INDIAN WELLS VALLEY GROUNDWATER BASIN

GSP Annual Report

Water Year 2019

(October 2018 to September 2019)

May 2020

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1.0 Executive Summary

The Indian Wells Valley Groundwater Authority (IWVGA) has prepared this Annual Report for the Indian Wells Valley Groundwater Basin (IWVGB or Basin), Basin 6-054, to be submitted to the California Department of Water Resources (DWR) in compliance with the Sustainable Groundwater Management Act (SGMA). This annual report presents required data for Water Year (WY) 2019 (October 2018-September 2019).

DWR has designated the IWVGB as a basin in critical overdraft. Overdraft in the IWVGB has been shown through several undesirable results, primarily the chronic lowering of groundwater levels, the degradation of water quality, and the reduction of groundwater in storage throughout the IWVGB. Consequently, the IWVGA must implement projects and management actions to mitigate and avoid undesirable results and reach sustainability by 2040.

The estimated groundwater storage change in the main basin of the IWVGB during WY 2019 is a loss of 10,450 acre-feet (AF). Total water use in the IWVGB in WY 2019 is estimated to be 24,090 AF which includes both groundwater production and recycled water reuse.

This Annual Report includes the following:

- General information (including Basin location)
- Progress towards GSP implementation and sustainability
- Hydrologic conditions
- Groundwater elevation data (including contours and hydrographs)
- Groundwater storage data
- Water supply data (including groundwater extraction data)

2.0 General Information

The IWVGA is the sole Groundwater Sustainability Agency (GSA) for the IWVGB and is responsible for complying with SGMA requirements, including the preparation and implementation of the Groundwater Sustainability Plan (GSP). The GSP for the IWVGB (Stetson, 2020) was adopted by the IWVGA Board of Directors on January 16, 2020 and was submitted to DWR on January 31, 2020.

The IWVGB is located in the northwestern part of the Mojave Desert in southern California and underlies approximately 382,000 acres or approximately 600 square miles of land area in portions of the Counties of Kern, Inyo, and San Bernardino. Figure 2-1 provides the location of the IWVGB and the extents of the IWVGA boundaries.

3.0 Progress Towards GSP Implementation and Sustainability

The IWVGB is characterized as a critically overdrafted basin by DWR. This classification accounts for the occurrence of undesirable results for the following sustainability indicators:

- Chronic lowering of groundwater levels
- Reduction of groundwater in storage
- Degraded water quality
- Potential for land subsidence

In compliance with SGMA, the IWVGB GSP provides Basin management strategies that will culminate in the absence of undesirable and unsustainable groundwater conditions in the IWVGB. The GSP recommends projects and management actions that are intended to achieve Basin sustainability while considering the unique geologic and hydrogeologic conditions of the IWVGB. Sustainable management criteria were established for measuring progress towards groundwater sustainability. The recommendations of the GSP will provide for long-term sustainable groundwater management in the IWVGB within 20 years (WY 2040) of GSP implementation.

During WY 2019, the preparation of the GSP was still in progress. Key milestones towards implementing the GSP and achieving sustainability that occurred during WY 2019 include, but are not limited to:

- Identification of projects and management actions to include in the GSP
- Selection of preliminary key wells to be representative monitoring sites in the IWVGB for monitoring progress towards sustainability
- Development of preliminary sustainable management criteria
- Numerical modeling of sustainable management scenarios
- Numerical modeling of salinity transport
- Evaluation of land subsidence
- Evaluation of impacts to shallow wells
- Identification of data gaps

- Field investigations for the installation of monitoring wells, stream gages, and weather stations
- Water Quality Sampling
- Well registration for tracking groundwater production
- Development of draft GSP sections

4.0 Hydrologic Conditions

The California Code of Regulations (CCR) requires that GSP Annual Reports contain information on current and historical water year types (23 CCR § 356.2). Water year type is defined as "the classification provided by the Department [DWR] to assess the amount of annual precipitation in a basin" (23 CCR § 351). DWR issues water year classifications for some areas of the state, including the Sacramento River and San Joaquin River basins. DWR has indicated that they intend to prepare water year classifications for more areas of the state (DWR, 2016), but at this time, a DWR-issued classification does not exist for precipitation in the IWVGB. Until that data is available, a water year type index has been developed based on local precipitation data for the IWVGB.

Historical precipitation data were previously presented in the GSP (Stetson, 2020; Figure 3-9) at two long-term stations: the Haiwee station (No. 043710) is located upgradient of the IVWGB in the Rose Valley; the China Lake NAF station (No. 041733) is located on the basin floor at the Naval Air Weapons Station China Lake (NAWS China Lake)[1]. The China Lake NAF station was used as the index station to classify water year types in IWVGB. The Haiwee station was not used because it has not reported data since 2017 (WRCC, 2020).

To classify water year types, the monthly precipitation record at China Lake NAF from 1945 through September 2019 was filled and checked. Months with missing or low-quality data were filled[2] with data from nearby cooperative stations at Trona (No. 049035) and Inyokern (No. 044278) (WRCC, 2020). Water year totals were computed for the 75-year record from 1945 through 2019. Total water year precipitation was then sorted and plotted as an exceedance curve, shown in Figure 4-1. The values on the x-axis of the graph are percentile values for annual exceedance; the y-axis values are the water year annual

[1] See Figure 3-8 of GSP (Stetson, 2020) for locations of precipitation stations.

[2] Data were filled using a linear adjustment factor between the two stations. The adjustment factor was computed from the ratio of the 1971-2000 NCDC Climate Normals (average annual precipitation) at the two stations (WRCC, 2018).

precipitation at China Lake NAF. The 50th percentile, or median annual precipitation, is 3.2 inches per year. Annual precipitation ranged from a minimum of 0.25 inches per year to a maximum of 11.0 inches per year.

Five water year types were developed by visual inspection of the exceedance curve in Figure 4-1. The five types are Wet, Above Normal, Normal, Below Normal, and Dry. Table 4-1 shows the thresholds for determining water year type. The thresholds correspond to the vertical lines dividing the categories in Figure 4-1. WY 2019 was a Wet year, with 6.1 inches of rain at the index station. Table 4-2 lists the historical classifications of water year type since WY 1945.

Table 4-1: Percent Exceedance Ranges and Dividing Thresholds for Five Water Year Types

Year Type	Percent Exceedance Range (%)	Threshold Between Year Type (in/yr)	Number of Years in Historical Record (WY 1945-2019)
Wet	0% - 10%	6.0	7
Above Normal	>10% - 33%	4.0	18
Normal	>33% - 67%	2.3	25
Below Normal	>67% - 90%	1.3	17
Dry	>90% - 100%	n/a	8
		Total years	75

Table 4-2: Historical Water Year Types based on Precipitation at China Lake NAF Station (No. 041733)

WY	Annual Precipitation (in/yr)	Water Year Type	WY	Annual Precipitation (in/yr)	Water Year Type
1945	4.90	AN	1985	2.79	N
1946	2.77	N	1986	4.15	AN
1947	3.81	N	1987	2.82	N
1948	1.97	BN	1988	5.40	AN
1949	1.21	D	1989	1.37	BN
1950	1.90	BN	1990	1.43	BN
1951	0.25	D	1991	3.84	N
1952	4.89	AN	1992	9.11	W
1953	1.75	BN	1993	7.12	W
1954	2.80	N	1994	1.08	D
1955	1.93	BN	1995	5.23	AN

WY	Annual Precipitation (in/yr)	Water Year Type	WY	Annual Precipitation (in/yr)	Water Year Type
1956	1.73	BN	1996	1.91	BN
1957	2.10	BN	1997	2.71	N
1958	4.45	AN	1998	6.06	W
1959	2.47	N	1999	1.53	BN
1960	3.13	N	2000	1.76	BN
1961	1.82	BN	2001	4.36	AN
1962	3.87	N	2002	0.54	D
1963	4.03	N	2003	4.35	AN
1964	1.54	BN	2004	3.22	N
1965	4.74	AN	2005	5.88	AN
1966	5.85	AN	2006	2.61	N
1967	2.57	N	2007	0.46	D
1968	4.65	AN	2008	3.18	N
1969	5.29	AN	2009	1.16	D
1970	3.68	N	2010	3.36	N
1971	2.95	N	2011	3.98	N
1972	1.55	BN	2012	1.32	D
1973	3.76	N	2013	0.83	D
1974	5.98	AN	2014	1.44	BN
1975	3.39	N	2015	3.67	N
1976	3.64	N	2016	1.38	BN
1977	4.01	N	2017	4.61	AN
1978	10.96	W	2018	1.43	BN
1979	6.53	W	2019	6.13	W
1980	5.66	AN			
1981	3.23	N			
1982	4.40	AN			
1983	10.42	W			
1984	4.05	AN			

Notes: W = Wet, AN = Above Normal; N = Normal; BN = Below Normal; D = Dry; see Table 5-1.

5.0 Groundwater Elevation Data

Since 1946, groundwater data have been collected in IWVGB for studies conducted by the Navy, U.S. Geological Survey, Department of Water Resources, the U.S. Bureau of Reclamation, and other agencies. In 1995, a groundwater monitoring program was established with Kern County Water Agency (KCWA) and the Navy collecting groundwater levels during the wet (spring) and dry (fall) seasons from approximately 140 to 190 wells throughout the IWVGB. In WY 2019, depth to groundwater (DTW) was measured at 143 wells in October 2018 and 151 wells in March 2019. Attachment A contains measured DTW data, the Land

Surface Datum (LSD) and the resulting groundwater elevations (feet, mean sea level) for WY 2019. These data were appended to the existing Database Management System (DMS)[3] developed by the IWVGA for basin management. Groundwater elevation data were used to produce equipotential contour maps and hydrographs for this annual report.

5.1 Groundwater Elevation Contour Maps

KCWA[4] produced October 2018 and March 2019 groundwater elevation contours for this WY 2019 Annual Report. Figure 5-1 shows the Fall 2018 contours and Figure 5-2 shows the Spring 2019 contours with pumping wells, groundwater basin boundary, and watershed extents for Indian Wells Valley. In general, the contour maps show groundwater flowing from Rose Valley in the northwest (about 2,250 feet, msl), the Sierra mountainfront fan deposits (about 2,190 feet, msl) along the west, and from El Paso Subarea (2,800 feet, msl) in the southwest towards the playa at the center of the basin. Pumping centers form depressions near discharge areas in the northwest (about 2,170 feet, msl), southwest (about 2,150 feet, msl), and southeast (about 2,120 feet, msl). There is a fault causing steep groundwater level contours from El Paso Subarea to the main IWVGB.

Fall 2018 and Spring 2019 groundwater elevation contours show few seasonal differences (i.e. the southeast pumping depression is smaller in Spring 2019 than Fall 2018) at the 10-foot contour level. The trends and changes in groundwater levels are better displayed on the hydrographs in the next section.

5.2 Hydrographs

Hydrographs have been developed for all wells in the monitoring program and are posted on the DMS website (www.iwvgsp.com). Hydrographs for 30 selected wells (Figure 5-3), which include the designated key wells in the GSP used to track Basin management, are included in this Report as Attachment B. The selected wells are located at 14 sites, and include seven nested multi-level piezometers, for a total of 30 wells. Groundwater level data collected by KCWA, the Navy, and other agencies were used to produce 14 hydrographs for these 30 wells (note: data for nested multi-level piezometers appear on the same hydrograph). Groundwater level data for the majority of the hydrographs begins in the late 1980s and

[3] The DMS is a public-accessible website (iwvgsp.com). The map view displays well locations that link to hydrographs.
[4] Michelle Anderson, PG; Kern County Water Agency geologist.

early 1990s when the wells were installed, with the exception of the Inyo Well. The Inyo Well (27S/39E-07R01), located in the southwest of the IWV main basin has the longest period of record for groundwater level data in the basin dating back to 1946.

The DMS website contains all of the groundwater monitoring program data. The map interface 'window' contains 198 monitoring wells with their respective data. Hydrographs and available well construction data can be observed by choosing the well symbol (dot) and "view well page" in the pop-up window. A separate tab will open to display the available well data and hydrograph. Where available, a depth to water axis is included on the hydrographs. The user can choose multiple wells to plot for comparison.

The hydrographs in Attachment B show the historical changes of groundwater levels throughout the IWVGB. The available posted data is through October 2019 (the start of WY 2020). This section will only include discussion through the spring (March) 2019 data, the second-to-last posted groundwater level. The following bullets walk through the changes of groundwater levels from spring 2015 through spring 2019 (4 years) at the selected wells shown on Figure 5-3.

- USBR-10 nested piezometers (Attachment B Figure B1, upper graph) These wells are located in the northwest near the subflow from Rose Valley. Groundwater level change (4 years) was -2.5 feet (shallow, 640-660 feet depth), +2.6 feet (shallow-mid, 1,180-1,220 feet depth), and -3.0 feet (deep, 1,930-1,950 feet deep). Groundwater pressure in the shallow and deep piezometers track together in a downward trend (about 0.7 feet/year), whereas the shallow-mid piezometer is disconnected, showing about 0.6 feet/year rise in groundwater levels.

- USBR-6 nested piezometers (Attachment B Figure B1, lower graph) These wells are located in the northwest near the fan deposits from San Canyon. Groundwater level change (4 years) was +1.8 feet (shallow, 330-350 feet depth), -3.8 feet (mid, 1,190-1,210 feet depth), and -2.8 feet (deep, 1,640-1,660 feet deep). The shallow piezometer records seasonal signature of higher groundwater levels in the spring with reduced pumping and lower groundwater levels in the fall following the summer irrigation season. Groundwater levels at the shallow piezometer have stabilized (stopped having a downward trend) since about 2010. The deep piezometer shows about 20 feet of artesian groundwater pressure above groundwater levels in the shallow piezometer. Groundwater levels in the mid and deep piezometers continue to decline from spring 2015 through spring 2019 at -0.95 feet/year and -0.70 feet/year, respectively. (note: the most recent higher groundwater level in the deep piezometer is from Oct 2019 in WY 2020.)

- USBR-5 nested piezometers (Attachment B Figure B2, upper graph) These wells are located in the northwest at the base of Indian Wells Canyon (mountainfront recharge) and near the agricultural pumping center. Groundwater level change (4 years) was -4.3 feet (shallow, 850-870 feet depth), -3.1 feet (mid, 1,590-1,610 feet depth), and -3.8 feet (deep, 1,960-1,980 feet deep). Declining groundwater levels have been observed since construction of USBR-5 in 1993 in the shallow, mid and deep piezometers and continue to decline from spring 2015 through spring 2019 at -1.08

feet/year, -0.77 feet/year, and -0.95 feet/year, respectively. (note: the most recent higher groundwater level in the deep piezometer is from Oct 2019 in WY 2020.)

- NR-2 nested piezometers (Attachment B Figure B2, lower graph) These wells are located in the northwest about one mile east of USBR-5 and near the agricultural pumping center. Groundwater level change (4 years) was -3.5 feet (shallow, 330-350 feet depth), and +3.1 feet (deep, 1,910-1,930 feet deep). The mid piezometer (1,540-1,560 feet depth) was not measured in spring 2019 for this comparison, but groundwater levels are expected to be similar to deep piezometer as groundwater levels have been similar historically. The spring 2019 rising groundwater level (+6.0 feet from Oct 2018) in the deep piezometer is possibly showing a pressure response to mountainfront recharge and wet hydrologic conditions observed in the winter of WY 2019. The lateral and vertical location of mountainfront recharge is not fully understood for this basin. The shallow piezometer is closer to larger pumping wells in the basin and show declining groundwater levels (-0.88 feet/year) from spring 2015 to spring 2019.

- Sandquist Spa Well (Attachment B Figure B3, upper graph) This well is located between the pumping centers and the playa (discharge area). Groundwater levels have shown a steady decline since the well started to be monitored in 1995. The recent 4 years (spring 2015 through spring 2019) show a change of -2.55 feet in groundwater level, an average of -0.64 feet/year.

- Kerr McGee 17 (Attachment B Figure B3, lower graph) This well is located east of Highway 395 about 3 miles southeast of NR-2 just inside the Navy fence line. This wells sees prominent seasonal signatures. Groundwater levels have shown a steady decline since monitoring began in 1994._The recent 4 years (spring 2015 through spring 2019) show a change of -3.75 feet in groundwater level, an average of -0.94 feet/year.

- MW-32 nested wells (Attachment B Figure B4, upper graph) These wells are located along Business Highway 395 to the east of Inyokern, in the vicinity of pumping wells. Groundwater level change (4 years) was +11.4 feet (shallow-mid, 880-900 feet depth), +2.0 feet (mid-deep, 1,240-1,260 feet depth), and -3.4 feet (deep, 1,900-1,920 feet deep). MW-32 shows artesian conditions (upward groundwater level gradient) at this location, with the highest pressure head measured from the deep piezometer. Groundwater levels observed in all of the piezometers show long term declining trends with seasonal fluxes from pumping stresses.

- USBR-4 well (Attachment B Figure B4, lower graph) This well is also located along Business Highway 395, about 2 miles west of MW-32 nested piezometers. The recent 4 years (spring 2015 through spring 2019) show a change of -1.4 feet in groundwater level (1,190-1,200 feet depth). The average annual change of -0.35 feet/year is within the seasonal flux of groundwater levels measured at this well.

- 26S/39E-32L1 (Attachment B Figure B5, upper graph) This wells is located about 2 miles south of the junction of U.S. Highway 395 and California State Route 178. Groundwater levels have shown a steady decline since monitoring bean in 1995._The recent 4 years (spring 2015 through spring 2019) show a change of -4.0 feet in groundwater level, an average of -1.0 feet/year.

- George Air Corridor well (Attachment B Figure B5, lower graph) This well is located in the southeast area on Navy property. This well shows a seasonal pumping signature. Groundwater levels have shown a steady decline since the well started to be monitored in 1989. The recent 4 years (spring 2015 through spring 2019) show a change of -1.60 feet in groundwater level, an average of -0.40 feet/year.

- USBR-3 nested piezometers (Attachment B Figure B6, upper graph) These wells are located to the west of Ridgecrest and near the new Indian Wells Valley Water District (IWVWD) production wells. Groundwater level change (4 years) was -5.3 feet (shallow, 650-670 feet depth), -12.3 feet (mid, 1,320-1,340 feet depth), and -7.9 feet (deep, 1,850-1,870 feet deep). Groundwater levels in the deep piezometer shows artesian conditions at this location. Declining groundwater levels have been observed since construction of USBR-3 in 1993 in the shallow, mid and deep piezometers and continue to decline from spring 2015 through spring 2019 at -1.32 feet/year, --3.08 feet/year, and -1.98 feet/year, respectively. (note: the most recent higher/lower groundwater levels in the hydrographs is from October2019 in WY 2020.)

- Inyo well (Attachment B Figure B6, lower graph) This well has the longest period of monitoring data, since 1946, and is located in the southwest area of the IWVWD new production wells. This well was deepened once, and is close to going dry[5]. Groundwater levels have shown a steady decline since about 1953. The recent 4 years (spring 2015 through spring 2019) show a change of -4.3 feet in groundwater level, an average of -1.07 feet/year.

- AB303-05 well (Attachment B Figure B7, upper graph) This well is located in the El Paso subarea to the southwest of the main IWV groundwater basin. Steady groundwater levels have been observed at this well with a slight rise in recent years. The recent 4 years (spring 2015 through spring 2019) show a change of +2.9 feet in groundwater level, an average of +0.73 feet/year.

- USBR-1 nested piezometers (Attachment B Figure B7, lower graph) These wells are also located in the El Paso subarea, southwest of a fault that separates this subarea from the main IWV groundwater basin. Steady groundwater levels have been observed at all four piezometers since about 1995, with a slight rise in recent years. Only the shallow and shallow-mid piezometers were measured in both spring 2015 and spring 2019 for a 4-year comparison, showing groundwater level changes +0.6 feet for both piezometers (shallow, 615-635 feet depth; and shallow-mid, 1,040-1,060 feet depth). These groundwater level changes correspond to average annual changes of +0.15 feet/year.

5.3 Estimated Change in Groundwater Storage from Spring 2015 to Spring 2019

Groundwater levels have declined in many parts of the IWVGB during the last four years from Spring 2015 through Spring 2019. There are some areas that show little change, or even a rise in groundwater levels, especially in the El Paso subarea. Two different methods were used to evaluate the changes in

[5] A Technical Support Services grant with DWR is being investigated for replacing this well to continue the historical record.

groundwater levels from Spring 2015 through Spring 2019 – (1) map color flood comparison of measured groundwater level change, and (2) Thiessen polygons method using 41 monitoring wells distributed throughout the basin to estimate changes in groundwater storage.

5.3.1 Groundwater Level Change from Spring 2015 to Spring 2019

Groundwater levels were measured at 134 wells during both Spring 2015 and Spring 2019. These groundwater data were compared to evaluate the average annual groundwater level change across the basin. The histogram in Figure 5-4 shows the distribution of average annual changes observed in groundwater levels from wells within the monitoring program. About 73% of wells measured observed a decrease in groundwater levels during the last four years.

Figure 5-5 shows the average annual groundwater elevation change from 2015 to 2019 displayed as gradational colors for the 134 monitoring wells with data for both Spring 2015 and Spring of 2019. The highest levels of groundwater elevation change observed (orange dots) appear to correlate with pumping and discharge areas. The largest decline in groundwater levels were observed at 25S/38E-34A01 (-13.9 feet/4-years) located near the northwest pumping center, and 27S/39E-11D02 (USBR-3-mid, -12.3 feet/4-years) located near the south/southwest pumping center. These wells can be seen as the two orange dots (< -3.0 feet/year) on Figure 5-5. The average change in measured groundwater levels was -1.26 feet/year and the median change in measured groundwater levels was -1.41 feet/year between 2015 and 2019.

No loss of groundwater storage is observed in 27% of the wells, shown as blue dots in Figure 5-5. This flat or slight rise in groundwater levels occurred in the El Paso subarea where there is very limited pumping; and near Ridgecrest where pumping was cut back as IWVWD moved its production further to the west.

5.3.2 Thiessen Polygon Method

The Thiessen Polygon Method (Dunne and Leopold, 1978) was used to estimate annual groundwater storage change within the IWVGB based on observed spring water levels at 41 wells from WY 2016 through WY 2019. The wells were chosen based on their period of record and distributed location throughout the basin to form the Thiessen Polygons. This method provides a weighted average of changes in groundwater storage based on annual observed groundwater levels.

Figure 5-6 displays the Thiessen polygons formed by the 41 wells. Each polygon was developed using geographical information system (GIS) to calculate perpendicular bisectors[6] and areas. The 41 polygons are summarized in Attachment C and represent a total of 304,726 acres. These polygons range in size from 2,662 acres (polygon TP-34) near Ridgecrest where there are many wells to 36,916 acres (polygon TP-22) in the northeast region of the IWVGB where there are few wells.

The change in groundwater storage for each polygon was calculated from the change in groundwater levels and the aquifer's specific yield (Sy) using the following equation:

Change of Groundwater in Storage (ft^3) = [area (ft^2)] x [Sy (unitless)] x [change in DTW (ft)]

Where:	*area*	*acreage of polygon (1 acre = 43,560 square feet)*
	Sy	*from calibrated groundwater model (GSP, Appendix 3-H)*[7]
	DTW	*from KCWA/Navy Groundwater Monitoring Program*

Attachment C tabulates the data used to calculate storage change at each of the 41 polygons for four years: WY 2016 through WY 2019. Table 5-1 summarizes these results for the IWV main groundwater basin and the El Paso subarea. Based on measured groundwater levels, the Thiessen polygon method estimates an annual decrease in groundwater storage within the IWV main basin for WY 2016 through WY 2019. This method estimates an overall increase in groundwater storage in the El Paso subarea where there is very limited pumping (and limited groundwater level data). The largest groundwater storage change (-21,930 acre-feet) occurred in WY 2018 during a below normal precipitation year. Figure 5-7 provides a plot of the estimated groundwater storage change from WY 2016 to WY 2019 along with the WY 2019 groundwater pumping. See Section 6.1 for the discussion of groundwater pumping.

[6] The edges of the polygons are equidistant to two measuring points. Each edge is setup by first drawing a line connecting two adjacent points; locating the bisector, and then draw a second line perpendicular to the first intersecting at the bisector. This second line is the edge of the Thiessen-weighted average polygon. This is done between all points in the basin until the entire two-dimensional plane within the specified boundaries is subdivided into multiple polygons.

[7] Stetson Engineers Inc, 2020.

Table 5-1: WY 2016 to WY 2019 Estimated Groundwater Storage Change, Thiessen Polygon Method

	Thiessen Area (acres)	**WY 2016** (AF)	**WY 2017** (AF)	**WY 2018** (AF)	**WY 2019** (AF)	**4-Year Cumulative Change** (AF)
Northwest	45,360	770	-7,310	-4,950	-8,730	-20,220
Southwest	26,550	-600	-2,530	-1,120	2,520	-1,740
Southeast	37,370	-1,450	-1,220	-3,180	-2,220	-8,070
Navy	128,820	-2,040	5,130	-10,130	-2,020	-9,060
IWV Main Basin	238,100	-3,320	-5,930	-19,380	-10,450	-39,090
El Paso subarea	66,640	4,700	4,430	-2,550	10,330	16,910
Total	304,740	1,380	-1,500	-21,930	-120	-22,180
Hydrologic Condition		*BN*	*AN*	*BN*	*W*	

6.0 Water Supply Data

6.1 Groundwater Extraction Data

Groundwater from the IWVGB is the sole source of potable water in the Indian Wells Valley. Groundwater is produced from approximately 930 wells. Figure 6-1 provides the location of the production wells in the IWVGB[8]. In 2018, the IWVGA began efforts to determine groundwater production in the IWVGB and compiled data from multiple existing reports and sources.

For the purpose of developing the numerical flow model, historical groundwater extractions were evaluated for establishing future baseline pumping conditions. The most recent available pumping data were compiled from known and cooperative individual groundwater producers. Through stakeholder outreach efforts, major pumpers provided estimates to use for future conditions that reflected their projected water demands. Prior studies were used to estimate pumping for groundwater producers where little data were available nor provided by stakeholder outreach. Through these efforts to establish baseline groundwater conditions in the IWVGB, an estimate of groundwater extractions to be modeled in

[8] There is insufficient data by well to display the volume of each production well on Figure 6-1; however, the figure shows the location of wells by well use category.

WY 2019 was determined. These groundwater production volumes are provided in Table 6-1. The Baseline (No Action) estimate of total groundwater extractions was greater than actual groundwater produced (and reported) in the IWVGB during WY 2019.

In mid-2018, the IWVGA began a well registration and well reporting effort for the purpose of collecting volumetric pumping fees. Non-*de minimis* users, other than federal entities, are required to register their groundwater production wells and report monthly groundwater production as of September 2018 (note: pumping fees also do not apply to federal entities). Currently, there are some non-compliant groundwater producers in the IWVGB. The methods that groundwater producers use to report their production include the following:

- Water meters
- Electrical meters
- Estimates based on land use
- Estimates based on population served by groundwater production well

These groundwater production data that were reported to the IWVGA during WY 2019 for the purposes of the volumetric pumping fee are provided in Table 6-1. This estimate of total groundwater extractions is less than actual groundwater produced in the IWVGB during WY 2019 due to inaccuracies of self-reporting, non-compliant groundwater producers, and groundwater producers present in the IWVGB that are not subject to reporting.

Additionally, in early 2020, the IWVGA requested historical pumping records from all non-*de minimis* pumpers (excluding federal entities) for the purpose of allocating the sustainable yield of the IWVGB. As with the required reported production for the pump fee, not all groundwater pumpers fully complied with the request. This self-reported data from groundwater pumpers was also used to estimate the total IWVGB production during WY 2019.

The best engineering estimate of WY 2019 pumping is derived from the combination of all pumping records and sources and is presented in the final column in Table 6-1, below. Attachment D provides a more detailed breakdown of pumping categories and the data source for each value. The IWVGA is continually working to improve its estimate of groundwater production in the IWVGB because these data are critical components of the water budget and essential for managing sustainability.

Table 6-1: IWVGB Groundwater Production Estimates

Water Use Sector	Estimated No Action Projections (AF)	WY 2019 Reported Pumping (incomplete) [3]	WY 2019 Total Estimated Pumping (AF) [6]
Urban	6,940	6,360	6,360
Industrial	2,910	2,690	2,690
Agriculture	21,630[2]	9,660	10,920
Other – Federal [1]	2,040	-- [4]	1,460
Other – Domestic/ Mutuals/Co-Ops	1,380	410 [5]	1,380
TOTAL	**34,900**	(incomplete)	**22,810**

1 Federal groundwater use is for NAWS China Lake. Estimates were provided by the U.S. Navy.

2 This value likely overestimates actual agricultural groundwater production in WY 2018-19 because some agriculture groundwater producers self-reported future planned water demands.

3 These values underestimate actual groundwater production in WY 2018-19 because not all non-de minimis groundwater producers submit data regularly to the IWVGA and because some groundwater producers were not required to report their groundwater production during WY 2018-19.

4 Federal entities are not required to report monthly production to the IWVGA for the purpose of the fee.

5 De minimis users (those that produce less than 2 acre-feet per year (AFY) or those that have four or fewer connections) are not required to report monthly production to the IWVGA for the purpose of the fee.

6 See Attachment D for a more detailed table.

6.2 Surface Water Supply

Natural surface waters are not used as a drinking water supply source in the IWVGB. Approximately 2,490 acre-feet of recycled water was produced at the City of Ridgecrest’s wastewater treatment plant during WY 2019 and was used for the following:

- Landscape irrigation
- Agricultural irrigation
- Partial maintenance of the Mojave Tui Chub habitat
- Discharge to evaporation/percolation ponds

Table 6-2 below provides the estimated breakdown of beneficial recycled water use in WY 2019.

Table 6-2: WY 2019 Recycled Water Use.

Recycled Water Use Sector	WY 2019 Estimated Use[1] (AF)
Urban[2]	350
Agriculture[3]	130
Other[4]	800
TOTAL	**1,280**

1 Data provided in email by the City of Ridgecrest to Joseph Montoya on April 9, 2020.
2 Used for irrigation of golf course on NAWS China Lake.
3 Used for irrigation of alfalfa fields for beneficial re-use.
4 Recycled water not used for urban and agricultural irrigation is disposed of in evaporation/percolation ponds. Approximately 2,010 AF was discharged to the ponds in WY 2019. It is estimated approximately 60 percent of the recycled water discharged to the ponds evaporates, with the remaining percolating to the groundwater (Provost and Pritchard Consulting Group, 2015). In addition, these ponds partially support the Mojave Tui Chub habitat on NAWS China Lake.

6.3 Total Water Use

Total water use in the IWVGB during WY 2019 is comprised of groundwater supplies and recycled water supplies. See Sections 6.1 and 6.2 above for additional detail on these supplies.

Table 6-3: WY 2019 Estimated Total Water Use in the IWVGB.

Use Category	WY 2019 Estimated Total Water Use (AF)
Groundwater Production	22,810
Recycled Water	1,280
TOTAL	**24,090**

7.0 References

California Code of Regulations (CCR). Title 23, Division 2. Chapter 1.5. Sections 351and 356.2.

Department of Water Resources. 2016. Water Budget Best Management Practice. https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Water_Budget_Final_2016-12-23.pdf December 2016.

Dunne, Thomas, and Luna Leopold, 1978. Water in Environmental Planning.

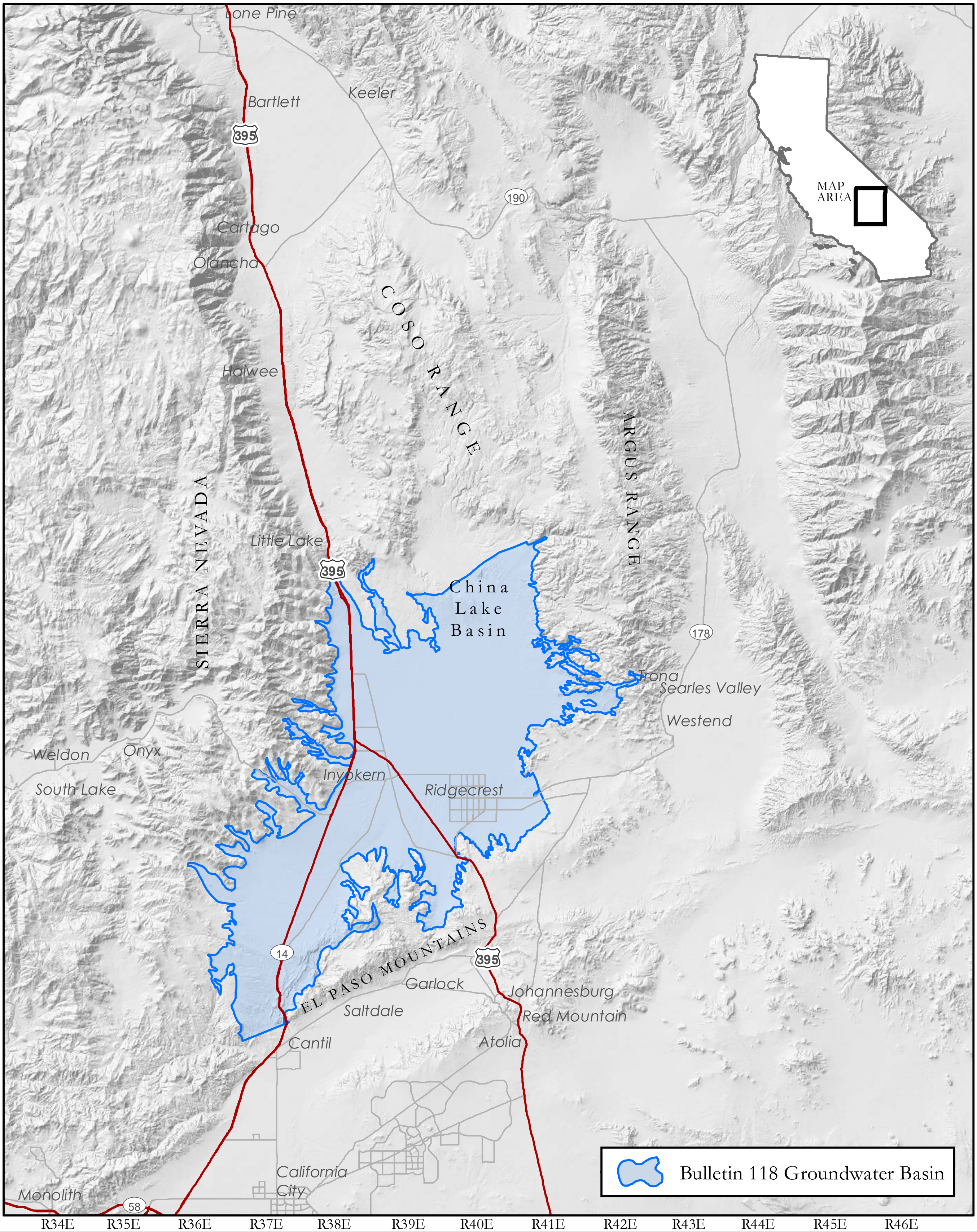
Provost & Pritchard, 2015. Wastewater Treatment Plant Facility Plan. Prepared for the City of Ridgecrest. October 2015.

Stetson Engineers Inc, 2020. *Indian Wells Valley Groundwater Authority;* Groundwater Sustainability Plan for the Indian Wells Valley Groundwater Basin, Bulletin 118 Basin No. 6-054.

Western Regional Climate Center (WRCC). 2018. 1971 – 2000 Climate Normals for Stations 041733 (China Lake NAF), 044278 (Inyokern), 049035 (Trona), 043710 (Haiwee), 047253 (Randsburg), and 044232 (Independence). Accessed at: https://wrcc.dri.edu/Climate/west_coop_summaries.php, December 5, 2018.

Western Regional Climate Center (WRCC). 2020. Period of Record Monthly Climate Summary for Cooperative Stations 041733 (China Lake NAF), 044278 (Inyokern), 049035 (Trona), 043710 (Haiwee). Accessed at: https://wrcc.dri.edu/Climate/west_coop_summaries.php, April 6, 2020.

Figures

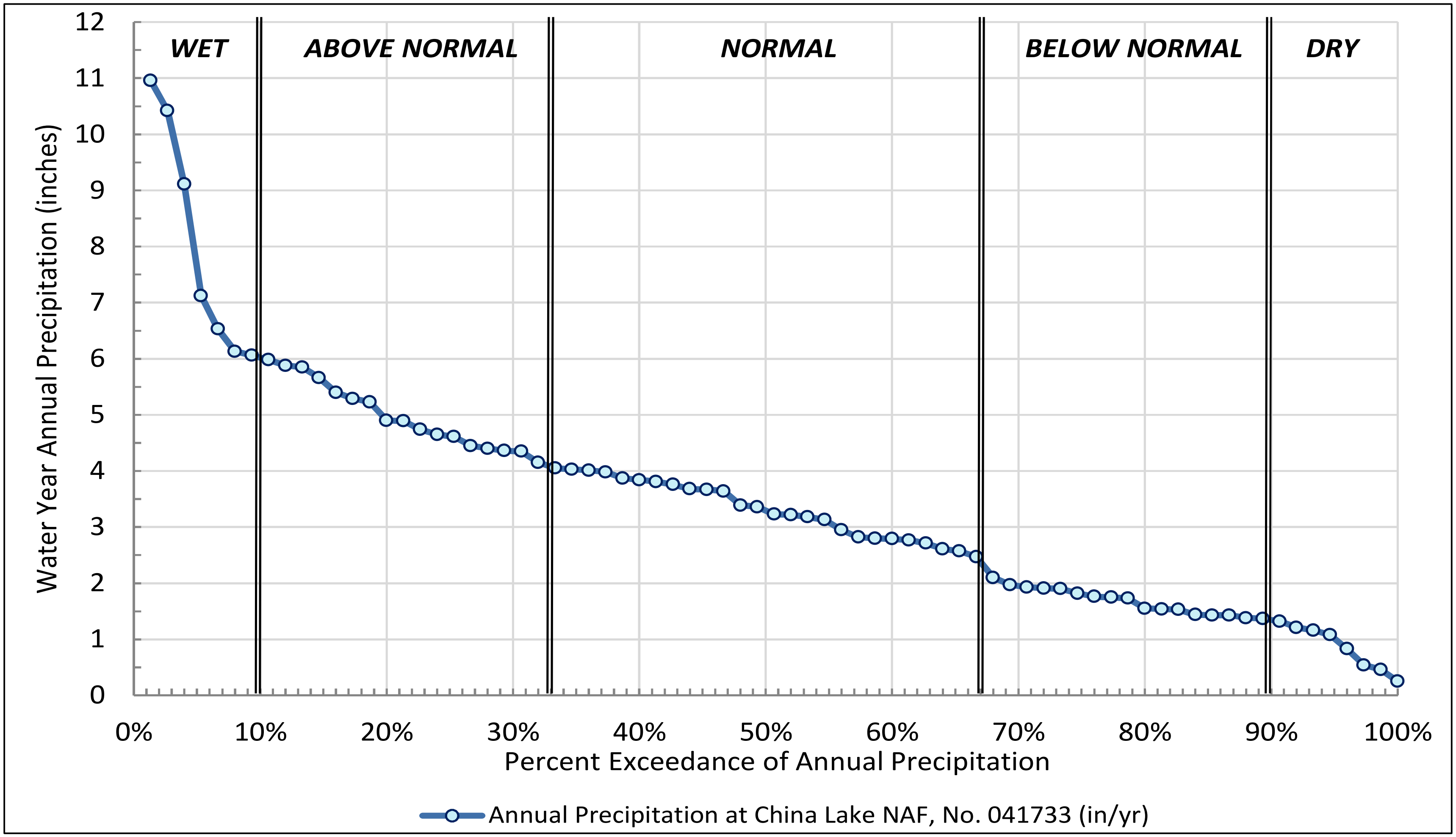


Document Path: J:\in2652\Fig2-1_IWV_GW_basin_authority.mxd

STETSON ENGINEERS INC.

INDIAN WELLS VALLEY GROUNDWATER BASIN AND INDIAN WELLS VALLEY GROUNDWATER AUTHORITY BOUNDARIES

(DWR BULLETIN 118 BASIN NO. 6-054)

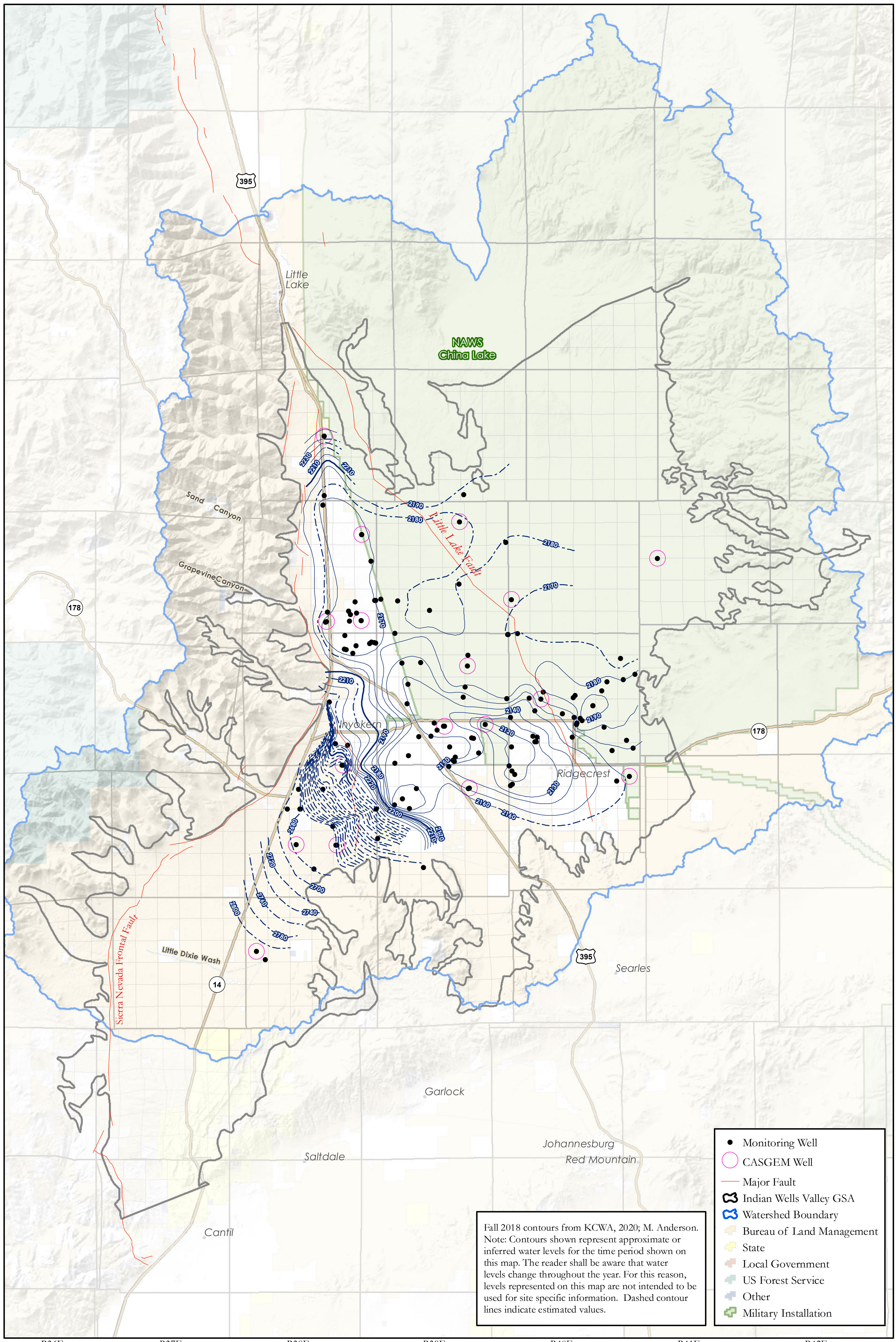


STETSON ENGINEERS INC.

PERCENT EXCEEDANCE OF ANNUAL PRECIPITATION AT INDEX STATION CHINA LAKE NAF
WATER YEAR 1945 - 2019

FIGURE 4-1

Document Path: J:\jn2652\IndianWellsValley_GWContour_Fall2018.mxd



STETSON ENGINEERS INC.

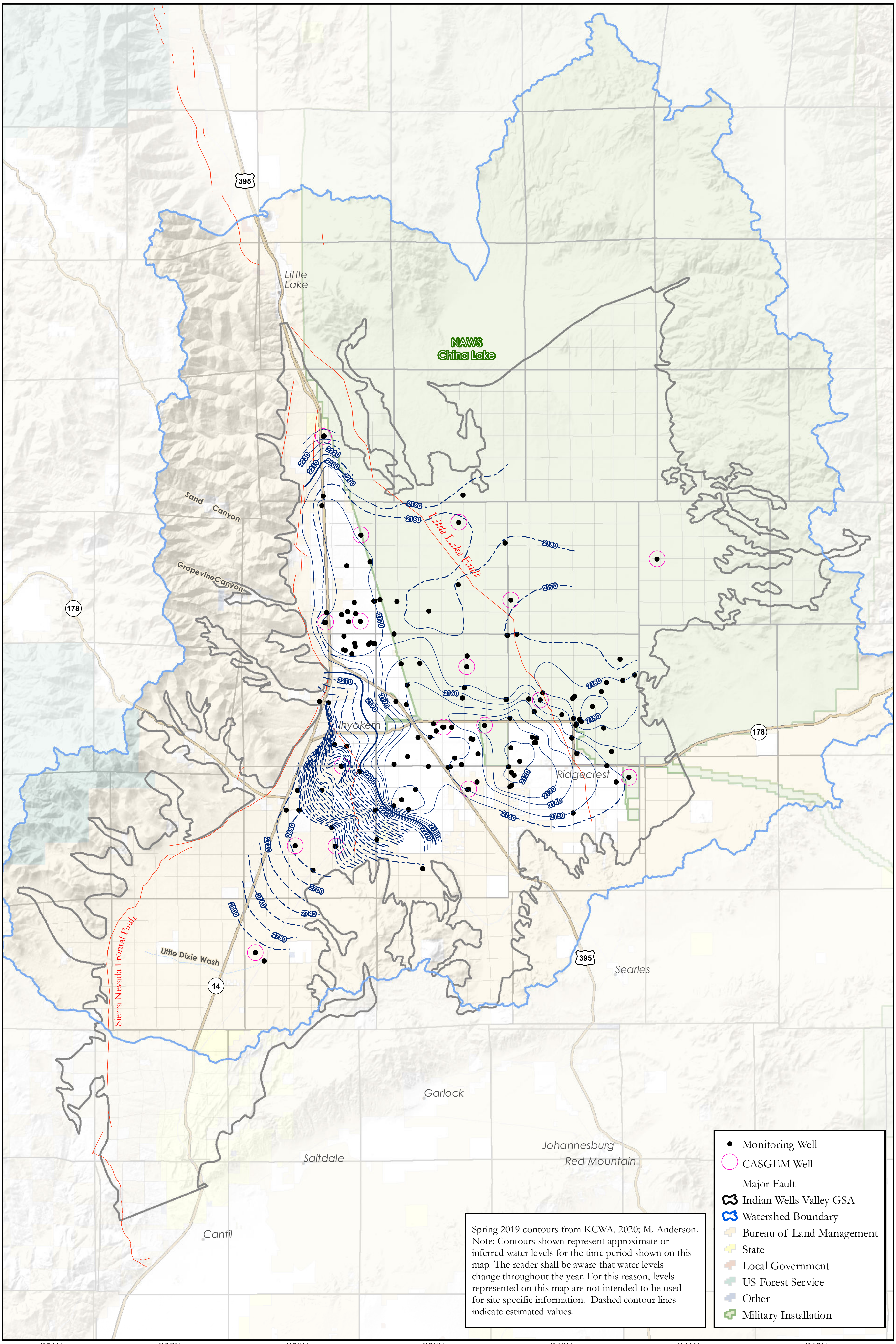
FALL 2018
GROUNDWATER ELEVATION CONTOURS
INDIAN WELLS VALLEY

0 2 4 Miles

N

FIGURE 5-1

Document Path: J:\jn2652\IndianWellsValley_GWContour_Spring2019.mxd



STETSON ENGINEERS INC.

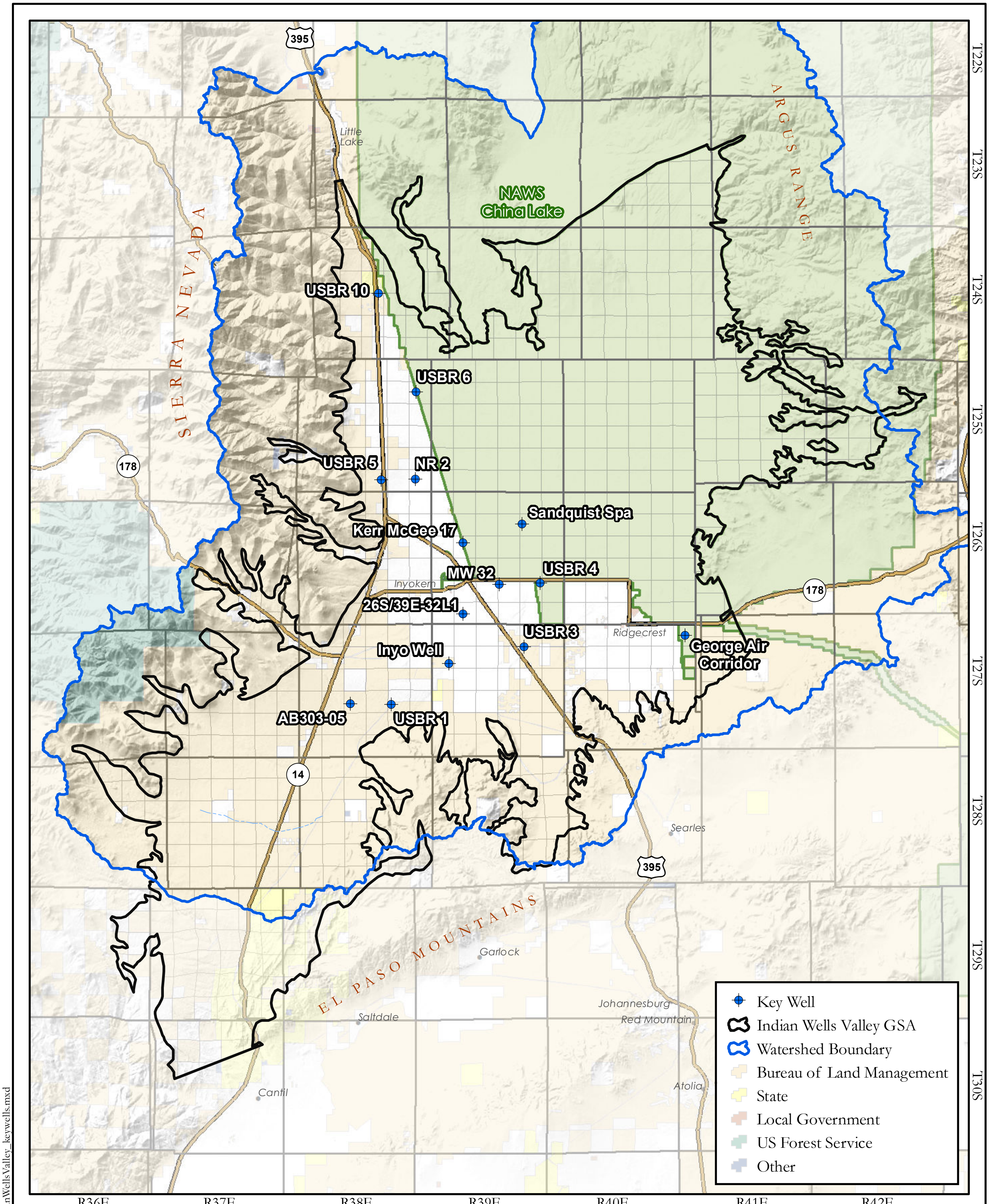
SPRING 2019
GROUNDWATER ELEVATION CONTOURS
INDIAN WELLS VALLEY

0 2 4 Miles

N

FIGURE 5-2

FIGURE 5-3

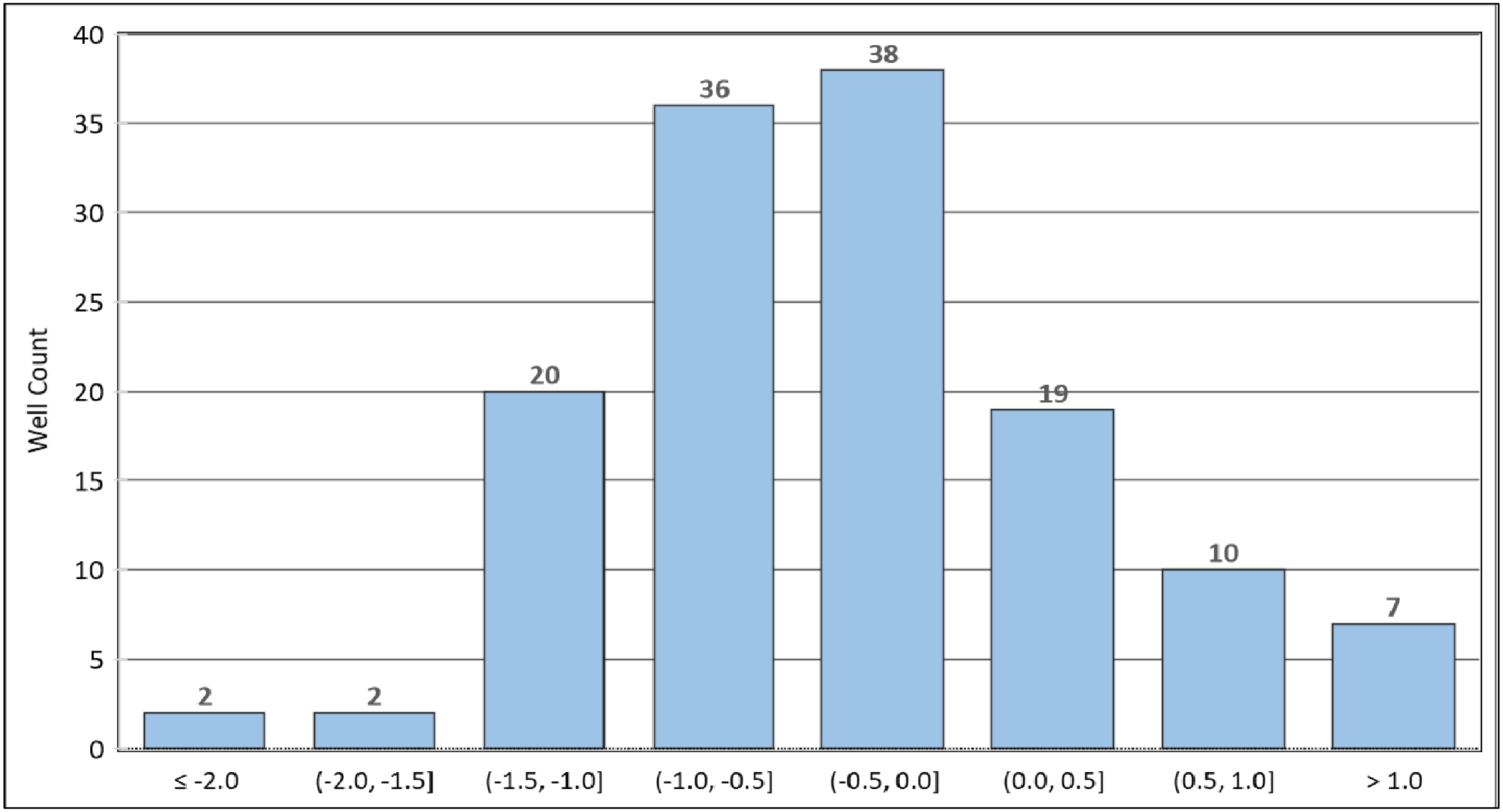


Document Path: I:\n2652\IndianWellsValley_keywells.mxd

STETSON ENGINEERS INC.

MONITORING WELLS WITH HYDROGRAPHS IN ATTACHMENT B

INDIAN WELLS VALLEY

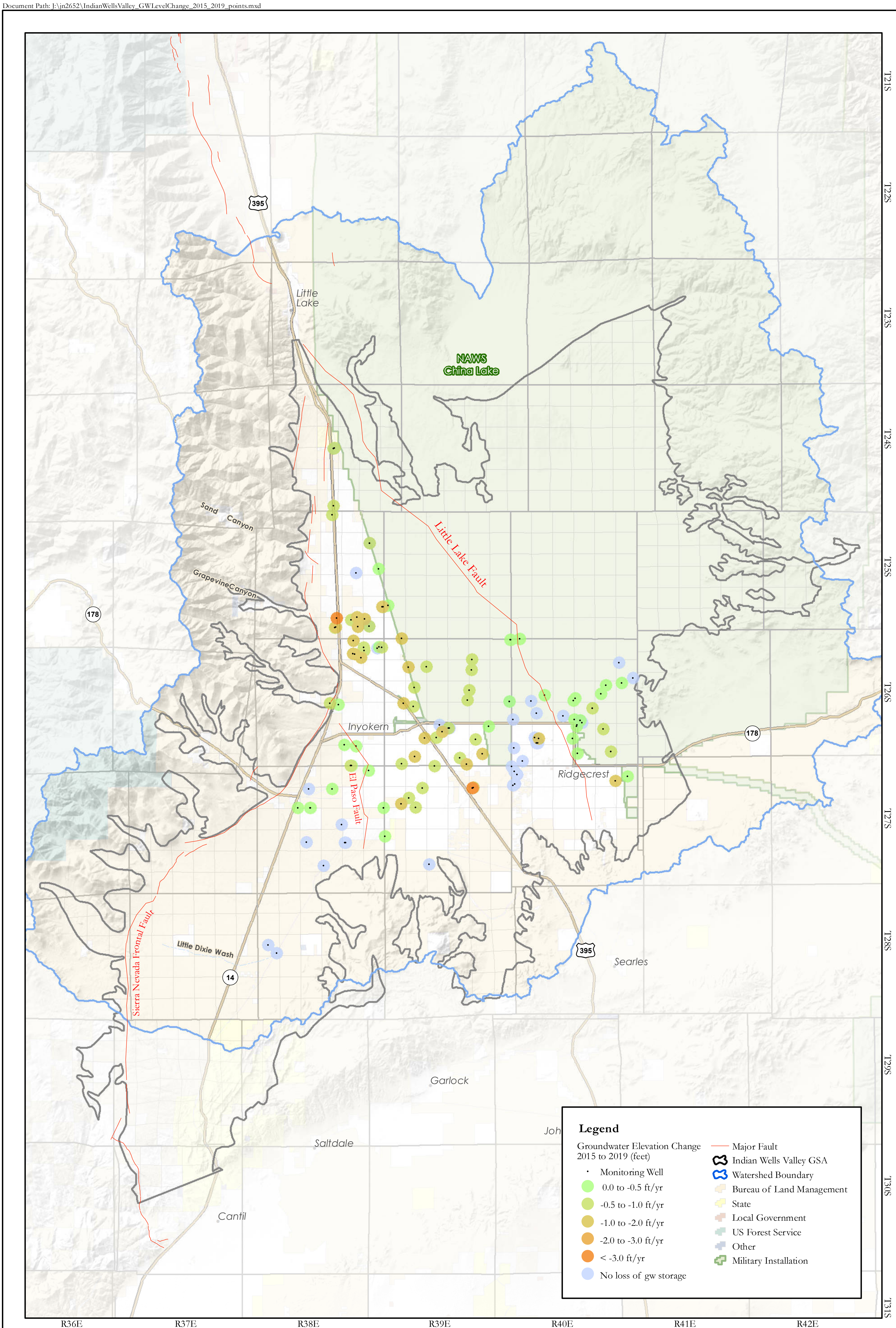


STETSON
ENGINEERS INC.

DISTRIBUTION OF GROUNDWATER LEVEL CHANGE DATA FROM 134 MONTIORING WELLS
AVERAGE ANNUAL CHANGE FROM SPRING 2015 TO SPRING 2019

FIGURE 5-4

Document Path: J:\jn2652\IndianWellsValley_GWLevelChange_2015_2019_points.mxd



STETSON ENGINEERS INC.

AVERAGE ANNUAL GROUNDWATER LEVEL CHANGE SPRING 2015 TO SPRING 2019

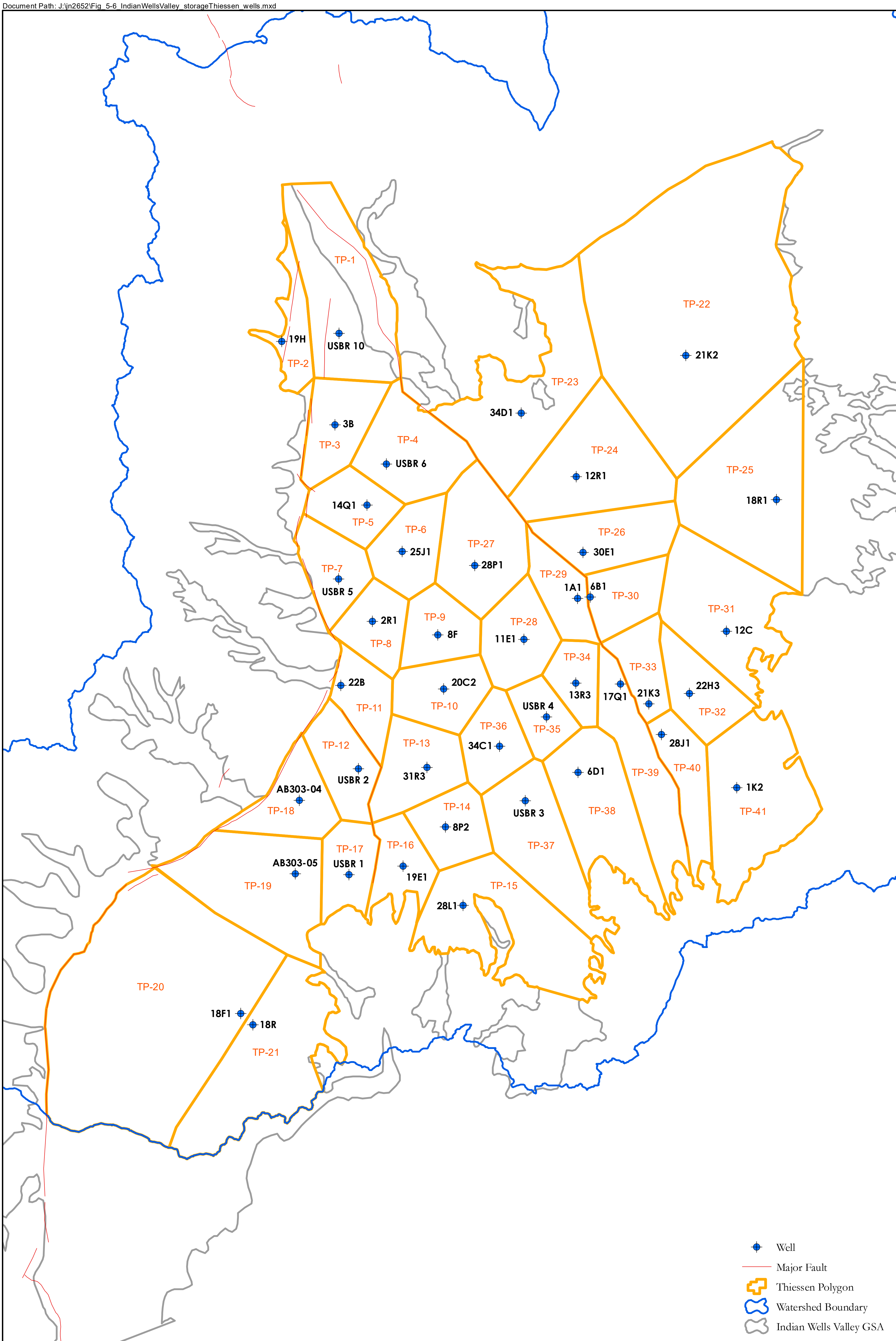
INDIAN WELLS VALLEY

0 2 4 Miles

N

FIGURE 5-5

Document Path: J:\jn2652\Fig_5-6_IndianWellsValley_storageThiessen_wells.mxd



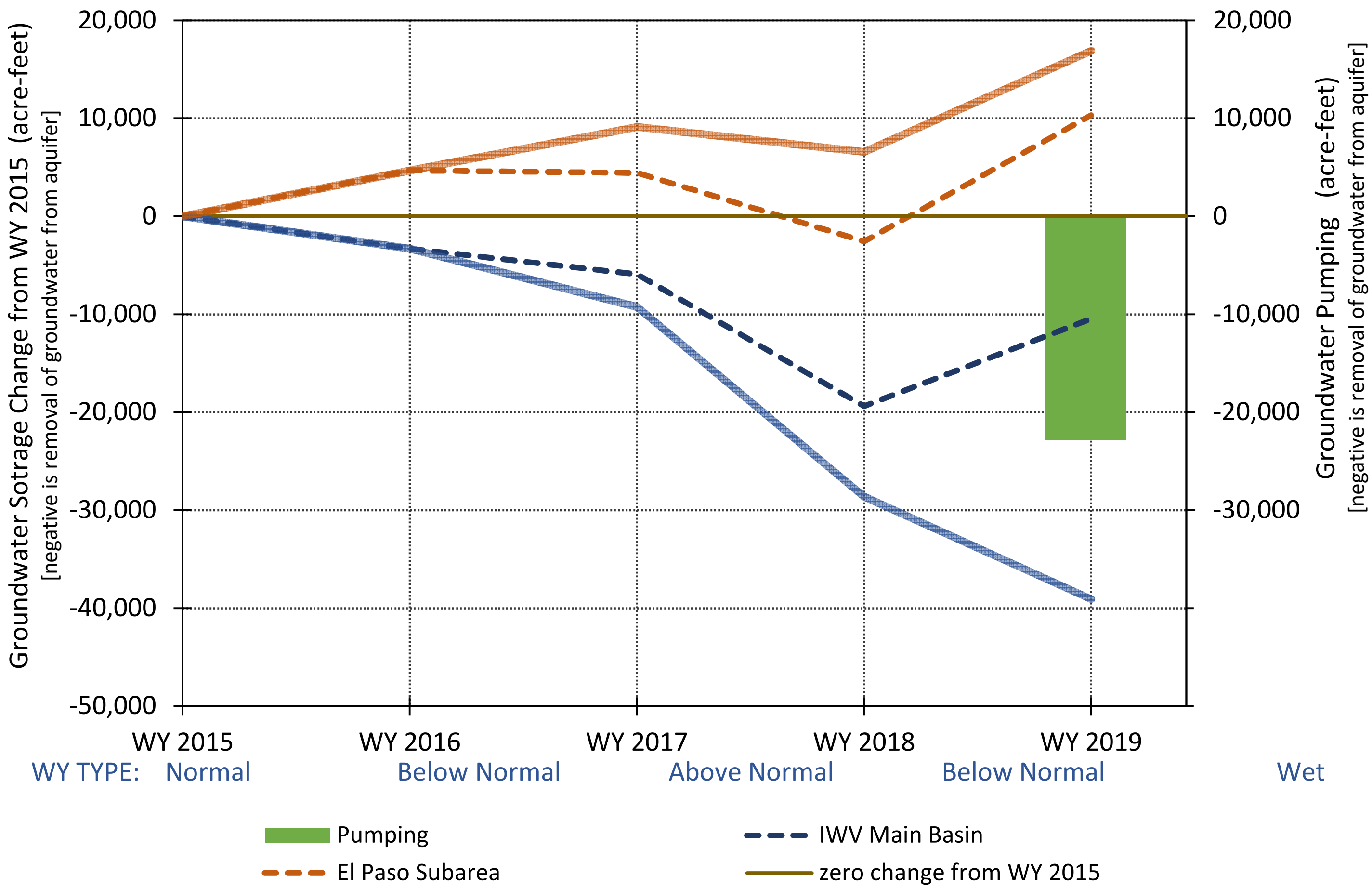
STETSON ENGINEERS INC.

THIESSEN POLYGONS
INDIAN WELLS VALLEY

0 1.5 3 Miles

N

FIGURE 5-6



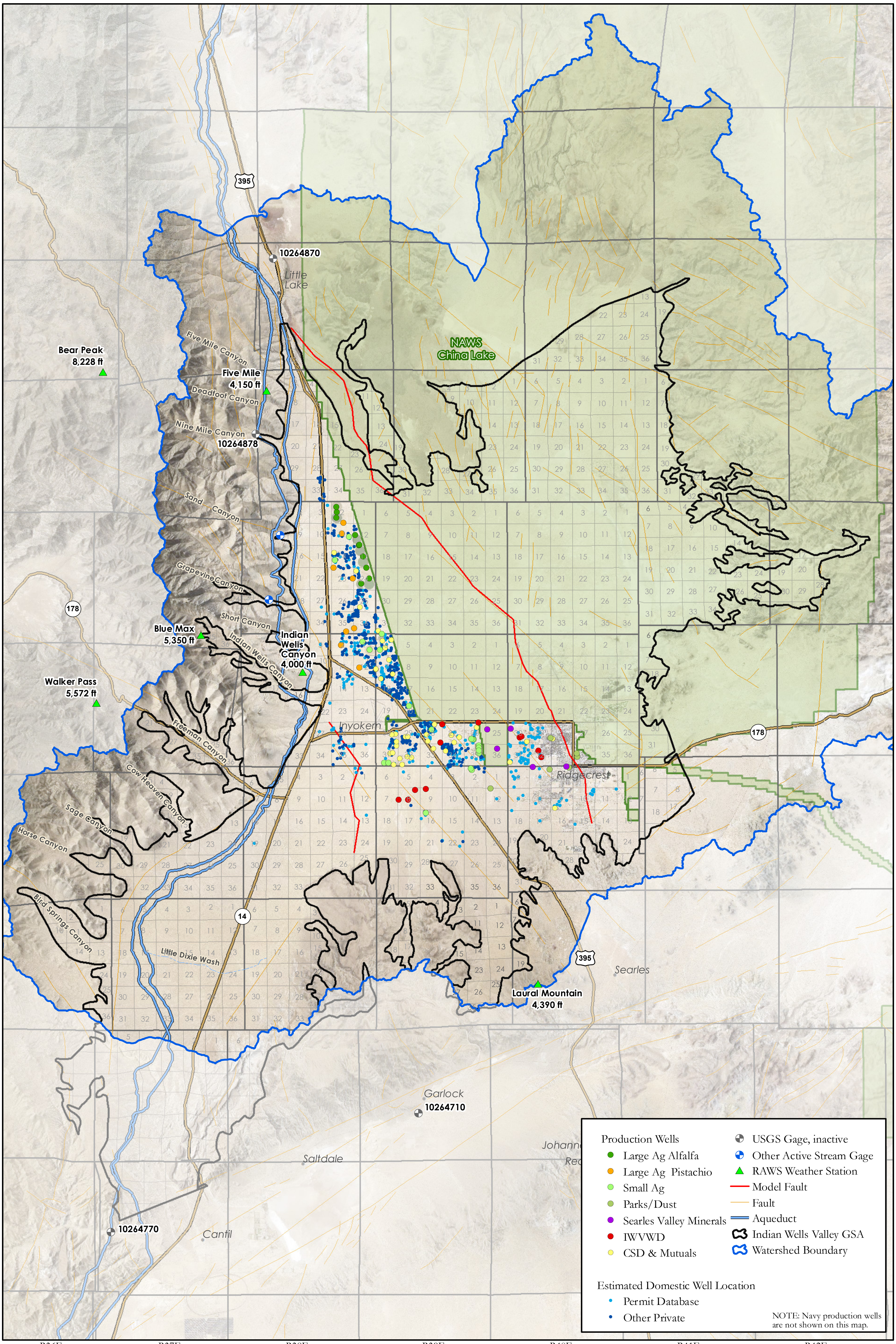
Note: Groundwater storage change is estimated based on the Thiesen polygon method (see IWV Annual Report)

STETSON ENGINEERS INC.

ESTIMATED GROUNDWATER STORAGE CHANGE FROM WY 2016 TO WY 2019 AND WY 2019 GROUNDWATER PUMPING

FIGURE 5-7

Document Path: J:\jn2652\IndianWellsValley_ShallowWellImpact_Locationmap.mxd



PUMPING WELL LOCATION MAP
INDIAN WELLS VALLEY

0 2 4 Miles

N

STETSON ENGINEERS INC.

FIGURE 6-1

Attachment A

Groundwater Level Data: Fall 2018 and Spring 2019

Attachment A: Groundwater Level Data

Fall 2018 & Spring 2019

					Fall 2018			Spring 2019			
State ID	CASGEM	Alternate Well Name	X	Y	Date	DTW (ft, bgs)	GW Elev (ft, msL)	Date	DTW (ft, bgs)	GW Elev (ft, msL)	Change in DTW WY 2019
24S/38E-21A01	✓	USBR-10-S	-117.87176	35.84143				3/11/2019	317.98	2,241	
24S/38E-21A02	✓	USBR-10-SM	-117.87258	35.84134	10/15/2018	318.09	2,241	3/11/2019	317.69	2,242	0.40
24S/38E-21A04	✓	USBR-10-D	-117.87258	35.84134	10/15/2018	316.96	2,242	3/11/2019	317.96	2,241	-1.00
24S/38E-33J02			-117.87258	35.80190	10/15/2018	295.40	2,171	3/11/2019	294.80	2,172	0.60
24S/39E-34D01			-117.75901	35.80213	10/15/2018	46.81	2,180	3/11/2019	46.85	2,180	-0.04
25S/38E-03B			-117.87382	35.79546	10/15/2018	288.90	2,167	3/11/2019	288.10	2,168	0.80
25S/38E-12L01	✓	USBR-06-S	-117.84203	35.77607	10/15/2018	183.45	2,169	3/11/2019	180.49	2,172	2.96
25S/38E-12L02	✓	USBR-06-M	-117.84203	35.77607	10/15/2018	187.72	2,165	3/11/2019	187.06	2,166	0.66
25S/38E-12L03	✓	USBR-06-D	-117.84203	35.77607	10/15/2018	165.98	2,187	3/11/2019	165.92	2,187	0.06
25S/38E-13J01			-117.83480	35.75829	10/15/2018	124.99	2,167	3/11/2019	122.88	2,169	2.11
25S/38E-14Q01			-117.85372	35.75542				3/11/2019	225.60	2,165	
25S/38E-25J01			-117.83175	35.73218	10/15/2018	117.00	2,160	3/11/2019	115.40	2,162	1.60
25S/38E-25J02			-117.83087	35.73208	10/15/2018	117.50	2,158	3/11/2019	117.20	2,159	0.30
25S/38E-25J03			-117.83175	35.73218	10/15/2018	121.80	2,154	3/11/2019	120.90	2,155	0.90
25S/38E-25M			-117.84767	35.73135	10/15/2018	205.00	2,168	3/11/2019	204.00	2,169	1.00
25S/38E-34A01			-117.87024	35.72453	10/15/2018	359.70	2,169	3/11/2019	359.40	2,169	0.30
25S/38E-34G01	✓	USBR-05-S	-117.87090	35.71813	10/15/2018	357.42	2,163	3/11/2019	357.32	2,163	0.10
25S/38E-34G02	✓	USBR-05-M	-117.87175	35.71801	10/15/2018	365.82	2,155	3/11/2019	365.02	2,155	0.80
25S/38E-34G03	✓	USBR-05-D	-117.87175	35.71801	10/15/2018	368.07	2,152	3/11/2019	367.67	2,153	0.40
25S/38E-35A			-117.85156	35.72272	10/15/2018	215.40	2,143				
25S/38E-35B01			-117.85286	35.72509	10/15/2018	235.34	2,161	3/11/2019	234.54	2,162	0.80
25S/38E-35C			-117.85805	35.72307				3/11/2019	260.60	2,163	
25S/38E-35H			-117.85238	35.71860	10/15/2018	195.50	2,161	3/11/2019	195.20	2,162	0.30
25S/38E-36D			-117.84667	35.72366	10/15/2018	179.70	2,164	3/11/2019	181.00	2,163	-1.30
25S/38E-36G01	✓	NR 2-S	-117.84271	35.71868	10/15/2018	154.56	2,160	3/11/2019	153.26	2,161	1.30
25S/38E-36G02	✓	NR 2-M	-117.84271	35.71868	10/15/2018	172.77	2,142				
25S/38E-36G03	✓	NR 2-D	-117.84271	35.71868	10/15/2018	175.76	2,139	3/11/2019	169.36	2,145	6.40
25S/39E-03R01	✓	Baker Range	-117.76257	35.78412	10/15/2018	50.16	2,176	3/11/2019	50.31	2,176	-0.15
25S/39E-12R01			-117.72496	35.77039	10/15/2018	24.15	2,178	3/11/2019	24.18	2,178	-0.03
25S/39E-22J01			-117.76290	35.74300	10/15/2018	41.28	2,177	3/11/2019	41.35	2,177	-0.07
25S/39E-28P01			-117.78701	35.72551	10/15/2018	44.54	2,185	3/11/2019	39.37	2,190	5.17
25S/39E-29M01			-117.81286	35.73190	10/15/2018	56.79	2,176	3/11/2019	57.41	2,175	-0.62
25S/39E-30E01			-117.82675	35.73301	10/15/2018	53.78	2,195	3/11/2019	53.54	2,195	0.24
25S/39E-31R01			-117.81536	35.71051	10/15/2018	89.07	2,173	3/11/2019	89.05	2,173	0.02
25S/40E-30E01	✓	TTBKMW14	-117.72033	35.73254	10/15/2018	14.11	2,177	3/11/2019	14.19	2,177	-0.08
25S/40E-31P			-117.71563	35.70996	10/15/2018	20.72	2,171	3/11/2019	20.48	2,171	0.24
25S/41E-18R01	✓	TTBKMW12	-117.60148	35.75969	10/15/2018	22.29	1,981	3/11/2019	22.10	1,981	0.19
26S/38E-01E03			-117.84716	35.70417				3/11/2019	202.90	2,170	
26S/38E-01G02			-117.83580	35.70363	10/15/2018	175.50	2,163	3/11/2019	175.30	2,163	0.20
26S/38E-01H03			-117.83079	35.70384	10/15/2018	156.56	2,162	3/11/2019	154.76	2,164	1.80
26S/38E-01H05			-117.83200	35.70406	10/15/2018	160.65	2,158	3/11/2019	158.75	2,160	1.90

Attachment A: Groundwater Level Data

Fall 2018 & Spring 2019

					Fall 2018			Spring 2019			
State ID	CASGEM	Alternate Well Name	X	Y	Date	DTW (ft, bgs)	GW Elev (ft, msL)	Date	DTW (ft, bgs)	GW Elev (ft, msL)	Change in DTW WY 2019
26S/38E-01H06			-117.83447	35.70453	10/15/2018	169.00	2,150	3/11/2019	167.80	2,151	1.20
26S/38E-01M05			-117.84707	35.70215	10/15/2018	211.80	2,162	3/11/2019	210.40	2,163	1.40
26S/38E-02B01			-117.85615	35.70886	10/15/2018	209.60	2,163	3/11/2019	211.10	2,162	-1.50
26S/38E-02Q01			-117.85645	35.70000	10/15/2018	250.00	2,159	3/11/2019	249.40	2,160	0.60
26S/38E-02Q02			-117.85503	35.69941	10/15/2018	247.70	2,162	3/11/2019	246.90	2,163	0.80
26S/38E-02R01			-117.84962	35.69703	10/16/2018	237.10	2,161	3/12/2019	236.40	2,162	0.70
26S/38E-22B			-117.86875	35.66466	10/15/2018	427.80	2,238	3/11/2019	426.60	2,240	1.20
26S/38E-22D			-117.87597	35.66566				3/11/2019	60.60	2,788	
26S/38E-35B			-117.85408	35.63608	10/15/2018	343.50	2,231	3/11/2019	342.40	2,232	1.10
26S/38E-35D			-117.86398	35.63714	10/15/2018	448.30	2,237	3/11/2019	447.80	2,237	0.50
26S/39E-01A01			-117.72341	35.70940	10/15/2018	48.23	2,169	3/11/2019	48.16	2,169	0.07
26S/39E-01A02			-117.72313	35.70940	10/15/2018	41.09	2,177	3/11/2019	41.11	2,177	-0.02
26S/39E-02N01			-117.75591	35.69579	10/15/2018	113.17	2,173	3/11/2019	113.37	2,173	-0.20
26S/39E-08F			-117.80952	35.69051	10/15/2018	164.70	2,155	3/11/2019	164.54	2,155	0.16
26S/39E-09E			-117.79452	35.69079	10/15/2018	171.50	2,141	3/11/2019	169.66	2,143	1.84
26S/39E-11E01	✓	Sandquist Spa	-117.75647	35.68857	10/15/2018	134.15	2,173	3/11/2019	134.35	2,173	-0.20
26S/39E-13R03			-117.72424	35.66663	10/15/2018	151.07	2,168	3/11/2019	151.17	2,168	-0.10
26S/39E-13R04			-117.72424	35.66663	10/15/2018	194.30	2,126	3/11/2019	190.01	2,130	4.29
26S/39E-14E01			-117.75841	35.67440	10/15/2018	168.06	2,167	3/11/2019	168.28	2,167	-0.22
26S/39E-15J			-117.75980	35.66774	10/15/2018	202.98	2,145	3/11/2019	202.85	2,145	0.13
26S/39E-17G02			-117.80452	35.67635	10/15/2018	207.14	2,149	3/11/2019	206.25	2,150	0.89
26S/39E-20C02			-117.80541	35.66337	10/15/2018	237.70	2,153	3/11/2019	237.40	2,153	0.30
26S/39E-20L			-117.81374	35.66560				3/11/2019	236.90	2,191	
26S/39E-26A03	✓	USBR-04-SM	-117.74213	35.64966	10/16/2018	257.95	2,119	3/12/2019	252.35	2,125	5.60
26S/39E-26P01			-117.75147	35.64024	10/16/2018	263.40	2,140	3/11/2019	260.90	2,142	2.50
26S/39E-26P02			-117.75313	35.64052	10/16/2018	267.30	2,139	3/11/2019	263.40	2,143	3.90
26S/39E-27C01			-117.76864	35.64849				3/11/2019	267.40	2,148	
26S/39E-27D02	✓	MW-32-SM	-117.77493	35.64852	10/16/2018	285.66	2,133	3/11/2019	283.06	2,135	2.60
26S/39E-27D03	✓	MW-32-DM	-117.77591	35.64857	10/16/2018	285.46	2,133	3/11/2019	283.06	2,135	2.40
26S/39E-27D04	✓	MW-32-D	-117.77591	35.64857	10/16/2018	277.75	2,141	3/11/2019	275.85	2,143	1.90
26S/39E-28B03			-117.78352	35.65050	10/15/2018	250.30	2,176	3/11/2019	250.50	2,176	-0.20
26S/39E-28G02			-117.78135	35.64601	10/15/2018	282.70	2,150	3/11/2019	282.80	2,150	-0.10
26S/39E-28L02			-117.78619	35.64182	10/15/2018	299.30	2,150	3/11/2019	299.90	2,149	-0.60
26S/39E-29J02			-117.79611	35.64181	10/15/2018	300.70	2,128	3/11/2019	300.00	2,129	0.70
26S/39E-31R03			-117.81543	35.62389	10/15/2018	359.80	2,140	3/11/2019	359.10	2,141	0.70
26S/39E-32L01			-117.80461	35.62902	10/15/2018	341.10	2,151	3/11/2019	340.70	2,151	0.40
26S/39E-34C01			-117.77080	35.63472	10/16/2018		2,153				0.00
26S/39E-34K03			-117.76635	35.62791	10/16/2018	325.10	2,151	3/11/2019	324.20	2,151	
26S/39E-34P04			-117.76819	35.62565	10/16/2018	332.20	2,147				
26S/39E-34Q01			-117.76733	35.62502	10/16/2018		2,149				0.00
26S/39E-34R02			-117.76068	35.62351				3/12/2019	319.10	2,132	

Attachment A: Groundwater Level Data

Fall 2018 & Spring 2019

					Fall 2018			Spring 2019			
State ID	CASGEM	Alternate Well Name	X	Y	Date	DTW (ft, bgs)	GW Elev (ft, msL)	Date	DTW (ft, bgs)	GW Elev (ft, msL)	Change in DTW WY 2019
26S/39E-35G01			-117.74730	35.63079	10/16/2018	280.50	2,141	3/11/2019	279.10	2,142	1.40
26S/40E-12C			-117.63174	35.69329	10/15/2018	4.91	2,161	3/11/2019	4.28	2,170	0.63
26S/40E-12R01			-117.61980	35.68246	10/15/2018	4.28	2,181	3/11/2019	4.18	2,181	0.10
26S/40E-13C02			-117.62952	35.67913	10/15/2018	10.73	2,178	3/11/2019	9.83	2,179	0.90
26S/40E-14B01			-117.64285	35.67774	10/15/2018	7.68	2,183	3/11/2019	7.39	2,184	0.29
26S/40E-14L01			-117.64702	35.67190	10/15/2018	20.07	2,186	3/11/2019	20.02	2,186	0.05
26S/40E-15N01			-117.67035	35.66718	10/15/2018	58.04	2,187	3/11/2019	57.95	2,187	0.09
26S/40E-15N02			-117.66869	35.66885	10/15/2018	50.89	2,185	3/11/2019	50.73	2,186	0.16
26S/40E-17J01			-117.69480	35.67107	10/15/2018	86.68	2,179	3/11/2019	86.79	2,179	-0.11
26S/40E-17N01			-117.70591	35.66690	10/15/2018	143.20	2,152	3/11/2019	142.92	2,152	0.28
26S/40E-17Q01	✓	S. Hanger 5	-117.69659	35.66638	10/15/2018		2,131	3/11/2019		2,132	0.00
26S/40E-19N02			-117.72147	35.65413	10/15/2018	206.30	2,131	3/11/2019	205.89	2,132	0.41
26S/40E-20L01			-117.70147	35.65857	10/15/2018	146.13	2,151	3/11/2019	145.96	2,151	0.17
26S/40E-21Q			-117.67924	35.65663	10/15/2018	103.16	2,164	3/11/2019	101.88	2,165	1.28
26S/40E-22H01			-117.65424	35.66190	10/15/2018	33.29	2,195	3/11/2019	33.19	2,195	0.10
26S/40E-22H02			-117.65424	35.66190	10/15/2018	32.80	2,196	3/11/2019	33.00	2,195	-0.20
26S/40E-22H03			-117.65424	35.66190	10/15/2018	33.28	2,194	3/11/2019	33.21	2,195	0.07
26S/40E-22N01			-117.66940	35.65423	10/16/2018	95.60	2,169	3/12/2019	97.20	2,167	-1.60
26S/40E-22P02			-117.66313	35.65191	10/16/2018	66.80	2,200	3/12/2019	66.40	2,201	0.40
26S/40E-22P03			-117.66452	35.65357	10/16/2018	117.40	2,141	3/12/2019	114.70	2,144	2.70
26S/40E-22P04			-117.66452	35.65357	10/16/2018	68.50	2,190	3/12/2019	66.10	2,193	2.40
26S/40E-25P			-117.62699	35.63875	10/16/2018	88.03	2,157				
26S/40E-26F01			-117.64508	35.64746	10/16/2018	58.00	2,175	3/12/2019	58.00	2,175	0.00
26S/40E-27D01			-117.66730	35.65052	10/16/2018	73.00	2,195	3/12/2019	72.70	2,195	0.30
26S/40E-27D02			-117.66785	35.64941	10/16/2018	45.80	2,221	3/12/2019	45.60	2,221	0.20
26S/40E-28J01			-117.67128	35.64121	10/17/2018	135.80	2,155	3/12/2019	135.30	2,156	0.50
26S/40E-29M01			-117.70314	35.64186	10/17/2018	200.60	2,130	3/12/2019	199.20	2,131	1.40
26S/40E-29M02			-117.69973	35.64125	10/17/2018	201.60	2,123	3/12/2019	200.20	2,124	1.40
26S/40E-29N01			-117.70175	35.63792	10/17/2018	209.70	2,123	3/12/2019	206.90	2,125	2.80
26S/40E-29P01			-117.70032	35.63791	10/17/2018	206.30	2,124	3/12/2019	203.30	2,127	3.00
26S/40E-31D02			-117.72079	35.63481	10/16/2018	255.50	2,117	3/12/2019	253.50	2,119	2.00
26S/40E-31K01			-117.71330	35.62580				3/12/2019	273.20	2,118	
26S/40E-34F01			-117.66690	35.63070				3/12/2019	149.00	2,145	
26S/40E-35H01			-117.63896	35.63191	10/16/2018	89.30	2,163	3/12/2019	89.30	2,163	0.00
26S/40E-35H02			-117.63869	35.63191	10/16/2018	99.60	2,152	3/12/2019	98.90	2,153	0.70
26S/40E-35Q02			-117.64257	35.62274				3/12/2019	93.40	2,159	
26S/40E-36A01			-117.62174	35.63357	10/15/2018	95.31	2,156				
27S/38E-01C			-117.84342	35.61944				3/11/2019	373.20	2,199	
27S/38E-02C01	✓	USBR-02-S	-117.85761	35.62280	10/15/2018	283.96	2,371	3/11/2019	282.86	2,372	1.10
27S/38E-02C02	✓	USBR-02-M	-117.85841	35.62274	10/15/2018	280.12	2,375	3/11/2019	279.22	2,376	0.90
27S/38E-02C03	✓	USBR-02-D	-117.85841	35.62274	10/15/2018	292.87	2,362	3/11/2019	292.07	2,363	0.80

Attachment A: Groundwater Level Data

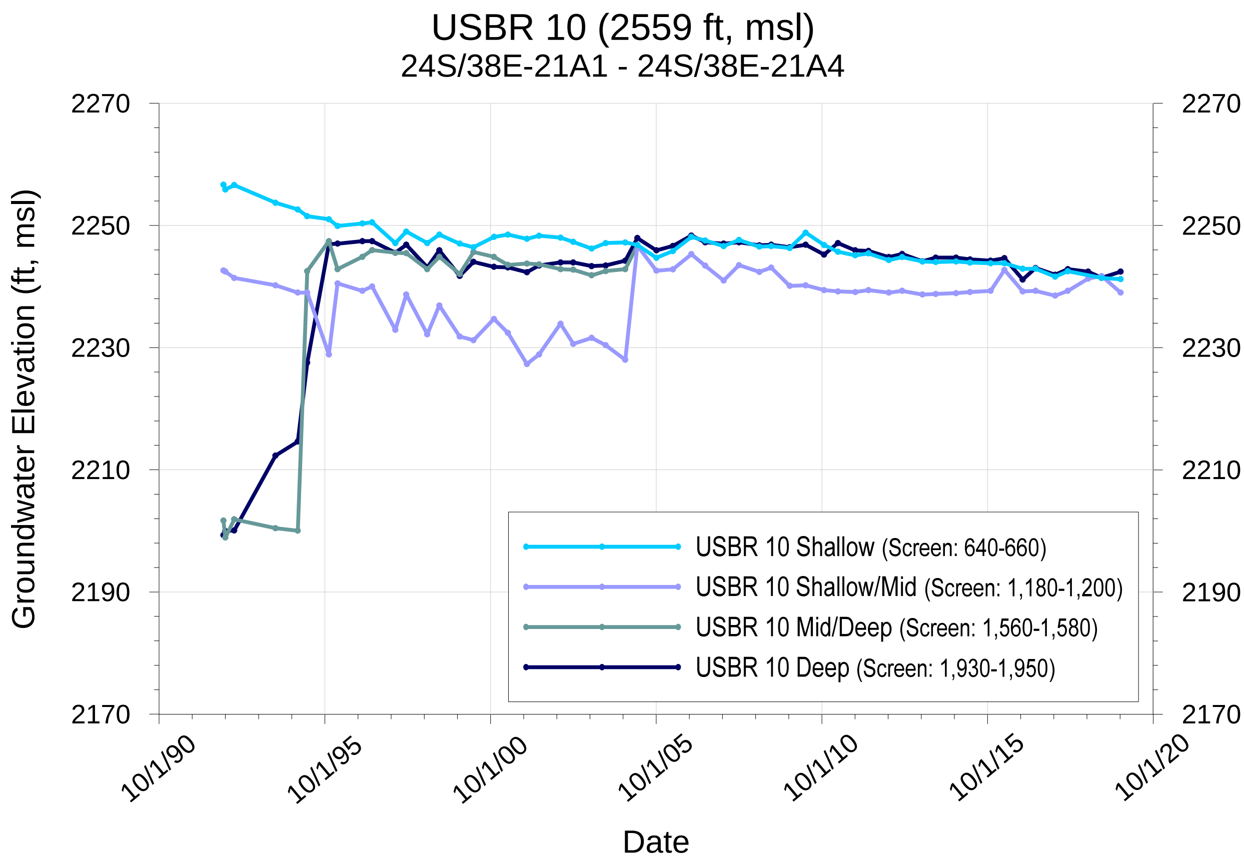
Fall 2018 & Spring 2019

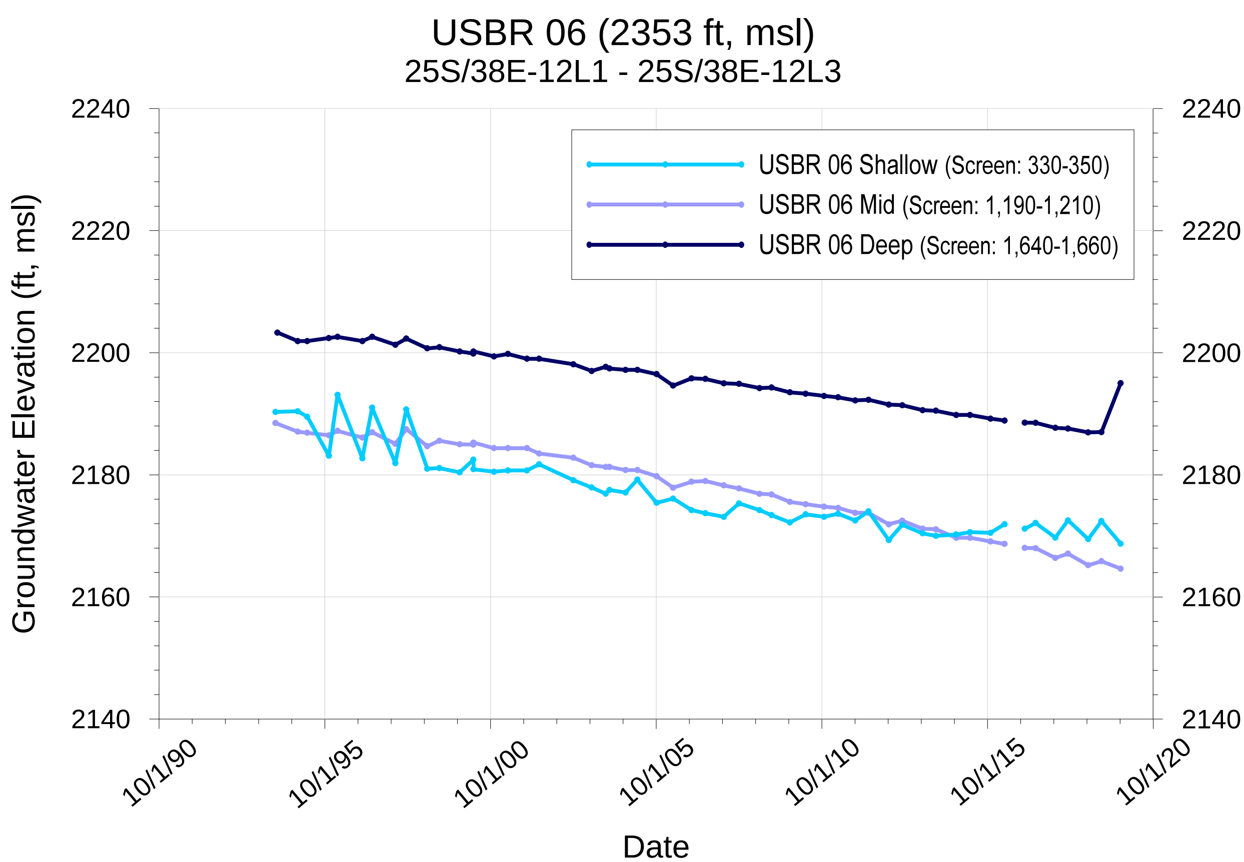
					Fall 2018			Spring 2019			
State ID	CASGEM	Alternate Well Name	X	Y	Date	DTW (ft, bgs)	GW Elev (ft, msL)	Date	DTW (ft, bgs)	GW Elev (ft, msL)	Change in DTW WY 2019
27S/38E-08R01			-117.90300	35.59367	10/15/2018	506.40	2,697	3/11/2019	506.90	2,696	-0.50
27S/38E-09C01		AB303-04	-117.89378	35.60665	10/15/2018	381.00	2,689	3/11/2019	381.10	2,689	-0.10
27S/38E-09P01			-117.89246	35.59363	10/15/2018	417.90	2,694	3/11/2019	418.10	2,694	-0.20
27S/38E-09Q02		AB303-02	-117.89262	35.59362	10/15/2018	420.20	2,685	3/11/2019	420.00	2,685	0.20
27S/38E-10B02		AB303-03	-117.87407	35.60662	10/15/2018	425.70	2,469	3/11/2019	425.70	2,469	0.00
27S/38E-13A01			-117.83060	35.59345	10/16/2018	224.35	2,430	3/12/2019	224.25	2,430	0.10
27S/38E-13A02		AB303-01	-117.83070	35.59369	10/15/2018	222.60	2,427	3/11/2019	222.20	2,428	0.40
27S/38E-15R01		AB303-06	-117.86617	35.58195	10/15/2018	274.30	2,658	3/11/2019	272.70	2,659	1.60
27S/38E-21L01	✓	AB303-05	-117.89592	35.56985	10/15/2018	359.89	2,664	3/11/2019	358.39	2,666	1.50
27S/38E-23F01	✓	USBR-01-S	-117.86289	35.56959	10/15/2018	183.34	2,667	3/11/2019	182.84	2,668	0.50
27S/38E-23F02	✓	USBR-01-SM	-117.86369	35.56968	10/15/2018	180.92	2,670	3/11/2019	180.32	2,670	0.60
27S/38E-23F04	✓	USBR-01-D	-117.86369	35.56968	10/15/2018	183.69	2,667				
27S/38E-27M01			-117.88132	35.55387	10/15/2018	194.70	2,678	3/11/2019	193.40	2,680	1.30
27S/39E-02K			-117.74813	35.61218				3/12/2019	312.20	2,146	
27S/39E-03C01			-117.77157	35.62174	10/16/2018	344.30	2,140	3/12/2019	344.10	2,140	0.20
27S/39E-03C02			-117.76995	35.62206				3/12/2019	341.60	2,142	
27S/39E-04C01			-117.78752	35.62224				3/11/2019	345.80	2,154	
27S/39E-07R01		Inyo	-117.81589	35.59634	10/15/2018	419.20	2,145	3/11/2019	417.20	2,147	2.00
27S/39E-08A01			-117.79818	35.60721	10/15/2018	390.80	2,143	3/11/2019	389.20	2,145	1.60
27S/39E-08M02			-117.80947	35.60045	10/15/2018	413.30	2,140	3/11/2019	410.00	2,143	3.30
27S/39E-08P02			-117.80371	35.59393	10/15/2018	436.50	2,144	3/11/2019	434.80	2,146	1.70
27S/39E-11D01	✓	USBR-03-S	-117.75485	35.60731	10/16/2018	362.64	2,148	3/12/2019	360.04	2,150	2.60
27S/39E-11D02	✓	USBR-03-M	-117.75563	35.60718	10/16/2018	366.38	2,144	3/12/2019	364.78	2,146	1.60
27S/39E-11D03	✓	USBR-03-D	-117.75563	35.60718	10/16/2018	332.49	2,178	3/12/2019	338.69	2,172	-6.20
27S/39E-19E01			-117.82969	35.57400	10/15/2018	204.40	2,435	3/11/2019	204.10	2,435	0.30
27S/39E-28L01			-117.79253	35.55472	10/15/2018	289.30	2,531	3/11/2019	288.20	2,532	1.10
27S/40E-01K02	✓	George Air Corridor	-117.62469	35.61470	10/17/2018	161.50	2,161	3/12/2019	162.10	2,161	-0.60
27S/40E-02J01			-117.63510	35.61176	10/17/2018	152.50	2,153	3/12/2019	151.80	2,153	0.70
27S/40E-06D01			-117.72253	35.62198	10/16/2018	292.65	2,114	3/12/2019	274.95	2,132	17.70
27S/40E-06E01			-117.72040	35.61855	10/16/2018	319.50	2,113	3/12/2019	317.00	2,116	2.50
27S/40E-06F01			-117.71810	35.61629	10/16/2018	324.00	2,116	3/12/2019	322.10	2,117	1.90
27S/40E-06N01			-117.72005	35.60996	10/16/2018	356.40	2,115	3/24/2019	353.10	2,118	3.30
27S/40E-06N02			-117.72155	35.60898	10/16/2018	359.70	2,114	3/12/2019	353.20	2,121	6.50
27S/40E-15D01			-117.67011	35.59143				3/12/2019	232.10	2,150	
28S/38E-18F01	✓		-117.92844	35.49928	10/15/2018	211.42	2,815	3/11/2019	210.92	2,816	0.50
28S/38E-18R			-117.92094	35.49364	10/15/2018	197.40	2,820	3/11/2019	196.80	2,820	0.60

Attachment B

Groundwater Elevation Hydrographs for Select Monitoring Wells

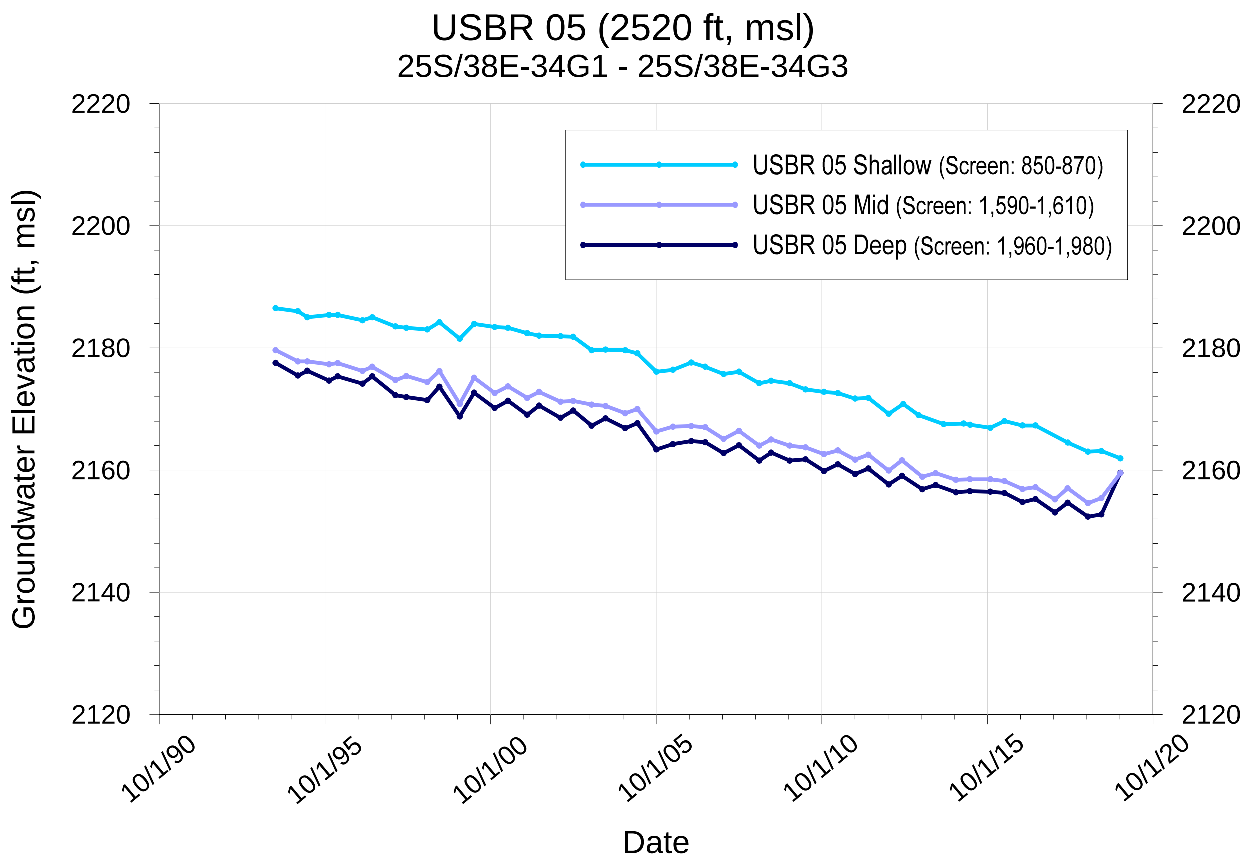
Groundwater Elevation Hydrographs

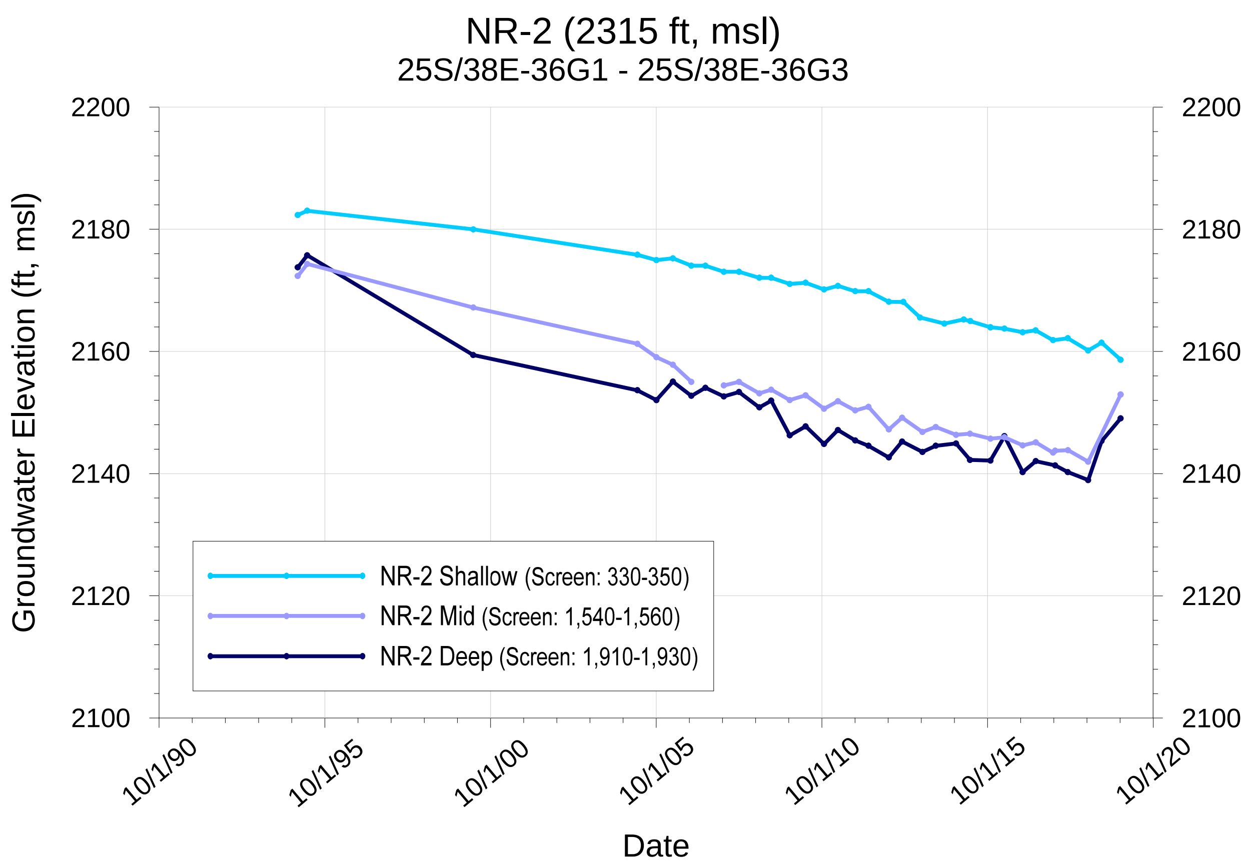




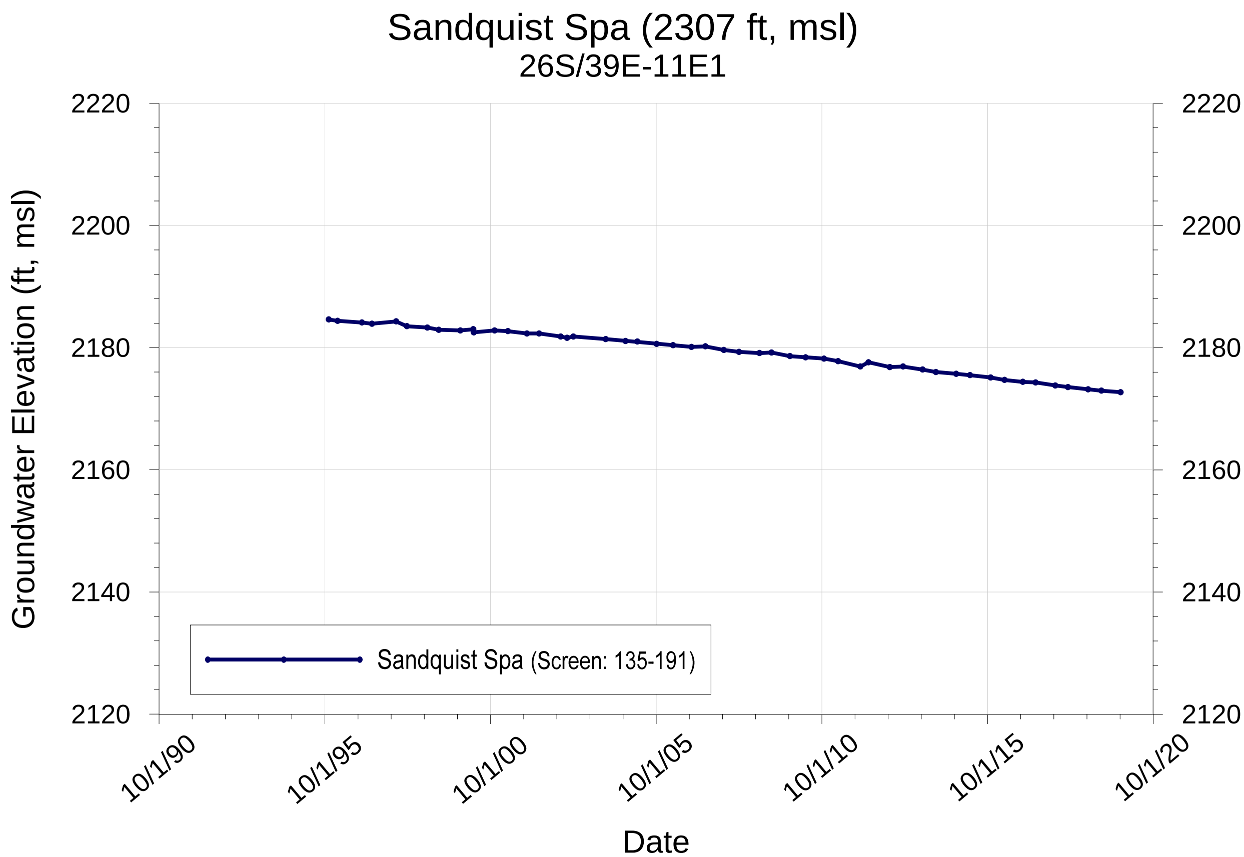
Attachment B
Figure B2

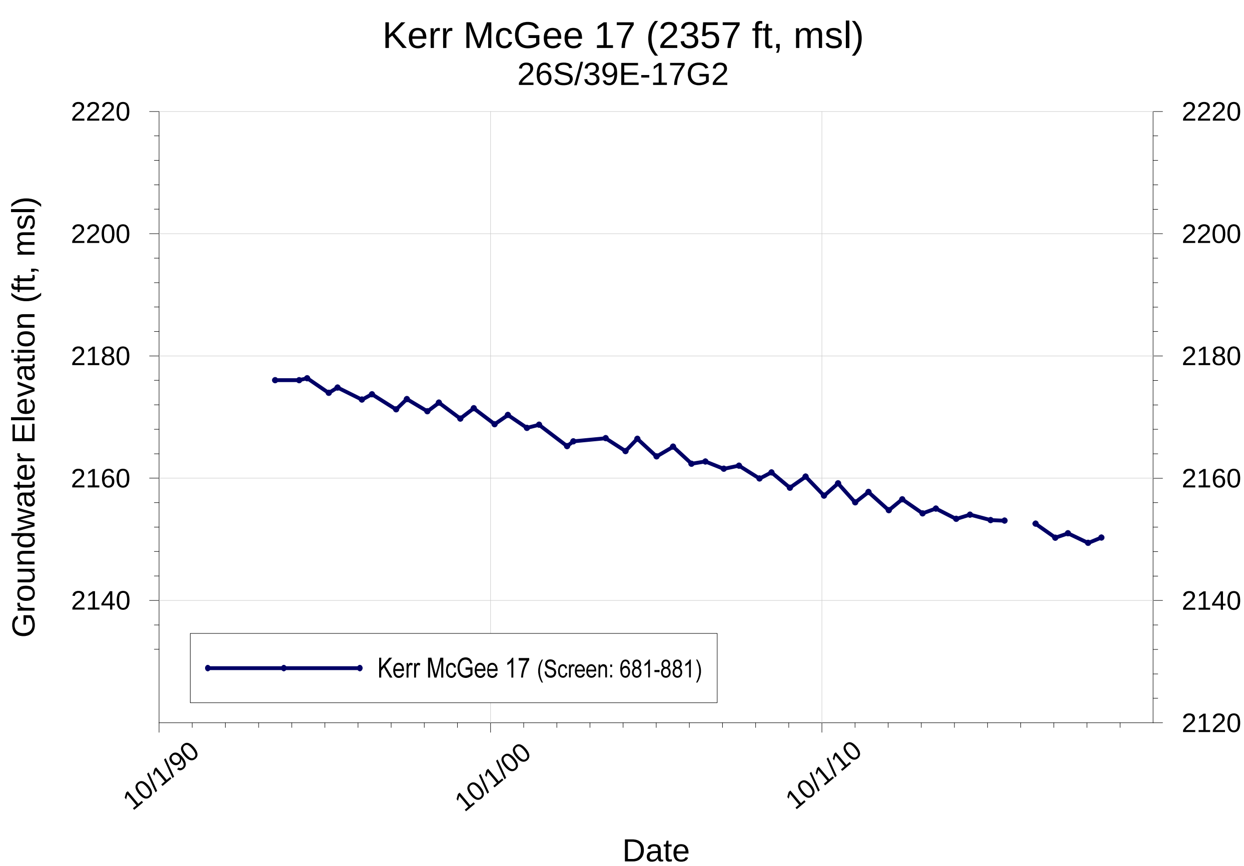
Groundwater Elevation Hydrographs





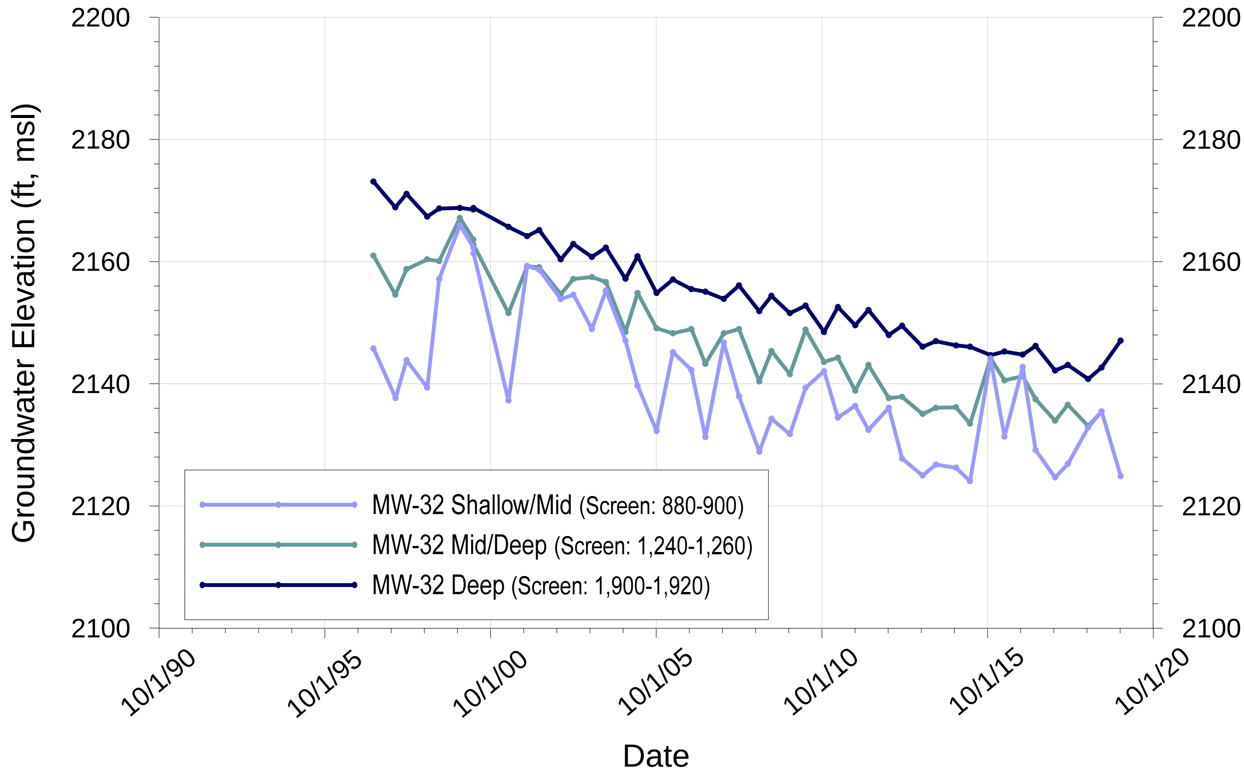
Groundwater Elevation Hydrographs



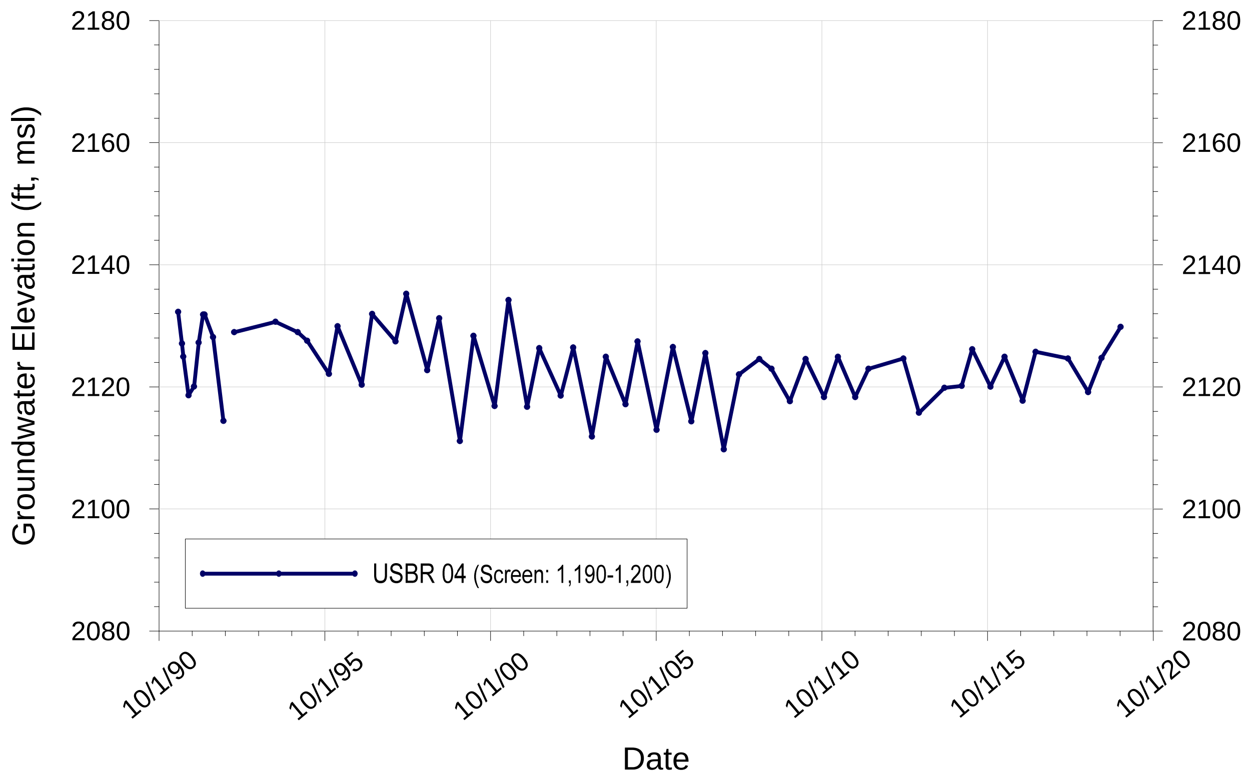


Groundwater Elevation Hydrographs

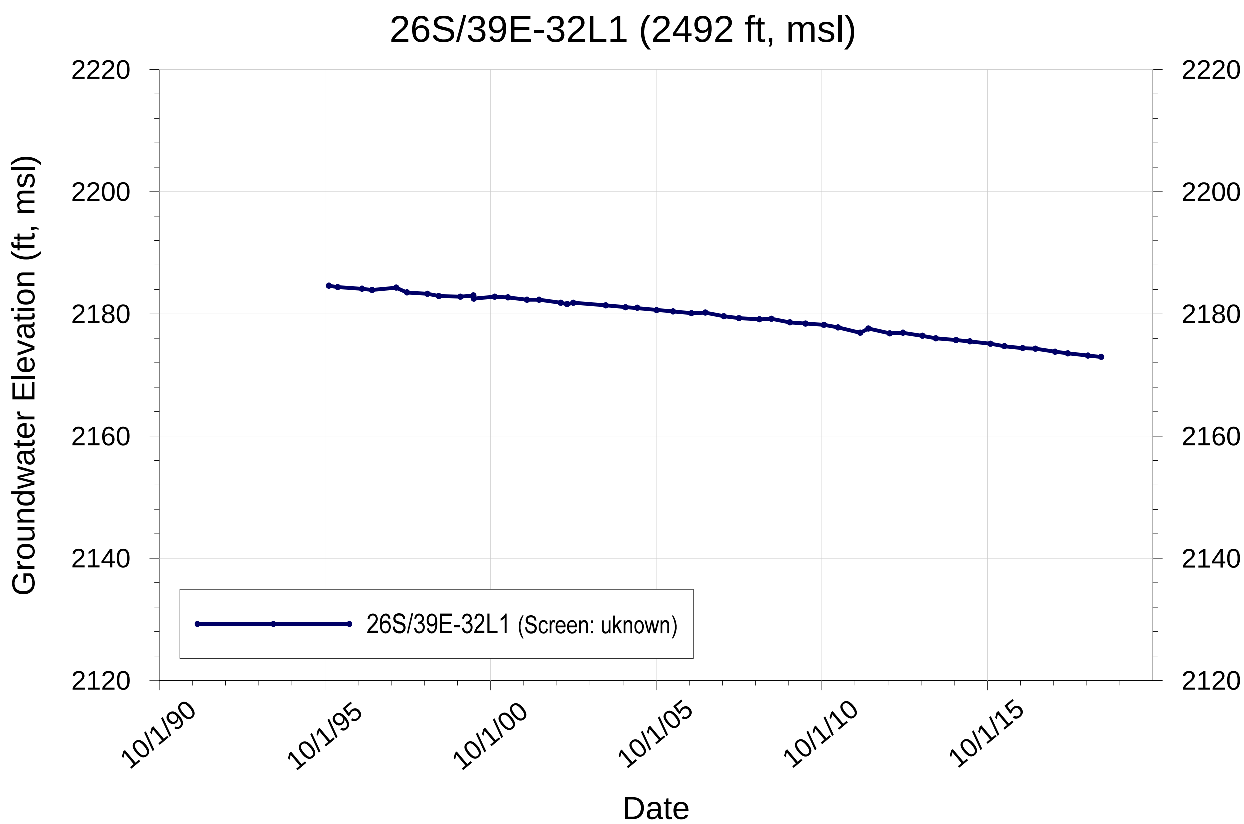
MW-32 (2419 ft, msl)
26S/39E-27D2 - 26S/39E-27D4

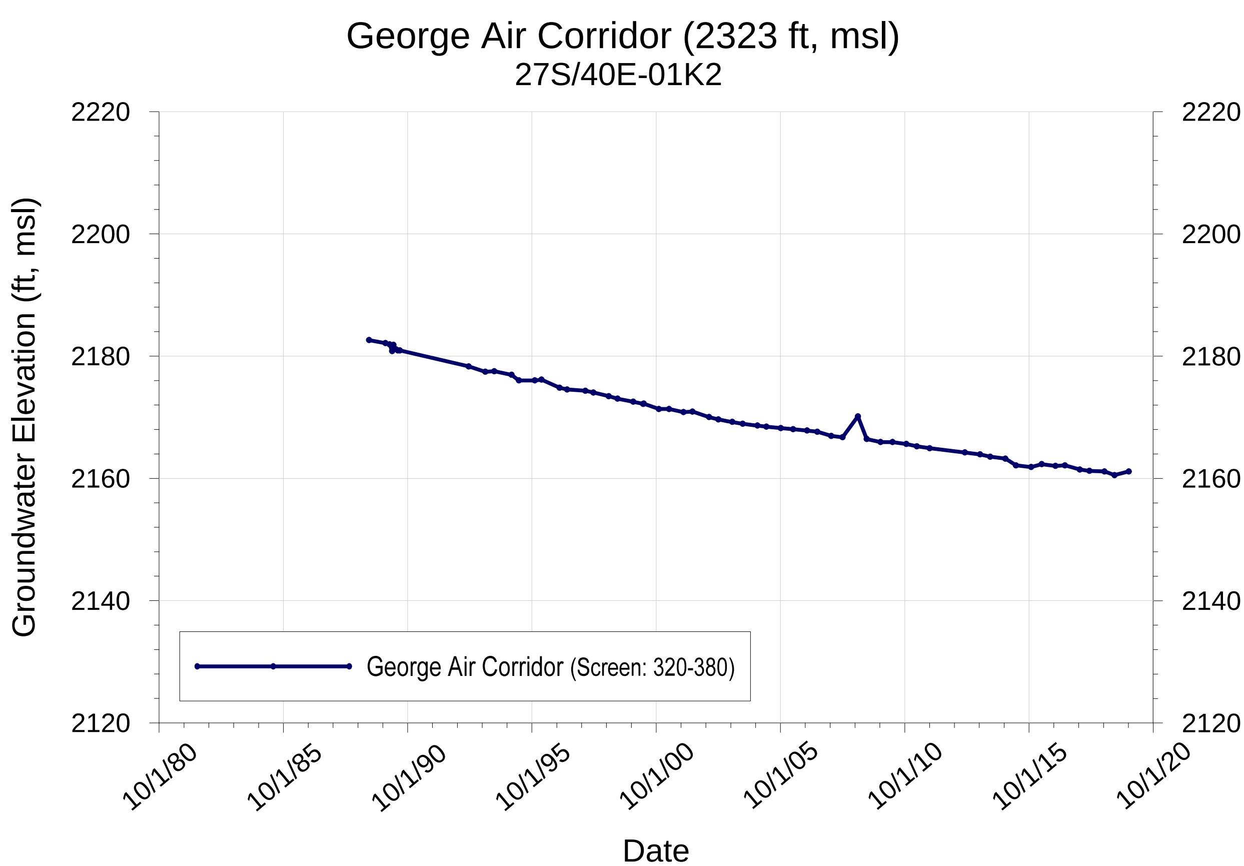


USBR 04 (2377 ft, msl)
26S/39E-26A3

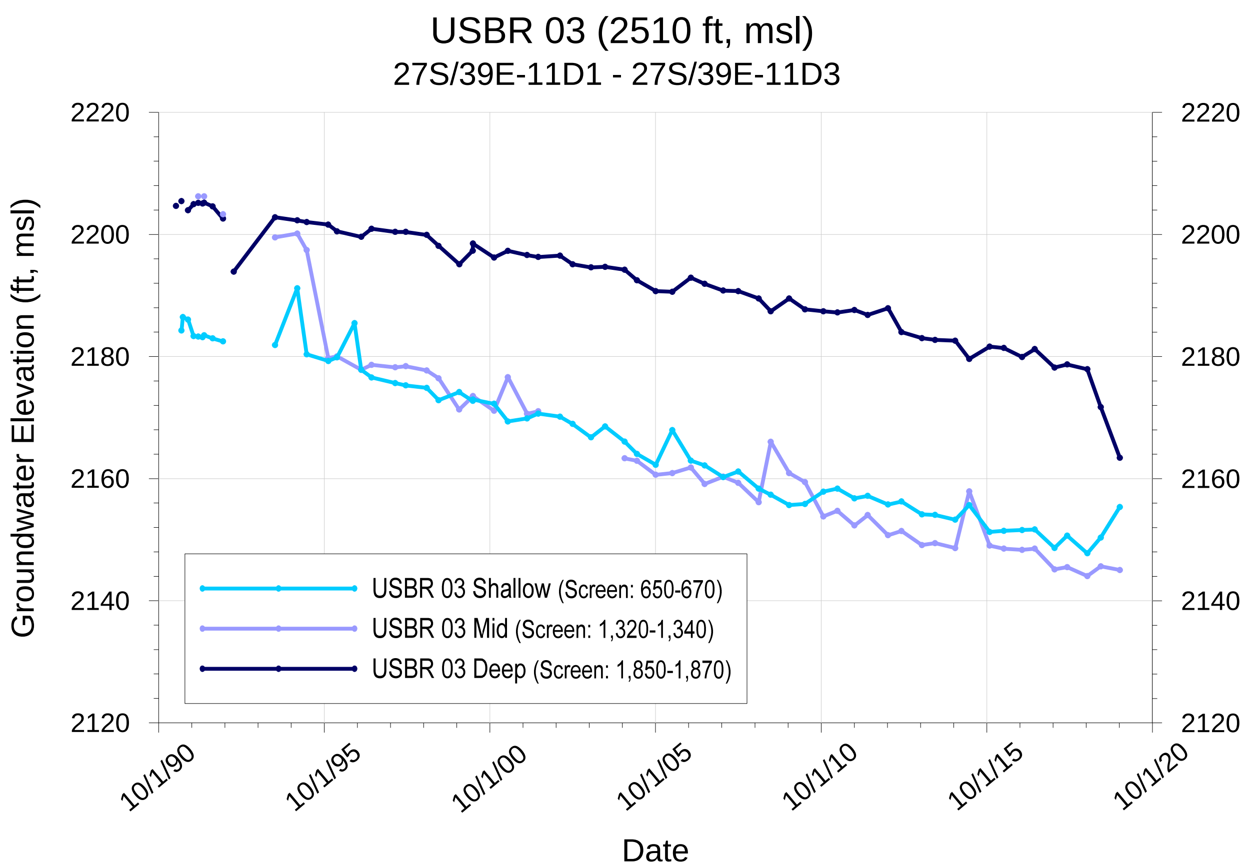


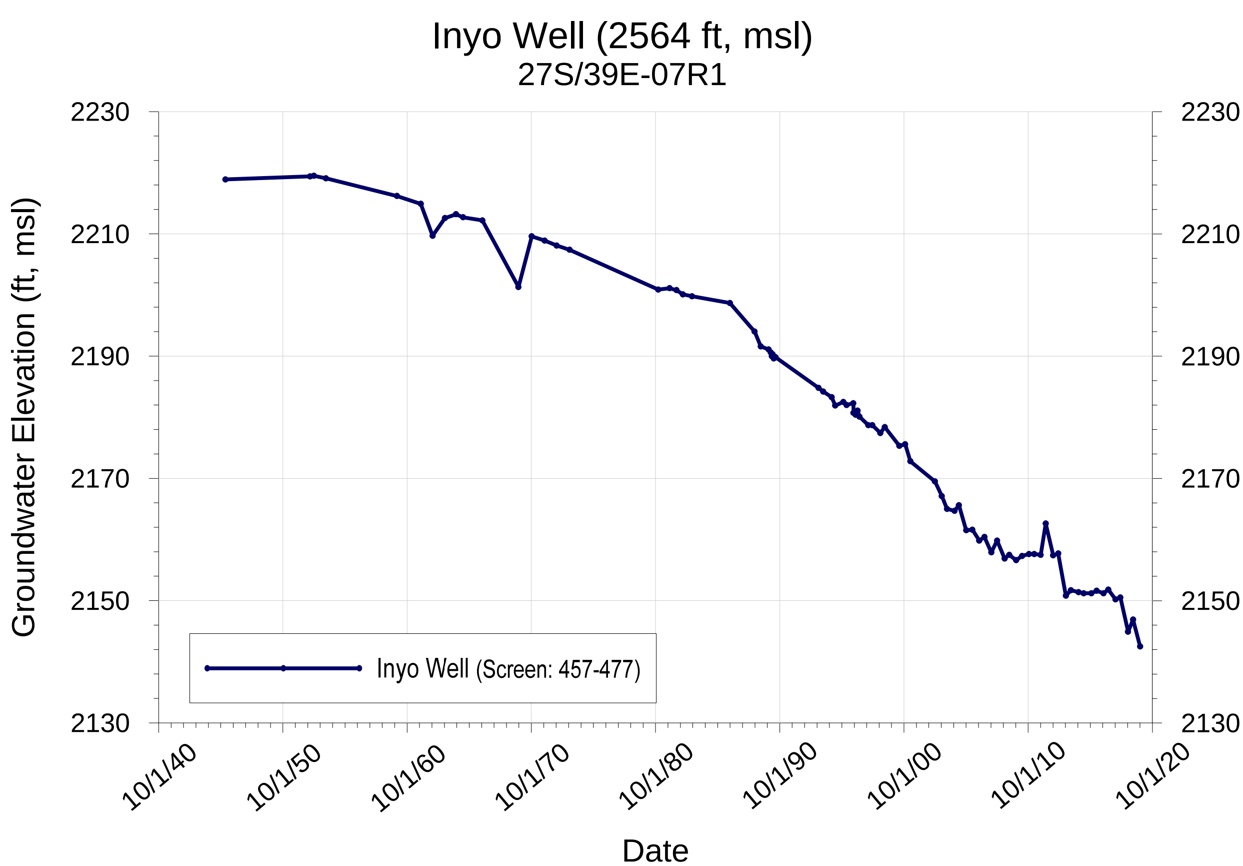
Groundwater Elevation Hydrographs



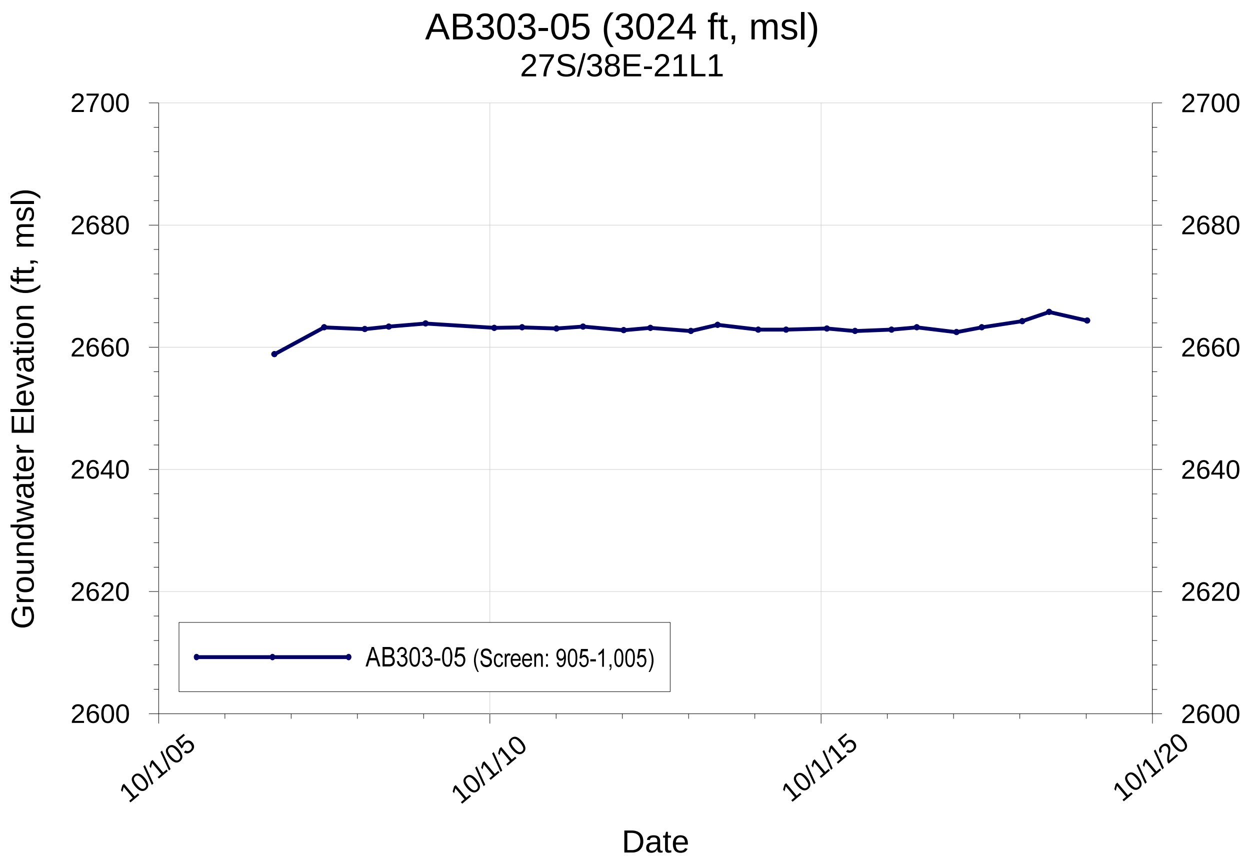


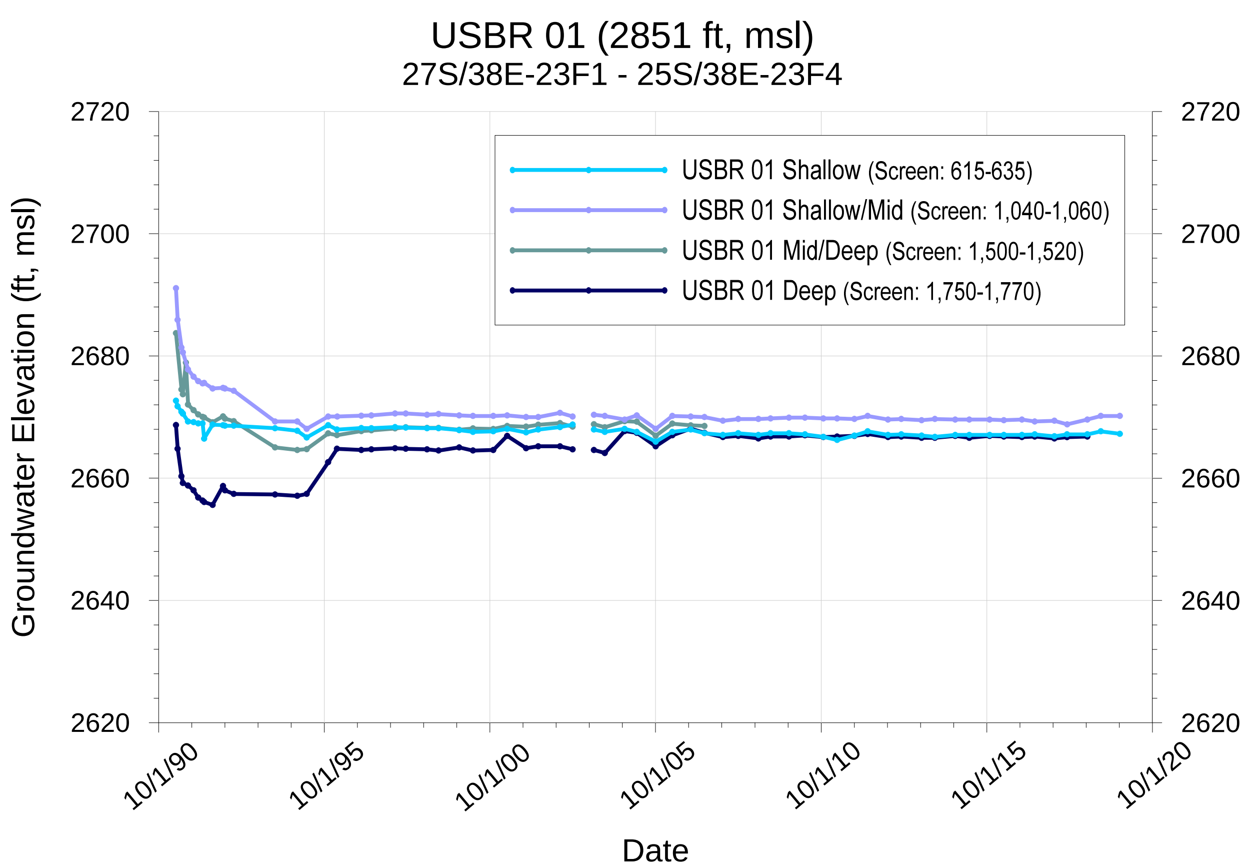
Groundwater Elevation Hydrographs





Groundwater Elevation Hydrographs





Attachment C

Groundwater Storage Change

Attachment C

INDIAN WELLS VALLEY GROUNDWATER BASIN

GROUNDWATER STORAGE CHANGE

Thiessen Polygon	State ID T/R-S	Basin Area	Specific Yield	Land Elevation (ft, msl)	Surface Area (Acres)		Spring Depth to Water (Feet) 2015	2016	2017	2018	2019	Change in Depth (Feet) 2015-2016	2016-2017	2017-2018	2018-2019	Annual Change in Storage (Acre-Feet) WY 2016	WY 2017	WY 2018	WY 2019	4-Year Cumulative Change
TP-1	24S/38E-21A01	NW	0.21	2,559	11,675		315.5	315.6	316.5	316.9	318.0	-0.1	-0.9	-0.4	-1.1	-245	-2,207	-981	-2,697	-6,129
TP-2	24S/38E-19H	NW	0.21		2,840	1					8.2					*-60*	*-537*	*-239*	*-656*	-1,491
TP-3	25S/38E-03B	NW	0.21	2,456	4,655		284.8	285.7	286.3	286.7	288.1	-0.9	-0.6	-0.4	-1.4	-880	-587	-391	-1,369	-3,226
TP-4	25S/38E-12L01	NW	0.21	2,353	6,627		182.3	181.0	180.8	180.4	180.5	1.3	0.2	0.4	-0.1	1,809	278	557	-139	2,505
TP-5	25S/38E-14Q01	NW	0.21	2,391	3,641		227.7	222.9	225.1	225.8	225.6	4.8	-2.2	-0.7	0.2	3,670	-1,682	-535	153	1,605
TP-6	25S/38E-25J01	NW	0.21	2,277	4,192		111.2	114.2	115.7	114.6	115.4	-3.0	-1.5	1.1	-0.8	-2,641	-1,321	969	-704	-3,698
TP-7	25S/38E-34G01	NW	0.21	2,520	3,859		353.0	352.4	353.1	355.9	357.3	0.6	-0.7	-2.8	-1.4	486	-567	-2,269	-1,135	-3,485
TP-8	26S/38E-02R01	NW	0.21	2,398	3,511		231.9	232.9	233.3	234.5	236.4	-1.0	-0.4	-1.2	-1.9	-737	-295	-885	-1,401	-3,318
TP-10	26S/39E-20C02	NW	0.18	2,391	4,359		233.6	234.4	234.9	236.4	237.4	-0.8	-0.5	-1.5	-1.0	-628	-392	-1,177	-785	-2,982
TP-11	26S/38E-22B	SW	0.21	2,666	3,350		426.3	426.5	430.5	430.6	426.6	-0.2	-4.0	-0.1	4.0	-141	-2,814	-70	2,814	-211
TP-13	26S/39E-31R03	SW	0.08	2,500	5,119		355.6	356.0	356.5	357.7	359.1	-0.4	-0.5	-1.2	-1.4	-164	-205	-491	-573	-1,433
TP-14	27S/39E-08P02	SW	0.08	2,581	3,760		431.3	432.1	432.3	433.8	434.8	-0.8	-0.2	-1.5	-1.0	-241	-60	-451	-301	-1,053
TP-15	27S/39E-28L01	SW	0.08	2,820	10,847		289.4	289.4	288.8	288.8	288.2	0.0	0.6	0.0	0.6	0	521	0	521	1,041
TP-16	27S/39E-19E01	SW	0.08	2,639	3,474		203.8	204.0	203.9	204.3	204.1	-0.2	0.1	-0.4	0.2	-56	28	-111	56	-83
TP-35	26S/39E-26A03	SE	0.18	2,377	2,690		251.0	252.2	251.4	252.5	252.4	-1.2	0.8	-1.1	0.1	-581	387	-533	48	-678
TP-36	26S/39E-34C01	SE	0.08	2,451	3,713		294.3	294.8	295.1	297.3	298.0	-0.5	-0.3	-2.2	-0.7	-149	-89	-654	-208	-1,099
TP-37	27S/39E-11D01	SE	0.08	2,510	7,907		354.7	358.9	358.7	359.7	360.0	-4.2	0.2	-1.0	-0.3	-2,657	127	-633	-190	-3,353
TP-38	27S/40E-06F01	SE	0.08	2,407	8,376		324.7	322.6	323.5	322.4	322.1	2.1	-0.9	1.1	0.3	1,407	-603	737	201	1,742
TP-40	26S/40E-28J01	SE	0.21	2,291	4,048		134.0	133.9	134.6	134.7	135.3	0.1	-0.7	-0.1	-0.6	85	-595	-85	-510	-1,105
TP-41	27S/40E-01K02	SE	0.21	2,323	10,631		160.5	160.3	160.5	161.4	162.1	0.2	-0.2	-0.9	-0.7	447	-447	-2,009	-1,563	-3,572
TP-9	26S/39E-08F	NVY	0.21	2,319	3,721		160.0	161.3	162.0	163.4	164.5	-1.3	-0.7	-1.4	-1.1	-1,016	-547	-1,094	-860	-3,517
TP-22	24S/40E-21K02	NVY	0.21		36,916	2					52.3					-1,551	-1,551	-1,551	-2,326	-6,977
TP-23	24S/39E-34D01	NVY	0.21	2,227	13,194	3				46.6	46.9				-0.3	-554	-554	-554	-831	-2,494
TP-24	25S/39E-12R01	NVY	0.21	2,202	10,162		23.3	23.5	23.7	23.9	24.2	-0.2	-0.2	-0.2	-0.3	-427	-427	-427	-640	-1,921
TP-25	25S/41E-18R01	NVY	0.21	2,003	13,523		22.1	22.0	21.9	22.2	22.1	0.1	0.1	-0.3	0.1	284	284	-852	284	0
TP-26	25S/40E-30E01	NVY	0.21	2,191	5,445		13.6	13.7	13.7	14.0	14.2	-0.1	0.0	-0.3	-0.2	-114	0	-343	-229	-686
TP-27	25S/39E-28P01	NVY	0.21	2,229	7,615		47.7	45.5	40.5	40.7	39.4	2.2	5.0	-0.2	1.3	3,518	7,995	-320	2,079	13,272
TP-28	26S/39E-11E01	NVY	0.21	2,307	4,642		131.8	132.6	133.0	133.8	134.4	-0.8	-0.4	-0.8	-0.6	-780	-390	-780	-585	-2,534
TP-29	26S/39E-01A01	NVY	0.21	2,218	3,308		47.2	47.7	47.7	48.1	48.2	-0.5	0.0	-0.4	-0.1	-347	0	-278	-70	-695
TP-30	25S/40E-31P	NVY	0.21	2,192	3,581		20.3	20.3	20.0	20.5	20.5	0.0	0.3	-0.5	0.0	0	226	-376	0	-150
TP-31	26S/40E-12C	NVY	0.21	2,166	9,875		4.3	4.6	4.1	4.7	4.3	-0.3	0.5	-0.6	0.4	-622	1,037	-1,244	830	0
TP-32	26S/40E-22H03	NVY	0.21	2,228	4,338		31.2	31.8	32.1	32.8	33.2	-0.6	-0.3	-0.7	-0.4	-547	-273	-638	-364	-1,822
TP-33	26S/40E-21K03	NVY	0.21	2,267	3,065		102.8	101.7	101.2	103.1	101.9	1.1	0.5	-1.9	1.2	708	322	-1,223	772	579
TP-34	26S/39E-13R03	NVY	0.21	2,319	2,662		149.7	150.0	150.5	150.8	151.2	-0.3	-0.5	-0.3	-0.4	-168	-280	-168	-224	-839
TP-39	26S/40E-17Q01	NVY	0.21	2,278	6,769	4			145.9	146.1	146.0			-0.2	0.1	*-426*	*-711*	-284	142	-1,279
TP-12	27S/38E-02C01	EP	0.21	2,655	4,116		282.2	282.4	281.9	282.9	282.9	-0.2	0.5	-1.0	0.0	-173	432	-864	0	-605
TP-17	27S/38E-23F01	EP	0.21	2,851	3,475		183.4	183.4	183.3	183.3	182.8	0.0	0.1	0.0	0.5	0	73	0	365	438
TP-18	27S/38E-09C01	EP	0.21	3,070	4,533		381.2	380.8	380.7	381.3	381.1	0.4	0.1	-0.6	0.2	381	95	-571	190	95
TP-19	27S/38E-21L01	EP	0.21	3,024	10,409		361.3	361.5	360.9	360.9	358.4	-0.2	0.6	0.0	2.5	-437	1,312	0	5,465	6,339
TP-20	28S/38E-18F01	EP	0.21	3,027	31,788		212.3	211.6	211.3	211.7	210.9	0.7	0.3	-0.4	0.8	4,673	2,003	-2,670	5,340	9,346
TP-21	28S/38E-18R	EP	0.21	3,017	12,317		197.3	197.2	197.0	196.4	196.8	0.1	0.2	0.6	-0.4	259	517	1,552	-1,035	1,293
					304,726		red: field measurement not available, estimated from hydrograph									red: calculated using nearby well's dtw change				

	WY 2016	WY 2017	WY 2018	WY 2019	4-Year Cumulative Change
IWV Main Basin	-3,316	-5,927	-19,382	-10,459	-39,083
El Paso Sub-area	4,702	4,432	-2,554	10,326	16,906
Total	1,387	-1,495	-21,936	-133	-22,177

Specific Yield values souced from Appendix 3-H GSP Model Documentation Appendix

Spring groundwater levels measured by Kern County Water Agency for Indian Wells Valley.

1- Well 24S/38E-19H was added to the monitoring program in Spring 2019. The DTW change for TP-1 was estimated to be equal to TP-2.

2- Well 24S/40E-21K02 was added to the monitoring program in Spring 2019. The DTW change for TP-22 was estimated to be equal to TP-24.

3- Well 24S/39E-34D01 was added to the monitoring program in Spring 2019. The DTW change for TP-23 was estimated to be equal to TP-24.

4- Well 26S/40E-17Q01 was added to the monitoring program in Spring 2017. The DTW change for TP-39 was estimated to be equal to TP-34.

Attachment D

Estimated WY 2019 Groundwater Production

Attachment D: WY 2019 Groundwater Production Estimate

Water Use Sector (DWR)	Water User	No Action Baseline note	No Action Baseline (AFY)	Reported Groundwater Pumping (Fee) WY 2018-2019 note	Reported Groundwater Pumping (Fee) WY 2018-2019 (AFY)	Estimated Groundwater Pumping WY 2018-2019 note	Estimated Groundwater Pumping WY 2018-2019 (AFY)
Urban	IWVWD	2	6,518	1	6,211	1	6,211
Urban	City/County	2	425	1	145	1	145
Industrial	Searles Valley Minerals	2	2,907	1	2,686	1	2,686
Other - Federal	U.S. Navy	2	2,041	1	--	6	1,462
Agriculture	Meadowbrook Farms	2	12,303	1	4,407	1	4,407
Agriculture	Mojave Pistachio	2	6,054	1, 3	3,756	1, 7	4,078
Agriculture	Simmons Farm	2	931	1	439	1	439
Agriculture	Sierra Shadows	2	765	1, 3	61	2	765
Agriculture	Quist Farms	2	674	1	628	1	628
Agriculture	Other Small Ag	2	901	1, 3, 4	369	8, 9	601
Other - Co-Ops/Mutuals	Co-Ops/Mutual	2	544	1, 3, 5	413	2	544
Other - Domestic	Domestic	2	832	1	--	2	832
			34,896		19,115		22,798

Notes:

1 Reported data for Pump Fee.

2 Estimated from GSP 'No Action' Baseline analysis.

3 Missing some monthly data. Partial year reported.

4 Unreported small agriculture: McGee, Bellino, Shacklett, and other potential small agriculture.

5 Missing data. Not all Co-Ops and Mutuals report data.

6 Data provided by Navy in email to Jean Moran dated April 20, 2020.

7 Adjusted from reported data for the pump fee to include missing months provided by Mojave Pistachios in separate data submittal to IWVGA.

8 Compiled from best available data source including reported data from pump fee, baseline analysis, and other reported data.

9 Does not include pumping estimates for McGee, Shacklett, or other potential small ag. Additional 100 acre-feet was included to estimate additional agricultural pumping.