GSPAC — Big Valley Updates, GSP Education and Discussion
June 24, 2021
Outline

Agenda Item #3 - Big Valley Updates
• 3.2 - Technical Support Services
• 3.3 - Feedback on 2020 COD Plans

Agenda Item #4 - GSP Education and Discussion
• 4.1 - Groundwater Modeling
• 4.2 - Database Management
• 4.3 - Groundwater Budgets

Agenda Item #5 – GSP Section Review
• 5.2 - Overview of Section 2.2.2

Agenda Item #6 - GSP Subcommittee and Ad Hoc Meetings
Technical Support Services

TSS General Application

- One application per subbasin
- Includes general questions about SGMA process, current funding programs within the Basin (e.g., How many GSPs?)
- Applicants must describe “the most challenging technical needs of the Basin”.
- Potential projects could include:
  1. Monitoring well installation
  2. Groundwater level monitoring training
  3. Borehole video logging
  4. Other field activities

Progress:

- Coordinate with regional DWR contact
- Groundwater Quality Sampling and Analysis (approx. 15 wells)
- Future Plan - Propose 1 multi-completion monitoring wells. One well per subbasin typically allowed.

Technical Support Services for
Groundwater Sustainability Plan Development and Implementation

How to Apply:
Applications for TSS will be evaluated on a continuous basis as funding allows. The application process is two-part - a General Application and Individual Service Requests - and must be submitted through an online application system made available to the applicant following consultation with DWR Region Offices. PDF and MS Word copies of the General Application and Service Requests are provided as a resource to help applicants prepare for applying.

Applicants are encouraged to contact a Region Coordinator at sgma_rd@water.ca.gov to discuss the type and level of services needed prior to submitting an application. For additional information on DWR’s Technical Support Services and other assistance offerings visit, https://www.water.ca.gov/Programs/Groundwater-Management/Assistance-and-Engagement.
First Decisions Released on Local SGMA Plans

- Staggered approach for releasing DWR decisions
- June 3 release included:

  **Approved Plans**
  1. Santa Cruz Mid-County Basin
  2. 180/400 Foot Aquifer Subbasin

  **Notified Locals to Consult on Plan Deficiencies**
  (final determination to be released by January 2022)
  3. Paso Robles Subbasin
  4. Cuyama Valley Basin

- Other critically-overdrafted basins will receive determinations throughout this year to meet DWR’s overall January 2022 statutory deadline
- Assessment information & video message:
  https://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management/Groundwater-Sustainability-Plans
DWR Feedback on 2020 COD Plans

- Undesirable Conditions
  - Locally Agreed Upon (Qualitative)

Sustainable Management Criteria

- Measurable Objectives
- Minimum Thresholds
- Interim Milestones

Undesirable Result – Combination of MT Exceedances

Locally Agreed Upon (Quantitative)
Initial GSP Findings

- Eliminating overdraft is central to SGMA but not the only requirement
- This should be done in concert with avoiding Undesirable Results and the development of Sustainable Management Criteria

**Sustainable Management Criteria**

**Undesirable Results**
- Sustainability Indicators
- Lowering GW Levels
- Reduction of Storage
- Seawater Intrusion
- Degraded Quality
- Land Subsidence
- Surface Water Depletion

**Measurable Objectives & Minimum Thresholds**
- Metric(s) Defined in GSP Regulations
- Groundwater Elevation
- Total Volume
- Chloride Concentration
- Migration of Plumes
- Number of supply wells
- Volume
- Location of isocenter
- Rate and Extent of Land Subsidence
- Volume or rate of surface water depletion

**Basin Sustainability Goal**

In general, the **sustainable yield** of a basin is the amount of groundwater that can be withdrawn annually without causing undesirable results.
Initial GSP Findings, cont.

- Identify and define undesirable results
  - What are the significant and unreasonable effects in your basin?

- Define the minimum thresholds & measurable objectives
  - Justification for the minimum thresholds
  - Evaluate and disclose the effects on beneficial uses and users

- Include projects and actions that are consistent with avoiding undesirable results and mitigating overdraft
  - Comprehensive approach with supply augmentation & demand reduction strategies

- Clearly show work and identify data gaps
Agenda Item # 4.1
Groundwater Modeling

Introduction
• Why integrated groundwater model?
• Model Framework
  • Groundwater Model
  • Basin Characterization Model
  • Farm Process
• Model Development
• Model Outcomes

July – Model Development

October – Water Budget Results
Groundwater Modeling

• All models are wrong, some are useful
• Groundwater models are used as a predictive tool to help manage the basin
• A good and well developed hydrogeologic conceptual model is the foundation of a good numerical groundwater model
• Groundwater models support decision making
• The initial groundwater model developed for the GSP will evolve and improve over time as more data is collected
Key Considerations

GSP Regulations
• Subbasin water budget and sustainable yield
• Evaluate groundwater sustainability indicators
• Evaluate projected water budget

Additional Objectives
• Evaluate streamflow and water demands for fish and groundwater dependent ecosystems
• Climate vulnerability
• Test efficacy of proposed management actions
Why an Integrated Hydrologic Model?

Integration of Various Data Types
- Many different data types
- Data are spatially and temporally variable

Future Hydrologic Response
- Reasonably bound future hydrologic conditions
- Evaluate future changes to climate, land use, etc.

Support Management and Policy Decisions
- Inform stakeholders and managers
- Inform monitoring and future data collection
Modeling Framework – Model Platforms

**One-Water**

Hydrologic Model (Groundwater System)

Integrated Hydrologic Model
- Groundwater
- Climate
- Landscape & surface water
- Stream-aquifer interaction
- Agricultural supply and demand

**Basin Characterization**

Model (Surface Layer System)

Regional Water Balance Model
- Undeveloped watersheds
- Simulates watershed recharge and runoff
- Provides estimate of reference evapotranspiration (ET) and precipitation
- Analysis of future climate change

U.S. Geological Survey Codes
Peer Reviewed
Open Source
Widely Applied
Supported by DWR for GSPs
Modeling Framework – Coupled Modeling Approach

One-Water Hydrologic Model
Supply and Demand
• Ag/Urban Water Demand
• Irrigation & Imports
• Conjunctive Use

Streamflow
• Diversions and Runoff

Groundwater Hydraulics
• Recharge
• Pumping
• 3D Groundwater Flow
• Stream-Aquifer Interaction

BCM
Inflows
Climate Inputs

Basin Characterization Model
Watershed Response in Contributing Watersheds

Inputs to One-Water
• Tributary Inflows
• Mountain Block Recharge
• Climate Inputs
  • Reference ET
  • Precipitation

Future Climate Analysis
• Micheli et al., 2016
Modeling Framework – Coupled Modeling Approach

Contributing Watersheds (Simulated Precipitation, ET, Recharge, Runoff by BCM)

Model Boundary

Integrated Groundwater Flow (Simulated by MODFLOW-OWHM)
Groundwater Modeling Background

**Model is a simplified representation of the hydrologic system**

- Divide aquifer system into 3D grid of cells
- Properties are assigned to each cell in grid
- Model stresses (i.e., pumping, recharge, streams), which vary with time, are assigned to each cell

Groundwater flow between cells is calculated by solving mathematical equations governing groundwater flow

\[
\frac{\partial}{\partial x} \left( K_{xx} \frac{\partial h}{\partial x} \right) + \frac{\partial}{\partial y} \left( K_{yy} \frac{\partial h}{\partial y} \right) + \frac{\partial}{\partial z} \left( K_{zz} \frac{\partial h}{\partial z} \right) + W = S \frac{\partial h}{\partial t}
\]

(Modified from McDonald & Harbaugh, 1988)
Groundwater Modeling Background

- Hydraulic conductivity (K) defined as the rate of flow of water through a unit cross-section under a unit hydraulic gradient.
- Transmissivity (T) defined as K times saturated thickness.
- Specific yield (Sy) defined as ratio of volume of water drained by gravity from saturated material to total aquifer volume (0.01 to 0.3).
- Storage coefficient (S) defined as ratio of volume of water derived from aquifer skeleton compression and water expansion to total aquifer volume (0.005 to 0.00005).
- T, S, and pumping (amount/duration) are key variables that define lateral/vertical extent of pumping cone of depression.
- Aquifer parameters most accurately defined by pumping tests.

(Figure from Driscoll, 1986)
Big Valley Integrated Hydrologic Model Development

Model Dimensions
- Big Valley divided into 500 x 500 ft (~6ac) horizontal cells
- Vertically represents aquifer system

Model Properties
- Geology captures key units and textural information
- Streams assignment refined to the reach scale
- Pumping assignment to the well scale
Farm Process Background

Calculation of Landscape Water Budgets

- Landscape water demand
- Landscape water supply

Provides Linkage Between Model Components

**Groundwater System**
- Groundwater pumping
- Groundwater recharge

**Surface Water System**
- Stream diversions
- Runoff from landscape

Utilizes Multi-scale approach
- Model cell scale
- Water balance subregion
Farm Process – Cell Scale

Properties Assigned By Cell

Climate
- Precipitation
- Reference ET

Land Use

Crop Inputs for Each Crop Type
- Crop coefficient
- Irrigation efficiency
- Rooting depth

Cell Water Budget
- Inflows (precipitation, irrigation, groundwater)
- Outflows (ET, runoff, deep percolation)
Farm Process – Water Balance Subregion

Water Balance Subregion (WBS)
- Grouping of cells where supply and demand are evaluated

Demand for each WBS
- Unmet ET demand met by irrigation

Supply and Order of Use for each WBS
- Precipitation and groundwater uptake
- Stream diversions & imports
- Groundwater pumping

Rural Domestic Use
- Specified directly from external estimates
- Account for percolation from septic
Big Valley Integrated Hydrologic Model Development

**Detailed Water Balance Subregions**
- Defined urban and agricultural areas

**Localized estimates of precipitation and ETo**
- High resolution distributed data derived from the Basin Characterization Model

**High Resolution Land Use**
- Integration of statewide and local data sources
- Refined to the field scale (cell fractions)
- Agricultural crops and native land use classes

**Local Analysis of Crop Water Usage**
- Local crop water analysis from remote sensing
- Coordination with Farm Bureau and growers
Model Outcomes

• Explore interrelation of diverse hydrologic conditions and impacts
• Subregional water budgets
• Water use by land use class
• Undesirable results
  • Potential for subregional groundwater depletion
  • Stream-aquifer interaction on a reach scale
• The predictive simulations come with uncertainty due to the uncertain future conditions defined as Scenarios

• The assessment outcomes include uncertainty due to the inherent uncertainty in many groundwater model components
Data Acquired

Data Request

Data Management System

“DMS, it is a software system that uses a standard method of cataloging, retrieving, and running queries on data. The DMS manages incoming data, organizes it, and provides ways for the data to be modified or extracted by users or other programs.”
Data Management & Importance of Local Data

SharePoint Folder
Lake County, DWR and others, stakeholders
Well construction
Groundwater Levels
lithology
geophysical logs
water diversions
Nitrate
Total Dissolved solids
NDVI & Groundwater Dependent Ecosystems
Land use & Crop type
Stream flows
InSAR for subsidence

“Stakeholder Data Request Status Update & Timing”
Data Management and DMS

- Multi-user access
- Scalability - works for small or large organizations
- Removes redundancy
- Ensures data security and integrity
- Ability to implement complex formulas / transactions
DMS Uses

• Data Storage

• Data QA/QC

• Reporting

• Interactive Visualizations
MS Access

Included with Office 365 - ☺
Easy to maintain without need for support - ☺
Ability to create charts, data tables, reports - ☺
Support for using with external software - ☺
Need for regular backups, repair and maintenance - 😞
Easy to set up and doesn’t require extensive training - ☺
Can be migrated to cloud-based database in future - ☻
Requires staff training - 😞
Data Reporting

- GSP Annual Report requirements (§ 356.2)
  - Groundwater level contours and hydrographs
  - Change in groundwater storage – *by aquifer*
  - Water use and water supplies – *by sector, source, location*
  - GSP implementation status – *projects/management actions, milestones*
  - Upload data to SGMA Portal and Monitoring Network Module

- GSP Five-Year Update – at least every five years (§ 356.4)
  - More comprehensive review of all GSP elements – *basin setting, sustainability indicators (milestones/MTs/MOs), update tech. analyses/modeling and monitoring network (as needed)*
Agenda Item # 4.3
Overview of Groundwater Budgets (Support Chapter 2)

1. Surface Water System
2. Land System
3. Groundwater System
Agenda Item # 4.3
Overview of Groundwater Budgets

Cumulative Departure from Mean Precipitation

Precipitation (in)

Cumulative Departure from Mean Precipitation (in)
• Annual precipitation is indicative of the Big Valley Basin hydrology
• Moderate or strong positive correlation between spring water levels of most wells & annual precipitation
<table>
<thead>
<tr>
<th>Water Budget</th>
<th>Analysis Period</th>
<th>Hydrology</th>
<th>Land Use</th>
<th>Water Supplies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Historical Simulation</strong></td>
<td>1985-2020</td>
<td>Historical</td>
<td>Historical</td>
<td>Historical</td>
</tr>
<tr>
<td><strong>Current Conditions</strong></td>
<td>1971-2018</td>
<td>Historical</td>
<td>TBD (2016/2018)</td>
<td>TBD (Current)</td>
</tr>
<tr>
<td><strong>Future Conditions (No Climate Change)</strong></td>
<td>1971-2018</td>
<td>Historical</td>
<td>Current, adjusted based on County General Plan</td>
<td>Current and projected Ag/Urban Demands</td>
</tr>
<tr>
<td><strong>Future Conditions, 2030 Climate Change</strong></td>
<td>1971-2018</td>
<td>Historical, Adjusted based on 2030 climate change</td>
<td>Current, adjusted based on General Plan</td>
<td>Current, adjusted based on climate change</td>
</tr>
<tr>
<td><strong>Future Conditions, 2070 Climate Change</strong></td>
<td>1971-2018</td>
<td>Historical, adjusted based on 2070 climate change</td>
<td>Current, adjusted based on General Plan</td>
<td>Current, adjusted based on climate change</td>
</tr>
</tbody>
</table>
Agenda Item # 4.3
Overview of Groundwater Budgets

Table 2-38. Comparison of Recent GWS Water Budget Periods (acre-feet, rounded)

<table>
<thead>
<tr>
<th>GWS Water Budget Component</th>
<th>Recent 10 Years (2009-2018)</th>
<th>Recent 5 Years (2014-2018)</th>
<th>Recent 3 Years (2016-2018)</th>
<th>Recent 1 Year 2018</th>
<th>Recent 1 Year 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Seepage</td>
<td>-76,050</td>
<td>-72,600</td>
<td>-53,340</td>
<td>-134,220</td>
<td>-21,520</td>
</tr>
<tr>
<td>Deep Percolation</td>
<td>52,310</td>
<td>52,630</td>
<td>64,310</td>
<td>24,970</td>
<td>95,550</td>
</tr>
<tr>
<td>Net Subsurface Flows</td>
<td>91,100</td>
<td>94,510</td>
<td>103,350</td>
<td>107,350</td>
<td>108,090</td>
</tr>
<tr>
<td>Groundwater Pumping</td>
<td>-86,520</td>
<td>-93,170</td>
<td>-89,160</td>
<td>-100,540</td>
<td>-75,850</td>
</tr>
<tr>
<td>Groundwater Uptake</td>
<td>-3,600</td>
<td>-2,720</td>
<td>-4,210</td>
<td>-1,400</td>
<td>-6,750</td>
</tr>
<tr>
<td>Annual Groundwater Storage Change(1) (\text{acre-feet})</td>
<td>-22,800</td>
<td>-21,400</td>
<td>20,900</td>
<td>-103,900</td>
<td>99,500</td>
</tr>
</tbody>
</table>

\(1\) Annual storage change volumes rounded to 100 af.

Note: positive values indicate inflows/increasing storage, negative values indicate outflows/decreasing storage.
2.2.2 Current and Historical Groundwater Conditions (Reg. § 354.16)

- Groundwater elevation data
- Estimate of groundwater storage
- Seawater intrusion conditions
- Groundwater quality issues
- Land subsidence conditions
- Identification of interconnected surface water systems
- Identification of groundwater-dependent ecosystems
  - Including potentially related factors such as instream flow requirements, threatened and endangered species, and critical habitat.
Groundwater Level Hydrographs

- Seasonal and climate-influenced short-term fluctuations
- Water levels stable during the last three decades
Trends of GW Level Change – 1990 to 2020

• Analysis of seasonal high water levels of 26 wells with a minimum of 30 winter/spring measurements from 1990 to 2020
  • 19 wells - No significant trend
  • 4 wells – decreasing trend (0.1 ft per year)
  • 3 wells – increasing trend (0.1 to 0.5 ft per year)
Groundwater Elevation Contours

Groundwater Elevations in 2019 (Wet climatic conditions)

- Generally northward flow
- Seasonal change about 10 ft throughout the Basin
Groundwater Elevation Contours

Groundwater Elevations in 2015 (Dry climatic conditions)

- Generally northward flow
- Magnitude of WL fluctuations between dry and wet climatic periods are from a few feet to less than 10 ft (significantly smaller than the seasonal fluctuations)
Undesirable Total Dissolved Solids (TDS) concentrations are not a widespread concern.

Maximum concentration: 802 mg/L (below upper SMCL of 1,000 mg/L)

42 samples from 16 wells tested since 1954 exceeded recommended SMCL of 500 mg/L, but only four samples exceeded 700 mg/L.

TDS concentration timeseries graphs

Maximum historic TDS concentration by well
- Undesirable nitrate concentrations are not a widespread concern
- Only one sample exceeded the MCL of 10 mg/L (measured as N) after 1970
- Recent analytical results (since 1980) do not show increasing nitrate concentrations at any well
Groundwater Quality - Boron

- Undesirable boron concentrations are not a widespread concern
- Concentrations over 1.0 mg/L were reported in the east and central areas
- Boron is not regulated for drinking water.
- CA notification Level of 1.0 mg/L for public drinking water. Certain crops are sensitive to boron over 0.50 mg/L.
- Concentrations over 0.5 mg/L have not been reported since 2007

Boron concentrations timeseries graphs
Groundwater Quality - Arsenic

- Undesirable arsenic concentrations are not a widespread concern
- Only 2 samples exceeded MCL of 10 µg/L since 1960

Arsenic concentrations timeseries graphs

Maximum historic arsenic concentrations
Groundwater Quality – Cleanup Sites

- 4 open cleanup sites
  - Airpower Inc
    - Potential Petroleum and VOC contamination
    - Currently in verification monitoring post-remediation
    - Unlikely to present contaminant concerns to groundwater
  - Kelseyville Hot Plant
    - Potential petroleum and chromium contamination
    - On-Site groundwater contamination detected but site vicinity contamination has not been adequately characterized
  - Two Jacks Kelseyville UST
    - Potential petroleum and fuel additive contamination
    - Plume delineation is still underway
    - New off-site monitoring wells have been installed
  - Two Jacks Kelseyville AST
    - Kerosene Spill
    - Off-Site plume delineation underway as of March 2020
Agenda Item # 6
Future GSP Subcommittee/Ad-Hoc Meetings

• Proposed Subcommittee/Ad-Hoc Topics
• Form Subcommittee/Ad-Hoc Groups
• Work with Subcommittee/Ad-Hoc to schedule meetings
Agenda Item # 6
Future GSP Subcommittee/Ad-Hoc Meetings

• Proposed Subcommittee/Ad-Hoc Topics
  • Integrated Hydrologic Modeling (July through October)
    • 2 to 3 meetings
  • Projects and Management Actions (August through October)
    • 2 to 3 meetings
  • Sustainable Management Criteria (July through October)
    • 6 to 8 meetings
  • Groundwater Dependent Ecosystems (July & August)
    • 2 to 4 meetings
  • GSP Implementation/Finance (September & October)
    • 2 to 4 meetings