portion of the Subbasin at the boundary with the Kaweah Subbasin to the north. This land subsidence is associated with localized continued decline in upper aquifer groundwater levels through the planning horizon.

7.0 References

Anderson, M.P, and Woessner, W.W., 1992. *Applied Groundwater Modeling, Simulation of Flow and Advective Transport*. Academic Press.

ASTM, 1993. Standard Guide for Application of a Groundwater Flow Model to a Site-Specific Problem. ASTM Standard D 5447-93.

Boyce, S.E., Hanson, R.T., Ferguson, I., Henson, W., Schmid, W., Reimann, T., Mehl, S.M., and Earll, M.M., 2018. *One-Water Hydrologic Flow Model—MODFLOW OWHM, version 2*. U.S. Geological Survey. https://doi.org/10.5066/P9CZM46C.

Boyce, S.E., Hanson, R.T., Ferguson, I., Schmid, W., Henson, W., Reimann, T., Mehl, S.M., and Earll, M.M., In Review. *One-Water Hydrologic Flow Model: A MODFLOW Based Conjunctive Use and Integrated Hydrologic Flow Model*. U.S. Geological Survey Techniques and Methods 6-AXX, 576 p.

California Department of Water Resources, 2003. *California's Groundwater*. Bulletin 118 – Update 2003.

California Department of Water Resources, 2016. *Best Management Practices for the Sustainable Management of Groundwater; Modeling BMP*. Sustainable Groundwater Management Program. December.

California Department of Water Resources Climate Change Technical Advisory Group, 2015. *Perspectives and Guidance for Climate Change Analysis*. DWR Technical Information Record.

California Energy Commission, 2006. Estimating Irrigation Water Use for California Agriculture: 1950s to Present. California Energy Commission, Public Interest Energy Research Program.

California Water Commission, 2016. Technical Reference – Water Storage Investment Program. Dated November 2016.

Doherty, J., 2003. Ground Water Model Calibration Using Pilot Points and Regularization. Groundwater 41, no. 2: 170-177.

Doherty, J., 2015. *Calibration and Uncertainty Analysis for Complex Environmental Models*. Watermark Numerical Computing, Brisbane, Australia. ISBN: 978-0-9943786-0-6.

Faunt, C.C., 2009. *Groundwater Availability of the Central Valley Aquifer, California*. USGS Professional Paper 1766.

Freeze, R.A., and Cherry, J.A., 1979. Groundwater. Prentice Hall.

Friant Water Authority, 2018. Technical Memorandum – Estimate of Future Friant Division Supplies for use in Groundwater Sustainability Plans, California.

Frink, J.W., and Kues, H.A., 1954. *Corcoran Clay – A Pleistocene Lacustrine Deposit in San Joaquin Valley, California*. American Association of Petroleum Geologists Bulletin Vol. 38, No. 11, pgs. 2357 – 2371.

Gianni, G., J. Doherty, and P. Brunner, 2019. Conceptualization and Calibration of Anisotropic Alluvial Systems: Pitfalls and Biases. Groundwater 57, no. 3: 409-419.

Hanson, R.T., Boyce, S.E., Schmid, Wolfgang, Hughes, J.D., Mehl, S.M., Leake, S.A., Maddock, Thomas, III, and Niswonger, R.G., 2014. *One-Water Hydrologic Flow Model (MODFLOW-OWHM)*: U.S. Geological Survey Techniques and Methods 6–A51, 120 p.

Hill, Mary C., and Tiedeman, Claire R., 2007. Effective Groundwater Model Calibration, with Analysis of Data, Sensitivities, Predictions, and Uncertainty. Wiley-Interscience, New Jersey.

Ireland, R.L., Poland, J.F., and Riley, F.S., 1984. Land Subsidence in the San Joaquin Valley, California, as of 1980. U.S. Geological Survey Professional Paper 437-I.

ITRC, 2003. California Crop and Soil Evapotranspiration for Water Balances and Irrigation Scheduling/Design. ITRC No. 03-001, dated January 2003.

Lofgren, B.E., and Klausing, R.L., 1969. *Land Subsidence due to Ground-Water Withdrawal Tulare-Wasco Area California*. USGS Professional Paper 437-B.

Luhdorff and Scalmanini, 2014. Land Subsidence from Groundwater Use in California. Prepared in Cooperation with the California Water Foundation.

Neuman, S.P., G.R. Walter, H.W. Bentley, J.J. Ward, and D.D. Gonzalez, 1984. Determination of horizontal aquifer anisotropy with three wells. Groundwater 22, no. 1: 66–72.

Ruud, N., Harter, T., and Naugle, A., 2003. *A Conjunctive Use Model for the Tule Groundwater Sub-basin Area in the Southern Eastern San Joaquin Valley, California.* Prepared for the U.S. Bureau of Reclamation.

Schmid, W. and Hanson, R.T., 2009, *The Farm Process Version 2 (FMP2) for MODFLOW-2005 – Modifications and Upgrades to FMP1.* U.S. Geological Survey Techniques in Water Resources Investigations, Book 6, Chapter A32, 102 p.

Schmidt, K., 2018. Hydrogeological Conceptual Model and Groundwater Conditions for the Tri-County WA GSP (Draft). Prepared for Tri-County Water Authority, Corcoran, California.

Sneed, M., 2001. *Hydraulic and Mechanical Properties Affecting Ground-Water Flow and Aquifer- System Compaction, San Joaquin Valley, California*. U.S. Geological Survey Open-File Report 01-35. Prepared in cooperation with the U.S. Bureau of Reclamation.

TH&Co, 2015. Analysis of the Hydrogeological Condition of the Tule Subbasin. Prepared for Spaletta Law PC and Lower Tule River Irrigation District, January 9, 2015.

TH&Co, 2017a. Technical Memorandum – Part II: Provide Support to Develop a Groundwater Flow Model. Prepared for Tule Subbasin MOU Group.

TH&Co, 2017b. Hydrogeological Conceptual Model and Water Budget of the Tule Subbasin. Prepared for the Tule Subbasin MOU Group.

TH&Co, 2020. Tule Subbasin Setting. Prepared for the Tule Subbasin Technical Advisory Committee. Dated January 2020.

TRA, 2018. Annual Report 2018 Water Year. Dated April 10, 2019.

Tables

Table 1

Monthly Crop Consumptive Use

Month	Grain and Grain Hay	Truck	Corn and Silage	Misc Field Crops	Grapes	Cotton	Deciduous & Fruit Trees	Alfalfa, Pasture	Nuts
	Consumptive Use (acre-ft/acre per month)	Consumptive Use (acre-ft/acre per month)	Consumptive Use (acre-ft/acre per month)	Consumptive Use (acre-ft/acre per month)	Consumptive Use (acre-ft/acre per month)	Consumptive Use (acre-ft/acre per month)	Consumptive Use (acre-ft/acre per month)	Consumptive Use (acre-ft/acre per month)	Consumptive Use (acre-ft/acre per month)
January	0.0631	0.0654	0.0000	0.0638	0.0627	0.0661	0.0655	0.0727	0.0666
Febuary	0.1362	0.0916	0.0000	0.0528	0.0556	0.0705	0.0728	0.1604	0.0729
March	0.2708	0.2445	0.0000	0.0689	0.0307	0.0092	0.0652	0.2829	0.0825
April	0.3941	0.3986	0.0000	0.1057	0.1147	0.1066	0.2591	0.4054	0.2797
May	0.2258	0.1097	0.1672	0.1620	0.2672	0.1288	0.5535	0.4944	0.4300
June	0.0000	0.0228	0.4521	0.4560	0.3819	0.4033	0.5758	0.5147	0.4440
July	0.0000	0.0006	0.5198	0.4681	0.3754	0.6839	0.5574	0.4931	0.4643
August	0.0000	0.0648	0.3509	0.1585	0.2991	0.6210	0.5029	0.4302	0.3805
September	0.0000	0.0887	0.0271	0.0011	0.1525	0.4401	0.3711	0.3359	0.2822
October	0.0186	0.0782	0.0194	0.0190	0.0301	0.1204	0.1917	0.1375	0.1288
November	0.0501	0.0811	0.0000	0.0494	0.0491	0.0659	0.0629	0.0917	0.0520
December	0.0676	0.0735	0.0000	0.0655	0.0656	0.0874	0.0843	0.0832	0.0698
Total:	1.23	1.32	1.54	1.67	1.88	2.80	3.36	3.50	2.75

Water Budget Area Irrigation Efficiencies

Water Budget Area	Irrigation Efficiency	
	1986 - 2002	2003 - 2017
1	NA	NA
2	0.81	0.83
3	0.75	0.79
4	0.87	0.87
5	0.83	0.86
6	0.76	0.82
7	0.87	0.87
8	0.85	0.85
9	0.85	0.85
10	0.72	0.76
11	0.75	0.78
12	0.81	0.86
13	0.74	0.79
14	0.74	0.77
15	0.77	0.84
16	0.76	0.77
17	0.72	0.83
18	0.75	0.77
19	0.87	0.87
20	0.74	0.78
21	0.83	0.85
22	0.72	0.76
23	0.76	0.79
24	0.71	0.74
25	0.72	0.72
26	0.74	0.74
27	0.75	0.69
28	0.76	0.76
29	0.77	0.77
30	0.76	0.78
31	0.76	0.79
32	0.78	0.82
33	0.84	0.87

Summary of Pumping Test Data

State Well Number	DWR Number or Well Name	Well Owner	Northing[1]	Easting[1]	Year of Pumping Test	Pumping Test Type[2]	Pumping Duration (hours)	Specific Capacity (gpm/ft)[3]	Estimated Transmissivity (ft^2/day)	Estimated Hydraulic Conductivity (ft/day)	Model Layer(s)	Aquifer[4]
20S/22E-03	69299	Private	1964458	6393954	1961	N/A[5]	N/A	10	3,580	8.1	1,2,3	C
20S/22E-11D	30877	Corcoran Irrigation District	1960307	6395313	1968	Short-Term	5	58	18,460	29	2,3	C
20S/22E-12	93080	Corcoran Irrigation District	1957724	6402835	1962	N/A	N/A	44	18,070	15	1,2,3	C
20S/22E-14	816223	Corcoran Irrigation District	1952412	6395485	2005	N/A	N/A	53	18,440	38	1,2,3	C
20S/22E-22	E0088663	Corcoran Irrigation District	1948606	6391849	2008	N/A	N/A	71	29,260	70	3	L
20S/22E-23	52338	Corcoran Irrigation District	1945904	6397224	1977	Short-Term	12	52	16,820	36	2,3	C
20S/22E-23	E0089134	Private	1946826	6397596	2008	N/A	N/A	18	7,170	38	2,3	C
20S/22E-23	30853	Private	1946788	6397137	N/A	N/A	N/A	71	25,030	40	1,2,3	C
20S/22E-24	23069	Corcoran Irrigation District	1946972	6402910	1966	N/A	N/A	10	3,330	6.5	1,2,3	C
20S/22E-25	23097	Corcoran Irrigation District	1941725	6402809	1967	N/A	N/A	37	13,000	19	1,2,3	C
20S/22E-26	816208	Corcoran Irrigation District	1942115	6396942	2005	N/A	N/A	22	8,890	59	2,3	C
20S/22E-26	816208	Corcoran Irrigation District	1942176	6397777	2005	N/A	N/A	22	8,890	59	2,3	C
20S/22E-33	E067353	Corcoran Irrigation District	1936561	6386700	2007	N/A	N/A	28	11,390	60	2,3	C
20S/22E-34	E064073	Corcoran Irrigation District	1934773	6394290	2007	N/A	N/A	53	21,560	65	3	L
20S/22E-34	23096	Corcoran Irrigation District	1936572	6392187	1967	N/A	N/A	37	15,120	54	3	L
20S/24E-26	51339	Private	1943782	6461424	1970	N/A	N/A	92	32,250	81	1,2,3	C
20S/24E-32	23065	Private	1934397	6444318	N/A	N/A	N/A	50	14,250	34	1,2,3	C
20S/24E-36	63090	Private	1937445	6466482	1960	N/A	N/A	15	4,390	44	1	U
20S/25E-26	77730	Private	1943785	6494191	1963	Short-Term	7	12	2,830	13	1,2,3	C
20S/25E-26	16908	Private	1941527	6493089	1960	N/A	N/A	30	11,840	118	1	U
20S/25E-32	817526	Private	1935863	6475757	1999	Short-Term	8	33	10,550	39	1,2,3	C
20S/26E-24	489251	Private	1943619	6529476	1992	Long-Term	12	13	3,010	17	2,3	C
20S/27E-19	104868	Private	1946702	6534872	1968	Short-Term	14	1.7	370	1.9	3	L
20S/27E-23	457006	N/A	1947311	6554769	1993	Short-Term	13	3.0	670	3.2	1,2,3	C
20S/27E-24	70661	Private	1944626	6561411	1972	Long-Term	24	1.0	220	2.4	2	U
20S/27E-24	104912	Private	1944010	6558821	N/A	N/A	N/A	5.4	1,540	7.3	1,2,3	C
20S/27E-26J	29264	Private	1941327	6556243	N/A	N/A	N/A	60	17,100	90	2,3	C
20S/27E-28	488474	N/A	1940323	6544742	1994	Short-Term	2.5	2.1	420	6.9	2,3	C
20S/27E-29	111529	Private	1941443	6540274	1965	N/A	N/A	50	14,250	475	3	L
20S/27E-30	24440	Private	1939464	6535006	1968	Short-Term	8.5	5.6	1,270	8.5	2,3	C
20S/27E-33	104875	Private	1935664	6544484	1970	Short-Term	4	12	2,750	13	2,3	C
20S/27E-33	93487	Strathmore Public Utilities District	1936750	6544158	1964	N/A	N/A	2.3	660	2.3	2,3	C
20S/27E-36	145307	Private	1934775	6561597	1976	Short-Term	8	1.6	340	3.4	2	U
20S/27E-36	145311	Private	1938414	6560586	1976	Short-Term	6	7.9	1,790	9.0	1,2,3	C

Summary of Pumping Test Data

State Well Number	DWR Number or Well Name	Well Owner	Northing[1]	Easting[1]	Year of Pumping Test	Pumping Test Type[2]	Pumping Duration (hours)	Specific Capacity (gpm/ft)[3]	Estimated Transmissivity (ft^2/day)	Estimated Hydraulic Conductivity (ft/day)	Model Layer(s)	Aquifer[4]
20S/27E-36	145312	Private	1938643	6562660	1976	N/A	N/A	3.6	1,030	5.6	1,2,3	C
21S/22E-01	726707	Corcoran Irrigation District	1930975	6402045	2002	Long-Term	47.83	2.1	770	1.8	2,3	C
21S/22E-01	726941	Corcoran Irrigation District	1930710	6403161	2004	N/A	N/A	44	17,830	41	3	L
21S/22E-01	816298	Corcoran Irrigation District	1934102	6399776	2005	N/A	N/A	31	12,830	32	3	L
21S/22E-01	E049826	Corcoran Irrigation District	1933595	6399594	2006	N/A	N/A	25	10,250	37	2,3	C
21S/22E-01	E049834	Corcoran Irrigation District	1933591	6399671	2006	N/A	N/A	46	13,050	50	1,2	C
21S/22E-02	1095719	City of Corcoran	1932572	6396670	2004	Long-Term	24	16	5,070	7.9	1,2,3	C
21S/22E-03	394345	Private	1933561	6388968	1992	Short-Term	2	6.0	1,260	12	1	U
21S/22E-24	93089	Private	1915216	6400010	1963	N/A	N/A	17	7,130	10	3	L
21S/22E-25	e077132	Private	1910179	6399351	2008	Long-Term	44	48	19,440	20	3	L
21S/22E-34	E077079	Private	1902762	6387498	2008	Long-Term	40	35	13,910	21	3	L
21S/23E-24	458728	Private	1915152	6430754	1996	N/A	N/A	50	14,250	356	1	U
21S/23E-25	Well #1	Private	1912488	6432652	2008	Long-Term	37	9.3	3,550	5.7	3	L
21S/23E-32	726554	Private	1901947	6409656	2001	N/A	N/A	1.0	280	3.5	1	U
21S/23E-34	726586	Private	1902306	6421830	2001	N/A	N/A	3.8	1,560	7.8	2,3	C
21S/23E-34Q01	34Q1	Private	1902308	6421770	2001	Long-Term	35	3.8	1,410	10	2,3	C
21S/23E-36	N/A	N/A	1906615	6434185	1966	Short-Term	1	27	5,860	34	1	U
21S/23E-36	23053	Private	1904603	6432254	N/A	N/A	N/A	27	7,610	38	1	U
21S/23E-6P1	112310	City of Corcoran	1928880	6405443	1975	Long-Term	24	41	10,790	43	1,2	C
21S/23E-7	515951	City of Corcoran	1927957	6405612	1997	Short-Term	12	0.5	170	0.3	2,3	C
21S/23E-7D1	112307	City of Corcoran	1927686	6403833	1975	Long-Term	24	34	9,000	33	1,2	C
21S/24E-15H01	15H1	Private	1921654	6455927	1979	Short-Term	3	17	3,800	95	1	U
21S/25E-17	517127	Private	1918909	6474558	2001	N/A	N/A	7.1	2,020	14	1	U
21S/25E-31	23057	Private	1901978	6468938	1966	N/A[4]	N/A	30	8,550	47	2,3	C
21S/26E-10	81896	Private	1926630	6519517	1965	Short-Term	6.5	10	2,380	15	2,3	C
21S/26E-14R01	14R1	N/A	1917675	6524644	2009	Short-Term	3	8.3	1,810	45	2	U
21S/26E-15B02	15B2	N/A	1922308	6517928	1992	Short-Term	3	1.9	380	3.8	1,2	C
21S/26E-28	R-7	City of Porterville	1907421	6543355	1979	N/A	N/A	17	4,930	123	1,2	C
21S/26E-34	27803	Poplar CSD	1903301	6519268	1966	N/A	N/A	55	15,530	55	1,2,3	C
21S/26E-34	748825	Private	1906530	6518086	2001	Short-Term	12	4.5	1,030	9.0	3	L
21S/27E-06	29627	Private	1931317	6533292	1980	Short-Term	5	13	2,880	90	2	U
21S/27E-1	145308	Private	1933470	6559675	N/A	N/A	N/A	3.2	910	9.1	2,3	C
21S/27E-1	145309	Private	1933496	6561552	N/A	N/A	N/A	1.8	510	5.1	2	U
21S/27E-21	C-29	City of Porterville	1912585	6541526	2006	N/A	N/A	7.7	2,700	10	4	L
21S/27E-22	C-10	City of Porterville	1913697	6550312	1968	N/A	N/A	5.6	1,600	4.8	2,3,4	C

Summary of Pumping Test Data

State Well Number	DWR Number or Well Name	Well Owner	Northing[1]	Easting[1]	Year of Pumping Test	Pumping Test Type[2]	Pumping Duration (hours)	Specific Capacity (gpm/ft)[3]	Estimated Transmissivity (ft^2/day)	Estimated Hydraulic Conductivity (ft/day)	Model Layer(s)	Aquifer[4]
21S/27E-22	40862	City of Porterville	1913430	6549953	N/A	N/A	N/A	17	4,820	15	2,3,4	C
21S/27E-24	53069	Private	1913654	6561699	N/A	N/A	N/A	1.3	370	2.1	1,2	C
21S/27E-24	64151	Private	1915011	6559028	N/A	N/A	N/A	1.5	430	1.1	1,2,3,4	C
21S/27E-25	64157	Private	1909663	6559097	N/A	N/A	N/A	1.9	540	2.7	1,2	C
21S/27E-25	19552	City of Porterville	1909780	6556729	N/A	N/A	N/A	5.0	1,420	10	2,3	C
21S/27E-25N01	C-11	City of Porterville	1907493	6557878	1959	N/A	N/A	3.6	1,260	4.9	3,4,5	C
21S/27E-25N1	53062	City of Porterville	1907680	6558074	1959	N/A	N/A	1.6	460	2.3	1	U
21S/27E-26	63436	City of Porterville	1908059	6553404	1960	Long-Term	24	2.2	500	1.5	2,3,4,5	C
21S/27E-26	C-16	City of Porterville	1912334	6546977	1978	N/A	N/A	11	3,860	13	3,4	C
21S/27E-26	C-21	City of Porterville	1909465	6555799	1987	N/A	N/A	18	4,990	55	2,3	C
21S/27E-26	C-3	City of Porterville	1907493	6555834	1961	N/A	N/A	4.1	1,440	4.4	3,4,5	C
21S/27E-26	C-6	City of Porterville	1910828	6553898	1949	N/A	N/A	14	3,930	12	2,3,4	C
21S/27E-26	19561	City of Porterville	1911164	6552505	1957	N/A	N/A	37	10,460	52	1	U
21S/27E-27	498597	Private	1912701	6549072	1992	Short-Term	1.5	21	4,650	52	2,3	C
21S/27E-27	L-7	City of Porterville	1909250	6549810	1979	N/A	N/A	25	7,210	60	1,2,3	C
21S/27E-27	C-17	City of Porterville	1907708	6547479	1986	N/A	N/A	13	3,620	19	3,4	C
21S/27E-27	C-20	City of Porterville	1910039	6546260	1988	N/A	N/A	4.3	1,230	4.9	2,3	C
21S/27E-27	L-1	City of Porterville	1908999	6547300	1958	N/A	N/A	16	4,620	33	1,2	C
21S/27E-28	C-18	City of Porterville	1912334	6544215	1986	N/A	N/A	7.6	2,660	5.0	1,2,3,4	C
21S/27E-28	L-8	City of Porterville	1911258	6542709	1979	N/A	N/A	11	3,220	22	1,2	C
21S/27E-28	C-22	City of Porterville	1907708	6545829	1996	N/A	N/A	21	6,070	24	1,2,3	C
21S/27E-28	L-5	City of Porterville	1907672	6544789	1967	N/A	N/A	28	8,010	57	1,2	C
21S/27E-34	942147	Private	1906000	6547259	2008	Short-Term	8	20	4,830	59	1,2	C
21S/27E-35	C-19	City of Porterville	1903943	6553862	1986	N/A	N/A	3.3	1,160	3.3	1,2,3,4,5	C
21S/27E-35	C-23	City of Porterville	1904983	6551459	1991	N/A	N/A	6.3	1,800	7.2	2,3,4	C
21S/27E-35	C-4	City of Porterville	1905628	6555117	1934	N/A	N/A	7.3	2,080	6.8	1,2,3	C
21S/27E-35F01	C-7	City of Porterville	1905556	6553217	1949	N/A	N/A	12	4,100	9.5	2,3,4,5	C
21S/27E-36	942151	Private	1902608	6558254	2009	Short-Term	4	0.4	70	1.1	1,2	C
21S/27E-36	e064534	Private	1904102	6556817	2007	Short-Term	4	0.2	40	0.5	1,2	C
21S/27E-36	e066452	Private	1903836	6559685	2007	Short-Term	0.75	0.1	30	0.9	1	U
21S/27E-36F01	C-8	City of Porterville	1906202	6557914	1965	N/A	N/A	5	1,480	4.2	1,2,3,4	C
22S/22E-02	E077072	Private	1901958	6397829	2008	Long-Term	40.5	39	15,640	23	3	L
22S/22E-02	E077119	Private	1897903	6397617	2008	Long-Term	38	55	22,290	13	3	L
22S/22E-03	101797	Private	1899103	6392312	1977	Long-Term	40	60	24,350	24	2,3	C
22S/22E-03	E077103	Private	1899874	6392401	2008	Long-Term	41.75	61	24,510	41	3	L

Summary of Pumping Test Data

State Well Number	DWR Number or Well Name	Well Owner	Northing[1]	Easting[1]	Year of Pumping Test	Pumping Test Type[2]	Pumping Duration (hours)	Specific Capacity (gpm/ft)[3]	Estimated Transmissivity (ft^2/day)	Estimated Hydraulic Conductivity (ft/day)	Model Layer(s)	Aquifer[4]
22S/22E-09	N/A	Private	1894109	6384592	2008	N/A	N/A	31	12,540	22	3	L
22S/22E-10	489122	Private	1895519	6391555	1994	Long-Term	36	46	18,420	34	3	L
22S/22E-9	E072646	Private	1894097	6384597	2008	N/A	N/A	31	12,540	157	3	L
22S/23E-05	E0079777	Private	1896575	6410653	2008	Short-Term	6	3.8	1,330	3.0	2,3	C
22S/23E-05	E0079779	Private	1867655	6426985	2008	N/A	N/A	5.0	2,050	3.1	3	L
22S/23E-06	69286	Private	1899108	6406730	1961	N/A	N/A	14	3,930	15	1,2	C
22S/23E-06	69271	Private	1899594	6404681	N/A	N/A	N/A	13	3,790	14	1,2	C
22S/23E-15	30891	Private	1886811	6423555	1970	Short-Term	4.5	40	9,600	53	1	U
22S/23E-17	489121	Private	1891332	6410938	1994	Long-Term	36	46	18,170	44	2,3	C
22S/23E-17	489124	Private	1891389	6389758	1994	Long-Term	30	19	7,320	11	2,3	C
22S/23E-18	30889	Private	1887434	6408224	1970	Short-Term	4	33	7,970	40	1	U
22S/23E-33	W7	Angiola W.D.	1875526	6418412	2007	N/A	N/A	26	7,290	10	2,3	C
22S/23E-33	W14	Angiola W.D.	1873383	6418660	2007	N/A	N/A	14	3,960	17	1,2	C
22S/23E-21	W13	Angiola W.D.	1873370	6418665	1997	N/A	N/A	39	15,900	15	3	L
22S/23E-21	W13	Angiola W.D.	1873370	6418665	2002	N/A	N/A	30	8,610	8	3	L
22S/23E-33	W18	Angiola W.D.	1875511	6417588	2015	N/A	N/A	16	N/A	N/A	N/A	N/A
22S/23E-21	G16	Angiola W.D.	1882036	6416141	1997	N/A	N/A	11	3,110	13	1,2	C
22S/23E-21	G18	Angiola W.D.	1883404	6416263	1997	N/A	N/A	23	9,470	30	3	L
22S/23E-21	G18	Angiola W.D.	1883404	6416263	2007	N/A	N/A	14	3,900	12	3	L
22S/23E-21	G19	Angiola W.D.	1880947	6416260	1997	N/A	N/A	38	15,490	55	3	L
22S/23E-21	G19	Angiola W.D.	1880947	6416260	2007	N/A	N/A	17	4,700	17	3	L
22S/23E-21L1	G1	Angiola W.D.	1883434	6416104	1997	N/A	N/A	8.1	2,310	12	1,2	C
22S/23E-21L1	G1	Angiola W.D.	1883434	6416104	2007	N/A	N/A	6.4	1,820	9	1,2	C
22S/23E-22	E072308	Angiola WD	1881613	6419172	2008	N/A	N/A	33	13,650	38	3	L
22S/23E-22	69285	Private	1883399	6421610	N/A	N/A	N/A	11	3,160	15	1,2	C
22S/23E-23	E-5	Angiola W.D.	1882044	6427880	1948	N/A	N/A	57	23,280	47	1	U
22S/23E-23	E-5	Angiola W.D.	1882044	6427880	2007	N/A	N/A	15	4,190	8	1	U
22S/23E-23	E-1	Angiola W.D.	1882043	6424309	1997	N/A	N/A	27	10,940	22	1	U
22S/23E-23	E-19	Angiola W.D.	1880938	6424567	1997	N/A	N/A	38	15,410	48	3	L
22S/23E-23	E-19	Angiola W.D.	1880938	6424567	2007	N/A	N/A	20	5,760	18	3	L
22S/23E-23J1	E-14	Angiola W.D.	1883355	6429374	2007	N/A	N/A	38	10,880	9	3	L
22S/23E-23J1	E-14	Angiola W.D.	1883355	6429374	1997	N/A	N/A	57	23,520	20	3	L
22S/23E-24	E064735	Angiola Water District	1883487	6433497	2007	N/A	N/A	42	17,210	172	3	L
22S/23E-25	E0078570	Angiola WD	1878313	6431119	2008	Long-Term	35	28	11,020	23	3	L
22S/23E-25	E-10	Angiola W.D.	1879483	6434628	1997	N/A	N/A	23	9,470	19	1	U

Summary of Pumping Test Data

State Well Number	DWR Number or Well Name	Well Owner	Northing[1]	Easting[1]	Year of Pumping Test	Pumping Test Type[2]	Pumping Duration (hours)	Specific Capacity (gpm/ft)[3]	Estimated Transmissivity (ft^2/day)	Estimated Hydraulic Conductivity (ft/day)	Model Layer(s)	Aquifer[4]
22S/23E-25	E-10	Angiola W.D.	1882044	6427880	2007	N/A	N/A	17	4,900	10	1	U
22S/23E-25	E-15	Angiola W.D.	1882044	6427880	2002	N/A	N/A	46	12,990	30	2,3	C
22S/23E-25	E-15	Angiola W.D.	1880672	6434027	1997	N/A	N/A	57	23,160	54	2,3	C
22S/23E-25	E-25	Angiola W.D.	1879532	6434581	2015	N/A	N/A	9	N/A	N/A	N/A	N/A
22S/23E-23	E-26	Angiola W.D.	1881019	6424628	2015	N/A	N/A	19	N/A	N/A	N/A	N/A
22S/23E-23	E-27	Angiola W.D.	1883431	6428305	2015	N/A	N/A	14	N/A	N/A	N/A	N/A
22S/23E-25	G25	Angiola W.D.	1875835	6419974	2010	N/A	N/A	16	4,560	19	1,2	C
22S/23E-25	G25	Angiola W.D.	1875835	6419974	2007	N/A	N/A	28.9	8,230	34.3	1,2	C
22S/23E-25F1	E-13	Angiola W.D.	1878305	6431117	1997	N/A	N/A	54	N/A	N/A	3	L
22S/23E-25F1	E-13	Angiola W.D.	1878305	6431117	2007	N/A	N/A	33	9,260	8	3	L
22S/23E-26	E-16	Angiola W.D.	1880723	6429293	1997	N/A	N/A	42	17,250	39	2,3	C
22S/23E-26	E-16	Angiola W.D.	1880723	6429293	2007	N/A	N/A	33	9,490	22	2,3	C
22S/23E-26	E-18	Angiola W.D.	1880789	6426889	1997	N/A	N/A	36	14,840	42	3	L
22S/23E-26	E-18	Angiola W.D.	1880789	6426889	2007	N/A	N/A	31	8,920	25	3	L
22S/23E-27	G11	Angiola W.D.	1877992	6421183	1997	N/A	N/A	60	24,430	49	1	U
22S/23E-27	G11	Angiola W.D.	1877992	6421183	2007	N/A	N/A	50	14,190	28	1	U
22S/23E-27	G14	Angiola W.D.	1875835	6419974	1997	N/A	N/A	4.4	1,250	13	1	U
22S/23E-27F1	W6	Angiola W.D.	1878271	6420551	2002	N/A	N/A	7.6	2,170	10	1,2	C
22S/23E-27F1	W6	Angiola W.D.	1878271	6420551	1997	N/A	N/A	6.1	1,740	8.3	1,2	C
22S/23E-28	G2 (new)	Angiola W.D.	1880493	6416151	1997	N/A	N/A	12	3,530	17	1,2	C
22S/23E-28	G20	Angiola W.D.	1878490	6416188	1997	N/A	N/A	15	6,150	10	1,2,3	C
22S/23E-28	G20	Angiola W.D.	1878490	6416188	2007	N/A	N/A	11	3,130	5	1,2,3	C
22S/23E-28	G23	Angiola W.D.	1882036	6416141	2010	N/A	N/A	3.6	1,030	4.9	1	U
22S/23E-28	G24	Angiola W.D.	1880147	6416158	2010	N/A	N/A	7.1	2,020	10	1,2	C
22S/23E-28	G29	Angiola W.D.	1878490	6416188	2010	N/A	N/A	15	6,190	17	3	L
22S/23E-27	G30	Angiola W.D.	1876132	6420248	2015	N/A	N/A	13	N/A	N/A	N/A	N/A
22S/23E-28A1	G3	Angiola W.D.	1880729	6417584	2007	N/A	N/A	10	2,820	9	1,2	C
22S/23E-28A1	G3	Angiola W.D.	1880729	6417584	1997	N/A	N/A	10	2,960	10	1,2	C
22S/23E-28J1	G5	Angiola W.D.	1878153	6418746	2007	N/A	N/A	9	1,250	4	1,2	C
22S/23E-28J1	G5	Angiola W.D.	1878153	6418746	1997	N/A	N/A	18	5,100	17	1,2	C
22S/23E-29	60512	Private	1878299	6410919	N/A	N/A	N/A	12	3,390	15	1,2	C
22S/23E-3	394406	Private	1896917	6421603	1992	N/A	N/A	15	4,270	61	1	U
22S/23E-33	Well 15	Angiola W.D.	1870545	6418643	2008	Long-Term	30	12	4,380	15	3	L
22S/23E-33	E077032	Angiola Water District	1870498	6418613	2008	N/A	N/A	12	4,710	20	3	L
22S/23E-34	E059018	Angiola Water District	1873846	6418472	2007	N/A	N/A	50	20,490	49	3	L

Summary of Pumping Test Data

State Well Number	DWR Number or Well Name	Well Owner	Northing[1]	Easting[1]	Year of Pumping Test	Pumping Test Type[2]	Pumping Duration (hours)	Specific Capacity (gpm/ft)[3]	Estimated Transmissivity (ft^2/day)	Estimated Hydraulic Conductivity (ft/day)	Model Layer(s)	Aquifer[4]
22S/23E-27	G21	Angiola Water District	1876256	6420150	2007	N/A	N/A	8	1,180	4	2,3	C
22S/23E-34	G22	Angiola W.D.	1873673	6423686	1997	N/A	N/A	3.0	1,230	3.8	3	L
22S/23E-34	G26	Angiola W.D.	1873673	6423686	2010	N/A	N/A	56.5	8,050	19.2	3	L
22S/23E-34	G26	Angiola W.D.	1873673	6423686	2010	N/A	N/A	101	41,560	99	3	L
22S/23E-34	G27	Angiola W.D.	1871634	6419991	2010	N/A	N/A	27	11,190	33	3	L
22S/23E-34	G28	Angiola W.D.	1870490	6423818	2010	N/A	N/A	13	5,160	14	3	L
22S/23E-6	60743	Private	1901983	6405985	1960	N/A	N/A	11	3,080	10	1,2	C
22S/24E-04	715329	Private	1896720	6446743	2000	Short-Term	4	33	10,270	38	1,2,3	C
22S/24E-6L	23071	Private	1899259	6437368	1966	N/A	N/A	22	6,270	31	1	U
22S/25E-19	23094	Private	1883307	6471350	1967	N/A	N/A	73	25,690	61	2,3	C
22S/26E-12	145318	Private	1896566	6524621	1977	Short-Term	4	35	8,500	43	1,2,3	C
22S/26E-16	489115	Private	1889982	6511214	1993	Long-Term	30	5.4	1,680	5.8	3	L
22S/26E-24	E0094537	Private	1881999	6529798	2009	Short-Term	12	14	5,100	9.3	3,4	C
22S/27E-01	81882	Private	1900689	6557479	1963	Short-Term	12	20	5,040	41	1,2	C
22S/27E-02B02	C-13	City of Porterville	1901145	6554185	1965	N/A	N/A	4.3	1,510	2.7	2,3,4,5	C
22S/27E-04	C-28	City of Porterville	1898492	6555368	2005	N/A	N/A	3.9	1,370	3.3	1,2,3,4,5	C
22S/27E-08B01	AP-2	City of Porterville	1892754	6539159	1969	N/A	N/A	11	3,790	8.4	3,4	C
22S/27E-09G01	AP-1	City of Porterville	1893220	6545040	1959	N/A	N/A	3.7	1,300	3.1	3,4	C
22S/27E-111	258408	Private	1894126	6555327	1987	N/A	N/A	1.9	540	7.1	1,2	C
22S/27E-14	29629	Private	1887668	6552052	1980	Short-Term	3	2.0	400	5.0	1,2	C
22S/27E-2	C-15	City of Porterville	1909645	6554866	1975	N/A	N/A	4.7	1,340	11	2,3	C
22S/27E-2	68313	Private	1897922	6556137	1970	N/A	N/A	9.1	2,590	108	1	U
22S/27E-23	C-1	City of Porterville	1909465	6557627	1982	N/A	N/A	20	5,810	48	2,3	C
22S/27E-24	48679	Private	1882267	6557577	1985	Long-Term	24	1.9	560	2.8	4,5	C
22S/27E-36	394404	Private	1870648	6560234	1992	Short-Term	4	0.4	70	0.5	1,2	C
23S/23E-27	E0080474	Private	1845436	6419740	2008	Long-Term	40	7.5	2,850	4.5	3	L
23S/23E-34	1095876	Alpaugh JPA	1842264	6418966	2004	Short-Term	12	13	4,910	27	3	L
23S/23E-4	E077033	Angiola Water District	1867979	6418614	2008	N/A	N/A	10	4,220	35	3	L
23S/24E-21	17959	Pixley Wildlife Refuge	1851746	6447543	N/A	N/A	N/A	6.0	2,460	8.2	3	L
23S/25E-11	23083	Private	1862033	6490060	1962	N/A	N/A	5.0	1,750	5.8	1,2	C
23S/25E-16N4	55087	U.S. Geological Survey	1855362	6477883	1959	N/A	N/A	4.0	1,140	28	1,2	C
23S/25E-27P01	3	DEID	1826671	6508537	2010	Step Test	12	26	6,440	7.0	3	L
23S/25E-28J02	2	DEID	1826688	6507154	2010	Step Test	12	26	6,720	7.0	3	L
23S/25E-33	944088	Private	1839910	6478963	2008	Short-Term	2	5.0	1,390	2.9	2,3	C
23S/25E-35G01	5	DEID	1826049	6506009	2010	Step Test	12	41	9,680	11	3	L

Summary of Pumping Test Data

State Well Number	DWR Number or Well Name	Well Owner	Northing[1]	Easting[1]	Year of Pumping Test	Pumping Test Type[2]	Pumping Duration (hours)	Specific Capacity (gpm/ft)[3]	Estimated Transmissivity (ft^2/day)	Estimated Hydraulic Conductivity (ft/day)	Model Layer(s)	Aquifer[4]
23S/25E-6P1	37263	Private	1865081	6468973	1956	Short-Term	20	44	14,470	49	2,3	C
23S/27E-03	120307	Terra Bella Irrigation District	1867501	6550348	1968	Short-Term	20	2.0	590	1.5	2,3,4	C
23S/27E-07	942277	Private	1859684	6531568	2008	Short-Term	16	2.4	850	0.7	3,4,5	C
23S/27E-12	942269	Private	1859644	6558813	2008	N/A	N/A	29	11,930	11	4	L
23S/27E-19R1	14164	Private	1849038	6535105	1957	Short-Term	6	95	36,620	38	3,4,5	C
23S/27E-20	16380	Private	1850262	6537921	1960	N/A	N/A	52	21,150	23	3,4,5	C
23S/27E-21	512022	Private	1854221	6541118	2002	Short-Term	8	0.6	160	0.4	2,3	C
23S/27E-27	925804	Private	1844925	6546660	2004	Long-Term	24	5.7	2,110	6.0	4,5	C
23S/27E-27	120303	Private	1846254	6543059	1967	N/A	N/A	1.8	630	0.9	2,3,4	C
23S/27E-33	e077722	Private	1840078	6543427	2008	Short-Term	3	34	12,400	13	4,5	C
23S/27E-34	E059519	Private	1839736	6548507	2007	Short-Term	8	77	29,840	30	4,5	C
23S/27E-7	104854	Private	1862230	6534629	1966	N/A	N/A	2.7	950	2.4	2,3	C
23S/27E-8	53055	Private	1863543	6536385	1958	N/A	N/A	1.3	370	1.2	2,3	C
24S/23E-29B	N/A	Tri County	1817447	6410754	N/A	Long-Term	12 to 24	26	4,950	15	3	L
24S/23E-30B	N/A	Tri County	1817561	6405468	N/A	Long-Term	12 to 24	52	11,900	22	3	L
24S/23E-3P	146126	Private	1835941	6421173	1978	N/A	N/A	47	16,370	55	1,2,3	C
24S/24E-14R	N/A	Tri County	1822868	6460904	N/A	Long-Term	12 to 24	30	4,810	5.9	3	L
24S/24E-1G	49066	Private	1836050	6463568	1982	Short-Term	12	74	28,830	39	3	L
24S/24E-22M	N/A	Tri County	1819619	6450477	N/A	Long-Term	12 to 24	27	7,890	12	3	L
24S/24E-23D	N/A	Tri County	1822669	6456143	N/A	Long-Term	12 to 24	10	3,340	4.5	3	L
24S/24E-23R	N/A	Tri County	1817617	6459648	N/A	Long-Term	12 to 24	20	3,740	4.5	3	L
24S/24E-24Q	N/A	Tri County	1817603	6464981	N/A	Long-Term	12 to 24	8.6	4,140	5.8	3	L
24S/24E-27F	N/A	Tri County	1814907	6451725	N/A	Long-Term	12 to 24	23	4,950	6.1	3	L
24S/24E-28R	N/A	Tri County	1812293	6449947	N/A	Long-Term	12 to 24	38	10,160	12	3	L
24S/24E-36E	58330	Private	1833430	6453091	1959	N/A	N/A	47	13,280	443	1	U
24S/24E-36E	N/A	Tri County	1809791	6460999	N/A	Long-Term	12 to 24	17	4,550	4.8	3	L
24S/25E-10	942275	Private	1832319	6484774	2008	Short-Term	16	16	4,930	11	3	L
24S/25E-19R	N/A	Tri County	1817586	6470931	N/A	Long-Term	12 to 24	14	2,010	5.3	3	L
24S/25E-20B	N/A	Tri County	1821475	6474297	N/A	Long-Term	12 to 24	19	8,960	12	3	L
24S/25E-30H	N/A	Tri County	1814947	6471559	N/A	Long-Term	12 to 24	19	3,880	5.2	3	L
24S/26E-15	N/A	Private	1827763	6516494	2008	Short-Term	6	13	4,540	3.5	3,4	C
24S/26E-17	942284	DEID	1826745	6505884	2008	Short-Term	12	11	3,330	4.2	3	L
24S/26E-17	1	DEID	1827088	6506032	2009	Step Test	12	30	5,530	7.0	3	L
24S/26E-17	4	DEID	1827967	6508026	2010	Step Test	12	19	4,450	5.0	3,4	C
24S/26E-22	N/A	Private	1817592	6516518	2008	Short-Term	6	7.8	2,310	3.8	3,4	C

Summary of Pumping Test Data

State Well Number	DWR Number or Well Name	Well Owner	Northing[1]	Easting[1]	Year of Pumping Test	Pumping Test Type[2]	Pumping Duration (hours)	Specific Capacity (gpm/ft)[3]	Estimated Transmissivity (ft^2/day)	Estimated Hydraulic Conductivity (ft/day)	Model Layer(s)	Aquifer[4]
24S/26E-30	e0094489	Private	1814991	6503110	2009	Short-Term	12	9.0	3,310	5.3	3	L
24S/27E-31	489110	Private	1812175	6530537	1992	Short-Term	14.5	0.1	10	0.1	3	L
25S/22E-1B	N/A	Tri County	1806903	6397730	N/A	Long-Term	12 to 24	65	13,900	30	2,3	C
25S/22E-2A	N/A	Tri County	1807009	6395021	N/A	Long-Term	12 to 24	58	18,050	41	2,3	C
25S/25E-17G	N/A	Tri County	1795022	6471792	N/A	Long-Term	12 to 24	21	4,010	9.1	3	L
25S/25E-5B	N/A	Tri County	1806820	6472905	N/A	Long-Term	12 to 24	23	3,340	8.1	3	L
25S/25E-7C	N/A	Tri County	1800572	6466017	N/A	Long-Term	12 to 24	37	11,230	19	3	L
25S/25E-7F	N/A	Tri County	1799281	6466010	N/A	Long-Term	12 to 24	45	11,360	19	3	L

Notes:

[1] NAD 83 California State Plane Zone 4

[2] Short-Term indicates less than 24 hours pumping duration, and long-term indicates 24 hours or more pumping duration.

[3] gpm/ft = gallons per minute per foot of drawdown

[4] U = Upper Aquifer, L = Lower Aquifer, C = Composite Aquifer

[5] N/A = Not Available

Tule Subbasin Historical Surface Water Budget - Inflow

		Surface Water Inflow (acre-ft)																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
Water Year	Water Year Type	Precipitation	Stream Inflow			Imported Water											Discharge from Wells		Total In
			Tule River	Deer Creek	White River	Saucelito ID	Terra Bella ID	Kern-Tulare WD	Porterville ID	Tea Pot Dome WD	LTRID	Pixley ID	Delano-Earlimart ID	Angiola WD	Alpaugh ID	Atwell Island WD	Agriculture Pumping	Municipal Pumping	
1986 - 1987	Below Average	219,000	70,029	8,389	2,496	23,879	13,136	10,899	15,337	5,490	89,541	9,356	114,782	7,278	794	1,109	724,000	13,500	1,329,000
1987 - 1988	Average	315,000	39,842	6,095	1,420	19,666	21,961	12,210	13,067	5,493	64,654	0	110,345	3,530	0	0	768,000	15,100	1,396,000
1988 - 1989	Below Average	254,000	49,667	7,795	1,942	22,426	22,561	11,991	13,106	6,226	63,922	5,289	105,980	6,026	0	0	728,000	15,700	1,315,000
1989 - 1990	Below Average	245,000	29,342	4,706	778	16,166	23,159	11,371	11,520	6,193	24,325	0	83,837	3,847	0	0	838,000	16,300	1,315,000
1990 - 1991	Average	331,000	51,275	7,247	1,362	19,848	18,725	9,762	11,322	5,636	71,430	0	106,877	925	0	0	799,000	16,700	1,451,000
1991 - 1992	Below Average	285,000	34,325	4,080	739	21,336	20,743	11,700	15,569	6,607	51,949	0	92,567	1,611	0	0	817,000	17,000	1,380,000
1992 - 1993	Above Average	462,000	115,640	15,422	3,623	41,261	18,180	12,357	12,310	6,968	321,973	96,890	133,359	3,420	12,219	6,423	496,000	17,200	1,775,000
1993 - 1994	Below Average	293,000	61,313	6,908	1,148	22,064	18,740	14,255	12,895	6,526	71,784	7,793	92,394	3,640	3,605	2,000	791,000	17,600	1,427,000
1994 - 1995	Above Average	610,000	218,480	32,053	10,596	37,477	16,186	11,681	9,455	6,562	229,683	55,365	124,388	8,918	8,263	5,395	574,000	17,600	1,976,000
1995 - 1996	Average	321,000	174,473	23,095	5,957	48,924	21,617	15,415	13,808	7,993	236,845	60,931	144,069	12,551	11,130	5,267	508,000	17,800	1,629,000
1996 - 1997	Above Average	450,000	353,968	58,781	12,920	40,908	20,158	15,736	13,379	7,298	192,934	37,048	153,967	12,383	0	0	567,000	18,700	1,955,000
1997 - 1998	Above Average	728,000	439,125	88,360	36,764	28,221	13,165	11,745	10,159	4,913	101,180	41,823	119,815	7,460	0	0	630,000	17,900	2,279,000
1998 - 1999	Above Average	373,000	108,466	18,410	7,469	37,062	17,567	14,527	16,107	9,218	183,971	34,736	124,051	9,778	0	0	620,000	18,000	1,592,000
1999 - 2000	Average	354,000	102,354	15,230	4,878	39,734	19,200	16,476	15,545	7,191	177,192	40,076	134,272	8,118	0	253	651,000	18,900	1,604,000
2000 - 2001	Below Average	265,000	55,249	7,016	4,695	25,252	19,194	17,550	15,436	6,456	83,405	9,098	117,746	3,824	0	0	719,000	19,100	1,368,000
2001 - 2002	Below Average	252,000	73,206	10,370	6,176	26,131	20,234	15,088	13,628	6,388	78,511	13,588	126,747	2,932	0	0	713,000	20,900	1,379,000
2002 - 2003	Below Average	247,000	125,004	15,678	5,875	33,692	18,356	14,591	14,646	5,844	131,470	32,195	121,277	4,728	104	0	610,000	20,600	1,401,000
2003 - 2004	Below Average	207,000	51,738	6,882	2,350	26,988	20,352	15,755	14,698	6,913	71,472	9,839	127,364	3,434	0	0	656,000	21,700	1,242,000
2004 - 2005	Above Average	395,000	172,558	22,758	6,502	42,840	15,266	13,495	14,748	5,217	247,595	59,211	119,847	11,741	14,490	0	479,000	20,600	1,641,000
2005 - 2006	Above Average	401,000	195,667	23,868	7,588	45,106	21,763	14,507	13,251	6,436	194,019	60,634	121,005	10,909	16,112	0	490,000	21,600	1,643,000
2006 - 2007	Below Average	170,000	38,587	6,901	1,815	16,280	20,797	15,133	9,775	5,489	33,174	7,200	79,111	6,641	0	0	746,000	22,700	1,180,000
2007 - 2008	Below Average	189,000	74,030	8,411	2,355	24,083	18,192	17,689	12,988	6,894	71,872	12,243	106,470	2,165	0	0	637,000	23,000	1,206,000
2008 - 2009	Below Average	203,000	54,737	6,620	1,751	31,282	19,701	15,524	18,000	6,165	113,189	23,620	111,556	191	2,131	0	660,000	22,500	1,290,000
2009 - 2010	Average	325,000	144,778	16,470	5,080	42,855	17,574	14,027	14,335	5,845	200,064	32,972	118,671	3,243	2,671	0	483,000	21,800	1,448,000
2010 - 2011	Above Average	479,000	266,473	44,873	14,997	46,733	16,381	13,405	9,387	6,105	229,763	48,391	127,447	6,476	10,951	0	514,000	21,800	1,856,000
2011 - 2012	Below Average	302,000	87,533	11,311	3,334	19,189	19,757	14,309	9,318	4,680	67,684	5,914	114,108	3,156	943	0	730,000	22,500	1,416,000
2012 - 2013	Below Average	139,000	30,283	4,777	1,145	14,102	20,628	14,955	10,298	4,354	37,073	5,012	87,302	1,492	0	0	790,000	22,700	1,183,000
2013 - 2014	Below Average	99,000	13,171	2,957	535	5,724	12,390	9,986	178	1,030	0	0	38,106	1,048	0	0	900,000	21,900	1,106,000
2014 - 2015	Below Average	142,000	8,820	1,994	253	1,503	12,012	5,438	114	260	0	0	18,591	575	0	0	890,000	19,700	1,101,000
2015 - 2016	Below Average	217,000	74,330	14,559	4,547	20,049	14,357	11,805	13,271	4,627	73,382	3,442	93,806	587	0	0	614,000	19,700	1,179,000
2016 - 2017	Below Average	227,000	352,963	51,145	17,241	51,137	16,089	14,203	21,651	6,694	273,151	82,363	137,773	12,146	2,367	0	429,000	20,100	1,715,000
86/87-16/17 Avg		306,000	118,300	17,800	5,800	28,800	18,300	13,500	12,600	5,900	122,200	25,600	109,900	5,300	2,800	700	664,000	19,400	1,477,000

Tule Subbasin Historical Surface Water Budget

Water Year	Water Year Type	Surface Water Outflow (acre-ft)																		
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
			Streambed Infiltration					Canal Loss			Recharge in Basins				Deep Percolation of Applied Water					
			Tule River		Native Deer Creek															
		Areal Recharge of Precipitation	Success to Oettle Bridge	Oettle Bridge to Turnbull Weir	Before Trenton Weir	Trenton Weir to Homeland Canal	White River	Tule River	Deer Creek	Imported Water	Tule River	Deer Creek	Imported Water	Recycled Water	Tule River	Deer Creek	Imported Water	Recycled Water	Agricultural Pumping	Municipal Pumping
1986 - 1987	Below Average	0	11,600	1,100	8,100	0	2,400	20,700	0	52,500	5,400	0	0	2,600	8,500	0	56,100	200	169,900	5,200
1987 - 1988	Average	4,000	8,000	900	5,800	0	1,300	8,800	0	32,700	5,000	0	0	3,200	5,500	0	48,100	200	183,200	5,400
1988 - 1989	Below Average	0	8,700	0	7,500	0	1,800	7,400	0	20,500	6,200	0	0	3,400	6,100	0	51,800	200	172,100	5,600
1989 - 1990	Below Average	0	5,000	0	4,400	0	700	2,900	0	7,400	3,700	0	0	3,600	2,700	0	36,200	200	199,700	5,700
1990 - 1991	Average	7,000	6,400	300	6,900	0	1,300	6,800	0	24,300	5,200	0	0	3,700	5,900	0	46,900	200	190,300	5,800
1991 - 1992	Below Average	1,000	4,300	0	3,800	0	700	3,100	0	16,100	3,700	0	0	3,800	3,500	0	44,700	200	194,900	5,900
1992 - 1993	Above Average	57,000	18,500	3,000	15,100	0	3,500	27,800	0	184,400	8,200	0	5,600	3,900	16,800	0	118,000	200	111,300	6,000
1993 - 1994	Below Average	2,000	6,100	200	6,600	0	1,100	14,200	0	35,600	5,000	0	700	4,000	8,700	0	51,800	200	187,400	6,100
1994 - 1995	Above Average	144,000	36,400	10,400	21,200	1,000	10,500	39,500	3,800	128,500	7,800	1,800	10,400	3,900	34,600	1,000	88,900	200	130,900	6,100
1995 - 1996	Average	5,000	20,700	4,000	13,700	700	5,800	26,200	2,800	87,600	21,200	700	39,500	3,900	31,800	1,200	119,000	200	115,700	6,200
1996 - 1997	Above Average	50,000	34,600	9,700	45,100	1,800	12,800	47,300	6,900	64,200	25,300	1,900	14,100	4,300	31,400	700	117,300	200	130,700	6,300
1997 - 1998	Above Average	219,000	41,100	9,000	14,900	12,700	36,600	79,100	48,800	54,100	32,000	900	16,200	3,900	41,100	3,100	65,200	200	143,800	6,300
1998 - 1999	Above Average	18,000	14,300	2,800	13,300	600	7,300	19,500	2,500	58,200	17,600	400	19,800	3,900	14,100	300	88,700	200	143,200	6,400
1999 - 2000	Average	12,000	16,900	2,900	10,100	600	4,800	11,100	2,400	64,400	8,900	500	13,000	4,200	15,200	300	93,200	200	152,400	6,500
2000 - 2001	Below Average	0	12,300	0	6,700	0	4,600	7,000	0	28,500	5,000	0	2,700	4,300	7,800	0	61,700	200	169,600	6,600
2001 - 2002	Below Average	0	14,800	700	10,100	0	6,100	13,400	0	24,800	5,800	0	100	4,900	9,000	0	65,200	300	169,100	6,900
2002 - 2003	Below Average	0	19,700	3,700	13,600	100	5,800	22,800	400	53,600	12,200	300	5,000	4,800	11,500	200	65,700	200	123,200	6,900
2003 - 2004	Below Average	0	9,900	300	6,600	0	2,300	7,700	0	19,600	3,900	0	0	5,100	6,200	0	57,800	200	134,000	7,100
2004 - 2005	Above Average	26,000	24,200	4,700	14,400	400	6,400	22,900	1,500	91,200	19,000	2,900	32,000	2,400	15,300	700	89,700	500	92,600	7,100
2005 - 2006	Above Average	28,000	28,100	7,200	14,400	900	7,500	40,500	3,400	78,000	23,300	3,200	26,600	2,000	29,300	400	91,000	700	95,700	7,300
2006 - 2007	Below Average	0	6,200	1,500	6,600	0	1,700	5,100	0	15,500	4,300	0	100	2,000	4,800	0	36,000	700	151,600	7,500
2007 - 2008	Below Average	0	11,700	1,100	8,100	0	2,300	15,900	0	22,100	6,900	0	1,600	2,000	7,800	0	45,500	800	129,700	7,600
2008 - 2009	Below Average	0	9,500	1,400	6,300	0	1,600	7,100	0	43,800	5,200	0	8,100	2,000	7,600	0	57,400	700	135,300	7,600
2009 - 2010	Average	6,000	25,600	4,500	16,100	0	5,000	34,600	0	72,700	14,300	0	29,900	2,000	19,200	0	77,700	600	93,900	7,500
2010 - 2011	Above Average	65,000	37,100	7,500	24,400	1,300	14,800	82,400	5,000	89,500	39,000	9,700	45,700	2,000	30,300	1,400	84,700	600	101,900	7,600
2011 - 2012	Below Average	3,000	13,600	300	11,000	0	3,200	17,800	0	23,100	8,100	0	7,000	2,000	11,900	0	46,200	700	151,300	7,700
2012 - 2013	Below Average	0	4,900	0	4,500	0	1,000	4,400	0	13,000	5,300	0	100	2,000	3,400	0	35,000	700	165,100	7,800
2013 - 2014	Below Average	0	2,300	0	2,700	0	400	0	0	0	3,800	0	0	2,000	1,000	0	13,000	600	183,400	7,700
2014 - 2015	Below Average	0	1,000	0	1,800	0	200	0	0	0	3,600	0	0	2,000	1,100	0	5,600	500	178,800	7,500
2015 - 2016	Below Average	0	16,000	5,500	14,300	0	4,400	11,400	0	28,600	6,600	0	3,700	2,000	5,900	0	35,300	400	123,500	7,600
2016 - 2017	Below Average	0	42,100	15,900	37,000	800	17,100	82,600	3,100	133,700	37,300	3,700	61,000	2,000	41,400	1,400	99,000	500	83,300	7,700
86/87-16/17 Avg		21,000	16,500	3,200	12,100	700	5,600	22,300	2,600	50,600	11,600	800	11,100	3,200	14,200	300	64,300	400	145,400	6,700

Groundwater Inflows to be Included in Sustainable Yield Estimates
Groundwater Inflows to be Excluded from the Sustainable Yield Estimates
Surface Water or ET Outflows Not Included in Groundwater Recharge or Sustainable Yield Estimates

Tule Subbasin Historical Surface Water Budget - Outflow

		Surface Water Outflow (acre-ft)													
		T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	
		Evapotranspiration											Surface Outflow		
Water Year	Water Year Type	Precipitation Crops/Native	Tule River		Deer Creek		White River	Imported Water	Ag. Cons. Use from Pumping	Recycled Water		Municipal (Landscape ET)	Tule River	Deer Creek	Total Out
			Agricultural Cons. Use	Stream Channel	Agricultural Cons. Use	Stream Channel	Stream Channel	Agricultural Cons. Use		Recharge in Basins	Agricultural Cons. Use				
1986 - 1987	Below Average	219,000	24,700	800	0	300	100	183,000	553,900	50	700	4,800	0	0	1,332,000
1987 - 1988	Average	311,000	13,800	400	0	300	100	170,100	584,700	50	900	5,300	0	0	1,399,000
1988 - 1989	Below Average	254,000	17,600	400	0	300	100	185,200	556,200	50	1,000	5,500	0	0	1,312,000
1989 - 1990	Below Average	245,000	8,800	400	0	300	100	136,700	638,100	50	1,000	5,700	0	0	1,308,000
1990 - 1991	Average	324,000	16,800	500	0	300	100	173,300	608,700	50	1,000	5,900	0	0	1,442,000
1991 - 1992	Below Average	284,000	10,800	400	0	300	100	161,300	622,000	50	1,100	6,000	0	0	1,372,000
1992 - 1993	Above Average	406,000	34,900	800	0	400	100	357,500	385,000	50	1,100	6,100	0	0	1,771,000
1993 - 1994	Below Average	291,000	21,100	500	0	300	100	167,600	603,800	50	1,100	6,200	0	0	1,421,000
1994 - 1995	Above Average	466,000	71,600	900	2,900	400	100	285,600	442,700	50	1,100	6,200	25,000	0	1,983,000
1995 - 1996	Average	316,000	62,600	1,000	3,600	400	100	332,300	392,200	50	1,100	6,300	7,000	0	1,629,000
1996 - 1997	Above Average	399,000	57,100	1,000	2,000	400	100	298,200	436,100	50	1,200	6,600	121,000	0	1,927,000
1997 - 1998	Above Average	509,000	98,000	1,000	9,100	400	200	203,000	485,800	50	1,100	6,300	132,000	0	2,274,000
1998 - 1999	Above Average	354,000	37,700	1,000	1,000	400	200	280,600	477,200	50	1,100	6,300	0	0	1,591,000
1999 - 2000	Average	342,000	39,200	700	900	400	100	286,800	498,600	50	1,200	6,600	5,000	0	1,601,000
2000 - 2001	Below Average	264,000	21,900	700	0	300	100	205,000	548,900	50	1,200	6,700	0	0	1,366,000
2001 - 2002	Below Average	252,000	22,600	700	0	300	100	213,200	543,800	50	1,400	7,400	0	0	1,373,000
2002 - 2003	Below Average	247,000	37,500	700	700	400	100	252,500	487,300	50	1,400	7,300	5,000	0	1,390,000
2003 - 2004	Below Average	207,000	18,200	600	0	300	100	219,400	522,200	50	1,500	7,700	1,000	0	1,239,000
2004 - 2005	Above Average	369,000	43,800	800	2,500	400	100	322,200	386,800	50	3,300	7,300	22,000	0	1,612,000
2005 - 2006	Above Average	373,000	58,800	800	1,300	400	100	308,200	394,100	50	4,000	7,600	11,000	0	1,647,000
2006 - 2007	Below Average	170,000	14,200	400	0	300	100	142,000	594,200	50	4,400	8,000	0	0	1,177,000
2007 - 2008	Below Average	189,000	24,300	600	0	300	100	203,400	507,600	50	4,500	8,100	1,000	0	1,202,000
2008 - 2009	Below Average	203,000	22,300	500	0	300	100	233,000	524,600	50	4,200	7,900	0	0	1,290,000
2009 - 2010	Average	320,000	45,400	800	0	400	100	275,700	388,600	50	3,900	7,700	0	0	1,452,000
2010 - 2011	Above Average	414,000	65,300	800	4,700	400	200	295,900	412,300	50	3,800	7,700	8,000	0	1,863,000
2011 - 2012	Below Average	299,000	33,800	600	0	300	100	182,700	578,500	50	4,100	7,900	10,000	0	1,424,000
2012 - 2013	Below Average	139,000	10,300	500	0	300	100	147,100	625,000	50	4,200	8,000	0	0	1,182,000
2013 - 2014	Below Average	99,000	2,400	300	0	300	100	55,500	716,500	50	3,800	7,700	0	0	1,103,000
2014 - 2015	Below Average	142,000	2,300	300	0	200	100	32,900	711,500	50	2,700	7,000	0	0	1,101,000
2015 - 2016	Below Average	217,000	19,400	500	0	300	100	167,700	490,200	50	2,700	7,000	0	0	1,170,000
2016 - 2017	Below Average	227,000	67,100	900	4,800	400	200	323,800	345,900	50	2,800	7,100	71,000	0	1,721,000
86/87-16/17 Avg		286,000	33,000	700	1,100	300	100	219,400	518,200	50	2,200	6,800	14,000	0	1,474,000

Groundwater Inflows to be Included in Sustainable Yield Estimates
Groundwater Inflows to be Excluded from the Sustainable Yield Estimates
Surface Water or ET Outflows Not Included in Groundwater Recharge or Sustainable Yield Estimates

Tule Subbasin Historical Groundwater Budget

		Groundwater Inflows (acre-ft)																					
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	
			Tule River Infiltration					Deer Creek Infiltration						Imported Water Deliveries				Municipal Pumping						
																			Recycled Water					
Water Year	Water Year Type	Areal Recharge from Precipitation	Success to Oettle Bridge Infiltration	Oettle Bridge to Turnbull Weir Infiltration	Canal Loss	Recharge in Basins	Return Flow	Before Trenton Weir Infiltration	Trenton Weir to Homeland Canal Infiltration	Canal Loss	Recharge in Basins	Return Flow	White River Infiltration	Canal Loss	Recharge in Basins	Return Flow	Agricultural Pumping Return Flow	Return Flow	Agricultural Return Flow	Artificial Recharge	Release of Water from Compression of Aquitards	Sub-surface Inflow	Mountain-Block Recharge	Total In
1986 - 1987	Below Average	0	11,600	1,100	20,700	5,400	8,500	8,100	0	0	0	0	2,400	52,500	0	56,100	169,900	5,200	200	2,600	120,000	113,000	28,000	605,000
1987 - 1988	Average	4,000	8,000	900	8,800	5,000	5,500	5,800	0	0	0	0	1,300	32,700	0	48,100	183,200	5,400	200	3,200	88,000	131,000	29,000	560,000
1988 - 1989	Below Average	0	8,700	0	7,400	6,200	6,100	7,500	0	0	0	0	1,800	20,500	0	51,800	172,100	5,600	200	3,400	71,000	131,000	29,000	522,000
1989 - 1990	Below Average	0	5,000	0	2,900	3,700	2,700	4,400	0	0	0	0	700	7,400	0	36,200	199,700	5,700	200	3,600	132,000	133,000	29,000	566,000
1990 - 1991	Average	7,000	6,400	300	6,800	5,200	5,900	6,900	0	0	0	0	1,300	24,300	0	46,900	190,300	5,800	200	3,700	126,000	144,000	29,000	610,000
1991 - 1992	Below Average	1,000	4,300	0	3,100	3,700	3,500	3,800	0	0	0	0	700	16,100	0	44,700	194,900	5,900	200	3,800	143,000	140,000	30,000	599,000
1992 - 1993	Above Average	57,000	18,500	3,000	27,800	8,200	16,800	15,100	0	0	0	0	3,500	184,400	5,600	118,000	111,300	6,000	200	3,900	44,000	93,000	30,000	746,000
1993 - 1994	Below Average	2,000	6,100	200	14,200	5,000	8,700	6,600	0	0	0	0	1,100	35,600	700	51,800	187,400	6,100	200	4,000	85,000	123,000	30,000	568,000
1994 - 1995	Above Average	144,000	36,400	10,400	39,500	7,800	34,600	21,200	1,000	3,800	1,800	1,000	10,500	128,500	10,400	88,900	130,900	6,100	200	3,900	33,000	101,000	30,000	845,000
1995 - 1996	Average	5,000	20,700	4,000	26,200	21,200	31,800	13,700	700	2,800	700	1,200	5,800	87,600	39,500	119,000	115,700	6,200	200	3,900	19,000	95,000	27,000	647,000
1996 - 1997	Above Average	50,000	34,600	9,700	47,300	25,300	31,400	45,100	1,800	6,900	1,900	700	12,800	64,200	14,100	117,300	130,700	6,300	200	4,300	19,000	111,000	28,000	763,000
1997 - 1998	Above Average	219,000	41,100	9,000	79,100	32,000	41,100	14,900	12,700	48,800	900	3,100	36,600	54,100	16,200	65,200	143,800	6,300	200	3,900	17,000	126,000	30,000	1,001,000
1998 - 1999	Above Average	18,000	14,300	2,800	19,500	17,600	14,100	13,300	600	2,500	400	300	7,300	58,200	19,800	88,700	143,200	6,400	200	3,900	18,000	122,000	30,000	601,000
1999 - 2000	Average	12,000	16,900	2,900	11,100	8,900	15,200	10,100	600	2,400	500	300	4,800	64,400	13,000	93,200	152,400	6,500	200	4,200	20,000	131,000	30,000	601,000
2000 - 2001	Below Average	0	12,300	0	7,000	5,000	7,800	6,700	0	0	0	0	4,600	28,500	2,700	61,700	169,600	6,600	200	4,300	42,000	142,000	30,000	531,000
2001 - 2002	Below Average	0	14,800	700	13,400	5,800	9,000	10,100	0	0	0	0	6,100	24,800	100	65,200	169,100	6,900	300	4,900	59,000	135,000	30,000	555,000
2002 - 2003	Below Average	0	19,700	3,700	22,800	12,200	11,500	13,600	100	400	300	200	5,800	53,600	5,000	65,700	123,200	6,900	200	4,800	42,000	123,000	29,000	544,000
2003 - 2004	Below Average	0	9,900	300	7,700	3,900	6,200	6,600	0	0	0	0	2,300	19,600	0	57,800	134,000	7,100	200	5,100	70,000	127,000	29,000	487,000
2004 - 2005	Above Average	26,000	24,200	4,700	22,900	19,000	15,300	14,400	400	1,500	2,900	700	6,400	91,200	32,000	89,700	92,600	7,100	500	2,400	26,000	96,000	29,000	605,000
2005 - 2006	Above Average	28,000	28,100	7,200	40,500	23,300	29,300	14,400	900	3,400	3,200	400	7,500	78,000	26,600	91,000	95,700	7,300	700	2,000	16,000	97,000	29,000	630,000
2006 - 2007	Below Average	0	6,200	1,500	5,100	4,300	4,800	6,600	0	0	0	0	1,700	15,500	100	36,000	151,600	7,500	700	2,000	78,000	125,000	29,000	476,000
2007 - 2008	Below Average	0	11,700	1,100	15,900	6,900	7,800	8,100	0	0	0	0	2,300	22,100	1,600	45,500	129,700	7,600	800	2,000	96,000	113,000	30,000	502,000
2008 - 2009	Below Average	0	9,500	1,400	7,100	5,200	7,600	6,300	0	0	0	0	1,600	43,800	8,100	57,400	135,300	7,600	700	2,000	125,000	108,000	30,000	557,000
2009 - 2010	Average	6,000	25,600	4,500	34,600	14,300	19,200	16,100	0	0	0	0	5,000	72,700	29,900	77,700	93,900	7,500	600	2,000	70,000	83,000	29,000	592,000
2010 - 2011	Above Average	65,000	37,100	7,500	82,400	39,000	30,300	24,400	1,300	5,000	9,700	1,400	14,800	89,500	45,700	84,700	101,900	7,600	600	2,000	34,000	93,000	29,000	806,000
2011 - 2012	Below Average	3,000	13,600	300	17,800	8,100	11,900	11,000	0	0	0	0	3,200	23,100	7,000	46,200	151,300	7,700	700	2,000	86,000	123,000	29,000	545,000
2012 - 2013	Below Average	0	4,900	0	4,400	5,300	3,400	4,500	0	0	0	0	1,000	13,000	100	35,000	165,100	7,800	700	2,000	145,000	130,000	29,000	551,000
2013 - 2014	Below Average	0	2,300	0	0	3,800	1,000	2,700	0	0	0	0	400	0	0	13,000	183,400	7,700	600	2,000	186,000	132,000	30,000	565,000
2014 - 2015	Below Average	0	1,000	0	0	3,600	1,100	1,800	0	0	0	0	200	0	0	5,600	178,800	7,500	500	2,000	189,000	124,000	30,000	545,000
2015 - 2016	Below Average	0	16,000	5,500	11,400	6,600	5,900	14,300	0	0	0	0	4,400	28,600	3,700	35,300	123,500	7,600	400	2,000	140,000	112,000	30,000	547,000
2016 - 2017	Below Average	0	42,100	15,900	82,600	37,300	41,400	37,000	800	3,100	3,700	1,400	17,100	133,700	61,000	99,000	83,300	7,700	500	2,000	61,000	95,000	29,000	855,000
86/87-16/17 Avg		21,000	16,500	3,200	22,300	11,600	14,200	12,100	700	2,600	800	300	5,600	50,600	11,100	64,300	145,400	6,700	400	3,200	77,000	118,000	29,000	617,000

Groundwater Inflows to be Included in Sustainable Yield Estimates
Groundwater Inflows to be Excluded from the Sustainable Yield Estimates
Surface Water or ET Outflows Not Included in Groundwater Recharge or Sustainable Yield Estimates

Tule Subbasin Groundwater Budget

		Groundwater Outflows (acre-ft)						
		W	X	Y	Z	AA		
		Groundwater Pumping						
Water Year	Water Year Type	Municipal	Irrigated Agriculture	Exports	Groundwater Banking Extraction	Sub-surface Outflow	Total Out	Change in Storage (acre-ft)
1986 - 1987	Below Average	13,500	724,000	6,550	0	61,000	805,000	-200,000
1987 - 1988	Average	15,100	768,000	34,180	0	53,000	870,000	-310,000
1988 - 1989	Below Average	15,700	728,000	38,290	0	51,000	833,000	-311,000
1989 - 1990	Below Average	16,300	838,000	50,430	0	53,000	958,000	-392,000
1990 - 1991	Average	16,700	799,000	46,300	0	61,000	923,000	-313,000
1991 - 1992	Below Average	17,000	817,000	41,250	0	52,000	927,000	-328,000
1992 - 1993	Above Average	17,200	496,000	14,550	0	73,000	601,000	145,000
1993 - 1994	Below Average	17,600	791,000	11,220	0	59,000	879,000	-311,000
1994 - 1995	Above Average	17,600	574,000	1,320	0	61,000	654,000	191,000
1995 - 1996	Average	17,800	508,000	0	0	65,000	591,000	56,000
1996 - 1997	Above Average	18,700	567,000	0	0	65,000	651,000	112,000
1997 - 1998	Above Average	17,900	630,000	0	0	62,000	710,000	291,000
1998 - 1999	Above Average	18,000	620,000	0	0	62,000	700,000	-99,000
1999 - 2000	Average	18,900	651,000	7,720	0	60,000	738,000	-137,000
2000 - 2001	Below Average	19,100	719,000	30,600	0	60,000	829,000	-298,000
2001 - 2002	Below Average	20,900	713,000	44,520	0	58,000	836,000	-281,000
2002 - 2003	Below Average	20,600	610,000	33,660	0	55,000	719,000	-175,000
2003 - 2004	Below Average	21,700	656,000	37,790	0	55,000	770,000	-283,000
2004 - 2005	Above Average	20,600	479,000	11,720	0	66,000	577,000	28,000
2005 - 2006	Above Average	21,600	490,000	150	0	64,000	576,000	54,000
2006 - 2007	Below Average	22,700	746,000	49,500	0	54,000	872,000	-396,000
2007 - 2008	Below Average	23,000	637,000	50,090	0	68,000	778,000	-276,000
2008 - 2009	Below Average	22,500	660,000	48,860	550	78,000	810,000	-253,000
2009 - 2010	Average	21,800	483,000	28,530	70	92,000	625,000	-33,000
2010 - 2011	Above Average	21,800	514,000	8,060	0	86,000	630,000	176,000
2011 - 2012	Below Average	22,500	730,000	43,570	3,860	76,000	876,000	-331,000
2012 - 2013	Below Average	22,700	790,000	63,640	5,990	68,000	950,000	-399,000
2013 - 2014	Below Average	21,900	900,000	58,030	5,590	69,000	1,055,000	-490,000
2014 - 2015	Below Average	19,700	890,000	53,270	1,150	64,000	1,028,000	-483,000
2015 - 2016	Below Average	19,700	614,000	50,000	70	70,000	754,000	-207,000
2016 - 2017	Below Average	20,100	429,000	11,330	0	90,000	550,000	305,000
		19,400	664,000	28,200	600	65,000	777,000	-160,000
							Cummulative Change in Storage	-4,948,000

Groundwater Inflows to be Included in Sustainable Yield Estimates

Groundwater Inflows to be Excluded from the Sustainable Yield Estimates

Surface Water or ET Outflows Not Included in Groundwater Recharge or Sustainable Yield Estimates

Summary of Projects Exclusive of Transitional Pumping

Eastern Tule GSA

No.	Lead Entity	Project Name	Description	Timeframe	Annual Volume	Water Source	Confidence
1	City of Porterville	Population Increase	Increase GW Production	2.5%/yr 2020-2040	9,500 af/yr by 2040	N/A	High
2	City of Porterville	Recycling Increase	Increase RW Applied to Ag	2.5%/yr 2020-2040	1,900 af/yr by 2040	Recycled Water	High
3	City of Porterville	Recycling Increase	Increase RW Recharge	2.5%/yr 2020-2040	1,600 af/yr by 2040	Recycled Water	High
4	City of Porterville	Tule River Recharge	Recharge Project	Starting 2019/20	900 af/yr	Tule River	High
5	City of Porterville	FKC Recharge	Recharge Project	Starting 2020/21	1,100 af/yr	FKC via Porterville ID	High
6	Porterville ID	SA 1 & 2	Expand distribution system	Starting 2018/19	3,200 af/yr	Tule River and FKC	High
7	Porterville ID	Falconer Bank	Develop water bank	Starting 2020/21	3,300 af/yr of leave-behind	FKC and others	High
8	Porterville ID	Recharge Policy	On-Farm recharge	Starting 2019/20	3,000 af/yr	Tule River and FKC	High
9	Saucelito ID	Conway Bank	Develop water bank	Starting 2020/21	1,100 af/yr of leave-behind	FKC and others	High
10	Saucelito ID	Recharge Policy	On-Farm recharge	Starting 2019/20	2,000 af/yr	FKC	High
11	Kern-Tulare WD	In-District Pricing	Pricing change	Starting 2020/21	2,600 af/yr	N/A	High
12	Kern-Tulare WD	Reservoir Storage	Surface water storage	Starting 2029/30	500 af/yr	FKC and others	Medium
13	Kern-Tulare WD	CRC Pipeline	Deliver produced water	Starting 2024/25	680 af/yr	CRC Produced water	High
14	Terra Bella ID	Deer Creek Recharge	Divert and recharge DC	Starting 2017/18	800 af/yr	Deer Creek	High
15	PWC, VWD, & CMDC	SREP	Success Dam Enlargement	Starting 2024/25	400 af/yr	Tule River	High
16	Hope WD	In-District Recharge	Recharge Project	Starting 2022/23	5,000 af/yr every 3 years	FKC and others / unknown	Medium
17	Ducor ID	In-District Recharge	Pipeline and Recharge Project	Starting 2023/24	4,000 af/yr	FKC and others / unknown	High

LTRID GSA

No.	Project Name	Description	Timeframe	Annual Volume	Water Source	Confidence
1	Creighton Ranch	Groundwater exports	Unknown	Unknown	Not applicable	N/A
2	LTRID - Pixley ID FKC	Continue FKC transfers to Pixley ID	Ongoing	13,670 af/yr	FKC	N/A
3	SREP	Success Dam Enlargement	Starting 2024/25	2,600 af/yr	Tule River	N/A

Pixley GSA

No.	Project Name	Description	Timeframe	Annual Volume	Water Source	Confidence
1	LTRID - Pixley ID FKC	Continue FKC transfers from LTRID	Ongoing	13,670 af/yr	FKC	N/A

DEID GSA

No.	Project Name	Description	Timeframe	Annual Volume	Water Source	Confidence
N/A	No planned projects	N/A	N/A	N/A	N/A	N/A

Tri-County GSA

No.	Project Name	Description	Timeframe	Annual Volume	Water Source	Confidence
1	Deep Pumping Reduction	Replace deep pumping with 24 new shallow wells	Start in 2019/20, completed in 2023/24	24,000 af/yr	Not applicable	High
2	Duck Club Project	Duck Club water transferred to farms	2019/20	5,400 af every 7 years	Unknown	High
3	Liberty Project	Participation in the Liberty Project surface water storage	Start in 2019/20, completed in 2022/23	5,000 af/yr	FID, FKC, KR, TR, KW, SWP	High
4	Recharge Scenario	Confidential. Capture and recharge flood water	Unknown	1,200 to 1,800 af/yr	Unknown	N/A

Alpaugh GSA

No.	Project Name	Description	Timeframe	Annual Volume	Water Source	Confidence
1	Water Capture	Deer Creek flood capture	Starting in 2022/23	1,100 af 2.5x per yr every 2 yrs	Deer Creek	N/A
2	Cropping Changes	Install drip irrigation on 1,900 acres	Starting 2019/20	Not applicable	Not applicable	N/A

Summary of Projects Exclusive of Transitional Pumping

Notes:

N/A= Not Available
af/yr = acre-foot per year
ID = Irrigation District
GW = Groundwater
RW = Recycled water
Ag = Agricultural
DC = Deer Creek
FKC = Friant-Kern Canal
SA = Service Area
CRC = California Resources Corporation
PWC = Pioneer Water Company
VMD = Vandalia Water District
CMDC = Campbell Moreland Ditch Company
SREP = Success Reservoir Enlargement Project
WD = Water District
MA = Management Area
FID = Fresno Irrigation District (Fresno Slough)
KR = Kaweah River
TR = Tule River
KW = Kaweah River
SWP = State Water Project

Planned Transitional Pumping by GSA

	Eastern Tule GSA	LTRID GSA	Pixley ID GSA	DEID-District Area	DEID White Lands Area	Tri-Co GSA	Alpaugh GSA
2020-2025	90% of over-pumping[1]	2.0 af/ac Over Cons. Use Target	Fallow 5,000 acres; Remaining 2.0 af/ac Over Cons. Use Target	No Change/ Sustainable	100% of over-pumping	100% of over-pumping	Reduce cropped area by 880 acres; 80% of overpumping
2025-2030	80% of over-pumping	1.5 af/ac Over Cons. Use Target	Fallow 5,000 acres; Remaining 1.5 af/ac Over Cons. Use Target[2]		Linear Transitional Pumping	Reduce pumping 10,000 af/yr	
2030-2035	30% of over-pumping	1.0 af/ac Over Cons. Use Target	Fallow 5,000 acres; Remaining 1.0 af/ac Over Cons. Use Target				50% of overpumping
2035-2040	Sustainable	0.5 af/ac Over Cons. Use Target	Fallow 5,000 acres; Remaining 0.5 af/ac Over Cons. Use Target		Sustainable	Sustainable	20% of overpumping
2040+		Sustainable	Sustainable				Sustainable

Notes:

[1]Over-pumping means pumping in excess of the consumptive use target

[2]Over consumptive use target means over pumping

Projected Future Tule Subbasin Surface Water Budget

	Surface Water Inflow (acre-ft)																				
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	
Water Year	Precipitation	Stream Inflow			Imported Water															Discharge from Wells		Total In
		Tule River	Deer Creek	White River	Saucelito ID	Terra Bella ID	Kern-Tulare WD	Porterville ID	Tea Pot Dome WD	City of Porterville	Hope WD	Ducor ID	LTRID	Pixley ID	Delano-Earlimart ID	Angiola WD	Alpaugh ID	Atwell Island WD	Private	Agriculture Pumping	Municipal Pumping	
2017 - 2018	306,000	131,258	19,410	6,347	34,567	18,786	15,335	19,803	6,528	0	0	0	143,186	31,763	116,902	5,911	3,680	0	0	549,000	21,700	1,430,000
2018 - 2019	306,000	131,258	19,410	6,347	34,567	18,786	15,335	19,803	6,528	0	0	0	143,186	31,763	116,902	5,911	3,680	0	0	548,000	23,400	1,431,000
2019 - 2020	306,000	131,258	19,410	6,347	34,567	18,786	15,335	23,103	6,528	0	0	0	143,186	31,763	116,902	7,961	3,680	0	0	529,000	25,000	1,419,000
2020 - 2021	306,000	131,258	19,410	6,347	35,667	18,786	17,935	23,103	6,528	1,100	0	0	143,186	31,763	116,902	9,211	3,680	0	0	526,000	25,400	1,422,000
2021 - 2022	306,000	131,258	19,410	6,347	35,667	18,786	17,935	23,103	6,528	1,100	0	0	143,186	31,763	116,902	10,461	3,680	0	0	524,000	25,700	1,422,000
2022 - 2023	306,000	131,258	19,410	6,347	35,667	18,786	17,935	23,103	6,528	1,100	1,667	0	143,186	31,763	116,902	13,590	3,680	0	0	523,000	26,100	1,426,000
2023 - 2024	306,000	131,258	19,410	6,347	35,667	18,786	17,935	23,103	6,528	1,100	1,667	4,000	143,186	31,763	116,902	18,926	3,680	0	0	522,000	26,500	1,435,000
2024 - 2025	306,000	134,258	19,410	6,347	34,893	20,304	18,229	24,339	6,594	1,100	1,667	4,000	135,513	31,763	117,661	24,261	3,680	0	1,500	494,000	26,900	1,412,000
2025 - 2026	306,000	134,258	19,410	6,347	34,118	21,823	17,843	25,575	6,661	1,100	1,667	4,000	127,841	31,763	118,420	29,597	4,813	0	1,500	487,000	27,400	1,407,000
2026 - 2027	306,000	134,258	19,410	6,347	33,343	23,341	17,458	26,812	6,727	1,100	1,667	4,000	120,168	31,763	119,180	34,933	4,751	0	1,500	481,000	27,800	1,402,000
2027 - 2028	306,000	134,258	19,410	6,347	32,568	24,860	17,072	28,048	6,793	1,100	1,667	4,000	112,496	31,763	119,939	40,268	4,689	0	1,500	474,000	28,200	1,395,000
2028 - 2029	306,000	134,258	19,410	6,347	31,794	26,378	16,687	29,285	6,860	1,100	1,667	4,000	104,823	31,763	120,698	43,725	4,627	0	1,500	468,000	28,700	1,388,000
2029 - 2030	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	4,565	0	1,500	412,000	29,200	1,328,000
2030 - 2031	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	5,737	0	1,500	413,000	29,600	1,331,000
2031 - 2032	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	5,737	0	1,500	410,000	30,100	1,328,000
2032 - 2033	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	5,737	0	1,500	407,000	30,600	1,326,000
2033 - 2034	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	5,737	0	1,500	405,000	31,100	1,324,000
2034 - 2035	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	5,737	0	1,500	345,000	31,700	1,265,000
2035 - 2036	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	6,970	0	1,500	344,000	32,200	1,266,000
2036 - 2037	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	6,970	0	1,500	344,000	32,800	1,266,000
2037 - 2038	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	6,970	0	1,500	344,000	33,300	1,267,000
2038 - 2039	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	6,970	0	1,500	344,000	33,900	1,267,000
2039 - 2040	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	6,970	0	1,500	303,000	34,500	1,227,000
2040 - 2041	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2041 - 2042	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2042 - 2043	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2043 - 2044	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2044 - 2045	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2045 - 2046	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2046 - 2047	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2047 - 2048	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2048 - 2049	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2049 - 2050	306,000	134,258	19,410	6,347	31,019	27,897	18,039	30,521	6,926	1,100	1,667	4,000	97,151	31,763	121,457	43,430	7,793	0	1,500	302,000	34,500	1,227,000
2050 - 2051	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2051 - 2052	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2052 - 2053	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2053 - 2054	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2054 - 2055	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2055 - 2056	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2056 - 2057	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2057 - 2058	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2058 - 2059	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2059 - 2060	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2060 - 2061	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2061 - 2062	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2062 - 2063	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2063 - 2064	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2064 - 2065	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2065 - 2066	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2066 - 2067	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2067 - 2068	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	43,209	7,793	0	1,500	297,000	34,500	1,189,000
2068 - 2069	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	45,214	7,793	0	1,500	297,000	34,500	1,191,000
2069 - 2070	306,000	130,581	18,943	6,143	29,378	26,278	18,039	28,441	6,524	1,100	1,667	4,000	84,084	31,763	112,046	24,476	7,793	0	1,500	297,000	34,500	1,170,000
17/18-69/70 Avg	306,000	132,500	19,200	6,300	31,200	25,700	17,800	28,300	6,700	1,000	1,500	3,500	100,500	31,800	117,100	37,800	6,600	0	1,300	361,000	32,000	1,268,000

Projected Future Tule Subbasin Surface Water Budget

	Surface Water Outflow (acre-ft)																	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
		Streambed Infiltration					Canal Loss			Recharge in Basins				Deep Percolation of Applied Water					
Water Year	Areal Recharge of Precipitation	Tule River		Native Deer Creek		White River	Tule River	Deer Creek	Imported Water	Tule River	Deer Creek	Imported Water	Recycled Water	Tule River	Deer Creek	Imported Water	Recycled Water	Agricultural Pumping	Municipal Pumping
		Success to Oettle Bridge	Oettle Bridge to Turnbull Weir	Before Trenton Weir	Trenton Weir to Homeland Canal														
2017 - 2018	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	12,200	1,300	15,900	2,000	15,500	800	66,900	600	110,400	7,900
2018 - 2019	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	12,200	1,300	15,900	2,000	15,500	800	66,900	700	110,300	8,100
2019 - 2020	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	13,100	1,300	19,200	2,500	15,500	800	68,100	400	106,600	8,300
2020 - 2021	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	13,100	1,300	21,400	2,600	15,500	800	68,700	400	106,000	8,300
2021 - 2022	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	13,100	1,300	21,400	2,600	15,500	800	68,900	400	105,700	8,400
2022 - 2023	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	13,100	1,300	23,000	2,700	15,500	800	69,100	500	105,400	8,400
2023 - 2024	21,000	17,900	3,900	11,600	600	6,200	17,000	2,100	65,200	13,100	1,300	27,000	2,800	15,500	800	69,100	500	105,300	8,500
2024 - 2025	21,000	17,900	3,900	11,600	600	6,200	18,200	2,100	62,400	13,700	1,300	27,900	2,800	15,800	800	69,600	500	100,200	8,500
2025 - 2026	21,000	17,900	3,900	11,600	600	6,200	18,400	2,100	59,600	13,700	1,300	27,300	2,900	15,800	1,100	70,200	500	98,900	8,600
2026 - 2027	21,000	17,900	3,900	11,600	600	6,200	18,700	2,100	56,800	13,700	1,300	26,700	3,000	15,800	1,100	70,500	500	98,000	8,600
2027 - 2028	21,000	17,900	3,900	11,600	600	6,200	19,000	2,100	53,900	13,700	1,300	26,100	3,100	15,800	1,100	70,900	500	97,000	8,700
2028 - 2029	21,000	17,900	3,900	11,600	600	6,200	19,300	2,100	51,100	13,700	1,300	25,500	3,100	15,800	1,100	71,300	500	96,000	8,700
2029 - 2030	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,200	15,500	1,100	71,800	500	86,900	8,800
2030 - 2031	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,300	15,500	1,100	72,100	600	86,900	8,800
2031 - 2032	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,400	15,500	1,100	72,100	600	86,400	8,900
2032 - 2033	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,500	15,500	1,100	72,100	600	85,900	8,900
2033 - 2034	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,500	15,500	1,100	72,100	600	85,400	9,000
2034 - 2035	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,600	15,500	1,100	72,100	600	74,000	9,100
2035 - 2036	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,700	15,500	1,100	72,400	600	73,700	9,100
2036 - 2037	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,800	15,500	1,100	72,400	700	73,700	9,200
2037 - 2038	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	3,900	15,500	1,100	72,400	700	73,700	9,300
2038 - 2039	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,000	15,500	1,100	72,400	700	73,700	9,300
2039 - 2040	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,400	700	64,300	9,400
2040 - 2041	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2041 - 2042	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2042 - 2043	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2043 - 2044	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2044 - 2045	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2045 - 2046	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2046 - 2047	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2047 - 2048	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2048 - 2049	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2049 - 2050	21,000	17,900	3,900	11,600	600	6,200	19,400	2,100	48,300	13,600	1,300	24,900	4,100	15,500	1,100	72,600	700	64,100	9,400
2050 - 2051	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2051 - 2052	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2052 - 2053	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2053 - 2054	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2054 - 2055	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2055 - 2056	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2056 - 2057	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2057 - 2058	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2058 - 2059	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2059 - 2060	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2060 - 2061	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2061 - 2062	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2062 - 2063	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2063 - 2064	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2064 - 2065	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2065 - 2066	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2066 - 2067	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2067 - 2068	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2068 - 2069	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
2069 - 2070	21,000	17,400	3,800	11,300	500	6,000	19,300	2,100	43,500	12,900	1,300	23,800	4,100	15,400	1,100	68,400	700	62,400	9,400
17/18-69/70 Avg	21,000	17,700	3,900	11,500	600	6,100	19,000	2,100	49,500	13,200	1,300	24,100	3,700	15,500	1,100	70,200	600	75,300	9,100

Projected Future Tule Subbasin Surface Water Budget

	Surface Water Outflow (acre-ft)													
	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	
	Evapotranspiration											Surface Outflow		
Water Year	Precipitation Crops/Native	Tule River		Deer Creek		White River	Imported Water	Ag. Cons. Use from Pumping	Recycled Water		Municipal (Landscape ET)	Tule River	Deer Creek	Total Out
		Agricultural Cons. Use	Stream Channel	Agricultural Cons. Use	Stream Channel	Stream Channel	Agricultural Cons. Use		Recharge in Basins	Agricultural Cons. Use				
2017 - 2018	285,000	47,400	700	2,900	300	100	250,700	438,600	50	3,500	7,700	15,000	0	1,431,000
2018 - 2019	285,000	47,400	700	2,900	300	100	250,700	437,800	50	4,300	8,200	8,000	0	1,425,000
2019 - 2020	285,000	47,400	700	2,900	300	100	254,400	420,400	50	2,600	11,200	8,000	0	1,414,000
2020 - 2021	285,000	47,400	700	2,900	300	100	257,400	417,300	50	2,600	11,400	8,000	0	1,417,000
2021 - 2022	285,000	47,400	700	2,900	300	100	258,200	416,100	50	2,700	11,600	8,000	0	1,417,000
2022 - 2023	285,000	47,400	700	2,900	300	100	259,000	414,900	50	2,800	11,800	8,000	0	1,418,000
2023 - 2024	285,000	47,400	700	2,900	300	100	259,000	414,500	50	2,800	12,000	8,000	0	1,422,000
2024 - 2025	285,000	48,500	700	2,900	300	100	262,700	392,000	50	2,900	12,200	8,000	0	1,400,000
2025 - 2026	285,000	48,500	700	3,800	300	100	266,800	385,800	50	3,000	12,400	8,000	0	1,396,000
2026 - 2027	285,000	48,500	700	3,800	300	100	269,800	380,300	50	3,000	12,600	8,000	0	1,390,000
2027 - 2028	285,000	48,500	700	3,800	300	100	272,900	374,800	50	3,100	12,800	7,000	0	1,383,000
2028 - 2029	285,000	48,600	700	3,800	300	100	276,000	369,300	50	3,200	13,100	7,000	0	1,378,000
2029 - 2030	285,000	47,400	700	3,800	300	100	280,300	322,400	50	3,300	13,300	7,000	0	1,322,000
2030 - 2031	285,000	47,400	700	3,800	300	100	281,200	323,200	50	3,400	13,600	7,000	0	1,325,000
2031 - 2032	285,000	47,400	700	3,800	300	100	281,200	321,100	50	3,400	13,800	7,000	0	1,323,000
2032 - 2033	285,000	47,400	700	3,800	300	100	281,200	319,000	50	3,500	14,100	7,000	0	1,321,000
2033 - 2034	285,000	47,400	700	3,800	300	100	281,200	316,900	50	3,600	14,300	7,000	0	1,318,000
2034 - 2035	285,000	47,400	700	3,800	300	100	281,200	268,900	50	3,700	14,600	7,000	0	1,260,000
2035 - 2036	285,000	47,400	700	3,800	300	100	282,200	267,800	50	3,800	14,900	7,000	0	1,260,000
2036 - 2037	285,000	47,400	700	3,800	300	100	282,200	267,700	50	3,900	15,200	7,000	0	1,261,000
2037 - 2038	285,000	47,400	700	3,800	300	100	282,200	267,600	50	4,000	15,500	7,000	0	1,261,000
2038 - 2039	285,000	47,400	700	3,800	300	100	282,200	267,500	50	4,100	15,800	7,000	0	1,261,000
2039 - 2040	285,000	47,400	700	3,800	300	100	282,200	236,000	50	4,200	16,100	7,000	0	1,221,000
2040 - 2041	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2041 - 2042	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2042 - 2043	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2043 - 2044	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2044 - 2045	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2045 - 2046	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2046 - 2047	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2047 - 2048	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2048 - 2049	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2049 - 2050	285,000	47,400	700	3,800	300	100	282,800	235,400	50	4,200	16,100	7,000	0	1,221,000
2050 - 2051	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2051 - 2052	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2052 - 2053	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2053 - 2054	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2054 - 2055	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2055 - 2056	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2056 - 2057	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2057 - 2058	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2058 - 2059	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2059 - 2060	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2060 - 2061	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2061 - 2062	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2062 - 2063	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2063 - 2064	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2064 - 2065	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2065 - 2066	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2066 - 2067	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2067 - 2068	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2068 - 2069	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
2069 - 2070	285,000	45,800	700	3,700	300	100	264,400	232,300	50	4,200	16,100	6,000	0	1,183,000
86/87-16/17 Avg	285,000	46,900	700	3,600	300	100	270,800	283,800	50	3,800	14,700	7,000	0	1,262,000

Projected Future Tule Subbasin Groundwater Budget

	Groundwater Inflows (acre-ft)																					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	
Water Year	Areal Recharge from Precipitation	Tule River Infiltration					Deer Creek Infiltration					White River Infiltration	Imported Water Deliveries			Agricultural Pumping Return Flow	Municipal Pumping			Release of Water from Compression of Aquitards	Sub-surface Inflow	Mountain-Block Recharge	Total In
		Success to Oettle Bridge Infiltration	Oettle Bridge to Turnbull Weir Infiltration	Canal Loss	Recharge in Basins	Return Flow	Before Trenton Weir Infiltration	Trenton Weir to Homeland Canal Infiltration	Canal Loss	Recharge in Basins	Return Flow		Canal Loss	Recharge in Basins	Return Flow		Return Flow	Recycled Water					
																		Agricultural Return Flow	Artificial Recharge				
2017 - 2018	21,000	17,900	3,900	17,000	12,200	15,500	11,600	600	2,100	1,300	800	6,200	65,200	15,900	66,900	110,400	7,900	600	2,000	52,000	73,000	33,000	537,000
2018 - 2019	21,000	17,900	3,900	17,000	12,200	15,500	11,600	600	2,100	1,300	800	6,200	65,200	15,900	66,900	110,300	8,100	700	2,000	56,000	71,000	33,000	539,000
2019 - 2020	21,000	17,900	3,900	17,000	13,100	15,500	11,600	600	2,100	1,300	800	6,200	65,200	19,200	68,100	106,600	8,300	400	2,500	58,000	68,000	33,000	540,000
2020 - 2021	21,000	17,900	3,900	17,000	13,100	15,500	11,600	600	2,100	1,300	800	6,200	65,200	21,400	68,700	106,000	8,300	400	2,600	60,000	64,000	33,000	541,000
2021 - 2022	21,000	17,900	3,900	17,000	13,100	15,500	11,600	600	2,100	1,300	800	6,200	65,200	21,400	68,900	105,700	8,400	400	2,600	62,000	60,000	33,000	539,000
2022 - 2023	21,000	17,900	3,900	17,000	13,100	15,500	11,600	600	2,100	1,300	800	6,200	65,200	23,000	69,100	105,400	8,400	500	2,700	64,000	57,000	33,000	539,000
2023 - 2024	21,000	17,900	3,900	17,000	13,100	15,500	11,600	600	2,100	1,300	800	6,200	65,200	27,000	69,100	105,300	8,500	500	2,800	66,000	55,000	33,000	543,000
2024 - 2025	21,000	17,900	3,900	18,200	13,700	15,800	11,600	600	2,100	1,300	800	6,200	62,400	27,900	69,600	100,200	8,500	500	2,800	61,000	51,000	33,000	530,000
2025 - 2026	21,000	17,900	3,900	18,400	13,700	15,800	11,600	600	2,100	1,300	1,100	6,200	59,600	27,300	70,200	98,900	8,600	500	2,900	59,000	50,000	33,000	524,000
2026 - 2027	21,000	17,900	3,900	18,700	13,700	15,800	11,600	600	2,100	1,300	1,100	6,200	56,800	26,700	70,500	98,000	8,600	500	3,000	59,000	50,000	33,000	520,000
2027 - 2028	21,000	17,900	3,900	19,000	13,700	15,800	11,600	600	2,100	1,300	1,100	6,200	53,900	26,100	70,900	97,000	8,700	500	3,100	59,000	50,000	33,000	516,000
2028 - 2029	21,000	17,900	3,900	19,300	13,700	15,800	11,600	600	2,100	1,300	1,100	6,200	51,100	25,500	71,300	96,000	8,700	500	3,100	59,000	51,000	33,000	514,000
2029 - 2030	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	71,800	86,900	8,800	500	3,200	52,000	51,000	33,000	495,000
2030 - 2031	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,100	86,900	8,800	600	3,300	50,000	50,000	33,000	492,000
2031 - 2032	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,100	86,400	8,900	600	3,400	49,000	51,000	33,000	492,000
2032 - 2033	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,100	85,900	8,900	600	3,500	48,000	51,000	33,000	490,000
2033 - 2034	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,100	85,400	9,000	600	3,500	47,000	51,000	33,000	489,000
2034 - 2035	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,100	74,000	9,100	600	3,600	38,000	50,000	33,000	468,000
2035 - 2036	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,400	73,700	9,100	600	3,700	35,000	50,000	33,000	465,000
2036 - 2037	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,400	73,700	9,200	700	3,800	34,000	50,000	32,000	463,000
2037 - 2038	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,400	73,700	9,300	700	3,900	33,000	51,000	32,000	463,000
2038 - 2039	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,400	73,700	9,300	700	4,000	32,000	53,000	32,000	465,000
2039 - 2040	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,400	64,300	9,400	700	4,100	23,000	51,000	32,000	444,000
2040 - 2041	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	21,000	51,000	32,000	442,000
2041 - 2042	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	20,000	52,000	32,000	442,000
2042 - 2043	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	19,000	52,000	32,000	441,000
2043 - 2044	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	19,000	52,000	32,000	441,000
2044 - 2045	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	18,000	52,000	32,000	440,000
2045 - 2046	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	17,000	53,000	32,000	440,000
2046 - 2047	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	17,000	53,000	32,000	440,000
2047 - 2048	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	16,000	53,000	32,000	439,000
2048 - 2049	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	16,000	53,000	32,000	439,000
2049 - 2050	21,000	17,900	3,900	19,400	13,600	15,500	11,600	600	2,100	1,300	1,100	6,200	48,300	24,900	72,600	64,100	9,400	700	4,100	16,000	53,000	32,000	439,000
2050 - 2051	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	16,000	52,000	31,000	423,000
2051 - 2052	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	16,000	52,000	32,000	424,000
2052 - 2053	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	16,000	53,000	31,000	424,000
2053 - 2054	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	15,000	53,000	31,000	423,000
2054 - 2055	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	15,000	53,000	31,000	423,000
2055 - 2056	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	15,000	53,000	32,000	424,000
2056 - 2057	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	14,000	53,000	31,000	422,000
2057 - 2058	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	14,000	53,000	31,000	422,000
2058 - 2059	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	14,000	53,000	31,000	422,000
2059 - 2060	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	14,000	54,000	31,000	423,000
2060 - 2061	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	13,000	54,000	31,000	422,000
2061 - 2062	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	13,000	54,000	31,000	422,000
2062 - 2063	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	13,000	54,000	31,000	422,000
2063 - 2064	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	13,000	54,000	31,000	422,000
2064 - 2065	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	12,000	54,000	31,000	421,000
2065 - 2066	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	12,000	54,000	31,000	421,000
2066 - 2067	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	12,000	54,000	31,000	421,000
2067 - 2068	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	12,000	55,000	31,000	422,000
2068 - 2069	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	11,000	55,000	31,000	421,000
2069 - 2070	21,000	17,400	3,800	19,300	12,900	15,400	11,300	500	2,100	1,300	1,100	6,000	43,500	23,800	68,400	62,400	9,400	700	4,100	11,000	55,000	31,000	421,000
17/18-69/70 Avg	21,000	17,700	3,900	19,000	13,200	15,500	11,500	600	2,100	1,300	1,100	6,100	49,500	24,100	70,200	75,300	9,100	600	3,700	30,000	54,000	32,000	462,000

Projected Future Tule Subbasin Groundwater Budget

	Groundwater Outflows (acre-ft)						
	W	X	Y	Z	AA		
	Groundwater Pumping						
Water Year	Municipal	Irrigated Agriculture	Exports	Groundwater Banking Extraction	Sub-surface Outflow	Total Out	Change in Storage (acre-ft)
2017 - 2018	21,700	549,000	22,920	2,200	83,000	679,000	-142,000
2018 - 2019	23,400	548,000	22,920	2,200	82,000	679,000	-140,000
2019 - 2020	25,000	529,000	22,920	2,200	83,000	662,000	-122,000
2020 - 2021	25,400	526,000	22,920	2,200	83,000	660,000	-119,000
2021 - 2022	25,700	524,000	22,920	2,200	84,000	659,000	-120,000
2022 - 2023	26,100	523,000	22,920	2,200	85,000	659,000	-120,000
2023 - 2024	26,500	522,000	22,920	2,200	85,000	659,000	-116,000
2024 - 2025	26,900	494,000	22,920	2,200	86,000	632,000	-102,000
2025 - 2026	27,400	487,000	20,010	2,200	90,000	627,000	-103,000
2026 - 2027	27,800	481,000	20,010	2,200	92,000	623,000	-103,000
2027 - 2028	28,200	474,000	20,010	2,200	94,000	618,000	-102,000
2028 - 2029	28,700	468,000	20,010	2,200	96,000	615,000	-101,000
2029 - 2030	29,200	412,000	20,010	2,200	94,000	557,000	-62,000
2030 - 2031	29,600	413,000	17,100	2,200	95,000	557,000	-65,000
2031 - 2032	30,100	410,000	17,100	2,200	94,000	553,000	-61,000
2032 - 2033	30,600	407,000	17,100	2,200	93,000	550,000	-60,000
2033 - 2034	31,100	405,000	17,100	2,200	92,000	547,000	-58,000
2034 - 2035	31,700	345,000	17,100	2,200	93,000	489,000	-21,000
2035 - 2036	32,200	344,000	14,190	2,200	93,000	486,000	-21,000
2036 - 2037	32,800	344,000	14,190	2,200	91,000	484,000	-21,000
2037 - 2038	33,300	344,000	14,190	2,200	89,000	483,000	-20,000
2038 - 2039	33,900	344,000	14,190	2,200	88,000	482,000	-17,000
2039 - 2040	34,500	303,000	11,280	2,200	90,000	441,000	3,000
2040 - 2041	34,500	302,000	11,280	2,200	90,000	440,000	2,000
2041 - 2042	34,500	302,000	11,280	2,200	90,000	440,000	2,000
2042 - 2043	34,500	302,000	11,280	2,200	90,000	440,000	1,000
2043 - 2044	34,500	302,000	11,280	2,200	90,000	440,000	1,000
2044 - 2045	34,500	302,000	11,280	2,200	90,000	440,000	0
2045 - 2046	34,500	302,000	11,280	2,200	89,000	439,000	1,000
2046 - 2047	34,500	302,000	11,280	2,200	89,000	439,000	1,000
2047 - 2048	34,500	302,000	11,280	2,200	89,000	439,000	0
2048 - 2049	34,500	302,000	11,280	2,200	89,000	439,000	0
2049 - 2050	34,500	302,000	11,280	2,200	88,000	438,000	1,000
2050 - 2051	34,500	297,000	11,280	2,200	88,000	433,000	-10,000
2051 - 2052	34,500	297,000	11,280	2,200	88,000	433,000	-9,000
2052 - 2053	34,500	297,000	11,280	2,200	87,000	432,000	-8,000
2053 - 2054	34,500	297,000	11,280	2,200	87,000	432,000	-9,000
2054 - 2055	34,500	297,000	11,280	2,200	87,000	432,000	-9,000
2055 - 2056	34,500	297,000	11,280	2,200	87,000	432,000	-8,000
2056 - 2057	34,500	297,000	11,280	2,200	86,000	431,000	-9,000
2057 - 2058	34,500	297,000	11,280	2,200	86,000	431,000	-9,000
2058 - 2059	34,500	297,000	11,280	2,200	86,000	431,000	-9,000
2059 - 2060	34,500	297,000	11,280	2,200	86,000	431,000	-8,000
2060 - 2061	34,500	297,000	11,280	2,200	85,000	430,000	-8,000
2061 - 2062	34,500	297,000	11,280	2,200	85,000	430,000	-8,000
2062 - 2063	34,500	297,000	11,280	2,200	85,000	430,000	-8,000
2063 - 2064	34,500	297,000	11,280	2,200	85,000	430,000	-8,000
2064 - 2065	34,500	297,000	11,280	2,200	85,000	430,000	-9,000
2065 - 2066	34,500	297,000	11,280	2,200	84,000	429,000	-8,000
2066 - 2067	34,500	297,000	11,280	2,200	84,000	429,000	-8,000
2067 - 2068	34,500	297,000	11,280	2,200	84,000	429,000	-7,000
2068 - 2069	34,500	297,000	11,280	2,200	84,000	429,000	-8,000
2069 - 2070	34,500	297,000	11,280	2,200	84,000	429,000	-8,000
17/18-69/70 Avg	32,000	361,000	14,600	2,200	88,000	498,000	-36,000

Projected Future Tule Subbasin Sustainable Yield

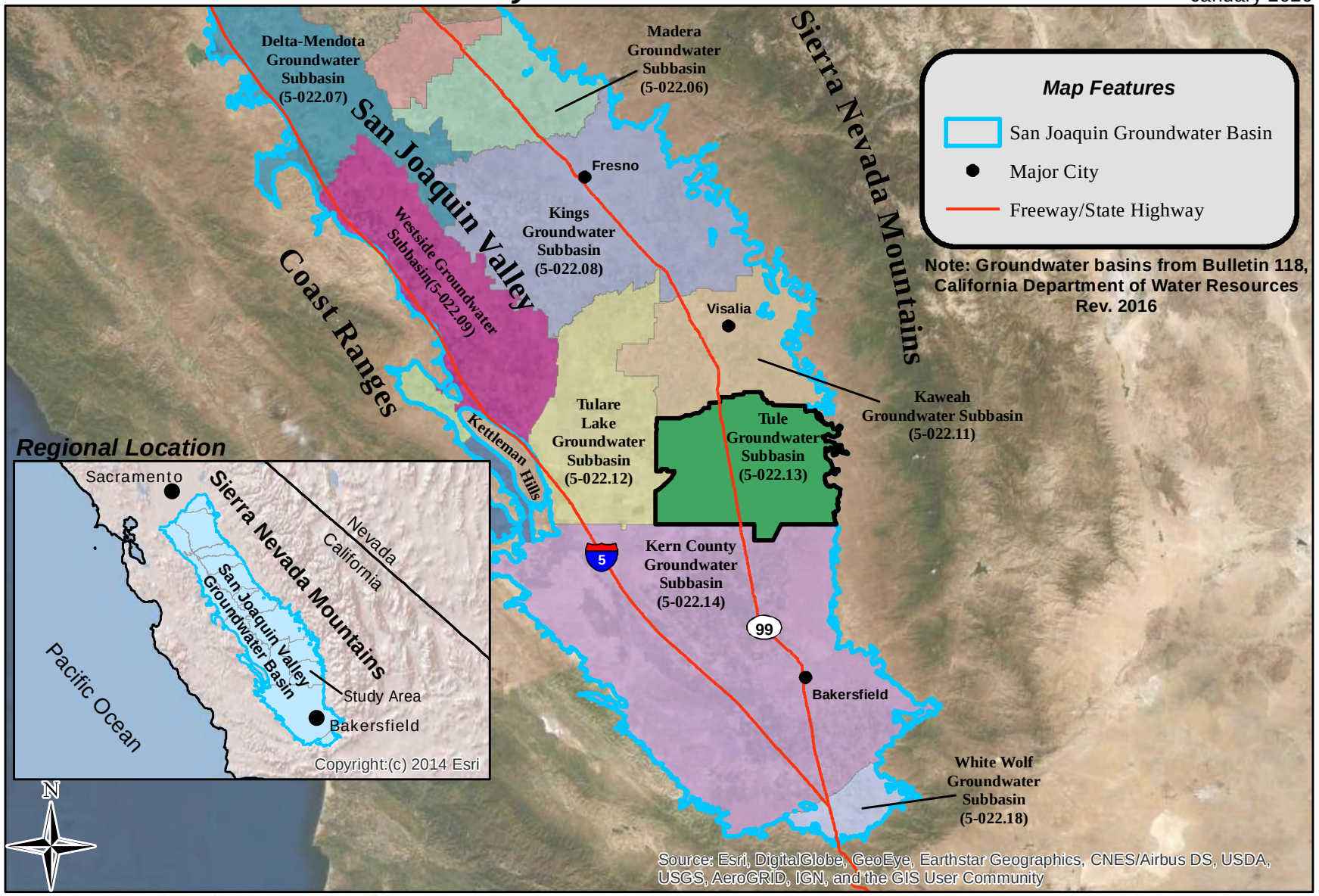
Water Year	Groundwater Inflows (acre-ft)										Groundwater Outflow (acre-ft)	Sustainable Yield
	A	B	C	D	E	F	G	H	I	J	K	
	Areal Recharge from Precipitation	Streambed Infiltration					Return Flow		Sub-surface Inflow	Mountain-Block Recharge	Sub-surface Outflow	
		Tule River		Deer Creek		White River	Irrigated Agriculture	Municipal				
		Success to Oettle Bridge	Oettle Bridge to Turnbull Weir	Before Trenton Weir Infiltration	Trenton Weir to Homeland Canal Infiltration							
2040 - 2041	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	51,000	32,000	90,000	127,700
2041 - 2042	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	52,000	32,000	90,000	128,700
2042 - 2043	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	52,000	32,000	90,000	128,700
2043 - 2044	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	52,000	32,000	90,000	128,700
2044 - 2045	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	52,000	32,000	90,000	128,700
2045 - 2046	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	53,000	32,000	89,000	130,700
2046 - 2047	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	53,000	32,000	89,000	130,700
2047 - 2048	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	53,000	32,000	89,000	130,700
2048 - 2049	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	53,000	32,000	89,000	130,700
2049 - 2050	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	53,000	32,000	88,000	131,700
40/41-49/50 Avg	21,000	17,900	3,900	11,600	600	6,200	64,100	9,400	52,000	32,000	89,000	129,700

Figures

Groundwater Flow Model of the Tule Subbasin

Tule Subbasin Technical Advisory Committee

January 2020



Thomas Harder & Co.
Groundwater Consulting

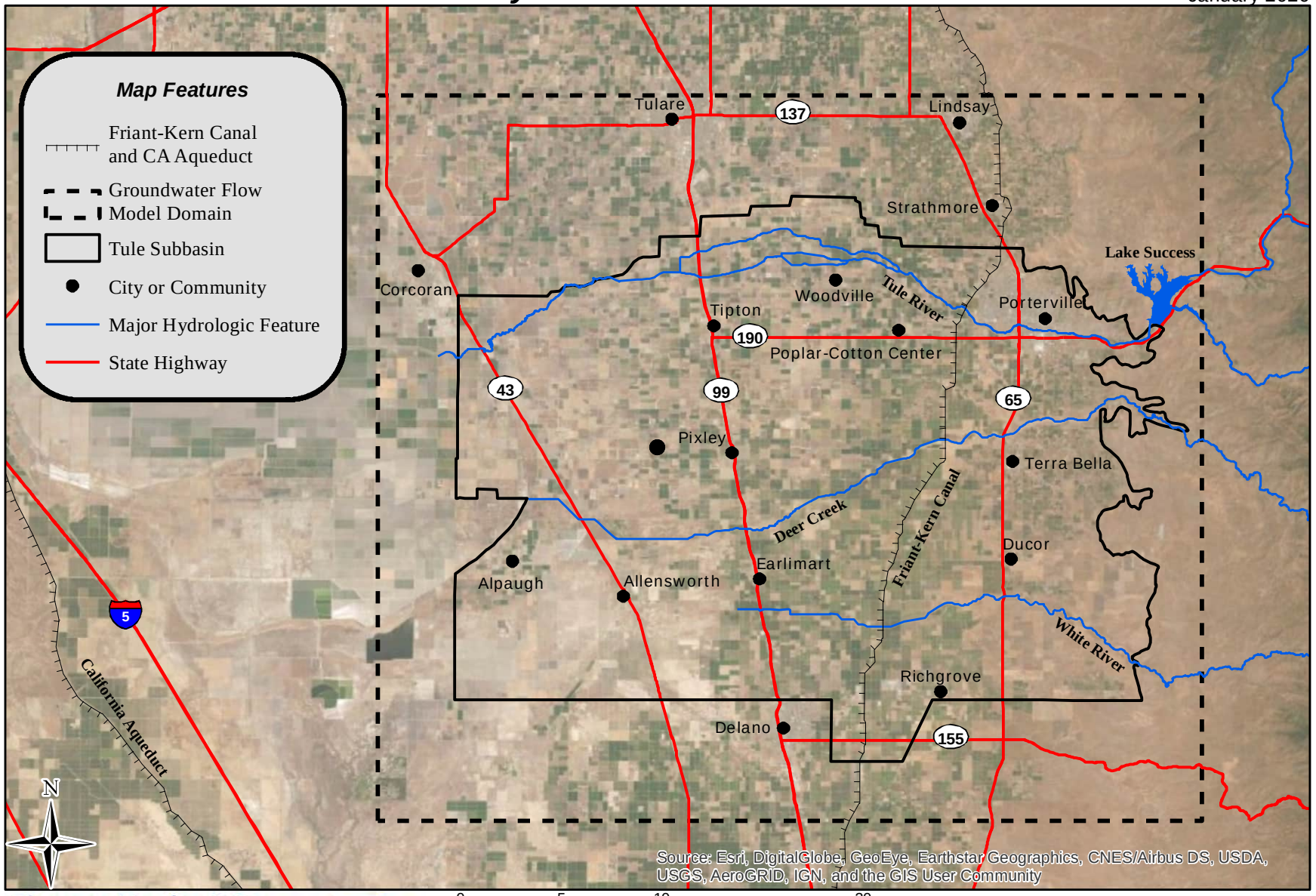
0 10 20 40
Miles

Regional Map
Figure 1

Groundwater Flow Model of the Tule Subbasin

Tule Subbasin Technical Advisory Committee

January 2020

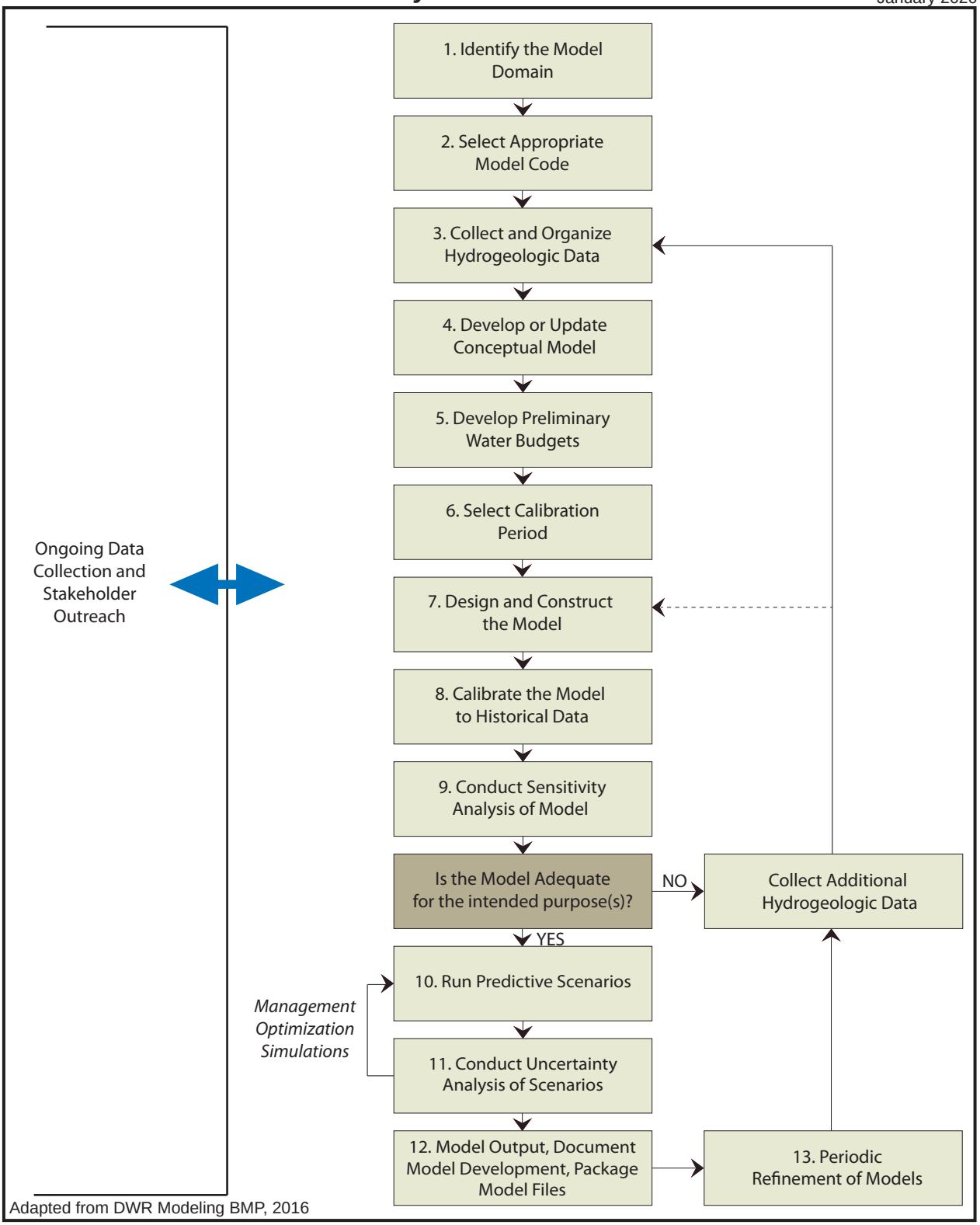


Thomas Harder & Co.
Groundwater Consulting

Study Area

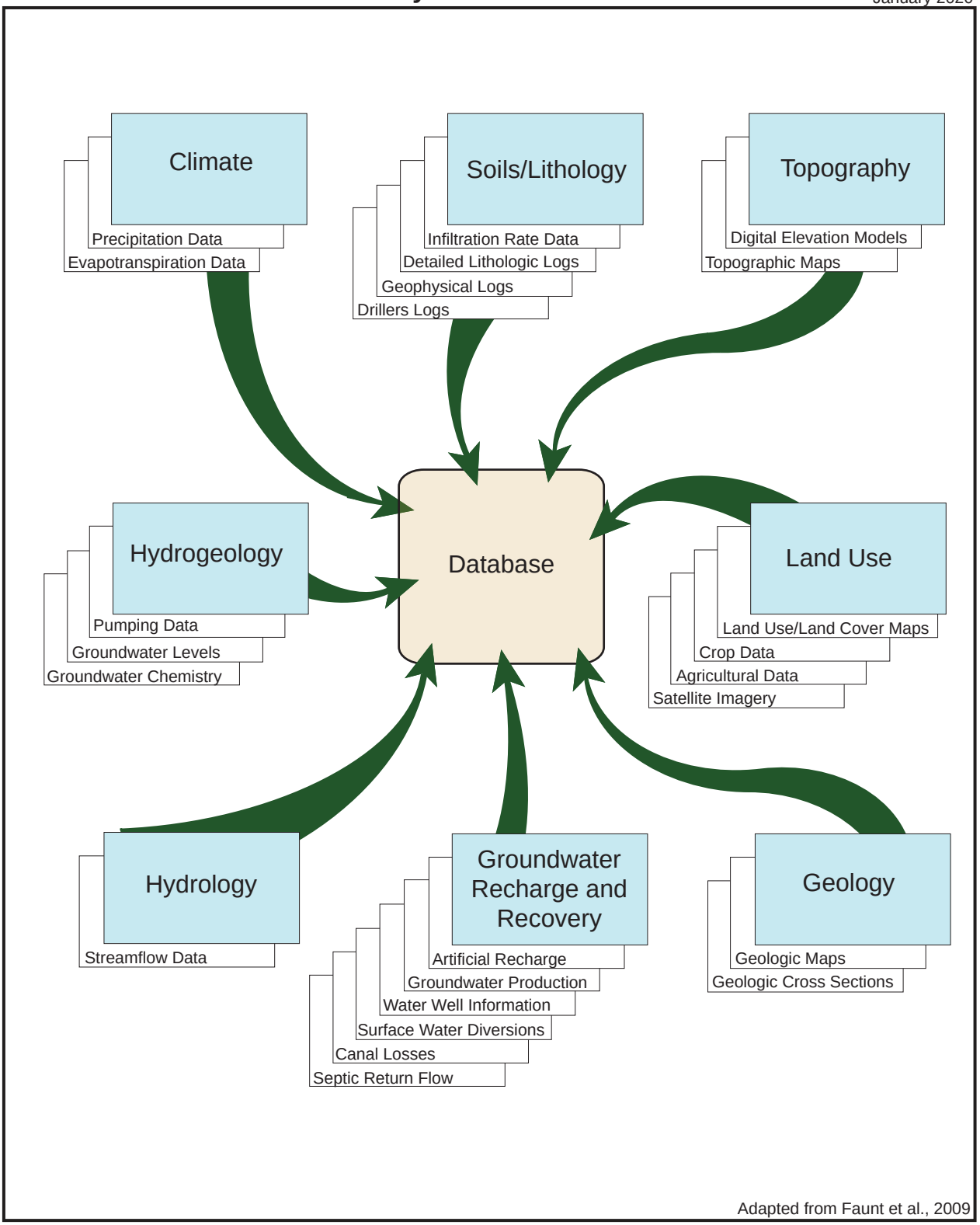
Figure 2

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

General Modeling Process
Figure 3



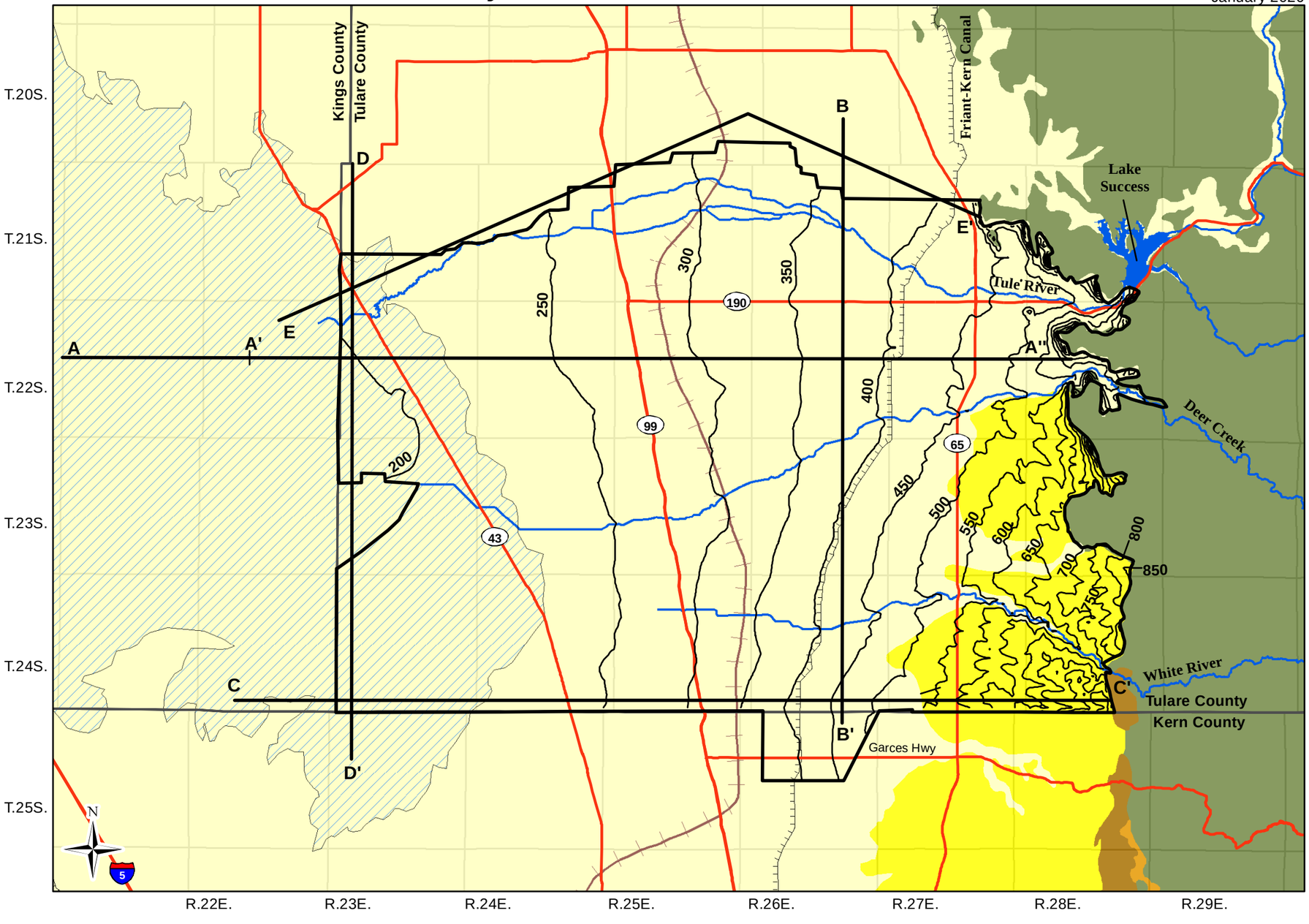
Adapted from Faunt et al., 2009

Thomas Harder & Co.
Groundwater Consulting

Data Type Diversity Flow Chart
Figure 4

Tule Subbasin Technical Advisory Committee

January 2020



Thomas Harder & Co.
Groundwater Consulting

Groundwater Flow Model of the Tule Subbasin

Map Features

- 300 — Land Surface Elevation Contour (ft amsl)
- Cross Section
- County Boundary
- Surficial Deposits
- Tertiary Loosely Consolidated Deposits
- Non-Marine Sedimentary Rocks
- Marine Sedimentary Rocks
- Crystalline Basement
- Approximate Eastern Extent of the Corcoran Clay
- Tulare Lake Surface Deposits
- Friant-Kern Canal
- Tule Subbasin
- Major Hydrologic Feature
- State Highway/Major Road

Corcoran Clay from USGS Professional Paper 1766,
http://water.usgs.gov/GIS/dsdl/pp1766_CorcoranClay.zip

Geologic units modified from USGS Open-File Report 2005-1305

Lake Deposits from California Geological Survey
Geologic Atlas of California Map No. 002
1:250,000 scale, Compiled by A.R. Smith, 1964
and Geologic Atlas of California Map No. 005,
1:250,000 scale, Compiled by: R.A. Matthews and J.L. Burnett

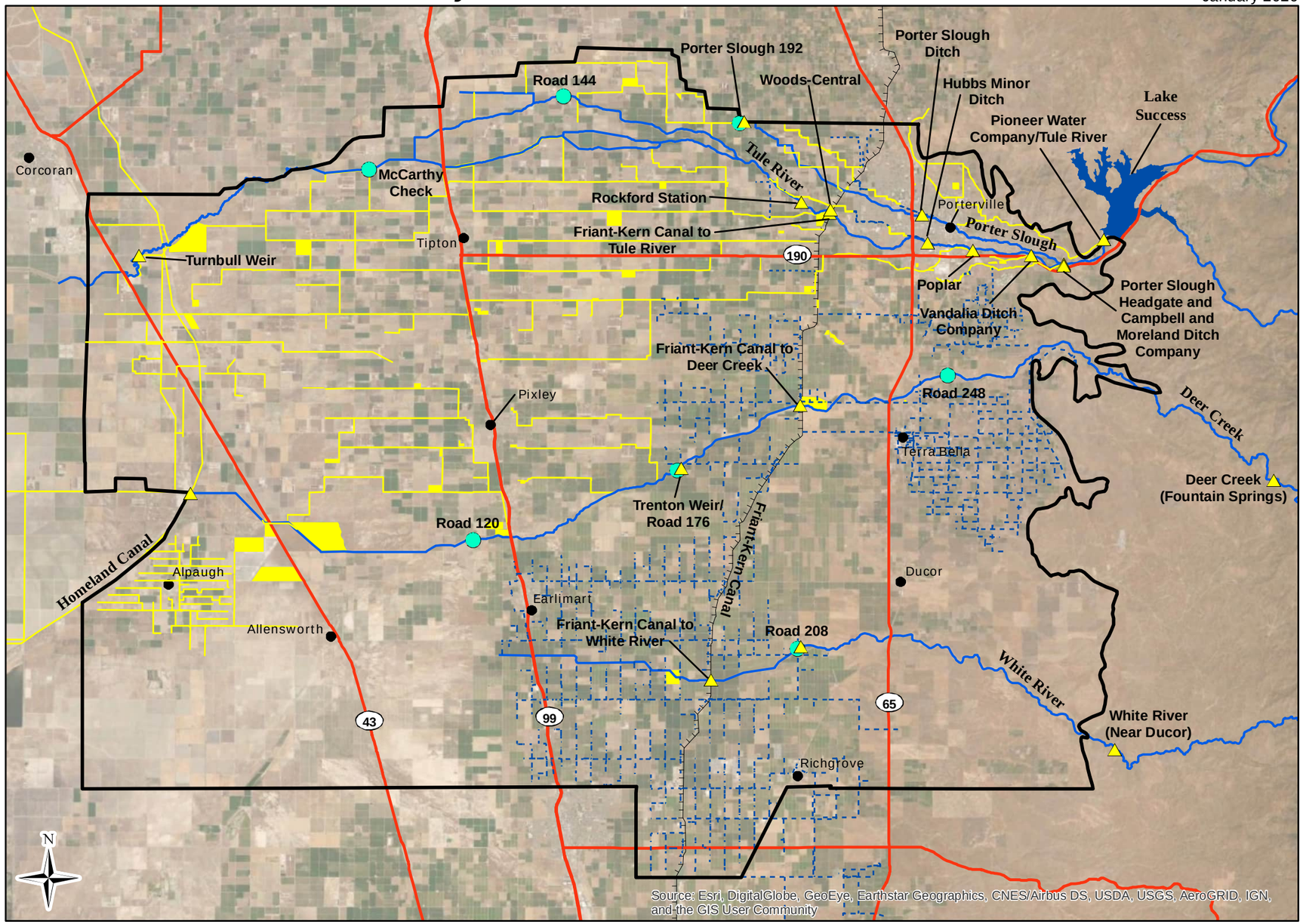
Geology and Cross Section Locations

Figure 5

Tule Subbasin Technical Advisory Committee

January 2020

Groundwater Flow Model of the Tule Subbasin



Map Features

- Artificial Recharge Basin
- Surface Water Quality Monitoring Location
- Gaging Location/Surface Water Diversion
- Major Hydrologic Feature
- Friant-Kern Canal and California Aqueduct
- Canal
- Pipe
- Tule Subbasin
- City or Community
- Freeway/State Highway

Thomas Harder & Co.
Groundwater Consulting

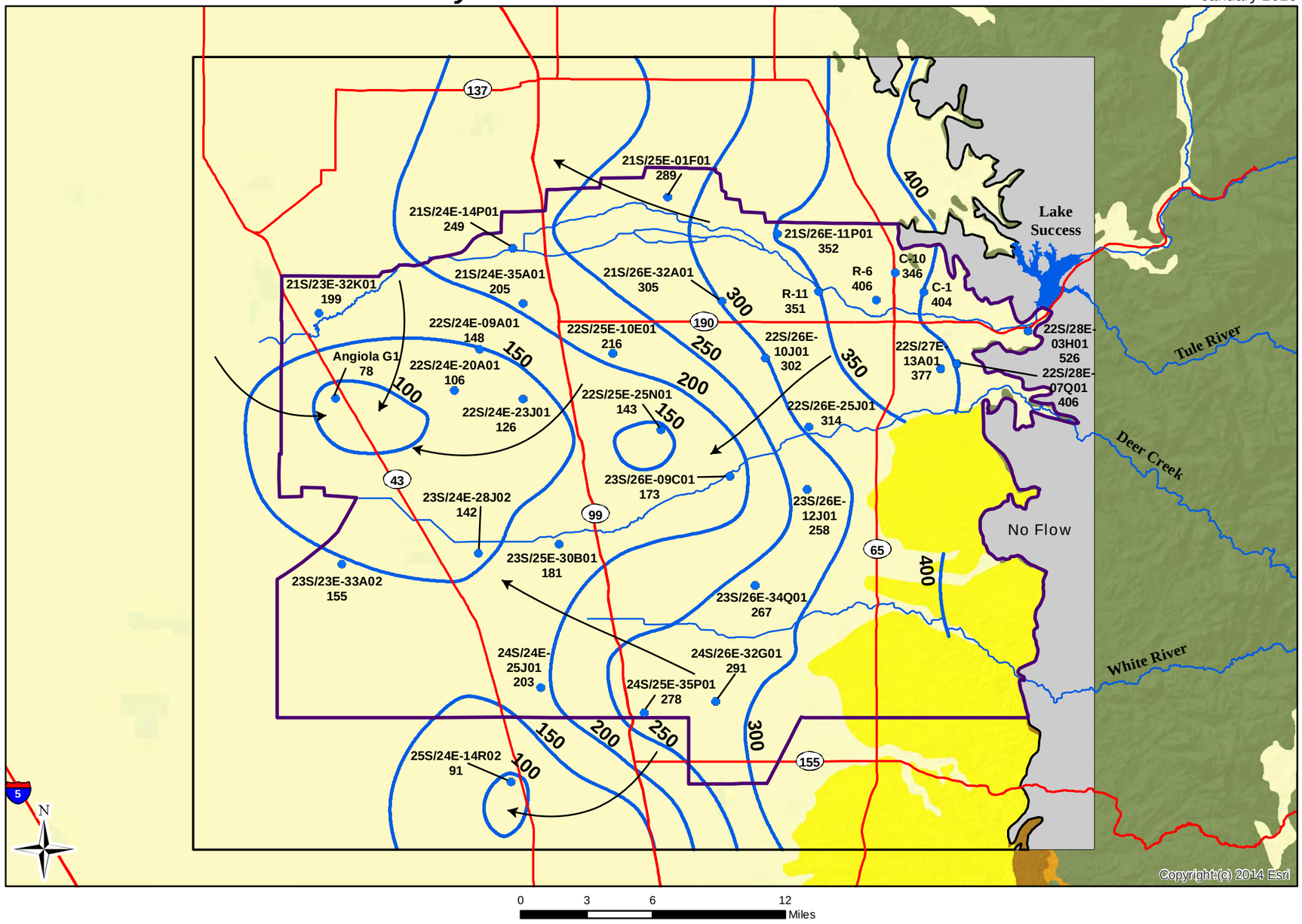
Surface Water Features in the Tule Subbasin and Vicinity

Figure 6

Tule Subbasin Technical Advisory Committee

January 2020

Groundwater Flow Model of the Tule Subbasin



NAD 83 State Plane Zone 4

Map Features

22S/25E-25N01
143
- Well with Groundwater Elevation (ft amsl)

150
- Groundwater Elevation Contour (ft amsl)
- Groundwater Flow Direction
- Surficial Deposits
- Tertiary Loosely Consolidated Deposits
- Non-Marine Sedimentary Rocks
- Marine Sedimentary Rocks
- Crystalline Basement
- State Highway/Major Road
- Tule Subbasin
- No Flow
- Model Domain

Note: All groundwater elevations in feet above mean sea level. Groundwater elevations measured from October 1986 to March 1990.

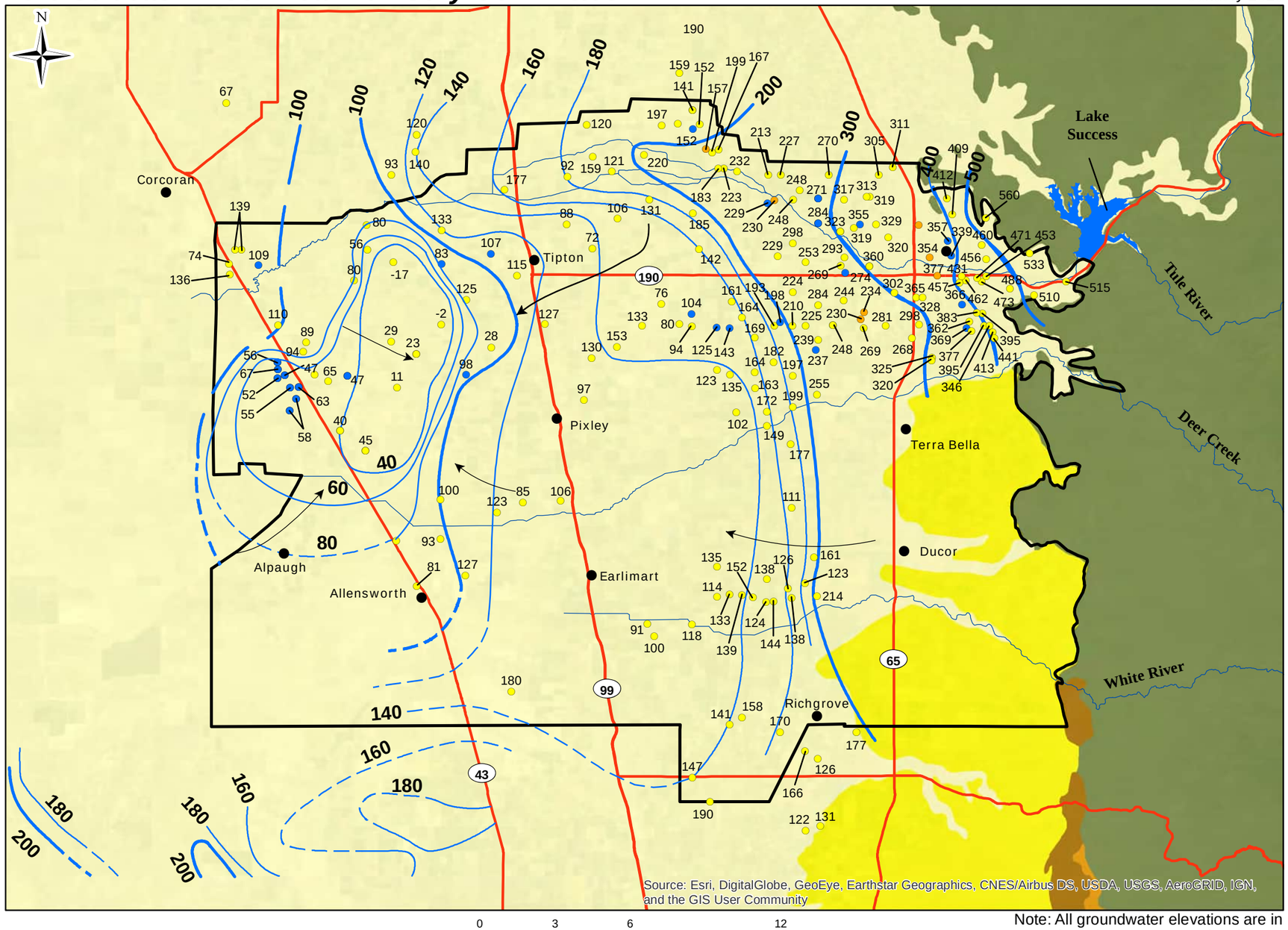
Thomas Harder & Co.
Groundwater Consulting

Initial Groundwater Elevations Upper Aquifer - Model Layer 1

Figure 7

Tule Subbasin Technical Advisory Committee

January 2020



0 3 6 12 Miles

NAD 83 State Plane Zone 4

Note: All groundwater elevations are in feet above mean sea level.

Groundwater Elevations are measured from January to May.

Groundwater Flow Model of the Tule Subbasin

Map Features

- 140 — Groundwater Elevation Contour, dashed where approximate (ft amsl)
- Groundwater Flow Direction
- Groundwater Elevations from Well with Unknown Perforation Interval
- Groundwater Elevations from Well with Perforations in the Upper and Lower Aquifer
- Groundwater Elevations from Well with Perforations in the Upper Aquifer
- Tule Subbasin
- City or Community
- Major Hydrologic Feature
- State Highway/Major Road
- Surficial Deposits
- Tertiary Loosely Consolidated Deposits
- Non-Marine Sedimentary Rocks
- Marine Sedimentary Rocks
- Crystalline Basement

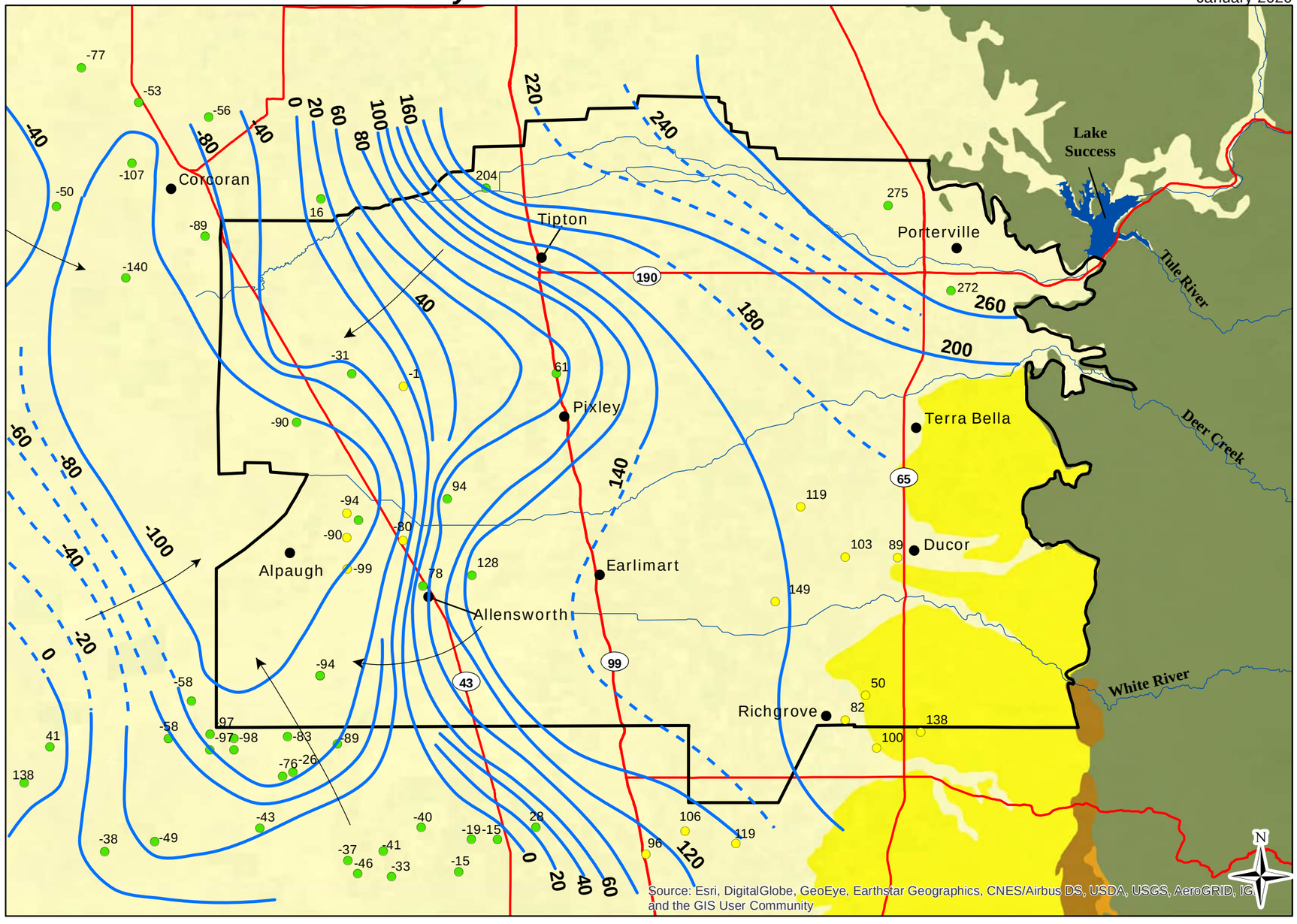
Groundwater contours shown south of the Tule Subbasin and west of Highway 43 are depicted based on Water-Level Elevations And Direction of Groundwater Flow For the Upper Zone (Spring 2017)

Spring 2017 Upper Aquifer Groundwater Elevation Contours

Figure 8

Tule Subbasin Technical Advisory Committee

January 2020



NAD 83 State Plane Zone 4

Thomas Harder & Co.
Groundwater Consulting

Groundwater Flow Model of the Tule Subbasin

Map Features

- 140 — Groundwater Elevation Contour, dashed where approximate (ft amsl)
- Groundwater Flow Direction
- Groundwater Elevations from Well with Perforations in the Deep Aquifer
- Groundwater Elevations from Well with Unknown Perforation Interval
- Tule Subbasin
- City or Community
- Major Hydrologic Feature
- State Highway/Major Road
- Surficial Deposits
- Tertiary loosely consolidated deposits
- Non-Marine Sedimentary Rocks
- Marine Sedimentary Rocks
- Crystalline Basement

Note: All groundwater elevations are in feet above mean sea level.

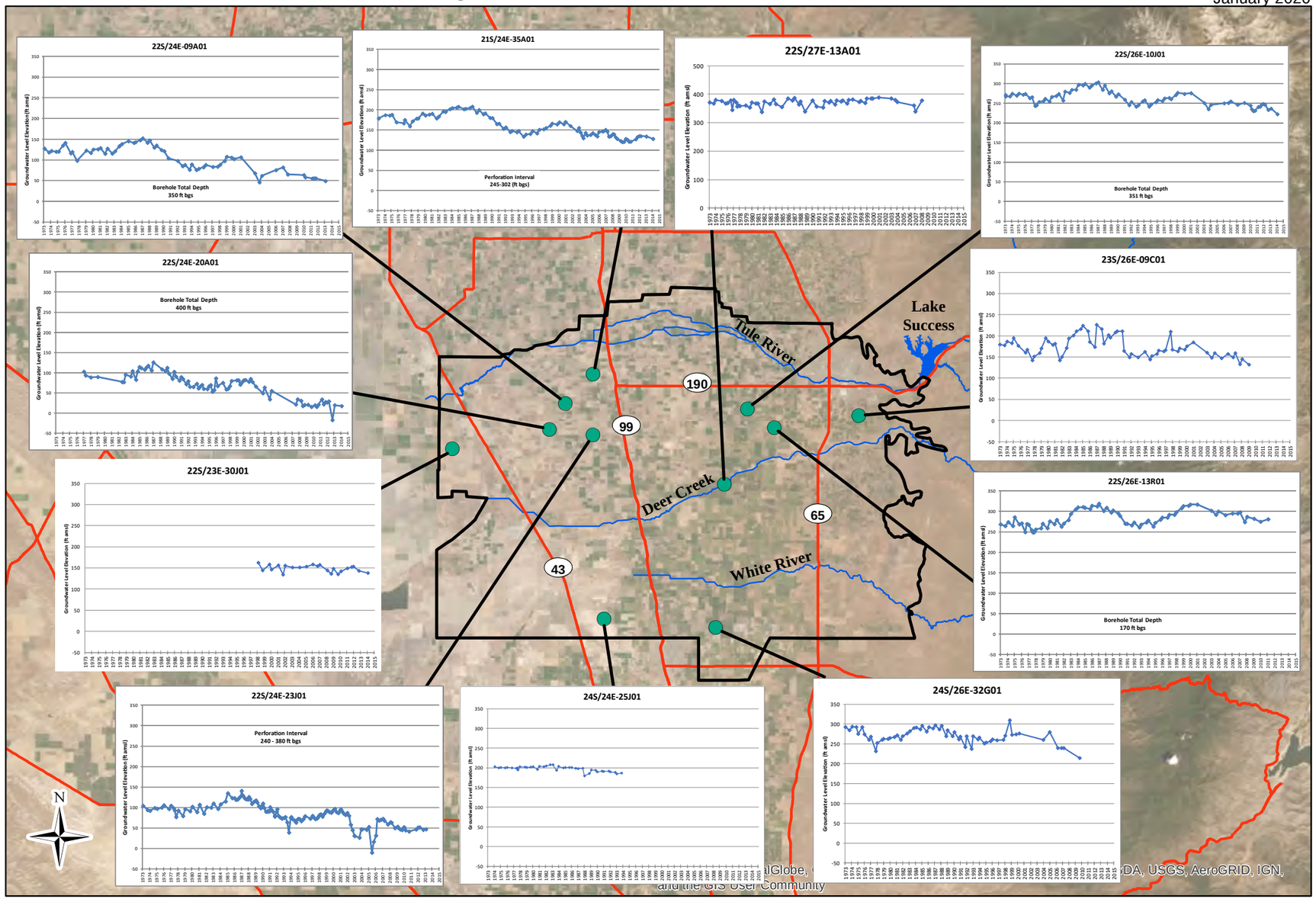
Groundwater Elevations are measured from October to December.

Fall 2010 Lower Aquifer Groundwater Elevation Contours

Figure 9

Tule Subbasin Technical Advisory Committee

January 2020



NAD 83 State Plane Zone 4

Groundwater Flow Model of the Tule Subbasin

Map Features

- Hydrograph Well
- Tule Subbasin
- Major Hydrologic Feature
- State Highway/Major Road

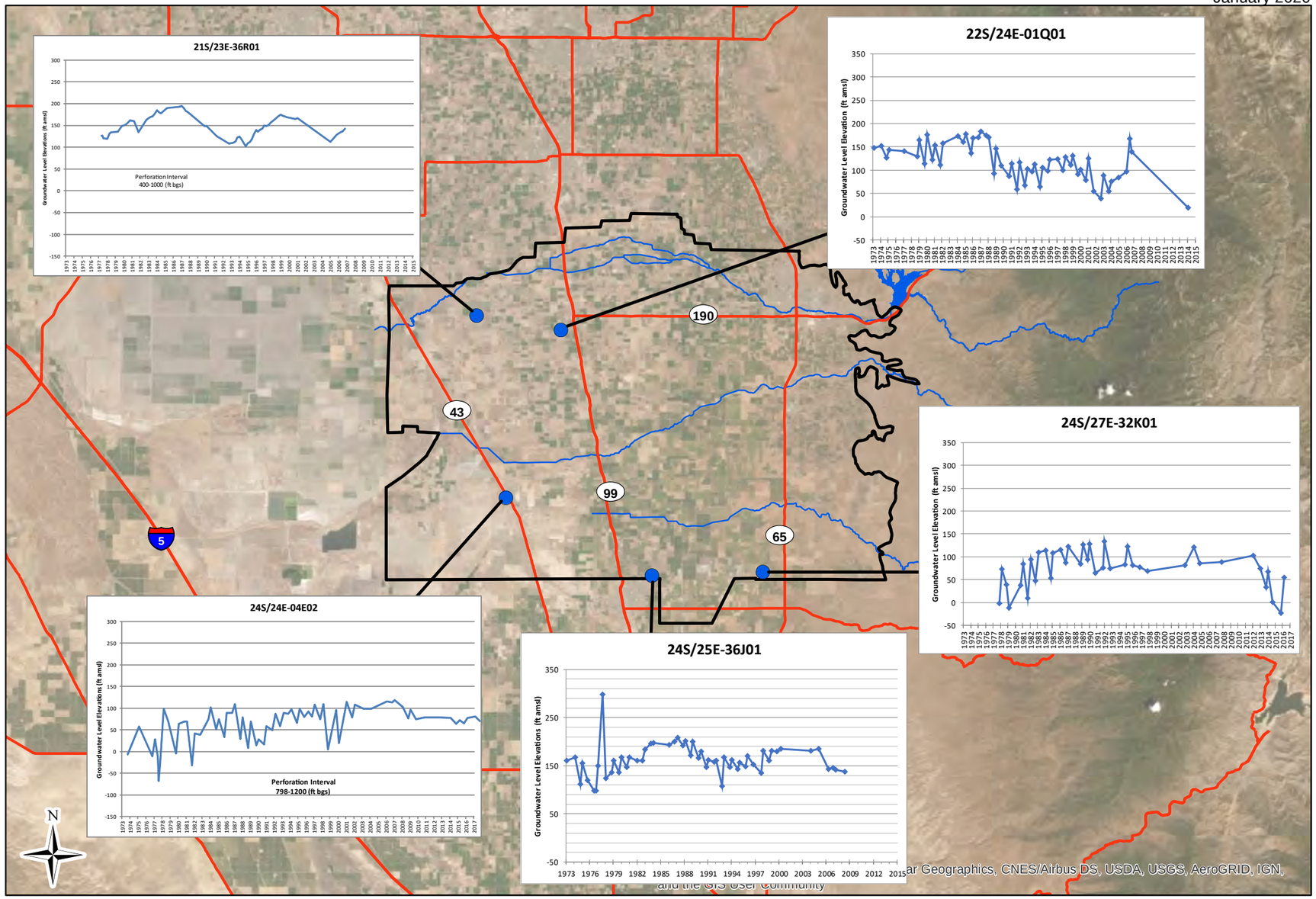
Thomas Harder & Co.
Groundwater Consulting

Upper Aquifer Groundwater Level Hydrographs

Figure 10

Tule Subbasin Technical Advisory Committee

January 2020



0 5 10 20 Miles

NAD 83 State Plane Zone 4

Groundwater Flow Model of the Tule Subbasin

Map Features

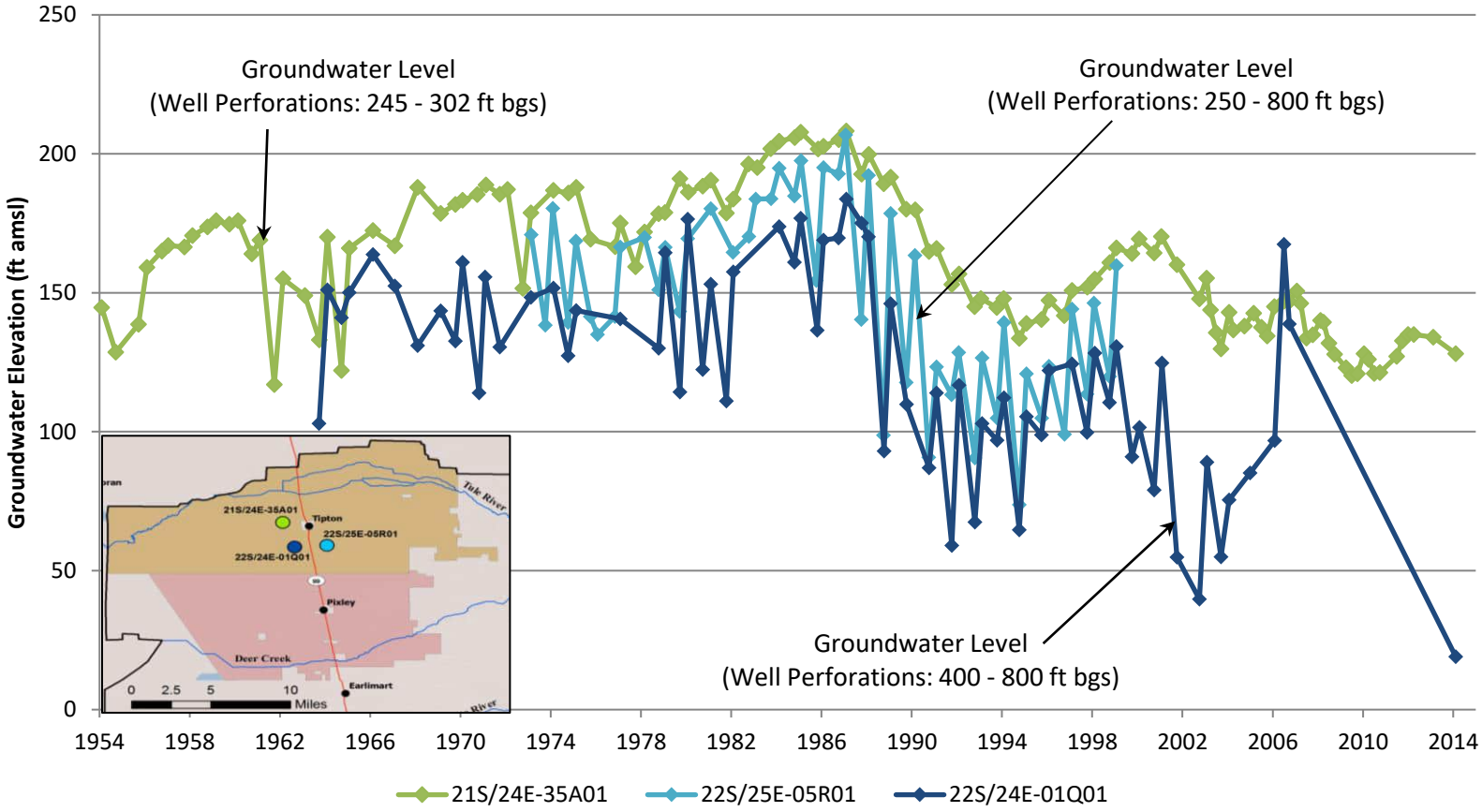
- Hydrograph Well
- Tule Subbasin
- Major Hydrologic Feature
- State Highway/Major Road

Thomas Harder & Co.
Groundwater Consulting

Lower Aquifer Groundwater Level Hydrographs

Figure 11

Comparison of Upper Aquifer and Lower Aquifer Groundwater Levels

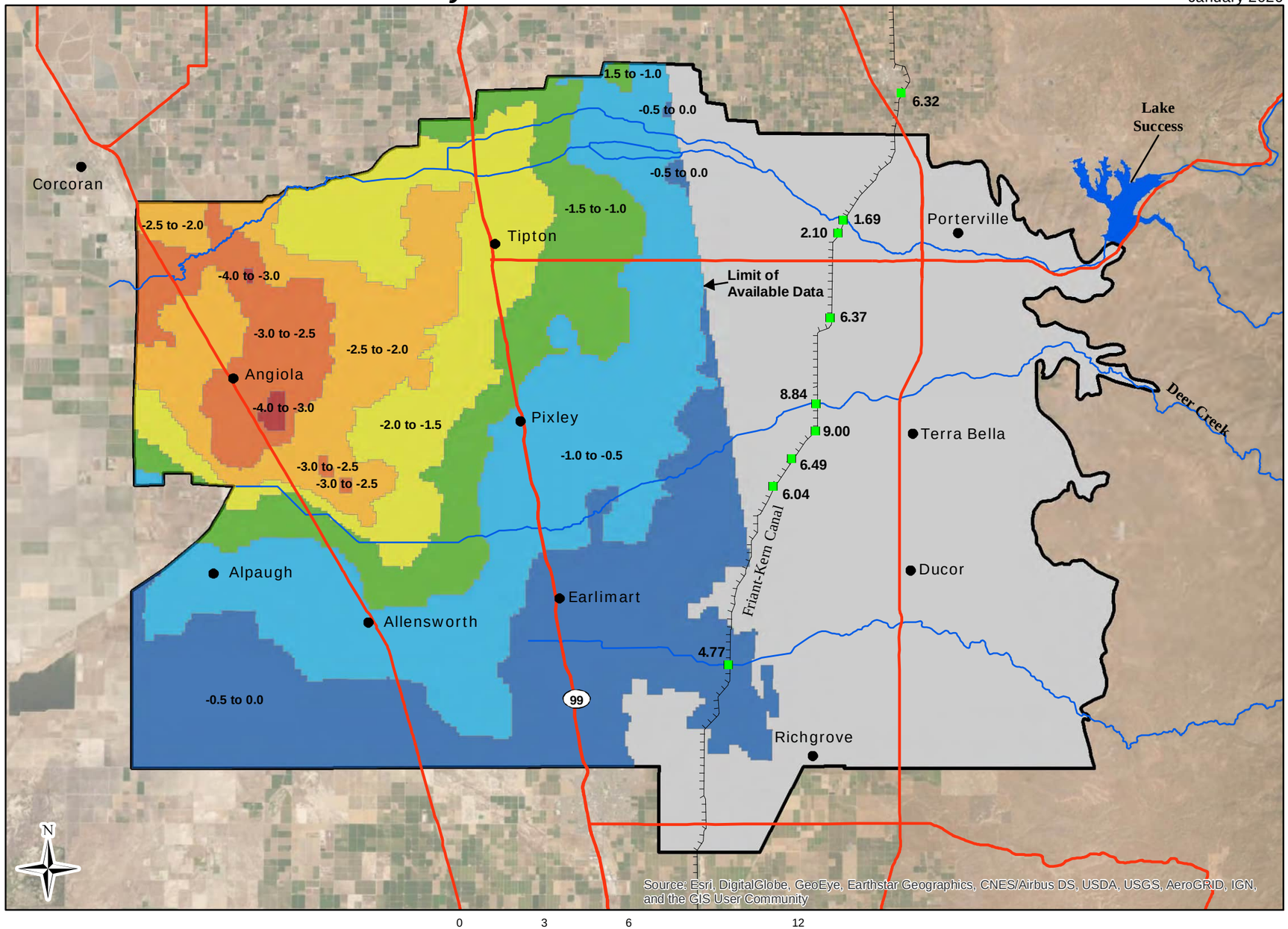


Note:

ft bgs = feet below ground surface.

Tule Subbasin Technical Advisory Committee

January 2020



Thomas Harder & Co.
Groundwater Consulting

Groundwater Flow Model of the Tule Subbasin

Map Features

2007 - 2011 Land Surface Subsidence* (ft)

- -4.0 to -3.0
- -3.0 to -2.5
- -2.5 to -2.0
- -2.0 to -1.5
- -1.5 to -1.0
- -1.0 to -0.5
- -0.5 to 0.0

Measured Subsidence Points along the Friant-Kern Canal (ft) 1959-2017

Friant-Kern Canal

Basin Boundary

City or Community

Major Hydrologic Feature

Freeway/State Highway

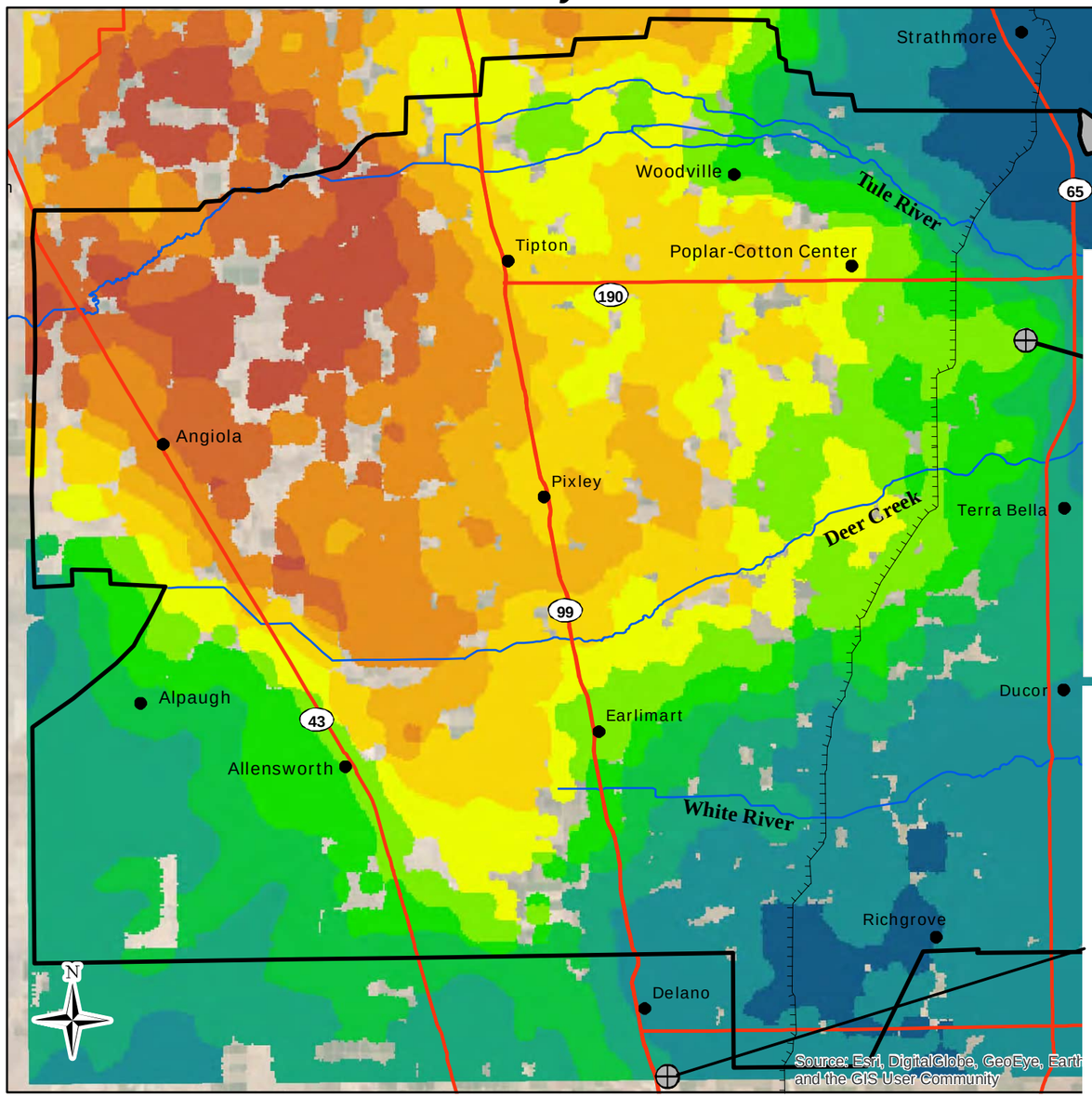
*From LSCE, 2014

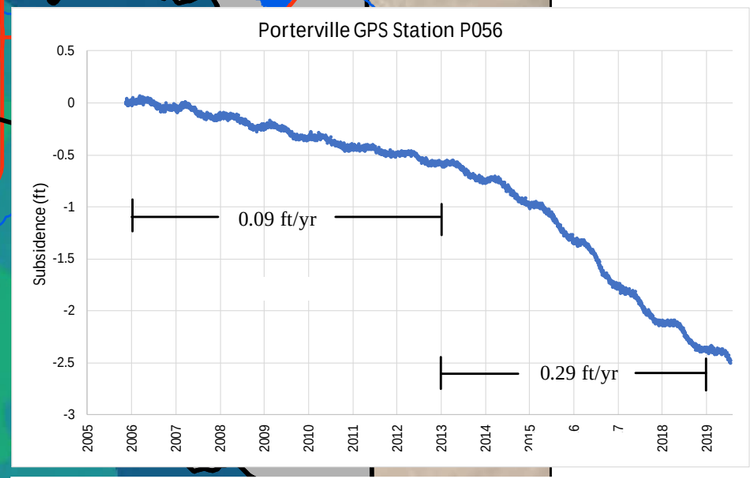
2007 to 2011 Land Subsidence

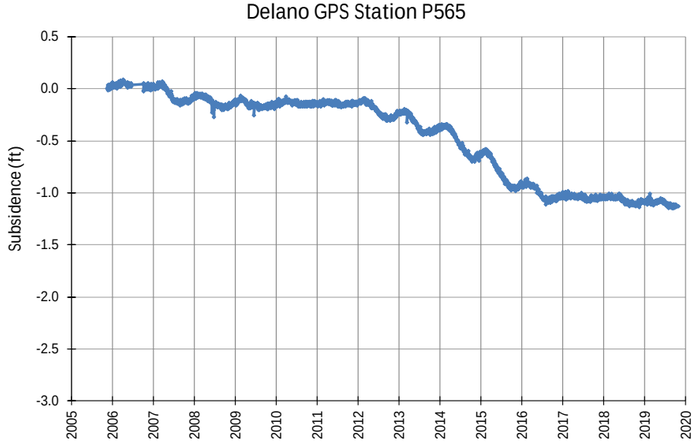
Figure 13

Tule Subbasin Technical Advisory Committee

January 2020







GPS data from UNAVCO 2005 - 2019
InSAR data from Tre Altamira Jan 2015 - June 2018

0 2 4 8 Miles

NAD 83 State Plane Zone 4

Groundwater Flow Model of the Tule Subbasin

Map Features

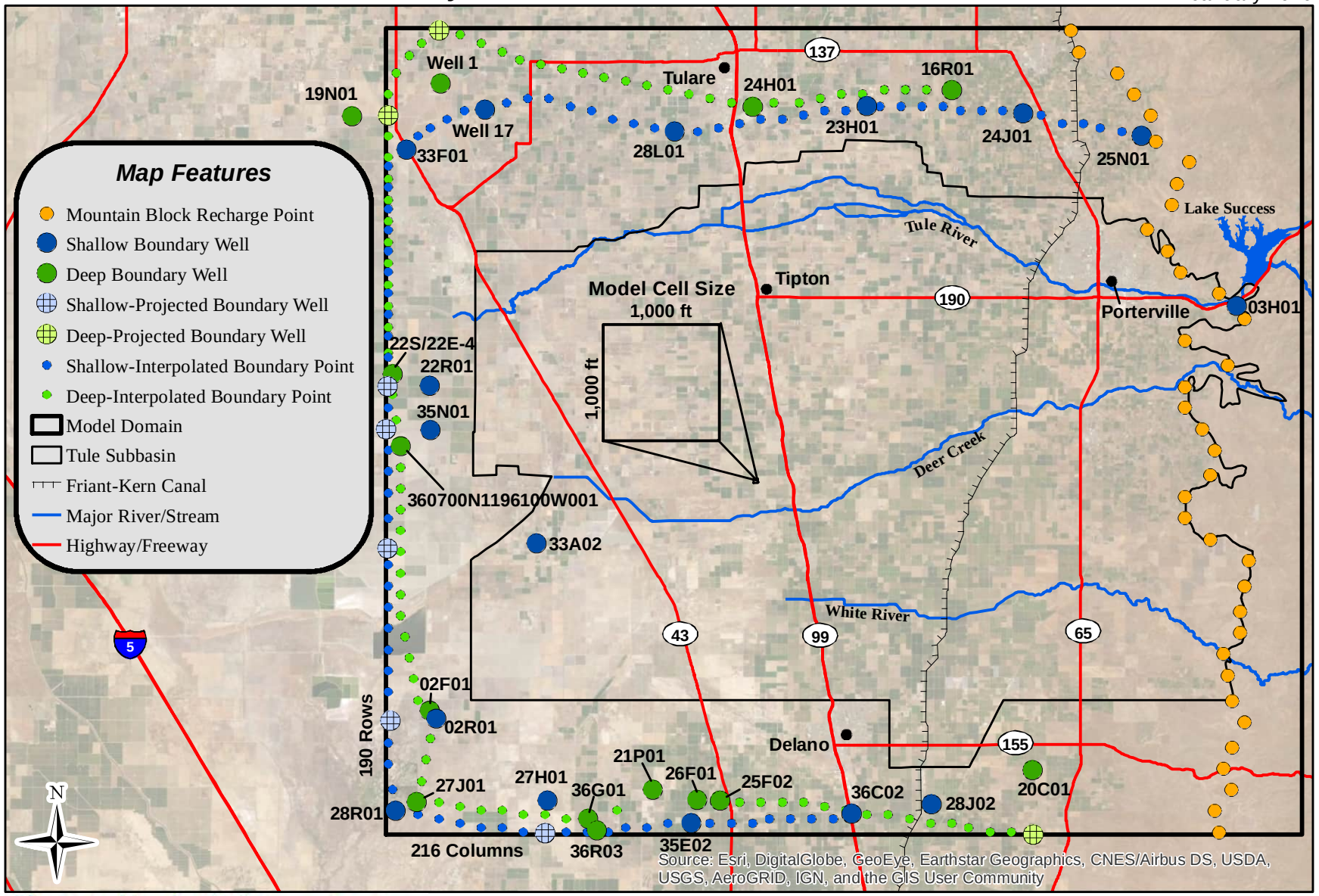
InSAR Subsidence from 2015 to 2018 (ft)

- -2.75 to -2.50
- -2.50 to -2.25
- -2.25 to -2.00
- -2.00 to -1.75
- -1.75 to -1.50
- -1.50 to -1.25
- -1.25 to -1.00
- -1.00 to -0.75
- -0.75 to -0.50
- -0.50 to -0.25
- -0.25 to 0
- 0 to 0.25
- 0.25 to 0.50
- GPS Station
- Friant-Kern Canal
- No Flow Boundary
- Tule Subbasin
- City or Community
- Major Hydrologic Feature
- State Highway/Major Road

Thomas Harder & Co.
Groundwater Consulting

2015 to 2018 Land Subsidence

Figure 14



Thomas Harder & Co.
Groundwater Consulting

0 2.5 5 10 Miles

NAD 83 State Plane Zone 4

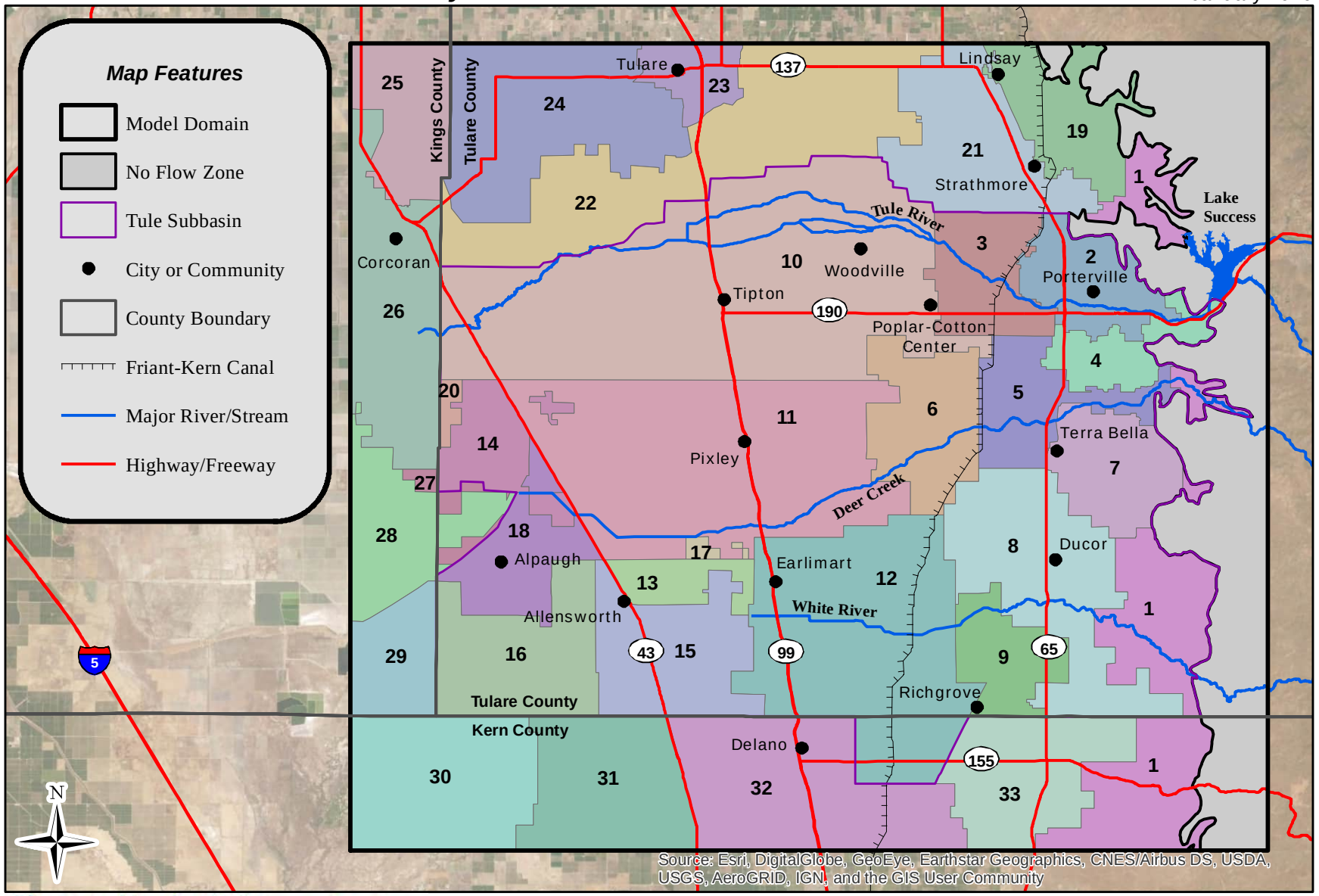
Model Domain and Boundary Conditions

Figure 15

Groundwater Flow Model of the Tule Subbasin

January 2020

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

0 2 4 8 Miles

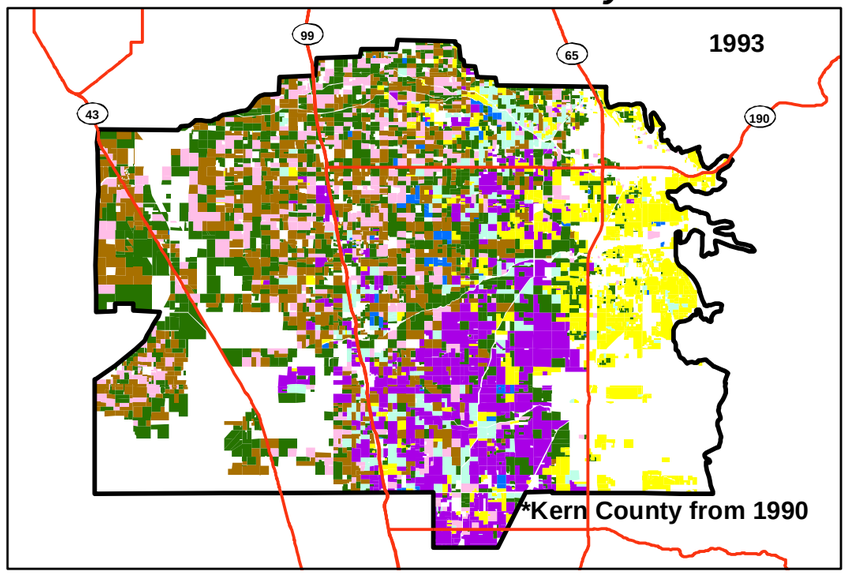
NAD 83 State Plane Zone 4

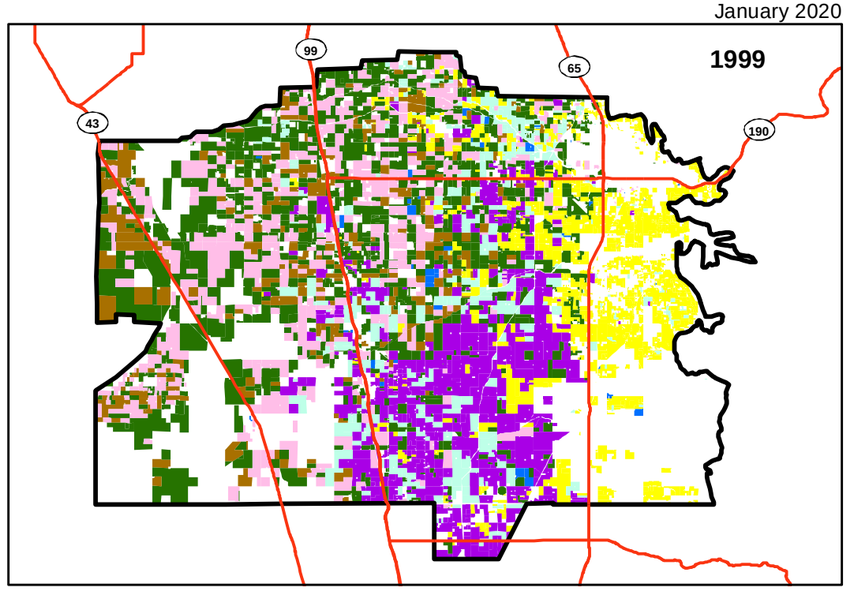
Water Budget Areas

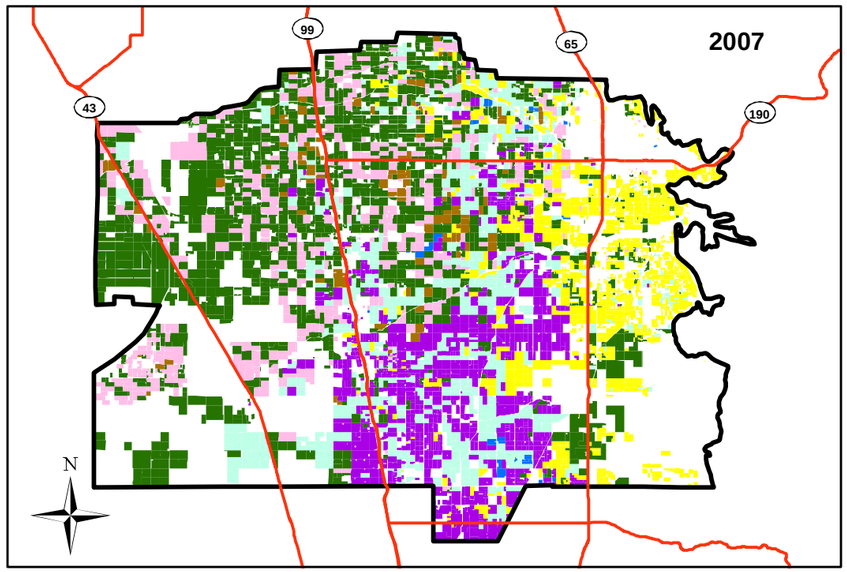
Figure 16

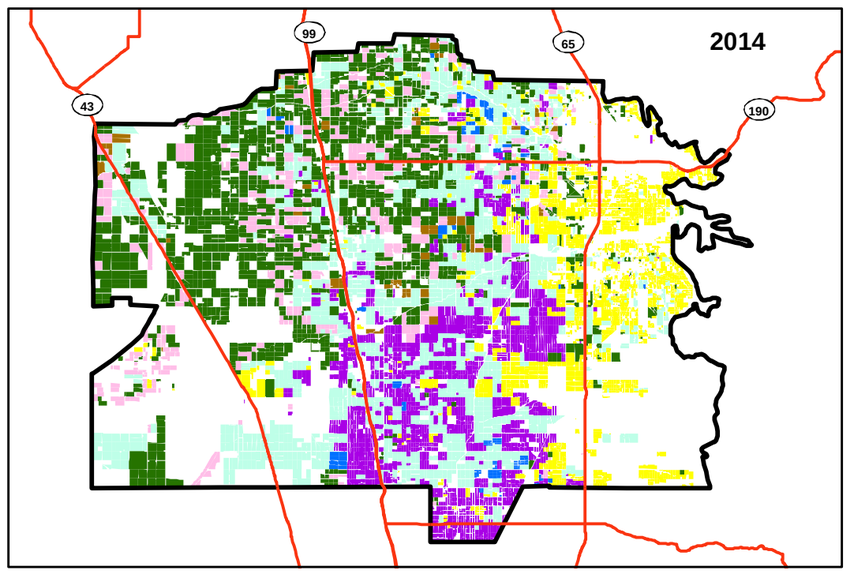
Tule Subbasin Technical Advisory Committee

January 2020









0 3 6 12
Miles

NAD 83 State Plane Zone 4

Thomas Harder & Co.
Groundwater Consulting

Groundwater Flow Model of the Tule Subbasin

Map Features

- Tule Groundwater Subbasin
- Alfalfa, Pasture
- Corn, Grain, Grain Hay, and Misc. Field Crops
- Cotton
- Deciduous & Fruit Trees
- Grapes
- Nuts
- Truck Crops
- Major Road

Notes: Data from California Department of Water Resources and Kern County Department of Agriculture and Measurement Standards

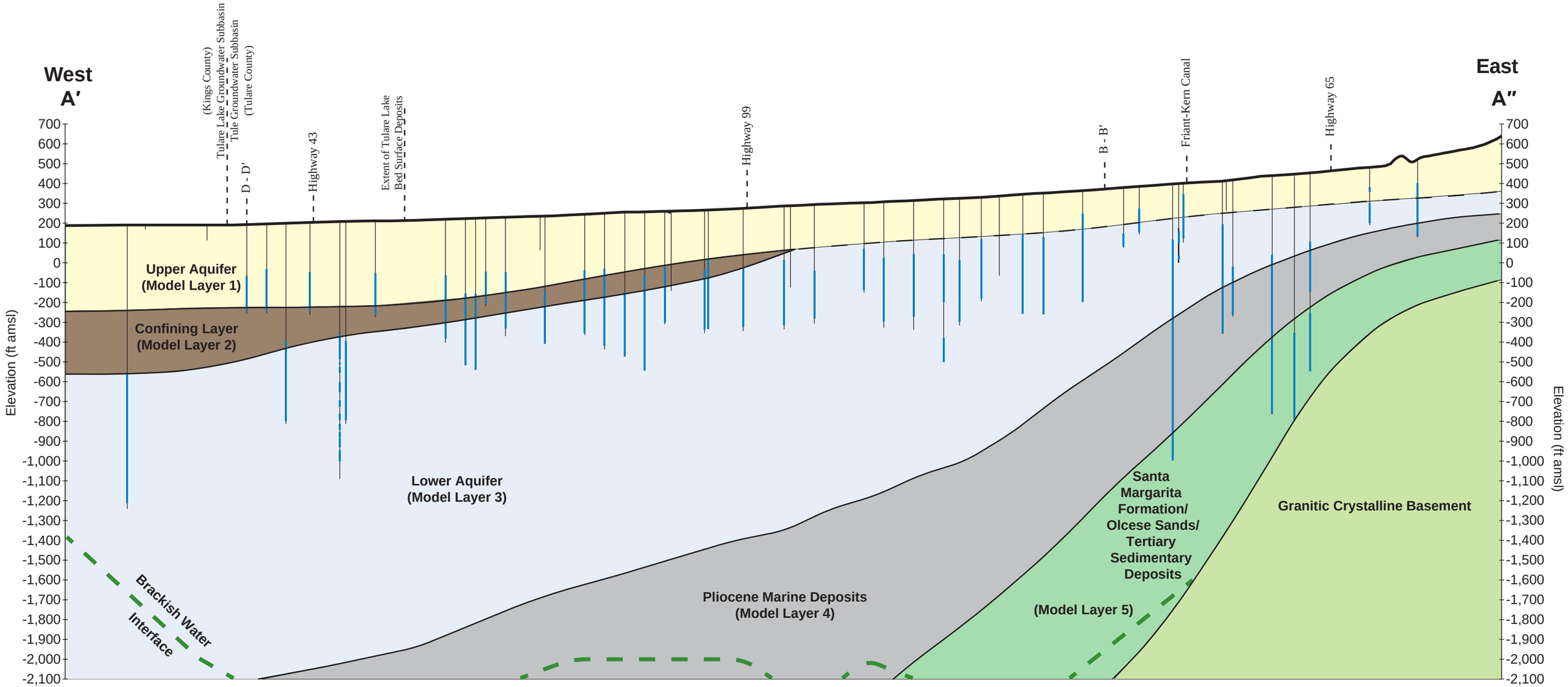
Irrigated crops only.

Tule Groundwater Subbasin Historical Crop Patterns

Figure 17

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin



Vertical Scale
0
100
200
400
Feet

Horizontal Scale
0 1/2 1 2 Miles

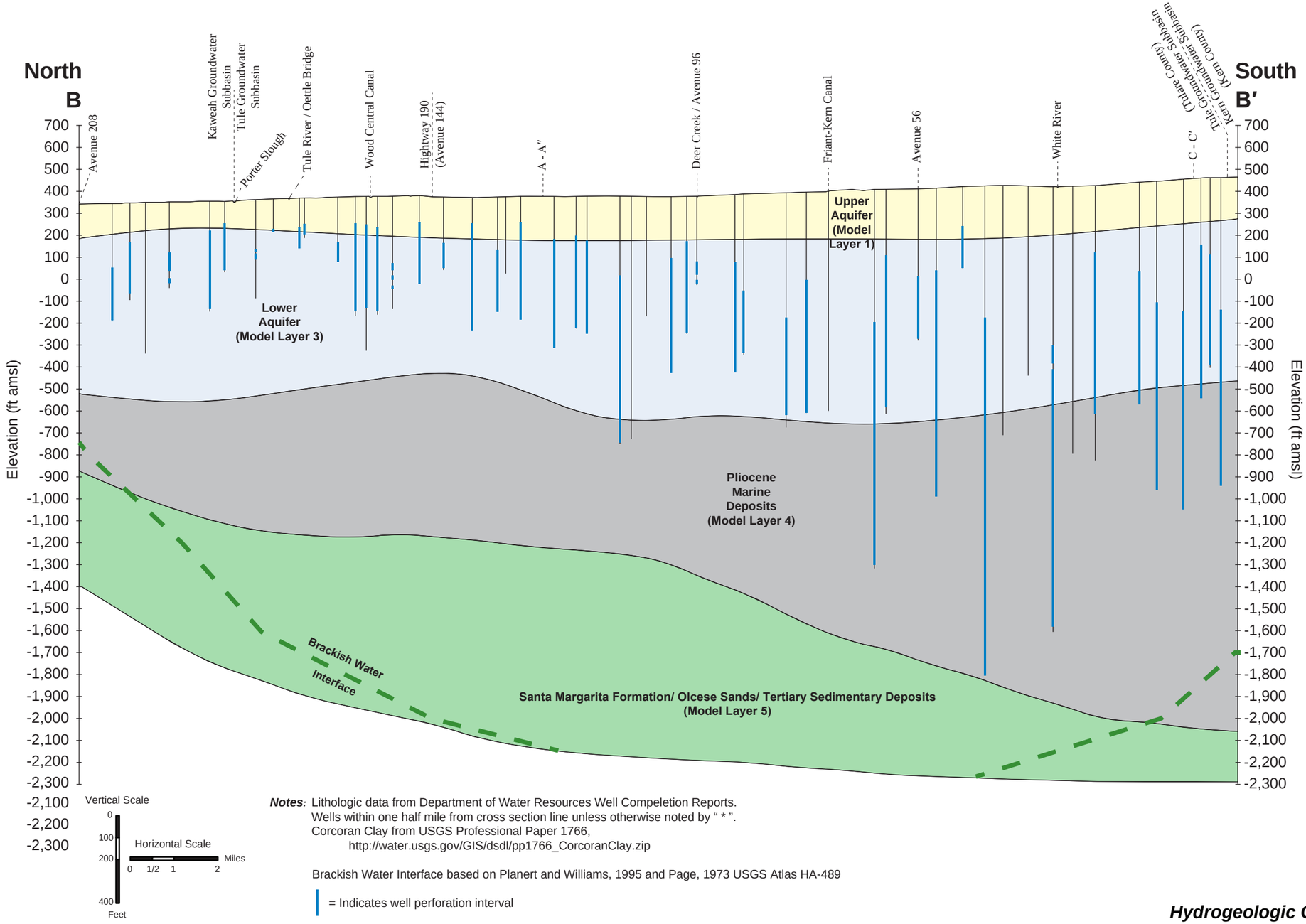
Notes: Lithologic data from Department of Water Resources Well Compeletion Reports.
Wells within one half mile from cross section line unless otherwise noted by " * ".
Corcoran Clay from USGS Professional Paper 1766,
http://water.usgs.gov/GIS/dsdl/pp1766_CorcoranClay.zip

Brackish Water Interface based on Planert and Williams, 1995 and Page, 1973 USGS Atlas HA-489

= Indicates well perforation interval

Thomas Harder & Co.
Groundwater Consulting

Hydrogeologic Cross Section A'-A"
Tule Groundwater Subbasin
Figure 18
January 2020



Vertical Scale
0
100
200
400
Feet

Horizontal Scale
0 1/2 1 2 Miles

Notes: Lithologic data from Department of Water Resources Well Compeletion Reports.
Wells within one half mile from cross section line unless otherwise noted by " * ".
Corcoran Clay from USGS Professional Paper 1766,
http://water.usgs.gov/GIS/dsdl/pp1766_CorcoranClay.zip

Brackish Water Interface based on Planert and Williams, 1995 and Page, 1973 USGS Atlas HA-489

| = Indicates well perforation interval

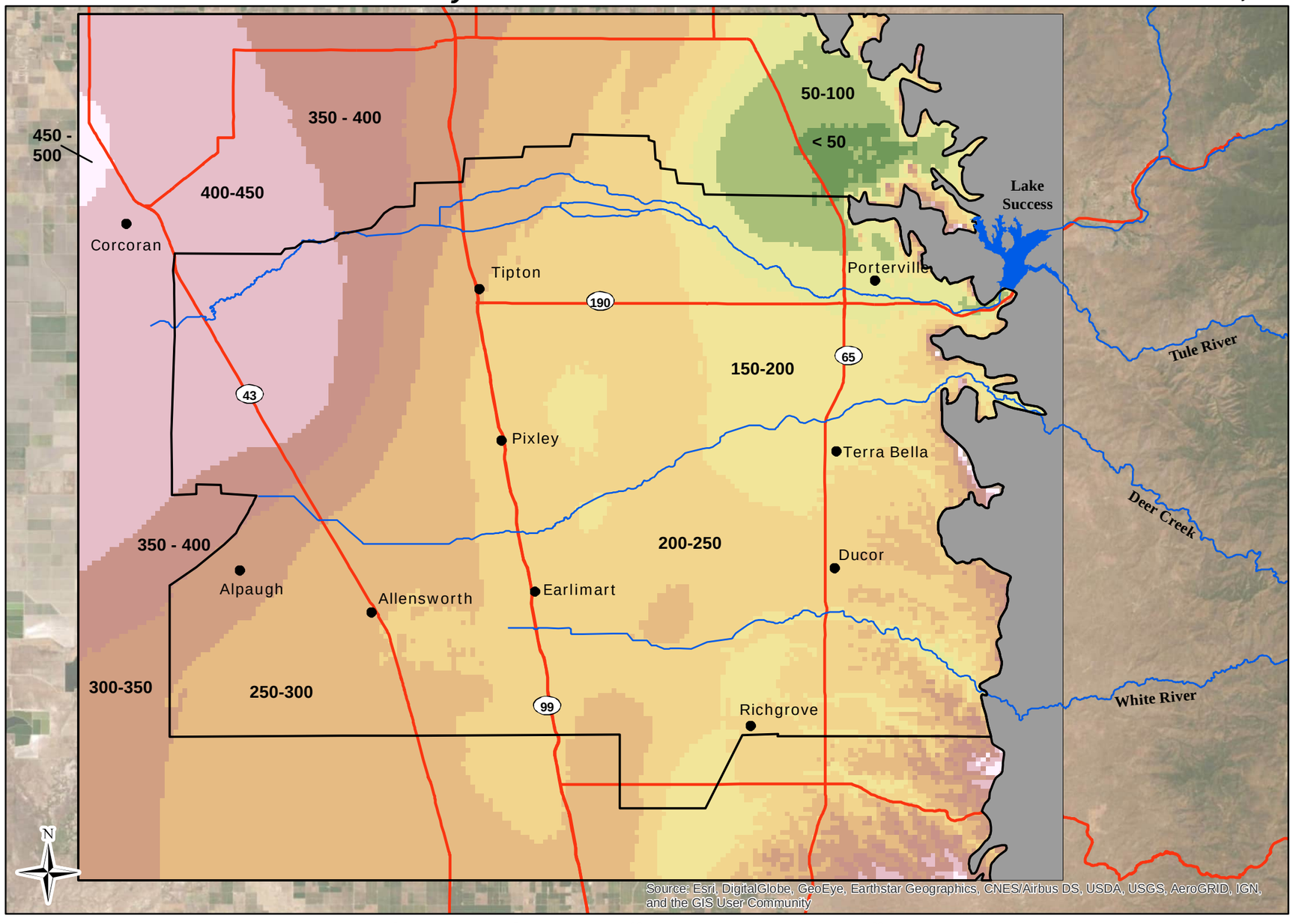
Thomas Harder & Co.
Groundwater Consulting

Hydrogeologic Cross Section B-B'
Tule Groundwater Subbasin
Figure 19
January 2020

Tule Subbasin Technical Advisory Committee

January 2020

Groundwater Flow Model of the Tule Subbasin



Map Features

Model Layer 1 Thickness (ft)

- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 450
- 450 - 500
- No Flow
- Model Domain
- Tule Subbasin
- City or Community
- Major Hydrologic Feature
- State Highway/Major Road

Thomas Harder & Co.
Groundwater Consulting

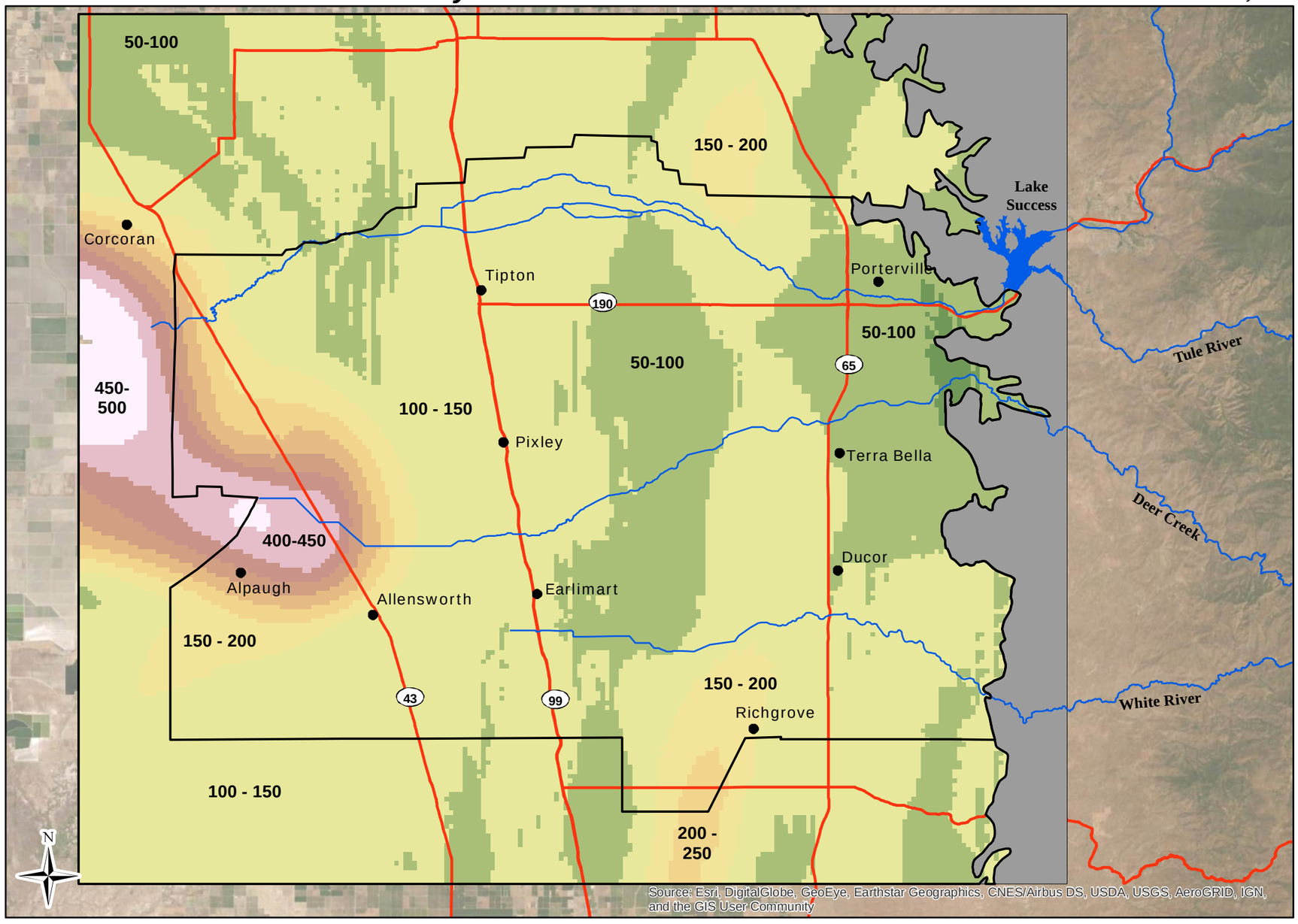
Layer 1 Thickness

Figure 20

Tule Subbasin Technical Advisory Committee

January 2020

Groundwater Flow Model of the Tule Subbasin



0 5 10 20 Miles

NAD 83 State Plane Zone 4

Map Features

Model Layer 2 Thickness (ft)

- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 450
- 450 - 500
- No Flow
- Model Domain
- Tule Subbasin
- City or Community
- Major Hydrologic Feature
- State Highway/Major Road

Layer 2 Thickness

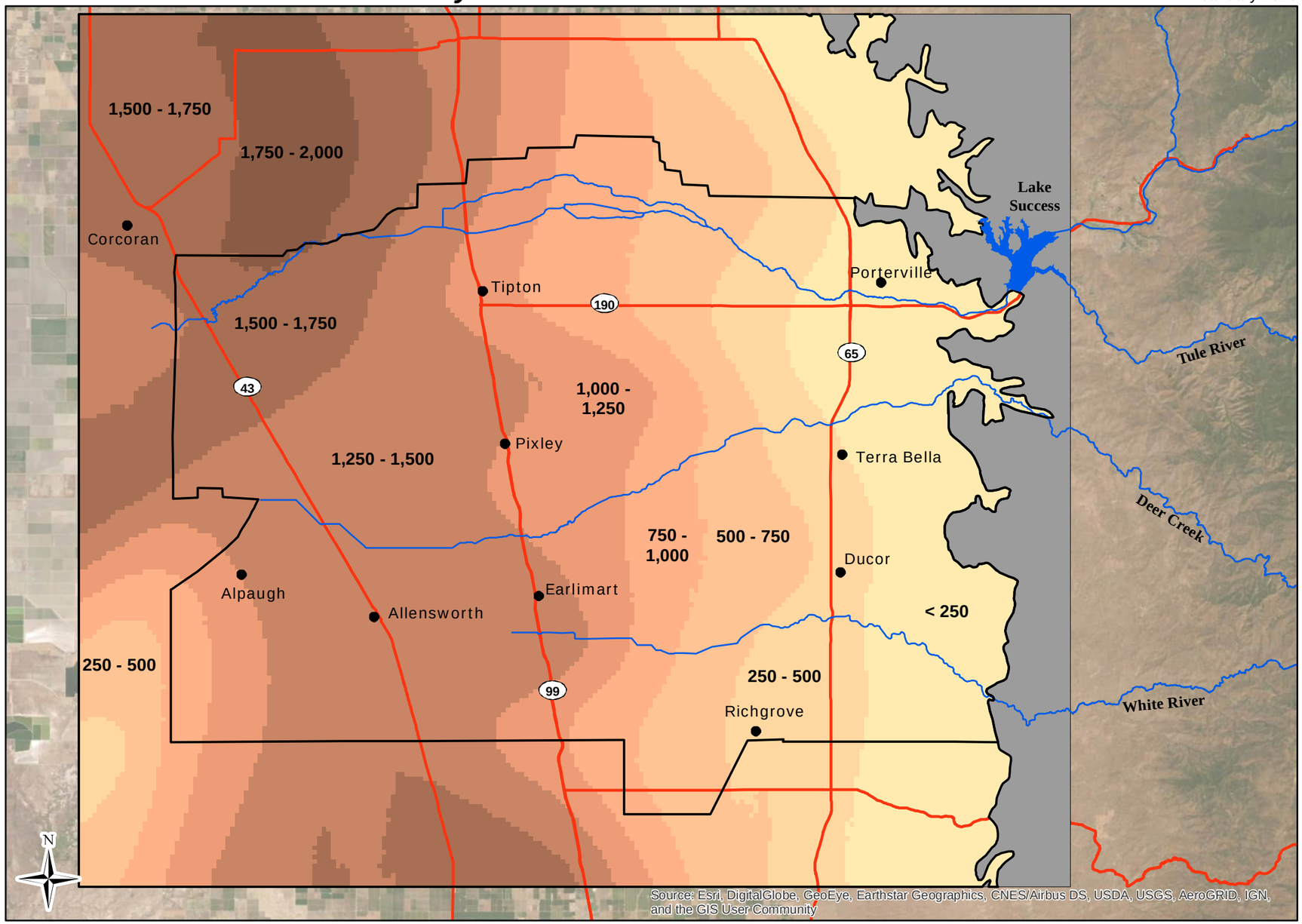
Figure 21

Thomas Harder & Co.
Groundwater Consulting

Tule Subbasin Technical Advisory Committee

January 2020

Groundwater Flow Model of the Tule Subbasin



Map Features

Model Layer 3 Thickness (ft)

- < 250
- 250 - 500
- 500 - 750
- 750 - 1,000
- 1,000 - 1,250
- 1,250 - 1,500
- 1,500 - 1,750
- 1,750 - 2,000
- No Flow
- Model Domain
- Tule Subbasin
- City or Community
- Major Hydrologic Feature
- State Highway/Major Road

Layer 3 Thickness

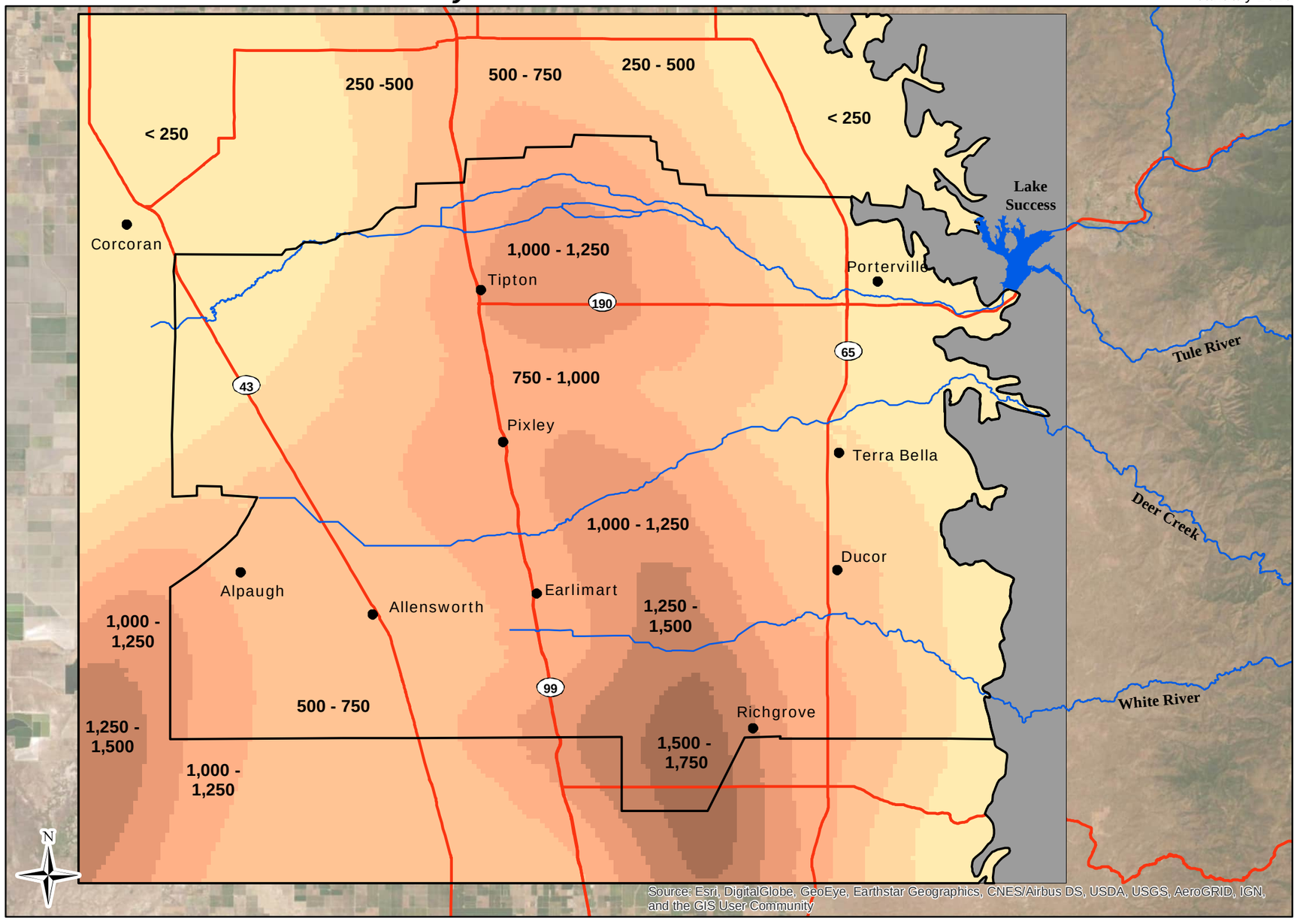
Figure 22

Thomas Harder & Co.
Groundwater Consulting

Tule Subbasin Technical Advisory Committee

January 2020

Groundwater Flow Model of the Tule Subbasin



0 5 10 20 Miles

NAD 83 State Plane Zone 4

Map Features

Model Layer 4 Thickness (ft)

- < 250
- 250 - 500
- 500 - 750
- 750 - 1,000
- 1,000 - 1,250
- 1,250 - 1,500
- 1,500 - 1,750
- 1,750 - 2,000
- No Flow
- Model Domain
- Tule Subbasin
- City or Community
- Major Hydrologic Feature
- State Highway/Major Road

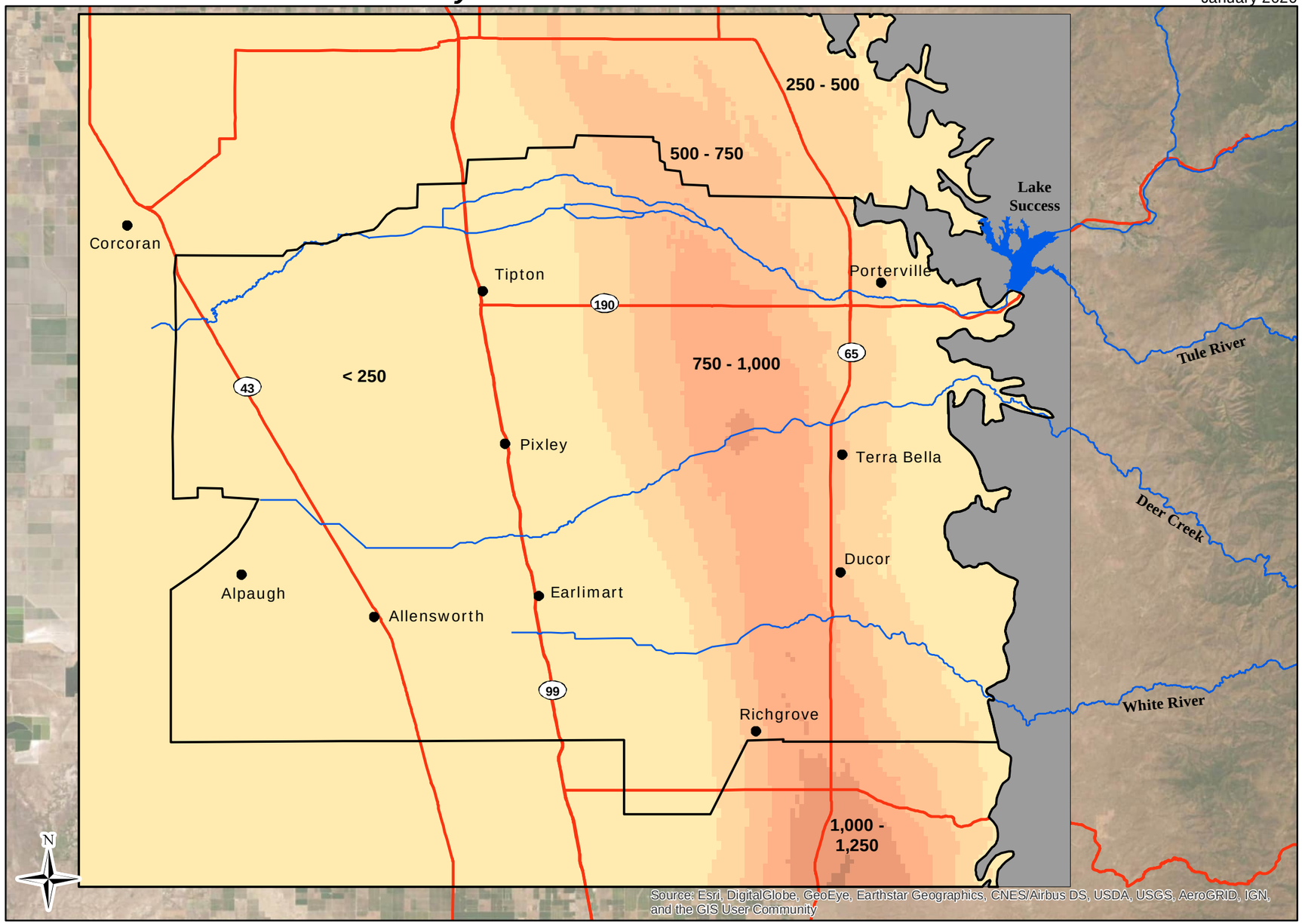
Thomas Harder & Co.
Groundwater Consulting

Layer 4 Thickness

Figure 23

Tule Subbasin Technical Advisory Committee

January 2020



0 5 10 20 Miles

NAD 83 State Plane Zone 4

Thomas Harder & Co.
Groundwater Consulting

Groundwater Flow Model of the Tule Subbasin

Map Features

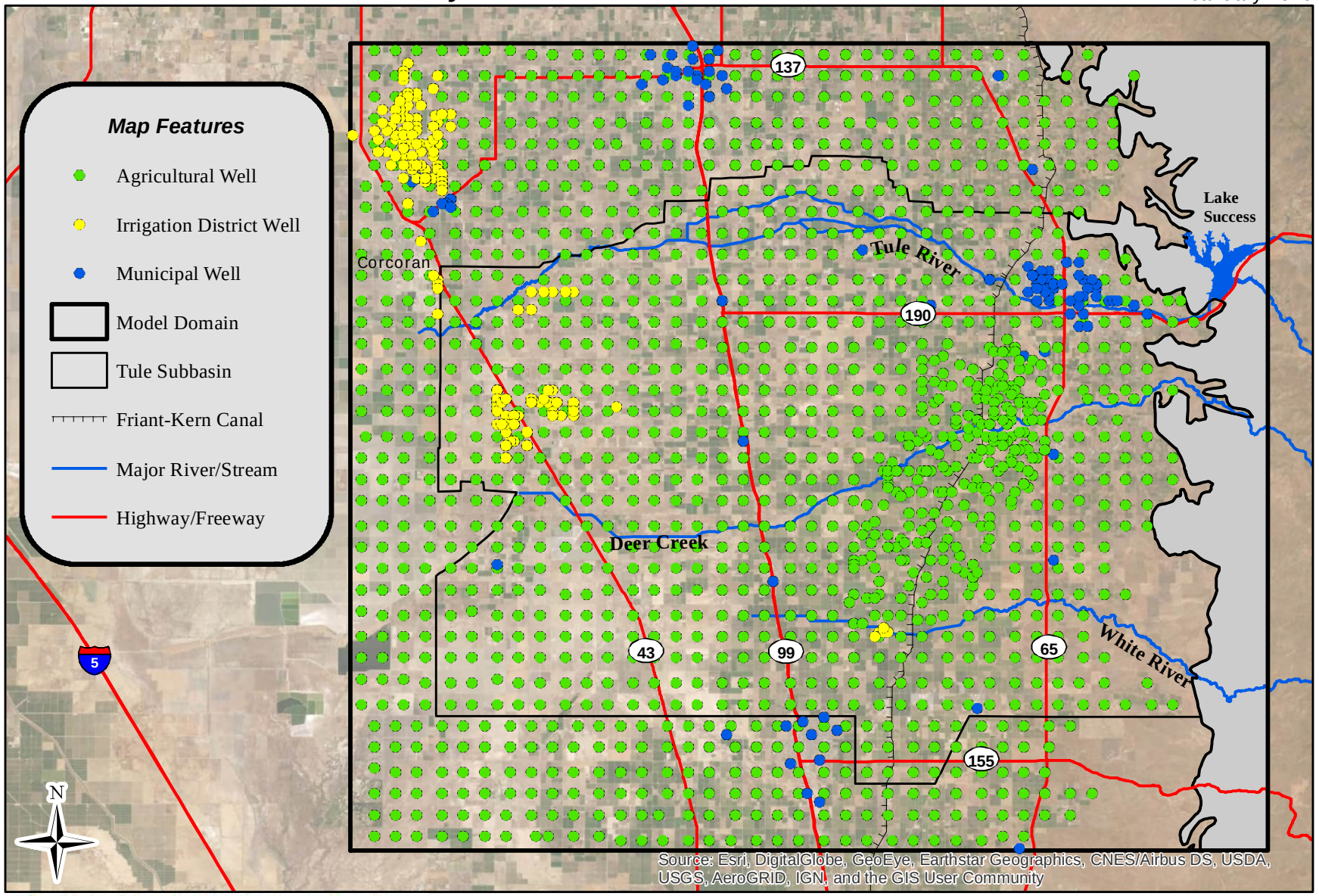
Model Layer 5 Thickness (ft)

- < 250
- 250 - 500
- 500 - 750
- 750 - 1,000
- 1,000 - 1,250
- 1,250 - 1,500
- 1,500 - 1,750
- 1,750 - 2,000
- No Flow
- Model Domain
- Tule Subbasin
- City or Community
- Major Hydrologic Feature
- State Highway/Major Road

Layer 5 Thickness

Figure 24

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

0 2 4 8 Miles

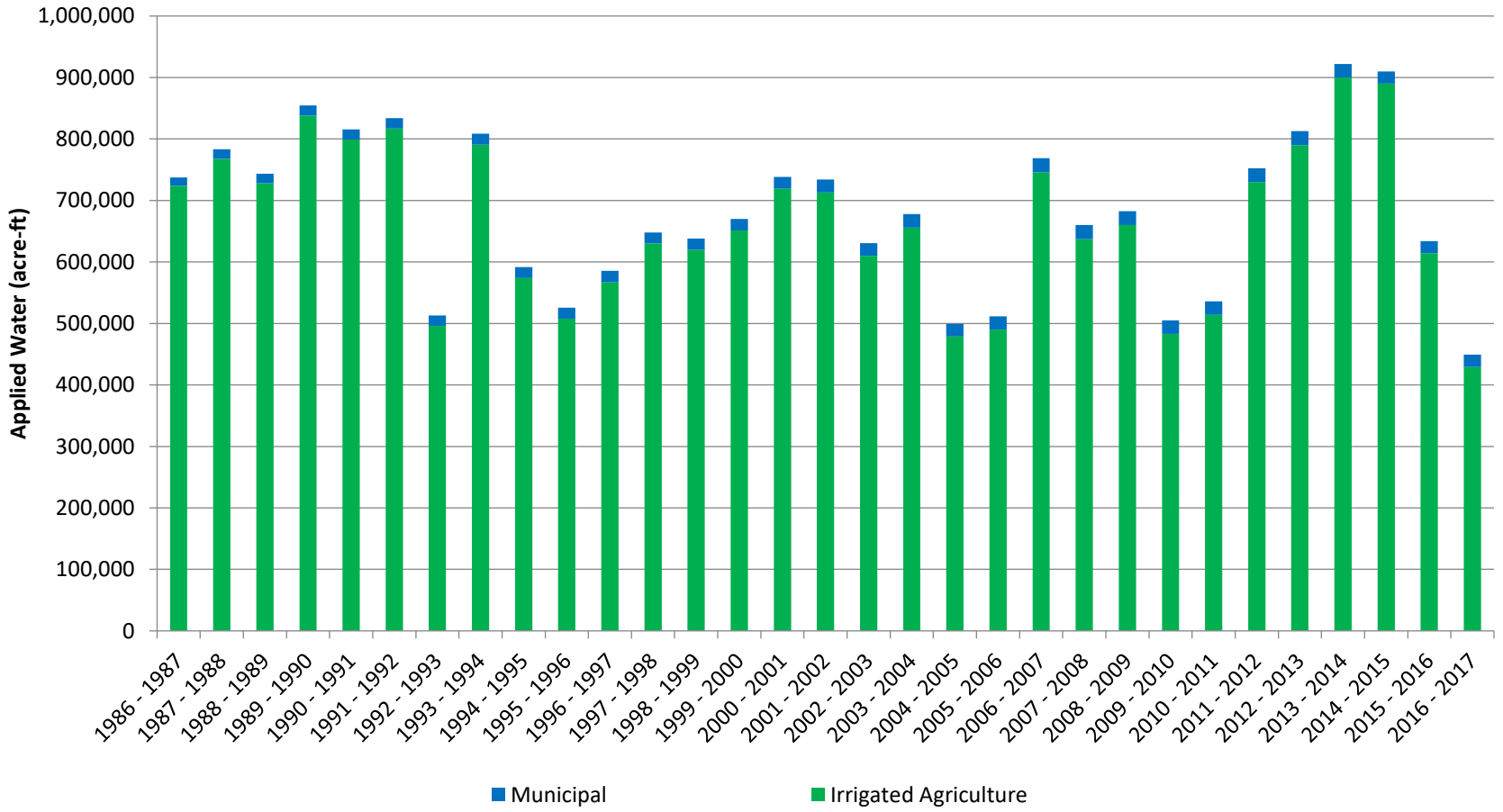
NAD 83 State Plane Zone 4

Wells in the Groundwater Flow Model

Figure 25

Figure 26

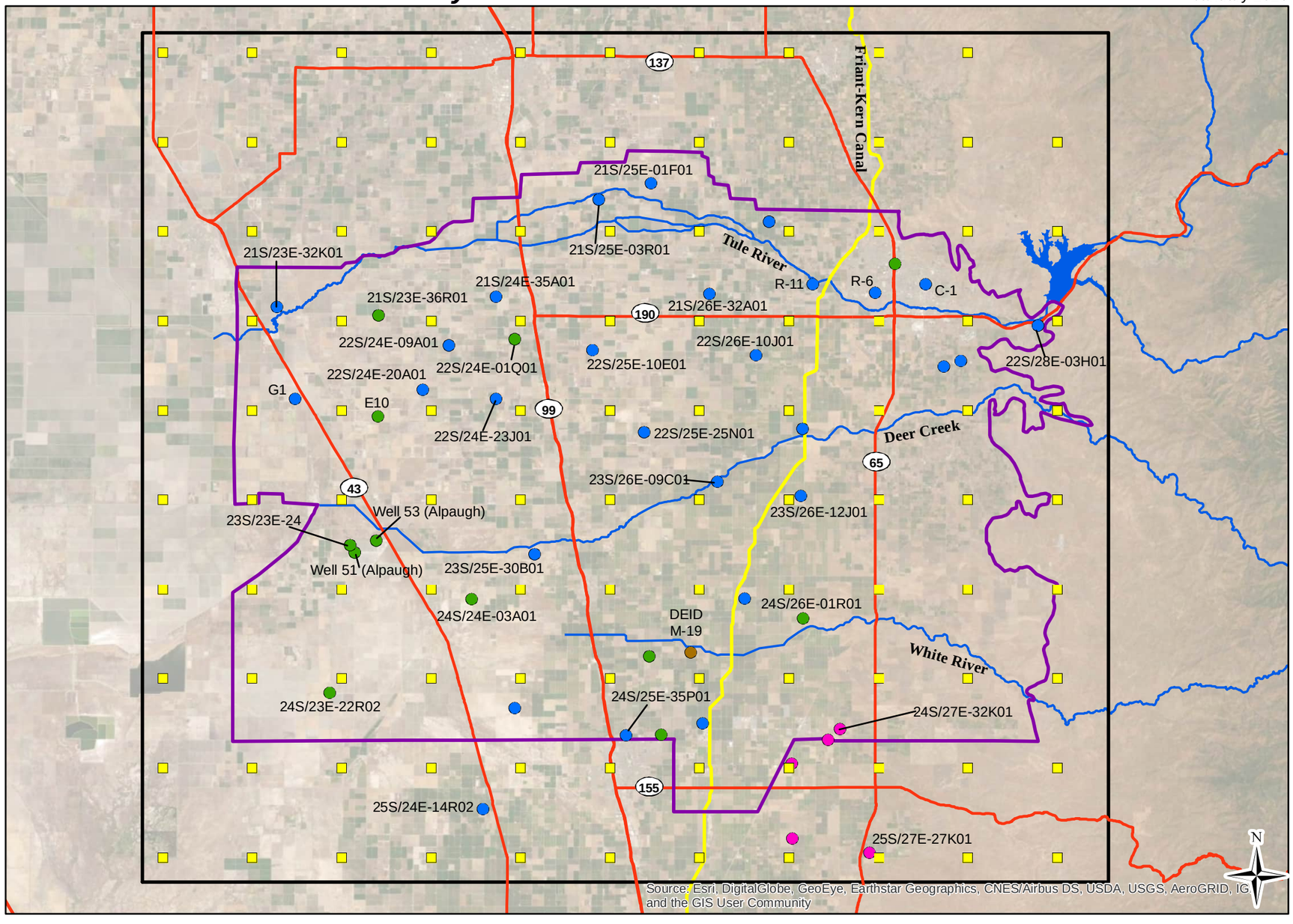
Estimated Historical Groundwater Pumping



Tule Subbasin Technical Advisory Committee

January 2020

Groundwater Flow Model of the Tule Subbasin



0 2.5 5 10 Miles

NAD 83 State Plane Zone 4

Map Features

- Layer 1 - Shallow Well
- Layer 3 - Deep Well
- Layer 4 - Deep Well
- DEID M-19 Nested (L1 and L3)
- Pilot Point
- State Highway/Major Road
- Friant-Kern Canal
- Major Hydrologic Feature
- Tule Subbasin
- Model Domain

Thomas Harder & Co.
Groundwater Consulting

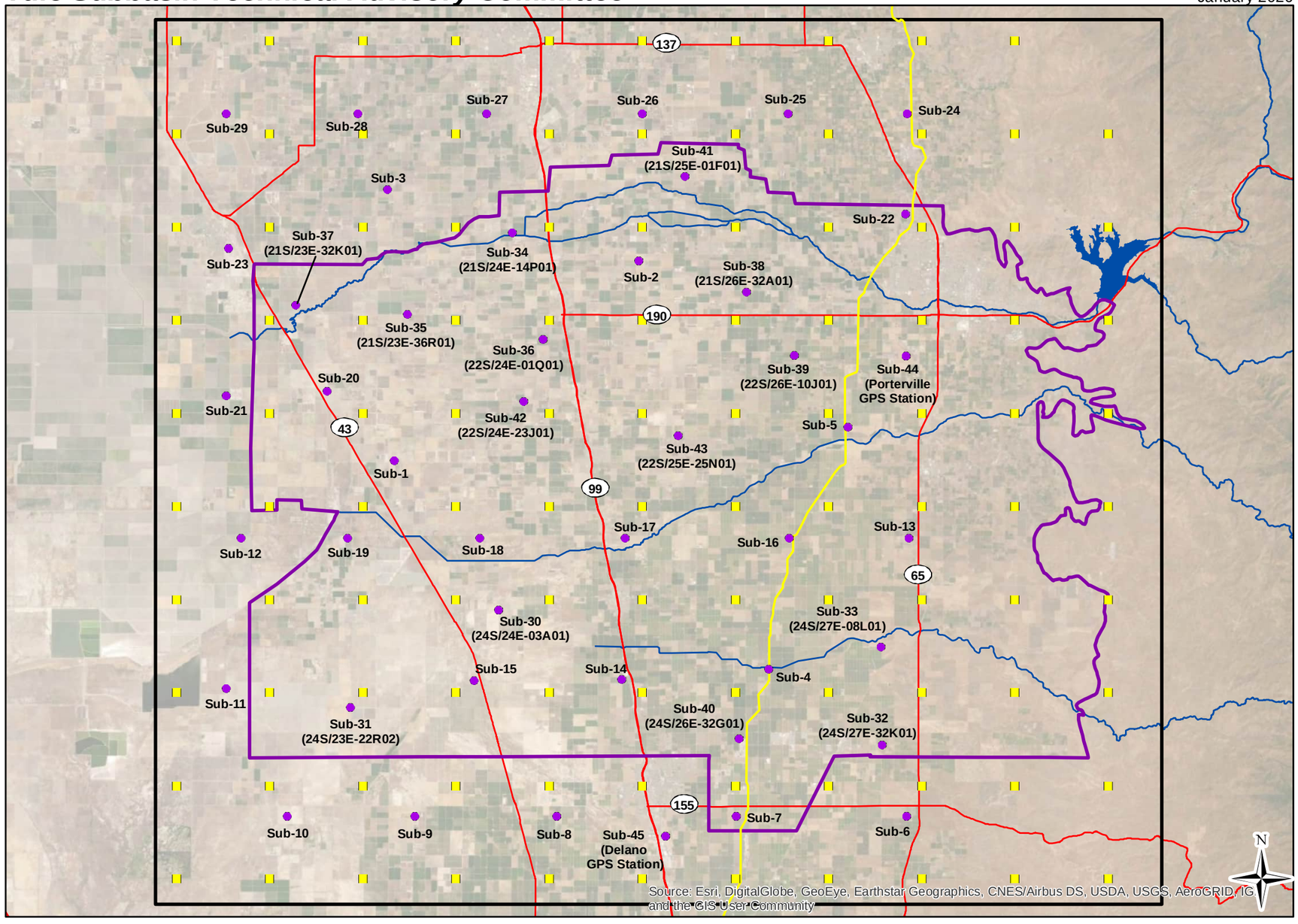
Groundwater Level Calibration Target Wells

Figure 27

Tule Subbasin Technical Advisory Committee

January 2020

Groundwater Flow Model of the Tule Subbasin



Map Features

- Pilot Point
- Subsidence Target
- Friant-Kern Canal
- Major Hydrologic Feature
- Major Road
- Tule Subbasin
- Model Domain

0 3 6 12 Miles

NAD 83 State Plane Zone 4

Thomas Harder & Co.
Groundwater Consulting

Subsidence Calibration Targets

Figure 28

Figure 29

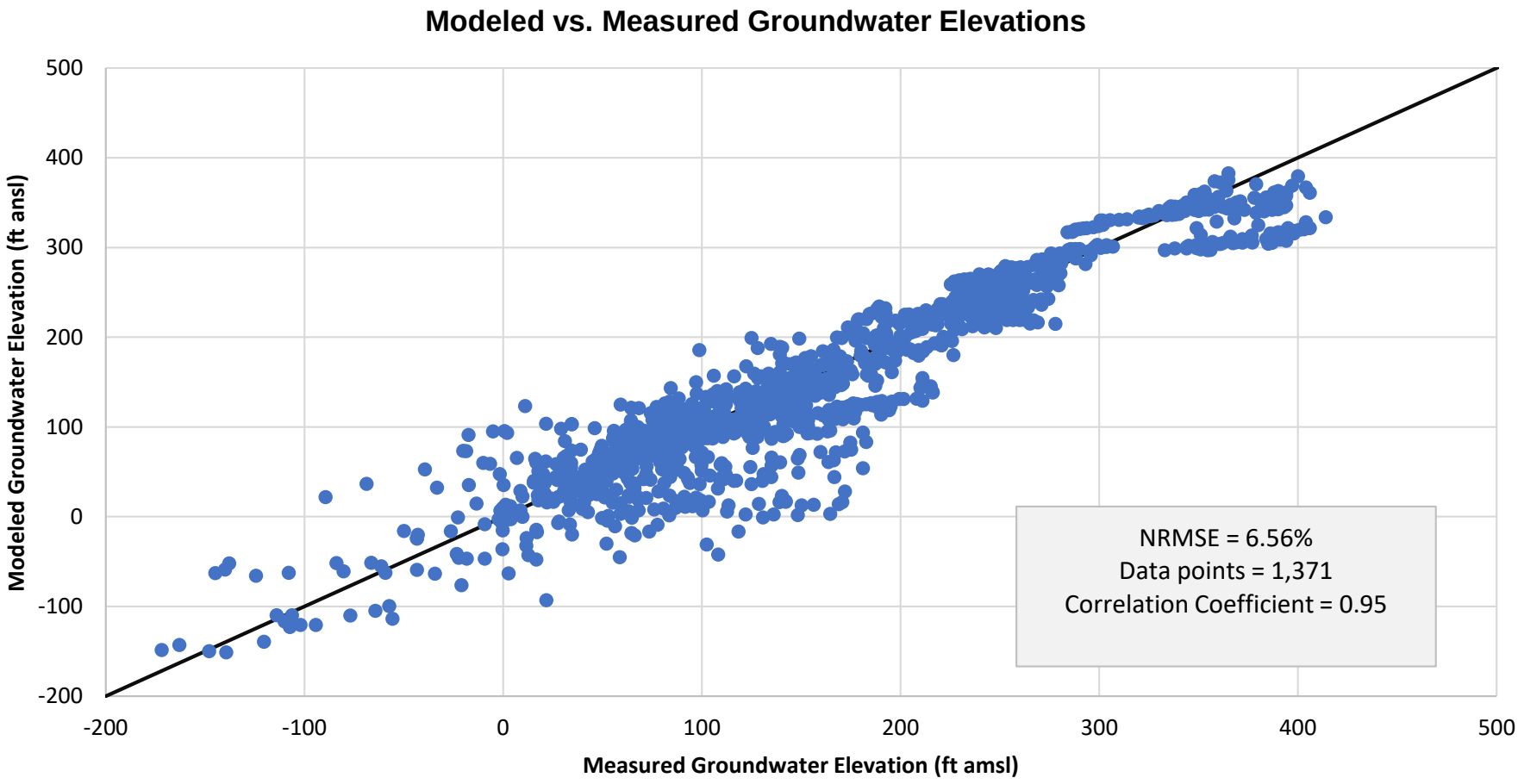

Modeled vs. Measured Groundwater Elevations
Modeled Groundwater Elevation (ft ansl)
Measured Groundwater Elevation (ft amsl)
500
400
300
200
100
0
-100
-200
-200
-100
0
100
200
300
400
500
NRMSE = 6.56%
Data points = 1,371
Correlation Coefficient = 0.95

Figure 30

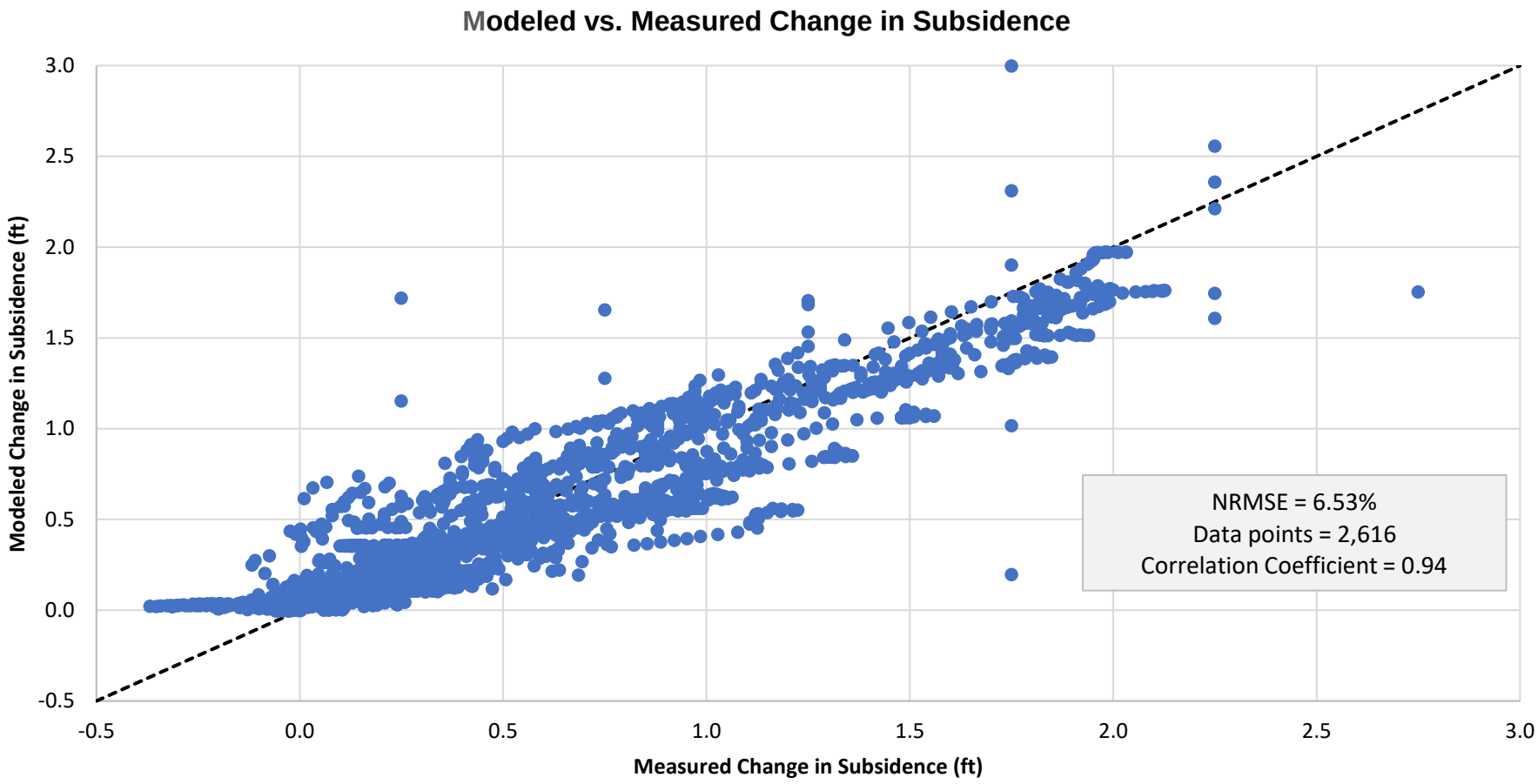
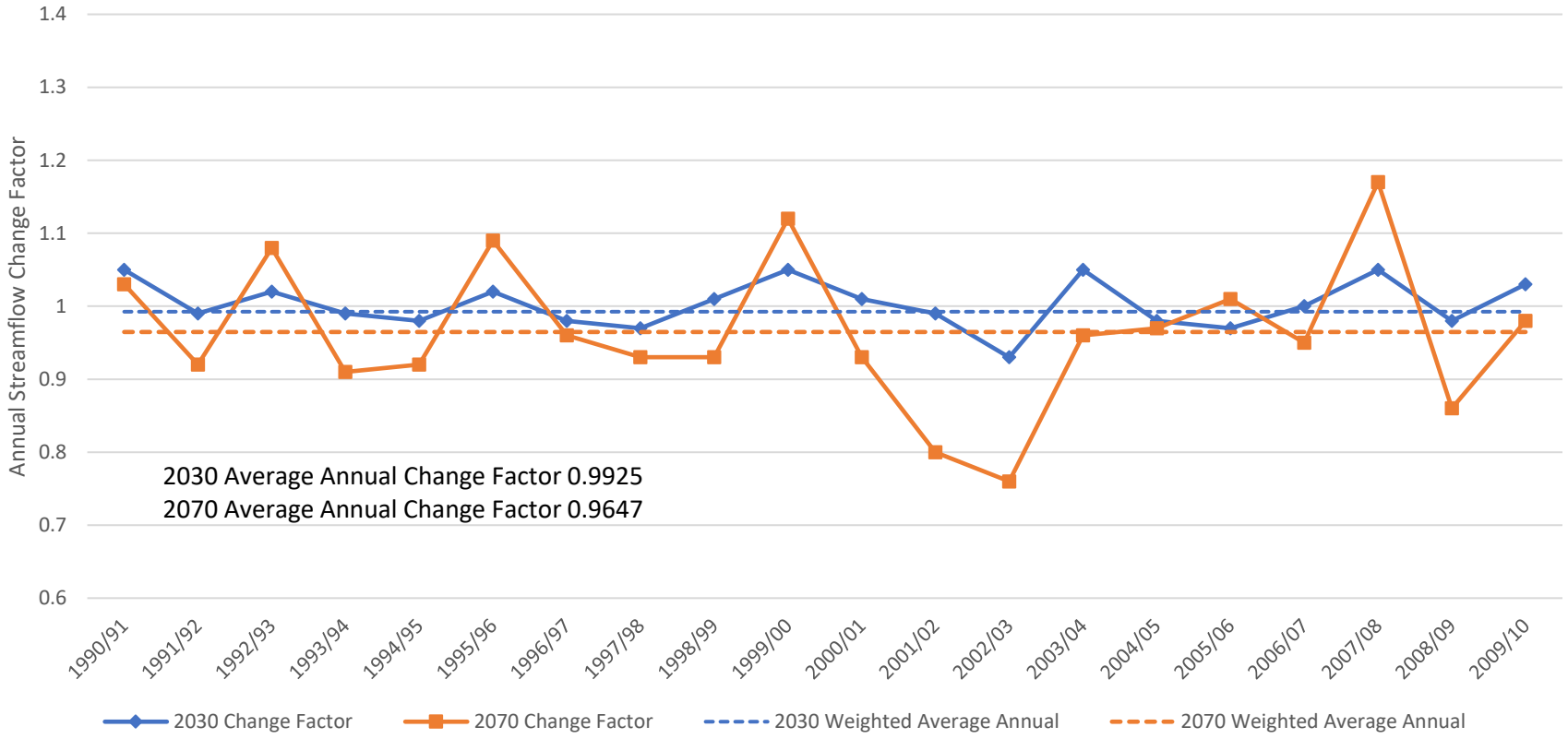

Modeled vs. Measured Change in Subsidence
Modeled Change in Subsidence (ft)
Measured Change in Subsidence (ft)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
NRMSE = 6.53%
Data points = 2,616
Correlation Coefficient = 0.94

Figure 31

Tule River - Inflow to Success
Future Climate Projections with Baseperiod 1990/91 through 2009/10



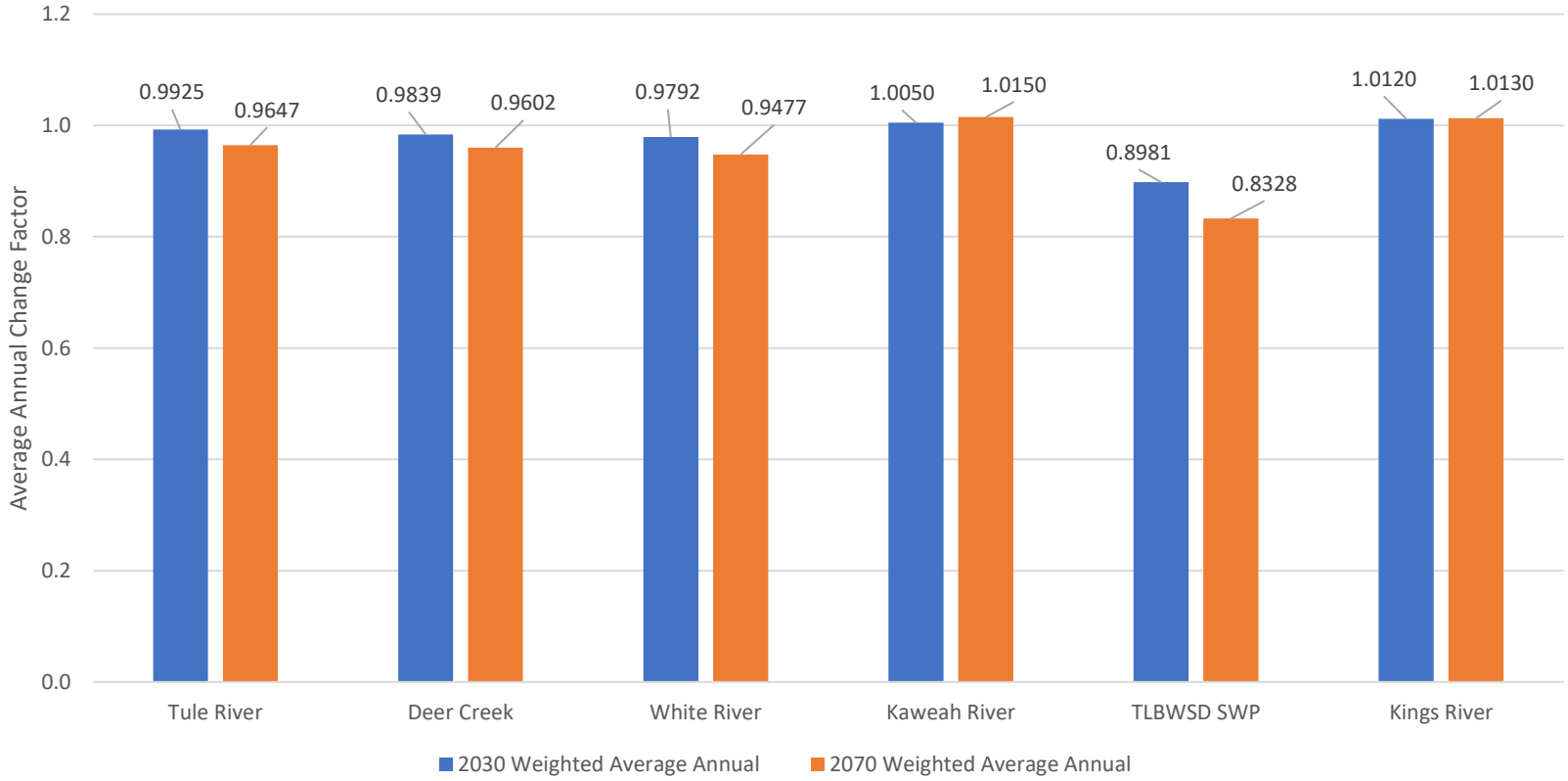
Notes:

Change factors from DWR SGMA Data Viewer, Climate Change Datasets.

2030 climate dataset used for 2017/18 through 2049/50 and 2070 climate dataset used for 2050/51 through 2069/70.

Figure 32

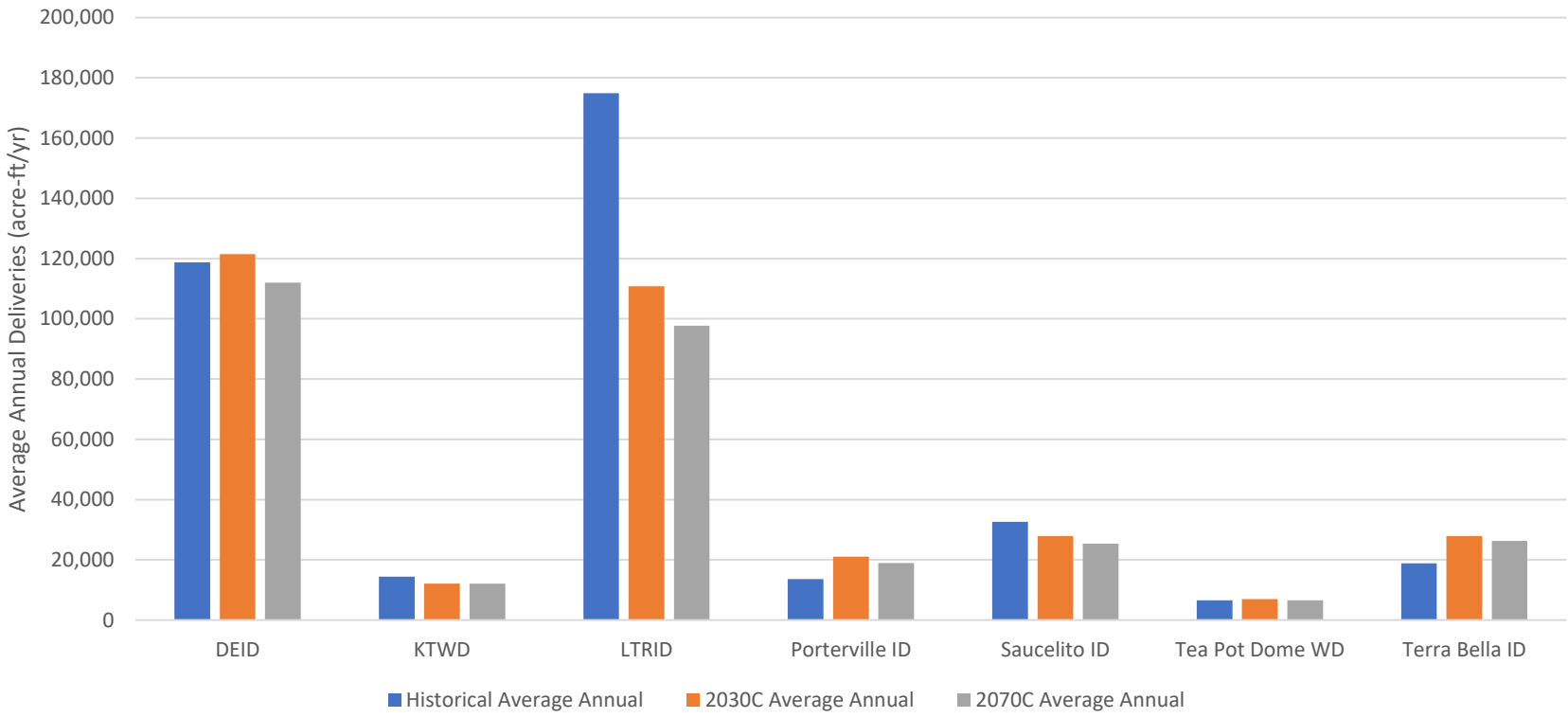
Summary of Average Annual Change Factors for Major Streams (Non Friant-Kern Canal Deliveries)



Notes:

Kaweah River, Tulare Lake Bed Water Storage District State Water Project (TLBWSD SWP), and Kings River for Angiola Water District

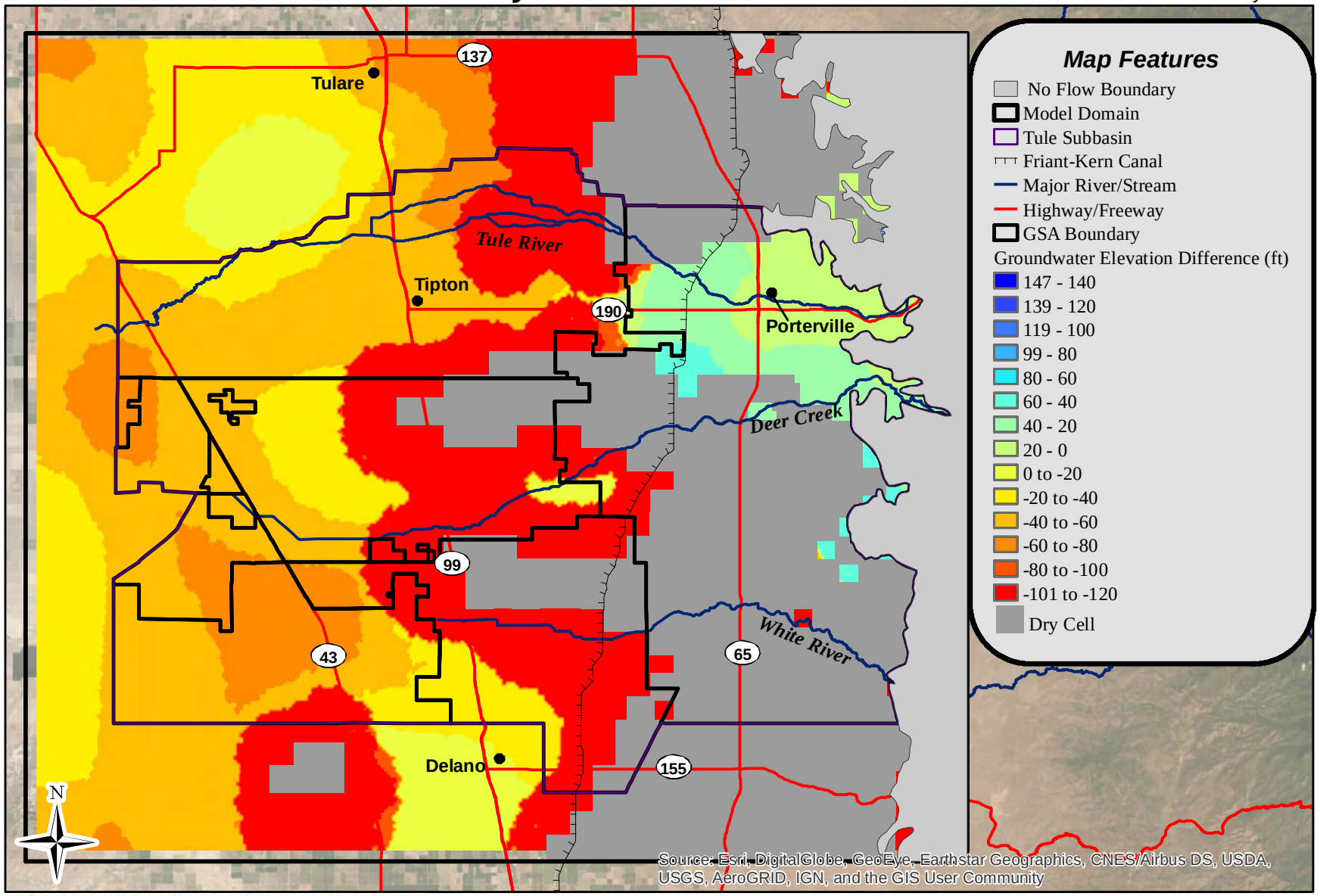
Historical and Future Projection Friant-Kern Canal Deliveries



Notes:

Historical average annual based on 1990/91 through 2009/10
Does not include future projects including transfers.
Include Class 1, Class 2/Other, 16B, and SKRRP Recapture (Class 1 and Class 2/Other)
KTWD projections provided by KTWD. KTWD deliveries within the Tule Subbasin only.

Tule Subbasin Technical Advisory Committee

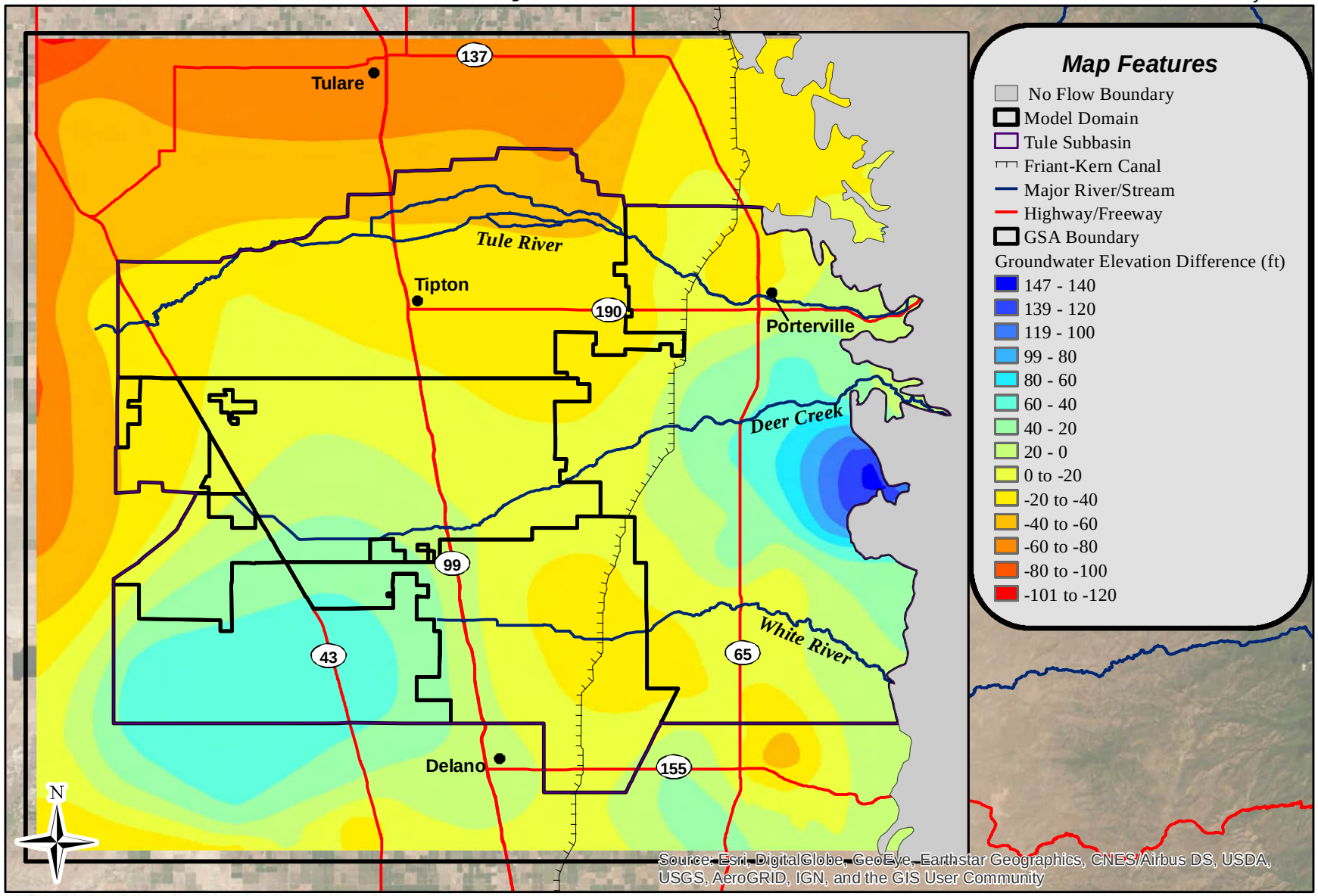


Thomas Harder & Co.
Groundwater Consulting

Model Simulated Change in Groundwater Level Between 2020 and 2040 (Layer 1)

Figure 34

Tule Subbasin Technical Advisory Committee



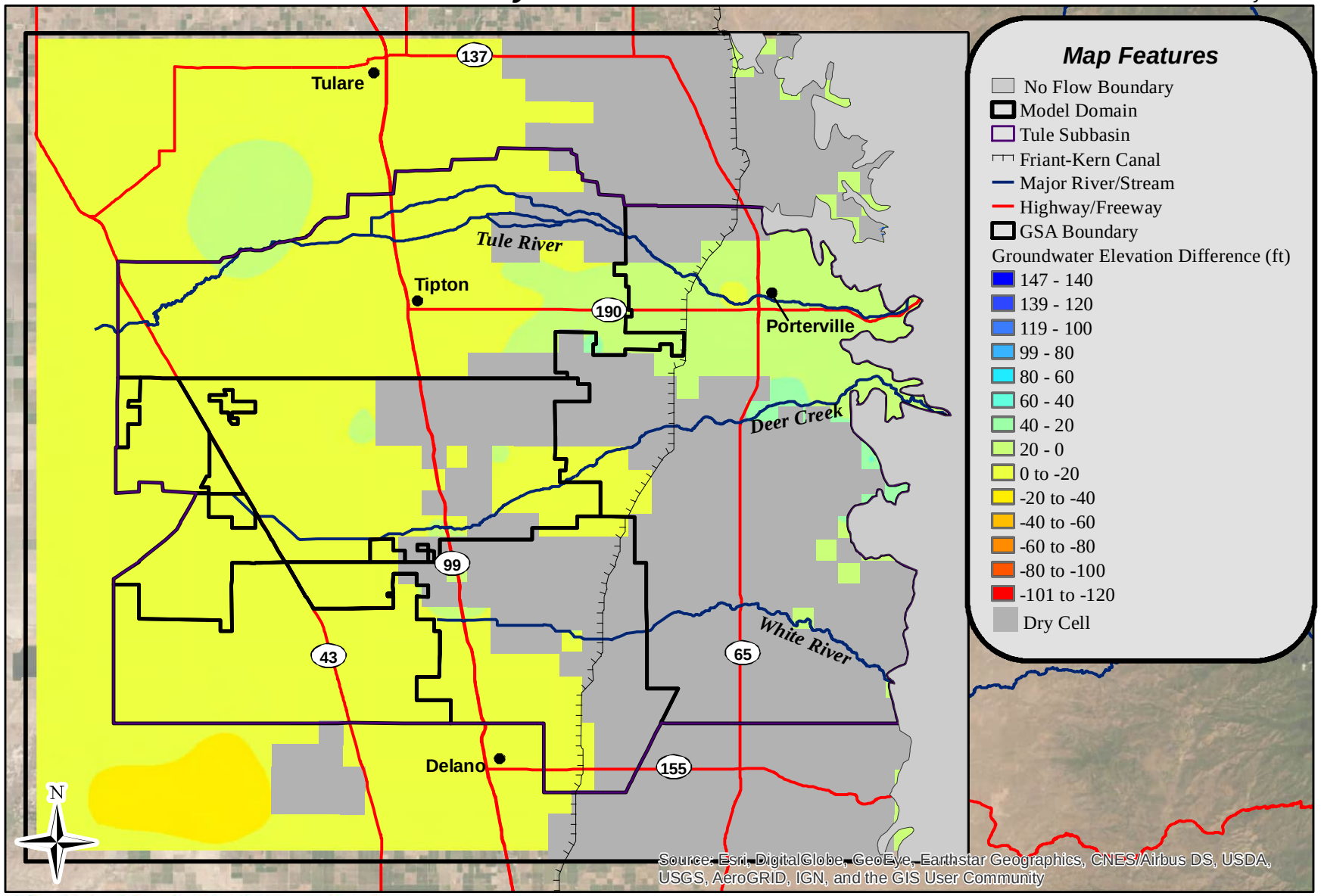
Thomas Harder & Co.
Groundwater Consulting

0 2.5 5 10 Miles

Model Simulated Change in Groundwater Level Between 2020 and 2040 (Layer 3)

Figure 35

Tule Subbasin Technical Advisory Committee

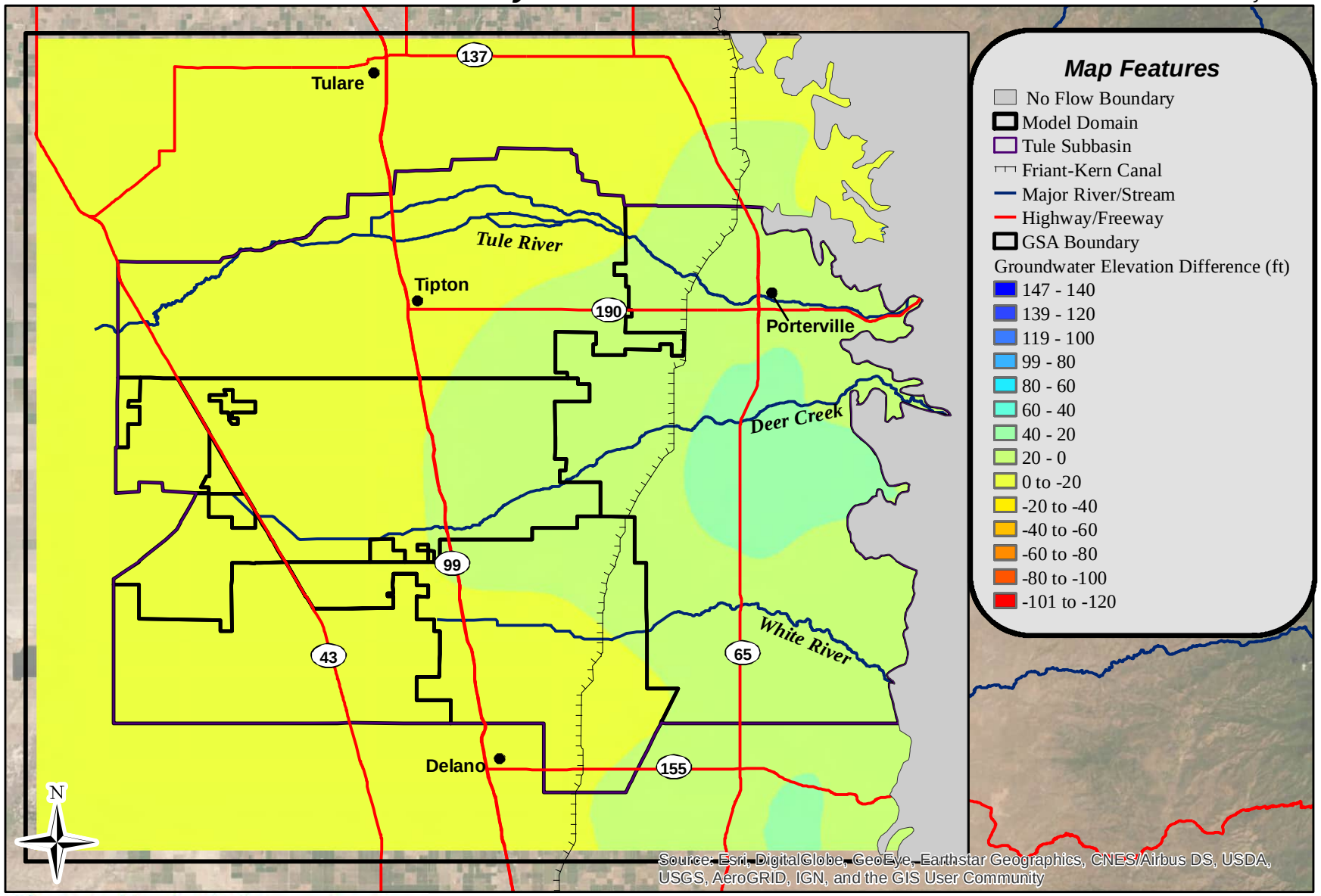


Thomas Harder & Co.
Groundwater Consulting

Model Simulated Change in Groundwater Level Between 2040 and 2050 (Layer 1)

Figure 36

Tule Subbasin Technical Advisory Committee

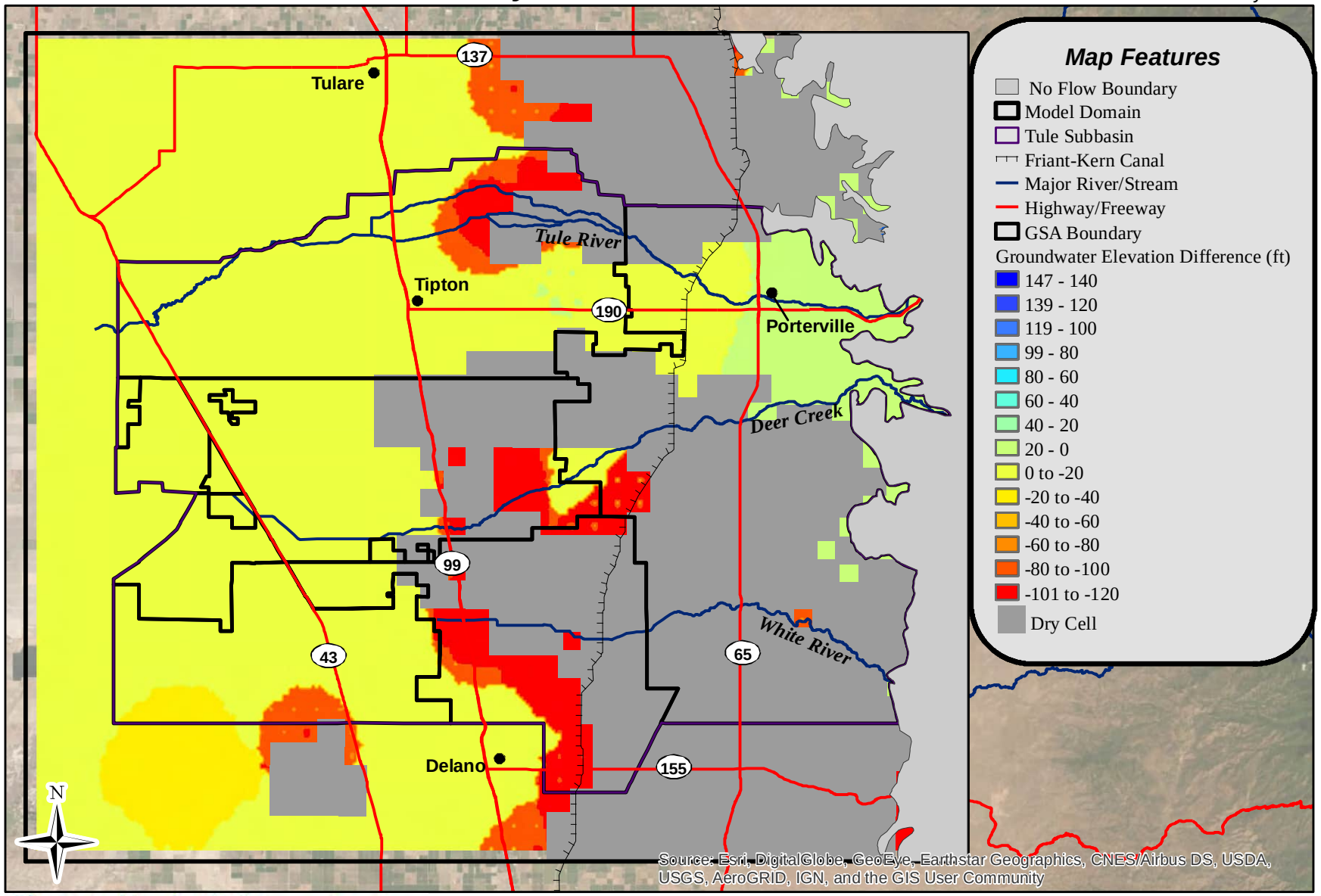


Thomas Harder & Co.
Groundwater Consulting

Model Simulated Change in Groundwater Level Between 2040 and 2050 (Layer 3)

Figure 37

Tule Subbasin Technical Advisory Committee

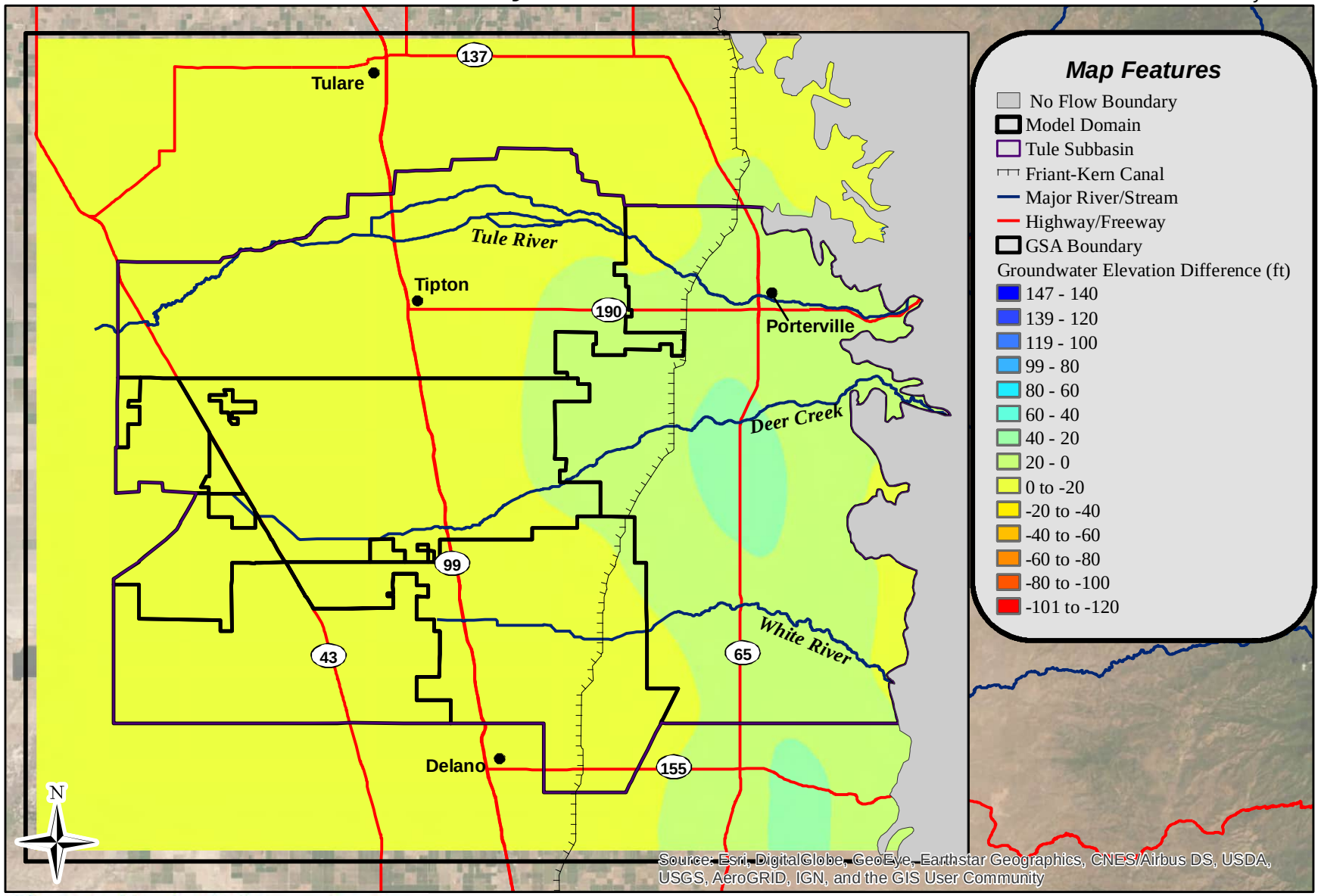


Thomas Harder & Co.
Groundwater Consulting

Model Simulated Change in Groundwater Level Between 2050 and 2070 (Layer 1)

Figure 38

Tule Subbasin Technical Advisory Committee



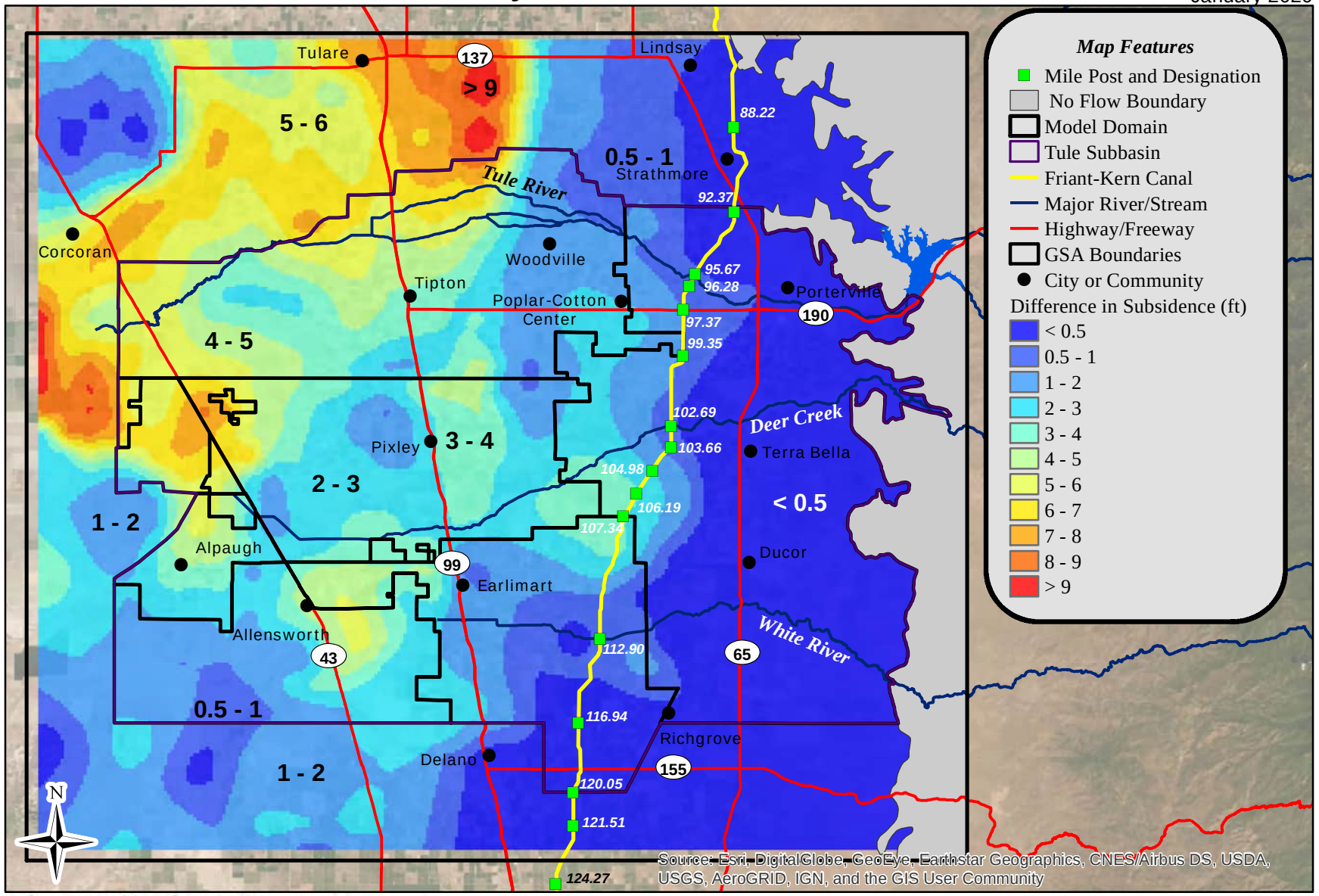
Thomas Harder & Co.
Groundwater Consulting

0 2.5 5 10 Miles

Model Simulated Change in Groundwater Level Between 2050 and 2070 (Layer 3)

Figure 39

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

0 2.5 5 10
Miles

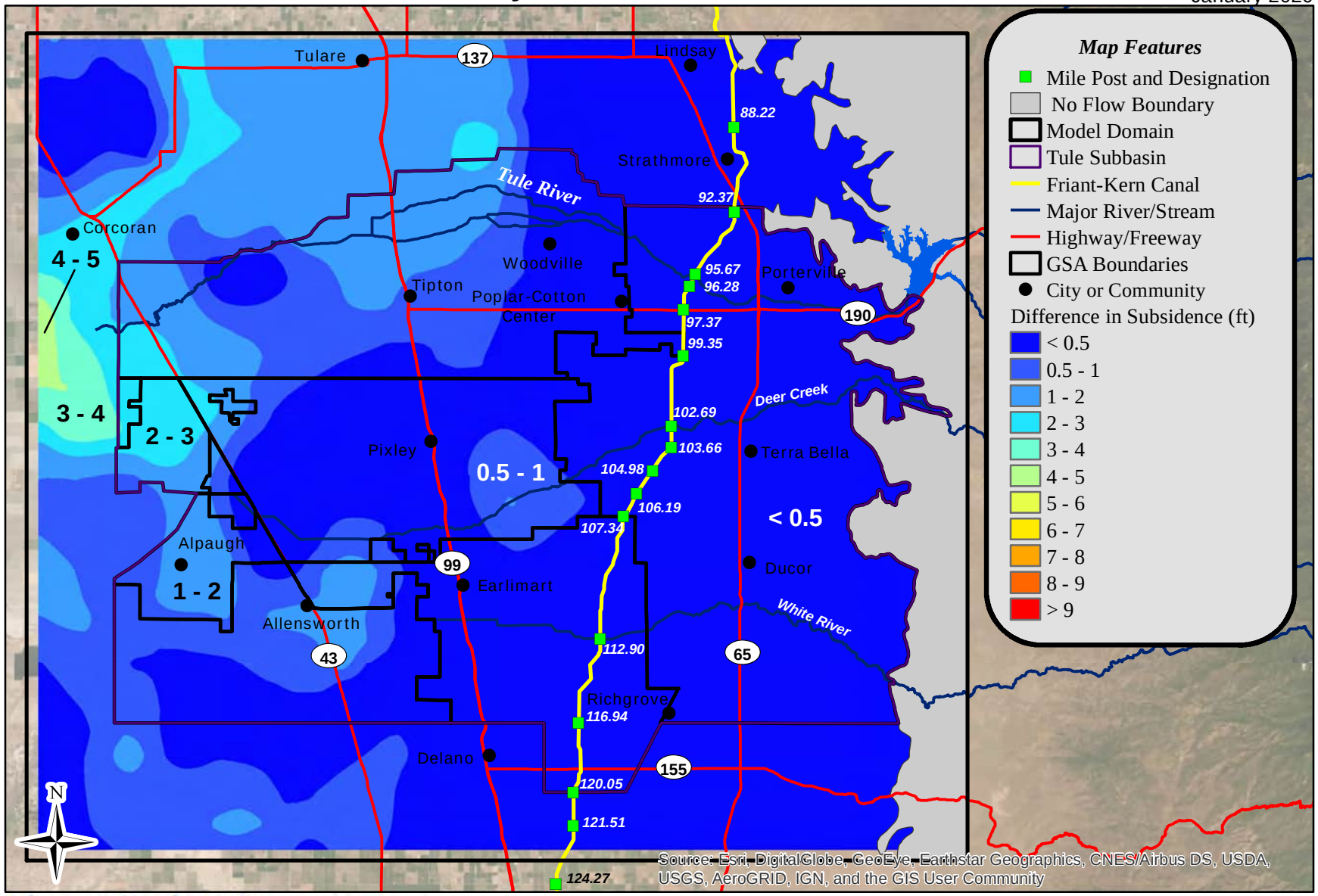
NAD 83 State Plane Zone 4

Cumulative Land Subsidence in the Tule Subbasin from 2020 to 2040

Figure 40

Note: This map shows the difference in subsidence from September 30, 2019 to September 30, 2039.

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

0 2.5 5 10 Miles

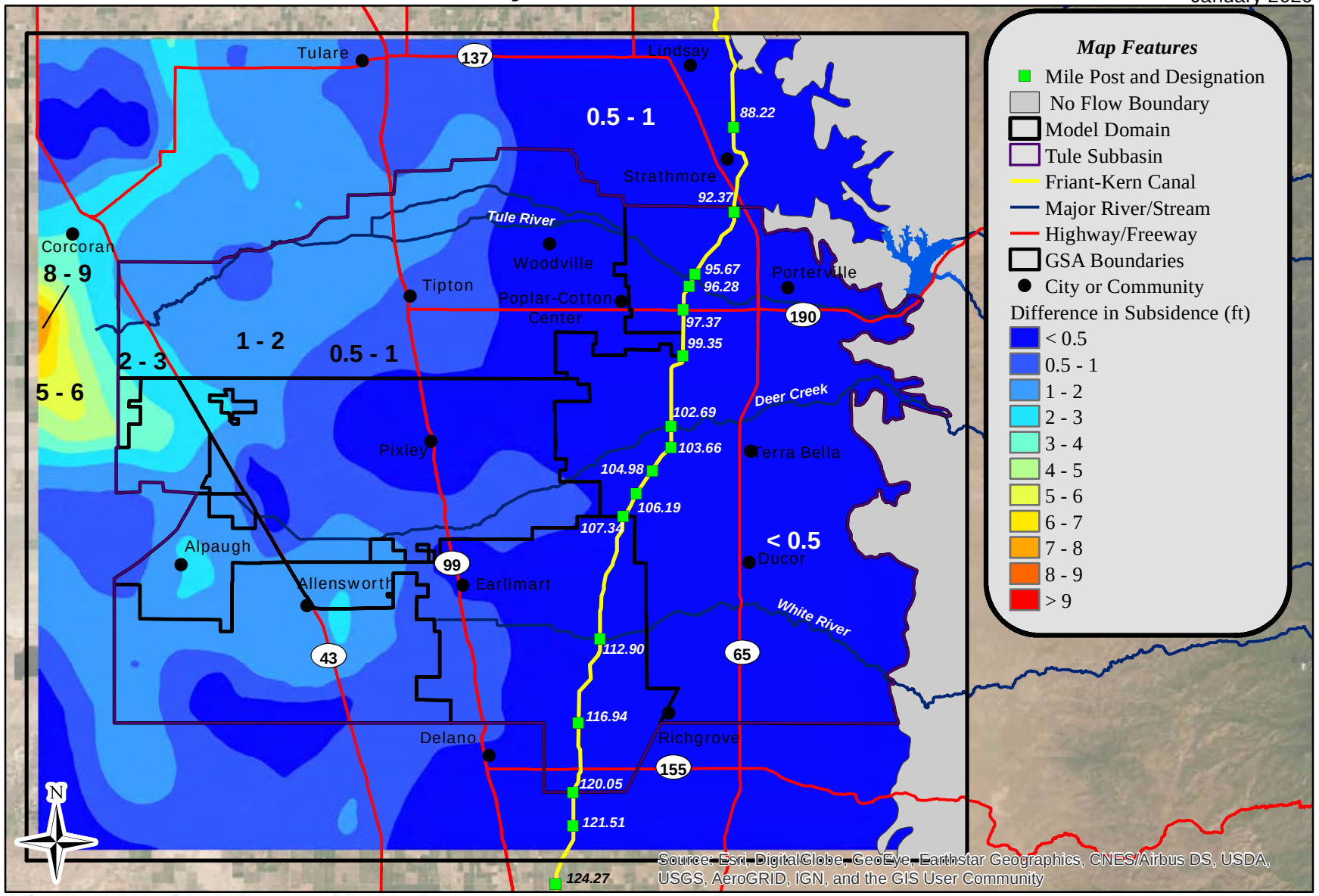
NAD 83 State Plane Zone 4

Cumulative Land Subsidence in the Tule Subbasin from 2040 to 2050

Figure 41

Note: This map shows the difference in subsidence from September 30, 2039 to September 30, 2049.

Tule Subbasin Technical Advisory Committee



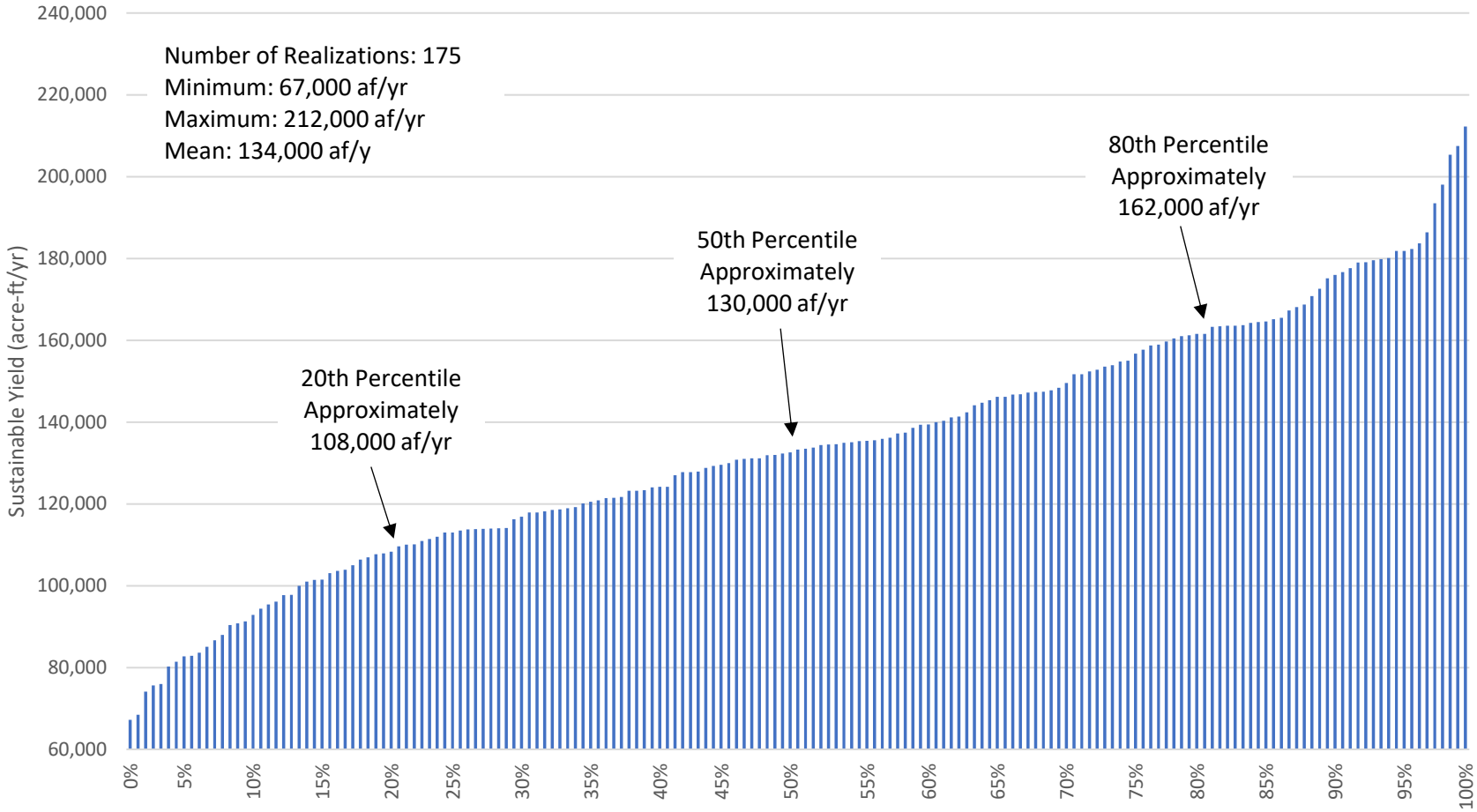
Thomas Harder & Co.
Groundwater Consulting

Cumulative Land Subsidence in the Tule Subbasin from 2050 to 2070

Figure 42

Note: This map shows the difference in subsidence from September 30, 2049 to September 30, 2069.

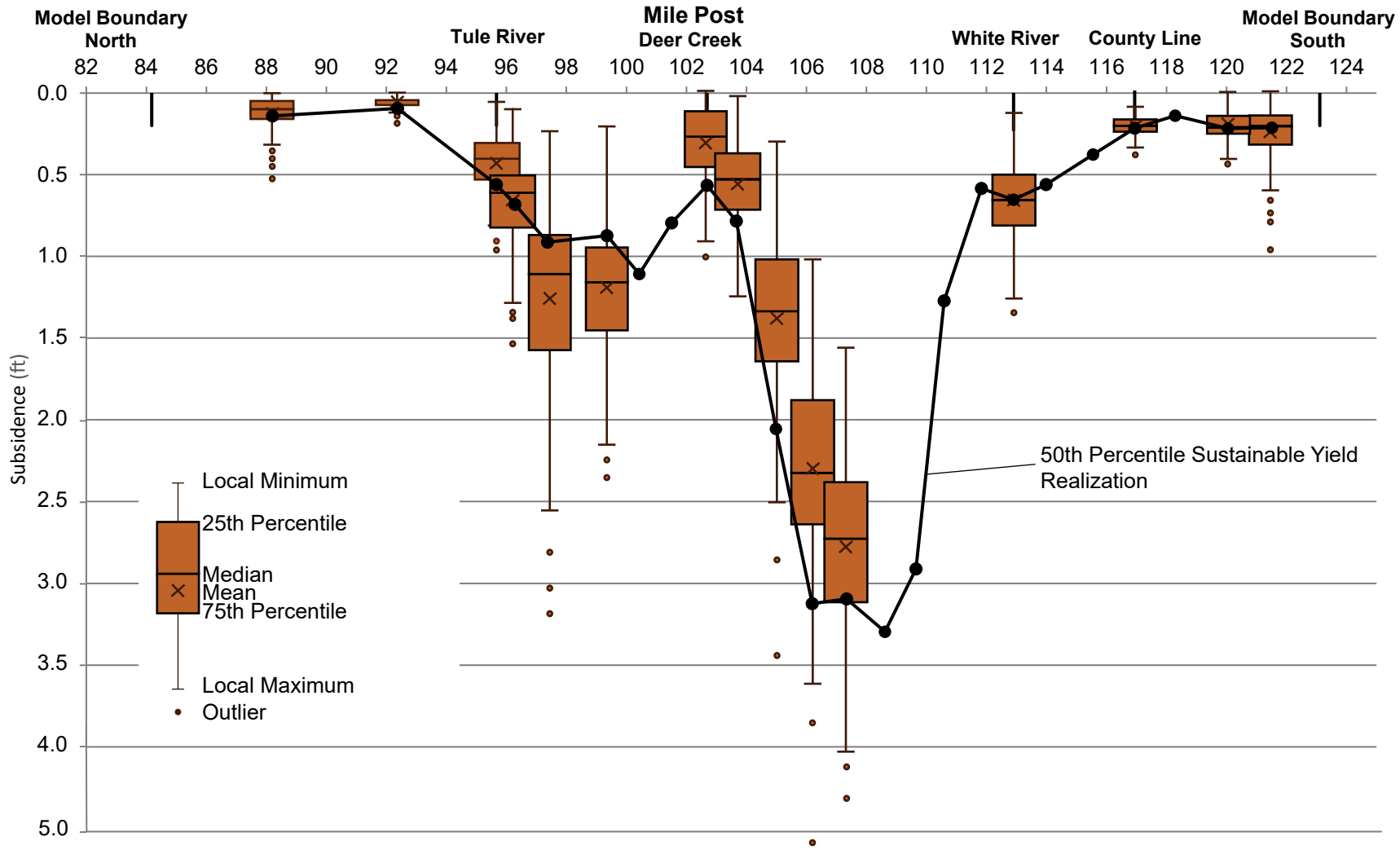
Uncertainty Analysis
2040/41 through 2049/50 Average Sustainable Yield



*Realizations with a storage change of -5,000 af/yr or greater

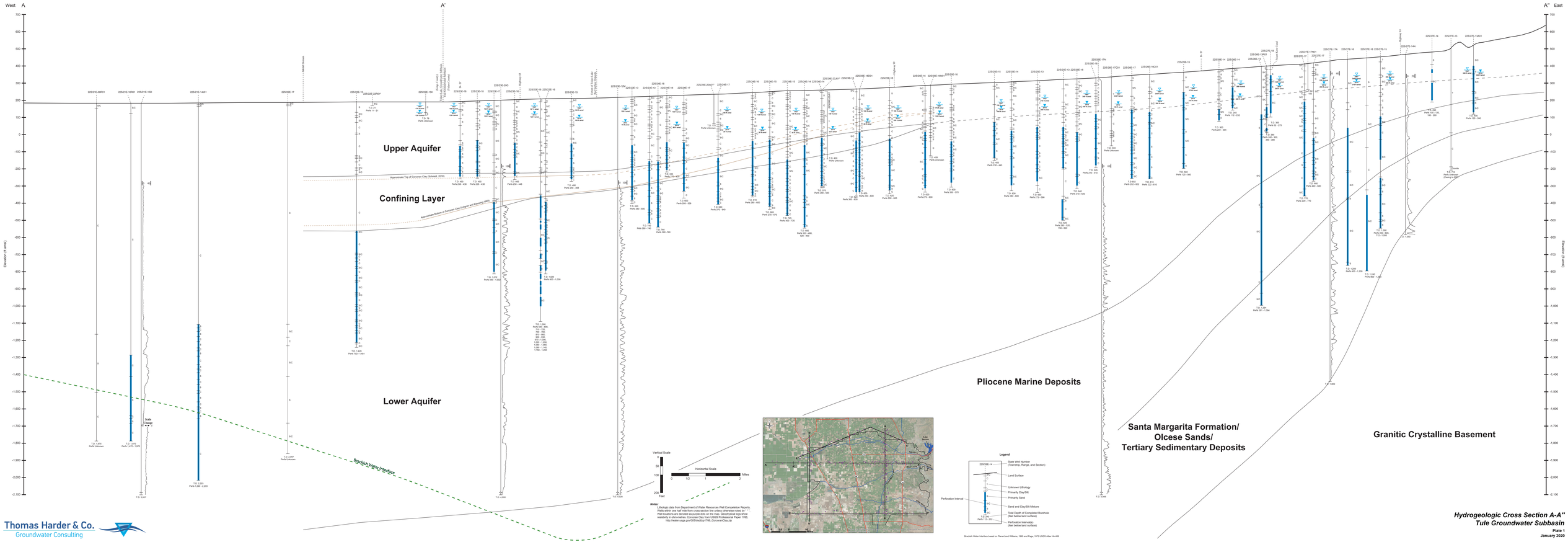
Figure 44

2020 through 2040 Model-Predicted Subsidence



Plates

Tule Subbasin Technical Advisory Commitee
Groundwater Flow Model of the Tule Subbasin



Thomas Harder & Co.
Groundwater Consulting

Hydrogeologic Cross Section A-A"
Tule Groundwater Subbasin
Plate 1
January 2020

North B

B′ South

Elevation (ft amsl)

Avenue 328

Kaweah Groundwater Subbasin / Tule Groundwater Subbasin / Poster Slough

Tule River / Oertle Bridge

Highway 190 / Avenue 144

Deer Creek / Avenue 96

Friant-Kern Canal / Deer Creek & Tule River Crossing

Avenue 56

White River

(Tulare County) Tule Groundwater Subbasin / Kern County Subbasin (Kern County)

A - A′

C - C′

20S/26E-26M1 — 1987 340 ft amsl; 2014 339.5 ft amsl; T.D. 538 Perfs 293 - 533

20S/26E-27 — 1987 340 ft amsl; T.D. 440 Perfs 180 - 410

20S/26E-34 — T.D. 687 Perfs Unknown (Casing to 677)

20S/26E-34L01 — 1987 336 ft amsl; 2014 335.5 ft amsl

21S/26E-02 — 1987 336 ft amsl; 2014 335.5 ft amsl; T.D. 390 Perfs 230 - 310, 350 - 370

21S/26E-03 — 1987 350 ft amsl; 2014 350 ft amsl; T.D. 500 Perfs 132 - 487

21S/26E-10 — 1987 350 ft amsl; 2014 350 ft amsl; T.D. 320 Perfs 100 - 148, 152 - 312

21S/26E-15 — 1987 355 ft amsl; 2014 350 ft amsl; T.D. 448 Perfs 228 - 236, 246 - 270

21S/26E-15F01 — T.D. 150 Open Hole 135 - 150

21S/26E-14P — T.D. 224 Perfs 130 - 224

21S/26E-14N01 — 1987 355 ft amsl; 2014 350 ft amsl; T.D. 174 Perfs 118 - 168

21S/26E-22A01 — 1987 350 ft amsl; 2014 349.5 ft amsl

21S/26E-22R01 — 1987 350 ft amsl; 2014 349.5 ft amsl; T.D. 290 Perfs 204 - 290

21S/26E-27 — T.D. 540 Perfs 120 - 520

21S/26E-26 — 1987 345 ft amsl; 2014 345 ft amsl; T.D. 750 Perfs 126 - 630

Wood Colony Canal

21S/26E-26 — T.D. 538 Perfs 140 - 521

21S/26E-34 — 1987 330 ft amsl; 2014 329.5 ft amsl; T.D. 510 Perfs 300 - 330, 360 - 376, 404 - 414

21S/26E-34 — 1987 330 ft amsl; 2014 329.5 ft amsl; T.D. 400 Perfs 120 - 400

22S/26E-02 — 1987 325 ft amsl; 2014 324.5 ft amsl; T.D. 330 Perfs 210 - 330

22S/26E-03 — 1987 325 ft amsl; 2014 324.5 ft amsl; T.D. 604 Perfs 120 - 604

22S/26E-10J01 — 1987 320 ft amsl; 2014 319.5 ft amsl

22S/26E-11 — T.D. 520 Perfs 240 - 520

22S/26E-15 — 1987 295 ft amsl; 2014 294.5 ft amsl; T.D. 560 Perfs 120 - 560

22S/26E-14L01 — 1987 295 ft amsl; 2014 294.5 ft amsl; T.D. 684 Perfs 192 - 684

22S/26E-23C — T.D. 351 Perfs Unknown

22S/26E-23 — T.D. 600 Perfs 180 - 600

22S/26E-23G01 — T.D. 626 Perfs 204 - 626

22S/26E-27 — 1987 290 ft amsl; 2014 289.5 ft amsl; T.D. 1,100 Perfs Unknown

22S/26E-26F01 — 1987 290 ft amsl; 2014 289.5 ft amsl; T.D. 1,125 Perfs 360 - 1,120

22S/26E-27R01 — T.D. 540 Perfs Unknown

22S/26E-34 — 1987 310 ft amsl; 2014 309.5 ft amsl; T.D. 800 Perfs 280 - 800

22S/26E-35 — 1987 310 ft amsl; 2014 309.5 ft amsl; T.D. 625 Perfs 205 - 622

23S/26E-03 — T.D. 400 Perfs 297 - 357, 377 - 397

23S/26E-03R01 — 1987 295 ft amsl; 2014 294.5 ft amsl

23S/26E-10 — T.D. 804 Perfs 304 - 804

23S/26E-11 — 1987 235 ft amsl; 2014 234.5 ft amsl; T.D. 1,069 Perfs 567 - 1,011

23S/26E-15H01 — 1987 235 ft amsl; 2014 234.5 ft amsl; T.D. 1,008 Perfs 400 - 600

23S/26E-15P01 — 1987 235 ft amsl; 2014 170 ft amsl; T.D. 1,000 Perfs 250 - 1,000

23S/26E-23R01 — 1987 235 ft amsl; 2014 234.5 ft amsl; T.D. 1,720 Perfs 600 - 1,700

23S/26E-27 — T.D. 1,020 Perfs 300 - 990

23S/26E-34 — 1987 235 ft amsl; 2014 160 ft amsl; T.D. 690 Perfs 393 - 681

23S/26E-35H01 — 1987 235 ft amsl; 2014 160 ft amsl; T.D. 1,400 Perfs 375 - 1,400

23S/26E-34Q1 — 1987 235 ft amsl; 2014 160 ft amsl; T.D. 372 Perfs 183 - 372

24S/26E-02 — T.D. 2,905 Perfs 600 - 2,225

24S/26E-02P01 — T.D. 1,125 Perfs Unknown

24S/26E-11D01 — T.D. 861 Perfs Unknown

24S/26E-15 — 1987 275 ft amsl; 2014 170 ft amsl; T.D. 2,020 Perfs 720 - 800, 820 - 2,000

24S/26E-15 — 1987 275 ft amsl; 2014 170 ft amsl; T.D. 1,215 Perfs Unknown (Casing to 1,215)

24S/26E-15 — T.D. 1,248 Perfs 315 - 1,040

24S/26E-22 — 1987 220 ft amsl; 2014 220 ft amsl; T.D. 1,010 Perfs 405 - 1,010

24S/26E-26F01 — T.D. 1,402 Perfs 550 - 1,400

24S/26E-26 — T.D. 1,500 Perfs 600 - 1,500

24S/26E-34 — 1987 220 ft amsl; 2014 220 ft amsl; T.D. 1,000 Perfs 300 - 1,000

24S/26E-35P01 — 1987 220 ft amsl; 2014 170 ft amsl; T.D. 864 Perfs 350 - 852

24S/26E-35H02 — T.D. 1,400 Perfs 600 - 1,400

Upper Aquifer

Lower Aquifer

Pliocene Marine Deposits

Santa Margarita Formation/ Olcese Sands/ Tertiary Sedimentary Deposits

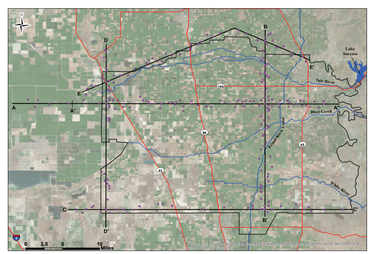
Brackish Water Interface

Vertical Scale: 0, 50, 100, 200 Feet

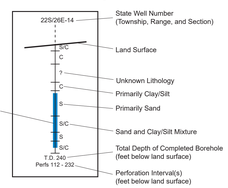
Horizontal Scale: 0, 1/2, 1, 2 Miles

Notes:

Lithologic data from Department of Water Resources Well Completion Reports. Wells within one half mile from cross section line unless otherwise noted by " * ". Well locations are denoted as purple dots on the map. Geophysical logs show resistivity in ohm-metres.



Legend



Brackish Water Interface based on Planert and Williams, 1995 and Page, 1973 USGS Atlas HA-489

Thomas Harder & Co.
Groundwater Consulting

Hydrogeologic Cross Section B-B'
Tule Groundwater Subbasin
Plate 2
January 2020

West C

C′ East

Elevation (ft amsl)

Upper Aquifer

Confining Layer

Lower Aquifer

Pliocene Marine Deposits

Santa Margarita Formation/ Olcese Sands/ Tertiary Sedimentary Deposits

Granitic Crystalline Basement

Brackish Water Interface

Model Domain
245/22E-33
T.D. 1,714
Perfs 241- 1,714

6th Ave
245/22E-34
T.D. 1,200
Perfs 500 - 1,200
245/22E-35E1
T.D. 1,200
Perfs 500 - 1,200

245/22E-35A
245/22E-29N01
T.D. 5,000
Scale Change

County Line
245/23E-31N1
T.D. 1,190
Perfs 490 - 1,190

D-D′
245/23E-32N1
T.D. 1,200
Perfs 500 - 1,200

245/23E-33G01
T.D. 940
Perfs 309 - 900

Road 40
245/23E-33
T.D. 850
Perfs 305 - 805

245/23E-34
T.D. 850
Perfs 347 - 801

245/23E-35L
T.D. 3,400
Scale Change

245/23E-36D
T.D. 6,705
Scale Change

245/24E-32K
T.D. 760
Perfs 301 - 751

245/24E-28L
T.D. 4,007
Scale Change

Highway 43
245/24E-27L01
T.D. 945
Perfs 320 - 925

245/24E-32H01
T.D. 870
Perfs 150 - 850

245/25E-32J01
T.D. 900
Perfs 150 - 850

245/25E-33
T.D. 830
Perfs 200 - 800

Highway 99
245/25E-35D01
T.D. 1,200
Perfs 294 - 1,200

Friant-Kern Canal
245/26E-32Q01
T.D. 870
Perfs 330 - 850

245/26E-33F02
T.D. 1,245
Perfs 324 - 1,195

B-B′
245/26E-34
245/26E-27R01
T.D. 1,095
Perfs 500 - 1,050

245/26E-26
T.D. 1,040
Perfs 340 - 900

245/26E-35H02
T.D. 900
Perfs 390 - 860

Richgrove Drive
245/27E-31
T.D. 850
Perfs 510 - 510
560 - 720
780 - 830

245/27E-32N21
T.D. 1,800
Perfs 1,050 - 1,800

245/27E-28M
T.D. 2,000

Highway 65
245/27E-34
T.D. 1,780
Perfs 600 - 1,750

245/27E-34
245/27E-35
T.D. 1,520
Perfs 500 - 1,448

245/28E-31
Bedrock
T.D. 1,301
Perfs 402 - 1,301

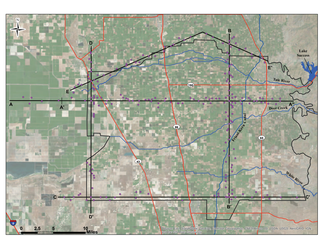
245/28S-32N01
Basin Boundary
Bedrock
T.D. 925
Perfs 605 - 840

Vertical Scale
0
50
100
200
Feet

Horizontal Scale
0 0.5 1 2 Miles

Notes

Lithologic data from Department of Water Resources Well Completion Reports. Wells within one half mile from cross section line unless otherwise noted by ". " Well locations are denoted as purple dots on the map. Geophysical logs show resistivity in ohm-metres.



Legend

225/26E-14
- State Well Number (Township, Range, and Section)
- Land Surface
- Unknown Lithology
- Primarily Clay/Silt
- Primarily Sand
- Sand and Clay/Silt Mixture
- Total Depth of Completed Borehole (feet below land surface)
- Perforation Interval(s) (feet below land surface)

T.D. 240
Perfs 112 - 232

Perforation Interval

Brackish Water Interface based on Planert and Williams, 1995 and Page, 1973 USGS Atlas HA-489

Thomas Harder & Co.
Groundwater Consulting

Hydrogeologic Cross Section C-C′
Tule Groundwater Subbasin
Plate 3
January 2020

Tule Subbasin Technical Advisory Committee
Groundwater Flow Model of the Tule Subbasin

North D

D′ South

Elevation (ft amsl)

Upper Aquifer

Confining Layer

Lower Aquifer

Pliocene Marine Deposits

Brackish Water Interface

Basin Boundary

Tulare Lake Basin Water Storage District, not in Tule Subbasin

Basin Boundary Avenue 54

Tule River

E-E'

Hwy 43

A - A'

C - C'

Tulare - Kern County Line Basin Boundary

Garces Highway

21S/23E-6P1 Avenue 192 — T.D. 310 Perfs 217- 467; T.D. 1,350 Perfs 515 - 1,000

21S/23E-7 — T.D. 1,020 Perfs 415 - 980

21S/23E-18 Avenue 176 — T.D. 640 Perfs 280 - 640

21S/23E-19 — T.D. 430 Perfs 210 - 420

21S/23E-19 — T.D. 430 Perfs 210 - 420

21S/23E-30 — T.D. 1,020 Perfs 415 - 980

21S/23E-31 — T.D. 680 Perfs 300 - 660

T.D. 450 Perfs 258 - 438

T.D. 470 Perfs 238 - 448

22S/23E-06 — T.D. 480 Perfs 258 - 468

22S/23E-06 — T.D. 455 Perfs 210 - 420

22S/23E-07 — T.D. 470 Perfs 260 - 460

22S/23E-07 — T.D. 1,020 Perfs 660 - 1,000

22S/23E-07 — T.D. 470 Perfs 260 - 460

22S/23E-18 — T.D. 456 Perfs 0 - 200

T.D. 470 Perfs 248 - 458

22S/23E-30J01 — T.D. 460 Perfs 240 - 450

22S/23E-30 — T.D. 460 Perfs 210 - 450

24S/23E-6D — T.D. 3,400

24S/23E-6G — T.D. 3,398

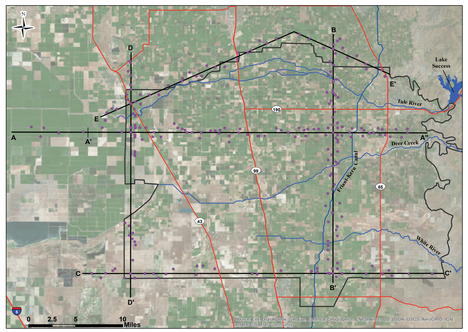
24S/23E-7R — T.D. 3,320

24S/23E-17E — T.D. 2,475

24S/23E-30A — T.D. 3,393

24S/23E-32N1 — T.D. 1,200 Perfs 500 - 1,200

Scale Change



Legend

- State Well Number (Township, Range, and Section) — 22S/26E-14
- Land Surface
- Unknown Lithology — ?
- Primarily Clay/Silt — C
- Primarily Sand — S
- Sand and Clay/Silt Mixture — S/C
- Total Depth of Completed Borehole (feet below land surface) — T.D. 240
- Perforation Interval(s) (feet below land surface) — Perfs 112 - 232
- Perforation Interval

Vertical Scale: 0, 50, 100, 200 Feet

Horizontal Scale: 0, 1/2, 1, 2 Miles

Notes:

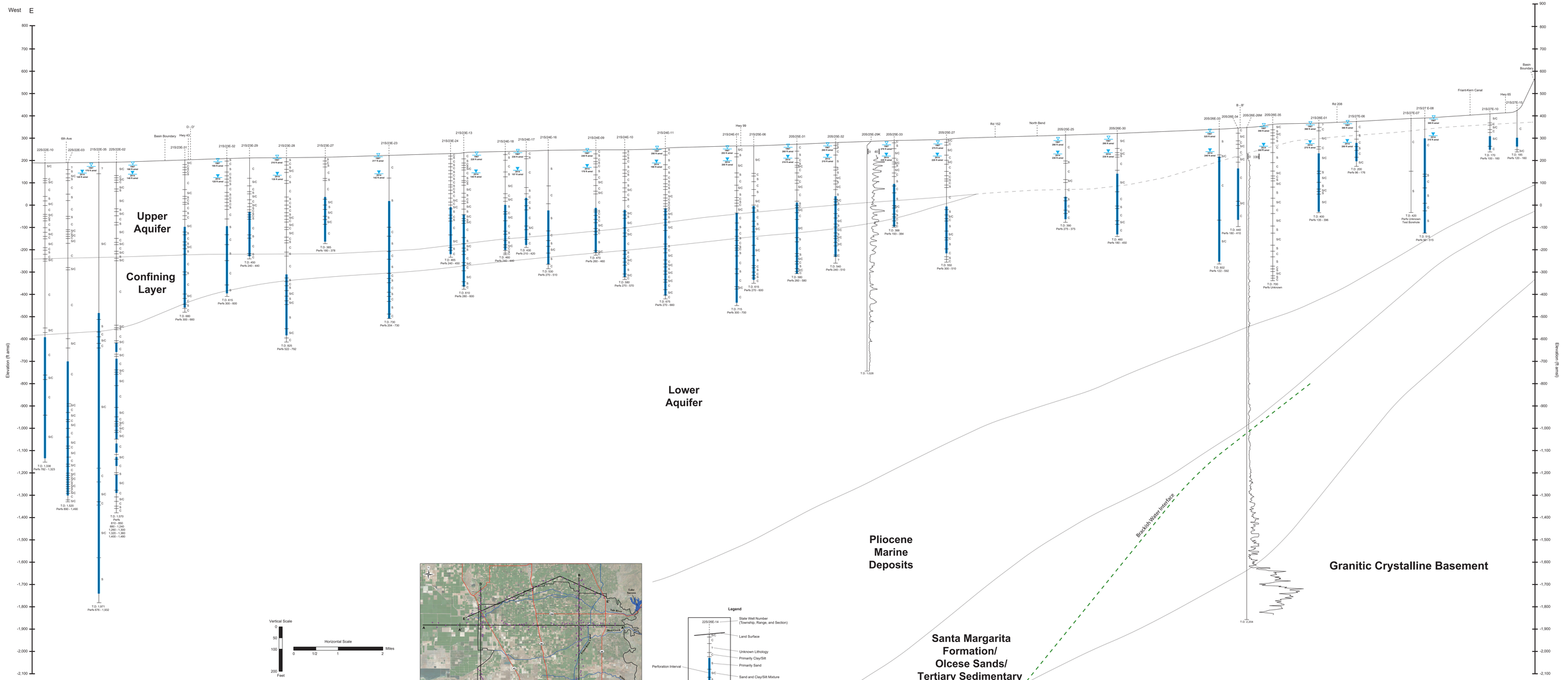
Lithologic data from Department of Water Resources Well Compeletion Reports. Wells within one half mile from cross section line unless otherwise noted by " * ". Well locations are denoted as purple dots on the map. Geophysical logs show resistivity in ohm-metres.

Brackish Water Interface based on Planert and Williams, 1995 and Page, 1973 USGS Atlas HA-489

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Thomas Harder & Co.
Groundwater Consulting

Hydrogeologic Cross Section D-D'
Tule Groundwater Basin
Plate 4
January 2020



Notes:

Lithologic data from Department of Water Resources Well Completion Reports. Wells within one half mile from cross section line unless otherwise noted by " * ". Well locations are denoted as purple dots on the map. Geophysical logs show resistivity in ohm-metres.

Thomas Harder & Co.
Groundwater Consulting

Hydrogeologic Cross Section E-E'
Tule Groundwater Basin
Plate 5
January 2020

Appendix A

Historical Agricultural Water Demand

Historical Agricultural Water Demand

Water Year	Total Applied Water	Total Cons. Use	Total Return Flow	Tule River			Deer Creek			Recycled Water			Imported Water			Groundwater Production		
				Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow
Subbasin-Wide																		
1986 - 1987	1,018,097	778,340	239,757	33,127	24,656	8,471	0	0	0	890	736	153	246,037	187,944	58,093	738,044	565,004	173,040
1987 - 1988	1,027,472	785,581	241,891	19,304	13,820	5,483	0	0	0	1,086	899	187	221,803	172,730	49,073	785,280	598,132	187,148
1988 - 1989	1,011,102	776,018	235,084	23,722	17,645	6,077	0	0	0	1,151	953	199	243,085	189,687	53,398	743,144	567,733	175,411
1989 - 1990	1,044,445	800,661	243,784	11,540	8,848	2,693	0	0	0	1,212	1,003	209	176,821	139,541	37,280	854,872	651,270	203,602
1990 - 1991	1,064,120	815,799	248,321	22,633	16,751	5,883	0	0	0	1,255	1,039	217	221,141	173,947	47,194	819,090	624,062	195,028
1991 - 1992	1,059,346	811,169	248,177	14,304	10,779	3,525	0	0	0	1,278	1,058	220	207,636	162,524	45,111	836,129	636,809	199,320
1992 - 1993	1,045,823	794,391	251,432	51,680	34,854	16,826	0	0	0	1,301	1,076	224	469,840	353,131	116,709	523,002	405,329	117,673
1993 - 1994	1,062,526	809,579	252,948	29,745	21,058	8,687	0	0	0	1,340	1,109	231	220,434	168,326	52,109	811,007	619,086	191,921
1994 - 1995	1,080,491	819,827	260,664	106,204	71,560	34,645	3,913	2,916	997	1,318	1,090	227	377,649	287,784	89,865	591,406	456,476	134,931
1995 - 1996	1,099,824	822,408	277,416	94,398	62,565	31,833	4,821	3,593	1,228	1,333	1,103	230	455,430	335,329	120,102	543,842	419,818	124,024
1996 - 1997	1,117,097	826,763	290,334	88,519	57,140	31,379	2,705	2,015	689	1,443	1,194	249	427,903	307,345	120,558	596,528	459,069	137,458
1997 - 1998	1,092,540	829,188	263,352	139,075	97,986	41,089	12,216	9,103	3,113	1,328	1,099	229	275,664	208,571	67,092	664,258	512,429	151,829
1998 - 1999	1,086,161	829,735	256,426	51,812	37,735	14,078	1,312	978	334	1,317	1,090	227	379,051	287,867	91,184	652,669	502,066	150,603
1999 - 2000	1,130,153	858,817	271,337	54,404	39,179	15,225	1,242	926	317	1,423	1,178	245	388,176	292,903	95,273	684,908	524,632	160,276
2000 - 2001	1,058,511	809,159	249,351	29,751	21,906	7,845	0	0	0	1,436	1,189	248	270,555	207,885	62,670	756,768	578,180	178,588
2001 - 2002	1,066,679	813,196	253,483	31,648	22,620	9,028	0	0	0	1,662	1,376	287	281,296	215,391	65,906	752,072	573,810	178,263
2002 - 2003	1,019,118	811,407	207,711	48,979	37,469	11,510	853	661	192	1,602	1,368	234	322,881	256,081	66,800	644,803	515,828	128,975
2003 - 2004	990,274	786,798	203,476	24,403	18,219	6,184	0	0	0	1,733	1,484	248	280,633	221,818	58,815	683,505	545,277	138,228
2004 - 2005	987,899	782,896	205,003	59,084	43,818	15,267	3,160	2,456	704	3,833	3,283	549	410,818	320,240	90,578	511,004	413,098	97,905
2005 - 2006	1,012,782	790,782	222,000	88,078	58,788	29,290	1,703	1,324	379	4,662	3,994	668	395,790	305,223	90,567	522,550	421,453	101,097
2006 - 2007	979,863	779,218	200,645	19,000	14,161	4,839	0	0	0	5,172	4,431	741	184,617	145,921	38,696	771,073	614,705	156,369
2007 - 2008	954,599	764,231	190,368	32,077	24,291	7,786	0	0	0	5,257	4,504	753	251,105	204,677	46,428	666,160	530,759	135,401
2008 - 2009	1,015,720	808,551	207,169	29,902	22,297	7,605	0	0	0	4,905	4,202	703	288,687	231,658	57,029	692,227	550,394	141,832
2009 - 2010	935,584	738,010	197,575	64,651	45,449	19,202	0	0	0	4,522	3,874	648	354,234	276,026	78,208	512,178	412,661	99,517
2010 - 2011	1,050,655	820,262	230,394	95,593	65,342	30,251	6,074	4,721	1,353	4,444	3,807	637	377,299	292,285	85,014	567,247	455,448	111,799
2011 - 2012	1,060,462	839,253	221,209	45,741	33,806	11,934	0	0	0	4,761	4,079	682	231,285	183,556	47,729	778,675	617,739	160,937
2012 - 2013	1,044,061	826,740	217,321	13,733	10,283	3,450	0	0	0	4,917	4,212	704	183,590	147,772	35,818	841,821	664,446	177,375
2013 - 2014	1,028,437	818,430	210,007	3,460	2,436	1,024	0	0	0	4,413	3,780	632	69,509	55,728	13,780	951,056	756,356	194,699
2014 - 2015	987,336	789,506	197,829	3,369	2,284	1,085	0	0	0	3,199	2,741	458	39,068	33,197	5,871	941,700	751,351	190,349
2015 - 2016	897,018	719,836	177,183	25,320	19,389	5,932	0	0	0	3,122	2,675	447	203,620	168,051	35,568	664,956	529,993	134,964
2016 - 2017	1,021,271	782,591	238,681	108,479	67,103	41,376	6,206	4,823	1,382	3,258	2,791	467	432,856	330,160	102,696	470,473	379,639	90,834

Historical Agricultural Water Demand

Water Year	Total Applied Water	Total Cons. Use	Total Return Flow	Tule River			Deer Creek			Recycled Water			Imported Water			Groundwater Production		
				Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow
Eastern Tule GSA																		
1986 - 1987	291,005	238,223	52,783	14,521	11,278	3,243	N/A	N/A	N/A	890	736	153	68,741	55,325	13,416	206,853	170,882	35,971
1987 - 1988	294,550	238,223	56,328	14,307	10,228	4,079	N/A	N/A	N/A	1,086	899	187	72,397	57,406	14,991	206,760	169,690	37,071
1988 - 1989	291,431	238,223	53,208	8,212	6,494	1,718	N/A	N/A	N/A	1,151	953	199	76,310	62,038	14,272	205,757	168,738	37,019
1989 - 1990	291,559	238,223	53,336	7,357	5,840	1,517	N/A	N/A	N/A	1,212	1,003	209	68,409	55,915	12,494	214,581	175,465	39,116
1990 - 1991	291,678	238,223	53,455	6,989	5,503	1,486	N/A	N/A	N/A	1,255	1,039	217	65,293	52,784	12,509	218,140	178,897	39,243
1991 - 1992	291,452	238,223	53,230	7,512	5,895	1,617	N/A	N/A	N/A	1,278	1,058	220	75,955	61,625	14,330	206,707	169,644	37,062
1992 - 1993	297,965	238,223	59,742	24,889	15,959	8,930	N/A	N/A	N/A	1,301	1,076	224	91,076	71,113	19,963	180,699	150,074	30,625
1993 - 1994	295,122	238,288	56,834	12,896	8,944	3,952	N/A	N/A	N/A	1,340	1,109	231	74,480	58,768	15,712	206,406	169,468	36,938
1994 - 1995	301,654	238,295	63,359	38,482	23,088	15,394	N/A	N/A	N/A	1,318	1,090	227	81,361	63,793	17,568	180,493	150,324	30,170
1995 - 1996	310,673	240,306	70,367	38,647	22,589	16,058	N/A	N/A	N/A	1,333	1,103	230	107,757	80,692	27,065	162,936	135,922	27,014
1996 - 1997	307,526	240,104	67,421	36,193	21,519	14,674	N/A	N/A	N/A	1,443	1,194	249	97,479	74,189	23,290	172,411	143,203	29,208
1997 - 1998	299,742	240,104	59,638	35,602	23,590	12,012	N/A	N/A	N/A	1,328	1,099	229	68,203	53,764	14,439	194,609	161,652	32,958
1998 - 1999	295,674	240,104	55,570	14,510	10,914	3,596	N/A	N/A	N/A	1,317	1,090	227	94,481	74,773	19,708	185,366	153,327	32,039
1999 - 2000	297,531	240,104	57,427	11,707	8,480	3,227	N/A	N/A	N/A	1,423	1,178	245	98,146	76,665	21,481	186,255	153,782	32,473
2000 - 2001	295,065	240,104	54,960	9,431	7,296	2,135	N/A	N/A	N/A	1,436	1,189	248	83,888	67,147	16,741	200,309	164,472	35,837
2001 - 2002	297,510	240,104	57,406	12,901	9,141	3,760	N/A	N/A	N/A	1,662	1,376	287	81,469	64,126	17,343	201,478	165,462	36,016
2002 - 2003	287,896	240,104	47,791	8,728	6,937	1,791	N/A	N/A	N/A	1,602	1,368	234	87,129	71,358	15,771	190,437	160,442	29,994
2003 - 2004	285,462	238,183	47,280	8,496	6,101	2,395	N/A	N/A	N/A	1,733	1,484	248	84,706	70,150	14,557	190,527	160,448	30,079
2004 - 2005	287,591	238,096	49,496	19,761	13,861	5,900	N/A	N/A	N/A	3,833	3,283	549	91,566	74,679	16,887	172,432	146,272	26,160
2005 - 2006	299,473	238,096	61,377	34,315	18,864	15,451	N/A	N/A	N/A	4,662	3,994	668	101,063	80,013	21,050	159,432	135,225	24,208
2006 - 2007	285,360	238,096	47,265	5,612	3,962	1,650	N/A	N/A	N/A	5,172	4,431	741	67,474	55,917	11,557	207,102	173,786	33,317
2007 - 2008	285,203	238,096	47,107	8,094	6,021	2,073	N/A	N/A	N/A	5,257	4,504	753	79,846	66,040	13,806	192,006	161,531	30,475
2008 - 2009	286,397	238,096	48,301	9,449	6,716	2,733	N/A	N/A	N/A	4,905	4,202	703	90,672	74,176	16,496	181,371	153,002	28,369
2009 - 2010	291,167	238,096	53,072	27,070	18,075	8,995	N/A	N/A	N/A	4,522	3,874	648	94,636	76,085	18,551	164,940	140,063	24,877
2010 - 2011	283,939	226,060	57,879	33,500	18,781	14,719	N/A	N/A	N/A	4,444	3,807	637	92,011	73,468	18,543	153,984	130,587	23,397
2011 - 2012	273,439	227,565	45,874	6,504	4,685	1,819	N/A	N/A	N/A	4,761	4,079	682	67,253	55,676	11,577	194,921	163,375	31,547
2012 - 2013	271,820	226,748	45,072	3,769	2,693	1,076	N/A	N/A	N/A	4,917	4,212	704	64,337	53,438	10,899	198,797	166,501	32,296
2013 - 2014	270,163	225,475	44,688	3,460	2,436	1,024	N/A	N/A	N/A	4,413	3,780	632	29,308	24,235	5,073	232,982	195,089	37,893
2014 - 2015	268,488	224,823	43,665	3,369	2,284	1,085	N/A	N/A	N/A	3,199	2,741	458	19,327	16,691	2,636	242,593	203,174	39,420
2015 - 2016	268,848	225,116	43,733	7,646	5,925	1,721	N/A	N/A	N/A	3,122	2,675	447	64,109	53,549	10,560	193,971	163,239	30,732
2016 - 2017	304,194	225,606	78,588	47,593	20,721	26,872	N/A	N/A	N/A	3,258	2,791	467	109,774	80,486	29,288	143,569	122,208	21,361

Historical Agricultural Water Demand

Water Year	Total Applied Water	Total Cons. Use	Total Return Flow	Tule River			Deer Creek			Recycled Water			Imported Water			Groundwater Production		
				Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow
Lower Tule River Irrigation District GSA																		
1986 - 1987	293,688	211,275	82,412	18,606	13,378	5,228	N/A	N/A	N/A	N/A	N/A	N/A	45,292	32,565	12,727	229,790	165,333	64,457
1987 - 1988	303,758	218,516	85,242	4,997	3,593	1,404	N/A	N/A	N/A	N/A	N/A	N/A	32,000	23,008	8,992	266,761	191,915	74,846
1988 - 1989	290,458	208,953	81,505	15,510	11,152	4,358	N/A	N/A	N/A	N/A	N/A	N/A	45,116	32,438	12,678	229,832	165,364	64,469
1989 - 1990	303,361	218,230	85,131	4,183	3,008	1,176	N/A	N/A	N/A	N/A	N/A	N/A	16,882	12,138	4,744	282,295	203,084	79,211
1990 - 1991	322,208	231,781	90,427	15,644	11,248	4,396	N/A	N/A	N/A	N/A	N/A	N/A	47,120	33,879	13,241	259,444	186,654	72,790
1991 - 1992	325,848	234,398	91,450	6,792	4,883	1,908	N/A	N/A	N/A	N/A	N/A	N/A	35,891	25,806	10,086	283,165	203,709	79,455
1992 - 1993	308,296	218,931	89,365	26,791	18,895	7,896	N/A	N/A	N/A	N/A	N/A	N/A	180,980	127,643	53,337	100,525	72,392	28,133
1993 - 1994	313,293	225,371	87,922	16,849	12,114	4,735	N/A	N/A	N/A	N/A	N/A	N/A	43,999	31,635	12,364	252,445	181,622	70,823
1994 - 1995	323,341	231,983	91,358	67,722	48,472	19,250	N/A	N/A	N/A	N/A	N/A	N/A	120,864	86,508	34,356	134,755	97,004	37,752
1995 - 1996	300,478	215,761	84,718	55,751	39,977	15,774	N/A	N/A	N/A	N/A	N/A	N/A	133,347	95,617	37,730	111,381	80,167	31,213
1996 - 1997	307,680	214,148	93,532	52,326	35,621	16,705	N/A	N/A	N/A	N/A	N/A	N/A	134,710	91,703	43,007	120,644	86,825	33,820
1997 - 1998	294,068	211,515	82,553	103,473	74,396	29,076	N/A	N/A	N/A	N/A	N/A	N/A	51,185	36,802	14,383	139,410	100,317	39,093
1998 - 1999	291,448	209,632	81,817	37,302	26,820	10,482	N/A	N/A	N/A	N/A	N/A	N/A	122,489	88,069	34,420	131,657	94,743	36,914
1999 - 2000	322,165	231,717	90,448	42,697	30,699	11,998	N/A	N/A	N/A	N/A	N/A	N/A	117,256	84,306	32,950	162,212	116,711	45,500
2000 - 2001	276,273	198,721	77,552	20,320	14,610	5,710	N/A	N/A	N/A	N/A	N/A	N/A	55,432	39,855	15,577	200,521	144,256	56,266
2001 - 2002	287,661	206,908	80,752	18,747	13,479	5,268	N/A	N/A	N/A	N/A	N/A	N/A	57,673	41,467	16,206	211,241	151,963	59,278
2002 - 2003	272,579	206,819	65,760	40,251	30,532	9,718	N/A	N/A	N/A	N/A	N/A	N/A	85,429	64,803	20,627	146,899	111,484	35,415
2003 - 2004	276,611	210,749	65,862	15,907	12,118	3,789	N/A	N/A	N/A	N/A	N/A	N/A	54,868	41,798	13,070	205,836	156,833	49,003
2004 - 2005	276,208	210,440	65,768	39,323	29,956	9,367	N/A	N/A	N/A	N/A	N/A	N/A	138,498	105,507	32,991	98,387	74,977	23,410
2005 - 2006	263,486	197,520	65,966	53,763	39,925	13,838	N/A	N/A	N/A	N/A	N/A	N/A	114,482	85,015	29,467	95,241	72,580	22,661
2006 - 2007	267,230	203,600	63,630	13,388	10,199	3,189	N/A	N/A	N/A	N/A	N/A	N/A	20,443	15,573	4,870	233,399	177,828	55,571
2007 - 2008	261,534	199,261	62,273	23,983	18,270	5,713	N/A	N/A	N/A	N/A	N/A	N/A	53,024	40,393	12,631	184,527	140,598	43,929
2008 - 2009	295,571	225,190	70,381	20,453	15,581	4,872	N/A	N/A	N/A	N/A	N/A	N/A	73,446	55,951	17,495	201,672	153,659	48,013
2009 - 2010	236,426	174,762	61,664	37,581	27,374	10,207	N/A	N/A	N/A	N/A	N/A	N/A	123,325	89,831	33,494	75,520	57,557	17,963
2010 - 2011	302,825	228,543	74,282	62,093	46,561	15,532	N/A	N/A	N/A	N/A	N/A	N/A	121,727	91,278	30,449	119,005	90,703	28,302
2011 - 2012	312,980	236,874	76,106	39,237	29,121	10,115	N/A	N/A	N/A	N/A	N/A	N/A	42,291	31,389	10,903	231,452	176,364	55,088
2012 - 2013	294,561	224,440	70,121	9,964	7,590	2,373	N/A	N/A	N/A	N/A	N/A	N/A	25,716	19,590	6,126	258,881	197,260	61,621
2013 - 2014	283,682	216,153	67,529	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	283,682	216,153	67,529
2014 - 2015	246,677	187,963	58,714	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	246,677	187,963	58,714
2015 - 2016	219,092	166,949	52,143	17,674	13,464	4,210	N/A	N/A	N/A	N/A	N/A	N/A	46,013	35,052	10,961	155,405	118,433	36,973
2016 - 2017	272,226	206,838	65,388	60,886	46,382	14,503	N/A	N/A	N/A	N/A	N/A	N/A	126,021	95,606	30,415	85,319	65,041	20,278

Historical Agricultural Water Demand

Water Year	Total Applied Water	Total Cons. Use	Total Return Flow	Tule River			Deer Creek			Recycled Water			Imported Water			Groundwater Production		
				Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow
Pixley Irrigation District GSA																		
1986 - 1987	153,767	114,587	39,180	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	1,151	858	293	152,616	113,729	38,887
1987 - 1988	153,767	114,587	39,180	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	0	0	0	153,767	114,587	39,180
1988 - 1989	153,767	114,587	39,180	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	3,627	2,702	924	150,141	111,884	38,256
1989 - 1990	174,387	129,953	44,434	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	0	0	0	174,387	129,953	44,434
1990 - 1991	176,516	131,539	44,977	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	0	0	0	176,516	131,539	44,977
1991 - 1992	166,792	124,293	42,499	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	0	0	0	166,792	124,293	42,499
1992 - 1993	165,032	122,982	42,051	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	53,530	39,890	13,639	111,503	83,091	28,411
1993 - 1994	177,163	132,021	45,141	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	0	0	0	177,163	132,021	45,141
1994 - 1995	182,108	135,706	46,401	N/A	N/A	N/A	3,913	2,916	997	N/A	N/A	N/A	29,783	22,194	7,589	148,411	110,596	37,816
1995 - 1996	163,604	121,918	41,687	N/A	N/A	N/A	4,821	3,593	1,228	N/A	N/A	N/A	38,375	28,597	9,778	120,408	89,728	30,680
1996 - 1997	168,324	125,435	42,889	N/A	N/A	N/A	2,705	2,015	689	N/A	N/A	N/A	22,254	16,584	5,670	143,365	106,835	36,530
1997 - 1998	175,112	130,493	44,619	N/A	N/A	N/A	12,216	9,103	3,113	N/A	N/A	N/A	24,467	18,233	6,234	138,430	103,157	35,272
1998 - 1999	178,373	132,923	45,450	N/A	N/A	N/A	1,312	978	334	N/A	N/A	N/A	21,160	15,769	5,392	155,900	116,176	39,724
1999 - 2000	187,825	139,967	47,858	N/A	N/A	N/A	1,242	926	317	N/A	N/A	N/A	26,366	19,648	6,718	160,217	119,394	40,824
2000 - 2001	165,472	123,309	42,163	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	6,410	4,777	1,633	159,062	118,532	40,529
2001 - 2002	159,902	119,159	40,743	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	9,550	7,117	2,433	150,352	112,042	38,310
2002 - 2003	151,591	117,459	34,132	N/A	N/A	N/A	853	661	192	N/A	N/A	N/A	19,578	15,170	4,408	131,160	101,628	29,532
2003 - 2004	143,885	111,838	32,047	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	6,828	5,307	1,521	137,057	106,531	30,526
2004 - 2005	143,267	111,358	31,909	N/A	N/A	N/A	3,160	2,456	704	N/A	N/A	N/A	35,846	27,862	7,984	104,261	81,039	23,222
2005 - 2006	170,036	132,164	37,871	N/A	N/A	N/A	1,703	1,324	379	N/A	N/A	N/A	36,731	28,550	8,181	131,602	102,291	29,311
2006 - 2007	147,335	114,519	32,815	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	4,449	3,458	991	142,886	111,061	31,824
2007 - 2008	133,635	103,871	29,764	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	7,434	5,778	1,656	126,201	98,093	28,108
2008 - 2009	157,297	122,263	35,034	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	14,865	11,554	3,311	142,432	110,709	31,723
2009 - 2010	131,420	102,149	29,271	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	16,593	12,897	3,696	114,827	89,252	25,575
2010 - 2011	169,047	131,396	37,651	N/A	N/A	N/A	6,074	4,721	1,353	N/A	N/A	N/A	31,321	24,345	6,976	131,652	102,330	29,322
2011 - 2012	181,603	141,156	40,448	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	2,291	1,781	510	179,312	139,375	39,937
2012 - 2013	182,553	141,894	40,659	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	3,251	2,527	724	179,302	139,367	39,935
2013 - 2014	184,161	143,144	41,017	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	0	0	0	184,161	143,144	41,017
2014 - 2015	184,057	143,063	40,994	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	0	0	0	184,057	143,063	40,994
2015 - 2016	121,082	94,114	26,968	N/A	N/A	N/A	0	0	0	N/A	N/A	N/A	2,164	1,682	482	118,918	92,432	26,486
2016 - 2017	149,868	116,489	33,379	N/A	N/A	N/A	6,206	4,823	1,382	N/A	N/A	N/A	51,171	39,774	11,397	92,492	71,891	20,600

Historical Agricultural Water Demand

Water Year	Total Applied Water	Total Cons. Use	Total Return Flow	Tule River			Deer Creek			Recycled Water			Imported Water			Groundwater Production		
				Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow
Delano-Earlimart Irrigation District GSA																		
1986 - 1987	165,921	128,557	37,363	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	114,782	87,645	27,138	51,138	40,912	10,226
1987 - 1988	162,123	128,557	33,566	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	110,345	87,125	23,221	51,778	41,432	10,345
1988 - 1989	162,104	128,557	33,547	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	105,980	83,591	22,390	56,124	44,966	11,157
1989 - 1990	161,755	128,557	33,198	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	83,837	65,868	17,969	77,918	62,689	15,229
1990 - 1991	160,014	128,557	31,457	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	106,877	86,019	20,858	53,137	42,538	10,599
1991 - 1992	162,084	128,557	33,527	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	92,567	72,699	19,868	69,517	55,858	13,659
1992 - 1993	160,750	128,557	32,193	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	127,775	102,414	25,360	32,976	26,143	6,833
1993 - 1994	163,728	128,160	35,568	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	91,696	70,257	21,439	72,032	57,903	14,129
1994 - 1995	159,899	128,101	31,798	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	119,936	96,276	23,659	39,963	31,825	8,138
1995 - 1996	177,394	132,583	44,811	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	142,817	105,755	37,061	34,577	26,827	7,749
1996 - 1997	182,282	132,512	49,770	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	148,693	106,548	42,145	33,589	25,964	7,625
1997 - 1998	172,420	132,512	39,907	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	116,888	88,704	28,184	55,532	43,808	11,724
1998 - 1999	169,495	132,512	36,983	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	121,365	94,723	26,642	48,130	37,789	10,341
1999 - 2000	171,523	132,512	39,011	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	129,847	99,972	29,875	41,676	32,541	9,135
2000 - 2001	170,597	132,512	38,085	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	117,178	90,422	26,756	53,419	42,090	11,329
2001 - 2002	170,441	132,512	37,929	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	126,740	98,325	28,415	43,702	34,188	9,514
2002 - 2003	163,870	132,512	31,357	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	121,277	97,456	23,820	42,593	35,056	7,537
2003 - 2004	162,319	128,366	33,953	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	127,364	99,687	27,677	34,955	28,679	6,276
2004 - 2005	158,692	128,185	30,506	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	119,767	96,113	23,654	38,925	32,072	6,852
2005 - 2006	158,146	128,185	29,961	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	119,850	96,651	23,200	38,296	31,535	6,761
2006 - 2007	156,416	128,185	28,231	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	78,970	63,155	15,815	77,446	65,030	12,416
2007 - 2008	152,562	128,185	24,376	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	106,470	89,981	16,489	46,092	38,205	7,887
2008 - 2009	155,593	128,185	27,408	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	109,078	89,619	19,459	46,515	38,567	7,948
2009 - 2010	155,866	128,185	27,681	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	112,888	92,645	20,243	42,978	35,540	7,438
2010 - 2011	153,971	124,818	29,153	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	118,032	95,977	22,055	35,939	29,599	6,341
2011 - 2012	152,311	124,812	27,499	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	113,031	92,032	20,998	39,281	32,458	6,823
2012 - 2013	151,444	124,812	26,632	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	87,302	70,960	16,342	64,143	53,729	10,414
2013 - 2014	148,827	124,812	24,015	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38,106	31,039	7,067	110,722	93,580	17,142
2014 - 2015	147,227	124,812	22,414	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18,591	15,905	2,685	128,636	108,907	19,729
2015 - 2016	147,227	124,812	22,414	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	90,160	77,138	13,023	57,066	47,675	9,392
2016 - 2017	155,082	124,812	30,270	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	121,326	98,215	23,111	33,756	27,731	6,025

Historical Agricultural Water Demand

Water Year	Total Applied Water	Total Cons. Use	Total Return Flow	Tule River			Deer Creek			Recycled Water			Imported Water			Groundwater Production		
				Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow
Tri-County Water Authority GSA																		
1986 - 1987	56,858	42,849	14,009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8,035	5,776	2,260	48,823	37,074	11,750
1987 - 1988	56,637	42,849	13,788	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,530	2,596	935	53,107	40,254	12,853
1988 - 1989	56,671	42,849	13,822	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6,026	4,459	1,567	50,645	38,390	12,255
1989 - 1990	56,692	42,849	13,843	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,847	2,810	1,037	52,845	40,039	12,806
1990 - 1991	56,852	42,849	14,003	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	925	632	293	55,926	42,217	13,710
1991 - 1992	56,585	42,849	13,736	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,611	1,197	414	54,974	41,652	13,322
1992 - 1993	56,890	42,849	14,041	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8,240	6,035	2,205	48,650	36,814	11,836
1993 - 1994	56,610	42,869	13,742	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5,130	3,833	1,297	51,481	39,036	12,445
1994 - 1995	56,744	42,870	13,874	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12,853	9,506	3,347	43,891	33,364	10,528
1995 - 1996	73,837	55,920	17,917	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16,567	12,333	4,234	57,270	43,587	13,683
1996 - 1997	75,642	57,282	18,361	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12,383	9,161	3,223	63,259	48,121	15,138
1997 - 1998	75,599	57,282	18,318	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7,460	5,534	1,926	68,139	51,748	16,391
1998 - 1999	75,585	57,282	18,304	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9,778	7,267	2,511	65,807	50,015	15,793
1999 - 2000	75,554	57,258	18,296	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8,281	6,156	2,124	67,274	51,102	16,172
2000 - 2001	75,552	57,256	18,296	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,824	2,842	982	71,728	54,415	17,314
2001 - 2002	75,582	57,256	18,326	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,932	2,179	754	72,650	55,078	17,572
2002 - 2003	71,592	57,256	14,335	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,734	3,647	1,087	66,858	53,609	13,249
2003 - 2004	60,999	48,831	12,167	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,434	2,438	995	57,565	46,393	11,172
2004 - 2005	61,070	47,408	13,662	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12,571	8,040	4,531	48,499	39,369	9,131
2005 - 2006	60,821	47,408	13,413	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11,831	7,497	4,335	48,990	39,912	9,078
2006 - 2007	61,761	47,408	14,352	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6,641	3,909	2,732	55,120	43,500	11,620
2007 - 2008	60,832	47,408	13,424	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,165	1,242	923	58,667	46,166	12,500
2008 - 2009	60,431	47,408	13,023	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	313	179	133	60,118	47,229	12,889
2009 - 2010	60,353	47,408	12,944	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,396	2,284	1,112	56,957	45,125	11,832
2010 - 2011	70,437	54,723	15,714	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7,104	3,608	3,495	63,333	51,114	12,219
2011 - 2012	70,064	54,423	15,641	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,210	1,339	1,870	66,854	53,083	13,771
2012 - 2013	71,841	54,423	17,418	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,492	628	864	70,349	53,795	16,555
2013 - 2014	70,802	54,423	16,379	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,048	227	820	69,754	54,195	15,559
2014 - 2015	70,443	54,423	16,021	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	575	300	275	69,868	54,122	15,746
2015 - 2016	70,385	54,423	15,962	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	587	316	271	69,798	54,107	15,691
2016 - 2017	69,951	54,423	15,528	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12,281	8,039	4,242	57,669	46,384	11,286

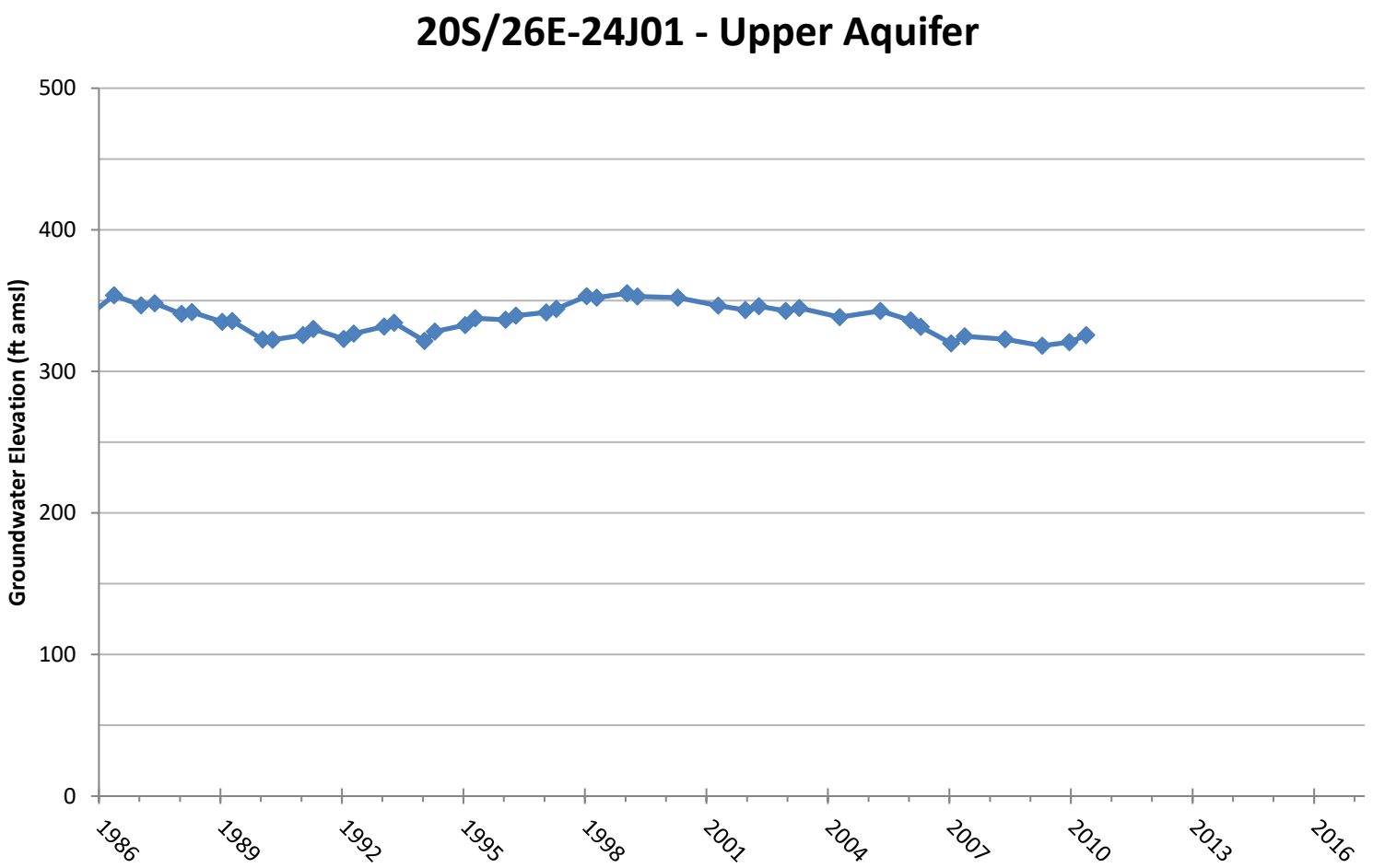
Historical Agricultural Water Demand

Water Year	Total Applied Water	Total Cons. Use	Total Return Flow	Tule River			Deer Creek			Recycled Water			Imported Water			Groundwater Production		
				Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow	Applied	Cons. Use	Return Flow
Alpaugh GSA																		
1986 - 1987	35,769	26,833	8,936	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,145	859	286	34,624	25,974	8,650
1987 - 1988	35,769	26,833	8,936	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	35,769	26,833	8,936
1988 - 1989	35,769	26,833	8,936	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	35,769	26,833	8,936
1989 - 1990	35,769	26,833	8,936	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	35,769	26,833	8,936
1990 - 1991	35,769	26,833	8,936	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	35,769	26,833	8,936
1991 - 1992	35,769	26,833	8,936	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	35,769	26,833	8,936
1992 - 1993	35,769	26,833	8,936	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13,821	10,368	3,453	21,948	16,465	5,483
1993 - 1994	35,779	26,841	8,939	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,115	3,087	1,028	31,664	23,754	7,910
1994 - 1995	35,780	26,841	8,939	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9,723	7,294	2,429	26,057	19,547	6,510
1995 - 1996	33,699	25,280	8,419	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12,381	9,288	3,093	21,318	15,992	5,326
1996 - 1997	33,482	25,118	8,365	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	33,482	25,118	8,365
1997 - 1998	33,482	25,118	8,365	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	33,482	25,118	8,365
1998 - 1999	33,482	25,118	8,365	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	33,482	25,118	8,365
1999 - 2000	33,472	25,110	8,362	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	91	68	23	33,381	25,042	8,339
2000 - 2001	33,471	25,109	8,362	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	33,471	25,109	8,362
2001 - 2002	33,471	25,109	8,362	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	33,471	25,109	8,362
2002 - 2003	32,637	25,109	7,528	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	98	75	23	32,540	25,034	7,506
2003 - 2004	30,217	23,308	6,909	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	30,217	23,308	6,909
2004 - 2005	30,556	23,017	7,539	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13,660	9,985	3,675	16,896	13,032	3,863
2005 - 2006	31,475	23,017	8,458	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15,189	10,454	4,734	16,287	12,563	3,724
2006 - 2007	29,840	23,017	6,823	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	29,840	23,017	6,823
2007 - 2008	29,840	23,017	6,823	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	29,840	23,017	6,823
2008 - 2009	29,840	23,017	6,823	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,009	1,550	459	27,831	21,467	6,364
2009 - 2010	29,840	23,017	6,823	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,518	1,943	576	27,322	21,075	6,247
2010 - 2011	20,679	15,175	5,504	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10,324	7,188	3,137	10,355	7,987	2,368
2011 - 2012	18,791	14,321	4,470	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	889	513	377	17,902	13,808	4,093
2012 - 2013	18,566	14,321	4,245	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	18,566	14,321	4,245
2013 - 2014	18,566	14,321	4,245	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	18,566	14,321	4,245
2014 - 2015	18,566	14,321	4,245	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	18,566	14,321	4,245
2015 - 2016	18,566	14,321	4,245	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	18,566	14,321	4,245
2016 - 2017	18,566	14,321	4,245	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,232	1,721	510	16,335	12,600	3,735

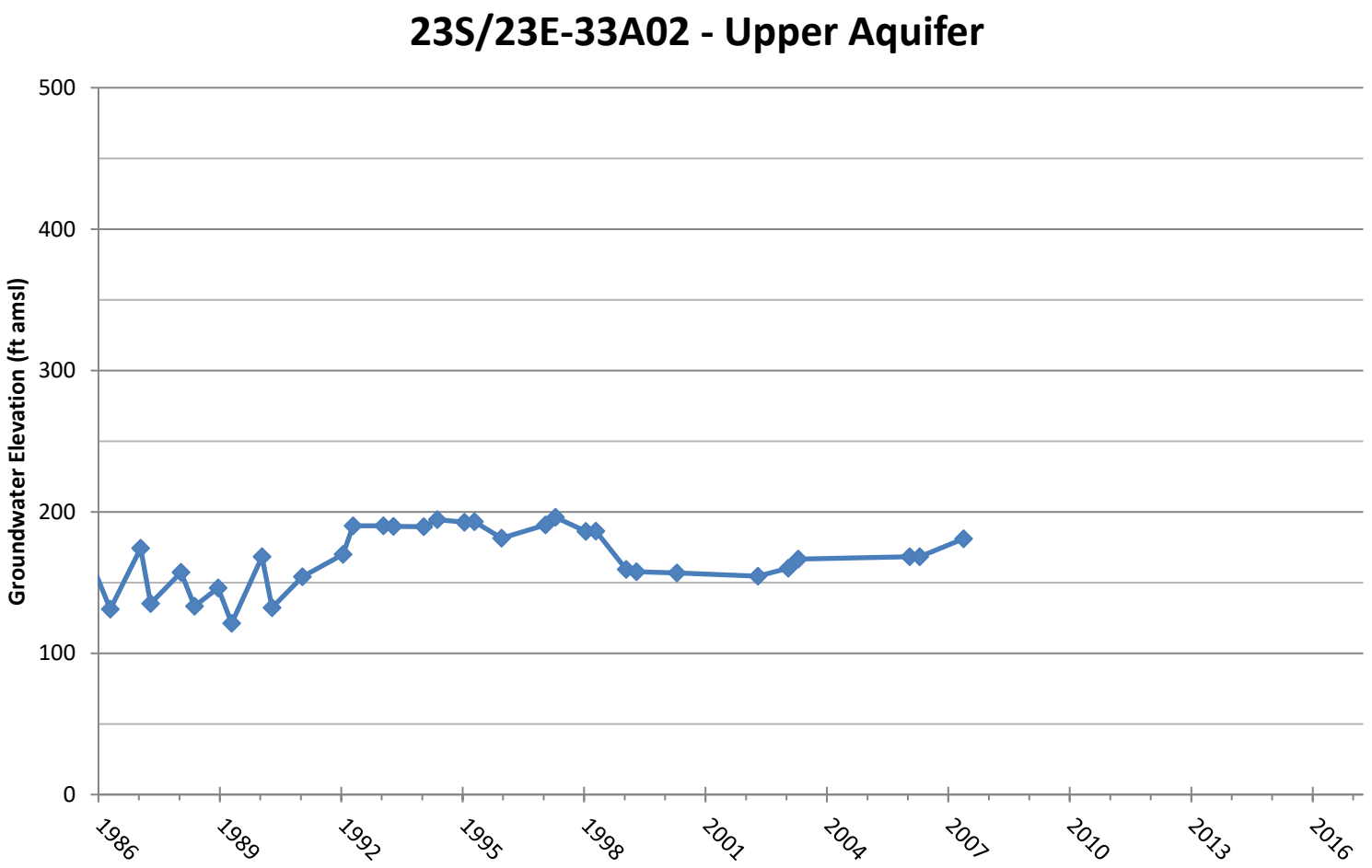
Appendix B

Hydrographs for Boundary Wells

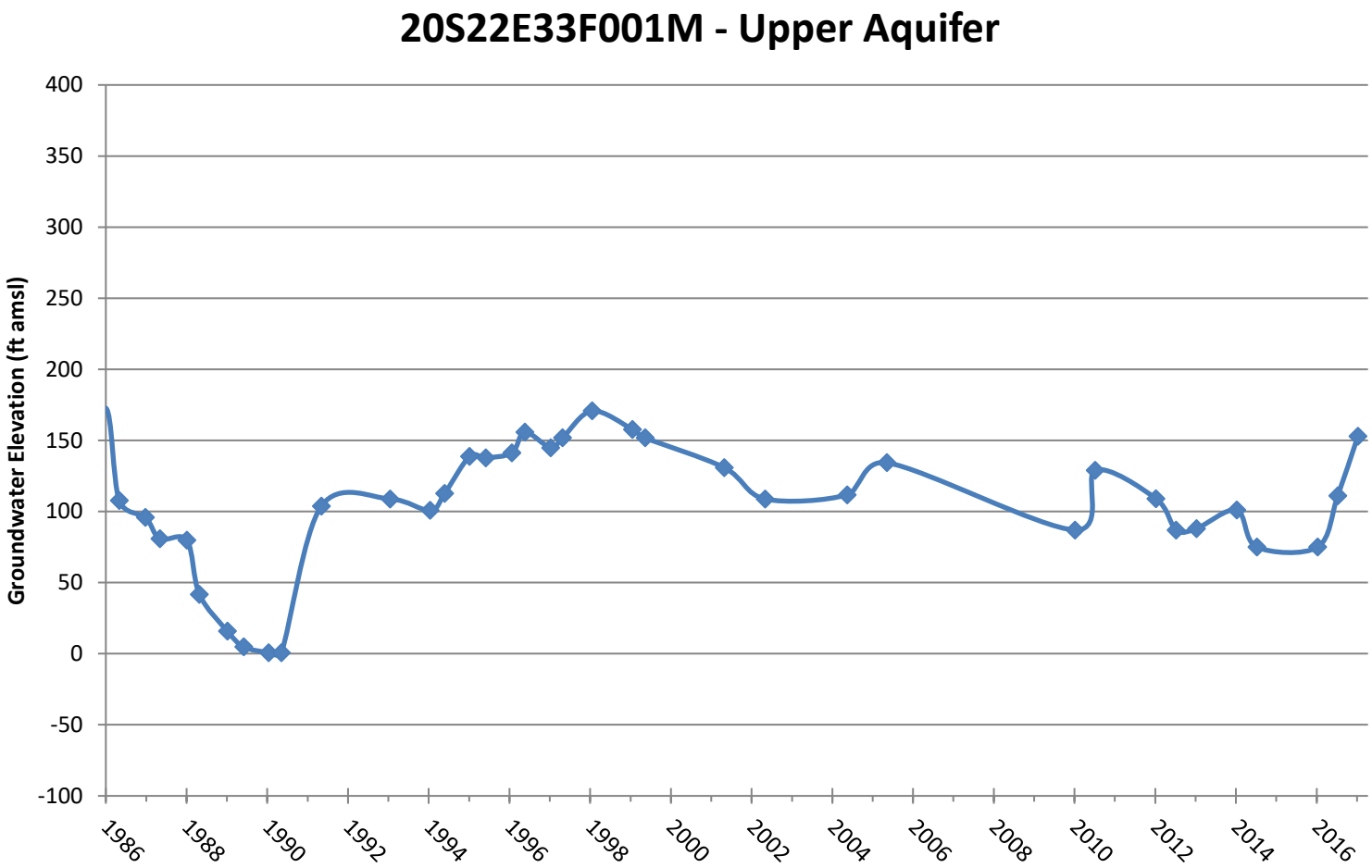
Boundary Condition Well Hydrograph



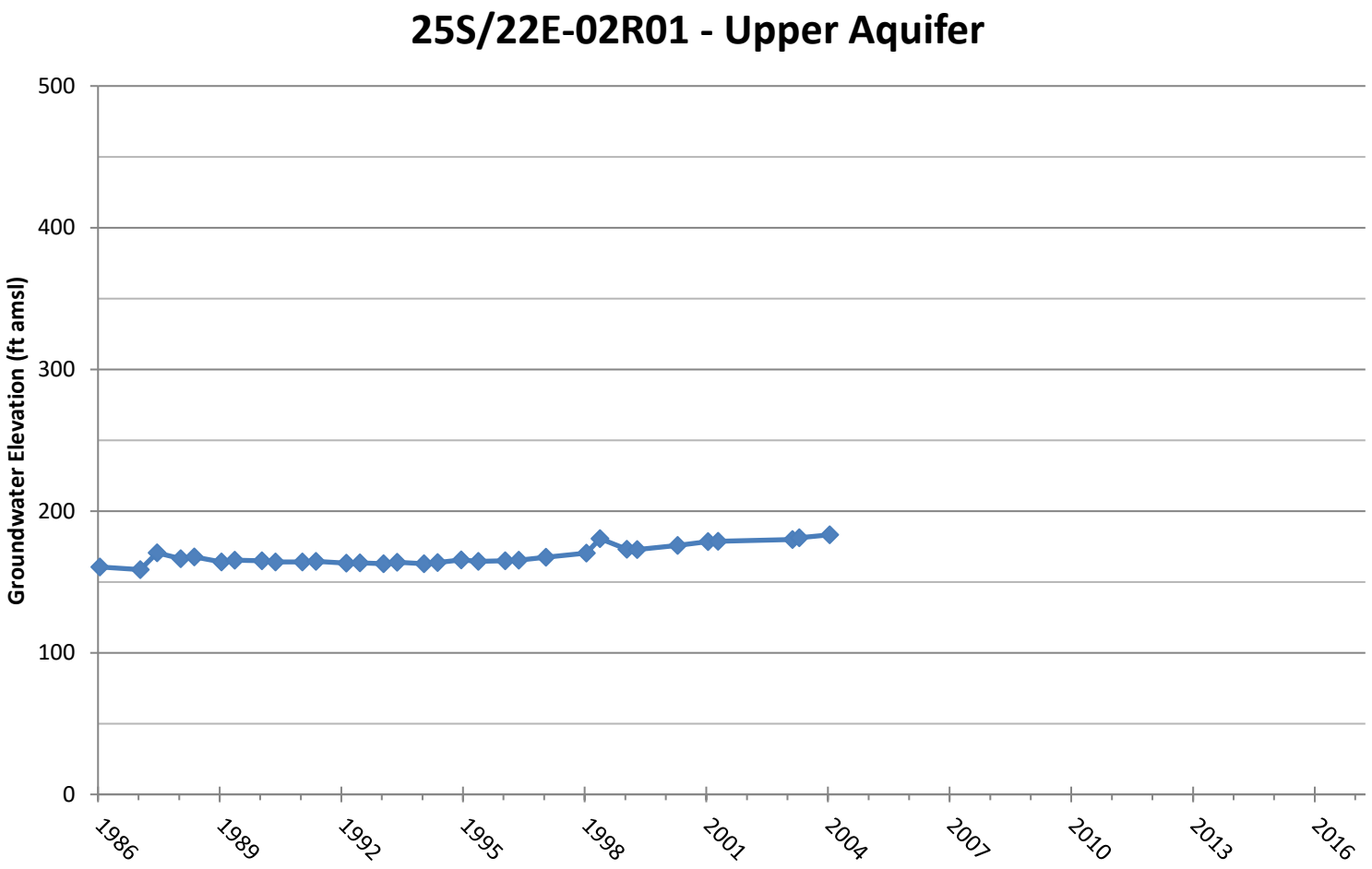
Boundary Condition Well Hydrograph



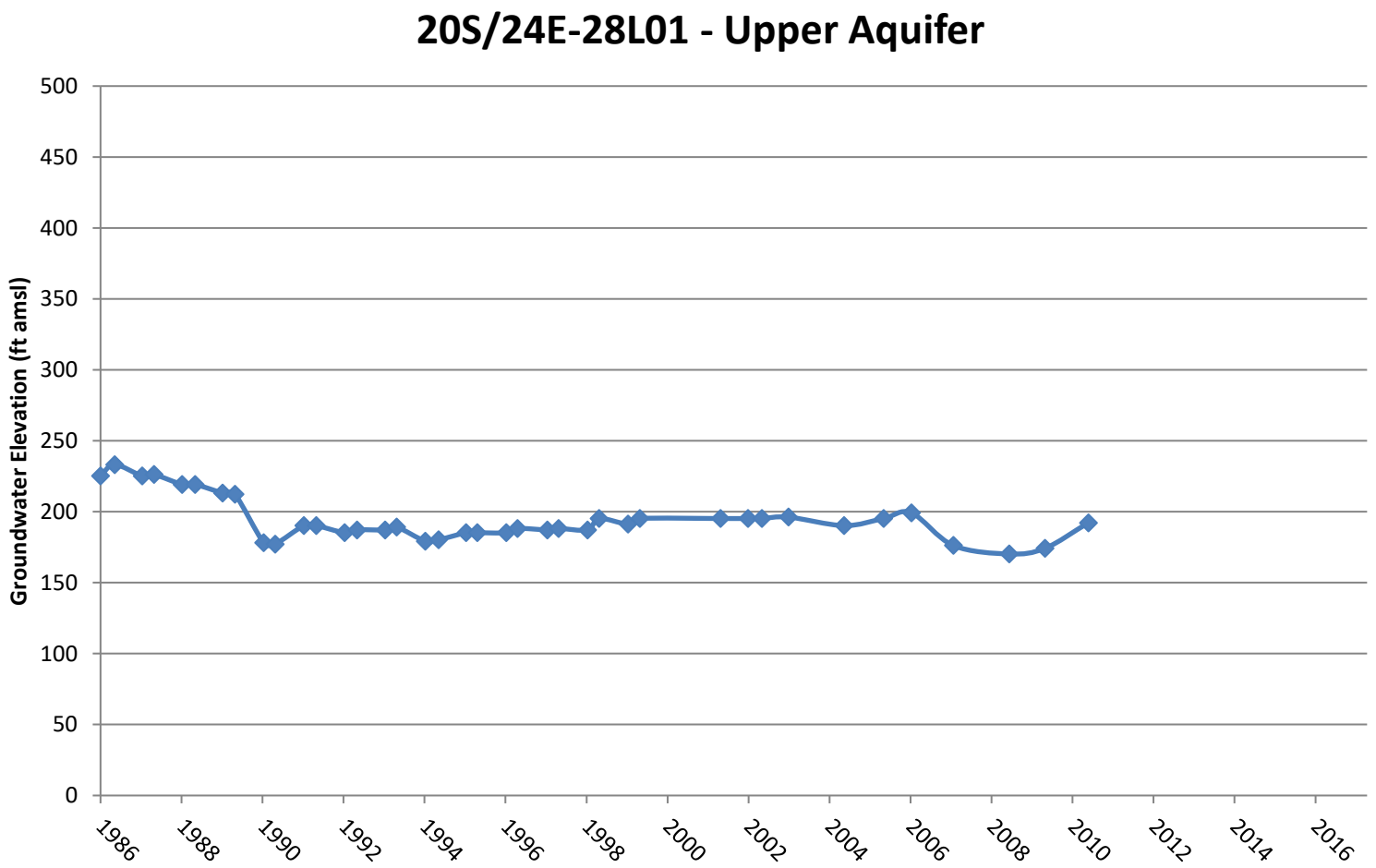
Boundary Condition Well Hydrograph



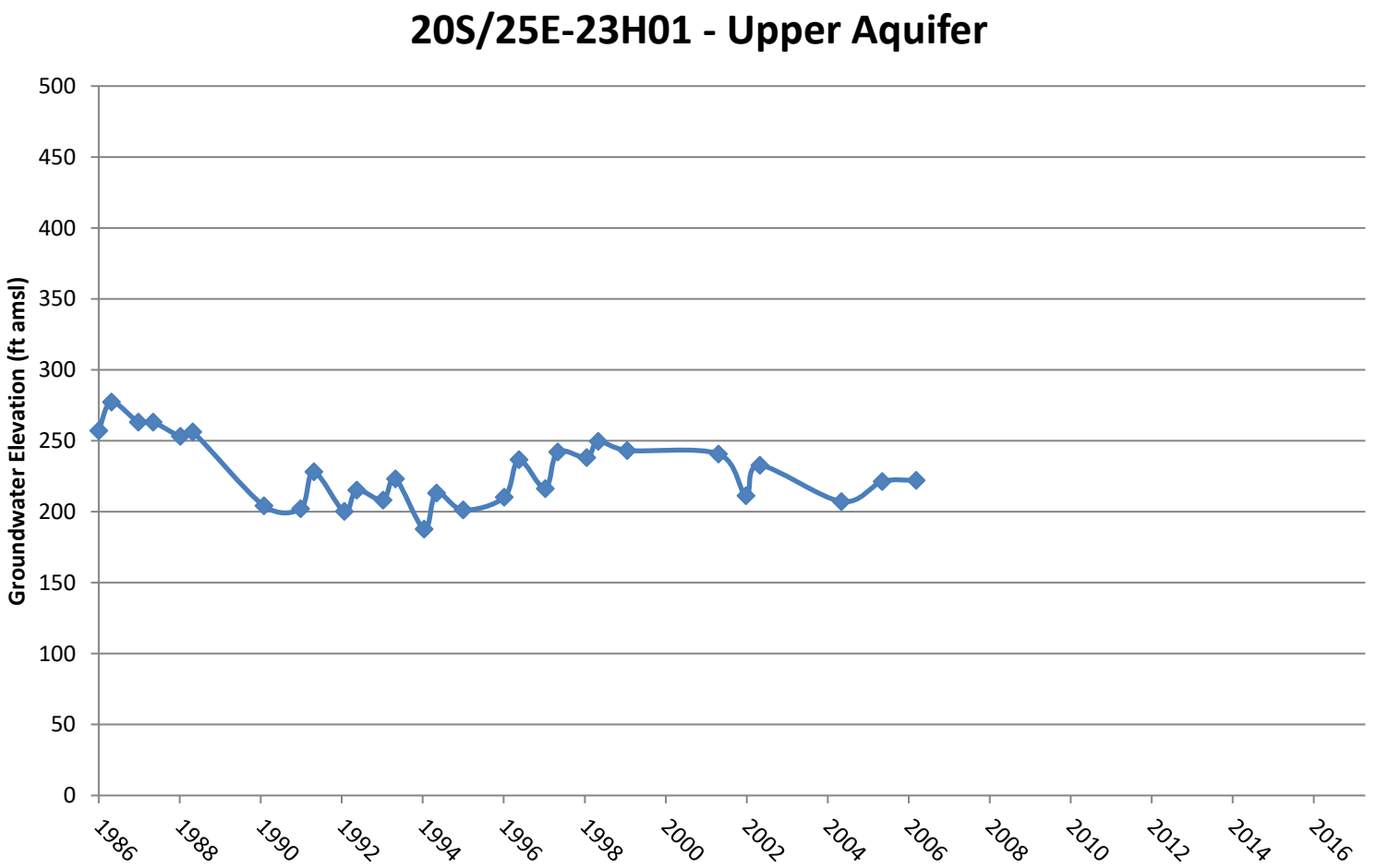
Boundary Condition Well Hydrograph



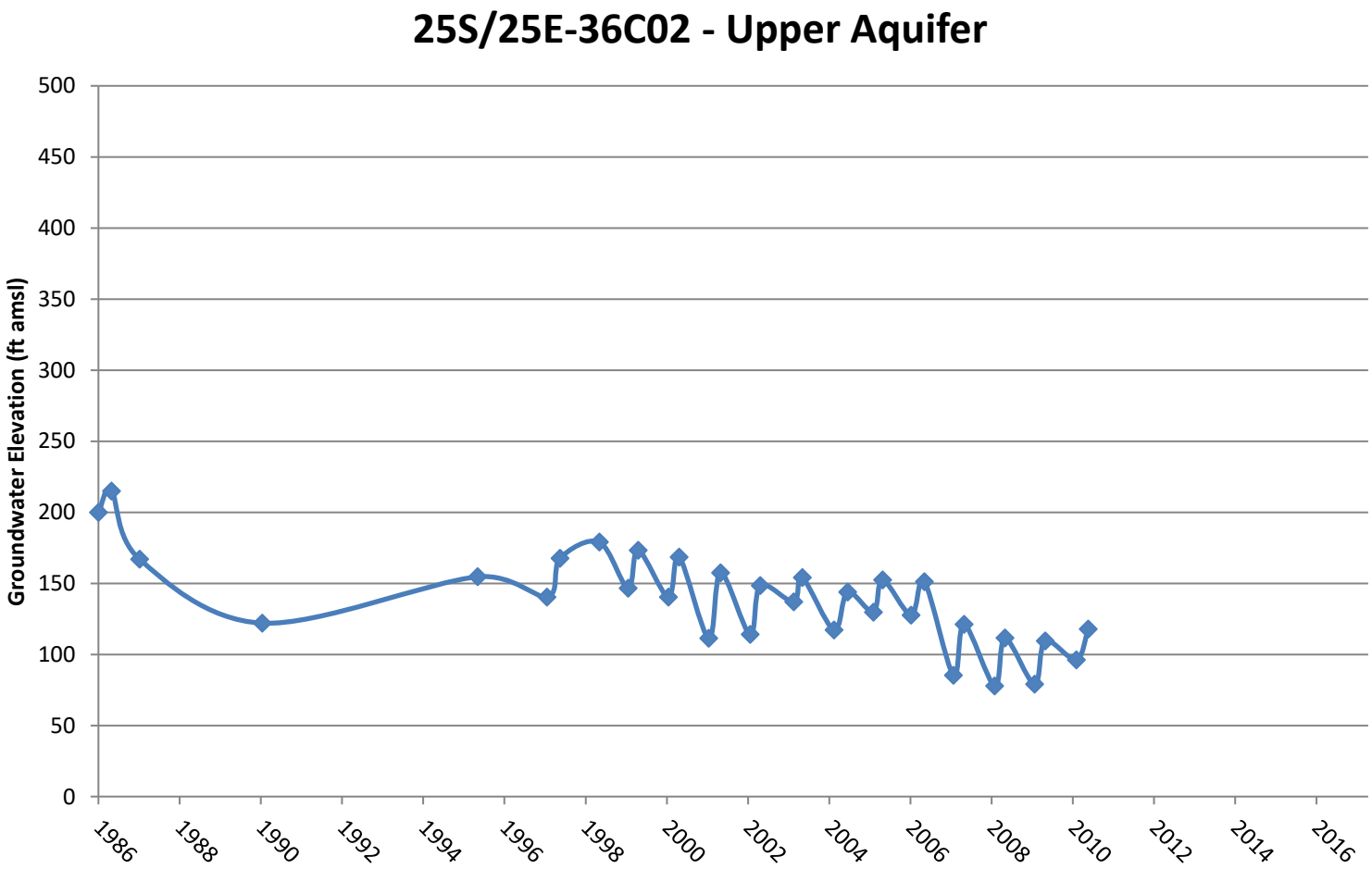
Boundary Condition Well Hydrograph



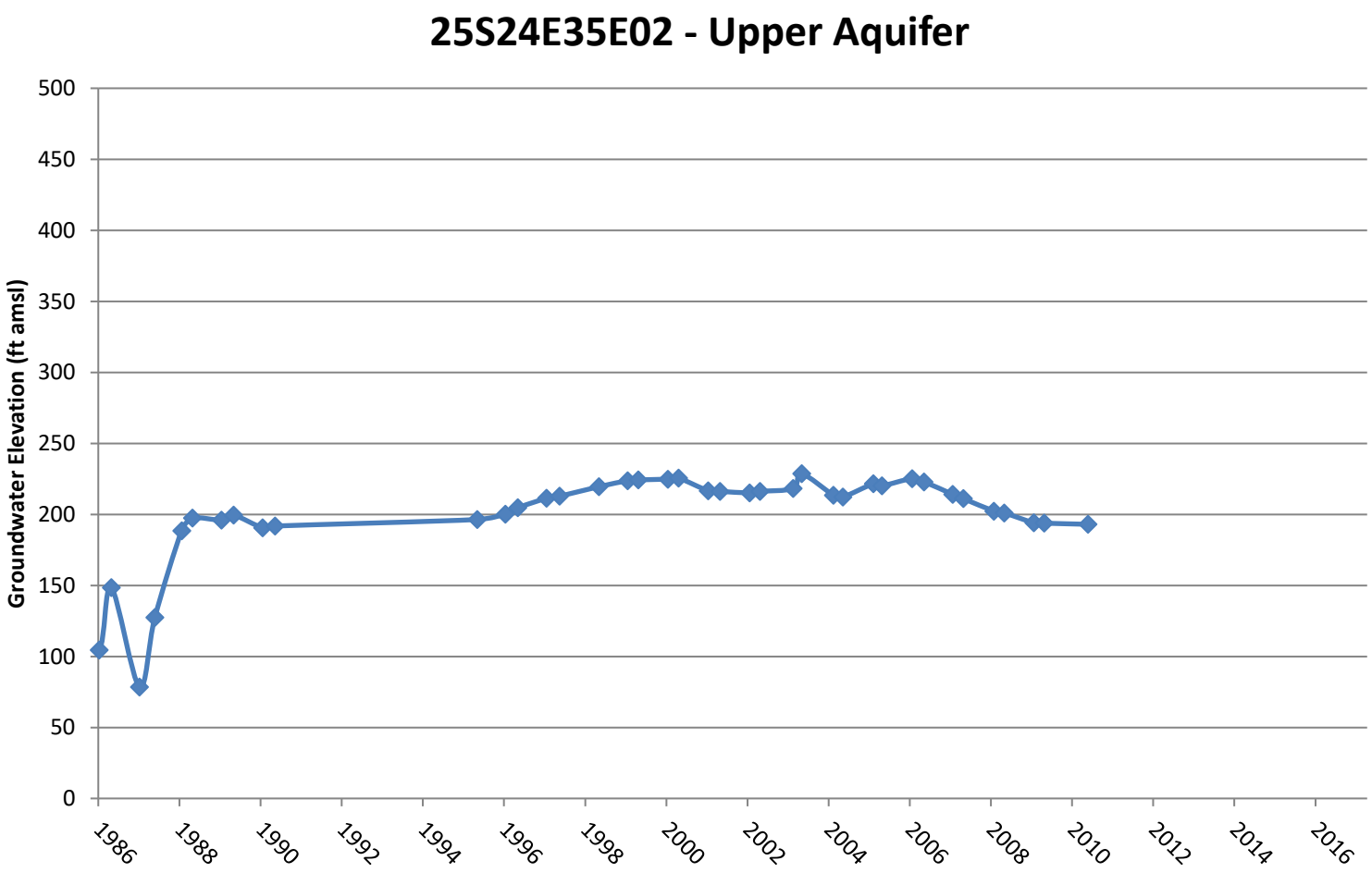
Boundary Condition Well Hydrograph



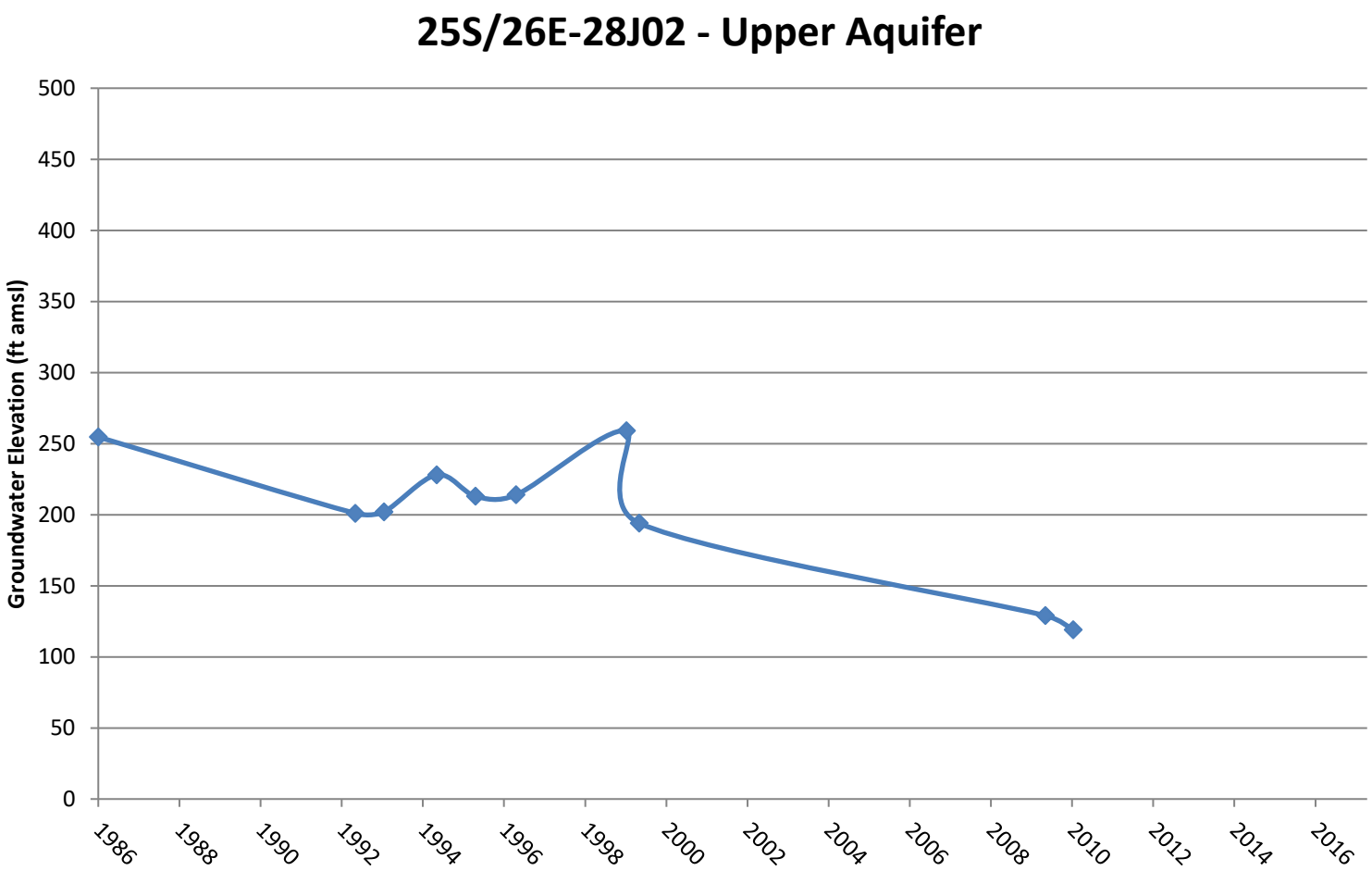
Boundary Condition Well Hydrograph



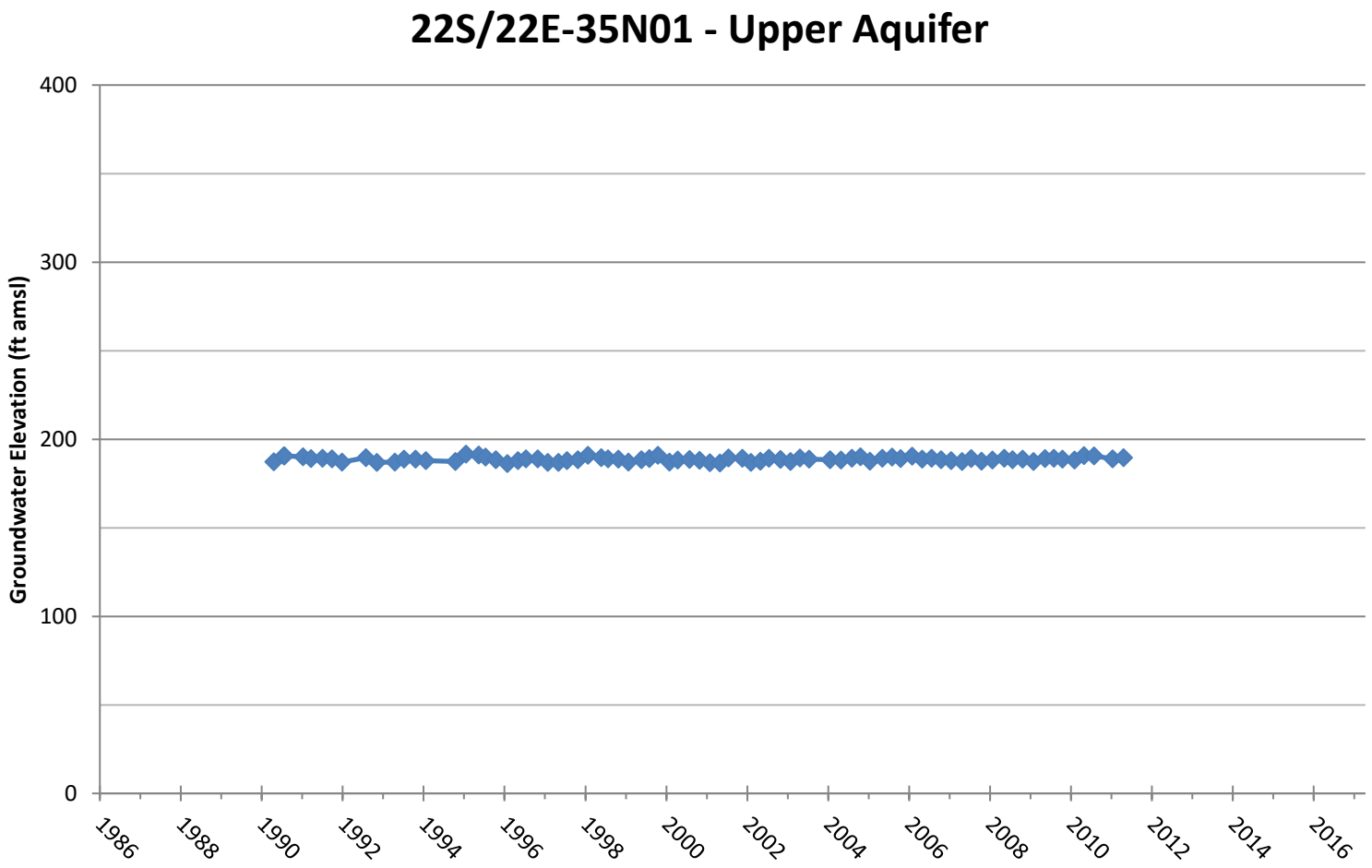
Boundary Condition Well Hydrograph



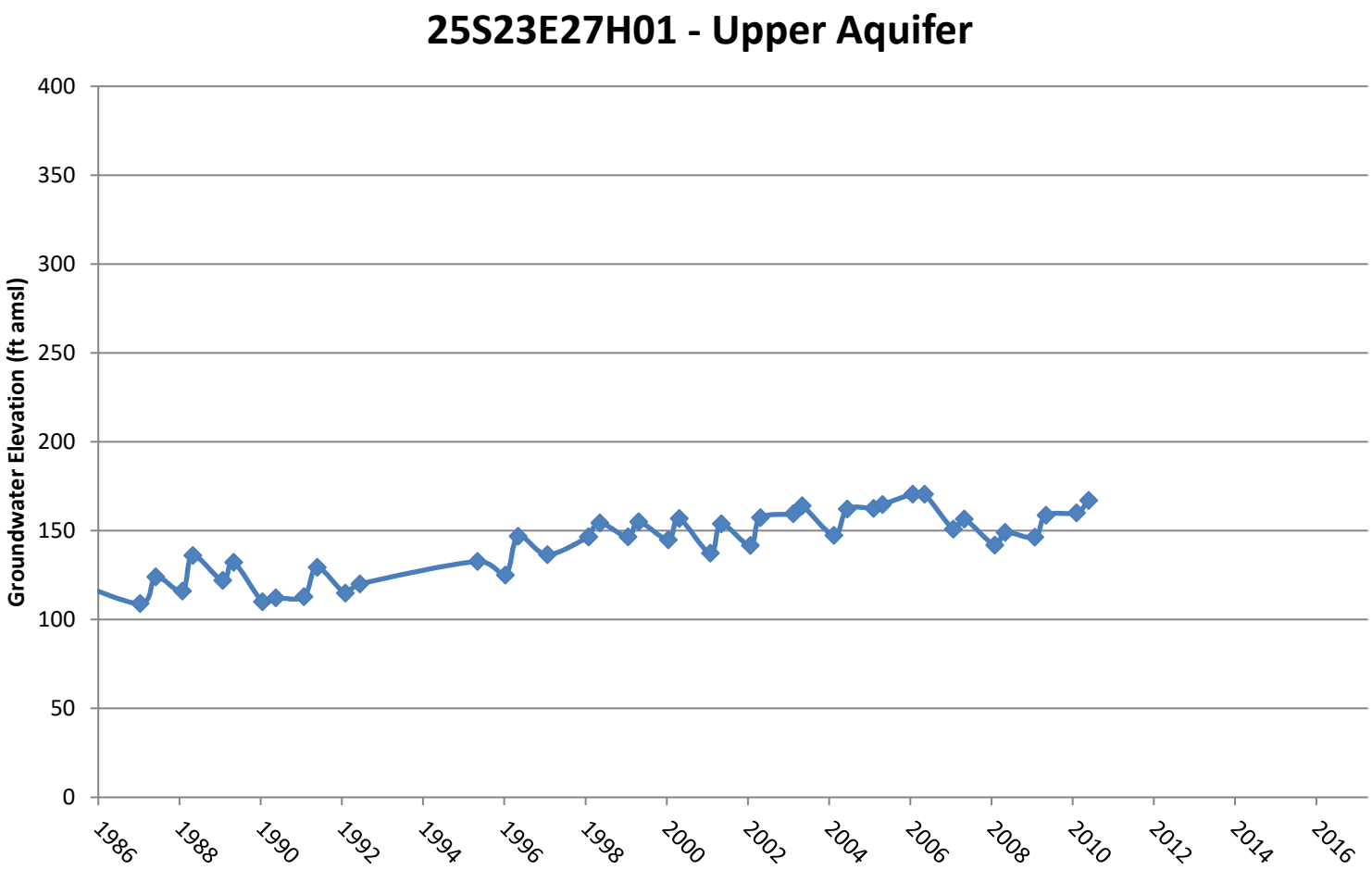
Boundary Condition Well Hydrograph



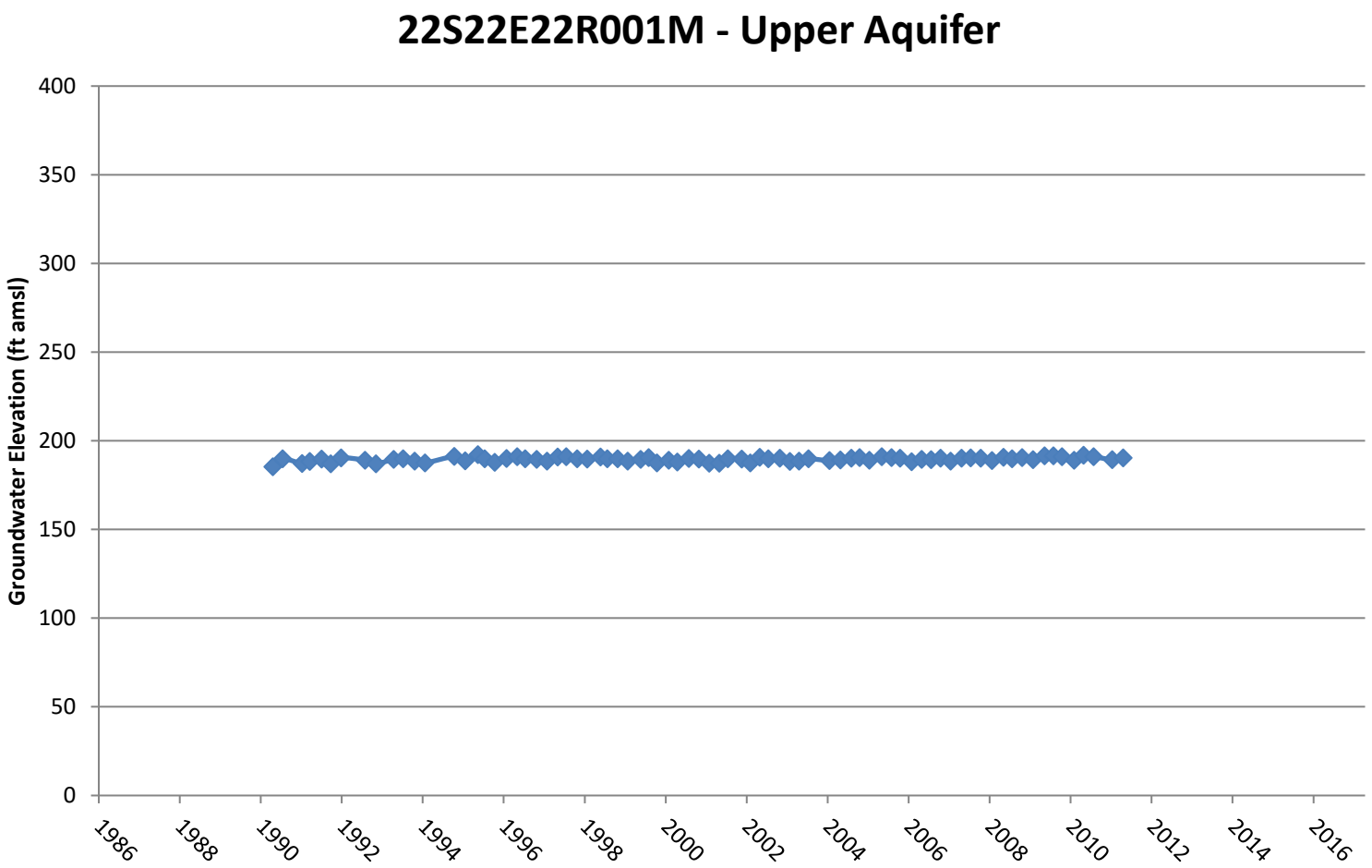
Boundary Condition Well Hydrograph



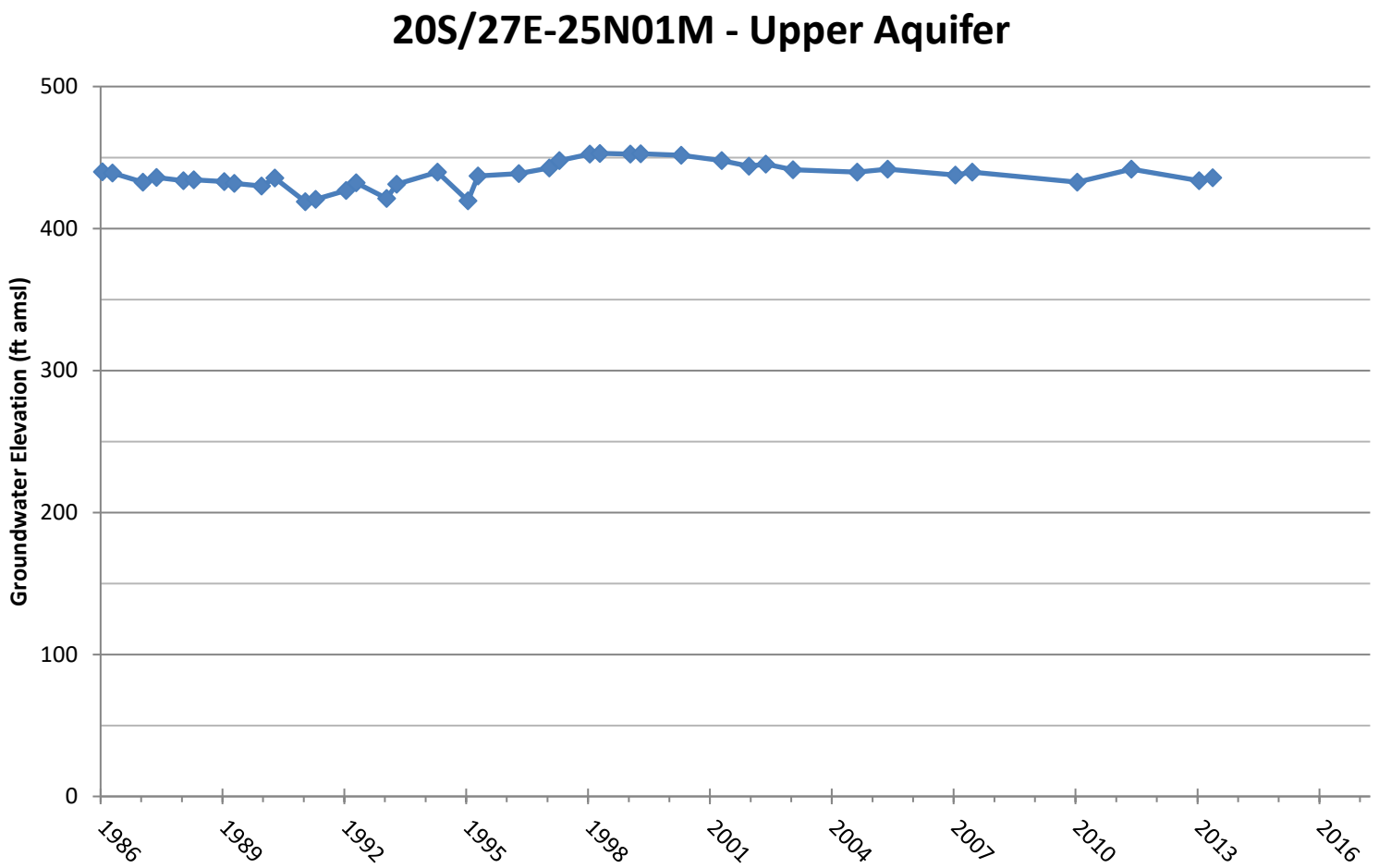
Boundary Condition Well Hydrograph



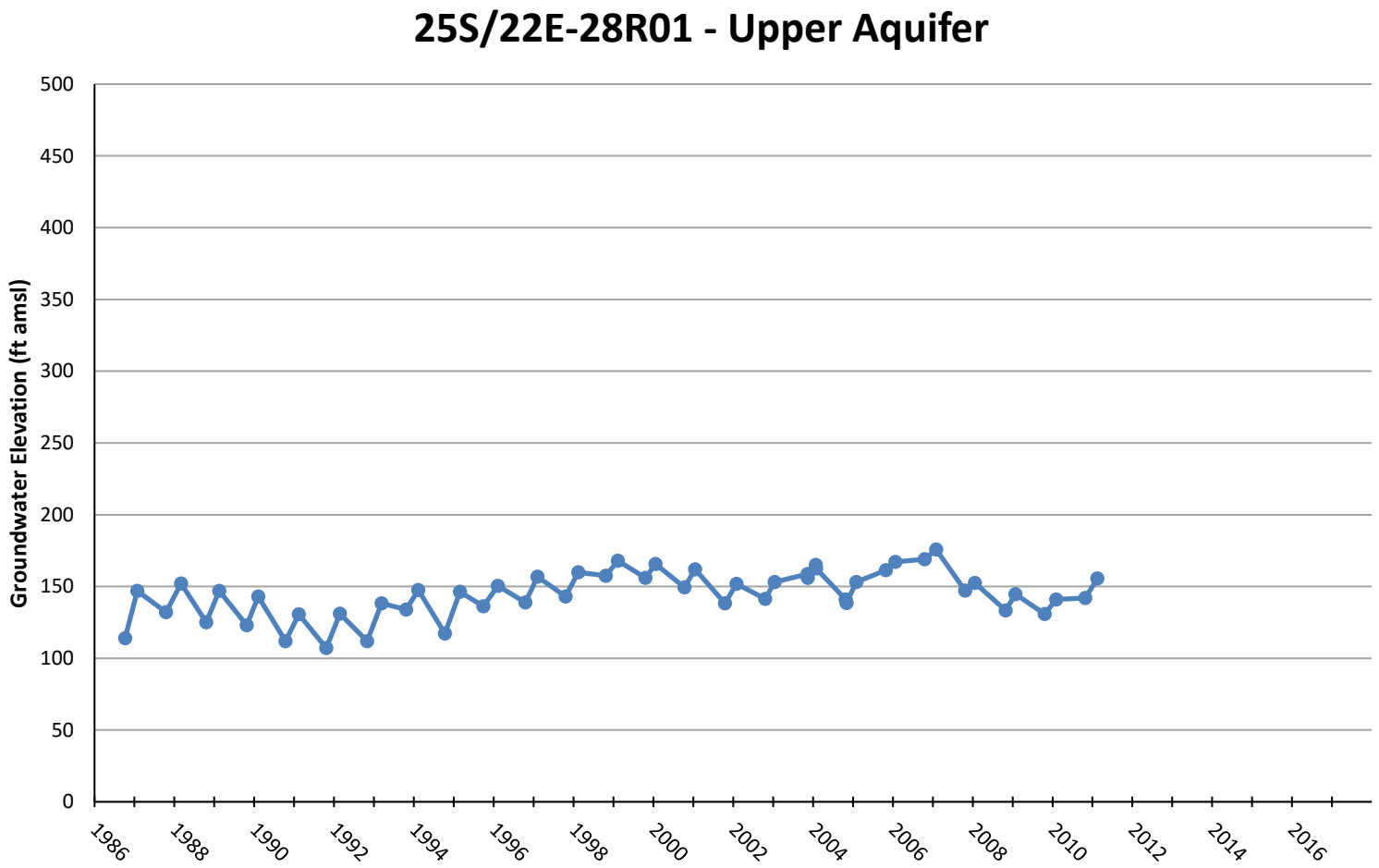
Boundary Condition Well Hydrograph



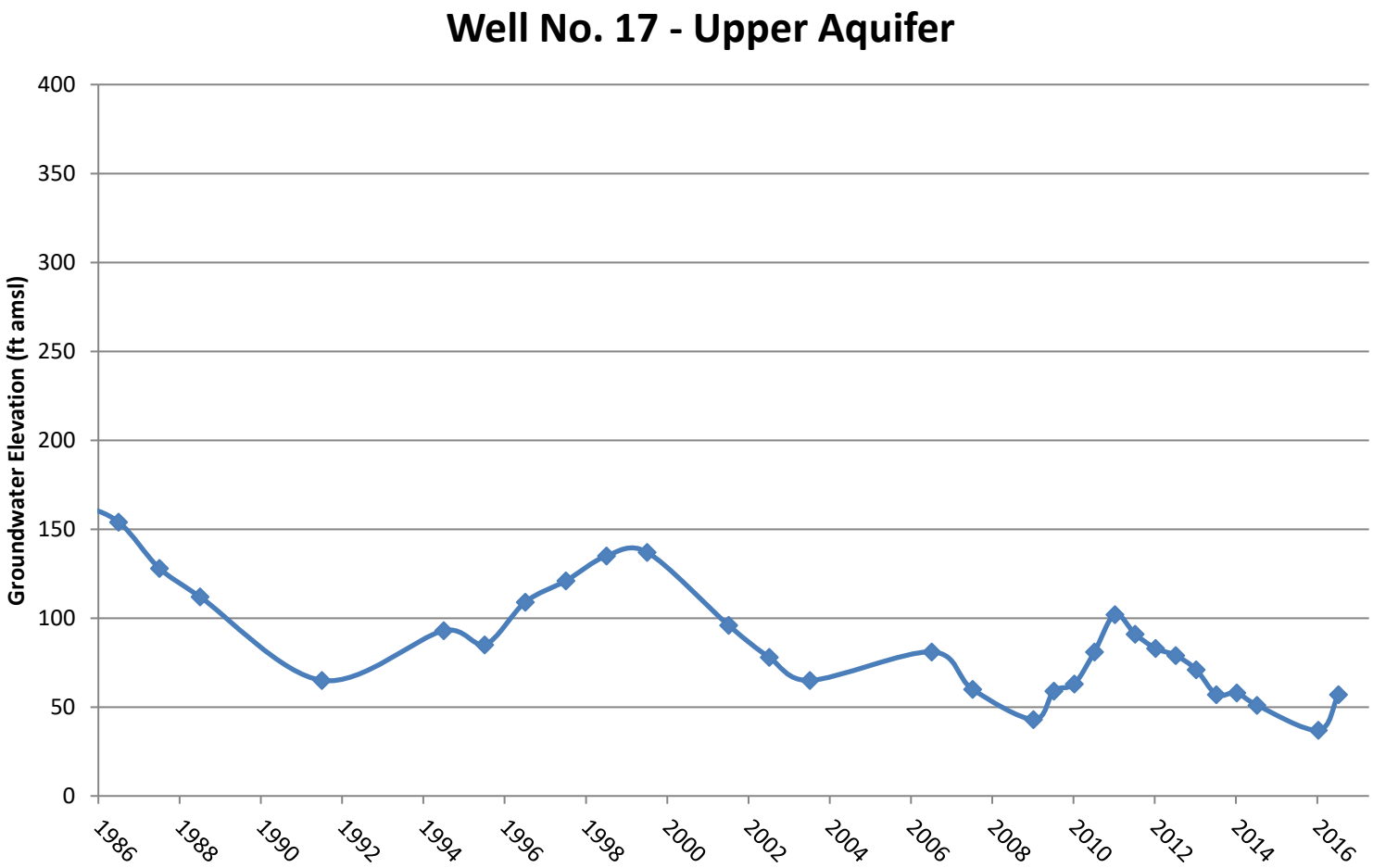
Boundary Condition Well Hydrograph



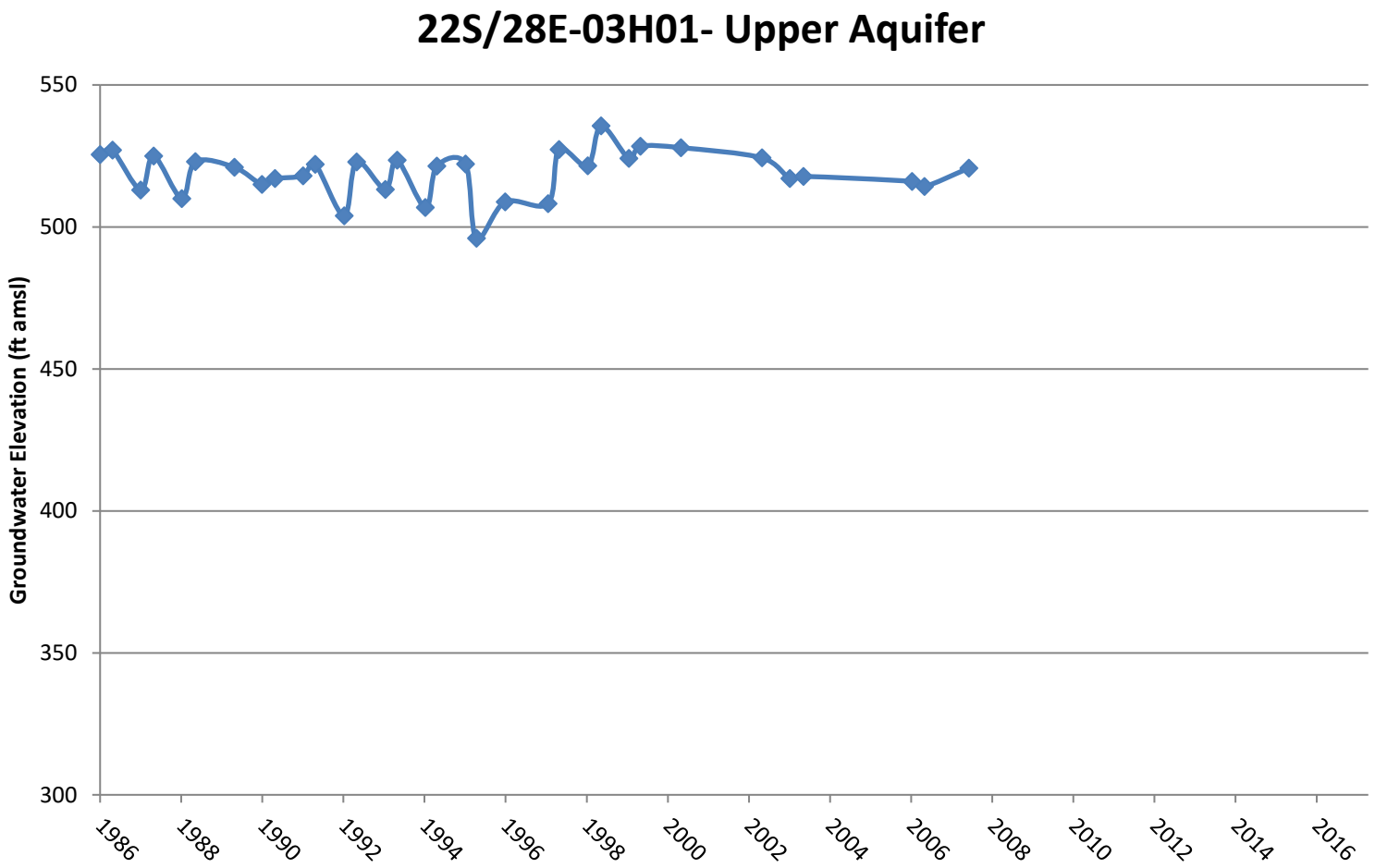
Boundary Condition Well Hydrograph



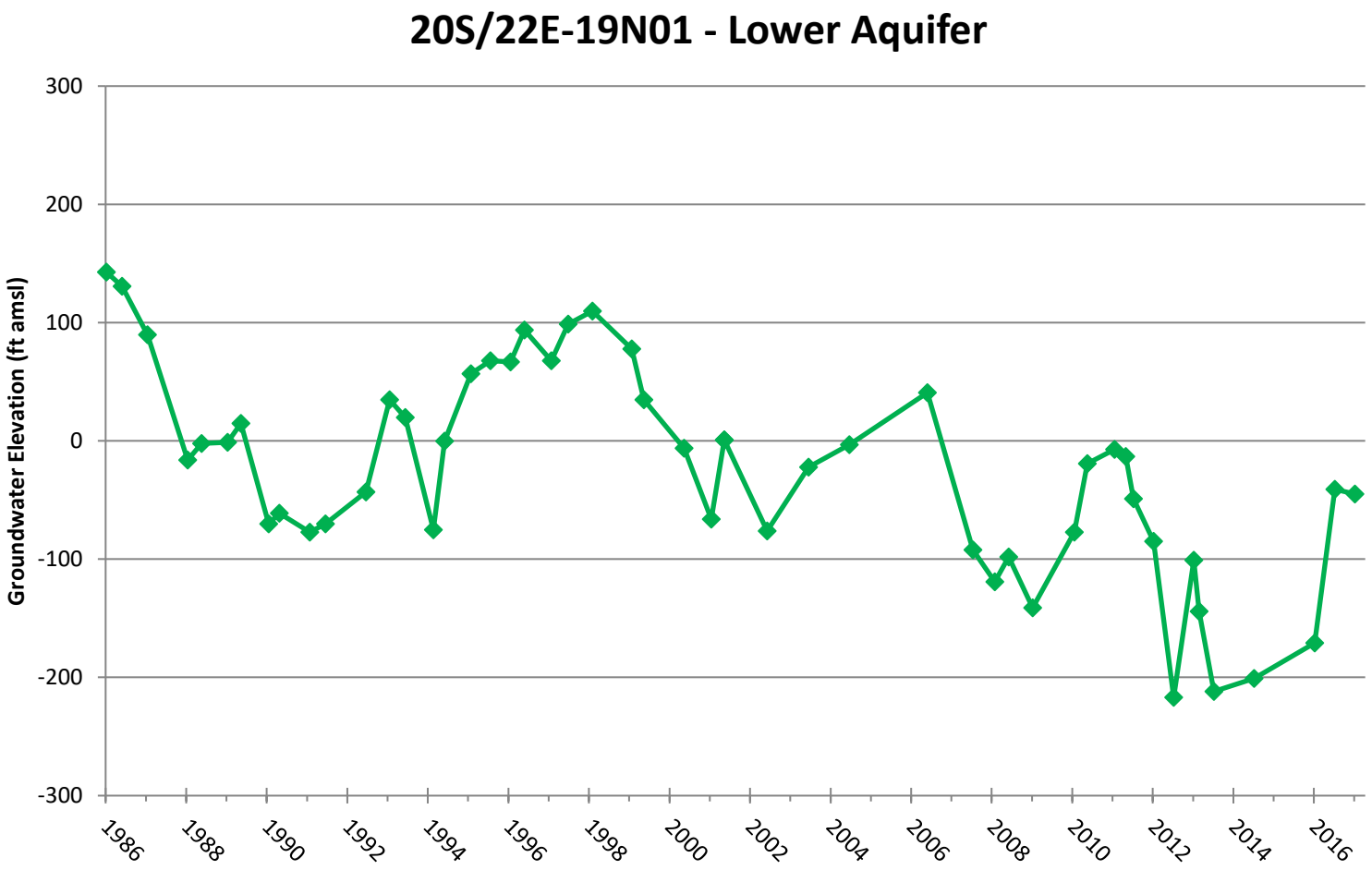
Boundary Condition Well Hydrograph



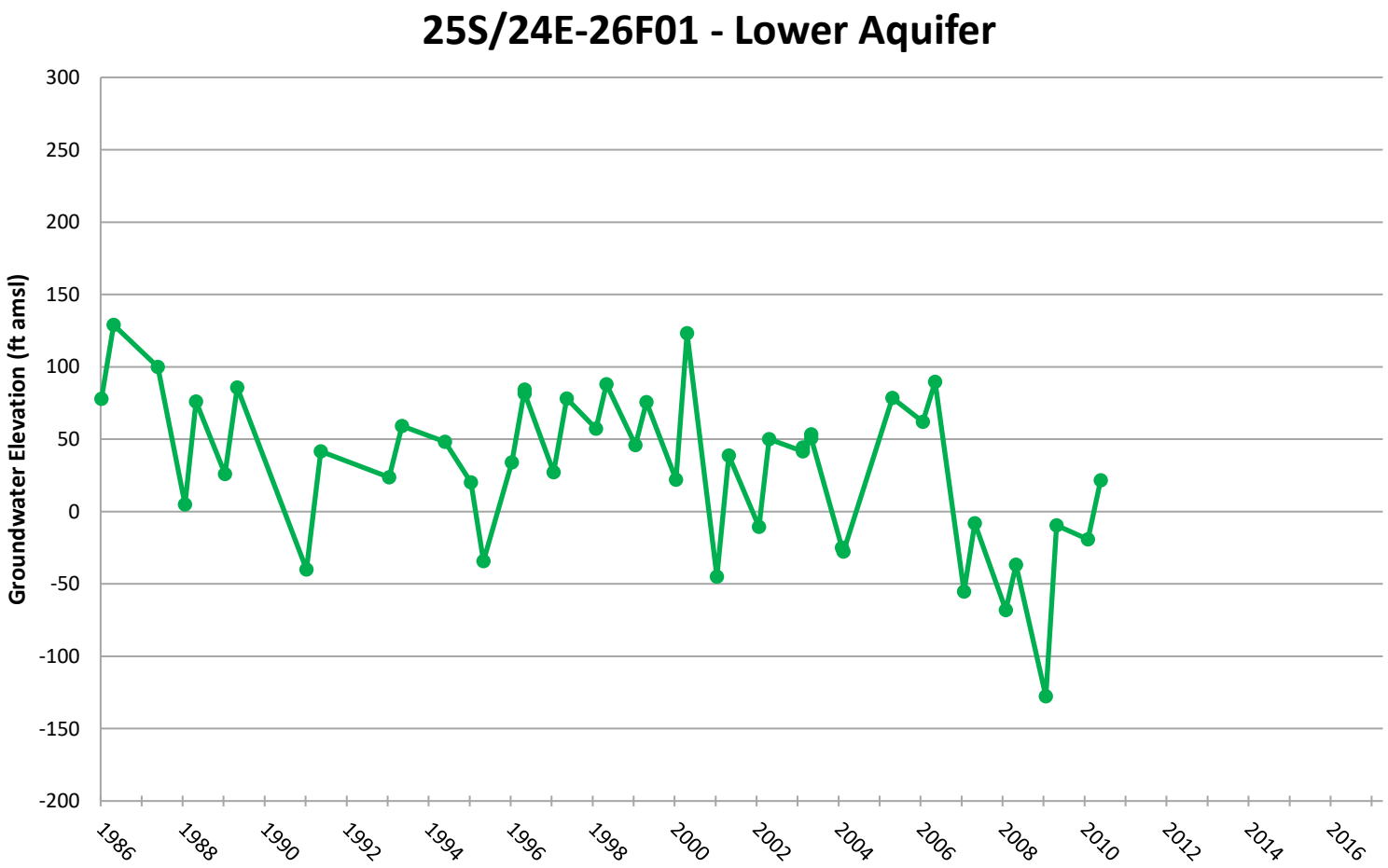
Boundary Condition Well Hydrograph



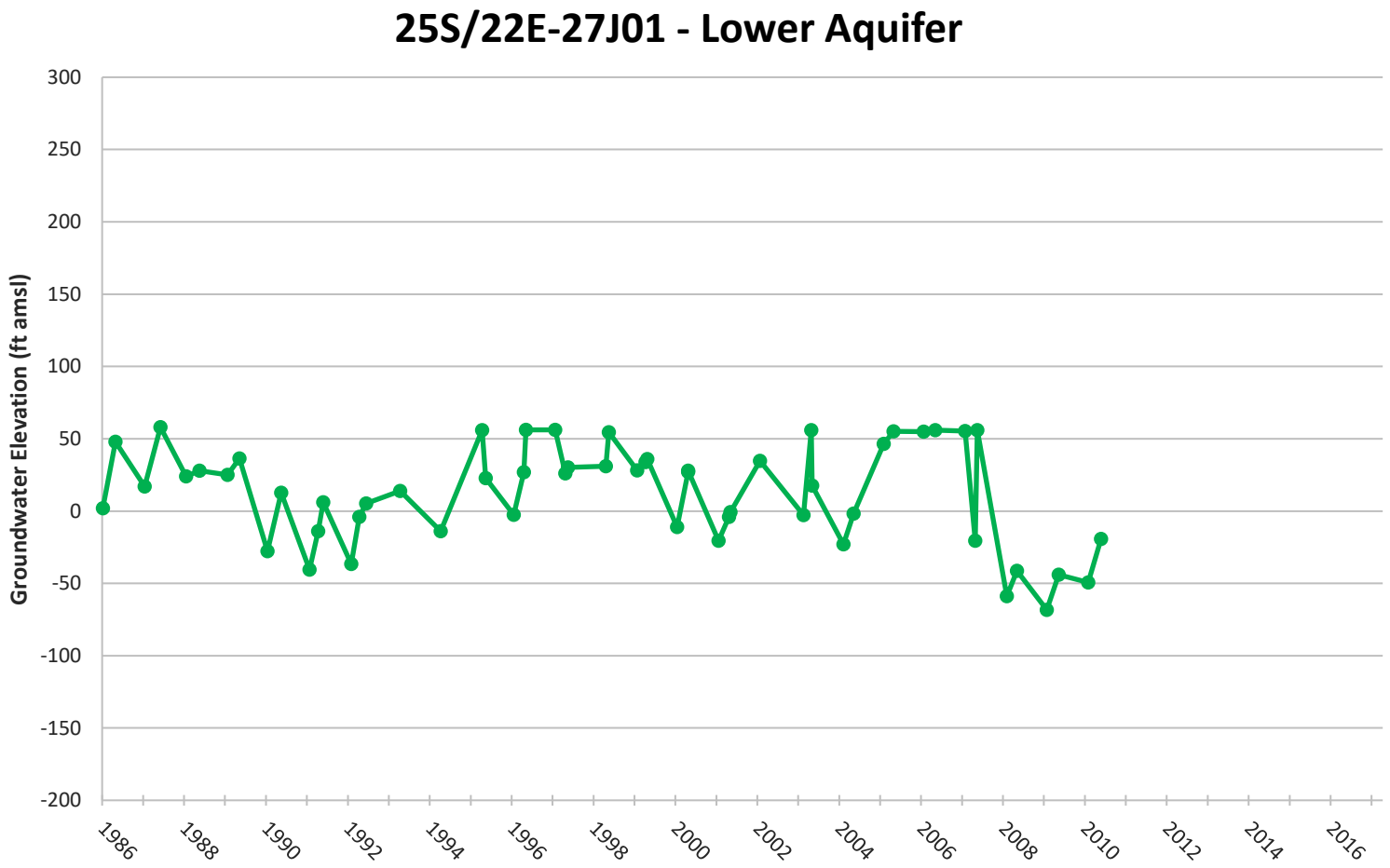
Boundary Condition Well Hydrograph



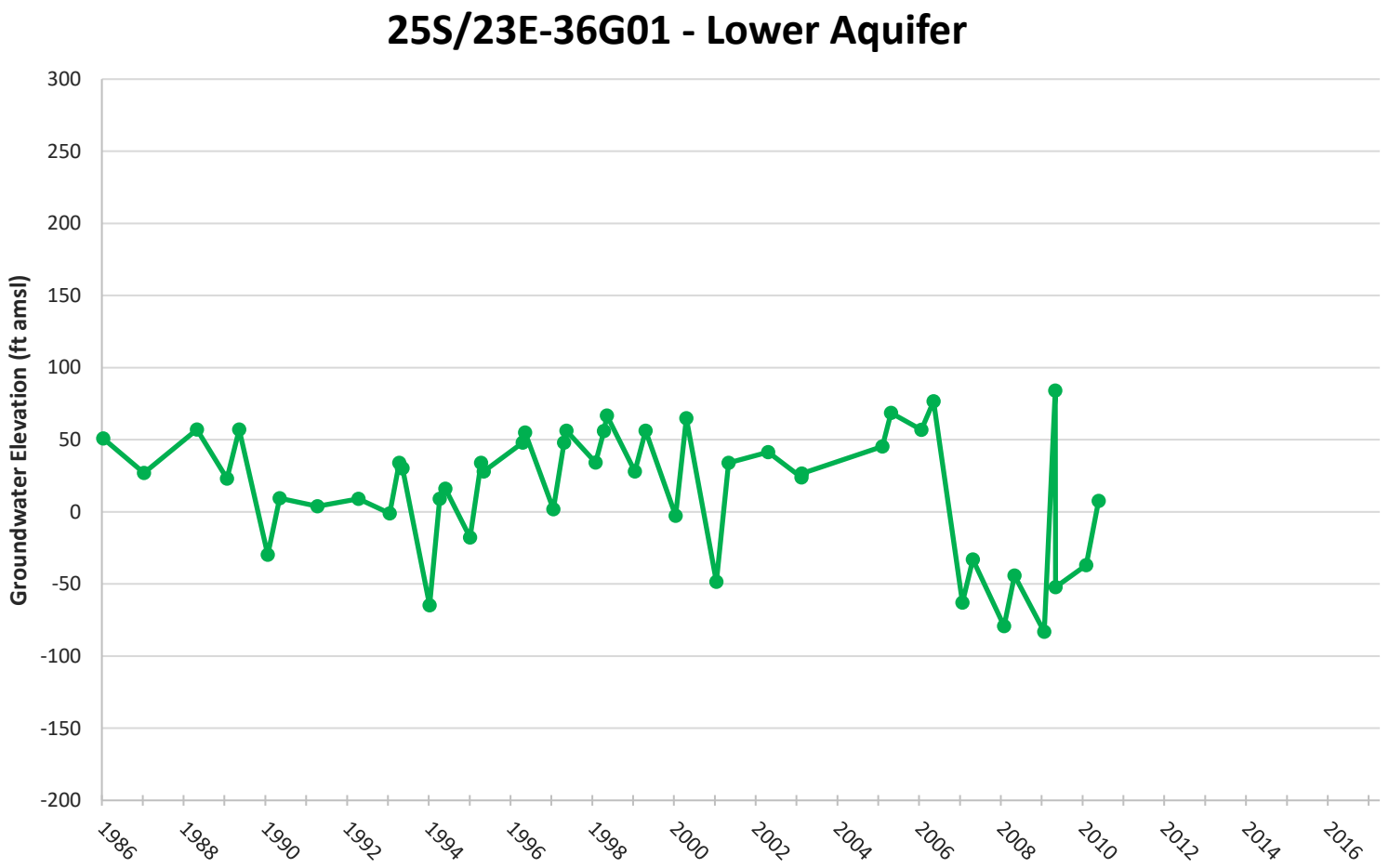
Boundary Condition Well Hydrograph



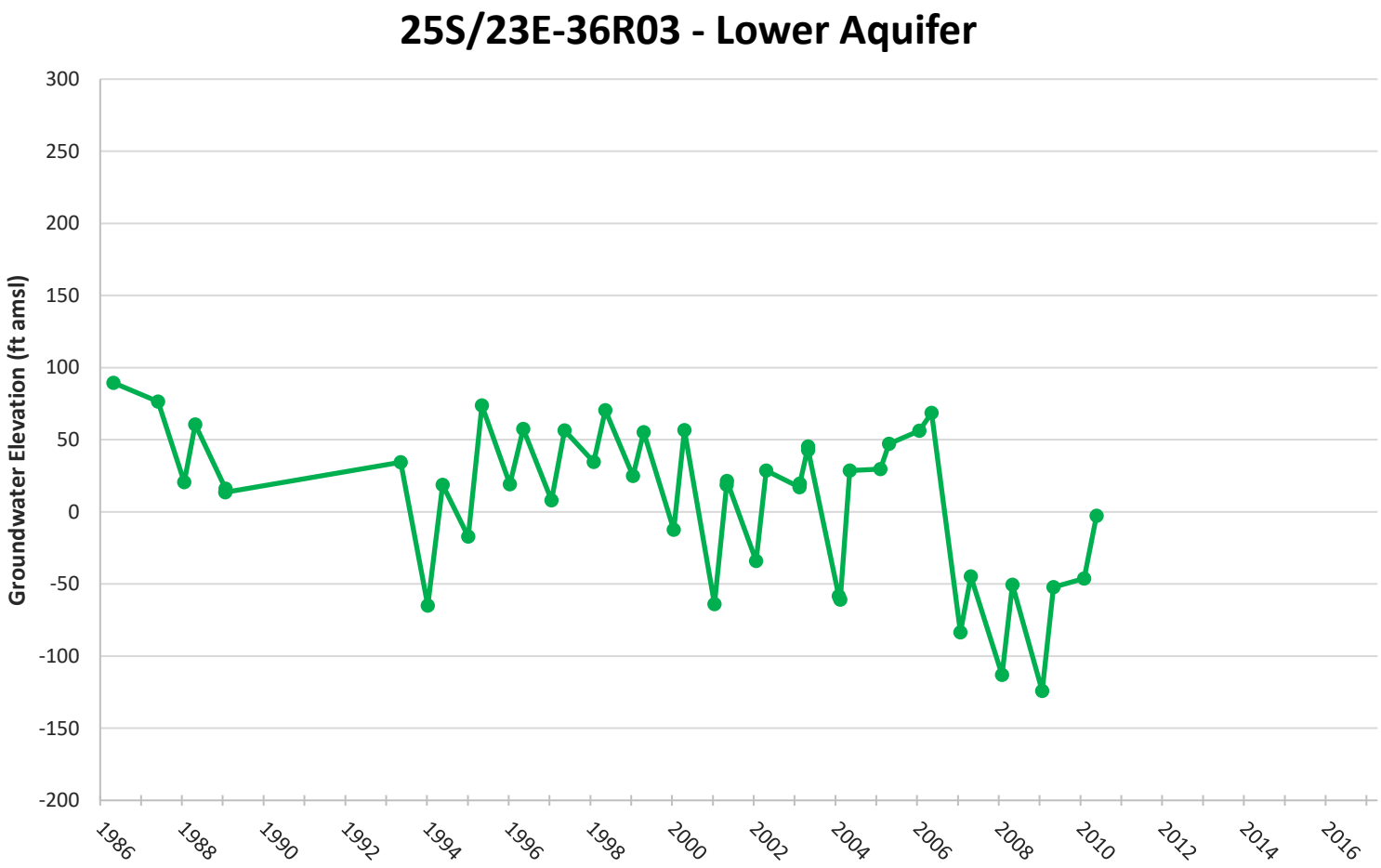
Boundary Condition Well Hydrograph



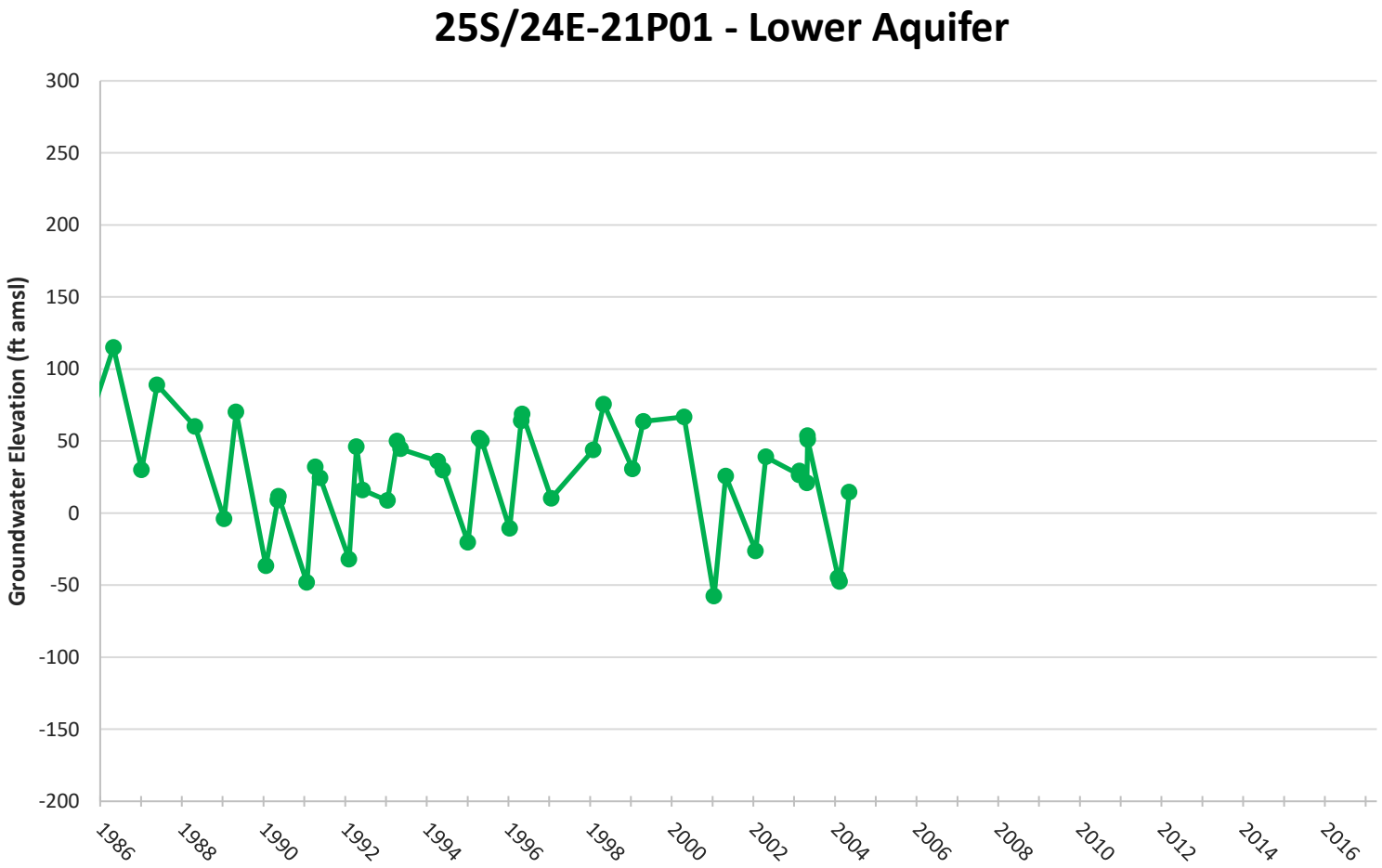
Boundary Condition Well Hydrograph



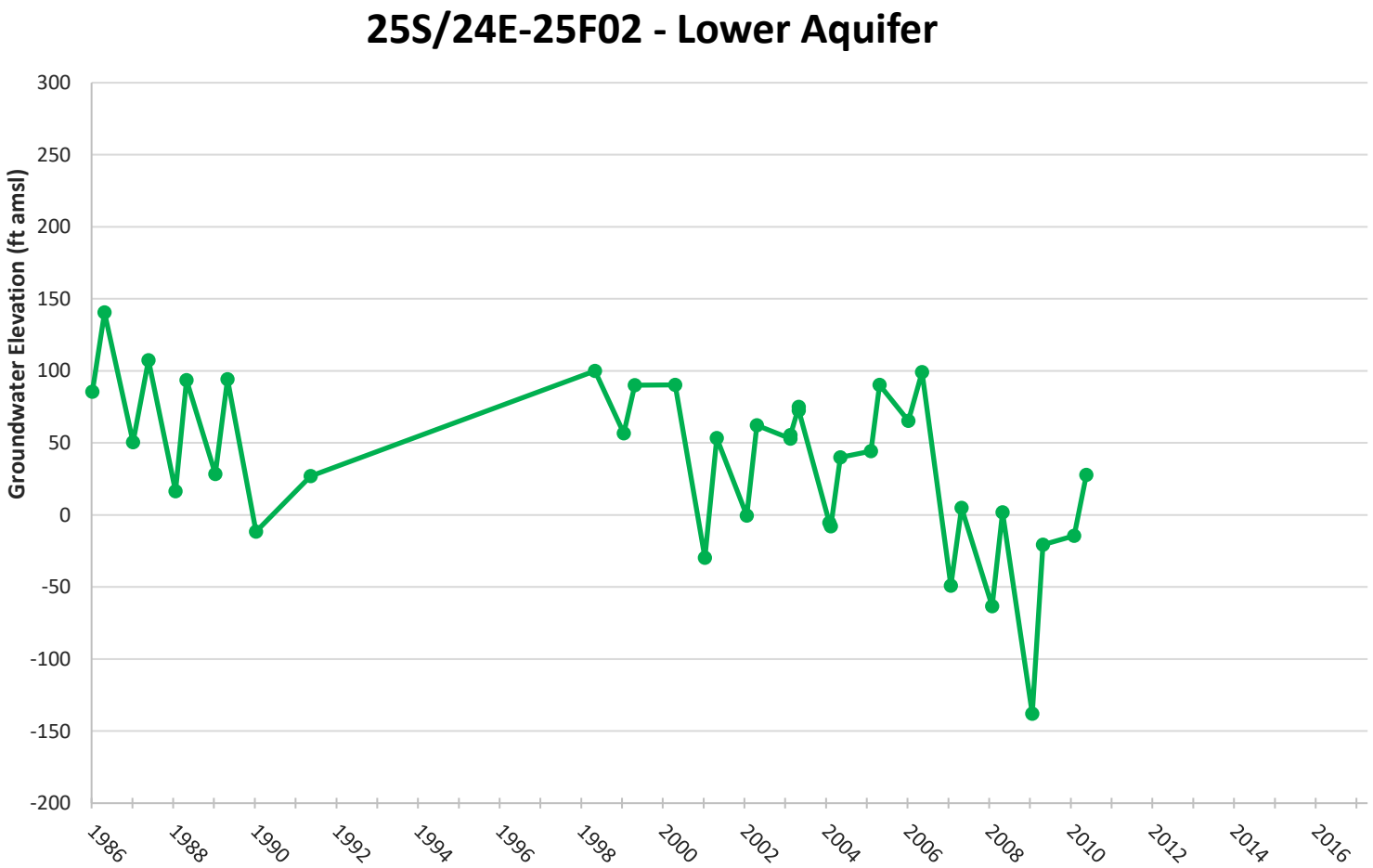
Boundary Condition Well Hydrograph



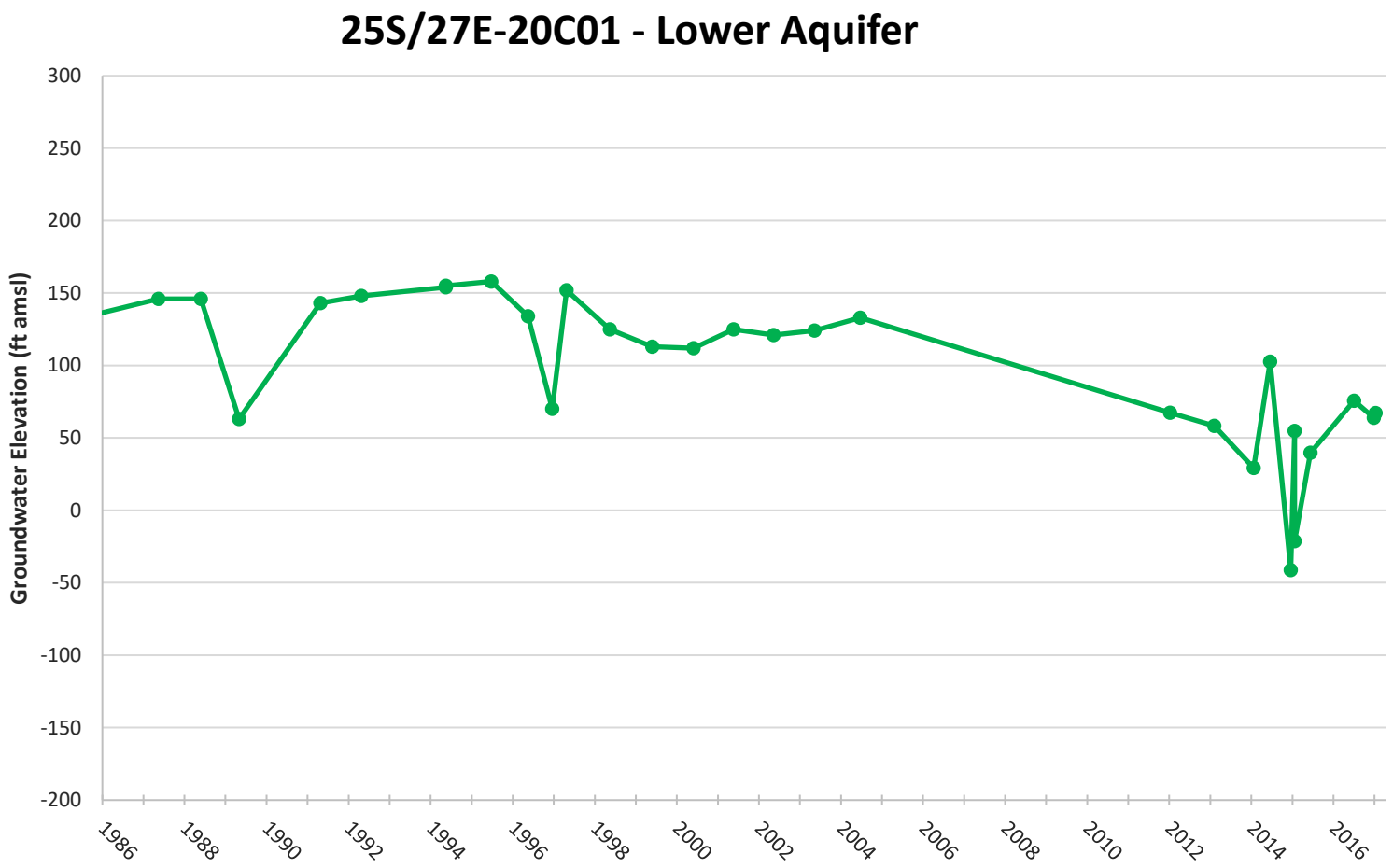
Boundary Condition Well Hydrograph



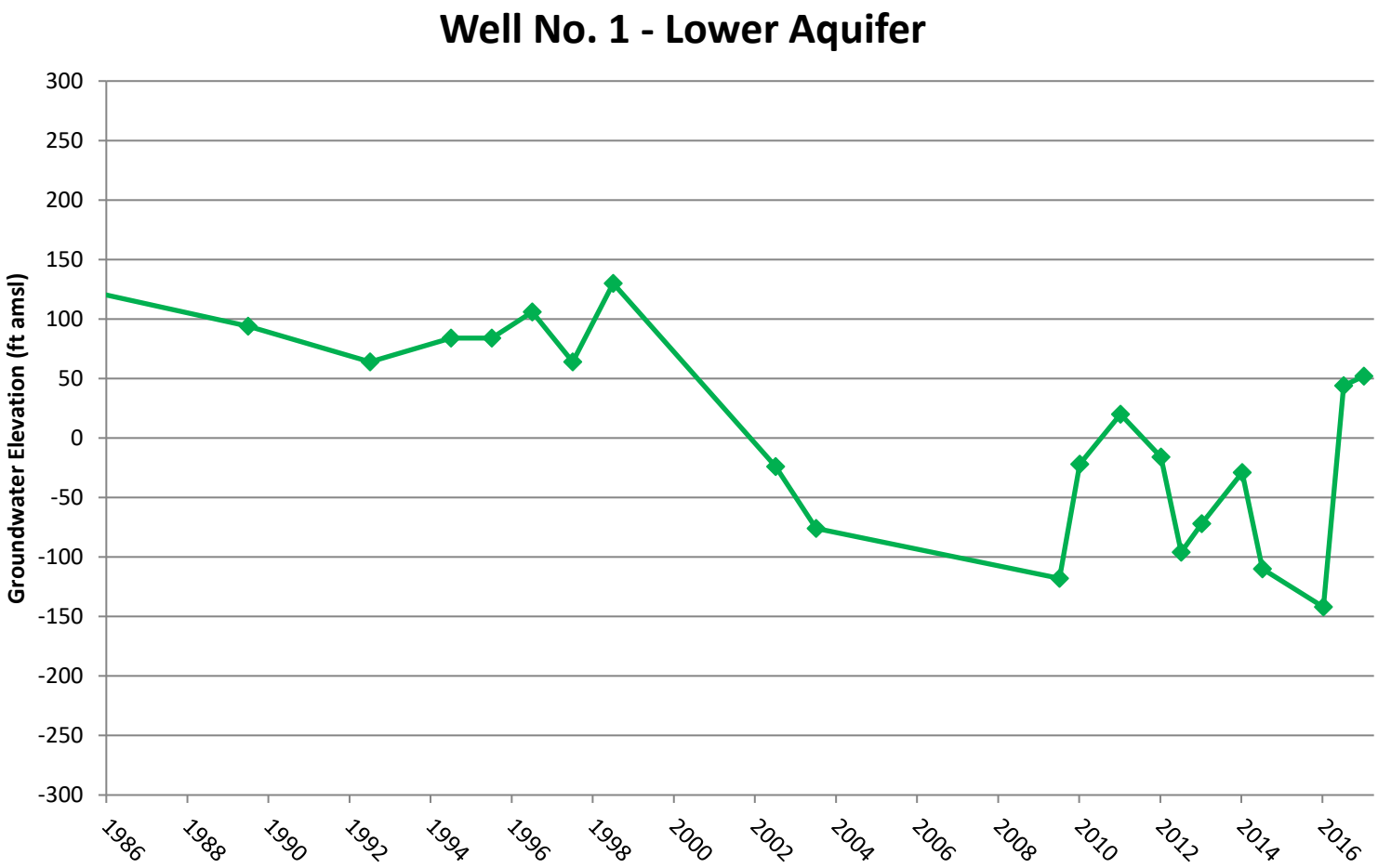
Boundary Condition Well Hydrograph



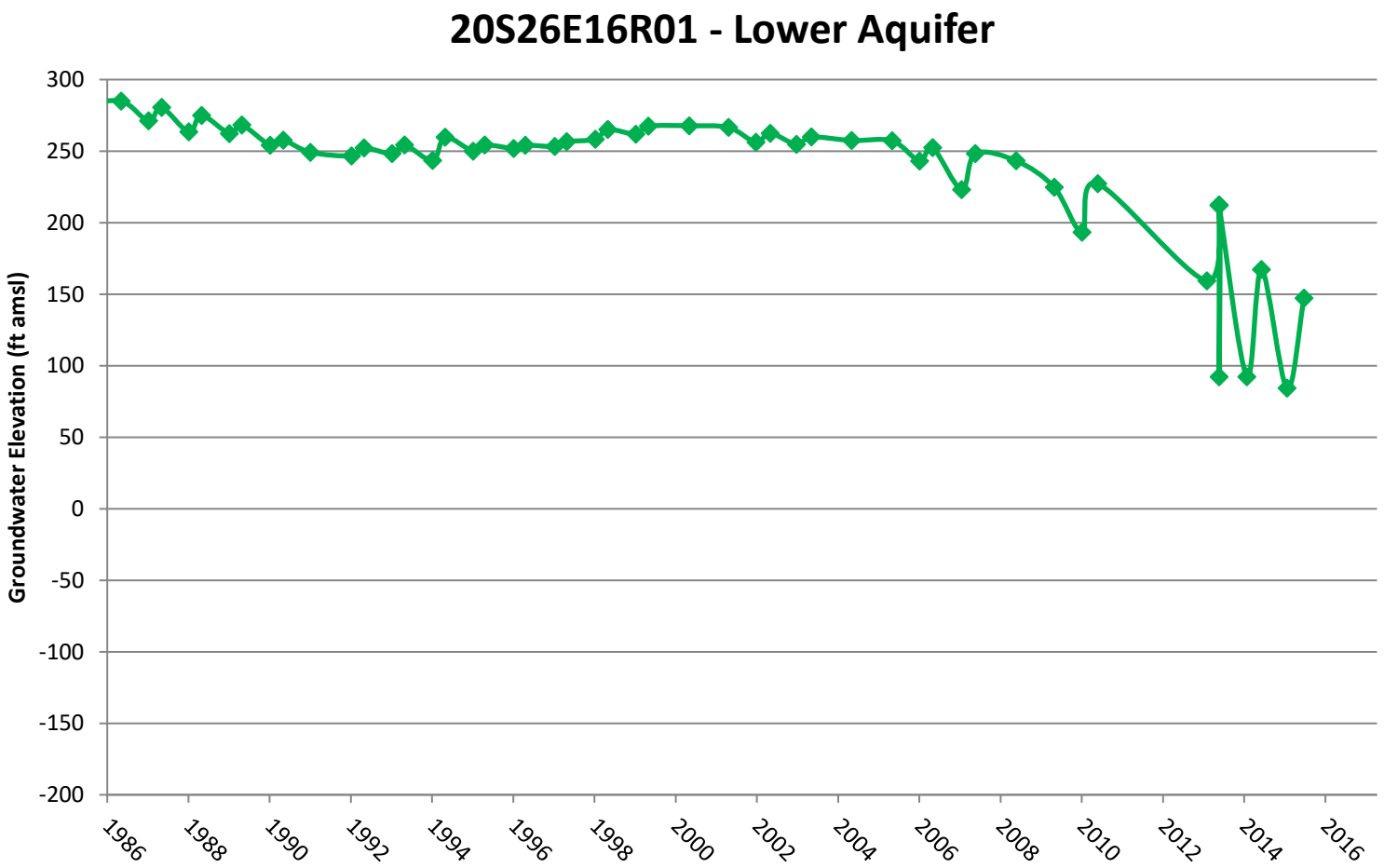
Boundary Condition Well Hydrograph



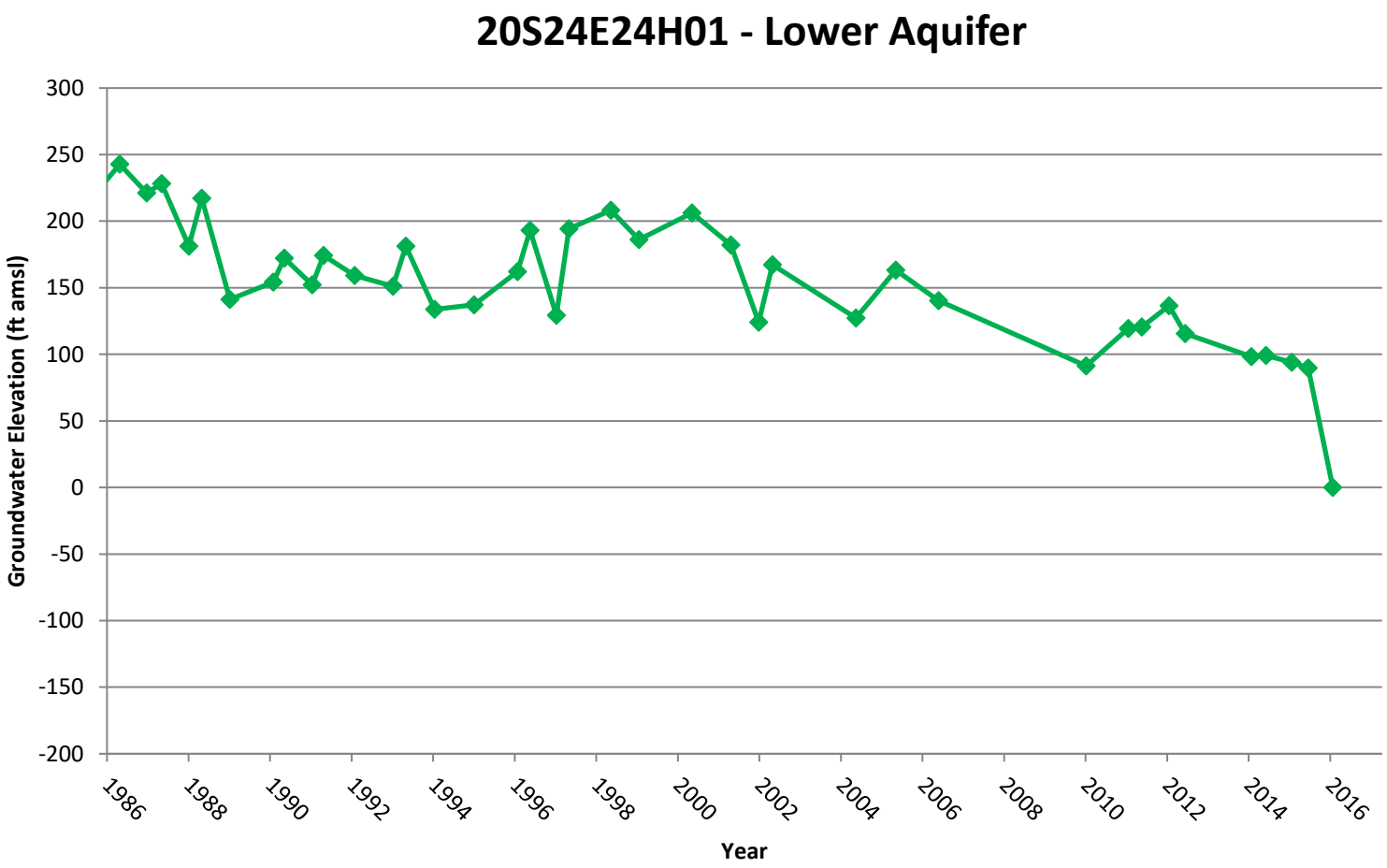
Boundary Condition Well Hydrograph



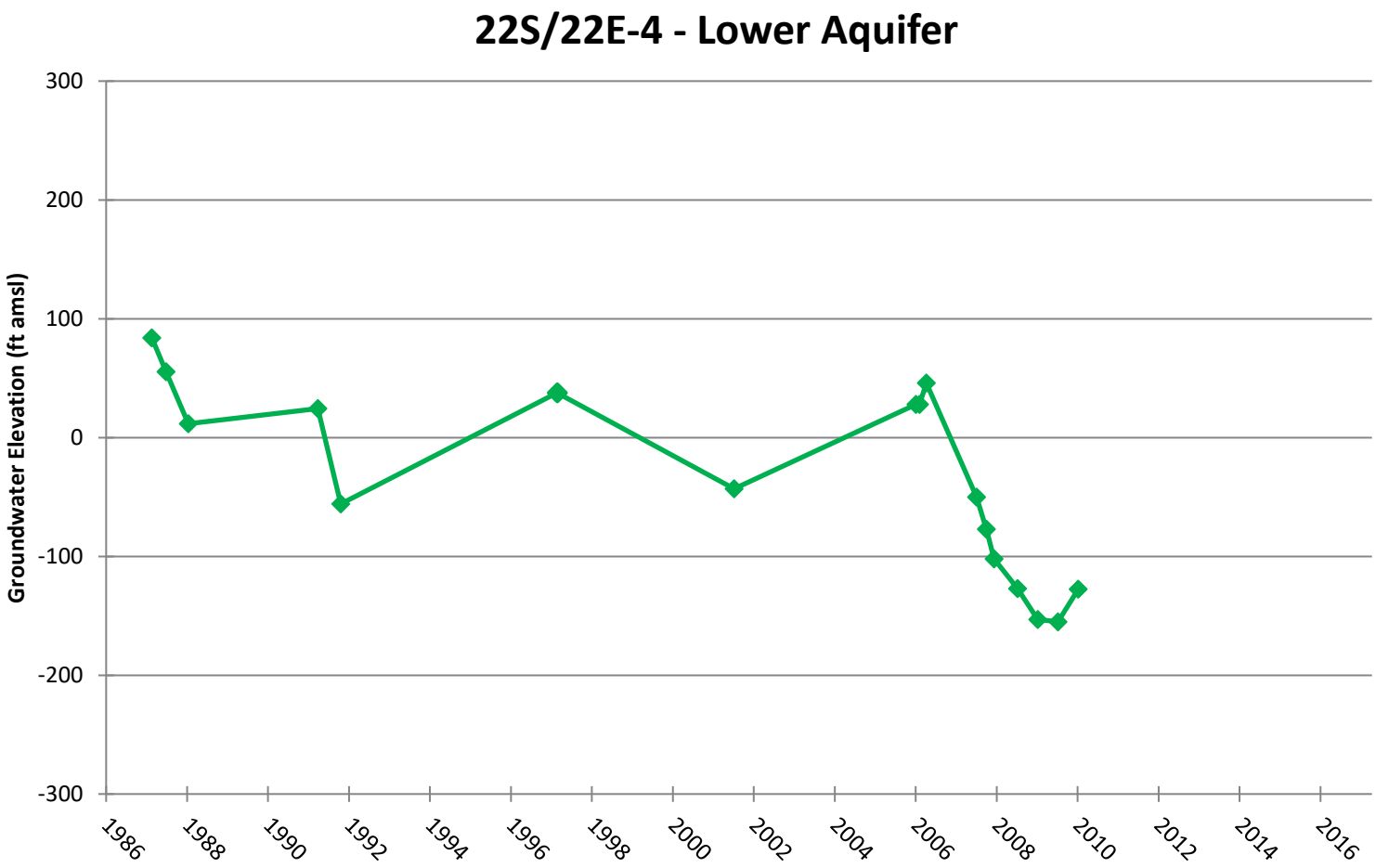
Boundary Condition Well Hydrograph



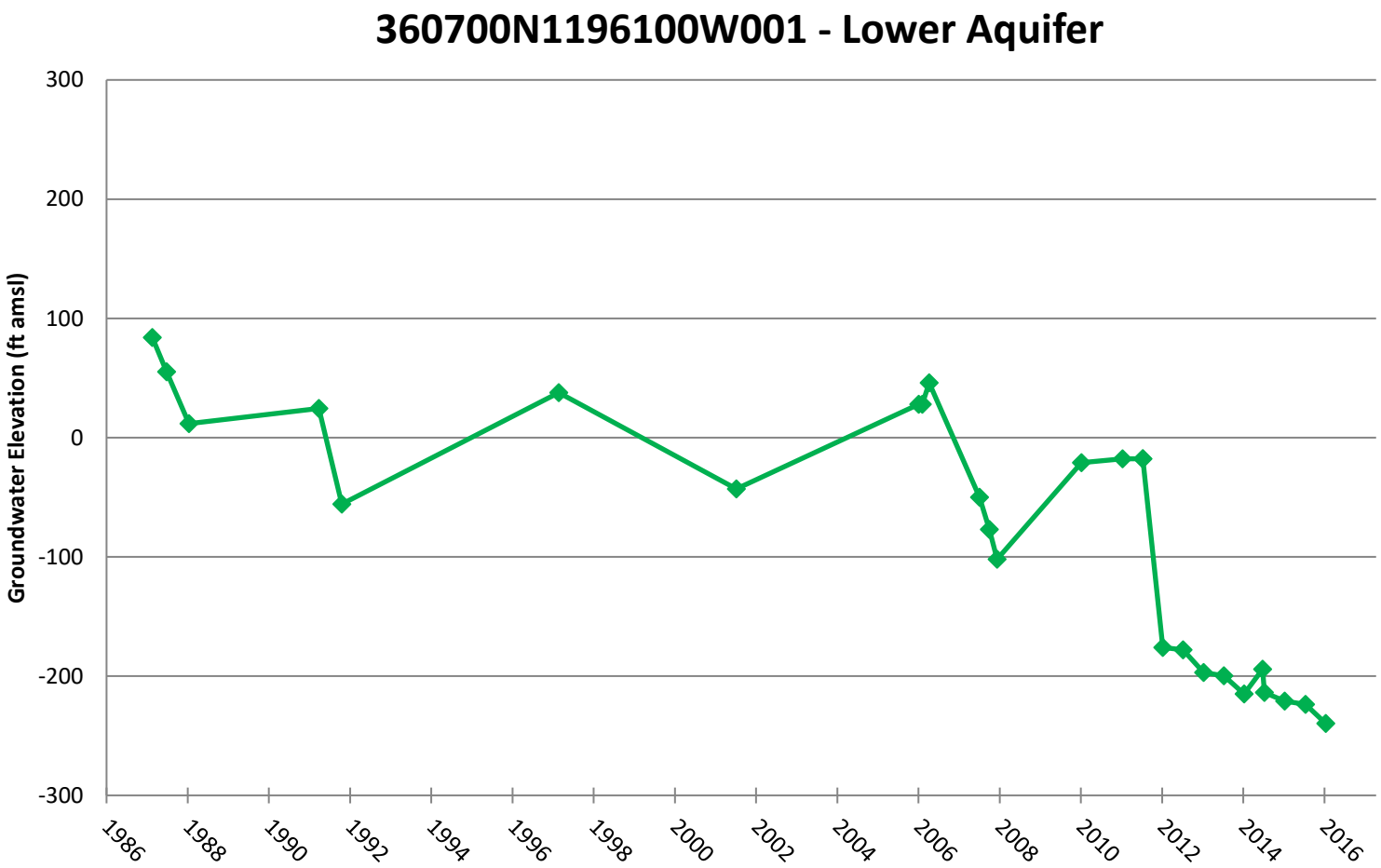
Boundary Condition Well Hydrograph



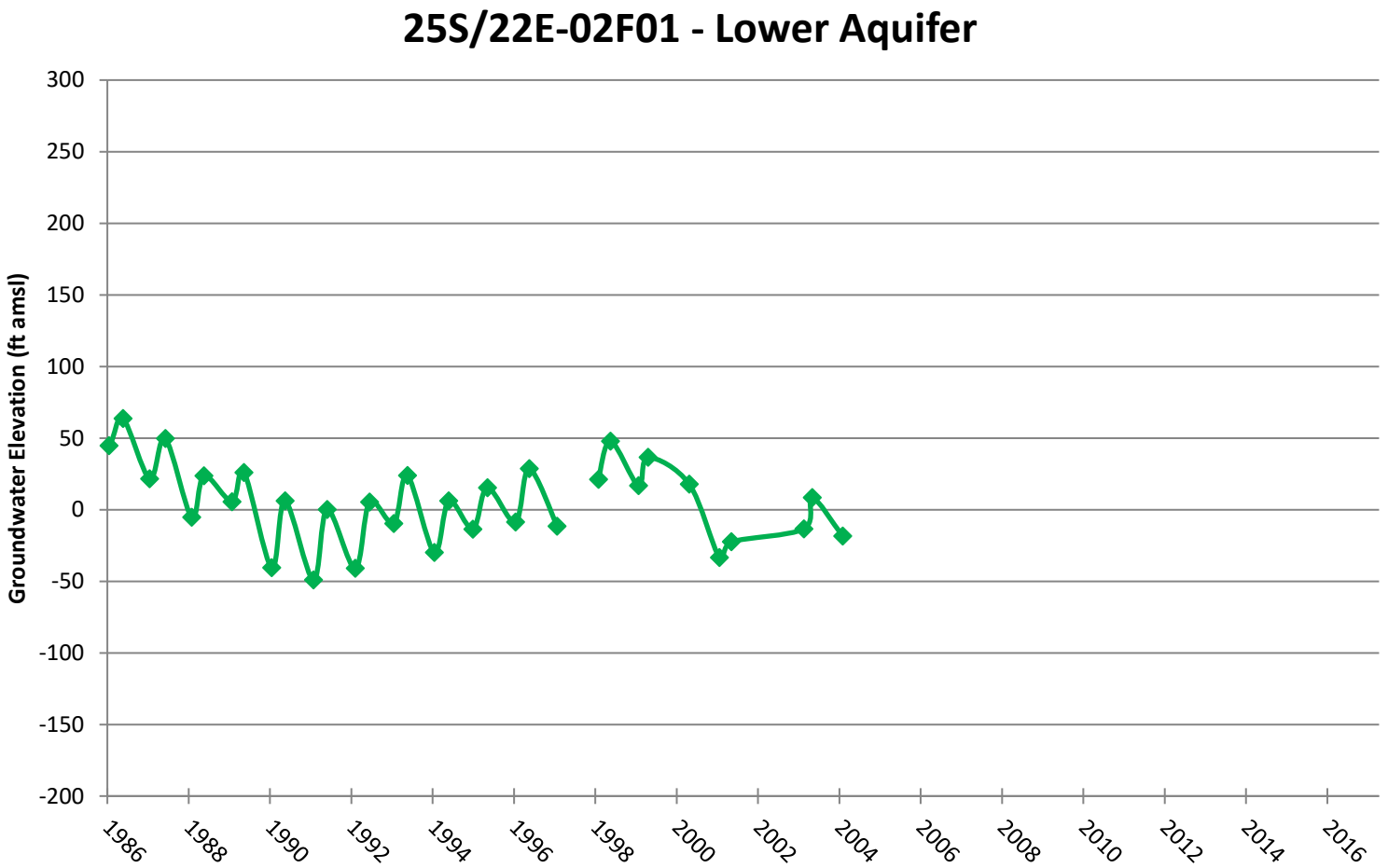
Boundary Condition Well Hydrograph



Boundary Condition Well Hydrograph



Boundary Condition Well Hydrograph



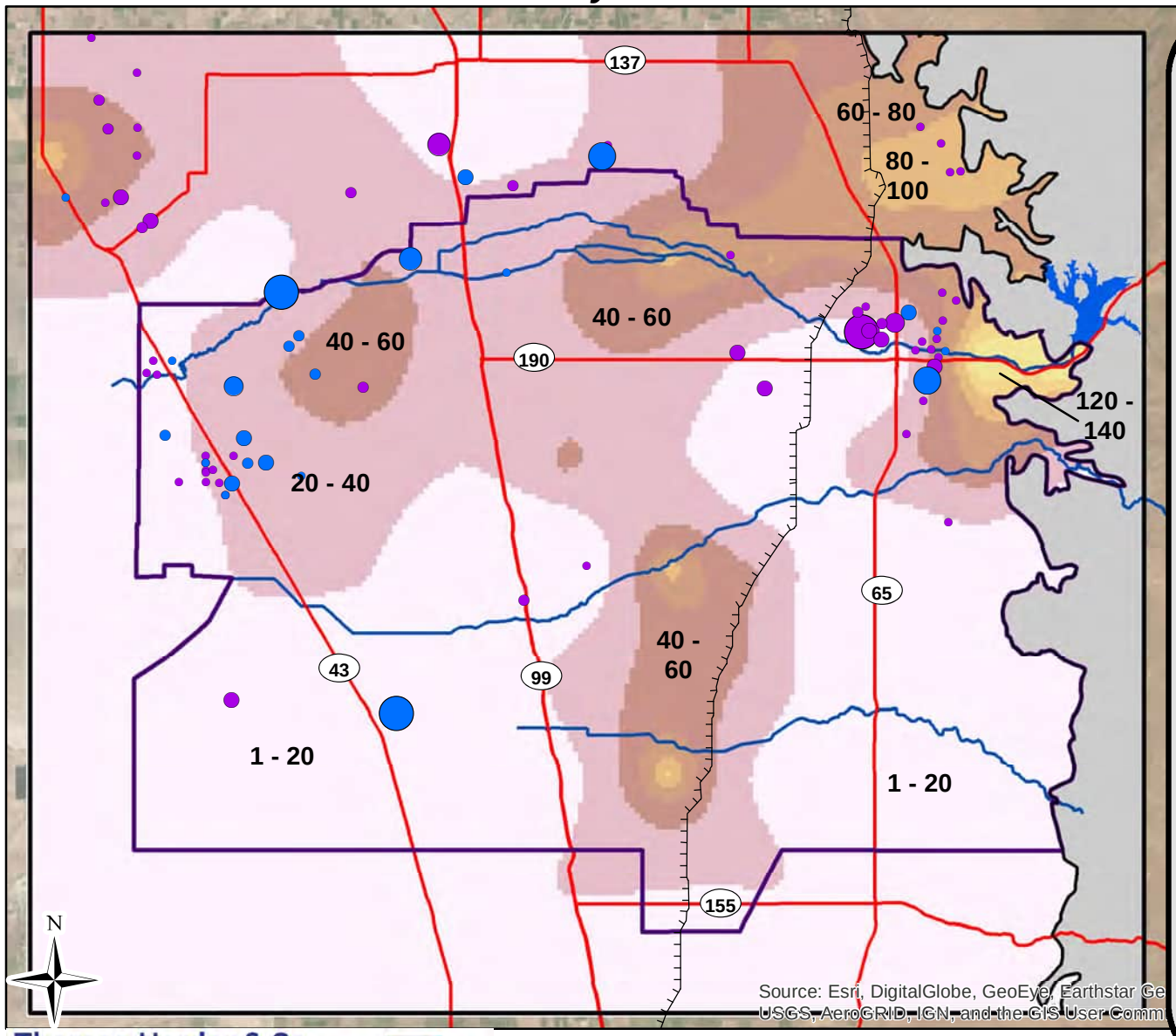
Appendix C

Calibration Parameters

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Map Features

Hydraulic Conductivity (ft/day)
in Wells Perforated in Layer 1

- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 120
- > 120

Hydraulic Conductivity (ft/day)
in Wells Perforated Across Multiple Layers
(Composite Wells)

- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 120
- > 120

Model Calibrated Horizontal
Hydraulic Conductivity (ft/day)

- 1 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 120
- 120 - 140
- 140 - 160
- 160 - 180
- 180 - 200
- Model Domain
- No Flow Zone

Thomas Harder & Co.
Groundwater Consulting

NAD 83 State Plane Zone 4

Note: Blue and purple dots indicate Hydraulic Conductivity values derived from controlled pumping tests (see Table 3).

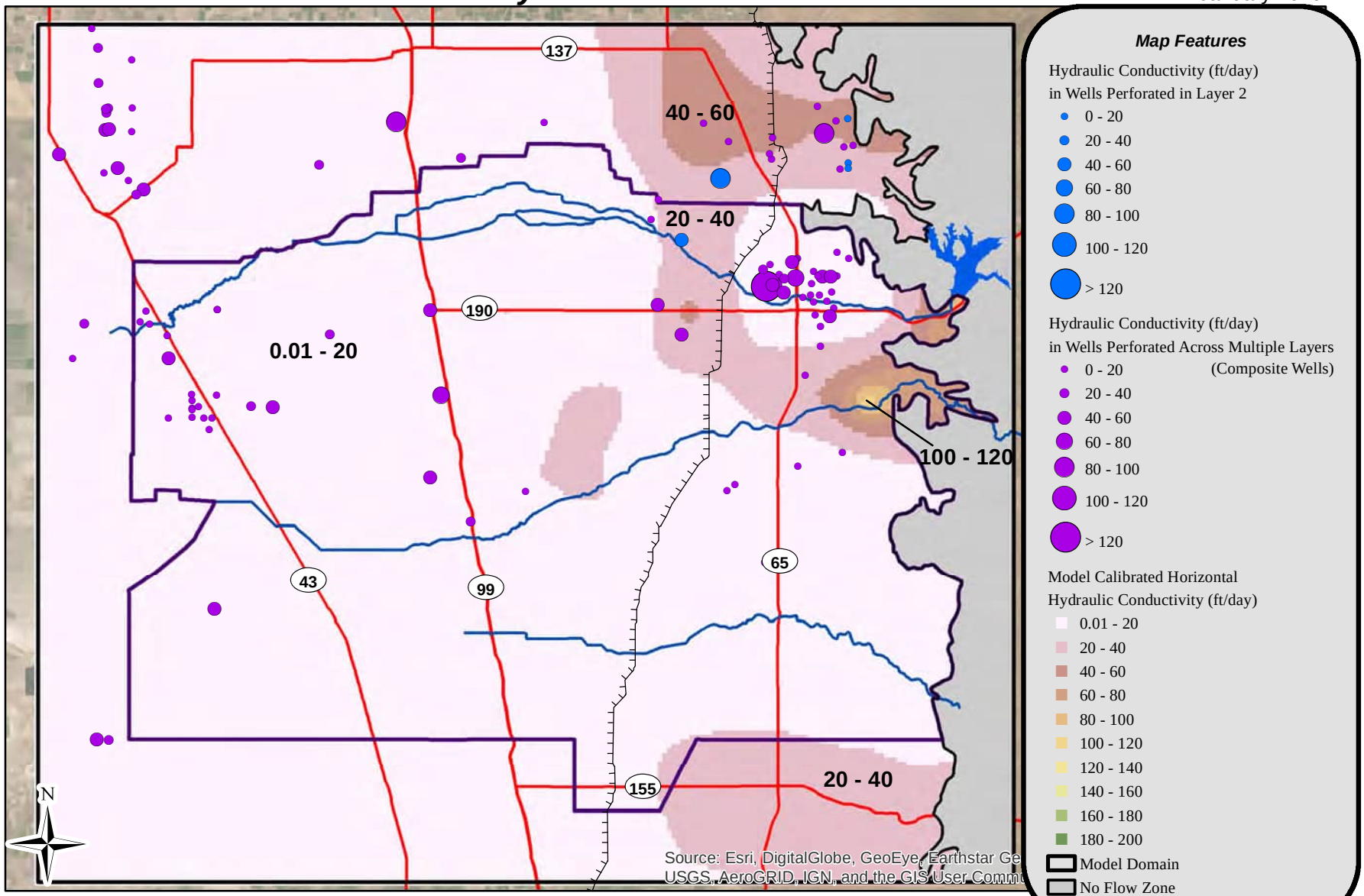
Layer 1 Horizontal Hydraulic Conductivity

Appendix C-1

Groundwater Flow Model of the Tule Subbasin

January 2020

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

NAD 83 State Plane Zone 4

Note: Blue and purple dots indicate Hydraulic Conductivity values derived from controlled pumping tests (see Table 3).

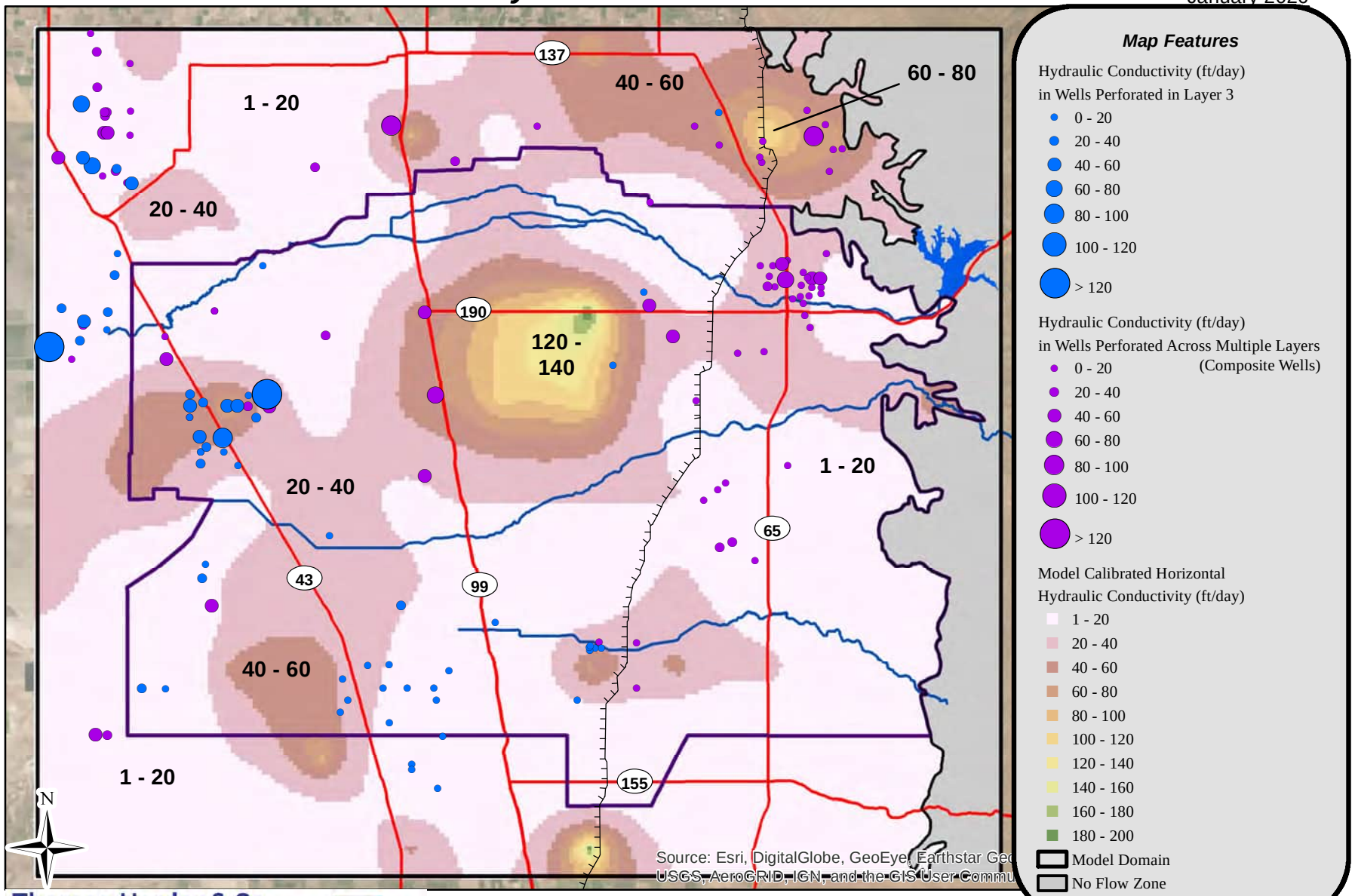
Layer 2 Horizontal Hydraulic Conductivity

Appendix C-2

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Map Features

Hydraulic Conductivity (ft/day) in Wells Perforated in Layer 3

- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 120
- > 120

Hydraulic Conductivity (ft/day) in Wells Perforated Across Multiple Layers (Composite Wells)

- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 120
- > 120

Model Calibrated Horizontal Hydraulic Conductivity (ft/day)

- 1 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 120
- 120 - 140
- 140 - 160
- 160 - 180
- 180 - 200
- Model Domain
- No Flow Zone

Thomas Harder & Co.
Groundwater Consulting

NAD 83 State Plane Zone 4

Note: Blue and purple dots indicate Hydraulic Conductivity values derived from controlled pumping tests (see Table 3).

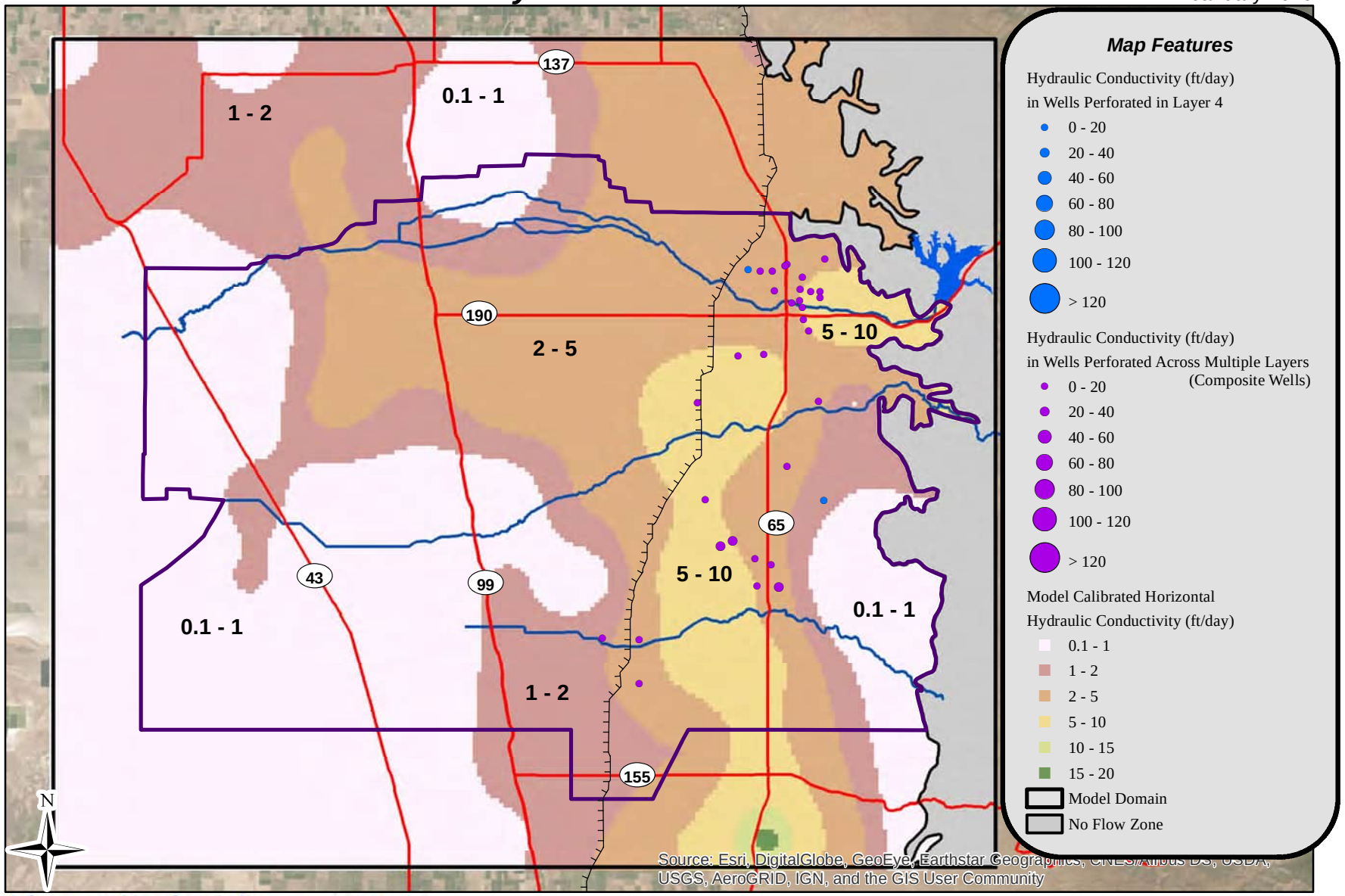
Layer 3 Horizontal Hydraulic Conductivity

Appendix C-3

Groundwater Flow Model of the Tule Subbasin

January 2020

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

NAD 83 State Plane Zone 4

Note: Blue and purple dots indicate Hydraulic Conductivity values derived from controlled pumping tests (see Table 3).

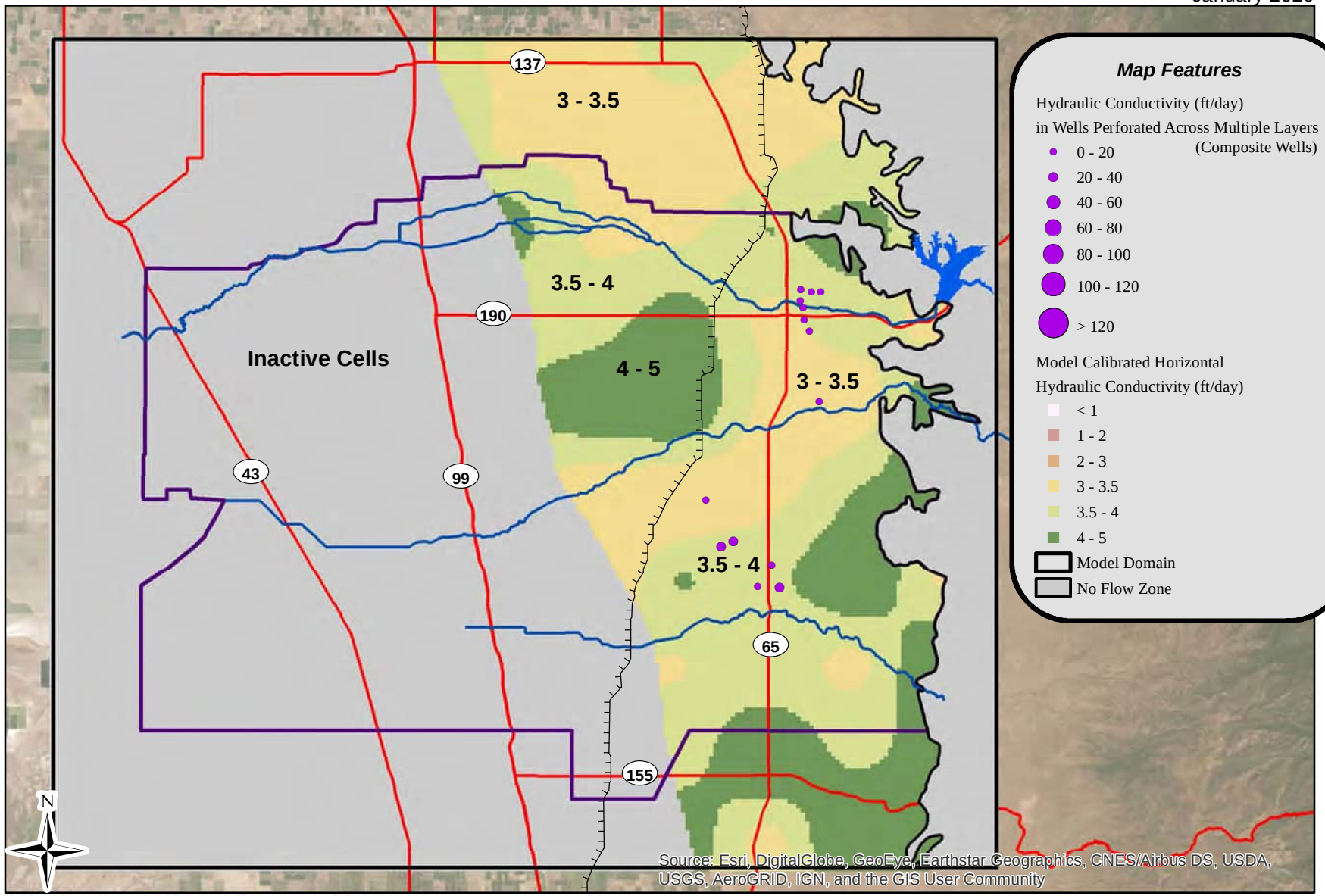
Layer 4 Horizontal Hydraulic Conductivity

Appendix C-4

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20 Miles

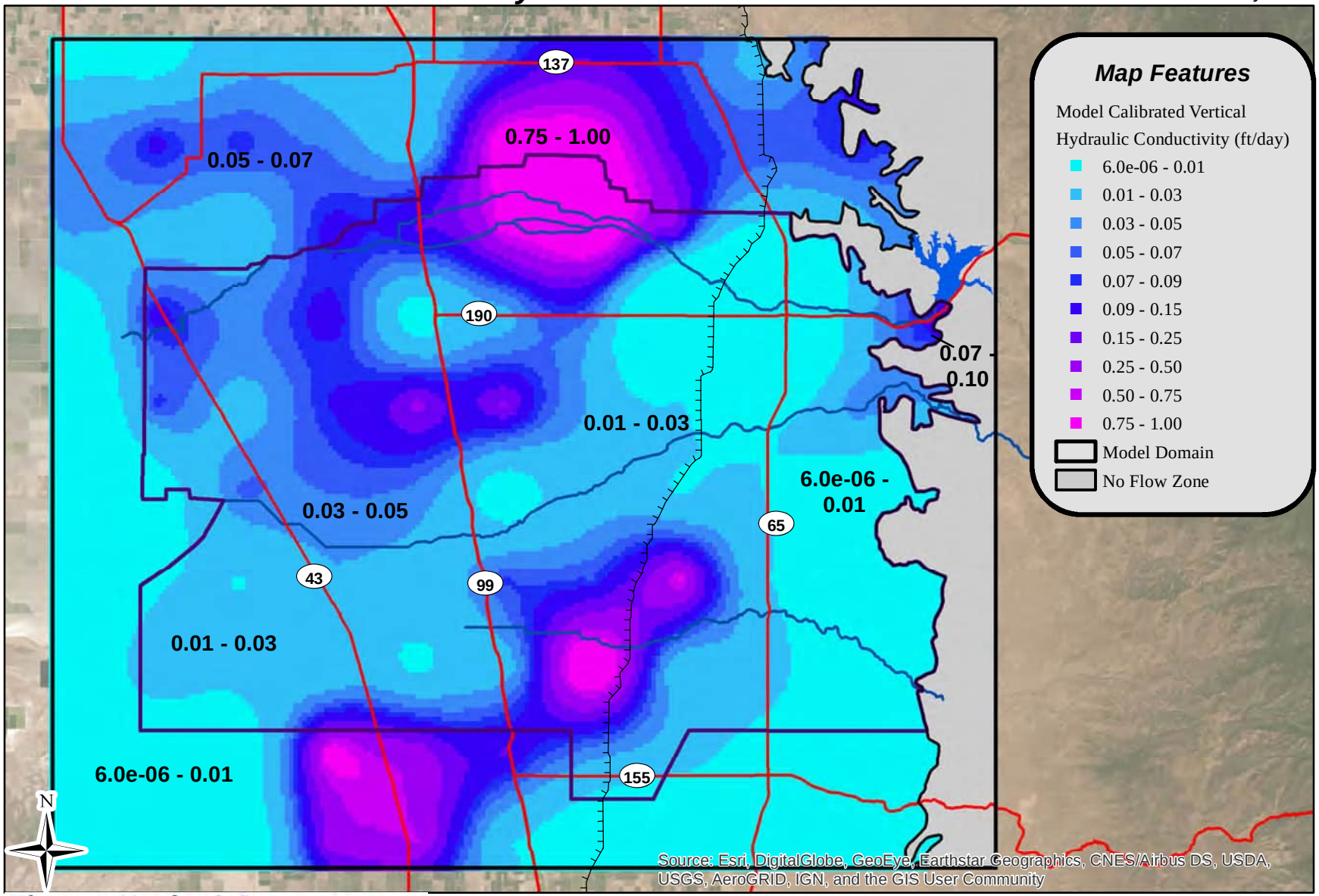
NAD 83 State Plane Zone 4

Note: Purple dots indicate Hydraulic Conductivity values derived from controlled pumping tests (see Table 3).

Layer 5 Horizontal Hydraulic Conductivity

Appendix C-5

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

NAD 83 State Plane Zone 4

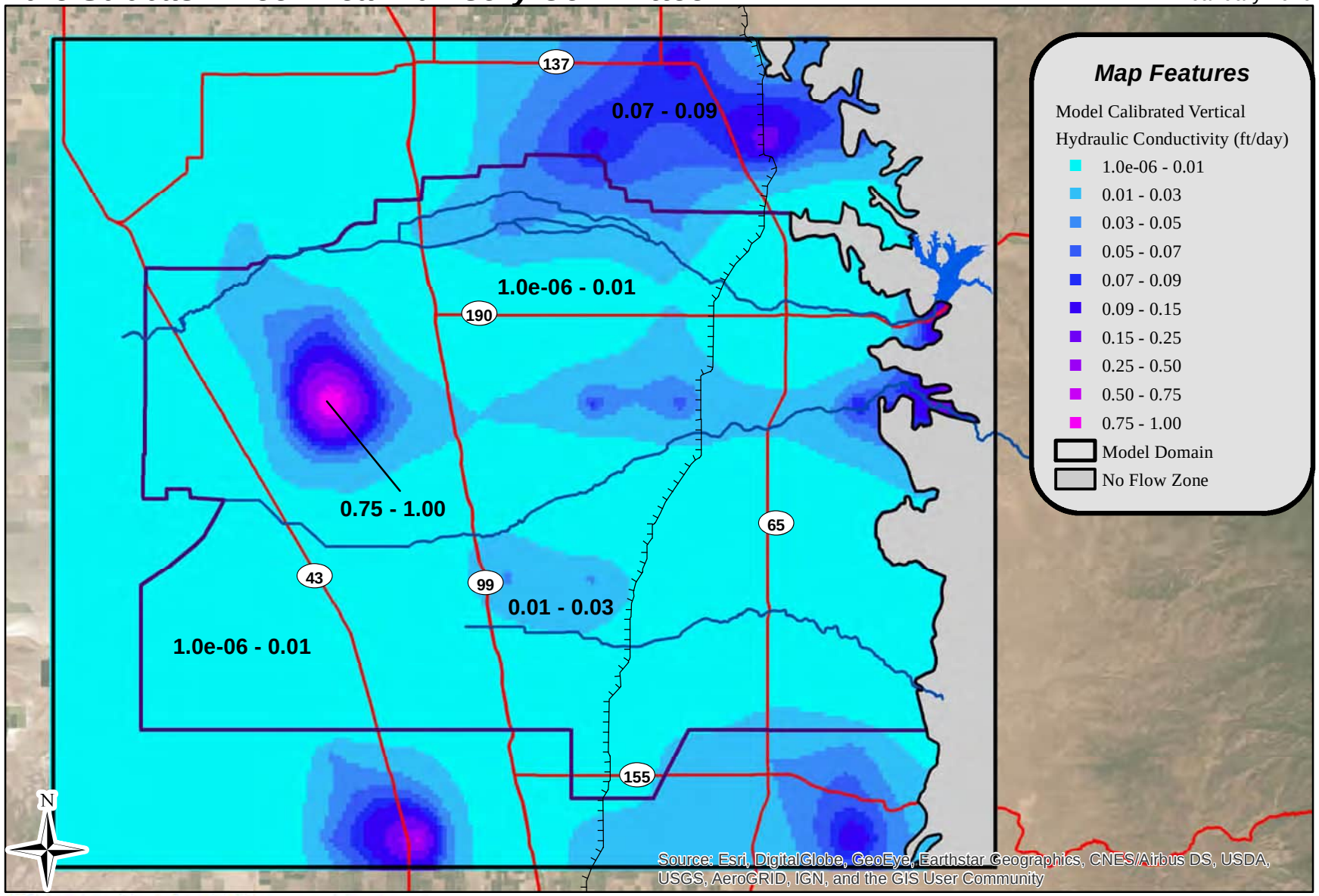
Layer 1 Vertical Hydraulic Conductivity

Appendix C-6

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20
Miles

NAD 83 State Plane Zone 4

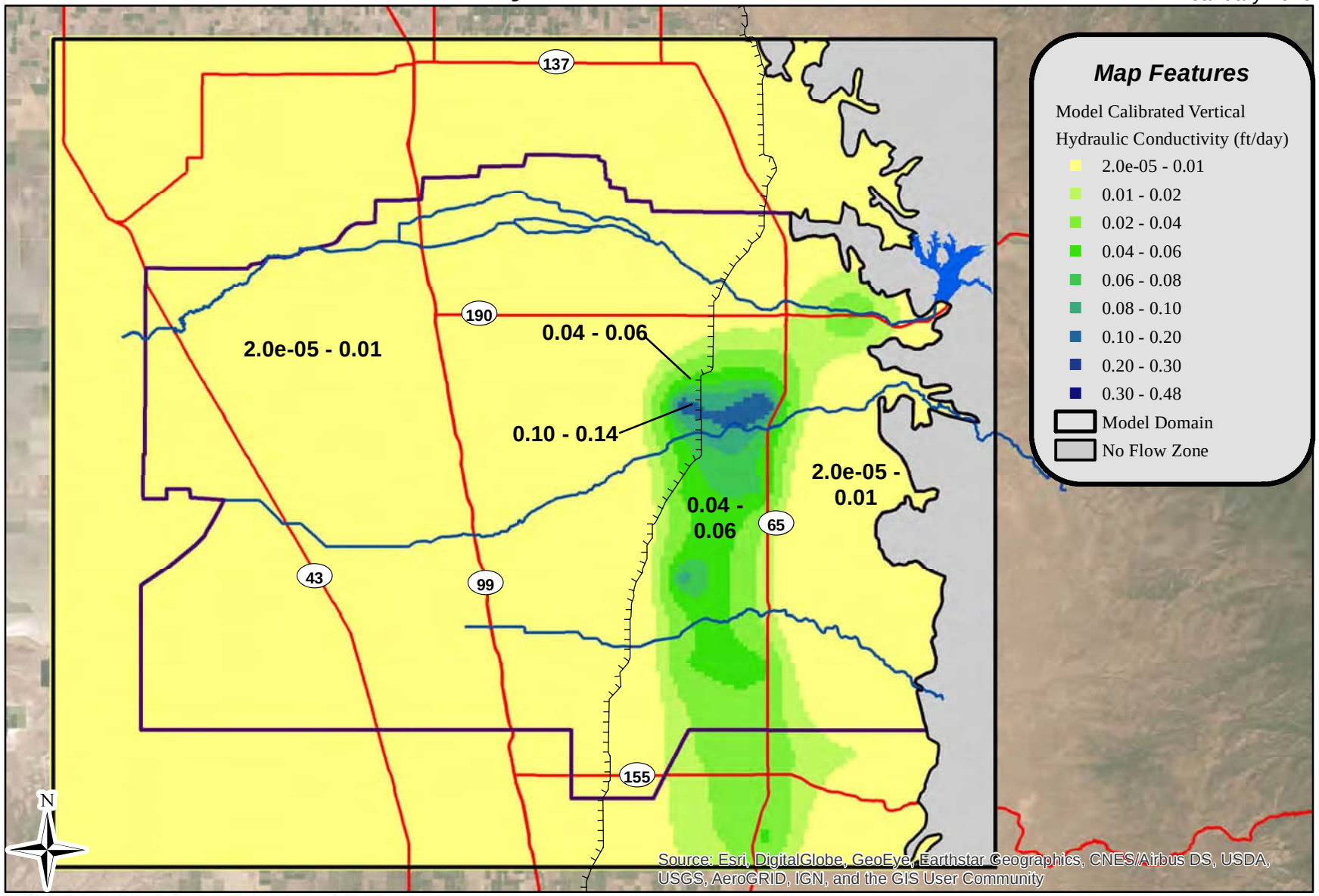
Layer 2 Vertical Hydraulic Conductivity

Appendix C-7

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20 Miles

NAD 83 State Plane Zone 4

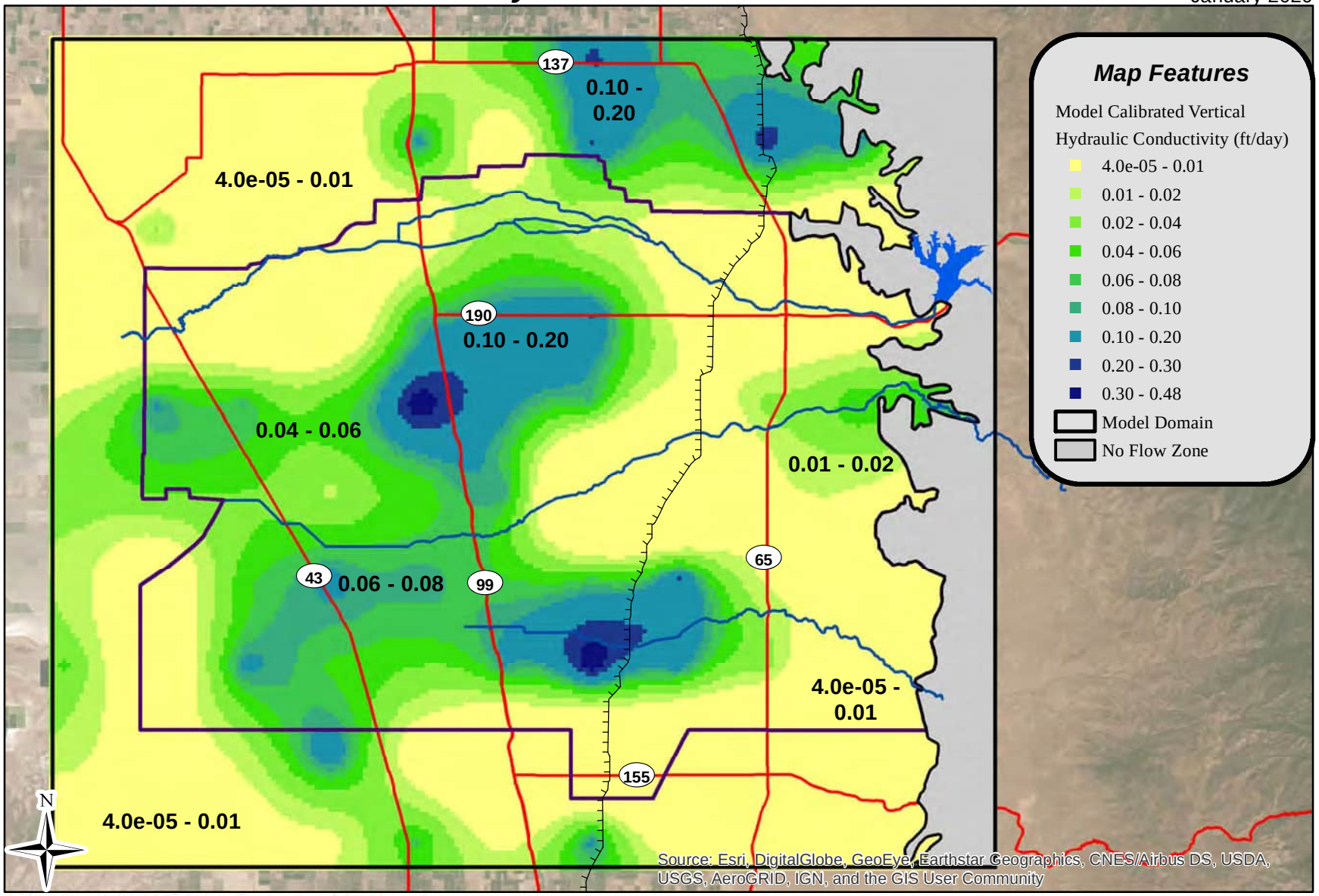
Layer 4 Vertical Hydraulic Conductivity

Appendix C-8

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Thomas Harder & Co.
Groundwater Consulting

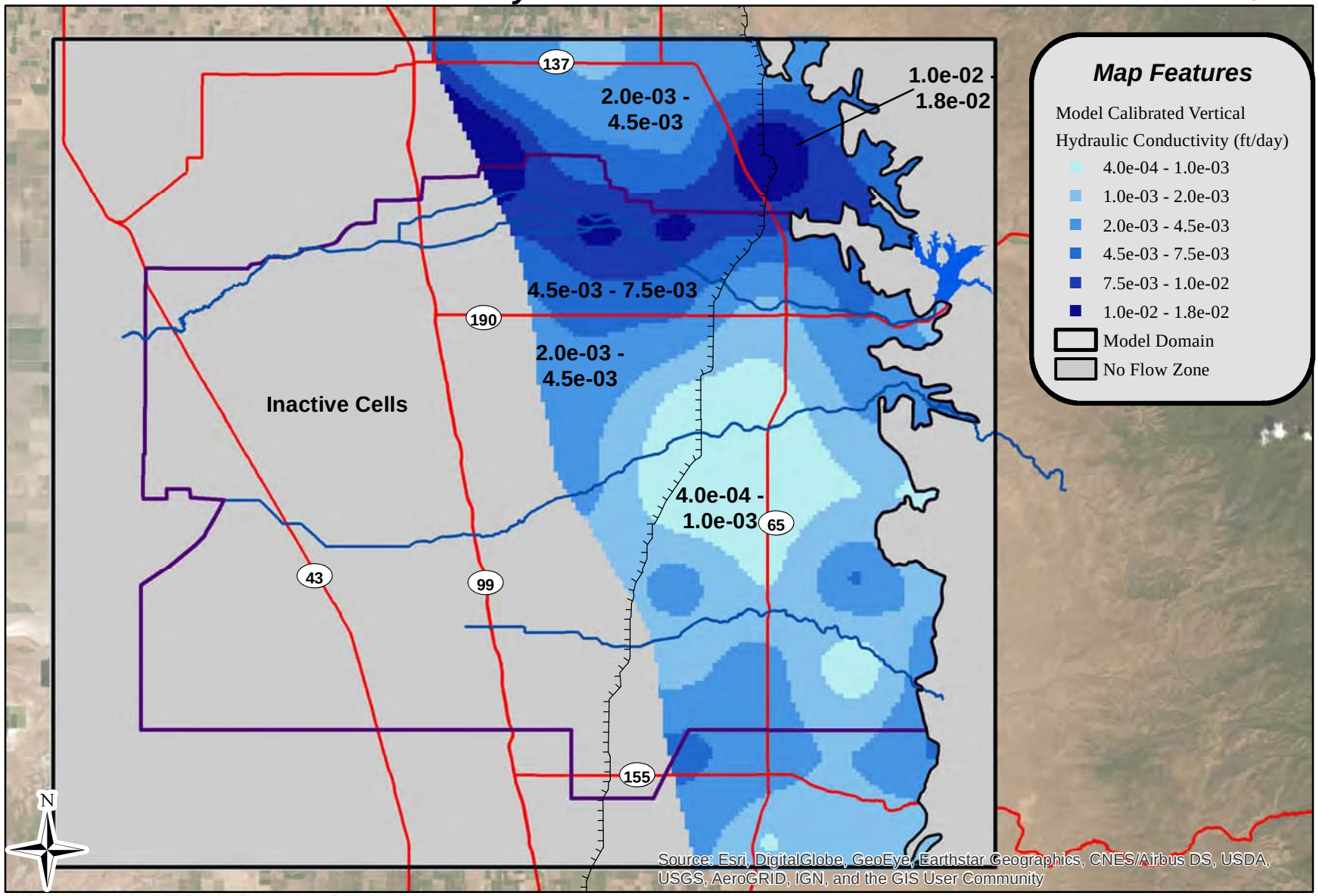
0 5 10 20 Miles

NAD 83 State Plane Zone 4

Layer 3 Vertical Hydraulic Conductivity

Appendix C-9

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

NAD 83 State Plane Zone 4

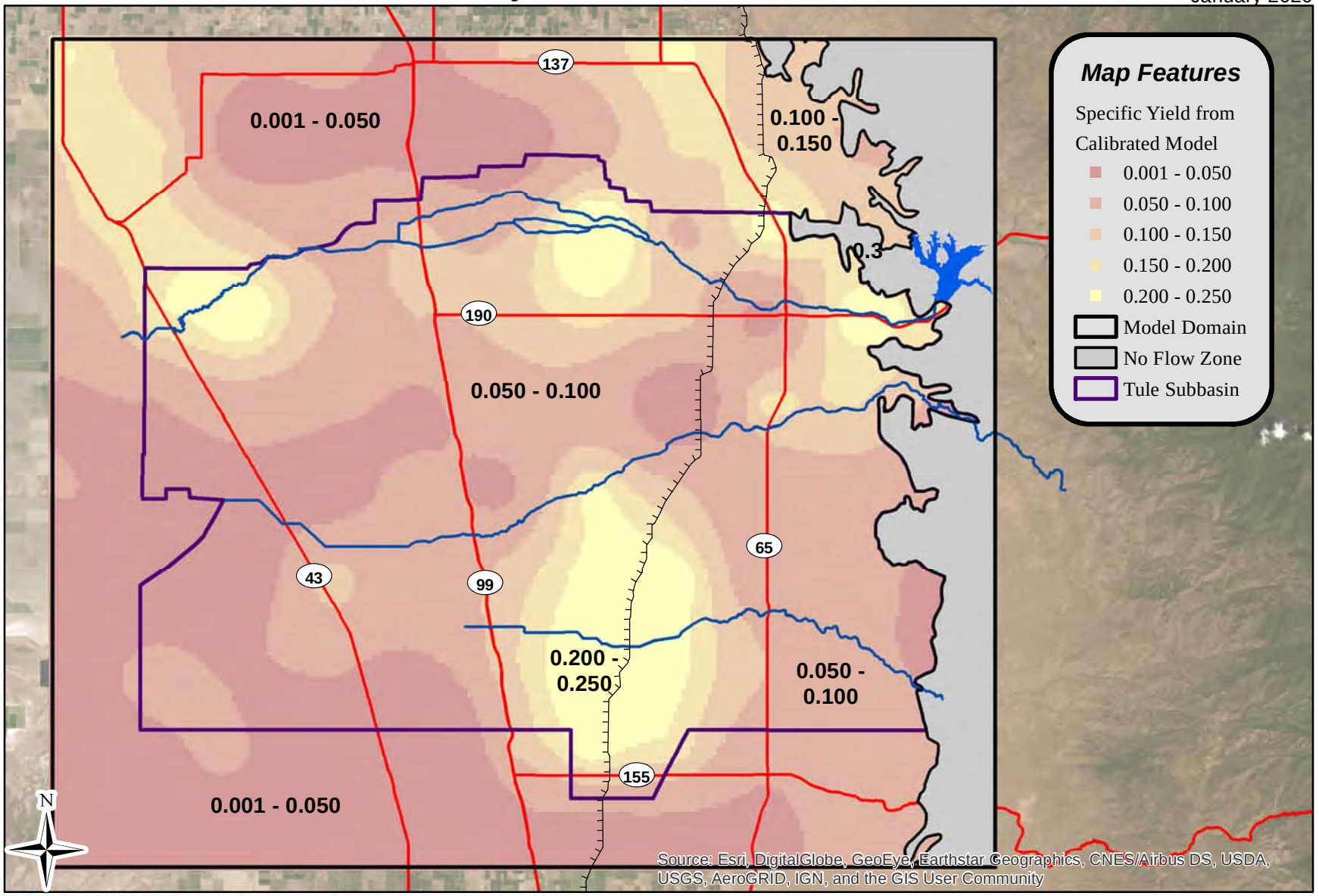
Layer 5 Vertical Hydraulic Conductivity

Appendix C-10

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20 Miles

NAD 83 State Plane Zone 4

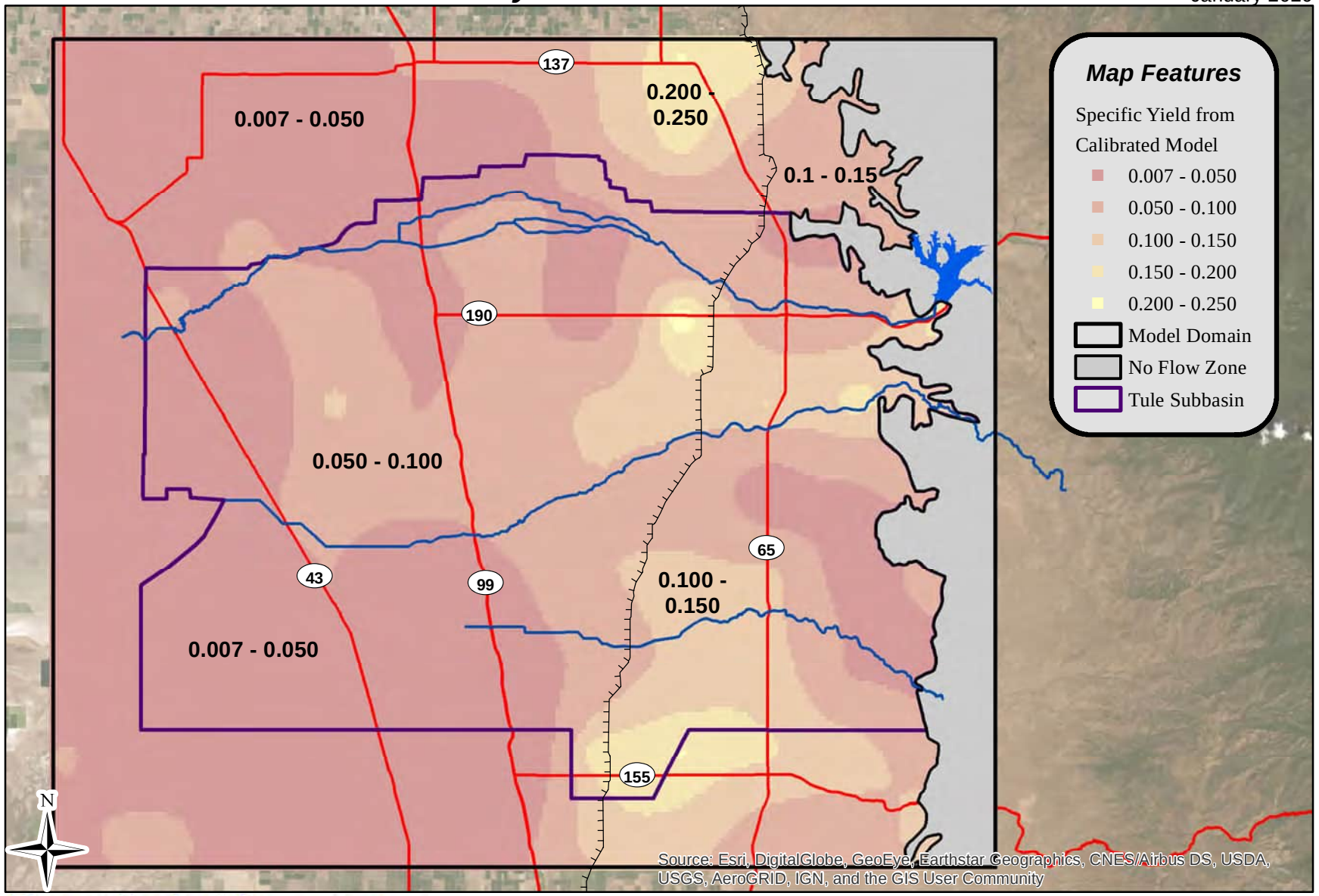
Layer 1 Specific Yield

Appendix C-11

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20
Miles

NAD 83 State Plane Zone 4

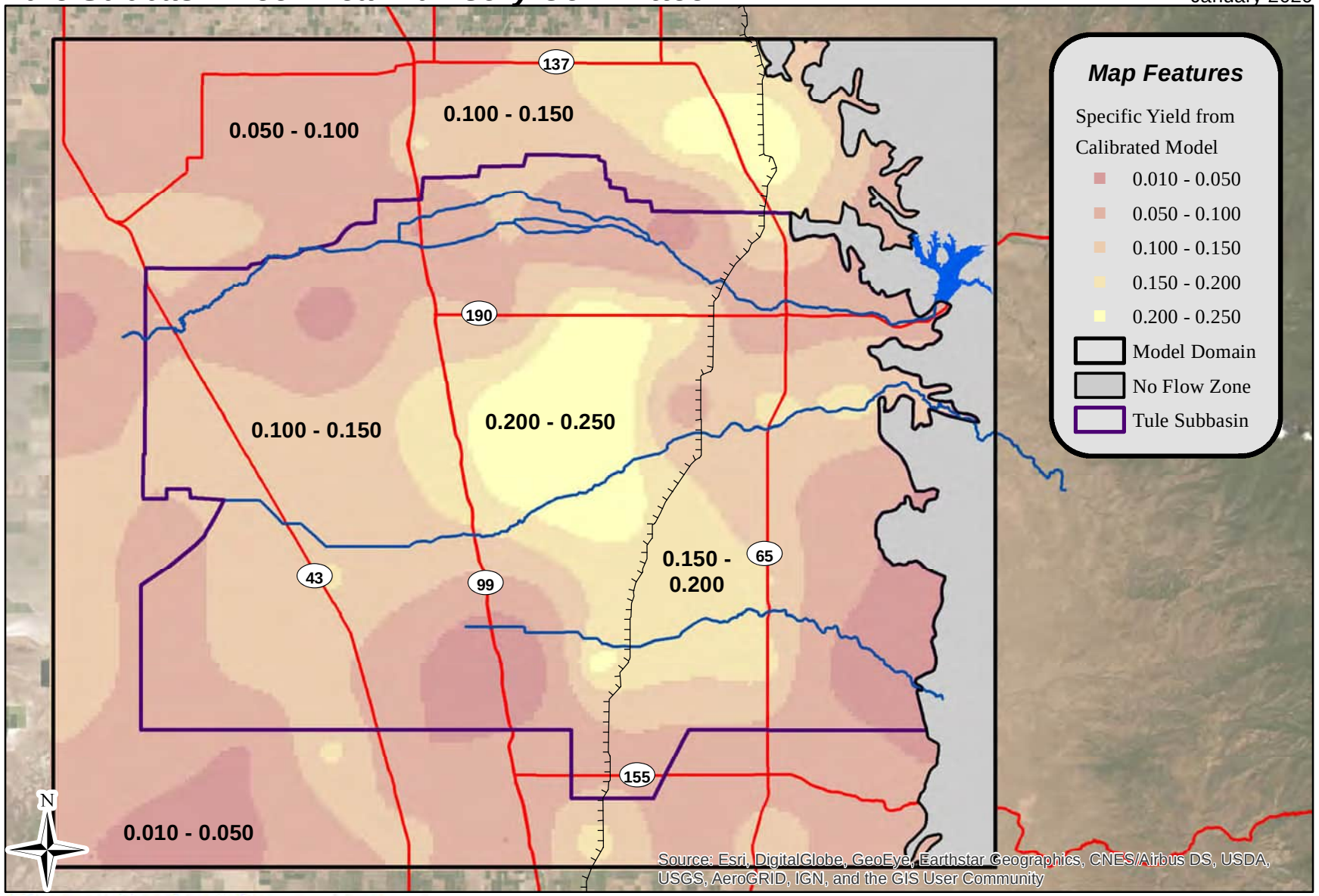
Layer 2 Specific Yield

Appendix C-12

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20 Miles

NAD 83 State Plane Zone 4

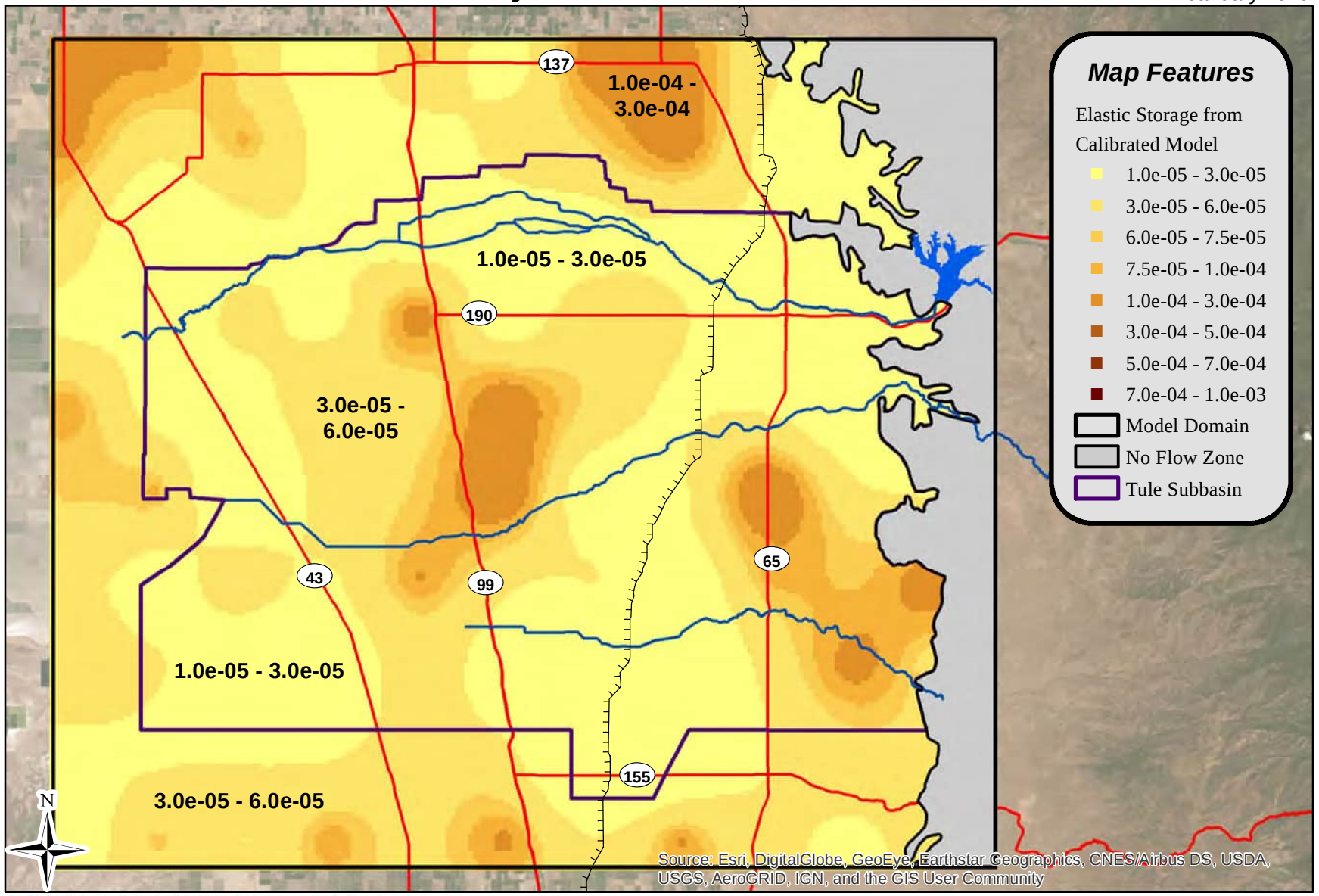
Layer 3 Specific Yield

Appendix C-13

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20 Miles

NAD 83 State Plane Zone 4

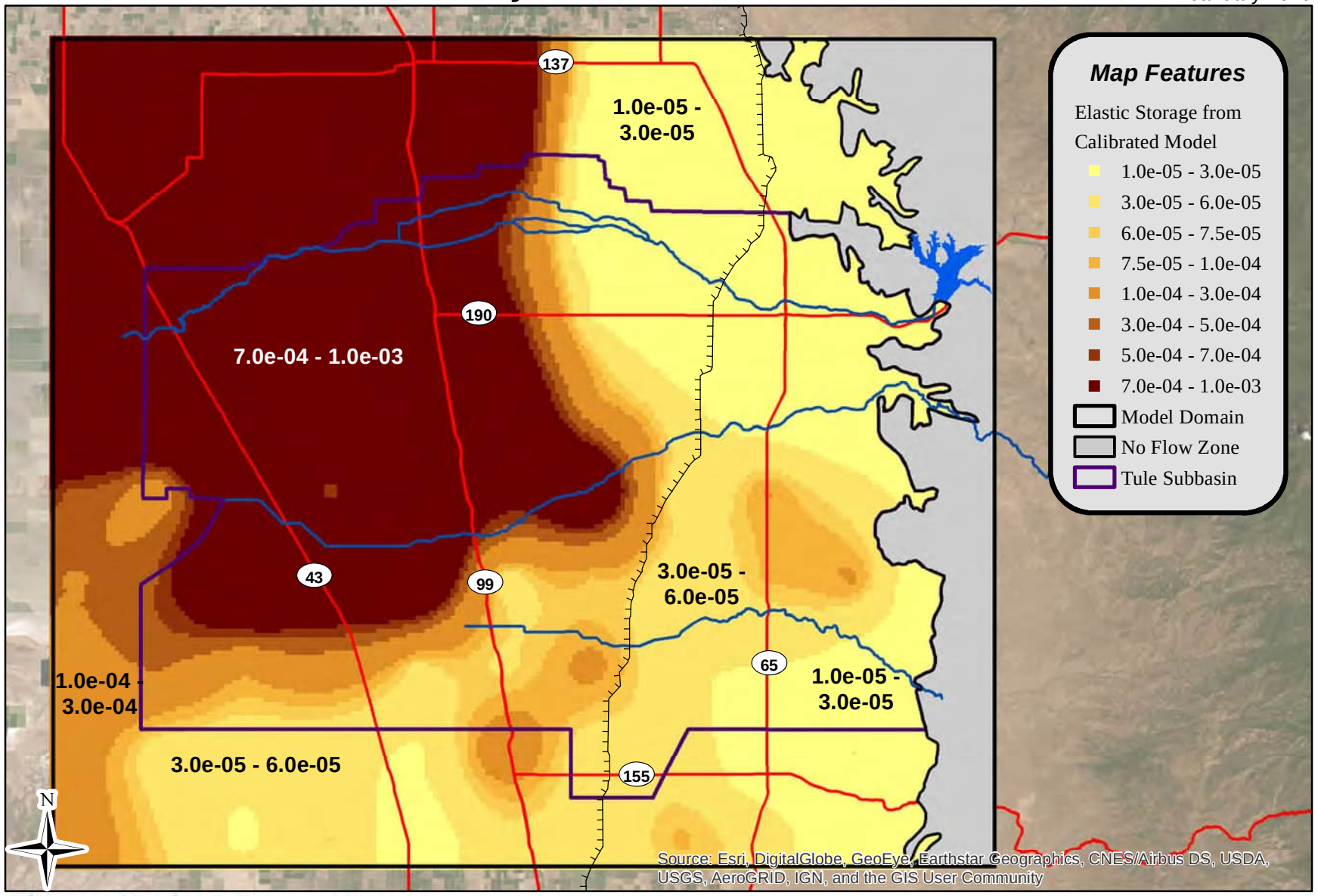
Layer 1 Elastic Storage

Appendix C-14

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20 Miles

NAD 83 State Plane Zone 4

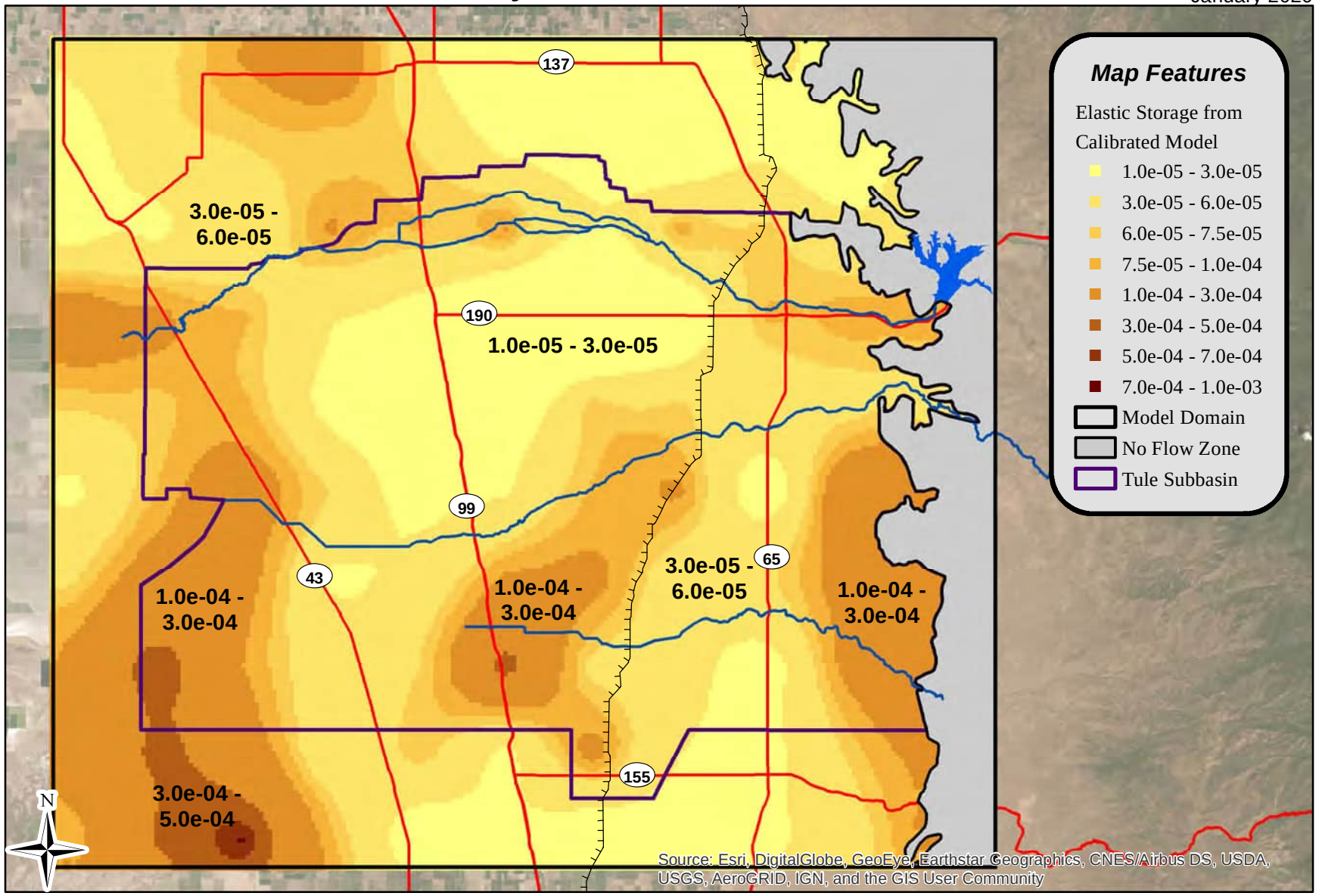
Layer 2 Elastic Storage

Appendix C-15

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20 Miles

NAD 83 State Plane Zone 4

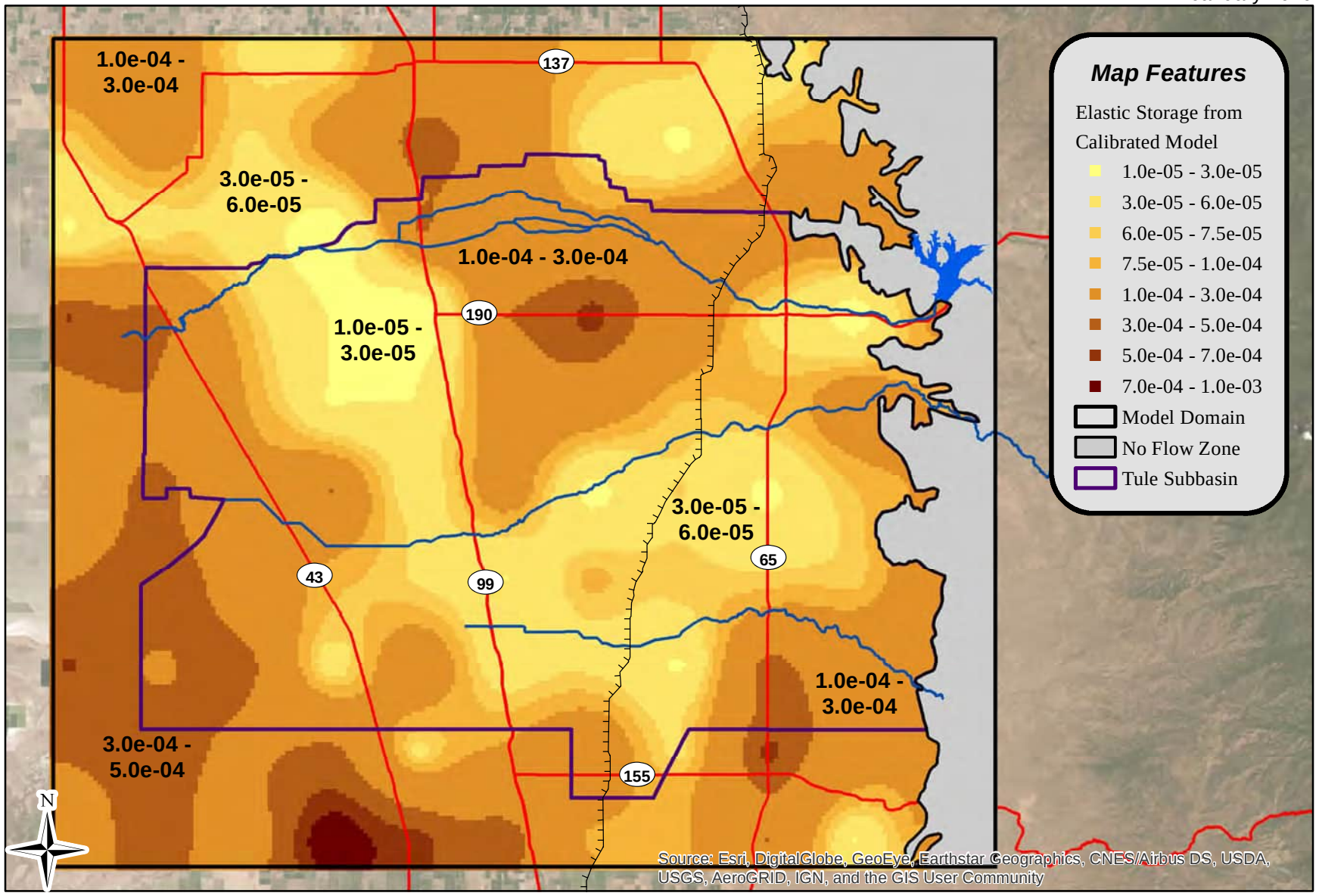
Layer 3 Elastic Storage

Appendix C-16

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



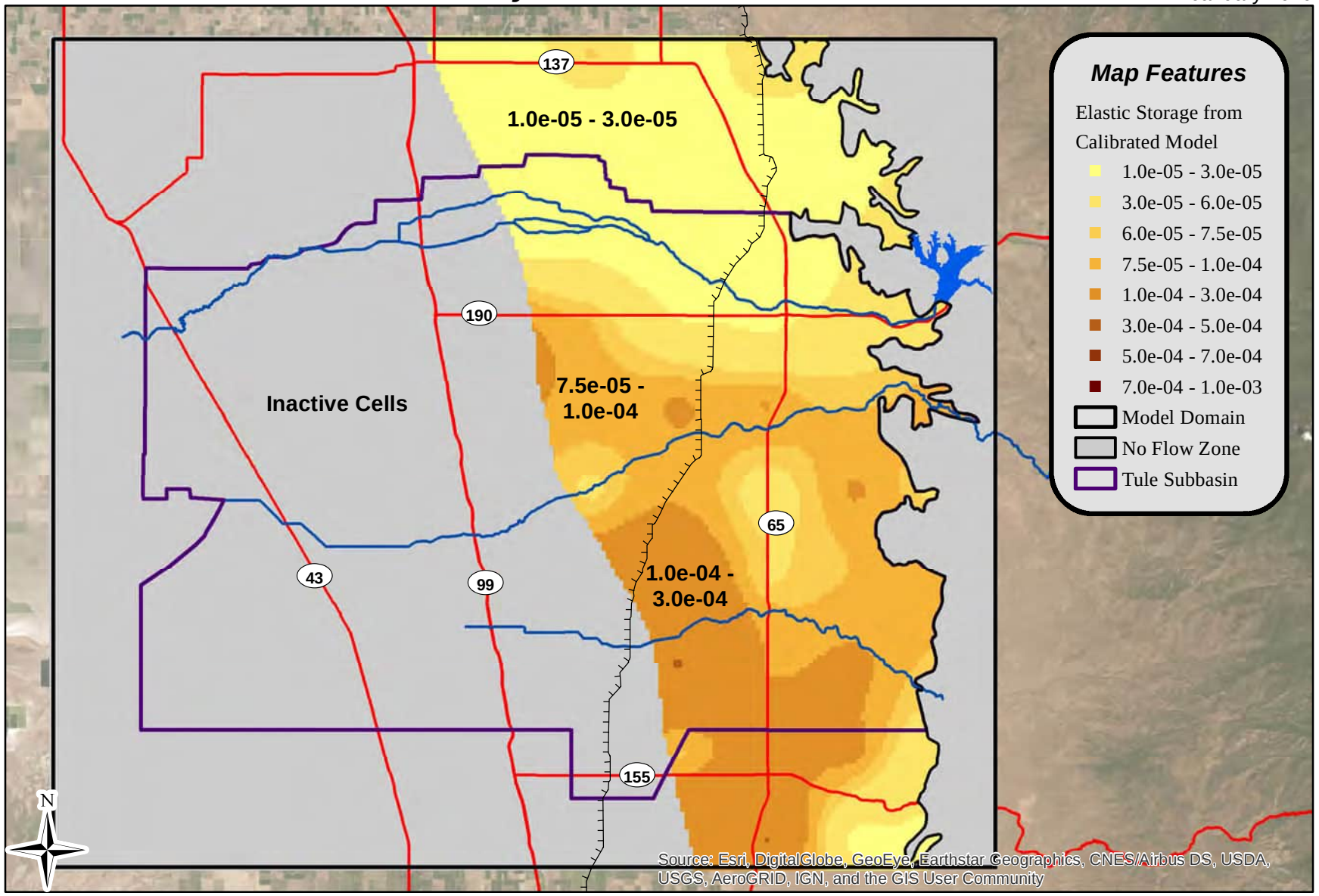
Thomas Harder & Co.
Groundwater Consulting

0 5 10 20 Miles

NAD 83 State Plane Zone 4

Layer 4 Elastic Storage

Appendix C-17

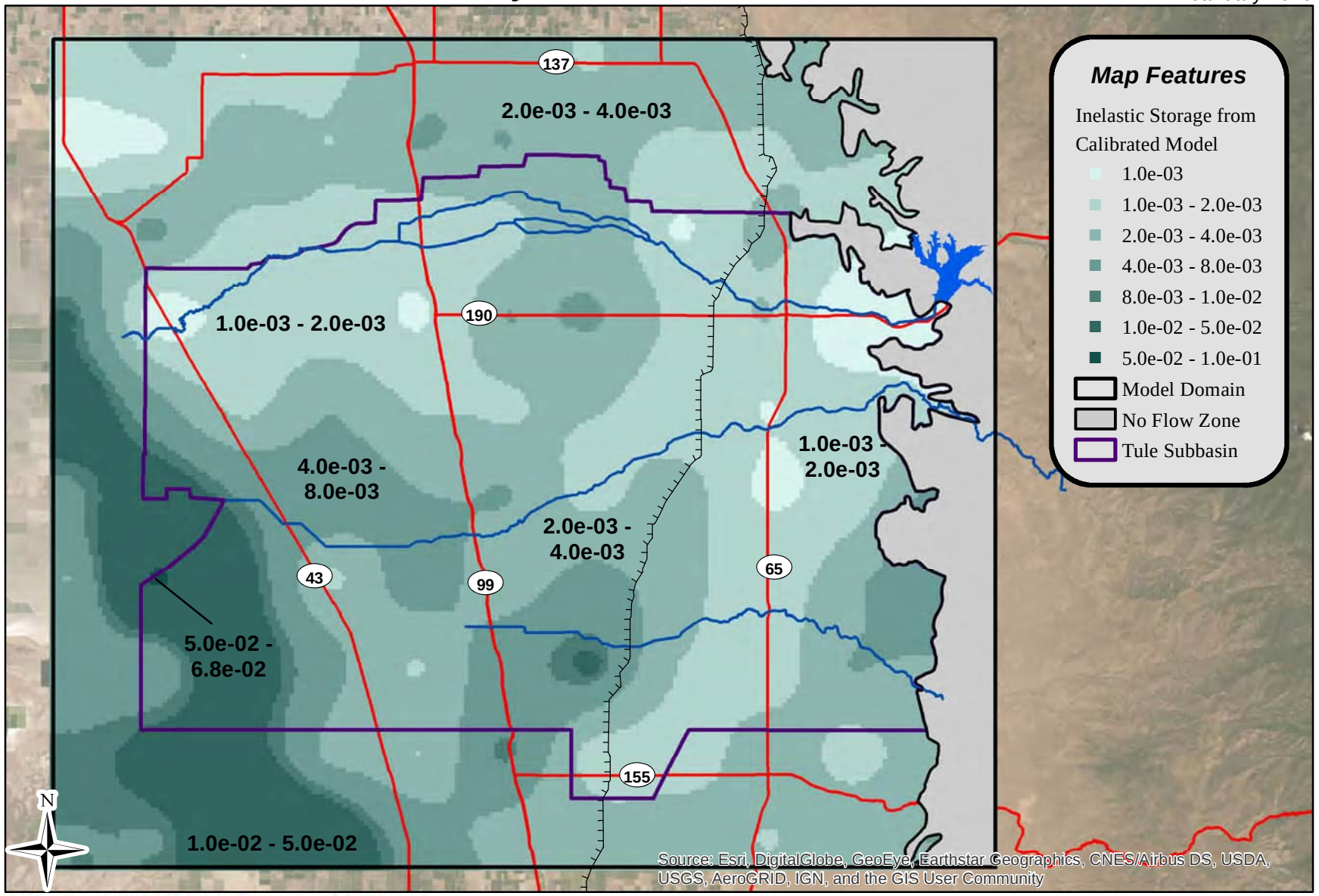


Thomas Harder & Co.
Groundwater Consulting

NAD 83 State Plane Zone 4

Layer 5 Elastic Storage

Appendix C-18

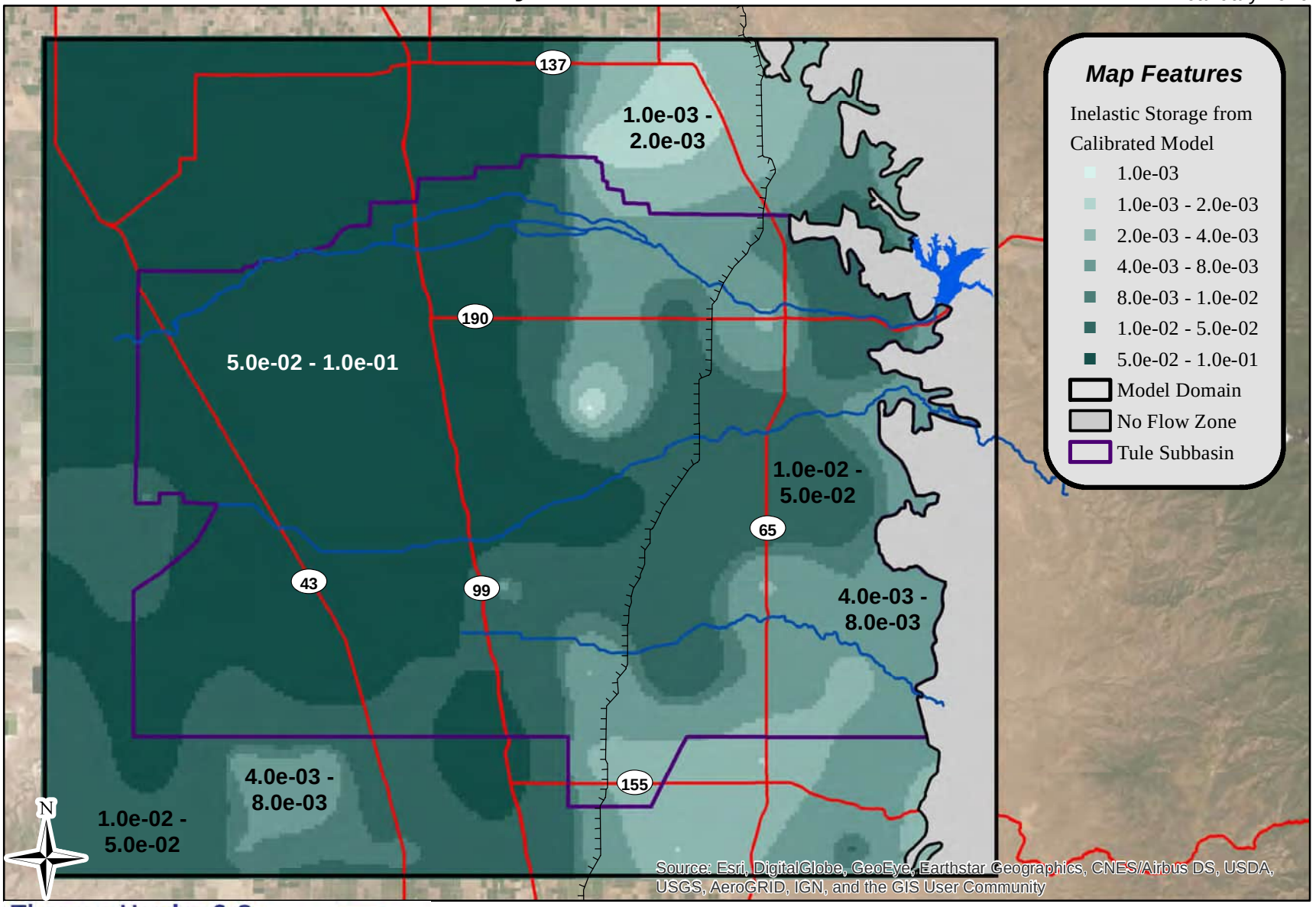


Thomas Harder & Co.
Groundwater Consulting

0 5 10 20
Miles

NAD 83 State Plane Zone 4

Layer 1
Inelastic Storage
Appendix C-19

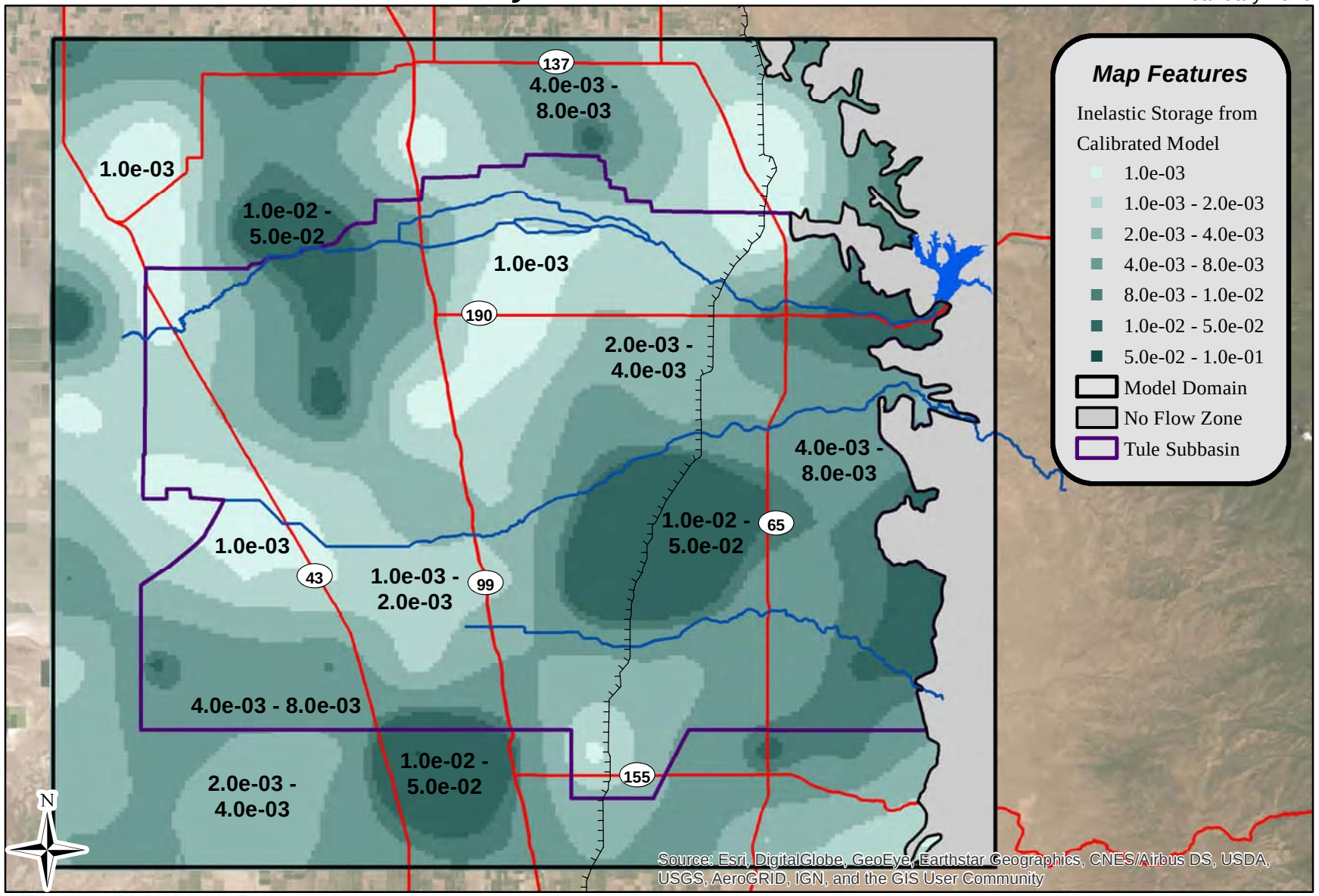


Thomas Harder & Co.
Groundwater Consulting

NAD 83 State Plane Zone 4

Layer 2
Inelastic Storage
Appendix C-20

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20
Miles

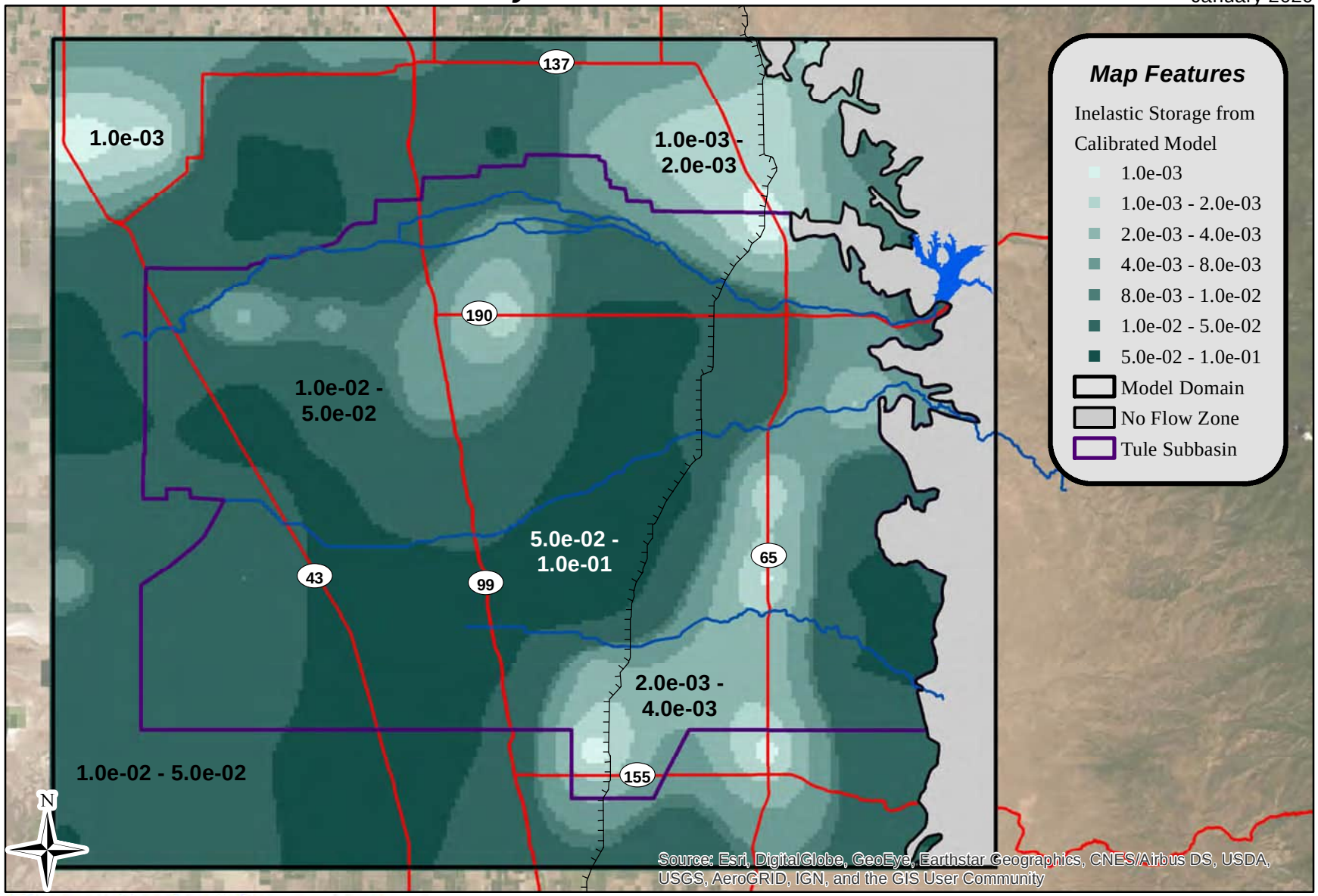
NAD 83 State Plane Zone 4

Layer 3
Inelastic Storage
Appendix C-21

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



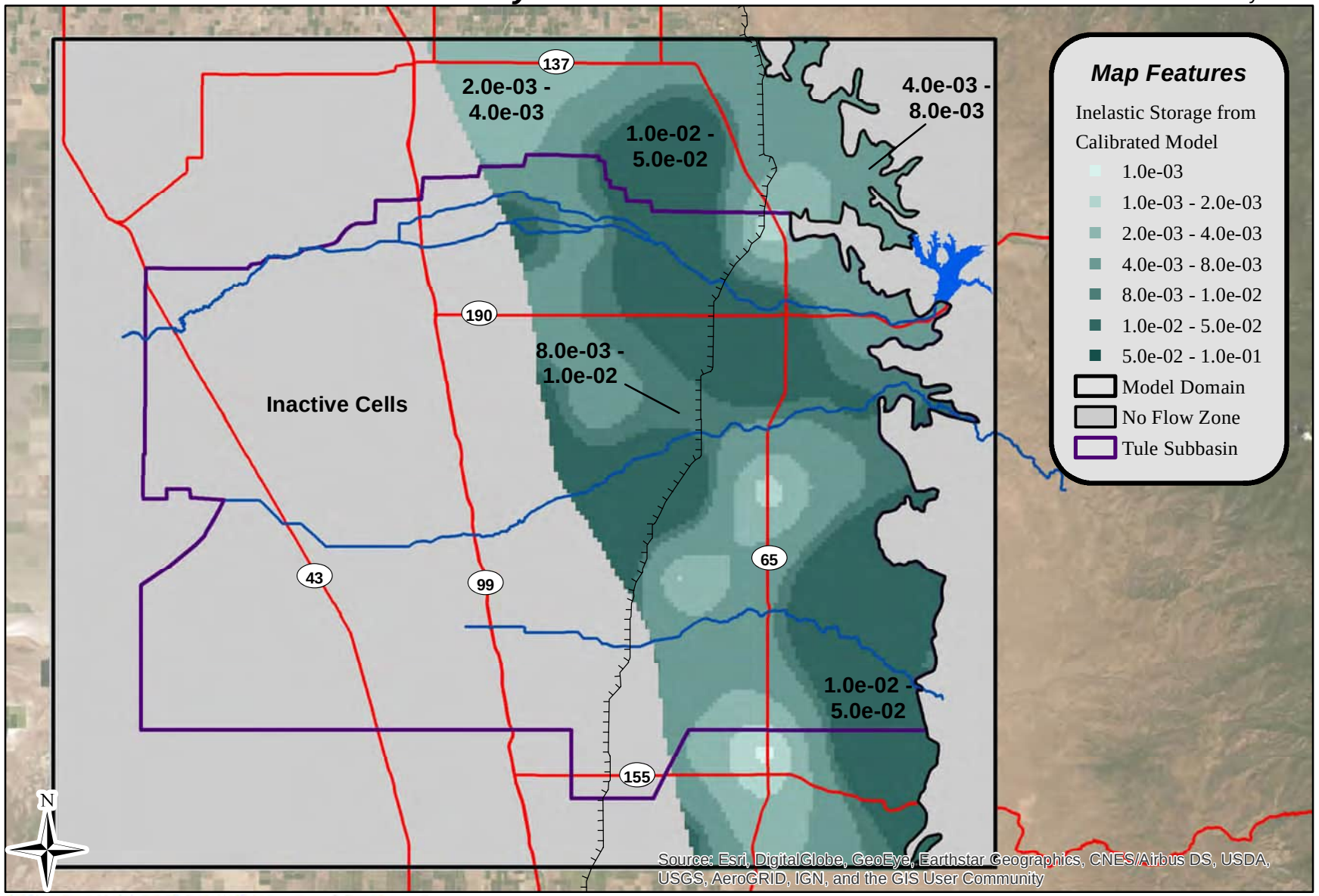
Thomas Harder & Co.
Groundwater Consulting

0 5 10 20 Miles

NAD 83 State Plane Zone 4

Layer 4
Inelastic Storage
Appendix C-22

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20
Miles

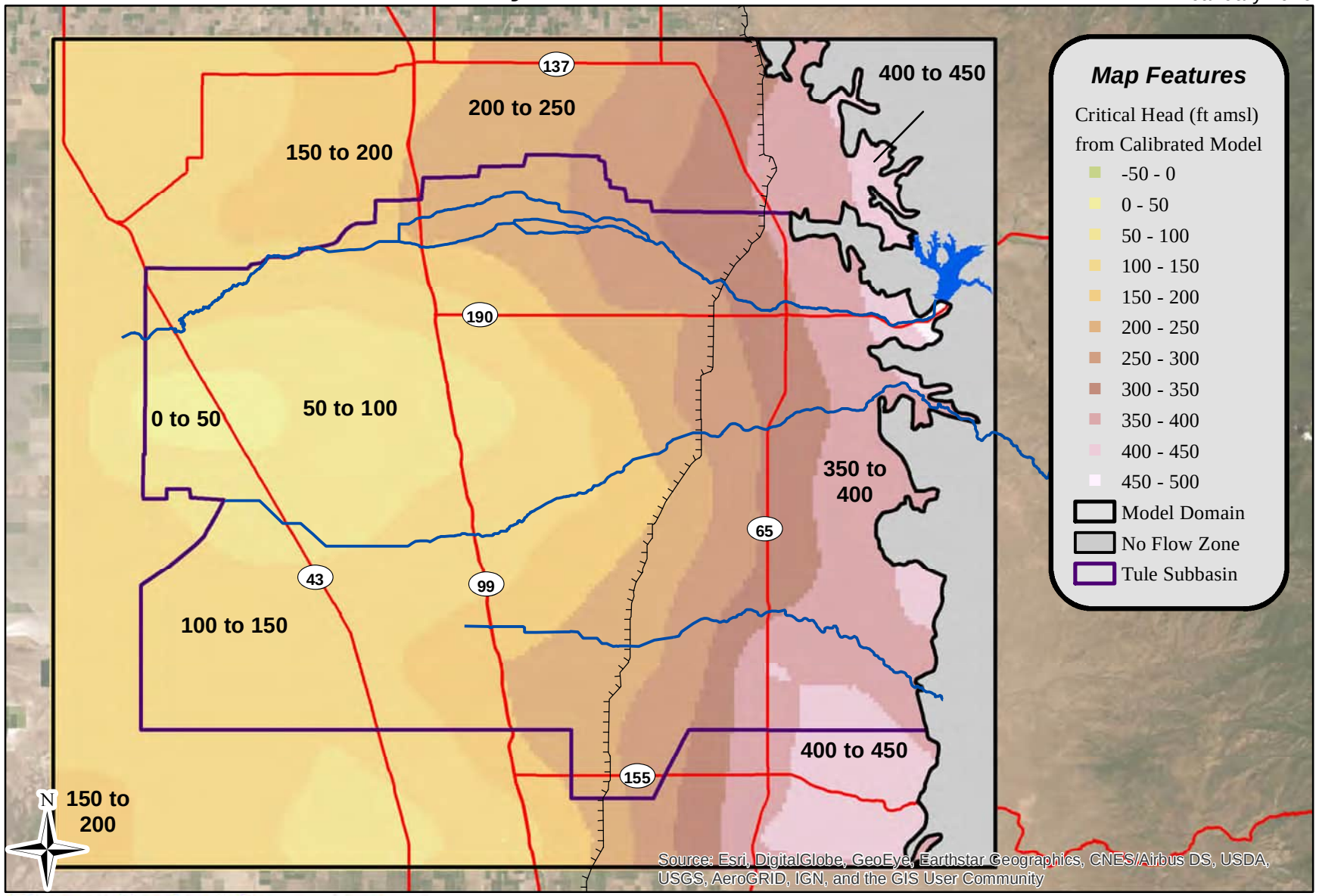
NAD 83 State Plane Zone 4

Layer 5
Inelastic Storage
Appendix C-23

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20
Miles

NAD 83 State Plane Zone 4

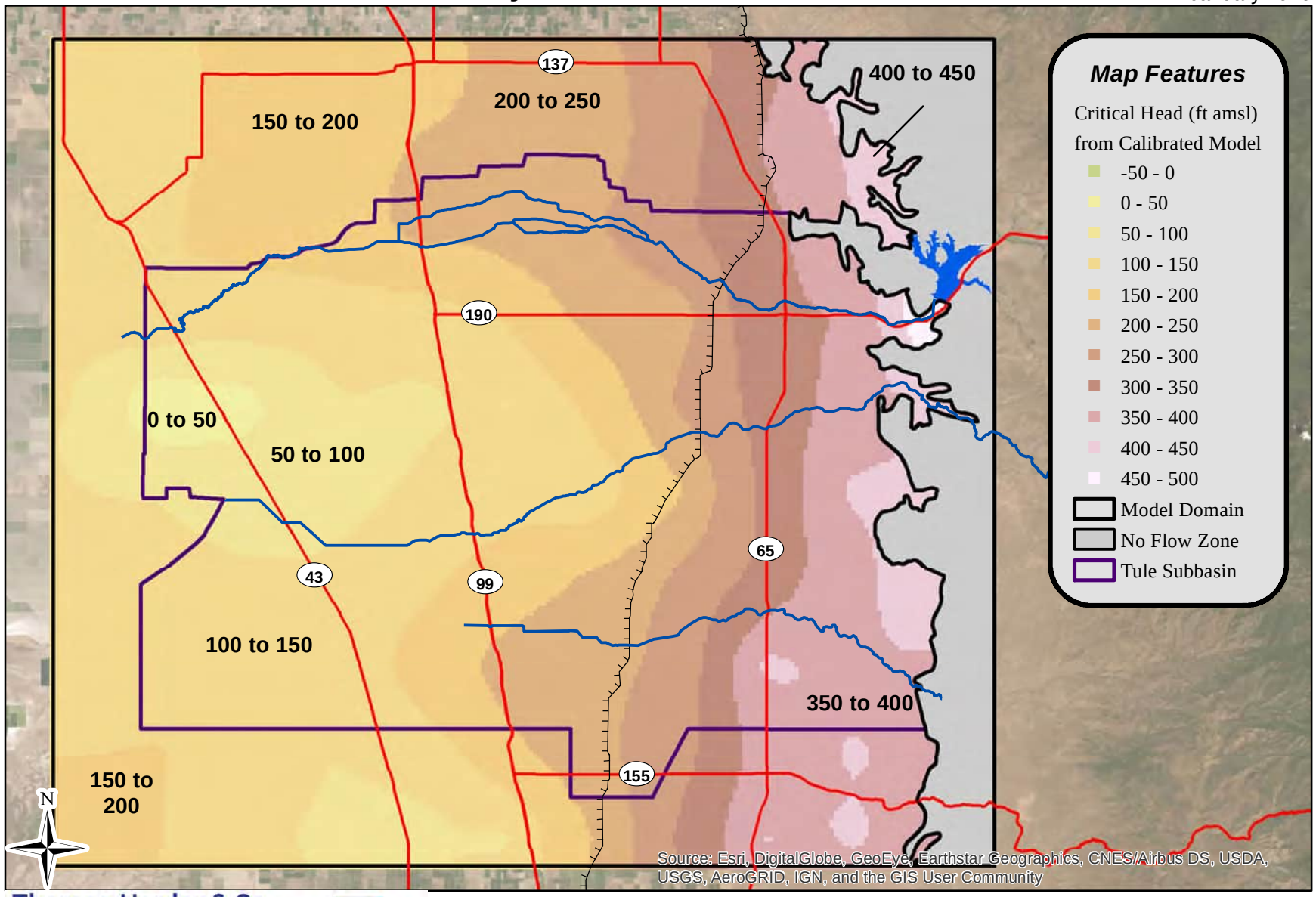
Layer 1 Critical Heads

Appendix C-24

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



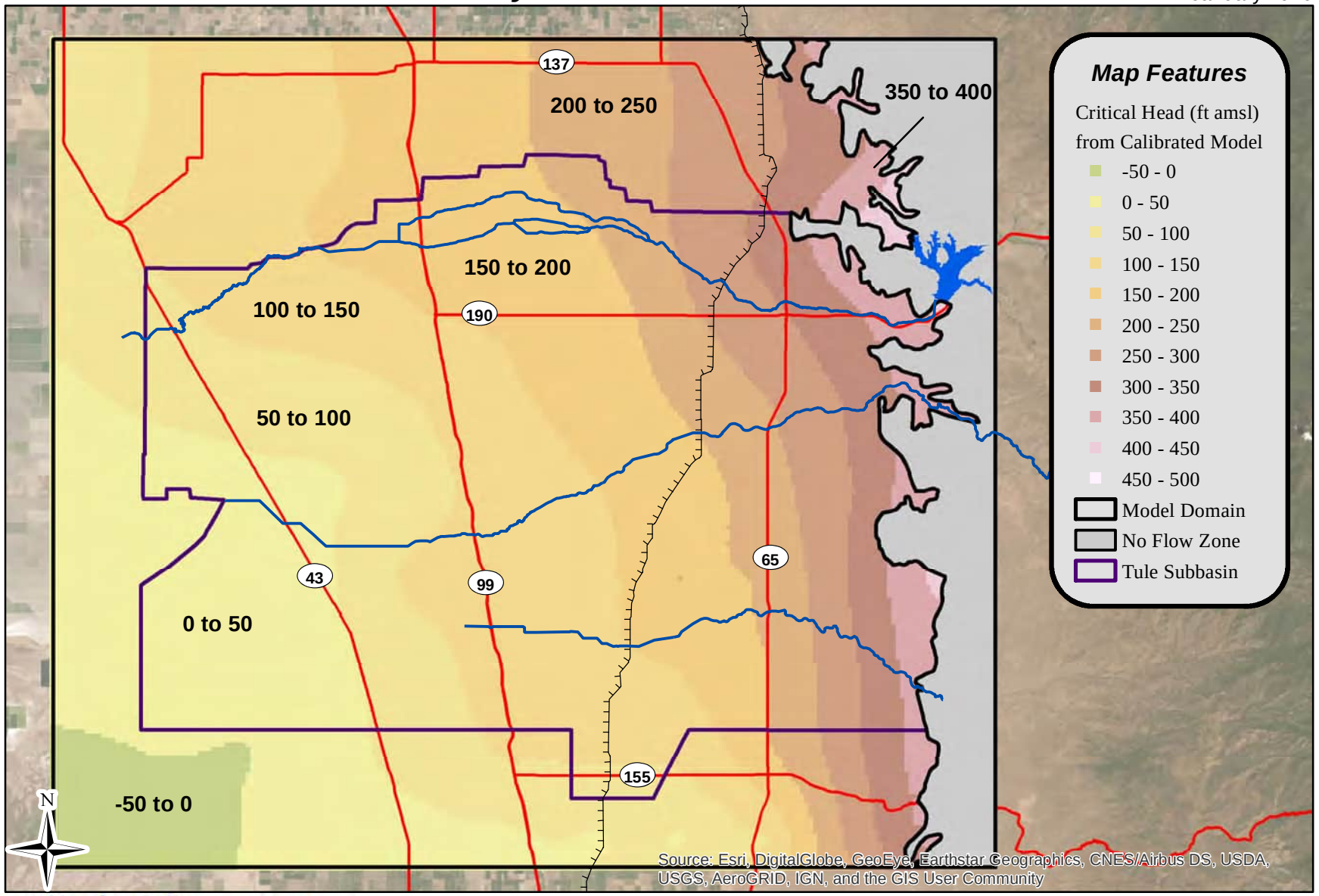
Thomas Harder & Co.
Groundwater Consulting

NAD 83 State Plane Zone 4

Layer 2 Critical Heads

Appendix C-25

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

0 5 10 20
Miles

NAD 83 State Plane Zone 4

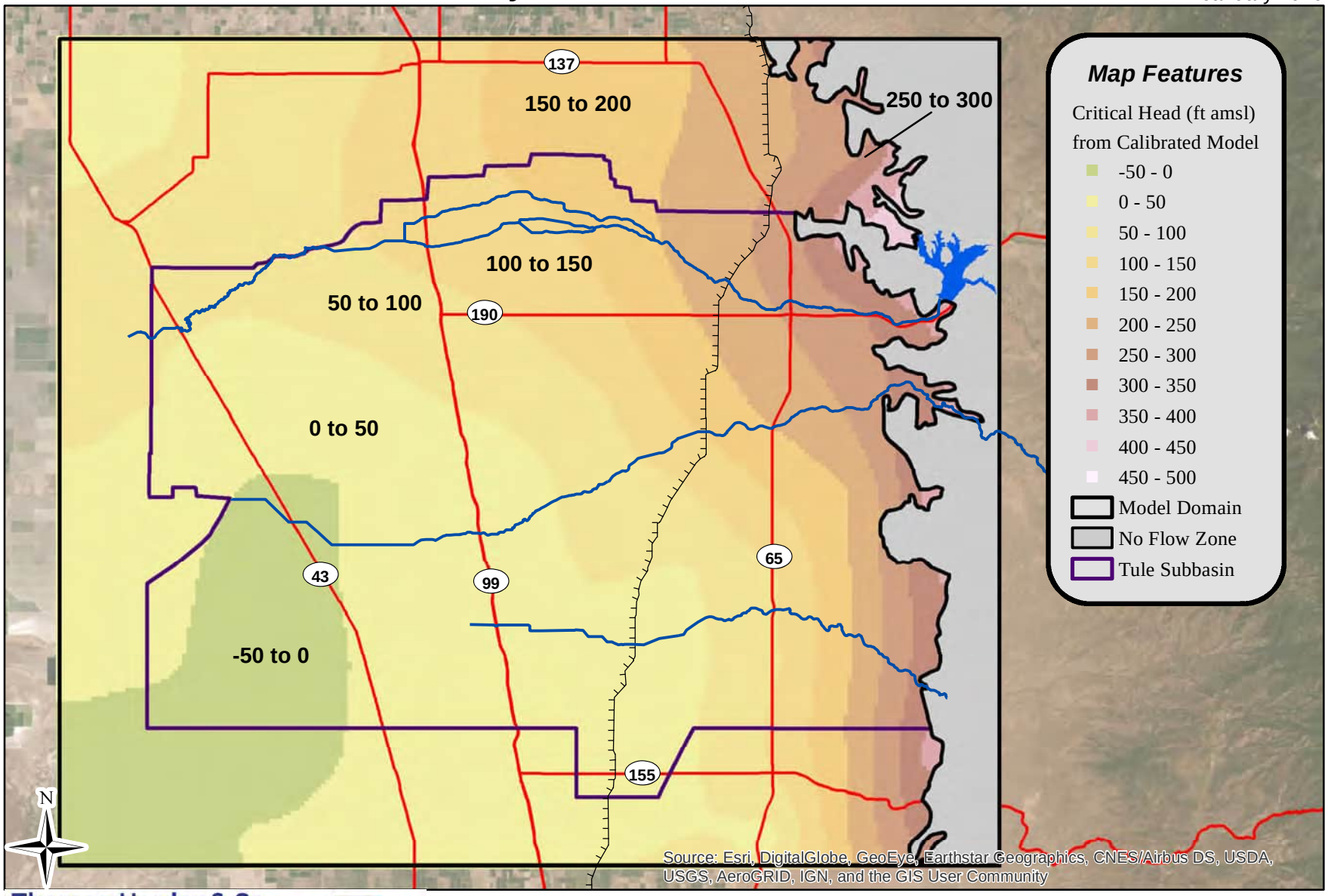
Layer 3 Critical Heads

Appendix C-26

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



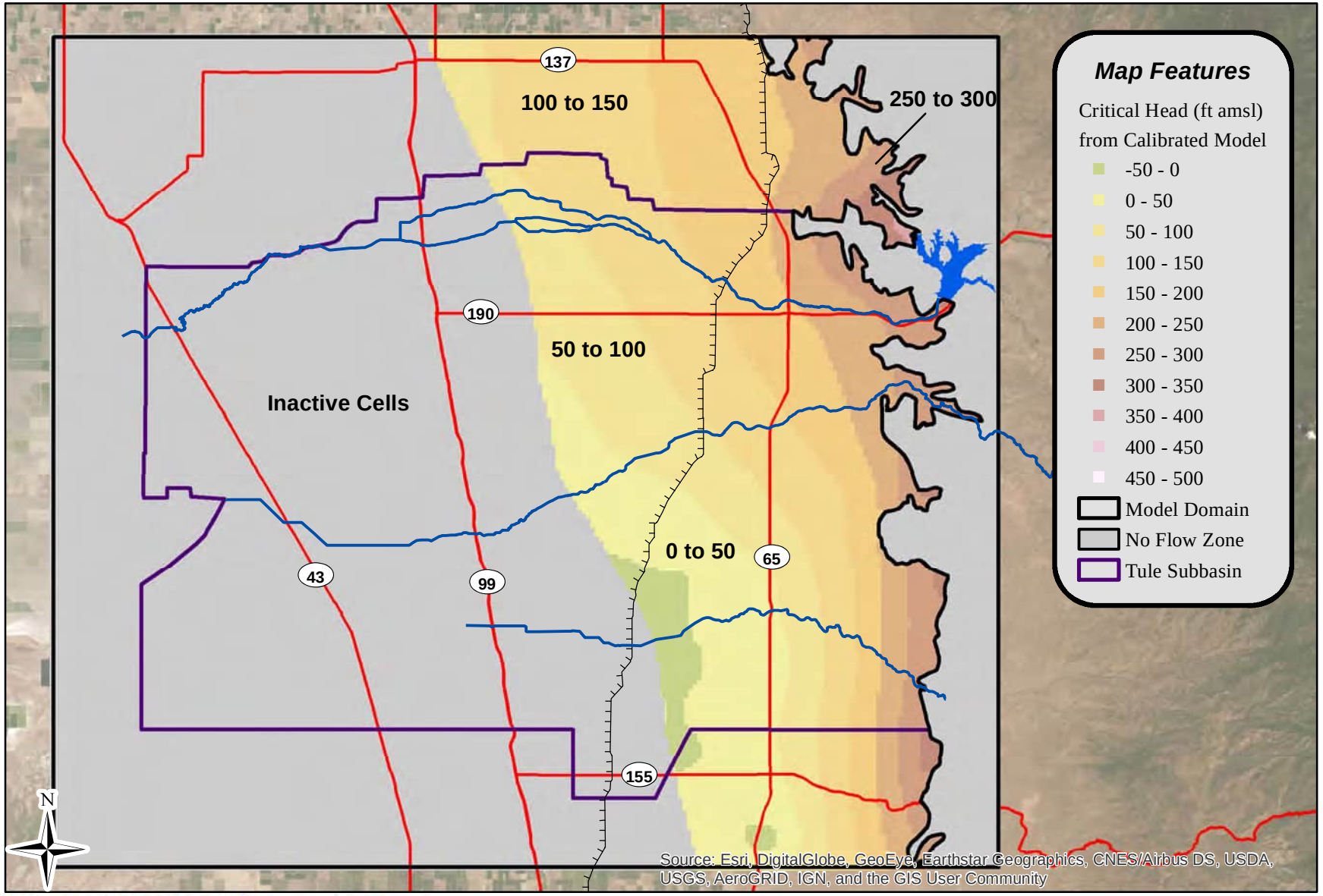
Thomas Harder & Co.
Groundwater Consulting

NAD 83 State Plane Zone 4

Layer 4 Critical Heads

Appendix C-27

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

NAD 83 State Plane Zone 4

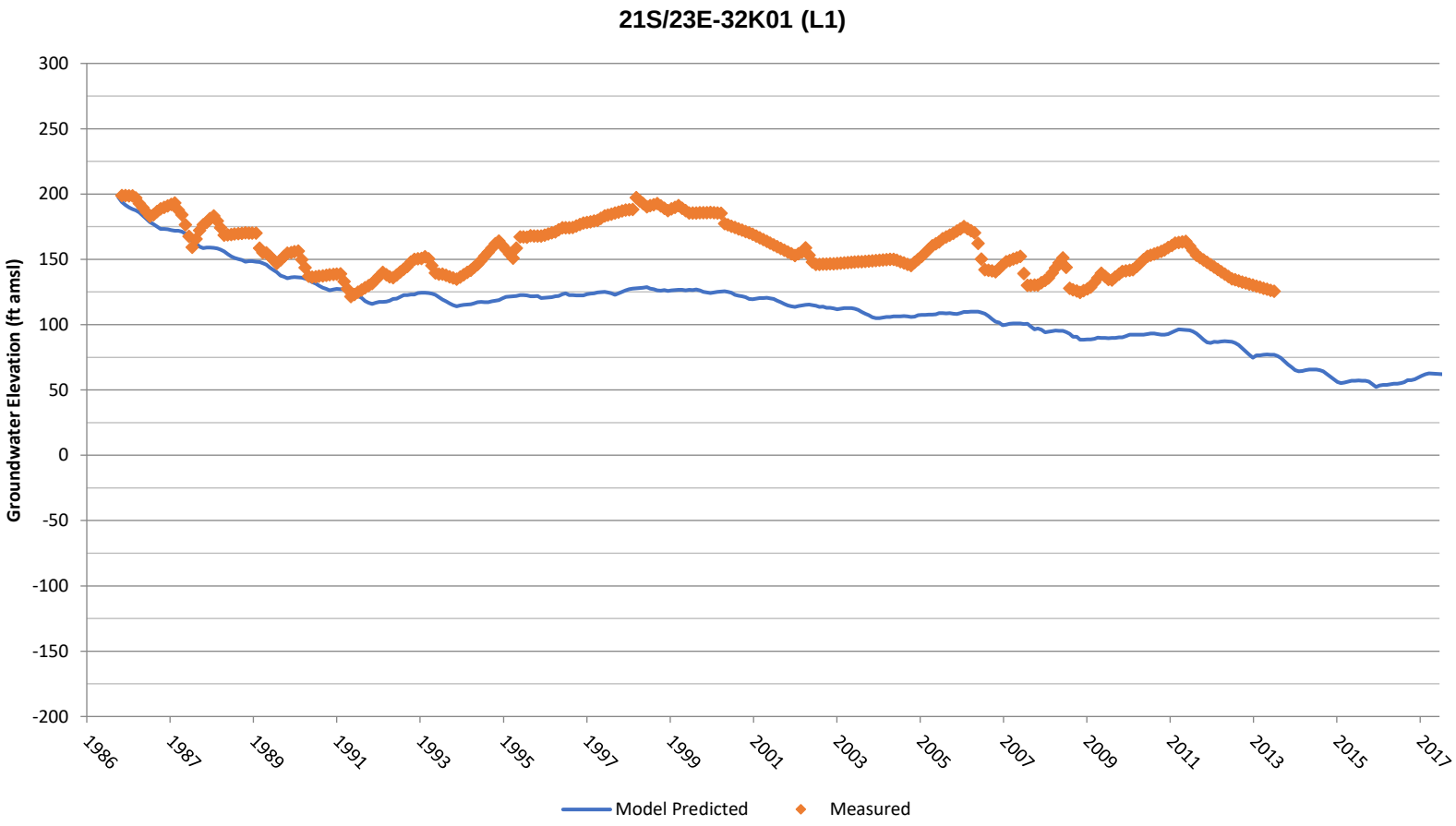
Layer 5 Critical Heads

Appendix C-28

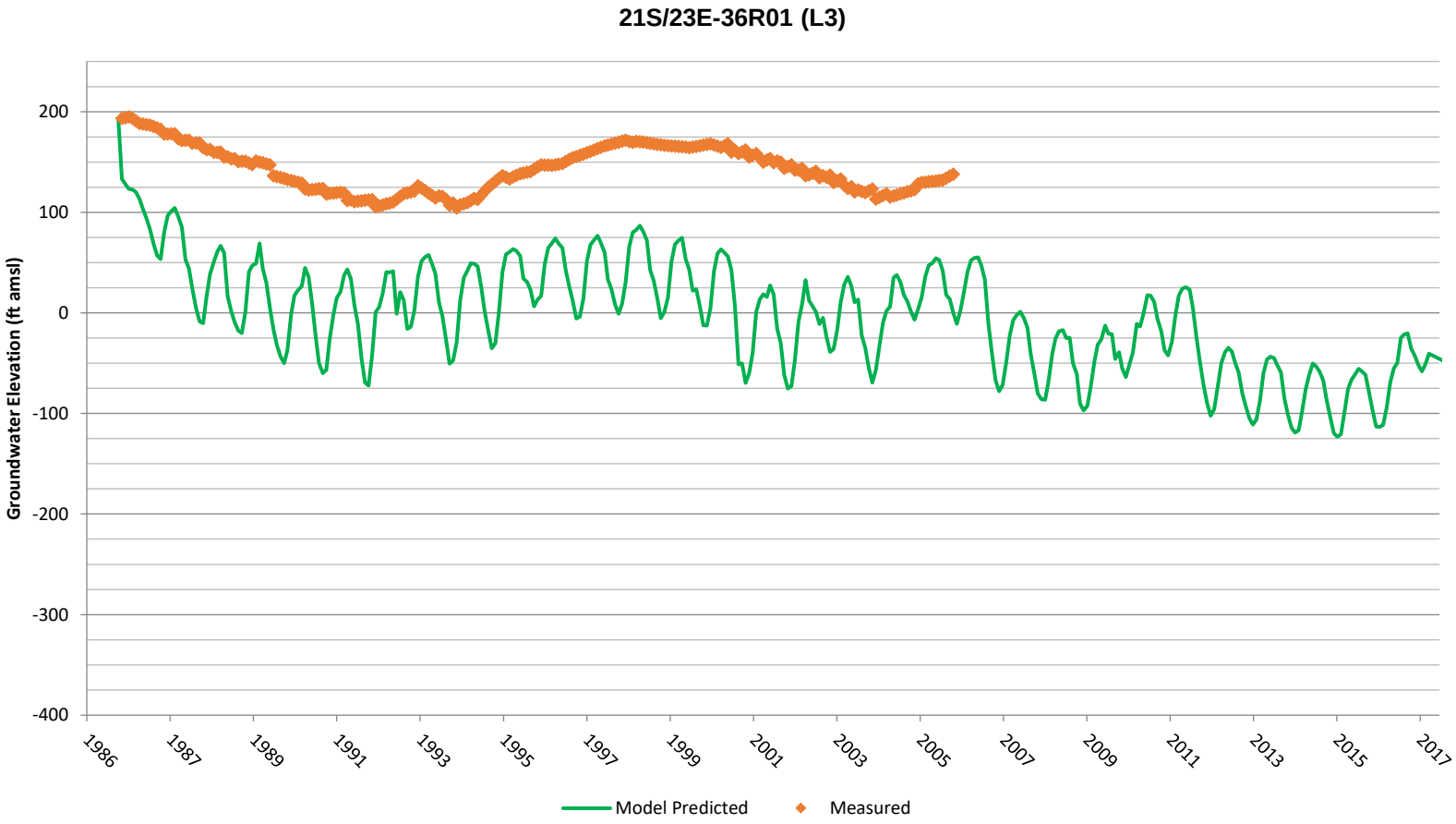
Appendix D

Model Calibration Hydrographs

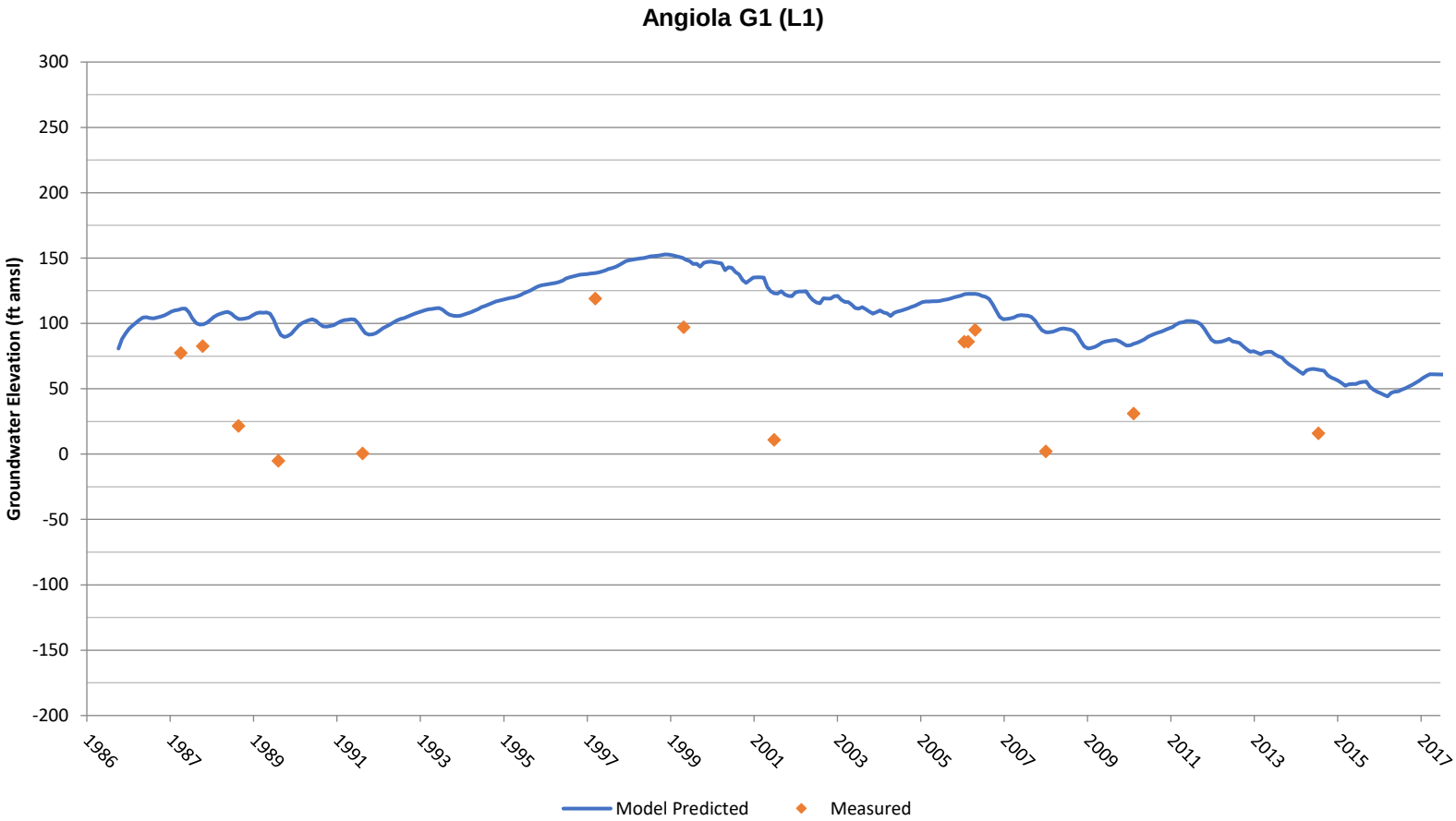
Model Calibration Hydrographs



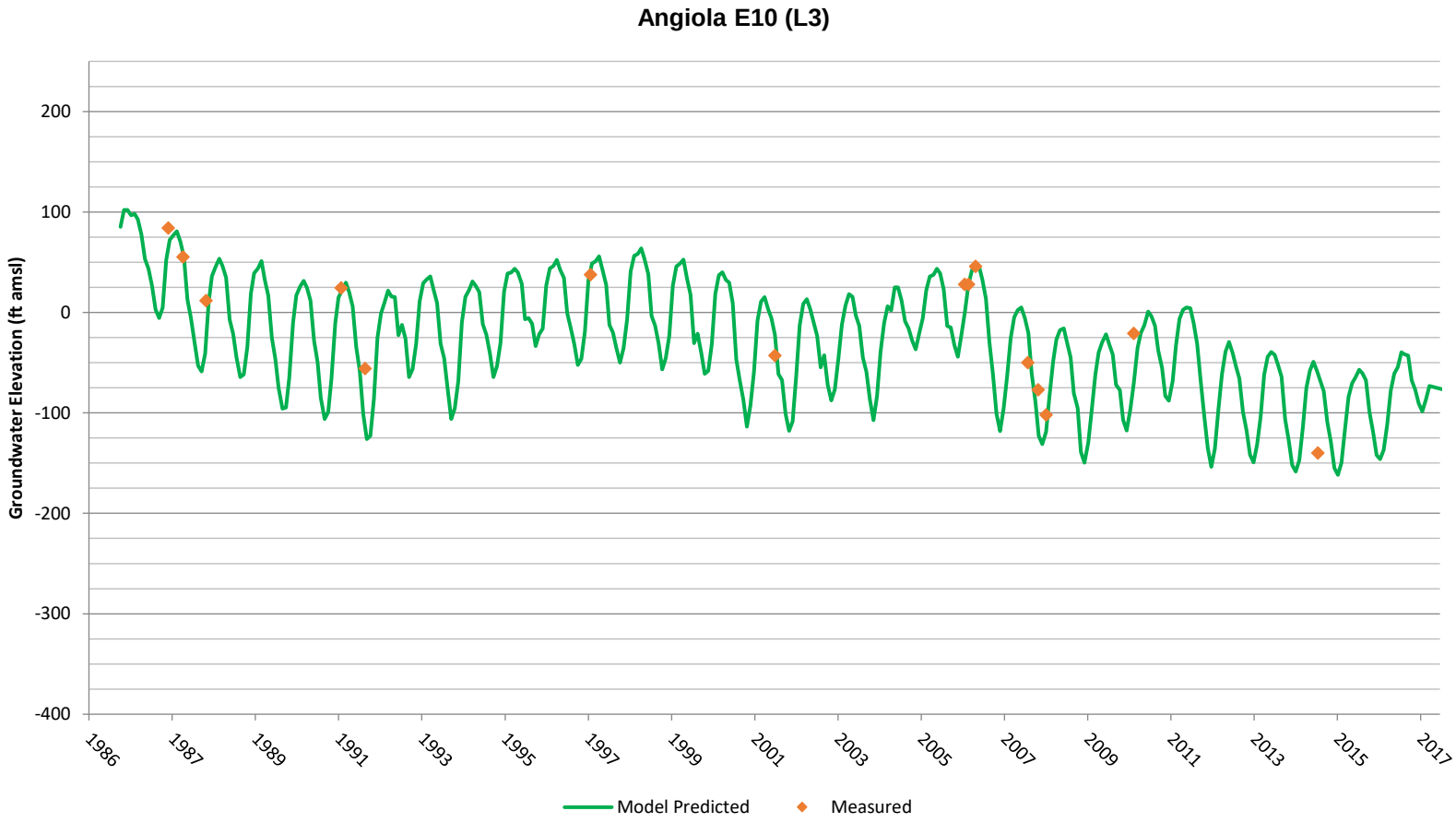
Model Calibration Hydrographs



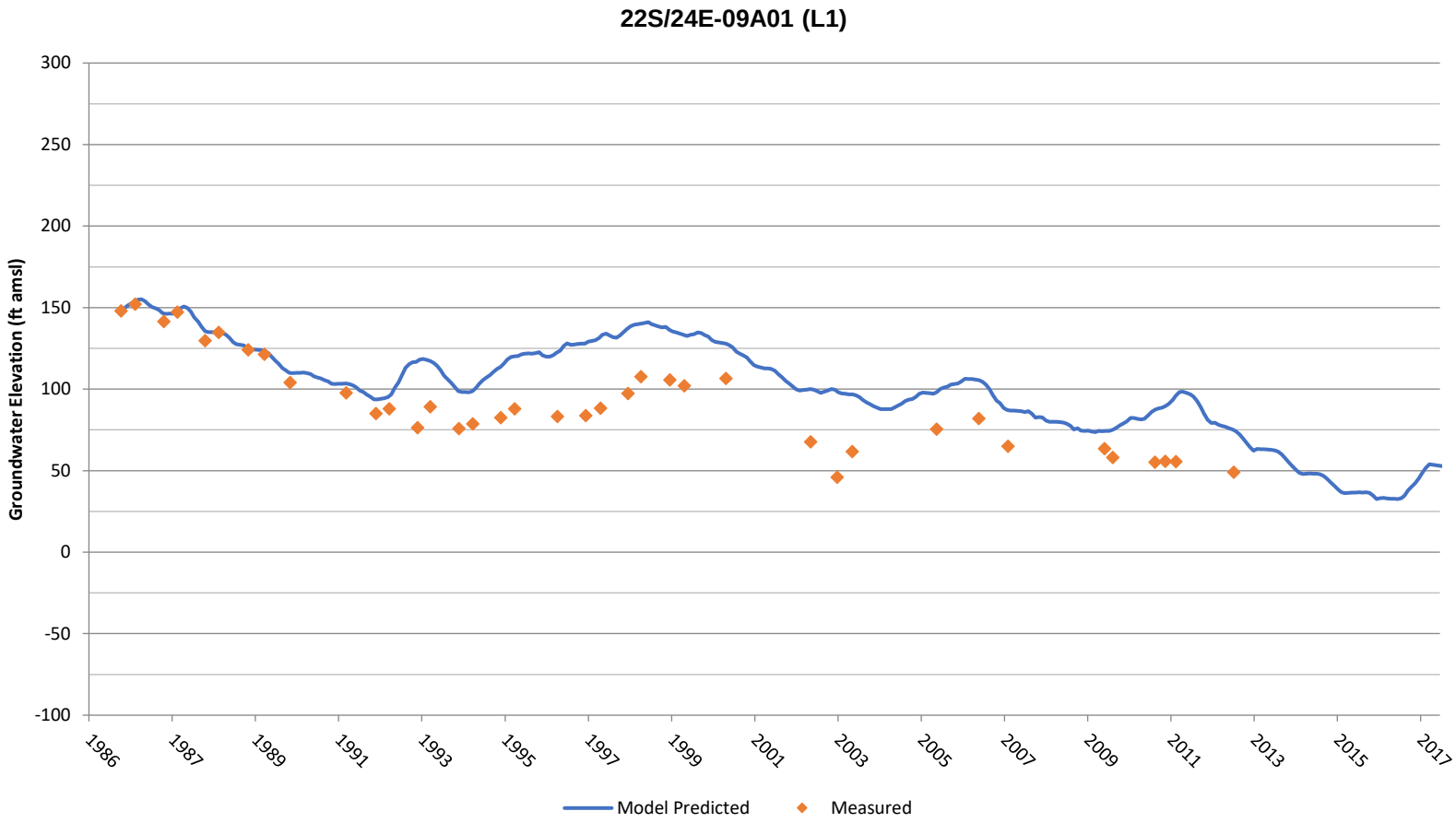
Model Calibration Hydrographs



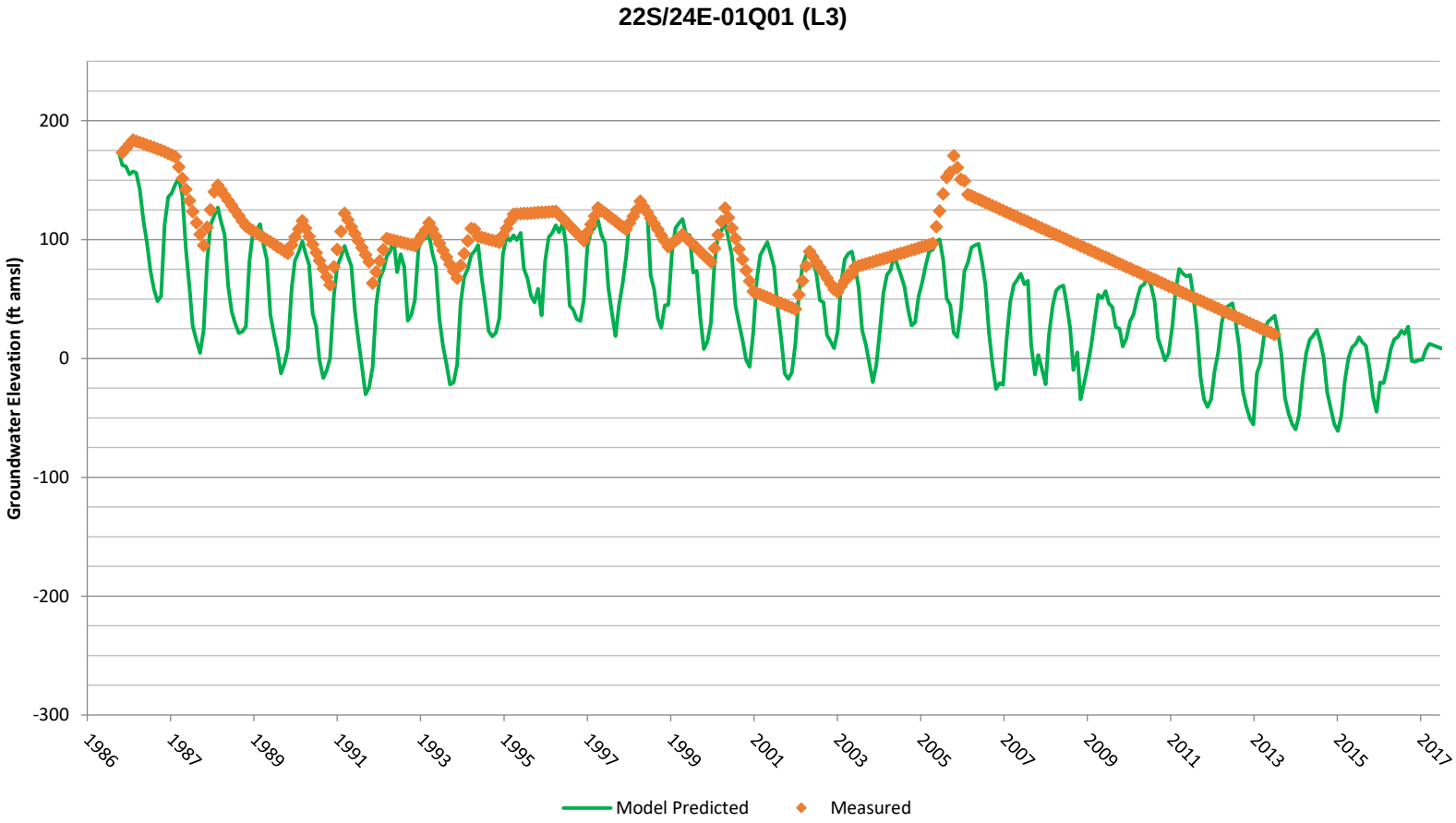
Model Calibration Hydrographs



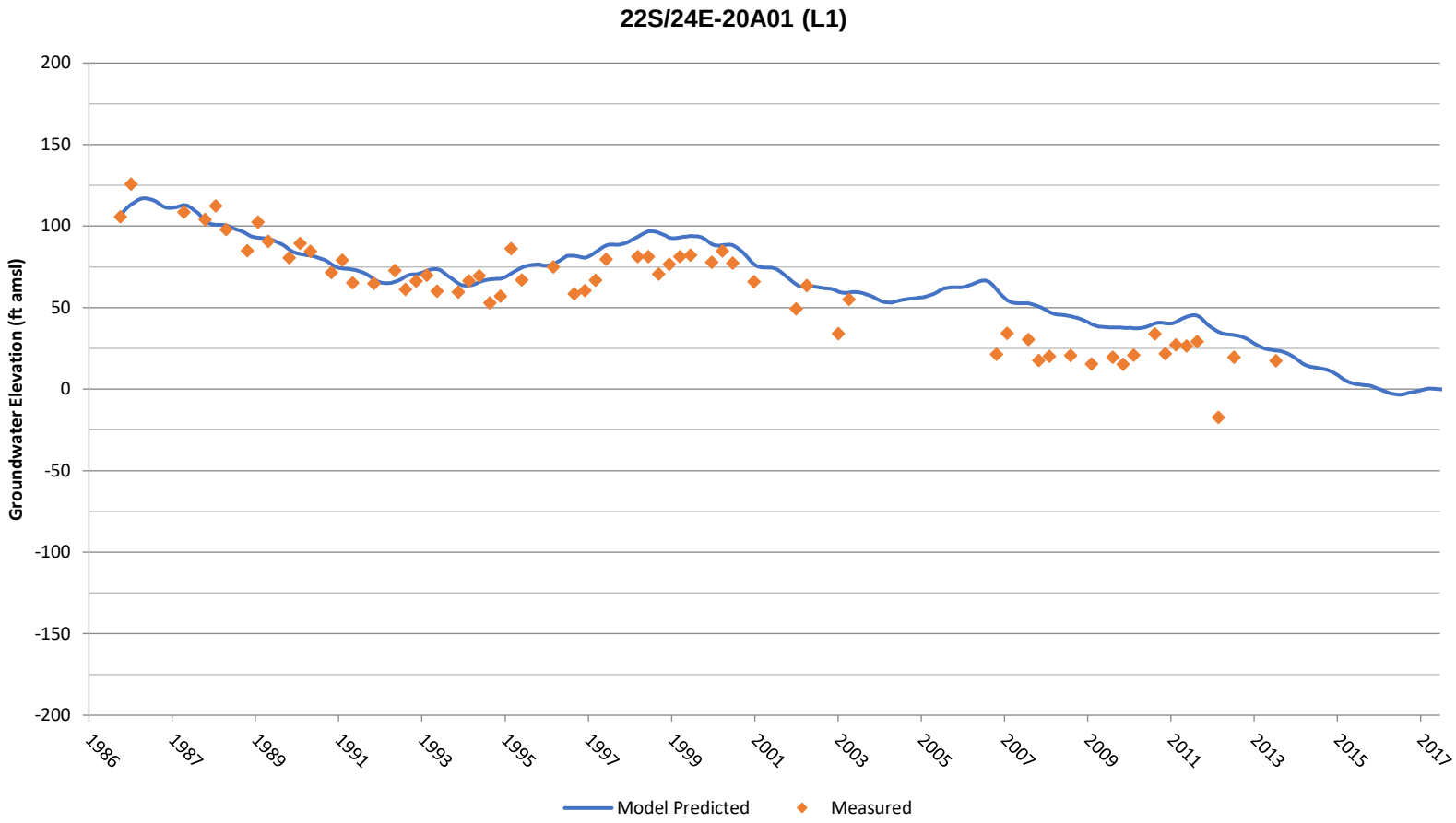
Model Calibration Hydrographs



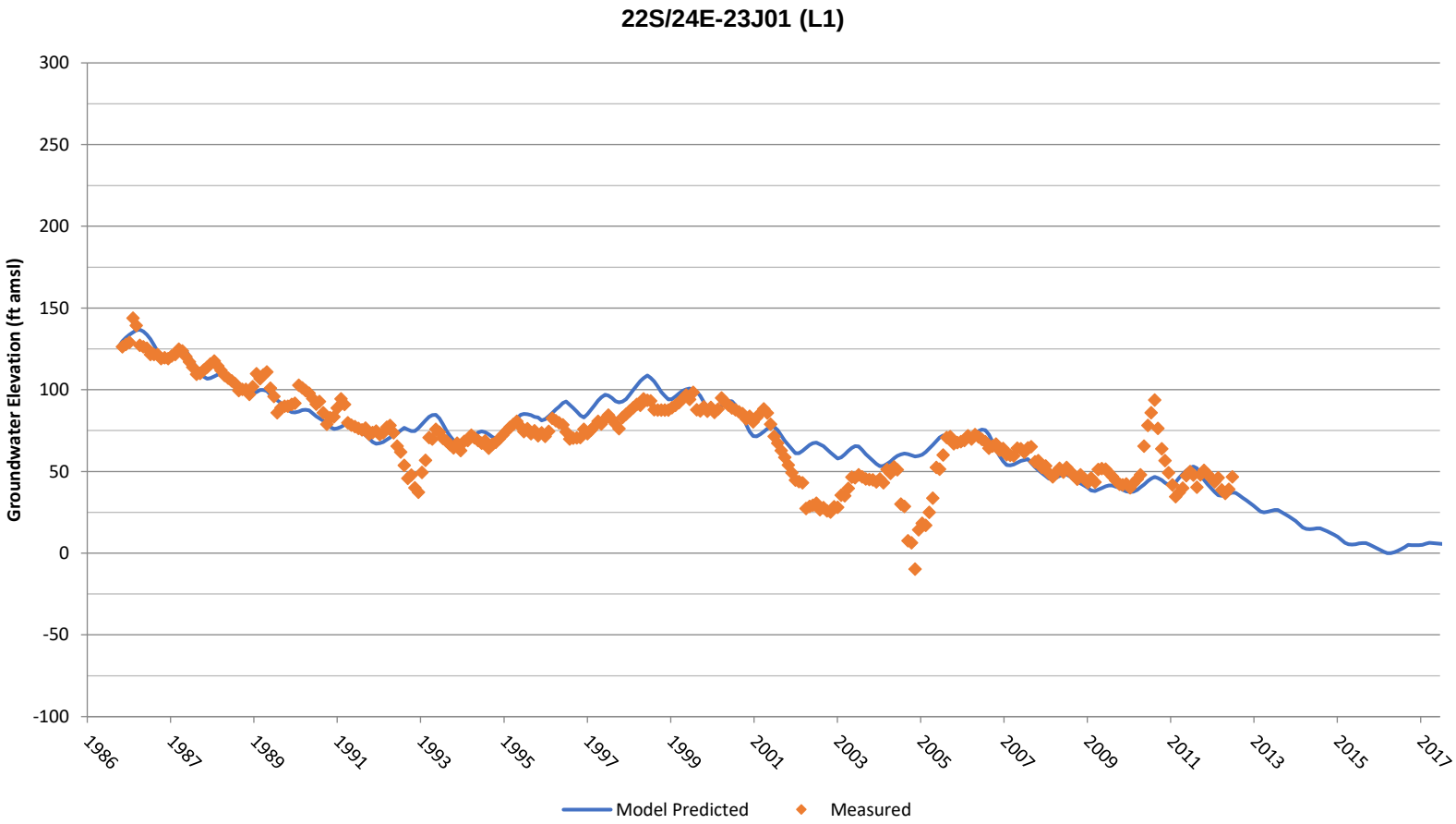
Model Calibration Hydrographs



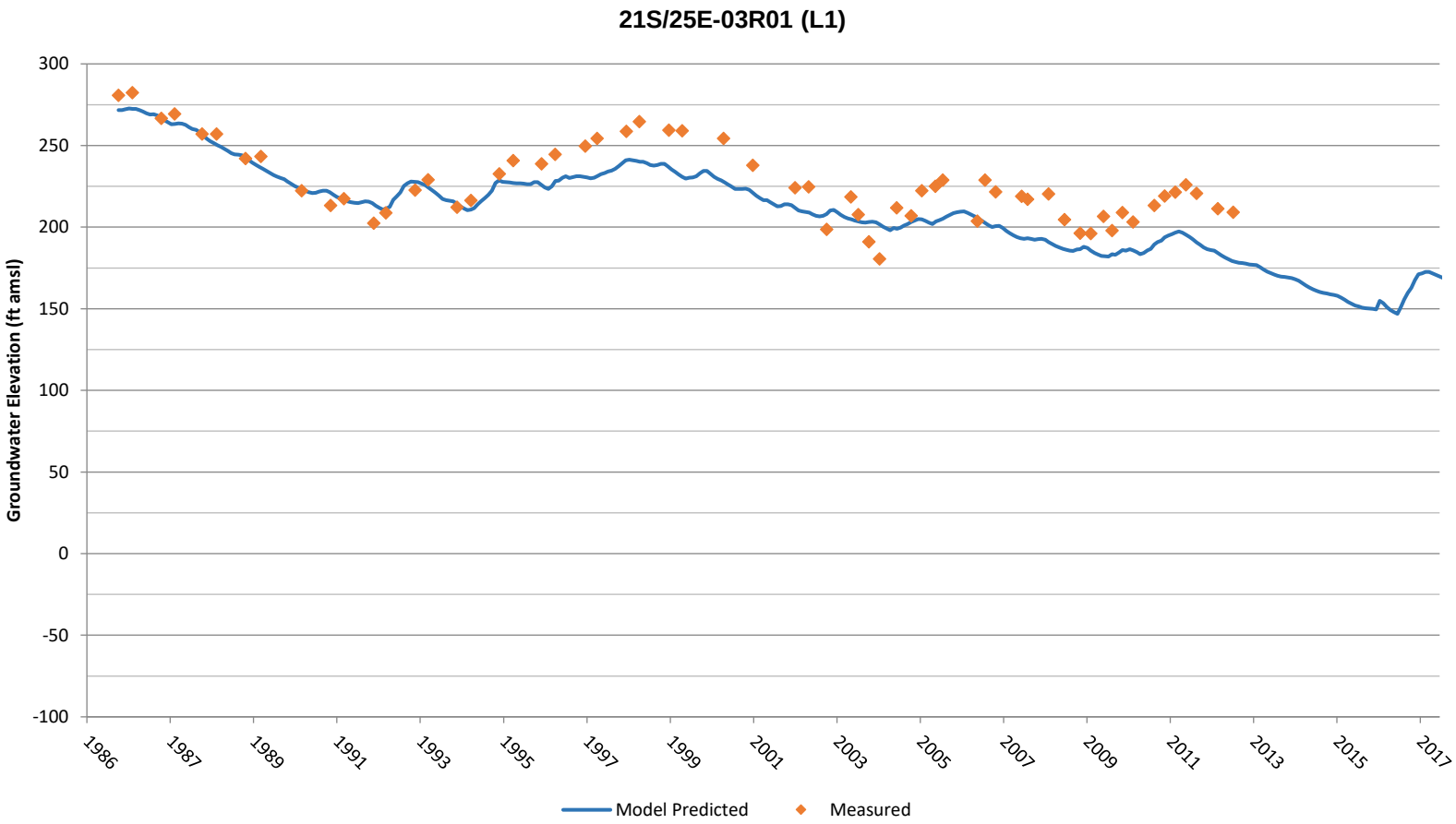
Model Calibration Hydrographs



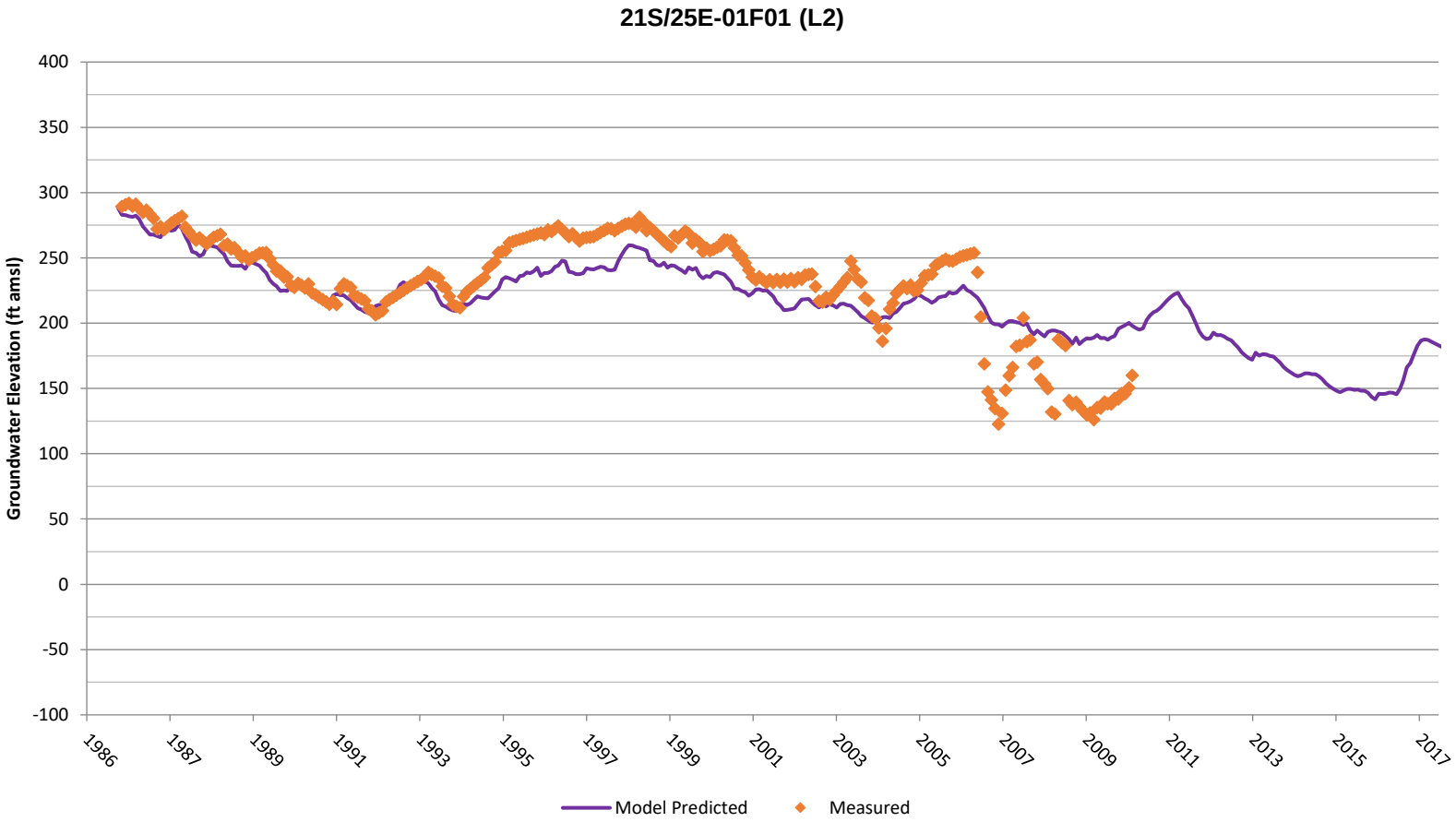
Model Calibration Hydrographs



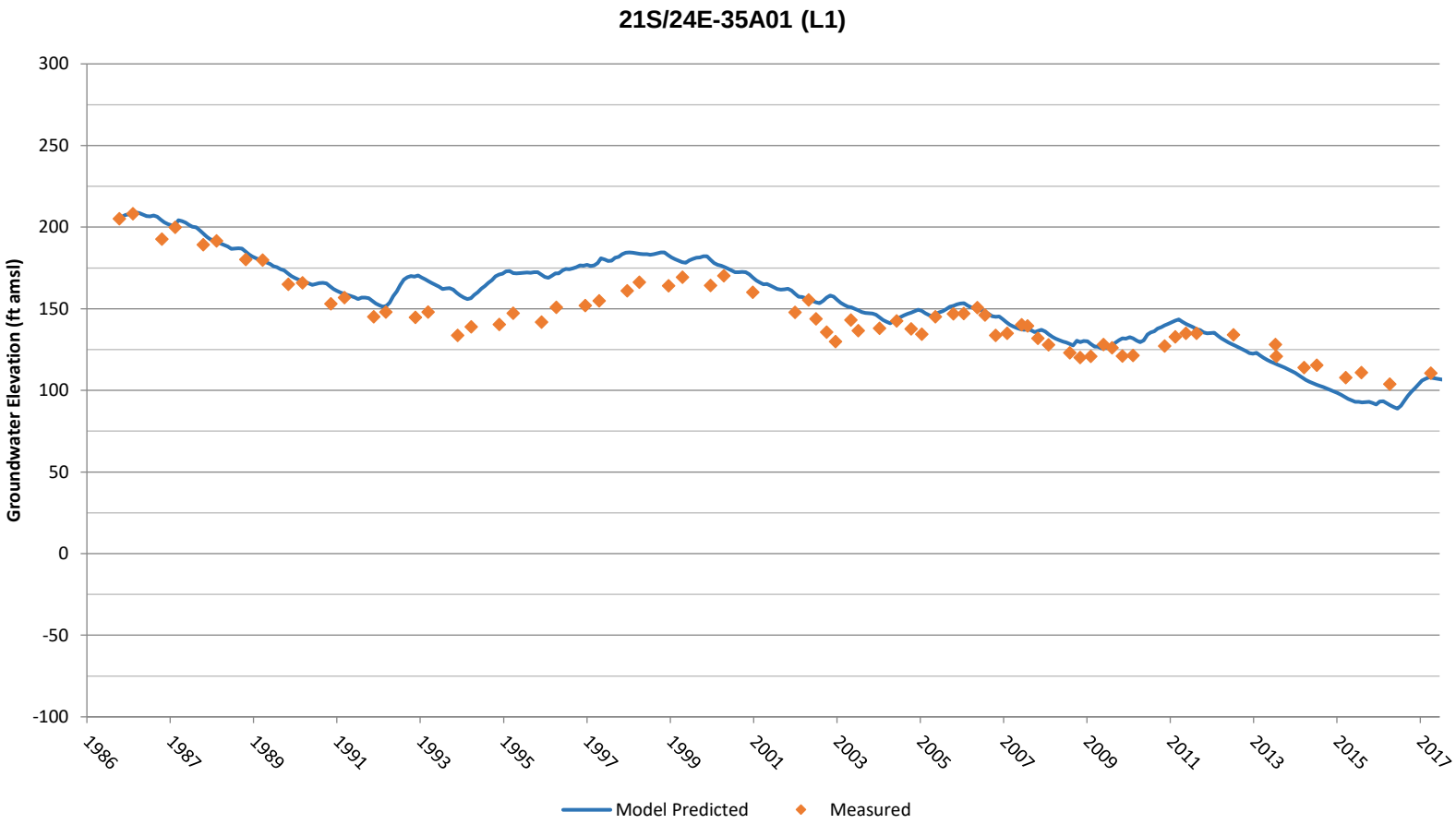
Model Calibration Hydrographs



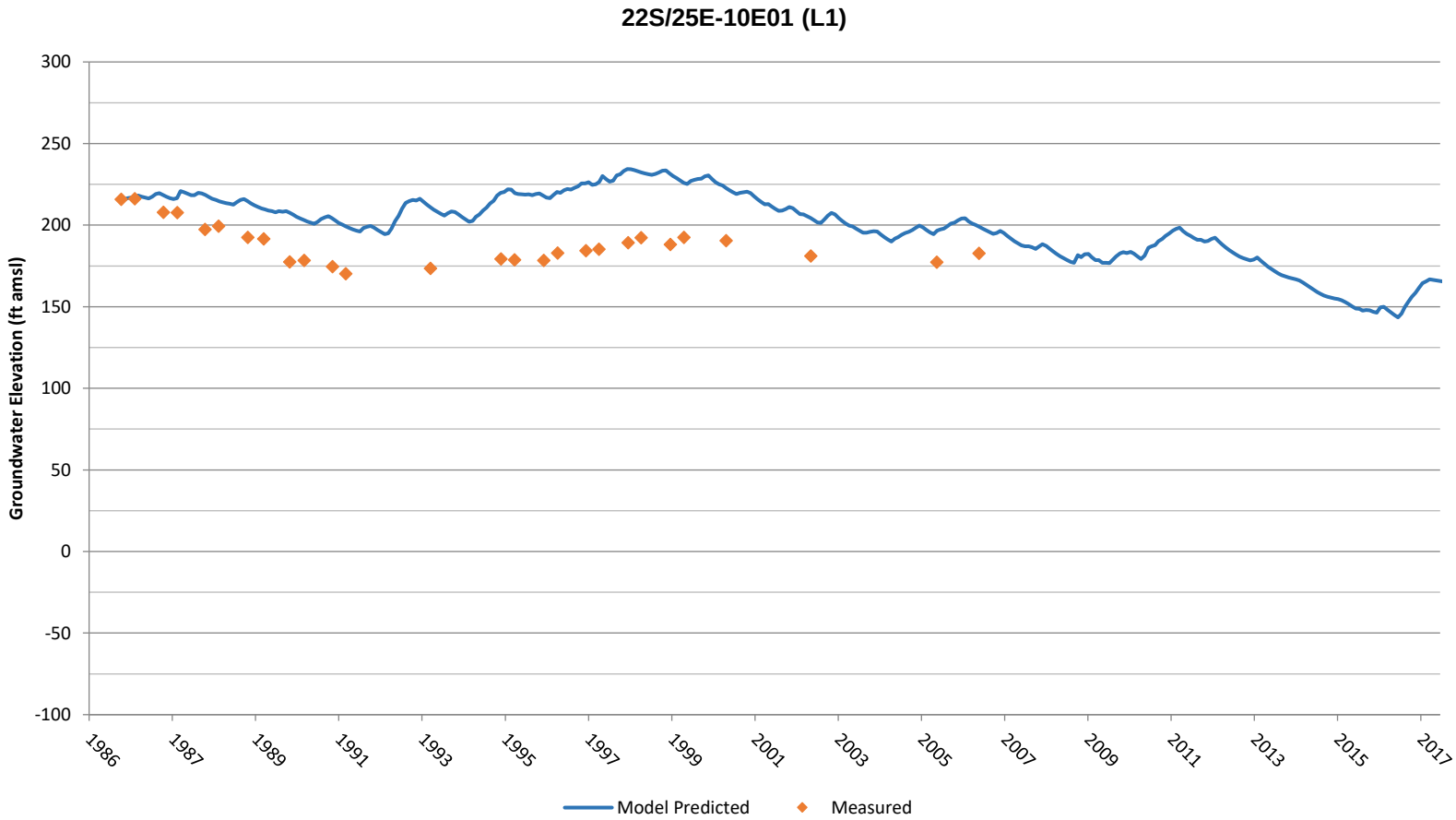
Model Calibration Hydrographs



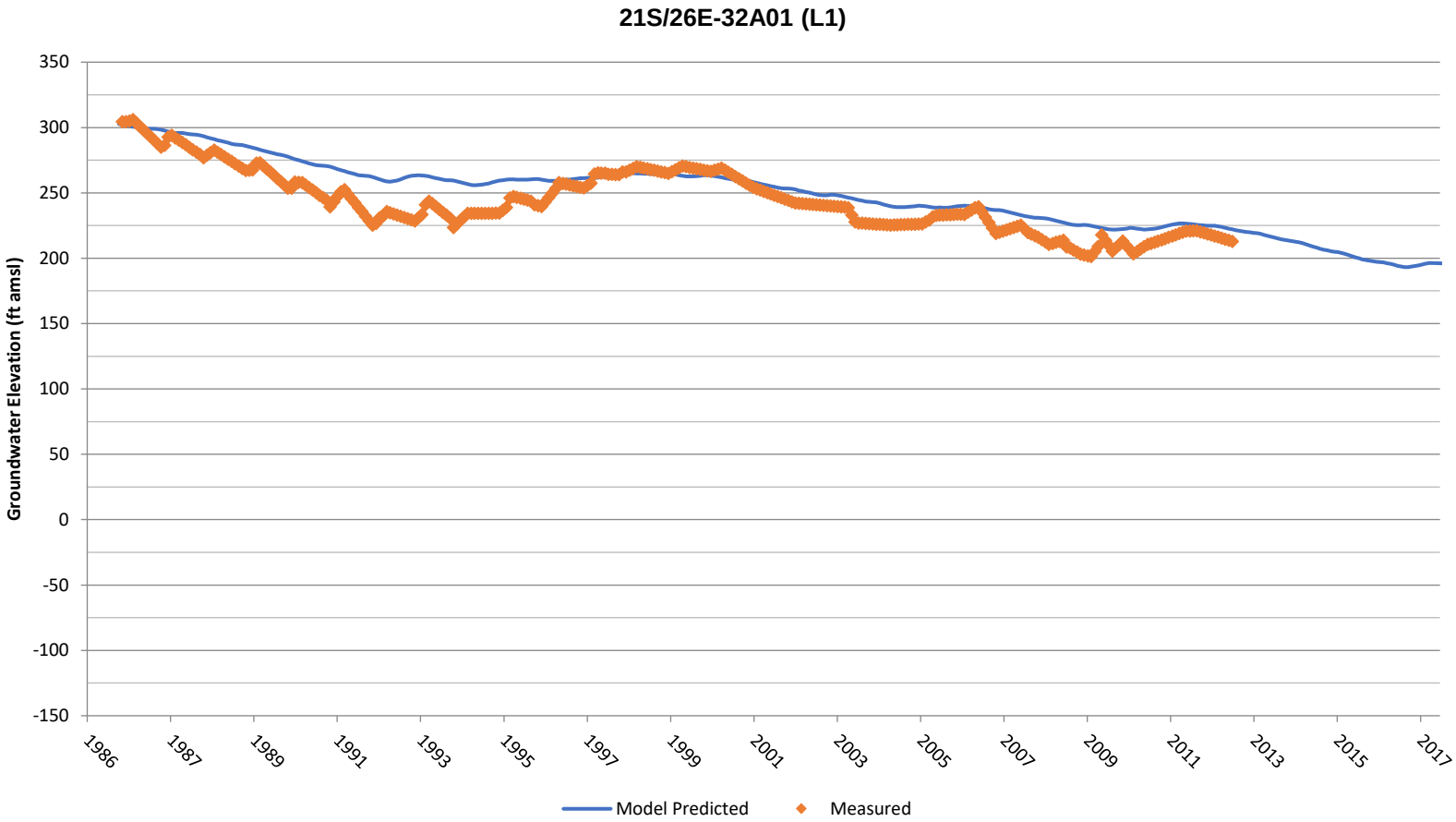
Model Calibration Hydrographs



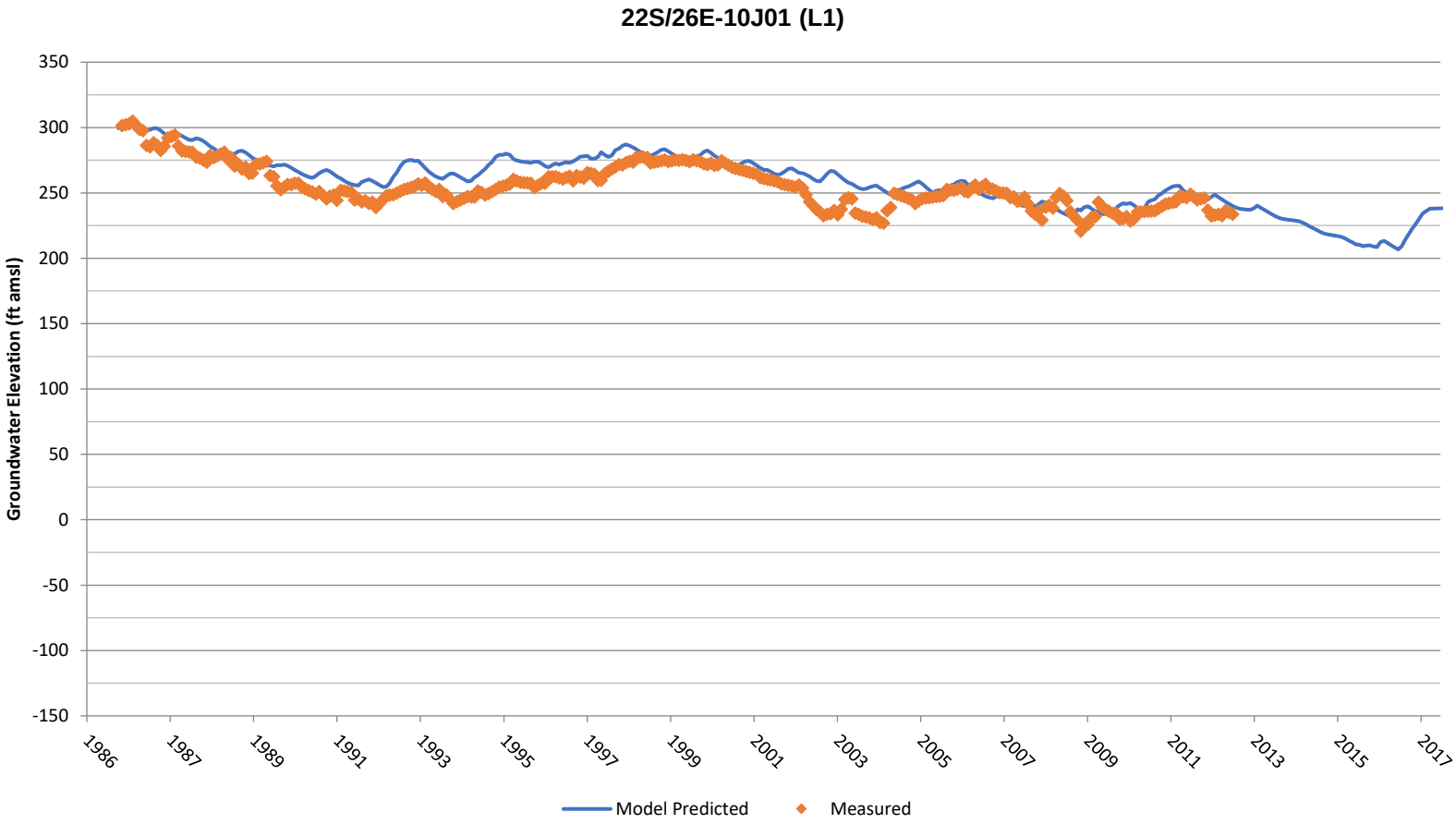
Model Calibration Hydrographs



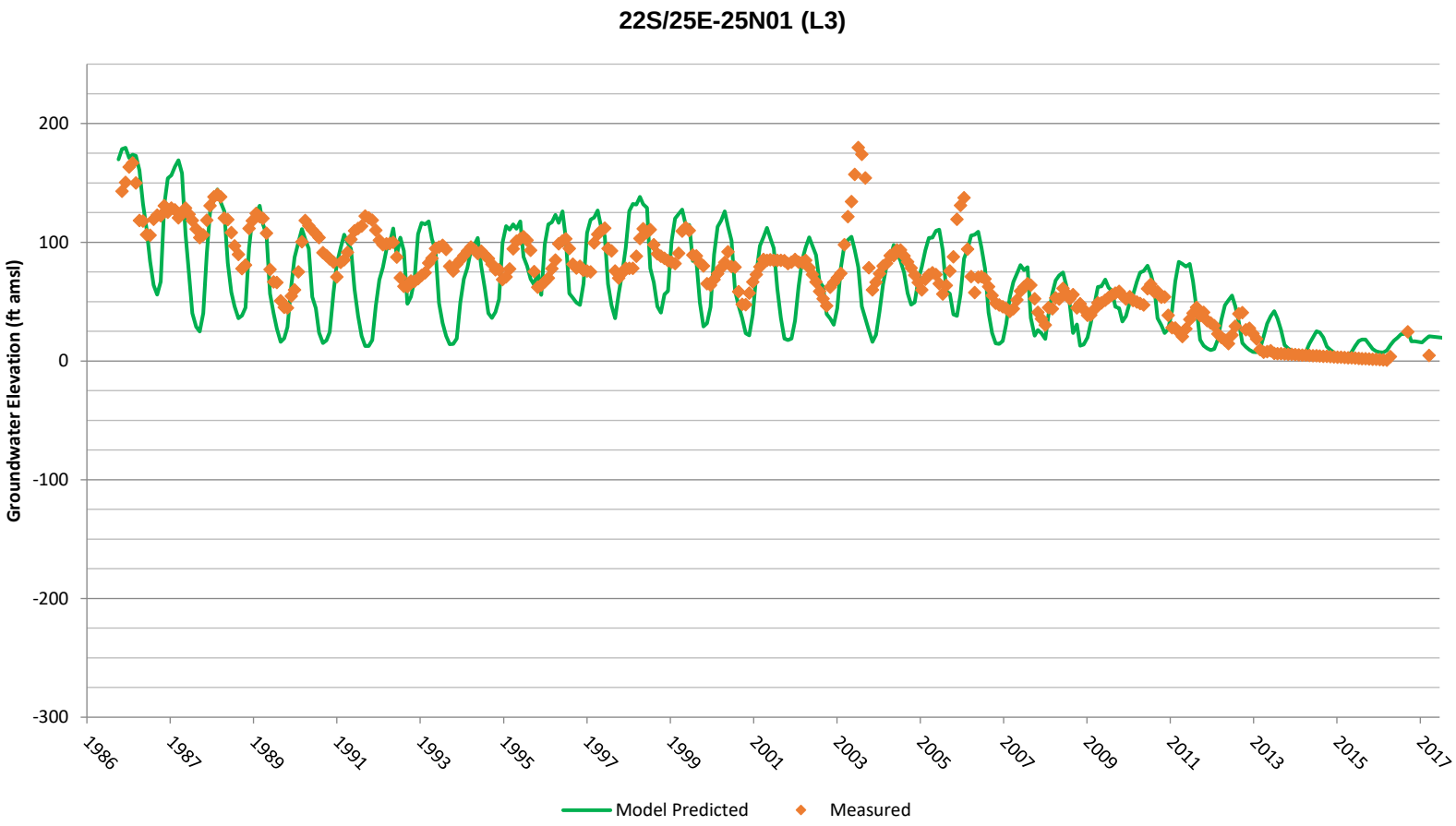
Model Calibration Hydrographs



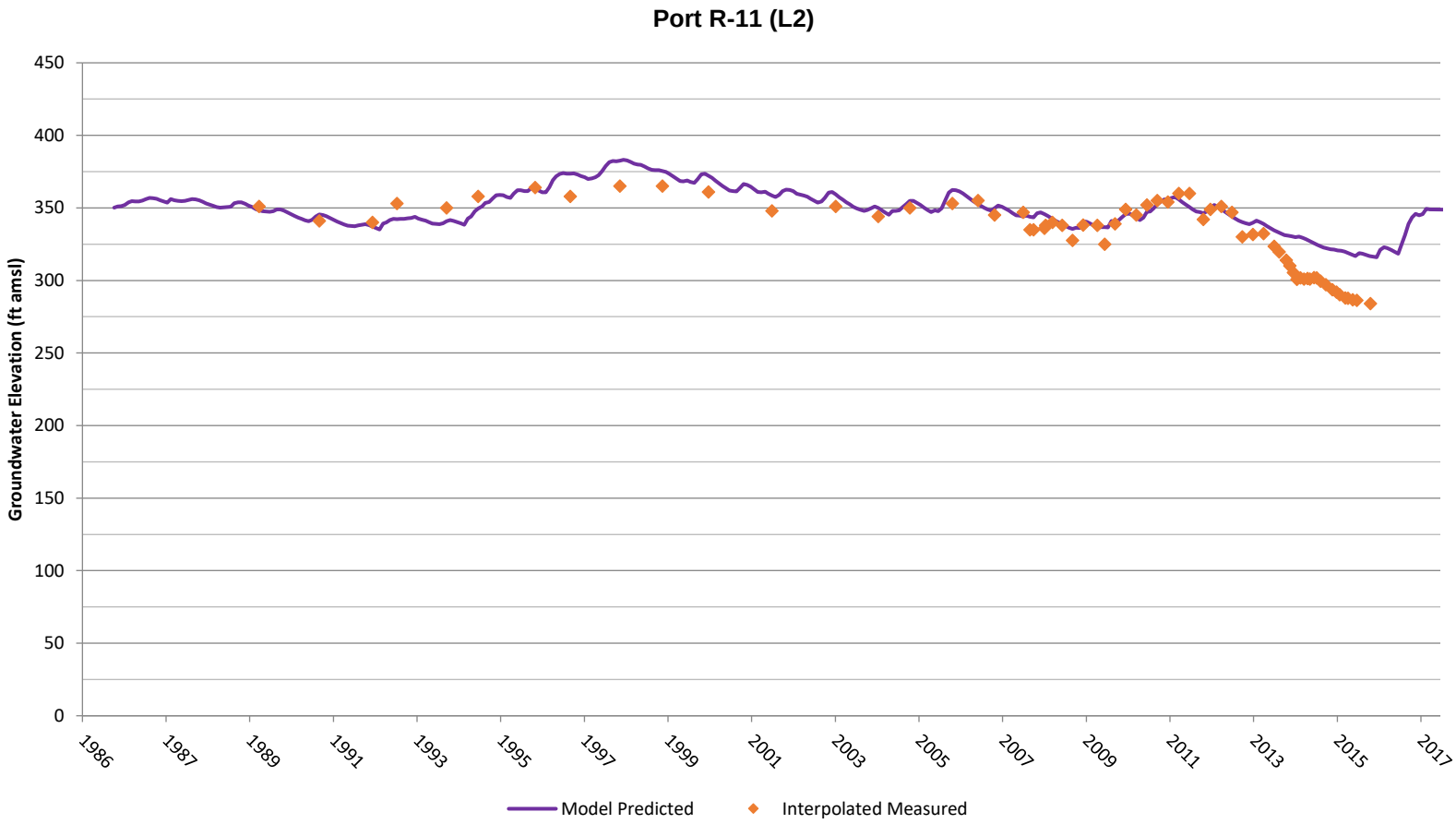
Model Calibration Hydrographs



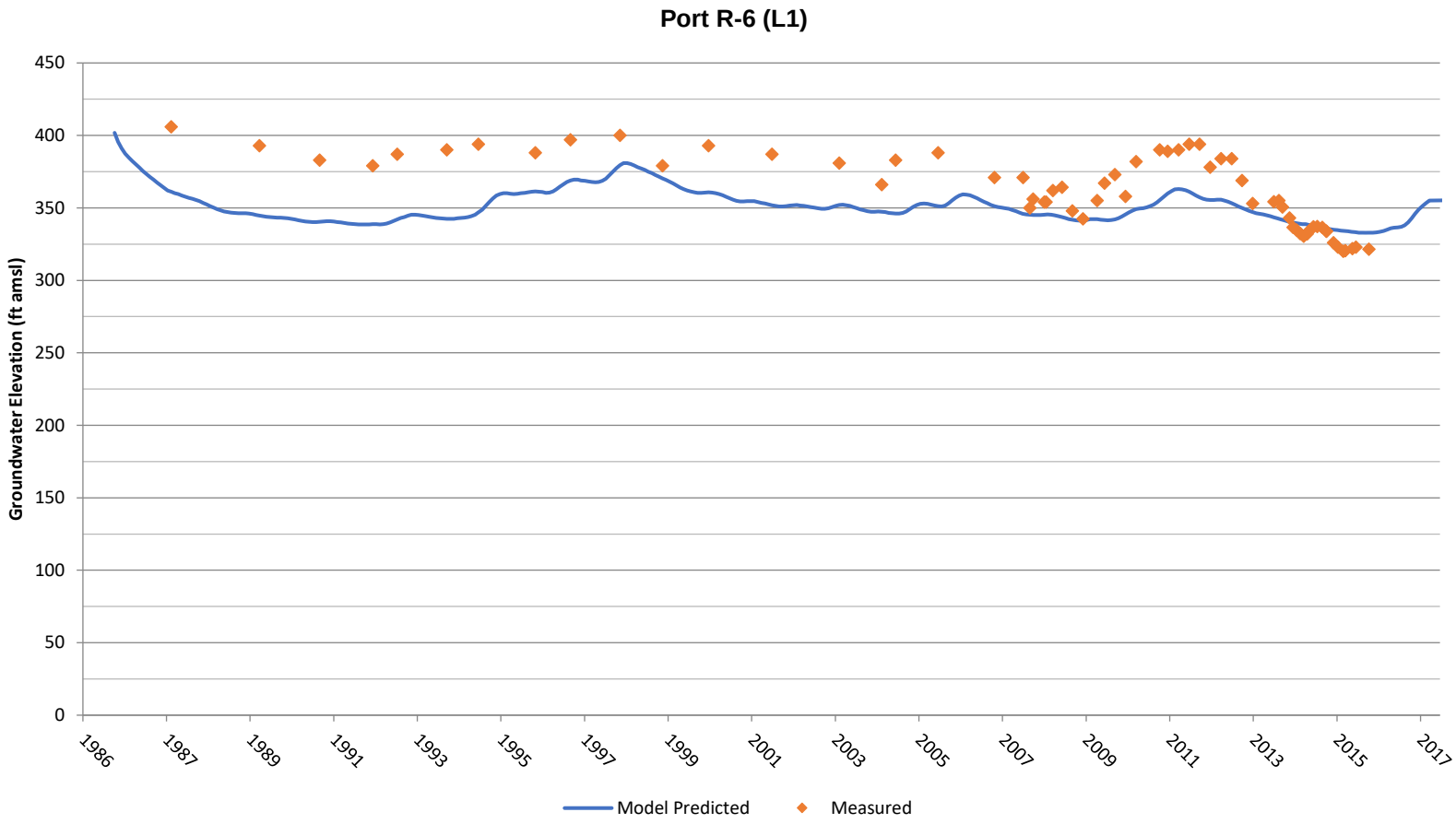
Model Calibration Hydrographs



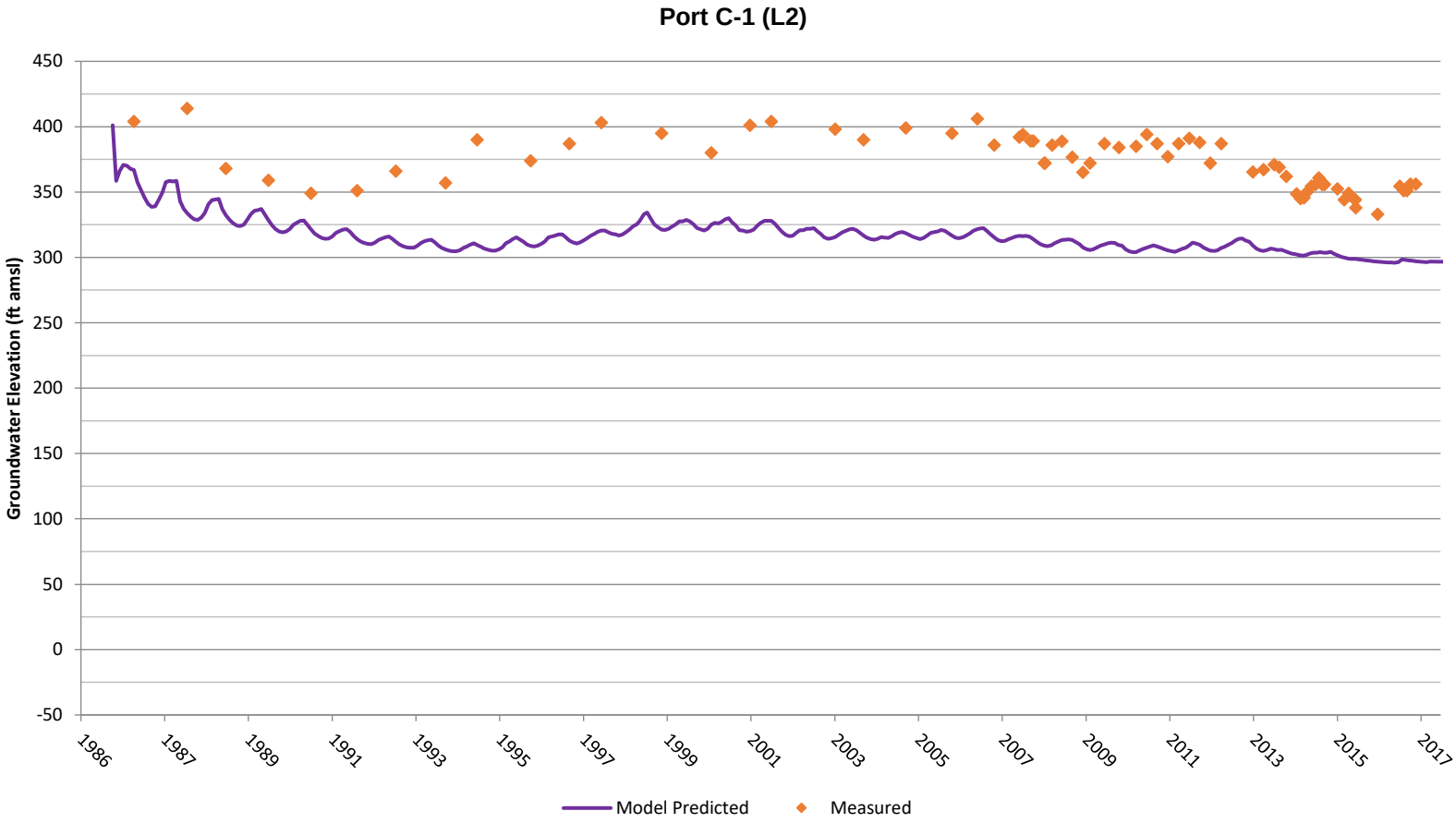
Model Calibration Hydrographs



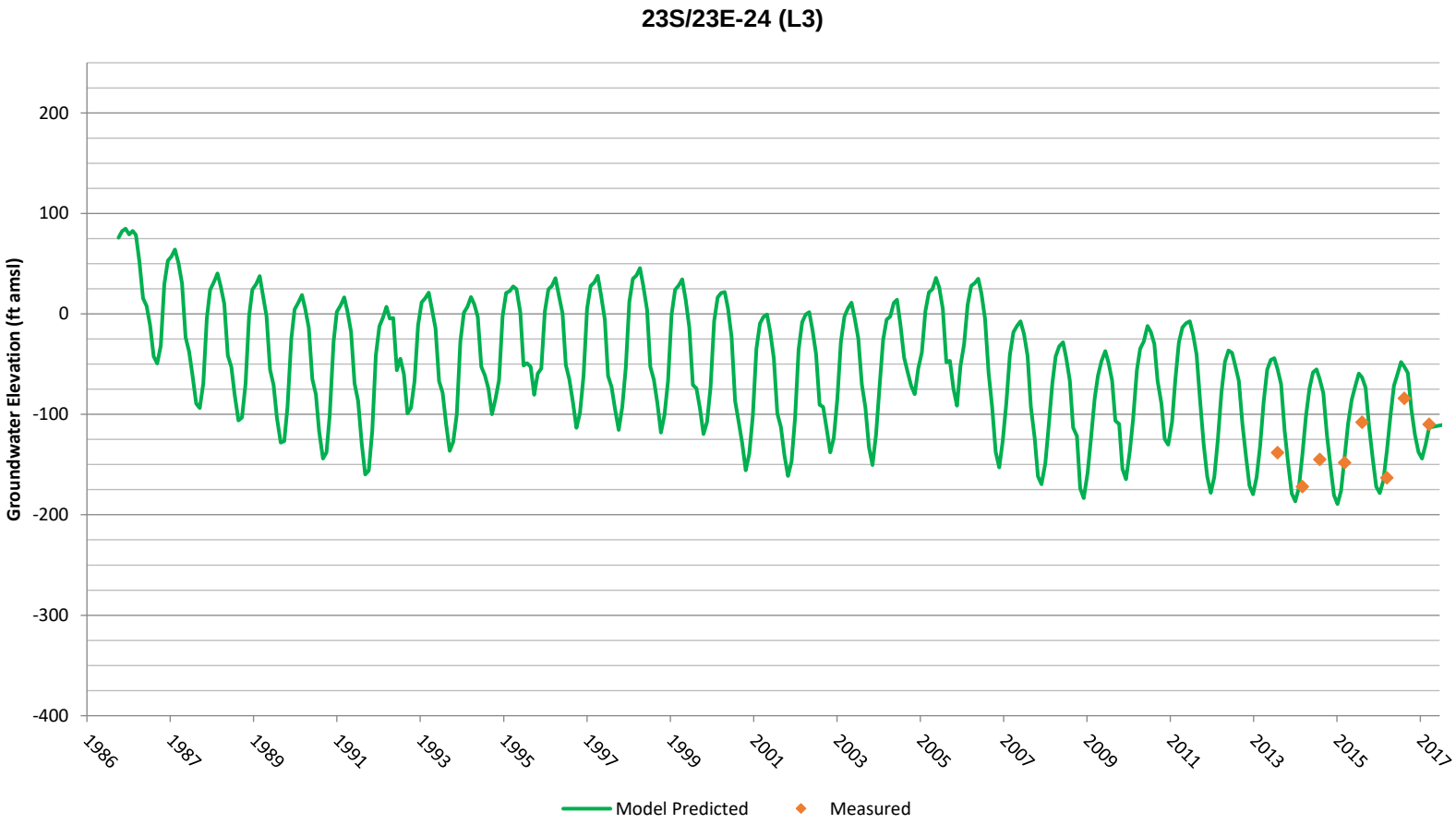
Model Calibration Hydrographs



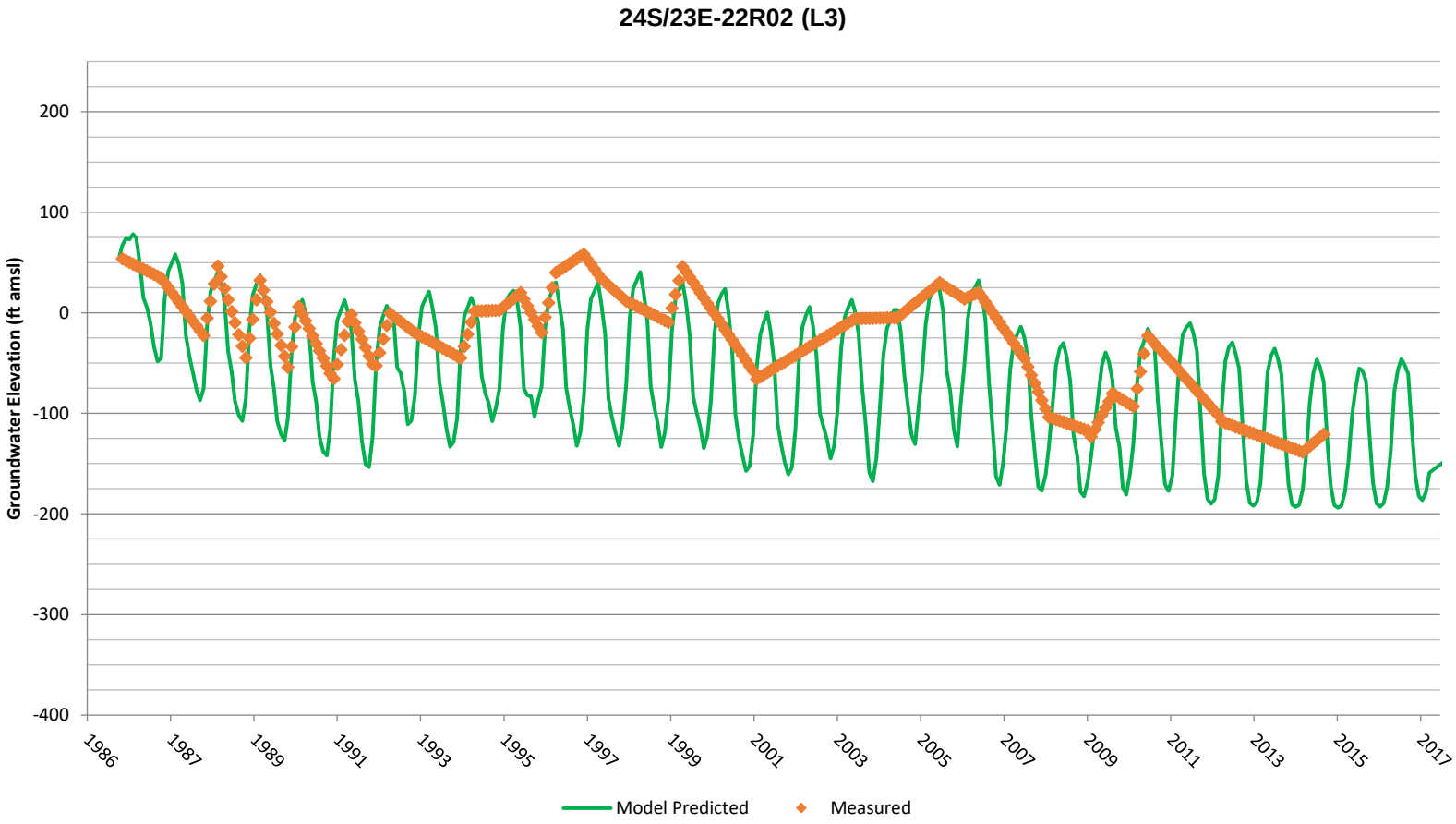
Model Calibration Hydrographs



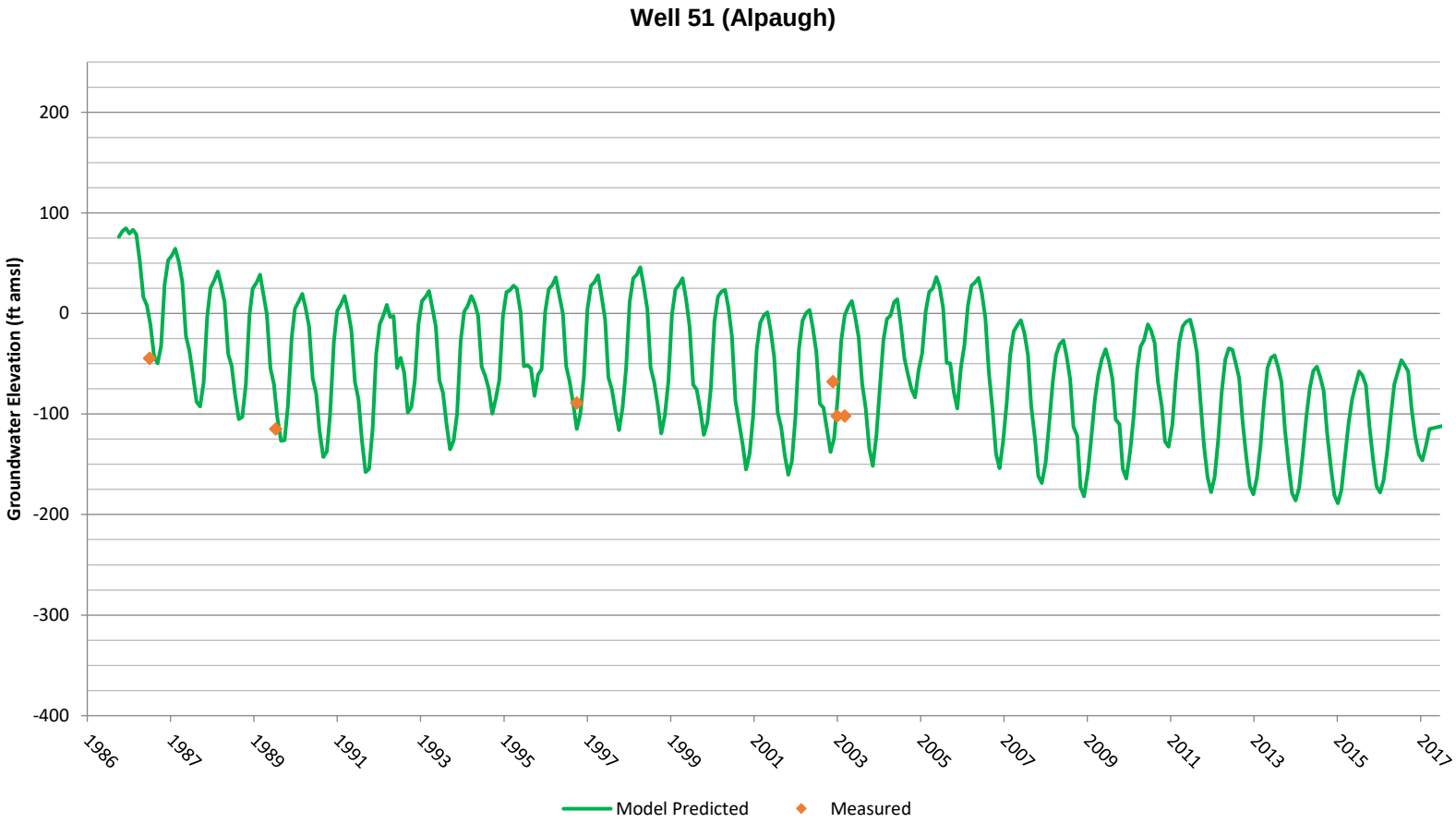
Model Calibration Hydrographs



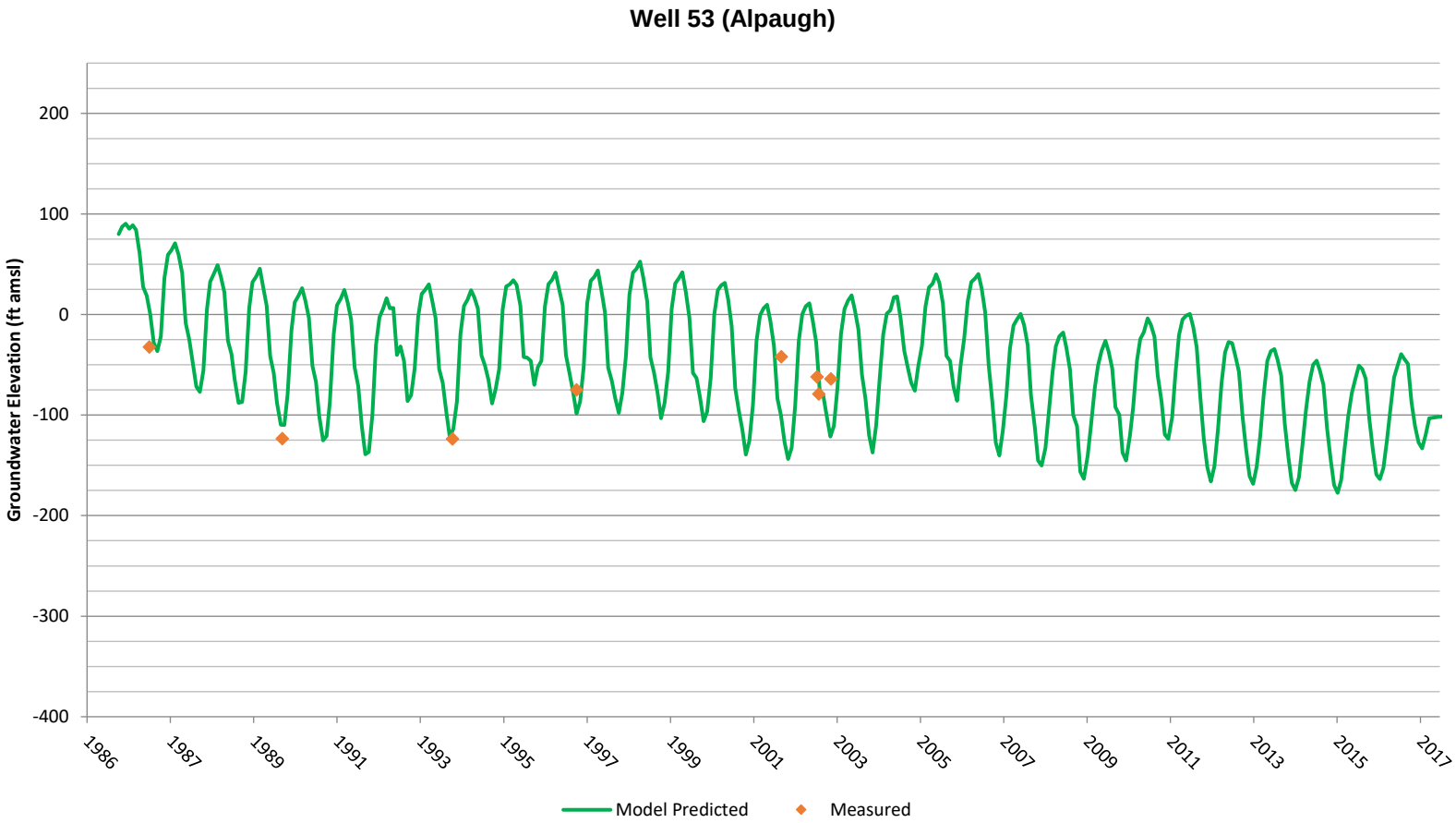
Model Calibration Hydrographs



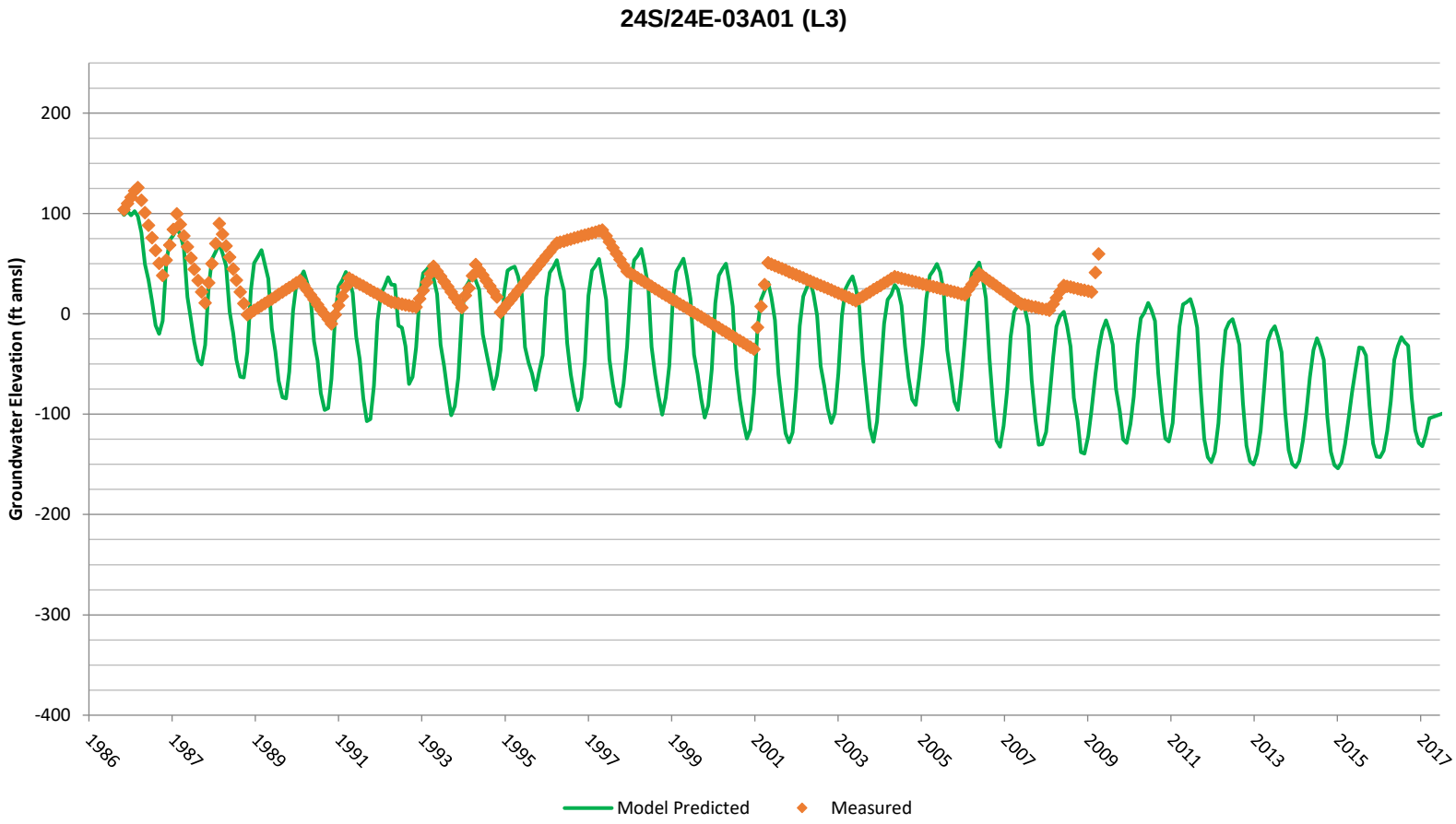
Model Calibration Hydrographs



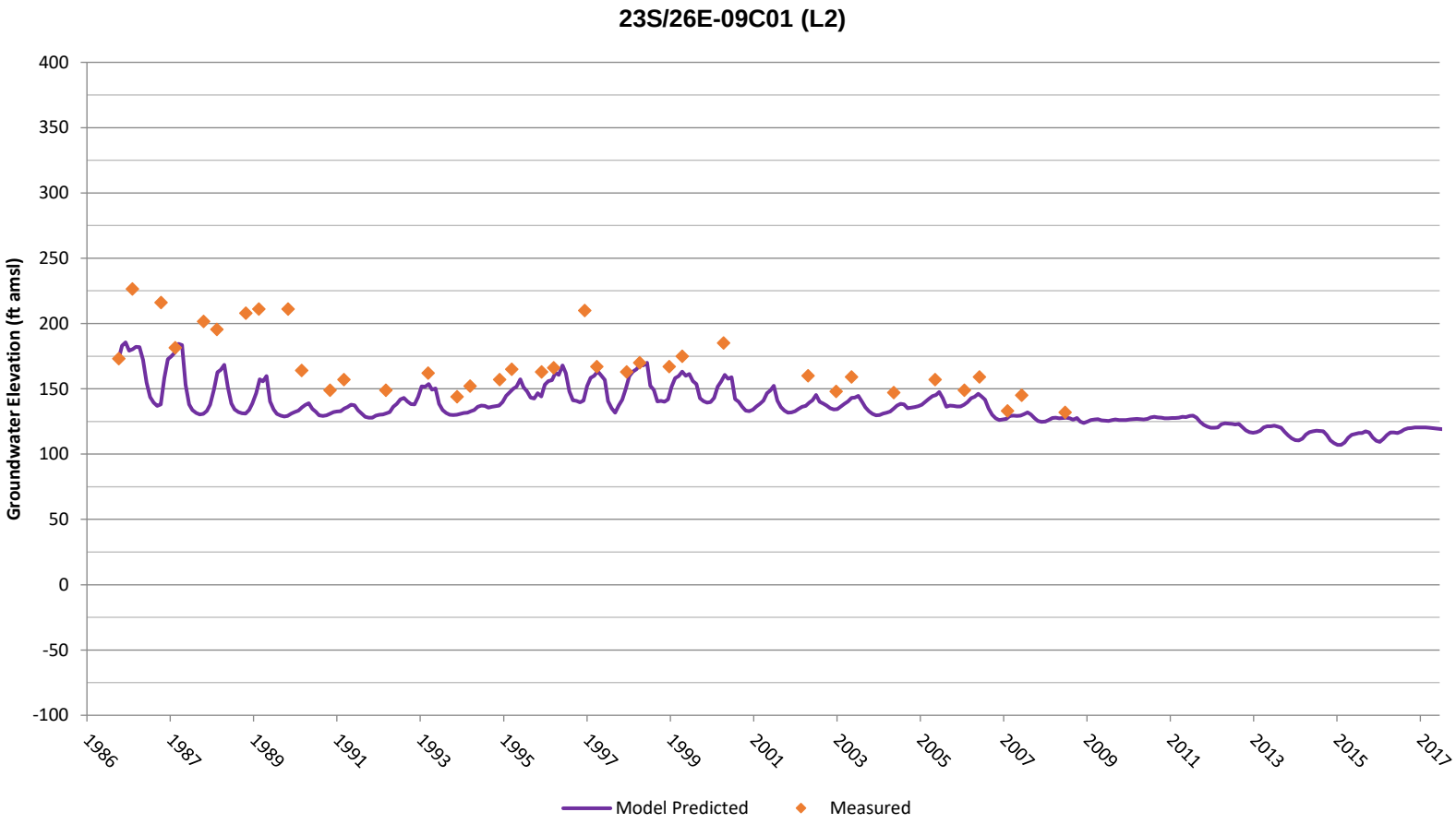
Model Calibration Hydrographs



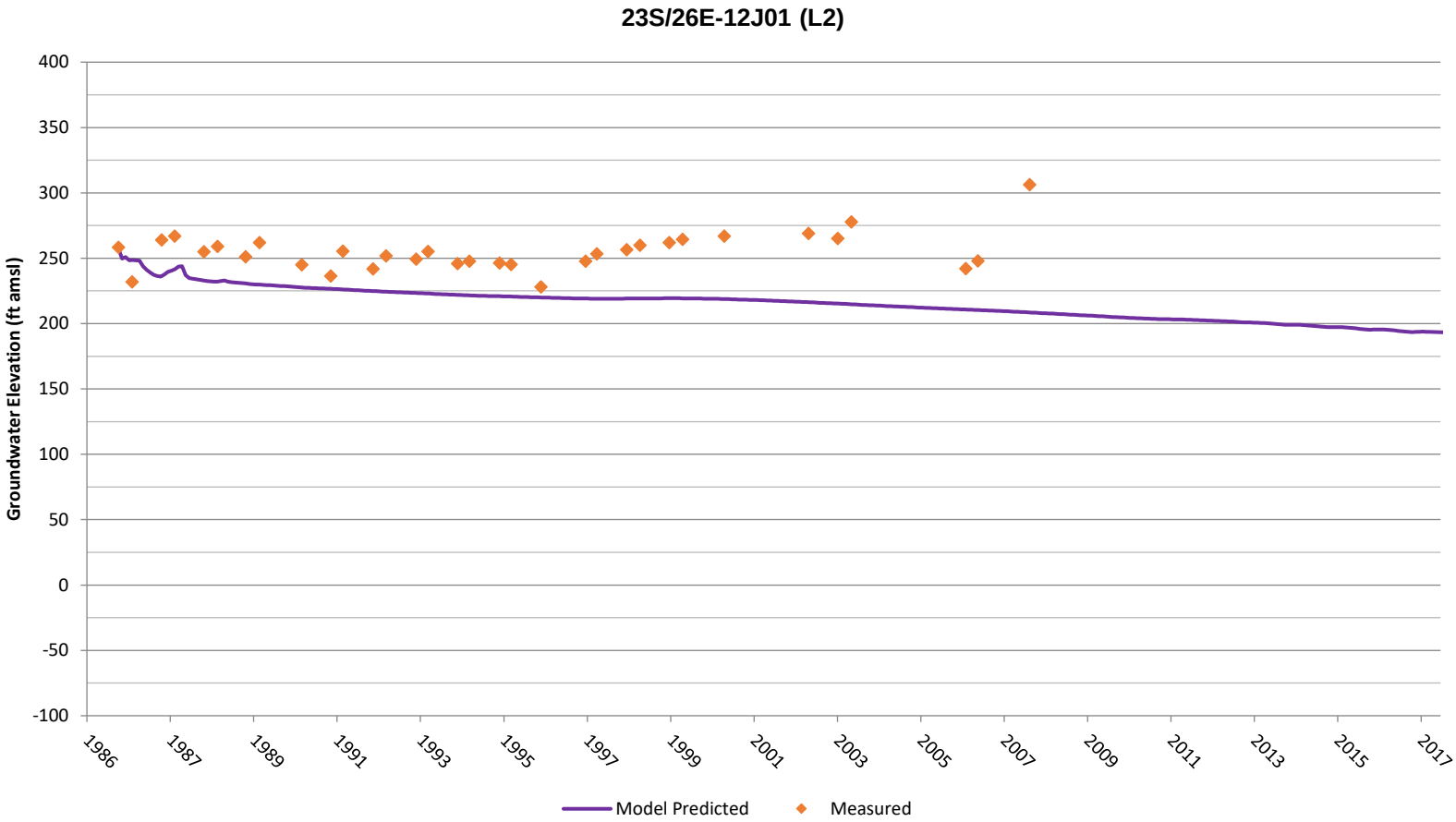
Model Calibration Hydrographs



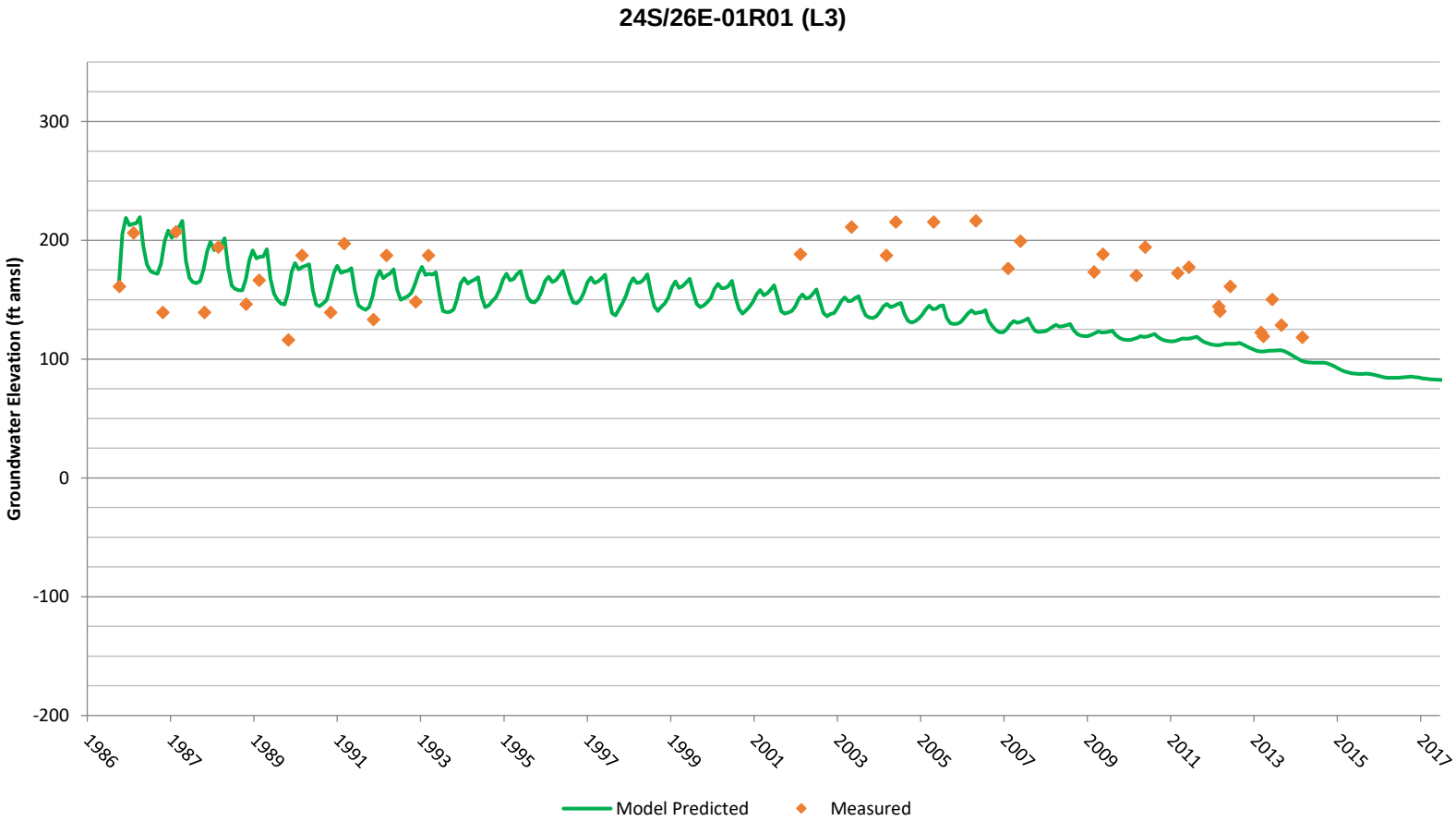
Model Calibration Hydrographs



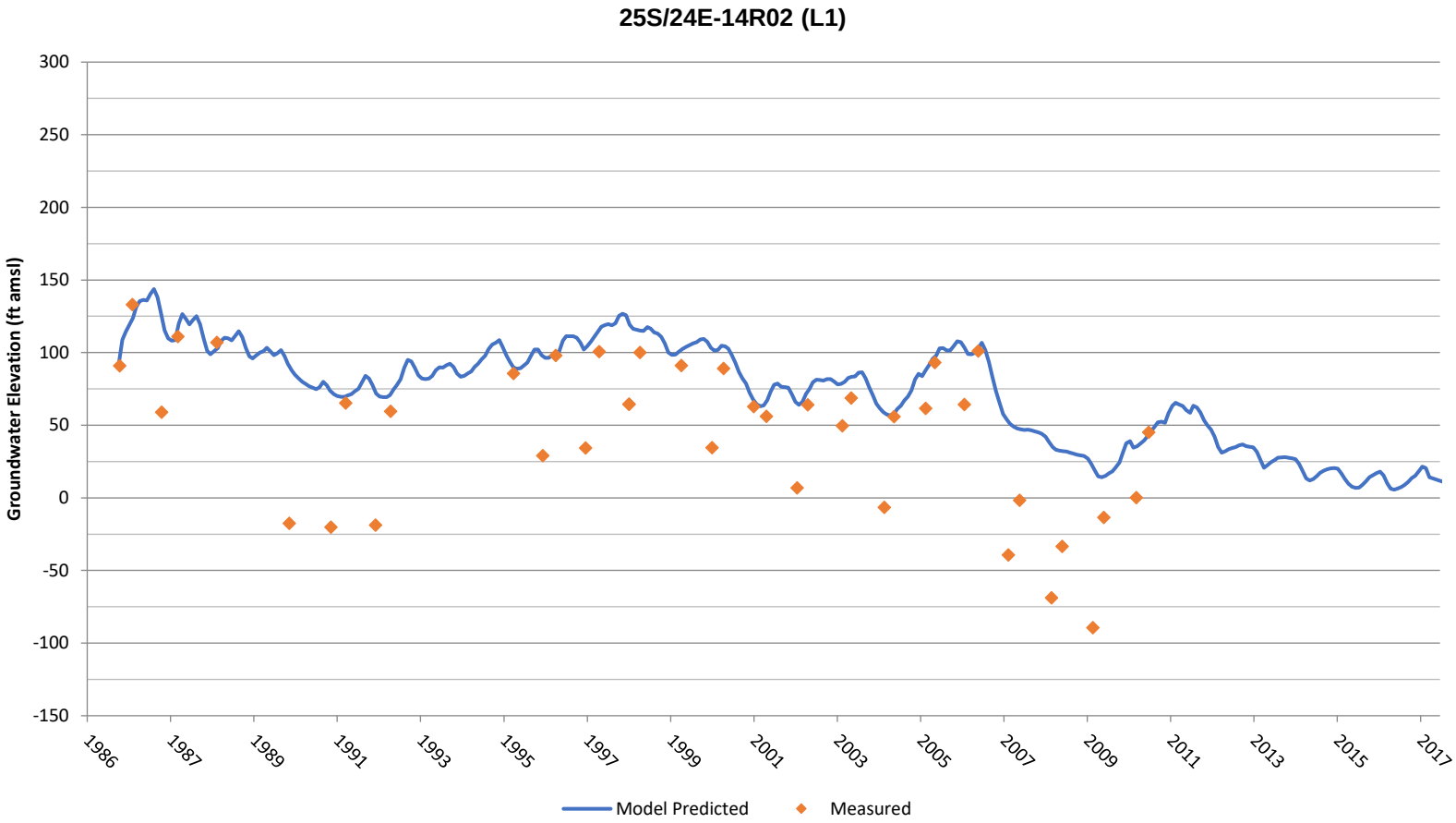
Model Calibration Hydrographs



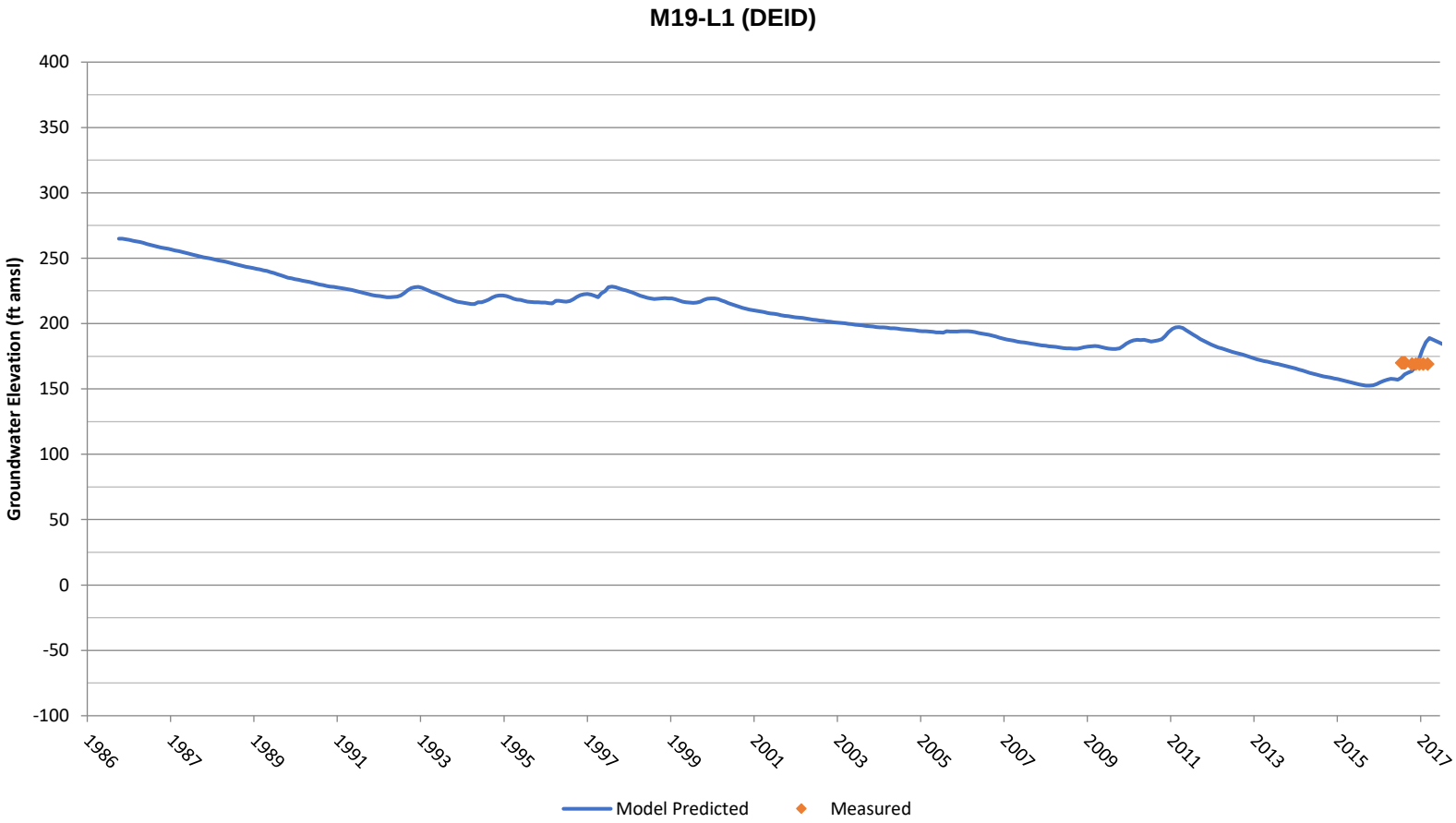
Model Calibration Hydrographs



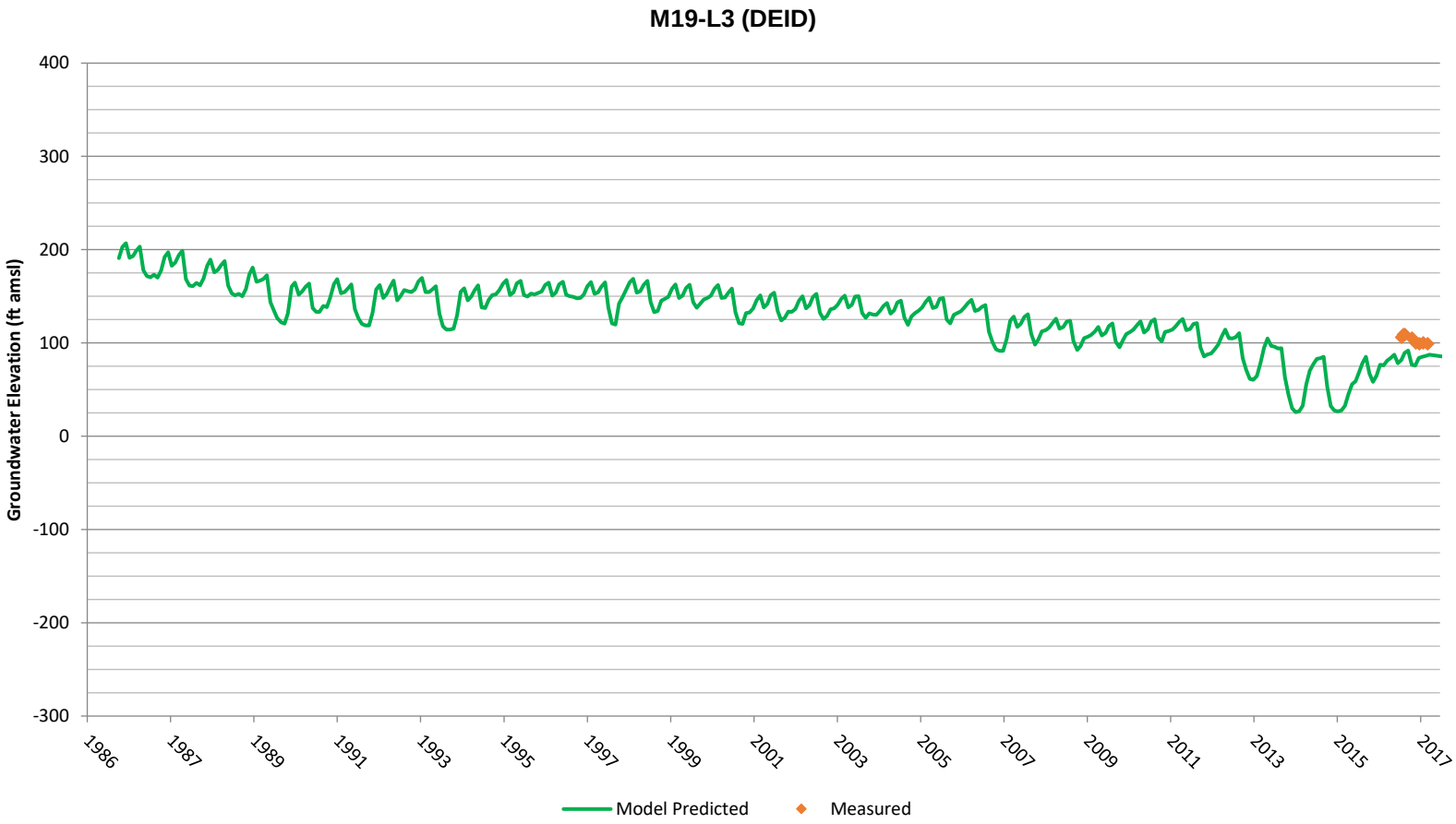
Model Calibration Hydrographs



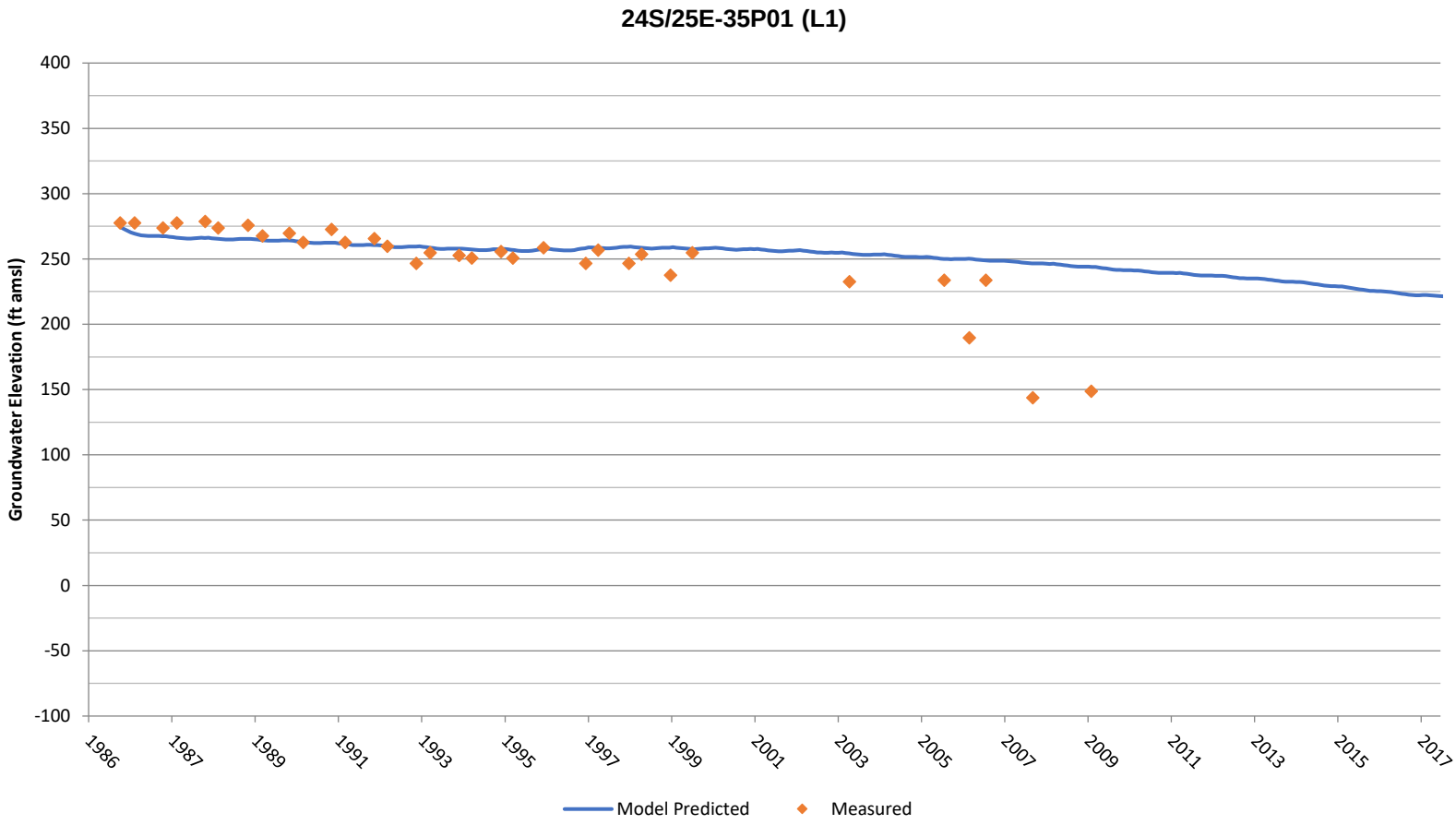
Model Calibration Hydrographs



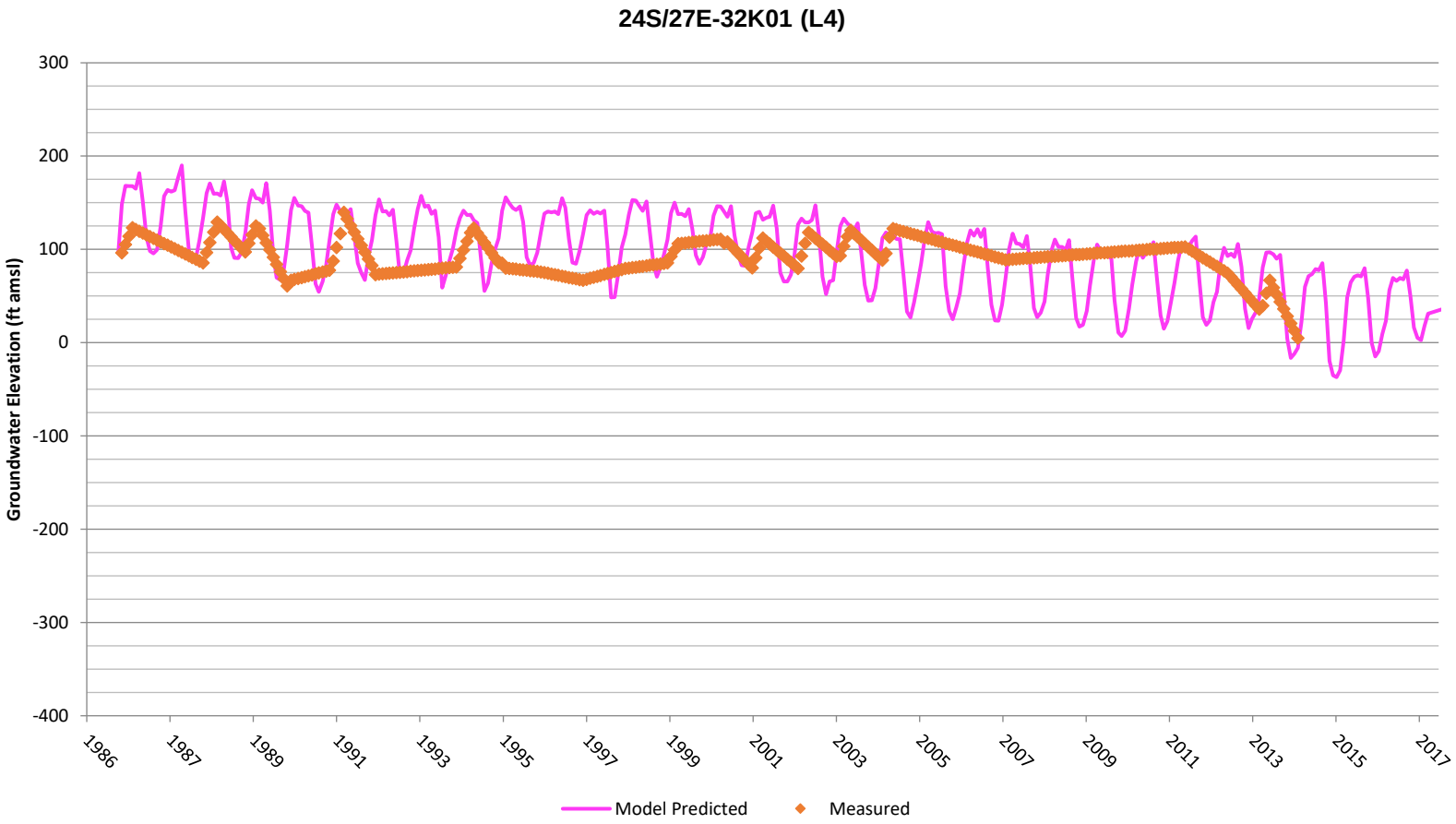
Model Calibration Hydrographs



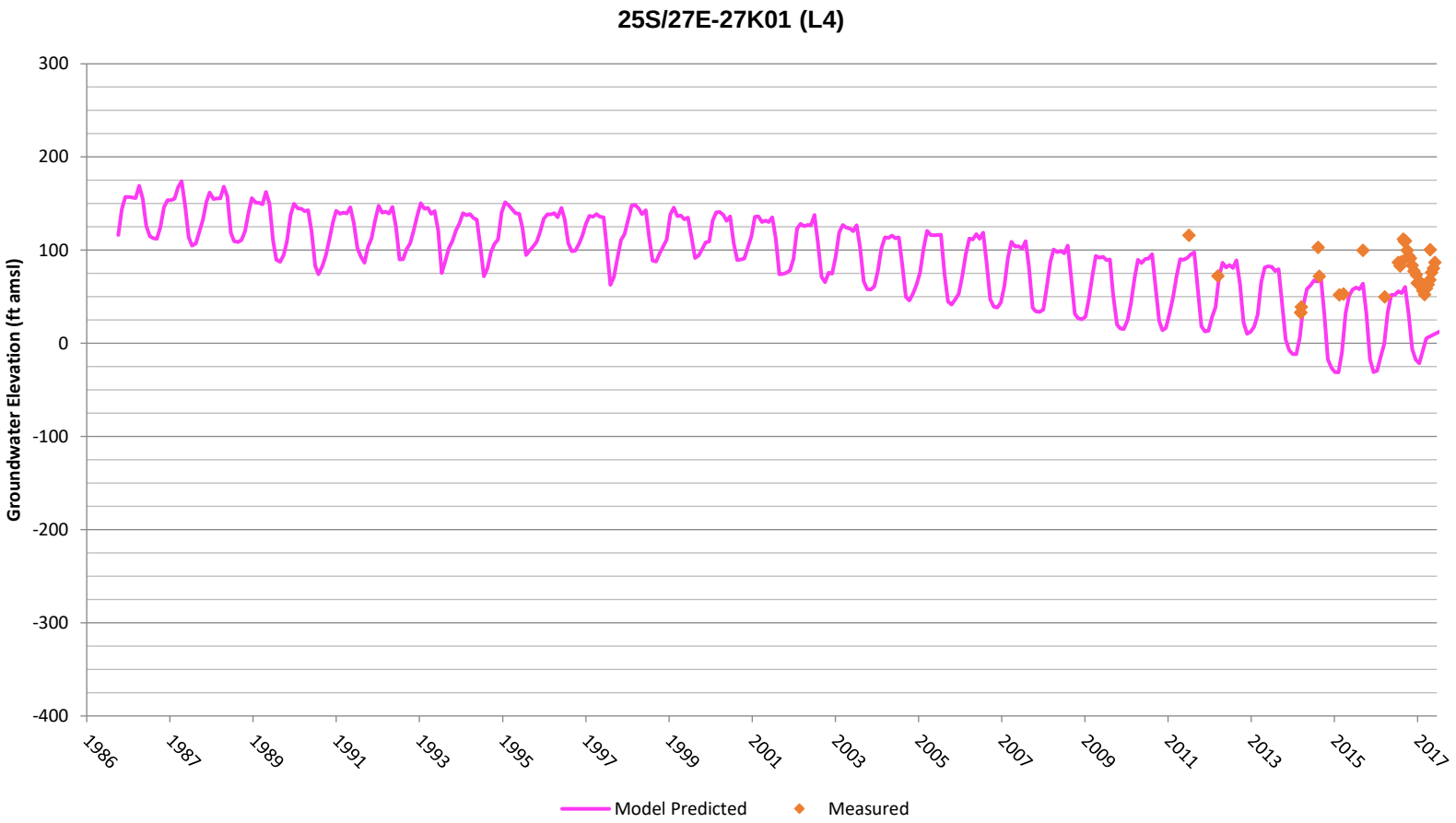
Model Calibration Hydrographs



Model Calibration Hydrographs



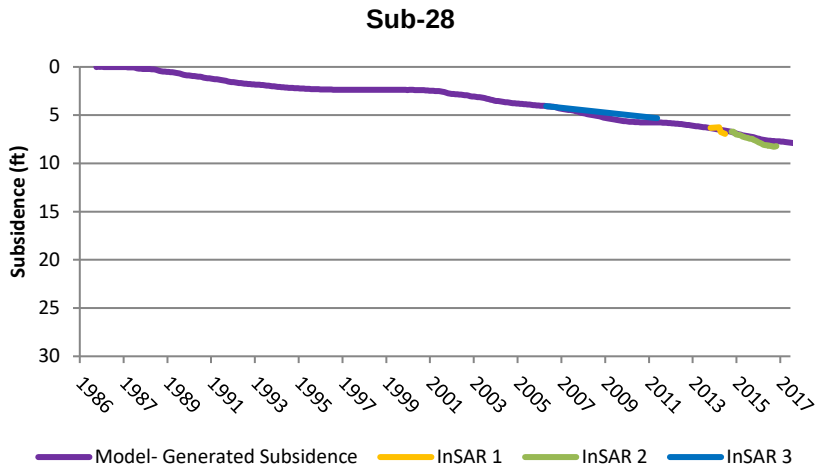
Model Calibration Hydrographs

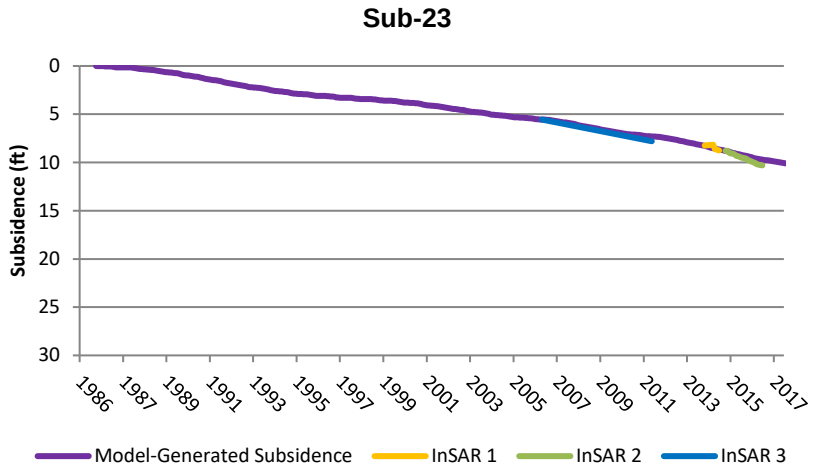


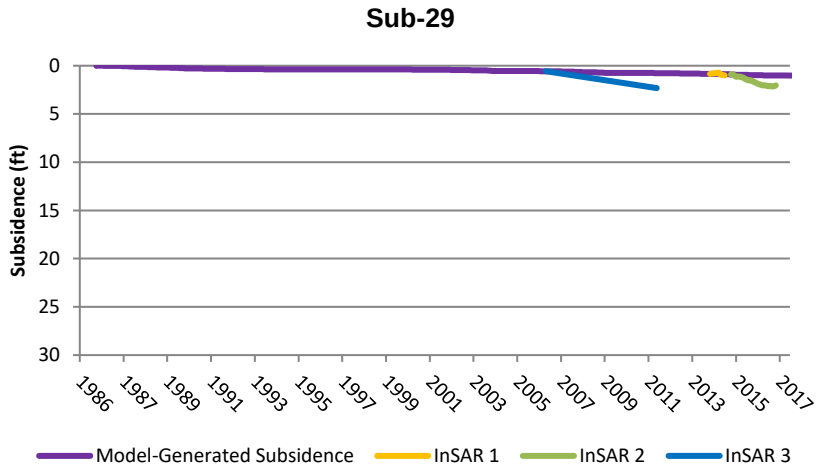
Appendix E

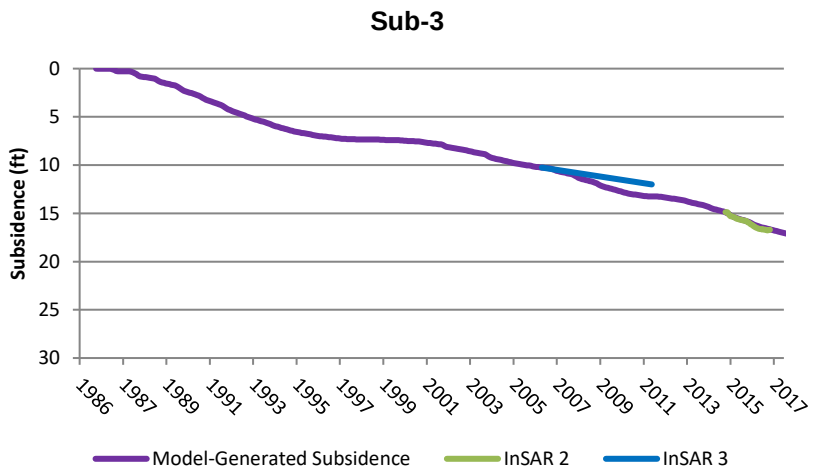
Land Subsidence Calibration Graphs

Land Subsidence Calibration Graphs



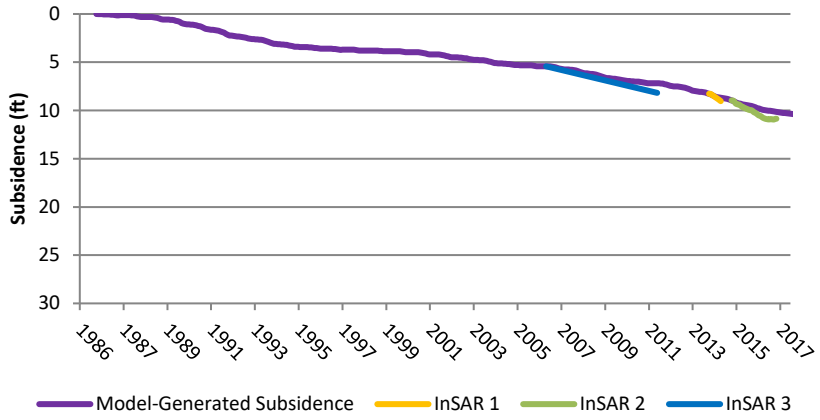




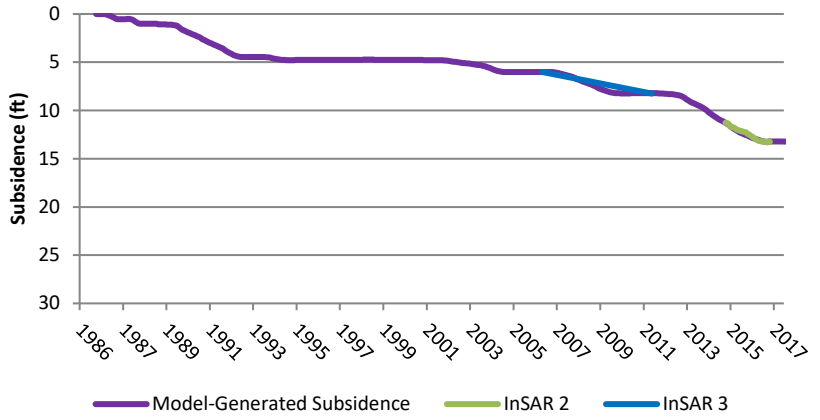


Land Subsidence Calibration Graphs

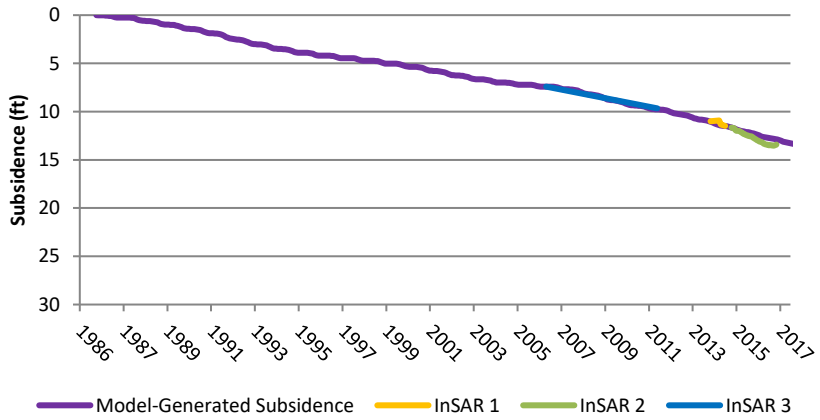
Sub-37 (21S/23E-32K01)



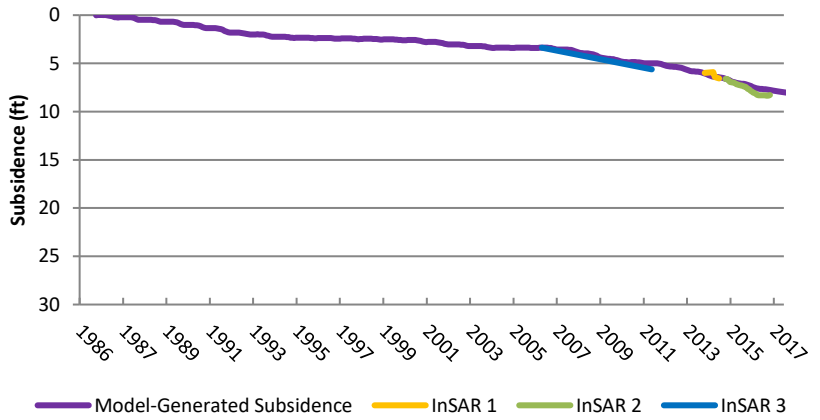
Sub-35 (21S/23E-36R01)



Sub-21

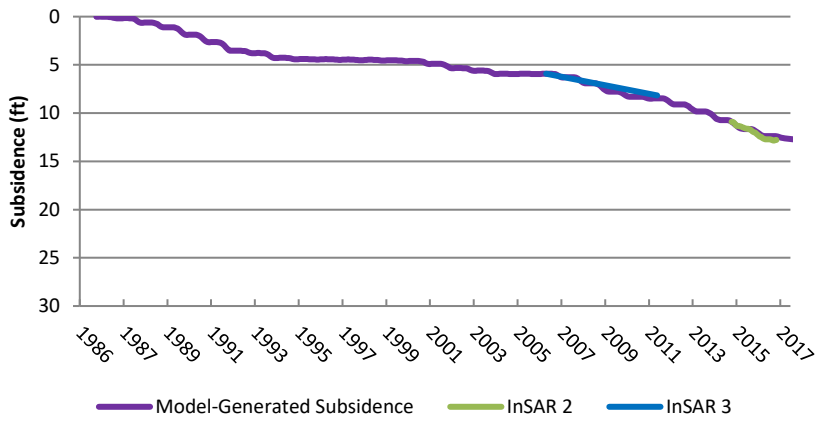


Sub-20

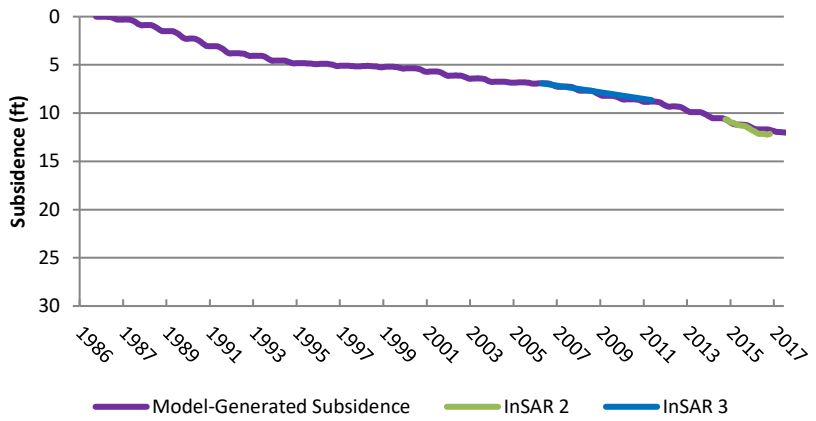


Land Subsidence Calibration Graphs

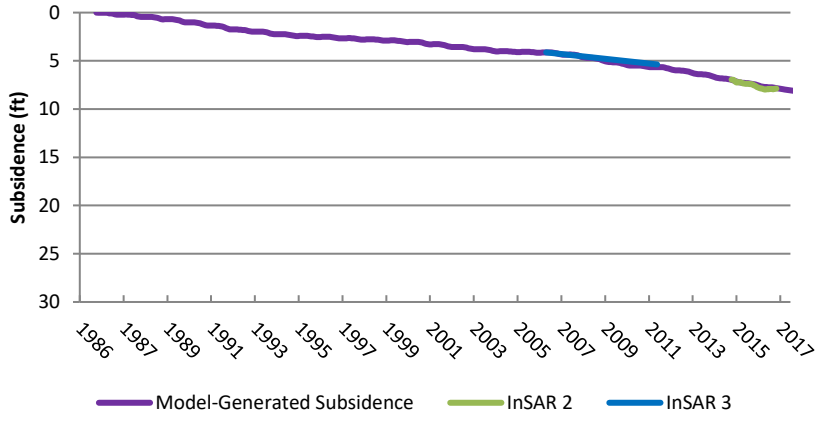
Sub-1



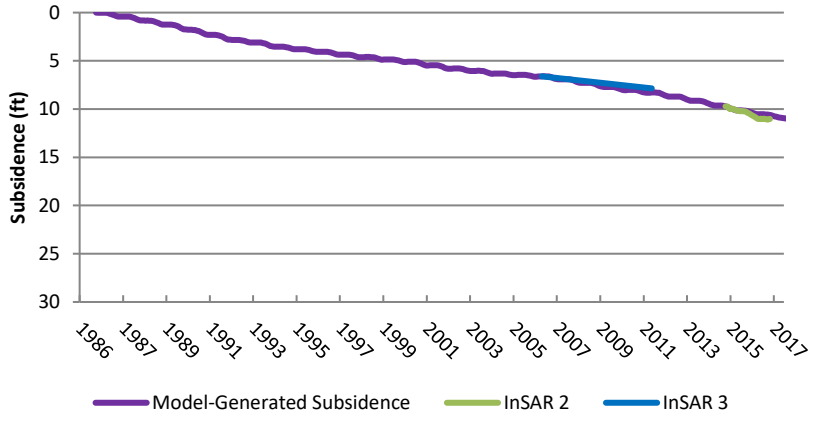
Sub-18



Sub-19

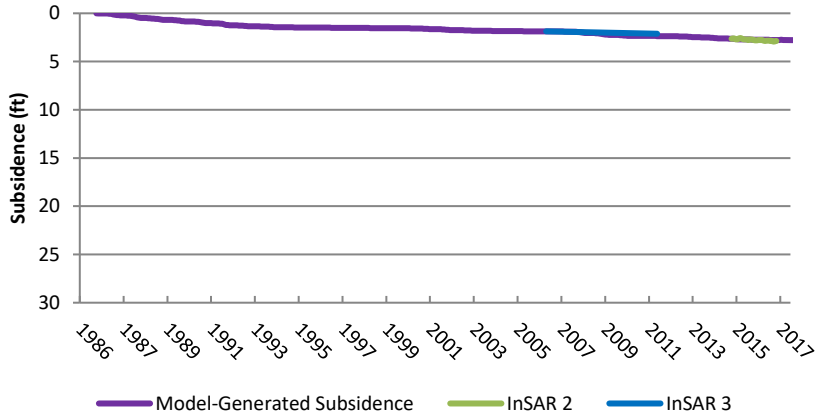


Sub-30 (24S/24E-03A01)

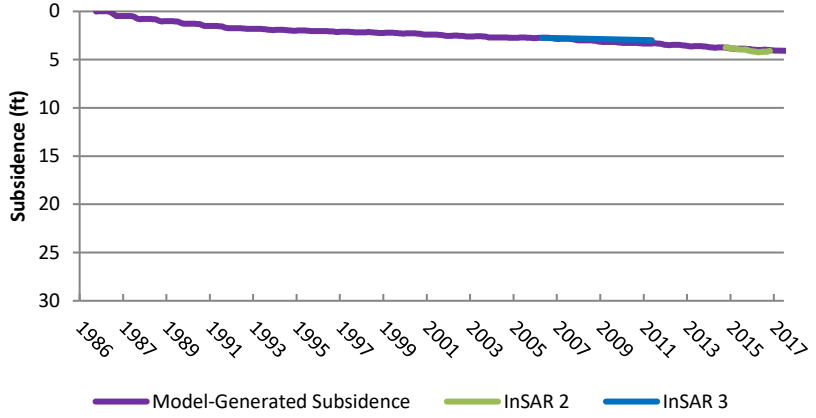


Land Subsidence Calibration Graphs

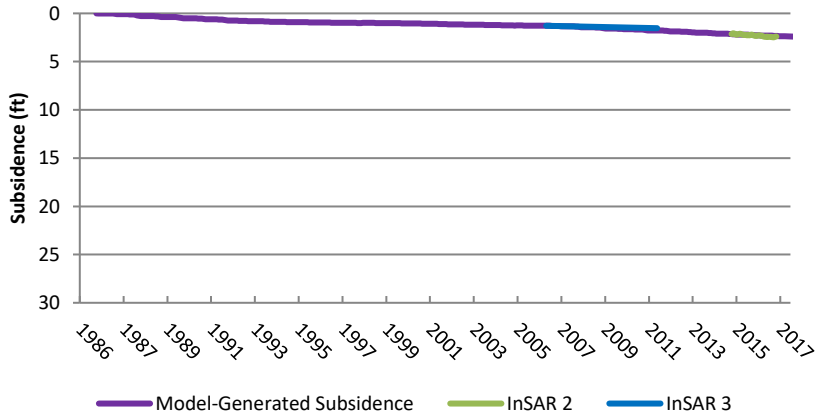
Sub-12



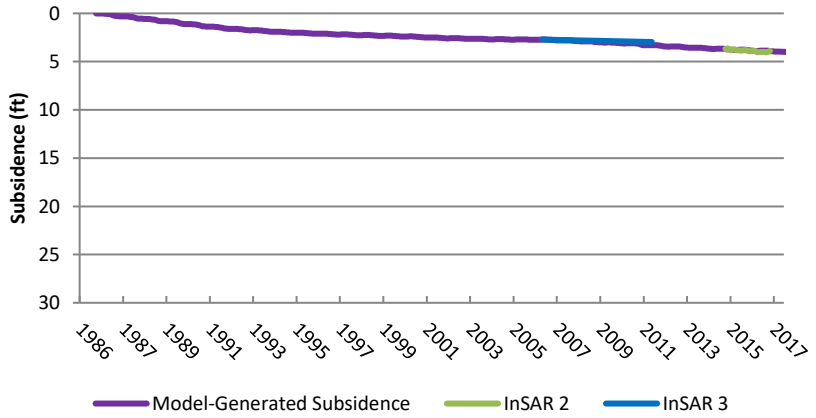
Sub-31 (24S/23E-22R02)



Sub-11

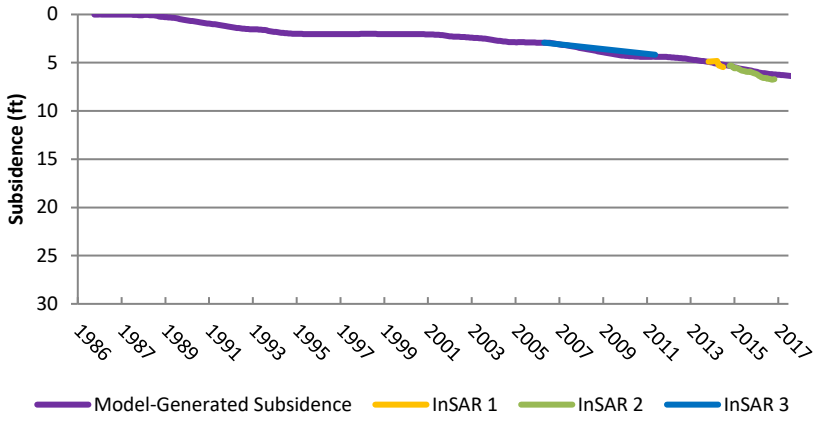


Sub-10

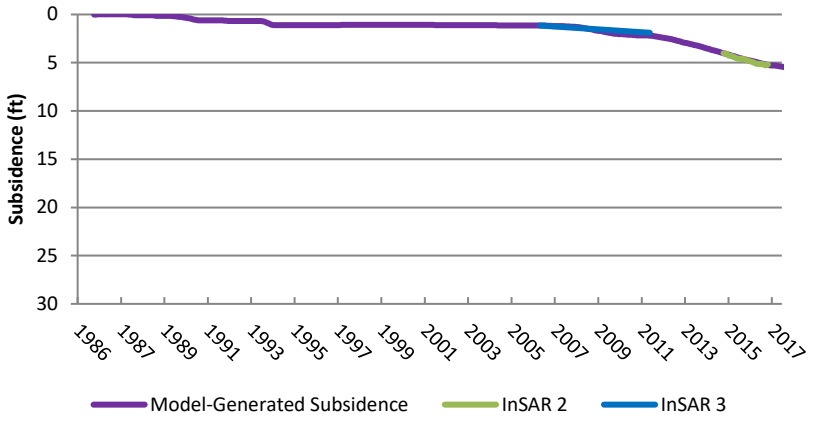


Land Subsidence Calibration Graphs

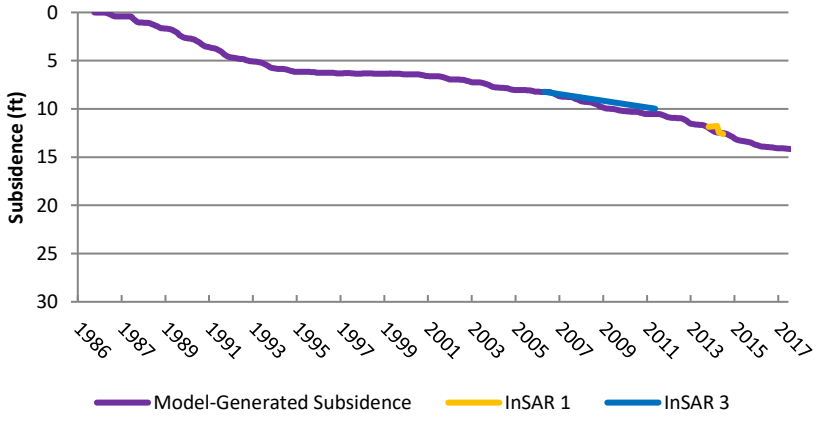
Sub-27



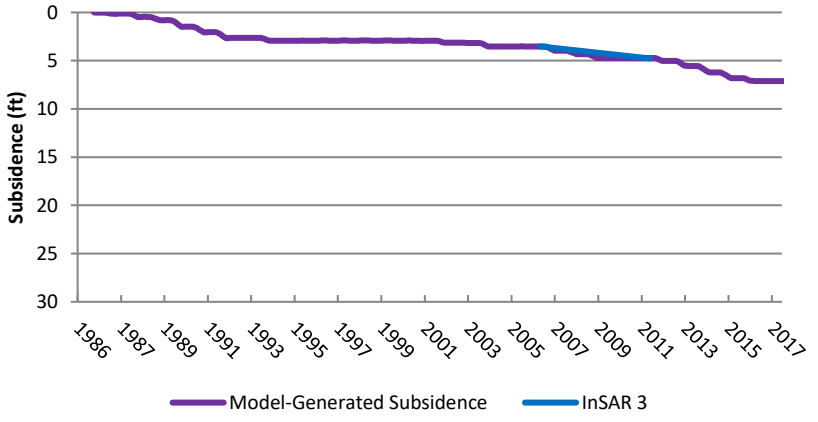
Sub-26



Sub-34 (21S/24E-14P01)

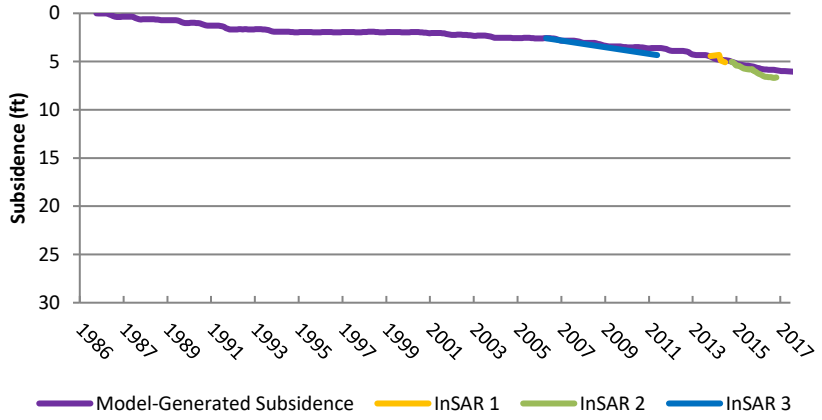


Sub-2

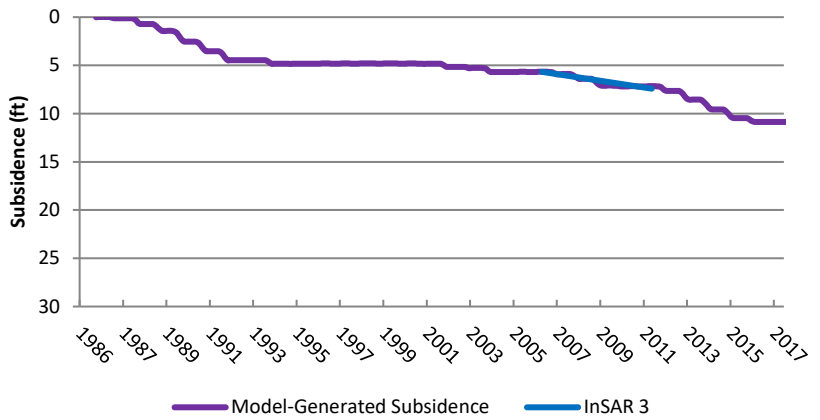


Land Subsidence Calibration Graphs

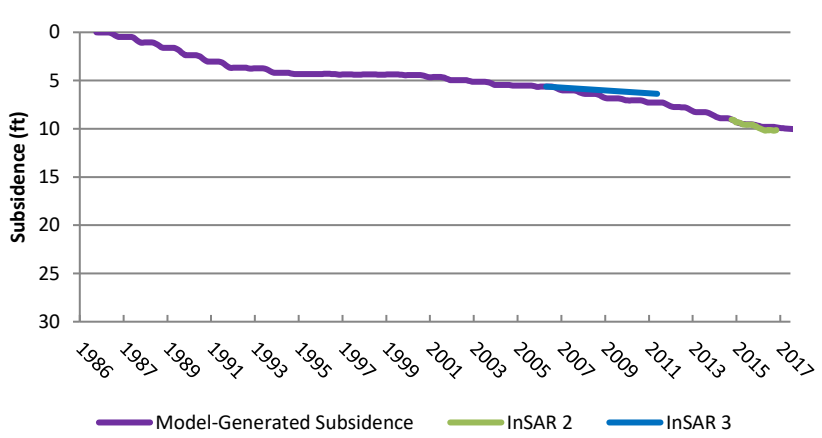
Sub-36 (22S/24E-01Q01)



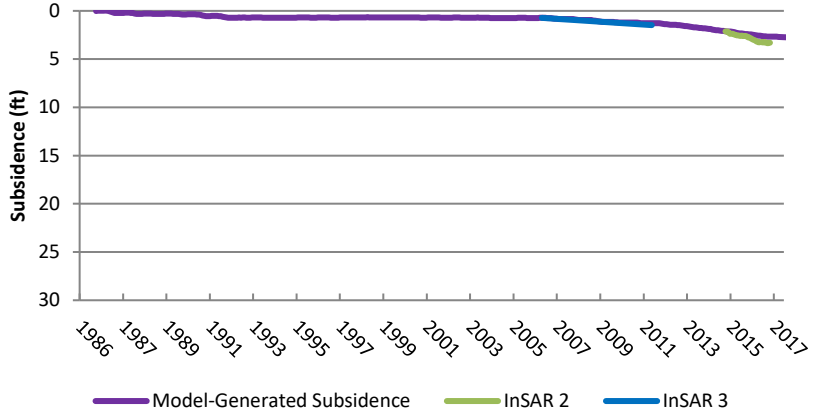
Sub-42 (22S/24E-23J01)



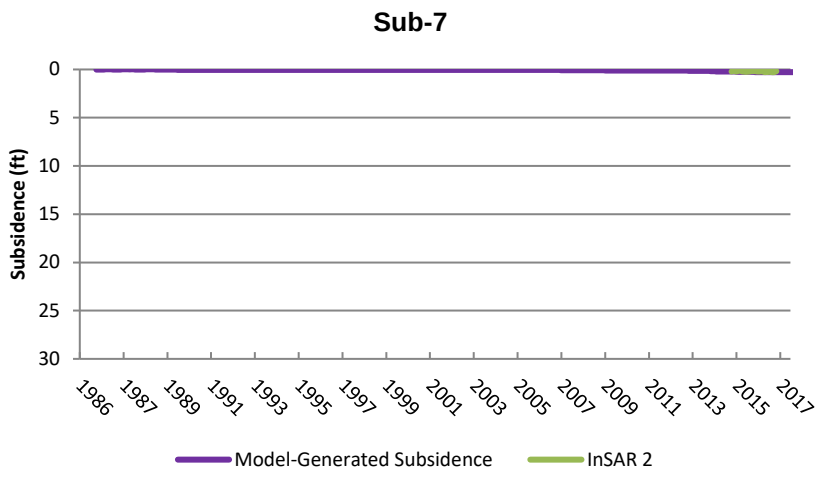
Sub-17

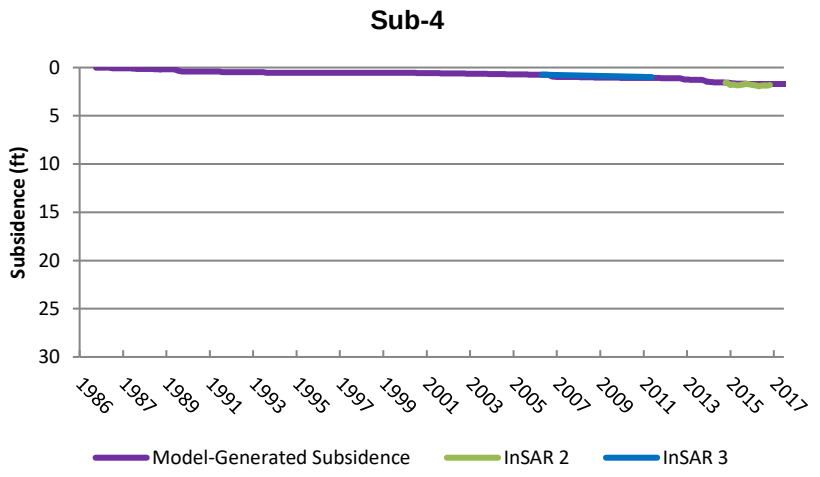


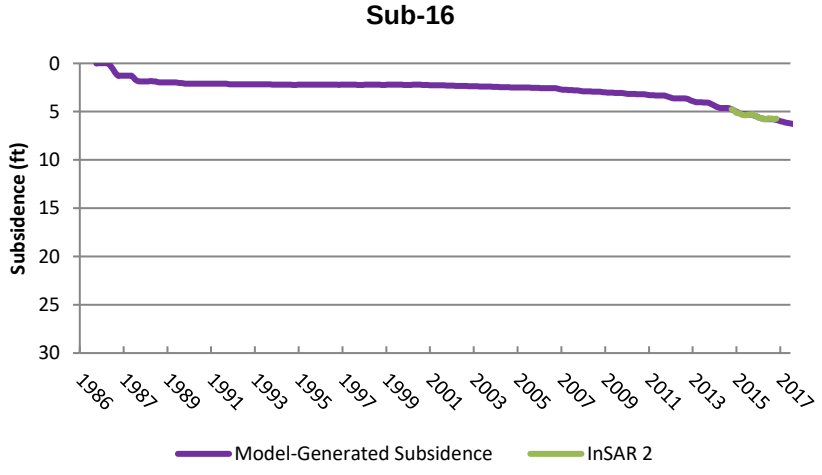
Sub-43 (22S/25E-25N01)

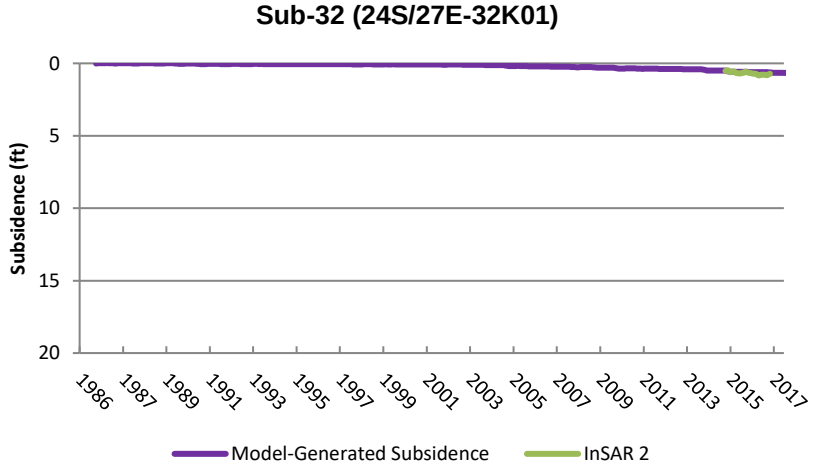


Land Subsidence Calibration Graphs

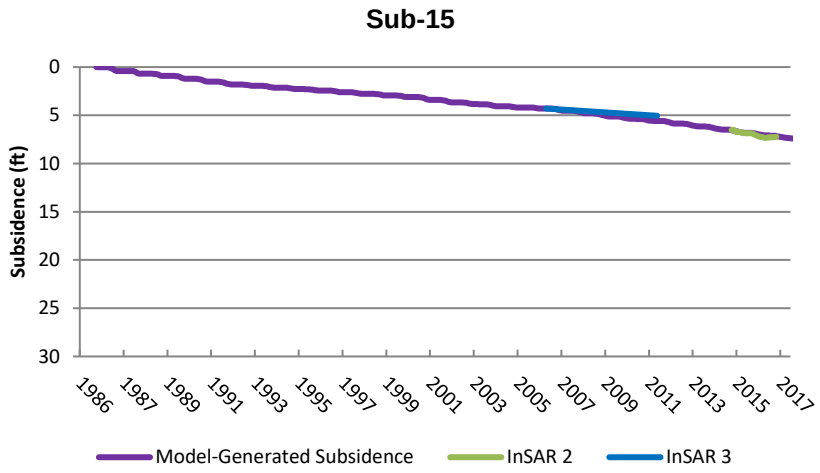


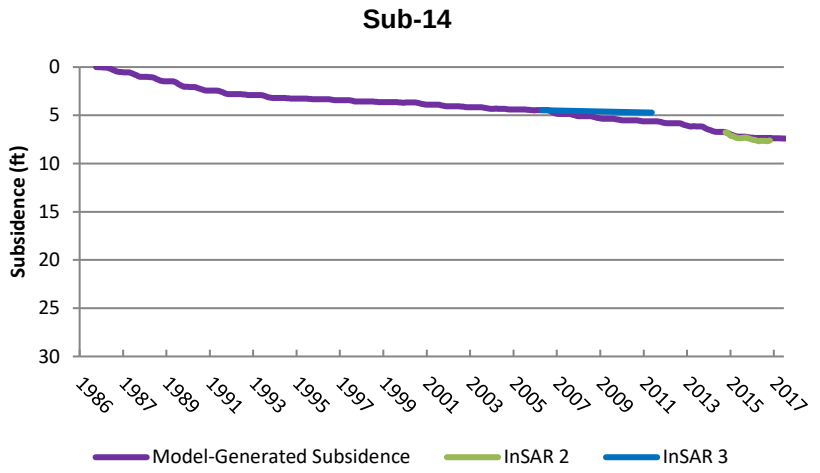


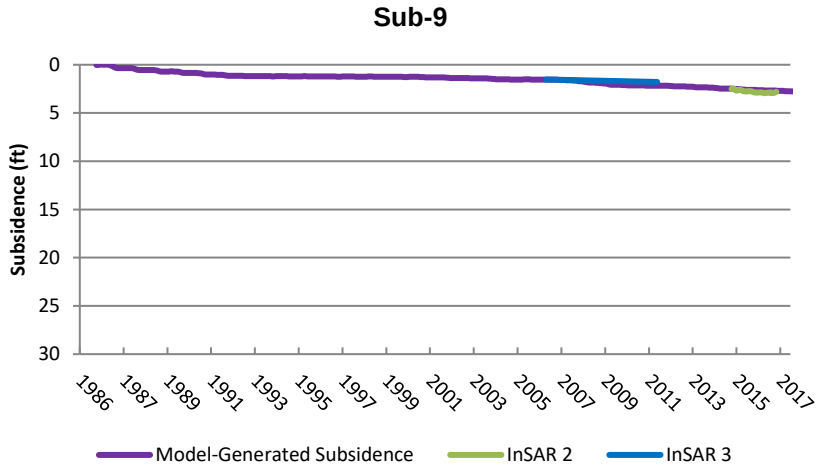


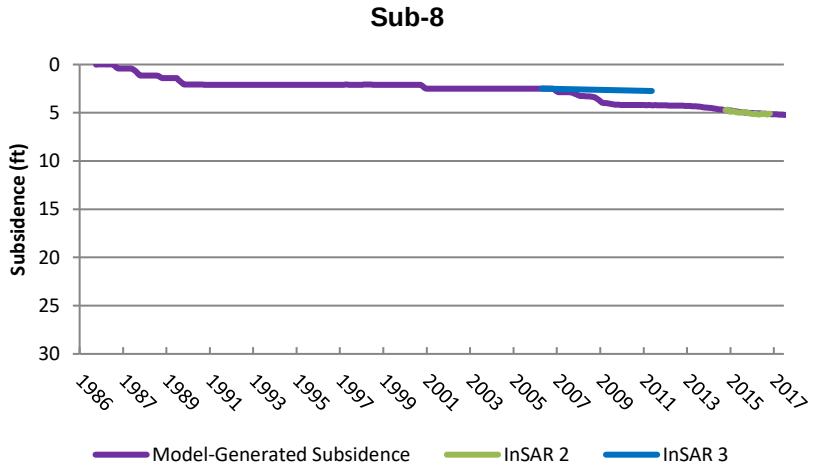


Land Subsidence Calibration Graphs



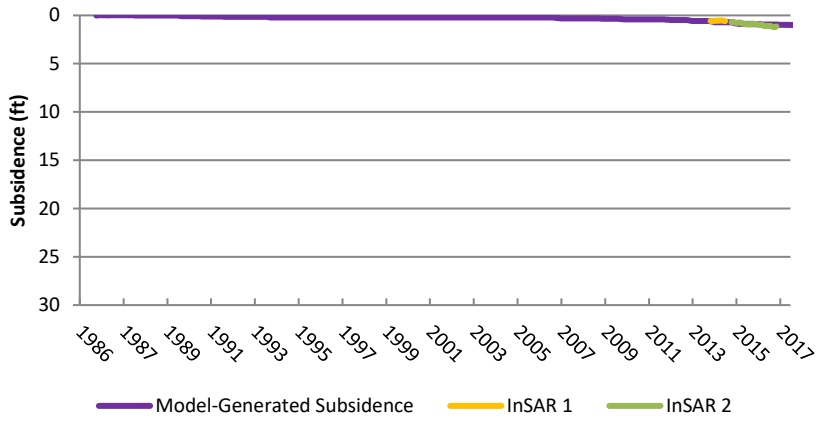




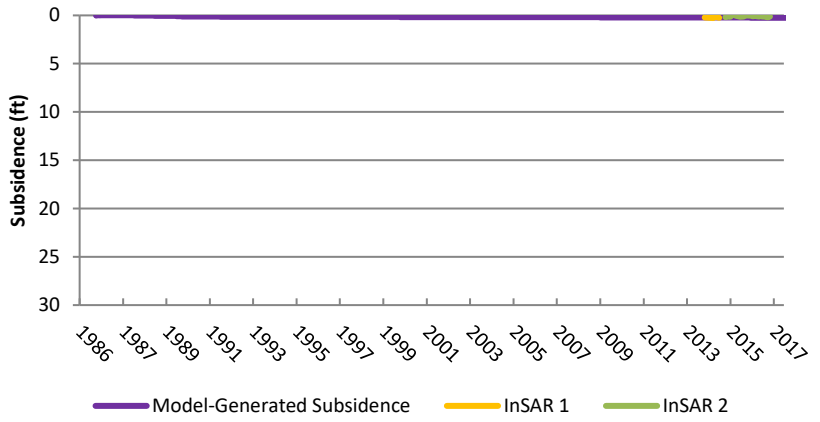


Land Subsidence Calibration Graphs

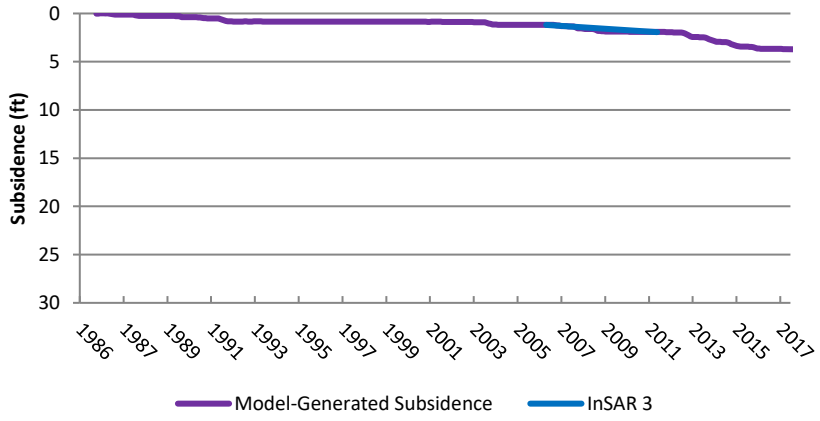
Sub-25



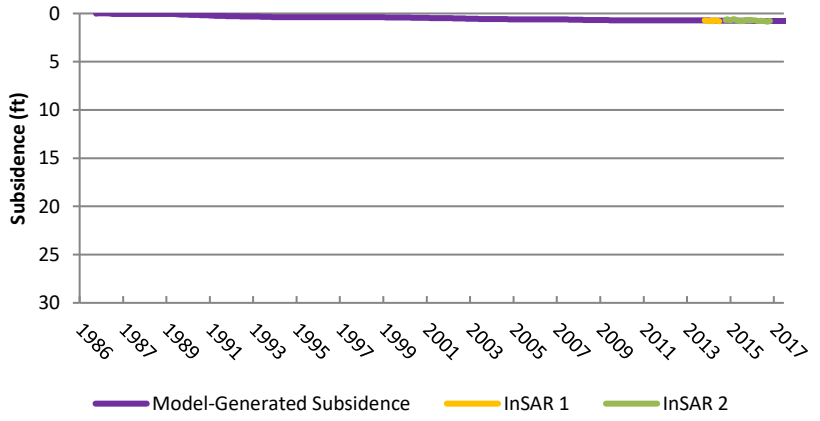
Sub-24



Sub-41 (21S/25E-01F01)

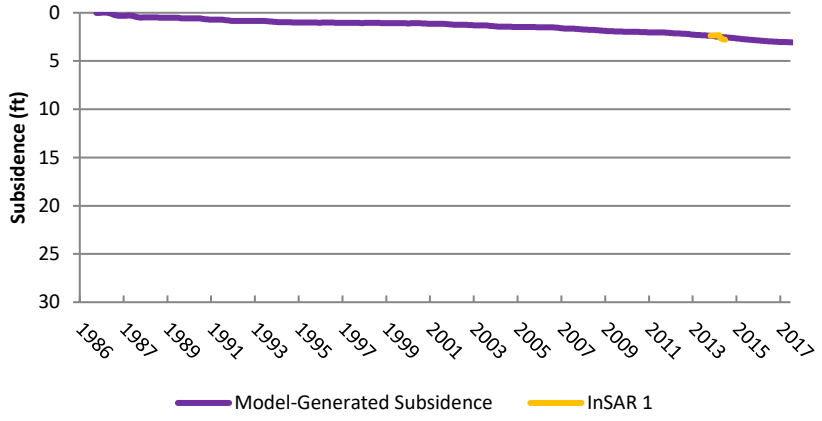


Sub-22

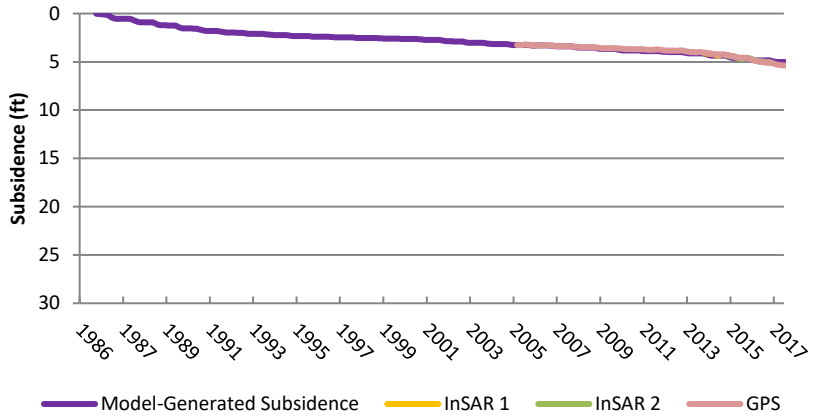


Land Subsidence Calibration Graphs

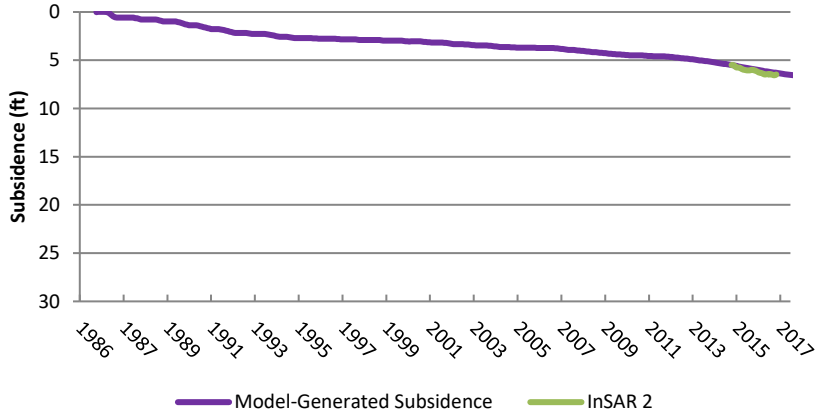
Sub-38 (21S/26E-32A01)



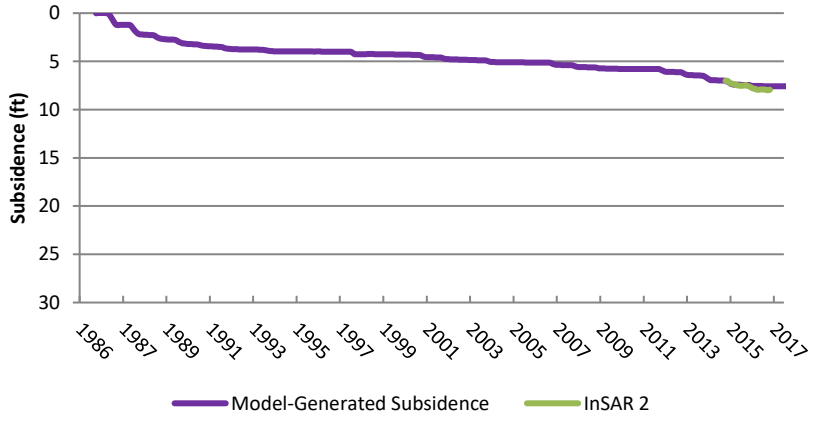
Sub-44 (Porterville GPS)



Sub-39 (22S/26E-10J01)

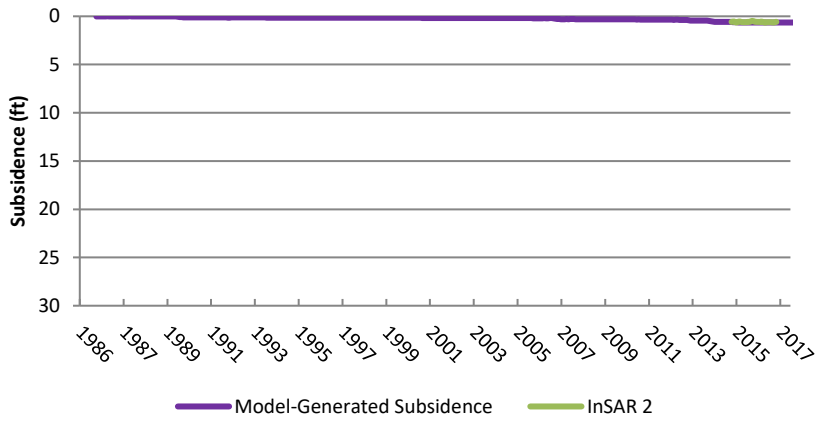


Sub-5

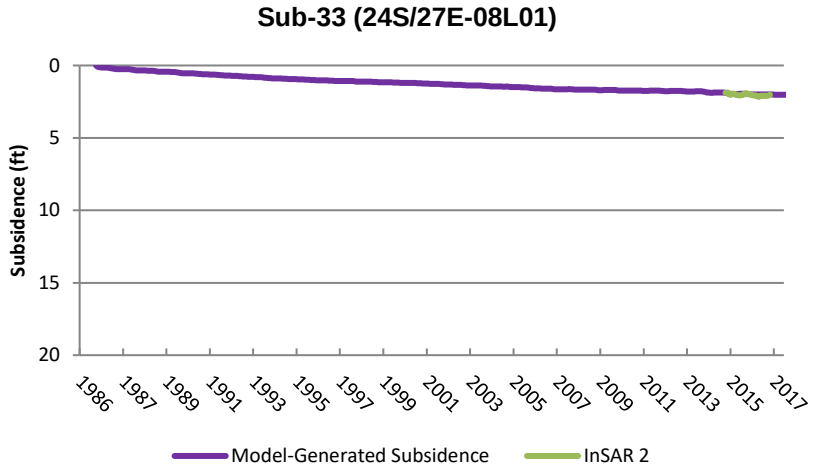


Land Subsidence Calibration Graphs

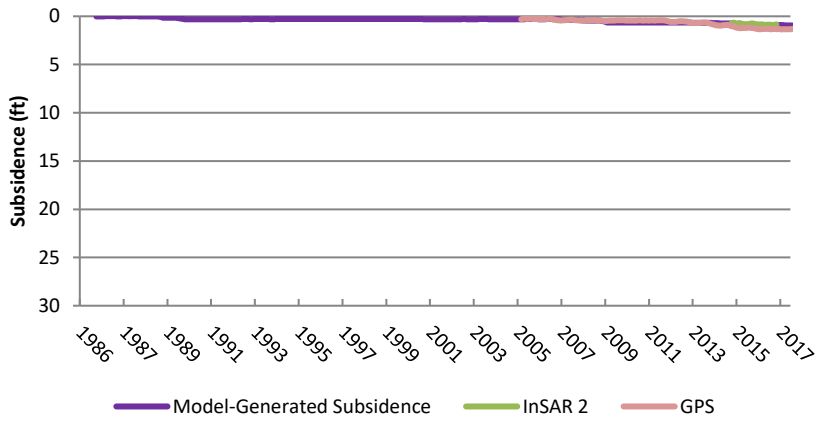
Sub-40 (24S/26E-32G01)



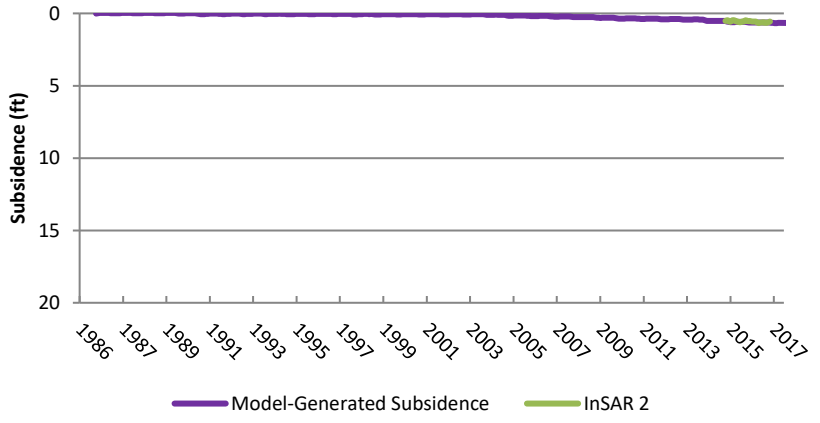
Sub-33 (24S/27E-08L01)



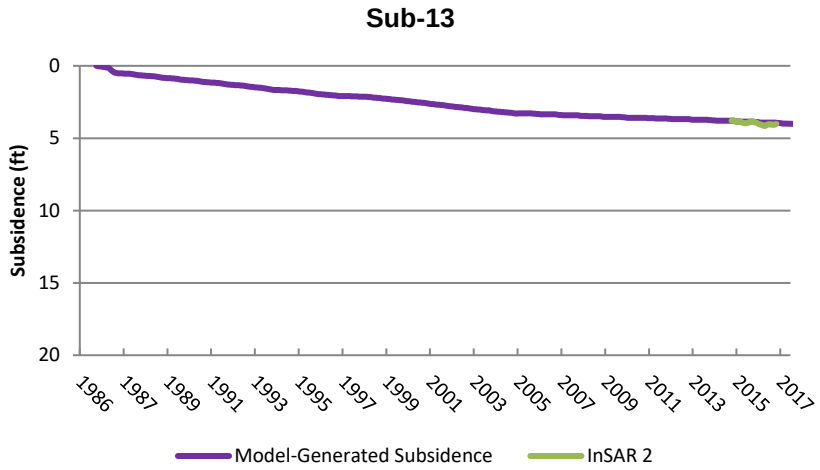
Sub-45 (Delano GPS)



Sub-6



Land Subsidence Calibration Graphs

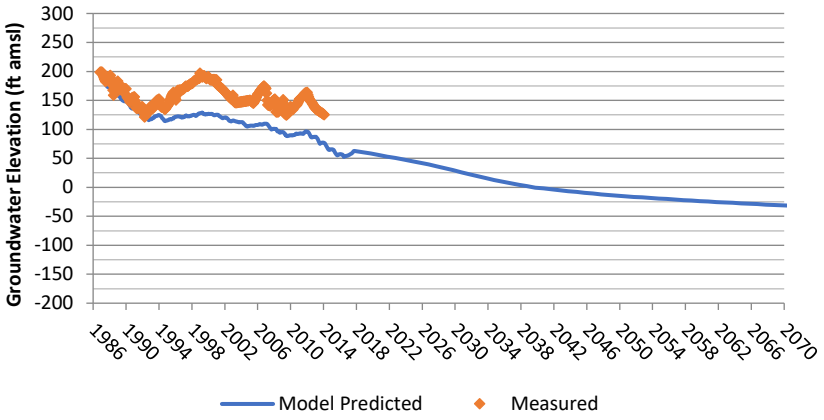


Appendix F

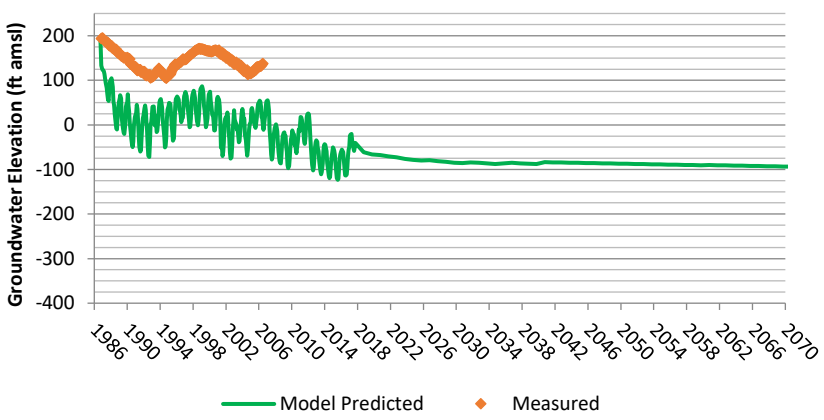
Model Simulated Hydrographs

Model Simulated Hydrographs

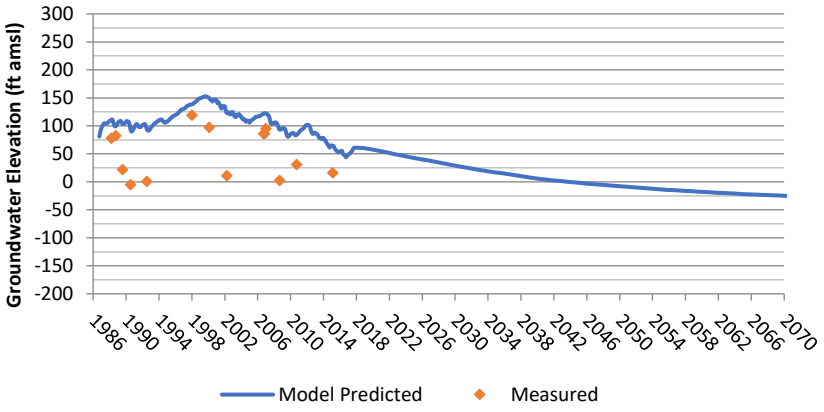
21S/23E-32K01 (L1)



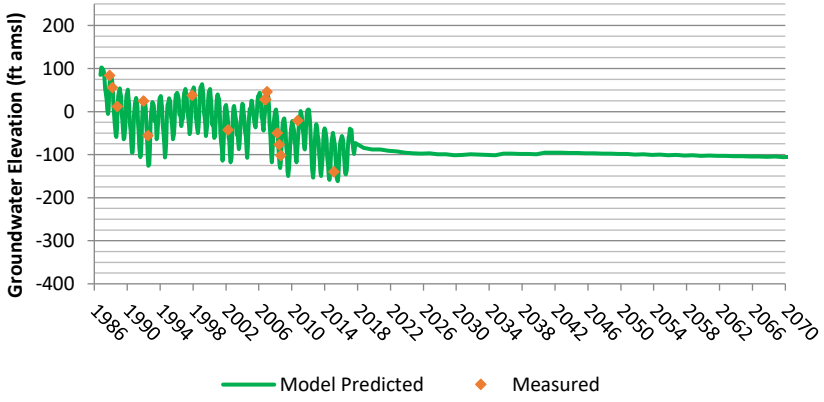
21S/23E-36R01 (L3)



Angiola G1 (L1)

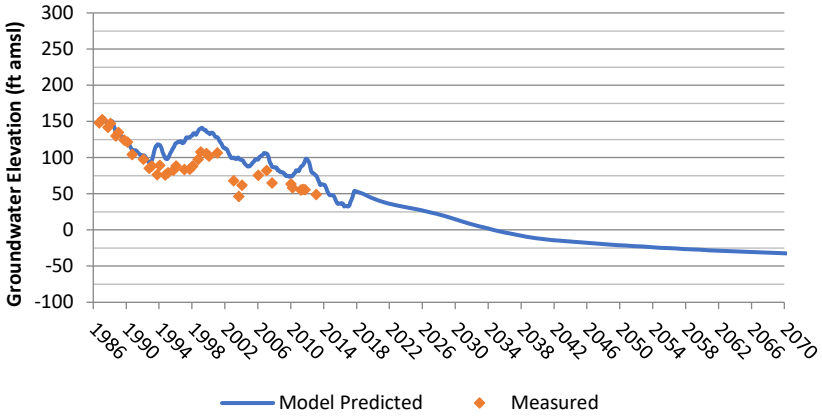


Angiola E10 (L3)

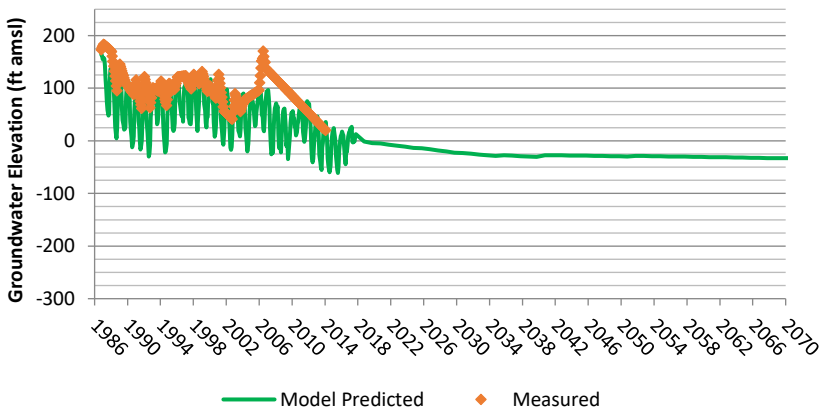


Model Simulated Hydrographs

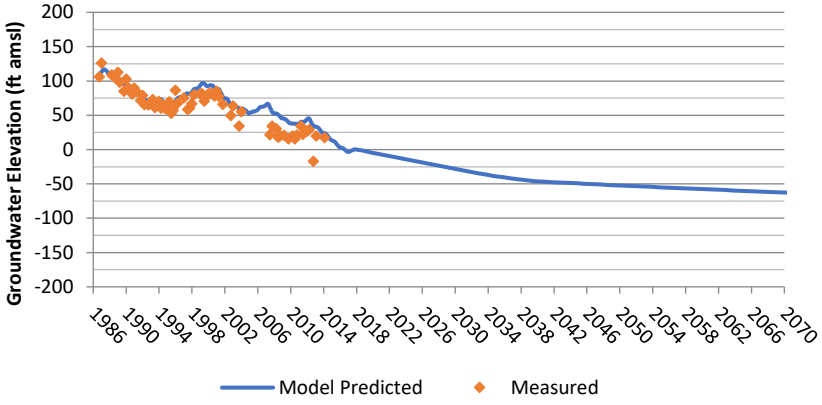
22S/24E-09A01 (L1)



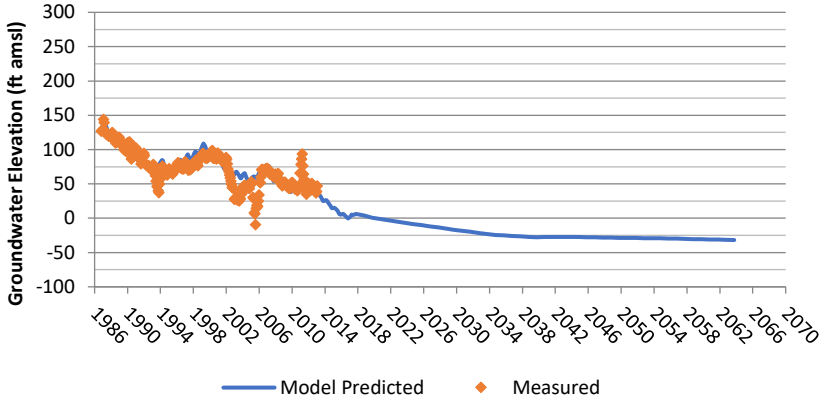
22S/24E-01Q01 (L3)



22S/24E-20A01 (L1)

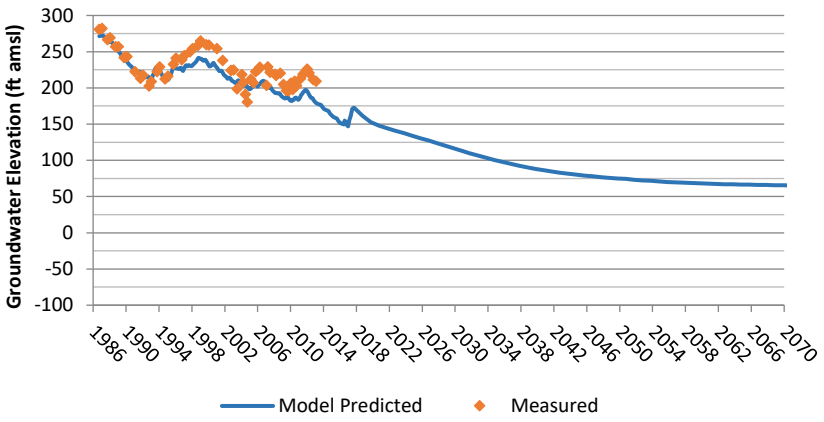


22S/24E-23J01 (L1)

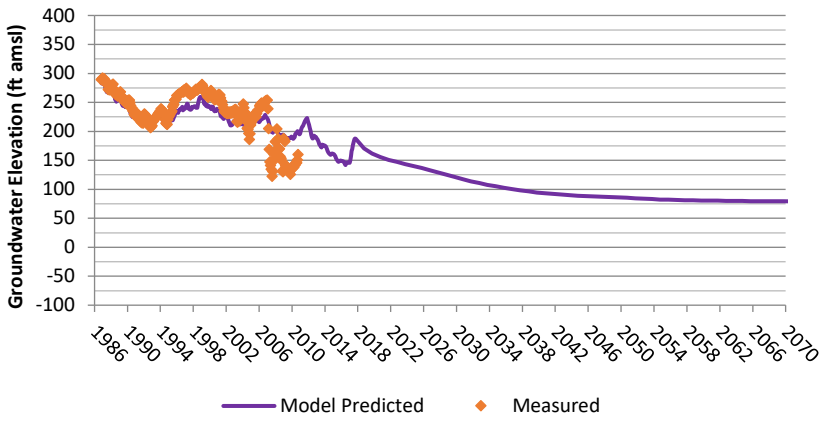


Model Simulated Hydrographs

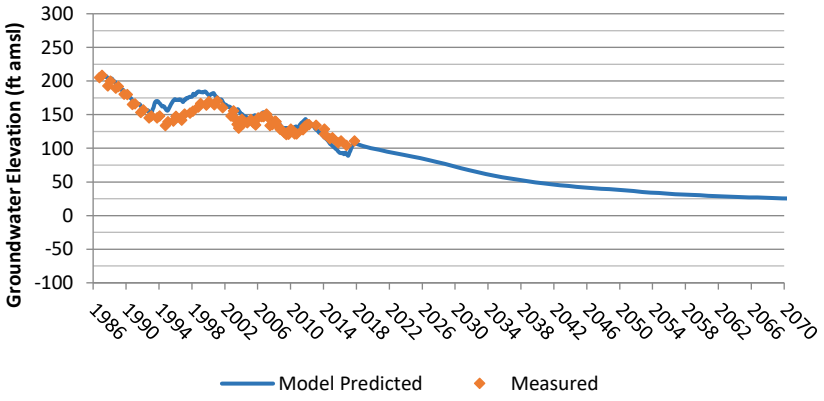
21S/25E-03R01 (L1)



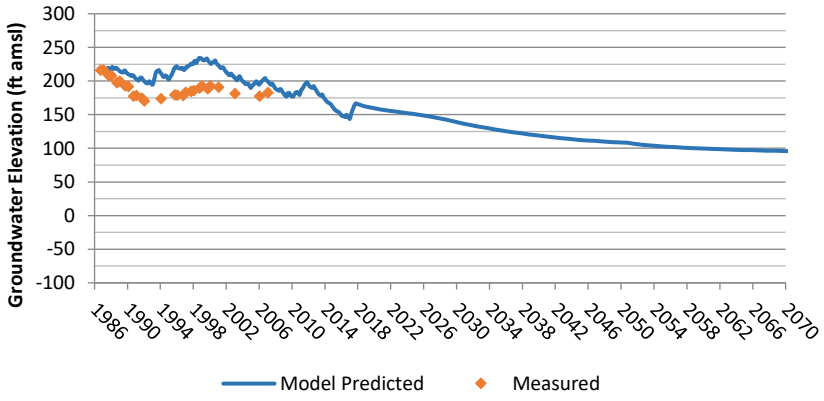
21S/25E-01F01 (L2)



21S/24E-35A01 (L1)

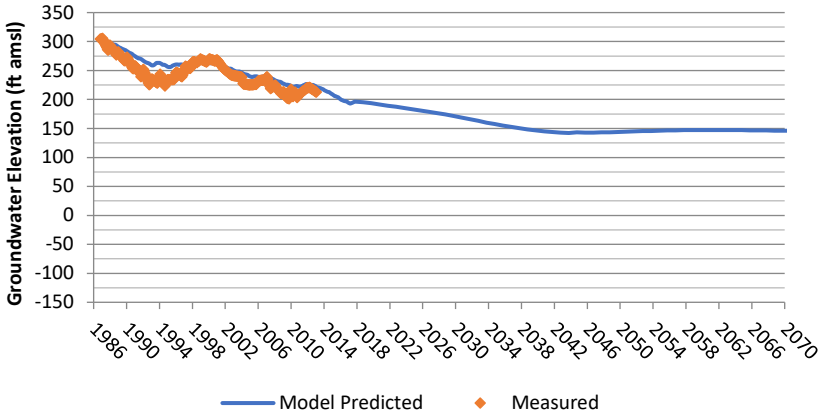


22S/25E-10E01 (L1)

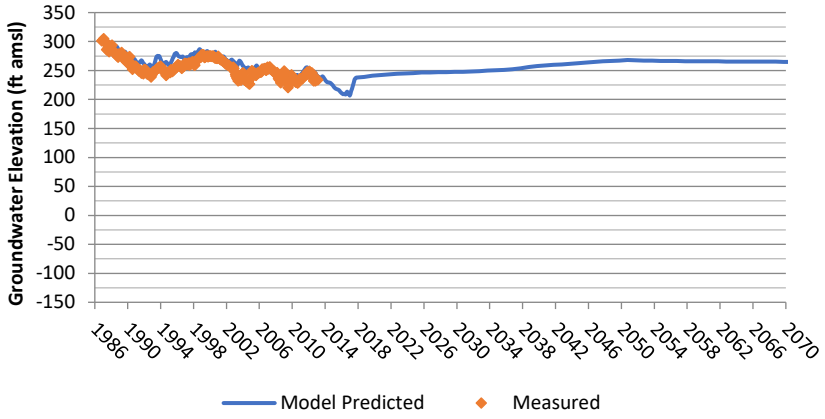


Model Simulated Hydrographs

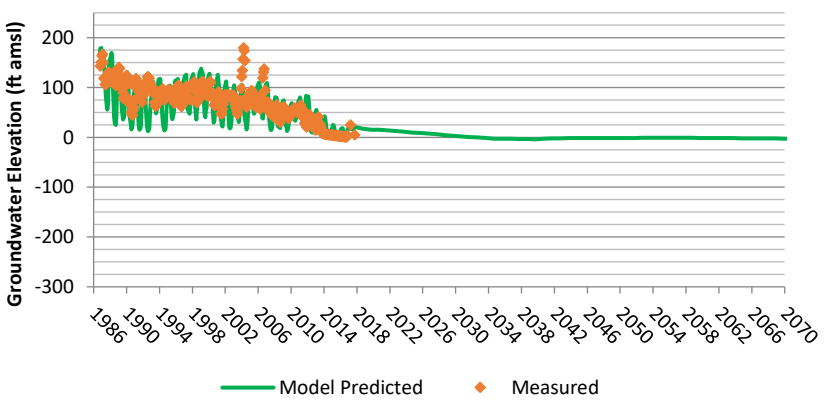
21S/26E-32A01 (L1)



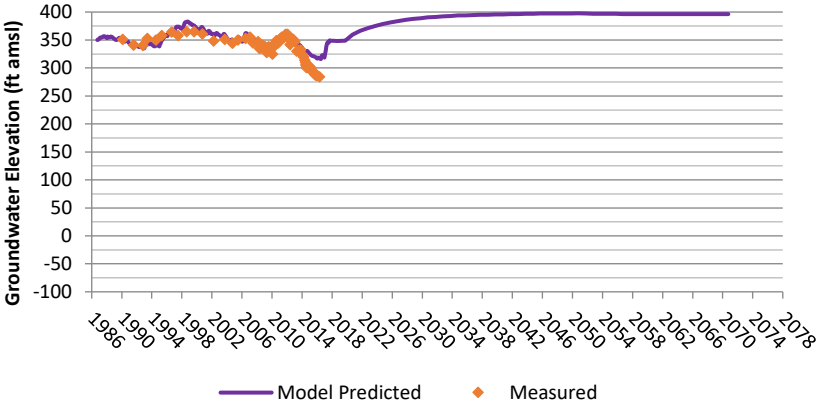
22S/26E-10J01 (L1)



22S/25E-25N01 (L3)

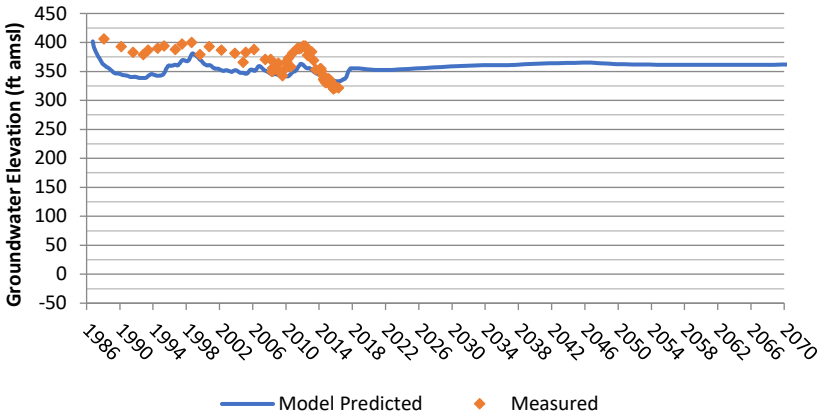


Port R-11 (L2)

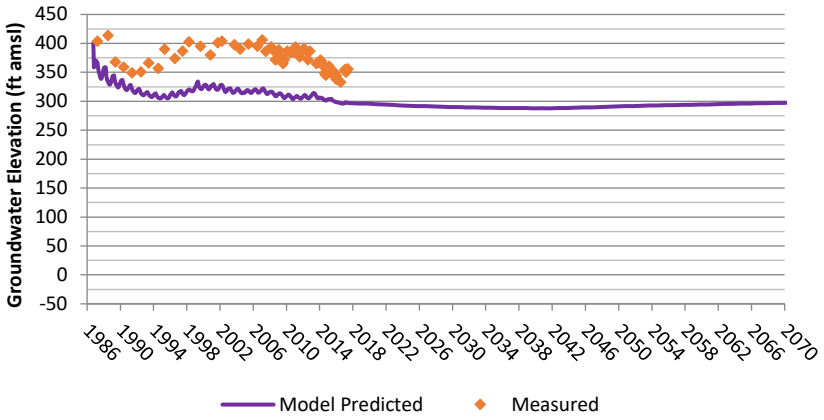


Model Simulated Hydrographs

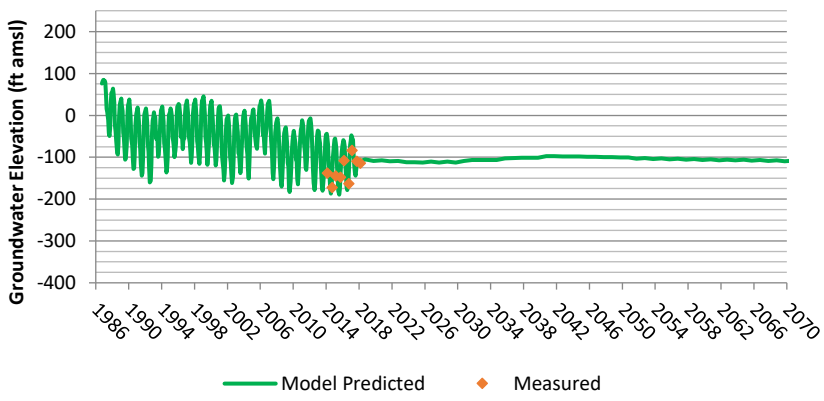
Port R-6 (L1)



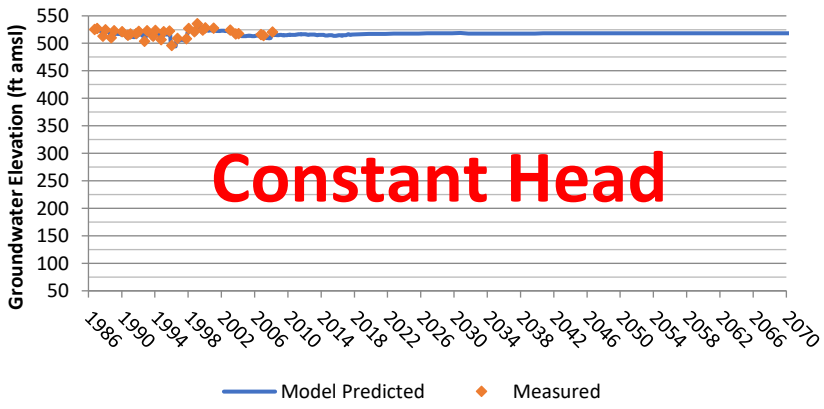
Port C-1 (L2)



23S/23E-24 (L3)

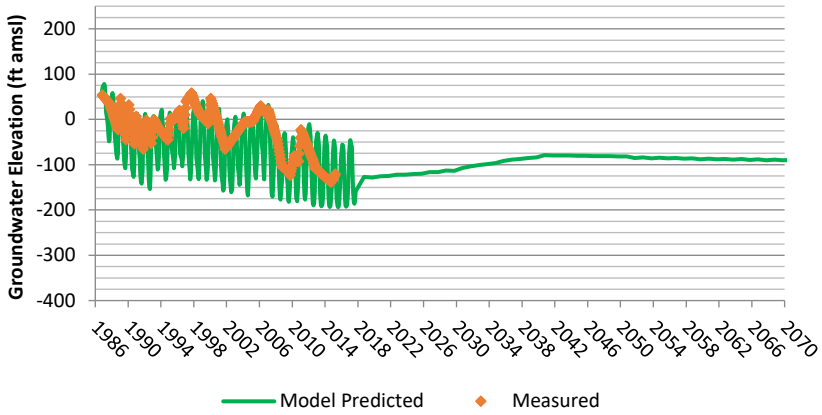


22S28E-03H01 (L1)

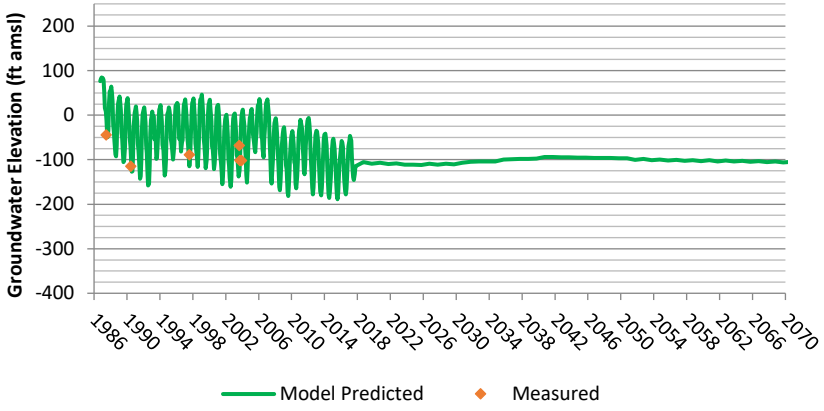


Model Simulated Hydrographs

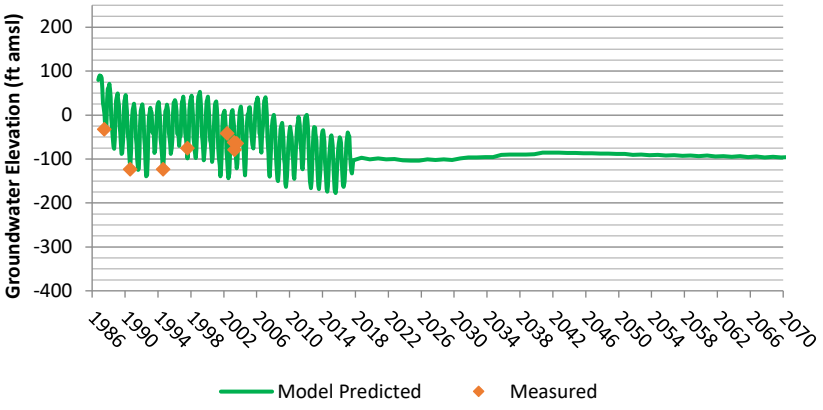
24S/23E-22R02 (L3)



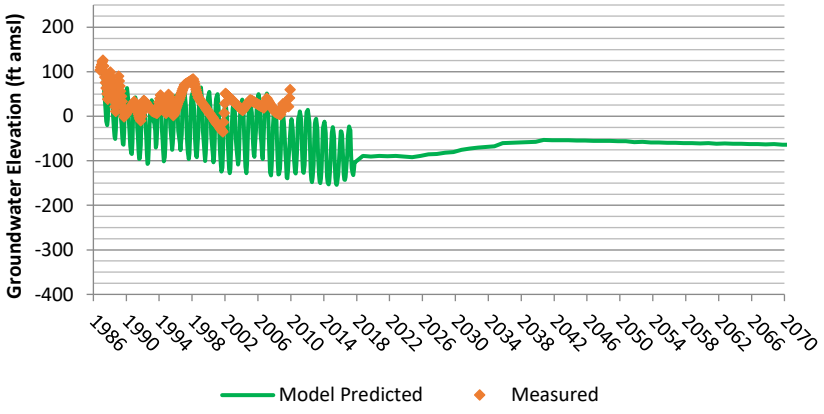
Well 51 (Alpaugh)



Well 53 (Alpaugh)

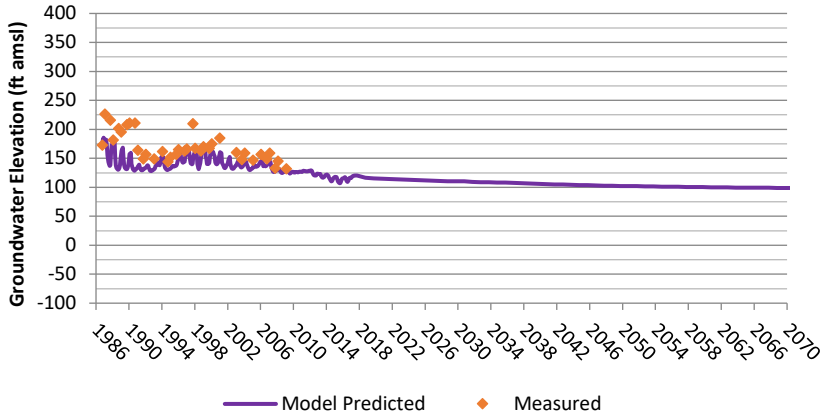


24S/24E-03A01 (L3)

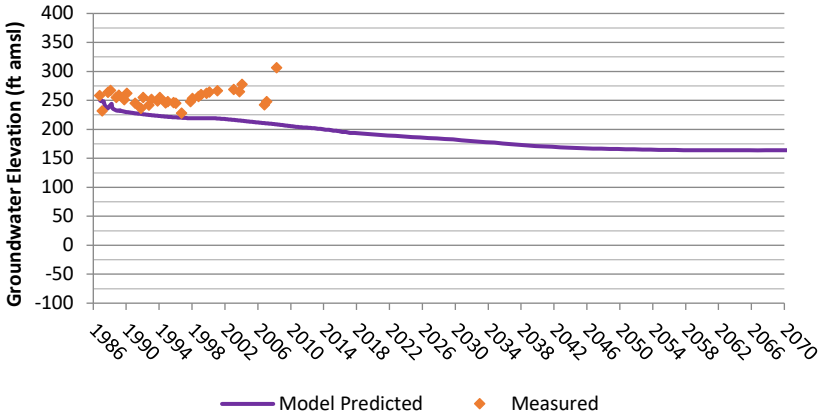


Model Simulated Hydrographs

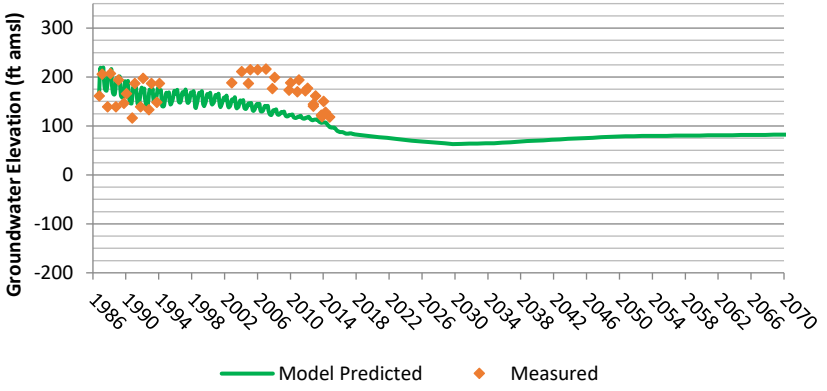
23S/26E-09C01 (L2)



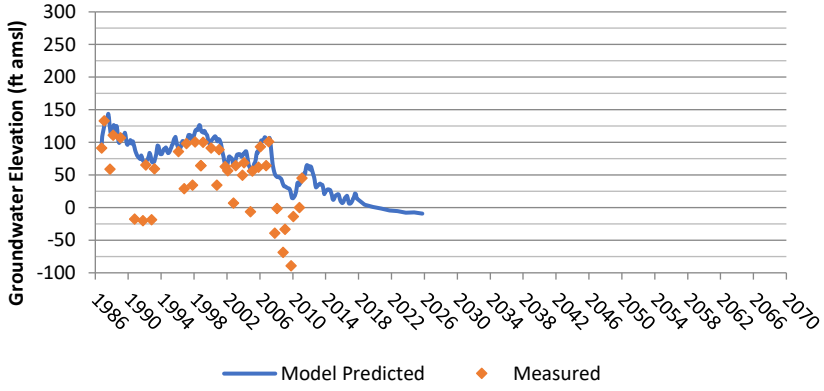
23S/26E-12J01 (L2)



24S/26E-01R01 (L3)

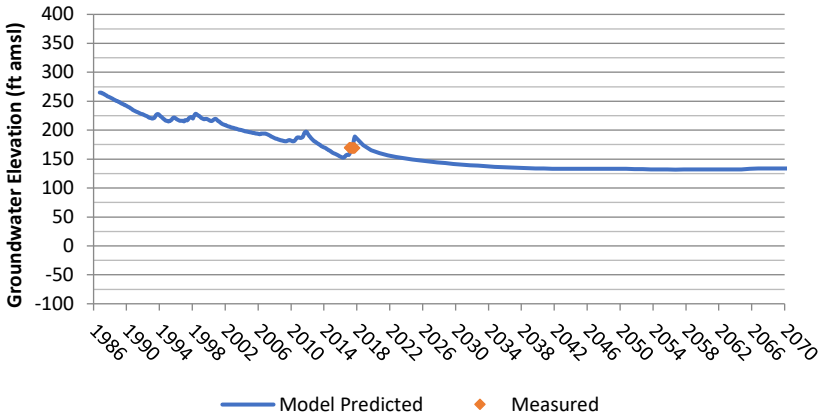


25S/24E-14R02 (L1)

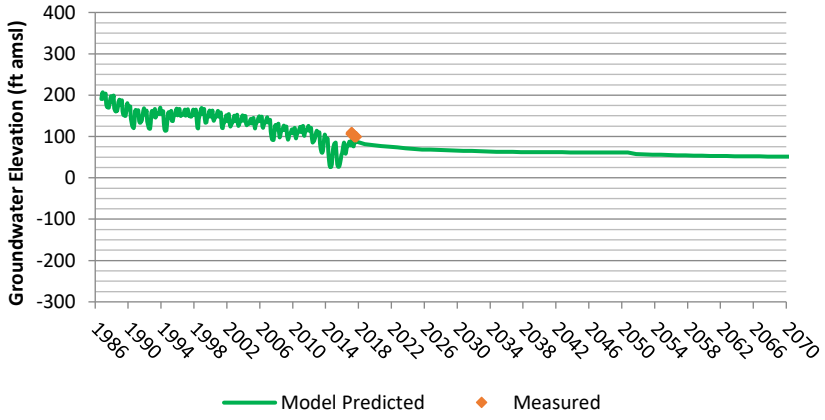


Model Simulated Hydrographs

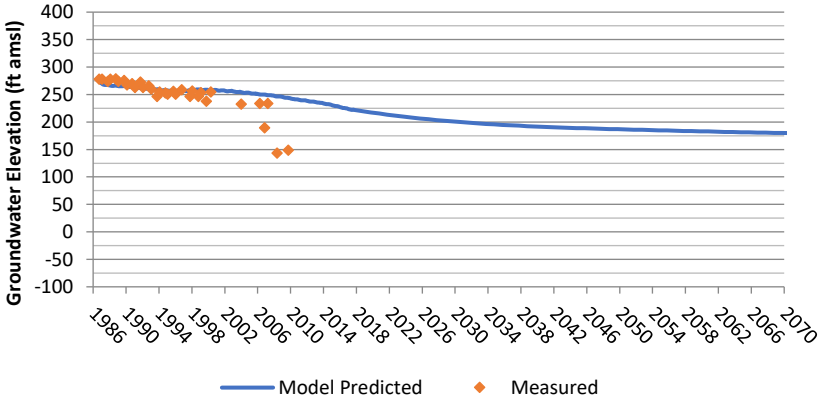
M19-L1 (DEID)



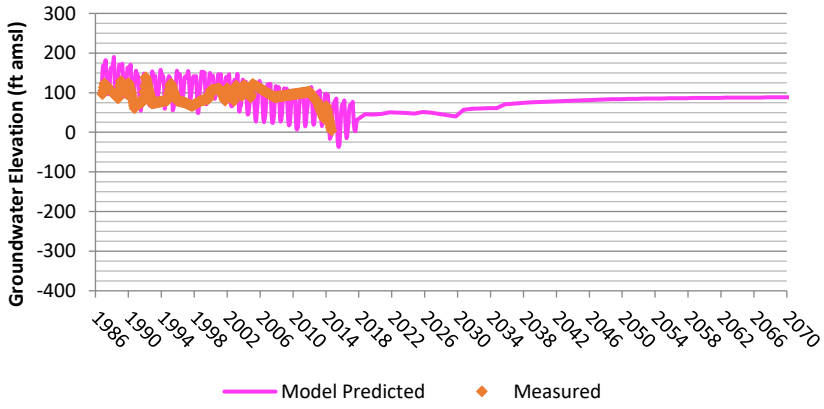
M19-L3 (DEID)



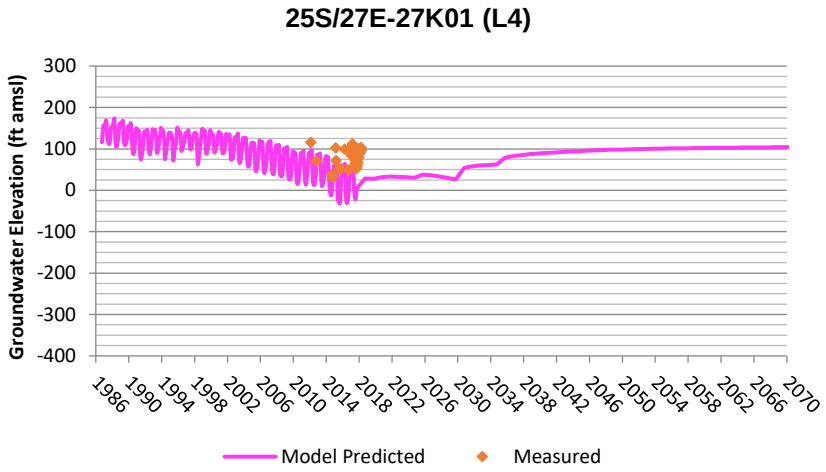
24S/25E-35P01 (L1)



24S/27E-32K01 (L4)



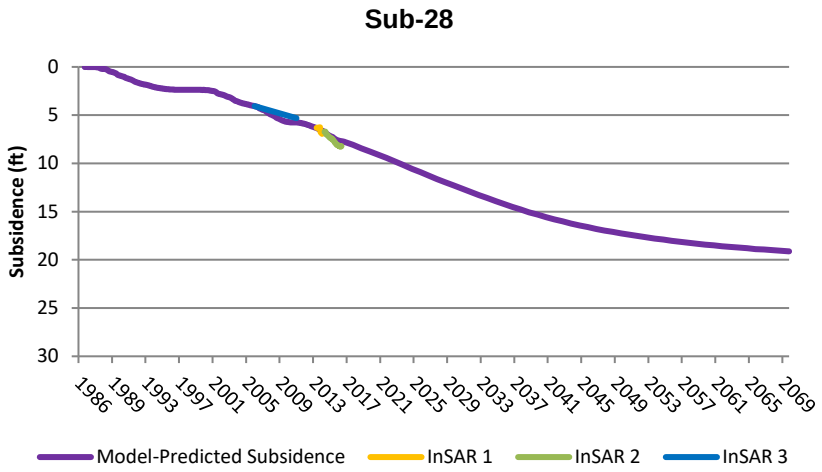
Model Simulated Hydrographs

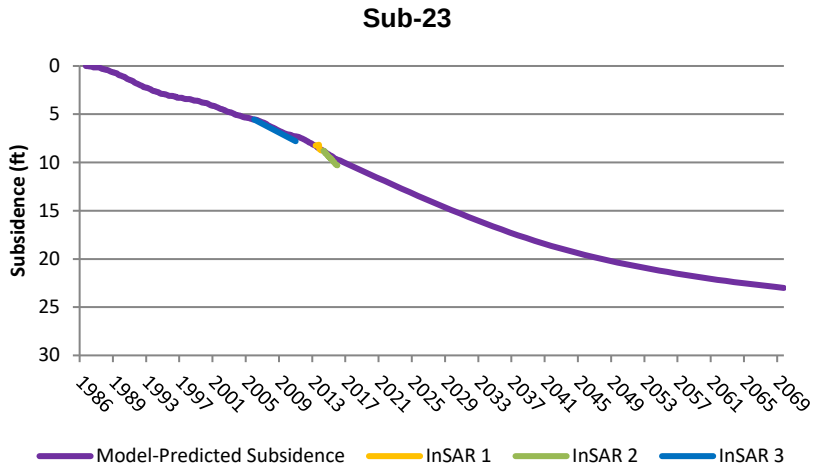


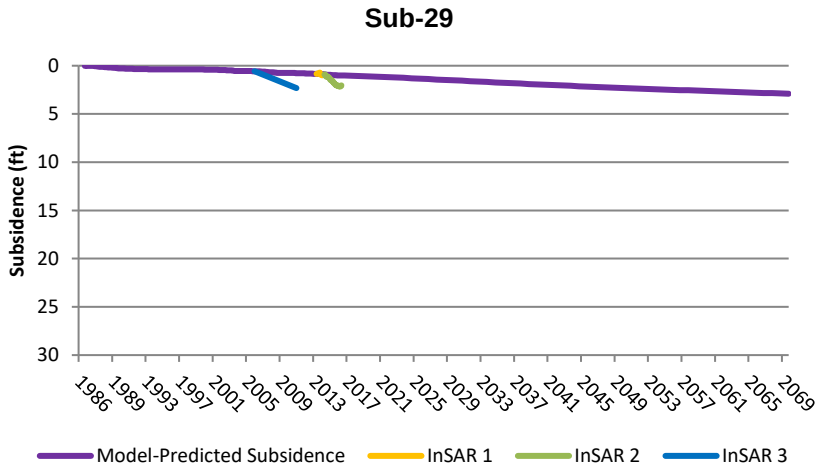
Appendix G

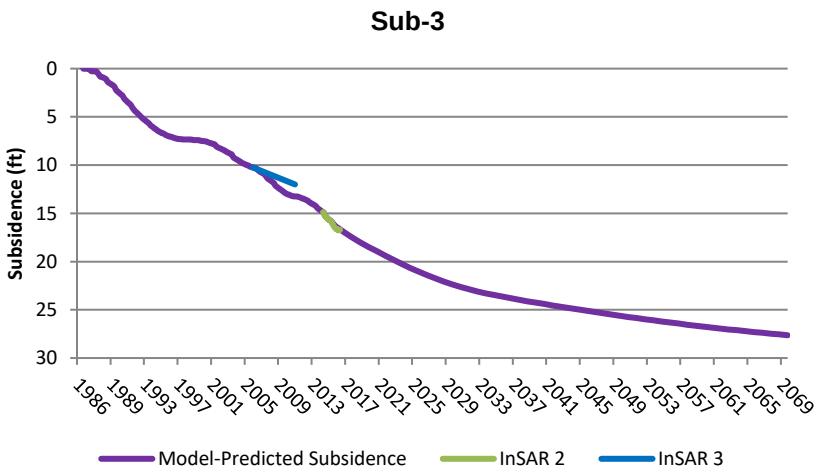
Model Simulation Land Subsidence Graphs

Model Simulation Land Subsidence Graphs



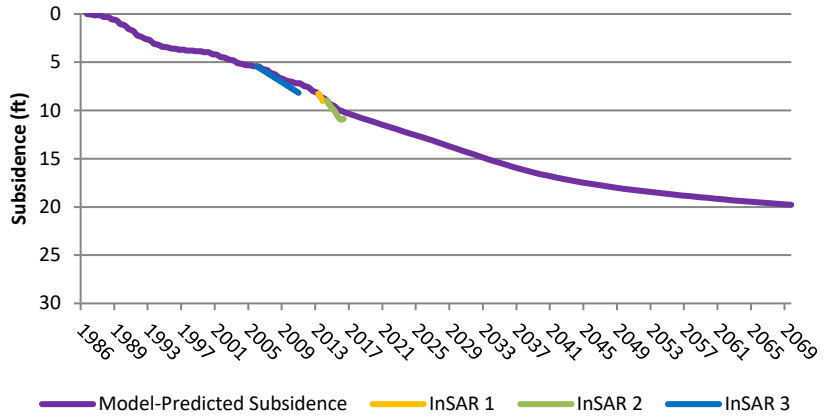




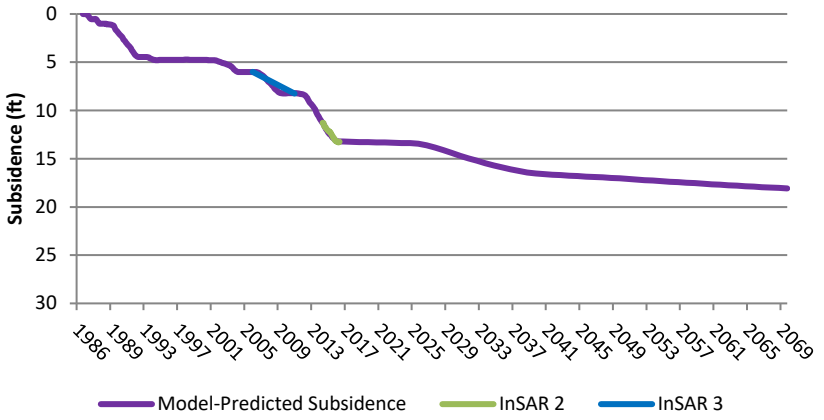


Model Simulation Land Subsidence Graphs

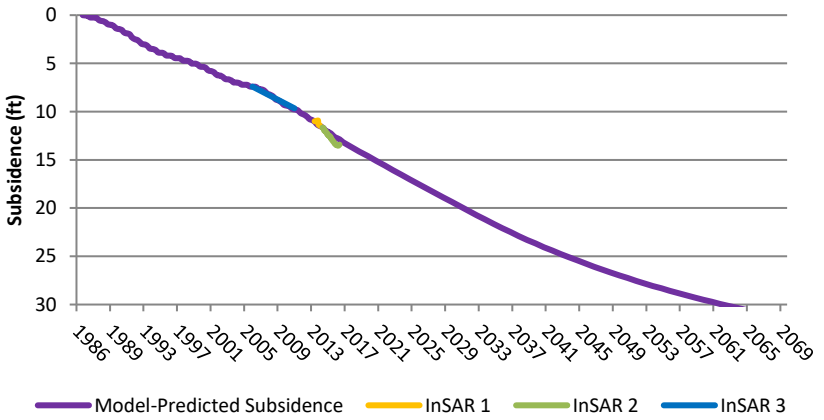
Sub-37 (21S/23E-32K01)



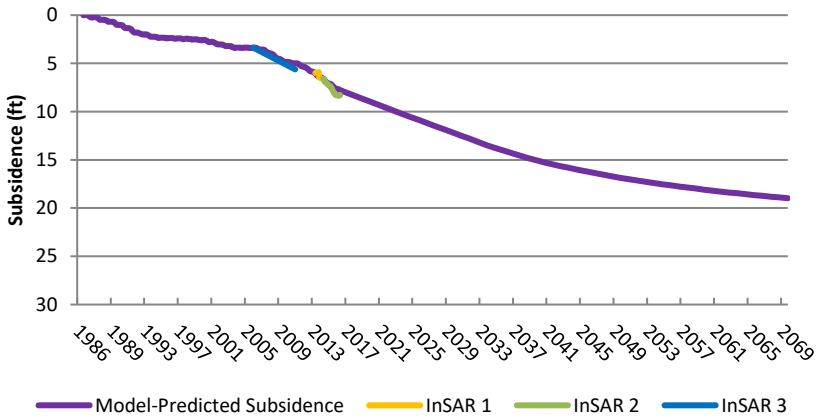
Sub-35 (21S/23E-36R01)



Sub-21

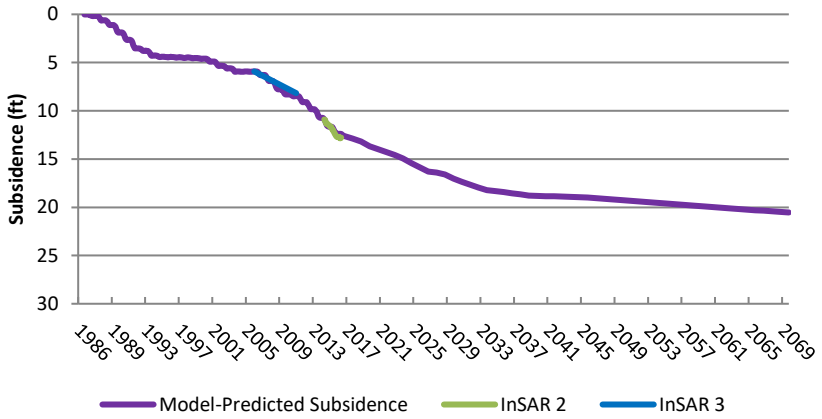


Sub-20

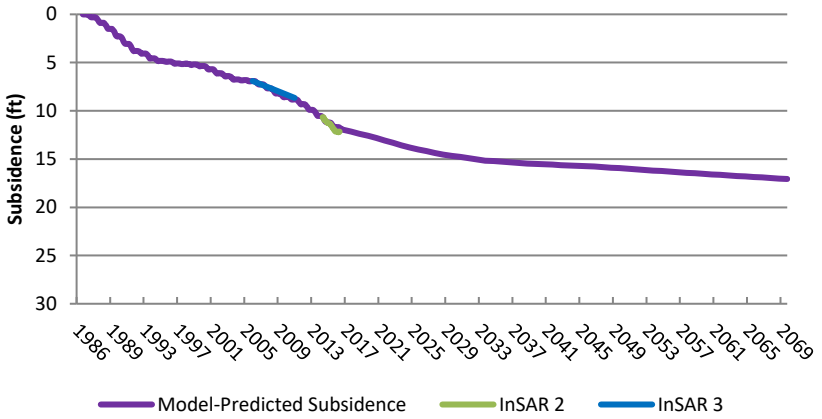


Model Simulation Land Subsidence Graphs

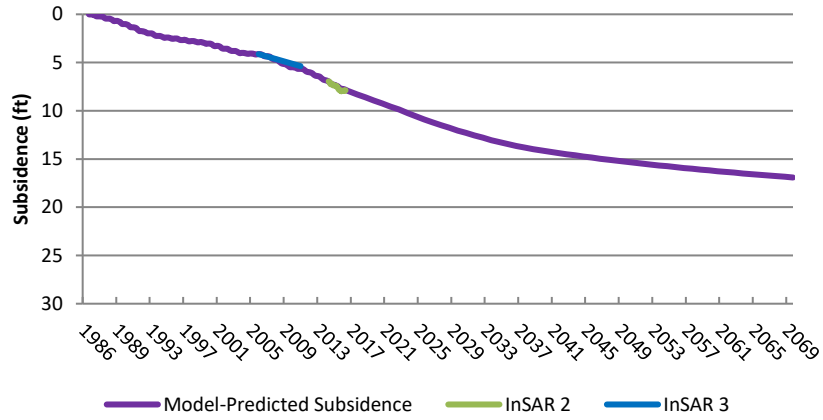
Sub-1



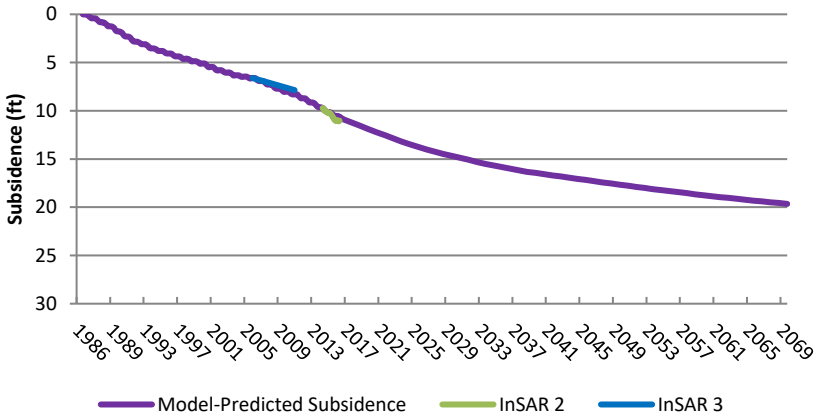
Sub-18



Sub-19

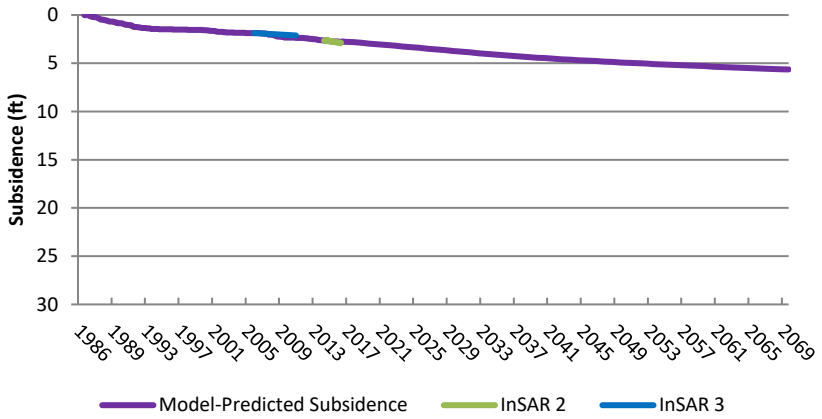


Sub-30 (24S/24E-03A01)

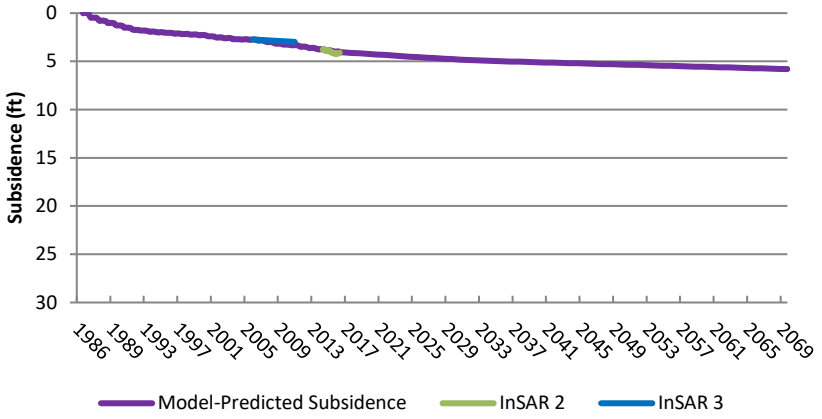


Model Simulation Land Subsidence Graphs

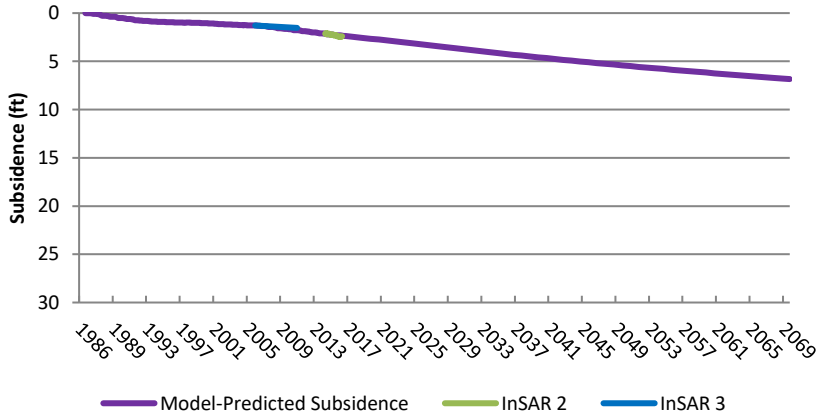
Sub-12



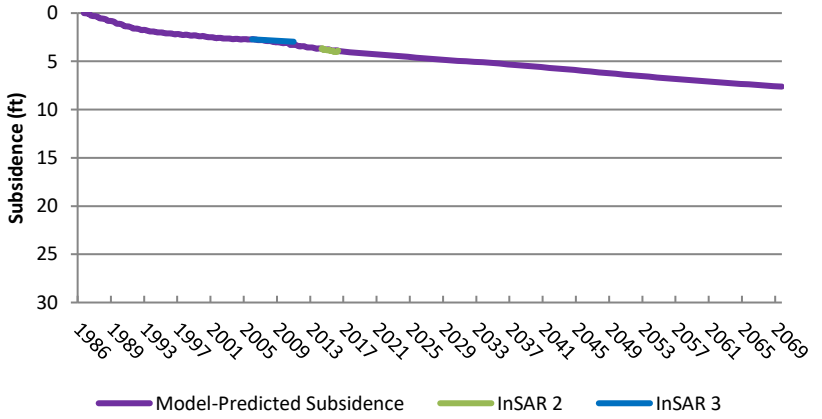
Sub-31 (24S/23E-22R02)



Sub-11

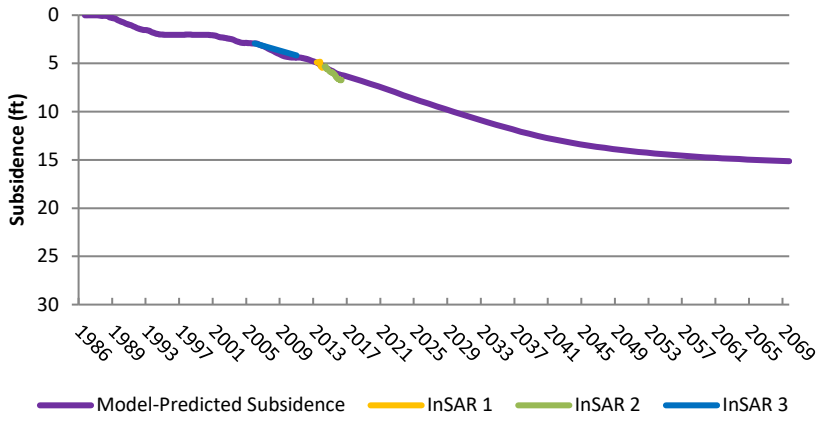


Sub-10

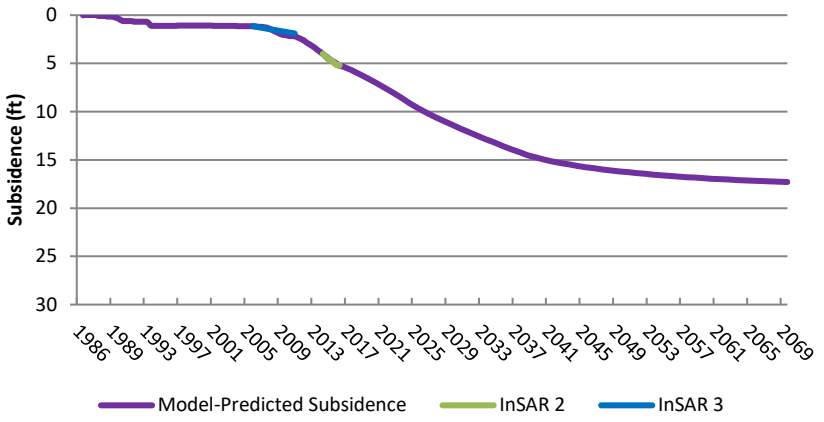


Model Simulation Land Subsidence Graphs

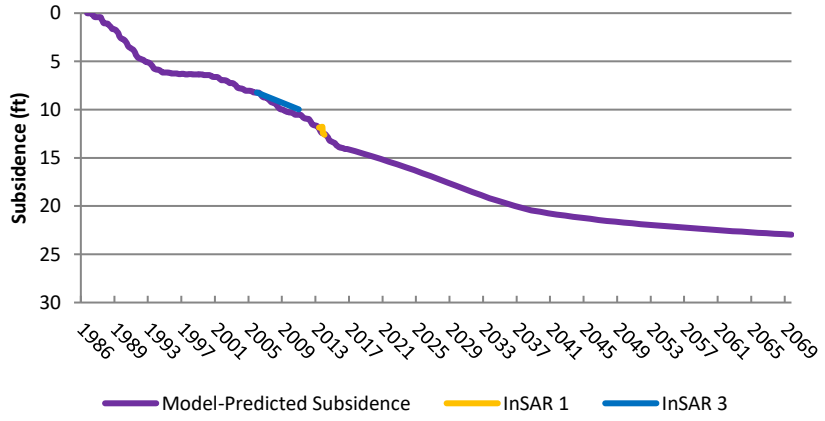
Sub-27



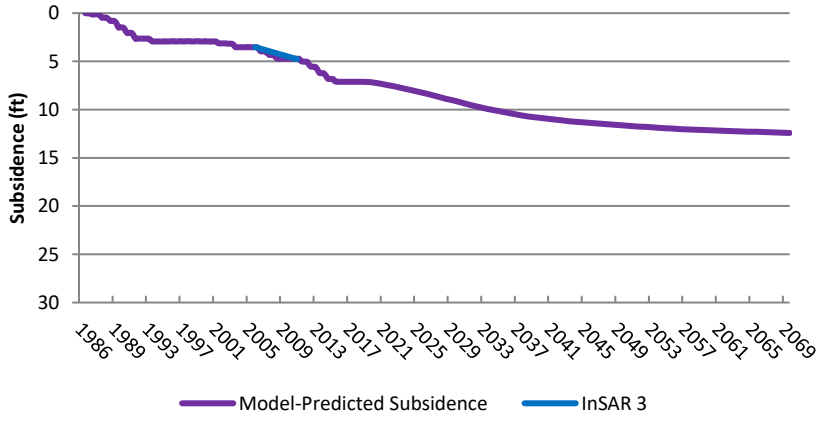
Sub-26



Sub-34 (21S/24E-14P01)

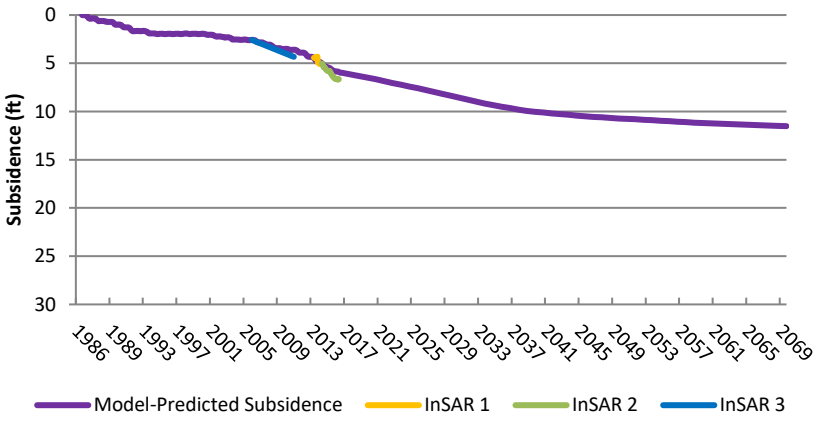


Sub-2

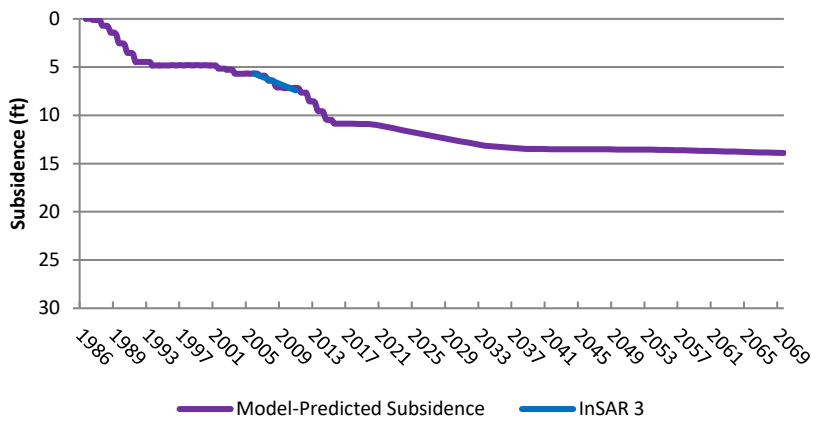


Model Simulation Land Subsidence Graphs

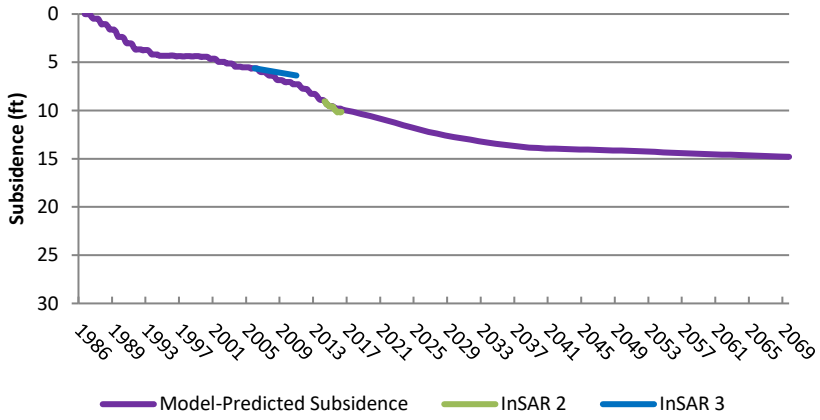
Sub-36 (22S/24E-01Q01)



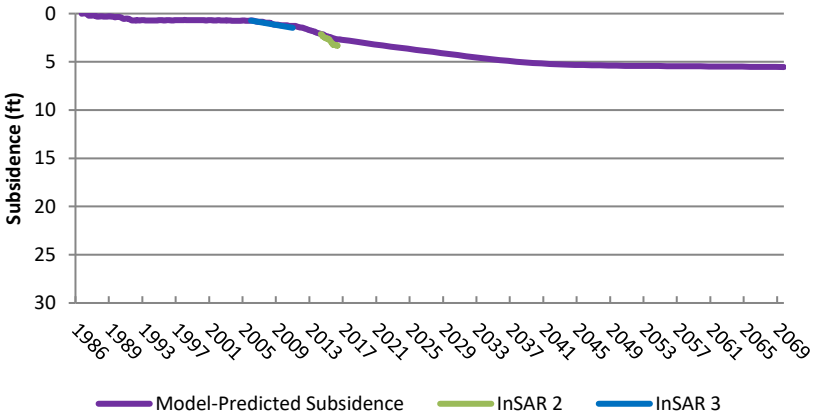
Sub-42 (22S/24E-23J01)



Sub-17

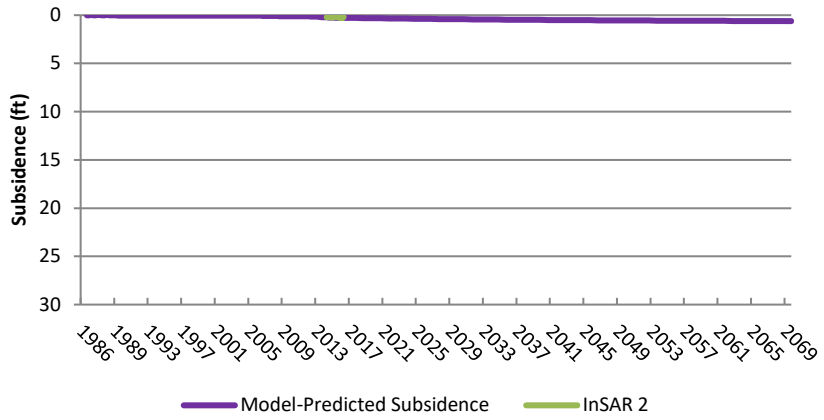


Sub-43 (22S/25E-25N01)

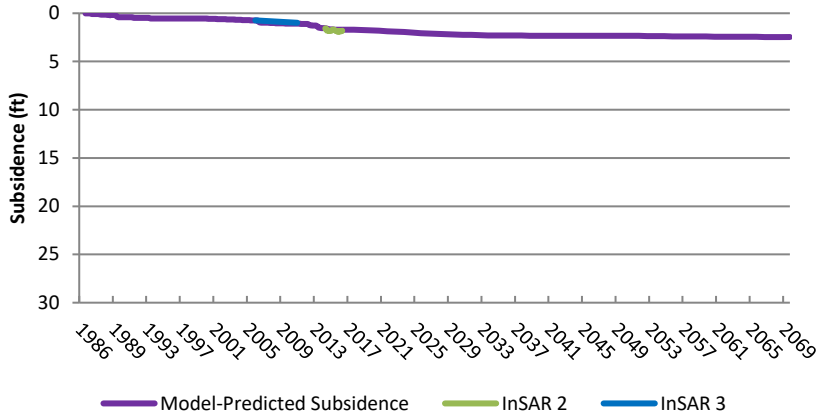


Model Simulation Land Subsidence Graphs

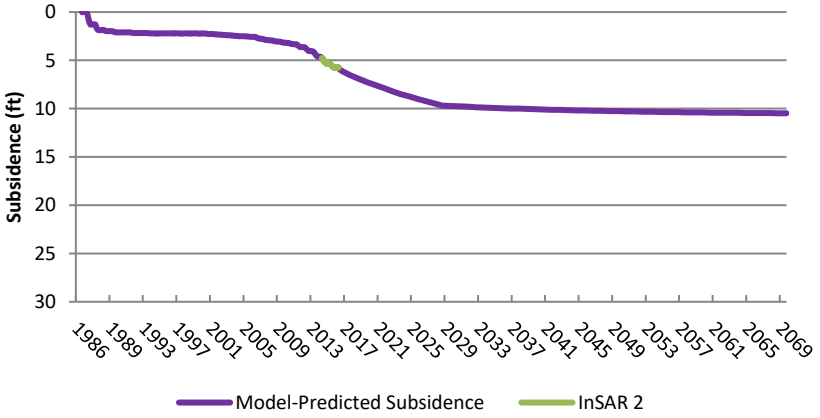
Sub-7



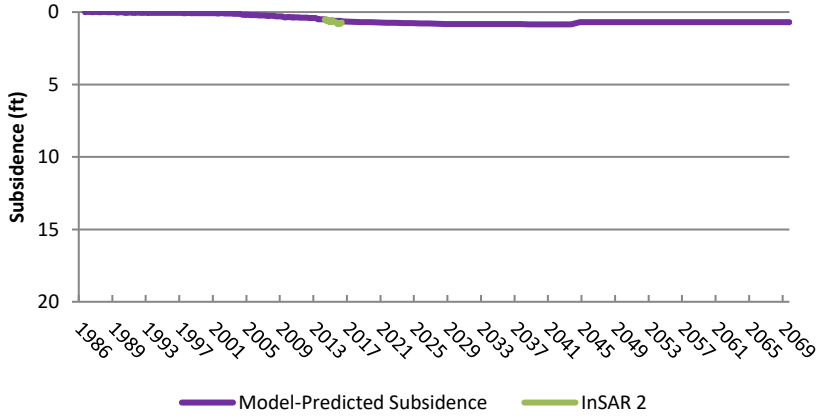
Sub-4



Sub-16

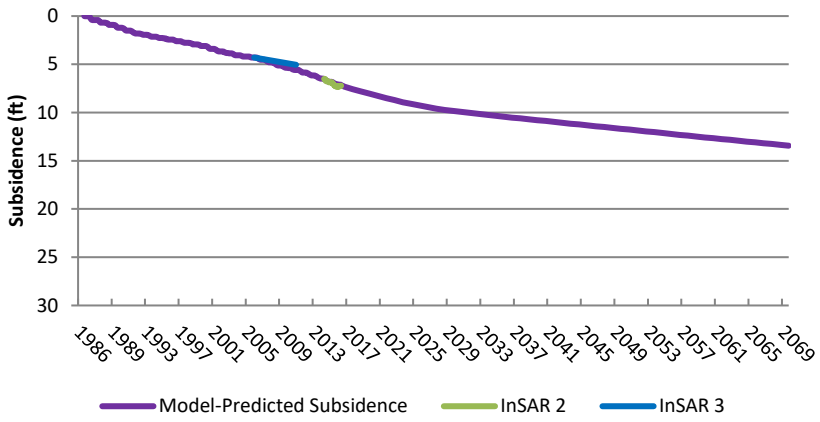


Sub-32 (24S/27E-32K01)

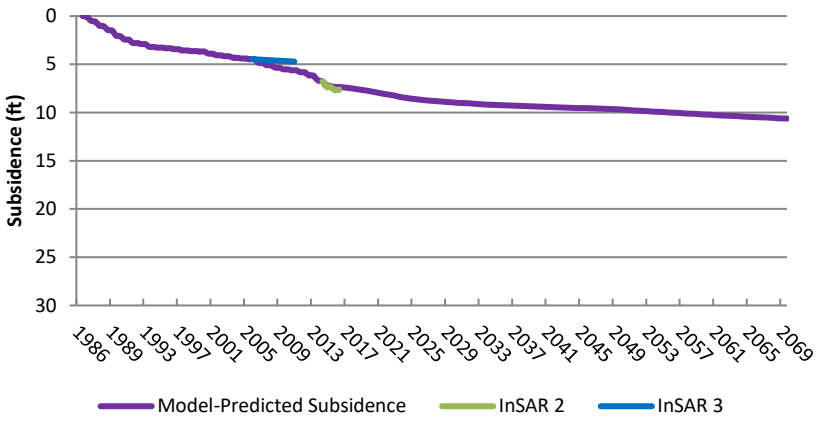


Model Simulation Land Subsidence Graphs

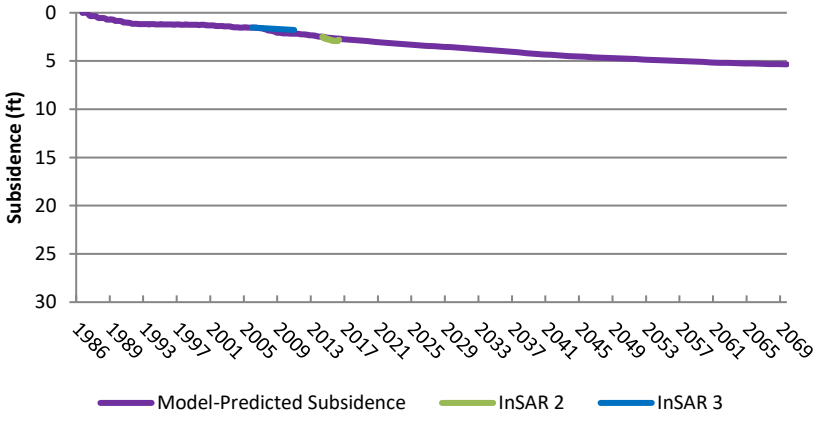
Sub-15



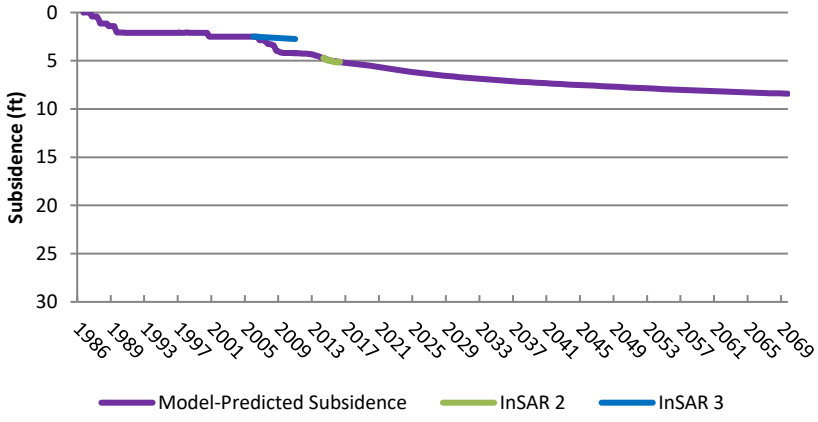
Sub-14



Sub-9

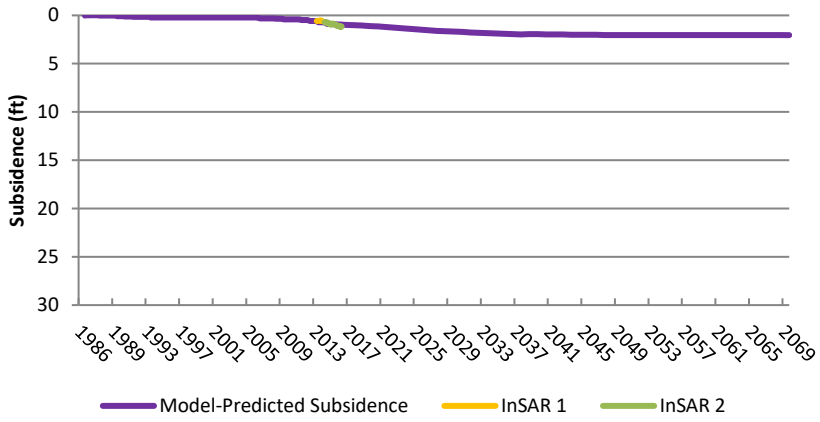


Sub-8

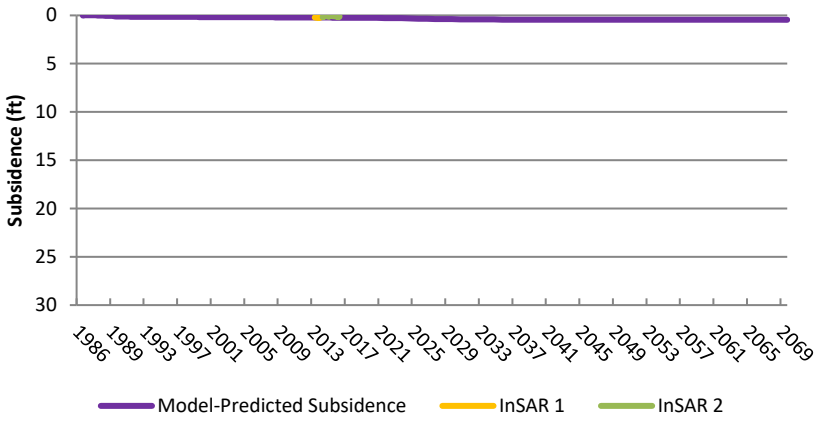


Model Simulation Land Subsidence Graphs

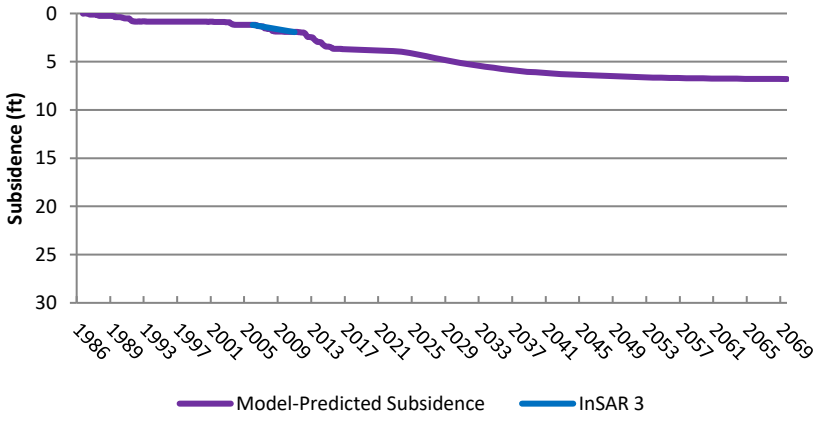
Sub-25



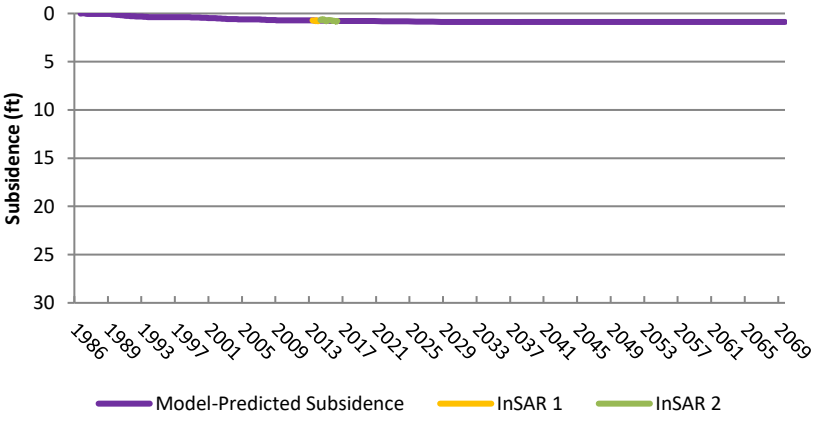
Sub-24



Sub-41 (21S/25E-01F01)

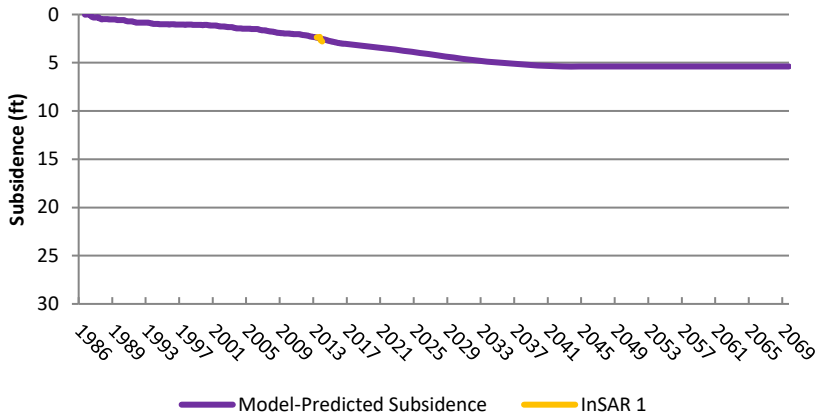


Sub-22

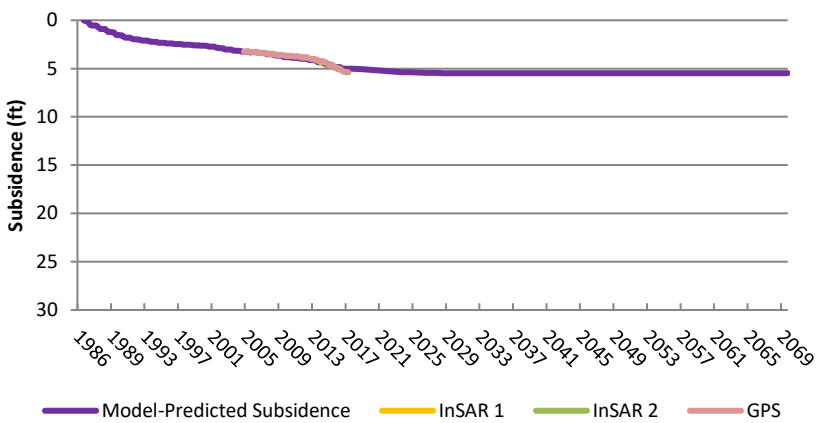


Model Simulation Land Subsidence Graphs

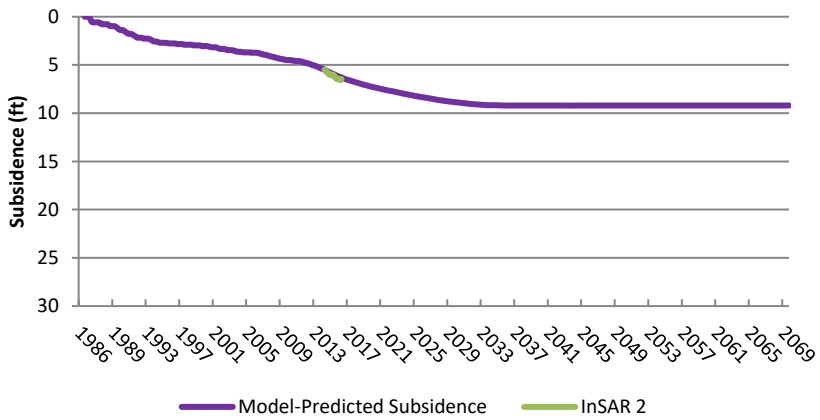
Sub-38 (21S/26E-32A01)



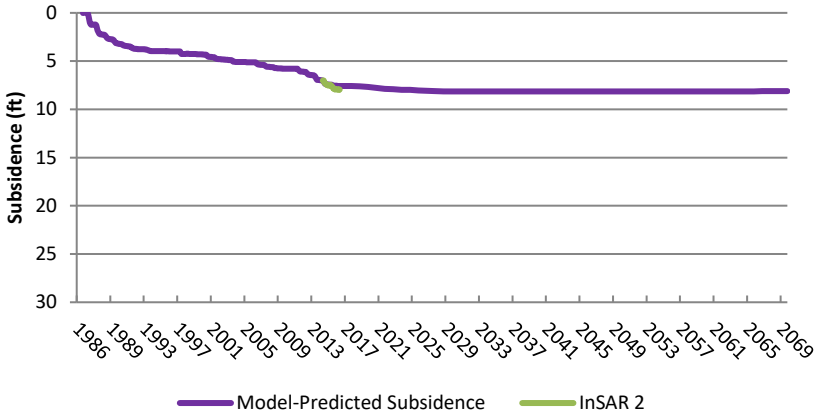
Sub-44 (Porterville GPS)



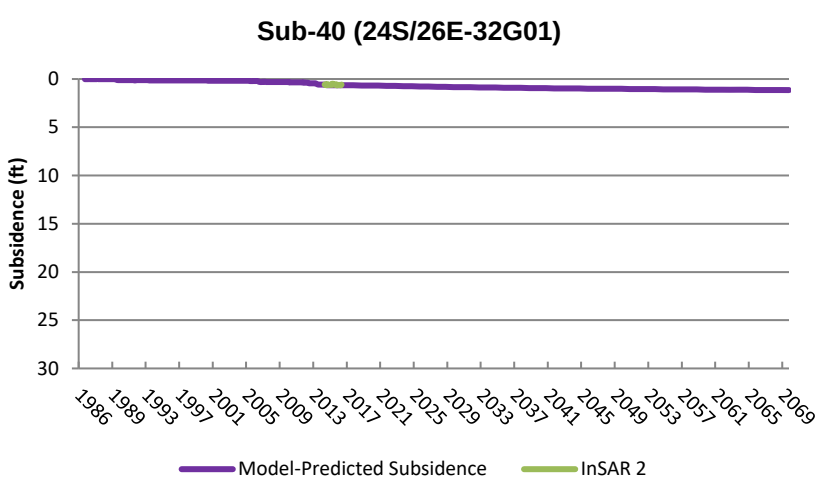
Sub-39 (22S/26E-10J01)

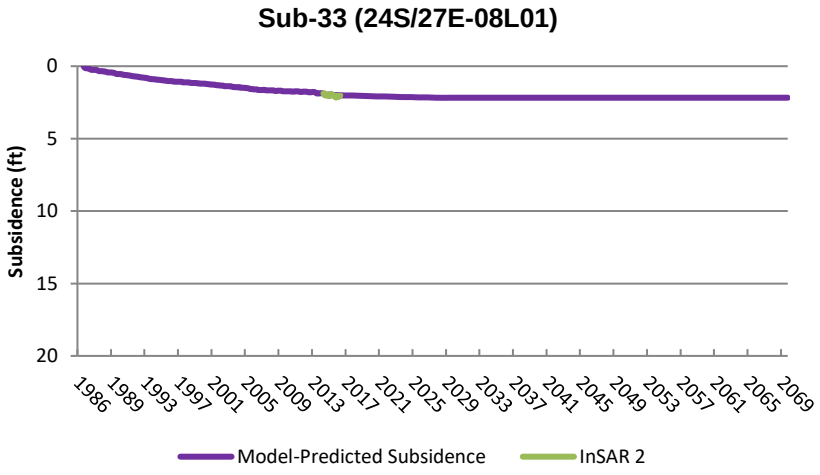


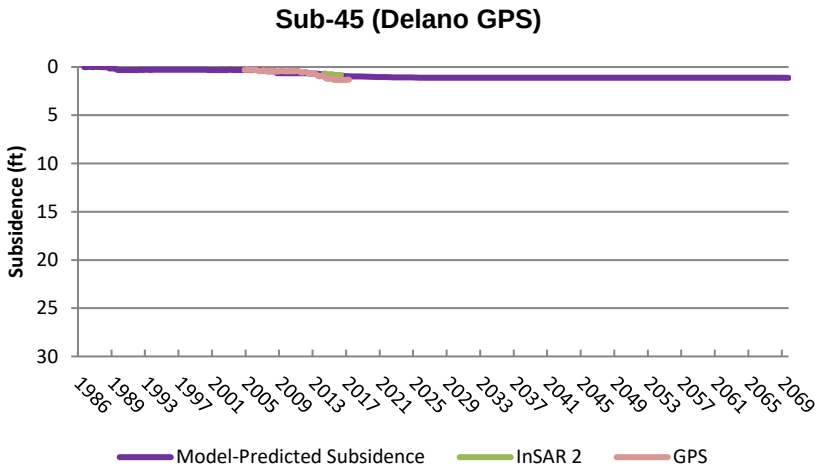
Sub-5

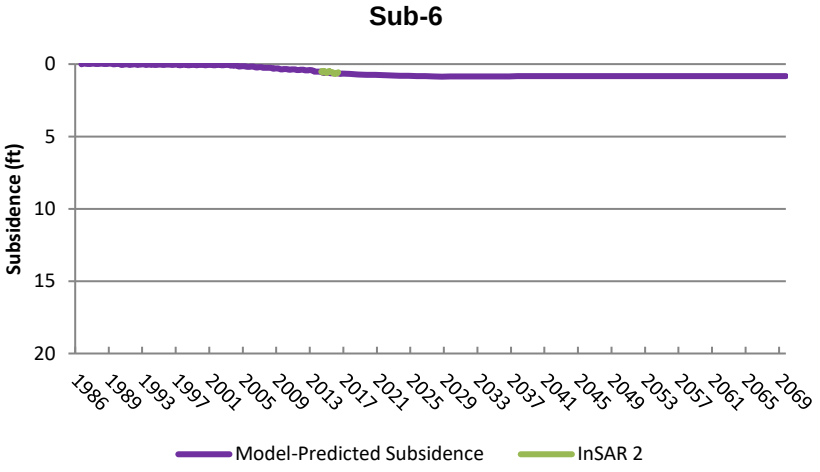


Model Simulation Land Subsidence Graphs

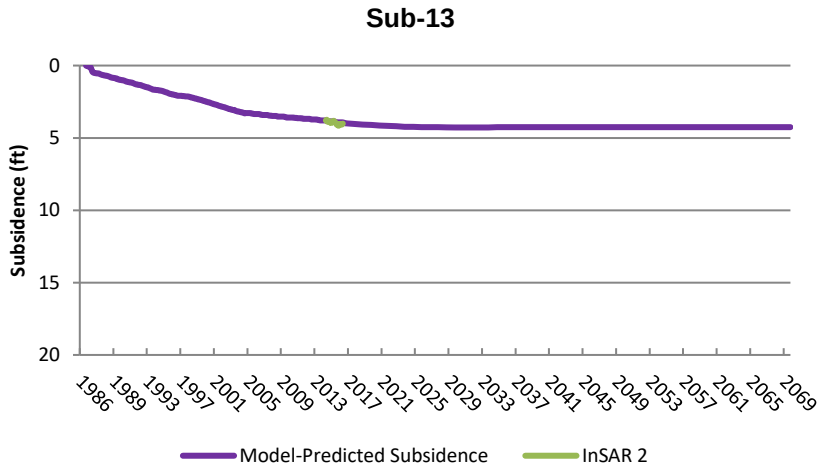








Model Simulation Land Subsidence Graphs



Technical Memorandum

To: Tule Subbasin Technical Advisory Committee

From: Thomas Harder, P.G., C.HG.
Thomas Harder & Co.

Date: 13-Jul-22

Re: Technical Support for Addressing Department of Water Resources Comments Regarding Groundwater Levels in the Tule Subbasin

1 Introduction

This technical memorandum (TM) summarizes an analysis of currently established minimum thresholds and measurable objectives as they relate to potential impacts to beneficial uses and users of groundwater in the Tule Subbasin in Tulare County, California (see Figure 1). This TM was prepared to address comments from the California Department of Water Resources (CDWR) on groundwater sustainability plans (GSPs) prepared by each of the six Groundwater Sustainability Agencies (GSAs) within the Tule Subbasin. Specifically, this TM addresses comments related to groundwater levels.

1.1 Background

The Tule Subbasin Coordination Agreement formerly identified the criteria for undesirable results related to groundwater levels as the following: "*…the criteria for an undesirable result for the chronic lowering of groundwater levels is defined as the unreasonable lowering of the groundwater elevation below the minimum threshold for two consecutive years at greater than 50% of GSA Management Area RMS Sites, which results in significant impacts to groundwater supply."*

The previous version of the Coordination Agreement further stated that "*…the avoidance of an undesirable result for the chronic lowering of groundwater levels is to protect unreasonable lowering of groundwater levels may effect groundwater users by causing well failures, additional operational costs for groundwater extraction from deeper pumping levels, and additional costs to lower pumps, deepen wells, or drill new wells."*

In their review of the Tule Subbasin GSPs, each of which refer to the Coordination Agreement, the CDWR made the following general comments:

The GSPs do not define undesirable results or set minimum thresholds and measurable objectives for groundwater levels in a manner consistent with the GSP Regulations.

1. *The GSPs do not describe, with information specific to the Subbasin, the groundwater level conditions that are considered significant and unreasonable and would result in undesirable results. The GSPs do not explain or justify how the quantitative definition of undesirable results is consistent with avoiding effects the GSAs have identified as undesirable results.*

2. *The GSPs do not explain how minimum thresholds at the representative monitoring sites are consistent with the requirement to be based on a groundwater elevation indicating a depletion of supply at a given location. The GSPs do not demonstrate that the established sustainable management criteria are based on a commensurate level of understanding of the basin setting or whether the interests of beneficial uses and users have been considered.*

Based on the CDWR comments, the Tule Subbasin Coordination Agreement has been modified to reflect the analysis of potentially significant and unreasonable groundwater level conditions presented herein.

1.2 Purpose and Scope

The purpose of this TM is to provide the basis for determining significant and unreasonable groundwater level conditions in each of the six GSAs of the Tule Subbasin and to provide a basis for modifications to the Tule Subbasin Coordination Agreement and GSPs to address CDWR comments to the GSPs. Potentially significant and unreasonable groundwater level conditions was evaluated through an analysis of the number of wells that could be impacted if groundwater levels were drawn down to the minimum thresholds (MTs) identified by each GSA. The analysis of potentially impacted wells is based on readily available well data for the Tule Subbasin, as published in the CDWR driller's log database. As this database does not contain information on well failures, operational costs for pumping groundwater, or pump settings for wells, the analysis to correlate MTs to significant and unreasonable conditions focuses on the total depth of wells and the number of those wells that would be rendered inoperable if groundwater levels are drawn down to the MTs.

1.3 Sources of Data

The sources of data used for this analysis include the following:

- CDWR's Online System for Well Completion Reports[1]
- Geographic Information System (GIS) shapefiles of the subbasin and GSA boundaries and wells,
- Minimum threshold groundwater level elevations for representative monitoring sites specific to both the Upper and Lower Aquifers in the Tule Subbasin,[2]
- Groundwater levels for January 2015 from the calibrated groundwater flow model of the Tule Subbasin,[3]
- Specific capacity data for wells in the Tule Subbasin.[4]

1.4 Beneficial Uses of Groundwater Addressed

As per Regional Water Quality Control Board – Central Valley Region Water Quality Control Plan for the Tulare Lake Basin,[5] the beneficial uses of water in the basin include:

- Agricultural Supply
- Domestic Supply
- Industrial Supply and
- Municipal Supply

[1] CDWR, 2022. https://data.ca.gov/dataset/well-completion-reports
[2] TH&Co, 2022. Tule Subbasin 2020/21 Annual Report. Prepared for the Tule Subbasin Technical Advisory Committee. Dated March 2022.
[3] TH&Co, 2021. Update to the Groundwater Flow Model of the Tule Subbasin. Technical Memorandum dated 7/30/21.
[4] TH&Co, 2020. Groundwater Flow Model of the Tule Subbasin. Report prepared for the Tule Subbasin MOU Group. Dated January 2020.
[5] RWQCB, 2018. Water Quality Control Plan for the Tulare Lake Basin, Section 2.

2 Analysis of Wells Potentially Impacted at the Minimum Thresholds in the Tule Subbasin GSPs

The premise behind the analysis presented herein is that wells rendered inoperable due to lowering of groundwater levels is a significant and unreasonable condition. While it is not possible to specifically identify, with accuracy, exactly how many wells in the Tule Subbasin would be impacted by lowering groundwater levels below the MTs, it is possible, using the CDWR database, to obtain an estimate of the number of wells that would be potentially impacted. Further, the database has been used, to the extent possible, to assess the beneficial uses served by the impacted wells, whether agricultural irrigation, domestic supply, industrial supply, or municipal supply.

The methodology to estimate the number of wells potentially impacted by lowering groundwater levels to the MTs included wells constructed in the Upper Aquifer, the Lower Aquifer, or both. While the reference MTs are different for each aquifer, the methodology to estimate potentially impacted wells was the same and included the following steps and assumptions:

- The MTs for each aquifer, as designated at representative monitoring sites, were contoured via kriging in Geographic Information System (GIS) to develop a MT surface across the subbasin (see Figures 2 and 3).
- Wells in the CDWR well database were sorted to include only those with total depth information.
- Non-pumping wells or wells documented for uses other than agricultural, private domestic, industrial, or municipal, (e.g. contaminant remediation, injection, monitoring) were also removed from the wells to be used in the analysis.
- The remaining wells were plotted on a map according to the location information in the CDWR database (see Figure 4). For wells with only township, range and section information, the well was plotted in the middle of the section. A total of 4,190 wells are shown on Figure 4.
- As per the Sustainable Groundwater Management Act (SGMA)[6] GSPs are not required to address undesirable results to wells associated with groundwater conditions prior to January 1, 2015. Thus, wells that would have been impacted prior to this time were removed from the analysis. To do this, a map was generated of the groundwater surface in January 2015 based on the calibrated groundwater flow model of the subbasin (see Figure 5).[7] The difference in groundwater level between January 2015 and the Upper Aquifer MTs across the Tule Subbasin is shown on Figure 6.

Wells at which the total depth or bottom of perforations were above the MT or where the total depth/bottom of perforations were below the MT but could not support pumping with a static

[6] California Water Code Part 2.74, Ch. 6, Section 10727.2 (b) (4)
[7] TH&Co, 2021. Update to the Groundwater Flow Model of the Tule Subbasin. Technical Memorandum prepare for the Tule Subbasin Technical Advisory Committee. Dated July 29, 2021.

groundwater level at the MT were considered "potentially impacted." Criteria for determining whether a well could support pumping when the static groundwater level was at the MT were the following:

- The pumps in all wells were assumed to be installed, or capable of being installed, within 10 feet of the bottom of the wells.
- It was assumed that the pumping groundwater level would need to be at least 20 feet above the pump intake to avoid cavitation or entrained air.
- Potential pumping drawdown was estimated based on specific capacity data from available wells and pumping rates reported on CDWR driller's logs.
- For each GSA, TH&Co used an average specific capacity from wells with specific capacity data in that GSA. Pumping rates were applied as an average rate for wells in each mile square section.
- The wells potentially impacted by lowering the groundwater level below the minimum thresholds, considering total well depth, adequate pump submergence, and drawdown, are summarized in Section 3.

3 Findings

Within the Tule Subbasin as a whole, 4,190 wells were identified from the CDWR database as having total depth information (see Figure 4). Of those wells, 1,692 were constructed completely within the Upper Aquifer and 2,498 wells were constructed either within the Lower Aquifer or as a composite well with perforations in both the Upper and Lower Aquifers.

Of the 4,190 wells, 568 wells would have already been impacted by January 2015 groundwater levels and were removed from consideration (see Figure 7). The remaining 3,622 wells were included in the analysis.

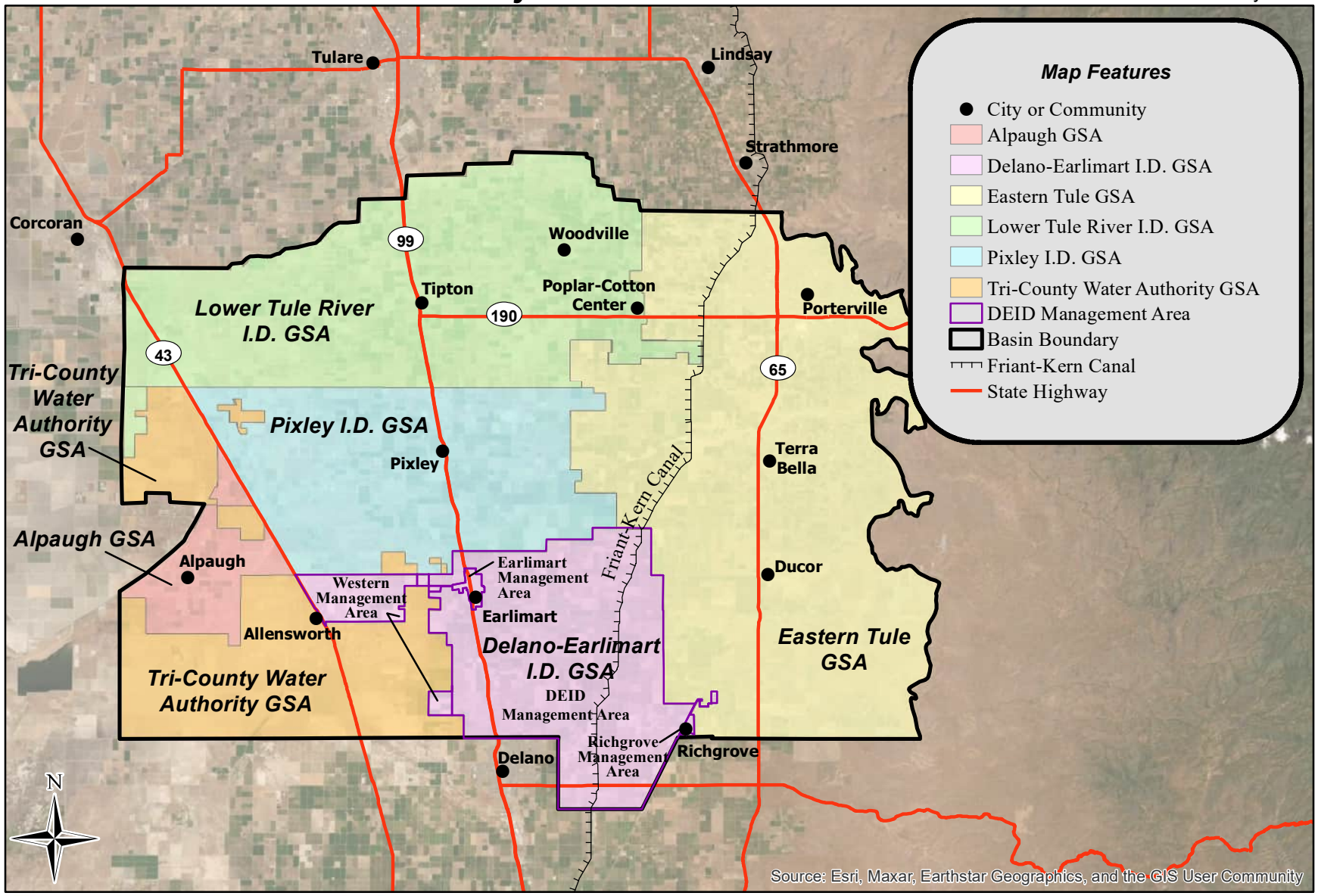
Of the 3,622 wells in the analysis, 776 wells would be impacted if groundwater levels were lowered to the MTs using the evaluation criteria described in Section 2 herein (see Figure 8). Some of these wells would be impacted before the MT groundwater levels were reached. Wells included in the analysis were completed in either the Upper Aquifer, the Lower Aquifer or both. The number of wells in each GSA predicted to be impacted if groundwater levels are lowered to the MTs, by beneficial use category, are as follows:

GSA	Number of Agricultural Irrigation Wells Potentially Impacted	Number of Domestic Wells Potentially Impacted	Number of Industrial Wells Potentially Impacted	Number of Municipal Wells Potentially Impacted	Number of Unknown Use Wells Potentially Impacted	Total Wells Potentially Impacted
Alpaugh ID GSA	1	0	0	0	0	1
DEID	1	6	0	0	1	8
ETGSA	91	428	15	8	19	561
LTRID GSA	49	92	5	0	4	150
Pixley ID GSA	6	38	1	0	6	51
Tri-County GSA	1	4	0	0	0	5
Total	149	568	21	8	30	776

DWR Comments - Groundwater Levels in the Tule Subbasin

July 2022

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

0 2.5 5 10 Miles

NAD 83 State Plane Zone 4

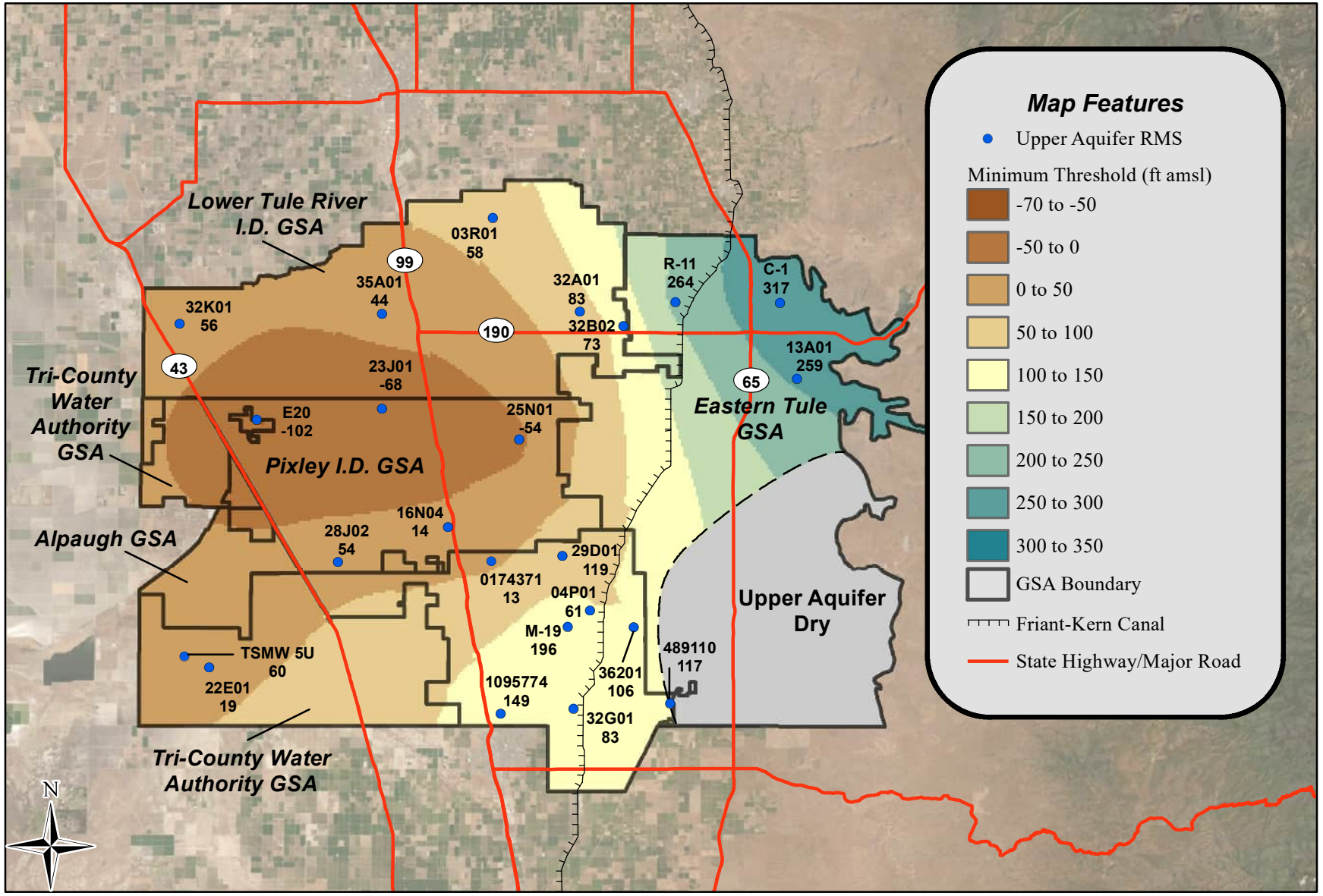
GSA Boundaries

Figure 1

DWR Comments - Groundwater Levels in the Tule Subbasin

July 2022

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co. Groundwater Consulting

0 2 4 8 Miles

NAD 83 State Plane Zone 4

Notes: ft amsl = feet above mean sea level
RMS = Representative Monitoring Site

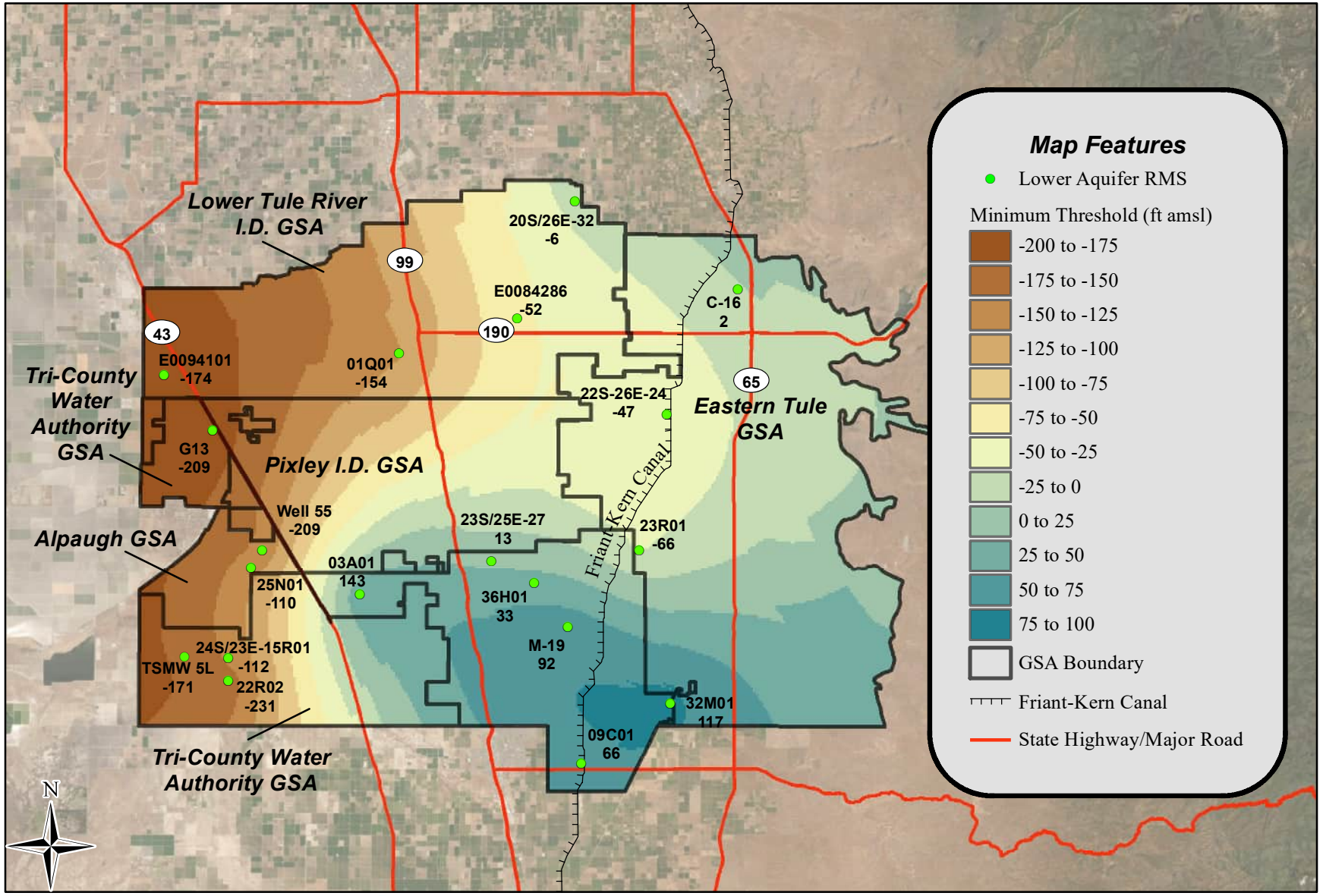
Minimum Thresholds - Upper Aquifer

Figure 2

DWR Comments - Groundwater Levels in the Tule Subbasin

July 2022

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

0 2 4 8
Miles
NAD 83 State Plane Zone 4

Notes: ft amsl = feet above mean sea level
RMS = Representative Monitoring Site

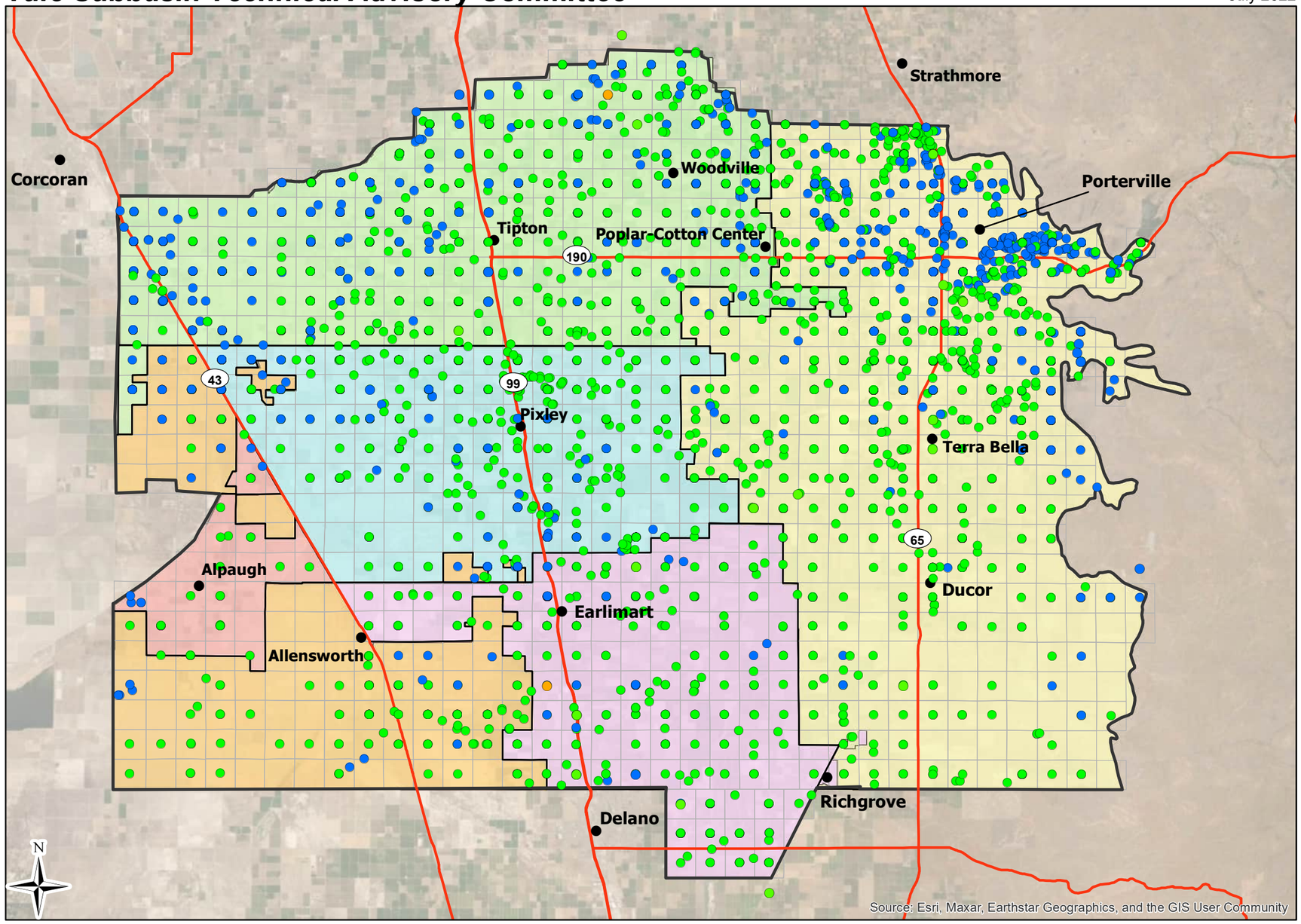
Minimum Thresholds - Lower Aquifer

Figure 3

Tule Subbasin Technical Advisory Committee

July 2022

DWR Comments - Groundwater Levels in the Tule Subbasin



0 2.5 5 10 Miles

NAD 83 State Plane Zone 4

Map Features

DWR Well
- Upper Aquifer Well
- Lower Aquifer Well
- Composite Well

City or Community

Mile-Square Section

- Alpaugh GSA
- Delano-Earlimart I.D. GSA
- Eastern Tule GSA
- Lower Tule River I.D. GSA
- Pixley I.D. GSA
- Tri-County Water Authority GSA

Basin Boundary

State Highway/Major Road

GSA	No. of Upper Aquifer Wells	No. of Lower Aquifer Wells
Alpaugh ID GSA	9	23
DEID	53	239
ETGSA	880	1,056
LTRID GSA	546	636
Pixley ID GSA	139	402
Tri-County GSA	65	142
Total	1,692	2,498

Thomas Harder & Co.
Groundwater Consulting

Note: The wells are plotted using coordinates provided by DWR. Many coordinates provided plot the well in the center of the section. Sections displaying only one well may actually have multiple wells plotted on top of one another.

Note: Wells include domestic, agricultural, industrial and public supply wells.

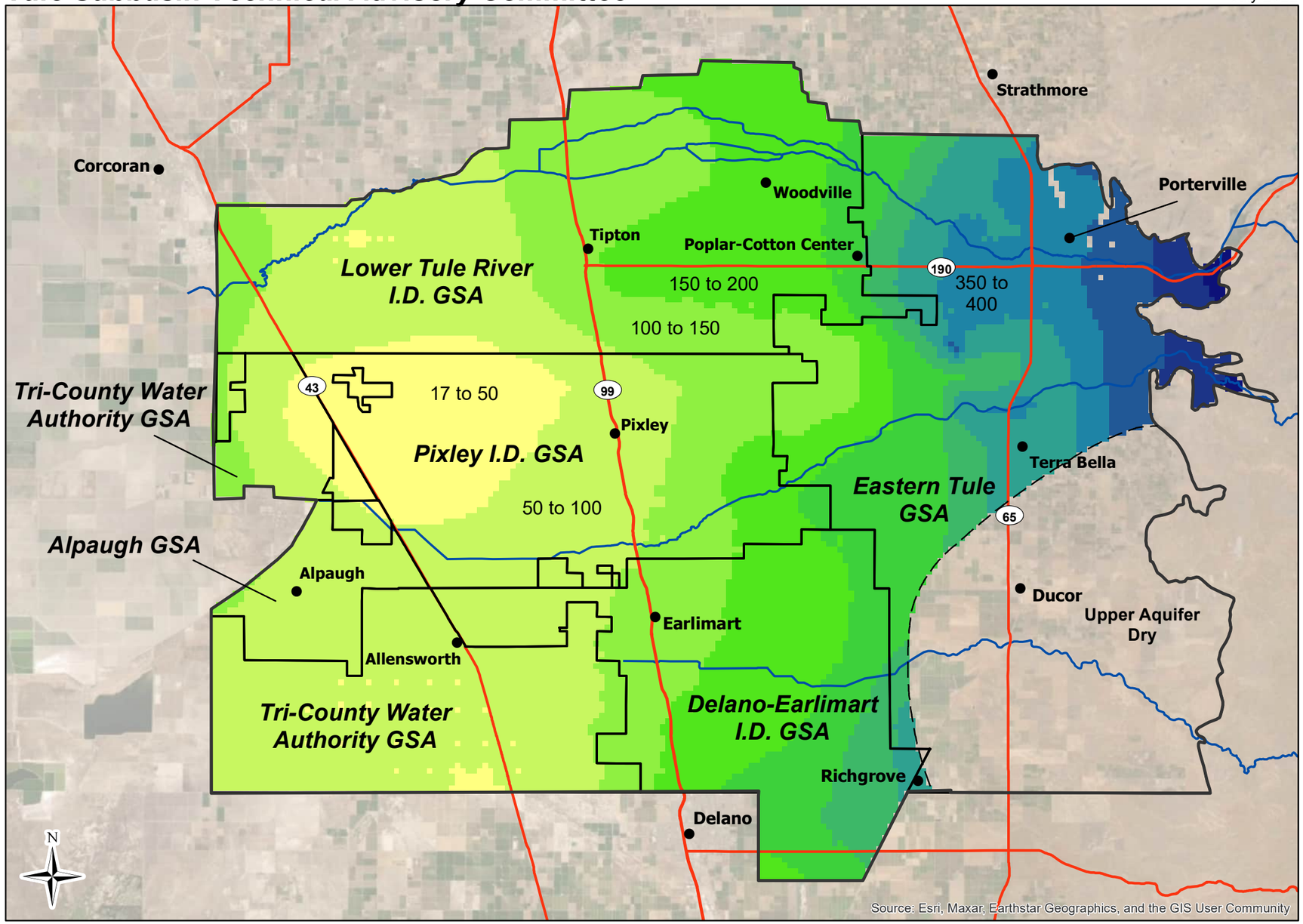
DWR Driller's Log Wells with Known Depth

Figure 4

DWR Comments - Groundwater Levels in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

July 2022



0 2.5 5 10 Miles

NAD 83 State Plane Zone 4

Map Features

Model Generated Groundwater Elevation (ft amsl)

- 17 to 50
- 50 to 100
- 100 to 150
- 150 to 200
- 200 to 250
- 250 to 300
- 300 to 350
- 350 to 400
- 400 to 450
- 450 to 500
- 500 to 550
- GSA Boundary
- Basin Boundary
- State Highway/Major Road
- Major Hydrologic Feature
- City or Community

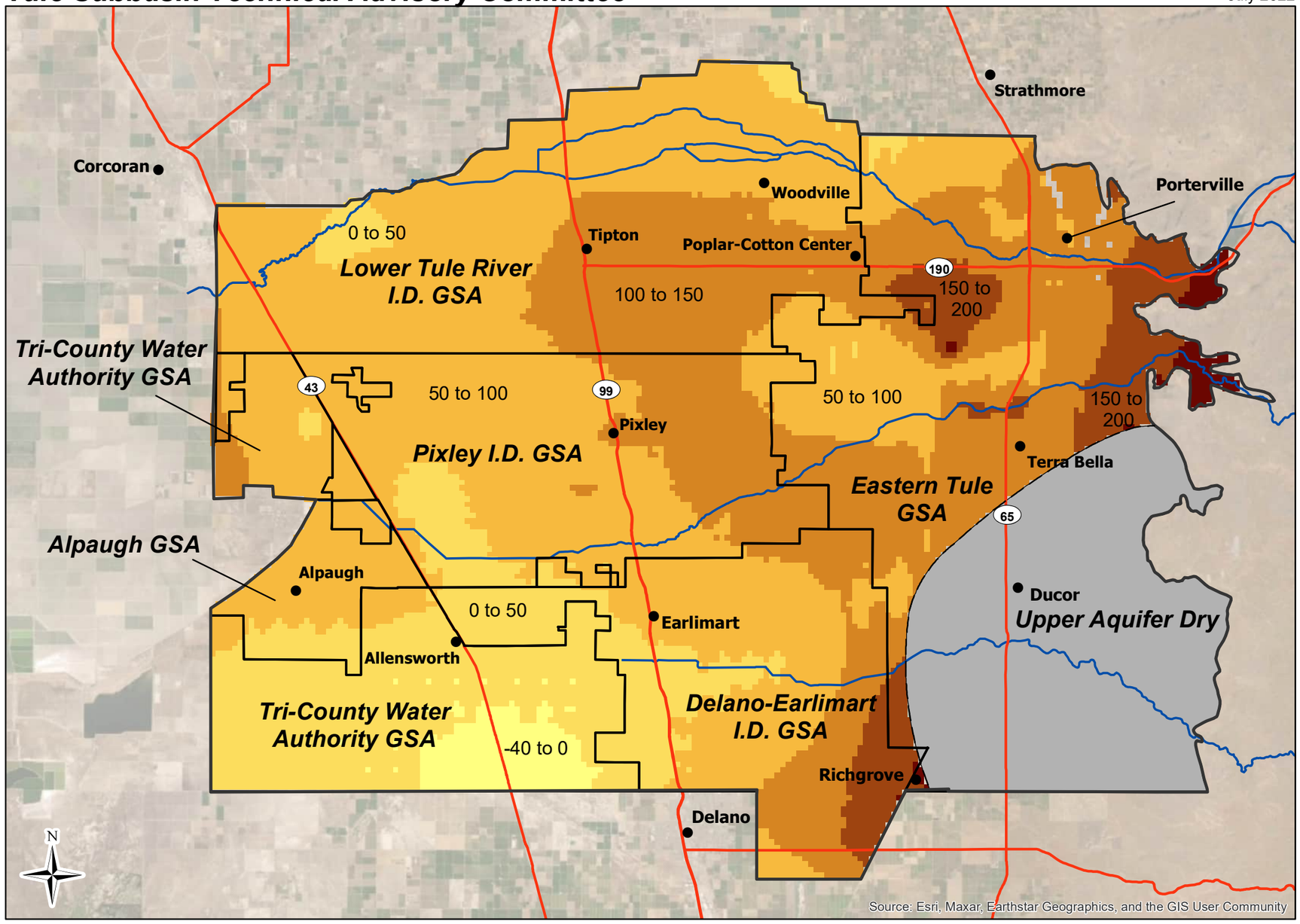
Model-Generated Upper Aquifer Groundwater Elevation - January 2015

Figure 5

Thomas Harder & Co.
Groundwater Consulting

Tule Subbasin Technical Advisory Committee

July 2022



0 2.5 5 10 Miles

NAD 83 State Plane Zone 4

Thomas Harder & Co.
Groundwater Consulting

DWR Comments - Groundwater Levels in the Tule Subbasin

Map Features

Groundwater Elevation Difference (ft)

- -40 to 0
- 0 to 50
- 50 to 100
- 100 to 150
- 150 to 200
- 200 to 260

Tule Subbasin GSA

Basin Boundary

State Highway/Major Road

Major Hydrologic Feature

City or Community

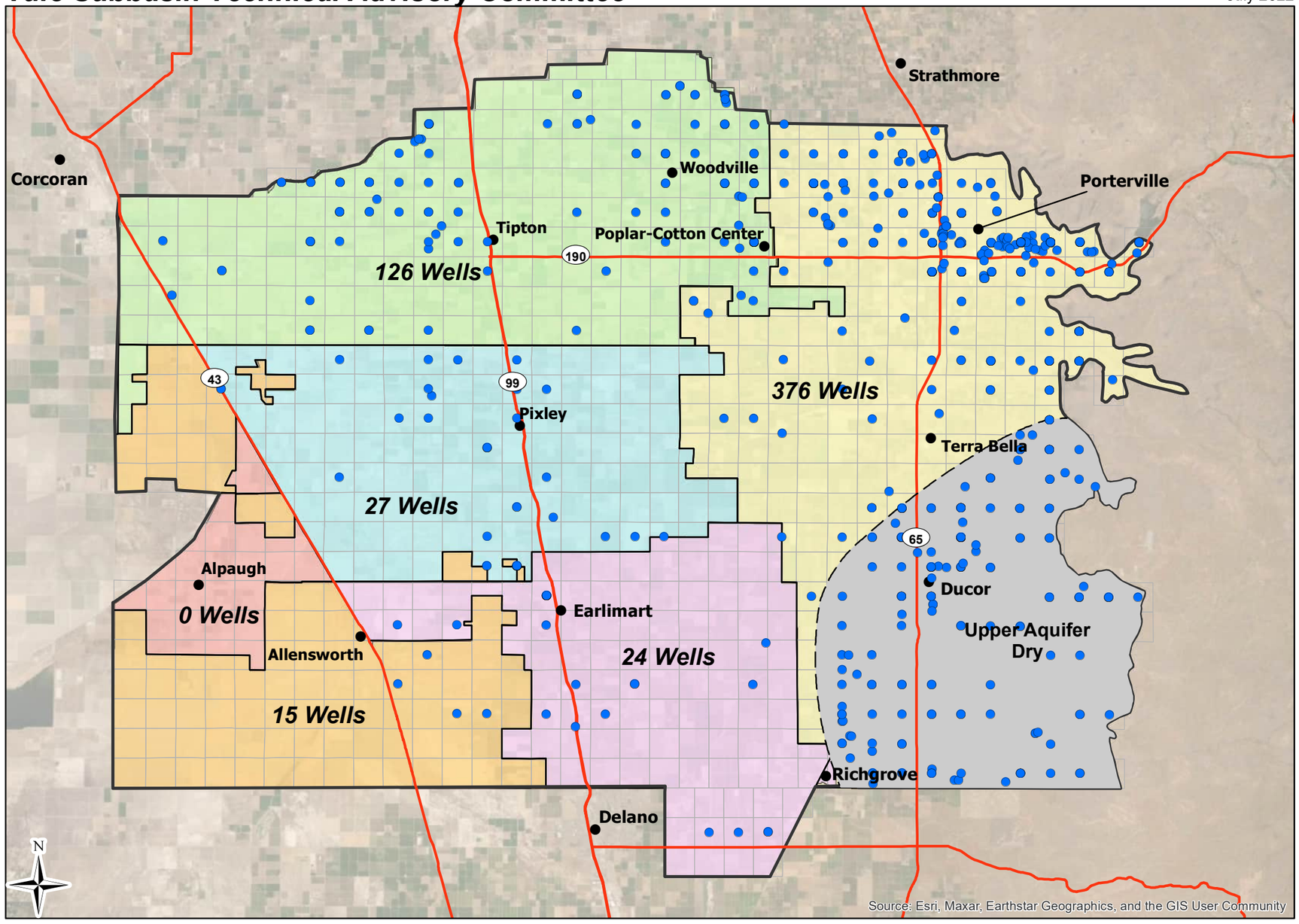
January 2015 to Minimum Thresholds Upper Aquifer Groundwater Elevation Difference

Figure 6

DWR Comments - Groundwater Levels in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

July 2022



Map Features

- Upper Aquifer Well
- City or Community
- Mile-Square Section
- Alpaugh GSA
- Delano-Earlimart I.D. GSA
- Eastern Tule GSA
- Lower Tule River I.D. GSA
- Pixley I.D. GSA
- Tri-County Water Authority GSA
- Basin Boundary
- State Highway/Major Road

GSA	No. Dry Wells
Alpaugh ID GSA	0
DEID	24
ETGSA	376
LTRID GSA	126
Pixley ID GSA	27
Tri-County GSA	15
Total	568

Wells Shallower than January 2015 Groundwater Levels*

Figure 7

Thomas Harder & Co.
Groundwater Consulting

Note: The wells are plotted using coordinates provided by DWR. Many coordinates provided plot the well in the center of the section. Sections displaying only one well may actually have multiple wells plotted on top of one another.

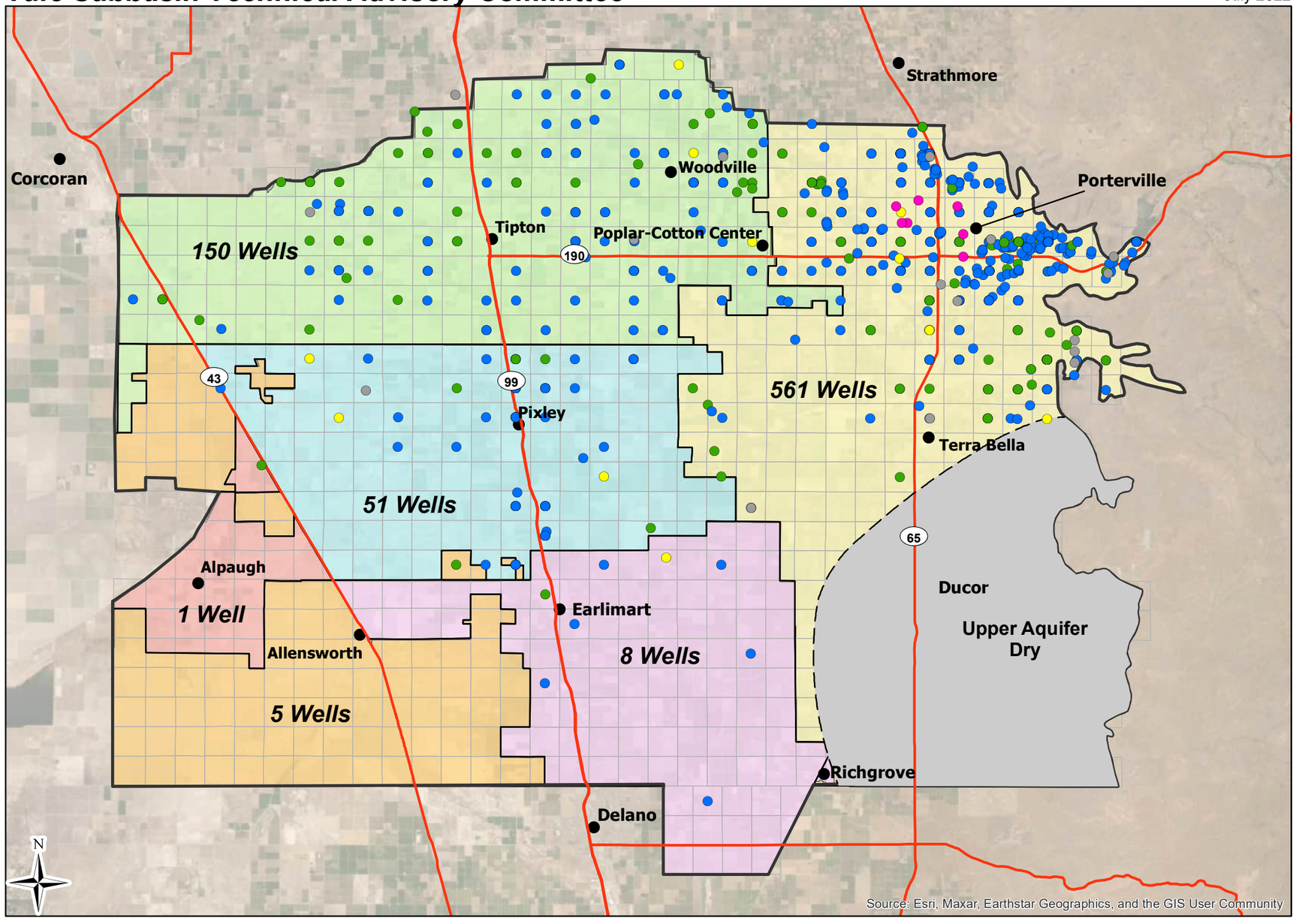
Note: Wells includes domestic, agricultural, industrial, and public supply wells.

*Includes drawdown and submegence assumptions.

Tule Subbasin Technical Advisory Committee

July 2022

DWR Comments - Groundwater Levels in the Tule Subbasin



0 2.5 5 10 Miles

NAD 83 State Plane Zone 4

Map Features

Affected Well
- Unknown
- Domestic
- Agricultural
- Municipal
- Industrial

City or Community

Mile-Square Section

Alpaugh GSA

Delano-Earlimart I.D. GSA

Eastern Tule GSA

Lower Tule River I.D. GSA

Pixley I.D. GSA

Tri-County Water Authority GSA

Basin Boundary

State Highway/Major Road

GSA	No. of Affected Wells
Alpaugh ID GSA	1
DEID	8
ETGSA	561
LTRID GSA	150
Pixley ID GSA	51
Tri-County GSA	5
Total	776

Affected Wells if Groundwater Levels Reach Minimum Thresholds*

Figure 8

Thomas Harder & Co.
Groundwater Consulting

Note: The wells, with the exception of municipal wells, are plotted using coordinates provided by DWR. Many coordinates provided plot the well in the center of the section. Sections displaying only one well may actually have multiple wells plotted on top of one another.

*Includes drawdown and submegence assumptions.

TECHNICAL MEMORANDUM

To: Tule Subbasin SGMA Managers

From: Don Tucker – 4Creeks, Inc.

Date: June 29, 2022

Re: Technical Support for Addressing DWRs Comments Regarding Groundwater Quality Sustainable Management Criteria in the Tule Subbasin

1 Introduction

This technical memorandum (TM) was prepared to address the groundwater quality comments from the California Department of Water Resources (CDWR) on groundwater sustainability plans (GSPs) prepared by each of the six Groundwater Sustainability Agencies (GSAs) within the Tule Subbasin.

1.1 Background

The originally submitted Tule Subbasin Coordination Agreement addressed undesirable results related to groundwater quality as stated: "*…the criteria for an undesirable result for the degradation of groundwater quality is defined as the unreasonable long-term changes of groundwater quality above the minimum thresholds at greater than 50% of GSA Management Area RMS wells caused by groundwater pumping and/or groundwater recharge.*"

The original Coordination Agreement further stated that "*…the avoidance of an undesirable result for degraded groundwater quality is to protect the those using the groundwater, which varies depending on the use of the groundwater. The effects of degraded water quality caused by recharge or lowering of groundwater levels may impact crop growth or impact drinking water systems, both of which would cause additional expense of treatment to obtain suitable water.*"

Each of the Tule Subbasin GSA originally submitted GSPs further described the process/methodology used for setting Sustainable Management Criteria: "*The following four (4) steps detail the process for setting interim milestones and the measurable objective at individual RMS related to Groundwater Quality:*

Step 1: *Locate the RMS defined in the Tule Subbasin Monitoring Plan, identify which portion of the aquifer it represents, and the associated Constituents of Concern (COC) at the RMS based on groundwater suitability (Agriculture use, Domestic Use, Municipal Use).*

Step 2*: Prepare a table summarizing available historical groundwater quality data for each COC at the RMS well.*

Step 3*: Establish interim milestones and the measurable objective at each RMS well with calculating a change above the baseline groundwater quality to not exceed 10% of long term 10 year running average.*

Step 4: *Each year, during the Plan Implementation Period, re-calculate the long term 10 year running average. Evaluate changes to groundwater quality based on reduction of groundwater elevation or from recharge efforts."*

Similar to the process described for interim milestones and measurable objectives, minimum thresholds at each RMS well were established to not exceed 15% change in the long-term 10-year running average.

Lastly, each of the Tule Subbasin GSA GSPs described the Constituent of Concerns (COC) that will be monitored at each RMS wells as follows: "*The COC vary depending on the suitability of the groundwater. Each of the COC to be monitored by the GSA at the RMS wells to serve as indicators for changes in groundwater quality are identified in the table below.*"

Municipal / Domestic	*Agricultural*
Arsenic	*pH*
Chromium (Total)	*Conductivity*
Nitrogen as N	*Nitrogen as N*
(any specific Title 22 MCL exceedance at baseline sampling event in Spring 2020)	

1.2 DWR Response

The CDWR made the following comments relating to addressing groundwater quality in the Coordination Agreement and individual GSPs within the Tule Subbasin:

"The GSPs do not provide sufficient information to justify the proposed sustainable management criteria for degraded water quality.

1. *The GSPs do not specify what groundwater conditions are considered suitable for agricultural irrigation and domestic use. The GSPs do not explain the choice of constituents (pH, conductivity, and nitrate) as a means of evaluating impacts to beneficial uses and users, especially agricultural irrigation.*

2. *The GSPs do not explain how the use of a 10-year running average to establish the sustainable management criteria will avoid undesirable results due to degraded groundwater quality and related potential effects of the undesirable results to existing regulatory standards. The GSPs do not explain how the criteria defining when undesirable results occur in the Subbasin was established, the rationale behind the approach, and why it is consistent with avoiding significant and unreasonable effects associated with groundwater pumping and other aspects of the GSAs' implementation of their GSPs.*

3. *The GSPs do not explain how the sustainable management criteria for degraded water quality relate to existing groundwater regulatory requirements in the Subbasin and how the GSAs will coordinate with existing agencies and programs to assess whether or not implementation of the GSPs is contributing to the degradation of water quality throughout the Subbasin."*

1.3 Purpose and Scope

The purpose of this TM is to provide the revised approach for re-establishing the sustainability management criteria (SMC) for groundwater quality as is relates to selection constituents of concerns for determining impacts to beneficial uses and users, the rationale used to quantify undesirable results as they relate to existing regulatory standards, and how impacts will be assessed to determine if GSA implementation efforts are a contributing factor to groundwater quality.

In general, the following items were prepared relating to DWRs comments for degradation of groundwater quality:

1. A detailed description of how the overlying beneficial uses and users were defined for determining constituent of concerns to monitor at each RMS groundwater quality well.
2. Redefined rationale for setting groundwater quality SMCs to align with existing regulatory requirements.
3. A detailed description of how ongoing coordination with existing groundwater regulatory agencies and programs will take place to evaluate if GSP implementation is contributing to degradation to groundwater quality.

1.4 Proposed Approach

1.4.1 Defining Beneficial Uses and Users at each RMS Well

Each groundwater quality RMS well will be designated as representative of agricultural or drinking water or both based on the beneficial use and users of groundwater within a representative area surrounding the well based on the following evaluation:

Drinking Water: The RMS well is within an urban MA or 1-mile of a public water system**.**

Agricultural: Greater than 50% of the pumping within the representative area is determined to be agricultural and there are no public water systems within a 1-mile radius.

An RMS well may be designated as representative of both agricultural and drinking water if it possesses a representative area with greater than 50% agricultural pumping and a public water system was within 1-mile.

The analysis used to determine the beneficial uses at each RMS well consisted of querying DWR well completion reports, public water systems, and schools using ArcGIS. The detailed breakdown of the steps to conduct analysis is described below.

1. Create a layer in ArcGIS by combining data from the following:
   - Well locations and well types from DWRs Well Completion Report Mapping Application
   - Boundaries of SWDIS Public Water Systems
   - Boundaries of Community/Urban areas from LAFCO
2. Overlay groundwater quality locations of RMS wells and create 1 mile buffer for analyzing.
3. Summarize the data identified in step 1 relative to each groundwater quality RMS well 1-mile buffer.
4. Define the groundwater quality RMS well as representative of drinking water and/or agricultural beneficial pumping beneficial use.

Wells types are categorized as drinking water, agricultural, or not applicable based on breakdown in **Table 1**.

Table 1: Categories of Well Types

Drinking Water	Agricultural	Not Applicable
Domestic	Irrigation - Agricultural	Cathodic Protection
Public	Other Irrigation	Destruction Monitoring
Water Supply	Water Supply Irrigation - Agricultural	Destruction Unknown Soil Boring
Water Supply Domestic	Water Supply Irrigation - Agriculture	Monitoring
Water Supply Public	Water Supply Stock or Animal Watering	Other Destruction
		Test Well
		Test Well Unknown
		Unknown
		Vapor Extraction
		Vapor Extraction n/a
		Water Supply Industrial
		Blanks

Results of this analysis are provided as part of the Monitoring Network Section of each GSP.

1.4.2 Rationale for Establishing Sustainable Management Criteria

Agricultural and drinking water constituents of concerns (COC) will be evaluated based on the established Maximum Contaminate Level (MCL) or Water Quality Objectives (WQO) by the responsible regulatory agency. In the case of drinking water, the following Title 22 constituents will be monitored and for agricultural the following Basin Plan Water Quality Objective (WQO) constituents of concern will be monitored:

Drinking Water Constituents of Concern

- Arsenic
- Nitrate as N
- Chromium-VI
- Dibromochloropropane (DBCP)
- 1,2,3- Trichloropropane (TCP)
- Tetrachloroethene (PCE)
- Chloride
- Total Dissolved Solids
- Perchlorate

Agricultural Constituents of Concern

- Chloride
- Sodium
- Total Dissolved Solids

Measurable objectives are proposed to be 75% of the regulatory limits for the COCs and the minimum thresholds are proposed to be the regulatory limits as identified in **Table 2**. For RMS wells that have historical exceedances of the MCLs or WQOs which were not caused by implementation of a GSP, minimum thresholds will not be set at the MCLs or WQOs, but rather the pre-SGMA implementation concentration. These RMS wells closely monitored to evaluate if further degradation is occurring at the RMS site as a result of GSP implementation into the future.

Table 2: Measurable Objectives and Minimum Thresholds for Groundwater Quality

Constituent	Units	Minimum Threshold		Measurable Objective	
		Drinking Water Limits (MCL/SMCL)	Agricultural Water Quality Objective	Drinking Water Limits (MCL/SMCL)	Agricultural Water Quality Objective
Arsenic	ppb	10	N/A	7.5	N/A
Nitrate as N	ppm	10	N/A	7.5	N/A
Hexavalent Chromium	ppb	10	N/A	7.5	N/A
Dibromochloropropane (DBCP)	ppb	0.2	N/A	0.15	N/A
1,2,3-Trichloropropane (TCP)	ppt	5	N/A	3.75	N/A
Tetrachloroethene (PCE)	ppb	5	N/A	3.75	N/A
Chloride	ppm	500	106	375	79.5
Sodium	ppm	N/A	69	N/A	51.75
Total Dissolved Solids	ppm	1,000	450	750	337.5
Perchlorate	ppb	6	N/A	4.5	N/A

Utilizing the criteria described above, the Tule Subbasin GSAs have revised the definition of undesirable results for degradation of groundwater quality in *Section 4.3.3.2 - Criteria to Define Undesirable Results (§354.26(b)(2))* in the Tule Subbasin Coordination Agreement as:

> *"..the exceedance of a minimum threshold at a groundwater quality RMS in any given GSA resulting from the implementation of a GSP. This condition would indicate that more aggressive management actions were needed to mitigate the overdraft."*

Additionally, the Tule Subbasin has developed a Mitigation Program Framework included as Attachment 7 of the Tule Subbasin Coordination Agreement, which describes the framework the Tule Subbasin GSAs would utilize to address impacts that occur from implementation of a GSP relative to degradation of groundwater quality due to GSA actions.

1.4.3 Coordination with Existing Groundwater Quality Regulatory Agencies and Programs

The monitoring and characterization of groundwater quality conditions has historically been conducted and reported by other public agencies and/or non-profits to meet requirements of other regulatory programs, which focus on the prevention of degradation of groundwater quality. The existing groundwater monitoring programs that the Tule Subbasin GSAs coordinate with are described in **Table 3**.

To prevent duplication of efforts and competing datasets for the ILRP, CV-Salts Nitrate Control Program, and SGMA GSAs, the Tule Subbasin utilizes a single group to manage the monitoring efforts within the Subbasin for collectively meeting the various requirements of these programs being implemented at the local level. This level of coordination between these agencies and groups ensures that the efforts performed under each program help provide a cohesive response to providing short term and long-term solutions to groundwater management.

The evaluation as to whether the implementation of a GSP may be contributing to the degradation of water quality will be completed as outlined in Attachment 7 of the Tule Subbasin Coordination Agreement. The types of mitigation for degradation of groundwater quality will vary by GSA and will be coordinated with the agencies listed in Table 2.

Other forms of mitigation may consist of joint ventures to secure grant funding to address GSA related impacts.

Table 3: Existing Groundwater Quality Monitoring Programs

Programs or Data Portals	Tule Subbasin Agency Coordinating with GSAs	Parameters	Monitoring Frequency	Program Objectives
AB-3030 and SB-1938 Groundwater Management Plans	Tule Subbasin GSAs, requirements incorporated into GSP Annual Reports	• Water levels are typically monitored annually. • Ag Suitability analysis (limited suite of general minerals) monitoring frequency between annual to once every 3 years.	Semiannual to Annual	
California SDWIS	Varies Public Water Systems	Database for all public water system wells and historical sample results. Data available includes all Title 22 regulated constituents.	• Title 22 General Minerals and Metals every 3 years. • Nitrate as N annually, if ≥ 5 ppm, sampled quarterly • VOCs and SOCs sampled every 3 years. • Uranium sampling depends on historical results but varies between 1 sample every 3 (when ≥ 10 pCi/L), 6 (when < 10 pCi/L) or 9 (when no historical detection) years.	Demonstrate compliance with Drinking Water Standards through monitoring and reporting water quality data.
CV-SALTS	Tule Basin Management Zone, Tule Basin Water Foundation	Sampling parameters required through Waste Discharge Requirements (WDR): typically include monthly sodium, chloride, electrical conductivity, nitrogen species (N, NO2, NO3, NH3), pH and other constituents of concern identified in the Report of Waste Discharge. A limited suite of general minerals is required quarterly from the source and annually from the wastewater.	Most constituents sampled monthly, quarterly general minerals from source water and annual general minerals from waste discharge.	To monitor degradation potential from wastewaters discharged to land application areas and provide interim replacement water when MCL for nitrate as N is exceeded while developing long term solutions for safe drinking water.
Department of Pesticide Regulation	County of Tulare	Pesticides	Annual	DPR samples groundwater to determine: (1) whether pesticides with the potential to pollute groundwater are present, (2) the extent and source of pesticide contamination, and (3) the effectiveness of regulatory mitigation measures.
GAMA (Collaboration with SWQCB, RWQCB, DWR, DPR, NWIS, LLNL)		• Constituents sampled vary by the Program Objectives. • Typically, USGS is the technical lead in conducting the studies and reporting data.	Varies	• Improve statewide comprehensive e groundwater monitoring. • Increase the availability of groundwater quality and contamination information to the public.
Geotracker and Envirostor Databases		Many contaminants of concern, organic and inorganic.	Depends on program. Monthly, Semiannually, Annually, etc.	Records database for cleanup program sites, permitted waste dischargers
ILRP	Tule Basin Water Quality Coalition	• Annually: static water level, temperature, pH, electrical conductivity, nitrate as nitrogen, and dissolved oxygen. • Once every five years: general minerals collection	Annual and Every 5 years	Monitor impacts of agricultural and fertilizer applications on first encountered groundwater
USGS California Water Science Center		Conducted multiple groundwater quality studies of the Tule Subbasin.	Reports, factsheet, and data publications range from 1994through 2017.	Special studies related to groundwater quality that provide comprehensive studies to characterize the basin.

Technical Memorandum

To:	Tule Subbasin Technical Advisory Committee
From:	Thomas Harder, P.G., C.HG. Thomas Harder & Co.
Date:	13-Jul-22
Re:	Technical Support for Addressing Department of Water Resources Comments Regarding Land Subsidence in the Tule Subbasin

1 Introduction

This technical memorandum (TM) summarizes an analysis of currently established minimum thresholds and measurable objectives for land subsidence as they relate to potential impacts to land use, property interests, and critical infrastructure in the Tule Subbasin in Tulare County, California (see Figure 1). This TM was prepared to address comments from the California Department of Water Resources (CDWR) on groundwater sustainability plans (GSPs) prepared by each of the six Groundwater Sustainability Agencies (GSAs) within the Tule Subbasin.

1.1 Background

The Tule Subbasin Coordination Agreement formerly addressed undesirable results related to groundwater levels as the following: *"…the criteria for an undesirable result for land subsidence is defined as the unreasonable subsidence below minimum thresholds at greater than 50% of GSA Management Area RMS resulting in significant impacts to critical infrastructure."*

The previous version of the Coordination Agreement further stated that *"…the avoidance of an undesirable result of land subsidence is to protect critical infrastructure for the beneficial uses within the Tule Subbasin, including out of the ordinary costs to fix, repair, or otherwise retrofit such infrastructure beyond those which are expected or normal and may also result in an interim loss of benefits to the users of such infrastructure. An exceedance of minimum thresholds to the extent that the undesirable result for the Tule Subbasin is experienced could likely induce financial hardship on land and property interests, such as the redesign of previously planned construction projects and the fixing and retrofitting of existing infrastructure."*

In their review of the Tule Subbasin GSPs, each of which refer to the Coordination Agreement, the CDWR outlined the following Corrective Actions:[1]

1. *For areas defined as adjacent to the Canal in the Eastern Tule GSP, Delano-Earlimart Irrigation District GSP, and Lower Tule River Irrigation District GSP areas, the GSAs should identify, through analysis, the total amount of subsidence that can be tolerated by the Canal during implementation of the GSPs to maintain the ability to reasonably operate to meet contracted water supply deliveries. Eastern Tule GSA, Delano-Earlimart Irrigation District GSA, and Lower Tule River Irrigation District GSA should explain how implementation of the projects and management actions is consistent both with achieving the long-term avoidance or minimization of subsidence and with not exceeding the tolerable amount of cumulative subsidence adjacent to the Canal.*
    a. *GSPs adjacent to the Canal should provide an updated description of the Land Subsidence Management and Monitoring Plan and the associated subsidence management in the vicinity of the Canal. The GSPs should include details of any projects, management actions, or mitigation programs associated with the management of land subsidence in the Subbasin.*
2. *For areas not adjacent to the Canal, the GSAs should identify facilities and/or structures, land uses and property interests that may be susceptible to impacts from land subsidence and should quantify the amount of land subsidence that would result in undesirable results. The GSAs should describe the rationale and any analysis performed to inform the quantification of undesirable results in these areas.*
3. *Tule Subbasin GSAs should define the criteria for when undesirable results occur in the Subbasin based on the results of analyses completed in response to Corrective Actions 1 and 2, the rationale behind the approach, and why it is consistent with avoiding the significant and unreasonable effects identified by the GSAs.*
4. *The GSAs should revise their minimum thresholds and measurable objectives for land subsidence to be consistent with the intent of SGMA that subsidence be avoided or minimized once sustainability is achieved. In doing that, the GSAs should identify a cumulative amount of tolerable subsidence that, if exceeded, would substantially interfere with groundwater and land surface beneficial uses and users in the Subbasin. The GSPs should explain how the extent of any future subsidence permitted by the GSPs would not substantially interfere with surface land uses. The GSAs should explain how implementation of the projects and management actions is consistent both with achieving the long-term avoidance or minimization of subsidence and with not exceeding the tolerable amount of cumulative subsidence.*

[1] CDWR, 2022. Statement of Findings Regarding the Determination of Incomplete Status of the San Joaquin Valley – Tule Subbasin Groundwater Sustainability Plans; Letter Dated January 28, 2022. Section 3.2.

The updated Coordination Agreement has been modified to reflect the analysis of land subsidence in the Tule Subbasin, as presented herein.

1.2 Purpose and Scope

In general, the purpose of this TM is to provide a technical basis for addressing the four general CDWR comments on the sustainable management criteria for land subsidence in the Tule Subbasin, as quoted in Section 1.1. The technical analysis described herein provides the basis for defining significant and unreasonable land subsidence conditions in the Tule Subbasin.

1.3 Sources of Data

The analysis presented herein is based on the best available data and background reports at the time of preparation. Sources of data used for this analysis include the following:

- Geographic Information System (GIS) shapefiles of hydrologic and water infrastructure from local agencies (e.g. Lower Tule River Irrigation District, Saucelito Irrigation District, etc.)
- GIS shapefile of railroads from the California Department of Transportation (CalTrans).
- GIS shapefile of bridges from the United States Department of Transportation, National Bridge Inventory
- AMEC Foster Wheeler, 2017. Ground Subsidence Study Report, Corcoran Subsidence Bowl, San Joaquin Valley, California. Prepared for California High Speed Rail Authority
- GIS shapefiles of Flood Insurance Rate Maps (FIRMs) from the Federal Emergency Management Agency (FEMA), National Flood Insurance Program (NFIP).
- Pipeline locations from the National Pipeline Mapping System (NPMS)
- United States Geological Survey (USGS) Digital Elevation Model (DEM)
- Geographic Information System (GIS) shapefiles of the subbasin and GSA boundaries and wells
- Tule Subbasin survey benchmark data[2]
- Minimum threshold groundwater level elevations for representative monitoring sites in the Tule Subbasin[3]

[2] Thomas Harder & Co, 2022. Tule Subbasin 2020/21 Annual Report. Prepared for the Tule Subbasin Technical Advisory Committee.
[3] Thomas Harder & Co, 2022. Tule Subbasin 2020/21 Annual Report. Prepared for the Tule Subbasin Technical Advisory Committee.

2 Land Subsidence Conditions

2.1 Mechanisms of Land Subsidence

Land surface subsidence from groundwater withdrawal occurs in areas where the subsurface aquifer system includes relatively thick aquitards and the groundwater level is lowered from groundwater pumping. Aquitards are low permeability layers with relatively high silt and clay content. As the aquitards are compressible, the release of pore pressure caused by the lowering of groundwater levels results in compression of the low permeability layers. Within a limited range of groundwater level fluctuation, the compressed aquitards can accept water back into their structure when groundwater levels rise resulting in elastic rebound. However, if groundwater levels are maintained at these lower levels for long enough periods of time as a result of groundwater pumping, the compression of aquitards becomes permanent. This permanent compression of subsurface layers results in land surface subsidence.

2.2 Rate and Extent of Land Subsidence in the Tule Subbasin

As described in the Tule Subbasin Setting (Attachment 2 to the Coordination Agreement), the rate of land subsidence in the Tule Subbasin varies both spatially, according to the geology of the subsurface sediments, and temporally with changes in groundwater levels. In general, land subsidence rates are highest in the northwestern part of the subbasin (see Figure 2). The average rate of change in land surface elevation between 1987 and 2018 for the area of maximum subsidence in the western part of the subbasin was estimated to be approximately 12 feet over the 32-year period for a rate of 0.4 ft/yr. At the Porterville GPS station, the annual rate of subsidence between 2006 and 2013 was approximately 0.09 ft/yr but increased to approximately 0.29 ft/yr between 2013 and 2019.

Groundwater flow model analysis forecasts that land subsidence will continue during the transitional pumping period from 2020 to 2040 as groundwater levels continue to drop in parts of the Subbasin.[4] In general, the greatest amounts of land subsidence (up to eight feet) is forecasted to occur in the northwestern part of the subbasin during this time period, which represents an average rate of 0.4 ft/yr (see Figure 3). Land subsidence rates as high as 0.2 ft/yr are forecasted to occur in the vicinity of the Friant-Kern Canal between Deer Creek and White River.

[4] Thomas Harder & Co., 2020. Groundwater Flow Model of the Tule Subbasin. Prepared for the Tule Subbasin MOU Group. Dated January 2020.

2.3 Regional vs Differential Subsidence

Land subsidence can manifest itself as a regional phenomenon or at a local scale. Regional land subsidence results in a large area (e.g. 10's to 100's of square miles) subsiding at similar rates such that the effect of the lowered land elevation cannot be discerned except through periodic surveying of bench marks or information from satellites. Impacts to land uses, property interests, and critical infrastructure from this type of land subsidence are most likely to occur in the form of reduced surface carrying capacity of gravity-driven water conveyance, well damage, and flood control. Differential land subsidence results in localized adjoining areas subsiding at different rates relative to each other. This can result in land fissuring and often occurs along a fault or geologic boundary. Differential land subsidence has the most potential to cause damage to surface infrastructure such as roads, bridges, and buildings.

The best available information to date indicates that land subsidence in the Tule Subbasin has been regional in nature with little evidence of differential land subsidence and no reports of damage to infrastructure associated with differential land subsidence.

3 Land Subsidence Along the Friant-Kern Canal

Differential land subsidence rates along the portion of the Friant-Kern Canal that extends through the ETGSA has had a significant impact on the ability of the FWA to deliver surface water downstream of the impacted areas. Where the FKC crosses the northern and southern ETGSA boundaries, land subsidence rates have been relatively low and cumulative land subsidence in those areas have been on the order of 1 to 2 feet between 1959 and 2019. Land subsidence between the Tule River and White River, however, have resulted in up to approximately 9 feet of cumulative land subsidence at the FKC. This differential land subsidence has resulted in a low spot along the canal in the vicinity of Deer Creek that restricts flow in the canal. The original design flow capacity of the FKC was approximately 4,000 cubic feet per second (cfs). As of 2019, the flow capacity at the canal at Deer Creek had been reduced to approximately 1,900 cfs (United States Bureau of Reclamation, 2019). The FWA is currently pursuing repairs to the FKC to restore the original flow capacity. The long-term effectiveness of the repairs at maintaining flow capacity in the canal relies on limiting additional land subsidence during the SGMA transition period from 2020 to 2040 within the design of the repairs and minimizing land subsidence after 2040.

Groundwater flow model analysis forecasts as much as three feet of additional land subsidence at some locations of the FKC during the transition period from 2020 to 2040 (Figure 4). Through coordination with the Friant Water Authority staff and consultants, this value became the basis for engineering design modifications to restore canal flow capacity to its original condition. Land subsidence along the canal exceeding three feet was determined to be an undesirable result because it would be beyond what the engineering design could accommodate to restore the flow capacity to its original condition and what the parties to the FWA/ETGSA/Pixley GSA settlement agreement agreed to mitigate.

To address land subsidence along the FKC, the ETGSA developed a Land Subsidence Monitoring Plan[5] and Management Plan[6]. These plans are separate from, and in addition to, the monitoring plan established for the Tule Subbasin. The goal of the Land Subsidence Monitoring and Management Plans is to implement groundwater management measures necessary to minimize future non-recoverable land subsidence along the FKC in the SGMA transition period from 2020 – 2040 and to arrest nonrecoverable land subsidence along the FKC after 2040. The area encompassed by the plan is shown on Figure 5, along with Management Zones that have been identified where management actions may be implemented.

The ETGSA Land Subsidence Monitoring Plan includes:

- An enhanced benchmark and groundwater level monitoring network,

[5] TH&Co, 2021. Eastern Tule Groundwater Sustainability Agency Land Subsidence Monitoring Plan. Dated September 2021.
[6] ETGSA, 2022. Eastern Tule Groundwater Sustainability Agency Land Subsidence Management Plan. Dated February 2022.

- Establishment of a Land Subsidence Monitoring and Management Committee, and
- Annual Reporting

The Land Subsidence Management Plan establishes management action criteria for implementing enhanced management actions should land subsidence in any given Management Area reach certain thresholds. Four land subsidence thresholds, or "Tiers" have been established:

- Tier 1 – 0 to 1.49 ft of land subsidence
- Tier 2 – 1.5 to 1.99 ft of land subsidence
- Tier 3 – 2.0 to 2.49 ft of land subsidence
- Tier 4 – 2.5 to 2.99 ft of land subsidence.

Progressively aggressive management actions have been identified for each tier. Land subsidence in any given Management Area that exceeds the criteria, as measured semi-annually using InSAR data, triggers the management actions in the next higher tier.

4 Other Land Uses, Property Interests, and Critical Infrastructure Vulnerable to Land Subsidence in the Tule Subbasin

4.1 Gravity-Driven Water Conveyance Infrastructure

Gravity-driven water conveyance infrastructure includes canals, turnouts, recharge basins, stream channels used to convey water, pipelines, and field irrigation (see Figure 6). This infrastructure utilizes the land surface slope to maintain hydraulic head and velocity (and therefore flow capacity). Land subsidence results in changes in the slope of the land surface. Positive changes in slope (i.e. steepening of slope) may result in increased water velocities, increased pressure in pipelines, and lower hydraulic head (e.g. at turnouts). Negative changes in slope (i.e. flattening of slope) may result in decreased water velocities, lower pressure in pipelines, and higher hydraulic head (e.g. at turnouts and under bridges).

For completeness, below is a list of gravity-driven water conveyance infrastructure in the Tule Subbasin that may be vulnerable to changes in land surface slope due to subsidence:

- Regional canals including the following:
  - Friant-Kern Canal
  - Homeland Canal
- Local canals owned and operated by the following:
  - Lower Tule River Irrigation District
  - Pixley Irrigation District
  - Porterville Irrigation District
  - Various Tule River Association members (e.g. Porter Slough, Campbell-Moreland Ditch, etc.)
  - Angiola Water District
  - Alpaugh Irrigation District
- Turnouts to landowners
- Turnouts to recharge basins
- Tule River, Deer Creek, and White River channels used to convey native and imported water
- Pipelines owned and operated by the following
  - Porterville Irrigation District
  - Saucelito Irrigation District
  - Delano-Earlimart Irrigation District
  - Terra Bella Irrigation District
  - Kern-Tulare Irrigation District
  - Tea Pot Dome Irrigation District
- Field irrigation (e.g. field furrows, field flooding, etc.)

4.1.1 Analysis of Potential Impacts to Gravity Driven Water Conveyance from Land Subsidence

Changes in land surface slope or localized changes in land surface elevation have the potential to impact the flow capacity of gravity driven conveyance facilities. Groundwater flow modeling has shown that land subsidence is likely to continue through the 2020 to 2040 transition period (see Figure 3).[7] Minimum Thresholds (MTs) for land subsidence were developed based, in part, on land subsidence forecasts by the groundwater flow model for the 2020 to 2040 transition period. To assess the potential for undesirable results on gravity driven water conveyance in the Tule Subbasin if the land subsidence exceeds the minimum thresholds, TH&Co conducted the following analysis:

- The difference between the 2020 land surface elevations surveyed at the Representative Monitoring Sites (RMS; Benchmark Network) and the forecast maximum land subsidence (MTs) at the RMS was contoured in a Geographic Information System (GIS) using a kriging algorithm to produce a distribution of potential future land subsidence between 2020 and 2040 (see Figure 7).
- The 2020 land surface elevation and land surface elevation at maximum subsidence were discretized with square cells 1,650 ft on each side.
- Using the GIS slope tool, TH&Co calculated the land surface slopes for both the 2020 and MT land surface elevation conditions (see Figures 8 and 9).
- The forecast change in slope was estimated as the difference between the 2020 and MT slopes (see Figure 10).

Results of the analysis showed a projected flattening of the land surface slope along Deer Creek and west of the Friant-Kern Canal, along the Tule River west of State Highway 99, and north of Deer Creek along State Highway 43 (see Figure 10). However, changes in slope are not projected to change surface flow directions except for the area north of Deer Creek and State Highway 43, where the land surface is already relatively flat. Flattening of the surface slope at the west end of Deer Creek could change surface flow directions and flooding patterns in this area.

4.1.2 Potential for Undesirable Results on Gravity Driven Water Conveyance from Land Subsidence

The greatest potential for undesirable results related to changes in land surface slope from forecast land subsidence during the 2020 to 2040 transition period are water delivery capacity in the Homeland Canal, the ability to divert water from the western end of Deer Creek, and potential changes in the cost and ability to deliver water in conveyance pipelines. Except for the Friant-Kern Canal, no undesirable results on gravity driven conveyance have been documented from

[7] Thomas Harder & Co., 2020. Groundwater Flow Model of the Tule Subbasin. Prepared for the Tule Subbasin MOU Group. Dated January 2020.

historical land subsidence in the Tule Subbasin. Further, impacts associated from potential future changes in land surface slope are not anticipated.

4.2 Domestic, Agricultural, and Other Wells

Wells are susceptible to damage from land subsidence. Subsidence is the result of cumulative aquifer system (i.e. aquifers and aquitards) compaction at depth. As the aquifer system compacts, it causes vertical compression on the well casing, which may result in collapsing, bending, ripping, rupturing, or otherwise breaking. This can lead to a damaged and/or unusable well. Protrusion of the well casing at the land surface may also occur.

Casing compression is proportional to the thickness of compressing sediment, which varies in the Tule Subbasin spatially and with depth. In the Tule Subbasin, compression of the Lower Aquifer is greater than that of the Shallow Aquifer. Therefore, wells constructed in the Lower Aquifer are more susceptible to damage from land subsidence than wells constructed only in the Upper Aquifer.

While well casing damage from land subsidence is known to occur in wells constructed in the Tule Subbasin, details regarding the number of impacted wells and the amount of land subsidence that leads to casing damage/failure is not documented. Further, many new wells constructed in the last approximately 20 years have been designed with compression sections in their casing to accommodate the effects of land subsidence. For wells not equipped with compression sections, studies in other areas of the Central Valley of California suggest that casing damage is not common where land subsidence is less than approximately one foot.[8] Given that land subsidence has exceeded one foot throughout most of the Tule Subbasin since at least 2015 (see Figure 2), well damage from historical land subsidence is likely in wells not equipped with compression sections. Further, forecasted land subsidence for 2020 to 2040 is also estimated to exceed one foot throughout much of the subbasin, which may cause to wells not equipped to accommodate it. Potential undesirable results include the need to repair or replace damaged wells and difficulty or inability to remove pumps.

4.3 Flood Control

The historical tendency of any given area to flood during a precipitation event or prolonged period of above-normal precipitation is dependent on the land elevation of the area relative to other areas. Flooding occurs in low-lying areas. Changes in the land surface elevation and slope can impact the direction of surface water runoff and areas subject to flooding. Infrastructure built in areas protected from historical flooding or dependent on historical land/channel slopes to deliver surface water may be impacted if the slope of the land changes. The Federal Emergency Management

[8] Borchers, J.W., Gerber, M., Wiley, J., and Mitten, H., 1998. Using Down-Well Television Surveys to Evaluate Land Subsidence Damage to Water Wells in the Sacramento Valley, California.

Agency (FEMA) has published maps showing areas susceptible to flooding (see Figure 11). While these maps were updated in 2009, it is our understanding that they were based on topographic data that was outdated. As land subsidence continues to occur in the Tule Subbasin, it will be necessary to update the FEMA flood maps after land subsidence rates are minimized.

Potentially impacted flood control infrastructure includes berms/levees around the Tule River, Deer Creek, White River, smaller channels, and the Tulare Lakebed. The location and design capacity of this infrastructure are presently unknown. As described in Section 4.1.2 herein, changes in land elevation may affect some stakeholder's ability to divert water from the western end of Deer Creek. AMEC Foster Wheeler (2017) noted that potential flooding of the Tulare Lakebed is the primary concern for subsidence impacts to the California High Speed Rail (CSHR), more so than potential physical impacts to the track structure.[9]

4.4 State Highways, Railroads, Pipelines, and Bridges

State Highways, railroads, pipelines, and bridges may be susceptible to differential subsidence, should it occur. State highways in the Tule Subbasin include Highways 99, 43, 65, 190, and 155 (see Figure 12). In addition, there are 156 bridges from the National Bridge Inventory within the Tule Subbasin. Railroads in the Tule Subbasin include the Burlington-Northern Santa Fe (BNSF), Union Pacific, San Joaquin Valley Railroad, West Isle Line, and the planned California High Speed Rail (CHSR). Pipelines identified from the National Pipeline Mapping System (NPMS) include gas transmission pipelines and liquid petroleum pipelines.

Historically, there has been no reported impacts to state highways, railroads, pipelines and bridges in the Tule Subbasin attributed to land subsidence. Further, there has been no evidence of differential land subsidence that has impacted infrastructure in the subbasin.

The CHSR, which is currently under construction, is located on the western side of the Tule Subbasin (see Figure 12). AMEC (2017) conducted a detailed evaluation of potential subsidence-related impacts to the CHSR. The report identified the following potential concerns:

> Rapid and large-magnitude subsidence poses several potential concerns to the HSR, including (1) changes in slopes, vertical curvature, horizontal curvature, and twist; (2) development of fissures or compaction faults; and (3) changes in floodplains and site drainage.

AMEC Foster Wheeler (2017) noted that potential flooding of the Tulare Lakebed, which is associated with regional land subsidence, is the primary concern for subsidence impacts to the CSHR, more so than potential physical impacts to the track structure associated.

[9] AMEC Foster Wheeler, 2017. Ground Subsidence Study Report – Corcoran Subsidence Bowl, San Joaquin Valley, California. Prepared for the High Speed Rail Authority. Dated December 2017.

4.5 Wastewater Collection

Wastewater collection (i.e. sewer systems) relies on networks of gravity-driven sewers that may be susceptible to impacts from land subsidence (see Section 4.4). For completeness, cities and communities that operate wastewater collection include the following (see Figure 13):

- City of Porterville
- Terra Bella Sewer Maintenance District (SMD)
- Woodville Public Utilities District (PUD)
- Tipton Community Services District (CSD)
- Pixley PUD
- Earlimart PUD
- Richgrove CSD

Historically, there has been no reported impacts to wastewater collection systems in the Tule Subbasin attributed to land subsidence. Further, there has been no evidence or studies documenting differential land subsidence that has impacted wastewater infrastructure in the subbasin.

4.6 Other Potential Land Uses, Property Interests, and Critical Infrastructure

Other potential land uses, property interests, and critical infrastructure that could be impacted by differential land subsidence include buildings, utilities, and other facilities. Historically, there has been no reported impacts to infrastructure in the Tule Subbasin attributed to land subsidence. Further, there has been no evidence or studies documenting differential land subsidence that has impacted buildings, utilities, and other facilities in the subbasin.

5 Prioritization of Land Uses Vulnerable to Land Subsidence

The land uses, property interests, and critical infrastructure vulnerable to land subsidence were prioritized based on input from Tule Subbasin GSAs, a review of documented subsidence impacts in the Tule Subbasin, and historical and projected subsidence rates.

High priority land uses are those that are potentially impacted by regional land subsidence regardless of if there is differential land subsidence. High priority land uses include:

- Gravity-Driven Water Conveyance
  - Canals
  - Turnouts
  - Stream Channels
  - Water Delivery Pipelines
  - Basins
- Wells
- Flood Control Infrastructure

Low priority land uses are not typically impacted by regional land subsidence but are susceptible to differential land subsidence if it occurs. Based on the best available information, these land uses have not been impacted by the regional land subsidence that has historically occurred in the Tule Subbasin. The low priority land uses include:

- Highways and Bridges
- Railroads
- Other Pipelines
- Wastewater Collection
- Utilities
- Buildings

In the context of the discussion of infrastructure and land uses vulnerable to land subsidence (Sections 3 and 4 herein), undesirable results associated with the cumulative amount of land subsidence accommodated by the Minimum Thresholds, as published in each GSA's GSP (see Figure 7), are not anticipated for most of the land uses in the Tule Subbasin. In those cases where an impact is reported, it is recommended that the Tule Subbasin GSAs establish a mitigation program to address such impacts.

6 Potential for Land Subsidence After 2040

Even with achievement of sustainable groundwater conditions by 2040, it is possible that ongoing land subsidence could occur in the Tule Subbasin after 2040. This additional land subsidence would take the form of:

- Elastic aquifer compaction and rebound whereby seasonal changes in groundwater levels result in lowering and raising of the land surface as the aquifer releases or takes in water. Changes in land elevation from elastic compaction (also known as "recoverable compaction") are typically on the order of tenths of feet or less.
- Residual compaction of clays after 2040 from the lowering of groundwater levels that occurred prior to 2040. Land subsidence associated with residual compaction is inelastic (i.e. permanent) and typically results in greater amounts of subsidence relative to recoverable compaction.

The greatest potential for undesirable results from land subsidence after 2040 is residual compaction associated with a groundwater condition that was established prior to 2040. Residual compaction rates and extents are hard to predict as they depend largely on the characteristics of the subsurface sediments at any given location. Recent studies by Smith and Knight (2019)[10] and Lees et al. (2022)[11] suggest that the duration and magnitude of residual land subsidence at any given location, assuming a stable groundwater level condition, is proportional to the thickness of subsurface clay at that location. Based on studies and modeling in the Kaweah Subbasin north of Tule Subbasin, residual subsidence rates could be on the order of 0.4 to 2 in/yr (1 to 5 cm/yr) (Lees et al., 2022) and last many years after groundwater levels have stabilized.

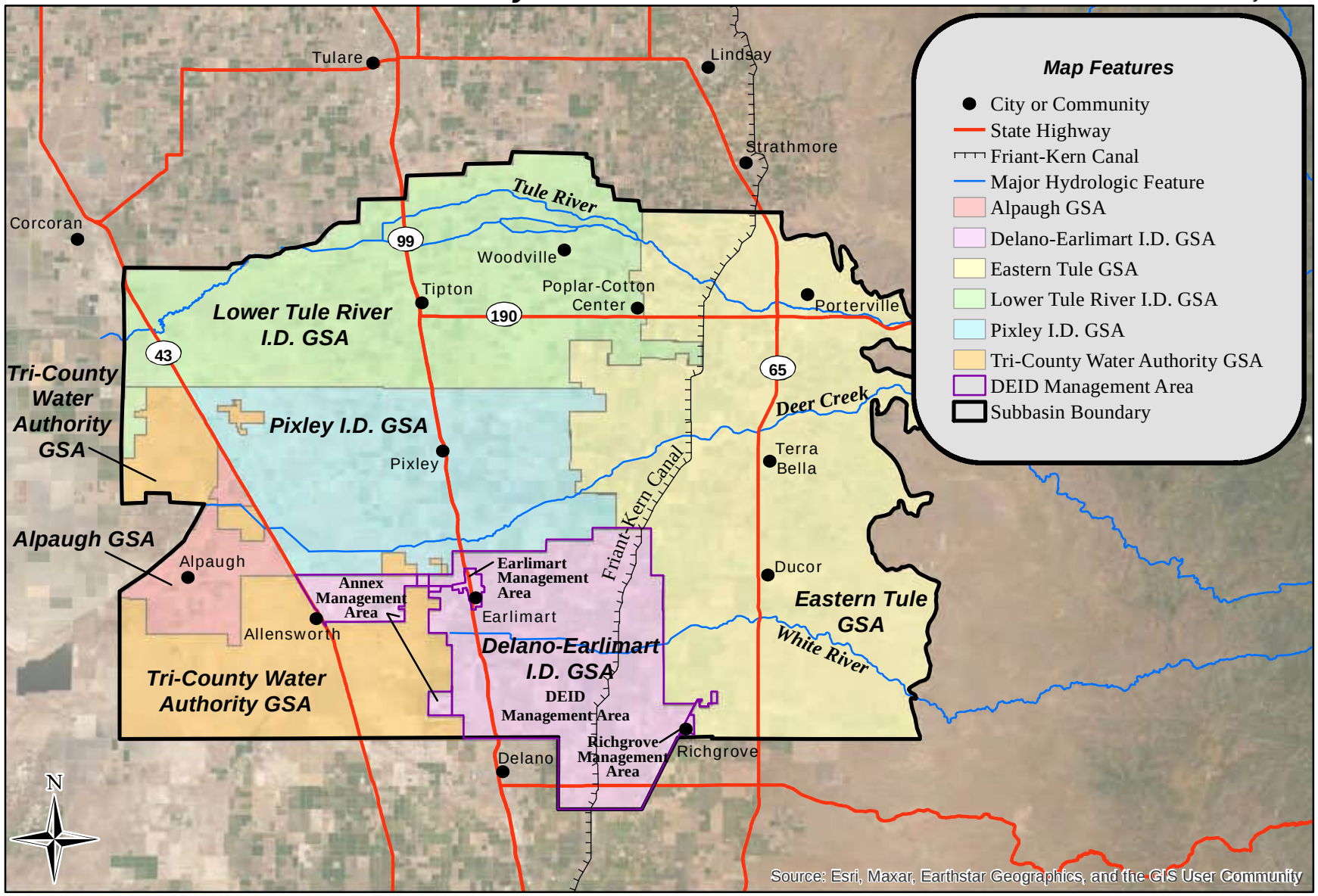
Given the uncertainty of residual compaction rates that could be expected at any given location in the Tule Subbasin after 2040, it is recommended to collect additional groundwater levels and land surface elevation data over time to establish more clearly the relationship between groundwater level changes and land subsidence in those areas of the Tule Subbasin where infrastructure and land uses are vulnerable to undesirable results. Further, construction of one or more extensometers in the areas of highest land subsidence rate is recommended to help establish the groundwater level at which land subsidence would be acceptably mitigated.

[10] Smith, R., and Knight, R., 2019. Modeling Land Subsidence Using InSAR and Airborne Electromagnetic Data. Water Resources Research, 55, 2801-2819.
[11] Lees, M., Knight, R., and Smith, R., 2022. Development and Application of a 1D Compaction Model to Understand 65 Years of Subsidence in the San Joaquin Valley. Water Resources Research, 58, e2021WR031390.

DWR Comments - Subsidence in the Tule Subbasin

July 2022

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

0 2.5 5 10 Miles

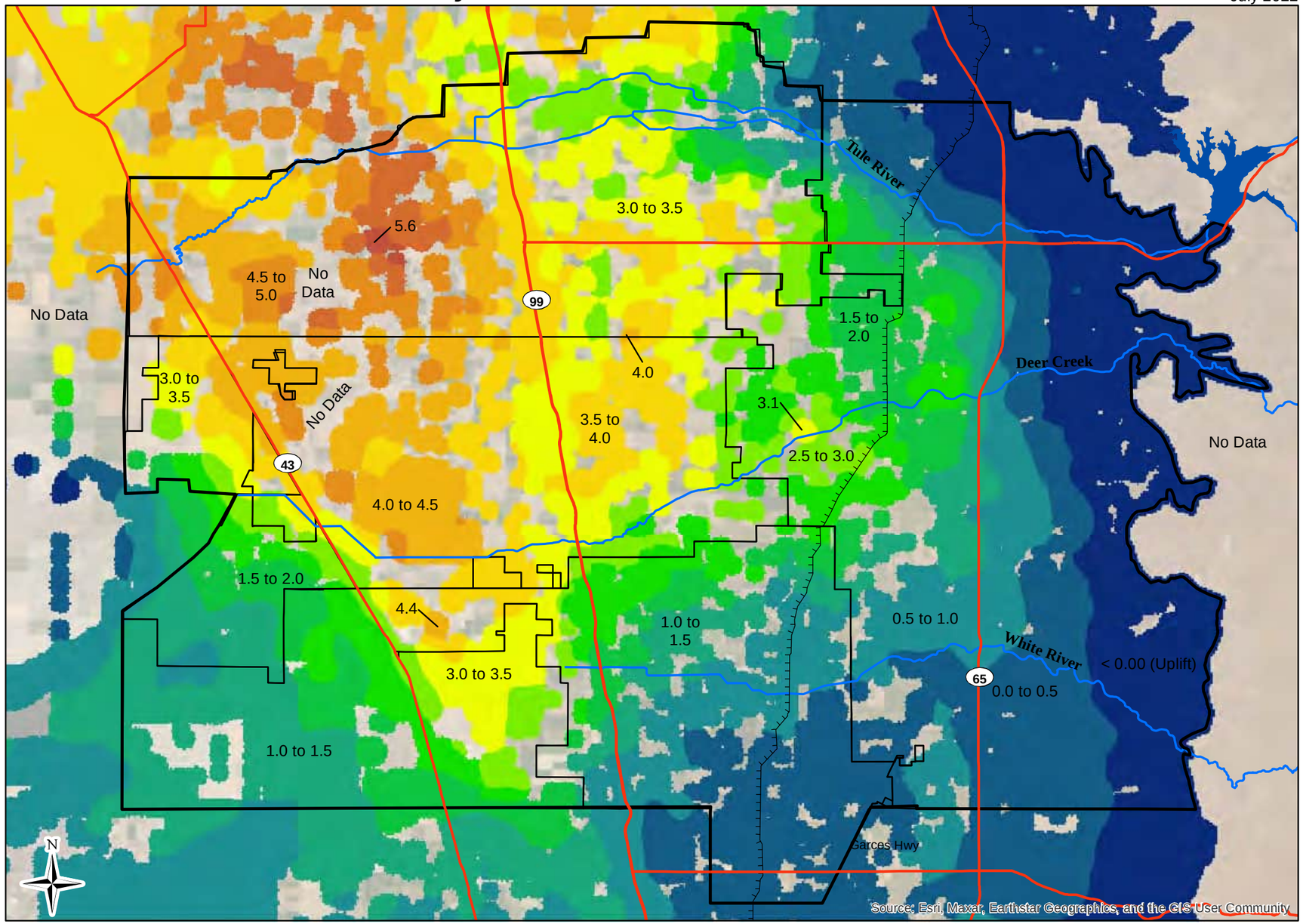
NAD 83 State Plane Zone 4

GSA Boundaries

Figure 1

Tule Subbasin Technical Advisory Committee

July 2022



DWR Comments - Subsidence in the Tule Subbasin

Map Features

Subsidence (ft)

- 5.5 to 6.0
- 5.0 to 5.5
- 4.5 to 5.0
- 4.0 to 4.5
- 3.5 to 4.0
- 3.0 to 3.5
- 2.5 to 3.0
- 2.0 to 2.5
- 1.5 to 2.0
- 1.0 to 1.5
- 0.5 to 1.0
- 0.0 to 0.5
- < 0.0 (Uplift)
- State Highway
- Friant-Kern Canal
- Major Hydrologic Feature
- GSA Boundary
- Subbasin Boundary

Thomas Harder & Co.
Groundwater Consulting

0 2 4 8 Miles

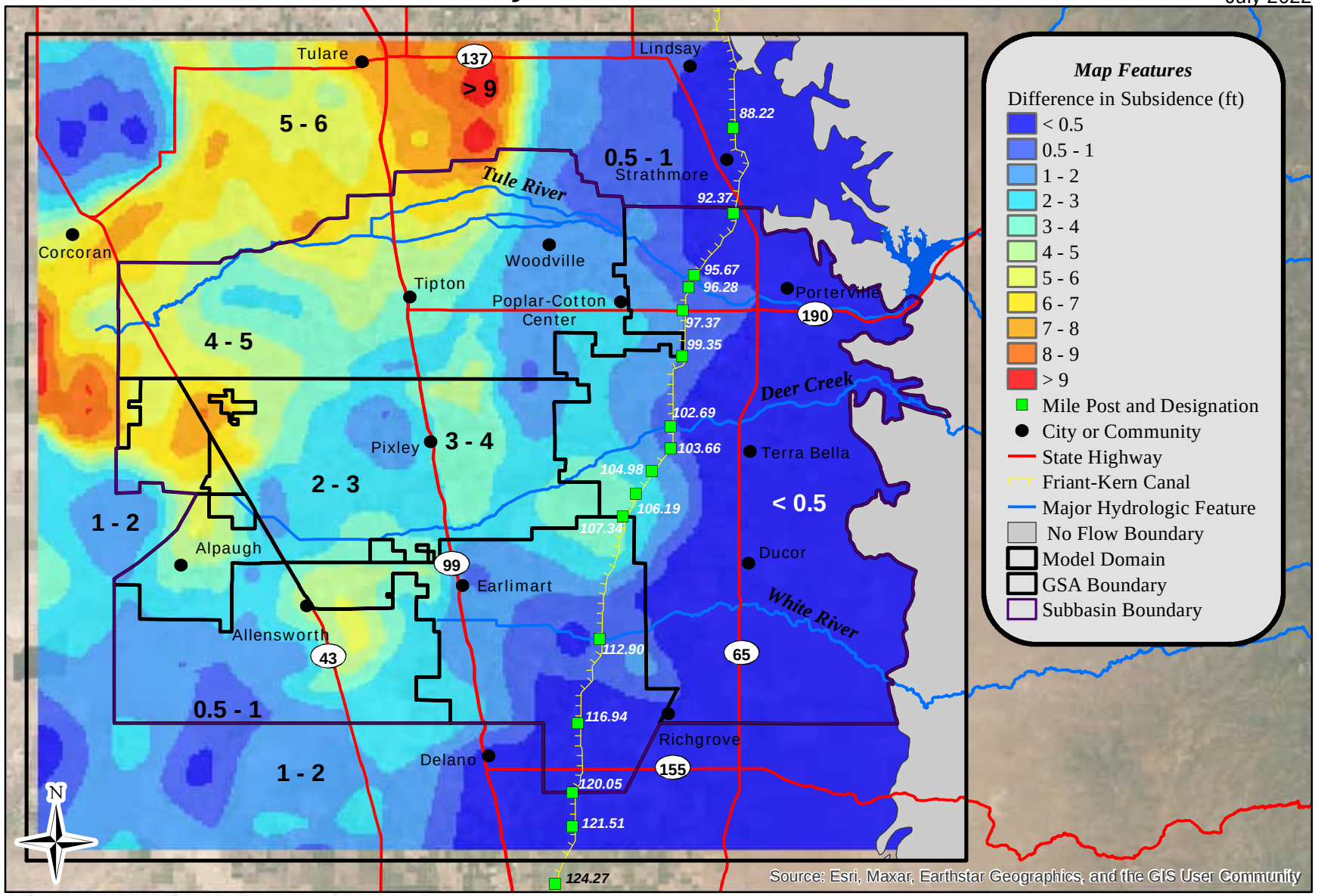
NAD 83 State Plane Zone 4

InSAR data from:
https://gis.water.ca.gov/arcgisimg/rest/services/SAR/Vertical_Displacement_TRE_ALTAMIRA_Total_Since_20150613_20211001/ImageServer

Land Subsidence June 2015 to September 2021

Figure 2

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

0 2.5 5 10 Miles

NAD 83 State Plane Zone 4

Note: This map shows the difference in subsidence from September 30, 2019 to September 30, 2039.

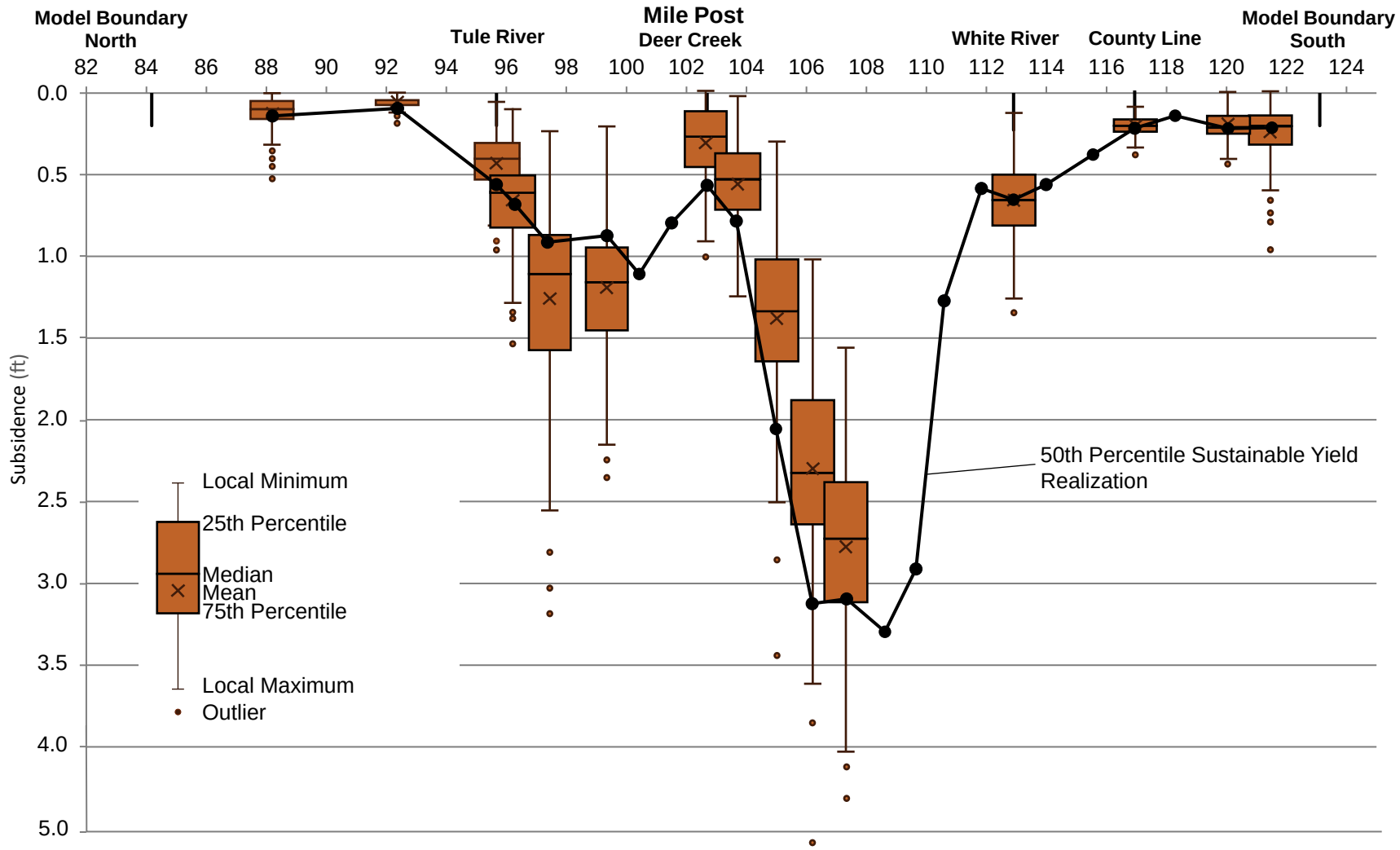
Cumulative Land Subsidence in the Tule Subbasin from 2020 to 2040

Figure 3

From Thomas Harder & Co., 2020. Groundwater Flow Model of the Tule Subbasin. Prepared for the Tule Subbasin MOU Group.

Figure 4

Model-Predicted Cumulative Land Subsidence Along Friant-Kern Canal From 2020 through 2040

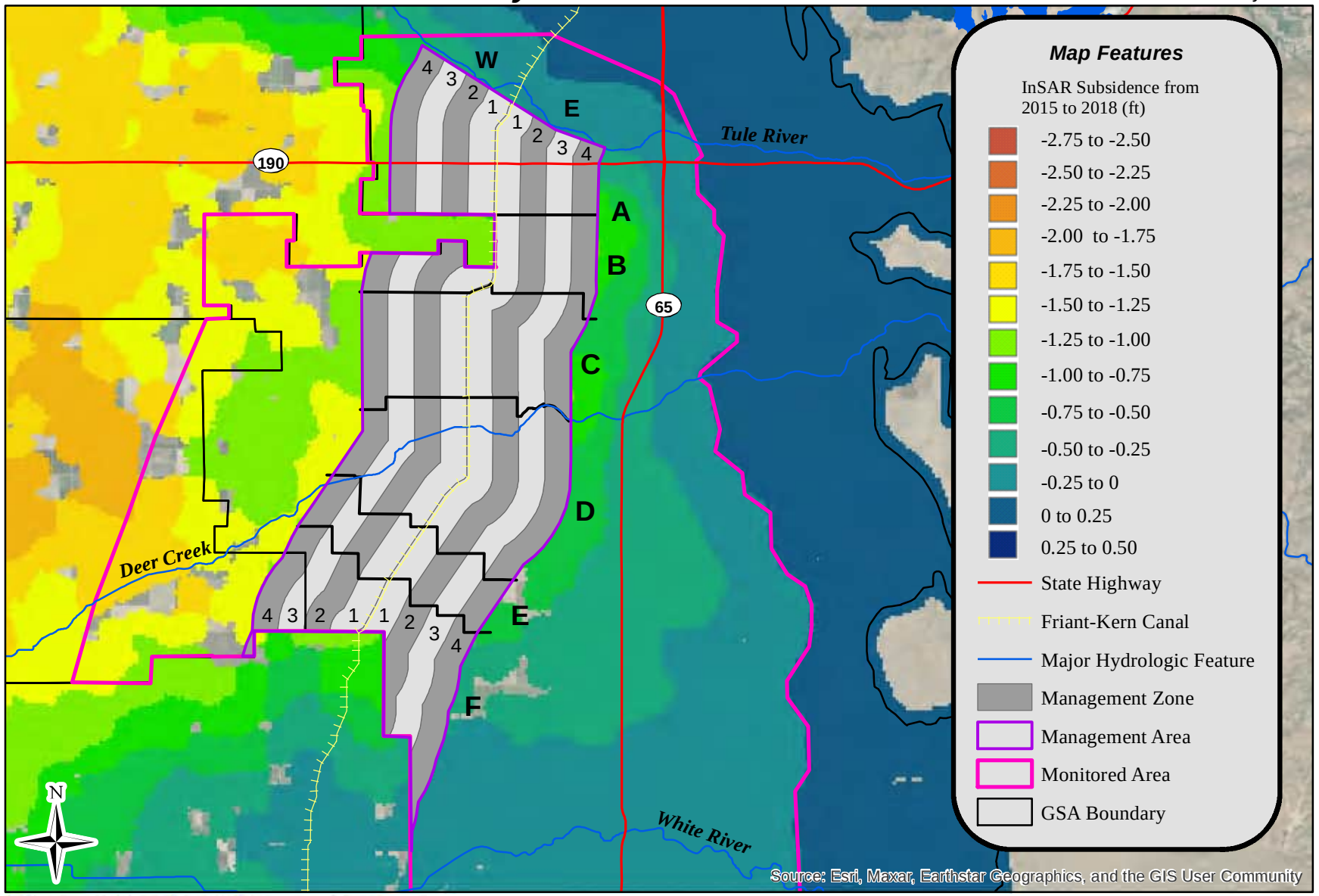


Thomas Harder & Co.
Groundwater Consulting

Note: From Thomas Harder & Co., 2020. Groundwater Flow Model of the Tule Subbasin. Prepared for the Tule Subbasin MOU Group.

DWR Comments - Subsidence in the Tule Subbasin
July 2022

Tule Subbasin Technical Advisory Committee



Thomas Harder & Co.
Groundwater Consulting

0 0.5 1 2 3 4 Miles

NAD 83 State Plane Zone 4

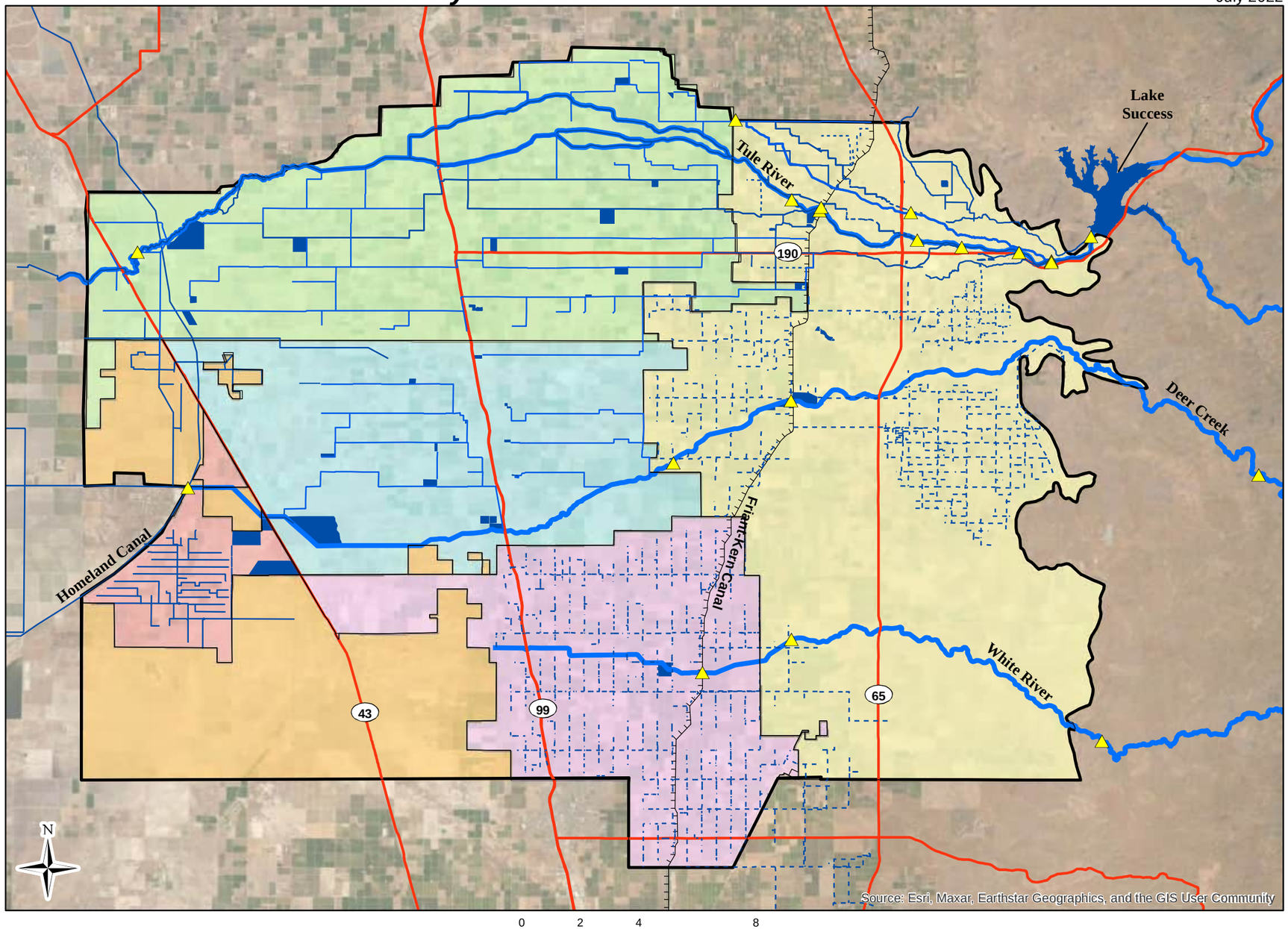
ETGSA Land Subsidence Managed Area with Management Subzones

Figure 5

Tule Subbasin Technical Advisory Committee

July 2022

DWR Comments - Subsidence in the Tule Subbasin



0 2 4 8 Miles

NAD 83 State Plane Zone 4

Map Features

- Gaging Location/Surface Water Diversion
- Canal
- Pipe
- State Highway
- Friant-Kern Canal
- Major Hydrologic Feature
- Artificial Recharge Basin
- Alpaugh GSA
- Delano-Earlimart I.D. GSA
- Eastern Tule GSA
- Lower Tule River I.D. GSA
- Pixley I.D. GSA
- Tri-County Water Authority GSA
- Subbasin Boundary

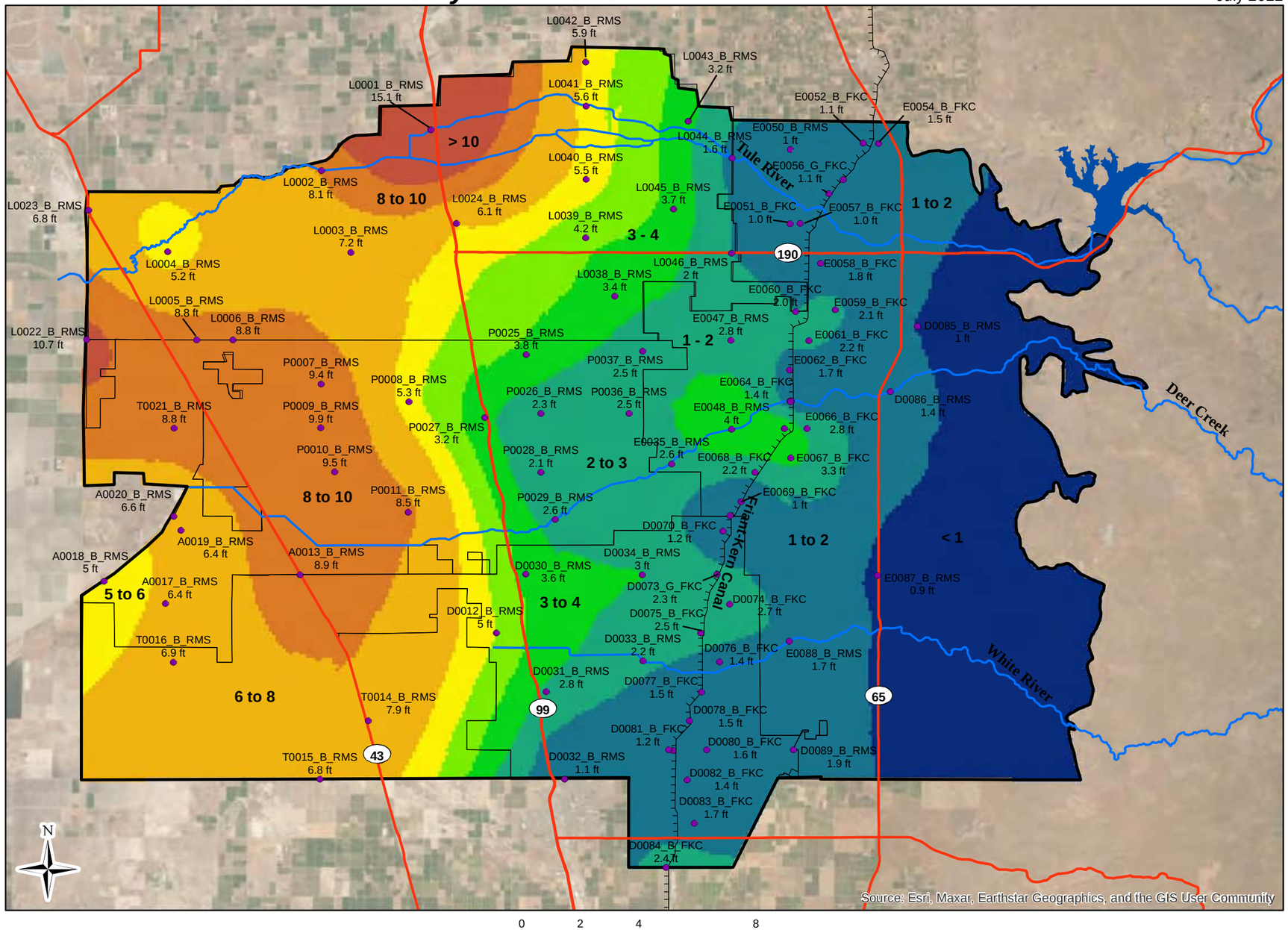
Thomas Harder & Co.
Groundwater Consulting

Gravity-Driven Water Conveyance Infrastructure

Figure 6

Tule Subbasin Technical Advisory Committee

July 2022



0 2 4 8 Miles

NAD 83 State Plane Zone 4

Thomas Harder & Co.
Groundwater Consulting

DWR Comments - Subsidence in the Tule Subbasin

Map Features

Minimum Threshold (ft)

- < 1
- 1 to 2
- 2 to 3
- 3 to 4
- 4 to 5
- 5 to 6
- 6 to 8
- 8 to 10
- > 10

Minimum Threshold at RMS (ft)

State Highway

Friant-Kern Canal

Major Hydrologic Feature

GSA Boundary

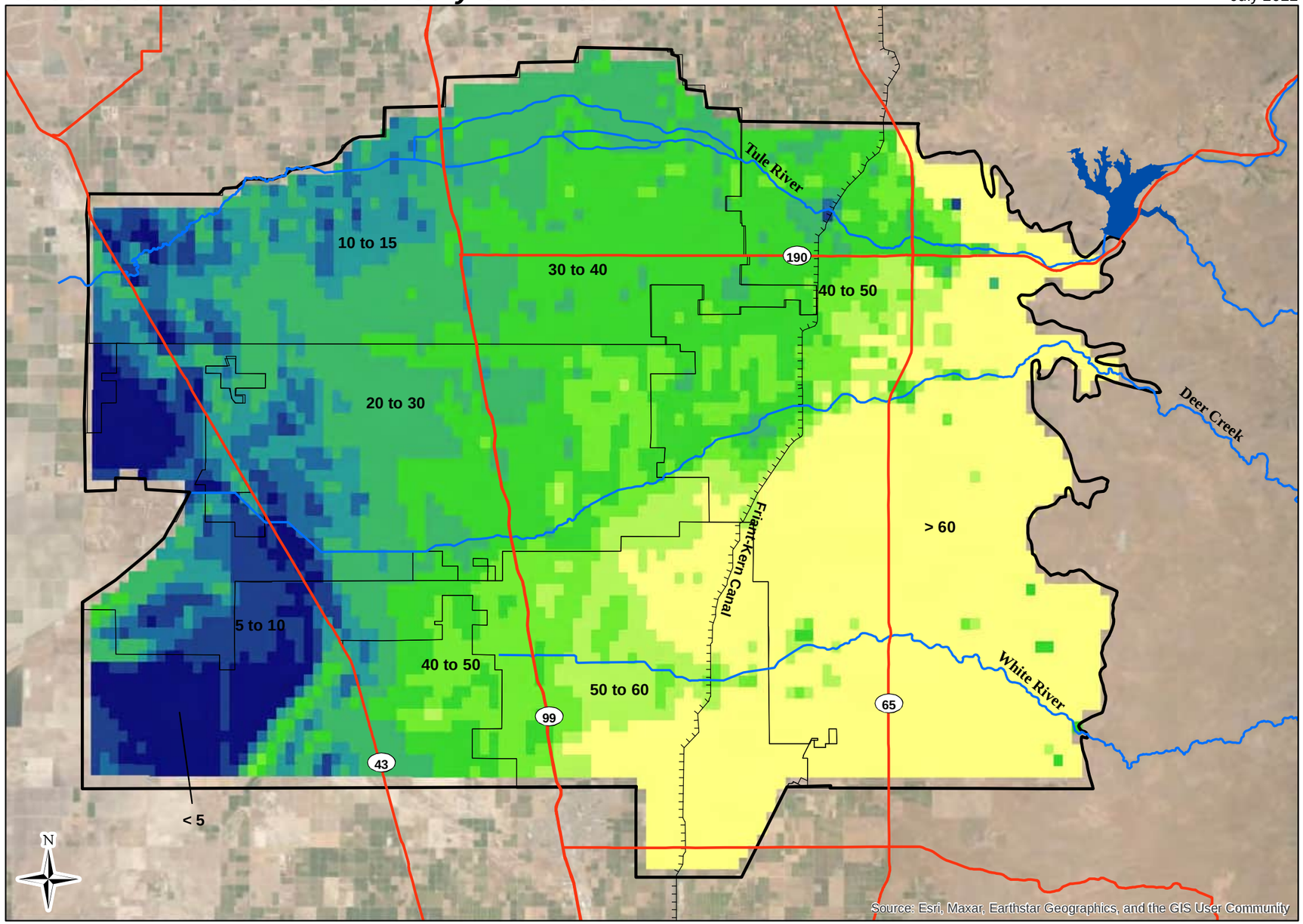
Subbasin Boundary

Minimum Threshold - Subsidence

Figure 7

Tule Subbasin Technical Advisory Committee

July 2022



0 2 4 8 Miles

NAD 83 State Plane Zone 4

Map Features

Slope (ft per mile)

- < 5
- 5 to 10
- 10 to 15
- 15 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- > 60
- State Highway
- Friant-Kern Canal
- Major Hydrologic Feature
- GSA Boundary
- Subbasin Boundary

Note: This map shows estimated land surface slope in 2020 based on the USGS DEM and 2020 benchmark elevations.

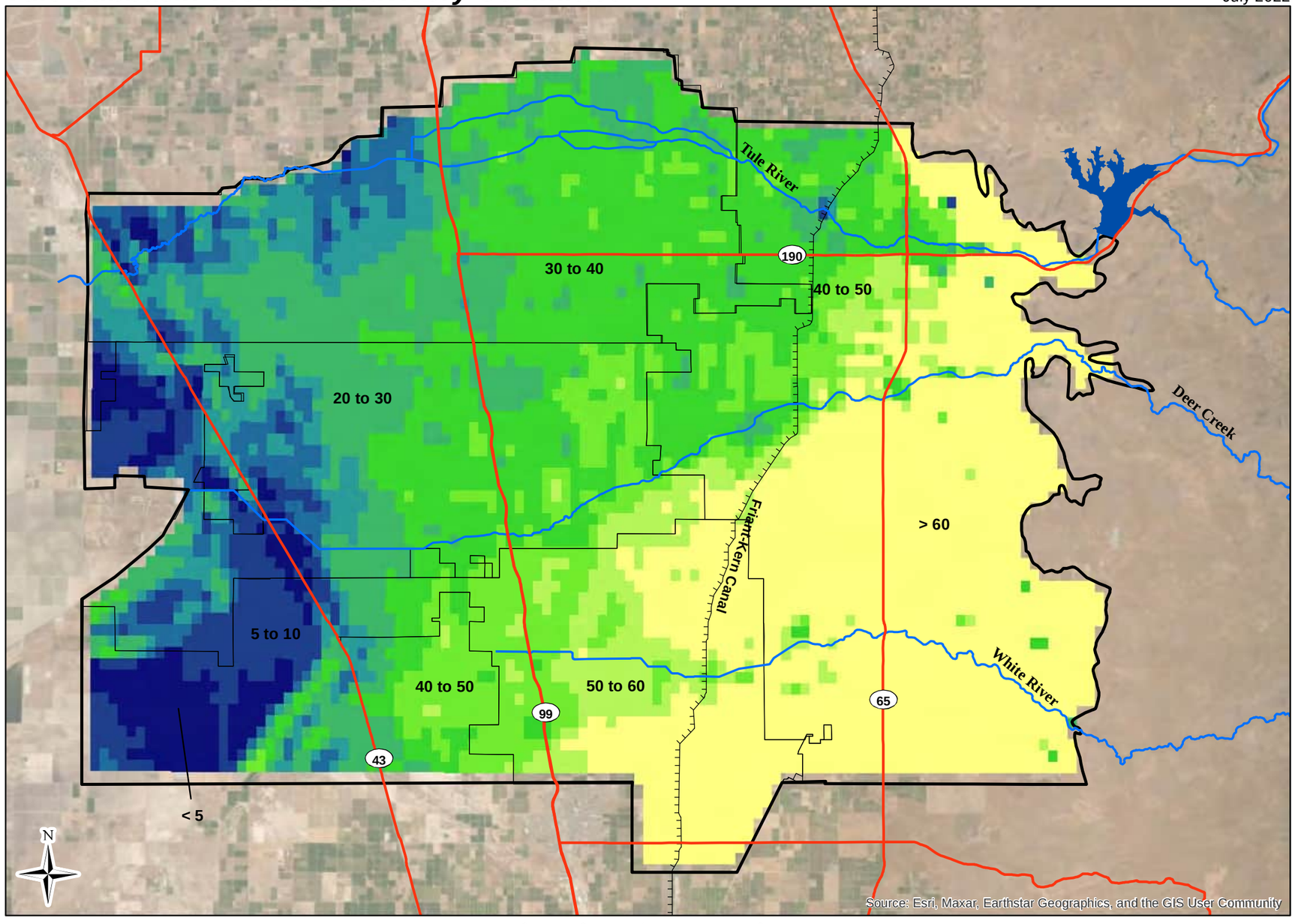
Thomas Harder & Co.
Groundwater Consulting

Estimated 2020 Land Surface Slope

Figure 8

Tule Subbasin Technical Advisory Committee

July 2022



0 2 4 8 Miles

NAD 83 State Plane Zone 4

Map Features

Slope (ft per mile)

- < 5
- 5 to 10
- 10 to 15
- 15 to 20
- 20 to 30
- 30 to 40
- 40 to 50
- 50 to 60
- > 60
- State Highway
- Friant-Kern Canal
- Major Hydrologic Feature
- GSA Boundary
- Subbasin Boundary

Note: This map shows predicted land surface slope if subsidence reaches minimum thresholds.

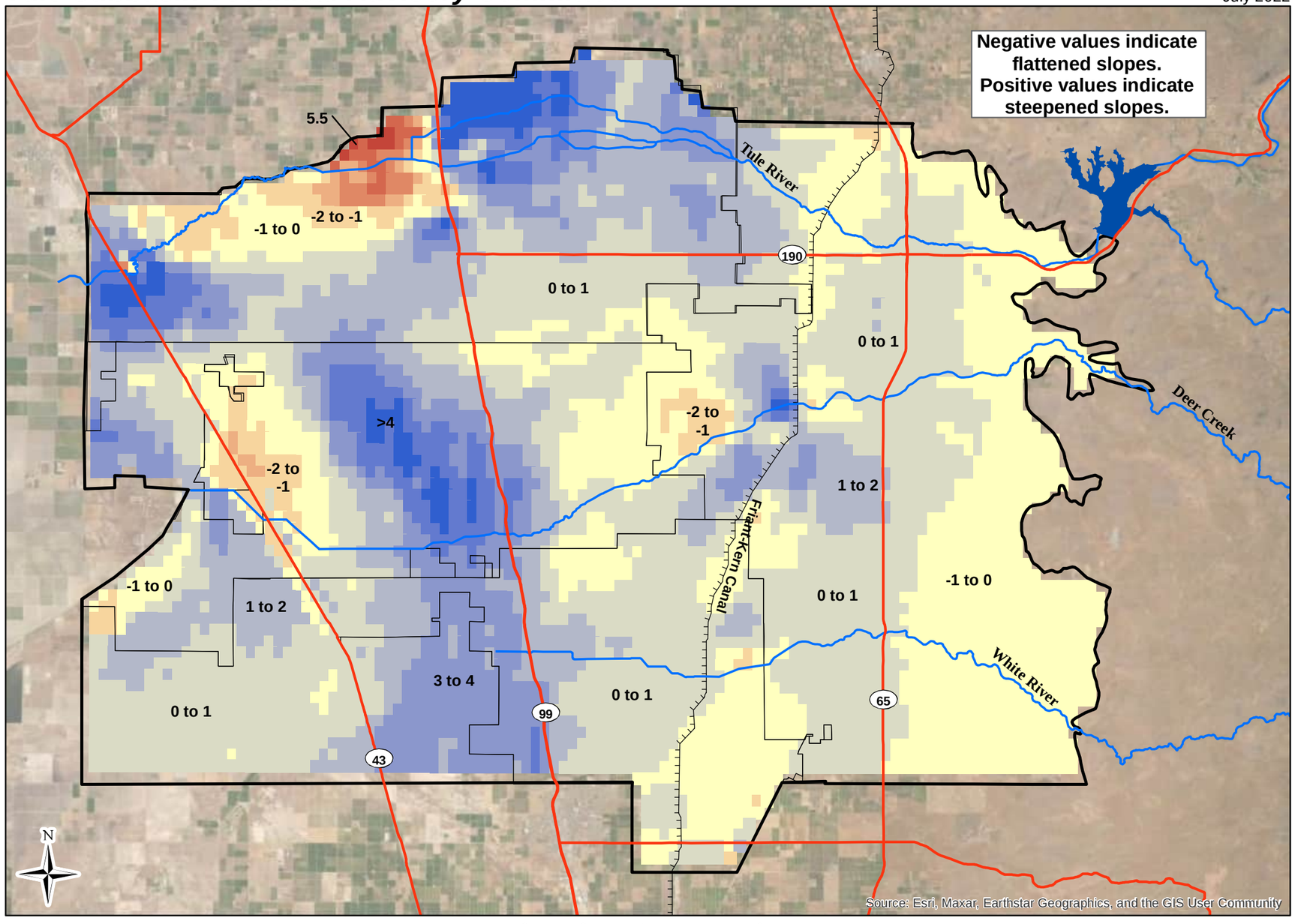
Estimated Land Surface Slope at Subsidence Minimum Thresholds

Figure 9

Thomas Harder & Co.
Groundwater Consulting

Tule Subbasin Technical Advisory Committee

July 2022



0 2 4 8 Miles

NAD 83 State Plane Zone 4

Thomas Harder & Co.
Groundwater Consulting

DWR Comments - Subsidence in the Tule Subbasin

Map Features

Change in Slope (ft per mile)

- < -5
- -5 to -4
- -4 to -3
- -3 to 2
- -2 to -1
- -1 to 0
- 0 to 1
- 1 to 2
- 2 to 3
- 3 to 4
- > 4

- State Highway
- Friant-Kern Canal
- Major Hydrologic Feature
- GSA Boundary
- Subbasin Boundary

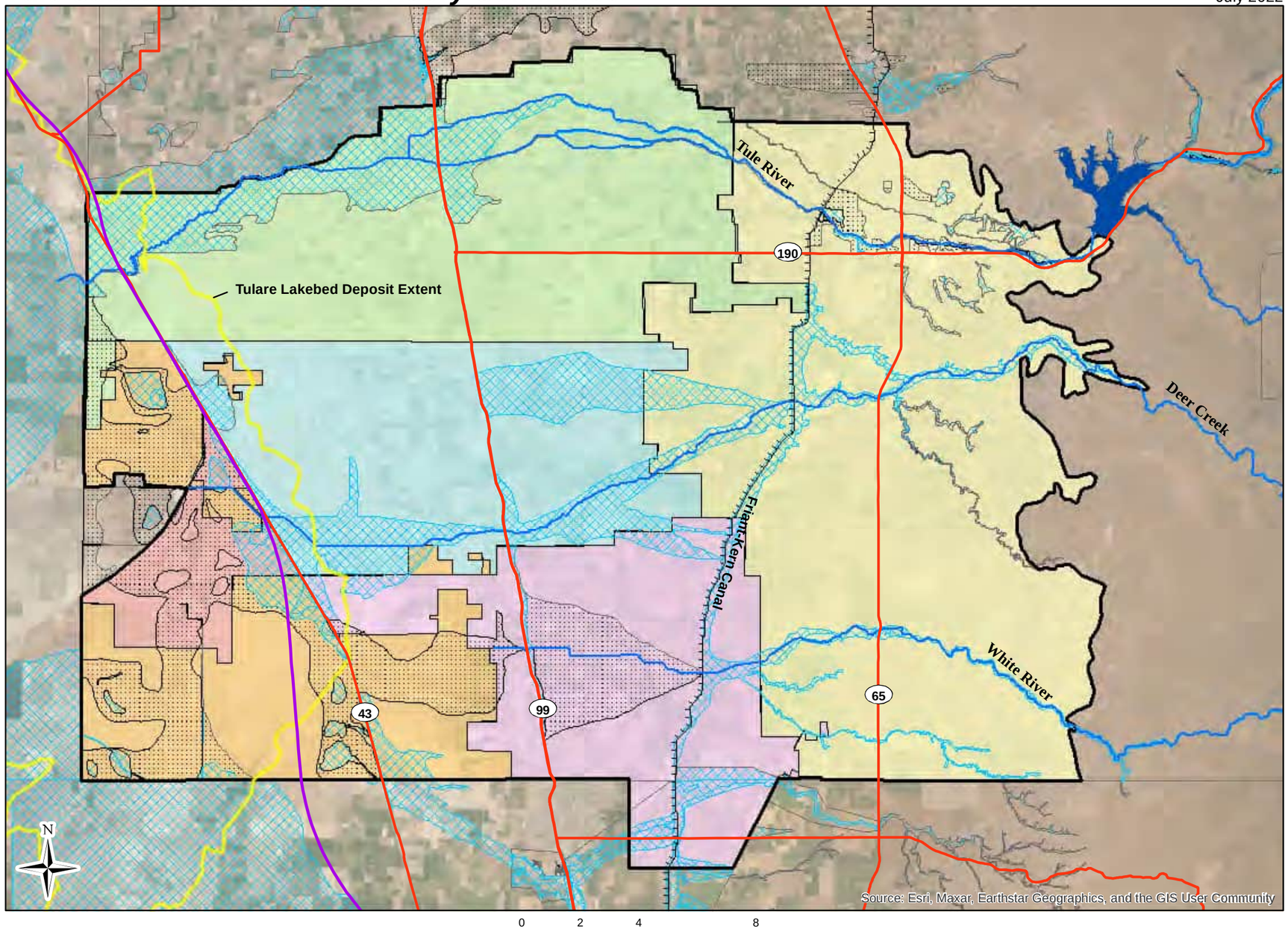
Note: This map shows estimated change in land surface slope at the subsidence minimum thresholds relative to 2020 conditions.

Estimated Change in Land Surface Slope

Figure 10

Tule Subbasin Technical Advisory Committee

July 2022



0 2 4 8 Miles

NAD 83 State Plane Zone 4

Thomas Harder & Co.
Groundwater Consulting

DWR Comments - Subsidence in the Tule Subbasin

Map Features

Simplified FEMA Flood Hazard Area*

- 1% Annual Chance Flood Area
- 0.2% Annual Chance Flood Area
- Outside 0.2% Chance Flood Area
- Tulare Lakebed Deposit Extent
- California High Speed Rail
- State Highway
- Friant-Kern Canal
- Major Hydrologic Feature
- Alpaugh GSA
- Delano-Earlimart I.D. GSA
- Eastern Tule GSA
- Lower Tule River I.D. GSA
- Pixley I.D. GSA
- Tri-County Water Authority GSA
- Subbasin Boundary

*Simplified data shown for illustrative purposes only. Not official National Flood Insurance Program (NFIP) reference.

Data modified from County Federal Emergency Management Agency (FEMA) maps.
https://www.fema.gov/flood-maps/national-flood-hazard-layer

Lake Deposits from California Geological Survey
Geologic Atlas of California Map No. 002
1:250,000 scale, Compiled by A.R. Smith, 1964
and Geologic Atlas of California Map No. 005,
1:250,000 scale, Compiled by: R.A. Matthews and J.L. Burnett

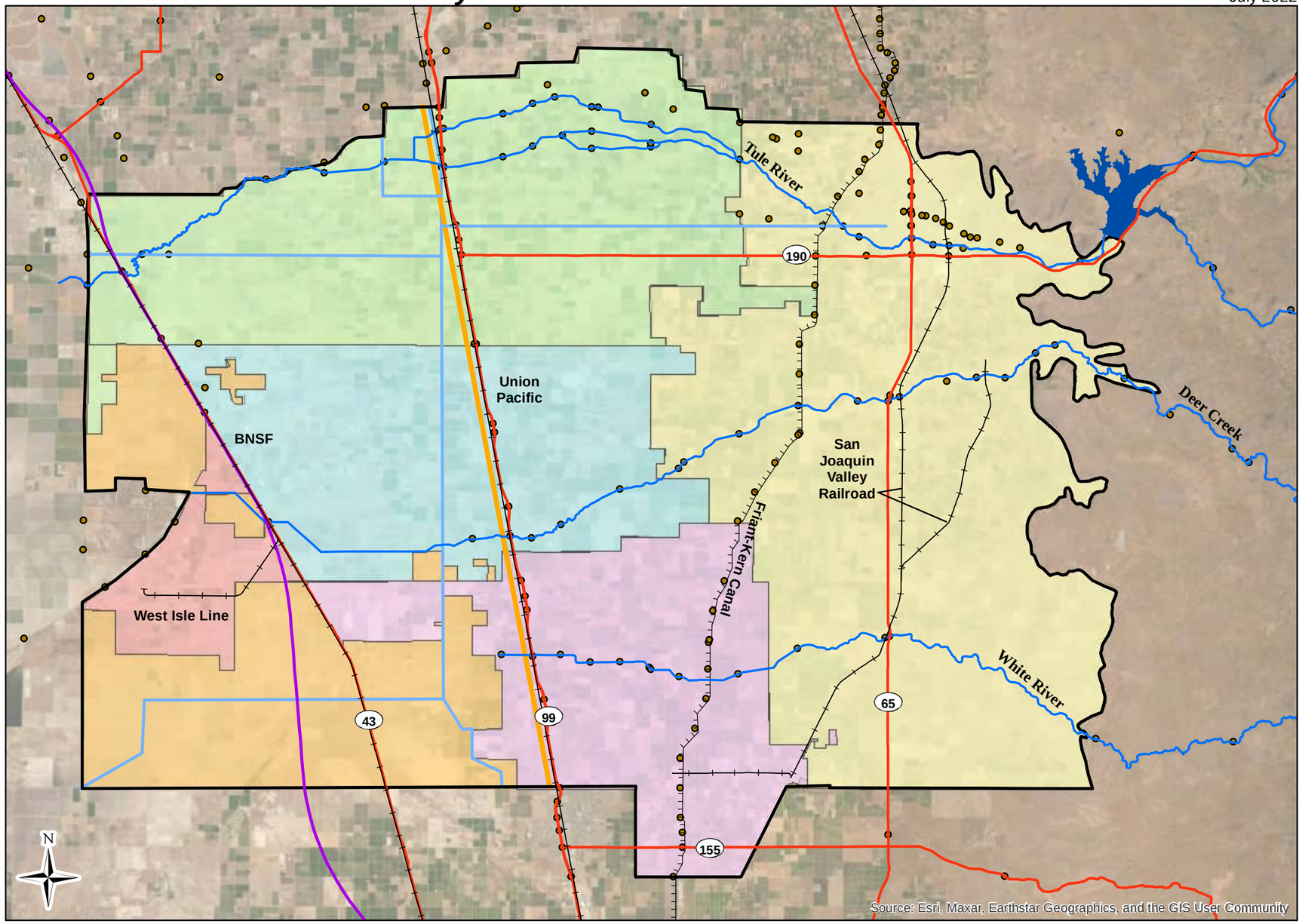
Simplified FEMA Flood Hazard Areas

Figure 11

DWR Comments - Subsidence in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

July 2022



NAD 83 State Plane Zone 4

Map Features

- Local Bridge
- Railroad
- California High Speed Rail
- Gas Transmission Pipeline
- Hazardous Liquid Pipeline
- State Highway
- Friant-Kern Canal
- Major Hydrologic Feature
- Alpaugh GSA
- Delano-Earlimart I.D. GSA
- Eastern Tule GSA
- Lower Tule River I.D. GSA
- Pixley I.D. GSA
- Tri-County Water Authority GSA
- Subbasin Boundary

Railroads from Caltrans.

Bridges from the US Department of Transportation, National Bridge Inventory.

Pipelines from the National Pipeline Mapping System (NPMS). Data shown for illustrative purposes only. https://pvnpms.phmsa.dot.gov/PublicViewer/

Thomas Harder & Co.
Groundwater Consulting

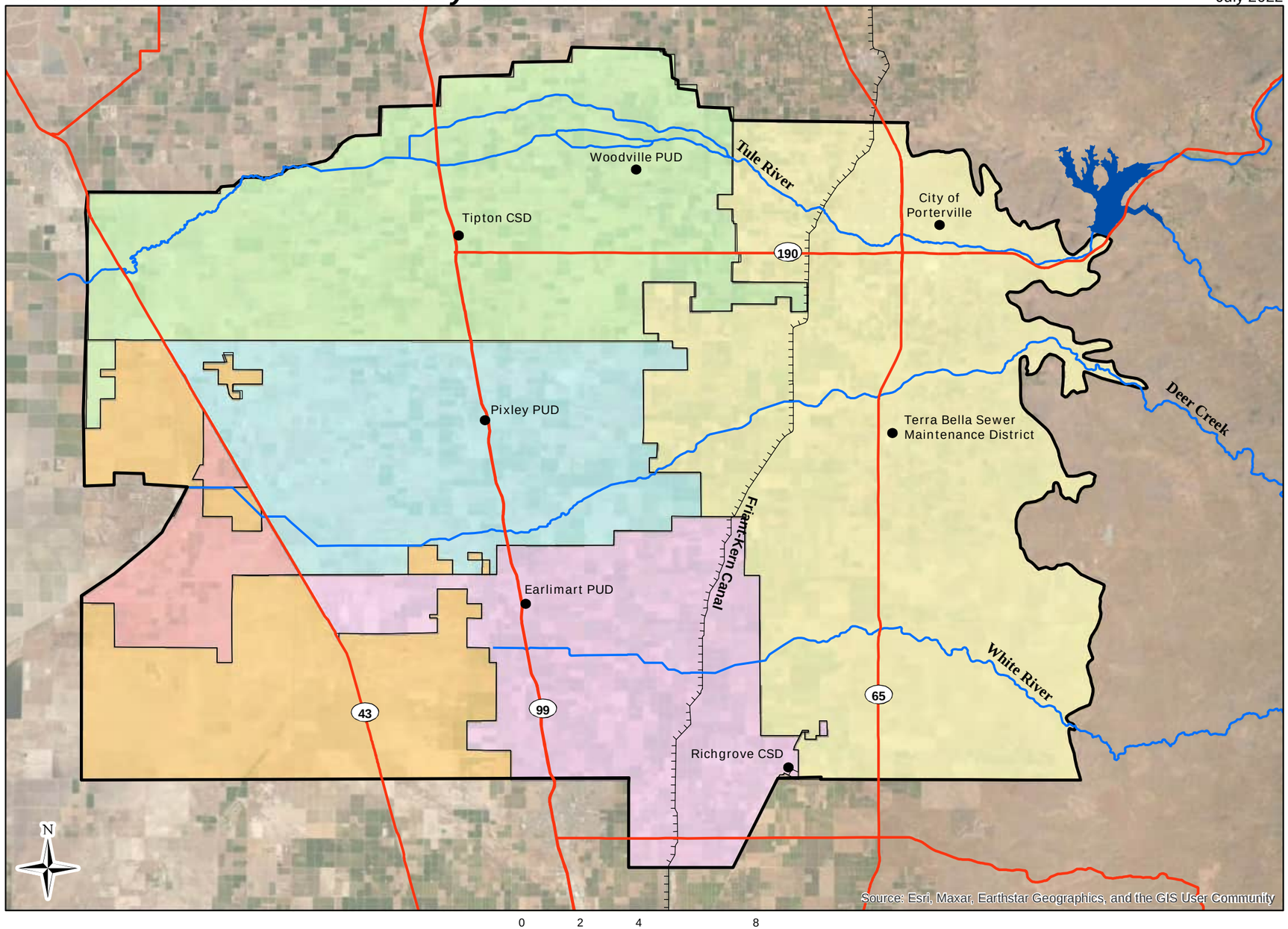
State Highways, Railroads, Pipelines, and Bridges

Figure 12

Tule Subbasin Technical Advisory Committee

July 2022

DWR Comments - Subsidence in the Tule Subbasin



Map Features

- City or Community with Wastewater Collection
- State Highway
- Friant-Kern Canal
- Major Hydrologic Feature
- Alpaugh GSA
- Delano-Earlimart I.D. GSA
- Eastern Tule GSA
- Lower Tule River I.D. GSA
- Pixley I.D. GSA
- Tri-County Water Authority GSA
- Subbasin Boundary

Wastewater Collection

Thomas Harder & Co.
Groundwater Consulting

Figure 13

MITIGATION PROGRAM FRAMEWORK
COORDINATION AGREEMENT ATTACHMENT 7
Framework for GSA Mitigation Programs to Address
Groundwater Levels, Land Subsidence and Groundwater Quality Impacts

Introduction

Sustainable management criteria identified in each of the Tule Subbasin Groundwater Sustainability Agencies' (GSAs) Groundwater Sustainability Plans (GSPs) have been developed to address significant and unreasonable impacts to agricultural, municipal, and industrial beneficial uses of groundwater. However, analysis based on available data suggests that numerous shallow domestic wells and potentially other wells may be impacted during the Sustainable Groundwater Management Act (SGMA) GSP implementation period between 2020 and 2040 as a result of continued lowering of groundwater levels during this period. Wells, land use, property, and infrastructure may also be impacted from land subsidence and changes in groundwater quality during this period.

The Tule Subbasin GSAs agree to each individually implement a Mitigation Program (Program) as needed to offset impacts associated with GSP-allowed activities, subject to the following framework and subject to the schedule provided herein. The goal of this framework is to establish a standard for mitigation programs to be implemented by each GSA for the purpose of mitigating anticipated impacts to beneficial uses to a level that avoids the occurrence of an Undesirable Result.

Each Mitigation Program may be extended or revised based on groundwater conditions in the future.

Mitigation Program Framework

The Subbasin has been in overdraft for many years, resulting in a significant lowering of regional and local groundwater levels. The GSPs are designed for the Subbasin to reach sustainability by 2040 and beyond. However, until sustainability is reached, some level of continued groundwater level decline and land subsidence is expected in areas of the Subbasin while the GSAs are in the process of implementing projects and management actions to achieve sustainability by 2040. The purpose of the GSAs' Mitigation Programs is to mitigate those wells, critical infrastructure, and land uses that are adversely affected by declining groundwater levels, land subsidence, and changes to groundwater quality while the GSAs reach sustainability.

Each GSA shall include a Program as a project or management action identified in that GSA's GSP, describing the following elements:

a) Identification of Impacts to be Addressed by Mitigation Program

Each Tule Subbasin GSA will adopt and implement a Mitigation Program to identify the specific needs for mitigation caused by pumping within the GSA's boundaries. Each GSA Mitigation

Program will separately identify the impacts to beneficial uses that the Program is intended to address. Each GSA Mitigation Program must provide a claim process to address impacts to (i) domestic and municipal wells, (ii) agricultural wells, and (iii) critical infrastructure. Decisions to include or exclude impacted users from participation in a GSA's Mitigation Program shall be supported by appropriate written technical data and analysis.

b) Process

For claims of impact to wells related to groundwater level declines, the process to be adopted by each GSA's Mitigation Program may include:

1) an application process by the well owner;
2) data collection by the GSA to verify the claim;
3) identification of suitable mitigation; and/or
4) response to said affected user.

For claims of impact to land uses from land subsidence, the process may include:

1) an application process by the affected party;
2) data collection by the GSA to verify the claim;
3) identification of suitable mitigation; and/or
4) coordination, as necessary, with said affected parties to implement the mitigation.

For claims of impact to groundwater quality that is attributable to pumping allowed by a GSA/GSP, the process may include:

1) an application process by the affected party;
2) data collection by the GSA to verify the claim;
3) identification of suitable mitigation; and/or
4) coordination, as necessary, with said affected parties to implement the mitigation.

SGMA requires GSAs and GSPs to measure sustainability from 2015 forward. As a result, GSAs do not necessarily need to provide mitigation for impacts that occurred prior to January 1, 2015.

For those claims that are shown not to be related to GSP-/GSA-approved or authorized activities, the GSA will, to the extent possible, provide assistance to the affected party to identify programs for addressing their issue.

c) *Investigation*

Once a claim of adverse impact has been made to a GSA, whether it be for well, specific land use, critical infrastructure or groundwater quality issue(s), the GSA will investigate the claim.

d) *Qualifications for Mitigation*

GSAs may determine whether to provide full or partial mitigation based on a user's compliance with the GSA's GSP, Rules & Regulations, and other laws or regulations. For example, a user whose own pumping has caused or contributed to overdraft or damage to their own well may not qualify for mitigation under the Program. Further, mitigation will be applied only to those claims that are shown to be attributable to GSP-/GSA-approved or authorized activities. Each GSA's Program will also address how claims that a GSA determines are caused by pumping outside the GSA's boundaries will be addressed.

e) *Mitigation*

Once a claim of impact has been confirmed to be due to GSP-/GSA-approved or authorized activities, the GSA will identify suitable mitigation to alleviate the impact.

For groundwater level impacts, this could be any of the following:

1) Deepening the well;
2) Constructing a new well;
3) Modifying pump equipment;
4) Providing temporary or permanent replacement water;
5) Coordinating consolidation of the domestic well owner with existing water systems; or
6) With the consent of the affected user, providing other acceptable means of mitigation.

For land use impacts, this could be any of the following:

1) Repair to canals, turnouts, stream channels, water delivery pipelines, and basins;
2) Repair to damaged wells;
3) Addressing flood control;
4) Addressing other damaged infrastructure; or
5) With the consent of the affected user, providing other acceptable means of mitigation.

For groundwater quality impacts (due to groundwater management/actions), this could be any of the following:

1) Adjusting groundwater pumping locations, rates, or schedules;
2) Modifying project operations;
3) Providing temporary or permanent replacement water;
4) Coordinating consolidation with existing water systems; or
5) With the consent of the affected user, providing other acceptable means of mitigation.

Various factors may reflect the proper mitigation methods for the specific issue. For example, age, location, financial impact to the beneficial user as a result of mitigation, and the beneficial user may reflect which mitigation measures are chosen by a particular GSA.

f) *Outreach*

Public outreach and education will be separately performed during development of the Mitigation Program and prior to implementation by each GSA.

Prior to implementation, extensive outreach will be needed to notify landowners of each GSA's Program requirements and how they can apply for assistance. Outreach may need to be performed in multiple languages as appropriate for each particular GSA. Outreach methods could include workshops, mailings, flyers, website postings, Board meeting announcements, etc.

g) Program Adoption Schedule

Each GSA will formulate and implement a mitigation claims process for domestic and municipal use impacts by December 31, 2022 and complete all other aspects of the Mitigation Program by June 30, 2023. During Program development, the GSAs will conduct community outreach and refer landowners and others to available local programs as well as other resources and funding programs from the County, State, or non-profit organizations, including the Tule Basin Water Foundation.

h) Mitigation Program Funding Source

Each GSA will develop a funding mechanism for the Program, which is dependent on the specific GSA needs for specific expected impacted wells, critical infrastructure, and land uses within each GSA. Funding is anticipated to be available for each GSA's Mitigation Program through implementation of assessments, fees, charges, and penalties. In addition, the GSAs will explore grant funding. The State has many existing grant programs for community water systems and well construction funding. County, state, and federal assistance will be needed to successfully implement the respective Mitigation Programs. Each GSA may, separately or in coordination with other GSAs, also work with local NGOs that may be able to provide assistance or seek grant monies to help fund the Program. GSAs may act individually or collectively to address and fund mitigation measures.

Appendix C
Netafim Cost Data

Feasibiltiy Cost Study for SDI on Alfalfa
System Components - Percentage of cost

CATEGORY	SUB-CATEGORY	% of TOTAL	TOTAL/ACRE	TOTAL / 80 ACRES	TOTAL/300 ACRES
Pump 50 hp centrifigal	1200 GPM finite flow	12%	$ 315.00	$ 25,200.00	$ 94,500.00
Filter 6 ea. 48" sand media	Mild steel epoxy lined 200 GPM ea	21%	$ 560.00	$ 44,800.00	$ 168,000.00
Main Valve PSNO	for better filter flushing efficacy	2%	$ 45.00	$ 3,600.00	$ 13,500.00
Flow Meter		2%	$ 50.00	$ 4,000.00	$ 15,000.00
Full Automation w/Single Net	Filter flushing + valve operation	6%	$ 150.00	$ 12,000.00	$ 45,000.00
Chemigation	Fert and Chem injection platform	6%	$ 150.00	$ 12,000.00	$ 45,000.00
Mainline,Valves & Air Vents		10%	$ 250.00	$ 20,000.00	$ 75,000.00
Sub-Mains, Flush Manifolds, Risers		6%	$ 150.00	$ 12,000.00	$ 45,000.00
Drip Lines 40" Spacing	TYP875 13.5 0.18GPH 18.00IN	19%	$ 500.00	$ 40,000.00	$ 150,000.00
System Installation		11%	$ 300.00	$ 24,000.00	$ 90,000.00
Electrical and Misc. Labor		3%	$ 75.00	$ 6,000.00	$ 22,500.00
Trenching and Backfilling		3%	$ 75.00	$ 6,000.00	$ 22,500.00
TOTALS		100%	$ 2,620.00	$ 209,600.00	$ 786,000.00

Case: 80 acre, 4 set .07 app rate

	yr 1	yr 2	yr 3
		Cost/acre	
Dripline Maintenance materials @ 1.5 ppm = $15.20/ac/f 3.5 ac/ft/yr	$ 53.20	$ 53.20	$ 53.20
Irrigation Labor @ $15/hr (45 irrigations 4 times)	$ 33.75	$ 33.75	$ 33.75
Mainline/Valves/Dripline fixes (Labor)			
Yr. 1	$ 27.10		
yr. 2		$ 19.44	
yr. 3			$ 12.35
Rodent Control (Labor)			
Yr. 1	$ 15.85		
yr. 2		$ 11.55	
yr. 3			$ 8.75
	$ 129.90	$ 117.94	$ 108.05