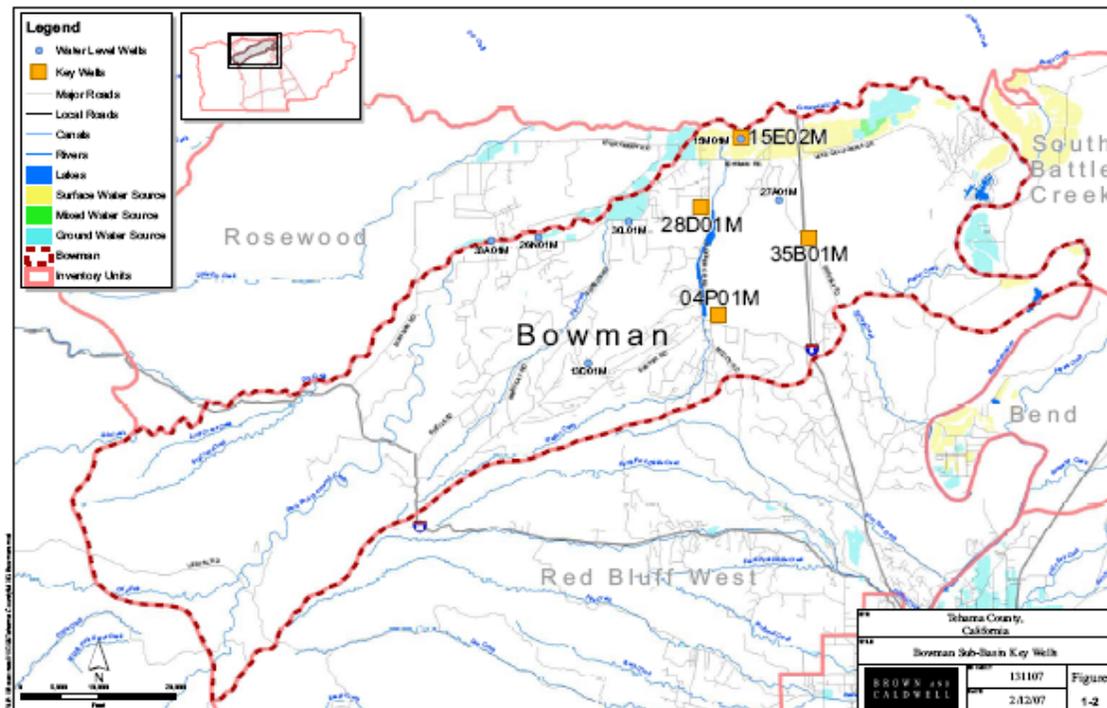


Tehama County AB-3030 Groundwater Management Plan



Technical Memorandum

For the Bowman 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 Bowman
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

1. INTRODUCTION

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 took three years to develop with citizen input, review, approval, and achieving final adoption by the Tehama County FCWCD in 1998.

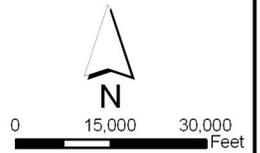
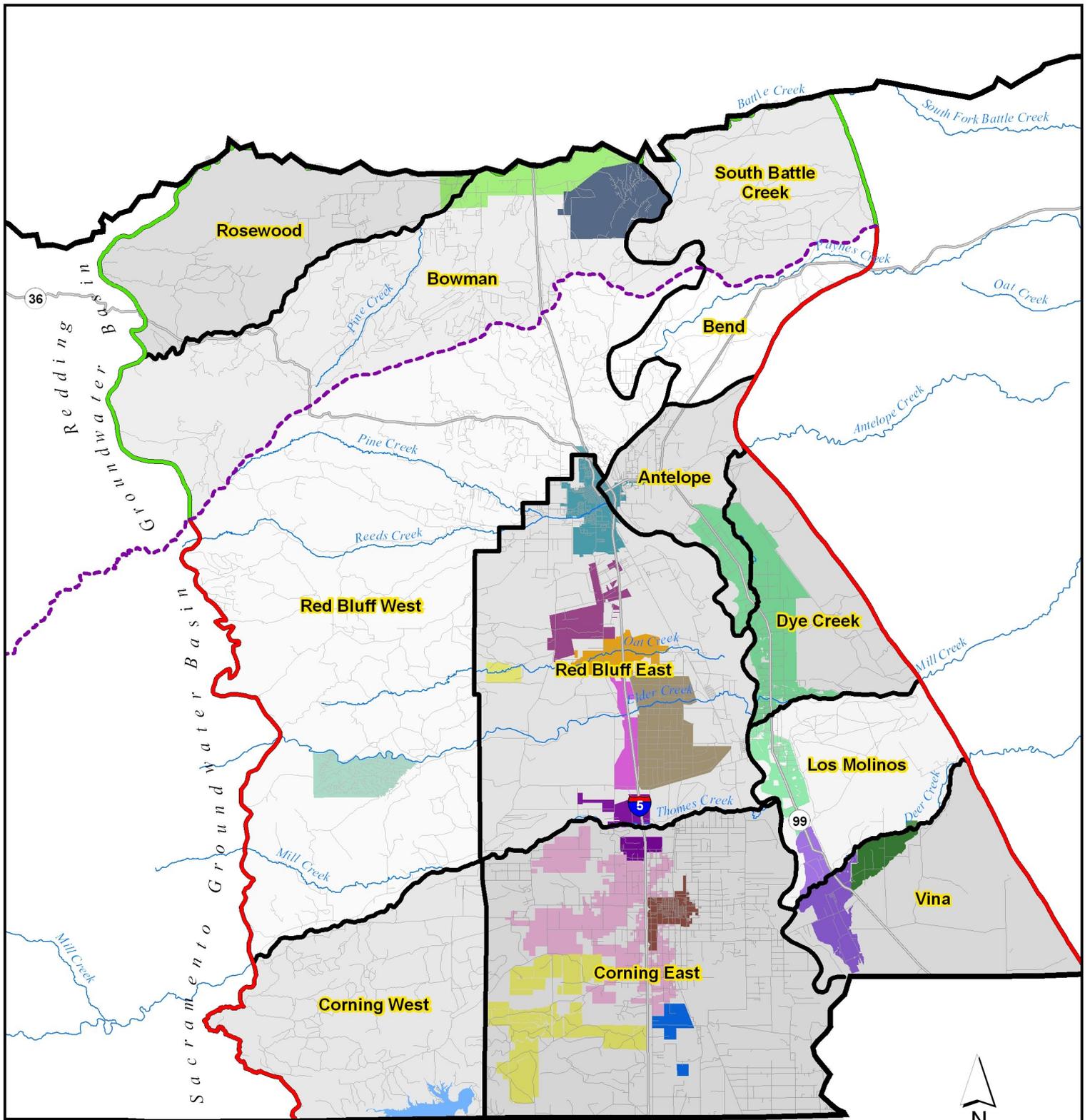
This Plan has provided guidance related to groundwater activities since adoption. Landowners and water purveyors alike recognize the need to move forward with groundwater resource protection by developing measures (trigger levels) that determine the level of active management needed within each sub-basin.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

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. The Plan defines trigger levels as increasing stages of groundwater decline that correspond with various levels of increased groundwater discussion, investigation or local management actions. This TM identifies trigger levels that correspond to three decreasing levels of groundwater in the spring, and one trigger level that corresponds with decreasing levels of groundwater in the summer and fall.

The Plan states that one of the District's functions under the Plan is to provide guidance in the development of trigger levels. Sections 325 through 329 of the Plan describe the trigger level concept and 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 TM presents the process for developing groundwater elevation trigger levels and provides specific suggestions for the Bowman 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/>.

The District understands that final trigger levels should reflect stakeholders' in-depth knowledge and management objectives for their sub-basin. Representatives from each sub-basin will review and provide input on the proposed trigger levels and suggested management actions contained herein for use in their sub-basin. The District is open to revisions that reflect stakeholder knowledge of groundwater conditions in their sub-basin. Ultimately, it is the District's desire to have management objectives that are understood and supported by groundwater users in the respective sub-basin.



Irrigation Districts

- | | | | |
|---------------------|----------------|---------------|-----------------|
| Aaction | Corning WD | Kirkwood ID | Rawson ID |
| Anderson-Cottonwood | Deer Creek | LMMWC | Rio Alto WD |
| City of Corning | El Camino ID | Proberta ID | Stanford Vina |
| City of Red Bluff | Elder Creek ID | Rancho Tehama | Thomes Creek ID |

Legend

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

BROWN AND CALDWELL	PROJECT 131107	SITE	Tehama County Groundwater Sub-Basins	Figure 1-1
	DATE 1/18/07	TITLE		

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 as illustrated 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 Bowman sub-basin is primarily a rural area, with agriculture throughout the area and new development occurring near I-5. 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_an_a.htm. Groundwater is used for agricultural, municipal, and domestic purposes. The trigger level's purpose in this sub-basin should reflect the needs of local water users. Some suggested trigger level purposes are:

- Maintain groundwater at an elevation that promotes the continued economical use of groundwater for irrigation, domestic, and municipal needs.
- Protect groundwater supplies for current and future domestic and irrigation use.
- Maintain a stable trend of groundwater in storage to ensure adequate drinking water and agricultural supplies during future drought periods.
- Monitor groundwater levels to record and compare changes to aid in identifying conditions that cause declines in groundwater levels.

Groundwater Use in Bowman:	
Irrigation:	42% (1,500 acre-ft)
Municipal, and Industrial:	58% (2,100 acre-ft)
Number of wells by type in Bowman:	
Irrigation:	37 wells
Domestic:	1051 wells
Municipal and Industrial:	14 wells

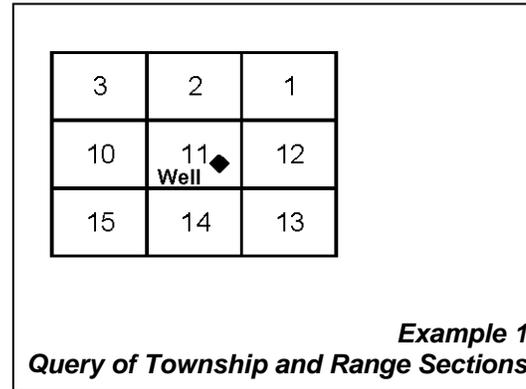
Step 2: Select one or more key wells within the sub-basin

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 begin management activities.

Key wells should be selected from the County groundwater level monitoring well network with consideration of duration of monitoring. The monitoring period of record in some wells is more than 30 years; the long period of record helps identify seasonal and long-term aquifer response over a wide range of climatic conditions (wet, normal or drought), changes in agricultural and domestic development, and changes in available water supply. Some monitoring wells may have short periods of record, but are located in a key area and have preferable depth and screened intervals. These wells may be useful as key wells also.

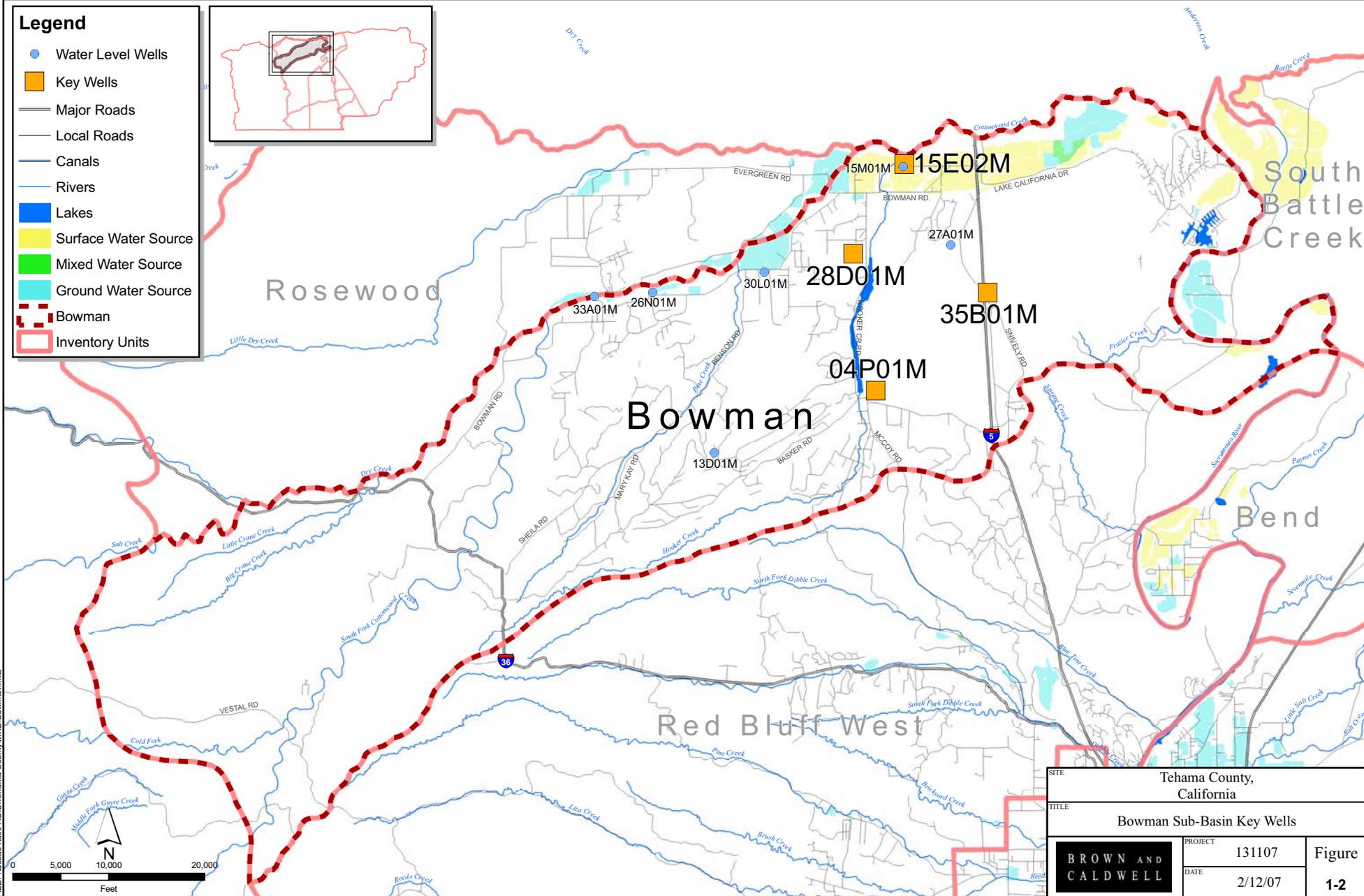
Key wells should be selected from the County groundwater level monitoring well network with consideration of location, total well depth, perforated interval from which the well produces water, and other well drilling records. Key wells should be distributed as evenly as possible throughout the sub-basin. Monitoring wells with screened intervals or depths near 100 to 250 feet below ground surface correspond to the average depth of domestic wells in the sub-basin and are good candidates for monitoring aquifer conditions associated with domestic use.

The locations of four proposed key wells are presented in Figure 1-2. Three of the proposed wells have a period of record is more than 30 years, which provides information on water levels during the drought of 1976-1977 and the drought during the late 1980s and early 1990s. A query was conducted to find nearby wells, their uses, and average depths. The query located wells in the section the well was in, and the eight sections surrounding that section (Example 1). Each section is one square mile in size. Each well is described in detail below:

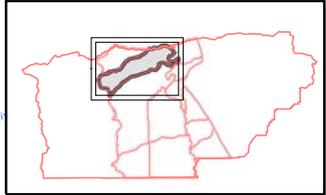


- **29N04W28D01M (28D01M)** – This monitoring well is in the northern portion of the sub-basin, is 134 feet deep with a screened interval from 130 to 134 feet below ground surface (bgs), and is 134 feet deep. This well is situated in an area of homesteads and native vegetation. This well has a period of record longer than 30 years. The nine square miles near this well contain 357 domestic wells with an average depth of 173 feet bgs, and 4 irrigation wells with an average depth of 283 feet bgs.
- **29N04W35B01M (35B01M)** – This monitoring well is in the eastern portion of the sub-basin, is 759 feet deep, and has a screened interval from 130 to 200 feet bgs. This well is situated near Interstate 5, away from irrigated areas. This well has a period of record longer than 30 years. The nine square miles near this well contain 43 domestic wells with an average depth of 264 feet bgs, and 1 irrigation well with a depth of 324 feet bgs.
- **29N04W15E02M (15E02M)** – This monitoring well is in the northern portion of the sub-basin and is 234 feet deep and has an unknown screened interval. This well is situated near areas of pasture that is irrigated with surface water. This well has a period of record longer than 30 years. The nine square miles near this well contain 223 domestic wells with an average depth of 154 feet bgs, and 7 irrigation wells with an average depth of 292 feet bgs.
- **28N04W04P01M (04P01M)**– This monitoring well is in the southeast portion of the sub-basin, is 270 feet deep, and has a screened interval from 200 feet to 270 feet bgs. This well is situated away from irrigated lands. This well has a period of record of 13 years. The nine square miles near this well contain 98 domestic wells with an average depth of 271 feet bgs, and 3 irrigation wells with an average depth of 429 feet bgs.

There are currently no monitoring wells in the southwestern corner of the Bowman sub-basin reflecting that no wells are monitored in that area. This may represent an area within the sub-basin where an additional monitoring well may eventually need to be established to begin to develop a groundwater level history in the southwestern area.



- Legend**
- Water Level Wells
 - Key Wells
 - Major Roads
 - Local Roads
 - Canals
 - Rivers
 - Lakes
 - Surface Water Source
 - Mixed Water Source
 - Ground Water Source
 - - - Bowman
 - Inventory Units



SITE		Tehama County, California	
TITLE			
Bowman Sub-Basin Key Wells			
BROWN AND CALDWELL	PROJECT	131107	Figure
	DATE	2/12/07	1-2

FILE: \\basac-nas01\GIS\Tehama County\MXD\Bowman.mxd

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 cumulative pumping impacts from a sub-basin 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 and can provide a warning of potential issues such as increased groundwater demand.

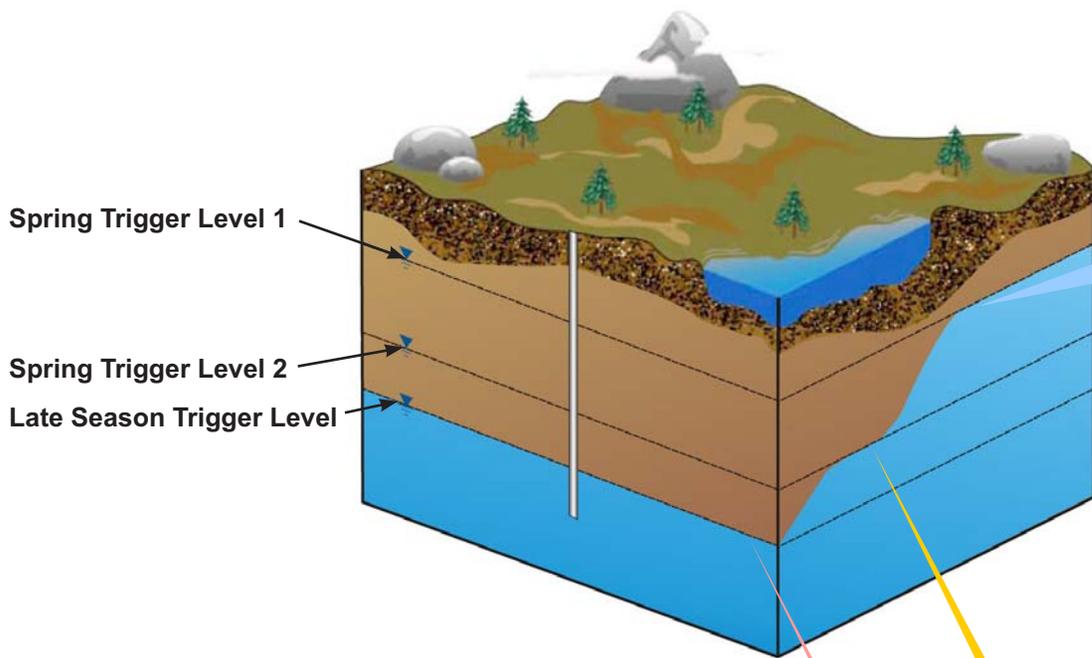
Steps 4 and 5: Establish trigger levels in selected key wells and define awareness actions associated with each trigger level

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 1-3).

Sub-basin representatives 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.

Suggested trigger levels and corresponding awareness actions were selected by the TAC and the District to provide the appropriate level of management in response to exceedance of trigger levels. The trigger levels and corresponding awareness actions should coincide with the severity of groundwater issues in the sub-basin. Figure 1-3 shows two suggested spring trigger levels and one suggested late season trigger level with corresponding actions. The methodology for the suggested trigger levels is provided in Table 1-1. A summary of associated awareness actions include:



Spring Trigger Level 1 Awareness Actions

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 an 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

Spring Trigger Level 2 Awareness Actions

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

Late Summer Trigger Level Awareness Actions

AWARENESS ACTIONS

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

Figure 1-3
Trigger Levels and Awareness Actions

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 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.

Figures 1-4 through 1-15 present hydrographs and suggested trigger levels for each of the four Bowman key wells. The figures are groundwater level hydrographs, showing water level elevation measurements over the monitoring period of record and the suggested trigger levels during a particular season. On each figure, the date of measurement is indicated on the bottom axis, the depth to water below ground surface in feet is on the right vertical axis, and the water surface elevation is indicated on the left vertical axis. The methodologies used to determine the suggested trigger levels for the key wells in the Bowman sub-basin are provided in Table 1-1. One key well (04P01M) had a limited historic record of groundwater level measurements that did not include a significant drought cycle, so the method of proposing spring and late season trigger levels was modified and is subject to change in annual reviews as more experience is gained.

Table 1-1. Trigger Level Methodology

Groundwater Trigger Level and Awareness Action	Bowman Monitoring Well Number			
	28D01M	35B01M	15E02M	04P01M
Spring Trigger Level 1 – Notify and Inform Public	Historical low of spring measurements plus 20 % of the range of spring measurements			Historical low 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			Historical low of spring measurements minus the range of spring measurements
Late Season Trigger Level – Notify public and begin investigations	Historical low of late season groundwater measurements			
Data Anomalies	None	None	None	None

Bowman Area Key Well 29N04W28D01 (Hooker Creek Road and Jeffries Road) Hydrograph over the 1970 - 2006 Period

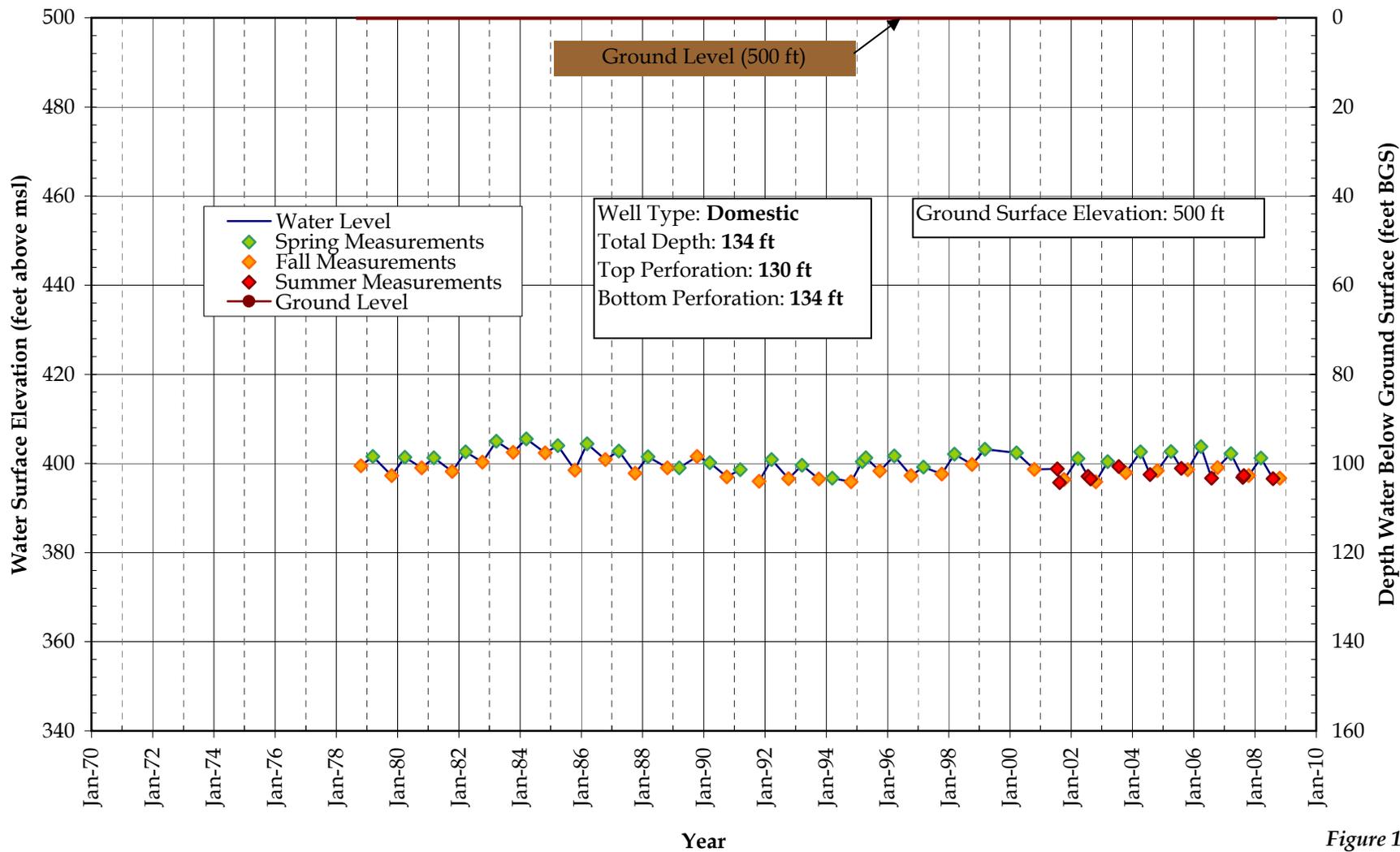


Figure 1-4
Hydrograph of Key Well 229N04W28D01

Bowman Area Key Well 29N04W28D01 (Hooker Creek Road and Jeffries Road) Spring Level Hydrograph

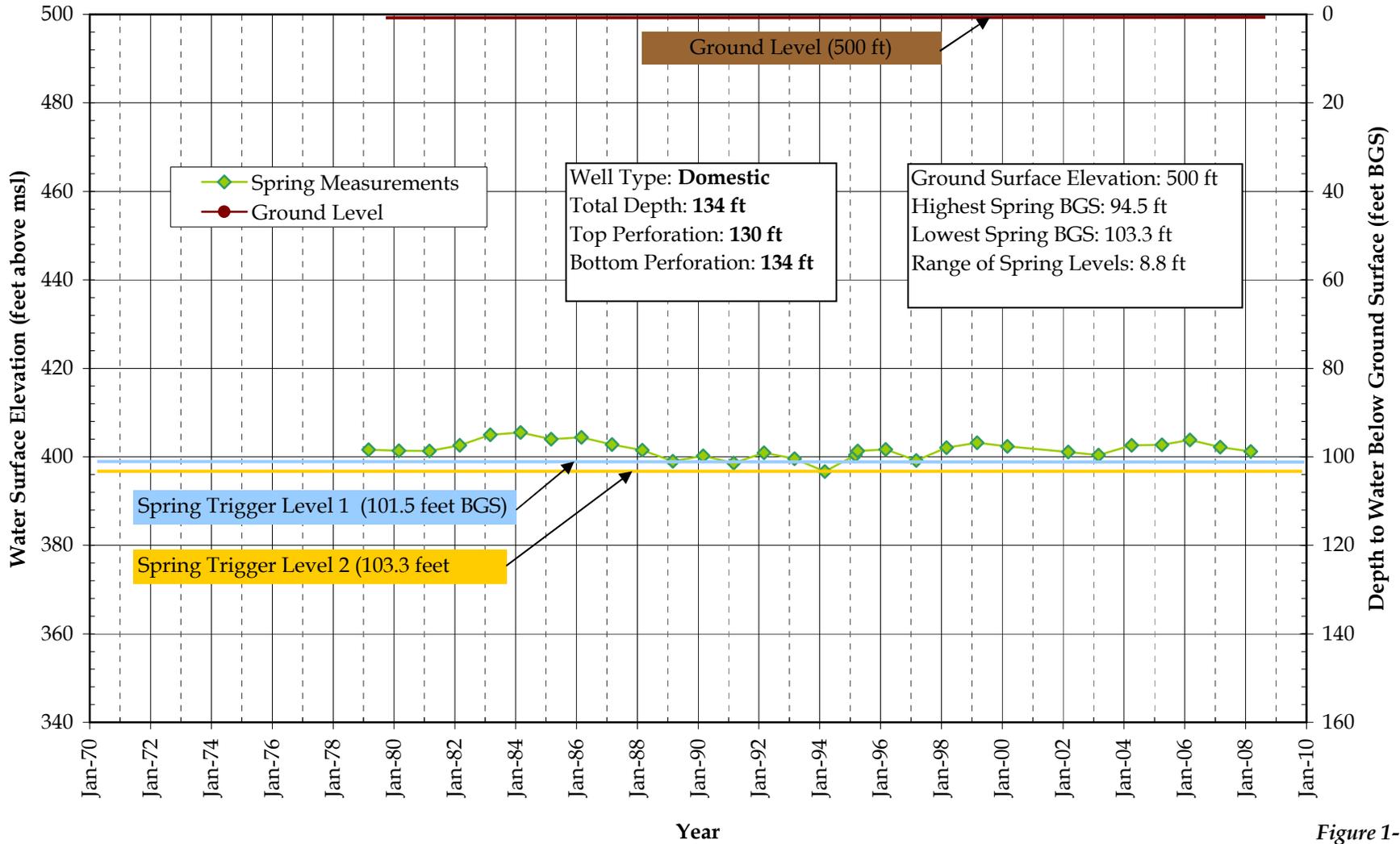
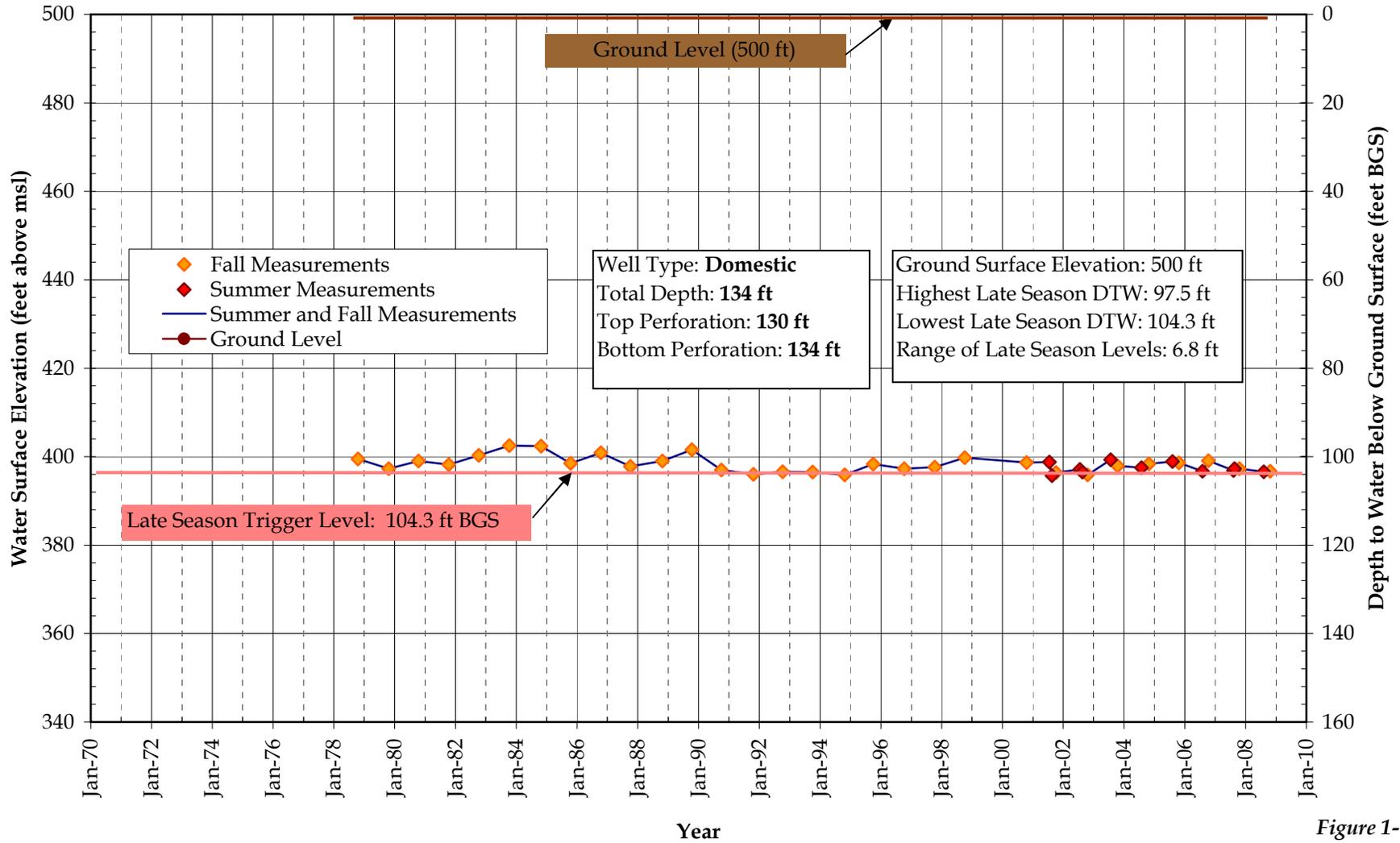


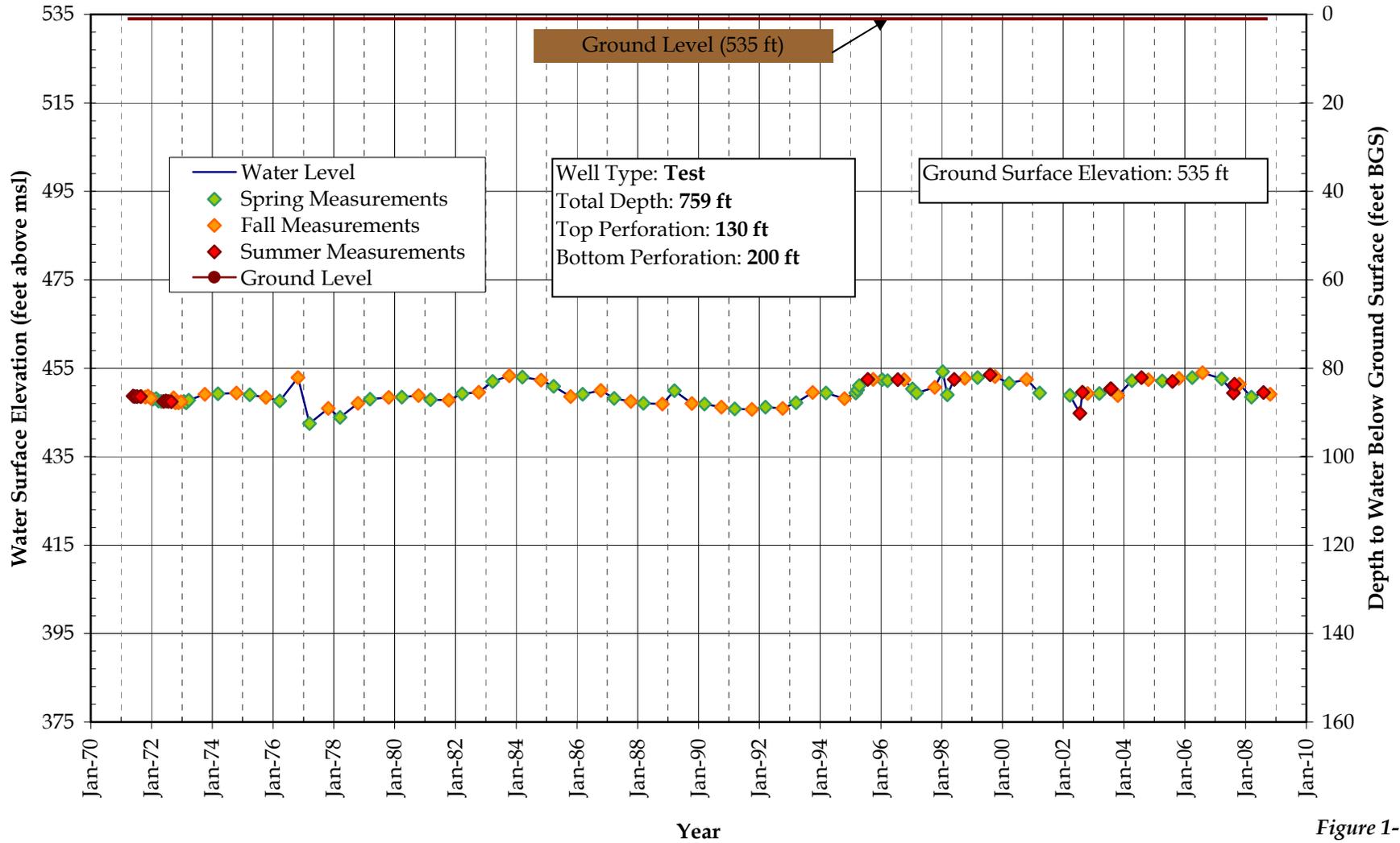
Figure 1-5
Spring Trigger Levels

**Bowman Area Key Well 29N04W28D01 (Hooker Creek Road and Jeffries Road)
Late Season (July, August, September, and October) Hydrograph**



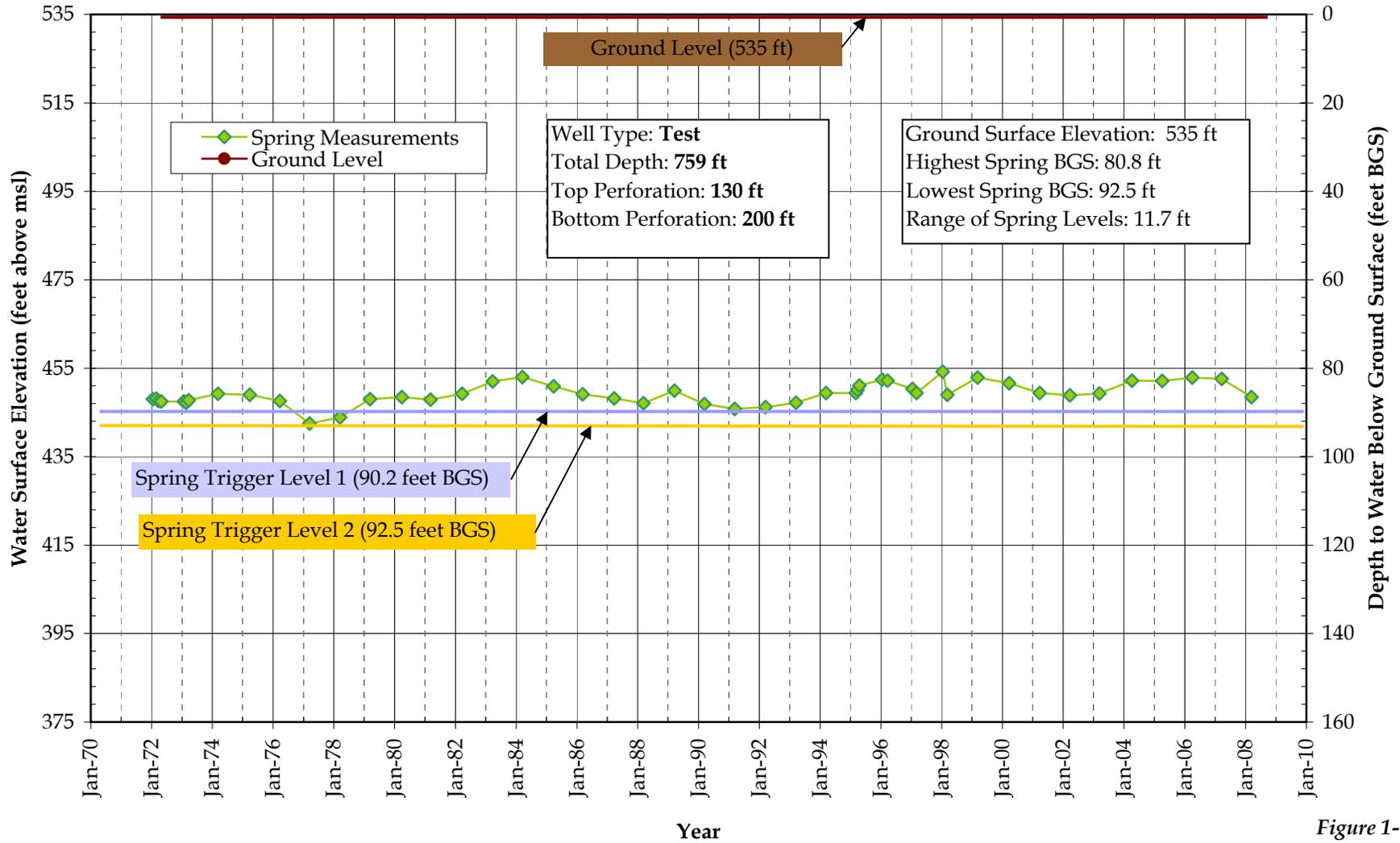
*Figure 1-6
Late Season Trigger Level*

**Bowman Area Key Well 29N04W35B01 (I5 and Snively Road)
Hydrograph over the 1970 - 2007 Period**



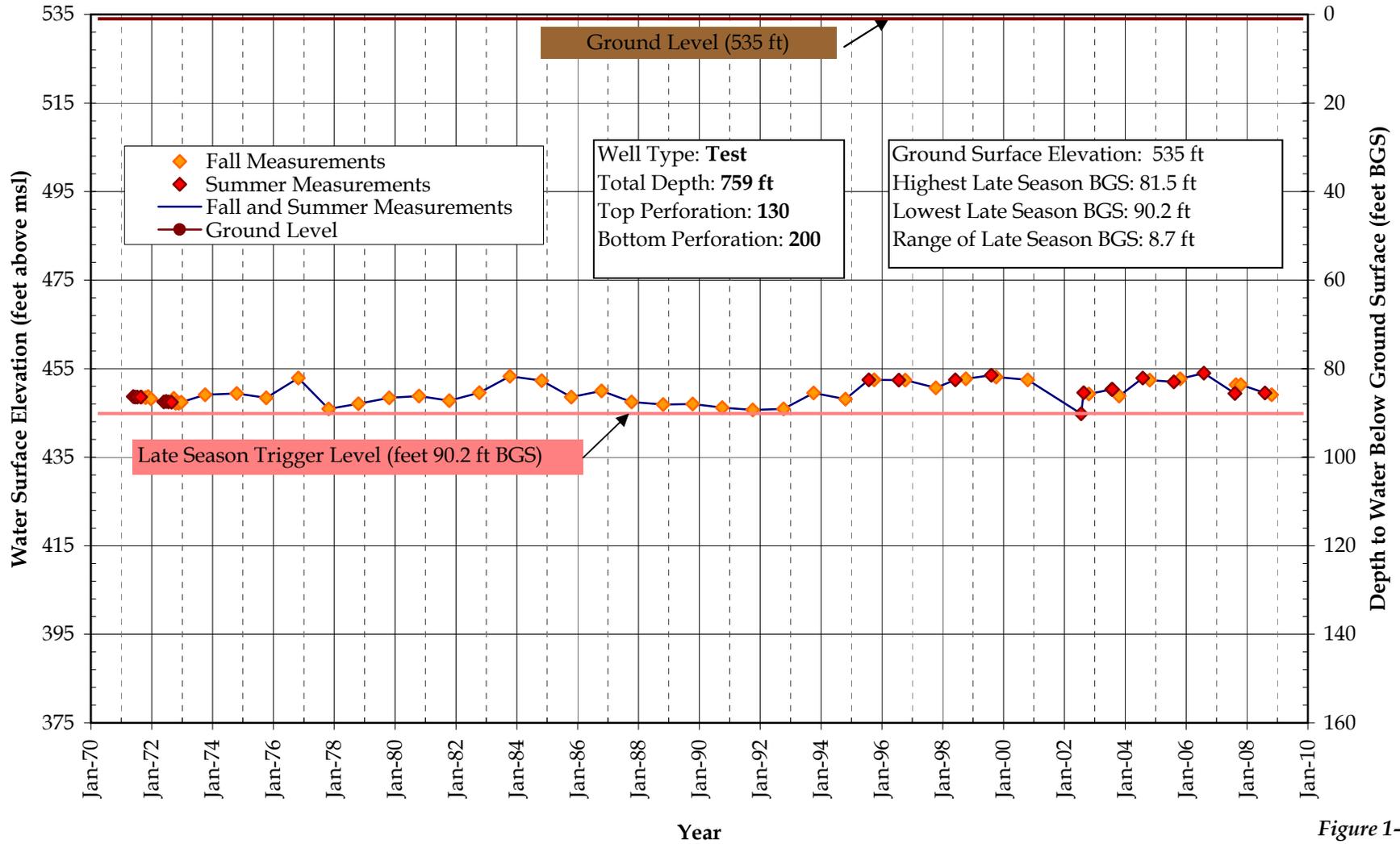
*Figure 1-7
Hydrograph of Key Well 29N04W35B01*

Bowman Area Key Well 29N04W35B01 (I5 and Snively Road) Spring Level Hydrograph



*Figure 1-8
Spring Trigger Levels*

**Bowman Area Key Well 29N04W35B01 (I5 and Snively Road)
Late Season (July, August, September, and October) Hydrograph**



*Figure 1-9
Late Season Trigger Level*

Bowman Area Key Well 29N04W15E02 (Draper Road and Oak Lane) Hydrograph over the 1970 - 2007 Period

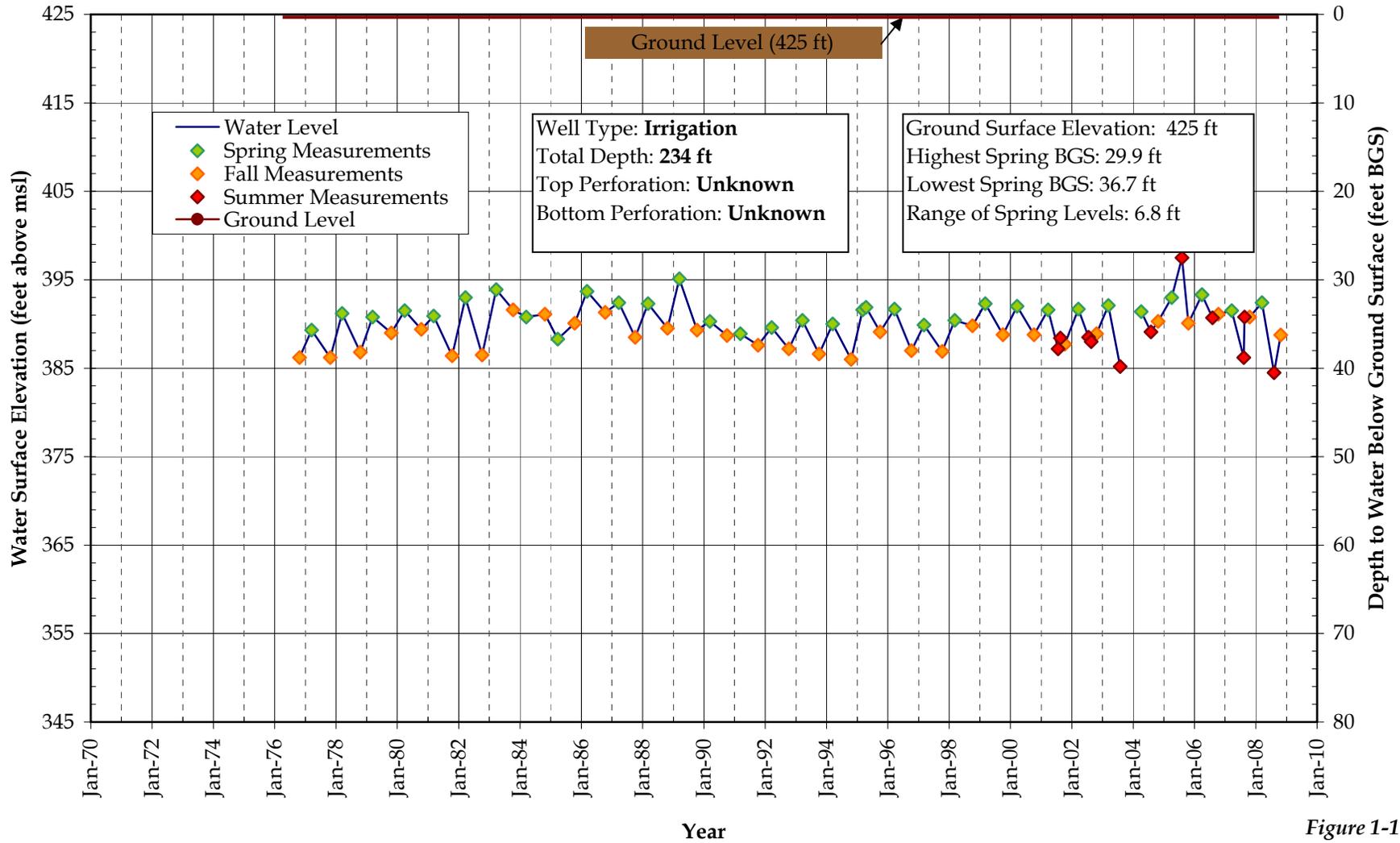


Figure 1-10
Hydrograph of Key Well 29N04W15E02

Bowman Area Key Well 29N04W15E02 (Draper Road and Oak Lane) Spring Level Hydrograph

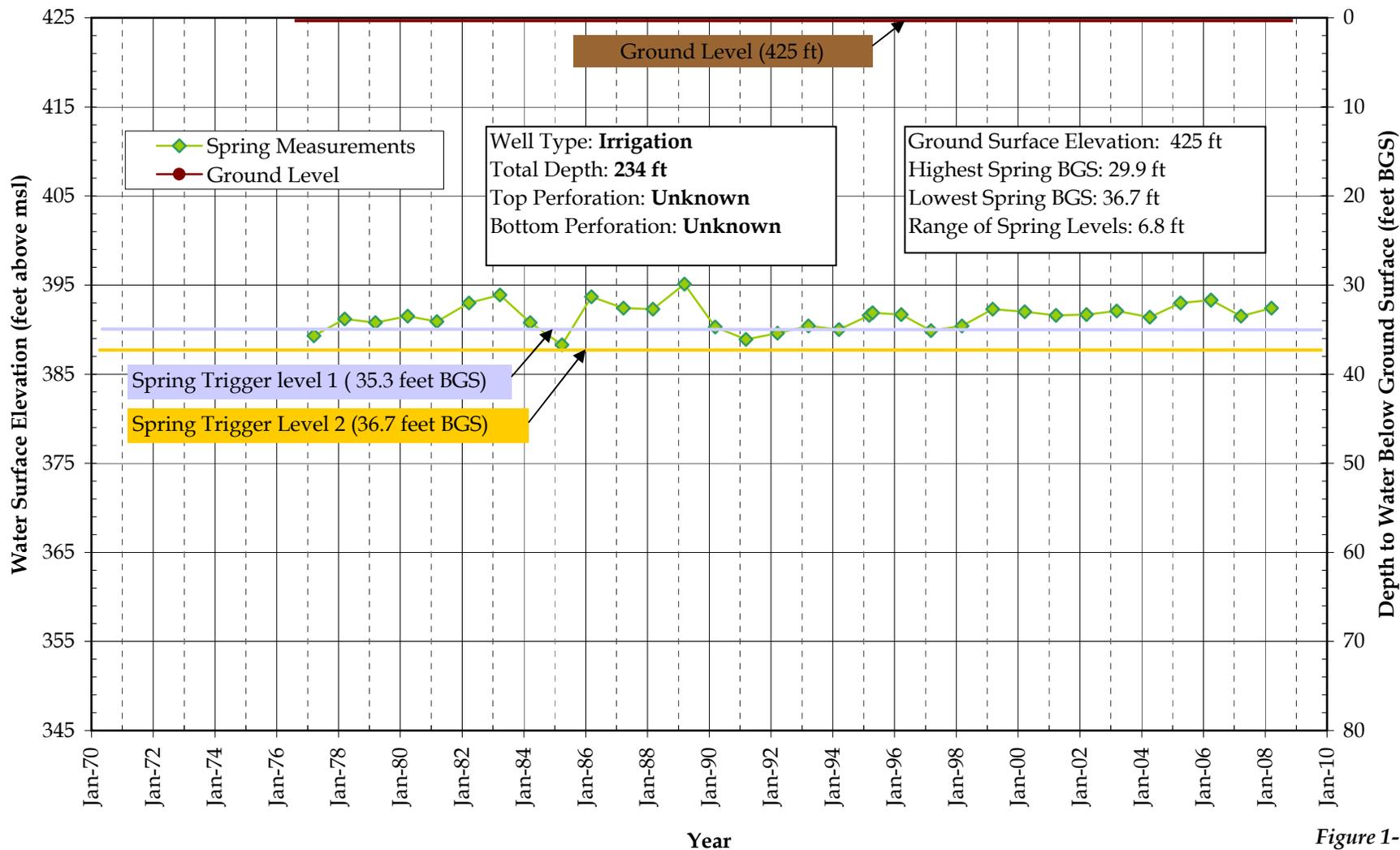


Figure 1-11
Spring Trigger Levels

**Bowman Area Key Well 29N04W15E02 (Draper Road and Oak Lane)
Late Season (July, August, September, and October) Hydrograph**

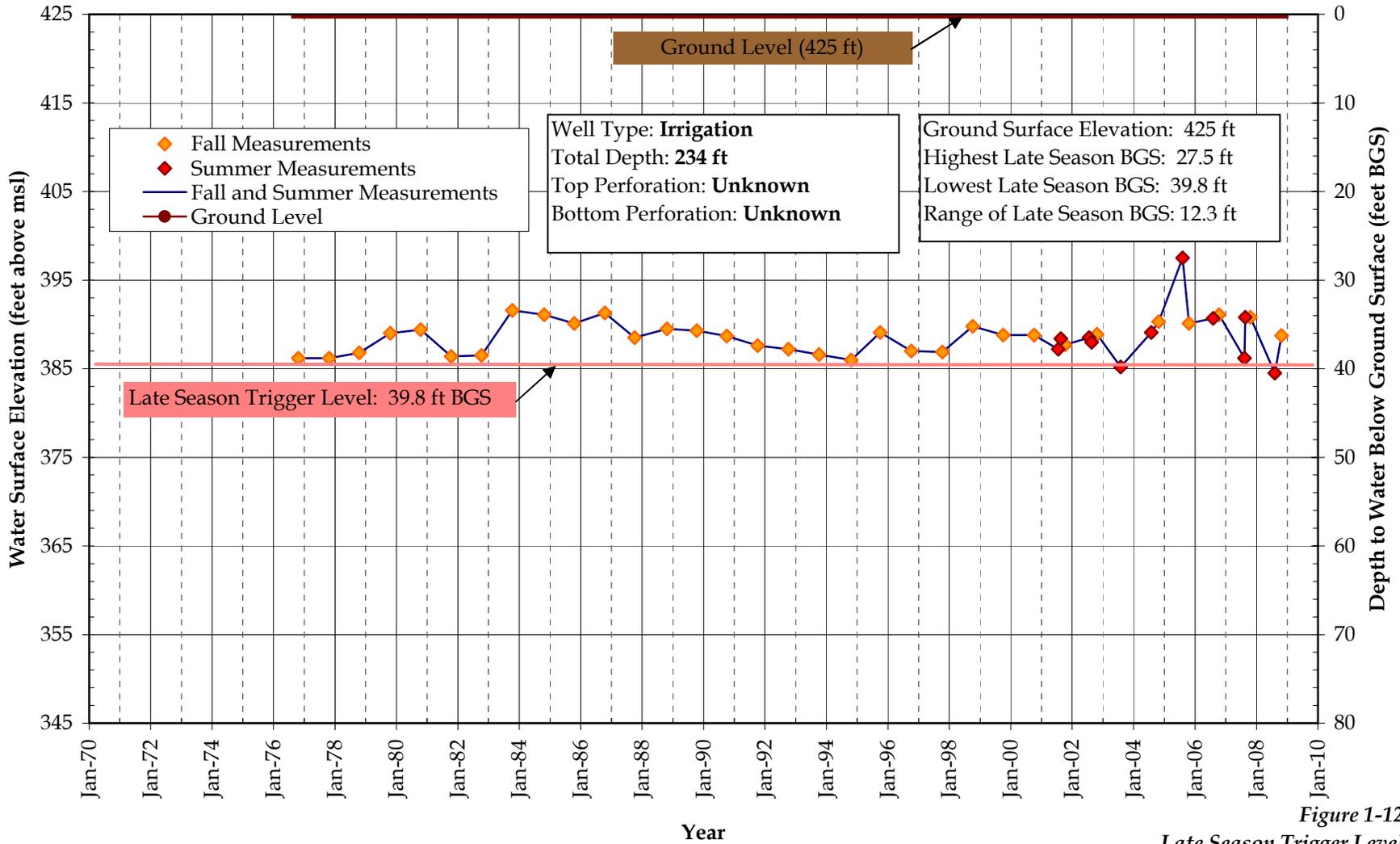


Figure 1-12
Late Season Trigger Level

Bowman Area Key Well 28N04W04P01 (Hooker Creek Rd and Hooker Rd) Hydrograph over the 1970 - 2007 Period

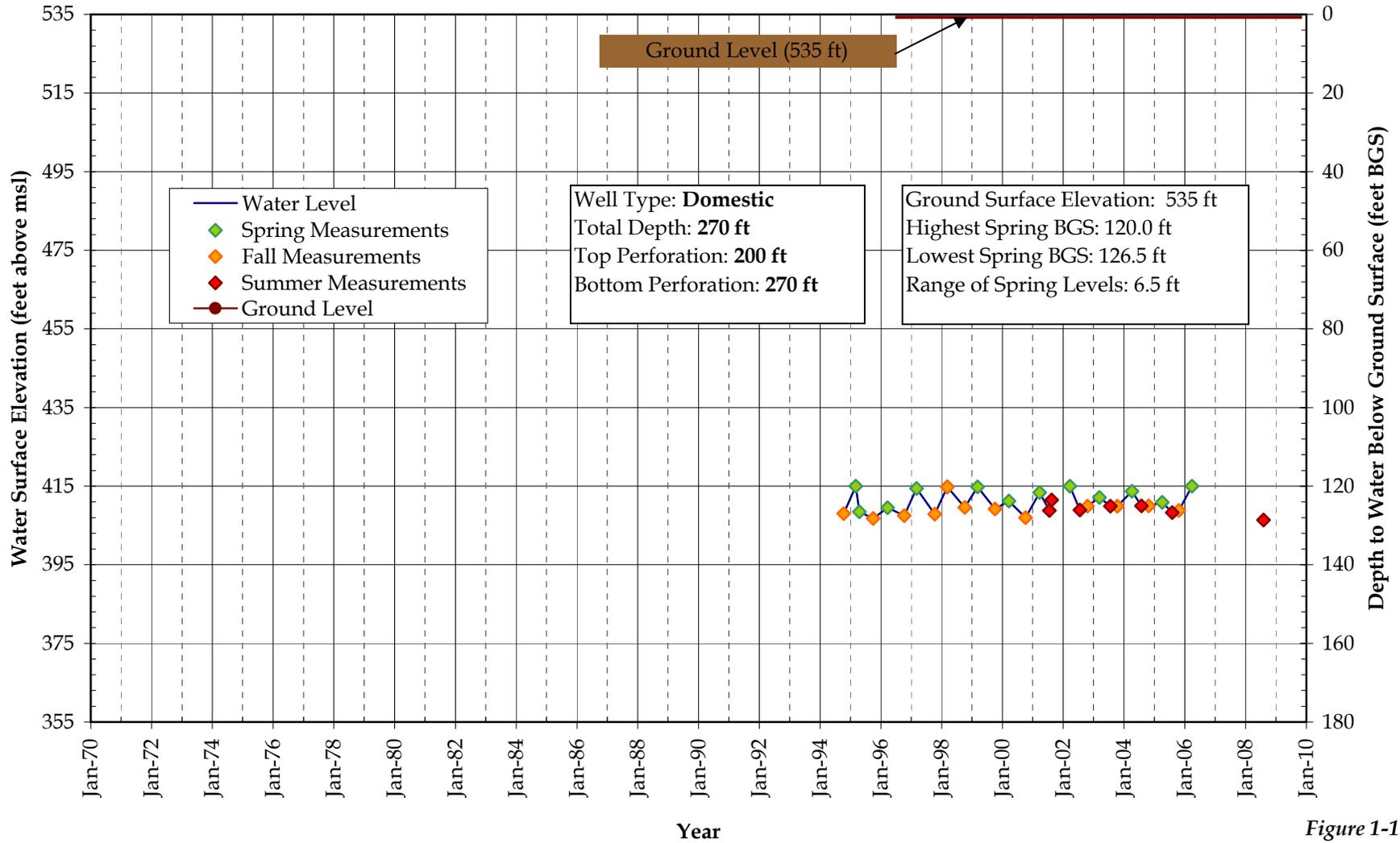
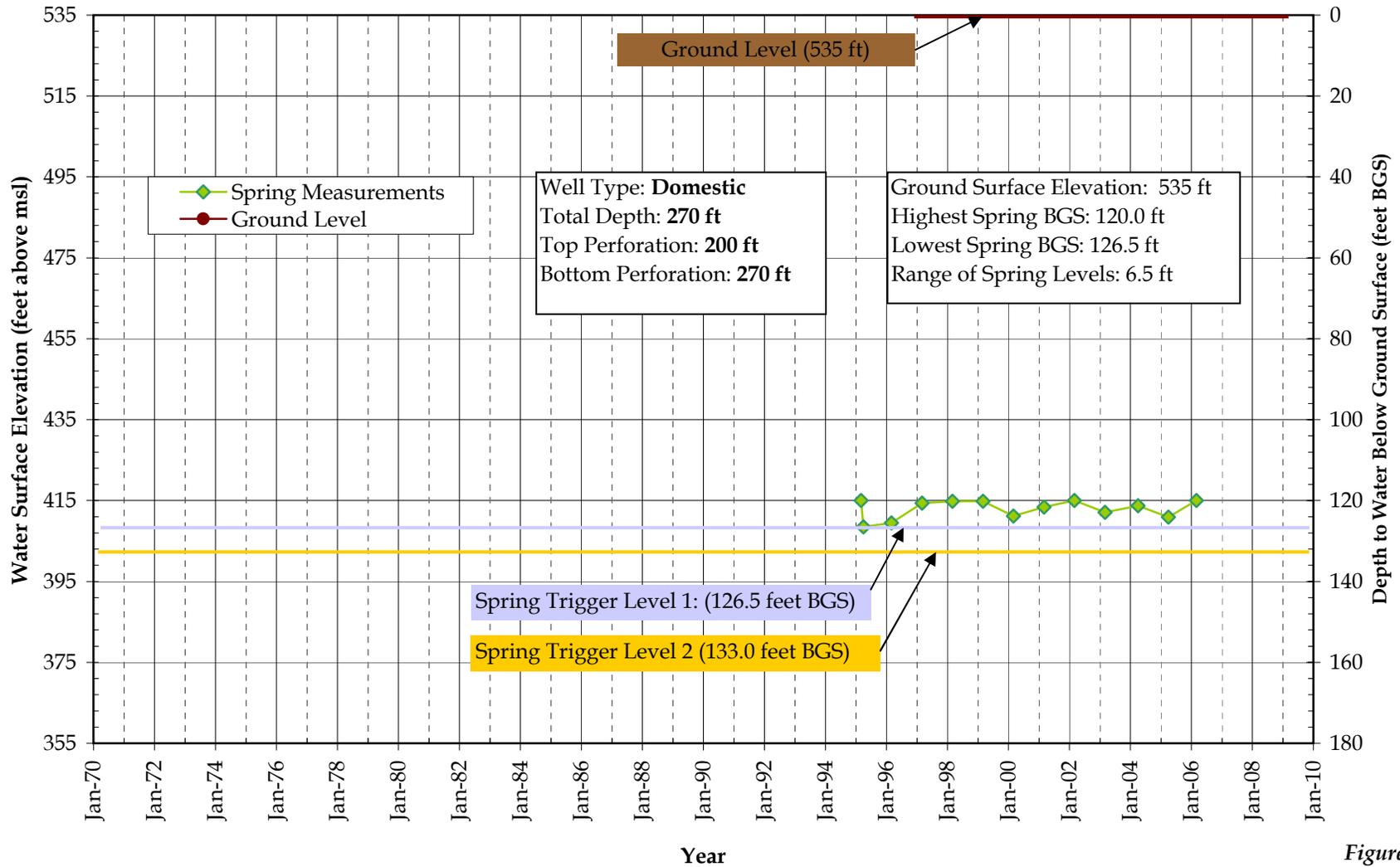


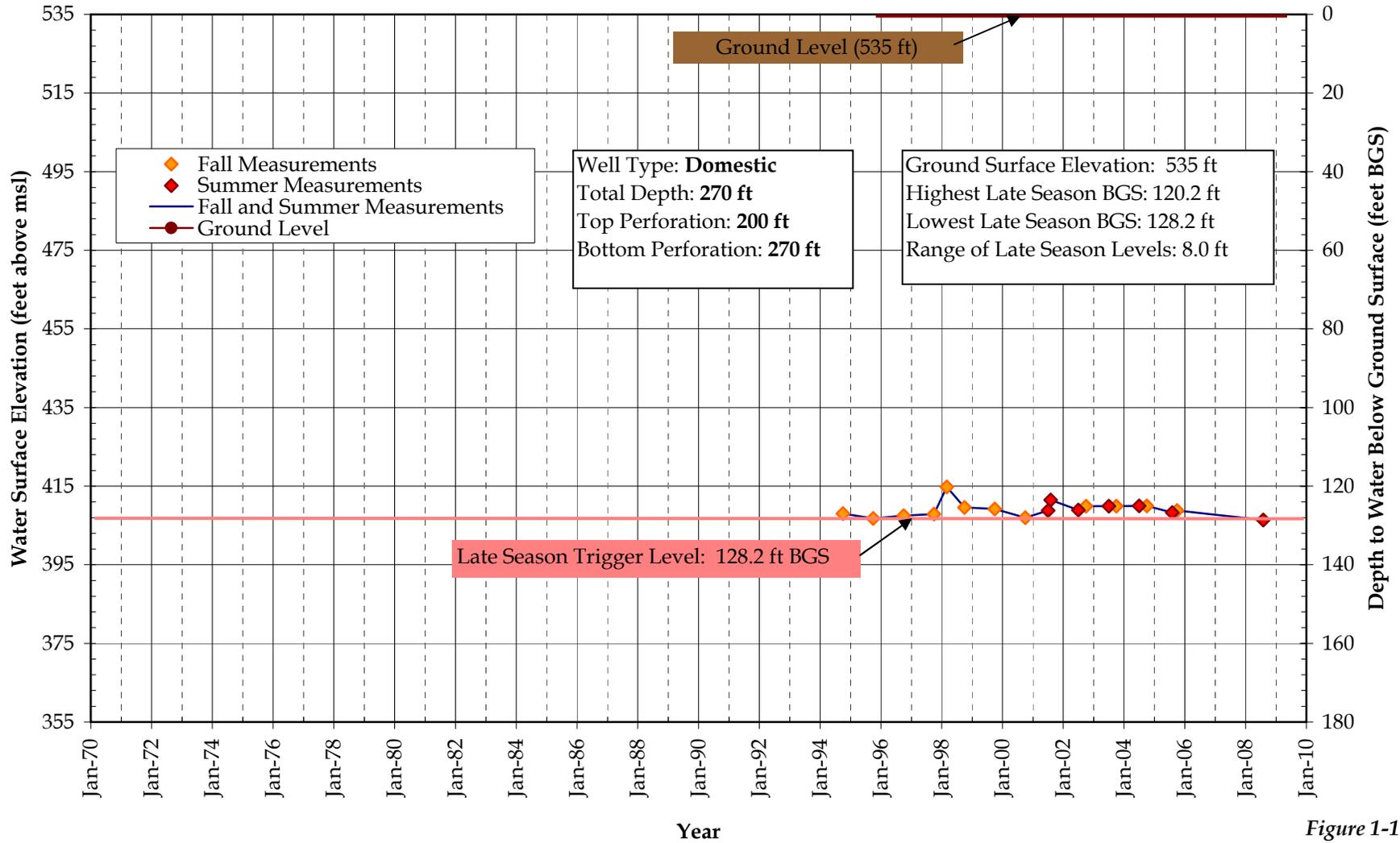
Figure 1-13
Hydrograph of Key Well 28N04W04P01

Bowman Area Key Well 28N04W04P01 (Hooker Creek Rd and Hooker Rd) Spring Level Hydrograph



*Figure 1-14
Spring Trigger Levels*

**Bowman Area Key Well 28N04W04P01 (Hooker Creek Rd and Hooker Rd)
Late Season (July, August, September, and October) Hydrograph**



*Figure 1-15
Late Season Trigger Level*