SECTION II. A: PUMPING MANAGEMENT AND GROUNDWATER CONDITIONS

2023-2024 Operations Plan Summary

In accordance with the Long Term Water Agreement (Water Agreement or LTWA), Los Angeles Department of Water and Power (LADWP) prepares an Operations Plan (Plan) each April for the ensuing 12-month runoff year spanning April 1 to March 31 of the following year. The 2023-2024 Plan includes projected amounts for runoff, pumping, water used in the Owens Valley, water exported to Los Angeles, and an update of the groundwater mining calculations. The plan must also comply with the pumping well On/Off provisions of the Water Agreement based on soil water and vegetation measurements. The Inyo County Water Department (ICWD) reviews LADWP's proposed operations plan, reviewing current conditions and performing an analysis of the effects of LADWP operations on groundwater levels in the Owens Valley. Following a Technical Group meeting to resolve concerns raised by the County, LADWP finalizes the plan.

Predicted runoff from the Owens River watershed during the 2023-24 runoff-year is forecast to be 955,600 acre-feet (ac-ft or AF) or 233% of the 50-year (1971-2020) average. The actual runoff value will be available in 2024 when all surface water measurements that constitute the sum have been verified and tabulated. Planned pumping for 2023-24 is between 40,130 to 51,470 ac-ft. LADWP is predicting 111,390 ac-ft of water will be used in the Owens Valley, 55,690 ac-ft of which is planned for irrigation. The 2023-24 water exports from the Eastern Sierra (Inyo and Mono Counties) are planned to be 395,000 ac-ft (73% of LADWP anticipated annual need).

The Water Agreement and Green Book include procedures to calculate a pumping limit to prevent groundwater mining to ensure that there is no long-term decline in aquifer storage; these calculations are summarized in Table 1.4 of LADWP's 2023-24 Operations Plan and are used to set a maximum pumping limit through September of 2023. Unlike the annual reporting periods which are based on runoff year (April to March), the annual period for the groundwater mining calculation is based on the water-year (October 1 through September 30). The mining calculation is a comparison of LADWP pumping and recharge for each wellfield on a water-year basis for the most recent 20-year period. The 19.5-year total of pumping (through April 2023) is subtracted from 20 years of recharge (recharge estimated through September 2023) to arrive at an April to September 2023 pumping limit for each wellfield and the Owens Valley as a whole.

For the 20-year water mining calculation, recharge is approximately 3.4 million ac-ft compared to 1.4 million ac-ft of pumping. The 2021-22 water-year groundwater recharge in the Owens Valley from the mining calculations was approximately 109,895 ac-ft compared to 68,203 ac-ft of pumping, and no wellfield was in violation of the groundwater mining provision in water-year 2021-22. The 2022-23 water-year estimate of groundwater recharge in the Owens Valley from the mining calculations was approximately 323,774 ac-ft compared to 22,458 ac-ft of actual pumping to-date, and no wellfield is projected to be in violation of the groundwater mining provision in 2023. LADWP's Table 1.4 summarized the water mining limits for each wellfield.

Groundwater Mining Calculation from LADWP's Table 1.4 (reproduced below) of its 2023-24 Annual Operations Plan.

Table 1.4. Summary of Recharge and Pumping for WY 2021 - 2022 and Estimated Pumping Limit for Apr-Sep 2023 (AF)

Water	OWENS VALLEY	LAWS		BISHOP		BIG PINE		TABOOSE-THIBAUT		IND-SYM-BAIRS		LONE PINE		OWENS VALLEY	
Year	Runoff Percent(c)	Recharge	Pumping	Recharge	Pumping	Recharge	Pumping	Recharge	Pumping	Recharge	Pumping	Recharge	Pumping	Recharge	Pumping
2004	71%	11,138	7,412	37,149	11,777	21,126	26,149	25,044	25,159	29,771	15,750	11,357	1,119	135,586	87,366
2005	120%	18,389	3,841	47,471	7,093	32,686	19,423	40,500	18,674	46,441	18,585	17,191	1,128	202,678	68,744
2006	138%	35,336	3,013	54,337	5,667	39,650	20,686	47,757	15,707	53,873	9,944	19,956	1,119	250,911	56,136
2007	64%	10,947	7,840	34,470	10,516	19,757	20,525	25,855	14,578	27,624	10,674	10,454	1,100	129,108	65,233
2008	68%	10,855	7,939	35,850	10,228	20,432	20,243	28,619	18,542	27,759	9,219	11,563	858	135,078	67,029
2009	73%	11,049	6,233	37,416	12,123	21,555	22,891	29,385	14,751	29,359	9,603	12,147	775	140,912	66,376
2010	93%	11,154	6,333	41,987	10,509	26,566	22,514	35,541	20,239	36,863	13,031	14,252	626	166,362	73,252
2011	134%	17,375	7,188	52,182	9,889	35,539	27,089	47,562	21,933	50,619	14,527	19,057	998	222,333	81,624
2012	72%	11,058	9,514	37,315	11,134	21,297	27,220	28,369	26,156	28,905	16,570	11,538	1,048	138,482	91,642
2013	62%	10,644	6,642	34,811	11,536	19,408	26,115	24,795	25,225	24,749	17,907	10,364	721	124,771	88,146
2014	50%	10,393	6,287	31,325	10,849	16,871	22,560	21,241	15,778	20,508	11,347	8,960	946	109,297	67,767
2015	43%	10,103	5,824	30,667	10,521	15,380	19,939	18,671	15,563	18,695	11,873	7,995	925	101,512	64,645
2016	63%	10,392	6,038	34,844	10,842	19,551	22,798	25,634	20,642	25,354	18,829	10,306	984	126,082	80,133
2017	175%	45,270	2,000	67,171	4,399	56,730	22,106	71,201	12,959	66,222	9,243	24,741	915	331,335	51,622
2018	93%	14,351	8,646	41,346	9,588	25,911	23,140	34,601	18,896	35,628	12,050	13,807	973	165,643	73,293
2019	130%	34,481	7,127	53,925	5,670	40,241	21,356	47,748	17,000	49,029	9,994	18,307	973	243,731	62,120
2020	73%	10,986	11,170	37,201	9,437	22,577	18,647	28,626	21,503	28,757	9,949	11,402	985	139,548	71,691
2021	44%	10,294	8,337	30,389	10,901	15,807	11,366	19,538	22,339	18,332	9,128	7,810	1,010	102,169	63,081
2022	50%	10,680	8,356	31,272	10,945	17,113	20,086	21,689	20,067	20,360	7,744	8,780	1,005	109,895	68,203
2023 (a)	191%	38,089	1,353	69,815	716	54,828	6,765	66,788	10,722	69,752	2,769	24,502	133	323,774	22,458
(b) TOTAL		342,986	131,093	840,940	184,340	543,028	421,618	689,164	376,433	708,601	238,736	274,490	18,341	3,399,209	1,370,561
Estimated Apr-Sep 2023 Pumping Limit			211,893		656,600		121,410		312,731		469,864		256,149		2,028,647

(a) Estimated Recharge for the 2023 Water Year; Approximate Pumping for First Half of Water year 2023 (Oct-Mar).

(b) Estimated 20 Year Total for Recharge; actual 19.5 Year Total for Pumping.

(c) Mining calculations are based on Water Year (October-September) instead of Runoff Year (April-March).

The Big Pine wellfield is the only wellfield close to its mining limit with pumping at 78% of the total recharge through water-year 2022-23 (20-year total recharge of approximately 543,000 ac-ft compared to 422,000 ac-ft pumping). Pumping exceeded recharge during the five-year period of the recent drought (2012-2016). This does not constitute a violation of the groundwater mining provision, but ICWD has suggested that pumping in this wellfield be curtailed to include only sole source, in-valley uses. A significant amount of water was spread into the Big Pine wellfield in 2017 and 2019, and pumping in Big Pine was reduced in 2020 due to a bacterial infection at the Fish Springs Hatchery. The relatively small difference between pumping and recharge remains a concern and will continue to be monitored.

For the Owens Valley, the percentage of pumping to recharge through water-year 2022-23 is projected to be 7% due to strong runoff and low pumping. Runoff (as an inflow) and pumping (as an outflow) are two of the components of the Owens Valley groundwater budget. It is important to note that evapotranspiration (evaporation and plant transpiration of groundwater primarily by native vegetation along the valley floor) is another primary component (as an outflow) of the groundwater budget; one that is implicitly protected by the Water Agreement. Therefore, looking at groundwater levels which track change in storage of the Owens Valley groundwater system and availability of groundwater to phreatophytic plants is of primary importance.

An expanded discussion of the 2023-24 Operations Plan is presented in the "2023-24 Operations Plan Details" subsection of this report.

2022-2023 Hydrologic Conditions

For the past runoff year, April 2022 through March 2023, the reported measured runoff was 240,277 ac-ft, approximately 59% of the 1971-2020 long-term average (Figure 1). Total LADWP pumping within the Owens Valley from Laws to Lone Pine for 2022-23 was 66,306 ac-ft, which was only 77% of LADWP's planned maximum pumping amount of 86,300 ac-ft (Table 1). Owens Valley water uses for 2022-23 were 89,800 ac-ft including 39,500 ac-ft of irrigation, and Eastern Sierra water exports were approximately 93,880 ac-ft, 20% of LADWP's 2022-23 anticipated annual demand (470,000 ac-ft).

Table 1. Planned and LADWP actual pumping by wellfield for the 2022-2023 runoff-year. Estimated minimum pumping prepared by Inyo County for sole source uses is included for reference.

Wellfield	Estimated Minimum Pumping (ac-ft)	Planned Maximum Pumping (ac-ft)	Actual 2022-23 Pumping (ac-ft)	Percent Actual vs. Planned
Laws	8,000	10,710	7,901	74%
Bishop	12,000	12,000	9,568	80%
Big Pine	18,120	23,100	16,446	71%
Taboose-Aberdeen	300	14,850	13,835	93%
Thibaut-Sawmill	8,400	10,920	9,482	87%
Independence-Oak	6,420	8,800	5,631	64%
Symmes-Shepherd	1,200	2,910	1,765	61%
Bairs-Georges	460	2,110	697	33%
Lone Pine	1,000	900	981	109%
Total	**55,900**	**86,300**	**66,306**	**77%**

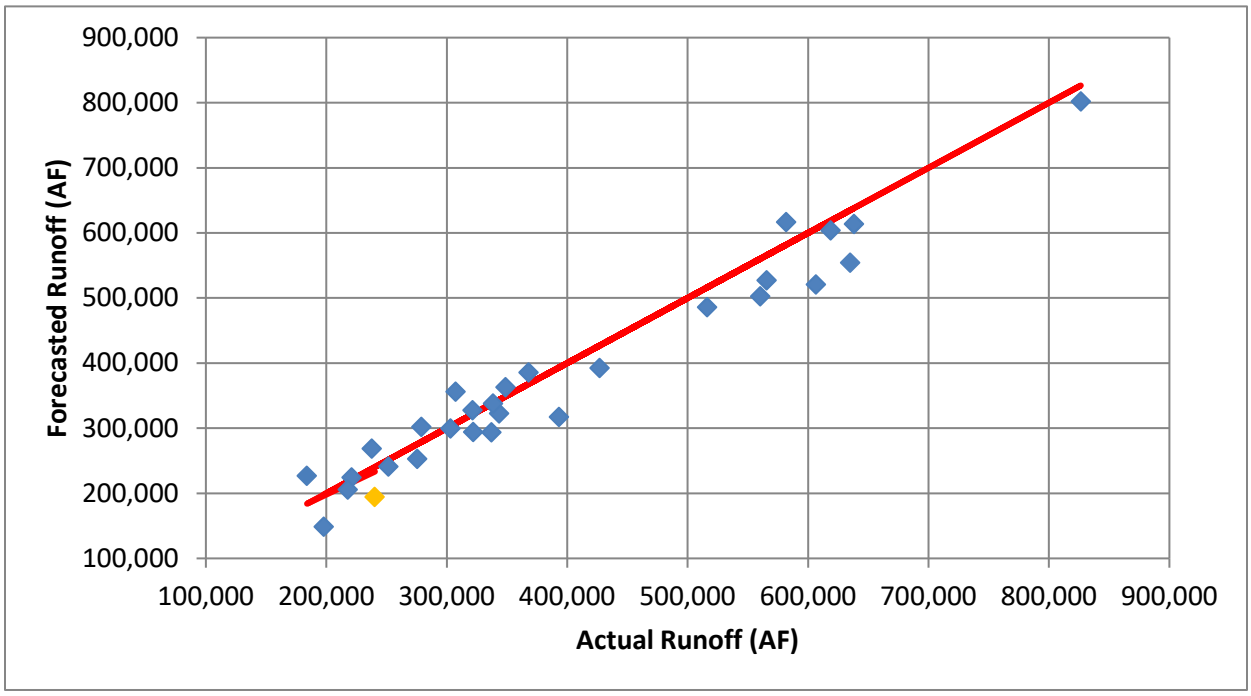

Figure 1. Comparison of actual and forecasted runoff 1994-2023 runoff years with 100% accuracy between forecast and actual runoff in red. The most recent year is the orange diamond (2022 actual runoff was 240,277 ac-ft; forecasted runoff was 194,300 ac-ft).

ICWD uses groundwater levels from a suite of key monitoring wells (Indicator wells) located throughout the Owens Valley near LADWP wellfields to both track and predict, using regression models, the effects of groundwater pumping on water tables. The effect of pumping and runoff in 2022-23 on water levels in the Indicator Wells is shown in the histogram in Figure 2 and listed in Table 2.

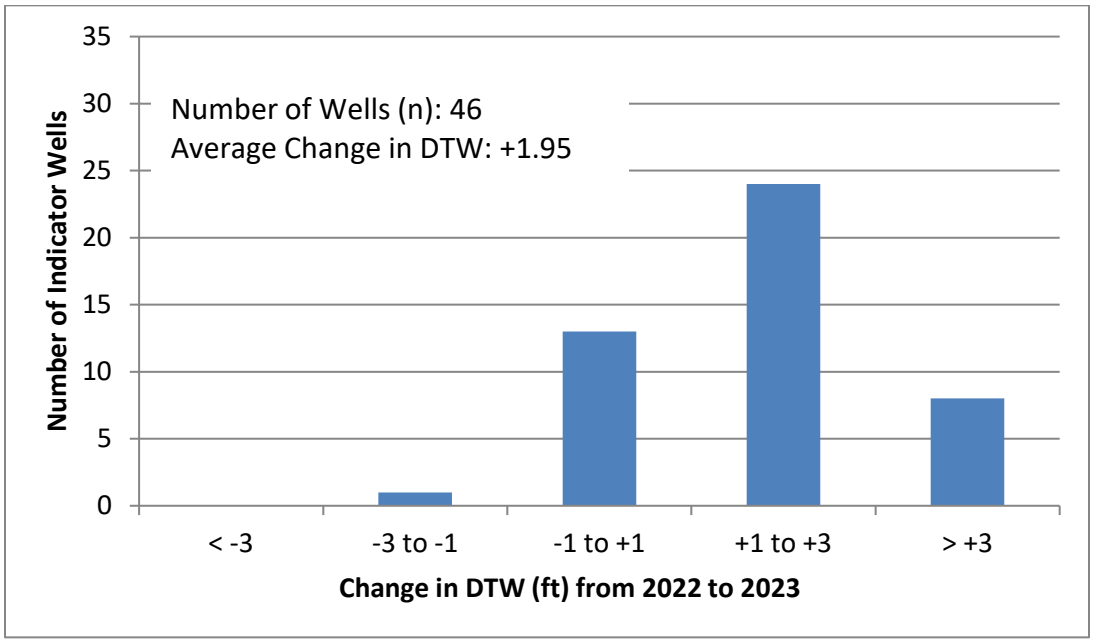

Figure 2. Histogram of change in Depth-to-Water between April 2022 and April 2023 for 46 Indicator test wells. Positive changes indicate rising (shallowing) water tables.

Groundwater levels increased in 40 of the 46 Indicator monitoring wells (Figure 2) due to a combination of low 2022-23 runoff (59% of average), record wet 2023 winter and low pumping (93% of 1992-2022 average). The average change in depth-to-water (DTW) in the 46 wells from April 1, 2022, to 2023 was an increase of 2.0 feet, with a median increase of 1.6 feet. The largest increases were observed in Laws (4.6 ft), Thibaut-Sawmill (3.1 ft), Independence-Oak (2.2 ft) and Bairs-Georges (1.7 ft) wellfields. Big Pine (1.0 ft), Taboose-Aberdeen (0.6 ft) and Symmes-Shepherd (0.8 ft) wellfields saw more moderate increases. Groundwater levels are below levels of the mid-1980's vegetation baseline period in about 48% (22 of 46) of the Indicator wells.

Table 2. Depth-to-water at Indicator wells, April 2023. All data are in feet from reference point on the test well. Negative values denote a decline in water level. Average values by wellfield are shown in orange text. Baseline at monitoring sites is the April average of water levels from years 1985-87. Baseline was predicted from monitoring site/Indicator wells regression models if the test well was not present from 1985-87.

Station ID, Monitoring site	DTW April 2023	Change from April 2022	Deviation from Baseline in 2023
Laws ***Avg.***		**4.6**	**2.4**
107T	25.58	4.51	-1.31
434T	6.32	1.17	1.28
436T	5.78	3.17	2.32
438T	13.03	2.79	-3.43
490T	13.21	2.81	-0.14
492T	25.29	5.75	7.51
795T, LW1	6.77	8.98	6.52
V001G, LW2	20.06	0.37	-0.44
574T, LW3†	3.78	11.86	9.30
Big Pine		**1.0**	**1.9**
425T	13.96	-0.47	0.94
426T	11.31	0.50	0.26
469T	22.10	0.32	-0.43
572T	8.11	2.19	3.79
798T, BP1	10.66	2.42	5.39
799T, BP2	19.02	0.55	-0.51
567T, BP3	11.61	1.79	2.35
800T, BP4	10.51	0.98	3.08
Taboose-Aberdeen		**0.6**	**-0.5**
417T	28.01	1.20	-1.04
418T	6.37	2.03	1.86
419T, TA1	4.82	1.47	1.81
421T	37.88	-2.77	-3.53

Station ID, Monitoring site	DTW April 2023	Change from April 2022	Deviation from Baseline in 2023
502T	10.97	-0.36	-3.48
504T	9.87	-0.12	0.90
505T	20.04	0.95	-1.44
586T, TA4	6.59	1.22	1.73
801T, TA5	14.33	1.27	-0.81
803T, TA6	9.50	1.10	-0.80
Thibaut-Sawmill		**3.1**	**5.3**
415T	11.47	1.64	7.03
507T	2.01	3.68	2.66
806T, TS2	6.92	4.07	6.26
Independence-Oak		**2.2**	**-2.1**
406T	1.13	2.98	0.44
407T	10.73	1.08	-3.43
408T	2.60	2.84	0.53
409T	4.96	2.11	-3.36
546T	5.17	2.84	-1.74
809T, IO1	11.79	1.62	-5.22
Symmes-Shepherd		**0.8**	**-4.7**
402T	10.12	0.88	-2.09
403T	6.50	0.86	-1.17
404T	4.64	1.73	-1.07
447T	36.89	-0.79	-15.02
510T	5.93	1.74	-0.93
511T	5.70	1.76	-1.07
V009G, SS1	18.14	-0.46	-11.31
Bairs-Georges		**1.7**	**-0.3**
398T	4.70	3.07	1.65
400T	5.16	1.13	1.14
812T, BG2	17.07	1.04	-3.73
Average of all Indicator Wells		**+2.0**	**0.0**

The history of Owens Valley runoff and pumping since 1970 is presented in Figures 3 and 4. Since the Water Agreement and Drought Recovery Policy were adopted and implemented (1992), annual pumping has averaged approximately 71,600 ac-ft and runoff 392,200 ac-ft.

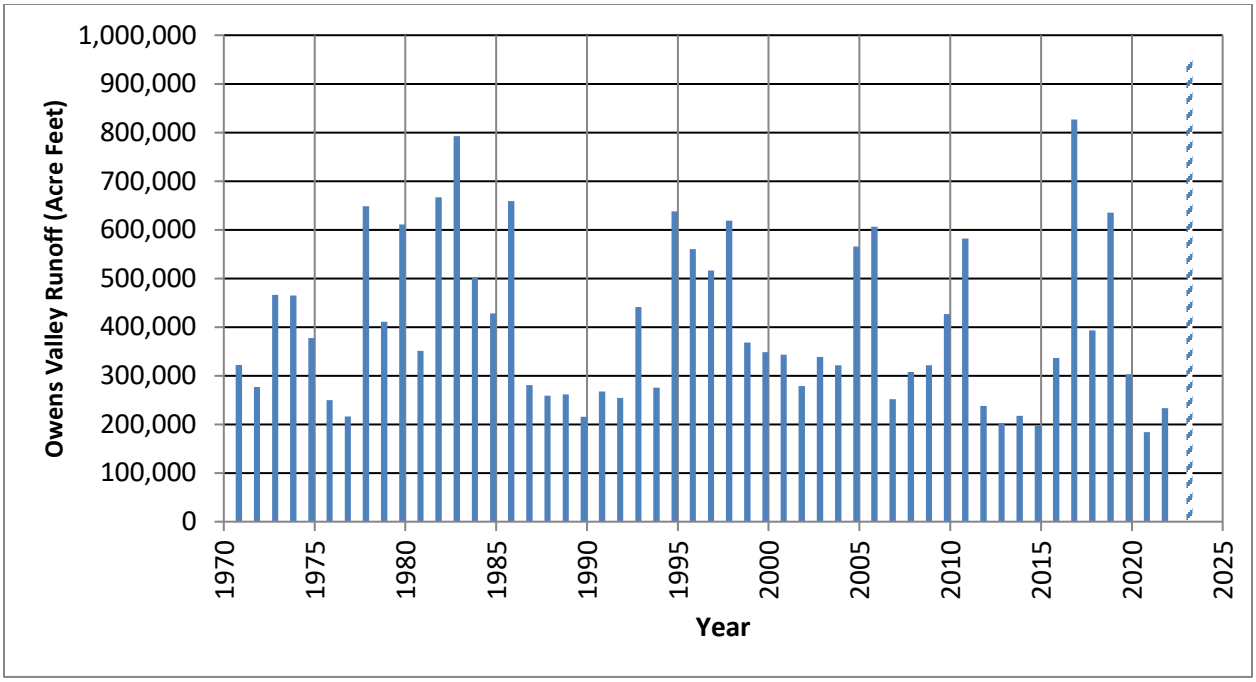

Figure 3. Measured Owens Valley runoff since 1970. Values are for the runoff year (e.g. runoff year 2022 includes April 1, 2022, through March 31, 2023. Dashed line is current runoff year estimate.

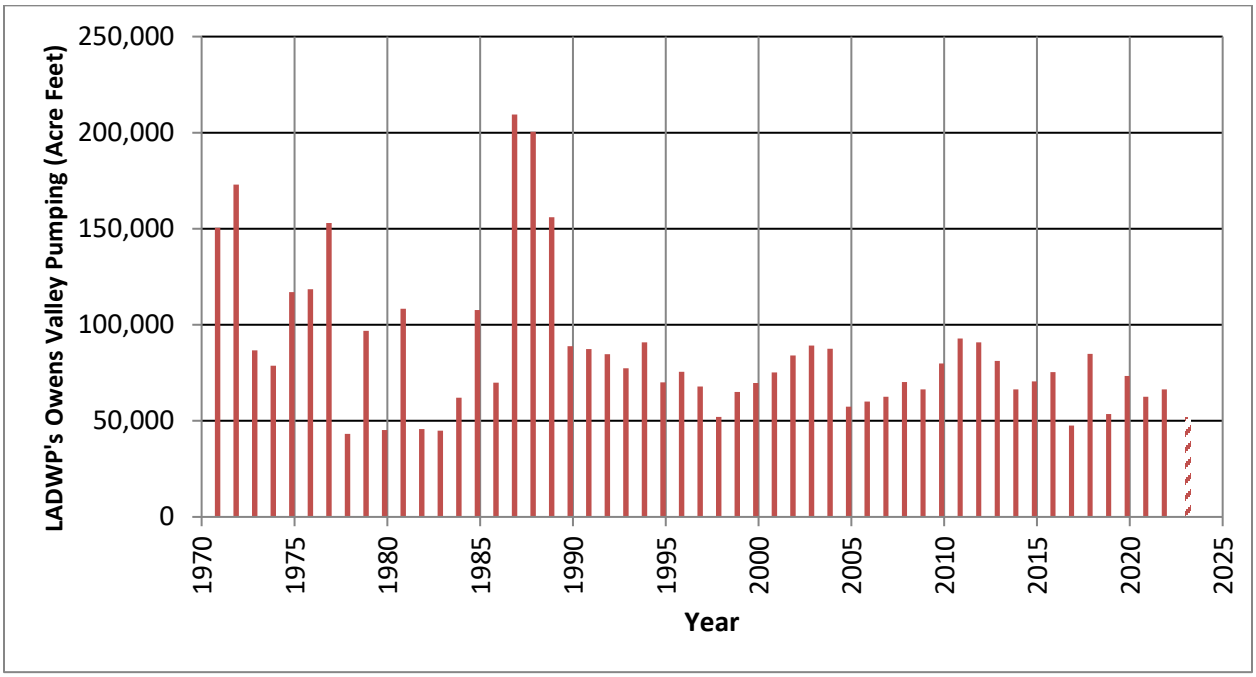

Figure 4. Total LADWP pumping in the Owens Valley since 1970 by runoff year. Dashed line is anticipated maximum pumping for current runoff year.

Groundwater data are collected from several hundred monitoring wells located throughout the Owens Valley each spring and fall. Most wells are also visited on more frequent (monthly-quarterly) schedules. A number of monitoring wells are also equipped with a pressure transducer and datalogger that records sub-daily water level measurements. Data presented in this section are depth-to-water (DTW) below ground surface measured in feet (ft-bgs).

In addition to using Indicator wells, another method to assess hydrologic conditions in the Owens Valley is to compare recent groundwater levels with historic conditions in monitoring wells across the valley. The Water Agreement uses the vegetation conditions documented from surveys conducted from 1984 to 1987 as its baseline for comparison of vegetation change. Therefore, ICWD uses the average April groundwater levels from 1985 to 1987 as a hydrologic "baseline." For more details and current vegetation status, see ICWD Annual Report Section II.c "Vegetation Conditions" available at https://www.inyowater.org/documents/reports/inyo-county-water-dept-annual-report/

While this hydrologic baseline is not specifically prescribed in the Water Agreement, it is a useful summary statistic representing the hydrology and the vegetation conditions of the baseline period. Also, the April timeframe is when DTW is typically shallowest each year for many of the wellfields. The hydrologic baseline DTW usually is an adequate indicator related to groundwater and vadose zone moisture availability for phreatophytic vegetation but should be considered a guide rather than a specific threshold that determines whether vegetation conditions are above or below baseline in the immediate vicinity of a monitoring well. Unlike the vegetation baseline, maintaining baseline DTW is not a requirement of the Water Agreement.

The very wet 2017, strong 2019, and record 2023 winter contributed to water table recovery from the recent drought periods. In April 2022, DTWs in many wellfields were at or slightly below baseline levels. However, the record wet 2023 winter and moderate pumping during the preceding year has increased groundwater levels (Figure 5), on average, in all wellfields. However, the majority of wellfields are below baseline as of April 2023 (Figure 6) based on a set of approximately 175 monitoring wells that have measurements from the mid-1980s to the present. Most wells in Taboose-Aberdeen, Independence-Oak, Symmes-Shepherd, and Bairs-Georges were below baseline. Average groundwater levels in Laws, Big Pine, and Thibaut-Sawmill are above or near baseline.

Hydrographs plotting DTW for selected wells are provided in the following discussions of conditions for each wellfield. The hydrographs presented below were selected as representative wells that provide insight on water level changes over time.

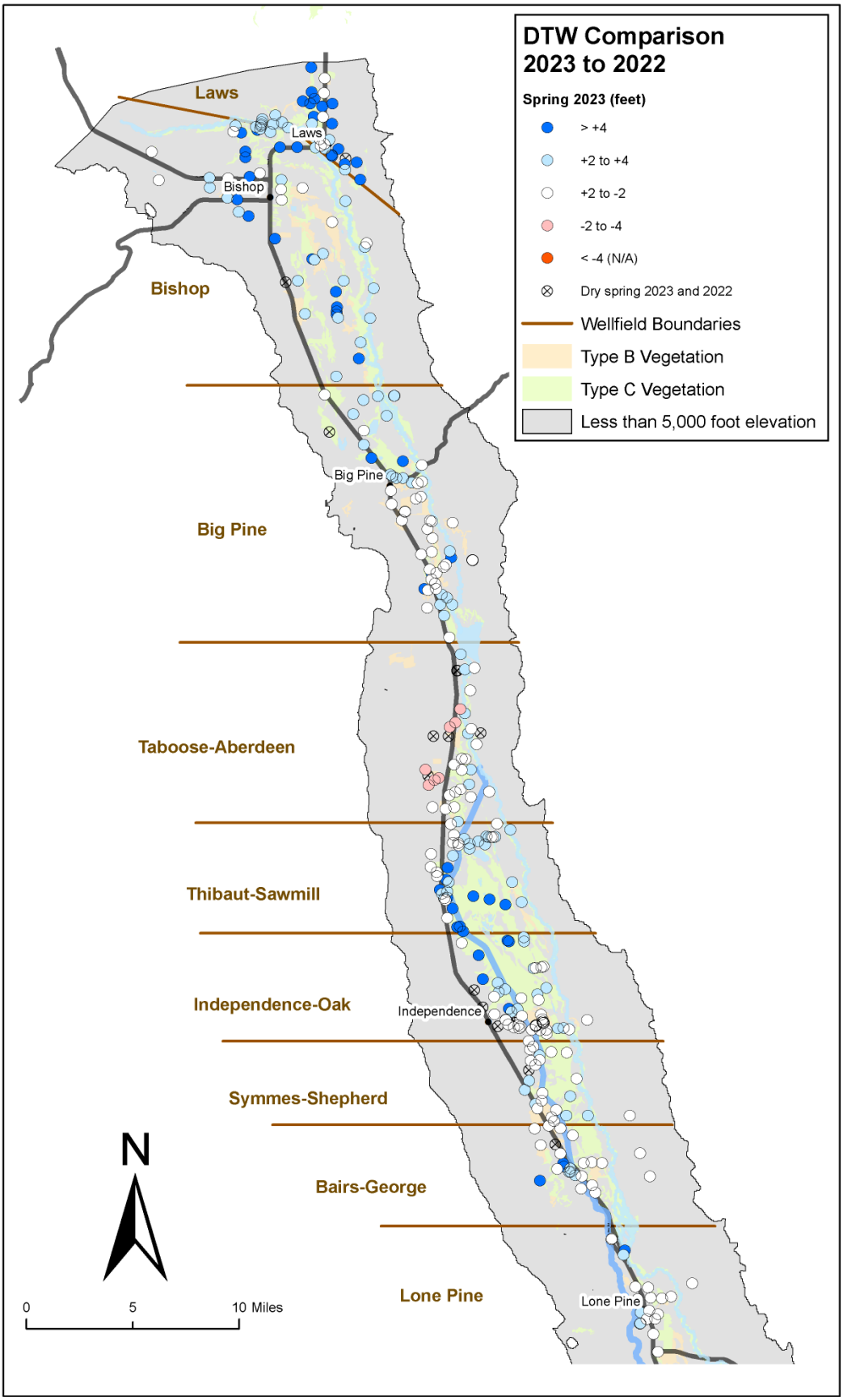

Figure 5. Change in water levels in Owens Valley monitoring wells from spring 2022 to 2023.

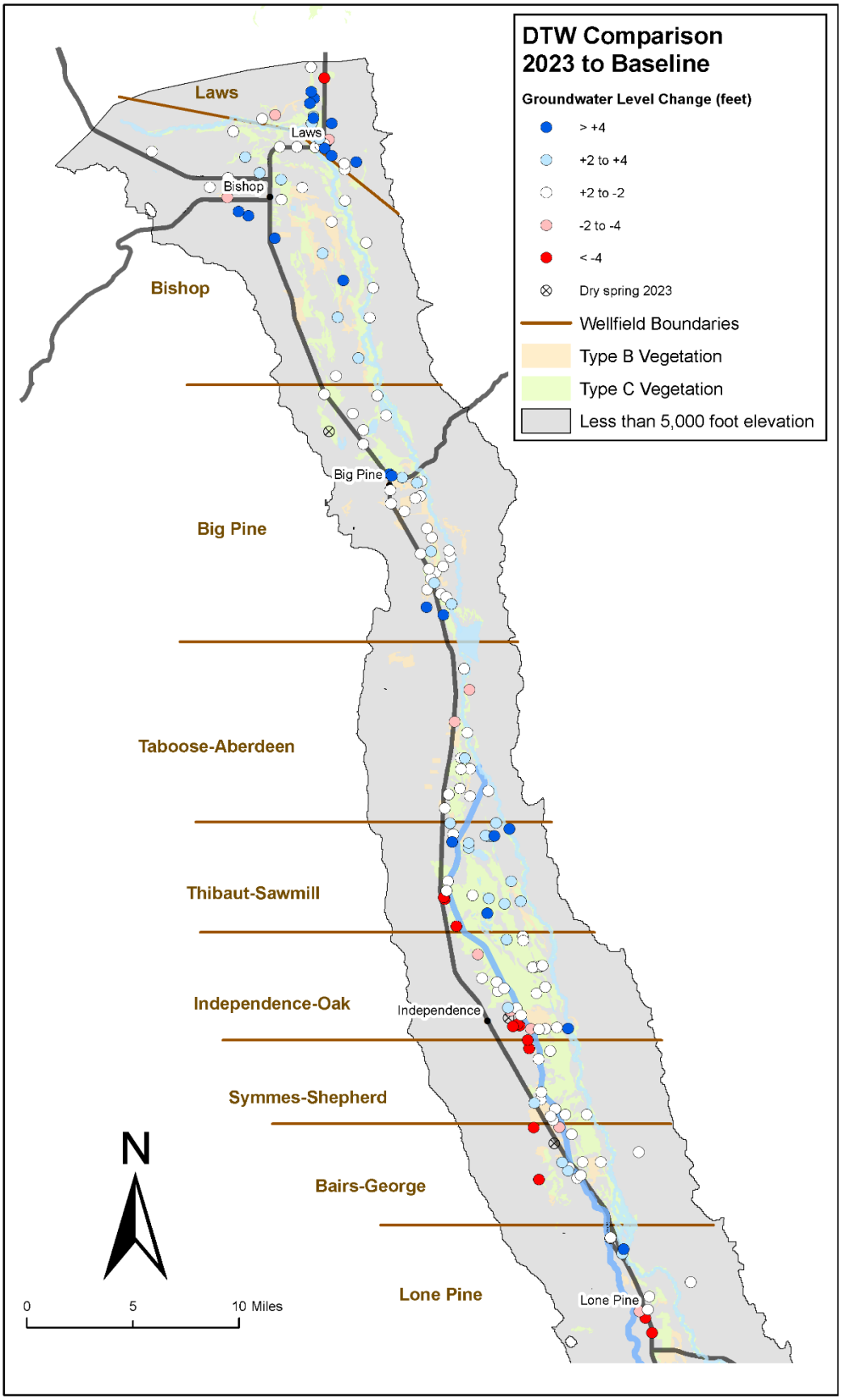

Figure 6. Spring 2023 groundwater levels wells compared with average water level in spring 1985-87.

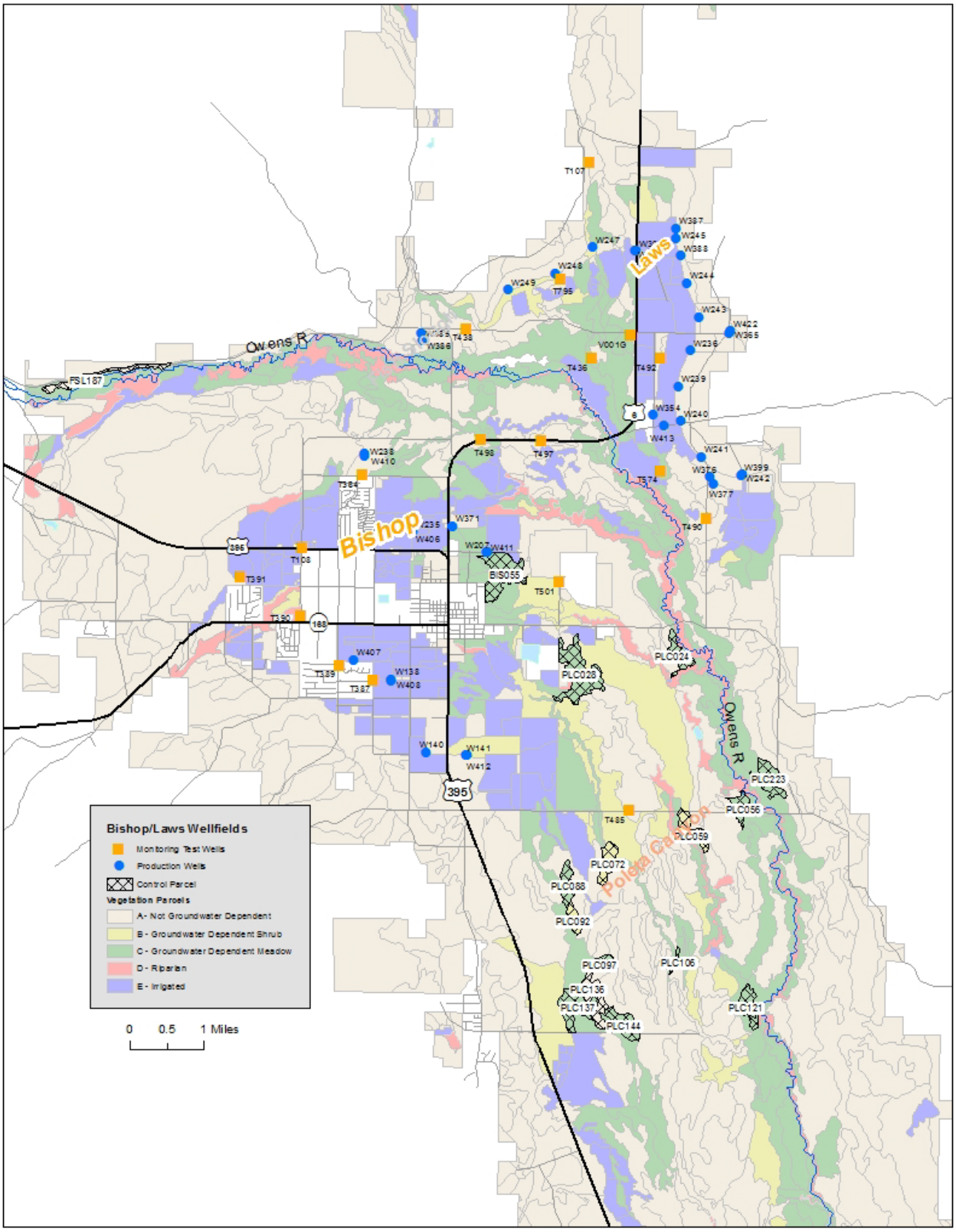

Figure 7. Map of monitoring wells and LADWP production wells in Laws and Bishop wellfields.

Laws Wellfield

In the 1970's and 80's, pumping along with irrigation and spreading from the Owens River via the McNally canals in Laws varied greatly from year-to-year, causing large fluctuations in the water table (Figures 8 and 9).

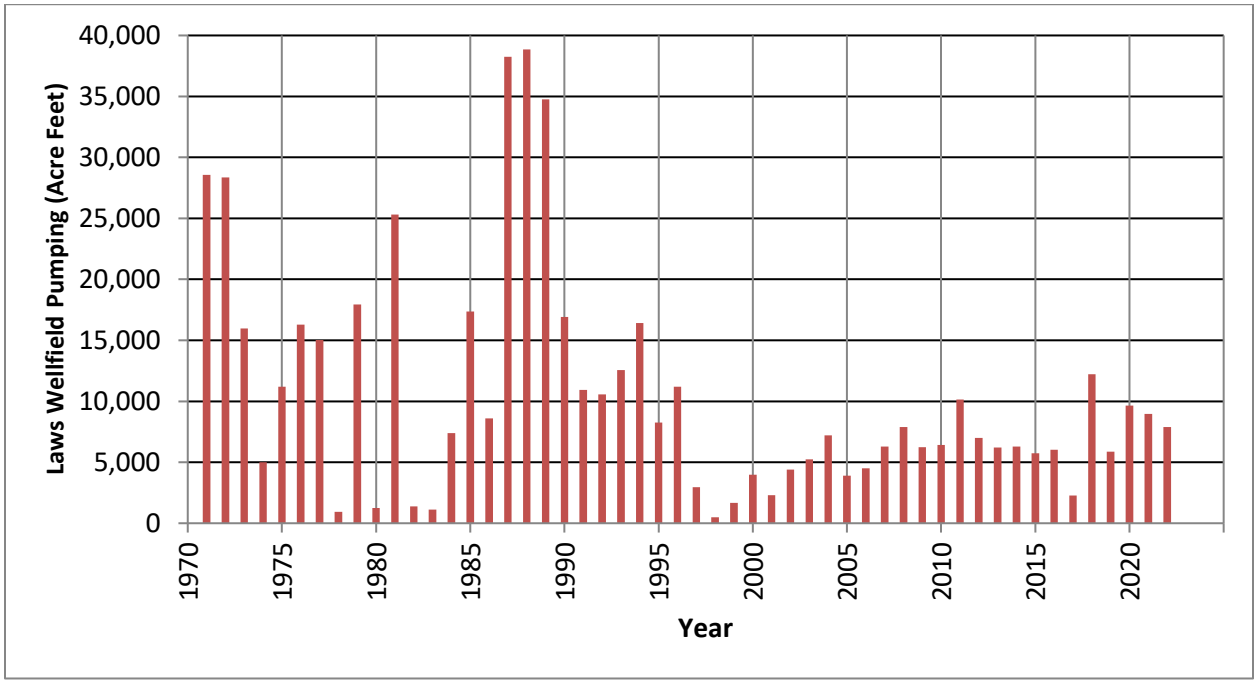

Figure 8. Pumping totals for the Laws wellfield.

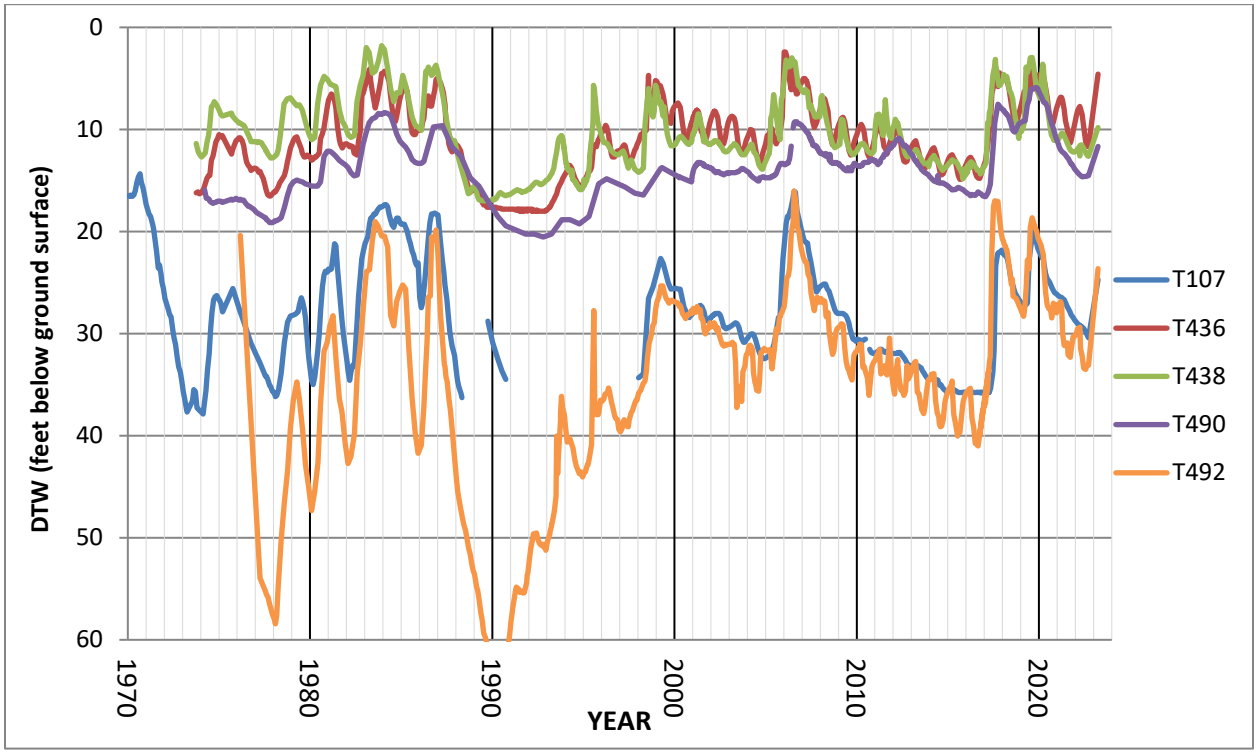

Figure 9. Hydrographs of Indicator wells in the Laws wellfield. Well T492 is dry if DTW is below 60 ft, and well T107 is dry if DTW is below 37 feet.

This was especially true for T107 and T492 due to their proximity to the McNally canals and LADWP pumping wells. Heavy pumping and low recharge in the late 1980's caused severe groundwater level decline in Laws. Under the Water Agreement, pumping has remained considerably below the maximum wellfield capacity. As a result, water levels rose, and beginning in 2000, water table fluctuations have been largely driven by pumping for local uses in the surrounding area and by water spreading following heavy snow winters (2005, 2006, 2011, 2017, 2019). In 2022-23, groundwater levels increased in all Indicator wells and four of the nine Indicator wells are below baseline as of April 2023 (Table 2).

Bishop Wellfield

Groundwater pumping in the Bishop wellfield is managed differently than other wellfields due to additional legal requirements governing LADWP operations. The environmental protections and goals of the Water Agreement still apply, however. The Water Agreement requires ICWD and Los Angeles to prepare an annual audit of pumping and uses on the Bishop Cone to demonstrate compliance with the Hillside Decree (the Decree itself does not contain audit procedures). The Hillside Decree is a 1940 Inyo County Superior Court stipulation and order under which LADWP groundwater extractions from both pumped and uncapped flowing wells cannot exceed the annual amount of water used on LADWP-owned land on the Bishop Cone.

The most recent Bishop Cone Audit examined conditions for the 2022-23 runoff year. Total LADWP groundwater extraction (pumping and flowing wells) on the Bishop Cone was 14,453 ac-ft compared with 27,339 ac-ft of recorded uses. Therefore, uses on the Bishop Cone exceeded extractions by approximately 12,886 ac-ft. If extractions had exceeded the amount of recorded uses, all groundwater could not have been used on the Bishop Cone and LADWP would be out of compliance with the Hillside Decree. This has not occurred since the audit procedures were implemented as part of the Water Agreement. See Section V for a review of the 2022-23 runoff year Bishop Cone Audit.

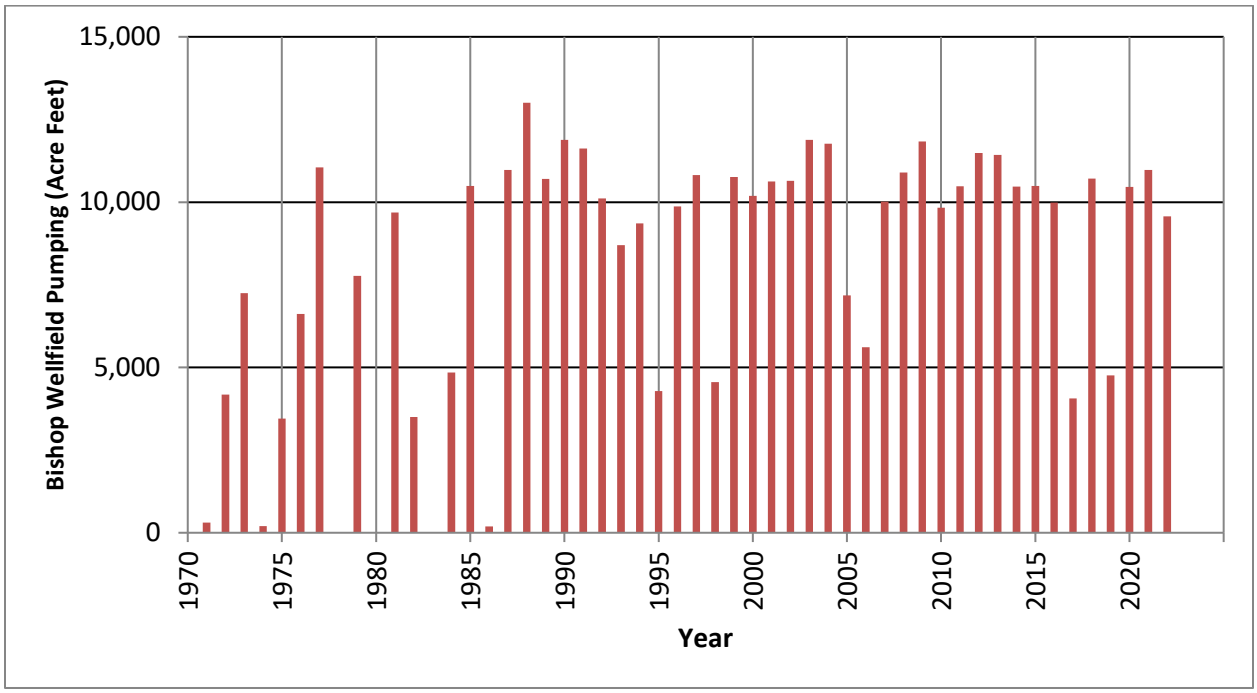

Figure 10. Pumping totals for the Bishop wellfield.

Pumping in the Bishop wellfield has been relatively constant for the past 25 years except in above-normal runoff years when pumping decreased, for example 1998, 2006, 2017, and 2019 (Figure 10). Because of the Hillside Decree and relatively constant pumping, ICWD does not routinely use Indicator wells to analyze LADWP's annual operations plan for this wellfield. Water levels in west Bishop typically peak after the summer irrigation season. Groundwater levels from 1980 to 2023 at several test wells located west, north, and east of the city of Bishop are presented in Figures 11.a-c. Constant pumping and consistent recharge from irrigation has historically resulted in relatively stable water levels in the Bishop wellfield. However, the effects of the 2012-2016 drought (e.g., Figure 11.a) and the recent 2020-2022 drought (e.g., Figure 11.b) can be seen in the groundwater levels from Bishop Cone wells.

It is likely that a combination of diminished surface water flows caused by the 2012-2016 drought and the change in Bishop Creek surface flows negatively affected shallow groundwater levels in west Bishop from fall of 2013 through the winter of 2014. Groundwater levels dropped precipitously, in some cases to their lowest recorded levels. Several domestic wells went dry. Hydrographs of these groundwater declines can be seen in Figure 12. The declining groundwater levels prompted both ICWD and LADWP to increase the frequency of their monitoring on the western half of the Bishop Cone in order to more fully understand the changes in groundwater levels during the prolonged drought.

Groundwater levels recovered from the low water tables of 2013-14. During this recovery, several residents of west Bishop noticed extremely shallow or perched water at their properties. It is theorized that once creek and ditch flows returned to the area in 2014, increased seepage of surface water led to the oversaturation of the near surface sediments. Additional investigations were conducted in 2016, including a report issued by the Department of Water Resources.

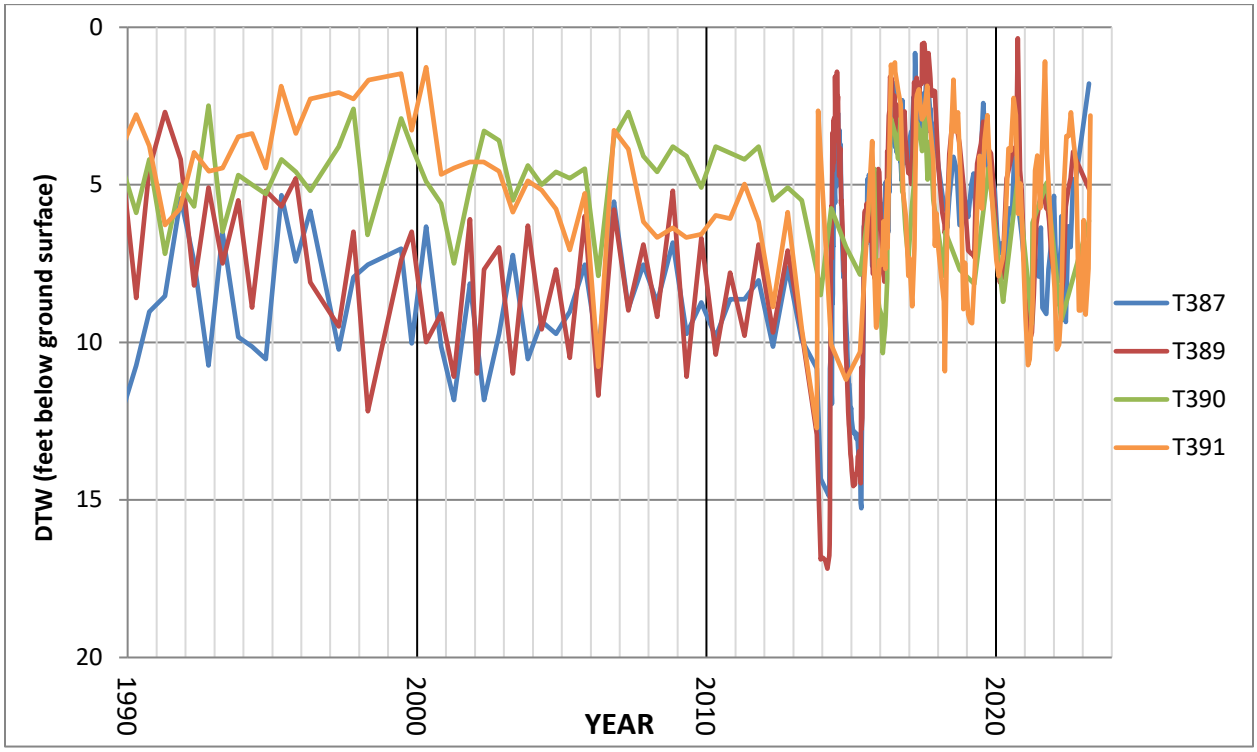

Figure 11.a. Hydrographs of selected monitoring wells in the western Bishop wellfield. Locations of the wells are shown in Figure 7.

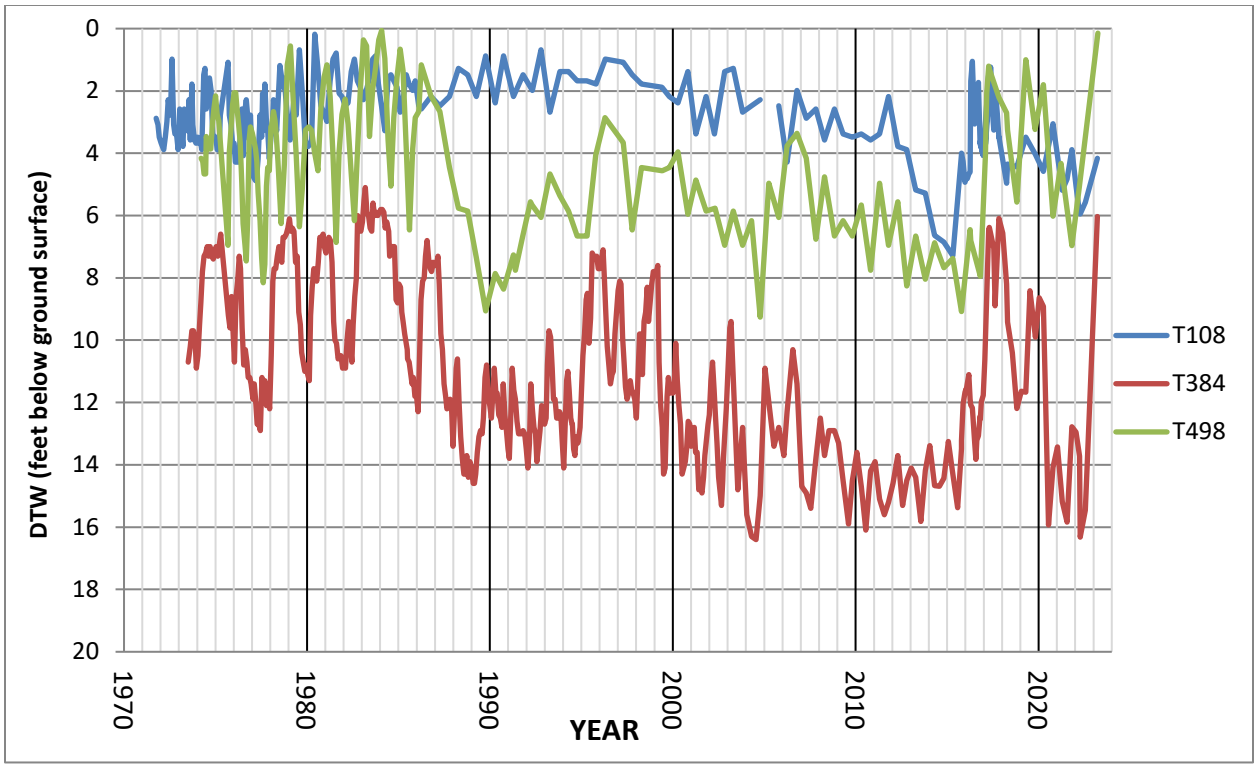

Figure 11.b. Hydrographs of selected monitoring wells in the northern Bishop wellfield. Locations of the wells are shown in Figure 7.

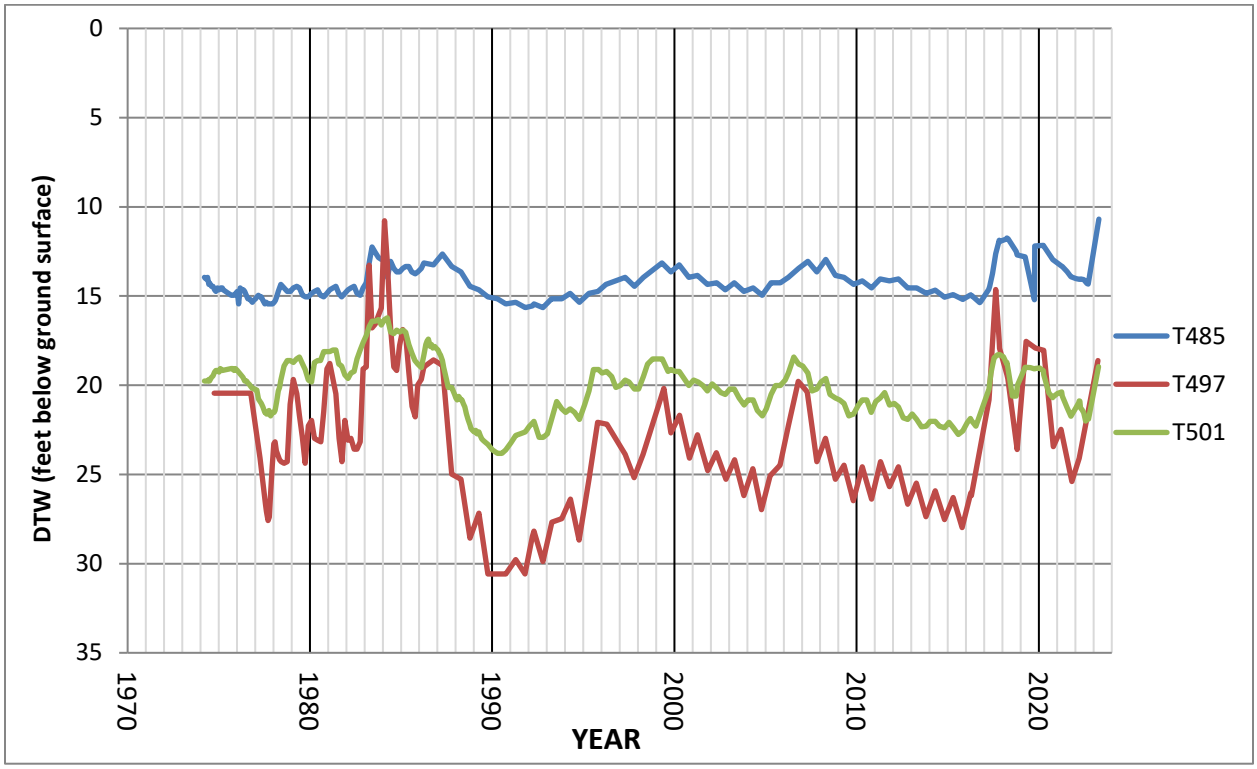

Figure 11.c. Hydrographs of selected monitoring wells in the eastern Bishop wellfield. Locations of the wells are shown in Figure 7.

After the summer/fall of 2017, fewer problems with shallow groundwater have been reported, and it is probable that the natural sealing caused by decaying biomass in ditches and ponds has led to a decrease in the 2014-15 seepage rates, lowering seepage back to their pre-2014 rates; and that the west Bishop hydrologic system has reverted to its historic equilibrium. Due to another significant winter, the 2019-20 flows in Bishop Creek significantly exceeded both the Chandler Decree minimums and also long-term averages, but no flooding problems were reported.

For 2022-23, snowpack in the Bishop Creek drainage was approximately 43% of average; for 2023-24 snow pack was 299% of the April 1 average. Creek flows are expected to be well-above long-term averages and are expected to exceed the primary Chandler flows for the 2023-24 season. Instead, it is likely that Bishop Creek flows will satisfy the drought provisions of the Chandler Decree with inflows to the reservoirs equal to outflows for much of the summer irrigation season. Groundwater levels in spring 2022, however, were still above lows seen in 2013-14 in part because flows in Bishop Creek during winter 2021-22 were at levels that allowed ditches to remain active.

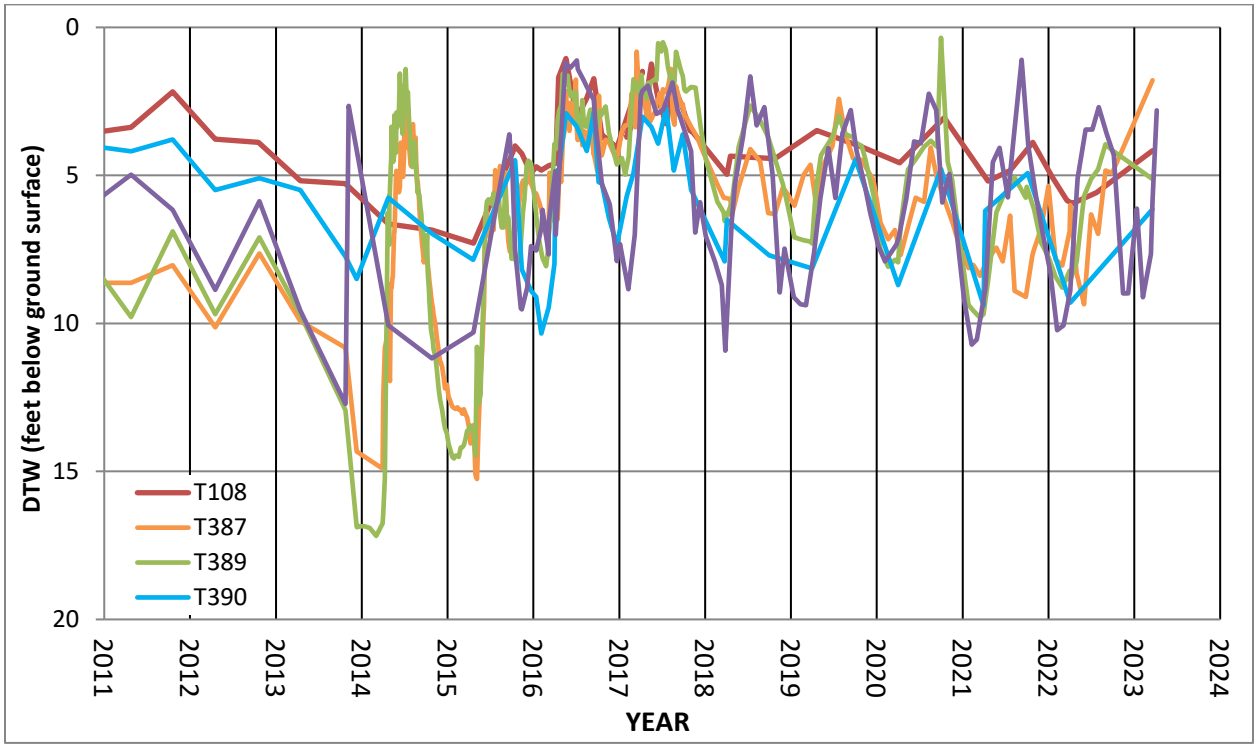

Figure 12. Recent hydrographs of selected monitoring wells in western Bishop wellfield. Locations of the wells are shown in Figure 7.

Important observations from recent Bishop Cone conditions:

- Surface water flows play an integral role in recharging shallow groundwater levels in west Bishop; and the interaction between surface water and groundwater recharge is very sensitive to changes in equilibrium conditions
- Semiannual monitoring in spring and fall does not capture the full range of groundwater fluctuations in the Bishop area
- Water management of Bishop Creek flows and the associated diversion and ditch flows should maintain some flow in area ditches during drought and/or low runoff years

- In west Bishop there is a delicate balance between enough surface water seepage to recharge area groundwater and too much seepage to overwhelm infiltration rates, leading to undesirable consequences to landowners from extremely shallow or perched water levels
- Many of the private wells in west Bishop are shallow and are, therefore, more vulnerable to impacts associated with lowered groundwater levels
- Conservative pumping practices should be used on LADWP wells W407 and W408 during drought and/or low runoff years
- Information gathered in west Bishop during the past several years should be taken into consideration in regard to LADWP's potential new wells at sites B2 and B5.

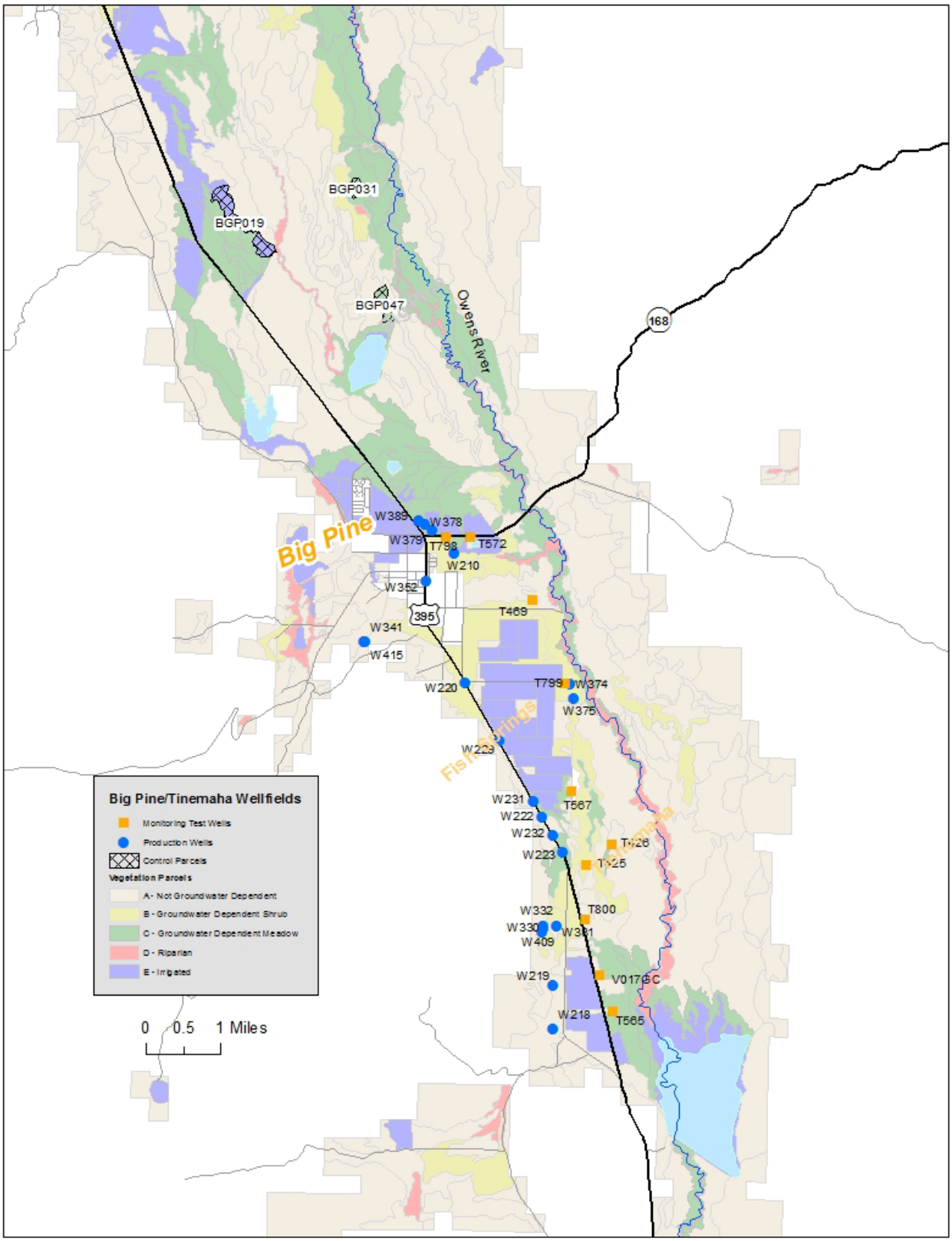

Figure 13. Map of monitoring wells and LADWP production wells in Big Pine wellfield.

Big Pine Wellfield

Since 1974, pumping in the Big Pine wellfield (Figure 13) has been consistently higher than other wellfields (Figure 14). Minimum pumping to supply uses in this wellfield include the Fish Springs Hatchery (approximately 20,000 ac-ft per year), Big Pine town supply (500 ac-ft per year), and the Big Pine northeast re-greening Project (100 ac-ft per year). Pumping under the Water Agreement has largely been to supply these uses. It should be noted that most of the hatchery pumped water also reaches the aqueduct.

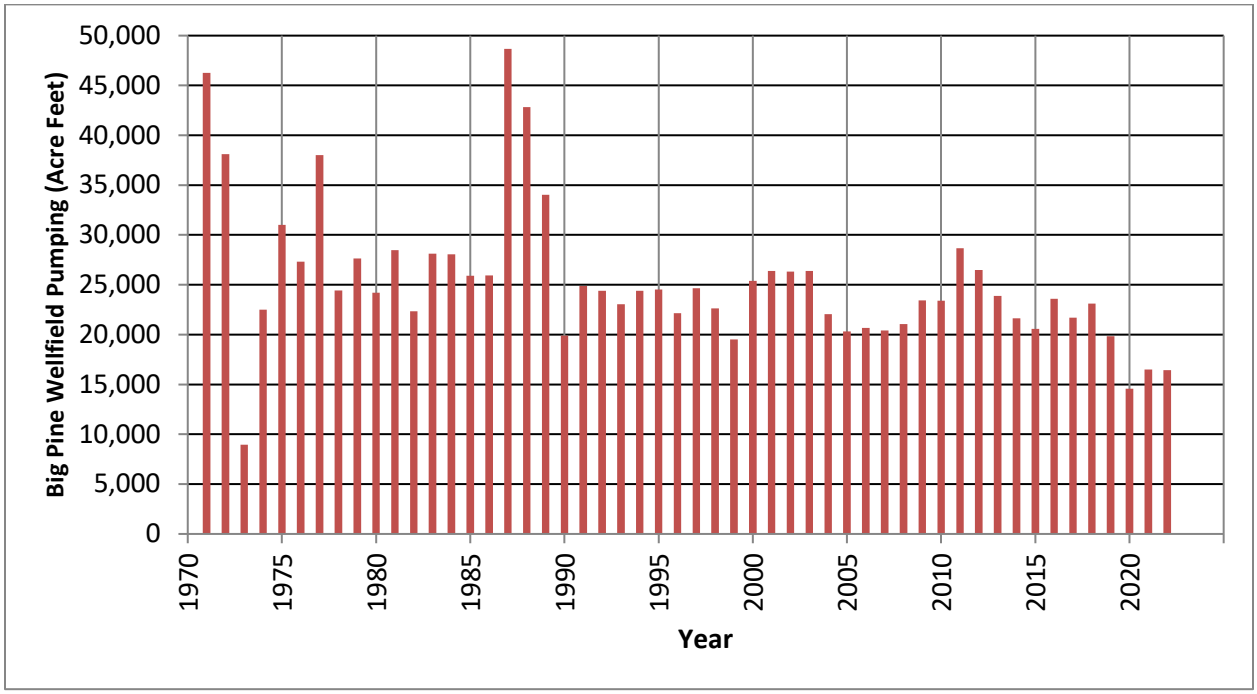

Figure 14. Pumping totals for the Big Pine wellfield.

Groundwater levels declined in one of the eight Big Pine Indicator and monitoring site wells in 2022-23 (Figure 15 and Table 2). Two of the eight monitoring wells are above baseline levels as of April 2023 with the Big Pine average at 1.9 feet above baseline. In addition to the Indicator wells, ICWD also examines two test wells located just east of U.S. 395 near W218 and W219 to assess possible impacts from the additional export pumping during extended droughts (Figure 16). Both V017GC and T565 are located in or adjacent to groundwater dependent vegetation. Water levels declined in response to drought and pumping from 2012 to 2016. In 2017, 2019, and 2023, LADWP actively spread water into the Big Pine wellfield, notably south of town along the Red Mountain cinder cone. Both V017GC and T565 have recovered significantly since 2017 and also remained above baseline levels as of April 2023.

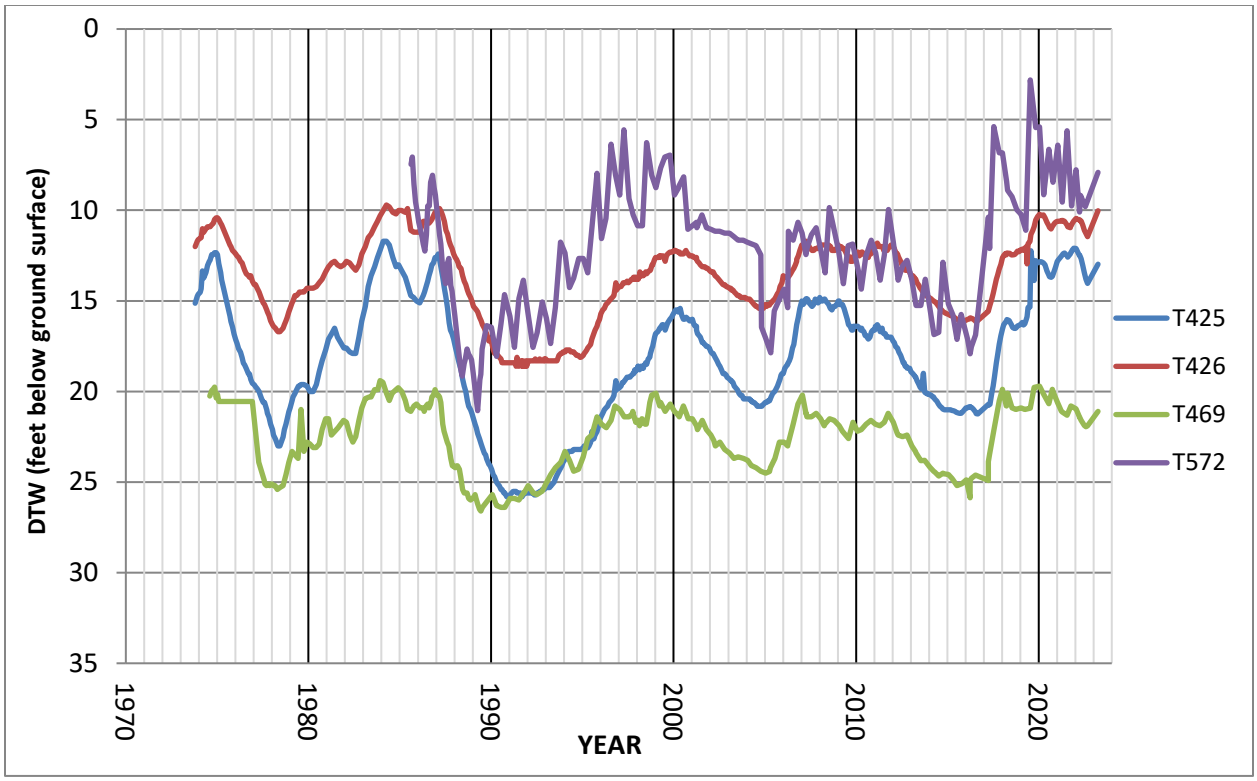

Figure 15. Hydrographs of Indicator wells in the Big Pine wellfield. Periods of missing data for T572 occurred when the well was plugged and in need of repair.

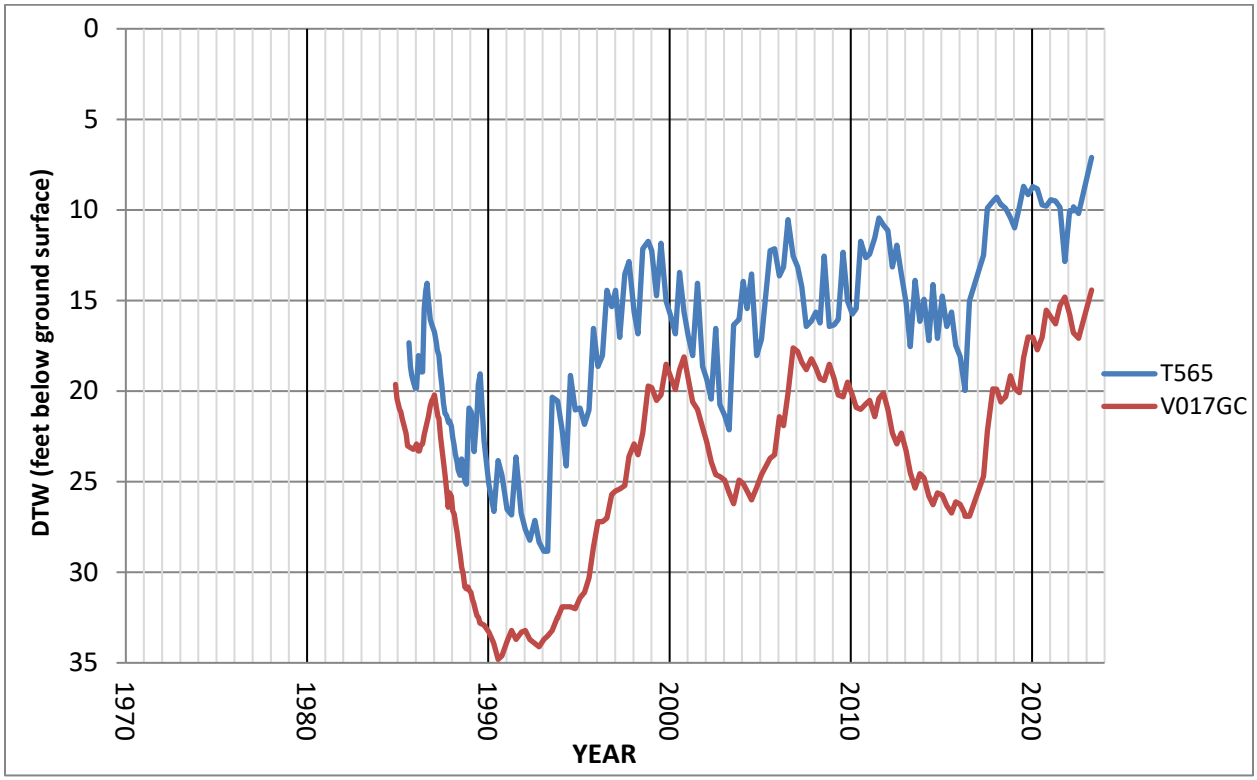

Figure 16. Hydrographs of monitoring wells in the southern Big Pine wellfield near pumping wells W218 and W219.

In 2020, a bacterial infection at the Fish Springs Fish Hatchery resulted in Department of Fish and Wildlife drying and then disinfecting the hatchery over a several month period. Fry were reintroduced in a portion of the hatchery in spring 2021. Pumping for the hatchery was, therefore, reduced for both runoff years, especially during the August through December 2020 period. ICWD is currently in discussion with DFW and LADWP staff to explore potential opportunities to increase water-use efficiency at the Fish Springs Hatchery with the goal of reducing annual pumping amounts.

To track the groundwater response to the reduced hatchery pumping stress, ICWD staff increased groundwater monitoring frequency in 2020 and 2021 with additional focus on wells completed in the volcanic basalt cinders which comprise a deeper hydro-stratigraphic unit that the hatchery wells primarily source water from ("T and V" series wells with total depths in the 100-300 foot range). In the southern half of the Big Pine wellfield, groundwater levels in these V wells recovered between eight and nine feet in this unit. The recovery was less notable in the more distant northern portion of the wellfield where additional hydrologic influences from fall through winter include declining seasonal flows in the Big Pine Creek, Big Pine Canal, and the Big Pine ditch systems. Recovery was also less discernible (less than 2 feet) in the shallower "T" wells screened primarily in the water table aquifer and not in the volcanic cinders. In addition to pumping stress, these shallow monitoring wells are also influenced by evapotranspiration demand, sub-irrigation from nearby fields and pastures, Owens River stage, and reduced runoff in the below-average 2020-22 years. A summary power-point (Director's Report) was presented at the March 31, 2021, Water Commission meeting; it can be found online at:
https://www.inyowater.org/meetings/water-commission/water-commission-meetings/

LADWP decommissioned W341, located west of Big Pine, and replaced its pumping with adjacent well W415 for Big Pine town water system supply. W415 has additional capacity as compared to W341 of approximately one cfs. On May 6, 2020, the Inyo/Los Angeles Technical Group approved test procedures for the initial period of operation of W415 at pumping amounts above the exemption for town supply that would be consistent with Green Book Section VI strictures and consistent with the LTWA, as amended in 2002, which committed LADWP to provide both surface and pumped groundwater for the Big Pine Irrigation and Improvement Association (BPIIA) ditch system. The W415 test of its additional capacity for use in the Big Pine ditch system has not commenced, but the hydrologic and vegetation monitoring program is in place. The *Proposed 6-month Operational Test of W415* report can be found online among the meeting materials for the May 6, 2020, Inyo/Los Angeles Technical Group meeting at:
https://www.inyowater.org/meetings/inyola-technical-group/inyola-technical-group-meetings/

Additionally, in an exchange of letters in 2020, Inyo and Los Angeles concurred that water exiting the Big Pine Community Service District into Big Pine Creek would be considered pumped make-up water for the BPIIA and issued as a credit.

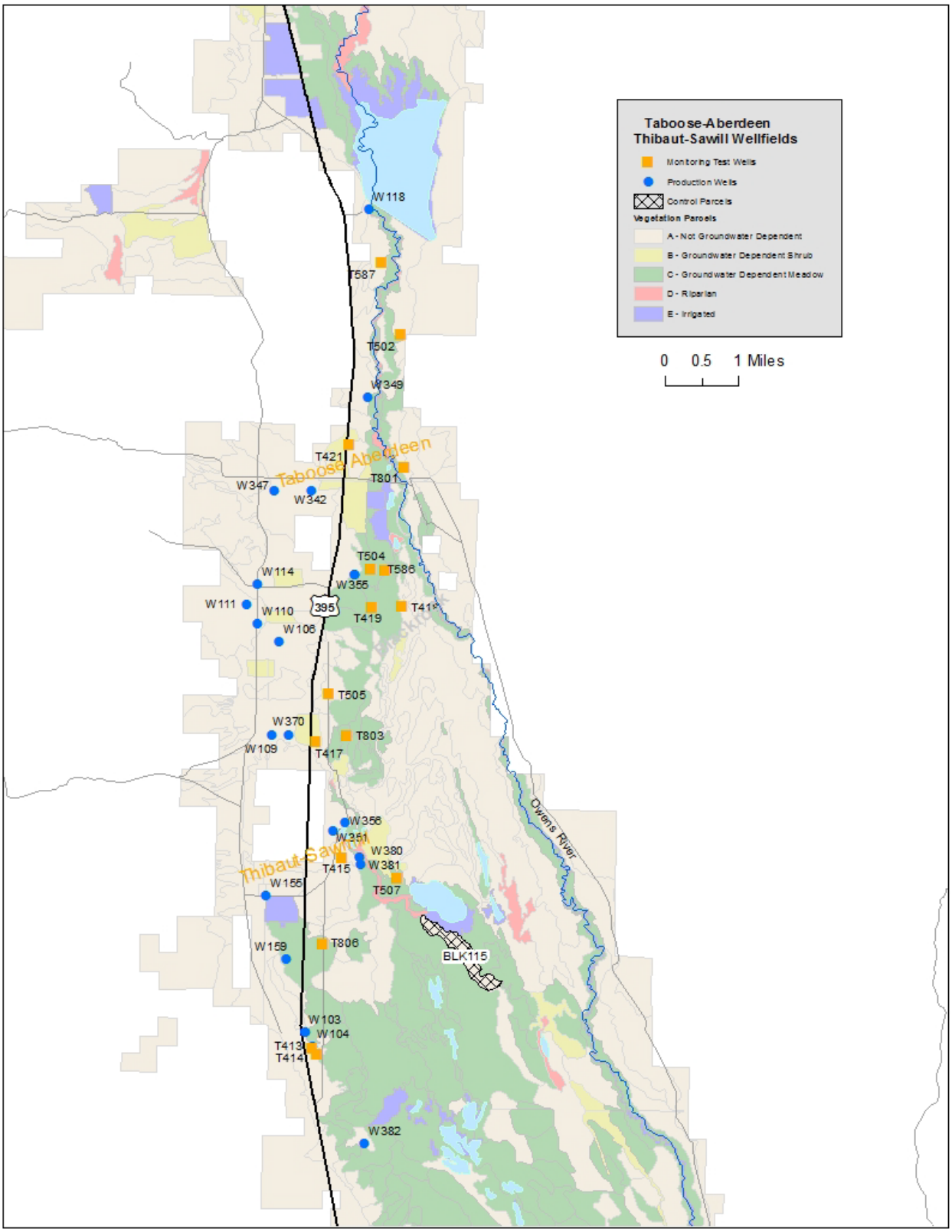

Figure 17. Map of monitoring and LADWP production wells in the Taboose-Aberdeen and Thibaut-Sawmill wellfields.

Taboose-Aberdeen Wellfield

Under the LTWA, pumping in the Taboose-Aberdeen wellfield (Figure 17) has remained much below the wellfield capacity (Figure 18). Minimum pumping for this wellfield is approximately 300 ac-ft to supply two mitigation projects at Big Seeley and Hines Springs, but nearly all of the pumping since 2010 has been for aqueduct supply. In April 2020, groundwater levels were above baseline levels in all but the two northern monitoring wells (T587 and T801). LADWP pumped more than 15,000 ac-ft of water from the wellfield in 2020-21 (the most pumping since 1989), and groundwater levels declined in all 10 Indicator wells by an average of -3.2 feet (Table 2). This past year, LADWP's pumping was 13,835 ac-ft but groundwater levels were relatively stable or increased slightly due to the record wet 2023 winter. As of April 2023, groundwater levels in the 10 Indicator wells varied between 1.9 feet above to -3.5 feet below baseline, and the wellfield average was -0.5 feet below baseline. Groundwater levels remain above lows seen in the 2012-16 drought.

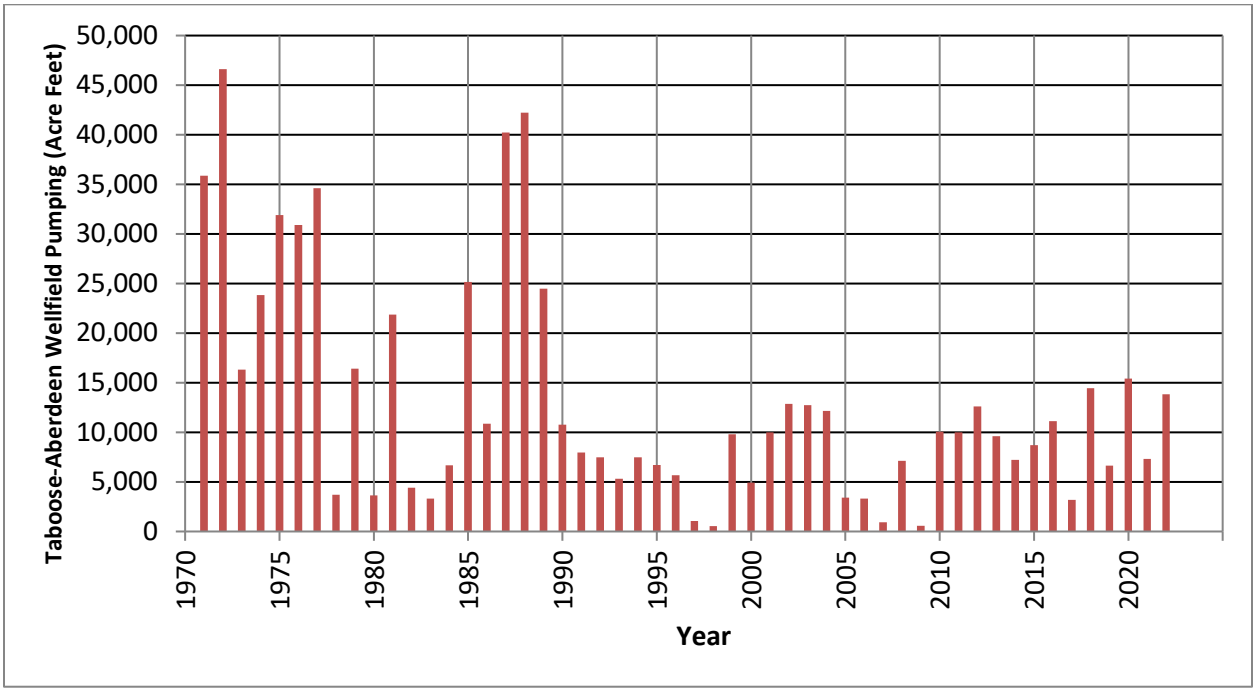

Figure 18. Pumping totals for the Taboose-Aberdeen wellfield.

Hydrographs for the Indicator wells exhibit similar response to fluctuations in pumping and runoff (Figures 19 and 20). Most of the recent pumping has been from well W349 and W118 located in the northern portion of the wellfield. Wells W349 and W118 pumped consistently from 2011 to 2016, were off for the majority of the 2017-18 runoff year, but resumed pumping in 2018. Data from monitoring well T587 (a non-Indicator well) are included because it is located adjacent to groundwater dependent vegetation near W118 and W349 and is used to assess the impacts of recent pumping.

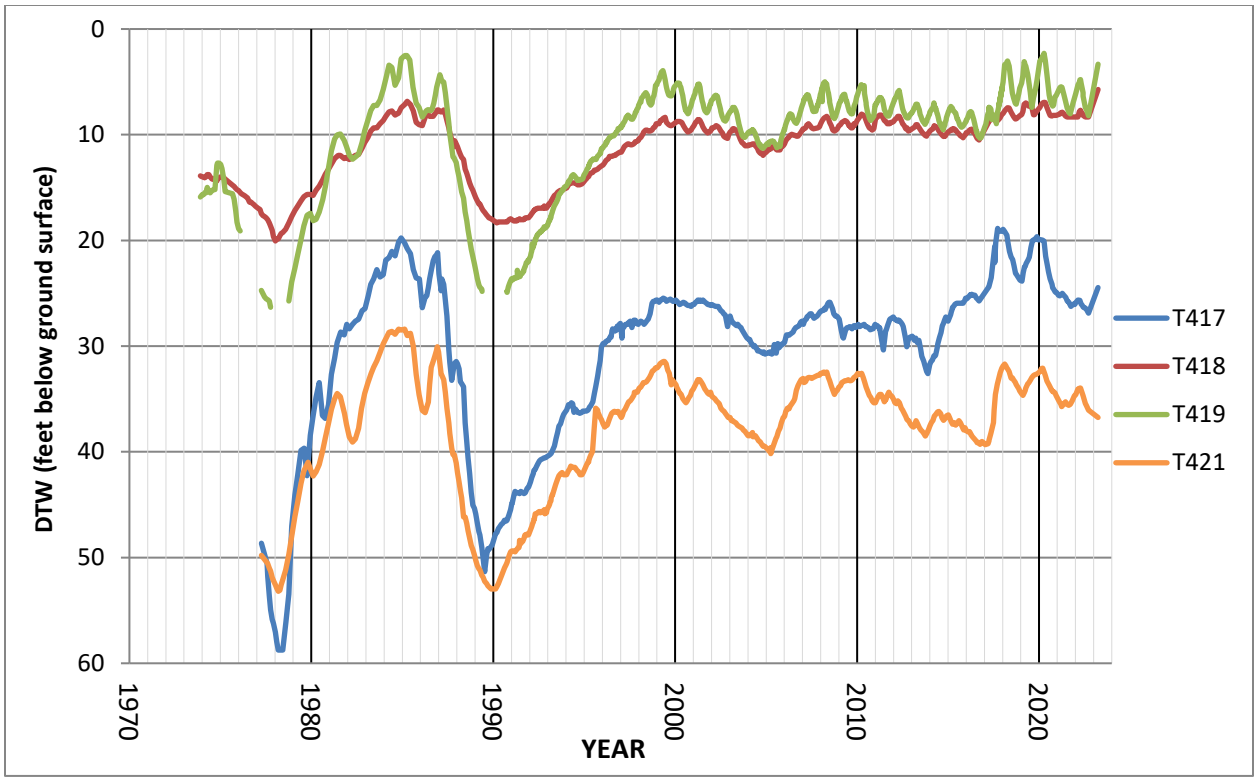

Figure 19. Hydrographs of Indicator wells in the Taboose-Aberdeen wellfield. Periods of missing data denote when the test well was dry.

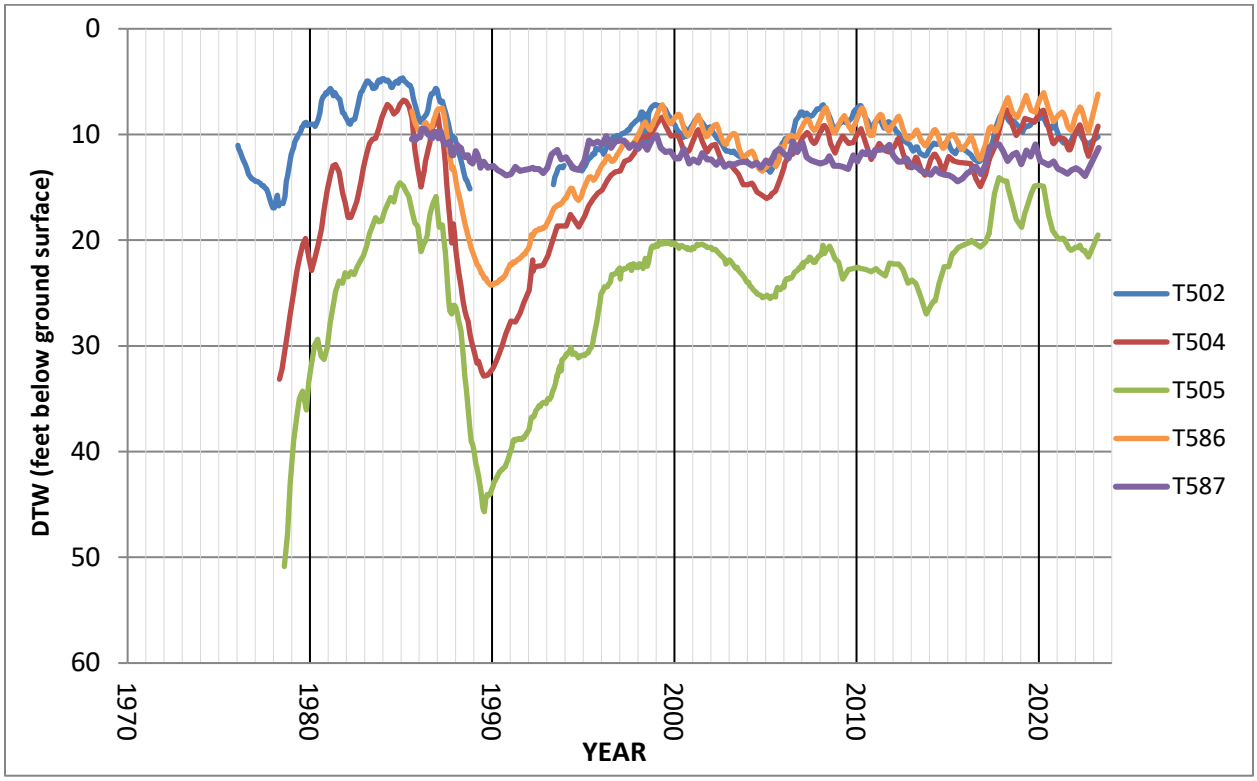

Figure 20. Hydrographs of Indicator wells and T587 in the Taboose-Aberdeen wellfield. Periods of missing data denote when the test well was dry.

Thibaut-Sawmill Wellfield

Historically, most pumping in the Thibaut-Sawmill wellfield has been to supply approximately 12,200 ac-ft annually to the Blackrock Fish Hatchery (Figure 21). In 2014, Inyo and Los Angeles agreed to reduce hatchery pumping to approximately 8,300 ac-ft as part of the settlement to the Blackrock 94 dispute.

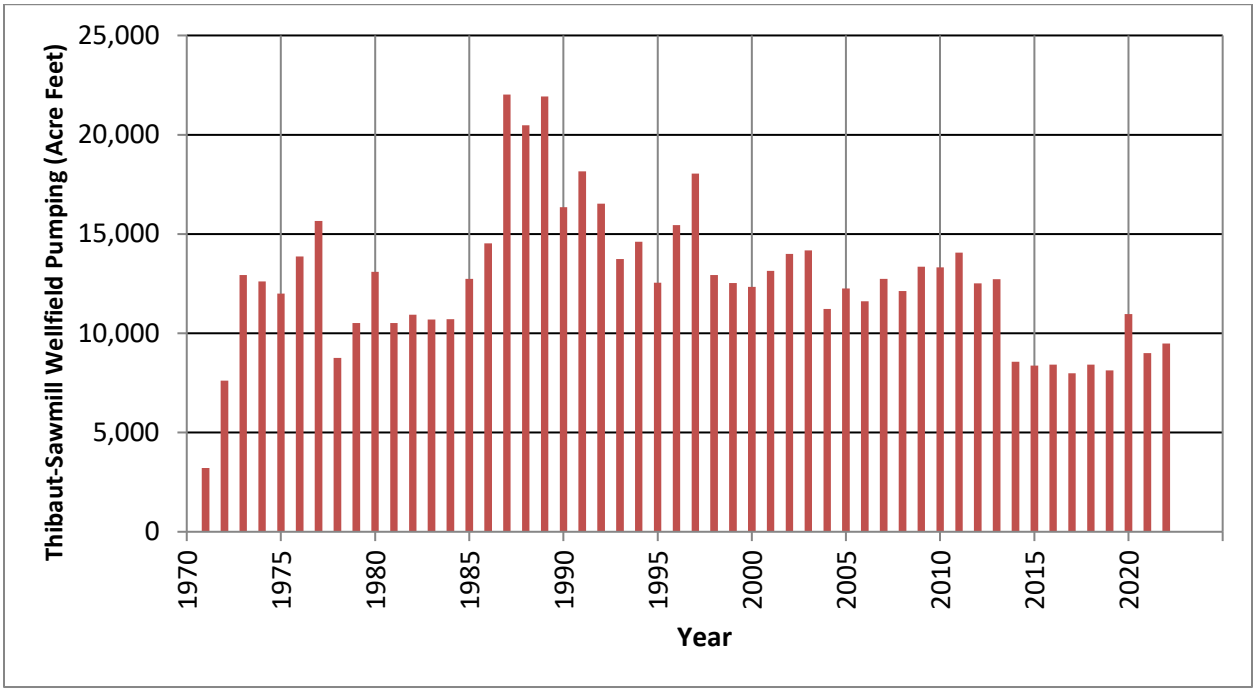

Figure 21. Pumping totals for the Thibaut-Sawmill wellfield.

Hydrographs of five test wells used to track water levels in Thibaut-Sawmill have exhibited different responses due to local water management within the wellfield (Figure 22). Wells T415, T507, and T806, responding to reduced hatchery pumping, exhibited a rising trend from 2014-2017 and are all above baseline levels. Over the past decade, the groundwater level at T507 has also responded to seasonal flooding associated with the Blackrock Waterfowl Management Area. In 2022-23, groundwater levels in these three Indicator wells increased between 1.6 and 4.1 feet from the previous year (Table 2) due to a record wet 2023 winter. All three Indicator wells are above baseline level.

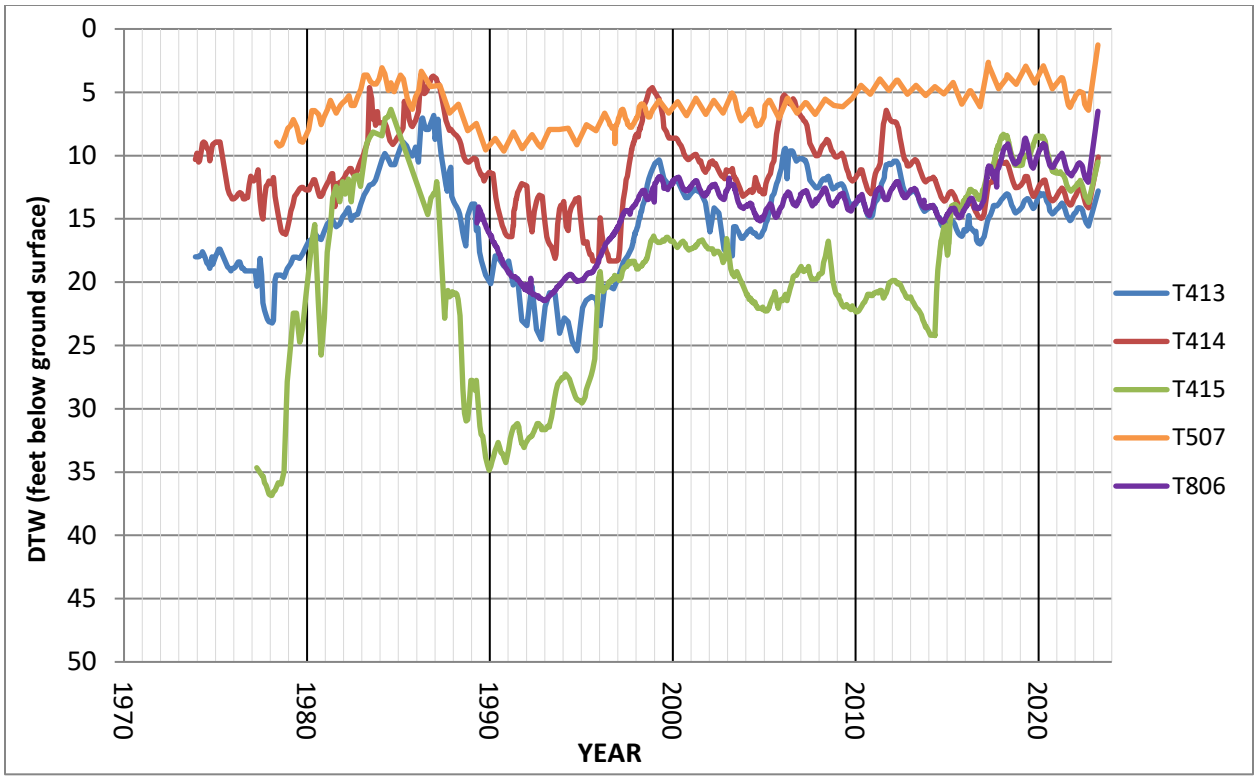

Figure 22. Hydrographs of selected test wells in the Thibaut-Sawmill wellfield.

Wells T413 and T414 are located in the southern portion of the wellfield and recovered several feet since the end of the recent drought. However, the reduction in the hatchery pumping is not nearly as evident in these wells. Despite the combination of lower runoff and increased pumping in the Thibaut-Sawmill wellfield in recent years, the record wet 2023 winter has led to 2022-23 increases in these wells. Both monitoring wells remain below their baseline levels.

Two parcels, IND026 and IND029, in the southern portion of this wellfield have chronically depressed water levels and grass cover. ICWD staff have recommended to LADWP that W382 not be pumped in order to recover water levels in the Thibaut Springs area.

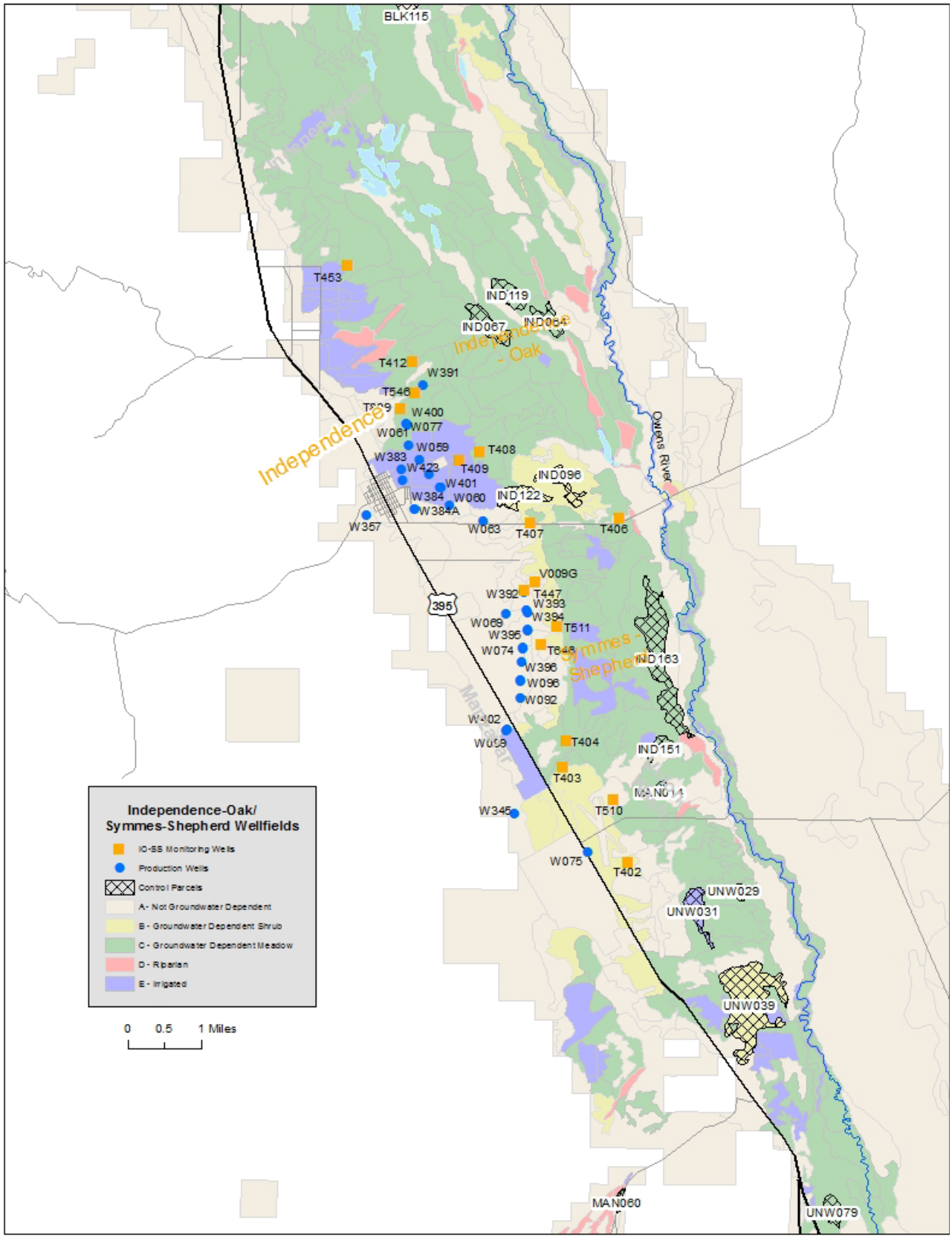

Figure 23. Map of monitoring and LADWP production wells in the Independence-Oak and Symmes-Shepherd wellfields.

Independence-Oak Wellfield

Pumping in this wellfield (Figure 23) is required to supply approximately 6,500 ac-ft annually for irrigation projects surrounding Independence and for town supply (Figure 24). LADWP pumped between 8,600-9,600 ac-ft from 2011 through 2016; however, with heavy 2017-18 and 2019-20 runoff, this wellfield was pumped less (approximately 7,800 ac-ft for the 2017-19 three-year average). This past year, LADWP's pumping was 5,631 ac-ft, primarily for irrigation.

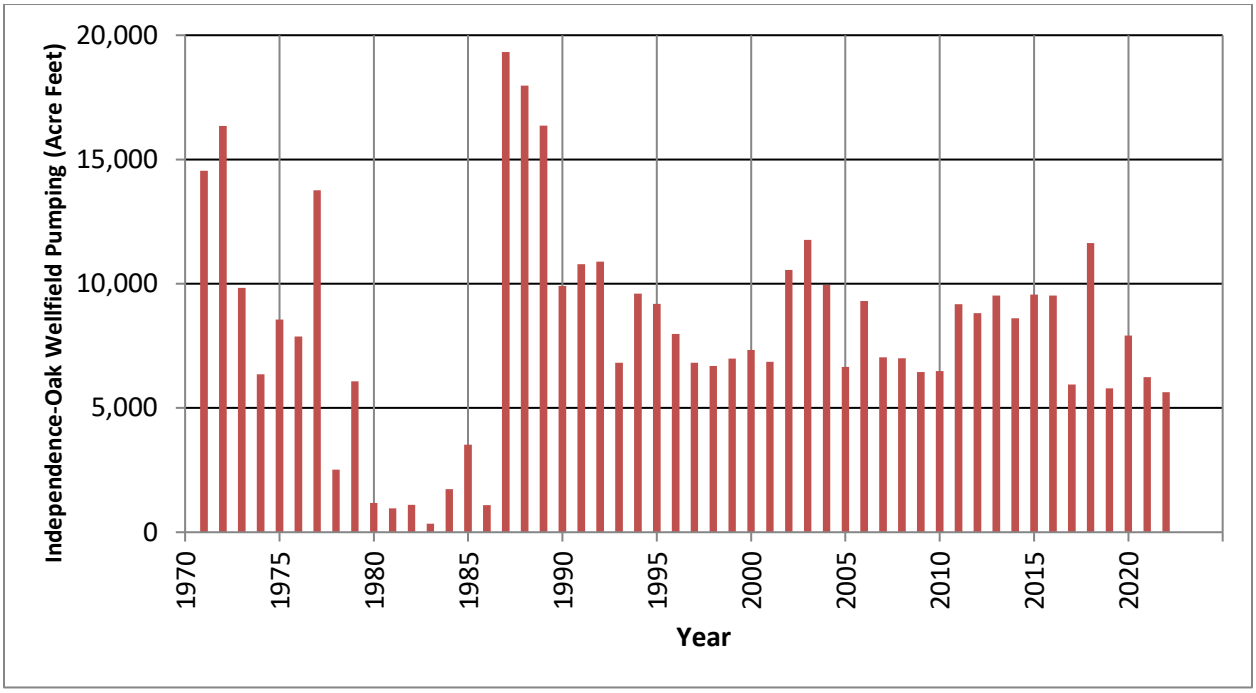

Figure 24. Pumping totals for the Independence-Oak wellfield.

Water levels were stable through the first decade of 2000 in the wells located in the center of the wellfield (T406, T407, T408, T409), but declined in response to the increased pumping during the second decade of 2000. However, in 2017 and 2019, the combination of reduced pumping for export and increased recharge from heavy runoff allowed water levels to rebound somewhat. As a result of lower runoff during the recent three-year drought (i.e., 2020-2022) and additional pumping for export in 2020-21, groundwater levels generally trended downward (Table 2, Figures 25 and 26). The record wet 2023 winter with corresponding lower pumping contributed to increases in groundwater levels in all six Indicator wells (wellfield average of 2.2 ft).

Four of the six Indicator wells in the Independence-Oak wellfield were below baseline in April 2023, ranging 0.5 feet above to -5.2 feet below, and the wellfield average was -2.1 feet below baseline (Table 2). Some of these declines from baseline are due to the additional irrigation associated with the Independence pasture, spring-field, and re-greening projects which were implemented after the mid-1980s and, although groundwater levels have declined in many of these wells, the majority are located in Type-E irrigated pastures. However, due to persistent declines in groundwater levels compared with the baseline period along the perimeter of the irrigated pasture lands (T546, T809, T407) ICWD staff has recommended that LADWP pumping for export be minimized in this wellfield, especially during severe droughts like the recent one.

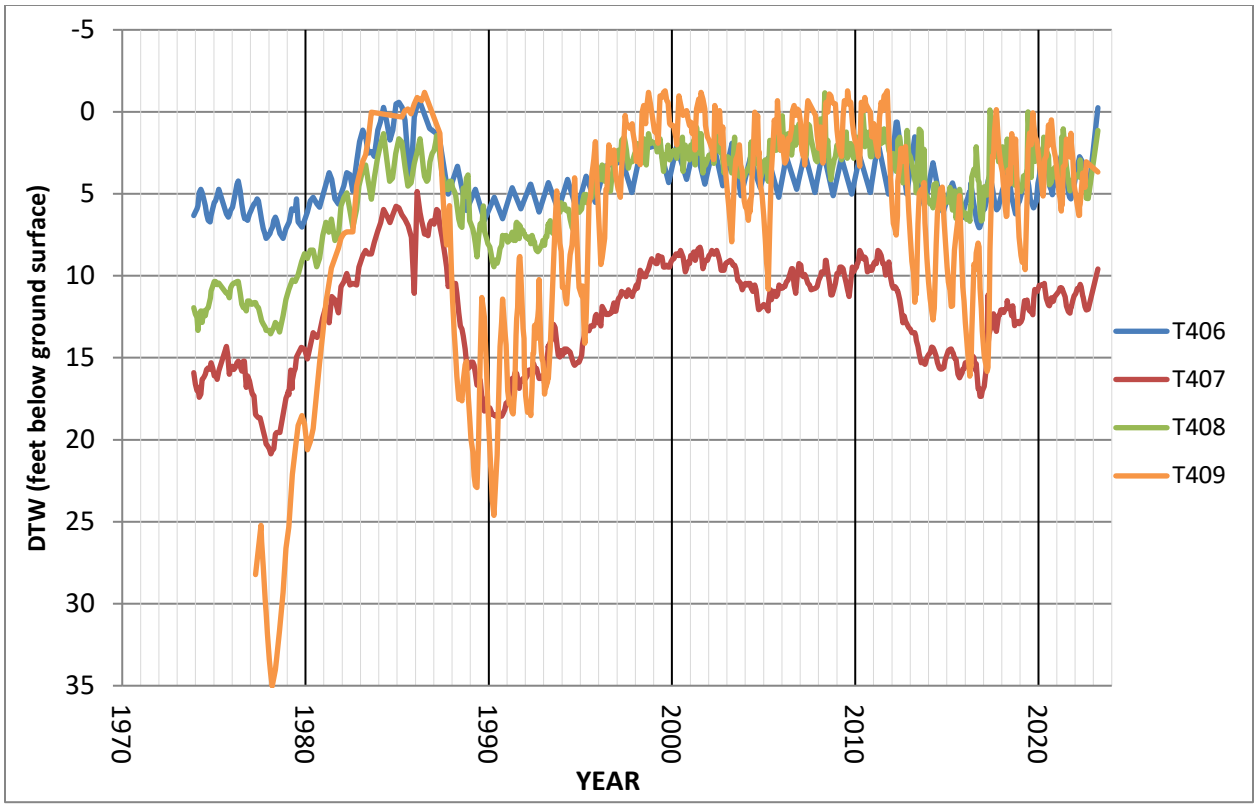

Figure 25. Hydrographs of selected test wells in the Independence-Oak wellfield.

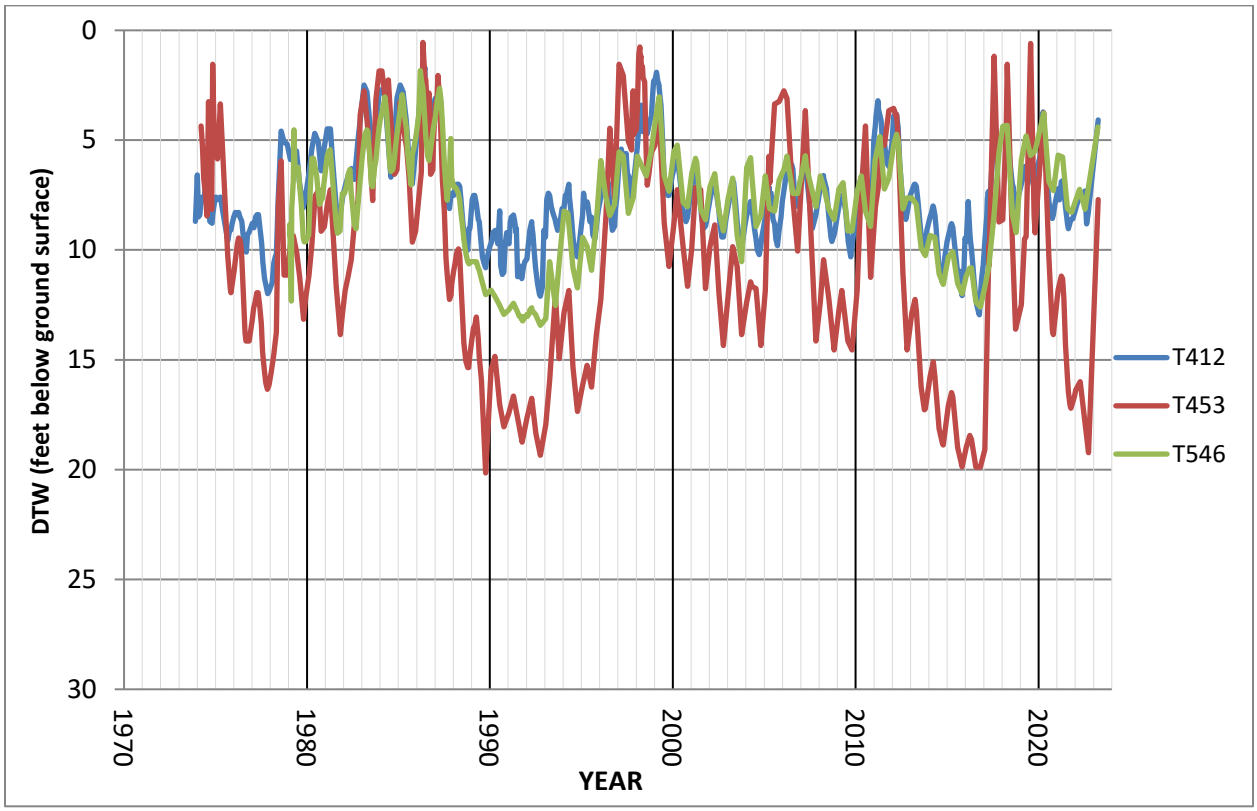

Figure 26. Hydrographs of selected test wells in the Independence-Oak wellfield.

Symmes-Shepherd Wellfield

In the 1970's and 80's, pumping in the Symmes-Shepherd wellfield (Figure 23) varied considerably (Figure 27). Under the Water Agreement, pumping was reduced with many of the wells linked to Green Book OFF status permanent monitoring sites (see Section II.b). Approximately 1,200 ac-ft of exempt-status pumping is required to supply one mitigation project (W402 for Shepherd Creek Alfalfa Field). However, pumping for aqueduct supply increased from 2010 to 2016, primarily in the northern part of the wellfield as one of the On/Off sites remained ON during much of that drought. All wells other than W402 did not pump from 2017 through 2020. As of April 2021, On/Off site SS3 went into On-status and has remained in On-Status. According to available records, LADWP pumped a limited amount of water from W396 this past year.

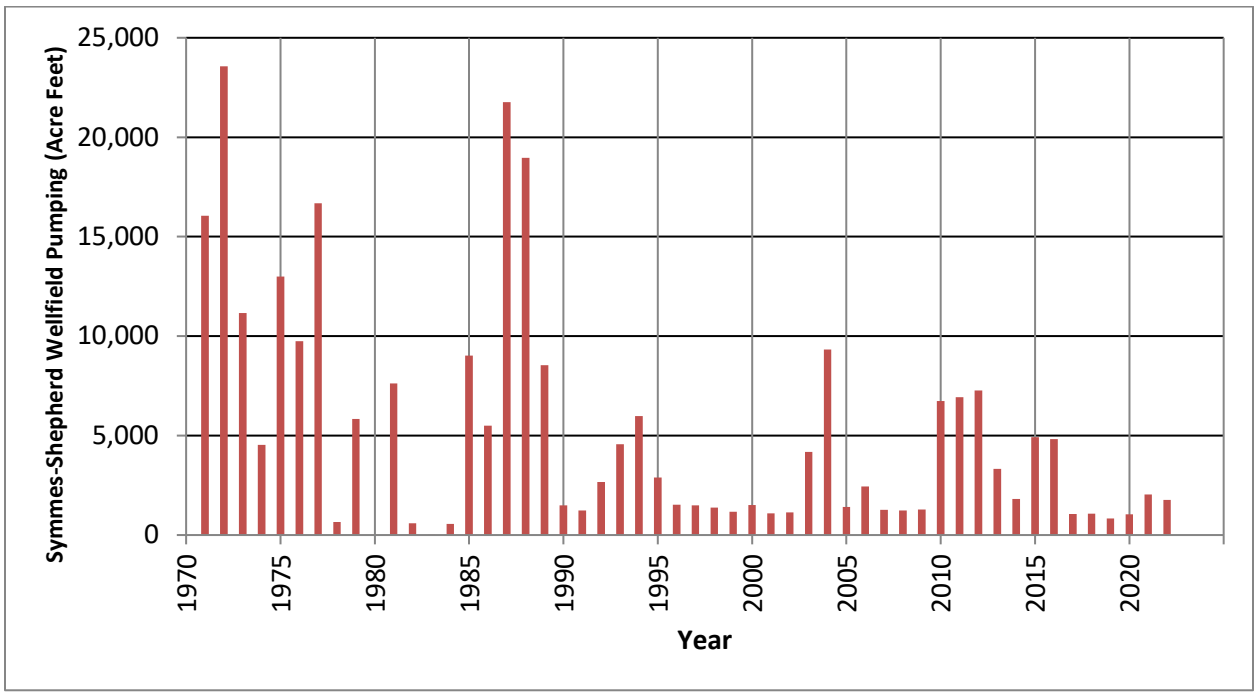

Figure 27. Pumping totals for the Symmes-Shepherd wellfield.

Groundwater levels were relatively stable in 2022-23, increasing moderately overall. Groundwater levels ranged from a decline of -0.8 feet to an increase of 1.8 feet (Table 2). Some test wells are influenced by their proximity to the Los Angeles Aqueduct (T402-404 and T510-511, see Figures 28 and 29) and water levels fluctuate little. Test wells T447 and V009G are located near pumping wells in the northwestern portion of the wellfield, and water levels responded by rising dramatically due to the reduction in pumping and ample runoff/water spreading in 2017-18. Water levels rose an additional three to four feet during the 2019 runoff year. Although groundwater levels have recovered to some extent, water levels in all seven Indicator wells continue to be below baseline as of April 2023 (Table 2).

Due to the declines in groundwater caused by pumping and the 2012-16 drought, Inyo County-owned contaminant monitoring wells at the Independence landfill were dry or within a few feet of becoming dry in spring 2017. Cessation of LADWP export pumping in 2017 combined with recharge has allowed water levels to recover approximately 15 feet in T447 and V009G (Figure 28). However, ICWD continues to be concerned with water levels in Symmes-Shepherd that remain below baseline, ranging -1 to -15 feet, as of 2023.

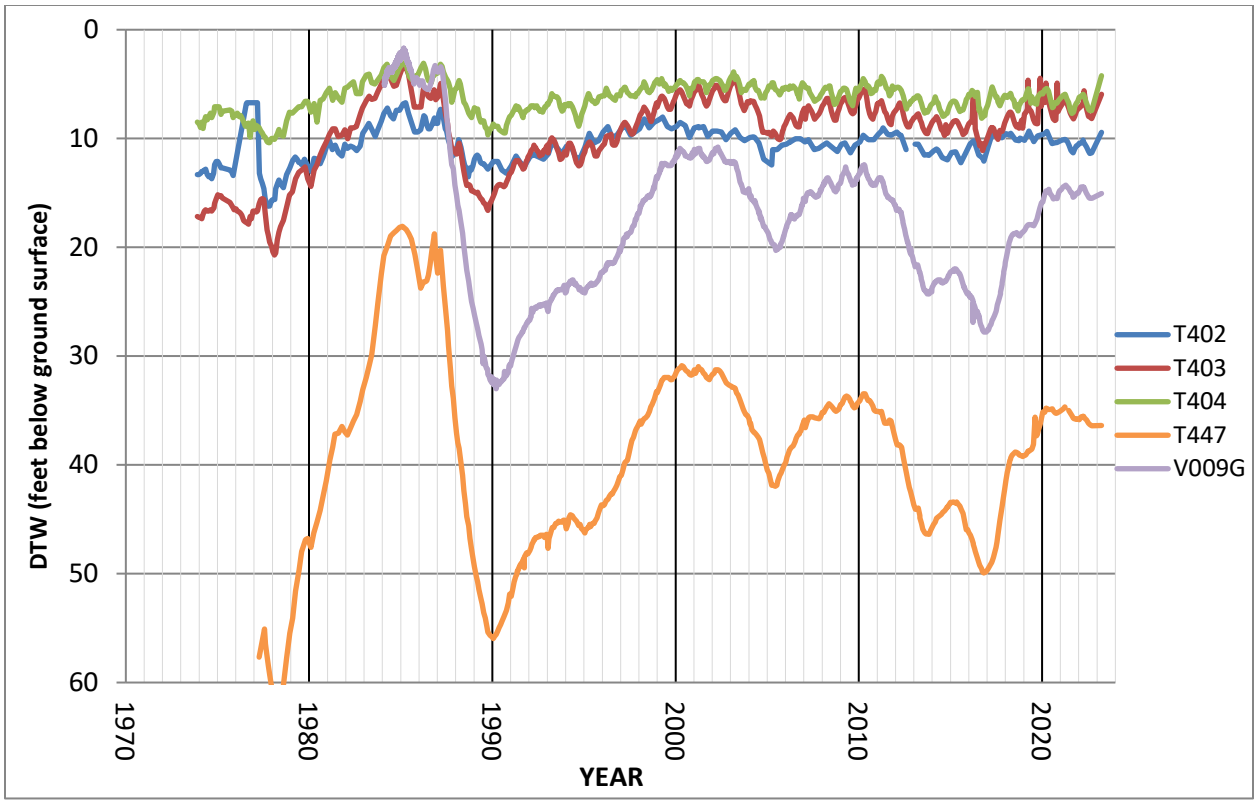

Figure 28. Hydrographs of Indicator wells in the Symmes-Shepherd wellfield.

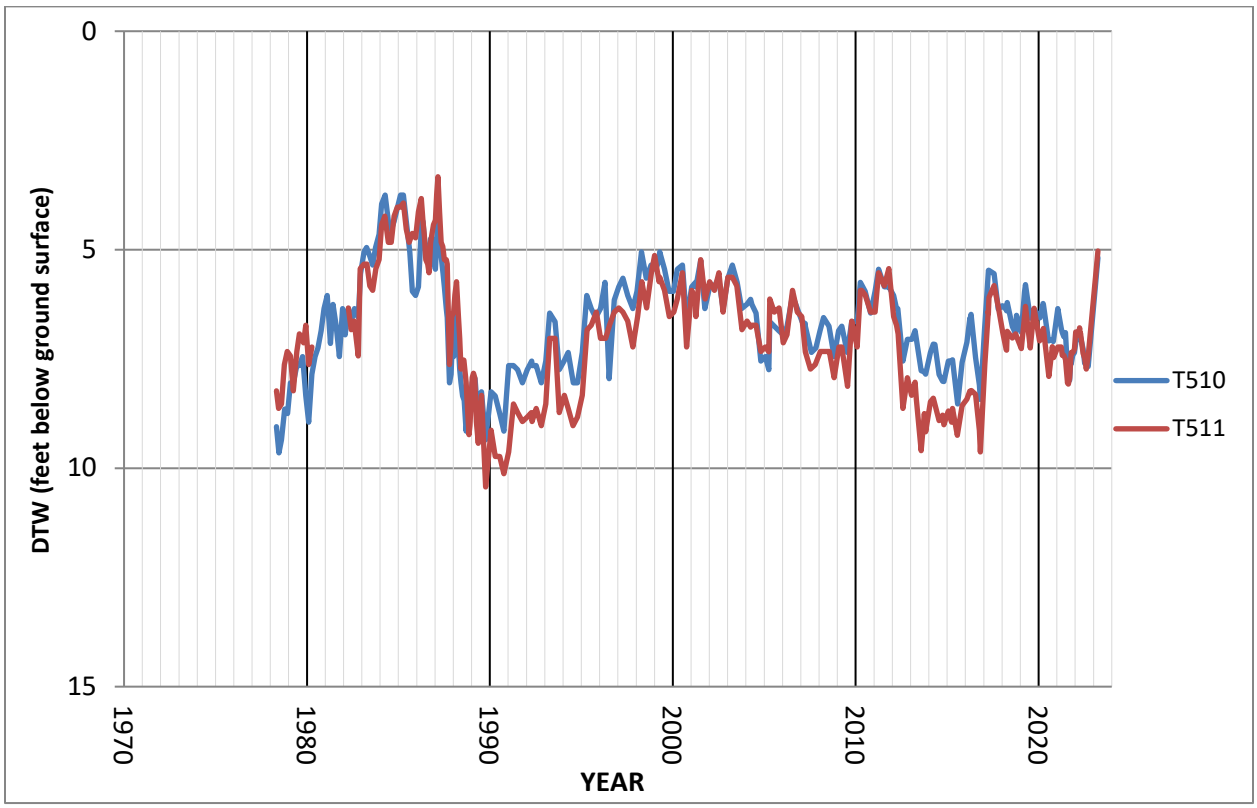

Figure 29. Hydrographs of Indicator wells in the Symmes-Shepherd wellfield.

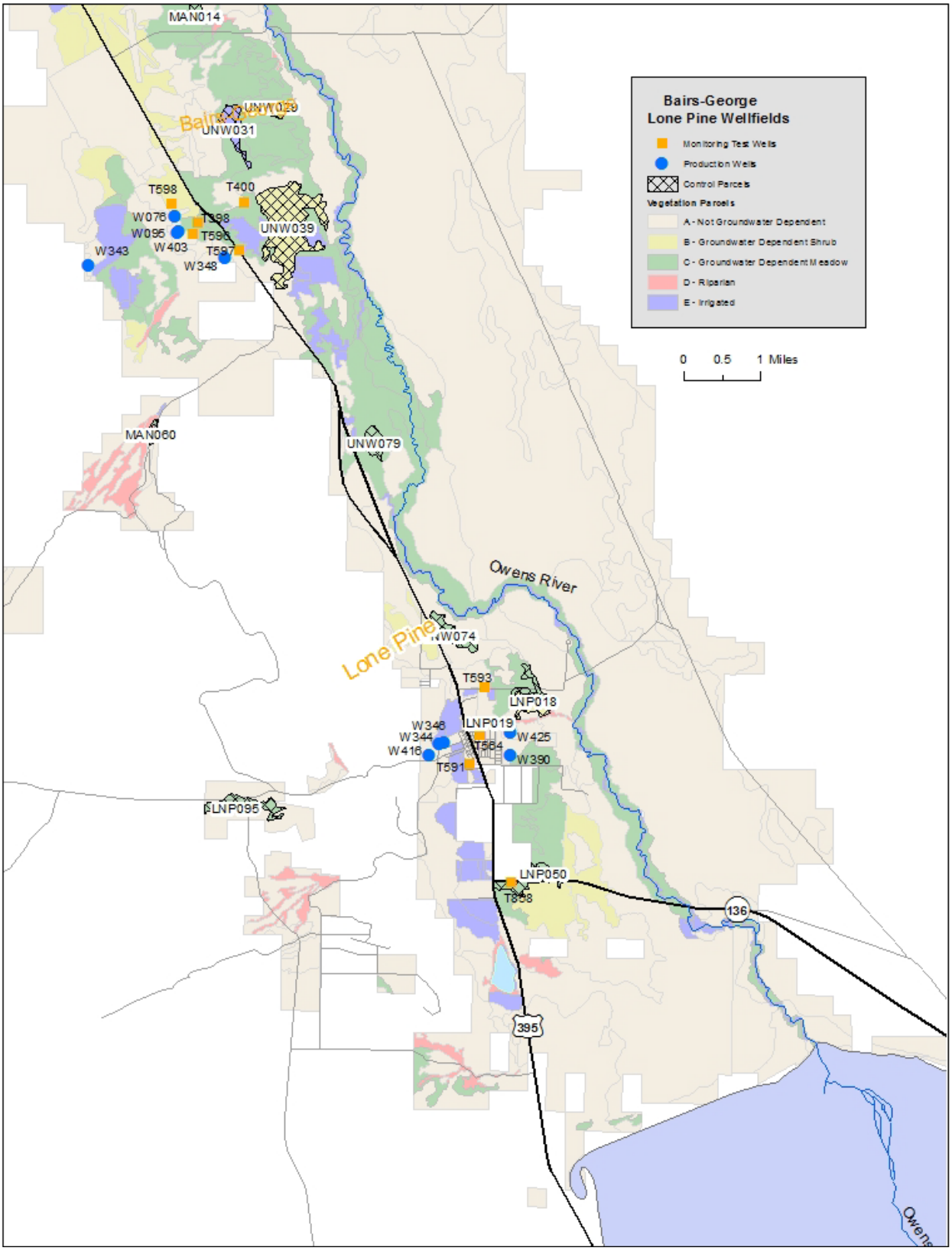

Figure 30. Map of monitoring and LADWP production wells in the Bairs-Georges and Lone Pine wellfields.

Bairs-Georges Wellfield

In the 1970's and 80's, pumping and water levels in the Bairs-Georges wellfield (Figures 30 and 31) varied considerably, but under the Water Agreement, pumping has been reduced substantially. In dry years when surface flows decline, well W343 is exempt and can be operated to supply irrigated pastures. Since the mid-1990's, groundwater levels in the three Indicator wells have been relatively stable. As in other wellfields, pumping for aqueduct supply increased in 2010-2016 compared with the lower amounts during the preceding 20 years. Both in 2018-2019 and 2020-21, LADWP pumped more than 2,000 ac-ft from the wellfield; the most pumping since 1989. Water levels declined several feet in response. As of April 2023, groundwater levels in central Bairs-Georges were at or near baseline levels, but to the north, T812 was -3.7 ft below baseline.

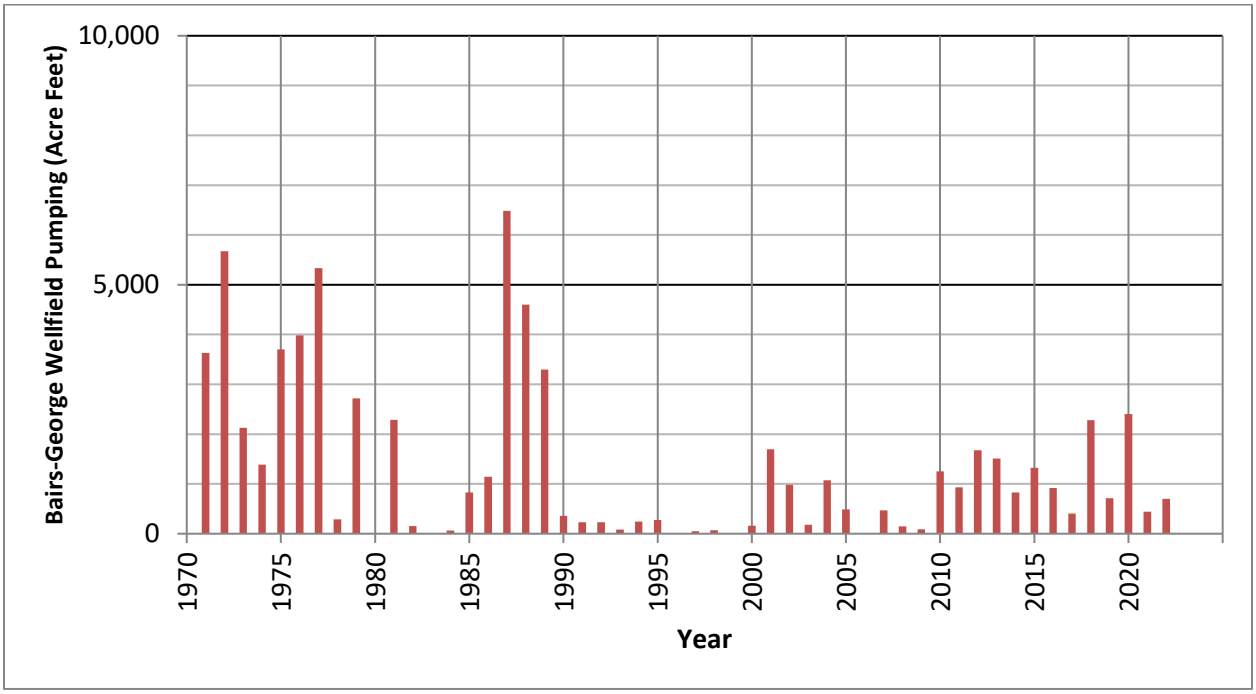

Figure 31. Pumping totals for the Bairs-Georges wellfield.

The pumping wells are located west of the Los Angeles Aqueduct. Monitoring wells T597 and T398 (Figure 32) are in the immediate vicinity of the aqueduct, and well T400 is east of the aqueduct. Water table fluctuations in these wells are lessened by the infiltration from the aqueduct, though the water table response from the increase in pumping since 2010 coupled with the 2012-2016 drought is evident in T398 and T597. Pumping effects are less evident in T400.

Monitoring wells T596, T598, and T812 are located west of the aqueduct, and they exhibit larger fluctuations due to pumping (Figure 33). Of particular concern are the lower groundwater levels seen from 2012-16 and the recent trend (2020 to 2022) in T598 and T812. Both wells showed moderate groundwater level increases in 2023. Bairs-Georges is a fault-bounded wellfield (to the west and east) and appears to have more limited recharge than other areas. Relatively low pumping stress in the wellfield and also from southern Symmes-Shepherd appears to have a measurable effect on groundwater levels. ICWD has communicated this concern with LADWP in annual letters regarding the operations plan and also in comments relating to the recent W076 Replacement Well (2021). Pumping in this wellfield and southern Symmes-Shepherd should be conservative during multi-year droughts.

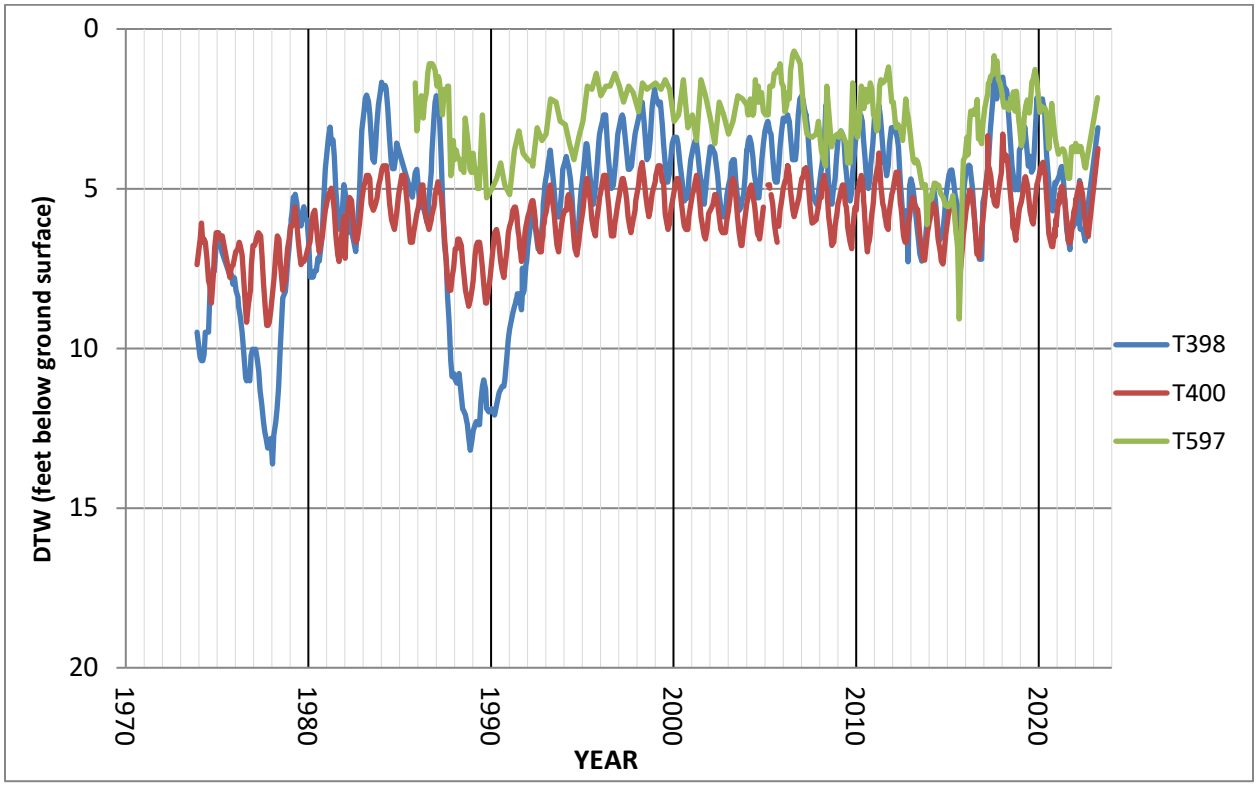

Figure 32. Hydrographs of Indicator wells and 597T in the Bairs-Georges wellfield.

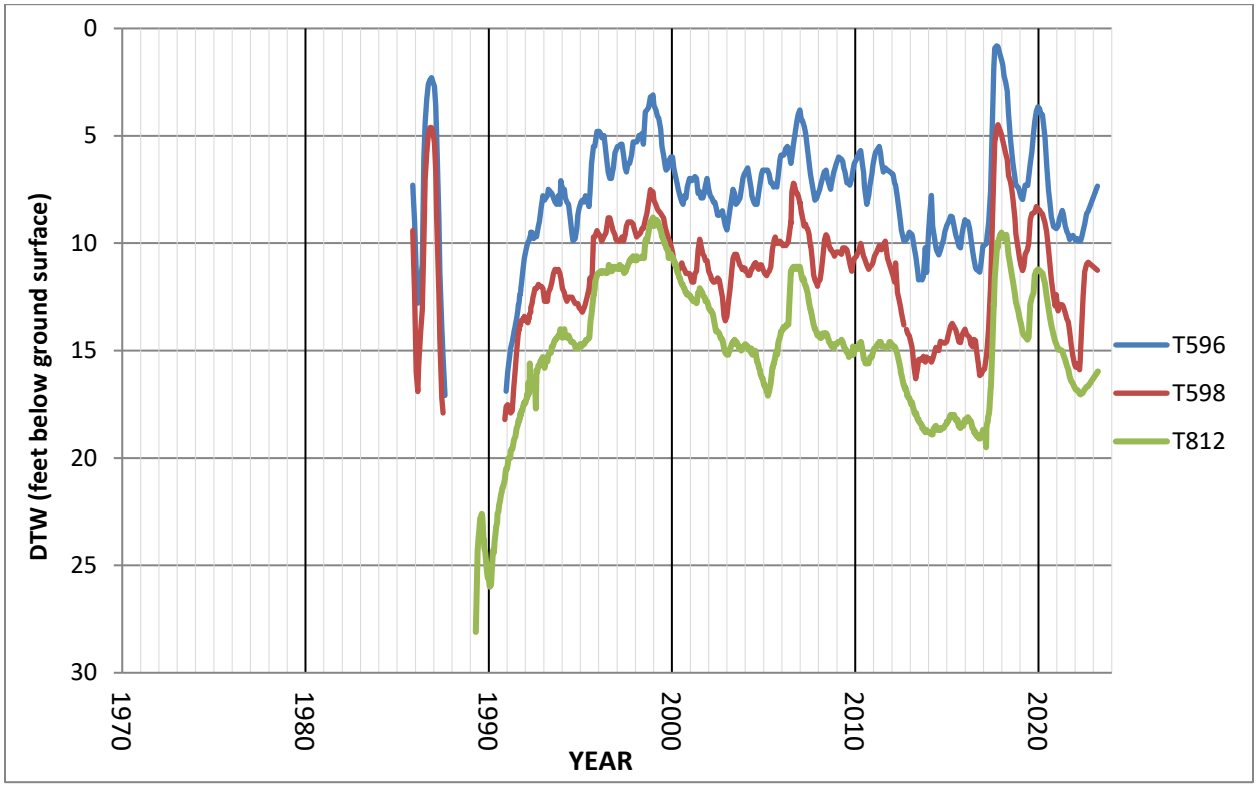

Figure 33. Hydrographs of selected wells in the Bairs-Georges wellfield.

Lone Pine Wellfield

Most pumping in the Lone Pine wellfield (Figure 30) has been to supply the town of Lone Pine and one mitigation project (approximately 1,300 ac-ft annually for irrigated agriculture). Pumping increased occasionally (e.g. in 2000) to offset aqueduct water previously supplied to Diaz Lake (Figure 34). In 2015, pumping also increased largely due to the operation of a new replacement Enhancement/Mitigation (E/M) well (W425) to supply Van Norman field. The previous well (W390) degraded and production declined noticeably in 2008. The replacement well has capacity to fully supply the project. Because of the relatively constant pumping for sole-source uses, ICWD does not routinely use Indicator wells to analyze the annual operations plan for this wellfield.

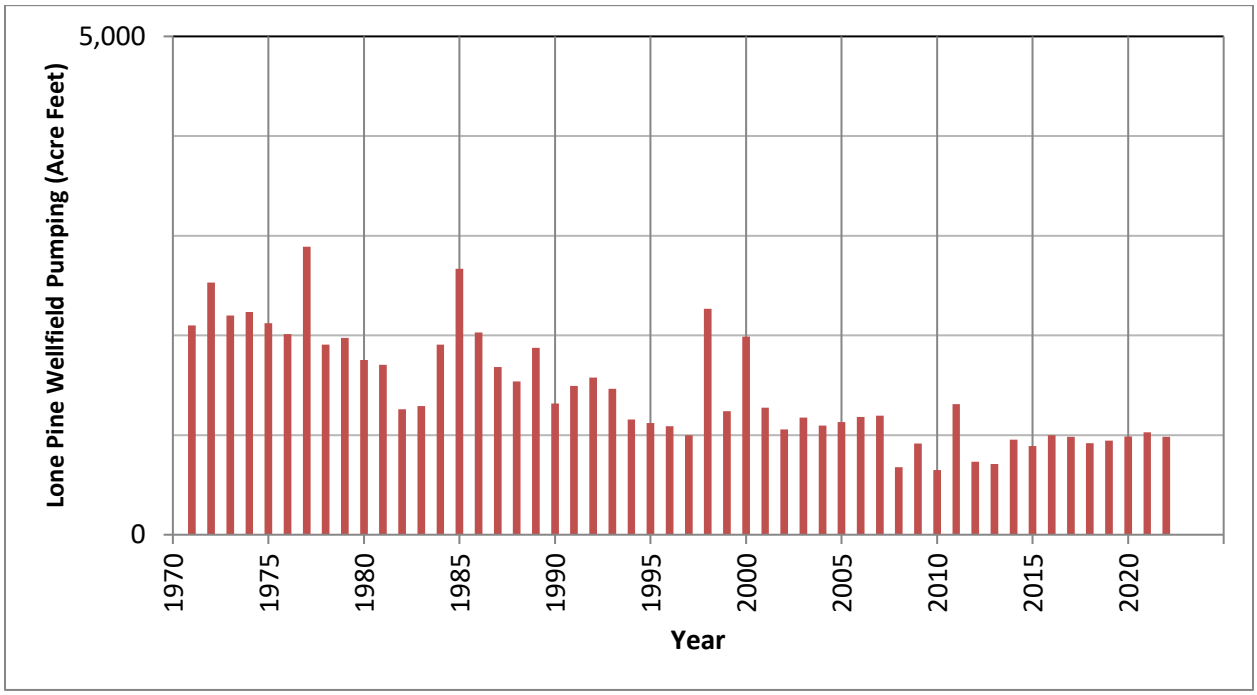

Figure 34. Pumping totals for the Lone Pine wellfield.

Hydrographs for test wells T564 and T591 are presented in Figure 35 to represent water levels near the town of Lone Pine where the LADWP pumping wells are located. Monitoring wells T593 and T858 are located in groundwater dependent vegetation north and south of Lone Pine, respectively. All wells exhibit seasonal fluctuations as well as water table response to decreased recharge due to drought. Pumping effects are not as evident. Water levels rose in 2017 and again in 2019 due to heavy runoff but declined during the 2020-2022 drought (Figure 6 and 35) and did not show recovery following the wet record wet 2023 winter. Groundwater levels are anticipated to increase following the summer 2023 runoff.

In early 2010, LADWP tested a new production well, W416, installed to increase aqueduct supply. This new production well has been modified, and initial tests to determine well capacity and performance have been completed. However, details of the operational monitoring have yet to be agreed upon by the Technical Group.

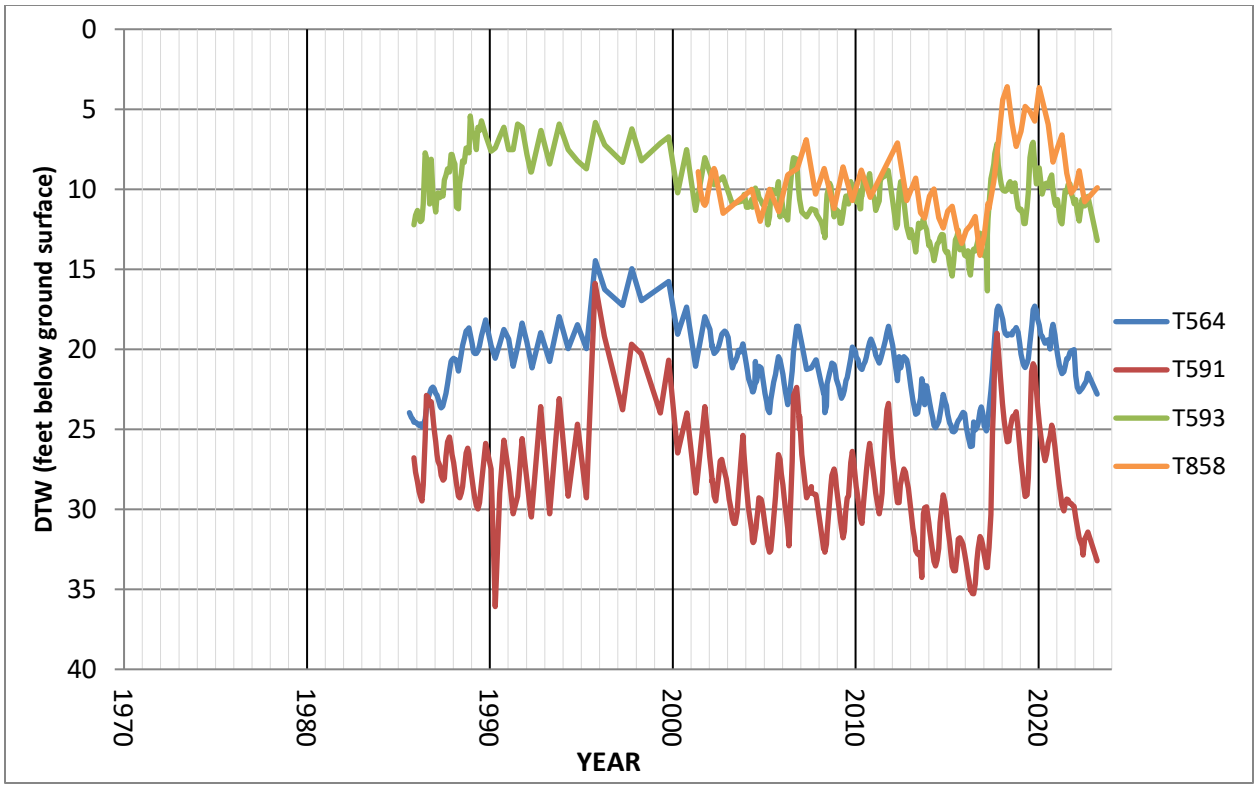

Figure 35. Hydrographs of selected test wells in the Lone Pine wellfield.

2023-24 Operations Plan Details

LADWP issued its annual operations plan for the upcoming 2023-24 runoff year on April 20, 2023. The forecasted runoff for the Owens River watershed is 955,600 ac-ft (233% of normal). LADWP provided a range of planned pumping for the year between 40,130 and 51,470 ac-ft (Table 3). The pumping, at the low-end, is for sole-source (in-valley) uses and no export; under LADWP's high pumping scenario no significant amount of pumping for aqueduct supply is planned (i.e., the proposed amounts by wellfield are less than the ICWD estimated minimum in-valley uses). For most years, ICWD recommends reduced pumping amounts below LADWP's minimum proposed pumping. However, with the abundance of surface water due to the extreme high runoff forecasted for 2023-24, LADWP's minimum proposed pumping is below ICWD's estimated in-valley uses so ICWD recommended that LADWP pump their proposed minimum. Reduced pumping was not proposed for the ensuing year.

Table 3. Planned LADWP pumping (acre-feet per year) by wellfield for 2023-24.

Wellfield	LADWP MIN (40,130 ac-ft/yr)	LADWP MAX (51,470 ac-ft/yr)	In-Valley Min (55,900 ac-ft/yr)
Laws	2,550	5,040	8,700
Bishop	3,180	3,990	12,000
Big Pine	16,200	20,400	18,120
Taboose-Aberdeen	1,200	3,900	480
Thibaut-Sawmill	8,000	8,000	8,400
Independence-Oak	6,900	7,200	6,420
Symmes-Shepherd	1,200	1,740	1,200
Bairs-Georges	0	300	460
Lone Pine	900	900	1,000
Total	**40,130**	**51,470**	**56,780**

ICWD analyzed the effect of the Operations Plan on groundwater levels in the Owens Valley using regression models for several monitoring wells (Table 4). Most models rely on measured DTW in April 2023, planned wellfield pumping for the entire runoff year, and Owens Valley runoff to predict water levels next April. For several wells, Owens Valley runoff was not a statistically significant variable in the regression model. Water levels in those wells are correlated with pumping, and the models are still useful for evaluating the pumping plan. Also, models in Laws use the amount of water diverted from the Owens River into the McNally canals as the variable associated with recharge instead of runoff. Spreading of 39,000 ac-ft is planned for Laws in 2023-24 (Table 2.8 of LADWP's Plan).

The models used by ICWD to analyze the annual Operations Plan predict water levels one year in the future (e.g. April 2023 to April 2024) based on annual pumping for each wellfield. Three pumping scenarios are presented in Table 4: upper and lower pumping limits from LADWP's proposed Draft Plan, and minimum pumping for in-valley uses.

Table 4. ICWD predicted water level changes at Indicator wells and monitoring sites for: i) LADWP's proposed minimum pumping, ii) LADWP's proposed maximum pumping, and iii) in-valley minimum pumping. Negative DTW values denote a decline. Predictions in this table are made to 0.1 ft. Extra digits are presented for rounding transparency. Average values by wellfield are shown in orange text.

Station ID, Monitoring site	LADWP MIN (40,130 AF) 2024 vs 2023	LADWP MIN (40,130 AF) 2024 vs Baseline	LADWP MAX (51,470 AF) 2024 vs 2023	LADWP MAX (51,470) AF 2024 vs Baseline	In-Valley MIN (56,780) AF 2024 vs 2023	In-Valley MIN (56,780) AF 2024 vs Baseline
	(DTW change ft)	(DTW change ft)	(DTW change ft)	(DTW change ft)	(DTW change ft)	(DTW change ft)
Laws **Avg.**	**4.9**	**7.3**	**4.2**	**6.6**	**4.9**	**7.3**
107T	8.53	7.22	7.70	6.40	6.49	5.18
434T	1.93	3.21	1.58	2.86	1.06	2.34
436T	3.23	5.55	2.87	5.19	2.34	4.66
438T	5.48	2.05	5.18	1.75	4.74	1.31
490T	3.49	3.35	3.34	3.20	3.11	2.97
492T	7.20	14.71	5.87	13.38	3.90	11.41
795T	3.78	10.30	2.60	9.12	0.86	7.38
V001g	12.23	11.79	11.55	11.11	10.54	10.10
574T	-2.16	7.14	-2.54	6.76	-3.09	6.21
Big Pine	**3.6**	**5.5**	**3.0**	**4.9**	**3.4**	**5.2**
425T	5.03	5.97	4.31	5.25	4.70	5.64
426T	3.39	3.65	2.99	3.24	3.21	3.46
469T	2.59	2.15	2.20	1.77	2.41	1.98
572T	5.01	8.80	4.23	8.02	4.66	8.45
798T, BP1	2.37	7.76	1.68	7.07	2.06	7.44
799T, BP2	2.57	2.06	2.20	1.69	2.40	1.89
567T, BP3	4.90	7.26	4.26	6.62	4.61	6.97
800T, BP4	3.25	6.33	2.38	5.46	2.85	5.93
Taboose-Aberdeen	**3.9**	**3.5**	**3.3**	**2.9**	**4.1**	**3.6**
417T	4.39	3.34	3.68	2.64	4.58	3.53
418T	2.14	4.01	1.84	3.70	2.23	4.09
419T, TA1	4.35	6.16	3.62	5.44	4.55	6.36
421T	6.74	3.21	6.00	2.47	6.93	3.41
502T	4.39	0.92	4.06	0.58	4.48	1.01
504T	5.12	6.02	4.22	5.12	5.36	6.26
505T	4.56	3.12	3.84	2.40	4.75	3.31
586T, TA4	2.43	4.16	1.83	3.56	2.59	4.32
801T, TA5	1.26	0.45	1.09	0.29	1.30	0.50
803T, TA6	3.96	3.16	3.29	2.50	4.14	3.34
Thibaut-Sawmill	**3.3**	**8.6**	**3.3**	**8.6**	**3.1**	**8.4**
415T	6.40	13.43	6.40	13.43	6.09	13.12
507T	-0.11	2.54	-0.11	2.54	-0.18	2.48
806T, TS2	3.52	9.78	3.52	9.78	3.44	9.70

Station ID, Monitoring site	LADWP MIN (40,130 AF) 2024 vs 2023	LADWP MIN (40,130 AF) 2024 vs Baseline	LADWP MAX (51,470 AF) 2024 vs 2023	LADWP MAX (51,470) AF 2024 vs Baseline	In-Valley MIN (56,780) AF 2024 vs 2023	In-Valley MIN (56,780) AF 2024 vs Baseline
	(DTW change ft)	(DTW change ft)	(DTW change ft)	(DTW change ft)	(DTW change ft)	(DTW change ft)
Independence-Oak	**1.9**	**-0.2**	**1.8**	**-0.3**	**2.1**	**-0.1**
406T	0.66	1.09	0.64	1.07	0.69	1.13
407T	-0.10	-3.53	-0.20	-3.63	0.06	-3.37
408T	-0.29	0.24	-0.36	0.17	-0.18	0.35
409T	3.48	0.12	3.27	-0.09	3.81	0.45
546T	2.33	0.59	2.29	0.55	2.40	0.66
809T, IO1	5.44	0.22	5.33	0.11	5.60	0.38
Symmes-Shepherd	**2.6**	**-2.0**	**2.5**	**-2.2**	**2.6**	**-2.0**
402T	1.57	-0.52	1.51	-0.59	1.57	-0.52
403T	1.84	0.67	1.67	0.50	1.84	0.67
404T	0.17	-0.90	0.11	-0.96	0.17	-0.90
447T	9.05	-5.97	8.66	-6.37	9.05	-5.97
510T	0.13	-0.80	0.07	-0.86	0.13	-0.80
511T	0.10	-0.97	0.03	-1.03	0.10	-0.97
V009G, SS1	5.51	-5.81	5.16	-6.16	5.51	-5.81
Bairs-Georges	**2.1**	**1.8**	**1.8**	**1.5**	**1.6**	**1.4**
398T	0.60	2.25	0.19	1.84	-0.03	1.62
400T	-0.36	0.78	-0.44	0.70	-0.48	0.66
812T	5.96	2.36	5.61	2.00	5.42	1.81
Wellfield Average	**+3.2**	**+3.5**	**+2.9**	**+3.1**	**+2.9**	**+3.2**

The analysis of water level changes if minimum pumping were conducted for specific uses in the Owens Valley is included as a basis for comparison with the higher levels of pumping in LADWP's proposed pumping amounts. Minimum pumping is not a constant and varies depending on runoff availability to supply irrigation or mitigation projects with surface water instead of groundwater where possible.

The upper limit of the pumping proposed in the Plan is used to evaluate LADWP's proposed pumping because (1) it represents the maximum impact on the water table that the Draft Plan could have, and (2) except in high runoff conditions (like the current year), LADWP has generally pumped near the upper end of the proposed range.

ICWD's analysis of the Plan and recommendations for pumping their minimum proposed pumping amounts are based on the goals and principles of the Water Agreement, the status of individual pumping wells according to Green Book soil water triggers, groundwater dependent vegetation conditions monitored by the Technical Group, water table conditions in each wellfield, and groundwater uses within each wellfield. LADWP's minimum proposed pumping of 40,130 AF for 2023-24 is well below the long-term average pumping for the Owens Valley under the Water Agreement (71,784 ac-ft). Even in dry years, LADWP's proposed annual Operation Plans typically do not include pumping for export from Bishop or Lone Pine wellfields as pumping in these wellfields is for in-valley uses.

Average groundwater levels are expected to increase in all wellfields under LADWP's 2023-24 maximum proposed pumping (Table 4). The average groundwater level change in the 46 Indicator wells is predicted to be an increase of 2.9 ft under LADWP's maximum pumping scenario, an increase of 2.9 ft with in-valley minimum pumping, and an increase of 3.2 ft under LADWP's minimum pumping scenario. By April 2024, under LADWP's maximum pumping scenario, average predicted water levels will be above baseline in all wellfields except Independence-Oak (-0.3 ft) and Symmes-Shepherd (-2.2 ft). In Laws, Big Pine, Taboose-Aberdeen, Thibaut-Sawmill, and Bairs-Georges, average water levels are predicted to be 1.5 to 8.6 feet above baseline. Concerns about and recommendations to LADWP's proposed 2023-24 Pumping Plan were described in the Inyo County Water Department's April 28, 2023, letter to LADWP. A summary of these comments is presented here:

The extraordinarily high amount of expected 2023-24 runoff presents an opportunity to recover groundwater levels to those comparable to or higher than the baseline vegetation mapping period of the mid-1980s. Given that LADWP has ample surface water supplies for export to Los Angeles and for use in Owens Valley, groundwater extraction should be minimized to take advantage of this opportunity for water table recovery. ICWD recommends that no pumped groundwater be used for aqueduct supply, especially near vegetation that is measurably and chronically below baseline levels. Shallow groundwater levels are particularly important to maintain perennial grasses which have seen more substantial declines than overall cover.

The combination of pumping less than anticipated in the 2022 Operations Plan, spreading beginning in January 2023, and record high precipitation contributed to spring 2023 average groundwater level increases (i.e., recovery) in all seven analyzed wellfields compared to spring 2022. However, the Taboose-Aberdeen, Independence-Oak, Symmes-Shepherd, and Bairs-Georges wellfields are still in need of water level increases to reach baseline levels as of April 2023. These unusually high runoff conditions should be directed to recover depressed water tables in these wellfields.

ICWD recommends pumping near the low end of LADWP's 2023-24 proposed range (about 40,130 AF) if operationally feasible. As LADWP acknowledges, there is an opportunity to utilize the large runoff year to maximize water table and vegetation recovery. Furthermore, there is ample surface water available for in-valley uses, so the typical minimum amount of groundwater required for in-valley uses (about 56,780 AF) is not necessary this year.

ICWD understands that 2023-24 is an unprecedented runoff year and that some decisions were made for operational reasons. As much as possible, water should be recharged within Owens Valley and Rose Valley in order to promote water table and vegetation recovery. In addition to the areas within the Owens Valley currently being considered by LADWP for water banking, the County of Inyo would like to proactively explore, in conjunction with LADWP, water banking opportunities in other areas within the valley. Specifically, the priority should be to bank water where it will promote phreatophytic vegetation, which requires minimal water table fluctuations.

Inyo County Water Department's full comment letter with detailed discussion of each wellfield can be found online at: https://www.inyowater.org/documents/pumping/dwp-annual-operations-plans/

Evaluation of 2022-2023 Depth to Water Predictions

As noted in the previous sub-section, ICWD routinely uses linear regression models for Indicator wells to predict the effects of pumping on DTW as part of its analysis of LADWP's annual Operations Plans. ICWD staff conducts an annual audit which examines the accuracy of these models by comparing the predictions with DTW measurements collected the following year on April 1. The regression models were constructed from historical data for wellfield pumping, Owens Valley runoff, and current water levels. The models in Laws rely on an estimate of the diversions into the McNally canals instead of Owens Valley runoff as the variable related to groundwater recharge. For four of the permanent monitoring sites, a second model was used that relies on predicted DTW in a nearby Indicator well that responds similarly to pumping and runoff. The models were originally developed by Harrington (1998) and Steinwand and Harrington (2003) and have been updated periodically. These reports are available on ICWD's website.

This analysis of the predictions includes uncertainty in the input variables (runoff forecast and planned pumping) as well as uncertainty in the empirical-based models. Model uncertainty includes all management actions and environmental conditions not captured in the regression model (e.g. atypical recharge or pumping operations near one of the test wells). Predictions for 46 Indicator wells made in April 2022 were compared to actual measured April 2023 DTWs (Table 2).

The 2023 predicted DTW values were based on the higher maximum pumping amount planned by LADWP in their 2022-23 pumping plan (86,300 ac-ft). Actual pumping was approximately 77% (66,306 ac-ft) of the maximum planned amount (Table 1). Wellfield pumping totals for the year differed by as much as 6,650 ac-ft (i.e., maximum planned pumping in Big Pine wellfield less actual) of the planned amounts in wellfields with Indicator wells. The discrepancies between planned and actual pumping decrease the accuracy of predictions. The model predictions also rely on forecasted Owens Valley runoff and unavoidably include the uncertainty in that prediction.

The LADWP runoff forecast has tracked actual runoff with accuracy since 1994. However, five of the past seven years have seen runoff extremes at both the high and low end of the historic data. In 2018 and 2019 runoff years, LADWP's forecast under-predicted runoff by 75,000 and 81,000 ac-ft, respectively (second and third largest errors since 1994, Figure 1). These consecutive under-predictions were possibly due to continued water hold-over from the very wet 2017-18 winter (third largest) and the large amounts of surface water spread in the valley. Shallow groundwater levels in the Owens Valley, not widely seen since the 1980s, may also have contributed to LADWP's under-predictions. LADWP over-predicted 2021-22 runoff (81% of actual) and under-predicted runoff for this past year (120% of actual, Figure 1). LADWP forecasted 2022-23 runoff was well below average (47%) and very dry antecedent conditions may have contributed to the under-prediction error compared to the actual runoff (59%).

Model performance in 2022-23 was much less accurate than previous years due to the combination of more runoff, significantly less pumping than planned, and the record wet 2023 winter. Measured versus predicted change in DTW are plotted in Figure 36. If the models were perfect predictors, the points would fall on the red 1:1 line. Actual groundwater levels were shallower in all 46 wells. The average absolute difference between 2022 water level predictions and 2023 measured water levels was 3.9 feet.

Only around one-fourth of the Indicator predictions (11 of 46) were within 1.5 ft of the actual deviation. This measure of model performance is much poorer than prior years.

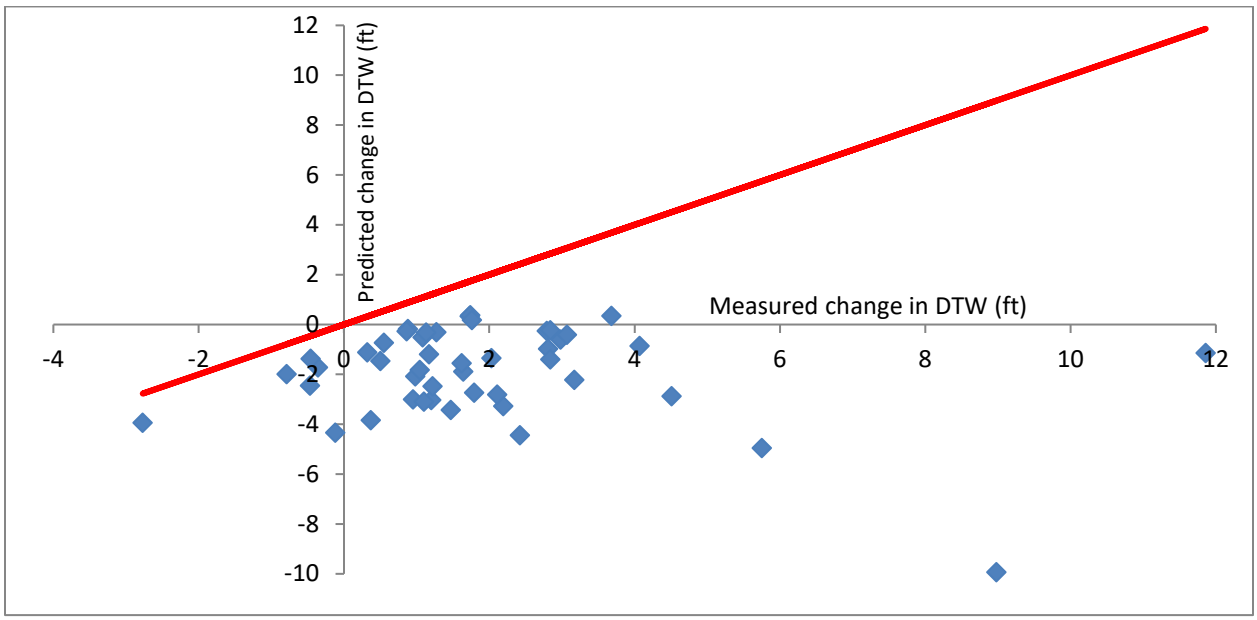

Figure 36. Measured and predicted change in DTW from April 2022 to April 2023 for 46 Indicator wells. The solid red line is the 1:1 line. Negative values denote decline in water level. Data points right of the red line indicate actual groundwater level changes were more positive (shallower) than predicted.

Despite model predictions being much less accurate than past years, the principal sources of error in 2022-23 predictions were a result of inaccurate inputs (more runoff and less pumping) combined with the record wet 2023 winter contributing three times the long-term average precipitation to the valley floor and unforecasted diversions into the McNally canals (impacting model predictions in Laws wellfield), but not in the regression models' formulas themselves. For confirmation, the 2022 prediction models were re-run with actual values of runoff and pumping (Figure 37). The subsequent model performance was improved, with the average absolute difference between predicted and modeled DTW of approximately 2.6 feet. Model predictions were within 1.5 ft of actual in 46% of the wells (21 of 46), and within one foot of actual in 26% of the wells (12 of 46). Overall, actual groundwater levels were still significantly shallower than predicted in most of the wells (44 of 46) due to the unanticipated record wet 2023 winter.

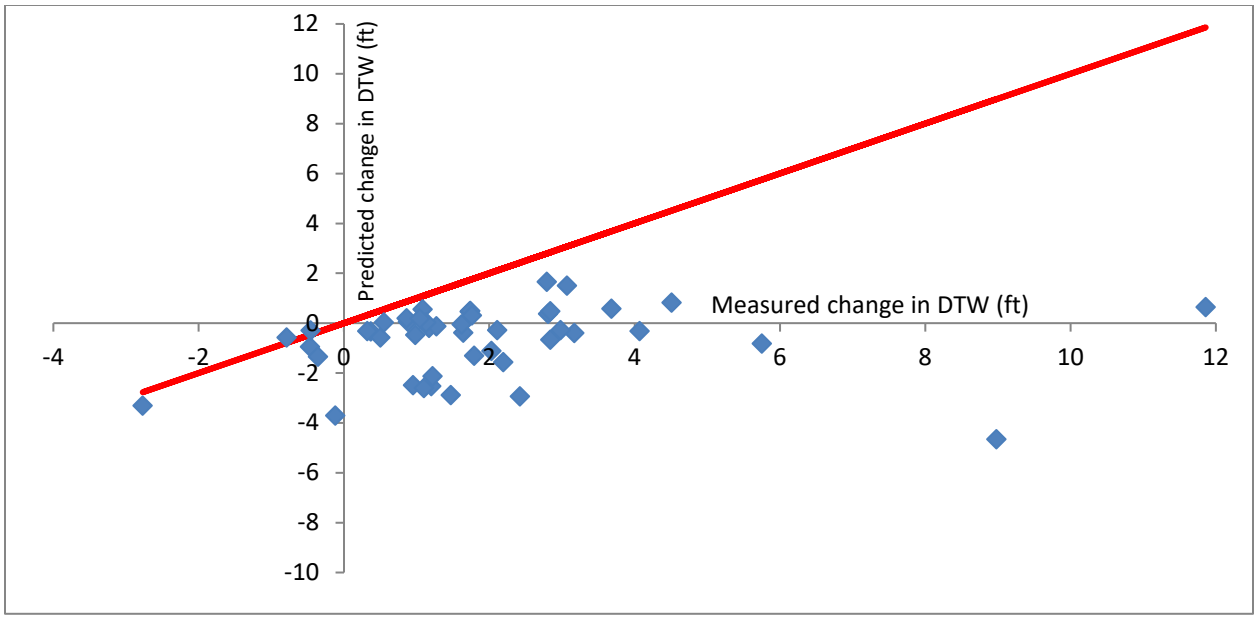

Figure 37. Corrected measured and predicted change in DTW from April 2022 to April 2023 for 46 Indicator well using actual pumping and runoff values. The solid red line is the 1:1 line. Negative values denote decline in water level. Data points right of the redline indicate actual groundwater level changes were more positive (shallower) than predicted.

References

Harrington, R. F., Multiple regression modeling of water table response to groundwater pumping and runoff, Inyo County Water Department report, 1998.

Steinwand, A.L, and R.F. Harrington. 2003. Simulation of water table fluctuations at permanent monitoring sites to evaluate groundwater pumping. Report to the Inyo/Los Angeles Technical Group, February 25, 2003.