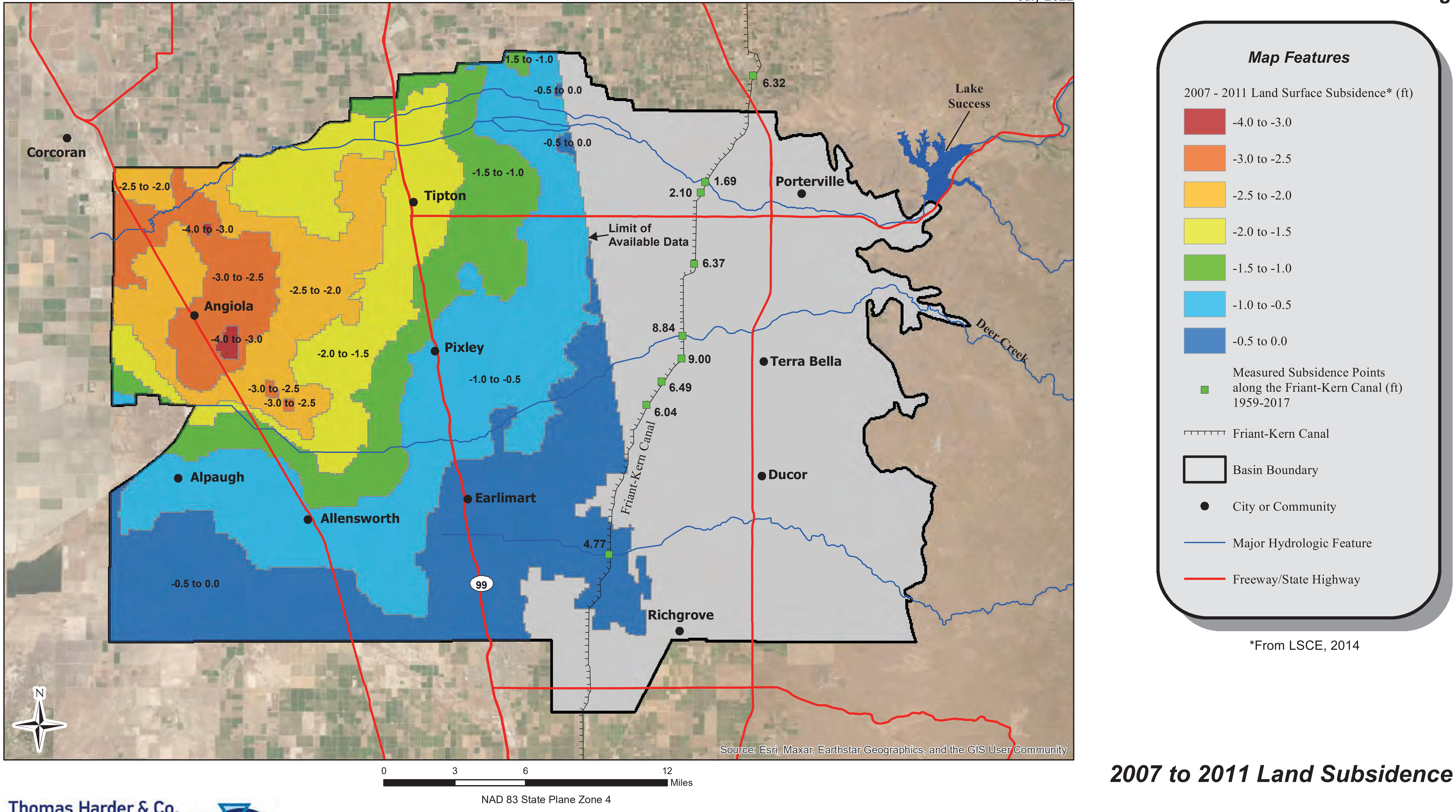
Tule Subbasin

July 2022



*From LSCE, 2014

2007 to 2011 Land Subsidence

Figure 2-24

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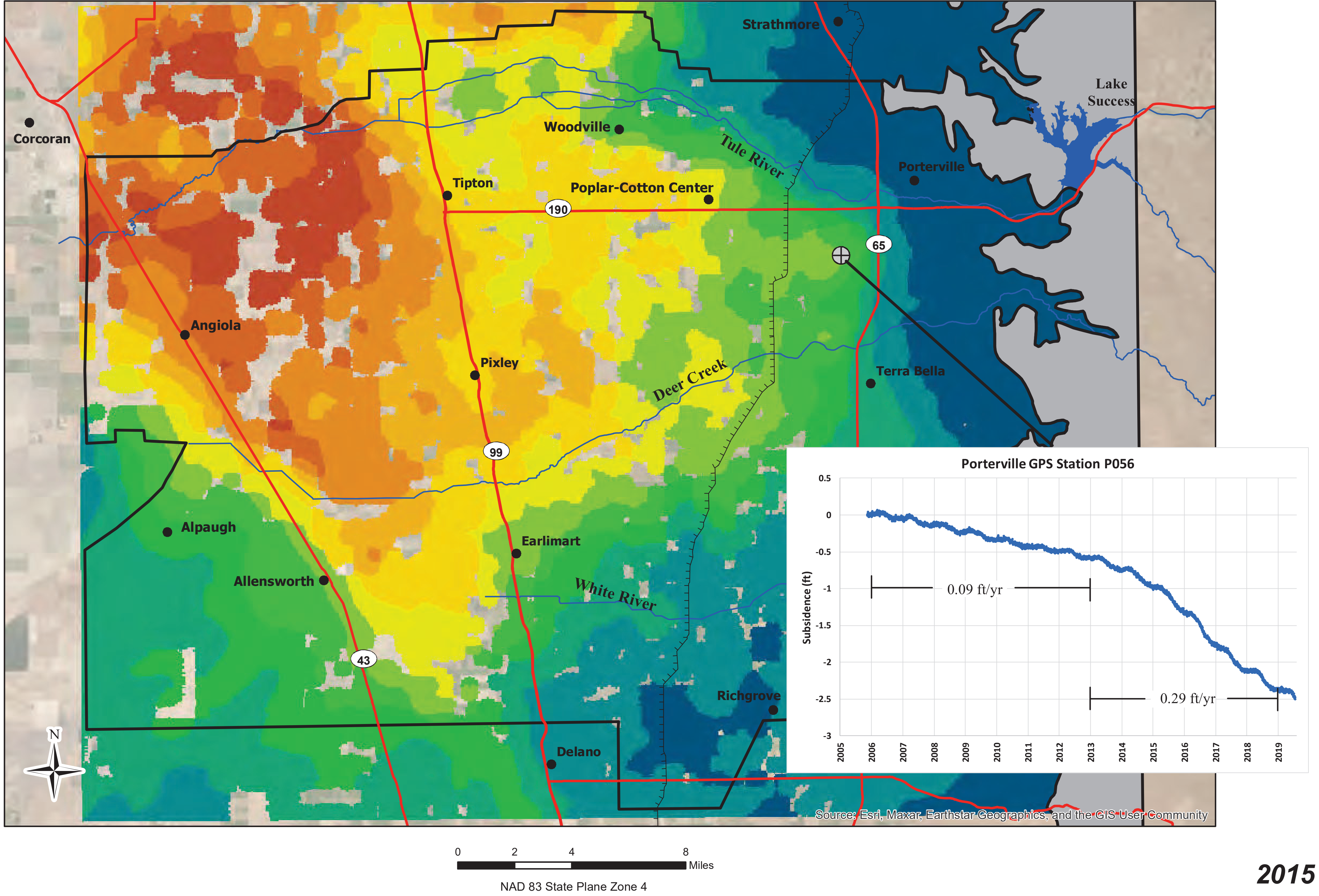
Tule Subbasin

July 2022



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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

┬┬┬┬┬┬┬	Friant-Kern Canal
▨	No Flow Boundary
☐	Basin Boundary
●	City or Community
—	Major Hydrologic Feature
—	State Highway/Major Road

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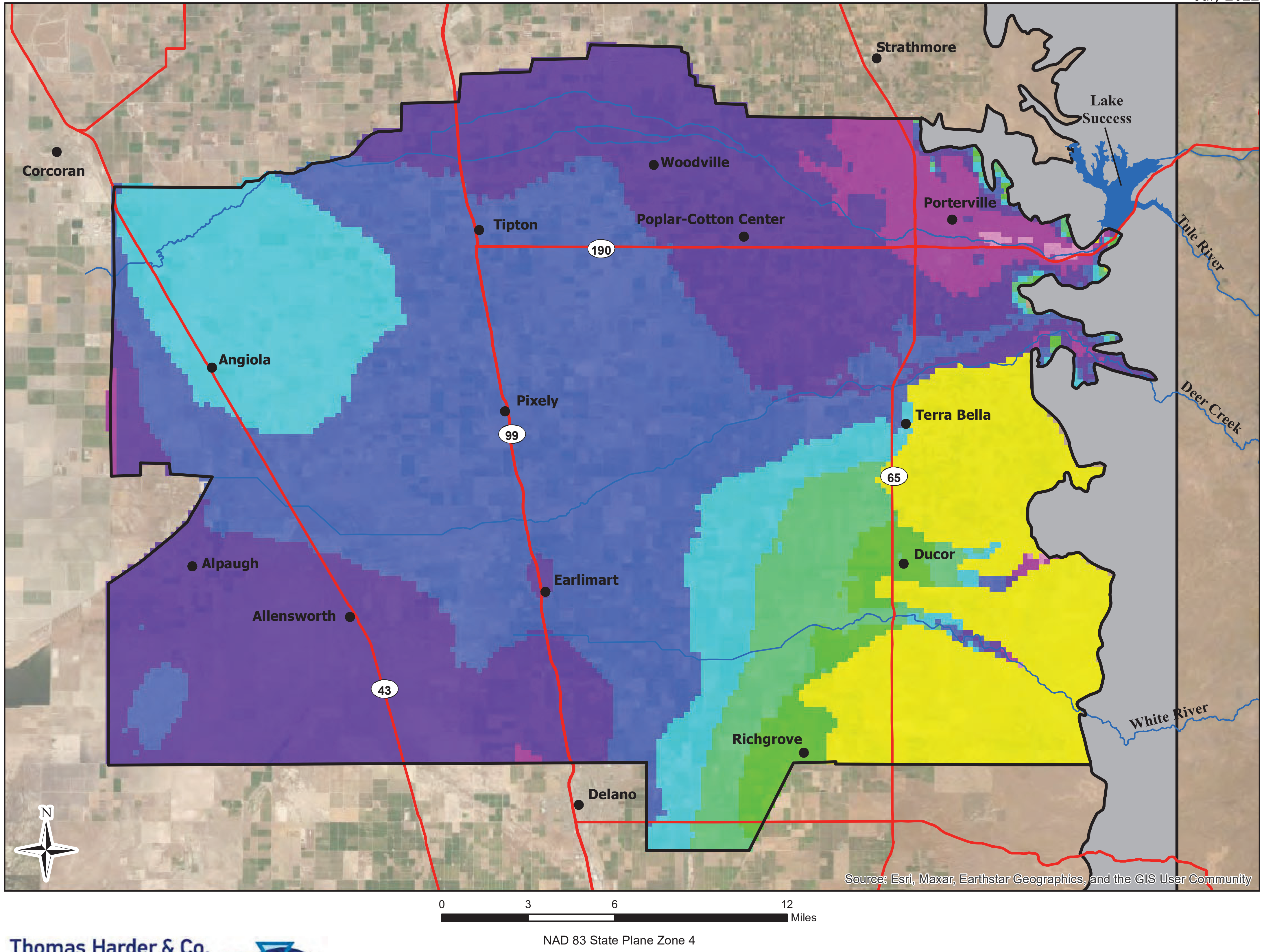
2015 to 2018 Land Subsidence

Figure 2-25

Tule Subbasin

July 2022



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

NAD 83 State Plane Zone 4

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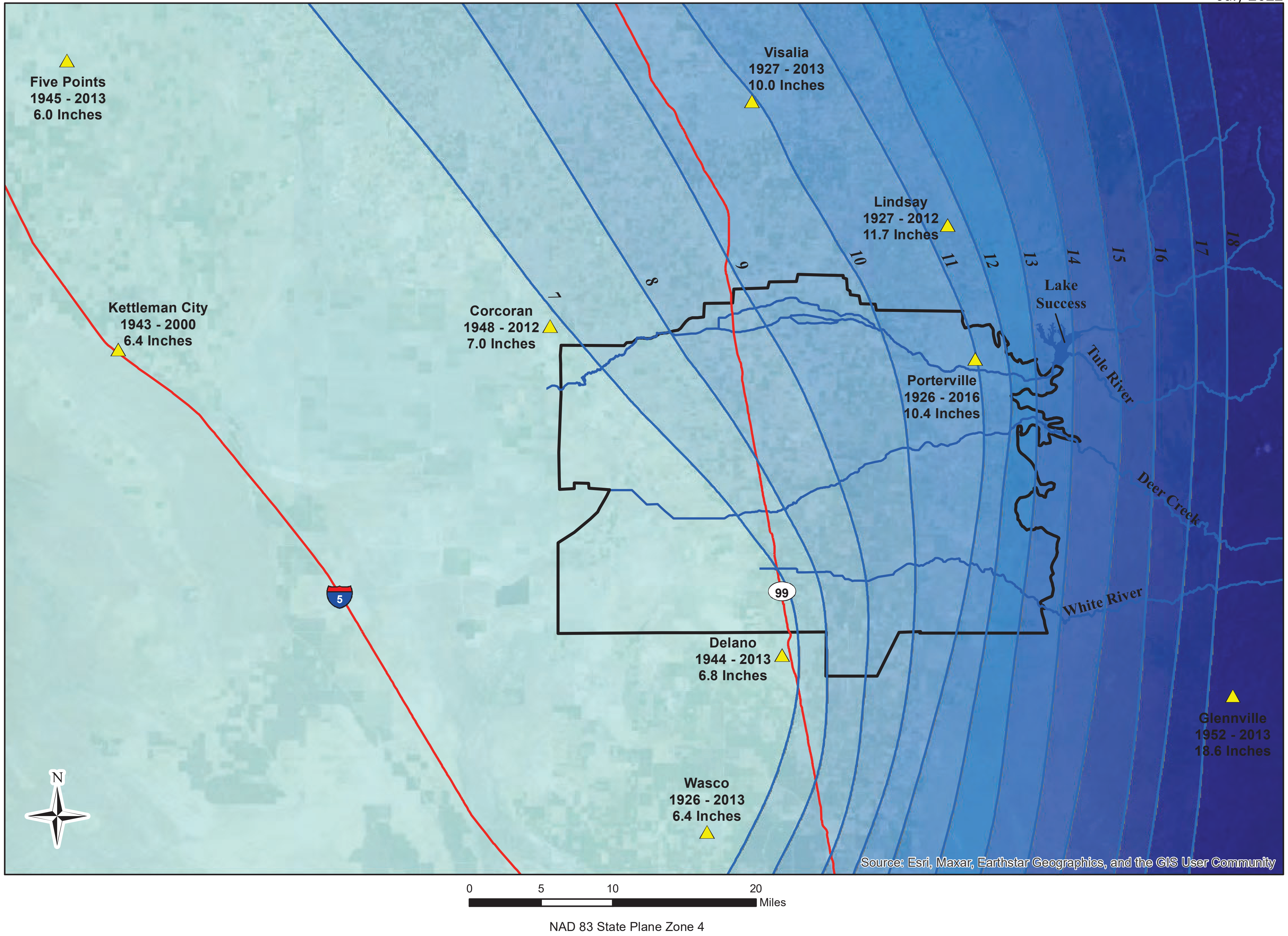
Depth to Groundwater
Upper Aquifer - January 2015

Figure 2-26

Tule Subbasin

July 2022



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Map Features

Lindsay
1927 - 2012
11.7 Inches
△ Precipitation Station, Period of Record, and Average Annual Precipitation

Average Annual Precipitation Inches Per Year

☐ Basin Boundary

Major Hydrologic Feature

Freeway/State Highway

Notes: Precipitation station data from Western Regional Climate Center (www.wrcc.dri.edu) and California Irrigation Management Information System.

Isohyetal data from Average Annual Precipitation Zones from the California Department of Forestry and Fire Protection (1998). Data for 1900 through 1960.

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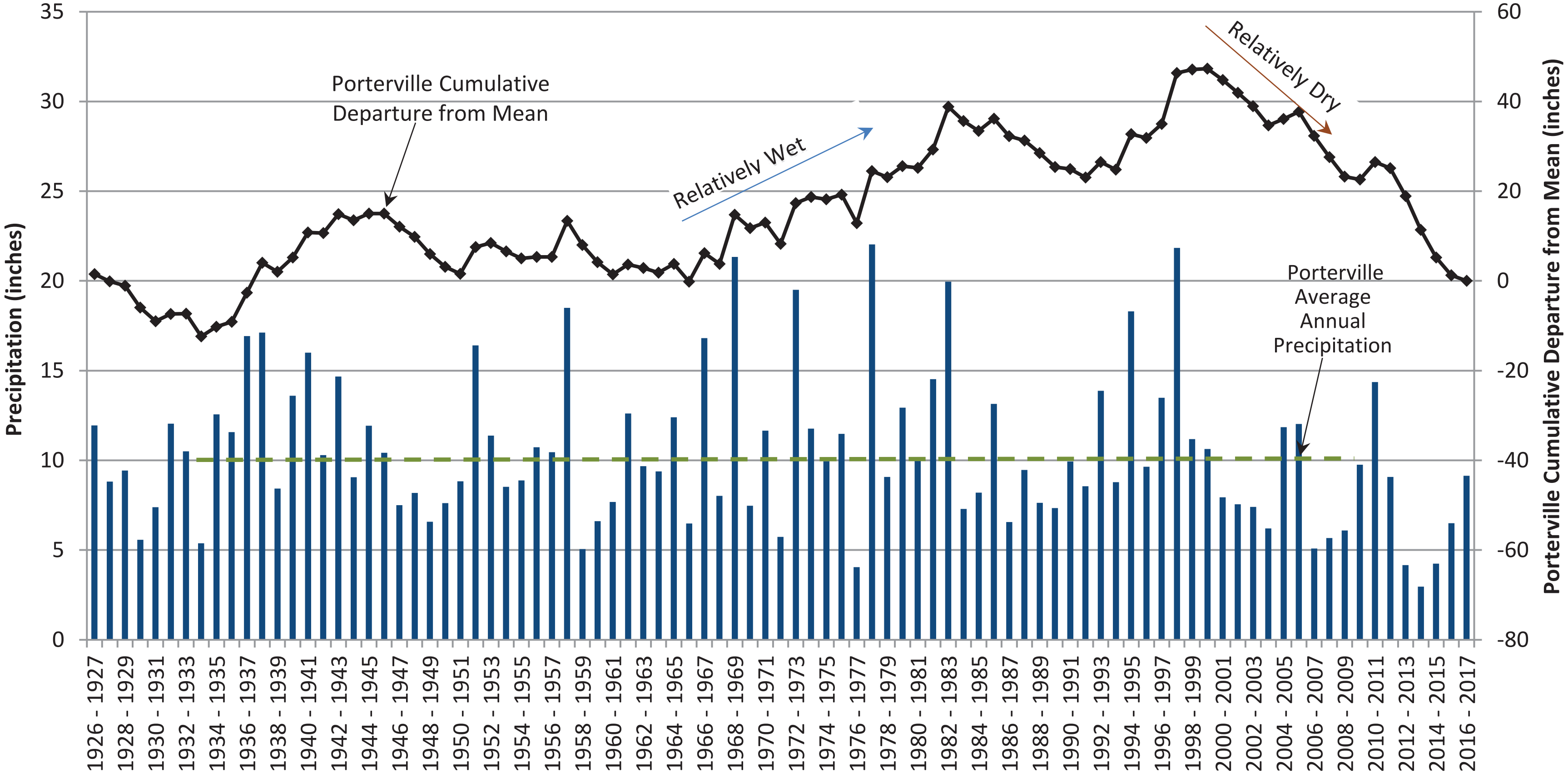
Isohyetal Map

Figure 2-27

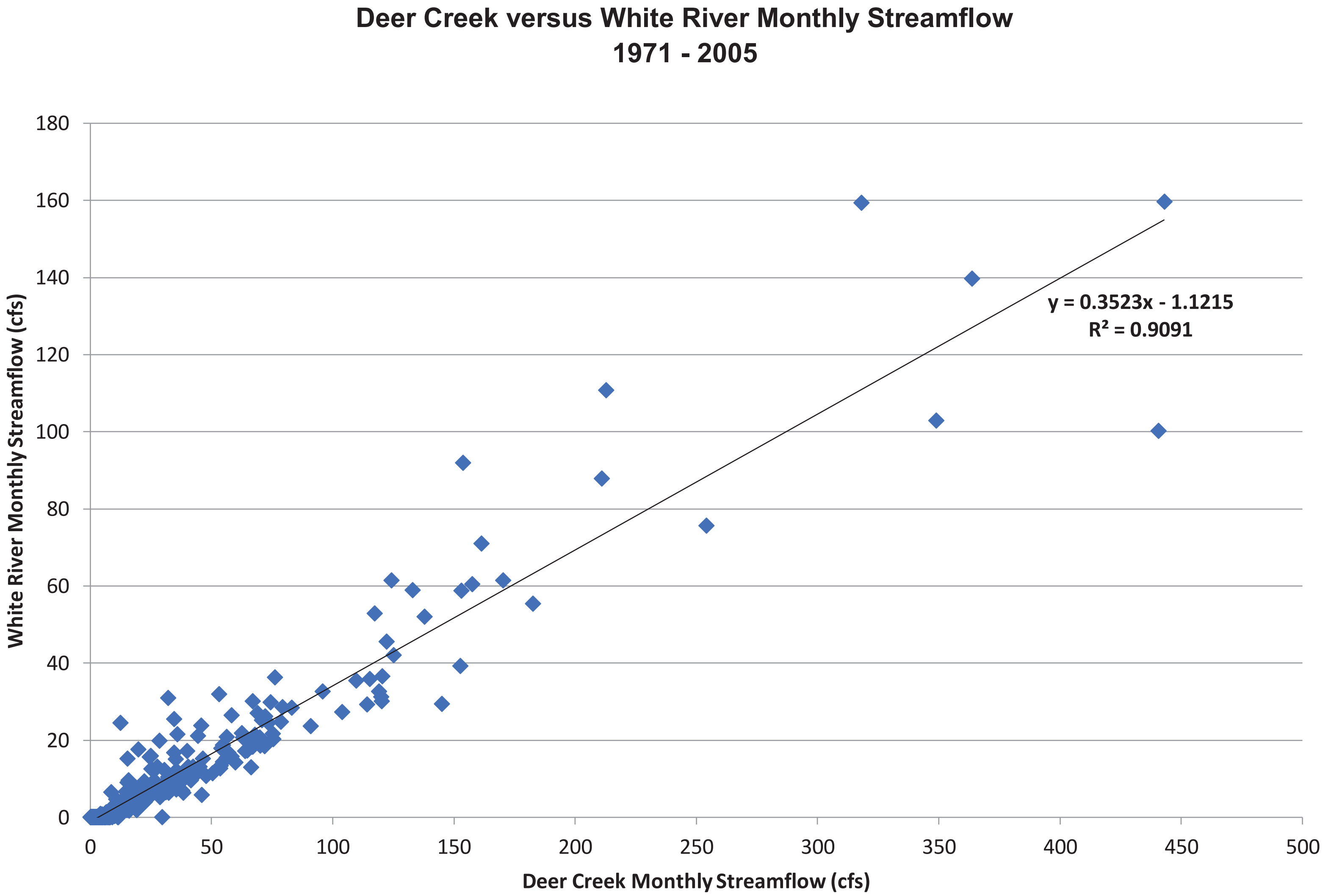
Annual Precipitation - Porterville Station



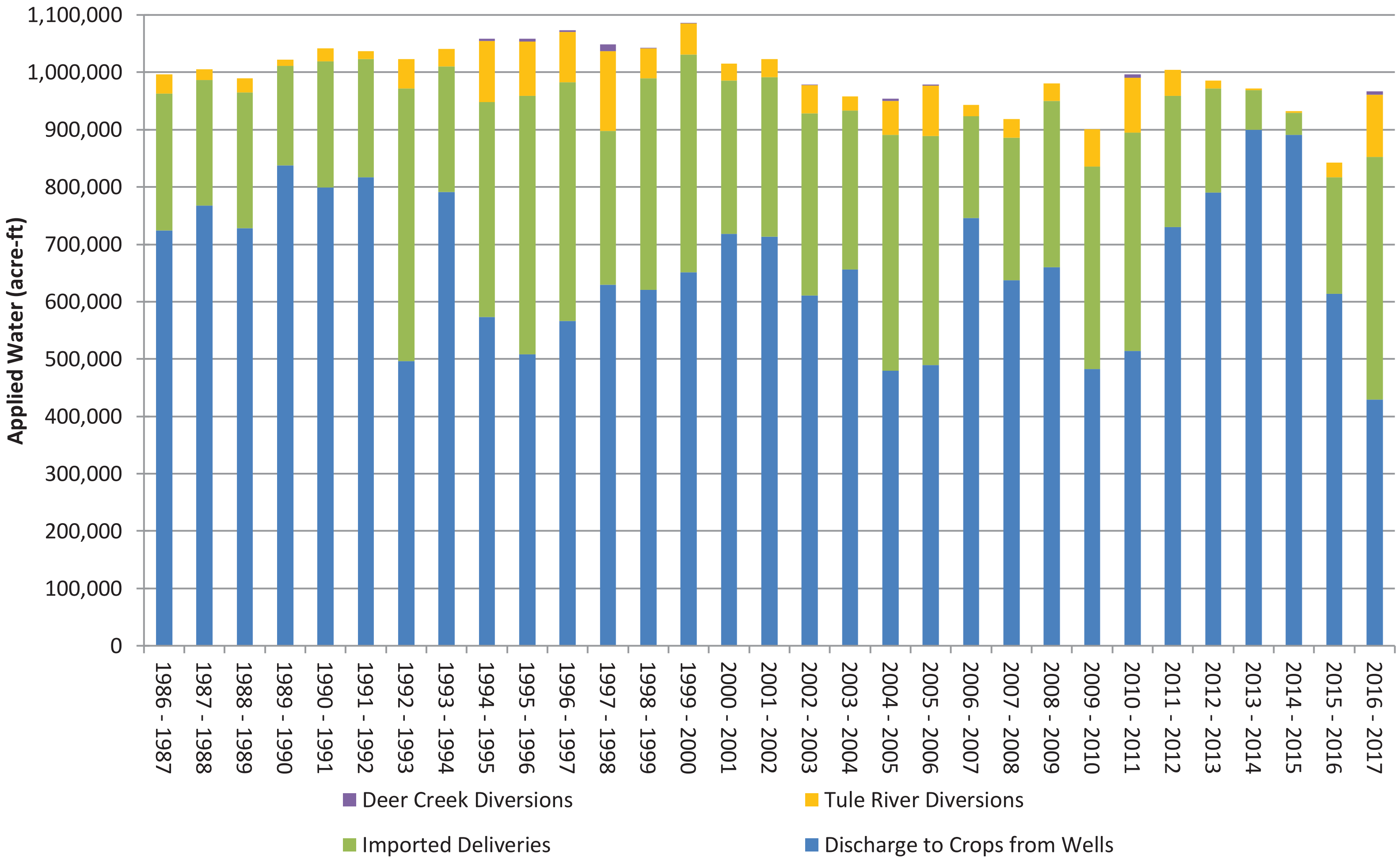
Notes:

Data in water years (October 1 to September 30).

Data from Western Regional Climate Center (1926-2001), California Irrigation Management Information System (2002-2016).


Deer Creek versus White River Monthly Streamflow
1971 - 2005
White River Monthly Streamflow (cfs)
0
20
40
60
80
100
120
140
160
180
Deer Creek Monthly Streamflow (cfs)
0
50
100
150
200
250
300
350
400
450
500
y = 0.3523x - 1.1215
R² = 0.9091

Applied Water to Irrigated Agriculture by Source



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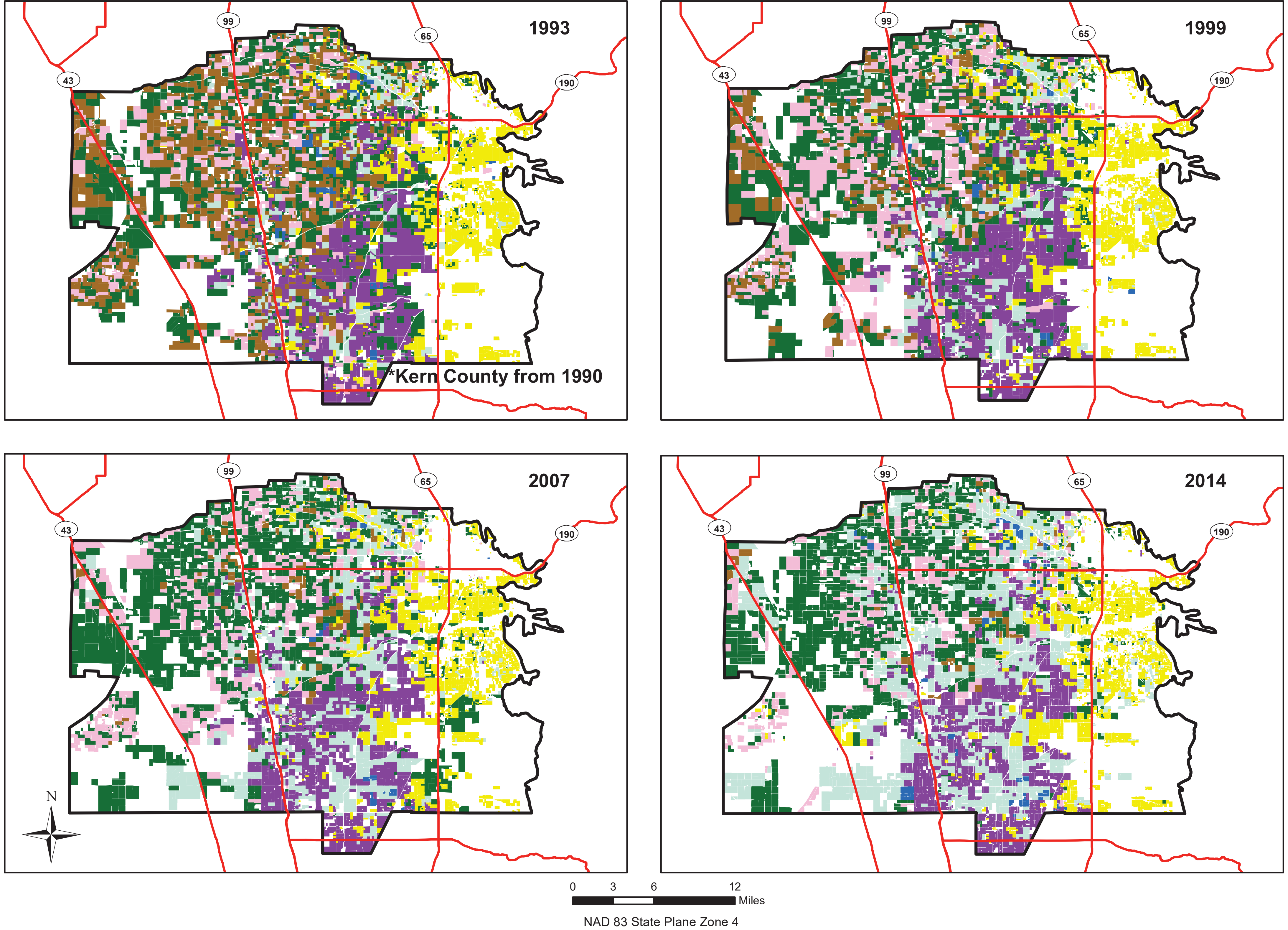
July 2022

Tule Subbasin

July 2022



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.

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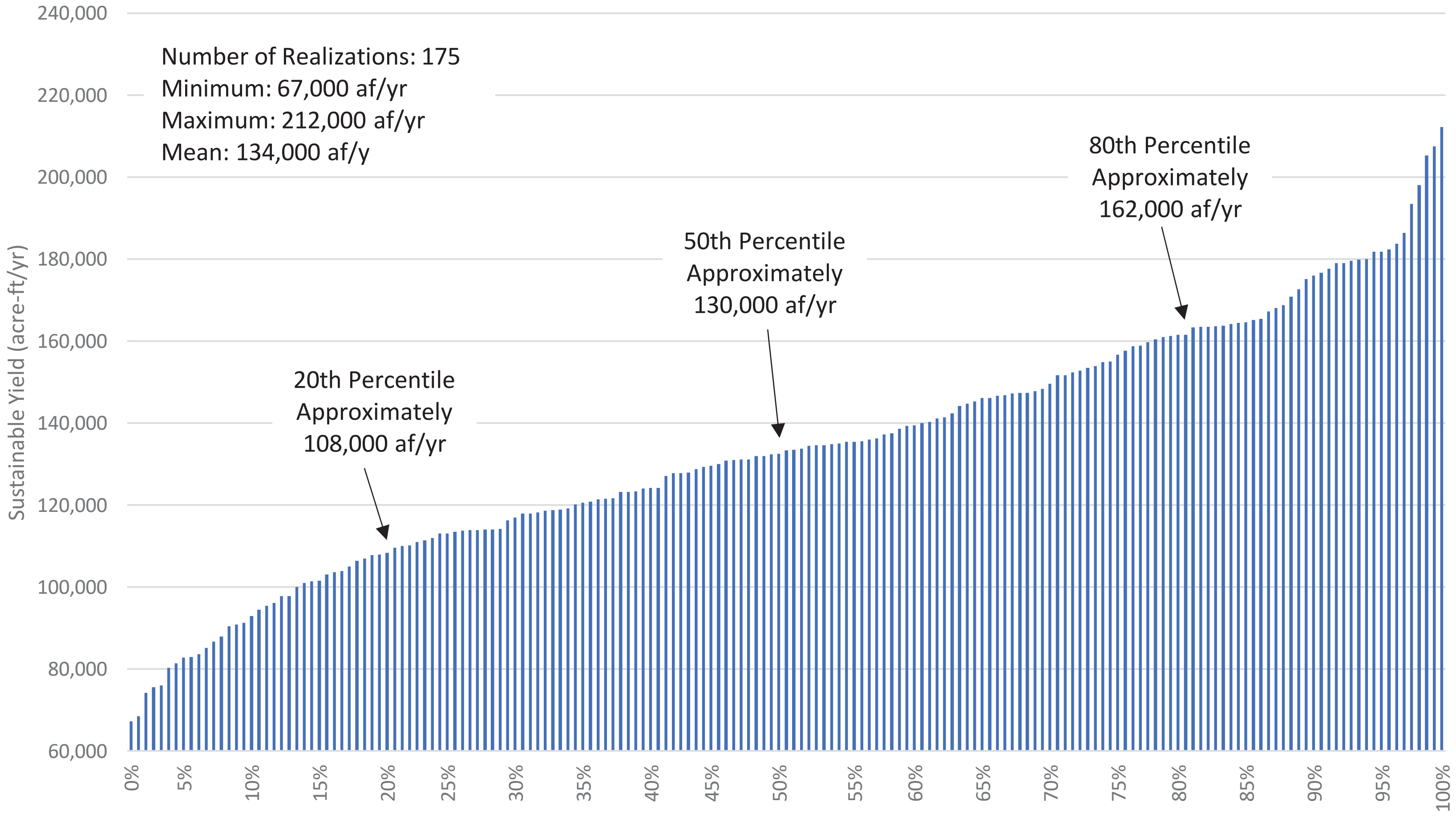
Tule Groundwater Subbasin Historical Crop Patterns

Figure 2-31

Figure 2-32

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

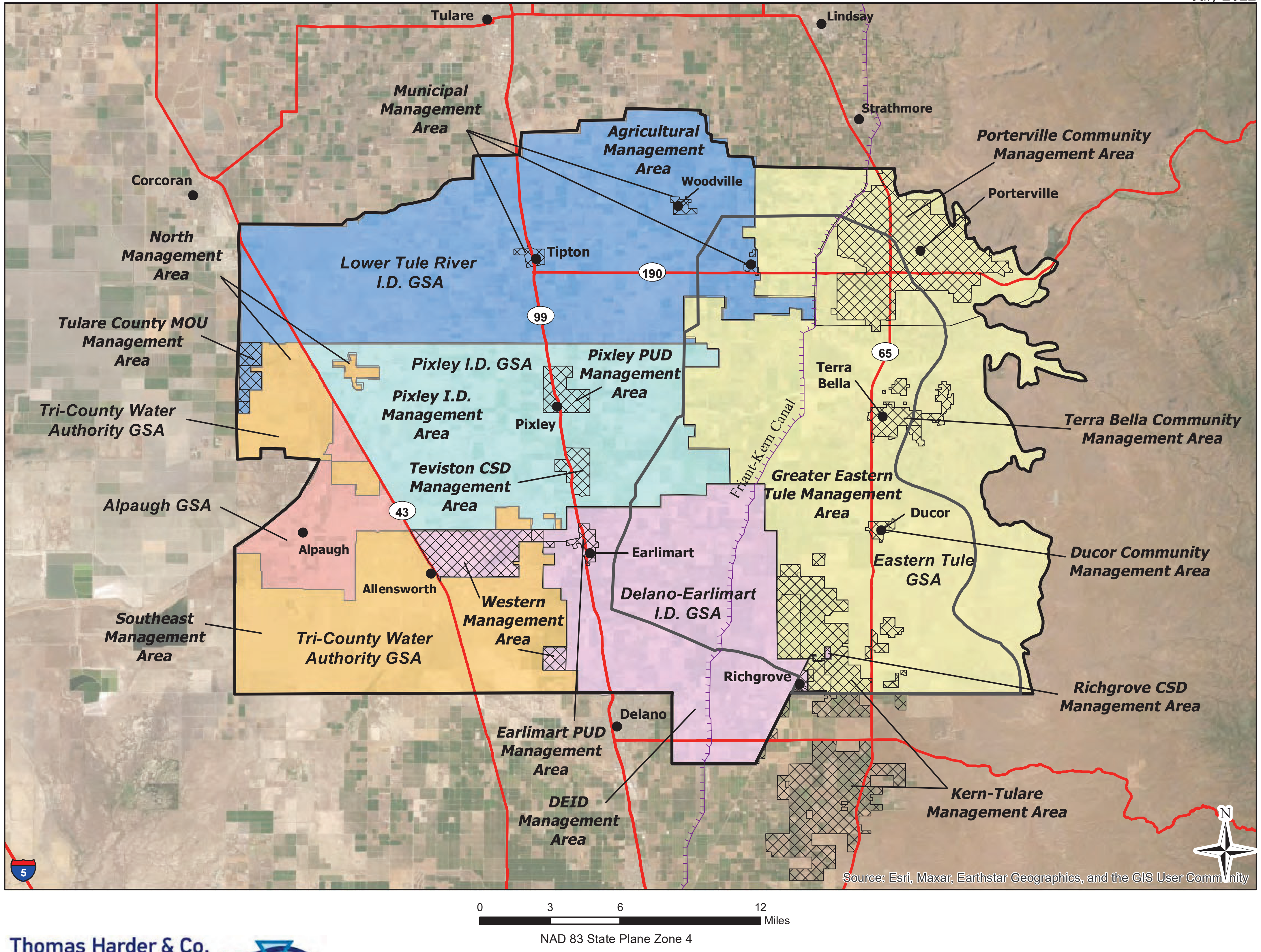


*Realizations with a storage change of -5,000 af/yr or greater

July 2022

Tule Subbasin

July 2022



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Map Features

GSA Name
- 🟥 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
- ▨ GSA Management Area
- — Friant-Kern Canal Land Subsidence Monitoring Zone
- ┼┼┼ Friant-Kern Canal
- ☐ Basin Boundary
- ● City or Community
- — State Highway/Major Road

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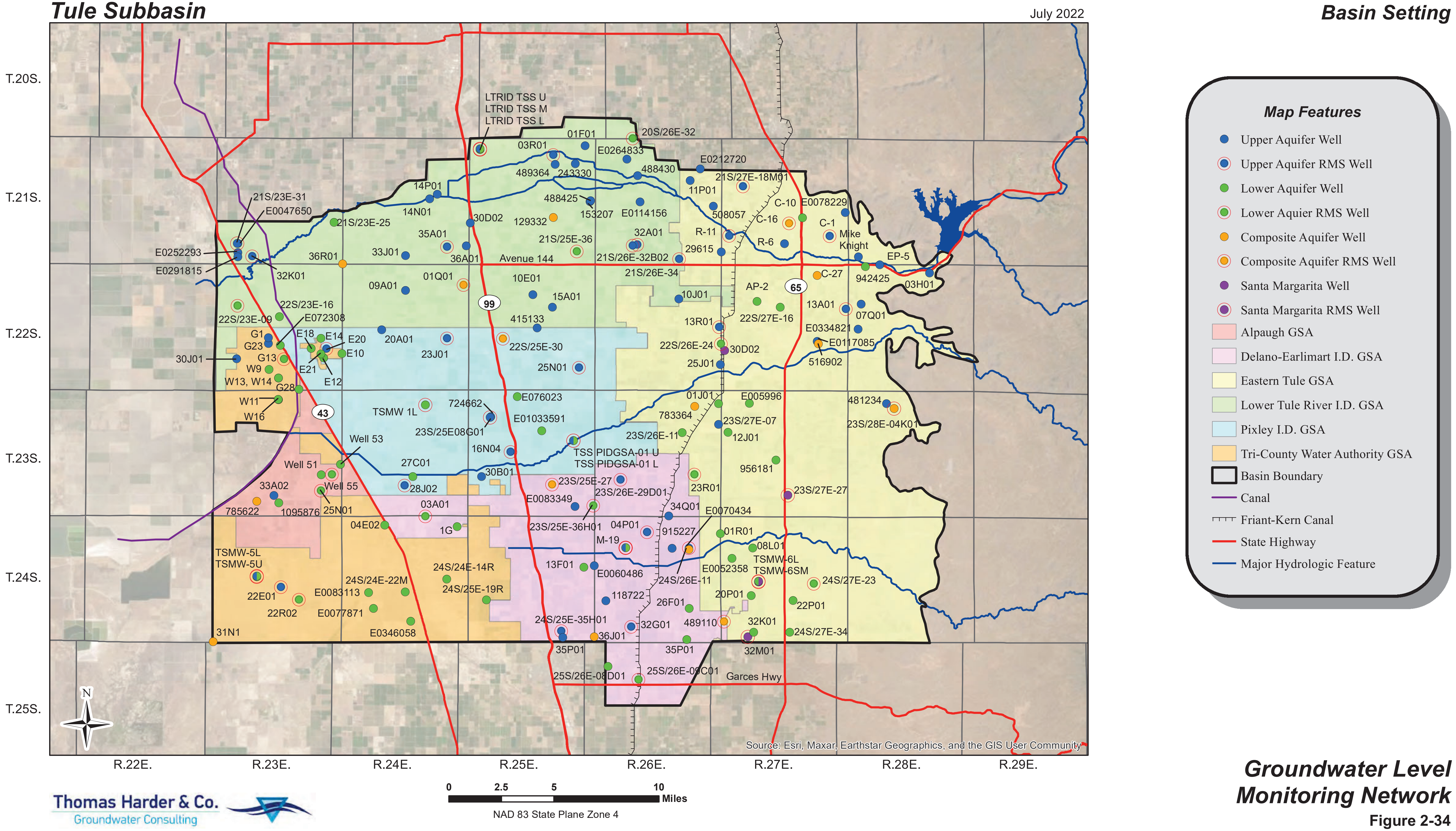
GSA Management Areas

Figure 2-33



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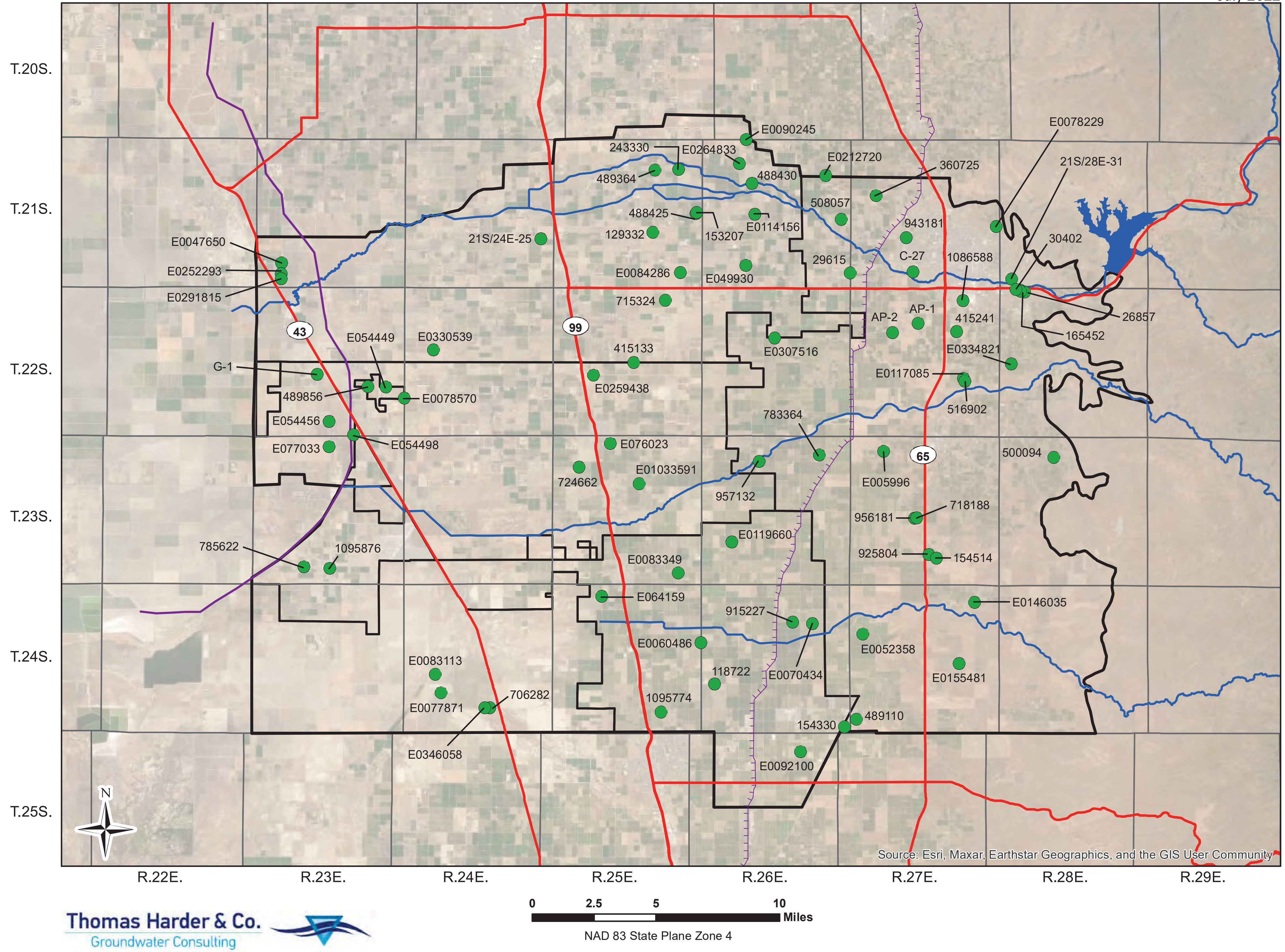
Groundwater Level Monitoring Network

Figure 2-34

Tule Subbasin

July 2022



NAD 83 State Plane Zone 4

Map Features

- ● Groundwater Quality Well Location
- Canal
- Friant-Kern Canal
- ☐ Basin Boundary
- ☐ GSA Boundaries
- State Highway/Major Road

Well Location data from:
Tule Basin Water Quality Coalition, 2017

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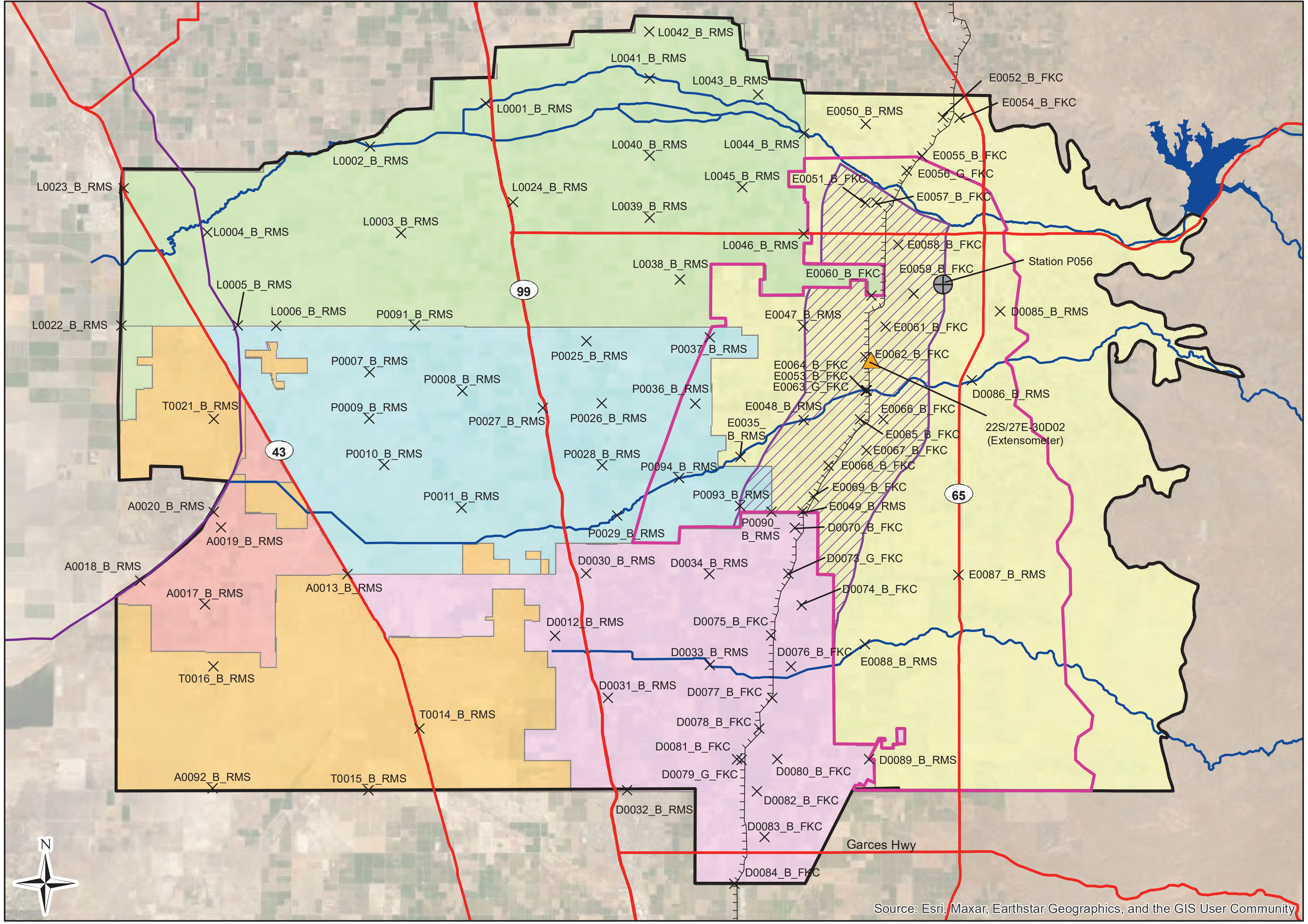
Groundwater Consulting

Groundwater Quality Monitoring Network

Figure 2-35

Tule Subbasin

July 2022



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Map Features

× Land Surface Elevation RMS
▲ Extensometer
⊕ GPS Station
🟥 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
┼┼┼ Friant-Kern Canal and California Aqueduct
— Canal
☐ ETGSA Monitored Area
▨ ETGSA Management Area
☐ Basin Boundary
— State Highway

0 2 4 8
Miles

NAD 83 State Plane Zone 4

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Land Surface Elevation Monitoring Network

Figure 2-36

Appendix A

Lower Tule River Irrigation District GSA

Water Budgets, Land Surface Elevations at Representative Monitoring Sites, and RMS Groundwater Elevation Hydrographs

Appendix A
Table 1a

Lower Tule River Irrigation District GSA
Historical Surface Water Budget 1986/87 to 2016/17

Water Year	Surface Water Inflow (acre-ft)					Total In
	Precipitation	Stream Inflow	Imported Water	Discharge from Wells		
		Tule River	LTRID	Agricultural	Municipal	
1986 - 1987	46,000	40,421	89,541	224,000	1,400	401,000
1987 - 1988	66,000	14,702	64,654	261,000	1,400	408,000
1988 - 1989	53,000	22,873	63,922	224,000	1,400	365,000
1989 - 1990	51,000	7,103	24,325	276,000	1,400	360,000
1990 - 1991	69,000	22,727	71,430	253,000	1,400	418,000
1991 - 1992	60,000	9,869	51,949	277,000	1,400	400,000
1992 - 1993	97,000	57,632	321,973	94,000	1,400	572,000
1993 - 1994	61,000	31,263	71,784	246,000	1,400	411,000
1994 - 1995	128,000	142,879	229,683	129,000	1,400	631,000
1995 - 1996	67,000	105,949	236,845	107,000	1,400	518,000
1996 - 1997	94,000	250,253	192,934	116,000	1,400	655,000
1997 - 1998	152,000	286,694	101,180	135,000	1,400	676,000
1998 - 1999	78,000	70,954	183,971	127,000	1,400	461,000
1999 - 2000	74,000	64,026	177,192	158,000	1,400	475,000
2000 - 2001	55,000	27,525	83,405	196,000	1,400	363,000
2001 - 2002	53,000	32,853	78,511	207,000	1,500	373,000
2002 - 2003	52,000	77,642	131,470	143,000	1,500	406,000
2003 - 2004	43,000	24,494	71,472	204,000	1,600	345,000
2004 - 2005	83,000	91,549	247,595	96,000	1,600	520,000
2005 - 2006	84,000	129,184	194,019	93,000	1,700	502,000
2006 - 2007	35,000	19,981	33,174	231,000	1,800	321,000
2007 - 2008	39,000	42,745	71,872	183,000	1,800	338,000
2008 - 2009	42,000	29,196	113,189	200,000	1,900	386,000
2009 - 2010	68,000	82,489	200,064	74,000	1,800	426,000
2010 - 2011	100,000	191,791	229,763	116,000	1,900	639,000
2011 - 2012	63,000	58,763	67,684	228,000	1,900	419,000
2012 - 2013	29,000	14,374	37,073	255,000	1,800	337,000
2013 - 2014	21,000	0	0	280,000	1,800	303,000
2014 - 2015	30,000	0	0	243,000	1,800	275,000
2015 - 2016	45,000	35,381	73,382	152,000	1,800	308,000
2016 - 2017	47,000	187,807	273,151	82,000	1,900	592,000
86/87-16/17 Avg	64,000	70,100	122,200	181,000	1,600	439,000

Appendix A
Table 1b

Lower Tule River Irrigation District GSA
Historical Surface Water Budget 1986/87 to 2016/17

	Surface Water Outflow (acre-ft)																	
Water Year	Areal Recharge of Precipitation	Streambed Infiltration	Canal Loss		Recharge in Basins		Deep Percolation of Applied Water				Evapotranspiration						Surface Outflow	Total Out
		Tule River	Tule River	Imported Water	Tule River	Imported Water	Tule River	Imported Water	Agricultural Pumping	Municipal Pumping	Precipitation Crops/Native	Tule River		Imported Water	Ag. Cons. Use from Pumping	Municipal (Landscape ET)	Tule River	
		Oettle Bridge to Turnbull Weir Infiltration										Agricultural Cons. Use	Stream Channel	Agricultural Cons. Use				
1986 - 1987	0	1,100	20,700	44,200	0	0	5,200	12,700	62,800	900	46,000	13,400	400	32,600	161,000	500	0	402,000
1987 - 1988	0	900	8,800	32,700	0	0	1,400	9,000	73,200	900	66,000	3,600	100	23,000	187,000	500	0	407,000
1988 - 1989	0	0	7,400	18,800	0	0	4,400	12,700	62,900	900	53,000	11,200	100	32,400	161,000	500	0	365,000
1989 - 1990	0	0	2,900	7,400	0	0	1,200	4,700	77,600	900	51,000	3,000	0	12,100	199,000	500	0	360,000
1990 - 1991	0	300	6,800	24,300	0	0	4,400	13,200	71,200	900	69,000	11,200	200	33,900	182,000	500	0	418,000
1991 - 1992	0	0	3,100	16,100	0	0	1,900	10,100	77,800	900	60,000	4,900	100	25,800	199,000	500	0	400,000
1992 - 1993	9,000	3,000	27,800	141,000	0	0	7,900	53,300	26,500	900	88,000	18,900	400	127,600	68,000	500	0	573,000
1993 - 1994	0	200	14,200	27,800	0	0	4,700	12,400	69,200	900	61,000	12,100	200	31,600	177,000	500	0	412,000
1994 - 1995	28,000	10,400	39,500	108,800	0	0	19,300	34,400	36,100	900	100,000	48,500	500	86,500	92,000	500	25,000	630,000
1995 - 1996	0	4,000	26,200	69,600	13,400	33,800	15,800	37,700	30,000	900	67,000	40,000	600	95,600	77,000	500	7,000	519,000
1996 - 1997	7,000	9,700	47,300	51,200	19,900	7,000	16,700	43,000	32,700	900	87,000	35,600	600	91,700	84,000	500	121,000	656,000
1997 - 1998	44,000	9,000	79,100	39,200	28,000	10,800	29,100	14,400	37,900	900	109,000	74,400	600	36,800	97,000	500	95,000	706,000
1998 - 1999	1,000	2,800	19,500	45,800	11,400	15,800	10,500	34,400	35,800	900	77,000	26,800	600	88,100	92,000	500	0	463,000
1999 - 2000	0	2,900	11,100	51,300	3,400	8,000	12,000	32,900	44,400	900	74,000	30,700	300	84,300	113,000	500	5,000	475,000
2000 - 2001	0	0	7,000	25,900	200	2,000	5,700	15,600	55,100	900	55,000	14,600	300	39,900	141,000	500	0	364,000
2001 - 2002	0	700	13,400	20,800	0	0	5,300	16,200	58,100	1,000	53,000	13,500	300	41,500	149,000	500	0	373,000
2002 - 2003	0	3,700	22,800	42,700	5,900	3,300	9,700	20,600	34,500	1,000	52,000	30,500	300	64,800	108,000	500	5,000	405,000
2003 - 2004	0	300	7,700	16,600	0	0	3,800	13,100	48,500	1,000	43,000	12,100	200	41,800	155,000	600	1,000	345,000
2004 - 2005	2,000	4,700	22,900	76,200	11,800	23,500	9,400	33,000	23,000	1,100	80,000	30,000	400	105,500	73,000	600	22,000	519,000
2005 - 2006	3,000	7,200	40,500	62,500	16,500	17,000	13,800	29,500	22,200	1,100	81,000	39,900	400	85,000	71,000	600	11,000	502,000
2006 - 2007	0	1,500	5,100	12,700	0	0	3,200	4,900	55,100	1,100	35,000	10,200	100	15,600	176,000	600	0	321,000
2007 - 2008	0	1,100	15,900	18,200	900	600	5,700	12,600	43,500	1,200	39,000	18,300	300	40,400	139,000	600	1,000	338,000
2008 - 2009	0	1,400	7,100	36,400	400	4,300	4,900	17,500	47,600	1,200	42,000	15,600	100	56,000	152,000	700	0	387,000
2009 - 2010	0	4,500	34,600	61,600	5,800	15,100	10,200	33,500	17,500	1,200	68,000	27,400	400	89,800	56,000	600	0	426,000
2010 - 2011	11,000	7,500	82,400	80,300	31,800	27,700	15,500	30,400	27,500	1,200	89,000	46,600	400	91,300	88,000	700	8,000	639,000
2011 - 2012	0	300	17,800	21,200	1,500	4,200	10,100	10,900	54,300	1,200	63,000	29,100	200	31,400	174,000	700	0	420,000
2012 - 2013	0	0	4,400	11,400	0	0	2,400	6,100	60,800	1,100	29,000	7,600	200	19,600	195,000	600	0	338,000
2013 - 2014	0	0	0	0	0	0	0	0	66,700	1,200	21,000	0	0	0	213,000	600	0	303,000
2014 - 2015	0	0	0	0	0	0	0	0	57,900	1,200	30,000	0	0	0	185,000	600	0	275,000
2015 - 2016	0	5,500	11,400	27,400	800	0	4,200	11,000	36,200	1,200	45,000	13,500	200	35,100	116,000	600	0	308,000
2016 - 2017	0	15,900	82,600	113,100	28,400	34,000	14,500	30,400	19,500	1,200	47,000	46,400	500	95,600	62,000	700	71,000	663,000
86/87-16/17 Avg	3,000	3,200	22,300	42,100	5,800	6,700	8,200	19,700	47,300	1,000	61,000	22,200	300	53,400	134,000	600	12,000	443,000

🟦	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

Appendix A
Table 2

Lower Tule River Irrigation District GSA
Historical Groundwater Budget 1986/87 to 2016/17

	Groundwater Inflows (acre-ft)														Groundwater Outflows (acre-ft)						
Water Year	Areal Recharge from Precipitation	Tule River				Imported Water Deliveries			Agricultural Pumping	Municipal Pumping	Release of Water from Compression of Aquitards	Sub-surface Inflow		Total In	Groundwater Pumping			Sub-surface Outflow		Total Out	Change in Storage (acre-ft)
		Oettle Bridge to Turnbull Weir Infiltration	Canal Loss	Recharge in Basins	Return Flow	Canal Loss	Recharge in Basins	Return Flow	Return Flow	Return Flow		From Outside Subbasin	From Other GSAs		Muni-cipal	Agri-cultural	Exports	To Outside Subbasin	To Other GSAs		
1986 - 1987	0	1,100	20,700	0	5,200	44,200	0	12,700	62,800	900	27,000	76,000	39,000	290,000	1,400	224,000	0	16,000	115,000	356,000	-66,000
1987 - 1988	0	900	8,800	0	1,400	32,700	0	9,000	73,200	900	26,000	90,000	38,000	281,000	1,400	261,000	15,940	16,000	108,000	402,000	-121,000
1988 - 1989	0	0	7,400	0	4,400	18,800	0	12,700	62,900	900	13,000	90,000	37,000	247,000	1,400	224,000	26,160	16,000	107,000	375,000	-128,000
1989 - 1990	0	0	2,900	0	1,200	7,400	0	4,700	77,600	900	38,000	87,000	39,000	259,000	1,400	276,000	26,590	16,000	97,000	417,000	-158,000
1990 - 1991	0	300	6,800	0	4,400	24,300	0	13,200	71,200	900	42,000	95,000	38,000	296,000	1,400	253,000	28,190	17,000	104,000	404,000	-108,000
1991 - 1992	0	0	3,100	0	1,900	16,100	0	10,100	77,800	900	53,000	97,000	38,000	298,000	1,400	277,000	17,420	17,000	101,000	414,000	-116,000
1992 - 1993	9,000	3,000	27,800	0	7,900	141,000	0	53,300	26,500	900	15,000	62,000	30,000	376,000	1,400	94,000	7,940	28,000	127,000	258,000	118,000
1993 - 1994	0	200	14,200	0	4,700	27,800	0	12,400	69,200	900	24,000	79,000	33,000	265,000	1,400	246,000	0	24,000	107,000	378,000	-113,000
1994 - 1995	28,000	10,400	39,500	0	19,300	108,800	0	34,400	36,100	900	9,000	62,000	33,000	381,000	1,400	129,000	0	26,000	123,000	279,000	102,000
1995 - 1996	0	4,000	26,200	13,400	15,800	69,600	33,800	37,700	30,000	900	2,000	53,000	30,000	316,000	1,400	107,000	0	30,000	126,000	264,000	52,000
1996 - 1997	7,000	9,700	47,300	19,900	16,700	51,200	7,000	43,000	32,700	900	1,000	60,000	31,000	327,000	1,400	116,000	0	28,000	132,000	277,000	50,000
1997 - 1998	44,000	9,000	79,100	28,000	29,100	39,200	10,800	14,400	37,900	900	0	72,000	32,000	396,000	1,400	135,000	0	26,000	134,000	296,000	100,000
1998 - 1999	1,000	2,800	19,500	11,400	10,500	45,800	15,800	34,400	35,800	900	2,000	73,000	30,000	283,000	1,400	127,000	0	28,000	139,000	295,000	-12,000
1999 - 2000	0	2,900	11,100	3,400	12,000	51,300	8,000	32,900	44,400	900	2,000	80,000	30,000	279,000	1,400	158,000	2,820	26,000	129,000	317,000	-38,000
2000 - 2001	0	0	7,000	200	5,700	25,900	2,000	15,600	55,100	900	6,000	94,000	31,000	243,000	1,400	196,000	17,290	22,000	119,000	356,000	-113,000
2001 - 2002	0	700	13,400	0	5,300	20,800	0	16,200	58,100	1,000	15,000	89,000	32,000	252,000	1,500	207,000	25,590	20,000	110,000	364,000	-112,000
2002 - 2003	0	3,700	22,800	5,900	9,700	42,700	3,300	20,600	34,500	1,000	10,000	75,000	29,000	258,000	1,500	143,000	20,610	22,000	117,000	304,000	-46,000
2003 - 2004	0	300	7,700	0	3,800	16,600	0	13,100	48,500	1,000	27,000	78,000	31,000	227,000	1,600	204,000	17,440	20,000	95,000	338,000	-111,000
2004 - 2005	2,000	4,700	22,900	11,800	9,400	76,200	23,500	33,000	23,000	1,100	9,000	56,000	27,000	300,000	1,600	96,000	7,720	26,000	107,000	238,000	62,000
2005 - 2006	3,000	7,200	40,500	16,500	13,800	62,500	17,000	29,500	22,200	1,100	2,000	53,000	27,000	295,000	1,700	93,000	0	29,000	115,000	239,000	56,000
2006 - 2007	0	1,500	5,100	0	3,200	12,700	0	4,900	55,100	1,100	24,000	71,000	30,000	209,000	1,800	231,000	27,930	22,000	85,000	368,000	-159,000
2007 - 2008	0	1,100	15,900	900	5,700	18,200	600	12,600	43,500	1,200	36,000	74,000	29,000	239,000	1,800	183,000	26,140	23,000	93,000	327,000	-88,000
2008 - 2009	0	1,400	7,100	400	4,900	36,400	4,300	17,500	47,600	1,200	47,000	74,000	31,000	273,000	1,900	200,000	21,470	24,000	96,000	343,000	-70,000
2009 - 2010	0	4,500	34,600	5,800	10,200	61,600	15,100	33,500	17,500	1,200	18,000	48,000	27,000	277,000	1,800	74,000	10,770	30,000	122,000	239,000	38,000
2010 - 2011	11,000	7,500	82,400	31,800	15,500	80,300	27,700	30,400	27,500	1,200	6,000	55,000	28,000	404,000	1,900	116,000	3,880	31,000	125,000	278,000	126,000
2011 - 2012	0	300	17,800	1,500	10,100	21,200	4,200	10,900	54,300	1,200	22,000	79,000	31,000	254,000	1,900	228,000	21,600	24,000	109,000	385,000	-131,000
2012 - 2013	0	0	4,400	0	2,400	11,400	0	6,100	60,800	1,100	53,000	88,000	33,000	260,000	1,800	255,000	39,910	25,000	88,000	410,000	-150,000
2013 - 2014	0	0	0	0	0	0	0	0	66,700	1,200	71,000	91,000	32,000	262,000	1,800	280,000	37,120	25,000	81,000	425,000	-163,000
2014 - 2015	0	0	0	0	0	0	0	0	57,900	1,200	74,000	83,000	31,000	247,000	1,800	243,000	33,170	24,000	84,000	386,000	-139,000
2015 - 2016	0	5,500	11,400	800	4,200	27,400	0	11,000	36,200	1,200	53,000	70,000	27,000	248,000	1,800	152,000	28,300	27,000	90,000	299,000	-51,000
2016 - 2017	0	15,900	82,600	28,400	14,500	113,100	34,000	30,400	19,500	1,200	16,000	55,000	24,000	435,000	1,900	82,000	6,810	33,000	112,000	236,000	199,000
36/87-16/17 Avg	3,000	3,200	22,300	5,800	8,200	42,100	6,700	19,700	47,300	1,000	24,000	74,000	32,000	289,000	1,600	181,000	15,200	24,000	110,000	332,000	-43,000

Cumulative Change in Storage | -1,290,000

🟦 Groundwater Inflows or Outflows to be Included in Sustainable Yield Estimates
🟪 Groundwater Inflows to be Excluded from the Sustainable Yield Estimates
🟨 Groundwater Outflows Not Included in Sustainable Yield Estimates

Appendix A
Table 3a

Projected Future Lower Tule River Irrigation District GSA Surface Water Budget

	Surface Water Inflow (acre-ft)					
Water Year	Precipitation	Stream Inflow	Imported Water	Discharge from Wells		Total In
		Tule River	LTRID	Agricultural	Municipal	
2017 - 2018	65,000	79,995	143,186	149,000	1,900	439,000
2018 - 2019	65,000	79,995	143,186	149,000	1,900	439,000
2019 - 2020	65,000	79,995	143,186	149,000	1,900	439,000
2020 - 2021	65,000	79,995	143,186	149,000	1,900	439,000
2021 - 2022	65,000	79,995	143,186	149,000	1,900	439,000
2022 - 2023	65,000	79,995	143,186	149,000	1,900	439,000
2023 - 2024	65,000	79,995	143,186	149,000	1,900	439,000
2024 - 2025	65,000	82,595	135,513	151,000	1,900	436,000
2025 - 2026	65,000	82,595	127,841	155,000	1,900	432,000
2026 - 2027	65,000	82,595	120,168	159,000	1,900	429,000
2027 - 2028	65,000	82,595	112,496	164,000	1,900	426,000
2028 - 2029	65,000	82,595	104,823	168,000	1,900	422,000
2029 - 2030	65,000	81,976	97,151	172,000	1,900	418,000
2030 - 2031	65,000	81,976	97,151	172,000	1,900	418,000
2031 - 2032	65,000	81,976	97,151	172,000	1,900	418,000
2032 - 2033	65,000	81,976	97,151	172,000	1,900	418,000
2033 - 2034	65,000	81,976	97,151	172,000	1,900	418,000
2034 - 2035	65,000	81,976	97,151	171,000	1,900	417,000
2035 - 2036	65,000	81,976	97,151	171,000	1,900	417,000
2036 - 2037	65,000	81,976	97,151	171,000	1,900	417,000
2037 - 2038	65,000	81,976	97,151	171,000	1,900	417,000
2038 - 2039	65,000	81,976	97,151	171,000	1,900	417,000
2039 - 2040	65,000	81,976	97,151	152,000	1,900	398,000
2040 - 2041	65,000	81,976	97,151	152,000	1,900	398,000
2041 - 2042	65,000	81,976	97,151	152,000	1,900	398,000
2042 - 2043	65,000	81,976	97,151	152,000	1,900	398,000
2043 - 2044	65,000	81,976	97,151	152,000	1,900	398,000
2044 - 2045	65,000	81,976	97,151	152,000	1,900	398,000
2045 - 2046	65,000	81,976	97,151	152,000	1,900	398,000
2046 - 2047	65,000	81,976	97,151	152,000	1,900	398,000
2047 - 2048	65,000	81,976	97,151	152,000	1,900	398,000
2048 - 2049	65,000	81,976	97,151	152,000	1,900	398,000
2049 - 2050	65,000	81,976	97,151	152,000	1,900	398,000
2050 - 2051	65,000	79,772	84,084	141,000	1,900	372,000
2051 - 2052	65,000	79,772	84,084	141,000	1,900	372,000
2052 - 2053	65,000	79,772	84,084	141,000	1,900	372,000
2053 - 2054	65,000	79,772	84,084	141,000	1,900	372,000
2054 - 2055	65,000	79,772	84,084	141,000	1,900	372,000
2055 - 2056	65,000	79,772	84,084	141,000	1,900	372,000
2056 - 2057	65,000	79,772	84,084	141,000	1,900	372,000
2057 - 2058	65,000	79,772	84,084	141,000	1,900	372,000
2058 - 2059	65,000	79,772	84,084	141,000	1,900	372,000
2059 - 2060	65,000	79,772	84,084	141,000	1,900	372,000
2060 - 2061	65,000	79,772	84,084	141,000	1,900	372,000
2061 - 2062	65,000	79,772	84,084	141,000	1,900	372,000
2062 - 2063	65,000	79,772	84,084	141,000	1,900	372,000
2063 - 2064	65,000	79,772	84,084	141,000	1,900	372,000
2064 - 2065	65,000	79,772	84,084	141,000	1,900	372,000
2065 - 2066	65,000	79,772	84,084	141,000	1,900	372,000
2066 - 2067	65,000	79,772	84,084	141,000	1,900	372,000
2067 - 2068	65,000	79,772	84,084	141,000	1,900	372,000
2068 - 2069	65,000	79,772	84,084	141,000	1,900	372,000
2069 - 2070	65,000	79,772	84,084	141,000	1,900	372,000
17/18-69/70 Avg	65,000	80,900	100,500	152,000	1,900	400,000

Appendix A
Table 3b

Projected Future Lower Tule River Irrigation District GSA Surface Water Budget

Water Year	Surface Water Outflow (acre-ft)																	Total Out
	Areal Recharge of Precipitation	Streambed Infiltration	Canal Loss		Recharge in Basins		Deep Percolation of Applied Water				Evapotranspiration						Surface Outflow	
		Tule River										Tule River		Imported Water				
		Oettle Bridge to Turnbull Weir Infiltration	Tule River	Imported Water	Tule River	Imported Water	Tule River	Imported Water	Agricultural Pumping	Municipal Pumping	Precipitation Crops/Native	Agricultural Cons. Use	Stream Channel	Agricultural Cons. Use	Ag. Cons. Use from Pumping	Municipal (Landscape ET)	Tule River	
2017 - 2018	3,000	3,900	17,000	52,400	6,400	11,400	10,800	19,400	35,400	1,200	61,000	33,500	300	59,900	113,000	700	15,000	444,000
2018 - 2019	3,000	3,900	17,000	52,400	6,400	11,400	10,800	19,400	35,400	1,200	61,000	33,500	300	59,900	113,000	700	8,000	437,000
2019 - 2020	3,000	3,900	17,000	52,400	6,400	11,400	10,800	19,400	35,400	1,200	61,000	33,500	300	59,900	113,000	700	8,000	437,000
2020 - 2021	3,000	3,900	17,000	52,400	6,400	11,400	10,800	19,400	35,400	1,200	61,000	33,500	300	59,900	113,000	700	8,000	437,000
2021 - 2022	3,000	3,900	17,000	52,400	6,400	11,400	10,800	19,400	35,400	1,200	61,000	33,500	300	59,900	113,000	700	8,000	437,000
2022 - 2023	3,000	3,900	17,000	52,400	6,400	11,400	10,800	19,400	35,400	1,200	61,000	33,500	300	59,900	113,000	700	8,000	437,000
2023 - 2024	3,000	3,900	17,000	52,400	6,400	11,400	10,800	19,400	35,400	1,200	61,000	33,500	300	59,900	113,000	700	8,000	437,000
2024 - 2025	3,000	3,900	18,200	49,600	6,600	10,800	11,200	18,400	35,900	1,200	61,000	34,600	300	56,700	115,000	700	8,000	435,000
2025 - 2026	3,000	3,900	18,400	46,800	6,600	10,200	11,200	17,300	36,900	1,200	61,000	34,600	300	53,500	118,000	700	8,000	432,000
2026 - 2027	3,000	3,900	18,700	44,000	6,600	9,600	11,200	16,300	37,900	1,200	61,000	34,600	300	50,300	121,000	700	8,000	428,000
2027 - 2028	3,000	3,900	19,000	41,200	6,600	8,900	11,200	15,300	38,900	1,200	61,000	34,500	300	47,000	125,000	700	7,000	425,000
2028 - 2029	3,000	3,900	19,300	38,400	6,600	8,300	11,200	14,300	40,000	1,200	61,000	34,500	300	43,800	128,000	700	7,000	422,000
2029 - 2030	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,200	40,900	1,200	61,000	34,200	300	40,600	131,000	700	7,000	417,000
2030 - 2031	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,200	40,900	1,200	61,000	34,200	300	40,600	131,000	700	7,000	417,000
2031 - 2032	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,200	40,900	1,200	61,000	34,200	300	40,600	131,000	700	7,000	417,000
2032 - 2033	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,200	40,900	1,200	61,000	34,200	300	40,600	131,000	700	7,000	417,000
2033 - 2034	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,200	40,900	1,200	61,000	34,200	300	40,600	131,000	700	7,000	417,000
2034 - 2035	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	40,700	1,200	61,000	34,200	300	40,600	130,000	700	7,000	416,000
2035 - 2036	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	40,700	1,200	61,000	34,200	300	40,600	130,000	700	7,000	416,000
2036 - 2037	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	40,700	1,200	61,000	34,200	300	40,600	130,000	700	7,000	416,000
2037 - 2038	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	40,700	1,200	61,000	34,200	300	40,600	130,000	700	7,000	416,000
2038 - 2039	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	40,700	1,200	61,000	34,200	300	40,600	130,000	700	7,000	416,000
2039 - 2040	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	36,200	1,200	61,000	34,200	300	40,600	116,000	700	7,000	398,000
2040 - 2041	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	36,200	1,200	61,000	34,200	300	40,600	116,000	700	7,000	398,000
2041 - 2042	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	36,200	1,200	61,000	34,200	300	40,600	116,000	700	7,000	398,000
2042 - 2043	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	36,200	1,200	61,000	34,200	300	40,600	116,000	700	7,000	398,000
2043 - 2044	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	36,200	1,200	61,000	34,200	300	40,600	116,000	700	7,000	398,000
2044 - 2045	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	36,200	1,200	61,000	34,200	300	40,600	116,000	700	7,000	398,000
2045 - 2046	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	36,200	1,200	61,000	34,200	300	40,600	116,000	700	7,000	398,000
2046 - 2047	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	36,200	1,200	61,000	34,200	300	40,600	116,000	700	7,000	398,000
2047 - 2048	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	36,200	1,200	61,000	34,200	300	40,600	116,000	700	7,000	398,000
2048 - 2049	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	36,200	1,200	61,000	34,200	300	40,600	116,000	700	7,000	398,000
2049 - 2050	3,000	3,900	19,400	35,600	6,500	7,700	11,200	13,300	36,200	1,200	61,000	34,200	300	40,600	116,000	700	7,000	398,000
2050 - 2051	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2051 - 2052	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2052 - 2053	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2053 - 2054	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2054 - 2055	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2055 - 2056	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2056 - 2057	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2057 - 2058	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2058 - 2059	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2059 - 2060	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2060 - 2061	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2061 - 2062	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2062 - 2063	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2063 - 2064	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2064 - 2065	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2065 - 2066	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2066 - 2067	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2067 - 2068	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2068 - 2069	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
2069 - 2070	3,000	3,800	19,300	30,800	6,300	6,700	10,900	11,500	33,600	1,200	61,000	33,300	300	35,100	108,000	700	6,000	372,000
17/18-69/70 Avg	3,000	3,900	19,000	36,800	6,400	8,000	11,000	13,700	36,100	1,200	61,000	33,800	300	42,000	116,000	700	6,900	400,000

Projected Future Lower Tule River Irrigation District GSA Groundwater Budget

	Groundwater Inflows (acre-ft)														Groundwater Outflows (acre-ft)						
Water Year	Areal Recharge from Precipitation	Tule River				Imported Water Deliveries			Agricultural Pumping	Municipal Pumping	Release of Water from Compression of Aquitards	Sub-surface Inflow		Total In	Groundwater Pumping			Sub-surface Outflow		Total Out	Change in Storage (acre-ft)
		Oettle Bridge to Turnbull Weir Infiltration	Canal Loss	Recharge in Basins	Return Flow	Canal Loss	Recharge in Basins	Return Flow	Return Flow	Return Flow		From Outside Subbasin	From Other GSAs		Muni-cipal	Agri-cultural	Exports	To Outside Subbasin	To Other GSAs		
2017 - 2018	3,000	3,900	17,000	6,400	10,800	52,400	11,400	19,400	35,400	1,200	10,000	44,000	42,000	257,000	1,900	149,000	11,640	41,000	98,000	302,000	-45,000
2018 - 2019	3,000	3,900	17,000	6,400	10,800	52,400	11,400	19,400	35,400	1,200	12,000	43,000	43,000	259,000	1,900	149,000	11,640	41,000	96,000	300,000	-41,000
2019 - 2020	3,000	3,900	17,000	6,400	10,800	52,400	11,400	19,400	35,400	1,200	14,000	41,000	44,000	260,000	1,900	149,000	11,640	41,000	93,000	297,000	-37,000
2020 - 2021	3,000	3,900	17,000	6,400	10,800	52,400	11,400	19,400	35,400	1,200	16,000	39,000	44,000	260,000	1,900	149,000	11,640	41,000	92,000	296,000	-36,000
2021 - 2022	3,000	3,900	17,000	6,400	10,800	52,400	11,400	19,400	35,400	1,200	17,000	37,000	45,000	260,000	1,900	149,000	11,640	41,000	91,000	295,000	-35,000
2022 - 2023	3,000	3,900	17,000	6,400	10,800	52,400	11,400	19,400	35,400	1,200	18,000	35,000	45,000	259,000	1,900	149,000	11,640	42,000	90,000	295,000	-36,000
2023 - 2024	3,000	3,900	17,000	6,400	10,800	52,400	11,400	19,400	35,400	1,200	19,000	33,000	46,000	259,000	1,900	149,000	11,640	42,000	89,000	294,000	-35,000
2024 - 2025	3,000	3,900	18,200	6,600	11,200	49,600	10,800	18,400	35,900	1,200	20,000	32,000	46,000	257,000	1,900	151,000	11,640	43,000	85,000	293,000	-36,000
2025 - 2026	3,000	3,900	18,400	6,600	11,200	46,800	10,200	17,300	36,900	1,200	20,000	31,000	47,000	254,000	1,900	155,000	8,730	43,000	83,000	292,000	-38,000
2026 - 2027	3,000	3,900	18,700	6,600	11,200	44,000	9,600	16,300	37,900	1,200	22,000	31,000	48,000	253,000	1,900	159,000	8,730	43,000	80,000	293,000	-40,000
2027 - 2028	3,000	3,900	19,000	6,600	11,200	41,200	8,900	15,300	38,900	1,200	23,000	31,000	48,000	251,000	1,900	164,000	8,730	43,000	78,000	296,000	-45,000
2028 - 2029	3,000	3,900	19,300	6,600	11,200	38,400	8,300	14,300	40,000	1,200	24,000	32,000	49,000	251,000	1,900	168,000	8,730	42,000	75,000	296,000	-45,000
2029 - 2030	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,200	40,900	1,200	24,000	32,000	50,000	249,000	1,900	172,000	8,730	42,000	70,000	295,000	-46,000
2030 - 2031	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,200	40,900	1,200	23,000	31,000	51,000	248,000	1,900	172,000	5,820	42,000	68,000	290,000	-42,000
2031 - 2032	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,200	40,900	1,200	23,000	32,000	51,000	249,000	1,900	172,000	5,820	42,000	67,000	289,000	-40,000
2032 - 2033	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,200	40,900	1,200	22,000	32,000	52,000	249,000	1,900	172,000	5,820	41,000	65,000	286,000	-37,000
2033 - 2034	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,200	40,900	1,200	22,000	32,000	52,000	249,000	1,900	172,000	5,820	41,000	64,000	285,000	-36,000
2034 - 2035	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	40,700	1,200	20,000	31,000	53,000	247,000	1,900	171,000	5,820	42,000	56,000	277,000	-30,000
2035 - 2036	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	40,700	1,200	18,000	31,000	53,000	245,000	1,900	171,000	2,910	42,000	54,000	272,000	-27,000
2036 - 2037	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	40,700	1,200	17,000	31,000	53,000	244,000	1,900	171,000	2,910	41,000	52,000	269,000	-25,000
2037 - 2038	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	40,700	1,200	16,000	31,000	53,000	243,000	1,900	171,000	2,910	41,000	50,000	267,000	-24,000
2038 - 2039	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	40,700	1,200	16,000	31,000	53,000	243,000	1,900	171,000	2,910	41,000	48,000	265,000	-22,000
2039 - 2040	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	36,200	1,200	12,000	29,000	53,000	232,000	1,900	152,000	0	42,000	47,000	243,000	-11,000
2040 - 2041	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	36,200	1,200	10,000	30,000	53,000	231,000	1,900	152,000	0	42,000	46,000	242,000	-11,000
2041 - 2042	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	36,200	1,200	10,000	30,000	53,000	231,000	1,900	152,000	0	42,000	45,000	241,000	-10,000
2042 - 2043	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	36,200	1,200	9,000	30,000	53,000	230,000	1,900	152,000	0	42,000	44,000	240,000	-10,000
2043 - 2044	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	36,200	1,200	8,000	30,000	53,000	229,000	1,900	152,000	0	42,000	43,000	239,000	-10,000
2044 - 2045	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	36,200	1,200	8,000	31,000	53,000	230,000	1,900	152,000	0	42,000	42,000	238,000	-8,000
2045 - 2046	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	36,200	1,200	7,000	31,000	53,000	229,000	1,900	152,000	0	41,000	42,000	237,000	-8,000
2046 - 2047	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	36,200	1,200	7,000	31,000	53,000	229,000	1,900	152,000	0	41,000	41,000	236,000	-7,000
2047 - 2048	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	36,200	1,200	7,000	31,000	54,000	230,000	1,900	152,000	0	41,000	41,000	236,000	-6,000
2048 - 2049	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	36,200	1,200	6,000	31,000	54,000	229,000	1,900	152,000	0	41,000	41,000	236,000	-7,000
2049 - 2050	3,000	3,900	19,400	6,500	11,200	35,600	7,700	13,300	36,200	1,200	6,000	32,000	54,000	230,000	1,900	152,000	0	41,000	40,000	235,000	-5,000
2050 - 2051	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	6,000	31,000	54,000	218,000	1,900	141,000	0	41,000	41,000	225,000	-7,000
2051 - 2052	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	6,000	31,000	54,000	218,000	1,900	141,000	0	41,000	41,000	225,000	-7,000
2052 - 2053	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	6,000	31,000	54,000	218,000	1,900	141,000	0	41,000	41,000	225,000	-7,000
2053 - 2054	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	6,000	31,000	54,000	218,000	1,900	141,000	0	41,000	40,000	224,000	-6,000
2054 - 2055	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	5,000	31,000	54,000	217,000	1,900	141,000	0	41,000	40,000	224,000	-7,000
2055 - 2056	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	5,000	32,000	54,000	218,000	1,900	141,000	0	41,000	40,000	224,000	-6,000
2056 - 2057	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	5,000	32,000	54,000	218,000	1,900	141,000	0	41,000	39,000	223,000	-5,000
2057 - 2058	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	5,000	32,000	54,000	218,000	1,900	141,000	0	41,000	39,000	223,000	-5,000
2058 - 2059	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	5,000	32,000	54,000	218,000	1,900	141,000	0	41,000	39,000	223,000	-5,000
2059 - 2060	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	5,000	32,000	54,000	218,000	1,900	141,000	0	41,000	39,000	223,000	-5,000
2060 - 2061	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	4,000	32,000	54,000	217,000	1,900	141,000	0	41,000	39,000	223,000	-6,000
2061 - 2062	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	4,000	33,000	54,000	218,000	1,900	141,000	0	41,000	39,000	223,000	-5,000
2062 - 2063	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	4,000	33,000	54,000	218,000	1,900	141,000	0	41,000	39,000	223,000	-5,000
2063 - 2064	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	4,000	33,000	54,000	218,000	1,900	141,000	0	41,000	39,000	223,000	-5,000
2064 - 2065	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	4,000	33,000	54,000	218,000	1,900	141,000	0	41,000	39,000	223,000	-5,000
2065 - 2066	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	4,000	33,000	54,000	218,000	1,900	141,000	0	41,000	38,000	222,000	-4,000
2066 - 2067	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	4,000	33,000	54,000	218,000	1,900	141,000	0	41,000	38,000	222,000	-4,000
2067 - 2068	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	3,000	33,000	54,000	217,000	1,900	141,000	0	41,000	39,000	223,000	-6,000
2068 - 2069	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	3,000	33,000	54,000	217,000	1,900	141,000	0	41,000	38,000	222,000	-5,000
2069 - 2070	3,000	3,800	19,300	6,300	10,900	30,800	6,700	11,500	33,600	1,200	3,000	33,000	54,000	217,000	1,900	141,000	0	41,000	38,000	222,000	-5,000
17/18-69/70 Avg	3,000	3,900	19,000	6,400	11,000	36,800	8,000	13,700	36,100	1,200	11,000	33,000	52,000	235,000	1,900	152,000	3,300	41,000	55,000	253,000	-18,000

DELANO – EARLIMART
IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX A-3

Groundwater Flow Model

2024
2nd Amended Groundwater Sustainability Plan

Groundwater Flow Model of the Tule Subbasin

January 2020

Prepared for
Tule Subbasin MOU Group

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Acronyms

AFY – Acre-ft per year

ASTM – American Society for Testing and Materials

AWD – Angiola Water District

BGS - Below Ground Surface

BMP – Best Management Practices

CASGEM – California Statewide Groundwater Elevation Monitoring

CDWR – Department of Water Resources (California)

CGS – California Geological Survey

CHB - Constant Head Boundary

CIMIS – California Irrigation Management Information System

DCTRA- Deer Creek and Tule River Authority

DEID – Delano-Earlimart Irrigation District

DEM – Digital Elevation Model

DOGGR – California Division of Oil, Gas and Geothermal Resources

ET- Evapotranspiration

ET_o – Reference Evapotranspiration

FMP – Farm Process Package of MODFLOW

FWA – Friant Water Authority

GFM – Tule Subbasin Groundwater Flow Model

GIS – Geographic Information System

GPM - Gallons per Minute

GPS – Global Positioning System

GSA – Groundwater Sustainability Agency

GSP – Groundwater Sustainability Plan

InSAR – Interferometric Synthetic Aperture Radar

ITRC – Irrigation Training and Research Center

JPL – Jet Propulsion Laboratory

KTWD – Kern-Tulare Water District

LPF – Layer Property Flow Package of MODFLOW

LTRID – Lower Tule River Irrigation District

MNWD2 – Multi-Node Well Package of Modflow

MOU – Memorandum of Understanding

NASA – National Aeronautics and Space Administration

NRMSE – Normalized Root Mean Squared Error

RMS - Root Mean Squared

SGMA – Sustainable Groundwater Management Act

SUB – Land Subsidence Simulation Package of MODFLOW

SWP – State Water Project

TAC – Tule Subbasin Technical Advisory Committee

TH&Co - Thomas Harder & Company

TRA – Tule River Association

USBR – United States Bureau of Reclamation

USGS – United States Geological Survey

UWMP - Urban Water Management Plan

WBA – Water Budget Area

1.0 Introduction

1.1 Background

In order to assist in groundwater basin management planning and inform the preparation of Groundwater Sustainability Plans (GSPs) as required by the Sustainable Groundwater Management Act (SGMA), the Tule Subbasin Technical Advisory Committee (TAC) commissioned the preparation of a numerical groundwater flow model (GFM) of the Tule Subbasin. The Tule Subbasin is approximately 733 square miles located in the southwestern portion of Tulare County within the southern San Joaquin Valley Groundwater Basin (CDWR, 2003; see Figure 1). The Subbasin is divided into seven Groundwater Sustainability Agencies (GSAs):

1. Lower Tule River Irrigation District GSA
2. Pixley Irrigation District GSA
3. Eastern Tule GSA
4. Delano-Earlimart Irrigation District GSA
5. Tri-County Water Authority GSA
6. Alpaugh Irrigation District GSA
7. County of Tulare GSA - Tule

It is noted that the entire geographic area of the Subbasin is covered and managed by the first six GSAs. While the County of Tulare GSA is responsible for some lands within the Tule Subbasin, these areas are managed by the other GSAs through agreements. As such, this report presents results relating to the areas of the first six GSAs listed above.

Utilization of a calibrated groundwater flow model is a CDWR Best Management Practice (BMP) for developing GSPs to comply with SGMA. A BMP "*... refers to a practice, or combination of practices, that are designed to achieve sustainable groundwater management and have been determined to be technologically and economically effective, practicable, and based on best available science.*" (GSP Regulations, §351[i]). Prior to preparing the GFM, TH&Co prepared a detailed hydrogeologic conceptual model (BMP No. 3) and water budget (BMP No. 4) of the Tule Subbasin. These documents provide the foundational information on which the GFM is based.

1.2 Groundwater Flow Model Objectives

The GFM was prepared to address the following:

- Validate the preliminary Subbasin-wide groundwater and surface water budget and, as necessary, refine the least-known elements of the water budget via model calibration;
- Evaluate the Subbasin-wide Sustainable Yield estimate based on a future projection of groundwater projects, management actions, and climate change;
- Develop water budget estimates for each of the six GSAs of the Subbasin, which incorporates historical hydrological data, surface water rights specific to the individual GSAs, and future projections of groundwater pumping and imported water; and
- Evaluate historical land subsidence in the Subbasin and predict future land subsidence in areas of critical infrastructure.

1.3 Model Domain

The model domain is the three-dimensional volume of hydrogeologic media evaluated by the model. Based on the objectives of the GFM, and in consideration of potential impacts of pumping and recharge outside the Tule Subbasin boundaries on the water budget within the Tule Subbasin, the lateral model area was selected as shown on Figure 2. This model area extends approximately five to ten miles north of the northern Tule Subbasin boundary, four miles west of the western boundary, three to six miles south of the southern Tule Subbasin boundary, and a few miles into the Sierra Nevada Mountains on the east. The area of the Sierra Nevada Mountains between the alluvial/bedrock interface and eastern model boundary is inactive. The total model area is 1,472 square miles and the active model area is approximately 1,320 square miles (i.e., approximately 845,000 acres).

The vertical model domain was developed to simulate groundwater flow in the primary aquifers and aquitards that were identified in the conceptual model of the Tule Subbasin. Accordingly, the model consists of five layers of variable thickness throughout the model domain based on cross-sections developed from the conceptual model. The layers are described as follows:

- Layer 1 simulates groundwater flow in the upper unconfined aquifer;
- Layer 2 is an underlying comparatively low permeability unit separating the upper and lower aquifers and generally coincides with the Corcoran Clay west of Highway 99;
- Layer 3 simulates groundwater flow in the lower aquifer. This layer is semi-confined in the east and confined below the Corcoran Clay in the west;
- Layer 4 simulates groundwater flow in the Pliocene marine deposits between the overlying lower aquifer and, in the eastern portion of the Subbasin, the underlying Santa Margarita Formation aquifer;
- Layer 5 simulates groundwater flow in the Santa Margarita Formation aquifer in the eastern portion of the Subbasin.

1.4 Model Development Approach

The process for developing the groundwater flow model was consistent with standard procedures outlined in literature and other guidelines (Anderson and Woessner, 1992; ASTM, 1993; CDWR, 2016). The process is outlined in Figure 3 and included:

1. **Identification of the Model Domain**. The model domain was selected to encompass the entire Tule Subbasin as described in Section 1.3 (see Figure 2). The model domain was presented to the Tule Subbasin TAC in TH&Co (2017a).

2. **Identification of the Model Software.** TH&Co selected a model code with capabilities to address the modeling objectives and provide a foundation for future model updates and applications. A detailed description of the model code and suite of modeling tools selected for the Tule Subbasin groundwater flow model are provided in Section 3.1 of this report. Selection of the model software was presented to the Tule Subbasin TAC in TH&Co (2017a).

3. **Data Compilation and Review.** It was necessary to compile and review geological, hydrological, hydrogeological, and other data (see Section 1.5) to develop the hydrogeologic conceptual model and provide data for calibration targets and boundary conditions. Compiled data was organized and stored in a database for easy access and analysis.

4. **Hydrogeologic Conceptual Model Development.** The conceptual model was developed through the generation of hydrogeologic cross sections, groundwater contour maps, hydrographs, pumping test data, and groundwater quality data. The data analyses resulted in determination of model boundary conditions, layers, initial groundwater levels, and an initial aquifer parameter distribution. The hydrogeologic conceptual model was presented to the Tule Subbasin TAC in TH&Co (2017b).

5. **Development of Preliminary Surface Water and Groundwater Budgets.** Streamflow, surface water imports, evapotranspiration data, land use, groundwater underflow, groundwater pumping, and other hydrogeologic data were compiled into comprehensive surface water and groundwater budgets. The water budgets provided initial flux estimates for input into the groundwater flow model. The preliminary detailed historical surface water

and groundwater budgets were presented to the Tule Subbasin TAC in TH&Co (2017b), prior to development of the numerical model.

6. **Selection of the Calibration Period.** The model calibration period was selected based on the quality and quantity of data available for development of the conceptual model and preliminary water budget. Using this criterion, the transient period for calibration was selected to be October 1986 through September 2017.

7. **Numerical Model Development.** Data and analyses from the conceptual model were converted into a form suitable for input into the numerical model. This included designing the model grid, determining the simulation stress periods, importing layer boundaries, developing model input files for the various hydrogeological stresses (e.g. groundwater production and recharge), and importing initial aquifer parameter zones.

8. **Model Calibration.** The process of model calibration involved adjusting aquifer properties and stresses until an acceptable match was obtained between measured groundwater levels and simulated groundwater levels. Simulated changes in land surface elevation were also calibrated to data from Global Positioning System (GPS) stations and satellite data.

9. **Sensitivity Analysis.** A sensitivity analysis was conducted to assess the impact of varying aquifer properties and stresses on the model calibration.

10. **Uncertainty Analysis.** Using Sustainable Yield as the metric for evaluating model uncertainty, TH&Co developed a range in potential Sustainable Yield values from over 200 calibrated realizations of the model. The range in potential Sustainable Yield represented the uncertainty in the model.

1.5 Types and Sources of Data

Compilation, review and analysis of multiple types of data were necessary to develop the groundwater flow model. The various types of data are summarized in Figure 4 and include geology, soils/lithology, hydrogeology, surface water hydrology, climate, crop types/land use, topography, and groundwater recharge and recovery. Groundwater levels, well construction information, groundwater quality, and pumping test data were stored in a relational database. Other types of data necessary for analysis were compiled into spreadsheets.

Data for the development of the groundwater flow model were obtained from multiple sources:

Geological Data including geologic maps and cross sections were obtained from the United States Geological Survey (USGS) and the California Geological Survey (CGS).

Soils/Lithological Data including detailed lithologic logs from wells and test boreholes, geophysical logs, and driller's logs from wells and test boreholes from the CDWR, the USGS, the City of Porterville, the California Division of Oil, Gas and Geothermal Resources (DOGGR), and various local irrigation districts.

Hydrogeologic Data including groundwater levels and pumping tests were obtained from the CDWR, Lower Tule River Irrigation District (LTRID), Deer Creek and Tule River Authority (DCTRA), Angiola Water District (AWD), the City of Porterville, Kern-Tulare Water District (KTWD), DEID, and the California Statewide Groundwater Elevation Monitoring (CASGEM) website.

Groundwater Recharge and -Pumping Data including spreading basin locations and dimensions, artificial recharge, water well construction, well locations, groundwater production, surface water diversions, canal losses, and river losses were obtained from LTRID, Pixley Irrigation District, DEID, AWD, CDWR, Porterville Irrigation District, Tule River Association (TRA) annual reports, and DCTRA annual reports.

Hydrological (i.e., Surface Water) Data consisted of stream gage data along the Tule River, Deer Creek, and White River were obtained from the USGS, DCTRA reports and TRA annual reports. Imported water deliveries were obtained from LTRID, Pixley ID, DEID, KTWD, AWD, and the United States Bureau of Reclamation (USBR).

Climate Data was acquired from CDWR's California Irrigation Management Information System (CIMIS), TRA reports, and the Western Regional Climate Center website.

Land Use Data was obtained from the CDWR, LTRID, Pixley ID, Porterville ID, Saucelito ID, and the USGS Earth Resources Observation and Science Center. Political boundaries were obtained from the California Cal-Atlas Geospatial Clearinghouse and the LTRID.

Topographical Data including Digital Elevation Models (DEMs), topographical maps, GPS data, and Interferometric Synthetic Aperture Radar (InSAR) satellite data were acquired from the USGS, CDWR, and National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL).

In addition to the various types of data, TH&Co reviewed numerous historical reports on the geology, hydrogeology and groundwater management of the model area. These reports included

USGS publications, CDWR reports and bulletins, consultant reports and academic publications. Publications relied on for the model preparation are summarized in the References (Section 7).

2.0 Hydrogeologic Conceptual Model

The hydrogeologic conceptual model is a description of the groundwater flow system of the Tule Subbasin and how it interacts with surface water and land use of the area. The conceptual model includes a description of the geologic setting, boundary conditions, principal aquifers, and aquitards. The hydrogeologic conceptual model for the GFM domain is addressed in detail in TH&Co (2017b). This section presents a summary of the hydrogeologic conceptual model from that report.

2.1 Geology

Geologic formations observed at the land surface and in the subsurface beneath the Tule Subbasin can be grouped into five generalized geologic units, described below in order of increasing age:

> **Unconsolidated Continental Deposits** – These sediments consist of alluvial, fluvial (i.e., streambed deposits), flood plain, and lacustrine (i.e., lakebed) deposits (labeled "surficial deposits" on Figure 5). The unconsolidated continental deposits range in thickness from 0 ft at the eastern contact with the Sierra Nevada Mountains to more than 3,000 ft near the margins of Tulare Lake in the western part of the Subbasin (see Figure 5; Lofgren and Klausing, 1969). Subsurface alluvial sediments consist of highly stratified layers of more permeable sand and gravel interbedded with lower permeability silt and clay. Clear correlation of individual sand or clay layers laterally across the Tule Subbasin is difficult due to the interbedded nature of the sediments. However, it is noted that the thickness of clay sediments in the upper 1,000 ft below ground surface (bgs) generally increases in the western portion of the Subbasin in the vicinity of Tulare Lake. The unconsolidated continental deposits form the primary groundwater reservoir in the Tule Subbasin.
>
> The lowermost portion of unconsolidated continental deposits is generally correlated with the Tulare Formation. The Tulare Formation is notable in that it includes the Corcoran Clay, a regionally extensive confining layer that has also been referred to as the "E-Clay" (see Figure 5) (Frink and Kues, 1954). The Corcoran Clay consists of a Pleistocene diatomaceous fine-grained lacustrine deposit (primarily clay; Faunt, 2009). In the Tule Subbasin, the Corcoran Clay is as much as 150 ft thick beneath the Tulare Lake lakebed but becomes progressively thinner to the east, eventually pinching out immediately east of Highway 99 (Lofgren and Klausing, 1969).
>
> **Pliocene Marine Deposits** – These sediments underlie the continental deposits and consist of consolidated to loosely consolidated marine siltstone with minor interbedded sandstone beds. The marine siltstone unit thickens to the west, ranging from approximately 500 ft thick near State Highway 65 to more than 1,600 ft beneath Highway 99 (Lofgren and

Klausing, 1969; see Figures 2-5 and 2-6). The marine siltstone beds dip sharply from the base of the Sierra Nevada Mountains on the east to the central portion of the valley in the west. The Pliocene marine strata have relatively low permeability and do not yield significant water to wells.

Santa Margarita Formation – This formation occurs beneath the Pliocene marine strata and consists of Miocene (approximately 5.3 to 23 million years before present) sand and gravel that is relatively permeable and yields water to wells. The formation is approximately 150 to 520 feet thick and occurs at depths ranging from 1,200 feet near State Highway 65 to greater than 3,000 feet beneath State Highway 99. This formation is a significant source of groundwater to wells in the southeastern portion of the Tule Subbasin near the community of Richgrove (Lofgren and Klausing, 1969).

Tertiary Sedimentary Deposits – Beneath the Santa Margarita Formation exists an interbedded assemblage of semi-consolidated to consolidated sandstone, siltstone and claystone of Tertiary age (approximately 2.6 to 66 million years before present). Some irrigation wells in the southeastern part of the Tule Subbasin are known to produce fresh water from the Olcese Sand Formation, which is in the uppermost portion of the unit (Ken Schmidt, 2019. Personal Communication). The water quality of the groundwater in the Tertiary sedimentary deposits becomes increasingly saline to the southwest and most of the groundwater in the unit is not useable for crop irrigation or municipal supply except near Highway 65 (Lofgren and Klausing, 1969).

Granitic Crystalline Basement – Sedimentary deposits beneath the Tule Subbasin are underlain by a basement consisting of Mesozoic granitic rocks that compose the Sierra Nevada batholith (Faunt, 2009). At depth, the basement rocks are assumed to be relatively impermeable.

There are no significant faults mapped in the Tule Subbasin that would form a groundwater flow barrier or affect groundwater flow.

2.2 Hydrology

The hydrology of the model domain includes five significant surface water features (see Figure 6):

Tule River and Lake Success

The Tule River is the largest natural drainage feature in the Tule Subbasin. From its headwaters in the Sierra Nevada Mountains, the Tule River flows first into Lake Success. Lake Success is a manmade reservoir created by the construction of Success Dam (see Figure 6). Success Dam controls and measures releases of the Tule River. Lake Success is not explicitly included in the model although releases from the reservoir to the Tule River and Pioneer Canal, as recorded in TRA reports, are the basis for inflows to these surface water features.

Downstream of Lake Success, the Tule River flows through the City of Porterville where it is diverted at various points before flowing into the LTRID. A significant diversion point is the Porter Slough, which flows to the north and semi-parallel to the main river channel and is used to convey surface water to various recharge facilities and canals. Downstream of Porterville, the Tule River ultimately discharges onto the Tulare Lakebed during periods of above-normal precipitation. Stream flow is measured via gages located below Success Dam, at Rockford Station downstream of Porterville, and at Turnbull Weir (see Figure 6).

Releases of water below Lake Success dam are diverted from the Tule River channel at various locations. Diversion points along the river are located at the Porter Slough headgate, Campbell and Moreland Ditch Company, Vandalia Water District, Poplar Irrigation Company, Hubbs and Miner Ditch Company, and Woods-Central Ditch Company. In the water budget, infiltration that occurs in the Porter Slough is included as infiltration from the Tule River. Downstream of the Friant-Kern Canal the Tule River channel is also used as a conveyance mechanism to convey imported water to the Porterville Irrigation District (Porterville ID), LTRID and AWD. Within the Porterville ID and LTRID, a combination of natural stream flow and imported water are further diverted into unlined canals for distribution to artificial recharge basins and farms. Any residual stream flow left in the Tule River after diversions is measured at the Turnbull Weir, located at the west end of the LTRID (see Figure 6).

As streambed infiltration in the Tule River is measured between the various stream gages by the TRA, the Tule River is incorporated into the GFM as part of the recharge package with separate zones delineated between the stream gages where streambed infiltration has been measured.

Deer Creek

Deer Creek is a natural drainage that originates in the Sierra Nevada Mountains, flowing in a westerly direction north of Terra Bella and into Pixley (see Figure 6). Although the Deer Creek channel extends past Pixley, discharges rarely reach the Tulare Lake lakebed. Stream flow in Deer Creek has been measured at the USGS gaging station at Fountain Springs from 1968 to present time. Friant-Kern Canal water is also diverted into the Deer Creek channel and again measured at Trenton Weir before being delivered to riparian lands via unlined canals (see Figure 6). During wet years, water that reaches the terminus of Deer Creek is discharged into the Homeland Canal.

Deer Creek is included in the GFM as part of the recharge package, with separate zones delineated between stream gages where streambed infiltration has been estimated.

White River

The White River drains out of the Sierra Nevada Mountains east of the community of Richgrove in the southern portion of the Tule Subbasin (see Figure 6). Stream flow in the White River has been measured at the USGS gaging station near Ducor from 1972 to 2005. Data after 2005 has been extrapolated. The White River channel extends as far as State Highway 99 but does not reach the Tulare Lake lakebed. All streamflow in the White River that is not lost to evaporation is assumed to become groundwater recharge.

The White River is included in the Tule Subbasin model as part of the recharge package.

Tulare Lake

During the calibration period (1986 through 2017), Tulare Lake has been a dry lakebed except for localized residual marshes and wetlands and occasional flooding. This surface water feature is not explicitly included in the model.

2.3 Hydrogeology

In general, five aquifer/aquitard units comprise the Tule Subbasin:

1. Upper Aquifer (Model Layer 1)
2. The Corcoran Clay Confining Unit and Other Confining Units (Model Layer 2)
3. Lower Aquifer (Model Layer 3)
4. Pliocene Marine Deposits (generally considered an aquitard) (Model Layer 4)
5. Santa Margarita and Olcese Formations of the Southeastern Subbasin (Model Layer 5)

Detailed descriptions of these aquifers/aquitards are provided in TH&Co (2017b) and TH&Co (2020).

In general, groundwater in the Tule Subbasin flows from areas of natural recharge along major streams at the base of the Sierra Nevada Mountains on the eastern boundary towards a groundwater pumping depression in the west-central portion of the Subbasin (see Figures 7, 8 and 9). The pumping depression has reversed the natural groundwater flow direction in the western portion of the Subbasin, inducing subsurface inflow across the southern and western boundaries. Recharge from the Tule River results in a groundwater flow divide in the upper aquifer along the northern boundary of the Tule Subbasin. As such, upper aquifer groundwater on the north side of the river flows to the north and out of the Subbasin. Groundwater flow patterns in the upper aquifer have generally not changed significantly since the late 1980s (see Figures 7 and 8).

In the lower aquifer, groundwater flows to the southwest toward a pumping depression in the western portion of the Subbasin (see Figure 9). This pumping depression extends from west of Corcoran in the northwest to the Alpaugh area in the southwestern Tule Subbasin west of Highway 43.

Groundwater level changes over time can be observed from hydrographs for wells monitored in the Tule Subbasin. Despite a relatively wet hydrologic period between 1995 and 1999 and periodic wet years (2005 and 2011), groundwater levels in upper aquifer wells show a persistent downward trend between approximately 1987 and 2017 (see Figure 10). Groundwater level trends in wells perforated exclusively in the lower aquifer vary depending on location in the Subbasin (see Figure 11). In the northwestern part of the Subbasin, lower aquifer groundwater levels have shown a persistent downward trend from 1987 to 2017. In the southern part of the Subbasin, groundwater levels were relatively stable between 1987 and 2007 but began declining after 2007.

Comparisons of hydrographs for wells perforated in the upper aquifer with nearby wells perforated predominantly in the lower aquifer show that groundwater levels in the upper aquifer are higher than groundwater levels in the lower aquifer (see Figure 12). This indicates a downward hydraulic gradient and indicates that the upper aquifer is recharging the lower aquifer of the Tule Subbasin. Faunt (2009) has suggested that the recharge of the lower aquifer via wells that are perforated across both aquifers has increased with the number of deep wells constructed in the San Joaquin Valley.

2.4 Land Subsidence

Land subsidence in the Tule Subbasin as a result of lowering the groundwater level due to groundwater production has been well documented (Ireland et al., 1984; Faunt, 2009; Luhdorff and Scalmanini, 2014). Prior to 1970, as much as 12 ft of land surface subsidence was documented for the area immediately south of Pixley (Ireland et al., 1984). As groundwater levels stabilized in the area throughout the 1970s and early 1980s, land subsidence was largely arrested. During this time, monitoring for land subsidence that had previously been conducted along the portion of the Friant-Kern Canal that is within the Tule Subbasin was discontinued.

From the late 1980s into the 2000s, it is suspected that land subsidence in the Tule Subbasin was reactivated as groundwater levels declined. Groundwater flow model simulations of land subsidence in the Central Valley by Faunt et al. (2009), which were calibrated to historical land subsidence that occurred in the 1960s, simulated an additional two to four feet of land subsidence between 1986 and 2003.

The reactivation of land subsidence in the Subbasin was confirmed in the late 2000s based on data from InSAR satellites and one GPS station located in Porterville, California. InSAR data showed as much as four feet of additional land subsidence occurring in the northwestern portion of the Tule Subbasin between 2007 and 2011 (see Figure 13) (Luhdorff and Scalmanini, 2014). The GPS data showed that approximately 0.4 ft of land subsidence occurred in the Porterville area between 2007 and 2011. From 2015 through 2018, land subsidence in the Tule Subbasin, as observed from InSAR data, continued with as much as 2.75 ft of additional land subsidence in the northwest portion of the Subbasin and as much as 0.75 ft of additional land subsidence at the Porterville GPS station (see Figure 14). GPS data from the Delano, California station, located outside the Subbasin, showed approximately 1 ft of subsidence between 2012 and 2016. Based on benchmarks located along the Friant-Kern Canal and monitored by the Friant Water Authority (FWA), cumulative land subsidence along the canal between 1959 and 2017 has ranged from approximately 1.7 ft in the Porterville area to 9 feet in the vicinity of Deer Creek (see Figure 13).

The rate of land subsidence in the Tule Subbasin varies both spatially, according to the geology of the subsurface sediments and scale of groundwater level declines, and temporally with changes in groundwater levels associated with wet and dry periods. The average rate of change in land surface elevation between 1987 and 2018 for the area of maximum subsidence 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 0.1 ft/yr but increased to approximately 0.3 ft/yr between 2013 and 2019 (see Figure 14).

3.0 Groundwater Flow Model

3.1 Description of Model Codes

The Tule Subbasin groundwater flow model was developed using the numerical groundwater flow model code MODFLOW. MODFLOW is a block centered, finite difference groundwater flow modeling code developed by the USGS for simulating groundwater flow (McDonald and Harbaugh, 1988). MODFLOW is one of the most widely used and critically accepted model codes available (Anderson and Woessner, 1992).

In order to simulate surface water and groundwater interaction, land surface subsidence, and agricultural water budget components in the Tule Subbasin, TH&Co utilized the MODFLOW variant One-Water Hydrologic-Flow Model or MODFLOW-OWHM (Hanson et al.,2014, Boyce et al., 2018, and Boyce et al., in review). Specifically listed in CDWR (2016), this model code is designed to simulate the use and movement of water in irrigated agricultural areas with unmetered pumping and is particularly applicable to the Tule Subbasin where the majority of surface water and groundwater use is for agricultural irrigation.

3.2 Model Size and Grid Geometry

The GFM domain is approximately 41 miles in the east-west direction and 36 miles in the north-south direction and encompasses approximately 1,472 square miles at the western base of the Sierra Nevada Mountains in the south-central portion of the San Joaquin Valley Groundwater Basin (see Figures 1 and 2).

The model domain is discretized into 216 columns and 190 rows with 1,000 ft by 1,000 ft cells (see Figure 15). Each model layer is divided into 41,040 cells with a total of 205,200 cells in the entire five-layer model. The site coordinate system for the model was established in NAD 83 State Plane CA Zone 4.

3.3 Temporal Discretization

Both recharge and discharge were applied to the GFM in monthly stress periods for the calibration period (October 1986 through September 2017). October 1986 was selected as the starting time to include multiple dry and wet hydrologic periods and to avail the analysis of a previous water budget conducted by TH&Co (2015) that accounts back to 1986. The model period ended in September 2017 which corresponds to the end of the 2016/17 water year because that was the last month of complete surface water data.

3.4 Water Budget Areas

The Farm Process Package of MODFLOW accounts for the application, consumption and movement of water at the land surface in irrigated agricultural areas. The surface water budget is coupled with the groundwater flow system in the sense that the applied water demand of any given agricultural area that is not met by surface water supplies (i.e., imported water, diverted streamflow, or precipitation) is assumed to be supplied by pumped groundwater. In the Farm Process Package, agricultural areas can be subdivided to account for differences in crop type, e.g., irrigation efficiency, and available surface water supply, among others. To account for these unique water budget areas, the Farm Process Package (FMP) for the Tule Subbasin model was divided into agricultural water budget areas (referred to as "Farms" in Schmid and Hanson, 2009 and "water budget areas" (WBAs) in subsequent publications [Boyce et al., in review]).

The water budget areas assigned to the GFM are shown on Figure 16. Some of the water budget areas in the Tule Subbasin were delineated to match, or at least resemble, established irrigation districts or GSA political boundaries (e.g., WBAs 9, 11 and 12, which represent LTRID, Pixley Irrigation District and DEID, respectively). Other WBAs were identified for areas of similar crop types or areas not specifically identified with an agency. Agricultural water budgets were developed for each WBA in accordance with the land use and surface water supply data available for those areas.

3.5 Agricultural Water Use

Agricultural water use is simulated in the GFM using the FMP. Agricultural water use is a function of the total water demand of any given water budget zone, which is supplied through a combination of precipitation, surface water supplies, and groundwater pumping.

3.5.1 Estimates of Total Agricultural Irrigation Demand

Total agricultural irrigation demand is the total water demand necessary to sustain a crop in any given area. It is estimated based on land use data showing the types and areas of crops grown, evapotranspiration estimates for the individual crop types, and assumptions for irrigation efficiency based on the types of irrigation used to supply water to the crops (e.g., spray, drip, row and furrow, etc.).

Information on the types and areas of crops for the LTRID, Pixley Irrigation District, Porterville Irrigation District, and Saucelito Irrigation District were obtained from annual crop surveys from each respective district. The types and areas of crops in other parts of the Tule Subbasin were estimated from land use maps and associated data published by the CDWR for 1993, 1999, 2007 and 2014 (see Figure 17). For the portion of the model in Kern County, land use maps were obtained from CDWR (1990 and 2014) and Kern County Department of Agriculture and

Measurement Standards (1999 and 2007). For the portion of the model in Kings County, land use maps were obtained from CDWR for 1991, 1996, 2003, and 2014.

Consumptive use estimates for the various crop types were based on demands specific to the crops in the Tule Subbasin area, as published in ITRC (2003). The crop consumptive use estimates took into account effective precipitation (i.e. consumptive use associated with precipitation was removed from the total demand resulting in consumptive use associated with irrigation only). Crop types were grouped into the following categories (see Table 1):

- Grain and Grain Hay
- Truck
- Corn and Silage
- Miscellaneous Field Crops
- Grapes
- Cotton
- Deciduous and Fruit Trees
- Alfalfa and Pasture
- Nuts

Where appropriate, crop consumptive use estimates for any given area accounted for double cropping.

Deep percolation of applied irrigation water (i.e., return flow) was estimated based on the irrigation method for each land use type reported in CDWR land use maps. Irrigation efficiencies were applied to the different irrigation methods based on tables reported in California Energy Commission (2006). The irrigation types and their respective efficiencies are as follows:

- Border Strip Irrigation – 77.5 percent
- Micro Sprinkler – 87.5 percent
- Surface Drip Irrigation – 87.5 percent
- Furrow Irrigation – 67.5 percent

TH&Co assigned a single crop consumptive use and irrigation efficiency estimate to each water budget zone for any given time period. Each was area-weighted according to the land use in that zone (see Table 2). In order to simulate changes in cropping patterns over time, TH&Co relied on CDWR land use maps for 1993, 1999, 2007, and 2014. TH&Co estimated area-weighted irrigation efficiencies for two time periods: 1986 to 2002 and 2003 to 2017.

Total estimated agricultural irrigation demand for any given time period was based on the area-weighted consumptive use estimate multiplied by the area of the water budget zone divided by the irrigation efficiency.

3.5.2 Estimates of Individual Water Supplies to Meet Irrigation Demand

Agricultural irrigation demand is met from three sources: precipitation, surface water deliveries, and groundwater pumping. Consumptive use estimates from ITRC accounted for effective precipitation (see Section 3.5.1). Thus, irrigation demand in the WBAs of the model was met from surface water supplies and groundwater pumping.

Surface water deliveries to crops occur via imported water from the Friant-Kern Canal and other canals in the Subbasin as well as diverted streamflow from the Tule River and Deer Creek. Monthly imported surface water deliveries for WBAs covering Porterville ID, Saucelito Irrigation District, Tea Pot Dome Water District, Alpaugh Irrigation District, Atwell Island Irrigation District, and Terra Bella Irrigation District were obtained from United States Bureau of Reclamation (USBR) Central Valley Operation Annual Reports. Monthly imported water data for LTRID and other agencies was provided by the respective agencies. Monthly surface water deliveries of diverted streamflow from the Tule River are based on TRA annual reports. Monthly surface water deliveries of diverted streamflow from Deer Creek were provided by agencies that divert the water.

Groundwater pumping is estimated in each water budget zone as the balance of the total water demand not met from precipitation and surface water supplies.

Historical agricultural water demand by source is summarized in Appendix A.

3.6 Boundary Conditions

Boundary conditions specify groundwater elevations (head boundaries) or flows (flux boundaries, for example pumping wells) near the perimeter and/or within the model domain. Functionally speaking, boundary conditions add or remove water from the groundwater system and can be specified anywhere in the model.

3.6.1 Lateral Model Boundaries

Boundary conditions applied near the perimeter of the model domain include no-flow cells (inactive), recharge points along the base of the Sierra Nevada Mountains, and time-varying specified head cells (see Figure 15). Due to the uncertainty of groundwater flow in the fractured bedrock of the Sierra Nevada Mountains, the portion of the model domain overlying the surface expression of the bedrock in this area was designated as “inactive” and assigned with “no-flow” cells. Groundwater recharge attributed to subsurface inflow from the mountain-block to the alluvial aquifer system was addressed using recharge points (i.e. injection wells) placed at the base of the mountains within the active model area. Groundwater levels at the north, west and southern Subbasin boundaries are constrained to measured groundwater levels in 29 wells located near the model boundary; 15 wells perforated in the upper aquifer and 14 wells perforated in the lower aquifer (see Figure 15). Groundwater levels in between the control wells were spatially and temporally interpolated for any given monthly stress period. Hydrographs for boundary control wells are provided in Appendix B.

3.6.2 Layer Elevations

Model layers were developed based on analysis of five hydrogeologic cross sections extended through the model domain (see Figures 5, 18, and 19; Plates 1 through 5). The cross sections were developed based on driller's logs, geophysical logs, and well construction information. The top of Layer 1 is the ground surface as imported from USGS DEMs with a horizontal 1 arc-second (approximately 10-meter) resolution and vertical accuracy of approximately 3 meters; these values were averaged for each 1,000 ft x 1,000 ft cell. The boundaries between each model layer were contoured using ESRI ArcMap v. 10.6.1 based on the layer top and bottom elevations from the cross sections and other control points from well logs and geophysical logs.

Model Layer 1 corresponds to the Upper Aquifer. The bottom of Layer 1 was selected to correlate with the top of the Corcoran Clay, where it exists, and is generally shallower than the top of perforations for most wells in the eastern part of the Tule Subbasin. The thickness of Layer 1 ranges from less than 50 feet in an area north of Porterville to approximately 450 feet near Corcoran (see Figure 20). This layer was designated as convertible (i.e., variably unconfined/confined) although given that groundwater levels are always below the land surface, this layer is always unconfined.

Layer 2 corresponds to the Corcoran Clay, where it exists, primarily west of Highway 99 (see Figure 18). The thickness of Layer 2 ranges from approximately 50 feet at the base of the Sierra Nevada Mountains in the eastern model domain to approximately 500 feet in the western part of the model domain (see Figure 21). This layer was designated as convertible such that when groundwater levels are above the top of the model layer, storage properties associated with confined conditions were applied and when groundwater levels are below the top of the model layer, storage properties associated with unconfined conditions were applied.

Layer 3 generally corresponds to the Lower Aquifer. This aquifer ranges in thickness from less than 250 feet at the base of the Sierra Nevada Mountains to approximately 2,000 feet in the northwest model domain (see Figure 22). Like the overlying layers, Layer 3 was designated as convertible.

Layer 4 generally correlates to Pliocene marine sedimentary deposits in the eastern portion of the Tule Subbasin. This layer is generally considered an aquitard separating the overlying Lower Aquifer (Layer 3) from the underlying Santa Margarita Formation aquifer (Layer 5). The thickness of Layer 4 ranges from less than 250 feet along the model edges to greater than 1,700 feet in the south-central model area (see Figure 23). This layer is modeled as confined.

Layer 5 represents the Santa Margarita Formation and upper portion of the Olcese Formation in the eastern part of the Tule Subbasin. The thickness of this layer ranges from 0 to 1,000 feet thick (see Figure 24). The bottom of Layer 5 is a no flow boundary. This layer is modeled as confined.

3.6.3 Groundwater Level Initial Conditions

The initial groundwater level conditions for the start of the model transient period was based on a groundwater contour map of the model domain generated from groundwater levels measured in from October 1986 to March 1990 (see Figure 7).

3.6.4 Groundwater Recharge

3.6.4.1 Agricultural Return Flow – Farm Process Package

Deep percolation and groundwater recharge of applied water from agricultural irrigation (i.e., return flow) was addressed using the FMP. Return flow was simulated using FMP based on the average consumptive use and irrigation efficiency assigned to each water budget zone.

3.6.4.2 Mountain-Block Recharge – Well Package

Subsurface inflow to the alluvial aquifer system from the fractured bedrock along the base of the Sierra Nevada Mountains was simulated using the Well Package (WEL). Thirty-seven injection wells were placed at the base of the Sierra Nevada Mountains along the bedrock alluvial interface to simulate the recharge (see Figure 15). Recharge was directed into Layer 3 of the model. As the contribution of recharge to the alluvial aquifer system from the mountain block is one of the least known aspects of the water budget, recharge rates in the injection wells were varied across a wide range during the calibration process in order to find the optimum recharge rate to achieve model calibration.

3.6.4.3 Subsurface Inflow in the Alluvial Channel of the Tule River

Some subsurface inflow of groundwater is expected in the Tule River channel at the eastern boundary of the active model area. This inflow was simulated with a time-varying specified head cell placed at the location of Well 22S/28E-03H01. The specified heads were fixed at the groundwater levels measured in this well for its period of record from October 1986 to February

2008 (see Appendix B). The flows from this boundary condition are represented as the Mountain Block Recharge in the water budget.

3.6.4.4 Other Recharge

For all other recharge in the Tule Subbasin Model, recharge was applied to the uppermost active model layer within 71 individual recharge zones using the MODFLOW Recharge Package (RCH). The following sources of groundwater recharge were simulated in the model using the Recharge Package:

- Deep percolation of precipitation
- Streambed infiltration and recharge in the Tule River (including Porter Slough), Deer Creek, and White River channels
- Artificial recharge in basins
- Infiltration in unlined canals
- Areas of septic return flow and urban landscape return flow

3.6.5 Groundwater Pumping

Groundwater pumping was simulated using the MODFLOW Multi-Node Well Package (MNW2). For agricultural groundwater production, pumping was assigned to individual wells based on the required pumping demand estimated from the FMP. For most areas of the model, representative wells were placed at mile-square centers and perforated in accordance with the average perforation interval of wells in their respective water budget zone from driller’s logs in the CDWR driller’s log database (see Figure 25). In the 10-mile corridor centered on the Friant-Kern Canal, a more detailed accounting of actual pumping wells was input with reported perforation intervals in order to provide for a more detailed analysis of land subsidence along the canal. A total of 1406 agricultural wells were included in the model.

For municipal pumping (e.g., City of Porterville) and agency pumping (e.g., Angiola Water District) where the locations and depth intervals of the wells were known or inferred, the wells were included in the model explicitly. A total of 273 municipal or irrigation district wells were included in the model (see Figure 25)

Groundwater production was assigned to each well in the model in monthly stress periods. Agricultural pumping was assigned to individual wells based on the required pumping demand estimated from the FMP. Annual agricultural and municipal groundwater pumping for the period of the model is shown in Figure 26.

3.7 Aquifer Characteristics

The propensity of aquifer sediments to transmit and store water is described in terms of transmissivity, hydraulic conductivity, and storativity. The aquifer system of the Tule Subbasin is highly heterogeneous and aquifer permeability and storage characteristics vary greatly both laterally and vertically. Where possible, TH&Co relied on long-term pumping test data to develop initial ranges of aquifer parameter estimates for input to the model (see Table 3). In the absence of this type of test, aquifer parameter estimates were also obtained from analysis of short-term pumping tests, textural analysis obtained from Faunt et al. (2009), and/or assignment of literature values based on the soil types observed in driller's logs. This section describes the aquifer parameters used in the GFM.

3.7.1 Transmissivity and Hydraulic Conductivity

Transmissivity is a measure of the propensity for groundwater to flow within an aquifer and was primarily developed for analysis of well hydraulics in confined aquifers (Freeze and Cherry, 1979). Multiple sources of data for estimating transmissivity were obtained, reviewed, and analyzed, including previous modeling efforts (Faunt et al., 2009), other technical reports, and pumping test data from local agencies (Schmidt, 2018). Transmissivity estimates were obtained from pumping test data for 225 wells, 29 of which were perforated only within the Upper Aquifer, 70 of which were perforated only within the Lower Aquifer, and 126 of which were perforated across multiple aquifers. Of the available pumping test data, 43 tests were known to be long-term tests (i.e., 24 hours or greater) and 55 tests were known to be short-term specific capacity tests (see Table 3). Details on the test duration for the remaining 125 wells was unknown.

The permeability of the sediments with respect to a given fluid (in this case, groundwater) in each layer of the model is expressed as hydraulic conductivity. Horizontal hydraulic conductivity is related to transmissivity through the following relationship:

$$K = \frac{T}{b}$$

Where:

K = Horizontal hydraulic conductivity (ft/day);
T = Transmissivity (ft/day); and
b = Aquifer thickness (ft)

Given our configuration of MODFLOW-OWHM, hydraulic conductivity was an input to the GFM whereas transmissivity was not. The distribution of horizontal hydraulic conductivity in each layer of the model was initially developed based on pumping test data and associated transmissivity estimates, supplemented with interpretation of soil properties through texture analysis, and finalized through the calibration process described in Section 3.8. The initial horizontal hydraulic conductivity distribution of each model layer was developed as a map that included pumping test-derived values overlaid on a visualization of percent coarse sediment by layer from soil textural analysis obtained from Faunt et al. (2009). Higher percentages of coarse-grained sediment were correlated with higher hydraulic conductivity values.

Hydraulic communication between adjacent model layers was addressed through vertical hydraulic conductivity. Because sediments are generally deposited in layers in alluvial/fluvial environments, horizontal hydraulic conductivity is often significantly greater than vertical hydraulic conductivity. Such sediments are said to be vertically anisotropic. Quantification of vertical hydraulic conductivity was accomplished via model calibration as described in Section 3.8. Similarly, the sediments may also be horizontally anisotropic as noted in Neuman et al. (1984) and more recently in Gianni et al. (2019). Like the vertical hydraulic conductivity, horizontal anisotropy was also quantified through model calibration.

3.7.2 Storage Properties

The release and uptake of water to and from storage was simulated using specific yield, specific storage, the elastic storage coefficient, and the inelastic storage coefficient. Specific yield and the elastic storage coefficient govern the reversible release and uptake of water whereas the inelastic storage coefficient governs the irreversible release of water due to compaction of porous media.

- Specific yield represents unconfined storage associated with draining or filling of porous media due to changes in the water table. It is defined as the difference between porosity and specific retention, where porosity is associated with the pore space volume and specific retention is associated with that portion of the pore space volume that does not drain.
- Specific storage represents confined storage associated with expansion or compression of both water and soil ‘skeleton’. These processes are simulated within MODFLOW-OWHM by considering both elastic (reversible) compression and expansion of the soil skeleton and inelastic (irreversible) compression of the soil skeleton. As the term is used here, inelastic compression is the irreversible reduction in pore space that results in land subsidence.

The values of these storage properties were quantified through model calibration as described in Section 3.8.

3.7.2.1 Specific Yield

Layers 1, 2, and 3 of the GFM may be unconfined or confined (i.e., they are specified to be 'convertible' as noted above) depending on groundwater level conditions, which vary transiently throughout the model simulation. The specific yield values for these three uppermost model layers are specified exclusively in the LPF package. Conversely, being specified as confined layers, values of specific yield are not assigned to Layers 4 and 5.

Although previous model studies of the Tule Subbasin provided estimates of specific yield (Ruud et el, 2003; Faunt et al., 2009), to date, there are no measured data with which to estimate specific yield.

3.7.2.2 Specific, Elastic, and Inelastic Storage

In MODFLOW, the layer property flow package (LPF) is linked to the subsidence package (SUB) displacements through changes in the elevations of cell-by-cell layer boundaries. Given this linkage, parameters associated with the elastic and inelastic storage are specified in both packages. Specifically, subsidence is computed using the values for specific storage in the LPF package (which have dimensions of 1/ft) and the dimensionless elastic and inelastic storage coefficients in the SUB package. The portion of elastic and inelastic storage associated with the compressibility of water is specified in the LPF package as the 'specific storage' whereas the portion associated with compressibility of the soil skeleton were assigned in the MODFLOW subsidence package. Elastic storage is associated with the reversible compressibility of the soil skeleton whereas inelastic storage is associated with the irreversible compressibility of the soil skeleton.

3.7.3 Critical Hydraulic Head

Land subsidence in the SUB package of the model is a function of the effective stress of the aquifer system and changes in hydraulic head.

Non-recoverable (i.e., irreversible or inelastic) land subsidence occurs in the SUB package when the change in effective stress under a given hydraulic head condition exceeds the previous maximum effective stress (or pre-consolidation stress) of the aquifer system. This maximum effective stress can generally be defined by the previous lowest groundwater level (Sneed, 2001), herein referred to as the "critical head."

In order to define the critical head in the Tule Subbasin groundwater model, TH&Co analyzed the previous lowest groundwater level in the Tule Subbasin prior to the start of the model transient period in 1986. In general, this groundwater level condition is indicative of the early to mid-1960s, as documented in Ireland et al., 1984. The historical low groundwater level prior to 1986 in each calibration target well was used to provide an initial estimate of critical head, which was refined through model calibration.

3.8 Model Calibration

As noted in CDWR (2016), model calibration is required by the GSP Regulations (*§*352.4(f)(2)). Calibration is performed to demonstrate that the model can reasonably reproduce (simulate) historical measurements (e.g., groundwater elevations and land subsidence measurements). Calibration generally involves iterative adjustments of various model parameters until the simulated results reasonably match historical measurements. As their precise values are unknown, aquifer characteristics such as those described in the previous subsection are commonly modified during model calibration. Adjustment of parameter values is constrained within a range of reasonable values through review of aquifer test data, borehole data, hydrographs, and literature data.

The precise values of the numerous aquifer characteristics described in the previous subsection (i.e., horizontal hydraulic conductivity, vertical hydraulic conductivity, horizontal anisotropy, specific yield, specific storage, elastic storage, inelastic storage, and critical head) vary laterally and vertically throughout the Subbasin and are unknown. Therefore, these characteristics were quantified through calibration. Given the functionality provided by MODFLOW-OWHM, consumptive use and mountain block recharge were refined from initial values through calibration.

Given the large number of these ‘calibration parameters’, their spatial variability within and across model layers, the interconnection between water levels and land subsidence, and the goal of conducting a predictive uncertainty analysis as described in CDWR (2016), ‘trial-and-error’ calibration (as described in Anderson and Woessner, 1992) was largely abandoned in favor of automated calibration using PEST (Doherty, 2003 and 2015). The GFM was calibrated to both measured groundwater levels and measured changes in land surface elevation.

3.8.1 Calibration Targets for Groundwater Levels

Simulated groundwater levels were calibrated to measured data collected between October 1986 and September 2017 in selected monitoring wells throughout the Tule Subbasin. The 32 target wells for the model calibration are shown on Figure 27. The model was specifically calibrated to groundwater level observations from wells perforated exclusively in either model Layers 1, 3, or 4. Calibration to observed groundwater levels in Layer 2 was not conducted due to a lack of observation wells perforated in this layer. Groundwater level data specific to Layer 5 is not available. Other criteria for selection of calibration target wells included:

1. Adequate historical groundwater level record.

2. Relative assurance that the measured data were indicative of static groundwater level conditions.

3.8.2 Calibration Targets for Land Subsidence

Land subsidence was calibrated at 45 target locations to Interferometric Synthetic Aperture Radar (InSAR) satellite data (see Figure 28). InSAR is a technique for measuring changes in land surface elevation using two or more radar images of the earth's surface to determine any change in land surface elevation. TH&Co obtained historical InSAR land subsidence data for the 45 target locations from the Jet Propulsion Laboratory (JPL). The 45 target calibration locations are generally evenly space across the Tule Subbasin area at 3- to 4-mile spacings. Data were available for the following periods of time:

- 2007 - 2011
- 2014 - 2015
- 2015 - 2017

TH&Co was also able to calibrate land subsidence to land surface elevation data from two Global Positioning Stations (GPS) located near the Porterville Airport and the City of Delano. Land surface elevation data was available for both stations for the period from November 2005 to May 2018 (see Figure 14).

Calibration of changes in land surface elevation was conducted based on relative changes in land surface elevation rather than actual elevation. Land surface elevation datum was not available at an accuracy that would provide a meaningful reference for calibrating actual land surface elevation. The top of the model is defined based on the USGS DEM, which has a vertical accuracy of plus/minus 3 meters (see Section 3.6.2). In addition, it is possible that the elevation defined by the DEM, which is based on NAVD 88, changed between the time the reference was defined and 1986 (the start of the transient model period). Given these limitations, TH&Co instead calibrated land subsidence based on relative change in land surface elevation indicated by the InSAR data for the three time periods indicated above and the data from the Porterville and Delano GPS stations.

3.8.3 Calibration Process

The general calibration process for the GFM included the following steps:

1. A plausible range of values for each of the 41 parameters was assigned to each of 109 pilot points evenly spaced within Layers 1 through 4 and 53 pilot points evenly spaced within

Layer 5 (see Figure 27). The magnitude of the range assigned to each parameter at each pilot point varied based on the quality of the data in the vicinity of the pilot point. For example, pilot points near wells with controlled pumping test data were given a smaller range than those in areas with no available pumping test data. The input parameter groupings that were adjusted during the calibration process included:

- Horizontal hydraulic conductivity (‘kh’);
- Vertical hydraulic conductivity (‘kv’);
- Horizontal anisotropy (‘hani’);
- Specific yield (‘sy’);
- Specific storage(‘ss’);
- Elastic storage (‘ske’);
- Inelastic storage (‘skv’);
- Critical head (‘ch’);
- Mountain block recharge (MBR; ‘wm’);
- Crop consumptive use (‘um’); and
- Well radius (‘rad’).

2. Some parameters are expected to be correlated with horizontal hydraulic conductivity (‘kh’). Therefore, they were expressed as functions of ‘kh’ based on literature values and professional judgment within PEST to maintain a reasonable degree of consistency among such parameters. For example, soils with high ‘kh’ values generally have high ‘sy’ values; conversely, soils with high ‘kh’ values generally have low ‘ske’ values.
3. Given the number of pilot points and associated calibration parameters, several thousand MODFLOW-OWHM runs through PEST and its utility programs were required to calibrate the GFM, complete the sensitivity analysis, and provide the information needed for the predictive uncertainty analysis.
4. The calibration parameters most sensitive parameters to model outcome (defined as the change to the objective function) are horizontal hydraulic conductivity of Layers 1 through 4 (kh1 through kh4) and specific yield of Layer 1 (sy1).

3.8.4 Calibration Results

Using PEST and its associated utility programs, over 200 calibrated models were generated. That is, owing to the non-uniqueness of the solution to hydrogeologic models in general, over 200 different spatial configurations of the calibration parameters that resulted in a calibrated model were generated. Additional calibrated models could have been generated but given the ultimate objective of quantifying the sustainable yield and its uncertainty, having over 200 calibrated models was deemed sufficient. Plan-view plots showing the spatial distribution of the calibration parameters for all five model layers for one of these calibrated models are provided in Appendix C. Visual inspection of these plots shows the calibrated values to be reasonable given the available Subbasin-specific and literature data (e.g., the calibrated values of horizontal hydraulic conductivity are in generally good agreement with those obtained from pumping tests as shown on the plan-view plots). The range of values for the most sensitive parameter groups (i.e., hydraulic conductivity and specific yield) are as follows:

	Horizontal Hydraulic Conductivity; kh (ft/day)*			**Specific Yield; sy (unitless)**		
Model Layer	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**	**Maximum**
1	2	20	160	0.001	0.09	0.25
2	0.01	9	120	0.007	0.06	0.25
3	1	20	200	0.01	0.1	0.25
4	0.1	2	20	Not applicable for confined layer		
5	3	4	5	Not applicable for confined layer		

* The anisotropy ratio is the ratio of horizontal hydraulic conductivity along model columns to that along model rows. It ranged from 0.3 to 3.0.

The range of values for elastic and inelastic storage are provided in the table below.

	Elastic Storage, S_e (unitless)			**Inelastic Storage, S_i (unitless)**		
Model Layer	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**	**Maximum**
1	1.00 x 10^{-5}	4.92 x 10^{-5}	2.68 x 10^{-4}	1.00 x 10^{-3}	4.49 x 10^{-3}	6.77 x 10^{-2}
2	1.00 x 10^{-5}	4.71 x 10^{-4}	1.00 x 10^{-3}	1.00 x 10^{-3}	5.17 x 10^{-2}	1.00 x 10^{-1}
3	1.00 x 10^{-5}	6.82 x 10^{-5}	4.61 x 10^{-4}	1.00 x 10^{-3}	5.33 x 10^{-3}	3.57 x 10^{-2}
4	1.27 x 10^{-5}	1.29 x 10^{-4}	6.62 x 10^{-4}	1.00 x 10^{-3}	2.61 x 10^{-2}	1.00 x 10^{-1}
5	1.20 x 10^{-5}	8.53 x 10^{-5}	3.17 x 10^{-4}	1.14 x 10^{-3}	9.74 x 10^{-3}	4.65 x 10^{-2}

Model calibration is typically judged using qualitative and quantitative methods. At first, a qualitative visual comparison of simulated groundwater elevations and subsidence rates to measured values was performed. Upon achieving visually acceptable results, quantitative methods as presented in the subsections below were applied to further evaluate the quality of the calibration. Finally, from a water accounting perspective, water budget errors are expected to be less than 1 percent (Hill and Tiedeman, 2007; Anderson and Woessner, 1992). The numerical water budget error for the final calibration was 0.1 percent, which is within the limits of acceptable error.

3.8.4.1 Groundwater Elevations

Calibration hydrographs showing both measured and model-generated groundwater elevations are provided in Appendix D. The simulated groundwater elevations reasonably match the measured elevations at most of the target wells in the model. A scatter plot of simulated versus measured groundwater elevations for the 1,371 groundwater level observations in the calibration is shown in Figure 29. The correlation coefficient between the simulated and measured values is 0.95, which is an acceptably large value that exceeds the benchmark value of 0.90 noted in CDWR (2016) and Hill and Tiedemann (2007).

Another common measure of model calibration is the normalized root mean squared error (NRMSE). The 'error' is the difference between the simulated head value and the measured head value. The error is referred to as the 'residual' and the RMSE, which is normalized by the measured range of groundwater elevations in the model ('range').

$$NRMSE = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n} R_i^2}}{range}$$

Where:

n = Number of observations; and
R = Residual (ft).

The NRMSE is expressed as a percent with results less than 10 percent generally considered to be acceptable. The NRMSE for the GFM with respect to groundwater elevations is at an acceptably low value of 6.6 percent (see Figure 29).

3.8.4.2 Land Subsidence

Calibration graphs showing both measured and simulated subsidence are provided in Appendix E. The simulated land subsidence reasonably matches that measured at the Porterville and Delano GPS stations and via satellite at most of the target locations. A scatter plot of simulated versus measured land subsidence for the 2,616 observations in the calibration is shown in Figure 30. The correlation coefficient between the simulated and measured values is at an acceptably large value of 0.94 and the NRMSE for the GFM with respect to land subsidence is at an acceptably low value of 6.5 percent (see Figure 30).

Given the nature of the subsidence data to which the GFM is calibrated, simulated land subsidence by the model is acceptably calibrated to enable projections of relative change in land surface elevation in the future (e.g. 2.1 feet of subsidence). It is not recommended to determine absolute values of projected land surface elevation.

3.8.4.3 Calibration Summary

Based on the acceptably low water budget error and NRMSE values along with the acceptably high correlation coefficients, the GFM is acceptable for its intended use to estimate the future water budget, project future groundwater level changes, and estimate relative changes in future land elevation for evaluating projects and managements actions and estimating the Sustainable Yield of the Subbasin.

The resulting surface and groundwater budgets produced by the calibrated model are presented in Tables 4a, 4b, and 5. A detailed description of the individual water budget items can be found in the Tule Subbasin Setting document (TH&Co, 2020).

4.0 Future Subbasin Management Scenario for Analysis with the Model

In order to evaluate planned projects and management actions of each of the six GSAs within the Tule Subbasin, refine the sustainable yield and develop a future water budget for inclusion in the Subbasin Setting document of the GSPs, TH&Co analyzed a future subbasin management scenario with the calibrated GFM. The future scenario began in October 2017 (the end of the model calibration period) and extended through September 2070 and utilized yearly (i.e., water year) stress periods. Projects and management actions were incorporated into the GFM starting in 2020. The purpose for analyzing the scenario was to assess the sustainability of the planned actions, assess the interaction of the planned actions on groundwater levels between the GSAs, and estimate the sustainable yield of the Subbasin.

4.1 Projects and Management Actions

Projects for incorporation in the future scenario were provided by basin managers from each of the six Tule Subbasin GSAs (see Table 6). Most of the projects involve increases in recycled water recharge, increased basin recharge, changes in water deliveries, capture of flood water, and water banking operations.

Management actions for incorporation into the model were focused on the reduction in crop consumptive use necessary to achieve sustainability (see Table 7). The reduction in crop consumptive use is directly correlated to a reduction in irrigated water demand and groundwater pumping. Each GSA provided a schedule to reduce consumptive use, starting in 2020, in order to achieve sustainable groundwater pumping by 2040. As the availability of surface water supplies from imported water and diverted streamflow is different between the GSAs, each GSA established a different consumptive use reduction, or “transitional pumping,” schedule (see Table 7).

4.2 Assumptions for Municipal Pumping

Future projections for municipal pumping were applied to the City of Porterville. Other cities and communities (e.g., Tipton, Richgrove, etc.) were assumed to continue 2017 pumping rates into the future.

4.3 Assumptions for Hydrology and Surface Water Deliveries on Major Streams

Baseline stream flow hydrology for the Tule River, Deer Creek and White River for the future projection model was based on the 20-yr average of historical stream flows measured or estimated between water years 1990/91 and 2009/10. This base period approximates the 115-year average surface water flow within the Tule River between 1903/04 and 2016/17 (TRA 2018 Annual Report, Appendix). Baseline surface water deliveries to agencies with diversion rights in the future projection were also based on the 20-yr average of deliveries for the period 1990/91 to 2009/10.

The baseline streamflow on the major streams used in the future projection for the model were adjusted to account for projections of future climate change. Adjustments were applied based on output from the DWR's CalSim-II model, which provided adjusted historical hydrology for major drainages based on scenarios recommended by the California Department of Water Resources Climate Change Technical Advisory Group (2015). Climate change adjustments to hydrology and surface water deliveries were applied over two time periods within the SGMA planning horizon, as defined by California Water Commission (2016):

1. A 2030 central tendency time period, which provides near-term projections of potential climate change impacts on hydrology, centered on the year 2030, and
2. A 2070 central tendency time period, which provides long-term projections of potential climate change impacts on hydrology, centered on the year 2070.

Change factors for the 2030 and 2070 central tendency time periods are shown for the hydrology associated with the Tule River historical baseline time period of 1990/91 to 2009/10 on Figure 31. Both the annual change factors and weighted average change factors are shown. In the future projection scenario for the model, TH&Co used the average 2030 change factor for each major stream providing water within the model domain (see Figure 32). The climate adjusted hydrology for these major streams after applying the 2030 change factors ranges from 98 percent to 101 percent of the historical baseline average. The climate adjusted hydrology after applying the 2070 change factors ranges from 95 percent to 101 percent of the historical baseline average. The 2030 central tendency change factors were applied to the future projection scenario from 2025 to 2049. The 2070 central tendency change factors were applied to the future projection from 2050 to 2070.

4.4 Assumptions for Friant-Kern Canal Deliveries

Projected surface water deliveries from the Friant-Kern Canal were based on climate adjusted historical average deliveries from 1990/91 to 2009/10 provided by the Friant Water Authority (FWA, 2018 and supporting Excel files). It is noted that the climate adjusted historical FWA data extended only to 2002/03. Thus, it was necessary to estimate the climate adjusted deliveries for 2003/04 through 2009/10 based on proxy years according to the following schedule:

- 2003/04 – 1946/47
- 2004/05 – 1935/36
- 2005/06 – 1939/40
- 2006/07 – 1975/76

- 2007/08 – 2001/02
- 2008/09 – 1963/64
- 2009/10 – 1950/51

The proxy years were selected based on years when the inflow to Success Reservoir was as close as possible.

The climate adjusted deliveries to each agency included Class I, Class II, and 16B deliveries. Climate adjusted deliveries were also adjusted to account for impacts to deliveries as a result of the San Joaquin River Restoration Project (SJRRP) implementation. All climate change and SJRRP adjustments were applied starting in 2025. Deliveries from the Friant-Kern Canal between 2020 and 2025 were based on the 20-year historical baseline based on 1990/91 to 2009/10. Climate change and SJRRP adjustments were phased in between 2025 and 2030 through a linear interpolation between 2025 baseline deliveries and full application of FWA adjusted deliveries in 2030. TH&Co applied the 2070 central tendency time period climate-related adjustments to imported water deliveries in the Tule Subbasin model projection for the period from 2050 to 2070.

Results of the climate adjustments show that future water deliveries are projected to be generally comparable to historical water deliveries for DEID, KTWD, and Tea Pot Dome WD. Future water deliveries for Porterville ID and Terra Bella ID are projected to increase relative to historical deliveries primarily due to a reduction or elimination of sales and/or transfers that historically occurred. Future water deliveries for LTRID are projected to decrease relative to historical deliveries due to the high proportion of Class 2 supplies which are most impacted by the FWA analysis. Finally, future water deliveries for Saucelito ID are projected to decrease relative to historical deliveries due to changes in sales and/or transfers. Results of the analysis are summarized on Figure 33.

5.0 Analysis of the Future Subbasin Management Scenario

TH&Co used the calibrated GFM to analyze the consumptive use that can be accommodated in the future, given each GSA's planned projects and management actions, without a long-term, subbasin-wide net negative change in groundwater storage. Consumptive use is linked to groundwater pumping (and, therefore, change in groundwater storage) as described in Section 3.5.

While the projects and management actions developed for the future projection scenario provided a conceptual schedule for reduction in consumptive use, they cannot provide the consumptive use necessary to make the Subbasin sustainable. Through an iterative process, the consumptive use in the future projection of the model was adjusted until there was no net negative change in groundwater storage from 2040 to 2050[1]. During this process, neither streamflow diversions nor imported water deliveries were modified from their projected values; the only changes were consumptive use and associated groundwater pumping. In order to maximize the available consumptive use in the Subbasin while avoiding a net negative change in storage, the target consumptive use in all WBAs, and therefore the transitional pumping schedule, was incrementally reduced from an initial condition that resulted in a negative change in storage to one that resulted in no net negative change in storage. The resulting sustainable level of consumptive use was estimated to be approximately 65,000 acre-ft/year. Additional consumptive use can be supported in any given area of the Subbasin by streamflow diversions and imported water supplies, where available.

5.1 Projected Groundwater Budget

The projected surface water and groundwater budgets, based on the future basin management scenario and sustainable consumptive use target for the Tule Subbasin, are shown in Tables 8a, 8b, and 9. The tables are based on the 50th percentile sustainable yield representation of the calibrated GFM. As shown in Table 9 the average annual projected change in groundwater storage between 2040 and 2050, after full implementation of transitional pumping, is positive 900 acre-ft/yr.

5.2 Projected Groundwater Levels

Projected groundwater level trends at calibration target wells within the Tule Subbasin are provided in Appendix F. All projected groundwater levels were generated using the 50th percentile sustainable yield representation of the calibrated GFM. As shown, groundwater levels simulated after 2040 level out for most of the upper and lower aquifer wells relative to their historical and transitional pumping downward trends. Exceptions are upper aquifer wells in the western part of

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[1] Stress periods in the future projection portion of the GFM are based on water years (i.e. October 1 through September 30) and all results are presented as water years (i.e. 2020 is October 1, 2019 through September 30, 2020).

the Subbasin (e.g., Angiola G1 and 32K01) where downward groundwater level trends continue beyond 2040.

5.2.1 2020 – 2040 Transitional Pumping Period

Projected changes in groundwater levels in the upper aquifer (Layer 1) for the transitional pumping time period from 2020 to 2040 are shown on Figure 34. As shown, groundwater levels are below the bottom of Layer 1 throughout much of the eastern portion of the Subbasin, except in the Porterville area where groundwater levels are above the bottom of the layer and projected to remain relatively stable during the transitional pumping period. Groundwater levels in this layer are projected to decline another 100 to 120 feet in the central portion of the Subbasin during the transitional pumping period. Layer 1 groundwater levels in the western portion of the Subbasin are projected to decline another 40 to 80 feet during the transitional pumping period.

Projected changes in groundwater levels in the lower aquifer (Layer 3) for the transitional pumping period from 2020 to 2040 are shown on Figure 35. Layer 3 groundwater levels in the eastern and southeastern parts of the Subbasin are projected to rise. Groundwater levels in the central and northwest parts of the Subbasin are projected to decline another 20 to 40 feet in Layer 3.

5.2.2 2040 – 2050 Sustainability Period

Projected changes in groundwater levels in the upper aquifer (Layer 1) for the time period from 2040 to 2050 are shown on Figure 36. Groundwater levels in Layer 1 during this time period are relatively stable throughout the Tule Subbasin, with slight groundwater level rise predicted for the Porterville area. In Layer 3 (Figure 37), groundwater levels show increases of 20 to 40 feet in the eastern portion of the Subbasin and stable to slightly decreasing groundwater levels in the western portion of the Subbasin.

5.2.3 2050 – 2070 Sustainability Period with Extended Climate Adjustments

Projected changes in groundwater levels in the upper aquifer (Layer 1) for the time period from 2050 to 2070 are shown on Figure 38. Groundwater levels in Layer 1 during this time period trend downward again in the central portion of the Tule Subbasin, with slight groundwater level rise predicted for the Porterville area. In Layer 3 (Figure 39), groundwater levels are predicted to remain stable during this time period with increases of 20 to 40 feet in the eastern portion of the Subbasin. It is noted that the 2070 central tendency climate adjustments were applied during this time period, which reduce the amount of surface water deliveries available to the GSAs and result in downward trends in groundwater levels in Layer 1.

5.3 Projected Land Subsidence

Projected groundwater level trends at calibration target wells within the Tule Subbasin are provided in Appendix G. As land subsidence is correlated with groundwater level decline, continued land subsidence is expected during the transitional pumping period from 2020 to 2040 as groundwater levels continue to drop in the central and northwest parts of the Subbasin (see Figure 40). As much as eight feet (average of 0.4 ft/yr) of additional land subsidence is predicted in the northern Tri-County Water Agency GSA, western Pixley Irrigation District GSA, and northern LTRID GSA. Up to four feet (average of 0.2 ft/yr) of land subsidence is also predicted beneath the Friant-Kern Canal between Deer Creek and White River (see Figure 40).

Between 2040 and 2050, the rate of land subsidence decreases as groundwater levels stabilize throughout most of the Subbasin (see Figure 41). Up to three feet (average of 0.3 ft/yr) of land subsidence is still predicted to occur in isolated areas of the northern Tri-County Water Agency GSA, western Pixley Irrigation District GSA, and northern LTRID GSA. Less than 0.5 feet (average of 0.05 ft/yr) of land subsidence is predicted in the vicinity of the Friant-Kern Canal during this time period.

Land subsidence between 2050 and 2070 is predicted to continue in the western part of the Tule Subbasin as a result of declining groundwater levels in Layer 1 in this area (see Figure 42). Up to four feet (average of 0.2 ft/yr) of land subsidence is predicted during this time period for the northern Tri-County Water Agency GSA at the western boundary of the Subbasin. Up to three feet (average of 0.15 ft/yr) of additional land subsidence is predicted for the southern Tri-County Water Agency GSA and Alpaugh Irrigation District GSA areas.

5.4 Sustainable Yield

The sustainable yield of the Tule Subbasin is a function of the overall water balance of the area. Changes in surface water/groundwater inflow to the basin and surface water/groundwater outflow from the basin impact the sustainable yield. As groundwater management and land use changes impact the water balance, they also impact the sustainable yield. A generalized expression of the water balance is as follows:

$$\text{Inflow} - \text{Outflow} = +/- \text{ Change in Storage} \qquad (1)$$

The water balance equation for pre-developed conditions (prior to human occupation) can be further expressed as:

$$(I_{pr} + I_{str} + I_{ss} + I_{mb}) - (O_{ss} + O_{et}) = \Delta S \qquad (2)$$

Where:

I_{pr} = Inflow from Areal Recharge of Precipitation
I_{str} = Inflow from Infiltration of Runoff in Stream Beds
I_{ss} = Inflow from Subsurface Underflow
I_{mb} = Inflow from Mountain-Block Recharge
O_{ss} = Subsurface Outflow
O_{et} = Evapotranspiration
ΔS = Change in Groundwater Storage

Under pre-developed conditions, the Subbasin would be in a state of equilibrium such that the inflow and outflow would balance and there would be no significant long-term change in storage assuming a static climatic condition. Under this condition, groundwater levels would be relatively stable.

Under developed land use conditions, the water balance changes as groundwater is pumped from the basin for irrigation and municipal supply, diversions of streamflow occur, and imported water is delivered to the Subbasin. Lowering of the groundwater table resulting from pumping reduces the amount of groundwater that would otherwise leave the Subbasin and reduces evapotranspiration losses in areas of shallow groundwater (e.g., Tulare Lake). Some of the pumped groundwater used for irrigation infiltrates past the roots of the plants and returns to the groundwater as return flow. Water imported into the area is applied to crops but some is lost as infiltration in unlined canals and as return flow. Groundwater return flow also occurs as a result of discharges from individual septic systems. Inflow from the compression of aquitards as a result of subsidence also contributes water to the aquifer system. Other sources of recharge to the groundwater under developed land use include wastewater treatment plant discharges and artificial recharge in spreading basins.

The water balance equation for developed land use conditions can be modified as follows (flows in **bold** are not included in the sustainable yield):

$$(I_{pr} + I_{str} + \mathbf{I_{can}} + \mathbf{I_{ar}} + \mathbf{I_{rfgw}} + \mathbf{I_{rfimp}} + \mathbf{I_{com}} + I_{ss} + I_{mb}) - (O_{ss} + O_{et} + \mathbf{O_{p}}) = \Delta S \qquad (3)$$

Where:

I_{can} = Inflow from Canal Losses
I_{ar} = Inflow from Artificial Recharge

I_{rfgw} = Inflow from Return Flow of Applied Water from Groundwater Pumping
I_{rfimp} = Inflow from Return Flow of Applied Water from Imported Water
I_{com} = Inflow of Water Released from Compression of Aquitards
O_p = Outflow from Groundwater Pumping

If the inflow terms exceed the outflow terms, then the groundwater in storage increases (become positive) and groundwater levels rise. If the outflow terms exceed the inflow, then the groundwater in storage decreases (become negative) and groundwater levels drop. It is assumed that the sustainable yield of the Tule Subbasin is the long-term average groundwater pumping rate, under projected land use conditions, that results in no significant long-term net negative change in groundwater storage in the basin. Based on this premise, the water balance equation can be rearranged and simplified to estimate sustainable yield:

$$\text{Sustainable Yield} = \Delta S + \mathbf{O_p} - \mathbf{I_{can}} - \mathbf{I_{ar}} - \mathbf{I_{rfimp}} - \mathbf{I_{com}} \qquad (4)$$

Thus, if the change in groundwater storage over the planning period is zero and there is no imported water or release of water from compression of aquitards, then the sustainable yield is equal to the pumping. This relationship is valid if the following conditions are met:

1. The sustainable yield incorporates a hydrology that is representative of a relatively long period of record that includes multiple wet and dry hydrologic cycles.
2. The land use conditions are representative of the time period.

The sustainable yield can also be expressed as all of the components of the water balance not explicitly expressed in Equation 4:

$$\text{Sustainable Yield} = I_{pr} + I_{str} + I_{rfgw} + I_{ss} + I_{mb} - O_{ss} \qquad (5)$$

It is noted that the Tule Subbasin Technical Advisory Committee has determined that recharge to the Tule Subbasin associated with the delivery of imported water and the diversion of water from the Tule River and Deer Creek associated with Pre-1914 water rights will not be included in the sustainable yield of the Subbasin. This includes canal losses from delivery of imported water and diverted stream flow, deep percolation of applied imported water and diverted stream flow, and managed recharge in basins.

Applying Equations 4 and 5 to the historical water budget of the Tule Subbasin does not result in a representative sustainable yield because the Subbasin was in overdraft during the historical water budget period. Groundwater pumping depressions that have developed in the western portion of the Subbasin have historically captured groundwater that would have otherwise left the Subbasin. This increase in groundwater inflow and decrease in groundwater outflow resulted in an apparent sustainable yield that was higher than was actually sustainable. Further, some of the return flow associated with historical overdraft contributed to the unrealistically high historical sustainable yield. The apparent sustainable yield based on the water budget from water year 1990/91 to 2009/10 was reported to be approximately 258,000 acre-ft/yr (TH&Co, 2017b). However, since the downward groundwater trends that resulted in this condition are not sustainable, the associated sustainable yield from this water budget is not representative.

The sustainable yield of the Tule Subbasin will change in the future as a result of changes in groundwater levels and flows associated with planned projects and management actions and changes in deep percolation of applied water (i.e., return flow) from reduced groundwater pumping. This necessary action will change the water budget by not only decreasing outflow from groundwater pumping but also reducing deep percolation of applied water (return flow) and changing the dynamics of inflow and outflow at the Subbasin boundaries. This new water budget regime will result in a sustainable yield that is different from what was realized historically. The projected groundwater budget from the analysis of the future basin management scenario using the calibrated groundwater flow model was the basis for the sustainable yield estimate of the Tule Subbasin. This analysis resulted in a sustainable yield of 130,000 acre-ft/yr.

5.5 Uncertainty Analysis

To paraphrase from CDWR (2016), gaining a sense of the magnitude of the uncertainty in model predictions allows decision makers to accommodate the reality that model results are imperfect forecasts and actual subbasin responses to management actions will vary from those predicted by modeling. To this end, output from PEST and its associated utility programs were used to address the uncertainty in estimates of sustainable yield for the Subbasin and subsidence along the Friant-Kern Canal. This approach provided 240 calibrated versions (‘realizations’) of the GFM. Each realization was comprised of different configurations of aquifer parameters, consumptive use, and mountain block recharge.

5.5.1 Uncertainty in Sustainable Yield Estimate

The future water budgets from each of the 240 calibrated realizations of the model were processed, based on Equation 5 in Section 5.4, to produce sustainable yield estimates for each year of the 50-yr implementation and planning horizon (2020 to 2070). Of the original 240 model realizations, 175 resulted in a projected average annual change in groundwater storage greater than -5,000 acre-ft/yr. The 50th percentile sustainable yield for the time period from 2040 to 2050 was used as the sustainable yield for the 175 model realizations resulting in greater than -5,000 acre-ft/yr of annual storage change. The 175 estimates of sustainable yield are normally distributed (see Figure 43). The time period from 2040 to 2050 was selected because it occurs after all planned projects and management actions have been implemented but before the time when the less reliable long-term climate change adjustments to hydrology and water deliveries are applied to the projected water budget (2050).

The projected future sustainable yield of the Tule Subbasin, which is the 50th percentile of the distribution of estimates derived from the uncertainty analysis, is estimated to be approximately 130,000 acre-ft/yr (see Table 10). The plausible range of sustainable yield was selected as the values between the 20th and 80th percentile, resulting in a range of approximately 108,000 to 162,000 acre-ft/yr (see Figure 43). The projected sustainable yield does not include:

- Diverted Tule River water canal losses, recharge in basins, and deep percolation of applied water,
- Diverted Deer Creek water canal losses, recharge in basins, and deep percolation of applied water,
- Imported water canal losses, recharge in basins, and deep percolation of applied water, and
- Deep percolation of applied recycled water and recycled water recharge in basins.

As the groundwater model predicts some continued land subsidence in the Tule Subbasin between 2040 and 2050, there is a contribution of approximately 18,000 acre-ft/yr of water to the aquifer from the compression of aquitards during this time period (see Table 9). This contribution is included in the water budget that results in no net negative change in groundwater storage over the time period. The implication for this is that the sustainable yield for the Subbasin is somewhat lower than reported because the contribution of water to the aquifer from compression of aquitards is not sustainable. Nonetheless, given the uncertainty in model results, the current estimate of 130,000 acre-ft/yr is recommended until more data are collected and the model is updated.

5.5.2 Uncertainty in Friant-Kern Canal Subsidence

The 240 realizations of the GFM were also used to assess the uncertainty in simulated land subsidence along the Friant-Kern Canal for the future subbasin management scenario. The target period for this assessment is the 2020 to 2040 transitional pumping period. Figure 44 displays the uncertainty in simulated subsidence at various milepost locations along the Canal using ‘box-and-whisker’ diagrams. These diagrams show various statistics for simulated subsidence. Specifically, the top of the ‘box’ portion (the brown-shaded, vertically-oriented rectangle) is the 25th percentile whereas the bottom is the 75th percentile. Within the box is a horizontal line (i.e., the 50th percentile or ‘median’) and an ‘X’, which identifies the arithmetic average (i.e. ‘mean’) value. The top and bottom of each whisker represents the ‘local minimum’ and ‘local maximum’ values. These ‘local’ statistics are those associated with the simulated values after outliers are removed. Outliers are defined as those values less than or greater than 1.5 times the interquartile range (i.e., 1.5 times the difference between the 25th and 75th percentile values).

Considering the simulated subsidence shown on Figure 44 for the two locations between Milepost 106 and 108, the plot shows the simulated values to range from 1.0 to 5.1 feet and 1.6 to 4.6 feet for the northern and southern locations, respectively.

For comparison, the simulated land subsidence associated with the realization for the 50th percentile sustainable yield (shown as the continuous thick black line extending from left to right across the figure) is approximately 3.2 feet at both locations. Considering the southern location (i.e., closer to Milepost 108), this value roughly corresponds to the 75th percentile. That is, the simulated subsidence for 25 percent of the 240 realizations (60 realizations) for this location exceed 3.2 feet. The simulated subsidence associated with the realization for the 50th percentile sustainable yield exceeds the median subsidence value at those locations with the highest simulated medians (i.e., those located between Milepost 105 and Milepost 108).

6.0 Summary of Findings

A calibrated numerical groundwater flow model has been developed for the Tule Subbasin in support of informing GSPs for the six GSAs within the Subbasin. The model has been calibrated to industry standards with respect to both groundwater levels and land subsidence and is sufficient for informing future potential groundwater level and land surface elevation changes associated with planned projects and management actions. The calibrated groundwater flow model was used to assess a future groundwater budget and determine a sustainable yield for the Tule Subbasin based on planned projects and management actions that resulted in no net negative change in groundwater storage for the ten-year period after the 2040 SGMA sustainability deadline.

The following summarizes the findings from the model analysis:

- The sustainable yield of the Tule Subbasin is estimated to be approximately 130,000 acre-ft/yr. The sustainable yield does not include recharge from imported water delivery losses, recharge in basins and return flow; recharge from surface water diversion from the Tule River and Deer Creek associated with delivery losses, recharge in basins and return flow; and recharge of recycled water return flow and recharge in basins.
- Uncertainty analysis indicates that the plausible range of sustainable yield is approximately 108,000 to 162,000 acre-ft/yr.
- The future sustainable yield of the Subbasin is lower than the historical sustainable yield as a result of reduced irrigation return flow, reduced subsurface inflow, and increased subsurface outflow along the subbasin boundaries.
- The amount of crop consumptive use that can be supported by the sustainable yield is estimated to be approximately 65,000 acre-ft/yr with additional consumptive use supported by streamflow diversions and imported water supplies, where available.
- Although the overall water budget for the Tule Subbasin is projected to be in balance between 2040 and 2050, there are areas of the Subbasin where groundwater levels are still projected to decline through the planning horizon. It is anticipated that these localized areas of recharge and discharge imbalance can be addressed through basin management actions in the individual GSAs in which they occur.
- As much as approximately four feet of additional land subsidence is projected to occur beneath the Friant-Kern Canal during the transitional pumping period from 2020 to 2040. The greatest land subsidence is projected to occur in the area of the canal between Deer Creek and White River.
- Land subsidence is projected to be arrested after 2040 throughout most of the Tule Subbasin as a result of projected stabilizing of groundwater levels. Continued land subsidence is projected in the northwestern portion of the Subbasin and in the northern

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.

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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 (ft²/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

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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

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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

Table 4a

Tule Subbasin Historical Surface Water Budget - Inflow

Water Year	Water Year Type	Surface Water Inflow (acre-ft)																	Total In
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
		Precipitation	Stream Inflow			Imported Water											Discharge from Wells		
			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

Table 4b

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					
		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														
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

Table 5

Tule Subbasin Historical Groundwater Budget

Water Year	Water Year Type	Groundwater Inflows (acre-ft)																						Total In
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	
		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	
			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				
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

Water Year	Surface Water Inflow (acre-ft)																					Total In
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	
		Stream Inflow			Imported Water															Discharge from Wells		
	Precipitation	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

Table 8b

Projected Future Tule Subbasin Surface Water Budget

Water Year	Surface Water Outflow (acre-ft)																		
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
	Areal Recharge of Precipitation	Streambed Infiltration					Canal Loss			Recharge in Basins				Deep Percolation of Applied Water					
		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

Table 8b

Projected Future Tule Subbasin Surface Water Budget

Water Year	Surface Water Outflow (acre-ft)													Total Out
	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	
	Evapotranspiration											Surface Outflow		
	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	
		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

Table 9

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		
Water Year	Groundwater Pumping				Sub-surface Outflow	Total Out	Change in Storage (acre-ft)
	Municipal	Irrigated Agriculture	Exports	Groundwater Banking Extraction			
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

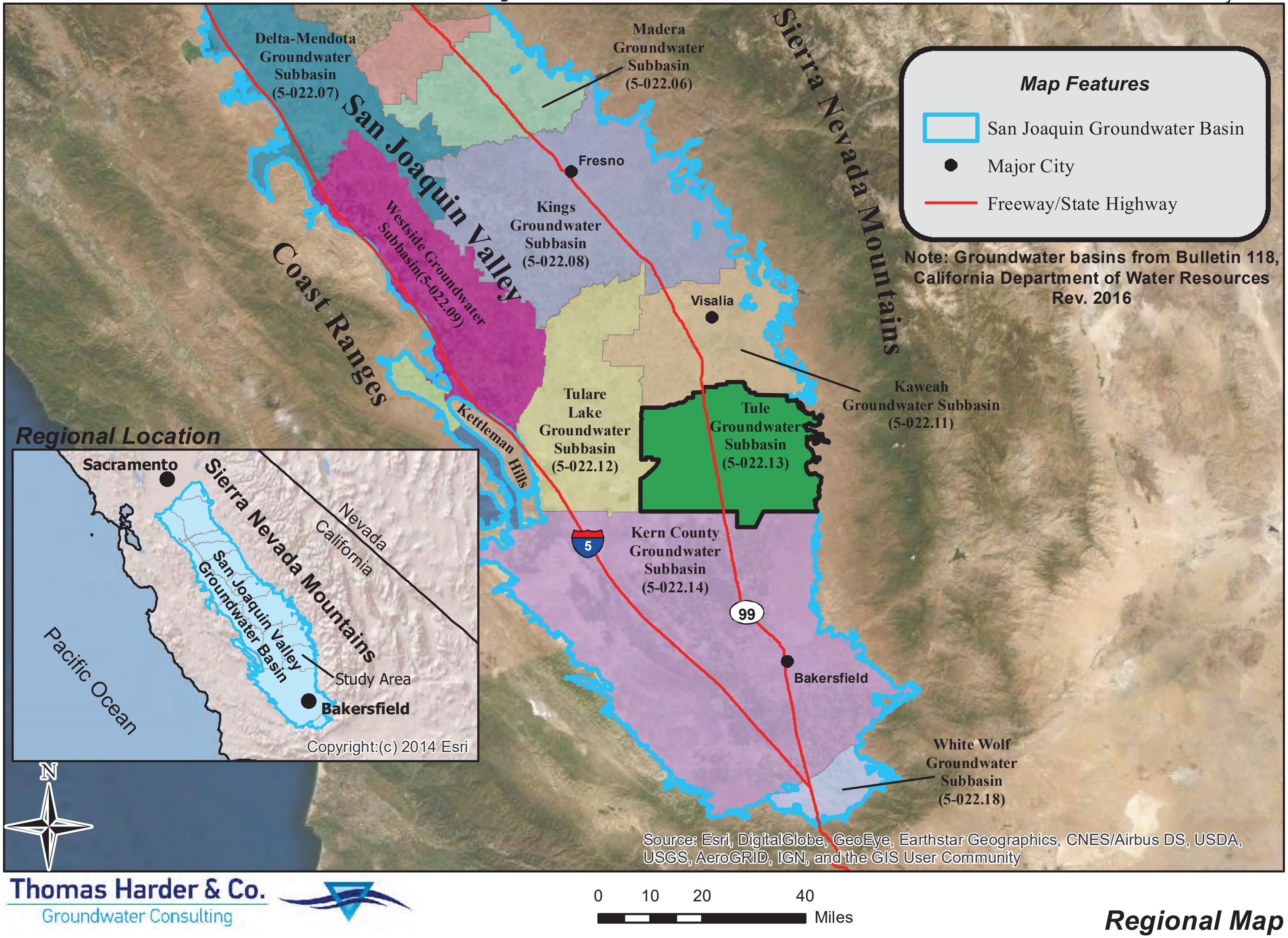
	Groundwater Inflows (acre-ft)										Groundwater Outflow (acre-ft)	
	A	B	C	D	E	F	G	H	I	J		
		Streambed Infiltration					Return Flow				K	
		Tule River		Deer Creek								
Water Year	Areal Recharge from Precipitation	Success to Oettle Bridge	Oettle Bridge to Turnbull Weir	Before Trenton Weir Infiltration	Trenton Weir to Homeland Canal Infiltration	White River	Irrigated Agriculture	Municipal	Sub-surface Inflow	Mountain-Block Recharge	Sub-surface Outflow	Sustainable Yield
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

January 2020

Tule Subbasin Technical Advisory Committee



Note: Groundwater basins from Bulletin 118, California Department of Water Resources Rev. 2016

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Thomas Harder & Co.
Groundwater Consulting

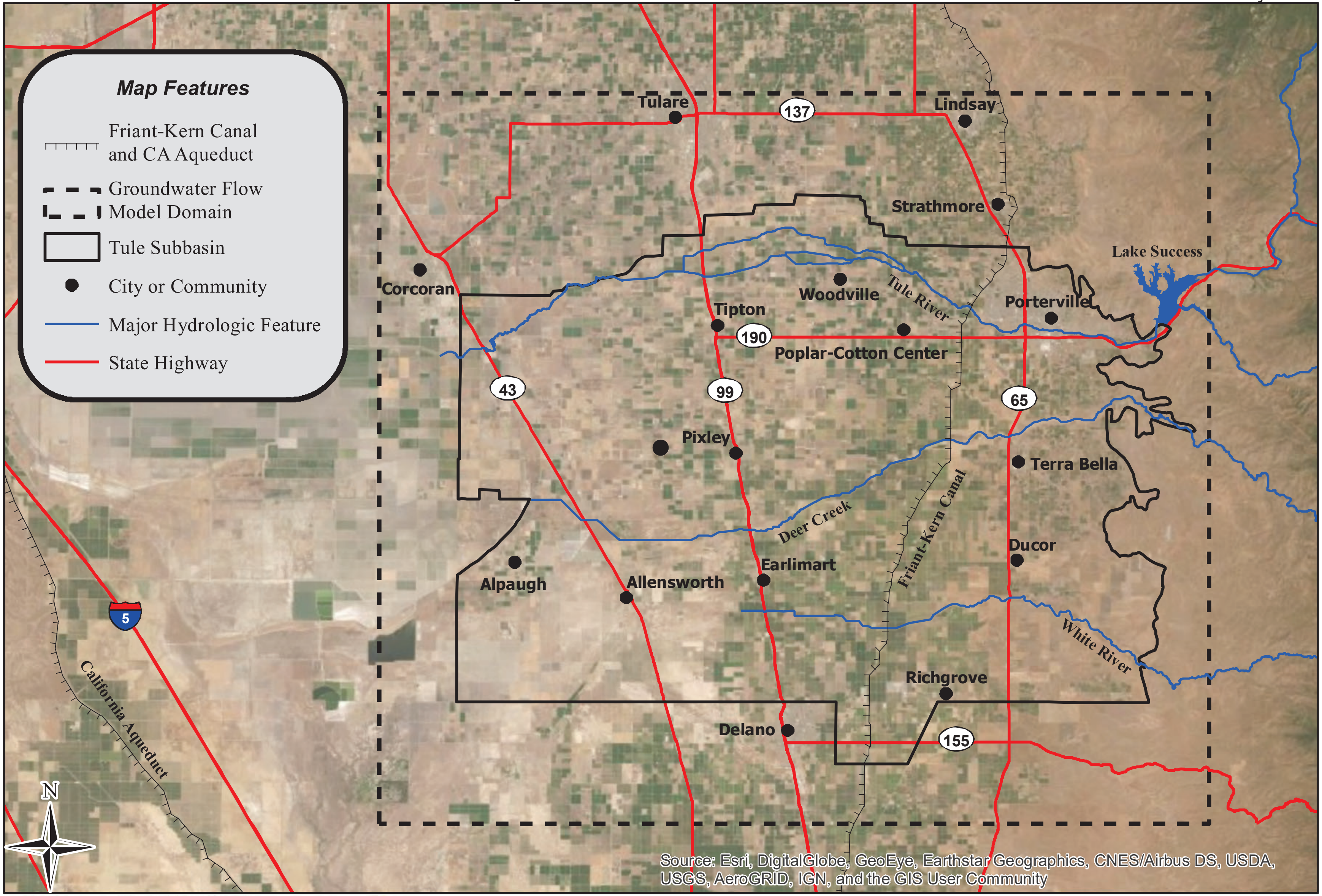
Regional Map

Figure 1

Tule Subbasin Technical Advisory Committee

Groundwater Flow Model of the Tule Subbasin

January 2020



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Thomas Harder & Co.
Groundwater Consulting

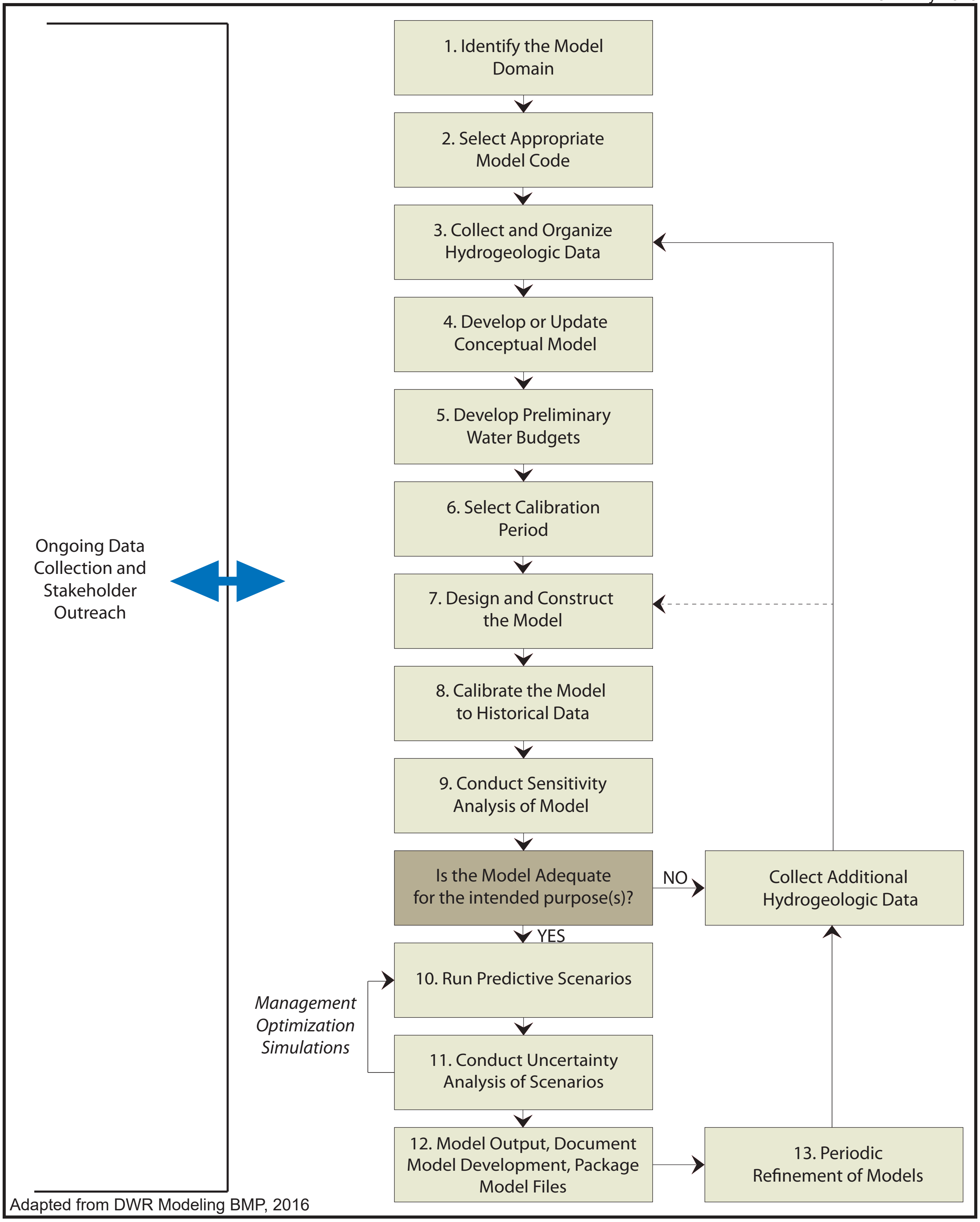
Study Area

Figure 2

Groundwater Flow Model of the Tule Subbasin

January 2020

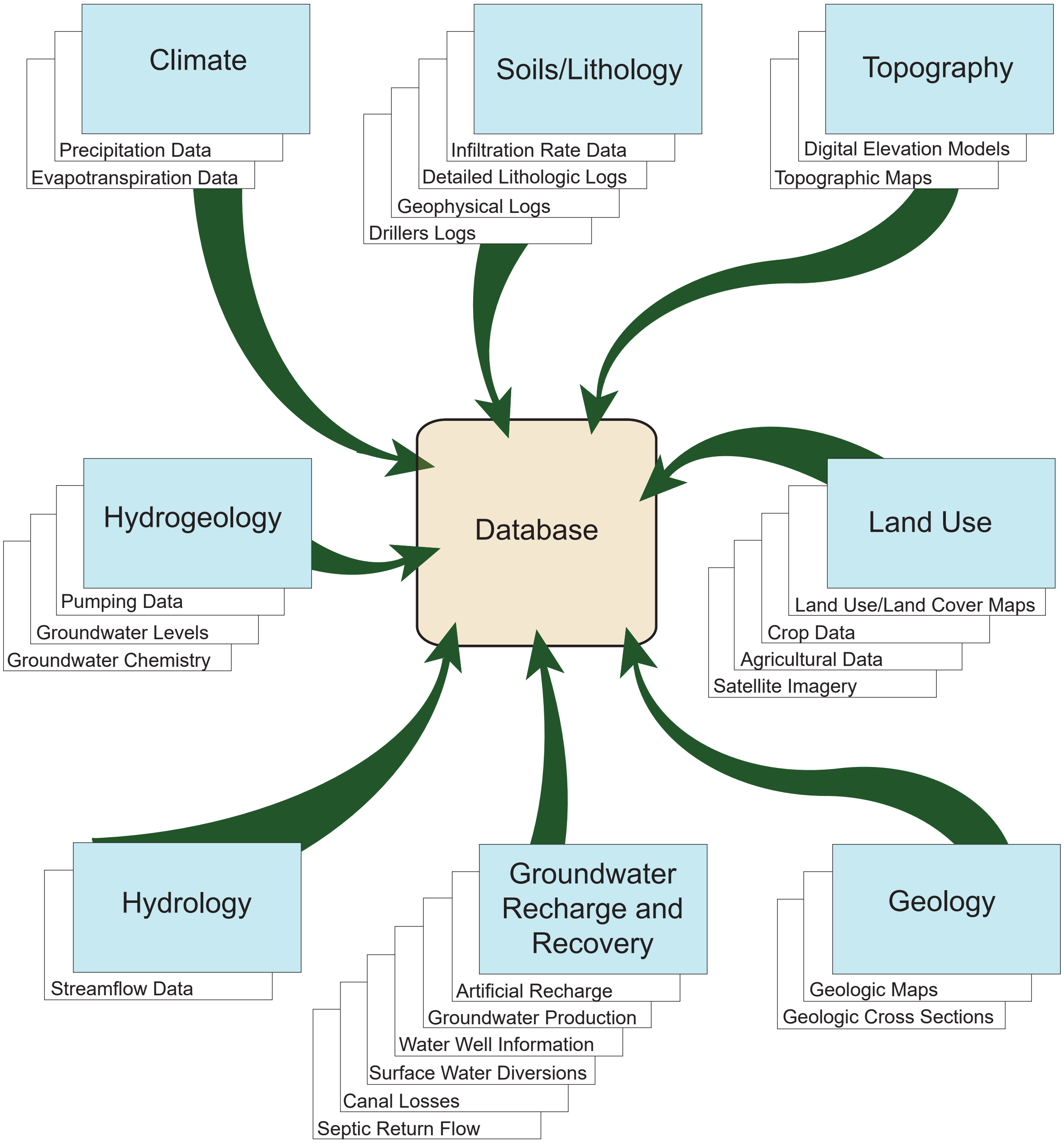
Tule Subbasin Technical Advisory Committee



Adapted from DWR Modeling BMP, 2016

Thomas Harder & Co.
Groundwater Consulting

General Modeling Process
Figure 3



Adapted from Faunt et al., 2009

DELANO – EARLIMART IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX A-4

Technical Support for Groundwater Levels

2024
2nd Amended Groundwater Sustainability Plan

Attachment 4

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

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[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

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[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.

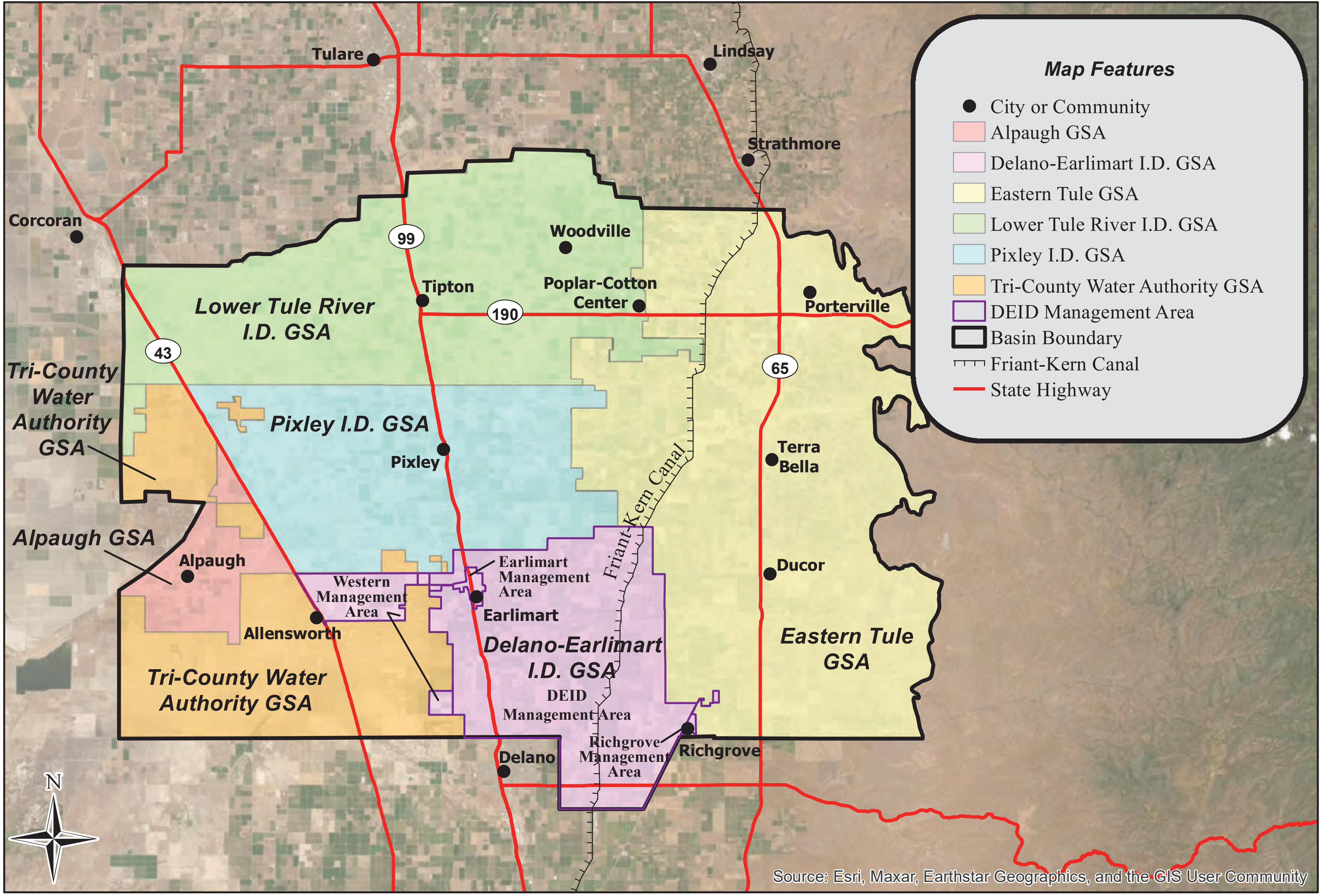
Of the 3,622 wells in the analysis, 776 wells would be impacted if groundwater levels were lowered to the MTs using the evaluation criteria described in Section 2 herein (see Figure 8). Some of these wells would be impacted before the MT groundwater levels were reached. Wells included in the analysis 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



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

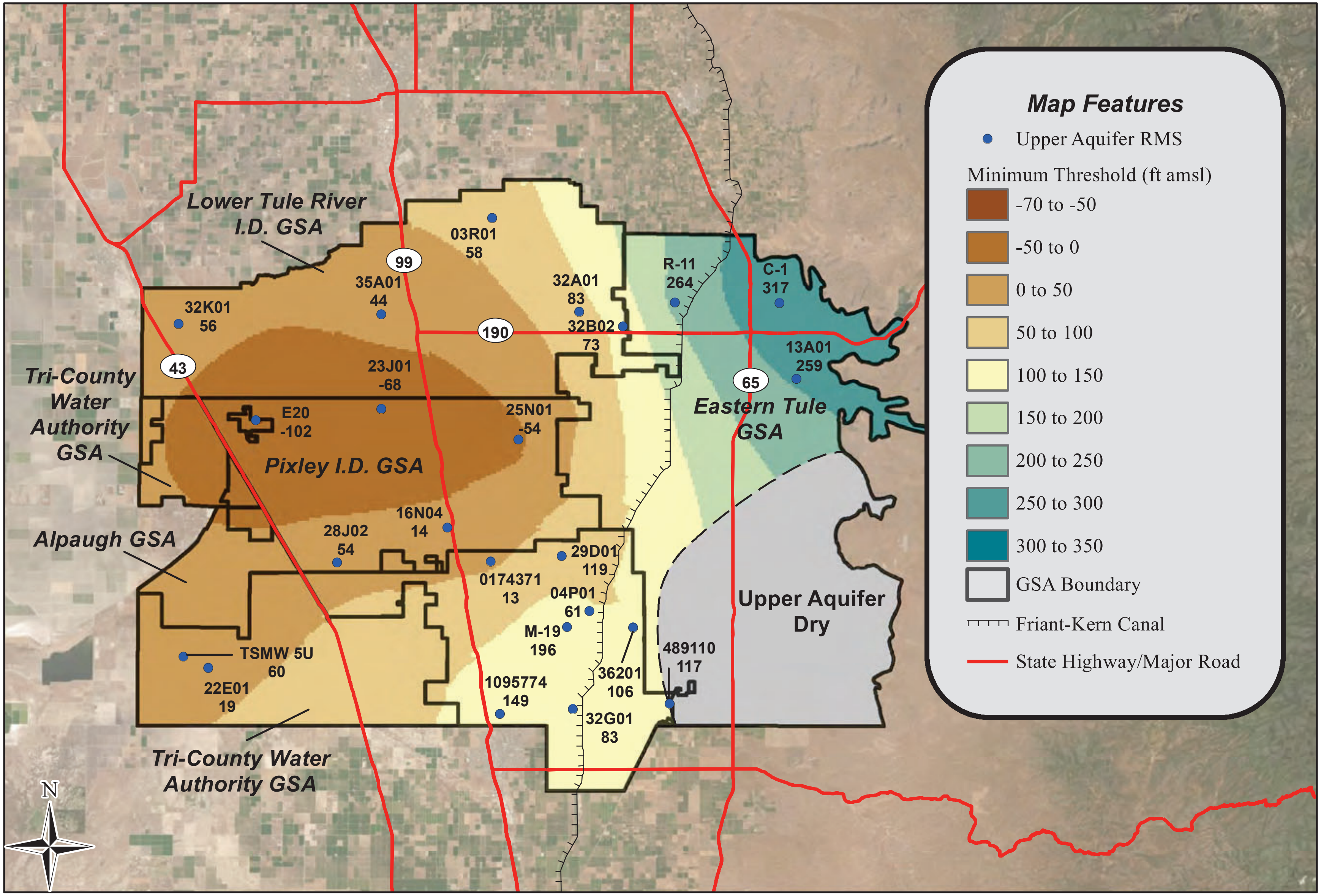
Thomas Harder & Co.
Groundwater Consulting

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

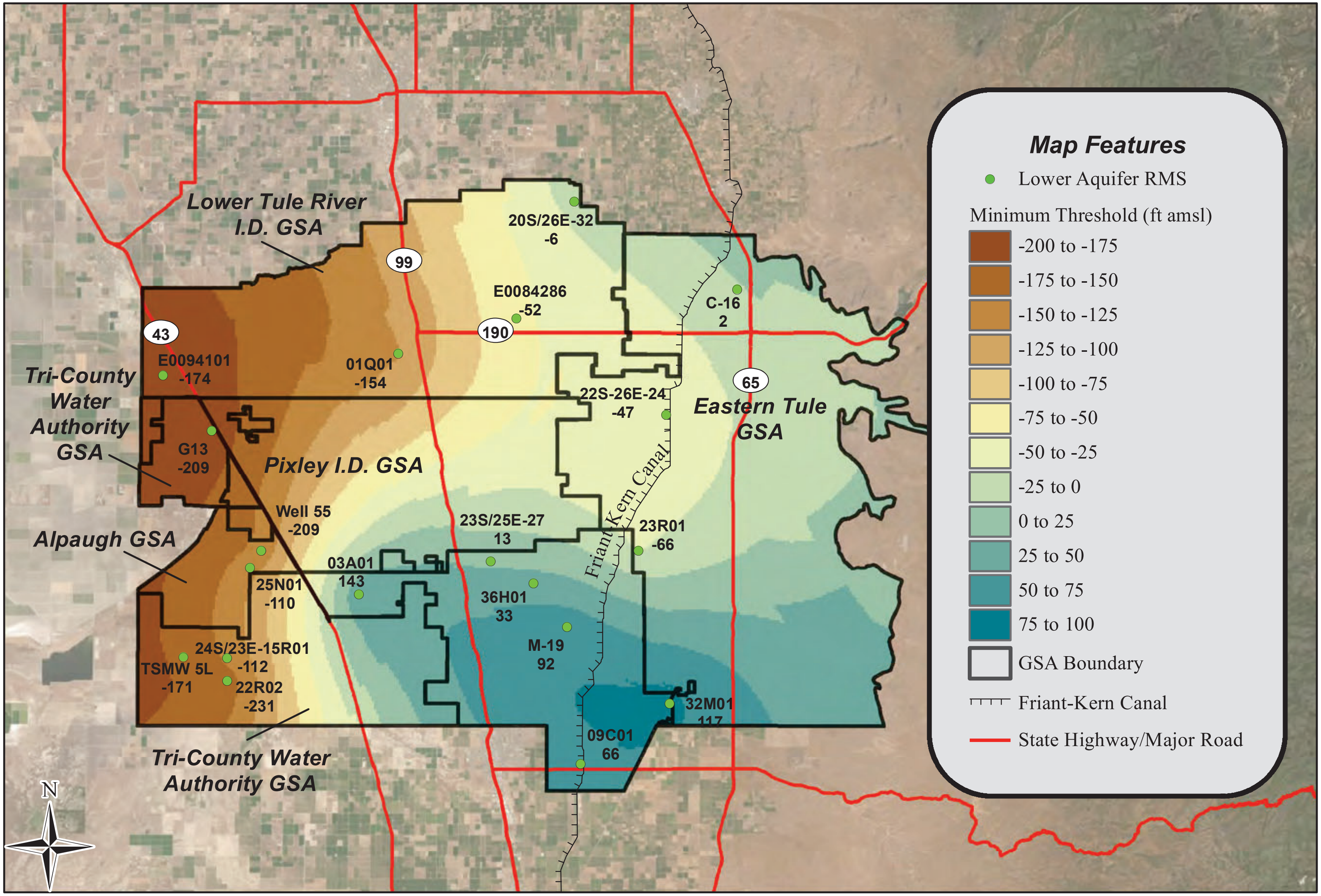
Minimum Thresholds - Upper Aquifer

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

Minimum Thresholds - Lower Aquifer

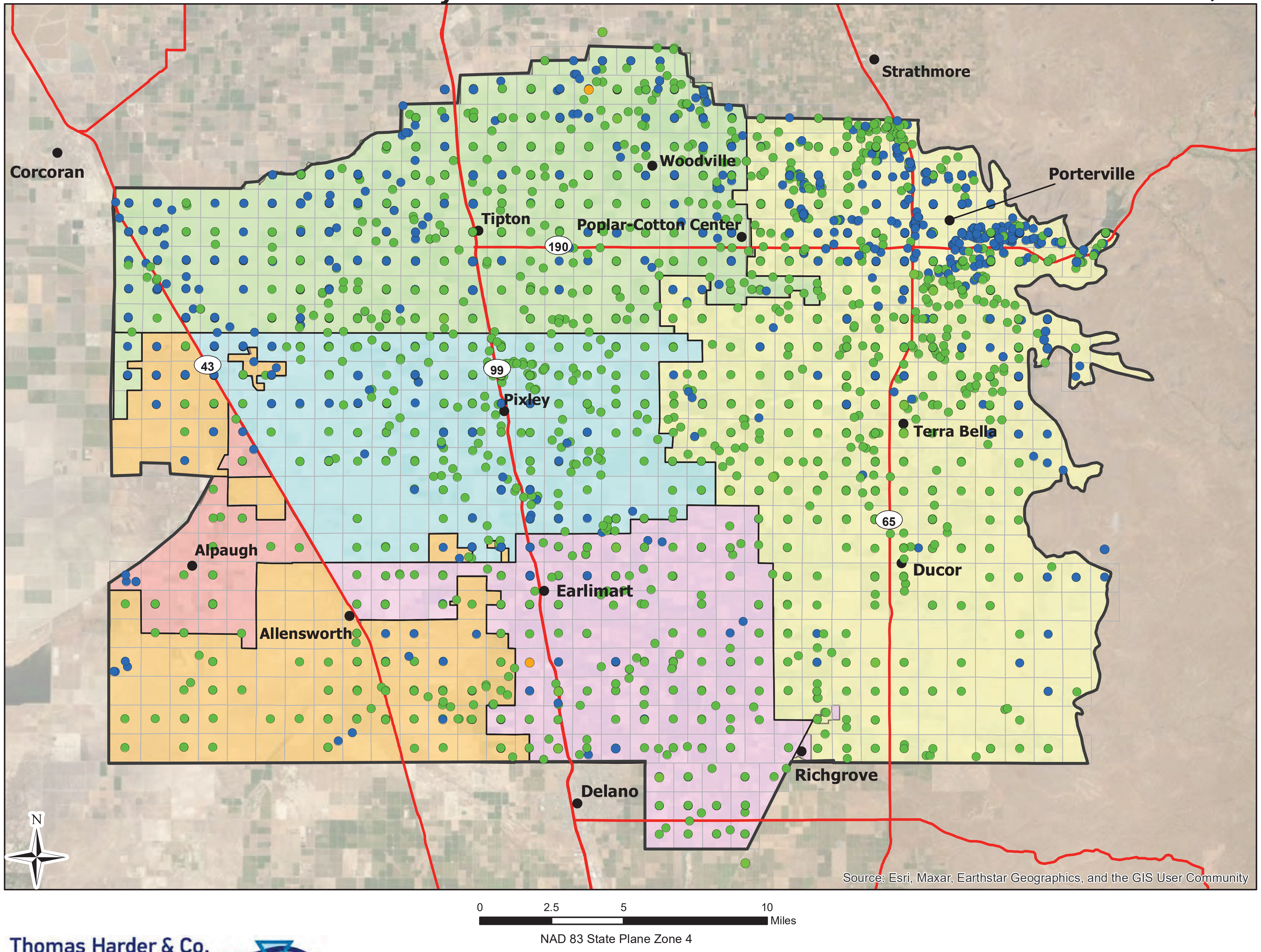
Figure 3

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

DWR Comments - Groundwater Levels in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

July 2022



NAD 83 State Plane Zone 4

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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

DWR Driller's Log Wells with Known Depth

Figure 4

Thomas Harder & Co.
Groundwater Consulting

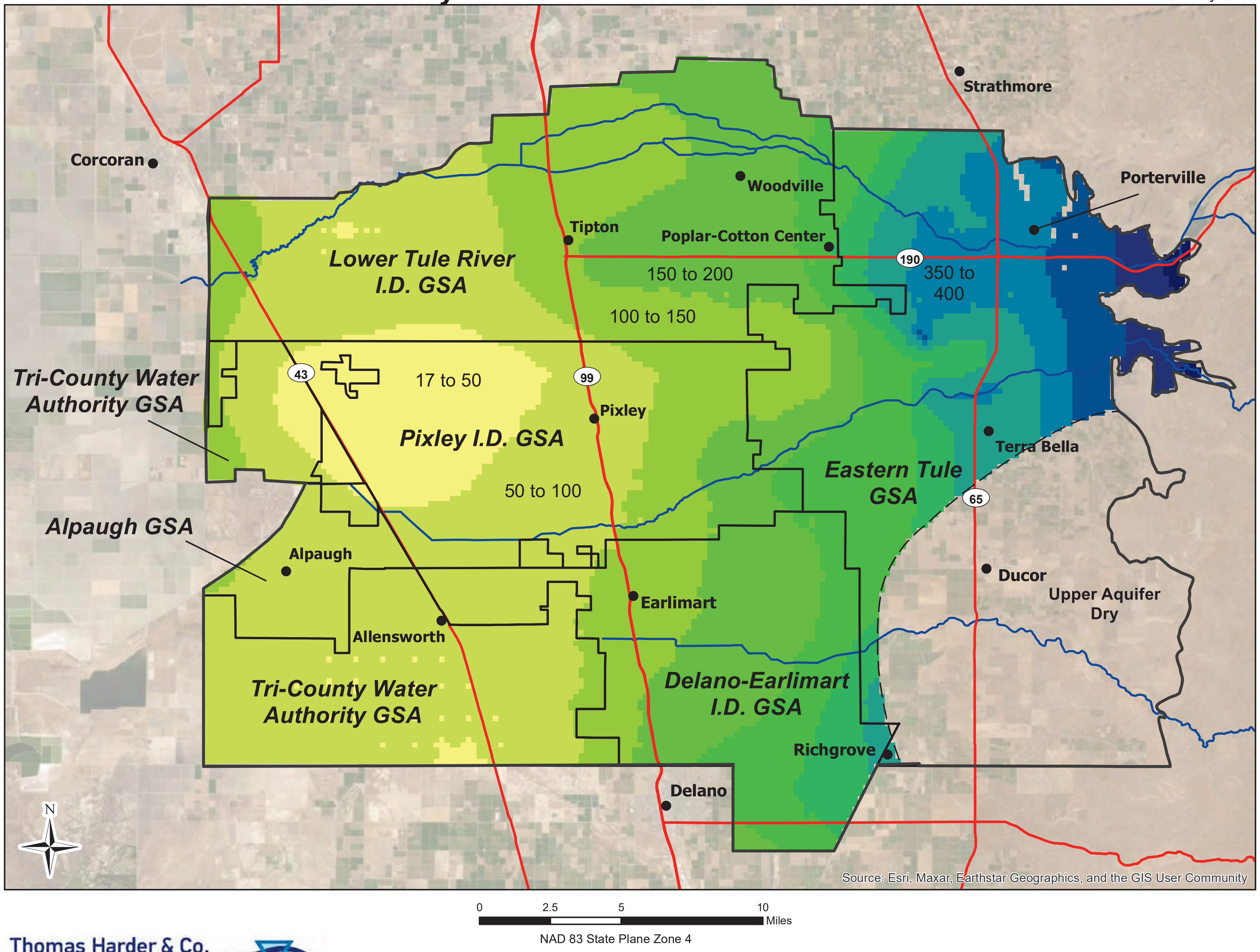
Note: The wells are plotted using coordinates provided by DWR. Many coordinates provided plot the well in the center of the section. Sections displaying only one well may actually have multiple wells plotted on top of one another.

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

Tule Subbasin Technical Advisory Committee

July 2022

DWR Comments - Groundwater Levels in the Tule Subbasin



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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

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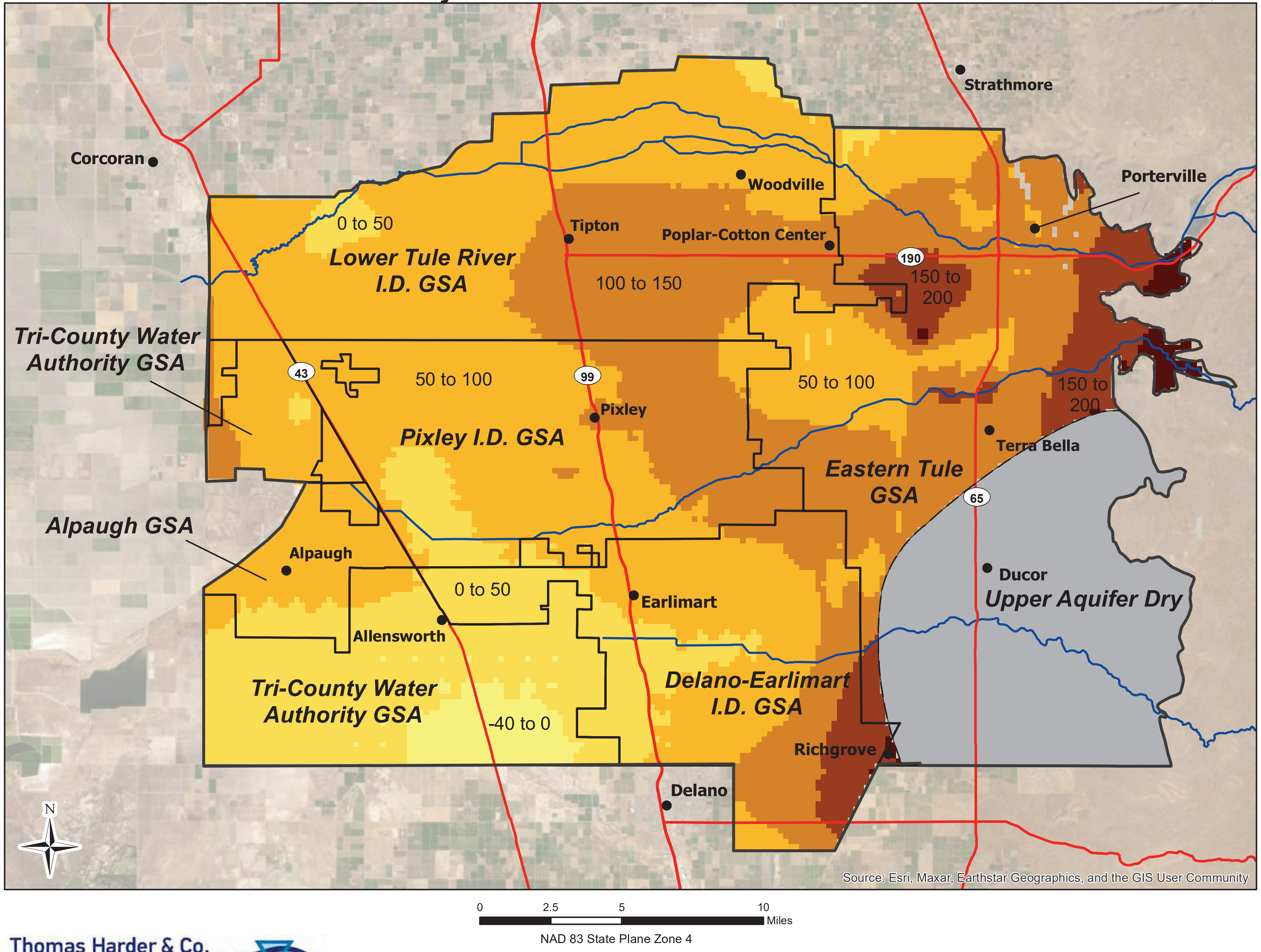
Model-Generated Upper Aquifer Groundwater Elevation - January 2015

Figure 5

DWR Comments - Groundwater Levels in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

July 2022



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

NAD 83 State Plane Zone 4

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

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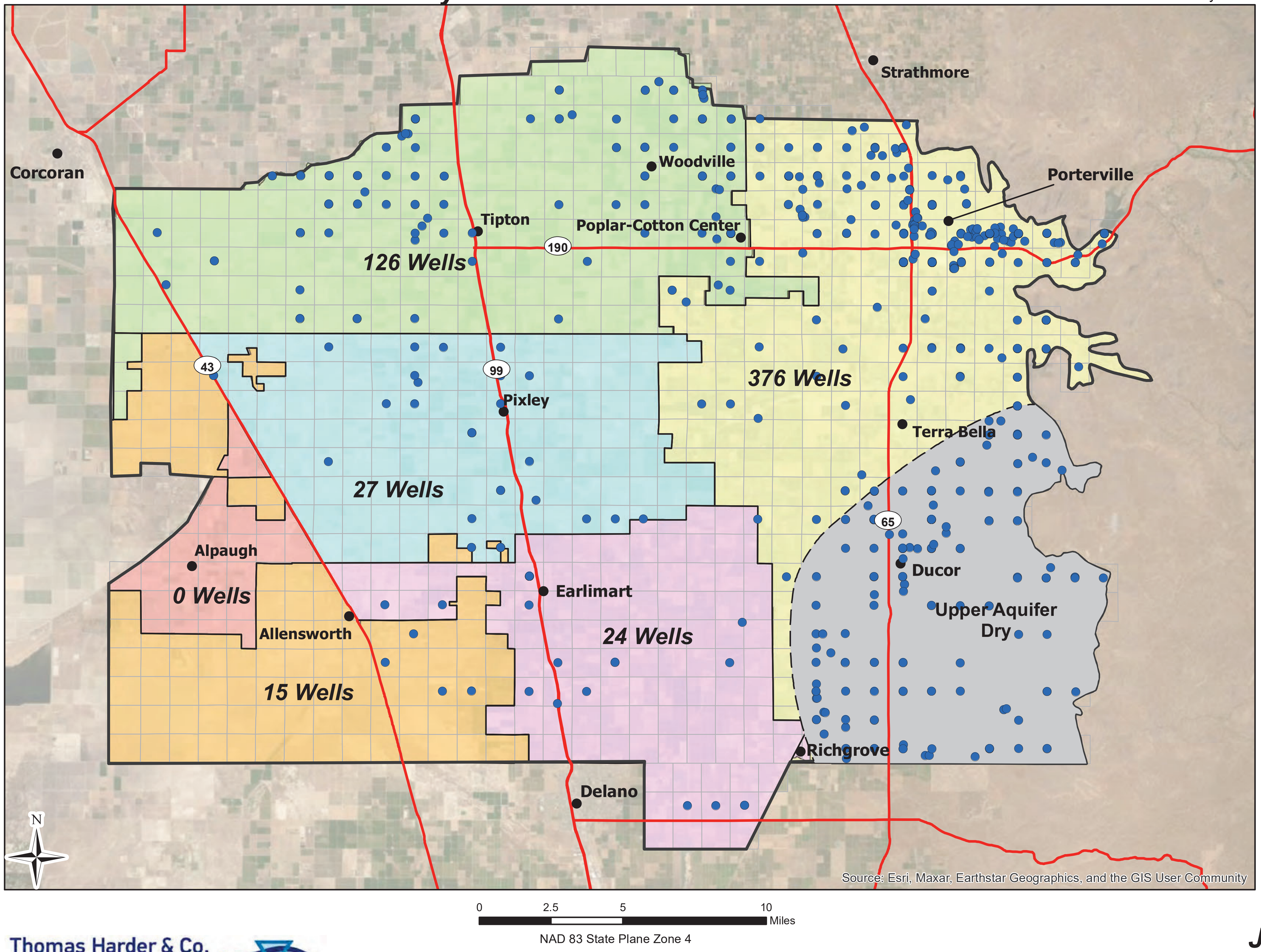
January 2015 to Minimum Thresholds Upper Aquifer Groundwater Elevation Difference

Figure 6

DWR Comments - Groundwater Levels in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

July 2022



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

NAD 83 State Plane Zone 4

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.

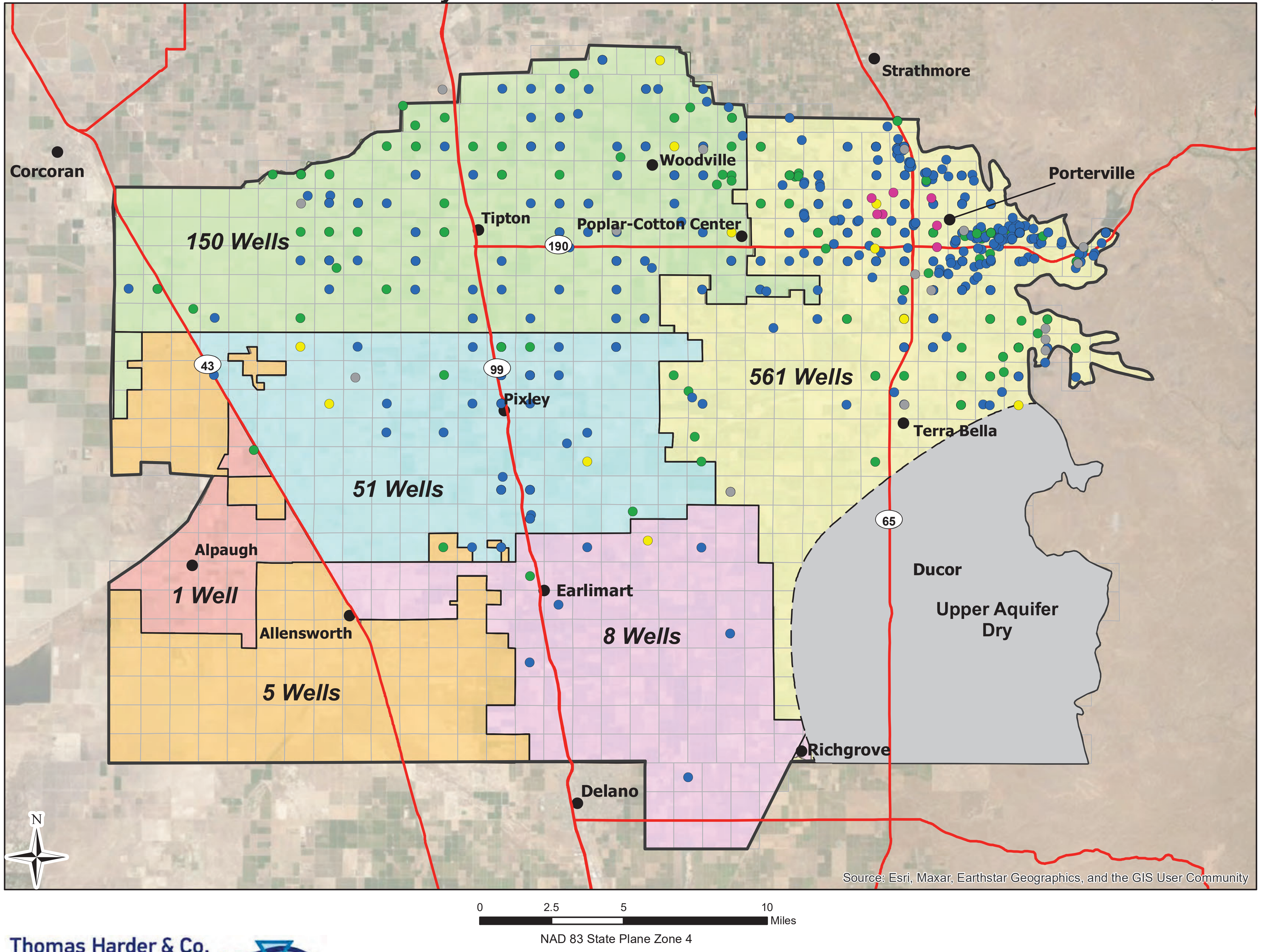
Note: Wells includes domestic, agricultural, industrial, and public supply wells.

*Includes drawdown and submegence assumptions.

DWR Comments - Groundwater Levels in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

July 2022



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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

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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.

Affected Wells* if Groundwater Levels Reach Minimum Thresholds

Figure 8

DELANO – EARLIMART
IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX A-5

Technical Support for Degraded Groundwater Quality

2024
2nd Amended Groundwater Sustainability Plan

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.

DELANO – EARLIMART IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX A-6

Technical Support for Land Subsidence

2024
2nd Amended Groundwater Sustainability Plan

Attachment 6

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.*

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[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]

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[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.

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[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,

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[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

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[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

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[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.

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[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.

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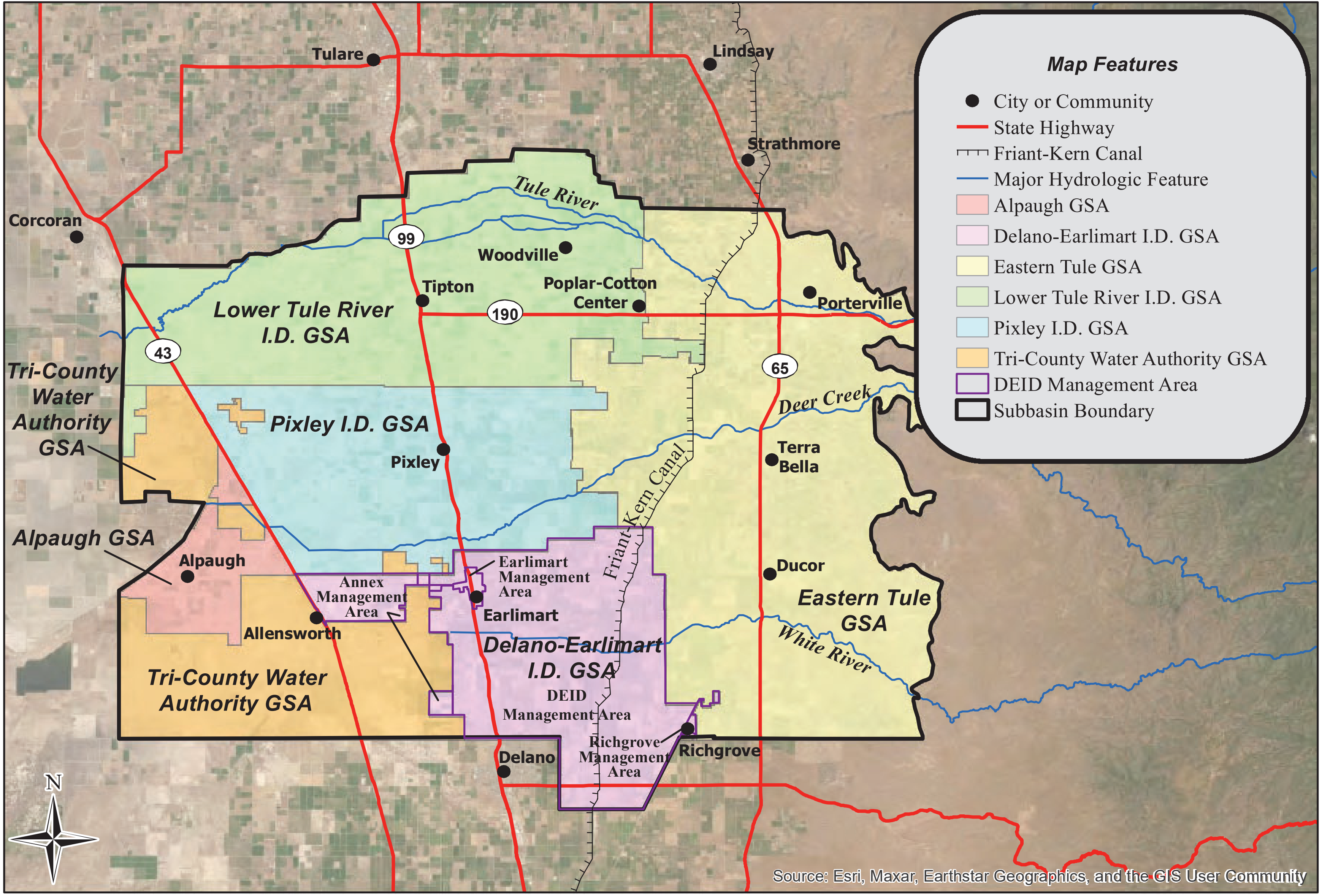
[10] Smith, R., and Knight, R., 2019. Modeling Land Subsidence Using InSAR and Airborne Electromagnetic Data. Water Resources Research, 55, 2801-2819.

[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



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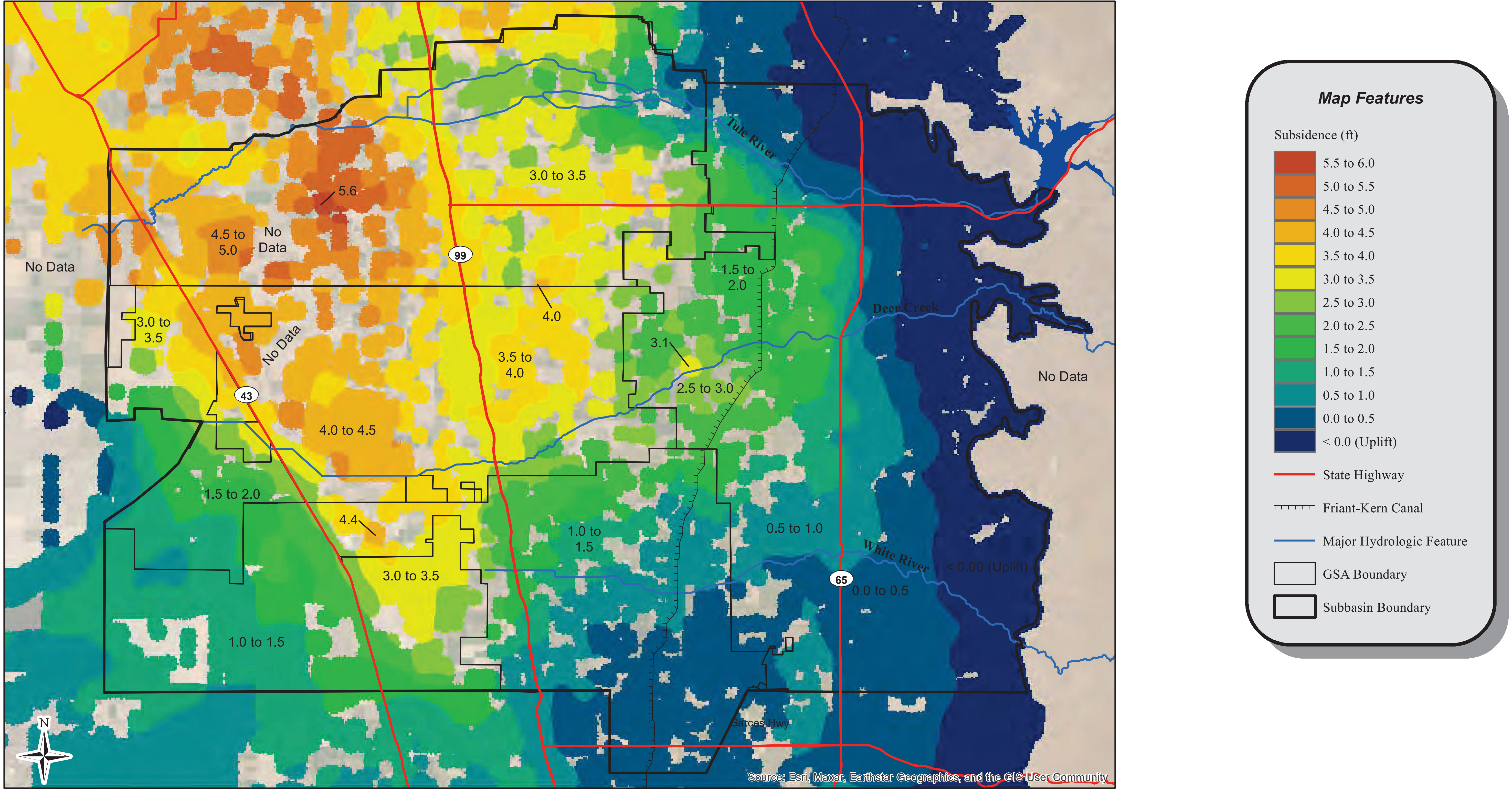
GSA Boundaries

Figure 1

DWR Comments - Subsidence in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

July 2022



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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

0 2 4 8 Miles
NAD 83 State Plane Zone 4

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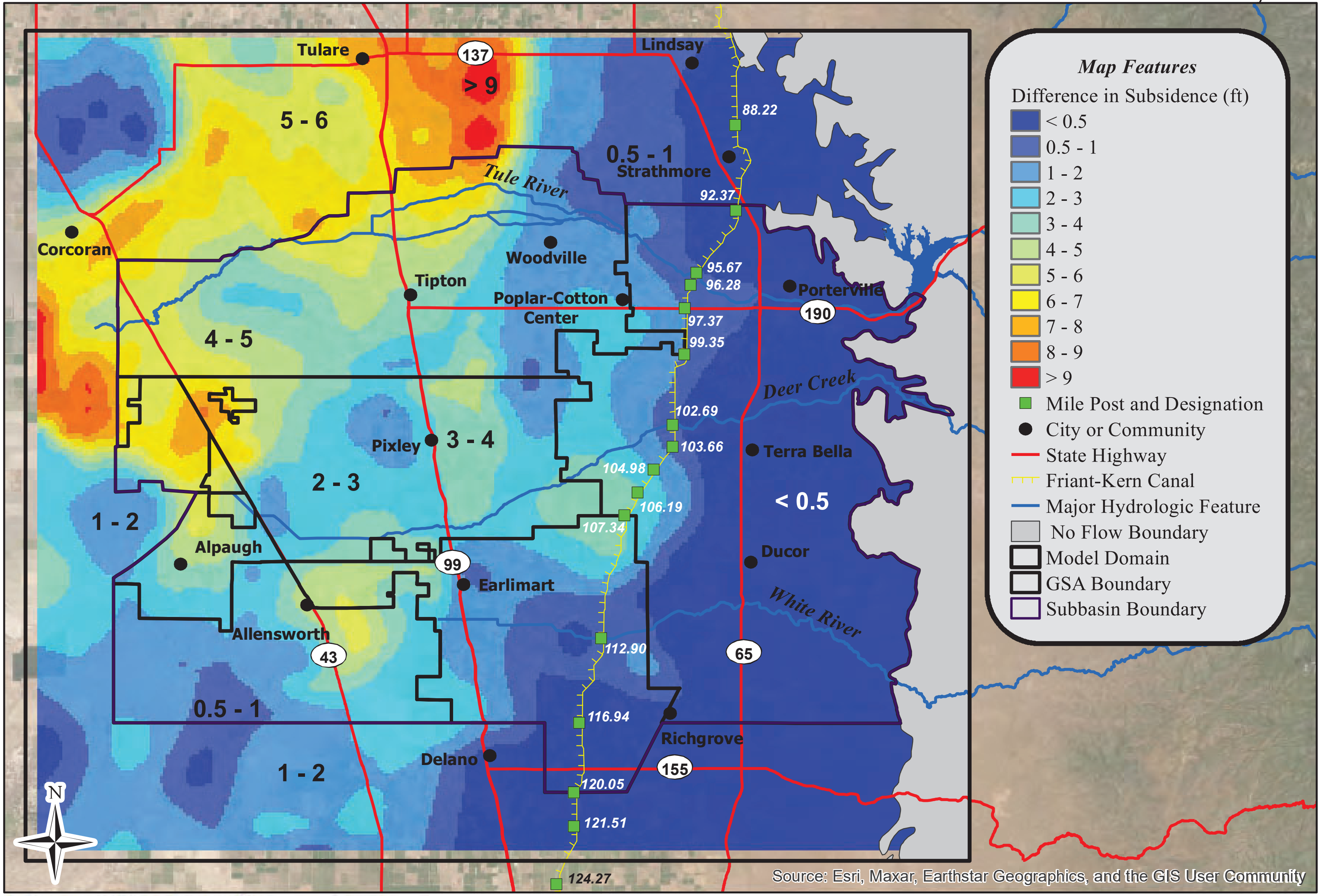
Land Subsidence
June 2015 to September 2021

Figure 2

DWR Comments - Subsidence in the Tule Subbasin

July 2022

Tule Subbasin Technical Advisory Committee



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0 2.5 5 10 Miles

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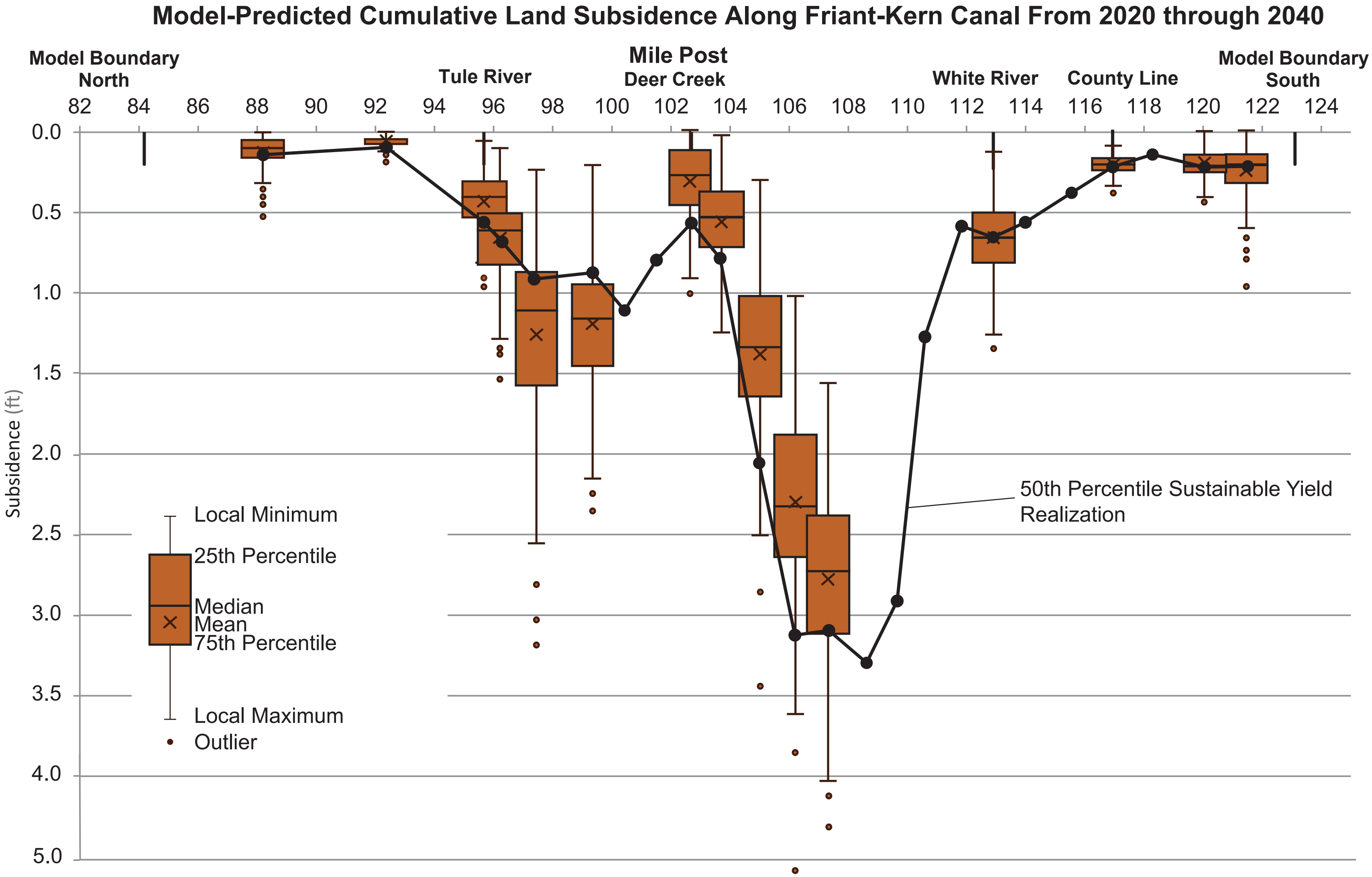
Note: This map shows the difference in subsidence from September 30, 2019 to September 30, 2039.

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

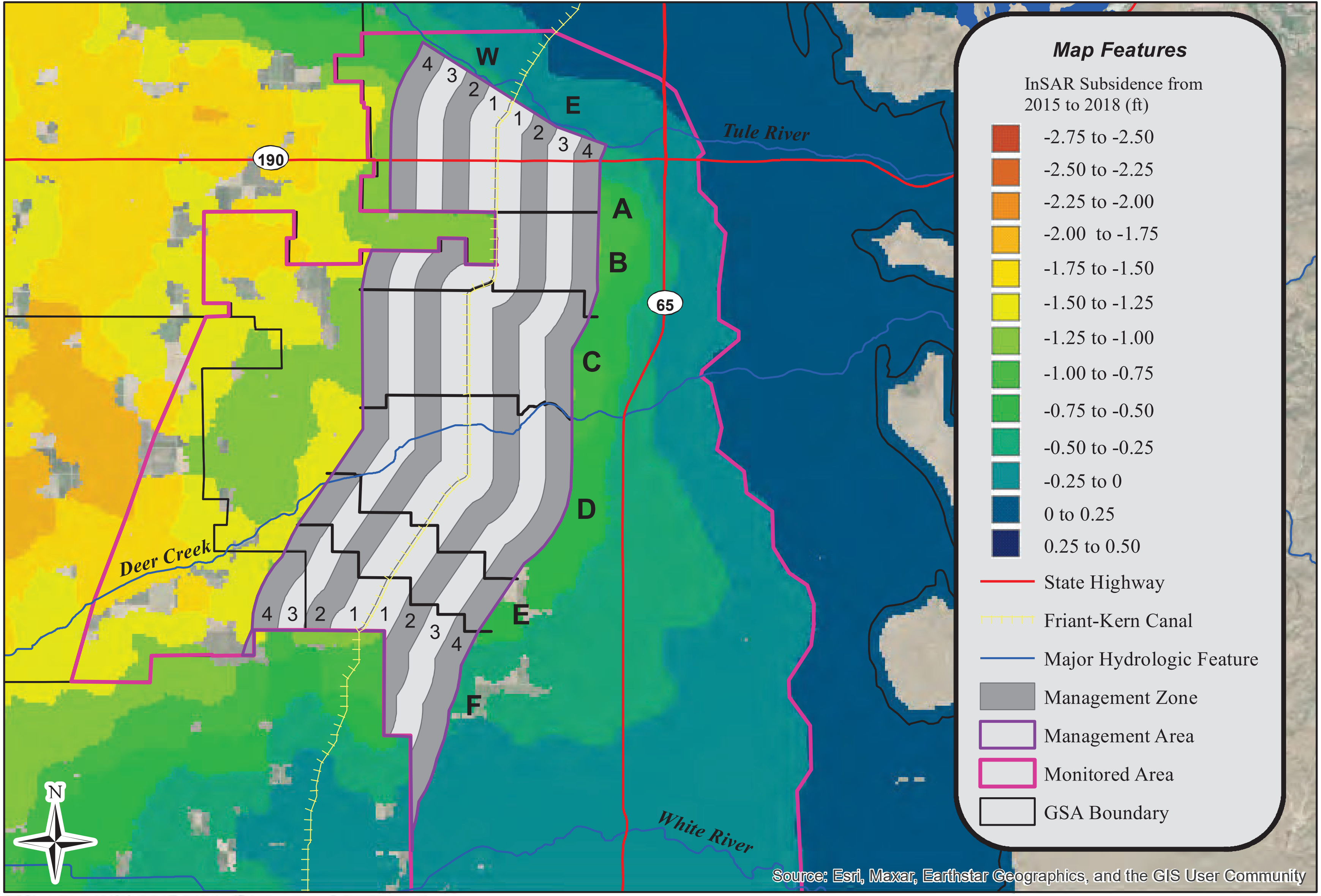


Note: From Thomas Harder & Co., 2020. Groundwater Flow Model of the Tule Subbasin. Prepared for the Tule Subbasin MOU Group.

DWR Comments - Subsidence in the Tule Subbasin

July 2022

Tule Subbasin Technical Advisory Committee



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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0 0.5 1 2 3 4
Miles

NAD 83 State Plane Zone 4

ETGSA Land Subsidence Managed Area with Management Subzones

Figure 5

DWR Comments - Subsidence in the Tule Subbasin

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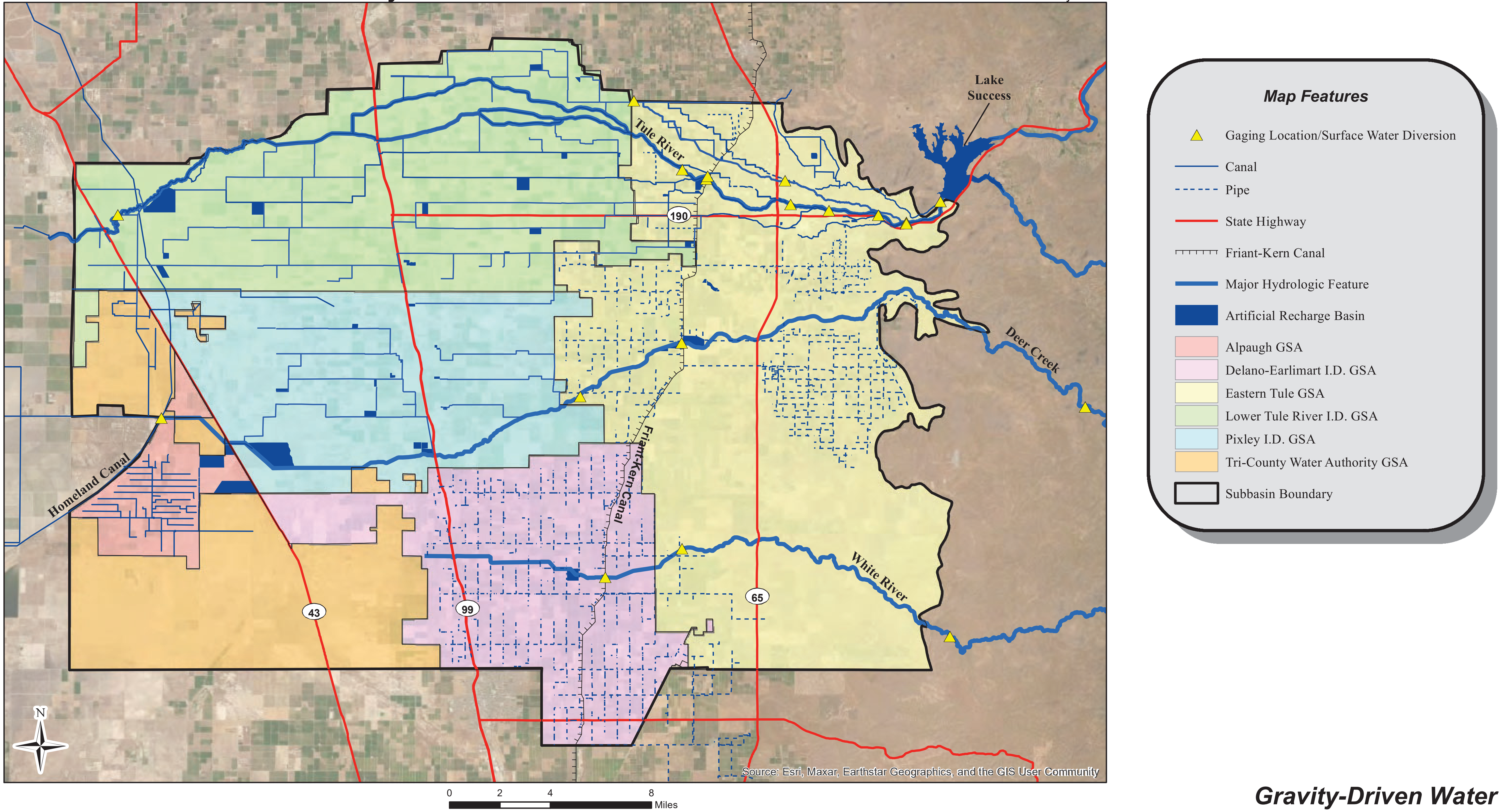
July 2022



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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Gravity-Driven Water Conveyance Infrastructure

Figure 6

DWR Comments - Subsidence in the Tule Subbasin

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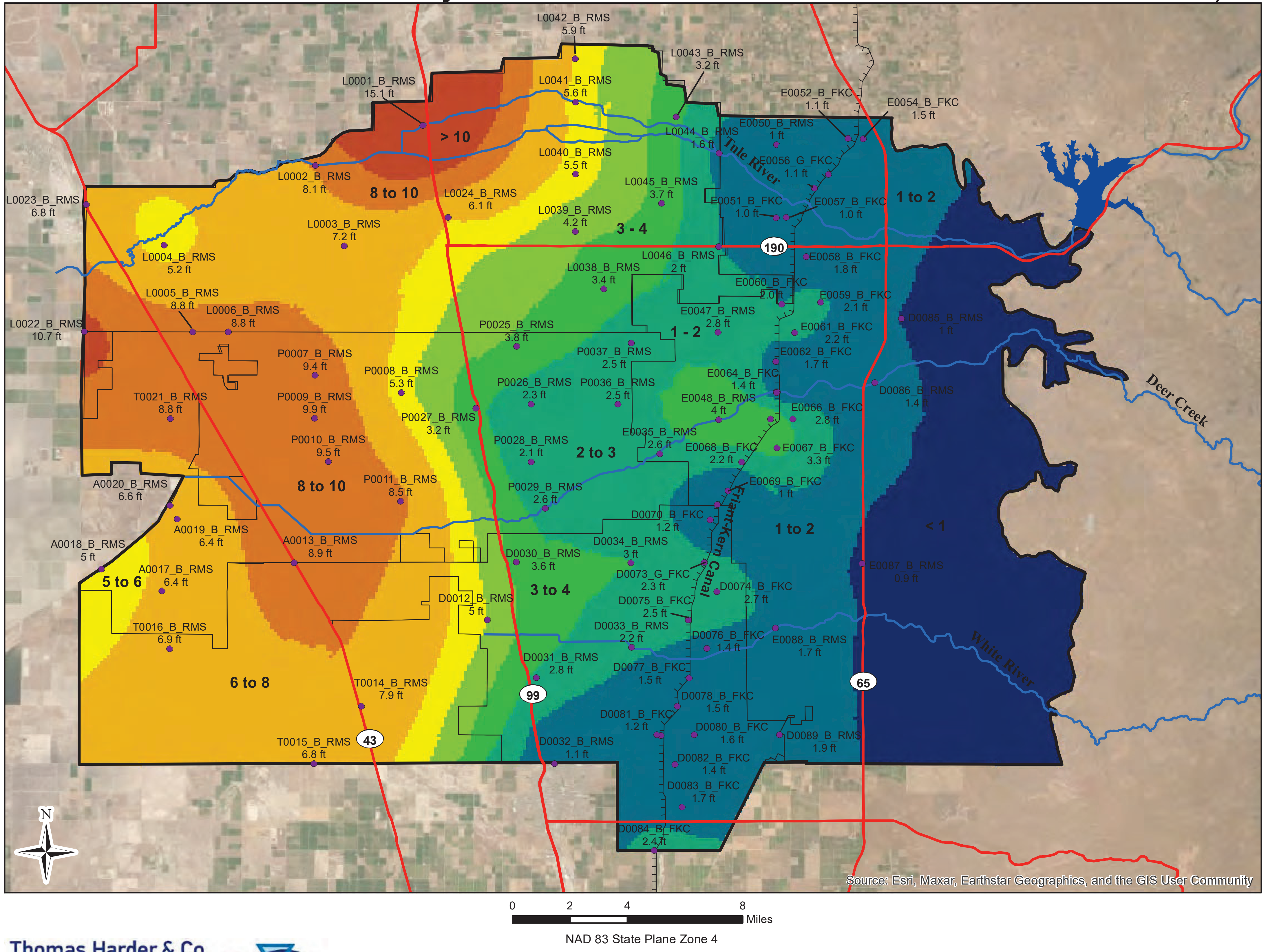

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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

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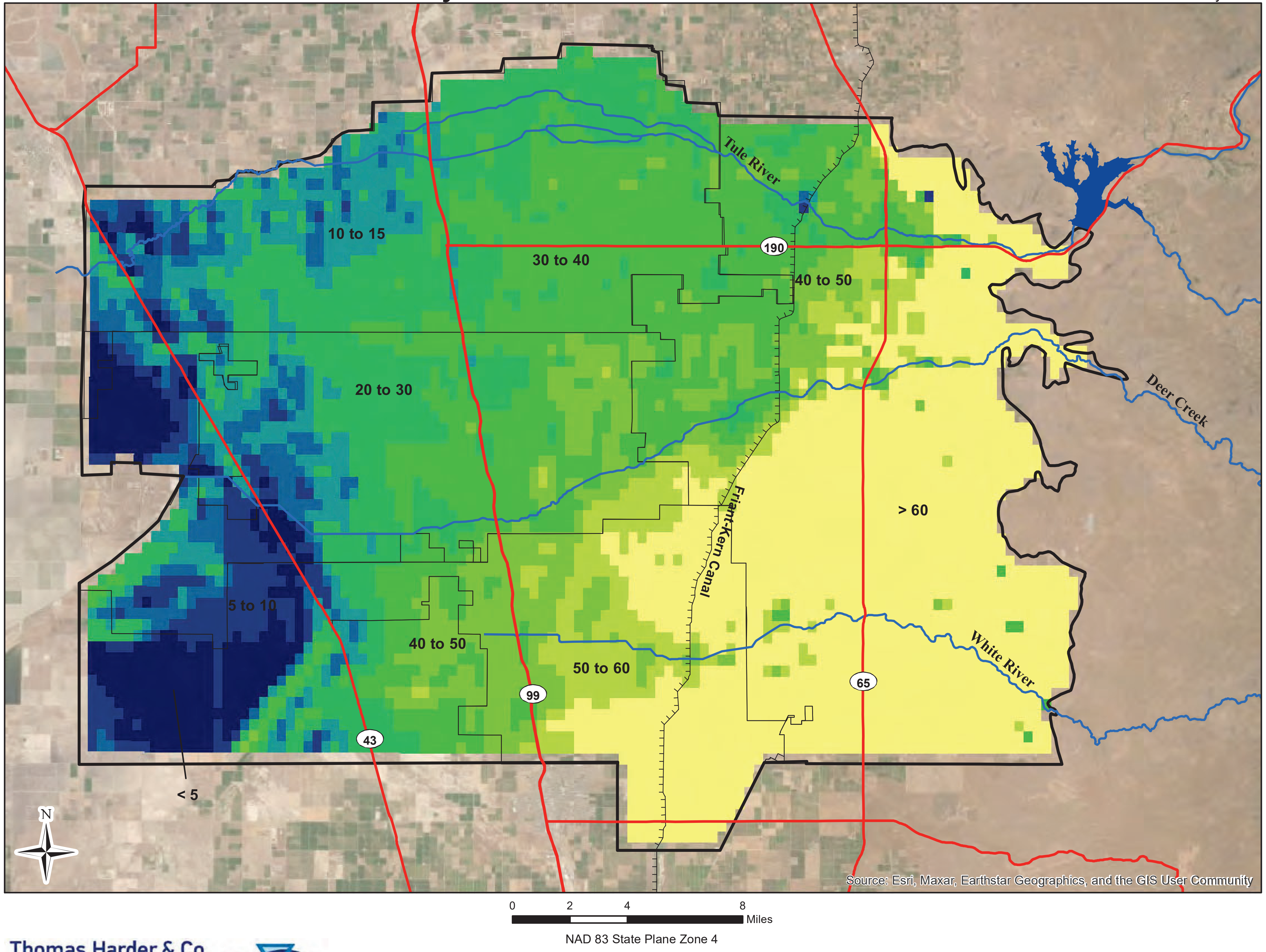
Minimum Threshold - Subsidence

Figure 7

DWR Comments - Subsidence in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

July 2022



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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.

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Estimated 2020 Land Surface Slope

Figure 8

DWR Comments - Subsidence in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

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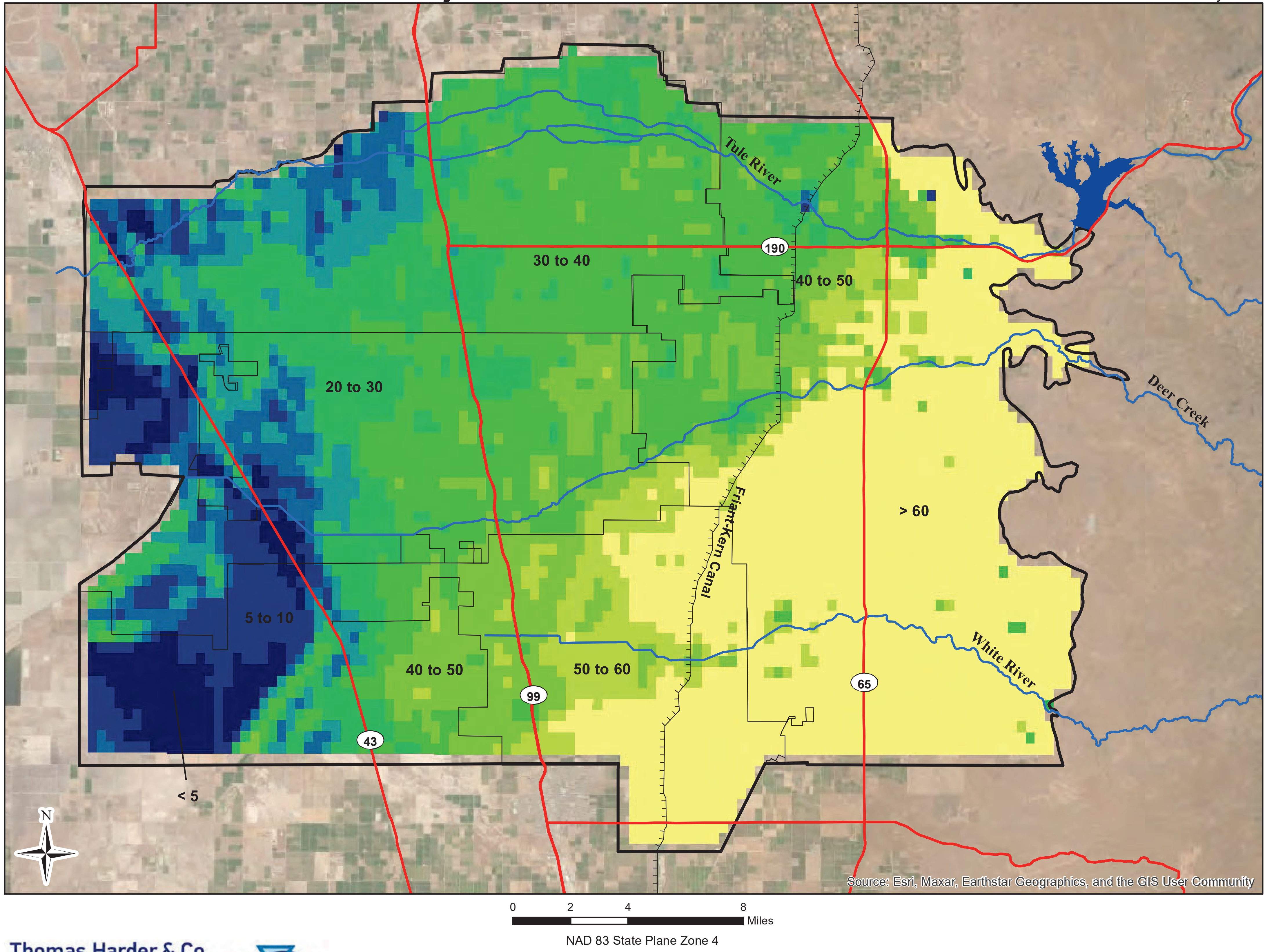

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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

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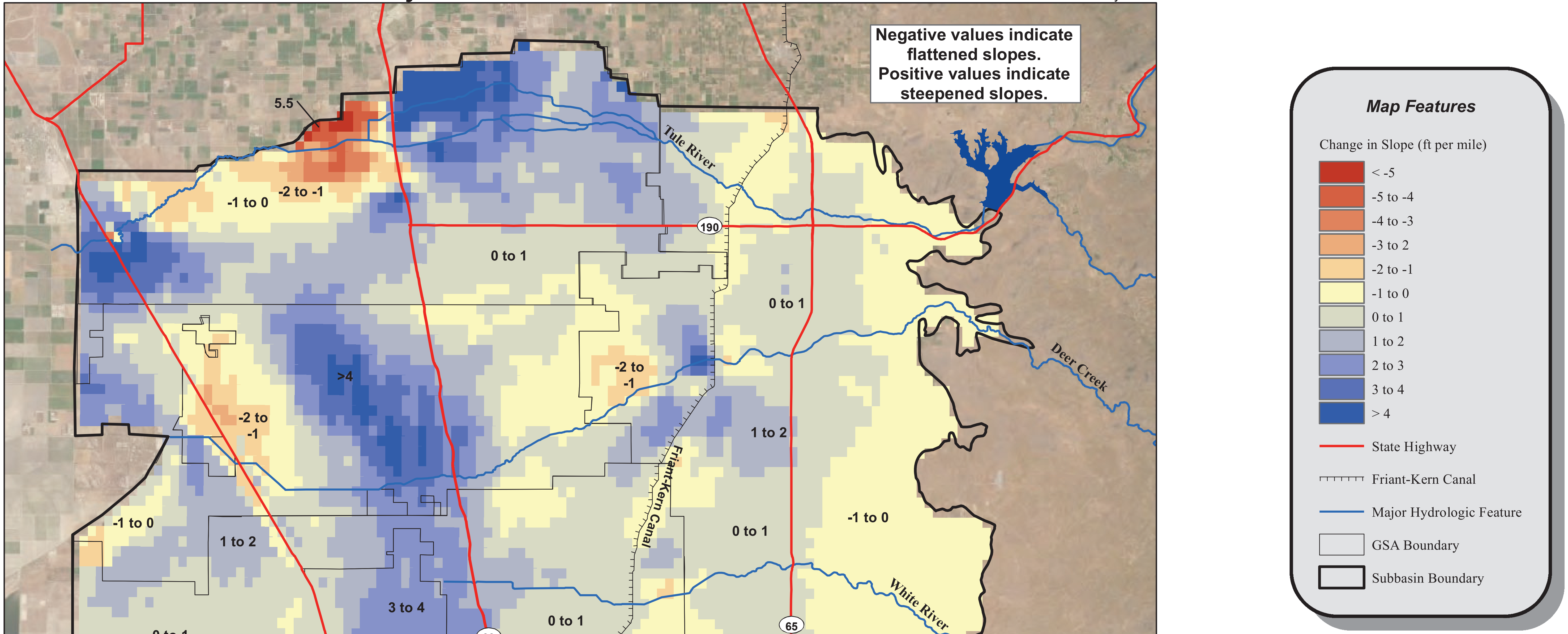
Figure 9

DWR Comments - Subsidence in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

July 2022



0 2 4 8 Miles

NAD 83 State Plane Zone 4

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

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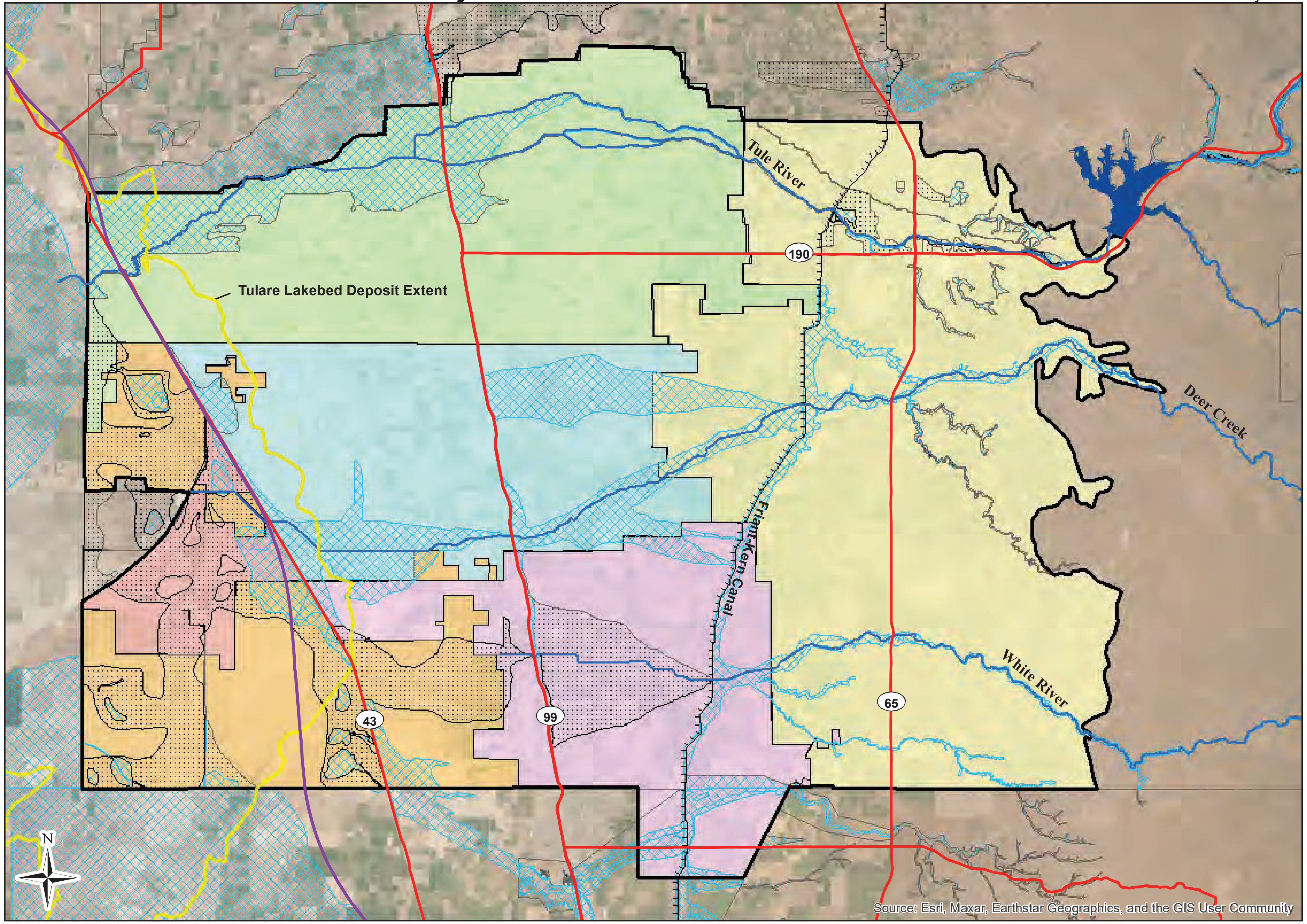
Estimated Change in Land Surface Slope

Figure 10

DWR Comments - Subsidence in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

July 2022



0 2 4 8 Miles

NAD 83 State Plane Zone 4

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

Thomas Harder & Co.
Groundwater Consulting

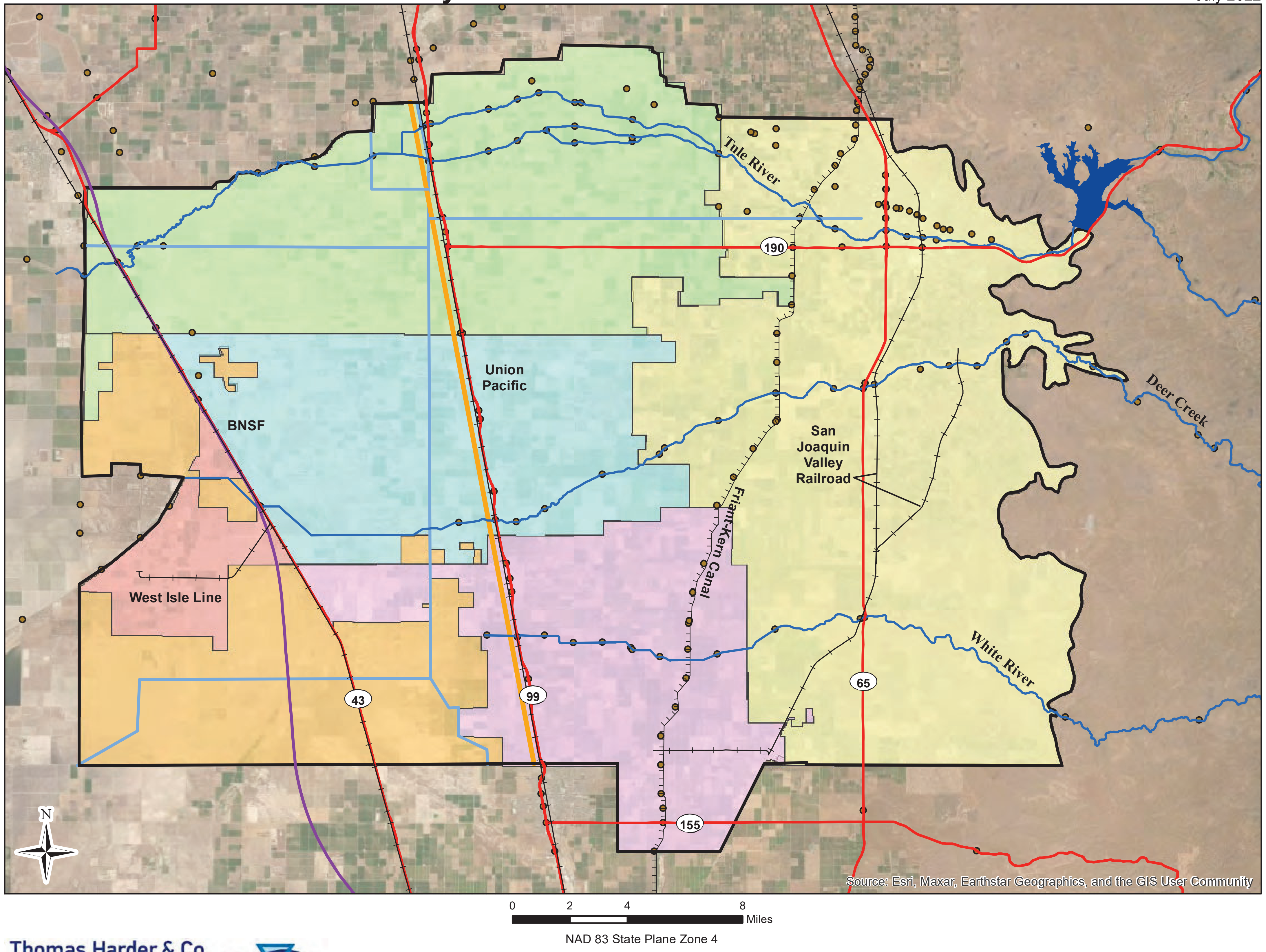
Simplified FEMA Flood Hazard Areas

Figure 11

Tule Subbasin Technical Advisory Committee

July 2022

DWR Comments - Subsidence in the Tule Subbasin



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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/

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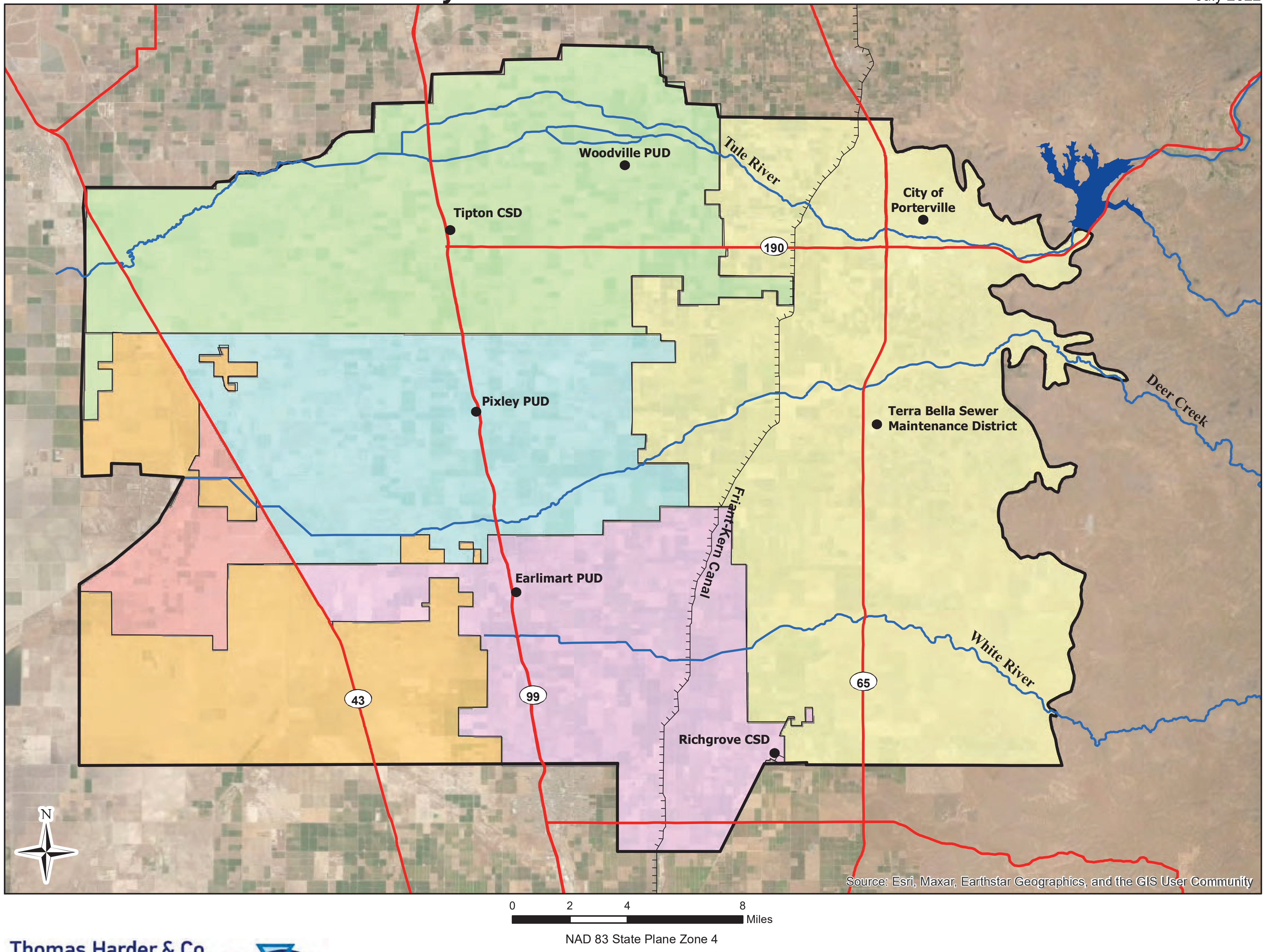
State Highways, Railroads, Pipelines, and Bridges

Figure 12

DWR Comments - Subsidence in the Tule Subbasin

Tule Subbasin Technical Advisory Committee

July 2022



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

NAD 83 State Plane Zone 4

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

Figure 13

Thomas Harder & Co.
Groundwater Consulting

DELANO – EARLIMART
IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX A-7

Mitigation Program Framework

2024
2nd Amended Groundwater Sustainability Plan

DELANO-EARLIMART IRRIGATION DISTRICT GSA

MITIGATION PLAN

VERSION 4.0
JULY 2024

Prepared for

DELANO – EARLIMART
IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

Prepared by

INTERA

Contents

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Acronyms & Abbreviations

AF	acre-feet
AFY	acre-feet per year
Ag	Agriculture
CVP	Central Valley Project
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
DAC	Disadvantaged Communities
DEID	Delano-Earlimart Irrigation District
DWR	Department of Water Resources
EPUD	Earlimart Public Utilities District
FARM	Fallowed Area Recharge Management
ft	foot/feet
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
ILRP	Irrigated Lands Regulatory Program
M&I	Municipal and Industrial
MA	Management Area
MCL	Maximum Concentration Level
MOU	Memorandum of Understanding
RCSD	Richgrove Community Services District
SAFER	Safe and Affordable Funding for Equity and Resilience
SDAC	Severely Disadvantaged Community
SHE	Self-Help Enterprises
SGMA	Sustainable Groundwater Management Act
Subbasin	Tule Subbasin
SWRCB	State Water Resources Control Board
USBR	US Bureau of Reclamation
WMA	Western Management Area
WQO	Water Quality Objective

If you have experienced a loss of drinking water, please contact **Self-Help Enterprises** at **(559) 802-1685**. Self-Help Enterprises is available to assist with accessing emergency drinking water and interim drinking water supplies.

For claims regarding drinking water wells (including agricultural wells used for drinking water purposes), please fill out the online intake form on Self-Help Enterprises' website: ***https://www.selfhelpenterprises.org/programs/emergency-services/water-sustainability/***

For claims regarding non-drinking water wells (such as agricultural wells) and critical infrastructure, please contact your Delano-Earlimart Irrigation District (DEID) Groundwater Sustainability Agency (GSA):

DELANO-EARLIMART IRRIGATION DISTRICT GSA
Primary Office: 14181 Avenue 24, Delano CA
Secondary Office: 2904 W Main St, Visalia, CA
Phone Number: (661) 725-2526
Website: www.deid.org/gsa
Email: info@deid.com
General Manager: Eric R. Quinley
District Engineer: David Wierenga

Si experencia pérdida de agua potable, comuníquese con **Self-Help Enterprises** al **(559) 802-1685**. Self-Help Enterprises está disponible para ayudarle con el acceso a agua potable de emergencia y suministros provisionales de agua potable.

Para reclamos relacionados con pozos de agua potable (incluidos los pozos agrícolas utilizados para fines de agua potable), complete el formulario de admisión en línea en el sitio web de Self-Help Enterprises: ***https://www.selfhelpenterprises.org/programs/emergency-services/water-sustainability***

Para reclamos relacionados con pozos de agua no potable (como pozos agrícolas) e infraestructura crítica, comuníquese con su respectiva Agencia de Sostenibilidad de Aguas Subterráneas (GSA) a través de la información de contacto anterior.

1 Introduction

1.1 Sustainable Groundwater Management Act Background

On September 16, 2014, Governor Jerry Brown signed into law a three-bill legislative package, composed of AB 1739 (Dickinson), SB 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act (SGMA) and is codified in Section 10720 et seq. of the California Water Code. In his signing statement, Governor Edmund G. Brown, Jr., emphasized that "groundwater management in California is best accomplished locally." This legislation created a statutory framework for groundwater management in a manner that can be sustained during the planning and implementation horizon without causing undesirable results.

SGMA requires governments and water agencies in high- and medium-priority basins that have elected to become groundwater sustainability agencies (GSAs) to achieve sustainability by avoiding undesirable results. Under SGMA, these basins should reach sustainability within 20 years of implementing their Groundwater Sustainability Plans (GSPs). For critically over-drafted basins, including the Tule Subbasin (California department of Water Resources [DWR] Bulletin 118 Basin No. 5-022.13), to which the Delano-Earlimart Irrigation District (DEID) GSA covers a portion, the deadline for achieving sustainability is 2040.

1.2 Delano-Earlimart Irrigation District Groundwater Sustainability Agency Background

The Tule Subbasin (Subbasin), as identified by DWR in Bulletin 118 as Subbasin No. 5.22-13 (DWR, 2016), is situated primarily in southern Tulare County with a small portion in Kern County within the southern portion of the Central Valley of California. The Subbasin is one of the top producing agriculture regions in the area, with very fertile soils and wide diversity of crops. The area of the Tule Subbasin is approximately 744 square miles (475,895 acres) and is located within Tulare County, except for the southernmost portion of the DEID GSA, which is in Kern County. The following seven GSAs are located within Tule Subbasin (see **Figure 1**):

- Eastern Tule Groundwater Sustainability Agency.
- Tri-County Water Authority Groundwater Sustainability Agency.
- Pixley Irrigation District Groundwater Sustainability Agency.
- Lower Tule River Irrigation District Groundwater Sustainability Agency.
- DEID GSA.
- Alpaugh Groundwater Sustainability Agency.
- Kern-Tulare Water District Groundwater Sustainability Agency.

The DEID GSA comprises three separate Management Areas (MAs) as detailed below. The total area covered by the DEID GSA is approximately 57,210 acres. It is in southern Tulare County with a small portion within northern Kern County. Its northern-most boundary is Avenue 72, eastern-most boundary is California Highway 65, southern-most boundary is Woollomes Avenue, and the western-most boundary is County Road 128. All boundaries are irregular.

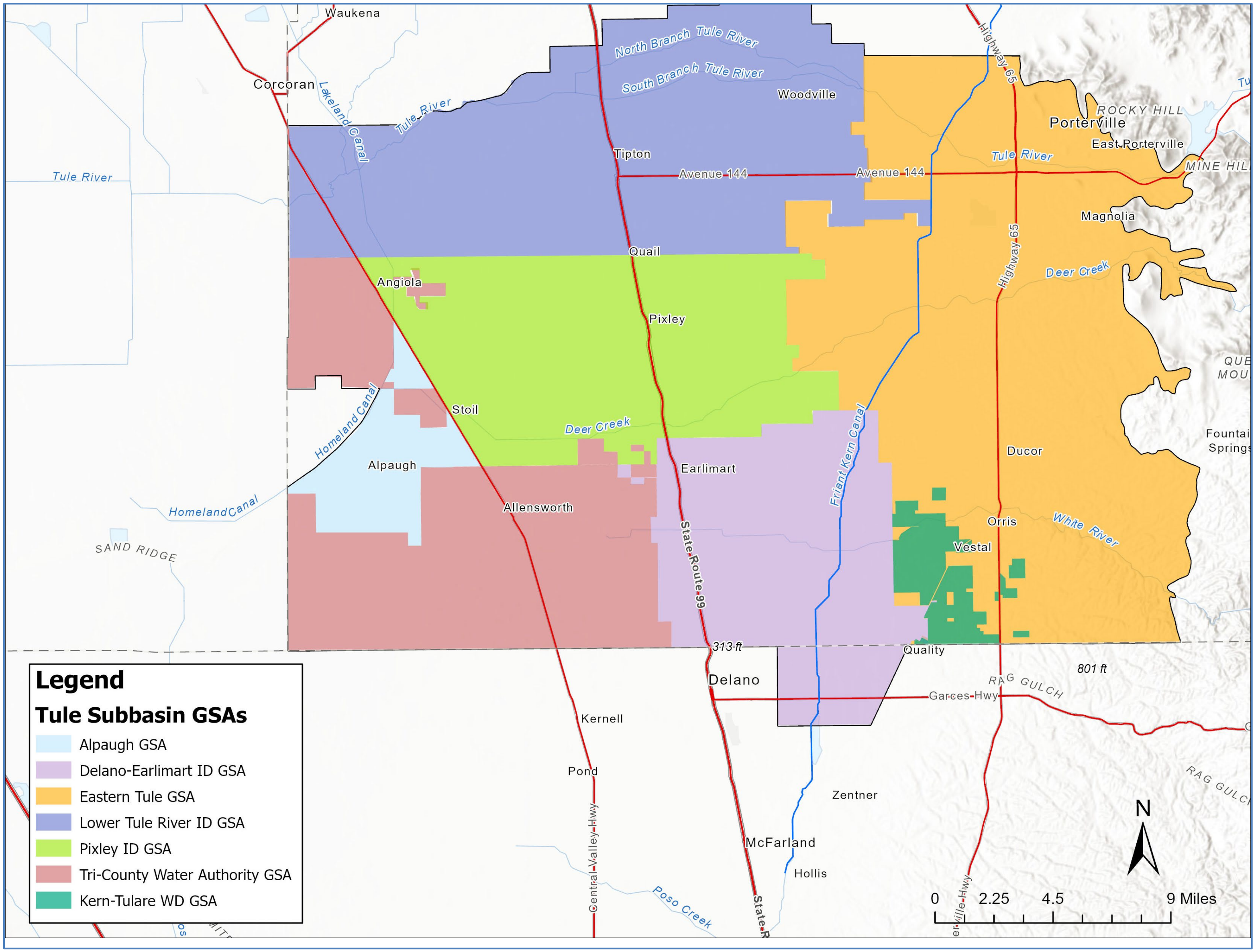

Figure 1 Tule Subbasin GSAs

The lands within the DEID GSA consist of the lands within the jurisdictional boundaries of Delano-Earlimart Irrigation District (DEID, District), the Earlimart Public Utility District (EPUD), and the Richgrove Community Services District (RCSD). DEID, EPUD, and RCSD are local agencies duly formed and given legal authority under the laws of the State of California (Division 11 of the Water Code, § 16461 of the California Public Utility District Act, and § 61060 of the Community Services District Law, respectively) with water supply and groundwater management responsibilities under SGMA within their jurisdictional boundaries. The DEID has entered into Memoranda of Understanding (MOUs) with EPUD, RCSD, and the County to manage water resources in those areas consistent with the terms and conditions of the DEID GSA GSP.

The area covered by the DEID GSA has been divided into three separate MAs corresponding to the jurisdictional status, principal land use, water use sector, and the water source type of those respective areas. For the purposes of this report, water conditions relating to each of the three MAs are described separate from each other, being that each MA is unique in the water resources available to it, and each manages water resources independently from the other MAs. **Figure 2** shows the boundaries of the MAs within the DEID GSA.

- Area 1: DEID MA: Consists of the lands within the DEID service area (56,571 acres).
- Area 2: RCSD MA: Consists of lands within the RCSD service area (234 acres).
- Area 3: EPUD MA: Consists of lands within the EPUD service area (773 acres).

The Western Management Area (WMA), a portion of unincorporated land within Tulare County, was removed from the DEID GSA jurisdictional boundary in June 2023. Following the termination of the MOU between Tulare County and DEID GSA, which outlined the inclusion of the WMA within the GSA, the WMA was returned to Tulare County GSA and later incorporated into Tri-County Water Authority GSA. **Figure 2** depicts the current MAs and GSA jurisdictional boundary.

1.3 Role of Delano-Earlimart Irrigation District in Maintaining Sustainability

DEID's role in the Subbasin is unique in many ways. Most critically, DEID is a net recharger of water into the Tule Subbasin. Irrigation in the Delano and Earlimart regions began in the late 1800s with artesian wells. By the 1930s, diminished groundwater supplies threatened the area's continued economic viability. By 1947 the mean depth to groundwater was dangerously low. The DEID was formed in 1938 and signed its original water service contract with the United States Bureau of Reclamation (USBR) in 1951 for water delivery from the Friant Unit of the Central Valley Project (CVP), after the average depth of groundwater had fallen every year since 1905. Since its inception, the DEID has provided consistent and reliable surface water to its constituents.

Over its 85-year history, DEID has invested heavily to provide renewable surface water to its growers. The DEID distribution system includes 172 miles of pipeline, 18 pumping plants, and five regulating reservoirs. The DEID water system is a nearly $341M investment in 2023 dollars. Since SGMA was enacted, DEID has invested more than $44 million in projects that expand DEID's ability to honor the sustainability commitment. This investment includes 944-acres of recharge and water banking facilities, referred to as the "Turnipseed Water Banking Facility" or "Turnipseed Recharge Basins" in this Mitigation Plan. Phases 1-5 of the Turnipseed Water Banking Facility are complete and currently operating. Phase 6 of the Turnipseed Water Bank is currently under construction with completion scheduled for September 2024. Upon the completion of Phase 6, the 944-acre facility will be capable of percolating 12,928 acre-feet per month and, at an average recharge opportunity of 2.41 months per year[1], will allow the District to deposit an average of 31,157 acre-feet per year into the aquifer. Accounting for operational losses and a conservative leave-behind factor, the average net supply available for future recovery in dry years is 28,041 acre-feet per year (of the 31,157 acre-feet per year stored water). It is important to note that the surface water delivered to these recharge facilities and stored in the aquifer is of very good quality, being sourced directly from the Sierra Nevada snowmelt and diverted through the Friant Kern Canal.

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[1] *The average number of months per year during which recharge opportunities are available to the District is derived from historic DEID recharge operations data, starting in 1993. On average, from 1993 to present, DEID has been able to conduct recharge operations for 2.41 months per year.*

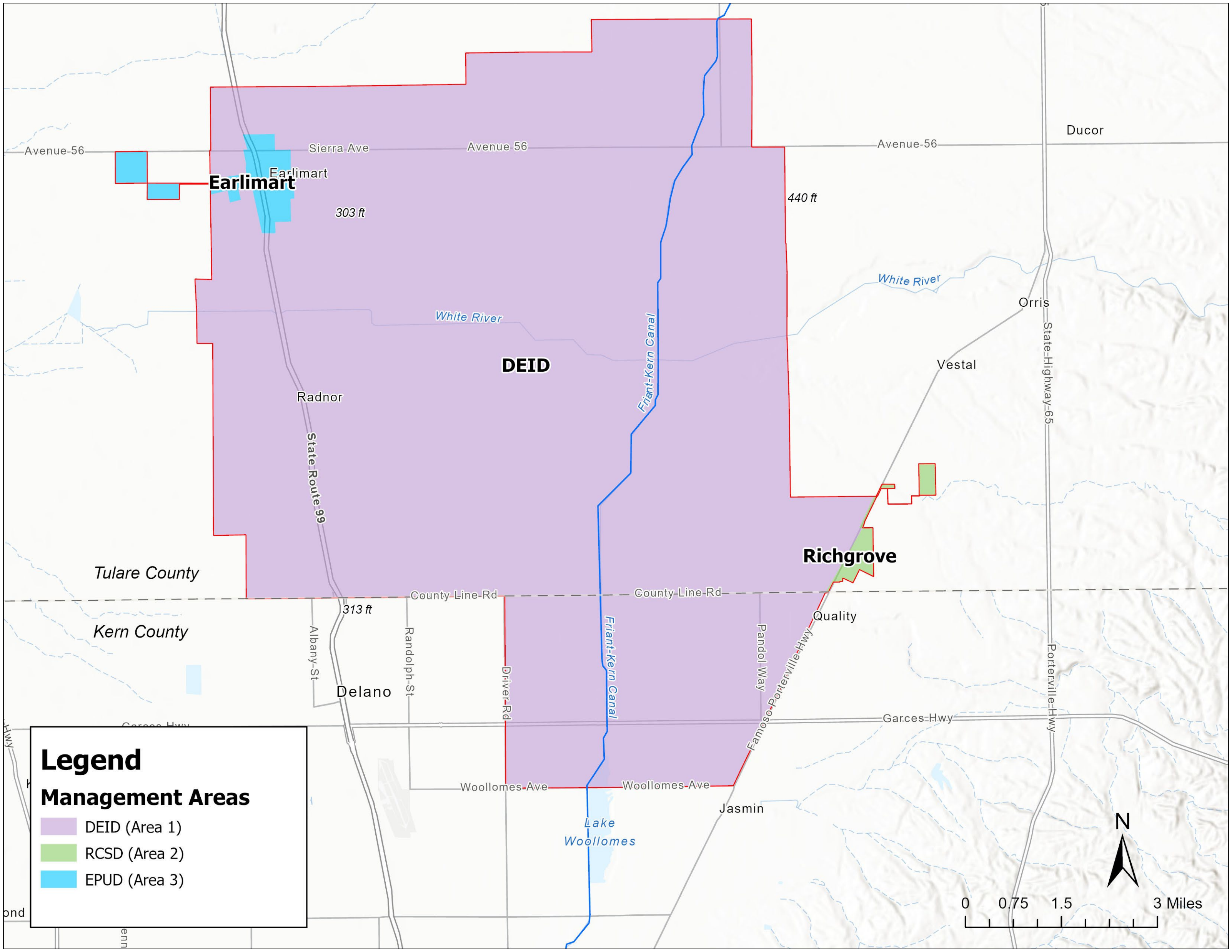

Figure 2 DEID GSA Plan Area

In addition to the Turnipseed Water Storage Facility recharge activities, an additional 700 acres enrolled in the DEID's "Fallowed Area Recharge Management" (FARM) program received 7,201 AF of recharge deliveries during the same period.

DEID supports more than 450 growers, and its primary purpose is to deliver water from the Friant-Kern Canal to farms in the region. DEID is the largest Class 1 contractor on the Friant-Kern Canal, with a contract for 108,800 AF of Class 1 water. DEID also contracts for 74,500 AF of Class 2 water. Class 1 and Class 2 supply is accessed via nine points of diversion from the Friant-Kern Canal (see **Figure 3**) and distributed through 473 active turnouts.

Water records from DEID indicate that from 1987 to 2023 DEID imported nearly 4.0 million acre-feet or an average of approximately 110,000 acre-feet per year. This figure is comprised of two categories: approximately 105,000 acre-feet of irrigation deliveries, and approximately 5,000 acre-feet of deliveries to in-District recharge facilities. Note that this average in-District recharge value encompasses two very distinct periods of District operations. From 1987 and up to the passage of SGMA in 2014, DEID's in-District recharge area had grown from nothing to 160 acres, with average annual deliveries of 1,490 acre-feet during this period. In 2015, following the passage of SGMA, DEID began to prioritize in-District recharge operations, maximizing the use of the existing facilities and implementing an aggressive plan to develop new facilities. The sixth and final phase of this expansion project will be completed in late summer of 2024, increasing the total in-District recharge area to 944 acres. From 2015 to 2023, average in-District recharge deliveries increased to nearly 13,000 acre-feet per year. During this same period of 2015 – 2023, which was comprised of primarily dry or critically dry year types, DEID continued to maintain deliveries to Out-of-District water banks averaging more than 14,000 acre-feet per year. When taking into consideration all available water to the DEID MA during the period of 1987-2023, which includes imported surface water used for irrigation and in-District recharge, precipitation, and sustainable yield, the amount of water available on an average annual basis was 154,842 acre-feet. Over the same 37-year period, the average annual consumptive demand of the District was 135,690 acre-feet per year. **Comparing these values yields an average net surplus of 19,152 acre-feet per year, indicating that DEID MA has been, on average, a net contributor of imported water to the Subbasin.**

Figure 4 depicts the DEID water storage inputs and withdrawals from water years 1987 to 2023.

DEID's investments in surface water infrastructure, water storage, and recharge activities play a significant role in water availability for Severely Disadvantaged Communities and Disadvantaged Communities (S/DACs) within and adjacent to DEID GSA. These S/DACs are solely reliant on groundwater supplies. DEID supports access to drinking water for these underrepresented communities through the District's significant water storage and recharge activities, as well as primarily using surface water in lieu of groundwater pumping. **Figure 3** depicts the S/DACs within and adjacent to DEID GSA as well as the critical infrastructure that supports the District and neighboring communities.

DEID is surrounded by other GSAs that are pumping non-sustainably (**Figure 1**). Groundwater pumping within neighboring GSAs continues to have a negative effect on groundwater levels and subsidence rates within the DEID GSA. While DEID imports significant amounts of surface water and provides a net benefit to the Tule Subbasin, its positive benefits to the Subbasin may be or have been significantly negated due to the actions of neighboring GSAs. This Mitigation Plan is intended to address impacts that may occur during the implementation period associated with groundwater overdraft (aka the SGMA planning and implementation horizon). DEID GSA has proposed that the Tule Subbasin consider an attribution-based funding mechanism for the Subbasin Wide Mitigation Program(s), to require those GSAs with allowable overdraft policies that cause impacts within DEID GSA (or other GSAs) to be responsible for funding these impacts. An attribution-based funding mechanism has not been adopted by the Tule Subbasin at the time of adopting Version 4.0 of the DEID Mitigation Plan, though such a plan is under consideration.

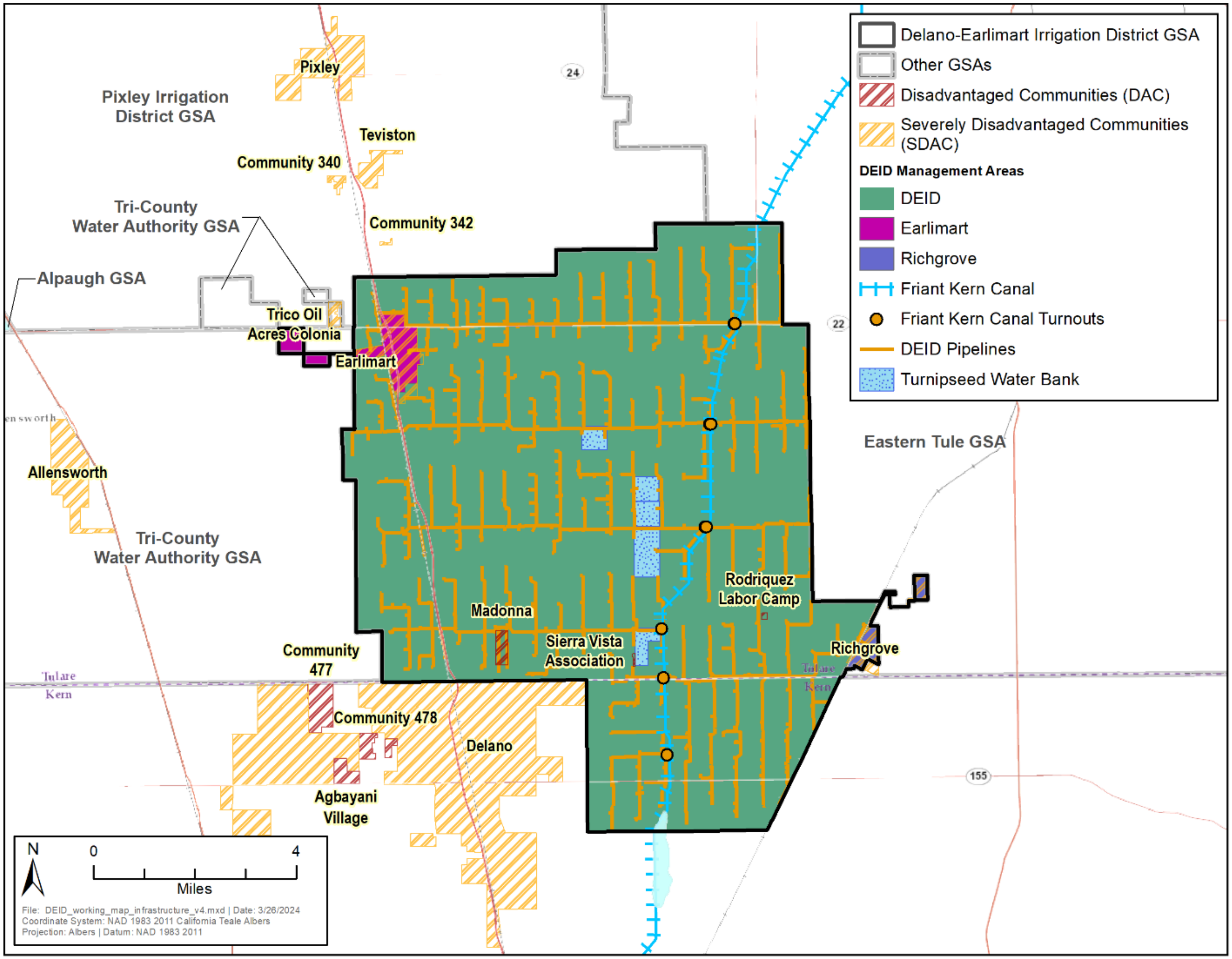

Figure 3 Severely/Disadvantaged Communities within and Adjacent to DEID GSA and DEID Critical Infrastructure

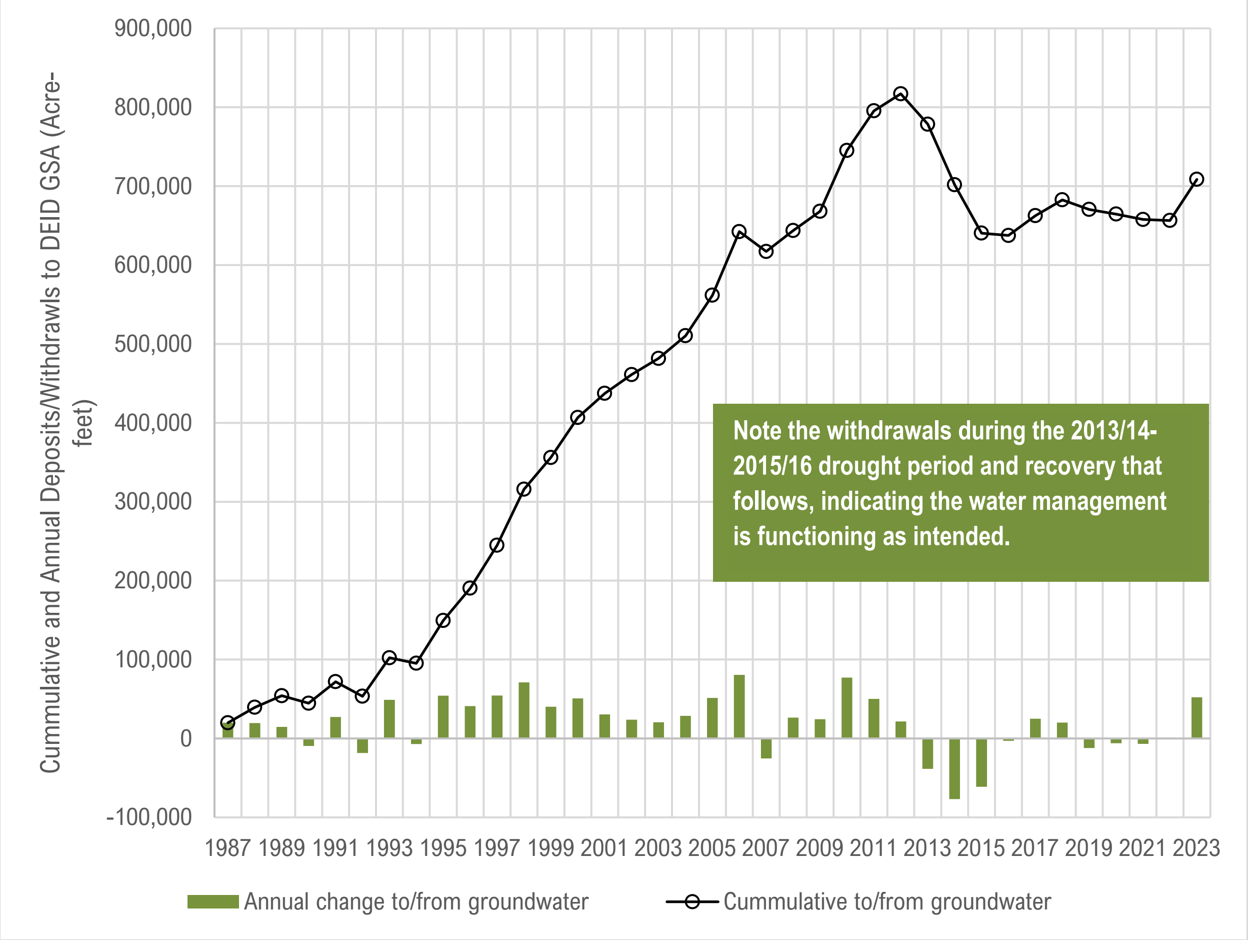

Figure 4 DEID GSA Water Storage Deposits and Withdrawals (1986/87-2022/23 Water Years)

1.4 Mitigation Plan Purpose

The purpose of the DEID GSA Mitigation Plan (Version 4.0) is to mitigate adverse impacts on drinking water wells affected by declining groundwater levels, land subsidence, and degraded groundwater quality. Although DEID GSA has been sustainable for decades through DEID's investments in water storage infrastructure and reliable Central Valley Project (CVP) surface water supplies from the Friant Kern Canal (**Figure 3**), neighboring GSAs' unsustainable water management and plans for allowable overdraft during the SGMA implementation period via the Tule Subbasin Transitional Pumping Program elevate the risk of impacts to wells and critical infrastructure within the GSA.

This Version 4.0 of the Mitigation Plan focuses on domestic wells as the most vulnerable beneficial users with the greatest urgency to receive emergency, interim, and long-term solutions to prioritize the health, safety, dignity, and opportunity of all residents within DEID GSA.

Because impacts to wells, critical infrastructure, and other beneficial users may be induced by activities outside of DEID GSA, all non-drinking water claims submitted to DEID GSA will be forwarded to the potentially responsible GSAs/parties through their respective GSAs' Mitigation Plans or Programs' claims process(es). Although impacts to domestic drinking water wells is likely induced by external activities, DEID GSA recognizes the urgency of addressing mitigation for these claimants and may work with neighboring GSAs for the potentially responsible party or parties to provide timely reimbursement funding. DEID GSA will cover expenses for domestic well claimants that qualify for mitigation through this mitigation plan in instances in which the responsible party is unable to fund reimbursement.

Information on the attribution analyses that informed the determination that the DEID GSA and its growers do not contribute to overdraft conditions and neighboring GSAs' unsustainable groundwater management does induce groundwater decline, loss of storage, and land subsidence within DEID GSA is included in Section 3 of the 2024 2nd Amended GSP.

The DEID GSA prepared and adopted a Preliminary Mitigation Plan (Version 1.0) in December 2022 dedicated to mitigating water level impacts in accordance with the Tule Subbasin's Mitigation Program's guidelines in July 2022, which included claims processes applicable to domestic and municipal wells. In August 2023, DEID GSA revised the Mitigation Plan to include mitigation of impacts induced by subsidence and water quality contamination associated with changes in water levels or groundwater management as well as offering technical assistance for non-drinking water wells, such as agricultural and industrial.

This Version 4.0 of the DEID GSA Mitigation Plan (2024) details improvements and clarification of the two tracks of the DEID Mitigation Plan: (1) Drinking Water Wells Track and (2) Technical Assistance Track. Such improvements include a 24-hour emergency and 72-hour interim drinking water supplies turnaround times, translation services, and a well stewardship education program via a partnership with Self-Help Enterprises (SHE) in which all administrative, technical, and materials associated with claims that qualify under this Mitigation Plan are reimbursed by DEID GSA.

1.5 Partnerships with Existing Mitigation Programs

Self-Help Enterprises (SHE) is a nationally recognized community development organization whose mission is to work together with low-income families to build and sustain healthy homes and communities in the San Joaquin Valley. Following the 2015 drought, SHE's services expanded to provide emergency and interim drinking water supplies as well as long-term solutions for disadvantaged households who have lost access to drinking water supplies. In March 2024, DEID GSA and SHE signed a Letter of Intent outlining the intentions to partner in the implementation of the DEID GSA Mitigation Plan's Drinking Water Well Mitigation Track.

With consideration of SHE's drinking water well mitigation expertise, local knowledge, translation service offerings, and to avoid confusion for claimants on where to apply, SHE's contribution greatly strengthens the effectiveness of the DEID GSA Mitigation Plan. The agreement between the DEID GSA and SHE is such that the GSA shall reimburse SHE for costs associated with program administration, groundwater quality sampling, interim drinking water supplies, and long-term mitigation measure for all drinking water well claims that qualify for Tule Subbasin mitigation within the DEID GSA[2].

There are many reasons why a well may experience operational failure. GSAs are responsible for mitigating wells that have been impacted by overdraft conditions since January 1, 2015. Impacts from

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[2] SHE serves as a contract mediator and lender for the claimants to arrange mitigation with well drillers to perform the long-term physical mitigation.

overdraft may be reflected by chronic lowering of groundwater levels dewatering a well, land subsidence causing structural damage to a well, and/or declining water levels or subsidence introducing new groundwater quality contamination to a well. Therefore, the GSAs are reimbursing SHE for addressing claims in which the impact was induced by groundwater overdraft after January 1, 2015 (see **Section 3** for more information). SHE offers emergency drinking water assistance and mitigation for households who have lost drinking water supplies due to non-groundwater overdraft induced well failure, and the funding for those activities are sourced by other state initiatives in the spirit of protecting the human right to water[3].

All claims for non-drinking water wells and critical infrastructure shall be administered, evaluated, and if applicable, funded directly by the DEID GSA or the GSAs attributed to have caused the impact and not by SHE. At the time of adopting this Mitigation Plan, the Tule Subbasin GSAs have not entered into an agreement detailing the process and commitments for an attribution-based funding model. In the interim, the District will fund qualifying claims.[4]

1.6 Evolving Program

As DEID GSA gathers data and information through processes to fill data gaps and new analytical tools become available, opportunities to refine the Mitigation Plan are expected. In addition to improved data and analytics, lessons will be learned through the implementation of the Mitigation Plan. Costs to mitigate wells, provide emergency and interim supplies, and administration may also evolve over the 15+ year implementation horizon. DEID GSA intends the Mitigation Plan to be iterative and evolve as new information, funding, and efficiencies are understood. Do note, this Mitigation Plan is identified as "Version 4.0" following Version 1.0 in 2022, Version 2.0 in 2023, and Version 3.0 in April of 2024 with the expectation of future versions.

1.7 Proactive Measures to Avoid the Need for Mitigation

In addition to the mitigation measures detailed in the Claims Process section below, DEID GSA's water management strategy is designed to avoid the need for mitigation altogether. Proactive measures refer to GSA activities to help prevent future impacts to beneficial users, uses, and property interests.

Use and Recharge of Reliable Surface Water Supplies

The first 800,000 AF of CVP Friant Division yield made available is considered Class 1 water. Class 2 water is the next 1.4 million AF. Historically, on average, about 650,000 AF of Class 2 water is made

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[3] Assembly Bill 685 (2012) made California the first state in the nation to legislate the Human Right to Water. Section 106.3 of the Water Code states that "every human being has the right to safe, clean, affordable, and accessible water for human consumption, cooking, and sanitary purposes." In instances in which a drinking water well may not meet the overdraft criteria above, the well user is encouraged to contact Self-Help Enterprises to access mitigation assistance via alternative programs.
Website: https://www.selfhelpenterprises.org/programs/community-development/safe-drinking-water/
SHE's Phone Number: (559) 802-1685

[4] DEID and SHE entered a Letter of Intent to partner on this Mitigation Plan in March 2023. DEID and SHE are nearing completion with contract discussions and are expected to have an executed agreement before final adoption the 2024 2nd Amended GSP.

available in a water year. DEID is the largest Class 1 Friant contractor, with a contract for 108,800 AF of Class 1 water. DEID also contracts for 74,500 AF of Class 2 water (USBR Contract Number I75r-3327D). Additionally, DEID's CVP contract provides opportunities to access other water supplies that are made available from time to time during particularly wet years.

As a result of DEID's efficient distribution system and its large CVP water contracts, the DEID MA has successfully implemented conjunctive use programs throughout its nearly 85-year history. When taking into consideration all available water to the DEID MA during the period of 1987-2023, which includes imported surface water used for irrigation and in-District recharge, precipitation, and sustainable yield, the amount of water available on an average annual basis was 154,842 acre-feet. Over the same 37-year period, the average annual consumptive demand of the District was 135,690 acre-feet per year. Comparing these values yields an average net surplus of 19,152 acre-feet per year, indicating that DEID MA has been, on average, a net contributor of imported water to the Subbasin.

Water Storage & Recharge Activities

DEID MA made substantial capital investment and expansion of its recharge facilities during the reporting period to optimize conjunctive water use.

Since SGMA was enacted, DEID has invested more than $44 million in projects that expand DEID's ability to honor the sustainability commitment described in FIGURE 0 3. This investment includes 944-acres of recharge and water banking facilities, referred to as the "Turnipseed Water Banking Facility" or "Turnipseed Recharge Basins" in this Plan. Phases 1-5 of the Turnipseed Water Banking Facility are complete and currently operating. Phase 6 of the Turnipseed Water Bank is currently under construction with completion scheduled for September 2024. Upon the completion of Phase 6, the 944-acre facility will be capable of percolating 12,928 acre-feet per month and, at an average recharge opportunity of 2.41 months per year[5], will allow the District to deposit an average of 31,157 acre-feet per year into the aquifer. Accounting for operational losses and a conservative leave-behind factor, the average net supply available for future recovery in dry years is 28,041 acre-feet

Figure 5 DEID's Turnipseed Water Banking Facility

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[5] *The average number of months per year during which recharge opportunities are available to the District is derived from historic DEID recharge operations data, starting in 1993. On average, from 1993 to present, DEID has been able to conduct recharge operations for 2.41 months per year.*

per year (of the 31,157 acre-feet per year stored water). It is important to note that the surface water delivered to these recharge facilities and stored in the aquifer is of very good quality, being sourced directly from the Sierra Nevada snowmelt and diverted through the Friant Kern Canal.

For historical context, DEID has, on average, been able to make recharge deliveries for approximately 2.4 months per year over the last 31 years using Phase I of the facility. **Table 1** summarizes annual average recharge activities at each of the phases of the DEID Turnipseed Water Storage Facility, pictured in **Figure 5. Figure 4.** illustrates the significant recharge contribution and functionality of withdrawing surface water stored in drought periods (see 2015 drought period).

Table 1 Turnipseed Water Storage Facilities – Average Annual Recharge[1]

Project Phase	Gross Area	Effective Recharge Area	Acre-Feet/Day	Acre-Feet/Year	Net Returnable Supply
	[ac]	[ac]	[ac-ft]	[ac-ft]	[ac-ft]
I	80	66	37	2,640	2,376
II	80	66	37	2,640	2,376
III	320	266	146	10,562	9,505
IV	160	133	73	5,281	4,753
V	156	129	71	5,149	4,634
VI	148	123	68	4,885	4,396
			Total	**31,157**	**28,041**

1) Phase VI is estimated to be completed in September 2024. All other phases are completed and operating.

Well Permit Review

In accordance with Governor Gavin Newsom's Executive Order N-7-22 dated March 28, 2022, Section 9(a) of the executive order requires a written verification from the applicable GSA to address whether groundwater extraction by a proposed well would be inconsistent with any sustainable groundwater management program established in any applicable GSP adopted by the GSA or would decrease the likelihood of achieving a sustainability goal for the basin covered by the GSP. Section 9(b) also requires a determination that the proposed well is not likely to interfere with the production and functioning of existing nearby wells, and not likely to cause subsidence that would adversely impact or damage nearby infrastructure.

In addition to reviewing agricultural well permit applications in compliance with Executive Order N-7-22 Section 9(a), DEID GSA has arranged that Tulare County send domestic well permit applications as well to evaluate the proposed well's risk of inducing impacts inconsistent with the GSA's sustainability goal. DEID GSA reviews each permit application with an impact susceptibility analysis. The impact susceptibility analysis evaluates if the proposed well would elevate the risk of inducing water level decline or subsidence impacts to nearby wells and/or critical infrastructure. Each permit application is evaluated on a case-by-case basis; however, the core criteria for evaluating if a proposed well requires additional analyses to assess risk is as follows:

1) The proposed well must be greater than 1,000 ft from the nearest well.

2) The proposed well must be greater than 5,280 ft (1 mile) from the Friant-Kern Canal.

In instances in which the originally proposed location for the well may result in impacts, DEID GSA staff works with the landowner to evaluate potential impacts based on review of multiple criteria (e.g., production rate, well depths, etc.) and if an impact is of potential concern, identify alternative locations that avoid the risk of impacts to neighboring domestic wells and/or critical infrastructure. Following the impact susceptibility analysis, DEID GSA provides Tulare County with a recommendation for approval or rejection of the application.

Coordination and Support for Local Communities' Wells

DEID GSA is home to several small underrepresented and Disadvantaged Communities, including Earlimart, Richgrove, Rodriguez Labor Camp, Sierra Vista Association, and Madonna. DEID is working with these communities to (1) identify their greatest immediate and long-term challenges, (2) identify opportunities for DEID to provide support, and (3) implement the identified support. The support may look like providing technical support, physical resources, state outreach, and serving as an advisory role.

DEID GSA's current water management strategy is designed to protect against overdraft related impacts to the communities within DEID GSA and the surrounding well users. See **Section 1.2** and **Section 1.3** of this Mitigation Plan for more information on how DEID's existing and future groundwater management is projected to be protective of all beneficial users, uses, and property interests within DEID GSA, including the small community wells and the households that rely on this drinking water supplies.

1.8 Well and Critical Infrastructure Vulnerabilities within DEID GSA

Despite DEID GSA's historic and projected sustainable groundwater management, unsustainable groundwater management may impose the risk of potential individual impacts within DEID GSA. The evaluation of vulnerabilities described in Section **1.8** are primarily based on conditions induced by neighboring GSAs' unsustainable groundwater management. As discussed in **Section 1.2** and **1.3** of this Mitigation Plan, DEID GSA is committed to continued sustainable groundwater management, investments in the infrastructure necessary to achieve maintain sustainability, and encouragement of neighboring GSAs to be more protective of all beneficial users, uses, and property interests.

Domestic Drinking Water Well Vulnerabilities

Where available from well permit information, the average depths of domestic wells are shown on **Figure 6.** Domestic drinking water wells in the DEID GSA are drilled to a depth more shallow than agricultural production wells, on average. Shallower wells are more vulnerable to chronically declining water levels.

Agricultural (Ag) Water Well Vulnerabilities

The agricultural wells in DEID GSA are often drilled deeper than domestic wells. The greatest vulnerability to the GSA's agricultural wells may be linked to the chronic lowering of groundwater levels. However, agricultural wells are also at risk of structural impacts due to subsidence as well. Average depths of agricultural wells are depicted in **Figure 7**.

Municipal and Industrial (M&I) Well Vulnerabilities

The largest communities within DEID GSA are Earlimart and Richgrove, both of which fall under the Small Community Water System category (see below).

Small Community Water System Well Vulnerabilities

The conditions that induce vulnerabilities for both drinking water wells and agricultural wells are comparable to the vulnerabilities for Small Community Water Systems. In DEID GSA, these system owners include EPUD, RCSD, Sierra Vista Association, Madonna, and Rodriguez Labor Camp. In summer of 2024, Rodriguez Labor Camp is expected to tie into Richgrove's public water system via a new well and pipeline.

Critical Infrastructure Vulnerabilities

The Tule Subbasin GSPs have identified critical infrastructure susceptible to land subsidence including but not limited to the following: Friant-Kern Canal, gravity-driven water conveyance infrastructure, domestic, agricultural, and other wells, flood control, State highways, railroads, pipelines, and bridges, wastewater collection and other critical infrastructure that could be impacted by differential land subsidence such as buildings, utilities, and other facilities.

Gravity-driven water conveyance infrastructure, wells and flood control infrastructure are most susceptible to regional land subsidence and were prioritized by the Tule Subbasin GSAs as high priority land uses. DEID is currently evaluating subsidence impacts to its surface water irrigation distribution pipeline system via consultation with an outside expert. Preliminary results indicate that the amount of further subsidence that the DEID pipeline system can withstand is limited, and in fact the pipeline system may not be able to withstand any further subsidence at all. The analysis of the DEID pipeline system is ongoing and is presented in full in our 2nd amended GSP.

The greatest vulnerability to critical infrastructure within the DEID GSA includes subsidence induced structural damage that may impair function of the DEID distribution pipelines, groundwater recharge and conjunctive use benefits. Attribution analyses completed in 2023-2024 conclude that subsidence within DEID GSA is primarily induced by neighboring lower aquifer extractions (Section 3 of the 2024 2nd Amended DEID GSA GSP) DEID GSA's contribution to subsidence is estimated to be within the measurement uncertainty and can be considered negligible. Therefore, claims associated with non-drinking water wells and critical infrastructure will be submitted to the responsible GSA's Mitigation Plan or Program, or to any Tule Subbasin Mitigation Advisory Committee established in the Tule Subbasin Mitigation Program.

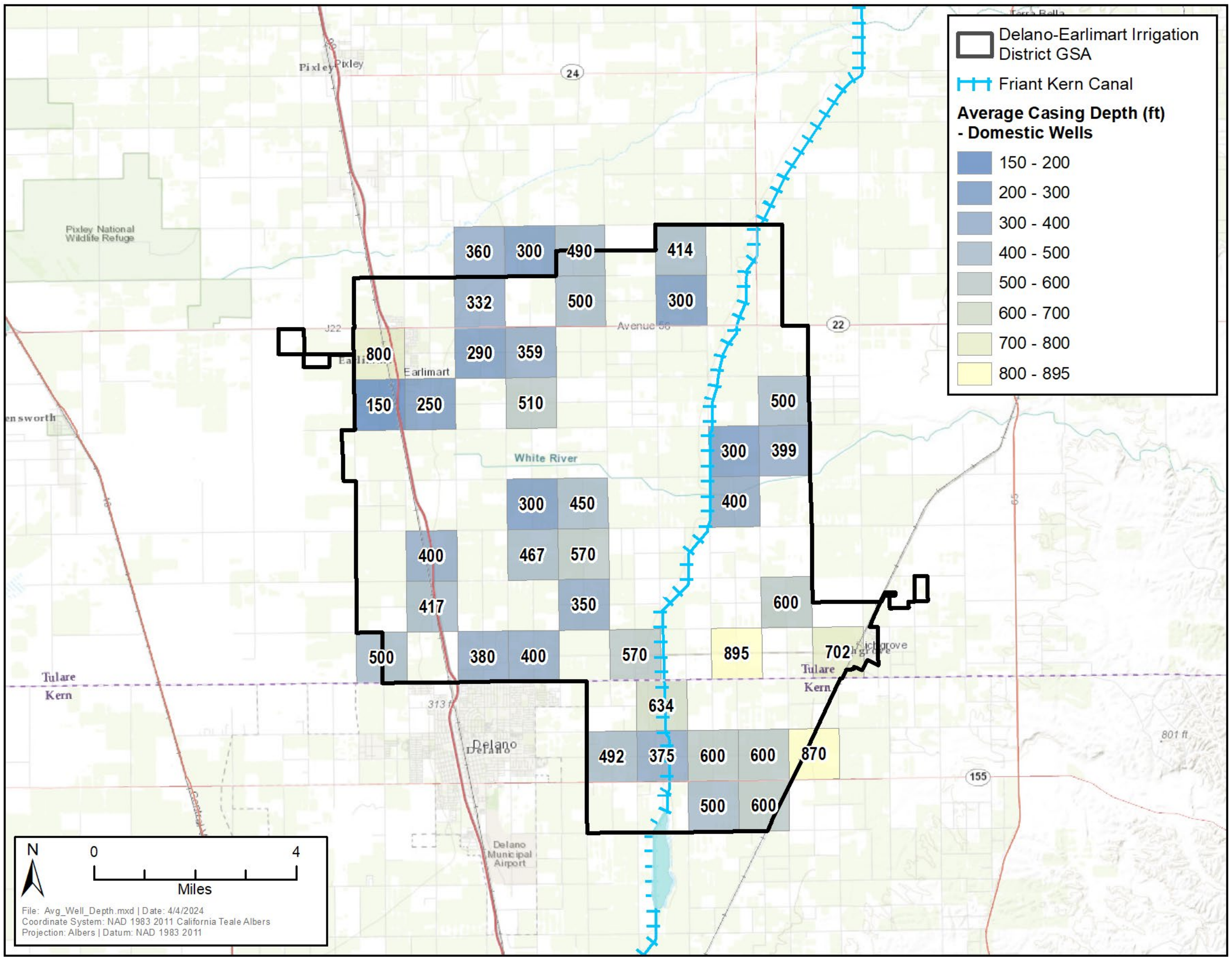

Figure 6 Average Depth of Domestic Wells in DEID GSA

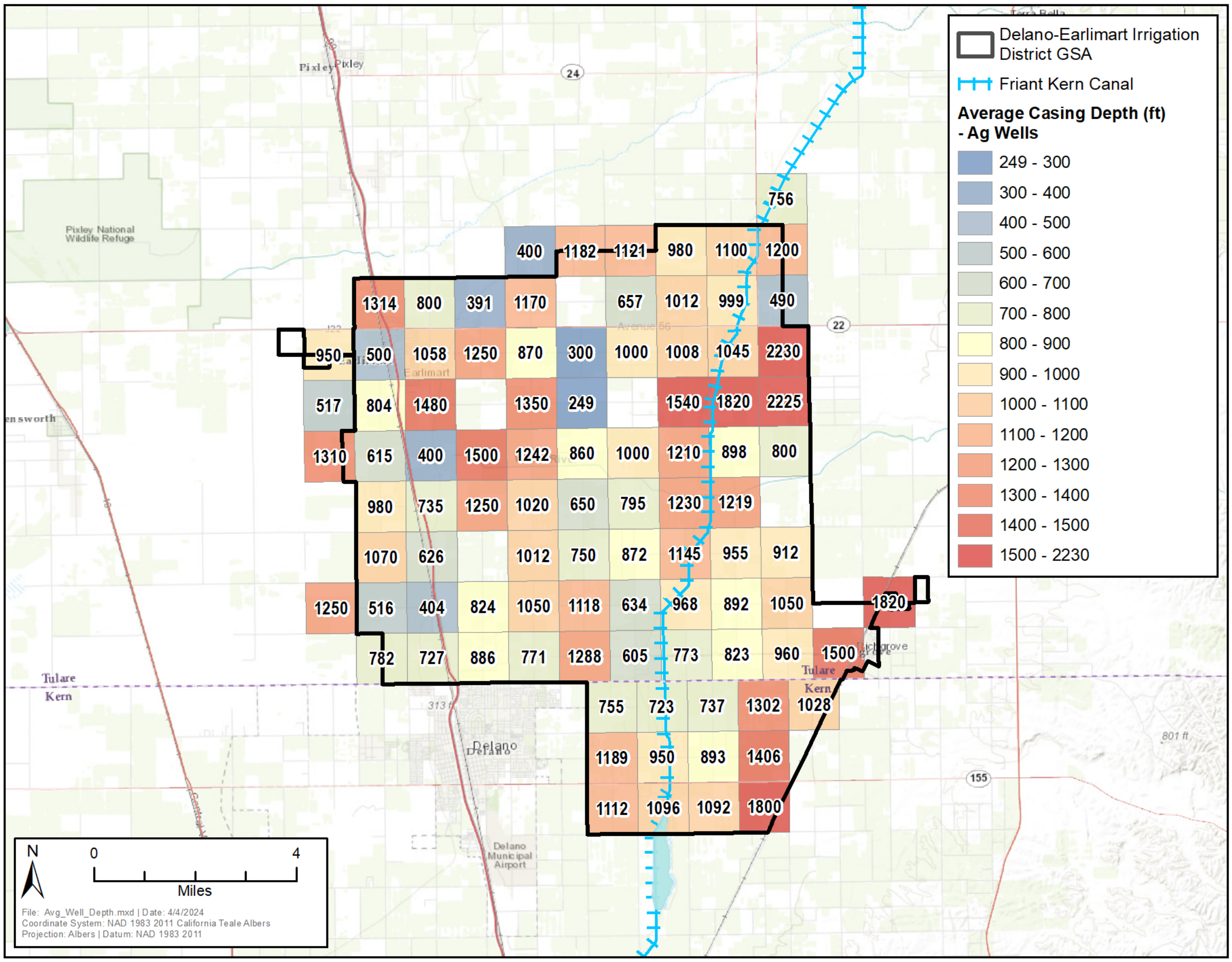

Figure 7 Average Depth of Agricultural Wells in DEID GSA

2 Mitigation Plan Description

The Mitigation Plan applies to owners of critical infrastructure and/or domestic, industrial, municipal, and agricultural wells whose assets are suffering from significant and unreasonable impacts to file a claim with the GSA in which the well and/or infrastructure is located. The Mitigation Plan is split into two tracks:

1. **Domestic Well Mitigation:** *for impacted domestic wells, multi-use wells that are used for supplying drinking water to a household. All claims are provided and administered through SHE in compliance with their existing process. DEID GSA reimburses all administrative, technical, field support, materials, and physical mitigation.*
2. **External Claims Application Support:** *for impacted agricultural, industrial and other non-potable wells and critical infrastructure. These claims are directed to the Tule Subbasin Mitigation Program and/or to the GSA likely responsible for the impact (which is determined with technical rationale by DEID staff and qualified technical consultants).*

See **Section 1.7** for an explanation of the proactive measures to avoid the need for mitigation at small community wells.

Figure 8 clarifies who can submit a claim in each track and **Figure 9** lists the criteria to qualify for mitigation under the DEID GSA Mitigation Plan.

For groundwater levels, a significant and unreasonable "impact" is defined as the inability of a beneficial user to pump groundwater of sufficient quantity to meet water supply needs due to lowered groundwater levels resulting from Tule Subbasin GSP-/GSA-approved or authorized activities.

For subsidence, a significant and unreasonable "impact" is defined as intolerable reduction in function and/or capacity of critical infrastructure and land uses. These impacts may include but are not limited to well collapse, canal sinking, pipeline damage, increased flood risk, and damaged transportation infrastructure such as rail lines and the High-Speed Rail.

For groundwater quality, a significant and unreasonable "impact" is defined as groundwater quality degraded below Maximum Concentration Limits (MCLs) or Water Quality Objective (WQO) standards (standard selected based on well use). To qualify for GSA-provided mitigation related to water quality related impacts, the water quality degradation must be directly related to GSP-/GSA-approved or authorized activities, such as declining water levels introducing new or elevated water quality concerns.

The GSAs are not required to address impacts that occurred prior to January 2015[6]. The DEID GSA may evaluate the cumulative effects of both pre- and post-2015 impacts. In some instances where data is lacking it may not be possible to make a distinction between a pre- and post-2015 impact and especially for domestic wells, the GSA may need to consider cumulative effects.

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[6] California Water Code Section 10727.2 (b)(4) states, "The plan may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015. Notwithstanding paragraphs (1) to (3), inclusive, a groundwater sustainability agency has discretion as to whether to set measurable objectives and the timeframes for achieving any objectives for undesirable results that occurred before, and have not been corrected by, January 1, 2015."

DEID GSA MITIGATION PLAN

VERSION 4.0

DOMESTIC WELL MITIGATION*

The Domestic Well Mitigation track is intended to provide emergency and interim drinking water supplies and long-term solutions for households reliant on a domestic well for drinking water supplies that have experienced a loss of access to drinking water due to groundwater overdraft conditions such as chronic lowering of groundwater levels, subsidence, and/or water quality induced by groundwater management.

WHO CAN APPLY?

domestic (house) well owners

multi-use drinking water well owners

HOW DOES A CLAIMANT APPLY?

The impacted well owner must submit an application over the phone with Self-Help Enterprises by calling **(559) 802-1685** (translation services available) or via the online submittal form: *selfhelpenterprises.org/programs/emergency-services/water-sustainability/*

Note: In the event the claim does not qualify for assistance via the DEID GSA's Mitigation Plan, Self-Help Enterprises will identify if the Claimant qualifies for other programs and continue with emergency, interim, and long-term solutions as applicable.

WHAT IS THE GENERAL PROCESS TO RECIEVE WELL MITIGATION?

1. Impacted domestic well owner submits an application to SHE.
2. SHE enrolls the household with emergency bottled water supplies within 24-hours and interim tank and hauled water supplies within 72-hours.
3. SHE staff perform field assessment and determine mitigation service recommendation sends results to DEID GSA.
4. DEID GSA and qualified technical consultants review findings for qualification. For well claims that do qualify, the same team reviews the recommendation from SHE and identify appropriate mitigation.
5. SHE and DEID GSA meet to agree on the mitigation services to be provided for qualifying claim.
6. DEID GSA Board considers approval of reimbursement for recommended services.
7. SHE works with driller and well owner to arrange long-term mitigation solution.

EXTERNAL CLAIMS SUPPORT

The External Claims Support track is intended to support impacted beneficial users in submitting claims to the party responsible for the causation of the impact. DEID GSA does not contribute to overdraft conditions; however, neighboring GSAs' unsustainable groundwater management can cause impacts within DEID GSA. DEID GSA staff and qualified technical consultants are available to support via data, results of existing attribution analyses, and other resources in making a mitigation claim with the GSA responsible for the impact.

WHO CAN APPLY?

agricultural well owners

critical infrastructure (pipeline, canals, etc) owners

non-potable industrial well owners

other non-drinking water well owners

HOW DOES A CLAIMANT APPLY?

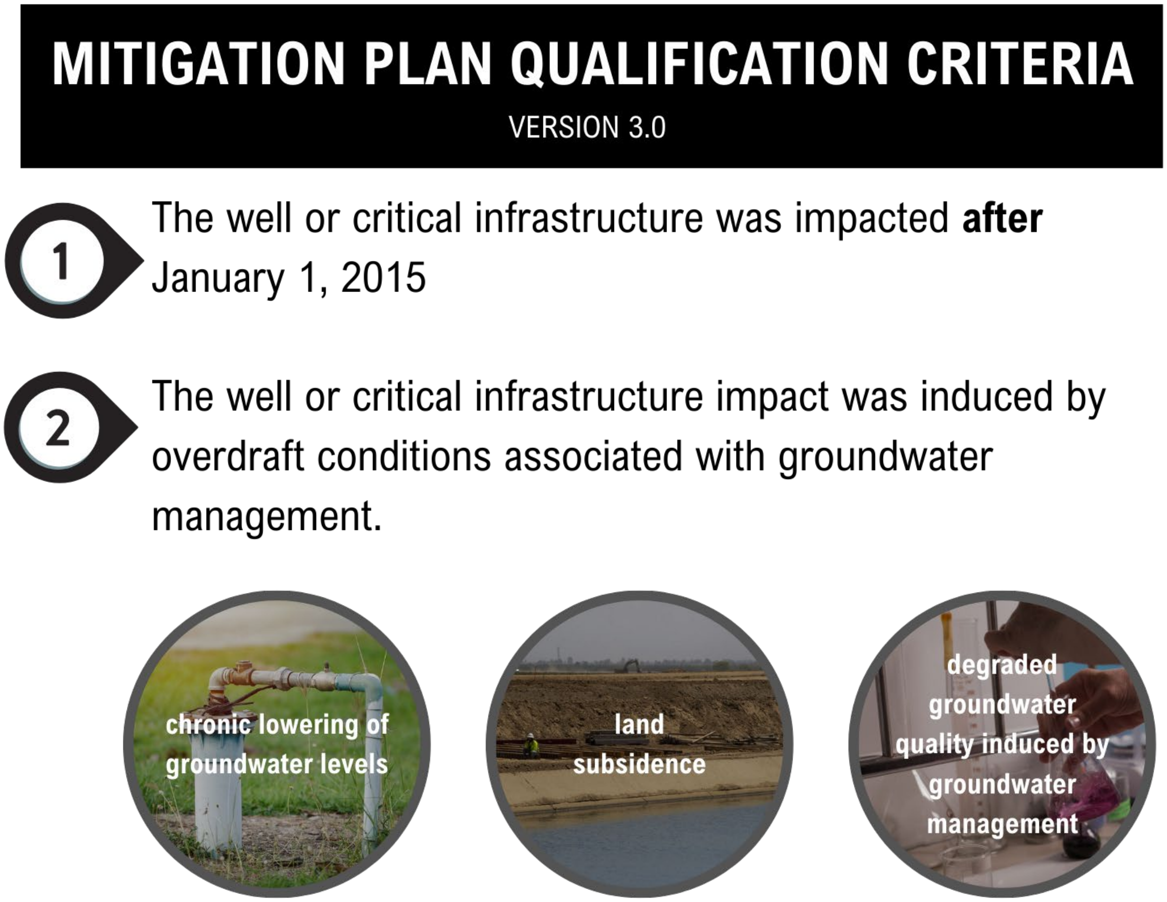
The impacted well or critical infrastructure owner must contact DEID GSA at info@deid.org or **(661) 725-2526.**

WHAT IS THE GENERAL PROCESS TO RECIEVE GSA SUPPORT FOR AN EXTERNAL MITIGATION CLAIM?

1. Impacted well or critical infrastructure owner contacts DEID GSA and describes the impact.
2. DEID GSA will request additional data, information, and may perform a site visit.
3. Impacted well or critical infrastructure owner shares requested data and information.
4. DEID GSA supports identification of responsible party for the impact.
5. DEID GSA provides all relevant data, existing attribution analyses results, or other helpful information to support the well or critical infrastructure owner in submitting a claim with the responsible GSA via their respective Mitigation Plan or Program.

**Small community wells are addressed via proactive measures outlined in the 'Proactive Measures' section of the DEID GSA Mitigation Plan Version 3.0*

Figure 8 DEID GSA Mitigation Plan Overview



MITIGATION PLAN QUALIFICATION CRITERIA

VERSION 3.0

① The well or critical infrastructure was impacted **after** January 1, 2015

② The well or critical infrastructure impact was induced by overdraft conditions associated with groundwater management.

Figure 9 DEID GSA Mitigation Plan Qualification Criteria

DEID GSA recognizes that different types of wells and infrastructure may be impacted from groundwater management activities within the Tule Subbasin. Furthermore, differences in well types and infrastructure may warrant different responses and mitigation. DEID GSA is prioritizing resources to provide solutions for impacted drinking water wells via the Domestic Well Mitigation Track and offering claims assistance for impacted non-domestic well and critical infrastructure owners in the External Claims Support Track (**Figure 10**).

Drinking water wells include all wells used for drinking water supply including private domestic wells, agricultural wells also used for domestic potable supply, and community wells. Municipal wells are considered drinking water wells; however, DEID GSA does not have any municipal wells within the GSA boundary. The largest capacity drinking water wells within the GSA are community systems within Earlimart and Richgrove. For this mitigation program, community wells are addressed via the proactive measures listed in **Section 1.7** and domestic wells (and multi-use wells used for domestic purposes) have their own dedicated track.

Non-drinking water wells are those wells used solely for irrigation or industrial uses (including agricultural wells). Critical infrastructure includes the Friant-Kern Canal, gravity-driven water conveyance infrastructure, domestic, agricultural, and other wells, flood control, State highways, railroads, pipelines, and bridges, wastewater collection and other critical infrastructure that could be impacted by differential land subsidence such as buildings, utilities, and other facilities.

Section 4 provides more information on vulnerabilities and types of impacts that beneficial uses, users, and property interests may experience associated with overdraft conditions in the Tule Subbasin.

3 Domestic Well Mitigation Claims Process

The Domestic Well Mitigation Track of the DEID GSA Mitigation Plan is intended for claims related to domestic (house or community) wells that have experienced issues induced by groundwater overdraft conditions. This may include (but not limited to), a well going dry, physical damage induced by subsidence, or new contamination being introduced to a domestic well due to groundwater management. The claims process for the DEID GSA Mitigation Plan's Domestic Well Mitigation Track is included in **Figure 10**.

! **Those who have lost access to drinking water at their household (tenants or landowners) are encouraged to call Self-Help Enterprises at they're earliest convenience to arrange emergency bottled water supplies within 24-hours. Due to property access laws, the landowner must be the claimant for interim supplies and long-term solution mitigation claims. To arrange, landowners are encouraged to submit an online intake form (link below) or call Self-Help Enterprises for assistance.**

Self-Help Enterprises
(559) 802-1685

8445 W Elowin Ct
Visalia, CA 93291

An online intake form is available on SHE's website:
https://www.selfhelpenterprises.org/programs/emergency-services/water-sustainability/

More information on the partnership between SHE and the DEID GSA is available under **Section 1.5 Partnerships with Existing Programs.**

Who is covered by the Domestic Well Mitigation Track?[7]

Private Domestic Well Owners

As stated in the California Water Code Section 106.3, "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." In the DEID GSA, there are private residences in the small communities and rural portions of the area rely on private wells to meet their domestic water supply needs. As these wells are typically shallow, they are vulnerable to, among other things, lowered groundwater levels from overdraft conditions. A primary objective of the DEID GSA Mitigation Plan is protection of the human right to water for the most vulnerable populations, which are residents who rely on individual domestic wells for their water supply.

The DEID GSA Mitigation Plan is structured to ensure a drinking water supply for domestic well owners impacted by overdraft conditions via emergency supplies, interim supplies, and full mitigation.

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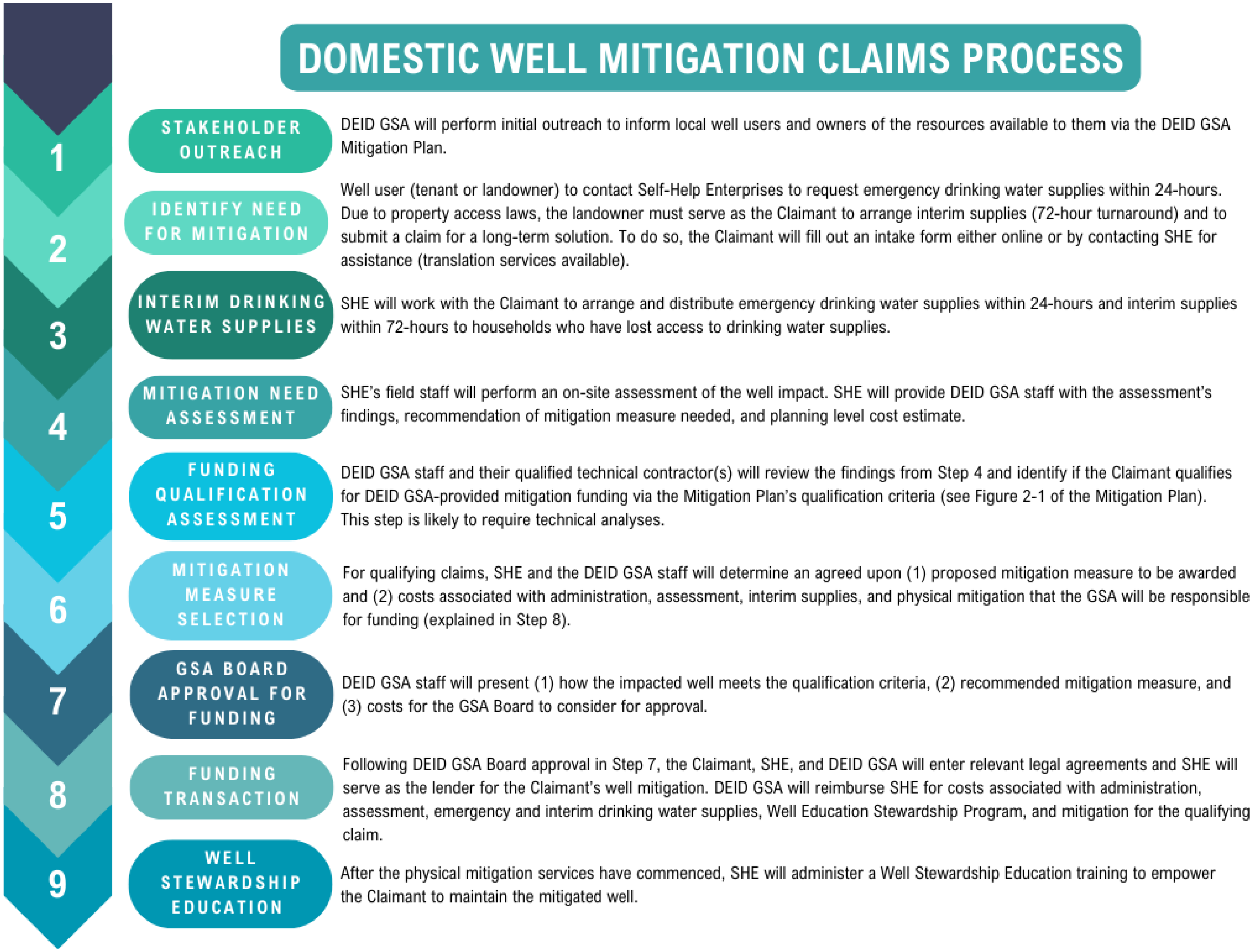
[7] See "Proactive Measures" portion of this Mitigation Plan for information on the proactive measures DEID GSA is continuing to take to prevent the need for mitigation of small community wells within the GSA.

Agricultural Well Owners Using Their Agricultural Well for Domestic Supply (Multi-Use Drinking Water Well Owners)

Some private well owners use their wells for both domestic potable supply and irrigation. Multi-use drinking water wells that are impacted by overdraft conditions may be eligible for emergency supplies, interim supplies, and full mitigation.



DOMESTIC WELL MITIGATION CLAIMS PROCESS

1	STAKEHOLDER OUTREACH	DEID GSA will perform initial outreach to inform local well users and owners of the resources available to them via the DEID GSA Mitigation Plan.
2	IDENTIFY NEED FOR MITIGATION	Well user (tenant or landowner) to contact Self-Help Enterprises to request emergency drinking water supplies within 24-hours. Due to property access laws, the landowner must serve as the Claimant to arrange interim supplies (72-hour turnaround) and to submit a claim for a long-term solution. To do so, the Claimant will fill out an intake form either online or by contacting SHE for assistance (translation services available).
3	INTERIM DRINKING WATER SUPPLIES	SHE will work with the Claimant to arrange and distribute emergency drinking water supplies within 24-hours and interim supplies within 72-hours to households who have lost access to drinking water supplies.
4	MITIGATION NEED ASSESSMENT	SHE's field staff will perform an on-site assessment of the well impact. SHE will provide DEID GSA staff with the assessment's findings, recommendation of mitigation measure needed, and planning level cost estimate.
5	FUNDING QUALIFICATION ASSESSMENT	DEID GSA staff and their qualified technical contractor(s) will review the findings from Step 4 and identify if the Claimant qualifies for DEID GSA-provided mitigation funding via the Mitigation Plan's qualification criteria (see Figure 2-1 of the Mitigation Plan). This step is likely to require technical analyses.
6	MITIGATION MEASURE SELECTION	For qualifying claims, SHE and the DEID GSA staff will determine an agreed upon (1) proposed mitigation measure to be awarded and (2) costs associated with administration, assessment, interim supplies, and physical mitigation that the GSA will be responsible for funding (explained in Step 8).
7	GSA BOARD APPROVAL FOR FUNDING	DEID GSA staff will present (1) how the impacted well meets the qualification criteria, (2) recommended mitigation measure, and (3) costs for the GSA Board to consider for approval.
8	FUNDING TRANSACTION	Following DEID GSA Board approval in Step 7, the Claimant, SHE, and DEID GSA will enter relevant legal agreements and SHE will serve as the lender for the Claimant's well mitigation. DEID GSA will reimburse SHE for costs associated with administration, assessment, emergency and interim drinking water supplies, Well Education Stewardship Program, and mitigation for the qualifying claim.
9	WELL STEWARDSHIP EDUCATION	After the physical mitigation services have commenced, SHE will administer a Well Stewardship Education training to empower the Claimant to maintain the mitigated well.

Figure 10 Drinking Water Well Mitigation Track Claims Process

Step 1. Stakeholder Outreach

Public participation and communication are critical to implementing an effective Mitigation Plan. Upon release of the DEID GSA Mitigation Plan, the GSA will conduct an outreach initiative to inform drinking water well users of the availability of the Mitigation Plan and how they can apply for assistance should their well be impacted. Outreach will be provided in multiple languages as determined appropriate by the GSA. Outreach will continue throughout the process to maintain stakeholder engagement with the Mitigation Plan.

Outreach activities may include bi-lingual flyers in public agency spaces, sharing outreach materials with local drinking water advocacy groups to share with their community partners, email blasts, and workshops.

Step 2. Identify Need for Mitigation

Those who have lost access to drinking water at their household (tenants or landowners) are encouraged to call Self-Help Enterprises at their earliest convenience to arrange emergency bottled water supplies within 24-hours. Due to property access laws, the landowner must be the claimant for interim supplies and long-term solution mitigation claims. To arrange, landowners are encouraged to submit an online intake form (link below) or call SHE for assistance.

Call Self-Help Enterprises at (559) 802-1685

Online intake form: https://www.selfhelpenterprises.org/programs/emergency-services/water-sustainability/

Step 3. Emergency and Interim Drinking Water Supplies

Following the Claimant notifying SHE of the potential need for mitigation, SHE shall arrange emergency drinking water supplies within 24 hours in the form of bottled water for Claimants who have lost access to drinking water due to impacted domestic or small community system wells. Interim supplies, which may include water tanks with delivered supplies, or other appropriate interim measures shall be arranged for these households within 72 hours. DEID GSA will fund and/or reimburse SHE for administering and supplying emergency and interim drinking water supplies for qualifying Claimants.

Step 4. Mitigation Need Assessment

SHE’s field staff shall perform an initial assessment, to include a site visit and discussions with the landowner and/or tenants. Translation services for Spanish, Punjabi, and/or Hmong are made available by SHE, as needed. Following the assessment, SHE shall provide DEID GSA staff and Claimant with their findings, documentation, initial recommendation for mitigation needed, and a planning level cost estimate.

Step 5. Funding Qualification Assessment

Following the receival of SHE’s Mitigation Need Assessment findings, documentation, initial recommendation for mitigation needs, and planning level cost estimate, GSA staff (and their technical contractors, as needed) shall review all materials. GSA staff (and qualified technical contractors) may evaluate additional localized data, such as groundwater level trends, recent-historical subsidence, groundwater quality, land use, and more to determine if the Claim qualifies for funding reimbursement under the DEID Mitigation Plan. Qualification criteria are listed in **Figure 8**.

To determine if an impact was induced by groundwater overdraft conditions, GSA Staff (and their technical contractors) will compare groundwater level trends local to the impacted well and compared to the well construction information, such as well completion depth, perforated intervals, pump depth, and nearby land use and groundwater extractions. If the impact is physical damage to the well casing and/or screen, recent-historical subsidence shall be evaluated.

The purpose of the technical contractors' involvement in the assessment phase is to:

- Review well evaluation and mitigation recommendations from SHE.
- Review other hydrogeological data, such as (but not limited to) groundwater level trends, precipitation trends, recent-historical subsidence, groundwater quality, and local land use.
- Conduct additional analyses, as needed, to assess the relationship of DEID and/or neighboring GSAs' pumping on the well impacts observed. This could include analyses using the calibrated groundwater flow model of the Tule Subbasin.
- Evaluate any links between the reported impact and groundwater pumping, in overdraft.
- If appropriate, coordinate with SHE to refine their recommendations based on additional analyses.
- Review and provide comments on the proposed mitigation planning-level cost estimate.
- Provide recommendations to the DEID GSA staff for their GSA Board's consideration to fund qualifying claims.

There may be limited data available, which may hinder the extent of the qualification assessment. The GSA staff shall coordinate with SHE and the Claimant, as needed, to determine reasonable mitigation solutions and impact attribution determinations.

Step 6. Mitigation Measure Selection Agreement

In cases where the claim meets the qualification criteria of the drinking water well being impacted by groundwater overdraft conditions and the impact occurring after January 1, 2015, SHE and DEID GSA staff shall agree on the proposed mitigation and costs association with administering, assessing, and implementing the mitigation (including interim supplies). DEID GSA and SHE shall determine the appropriate funding mechanism, which may involve reimbursement following the completion of the long-term mitigation installation with an up-front deposit. The funding transaction protocol shall be assessed on a case-by-case basis until SHE and DEID GSA have identified the most effective and efficient method. Lessons are expected to be learned during the first years of Mitigation Plan implementation, and intentional flexibility is necessary for case-by-case nuances.

In instances where the claim does not meet the qualification criteria, the Claimant may qualify for mitigation support via other programs that SHE administers. SHE will work directly with those Claimants to discuss what options they may have. SHE and the GSA staff shall consider each claim on a case-by-case basis to identify the most effective long-term mitigation measure. Long-term solutions for drinking water wells may include (but not necessarily limited to):

1. Deepen the well.
2. Construct a new well.
3. Modify pump equipment, including lowering the pump.
4. Consolidation with an existing water system in the vicinity.
5. Establishment of a new small public water system.
6. With the consent of the affected user, providing other acceptable means of mitigation.

Step 7. GSA Board Approval for Funding

Following SHE and DEID GSA staff agreement on an appropriate mitigation measure for qualifying claims, DEID GSA staff shall present the recommended mitigation measure and cost estimates for the GSA Board to consider approval for deposit and reimbursements. The GSA Board shall consider the reimbursement within one GSA Board Meeting cycle, following SHE and GSA staff completion of Step 6.

Step 8. Mitigation Funding Award

Following completion of all necessary legal and transactional agreements, SHE shall lend the Claimant funding to implement the agreed upon mitigation measure. SHE does not carry out the mitigation measures but acts as a contract coordinator and lender between the driller/pump contractor and the Claimant. The DEID GSA will reimburse SHE for the funding lent to the Claimant for all mitigation support services, including interim supplies and Mitigation Plan administration. SHE and DEID GSA may agree to deposits to maintain sustainable cashflow for SHE's administration of the Mitigation Program.

Step 9. Well Stewardship Education

After the qualifying claim's long-term mitigation is implemented and the household is no longer provided interim supplies, SHE will coordinate and host a Well Stewardship Training for the Claimant to educate and empower long-term maintenance and financial planning associated with well ownership. Following completion of the training, the Claimant will be supplied with educational resources to reference in the future (translation services available).

4 External Claims Support Process

The External Claims Support Track of the DEID GSA Mitigation Plan is intended to support impacted (non-domestic) well and critical infrastructure owners in applying for mitigation through the responsible GSAs' Mitigation Program's claims process. The claims process is detailed in **Figure 11**.

As discussed in **Section 1.2** and **Section 1.3**, DEID GSA does not contribute to overdraft and is a net recharger to the Tule Subbasin. Attribution analyses (discussed in Section 3 of the 2024 2nd Amended DEID GSA GSP) conclude that potential impacts in DEID GSA are induced by neighboring GSAs' unsustainable groundwater management.

This track is designed to support impacted DEID GSA landowners in (1) identifying the likely responsible party associated with the impact and (2) provide supporting data and information to submit an informed claim via the responsible GSAs' Mitigation Program.

For those interested in submitting a claim, please send an email to and/or call DEID GSA:

DELANO-EARLIMART IRRIGATION DISTRICT GSA

Primary Office: 14181 Avenue 24, Delano CA
Secondary Office: 2904 W Main St, Visalia, CA
Phone Number: (661) 725-2526
Website: www.deid.org/gsa
Email: info@deid.com
General Manager: Eric R. Quinley
District Engineer: David Wierenga

Who is covered by the External Claims Support Track?

Non-Potable Agricultural (Ag) Well Owners

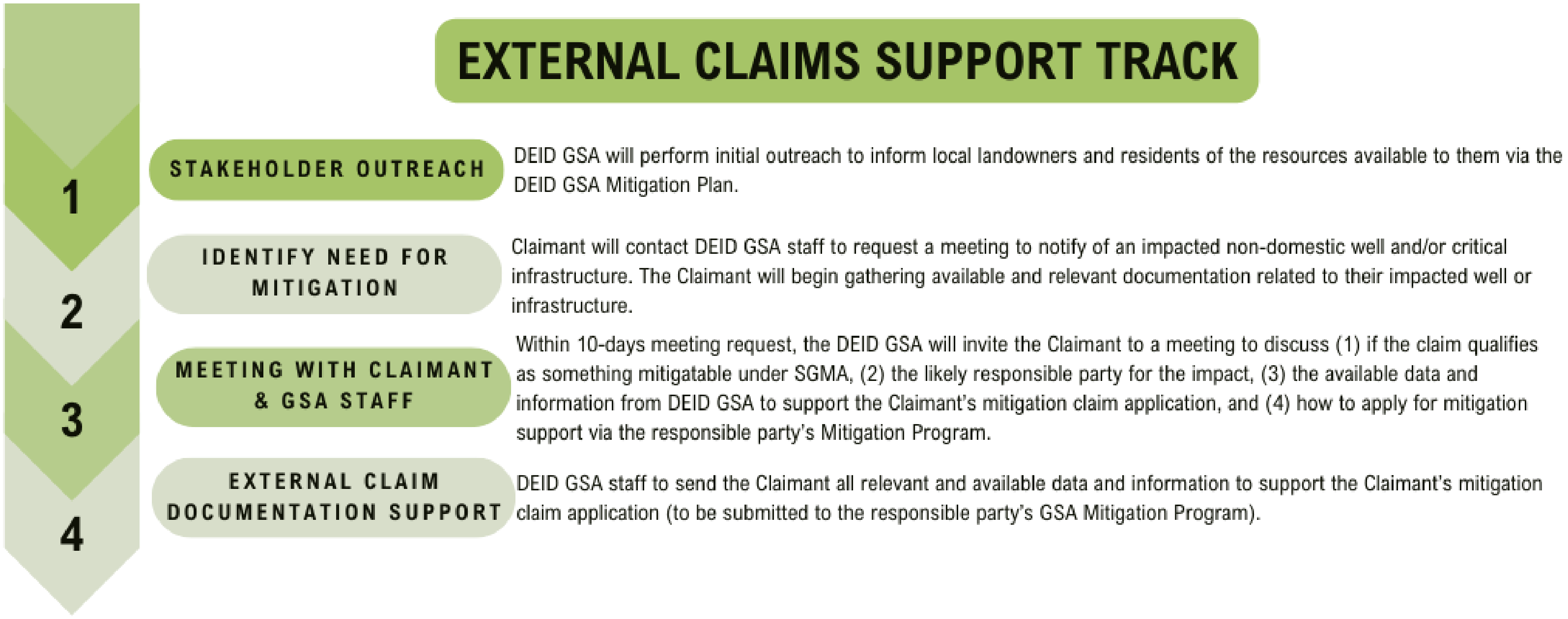
Agricultural wells used exclusively for non-potable irrigation water supply that are impacted by overdraft conditions may be eligible for technical assistance from the DEID GSA to identify the cause of the impact, management actions to prevent further impacts, and mitigation options. Agricultural irrigation supply well owners (non-potable) will not be eligible for full mitigation (e.g. well replacement, lowering pumps, wellhead treatment, etc.).

Industrial Well Owners

Industrial wells used for non-potable water supply that are impacted by overdraft conditions may be eligible for technical assistance from the DEID GSA to identify the cause of the impact, management actions to prevent further impacts, and mitigation options. Industrial non-potable water supply well owners will not be eligible for full mitigation (e.g. well replacement, lowering pumps, wellhead treatment, etc.).

Critical Infrastructure Owners

Critical infrastructure (canals, levees, pipelines, roads, bridges, electrical lines, and railways) impacted by overdraft conditions may be eligible for technical assistance from the DEID GSA to identify the cause of the impact, management actions to prevent further impacts, and mitigation options. Critical infrastructure owners will not be eligible for full mitigation (e.g. canal replacement, pipeline repair, etc.).



1 STAKEHOLDER OUTREACH

DEID GSA will perform initial outreach to inform local landowners and residents of the resources available to them via the DEID GSA Mitigation Plan.

2 IDENTIFY NEED FOR MITIGATION

Claimant will contact DEID GSA staff to request a meeting to notify of an impacted non-domestic well and/or critical infrastructure. The Claimant will begin gathering available and relevant documentation related to their impacted well or infrastructure.

3 MEETING WITH CLAIMANT & GSA STAFF

Within 10-days meeting request, the DEID GSA will invite the Claimant to a meeting to discuss (1) if the claim qualifies as something mitigatable under SGMA, (2) the likely responsible party for the impact, (3) the available data and information from DEID GSA to support the Claimant's mitigation claim application, and (4) how to apply for mitigation support via the responsible party's Mitigation Program.

4 EXTERNAL CLAIM DOCUMENTATION SUPPORT

DEID GSA staff to send the Claimant all relevant and available data and information to support the Claimant's mitigation claim application (to be submitted to the responsible party's GSA Mitigation Program).

Figure 11 External Claims Support Process (Non-Domestic Wells and Critical Infrastructure)

5 Claims Dispute

Because DEID GSA is a net recharger to the Tule Subbasin and because the mitigation services awarded in this plan go through Self-Help Enterprises' existing program, it is unlikely that claims disputes will occur. However, in the event a claimant disagrees with the mitigation proposed by the GSA, the claimant will have the right to appeal to the DEID General Manager and/or the DEID GSA Board of Directors. The DEID GSA and claimant may also agree to retain a third party to perform a neutral evaluation of the claim to facilitate DEID staff / board review of the claim. In the event the claimant would prefer to arrange and fund his or her own third-party evaluation of a claim, the GSA will consider the findings of any such evaluation.

Should the parties decide that mediation services would facilitate the claim review process, DEID GSA may arrange a mediation as well.

Claimants should also be aware that some claims may be referred to the Subbasin wide mitigation program for review and resolution, to the extent damages or injury to the claimant's well or other infrastructure has been caused fully or partially by pumping or other activities outside of DEID boundaries. Claimants also agree that, if DEID GSA provides funding for mitigation, but it is ultimately determined that another GSA is responsible for causing the damage, DEID GSA shall have the right to seek reimbursement from the responsible GSA.

The claims dispute process may evolve as Mitigation Plan implementation lessons are learned.

6 Data and Information Privacy

Once a claim application and subsequent information is provided to the GSA, it becomes subject to the California Public Records Act, which may allow the information provided to become public. If a Claimant is concerned about sensitive information requested by SHE (and/or DEID GSA), DEID GSA requests the Claimant contact the GSA to discuss data and information-sharing confidentiality solutions.

7 Criteria for Determining GSA-Related Impacts to Wells and Infrastructure

7.1 Groundwater Level Impacts

Groundwater pumping in overdraft results in systemic, long-term lowering of groundwater levels. While overdraft can result in land subsidence (see **Section 4.2** herein), the most vulnerable infrastructure to lowered groundwater levels is water wells, and particularly shallow wells. In a water well, if the groundwater levels decline such that a pump in the well is no longer adequately submerged, the pump may not operate correctly. Further lowering of groundwater levels below the pump's intake will render the pump inoperable. If there is no room to further lower the pump in the well, the well is considered dry (**Figure 12**). DWR released a guidance document in March 2023 detailing additional considerations to identify adverse impacts to drinking water wells. This guidance document has informed the DEID GSA Mitigation Plan.[8]

7.2 Groundwater Quality Impacts

Lowering of groundwater levels has been shown in some cases to degrade groundwater quality (Levy, et al. 2021).[9] While most groundwater meets drinking water standards, some groundwater can contain high concentrations of nitrate, uranium, arsenic, pesticides, and other contaminants. Nitrate is the most common groundwater quality constituent found at concentrations higher than regulatory standards in shallow aquifers in the Tule Subbasin. While nitrate can naturally occur in groundwater in the Tule Subbasin, most nitrate contamination is associated with its application in widespread fertilizer use, releases from dairy operations, and from septic systems throughout the Tule Subbasin. Because nitrate is introduced into shallow groundwater from prevalent land use practices, there are no defined nitrate plumes (Burton, 2012). Nitrate contamination in groundwater within the region is induced by legacy agricultural irrigated land management. The Irrigated Lands Regulatory Program (ILRP) is a state-enforced program to monitor and prevent future contamination of soil and groundwater through land management strategies. The agricultural lands within DEID GSA fall under the jurisdiction of the ILRP through the Tule Basin Water Quality Coalition. As irrigated lands within the Tule Basin Water Quality Coalition, landowners are required to implement Nitrate Management Plans to avoid and minimize contamination of nitrates in the underlying aquifer. In addition to nitrates, other groundwater contamination is monitored and prevented/minimized via the ILRP.

Figure 8 outlines the qualification criteria for claims in the DEID Mitigation Plan. For groundwater quality, GSAs are responsible for mitigating groundwater quality impacts that are induced or exacerbated by groundwater management activities. The causation and correlations of changes in groundwater quality are to be considered during the mitigation need assessment and funding qualification assessment phases of the mitigation claims process.

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[8] DWR. March 2023. Considerations for Identifying and Addressing Drinking Water Well Impacts. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Files/Considerations-for-Identifying-and-Addressing-Drinking-Water-Well-Impacts_FINAL.pdf

[9] https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2021GL094398

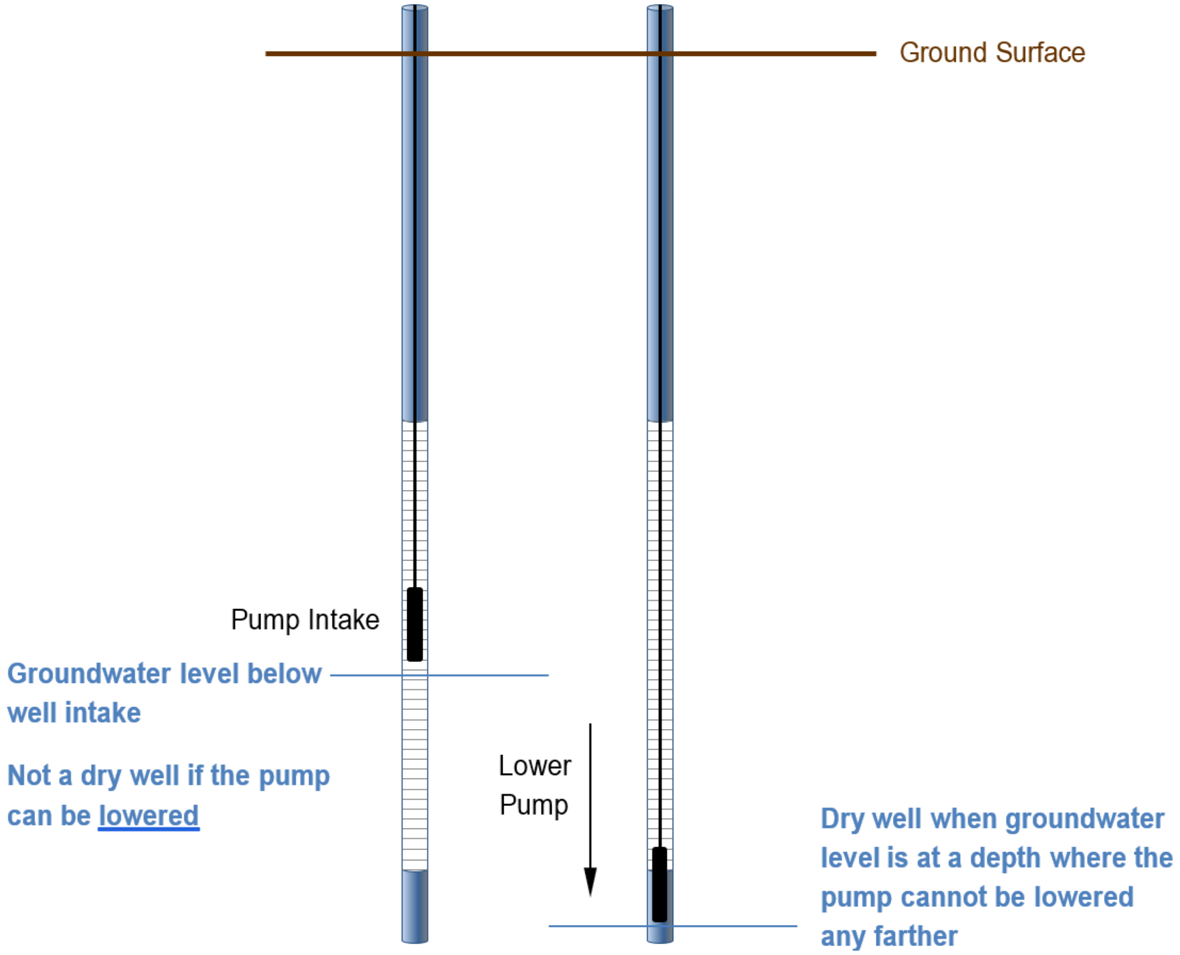

Figure 12 Groundwater Levels Relative to Pump Intake and Bottom of Well

During the funding qualification assessment (Step 5 of Section 3), groundwater pumping in overdraft conditions will need to be distinguished from seasonal and longer-term precipitation patterns (i.e. drought). These differences can be distinguished through an analysis of groundwater level hydrographs for representative monitoring wells in the vicinity of the claim of impact. The overriding conclusion from claims of impact in the DEID GSA during periods when neighboring GSAs' groundwater reliance and use of allowable overdraft via the Tule Subbasin Transitional Pumping Program is that the impact is associated with overdraft conditions. See **Section 1.2**, **Section 1.3**, and **Section 1.7** regarding DEID GSA's sustainable water management and proactive measures to avoid impacts from unsustainable practices from neighboring GSAs.

7.3 Subsidence Impacts

Groundwater pumping in the lower aquifer of the DEID GSA can cause land subsidence. Attribution analyses in 2023 and 2024 concluded nearly all subsidence within DEID GSA is caused by lower aquifer pumping in neighboring GSAs and not by DEID GSA. Not only is DEID GSA a net recharger to the Tule Subbasin, but the Corcoran Clay (regional compressible aquitard) tapers off at the eastside of DEID GSA, providing opportunities for recharge to the lower aquifer within the DEID GSA. This recharge can be hindered by neighboring GSAs' overdraft activities.

Subsidence related impacts DEID GSA may include but are not limited to conveyance infrastructure damage (pipeline, canals, etc.), transportation infrastructure damage (roads, railways, etc.), powerline damage, and impact to well structural integrity (**Figure 13**).

DEID GSA performed a subsidence-risk analysis for the pipeline infrastructure extending across DEID (**Figure 3**). This evaluation indicates that current subsidence rates at select locations along the laterals would have to nearly triple (increase from rates of 0.3 ft/year to 0.8 ft/year) to exceed the pressure class in susceptible areas along the pipeline. Although the pressure class is not exceeded based on projected head calculations due to subsidence, piping failure can be caused by a pressure surge or high-pressure shockwave (i.e., water hammer). Therefore, there is likely an increased risk of future failure susceptibility to DEID's pipelines due to subsidence.

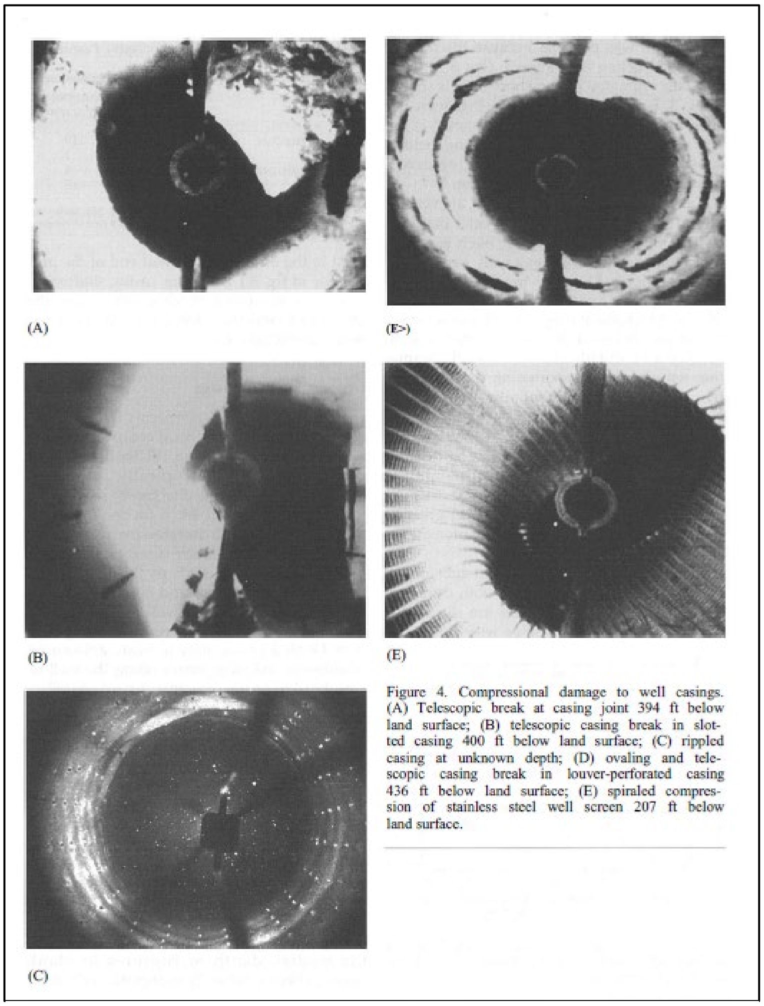

Figure 4. Compressional damage to well casings. (A) Telescopic break at casing joint 394 ft below land surface; (B) telescopic casing break in slotted casing 400 ft below land surface; (C) rippled casing at unknown depth; (D) ovaling and telescopic casing break in louver-perforated casing 436 ft below land surface; (E) spiraled compression of stainless steel well screen 207 ft below land surface.

Figure 13 Well Damage Attributed to Subsidence (Borchers et al., 1998)

Wells are also at risk of subsidence-related impacts via well casing failure. The most common cause of subsidence in DEID GSA is related to neighboring GSA groundwater extraction influencing subsurface pressure gradients. In this case, subsidence occurs when groundwater overdraft decreases pressure in subsurface clay layers, causing the clays to permanently collapse. Wells installed across subsiding clay layers are subject to compressive forces that can deform and eventually break well casing. Potential damage from subsidence, shown on **Figure 13,** includes breaks or ruptures in casing, spiraling casing, oval casing or out-of-round casing, and rippling casing. A well can be destroyed by subsidence, but in some less severe cases the damage can be repaired. Often wells can be repaired by installing a sleeve to patch the damaged area, commonly called swaging.

Low-priority land uses are not typically impacted by regional land subsidence but are susceptible to differential land subsidence if it occurs and includes highways and bridges, railroads, other pipelines, wastewater collection, utilities, and buildings.

See **Appendix A** which details the type of data and information involved with evaluating causation for impacts. In addition to the activities listed in **Appendix A,** DEID GSA may perform attribution analyses using the Groundwater Flow Model for the Tule Subbasin and consult with the well and/or critical infrastructure design engineers to understand design capacity and resiliency.

8 Mitigation Funding and Anticipated Costs

DEID is surrounded by other GSAs that are pumping or that authorize well owners within their jurisdictions to pump non-sustainably (**Figure 1**). Groundwater pumping within neighboring GSAs continues to have a negative effect on groundwater levels and subsidence rates within the DEID GSA. While DEID imports significant amounts of surface water and provides a net benefit to the Tule Subbasin, its positive benefits to the Subbasin have been significantly reduced due to the actions of neighboring GSAs. This Mitigation Plan is intended to address impacts that may occur during the implementation period associated with groundwater overdraft. DEID GSA has proposed that the Tule Subbasin consider an attribution-based funding mechanism for the Mitigation Programs, to require those GSAs with allowable overdraft policies that cause impacts within DEID GSA (or other GSAs) to be responsible for funding the needed mitigation. No attribution-based funding mechanism or policy is currently in place within the Tule Subbasin (as of July 2024); however, the draft Mitigation Program for the Tule Subbasin (July 2024) includes the option for external GSAs to submit claims in instances in which the GSA is responsible for the impacts outside of their respective jurisdictional boundary.

In the interim, DEID GSA has performed a dry well susceptibility analysis and compared Self-Help Enterprises' estimates of wells at risk to identify mitigation cost estimates. DEID GSA can afford implementation of the Mitigation Plan via DEID funding the Mitigation Plan. Although the District has sufficient funds to implement the Mitigation Plan, DEID GSA continues to prioritize attribution-based mitigation funding responsibilities in the Tule Subbasin. This policy is expected to motivate meaningful and needed changes in demand management in neighboring GSAs. The costs to cover the full contribution for mitigation need due to GSA authorized overdraft activities (including outside of their GSA) will require increased funding which will be difficult for the other GSAs to generate. This will require the Tule Subbasin GSAs to evaluate challenging but necessary changes in demand management to move the Tule Subbasin toward achieving the sustainability goal.

DEID has set aside $1 million for the initial year of this Mitigation Plan implementation.

DEID GSA will revisit the funding mechanisms and mitigation budgets as needed to meet the mitigation commitments described in this Mitigation Plan.

In addition to District funding and potential future attribution-based funding from neighboring GSAs, the GSA will explore grant funding at the state and federal levels. The state has many existing grant programs for community water systems and well construction funding; however, the state's Safe and Affordable Funding for Equity and Resilience (SAFER) funding is not permitted to be used for Mitigation Program implementation. County, state, and federal assistance may be needed to best maximize the Mitigation Program in conjunction with similar programs that support similar regulatory programs to SGMA, like the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS). The GSAs will also work with local non-governmental organizations that may be able to aid or seek grant monies to assist Mitigation Program implementation.

9 References

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Attachment A

Claims Process – Assessment Phase

Claims Process - Assessment Phase

This process applies for (1) chronic lowering of groundwater levels, (2) land subsidence, and (3) degraded water quality

IMPACT ASSESSMENT

GSA to perform desktop assessment:

Claims related to chronic lowering of groundwater levels

GSA to review:
Historic static groundwater levels
Historic pumping groundwater levels
Well operation and maintenance history
Well construction history
Historic monthly production volume
Potential for consolidation to public water system
Nearby historic land and water use
Nearby conjunctive use activity
Well depth, perforated intervals, pump depth

Claims related to degraded water quality

GSA to review:
Historic groundwater quality at well
Historic groundwater quality at nearby wells
Historic static groundwater levels
Historic pumping groundwater levels
Well operation and maintenance history
Well construction history
Historic monthly production volume
Potential for consolidation
Nearby historic land and water use
Nearby conjunctive use activity
Well depth, perforated intervals, pump depth

Claims related to land subsidence

GSA to review:
Historic InSAR data
Historic static & pumping groundwater levels
Operation and maintenance history
Construction history
Design documentation
Historic monthly capacity
Potential for consolidation (wells)
Nearby historic land and water use
Nearby conjunctive use activity
Well depth, perforated intervals, pump depth (wells)
Photos of physical damage

GSA to perform field assessment:

GSA may perform the following:
(1) Pull pump and measure pump intake depth, well bottom, static water level.
(2) Modify wellhead to install sounding port to measure static and pumping level.
(3) Modify wellhead to install flowmeter
(4) Conduct video log
(5) Investigate site to inform estimated water demand
(6) Investigate nearby land and water use
(7) Investigate site for consolidation feasibility

GSA may perform the following:
(1) Pull pump and measure pump intake depth, well bottom, static water level.
(2) Modify wellhead to install sounding port to measure static and pumping level.
(3) Modify wellhead to install flowmeter
(4) Conduct video log
(5) Collect water quality samples at Claimants well
(6) Collect water quality samples at wells nearby impacted well
(7) investigate site for consolidation feasibility
(8) Investigate site and nearby land use impact

Well Claims:
In addition to activities listed under Chronis Lowering of Groundwater, GSA to investigate signs of visible well casing collapse, damage, or protrusion attributable to subsidence.

Critical Infrastructure Claims
(1) May perform Land Survey
(2) May perform water hammer analysis for pipeline infrastructure with site visit
(3) Consultation and site visit with design engineer(s)

GSA may request additional data and information. GSA may reach out to original driller or design engineer to confirm information provided.

Mitigation Claim proceeds to Qualification phase.

DELANO – EARLIMART
IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX B

Notice of the Delano-Earlimart Irrigation District to serve as a Groundwater Sustainability Agency for a portion of the Tule Subbasin

2024
2nd Amended Groundwater Sustainability Plan

DELANO –
EARLIMART
IRRIGATION DISTRICT

September 6, 2016

Mark Nordberg, GSA Project Manager
Senior Engineering Geologist
California Department of Water Resources
901 P Street, Room 213-B
P.O. Box 942836
Sacramento, CA 94236
Mark.Nordberg@water.ca.gov

Delivered via email and U.S. mail

COPY

RE: Notice of the Delano-Earlimart Irrigation District's election to serve as a Groundwater Sustainability Agency for a portion of the Tule Subbasin

Dear Mr. Nordberg:

Please accept this letter as notice by the Delano-Earlimart Irrigation District (DEID) that it has elected to become a Groundwater Sustainability Agency (GSA) for a portion of the Tule Subbasin and Kern County Subbasin, pursuant to the Sustainable Groundwater Management Act (SGMA). Please note that this notice of election has been filed within 30 days of the date that DEID's board of directors approved its resolution electing to become a GSA.

All information required under Section 10723.8(a) of the Water Code has been included in this notice, to wit:

- Maps depicting the proposed Delano-Earlimart Irrigation District GSA boundary. A description of the included maps are as follows:
  - Exhibit A identifies the overall proposed boundary of the DEID GSA. The map includes an aerial overlay, locations of waterways, location of communities, and main roads/highways. In addition, a subset is included identifying where the proposed DEID GSA is located within the greater Tule Subbasin and greater Kern County Subbasin.
  - Exhibit B identifies the location and boundary of each of the public agencies within the DEID GSA, which includes the Earlimart Public Utility District and Delano Earlimart Irrigation District.
  - Exhibit C identifies the Township, Range, and Section for the area of the proposed DEID GSA.

  Please note that the proposed boundaries of the DEID GSA include lands that are part of a basin boundary modification that has been requested by DEID and is awaiting final state action. The boundary modification is categorized as 'jurisdictional internal" that would place all of the lands within the current boundaries of DEID into the Tule Subbasin and thus provide consistency in the implementation of SGMA for all DEID landowners. DWR has recommended approval of the request.

- An executed Memorandum of Understanding (MOU) between DEID and EPUD providing for the inclusion of EPUD lands in the DEID GSA.
- Proof of publication for the legal notices that were required in advance of the August 25, 2016 public hearing (Water Code Section 10723(b).
- A resolution dated August 25, 2016 that was adopted by the DEID board of directors to become a GSA following the public hearing.

The DEID GSA will continue to cooperatively work with other GSAs within the Tule Subbasin and Kern County Subbasin to coordinate all activities and efforts relative to implementation of SGMA.

Pursuant to Water Code Section 10723.2 the following is a list of all beneficial uses and users of groundwater, as well as those responsible for implementing Groundwater Sustainability Plans (GSP), that have been considered:

(a) Holders of overlying groundwater rights, including:

> (1) Agricultural Users-With the exception of the lands served by the EPUD, almost all of the lands are composed of agricultural users and are DEID customers. DEID has preexisting relationships with these water users.
>
> (2) Domestic well owners- There are farmsteads located throughout the DEID GSA that are served by small domestic wells. In most cases they are also agricultural users and will be considered by the DEID GSA through our preexisting relationships.

(b) Municipal well operators- There are no incorporated cities within the GSA boundary.

(c) Public water systems- There is one public water systems within the proposed DEID GSA: the Earlimart Public Utility District. EPUD has formally agreed to become a part of the DEID GSA through execution of a Memorandum of Understanding with DEID. EPUD operates wells within the GSA and have been fully considered as a cooperating entity.

(d) Local land use planning agencies- The DEID GSA includes lands within both the County of Tulare and the County of Kern. The DEID GSA will work with both county governments on land use planning issues and concerns.

(e) Environmental users of groundwater- None known.

(f) Surface water users, if there is a hydrologic connection between surface and groundwater bodies- None known.

(g) The federal government, including, but not limited to, those served by private domestic wells or small community water systems- DEID holds a water contract for surface waters from the Central Valley Project with the U.S. Bureau of Reclamation. The District interacts routinely with Reclamation personnel and will continue to consider Reclamation as applicable.

(h) California Native American Tribes- None known.

(i) Disadvantaged communities, including, but not limited to, those served by private domestic wells or small community water systems- the unincorporated community of Earlimart is within the DEID GSA (see discussion above).

(j) Entities listed in Water Code Section 10927 that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin managed by a groundwater sustainability agency- DEID has monitored groundwater elevations since the 1950s as part of its water service contracts with the U.S. Bureau of Reclamation. Additionally, DEID participates in regional reporting of groundwater elevations as a part of CASGEM.

DEID will continue to work with interested stakeholders to develop and implement a GSP in a cooperative manner with other GSAs in the Tule Subbasin and Kern County Subbasin. Interested parties will have opportunities, both formally and informally, to provide input into the DEID GSA throughout the process of developing, operating, and implementing the GSA and GSP. Such opportunities may include, but are not limited to, public hearings required by SGMA, public comment periods during DEID regular and special board meetings, and other times to be determined and notices pursuant to Water Code Section 10727.8(a).

Please contact the undersigned should you have any questions.

Sincerely,

Dale Brogan, Special Projects Manager
Delano-Earlimart Irrigation District

DELANO – EARLIMART IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX C

MOU Between DEID GSA and Earlimart Public Utility District

2024
2nd Amended Groundwater Sustainability Plan

Revised Memorandum of Understanding Regarding Groundwater Sustainability Agency Participation

This Revised Memorandum of Understanding, referred to herein as "Revised Agreement" is entered into on 6/13, 2019 between the Delano-Earlimart Irrigation District, an irrigation district organized under the laws of the State of California, referred to herein as "DEID," and the Earlimart Public Utilities District, a public utilities district organized under the laws of the State of California, referred to herein as "EPUD".

This Agreement is made in reference to the following facts:

WHEREAS, in September 2014, three bills (SB 1168, SB 1319, and AB 1739) were signed into law creating the Sustainable Groundwater Management Act of 2014 (the Act); and

WHEREAS, the Act requires the formation of a Groundwater Sustainability Agency ("GSA") that will be responsible for implementing provisions of the Act as to each groundwater basin and groundwater subbasin falling within the provisions of the Act, multiple GSAs are allowed within basin or subbasin although the Act requires a coordination agreement between the GSAs within a basin or subbasin; and

WHEREAS, the Act calls for ensuring the sustainability of each groundwater basin and subbasin by each GSA or GSAs covering the basin drafting a Groundwater Sustainability Plan ("GSP") meeting the requirements of the Act to cover the territory of the GSA; and

WHEREAS, DEID and EPUD are both within the San Joaquin Valley Groundwater Basin, Tule Subbasin, a groundwater basin recognized in California Department of Water Resources Bulletin 118 as Groundwater Basin Number: 5-22.13; and

WHEREAS, under the Act, the Tule Subbasin is required to show complete GSA coverage, either through the formation of a single GSA or multiple GSAs by July 1, 2017, and

WHEREAS DEID, and EPUD are each authorized by the Act to exercise powers related to groundwater management within their jurisdictional boundaries; and

WHEREAS, on May 23, 2016, DEID and EPUD jointly formed the Delano-Earlimart Irrigation District GSA ("DEID GSA") that encompassed their respective territories; and

WHEREAS, on March 27, 2019, the Richgrove Community Services District (RCSD) entered into a Memorandum of Understanding with DEID ("RCSD Agreement") to join the DEID GSA, which was acknowledged by the EPUD board of directors on March 18, 2019; and

WHEREAS, because of the inclusion of the RCSD into the DEID GSA and other recommended updates to the original MOU, this Revised Agreement has been written by the parties to state the revised and updated terms and conditions of GSA coverage, subject to later revision as necessary to meet state regulatory requirements.

ACCORDINGLY, THE PARTIES AGREE AS FOLLOWS:

1. Incorporation of Recitals: The recitals stated above are incorporated herein by reference.

2. No Intent to Create a JPA: The parties to this Agreement specifically acknowledge they do not intend to create a joint powers agreement under the California Government Code or to form a joint powers agency as a result of this Agreement.

3. Inclusion Within GSA Boundaries: EPUD has previously agreed that the area subject to its jurisdiction will be within the jurisdictional boundaries of the DEID GSA and acknowledges that DEID has previously provided statutory notice under the Act of its GSA boundaries. The Parties hereby agree the DEID GSA boundaries will be modified to include the area or territory that is within the jurisdictional boundaries of the EPUD and of the RCSD as specified in the RCSD Agreement. By executing this Revised Agreement, EPUD confirms its previous agreement to be part of, and governed by, the DEID GSA.

4. Acknowledgment Regarding ID Boundaries: Parties agree this MOU is for the purpose of compliance with the Act. EPUD is not being included within the jurisdictional boundaries of DEID for any other purpose and will not incur liability for any DEID assessments charged to DEID landowners or have the right to receive any surface water from DEID, provided however that DEID and EPUD may mutually agree to develop and operate a water importation program for the purpose of EPUD being in water balance under the terms of the DEID GSP.

5. Individual Costs: It is acknowledged that the individual parties will incur costs in complying with the Act, including but not limited to the development and implementation of this MOU.

6. Cost Recovery:

   6.1 GSA Formation Cost: EPUD acknowledges that DEID has and is incurring costs to comply with the Act, which included the formation of the DEID GSA, GSA administration costs, costs in preparation of a coordination agreement between the various GSAs within the Tule Subbasin and GSP preparation/approval process costs. The Parties acknowledge that EPUD has paid $10,000 (ten thousand dollars) to reimburse DEID for its past and future share of the costs listed above with said payment being the full sum required from EPUD, provided that this sum may be adjusted in the future should litigation and/or adjudication costs associated with the GSA or GSP occur prior to submittal of the final GSP to DWR.

   6.2 GSA Administration Cost: Following submittal of the GSP to DWR, EPUD agrees to pay to DEID a proportional share of ongoing GSA administration cost based on a per acre charge. Said per acre charge shall be determined by dividing the ongoing GSA administrative expenses by the total number of acres within the GSA, and then multiplying the cost per acre by the number of acres in the EPUD service area. Said expenses shall be billed to EPUD not less than quarterly and shall be paid within 30 days of receipt.

   6.3 Coordination Agreement Cost: Following submittal of the GSP to DWR, further development and revision of the Coordination Agreement will be required to meet the requirements under the Act and subsequent regulations for reporting to the state. Additionally, specific costs will be incurred through the Coordination Agreement to meet the requirement that all GSPs within the Tule Subbasin utilize the same data and methodologies including, but not limited to, the following items: (a) groundwater elevation data; (b) groundwater extraction data; (c) surface water supply; (d) total water use; (e) change in groundwater storage; (f) water budget; and (g) sustainable yield. EPUD agrees to pay to DEID a proportional share of the above described costs associated with the Coordination

Agreement on a per acre charge, said proportional share to be determined and billed to EPUD as described in 6.2 of this MOU.

6.4 Annual GSP Implementation Cost: Following submittal of the GSP to DWR, the DEID GSA will begin implementation of the provisions of the GSP within the lands of the GSA. EPUD agrees to pay to DEID a proportional share of GSP implementation expenses, said proportional share to be determined and billed to EPUD as described in 6.2 of this MOU.

6.5 Additional Fee for Importing Water: DEID anticipates that as part of its required coordination with other GSAs and associated GSPs, a maximum baseline level of groundwater pumping will be established for the Tule Subbasin (herein referred to as the "sustainable yield"). EPUD agrees to enter into separate agreement(s) with DEID for the purchase of additional surface water that can be imported into the DEID GSA if EPUD is determined to be a net user of water in excess of its total sustainable yield. DEID, and EPUD agree to develop mutually agreeable methods for determining the sustainable yield, baseline pumping levels and methods for accounting the balances and will include that methodology in the GSP.

Parties acknowledge reimbursement of costs under this section does not include costs or fees established by DEID to bring water into the Tule Subbasin for purposes of increasing the applicable groundwater pumping safe yield for DEID's service area. DEID agrees that it will not charge such fees to EPUD unless either or both agrees to do so in exchange for the increases to the applicable safe yield amounts for the area included in the EPUD service area.

DEID agrees that EPUD may develop and operate its own water importation program(s) for the purpose of being in water balance under the terms of the DEID GSP.

EPUD agrees that it shall participate in joint programs with DEID in securing funds that may be available to it as a designated disadvantaged community for the purpose of being in water balance under the terms of the DEID GSP.

6.6 Accounting: DEID agrees it will provide on an annual basis a summary stating all costs it has incurred in meeting the requirements of the Act to EPUD beginning in any year where reimbursement of expenses is billed to EPUD.

7. Consideration as a Separate Management Area: Parties acknowledge that the applicable state regulations establishing acceptable GSP requirements and elements include that a GSA may define one or more management areas where conditions are different from other areas of a GSA and a separate management area would facilitate implementation of the GSP.

   The Parties agree that the area within EPUD will be a separate management area within the final DEID GSP.

8. Data Collection and Review: EPUD agrees to provide DEID with all required data necessary for the development and implementation of the GSP and SGMA reporting requirements at its expense. Required data shall include but is not limited to: (a) pumping data; (b) groundwater elevation data; and (c) wastewater discharges that are returned to the groundwater basin.

DEID shall provide to EPUD any reports and findings made by DEID that are based on the data provided for review and comment in a timely manner and as part of the development, adoption, and implementation of the DEID GSP.

9. No Guarantee of Water Quantity or Water Quality: This MOU is being entered into by the parties for the purposes of compliance with the Act. DEID is not agreeing that any specific quantity of water or water of any specified quality will be available to EPUD.

10. GSA Governance and Meetings: DEID anticipates the governance of the DEID GSA and GSP will be accomplished in the following manner:

    10.1 Stakeholder and interested parties (Stakeholders): DEID has established a series of meetings that are open to all DEID stakeholders and other interested parties for the purposes of advising the DEID Board of Directors on matters dealing with GSA and GSP development, GSP implementation, and other GSA/GSP matters. EPUD shall endeavor to have a representative at all Stakeholder meetings and further agrees to host Stakeholder meetings specific to the EPUD Management Area. Hosting shall include providing a place for said meetings, required supplies, and Spanish translation services. EPUD acknowledges that additional participation from other interested parties in the development and implementation of the GSA and GSP per Water Code section 10727.8 will be pursued for all Stakeholder meetings. All Stakeholder meetings will be noticed and open to the public.

    EPUD agrees it shall share equally with RCSD in costs associated with Spanish translation services for printed materials produced as part of the GSA's public outreach program.

    10.2 DEID Board of Directors (BOD): The DEID BOD shall be responsible for all final decisions relative to the development of the GSA, GSP adoption, implementation of the GSP, and other related matters, fully considering the recommendations of the EPUD. Both DEID and EPUD acknowledge decisions made with respect to the development of the GSA, GSP adoption, implementation of the GSP and other related matters may be in whole or part challenged legally. It is the intent of both parties to fully cooperate in defending any legal challenges, with each party being responsible for the costs to defend said challenges that are exclusive to its respective management area.

    10.3 Subbasin Coordination Committee Meetings: DEID anticipates continued Subbasin Coordination Committee meetings among subbasin GSAs and other stakeholders.

    If requested by EPUD, DEID shall provide notice in advance to EPUD of all Subbasin Coordination Committee meetings, and any BOD meeting where GSA/GSP matters will be discussed and/or decided upon.

11. Dispute Resolution: Parties agree that should any controversy arise between the two parties, then each district shall appoint from its board of directors one director to serve on a dispute resolution committee for the purpose of meeting informally and attempting to resolve the dispute.

    Should such informal dispute resolution fail then disputes may be settled by a civil action to resolve disputes over or to enforce this agreement. In any civil action the prevailing party may be awarded attorney's fees and costs.

12. Termination by EPUD: This MOU shall stay in effect until terminated by the parties, which either Party may do upon 90 days written notice, provided however, that no party may terminate this Agreement unless provision has been made for EPUD's service area to be included into another GSA upon termination, either by EPUD taking steps necessary under the Act to serve as its own GSA, entering into a joint powers agreement or similar type of agreement with another entity to serve as a GSA for EPUD's service area, or agreeing to be within the boundaries of a separate GSA. All costs owed to DEID must be paid prior to termination.

13. Entire Agreement: This MOU represents the entire agreement among the parties as to its subject matter and no prior oral or written understanding shall be of any force or effect. No part of this MOU may be modified without the written consent of each party.

14. Headings: Section headings are provided for organizational purposes only and do not in any manner impact the scope, meaning, or intent of the provisions under the headings.

15. Notices: Except as may be otherwise required by law, any notice to be given shall be written and shall be either personally delivered, sent by first class mail, postage prepaid and addressed as stated below. Notices delivered personally are deemed to be received upon receipt. Notices sent by first class mail shall be deemed received on the fourth day after the date of mailing. Either party can change the address listed below by giving written notice pursuant to this Section.

DEID
Attn: General Manager
14181 Avenue 24
Delano, Ca 93215

EPUD
Attn: General Manager
Box 10148
Earlimart, CA 93219-0148

16. Construction: This MOU reflects the contributions of all parties and accordingly the provisions of Civil Code Section 1654 shall not apply to address and interpret any uncertainty.

17. No Third Party Beneficiaries Intended: Unless specifically set forth, the parties to this MOU do not intend to provide any other party with any benefit or enforceable legal or equitable right or remedy.

18. Waivers: The failure of any party to insist on strict compliance with any provision of this MOU shall not be considered a waiver of any right to do so, whether for that breach or any subsequent breach.

19. Conflict with Laws or Regulations/Severability: This MOU is subject to all applicable laws and regulations. If any provision of this MOU is found by any court or other legal authority, or is agreed by the parties, to be in conflict with any code or regulation governing its subject, the conflicting provision shall be considered null and void. If the effect of nullifying any conflicting provision is such that a material benefit of the MOU to any party is lost, the MOU may be terminated at the option of the affected party. In all other cases the remainder of the MOU shall continue in full force and effect.

20. Further Assurances: Each party agrees to execute any additional documents and to perform any further acts that may be reasonably required to affect the purposes of this MOU.

21. Counterparts: This MOU may be signed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

Parties, having read and considered the above provisions, indicate their agreement by their authorized signatures.

Delano-Earlimart Irrigation District	Earlimart Public Utility District
President, Board of Directors	President, Board of Directors

DELANO – EARLIMART IRRIGATION DISTRICT
GROUNDWATER SUSTAINABILITY AGENCY

APPENDIX D

MOU Between DEID GSA and Richgrove Community Service District

2024
2nd Amended Groundwater Sustainability Plan

Memorandum of Understanding Regarding Groundwater Sustainability Agency Participation

This Memorandum of Understanding, referred to herein as "Agreement" is entered into on 3/14/2019 2019 between the Delano-Earlimart Irrigation District, an irrigation district organized under the laws of the State of California, referred to herein as "DEID," and the Richgrove Community Services District, a public utilities district organized under the laws of the State of California, referred to herein as "RCSD".

This Agreement is made in reference to the following facts:

WHEREAS, in September 2014, three bills (SB 1168, SB 1319, and AB 1739) were signed into law creating the Sustainable Groundwater Management Act of 2014 (the Act); and

WHEREAS, the Act requires the formation of a Groundwater Sustainability Agency ("GSA") that will be responsible for implementing provisions of the Act as to each groundwater basin and groundwater subbasin falling within the provisions of the Act, multiple GSAs are allowed within basin or subbasin although the Act requires a coordination agreement between the GSAs within a basin or subbasin; and

WHEREAS, the Act calls for ensuring the sustainability of each groundwater basin and subbasin by each GSA or GSAs covering the basin drafting a Groundwater Sustainability Plan ("GSP") meeting the requirements of the Act to cover the territory of the GSA.

WHEREAS, DEID, and RCSD are both within the San Joaquin Valley Groundwater Basin, Tule Subbasin, a groundwater basin recognized in California Department of Water Resources Bulletin 118 as Groundwater Basin Number: 5-22.13; and

WHEREAS, under the Act, the Tule Subbasin was required to show complete GSA coverage, either through the formation of a single GSA or multiple GSAs by July 1, 2017, and

WHEREAS, DEID, and RCSD are each authorized by the Act to exercise powers related to groundwater management within their jurisdictional boundaries; and

WHEREAS, at this time DEID has jointly formed a GSA with the Earlimart Public Utility District (EPUD) to encompass their respective territories, known as the Delano-Earlimart Irrigation District GSA (DEID GSA), which is adjacent to the territory of RCSD; and

WHEREAS, RCSD is currently a part of the Eastern Tule GSA and now wishes to be included within the boundaries of the DEID GSA; and

WHEREAS, by this MOU the parties intend to state the terms and conditions of such GSA coverage, subject to later revision as necessary to meet state regulatory requirements.

ACCORDINGLY, THE PARTIES AGREE AS FOLLOWS:

1. Incorporation of Recitals: The recitals stated above are incorporated herein by reference.

2. No Intent to Create a JPA: The parties to this Agreement specifically acknowledge they do not intend to create a joint powers agreement under the California Government Code or to form a joint powers agency as a result of this Agreement.

3. Inclusion Within GSA Boundaries: RCSD agrees that the area subject to its jurisdiction will be within the jurisdictional boundaries of the DEID GSA, with the exception of Tulare County parcel 340-060-081. DEID GSA has previously provided statutory notice under the Act of its GSA boundaries. The Parties hereby agree the DEID GSA shall take such actions as are necessary to modify its jurisdictional boundaries so as to encompass the area or territory that is within the jurisdictional boundaries of RCSD, with the exception of Tulare County parcel 340-060-081. The Parties acknowledge that it may also be necessary to secure the agreement of the Eastern Tule GSA, the Kern-Tulare Water District, and/or the County of Tulare to take actions to facilitate or effectuate the modification of the DEID GSA boundaries. By executing this Agreement, RCSD is agreeing it will be part of, and governed by, the DEID GSA. RCSD further agrees to reimburse DEID for any costs associated with modifying the DEID GSA boundaries to encompass RCSD, including but not limited to the cost of any requirements that may be imposed by DWR. These costs are in addition to any costs recovery obligations of RCSD established under Section 6 of this Agreement.

4. Acknowledgment Regarding ID Boundaries: Parties agree this MOU is for the purpose of compliance with the Act. RCSD is not being included within the jurisdictional boundaries of DEID for any other purpose and will not incur liability for any DEID assessments charged to DEID landowners or have the right to receive any surface water from DEID, provided however that DEID and RCSD may mutually agree to develop and operate a water importation program for the purpose of RCSD being in water balance under the terms of the DEID GSP.

5. Individual Costs: It is acknowledged that the individual parties will incur costs in complying with the Act, including but not limited to the development and implementation of this MOU.

6. Cost Recovery:

   6.1 Formation Costs: RCSD acknowledges that DEID has and is incurring costs to comply with the Act, which included the formation of the DEID GSA, GSA administration costs, costs in preparation of a coordination agreement between the various GSAs within the Tule Subbasin, and GSP preparation/approval process costs. RCSD acknowledges it has a responsibility to reimburse its respective share of these costs. RCSD agrees that it will pay $10,000 (ten thousand dollars) to reimburse DEID for its past and future share of the costs listed above, with said payment being the full sum required from RCSD, provided that this sum may be adjusted in the future should litigation and/or adjudication costs associated with the GSA or GSP occur prior to submittal of the final GSP to DWR. RCSD agrees to pay said $10,000 to DEID upon execution of this MOU

   6.2 GSA Administration Cost: Following submittal of the GSP to DWR, RCSD agrees to pay to DEID a proportional share of ongoing GSA administration cost based on a per acre charge. Said per acre charge shall be determined by dividing the ongoing GSA administrative expenses by the total number of acres within the GSA, and then multiplying the cost per acre by the number of acres in the RCSD boundaries also within the DEID GSA. Said expenses shall be billed to RCSD not less than quarterly and shall be paid within 30 days of receipt.

   6.3 Coordination Agreement Cost: Following submittal of the GSP to DWR, further development and revision of the Coordination Agreement will be required to meet the requirements under the Act and subsequent regulations for reporting to the state.

Additionally, specific costs will be incurred through the Coordination Agreement to meet the requirement that all GSPs within the Tule Subbasin utilize the same data and methodologies including, but not limited to, the following items: (a) groundwater elevation data; (b) groundwater extraction data; (c) surface water supply; (d) total water use; (e) change in groundwater storage; (f) water budget; and (g) sustainable yield. RCSD agrees to pay to DEID a proportional share of the above described costs associated with the Coordination Agreement on a per acre charge, said proportional share to be determined and billed to RCSD as described in 6.2 of this MOU.

6.4 Annual GSP Implementation Cost: Following submittal of the GSP to DWR, the DEID GSA will begin implementation of the provisions of the GSP within the lands of the GSA. RCSD agrees to pay to DEID a proportional share of GSP implementation expenses, said proportional share to be determined and billed to RCSD as described in 6.2 of this MOU.

6.5 Additional Fee for Importing Water: DEID anticipates that as part of its required coordination with other GSAs and associated GSPs, a maximum baseline level of groundwater pumping will be established for the Tule Subbasin (herein referred to as the "sustainable yield"). RCSD agrees to enter into separate agreement(s) with DEID for the purchase of additional surface water that can be imported into the DEID GSA if RCSD is determined to be a net user of water in excess of its total sustainable yield. DEID, and RCSD agree to develop mutually agreeable methods for determining the sustainable yield, baseline pumping levels and methods for accounting the balances and will include that methodology in the GSP.

Parties acknowledge reimbursement of costs under this section does not include costs or fees established by DEID to bring water into the Tule Subbasin for purposes of increasing the applicable groundwater pumping safe yield for DEID's service area. DEID agrees that it will not charge such fees to RCSD unless either or both agrees to do so in exchange for the increases to the applicable safe yield amounts for the area included in the RCSD boundaries.

DEID agrees that RCSD may develop and operate its own water importation program(s) for the purpose of being in water balance under the terms of the DEID GSP.

RCSD agrees that it shall participate in joint programs with DEID in securing funds that may be available to it as a designated disadvantaged community for the purpose of being in water balance under the terms of the DEID GSP.

6.6 Accounting: DEID agrees it will provide on an annual basis a summary stating all costs it has incurred in meeting the requirements of the Act to RCSD beginning in any year where reimbursement of expenses is billed to RCSD.

7. Consideration as a Separate Management Area: Parties acknowledge that the applicable state regulations establishing acceptable GSP requirements and elements include that a GSA may define one or more management areas where conditions are different from other areas of a GSA and a separate management area would facilitate implementation of the GSP.

   The parties agree that the area within RCSD will be a separate management area within the final DEID GSP.

8. Data Collection and Review: RCSD agrees to provide DEID with all required data necessary for the development and implementation of the GSP and SGMA reporting requirements at its expense. Required data shall include but is not limited to: (a) pumping data; (b) groundwater elevation data; and (c) wastewater discharges that are returned to the groundwater basin.

   DEID shall provide to RCSD any reports and findings made by DEID that are based on the data provided for review and comment in a timely manner and as part of the development, adoption, and implementation of the DEID GSP.

9. No Guarantee of Water Quantity or Water Quality: This MOU is being entered into by the parties for the purposes of compliance with the Act. DEID is not agreeing that any specific quantity of water or water of any specified quality will be available to RCSD.

10. GSA Governance and Meetings: DEID anticipates the governance of the DEID GSA and GSP will be accomplished in the following manner:

    10.1 Stakeholder and interested parties (Stakeholders): DEID has established a series of meetings that are open to all DEID GSA stakeholders and other interested parties for the purposes of advising the DEID Board of Directors on matters dealing with GSA and GSP development, GSP implementation, and other GSA/GSP matters. RCSD shall endeavor to have a representative at all Stakeholder meetings and further agrees to host stakeholder meetings specific to the RCSD Management Area. Hosting shall include providing a place for said meetings, required supplies, and Spanish translation services. RCSD acknowledges that additional participation from other interested parties in the development and implementation of the GSA and GSP per Water Code section 10727.8 will be pursued for all stakeholder meetings in all management areas. All Stakeholder meetings will be noticed and open to the public.

    RCSD agrees it shall share equally with EPUD in costs associated with Spanish translation services for printed materials produced as part of the GSA's public outreach program.

    10.2 DEID Board of Directors (BOD): The DEID BOD shall be responsible for all final decisions relative to the development of the GSA, GSP adoption, implementation of the GSP, and other related matters, fully considering the recommendations of the RCSD.

    Both DEID and RCSD acknowledge decisions made with respect to the development of the GSA, GSP adoption, implementation of the GSP and other related matters may be in whole or part challenged legally. It is the intent of both parties to fully cooperate in defending any legal challenges, with each party being responsible for the costs to defend said challenges that are exclusive to its respective management area.

    10.3 Subbasin Coordination Committee Meetings: DEID anticipates continued Subbasin Coordination Committee meetings among subbasin GSAs and other stakeholders.

    If requested by RCSD, DEID shall provide notice in advance to RCSD of all Subbasin Coordination Committee meetings and any BOD meeting where GSA/GSP matters will be discussed and/or decided upon.

11. Dispute Resolution: Parties agree that should any controversy arise between the two parties, then each district shall appoint from its board of directors one director to serve on a

dispute resolution committee for the purpose of meeting informally and attempting to resolve the dispute.

Should such informal dispute resolution fail then disputes may be settled by a civil action to resolve disputes over or to enforce this agreement. In any civil action the prevailing party may be awarded attorney's fees and costs.

12. Termination by RCSD: This MOU shall stay in effect until terminated by the parties, which either Party may do upon 90 days written notice, provided however, that no party may terminate this Agreement unless provision has been made for RCSD's area within the DEID GSA to be included into another GSA upon termination, either by RCSD taking steps necessary under the Act to serve as its own GSA, entering into a joint powers agreement or similar type of agreement with another entity to serve as a GSA for RCSD's area within the DEID GSA, or agreeing to be within the boundaries of a separate GSA. All costs owed to DEID must be paid prior to termination.

13. Entire Agreement: This MOU represents the entire agreement among the parties as to its subject matter and no prior oral or written understanding shall be of any force or effect. No part of this MOU may be modified without the written consent of each party.

14. Headings: Section headings are provided for organizational purposes only and do not in any manner impact the scope, meaning, or intent of the provisions under the headings.

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Attn: General Manager
14181 Avenue 24
Delano, Ca 93215

RCSD
Attn: General Manager
20986 Grove Drive
Richgrove, CA 93261

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conflicting provision is such that a material benefit of the MOU to any party is lost, the MOU may be terminated at the option of the affected party. In all other cases the remainder of the MOU shall continue in full force and effect.

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Parties, having read and considered the above provisions, indicate their agreement by their authorized signatures.

Delano-Earlimart Irrigation District

President, Board of Directors

Richgrove Community Services District

President, Board of Directors

Acknowledged and Agreed to:

Earlimart Public Utilities District

President, Board of Directors