Borrego Springs Watermaster
Technical Advisory Committee Meeting
June 5, 2023
AGENDA ITEM III

To: Technical Advisory Committee (TAC)

From: Andy Malone, PG (West Yost), Lead Technical Consultant

Date: May 31, 2023

Subject: Review Results of Task 1 and Task 2 to Redetermine the Sustainable Yield by 2025

Background

At its meeting on February 9, 2023, the Watermaster Board, in consideration of a TAC-majority recommendation, approved a revised scope of work and budget for water year (WY) 2023 and 2024 to update the Borrego Valley Hydrologic Model (BVHM) and Redetermine the Sustainable Yield by 2025. Exhibit 1 (attached) provides a detailed description, schedule, and cost estimate for each approved task. Table 1 below summarizes the Board-approved revised scope of work with a cost estimate of $348,204.

Table 1. Scope of Work to
Redetermine the Sustainable Yield by 2025
WY 2023 and WY 2024

Task No.	Task	Cost Estimate
1	Compare FMP-estimated Pumping to Actual Pumping for WY 2022	$20,222
2	Update Water-Use Factors in the FMP	$39,196
3	Correct Errors Identified in 2021 BVHM	$22,577
4	Perform Model Recalibration	$128,510
5	Determine the Sustainable Yield (including documentation)	$137,699
	Total Cost for All Tasks	**$348,204**

As described in Exhibit 1, both Tasks 1 and 2 involve the Farm Process package (FMP) in the BVHM. The FMP is used in the BVHM to estimate the irrigation demand for different land use classifications and crop types in the Borrego Springs Subbasin (Basin) and estimates how water supplies can be used to meet the irrigation demand. The irrigation demand is first satisfied with precipitation and shallow groundwater from root uptake (if available). The remaining irrigation demand is met with groundwater pumping, which is estimated by the FMP as:

$$GW = \frac{ET_0 \times KC \times Area}{OFE} - P - RU$$

where,

GW is the volume of groundwater pumping to satisfy the irrigation demand

ET_o is the reference evapotranspiration (ET)

KC is the crop coefficient—the ratio of the actual ET for a specific crop to the ET_o

OFE is the On-Farm Efficiency—the ratio of the actual ET to the applied irrigation

P is precipitation available to meet the actual ET

RU is root uptake of shallow groundwater available to meet the actual ET

The FMP is used in the BVHM to estimate groundwater pumping at historically unmetered wells in the Basin. However, due to the Watermaster's expanded metering program, nearly all wells in the Basin are now metered.[1]

In WY 2021, the FMP-estimated groundwater pumping was compared to metered groundwater pumping (*i.e.,* Actual Pumping) for the first time to understand the ability of the FMP to estimate pumping. The result of this comparison was that the FMP underestimated Actual Pumping by 4,456 acre-feet (af) in WY 2021—a 42% difference. The TAC concluded that the difference between FMP-estimated pumping and Actual Pumping was significant and likely indicated that the BVHM is not sufficiently calibrated. However, the TAC acknowledged that the comparison in WY 2021 relied on only one year of Actual pumping data. The TAC recommended that additional comparisons of FMP-estimated pumping versus Actual Pumping are necessary to confirm, modify, or refute the conclusions of the extension of the BVHM through WY 2021, which is the objective of Task 1 of the revised scope of work.

West Yost has completed Task 1 and is currently performing Task 2 (see "Discussion" below).

Discussion

Results of Task 1 – Compare FMP-Estimated Pumping to Actual Pumping for WY 2022

Under Task 1, the BVHM was extended through WY 2022 and FMP-estimated groundwater pumping was compared to Actual Pumping for WY 2022. Once again, the FMP underestimated groundwater pumping by 3,224 af (approximately a 35% difference). The results of this comparison showed that the FMP continues to underestimate groundwater pumping, which could indicate that the water-use factors used in the FMP to estimate actual ET and groundwater pumping are inaccurate.

Based on the results of Task 1, West Yost recommended that *Task 2 – Update Water-Use Factors in the FMP* be performed next. West Yost prepared a summary of the objectives, methods, results, and recommendations from performing Task 1 and transmitted the summary via email to the TAC on April 24, 2023 (Exhibit 2). The TAC was asked to review the summary and respond to the email to either

[1] Pumping at a few unmetered wells are still estimated by Watermaster staff.

recommend (i) perform Task 2 or (ii) do not perform Task 2 and instead begin work on *Task 3 – Correct Errors Identified in the 2021 BVHM*. Based on the responses of the TAC members, West Yost began performing Task 2.

Description of Work Performed To Date on Task 2 – Update Water-Use Factors in the FMP

The water-use factors currently used in the FMP were developed by the United States Geological Survey (USGS) during the initial development of the BVHM. The factors were initially based on various agricultural water-use studies (Allen et al., 1998[2]; Snyder et al., 1987a[3], Snyder et al., 1987b[4]) and adjusted during model calibration. As described in the "Background" section of this memo, there are two main water-use factors used in the FMP that influence the estimate of groundwater pumping:

- **KC** – the crop coefficient. KC is the ratio of actual ET for a specific crop to the reference ET ($\mathbf{ET_o}$) and is used to estimate how much water a specific crop needs to grow. Higher KC values result in higher estimates of groundwater pumping.
- **OFE** – the On-Farm Efficiency. OFE accounts for inefficiencies and losses from the irrigation method, such as runoff and/or deep infiltration of irrigation past the root zone (return flows). OFE typically ranges between 0 to 1, where low OFE ratios represent inefficient irrigation systems/operations with high water losses and high OFE ratios represent efficient irrigation systems/operations with low water losses. Lower OFE values result in higher estimates of groundwater pumping.

The first step in performing Task 2 was to identify and summarize the KC and OFE values currently used in the FMP. Next, the KC and OFE values used in the FMP were compared to coefficients used in other studies or within the literature, including:

- Studies that estimated historical groundwater pumping to calculate the Baseline Pumping Allocation (BPA) in the Borrego Springs Subbasin.
- Groundwater modeling studies for SGMA compliance in the Coachella Valley.
- Other sources in the scientific literature.[5]

Tables 2 and 3 below display the comparisons for KC and OFE, respectively, for irrigated crop types in simulated in the FMP.

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[2] Allen, R.G., Pereira, L.S., Raes, D., and Smith, M. 1998. Crop evapotranspiration—Guidelines for computing crop water requirements: Food and Agriculture Organization of the United Nations, Irrigation and Drainage Paper 56. Accessed December 12, 2022 on https://www.fao.org/3/X0490E/X0490E00.htm.

[3] Snyder, R.L., Lamina, B.J., Shaw, D.A., and Pruitt, W.O. 1987a. Using reference evapotranspiration (ET_o) and crop coefficients to estimate crop evapotranspiration (ET_c) for agronomic crops, grasses, and vegetable crops. Accessed December 12, 2022 on https://calisphere.org/item/e4408893-9141-4766-89f2-c25c667071a7/.

[4] Snyder, R.L., Lamina, B.J., Shaw, D.A., and Pruitt, W.O. 1987b. Using reference evapotranspiration (ET_o) and crop coefficients to estimate crop evapotranspiration (ET_c) for trees and vines Accessed December 12, 2022 on https://calisphere.org/item/fbc9dc78-de6e-4d99-a561-0028370f8107/.

[5] Howell, T. 2003. Irrigation Efficiency; Fogg, G.E., G.T. O'Neill, E.M. LaBolle, and D.J. Ringel, 2000. Groundwater Flow Model of Coachella Valley, California: An Overview; Van der Gulik, T. and Nyvall, J. 2001. Crop Coefficients for use in Irrigation Scheduling.

Table 2. KC Values for Irrigated Crops in the FMP and Other Sources

Crop Type	KC Value by Source			
	FMP	BPA	Coachella Valley Models	Other Sources
Citrus	0.55 – 0.70	0.65	1	-
Dates	0.71 - 0.88	0.60	0.95	0.80 - 1.0
Golf courses	0.81 – 1.02	0.70	0.80	-
Nursery	0.81 – 1.02	0.60	1	0.70 – 1.0
Palm	0.82 – 1.04	0.50	-	-
Potatoes	0.09 – 1.04	-	0 – 1.1	0.5 – 1.15
Row Crops	0.60 – 0.97	-	0 – 0.91	0.3 – 1.15
Semiagricultural	0.43 – 0.54	-	-	-
Grapes	0.35 – 0.73	-	0.5 – 1.04	0.45 – 0.90

Table 3. OFE Values used in the FMP and Other Sources

Crop Type	OFE Value by Source			
	FMP	BPA[1]	Coachella Valley Models	Other Sources
Citrus	0.98	0.80	0.70	Sprinkler method: 0.60 – 0.90 Surface method: 0.40 – 0.70 Center pivot method: 0.75 – 0.90
Dates	0.99	0.80		
Golf courses	0.94	0.70		
Nursery	0.99	0.80		
Palm	0.99	0.80		
Potatoes	0.99	0.80		
Row Crops	0.93	0.80		
Semiagricultural	0.95	-		
Grapes	0.96	0.80		

1. Assumed 0.70 for rotor irrigation method and 0.80 for drip irrigation method.

Based on these comparisons:

- The KC values currently used in the FMP are typically higher than the KC values used in other studies. This indicates that the actual ET calculated by the FMP is already near a maximum for nearly all irrigated crop types in the FMP. Since the FMP currently underestimates groundwater pumping, lowering the KC values would result in even less groundwater pumping estimated by the FMP. Increasing the KC values may result in unrealistic actual ET for the crops in the Basin.
- OFE values in the FMP simulate nearly 100% efficient irrigation, which is not likely an accurate assumption. Lowering the OFE to a value(s) to be consistent with other studies would increase the FMP estimates for groundwater pumping. It should also be noted that lowering OFE values will also result in an increase in irrigation return flows.

Considering the results of the comparison, West Yost recommends that the OFE values be adjusted downward to test its influence on FMP-estimated groundwater pumping.

Next Steps

At the TAC meeting, West Yost will share a presentation on the results of Task 1 and the work performed to date on Task 2. The TAC should come prepared to discuss West Yost's proposed approach to adjust the OFE values in the FMP and any other suggestions or recommendations regarding Task 2.

Following the TAC meeting, West Yost will update the water-use factors in the FMP, run the BVHM through WY 2022, and compare the updated FMP-estimated pumping to the Actual Pumping for WYs 2021 and 2022 to determine if the updated water-use factors improved the ability of the FMP to estimate groundwater pumping. If the updated FMP still fails to accurately estimate Actual Pumping, the water-use factors will need to be adjusted during the model recalibration (Task 4).

West Yost will notify the TAC of the model results via email and request written comments. At the TAC's request, another TAC meeting may be held to discuss the results of Task 2 before proceeding to *Task 3—Correct Errors Identified in the 2021 BVHM*. Otherwise, West Yost will begin work on Task 3.

Enclosures

Exhibit 1: Scope of Work to Redetermine the Sustainable Yield by 2025

Exhibit 2: Presentation of Task 1 – Compare FMP-Estimated Pumping to Actual Pumping for WY 2022 (emailed to the TAC on 4/24/2023)