

**Basin Management Objective
Butte County
Sub-Inventory Unit – CHEROKEE**

Butte County Water Advisory Committee Member – Gary Cole

Contact Information

Phone Number: 530-343-0916

Email Address: colewaterinfo@yahoo.com

Description of the Cherokee Sub-Inventory Unit: Cherokee Sub-Inventory Unit covers and area of approximately 14, 700 acres.

Cherokee Sub-Inventory Unit (SIU) is bordered on the north and east by the foothill area. To the northwest are the Pentz and Esquon Sub-Inventory Units (SIU), to the southwest lies the Western Canal SIU, and due south is the Thermalito SIU.

Larger capacity agriculture and business production wells tap into the Lower Tuscan Aquifer (Formation Unit B). The Lower Tuscan Unit B (Lower Tuscan) varies from approximately 700 feet deep from surface level in the western portion of the Cherokee SIU and slopes upward to zero feet thick in some portions on the eastern edge of the Cherokee SIU. The bottom of the Lower Tuscan slopes upward to the surface in some areas of the eastern part of the Cherokee SIU. Underlying the Lower Tuscan are ancient marine layers, and salty waters exist.

Some domestic wells of approximately 50-75 feet in depth in the western part of the Cherokee SIU extract water from deposits overlying the Lower Tuscan aquifer. The majority of domestic wells in the SIU are pumping from the Lower Tuscan.

In the easterly areas (Butte Valley), the potable water aquifer varies from zero feet to a few hundred feet as one travels westward. Drilling too deeply, through the Lower Tuscan, produces non-drinkable water from marine layers beneath the Lower Tuscan.

Additionally, upper and lower boundary elevations of the Lower Tuscan slope upward to the east. The top of the Lower Tuscan goes from elevations of approximately 120 feet above sea level to the west and south to approximately 400 feet above sea level in the east and comes to the ground surface in some areas. The bottom of the Tuscan B aquifer slopes from approximately 500 feet below sea level in the west to 400 feet above sea level in the east and comes to the ground surface in some areas.

The majority of water volume pumped from groundwater in the Cherokee SIU is for farmland irrigation. Domestic water supply usage from the aquifer is of smaller volume but equally critical. There are presently few other sources of water for domestic use in the Cherokee SIU. All residents are totally dependent on water from the aquifer system except for few who use water from natural springs near the eastern perimeter of the

Cherokee SIU. Rural housing is quickly developing and increasing in numbers in Butte Valley and will increase demands for groundwater in the Cherokee SIU.

According to the Department of Water Resources (DWR), there are 183 wells total in the Cherokee SIU. There are 104 domestic wells (depth from surface: shallow to 260 feet). There are 62 irrigation wells (depth from surface: approximately 300-600 feet). There are three wells for monitoring purposes only, and 15 additional wells classified as other, which could mean a number of things from stock animals supply to some other monitoring purpose. According to 1997 estimates, approximately 24, 000 acre feet of water was being pumped from groundwater and used in the Cherokee SIU.

Philosophy of the Cherokee Sub-Inventory Unit Stakeholders –

Cherokee SIU stakeholders want to participate in the Butte County BMO process, and we want to have direct influence on the management of our underlying groundwater and aquifer systems.

Because of the vital importance of the Lower Tuscan Aquifer underlying the Cherokee SIU for the existing environments and habitats, businesses, agriculture, domestic needs, recharge, plant and animal needs, economic value of our properties, and future residential growth and needs, we want to be proactive in its management. Our goals center around maintaining water levels and volume in the Lower Tuscan aquifer at economical levels to sustain and improve its functions for all overlying users.

In the long chain of water users in California, we believe lands overlying aquifers have first rights for use of that groundwater for their needs. Stakeholders have responsibilities to protect all aspects of the aquifers, overlying lands relating to the aquifers, and not pump more than is needed for those overlying lands.

Groundwater is not a commodity to be sold if it causes harm to other stakeholders. It is a resource to be used wisely without harming other overlying stakeholders and environments.

Management Objectives –

1. To maintain upper groundwater elevations in the Lower Tuscan at affordable extraction elevations now and into the future.
 - a. To maintain adequate water elevations in our underlying aquifer, the Lower Tuscan, throughout the year at affordable and dependable elevations from the surface for farming and other larger volume users.
 - b. To maintain adequate water elevations in the Lower Tuscan aquifer throughout the year for affordable and dependable domestic needs.

2. To maintain dependable and adequate supply (volume) throughout the year at affordable extraction elevations now and into the future.
 - a. To maintain a volume of groundwater in the Lower Tuscan aquifer system that will insure adequate amounts at affordable extraction elevations for farming and other larger volume users throughout the year.

- b. To maintain a volume of groundwater in the Lower Tuscan at affordable extraction elevations for domestic needs throughout the year.
 - c. To maintain sufficient volume and elevation of groundwater in the Lower Tuscan to prevent up-welling and excessive mixing of salt water from underlying marine layers.
3. Monitor for changes in water quality. Changes in groundwater parameters of temperature, pH and EC (electrical conductivity) can indicate impacts to the groundwater system. These parameters will be evaluated annually according to Chapter 33A of the Butte County Code.
4. Monitor for permanent land subsidence. If it is detected anywhere in Butte County where similar geological/aquifer structure and groundwater extraction conditions exist, the we will immediately review the Cherokee SIU conditions and take appropriate actions. Since permanent subsidence by definition has already permanently caused damage, our main goal will be to prevent additional subsidence/damage over a larger area or to a greater extent.
5. Monitor to avoid threats of environmental degradation. Degradation could cause additional management expenses from accessing water for overlying uses.
6. Monitor to avoid water levels dropping below historical operating ranges to insure pumps function adequately at designed pressures for irrigation systems in orchards, and to deliver designed pressure, volume, and coverage for maximum production of crops and prevent crop damage from less than adequate watering.
7. Sufficiently investigate practices within and around the Cherokee SIU when Alert Stages are reached in order to determine if they have been created by or accentuated by actions or forces from outside Cherokee SIU.

Geologic Formations Identified In Sub-Inventory Unit:

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

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

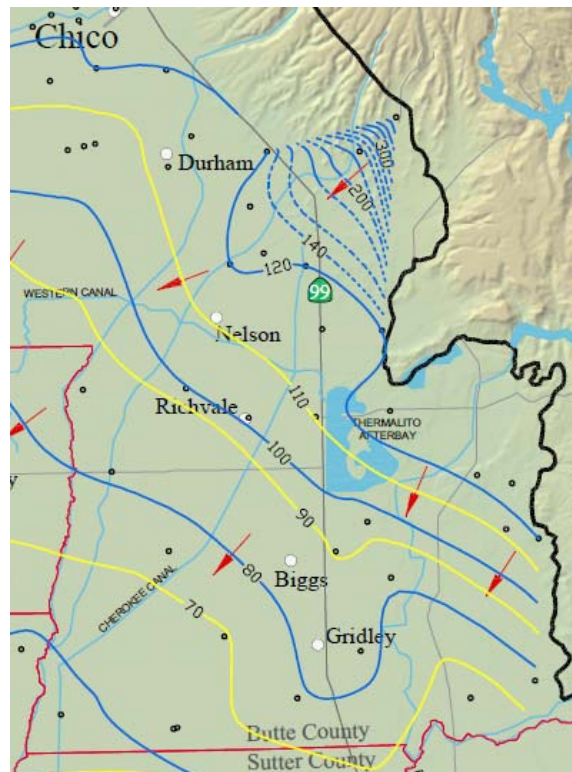
Fresh Water-bearing Units. In the Sacramento Valley Region of Butte County, fresh groundwater-bearing units include, from youngest (shallowest) to oldest (deepest), the Modesto, Riverbank, Laguna, Tehama and Tuscan Formations. Those included in the Cherokee SIU are:

- Modesto Formation

Tuscan Unit C (Upper Tuscan)
Tuscan Unit B (Lower Tuscan)

Groundwater Flow in the Cherokee Sub-Inventory Unit –

The below figure is a cropped segment of a map prepared by DWR Northern District. It shows the groundwater elevation contours in your sub-inventory unit with arrows indicating the direction of groundwater movement. This graphic indicates that the regional pattern of spring groundwater movement in the Cherokee SIU is in a southwesterly direction, at a gradient of about 8 feet per mile, adjacent to Butte Creek and Dry Creek.



Arrows show the direction of groundwater movement.

2009 Groundwater contours were constructed using groundwater level measurements taken by the Department of Water Resources and Local Cooperators between March 1st and March 20th, 2009. Groundwater contours are based on groundwater level measurements taken from wells constructed within the middle portion of the aquifer system (100 to 400 feet deep). This portion of the aquifer supplies approximately 70% of all domestic, agricultural and municipal wells. Blue contour lines represent 20 foot intervals and yellow contour lines represent 10 foot intervals. Full size contour maps are included in the annual Groundwater Status Report posted on the Department of Water and Resource Conservation website.

BMO Key Wells Selected for Groundwater Level Monitoring –

Groundwater Levels – Six monitoring wells have been selected for establishing BMO levels as per the ordinance requirements of groundwater level monitoring. Three of those wells are located in the most heavily farmed areas, with one major business water user. Two additional wells, two in central Butte Valley and one on the northeasterly edge of the Cherokee SIU, were selected as primary monitoring wells. Both of the last two wells are in close proximity to the most populated areas of the Cherokee SIU. The agricultural wells selected are critical to our evaluation times because they are continuously monitored. Note, the newest well added to the BMO monitoring does not have sufficient historical measurements to establish Alert Stages. They will be established when sufficient data has been recorded.

SPRING

Well ID	Aquifer System	Well Type	Stage 1 & 2 Alert Elev. (ft)	Stage 3 Alert Elev. (ft)
20N02E24C01M	Tuscan B	Monitoring	123.1	117.9
20N02E24C02M	Tuscan B	Monitoring	123.1	118.0
20N02E24C03M	Tuscan B	Monitoring	122.8	117.3
20N03E31M01M	Tuscan B	Monitoring	120.1	117.1
20N03E33L01M	Tuscan B	Irrigation	112.2	118.3
21N03E22C01M	Tuscan B	Domestic	369.7	358.5
21N03E32B01M	Tuscan B	Irrigation	223.4	222.1

Fall

Well ID	Aquifer System	Well Type	Stage 1 & 2 Alert Elev. (ft)	Stage 3 Alert Elev. (ft)
20N02E24C01M	Tuscan B	Monitoring	113.9	109.1
20N02E24C02M	Tuscan B	Monitoring	113.7	108.1
20N02E24C03M	Tuscan B	Monitoring	113.8	108.2
20N03E31M01M	Tuscan B	Monitoring	111.4	106.5
20N03E33L01M	Tuscan B	Irrigation	114.4	111.0
21N03E22C01M	Tuscan B	Domestic	355.5	345.5
21N03E32B01M	Tuscan B	Irrigation	216.2	212.9

An additional domestic well (SWN 21N03E29J03) was added to the DWR monitoring network in the Cherokee Sub-Inventory Unit in the Fall of 2007. Groundwater elevation data will be presented in this BMO once enough years of data have been collected for analyzation.

BMO Key Wells Selected for Groundwater Quality Monitoring–

Groundwater Quality- Currently, Butte County Department of Water and Resource Conservation is monitoring two wells annually in the Cherokee SIU for water quality. One well was sampled for the first time in 2007, the other has been monitored since 2002. The new well replaces a well previously monitored in the Butte Valley area that was discontinued from the monitoring grid because of new property owners that did not wish to participate in the program. The available results for the measured constituents of temperature, total dissolved solids, electrical conductivity and pH are included in this BMO packet.

Groundwater Temperature - 2002 through 2009

State Well Number	2002 Temp °C	2003 Temp °C	2004 Temp °C	2005 Temp °C	2006 Temp °C	2007 Temp °C	2008 Temp °C	2009 Temp °C
20N02E24QO1M	22.4	21.9	21.2	21.4	21.1	20.7	21.0	20.9
*21N03E29J003M						22.2	21.5	21.3
21N03E26EO1M	27.0	26.4	26.7	23.2				

The distance between the previously monitored Butte Valley well and the new one is approximately 2.4 miles.

Groundwater pH - 2002 through 2009

State Well Number	2002 pH	2003 pH	2004 pH	2005 pH	2006 pH	2007 pH	2008 pH	2009 pH
20N02E24QO1M	7.3	7.5	7.1	7.4	7.5	7.4	7.2	7.4
*21N03E29J003						7.6	7.4	7.5
21N03E26EO1M	7.1	6.9	7.3	6.2				

Groundwater EC - 2002 through 2009

State Well Number	2002 EC	2003 EC	2004 EC	2005 EC	2006 EC	2007 EC	2008 EC	2009 EC
20N02E24QO1M	222.0	232.0	215.0	266.0	242.0	267.0	268.0	243.0
*21N03E29J003						218.0	229.0	227.0
21N03E26EO1M	195.0	186.0	211.0	240.0				

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

Land Subsidence is continuously monitored by the Department of Water Resources and Butte County Department of Water and Resource Conservation in the closest Sub-Inventory Unit at State Well number 20N01E18L03M, located within the Western Canal Sub-Inventory Unit.

BMO Alert Stage Definitions and Compliance Methodologies–

The Cherokee Sub-Inventory Unit will use the following guidelines in the management of the groundwater resources. The groundwater level, groundwater quality, and land subsidence management objectives are intended to trigger predetermined voluntary Ground Water Management Actions, as defined in the staff report, to remedy declining ground water levels that are not recovering to compliance levels for each index well. They are also intended to trigger voluntary Groundwater Managements Actions to prevent land subsidence or degradation of groundwater quality.

Groundwater Level –

The Butte Basin Groundwater model uses the historical hydrology (e.g. precipitation pattern, stream inflows) from October 1970 through October 1999 in the base case simulation. Using historical hydrology allows for the assessment of water resources conditions based on a known range of hydrology, from wet to critical. Each hydrograph for the BMO process shows the static groundwater elevation measurements from the time period of 1970 to 2006, or as many recent

years of data available for each selected key wells. The measurements taken during this 36 year window reflect periods of drought and recovery, as well as wet years. These methodologies will apply for both Spring and Fall analysis.

- A. For wells that have a period of record dating back to at least 1970, the subcommittee suggests that the range of measurements from the first year through 2006 be used in calculating Alert Stages 1 and 2 and the Historic Low will be used as the Alert Stage 3. Once the range is defined for each well, 20% of that range will be calculated and added to the Historic Low to establish Alert Stages 1 and 2. The measurements plotted after 2006 are for reference purposes only, and are not included in the calculation of the range.
- B. In the instances where the period of record does not date back to 1970, the Historic Low before 2006 will be used for Alert Stages 1 and 2, and the Historical Low minus the range of measurements shall be used for Alert Stage 3. The measurements plotted after 2006 are for reference purposes only, and are not included in the calculation of the range.

Groundwater Quality –

Any change that exceeds a 20 percent change from Butte County's 2009 water quality assessment will be cause for review and investigation by the Technical Advisory Committee. Additionally, levels for temperature, pH and EC will be reviewed annually at the time of sampling to determine if they remain within the US EPA preferable ranges. Dept. of Health Services guidelines Secondary Water Quality Thresholds (Can be detected, but no health or crop risks).

Electrical Conductivity (EC uS) Goals

Drinking Water	less than 900
Agricultural Water	less than 700

Acid-Base (ph) for all Waters (USEPA) Preferable Range

Between 6.5 and 8.5

Land Subsidence –

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

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

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

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

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

Future Monitoring Recommendations –

Management Goals – for the immediate, on-going and long-term:

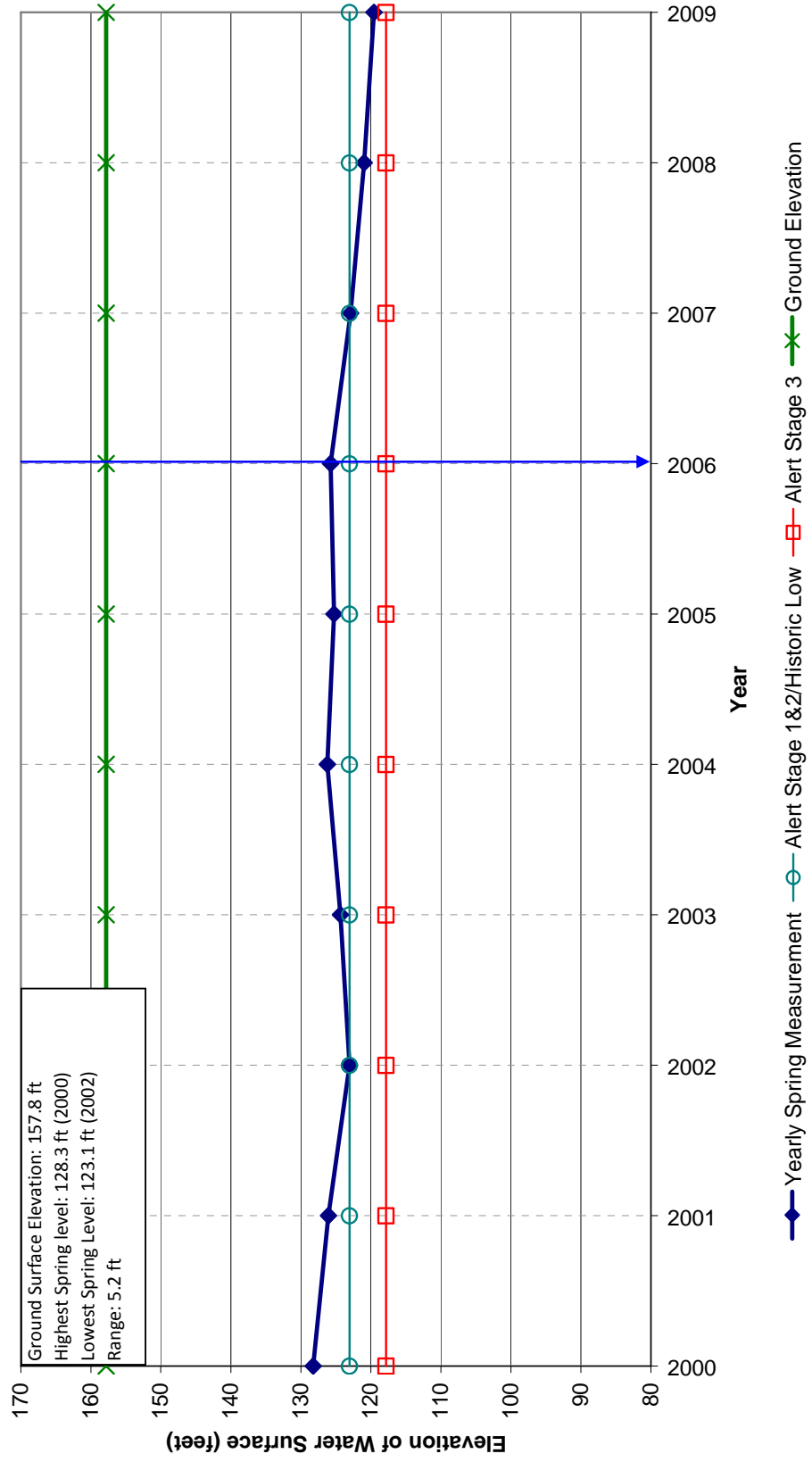
1. Expand domestic well monitoring on the east side of Clark Road in Butte Valley.
2. Add additional agricultural monitoring wells if stakeholders indicate presently selected wells do not accurately reflect the intent of the Cherokee SIU BMO.
3. Continue to receive and accumulate well data from the production well being monitored on Butte College Campus so trends and alert levels can be established for better management of the Cherokee SIU
4. Keep the Lower Tuscan Aquifer a healthy system now and into the future so all overlying land owners have “good water” at an affordable pumping cost and adequate amounts for their overlying needs. Have an aquifer system that may be used by its stakeholders without doing harm to others by increasing extraction costs or decreasing extraction amounts needed by surrounding stakeholders.
5. Work with Cherokee Watershed, Butte County, and other agencies to promote good management of the Cherokee watershed in groundwater related issues related to the Lower Tuscan Aquifer.
6. Participate in General Plan development to initiate protection of recharge areas for the Lower Tuscan aquifer.
7. Maintain adequate aquifer water levels and volume during fall and winter seasons for the tree farmers, business users, and domestic needs that exist year round.

Supporting Data –

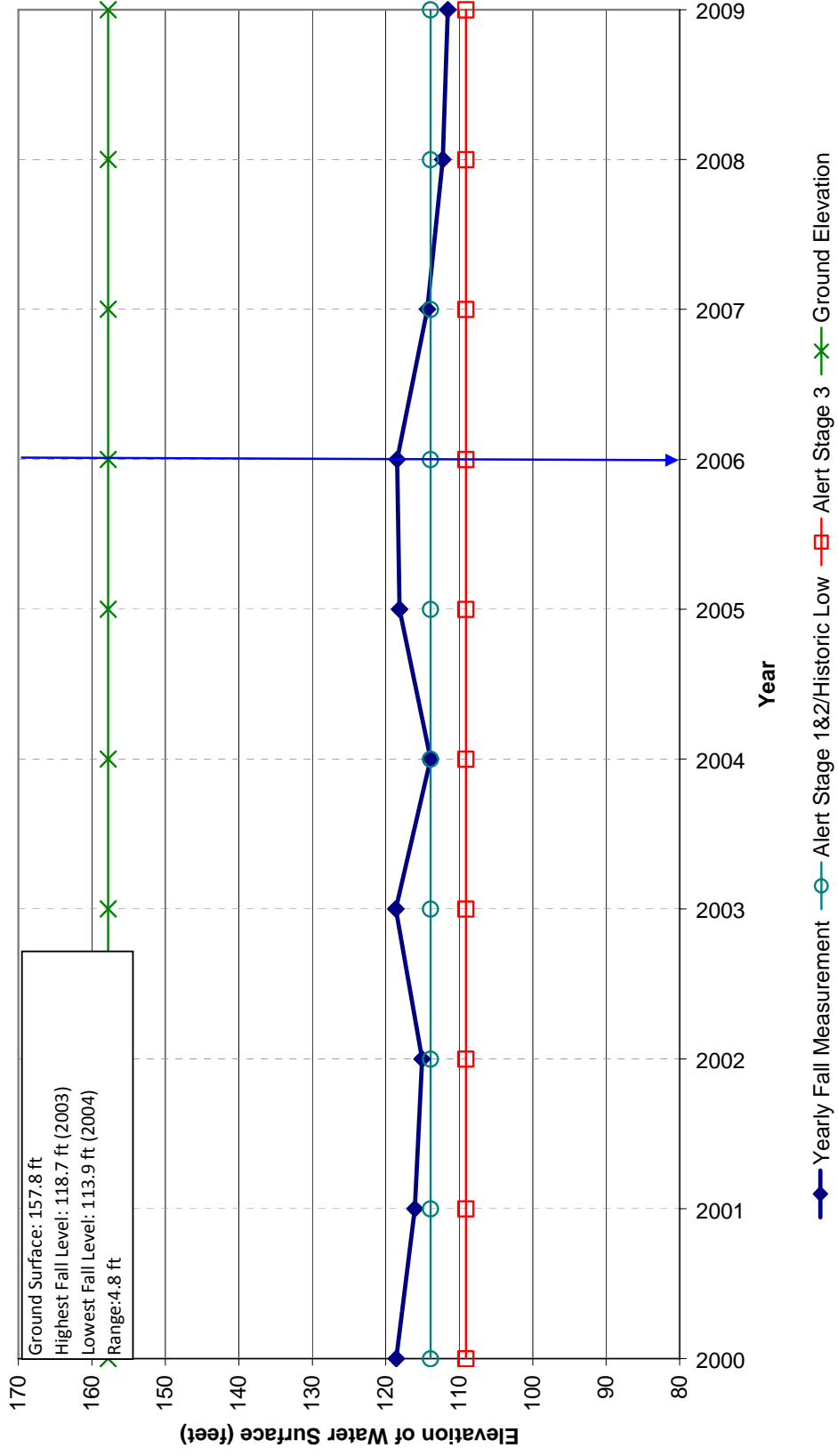
Hydrographs depicting yearly spring level measurements, including 2009 data, with established alert levels for calendar year 2010.

Summary charts of water quality monitoring.

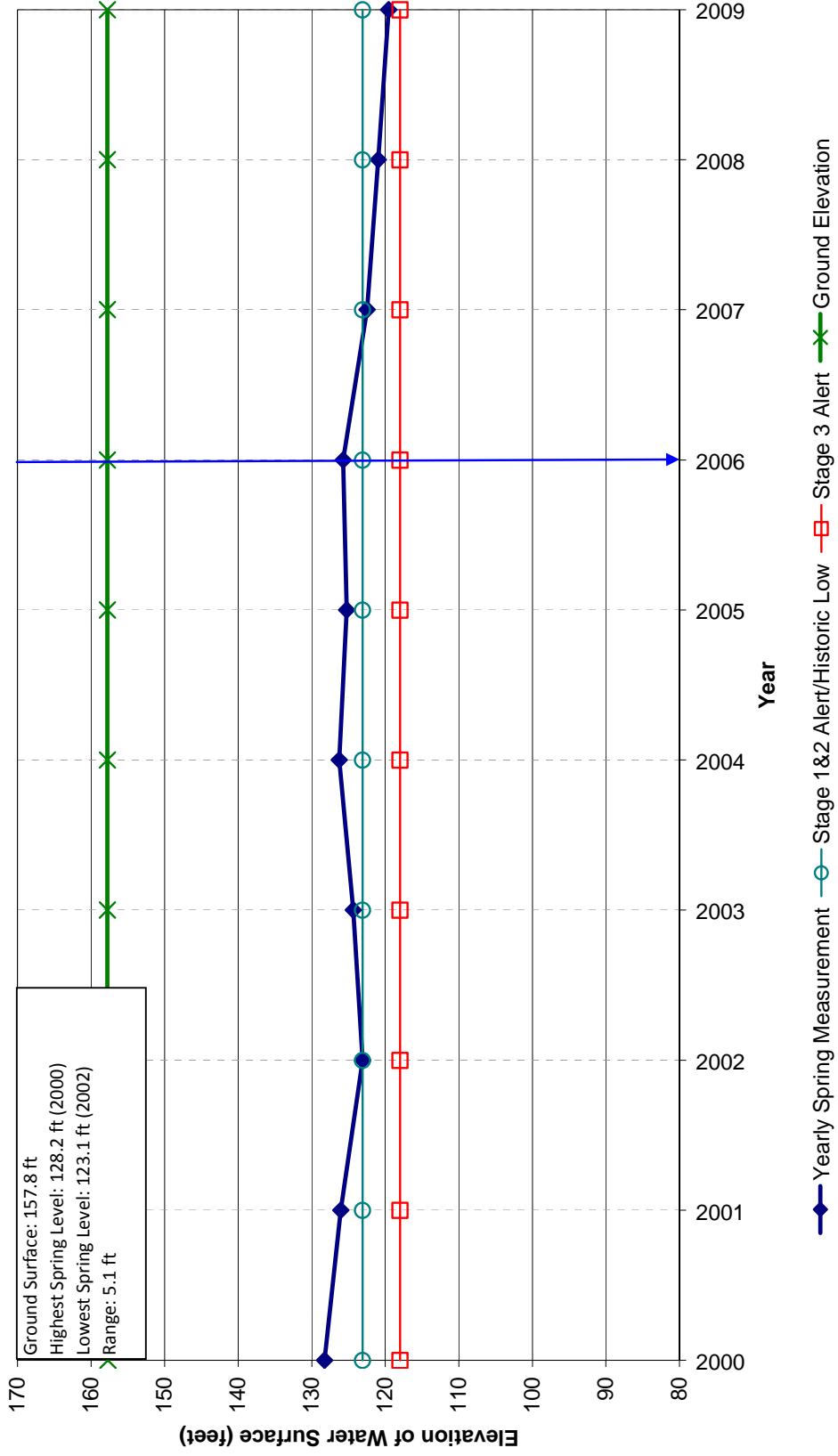
**Spring Groundwater Levels
Cherokee - 20N02E24C01
Range of Measurements 2000-2006**



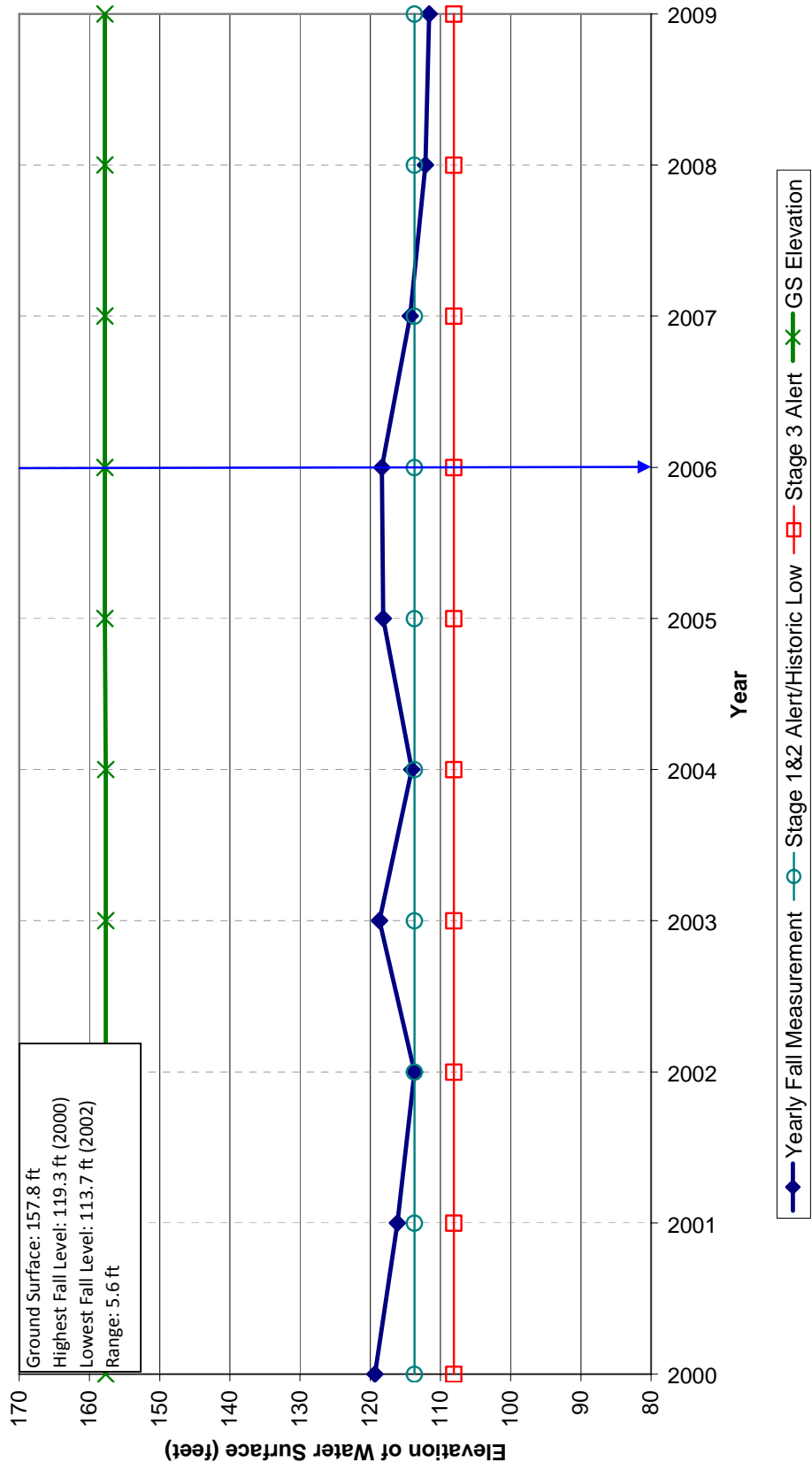
**Fall Groundwater Levels
Cherokee - 20N02E24C01
Range of Measurements 2000-2006**



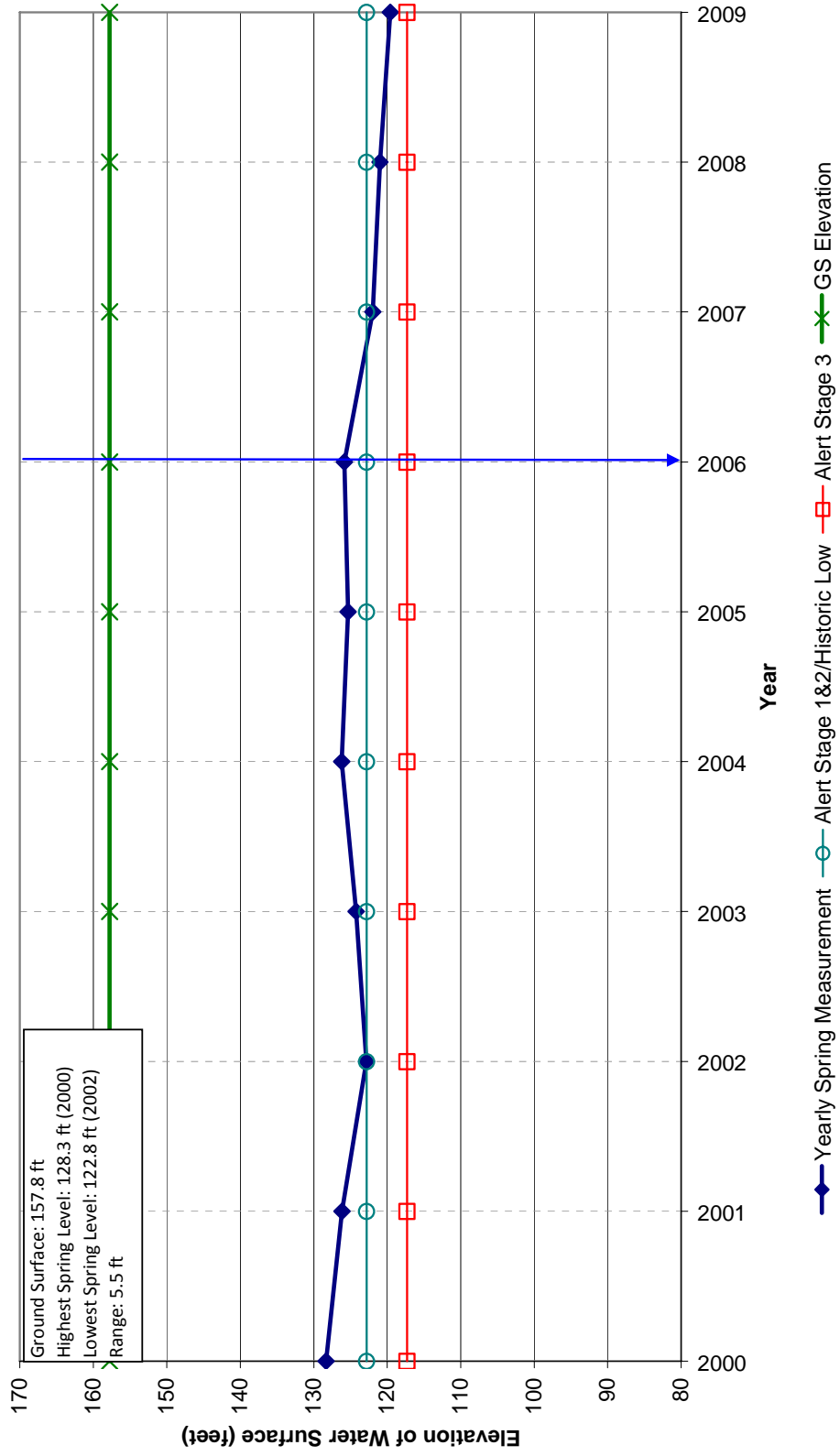
Spring Groundwater Levels
Cherokee - 20N02E24C02
Range of Measurements 2000-2006



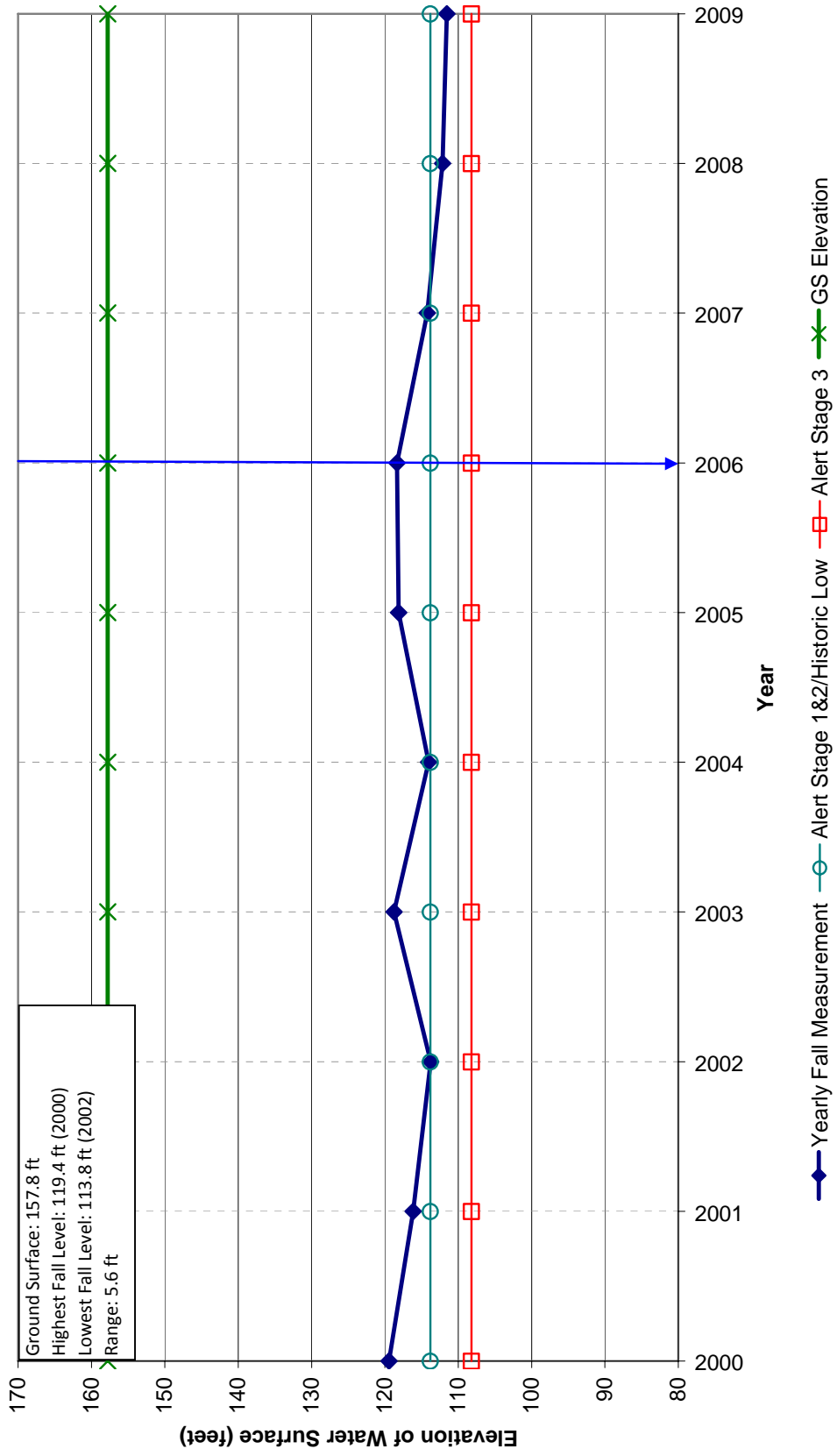
Fall Groundwater Levels
Cherokee - 20N02E24C02
Range of Measurements 2000-2006



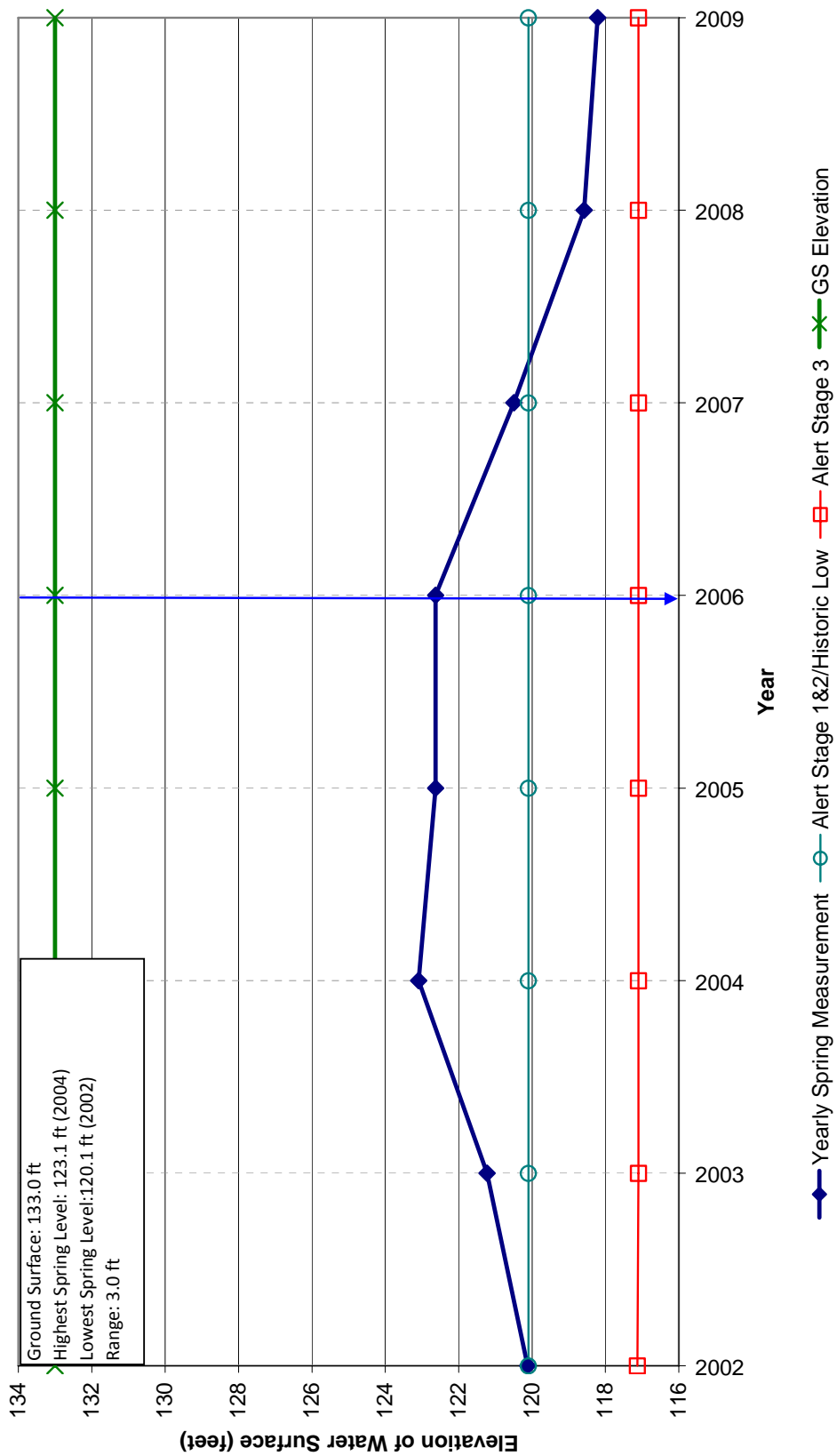
**Spring Groundwater Levels
Cherokee - 20N02E24C03
Range of Measurements 2000-2006**



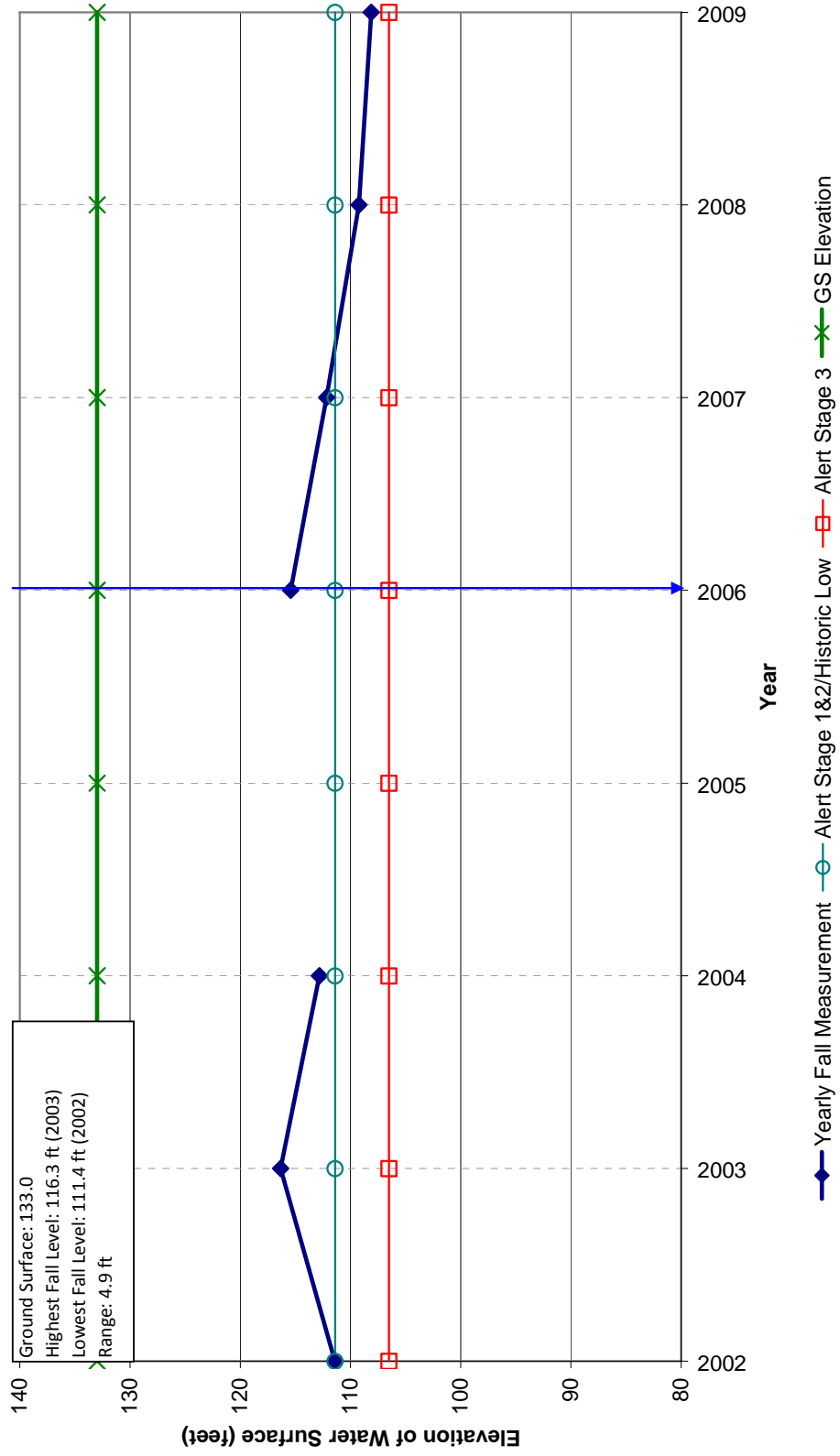
**Fall Groundwater Levels
Cherokee - 20N02E24C03
Range of Measurements 2000-2006**



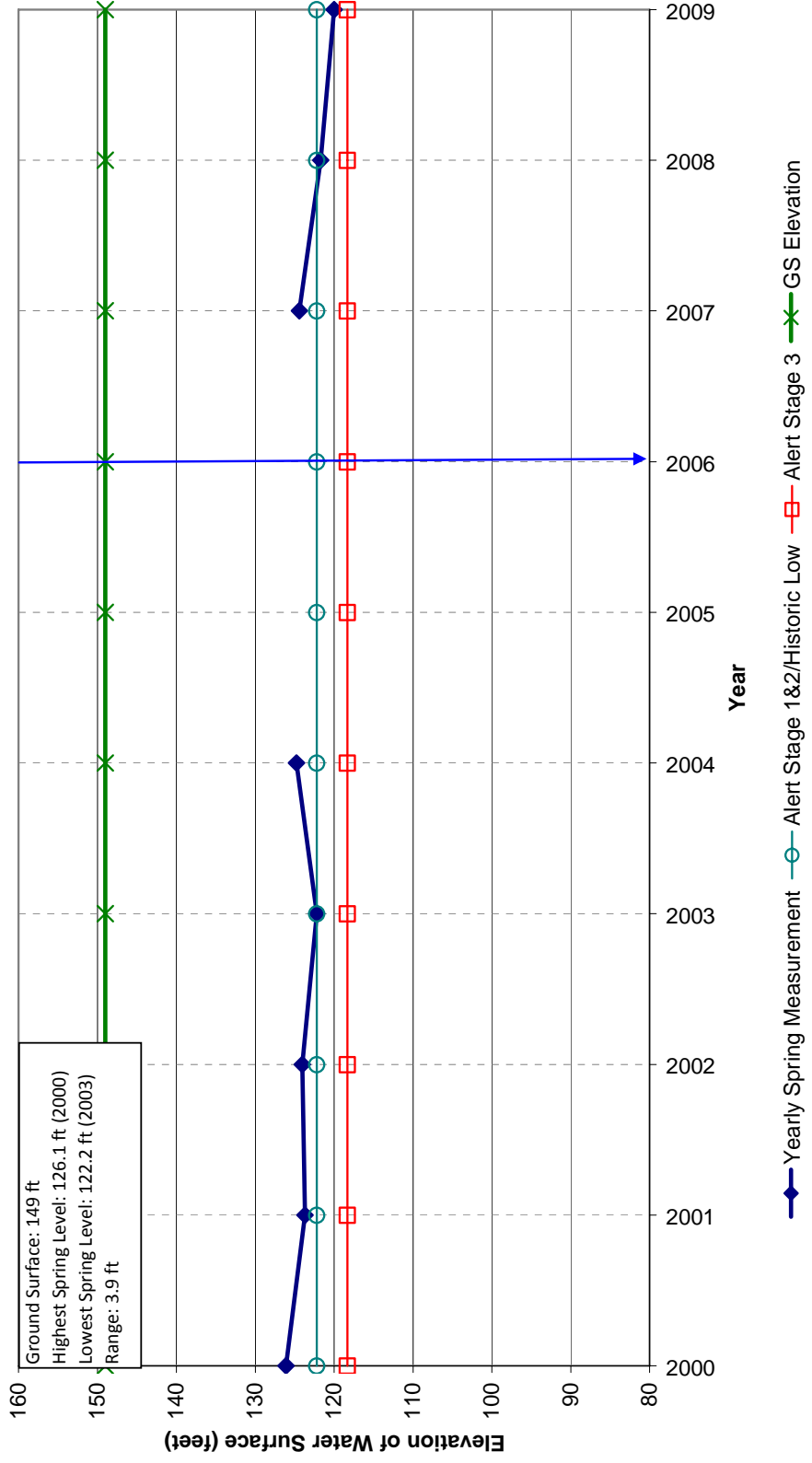
Spring Groundwater Levels Cherokee - 20N03E31M01 Range of Measurements 2002-2006



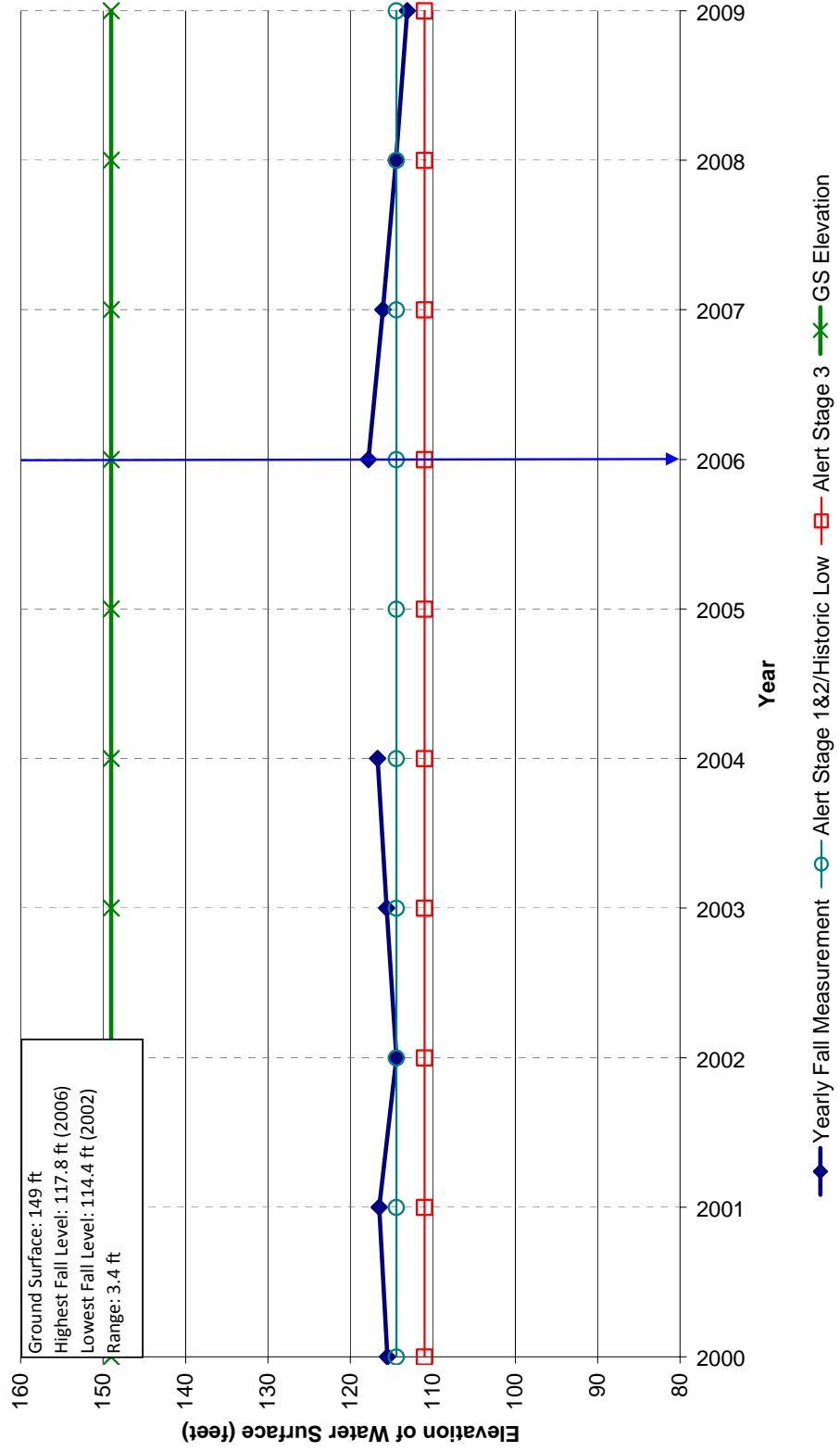
**Fall Groundwater Levels
Cherokee - 20N03E31M01
Range of Measurements 2002-2006**



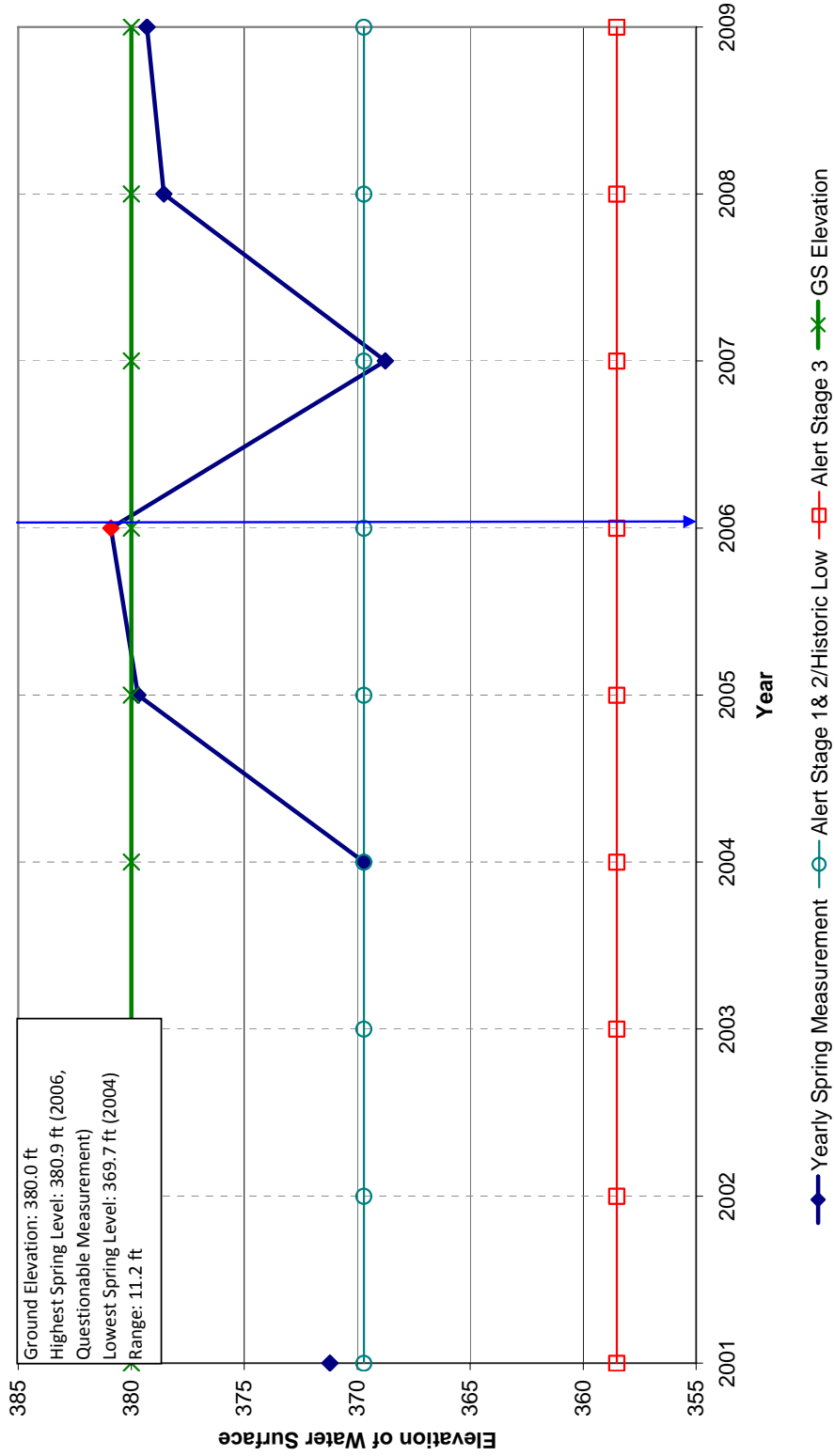
**Spring Groundwater Levels
Cherokee - 20N03E33L01
Range of Measurements 2000-2006**



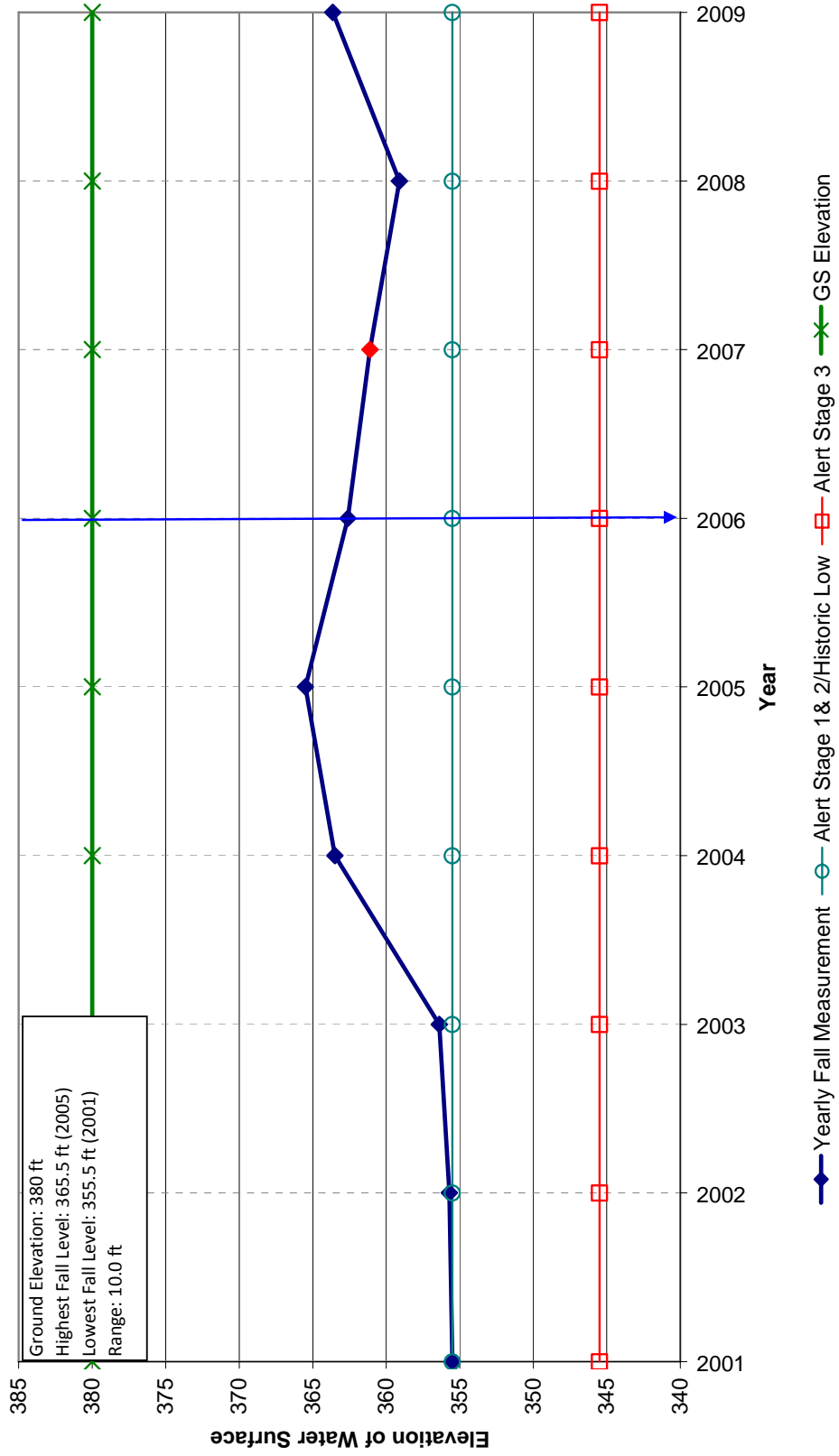
**Fall Groundwater Levels
Cherokee - 20N03E33L01
Range of Measurements 2000-2006**



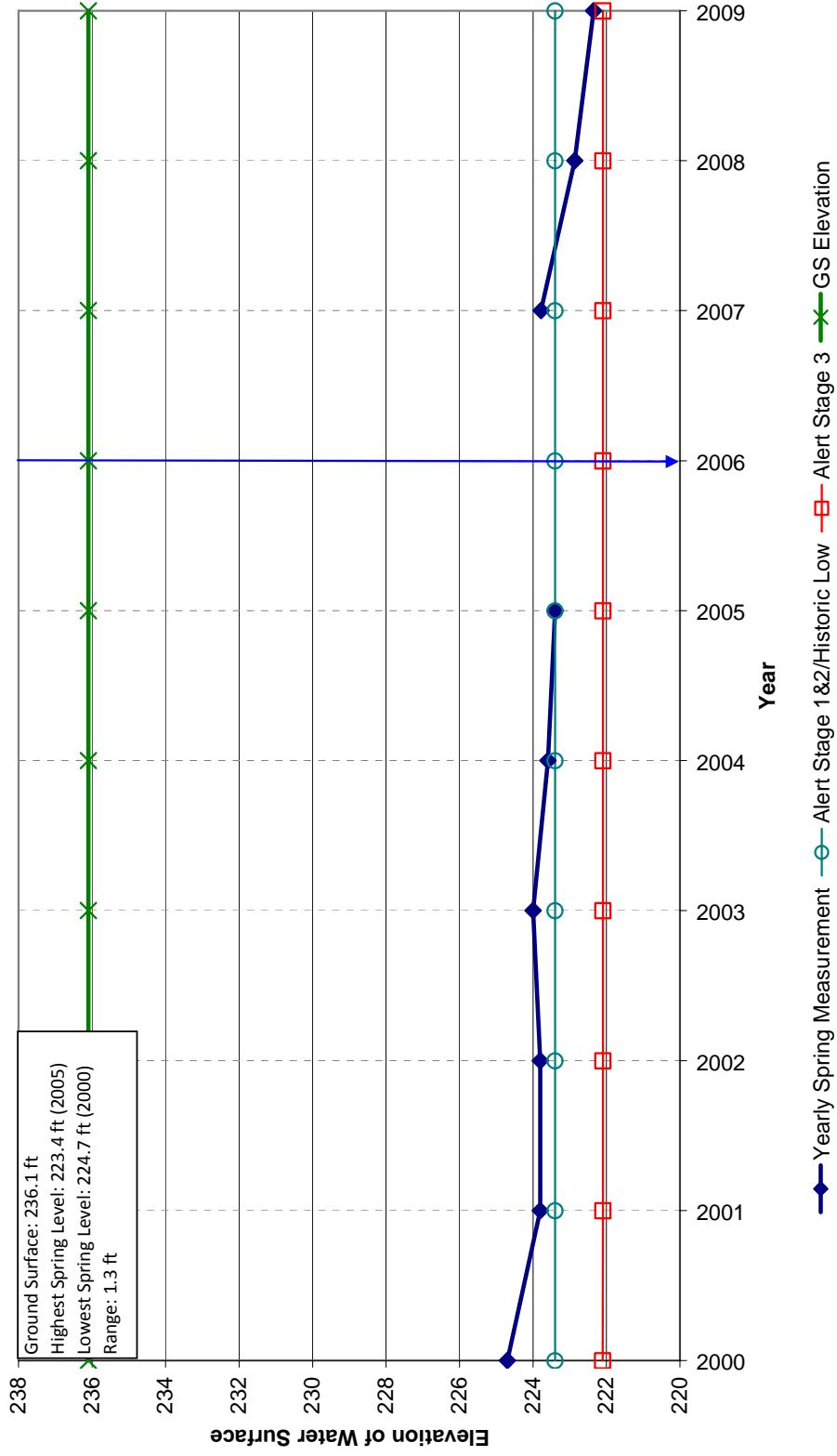
Spring Groundwater Levels Cherokee - 21N03E22C01 Range of Measurements 2001-2006



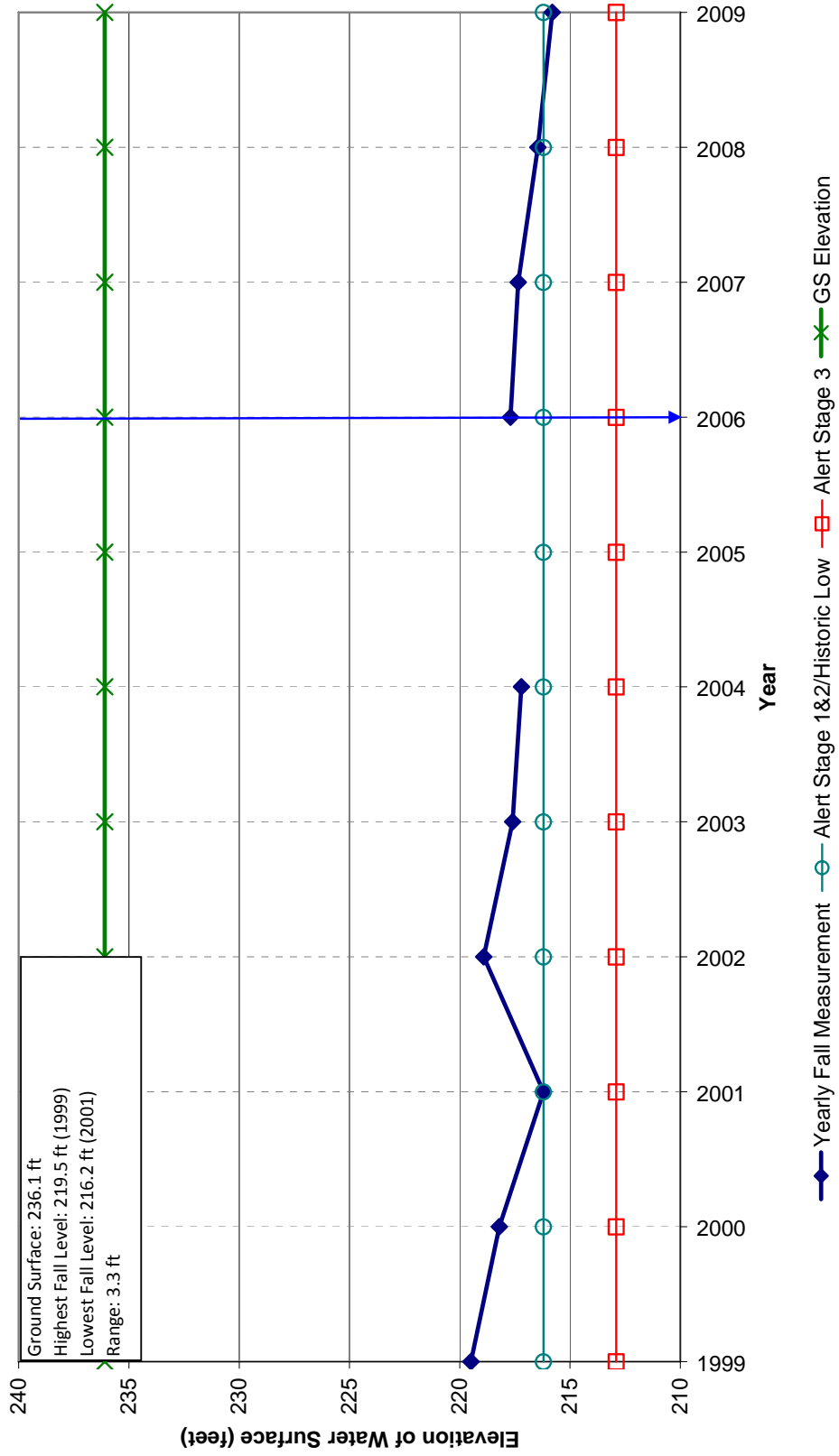
**Fall Groundwater Levels
Cherokee - 21N03E22C01
Range of Measurements 2001 -2006**



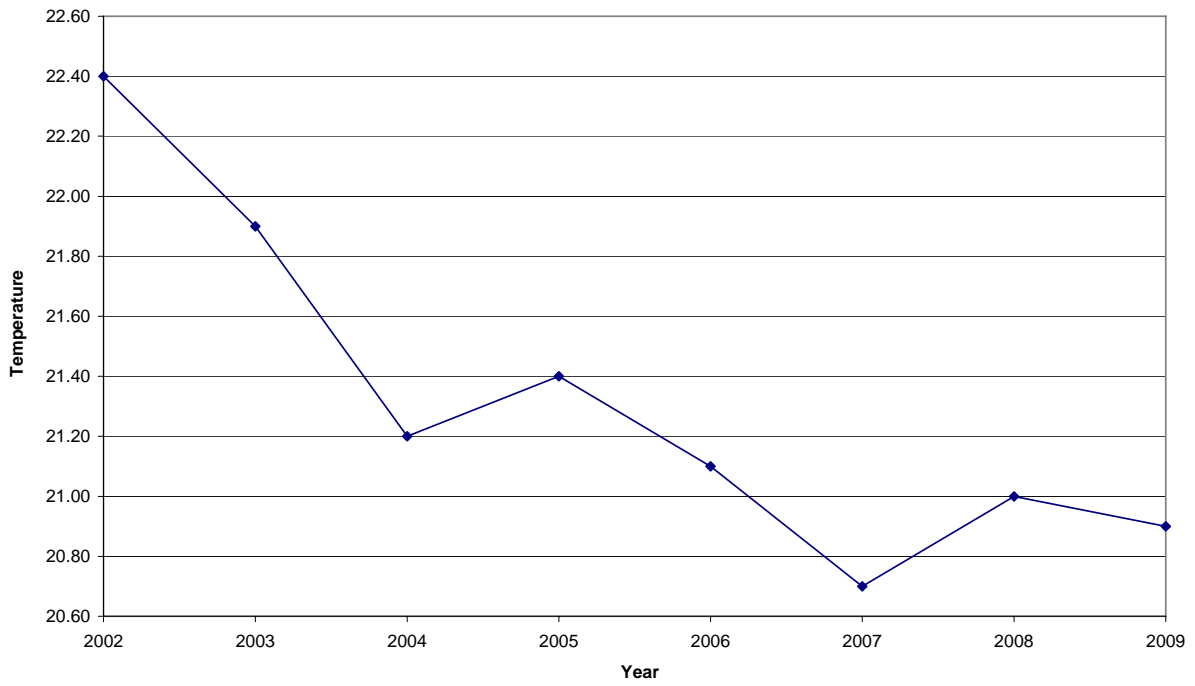
**Spring Groundwater Levels
Cherokee - 21N03E32B01
Range of Measurements 2000-2006**



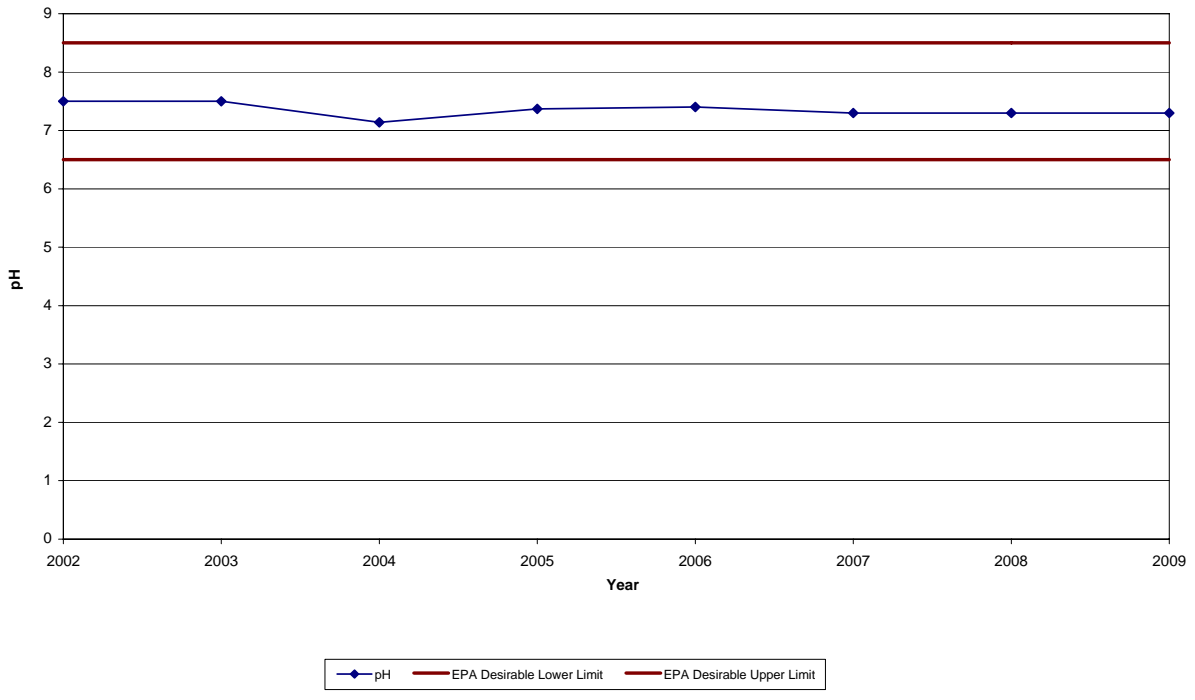
**Fall Groundwater Levels
Cherokee - 21N03E32B01
Range of Measurements 1999-2006**



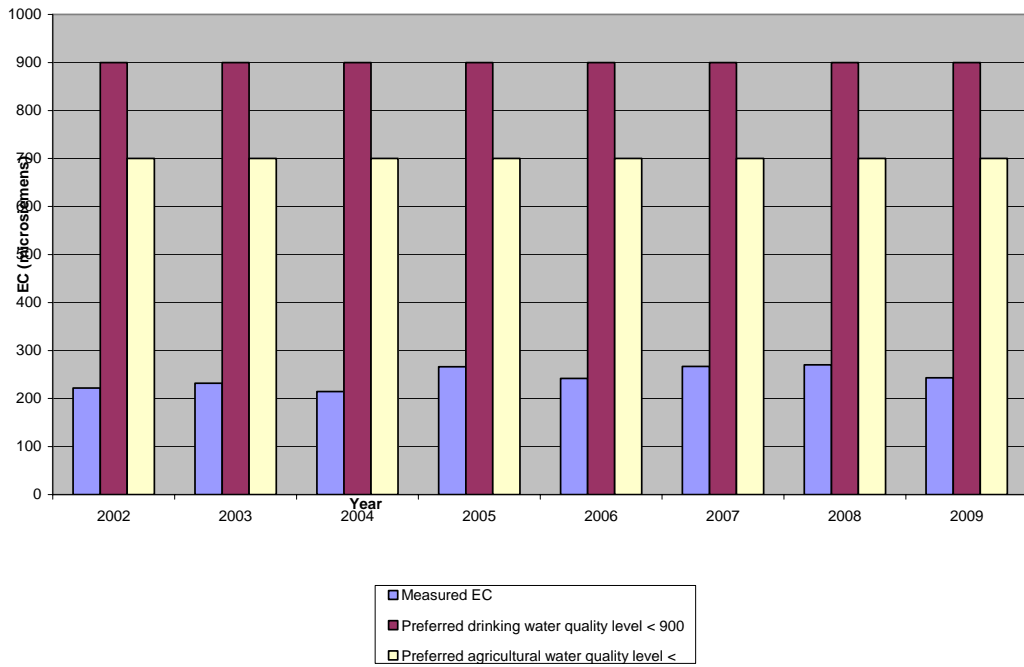
Temperature in oC
SWN - 20N02E24Q01



pH
SWN 20N02E24Q01M



Electrical Conductivity
SWN 20N02E24Q01M



Temperature in oCelsius
SWN 21N03E26E01M &
21N03E29J003M

