Colusa County
Prop. 1 Counties with Stressed Basins Grant Update

Prepared by
Davids Engineering, Inc.
June 20, 2017
Overview

• Grant Summary
• Preliminary Results
  • Characterization of Groundwater Development
  • Potential Future Irrigation Demands
• Next Steps
• Discussion
Prop 1 Stressed Basin Grant

• Supports SGMA Planning and Implementation

• Initial Steps to Prepare and Implement a Groundwater Sustainability Plan (GSP)

• $375,932 Total Project Cost
  • $250,000 Prop 1 Funding
  • $125,932 Local Funding from Colusa County

• Targeted Completion Date December 31, 2017
Task 1: Grant Administration

- General Grant Management and Admin
  - Management
  - Reporting
  - Coordination

- Funded through Local Cost Share from Colusa County

- Status: Ongoing.
Task 2: Update and Implement Local Ordinances

- Implement Temporary Urgency Ordinance
- Funded through Local Cost Share from Colusa County
- Informed by County-Wide Groundwater Assessment (Task 3)
Task 3: County-Wide Groundwater Assessment

• County-Wide Assessment with Detailed Evaluation of Area of Interest (AOI)
  • Evaluate factors contributing to declines in AOI
  • County-wide risk assessment of SGMA undesirable results

• Funded through Local Cost Share from Colusa County

Task 4: Groundwater Development Characterization

- Characterize Existing and Potential Future Groundwater Development and Demands
  - Develop database of well locations and construction details
  - Characterize potential future irrigation demands
- Builds on work previously done by County
- Primarily Grant-Funded
- Status: Ongoing. Preliminary results presented today.
Task 5: County-Wide Groundwater Monitoring Network

• Evaluate Existing Network and Need for Additional Wells
  • Assess existing network
  • Consider hydrogeologic conditions and well construction info
  • Evaluate other wells for inclusion
  • Evaluate need for additional monitoring wells

• Primarily Grant-Funded

• Status: Temporarily on hold in anticipation of
  • Sacramento Valley Simulation Model (SVSim) texture model from DWR
  • DWR monitoring network evaluation
Task 6: Groundwater Data Management Program

- Initiate Development and Implementation of a Data Management System (DMS) for SGMA Implementation
  - Define DMS requirements
  - Assess and document existing systems
  - Develop phased implementation plan
  - Implement initial DMS

- Primarily Grant-Funded

- Status: Underway, though somewhat delayed to evaluate data to be provided by DWR.
Preliminary Results: Existing Groundwater Development
Purpose

• Better understand spatial distribution of domestic and irrigation wells within Colusa County

• Better understand well construction details (depths, screened intervals, diameters)

• Inform evaluation of existing groundwater level monitoring network

• Identify need for and support selection of additional wells for inclusion as required by Groundwater Sustainability Plan (GSP) regulations
Approach

- Refine well locations using DWR Well Completion Reports (WCRs)
- Update well construction details in database
- Inventory wells relative to subbasins and water sources
- Characterize well development over time
- Characterize construction details
  - Depth
  - Screen length
  - Diameter
  - Specific capacity
Domestic Well Development over Time

Legend

Year
- ▲ 1951 - 1960
- ▲ 1961 - 1970
- ▲ 1971 - 1980
- ▲ 1981 - 1990
- ▲ 1991 - 2000
- ▲ 2001 - 2010
- ▲ 2011 - 2015

• Cities
- Major Waterways
- Highways
- Lakes
- Basins/Subbasins
- Counties

Date Created: 9/22/2016
Domestic Well Construction: 1941-2015

Well Completion Reports

Cumulative Well Completion Reports

1941-1945
1946-1950
1951-1955
1956-1960
1961-1965
1966-1970
1971-1975
1976-1980
1981-1985
1986-1990
1991-1995
1996-2000
2001-2005
2006-2010
2011-2015

0
20
40
60
80
100
120
140
160
180
200
150
300
450
600
750
900
1,050
1,200
1,350
1,500

Stressed Basins Grant Update
June 20, 2017
Irrigation Well Development over Time

Irrigation Wells Drilled through 2015

Legend

Year
- 1951 - 1960
- 1961 - 1970
- 1971 - 1980
- 1981 - 1990
- 1991 - 2000
- 2001 - 2010
- 2011 - 2015

- Cities
- Major Waterways
- Highways
- Basins/Subbasins
- Counties

Date Created: 9/23/2016
Cumulative Well Completion Reports

Irrigation Well Construction: 1941-2015

Well Completion Reports

0 20 40 60 80 100 120 140 160 180 200 220


Stressed Basins Grant Update
June 20, 2017
Preliminary Results: Potential Future Irrigation Demands
Purpose

• Provide insight into potential for increased irrigation demands in the future
• Identify factors potentially affecting ability to manage subbasins sustainably
• Support evaluation of water supplies needed to maintain agriculture in the long term
• Support development of projected water budgets as required by Groundwater Sustainability Plans (GSP) regulations
Approach

• Identify areas on or adjacent to the valley floor where:
  • Irrigated agriculture could expand
  • Cropping could shift to higher intensity demands

• Evaluate changes in demand for existing crops over time (increased vigor and evapotranspiration)

• Quantify potential demand increases

• Increased demands could be met by increased groundwater pumping or increased surface water supplies
Potential For Expansion of Irrigated Lands

- Based on California Storie Index (Storie 1978, O’Geen et al. 2008)
- Considers slope, soil characteristics, and potentially other factors
- Calibrated based on Colusa County existing conditions

A Revised Storie Index for Use with Digital Soils Information

ANTHONY TOBY O’GEEN, Cooperative Extension Soil Resource Specialist, Department of Land, Air, and Water Resources, University of California, Davis; SUSAN B. SOUTHARD, USDA Natural Resources Conservation Service, Davis, and RANDAL J. SOUTHARD, Professor of Soil Science, Department of Land, Air, and Water Resources, University of California, Davis

The Storie Index is a widely known and accepted method of rating soils for land use and productivity in California. This soil-based land classification system has been used in California for over 50 years. Storie ratings can be found in published soil surveys throughout California. The latest version of the Storie Index was published in 1978 (Storie 1978). Traditionally, Storie Index ratings have been hand generated by soil survey staff and collaborators. These ratings can be highly subjective because no single person has generated Storie ratings for the entire state, and because of the inherent biases associated with the design of the classification system.

We have developed a revised version of the Storie Index that generates ratings digitally from the USDA Natural Resources Conservation Service (NRCS) National Soil Information System (NASIS). This revised Storie Index is generated from a wide range of soil profile and landscape characteristics similar to those in the Storie 1978.

Since 2005, the NRCS has published Storie Index ratings generated by our revised Storie Index method, which will reduce the subjectivity associated with this form of land classification. The revised model is well correlated with statewide trends in hand-generated Storie ratings (O’Geen and Southard 2005). The purpose of this publication is to document our approach in converting Storie 1978 into the revised Storie Index modeled in NASIS. As such, this publication will serve as an official source of metadata for soil survey users, USDA NRCS technical service providers, and the National Cooperative Soil Survey (NCSS).

BACKGROUND

The Storie Index is a semiquantitative method of rating soils used mainly for irrigated agriculture based on crop productivity data collected from major California soils in the 1930s and 1950s (Storie 1953; Rognalnd and Singer 1970). The Storie Index assesses the productivity of a soil from the following four characteristics: Factor A, the degree of soil profile development; Factor B, surface texture; Factor C, slope; and Factor X, other soil and landscape conditions including the subfactors drainage, alkali, fertility, acidity, erosion, and microlrelief. A score ranging from 0 to 100 is determined for each factor, and the scores are then multiplied together to generate an index rating (Storie 1978).

One shortcoming of hand-generated Storie ratings is that the scoring options for a particular factor or subfactor have broad and somewhat arbitrary ranges, which creates a great potential for subjectivity among scientists (O’Geen and Southard 2005). Our goal was to develop a model in NASIS to rapidly generate Storie ratings without inherent scoring discrepancies associated with hand-generated ratings.

Storie index rating = (Factor A/100) × (Factor B/100) × (Factor C/100) × (Factor X/100) × 100
Irrigability Index

• Irrigability Index ($I^2$) calculated as the product of three factors:

$$I^2 = \left[ \frac{(\text{Factor } A)}{100} \right] \times \left[ \frac{(\text{Factor } B)}{100} \right] \times \left[ \frac{(\text{Factor } C)}{100} \right] \times 100$$

• Factor A is based on slope
• Factor B is based on soil depth to a restrictive layer
• Factor C is based on the percent of rock fragments present

• A minimum value of $I^2$ is selected and used to estimate whether currently non-irrigated lands within or adjacent to the Colusa and West Butte subbasins have the potential to be irrigated.
Characteristics of Existing and Potential Irrigated Lands

**Irrigated, Non-Rice**

- **Percent Slope**
  - 0
  - 1-2
  - 2-3
  - 3-4
  - 4-5
  - 5-6
  - 6-7
  - 7-8
  - 8-9
  - 9-10
  - >10

- **Depth to Restrictive Layer (in)**
  - 0
  - 10-20
  - 20-30
  - 30-40
  - 40-50
  - 50-60
  - 60-70
  - 70-80
  - >80

- **Fragment Volume (%)**
  - >70
  - 60-70
  - 50-60
  - 40-50
  - 30-40
  - 20-30
  - 10-20
  - 0-10
  - 0

**Native or Non-Irrigated Grain/Pasture**

- **Percent Slope**
  - 0
  - 1-2
  - 2-3
  - 3-4
  - 4-5
  - 5-6
  - 6-7
  - 7-8
  - 8-9
  - 9-10
  - >10

- **Depth to Restrictive Layer (in)**
  - 0
  - 10-20
  - 20-30
  - 30-40
  - 40-50
  - 50-60
  - 60-70
  - 70-80
  - >80

- **Fragment Volume (%)**
  - >70
  - 60-70
  - 50-60
  - 40-50
  - 30-40
  - 20-30
  - 10-20
  - 0-10
  - 0
Irrigability Index Factors

\[ I^2 = \left( \frac{\text{Factor A}}{100} \right) \times \left( \frac{\text{Factor B}}{100} \right) \times \left( \frac{\text{Factor C}}{100} \right) \times 100 \]

Factor A (slope)

Factor B (depth)

Factor C (rocks)

Example 1: \( I^2 = (93/100 \times 95/100 \times 98/100) \times 100 = 87 \)

Example 2: \( I^2 = (80/100 \times 57/100 \times 100/100) \times 100 = 46 \)

Example 3: \( I^2 = (35/100 \times 83/100 \times 25/100) \times 100 = 7 \)
Grey Areas Are Currently Irrigated Based on DWR Surveys
Potentially Irrigable Lands

- Parcel Average Irrigability Index > 53 (97 percent exceedance value for irrigated, non-rice lands)
- At least 10 contiguous acres
- Exclude
  - Freeway medians; wildlife refuges; flood bypasses; riparian areas; washes prone to flooding
  - Long, thin polygons (not “farmable”)
  - Government owned, zoned commercial and industrial
Results:
10,100 potential irrigable acres in/adjacent to Colusa Subbasin
Potential Changes in Cropping Patterns

• Based on historical (and recent) cropping trends

• Valley floor subdivided based on existing cropping patterns and soil characteristics

• Trends evaluated by subarea

• Judgement applied when projecting trends into the future

• Potential future cropping represents approximately mid-century
Ricelands (Colusa Subbasin)

### Historical
- **1993**
  - Rice: 75%
  - Orchard & Vineyard: 5%
  - Pasture & Hay: 5%
  - Field Crops: 5%
  - Truck Crops: 5%
  - Grain: 5%
- **1998**
  - Rice: 70%
  - Orchard & Vineyard: 10%
  - Pasture & Hay: 5%
  - Field Crops: 5%
  - Truck Crops: 5%
  - Grain: 10%
- **2003**
  - Rice: 65%
  - Orchard & Vineyard: 10%
  - Pasture & Hay: 5%
  - Field Crops: 10%
  - Truck Crops: 5%
  - Grain: 5%
- **2009**
  - Rice: 60%
  - Orchard & Vineyard: 10%
  - Pasture & Hay: 5%
  - Field Crops: 10%
  - Truck Crops: 5%
  - Grain: 5%

### Recent
- **2014**: Rice: 60%
- **Mid-Century**: Rice: 55%

### Potential
- **Mid-Century**: Rice: 50%
North Sac. River Corridor (West Butte Subbasin)

Historical

- 1993
- 1998
- 2003
- 2009

Recent

- 2014

Potential

- Mid-Century

Acreage (thousands):

- Rice
- Orchard & Vineyard
- Pasture & Hay
- Field Crops
- Truck Crops
- Grain

Stressed Basins Grant Update
June 20, 2017
Preliminary Potential Changes

- Western Valley Floor and Foothills
  - Continued increase in orchards
  - Continued decrease in other, non-rice crops

- Ricelands
  - Little change

- North Sac. River
  - Decrease in non-rice acres (Colusa)
  - Increase in orchards and decrease in other, non-rice crops
  - Overall decrease due to potential development

- South Sac. River
  - Increase in orchards and decrease in other, non-rice crops
Potential Changes in Cropping Intensity

- Change in consumptive demand (evapotranspiration or ET) for existing crops
- Satellite remote sensing analysis using energy balance (SEBAL) and vegetation index (NDVI)
- Normalize for inter-annual weather variability
- Evaluate historical ET demands by crop for DWR land use survey years
Rice Annual Evapotranspiration

(Black dashes represent standard deviation)
Tomato Annual Evapotranspiration

(Black dashes represent standard deviation)

Average Annual Evapotranspiration (in)

- 1993
- 1998
- 2003
- 2009
- 2014

Stressed Basins Grant Update
June 20, 2017
Tomato Monthly Evapotranspiration

Average Actual Evapotranspiration (in)

Month

1993
1998
2003
2009
2014

1993
1998
2003
2009
2014

Month
1
2
3
4
5
6
7
8
9
10
11
12

Average Actual Evapotranspiration (in)
Walnut Annual Evapotranspiration

(Black dashes represent standard deviation)

Average Annual Evapotranspiration (in)

Preliminary Results

• Little change in cropping intensity (ET) for most crops over last 25 years
• Increase in ET for tomatoes
• Increase in ET for almonds

Moving forward:
• Assume additional ET increase of ~10% for orchards (2/3 of current orchards are almonds)
• Assume additional ET increase of ~5% for truck crops (3/4 of current truck crops are tomatoes)
Summing It Up...

• Potential for increased irrigated area in Colusa Subbasin (~10,000 acres)
• Potential for continued increase in orchard acres within non-rice area (with likely limits)
• Potential for increased intensity (ET) for orchards (i.e. almonds) and truck crops (i.e. tomatoes)
• Increased irrigation demands due to increased ET likely offset, in part, by increased irrigation efficiency (though this will not help sustainability)
Increased ET Demands

- Expansion of Irrigated Area: 23,000 af
- Land Use Shifts: 11,000 af
- Intensification on Existing Crops: 24,000 af
- Total Increase in ET Demands: 58,000 af

Total Current ET Demands*: 826,000 af
Total Potential ET Demands*: 884,000 af
Potential Percent Increase: 7 %

* Includes irrigated croplands only
### Increased Irrigation Demands*

<table>
<thead>
<tr>
<th>Description</th>
<th>Demand (af)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expansion of Irrigated Area</td>
<td>25,000</td>
</tr>
<tr>
<td>Land Use Shifts</td>
<td>5,000</td>
</tr>
<tr>
<td>Intensification on Existing Crops</td>
<td>27,000</td>
</tr>
<tr>
<td>Increased Irrigation Efficiency</td>
<td>-27,000</td>
</tr>
<tr>
<td><strong>Total Increase in Demands</strong></td>
<td><strong>30,000</strong></td>
</tr>
</tbody>
</table>

- **Total Current Irrigation Demands:** 1,240,000 af
- **Total Potential Irrigation Demands:** 1,270,000 af

- **Potential Percent Increase:** 2 %

* Assumes 5–10% increase in Irrigation Efficiency for Non-Rice Crops.
Next Steps

• (Continued) coordination with Glenn County
• Potential refinements to groundwater development characterization and assessment of potential future demands
• Evaluation of Colusa County monitoring network and development of recommendations related to tracking sustainability indicators
• Initial development of data management system and implementation plan
Discussion