San Pasqual Valley Groundwater Basin Sustainable Groundwater Management Act Handout #4

Sensitivity Analysis on Subsurface Inflow from Contributing Catchments

January 11, 2021

Draft Work Product

Subsurface Inflow Evaluation Approach

- A concern was raised during the 17-Dec TPR meeting regarding lack of subsurface inflow across no-flow boundaries from contributing catchments surrounding SPV GSP Model domain
- We evaluated five different ranges of subsurface inflow assumptions
  - 0%, 25%, 50%, 75%, and 100% of GW recharge estimated with Basin Characterization Model (BCM) over the historical 15-year calibration period (WY2005 thru WY2019)
  - We assigned monthly subsurface inflows as specified fluxes along the associated domain boundary cells in Model Layers 3 and 4 (deeper bedrock layers)
- Evaluated impacts of these boundary inflows to…
  - GW-level hydrographs at target wells within SPV GW Basin
  - Modeled outflows to Lake Hodges
  - Modeled GW pumping rates at ag wells within SPV GW Basin
  - Modeled change in Basin GW storage during calibration period

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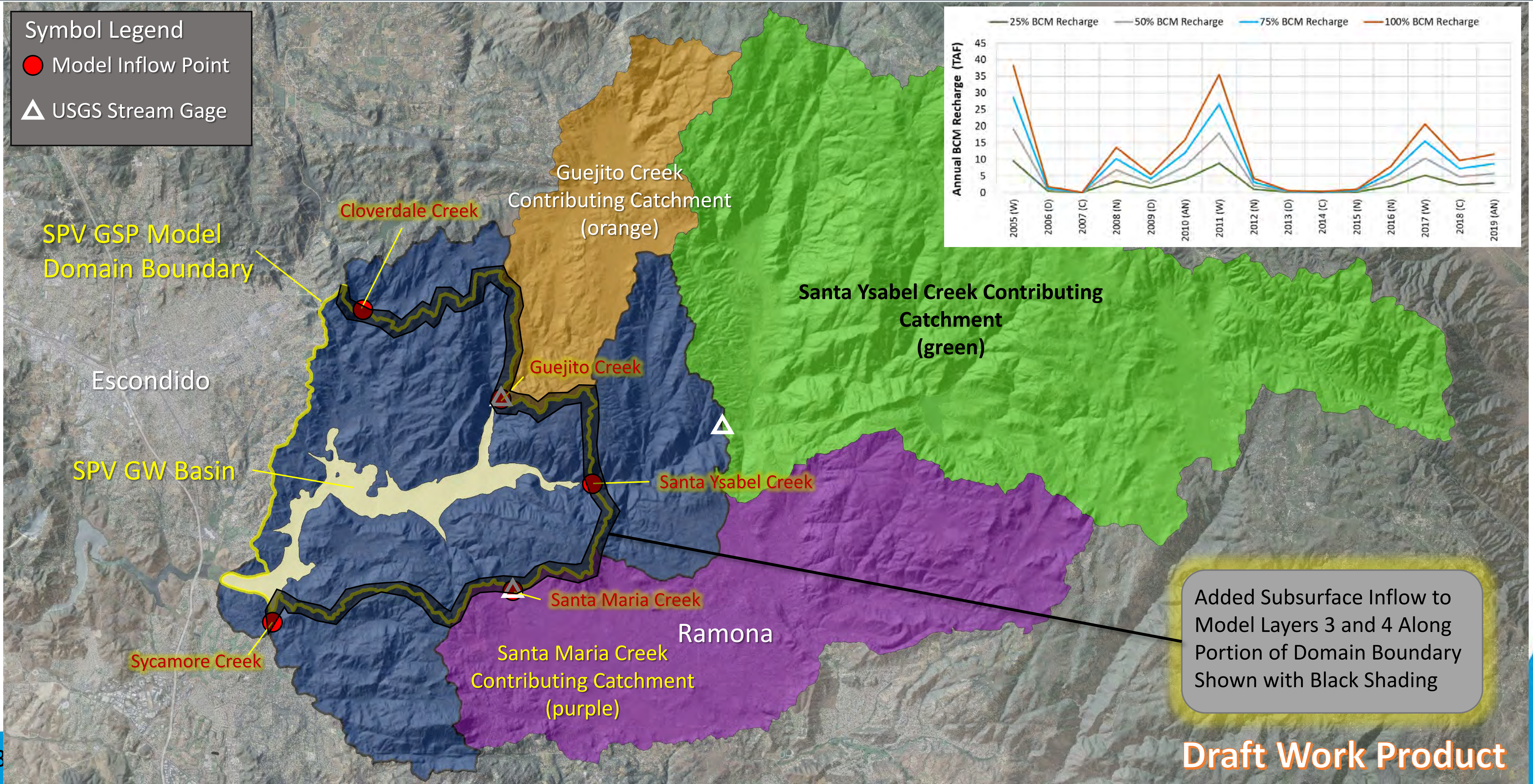
Graphical Depiction of Subsurface Inflow Approach



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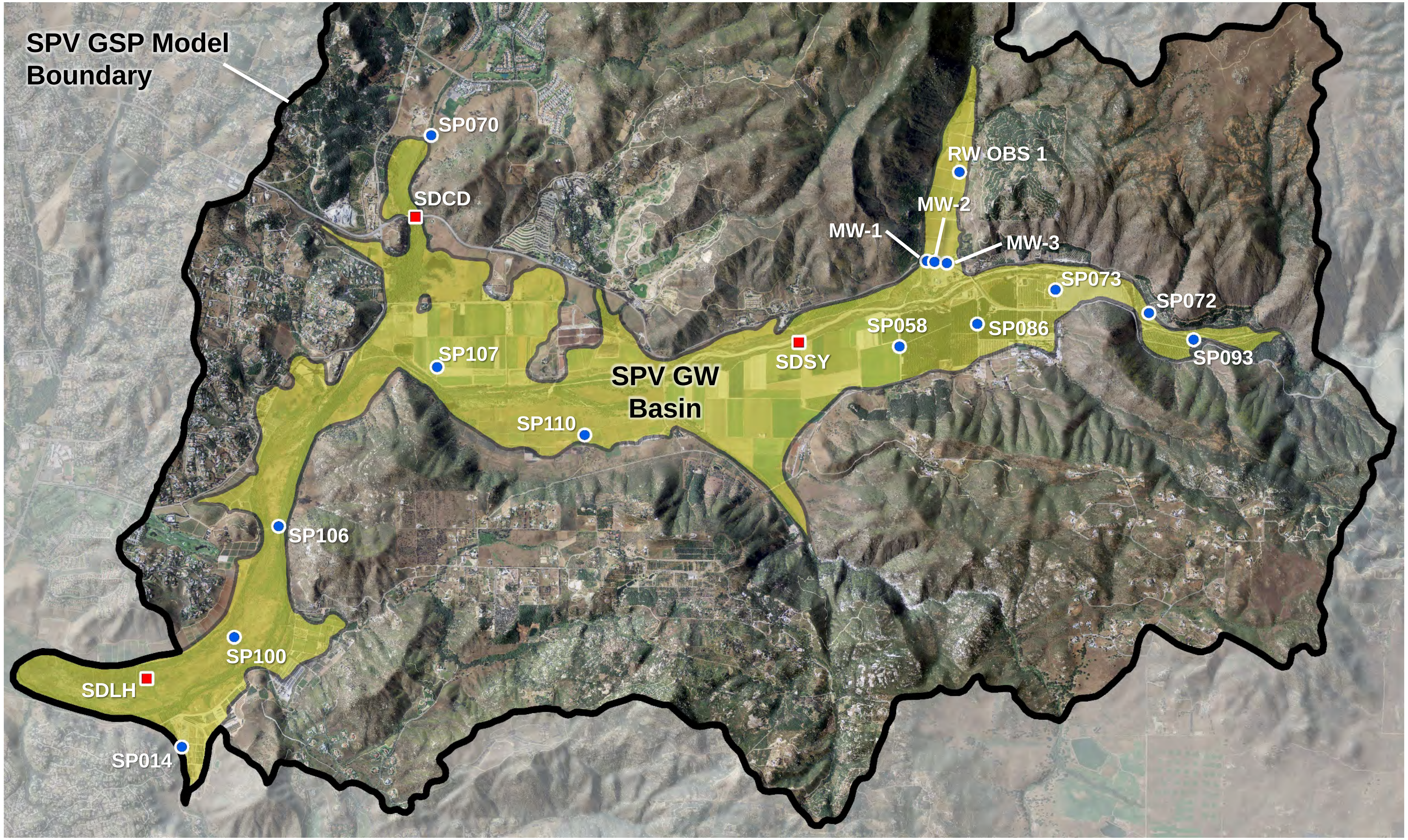
Groundwater-level Hydrographs

Calibration Target Well Locations



Calibration Target

- Single-completion Target Well Location (count=15)
- Multi-completion Target Well Location (count=3)

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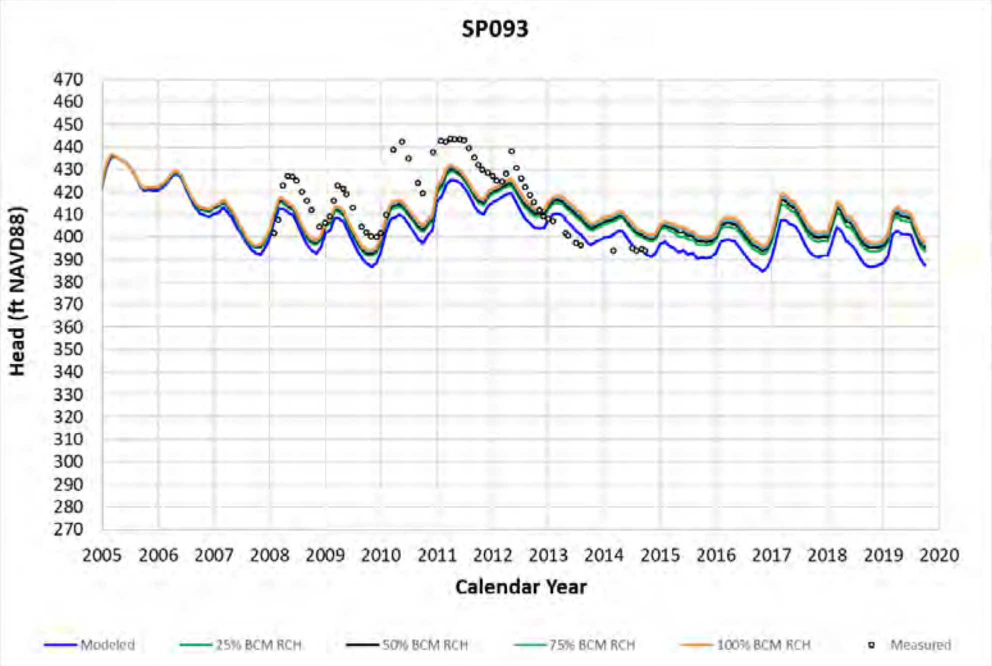
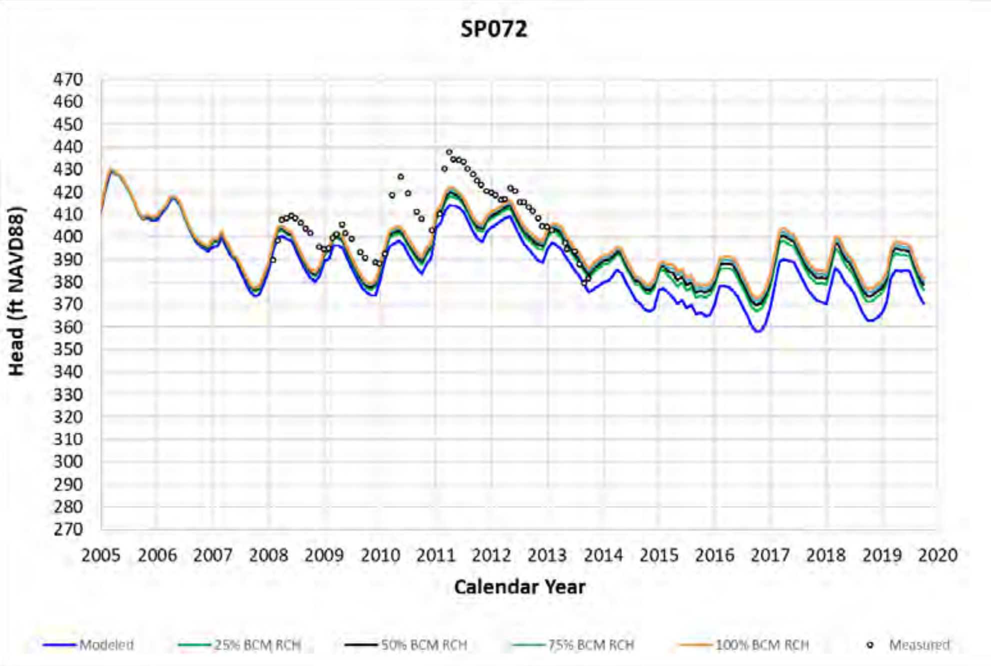
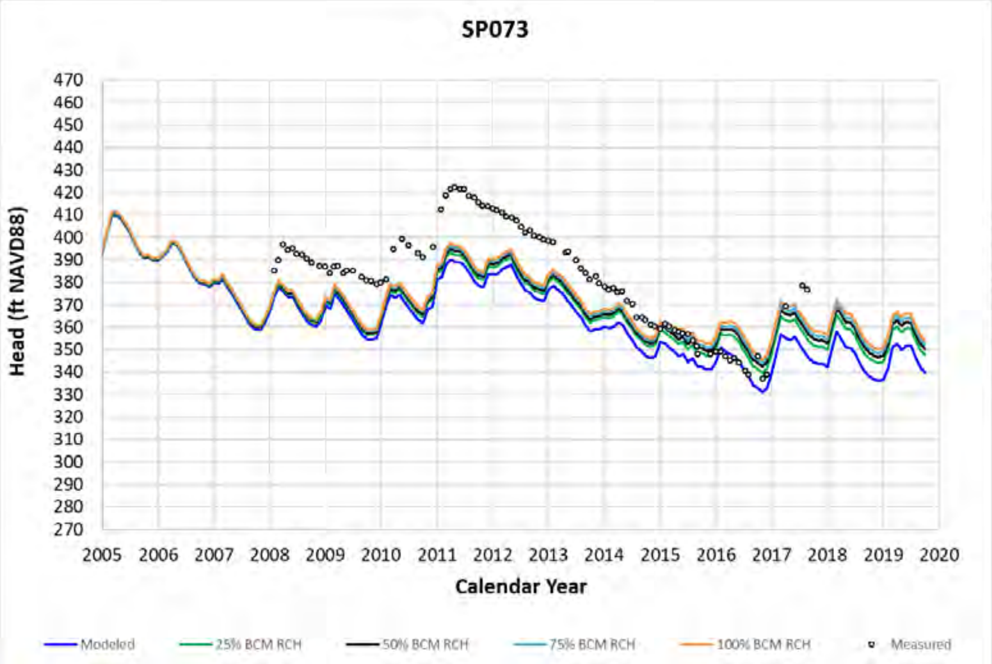
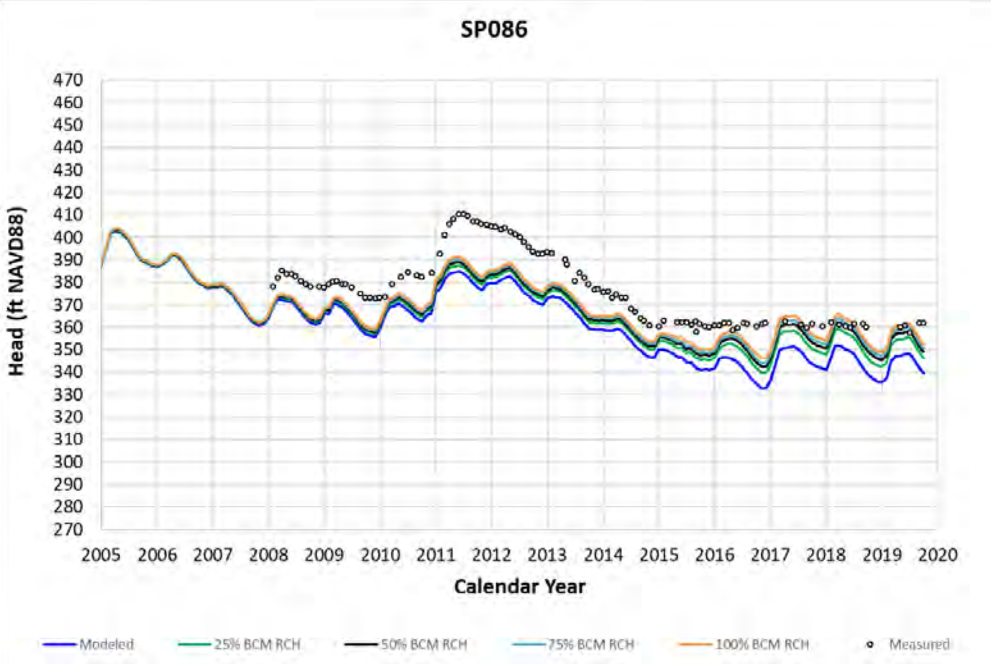
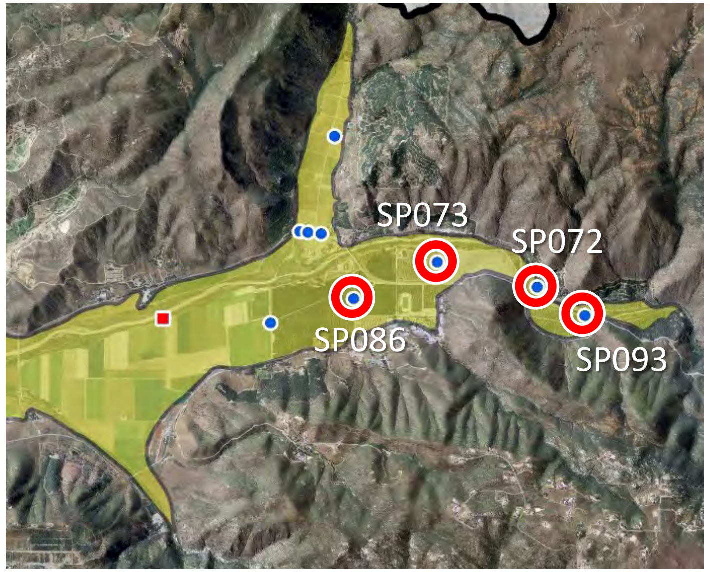
Sensitivity Analysis: East Santa Ysabel Area











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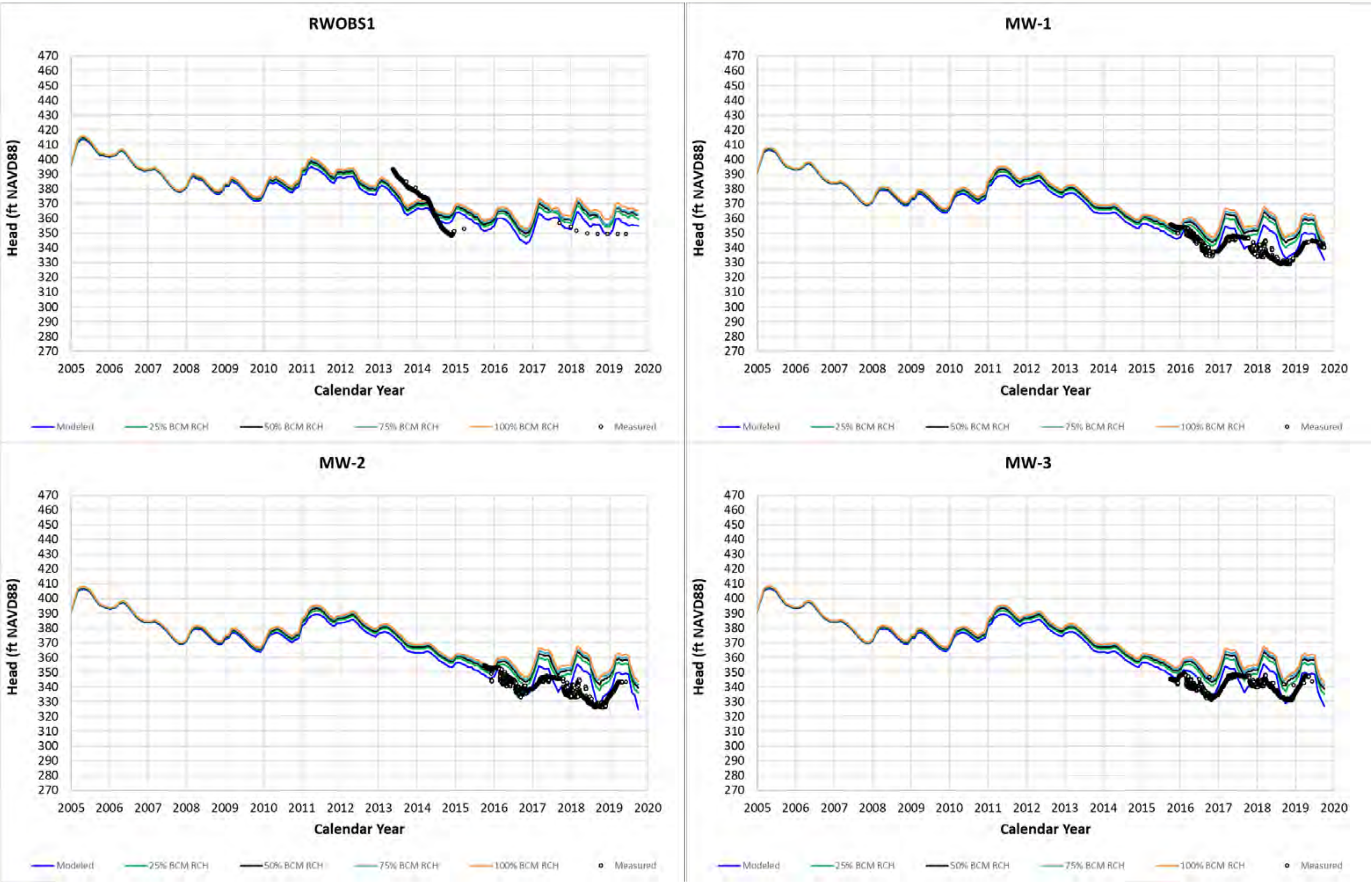
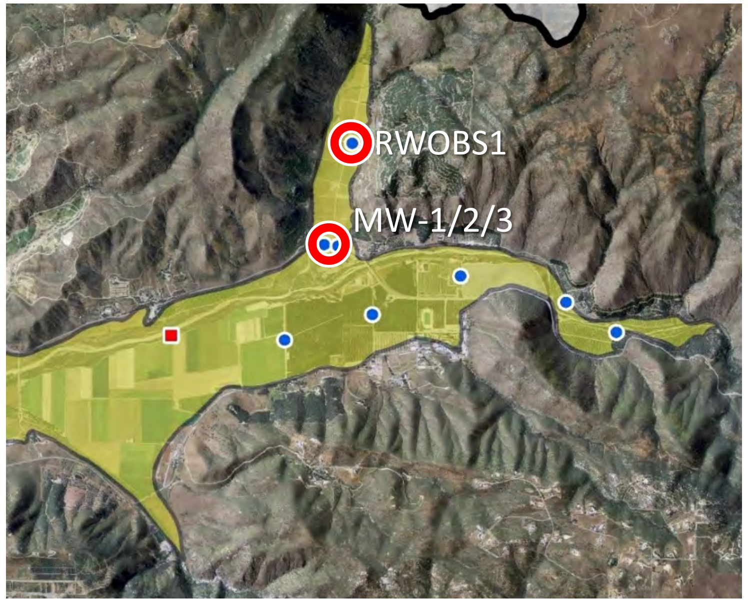
Sensitivity Analysis: Rockwood Canyon





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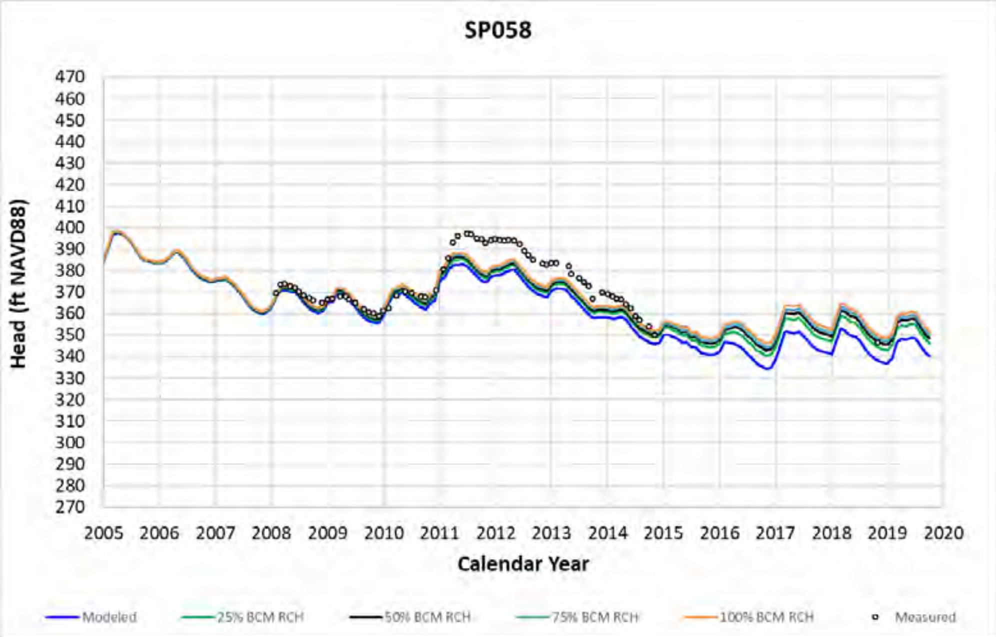
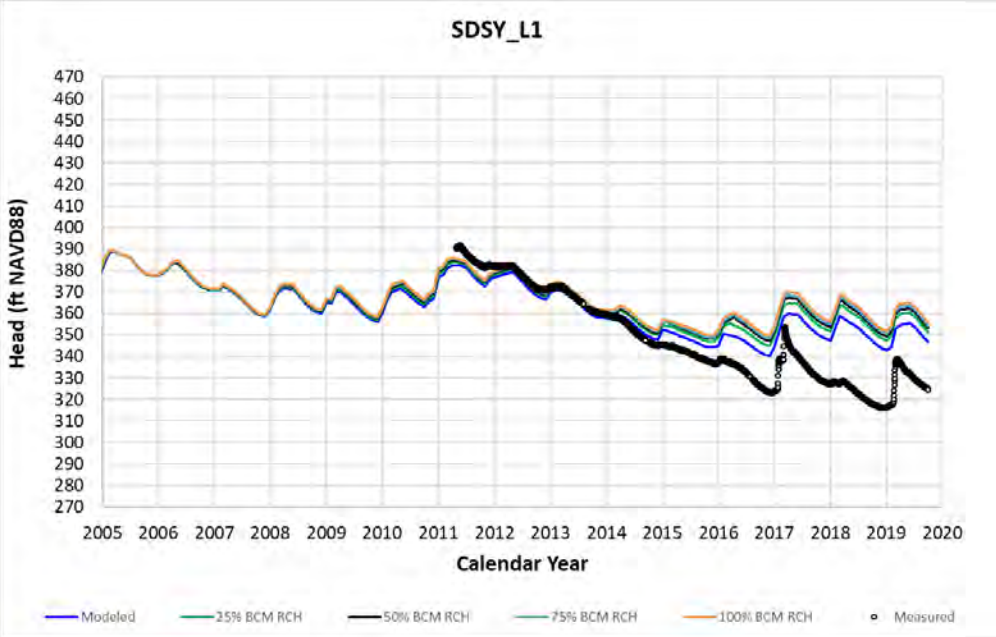
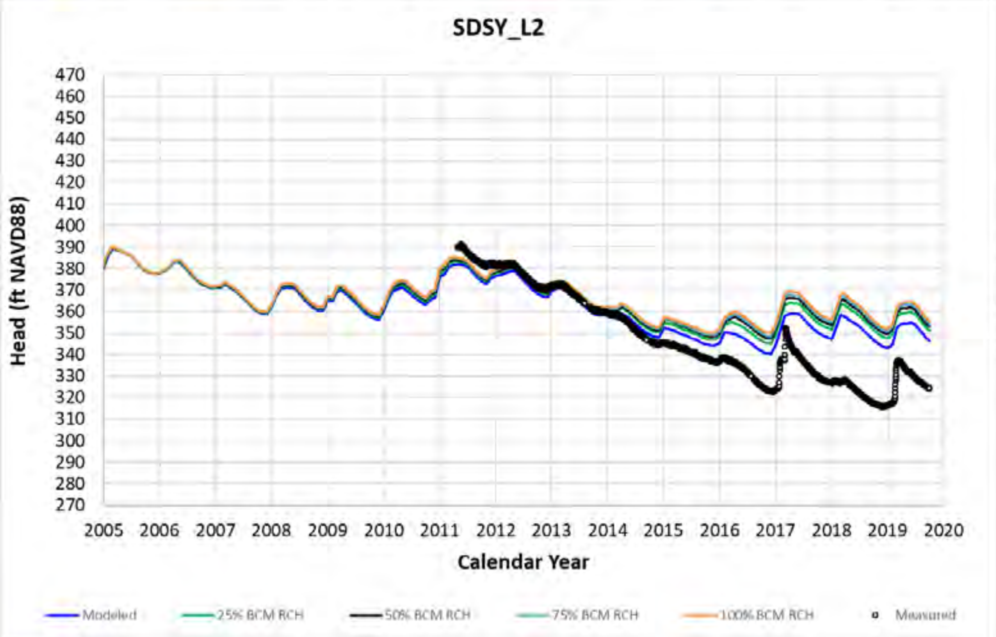
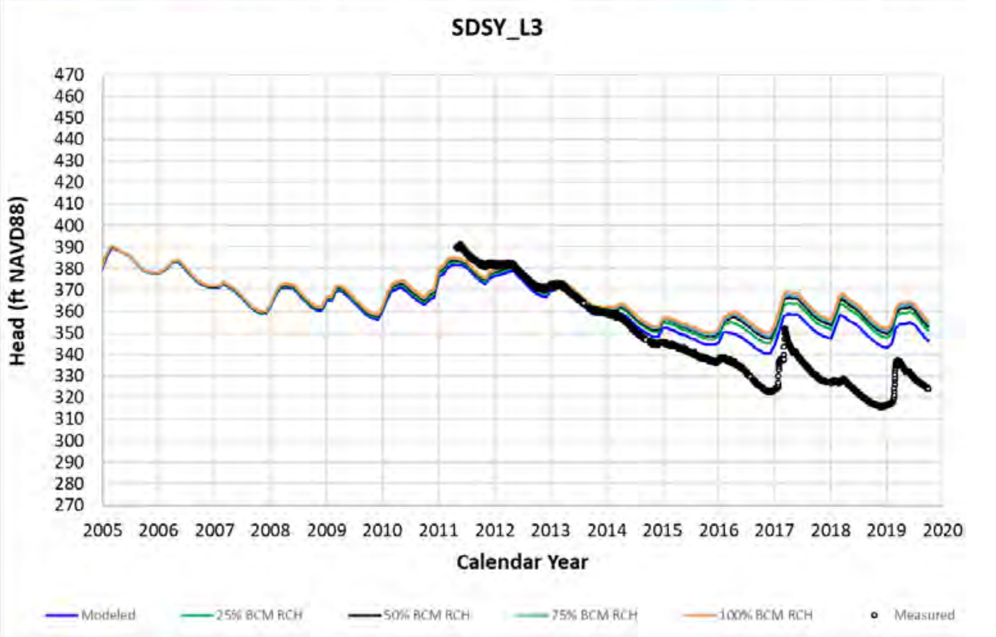
Sensitivity Analysis: Central Santa Ysabel Area









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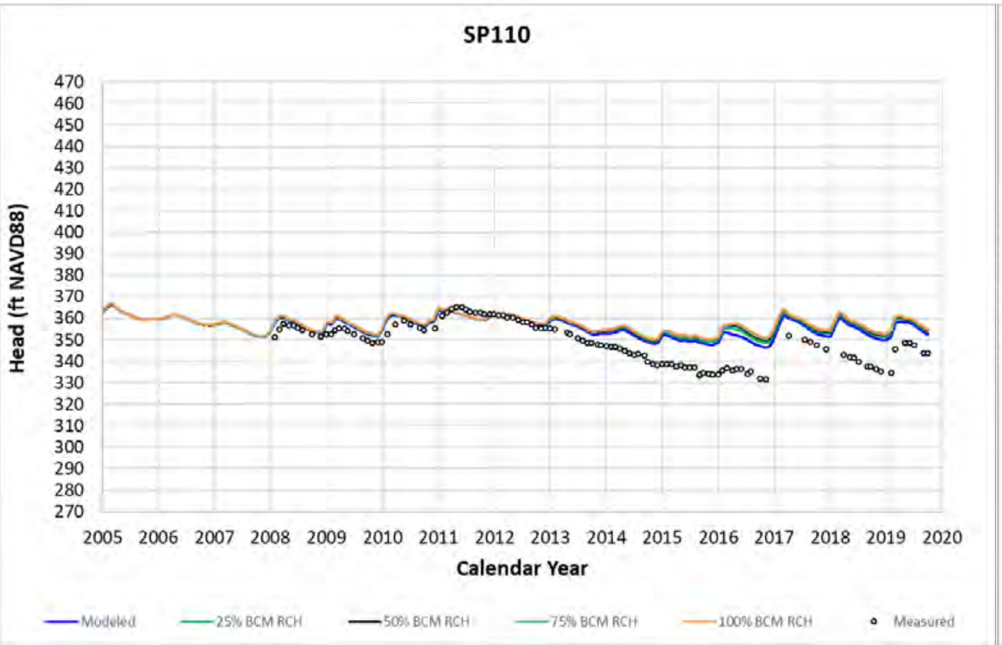
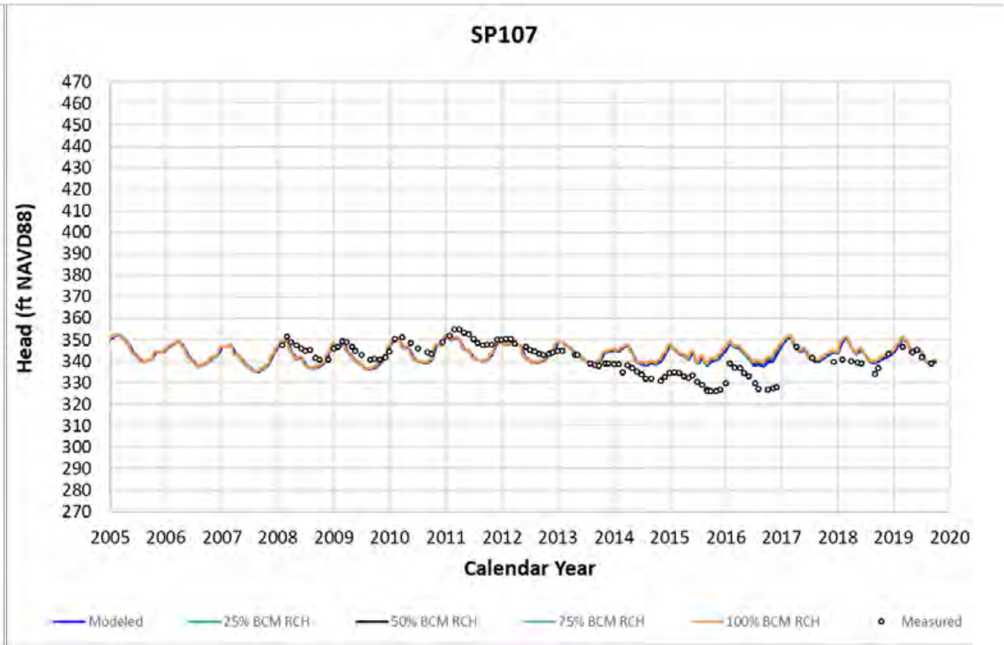
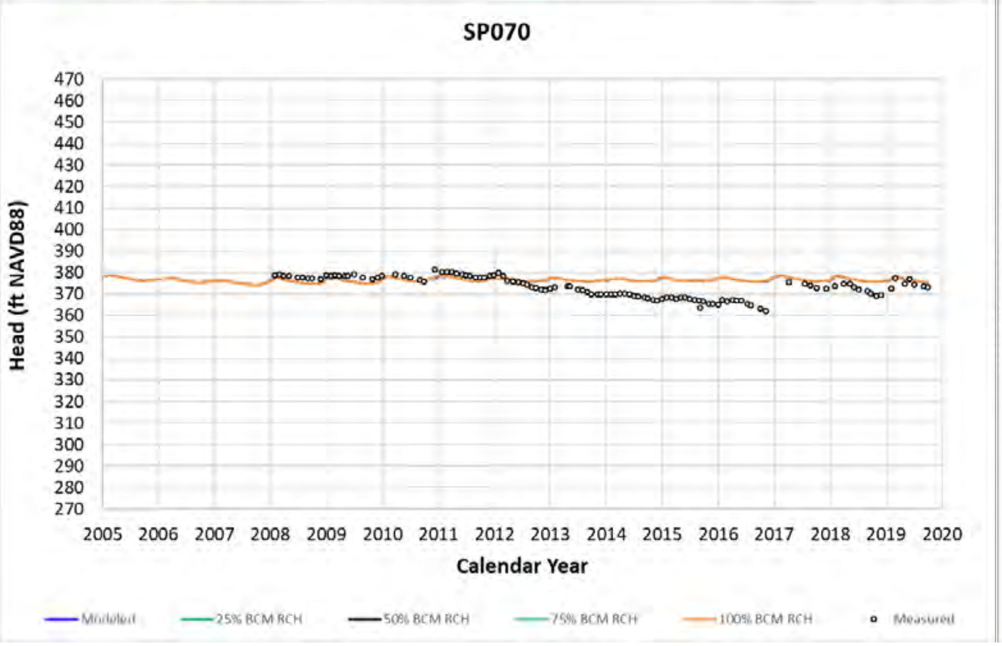
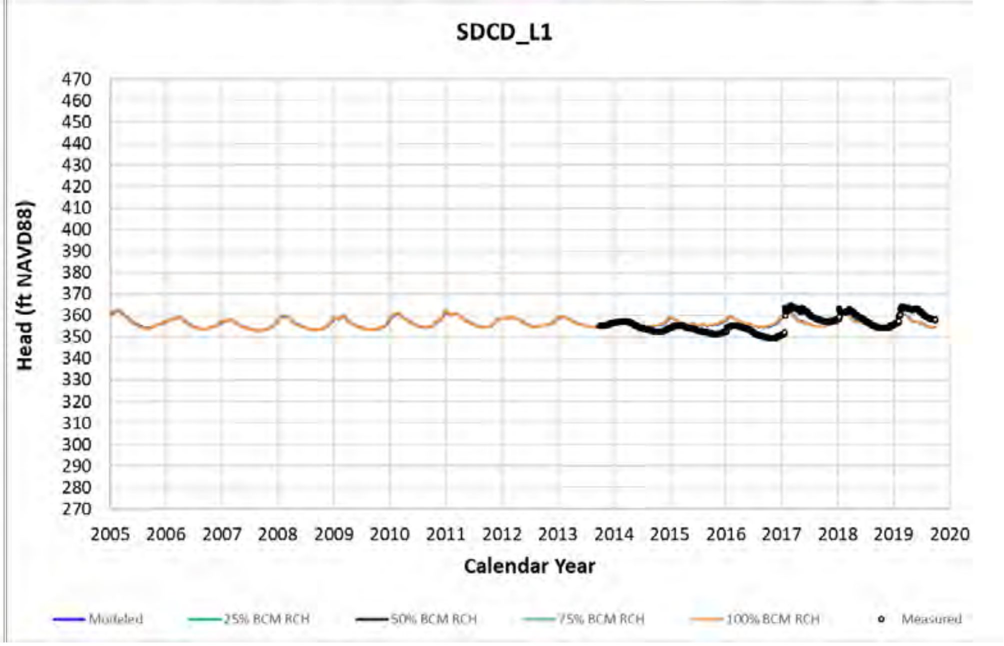
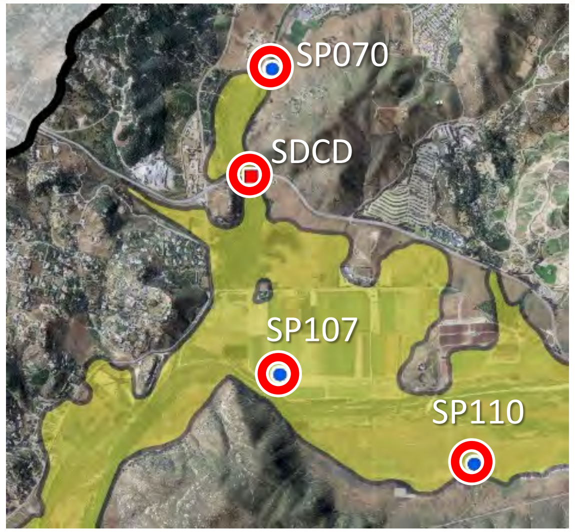
Sensitivity Analysis: San Dieguito & Cloverdale Areas











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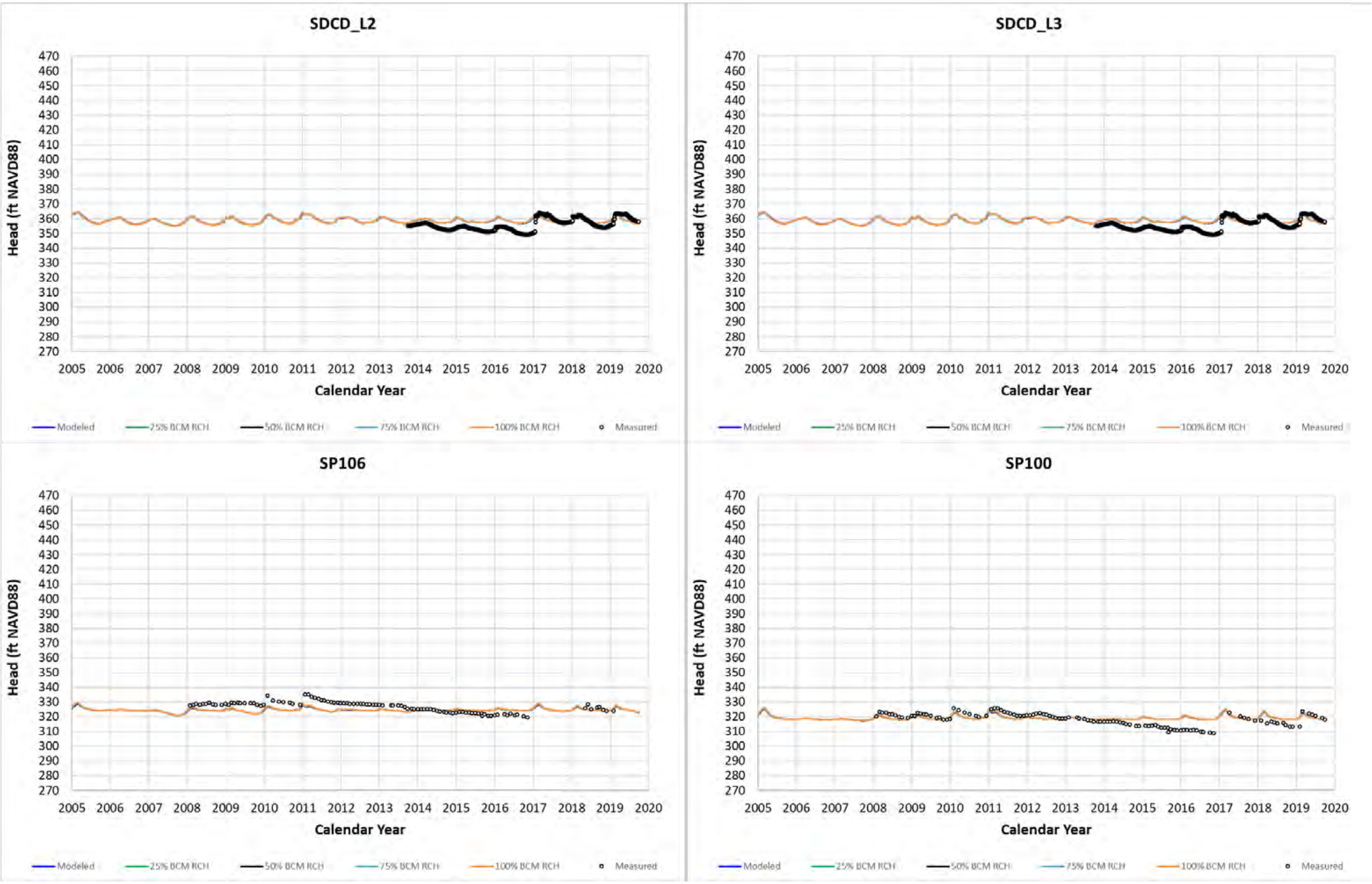
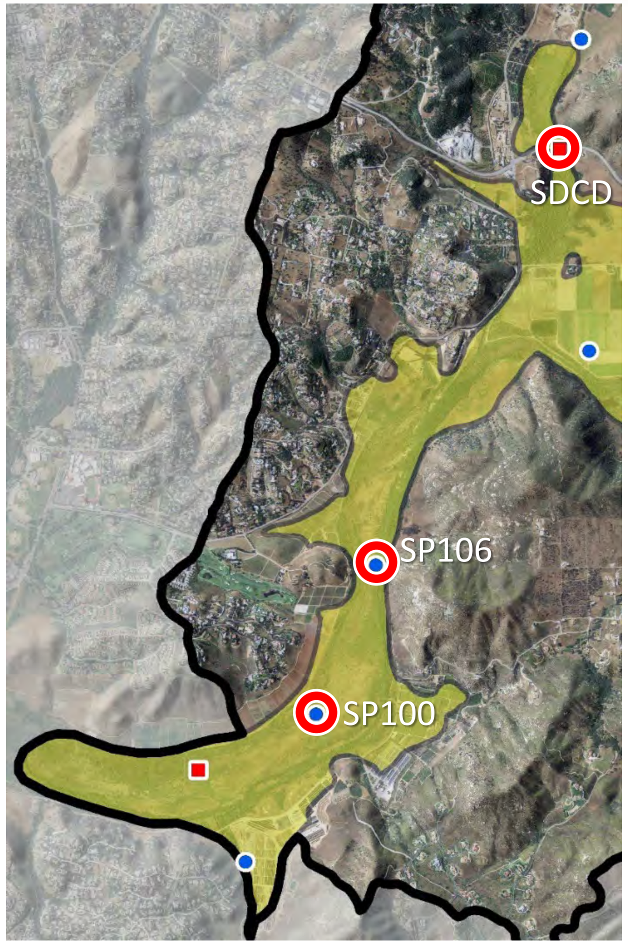
Sensitivity Analysis: Cloverdale and Narrows





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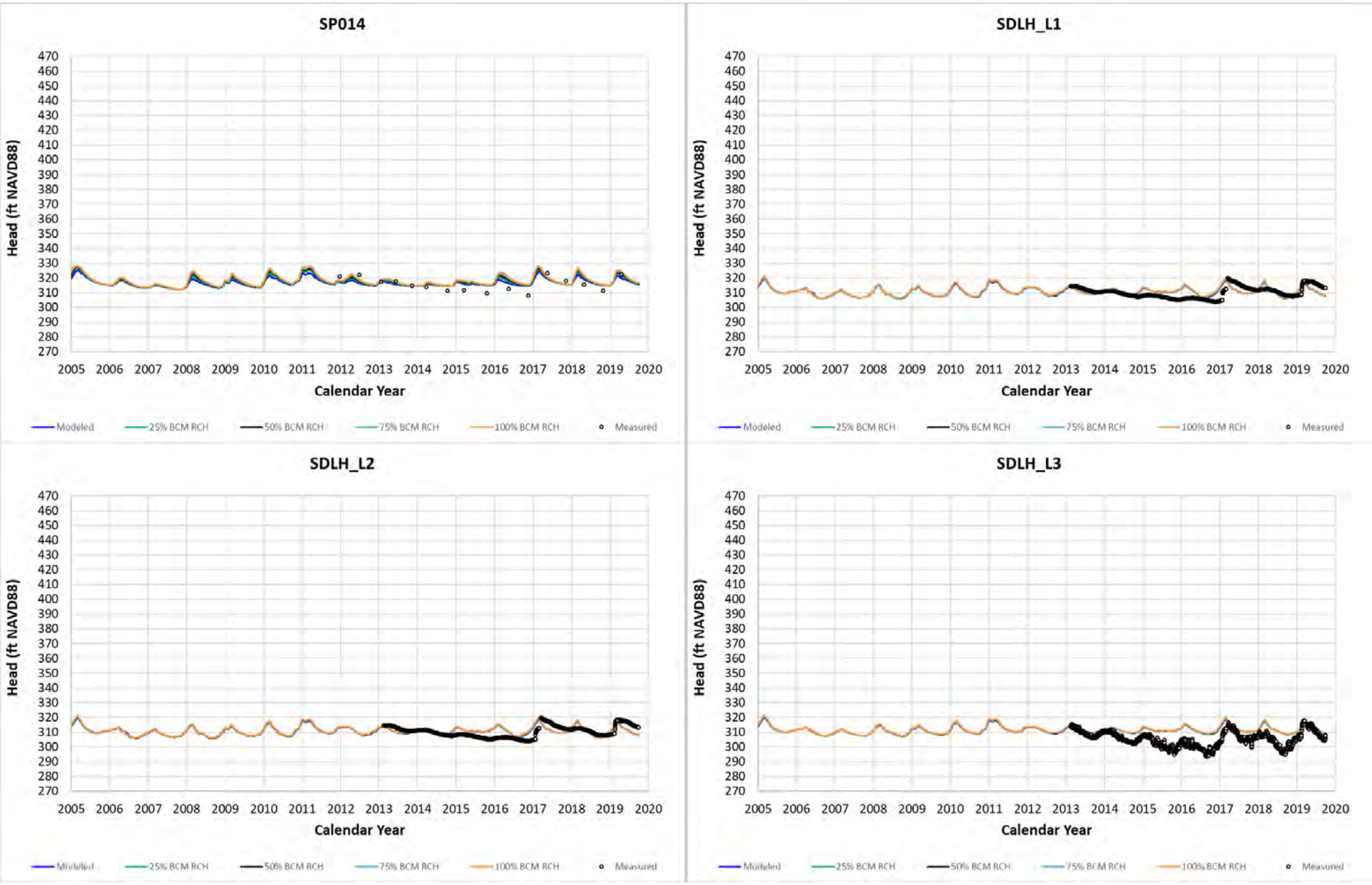
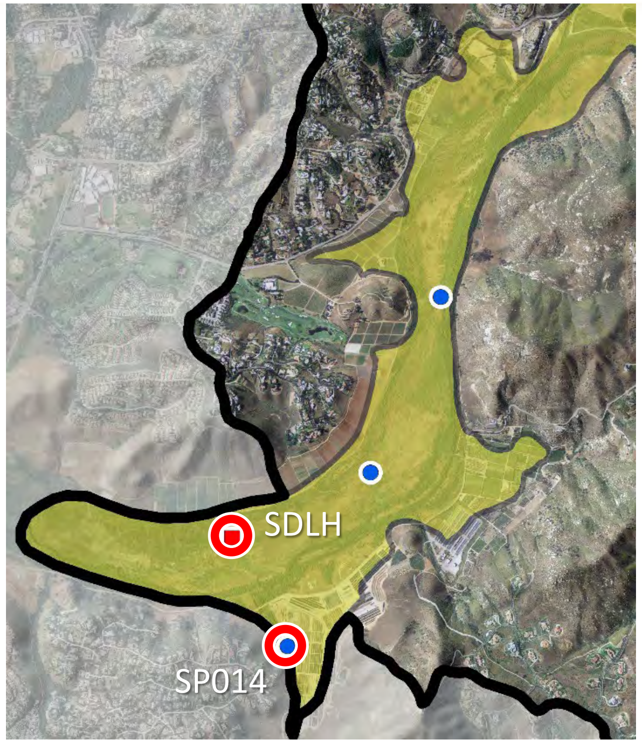
Sensitivity Analysis: San Dieguito Near Hodges





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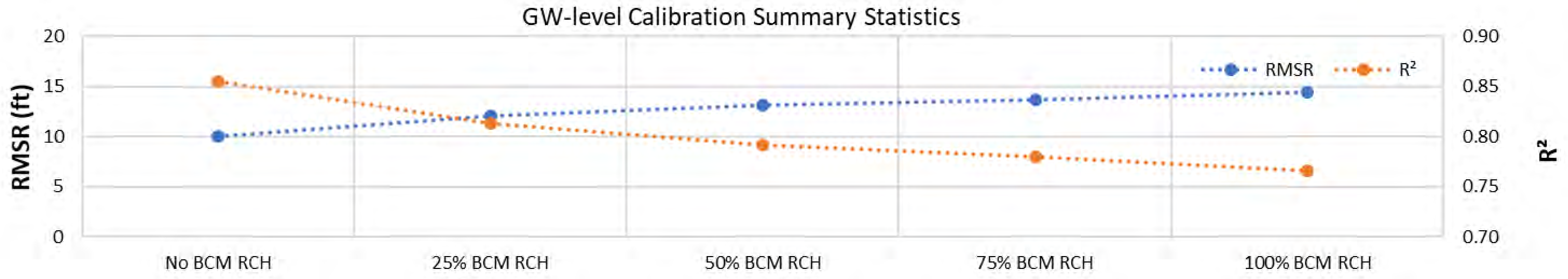
Sensitivity Analysis Outcome: Hydrographs

- GW-level hydrographs in the eastern Basin are more sensitive to inclusion of subsurface inflow than hydrographs in the western Basin; however, general trends in GW levels among sensitivity simulations are similar
- Global calibration statistics indicate increasingly worse fits with greater percentages of subsurface inflow from contributing catchments outside the domain



RMSR = root mean squared residual

- However, locally GW-level hydrographs in eastern Santa Ysabel portion of Basin at SP093, SP072, SP073, & SP086 more closely match observations with increased subsurface inflow from contributing catchments

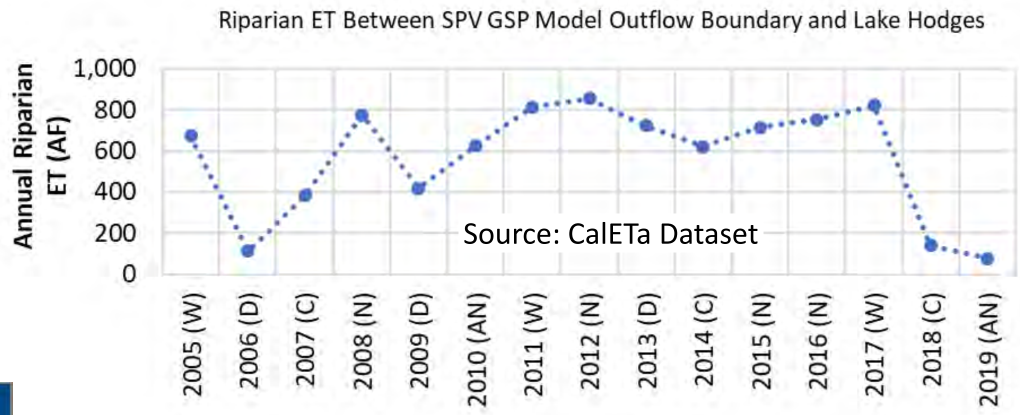
Modeled Outflows to Lake Hodges

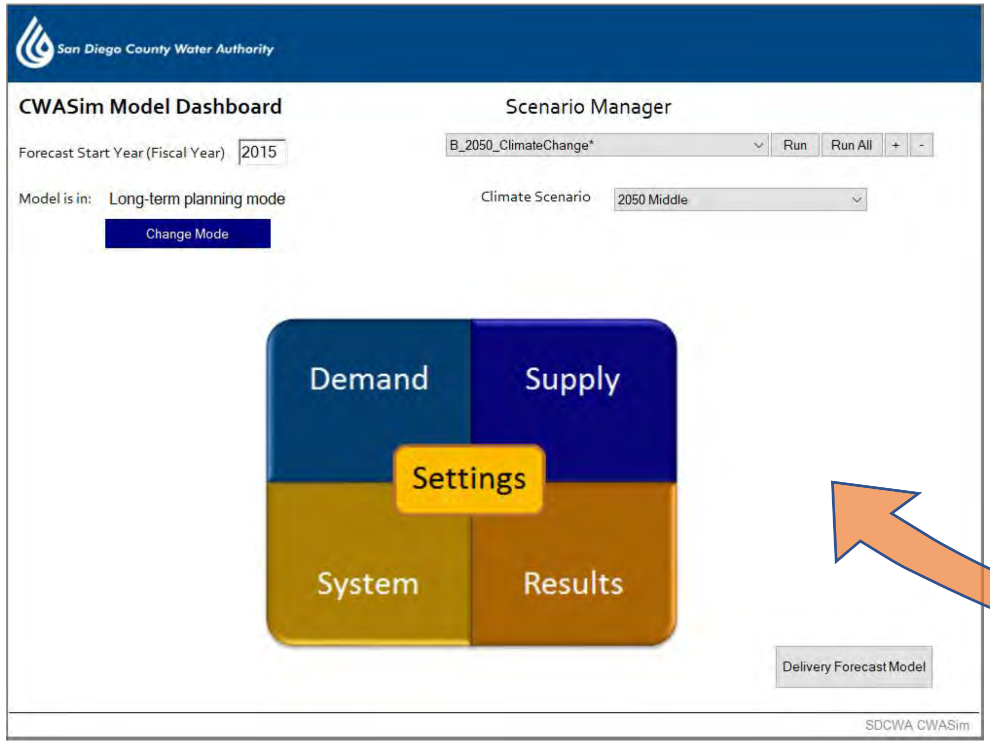
The City of SAN DIEGO

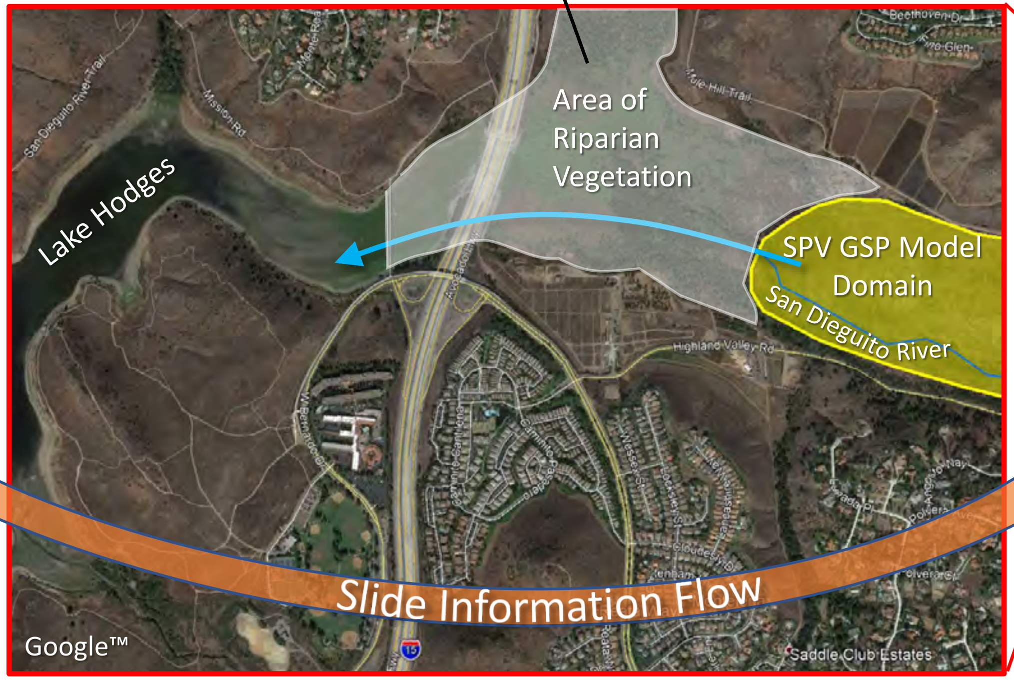
Outflow Estimates to Lake Hodges (LH): Considerations

LH Inflow = SPV GSP Model SW & GW outflow + Other SW & GW inflows (downgradient from SPV GSP Model) + LH Precip – Riparian ET – LH Evaporation – LH Withdrawals – LH Releases

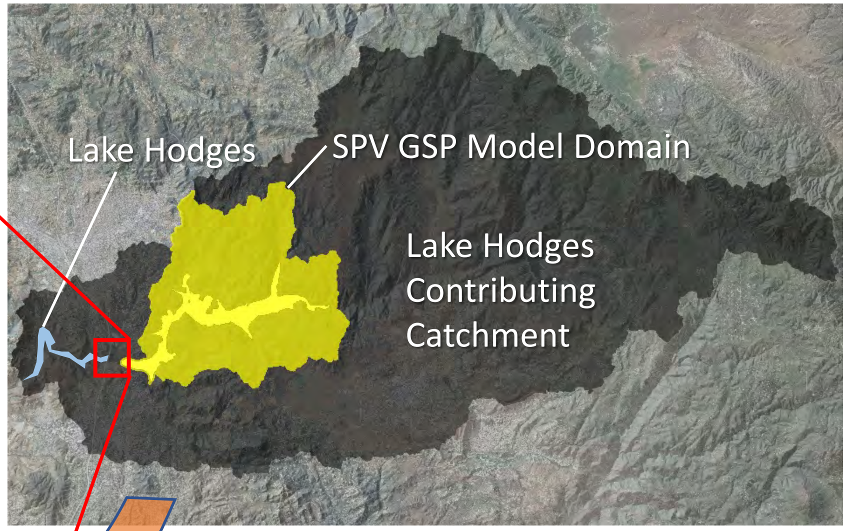
San Diego Water Authority has compiled local surface water supply data at inflow locations to reservoirs. These inflows were extended from 1990 through 2011 as part of the 2013 Regional Water Facilities Optimization and Master Plan (2013) and used in the CWASim model, regional planning tool. Recently, this model has been updated and used in the San Diego Basin Study (2019).







Subarea Map Near Lake Hodges



Regional Catchment Map

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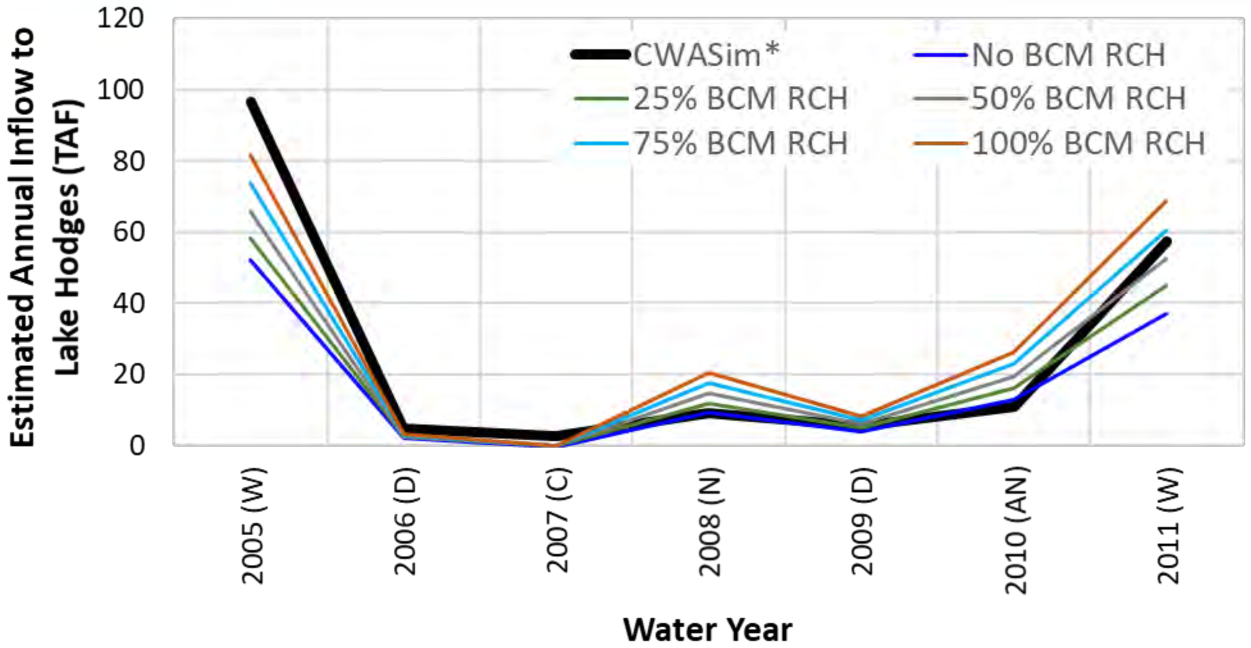
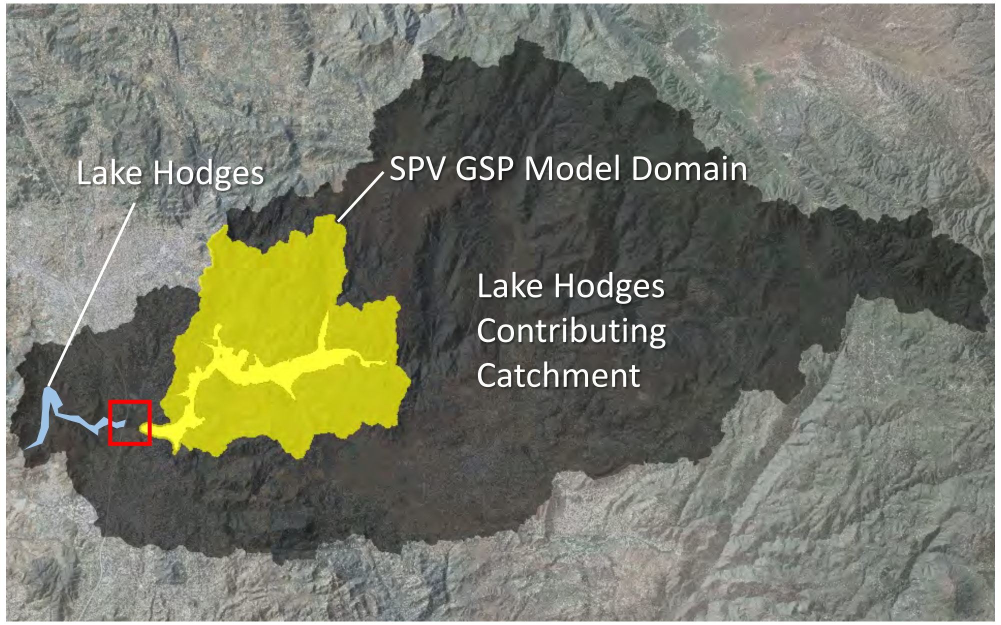
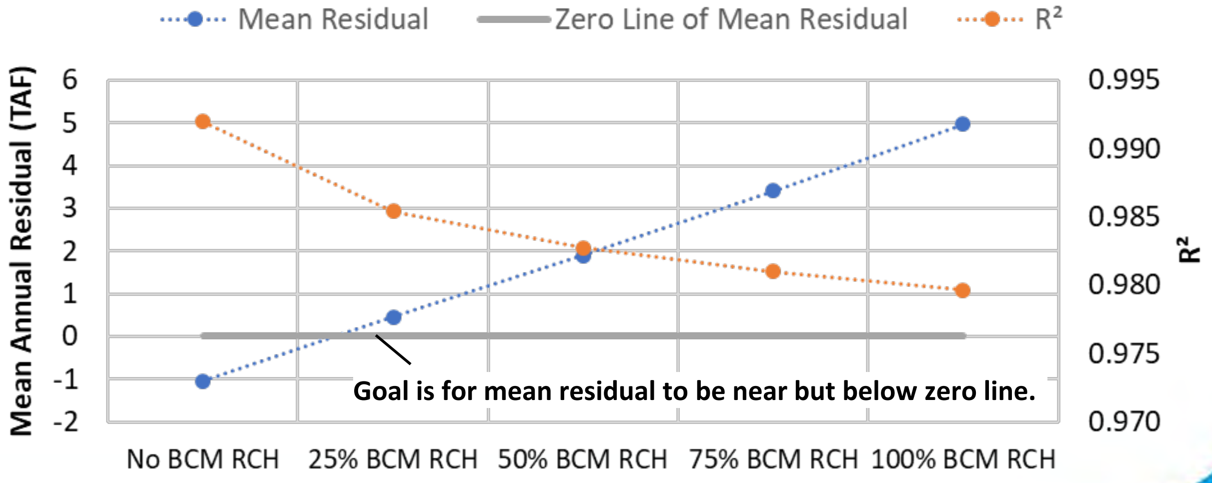
Sensitivity Analysis Outcome: Lake Hodges Inflows



* Model reservoir inflow data provided by SDWA thru 1990 and extended thru 2011 by (CH2M-B&V). 2013 Master Plan Appendix F San Diego Region Hydrology Extension. Reference: https://www.sdcwa.org/sites/default/files/files/master-plan-docs/05_2013_Master_Plan_Appendices.pdf



2006 thru 2010 Fitting Statistics for LH Inflows as Compared with CWASim



Goal

For outflow from SPV GW Model minus riparian ET (inflow to Lake Hodges) to come close to, but not exceed the non-wet CWASim estimates for inflows to Lake Hodges.

Outcome

≤ 25% BCM recharge simulations provide best statistical match to CWASim estimates of Lake Hodges inflows during non-wet years, while meeting the goal stated above.

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Modeled Ag Pumping Rates within SPV GW Basin

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Sensitivity of Ag Pumping to Subsurface Inflow Simulations

Water Year[a]	No BCM Recharge (AF)	25% BCM Recharge (AF)	50% BCM Recharge (AF)	75% BCM Recharge (AF)	100% BCM Recharge (AF)
2005 (W)	4,928	4,928	4,924	4,924	4,924
2006 (D)	5,881	5,881	5,878	5,877	5,877
2007 (C)	6,739	6,739	6,738	6,738	6,736
2008 (N)	5,936	5,936	5,936	5,936	5,936
2009 (D)	6,482	6,482	6,485	6,485	6,480
2010 (AN)	5,293	5,293	5,293	5,292	5,291
2011 (W)	4,752	4,750	4,749	4,749	4,748
2012 (N)	5,574	5,573	5,573	5,573	5,573
2013 (D)	6,351	6,353	6,354	6,354	6,354
2014 (C)	5,897	5,864	5,865	5,866	5,866
2015 (N)	5,419	5,389	5,390	5,391	5,392
2016 (N)	5,593	5,577	5,580	5,581	5,581
2017 (W)	6,005	5,977	5,977	5,971	5,963
2018 (C)	6,661	6,681	6,680	6,676	6,680
2019 (AN)	6,503	6,507	6,511	6,511	6,510

Historical Average (2005–2019)	5,868	5,862	5,862	5,862	5,861
Current Average (2015–2019)	6,036	6,026	6,028	6,026	6,025

[a] Water year types are shown in parentheses and defined as follows: W=wet, AN=above normal, N=normal, D=dry, and C=critically dry.

BCM = Basin Characterization Model

Modeled ag pumping rates are not sensitive to the range of subsurface inflow rates we evaluated (<0.2% difference among sensitivity simulations)

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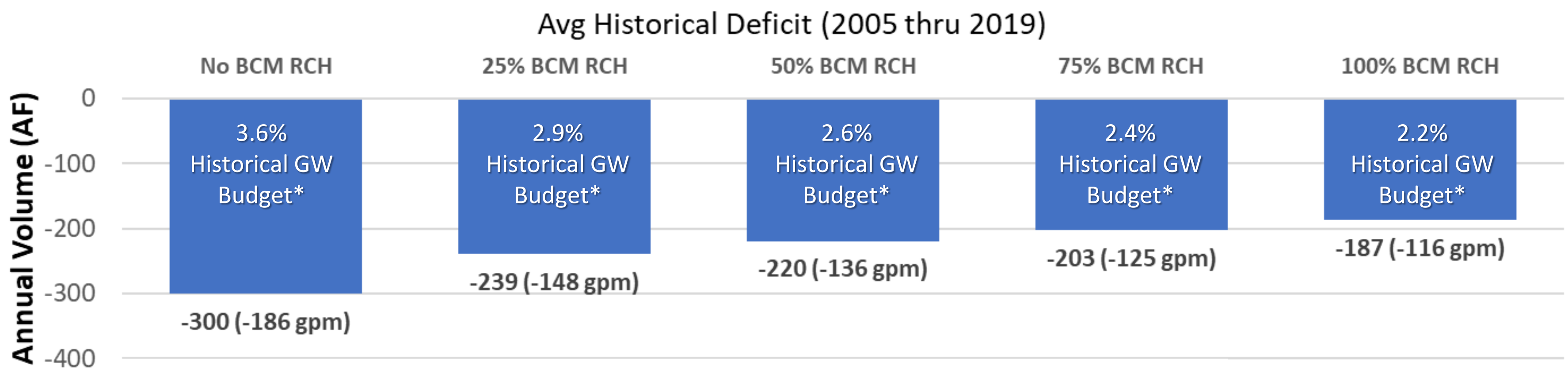
Modeled Change in GW Storage within SPV GW Basin

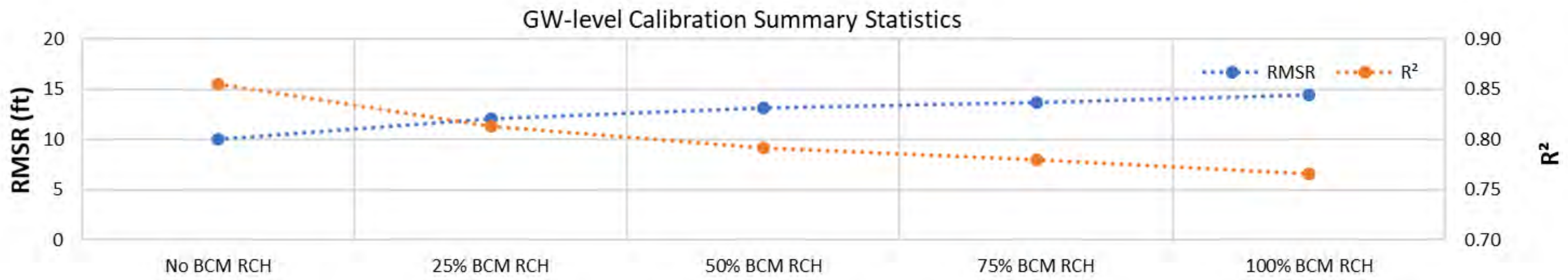
The City *of* SAN DIEGO

Sensitivity of Change in GW Storage to Subsurface Inflow

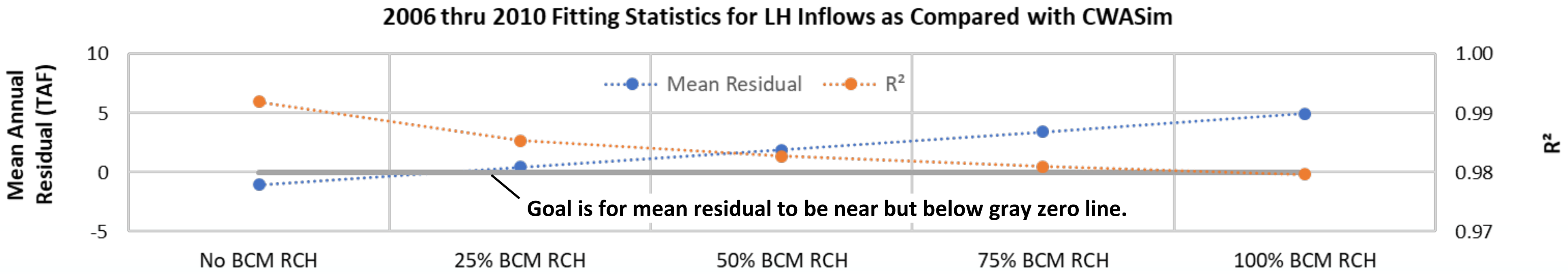


* Historical GW budget = 2005-2019 average of total GW inflows and total GW outflows = 8,361 AFY

Subsurface inflow affects average GW storage depletion magnitudes, but all sensitivity simulations indicate average GW storage deficits over the 15-year calibration period.



Root mean squared residual (RMSR) and R^2 global fitting statistics to GW levels worsen with increasing subsurface inflows.



Mean residuals related to independent estimates of Lake Hodges inflows worsen with increasing subsurface inflows >~25% of BCM recharge. R^2 worsens with any increase in subsurface inflows.

Sensitivity Analysis Outcome

- Modeled ag pumping rates are not sensitive to subsurface inflow rates
- Generally, global goodness-of-fit types of statistics worsen with increasing subsurface inflow
  - Local exceptions
    - A small amount (≤ ~25%) of BCM recharge could be tolerated and reasonably fit independent estimates of Lake Hodges inflows
    - Including 25% BCM recharge would also improve fits to GW levels at SP093, SP073, SP072, & SP086, but would slightly compromise fits at other calibration monitoring wells
- Although including subsurface inflow reduces average GW storage depletions, all sensitivity simulations indicate average GW storage deficits over the 15-year calibration period

Recommendation

The modeling team will move forward incorporating 25% BCM recharge as subsurface inflow in Model Layers 3 and 4 along the northern, eastern, and southern boundaries of the SPV GSP Model domain. Doing so will slightly compromise global calibration statistics for GW levels, but will locally improve fits to eastern Santa Ysabel GW levels and inflows to Lake Hodges. Addition of some amount of subsurface inflow also addresses concerns around this topic raised by a TPR member during the 17-Dec TPR meeting.