Update of the Safe Yield Reset Methodology

Stakeholder Meeting

May 16, 2022

Agenda

- Welcome
- Background and Objectives
- Overview of Uncertainty in Modeling and the CVM
- Q&A
- Methods for Characterizing and Addressing Uncertainty
- Recommended Process to Calculate the Safe Yield
- Next Steps and Schedule

Background – April 28, 2017 Court Order

- April 28, 2017 Court Order
  - Approved current Safe Yield reset methodology
  - Included a provision to update the Safe Yield reset methodology
  - Required a peer review process

"4.4 Safe Yield Reset Methodology. […] In furtherance of the goal of maximizing the beneficial use of the waters of the Chino Basin, Watermaster, with the recommendation and advice of the Pools and Advisory Committee, may supplement the Reset Technical Memorandum's methodology to incorporate future advances in best management practices and hydrologic science as they evolve over the term of this order."

Background – 2020 Safe Yield Recalculation

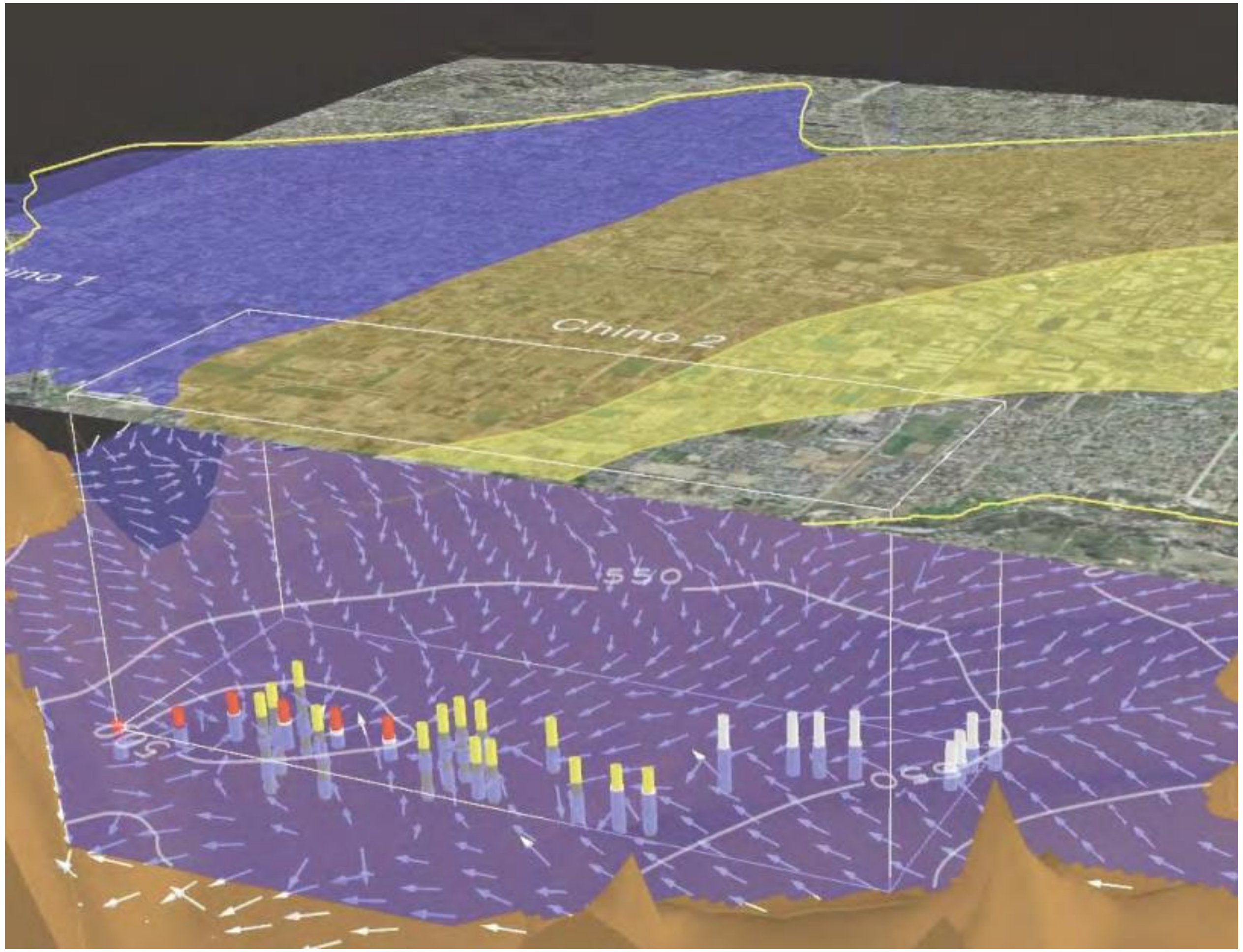
- Used Court-approved methodology to reset the Safe Yield for FY 2021 through 2030
- Several peer review comments recommended that the SY reset methodology account for:
  - Model parameter uncertainty
  - Predictive uncertainty (hydrology and water demands/supply plans)

Background – Scope to Implement Court Order

- Spring 2021 – Watermaster proposed a scope of work to update the SY Reset methodology to address uncertainty
- Appropriative Pool requested modified scope to solicit feedback early in the process
- Peer review meeting in October 2021 to define sources of uncertainty to be addressed in update of SY Reset methodology

What is Uncertainty?

- Difference between the model and the physical system that it represents
- Inherent and unavoidable in all models

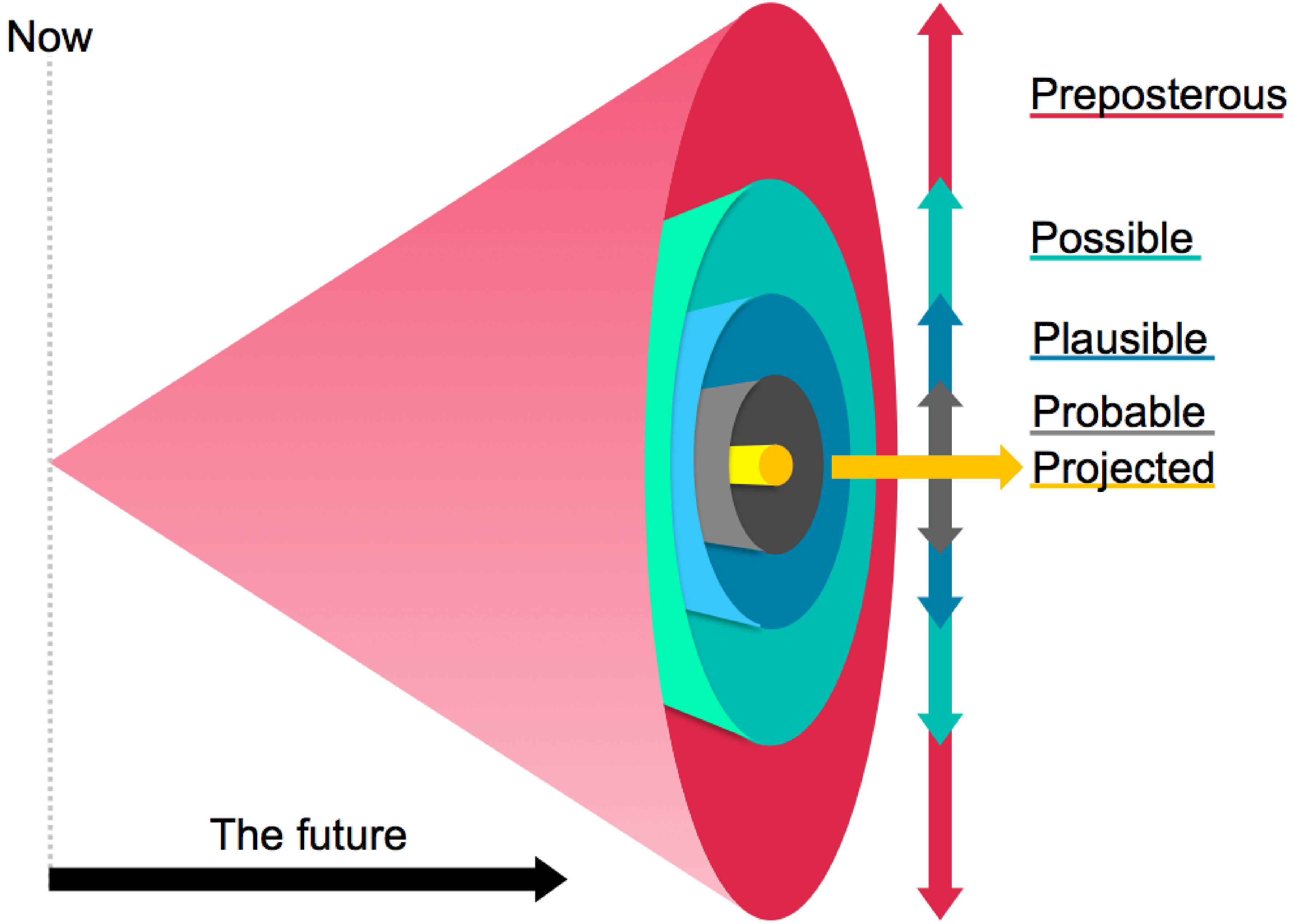


Sources of Uncertainty in Surface Water and Groundwater Modeling

- Historical data
- Model parameter uncertainty
- Predictive uncertainty
  - Demand and supply plans
  - Climate/hydrology

Why Consider Uncertainty?

- Better understand effects of model assumptions
- Identify data gaps
- Better quantify risk
- Make more informed management decisions



Envisioning the future for strategic planning - Goal Atlas

Uncertainty in the CVM

- Well-constrained and well-calibrated
- Model parameter uncertainty
- Predictive uncertainty

Approaches for Addressing Uncertainty

- Deterministic
  - One “calibrated realization” + one scenario
- Robust Decision Making (RDM)
  - Multiple calibrated realizations + multiple scenarios
- Dynamic Planning Framework
  - Dynamic behaviors triggered by management thresholds

Approaches for Addressing Uncertainty

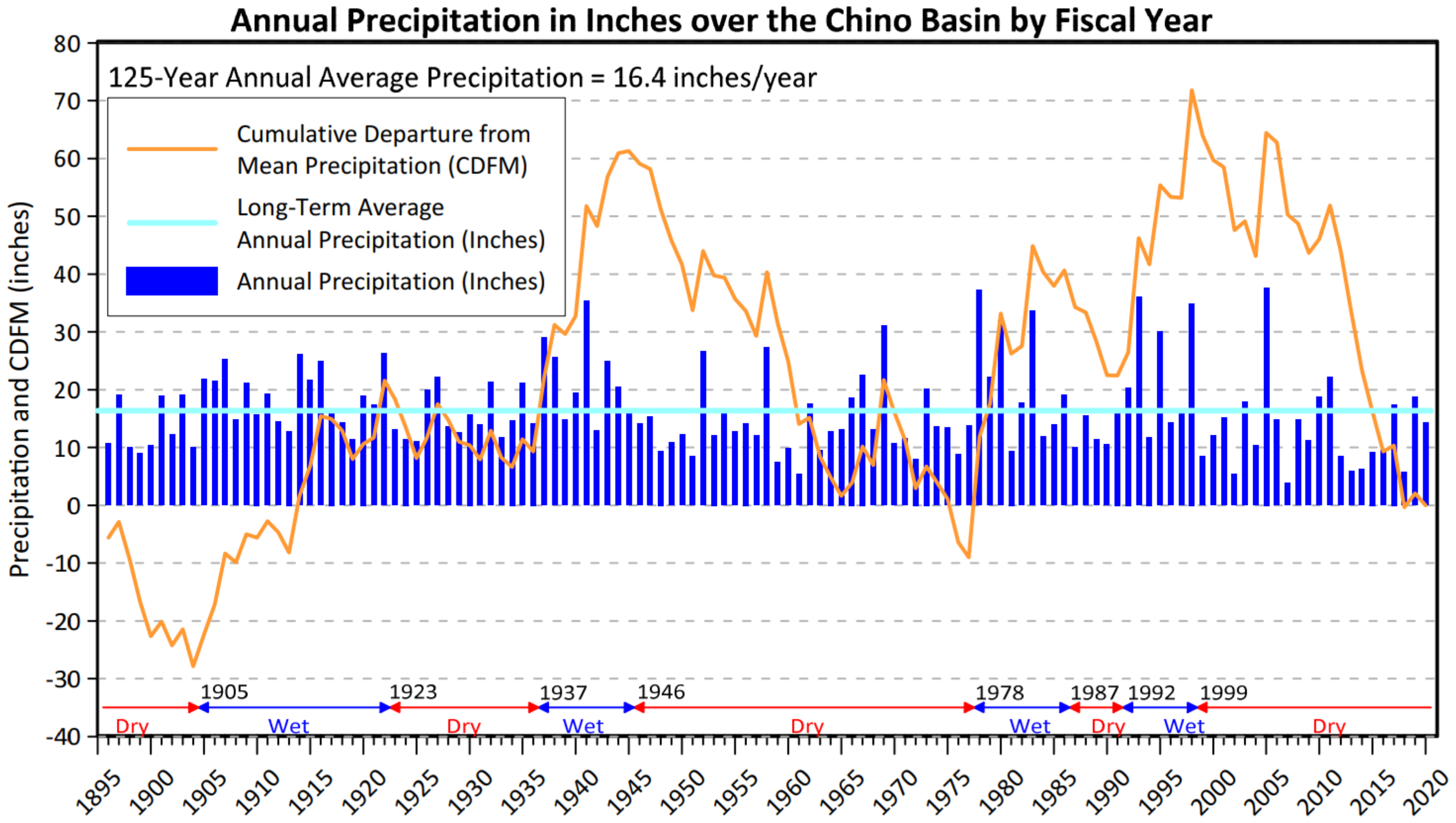
- Deterministic
  - One “calibrated realization” + one scenario
- **Robust Decision Making (RDM)**
  - **Multiple calibrated realizations + multiple scenarios**
- Dynamic Planning Framework
  - Dynamic behaviors triggered by management thresholds

Recommended Approach:
Robust Decision Making

- *"The RDM approach identifies a range of plausible future scenarios, assesses an agency's risk to each modeled scenario and, ultimately, identifies a robust strategy that is likely to perform well across all plausible outcomes."* (Moran, 2016)
- Recommended approach to address uncertainty in SGMA groundwater models
- Allows for exploration of possible futures without complexity of dynamic planning

Addressing Uncertainty:
Historical Data

- Includes directly observed data and estimated data calculated from observations
- Availability of a lot of data from varying sources
- Will honor historical data



Addressing Uncertainty:
Surface Water and Groundwater Model Parameters

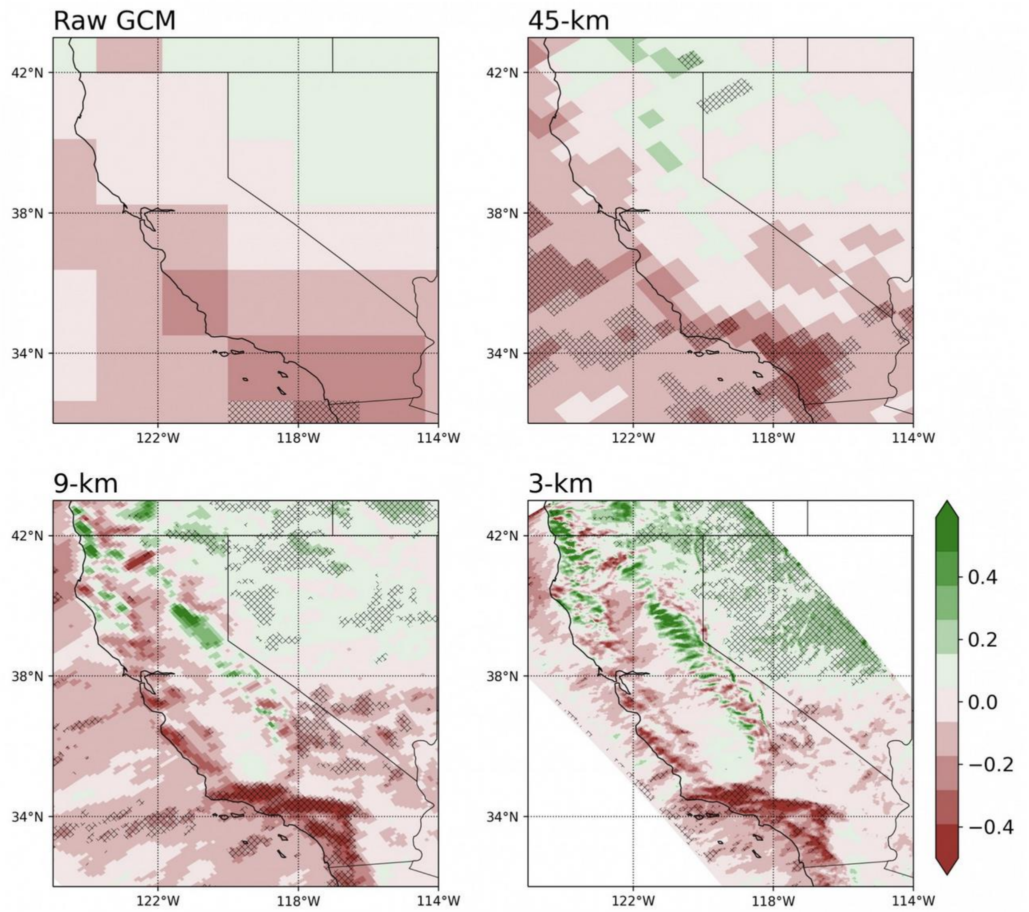
- Recommended method: Iterative Ensemble Smoother, implemented with PESTPP-IES
  - Efficient, flexible method to automatically generate multiple calibrated realizations
  - Widely used and well-documented

Addressing Uncertainty:
Future Water Demands and Supply Plans

- Recommended method:
  - Identify drivers of changes in future demands and supplies (e.g., population growth, water conservation mandates, climate change)
  - Develop scenarios based on combinations of drivers
  - Quantify water supply plans for selected scenarios
  - Translate water supply plans into model inputs
  - Supported by stakeholder process (Parties, wholesale agencies)

Addressing Uncertainty:
Future Climate and Hydrology

- Global Circulation Models (GCMs)
  - Precipitation and ET_0
  - Data used for SGMA planning
- GCMs were recently updated in 2021
- Results need to be "downscaled" to be appropriate for basin-scale models
- Propose to use downscaled data available from latest GCMs



Future (2080-2100 average) minus historical (1980-2015 average) simulated precipitation anomalies [mm/d] from a raw GCM and from WRF downscaling grids. Hatching denotes statistical significance greater than 0.9, and cross hatching denotes significance greater than 0.99.

https://dept.atmos.ucla.edu/alexhall/downscaling-cmip6

Combining the Proposed Methods

- "Projection realization" includes:
  1. Calibrated groundwater model
  2. Water demand and supply plan scenario
  3. Climate scenario
- Total number of projection realizations is the product of (1) through (3)
  - *40 calibrated models* X *3 demand/supply plan scenarios* X *5 climate scenarios* = **600 projection realizations**
- All projection realizations = model ensemble

Sounds like a lot of models. Is that feasible?

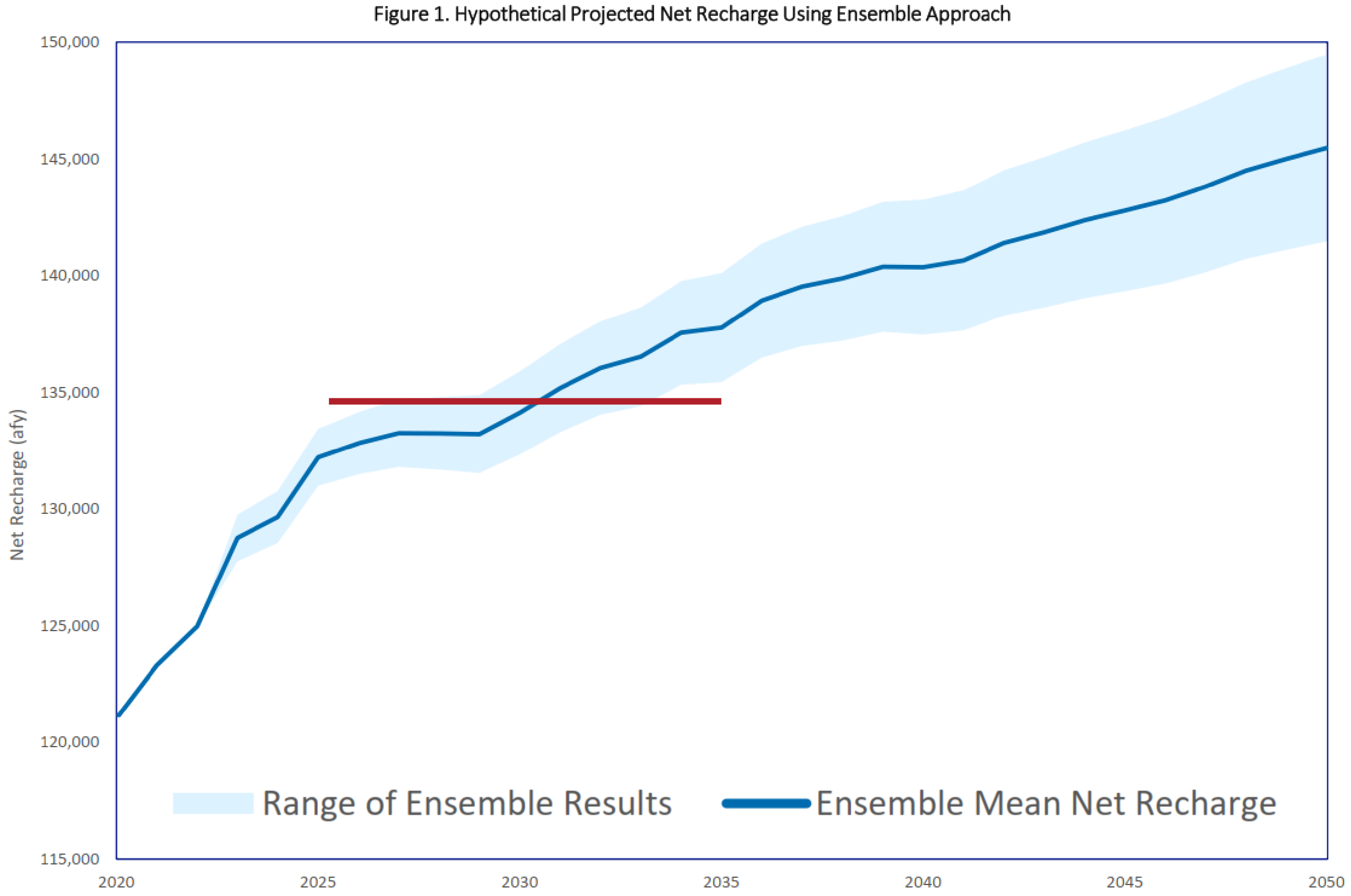
https://www.gaapdynamics.com/images/user-uploads/9.11_Inline_Image_1_copy.jpg

- Yes, thanks to cloud computing.
- Amazon Web Services = $4k/month
- 6 months of use = $24k

How should we interpret the model ensemble?

- Automate the generation of key model outputs, including:
  - Water budget
  - Net recharge
  - Extent of potential MPI (land subsidence, pumping sustainability, water quality)
  - Hydraulic Control
- Use the ensemble statistics to calculate Safe Yield and evaluate MPI and undesirable results

How should we interpret the model ensemble?



How should we interpret the model ensemble?

- Risk of MPI and undesirable results should be evaluated based on thresholds
  - What is the threshold for the potential for MPI in a single projection realization?
  - What constitutes a significant percentage of projection realizations that indicate potential for MPI?
- Examining the ensemble allows us to identify the causes of potential risks
  - What we learn can provide guidance for Basin optimization

Proposed Updated Methodology to Calculate the Safe Yield (1/2)

1. Update model and generate multiple calibrated groundwater model realizations
2. Develop future scenarios of demands, water-supply plans, and climate/hydrology based on the recommended methods
3. Generate projection realizations (up to 600)
4. Simulate the ensemble

Proposed Updated Methodology to Calculate the Safe Yield (2/2)

5. Conduct statistical analyses of ensemble results, including
    a. Water budget and net recharge over 50-year planning period
    b. **Safe Yield = ensemble mean net recharge over prospective 10-year period**
    c. Statistics of projection realizations for potential MPI or hydraulic control
6. Evaluate risk of potential MPI and violation of hydraulic control based on statistics. *"Identify and implement prudent measures necessary to mitigate [MPI and undesirable results], set the value of Safe Yield to ensure there is no [MPI and undesirable results], or implement a combination of mitigation measures and a changed Safe Yield."*

Planning-Level Scope, Schedule, and Budget to Implement the Proposed Updated Safe Yield Reset Methodology

- **FY 2023:** Update of hydrogeologic conceptual model and initiate the stakeholder process to prepare the projection scenarios for demands and water-supply plans
  - $259,000
- **FY 2024:** Conduct the model calibration and uncertainty analysis, prepare the ensemble of projection scenarios, and begin simulating ensemble of projection scenarios
  - $900,000 to $1,100,000
- **FY 2025:** Complete the simulation and evaluation of the ensemble of projection scenarios, calculate Safe Yield, and prepare report (must be completed by June 30, 2025)
  - $600,000 to $900,000

Next Steps and Schedule

- Peer review workshop on Thursday, May 19th
- Collect additional feedback by Friday, June 10th
- Update draft TM and distribute for peer review by Friday, June 24th
- Peer review meeting to be scheduled in early July

CHINO BASIN WATERMASTER

Partners in Basin Management

THANK YOU