# GROUNDWATER STATUS REPORT

**Prepared for**

**BUTTE COUNTY WATER COMMISSION**

**by**

**BUTTE BASIN WATER USERS ASSOCIATION**

February 2007

# Table of Contents


| | |
|---|---|
| Foreword | ii |
| Summary | 1 |
| Introduction | 1 |
| Measurement Frequency and Period of Record | 2 |
| Monitoring Well Locations | 2 |
| Land Subsidence | 3 |
| Precipitation | 3 |
| Surface Water Deliveries | 4 |
| Groundwater Contour Maps | 5 |
| Groundwater Level Trends | 9 |
| North Yuba Sub-Area | 10 |
| Thermalito Sub-Area | 12 |
| Western Canal Sub-Area | 13 |
| Richvale Sub-Area | 15 |
| Pentz Sub-Area | 17 |
| Esquon Sub-Area | 19 |
| Butte Sink Sub-Area | 20 |
| Butte Sub-Area | 22 |
| Biggs-West Gridley Sub-Area | 23 |
| M&T Sub-Area | 25 |
| Durham-Dayton Sub-Area | 26 |
| Vina Sub-Area | 28 |
| Cherokee Sub-Area | 29 |
| Llano Seco Sub-Area | 31 |
| California Water Service (Chico) Sub-Area | 33 |
| Butte County Monitoring Well Locations | Appendix A |

## FOREWORD

In November 1996, the voters in Butte County voted in "AN ORDINANCE TO PROTECT THE GROUNDWATER RESOURCES IN BUTTE COUNTY". One of the stated purposes of the Ordinance was that "The groundwater underlying Butte County is a significant water resource which must be reasonably and beneficially used and conserved for the benefit of the overlying land by avoiding extractions which harm the Butte Basin aquifer, causing exceedance of the safe yield or a condition of overdraft." The ordinance is now codified as Chapter 33 of the Butte County Code relating to groundwater conservation.

Prior to 2000, Butte County Code, Chapter 33, required that the Groundwater Status Report be delivered to the County by January 15th of each year. During 2000, the Butte County Board of Supervisors amended Chapter 33 to require the Groundwater Status Report be delivered by February 21st of each year.

Section 3.01 – "Groundwater Planning Process" requires that the Butte Basin Water Users Association prepare a groundwater status report based upon the data gathered and analyzed pursuant to Section 3.02 – "Groundwater Monitoring". The Groundwater Status Report is in response to this requirement. This report was prepared with assistance from Department of Water Resources (DWR), Northern District.

The purpose of this report is to summarize groundwater level and land subsidence data collected by Butte County and DWR up to and through October 2006. The report presents locations of wells and extensometers, information related to groundwater level trends, and hydrographs depicting groundwater levels over time. This report is intended to serve as a basis for understanding groundwater level trends, and associated aquifer conditions, in Butte County.

Michael Pembroke, Chairman
Butte Basin Water Users Association

## SUMMARY

The precipitation total for water year 2006 was the sixth highest since 1960. A significant portion of this precipitation took place during the spring months which contributed to delays in groundwater pumping for agricultural use and extended recharge of the aquifer. Overall, 73 of the 75 monitoring wells that had both spring 2005 and spring 2006 measurements showed increased water levels for spring 2006 as compared to spring 2005.

A summary of the status of Butte County groundwater, based upon the 2006 groundwater level monitoring is provided below.

- Review of groundwater level trends indicates:
    1) Six wells in the southwest valley portion of the county show no declining trend.
    2) Five wells approximately along a line trending northwest to the southeast in the valley portion of the county previously displayed declining groundwater levels trend, but show significant recovery in 2006.
    3) Five wells (one located in Chico, one west of Chico, and one south of Durham, one east of Durham, and one east of Nelson) indicate declining groundwater levels ranging from less than 5 feet, to more than 20 feet, without significant recovery.
    4) Areas east of Durham (well 21N02E26F001M) and within Chico (well 22N02E18N001M), experienced the most significant declining trends, with groundwater levels averaging approximately 25 feet below the previous highs recorded in the mid-1980s.

- No land subsidence was detected in the County from an evaluation of the extensometer records in the Western Canal, M&T, California Water Service, Richvale, and Biggs-West Gridley sub-areas.

## INTRODUCTION

This report is a compilation of information related to the monitoring activities in Butte County and includes groundwater hydrographs from "key wells" within each hydrologic sub-area. Groundwater hydrographs for the other wells monitored in the County are available on the DWR website at http://wdl.water.ca.gov.

This report was prepared by the Department of Water Resources, Northern District Groundwater Section under the request for local assistance by the Butte Basin Water Users Association. Much of the background material for this report consists of updated excerpts taken from the 2005 Butte County Groundwater Inventory Analysis report prepared by the Department of Water Resources, Northern District. This was done to achieve a level of consistency between the findings of the BBWUA, and those of the Butte County Water Inventory and Analysis report which was prepared cooperatively by Butte County Department of Water and Resource Conservation, Camp, Dresser and McKee, Inc., and the Department of Water Resources in March 2001

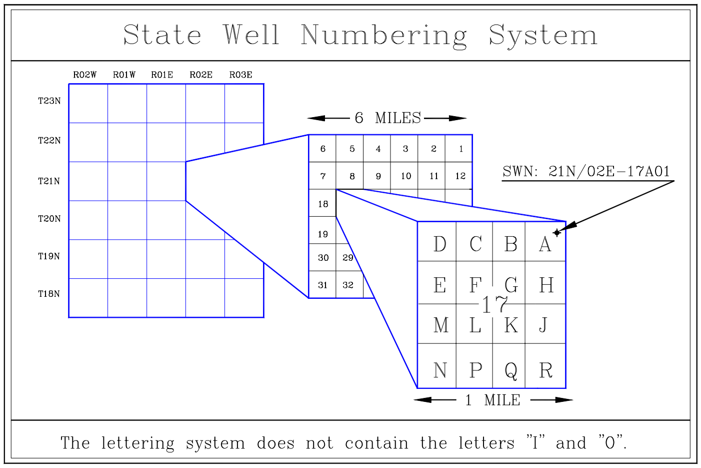
## MEASUREMENT FREQUENCY AND PERIOD OF RECORD

Groundwater level monitoring in the Sacramento Valley portion of Butte County is currently being conducted by several private and public agencies. Historically, the Department of Water Resources has maintained the most comprehensive, long-term groundwater level monitoring grid, with approximately 210 different wells monitored over the last 50 years in the Sacramento Valley portion of Butte County. Within this period of time, the annual size of the monitoring grid has fluctuated from as few as 50 wells, to as many as 180 wells, depending upon the activity of special studies in the area. Until 1989, the majority of these wells were measured semi-annually, during the spring and fall. Beginning in 1990, the frequency of groundwater level monitoring was increased to monthly, before returning to a semi-annual measurement in 1995. In 1997, the Butte County Department of Water and Resource Conservation, in cooperation with the Department of Water Resources, began to expand the number and frequency of groundwater level monitoring in the valley portion of Butte County. Currently, approximately 105 wells are monitored in Butte County. These wells consist of a mixture of domestic and irrigation wells, along with dedicated observation wells. Two new multi-completion observation wells were installed in the Western Canal sub-area during 2005, and data collection at these wells will begin in 2006. Approximately 35 of the monitoring wells are equipped with continuous monitoring equipment which records changes in groundwater levels on an hourly basis. The remaining wells are measured four times per-year, during March, July, August and October. The locations of wells monitored in Butte County are shown in Appendix A.

In addition to the groundwater level monitoring conducted by Butte County and Department of Water Resources, California Water Service Company currently measures monthly groundwater levels in approximately 60 municipal groundwater supply wells in the Chico Urban area. California Water Service wells are typically deep wells that draw from the Tuscan Formation aquifer system. The U. S. Bureau of Reclamation and USGS are not currently measuring groundwater levels in Butte County, but both agencies have monitored wells in the past.

## MONITORING WELL LOCATIONS

Locations of Butte County monitoring wells, including continuously monitored wells and extensometers, are shown in Appendix A. The well locations are approximate, but are estimated to be within 500 feet. The monitoring wells are numbered using the State Well Numbering System. The State Well Numbering System identifies each well by its location according to the township, range, section, and tract system. The figure below illustrates how a State Well Number (SWN) is assigned.



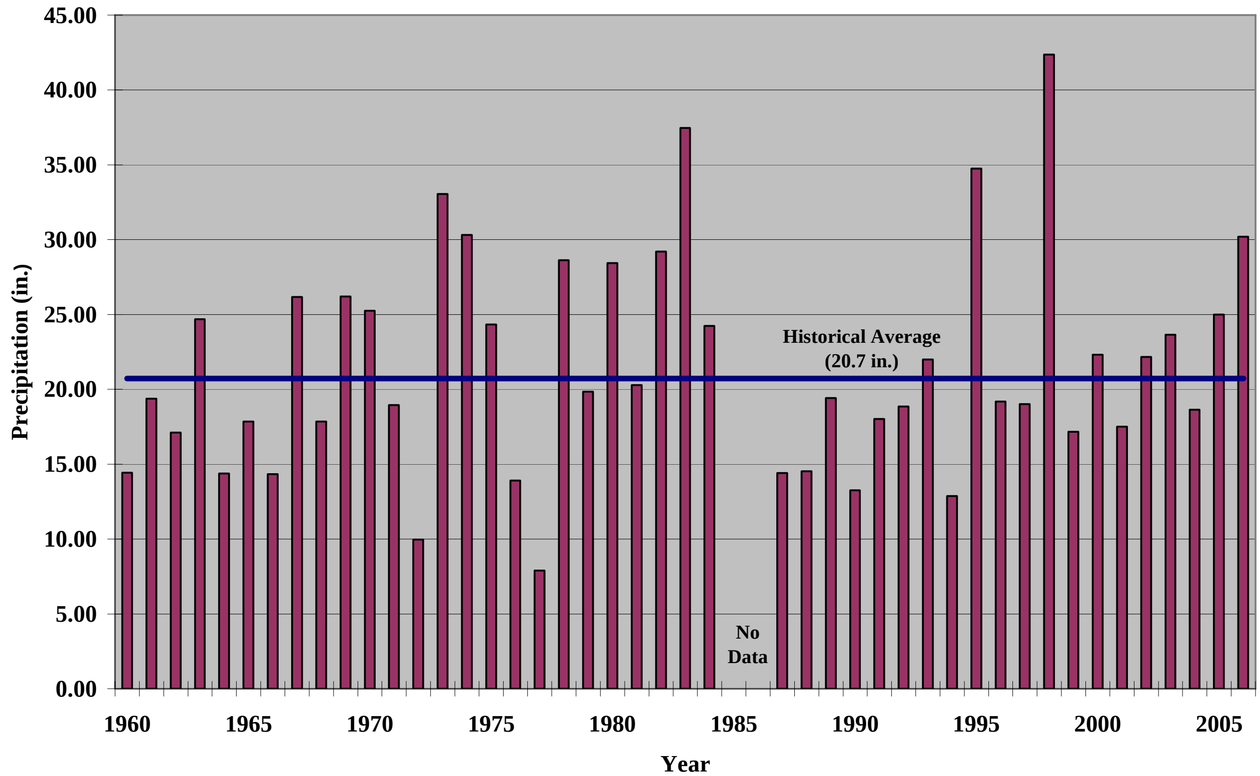

**State Well Numbering System**

## LAND SUBSIDENCE

The locations of the five extensometers that measure land subsidence within the County are shown in Appendix A. These extensometers were installed during 1999 and 2003. Records from these extensometers are available by contacting the Department of Water Resources Northern District or on the Northern District web page (http://www.nd.water.ca.gov/Data/Extensometers/index.cfm). To date, no land subsidence has been recorded in Butte County.

## PRECIPITATION

Precipitation for the water year ending September 30, 2006 at the Western Canal Nelson Climatological Observation Station was 30.19 inches, which is 9.47 inches above the 45-year average of 20.72 inches. The figure below represents the total annual precipitation at the Western Canal Station for the 45-year period 1960 through 2005. Only three of the past seven water year annual totals have been below the 45-year average resulting in a 7-year average approximately 2 inches greater than the 45-year average.




**Butte County Annual Precipitation, Western Canal at Nelson Station**

## SURFACE WATER DELIVERIES

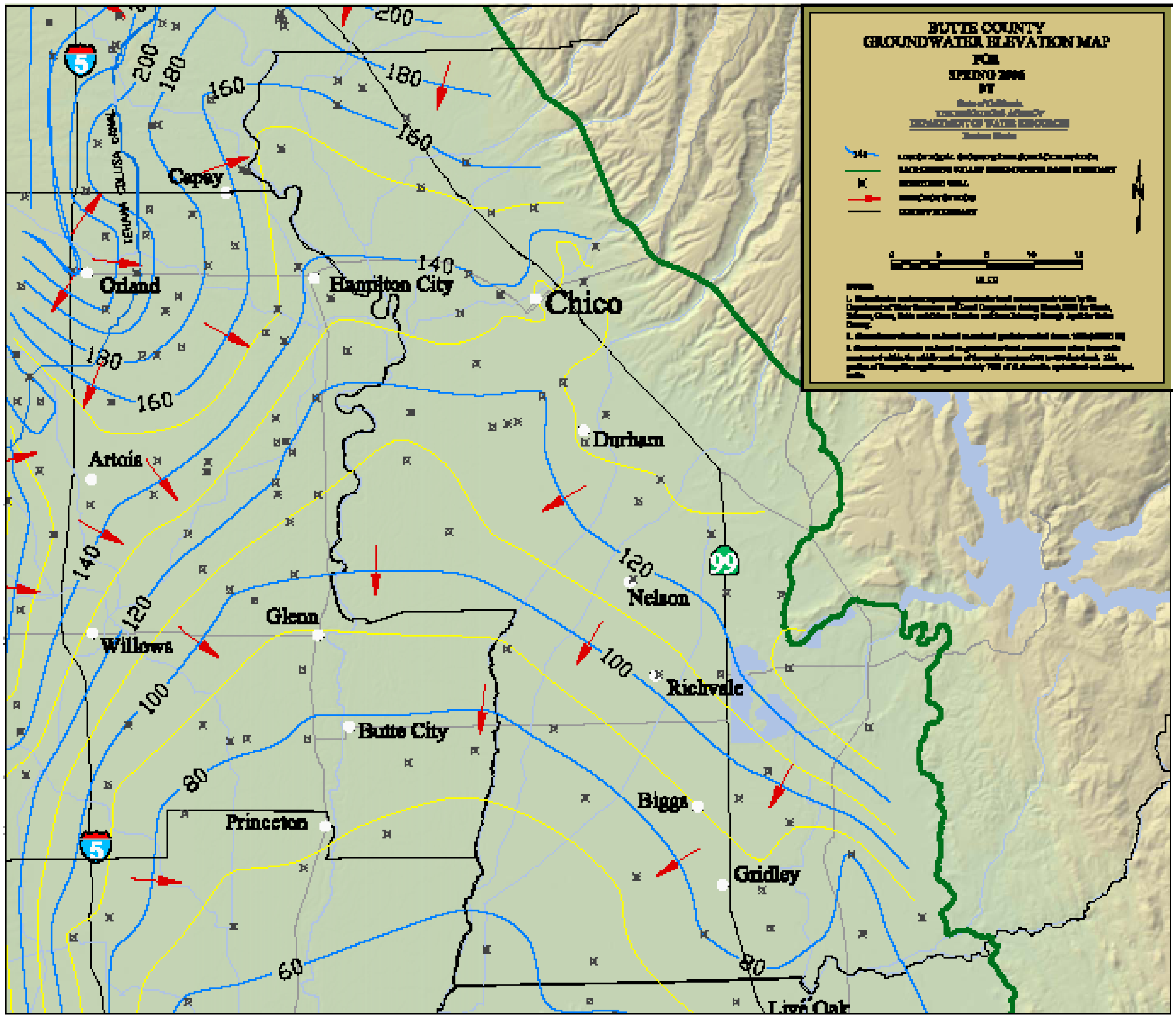
Surface water is an important component to aquifer recharge in the Butte Basin. During the 2006 water year 1,104,242 acre-feet of water were delivered to Western Canal Water District and the Joint Water District Board. The 2006 water deliveries were nearly 70,000 acre-feet more than what was delivered in 2005, and approximately 575,000 acre-feet greater than what was delivered in 1991. The increase in water demand since 1991 is primarily the result of late season water needs for rice straw decomposition and for waterfowl habitat. Summarized below are the deliveries to Western Canal Water District and the Joint Water District Board for the years 1991 to 2006 in acre-feet.

| Water Year | Western Canal Water District | Joint Water District Board | Total |
|---|---|---|---|
| 1991 | 185,273 | 344,768 | 529,915 |
| 1992 | 198,797 | 349,036 | 547,631 |
| 1993 | 216,521 | 515,292 | 729,827 |
| 1994 | 224,768 | 586,622 | 811,377 |
| 1995 | 210,110 | 568,481 | 778,598 |
| 1996 | 257,195 | 615,004 | 872,187 |
| 1997 | 272,003 | 658,540 | 934,214 |
| 1998 | 229,528 | 590,727 | 820,248 |
| 1999 | 293,364 | 690,847 | 984,248 |
| 2000 | 314,737 | 707,018 | 1,032,392 |
| 2001 | 302,784 | 718,489 | 1,021,562 |
| 2002 | 305,460 | 597,529 | 902,989 |
| 2003 | 271,867 | 682,403 | 954,270 |
| 2004 | 329,700 | 790,663 | 1,120,363 |
| 2005 | 284,188 | 750,128 | 1,034,316 |
| 2006 | 306,977 | 797,265 | 1,104,242 |

## GROUNDWATER CONTOUR MAPS

Groundwater level data can be used to develop groundwater elevation and change in groundwater elevation contour maps. Using this method, groundwater level measurements taken in individual wells can be combined to examine the groundwater levels in the aquifer system on a larger, more regional scale. Groundwater elevation contours represent lines of equal groundwater elevation and provide a snap-shot of groundwater conditions during a particular monitoring period. Similar to topographic contours, the pattern and spacing of groundwater elevations contours can be used to help estimate the direction and gradient of groundwater movement.

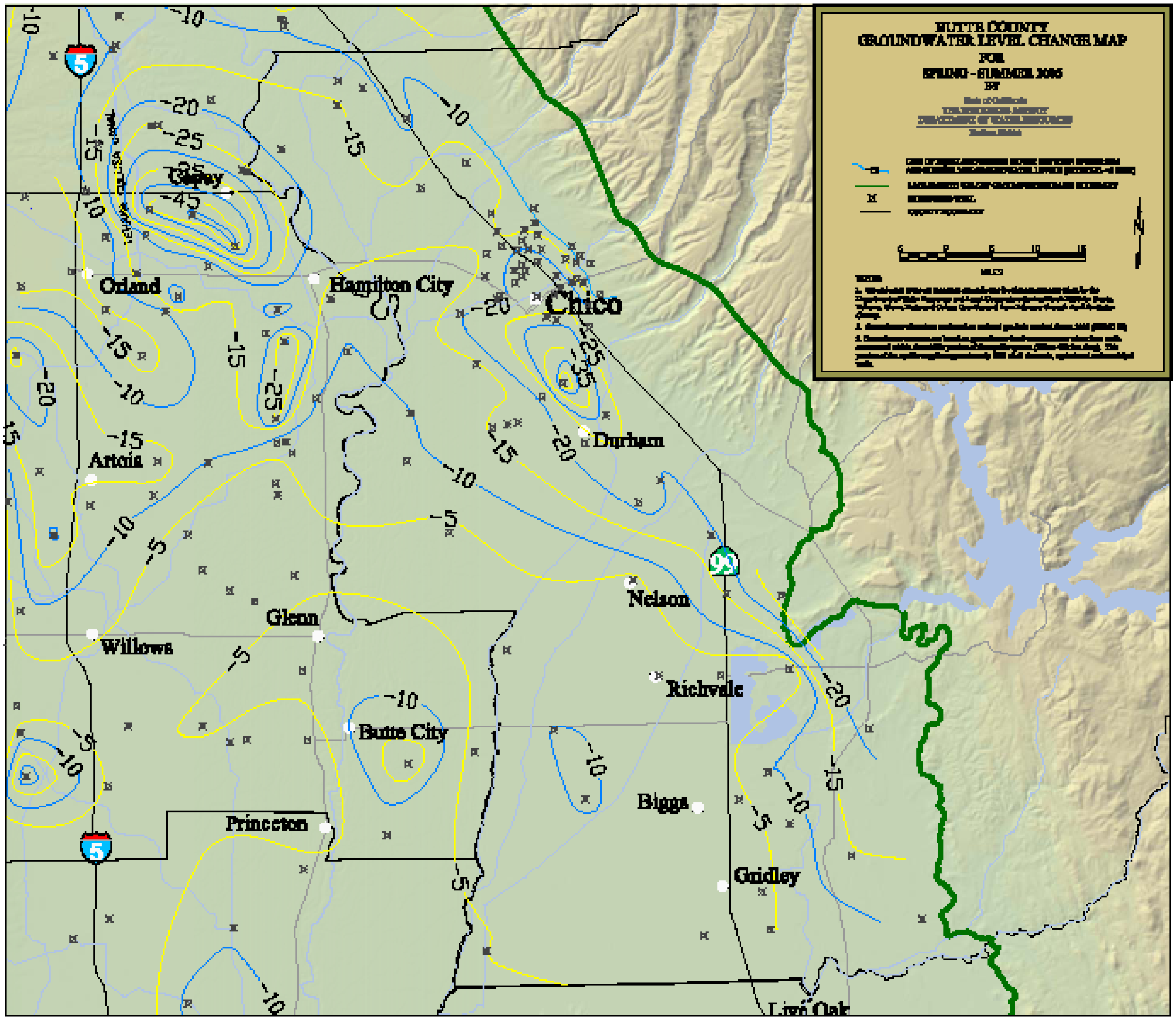
The groundwater level measurements used to create the elevation contour maps are from wells which draw water from aquifers between the depths of 100 feet and 400 feet. They represent a mixture of confined and unconfined aquifers. Due to the potential variation in groundwater levels between the confined and unconfined aquifer systems care should be taken when using the contour maps to interpret groundwater occurrence, movement, and changes in storage at a local scale. These groundwater elevation contour maps were developed using groundwater level data from Butte, Glenn, Colusa, Tehama, Sutter, and Yuba counties.




<u>**Spring 2006 Groundwater Elevation Contour Map**</u>

**Spring 2006**

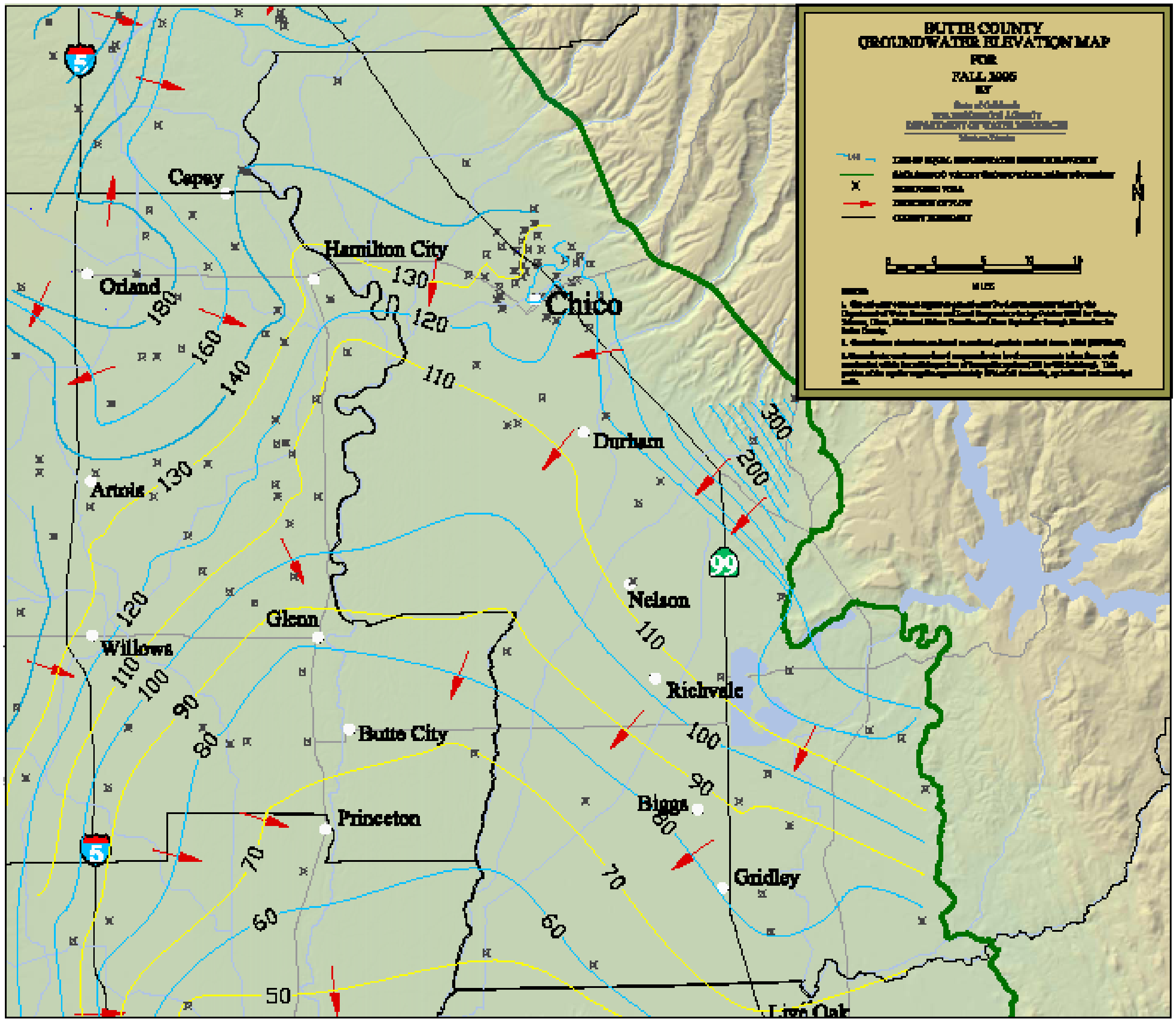
Spring 2006 groundwater level contours for Butte County show that groundwater is highest in the northern portion of the county and lowest in the southwest portion of the county. It ranges from a high of 180 feet above sea level to a low of 60 feet above sea level. It appears that there are two groundwater "troughs", one along the Sacramento River in the northern part of the county and one southwest of Chico. There is also a groundwater "mound" south of the Thermalito Afterbay. The red arrows indicate the approximate groundwater flow direction based on the groundwater elevation contours.




## Spring-to-Summer 2006 Groundwater Elevation Change Contour Map

### Spring-to-Summer Change 2006

The spring to summer change map depicts the difference between the groundwater elevations measured in spring and summer (July-August) of 2006. The contour lines on this map do not indicate elevation, only the change in elevation compared to the spring measurement. The general, county-wide summer decline ranges between 25 feet at the eastern edge of the basin near Oroville and 5 feet in the southwestern portion of the county. With the exception of localized areas, the groundwater declines are generally greater along the eastern edge of the valley floor and least in the Butte Basin region. Localized areas of detectable decline in groundwater levels can be seen between Chico and Durham, northwest and southwest of Hamilton City and in the Butte City area. The majority of these areas is outside of Butte County, but may affect groundwater levels in nearby areas of Butte County.




__Fall 2006 Groundwater Elevation Contour Map__

**Fall 2006**

Fall 2006 groundwater level contours for Butte County show that groundwater is highest in the northern and eastern portions of the county and lowest in the southwest portion of the county. It ranges from a high of 300 feet above sea level to a low of 55 feet above sea level. It appears that there are two groundwater "troughs", one along the Sacramento River in the northern part of the county and one southwest of Chico. There is also a groundwater "mound" south of the Thermalito Afterbay. The red arrows indicate the approximate groundwater flow direction based on the groundwater elevation contours.

## GROUNDWATER LEVEL TRENDS

Groundwater levels typically fluctuate seasonally and from year to year. Seasonal fluctuation of groundwater levels occur in response to recharge and extraction or natural discharge. Precipitation, applied irrigation water, local creeks and rivers, and Thermalito Afterbay all recharge groundwater in Butte County. Levels are usually highest in the spring and lowest during the irrigation season in the summer months.

Long-term fluctuations occur when there is an imbalance between the volume of water recharged into the aquifer and the volume of water removed from the aquifer, either by extraction or natural discharge to surface water bodies. If, over a period of years, amount of water recharged to the aquifer exceeds the amount of water, removed from the aquifer, then groundwater levels will increase. Conversely, if, over time, the amount of water removed from the aquifer exceeds amount of water recharged then groundwater levels will decline. These long-term changes can be linked to various factors including increased or decreased groundwater extraction or variations in recharge associated with wet or dry climatic cycles.

The seasonal and long-term changes in groundwater levels are determined using water level measurements in wells. This data are typically depicted on hydrographs, which are graphical plots of the water level measurement history. Prior to 1997, data points for each of the hydrographs in Butte County generally consisted of two measurements per year. Since 1997, four measurements are recorded each year. The addition of these summer measurements gives the hydrographs the appearance of greater fluctuation.

Described below, by sub-area, are groundwater level assessments for key wells. Each sub-area assessment includes a discussion of the land use, the historical trend in groundwater levels, and a 2006 update describing recent trends and pertinent findings. The key wells were chosen as being representative of groundwater level conditions within each sub-area. It should be noted that the sub-areas are consistent with the sub-inventory units used in the 2001 Butte County Water Inventory and Analysis report.

When reviewing the hydrographs for the key wells, it is important to note that the solid points indicate a static groundwater level measurement while enlarged, red symbols indicate a measurement that has been qualified as questionable. The Department of Water Resources assigns a numerical code to all questionable groundwater level measurements in an effort to help increase the accuracy of data analysis. Questionable measurement codes are used to differentiate between static versus pumping groundwater level measurements, identify if nearby wells are in operation during the measurement, or note that other conditions were present that could impact the accuracy of the measurement. A questionable measurement code key is shown on each hydrograph.

The accuracy of the groundwater level measurement is 0.1 feet. The accuracy of the well elevation is dependent on the source of the information. Some of the well elevations have been surveyed, but in the majority of cases the well elevation was estimated from its location on a USGS topographic map. The elevation accuracy is typically considered to be within 1 USGS topographic map contour interval. As a result the accuracy of the elevation should be considered to be between 5 and 20 feet.

When interpreting short-term changes in groundwater levels, care should be used to compare only those measurements taken during similar times of the year. To facilitate this, the graphs in this report have been color-coded by season of measurement. Blue points indicate measurements that were taken in March, April or May (spring). Green points represent measurements that were taken in June, July, or August (summer). Black points represent measurements taken in September, October, or November (fall). Discontinuities or breaks in a hydrograph represent missing measurements.

When using a hydrograph to evaluate long-term groundwater level data, comparison of the spring measurements is usually recommended. When evaluating spring to spring trends it is also important to consider that, although the measurement was taken in the spring, it may not truly represent the highest water level for the year due to various factors such as timing of spring precipitation and the beginning of agricultural pumping in the area. Following is the list of the key wells presented in this report:

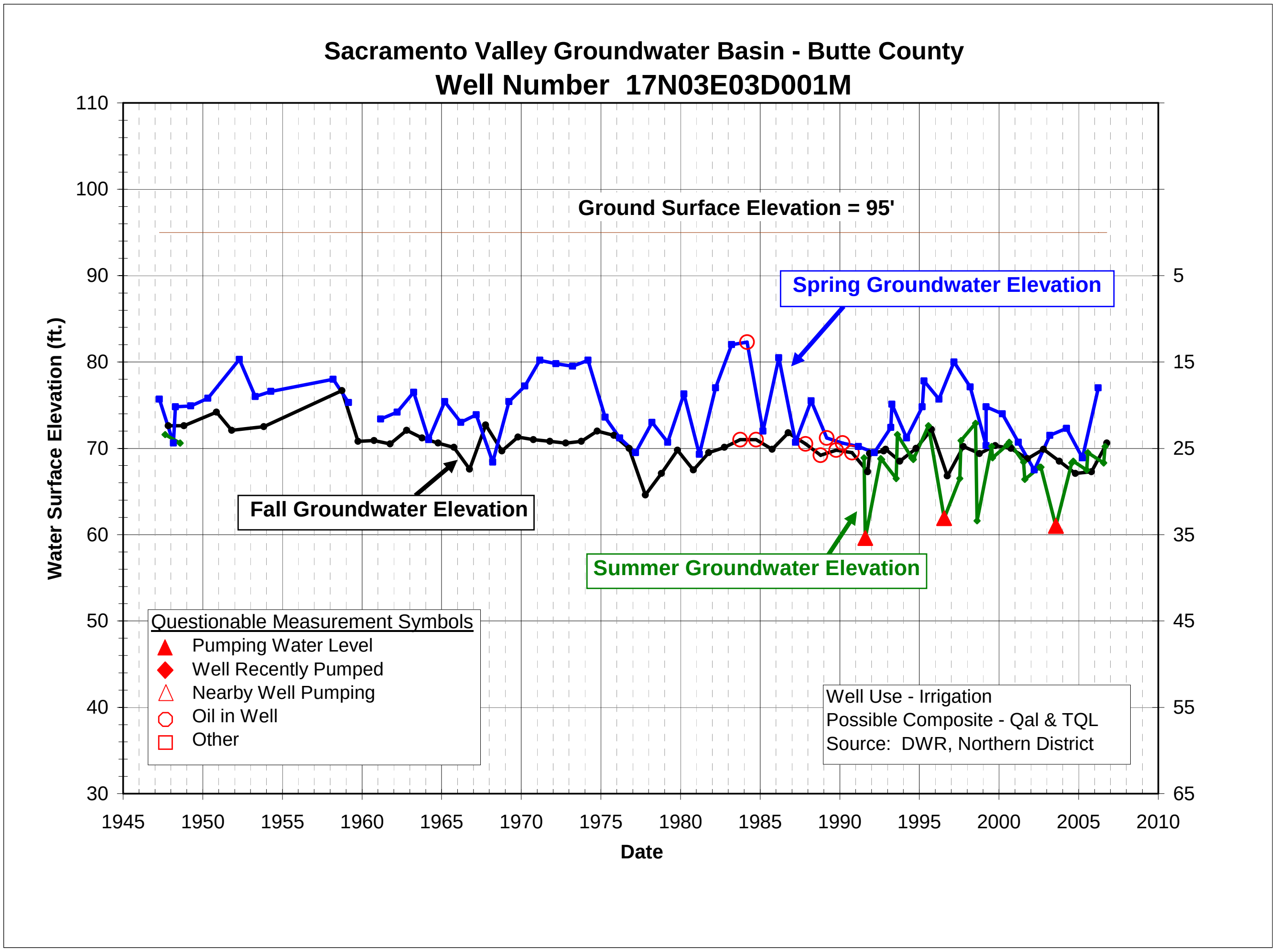
- North Yuba Sub-Area (Well Number 17N/03E-03D001M)
- Thermalito Sub-Area (Well Number 18N/03E-21G001M)
- Western Canal Sub-Area (Well Number 20N/01E-35C001M)
- Richvale Sub-Area (Well Numbers 19N/01E-28R001M & 19N/01E-35B001M)
- Pentz Sub-Area (Well Number 21N/02E-26F001M)
- Esquon Sub-Area (Well Number 20N/02E-09L001M)
- Butte Sink Sub-Area (Well Number 17N/01E-17F001M)
- Butte Sub-Area (Well Number 17N/03E-16N001M)
- Biggs-West Gridley Sub-Area (Well Number 18N/02E-16F001M)
- M & T Sub-Area (Well Number 22N/01E-29R001M)
- Durham-Dayton Sub-Area (Well Number 20N/02E-06Q001M)
- Vina Sub-Area (Well Number 23N/01W-09E001M)
- Cherokee Sub-Area (Well Numbers 20N/02E-13E002M & 20N/02E-24C002M)
- Llano Seco Sub-Area (Well Numbers 20N/01W-26H002 & 20N/01E-18L002M)
- California Water Service (Chico) Sub-Area (Well Numbers 22N02E18N001M & 22N01E26L002M)

**North Yuba Sub-Area (Well Number 17N/03E-03D001M):**

The figure below is a hydrograph for well 17N/03E-03D001M, located in the western portion of the North Yuba Sub-area. The area surrounding the well is characterized by rural, agricultural land use supported by the application of both surface and groundwater. The well is an active irrigation well drawing water from the upper and middle portions of the aquifer system, with a groundwater level measurement record dating back to the late 1940s. The groundwater level in this well was monitored on a semi-annual basis until 1991, on a monthly basis from 1991 to approximately 1995, and is currently being measured four times per year, March, July, August and October.

Historical Trend

The figure shows that the seasonal fluctuation (spring to fall) in groundwater levels is about 5 to 15 feet during years of average precipitation and less than 5 feet during years of drought. Long-term comparison of spring-to-spring groundwater levels shows about a 10-foot decline in spring groundwater levels associated with 1976-77 and 1986-94 droughts and the period of 2001-05. Fall groundwater levels remain particularly consistent even during years of below average precipitation. This is likely due to the well's close proximity to the Feather River. Although spring groundwater levels have remained within 10-12 feet of historical high levels, the majority of measurements in the past 6 years have been closer to historical lows.




**Hydrograph for Well 17N/03E-03D001M**

2006 Update

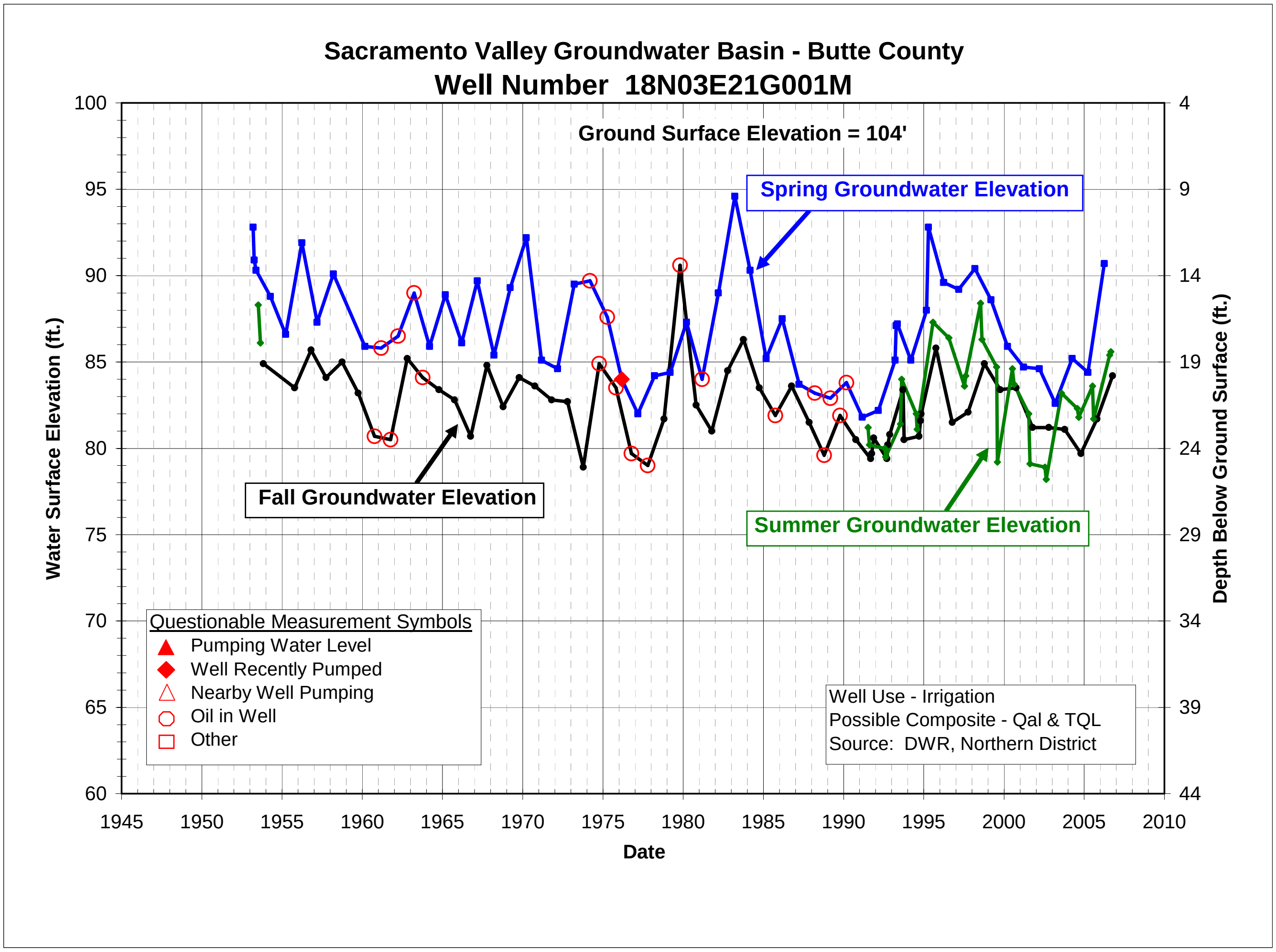
The spring 2006 groundwater elevation is approximately 8 feet higher than in spring of 2005. It is the highest level measured since 1998 and is comparable to average historical spring groundwater elevations. Continued observation is necessary to determine whether the groundwater level increase in 2006 marks the end of the decline observed between 2001 and 2005.

**Thermalito Sub-Area (Well Number 18N/03E-21G001M):**

The figure below is a hydrograph for well 18N/03E-21G001M, located in the southern portion of the Thermalito Sub-area, approximately one-mile west of the Feather River. The area surrounding this well is characterized as rural agricultural. Agricultural cultivation in this area consists of orchard crops supported primarily by groundwater extraction. This well is an active irrigation well producing groundwater from the shallow to intermediate portion of the aquifer system. The groundwater level measurement record dates back to the late 1940s. Groundwater levels in this well were monitored on a semi-annual basis until 1991, on a monthly basis from 1991 to about 1994, and are currently being monitored four times a year during March, July, August and October.

Historical Trend

The figure shows that the seasonal fluctuation (spring to fall) in groundwater levels is about 3 to 8 feet during years of average precipitation and less than 3 to 5 feet during years of drought. Long-term comparison of spring-to-spring groundwater levels shows about an 8-foot decline in spring groundwater levels associated with 1976-77 and 1986-94 droughts and also during the period of 2001-05. Fall groundwater levels also fluctuate with annual precipitation, declining approximately 3-5 feet during the same drought periods. Although spring groundwater levels have remained within 5-8 feet of historical high levels the majority of measurements in the past 6 years have been closer to historical lows.




**Hydrograph for Well 18N/03E-21G001M**

<u>2006 Update</u>

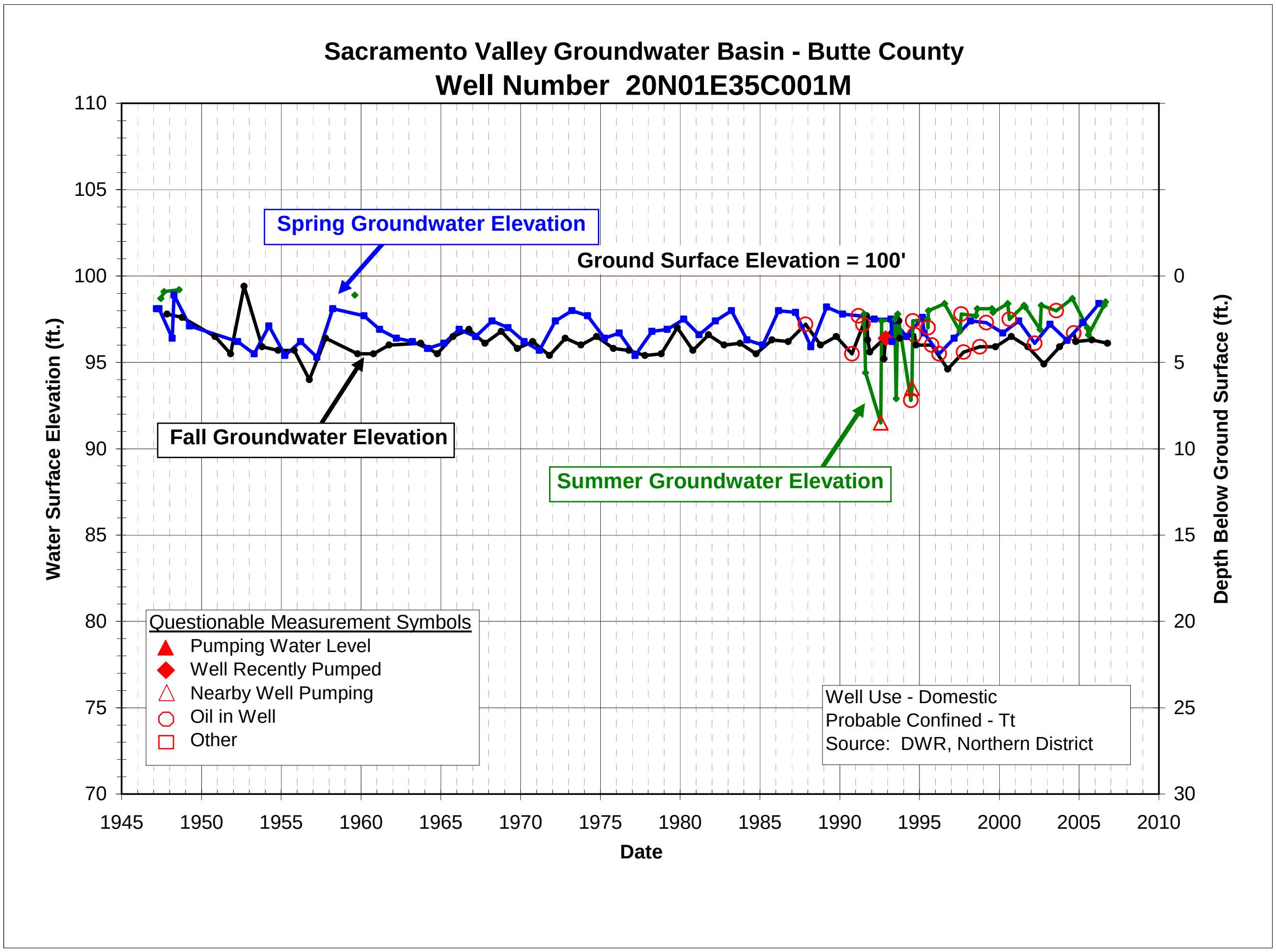
The spring 2006 groundwater elevation is approximately 6 feet higher than in spring of 2005. It is the highest level measured since 1998 and is comparable to average historical spring groundwater elevations. Continued observation is necessary to determine whether the groundwater level increase in 2006 marks the end of the decline observed between 2001 and 2005.

**Western Canal Sub-Area (Well Number 20N/01E-35C001M):**

The figure below is a hydrograph for an active domestic well 20N/01E-35C001M, in the central portion of the Western Canal Sub-area. The area surrounding this well is characterized as rural agricultural. Agricultural cultivation in this area consists of rice production supported by surface water in normal years and a combination of surface and groundwater in drought years. The well is constructed in the uppermost aquifer system. The groundwater level measurement for this well record dates back to the mid-1960s. Groundwater levels in this well were monitored on a semi-annual basis until 1991, and on a monthly basis from 1991 to about 1994, and are currently being monitored four times a year during March, July, August and October.

Historical Trend

The figure shows that the spring to fall fluctuation in groundwater levels averages less than 3 feet during years of normal precipitation and the same during years of drought. Summer groundwater level monitoring indicates that the upper aquifer recharges during summer months due to flood irrigation for rice production producing groundwater level measurements that are higher in the summer than in either the spring or fall. Long-term comparisons of spring-to-spring groundwater levels show almost no change associated with the 1976-77 drought or the 1986-94 drought. Further long-term analysis of spring-to-spring groundwater levels indicates very little change since the late 1940s.




**Hydrograph for Well 20N/01E-35C001M**

2006 Update

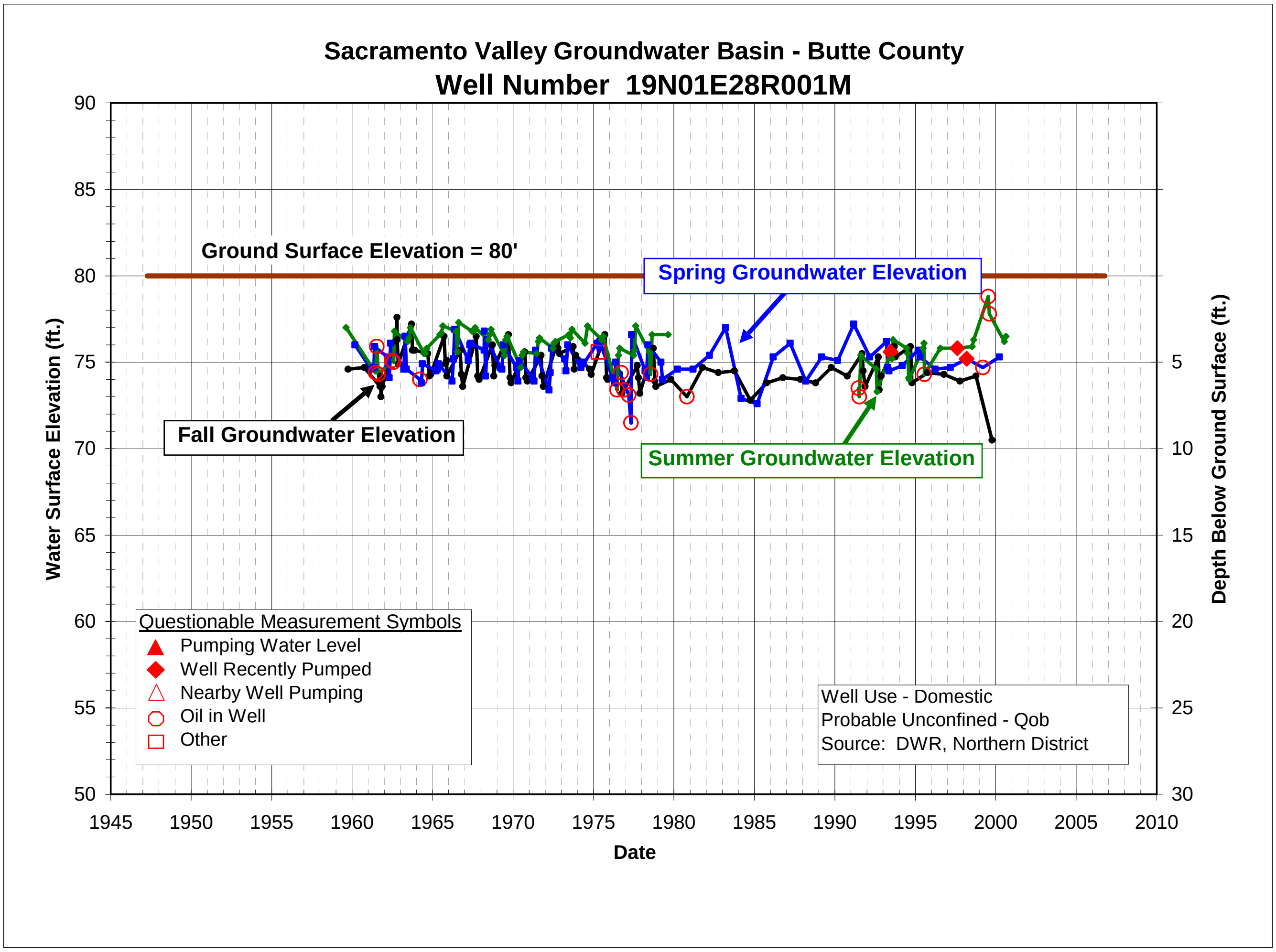
No recent trends or points of concern were observed for 2006. Water levels remain consistent with historical levels.

**Richvale Sub-Area (Well Number 19N/01E-28R001M & 19N/01E-35B001M):**

The figure below is a hydrograph for well 19N/01E-28R001M, located in the western portion of the Richvale Sub-area. The area surrounding this well is characterized as rural agricultural. Agricultural cultivation in this area consists of rice production supported by surface water in normal years and a combination of surface and groundwater in drought years. The well is an active domestic well constructed in the upper portion of the aquifer, with a groundwater level measurement record dating back to the late-1950s. Groundwater levels in this well were monitored on a monthly basis from 1959 to 1979, on a semi-annual basis (spring and fall) from 1979 to 1991 and on a monthly basis again from 1991 to about 1994, and on a semi-annual basis until measurements were discontinued in 2000.

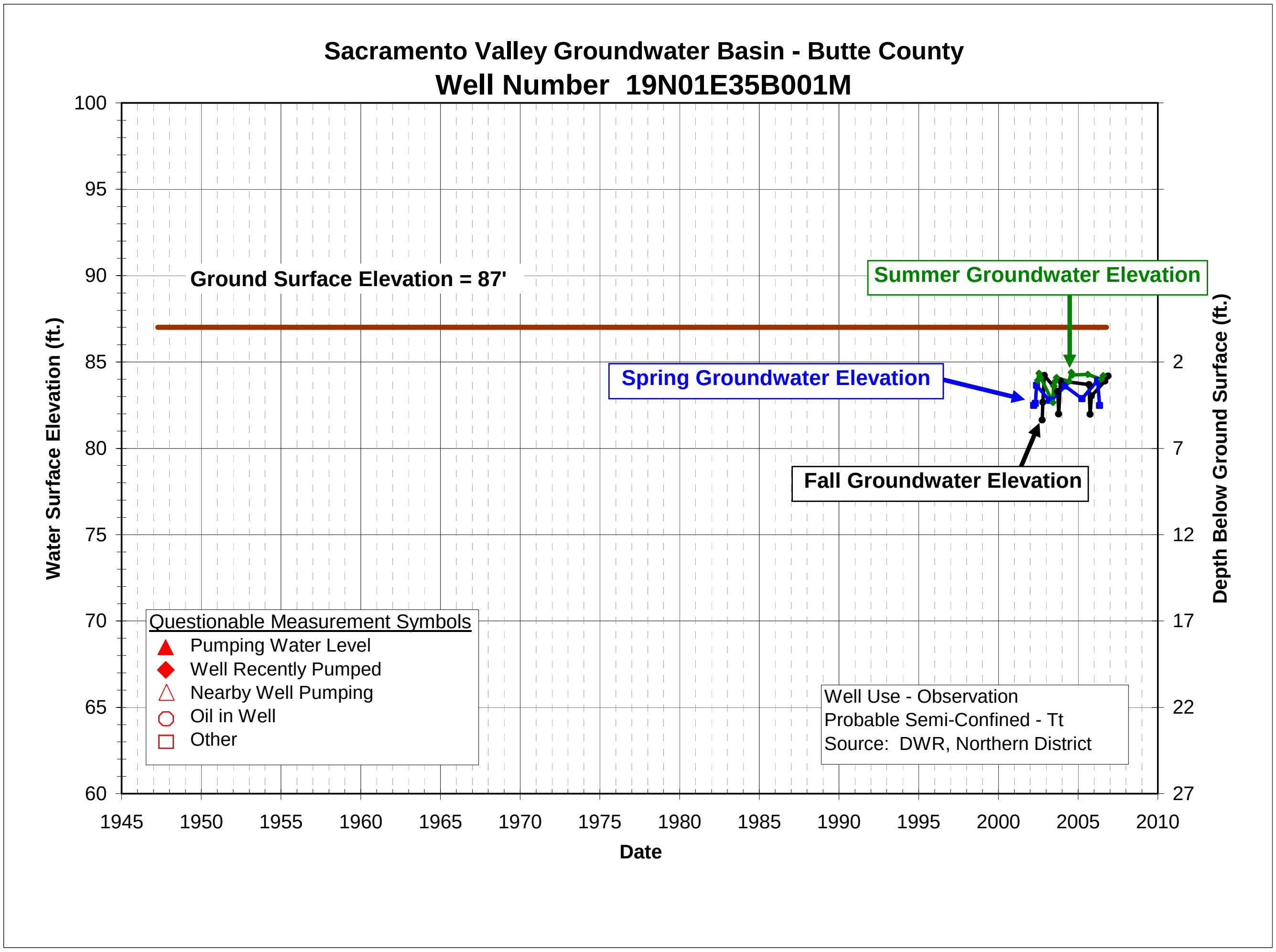
Historical Trend

The figure shows that the spring to fall fluctuation of groundwater levels in the unconfined portion of the aquifer system averages only 1 to 3 feet during years of normal precipitation and the same during years of drought. Summer groundwater level monitoring indicates that the upper aquifer recharges during summer months due to flood irrigation for rice production producing groundwater level measurements that are higher in the summer than in either the spring or fall Long-term comparison of spring-to-spring groundwater levels show almost no change in groundwater levels associated with either the 1976-77 and or the 1986-94 droughts. Further long-term analysis of spring-to-spring groundwater levels indicates very little change in groundwater levels since the late 1950s.




**Hydrograph for Well 19N/01E-28R001M**

Well 19N/01E-35B001 was chosen to replace 19N/01E-28R001M as a key well in the Richvale Sub-area. This is a new dedicated monitoring well that was installed by Butte County during 2001. This well is in the west central portion of the sub-area, east of the original key well. Measurements in this well represent groundwater conditions at a depth of 95-200 feet, in the semi-confined portion of the Upper Tuscan aquifer system.




**Hydrograph for Well 19N/01E-35B001M**

<u>2006 Update</u>

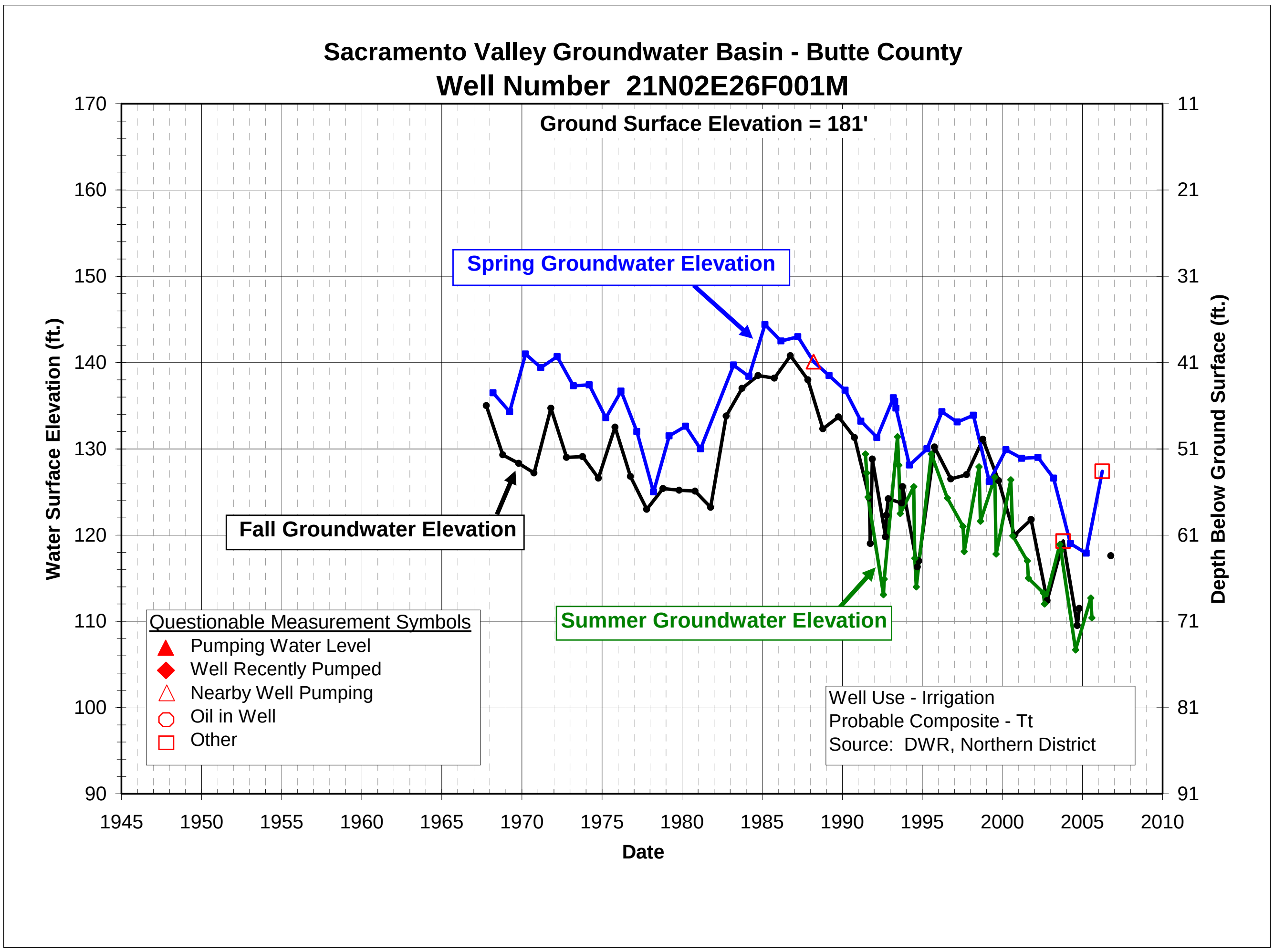
An evaluation of data from both key wells reveals that groundwater levels have changed very little since about 1960. No recent trends or points of concern were observed for 2006. Water levels remain consistent with historical levels.

**Pentz Sub-Area (Well Number 21N/02E-26F001M):**

The figure below is a hydrograph for an active irrigation well 21N/02E-26F001M, just west of Highway 99E, near the intersection of Durham-Pentz Road and Oro-Chico Highway. Within a two-mile radius of the well, groundwater is used to support agricultural production of orchard and row crops, and small-scale industrial uses associated with a beverage distribution plant. The well is a deep irrigation well with shallow casing, and a groundwater level measurement record dating back to the mid-1960s. Groundwater levels in this well represent a mixture of the unconfined and confined portions of the aquifer system. The groundwater levels in this well were monitored on a semi-annual basis (spring and fall) until 1991, on a monthly basis from 1991 to about 1994, and are currently being monitored four times a year during March, July, August and October.

Historical Trend

The figure shows that the average seasonal fluctuation (spring to fall) in groundwater levels averages about 3 to 10 feet during years of normal precipitation and approximately 3 to 5 feet during years of drought. Long-term comparison of spring-to-spring groundwater levels shows a decline in groundwater levels during the period of 1971-1981, perhaps associated with the 1976-77 drought. Since a groundwater elevation high of approximately 145 feet in 1985 the measured groundwater levels in this well have continued to decline. Recent groundwater level measurements indicate that the groundwater elevation in this well is approximately 15-25 feet lower than the historical high in 1985.




**Hydrograph for Well 21N/02E-26F001M**

2006 Update

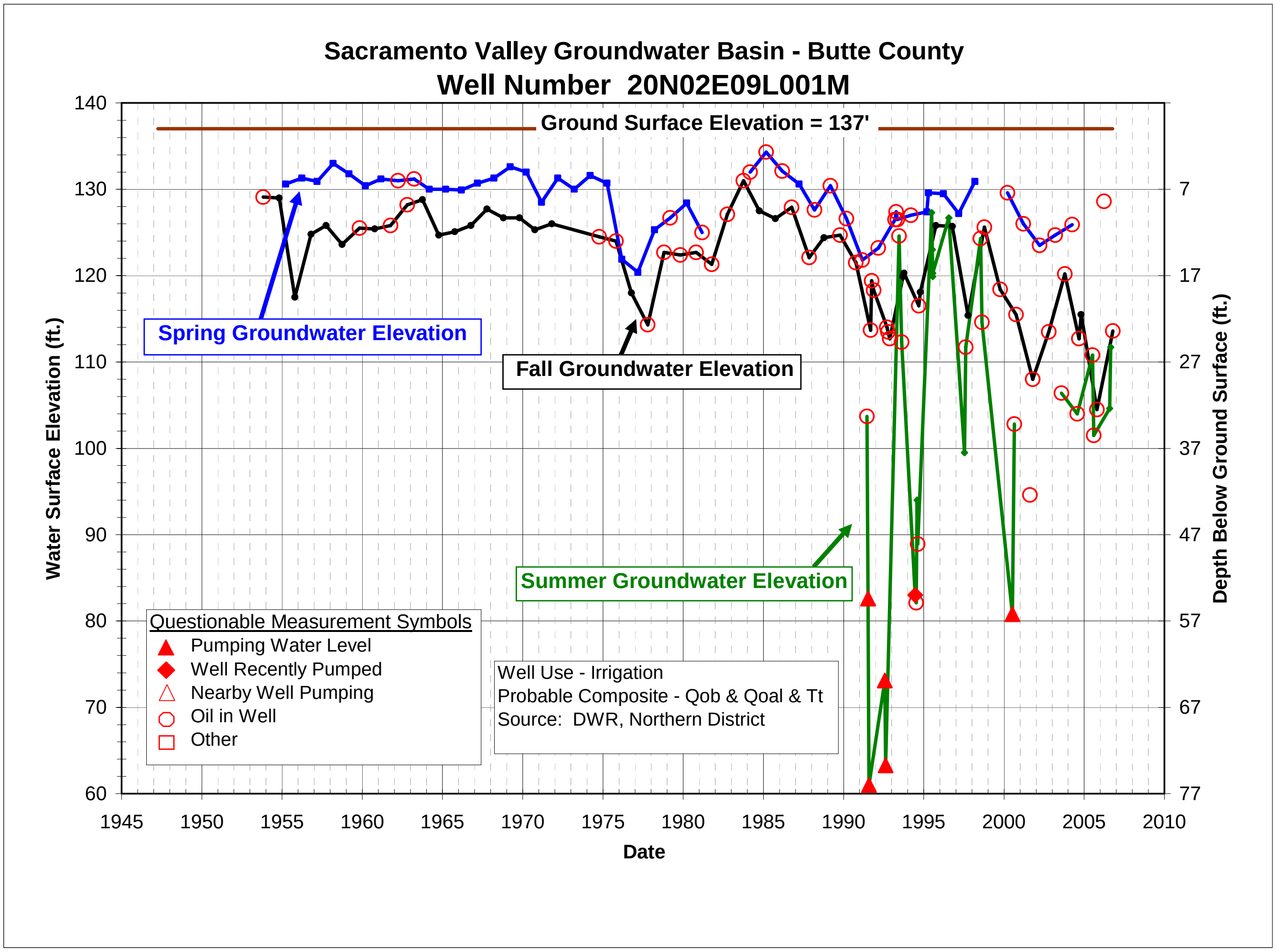
Since 1985 spring groundwater levels in this well have been declining. Although the spring 2006 measurement was approximately 10 feet higher than the previous spring measurement the water level remained 10-15 feet below historical high levels and continues the downward trend on the hydrograph. The long-term trend of decline observed in this well is a point of concern and further efforts need to be made to expand monitoring and evaluate the potential causes for the decline.

**Esquon Sub-Area (Well Number 20N/02E-09L001M):**

The figure below is a hydrograph for an active irrigation well 20N/02E-09L001M, in the southern portion of the Esquon Sub-area. The area surrounding the well consists primarily of rice production using both surface and groundwater. The well is a deep irrigation well with shallow casing, and a groundwater level measurement record dating back to the 1950s. Groundwater levels in this well represent a mixture of the unconfined and confined portions of the aquifer system. The groundwater levels in this well were monitored on a semi-annual basis until 1991, on a monthly basis from 1991 to about 1994, and are currently being monitored four times a year during March, July, August and October.

Historical Trend

The figure shows that the historical spring to fall fluctuation in groundwater levels averages 3 to 8 feet during years of normal precipitation and drought periods. Long-term comparison of spring-to-spring groundwater levels shows about a 10 foot decline in groundwater levels associated with the 1976-77 drought, followed by a similar decline between 1990 and 1994, perhaps associated with the 1986-94 drought. Groundwater levels in this well appear to recover from the 1986-94 drought to groundwater levels similar to those of the early 1980s. However, further long-term analysis of spring-to-spring groundwater levels indicates about a 5-foot decline in groundwater levels since the late 1950s.




**Hydrograph for Well 20N/02E-09L001M**

<u>2006 Update</u>

The spring 2006 groundwater level measurement was approximately 3 feet higher than the previous spring measurement, but is remains approximately 2-3 feet below the historical spring levels. Fall groundwater levels are approximately 5 to 8 feet lower than those measured during either of the previous drought periods on the hydrograph. At this time this it appears that there may be a downward trend in groundwater levels in this well.

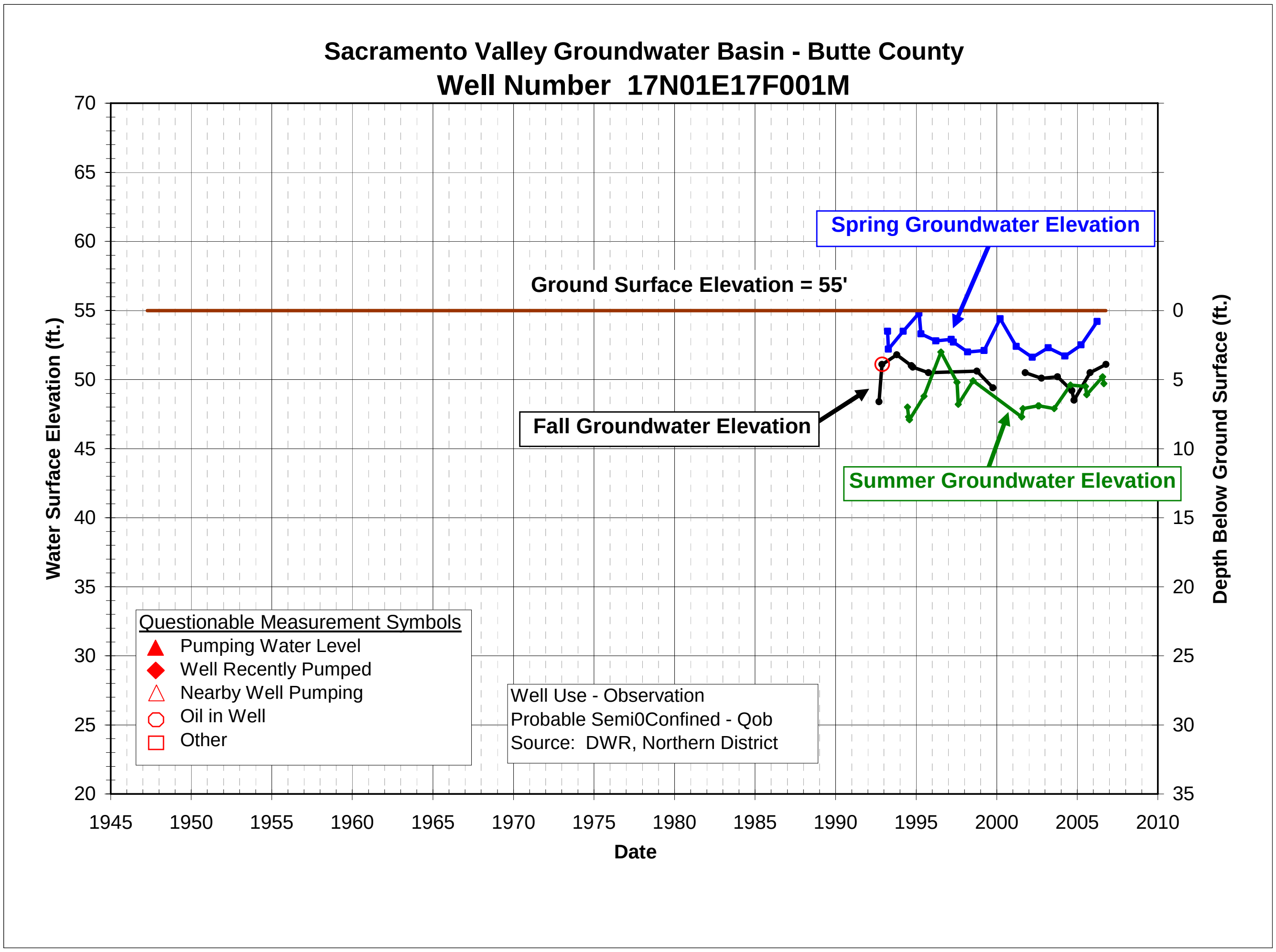
**Butte Sink Sub-Area (Well Number 17N/01E-17F001M):**

The figure below is a hydrograph for well 17N/01E-17F001M, in the northwestern portion of the Butte Sink Sub-area. The land use surrounding this well is characterized as native riparian and agricultural. Agricultural cultivation in this area consists of rice production supported primarily by surface water. Surface water is also used as the primary source for flooding of native riparian land for waterfowl habitat. This well is a dedicated monitoring well constructed in the upper to middle portions of the aquifer, with a groundwater level measurement record dating back to

1992. The groundwater levels in this well were monitored on a monthly basis from 1992 to 1995, and are currently monitored four times a year during March, July, August and October.

Historical Trend

The figure shows that the spring to summer fluctuation of groundwater levels in the unconfined portion of the aquifer system averages only 3 to 5 feet during years of normal precipitation. Monitoring in this well began during the 1986-94 drought period so it is not possible to fully determine the impact of this drought period on the water level in this well. All groundwater level measurements (spring, summer, and fall) have been within 8 feet of the ground surface. Further long-term analysis of spring-to-spring groundwater levels is not possible due to the short monitoring history.




**Hydrograph for Well 17N/01E-17F001M**

2006 Update

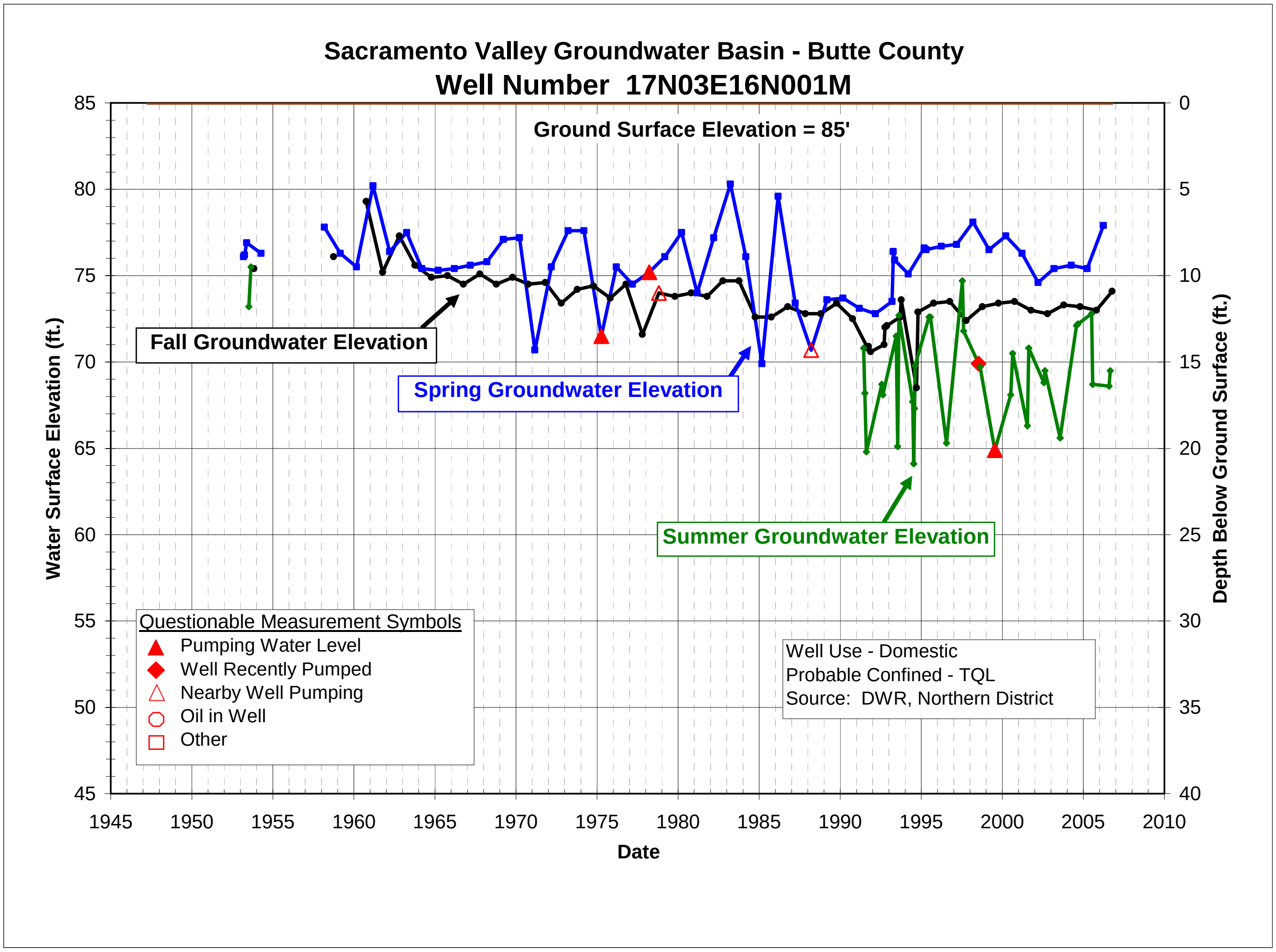
The spring 2006 groundwater level is approximately 2 feet higher than the previous spring level. There does appear to be a minor (approximately 3 feet) decline in groundwater levels over the period of record, but with the limited period of record this may not indicate an actual downward trend in groundwater levels.

**Butte Sub-Area (Well Number 17N/03E-16N001M):**

The figure below is a hydrograph for well 17N/03E-16N001M, in the southeastern portion of the Butte Sub-area. The area surrounding this well is characterized as rural agricultural. Agricultural cultivation in this area consists primarily of orchard crops supported by groundwater. The well is an active domestic well constructed over the upper and middle portions of the aquifer, with a groundwater level measurement record dating back to the mid-1950s. The groundwater levels in this well were monitored on a semi-annual basis until approximately 1991, on a monthly basis from approximately 1991 to 1995, and are currently monitored four times a year during March, July, August and October.

Historical Trend

The figure shows that the spring to fall fluctuation of groundwater levels in the unconfined portion of the aquifer system averages only 3 to 6 feet during years of normal precipitation and 1 to 3 feet during years of drought. Long-term comparisons of spring-to-spring groundwater levels shows a small decline in spring groundwater levels associated with the 1976-77 and the 1986-94 droughts, followed by recovery to normal levels. Further long-term analysis of spring-to-spring groundwater levels indicates very little change in spring groundwater levels since the 1950s. Fall groundwater levels have declined approximately 3 feet over the period of record.




**Hydrograph for Well 17N/03E-16N001M**

<u>2006 Update</u>

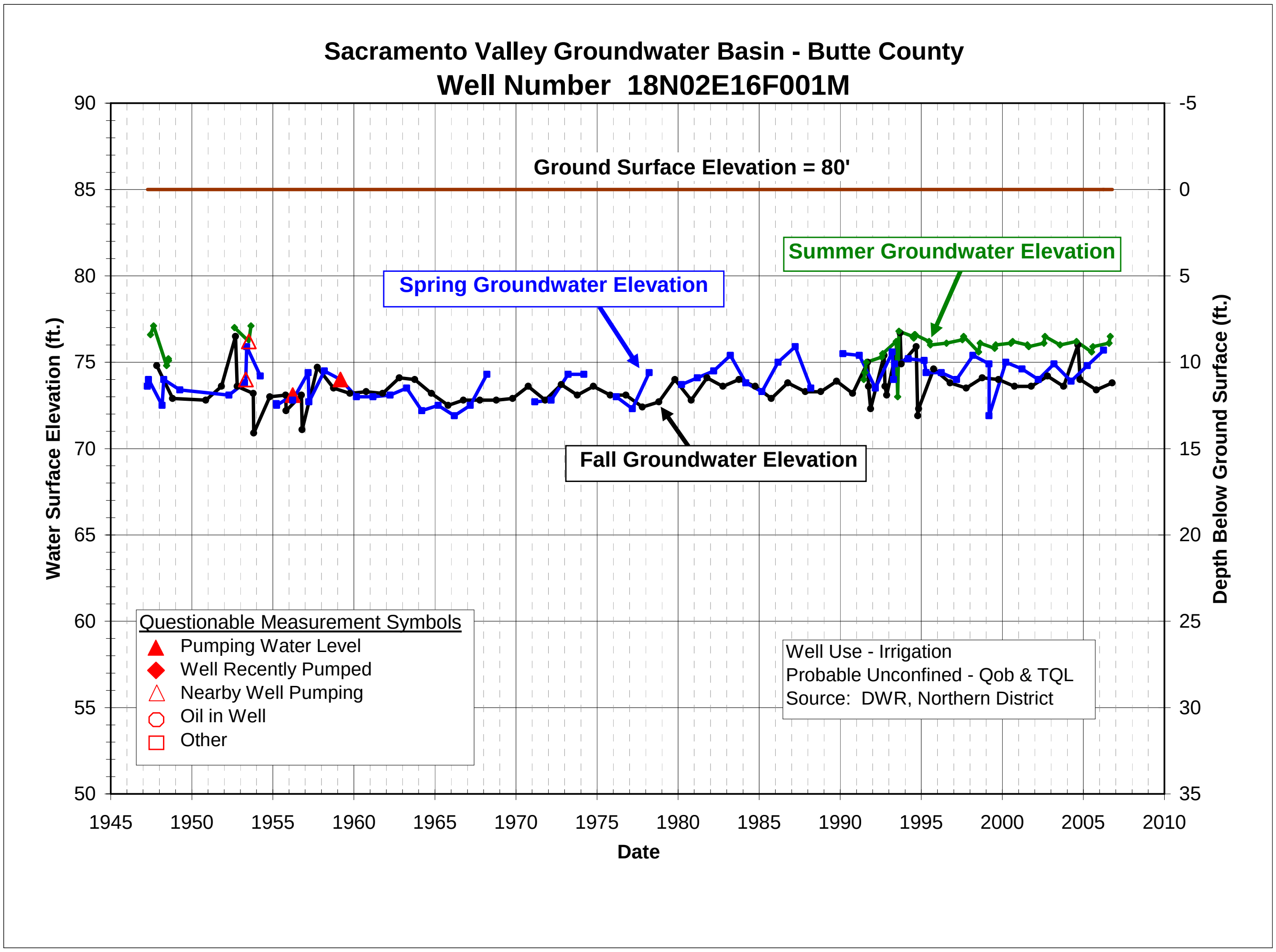
The spring 2006 groundwater level measurement was approximately 3 feet higher than the previous spring measurement. There does not appear to be any long term trends in the spring groundwater levels. There does appear to be decline in the fall groundwater levels over the period of record of about 3 feet.

**Biggs-West Gridley Sub-Area (Well Number 18N/02E-16F001M):**

The figure below is a hydrograph for well 18N/02E-16F001M, in the north-central portion of the Biggs-West Gridley Sub-area. The area surrounding this well is characterized as rural agricultural. Agricultural cultivation in this area consists primarily of rice production supported by a combination of surface and groundwater. The well is an active irrigation well constructed in the upper portion of the aquifer, with a groundwater level measurement record dating back to the late 1940s. Groundwater levels in this well were monitored on a semi-annual basis until 1991, on a monthly basis from 1991 to about 1994 and are currently being monitored four times a year in March, July, August and October.

Historical Trend

The figure shows that the spring to fall fluctuation of groundwater levels in the unconfined portion of the aquifer system averages only 1 to 2 feet during years of normal precipitation and years of drought. Close examination of the spring to summer fluctuations indicate that groundwater levels rise during the summer months as the upper aquifer recharges due to flood irrigation for rice production. Long-term comparison of spring-to-spring groundwater levels shows almost no change in groundwater levels associated with either the 1976-77 and or the 1986-94 droughts. Further long-term analysis of spring-to-spring groundwater levels indicates that there has been an increase of about 2 feet in groundwater levels since the late 1940s.




**Hydrograph for Well 18N/02E-16F001M**

2006 Update

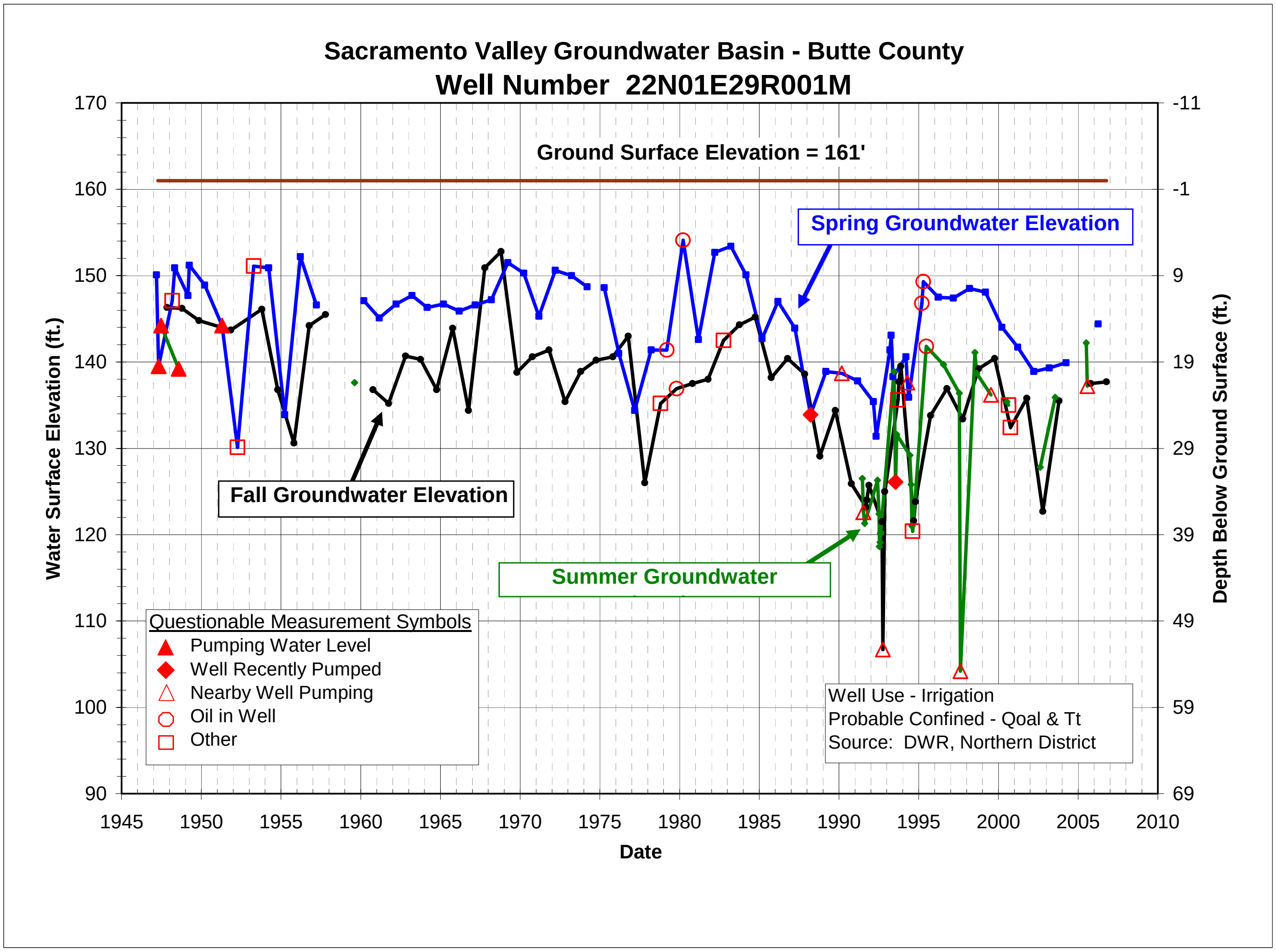
No recent trends or points of concern were observed for 2006. Water levels remain consistent with historical levels.

**M & T Sub-Area (Well Number 22N/01E-29R001M):**

The figure below is a hydrograph for well 22N/01E-29R001M, located just south of Big Chico Creek in the northern portion of the M&T Sub-area. The well is surrounded by agricultural orchard production, supported by groundwater extraction. This well is an inactive irrigation well of intermediate depth, with a groundwater level measurement record dating back to the late-1940s. Groundwater levels in this well represent the confined portion of the aquifer. The groundwater levels in this well were monitored on a semi-annual basis until 1991, on a monthly basis from 1991 to about 1994, and are currently being monitored four times a year during March, July, August and October.

Historical Trends

The figure shows that the average seasonal fluctuation (spring to fall) in groundwater levels is about 5 to 10 feet during years of normal precipitation and about 5 or less feet during years of drought. Long-term comparison of spring-to-spring groundwater levels shows a decline of about 10 to 15 in groundwater levels associated with the 1976-77 drought, followed by a decline of about 15 to 20 associated with the 1986-94 drought. Overall comparison of spring to spring groundwater levels associated with this confined portion of the aquifer system indicates that there was little change in spring groundwater levels until 2000. Spring groundwater levels have declined about 8 feet since 2000.




**Hydrograph for Well 22N/01E-29R001M**

<u>2006 Update</u>

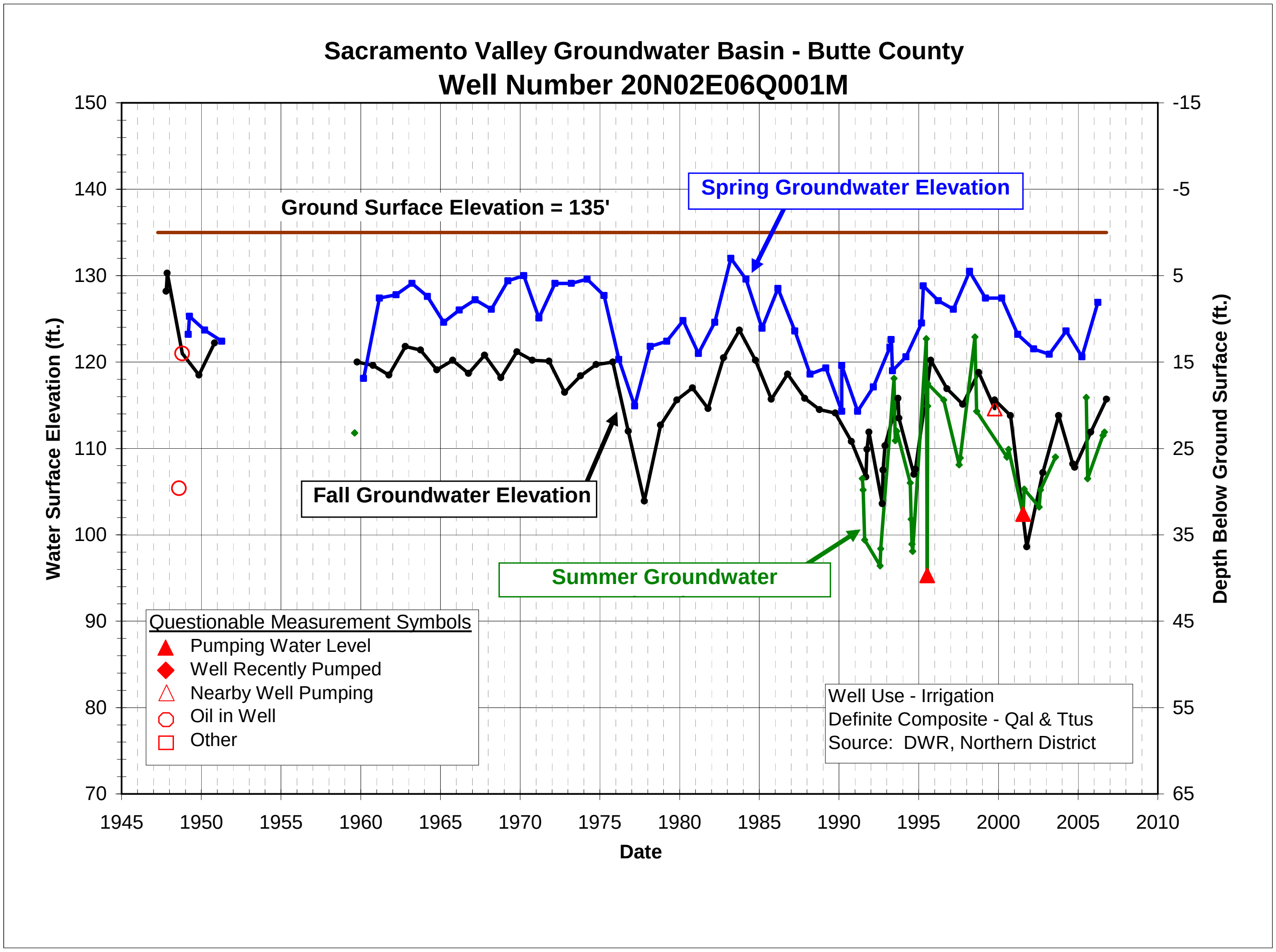
The spring 2006 groundwater level measurement is approximately 4 feet higher than the previous spring measurement, but is still 4 feet below spring levels in the late 1990's. Fall groundwater levels have also declined a similar amount during the same period.

**Durham-Dayton Sub-Area (Well Number 20N/02E-06Q001M):**

The figure below is a hydrograph for well 20N/02E-06Q001M, located about two miles south of Durham. This area marks a change in agricultural water uses from groundwater to the north and surface water use to the south. The well is a deep irrigation well with shallow casing, and a groundwater level measurement record dating back to the late-1940s. Groundwater levels in this well represent a mixture of the unconfined and confined portions of the aquifer system. The groundwater levels in this well were monitored on a semi-annual basis until 1991, on a monthly basis from 1991 to about 1994, and are currently being monitored four times a year during March, July, August and October.

Historical Trend

The figure shows a seasonal fluctuation (spring to fall) in groundwater levels of about 10 to 15 feet during years of normal precipitation and less than 5 feet during years of drought. Long-term comparison of spring-to-spring groundwater levels shows a decline of approximately 15 feet associated with the 1976-77 and 1986-94 droughts. Overall comparison of spring to spring groundwater levels associated with this composite portion of the aquifer system indicates that there was little change in spring groundwater levels until 2000. Since 2000 spring groundwater levels have declined approximately 8 feet.




**Hydrograph for Well 20N/02E-06Q01M**

2006 Update

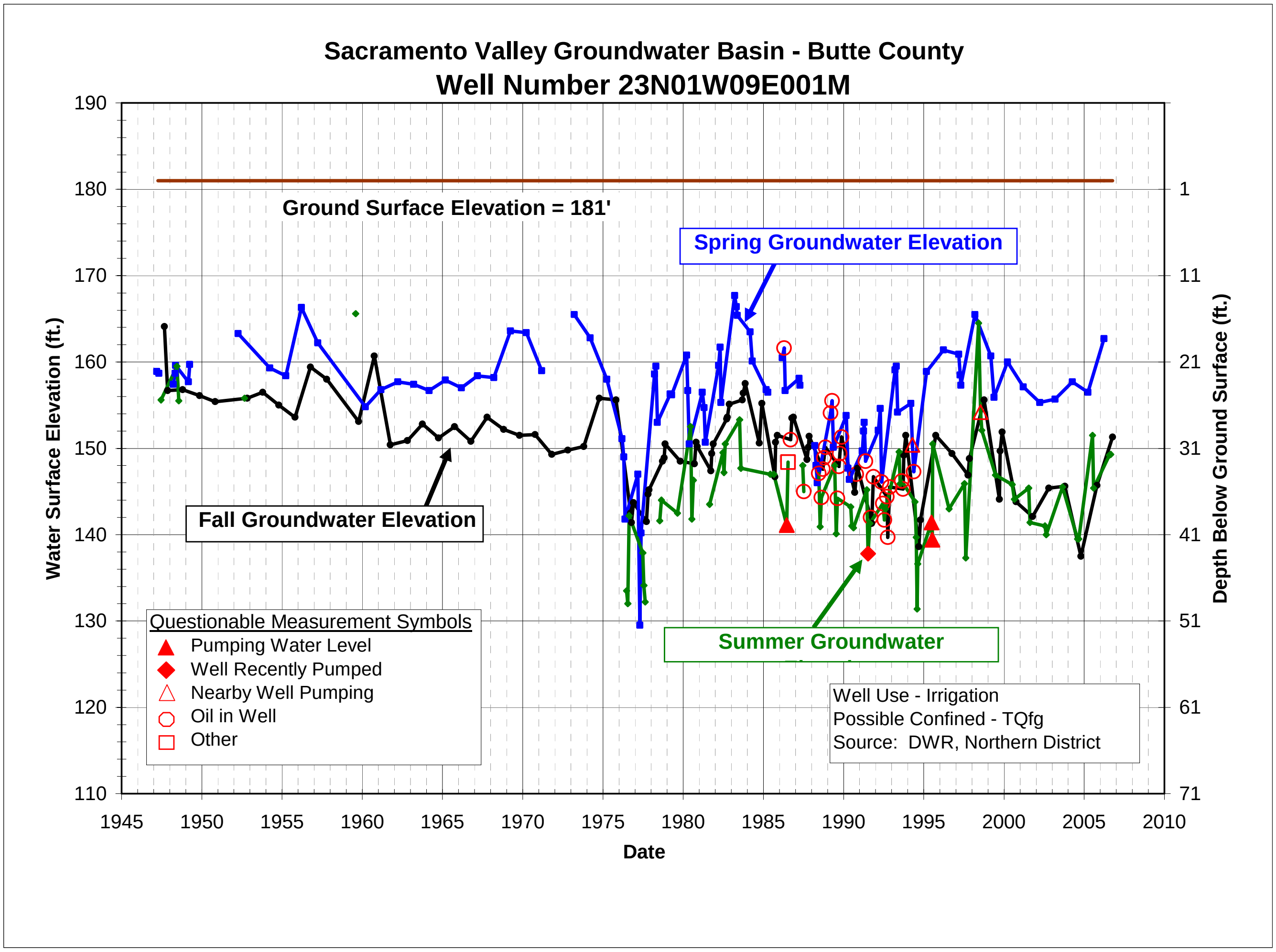
The spring 2006 groundwater level measurement was approximately 6 feet higher than the previous spring measurement. It was, however, still 2 to 4 feet below historical levels. The fall measurements follow a similar trend, indicating a decline in fall groundwater levels since 1999 of about 4 feet.

**Vina Sub-Area (Well Number 23N/01W-09E001M):**

The figure below is a hydrograph for well 23N/01W-09E001M, in the northern Vina Sub-area. The area surrounding this well is characterized by rural, agricultural land use supported by groundwater. This well is an irrigation well constructed in the confined portion of the aquifer system, with a groundwater level measurement record dating back to the mid-1940s. The groundwater levels in this well were monitored on a semi-annual basis until the mid-1970s, on a monthly basis from the mid-1970s to 1996, and are currently monitored four times a year during March, July, August and October.

<u>Historical Trend</u>

The figure shows a seasonal fluctuation (spring to fall) in groundwater levels of about 5 to 15 feet during years of normal precipitation and less than 5 feet during years of drought. Long-term comparison of spring-to-spring groundwater levels shows a decline of approximately 30 feet associated with the 1976-77 and approximately 10 to 12 feet associated with the 1986-94 drought period. Overall comparison of spring to spring groundwater levels associated with this confined portion of the aquifer system indicates that there has been little change in the spring groundwater levels since the late 1940's. Long term comparison of fall groundwater levels does indicate that the fall groundwater level has declined 5 to 10 feet over the period of record.




**Hydrograph for Well 23N/01W-09E001M**

<u>2006 Update</u>

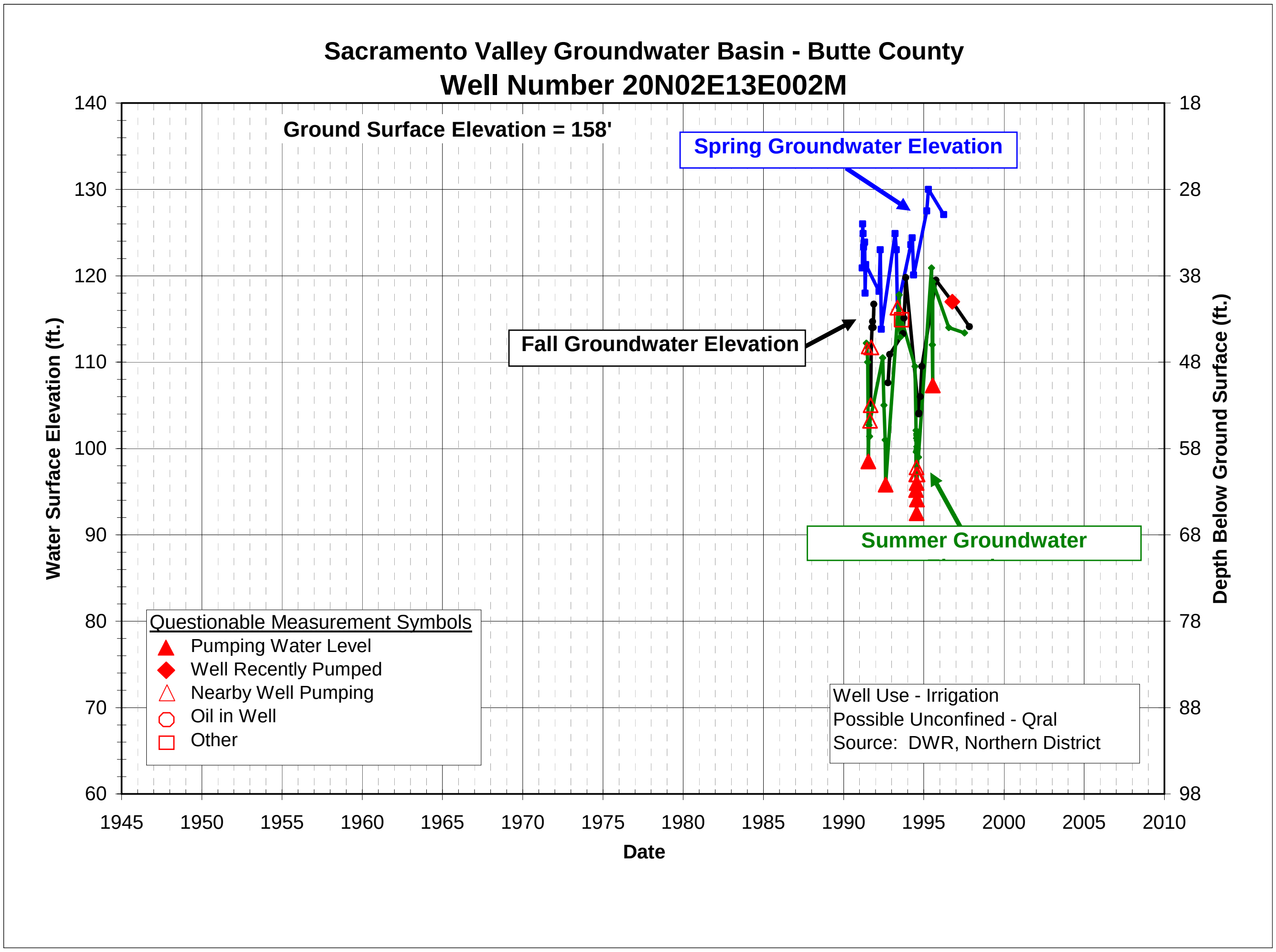
The spring 2006 groundwater level measurement was approximately 8 feet higher than the previous spring measurement. The spring 2006 measurement is among the higher levels groundwater levels recorded for this well. The fall 2006 measurement is 5 feet higher than the previous (2005) measurement and 15 feet higher than the 2004 measurement, but it still remains several feet below historical measurements.

**Cherokee Sub-Area (Well Number 20N/02E-13E002M & 20N/02E-24C002M):**

The figure below is a hydrograph for well 20N/02E-13E002M, located in the western portion of the Cherokee Sub-area. The area surrounding this well is characterized by agricultural production of orchard, rice and row crops supported by both groundwater and surface water. This well is a shallow irrigation well constructed in the unconfined portion of the aquifer system. The groundwater levels in this well were monitored on a monthly basis from 1991 to 1995 and on a semi-annual basis from 1995 to 1996.

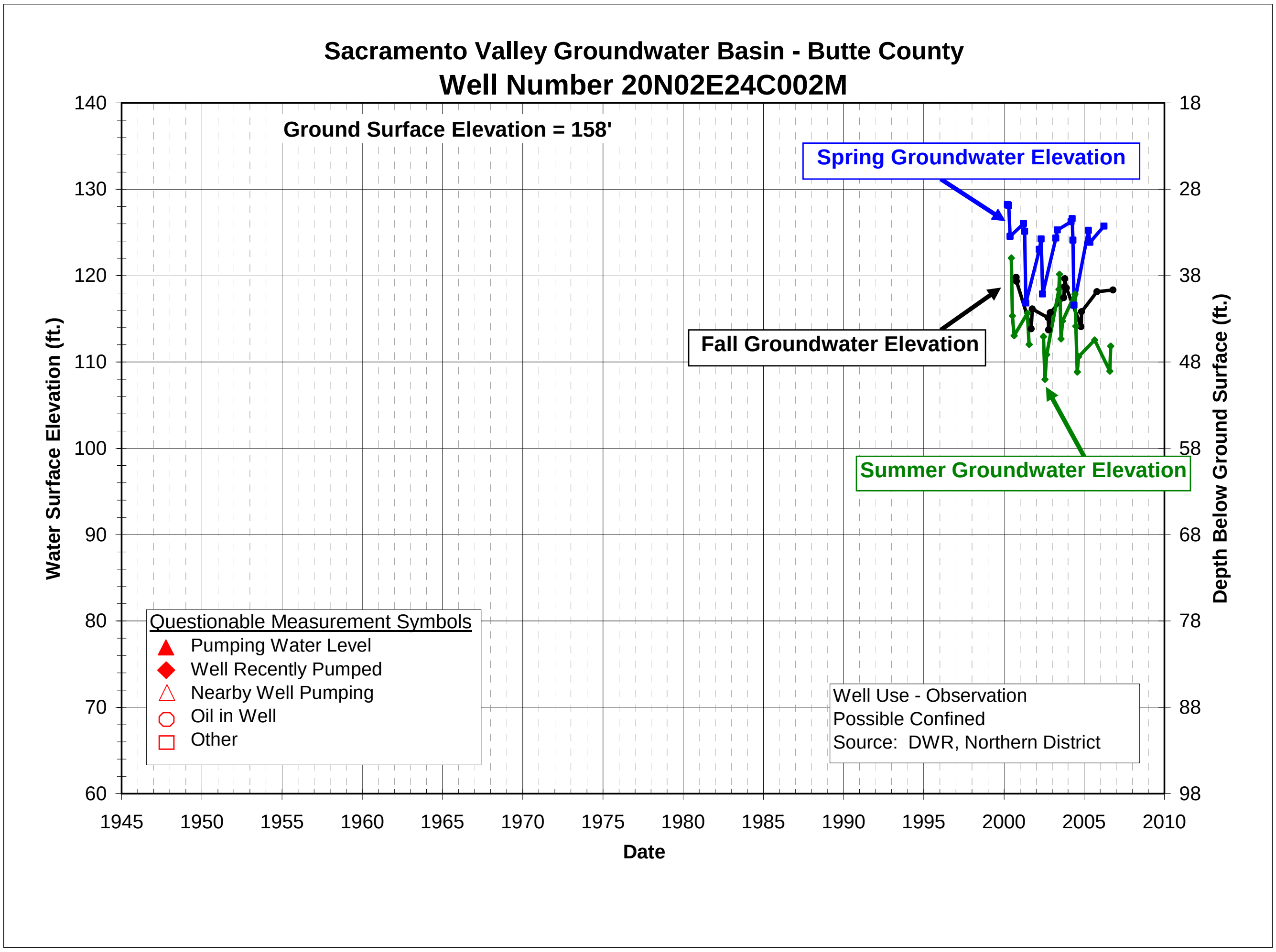
Historical Trend

Due to active pumping within the monitoring well and nearby pumping of surrounding wells, the true seasonal fluctuation of static groundwater levels is difficult to accurately determine.




**Hydrograph for Well 20N/02E-13E002M**

Groundwater level monitoring was discontinued in this well. Well 20N/02E-24C002M was chosen to replace this key well in the Cherokee Sub-area. The new key well is part of a dedicated, multi-completion monitoring well set that was installed during 1999. The well is in the west central portion of the sub-area south of the initial key well. Measurements in this well represent groundwater conditions between 336 to 377 feet in the semi-confined portion of the Lower Tuscan aquifer system.




**Hydrograph for Well 20N/02E-24C02M**

<u>2006 Update</u>

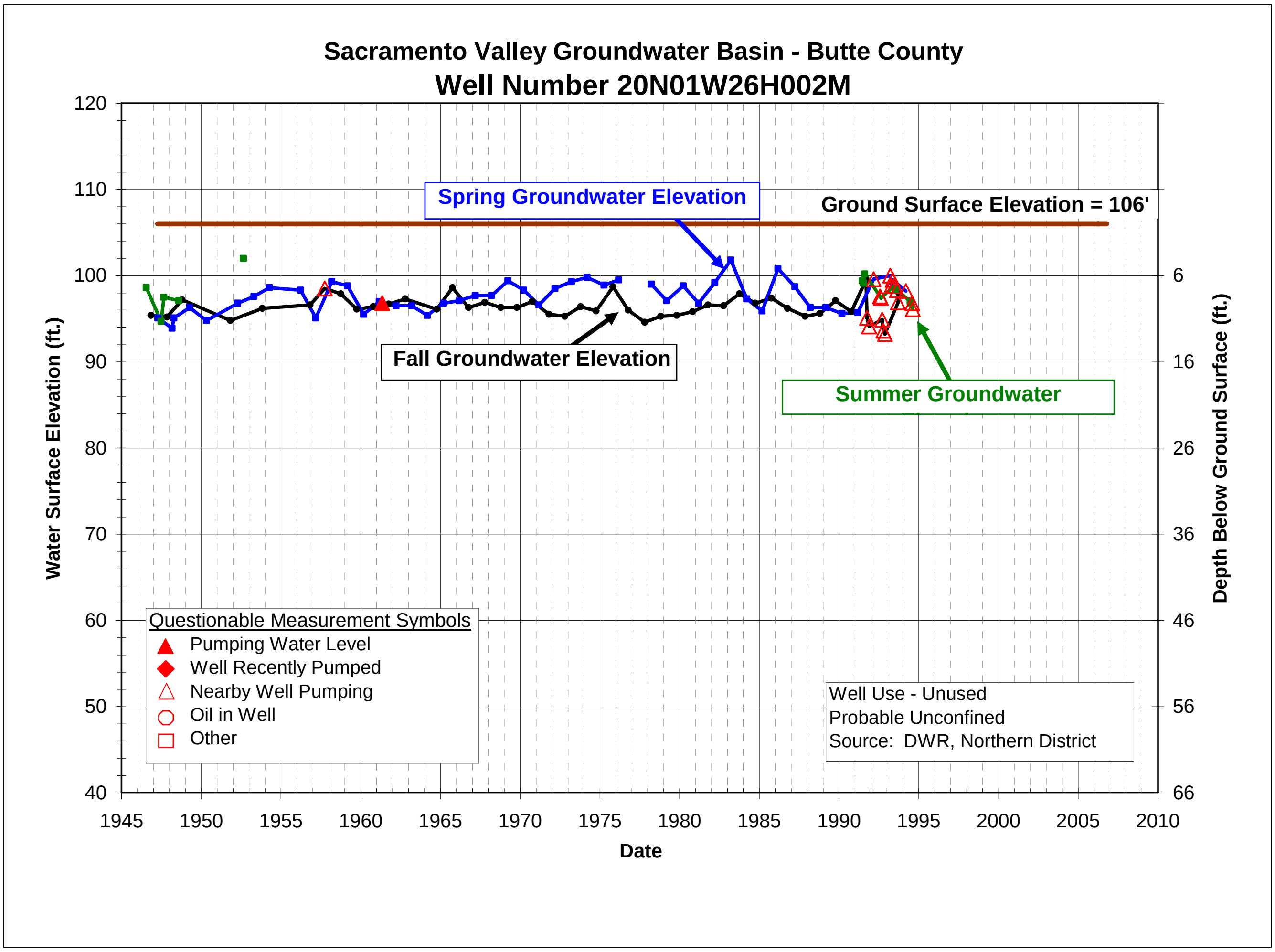
The spring 2006 groundwater level measurement was approximately .5 feet higher than the previous spring measurement. The short period of record for this well makes analysis of trends difficult, but spring groundwater levels have declined slightly (approximately 2.5 feet), but consistently since the spring of 2000.

**Llano Seco Sub-Area (Well Number 20N/01W-26H002M & 20N/01E-18L002M):**

The figure below is a hydrograph for well 20N/01W-26H002M, located in the southern portion of the Llano Seco Sub-area. The area surrounding this well is characterized by rural agricultural land use, supported primarily by the application of surface water. This well is an unused irrigation well constructed in the unconfined portion of the aquifer system, with a groundwater level measurement record dating back to the early 1940s. The groundwater levels in this well were monitored on a semi-annual basis until 1991 and on a monthly basis from 1991 to about 1994, when monitoring of this well was discontinued.

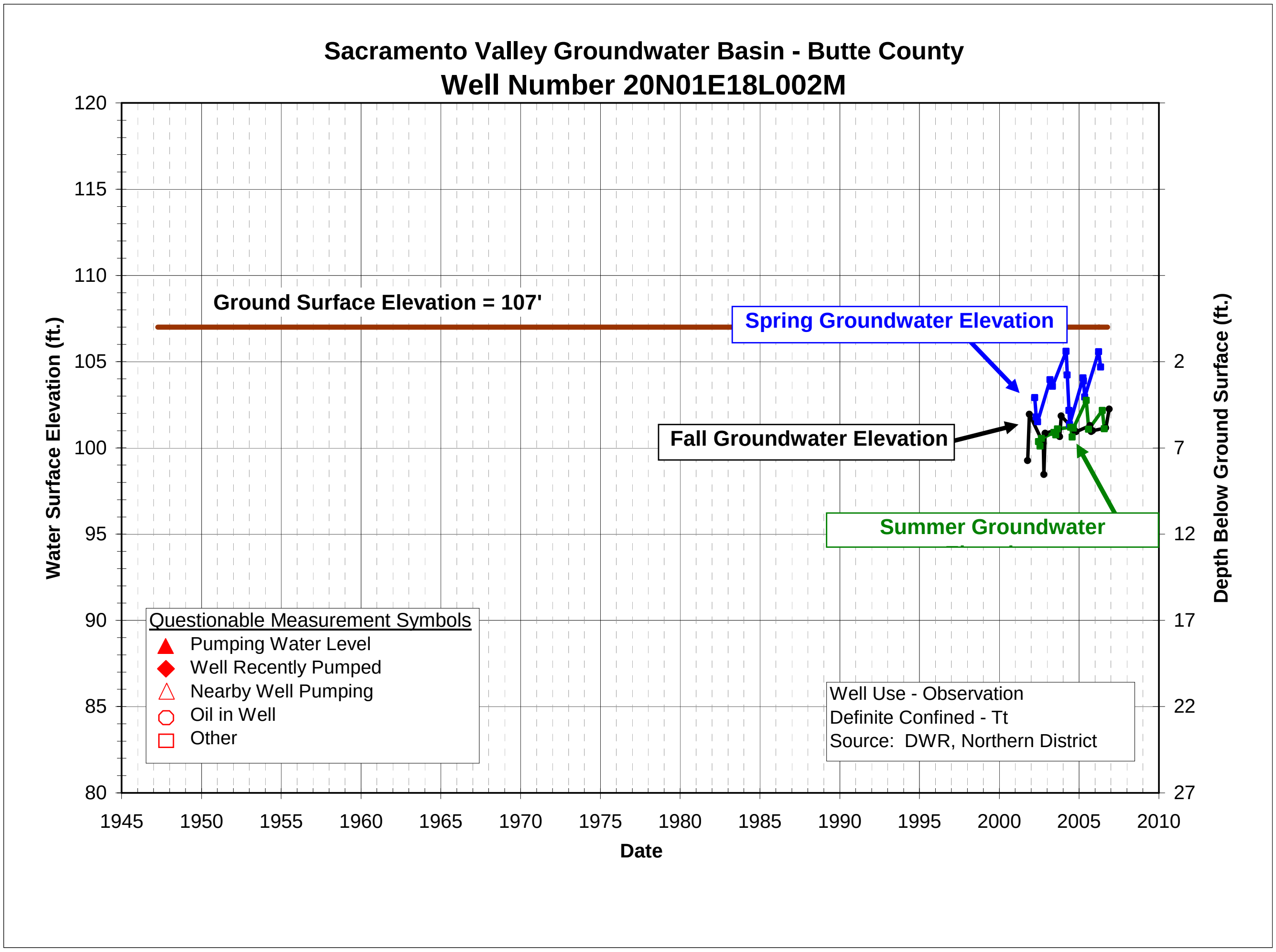
Historical Trend

The figure shows that the average seasonal fluctuation (spring to fall) in groundwater levels is about 1 to 5 feet during normal and drought years. Long-term comparison of spring-to-spring groundwater levels show little, if any, decline in groundwater levels associated with the 1976-77 and 1986-94 droughts. Overall comparison of spring-to-spring groundwater levels show that there has been very little change in the unconfined aquifer system within this portion of the Llano Seco Sub-area since the early 1940s.




**Hydrograph for Well 20N/01W-26H002M**

Groundwater level monitoring was discontinued in this well in 1994. Well 20N/01E-18L002M was chosen to replace the original key well in the Llano Seco Sub-area. This new well is part of a dedicated, multi-completion monitoring well set that was installed during 2001. The well is along the eastern margin of the sub-area, due east from the original key well. Measurements in this well represent groundwater conditions between 510-560 feet in the confined portion of the Upper Tuscan aquifer system.




**Hydrograph for Well 20N/01E-18L002M**

<u>2006 Update</u>

The spring 2006 groundwater level measurement was approximately 2 feet higher than the previous spring measurement, and it is consistent with previous spring measurements. The limited period of record for this well makes trend analysis difficult, but the available data do not indicate any trends in groundwater levels in this well.

**California Water Service (Chico) Sub-Area (Well Numbers 22N02E18N001M & 22N01E26L002M):**

Groundwater hydrographs for the California Water Service monitoring wells were developed using static groundwater level data, provided by California Water Service Company. Although the groundwater level measurements presented in the California Water Service hydrographs were collected when the wells were not pumping (static groundwater levels), it should be noted that the effects from the recent pumping of these production wells could result in groundwater level readings that are deeper than stable static conditions. Hydrographs from two representative wells in the California Water Service Sub-area are shown below.

Historical Trend

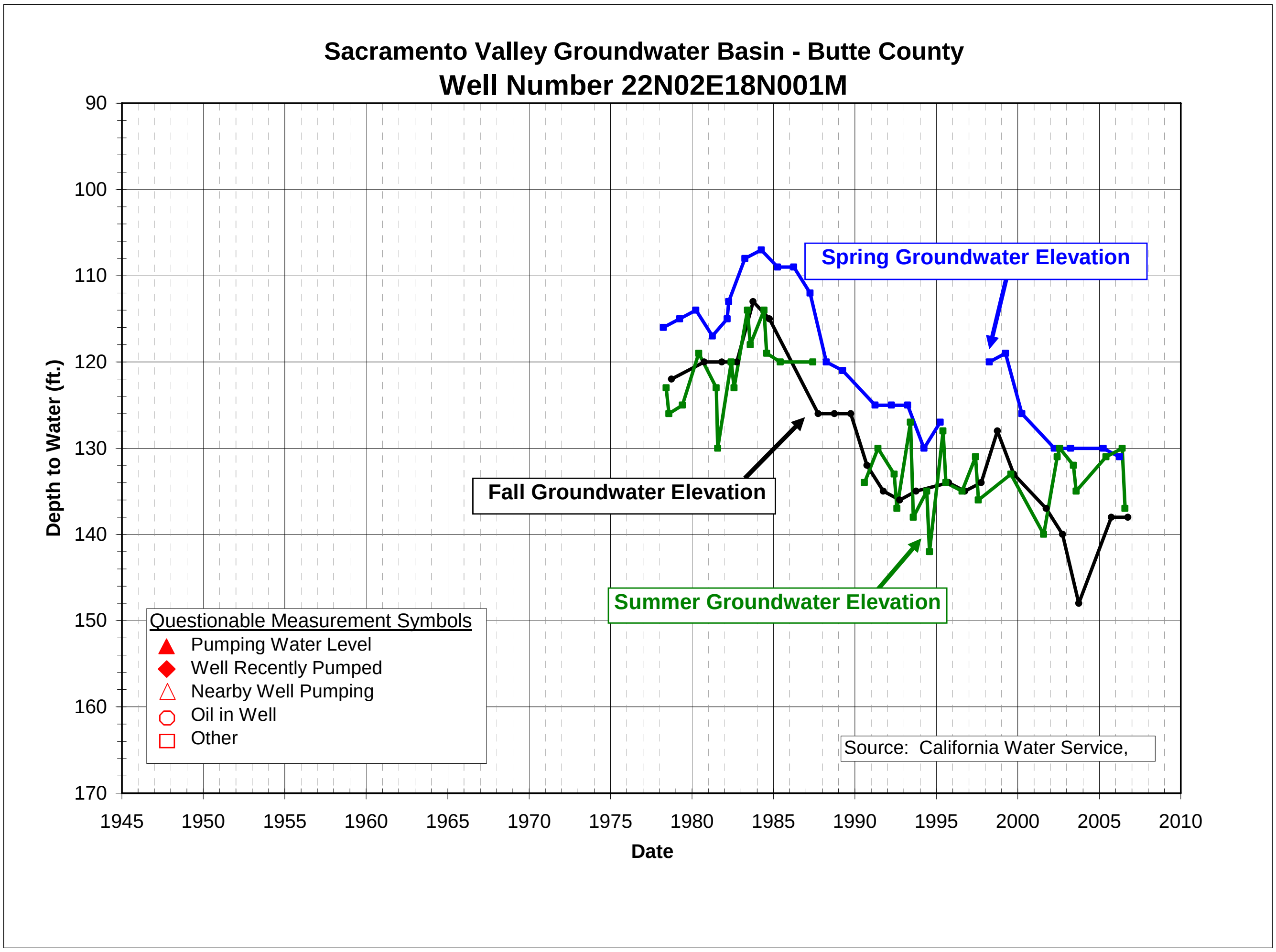
Overall analysis of the seasonal fluctuation of groundwater levels in all of the California Water Service wells with available data indicates a rather consistent seasonal fluctuation (spring to fall) of 8 to 20 feet during normal years. Analysis of seasonal groundwater levels during drought years shows a wide range of fluctuation depending upon the individual well. Many wells show little or no seasonal change between wet, normal and dry years, while other wells show large differences. The wide range of response to seasonal change in normal versus drought years is likely due to the wide range of operational scenarios that can be imposed upon these municipal wells.

Overall analysis of these hydrographs indicate that groundwater levels in the California Water Sub-area have declined an average of 12 feet between 1978 and 2000, with most of the decline occurring during the 1987-1994 drought. Analysis of the hydrographs also indicates that groundwater levels in the California Water Service wells have generally stabilized since the drought in 1995.

The long-term trend of groundwater levels decline in the California Water Sub-area, tends to fluctuate based on the residential development and subsequent increase in demand. In municipal service areas it is typical for groundwater levels to experience an initial drop as the demand increases or drought conditions occur. After the initial decline, if demand remains consistent, groundwater levels will commonly reach a new equilibrium, thereby limiting further declines in groundwater levels.

The hydrograph for well 22N02E18N001M demonstrates this relationship between demand and precipitation. It shows an increase in groundwater levels during the 1995-2000 period. This period was characterized by higher than normal precipitation and moderate increases in residential development. Normal precipitation and rapidly increasing development during the 2000-2006 period appears to contribute to declining water levels measured during this period of time.

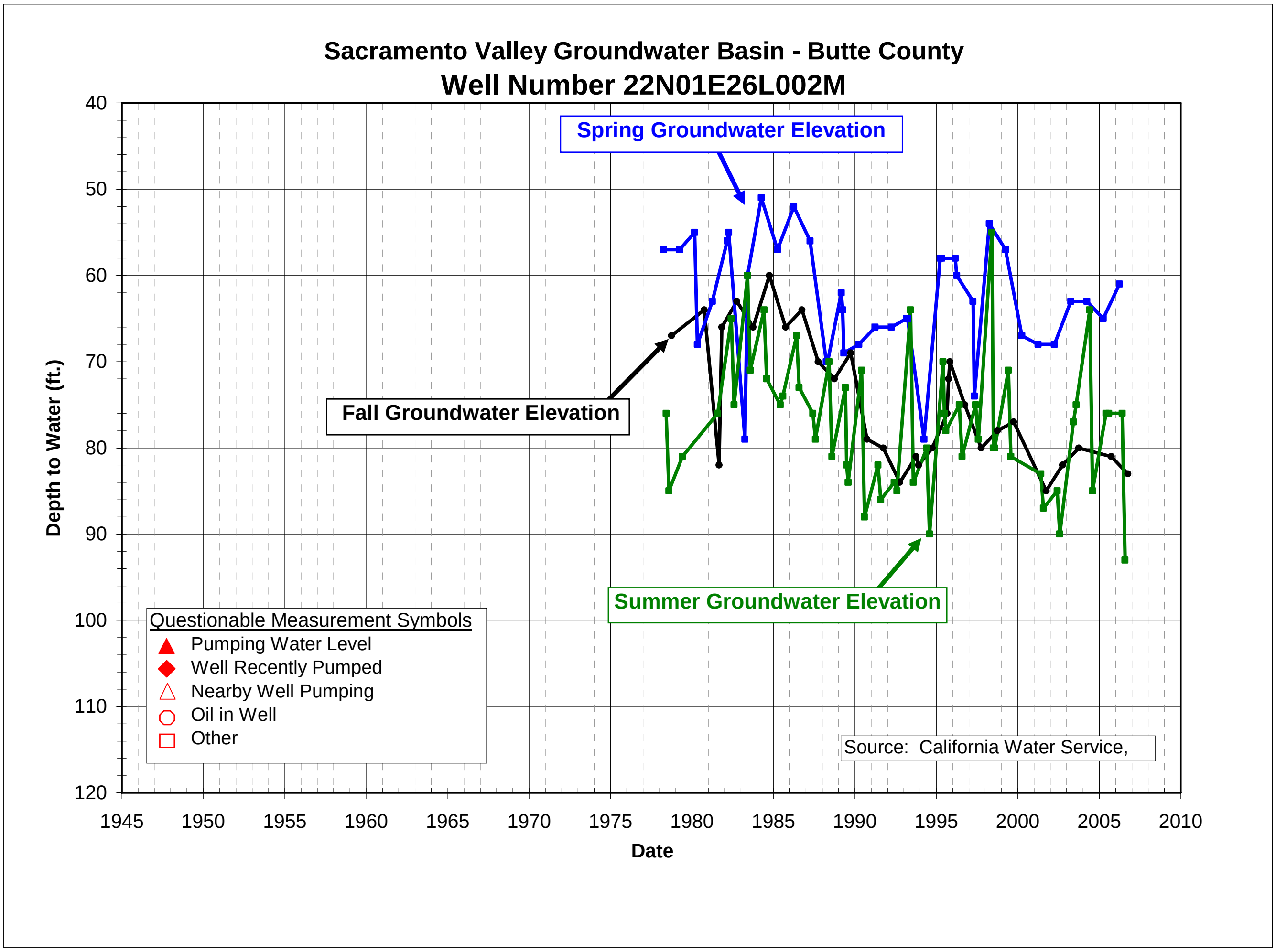
The above analysis was completed in 2000 (except where more recent dates are noted) as part of the Butte County Groundwater Inventory Analysis report. Hydrographs from numerous California Water Service wells were evaluated using all of the available data at that time. The two hydrographs presented below include all data available at the time this report was prepared. They are included to demonstrate the general findings presented previously and to continue the evaluation of groundwater level trends in the Chico urban area. Well 22N02E18N001M is located in the northeastern portion of the California Water Service area and well 22N01E26L002M is located just southwest of the center of the California Water Service area.




**Hydrograph for California Water Service Well 22N/02E-18N001M**

2006 Update

The spring 2006 water level was 1 foot lower than the previous spring measurement, making it the lowest spring measurement for the period of record in this well. Although the downward trend has leveled off over the previous 5 years, water levels are at or below previous historical low levels. This represents a decline of approximately 25 feet from historical high water levels recorded in the mid-1990s.

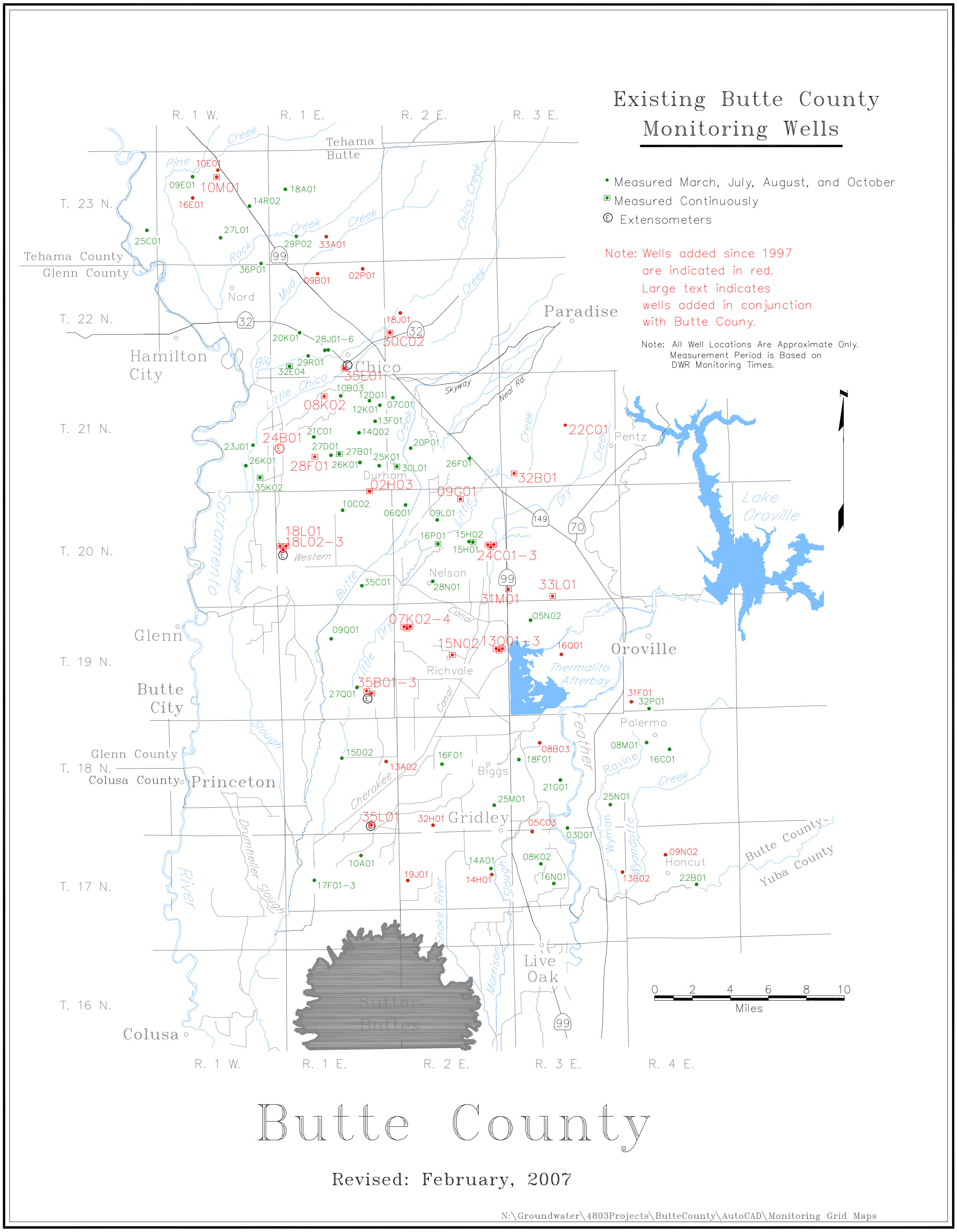



**Hydrograph for California Water Service Well 22N/01E-26L002M**

2006 Update

The spring 2006 water level was 3 feet higher than the previous spring measurement making the spring 2006 groundwater level about average among historical measurements. Recent data indicate a decline from 2000-02, but data from 2003-06 indicate continued, modest recovery. In contrast, fall water level measurements have continued to decline since about 1985. Currently that decline is approximately 22 feet from the historical high level in 1984.

# Butte County Monitoring Grid
# Appendix A


Existing Butte County Monitoring Wells
Measured March, July, August, and October
Measured Continuously
Extensometers
Note: Wells added since 1997 are indicated in red. Large text indicates wells added in conjunction with Butte Couny.
Note: All Well Locations Are Approximate Only. Measurement Period is Based on DWR Monitoring Times.
R. 1 W.
R. 1 E.
R. 2 E.
R. 3 E.
R. 4 E.
T. 23 N.
T. 22 N.
T. 21 N.
T. 20 N.
T. 19 N.
T. 18 N.
T. 17 N.
T. 16 N.
Tehama County
Glenn County
Tehama
Butte
Colusa County
Butte County
Yuba County
Hamilton City
Chico
Paradise
Nord
Durham
Nelson
Richvale
Oroville
Pentz
Palermo
Biggs
Gridley
Honcut
Live Oak
Glenn
Butte City
Princeton
Colusa
Sutter Buttes
Lake Oroville
Thermalito Afterbay
Sacramento River
Feather
Skyway
Neal Rd.
10E01
09E01
10M01
16E01
18A01
14R02
25C01
27L01
29P02
33A01
36P01
09B01
02P01
18J01
30C02
20K01
28J01-6
29R01
32E04
35E01
10B03
12D01
07C01
08K02
12K01
13F01
21C01
14Q02
22C01
23J01
24B01
27D01
27B01
25K01
20P01
26F01
26K01
28F01
30L01
32B01
35K02
02H03
09G01
10C02
06Q01
09L01
18L01
8L02-3
16P01
15H02
15H01
24C01-3
35C01
28N01
33L01
31M01
05N02
07K02-4
09Q01
15N02
13Q01-3
16Q01
35B01-3
27Q01
31F01
32P01
08M01
16C01
15D02
08B03
18F01
16F01
13A02
21G01
25M01
25N01
35L01
32H01
05C03
03D01
10A01
14A01
08K02
09N02
19J01
14H01
16N01
13B02
22B01
17F01-3
0 2 4 6 8 10
Miles
Butte County
Revised: February, 2007
N:\Groundwater\4803Projects\ButteCounty\AutoCAD\Monitoring Grid Maps