Mojave Basin Area Watermaster

Appendix A

Alto & Centro Subarea

Water Supply Update

Prepared by:

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February 28, 2024

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MEMORANDUM

To: Mojave Basin Area Watermaster

From: Robert C. Wagner, P.E.

Date: February 28, 2024

Re: **Production Safe Yield Update for Alto and Centro Subarea; Calculation of Outflow from Alto to the Transition Zone, and Calculation of Outflow to Centro.**

This memorandum presents the update for Production Safe Yield (PSY) for the Alto and Centro Subareas. These areas are shown on Figure 1, attached hereto. The Transition Zone described in Appendix B, is considered to be part of the Alto subarea by the Judgment, and serves to hydraulicly connect the portion of Alto above the Lower Narrows, to Centro, downstream from the Helendale Fault. For our analysis, the Transition Zone is treated separately in order to calculate the discharge across the Helendale Fault, as there is no long-term reliable measurement at that location. The calculation is described in Appendix B, Transition Zone Water Balance.

The Upper Mojave Basin Model (UMBM, Appendix G) was used to calculate the change in storage in Alto (above Lower Narrows), from 1951-2020, a 70 year period. For purposes of this analysis, we selected the 20 year period from 2001-2020 as the hydrologic base period for evaluating the change in storage (surplus/deficit) in Alto. Figure 2, shows the annual change and cumulative change storage in Alto, for 70 years. Approximately 1.1 million acre feet of groundwater has been depleted from the upper part of Alto since 1951.

The purpose of the Judgment is to arrest overdraft and to provide a funding mechanism to raise money to purchase imported water, to offset any annual deficit. The purpose of the PSY calculation is to help set the Free Production Allowance (FPA) to allocate the cost of imported water to producers that over pump their FPA. The UMBM is useful to determine the annual deficit (see Appendix G). The annual surplus/deficit in Alto, as indicated by the UMBM is -17,475 acre feet per year.

Table 5-1 Proposed for Alto and Centro is the water balance for Alto, Transition Zone and Centro Subareas (Table 1). Inflow to Alto, is the sum of the average gaged inflow (2001-2020) as measured at the USGS gaging stations at West Fork Mojave River, and Deep Creek near Hesperia; this sum is commonly referred to as the "flow at the Forks." Also included is mountain front recharge, ungaged inflow and deep percolation of precipitation, and subsurface inflow from Oeste and Este subareas, as developed by the UMBM. Outflow consists of subsurface outflow, consumptive uses of production, phreatophyte use, and a calculation of outflow to Centro,

shown as surface water outflow. This value is determined from the water balance for the Transition Zone.

For the Alto subarea, the water balance calculation produces a PSY value of 62,333 acre feet; Total production (including the Transition Zone) for the representative year (2022) less the deficit based the 2001-2020 average water supply (Table 1).

Figure 3, compares the PSY calculation based on Table 1 (Table 5-1) described above with the PSY calculation based on the UMBM. The model treats pumping from all sources the same. The Judgment however, only considers pumping for consumptives uses, as included in the Judgment as "B1" production. "B2" production is not considered for purposes of determining PSY. In the Alto subarea, a portion the water produced by the party Jess Ranch Water Company for its fish hatchery, was excluded from the Judgment and assigned "B2" status, recirculated water. The same status was assigned to the California Department of Fish and Wildlife fish hatchery pumping. Thus, to calculate the indicated PSY using the UMBM we subtract the "B2" pumping from total pumping. The calculation, production plus the surplus/deficit then equals the PSY.

As shown on Figure 3, the PSY value from the UMBM is 62,005 acre feet, and the Water Balance calculation is 62,233 acre feet or a difference of 0.37%. We note however that the model produces a larger deficit, 17,475 acre feet vs, 15,914 acre feet (9% greater). We note an important difference between the two, is the model's deficit is the average deficit for all uses calculated over a 20 year base period. The Water Balance calculation assumes an average water supply, but pumping, consumptive uses, and portions of outflow from a specific year (2022). The PSY is used to determine the FPA. In this case we recommend using the value from the UMBM (62,005).

The inflow to Centro is considered to be the outflow from Alto. The outflow from Centro consists of average discharge (2001-2020) at the USGS Barstow gaging station, the net discharge from the Barstow wastewater treatment plant, subsurface discharge to the Baja subarea, water use by phreatophytes and consumptive use of production.

The subarea boundary between Baja and Centro is the Waterman Fault, located several miles downstream of the Barstow gage and downstream of the Barstow Wastewater discharge. However, for this purpose we have considered that the change in groundwater storage is small in the area upstream of the Watermaster Fault based on the limited change in water levels registered over time (see Centro hydrographs)

The resulting PSY calculation for Centro shows a surplus of 11,540 acre feet. The PSY is the sum of total pumping and the indicated deficit of 28,495 acre feet. However, we note that if the surplus were to be pumped and water use was similar to the current patterns of use, a return flow of 2,885 acre feet would result increasing the PSY to 31,420 acre feet (Table 1).

The UMBM was also used to simulate how the flow at Lower Narrows would change by purchasing and recharging the Alto deficit (-17,475 acre feet/year). Simulations assumed that the water supply for the period 2001-2020 repeated for the next 20 years, and production and

consumptive uses were constant at the 2020 amount. The results are shown on Figure 4 and Table 2. Compared to no recharge, Baseline Scenario, the recharge scenario increased flow downstream of Lower Narrows by 9,022, acre feet per year.

Based on the foregoing, we recommend a PSY for Alto of 62,005 acre feet and for Centro of 31,420 acre feet.

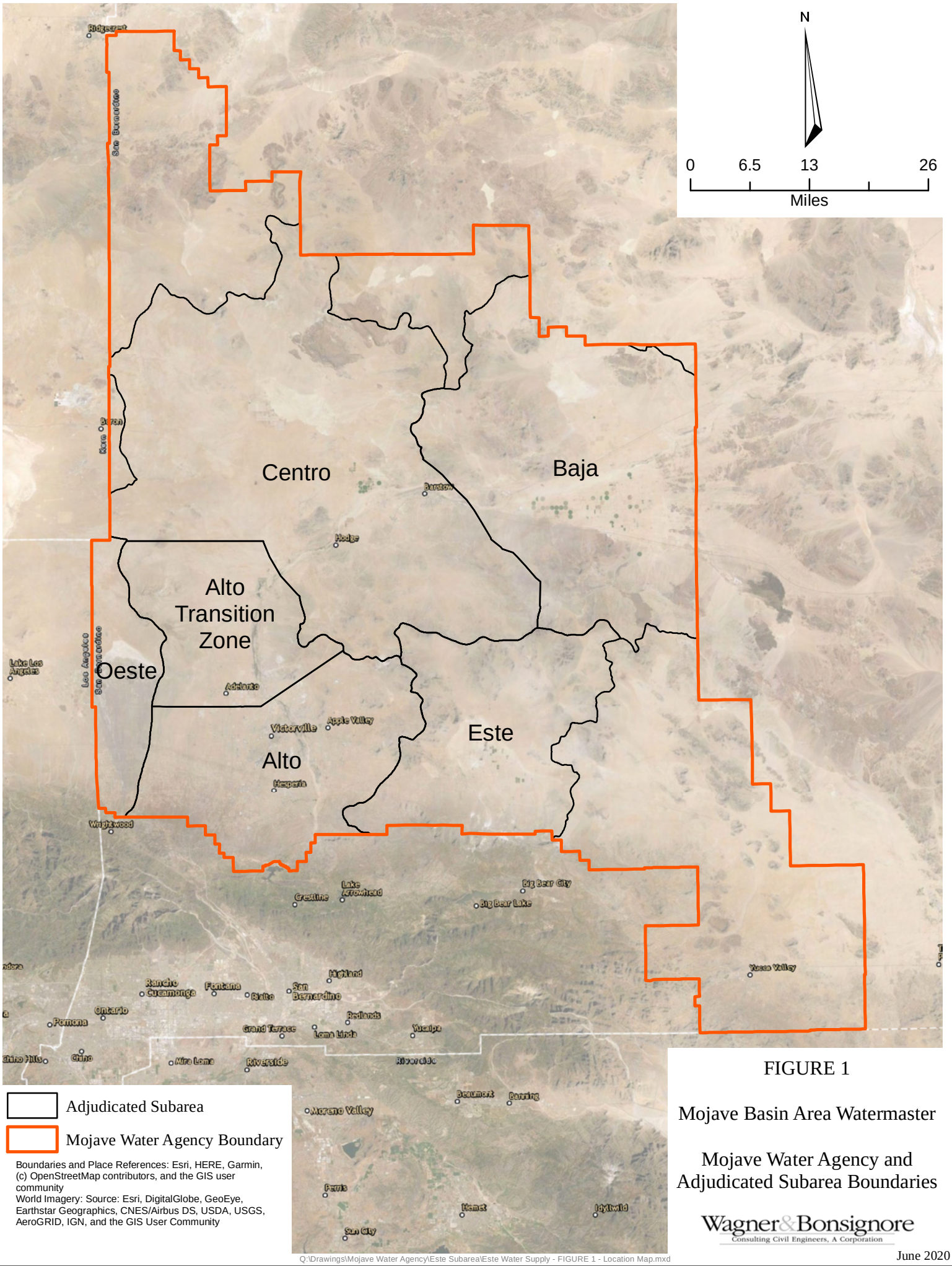


FIGURE 1

Mojave Basin Area Watermaster

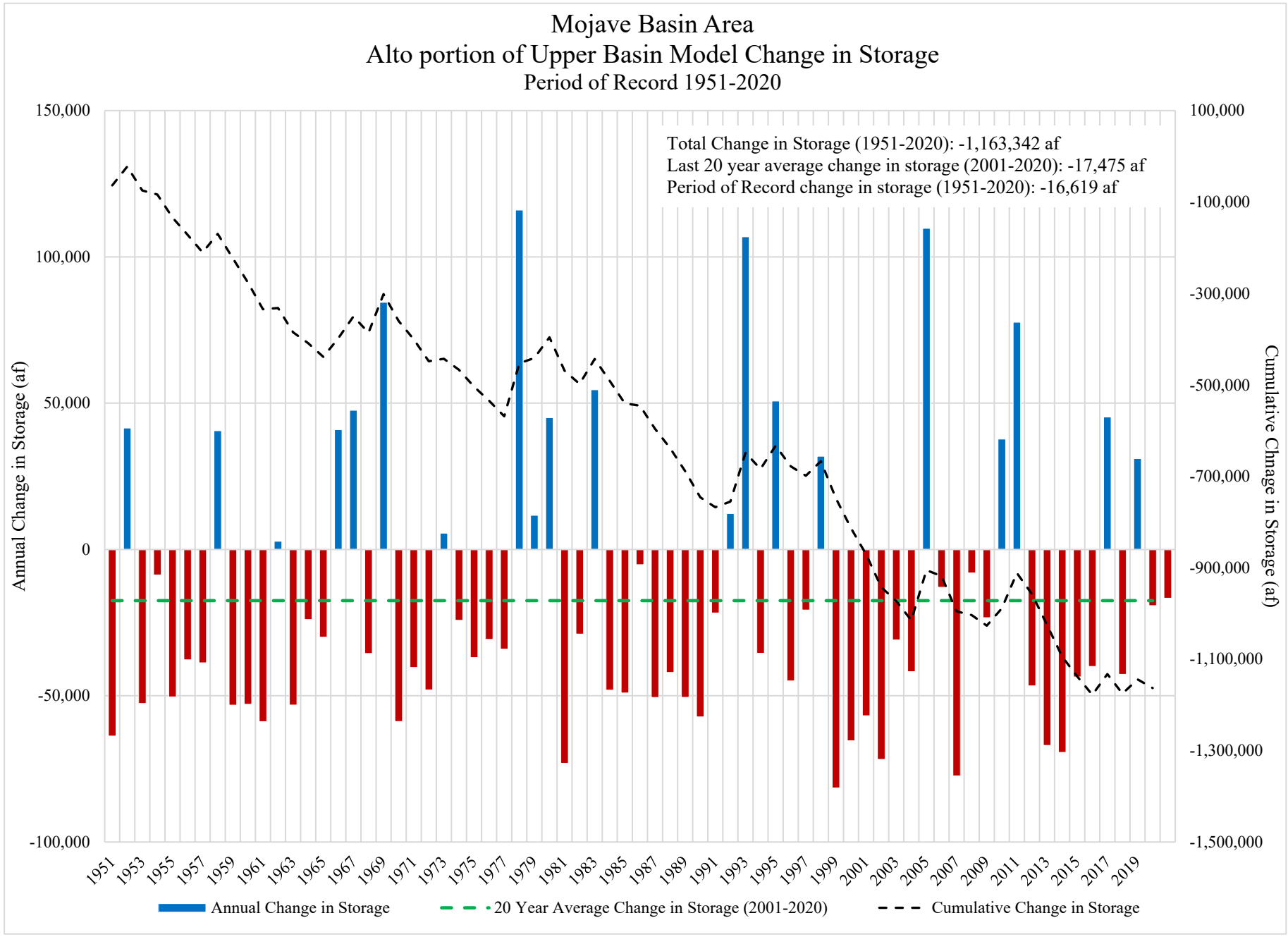
Mojave Water Agency and Adjudicated Subarea Boundaries

Wagner&Bonsignore
Consulting Civil Engineers, A Corporation

June 2020

Q:\Drawings\Mojave Water Agency\Este Subarea\Este Water Supply - FIGURE 1 - Location Map.mxd

FIGURE 2



G:\MOJAVE ADJUDICATION - 3020\Analysis\Groundwater Modeling\1-Alto\3020-009M-Table 6.1 Summary of Model Parameters Alto-V4.xlsx

FIGURE 3

Production Safe Yield Based on Model Output and 2021-2022 Current Year Pumping and Consumptive Use	
Alto above Narrows Production Average 2001 - 2020 (acre-feet)	81,968
2001 - 2020 Average Alto B2 Pumping (acre-feet)	14,118
Alto above Narrows B1 Pumping (acre-feet)	67,850
TZ (2001 - 2020) Average Pumping (acre-feet)	11,630
Modeled Pumping Alto + Transition Zone (acre-feet)	79,480
Alto above Narrows Modeled Deficit (2001 - 2020)	-17,475
Modeled Production Safe Yield (acre-feet)	62,005
Table 5-1 Production Safe Yield (acre-feet)	62,233
% Difference	0.37%

Current Production Safe Yield 59,409

FIGURE 4

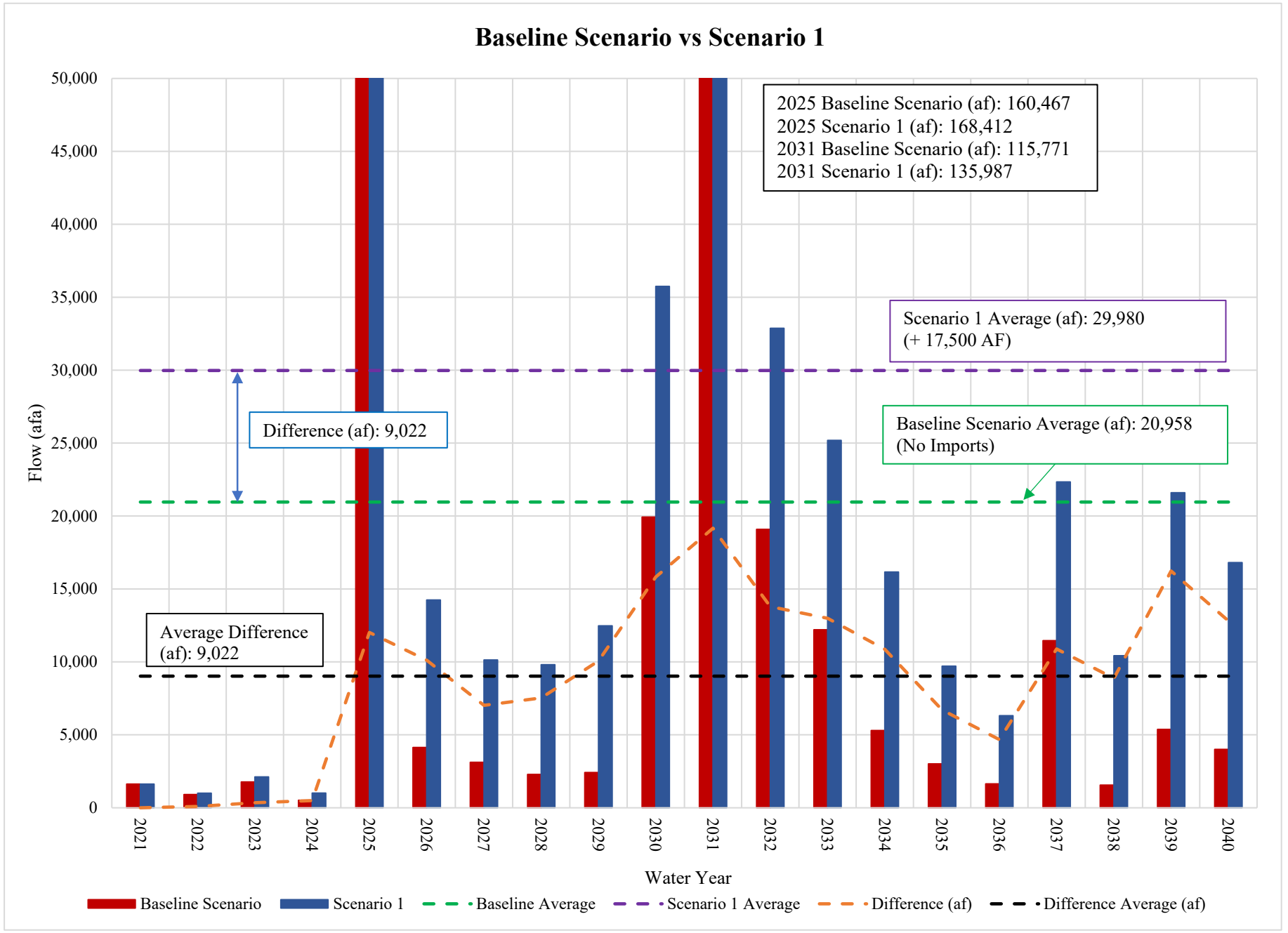


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TABLE 1

TABLE 5-1 Proposed

HYDROLOGICAL INVENTORY BASED ON VARIOUS SUPPLY ASSUMPTIONS AND 2021-22 CONSUMPTIVE USE, RETURN FLOW AND IMPORTS

(ALL AMOUNTS IN ACRE-FEET)

	ALTO	TRANSITION ZONE	CENTRO
WATER SUPPLY	**2001-2020**	**2001-2020**	**2001-2020**
Surface Water Inflow [1]	61,635	24,808	36,725
Mountain Front Recharge [2]	8,511	0	0
Groundwater Discharge to the Transition Zone [3]	0	5,112	0
Subsurface Inflow [4]	0	7,053	2,000
Este/Oeste Inflow [5]	4,785	62	
Imports[6]	0	15,095	
TOTAL	**74,931**	**52,130**	**38,725**
CONSUMPTIVE USE AND OUTFLOW			
Surface Water Outflow	36,725 [7]	36,725 [7]	7,500 [14]
Barstow Treatment Plant Discharge			2,475
Subsurface Outflow [8]	2,000	2,000	1,462
Consumptive use [9]			
Agriculture	949	949	5,863
Urban	40,171	6,456	6,885
Phreatophytes [10]	11,000	6,000	3,000
TOTAL	**90,845**	**52,130**	**27,185**
Surplus / (Deficit) [11]	(15,914)		11,540
Total Estimated Production[12]	78,147		16,995
Potential Return Flow from Surplus	0		2,885
PRODUCTION SAFE YIELD[13]	**62,233**		**31,420**

1 Average discharge of Mojave River by USGS, 2001-2020 (USGS stations at West Fork Mojave River Near Hesperia, CA (10261000), Deep Creek Near Hesperia, CA (10260500) and Lower Narrows Near Victorville, CA (10261500)).

2 Mountain front recharge as developed from Upper Basin Alto Model.

3 Groundwater discharge lost to Transition Zone below the Narrows.

4 Portion of water lost to Transition Zone from Alto (Upper Basin Model). Groundwater discharge to Harper Lake (USGS Stamos 2001).

5 Subsurface Inflow to Alto from Este and Oeste Subareas (Upper Basin Model).

6 Total discharge to Transition Zone from VVWRA, 2021-22 Water Year.

7 Estimated based on reported flows at USGS gaging station, Mojave River at Victorville Narrows and 2001-2020

8 Groundwater discharge to Baja 1462 AF; 3501 AF groundwater discharge from Barstow area to Harper Lake. (USGS Stamos 2001)

9 Includes consumptive use of "Minimals Pool" (estimated Minimal's production is 2,104 af).

10 From USGS Water-Resurces Investigation Report 96-4241 "Riparian Vegetation and Its Water Use During 1995 Along the Mojave River, Southern California" 1996. Lines and Bilhorn

11 Amount necessary to offset overdraft under the above assumptions.

12 Water production for 2021-22. Included in the production values are the estimated minimal producer's water use.

13 Imported State Water Project water purchased by MWA is not reflected in the above table.

14 Reported flows at USGS gaging station, Mojave River at Barstow (10262500).

TABLE 2

Annual Flow at the Lower Narrows Under Baseline Scenario and Scenario 1			
Water Year Stream Flow			
20 Year Scenario Runs			
Water Year	Baseline Scenario (af)[1]	Scenario 1 (af)[2]	Difference (af)[3]
2021	1,623	1,623	0
2022	907	994	87
2023	1,768	2,110	343
2024	515	1,006	491
2025	183,550	195,565	12,015
2026	4,128	14,243	10,115
2027	3,117	10,132	7,015
2028	2,285	9,809	7,524
2029	2,417	12,474	10,057
2030	19,925	35,744	15,819
2031	135,332	154,500	19,167
2032	19,083	32,874	13,791
2033	12,198	25,182	12,984
2034	5,296	16,157	10,861
2035	3,005	9,710	6,704
2036	1,639	6,310	4,671
2037	11,451	22,336	10,885
2038	1,550	10,425	8,876
2039	5,367	21,595	16,228
2040	4,002	16,806	12,804
Average	**20,958**	**29,980**	**9,022**

Note:

(1) Baseline Scenario: The last 20 years hydrology extended in the future with 2020 levels of production and return flows

(2) Scenario 1: Similar to the Baseline Scenario with 17,500 acre-feet imports per year spread out over three months (June-July-August) and delivered at Deep Creek.

(3) Difference: Baseline Scenario flow subtracted from Scenario 1 flow at the Lower Narrows.