Groundwater Conditions in Colusa County Relative to Final Groundwater Sustainability Plan Regulations

Davids Engineering, Inc.

July 15, 2016
Approach

• Governance is all about decision making
  • If important decisions will be made, then governance is important; otherwise, not so much

• What are the key decisions embedded in preparing Groundwater Management Plan (or Plans)?
  • “Key decisions” are ones that could affect the availability and/or the cost of groundwater to overlying landowners

• Be thinking about: “How should GSA’s be formed to make these key decisions (and many others) appropriately?”
Notes and Ground Rules

• Publicly available data sources used primarily
• Judgment necessarily involved; feel free to disagree, draw your own conclusions
• Acknowledge uncertainty in numbers
• Covering a wide technical range
• Burning questions okay; please hold comments and discussion for later
Outline

• Final Groundwater Sustainability Plan (GSP) Regulations
  • Focus on Key Decisions embedded in GSP development

• Groundwater Conditions and Potential Sustainability Challenges in Colusa County
  • Implications to GSP Development

• Thoughts on Delineating Management Areas

• Questions & Answers, Discussion
GSP Regulations

- Finalized on May 18, 2016 (since last meeting)
- California Code of Regulations, Title 23. Waters, Division 2, Department of Water Resources, Chapter 1.5, Groundwater Management, Subchapter 2. Groundwater Sustainability Plans
  - Article 1. Introductory Provisions
  - Article 2. Definitions
  - Article 3. Technical and Reporting Standards
  - Article 4. Procedures
  - **Article 5. Plan Contents**
  - Article 6. Department Evaluation and Assessment
  - Article 7. Annual Reports and Periodic Evaluation by the Agency
  - Article 8. Interagency Agreements
  - Article 9. Adjudicated Areas and Alternatives
Article 5. Plan Contents

- Subarticle 1. Administrative Information
- Subarticle 2. Basin Setting
- Subarticle 3. Sustainable Management Criteria
- Subarticle 4. Monitoring Networks
- Subarticle 5. Projects and Management Actions
Key Decisions Embedded in GSP Development

• Subarticle 3. Sustainable Management Criteria
  • Defining “Undesirable Results”: do they exist now; will they potentially occur in the future?
  • Establishing “Minimum Thresholds” and “Measureable Objectives” for each Sustainability Indicator (groundwater levels, water quality, land subsidence, etc.)

• Subarticle 5. Projects and Management Actions
  • Identifying “Potential Projects and Management Actions” needed to achieve sustainable basin management
Key Decisions: Defining Undesirable Results

- For each Sustainability Indicator, do significant and unreasonable effects currently exist or could they develop in the future?

<table>
<thead>
<tr>
<th>Chronic Lowering of GW Levels</th>
<th>Degraded Water Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction of GW Storage</td>
<td>Land Subsidence</td>
</tr>
<tr>
<td>Seawater Intrusion</td>
<td>Depletions of Interconnected Surface Water</td>
</tr>
</tbody>
</table>

- Do not need to address Sustainability Indicators if the GSA can demonstrate that undesirable results are not present and are not likely to occur.
Key Decision: Establishing Minimum Thresholds and Measurable Objectives

• Numeric, site-specific criteria for each Sustainability Indicator establishing a point at which, if exceeded, significant and unreasonable results may occur.

<table>
<thead>
<tr>
<th>• Chronic Lowering of GW Levels</th>
<th>• Degraded Water Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reduction of GW Storage</td>
<td>• Land Subsidence</td>
</tr>
<tr>
<td>• Seawater Intrusion</td>
<td>• Depletions of Interconnected Surface Water</td>
</tr>
</tbody>
</table>

• Must be established to avoid causing undesirable results in adjoining basins

• Must evaluate effects on the interests of beneficial uses and users of groundwater or land uses and property interests
Key Decision: Defining Projects and Management Actions

- Describe Projects and Management Actions needed to observe Minimum Thresholds and Measureable Objectives
- Describe circumstances under which Projects or Management Actions shall be implemented
- Describe required legal authority and permitting and regulatory process to implement projects
- Explain expected benefits, costs and how costs will be met
### Key Decisions by Sustainability Indicator Matrix

**Sustainability Indicators**

<table>
<thead>
<tr>
<th>#1 - Chronic Lowering of Groundwater Levels</th>
<th>#2 - Reduction of Groundwater Storage</th>
<th>#3 - Seawater Intrusion</th>
<th>#4 - Degraded Water Quality</th>
<th>#5 - Land Subsidence</th>
<th>#6 - Depletions of Interconnected Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>

**Sustainability Goal:**

Essentially: Operate the subbasin within sustainable yield, with no Undesirable Results over time.

---

**Undesirable Results (§ 354.26)**

For each Sustainability Indicator, do significant and unreasonable effects currently exist or could they develop in the future?

**Minimum Threshold (§ 354.28)**

Numeric, site-specific criteria for each Sustainability Indicator establishing a point at which, if exceeded, significant and unreasonable results may occur.

**Measureable Objective and 5-Year Interim Milestones (§ 354.44)**

Numeric, site-specific criteria for each Sustainability Indicator describing prudent operational limits with "reasonable margin of operational flexibility" factored in.

**Projects and Management Actions (§ 354.44)**

Descriptions of projects and management actions the GSA has determined will achieve the sustainability goal for the basin.
Pre-existing Undesirable Results

• GSPs may, but are not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015 (per authorizing legislation; not expressed in GSP regs)
Sustainability Indicator #3: Seawater Intrusion

- Physically impossible; therefore, exempt
Sustainability Indicator #2: Reduction of Groundwater Storage

• Minimum Threshold: “...a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results.” § 354.28 (c) (2)

• Potential Undesirable Results:
  • Reduced water supply reliability (reduced drought reserves)
Sustainability Indicator #2: Reduction of Groundwater Storage Subbasin Storage Capacities (DWR Bulletin 118)

• Colusa Subbasin
  ~13 million acre-feet basinwide
  ~5.5 million acre-feet in Colusa County (43%)

• West Butte Subbasin: ~3 MAF (basinwide)
  ~3 million acre-feet basinwide
  ~0.7 million acre-feet in Colusa County (24%)

• Countywide GW Storage Capacity = ±6.2 million acre-feet
Sustainability Indicator #2: Reduction of Groundwater Storage
Colusa and West Butte Subbasins in Colusa County (2009 through 2016)

Change in Storage (taf)

Year

Spring Change in Storage from Prior Year
Cumulative Change in Storage


-700 -600 -500 -400 -300 -200 -100 0 100 200 300 400 500 600 700

July 15, 2016
Sustainability Indicator #2: Reduction of Groundwater Storage West Butte Subbasin in Colusa County (2009 through 2016)

![Graph showing change in storage over years]

- **Spring Change in Storage from Prior Year**
- **Cumulative Change in Storage**

Year:
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016

Change in Storage (taf):
- 0
- 5
- 10
- 15
- 20
- 25
- 30

Colusa County SGMA Governance Working Group Meeting 5
July 15, 2016
Sustainability Indicator #2: Reduction of Groundwater Storage Colusa Subbasin in Colusa County (2009 through 2016)
Sustainability Indicator #2: Reduction of Groundwater Storage Colusa Subbasin in AOI (2009 through 2016)
Sustainability Indicator #2: Reduction of Groundwater Storage
Colusa Subbasin outside AOI (2009 through 2016)

Spring Change in Storage from Prior Year
Cumulative Change in Storage

Change in Storage (taf)

Year


2009 - 2016

Cumulative Change in Storage

Spring Change in Storage from Prior Year
Sustainability Indicator #2: Reduction of Groundwater Storage

Crystal Ball:

• Will need to address in GSP
• Recent reductions in groundwater storage (during the past 8 years) are modest relative to the total volume of groundwater in storage (<10%)
• Other Sustainability Indicators (e.g., GW levels, subsidence, or streamflow depletion) are likely to pose operational limits before depletion of storage
Sustainability Indicator #4: Degraded Water Quality

- Minimum Threshold: “...degradation of water quality...that may lead to undesirable results.” § 354.28 (c) (4)
- Potential Undesirable Results:
  - Unsuitable quality for beneficial uses
    - Agriculture
    - Drinking water
    - Stock water
    - Environmental uses
  - Reduced crop yields
  - Increased water treatment costs
  - Inability to comply with regulatory standards
    - Drinking water regs
    - Basin Water Quality Control Plan
Sustainability Indicator #4: Degraded Water Quality
(Findings from 2008 Colusa County GMP)

• WQ raised as an issue of concern during outreach: salinity, arsenic, manganese

• GW quality generally suitable for ag and domestic uses, with some exceptions
  • Localized elevated salinity north of Hwy 20 between Colusa and Williams
  • Elevated boron SW of Arbuckle (crop limitations?)
  • Elevated manganese in eastern portion of County (taste and odor issue, not a health threat)

• Hydrogeology of County as it relates to WQ is not well understood
Sustainability Indicator #4: Degraded Water Quality

Crystal Ball:

• Relationships between basin operation (e.g. water levels) and water quality are not sufficiently understood to conclude that undesirable effects have or will be caused by operational factors.

• Water quality will definitely need to be addressed in GSP

• Unlikely that water quality will or may pose operational limitations, at least until additional investigations have been conducted
Sustainability Indicator #5: Land Subsidence

• Minimum Threshold: “...the rate and extent of subsidence that substantially interferes with land surface uses and may lead to undesirable results.” § 354.28 (c) (5)

• Potential Undesirable Results:
  • Permanent loss of aquifer storage capacity
  • Damage to foundations, roads, bridges, other infrastructure
  • Change in surface topography that reduces conveyance capacities of canals, natural channels, floodplains
  • Other effects
Sustainability Indicator #5: Land Subsidence

- Summary of Recent, Historical and Estimated Potential for Future Land Subsidence in California (DWR 2014)

- Existing subsidence monitoring:
  - Two extensometer wells in County
  - 28 GPS stations in County as part of DWR/USBR Sacramento Valley GPS Subsidence Project
    - Collaborative effort with various Sac Valley local agencies
    - Originally surveyed in 2008
    - Recently resurveyed but results not yet available

- Interferometric Synthetic Aperture Radar (InSAR) Study (NASA, 2015)
Sustainability Indicator #5: Land Subsidence

Two Colusa County Extensometer Wells

Estimated Potential for Future Land Subsidence

- Insufficient Data
- Lower
- Higher

- Continuous GPS Station Cumulative Subsidence
- Active Extensometer Station Trend

- 0 - < 1 Inch
- ≥ 1 - 2.5 Inches
- ≥ 2.5 - 5 Inches
- ≥ 5 - 10 Inches

- Subsiding
- Not Subsiding
- Unknown
Sustainability Indicator #5: Land Subsidence: Extensometer Data
Sustainability Indicator #5: Land Subsidence: Extensometer Data
Sustainability Indicator #5: Land Subsidence: NASA Report 2015

"...an unusually small heavily subsiding area just west of Arbuckle showed a maximum subsidence of about 5 inches."

Figure 6. Total subsidence in the Sacramento Valley for the period 20 May 2014 – 28 November 2014 as measured by the Canadian Radarsat-2 and processed at JPL. Two diffuse subsidence areas can be seen west and north of Yolo and a small, deep subsidence bowl is evident just west of Arbuckle.
Sustainability Indicator #5: Land Subsidence

Crystal Ball:

• There is known potential for land subsidence in the County and some early signs of actual subsidence
  • Will know more when new GPS survey results are published
• Land subsidence will definitely need to be addressed in GSP
• Highly uncertain whether land subsidence will or may pose operational limitations
Sustainability Indicator #6  
Depletions of Interconnected Surface Water

• Minimum Threshold: “…the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of surface water and may lead to undesirable results.”

• Potential Undesirable Results:
  • Reduced water availability to “Groundwater Dependent Ecosystems” (GDE’s) – TNC leading this
  • Reduced water availability to legal users of surface water
Sustainability Indicator #6
Depletions of Interconnected Surface Water

• Interaction depends on relative groundwater levels and properties of streambed and aquifer

• The uppermost groundwater sustains Groundwater Dependent Ecosystems, and river and stream flows

Source: The Nature Conservancy
According to DWR’s existing C2VSim model, Sacramento Valley streams have gone from net “gainers” to net “losers” over recent decades.
Sustainability Indicator #6
Depletions of Interconnected Surface Water

Groundwater Levels for State Well Number 18N02W36B001M

Station Data
Well Use: Irrigation
Latitude: 39.3772
Longitude: -122.0298
Well Status: Active

Note: Red Points = Identified as 'Questionable Data' by DWR
Sustainability Indicator #6
Depletions of Interconnected Surface Water

Groundwater Levels for State Well Number 16N01W20F001M

Station Data
Well Use: Residential
Latitude: 39.2258
Longitude: -121.9984
Well Status: Active

Note: Red Points = Identified as 'Questionable Data' by DWR
Sustainability Indicator #6
Depletions of Interconnected Surface Water

Groundwater Levels for State Well Number 14N01W04K003M

Station Data
Well Use: Irrigation
Latitude: 39.092938
Longitude: -121.97674
Well Status: Active

Note: Red Points = Identified as 'Questionable Data' by DWR
Unofficial DWR Stance

- Anticipating that effects on both Groundwater Dependent Ecosystems and streamflow depletion may become significant issues in the Sacramento Valley
- Let local agencies define the challenges, recognizing that some local agencies might be from outside the Sacramento Valley
- Working on technical tools to assist local agencies
  - C2VSim Model Update (fine grid)
  - Best Management Practices (BMPs) for local agencies to consider adopting for monitoring and analyzing effects of declining groundwater elevations
Sustainability Indicator #6
Depletions of Interconnected Surface Water

Crystal Ball:

- Potential effects of declining groundwater levels on GDE’s and streamflow widely recognized, but physical relationships poorly understood
- Will definitely need to be addressed in GSP
  - TNC developing tools to assist in GSP preparation
- With respect to Sacramento River, potential effects are cumulative among subbasins
- Highly uncertain whether land subsidence will or may pose operational limitations
Sustainability Indicator #1
Chronic Lowering of Groundwater Levels

• Minimum Threshold: “...the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results.”

• Potential Undesirable Results:
  • Well stranding
  • Increased well construction costs
  • Increased groundwater pumping costs
  • Inelastic land subsidence
  • Streamflow depletion
  • Impacts to Groundwater Dependent Ecosystems
  • Induced water quality degradation
  • Others?
Change in Groundwater Elevations Spring 2008 to Spring 2016

Legend
- Basins/Subbasins
- Counties
- Cities
- Major Canals and Drains
- State Highways
- US Highways

Change in Spring G.W.E. (2008-16)

Value
- High: 20
- Low: -100

Date Created: 7/13/2016
AOI Water Balance Results
Presented to Board of Supervisors in January 2016

• Net Recharge in the AOI over the most recent nine-year period (2007 through 2015) has been about 63,000 AF per year less than the preceding nine-year period (1998 through 2006)

• About one-sixth of the reduction in Net Recharge is associated with land use (primarily crop) changes, and five-sixths due to “other factors”, generally associated with “drought”

• “Drought” (beginning in 2007) has had the dominant effect on declining groundwater levels
  • Reduced surface water availability
  • Reduced winter precipitation
Current groundwater conditions reflect the accumulation of nine years of dry conditions (as well as land use changes)

If “Normal” conditions ensue, it likely will take multiple years for groundwater levels to recover

The rate of recovery could be hastened by increasing use of supplemental surface water in the mixed supply and groundwater supply areas

The rate of recovery will be slowed to the extent that recent trends toward relatively high water use crops continue
Sustainability Indicator #1
Chronic Lowering of Groundwater Levels

Crystal Ball:

• Will definitely need to be addressed in GSP, despite the fact that contributing factors up to this point are primarily drought related

• Minimum Thresholds, Measureable Objectives and Interim Milestones will need to be established in the GSP, along with Projects and Management Actions

• Implementation actions possible if drought, crop intensification continues

• A sufficiently reliable groundwater flow model will be needed during GSP development
Sustainability Indicators
Summary “Risk Assessment”

• Will or may be able to remove from consideration:
  • Seawater Intrusion (#3)

• Will need to address but unlikely to pose operational constraints, at least in near term:
  • Reduction of Groundwater Storage (#2)
  • Degraded Water Quality (#4)

• “Wildcards” with known, significant potential for undesirable effects but highly uncertain operational implications:
  • Land Subsidence (#5)
  • Depletions of Interconnected Surface Water (#6)

• Significant risk of imposing operational constraints:
  • Chronic Lowering of Groundwater Levels (#1)
How should governance be structured to make key decisions appropriately?
Thoughts on Management Areas
Management Areas Described Differently in the Regs

• “...an area within a basin for which the Plan may identify different minimum thresholds, measureable objectives, monitoring or projects and management actions based on water use sector, water source type, geology, aquifer characteristics, or other factors.” § 351 (r)

• “Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the plan.”
Potential Themes for Delineating Management Areas

- Similar institutional factors
- Physical connectedness
  - Upslope-downslope groundwater flow
- Shared groundwater challenges and similar likelihood that potential projects or management actions will be needed
  - Areas where Measureable Objectives may not be met
- Relative benefit from GW use

Note: Delineation of Management Areas does not preclude coordinated actions across Management Area boundaries.
Discussion