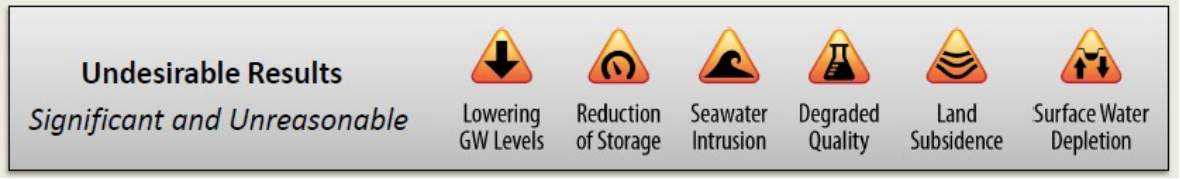
Addressing Interconnected Subbasins under SGMA

Since many subbasins are hydrologically connected to adjoining subbasins, sustainable groundwater management will require accounting for groundwater interactions between adjoining subbasins. For example, groundwater pumping in one subbasin can result in a groundwater depression which causes surrounding groundwater to flow towards the pumping area. This dynamic can affect interbasin flow to the subbasin. Other processes such as artificial recharge, irrigation, and changes in climate could change aquifer conditions and therefore also the interbasin flow rates. Understanding and quantifying these dynamics in the region's Groundwater Sustainability Plans (GSPs) will be an important component of successfully implementing the Sustainable Groundwater Management Act (SGMA) in the northern Sacramento Valley region.

Groundwater Models will be a Part of Our Future

The complexity of processes affecting interbasin groundwater flows make groundwater models effective and necessary tools for quantifying these flows. Local investment has been made in technical tools such as surface layer models (accounting for agricultural and urban water use) and other water budget approaches. While these are valuable planning and operations tools for local agencies, they typically do not calculate interbasin flows or groundwater-surface water interaction and are generally not well suited for predictive simulation. SGMA does not legally require the use of a groundwater model. Yet, successfully avoiding the 6 Undesirable Results defined by SGMA will require accounting for a complete surface water and groundwater budget and the ability to evaluate the effects of changes in the water budget (i.e. increased pumping or increased recharge) on groundwater conditions over time. Water budgets must account for interbasin flows and groundwater-surface water interaction. Since groundwater modeling will be a part of our future under SGMA, it will be key to leverage local data sets and knowledge to improve existing groundwater models or to develop new ones.

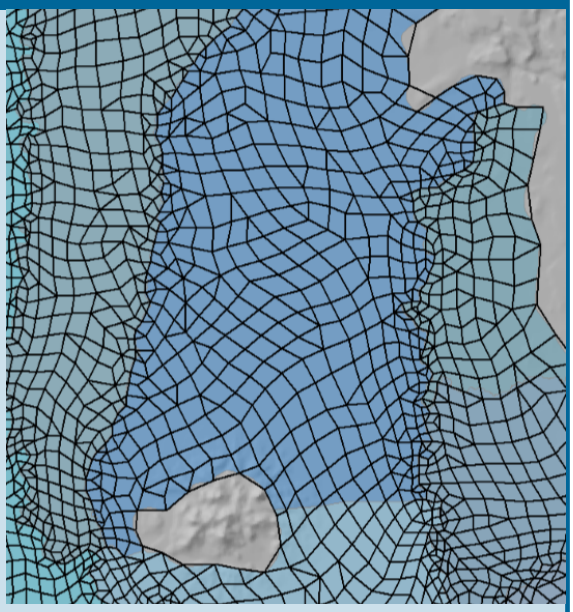


WATER BUDGETS and MODELING

A water budget takes into account the storage and movement of water between the four physical systems of the hydrologic cycle: the atmospheric system, the land surface system, the river and stream system, and the groundwater system. It is an accounting of the total groundwater and surface water entering and leaving a basin or other user-defined area over a defined period of time (DWR Water Budgets BMP 2016).

A model is any computational method that represents an approximation of the hydrologic system. While models are, by definition, a simplification of a more complex reality, they have proven to be useful tools over several decades for addressing a range of groundwater management challenges and supporting the decision-making process. Models can be useful tools for estimating the potential hydrologic effects of proposed water management activities (DWR Modeling BMP 2016).

In a numerical groundwater-surface water model, data and parameters are specified for accounting units that make up a model grid. Groundwater and surface water processes are simulated at this scale. A model organizes and incorporates available data from a wide variety of sources and presents approaches to quantify the major flow paths. With a calibrated model (i.e. results simulate historical data reasonably well), scenarios representing changes in water demands, land use changes, or recharge projects can be run to understand the possible range of system responses to changes in processes.



Example of a model grid for a numerical groundwater model, area just north of the Sutter Buttes

"Special thanks to the Technical Collaborators who generated these recommendations."

For the full Report, Assessment of Interconnected Subbasins, and list of Technical Collaborators visit: https://www.buttecounty.net/waterresourceconservation/SpecialProjects/InterbasinGroundwaterFlowProject.

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Existing Tools and Model Selection

The northern Sacramento Valley project area is covered by three regional models including two Central Valley-wide models: 1) C2VSim developed by the Department of Water Resources (DWR), and 2) CVHM developed by the United States Geological Survey (USGS). These models are both undergoing significant updates. Another regional, Sacramento Valley-wide model is currently being developed by DWR called SVSim. Local groundwater models also exist. Examples include models currently being updated or developed by Butte and Yuba Counties. None of the existing regional or local groundwater models were specifically developed for SGMA. The regional models were developed prior to SGMA for other purposes and as such, they have limitations, yet also provide opportunities. Although they provide a valuable starting point, they have significant differences in both approach to simulating hydrological processes and contain inputs developed from different data sources. This results in significant differences in water budget results in some cases and differing results in simulating groundwater level conditions.

Given these differences, agencies should consider the following question when considering which groundwater model to use for GSP development: **How well does the model match my current understanding of the land surface layer and groundwater budgets in my area?** This question can be answered by considering the quality and amount of data, supply and demand, boundary conditions, water budget results, and calibration, including whether aquifer parameters are realistic. Since there is not an obvious choice of one of the regional models for the northern Sacramento Valley, each subbasin should compare the model inputs and results to locally available historical data, if possible. An existing surface layer model or other water budget datasets should be used only to assist in selecting the appropriate groundwater model. It is not appropriate to mix output from the groundwater model with other local water budget sources. Groundwater model results should be presented in full to keep the results internally consistent. In addition, simulated groundwater elevations near the boundaries have the most effect on quantifying interbasin groundwater flows. Therefore, evaluating a model's representation of groundwater levels in comparison to historical data is important, particularly in the areas along subbasin boundaries.

Cooperation and Uncertainty

The most critical factor to address interbasin conditions will not come from a pure technical remedy, but rather from cooperation. Early cooperation with neighboring subbasins to compare interbasin flow estimates is very important. Although the exact values may be different, the interbasin flow magnitude and direction should be similar. The differences in part reflect the uncertainty in the modeled systems.

As knowledge of the system and data improves, models are updated to better represent the system. A long term commitment is needed to develop these tools to help us better understand the dynamics of the groundwater system. As a result, promising management actions can more effectively be identified to solve problems and achieve sustainability. The existing tools may provide a reasonable starting point but local knowledge and data will make them better. GSPs should address how they would anticipate and incorporate model updates or new models into resource management. Inevitably, updates or new models will generate different results to some degree. The key is to allow for incorporation of the new information without resulting in sudden and disruptive shifts in management actions. In the end, the model is a tool to achieve objectives based on real data. Proper planning can allow for using the best available science while maintaining a groundwater management structure that is not destabilized by changes in the model and its results.

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