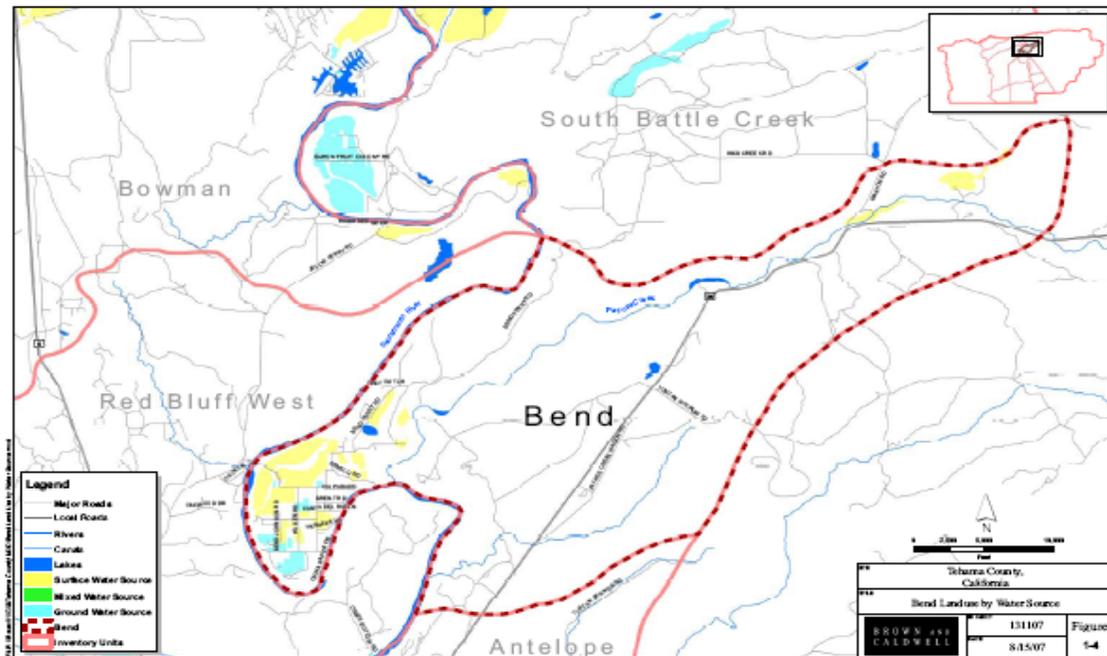


# Tehama County AB-3030 Groundwater Management Plan



## Technical Memorandum

### For the Bend Sub-basin of Tehama County



Draft for Public Review and Comment

Proposed Groundwater Trigger Levels and Awareness Actions

July 1, 2008

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Prepared for: Tehama County Flood Control and Water Conservation District

Project Title: BMO Trigger Level Development

Project No: 131107

Technical Memorandum

Subject: Proposed Groundwater Trigger Levels and Awareness Actions for the Bend Sub-basin

Date: July 1, 2008

To: Mr. Ernie Ohlin, Water Resources Manager

From: John Ayres, PG

Prepared by: John Ayres, PG

Reviewed by: Robert Vince, PG, CHG

## INTRODUCTION

Groundwater trigger levels represent declines in groundwater levels that, when reached or exceeded, may cause some type of action such as public outreach, increased monitoring, or consideration of modifying the groundwater trigger level. Trigger Levels are developed through a five step process as described in Section 1. Bend does not have monitoring wells, and instead of developing trigger levels, will determine priority areas for future monitoring as described in Section 2.

The Tehama County Flood Control and Water Conservation District (District) cooperated with private landowners, County groups, and local agencies overlying the groundwater basin to develop a Groundwater Management Plan (Plan) focusing on groundwater resources protection and management. The Plan incorporated citizen input, review, and approval over a period of three years, Final adoption by the Tehama County FCWCD was achieved in 1998.

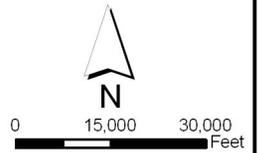
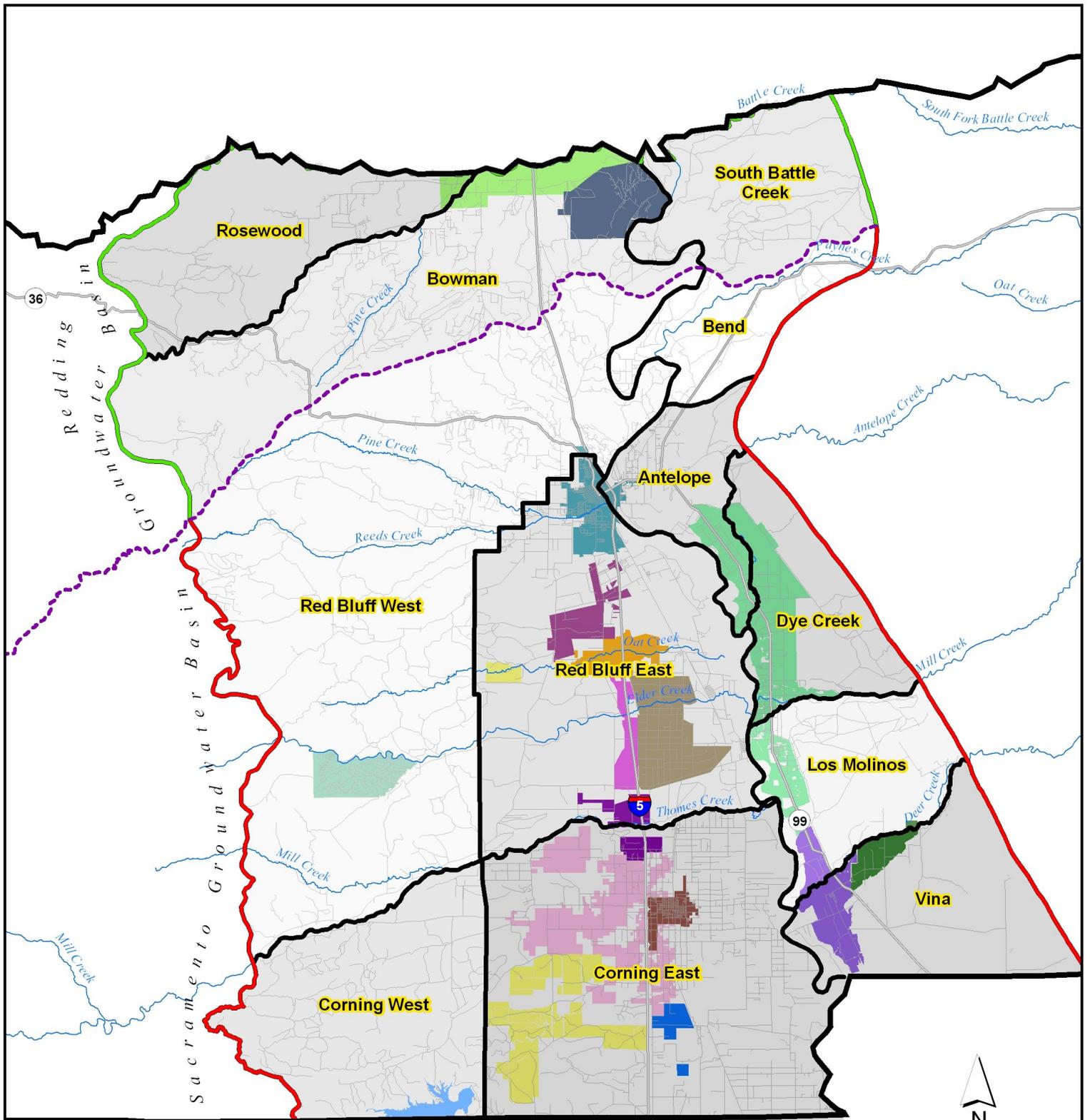
The Plan states that one of the District's functions under the Plan is to provide guidance in the development of groundwater trigger levels. The Plan defines trigger levels as increasing stages of groundwater decline that correspond with various trigger levels of increased groundwater discussion, investigation or local management actions.

Sections 325 through 329 of the Plan describe the trigger level concept and detail the District's role in trigger level development. The District, working with a Technical Advisory Committee (TAC) composed of local representatives, identified twelve groundwater sub-basins where trigger levels may be established (Figure 1-1).

This Technical Memorandum (TM) focuses on groundwater level trigger level development for the Bend sub-basin. Since its inception, the Plan has provided guidance related to groundwater activities. Landowners and water purveyors alike recognize the need to move forward with groundwater resource protection by developing measures (trigger levels) that determine the level of active management needed within each sub-basin. Trigger levels can be established for groundwater levels, groundwater quality, or inelastic land subsidence due to groundwater extraction. Section 1 of this TM describes the methodology used to develop trigger levels.

Because the Bend Sub-Basin does not have formal groundwater monitoring, such as a dedicated monitoring well or wells included in the Department of Water Resources (DWR) monitoring grid, Section 2 of this TM identifies potential areas for new groundwater monitoring within the Bend Sub-Basin.

Additional information on the trigger level development process and regional hydrogeology is available in the *Trigger Level Background Technical Memorandum*, available on the District's website at: <http://www.tehamacountywater.ca.gov/>. Ultimately, it is the District's desire to have management objectives that are understood and supported by groundwater users in each sub-basin.



**Irrigation Districts**

- |   |   |  |   |
|---|---|--|---|
| <span style="display:inline-block; width:15px; height:15px; background-color:yellow; border:1px solid black;"></span> Aaction                 | <span style="display:inline-block; width:15px; height:15px; background-color:lightpink; border:1px solid black;"></span> Corning WD   | <span style="display:inline-block; width:15px; height:15px; background-color:blue; border:1px solid black;"></span> Kirkwood ID        | <span style="display:inline-block; width:15px; height:15px; background-color:purple; border:1px solid black;"></span> Rawson ID       |
| <span style="display:inline-block; width:15px; height:15px; background-color:lightgreen; border:1px solid black;"></span> Anderson-Cottonwood | <span style="display:inline-block; width:15px; height:15px; background-color:darkgreen; border:1px solid black;"></span> Deer Creek   | <span style="display:inline-block; width:15px; height:15px; background-color:lightgreen; border:1px solid black;"></span> LMMWC        | <span style="display:inline-block; width:15px; height:15px; background-color:darkblue; border:1px solid black;"></span> Rio Alto WD   |
| <span style="display:inline-block; width:15px; height:15px; background-color:brown; border:1px solid black;"></span> City of Corning          | <span style="display:inline-block; width:15px; height:15px; background-color:tan; border:1px solid black;"></span> El Camino ID       | <span style="display:inline-block; width:15px; height:15px; background-color:orange; border:1px solid black;"></span> Proberta ID      | <span style="display:inline-block; width:15px; height:15px; background-color:purple; border:1px solid black;"></span> Stanford Vina   |
| <span style="display:inline-block; width:15px; height:15px; background-color:teal; border:1px solid black;"></span> City of Red Bluff         | <span style="display:inline-block; width:15px; height:15px; background-color:magenta; border:1px solid black;"></span> Elder Creek ID | <span style="display:inline-block; width:15px; height:15px; background-color:lightteal; border:1px solid black;"></span> Rancho Tehama | <span style="display:inline-block; width:15px; height:15px; background-color:purple; border:1px solid black;"></span> Thomes Creek ID |

**Legend**

- Red Bluff Arch
- Redding Groundwater Basin
- Sacramento Valley Groundwater Basin



PROJECT  
131107

DATE  
1/18/07

SITE

TITLE

Tehama County

Groundwater Sub-Basins

Figure

1-1

## 1. Groundwater Level Trigger Level Development Methodology

Groundwater trigger levels are derived through interpretation of historic groundwater levels. A series of awareness actions are proposed for each trigger level stage. Development of groundwater level triggers is a five-step process, listed below:

*Step 1: Describe the trigger level's purpose.*

*Step 2: Select one or more key wells within the sub-basin.*

*Step 3: Designate the time of seasonal measurement.*

*Step 4: Establish trigger levels in the selected key wells.*

*Step 5: Define awareness actions associated with each trigger level.*

### **Step 1: Describe the trigger level's purpose.**

The trigger level's purpose describes the intent of the trigger levels in the area. The purpose may reflect the desire of sub-basin planners to protect historic groundwater uses, minimize long-term drawdown of groundwater levels, maintain springs and habitat, and/or protect groundwater supplies for domestic and irrigation uses.

### **Step 2: Select one or more key wells within the sub-basin.**

Key wells are monitoring wells that are representative of groundwater conditions within a particular aquifer interval, or range of aquifer intervals underlying the sub-basin. Groundwater levels in key wells provide information necessary to initiate management activities. If no monitoring wells are available in a sub-basin, such as Bend, then locations for new monitoring wells should be selected.

When selecting new areas for monitoring, the choice should be guided by a number of criteria including land use, agricultural water source, existing well infrastructure, accessibility, and monitoring in adjacent sub-basins.

**Land Use:** Groundwater levels are more likely to be stressed in areas of active land use. Areas with fixed water demand from crops such as orchards should be higher priority areas for monitoring.

**Water Source:** Groundwater supplies in areas irrigated with groundwater are more likely to be stressed during drought periods. Locating monitoring wells in areas reliant on groundwater would provide useful information for groundwater management, and should be higher priority areas for monitoring.

**Existing Well Infrastructure:** Well drilling records should be considered. The screened intervals of monitoring wells should be similar to the average screened interval of production wells in the area.

**Accessibility:** The monitoring well should be located in an accessible area to allow for monitoring activities. New monitoring should occur in areas with cooperative landowners that provide a right of entry to monitoring activities.

**Monitoring in Adjacent Sub-Basins:** A new monitoring well should not be sited near an existing monitoring well.

Once monitoring wells have been located and developed in an area, the remaining three trigger level steps can take place.

### **Step 3: Designate the time of seasonal measurement.**

Groundwater levels fluctuate seasonally, and measurements from the different seasons provide different snapshots of groundwater conditions. Spring measurements provide information on whether the basin has recharged during the wet season to elevations observed in previous years. Typically, spring water levels are the highest water levels observed during the year. Summer and fall water level elevation measurements provide information about decreased water levels during groundwater pumping and illustrate the pumping impacts within a season.

The District suggests that spring measurements be used to set trigger levels with associated awareness actions, and late season measurements (summer and fall) be used to set an additional trigger level with associated awareness actions that is sensitive to groundwater levels during the seasons of heavy groundwater use that can provide a warning of potential issues such as increased groundwater demand.

### **Steps 4 and 5: Establish trigger levels in selected key wells and define awareness actions associated with each trigger level.**

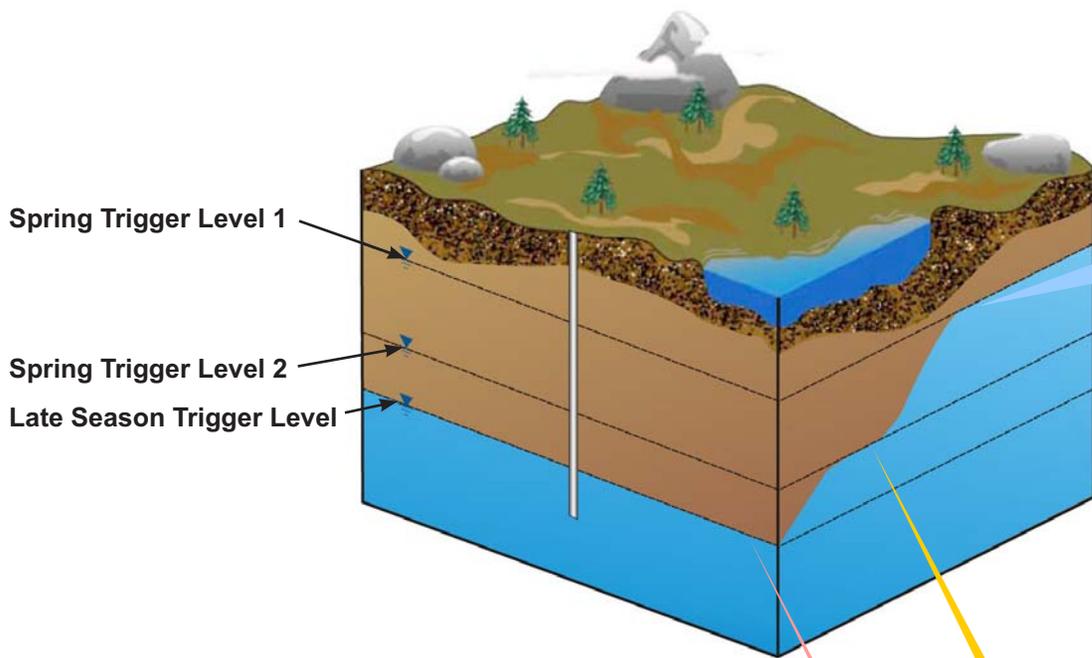
Trigger levels act as an early warning system for identifying potential problems. A trigger level corresponds to a predetermined target groundwater level during a season of measurement. For example, if a trigger level is set at a water surface elevation of 50 feet below ground surface (bgs) in the spring, then only spring measurements should be compared to the trigger level. A spring measurement of 40 feet bgs would not require an awareness action in this case. A spring measurement of 60 feet bgs, on the other hand, would be below the trigger level, and should prompt awareness actions (Figure 1-2).

After key wells have been identified, the seasonal measurements have been designated, and a history of groundwater level measurements have begun to develop, sub-basin representatives may review and provide input on the proposed trigger levels within their sub-basin and the awareness actions associated with each level. Potential trigger levels, and the accompanying awareness actions, may range from a small decrease in groundwater levels compared to historical levels, (indicating a need to disseminate information or further investigation of groundwater levels), to a larger change in groundwater levels, (indicating a need to take action to stop or reduce the lowering of groundwater levels).

For each trigger level, sub-basin representatives should work with local groundwater users and the District to implement the awareness actions associated with the trigger level. Management actions may include providing information on trigger level exceedance to the public, investigating the trigger level exceedance, and taking action to remedy the issue.

A summary of associated awareness actions with each trigger level include:

**Spring Trigger Level 1:** The first trigger level would cause the dissemination of information to the public about the potential groundwater issue. Additional awareness actions are triggered by a second consecutive year of groundwater levels at or below Spring Groundwater Trigger Level 1.



### Spring Trigger Level 1 Awareness Actions

#### ONE YEAR BELOW TRIGGER LEVEL 1

- TAC meetings to address issues in the area
- Water user/stakeholder meeting for the subbasin
- Send mail to known water users in subbasin, notifying them about a overall decrease in water levels or quality in the subbasin
- Notify public of groundwater issue
  - County to make a press release
  - Updates to the District website
  - District to attend agriculturally related and city meetings
  - Site visits
- Review recent precipitation trends to look for drought trends

#### CONSECUTIVE YEARS BELOW TRIGGER LEVEL 1

- Continue to inform water users and general public
- Verify data
- Increase monitoring frequency in subbasin
- Add new monitoring location in subbasin
- Begin monitoring land subsidence
- Install data loggers
- Investigate cause of low groundwater levels

AWARENESS ACTIONS

### Spring Trigger Level 2 Awareness Actions

- Continue Spring Trigger Level 1 Awareness Actions
- Solicit voluntary public involvement in resolving issues in the area
- Consider groundwater recharge efforts
- Review condition of approval for new development reliant on groundwater by the County
- Review of the County's approval process regarding water supply for development or additional groundwater pumping projects
- Increase land subsidence monitoring

AWARENESS ACTIONS

### Late Summer Trigger Level Awareness Actions

- Perform Spring Trigger Level 1 and 2 Awareness Actions
- Investigate potential higher groundwater demand or other causes

AWARENESS ACTIONS

Figure 1-2  
Trigger Levels and Awareness Actions

**Spring Trigger Level 2:** The second and deeper spring groundwater trigger level would lead to increased monitoring activities and continued public information on the groundwater condition plus investigations and the development of actions to remedy the groundwater issue.

**Late Season Trigger Level:** The late season trigger level would cause the dissemination of information to the public and the beginning of investigations to understand the cause. Late season measurements are sensitive to groundwater levels during the seasons of heavy groundwater use and can provide a warning of potential issues such as increased groundwater demand.

## 2. Bend Trigger Level Development

Because Bend does not have monitoring wells, this section is focused on the implementation of the first two steps of the five-step methodology:

### Step 1: Describe the trigger level’s purpose.

The Bend sub-basin is primarily a rural area, with agriculture in the western end of the sub-basin. Groundwater is used for agricultural and domestic purposes. There is one irrigation district, the Bend Water Users Association, in the Bend sub-basin, as indicated in Figure 1-1. Additional water use information is available in the Tehama County Water Inventory and Analysis, available in PDF format at: [http://www.tehamacountywater.ca.gov/grndwtr\\_inv\\_ana.htm](http://www.tehamacountywater.ca.gov/grndwtr_inv_ana.htm). The trigger level’s purpose in this sub-basin should reflect the needs of local water users. Some suggested trigger level purposes are:

- Maintain a stable trend of groundwater in storage to ensure adequate drinking water and agricultural supplies to protect supplies for current and future uses.
- Monitor groundwater levels to record and compare changes to aid in identifying conditions that cause declines in groundwater levels.

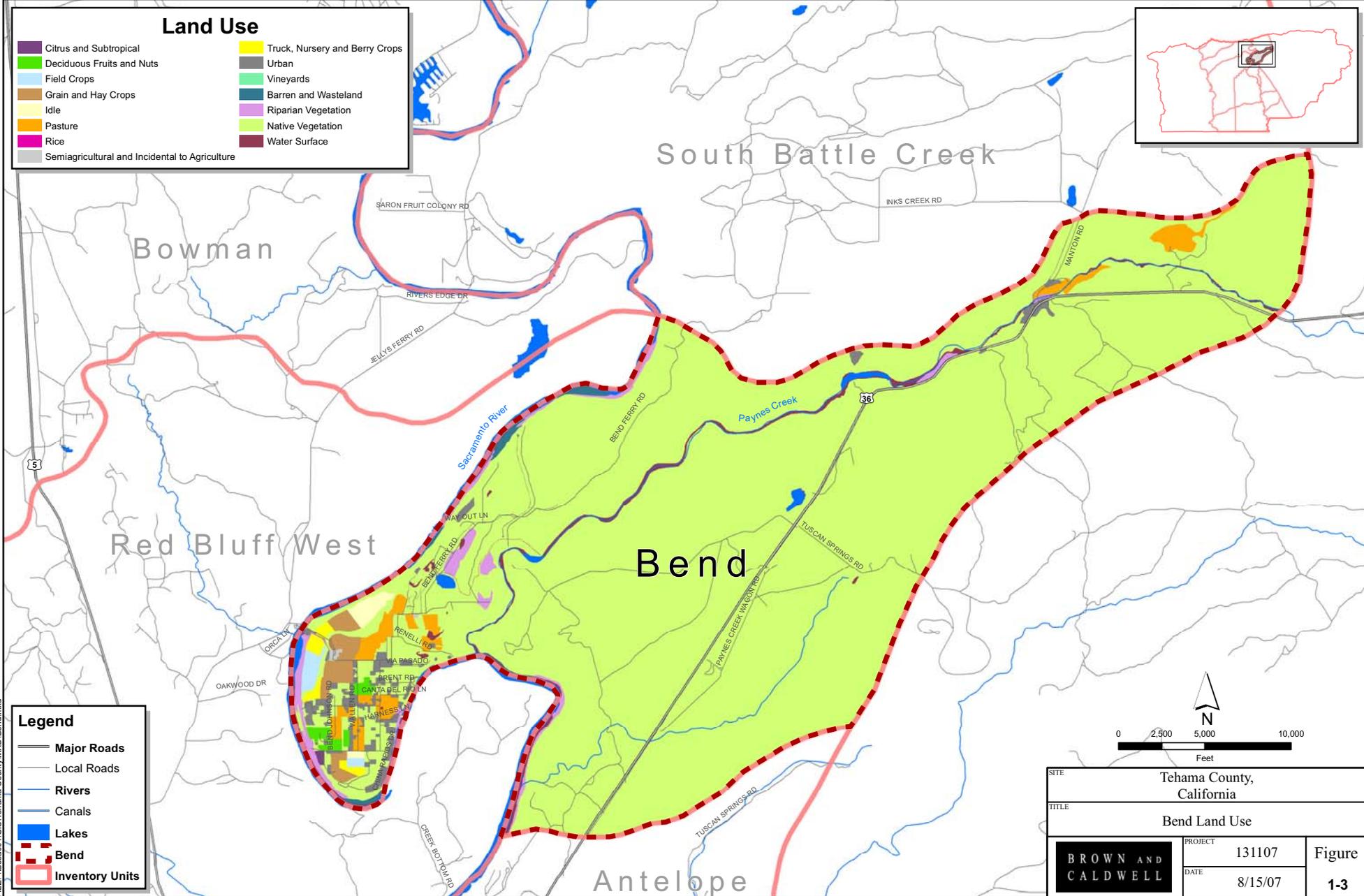
### Step 2: Select one or more key wells within the sub-basin.

There are currently no monitoring wells located within the Bend sub-basin. According to the DWR database, there are 163 reported wells in Bend, none of which included in the DWR monitoring grid. Groundwater levels in key wells provide information necessary to initiate management activities. To begin the trigger level process, the District suggests that priority areas for new monitoring be selected in the Bend area.

<b>Groundwater Use in Bend:</b>	
Irrigation:	50% (200 acre-ft)
Municipal, and Industrial:	50% (200 acre-ft)
<b>Number of wells by type in Bend:</b>	
Irrigation:	19 wells
Domestic:	144 wells
Municipal and Industrial:	0 wells

When picking areas for monitoring wells in Bend, the choice should be guided by a number of criteria including land use, agricultural water source, existing well infrastructure, accessibility, and monitoring in adjacent sub-basins.

**Land Use:** Figure 1-3 presents the land use in the Bend area. Agriculture in Bend is predominantly in the west, with orchards and pasture the predominant crop types. Future land use in Bend is anticipated to be similar to current land use. Additional land use information can be obtained by obtaining the zoning information for the Bend area.



**Land Use**

Citrus and Subtropical	Truck, Nursery and Berry Crops
Deciduous Fruits and Nuts	Urban
Field Crops	Vineyards
Grain and Hay Crops	Barren and Wasteland
Idle	Riparian Vegetation
Pasture	Native Vegetation
Rice	Water Surface
Semiagricultural and Incidental to Agriculture	

**Legend**

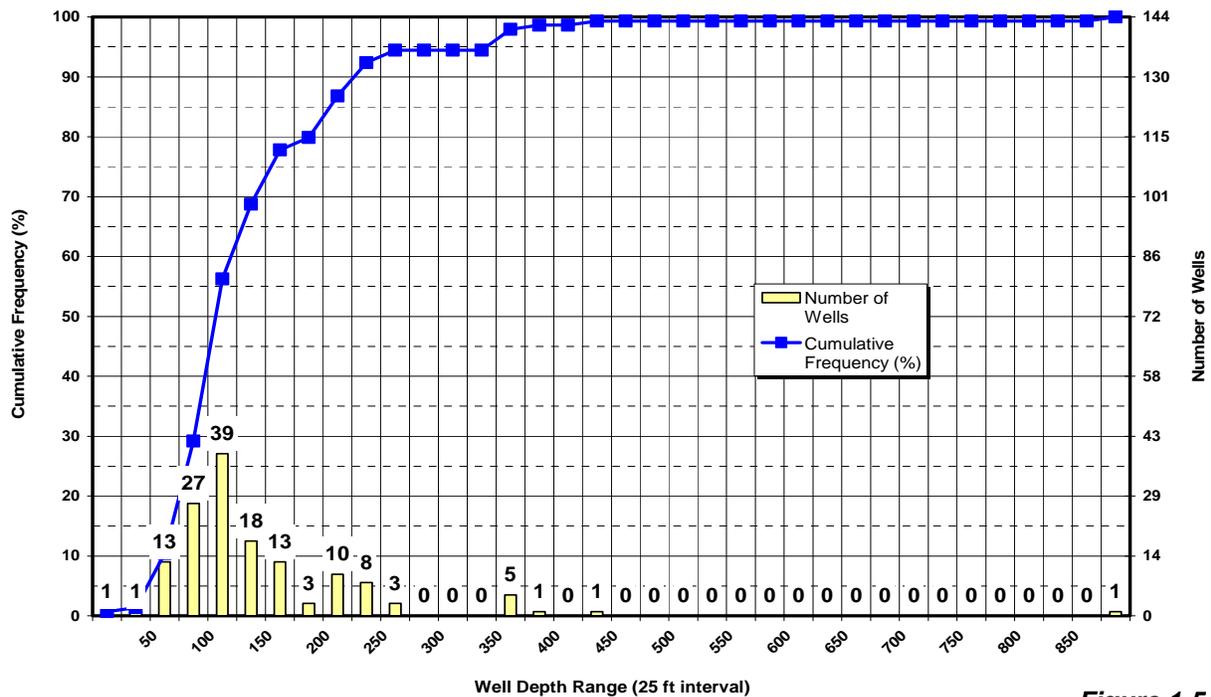
	Major Roads
	Local Roads
	Rivers
	Canals
	Lakes
	Bend
	Inventory Units

SITE		Tehama County, California	
TITLE			
Bend Land Use			
	PROJECT	131107	Figure
	DATE	8/15/07	1-3

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**Water Source:** Figure 1-4 presents agricultural land use by water source in the Bend area. Figure 1-4 demonstrates that agriculture in the northwestern corner of Bend is irrigated with surface water, and that agriculture in the southwestern point of Bend is irrigated with groundwater.

**Existing Well Infrastructure:** Figure 1-5 shows the cumulative frequency curve for domestic wells in Bend. There are 144 domestic wells and 19 irrigation wells in the Bend sub-basin. Fifty percent of the domestic wells are shallower than 50 feet deep, and fifty percent of the irrigation wells are shallower than 165 feet deep. Existing well infrastructure data was developed from DWR’s well completion report database. DWR’s database contains information on the majority of wells drilled after 1947, while wells drilled prior to 1947 are generally not included. Some wells drilled after 1947 may not have been reported to DWR (potentially up to 30%), and therefore are not included in the database.



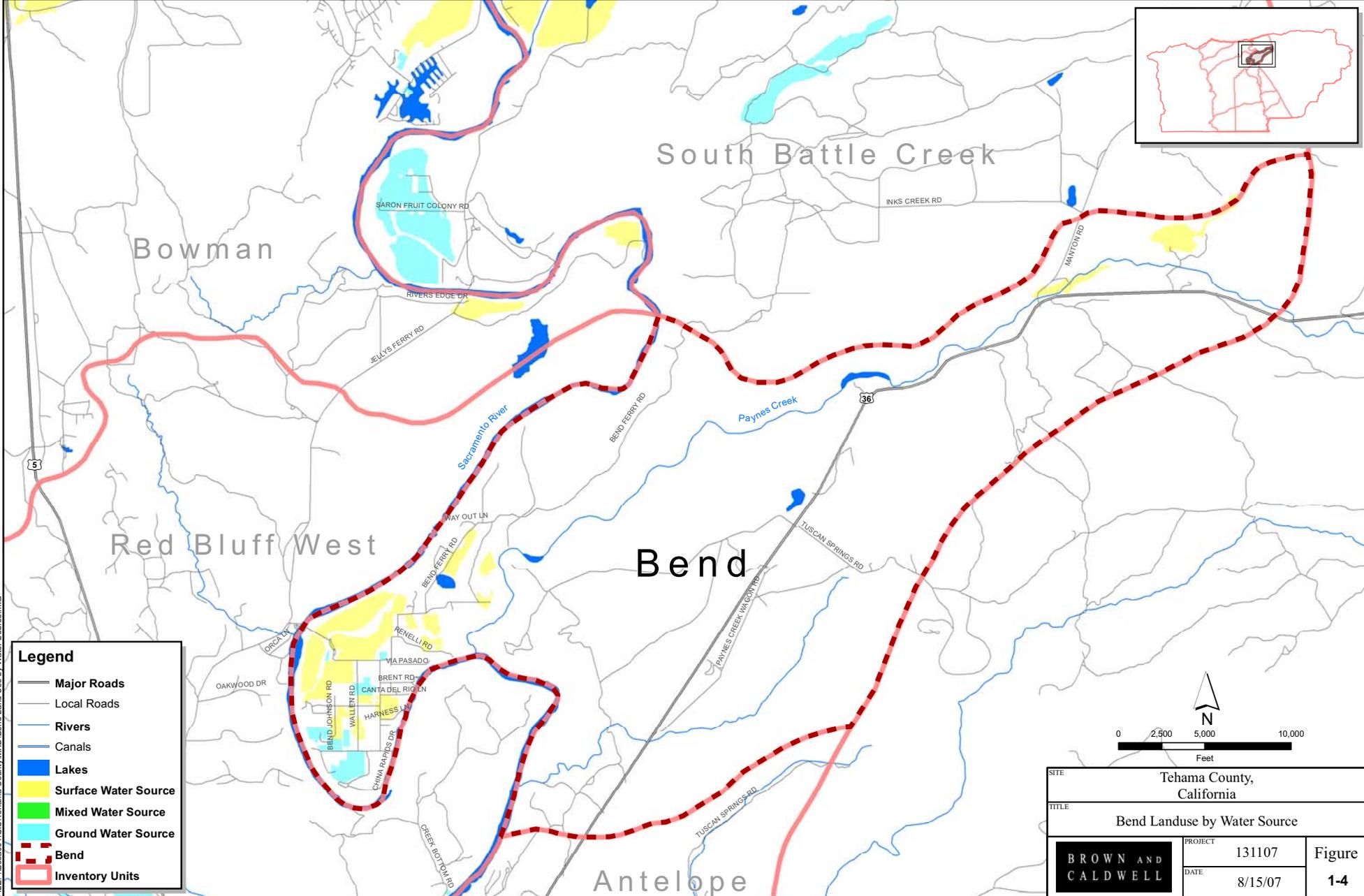
**Figure 1-5**  
**Cumulative Frequency Curve of Domestic Wells in the Bend Sub-Basin**

**Accessibility:** The monitoring well should be located in an accessible area to allow for monitoring activities. New monitoring should occur in areas with cooperative landowners that provide a right of entry to monitoring activities.

**Monitoring in Adjacent Sub-Basins:** A new monitoring well should not be sited near an existing monitoring well. Figure 1-4 shows the locations of any monitoring wells adjacent to Bend. As indicated by Figure 1-4, there are no monitoring wells near the boundary of Bend, and new monitoring wells can be sited near the boundary of the sub-basin.

**Suggested Monitoring Well Areas:**

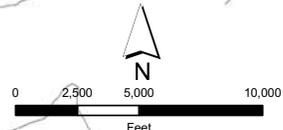
There are two suggested areas for new monitoring wells in the Bend area which are indicated in Figure 1-6. Monitoring wells installed in the Bend area should be screened to monitor groundwater



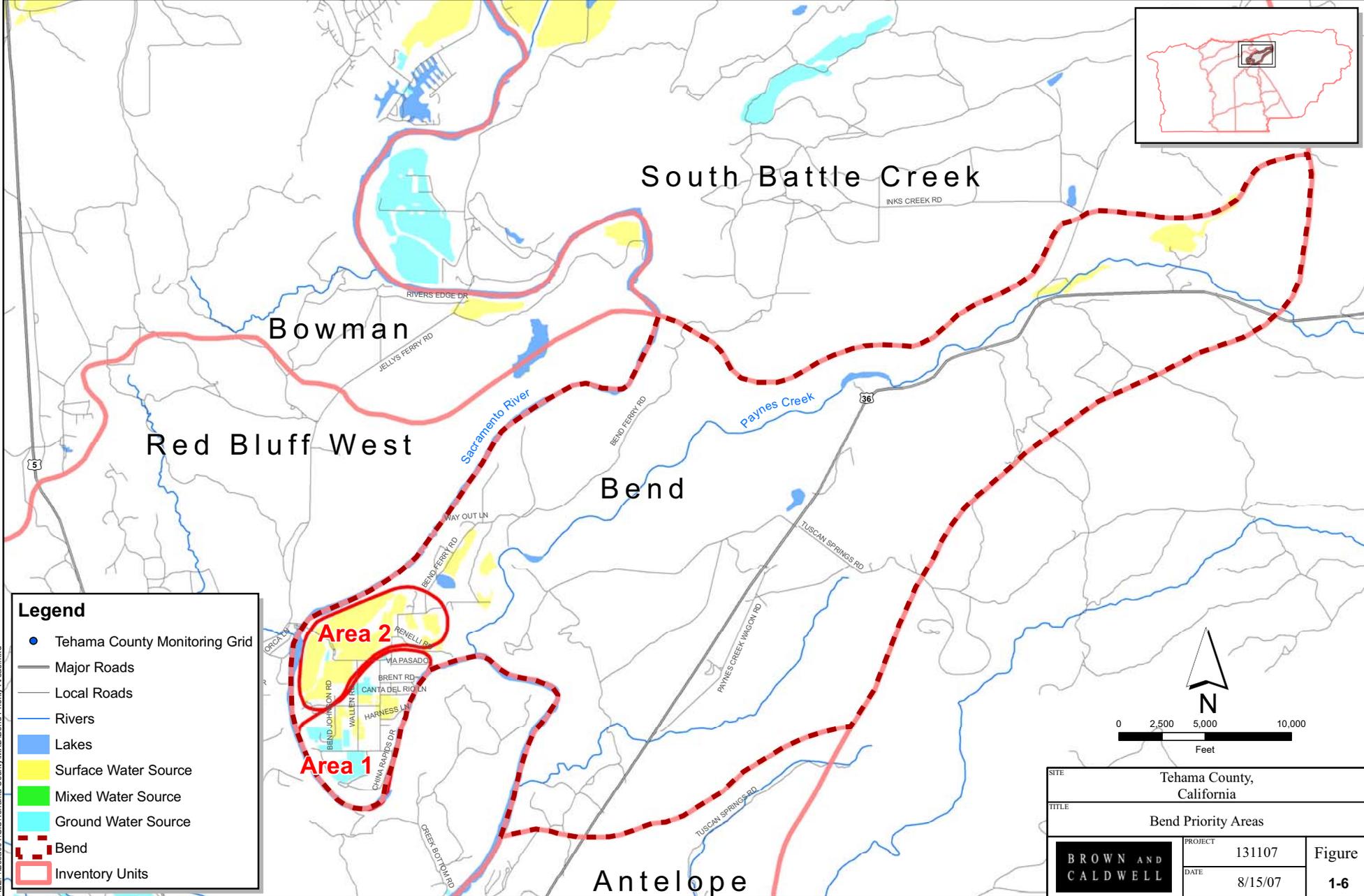
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**Legend**

- Major Roads
- Local Roads
- Rivers
- Canals
- Lakes
- Surface Water Source
- Mixed Water Source
- Ground Water Source
- Bend
- Inventory Units



SITE		Tehama County, California	
TITLE			
Bend Landuse by Water Source			
<b>BROWN AND CALDWELL</b>	PROJECT	131107	<b>Figure 1-4</b>
	DATE	8/15/07	



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**Legend**

- Tehama County Monitoring Grid
- Major Roads
- Local Roads
- Rivers
- Lakes
- Surface Water Source
- Mixed Water Source
- Ground Water Source
- Bend
- Inventory Units



0 2,500 5,000 10,000  
Feet

<small>SITE</small>	Tehama County, California	
<small>TITLE</small>	Bend Priority Areas	
<b>BROWN AND CALDWELL</b>	<small>PROJECT</small>	131107
	<small>DATE</small>	8/15/07
	<b>Figure</b>	<b>1-6</b>

at depths similar to those used for production by domestic and irrigation wells. The majority of domestic and irrigation wells in Bend are screened between 40 and 200 feet below ground surface. The two suggested areas are in the more developed, western end of the sub-basin as listed below:

- The first suggested area (Area 1) is in the southwestern point of the sub-basin, and is a priority area of orchards and pasture irrigated with groundwater, with mixed urban uses. Area 1 is not near other monitoring wells.
- The second suggested area (Area 2) is in the northwestern portion of the sub-basin, north of Area 1. Area 2 is a priority area of grain, hay, and pasture that is irrigated by surface water. Area 2 is not near other monitoring wells.

### 3. Next Steps

**Steps 1 and 2:** With the proposed priority areas selected, the next step will be confirmation of priority areas with stakeholders. Once stakeholders have provided local information and input to priority area selection, the availability of existing wells for monitoring and the need for new monitoring wells can be assessed. As monitoring locations are selected and developed, the monitoring program for the Bend sub-basin can be implemented.

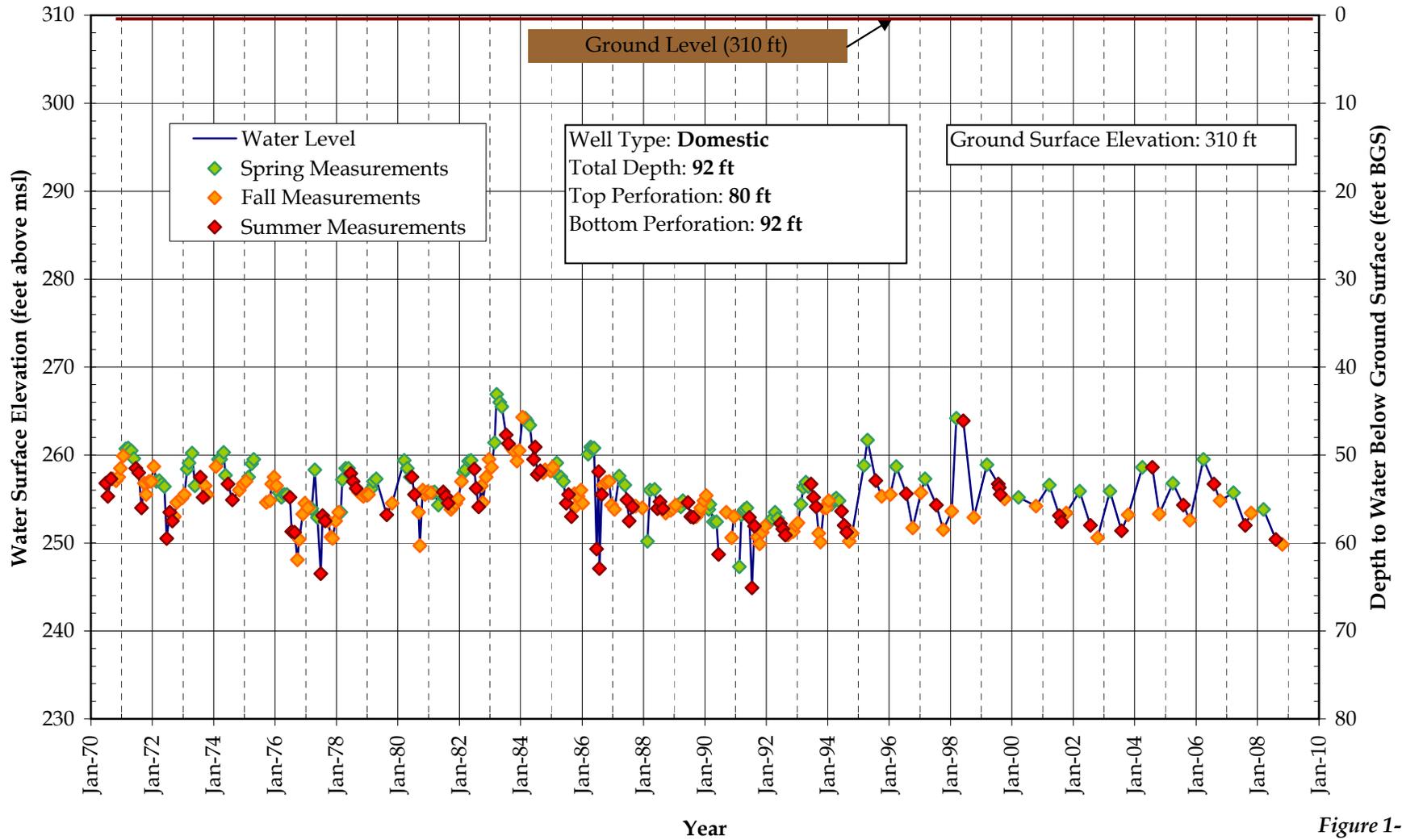
**Steps 3, 4 and 5:** Once the monitoring program is in place, steps 3 through 5 of the trigger level development process can be completed as described in the methodology section. Example trigger levels from the Antelope sub-basin are provided below.

Figures 1-7 through 1-9 present hydrographs and suggested trigger levels for an example key well located in the Antelope sub-basin. The figures are groundwater level hydrographs, demonstrating water level elevation measurements over the monitoring period of record and the suggested trigger levels during a particular season. The methodologies used to determine the suggested trigger levels for the example key well is provided in Table 1-1.

**Table 1-1. Trigger Level Methodology**

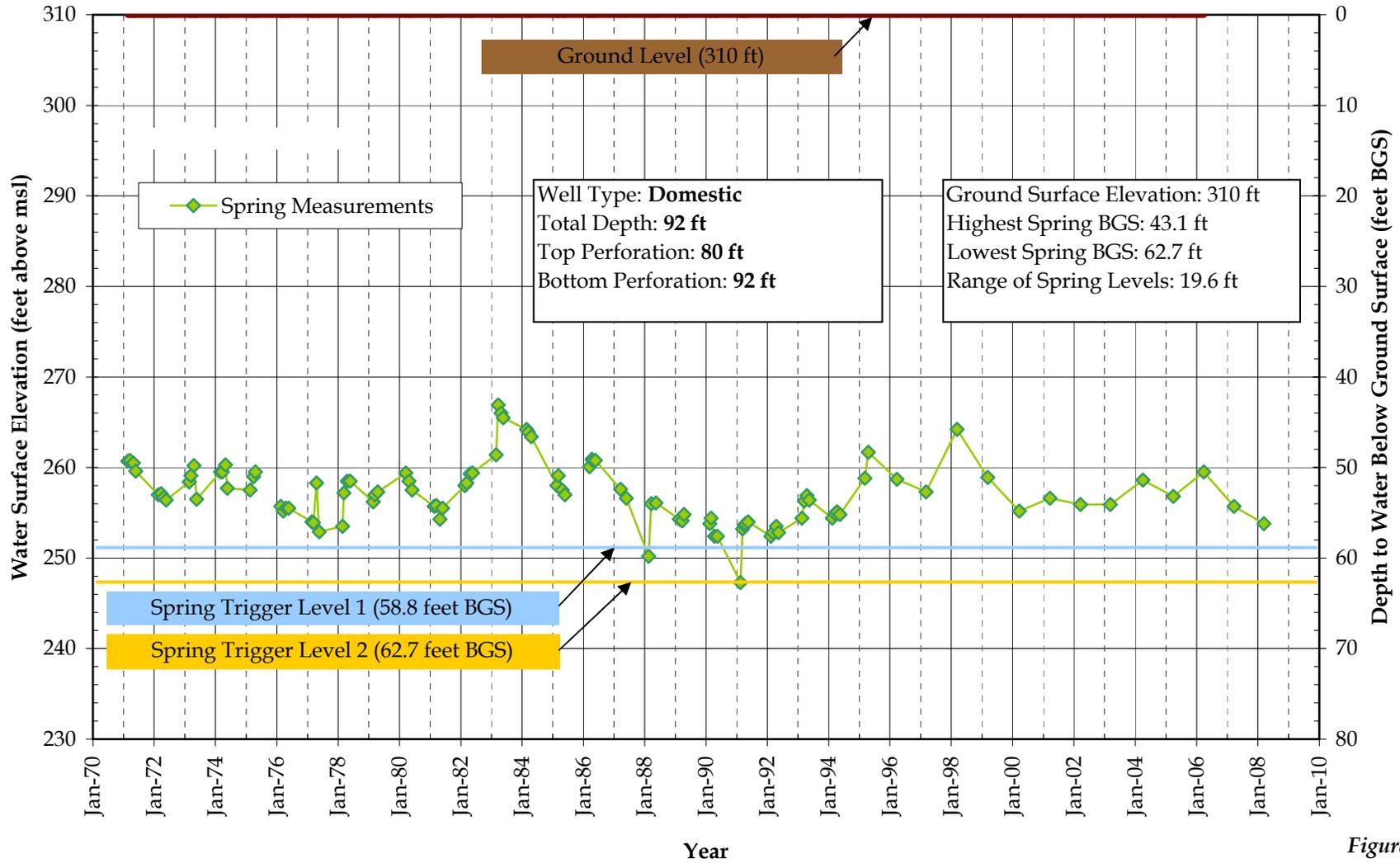
Groundwater Trigger Level and Awareness Action	Antelope Monitoring Well Number				
	10B01M	16N02M	23D01M	31C01M	17E01M
Spring Trigger Level 1 – Notify and Inform Public	Historical low of spring measurements plus 20 % of the range of spring measurements				
Monitor and investigate Cause	Second consecutive year of groundwater levels at or below Spring Trigger Level 1				
Spring Trigger Level 2 – Consider Management Options	Historical low of spring measurements				
Late Season Trigger Level – Notify public and begin investigations	Historical low of late season groundwater measurements				
<b>Data Anomalies</b>	None	None	None	None	None

**Antelope Area Key Well 27N03W10B01M (St. Marys Ave and Trinity Ave)  
Example Hydrograph over the 1970 - 2006 Period**



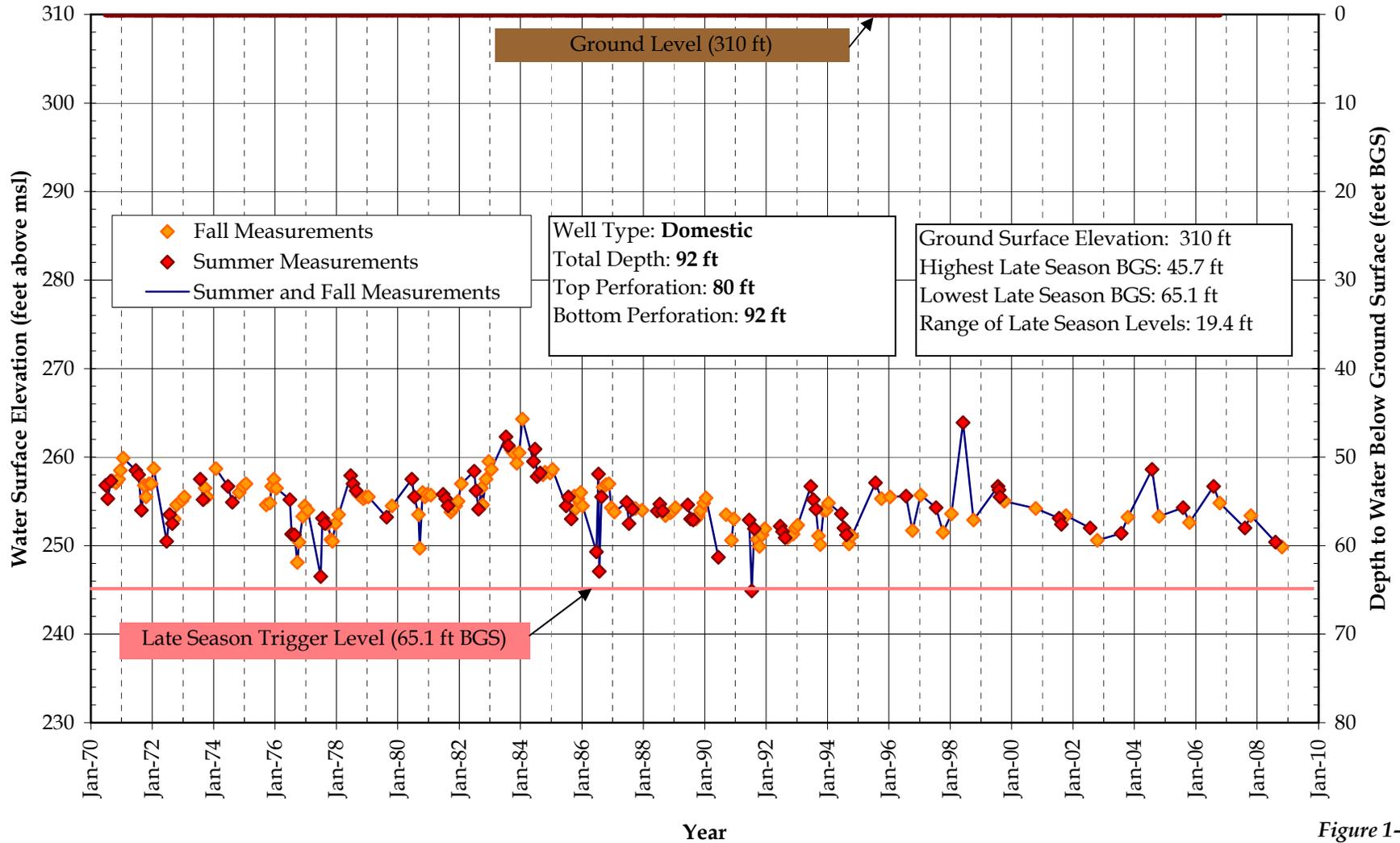
**Figure 1-7**  
*Hydrograph of Key Well 27N03W10B01M*

### Antelope Area Key Well 27N03W10B01M (St. Marys Ave and Trinity Ave) Example Spring Level Hydrograph



*Figure 1-8  
Spring Trigger Levels*

**Antelope Area Key Well 27N03W10B01M (St. Marys Ave and Trinity Ave)  
Example Late Season (July, August, September, and October) Hydrograph**



**Figure 1-9**  
*Late Season Trigger Levels*