

# Tehama County Reconnaissance-Level Groundwater Sustainability Risk Assessment

Dauids Engineering, Inc.

August 9, 2017

# Approach

- **What are the key decisions embedded in preparing a Groundwater Sustainability Plan (GSP)?**
- **“Key decisions” are ones that could affect the availability and/or the cost of groundwater to overlying landowners**
- **Where should resources be focused to maintain sustainability while controlling costs?**

# Outline

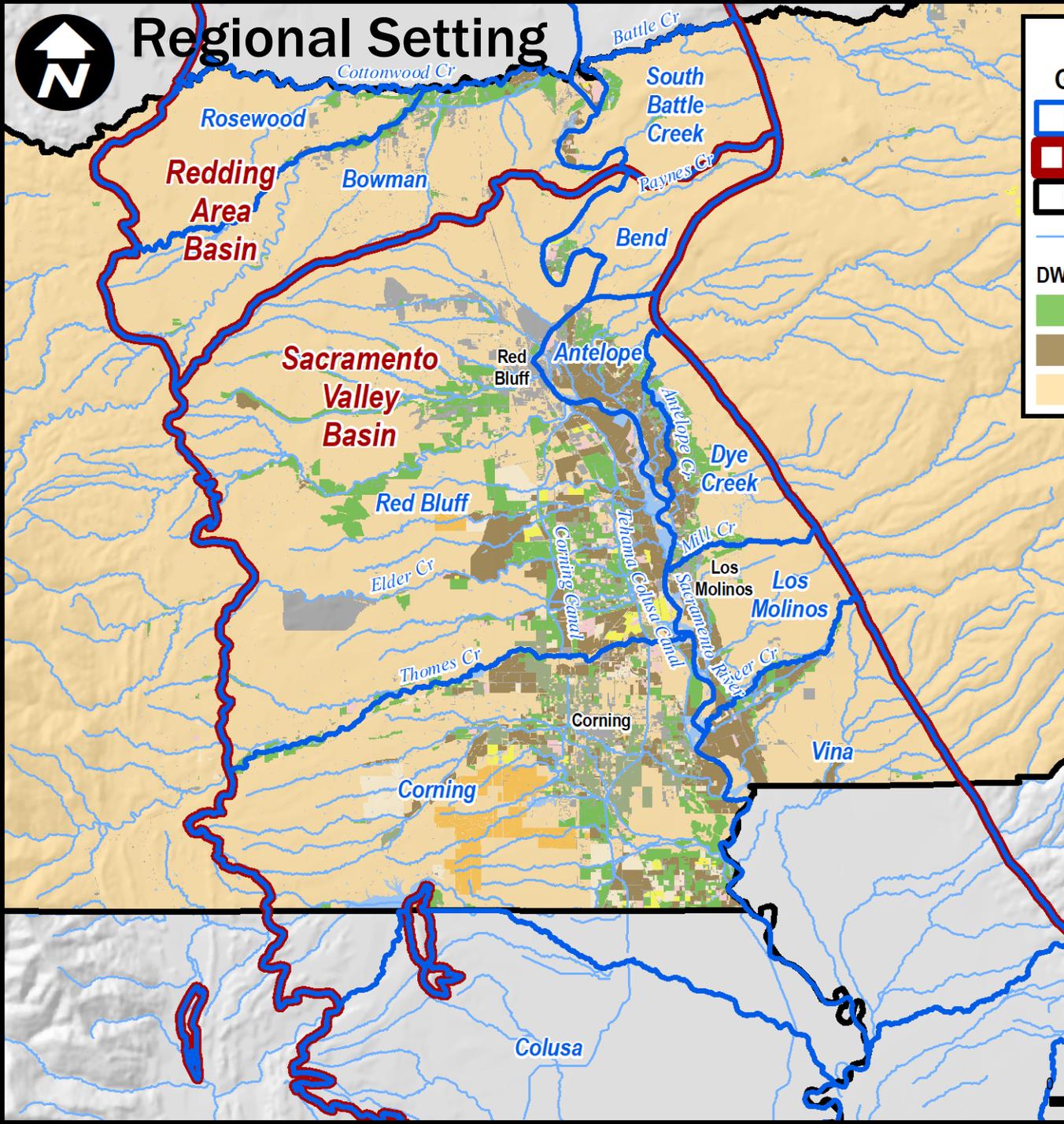
- **Tehama County Setting**
- **Key Decisions Embedded in GSP Development**
- **Sustainability Assessment by Groundwater Sustainability Indicator**
  - **Look into the Crystal Ball**
  - **Identify likely approach to address in GSP**
- **Questions & Answers, Discussion**

# 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; otherwise, please hold comments and discussion for later



# Regional Setting



### Tehama County Groundwater Basins and Land Use

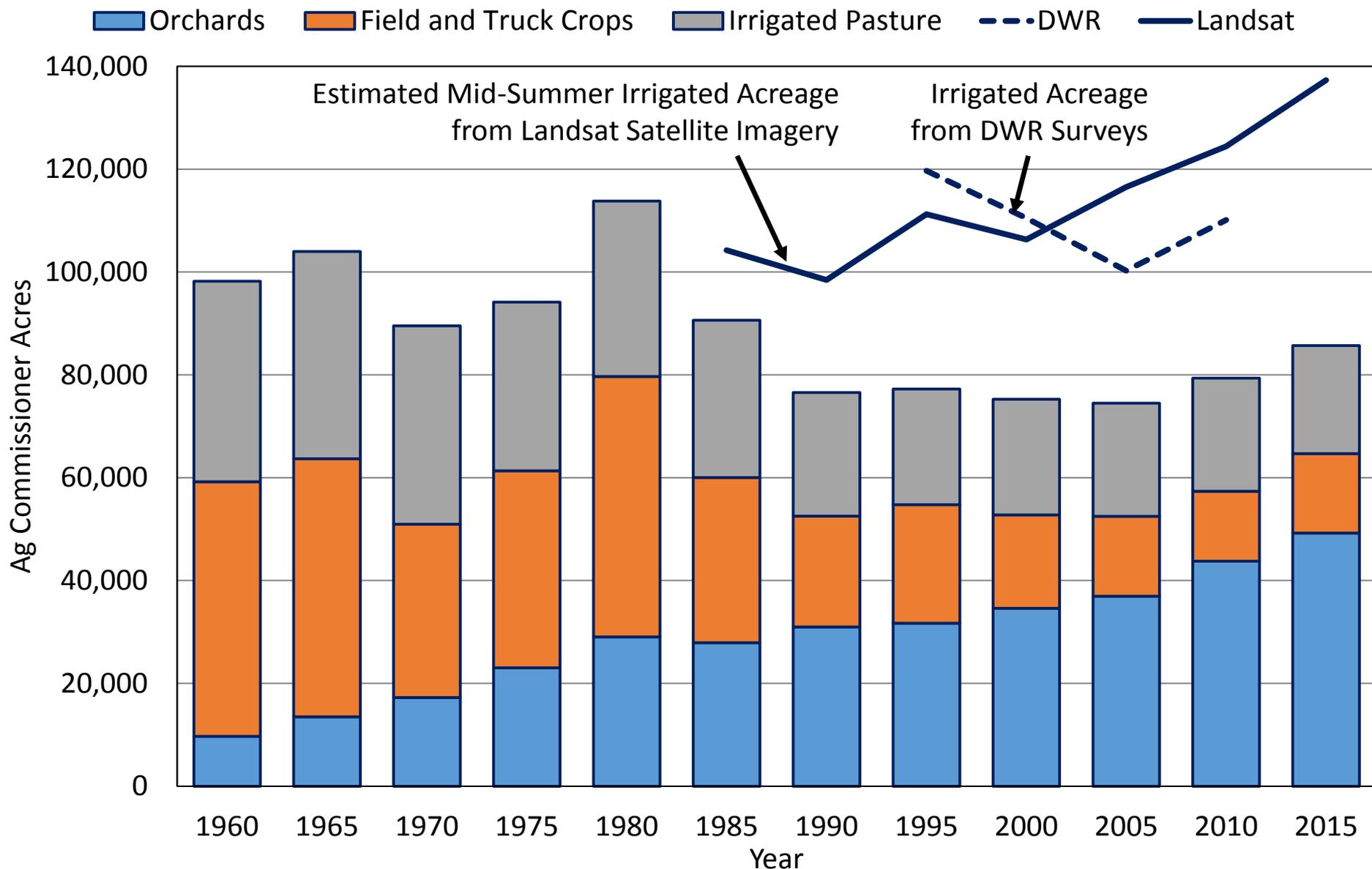
- Groundwater Subbasins
- Groundwater Basins
- County Boundary
- Streams
- Pasture and Alfalfa
- Deciduous Orchards
- Native
- Field and Truck
- Grain
- Idle Cropland
- Misc. Subtropical
- Olives
- Riparian
- Developed

### Groundwater Basin Areas

Basin	Subbasin	Acres
Redding Area	Bowman	79,561
	Rosewood	42,695
	South Battle Creek	32,547
	Anderson	564
	Millville	1,169
	TOTAL	156,537
Sacramento Valley	Red Bluff	271,794
	Corning	161,262
	Vina	40,638
	Los Molinos	30,994
	Dye Creek	28,027
	Bend	22,676
	Antelope	19,091
TOTAL	574,481	
GRAND TOTAL		731,019

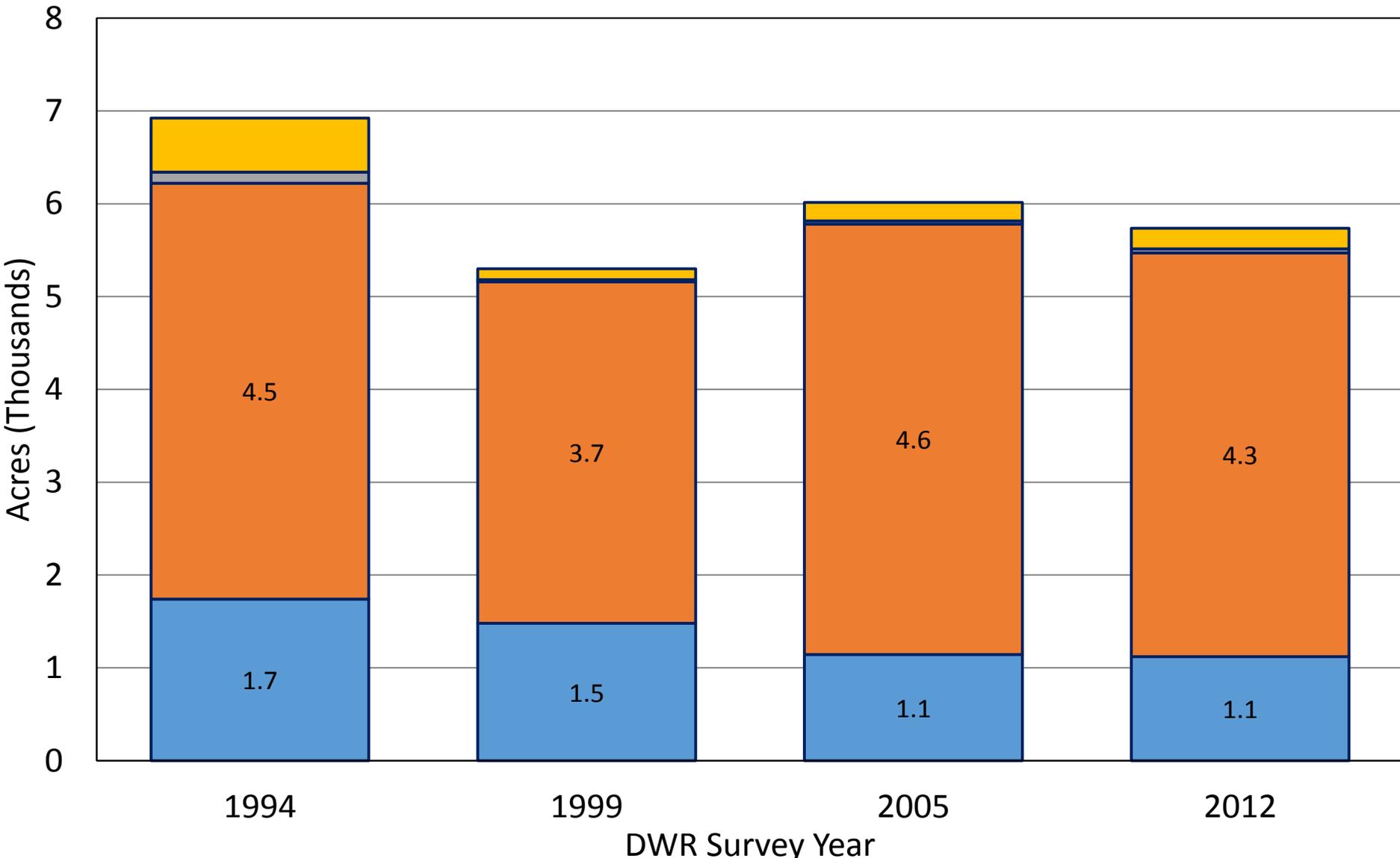


# Tehama County Land Use Trends



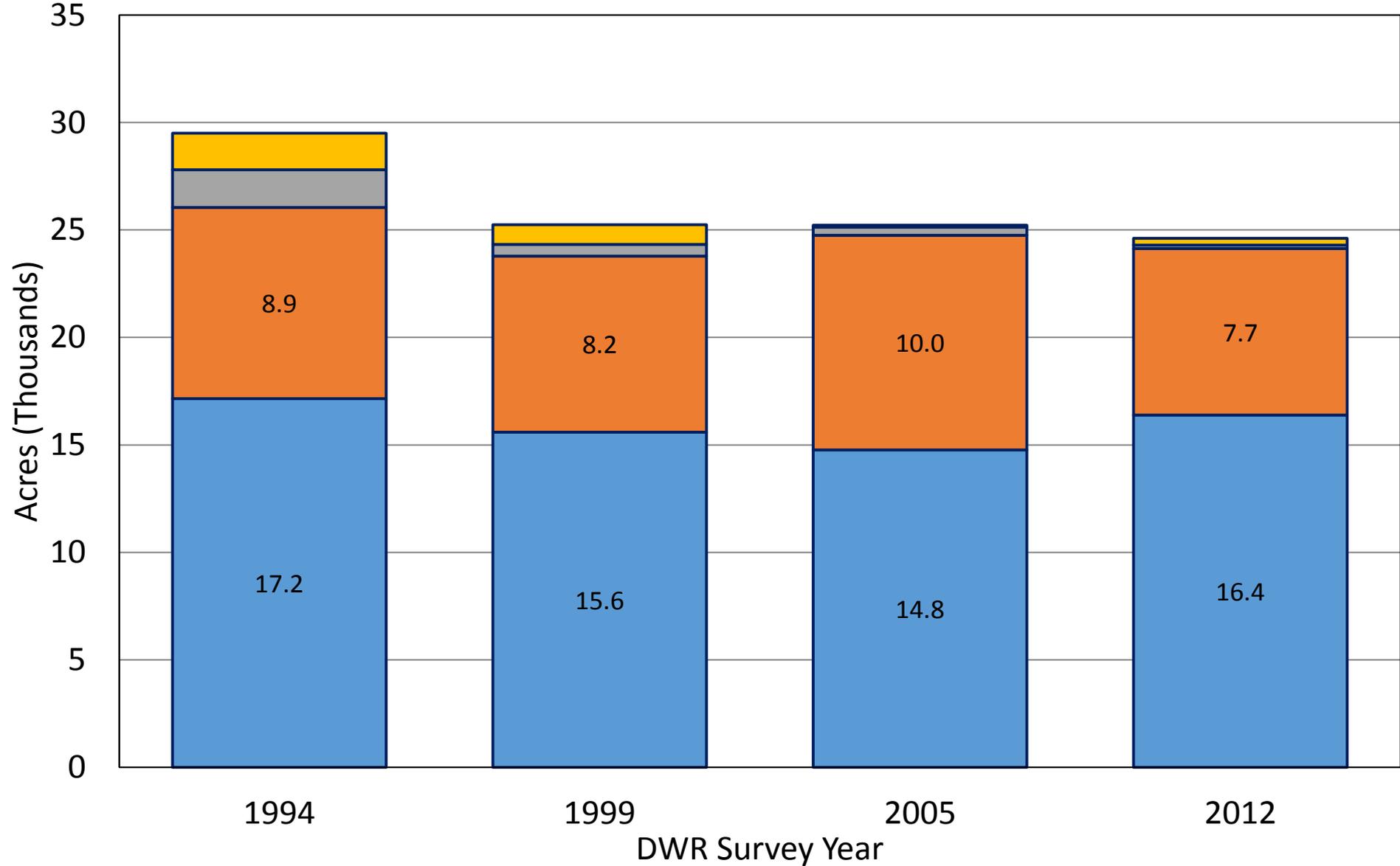
# Redding Area Basin in Tehama County

Orchards & Vineyards    Pasture & Hay, Irrigated    Field & Truck    Grain, Irrigated    Rice



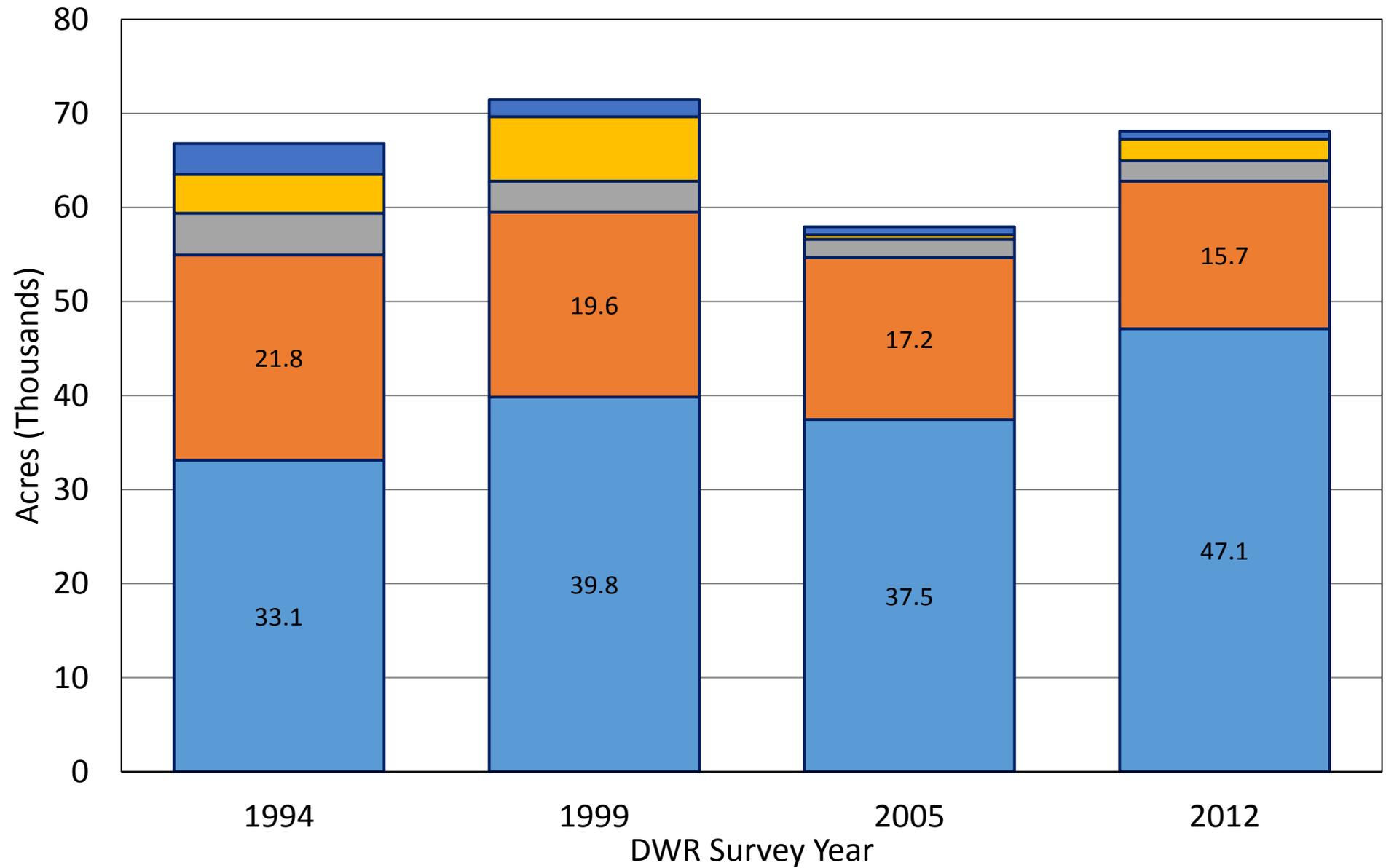
# Sacramento Valley Basin East of Sacramento River

Orchards & Vineyards    Pasture & Hay, Irrigated    Field & Truck    Grain, Irrigated    Rice



# Sacramento Valley West

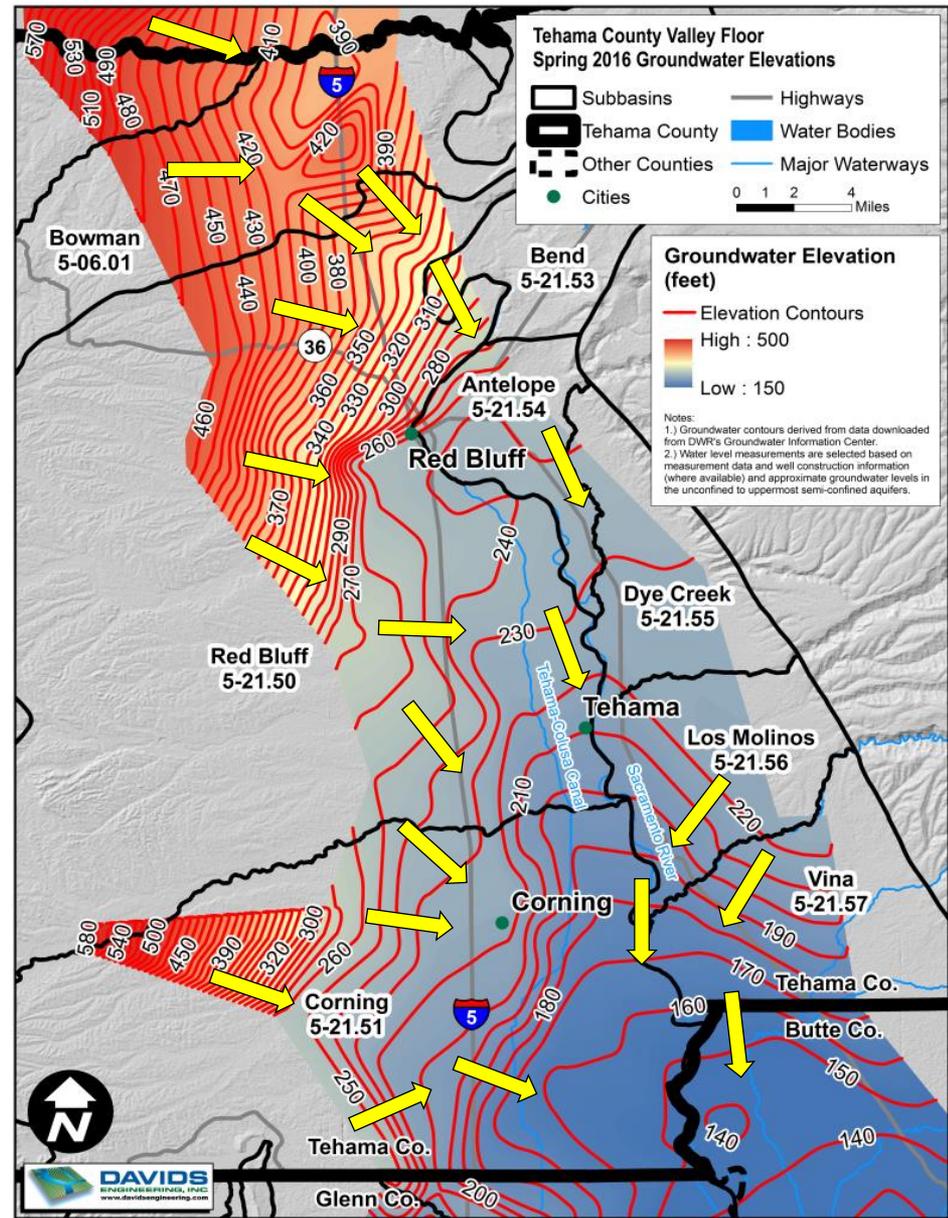
■ Orchards & Vineyards   
 ■ Pasture & Hay, Irrigated   
 ■ Field & Truck   
 ■ Grain, Irrigated   
 ■ Rice



# Tehama County Regional Setting

Groundwater Basin Areas		
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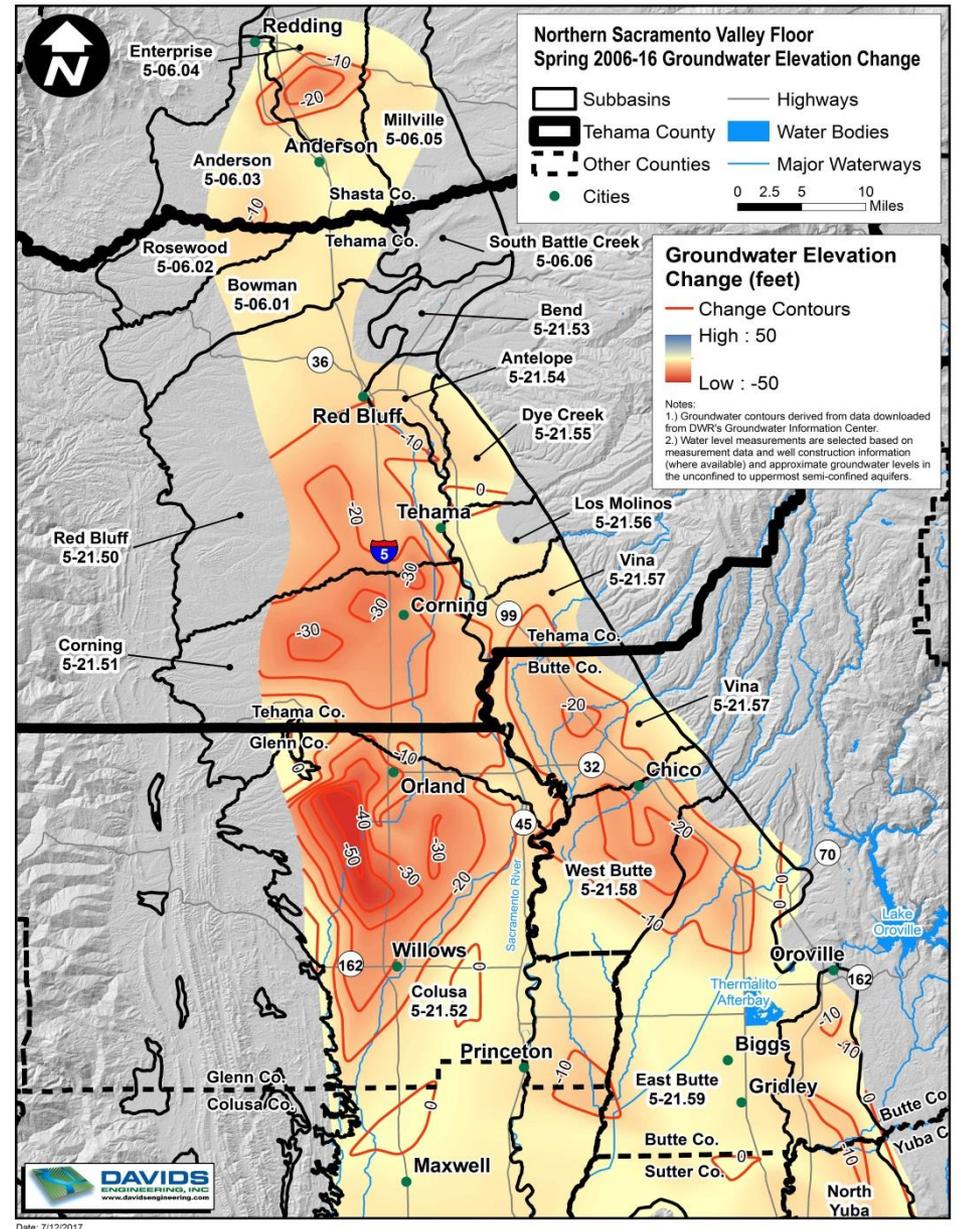
- Approx. 45,000 additional acres in Corning Subbasin in Glenn County
- Approx. 84,000 additional acres in Vina Subbasin in Butte County



Date: 6/19/2017

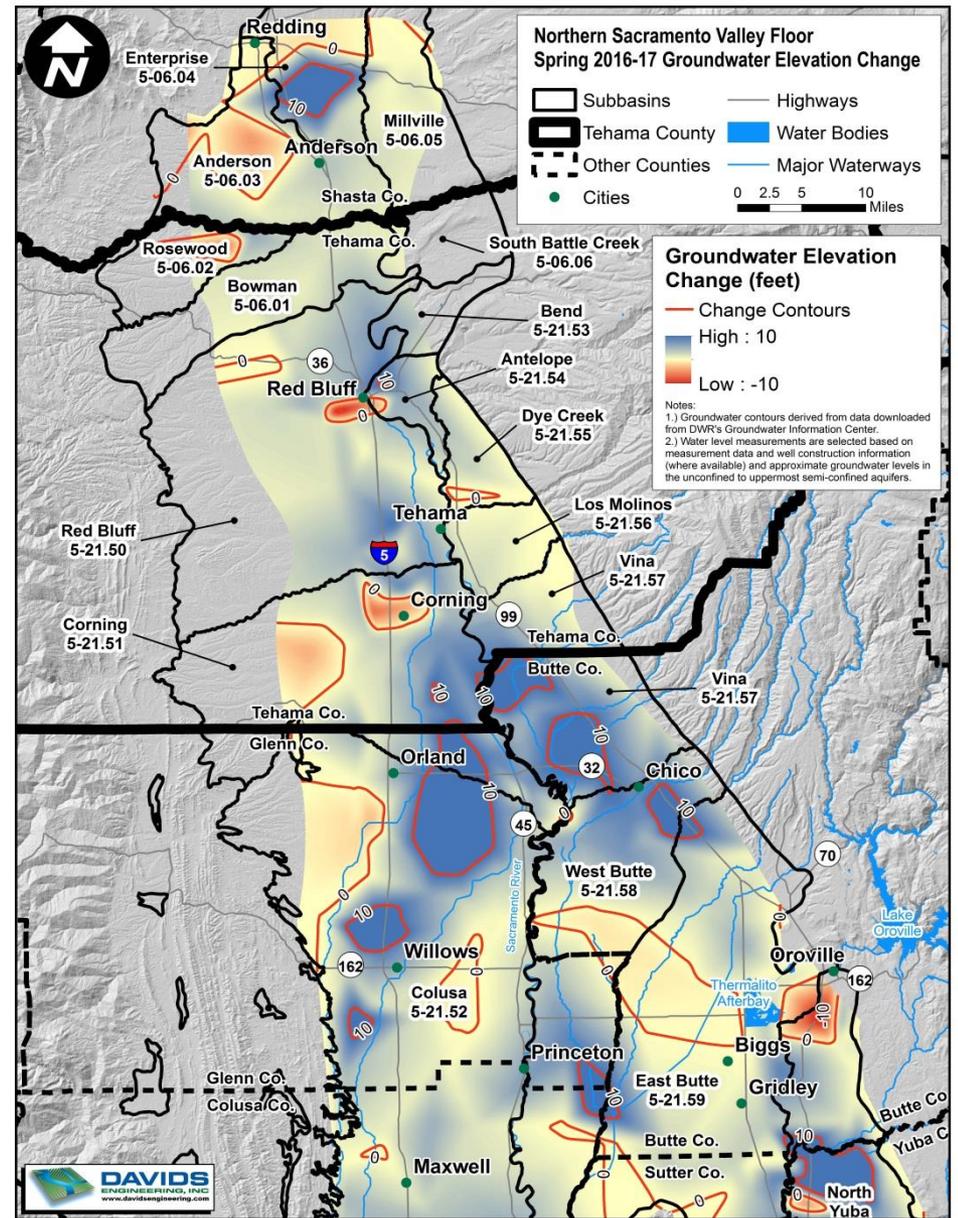
# Tehama County Regional Setting: Groundwater Elevation Change 2006 to 2016

Data Source: DWR  
Groundwater Information  
Center. Water level  
measurements are from wells  
in the unconfined to  
uppermost semi-confined  
aquifers. (Generally  
corresponding to wells depths  
between 100 and 450 feet.)

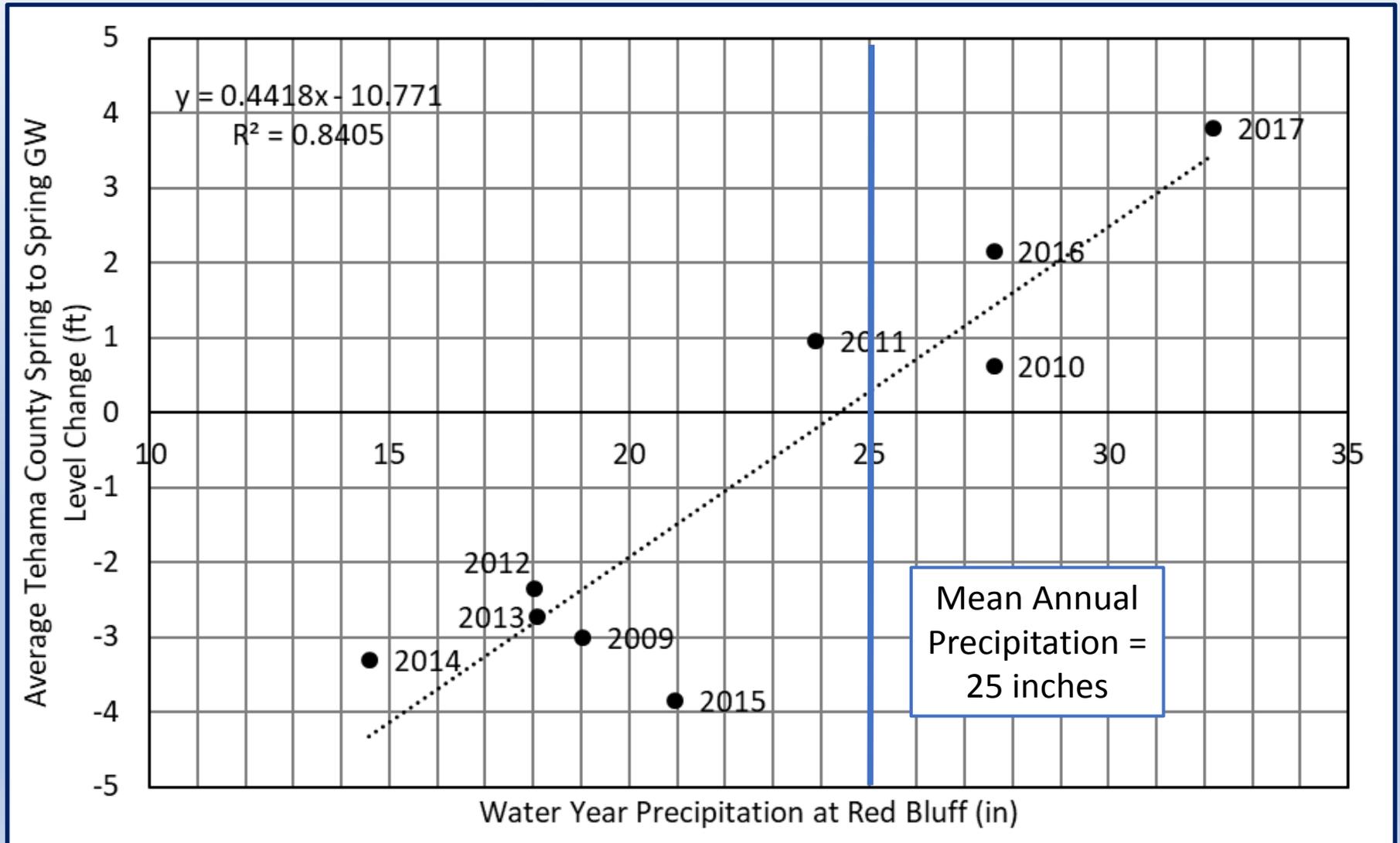


# Tehama County Regional Setting: Groundwater Elevation Change 2016 to 2017

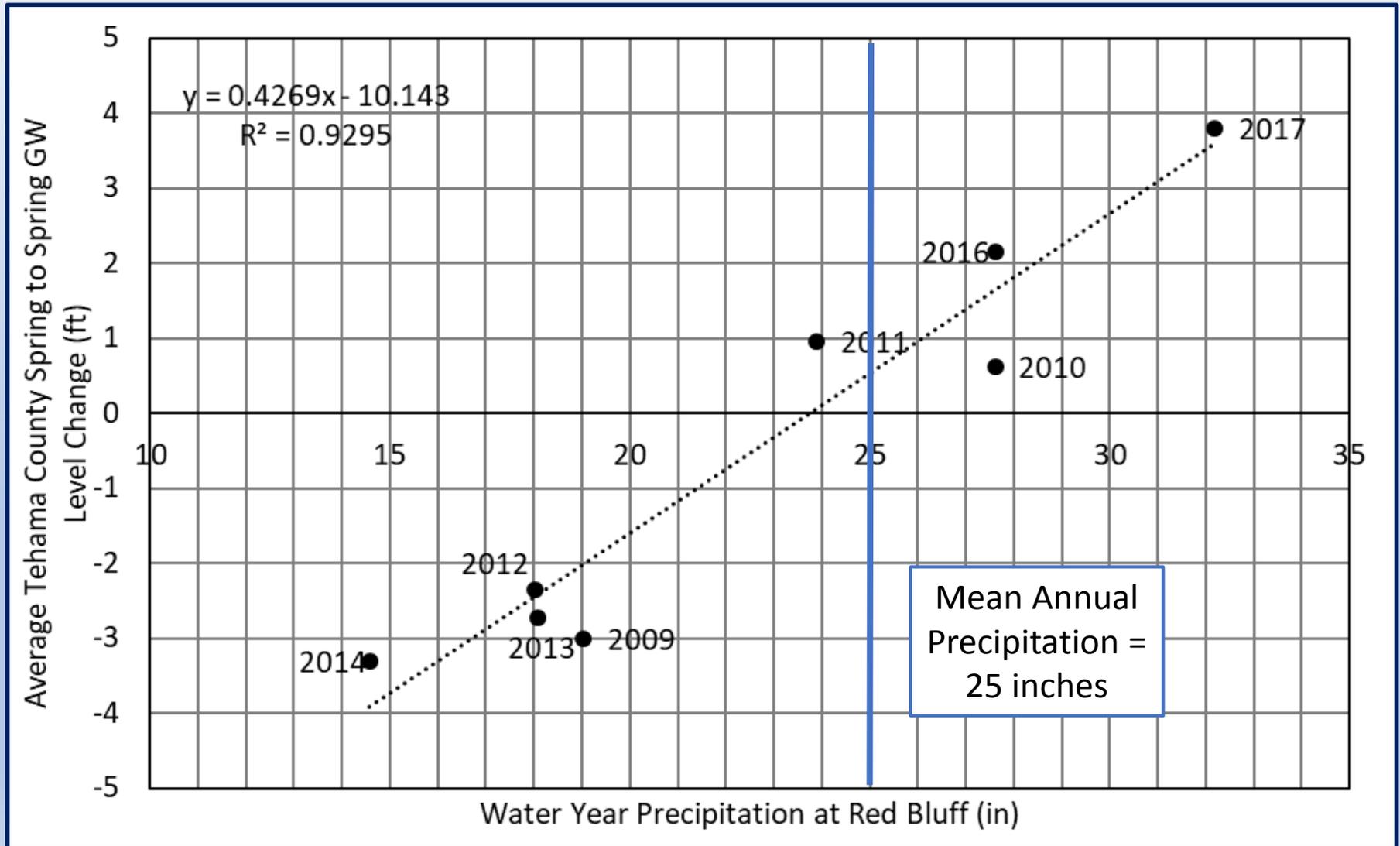
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# Change in Groundwater Levels Relative to Annual Precipitation



# Change in Groundwater Levels Relative to Annual Precipitation



# Key Decisions Embedded in GSP Development

- **Setting criteria for how the basin will be sustainably managed**
  - Defining “Undesirable Results”: do they exist now; will they potentially occur in the future?
  - Establishing “Minimum Thresholds” and “Measureable Objectives” for each Sustainability Indicator
- **Deciding how sustainability will be achieved**
  - What Management Actions and Projects may be required?
  - Where?
  - Cost and who pays?

# SGMA Sustainability Indicators

- 1) Chronic Lowering of Groundwater Levels
- 2) Reduction of Groundwater Storage
- 3) ~~Seawater Intrusion~~
- 4) Degraded Water Quality
- 5) Land Subsidence
- 6) Depletions of Interconnected Surface Water

# 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)**
- **An agency that is able to demonstrate that undesirable results...are not present and are not likely to occur...shall not be required to establish criteria (in the GSP) (§354.26)**

# Sustainability Indicator #1

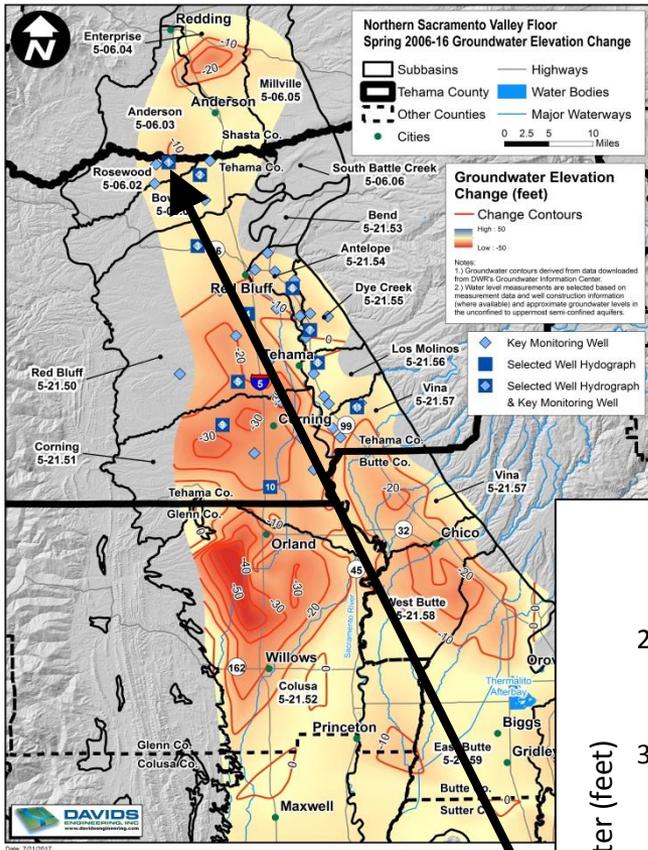
## Chronic Lowering of Groundwater Levels

- **Minimum Threshold: “...the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results.”**  
**§ 354.28 (c) (1)**
- **Potential Undesirable Results:**
  - Well stranding
  - Increased well construction costs
  - Increased groundwater pumping costs
  - Induced water quality degradation
  - Inelastic land subsidence
  - Streamflow depletion
  - Impacts to Groundwater Dependent Ecosystems
  - Others?

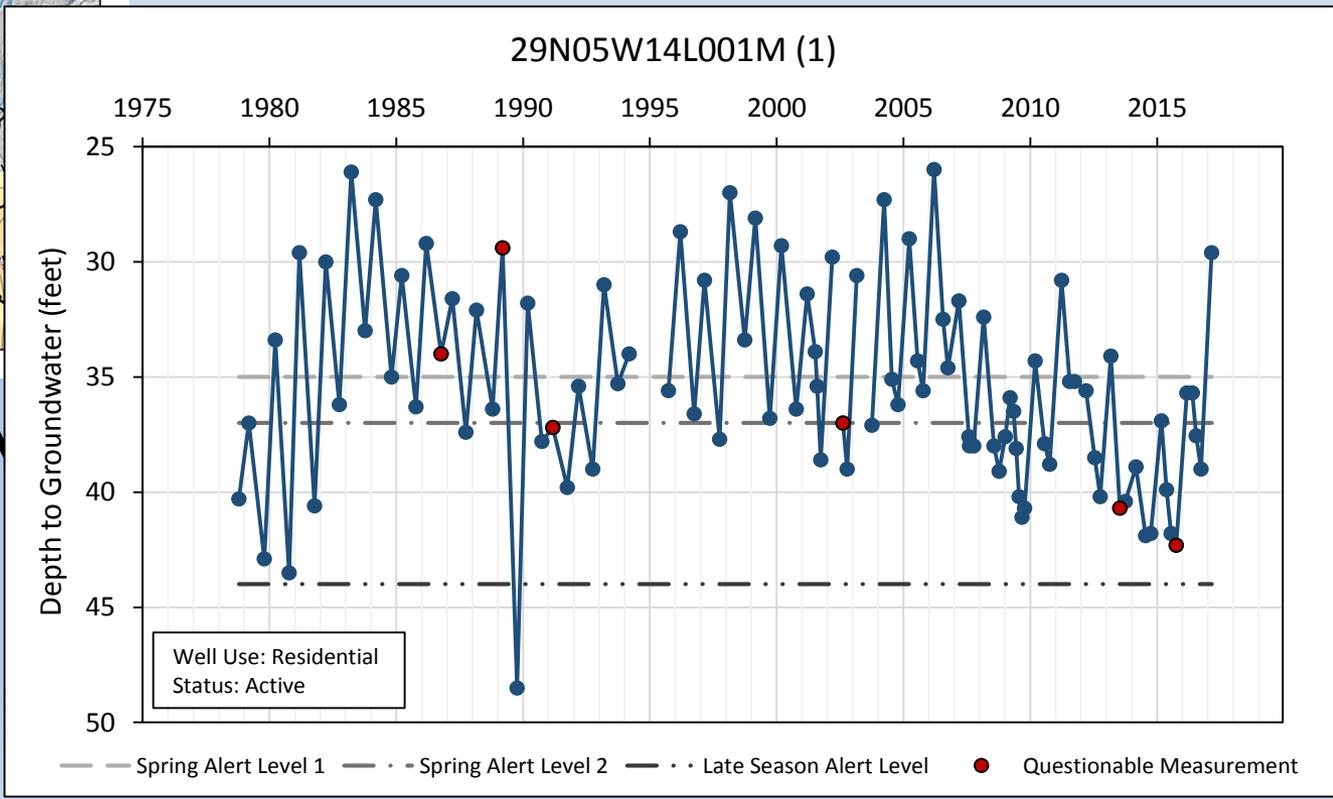
# Excluded Subbasins

- **Anderson**
  - Included in Tehama County due to border delineation discrepancies that will be corrected by DWR
- **Millville**
  - Intent is to modify boundary to move north to Shasta County line
- **South Battle Creek and Bend**
  - Insufficient data available
  - Groundwater use in the portions of these subbasins within Tehama County is not anticipated to be significant

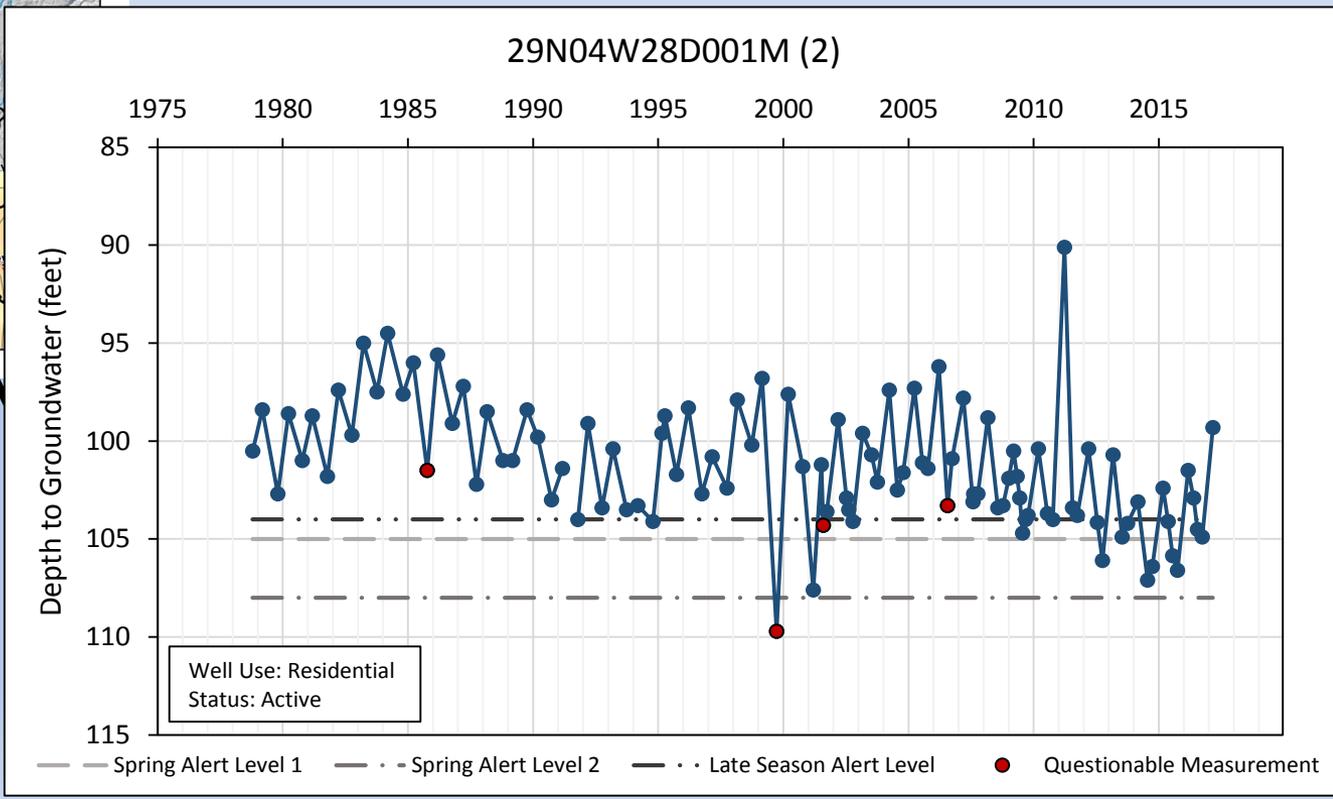
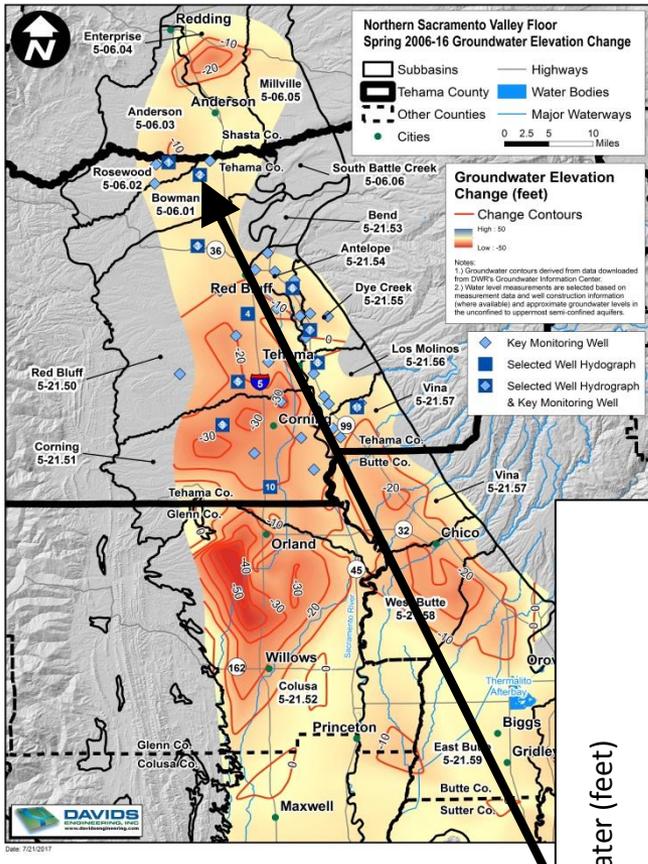
# Sustainability Indicator #1 Chronic Lowering of Groundwater Levels (Rosewood Subbasin)



**\* Tehama County  
Key Monitoring  
Well**

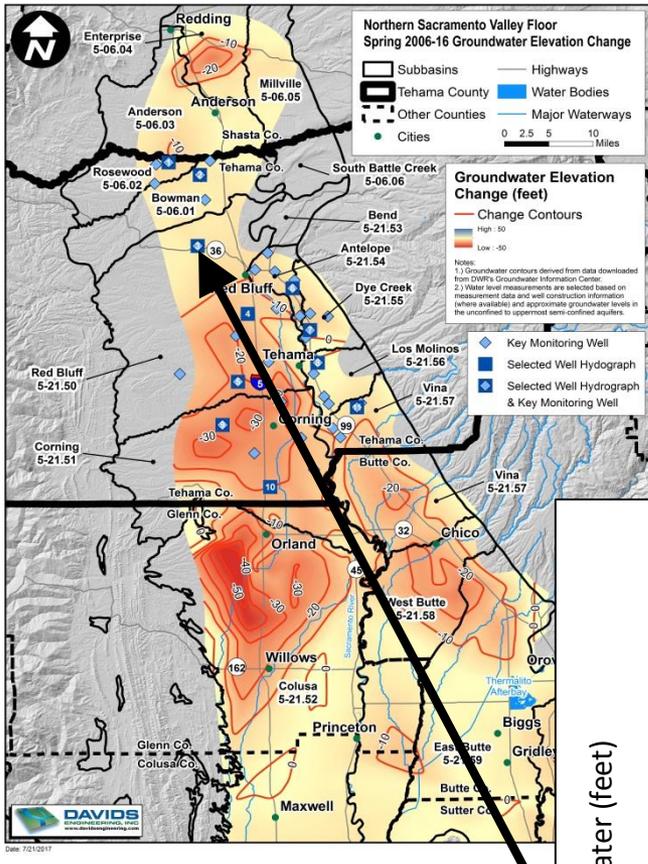


# Sustainability Indicator #1 Chronic Lowering of Groundwater Levels (Bowman Subbasin)

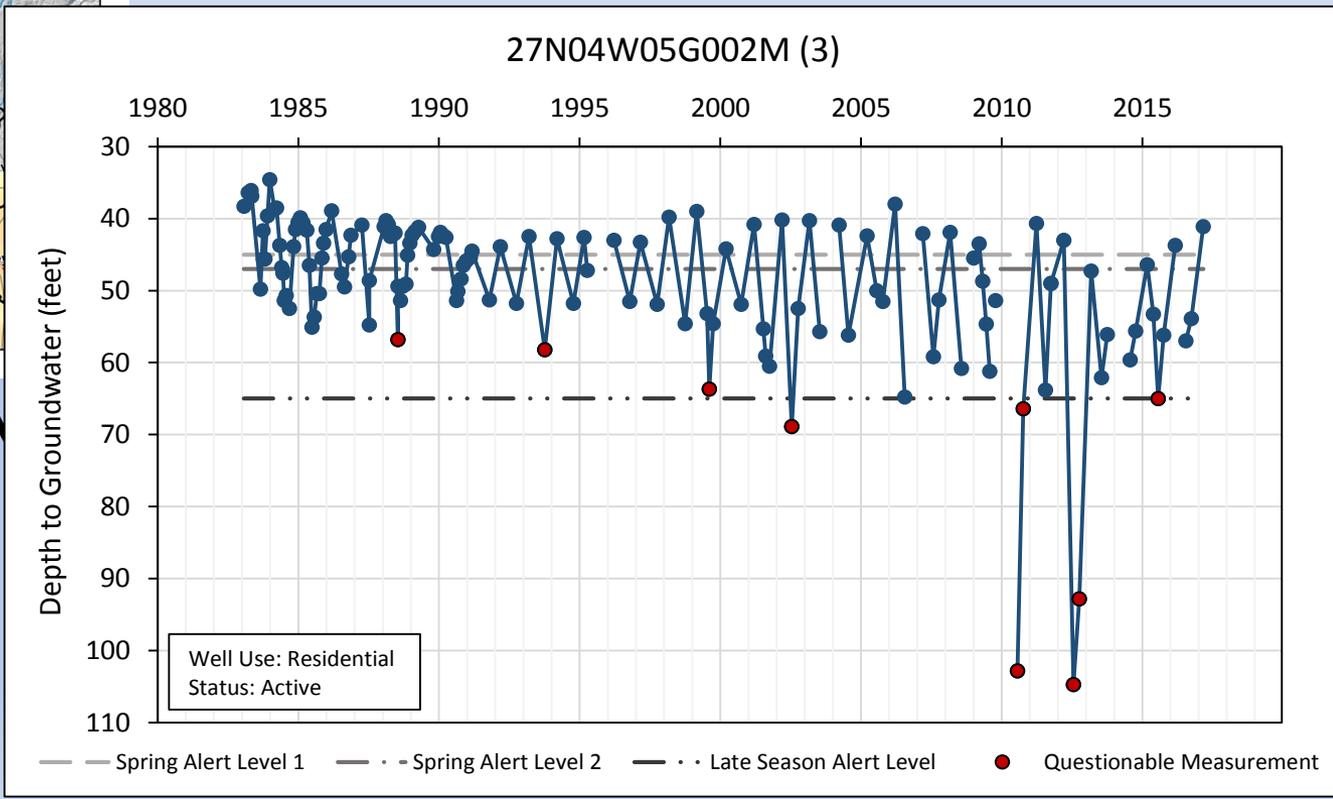


\* Tehama County  
Key Monitoring  
Well

# Sustainability Indicator #1 Chronic Lowering of Groundwater Levels (Red Bluff Subbasin)



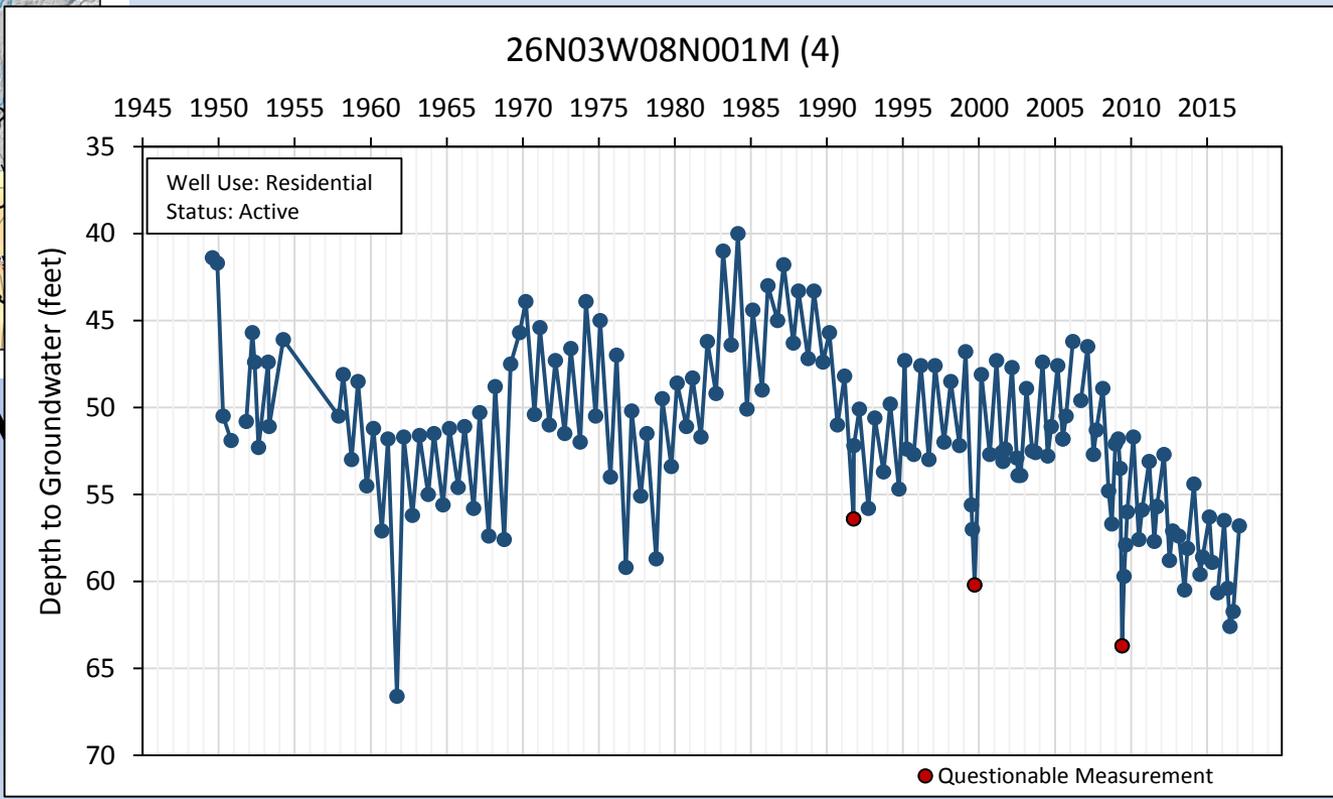
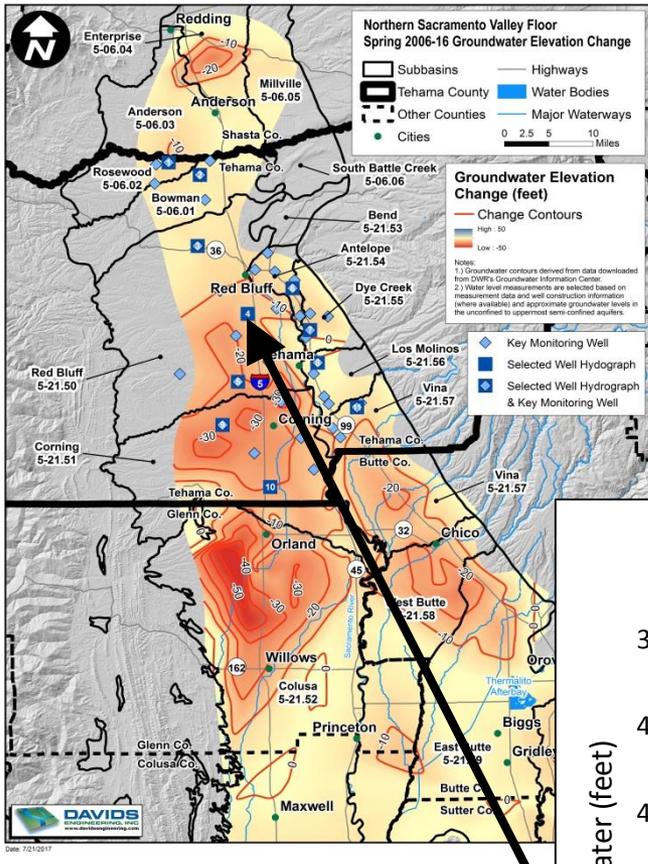
**\* Tehama County  
Key Monitoring  
Well**



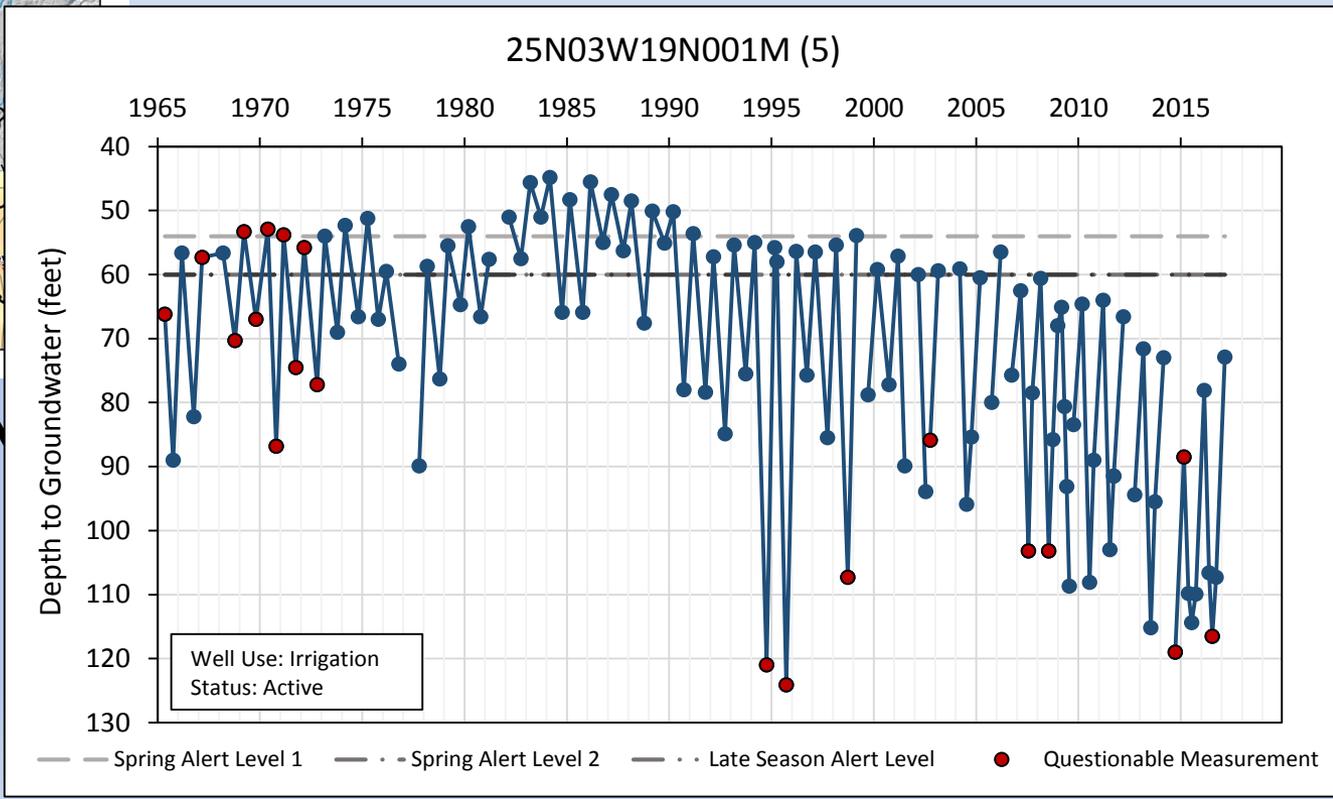
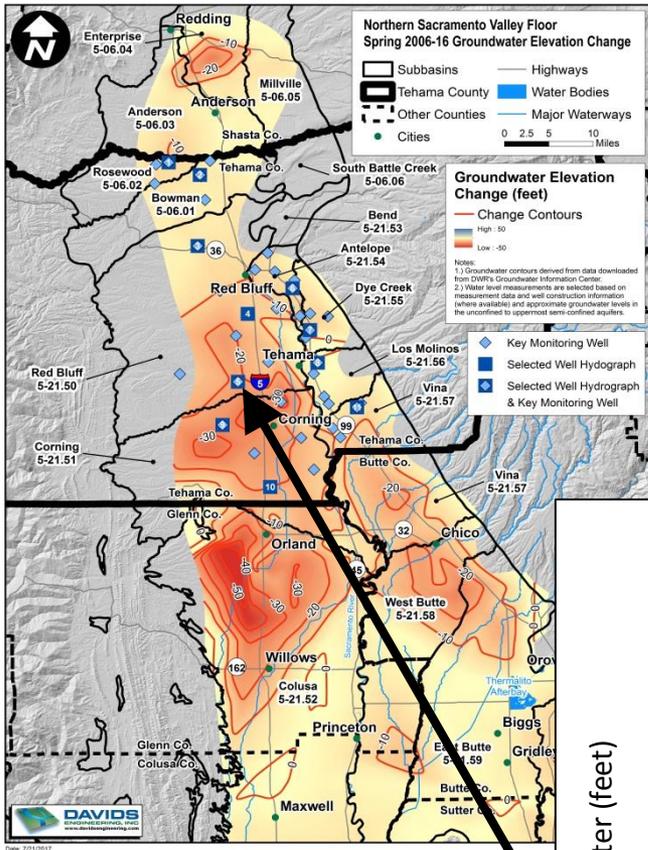
# Sustainability Indicator #1

## Chronic Lowering of Groundwater Levels

### (Red Bluff Subbasin)

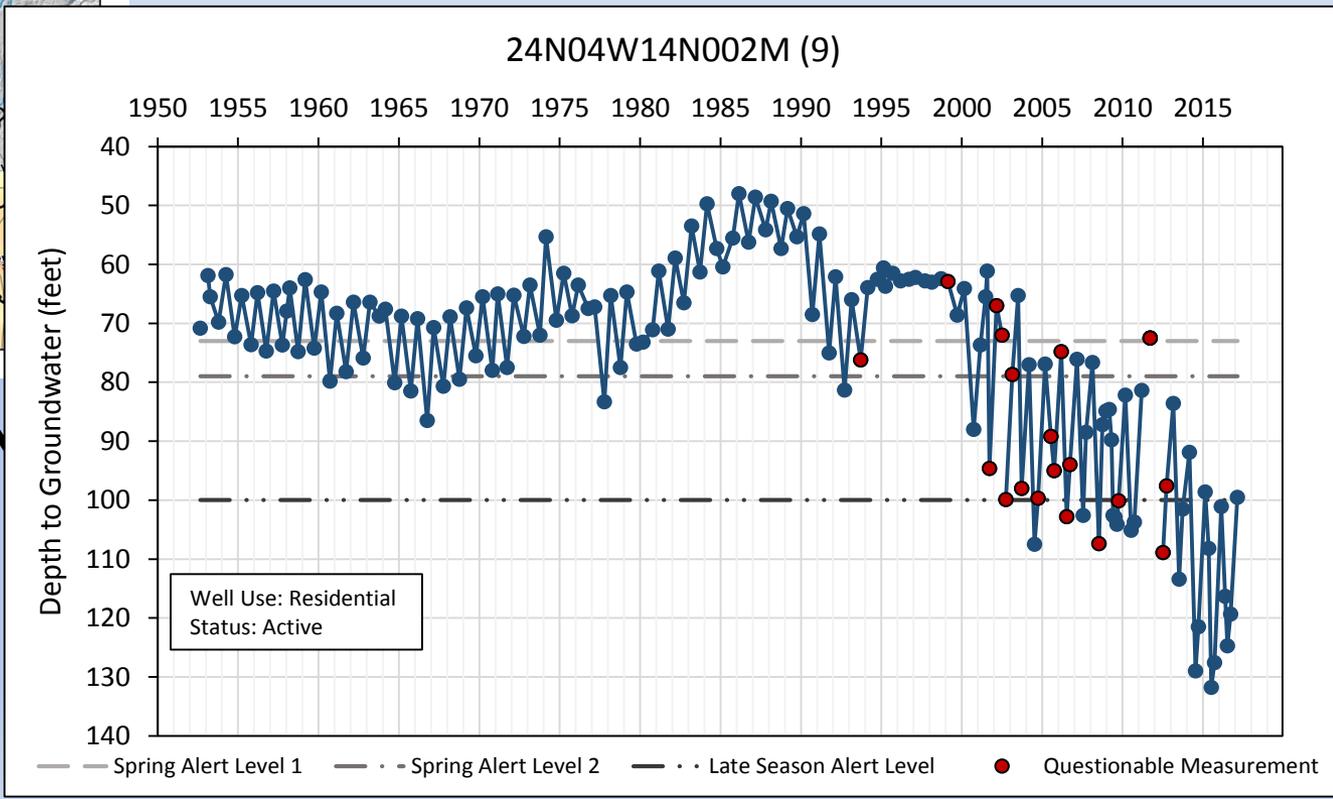
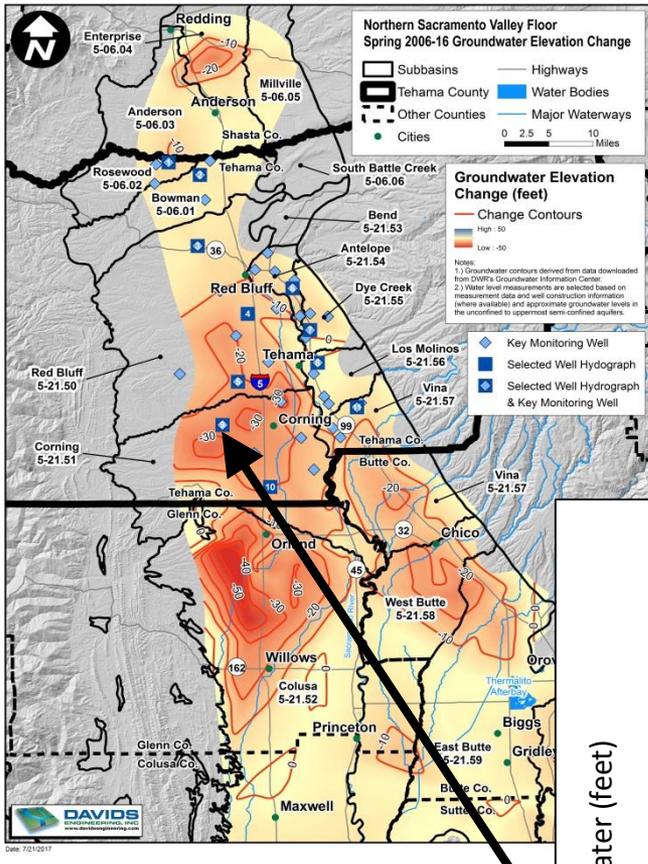


# Sustainability Indicator #1 Chronic Lowering of Groundwater Levels (Red Bluff Subbasin)



**\* Tehama County  
Key Monitoring  
Well**

# Sustainability Indicator #1 Chronic Lowering of Groundwater Levels (Corning Subbasin)

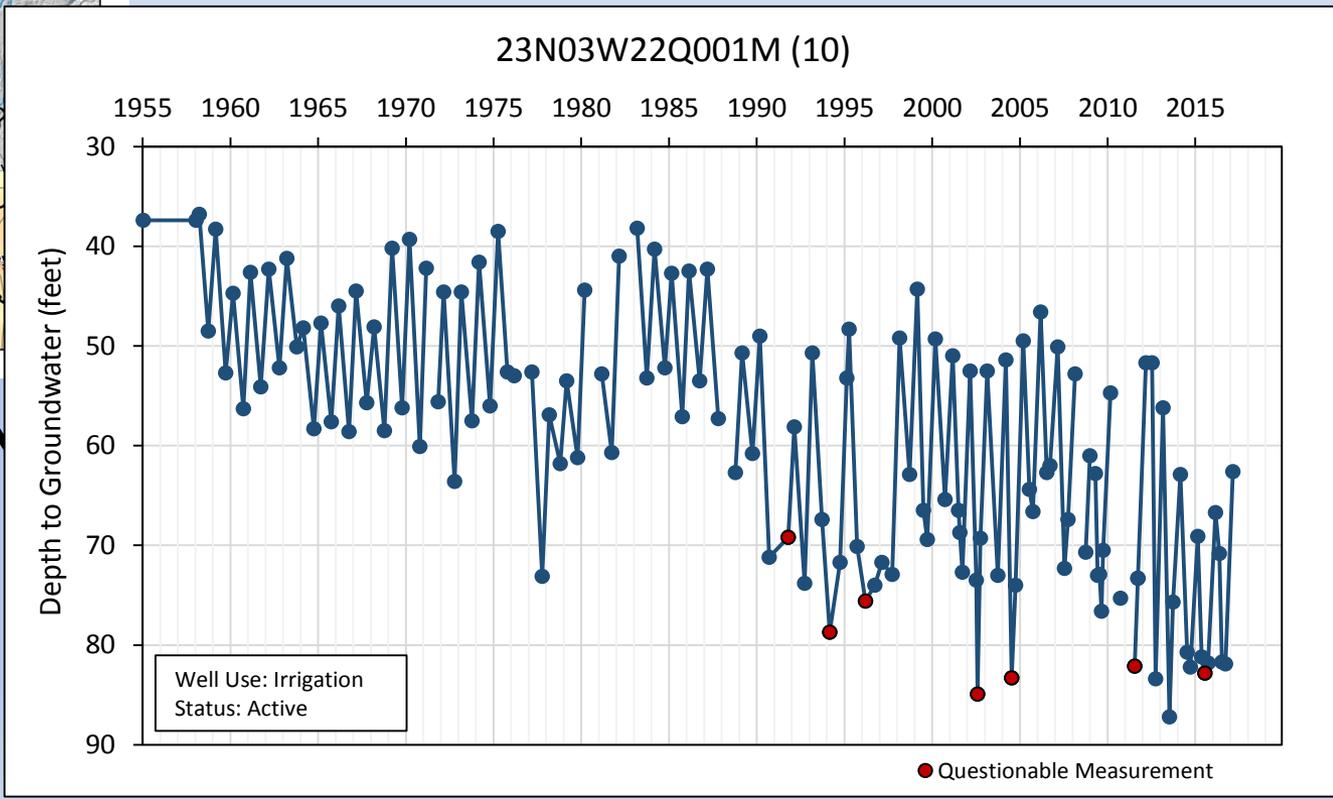
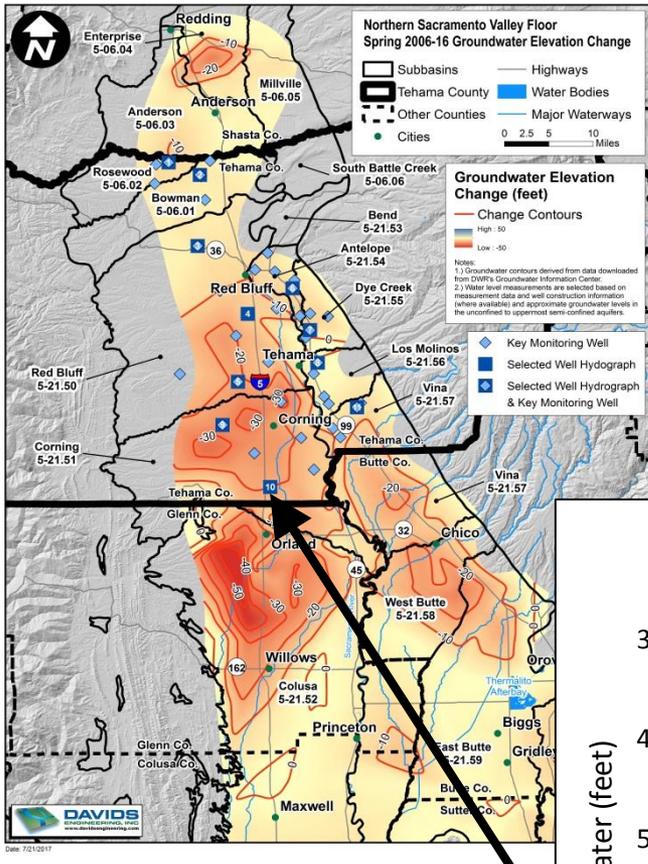


\* Tehama County  
Key Monitoring  
Well

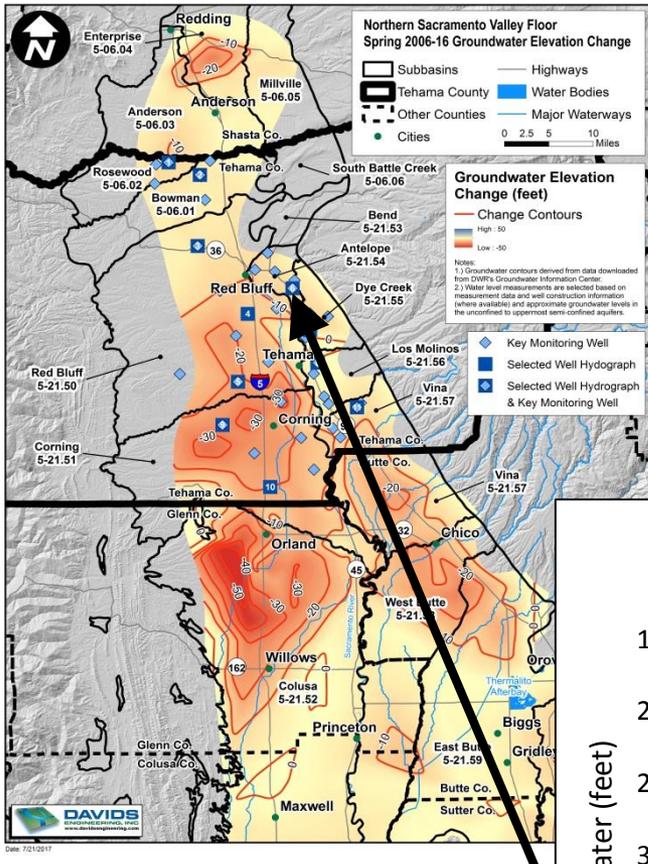
# Sustainability Indicator #1

## Chronic Lowering of Groundwater Levels

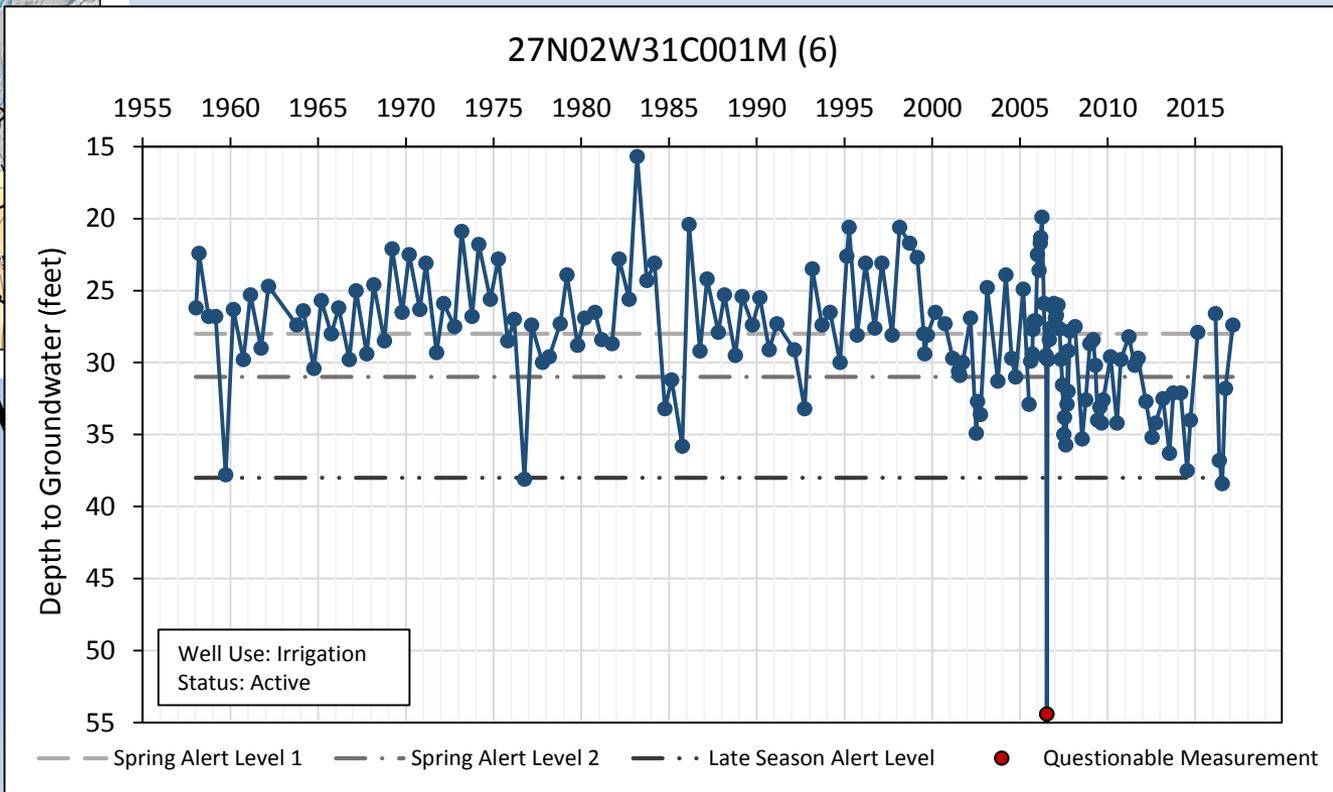
### (Corning Subbasin)



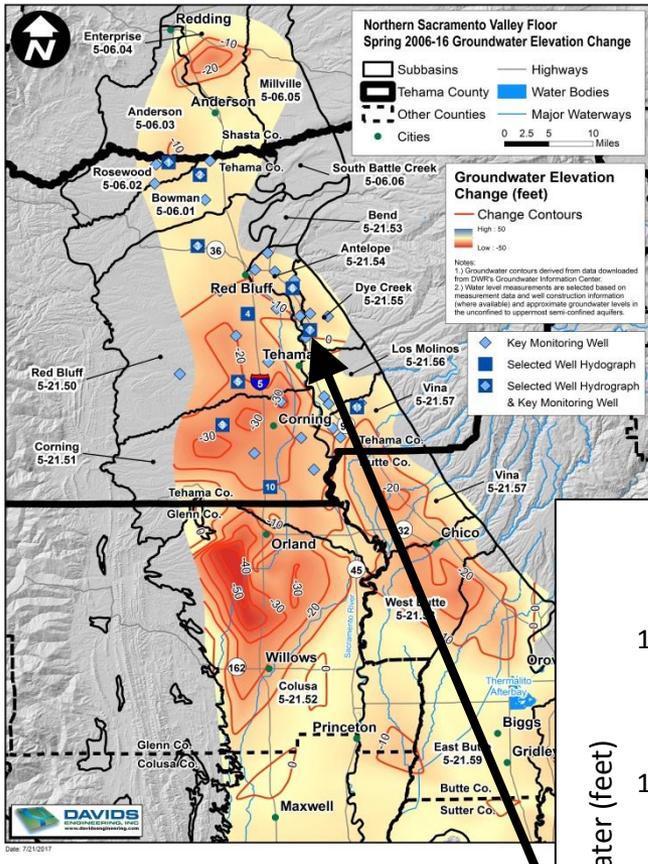
# Sustainability Indicator #1 Chronic Lowering of Groundwater Levels (Antelope Subbasin)



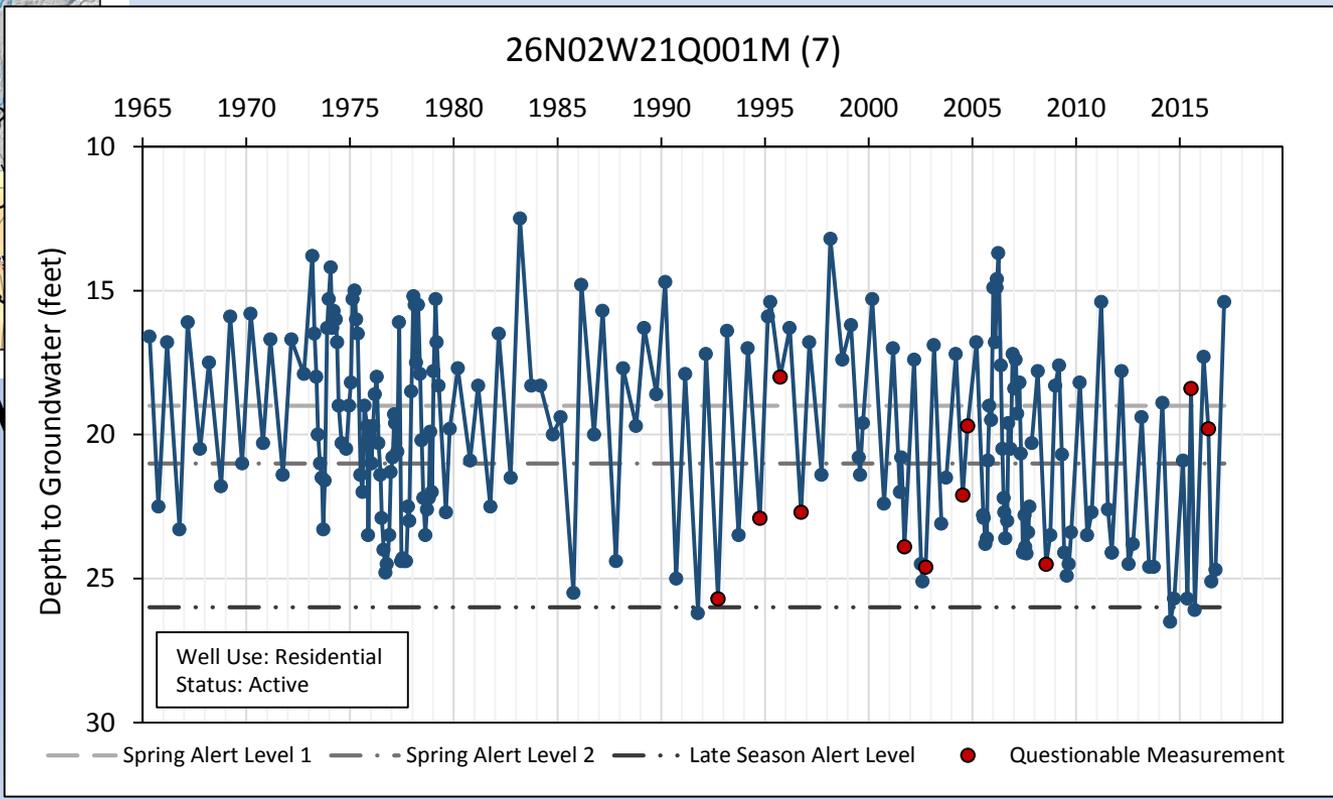
\* Tehama County  
Key Monitoring  
Well



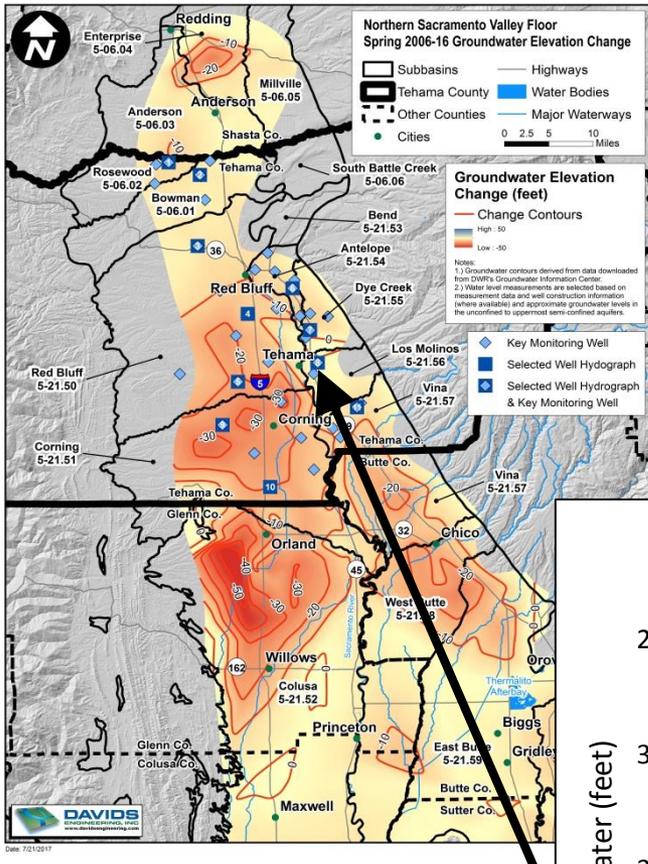
# Sustainability Indicator #1 Chronic Lowering of Groundwater Levels (Dye Creek Subbasin)



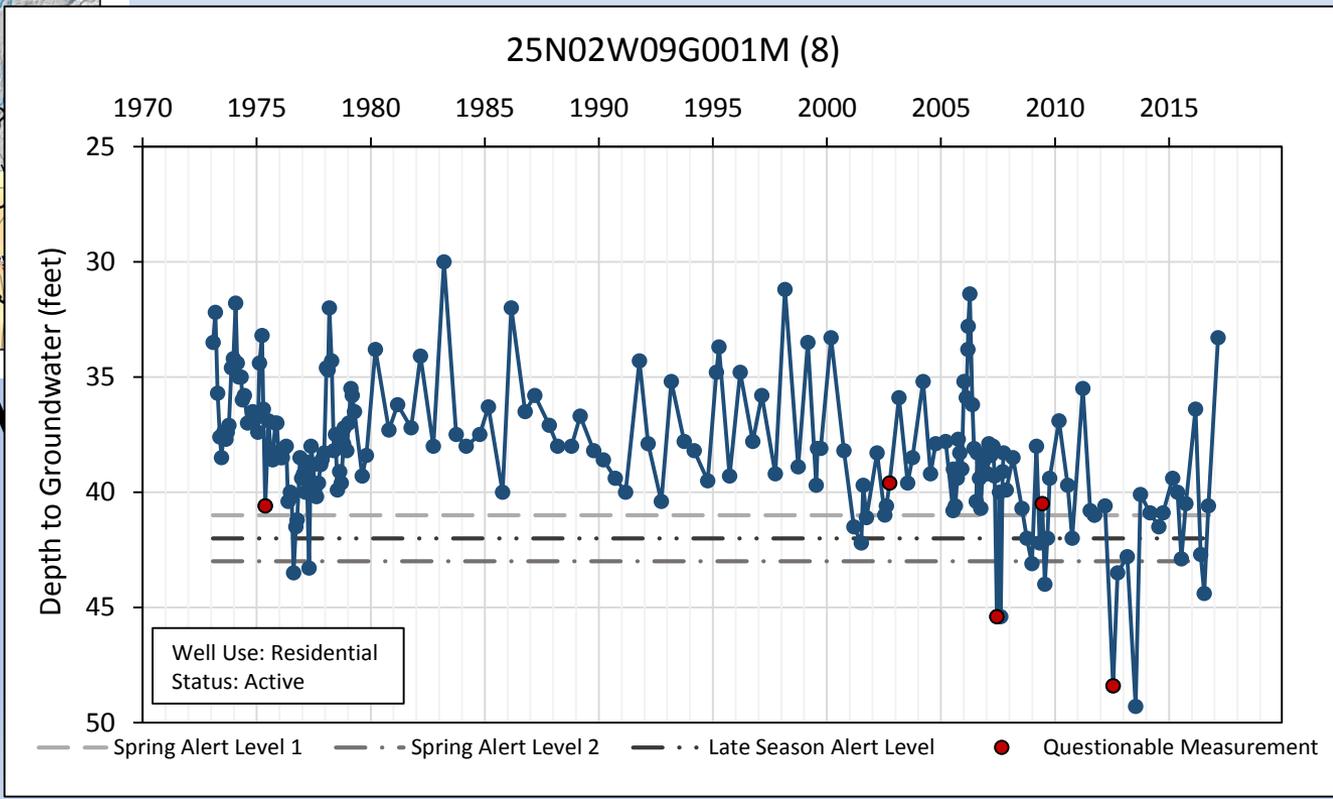
\* Tehama County  
Key Monitoring  
Well



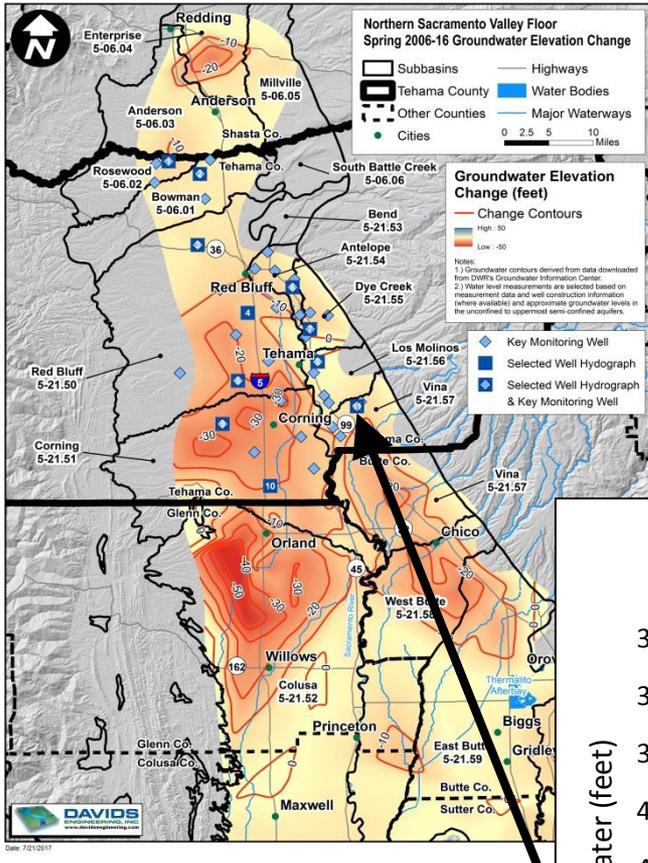
# Sustainability Indicator #1 Chronic Lowering of Groundwater Levels (Los Molinos Subbasin)



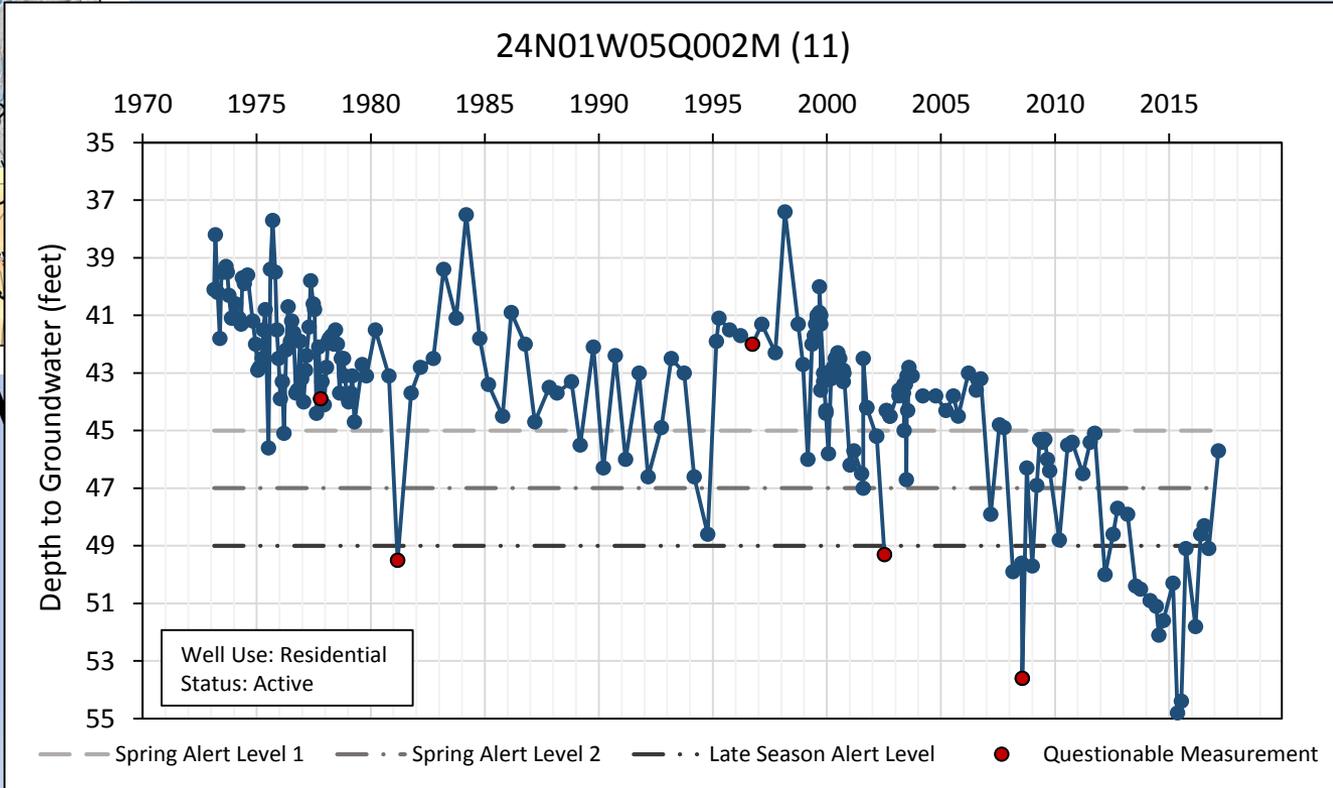
\* Tehama County  
Key Monitoring  
Well



# Sustainability Indicator #1 Chronic Lowering of Groundwater Levels (Vina Subbasin)



\* Tehama County  
Key Monitoring  
Well



# **Sustainability Indicator #1**

## **Chronic Lowering of Groundwater Levels**

### **Crystal Ball:**

- **Will definitely need to be addressed in GSP, primarily in the Red Bluff, Corning, and Vina subbasins**
- **Minimum Thresholds, Measureable Objectives and Interim Milestones will need to be established in the GSP**
  - **At what elevations do results become undesirable?**
  - **Opportunity to incorporate/refine existing network and alert levels**
- **Projects and Management Actions may need to be identified in GSP if levels continue to decline**

# 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)

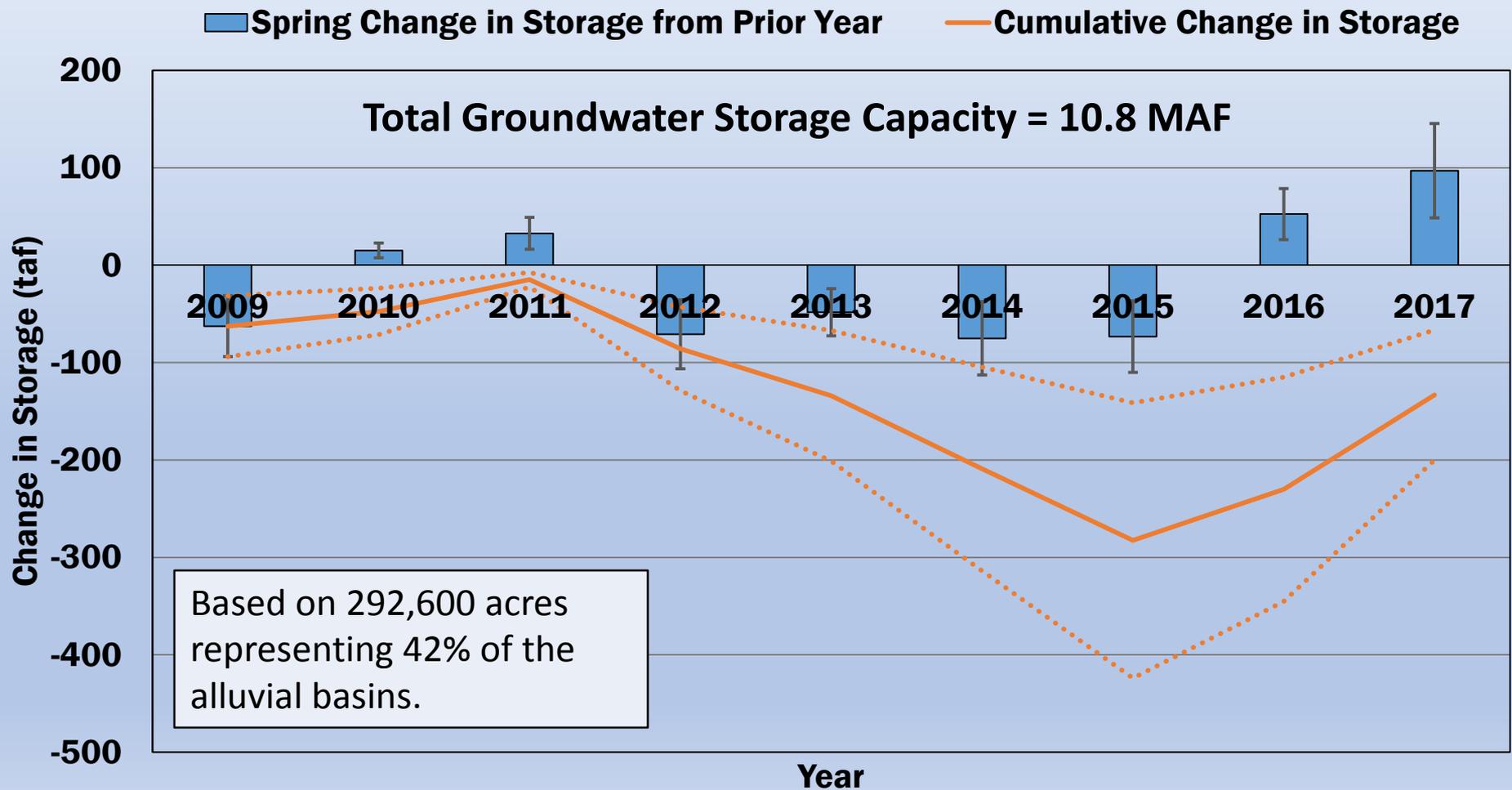
# Sustainability Indicator #2: Reduction of Groundwater Storage Subbasin Storage Capacities (DWR Bulletin 118-2003)

\* Bend Estimated  
from Adjacent  
Subbasins

Basin	Subbasin	Total Area (acres)	Area in Tehama County (acres)	% of Area in Tehama County	Total Subbasin Storage Capacity (TAF) (Bulletin 118)	Est. Storage Capacity in Tehama County (TAF)
Redding Area	Bowman	79,686	79,561	100%	1,343	1,341
	Rosewood	42,848	42,695	100%	722	719
	South Battle Creek	32,552	32,547	100%	549	548
	Millville	66,780	1,169	2%	1,125	20
	<b>TOTAL</b>	<b>221,866</b>	<b>155,972</b>	<b>70%</b>	<b>3,739</b>	<b>2,628</b>
Sacramento Valley	Red Bluff	271,794	271,794	100%	4,209	4,209
	Corning	206,886	161,262	78%	2,753	2,146
	Bend*	22,676	22,676	100%	NA	351
	Antelope	19,091	19,091	100%	269	269
	Dye Creek	28,027	28,027	100%	332	332
	Los Molinos	30,994	30,994	100%	398	398
	Vina	126,028	40,638	32%	1,468	473
	<b>TOTAL</b>	<b>705,496</b>	<b>574,482</b>	<b>81%</b>	<b>9,429</b>	<b>8,178</b>
<b>GRAND TOTAL</b>		<b>927,362</b>	<b>730,454</b>	<b>79%</b>	<b>13,168</b>	<b>10,806</b>

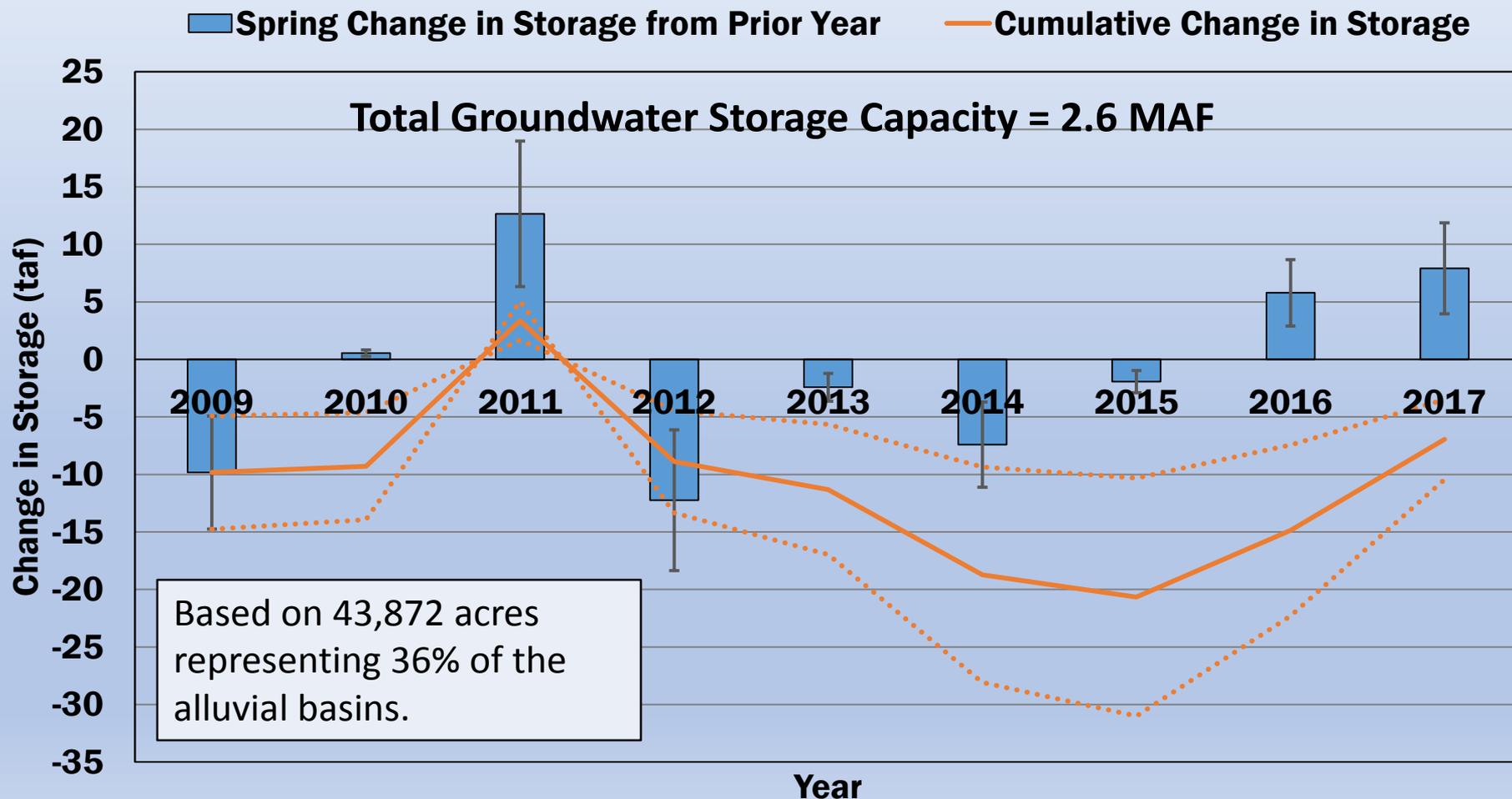
# Sustainability Indicator #2: Changes in Groundwater Storage 2009 through 2017

## All Subbasins in Tehama County



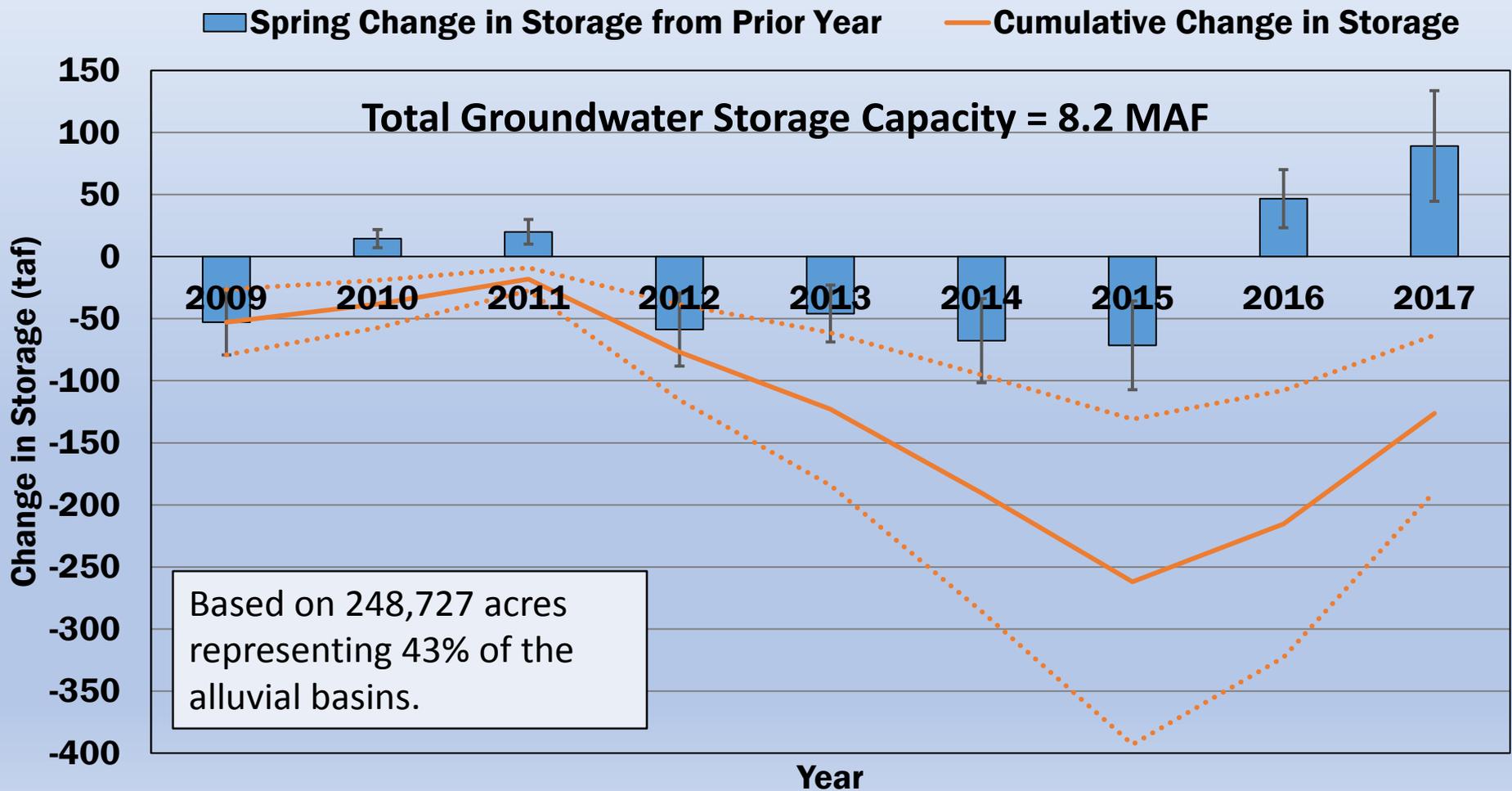
# Sustainability Indicator #2: Changes in Groundwater Storage 2009 through 2017

## Redding Area Basin in Tehama County



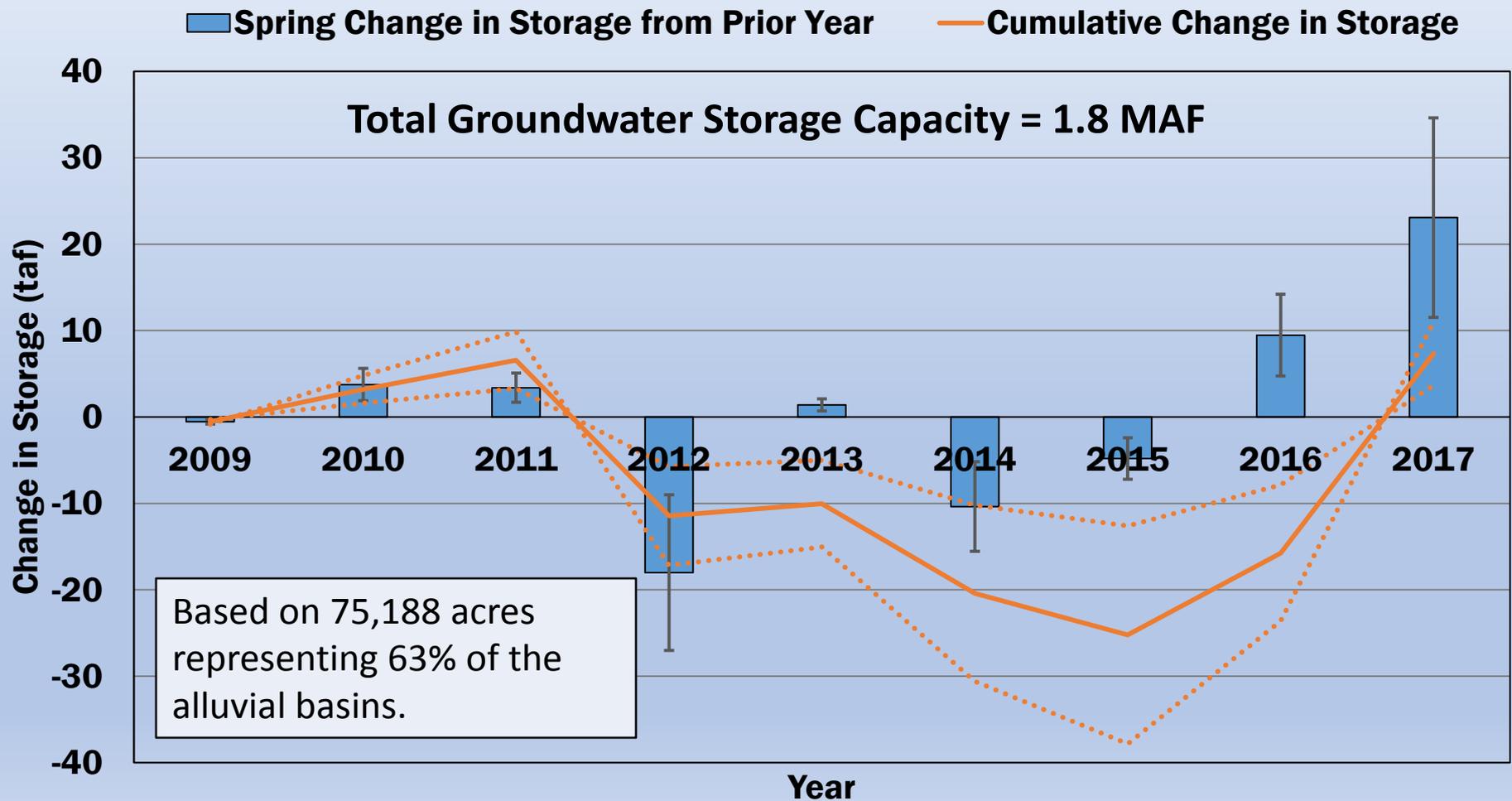
# Sustainability Indicator #2: Changes in Groundwater Storage 2009 through 2017

## Sacramento Valley Basin in Tehama County



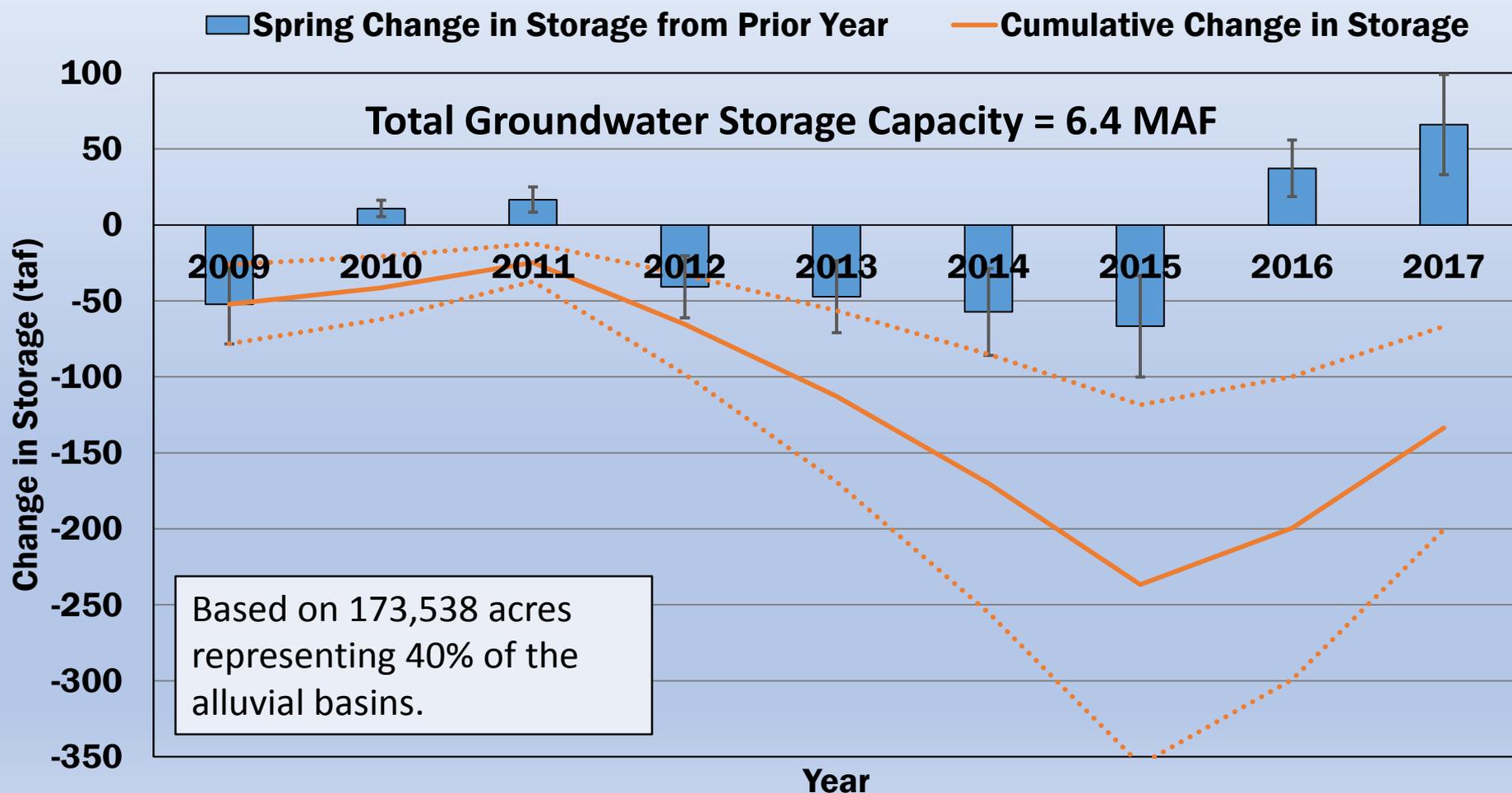
# Sustainability Indicator #2: Changes in Groundwater Storage 2009 through 2017

## Eastern Sacramento Valley Basin in Tehama County



# Sustainability Indicator #2: Changes in Groundwater Storage 2009 through 2017

## Western Sacramento Valley Basin in Tehama County



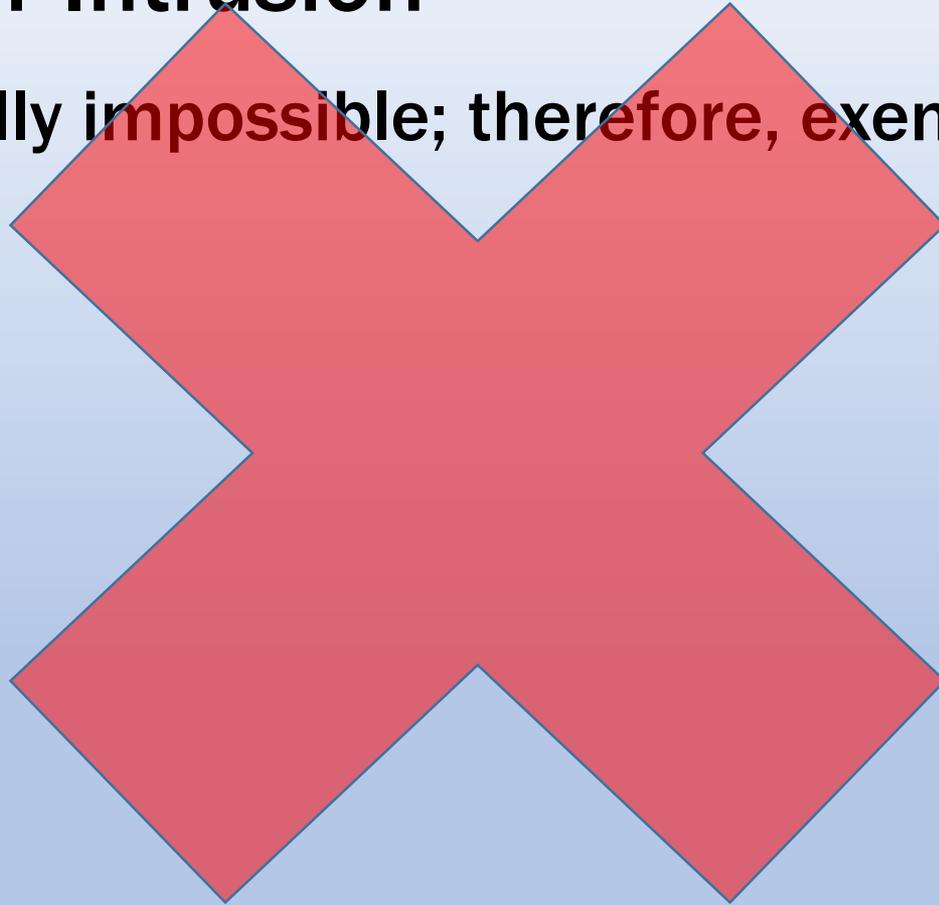
# Sustainability Indicator #2: Reduction of Groundwater Storage

## Crystal Ball:

- Recent reductions in groundwater storage (2008-2017) are modest relative to the total volume of groundwater in storage (~2%)
- Greatest reductions are in Sacramento Valley Basin west of Sacramento River (Red Bluff and Corning subbasins)
- Other sustainability indicators will pose sustainability challenges or subbasin operational limits before reduction of groundwater storage
- May be able to treat summarily in GSP

# Sustainability Indicator #3: Seawater Intrusion

- Physically impossible; therefore, exempt



# 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/cost to comply with regulatory standards
    - Drinking water regulations
    - Basin Water Quality Control Plan

# **Sustainability Indicator #4: Degraded Water Quality**

- **Information Sources**

- **Tehama County Groundwater Management Plan (TCFCWCD 2012)**
- **Sacramento Valley Water Quality Coalition Comprehensive Groundwater Quality Assessment Report (NCWA 2014)**
- **Sacramento Valley Water Quality Coalition Comprehensive Groundwater Quality Management Plan (NCWA 2017)**

# Sustainability Indicator #4: Degraded Water Quality

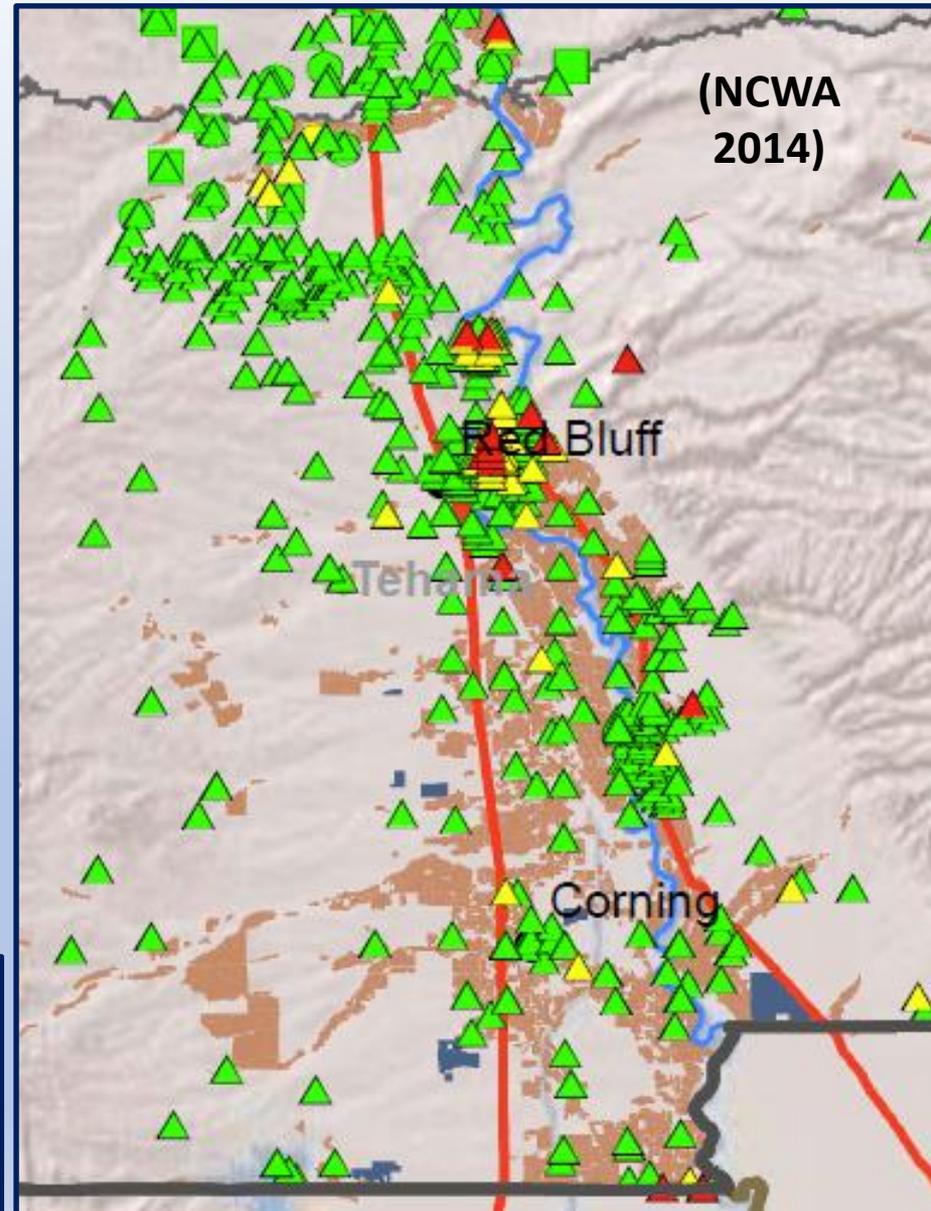
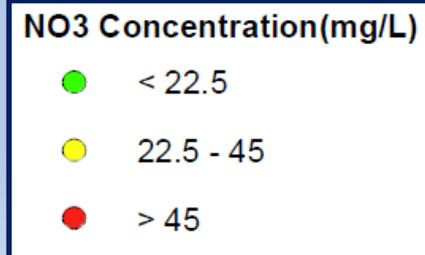
- **Groundwater Quality**
  - Generally excellent
  - Some areas of concern for nitrate
  - Some areas of concern for arsenic
  - Potential for alkalinity to plug drip and micro systems
  - Other possible localized concerns:
    - Naturally occurring metals
    - Coliform bacteria from septic systems
    - Boron toxicity to crops

# Sustainability Indicator #4: Degraded Water Quality

- **Groundwater Vulnerability**
  - **Intrinsic factors**
    - Soils and hydrogeology
    - Naturally occurring contaminants (arsenic, boron, etc.)
    - Geochemical characteristics (salinity, alkalinity, etc.)
  - **Anthropogenic (human) factors**
    - Cropping, irrigation, nutrient, and pesticide management practices
    - Wastewater treatment and disposal practices
    - Domestic and municipal well construction

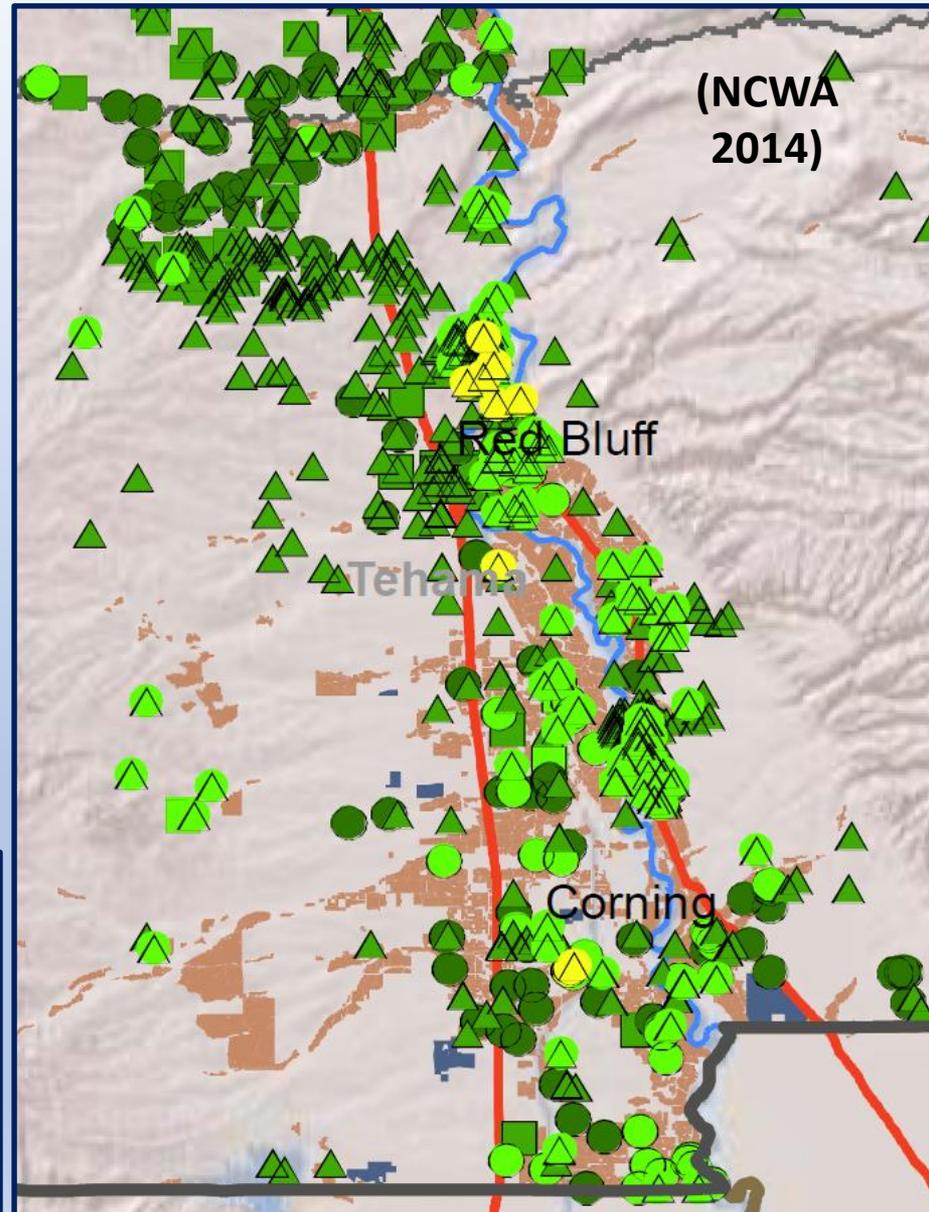
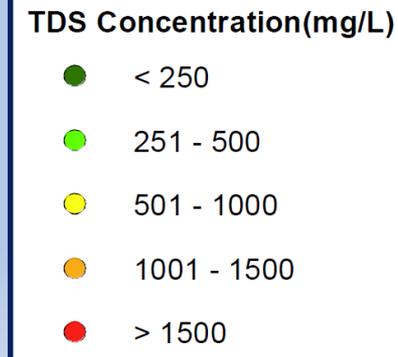
# Sustainability Indicator #4: Degraded Water Quality

- Elevated nitrate in Red Bluff/Antelope areas
- Generally below drinking water standards
- Believed to originate primarily from wastewater treatment systems



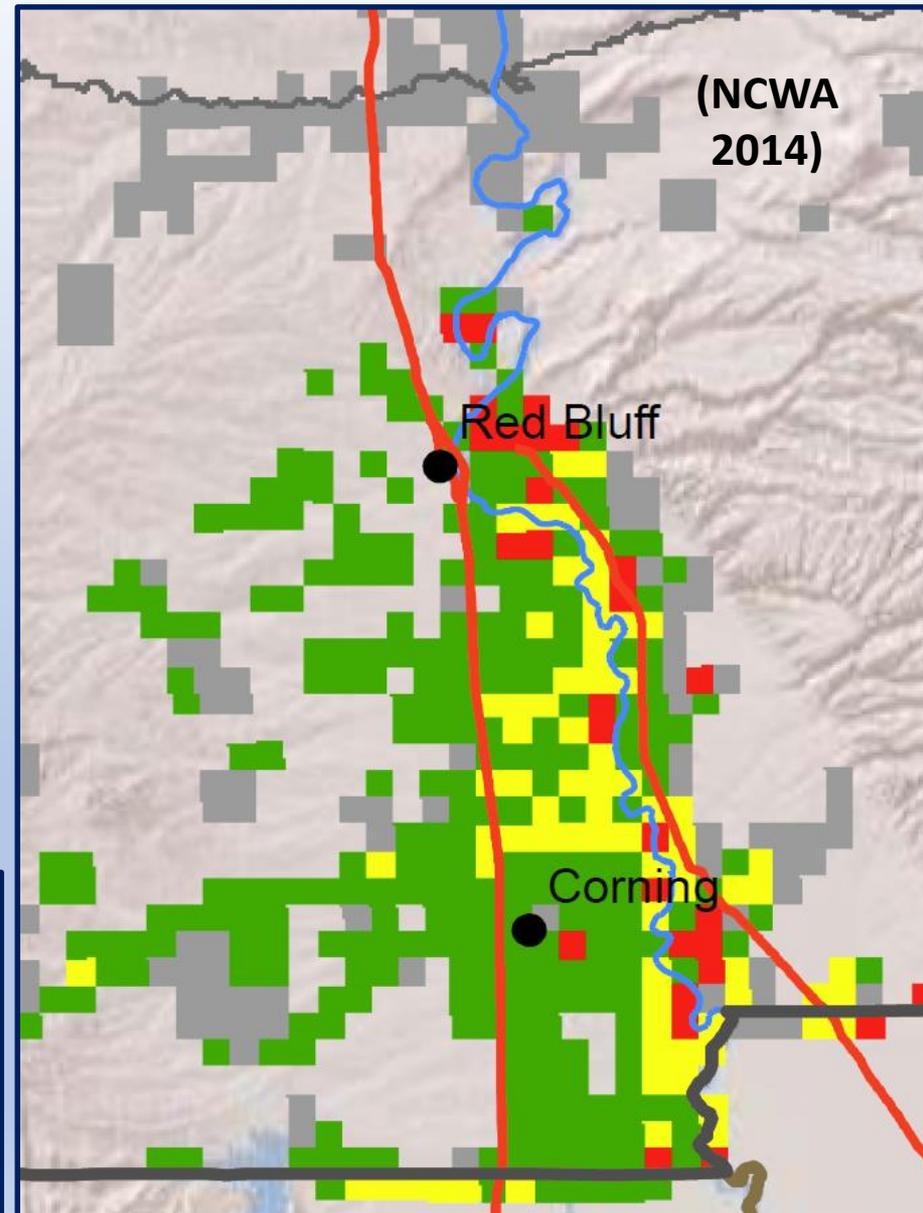
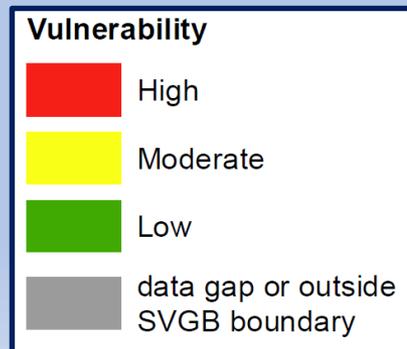
# Sustainability Indicator #4: Degraded Water Quality

- Low to moderate salinity detected north of Red Bluff
- Potentially resulting from wastewater treatment



# Sustainability Indicator #4: Degraded Water Quality

- NCWA vulnerability assessment suggests limited vulnerability to nitrate, salinity, or pesticide concerns
- Areas of greater vulnerability generally related to soil texture



# Observations from Available Water Quality Data

- Groundwater quality generally excellent for agricultural, domestic, and other purposes
- Efforts underway to conduct trend monitoring through Sacramento Valley Groundwater Regional Monitoring Plan

# Sustainability Indicator #4: Degraded Water Quality

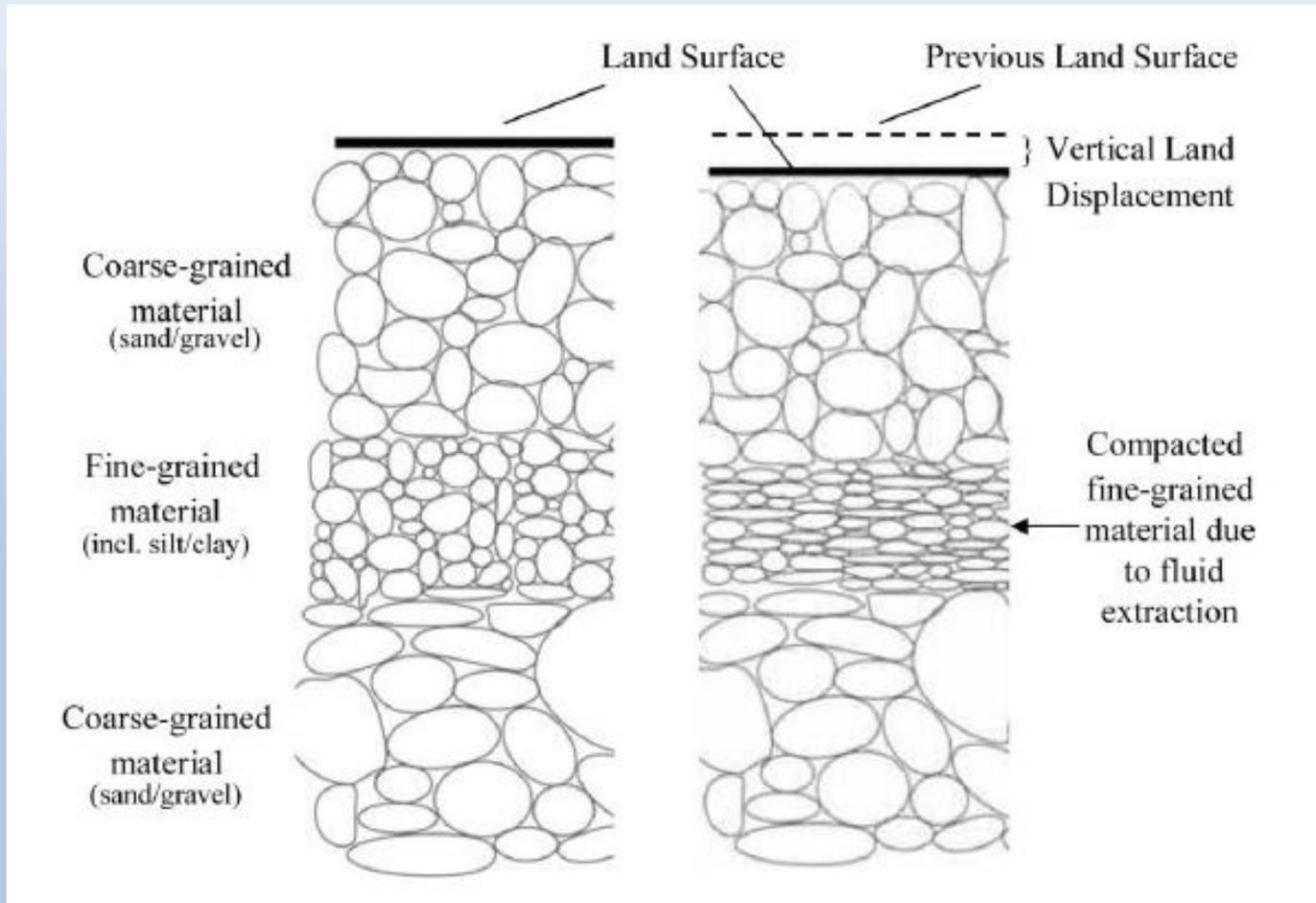
## Crystal Ball:

- Subject to ongoing monitoring, unlikely that water quality degradation will pose sustainability challenges or subbasin operational limitations
- Existing efforts by Sacramento Valley Groundwater Quality Coalition provide a starting point to address SGMA requirements
- Drinking water quality and contaminant plumes, if identified, will need to be addressed separately

# Sustainability Indicator #5: Land Subsidence

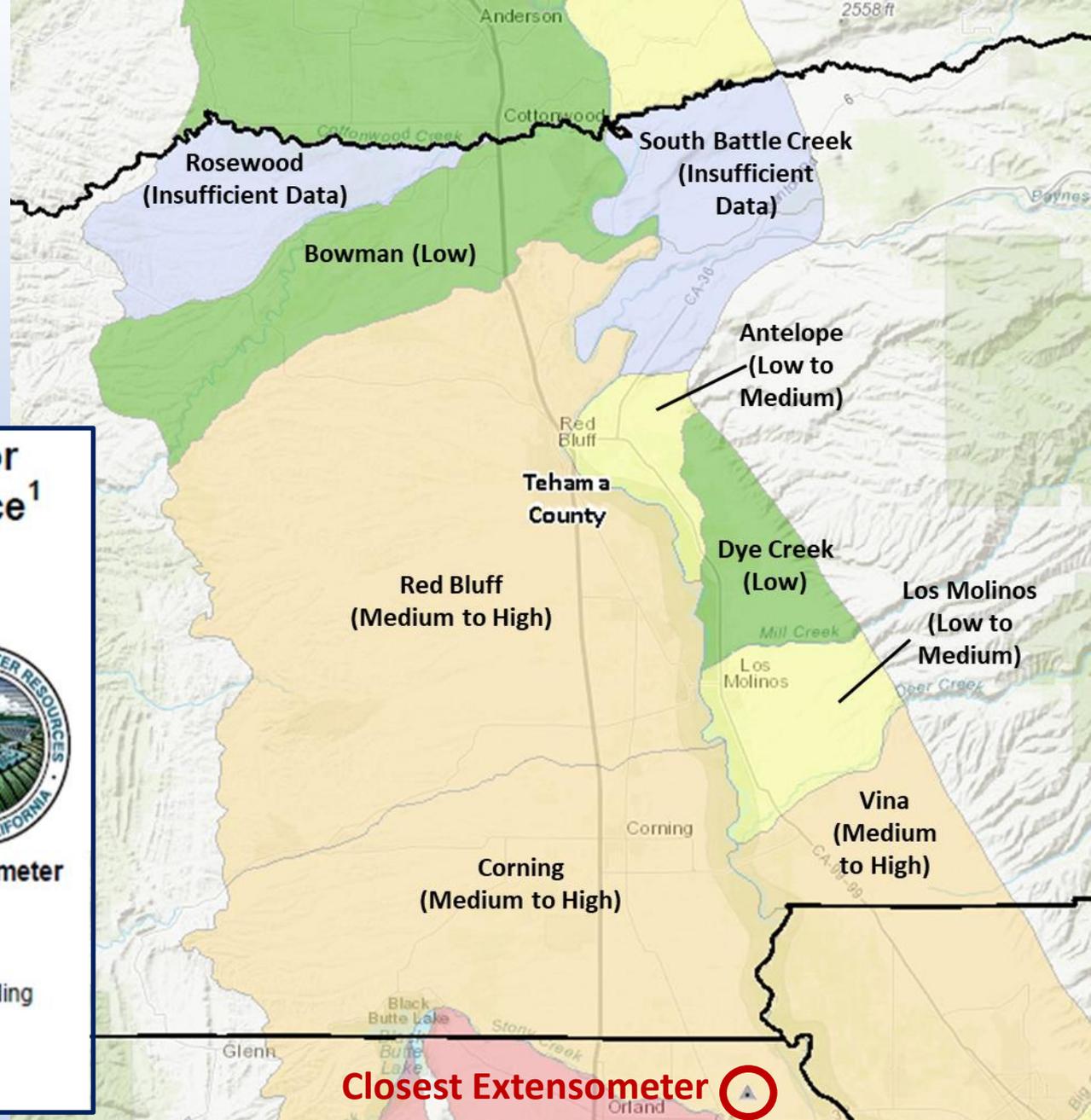
- **Minimum Threshold:** “...the rate and extent of subsidence that substantially interferes with land surface uses and may lead to undesirable results.” § 354.28 (c) (5)
- **Potential Undesirable Results:**
  - Permanent loss of aquifer storage capacity
  - Damage to foundations, roads, bridges, other infrastructure
  - Change in surface topography that reduces conveyance capacities of canals, natural channels, floodplains
  - Other effects

# Sustainability Indicator #5: Land Subsidence



Source: Land Subsidence from Groundwater Use in California,  
Luhdorff & Scalmanini Consulting Engineers

# Sustainability Indicator #5: Land Subsidence



### Estimated Potential for Future Land Subsidence<sup>1</sup>

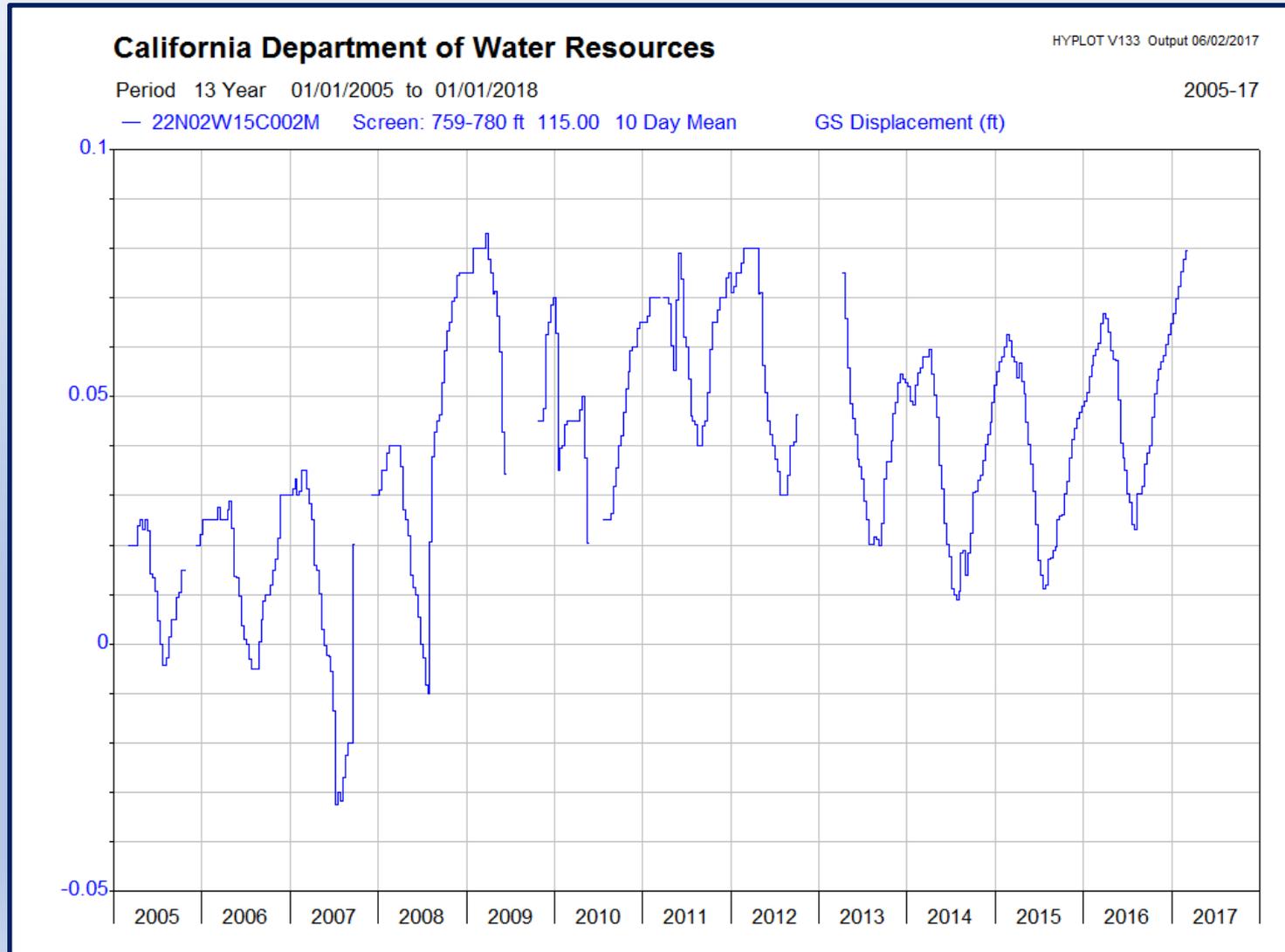
	Insufficient Data
	Lower
	↕
	Higher



Continuous GPS Station Cumulative Subsidence <sup>3</sup>	Active Extensometer Station Trend <sup>4</sup>
0 - < 1 Inch	Subsiding
≥ 1 - 2.5 Inches	Not Subsiding
≥ 2.5 - 5 Inches	Unknown
≥ 5 - 10 Inches	

**Closest Extensometer**

# Sustainability Indicator #5: Land Subsidence (Glenn County Extensometer)



# Sustainability Indicator #5: Land Subsidence

## Crystal Ball:

- Relatively greater potential for subsidence in Red Bluff, Corning, and Vina subbasins
- No evidence of inelastic subsidence in Corning Subbasin in Glenn County
- Will know more when new GPS survey results are published in 2017 (likely mid-2018)
- Land subsidence will definitely need to be addressed in GSP, with emphasis on monitoring
- May be able to defer determination of Minimum Thresholds and Measureable Objectives until “significant” subsidence is detected

# 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 legal users of surface water
  - Reduced water availability to “Groundwater Dependent Ecosystems” (GDE’s)

# Sustainability Indicator #6

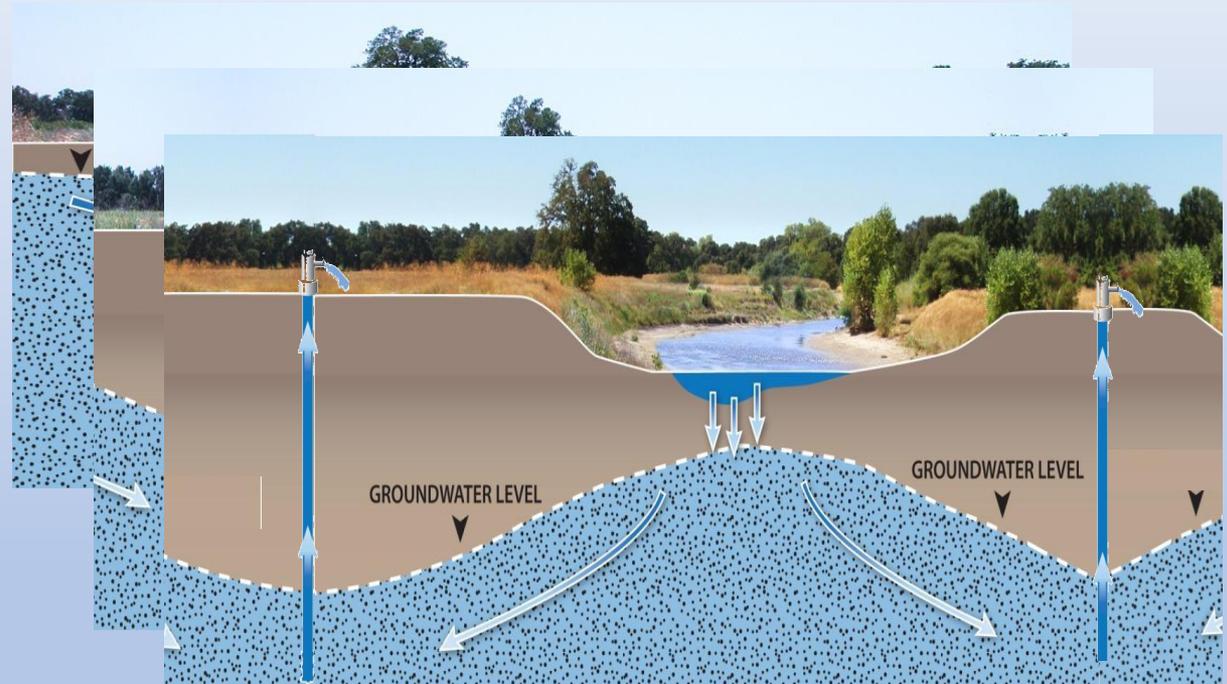
## Depletions of Interconnected Surface Water

- Effects of pumping on both Groundwater Dependent Ecosystems (GDEs) and streamflow depletion potentially significant but conclusive data are lacking
- DWR developing new analytic tool specifically to address surface water-groundwater interaction
  - SVSim Model (due for initial release end of 2017)
  - Best Management Practices (BMPs) for local agencies to consider adopting for monitoring and analyzing effects of declining groundwater elevations
- The Nature Conservancy leading statewide effort to develop GDE guidelines for local agencies

# Sustainability Indicator #6

## Depletions of Interconnected Surface Water

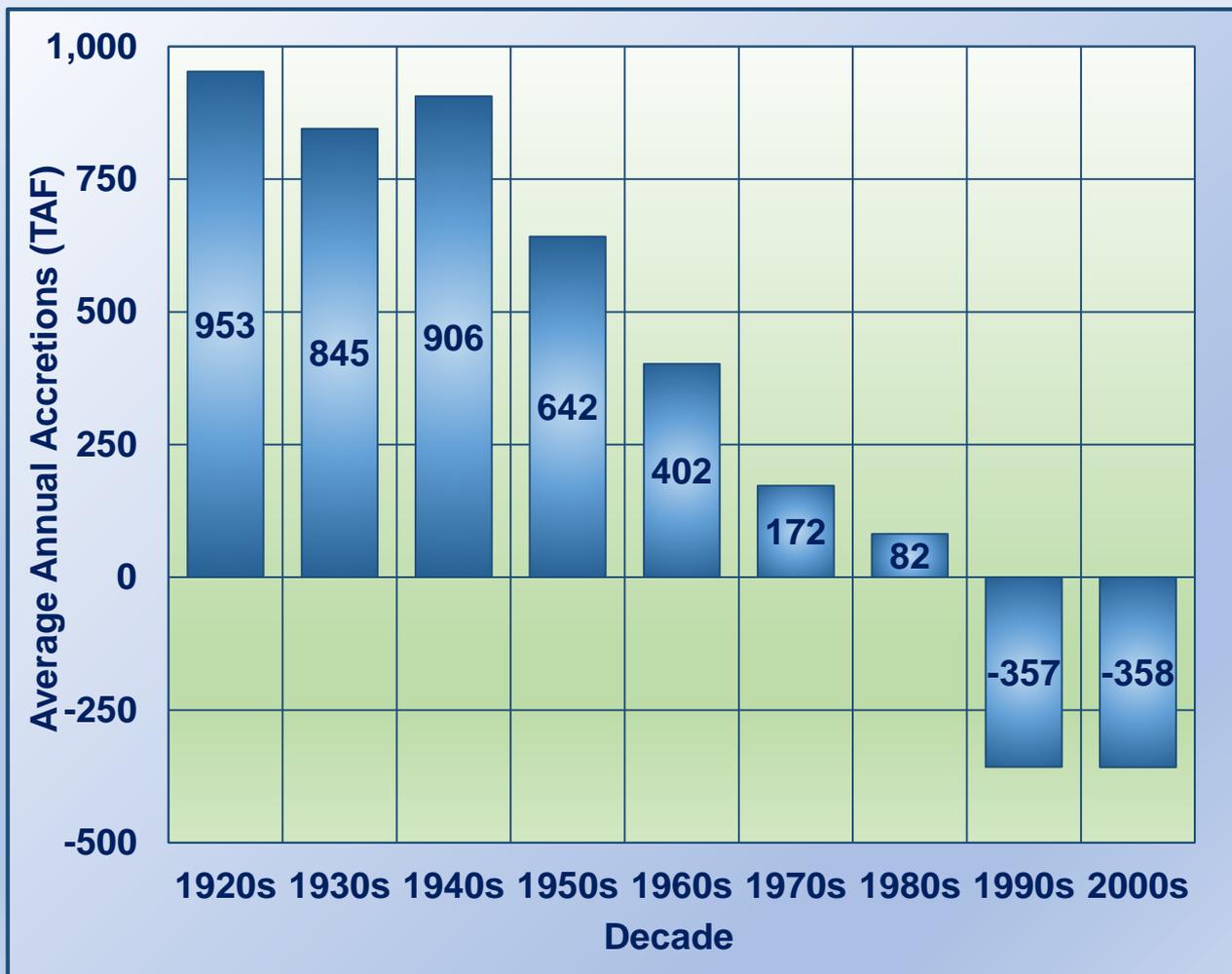
- Interaction depends on relative groundwater levels and properties of streambed and aquifer
- The uppermost groundwater sustains Groundwater Dependent Ecosystems, and river and stream flows



Source: The Nature Conservancy

# Sustainability Indicator #6

## Depletions of Interconnected Surface Water

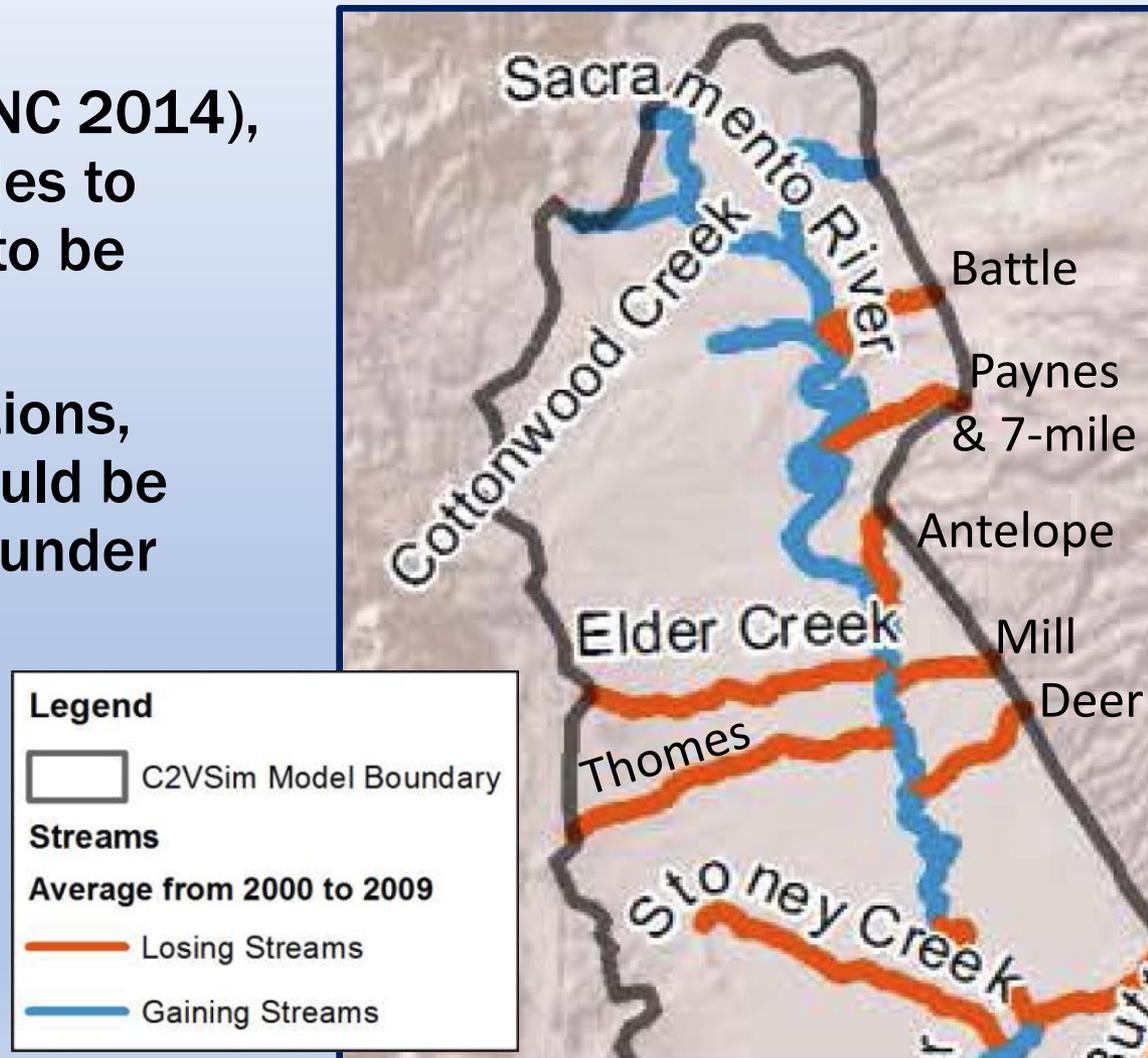


**According to DWR's existing C2VSim model, Sacramento Valley streams have gone from net gains to net losses over recent decades.**

# Sustainability Indicator #6

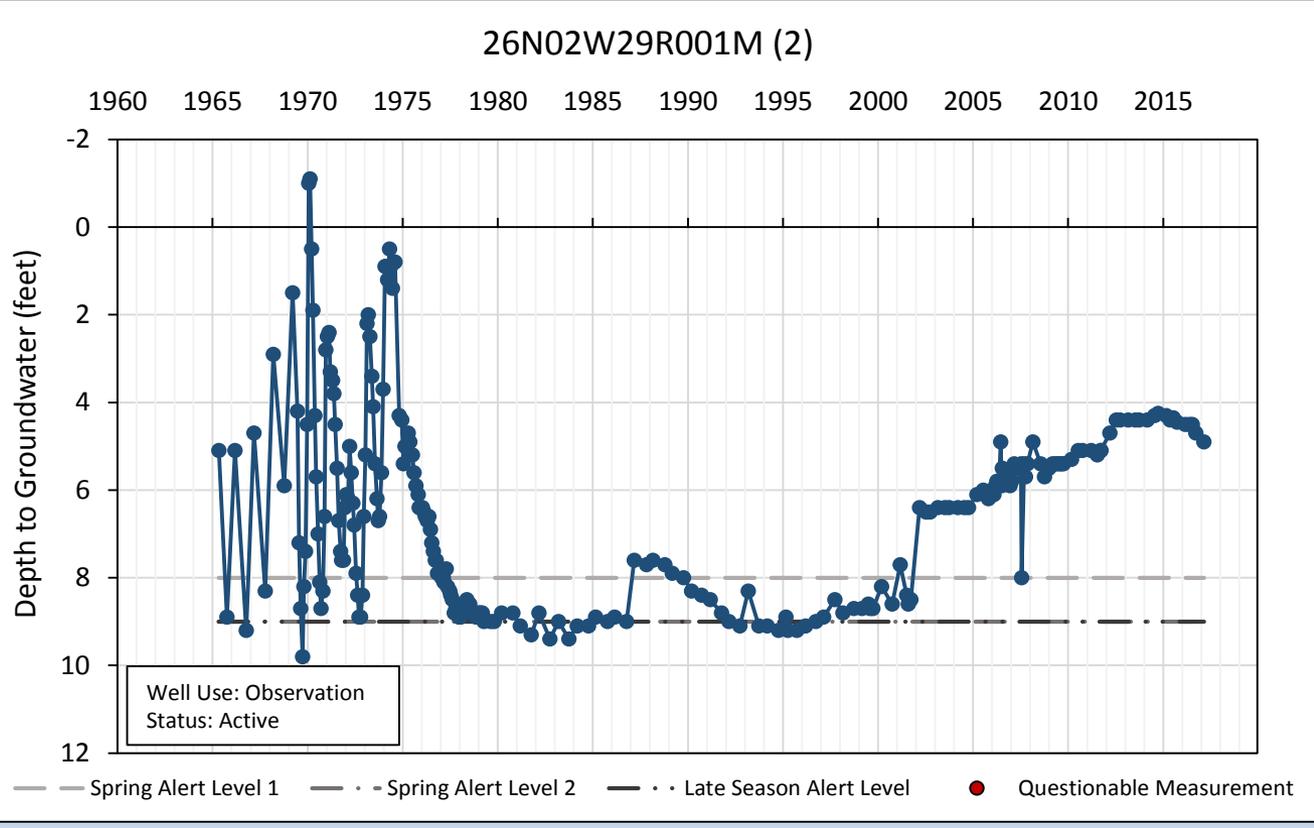
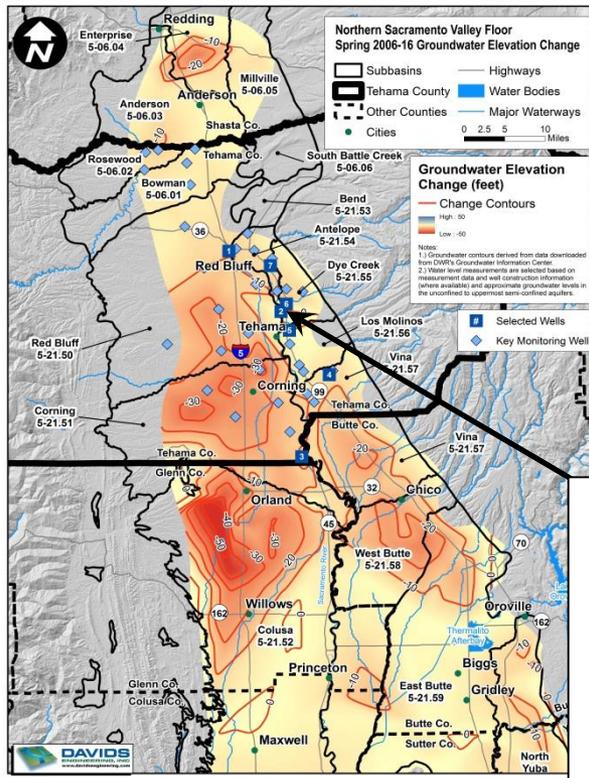
## Depletions of Interconnected Surface Water

- According to C2VSim (TNC 2014), Tehama County tributaries to Sacramento River tend to be losing streams
- Despite historical conditions, additional depletions could be considered undesirable under SGMA



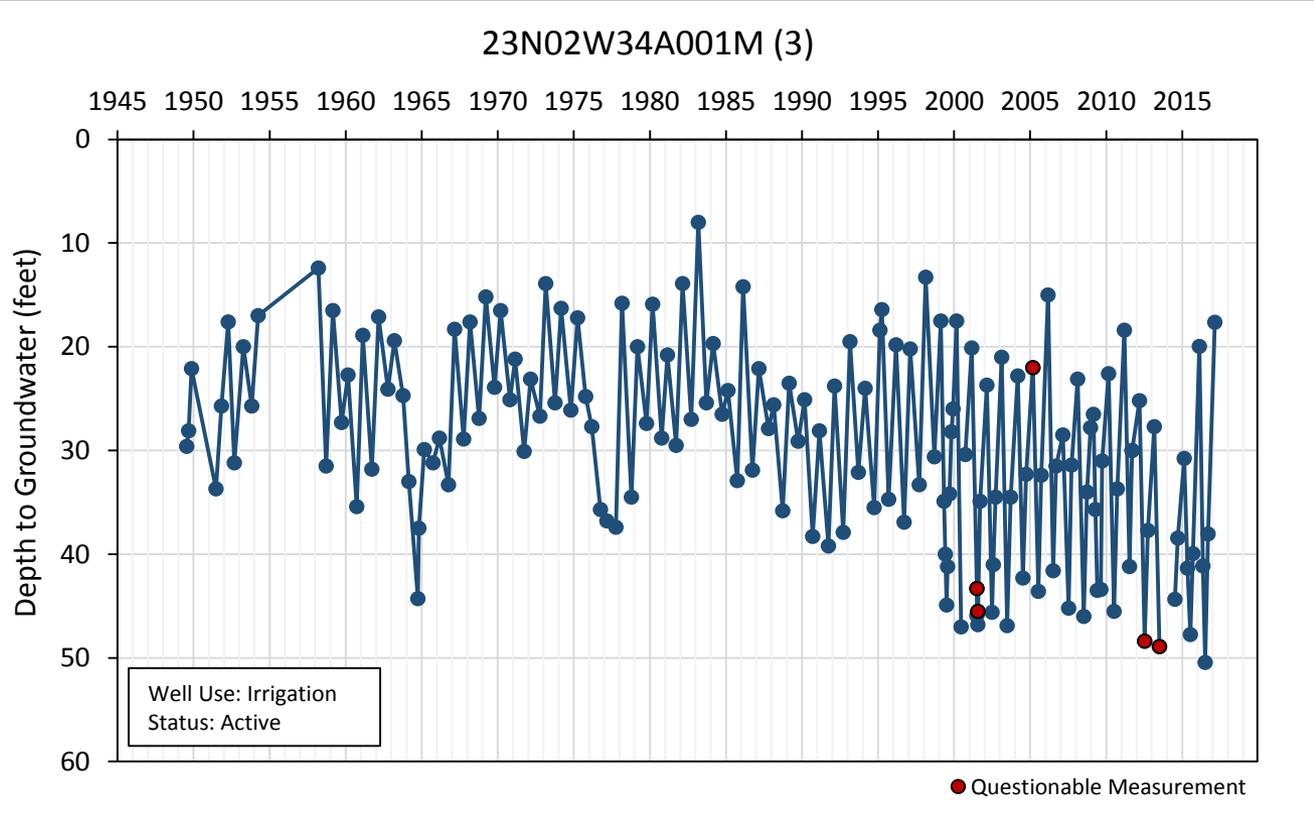
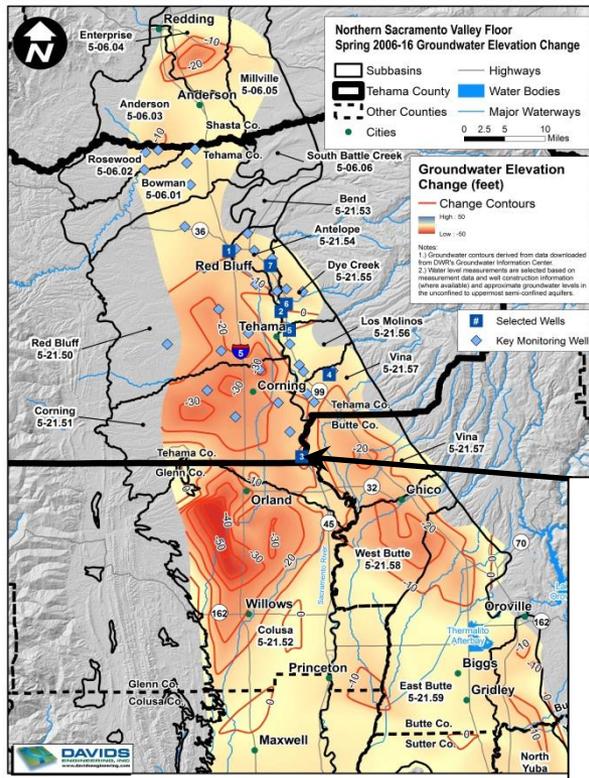
# Sustainability Indicator #6

## Depletions of Interconnected Surface Water: Sacramento River



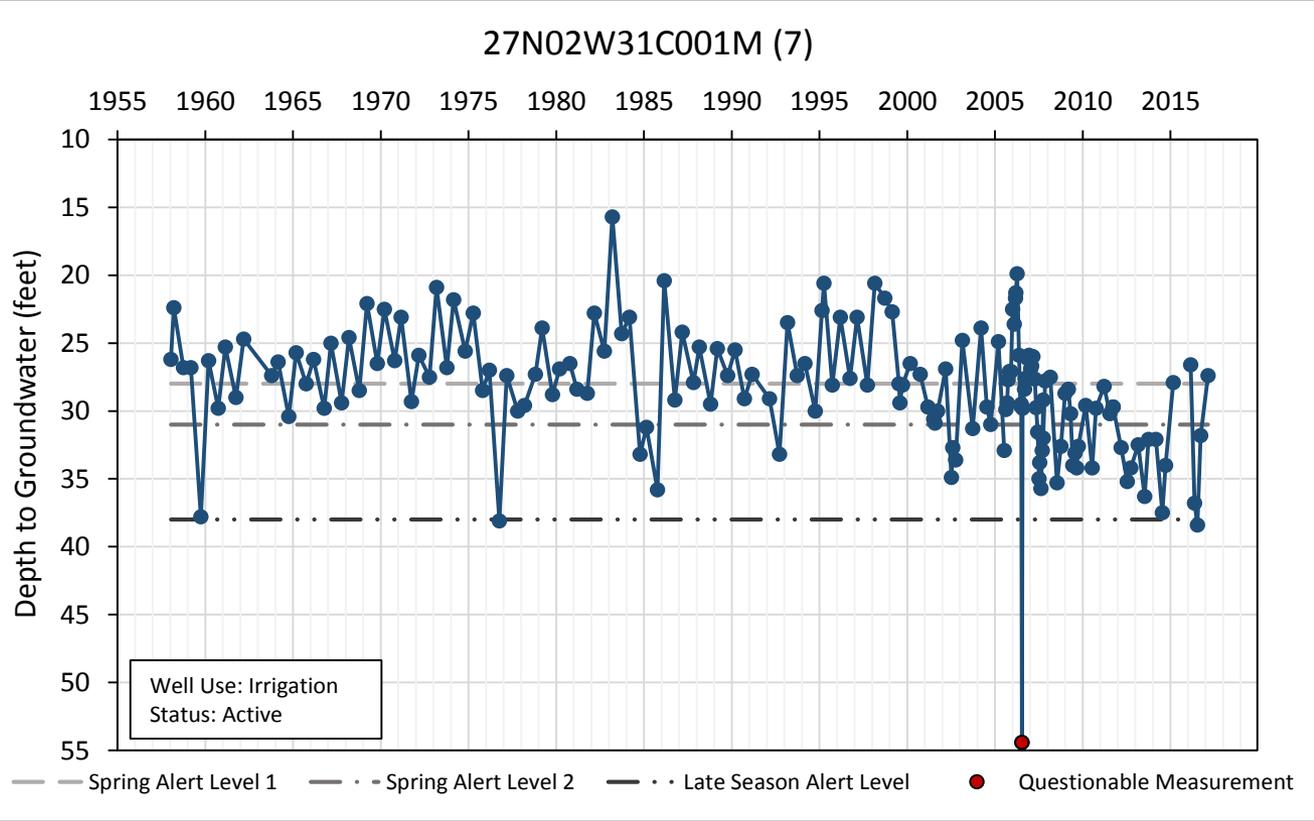
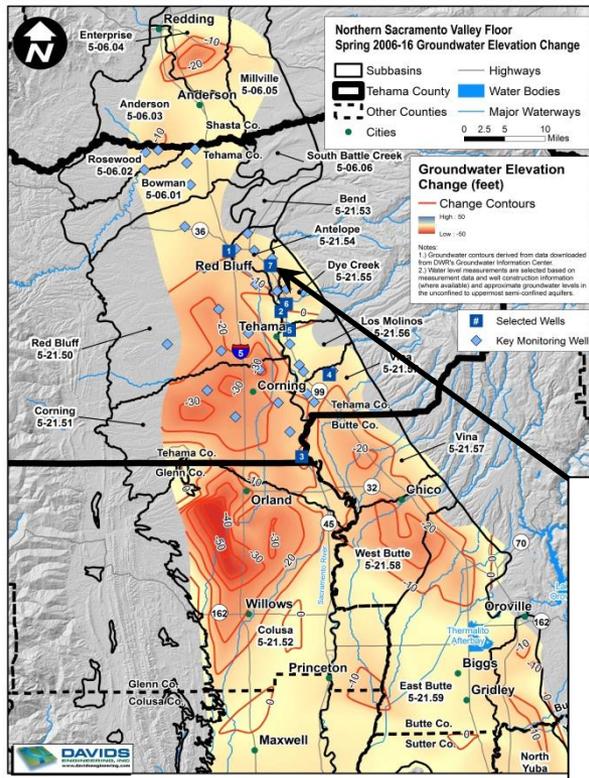
# Sustainability Indicator #6

## Depletions of Interconnected Surface Water: Sacramento River

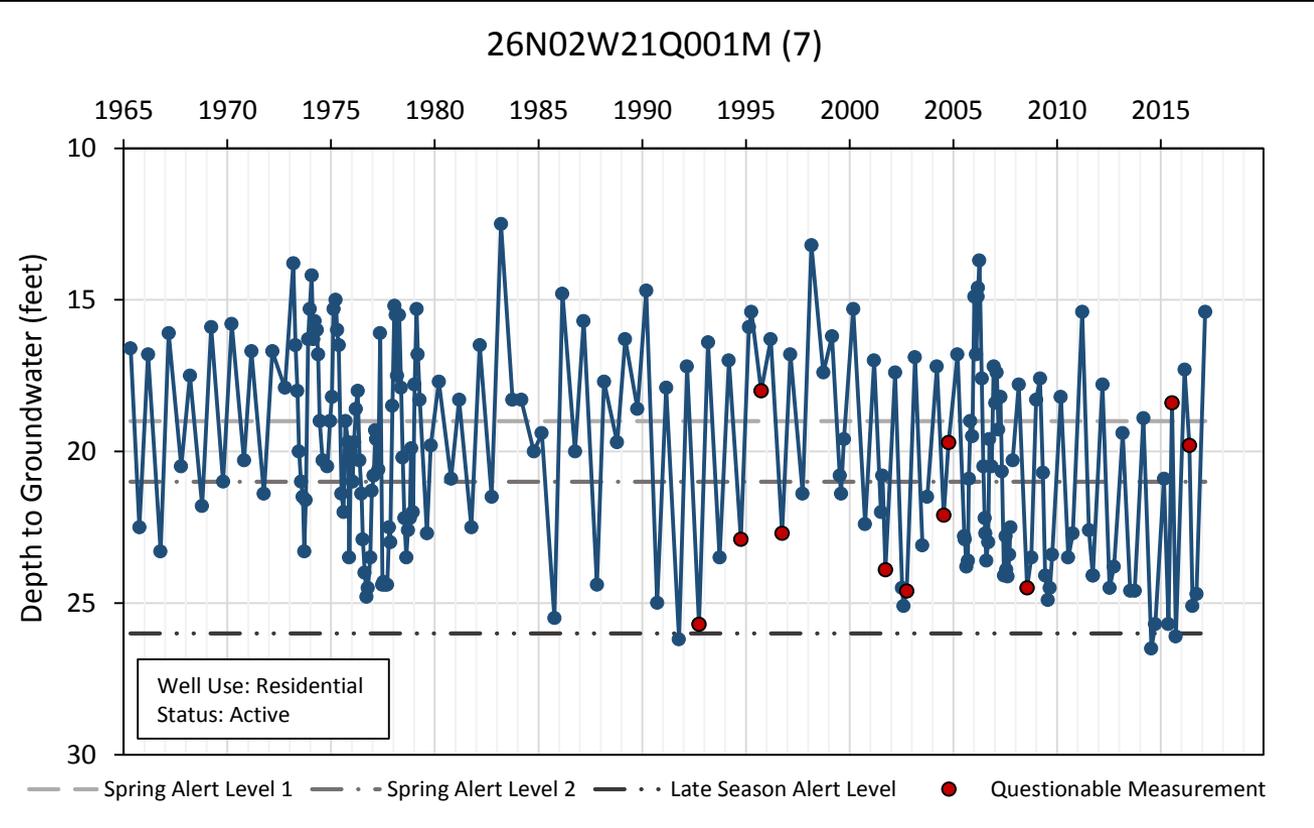
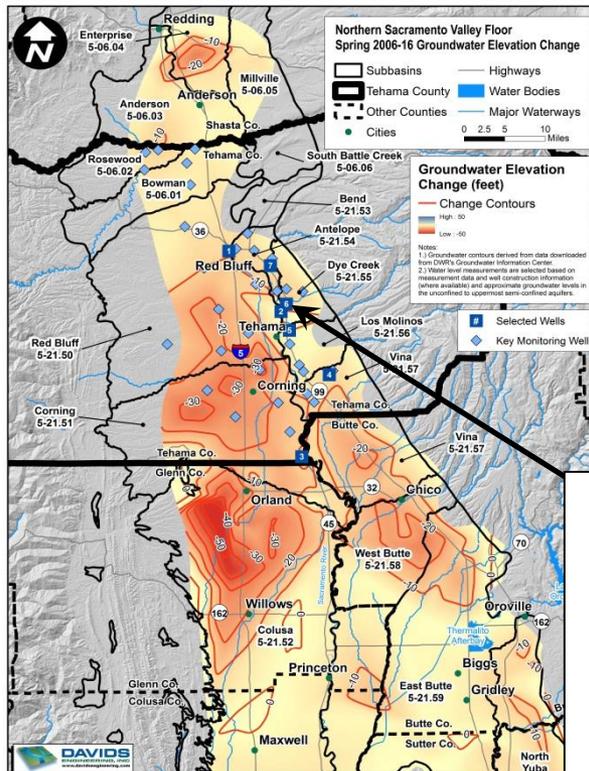


# Sustainability Indicator #6

## Depletions of Interconnected Surface Water: Antelope Creek

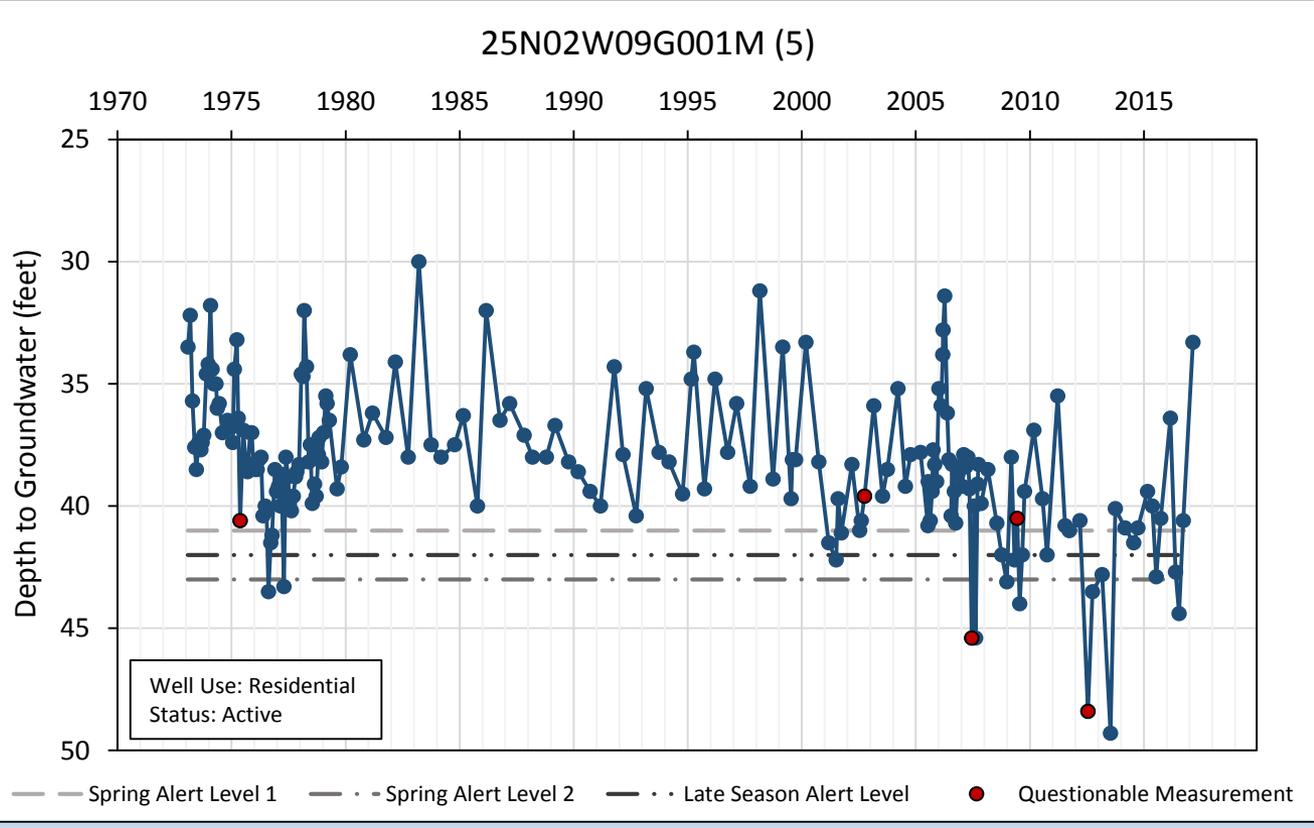
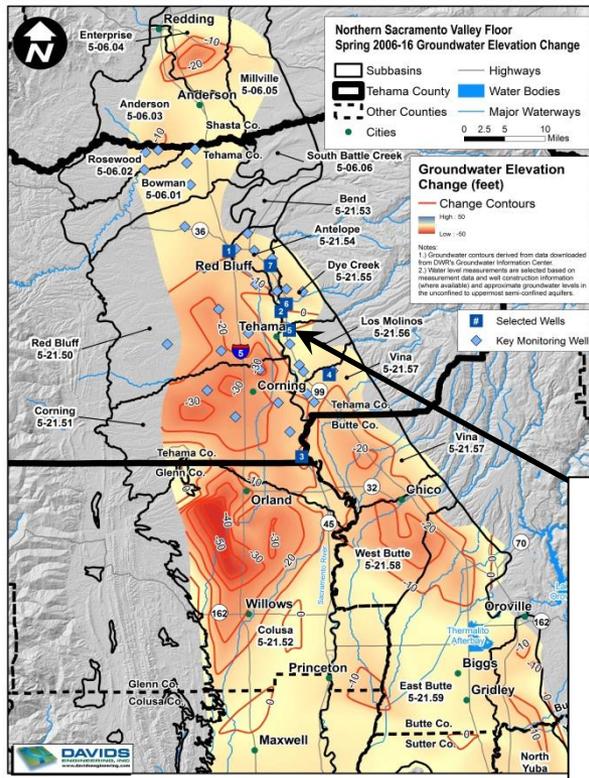


# Sustainability Indicator #6 Depletions of Interconnected Surface Water: Dye Creek

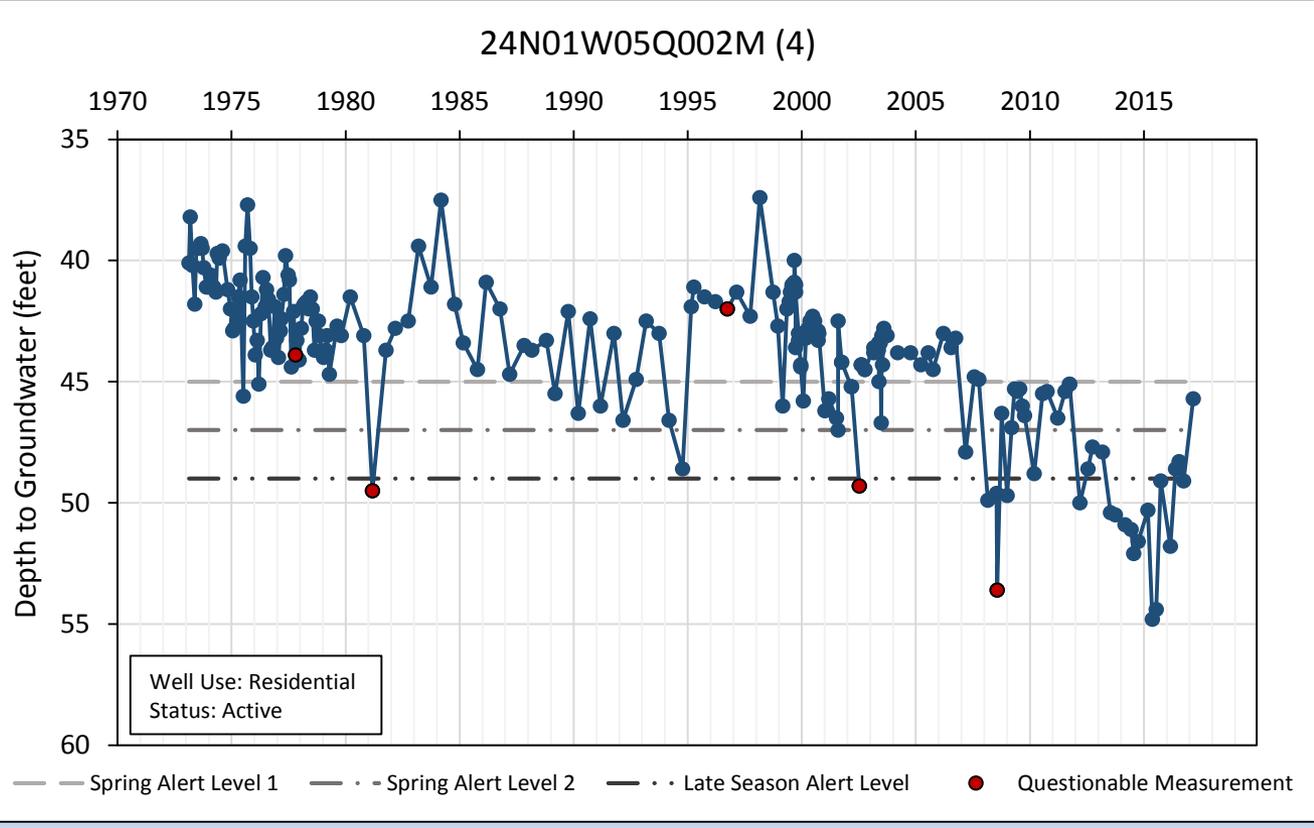
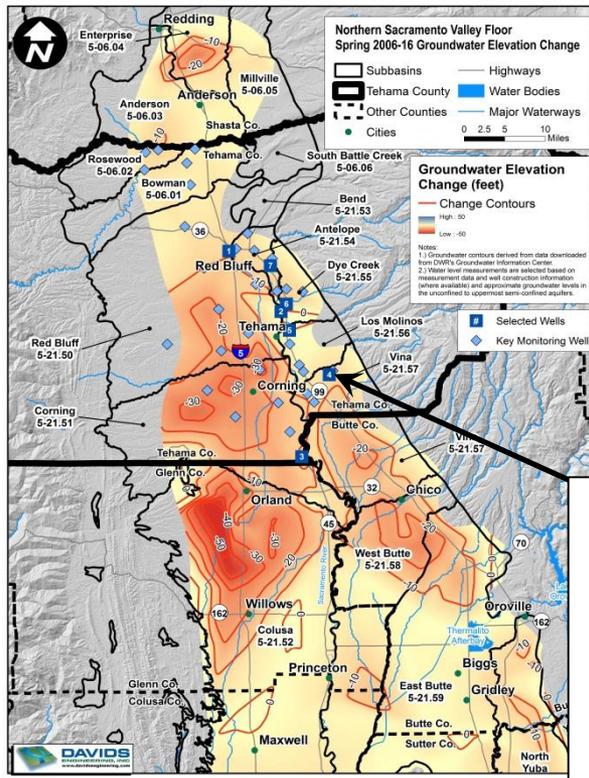


# Sustainability Indicator #6

## Depletions of Interconnected Surface Water: Mill Creek



# Sustainability Indicator #6 Depletions of Interconnected Surface Water: Deer Creek



# **Sustainability Indicator #6**

## **Depletions of Interconnected Surface Water**

### **Crystal Ball:**

- Will definitely need to be addressed in GSP with emphasis on monitoring to fill data gaps and analysis to characterize connections**
- Highly uncertain whether streamflow depletion will or may pose operational limitations**
- Effects of streamflow depletion are cumulative within the basin as a whole**

# Sustainability Indicators

## Summary Recon-Level “Risk Assessment”

- **Categorically eliminate from consideration:**
  - Seawater Intrusion (#3)
- **Address but unlikely to pose operational constraints; focus on monitoring:**
  - Reduction of Groundwater Storage (#2)
  - Degraded Water Quality (#4)
- **Potential to pose operational constraints and require Projects and/or Management Actions:**
  - Chronic Lowering of Groundwater Levels (#1)
  - Land Subsidence (#5)
  - Depletions of Interconnected Surface Water (#6)

# Discussion