MONTGOMERY
& ASSOCIATES
Water Resource Consultants

www.elmontgomery.com
1550 East Prince Road
Tucson, AZ 85719
520.881.4912

TECHNICAL MEMORANDUM

DATE: September 13, 2018 **PROJECT #**: 605.75

TO: Victoria Peacey, RESOLUTION COPPER

FROM: Brittney Bates, Tim Bayley, and Hale Barter

PROJECT: Resolution Copper

SUBJECT: Simulation of Drawdown Impacts from Desert Wellfield

Introduction

At the request of Resolution Copper (RC), Montgomery & Associates (M&A) evaluated potential drawdown impacts from groundwater pumping to supply water for the proposed Resolution Copper mine. The groundwater pumping is planned to take place at a proposed wellfield, referred to as the Desert Wellfield, which is located in the East Salt River Valley, of the Phoenix Active Management Area (AMA), approximately 3.5 miles southwest from the junction of Superstition Freeway (US-60) and AZ-79, as shown on **Figure 1**.

Potential drawdown impacts from proposed Desert Wellfield pumping were simulated using a modified version of the regional Salt River Valley (SRV) flow model published by the Arizona Department of Water Resources (ADWR) (Freihoefer and others, 2009). In this study, six pumping alternatives are evaluated based on water demands for five alternative tailings designs being considered by the United States Forest Service (USFS) as part of the ongoing RC Environmental Impact Statement. One of the six pumping alternatives is a baseline simulation with no Desert Wellfield pumping associated with the "no action" alternative. Each model alternative includes a pre-mining pumping period from 2018 through 2027, Life of Mine (LOM) pumping period from 2028 through 2068, and an additional 200-year post-pumping period from 2069 through 2268.

RC began storing water in the Phoenix and Pinal AMAs in 2006. The water was stored in several Groundwater Savings Facilities (GSFs) and Underground Storage Facilities (USFs). A summary of the facilities and the amount stored is shown in **Table 1**. Statutes stipulate that a 5 percent deduction for long term storage credits (LTSCs) be applied as a cut to the aquifer (**Table 1**) and may only be withdrawn from within the AMA in which they were stored. The closest storage facility to the proposed Desert Wellfield is the New Magma Irrigation and Drainage District (NMIDD) GSF. RC has accrued 187,575 acre-feet

(AF) of recoverable long-term storage credits in NMIDD during the period 2006 to 2011. In addition, RC purchased 36,936 AF of recoverable long-term storage credits at NMIDD GSF from Gila River Water Storage, LLC (GRWS). The other facilities in the Phoenix AMA with RC LTSCs include Tonopah USF and Roosevelt Water Conservation District GSF in West Salt River Valley. A total of 256,355 AF of recoverable water has been stored in the Phoenix AMA.

In addition to the recoverable groundwater stored in the Phoenix AMA, RC has stored water for which they are not accruing credits or that is outside of the AMA. Within the Phoenix AMA, RC has delivered 9,360 AF of shaft dewatering water to farmers in NMIDD. This water does not accrue LTSCs, but presumably has had the same effect as a GSF by lessening NMIDD groundwater demand. RC has also stored 56,780 AF in the Hohokam Irrigation & Drainage District GSF in the Pinal AMA. These should be noted in assessment of the overall impact of mine water demand.

Table 1. Summary of Phoenix AMA Long Term Storage Credits accrued by RC

Facility Permit Number	RC Water Storage Permit Number	Facility Name	Total (AF)	Total after 5% Deduction (AF)
Phoenix Active Management Area				
72-534888	73-534888.0601	New Magma Irrigation and Drainage District (NMIDD) GSF	195,630	187,575
73-534888	---	Long-Term Storage Credits purchased from Gila River Water Storage LLC stored at NMIDD	---	36,936
72-545695	73-545695.1400	Roosevelt Water Conservation District (RWCD) GSF	14,000	13,300
71-593305	73-593305.1800	Tonopah USF	19,637	18,544
		Phoenix AMA Total	**---**	**256,355**
Pinal Active Management Area				
72-534489	73-534489.0500	Hohokam Irrigation & Drainage District GSF	60,390	56,780
		Pinal AMA Sub-total	**60,390**	**56,780**
		Phoenix and Pinal AMA Total	**---**	**313,135**

AF = acre-feet; Data from annual reports submitted to ADWR and accessed through ADWR imaged records

Groundwater that RC has stored at the NMIDD GSF has contributed to groundwater level rise in NMIDD and surrounding areas. Groundwater levels in some wells near the Desert Wellfield have risen by over 100 feet since the early 1990s and continue to rise. The potential impacts of Desert Wellfield pumping on groundwater levels should be viewed in the context of recharge and groundwater saving accrued by the mine. To date, and depending on the tailings storage facility alternative, Resolution has stored 43 to 143 percent of its projected water demands expected in the form of LTSCs in the Phoenix AMA and between 53 percent and 175 percent of its projected water demands in the form of LTSCs in the combined Phoenix and Pinal AMAs (**Table 2**).

Table 2. Summary of Groundwater Pumping for Each Desert Wellfield Pumping Alternative and Comparison to Resolution Storage Credits

Groundwater Pumping Alternative	Pre-Mining (2018 - 2027)	Mining (2028 -2068)		Percent of Demand Offset by Storage Credits in Phoenix AMA	Percent of Demand Offset by Storage Credits in Phoenix and Pinal AMAs
	Total Volume (AF)	Average Rate (AF/year, *gpm**)	Total Volume (AF)		
1 – No Mining	0	0	0	Not Applicable	Not Applicable
2 – Near West Wet	3,484	14,305 *8,862**	586,512	43%	53%
3 – Near West Drier		12,056 *7,469**	494,290	52%	63%
4 – Silver King Filtered		4,288 *2,656**	175,804	143%	175%
5 – Peg Leg		13,287 *8,231**	544,765	47%	57%
6 – Skunk Camp		13,289 *8,233**	544,862	47%	57%

gpm = gallons per minute; AF = acre-feet

Groundwater Flow Model

In 2009 ADWR published an updated SRV model for the purpose of examining regional impacts of future water use scenarios within the SRV (Freihoefer and others, 2009). The 2009 model simulates groundwater conditions between 1983 and 2006 using the model code MODFLOW 2000 (Harbaugh and others, 2000). For this current study, the 2009 ADWR model is extended to include years 2007 through 2016 using updated groundwater pumping and recharge volumes provided by ADWR. The model was further extended to include a predictive period through 2268. This extended model will herein be referred to as the SRV-DW model.

Grid spacing, layering, and aquifer hydraulic parameters are not changed from the original 2009 SRV model. Grid spacing is uniformly 0.5 by 0.5 miles throughout the model. The model is divided into three layers with variable thicknesses reflecting the regional hydrogeology. Model boundary conditions for evapotranspiration (EVT), specified-head (CHD), and stream flow (STR) are extended in the SRV DW model through 2268 and are set to the 2006 specifications in the original 2009 SRV model. Additional documentation of these properties can be found in the 2009 ADWR model report (Freihoefer and others, 2009).

An additional modification to the 2009 SRV model includes lowering the bottom elevation of select model cells in layer 3 to maintain wetted active cells during model simulations. This change allows for improved cell rewetting during the recovery period after cessation of Desert Wellfield pumping.

Pumping and recharge updates to the model include:

- **Non-Desert Wellfield groundwater pumping 2007 to 2016** – Groundwater pumping for the entire SRV model is updated to include reported pumping from 2007 to 2016. These updates are based on well files provided by ADWR (data request July 24, 2017 and May 31, 2018). Several minor corrections were made to well pumping rates that were noted and approved by ADWR (personal communication with Dale Mason at ADWR).

- **Non-Desert Wellfield groundwater pumping 2017 to 2268** – Groundwater pumping for years 2017 to 2268 is conservatively held constant at 2016 pumping rates.

- **Recharge from 1983 to 2006** – Groundwater recharge is unchanged from the 2009 ADWR model. Annual volumes of simulated recharge components are shown on **Figure 2**.

- **Agricultural Recharge from 2007 to 2025** – In the 2009 SRV model, a variable lag time is assumed for agricultural return flows based on the estimated depth to groundwater. Historically this lag time has been assumed to be 10 to 15 years (Freihoefer and others, 2009). ADWR provided M&A with SRV model agricultural return flow estimates for years 2003 through 2015 (data request June, 2018). Using the 10-year lag assumption, these returns flows were simulated as recharge for the period 2013 through 2025. For years 2007 through 2012, the simulated agricultural recharge is extrapolated linearly between 2006 and 2013 rates (**Figure 2**).

- **Agricultural Recharge from 2026 to 2268** – Simulated agricultural recharge is held constant at 2025 rates for the period 2026 through 2268, with the exception that NMIDD agricultural recharge was ended in 2041 (**Figure 1 and Figure 2**). The termination of NMIDD agricultural recharge assumes irrigated agricultural and returns flows will potentially continue until 2030 based on a report by Water Resources Research Center at the University of Arizona (Lahmers and Eden, 2018), combined with a 10-year lag time to recharge the aquifer. This assumption, combined with the assumption that all groundwater pumping continues at 2016 rates, is considered conservative because a reduction in agricultural return flows recharge would also likely accompany a reduction is groundwater pumping.

- **USF Recharge 2007 to 2016**– Reported recharge from all SRV USF facilities is updated in the model through 2016 (**Figure 2**).

- **USF Recharge 2017 to 2268**– Simulated recharge rates for effluent and surface water - sourced USFs for 2017 through 2268 are held constant at 2016 rates, regardless of permit end dates. Simulated recharge for CAP-sourced USFs is held constant at 2016 rates until the end of 2030 and then discontinued from 2031 to 2068 based on the assumption that CAP water may not be available after 2030 (**Figure 2**). This assumption is considered to be conservative because it assumes CAP water is never available for recharge after 2030.

- **Other recharge 2007 to 2268** – All other recharge sources besides USF and agricultural components are held constant at 2006 rates from 2007 through 2268 (**Figure 2**).

Desert Wellfield Pumping

In June 2018, RC provided six pumping alternatives for Desert Wellfield based on five alternative mine tailings plans and one "no action" pumping alternative with no mining and consequently, no Desert Wellfield pumping. The no-pumping alternative is used as a baseline to determine drawdown impacts for the other five Desert Wellfield pumping alternatives. All active Desert Wellfield pumping alternatives use the same well layout shown on **Figure 1**. The simulated wellfield is located in a linear pattern along the Magma Arizona Railroad Company (MARRCO) private land and/or Right of Way. The wellfield layout includes 12 wells with approximate 1,780-foot spacing between wells. The total well number was chosen based on the maximum pumping demand of 11,353 gallons per minute (gpm) in Alternative 2. Assuming a maximum well pumping capacity of 1,500 gpm and a need for three additional reserve wells, a total of 12 wells are estimated to be required to cover the maximum demand. Groundwater pumping for all alternatives is distributed uniformly between all 12 wells with pumping simulated in model layer 3. Depth to the top of model layer 3 is approximately 450 feet to 740 feet below land surface at the Desert Wellfield site.

Simulated Desert Wellfield pumping rates for each alternative are summarized below in **Table 2**. Detailed annual pumping rates for each model simulation are shown in **Table 3** and on **Figure 3**.

For 2018 through 2027, Alternatives 2 through 6 have the same pre-mining pumping demands. During the following 41 years of planned mining operations, 2028 through 2068, pumping demands for each alternative vary depending on the tailings site and design. The lowest pumping rate is for Alternative 4 and highest for Alternative 2. All alternatives simulations project impacts for an additional 200 years after cessation of Desert Wellfield pumping.

Results

Alternative 1 – Baseline

Alternative 1 is the baseline no-mining alternative with no Desert Wellfield pumping (**Table 3 and Figure 3**). The results from this model simulation are used to calculate projected drawdown impacts for the pumping alternatives.

Alternative 2 – Near West Wet

Alternative 2 corresponds to water demands for Alternative 2 – Near West Wet tailings design. Total simulated groundwater withdrawal during mining (2028 through 2068) is 586,512 AF, with an average pumping rate of 14,305 AF/year (8,862 gpm) (**Tables 2 and 3**). Pumping is largest from 2035 (mine year 8) through 2058 (mine year 31) (**Table 3 and Figure 3**). RC groundwater recharge activities in the Phoenix AMA offset 43 percent of the withdrawals from groundwater pumping that would occur under this alternative implying that RC's overall net withdraw on the Phoenix AMA is only 57 percent of what is projected by the model. For both Phoenix and Pinal AMAs, RC recharge activities offset 53 percent of Alternative 2 groundwater pumping.

Projected drawdown at the wellfield center is shown on **Figure 4** for the entire predictive simulation period. Drawdown begins increasing substantially after the start of mining operations in 2028 and continues to increase until 2058 (mine year 31). Maximum projected drawdown of 228 feet occurs at the wellfield center in 2058. Drawdown at the wellfield center is projected to be 96 feet at the cessation of the groundwater pumping in 2068. By the end of 200 years of post-pumping, drawdown is projected to be 17 feet at the wellfield center.

The first map panel on **Figure 5** shows the 10-foot projected drawdown contours at the time of maximum drawdown (2058). The second map panel on **Figure 5** shows the 10-foot projected drawdown contours at the end of pumping (2068). The maximum areal extent of the projected 10-foot drawdown contour does not occur until 120 to 125 years after the end of pumping (2189 to 2194) as shown on the last map panel on **Figure 5**. The model projects 10 feet of drawdown to extend a maximum of 18 to 20 miles northwest from the Desert Wellfield.

Alternative 3 – Near West Drier

Alternative 3 corresponds to water demands for Alternative 3 – Near West Drier tailings design. Total simulated groundwater withdrawal during mining (2028 through 2068) is 494,290 acre-feet, with an average pumping rate of 12,056 AF/year (7,469 gpm) (**Tables 2 and 3**). Pumping is largest from 2035 (mine year 8) through 2058 (mine year 31) (**Table 3 and Figure 3**). RC groundwater recharge activities in the Phoenix AMA offset 52 percent of the impact from groundwater pumping that would occur under this alternative implying that RC's net impact on the AMA is only 48 percent of what is projected by the model. For both Phoenix and Pinal AMAs, RC recharge activities offset 63 percent of Alternative 3 groundwater pumping.

Projected drawdown at the wellfield center is shown on **Figure 4** for the entire predictive simulation period. Drawdown begins to increase substantially after start of mining operations in 2028 and continues to increase until 2058 (mine year 31). Maximum projected drawdown of 177 feet occurs at the wellfield center in 2058. Drawdown at the wellfield center is projected to be 91 feet at the cessation of the groundwater pumping in 2068. By the end of 200 years of post-pumping, drawdown is projected to be 14 feet at the wellfield center.

The first map panel on **Figure 6** shows the 10-foot projected drawdown contours at the time of maximum drawdown (2058). The second map panel on **Figure 6** shows the 10-foot projected drawdown contours at the end of pumping (2068). The maximum areal extent of the projected 10-foot drawdown contour does not occur until 120 to 125 years after the end of pumping (2189 to 2194) as shown on the last map panel on **Figure 6**. The model projects 10 feet of drawdown to extend a maximum of 17 to 20 miles northwest from the Desert Wellfield.

Alternative 4 – Silver King Filtered

Alternative 4 corresponds to water demands for Alternative 4 – Silver King Filtered tailings design. Total simulated groundwater withdrawal during mining (2028 through 2068) is 175,804 acre-feet, with an average pumping rate of 4,288 AF/year (2,656 gpm) (**Tables 2 and 3**). Pumping is largest from 2035 (mine year 8) through 2058 (mine year 31) (**Table 3 and Figure 3**). RC groundwater recharge activities in the Phoenix AMA offset 143 percent of the impact from groundwater pumping that would occur under this alternative, indicating that RC's presence in the AMA would have a net positive benefit to the aquifer.

Projected drawdown at the wellfield center is shown on **Figure 4** for the entire predictive simulation period. Drawdown begins to increase substantially after start of mining operations in 2028 and continues to increase until 2058 (mine year 31). Maximum projected drawdown of 53 feet occurs at the wellfield center in 2058. Drawdown at the wellfield center is projected to be 30 feet at the cessation of the groundwater pumping in 2068. By the end of 200 years of post-pumping, drawdown is projected to be 5 feet at the wellfield center.

The first map panel on **Figure 7** shows the 10-foot projected drawdown contours at the time of maximum drawdown (2058). The second map panel on **Figure 7** shows the

10-foot projected drawdown contours at the end of pumping (2068). The maximum areal extent of the projected 10-foot drawdown contour occurs 11 years after the end of Desert Wellfield pumping (2079) as shown in the middle map panel on **Figure 7**. The model projects 10 feet of drawdown to extend a maximum of 7 to 11 miles northwest from the Desert Wellfield.

Alternative 5 – Peg Leg

Alternative 5 corresponds to water demands for Alternative 5 – Peg Leg tailings design. Total simulated groundwater withdrawal during mining (2028 through 2068) is 544,765 acre-feet, with an average pumping rate of 13,287 AF/year (8,231gpm) (**Tables 2 and 3**). Pumping is largest from 2035 (mine year 8) through 2058 (mine year 31) (**Table 3 and Figure 3**). RC groundwater recharge activities in the Phoenix AMA offset 47 percent of the impact from groundwater pumping that would occur under this alternative implying that RC's net impact on the Phoenix AMA is only 53 percent of what is projected by the model. For both Phoenix and Pinal AMAs, RC recharge activities offset 57 percent of Alternative 5 groundwater pumping.

Projected drawdown at the wellfield center is shown on **Figure 4** for the entire predictive simulation period. Drawdown begins to increase substantially after start of mining operations in 2028 and continues to increase until 2058 (mine year 31). Maximum projected drawdown of 199 feet occurs at the wellfield center in 2058. Drawdown at the wellfield center is projected to be 97 feet at the cessation of the groundwater pumping in 2068. By the end of 200 years of post-pumping, drawdown is projected to be 16 feet at the wellfield center.

The first map panel on **Figure 8** shows the 10-foot projected drawdown contours at the time of maximum drawdown (2058). The second map panel on **Figure 8** shows the 10-foot projected drawdown contours at the end of pumping (2068). The maximum areal extent of the projected 10-foot drawdown contour does not occur until 120 to 125 years after the end of pumping (2189 to 2194) as shown on the last map panel on **Figure 8**. The model projects 10 feet of drawdown to extend a maximum of 18 to 20 miles northwest from the Desert Wellfield.

Alternative 6 – Skunk Camp

Alternative 6 corresponds to water demands for Alternative 6 – Skunk Camp tailings design. Total simulated groundwater withdrawal during mining (2028 through 2068) is 544,862 acre-feet, with an average pumping rate of 13,289 AF/year (8,233 gpm) (**Tables 2 and 3**). Pumping is largest from 2035 (mine year 8) through 2058 (mine year 31) (**Table 3 and Figure 3**). RC groundwater recharge activities in the Phoenix AMA offset 47 percent of the impact from groundwater pumping that would occur under this alternative implying that RC's net impact on the AMA is only 53 percent of what is projected by the model. For both Phoenix and Pinal AMAs, RC recharge activities offset 57 percent of Alternative 6 groundwater pumping.

Projected drawdown at the wellfield center is shown on **Figure 4** for the entire predictive simulation period. Drawdown begins to increase substantially in 2028 and continues to increase until 2058 (mine year 31). Maximum projected drawdown of 198 feet occurs at the wellfield center in 2058. Drawdown at the wellfield center is projected to be 117 feet at the cessation of the groundwater pumping in 2068. By the end of 200 years of post-pumping, drawdown is projected to be 16 feet at the wellfield center.

The first map panel on **Figure 9** shows the 10-foot projected drawdown contours at the time of maximum drawdown (2058). The second map panel on **Figure 9** shows the 10-foot projected drawdown contours at the end of pumping (2068). The maximum areal extent of the projected 10-foot drawdown contour does not occur until 120 to 125 years after the end of pumping (2189 to 2194) as shown on the last map panel on **Figure 9**. The model projects 10 feet of drawdown to extend a maximum of 18 to 20 miles northwest from the Desert Wellfield.

Drawdown Comparison between Alternatives 2 through 6

Table 4 summarizes projected drawdown results for Alternatives 2 through 6. Projections indicate drawdown impacts will be mainly confined to the southern portion of the East Salt River Valley. Differences in projected drawdown are consistent with the different pumping rates for each alternative (**Tables 2 and 3**). Alternative 2 is projected to have the largest drawdowns at the wellfield and the largest areal 10-foot drawdown impact; whereas, Alternative 4 has the smallest drawdown at the wellfield and the smallest areal extent of the 10-foot drawdown. Alternatives 3, 5, and 6 have similar projected drawdown impacts.

The timing of the maximum drawdown impacts at the wellfield center are similar between all the model simulations with maximum drawdown occurring at the end of mine year 31 (2058). Recovery is still occurring after 200 years post-pumping; drawdown at the wellfield center has recovered to less than 20 feet for all alternatives by 2268 (**Table 4 and Figure 4**). The timing for the maximum areal extent of the 10-foot drawdown is the same for Alternatives 2, 3, 5 and 6 at 120 to 125 years post-pumping (year 2189 to 2194), but is much earlier for Alternative 4 which is projected to be 11 years after the end of pumping in 2068.

Table 4. Summary of Projected Drawdown Impacts

Pumping Alternative	Projected Drawdown at Center of Desert Wellfield (feet)			Extent of maximum 10-foot drawdown contour (miles)
	End of Maximum Pumping (end of mine year 31, year 2058)	End of Pumping (end of mine year 41, year 2068)	200 years post-pumping (year 2268)	
1 – No Mining	0	0	0	0
2 – Near West Wet	228	96	17	18 - 20
3 – Near West Drier	177	91	14	17 - 20
4 – Silver King Filtered	53	30	5	7 - 11
5 – Peg Leg	199	97	16	18 - 20
6 – Skunk Camp	198	117	16	18 - 20

Comparison to Historical Groundwater Trends to Projected Dewatering

Groundwater savings at NMIDD, combined with other ongoing groundwater savings and storage activities in the area have resulted in a substantial rebound of groundwater levels in the vicinity of the Desert Wellfield from the mid 1980's to present. These trends can be seen on **Figure 10** for three GWSI wells near the Desert Wellfield and west of Desert Wellfield in close to the center of NMIDD. The locations of these wells are shown on **Figure 1**. The maximum projected drawdown for each alternative is shown beside the measured groundwater levels. Comparing measured groundwater levels to the projected drawdowns show that the projected drawdowns are similar to historical maximum drawdown and recovery particularly west of the Desert Wellfield where past groundwater pumping has been large. East of the Desert Wellfield historical drawdowns have been less, likely due to lack of groundwater development in the area.

Conclusion

Model results provide an evaluation of potential drawdown impacts for the Desert Wellfield pumping alternatives and associated tailings water demands. The model simulations demonstrate that drawdown impacts will be confined mainly to the southeast portion of the East Salt River Valley (**Figures 5 through 9**). Lower pumping alternatives have comparably smaller drawdown and areal extent of impacts than larger pumping alternatives. For Alternative 2, the highest demand pumping alternative, maximum projected drawdown at the Desert Wellfield center is 228 feet and maximum extent of the 10-foot drawdown contour is approximately 18 to 20 miles. Drawdown projections for all alternatives have a similar range compared to measured historic groundwater level variability in the vicinity of the Desert Wellfield (**Figure 10**). Historic groundwater level rise shown on **Figure 10** hydrographs in part reflects RC's contribution to the nearby NMIDD GSF. Depending on the alternative selected, RC has recharged 43 to 143 percent of projected demands in the Phoenix AMA and recharged between 53 and 175 percent for all stored water in Phoenix and Pinal AMAs for future use. RC's overall net impact for the Phoenix AMA ranges from 57 percent of model projected impacts for Alternative 2 to a positive impact for Alternative 4.

References

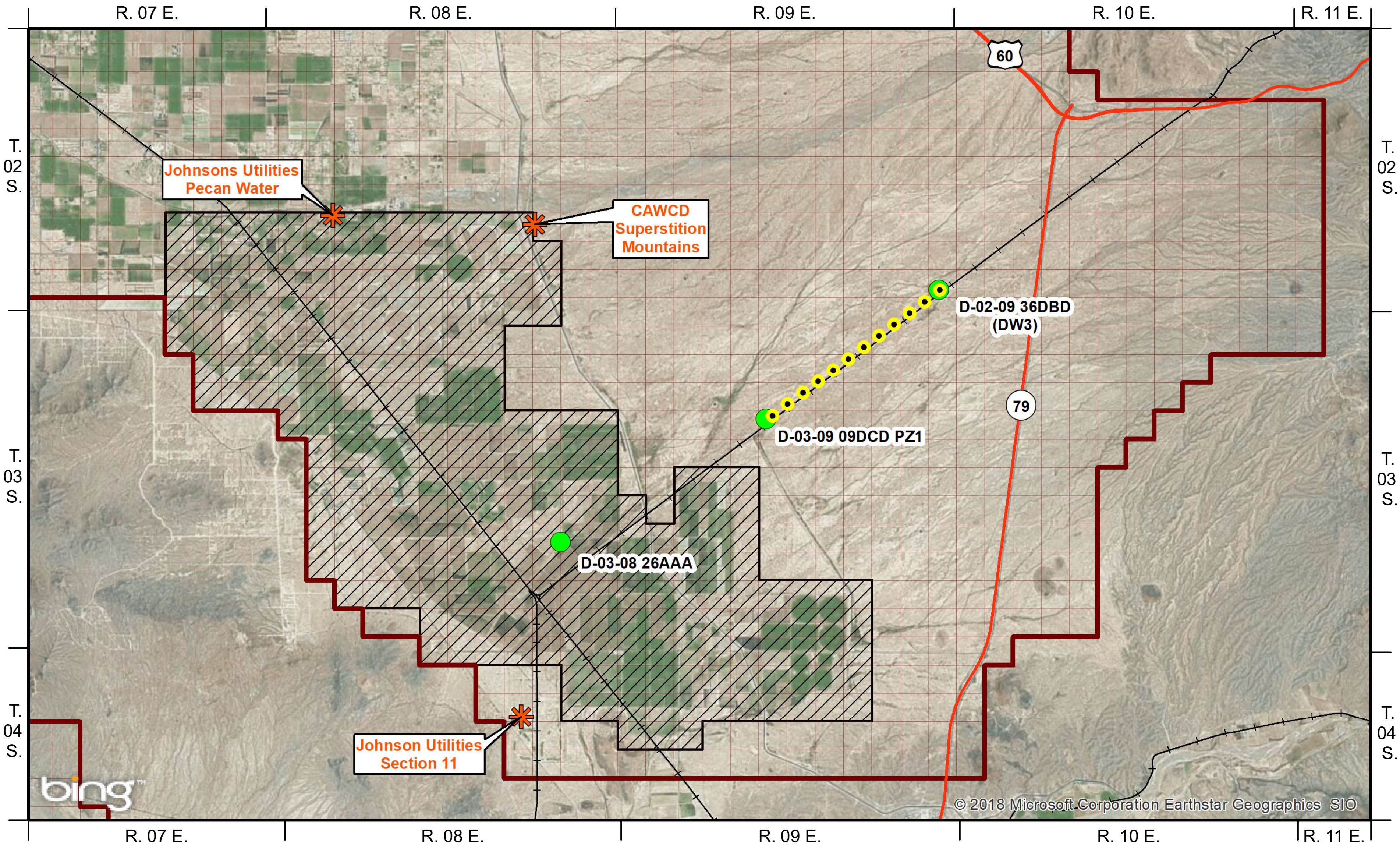
Freihoefer, A., D. Mason, P. Jahnke, L. Dubas, and K. Hutchinson, 2009, **Regional Groundwater Flow Model of the Salt River Valley, Phoenix Active Management Area, Model Update and Calibration**: Arizona Department of Water Resources, Modeling Report No. 19.

Harbaugh, A.W., E.R. Banta, M.C. Hill, and M.G. McDonald, 2000, **MODFLOW-2000, the U.S. Geological Survey modular ground-water model – user guide to modularization concepts and the ground-water flow process:** U.S. Geological Survey Open-File Report 00-92.

Lahmers, T. and S. Eden, 2018, "Water and Irrigated Agriculture in Arizona," Arroyo, University of Arizona Water Resources Research Center, Tucson, AZ.

TABLE 3. SIMULATED ANNUAL DESERT WELLFIELD PUMPING

		Model Stress Period	Year	Mine Year	Groundwater Pumping Alternative (gallons per minute): 1- No Mining	2 - Near West Wet	3 - Near West Dry	4 - Silver King Filtered	5 - Peg Leg	6 - Skunk Camp
Pre-Mining Pumping		36	2018	-9	0.0	319.1	319.1	319.1	319.1	319.1
		37	2019	-8	0.0	408.8	408.8	408.8	408.8	408.8
		38	2020	-7	0.0	432.3	432.3	432.3	432.3	432.3
		39	2021	-6	0.0	179.0	179.0	179.0	179.0	179.0
		40	2022	-5	0.0	149.1	149.1	149.1	149.1	149.1
		41	2023	-4	0.0	138.4	138.4	138.4	138.4	138.4
		42	2024	-3	0.0	92.7	92.7	92.7	92.7	92.7
		43	2025	-2	0.0	32.2	32.2	32.2	32.2	32.2
		44	2026	-1	0.0	43.6	43.6	43.6	43.6	43.6
		45	2027	0	0.0	363.1	363.1	363.1	363.1	363.1
Period of Active Mine Operations		46	2028	1	0.0	5,669.8	4,583.2	1,489.5	2,459.5	3,592.0
		47	2029	2	0.0	5,670.0	4,583.4	1,489.6	2,437.0	3,592.2
		48	2030	3	0.0	5,741.1	4,654.5	1,560.7	2,724.7	3,663.3
		49	2031	4	0.0	5,797.6	4,711.0	1,617.2	4,389.7	3,719.8
		50	2032	5	0.0	4,606.5	3,519.9	426.2	4,729.6	2,528.7
		51	2033	6	0.0	5,539.1	4,452.5	1,358.7	7,058.3	3,461.3
		52	2034	7	0.0	5,709.8	4,623.2	1,529.4	8,359.2	3,632.0
	Period of Maximum Groundwater Pumping	53	2035	8	0.0	12,021.8	9,741.4	3,343.9	9,390.8	10,796.4
		54	2036	9	0.0	12,187.6	9,907.3	3,509.7	9,648.6	10,962.3
		55	2037	10	0.0	12,143.4	9,863.0	3,465.5	9,698.0	10,918.0
		56	2038	11	0.0	12,289.4	10,009.1	3,611.6	10,293.7	11,064.1
		57	2039	12	0.0	12,333.9	10,053.6	3,656.1	10,349.7	11,108.6
		58	2040	13	0.0	12,312.3	10,032.0	3,634.5	10,303.8	11,087.0
		59	2041	14	0.0	12,216.8	9,936.4	3,538.9	10,247.2	10,991.4
		60	2042	15	0.0	12,344.0	10,063.7	3,666.2	10,418.9	11,118.7
		61	2043	16	0.0	12,374.2	10,093.8	3,696.3	10,473.4	11,148.8
		62	2044	17	0.0	12,328.0	10,047.7	3,650.2	10,504.7	11,102.7
		63	2045	18	0.0	12,337.9	10,057.5	3,660.0	10,579.7	11,112.5
		64	2046	19	0.0	12,371.4	10,091.0	3,693.5	10,712.1	11,146.0
		65	2047	20	0.0	12,383.8	10,103.4	3,705.9	10,912.2	11,158.4
		66	2048	21	0.0	12,500.6	10,220.2	3,822.7	11,147.7	11,275.2
		67	2049	22	0.0	12,561.0	10,280.6	3,883.1	11,441.5	11,335.6
		68	2050	23	0.0	12,578.8	10,298.4	3,900.9	11,158.4	11,353.4
		69	2051	24	0.0	12,563.2	10,282.9	3,885.4	11,020.2	11,337.9
		70	2052	25	0.0	12,502.5	10,222.1	3,824.6	11,050.9	11,277.1
		71	2053	26	0.0	12,317.9	10,037.5	3,640.0	11,011.8	11,092.5
		72	2054	27	0.0	12,372.9	10,092.6	3,695.0	11,130.6	11,147.6
		73	2055	28	0.0	12,405.2	10,124.8	3,727.3	11,105.6	11,179.8
		74	2056	29	0.0	12,335.9	10,055.5	3,658.0	11,258.0	11,110.5
		75	2057	30	0.0	12,262.9	9,982.5	3,585.0	11,383.7	11,037.5
		76	2058	31	0.0	12,211.1	9,930.8	3,533.3	11,134.1	10,985.8
		77	2059	32	0.0	3,400.6	3,921.0	1,710.6	9,561.2	5,215.7
		78	2060	33	0.0	3,235.3	3,755.7	1,545.3	8,182.4	5,050.4
		79	2061	34	0.0	2,909.3	3,429.7	1,219.4	6,679.6	4,724.4
		80	2062	35	0.0	2,854.8	3,375.2	1,164.8	5,563.7	4,669.9
		81	2063	36	0.0	2,581.3	3,101.7	891.4	4,600.4	4,396.4
		82	2064	37	0.0	2,526.8	3,047.2	836.8	3,571.9	4,341.9
		83	2065	38	0.0	2,507.2	3,027.6	817.2	2,835.9	4,322.3
		84	2066	39	0.0	2,520.9	3,041.3	830.9	2,537.0	4,336.0
		85	2067	40	0.0	2,531.7	3,052.1	841.7	2,383.5	4,346.8
		86	2068	41	0.0	3,282.2	3,802.5	1,592.2	3,029.7	5,097.3
End of Pumping		87-286	2069 - 2268	42 - 241	0.0	0.0	0.0	0.0	0.0	0.0



EXPLANATION

- Desert Wellfield Well Location
- GWSI Well Location and Identifier
- Underground Storage Facility
- Active Model Domain
- NMIDD Area

0 1 2 3

Miles

FIGURE 1. DESERT WELLFIELD LOCATION MAP

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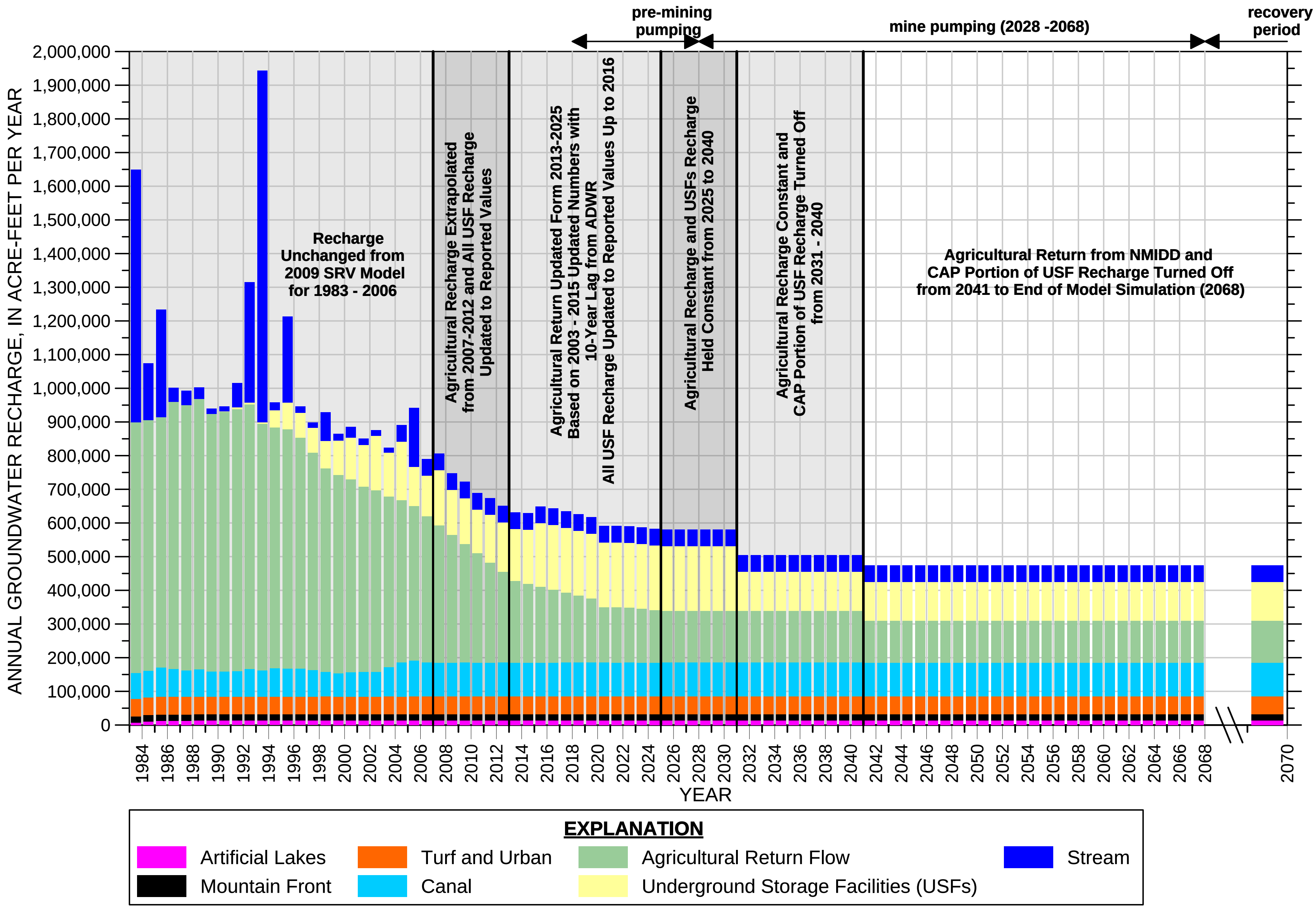

FIGURE 2. SIMULATED ANNUAL RECHARGE COMPONENT VOLUMES

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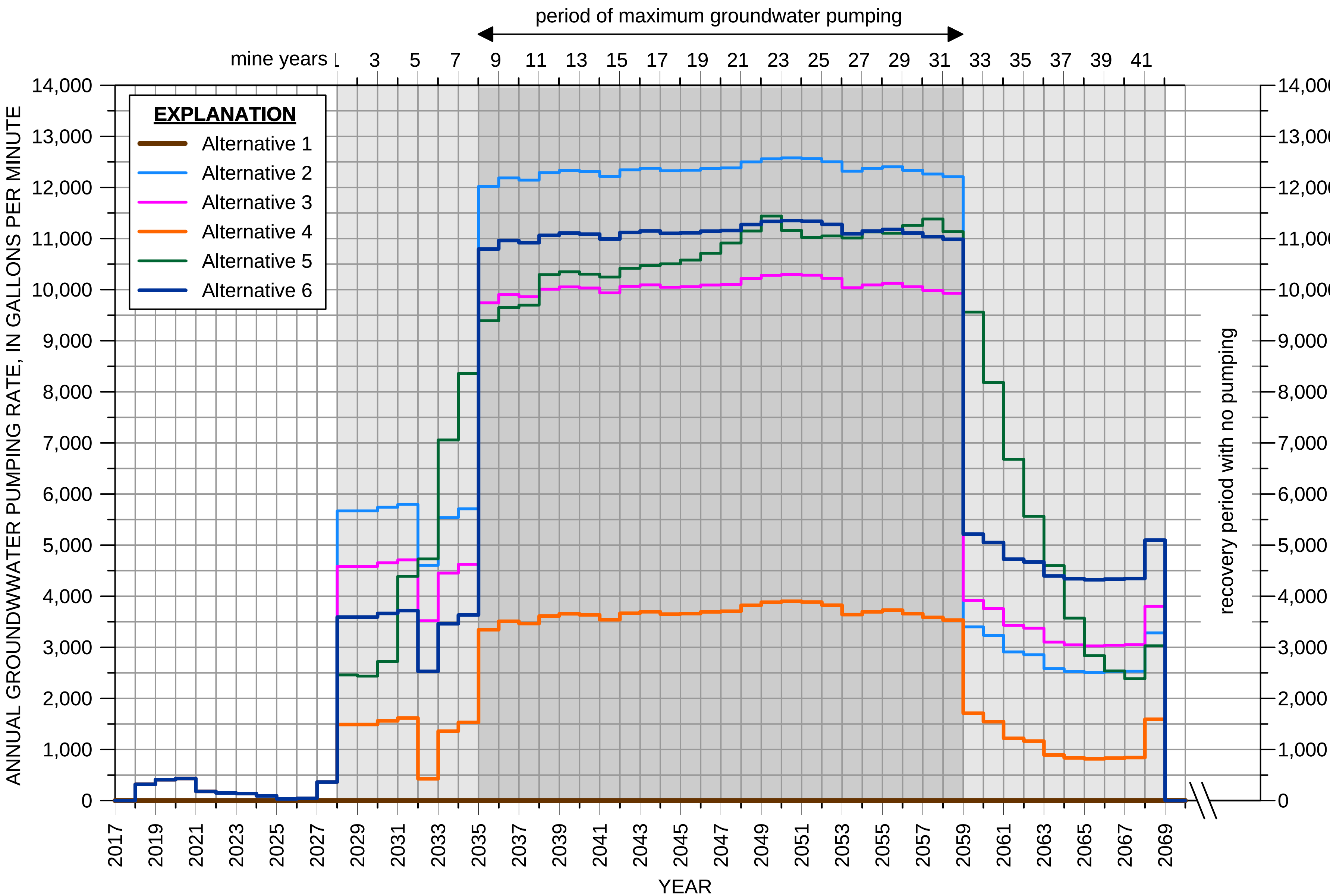

FIGURE 3. SIMULATED DESERT WELLFIELD PUMPING FOR THE FOR SIX TAILINGS WATER DEMAND ALTERNATIVES

605.7 Misc Investigations\605.751_Desert Wellfeild Modeling\Report_TM2018_DesertWellfield\Figures\PumpingDesert_Wellfield.grf 27Aug2018

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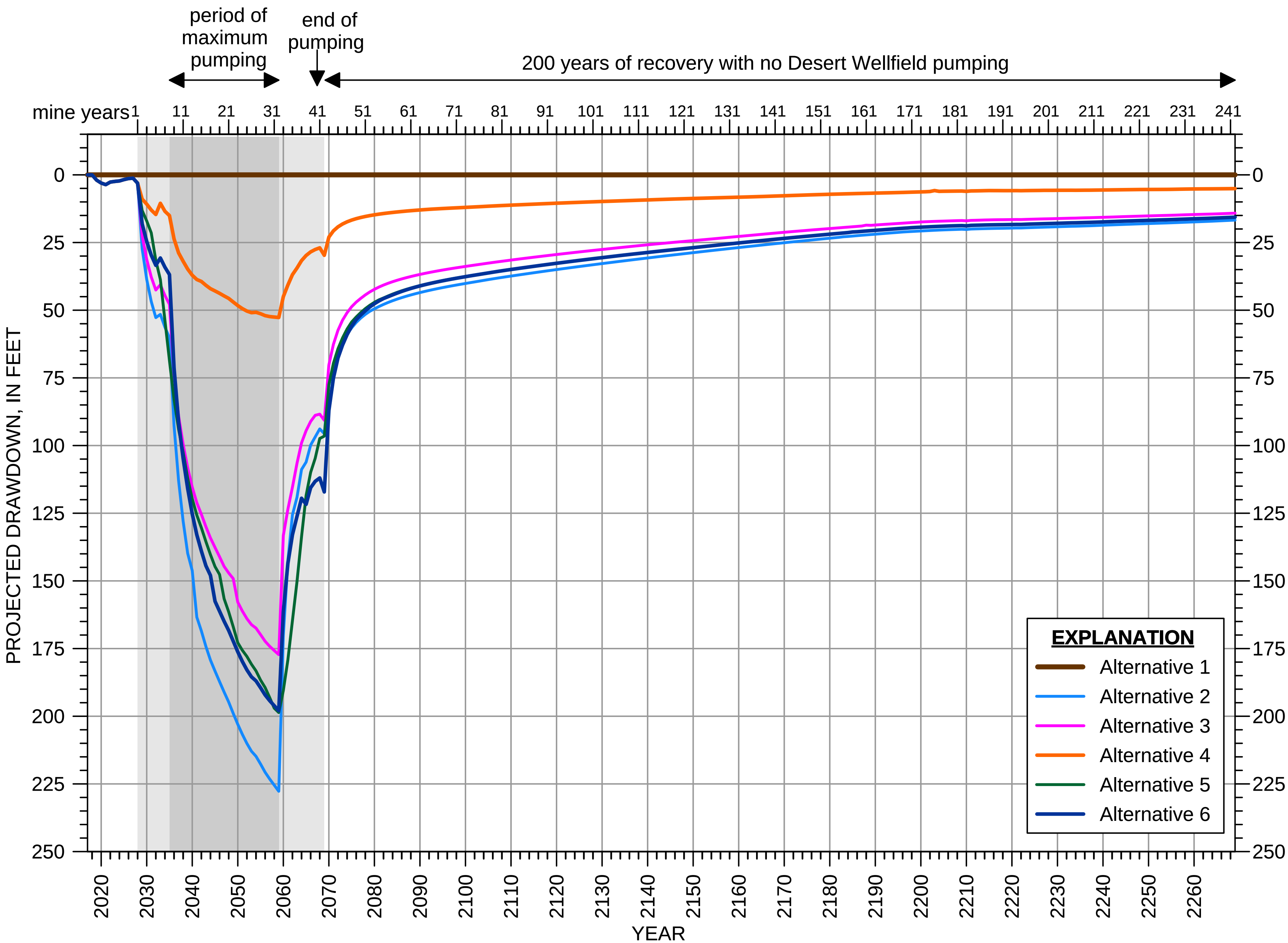

FIGURE 4. HYDROGRAPHS OF PROJECTED DRAWDOWN IMPACTS AT THE DESERT WELLFIELD CENTER FOR SIX TAILINGS WATER DEMAND ALTERNATIVES

605.7\605.751_Desert Wellfeild Modeling\Report_TM2018_DesertWellfield\Figures\Drawdown_DesertWellfield_200yrs.grf 27Aug2018

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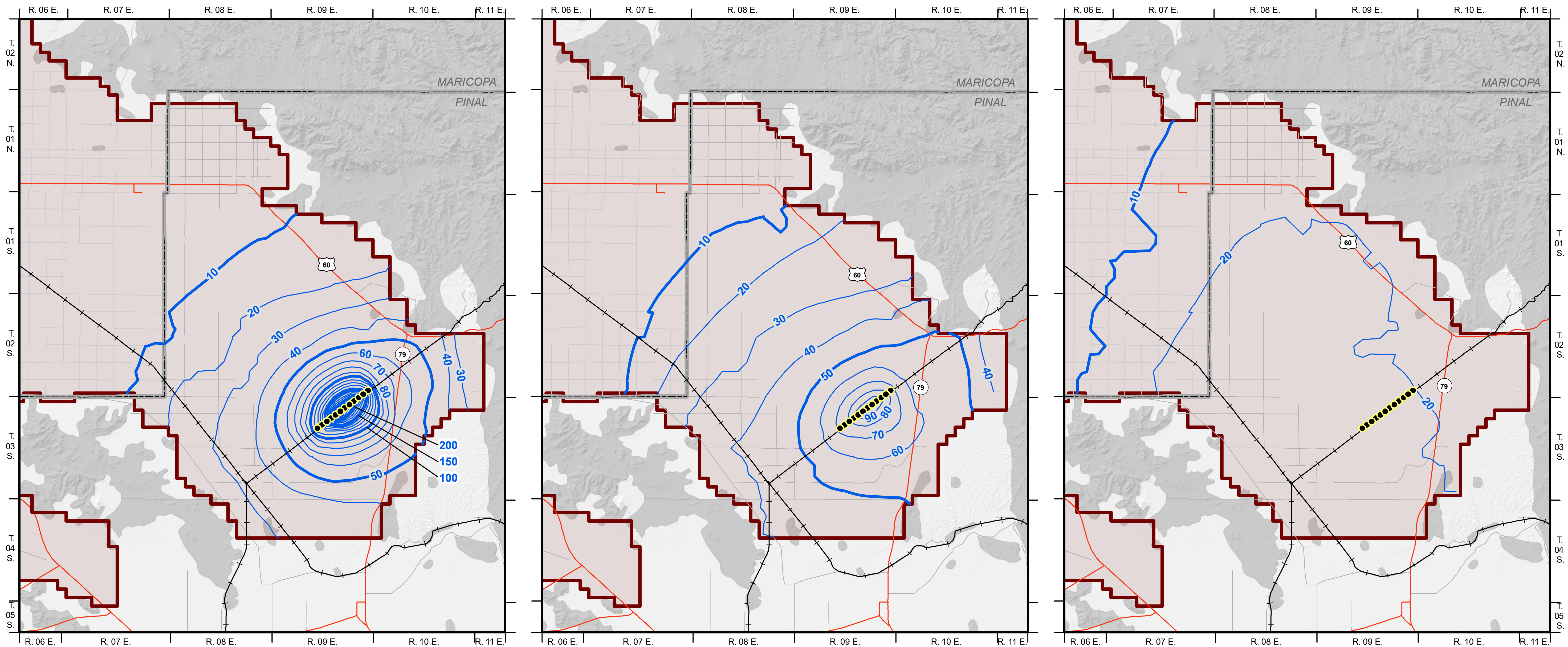
Projected Drawdown at End of Desert Wellfield Maximum Pumping Period (end of mine year 31, year 2058)

Projected Drawdown at End of Desert Wellfield Pumping (end of mine year 41, year 2068)

Projected Maximum Extent of 10-foot Drawdown Contour After Cessation of Desert Wellfield Pumping (124 years after end of pumping, year 2192)

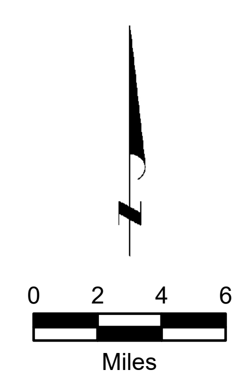


EXPLANATION

Desert Wellfield Well Location

10 Projected Drawdown from Desert Wellfield Groundwater Pumping, in feet

Active Model Domain



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PROJECTED DRAWDOWNS FOR ALTERNATIVE 2

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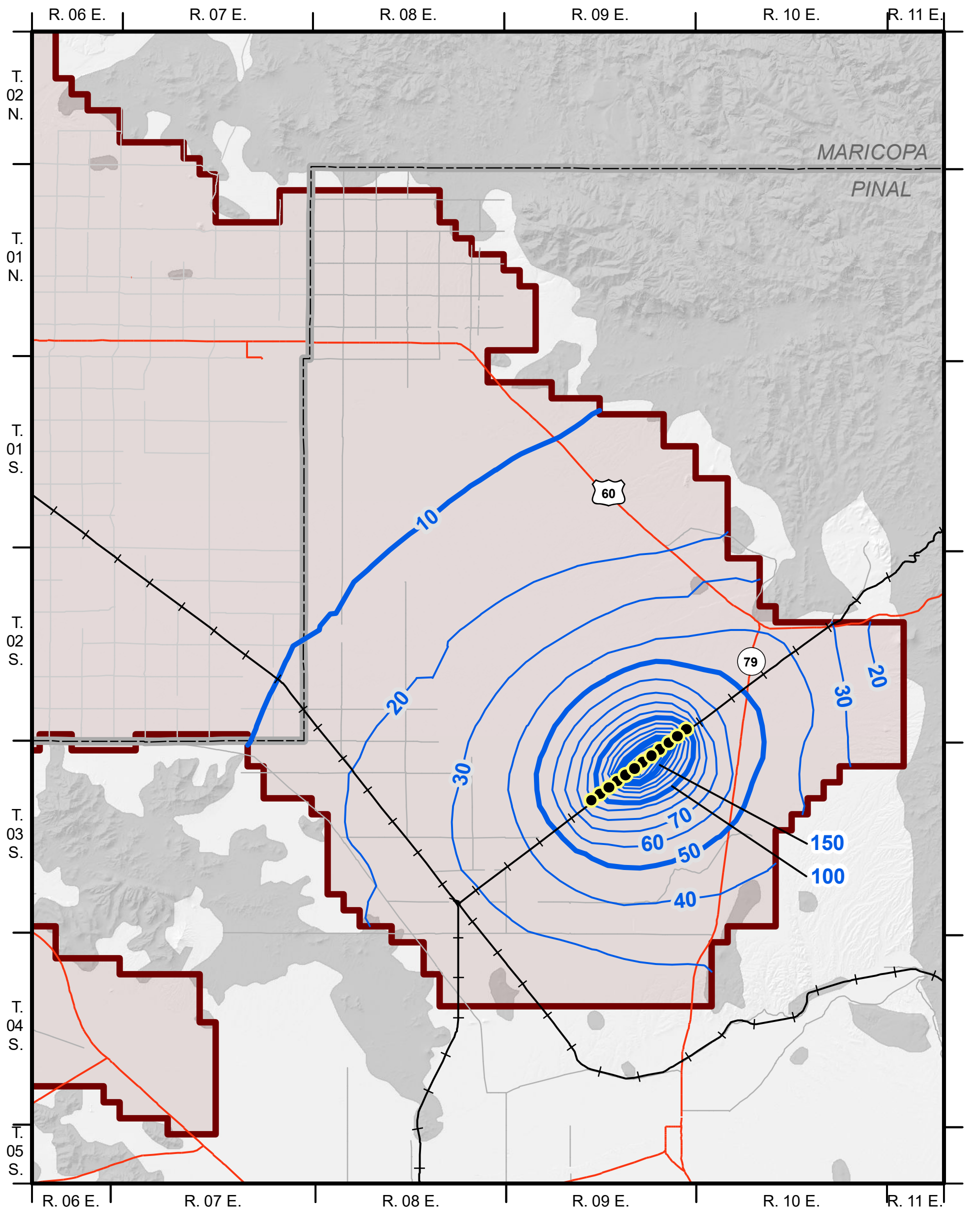
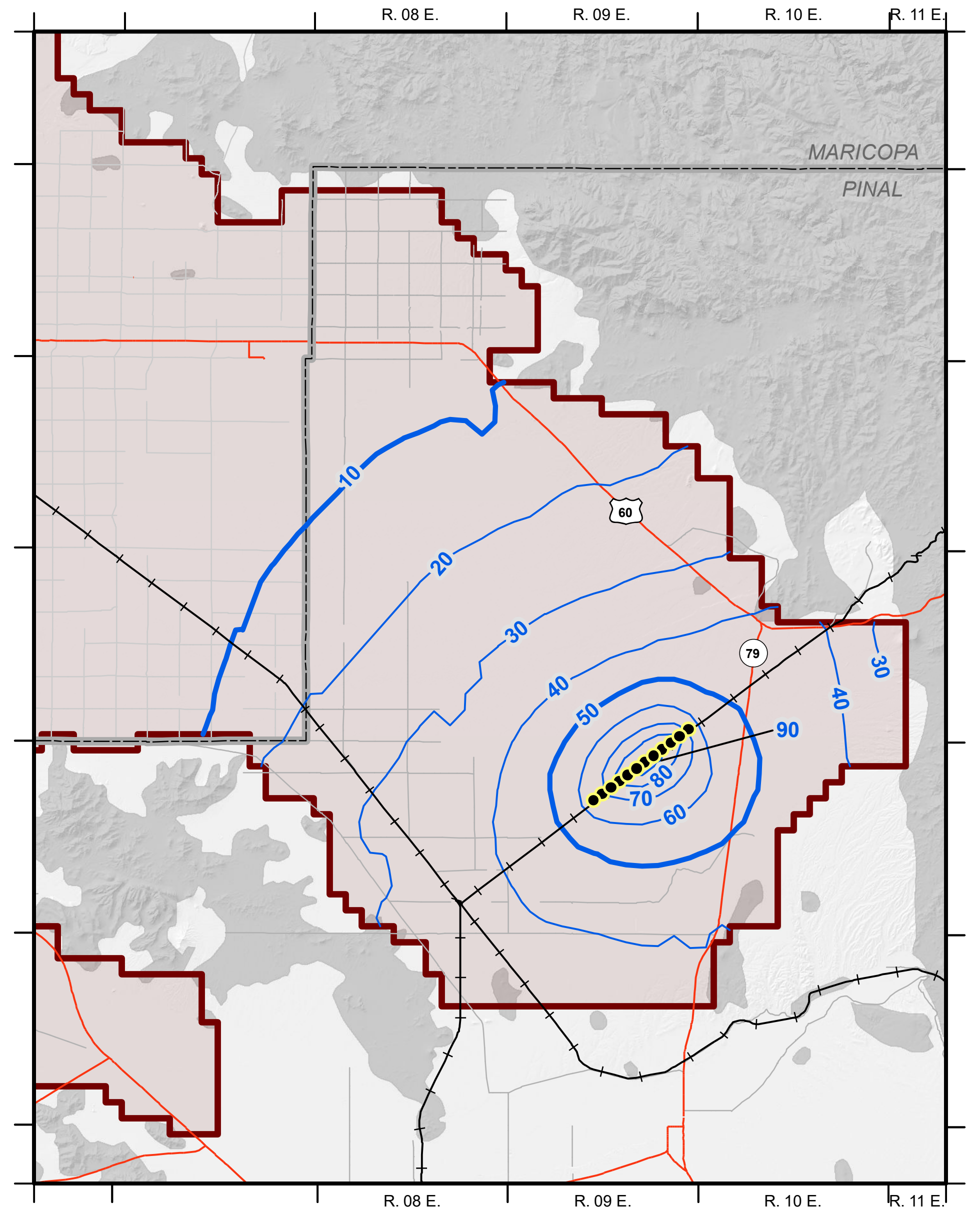
FIGURE 5

G:\GIS-Tuc\Projects\605\605.75\605.7513DesertWellfield2018\\Map_TechMemo_DW201809\Drawdown_Alt02 12Sep2018

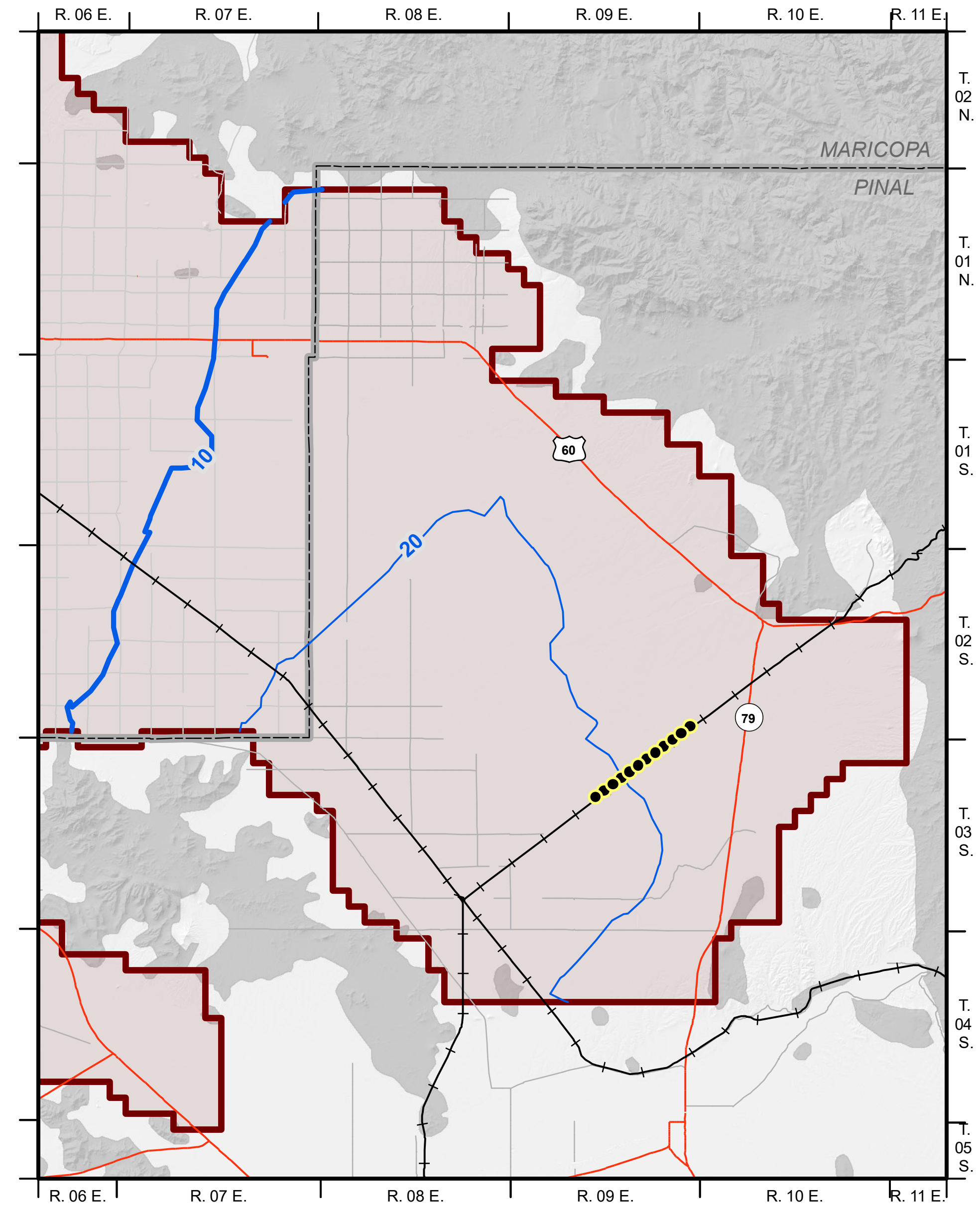
Projected Drawdown at End of Desert Wellfield Maximum Pumping Period (end of mine year 31, year 2058)



Projected Drawdown at End of Desert Wellfield Pumping (end of mine year 41, year 2068)



Projected Maximum Extent of 10-foot Drawdown Contour After Cessation of Desert Wellfield Pumping (124 years after end of pumping, year 2192)



EXPLANATION

- Desert Wellfield Well Location
- 10 — Projected Drawdown from Desert Wellfield Groundwater Pumping, in feet
- Active Model Domain

0 2 4 6
Miles

RESOLUTION COPPER

PROJECTED DRAWDOWNS FOR ALTERNATIVE 3

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FIGURE 6

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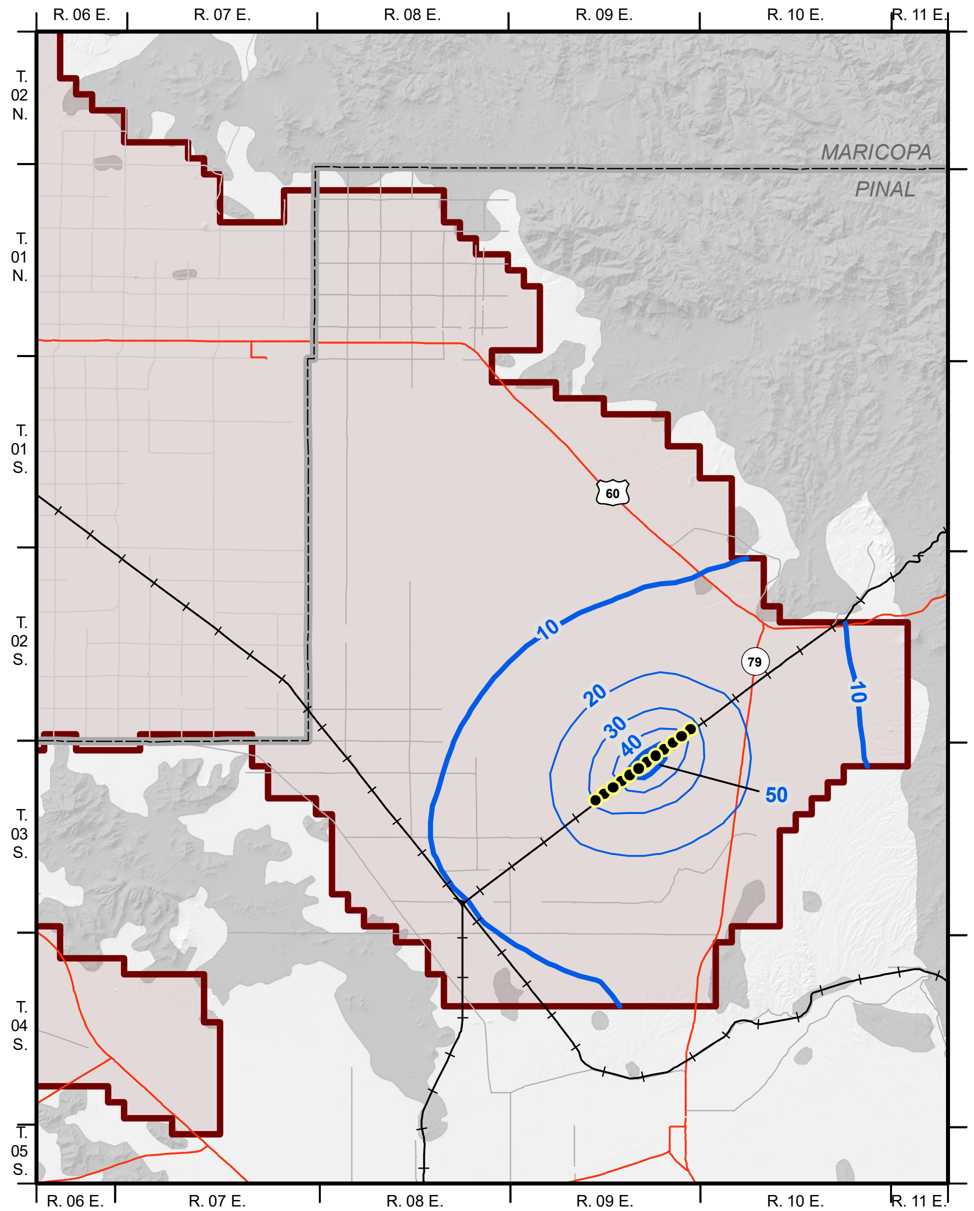
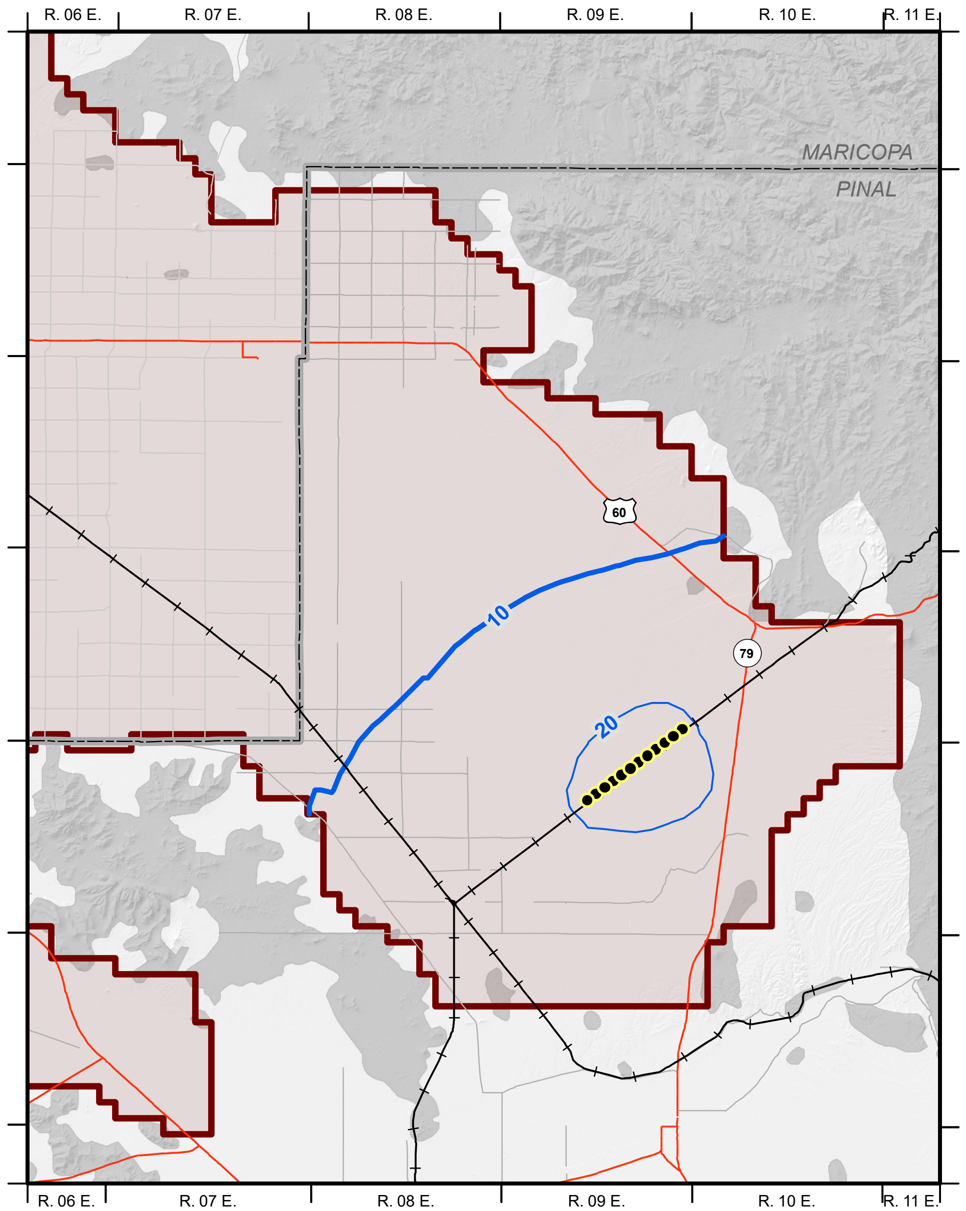
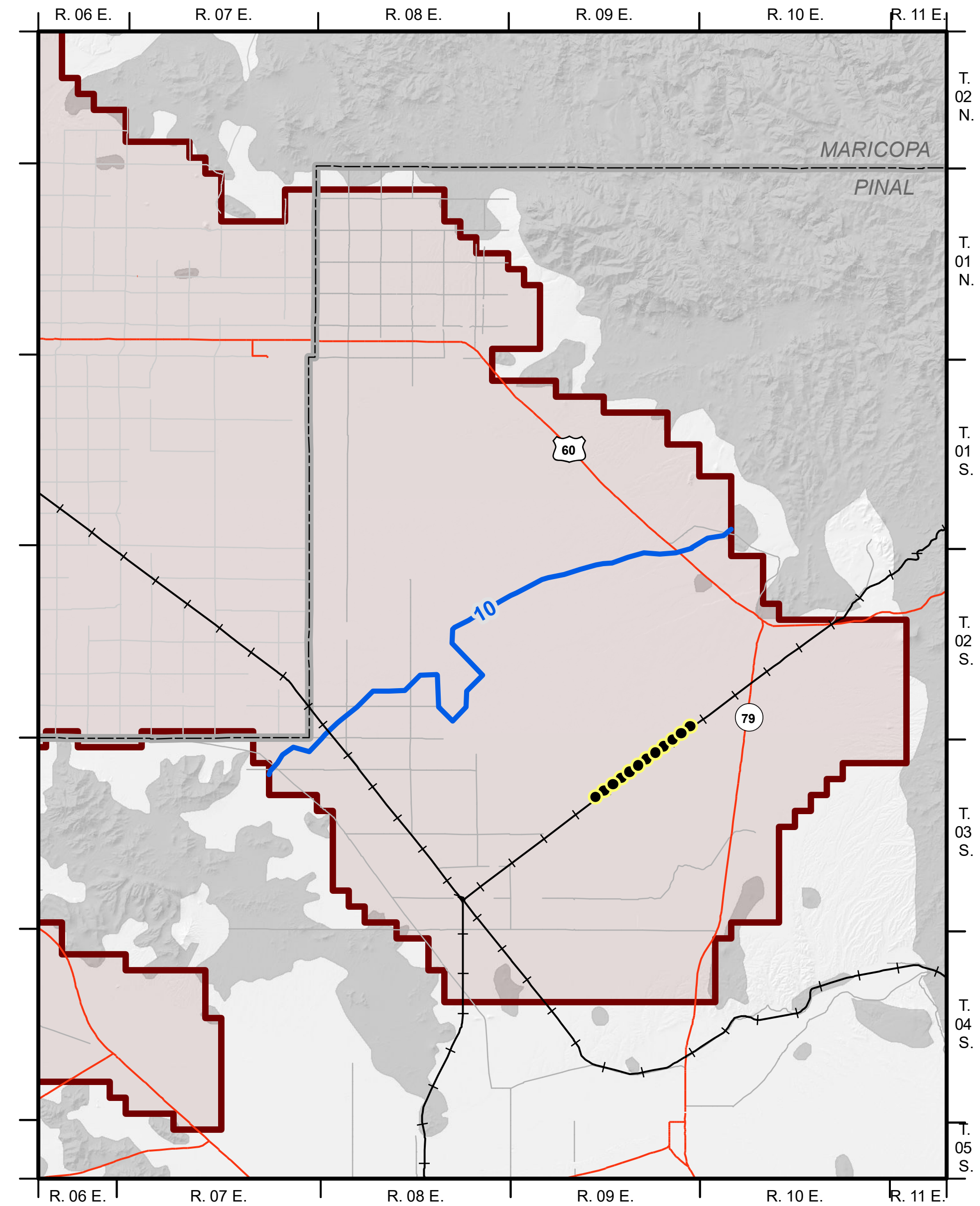
Projected Drawdown at End of Desert Wellfield Maximum Pumping Period (end of mine year 31, year 2058)



Projected Drawdown at End of Desert Wellfield Pumping (end of mine year 41, year 2068)



Projected Maximum Extent of 10-foot Drawdown Contour After Cessation of Desert Wellfield Pumping (11 years after end of pumping, year 2079)



EXPLANATION

- Desert Wellfield Well Location
- 10 — Projected Drawdown from Desert Wellfield Groundwater Pumping, in feet
- Active Model Domain

0 2 4 6
Miles

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PROJECTED DRAWDOWNS FOR ALTERNATIVE 4

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FIGURE 7

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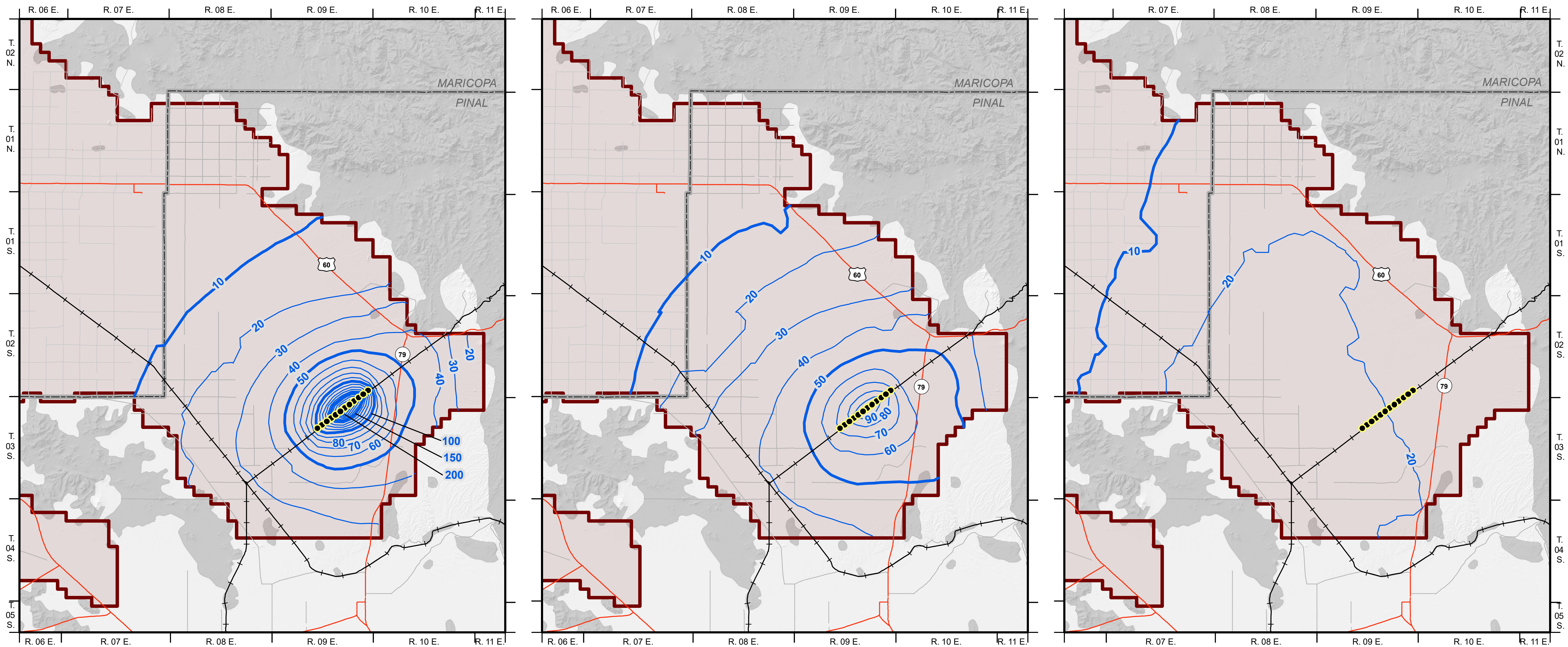
Projected Drawdown at End of Desert Wellfield Maximum Pumping Period (end of mine year 31, year 2058)

Projected Drawdown at End of Desert Wellfield Pumping (end of mine year 41, year 2068)

Projected Maximum Extent of 10-foot Drawdown Contour After Cessation of Desert Wellfield Pumping (124 years after end of pumping, year 2192)



EXPLANATION

Desert Wellfield Well Location

10 Projected Drawdown from Desert Wellfield Groundwater Pumping, in feet

Active Model Domain

0 2 4 6
Miles

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PROJECTED DRAWDOWNS FOR ALTERNATIVE 5

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FIGURE 8

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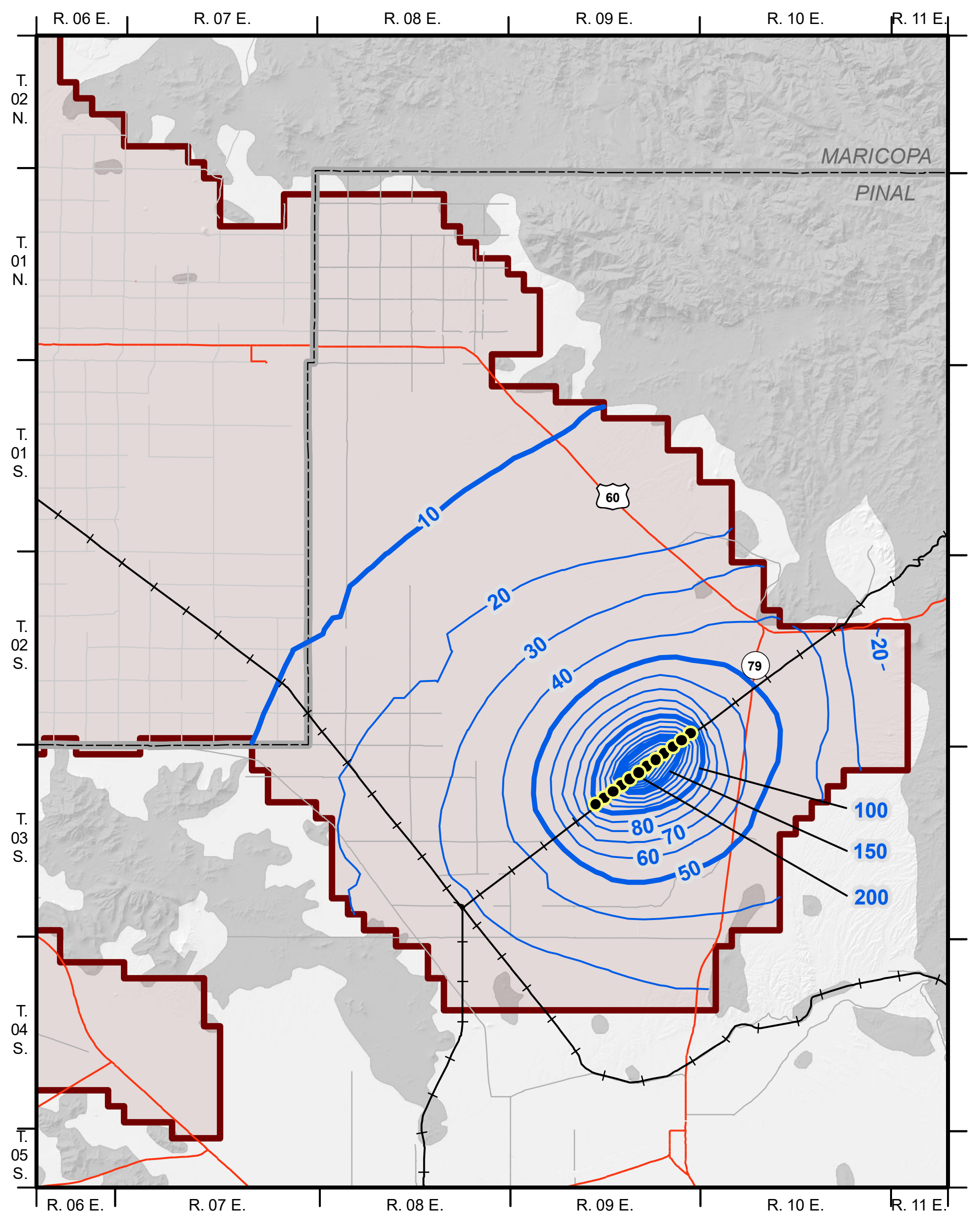
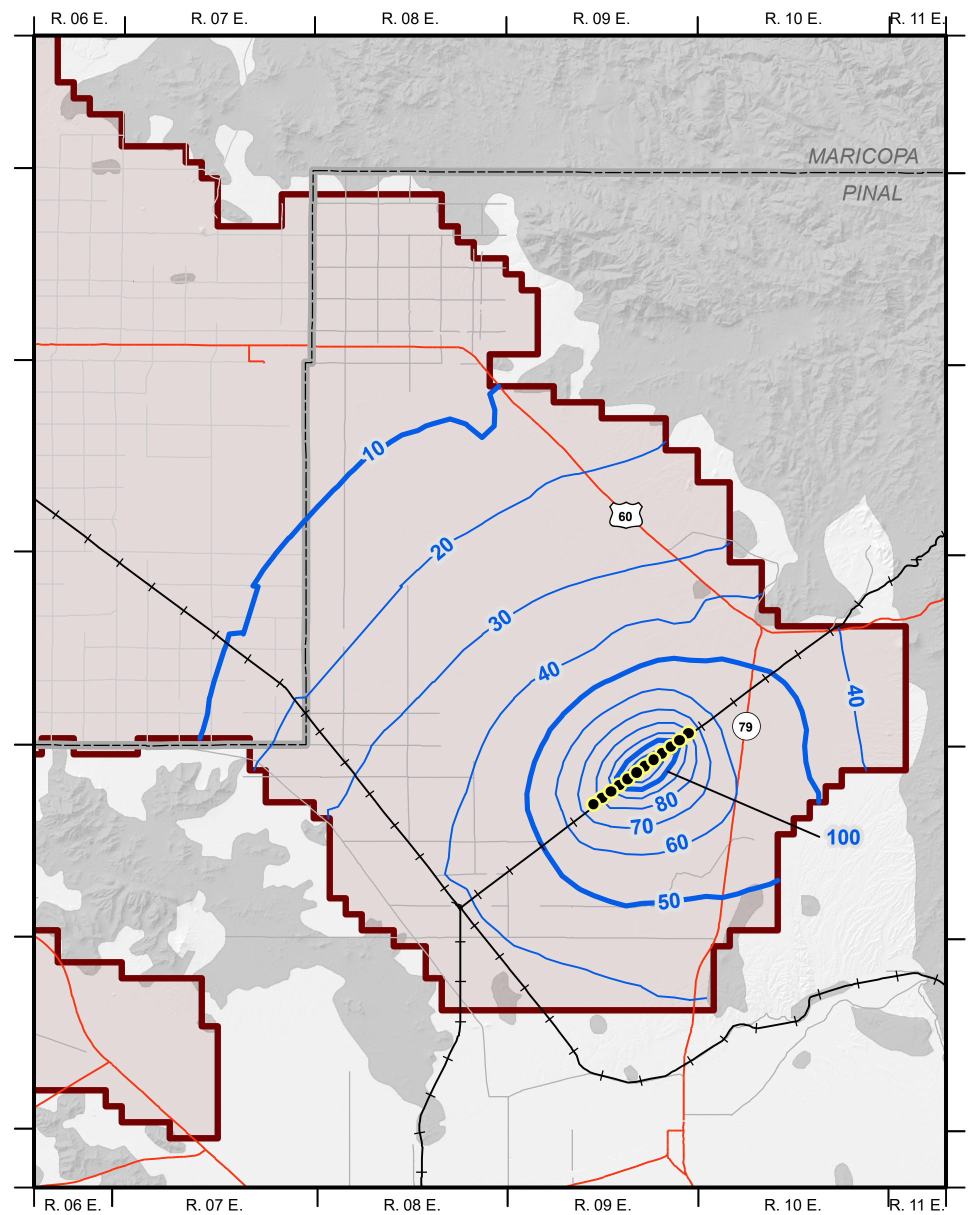
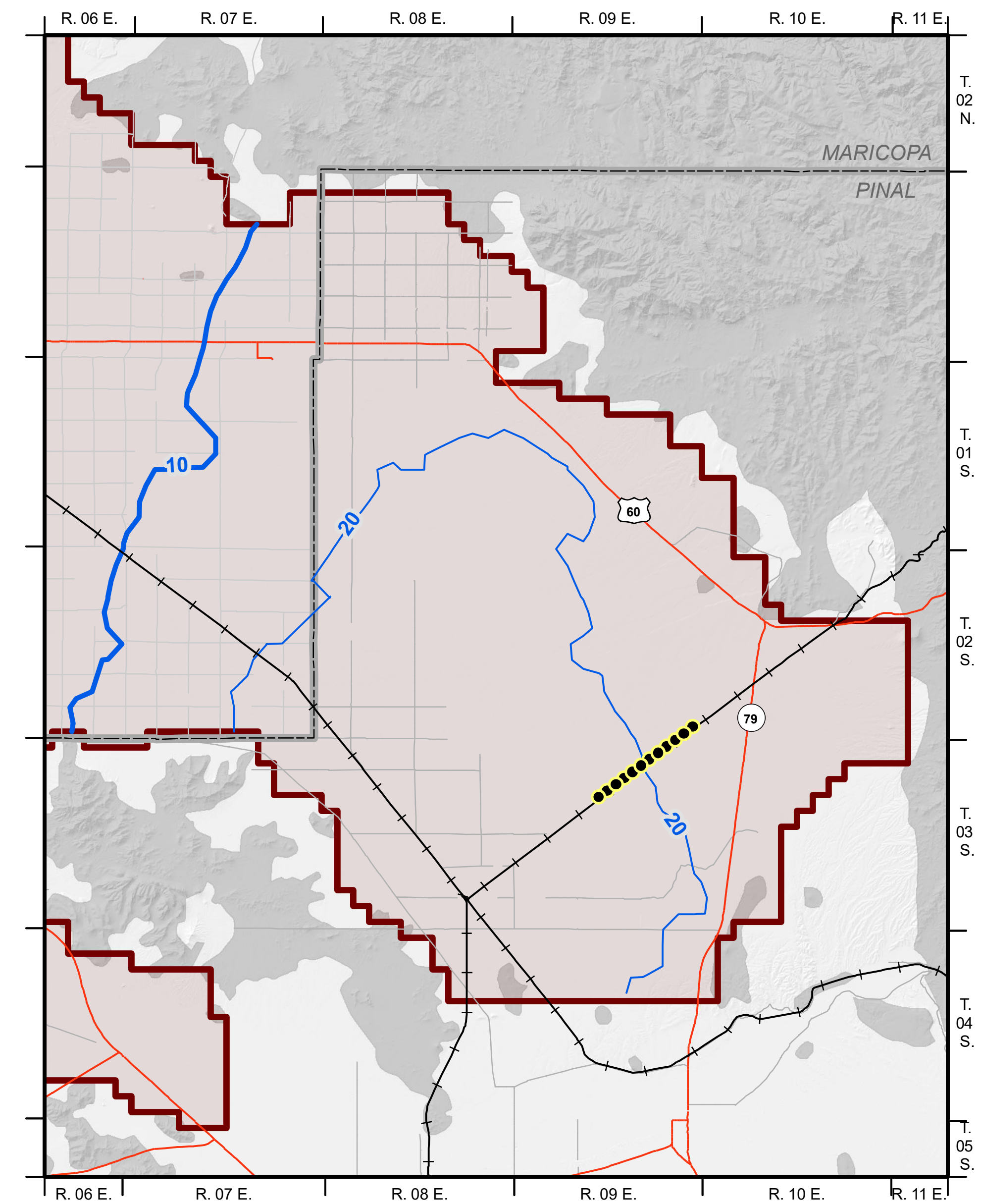
Projected Drawdown at End of Desert Wellfield Maximum Pumping Period (end of mine year 31, year 2058)



Projected Drawdown at End of Desert Wellfield Pumping (end of mine year 41, year 2068)



Projected Maximum Extent of 10-foot Drawdown Contour After Cessation of Desert Wellfield Pumping (124 years after end of pumping, year 2192)



EXPLANATION

Desert Wellfield Well Location

10 — Projected Drawdown from Desert Wellfield Groundwater Pumping, in feet

Active Model Domain

0 2 4 6
Miles

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PROJECTED DRAWDOWNS FOR ALTERNATIVE 6

MONTGOMERY & ASSOCIATES
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FIGURE 9

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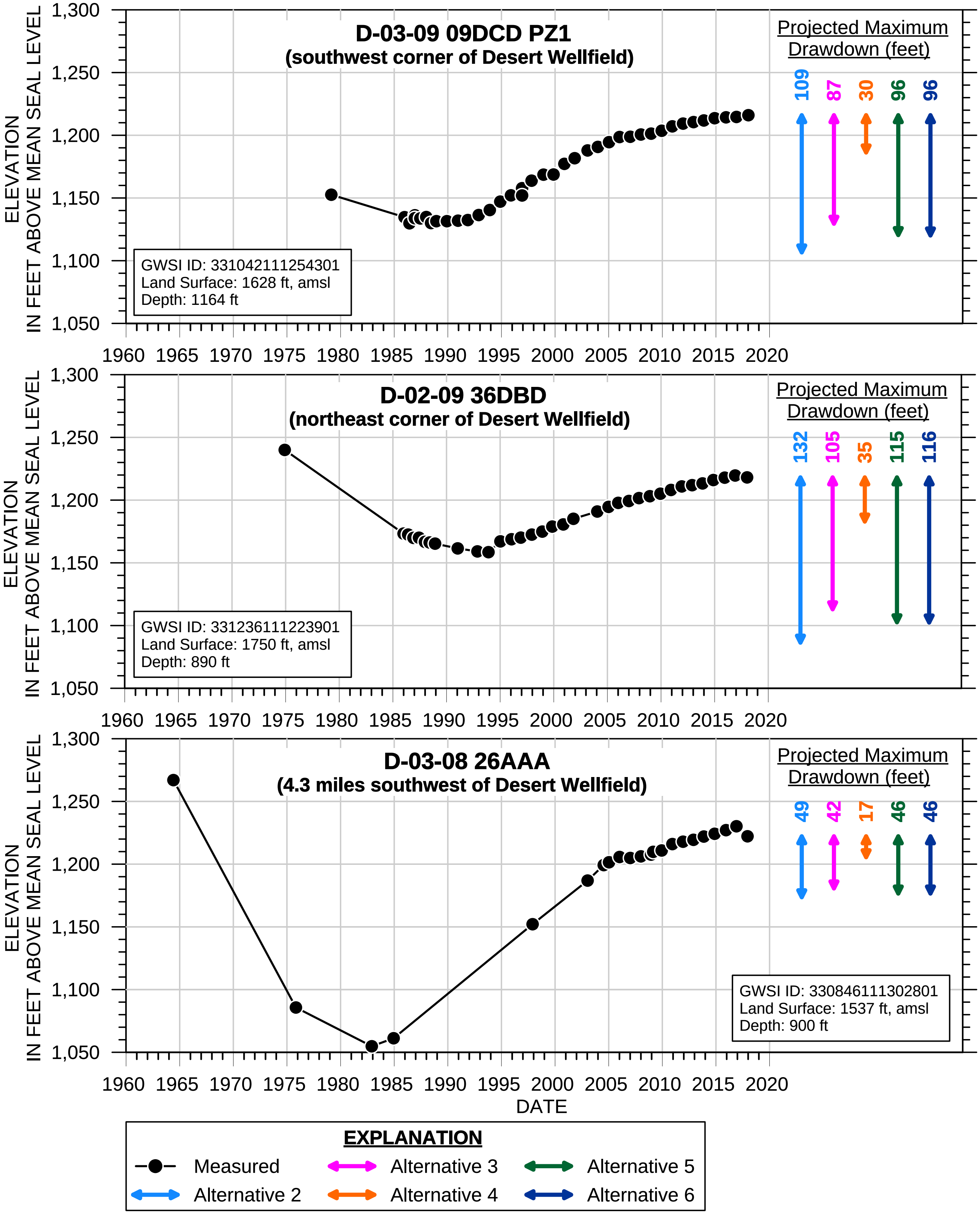

FIGURE 10. HYDROGRAPHS OF MEASURED GROUNDWATER ELEVATIONS AND PROJECTED DRAWDOWNS AT SELECTED GWSI WELLS FOR DESERT WELLFIELD PUMPING ALTERNATIVES

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102 Magma Heights – P.O. Box 1944
Superior, AZ 85173
Tel.: 520.689.9374
Fax: 520.689.9304

September 13, 2018

Ms. Mary Rasmussen
US Forest Service
Supervisor's Office
2324 East McDowell Road
Phoenix, AZ 85006-2496

Subject: Follow-up to July 17, 2018 Groundwater Modeling Workgroup Meeting – East Salt River Valley water supply analysis

Dear Ms. Rasmussen,

As a follow-up to the July 17, 2017 Groundwater Modeling Workgroup Meeting and agenda item titled "*Discussions of expectations for East Salt River Valley water supply analysis*" please see the attached technical report from Montgomery and Associates (*Simulation of Drawdown Impacts from Desert Wellfield*) for your review and consideration.

Sincerely,

Vicky Peacey

Vicky Peacey,

Senior Manager, Environment, Permitting and Approvals; Resolution Copper Company, as Manager of Resolution Copper Mining, LLC

Cc: Ms. Mary Morissette; Senior Environmental Specialist; Resolution Copper Company

Enclosure(s):

Montgomery and Associates, September 2018. Simulation of Drawdown Impacts from Desert Wellfield