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Borrego Springs Watermaster

Technical Advisory Committee Meeting

July 1, 2024

Today's Agenda

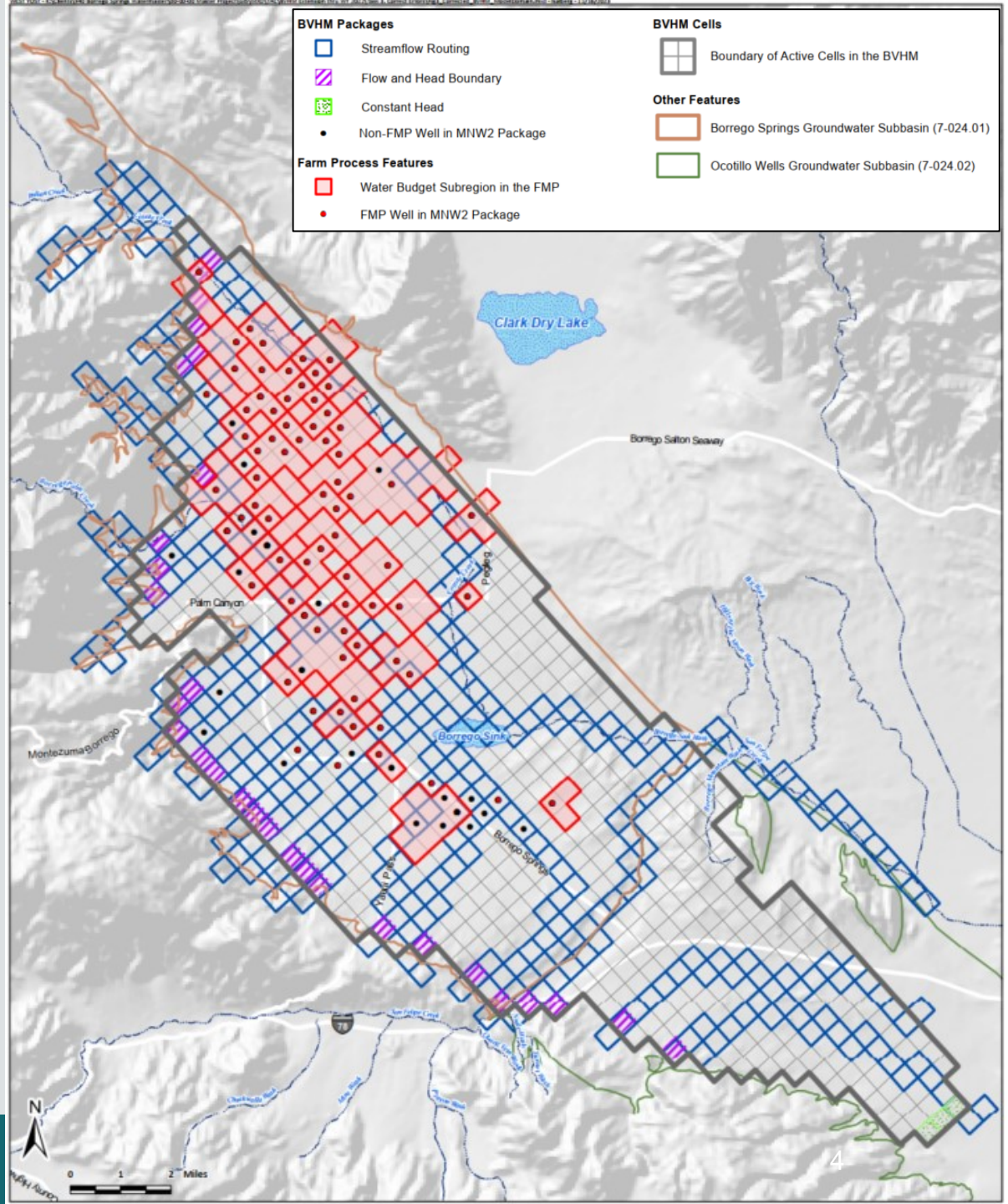
1. Public Comment
2. Review Results of Task 4 – *Model Recalibration* to Redetermine the Sustainable Yield by 2025
3. Status update: 5-Year GMP Assessment Report
4. Public comment

Objective of Task 4 – Model Recalibration

- Improve the ability of the BVHM to estimate ***historical*** and ***future***:
  - Groundwater Pumping (FMP only)
  - ET (FMP only)
  - Groundwater Elevations
  - Water Budget → Used to estimate the Sustainable Yield
    - Inflows
    - Outflows
    - Change in Storage

Version of BVHM to Re-calibrate

- Use the geometry/layering and spatial/temporal resolution from *Initial BVHM*
- Use corrected model packages from *Task 3*
- Updated KC and OFE water-use factors in the FMP from *Task 2*, which includes:
  - Initial KC values (entire model simulation period)
  - Initial OFE values (recent years)
  - Adjusted OFE values to reflect the evolution of irrigation methods used in the Basin since WY 1946 (historical period)
- Use the recalibrated FMP



Recalibration Process

Recalibrate FMP (Manual)

- Ensure model matches measured behaviors → **Better match of FMP-estimated pumping to Actual pumping**
- Ensure model runs reasonably → **Validate FMP-estimated ET with OpenET models**

Recalibrate BVHM (PESTPP-IES)

- Ensure model matches measured behaviors → **Match groundwater elevations**
- Ensure model runs reasonably → **Evaluate water budget**

FMP Recalibration Methods

1. Adjusted parameters in the FMP
2. Ran the FMP from WY 1930 through WY 2022
3. Compared calibration results:
    - FMP-estimated pumping vs. Actual pumping in WY 2021 and 2022
    - FMP-estimated ET vs. OpenET models (geeSEBAL and eeMETRIC)
4. Repeated steps #1-3 until ‘acceptable’ calibration results are achieved
    - FMP-estimated pumping is within +/- 10% of Actual pumping
    - FMP-estimated ET vs. OpenET used as a validation check only

How the FMP Estimates Groundwater Pumping

$$GW = \underbrace{\frac{ET_0 \times KC \times Area}{OFE}}_{\text{“Crop demand”}} - P - RU$$

where,

GW = volume of groundwater pumping to satisfy the irrigation demand

ET_0 = reference ET

Area = area of similar crop type

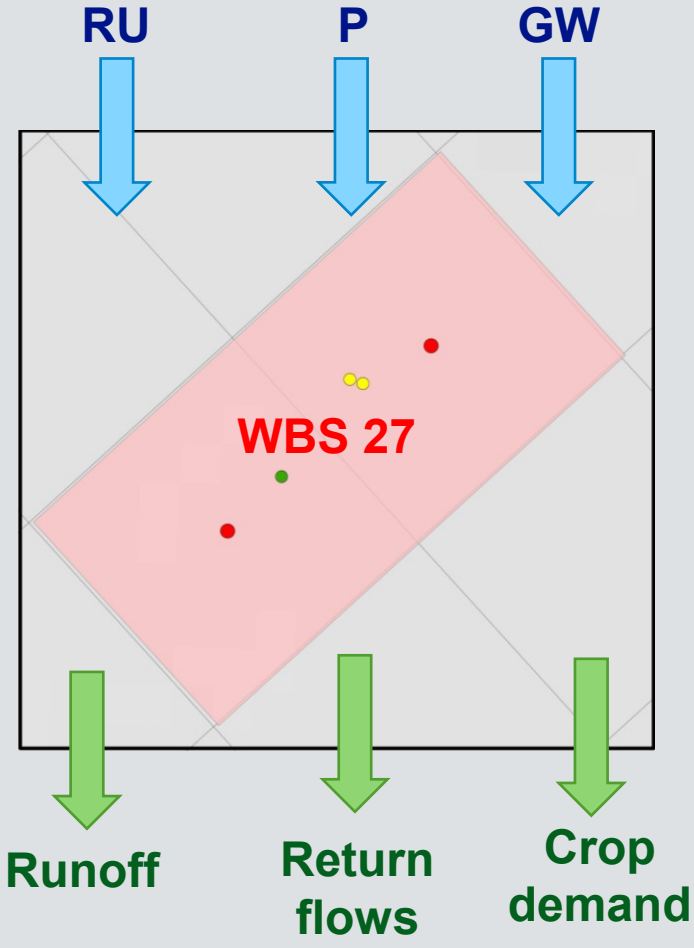
P = precipitation available to meet the actual ET

Adjustable parameters!

KC = Crop Coefficient - ratio of actual ET for a specific crop to ET_0

OFE = On-Farm Efficiency – ratio of the actual ET to applied irrigation

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



How the FMP Estimates ET

$$ET = \underbrace{T_p + T_{gw} + T_i}_{\text{Transpiration}} + \underbrace{E_p + E_{gw} + E_i}_{\text{Evaporation}}$$

where,

p = precipitation

gw = root uptake of shallow groundwater

i = irrigation water

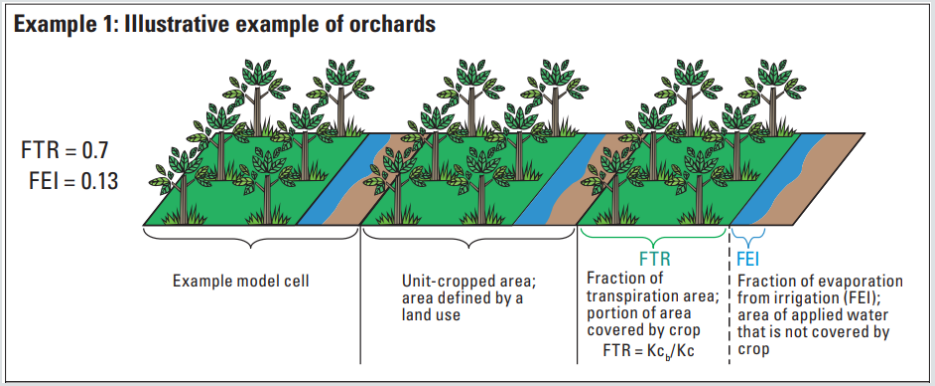
Adjustable parameters:

- **Fractions of consumptive use (evaporation and transpiration)**
- **Fraction of inefficiency losses from precipitation and surface water**
- **Pressure heads (zones available for root uptake)**

Recalibration Results – FMP Parameters

Recalibrated FMP parameters:

- **OFE** → values based on literature review and interviews
  - Flood & furrow = 0.50
  - Broadcast sprinkler = 0.70
  - Micro-sprinkler = 0.74
- **KC and KC scalars** → values based on literature review
  - KC values vary by crop
  - KC scalars vary by month
- **Transpiration Fraction of Consumptive Use (FTR)** → Values based on USGS documentation
  - Golf course: 0.70 → 0.80
  - Potato: 0.30 → 0.65
  - Grapes: 0.40 → 0.75



Source: OWHM Documentation, Appendix 4. Consumptive Use and ET in the FMP

Recalibration Results: FMP-Estimated vs. Actual Pumping

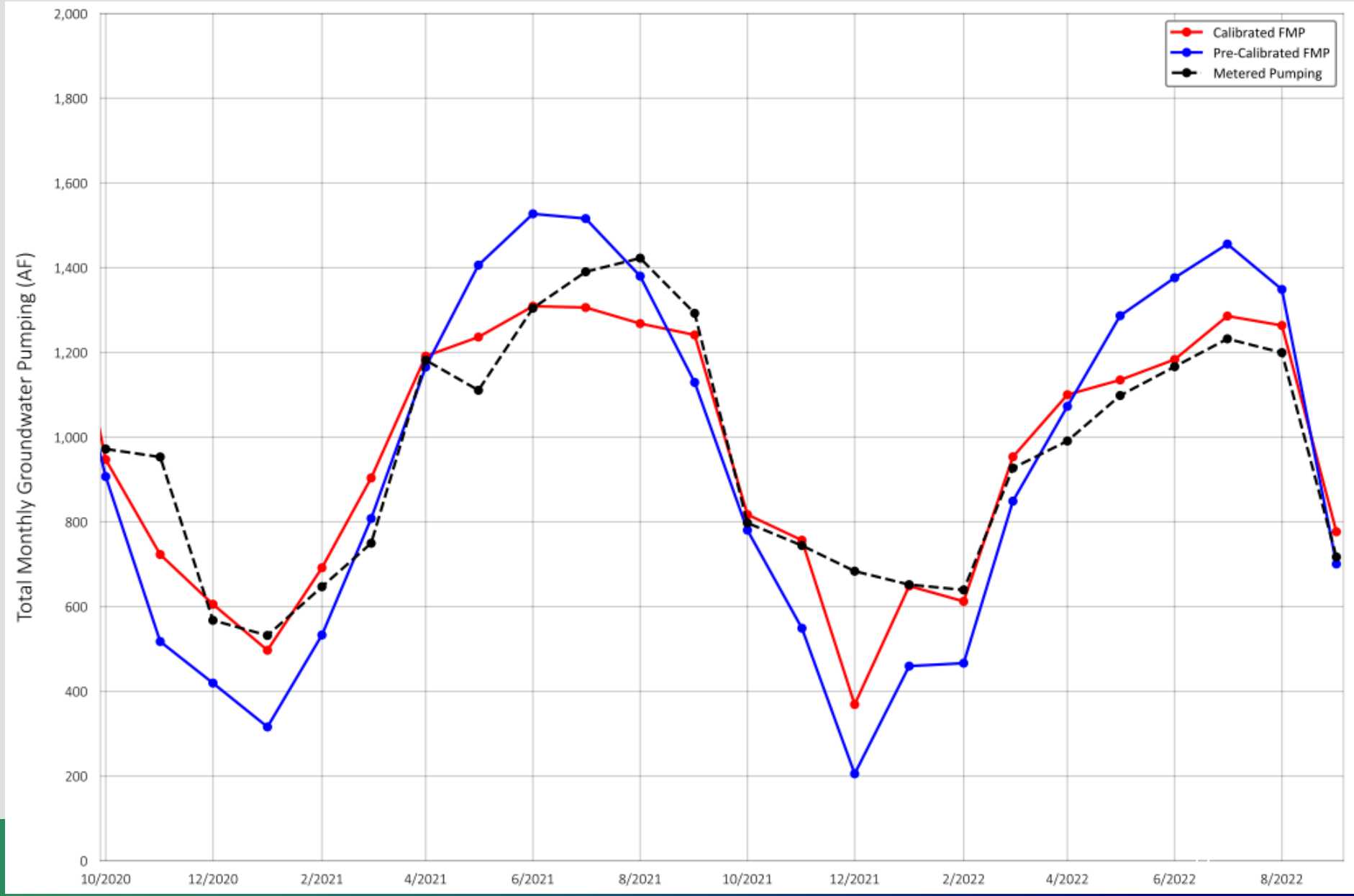
FMP-estimated Pumping is within +/-10% of Actual Pumping

WY	Actual Pumping (af)	FMP-Estimated Pumping (af)	Difference (af)	% Difference
	(a)	(b)	(c) = (b) - (a)	(d) = (c)/ ([(a)+(b)]/2)
2021	12,124	11,920	-204	-1.7%
2022	10,848	10,902	54	0.5%

Monthly FMP-Estimated vs. Actual Pumping

Monthly FMP-estimated pumping more closely matches Actual pumping

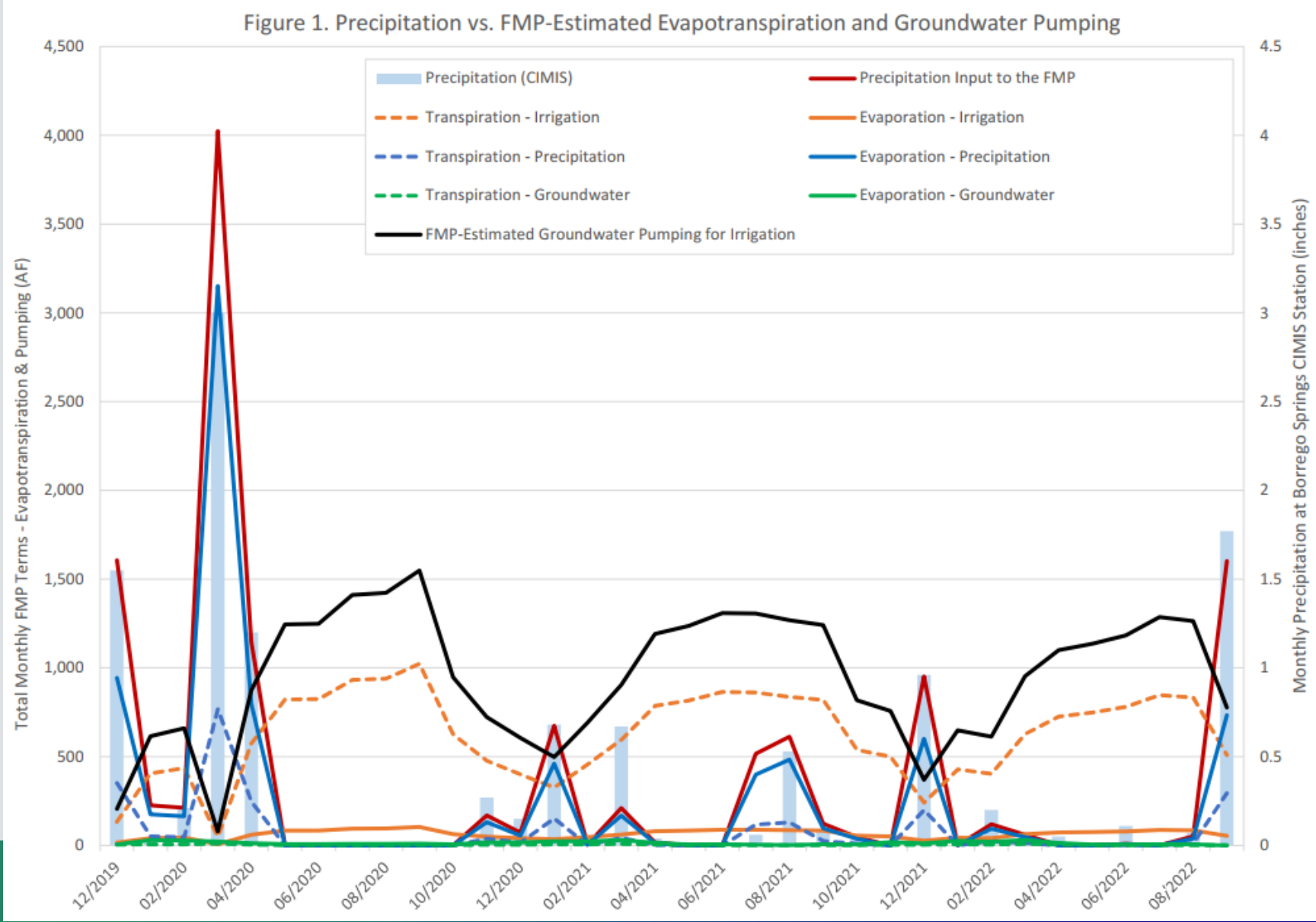
(Calibrated FMP vs. Pre-Calibrated FMP)



Recalibration Results: FMP-Estimated ET

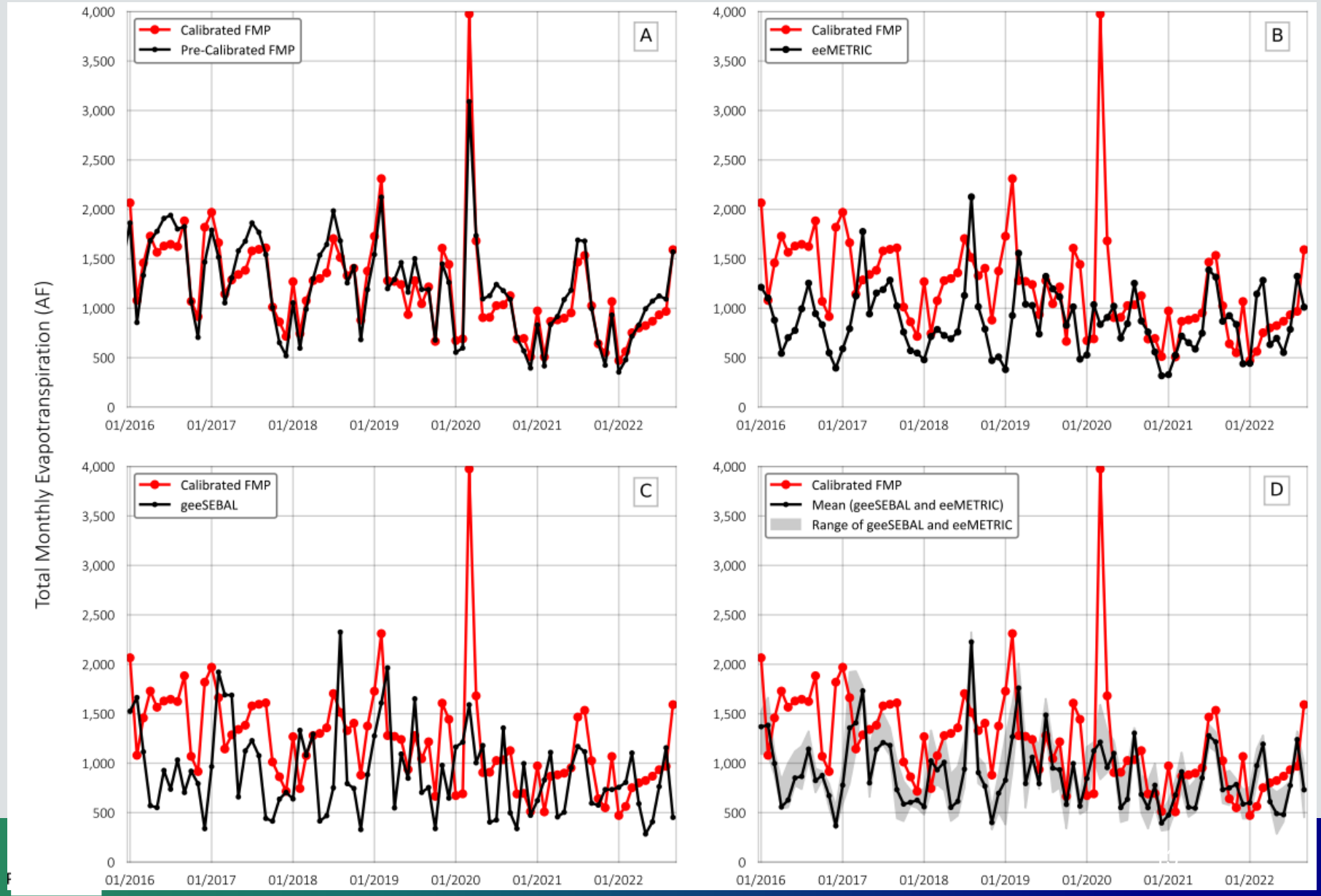
Validation of FMP-estimated ET:

- During wet months:
  - Transpiration of precipitation used to meet crop demands
  - ET of irrigation is reduced
- During dry months:
  - Transpiration of irrigation water increases (groundwater pumping is only supply to meet crop demands)
- **Monthly FMP-estimated ET and groundwater pumping are reasonable → respond to seasonal precipitation**



OpenET vs. FMP-Estimated ET

- OpenET underestimates ET compared to the FMP, especially 2016-2019
  - Known limitation of OpenET → underestimate ET in arid regions
  - March 2020 – FMP-estimated ET exceeds OpenET due to evaporation of precipitation (captured by CIMIS)
- OpenET and the FMP estimates of ET match more closely in 2020-2022
- **Overall, FMP-estimated ET is similar in pattern and magnitudes as OpenET**



Recalibration Process

Recalibrate FMP (Manual)

- Ensure model matches measured behaviors → **Better match FMP-estimated to Actual pumping**
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Recalibrate BVHM (PESTPP-IES)

- Ensure model matches measured behaviors → **Match groundwater elevations**
- Ensure model runs reasonably → **Evaluate water budget**

BVHM Recalibration Methods

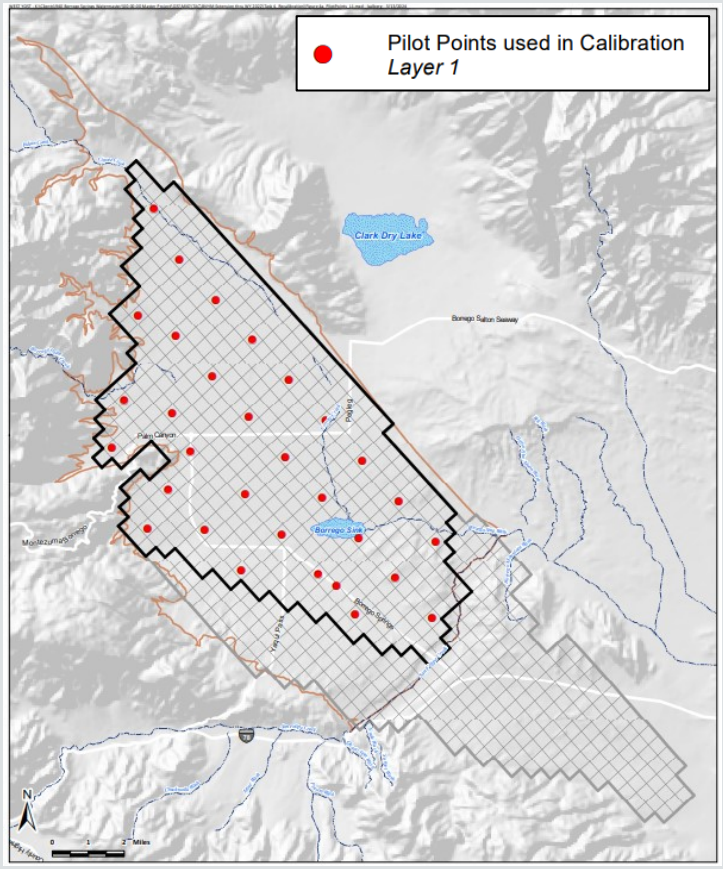
1. Calibration period → 1945-2022
2. Adjustable model parameters:
    - Aquifer parameters
        - Hydraulic conductivity (horizontal and vertical)
        - Specific storage
        - Specific yield
    - Scalar multipliers
        - Underflow (FHB)

BVHM Recalibration Methods

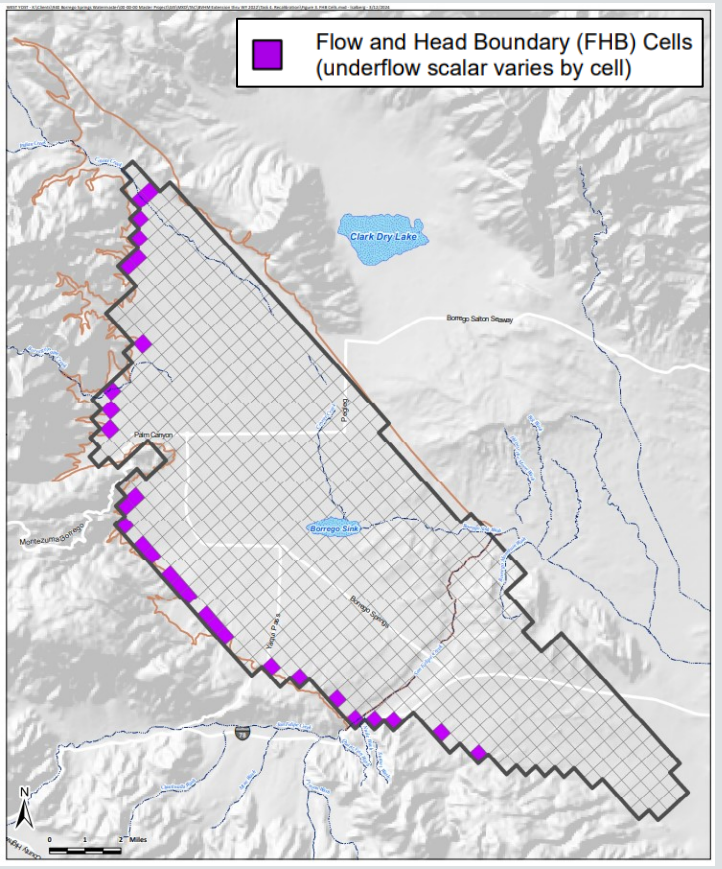
Step #3 - Assign Pilot Points and Scalars

Pilot Points used for hydraulic and storage properties

- Pilot Points placed across model domain
- Aquifer parameters from *Pre-Calibrated BVHM* assigned as initial values to Pilot Points



Scalar multipliers used for boundary inflows

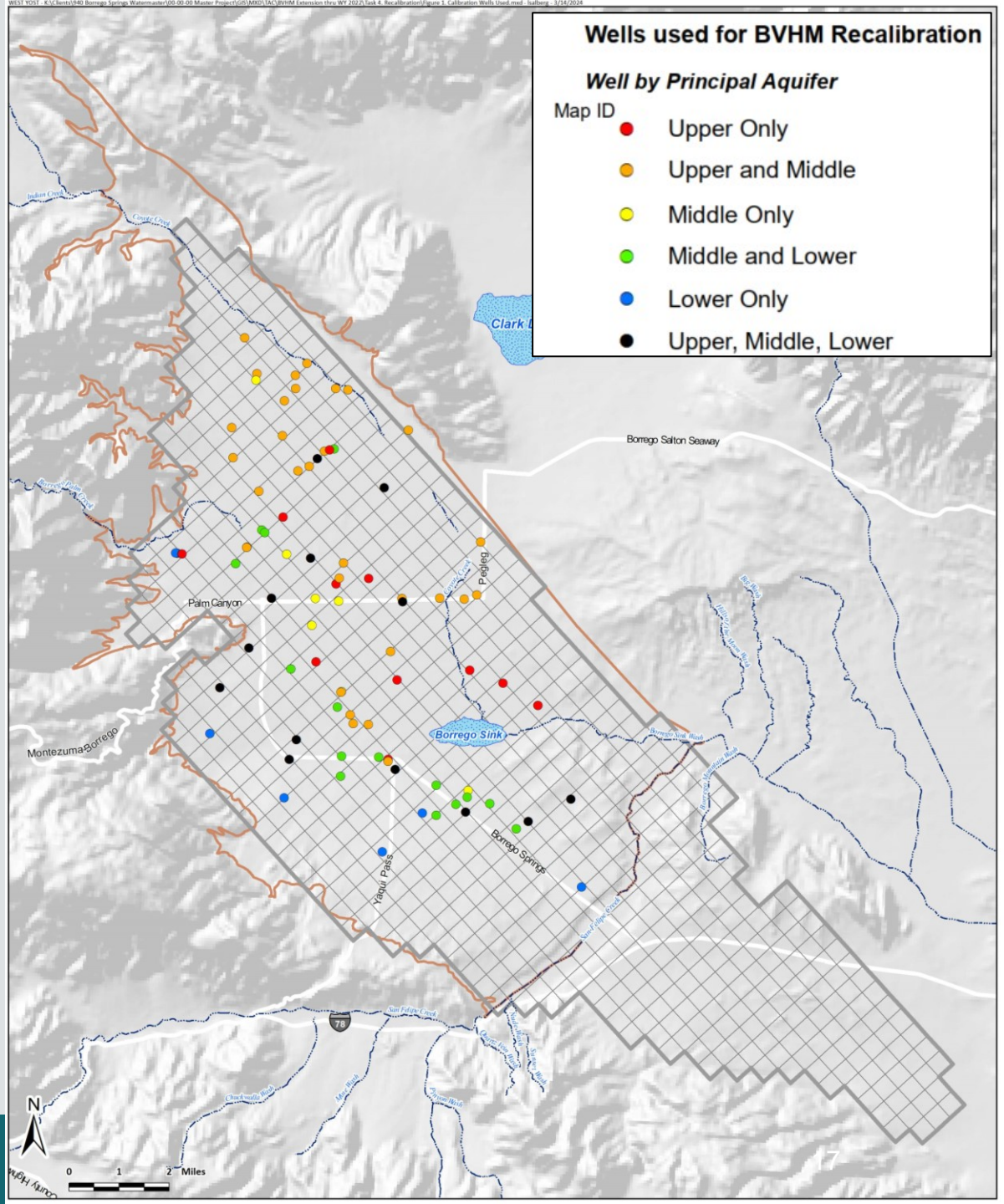


BVHM Recalibration Methods

Step #4. Select Calibration Targets (Groundwater Elevation)

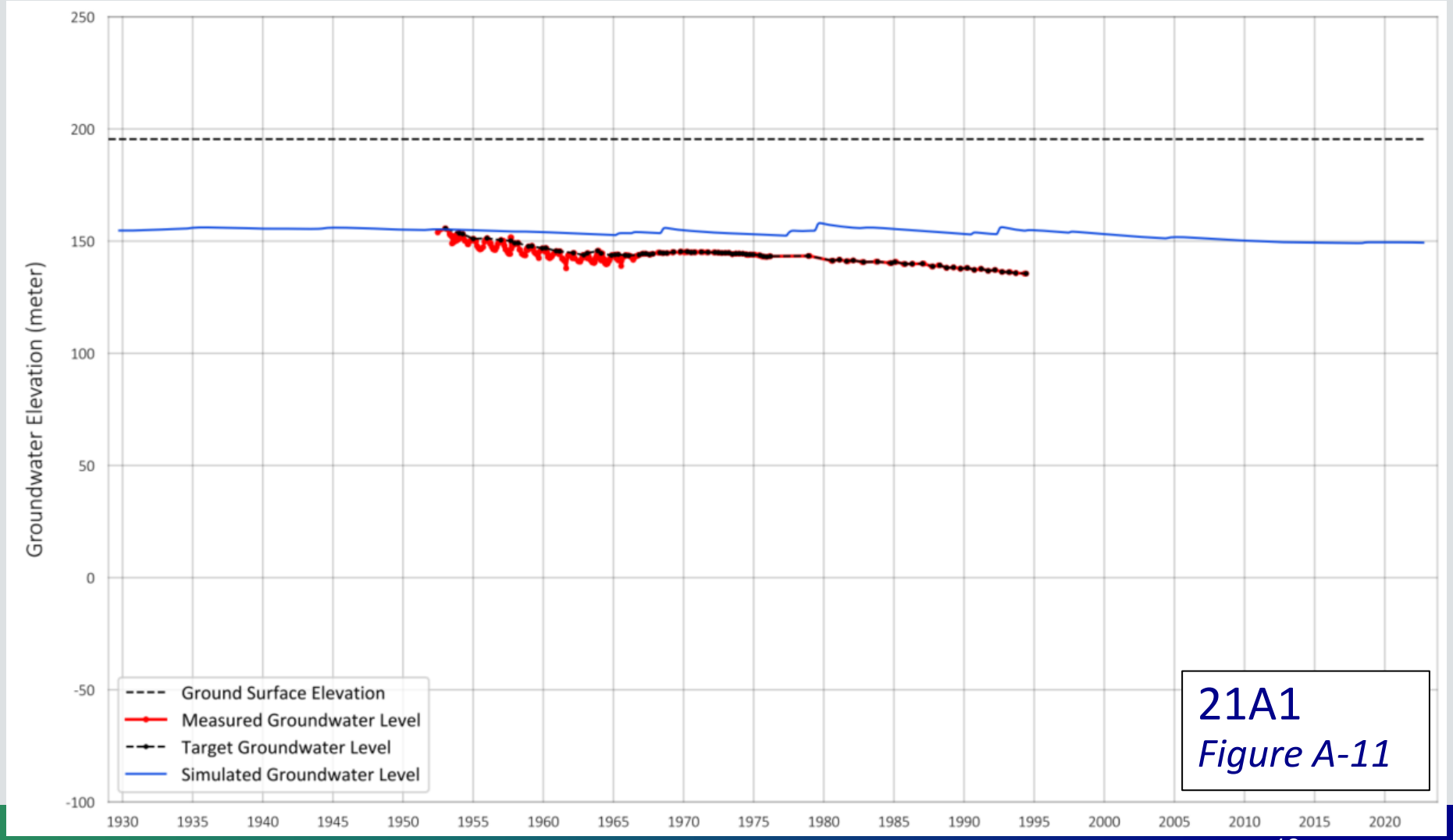
Wells used in calibration:

- Are spatially and vertically distributed across the model domain
- Have groundwater-elevation measurements evenly distributed over time (1945-2022)
- Include wells used by the USGS during calibration and new wells/measurements collected since last calibration
- **Total of 85 wells**
- **Total of 1,963 groundwater-elevation measurements**



Example of Calibration Target Selection

- Data ranges from a single measurement to every 15-minutes from transducers

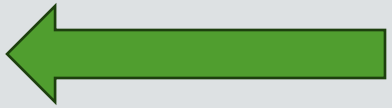


Recalibration Methods (cont.)

5. Configure PEST settings and prepare input files for PEST
   - Aquifer parameters of pilot points are based on the original BVHM and adjusted by PEST.
   - Scalar multipliers of boundary inflows are initially set to 1 and are adjusted by PEST.
   - Water use factors are based on the Recalibrated FMP and are not adjusted by PEST.
   - PEST input files were configured to include 478 parameters (434 pilot points, 44 scalar multipliers).
6. Perform model recalibration with PEST
   - PEST was used to adjust aquifer parameters at pilot points and scalar multipliers of boundary inflows by minimizing the differences between the simulated groundwater levels and selected calibration targets.

Recalibration Methods (cont.)

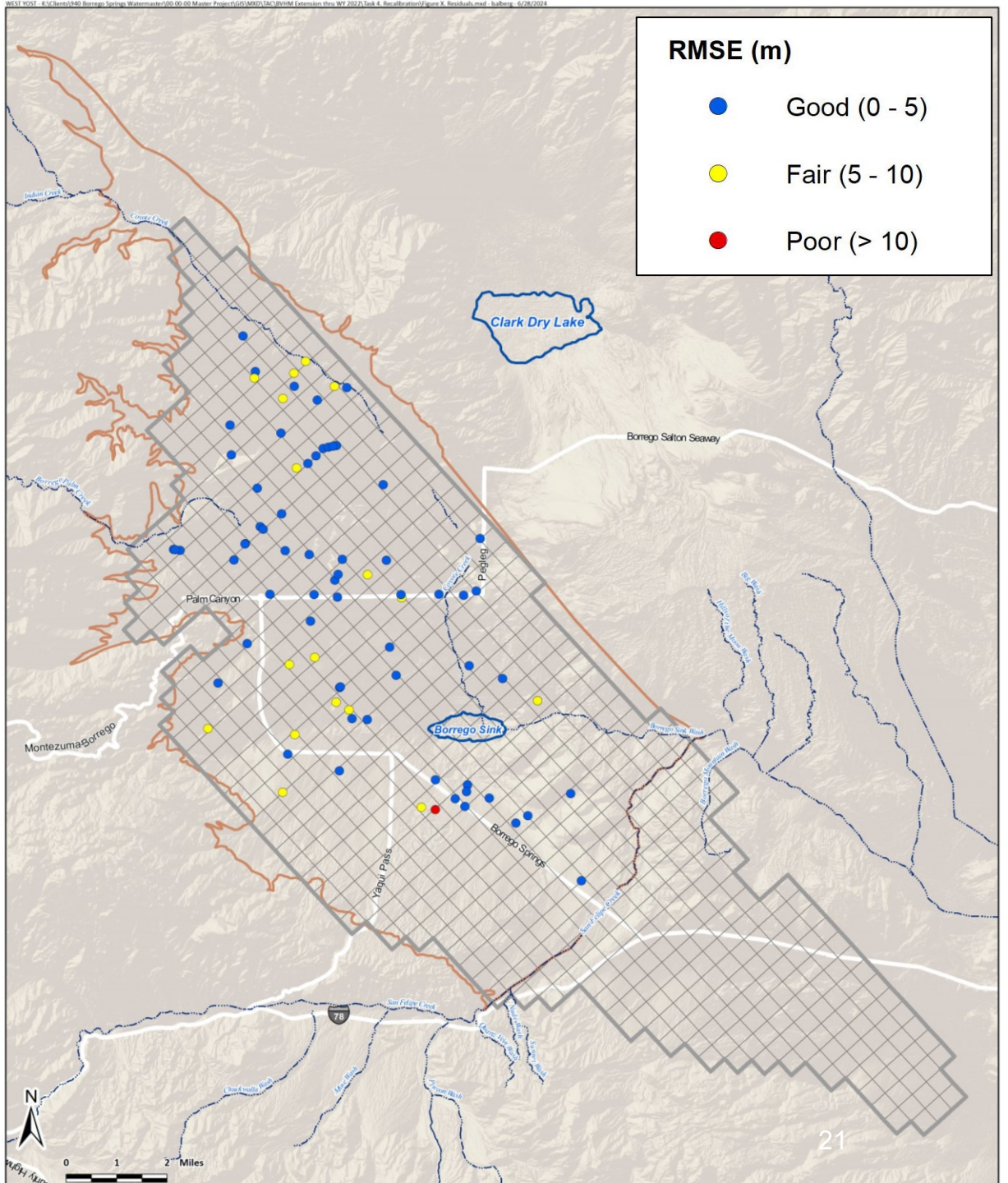
7. Review calibration results
   - Map and table of final model parameters
   - Table of calibration statistics
   - Map of mean residual by well
   - Table and time-series chart of the annual water budget
   - Scatter plots and time-series charts that compare simulated vs. observed groundwater elevations at wells
   - Time-series chart of simulated surface-water discharge vs. precipitation
8. **Repeat Steps #1-7 until calibration results are satisfactory**
9. Document calibration process and results in TM



Current Step (repeat #7)

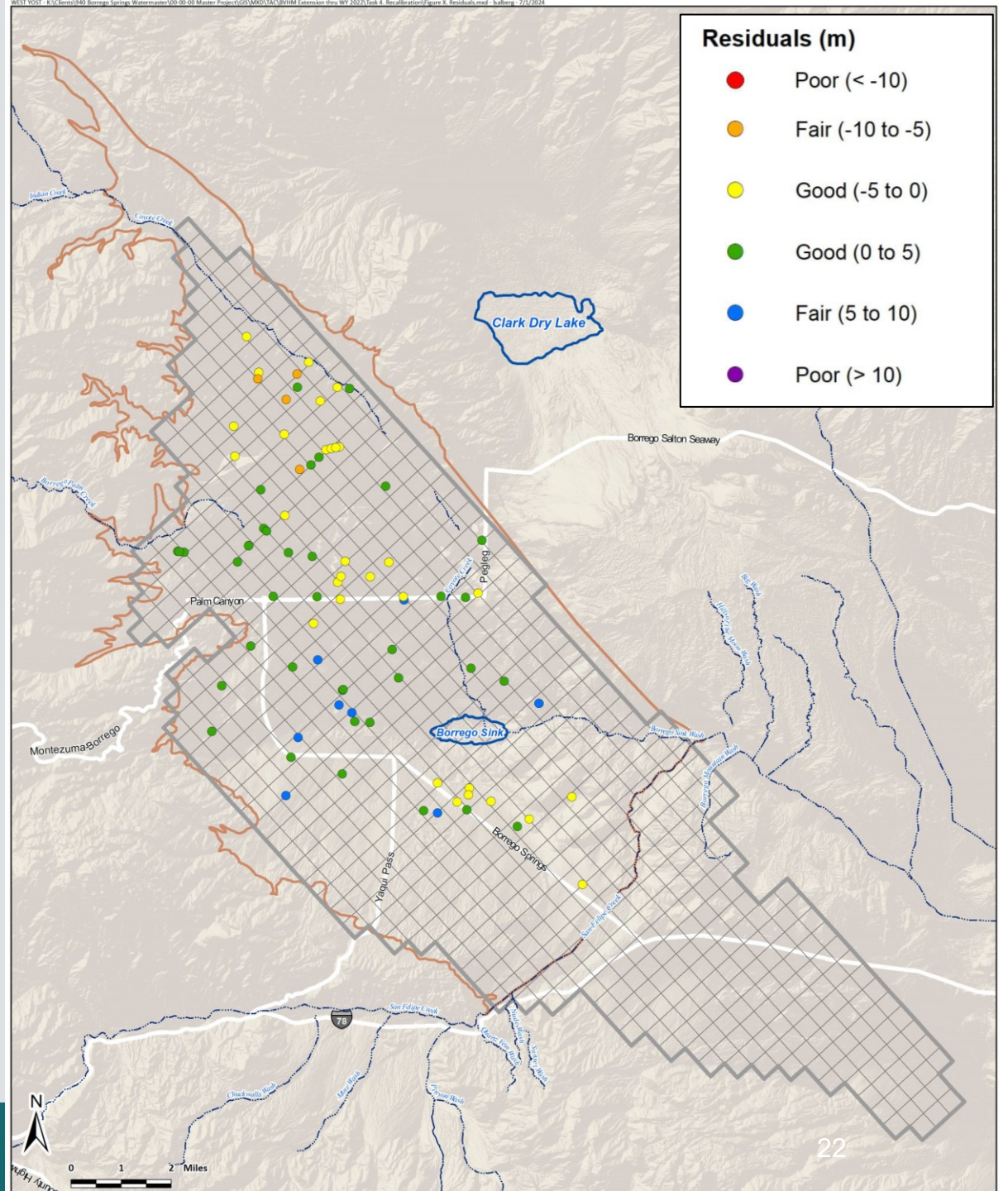
Preliminary Recalibration Results

- Root Mean Square Error (**RMSE**) identifies the average difference between model-estimated and measured groundwater levels
- Lower RMSE values indicate model is a better "fit" for a dataset
- Calibrated results are generally a 'good' fit for groundwater elevations



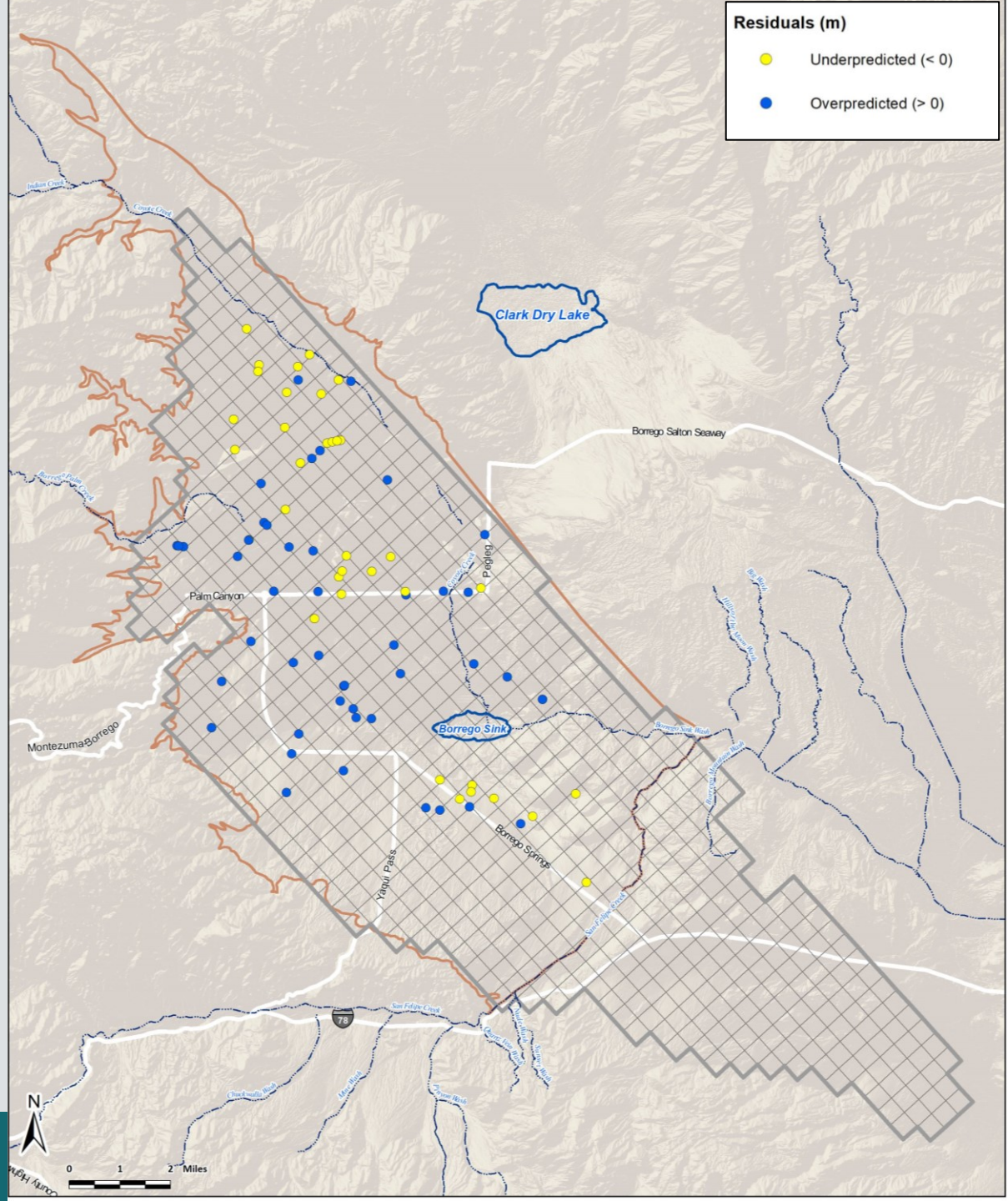
Preliminary Recalibration Results

- Residual = difference between observed value and model-estimated value
- Calibrated results are generally a 'good' fit for groundwater elevations

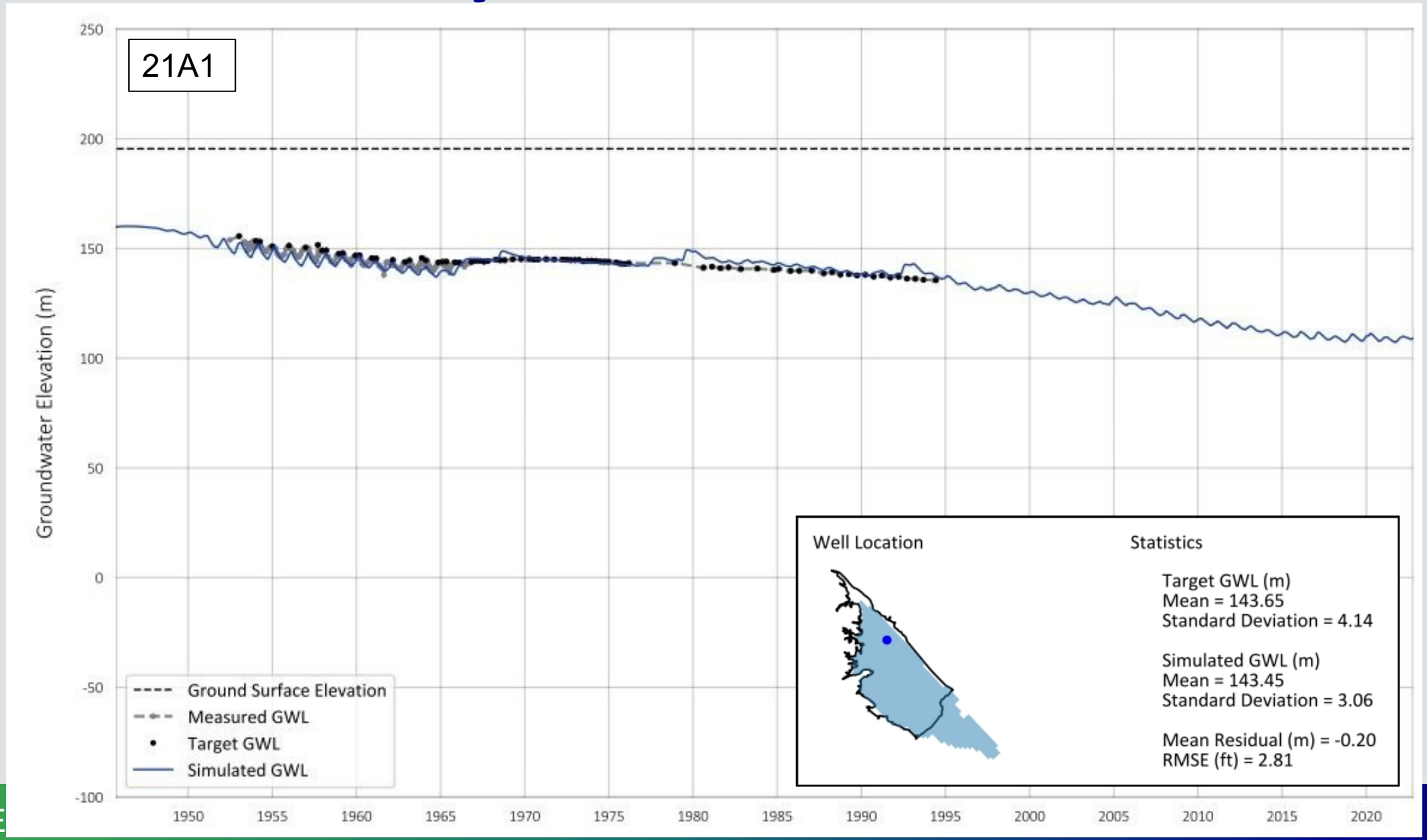


Preliminary Recalibration Results

- Negative value = model under-predicts elevation
- Positive value = model over-predicts elevation



Preliminary Recalibration Results



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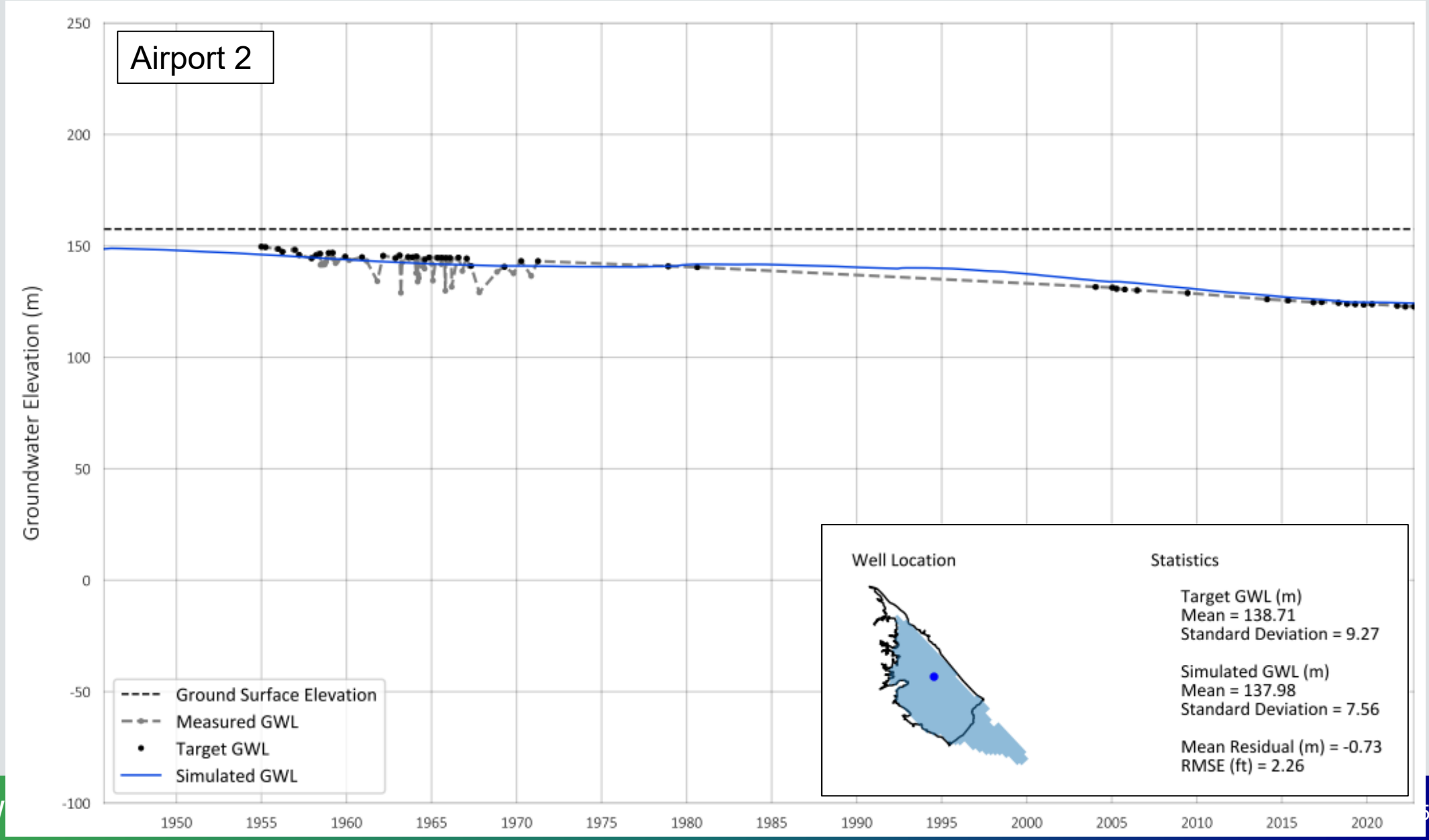

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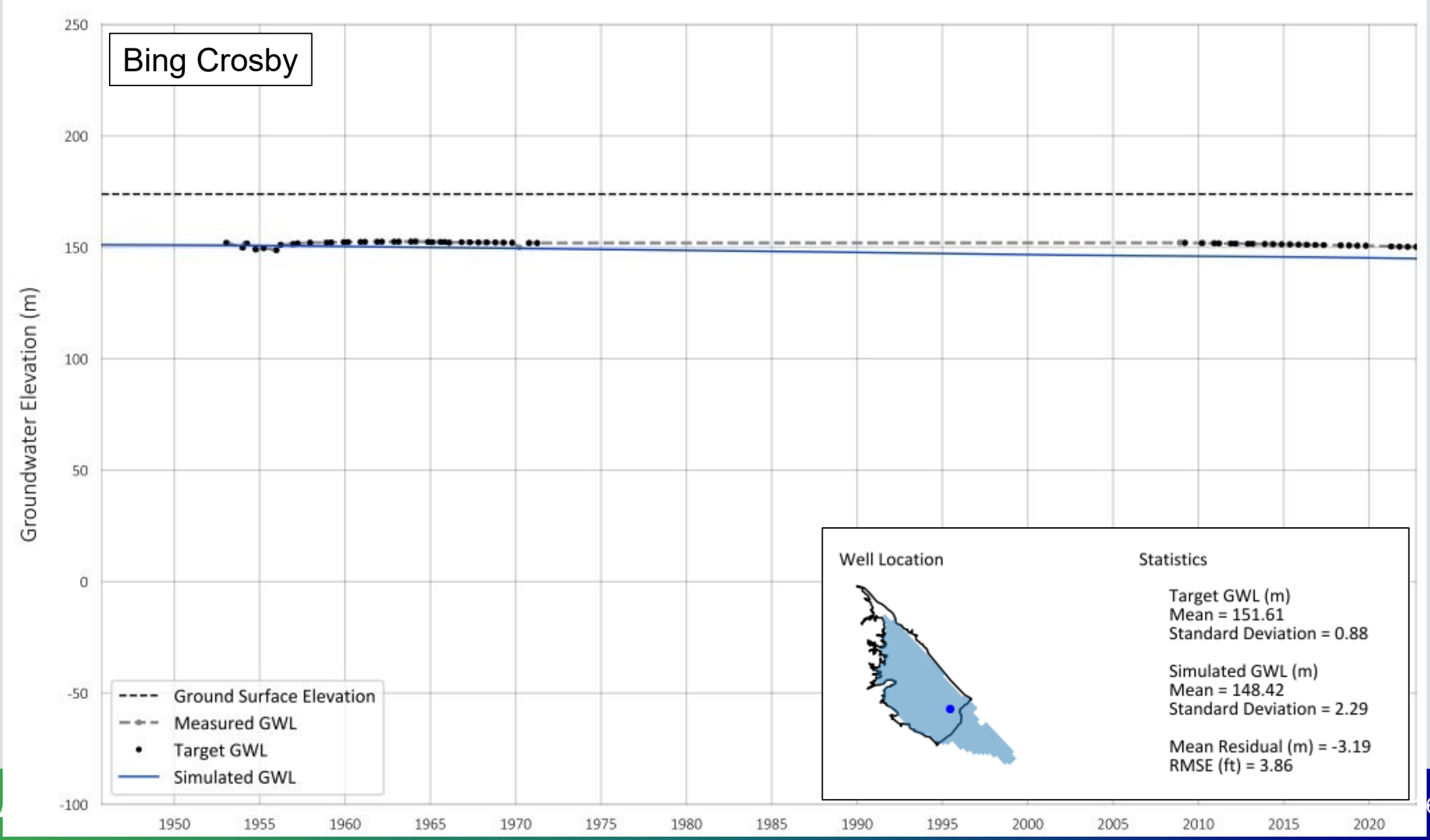
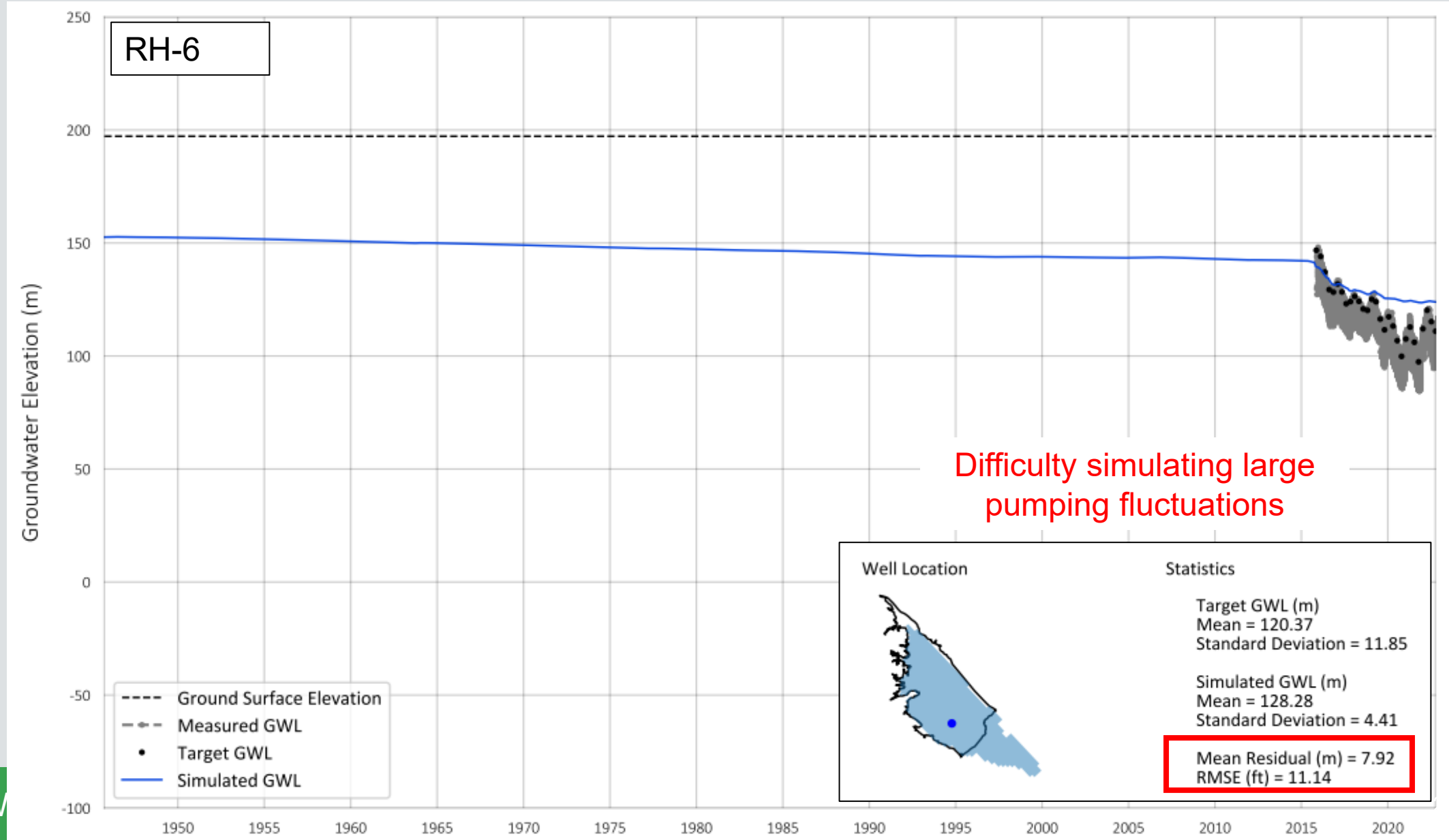
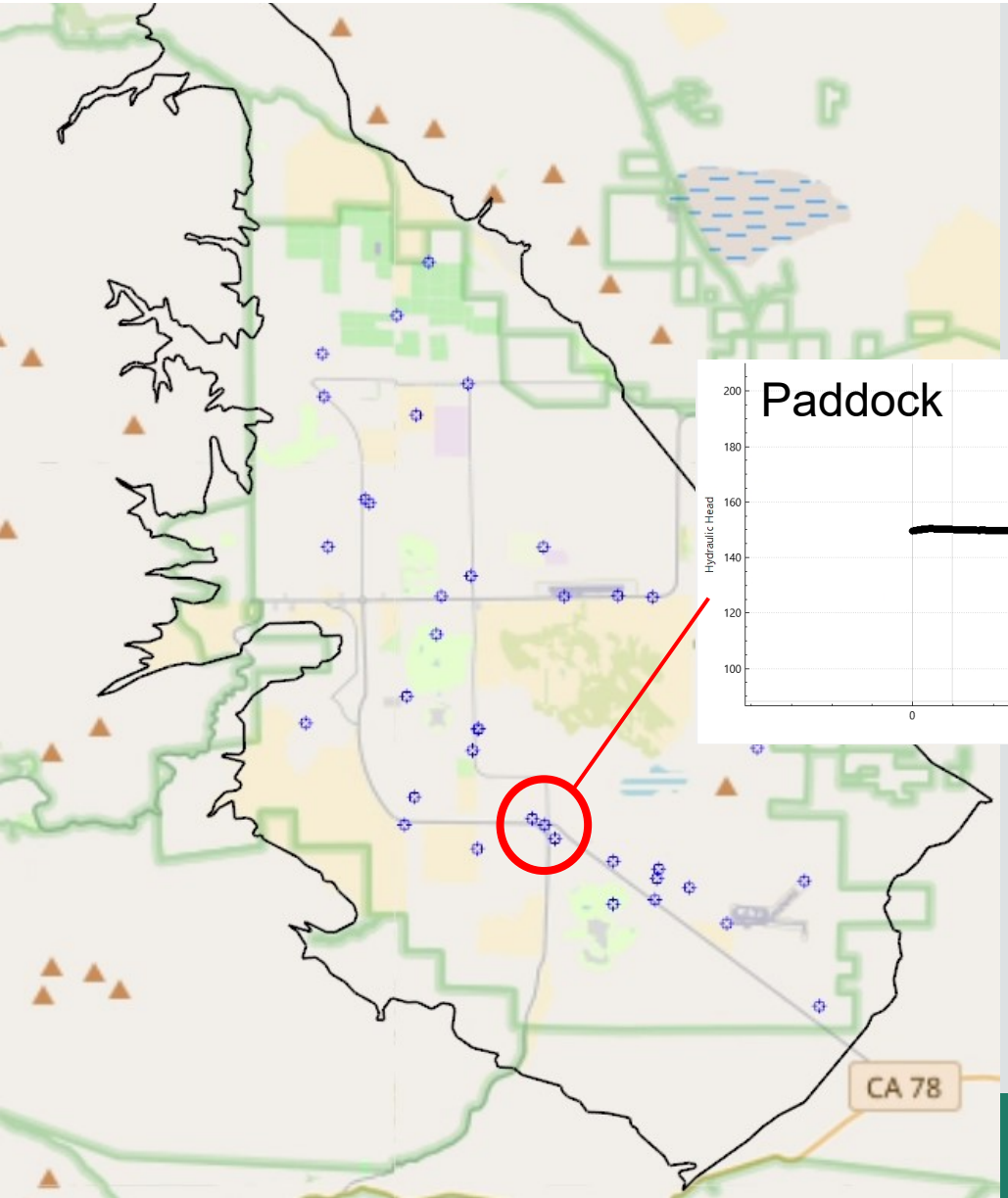
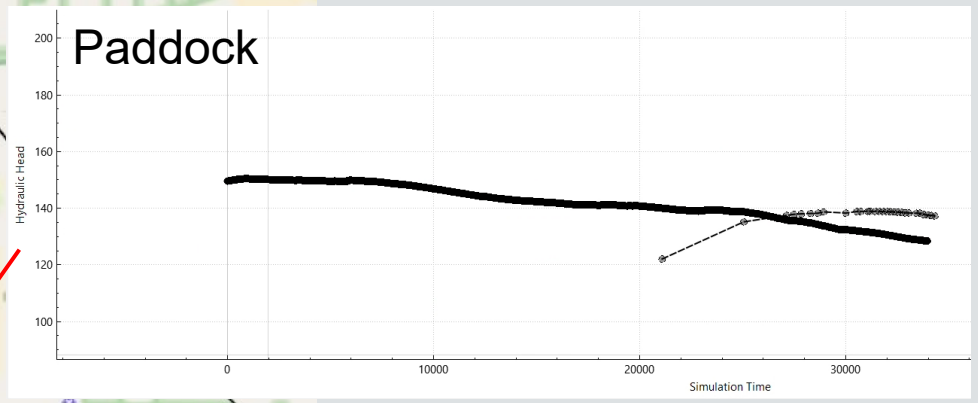


Preliminary Recalibration Results



Unable to Calibrate 3 Wells





- 3 wells show increase in groundwater levels (1980s to 2000s) → not seen in any other well
  - Wells removed from calibration
- Localized geology may be influencing groundwater levels and dynamics
- Recommendation to improve conceptual model this area → Use results of AEM surveys

Next Steps

1. Finish recalibration
2. Send email to TAC with results of recalibration
   - TAC will have up to one-week to provide comments on results of recalibration
   - At the TAC's request, Ad-Hoc TAC meeting may be called
3. Circulate draft TM on the methods and results of Task 4 to the TAC by mid-July for review and comment.
4. Continue work on Task 5 – *Determine the Sustainable Yield*
   - TAC meeting to discuss projection scenarios and methods (August)
   - Workshop with TAC and Board to discuss pumping projection scenarios (August)

Today's Agenda

1. Public Comment
2. Review Results of Task 4 – *Model Recalibration* to Redetermine the Sustainable Yield by 2025
3. **Status update: 5-Year GMP Assessment Report**
4. Public comment

Five-Year Assessment of GMP

- The Judgment and GMP represent the "Alternative" to the GSP
- Title 23 § 356.4 of CCR requires an assessment of GSPs, including Alternative Plans, every five years
  - **5-Year Assessment Report**
- The redetermination of the Sustainable Yield and the 5-Year Assessment Report may necessitate updates to the GMP
  - **Updates to management plans are at the discretion of plan managers**
- 5-year assessments for GSPs or alternative plans will not be reviewed or considered by DWR until the DWR has approved the plan.
  - ***DWR findings/corrective actions on the Judgment/GMP are forthcoming, and hence, hinders our ability to complete the 5-year assessment report***

Objectives of 5-Year Assessment Report

- Describe status of implementation of the Judgment/GMP
- Describe new information available to assess basin hydrogeology and conditions
- Evaluate if implementation of the Judgment/GMP is progressing towards meeting the Sustainability Goal of the Basin by 2040
- Describe how any corrective actions identified by DWR will be addressed
- Identify/recommend updates to the GMP (if any)
- Inform technical scope of work for next five-year period

- Additional Watermaster Objectives for this first 5-year assessment
  - Maximize use of grant funding
  - Set up template/framework for future efficiency in performing the 5-year assessment

OCTOBER 2023

Groundwater Sustainability Plan Implementation:

A Guide to Annual Reports, Periodic Evaluations, & Plan Amendments

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EXHIBIT 2.
DRAFT ANNOTATED OUTLINE OF 5-YEAR ASSESSMENT REPORT FOR THE GMP

EXECUTIVE SUMMARY

This section will provide a high-level overview of GSP implementation activities, address whether implementation is on track for reaching the basin's sustainability goal and provide an overview of significant new information received and included in the assessment.

SECTION 1. BACKGROUND & OBJECTIVES

1.1 Background on the Judgment/GMP

1.2 DWR Requirements for 5-year Assessment of GMP

1.3 Objective of the 5-Year GMP Assessment Report

1.4 Report Organization

SECTION 2. STATUS OF PROJECTS AND MANAGEMENT ACTIONS

DWR Requirement(s):

Title 23 § 356.4 (b): A description of the implementation of any projects or management actions, and the effect on groundwater conditions resulting from those projects or management actions.

Description of Section:

The GMP was drafted prior to the Judgment as a draft GSP. Together, the Judgment and GMP represent the Physical Solution for the Basin that will achieve sustainable groundwater management; however, the Judgment controls over and supersedes any contrary provisions contained in the GMP. There are certain management actions in the Judgment that replace the specific PMAs listed in the GMP. Table 1 in this section will describe the relationship between the management actions in the Judgment and the PMAs in the GMP. Each of the management actions in the Judgment will be described along with: implementation status; effects on groundwater conditions due to implementation; and progress made toward sustainability. Any additions, subtractions, or modifications to management actions will be described along with supporting information regarding the change to the management action.

2.1 Summary of Management Actions in the Judgment

2.2. Summary of PMAs in the GMP

2.3 Relationship between Judgment Management Actions and GMP PMAs

2.4 Implementation of Judgment Management Actions and effects on Groundwater Conditions

Five-Year Assessment of GMP

Section 1. Background & Objectives → **In development, subsections pending DWR findings**

Section 2. Status of Projects and Management Actions → **Drafted**

Section 3. Administrative, Legal, and Coordination Activities → **In development**

Section 4. New Information → **In development**

Section 5. Current Groundwater Conditions vs. Sustainable Management Criteria → **In development**

Section 6. Monitoring Program → **Drafted, pending updates following outcomes of well conversions**

Section 7. Basin Setting based on New Information → **In development, pending completion of SY update**

Section 8. Corrective Actions → **Unable to begin until DWR issues findings**

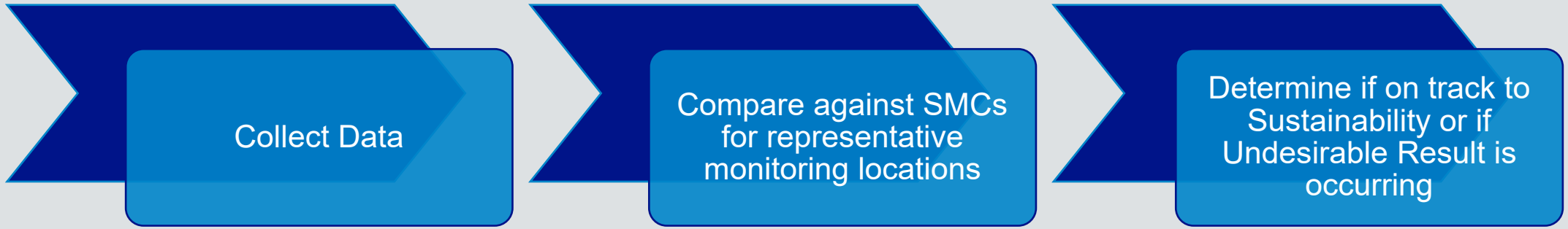
Section 9. Summary of Completed or Proposed Plan Updates → **Unable to begin until all prior sections completed**

Sustainable Management Criteria: Terminology

- **Minimum Threshold** (MT) is a quantitative value that represents groundwater conditions at a representative monitoring site that, when exceeded, may cause **Undesirable Results**.
- **Measurable Objective** (MO) is a specific, quantifiable goal for the maintenance or improvement of specified groundwater conditions to achieve the sustainability goal for the Basin.
- **Interim Milestones** identify a planned pathway to sustainability and are meant to track progress toward achieving sustainability.
- **Undesirable Results** occur when significant and unreasonable effects for any of the relevant sustainability indicators are caused by groundwater conditions occurring in one of the Basin's three management areas, or throughout the Basin.

Evaluation of SMCs and Sustainability

- GMP defines Sustainable Management Criteria (SMC) for the following Sustainability Indicators: Groundwater Storage, Groundwater Levels, Groundwater Quality
- Objective for Assessment is to use the latest available data to demonstrate how current conditions compare against SMCs
  - Information lives in multiple tables and sections in the GMP



How the BVHM was Used to set SMCs

- Multiple BVHM projection scenarios:
  - Different future pumping scenarios (pumping under no GMP vs. Pumping Rampdown)
  - Different future climate scenarios - Monte Carlo Simulation of variable climate/recharge
- **MTs** based on 20th percentile Monte Carlo simulation and the corresponding predicted changes in groundwater elevations at each representative well
- **MOs and Interim Milestones** based on 55thth percentile Monte Carlo simulation based on results from a future BVHM scenario that simulated average recharge (e.g 5,700)

Sustainable Management Criteria: Reductions in Groundwater Storage

Sustainability Goal: *"Long-term, aggregate groundwater use is less than or equal to the Subbasin's estimated sustainable yield, as defined by SGMA."* (Section 2.2.3.6) *Emphasis added

BVHM used to establish Sustainable Yield → determines future groundwater pumping

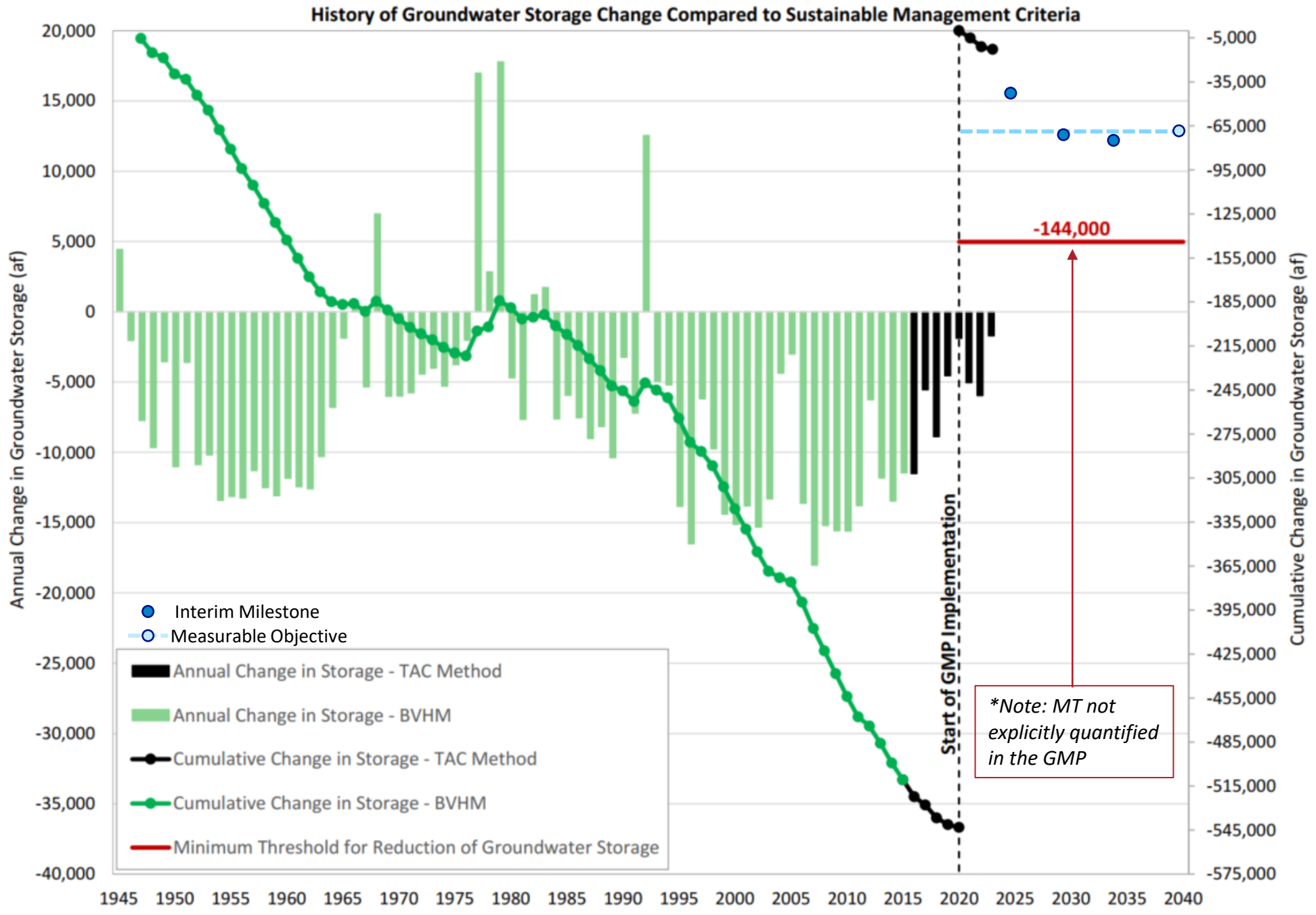
Table 3-8

Reduction of Groundwater in Storage Interim Milestones and Measurable Objectives

Year	Percent Pumping Reduced	Pumping Allowance (percent)	Pumping Allowance (acre-feet per year)	Cumulative Reduction of Groundwater in Storage (acre-feet)
0 (Baseline)	0.0%	100%	22,600[a]	0
5 (Interim Milestone)	19%	81%	18,376	43,500
10 (Interim Milestone)	37%	63%	14,151	73,000
15 (Interim Milestone)	56%	44%	9,925	76,600
20 (Measurable Objective)	75%	25%	5,700	72,000

Notes:

[a] The Baseline Pumping Allocation currently does not include Water Credits that may be converted to Baseline Pumping Allocation during GSP implementation


History of Groundwater Storage Change Compared to Sustainable Management Criteria
Annual Change in Groundwater Storage (af)
Cumulative Change in Groundwater Storage (af)
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
-25,000
-30,000
-35,000
-40,000
-5,000
-35,000
-65,000
-95,000
-125,000
-155,000
-185,000
-215,000
-245,000
-275,000
-305,000
-335,000
-365,000
-395,000
-425,000
-455,000
-485,000
-515,000
-545,000
-575,000
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
-144,000
Start of GMP Implementation
Interim Milestone
Measurable Objective
Annual Change in Storage - TAC Method
Annual Change in Storage - BVHM
Cumulative Change in Storage - TAC Method
Cumulative Change in Storage - BVHM
Minimum Threshold for Reduction of Groundwater Storage
*Note: MT not explicitly quantified in the GMP

Sustainable Management Criteria: Groundwater Levels

Sustainability Goal(s):

"Groundwater levels are maintained at elevations necessary to avoid undesirable results. Lowering of groundwater levels potentially leading to significant and unreasonable depletions of available water supply for beneficial use could occur if groundwater levels fall below the top of screened intervals for key municipal water wells, or result in the loss of water availability for domestic well users." (Section 2.2.2.1)

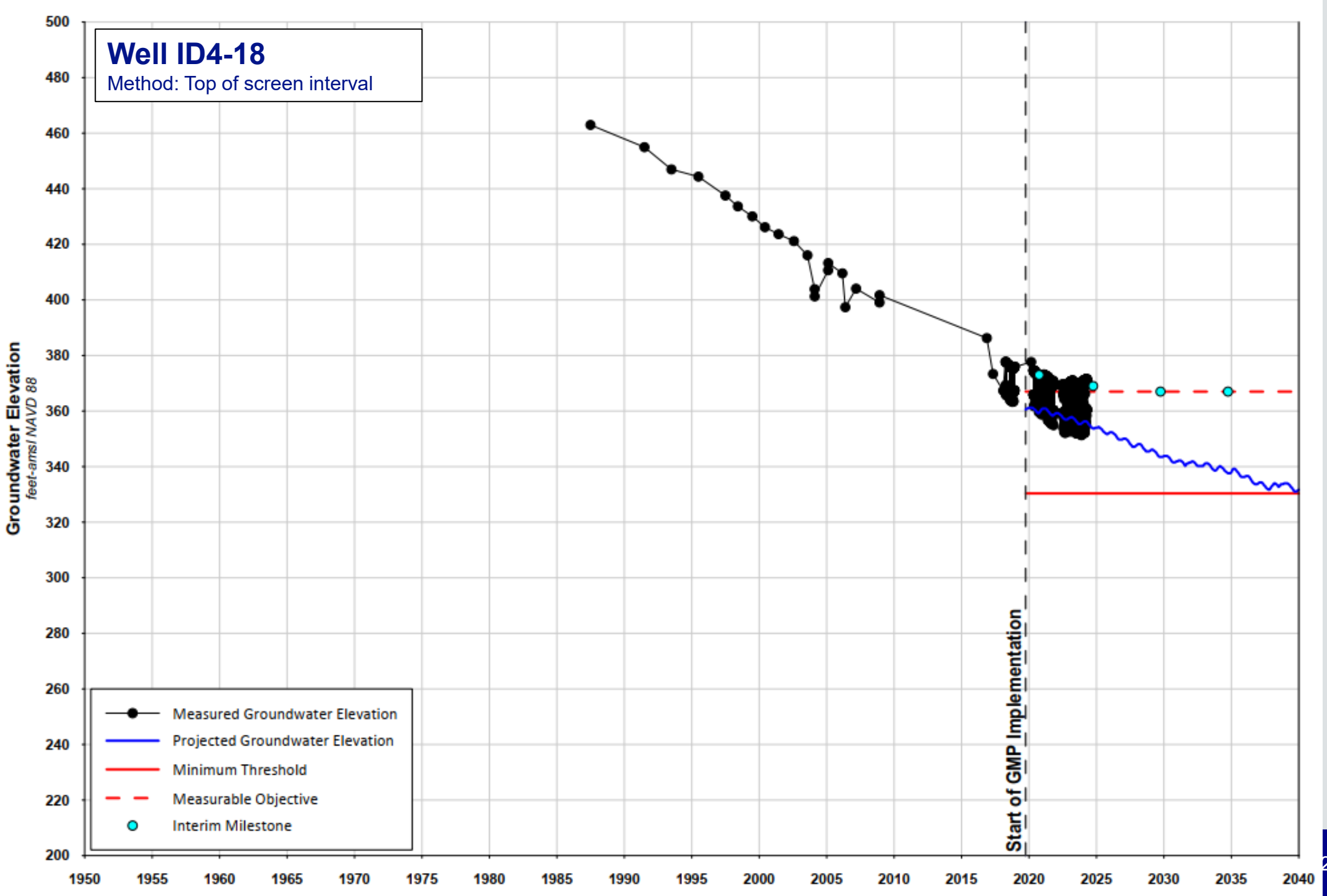
"The rate of groundwater level change within the Subbasin, averaged across indicator wells in the previous reporting period, is generally stable or increasing when compared to the contemporary groundwater level trend (i.e., 10-year trend 2010-2020 or trend based on available data)." (Section 2.2.2.1)

*Emphasis added

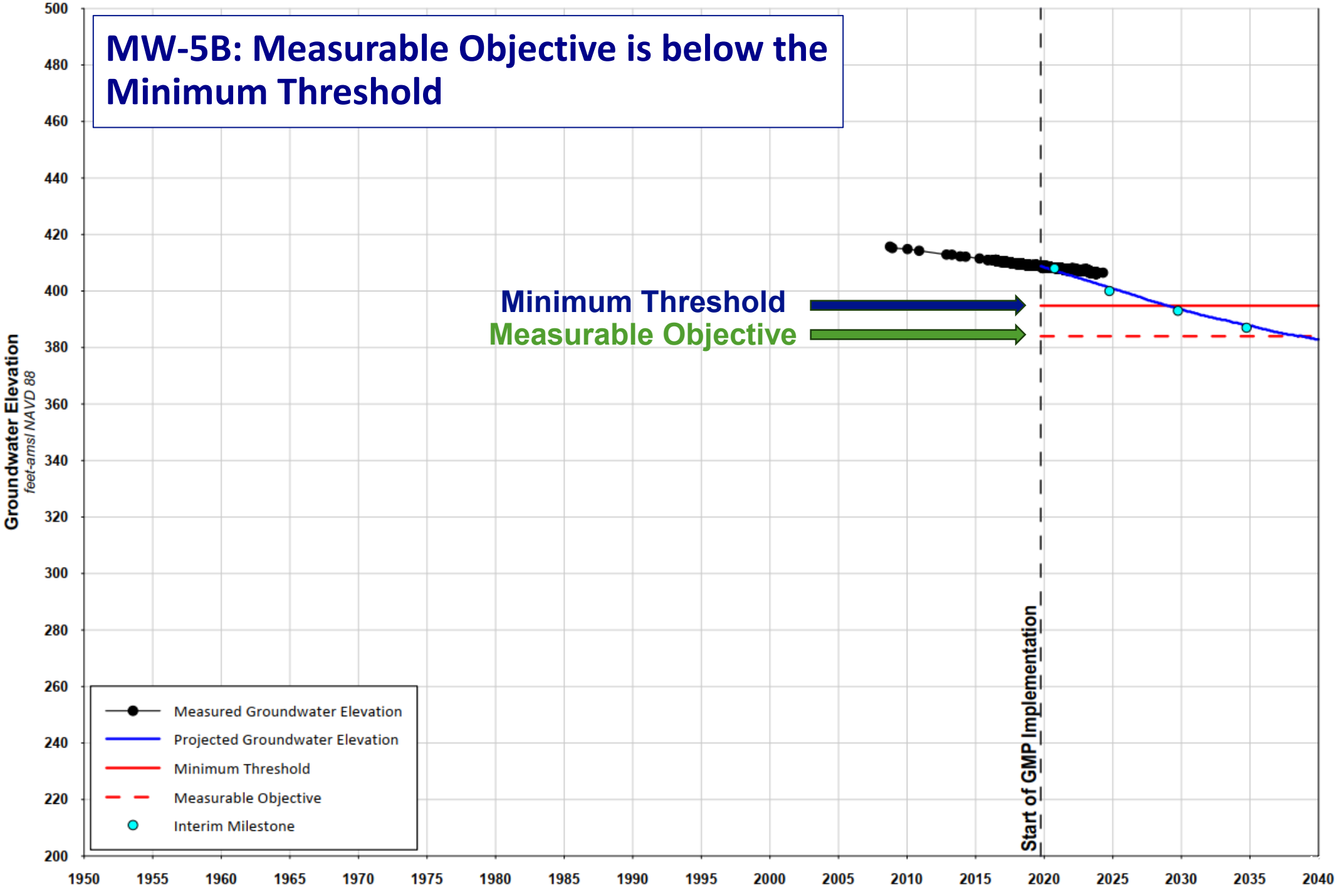
Minimum Thresholds & Measurable Objectives: Groundwater Levels

- GMP defines a network of wells for groundwater levels and quantifies Sustainable Management Criteria
  - Total number of wells: 16
    - 4 municipal wells
    - 12 monitoring, domestic, and ag wells (other wells)

- Methods used:
  - Minimum Thresholds
    - Top of well screen (municipal wells)
    - Future groundwater elevations from BVHM projections (other wells)
  - Measurable Objectives & Interim Milestones
    - Trends of historical groundwater elevations expressed as a rate of change (all wells)
    - Future groundwater elevations from BVHM projections under average recharge conditions


Well ID4-18
Method: Top of screen interval
Groundwater Elevation
feet-amsl NAVD 88
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
Start of GMP Implementation
Measured Groundwater Elevation
Projected Groundwater Elevation
Minimum Threshold
Measurable Objective
Interim Milestone

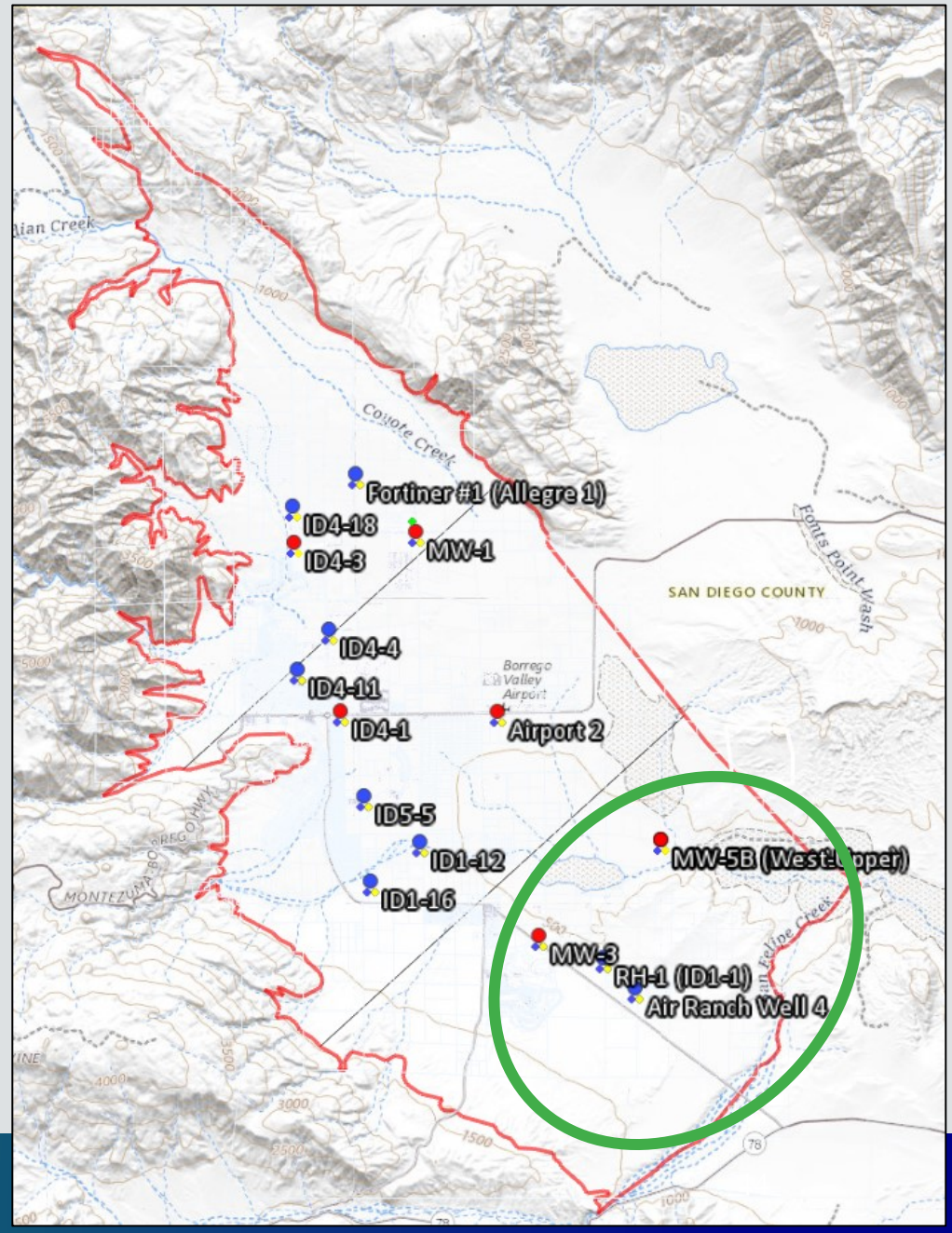
MW-5B: Measurable Objective is below the Minimum Threshold



MOs are below the MTs

- Methods used to set MTs/MOs resulted in discrepancies in projections:
  - Minimum Thresholds assume future GWLs will not decline in the SMA → BVHM doesn't simulate future groundwater pumping in the SMA
  - Measurable Objectives assume future GWLs will decline in the SMA → based on projected trends from historical groundwater levels
- All 5 Representative Monitoring Wells in the SMA have Measurable Objectives below the Minimum Threshold

Representative Monitoring Wells



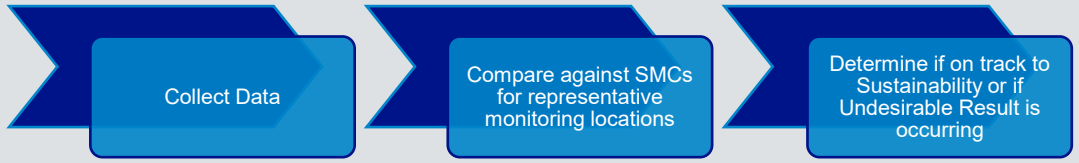
Undesirable Results: Reductions in Groundwater Storage and Levels

Undesirable Result: Groundwater level and storage declines would be significant and unreasonable if they are sufficient in magnitude to lower the rate of production of pre-existing groundwater extraction wells below that needed to meet the minimum required to support the overlying beneficial use(s), and that alternative means of obtaining sufficient groundwater resources are not technically or financially feasible.

Undefined: How many wells can exceed minimum threshold, or how many wells can reduce capacity, before it is considered significant and unreasonable?

Initial Recommendations Considered: Groundwater levels and Storage SMCs

- Use the Recalibrated BVHM to update the SMCs for groundwater levels and storage
  - Requires completion of the scope of work to Redetermine the Sustainable Yield
- Update network of Representative Monitoring Wells based on updated monitoring program
- More clearly define results that indicate an undesirable result is occurring, such as:
  - How many wells can have groundwater levels below an MT to be considered an Undesired Result for chronic lowering of groundwater levels?
  - How many wells can exceed minimum threshold?



Next Steps

- Once DWR findings received, hold meeting with DWR and Watermaster to discuss comments
- Update schedule (and scope, if needed) for completing Assessment Report
- Proceed to complete the 5-year assessment report

Today's Agenda

1. Public Comment
2. Review Results of Task 4 – *Model Recalibration* to Redetermine the Sustainable Yield by 2025
3. Status update: 5-Year GMP Assessment Report
4. **Public comment**

Future Meetings

- Next TAC meeting: August 2024
- Draft Agenda:
  - Discuss projection scenarios and methods for Task 5 – *Determine the Sustainable Yield*
  - Status Update: 5-Year GMP Assessment Report

Thank You!