138	---	1.74	20.88	1.18	14.16	89%
2011	10,667	---	1.66	19.92	1.13	13.51	85%
2012	11,296	---	1.76	21.12	1.19	14.33	90%
2013	12,091	---	1.89	22.68	1.28	15.39	97%
2014	9,262	---	1.44	17.28	0.98	11.72	74%
2015	8,868	---	1.38	16.56	0.94	11.23	70%
2016	11,276	---	1.76	21.12	1.19	14.33	90%
2017	10,348	---	1.61	19.32	1.09	13.11	82%
2018	10,231	---	1.60	19.20	1.09	13.03	82%
2019	9,790	---	1.53	18.36	1.04	12.46	78%

Notes

[a] Pumping by Five Point (the Newhall Land & Farming Company). See Table 2 in Appendix A of the *2019 Santa Clarita Valley Water Report* (LSCE, 2020).

[b] See the water use values shown in Figure B-4. Values are from Appendix 2.5m in the document titled *Draft Additional Analysis to the Newhall Ranch Specific Plan and Water Reclamation Plant, Final Environmental Impact Report* (Impact Sciences, 2001).

[c] Calculated as two-thirds of the average infiltration rate of 2.9 AF/acre/yr that has been estimated for the time period 1996 through 2000 as shown in Figure B-4.

[d] Multiply by 12 to convert the infiltration rates from ft/yr to inches/yr.

[e] Actual acreage is 877 acres; in contrast, the acreage of the model cells that partially or fully contain irrigated agricultural land is 1,292.76 acres. Hence, a correction factor is applied to the infiltration rates for use in the model. The correction factor equals 877 / 1,292.76 = 0.6784.

[f] Equals the infiltration rate in a given year divided by the average infiltration rate during the time period 1996 through 2000.

AF/yr = acre-feet per year   ft/yr = feet per year   in/yr = inches per year

Table B-7

Comparison of WRP Discharges with Urban Water Demands (1980-1999)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Calendar Year	Urban Water Use (AF/yr)	Estimated Flows to Septic Systems (AF/yr)	Measured Discharges from WRPs (AF/yr)	Indoor Urban Water Use (AF/yr)	Outdoor Urban Water Use (AF/yr)	Percentage of Urban Demand Used Indoors (Routed to WRPs and Septic Systems)	Percentage of Urban Demand Used Outdoors
1980	21,765	1,920	7,374	9,294	12,471	42.7	57.3
1981	24,299	1,920	7,950	9,870	14,429	32.7	67.3
1982	21,912	1,920	8,438	10,358	11,554	38.5	61.5
1983	21,386	1,920	9,422	11,342	10,044	44.1	55.9
1984	27,386	1,920	9,514	11,434	15,952	34.7	65.3
1985	28,482	1,920	9,616	11,536	16,946	33.8	66.2
1986	31,152	1,920	10,821	12,741	18,411	34.7	65.3
1987	33,877	1,920	11,844	13,764	20,113	35.0	65.0
1988	37,634	1,920	12,365	14,285	23,349	32.9	67.1
1989	42,813	1,920	13,561	15,481	27,332	31.7	68.3
1990	43,066	1,920	14,007	15,927	27,139	32.5	67.5
1991	39,793	1,920	14,109	16,029	23,764	35.5	64.5
1992	41,266	1,920	15,703	17,623	23,643	38.1	61.9
1993	43,352	1,920	17,182	19,102	24,250	39.6	60.4
1994	45,988	1,920	17,023	18,943	27,045	37.0	63.0
1995	45,673	1,920	17,825	19,745	25,928	39.0	61.0
1996	50,147	1,920	16,831	18,751	31,396	33.6	66.4
1997	54,173	1,920	15,777	17,697	36,476	29.1	70.9
1998	48,858	1,920	17,691	19,611	29,247	36.2	63.8
1999	57,250	1,920	17,985	19,905	37,345	31.4	68.6
Statistics for 1980 through 1999							
Minimum	**21,386**	**1,920**	**7,374**	**9,294**	**10,044**	**29.1**	**55.9**
Maximum	**57,250**	**1,920**	**17,985**	**19,905**	**37,345**	**44.1**	**70.9**
Average	**38,014**	**1,920**	**13,252**	**15,172**	**22,842**	**35.6**	**64.4**
Median	**40,530**	**1,920**	**13,784**	**15,704**	**23,704**	**34.9**	**65.1**

Notes

AF/yr = acre-feet per year

WRP = water reclamation plant

Table B-8

Calculation of Outdoor Irrigation Infiltration Rates to Groundwater for Non-Agricultural Water Uses (1980-1999)

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Term	Value	Units	Reference or Calculation Method	Comment
NCWD Annual Water Use, 5-Year Average 1994 through 1998	8,150	AF/yr	Table III-6 in *1999 Annual Basin Report* (Luhdorff and Scalmanini Consulting Engineers, 2000)	16 percent of retailer-supplied water.
SCWD Annual Water Use, 5-Year Average 1994 through 1998	20,920	AF/yr		42 percent of retailer-supplied water.
VWC Total Annual Use, 5-Year Average 1994 through 1998	19,330	AF/yr		40 percent of retailer-supplied water.
LA County 36 Annual Water Use, 5-Year Average 1994 through 1998	570	AF/yr		1 percent of retailer-supplied water.
Valencia Country Club (VCC) Annual Water Use, 5-Year Average 1994 through 1998	490	AF/yr		1 percent of retailer-supplied water.
Annual Water Use, 5-Year Average 1994 through 1998	**49,460**	**AF/yr**		
Area of Water Use (excluding agriculture and undeveloped)	17,691	acres	Aerial photography (1999).	Area where retailer-supplied water is used.
Alluvial Aquifer Area of Water Use (excluding agriculture and undeveloped)	8,000	acres		Alluvial area where retailer-supplied water is used.
Saugus Area of Water Use (excluding agriculture and undeveloped)	9,691	acres		Saugus area where retailer-supplied water is used.
Alluvial Aquifer Lands – Suburban Residential Area	4,765	acres	Aerial photography (1999) and geologic mapping.	60 percent of alluvium area receiving applied water.
Alluvial Aquifer Lands – Retail – Office – Industrial Area	2,900	acres		36 percent of alluvium area receiving applied water.
Alluvial Aquifer Lands – Recreational Area	0	acres		No recreational areas were identified as overlying alluvium.
Alluvial Aquifer Lands – Golf Course Area	335	acres		4 percent of alluvium area receiving applied water.
Saugus Lands – Suburban Residential Area	8,192	acres		85 percent of Saugus area receiving applied water.
Saugus Lands – Retail - Office – Industrial Area	1,411	acres		15 percent of Saugus area receiving applied water.
Saugus Lands – Recreational Area	46	acres		Less than 1 percent of Saugus area receiving applied water.
Saugus Lands -- Golf Course Area	42	acres		Less than 1 percent of Saugus area receiving applied water.
Percent Annual Water Consumption for Outdoor Use -- Suburban Residential	65		Comparison of historical water use records and WRP flow records. See Table B-71.	
Percent Annual Water Consumption for Outdoor Use -- Retail/Office/Industrial	30			
Percent Annual Water Consumption for Outdoor Use -- Recreational	65			
Percent Annual Water Consumption for Outdoor Use -- Golf Course	100			
Percent Applied Water Going to Deep Percolation -- Suburban Residential	10		Assumed irrigation efficiency is 10 percent for all urban land uses where irrigation occurs.	
Percent Applied Water Going to Deep Percolation -- Retail/Office/Industrial	10			
Percent Applied Water Going to Deep Percolation -- Recreational	10			
Percent Applied Water Going to Deep Percolation -- Golf Course	30			
Percent Total Water Use Going to Deep Percolation -- Suburban Residential	6.5		Calculated.	Equals 65 percent times 10 percent.
Percent Total Water Use Going to Deep Percolation -- Retail/Office/Industrial	3.0			Equals 30 percent times 10 percent.
Percent Total Water Use Going to Deep Percolation -- Recreational	6.5			Equals 65 percent times 10 percent
Percent Total Water Use Going to Deep Percolation -- Golf Course	30.0			Equals 100 percent times 30 percent.
Alluvial Aquifer Annual Deep Percolation – Suburban Residential	866	AF/yr	Calculated from total water use (49,460 AF/yr), the area overlying the alluvium for each land use category, and the percentage of total water use going to recharge.	Equals 49,460 AF/yr * (4765 acres / 17691 acres) * 6.5 percent.
Alluvial Aquifer Annual Deep Percolation -- Retail/Office/Industrial	243	AF/yr		Equals 49,460 AF/yr * (2900 acres / 17691 acres) * 3.0 percent.
Alluvial Aquifer Annual Deep Percolation – Recreational	0	AF/yr		No recreational areas overlie alluvium.
Alluvium Annual Deep Percolation -- Golf Course	130	AF/yr		Equals 490 AF/yr * (335 acres / (335+42 acres)) * 30.0 percent.
Alluvial Aquifer Annual Deep Percolation	**1,239**	**AF/yr**		
Alluvial Aquifer 5-Year Deep Percolation (1994 through 1998)	**6,195**	**AF**		
Saugus Annual Deep Percolation – Suburban Residential	1,489	AF/yr	Calculated from total water use (49,460 AF/yr), the area overlying the Saugus for each land use category, and the percentage of total water use going to recharge.	Equals 49,460 AF/yr * (8192 acres / 17691 acres) * 6.5 percent.
Saugus Annual Deep Percolation – Retail/Office/Industrial	118	AF/yr		Equals 49,460 AF/yr * (1411 acres / 17691 acres) * 3.0 percent.
Saugus Annual Deep Percolation – Recreational	8	AF/yr		Equals 49,460 AF/yr * (46 acres / 17691 acres) * 6.5 percent.
Saugus Annual Deep Percolation – Golf Course	16	AF/yr		Equals 490 AF/yr * (42 acres / (335+42 acres) * 30.0 percent.
Saugus Annual Deep Percolation	**1,631**	**AF/yr**		
Saugus 5-Year Deep Percolation (1994 through 1998)	**8,155**	**AF**		
Average Area-Wide Deep Percolation -- Suburban Residential	2.2	in/yr	Calculated from applied water volumes in Alluvial and Saugus samples, as well as combined area in alluvium and Saugus occupied by each land use category.	Equals (12 in/ft)* (866+1,489 AF/yr) / (4,765+8,192 acres).
Average Area-Wide Deep Percolation -- Retail/Office/Industrial	1.0	in/yr		Equals (12 in/ft)* (243+118 AF/yr) / (2,900+1411 acres).
Average Area-Wide Deep Percolation -- Recreational	2.2	in/yr		Equals (12 in/ft)* (0+8 AF/yr) / (0+46 acres).
Average Area-Wide Deep Percolation -- Golf Course	4.6	in/yr		Equals (12 in/ft)* (130+16 AF/yr) / (335+42 acres).

Notes

Applied water recharge to the Saugus Formation includes areas where terrace deposits are present at the ground surface.
AF/yr = acre-feet per year
in/ft = inches per foot
LA = Los Angeles

NCWD = Newhall County Water District (now the Newhall Water Division of the Santa Clarita Valley Water Agency)
SCWD = Santa Clarita Water Division (now the Newhall Water Division of the Santa Clarita Valley Water Agency)
VCC = Valencia Country Club
VWC = Valencia Water Company (now the Newhall Water Division of the Santa Clarita Valley Water Agency)

Table B-9
Irrigation Infiltration Rates over the Year 1999 Suburban Residential Area (1980-2019
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Year	Urban Water Use (AF/yr)	Indoor Urban Water Use (AF/yr)	Estimated Flows to Septic Systems (AF/yr)	Measured Discharges from WRPs (AF/yr)	Outdoor Urban Water Use (AF/yr)	Percentage of Urban Demand Used Outdoors	Outdoor Use as Percentage of Year 2000 Outdoor Use	Equivalent Infiltration Rate Over 1999 Suburban Residential Area (in/yr)
1980	21,765	9,294	1,920	7,374	12,471	57.3%	30.9%	0.68
1981	24,299	9,870	1,920	7,950	14,429	59.4%	35.8%	0.79
1982	21,912	10,358	1,920	8,438	11,554	52.7%	28.6%	0.63
1983	21,386	11,342	1,920	9,422	10,044	47.0%	24.9%	0.55
1984	27,386	11,434	1,920	9,514	15,952	58.2%	39.5%	0.87
1985	28,482	11,536	1,920	9,616	16,946	59.5%	42.0%	0.92
1986	31,152	12,741	1,920	10,821	18,411	59.1%	45.6%	1.00
1987	33,877	13,764	1,920	11,844	20,113	59.4%	49.9%	1.10
1988	37,634	14,285	1,920	12,365	23,349	62.0%	57.9%	1.27
1989	42,813	15,481	1,920	13,561	27,332	63.8%	67.7%	1.49
1990	43,066	15,927	1,920	14,007	27,139	63.0%	67.3%	1.48
1991	39,793	16,029	1,920	14,109	23,764	59.7%	58.9%	1.30
1992	41,266	17,623	1,920	15,703	23,643	57.3%	58.6%	1.29
1993	43,352	19,102	1,920	17,182	24,250	55.9%	60.1%	1.32
1994	45,988	18,943	1,920	17,023	27,045	58.8%	67.0%	1.47
1995	45,673	19,745	1,920	17,825	25,928	56.8%	64.3%	1.41
1996	50,147	18,751	1,920	16,831	31,396	62.6%	77.8%	1.71
1997	54,173	17,697	1,920	15,777	36,476	67.3%	90.4%	1.99
1998	48,858	19,611	1,920	17,691	29,247	59.9%	72.5%	1.59
1999	57,250	19,905	1,920	17,985	37,345	65.2%	92.6%	2.04
2000	60,988	20,641	1,920	18,721	40,347	66.2%	100.0%	2.20
2001	60,736	20,839	1,920	18,919	39,897	65.7%	98.9%	2.18
2002	68,220	22,070	1,920	20,150	46,150	67.6%	114.4%	2.52
2003	67,444	22,168	1,920	20,248	45,276	67.1%	112.2%	2.47
2004	72,296	22,594	1,920	20,674	49,702	68.7%	123.2%	2.71
2005	70,731	25,164	1,920	23,244	45,567	64.4%	112.9%	2.48
2006	73,528	24,844	1,920	22,924	48,684	66.2%	120.7%	2.65
2007	77,311	24,851	1,920	22,931	52,460	67.9%	130.0%	2.86
2008	75,900	25,052	1,920	23,132	50,848	67.0%	126.0%	2.77
2009	69,974	24,449	1,920	22,529	45,525	65.1%	112.8%	2.48
2010	64,066	24,187	1,920	22,267	39,879	62.2%	98.8%	2.17
2011	64,805	23,758	1,920	21,838	41,047	63.3%	101.7%	2.24
2012	69,712	23,874	1,920	21,954	45,838	65.8%	113.6%	2.50
2013	73,460	23,580	1,920	21,660	49,880	67.9%	123.6%	2.72
2014	68,178	23,016	1,920	21,096	45,162	66.2%	111.9%	2.46
2015	54,491	22,078	1,920	20,158	32,413	59.5%	80.3%	1.77
2016	57,966	21,813	1,920	19,893	36,153	62.4%	89.6%	1.97
2017	63,555	22,203	1,920	20,283	41,352	65.1%	102.5%	2.25
2018	65,220	21,997	1,920	20,077	43,223	66.3%	107.1%	2.36
2019	60,078	21,999	1,920	20,079	38,079	63.4%	94.4%	2.08

Notes

The infiltration rate is calculated as the year 2000 residential infiltration rate of 2.2 in/yr times the percentage of outdoor water use in a given year compared with the outdoor water use in the year 2000.

Table B-10
Irrigation Infiltration Rates over the Year 1999 Commercial/Industrial Area (1980-2019)
Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Year	Urban Water Use (AF/yr)	Indoor Urban Water Use (AF/yr)	Estimated Flows to Septic Systems (AF/yr)	Measured Discharges from WRPs (AF/yr)	Outdoor Urban Water Use (AF/yr)	Percentage of Urban Demand Used Outdoors	Outdoor Use as Percentage of Year 2000 Outdoor Use	Equivalent Infiltration Rate Over 1999 Commercial/Industrial Area (in/yr)
1980	21,765	9,294	1,920	7,374	12,471	57.3%	30.9%	0.31
1981	24,299	9,870	1,920	7,950	14,429	59.4%	35.8%	0.36
1982	21,912	10,358	1,920	8,438	11,554	52.7%	28.6%	0.29
1983	21,386	11,342	1,920	9,422	10,044	47.0%	24.9%	0.25
1984	27,386	11,434	1,920	9,514	15,952	58.2%	39.5%	0.40
1985	28,482	11,536	1,920	9,616	16,946	59.5%	42.0%	0.42
1986	31,152	12,741	1,920	10,821	18,411	59.1%	45.6%	0.46
1987	33,877	13,764	1,920	11,844	20,113	59.4%	49.9%	0.50
1988	37,634	14,285	1,920	12,365	23,349	62.0%	57.9%	0.58
1989	42,813	15,481	1,920	13,561	27,332	63.8%	67.7%	0.68
1990	43,066	15,927	1,920	14,007	27,139	63.0%	67.3%	0.67
1991	39,793	16,029	1,920	14,109	23,764	59.7%	58.9%	0.59
1992	41,266	17,623	1,920	15,703	23,643	57.3%	58.6%	0.59
1993	43,352	19,102	1,920	17,182	24,250	55.9%	60.1%	0.60
1994	45,988	18,943	1,920	17,023	27,045	58.8%	67.0%	0.67
1995	45,673	19,745	1,920	17,825	25,928	56.8%	64.3%	0.64
1996	50,147	18,751	1,920	16,831	31,396	62.6%	77.8%	0.78
1997	54,173	17,697	1,920	15,777	36,476	67.3%	90.4%	0.90
1998	48,858	19,611	1,920	17,691	29,247	59.9%	72.5%	0.72
1999	57,250	19,905	1,920	17,985	37,345	65.2%	92.6%	0.93
2000	60,988	20,641	1,920	18,721	40,347	66.2%	100.0%	1.00
2001	60,736	20,839	1,920	18,919	39,897	65.7%	98.9%	0.99
2002	68,220	22,070	1,920	20,150	46,150	67.6%	114.4%	1.14
2003	67,444	22,168	1,920	20,248	45,276	67.1%	112.2%	1.12
2004	72,296	22,594	1,920	20,674	49,702	68.7%	123.2%	1.23
2005	70,731	25,164	1,920	23,244	45,567	64.4%	112.9%	1.13
2006	73,528	24,844	1,920	22,924	48,684	66.2%	120.7%	1.21
2007	77,311	24,851	1,920	22,931	52,460	67.9%	130.0%	1.30
2008	75,900	25,052	1,920	23,132	50,848	67.0%	126.0%	1.26
2009	69,974	24,449	1,920	22,529	45,525	65.1%	112.8%	1.13
2010	64,066	24,187	1,920	22,267	39,879	62.2%	98.8%	0.99
2011	64,805	23,758	1,920	21,838	41,047	63.3%	101.7%	1.02
2012	69,712	23,874	1,920	21,954	45,838	65.8%	113.6%	1.14
2013	73,460	23,580	1,920	21,660	49,880	67.9%	123.6%	1.24
2014	68,178	23,016	1,920	21,096	45,162	66.2%	111.9%	1.12
2015	54,491	22,078	1,920	20,158	32,413	59.5%	80.3%	0.80
2016	57,966	21,813	1,920	19,893	36,153	62.4%	89.6%	0.90
2017	63,555	22,203	1,920	20,283	41,352	65.1%	102.5%	1.02
2018	65,220	21,997	1,920	20,077	43,223	66.3%	107.1%	1.07
2019	60,078	21,999	1,920	20,079	38,079	63.4%	94.4%	0.94

Notes

The infiltration rate is calculated as the year 2000 commercial/industrial infiltration rate of 1.0 in/yr times the percentage of outdoor water use in a given year compared with the outdoor water use in the year 2000.

For example, in 1980, the infiltration rate equals (1.0 in/yr) * (30.9%) = 0.31 in/yr, with the value of 30.9% being equal to 12,471 AF/yr outdoor use in 1980 divided by 40,437 AF/yr outdoor use in 2000.

AF/yr = acre-feet per year   in-year = inches per year

FIGURES

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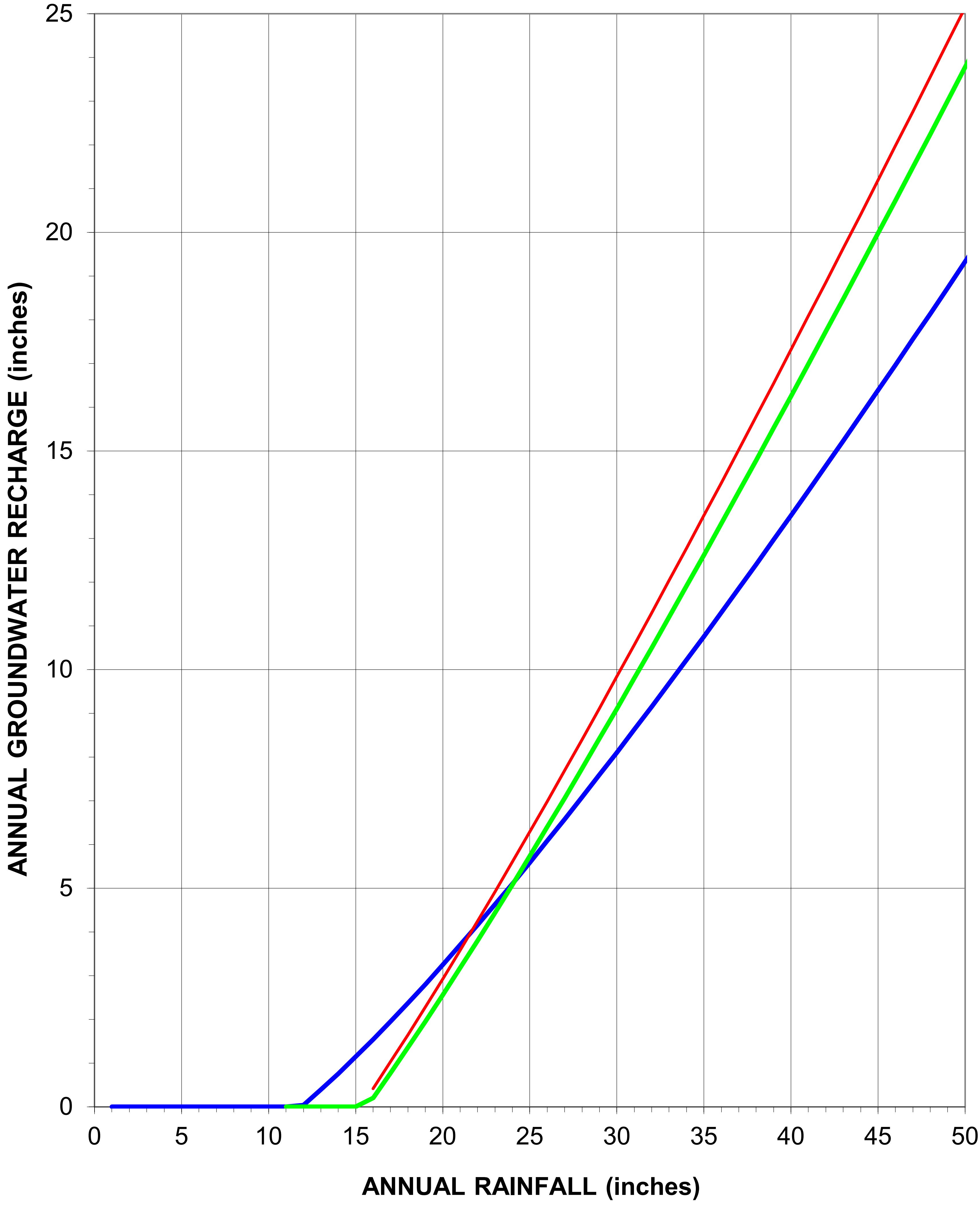

LEGEND

- Statewide Average (A = 2.32 and B = 0.66)
- 2004 Finite-Element Groundwater Flow Model (A = 4.60 and B = 0.445)
- 2020 MODFLOW-USG Groundwater Flow Model (A = 5.00 and B = 0.41)

NOTE

Turner (1986): Annual Recharge = Annual Rainfall - A * (Annual Rainfall ^ B)

FIGURE B-1

Rainfall-Recharge Relationship for the Groundwater Flow Model

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

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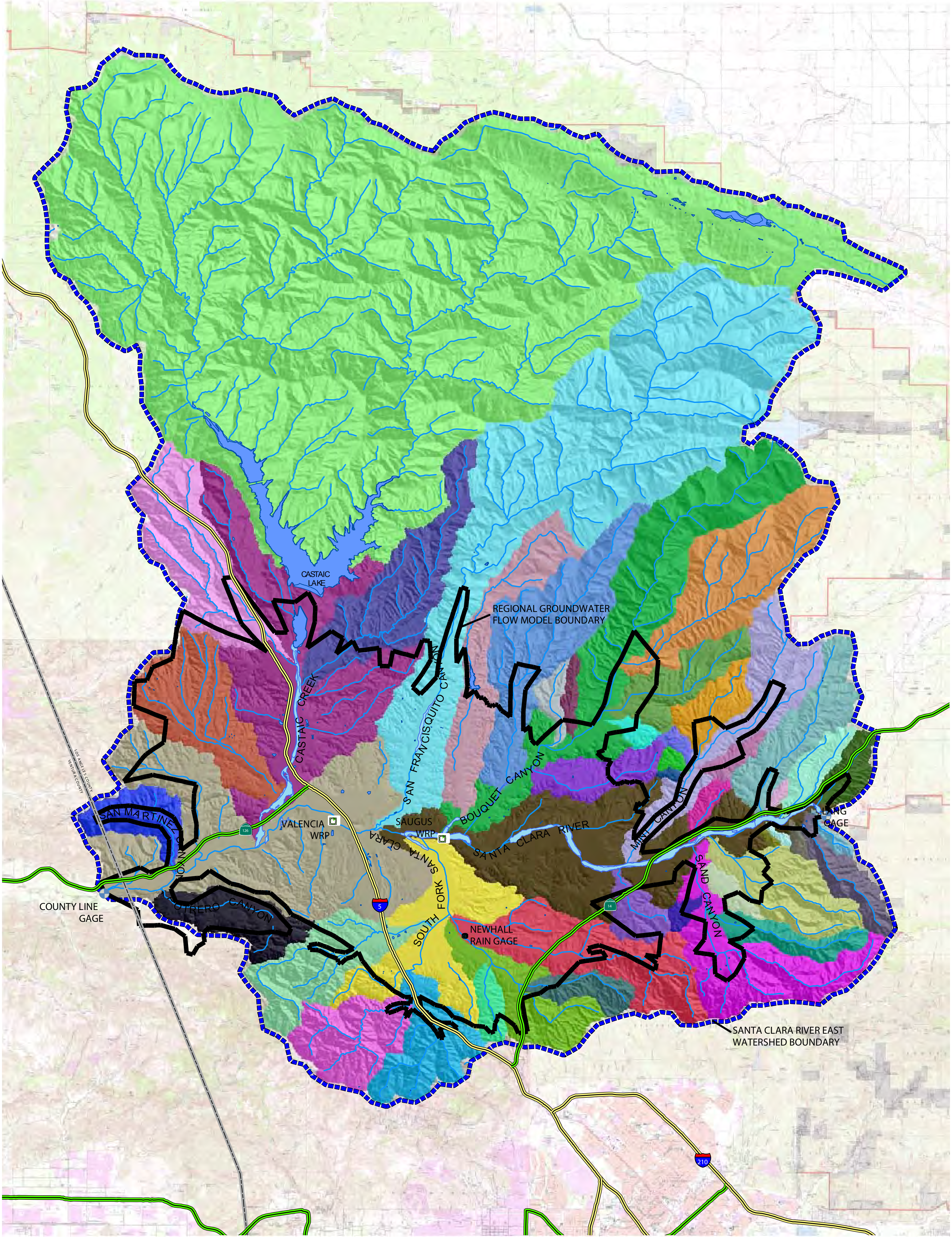

LEGEND

Hydrography

Lake

Stream

Stream Gage

Major Road

Interstate

State Highway

Data Sources: CH2M HILL, 2004

FIGURE B-2

Contributing Watersheds to the Santa Clara River Valley East Groundwater Subbasin

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

N

0 2.5 5

Miles

GSI Water Solutions, Inc.

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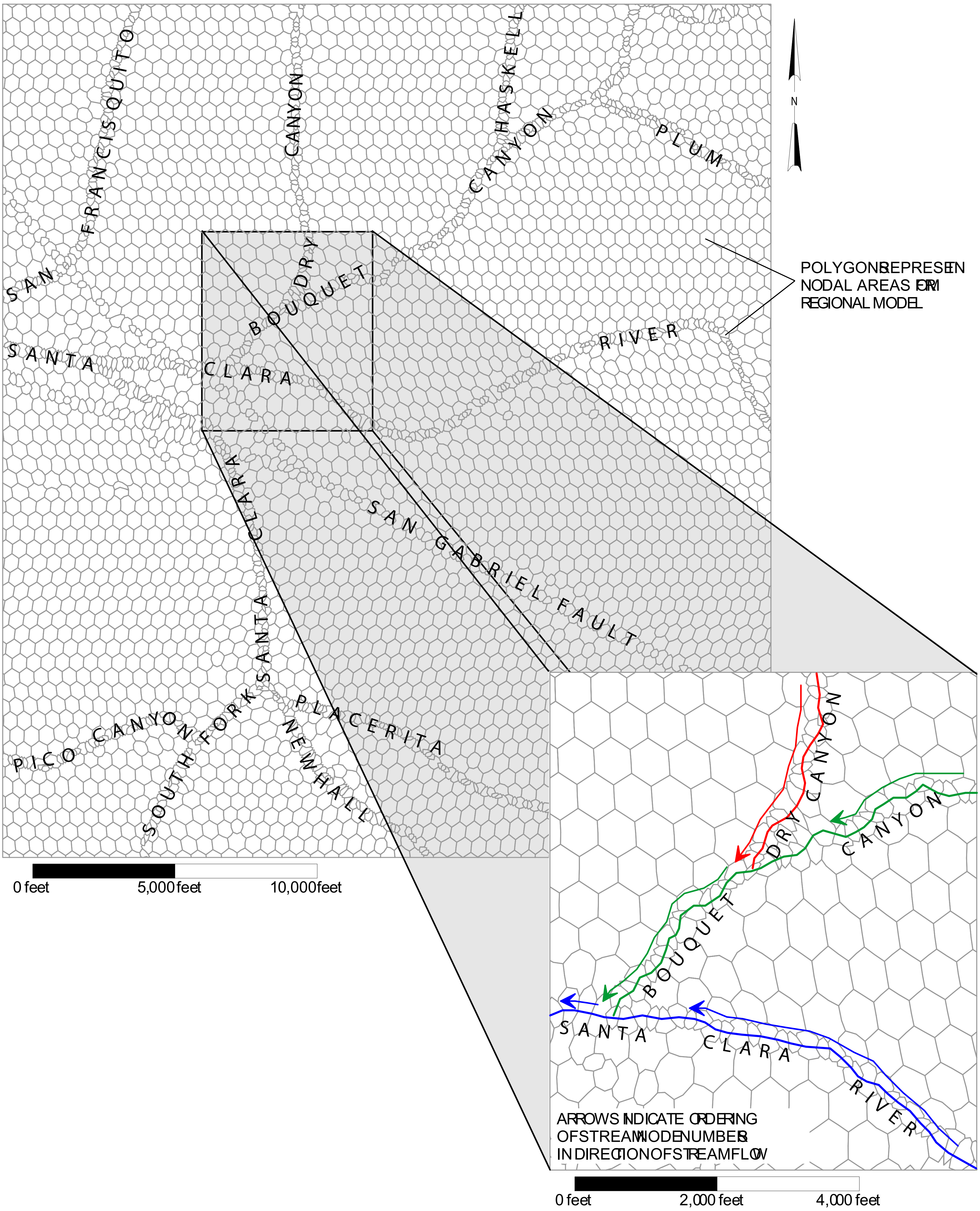

LEGEND

- STREAM RANK = 1
- STREAM RANK = 2
- STREAM RANK = 3

FIGURE B-3

Map Showing Example of Stream Ranking

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

Data Sources: CH2M HILL, 2004

GSI Water Solutions, Inc.

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Year	Acres: Alfalfa	Acres: Sudan	Acres: Vegetables	Acres: Total	Acreage %: Alfalfa	Acreage %: Sudan	Acreage %: Vegetables
1996	105	170	537	812	12.9%	20.9%	66.1%
1997	160	103	663	926	17.3%	11.1%	71.6%
1998	115	100	590	805	14.3%	12.4%	73.3%
1999	55	150	709	914	6.0%	16.4%	77.6%
2000	55	150	722	927	5.9%	16.2%	77.9%
Average	**98**	**134.6**	**644.2**	**876.8**	**11.3%**	**15.4%**	**73.3%**

Year	CIMIS AF/yr: Alfalfa	Sudan	Vegetables
1996	10.21	10.21	7.3
1997	10.22	10.22	7.3
1998	9.4	9.4	6.71
1999	10.51	10.51	7.51
2000	10.37	10.37	7.41
Average	**10.142**	**10.142**	**7.246**

Year	Water Use (AF/yr): Alfalfa	Sudan	Vegetables	Total
1996	1,072	1,736	3,920	6,728
1997	1,635	1,053	4,840	7,528
1998	1,081	940	3,959	5,980
1999	578	1,577	5,325	7,479
2000	570	1,556	5,350	7,476
Average	**987**	**1,372**	**4,679**	**7,038**

Irrigation Efficiency: Alfalfa	Sudan	Vegetables
50%	**50%**	**70%**

Year	Estimated Infiltration (AF/yr): Alfalfa	Sudan	Vegetables	Total
1996	536	868	1,176	2,580
1997	818	526	1,452	2,796
1998	541	470	1,188	2,198
1999	289	788	1,597	2,675
2000	285	778	1,605	2,668
Average	**494**	**686**	**1,404**	**2,583**

Year	Estimated Infiltration (AF/acre/yr): Alfalfa	Sudan	Vegetables	Total
1996	5.1	5.1	2.2	3.2
1997	5.1	5.1	2.2	3.0
1998	4.7	4.7	2.0	2.7
1999	5.3	5.3	2.3	2.9
2000	5.2	5.2	2.2	2.9
Average	**5.1**	**5.1**	**2.2**	**2.9**

AF/yr = acre-feet per year
CIMIS = California Irrigation Management Information System

This represents the average shallow infiltration on irrigated acreage from 1996 through 2000, consistent with the water application of an average 7,038 AF/yr during this period. Values are in AF/acre/year, which is equivalent to feet/year.

SOURCE
Appendix 2.5(m) of Draft Additional Analysis to the Newhall Ranch Specific Plan and Water Reclamation Plant, Final Environmental Impact Report Impact Sciences, Inc. (April 2001)

FIGURE B-4

Analysis of Agricultural Water Use and Associated Watering Occurring Beyond Crop Water Demand Requirements

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

GSI Water Solutions, Inc.

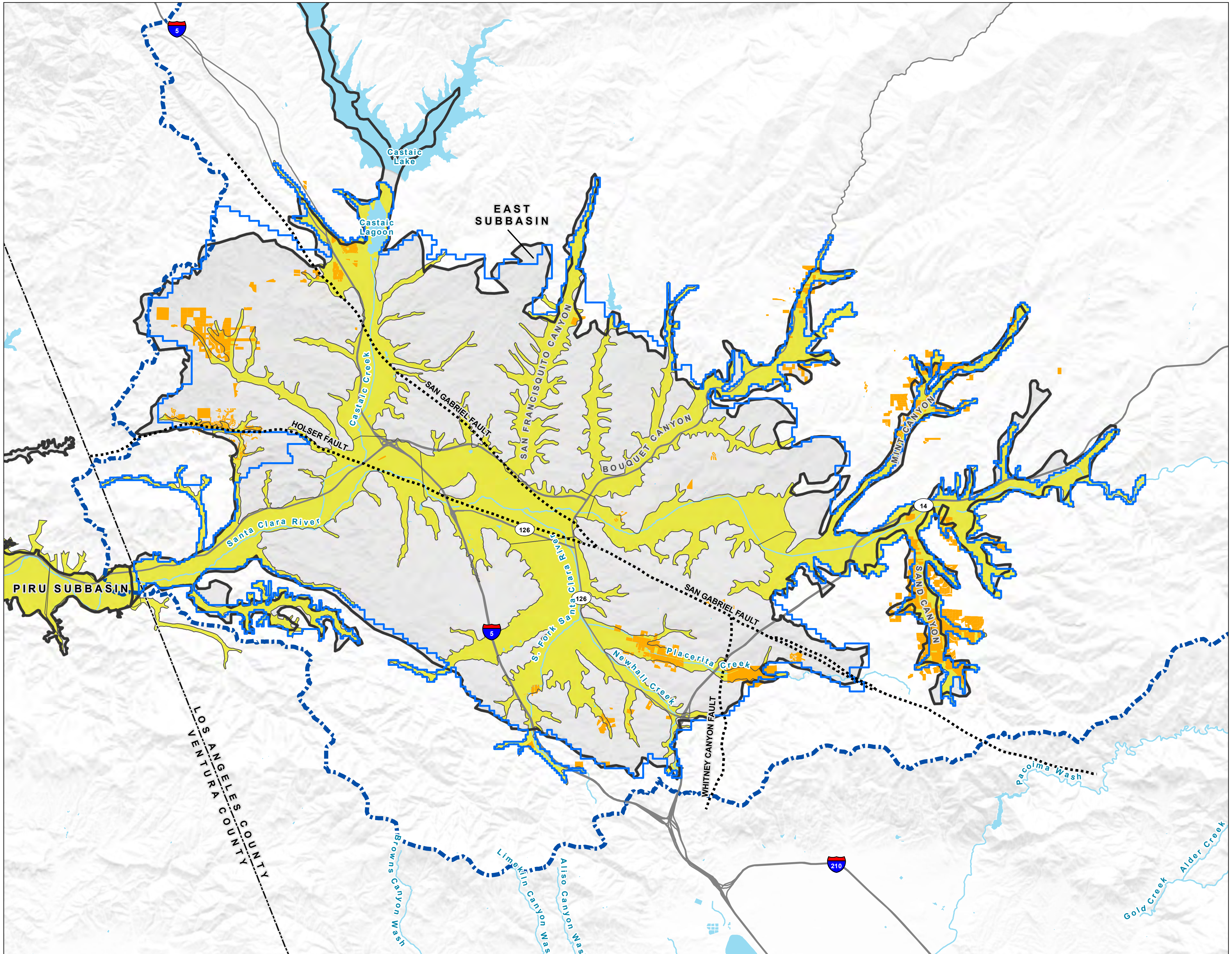

FIGURE B-5

Septic System Locations

Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin

LEGEND

- Model Grid Outline
- Septic System Present
- Alluvial Aquifer
- Santa Clara River Valley Groundwater Basin
- Watershed Boundary

All Other Features

- County Boundary
- Major Road
- Watercourse

N

0 5,000 10,000 15,000
Feet

Date: December 9, 2021
Data Sources: USGS, DWR Bulletin 118

GSI Water Solutions, Inc.

Document Path: Y:\0420_CLWA\Source_Figures\019_EastSubbasinGSP\Santa_Clarita_Modeling_Report\AppendixB\FigureB5_Septic_System_Locations.mxd, abarry

Appendix C. 2007 Geophysical Study Report

December 2021

Prepared by:

GSI Water Solutions, Inc.

5855 Capistrano Avenue, Suite C, Atascadero, CA 93422

Memorandum

DRAFT

TO:	Groundwater/Surface Water Interaction Modeling Subcommittee	**DATE:**	June 18, 2007
FROM:	Tim Keuscher	**PROJ. NO.:**	10354.000.0
CC:	Jeff Weaver	**PROJ. NAME:**	USCR Chloride TMDL Support
SUBJECT:	**Surface Geophysics Program in the Vicinity of Blue Cut**		

Geomatrix Consultants, Inc. (Geomatrix) has prepared this memorandum to summarize results of the surface geophysics program performed in the vicinity of Blue Cut. Data collected during this surface geophysics program will support development of the Groundwater/Surface Water Interaction (GSWI) Model for the Upper Santa Clara River (USCR) TMDL Study. Field work was conducted between February 12 and 27, 2007 and on March 20, 2007.

Purpose

The purpose of this task was to evaluate the depth to bedrock, thickness of alluvium, and thickness of saturated alluvium along the Santa Clara River (SCR) in the Blue Cut area by collecting data using a combination of spectral analysis of surface waves (SASW) and multi-channel analysis of surface wave (MASW) geophysical survey methods. The bedrock in this area is known as the Pico Formation shale. The results of the surface geophysics program will be and have been used for the project in two primary ways. First, the geophysical data will be used to incorporate the subsurface alluvial geometry of the Blue Cut area into the groundwater-surface water interaction model being developed by CH2MHill and HydroGeoLogic (HGL). Second, the data has been used to develop final locations, drilling depths, and well construction details for the proposed groundwater monitoring wells in the Blue Cut area. Locations of the four surface geophysical profiles (Lines 1 through 4), along with Array profiles A, B, and C in the Blue Cut area, are shown on Figure 1.

Background

Characterizing groundwater flow in the alluvial system through Blue Cut was recognized as a key data gap in the GSWI study by the modeling team and GSWI Modeling Subcommittee.

With concurrence of the GWSI Modeling Subcommittee, Geomatrix is addressing this data gap using a three-phased field program. In the first phase, Geomatrix drilled exploratory borings in the Blue Cut area to gain a better understanding of the nature and extent of alluvium and depth to bedrock in this area. This work is summarized below and described in more detail in a previous

510 Superior Avenue, Suite 200
Newport Beach, California 92663-3627
Tel 949.642.0245
Fax 949.642.4474
www.geomatrix.com

Memorandum

memorandum. The second phase included performing the surface geophysical surveys described in this memorandum. The third phase (to be completed) will involve installing three groundwater monitoring wells in the Blue Cut area. Tentative locations for the three monitoring wells were selected before commencing the first and second phases of the field program. It was anticipated that these locations could be revised based on the results of the first and/or second phases.

Geomatrix conducted an exploratory soil boring program from October 30 through November 3, 2006, which consisted of drilling four soil borings (designated GSWI-SB01, GSWI-SB02, GSWI-SB03, and GSWI-SB04) to total depths ranging from 17.5 feet (ft) below ground surface (bgs) to 90 feet bgs. The exploratory borehole locations are shown on Figure 1. Results of the exploratory soil boring program were discussed in detail in a Geomatrix memorandum dated December 22, 2006. In general, bedrock appears to be shallow in the Blue Cut area, with estimated top of bedrock in the four borings being about 5 to 10 feet below the elevation of the river bottom.

As part of the exploratory soil boring program, Geovision Geophysical Services (Geovision) of Corona, California performed geophysical P-S suspension logging in exploratory borehole GSWI-SB03 to collect in-situ shear wave (S-wave) and compressional wave (P-wave) velocities of the alluvium and bedrock. Geovision used the results from the geophysical logging to evaluate the applicability of surface geophysical methods as an aid in further estimating the depth to bedrock and how it varies in the Blue Cut area.

Results of P-S Suspension Logging

P-wave velocities in the alluvium and bedrock were shown to range from approximately 1,150 to 2,000 feet per second (ft/s) and 6,000 to 6,750 ft/s, respectively. The large contrast in P-wave velocities for the alluvium and bedrock indicate that P-wave seismic refraction techniques would be effective at mapping depth to Pico Formation shale bedrock. However, the P-wave velocity of saturated alluvium is expected to be approximately 6,000 ft/s and, therefore, P-wave seismic refraction techniques could not distinguish between saturated alluvium and bedrock.

S-wave velocities in the alluvium and bedrock were shown to range from 550 to 800 ft/s and 950 to 1,700 ft/s, respectively. The S-wave velocities in bedrock increase with depth as weathering decreases. Unlike P-wave velocity, S-wave velocity does not increase significantly at the water table. Geovision indicated that there is sufficient difference in S-wave velocities between alluvium and bedrock that one-dimensional (1-D) or two-dimensional (2-D) surface wave geophysical techniques would be effective to help estimate approximate depths to bedrock in the Blue Cut area.

510 Superior Avenue, Suite 200
Newport Beach, California 92663-3627
Tel 949.642.0245
Fax 949.642.4474
www.geomatrix.com

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Geophysics Scope of Work

The surface geophysical program consisted of a combination of MASW and seismic refraction surveys along four profiles (Lines 1 to 4) totaling approximately 9,000 linear feet as shown on Figure 1. In addition, SASW and/or MASW and seismic refraction soundings were conducted at the original three proposed monitoring well locations (Arrays A, B, and C on Figure 1). Geovision performed the surface geophysical work with oversight by Geomatrix. Representatives of Geomatrix and CH2MHill initially selected surface geophysical profile locations. These locations were selected based on site access, identifying subsurface conditions in the vicinity of the original proposed monitoring well locations, and providing CH2MHill with several cross sections in the Blue Cut area for the GSWI model. Attachment 1 to this memorandum is a detailed discussion of the methodology, instrumentation, field measurement procedures, data reduction and modeling, and results of the surface geophysical investigation. The following paragraphs provide a summary of this information.

The initial task of the surface geophysics program consisted of conducting SASW and/or MASW and seismic refraction soundings at the three proposed monitoring well locations (Arrays A, B, and C), one of which had a known depth to bedrock (GSWI-SB02). The primary purpose of this initial task was to evaluate whether: 1) surface wave techniques could provide reliable estimates of depth to bedrock, 2) saturated alluvium was present at these locations, and 3) the proposed monitoring well locations are appropriate for the subsurface conditions identified. Results from the initial task also helped select the most appropriate surface wave technique for the surface geophysics program (i.e., 1-D SASW soundings or 2-D MASW imaging). The subsequent task of the geophysics program was to conduct 1-D or 2-D surface wave surveys along four profiles (Lines 1 to 4 on Figure 1) to estimate the approximate depth to bedrock along these profiles.

The initial task indicated that active surface wave techniques (SASW and MASW) would provided a reasonable estimate of depth to bedrock at the control location (Array A located adjacent to GSWI-SB02). Additionally, the combined surface wave and seismic refraction soundings found that two of the proposed monitoring well locations (Array A and Array B) did not have saturated alluvium overlying bedrock. As such, alternative locations for these two monitoring wells needed to be evaluated. The absence of saturated alluvium at two of the three proposed monitoring well locations made it important to develop a cost-effective means to estimate both depth to groundwater and bedrock along the four profiles. A decision was made to conduct 2-D MASW soundings along the four profiles and also acquire seismic refraction data using the same geophone array. A total of 52 combined seismic refraction and surface wave soundings (MASW) were performed as part of the geophysics program.

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Technical Approach
Seismic refraction and MASW equipment consisted of two Geometrics Geode signal enhancement seismographs, 4.5-Hz vertical geophones, seismic cable, and two accelerated weight drop (AWD) energy sources. Each station consisted of a single spread of 48 geophones spaced 3.3 ft apart along a linear array for a length of 154 ft. The geophones were mounted on Kevlar reinforced webbing (landstreamer) so they could be towed from station to station using a utility vehicle. Four or more shot point locations were occupied at each station: an end shot 3.3 ft from geophones numbered 1 and 48; a center shot (Arrays A, B, and C only), and one or more off-end shots. An AWD was used as the energy source for each shot point. Seismic refraction and MASW data were acquired at all geophysical stations shown on Figure 1. By utilizing a 1-second record length and a 0.125-millisecond sample rate, it was possible to acquire both seismic refraction and MASW data, simultaneously.

SASW data were collected at Array A with base receiver spacings of 6.6, 13.1, 26.2, 39.4, and 65.6 ft. SASW data were monitored by two Oyo Geospace 1-Hz or 4.5-Hz geophones and recorded by an HP 35670A dynamic signal analyzer. Rock hammers, 3-lb hammers, 12- and 20-lb sledgehammers and an AWD were used as energy sources.

Geovision established the surface geophysical survey stations and then surveyed them using a Nikon total station system. At a minimum, geophysical stations were established at 197 ft intervals along each profile. Psomas, a licensed surveyor from Santa Clarita, California, surveyed the ends of the geophysical profiles to tie the survey to the state plane coordinate system.

<u>Results and Interpretations</u>
In general, results from the surface geophysical profiles included estimated depths to bedrock from the MASW soundings, and to groundwater or bedrock from the seismic refraction soundings. The travel time data, velocity model, and depth sections for the seismic refraction soundings at Arrays A, B, and C are presented in Figures 2 through 4. In general, two layers are interpreted in the depth sections; low velocity unsaturated alluvium and high velocity saturated alluvium or bedrock. The fit of the theoretical dispersion curve to the field data collected at Arrays A, B, and C along with the modeled shear wave velocity profiles are presented in Figures 5 through 7. There is excellent agreement between the dispersion curves (red, blue, and green dots) generated from the SASW, MASW, and passive surface wave data and the theoretical dispersion curves (black circles). Geologic cross-sections showing interpreted depth to saturated alluvium and bedrock along the surface geophysical profiles (Lines 1 through 4; Figure 1) are presented in Figures 8 through 11. Accuracy of the interpreted saturated alluvium, layer thickness, and bedrock depths provided in this memorandum and shown on figures are expected

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to be about 2.5 feet plus 10% of total depth. Subsurface conditions at Arrays A, B, and C and along surface geophysical profile Lines 1 through 4 are discussed and interpreted in greater detail below.

Array A

The shear wave velocity profile for Array A (Figure 5) indicates that shear wave velocity increases with depth from approximately 525 feet per second (ft/s) near the surface to 623 ft/s at a depth of 9.8 ft below ground surface (bgs). A higher velocity layer of approximately 1,230 ft/s was modeled at a depth of 15.6 ft bgs. The shear wave velocity profiles used to match the field data are provided in the table below.

Depth to top of layer (ft)	Layer Thickness (ft)	Shear Wave Velocity (ft/s)
0.0	3.3	525
3.3	6.6	476
9.8	5.7	623
15.6	32.8	1,230
48.4	>50.0	2,297

These results indicate unsaturated alluvium in the shallow depths down to 15.6 ft. The higher velocity layer below 15.6 ft is interpreted as weathered bedrock. The increase in shear wave velocity at a depth of 48.4 ft bgs is likely due to bedrock becoming more competent with depth.

Bedrock was modeled at a depth of 15.6 ft bgs at Array A (proposed monitoring well GSWI-MW01) using both seismic refraction (Figure 2) and MASW techniques. Bedrock was encountered at 16 ft bgs during the advancement of exploratory borehole GSWI-SB02 (located adjacent to Array A; see Figure 1). Both the seismic refraction and MASW soundings modeled depth to bedrock at 15.6 ft bgs; therefore, saturated alluvium does not appear to exist in the vicinity of Array A.

Array B

The shear wave velocity profile for Array B (Figure 6) indicates that shear wave velocity increases slightly with depth from approximately 591 ft/s near the surface to 623 ft/s at a depth of 18.0 ft bgs. A higher velocity layer of approximately 1,148 ft/s was modeled at a depth of 27.9 ft bgs. The shear wave velocity profiles used to match the field data are provided in the table below.

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Depth to top of layer (ft)	Layer Thickness (ft)	Shear Wave Velocity (ft/s)
0.0	6.6	591
6.6	11.5	558
18.0	9.8	623
27.9	16.4	1,148
44.3	>54.1	2,789

These results indicate unsaturated alluvium in depths down to 27.9 ft. The higher velocity layer below 27.9 ft is interpreted as weathered bedrock. The increase in shear wave velocity at a depth of 44.3 ft bgs is likely due to bedrock becoming more competent with depth.

Bedrock was modeled at a depth of 27.1 ft bgs and 27.9 ft bgs at Array B (proposed monitoring well GSWI-MW03) using seismic refraction (Figure 3) and MASW techniques, respectively. Because MASW and seismic refraction soundings are within 0.8 ft of each other, it appears both geophysical methods modeled depth to bedrock; therefore, saturated alluvium does not appear to exist in the vicinity of Array B.

Array C

The shear wave velocity profile for Array C (Figure 7) indicates that shear wave velocity increases with depth from approximately 361 ft/s near the surface to 705 ft/s at a depth of 12.3 ft, likely due to increase in moisture content and/or density of sediments. A higher velocity layer of approximately 1,148 ft/s was modeled at a depth of 37.7 ft bgs. The shear wave velocity profiles used to match the field data are provided in the table below.

Depth to top of layer (ft)	Layer Thickness (ft)	Shear Wave Velocity (ft/s)
0.0	3.3	361
3.3	9.0	509
12.3	25.4	705
37.7	55.8	1,148
93.5	>4.9	2,297

These results indicate unsaturated alluvium in the shallow depths down to 12.3 ft, with increasing saturation with depth. Saturated alluvium extends to a depth of 37.7 ft. The higher velocity layer below 37.7 ft is interpreted as weathered bedrock. The increase in shear wave velocity at a depth of 93.5 ft is likely due to bedrock becoming more competent with depth.

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Bedrock was modeled at a depth of 37.7 ft bgs bgs at Array C (proposed monitoring well GSWI-MW02) using MASW techniques. Groundwater was modeled at a depth of 9.8 feet bgs using seismic refraction techniques. Results of these soundings indicate there is approximately 18 feet of saturated alluvium in the vicinity of Array C.

Line 1
The scaled interpreted 2D geologic cross-section for Line 1 is presented as Figure 8. Seismic refraction and MASW soundings were collected along Line 1 at fifteen locations. Results of the seismic refraction and MASW soundings conducted along Line 1 are provided in the table below.

Station ID	Bedrock Depth (ft) MASW	Bedrock OR Groundwater Depth (ft) Seismic Refraction
L1-30	19.7	23.0
L1-90	16.4	18.0
L1-150	18.0	17.2
L1-210	14.8	11.5
L1-270	9.8	4.9
L1-360	6.6	2.5
L1-510	24.6	23.8
L1-570	31.2	18.9
L1-630	30.3	16.4
L1-703	36.1	21.3
L1-747	41.0	28.7
L1-810	55.8	41.8
L1-870	55.8	39.4
L1-930	55.8	44.3
L1-990	55.8	50.9

These results indicate three distinct layers; alluvium, saturated alluvium, and bedrock (Figure 8). Saturated alluvium does not appear to exist north of the river along Line 1 (stations L1-30, L1-90, and L1-150). There appears to be a thin layer of saturated alluvium beneath the present day river between stations L1-150 and L1-510. The thickest section of saturated alluvium appears to be in the vicinity of Salt Creek (between stations L1-630 and L1-703).

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Newport Beach, California 92663-3627
Tel 949.642.0245
Fax 949.642.4474
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Line 2

The scaled interpreted 2D geologic cross-section for Line 2 is presented as Figure 9. Seismic refraction and MASW soundings were collected along Line 2 at nine locations. Results of the seismic refraction and MASW soundings conducted along Line 2 are provided in the table below.

Station ID	Bedrock Depth (ft) MASW	Bedrock OR Groundwater Depth (ft) Seismic Refraction
L2-30	52.5	49.2
L2-90	45.9	44.3
L2-150	37.7	36.1
L2-204	36.1	36.9
L2-266	32.8	32.8
L2-293.5	32.8	31.2
L2-371.5	18.9	10.7
L2-390	19.7	9.8
L2-421.5	15.6	9.8

These results indicate three distinct layers; alluvium, saturated alluvium, and bedrock (Figure 9). There appears to be a thin layer of saturated alluvium near the southern end of Line 2 between stations L2-371.5 and L2-421.5.

Line 3

The scaled interpreted 2D geologic cross-section for Line 3 is presented as Figure 10. Seismic refraction and MASW soundings were collected along Line 3 at thirteen locations. Results of the seismic refraction and MASW soundings conducted along Line 3 are provided in the table below.

Station ID	Bedrock Depth (ft) MASW	Bedrock OR Groundwater Depth (ft) Seismic Refraction
L3-0	24.6	25.4
L3-30	24.6	23.8
L3-90	20.5	21.3
L3-150	19.7	18.0
L3-210	10.7	12.3
L3-270	9.8	13.1
L3-330	9.0	9.8

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Station ID	Bedrock Depth (ft) MASW	Bedrock OR Groundwater Depth (ft) Seismic Refraction
L3-390	8.2	7.4
L3-559	12.3	11.5
L3-600	13.1	9.8
L3-660	14.8	9.0
L3-720	15.6	9.8
L3-780	19.7	8.2

These results indicate three distinct layers; alluvium, saturated alluvium, and bedrock (Figure 10). There appears to be a thin layer of saturated alluvium north of the river between stations L3-559 and L3-780 (southern portion of Line 3); however, saturated alluvium does not appear to exist in the northern portion (L3-0 through L3-390) of Line 3.

Line 4
The scaled interpreted 2D geologic cross-section for Line 4 is presented as Figure 11. Seismic refraction and MASW soundings were collected along Line 4 at thirteen locations. Results of the seismic refraction and MASW soundings conducted along Line 4 are provided in the table below.

Station ID	Bedrock Depth (ft) MASW	Bedrock OR Groundwater Depth (ft) Seismic Refraction
L4- -105	31.2	15.6
L4- -60	32.8	11.5
L4-0	39.4	9.8
L4-30	37.7	9.8
L4-90	37.7	9.0
L4-120	37.7	6.6
L4-180	31.2	1.6
L4-287	32.0	3.0
L4-330	29.5	5.7
L4-390	28.7	9.8
L4-450	26.2	9.8
L4-510	24.6	10.7
L4-570	16.4	13.1

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These results indicate three distinct layers; alluvium, saturated alluvium, and bedrock (Figure 11). There appears to be a thin layer of alluvium along the entire length of Line 4. There also appears to be a thick section of saturated alluvium along the entire length of Line 4.

Summary of Geophysical Results

Geophysical results confirm that bedrock is relatively shallow in the Blue Cut area, and that saturated alluvium is locally isolated, with thicknesses ranging from 0 to a maximum of approximately 30 feet in the areas investigated. The shallow depth to bedrock in the Blue Cut area is consistent with findings from the exploratory boring program. Geomatrix and Geovision have evaluated the results from the surface geophysics to estimate saturated alluvial thickness at the original locations for the proposed monitoring wells. Based on the results of the surface geophysics, saturated alluvium does not appear to exist in the vicinity of two of the three originally proposed monitoring well locations (GSWI-MW01 and GSWI-MW03). However, areas where some saturated alluvium likely exists were identified along the profiles that coincide with the original locations for the proposed monitoring wells. Therefore, new locations are proposed for monitoring wells GSWI-MW01 and GSWI-MW03 as shown on Figure 1. Recommendations for the new proposed well locations and well construction details will be provided in a separate memorandum.

Enclosures:

Figure 1	Surface Geophysical Profiles in Blue Cut Area
Figure 2	Seismic Refraction Model – Array A
Figure 3	Seismic Refraction Model – Array B
Figure 4	Seismic Refraction Model – Array C
Figure 5	Velocity Model for Active and Passive Surface Waves – Array A
Figure 6	Velocity Model for Active and Passive Surface Waves – Array B
Figure 7	Velocity Model for Active and Passive Surface Waves – Array C
Figure 8	Geologic Cross Section – Line 1
Figure 9	Geologic Cross Section – Line 2
Figure 10	Geologic Cross Section – Line 3
Figure 11	Geologic Cross Section – Line 4
Attachment 1	Geovision Draft Report – Geophysical Investigation, Blue Cut Area

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Newport Beach, California 92663-3627
Tel 949.642.0245
Fax 949.642.4474
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Explanation

- Surface Geophysical Profile
- Seismic Refraction and Surface Wave Sounding
- Exploratory Surface Geophysical Array
- Exploratory Borehole
- Proposed Monitoring Well Location (subject to change)

Note: Aerial photo not to scale

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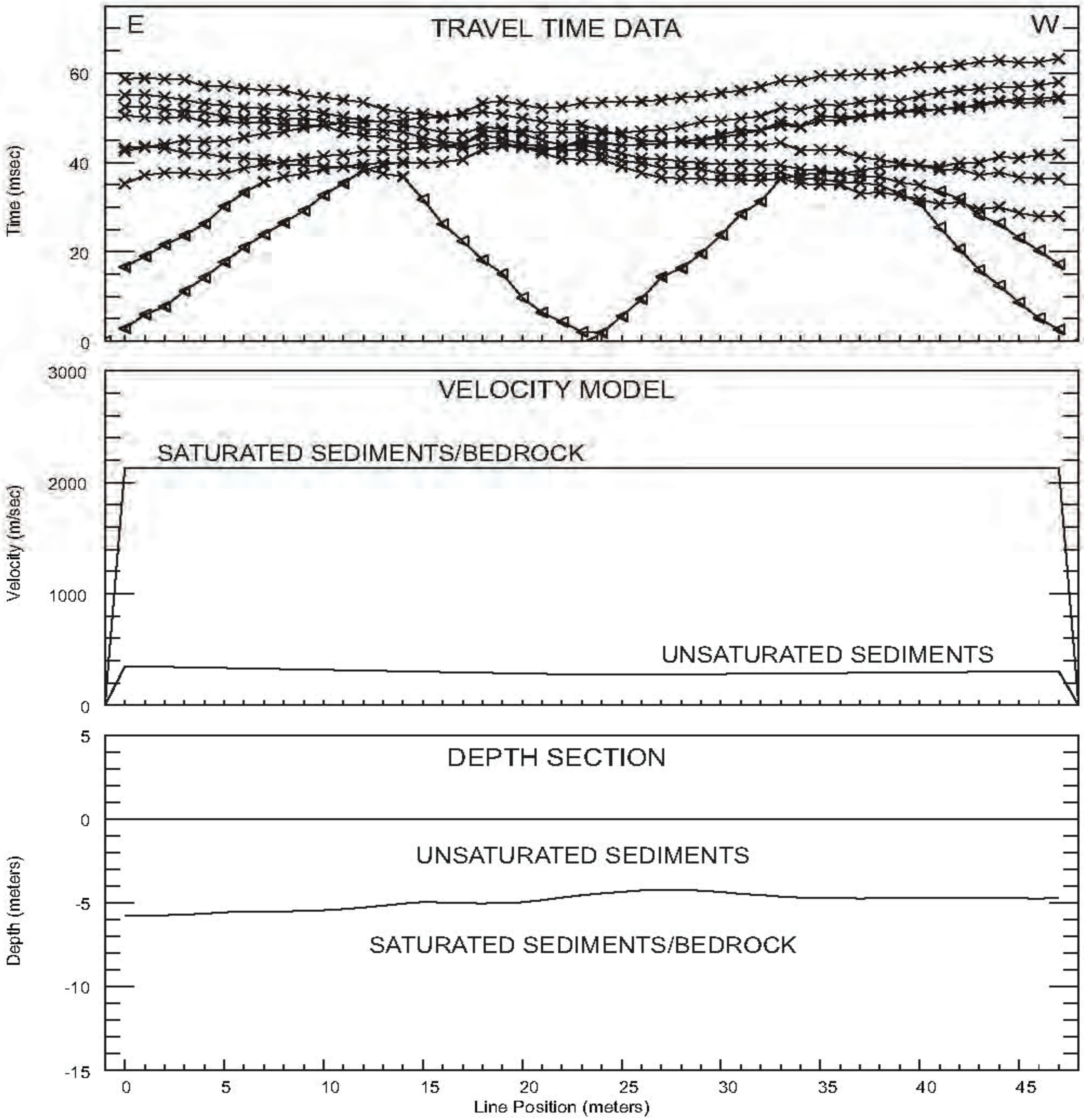
SURFACE GEOPHYSICAL PROFILES IN BLUE CUT AREA

Task 1B - Data Collection Upper Santa Clara River Chloride TMDL Collaborative Process

By: PRJ | Date: 05/11/07 | Project No. 10354.000

Geomatrix

Figure 1



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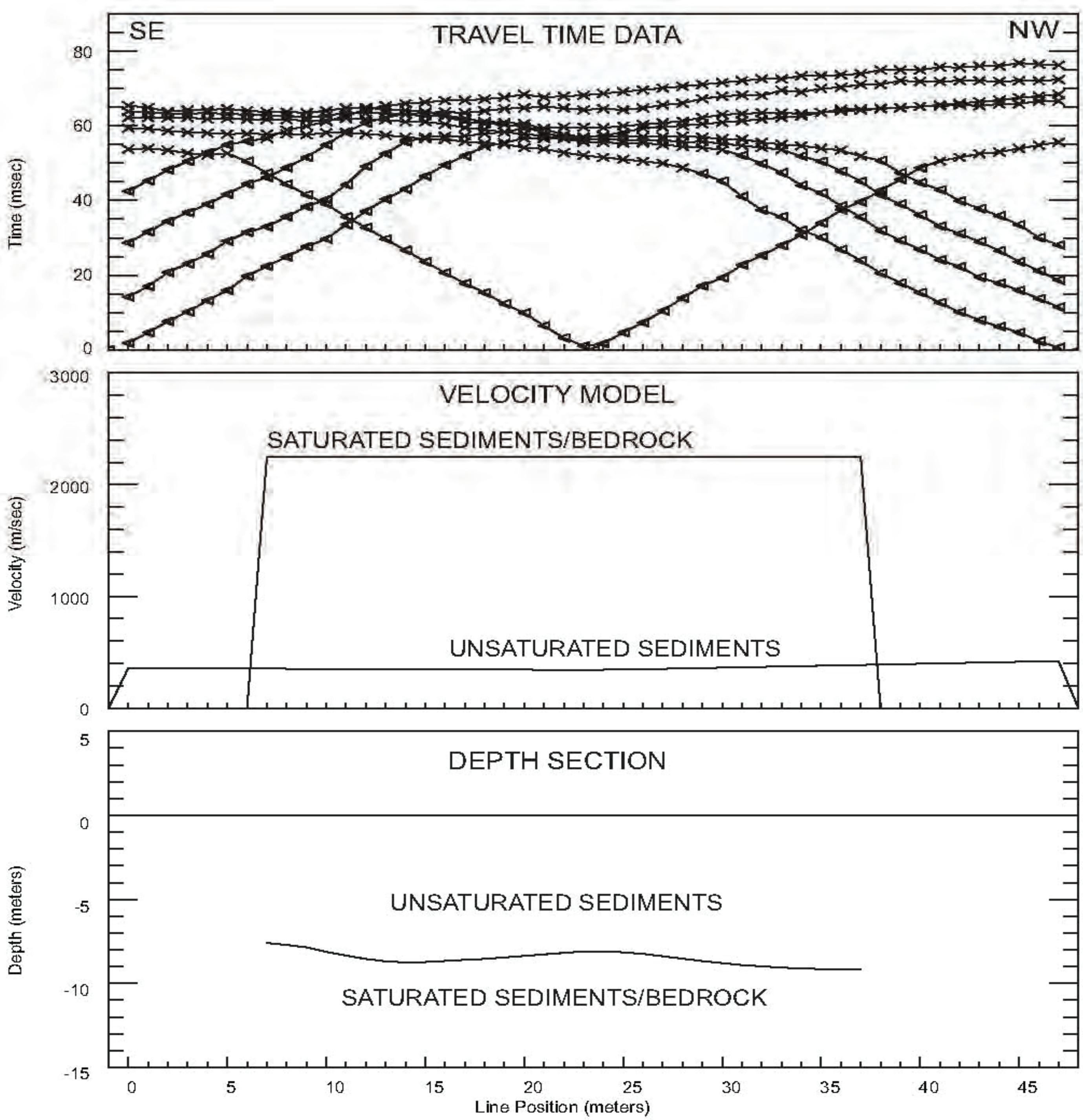
SEISMIC REFRACTION MODEL
ARRAY A

Task 1B - Data Collection Upper Santa Clara River Chloride TMDL Collaborative Process

By: PRJ	Date: 05/15/07	Project No. 10354.000
Geomatrix		Figure 2



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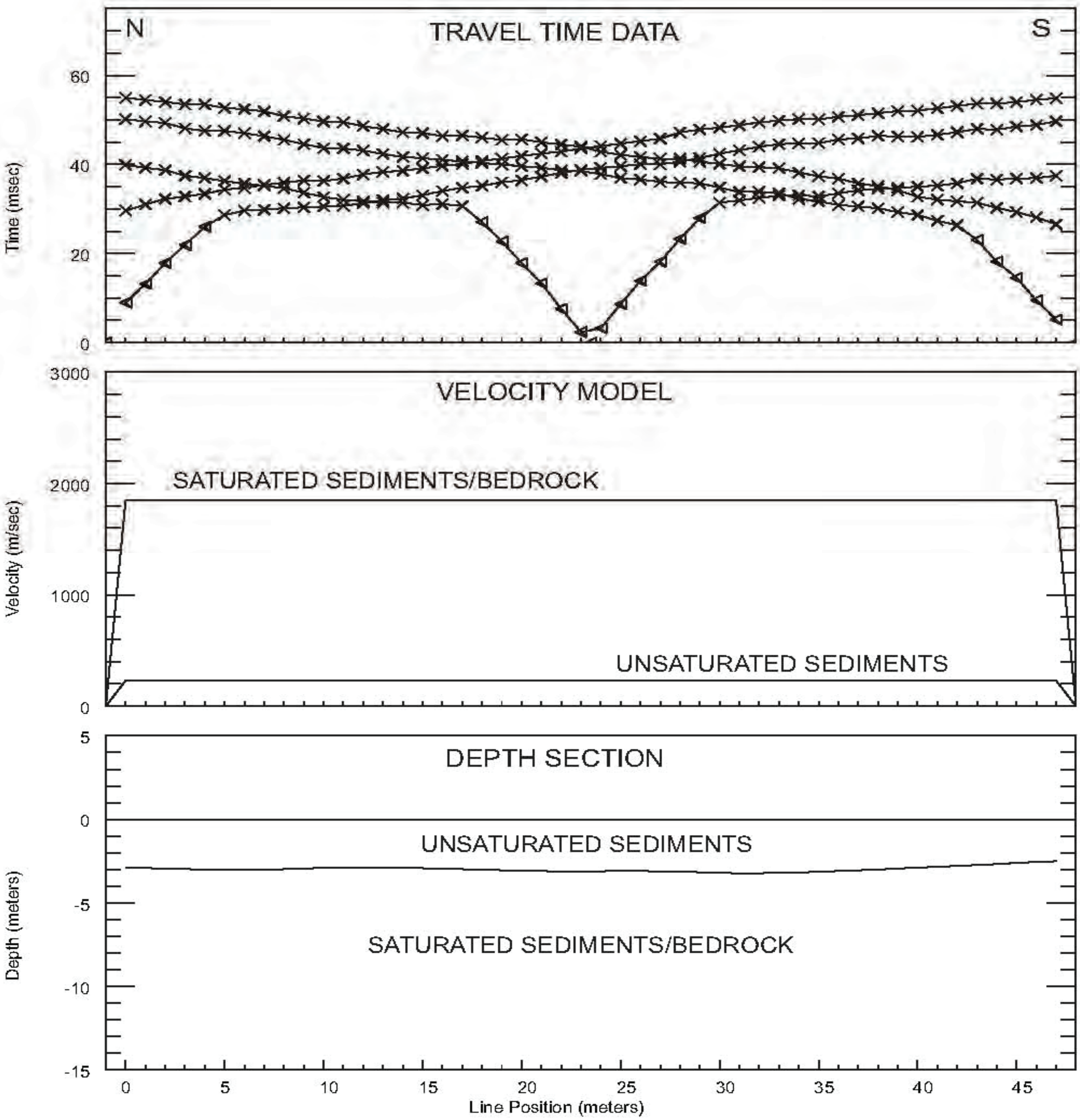
SEISMIC REFRACTION MODEL ARRAY B Task 1B - Data Collection Upper Santa Clara River Chloride TMDL Collaborative Process		
By: PRJ	Date: 05/15/07	Project No. 10354.000
Geomatrix		Figure 3



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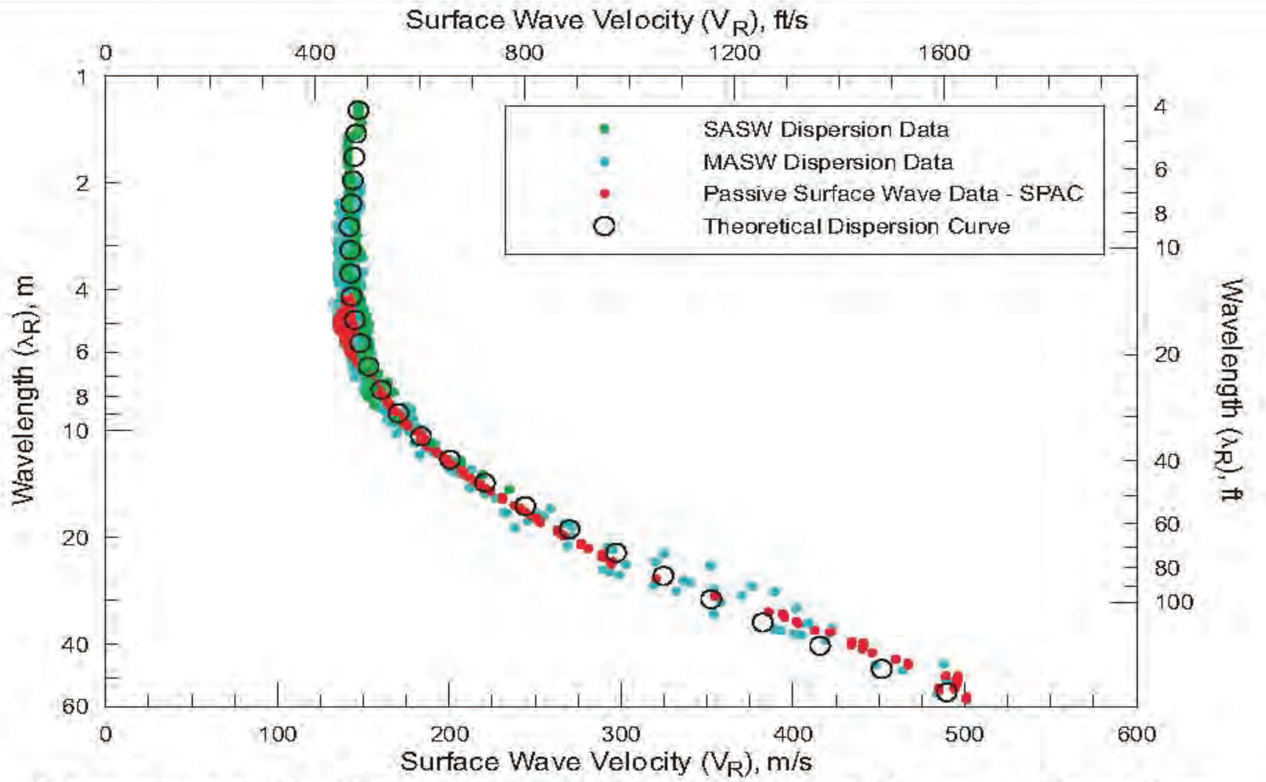
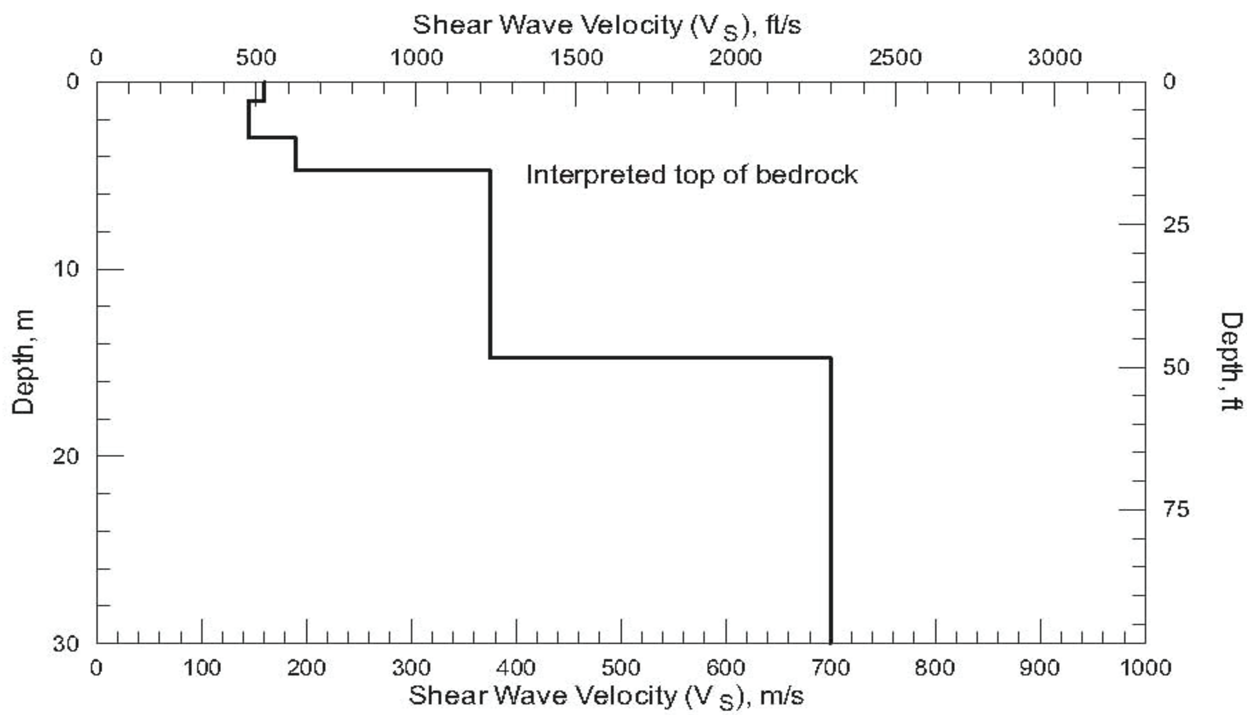
SEISMIC REFRACTION MODEL
ARRAY C
Task 1B - Data Collection Upper Santa Clara River Chloride TMDL Collaborative Process

By: PRJ	Date: 05/15/07	Project No. 10354.000
Geomatrix		Figure 4



Comparison of Field Experimental Data and Theoretical Dispersion Curve from Active and Passive Surface Wave Array A (next to GSWI-SB02)



V_S Profile from Active and Passive Surface Wave Array A (next to GSWI-SB02)

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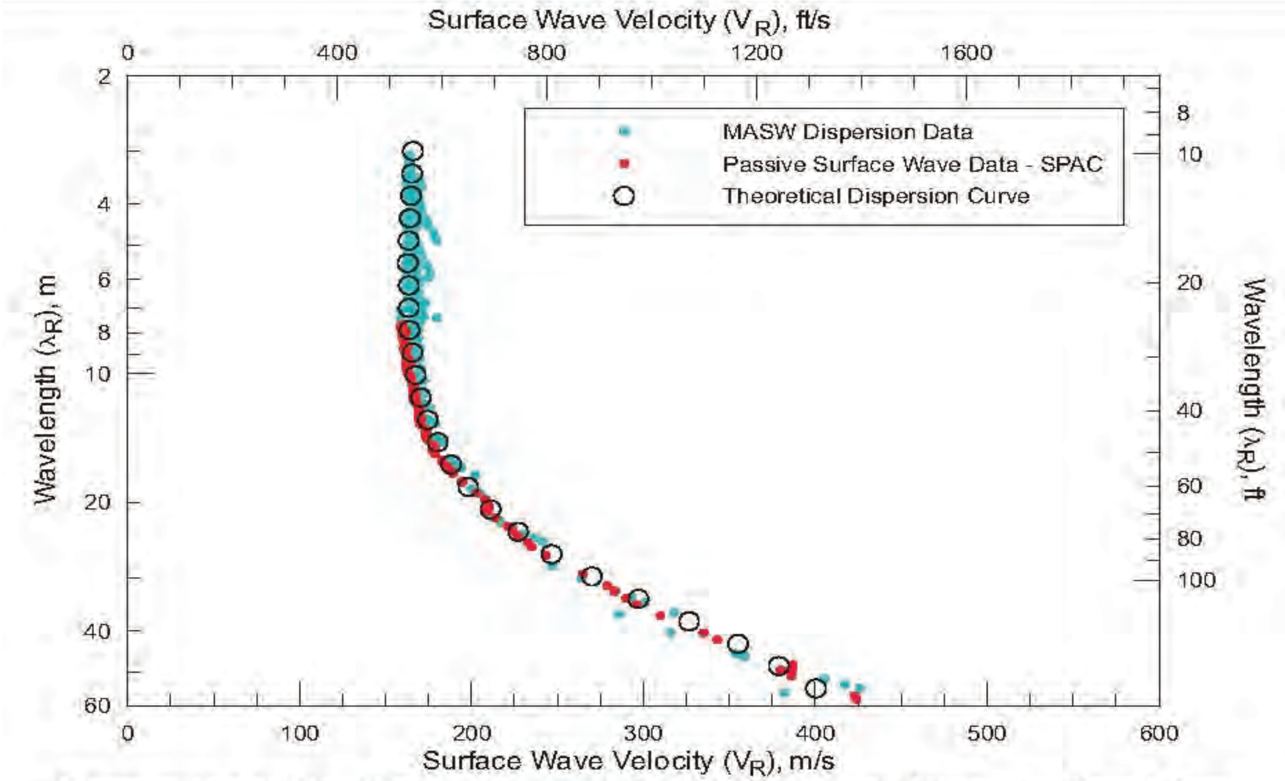
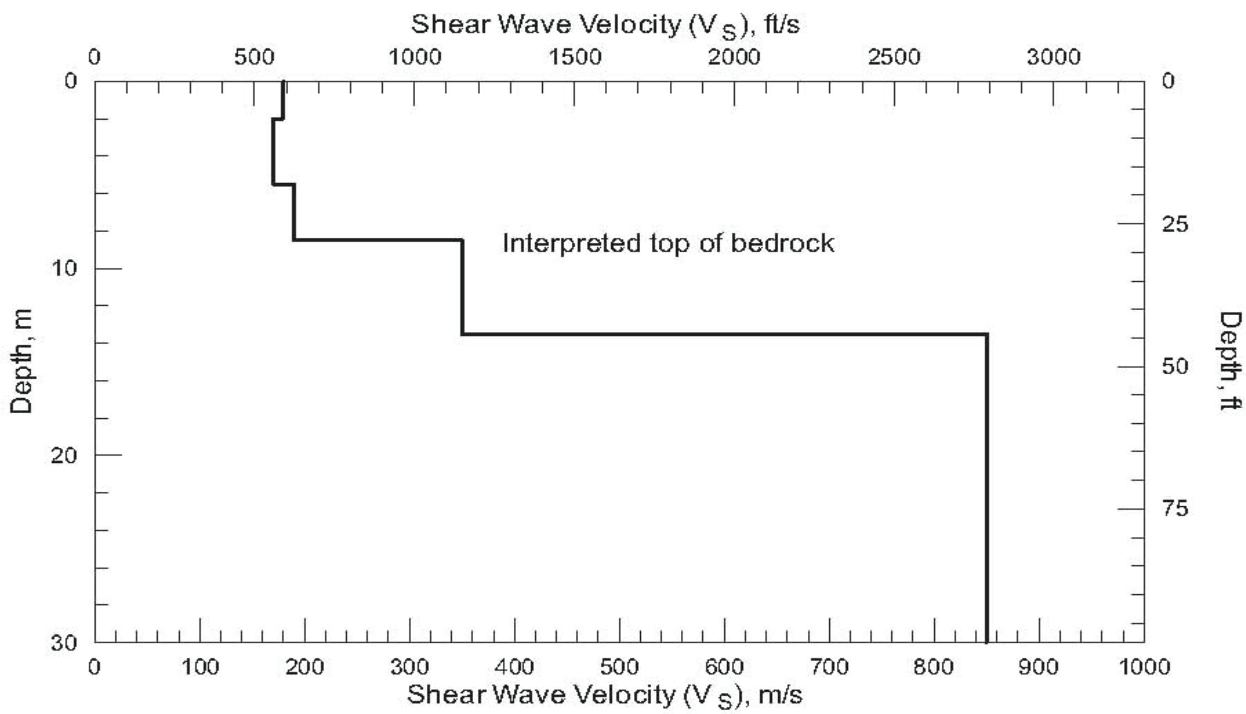
VELOCITY MODEL FOR ACTIVE AND PASSIVE SURFACE WAVES - ARRAY A Task 1B - Data Collection Upper Santa Clara River Chloride TMDL Collaborative Process		
By: PRJ	Date: 05/15/07	Project No. 10354.000
Geomatrix		Figure 5



Comparison of Field Experimental Data and Theoretical Dispersion Curve from Active and Passive Surface Wave Array B



V_S Profile from Active and Passive Surface Wave Array B

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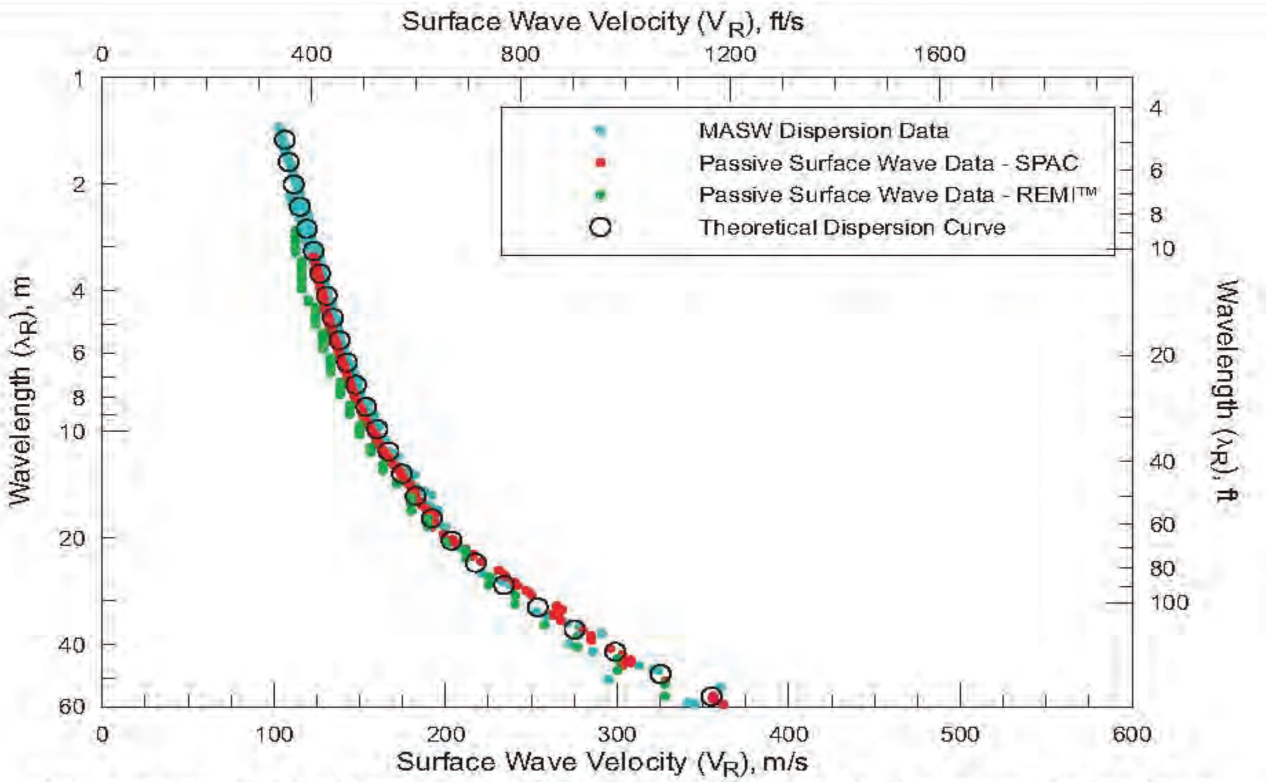
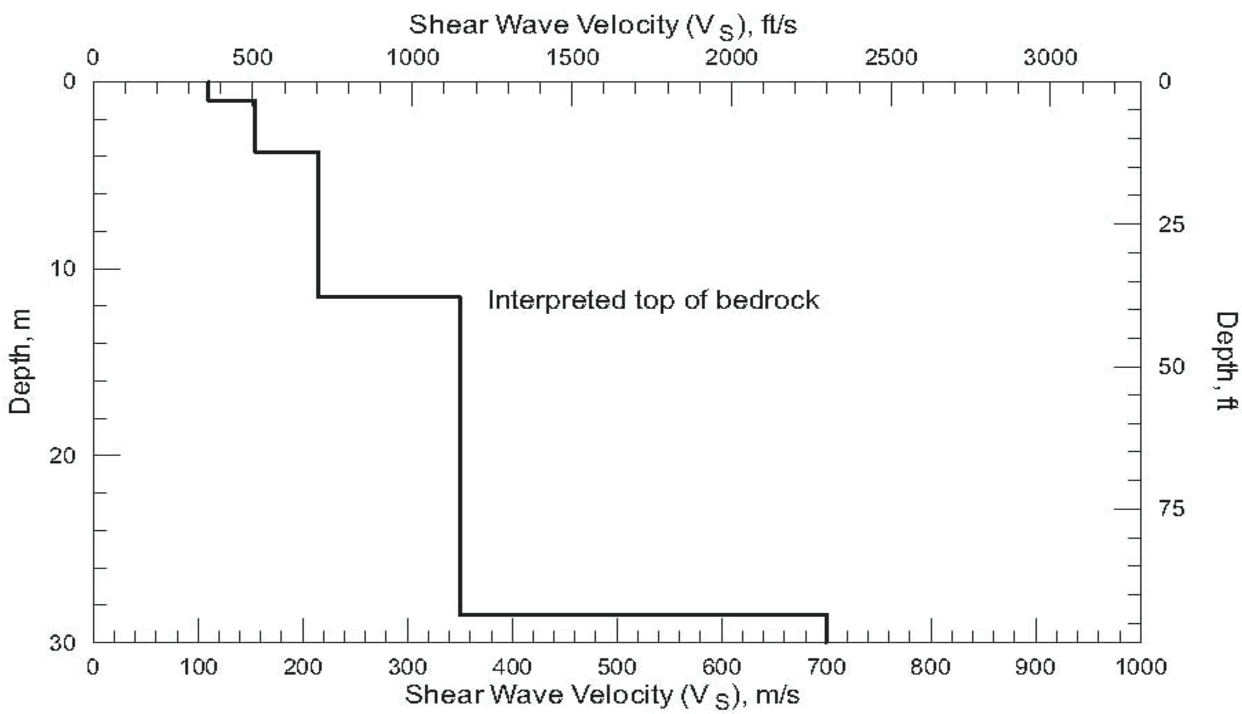
VELOCITY MODEL FOR ACTIVE AND PASSIVE SURFACE WAVES - ARRAY B Task 1B - Data Collection Upper Santa Clara River Chloride TMDL Collaborative Process		
By: PRJ	Date: 05/15/07	Project No. 10354.000
Geomatrix		Figure 6



Comparison of Field Experimental Data and Theoretical Dispersion Curve from Active and Passive Surface Wave Array C (Line 4, Station 30 m)



V_S Profile from Active and Passive Surface Wave Array C (Line 4, Station 30 m)

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VELOCITY MODEL FOR ACTIVE AND PASSIVE SURFACE WAVES - ARRAY C

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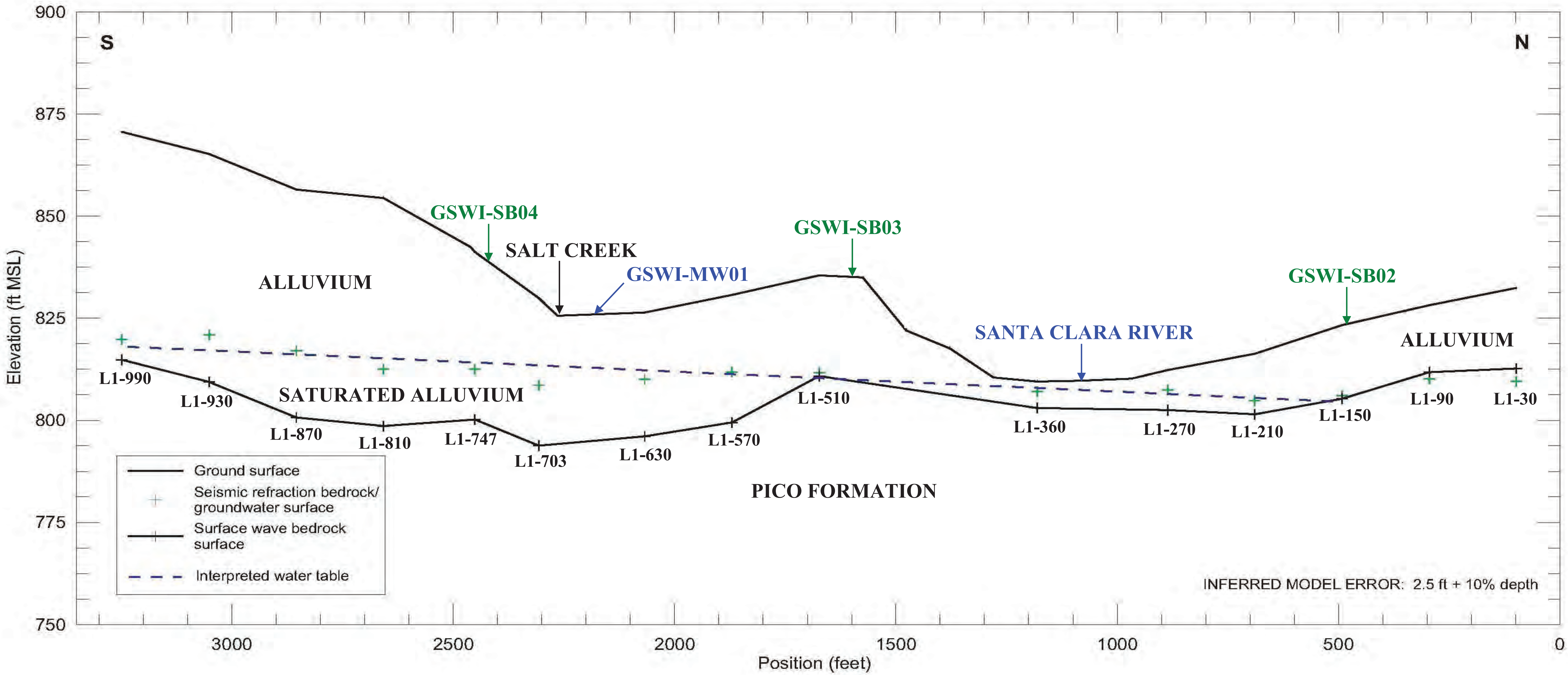
By: PRJ	Date: 05/15/07	Project No. 10354.000
Geomatrix		Figure 7



Explanation

GSWI-SB02 Exploratory Borehole
GSWI-MW01 Proposed Monitoring Well Location (subject to change)
L1-990 Seismic Refraction and Surface Wave Sounding Station ID

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GEOLOGIC CROSS SECTION LINE 1		
Task 1B - Data Collection Upper Santa Clara River Chloride TMDL Collaborative Process		
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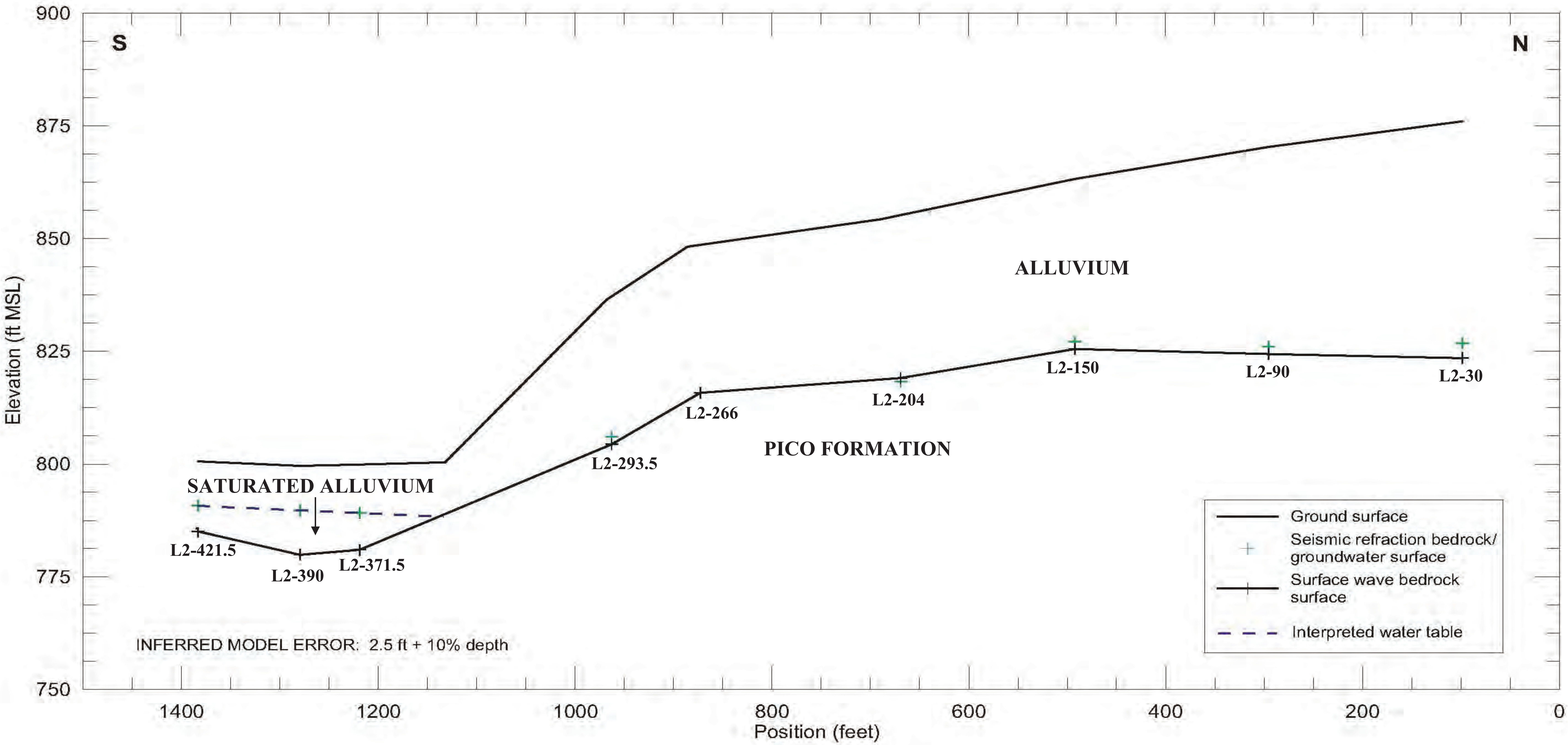
Geomatrix		Figure 8



Explanation

L2-30 Seismic Refraction and Surface Wave Sounding Station ID

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GEOLOGIC CROSS SECTION
LINE 2

Task 1B - Data Collection Upper Santa Clara River Chloride TMDL Collaborative Process

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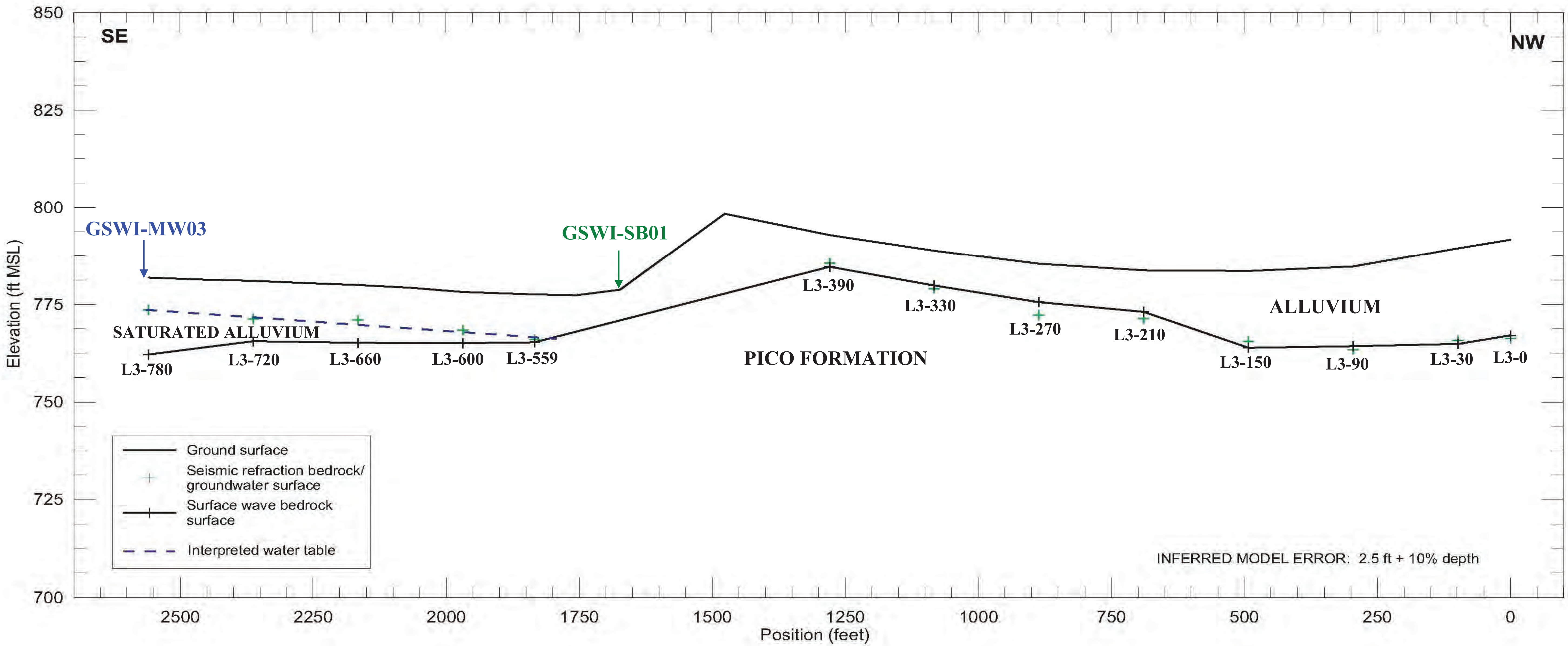
Geomatrix		Figure 9



Explanation

GSWI-SB01	Exploratory Borehole
GSWI-MW03	Proposed Monitoring Well Location (subject to change)
L3-30	Seismic Refraction and Surface Wave Sounding Station ID

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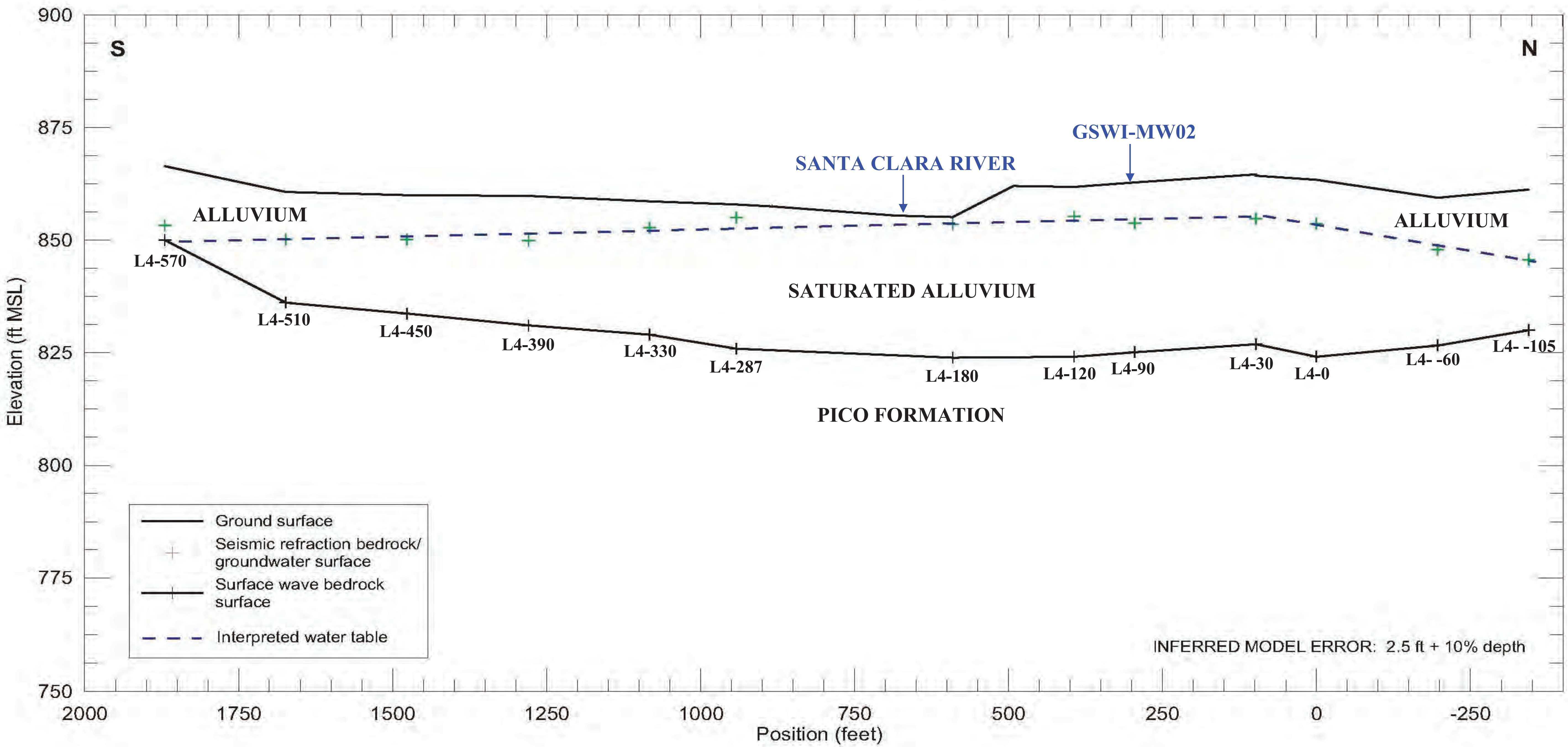
GEOLOGIC CROSS SECTION
LINE 3

Task 1B - Data Collection Upper Santa Clara River Chloride TMDL Collaborative Process

By: PRJ | Date: 05/11/07 | Project No. 10354.000

Geomatrix | **Figure** 10



Explanation

GSWI-MW02 Proposed Monitoring Well Location (subject to change)
L4-30 Seismic Refraction and Surface Wave Sounding Station ID

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GEOLOGIC CROSS SECTION
LINE 4

Task 1B - Data Collection Upper Santa Clara River Chloride TMDL Collaborative Process

By: PRJ | Date: 05/11/07 | Project No. 10354.000

Geomatrix

Figure 11

Appendix D. Published Groundwater Elevation Contour Maps for the Year 2000

December 2021

Prepared by:
GSI Water Solutions, Inc.
5855 Capistrano Avenue, Suite C, Atascadero, CA 93422

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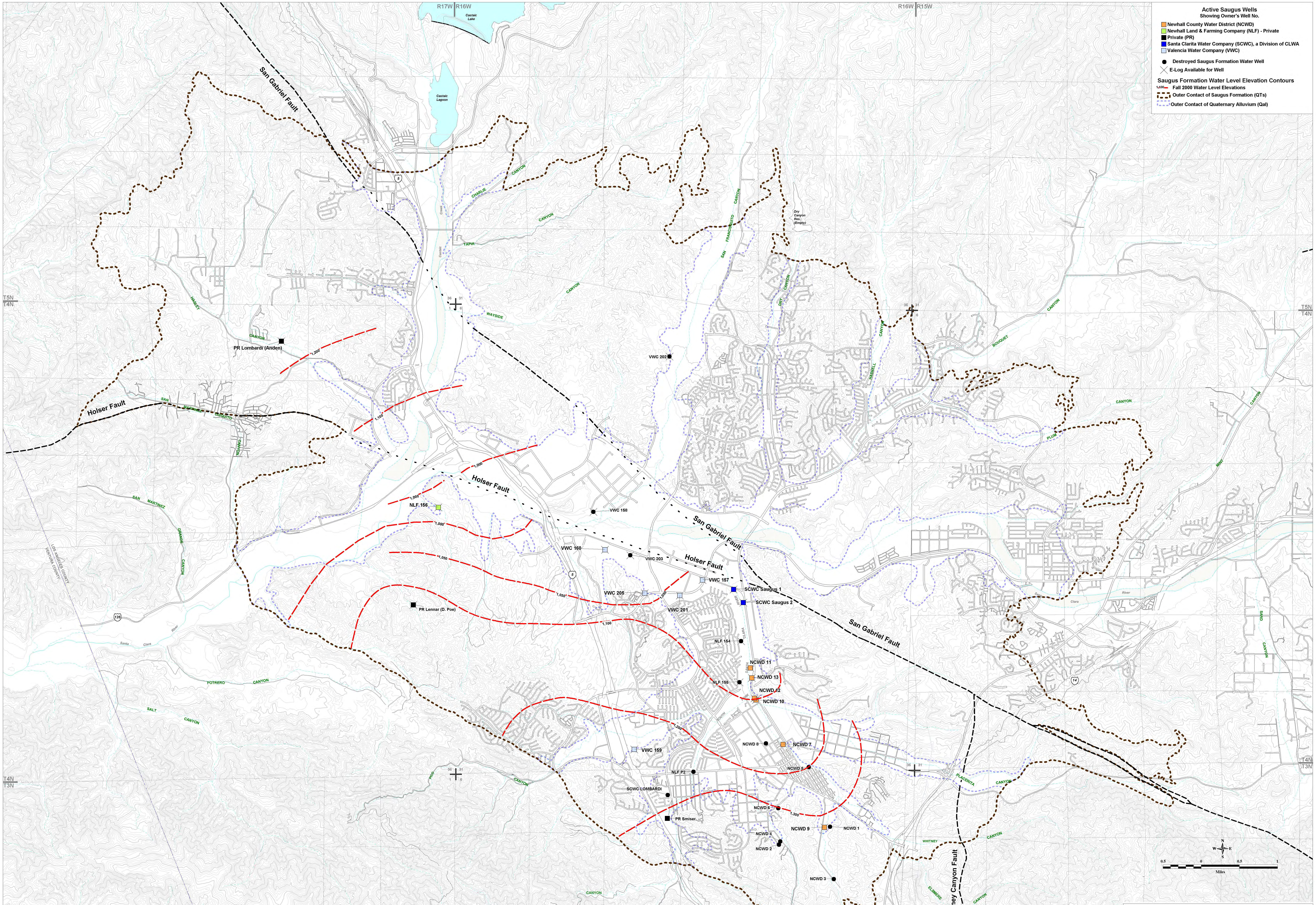
Active and Inactive Alluvial Water Wells
Showing Owner's Well Number
L. A. County Flood Control District (LACFCD)
Newhall County Water District (NCWD)
Newhall Land & Farming Company (NLF) - Private
Private (PR)
Santa Clarita Water Company (SCWC), a Division of CLWA
Seward Enginering (SE)
Valencia Water Company (VWC)
Wayside Honor Rancho (WHR)
Outer Contact of Saugus Formation (Qts)
Area of Quaternary Alluvium
1,600
Water Level Elevation Contour for Spring 2000 (ft asl)
See text for details of contouring method.
RCS
Richard C. Slade & Associates LLC
Consulting Groundwater Geologists
Project No: S9920
Date:
June 2002
Author: TAW/EGM
Projection: Custom Projection
Plate 4.3
Map of Alluvial Water Level
Elevation Contours
Spring 2000
6442 Coldwater Canyon Ave., Ste. 214, North Hollywood, CA 91606
Phone: (818) 506-0418 Fax: (818) 506-1343



Richard C. Slade & Associates LLC
Consulting Groundwater Geologists

Project No: S9920
Date: June 2002
Author: TAW/EGM
Projection: Custom Projection

Plate 5.3
Map of Saugus Formation Groundwater Elevation Contours, Fall 2000

6442 Coldwater Canyon Ave., Ste. 214, North Hollywood, CA 91606
Phone: (818) 506-0418 Fax: (818) 506-1343

Appendix E. Stream Gage Sites

December 2021

Prepared by:
GSI Water Solutions, Inc.
5855 Capistrano Avenue, Suite C, Atascadero, CA 93422

Current Gage (Station 11109000)

USGS Site Map for USG | 11109000_gh.jpg | Santa Clara River USGS Stre | Santa Clara River California | USGS Site Map for USGS 11

https://waterdata.usgs.gov/ca/nwis/nwismap/?site_no=11109000&agency_cd=USGS

USGS 11109000 SANTA CLARA R NR PIRU CA

Available data for this site Location map GO

Ventura County, California
Hydrologic Unit Code 18070102
Latitude 34°24'13", Longitude 118°44'18" NAD27
Drainage area 645 square miles
Gage datum 710 feet above NGVD29

Location of the site in California

Source: USGS Website at https://waterdata.usgs.gov/ca/nwis/nwismap/?site_no=11109000&agency_cd=USGS

GSI Water Solutions

Current Gage (Station 11109000)

USGS Site Map for USG | 11109000_gh.jpg | Santa Clara River USGS Stre | Santa Clara River California | USGS Site Map for USGS 11

https://waterdata.usgs.gov/ca/nwis/nwismap/?site_no=11109000&agency_cd=USGS

USGS 11109000 SANTA CLARA R NR PIRU CA

Available data for this site Location map GO

Ventura County, California
Hydrologic Unit Code 18070102
Latitude 34°24'13", Longitude 118°44'18" NAD27
Drainage area 645 square miles
Gage datum 710 feet above NGVD29

Location of the site in California

Source: USGS Website at https://waterdata.usgs.gov/ca/nwis/nwismap/?site_no=11109000&agency_cd=USGS

GSI Water Solutions

Current Gage (Station 11109000)

USGS Site Map for USG | 11109000_gh.jpg | Santa Clara River USGS Stre | Santa Clara River California | USGS Site Map for USGS 11

https://waterdata.usgs.gov/ca/nwis/nwismap/?site_no=11109000&agency_cd=USGS

USGS 11109000 SANTA CLARA R NR PIRU CA

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Location of the site in California

Source: USGS Website at https://waterdata.usgs.gov/ca/nwis/nwismap/?site_no=11109000&agency_cd=USGS

Current Gage (Station 11109000)

GSI Water Solutions

Old Gage (Station 11108500)

USGS Site Map for USGS 11 | 11109000_gh.jpg | Santa Clara River USGS Stre | Santa Clara River California | USGS Site Map for USG

https://nwis.waterdata.usgs.gov/ca/nwis/nwismap/?site_no=11108500&agency_cd=USGS

USGS 11108500 SANTA CLARA RIVER AT L.A.-VENTURA CO. LINE CA

Available data for this site Location map GO

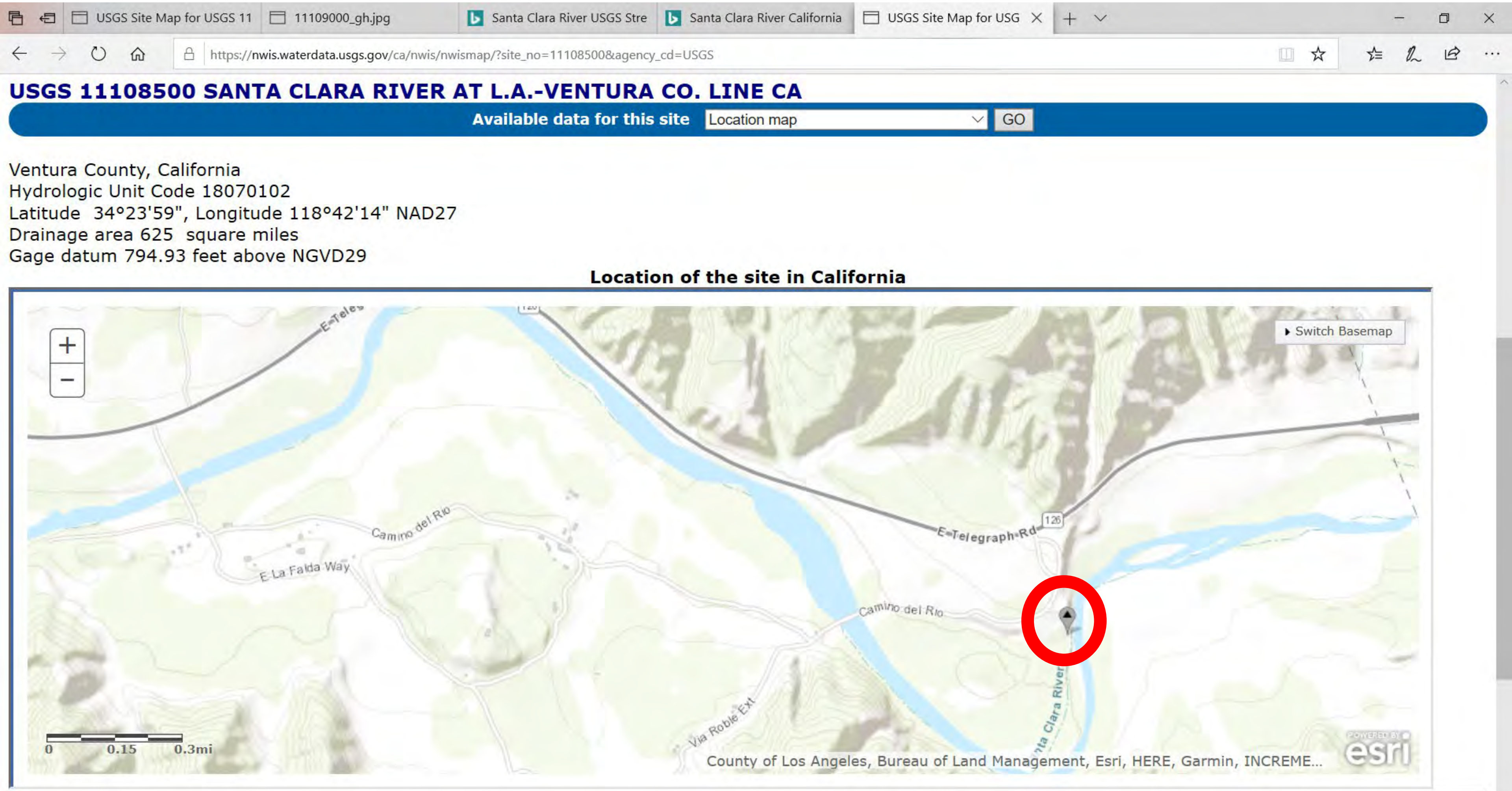
Ventura County, California
Hydrologic Unit Code 18070102
Latitude 34°23'59", Longitude 118°42'14" NAD27
Drainage area 625 square miles
Gage datum 794.93 feet above NGVD29

Location of the site in California

Source: USGS Website at https://waterdata.usgs.gov/ca/nwis/nwismap/?site_no=11108500&agency_cd=USGS

GSI Water Solutions

Old Gage (Station 11108500)



Source: USGS Website at https://waterdata.usgs.gov/ca/nwis/nwismap/?site_no=11108500&agency_cd=USGS

Old Gage (Station 11108500)

USGS Site Map for USGS 11 | 11109000_gh.jpg | Santa Clara River USGS Stre | Santa Clara River California | USGS Site Map for USG

https://nwis.waterdata.usgs.gov/ca/nwis/nwismap/?site_no=11108500&agency_cd=USGS

USGS 11108500 SANTA CLARA RIVER AT L.A.-VENTURA CO. LINE CA

Available data for this site Location map GO

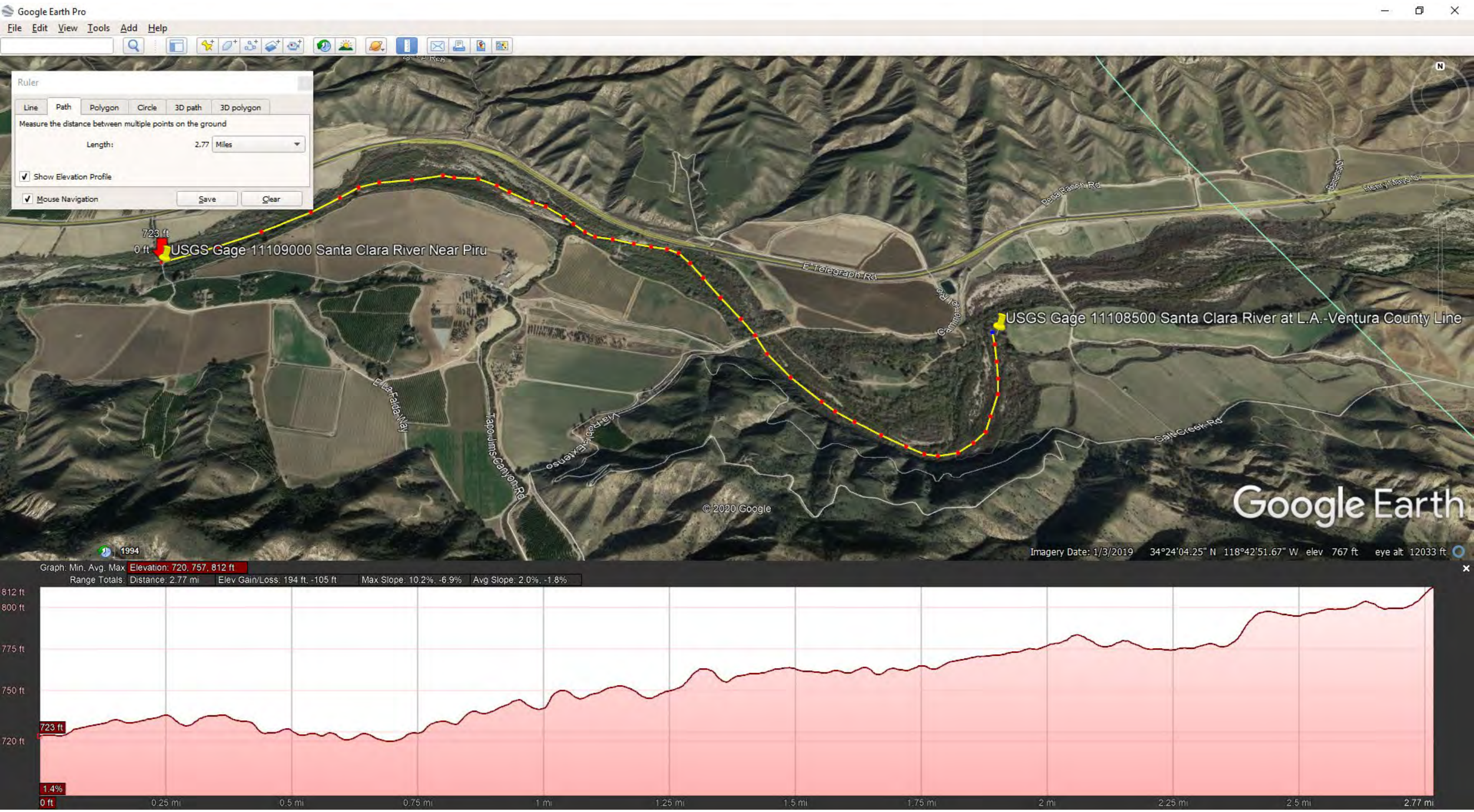
Ventura County, California
Hydrologic Unit Code 18070102
Latitude 34°23'59", Longitude 118°42'14" NAD27
Drainage area 625 square miles
Gage datum 794.93 feet above NGVD29

Location of the site in California

Source: USGS Website at https://waterdata.usgs.gov/ca/nwis/nwismap/?site_no=11108500&agency_cd=USGS

GSI Water Solutions

Distance Between Gages
(2.75 Miles, Bed Elevation 810 to 723 feet)



GSI Water Solutions

Source: Google Earth (Accessed on April 21, 2020)

APPENDIX H

Groundwater Model Peer Review Summary Report

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Groundwater Model Peer Review

Groundwater Peer Review Summary Report

Final

July 14, 2021

Santa Clarita Valley Water Agency

Groundwater Model Peer Review

Project No:	W9Y30800
Document Title:	Groundwater Peer Review Summary Report
Document No.:	PPS0706211040RDD
Revision:	0
Date:	July 14, 2021
Client Name:	Santa Clarita Valley Water Agency
Project Manager:	BJ Lechler
Author:	Nate Brown
File Name:	Final_SCVWA_GwModelPeerRevSummaryRpt.docx

Jacobs Engineering Group Inc.

2525 Airpark Drive
Redding, CA 96001-2443
United States
T +1.530.243.5831
F +1.530.243.1654
www.jacobs.com

Contents

Acronyms and Abbreviations

AF	acre-foot (or acre-feet) per year
AFY	acre-foot (or acre-feet) per year
BMP	Best Management Practice
CHD	constant head
CLN	connected linear network
cm/s	centimeter(s) per second
DWR	California Department of Water Resources
ERP	expert review panel
ESI	Environmental Simulations Incorporated
ET	evapotranspiration
ft	foot or feet
ft/d	foot (or feet) per day
GDE	groundwater dependent ecosystem
GFM	groundwater flow model
GFM Report	"Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin"
GHB	general head boundary
gpd/ft	gallon(s) per day per foot
GSA	Groundwater Sustainability Agency
GSI	GSI Water Solutions, Inc.
GSP	Groundwater Sustainability Plan
GSP Regs	Groundwater Sustainability Plan Regulations
GUI	graphical user interface
GW	groundwater
HCM	Hydrogeologic Conceptual Model
HFB	horizontal flow barrier
in/yr	inch(es) per year
Jacobs	Jacobs Engineering Group, Inc.
K	hydraulic conductivity
Kh	horizontal hydraulic conductivity
Kv	vertical hydraulic conductivity
LA	Los Angeles
LACWWD	Los Angeles County Waterworks District

LADWP	Los Angeles Department of Water and Power
mm	millimeter(s)
MO	Measurable Objective
MT	Minimum Threshold
PEST	Parameter Estimation
precip	precipitation
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RCH	recharge
RCS	Richard C. Slade & Associates LLC
RMS	Representative Monitoring Site
SCR	Santa Clara River
SCV	Santa Clarita Valley
SCV-GSA	Santa Clarita Valley Groundwater Sustainability Agency
SCVGWFM	Santa Clarita Valley Groundwater Flow Model
SCV Water or SCVWA	Santa Clarita Valley Water Agency
SFR	streamflow routing package
SGMA	Sustainable Groundwater Management Act
SMC or SMCs	Sustainable Management Criteria
SMC Section	"Section 8: Sustainable Management Criteria"
Ss	specific storage
Subbasin	Santa Clara River Valley East Groundwater Subbasin
SW	surface water
SWP	State Water Project
Sy	specific yield
T	transmissivity
TIB	transient IBOUND
USG	MODFLOW-Unstructured Grid
USGS	United States Geological Survey
UWCD	United Water Conservation District
UWMP	Urban Water Management Plan
Water Budget Report	"Water Budget Development for the Santa Clara River Valley East Groundwater Subbasin"
WRP	water reclamation plant

1. Introduction

A numerical groundwater flow model (GFM) has been developed by GSI Water Solutions, Inc. (GSI) to support preparation of a Groundwater Sustainability Plan (GSP) for the Santa Clara River Valley East Groundwater Subbasin (Subbasin) in Los Angeles County, California. This GFM is referred to as the Santa Clarita Valley Groundwater Flow Model (SCVGWFM). The development of the GSP is being led by the Santa Clarita Valley Groundwater Sustainability Agency (SCV-GSA), which is composed of four member agencies: Santa Clarita Valley Water Agency (SCV Water), the City of Santa Clarita, Los Angeles County Waterworks District No. 36, Val Verde, and the County of Los Angeles. At the request of SCV Water, Jacobs Engineering Group Inc. (Jacobs) convened an expert review panel (ERP) on behalf of the SCV-GSA to conduct a peer review of the SCVGWFM and selected GSP documentation for the SCV-GSA. The goal of the ERP review was for ERP members to assess whether the SCVGWFM was supported by sufficient model documentation, suitable to prepare water budgets, and appropriate for use to forecast potential future groundwater levels. If suitable for these purposes, it would be considered appropriate for the SCV-GSA to use the SCVGWFM to help establish Sustainable Management Criteria (SMCs) and develop the 2022 GSP.

This review effort incorporated the scope of work described in a grant agreement between the California Department of Water Resources (DWR) and SCV Water. A summary of that scope of work is as follows:

- Arrange for expert review of critical model components and coordination with Piru and Fillmore Basins GSA for incremental model improvements as reasonably as can be made within the GSP development timeframe.
- Review the model calibration and refinement.
- Review the model's quantification of groundwater-surface water exchanges.
- Review the model's suitability for informing minimum thresholds and measurable objectives.
- Hold up to three meetings amongst the peer review work group.
- Develop a report describing the key work, findings, and appropriateness of the model for its intended use.

The ERP consisted of Dr. Jason Sun of United Water Conservation District (UWCD), Mr. Jim Rumbaugh of Environmental Simulations Incorporated (ESI), and Mr. Nate Brown of Jacobs, who was tasked by SCV Water to lead the ERP review process. Exhibit 1-1 shows the organization and communication chart for the groundwater peer review. As shown in Exhibit 1-1, ERP members were permitted to communicate freely among themselves and with GSI as needed during the review process. This arrangement resulted in a productive and collaborative peer review process.

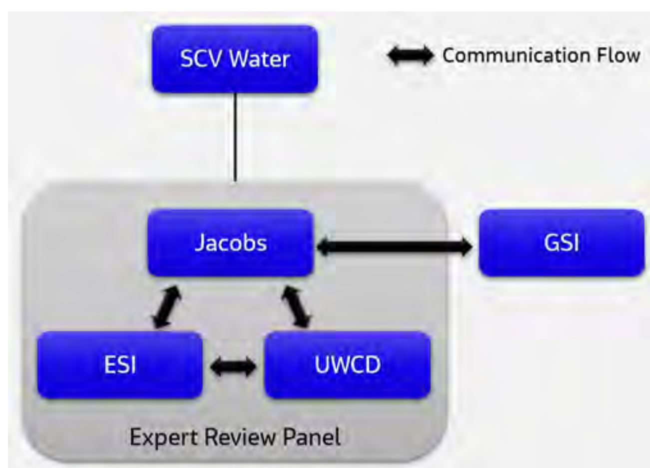

Exhibit 1-1. Organization and Communication Chart

Three reports were reviewed as part of the groundwater peer review process. A description of these reports and the focus of the ERP reviews are as follows:

1) **"Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin" (GFM Report) (GSI 2020a).** The GFM Report describes the development and calibration of the SCVGWFM. The primary goals of the ERP review of this report were to examine

critical model components and calibration, provide feedback to the lead modeler (i.e., John Porcello of GSI), and provide recommendations for improving the GFM and its associated documentation relative to the GFM's intended uses. A summary of ERP member comments associated with the GFM Report are provided in Section 3. Attachment A contains all ERP member comments and GSI's responses associated with the GFM Report.

2) **"Water Budget Development for the Santa Clara River Valley East Groundwater Subbasin" (Water Budget Report) (GSI 2020b).** The Water Budget Report describes the historical, current, and future water budgets for the Subbasin. The primary goals of the ERP review of this report were to gain a general understanding of water entering and exiting the Subbasin, assess groundwater/surface-water exchanges with a focus in areas of identified surface-water depletion and potential groundwater dependent ecosystems (GDEs), assess whether uncertainties associated with sources of supply in the future have been adequately characterized, and evaluate the suitability of the SCVGWFM to provide defensible water budgets. A summary of ERP member comments associated with the Water Budget Report are provided in Section 3. Attachment B contains all ERP member comments and GSI's responses associated with the Water Budget Report.

3) **"Section 8: Sustainable Management Criteria" (SMC Section) (GSI 2021).** The SMC Section describes how the SCVGWFM was used to help guide the SCV-GSA in establishing the sustainable management criteria (SMCs) necessary to comply with GSP regulations. The primary goal of this review was to assess the GFM capabilities relative to informing minimum thresholds and measurable objectives for three of the six sustainability indicators, including chronic lowering of groundwater levels, reduction of groundwater storage, and depletion of interconnected surface water. ERP members were not tasked with reviewing content related to the other three sustainability indicators including seawater intrusion, land subsidence, and degradation of water quality. A summary of ERP member comments associated with the SMC Section are provided in Section 3. Attachment C contains all ERP member comments and GSI's responses associated with the SMC Section. Dr. Jason Sun of UWCD was unavailable for this particular review, so the comments associated with the SMC Section consist of those from Jim Rumbaugh of ESI and Nate Brown of Jacobs.

The following section describes the approach developed and implemented by the ERP members to conduct their reviews of the GFM Report, Water Budget Report, and SMC Section.

2. Approach

Exhibit 2-1 illustrates the groundwater peer review process, which involved reviewing materials, hosting meetings to discuss comments with GSI and SCV Water, preparing written comments, and reporting the findings in this report.

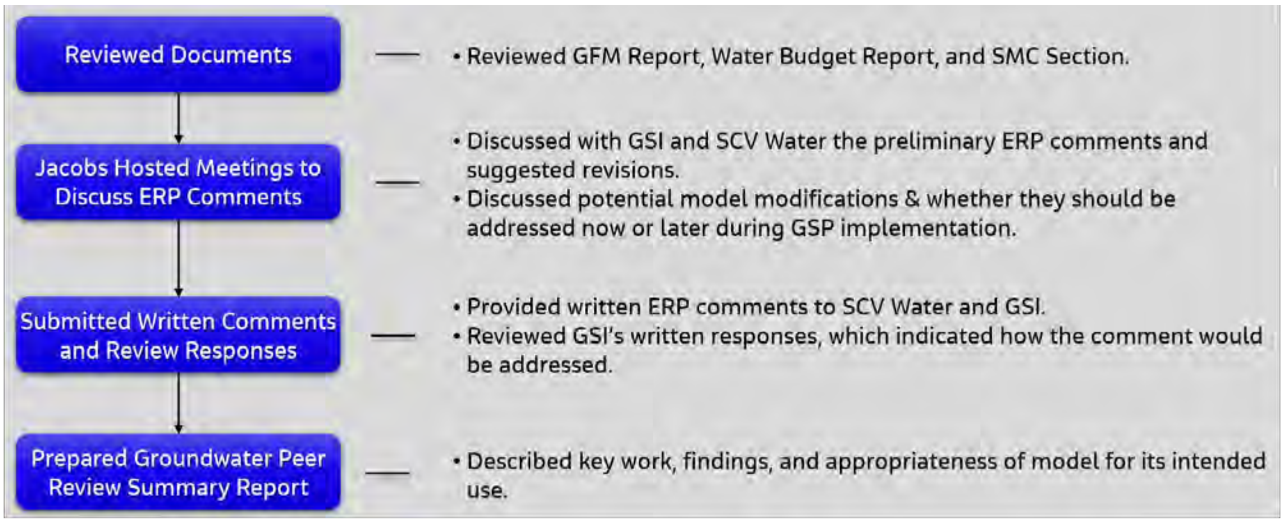

Exhibit 2-1. Groundwater Peer Review Process

A comment-classification system was developed and implemented by the ERP members to help streamline the document-review process and help organize the comments, as follows:

- **General Comment.** This category includes any general comments on the report as a whole. General comments are intended to describe at a high level the general impressions of the report, leaving the more detailed comments for the Specific Comment category.
- **Specific Comment.** This category is reserved for specific comments on individual report statements, tables, figures, and appendices. Each comment in this category was also labelled thematically as follows:
  - ***More Information Needed.*** This theme was indicated if the ERP member felt the documentation was insufficient to understand statements made in the report.
  - ***Needs Clarification.*** This theme was indicated if the ERP member felt that additional explanation was needed to avoid having the reader misinterpret the statements.
  - ***Defensibility.*** This theme was indicated if the ERP member felt the basis for the statement was not adequately supported by the documentation and/or there was a potential for the SCV-GSA to end up with a deficient GSP.
  - ***Miscellaneous.*** This theme was indicated if the ERP member felt the comment did not fit into one of the aforementioned themes (General and Editorial comments were also listed with a Miscellaneous theme).

Editorial Comment. This category is reserved for those comments that, once addressed, would improve the readability and clarity of the report (e.g., misspellings, typos, incorrect references to sections, figures, tables, etc.). Although the ERP members were not asked to edit the reports as part of their review, this category was included for editorial comments if the ERP members chose to provide them.

The ERP members focused on identifying potential deficiencies to not only achieve the scope of work of the groundwater peer review, but also to help the SCV-GSA achieve its goal of delivering to DWR a compliant and defensible GSP.

3. Overview of ERP Comments

Tables A-1, B-1, and C-1 in Appendices A, B, and C, list the ERP member comments on the GFM Report (GSI 2020a), Water Budget Report (GSI 2020b), and SMC Section (GSI 2021), respectively. These tables also include GSI's responses to ERP comments. Exhibit 3-1 shows a summary of the types and themes of ERP member comments. The values listed at the tops of the stacked bars in Exhibit 3-1 indicate the total number of comments made for the indicated comment type.

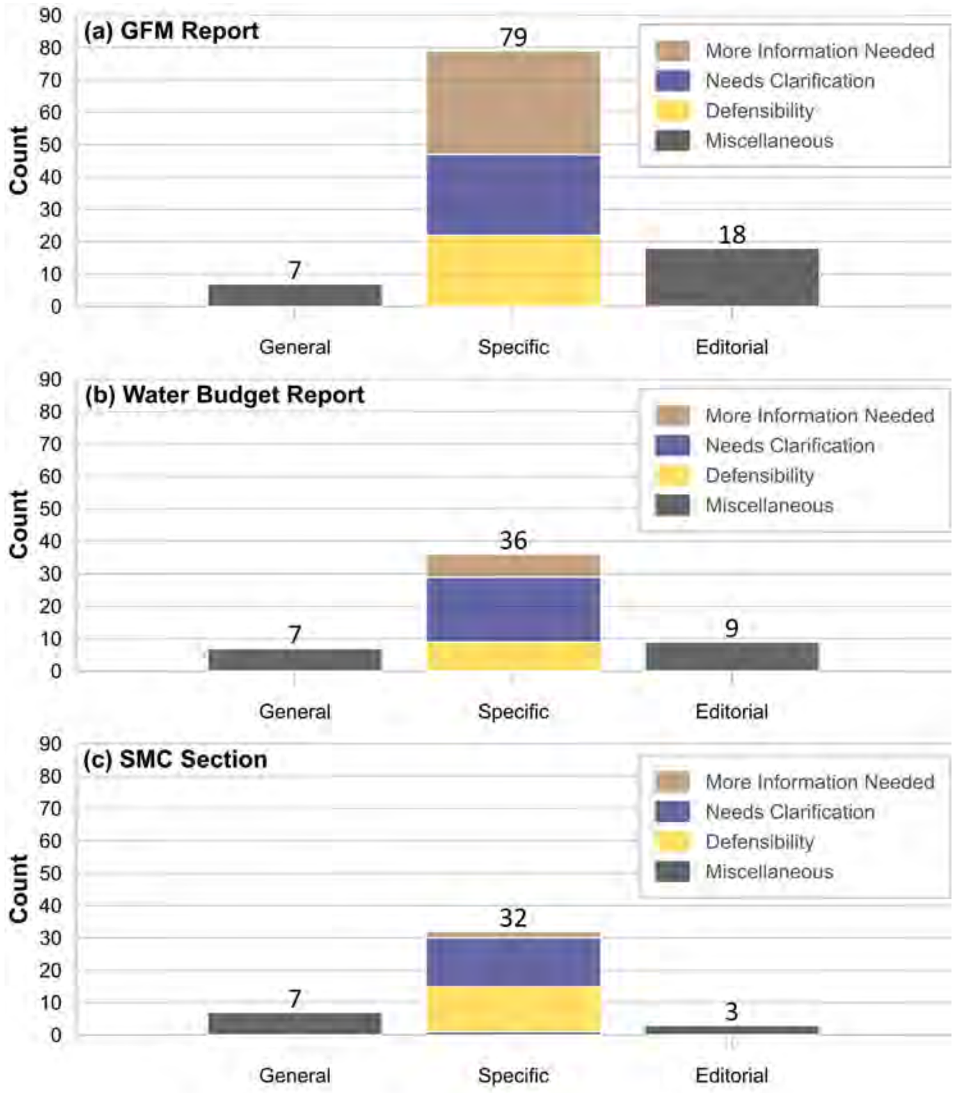

Exhibit 3-1. Overview of ERP Comments

The ERP members provided a total of 104 comments on the GFM Report (Exhibit 3-1a; top chart). Approximately 72 percent of the Specific comments are classified in the More Information Needed and Needs Clarification categories with the other 28 percent classified in the Defensibility category. Attachment A includes all ERP comments and GSI's responses to the ERP comments on the GFM Report.

The ERP members provided a total of 52 comments on the Water Budget Report (Exhibit 3-1b; middle chart). Approximately 75 percent of the Specific comments are classified in the More Information Needed and Needs Clarification categories with the other 25 percent of the Specific comments classified in the

Defensibility category. Attachment B includes all ERP comments and GSI's responses to the ERP comments on the Water Budget Report.

The ERP members provided a total of 42 comments on the SMC Section (Exhibit 3-1c; bottom chart). Approximately 53 percent of the Specific comments are classified in the More Information Needed and Needs Clarification categories, whereas approximately 44 percent of the Specific comments are classified in the Defensibility category. The remaining 3 percent of the Specific comments are classified in the Miscellaneous category. Attachment C includes all ERP comments and GSI's responses to the ERP comments on the SMC Section.

4. Summary and Conclusions

At the request of SCV Water, the ERP was convened on behalf of the SCV-GSA to conduct a peer review of the SCVGWFM. The goal of the ERP review was for ERP members to assess whether the SCVGWFM was supported by sufficient model documentation, suitable to prepare water budgets, and appropriate for use to forecast potential future groundwater levels. If suitable for these purposes, it would be considered appropriate for the SCV-GSA to use the SCVGWFM to help establish SMCs and develop the 2022 GSP. This review effort incorporated the scope of work described in the grant agreement between DWR and SCV Water. Table 4-1 lists the grant agreement requirements and the status of each requirement.

Table 4-1. Status of Scope Items

Scope Item	Status
Arrange for expert review of critical model components and coordination with Piru and Fillmore basin GSA for incremental model improvements as reasonably can be made within the GSP development timeframe.	**Complete.** The ERP consisted of Dr. Jason Sun of UWCD, Mr. Jim Rumbaugh of ESI, and Mr. Nate Brown of Jacobs. Mr. Brown was tasked by SCV Water to lead the ERP review process. Jacobs received the notice to proceed on September 29, 2020.
Review the model calibration and refinement.	**Complete.** In November 2020, the ERP members reviewed and provided written comments (Jacobs 2020a) on the draft GFM Report (GSI 2020a). GSI submitted written responses to the ERP comments in December 2020.
Review the model's quantification of groundwater-surface water exchange.	**Complete.** In November 2020, the three ERP members reviewed and provided written comments (Jacobs 2020b) on the draft Water Budget Report (GSI 2020b). GSI submitted written responses to the ERP comments in December 2020.
Review the model suitability for informing minimum thresholds and measurable objectives.	**Complete.** In March 2021, two of the three ERP members (i.e., Mr. Brown and Mr. Rumbaugh) reviewed and provided written comments (Jacobs 2021) on the draft SMC Section (GSI 2021). Dr. Sun had unavoidable schedule conflicts and was not available to review the SMC Section; however, he provided verbal comments during a February 2021 meeting during which GSI presented the contents of the SMC Section. GSI submitted written responses to the written and verbal ERP comments in May 2021.
Hold up to three meetings amongst the peer review work group.	**Complete.** Meetings associated with the draft GFM Report and draft Water Budget Report were conducted with SCV Water, GSI, and ERP members on the 15th and 20th of October 2020 and an ERP workshop was conducted on November 2, 2020. A meeting associated with the SMC Section was conducted on February 18, 2021 and its associated ERP workshop took place on March 3, 2021.
Develop a report describing the key work, findings, and appropriateness of the model for its intended use.	**Complete.** The report provided herein is intended to satisfy the requirements of this final scope item.

Key objectives were met during the review effort. ERP members were not asked to independently review the model files associated with the review materials or to operate the model. Furthermore, the GSP development schedule required final reports in Fall 2021, months after the ERP review effort was completed. Thus, the ERP members were not tasked with assessing whether their comments were addressed in the final versions of the documents.

In summary, the ERP members by virtue of their signatures below attest to their completion of the scope of work described herein with the understanding that ongoing improvements would be made to the SCVGWFM and its associated documentation, based on ERP comments. Based on this understanding, the ERP members conclude that it would be appropriate for the SCV-GSA to use the SCVGWFM to prepare water budgets, to forecast potential future groundwater levels, and help establish SMCs as part of the 2022 GSP process.

Nate Brown, PG, CHG Principal Hydrogeologist Jacobs Engineering Group	Jason Sun, PhD, PE Senior Modeler United Water Conservation District	James Rumbaugh Principal Hydrogeologist Environmental Solutions Inc.

5. Works Cited

GSI Water Solutions, Inc. (GSI). 2020a. *Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin, Santa Clarita, California*. Draft report prepared for Santa Clarita Valley Water Agency. September.

GSI Water Solutions, Inc. (GSI). 2020b. *Water Budget Development for the Santa Clara River Valley East Groundwater Subbasin, Santa Clarita, California*. Draft report prepared for Santa Clarita Valley Water Agency. October.

GSI Water Solutions, Inc. (GSI). 2021. *Santa Clara River Valley East Groundwater Subbasin, Groundwater Sustainability Plan, Section 8: Sustainable Management Criteria*. Draft report section prepared for Santa Clarita Valley Groundwater Sustainability Agency. February.

Jacobs Engineering Group, Inc. (Jacobs). 2020a. *Peer Review Comments on "Development of a Numerical Groundwater Flow Model for the Santa Clara River Valley East Groundwater Subbasin"*. Draft Memorandum. November.

Jacobs Engineering Group, Inc. (Jacobs). 2020b. *Peer Review Comments on "Water Budget Development for the Santa Clara River Valley East Groundwater Subbasin"*. Draft Memorandum. November.

Jacobs Engineering Group, Inc. (Jacobs). 2021. *Peer Review Comments on " Santa Clara River Valley East Groundwater Subbasin, Groundwater Sustainability Plan, Section 8: Sustainable Management Criteria "*. Draft Memorandum. March.

Attachment A
Comments and Responses on the GFM Report

Table A-1. ERP Member Comments and GSI Responses on the GFM Report (GSI 2020a).

Comment Number	Reviewer	Section	Page	Figure	Table	ERP Comment	GSI Response	Theme
General Comments								
G-1	N.Brown	---	---	---	---	It is clear from the report and appendices that substantial effort went into converting the finite-element MicroFEM model into a MODFLOW-USG framework, recalibrating the model to support the SCV-GSA with the development of its GSP, and documenting the modeling effort. The report contains most of the typical information that one would expect to see in a model report. However, it lacks some key maps, which could include, but are not limited to boundary conditions, GW and SW calibration target locations, calibration residuals, cross-section locations, rain gage locations, diversions, delivery locations of imported water, and point-discharge locations. Additional clarification on some statements is needed as well.	Comment noted. Some of these items are contained in other reports that are being developed as part of the GSP process and will be a companion to this model development report. Nonetheless, some of the items discussed in this comment will be added to the model development report.	Miscellaneous
G-2	N.Brown	---	---	---	---	Given the importance of the water budgets under SGMA, the report needs to define water budget terminology and stick with that terminology throughout the report, appendices, tables, and figures. Using inconsistent water budget terminology creates opportunities for confusing the reader. The standardization of water budget terms should be implemented in the GFM Report, Water Budget Report, and the associated appendices of both reports.	Comment noted.	Miscellaneous
G-3	J.Sun	B4.2.5	---	---	---	There is no quantification information on streamflow percolation; only mention of the SCR recharge compiler. Need to know more on the SCR recharge compiler. Are storm flows considered in some way in the GFM? How are releases and storm flows used to estimate the percolation along the stream bed?	These topics are discussed in Appendix B of this report and in the water budget report. Note that storm flows are specified only in the SCV Recharge Compiler; storm flows are not programmed into the SFR package.	Miscellaneous
G-4	J.Rumbaugh	---	---	---	---	I would like to see a discussion of how this model compares to the UWCD model at the boundary between the two.	Comment noted. For the subsurface flow term across the County Line, the latest version of the UWCD model simulates 5,000 AFY while the East Subbasin model simulates a long-term average of 7,475 AFY for the 40-year calibration period (1980-2019). UWCD does not appear to report the simulated surface flow amounts into the Piru Basin in their report, though there are tables and figures summarizing the gage data from the	Miscellaneous

Table A-1. ERP Member Comments and GSI Responses on the GFM Report (GSI 2020a).

Comment Number	Reviewer	Section	Page	Figure	Table	ERP Comment	GSI Response	Theme
							former County Line gage and the existing Piru gage (at the Las Brisas Bridge).	
G-5	J.Rumbaugh	---	---	---	---	It is impossible to provide a thorough review of a model without seeing the model input and output files.	Comment noted.	Miscellaneous
G-6	J.Rumbaugh J.Sun	---	---	---	---	There is no discussion of numerical mass balance results for the model. There should be more info on this since we do not have the model files. There should be a flow budget listing all major components from the numerical model runs.	These topics are discussed in the water budget report, rather than in this report.	Miscellaneous
G-7	J.Rumbaugh	---	---	---	---	I cannot render an opinion or review the calibration results and Section 5 without seeing the model files.	Comment noted.	Miscellaneous
Specific Comments								
S-1	N.Brown	1.4	5	---	---	GW discharge processes listed at the top of the page do not include remediation pumping. Does this mean the magnitude of remediation pumping does not warrant including it in the model or is it actually included in the model and its inclusion should be stated in the report?	The remedial pumping occurring within the Whittaker Bermite site during the past few years is included in the model and will be added to this list in the report.	More Information Needed
S-2	N.Brown	2.1	8	---	---	It is stated, "However, the CLN package allows for specification of well efficiency values, whereas MNW2 makes use of empirical well-loss coefficients that are often unmeasured or are substantially harder to derive than well efficiency estimates". I'm not sure this is a true statement. One can also input a skin factor in the MNW2 package to address well inefficiency.	We can soften the language a bit. Well efficiencies are more commonly available than skin coefficients because they are more readily estimated from traditional aquifer-test methods. (We agree that they are both uncertain, as the comment implies.)	Needs Clarification
S-3	J.Rumbaugh	2.3.1	11	---	---	Well package in USG contains pumping assigned to CLN wells, so they should be discussed here.	Agree. We will clarify that in the report.	More Information Needed
S-4	J.Rumbaugh	2.4.2	12	---	---	Was recharge compiler used in the PEST run?	No. We have not conducted runs using PEST software for this model, because of the model's long run times.	More Information Needed
S-5	N.Brown	2.4.2	---	2-1	---	Figure 2-1 shows that the SCR Recharge Compiler ultimately only computes deep perc of the rainfall and runoff from contributing catchments. Thus, there is an inherent assumption that streamflow does not continue and join up with the SFRs. Is this correct? The	Correct; we do not directly model the routing of stormflows in these tools. As we point out in the text, dry-weather flows are the focus of the streamflow analyses that are derived from the SFR package. We will look to improve the explanation of the SFR package (such as in Sections 2.3.1 and 3.3) to make sure the reader understands that the	Needs Clarification

Table A-1. ERP Member Comments and GSI Responses on the GFM Report (GSI 2020a).

Comment Number	Reviewer	Section	Page	Figure	Table	ERP Comment	GSI Response	Theme
						assumptions inherent in this tool need to be better described.	focus is on dry-weather flows, and that storm flows are not directly modeled in SFR. (Storm flows are defined in the SCV Recharge Compiler to derive the storm-related recharge to groundwater.)	
S-6	J.Rumbaugh	3.2.1.2	16	---	---	What is the saturated thickness at western boundary in CHD cells? How does this compare to the eastern edge of UWCD's model?	We will add this information to the last bullet on this page. It ranges from 28 feet on the north side of the alluvium to 23 feet on the south side. We don't have the latest input from the UWCD model, so we are not sure how the saturated thicknesses compare at the basin boundary.	More Information Needed
S-7	J.Rumbaugh	3.2.2	16	---	---	It seems like the MicroFEM model used constant thickness layers, but this model was variable. How was layer thickness variability determined?	The layering between the two models is actually similar. In both models, the thickness of the alluvium and the total thickness of the Saugus Formation are based on estimates presented in local geologic reports by RCS. The Saugus was subdivided into layers of typically 250-foot or 500-foot thickness based on the depths of the open intervals of production wells. Spatially variability in the thickness of individual model layers is less than may appear on the maps (given the choice of contour intervals/ranges), with noteworthy differences occurring primarily along the outer margins of each layer. We will review the report text to see if we can provide clarity on this point.	More Information Needed
S-8	J.Sun	3.2.2 & 3.3.2	16 & 18	---	3-1 & 3-3	Wells NWD-7, -9, -10, and -11 are inactive in Table 3-1. Table 3-3 shows these wells are used. Please clarify.	The next-to-last column in Table 3-3 shows that some wells are not present in 2019. The second column in Table 3-1 should say "Status as of 2019". We will make that change and check that these two tables are consistent.	Needs Clarification
S-9	J.Rumbaugh N.Brown	3.3.1	17	---	---	Is there a back-of-the-envelope calculation that could be provided to justify the 1,675 AFY number for subsurface inflow? What does this really represent?	It was a term we adjusted during calibration. It represents flow that could be occurring underneath the dam, given that the alluvium is thick in this area.	Needs Clarification
S-10	J.Rumbaugh	3.3	17	---	---	CLN well flow rates are actually part of the well package. Also, no discussion has been provided for how the alluvial production wells were handled (CLN? Well?).	We will clarify these items in the report, per the comment. The alluvial wells were handled in the WELL package, not the CLN package.	More Information Needed

Table A-1. ERP Member Comments and GSI Responses on the GFM Report (GSI 2020a).

Comment Number	Reviewer	Section	Page	Figure	Table	ERP Comment	GSI Response	Theme
S-11	J.Rumbaugh N.Brown	3.3	17	---	---	The report needs a figure(s) showing boundary condition locations (e.g., specified heads, specified fluxes, and head-dependent boundaries). It not possible to effectively review boundary conditions without knowing where they are located.	We will try to generate a figure, but it will be challenging to make the GHBs visible because of the small grid cell sizes in the alluvium, which is where the lateral inflow boundary types are located. This is why we took the approach of simply describing in the text where the various boundary conditions are used.	More Information Needed
S-12	J.Sun	3.3.4	18	---	---	TIB is used to simulate the conduit flow in pumping wells not in operation. How significant is the conduit flow? From some of the hydrographs, there is no significant vertical difference in water levels between model layers. If possible, provide the total conduit flow between model layers by region or by group.	TIB is used simply to provide a realistic representation of when those wells are in the ground and when they are not. We use one CLN node per well for each conduit well. Our focus is on water levels in the well; evaluating all the details of any potential vertical flow is information that doesn't help us evaluate during calibration how the modeled in-well water levels compare with historical water levels inside each well.	More Information Needed
S-13	N.Brown	3.3.2	18	---	3-2	Table 3-2 indicates K values ≤ 1 ft/d (≤ 3.5E-4 cm/s), which is toward the lower end of a silty sand, according to Table 2.2 of Freeze and Cherry (1979). This K value range is much lower than the range of calibrated K values for the Alluvial Aquifer. Why do such low K values for alluvium in the GHB areas make sense?	We don't have any information regarding the thickness of the alluvium at the GHB locations, other than knowing that the DWR basin boundary conforms to the upstream extent of alluvium that has been mapped by local geologists along the various tributaries. So the purpose of using a low Kh value on the GHBs is to avoid the potential for adding too much water into the model. We can mention this in the report. The calibration results discussed in this report (and the water budget results that are discussed in a separate report) are reasonable and suggest that we don't need to modify the GHB boundary conditions.	Defensibility
S-14	J.Rumbaugh	3.3.3	18	---	3-3	Text says one CLN node per well, but table shows multiple. Perhaps table should show layers penetrated.	Agree; the table heading will be changed, to show the number of layers (not the number of CLN nodes). We used one CLN node per CLN well.	Needs Clarification
S-15	J.Rumbaugh	3.3.3	18	1-3	---	Text says 18 CLN wells, but figure shows only 15 by my count. Also, no mention of the alluvial production wells.	We will check all of this, including consistency with Table 3-3. Note that Figure 1-3 shows the Saugus wells that are present in 2019; some Saugus wells were present in the past that are not present in 2019. Also, we do not mention alluvial wells in this section of the text, because the alluvial wells are not modeled using CLNs.	Needs Clarification

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S-16	N.Brown	3.3.5	19	---	---	What is the basis for the 0.0001 ft/d (~0.4 in/yr) value?	We just picked a low rate -- something that was non-zero and not in the same order of magnitude as the higher potential ET rates for riparian and coastal live-oak habitats. Based on the overall magnitudes of the ET values, we think this is contributing little if anything to the basin-wide model estimates of ET.	More Information Needed
S-17	N.Brown J.Rumbaugh	3.3.6	20	---	---	Given the GSP model is transient, does the decision to assign a specified-head boundary at the county line leave you vulnerable to criticism for using a static-fixed head from 20 years ago at such an important boundary? A specified-gradient boundary would allow the head to fluctuate, while maintaining a hydraulic gradient.	Switching from a specified head to a specified gradient boundary condition at this location is something we will consider for the future. This should not have a large bearing on decision-making related to the GSP, because the use of a fixed-head boundary condition is consistent with available water level data, which show that the western-most portion of the alluvium (see Figure 4-23) historically has shown little variability in groundwater levels historically compared with the fluctuations elsewhere in the alluvium (see Figures 4-14 through 4-22).	Defensibility
S-18	N.Brown	3.3.6	20	---	---	Are there potential Project & Management Actions that could in the future affect heads near the county line, making the assignment of static-fixed heads at the county line less defensible/appealing?	No future projects and management actions have been identified to date at or near the County Line. Arundo removal could potentially become a project along the perennial reach of the river. We see any changes to this model boundary condition as being driven by the assessment discussed above for comment Min-16.	Defensibility
S-19	J.Rumbaugh	3.3.6	20	---	---	How does the head assigned to the CHD compare to the head at the eastern edge of the UWCD model?	The UWCD model does not use a specified-head or specified-gradient boundary condition, but rather a specified underflow term of 5,000 acre-feet per year. We feel that the underflow rate can vary over time, which we see in our model results despite the use of a fixed-head boundary in our model. Underflow during 1980-2019 at the County Line is estimated by SCV Water's model as ranging between approximately 555 and 775 AF/month, with a long-term average of 625 AF/month. (On an annual basis, these flows average 7,500 AFY and range from about 7,000 to 8,100 AFY during the 1980-2019 calibration period.)	More Information Needed

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S-20	N.Brown J.Rumbaugh	3.3.7	20	---	---	The K of the HFB (1E-8 ft/d) is equivalent to 3.5E-12 cm/s, which is an unnaturally low value; less than the low end of Freeze & Cherry (1979) Table 2.2 K values. The ultimate resistance of the HFB is also a function of its thickness. What thicknesses are assumed for the HFBs? Is it possible you needed such low HFB-K values because you might be underestimating the thickness of the feature/zone you're representing with the HFB? The text indicates the K value could have just as easily been 1E-5 ft/d (3.5E-9 cm/s).	The HFBs are used along the San Gabriel Fault zone, which is described by local geologists as a zone, not a simple linear trace. So it is possible that the 100-foot thickness we are using might be low. But since we have sparse well data along the fault trace, the best approach is to raise the HFB Kh value to 1E-5 ft/day and leave the 100-foot thickness alone. This change (and the removal of low-K zones across the fault zone) was recently made and did not materially change the simulation results.	Defensibility
S-21	N.Brown	3.3.8	20	---	---	The advantages of splitting streamflows between SFR and the recharge package are not immediately obvious to me. Splitting streamflows in this manner makes it more difficult to review.	See response to comment number S-67.	Defensibility
S-22	N.Brown J.Rumbaugh	3.3.8	20	---	---	The report needs to include a map showing the locations of modeled streams and SFR segment numbers to be able follow the description.	We can provide the map requested in this comment. Note that it is possible the segment numbering system could change for specific model applications in the future; it is not meant to be a static (permanent) numbering system.	More Information Needed
S-23	J.Rumbaugh	3.3.8	20	---	---	How does the recharge model distribute the storm flows to the stream channel?	This is described in Section 4.2.5 of Appendix B. Note that storm flows are specified only in the SCV Recharge Compiler; storm flows are not programmed into the SFR package.	More Information Needed
S-24	J.Rumbaugh	3.3.8	21	---	---	What values of Kv were assigned to the SFR cells. Should have this in Table 3-5 along with stream width.	Comment noted. We will add this info to this section of the report.	More Information Needed
S-25	N.Brown	3.3.8	21	---	---	I'm confused. The lead-in paragraph to the three bullets indicates discharges were assigned to the same location as the Saugus WRP outfall, but the bullets indicate different SFR segments receiving such discharges.	Comment noted. We will fix the lead-in paragraph. The bullets are correct, however.	Needs Clarification
S-26	N.Brown	3.4	22	---	---	Bulleted items listed do not mention anything regarding the runoff process. How is overland runoff handled?	As was done in the MicroFEM model, we do not explicitly model overland runoff. Instead, we assume that a portion of all precipitation falling within the basin infiltrates (with the portion varying from year to year, and in some years being zero). Local runoff may infiltrate at a different location than where it is generated, but we don't	More Information Needed

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							route and track this. Only the streamflow entering the basin from outside areas is tracked and routed. We will review this section again for possible additions/clarifications and/or to point to Appendix B.	
S-27	N.Brown	3.4	22	---	---	Monthly PRISM rasters could be used as an alternative to using static isohyetal maps for handling precipitation and might be perceived as a more reliable data source for precipitation rates and patterns throughout the model domain and contributing catchments.	This is something we may consider in the future. However, we suspect any such changes to the data source would not significantly change the model on a large-scale, since we are accounting for geographic variations in rainfall already (albeit with an older data source).	Defensibility
S-28	N.Brown	3.4	22	---	---	If I'm understanding the statement regarding Bouquet Reservoir, it would appear the reservoir releases are being used directly as an inflow to the GW basin, despite several river miles of separation between these locations. It would seem prudent to demonstrate reasonableness through some calculations or lines of reasoning. For example, is there much variability in monthly Bouquet Reservoir releases or tributary flows to Bouquet Creek upgradient from the stream gauge?	We will review this text again. The releases are governed by an agreement between LADWP and United Water that calls for steady releases at a certain rate during the summer and a certain rate the rest of the year. We assume that 5% of the Bouquet releases enter the basin as surface flow (handled in the SCV Recharge Compiler). Between the reservoir and the basin boundary, the remainder of the Bouquet releases are likely lost to ET with a small amount infiltrating into thin alluvium (handled as GHB inflow), plus a portion is pumped by a small number of domestic wells outside the basin boundary.	Defensibility
S-29	J.Rumbaugh	3.4	22			Normally I would think releases from a dam would go into the SFR package. How do you determine which model cells receive these releases (i.e., how far downstream they get applied)?	This is done in the SCV Recharge Compiler by identifying the node number where the inflow enters the model, and then using the methods described in Section 4.2.5 of Appendix B to allocate the recharge from that flow.	More Information Needed
S-30	N.Brown	3.4	22	---	---	The last paragraph indicates use of the SCV Recharge Compiler. Splitting stream-related flows and reservoir releases between SFR7 and this tool adds complexity for reviewers. I understand why this tool was developed and used in the past, before SGMA. However, given the SW and GW budget requirements of SGMA now, the benefits of splitting stream-related flows in this manner, when SFR is capable of handling them in one boundary condition, are not immediately obvious to me.	In the case of Bouquet Reservoir, we are not splitting the storm-related flows and reservoir releases between SFR7 and the SCV Recharge Compiler. They are added together in the recharge compiler as they enter the model boundary. For Castaic Lake, the dam impedes all stormwater generated upstream of the basin boundary; hence those flows enter the model domain only when there are releases from the dam. These flows are specified only in the SCV Recharge Compiler -- not	Defensibility

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							in SFR7. SFR7 is used here and elsewhere solely to bleed off (drain) groundwater whenever/wherever the water table is above the streambed elevation, and to allow that water to potentially reinfiltrate downstream. SFR7 is also used to specify point discharges into the Santa Clara River from the two local WRPs and permitted discharges from other groundwater treatment systems (Whittaker Bermite, plus historical temporary discharges of perchlorate-treated water from three municipal wells). We will review the text of Section 3.4 and Appendix B to make sure these distinctions are clearly explained.	
S-31	J.Sun	3.5	22	---	---	How many pumping wells are screened over multiple model layers? How are the pumping rates implemented for each model layer?	This is discussed elsewhere, but can be mentioned here.	More Information Needed
S-32	J.Rumbaugh	3.5	23		3-11	How were the alluvial wells simulated (CLN or normal well package)?	Pumping from the Alluvial Aquifer is simulated using the WELL package (not the CLN package). We will check the report text to make sure this is clearly stated.	More Information Needed
S-33	J.Rumbaugh J.Sun N.Brown	3.6	23		3-31	K values are hard to review, because the figures do not show actual K values and zones are not sorted in order by K magnitude. Please include the K-zone table on the figure or just display the K values.	Comment noted. We will likely revise the figures and/or the table.	Needs Clarification
S-34	N.Brown	3.6.1	24	---	---	It is stated that "...it has become apparent that a large percentage of the specific capacity data collected in Alluvial Aquifer wells result in underestimation of the hydraulic conductivity of this aquifer". Interesting, given that specific capacity tests would logically overestimate T, because of the shorter-duration nature of such tests with less drawdown than would occur with longer pumping durations. Perhaps there is some underestimation bias of the pumping rates achieved during specific capacity testing. This might have more to do with going from the arithmetic to harmonic averaging of interblock conductances when switching from MicroFEM to USG.	We respectfully disagree, based on our experiences with the calibration process here and with projects/studies/models we've been involved in elsewhere. While it is true that the drawdowns might not be fully stabilized before a specific-capacity test ends, it is more likely that the error from that aspect of the test is less significant than the fact that the drawdown data are being collected inside the well and hence are affected by well losses (which create greater drawdown in the well than in the aquifer). We have found in other highly permeable aquifers (as permeable or more permeable than the alluvial material in this basin) that controlled aquifer tests almost always lead to	Needs Clarification

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							higher T and K estimates than developed from specific capacity tests.	
S-35	N.Brown	3.6.1	24	---	---	You might consider adding some text as to whether these ranges of K values look reasonably consistent with lithologic descriptions in boring logs, if such information is available.	Comment noted.	Defensibility
S-36	J.Rumbaugh	3.6.2	---	---	3-15	Should include the K zone of the area of the test, so we can judge the model against the test. Should also show test locations on the K maps for same reason.	We will consider adding well locations to the K maps (Figures 3-31 through 3-37).	Defensibility
S-37	J.Rumbaugh	3.6.2	---	---	3-16	Include K zones as in Table 3-15 and replace "T (gpd/ft)" column with K value in ft/d.	This will be tricky because the wells span multiple model layers, with the K zones and values sometimes differing between model layers. We might be able to pull the data from Table 3-1 to do this; otherwise, we might point back to Table 3-1 for these details.	Needs Clarification
S-38	J.Rumbaugh	3.6.2	24	3-32		Zone 66 does not seem to make geologic sense. If there is a disconnect between these areas, then perhaps a fault should be added.	We agree that there is not a clear geologic-based explanation available. However, a fault has not been specifically mapped in this area, which is why we originally chose to use a zone. We do not know if the higher water levels in well LACWWD-36 versus other Saugus wells are due to a fault somewhere south of LACWWD36 or differences in Kh values over a broad area. Nonetheless, we have converted from a low-K zone to the HFB package, using the same HFB parameters as we use on the San Gabriel Fault Zone (K=1E-05 ft/day and thickness of 100 feet). This change caused the water levels at the upgradient calibration well (production well LACWWD36-19) to decrease by about 10 feet, which was a small degradation of its calibration quality but acceptable to us given the lack of wells and data in that area.	Defensibility
S-39	J.Rumbaugh	3.6.2	24	3-32		Zones 41 and 42 along the San Gabriel Fault should probably not be there. Does it make any difference to the model results?	They are used as a visual aid, and have slightly lower Kh values than surrounding zones. We will change this before the report is finalized. It is not important for GSP decision-making purposes.	Defensibility

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S-40	N.Brown	4.1.1	27	---	---	Changing land use is mentioned. If land use changes through time in the model, then please explain how this is simulated.	This is discussed in Appendix B (Sections 4.3 through 4.5). We may point to that appendix in this portion of the main report.	More Information Needed
S-41	J.Rumbaugh	4.1.2	28			Absolute residual mean should be included in the goals and statistics presented in the calibration section.	Comment noted.	Defensibility
S-42	N.Brown	4.1.2.2	28	---	---	Calibration Goals 3 and 4 do not read as though they are quantitative calibration targets, given there are no statistical means for evaluating them.	They are semi-quantitative; they certainly aren't as qualitative as goals 1 and 2.	Needs Clarification
S-43	N.Brown	4.1.2.2	29	---	---	Shouldn't streamflows be qualitative as well, given there are no statistical calculations performed for them?	They are semi-quantitative; they certainly aren't as qualitative as goals 1 and 2.	Needs Clarification
S-44	N.Brown	4.1.2.2	28-29	---	---	Given the long-term, water-supply-planning nature of the GSP, tracking the ability of the model to match cumulative streamflows during the calibration period at gaged locations is important. Such tracking would allow one to assess the model's ability to track the overall throughput of water moving through the basin into the next downgradient basin. Small monthly residuals in streamflows can add up to surprising volumes when tracked over multiple years.	This is a trickier -- and potentially less reliable -- idea than one might think, given that we are focusing on dry-weather flows and not modeling storm events and storm flows in an explicit sense. The only way we can think of to do a cumulative flow calculation that has any hope of being helpful is to focus just on the three driest months of each year for the 1980-2019 time period. We have looked at the historical flows and found that July through September are the driest months and show the least day-to-day variability in flows that would be indicative of daily storm influences. We will think about how best to address this in the report.	Defensibility
S-45	J.Rumbaugh	4.1.3	29	---	---	How was the model calibrated? There are PEST references in the report but no mention of PEST in the calibration section.	We used manual calibration techniques; we did not use PEST due to the model's long run times. We only mention PEST where we describe why we are using GV as the GUI for this model.	Needs Clarification
S-46	J.Rumbaugh	4.1.3.2	29			Need a map of specific yield values or a table. It is not clear how variable specific yield values were calibrated and what the final value was. Also was specific storage calibrated?	There isn't much spatial variability in specific yield. The Sy and Ss values were all selected during manual calibration of the model. We will consider adding a map for the alluvium. For the Saugus, no map is needed because Ss is uniform.	Needs Clarification
S-47	J.Rumbaugh	4.2.3	31			Should show graphs at other points along the river showing response over time and perhaps compare to	Comment noted. A separate draft report has been prepared which discusses groundwater/surface water interactions and identifies gaining versus	Defensibility

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						anecdotal information to illustrate how realistic the SFR response is.	losing reaches, including how those vary over time (in wet vs. normal vs. dry years).	
S-48	N.Brown J.Sun	4.3.1.2	32	4-11a	---	The model underestimates vertical hydraulic gradients at Saugus well locations shown on Figure 4-11a. Do you see this as a serious limitation, when considering the intended model use to support developing the GSP (e.g., water budgets, supporting SMC development, and forecasting projects and management actions)? Are there any multi-level monitoring wells in other areas? It would be good to check whether there are significant vertical head differences in other areas.	This issue is discussed in the text of the 2nd bullet in Section 4.3.1.2. Figure 4-11a shows one well (MP-1) where the vertical gradients are actually reasonably well simulated, but we agree the vertical gradients are not as well matched in the other three wells. However, we do not see this as a limitation in the use of the model for GSP purposes, because the primary purpose of Figures 4-11a and 4-11b is to evaluate whether the model is simulating the trends in water levels over time. The two figures show a good match to the temporal trends in these piezometers, like is the case for the production wells. As for other locations not shown in Figure 4-11a, the Mall well in Figure 4-11b shows a reasonably good simulation of the observed vertical gradients. We will review the text to make sure we discuss these points.	Defensibility
S-49	N.Brown J.Rumbaugh	4.2	30	---	---	The report needs to include a map(s) showing the calibration target locations by model layer.	Comment noted. We will differentiate them by aquifer, rather than by layer, because the Saugus wells span multiple model layers. (We use the CLN observation well method in Groundwater Vistas for Saugus production wells.)	More Information Needed
S-50	J.Rumbaugh N.Brown	4.2	30			The report should include a map(s) showing root mean squared error or residual mean next to well name to allow assessment of spatial bias by model layer.	Comment noted.	More Information Needed
S-51	J.Sun	4.3	31	4-9 to 4-21		There are water level measurements in pumping wells. It will be good to see the simulated water level within the well boring for comparison.	Not sure why this is needed, given that we are calibrating to data collected in wells.	More Information Needed
S-52	J.Rumbaugh	4.3.1.2	---			The hydrograph figures are hard to read due to the thickness of the lines used for simulated heads. This makes it difficult to interpret the calibration since we do not have the model datasets and files.	We feel the line width helps visually distinguish the modeled data from the raw field data (light blue dots and black x marks).	Needs Clarification
S-53	N.Brown	4.3.1.2	32		4-9	It is stated that, "Simulated groundwater elevations at times are slightly above the ground surface beneath streams entering the groundwater basin in some	The term "at times" refers to wet time periods.	Needs Clarification

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						tributary valleys…". However, Figure 4-1 only shows one snapshot in time, so what is meant by "at times"?		
S-54	N.Brown	4.3.2.1	33	4-1	---	It is challenging to show calibration results at the county line without a co-located stream gage. It would be good to see how cumulative volumes of modeled streamflow at the county line compare with measured cumulative volumes at Blue Cut and Las Brisas, given the importance of simulating appropriate throughput to the next downgradient basin.	Will consider this. See response to comment number S-44.	More Information Needed
S-55	J.Rumbaugh J.Sun N.Brown	4.3.2.2	33-34	4-14 to 4-19		Many of the hydrographs have the right overall fluctuation, but the recession portions of the modeled Alluvial Aquifer hydrographs decline too rapidly as compared with measured heads. This might be related to specific yield, possibly an artifact of the choice to increase K values because of switching from arithmetic interblock averaging of MicroFEM to harmonic interblock averaging in USG, lack of stream percolation, or some combination thereof.	The K values in the eastern portion of the Alluvial Aquifer had been increased over the past several years as part of updating the calibration of the MicroFEM model to water level data collected after the model was first developed. The higher K values were raised slightly further during development of the MODFLOW-USG model, primarily because of calibration to the 2016-2019 time period. We consider the overly rapid recession of the curves to be less important for the GSP and other likely model uses than the need to match the historical high and low water levels as closely as possible, which has been improved compared with the prior MicroFEM model. We will add some text noting this discrepancy but discussing how it does not limit the model's usefulness for GSP and other purposes. If time allows, we will run a test using the arithmetic averaging method to see what effect it has.	Defensibility
S-56	N.Brown	4.3.3	35	4-24	---	Please explain how GW level changes are computed.	Comment noted. We assume this comment is referring to Section 4.3.4, given that Section 4.3.3 is about streamflows and not GW levels (or changes in GW levels). We have added a sentence to Section 4.3.4 (which is now Section 4.3.5) stating that the GW level change at a given well is computed as the change since the time of the first GW level measurement that occurred at that well during the 1980-2019 calibration period.	More Information Needed

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S-57	J.Rumbaugh	4.3.4	35	---	4-3	It is hard to follow the discussion on sensitivity without zone numbers and maps highlighting the area under discussion.	We assume this comment is about Section 4.4. We can add text to this section to point the readers back to the existing maps where this information is presented.	Needs Clarification
S-58	N.Brown J.Sun J.Rumbaugh	4.3.3	35	4-24	---	Figure 4-24 and the associated text are not intuitive, and they need to be, because it's an important calibration location. For example, the upper right and lower left plots have identical axes/labels/descriptions, but the modeled results are clearly different. What is the reader intended to take from this sequence of plots? Consider simplifying this figure to make clear the intended information.	Comment under consideration. As discussed in Section 4.3.3, we felt it was important to show all four plots in order to make the point that the stream is losing as it approaches the County Line, and that the adjustment factor to get from the County Line to the former gage location (which is 0.85 miles downstream of the model/basin boundary) was not an unreasonable adjustment. We will review this for possible clarifications as we finalize the report.	More Information Needed
S-59	N.Brown	4.4	36			What is an example of an "artificial" boundary influence? Selecting the model boundary to roughly coincide with the Bulletin 118 boundary also presents some challenges, because there exist areas outside the Bulletin 118 boundary that exchange SW and GW with the Bulletin 118 basin.	Technically that is correct. But the underlying assumption is that any such exchanges outside of the basin boundary are negligible compared with the exchanges occurring within the basin boundary, especially when considering that past geologic mapping of the extent of the alluvium (and Saugus) was the basis for the Bulletin 118 boundary definition. Hence, we are minimizing the potential for artificial influences by selecting the model boundary and associated boundary conditions to conform to the Bulletin 118 definition.	Needs Clarification
S-60	N.Brown	4.5	38	---	---	Are there ways to better demonstrate the model's ability regarding GW/SW interaction, given the importance of this in the SGMA process? For example, the report does not discuss modeled and inferred gaining and losing reaches of key streams, tendency of modeled dry gaps in streams as compared with historical aerial photography, or how the SCV Recharge Compiler streamflow compares to available stream gage data at Mint Canyon (F328-R) and Bouquet Canyon (F377-R). Without such comparisons, it is not clear whether the GW/SW interaction process has been adequately characterized.	See response to comment S-47	More Information Needed

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S-61	N.Brown	5.1	40	---	---	It is mentioned that the Sunshine Ranch Member of the Saugus Formation contains brackish water and is generally not useful for municipal supply purposes. SGMA requires defining "principal aquifers". When describing the different geologic units, it would be good to indicate whether the unit is in whole or a part of a principal aquifer.	Comment noted. Not sure this needs to be done here though.	More Information Needed
S-62	N.Brown	A4	A-4	---	---	DWR also has available 2014 and 2016 crop mapping (https://gis.water.ca.gov/app/CADWRLandUseViewer/). Was that information considered along with the referenced USGS and LA County land use mapping?	No. Ag land uses have not changed significantly over the past two decades, other than the typical changes that occur with crop rotations.	Needs Clarification
S-63	N.Brown	A2	A-2	A-1	---	Why rely on an isohyetal map that represents conditions 60 to 120 years ago? With the evolving climate patterns and availability of monthly PRISM datasets, using more recent isohyetal patterns would likely be perceived as more defensible.	See response to comment number S-27.	Defensibility
S-64	N.Brown	A3	A-3	A-4	---	Are there any boring logs in areas with lithologic descriptions of clean sand and/or gravel to corroborate this higher end of the K range (1,500 ft/d; 5.3E-1 cm/s)?	Yes, there are several such logs. We can discuss this in the report.	Defensibility
S-65	N.Brown	A5.1	A-5	---	---	Why rely on an isohyetal map that represents conditions 60 to 120 years ago? With the evolving climate patterns and availability of monthly PRISM datasets, using more recent isohyetal patterns would likely be perceived as more defensible.	See response to comment number S-27.	Defensibility
S-66	N.Brown	A5.3	A-7	---	---	For such an important section of the report (i.e., GW recharge and discharge), this section sure feels light at less than half a page. Bullets also seem focused largely on the Saugus Formation. What about GW recharge and discharge components for each principal aquifer?	Comment noted. We will beef this up more, primarily using text from the main body of the report and other companion documents developed in support of the GSP.	More Information Needed
S-67	N.Brown	B3	B-3	---	---	It is indicated that "...a decision was made during the model grid design process to use the RCH package, rather than the Stream-Flow Routing (SFR7) package, to simulate streambed infiltration of stormwater in the ephemeral reach of the Santa Clara River and in its tributaries". Why? Water budgets under SGMA need to be representative of the SW system and GW system. It would seem that splitting the SW system up with	We chose to use different methods, mainly to be consistent with the approaches used in the MicroFEM model. We do not see an indication of inconsistent physics or unreasonable results when (1) we think back on how the model calibration effort proceeded and (2) we consider the water budget results that are presented in the separate water budget report.	Defensibility

Table A-1. ERP Member Comments and GSI Responses on the GFM Report (GSI 2020a).

Comment Number	Reviewer	Section	Page	Figure	Table	ERP Comment	GSI Response	Theme
						different boundary conditions creates the opportunity for human error and inconsistent physics of modeled hydrologic stream processes.		
S-68	N.Brown	B4.1	B-2	---	---	Three terms are defined here (ET, runoff, and infiltration), but somewhere in the report all water budget terminology used in the reports, appendices, tables, and figures needs to be defined and used to avoid confusion in terms.	Comment noted. We may or may not make changes to this particular section, given that the water budget report provides the details.	Needs Clarification
S-69	N.Brown	B4.1	B-4	---	---	It is important to note that Equations B-1 and B-2 are for annual rates of infiltration, runoff, and precipitation. The text around these equations discusses storm events relative to these equations. These equations would not be appropriate for examining processes for subannual storm events. I would suggest indicating "Annual" infiltration, runoff, and precipitation in Equations B-1 and B-2 to make this point clear. Further, this equation assumes units of inches and this should be emphasized in the text.	Comment noted.	Needs Clarification
S-70	N.Brown	B4.1.2	B-5	---	---	It is mentioned that under full build-out conditions, Newhall Ranch will no longer receive ag irrigation recharge. Will there still be deep perc of applied water from landscape irrigation in this area in the future?	Yes, but much of that will occur in different locations.	More Information Needed
S-71	N.Brown	B.4.2.1	B-6	---	---	As pointed out in Equations B-1 and B-2, the SCV Recharge Compiler computes annual (and then monthly) infiltration plus runoff. Section B4.2.1 indicates "...at any given time, each sub-watershed receives different magnitudes of precipitation, and yields different quantities of surface water runoff and subsurface inflow into the groundwater basin". Wouldn't assignment of subsurface inflow from the SCV Recharge Compiler double count the subsurface inflows provided by the GHBs described in Section 3.3.2 in the main report?	We do not include subsurface inflows in the recharge compiler; they are handled exclusively in the GHB package in the groundwater model itself. Hence there is no double-counting. We will review the text to make sure this distinction is clear.	Needs Clarification
S-72	N.Brown	B.4.2.1	B-7	---	---	Are there ways to better demonstrate the model's ability regarding GW/SW interaction, given the importance of this in the SGMA process? For example, the report does not discuss modeled and inferred gaining and losing reaches of key streams, tendency of modeled dry gaps in streams as compared with	See response to comments S-47 and S-60. Regarding Mint Canyon and Bouquet Canyon gage data, we will obtain and review the data from those two gages either before report finalization or during the next 5-year review process.	Defensibility

Table A-1. ERP Member Comments and GSI Responses on the GFM Report (GSI 2020a).

Comment Number	Reviewer	Section	Page	Figure	Table	ERP Comment	GSI Response	Theme
						historical aerial photography, or how the SCV Recharge Compiler streamflow compares to available stream gage data at Mint Canyon (F328-R) and Bouquet Canyon (F377-R).		
S-73	J.Sun	B4.2.5.2	B-9	---	---	It seems that the SCV Recharge Compiler does not consider the gradient from SW level in stream to GW level below for streambed infiltration. The streambed infiltration rates in dry and wet conditions are different. Suggest adding more discussion to support the assumption.	See response to comment below. The recharge compiler assumes that water infiltrating through the streambeds is reaching the groundwater table quickly, which is based on the historically observed rapid response of alluvial water levels to large storm and runoff events. Use of an unsaturated-flow method is not needed beneath streambeds for this reason. We will clarify/mention this in Section 4.2.5.2.	Needs Clarification
S-74	N.Brown	B4.2.5.2	B-9	---	---	How does streambed infiltration capacity vary in the model? A figure and table with this information would be good additions to the report.	We use higher streambed infiltration capacities in the Santa Clara River than in most of its tributaries to account for differences in channel/floodplain width. The infiltration capacities are not varied over time, except during a few particularly large flow events. We will add a bit more discussion to the text of this section describing the general amounts of these differences, as trying to display them visually or in tables will be too involved and difficult while not adding much information that can't be conveyed in words.	More Information Needed
S-75	N.Brown	B4.3	B-10	---	---	Given the importance of the water budgets in the GSP, it is important to use consistent terminology for water budget terms throughout the report, appendices, tables, and figures. Terms like "return flow to groundwater" and "return flow to surface water" have not been used up to this point.	Comment noted.	Needs Clarification
S-76	N.Brown	B4.3	B-10	---	B-6	Table B-6 needs to be better explained. I failed in attempts to recreate some of the numbers in the table. Perhaps an example calculation of one of the table entries could be provided in the text to improve clarity.	We will review the table and consider this comment when we finalize the report.	More Information Needed
S-77	N.Brown	B4.4.1	B-11	---	B-7 & B-8	Why do Tables B-7 and B-8 only show data from 1980-1999, when the calibration period is from 1980-2019? Values should be included for the whole 1980-2019 calibration period.	These rates were developed from the land use coverages available in the late 1990s/early 2000s, when we were building the original MicroFEM model. The purpose of Tables B-7 and B-8 is to show how recharge was defined at that time. We	More Information Needed

Table A-1. ERP Member Comments and GSI Responses on the GFM Report (GSI 2020a).

Comment Number	Reviewer	Section	Page	Figure	Table	ERP Comment	GSI Response	Theme
							see no reason to change these rates for the purpose of this discussion. A comprehensive water budget through the year 2019 is presented in the water budget report.	
S-78	N.Brown	B4.4.1	B-11	---	---	Return flow to SW is mentioned at the end of the first paragraph, but this would imply (1) the source of irrigation water is SW and (2) that water would first need to recharge the aquifer before discharging to a SW body. This sentence seems incorrect and inconsistent with the previous sentence, which indicates only 10% of the applied water could potentially recharge GW. So, if only 10% could potentially recharge GW, then within the other 90%, return flow should not be included.	This particular "return flow to surface water" term refers to water that likely occurs in shallow soil strata (interflow above the water table and capture by field drainage systems). We will review the text to possibly re-phrase this for improved clarity. (Note: in this basin, the source of agricultural irrigation water supply is solely groundwater.)	Needs Clarification
S-79	N.Brown	B4.4 & B4.5	B-10 - B-13	---	B-6 - B-10	Without example calculations in the report, it is not easy to follow all the numbers being presented in Tables B-6 through B-10.	We will review the tables to see if we should add any additional columns that facilitate the reader's ability to follow the calculations. We do not want to interrupt the main messages in the text with sample calculations that can be confusing and distracting.	More Information Needed
Editorial Comments								
E-1	J.Rumbaugh	1.4	4	1-5	---	I assume the colors on this figure are for the subbasins. Would be good to have subbasin names/numbers in legend.	Adding the subbasin names/numbers isn't necessary because we don't discuss these sub-watersheds anywhere else in this document or in the water budget report. Adding this information also would require recreating the entire figure from scratch.	Miscellaneous
E-2	N.Brown	3.2.1.2	16	---	---	Last bullet before Section 3.2.2 begins with "However", but there is no lead-in sentence.	Comment noted.	Miscellaneous
E-3	N.Brown	3.3.5	18	---	---	The second sentence is incomplete.	Comment noted.	Miscellaneous
E-4	J.Rumbaugh	3.3.5	19	---	3-4	Report is loaded with mixed units which makes it difficult to compare numbers. Should use inches on this table instead of mm.	The reference sources use millimeters. Side note: We will add notes to the table that list the references (which are already listed in the text).	Miscellaneous
E-5	J.Rumbaugh	3.3.5	19	---	---	Extinction depth is the water table depth - should be -" extinction depth is the depth below the ET surface at which…"	Comment noted.	Miscellaneous
E-6	N.Brown	3.5	---	---	3-11	Some of the table headers/captions are truncated.	They look OK to me, except for the "Note".	Miscellaneous

Table A-1. ERP Member Comments and GSI Responses on the GFM Report (GSI 2020a).

Comment Number	Reviewer	Section	Page	Figure	Table	ERP Comment	GSI Response	Theme
E-7	J.Rumbaugh	3.6	23			Units of gpd/ft are antiquated and should not be used.	We generally agree. However, we are inclined to keep using these units (along with ft^2/day) simply because they were used in prior reports in this basin.	Miscellaneous
E-8	N.Brown J.Sun	4.1.2.2	28	---	---	In the first sentence before the bullets, should "quantitative" be indicated rather than "qualitative", given the Section 4.1.2.2 header reads Quantitative Calibration Goals?	Agree. However, see prior comments S-42 and S-43.	Miscellaneous
E-9	N.Brown	4.3.1.1	32	---	---	It is cumbersome to flip back and forth between Appendix D and Section 4 potentiometric-contour figures. Also, Appendix D figure labels in the PDF are not clear enough to allow for a meaningful comparison.	We are not sure we can get access to the GIS files of the Appendix D contours to do an overlay; we can check. However, the main point of Figure 4-1 is to show that groundwater flow directions are consistent … not to compare elevations directly. (The hand contours are heavily interpreted in areas with sparse or no wells.)	Miscellaneous
E-10	N.Brown	4.3.1.2	---	4-9	---	It would be preferred for hydrographs to have standardized y-axis ranges (i.e., max minus min), in addition to consistent x-axis ranges. The y-axis range for the NWD-11 hydrograph is 400 ft, but the other hydrographs on this figure have a y-axis range of 450 ft.	Comment noted.	Miscellaneous
E-11	N.Brown	4.3.1.2	---	4-12	---	It would be preferred for hydrographs to have standardized y-axis ranges (i.e., max minus min), in addition to consistent x-axis ranges. The y-axis range for the LACWWD36-19 hydrograph is 500 ft, but the other hydrographs on this figure have a y-axis range of 400 ft.	See the response to comment E-10.	Miscellaneous
E-12	J.Rumbaugh	4.3.4	35	4-25		These scatter plots should have the same length for x and y axes	They look identical to us, though the scales for the change residuals are intentionally different than the scales for the elevation residuals.	Miscellaneous
E-13	N.Brown	---	40	---	---	In the second bullet from the bottom, it reads "Specifically, the model simulates the discharge of treated water to the Santa Clara River from the Saugus and Valencia WRPs, the and the spatial changes in flow in the river arising from streambed seepage to the water table in losing reaches...". Delete "the and the".	Comment noted.	Miscellaneous

Table A-1. ERP Member Comments and GSI Responses on the GFM Report (GSI 2020a).

Comment Number	Reviewer	Section	Page	Figure	Table	ERP Comment	GSI Response	Theme
E-14	N.Brown	A5.2	A-6	A-8	---	Please provide a companion map showing the cross-section location.	Comment under consideration. We may add its location to Figure A-6.	Miscellaneous
E-15	N.Brown	A5.2	A-6	A-8	---	GSP Regs require at least two scaled cross sections. This does not mean the model write-up must contain at least two cross sections, but I thought it was worth mentioning in case it is your intent to have Appendix A contain SGMA-related information for the Hydrogeologic Conceptual Model.	These are in a Hydrogeologic Conceptual Model (HCM) report that will be a companion document to the GSP.	Miscellaneous
E-16	N.Brown	A6	A-6	---	---	Several intended superscript values are not displayed as superscripts.	Comment noted.	Miscellaneous
E-17	N.Brown	B4.2	B-6	---	B-4	Values presented in Table B-4 are to two decimal places, which seems excessive. The other flow tables only display whole numbers.	The table displays what is being reported to us, so we will leave it as is.	Miscellaneous
E-18	N.Brown	B4.3	B-9	B-4	---	Consider switching "Crop Efficiency" with "Irrigation Efficiency" given the latter is a more typical terminology. It is the irrigation method that is in reference to the efficiency, rather than the crop.	Comment under consideration. Some entities in this basin use the term "crop efficiency" in their documentation of ag irrigation demands.	Miscellaneous

See the **Acronyms** section for a complete listing of acronyms used in this table.

Attachment B
Comments and Responses on the Water Budget Report

Table B-1. ERP Member Comments and GSI Responses on the Water Budget Report (GSI 2020b).

Comment Number	Reviewer	Section	Page	Figure	Table	ERP Comment	GSI Response	Theme
General Comments								
G-1	N.Brown	---	---	---	---	The report contains some graphics and tables that are not given any official figure or table numbering. This makes providing comments a bit more cumbersome. Perhaps consider calling these items Exhibits with their own numbering system to differentiate them from the figures and tables.	Comment noted.	Miscellaneous
G-2	N.Brown	---	---	---	---	According to GSP Regs, water year types are to be subdivided into five categories ranging from wet, above normal, below normal, dry, and critically dry. The report only lists wet, normal, and dry without any description of how they were established for historical and future water years. As such, the water budget information provided in the report might not be fully compliant with the GSP Regs.	We respectfully disagree. The GSP regulations do not specifically state that these five categories must be used. The water budget BMP has one sentence suggesting they should be used, but this guidance document just provides recommendations and not firm regulatory requirements. We prefer to use the wet/normal/dry nomenclature because it is more intuitive with respect to local rainfall conditions in the basin and also is consistent with the terminology used in the basin's current and prior Urban Water Management Plans (UWMPs).	Miscellaneous
G-3	N.Brown	---	---	---	---	The report needs to better clarify general terms like "demand", given that DWR/SGMA will not view water budgets solely from a "retailed water demand" perspective. There are other beneficial users of water when viewing the subbasin through a SGMA lens (e.g., ecological). Some of the total water demand (beyond retail demand) that is met by precipitation and GW uptake, for example.	We agree, particularly with the point that the ecological demands are beneficial uses in the DWR/SGMA lens. We may use a term like "anthropogenic water demand" because some water demands are met by privately owned wells (not retail water services).	Miscellaneous

Table B-1. ERP Member Comments and GSI Responses on the Water Budget Report (GSI 2020b).

Comment Number	Reviewer	Section	Page	Figure	Table	ERP Comment	GSI Response	Theme
G-4	J.Sun	---	---	---	---	I cannot find the numerical mass balance. It will be good to compare the historical data-based flow budget based with the flow budget from numerical model.	The groundwater budgets are directly from the mass balance in the numerical model, because they cannot be easily estimated with data alone (i.e., without a model). The change-in-storage terms are particularly difficult to estimate without a model. Similarly, actual ET depends on water table depth, not just the potential ET. The water budgets presented in the report are a combination of data inputs to the model and necessary computations by the model.	Miscellaneous
G-5	J.Sun	---	---	---	---	The flow budget seems to be a compilation of several sources (data, modeling, and others). It is difficult to review the compiled flow budget without reviewing the individual sources independently. Suggest to break up the compiled flow budget based on sources. Discuss the flow budget from each source to identify the flow terms that are credible or justifiable. Put all the credible flow terms together to form a flow budget that can be reviewed clearly. Also elaborate on the quality of the selected flow terms.	The flow budgets have been assembled in the manner suggested by DWR in their BMP for water budgets. Tables 2-1 through 2-4 of the report provide the information on which flow terms are obtained directly from data versus computed by the model. Footnotes in the detailed water budget tables (Appendices B through F) provide further information on which packages (methods) in the MODFLOW-USG software conduct the calculations of the modeled water budget terms.	Miscellaneous
G-6	J.Rumbaugh J.Sun N.Brown	---	---	---	---	It is not always clear which model is being referred to in the report (e.g., conceptual model, numerical model, historical model, etc.). We suggest giving formal names/acronyms to the relevant models and then always using the proper model name in an effort to limit reviewer confusion.	Comment noted.	Miscellaneous

Table B-1. ERP Member Comments and GSI Responses on the Water Budget Report (GSI 2020b).

Comment Number	Reviewer	Section	Page	Figure	Table	ERP Comment	GSI Response	Theme
G-7	J.Rumbaugh	---	---	---	---	The report provides modeled water budgets without discussing whether the water budgets are consistent with the conceptual model. For example, one could take the total ET for key stress periods and compare the values to acreages of various plant types and their typical water use to see if they are reasonable. This type of discussion (why modeled water budget numbers make sense) is missing.	We are not confident of how useful such an exercise would be. For ET, we depend on the model to compute actual ET based on water table depth and potential ET (i.e., ET demand) rates. For other water budget terms, they are either defined inputs as listed in Tables 2-1 and 2-2 or are calculated by the model to obtain better estimates than can be developed by hand (as in the case of storage changes in groundwater).	Miscellaneous
Specific Comments								
S-1	N.Brown	1.1.1	1	---	---	The exhibit showing the basin water balance components does not seem conceptually accurate. For example, GW pumping and plant uptake of GW should be outflow components of the GW system. Terms presented in the text and water budget tables should be included in this conceptual graphic.	Revisions to the diagram are being made to address this comment and provide a conceptually complete diagram. A much more detailed diagram is being added as well in Section 2.	Defensibility
S-2	N.Brown	1.1.3	6	---	---	When water is banked, is that strictly a financial arrangement between SCV Water and Kern County or is there some kind of physical exchange of water?	SCVWA's long-term water banking programs are described in its 2015 UWMP. Water is physically delivered through turnout from the California Aqueduct and stored in the partners' groundwater basin through spreading basins or by in-lieu means. Return water is either physically delivered to the aqueduct or exchanged for the banking partners' SWP water supplies. We will provide clarification in the report.	Needs Clarification