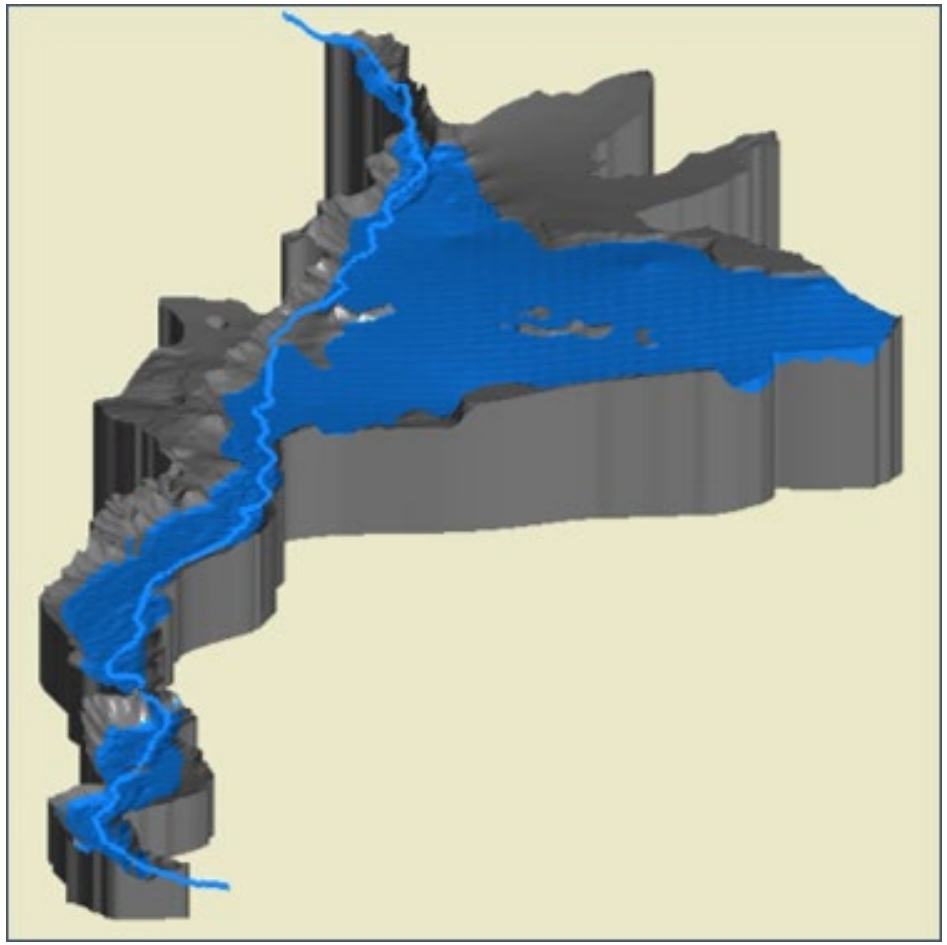

UVRGA Model Calibration Update Project

Upper Ventura River GROUNDWATER AGENCY
SUSTAINABLE MANAGEMENT

October 9, 2025

INTERA

Agenda

1. Background
2. Summary of Work Performed
3. Results
4. Recommendations

INTERA

Background

1. Model Background
2. Model Calibration Basics
3. Model History

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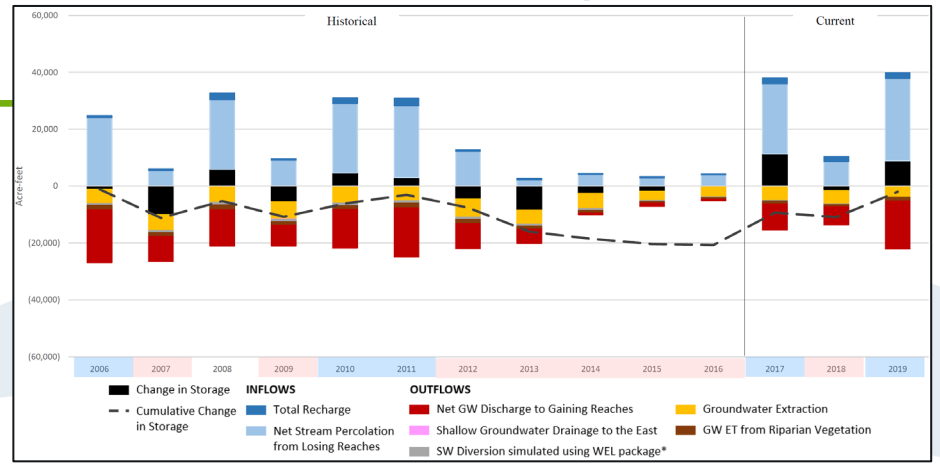
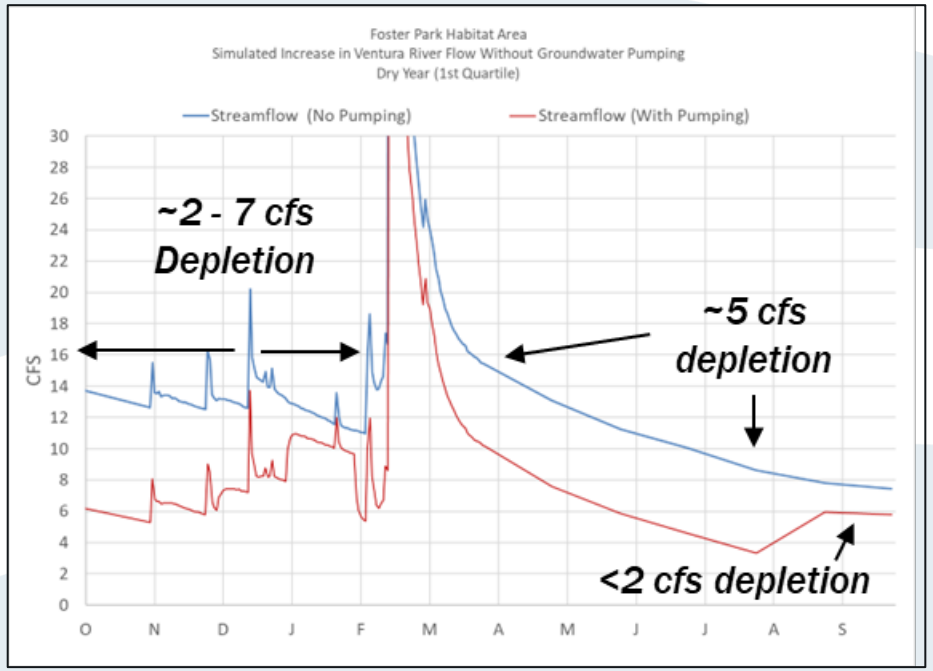
Model Background

- Numerical Model is a SGMA requirement:
  - Water budget
  - Interconnected Surface Water (ISW) Depletion
- No prior model – model developed from scratch
  - Intera developed model with Executive Director oversight and review
- Model simulates groundwater and surface water flow in Upper Ventura River Basin
  - Model developed and calibrated using data available during GSP development (i.e., 2005 – 2019 data)
  - Model extended incrementally when preparing annual reports (w/o additional calibration)

Example Water Budget Chart



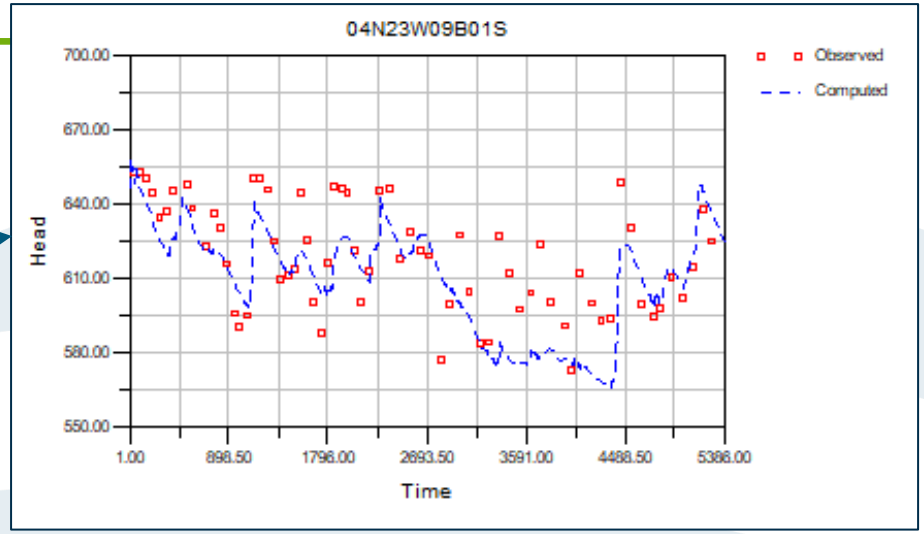
Example Depletion Estimates at Foster Park



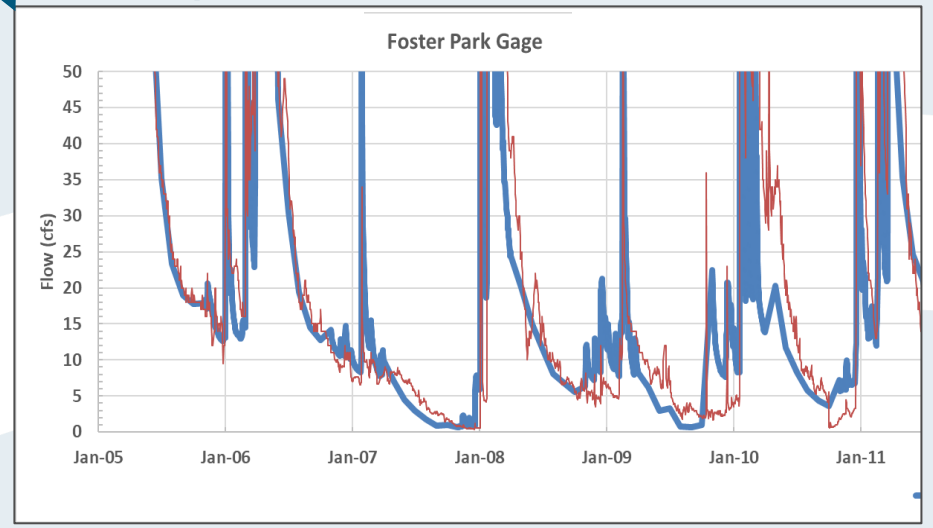
Model Calibration Basics

- Model Calibration
  - Process of adjusting model inputs to match model outputs to field measured data
    - Measured groundwater levels
    - Measured streamflow (USGS Foster Park Gage)
  - Calibration Measures:
    - *Quantitative*: model vs. measured statistics
      Qualitative: visual review of model vs. measured
  - Sensitivity Analysis
    - Varies model inputs to understand relative impact on model calibration:
      - Helps guide calibration process
      - Helps understand model uncertainty

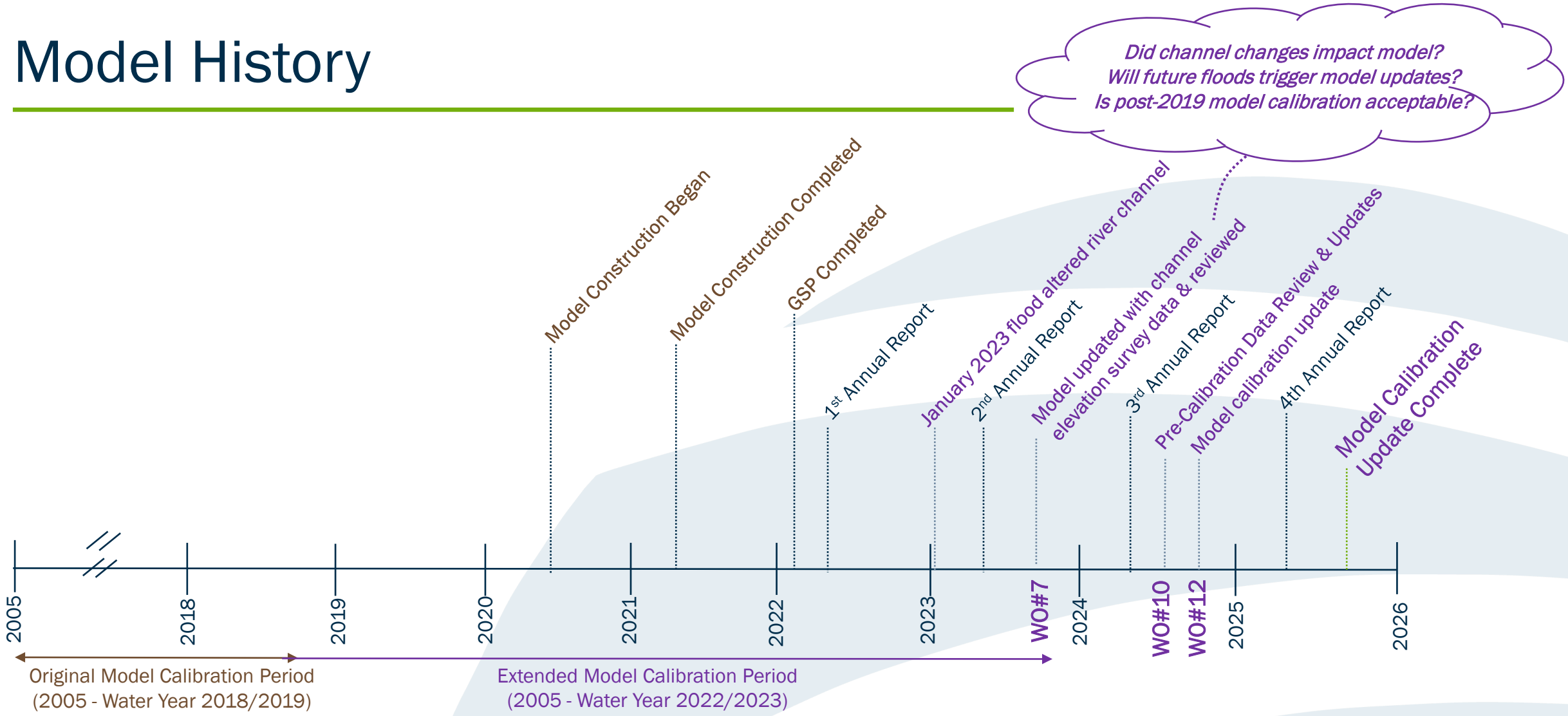
Example Groundwater Level Calibration Chart



Example Streamflow Calibration Chart

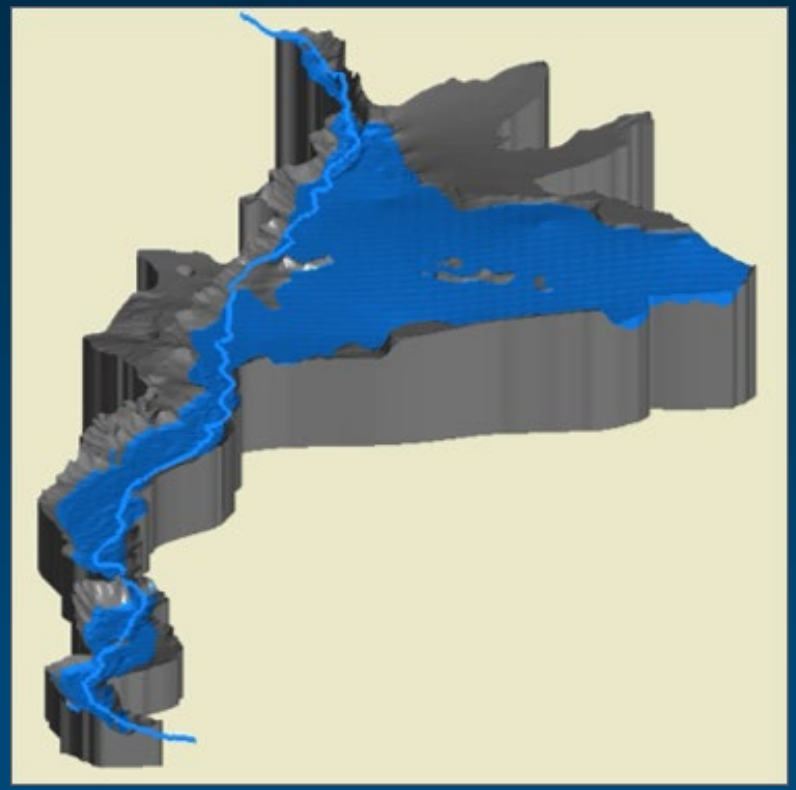


Model History



Summary of Work Performed

1. Summary of Work Orders and Key Findings
2. Streamflow Data Evaluation
3. Model Updates
4. Model Calibration Update



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Work Order No. 7 –Post 2023 Flood Model Update/Review

Work Completed	Key Findings
River Channel Change Evaluation: • Evaluated impacts of changes in river channel geomorphology from January 2023 flooding event on model (LiDAR survey completed) • Updated model with changes in channel	• Model results generally insensitive to changes in streambed elevation and location of channel. • Future updates to channel geomorphology following extreme flood events do not appear to be critical for model performance.
Model Verification: • Checked model performance using data post-calibration data (i.e., data after 2018)	• Model found to overpredict low streamflows during post-calibration period (i.e., after 2018). • Additional model calibration recommended to improve model use for ISW depletion estimation.

Model Calibration Comparison

	Jan2005-WY 2018	WY 2018-WY 2022
RMSE	2.4 cfs	5 cfs
ME	1.2 cfs	4.4 cfs

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Work Order No. 10 – Pre-Calibration Data Review & Updates

Work Completed	Key Findings
Critical Review of Streamflow Data: • Communication with USGS and Ventura County staff • Quantified errors in streamflow datasets used for model inputs and calibration	• Uncertainty in streamflow data is significant and impacted prior model calibration. • Removed unreliable data: Switched streamflow calibration dataset at USGS gage to error-barred, location-based measurements instead of rating curve. • Bracketed model uncertainty with error in streamflow inputs
Incorporation of New Data: • Updated bedrock depth, pumping, model stress periods	• New well logs • Groundwater levels • UVRGA well registration and reporting info • Changed model to daily for improved calculations of ISW Depletion

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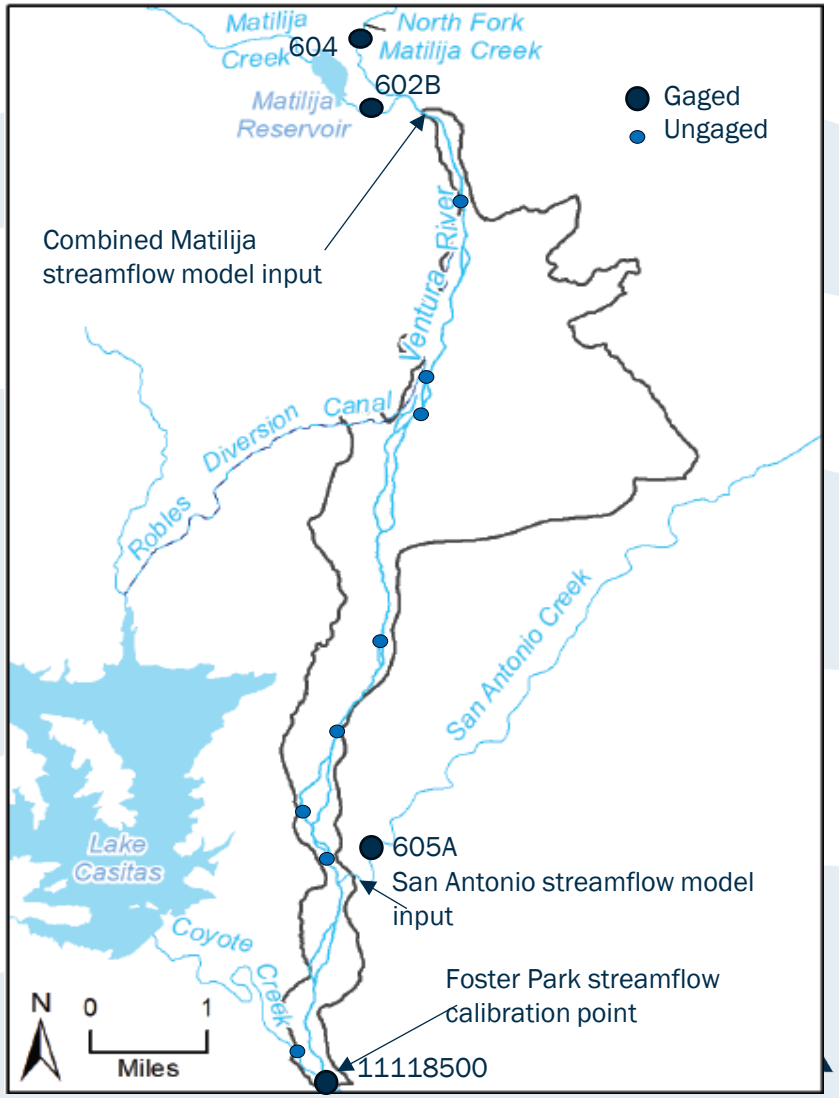
Work Order No. 12 – Model Calibration Update

Work Completed	Key Findings
Sensitivity Analysis: • Assessed sensitivity of model inputs.	• Narrowed scope of calibration task by identifying key model parameters in different areas that impact model calibration the most.
Model Calibration Update: • Updated the model calibration.	• The model's ability to represent streamflow (especially low flows) was significantly improved .
Review of Model Limitations & Uncertainty: • Assessed uncertainty in model inputs and calibration data.	• USGS Foster Park gage measurement location variability has very significant on model calibration • Error in measured and estimated streamflow entering basin can significantly impact model results • Bedrock depth data remains a significant limitation
Recommendations: • Reviewed updated calibration results and developed recommendations.	• Streamflow measurement improvements • Synoptic Streamflow study in Foster Park • Collect more bedrock depth data • Improve groundwater level calibration (upstream areas) • Quantify uncertainty in depletion estimates

Upper Ventura River Basin Inflows and Outflows

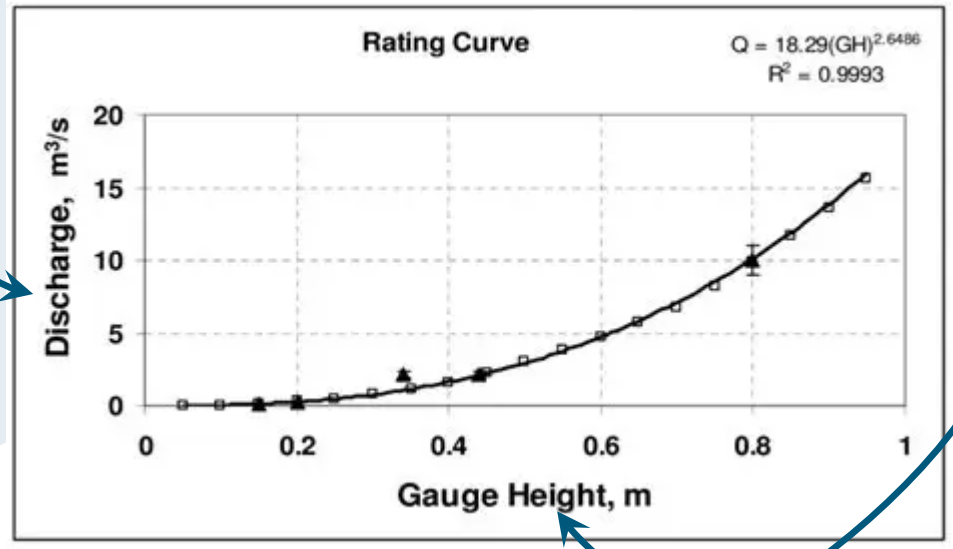
- Where is surface water inflow gaged?
  - Three locations
    - Both forks of Matilija Creek (proxy for basin inflow)
    - San Antonio Creek near Ventura River Confluence
- Where is surface water inflow not gaged?
  - Several unnamed tributaries
  - Coyote Creek
- Where is surface water outflow gaged?
  - Foster Park USGS gage – *used for model calibration*
  - Robles Diversion (not shown on map)
- Where is surface water outflow not gaged?
  - Not applicable

Stream Inflow and Outflow Locations

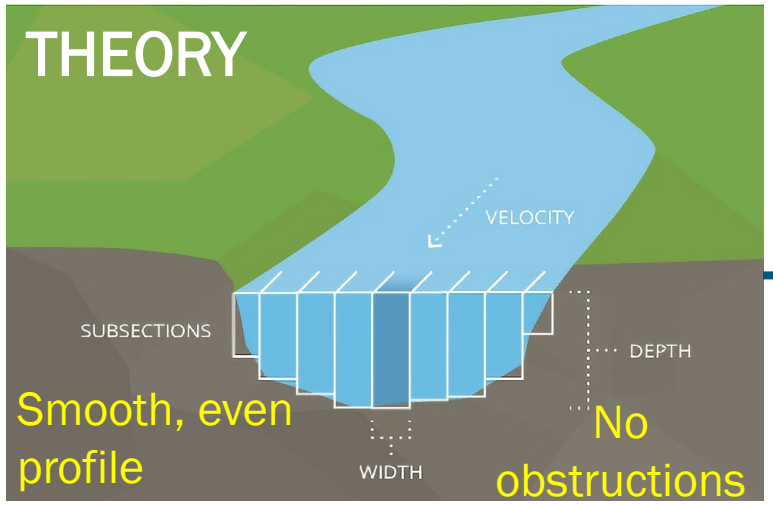


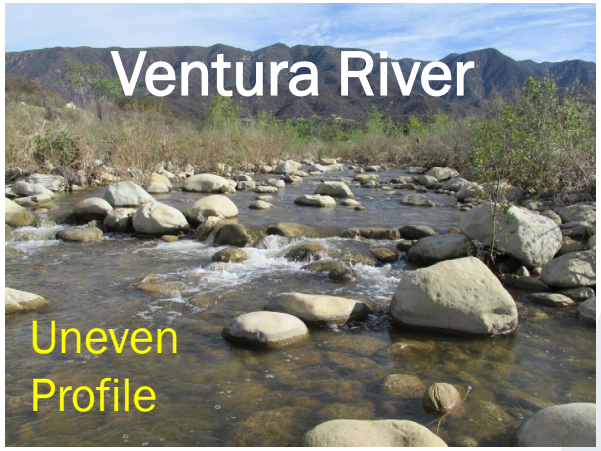
How Does Stream Gaging Work?

- Manual stream discharge measurements made periodically
- Gage sensor measures continuous river height (“river stage” or “gage height”)
- Develop mathematical relationship between discharge and stage (“rating curve”)



Ventura River Flow Measurement Challenges

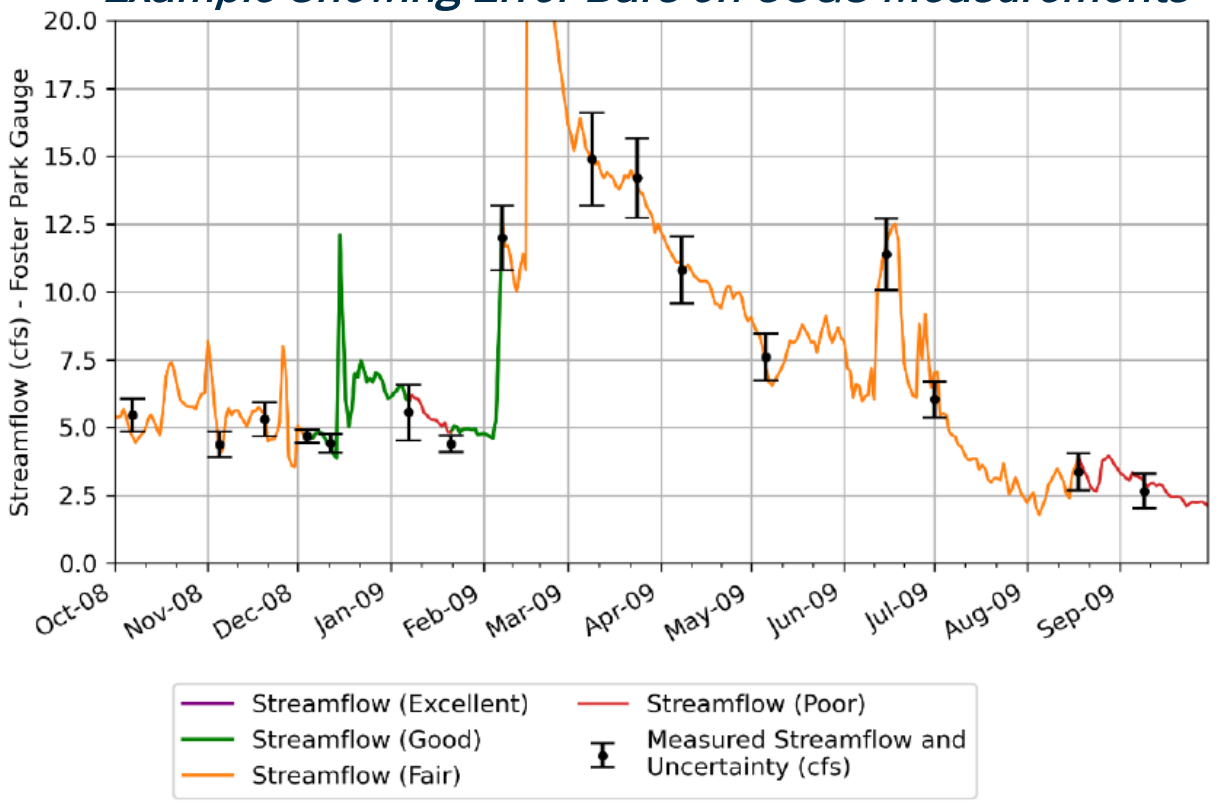




USGS Foster Park Gage Discharge Measurement Error

- Manual measurements of streamflow are difficult due to channel conditions and environmental factors
  - Measurement Rating System:
    - Excellent = 5% Error
    - Good = 5-10% Error
    - Fair = 10-15% Error
    - Poor = 15+% Error

Example Showing Error Bars on USGS Measurements



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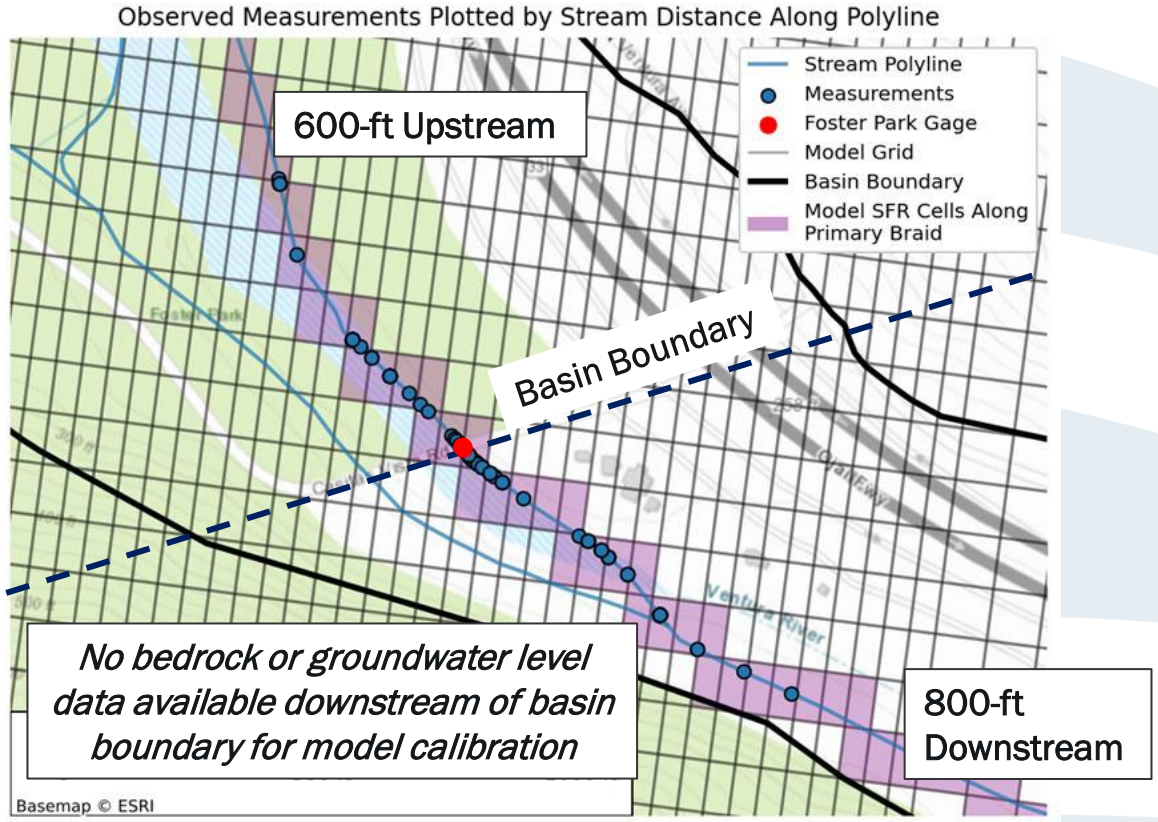
USGS Foster Park Gage Discharge Measurement Location Variability

- USGS rarely measures flow at stage recorder location
  - Rating curve represents flow at various locations, not the stage recorder location
  - Measurement locations change frequently
  - Many measurements at unspecified location

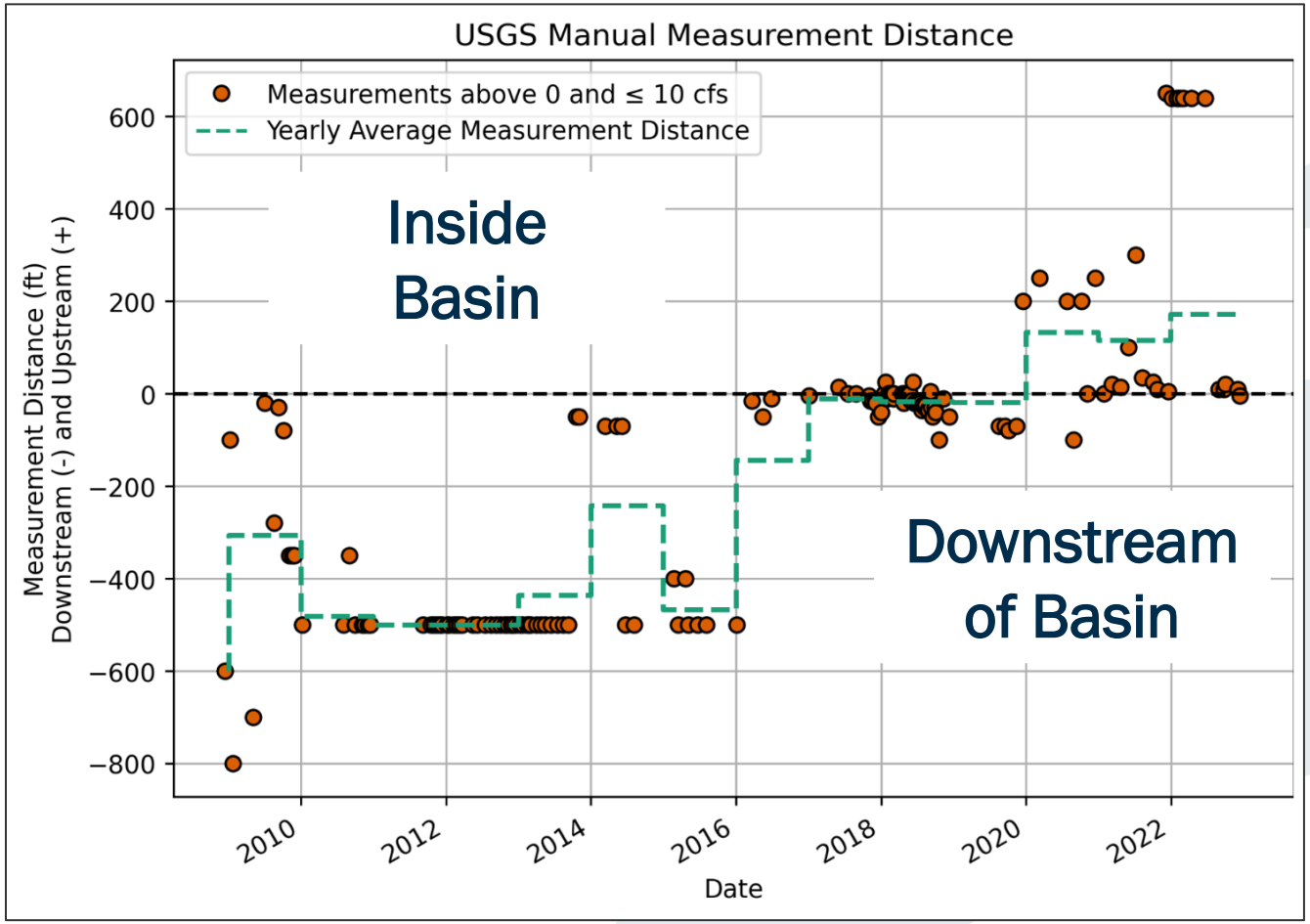
PROBLEM:

Model suggests that streamflow varies significantly upstream/downstream of stage recorder by as much as 5 cfs.

USGS Measurements Locations



USGS Foster Park Gage Discharge Measurement Location Variability (Continued)



- Most measurements during original calibration period for low flows were performed downstream of the gage or at an unknown location, but *no data are available for model calibration downstream of basin.*

- Measurements since calibration have been mostly upstream or at the gage (i.e., within basin), where we have data for model calibration.

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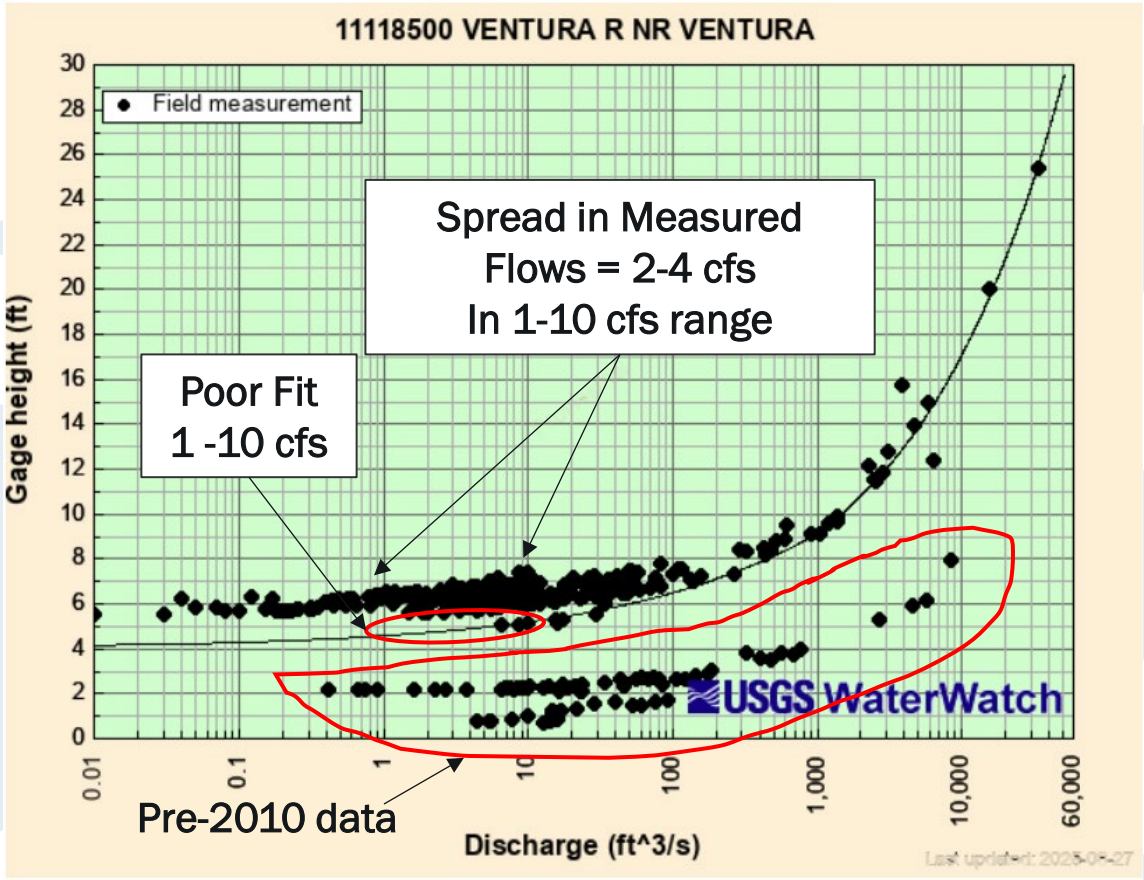
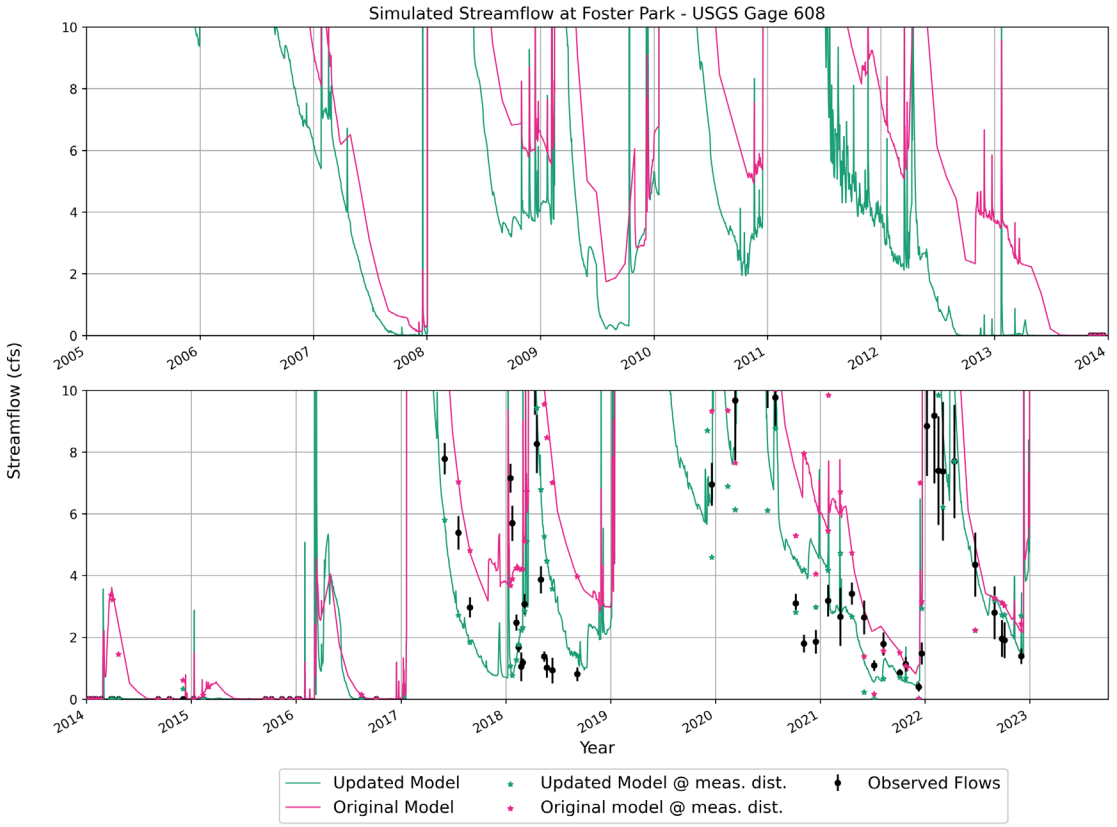
USGS Foster Park Rating Curve
Not Appropriate for Model Calibration Use

- Data do not represent flow at stage recorder
- Mixture of different measurement locations with variable flow bias:
  - Flows vary 2-4 cfs in range of most interest for GSP (i.e., 1 - 10 cfs)
- Curve has poor fit with data in flow range of most interest for GSP (i.e., 1 - 10 cfs)
- Significant change in rating curve observed starting in water year 2010



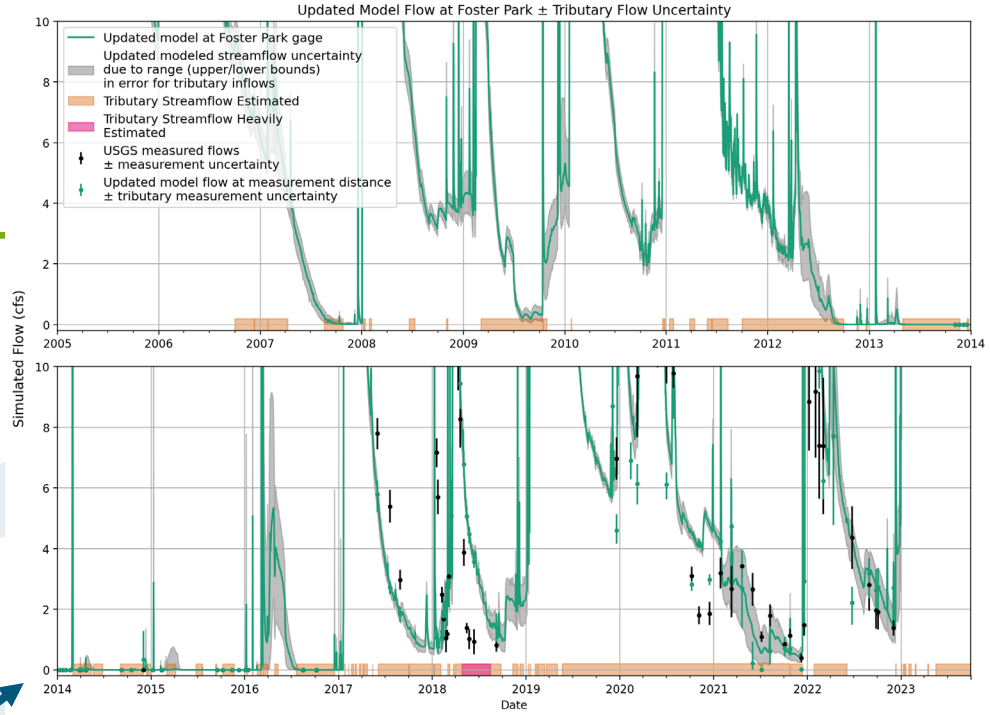
USGS Foster Park Model Calibration Dataset

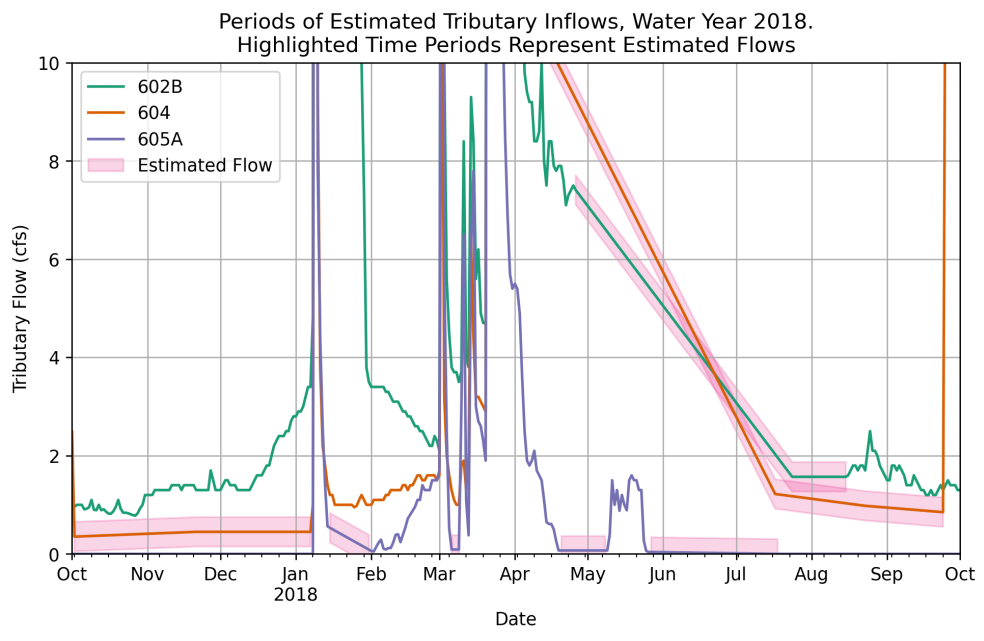
- Quantitative Calibration Evaluation:
  - Streamflow measurements located inside basin at known distances from stage recorder
    - Black dots on graphs
    - Bars account for measurement error
    - Significantly limits data for quantitative calibration evaluation
      - (66 measurements)
      - No data for prior to 2017
- Qualitative Calibration Evaluation:
  - Rating curve data used for qualitative calibration evaluation only



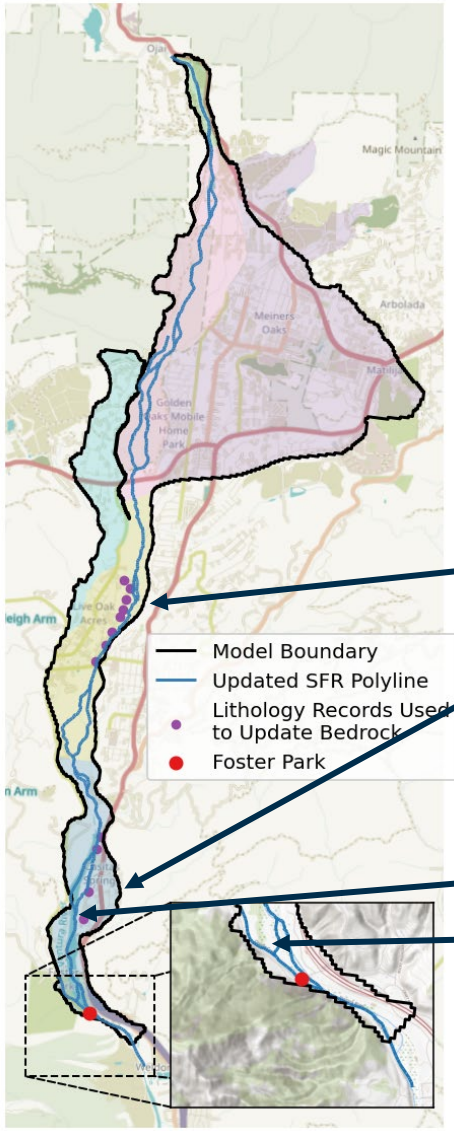
Evaluation of Ventura County Stream Gage Data

- County gages measure key inflows to basin
- Discharge measurements more frequent than USGS and near stage recorder
- Need continuous record for model input
  - Used rating curve data with error estimated based on manual measurement ratings
  - Periods of estimated data noted (orange and red band on upper chart)
    - Most estimated data appears reasonable
    - 2018 estimates have significant impact on model (2018)
      - Estimates do not follow expected baseflow recession curve





Summary of Model Updates Before Calibration Update



- **Model Updates**:
  - Model converted to 100% daily simulation
  - Groundwater pumping updated based on UVRGA well registration responses and flowmeter data
  - Streamflow data provisional data replaced with approved data
  - Bedrock depth updated in two areas with new data
  - Streambed slope corrections
  - Additional channel braid upstream of Foster Park to better represent Coyote Creek confluence

Model Calibration Update Approach

- Calibration Goal: Improve match to measured streamflow at Foster Park
  - Focus on baseflow recession and low-flow (<10 cfs) conditions at Foster Park
  - Focus period with usable Foster Park streamflow measurement (i.e. 2017+):
  - Included new groundwater level data to ensure model accuracy

- Performed sensitivity analysis to identify streambed and aquifer property inputs to model that impact calibration the most
  - Reduced calibration effort and helps quantify model uncertainty

- Performed model calibration using tool called PEST that helps automate the calibration process
  - Hundreds of simulations with different input parameter combinations

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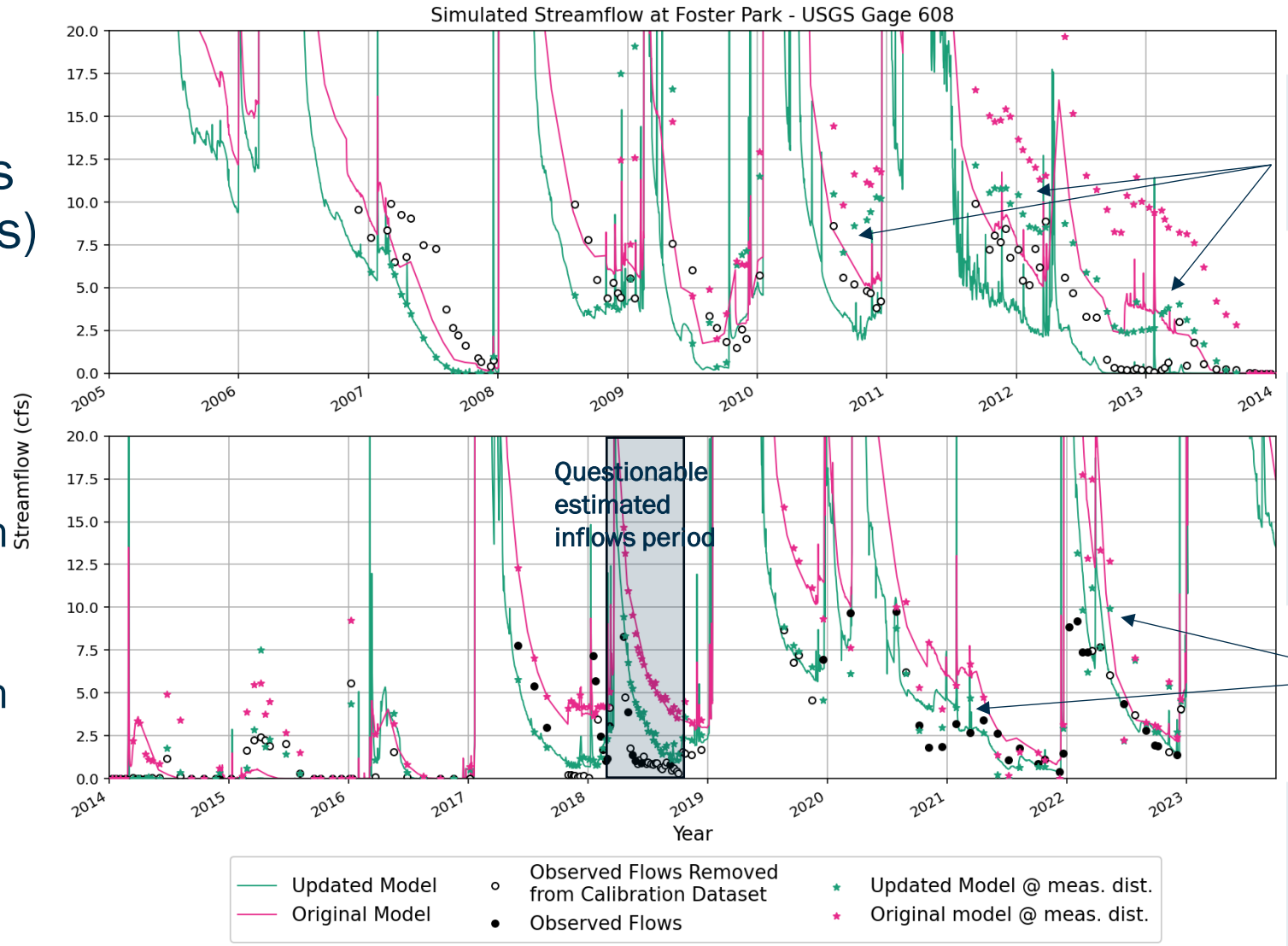
Calibration Results

1. Removed streamflow overestimation bias (green vs. pink lines)

2. Improved match to streamflow measurements
   a) Closer match with downstream measurements
   b) Closer match with measurements within basin

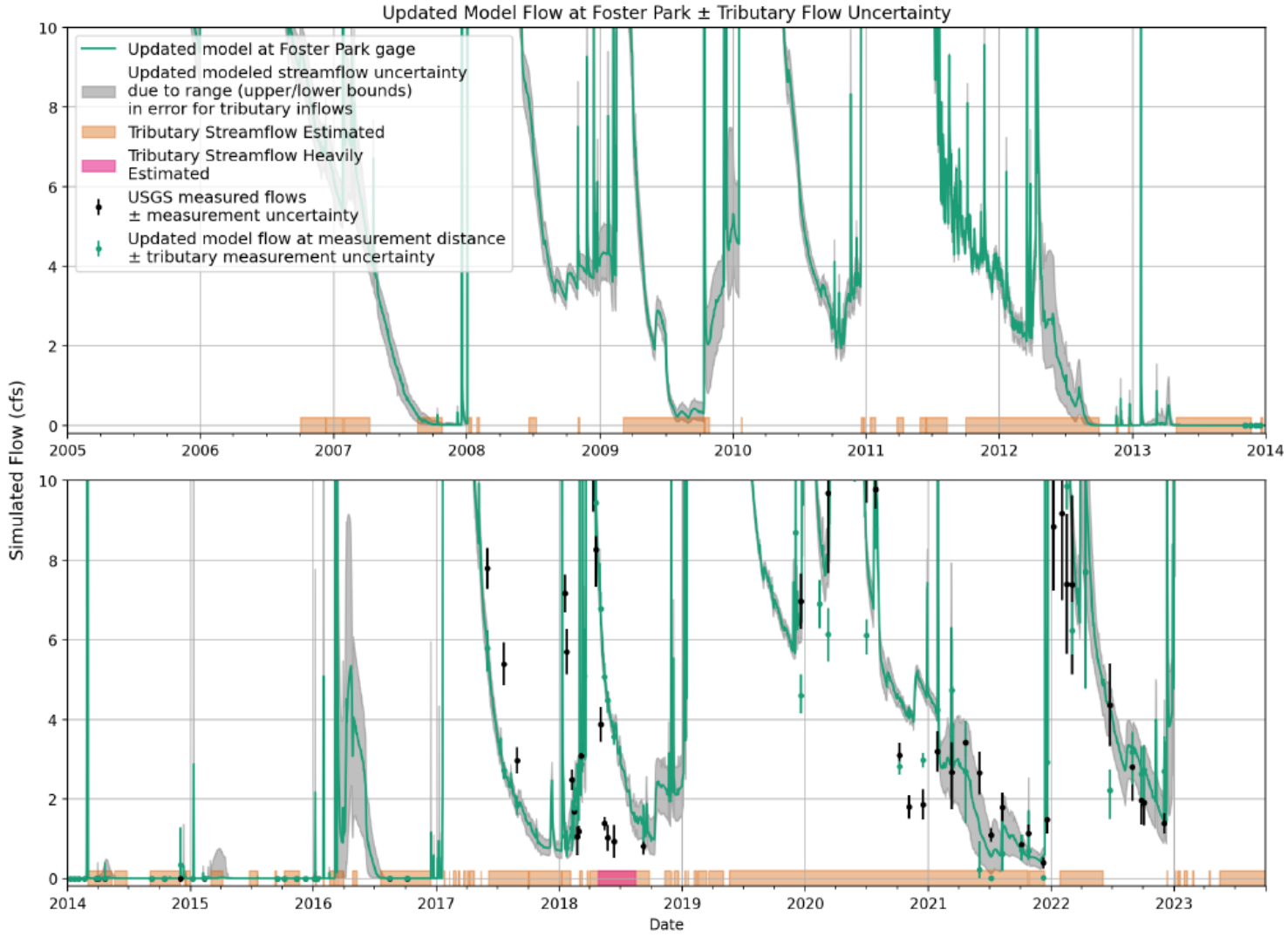


Improved match with measurements made downstream of basin

Improved match with measurements made inside basin

Evaluation of Tributary Inflow Uncertainty on Model Calibration

- Gray shading indicates impact of streamflow uncertainty on model calibration



Conclusions

- Changes to the Ventura River channel geometry did not materially impact the model.
- Model updates addressed several factors hindering the model's performance.
- Original model streamflow calibration was not representative because USGS Foster Park streamflow measurements were assumed to be at stage recorder location.
- Updated calibration:
  - Correctly accounts USGS streamflow measurement locations.
  - Only uses data that is appropriate for quantify model calibration.
  - Improved calibration to streamflow measurements, particularly at low flows relevant to GSP.
  - Preserves a good match to an expanded dataset of measured groundwater levels, although some areas could benefit from additional calibration.
- Estimated surface water inflows can significantly impact model calibration to USGS gage.

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Conclusions (continued)

- Although un-gaged tributary inflow uncertainty is large during storms, the uncertainty is small during the low-flow periods of interest to GSP.
- Very limited streamflow data for model calibration due to USGS Foster Park gage challenges – model calibration will need to be revisited as more data becomes available over time.
- Availability of bedrock depth information remains a significant limitation.

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Recommendations

- River discharge measurements should be consistent and well documented to support future model calibration efforts.
- Perform synoptic streamflow survey in Foster Park area in partnership with others.
  - Concurrent flow measurements at different locations to understand spatial variability in flow suggested by model.
- Coordination with stream gage operators, esp. USGS, is important.
- Continue pursuing UVRGA/DWR gage at Camino Cielo to reduce uncertainty in Matilija Creek inflows to basin.
- Quantify uncertainty in ISW depletion estimates (included in proposed Work Order No. 13).
- Seek opportunities to add more bedrock depth data, esp. in lower part of basin.
- Perform additional model calibration when significant new data becomes available.
  - Calibration of groundwater levels in northern part of basin could be improved now.

INTERA