

**Basin Management Objective  
Butte County  
Sub-Inventory Unit – ANGEL SLOUGH**

**Butte County Water Advisory Committee Member – Catherine Cottle**

**Contact Information**

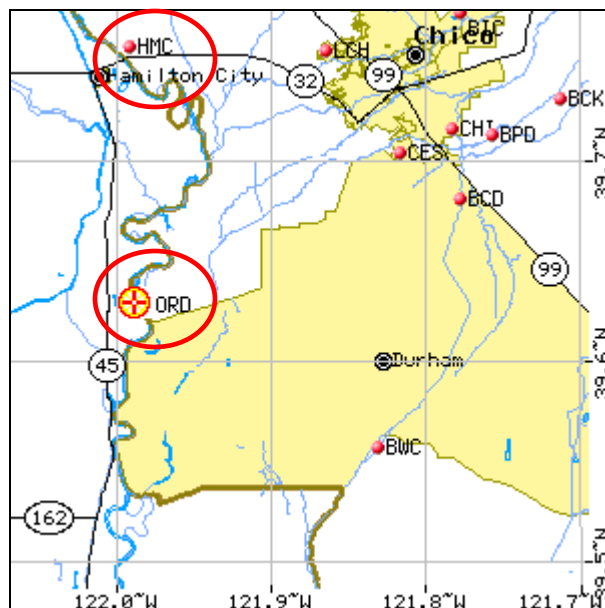
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**Description of the Angel Slough Sub-Inventory Unit –**

The Angel Slough Sub-inventory Unit covers an area of about 5400 acres in the southwest portion of the West Butte Inventory Unit. In summer, in a normal year, at least 70% of this area is supported by groundwater. To the northern and easterly directions it is bordered by the M&T Sub-inventory Unit. The Llano Seco Sub-Inventory Unit borders it to the south and to the west it is bordered by the Sacramento River.

In times of flooding, water flows directly from the river into Angel Slough. Known to many as "the dips" on River Road, it is actually where Angel Slough crosses River Road. This results in flooding of orchard and row crops normally supported by surface water and groundwater and makes River Road impassable by vehicles. At these times, releases by Keswick Dam into the Sacramento River directly effect how long orchard and row crops remain flooded. Monitoring stations at Hamilton City (HMC) and Ord Bend (ORD) track river level data. This information can be found on the California Data Exchange Center (CDEC) website <http://cdec.water.ca.gov/>.



**Management Objective –**

It is the intent of this objective to maintain the groundwater surface elevation during the peak summer irrigation season (July and August) in all aquifer systems at a level that will assure an adequate and affordable irrigation groundwater supply, and to assure a sustainable agricultural supply of good quality water now and into the future. The management objective is also to assure a sustainable groundwater supply of good quality from the alluvial aquifer system for all domestic users in the sub-inventory unit and to assure the water supply can be utilized without injuring groundwater quality or inducing land subsidence.

**Geologic Formations Identified In Sub-Inventory Unit:**

Geologic formations in the Angel Slough SIU, from youngest (shallowest) to oldest (deepest), include:

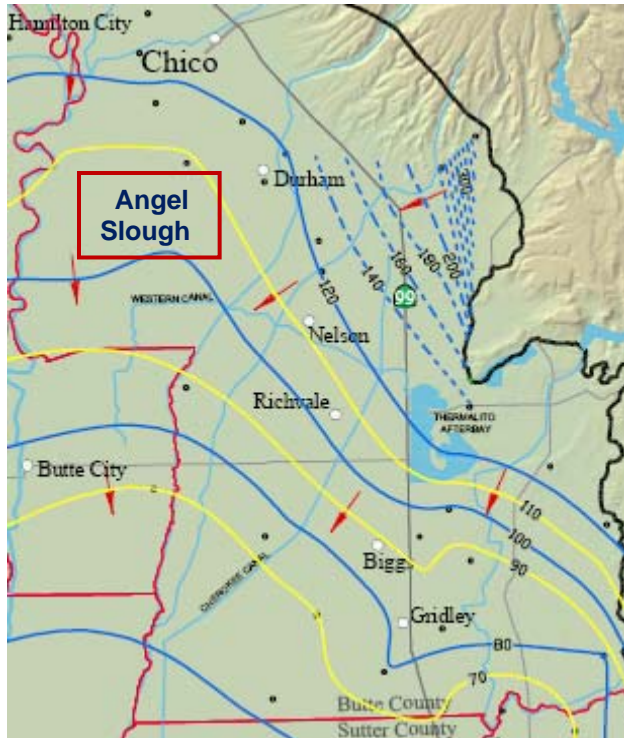
- Quaternary Alluvium
- Modesto Formation
- Tehama Formation
- Tuscan Unit C (Upper Tuscan)
- Tuscan Unit B (Lower Tuscan)

**Fresh Water-bearing Units.** In the Sacramento Valley Region of Butte County, fresh groundwater-bearing units include, from youngest (shallowest) to oldest (deepest), the Modesto, Riverbank, Laguna, Tehama and Tuscan Formations. Those included in the Angel Slough SIU are:

- Modesto Formation
- Tehama Formation
- Tuscan Unit C (Upper Tuscan)
- Tuscan Unit B (Lower Tuscan)

**Groundwater Flow in the Angel Slough Sub-Inventory Unit –**

The below figure is a cropped segment of a map prepared by DWR Northern District. It shows the groundwater elevation contours in your sub-inventory unit with arrows indicating the direction of groundwater movement. This graphic indicates that the regional pattern of spring groundwater movement in the Angel Slough SIU is in a south-to-southwesterly direction, at a gradient of about 7 feet per mile, toward the Sacramento River and Angel Slough. The direction of groundwater movement indicates that the Sacramento River is serving as a drain for groundwater from the Angel Slough SIU.



Arrows show the direction of groundwater movement.

2008 Groundwater contours were constructed using groundwater level measurements taken by the Department of Water Resources and Local Cooperators between March 1st and March 20th, 2008. Groundwater contours are based on groundwater level measurements taken from wells constructed within the middle portion of the aquifer system (100 to 400 feet deep). This portion of the aquifer supplies approximately 70% of all domestic, agricultural and municipal wells. Blue contour lines represent 20 foot intervals and yellow contour lines represent 10 foot intervals. Full size contour maps are included in the annual Groundwater Status Report posted on the Department of Water and Resource Conservation website.

**BMO Key Wells Selected for Groundwater Level Monitoring –  
SPRING**

Well ID	Aquifer System	Well Type	Stage 1 & 2 Alerts** Elev. (ft)	Stage 3 Alerts** Elev. (ft)
21N01W23J01M	Alluvium	Irrigation	108.75	105.8
21N01W35K002	Alluvium	Irrigation	97.21	92.50

**FALL**

Well ID	Aquifer System	Well Type	Stage 1 & 2 Alerts** Elev. (ft)	Stage 3 Alerts** Elev. (ft)
21N01W23J01M	Alluvium	Irrigation	105.25	103.0
21N01W35K002	Alluvium	Irrigation	95.55	95.10

### **BMO Key Wells Selected for Groundwater Quality Monitoring–**

Stakeholders in the Angel Slough SIU will work with staff to locate additional wells, either irrigation or domestic, with sufficient historical construction information to include in the water quality monitoring network, and possibly initiate data collection in August 2009.

### **BMO Key Well(s) Selected for Land Subsidence Monitoring–**

Land Subsidence is continuously monitored by the Department of Water Resources and Butte County Water and Resource Conservation at the closest extensometers in the Western Canal Water District and M&T Ranch sub-inventory units.

Butte County staff participated in the Sacramento Valley Height Modernization Project during March 2008 as a means to enhance the subsidence monitoring program in the county and the region. This cooperative project between the Department of Water Resources (DWR), the Bureau of Reclamation and local County agencies helped to establish baseline ground elevations in Butte County and other portions of the valley. Land elevations were measured using Global Positioning System (GPS) survey equipment and survey monuments located on an approximate three to five mile grid. Re-observations are to be done in approximately three years, and will give measurements to compare against the baseline data in order to determine whether or not any subsidence has occurred.

### **BMO Alert Stage Definitions and Compliance Methodologies–**

The Angel Slough Sub-Inventory Unit will use the following guidelines in the management of the groundwater resources. The groundwater level and land subsidence management objectives are intended to trigger predetermined voluntary Ground Water Management Actions, as defined in the Cover Report, to remedy declining ground water levels that are not recovering to compliance levels for the index well.

#### **Groundwater Level – Specific Depth and Lowest Record**

Stage 1: The first year that spring groundwater levels reach or fall below the alert level established for the well. *This alert level represents the mid point between the median spring or fall measurement and the historic low.* The median is utilized for the purposes of statistical analysis. When looking at all of the groundwater level measurements per season, the median is the middle number of a group of numbers; that is, half the numbers have values that are greater than the median, and half the numbers have values that are less than the median.

Stage 2: Stage 2 is reached if spring or fall groundwater levels, for a second consecutive year, remain at or below the Stage 1 alert level established for the well.

Stage 3: Stage 3 is reached if the spring or fall groundwater levels fall below the lowest historic water level on record.

**Groundwater Quality –**

Staff and stakeholders are hopeful that an appropriate water quality monitoring well will be located prior to the August 2009 monitoring period.

**Land Subsidence –**

Land Subsidence will be monitored at the closest extensometers located in the M&T and Western Canal sub inventory units. Maximum annual inelastic land subsidence shall not exceed 0.01 feet per year.

Stage 1: is reached when the annual elastic subsidence exceeds the average annual elastic subsidence measured over the period of record of the extensometer.

Stage 2: is reached when the annual elastic subsidence exceeds the maximum recorded elastic subsidence over the period of record for the extensometer.

Stage 3: is when inelastic subsidence is detected. Inelastic subsidence shall be detected by comparing reading from the extensometer taken on March 1 of each year against previous March 1 measurements.

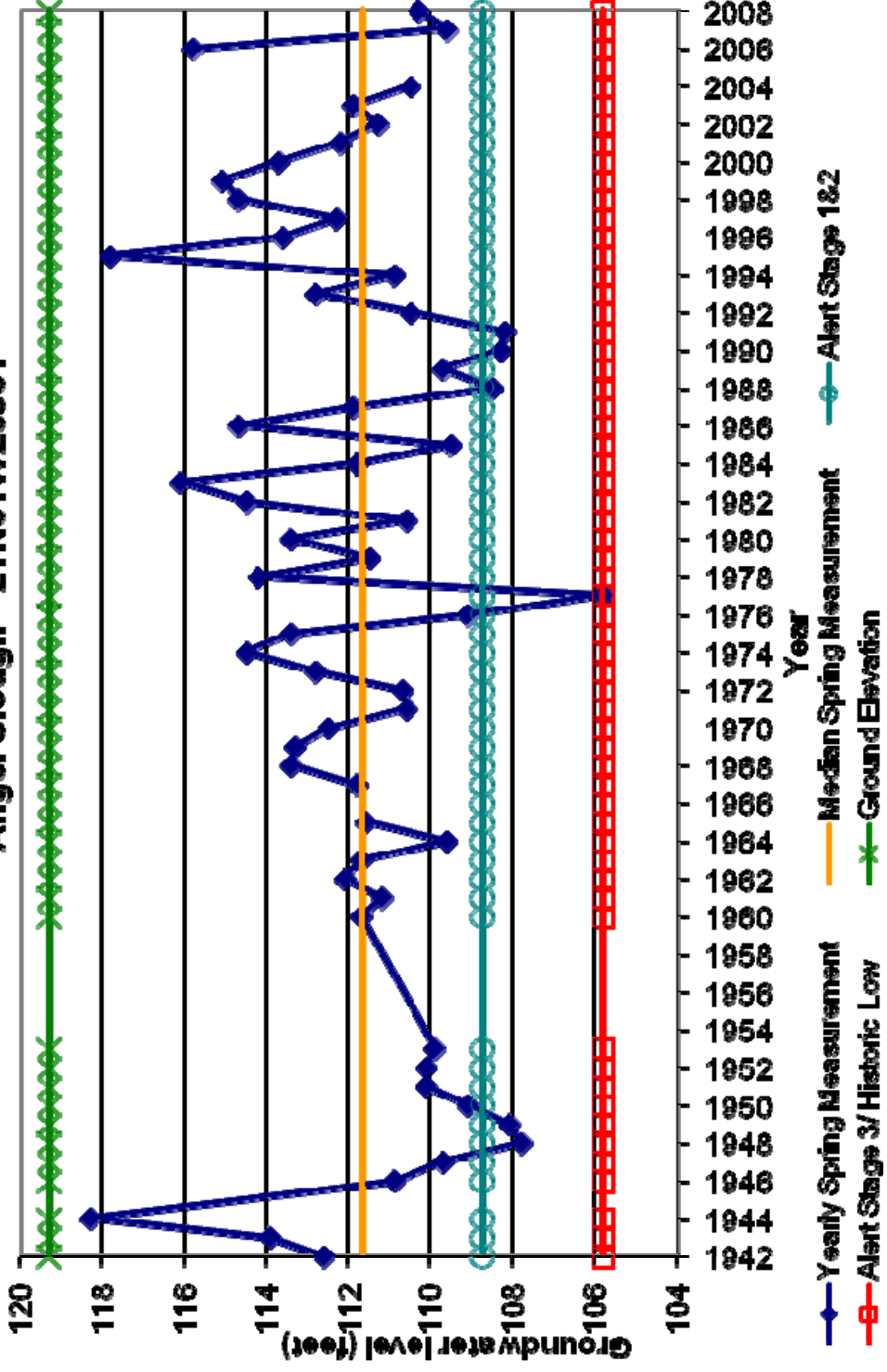
**Future Monitoring Recommendations –**

Efforts will be made to identify additional domestic wells that could be added to the existing monitoring well network in the sub-inventory unit to allow for development of additional management objectives for the alluvial aquifer system. Locate additional wells, either irrigation or domestic, with sufficient historical construction information to include in the water quality monitoring network, and initiate data collection in August 2009.

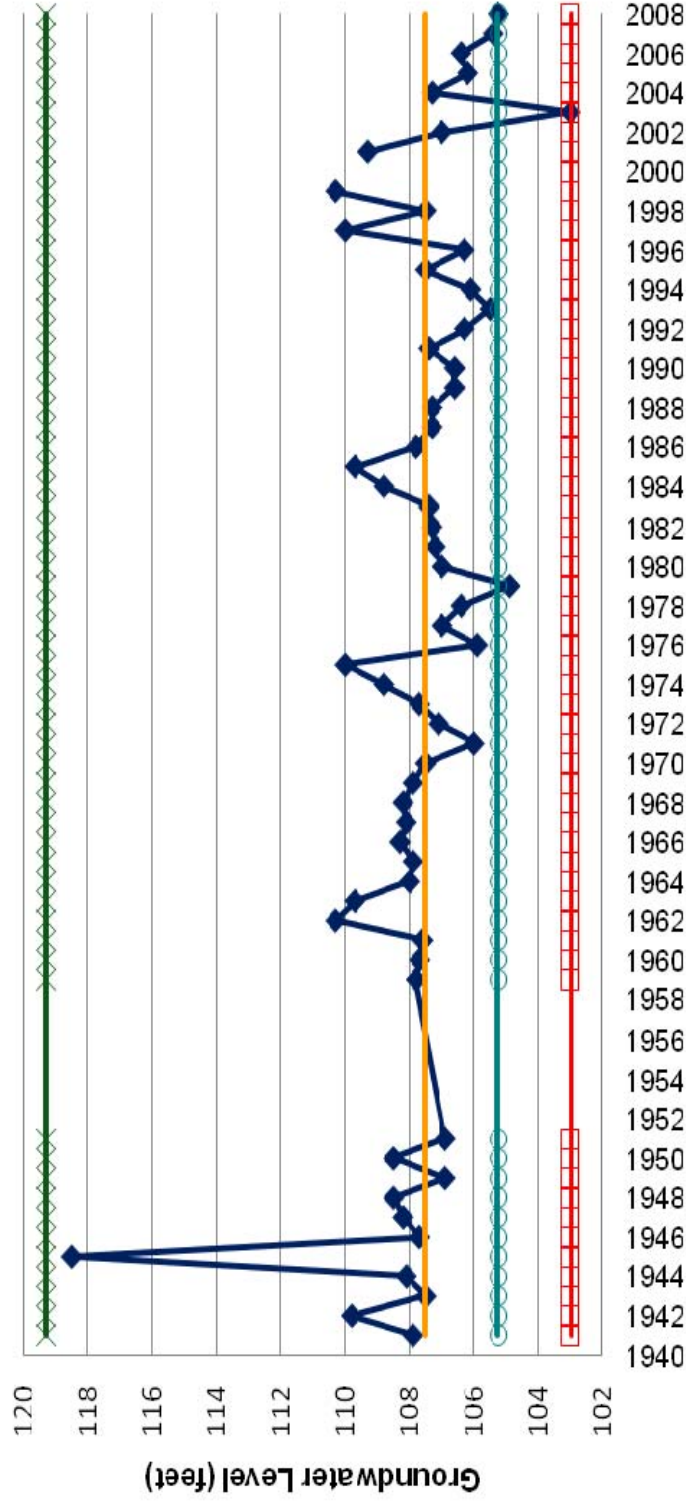
**Supporting Data –**

Hydrographs depicting yearly spring and fall level measurements, including 2008 data, with established alert levels for the 2009 calendar year.

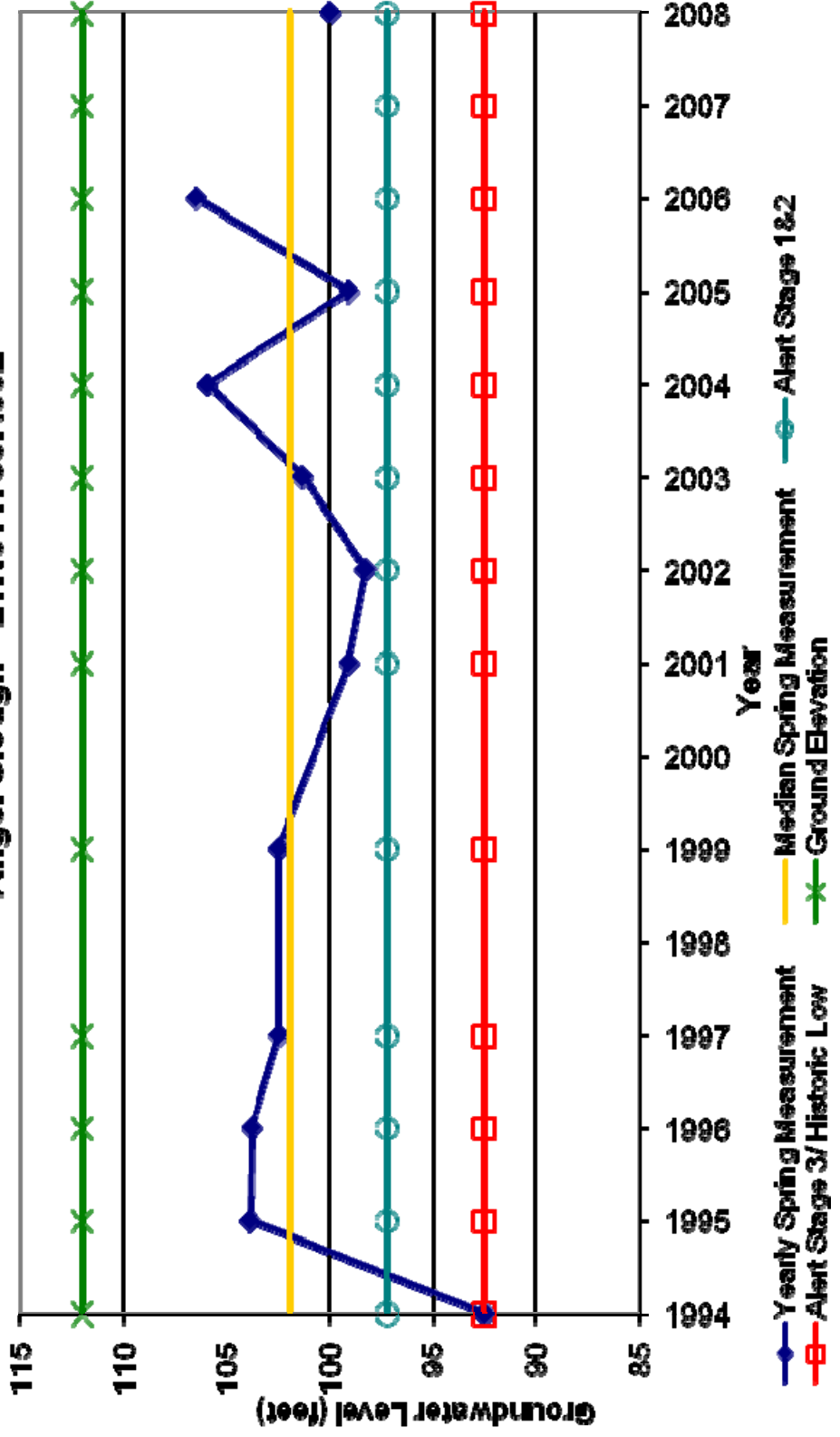
### Spring Groundwater Levels Angel Slough - 21N01W23J01



## Fall Groundwater Levels Angel Slough - 21N01W23J01



### Spring Groundwater Levels Angel Slough - 21N01W35K002



## Fall Groundwater Levels Angel Slough - 21N01W35K002

