Appendix 6A

Analysis Steps to Develop Preliminary Thresholds and Measurable Objectives

APPENDIX 6A. ANALYSIS STEPS TO DEVELOP PRELIMINARY MINIMUM THRESHOLDS AND MEASURABLE OBJECTIVES

This appendix details the methodology used to establish preliminary groundwater elevation minimum thresholds and measurable objectives. These minimum thresholds and measurable objectives were set to address the beneficial uses and users in the subbasin and provide reasonable initial goals. The preliminary results were modified based on public input and CSAB reviews (Section 6.6).

Establish a List of Key Wells for Testing the SMC Methodology

The SMC general methodology largely follows a previous analysis conducted in Glenn and Tehama Counties during development of BMOs and potential triggers for groundwater management.

Fifteen wells were selected to test the methodology: 10 wells in Tehama County and 5 wells in Glenn County (Figure 6A-1).

- Ten wells were selected as a single observation well from a multi-well cluster (orange symbols). In general, this was the shallowest well in the cluster that was at least 100 feet deep.
- Five wells were domestic or irrigation wells from the Tehama County Groundwater Management Plan (TCFCWCD, 2012) (purple symbols).

Glenn County BMO wells were not used as key wells because most are in close proximity to more recently installed monitoring well clusters.

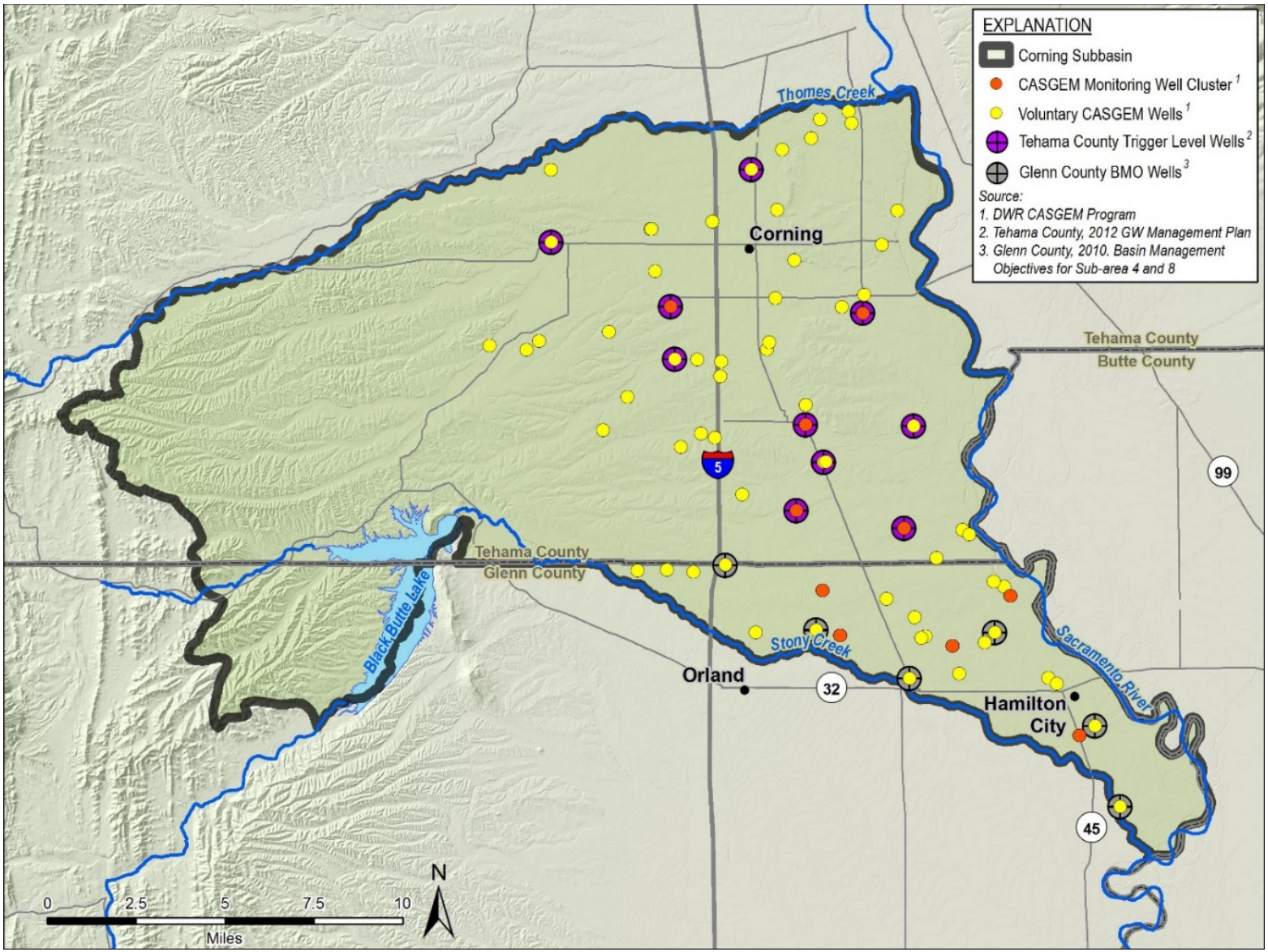


Figure 6A-1. Selection of Key Wells for Water Level Minimum Threshold Analysis

Verify Groundwater Elevations in Domestic Wells Near Key Wells

Domestic wells within a 2-mile radius of each key well were identified and are shown on Figure 6A-2. The casing depth for each domestic well was available for all wells, whereas other information such as well screen intervals was only available for some wells. Therefore, casing depth was used as a proxy for establishing whether low groundwater levels would impact the domestic well.

- Glenn County domestic well data were derived from the county DMS.
- Tehama County domestic well data were derived from the DWR well completion report database.
- Wells more than 30 years old were excluded because this is the anticipated lifespan of low carbon steel wells, which is the most common casing type used for domestic wells in this area.
- The depths of the shallowest 10% and 20% of domestic wells within 2 miles of each key well were deemed to be protective of relatively shallow domestic wells.
- A safety factor of 25 feet was subtracted from the shallow domestic well depths to maintain sufficient water in domestic wells to operate pumps.

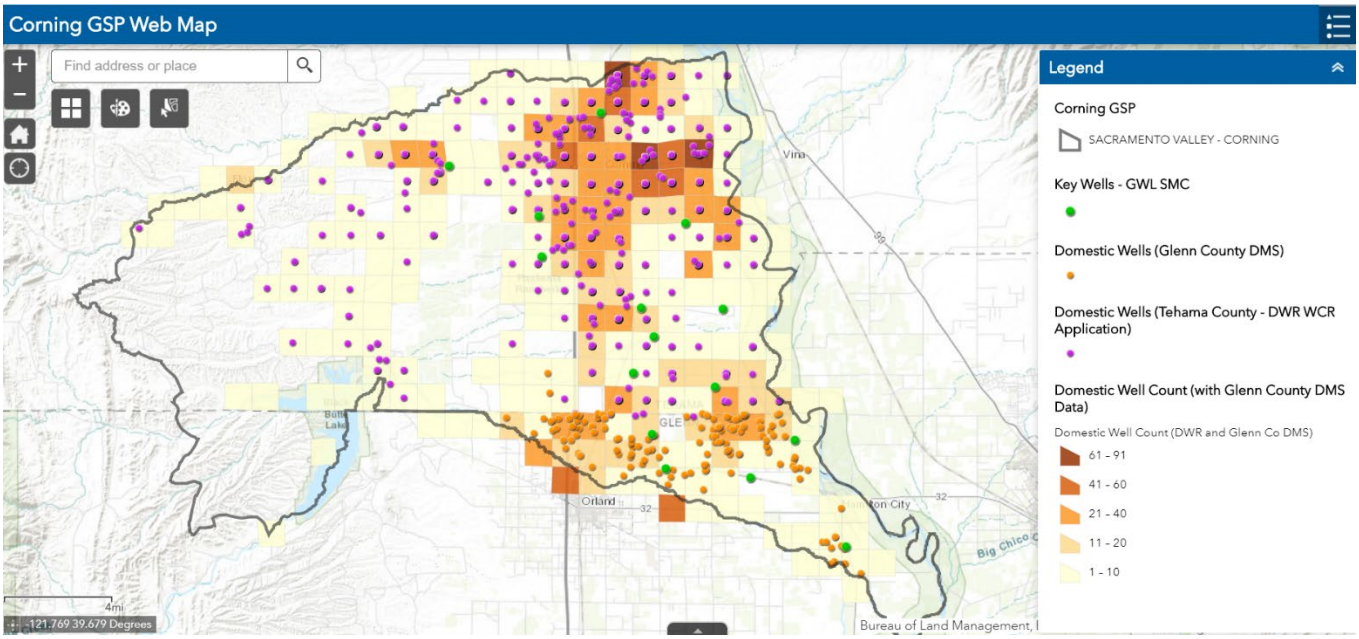


Figure 6A-2. Domestic Well Distribution in the Subbasin Relative to Key Wells

The following minimum threshold options were reviewed to assess if water level goals may cause domestic wells to go dry, as a protective level for domestic well users:

- Minimum water level measurement (Tehama Trigger Level Method)
  - All years from historical dataset
  - Specific year (2012, 2015, 2018)
- Average water level minus 2 times the standard deviation (Glenn BMO Method)
  - Comparable to minimum water level method but statistically removes outliers
- Water level linear trend of recent historical data extrapolated to 2042
  - Trend of all water level measurements
  - Annual minimum water level trend

The depth of 10% or 20% of the domestic wells within a 2-mile radius of the key well, plus a safety factor of 25 feet to maintain sufficient water in domestic wells to operate pumps, was assessed to establish a protective level for domestic well users.

Select Preliminary Minimum Thresholds and Measurable Objectives

The general methodology for selecting SMC for chronic lowering of groundwater levels was presented at the CSAB meeting on October 7, 2020. Feedback from CSAB members and the public was received at the meeting. CSAB members and other local stakeholders acknowledged that recent minimum groundwater levels caused domestic and shallow irrigation wells to go dry, requiring well replacement and deepening of well pumps. Based on this information the CSAB agreed that the current minimum (or fall 2019) groundwater levels were generally causing significant and unreasonable conditions in the Subbasin.

The preliminary measurable objective options considered were the minimum 2012 water level and the average water level between 2002 and 2012. In 2012, groundwater levels in most wells were higher than they were in 2019 at a level that would provide significant operational flexibility above the minimum threshold. The 2012 minimum water level was selected as a preliminary measurable objective for the Subbasin.

Refinement of Minimum Threshold and Measurable Objectives:

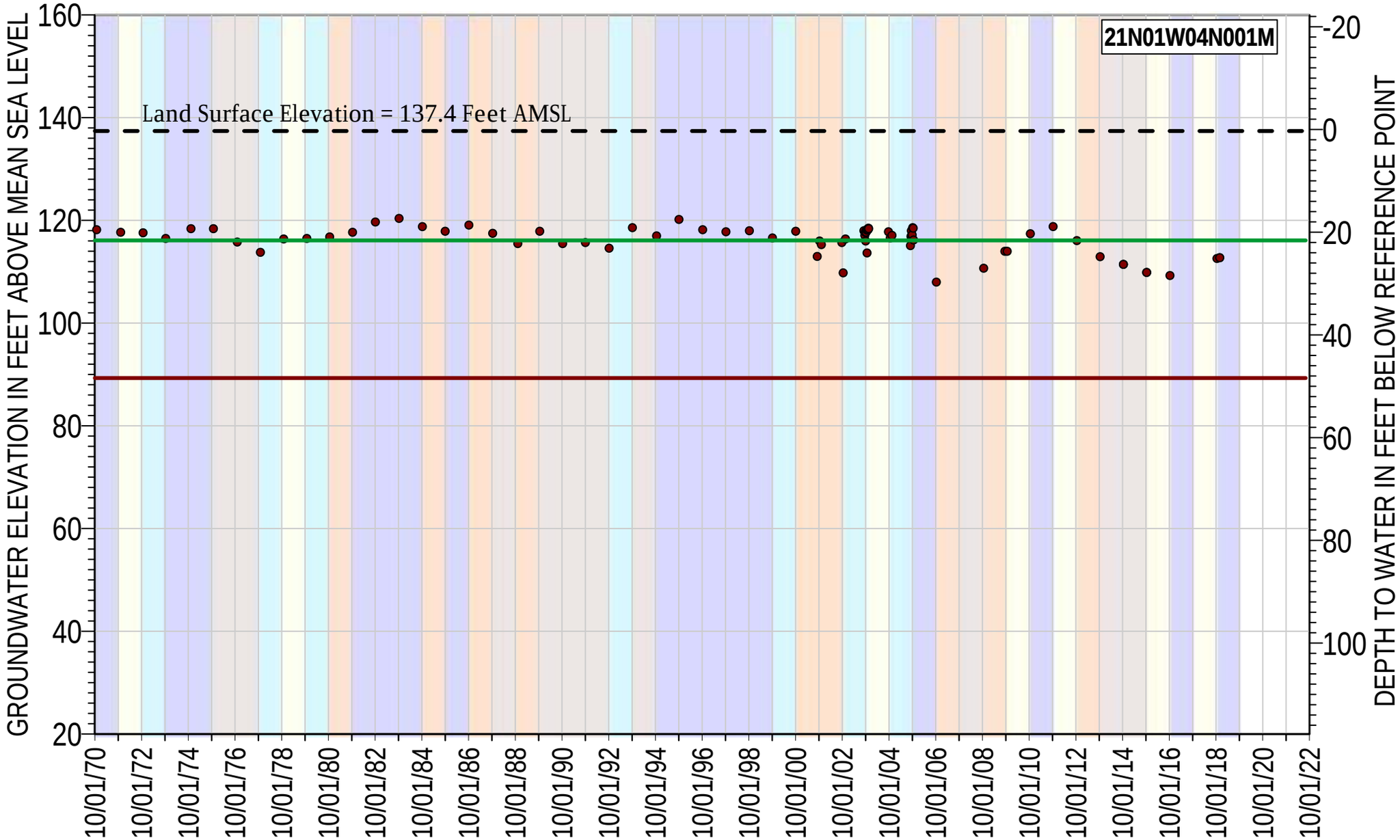
Hydrographs of groundwater levels over time for shallow and deep RMP wells were reviewed in order to refine minimum threshold and measurable objective options. Groundwater elevation trends in the Subbasin are described in more detail in Section 3.2. Upon further review, the late summer or fall minimum water level in 2018 was generally considered to be the lowest on record in more wells than in 2019, and consequently was considered more representative of the locally

defined significant and unreasonable conditions in the Subbasin. The measurable objective was refined to be the maximum spring water level in 2012; this value provided more operational flexibility than the initial proposed 2012 minimum values.

This approach was a good initial estimate to have discussions with stakehodlers and identify potential significant and unreasonable conditions in the Subbasin, but did not take into account that current conditions are different than prior to the drought, when the original Glenn BMOs and Tehama trigger levels were developed. This, a more realistic approach was developed and is described in Section 6.6

Appendix 6B

RMP Hydrographs with SMC



21N01W04N001M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

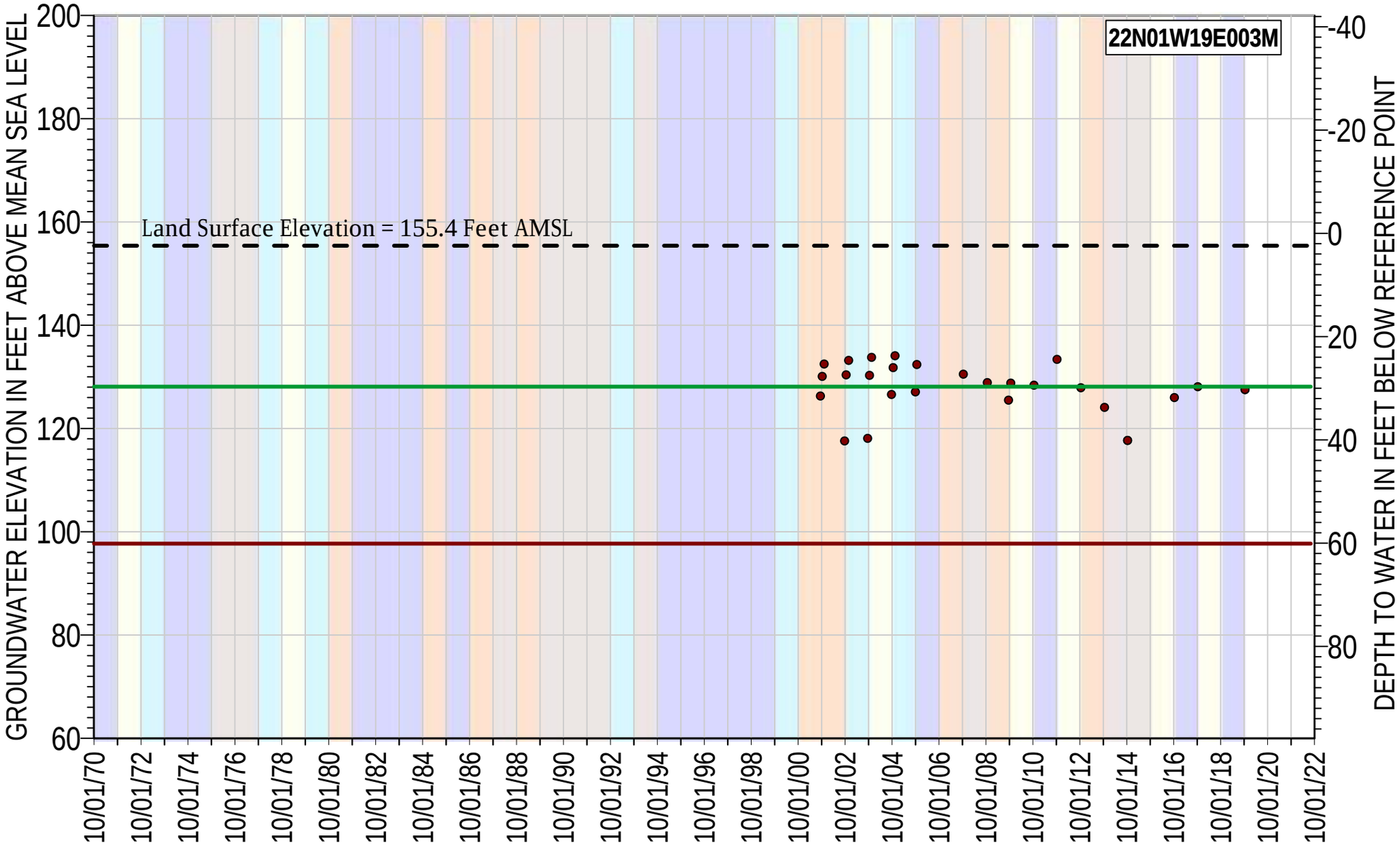
Minimum Threshold

Reference Point Elevation= 137.7 ft AMSL
Well Type: Domestic
Total Depth: 100 ft bgs
Well Screen Interval= Unknown ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





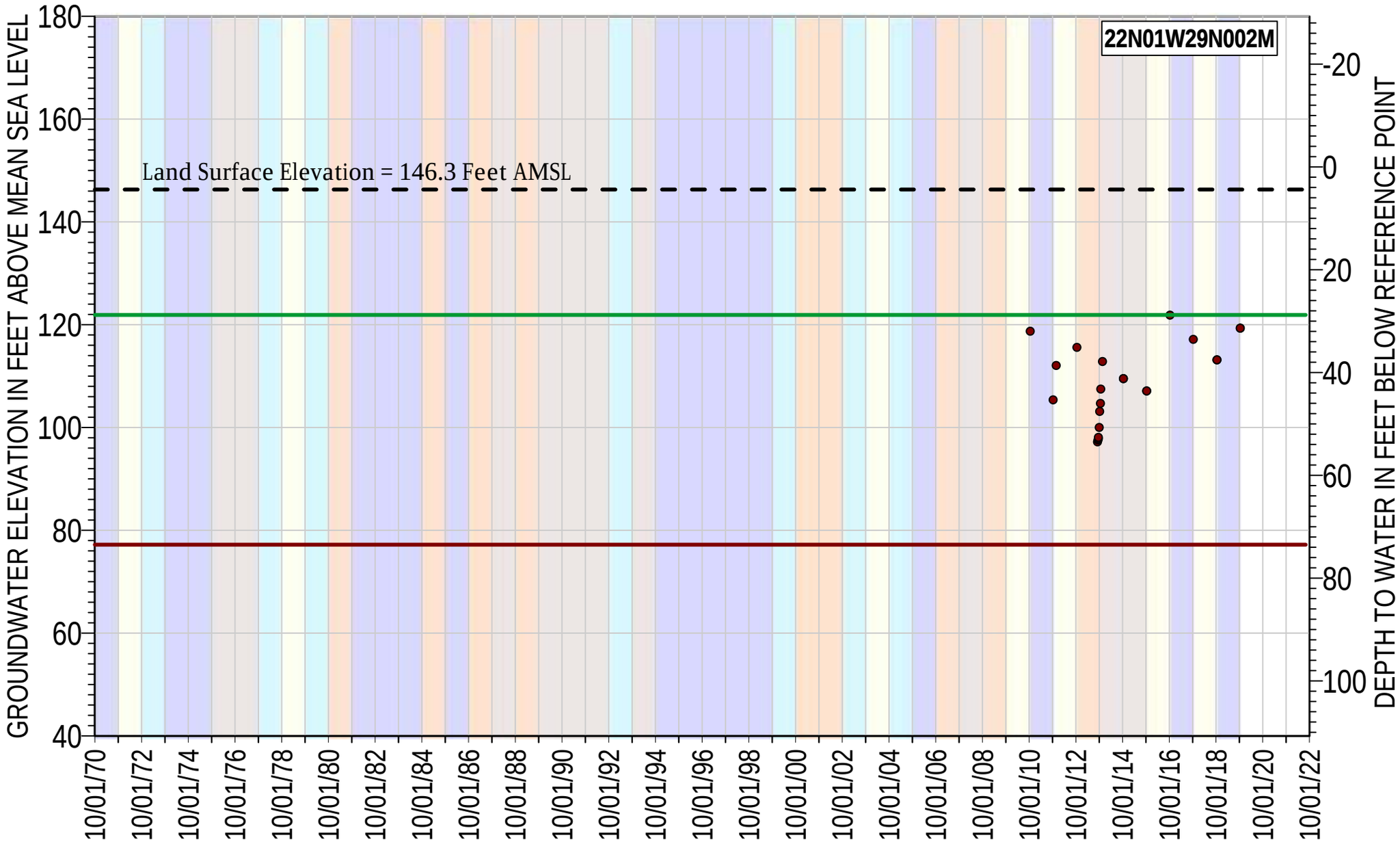
22N01W19E003M Fall Groundwater Elevation
Land Surface Elevation
Measurable Objective
Minimum Threshold

Reference Point Elevation= 157.8 ft AMSL
Well Type: Irrigation
Total Depth: 500 ft bgs
Well Screen Interval= 80 - 400 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





22N01W29N002M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

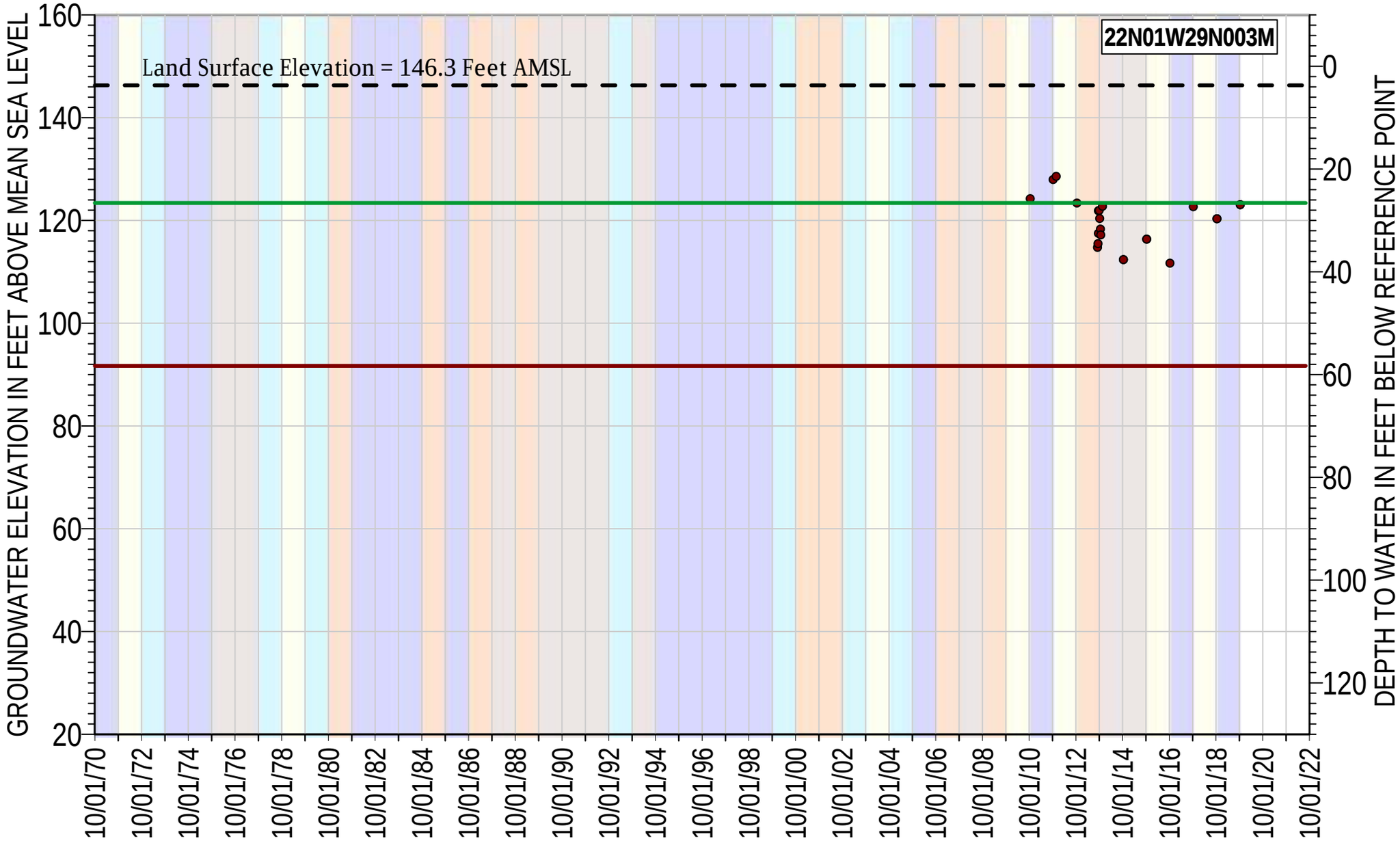
Minimum Threshold

Reference Point Elevation= 150.7 ft AMSL
Well Type: Observation
Total Depth: 670 ft bgs
Well Screen Interval= 549 - 641 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





22N01W29N003M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

Minimum Threshold

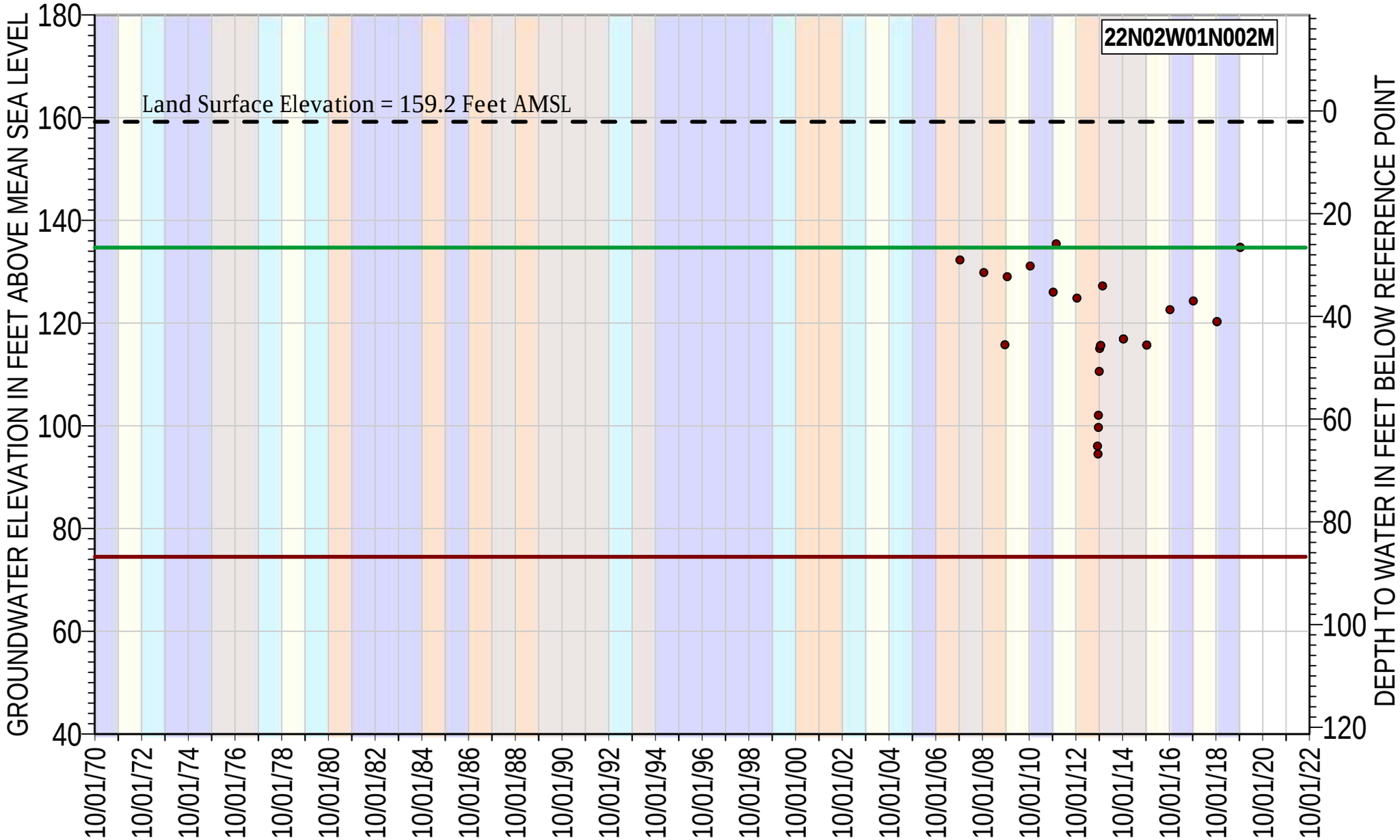
Reference Point Elevation= 150 ft AMSL
Well Type: Observation
Total Depth: 400 ft bgs
Well Screen Interval= 189 - 380 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



Stable Trend



22N02W01N002M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

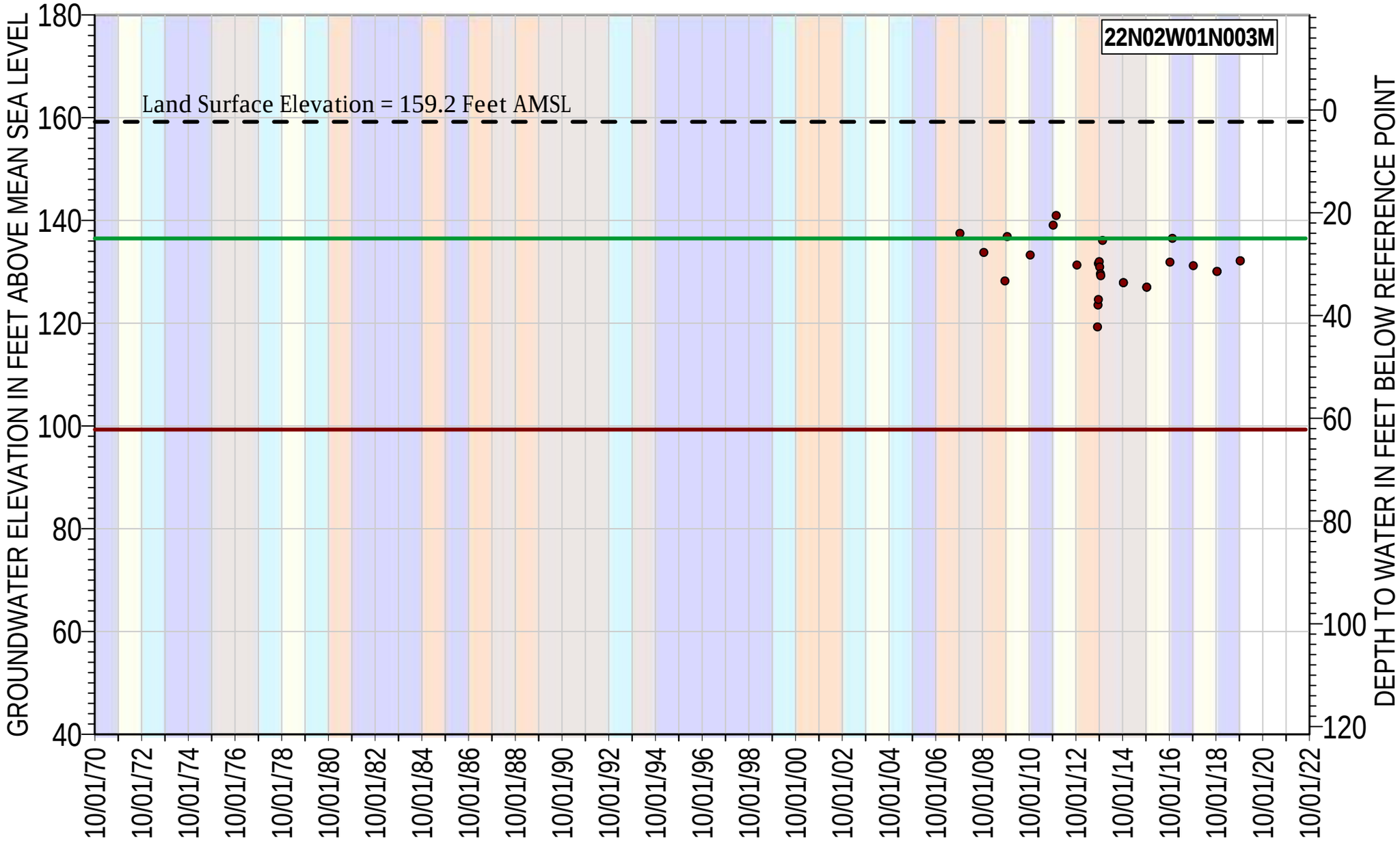
Minimum Threshold

Reference Point Elevation= 161.3 ft AMSL
Well Type: Observation
Total Depth: 730 ft bgs
Well Screen Interval= 700 - 710 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





22N02W01N003M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

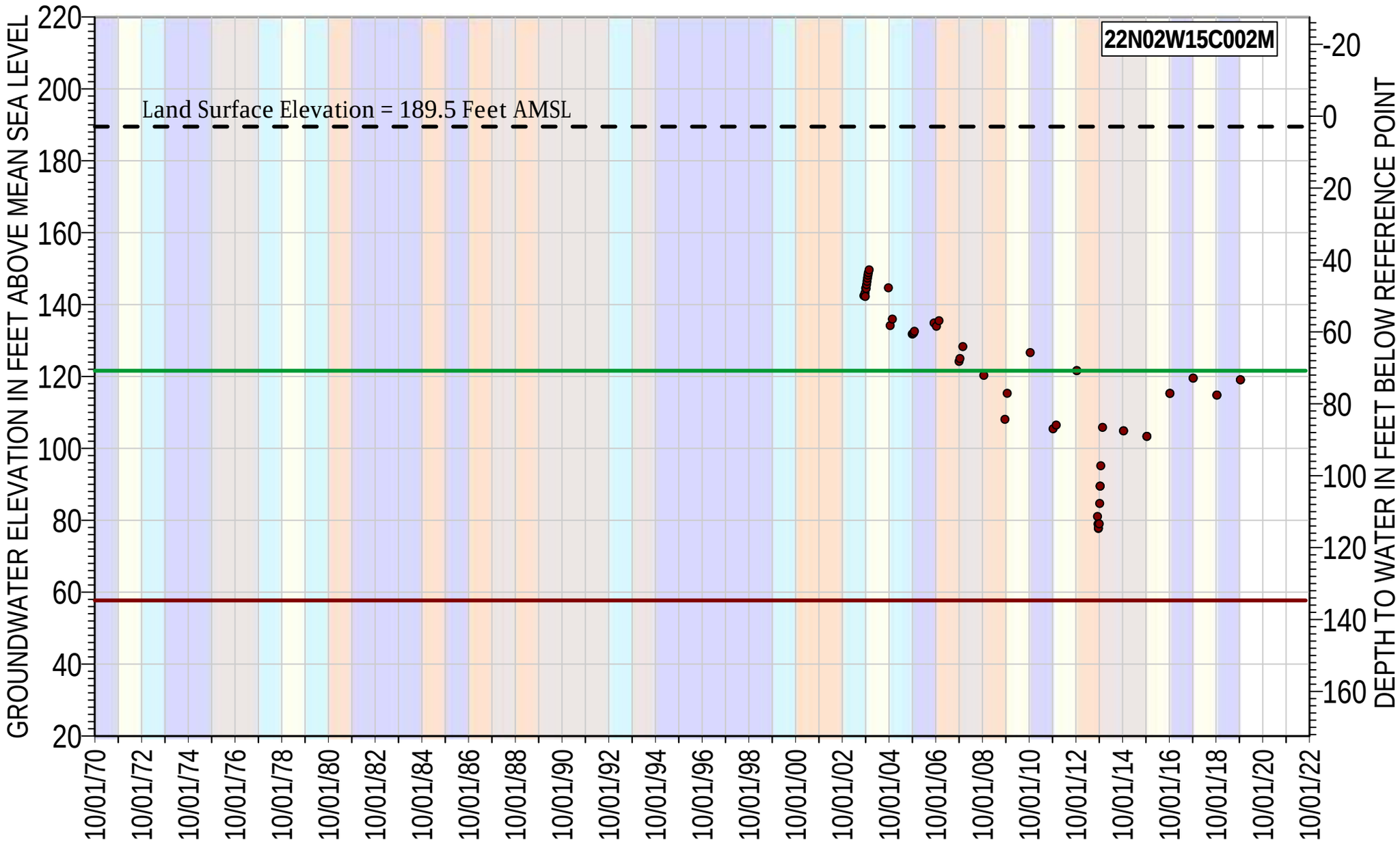
Minimum Threshold

Reference Point Elevation= 161.5 ft AMSL
Well Type: Observation
Total Depth: 440 ft bgs
Well Screen Interval= 210 - 370 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





22N02W15C002M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

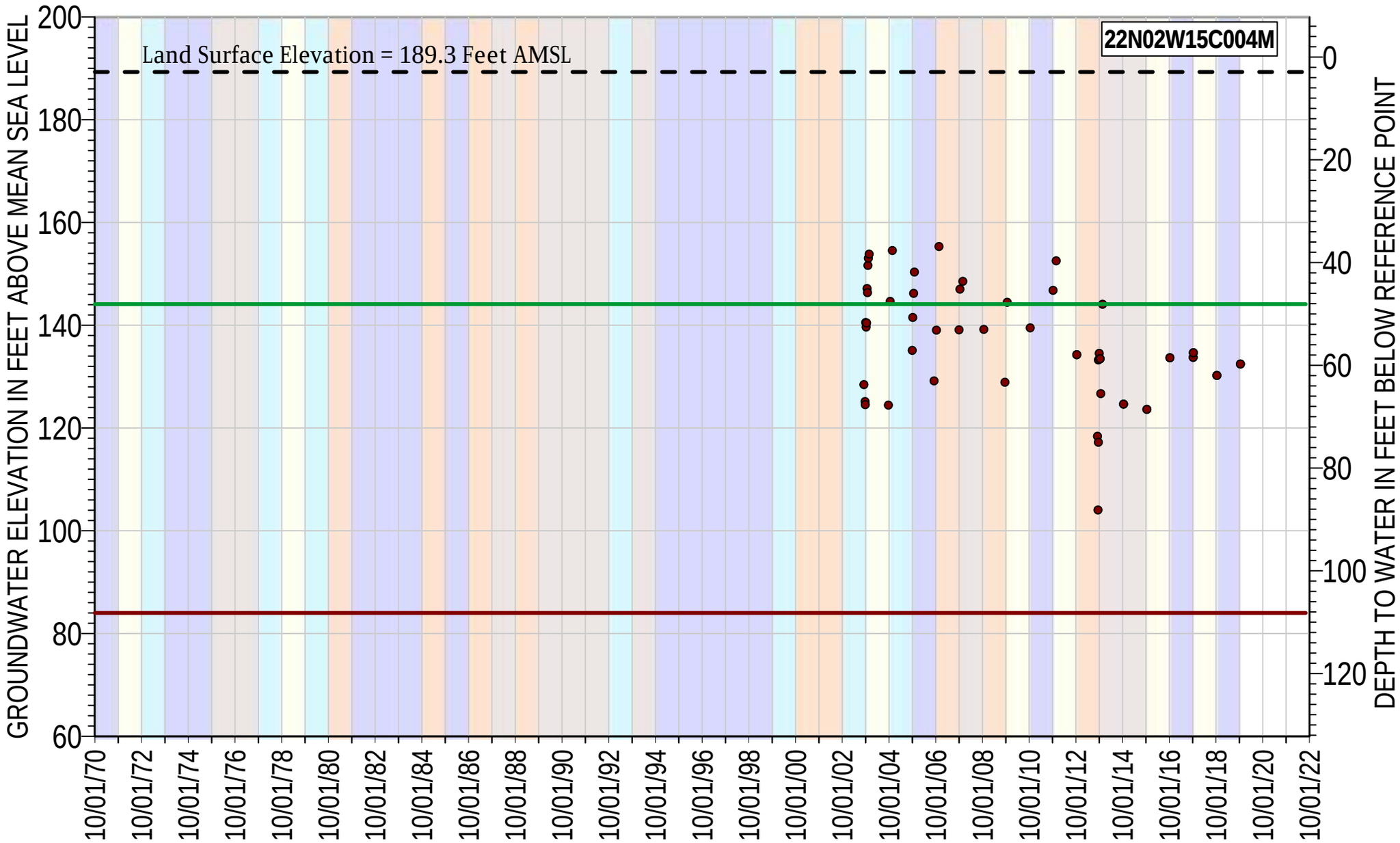
Minimum Threshold

Reference Point Elevation= 192.4 ft AMSL
Well Type: Observation
Total Depth: 825 ft bgs
Well Screen Interval= 760 - 781 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





22N02W15C004M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

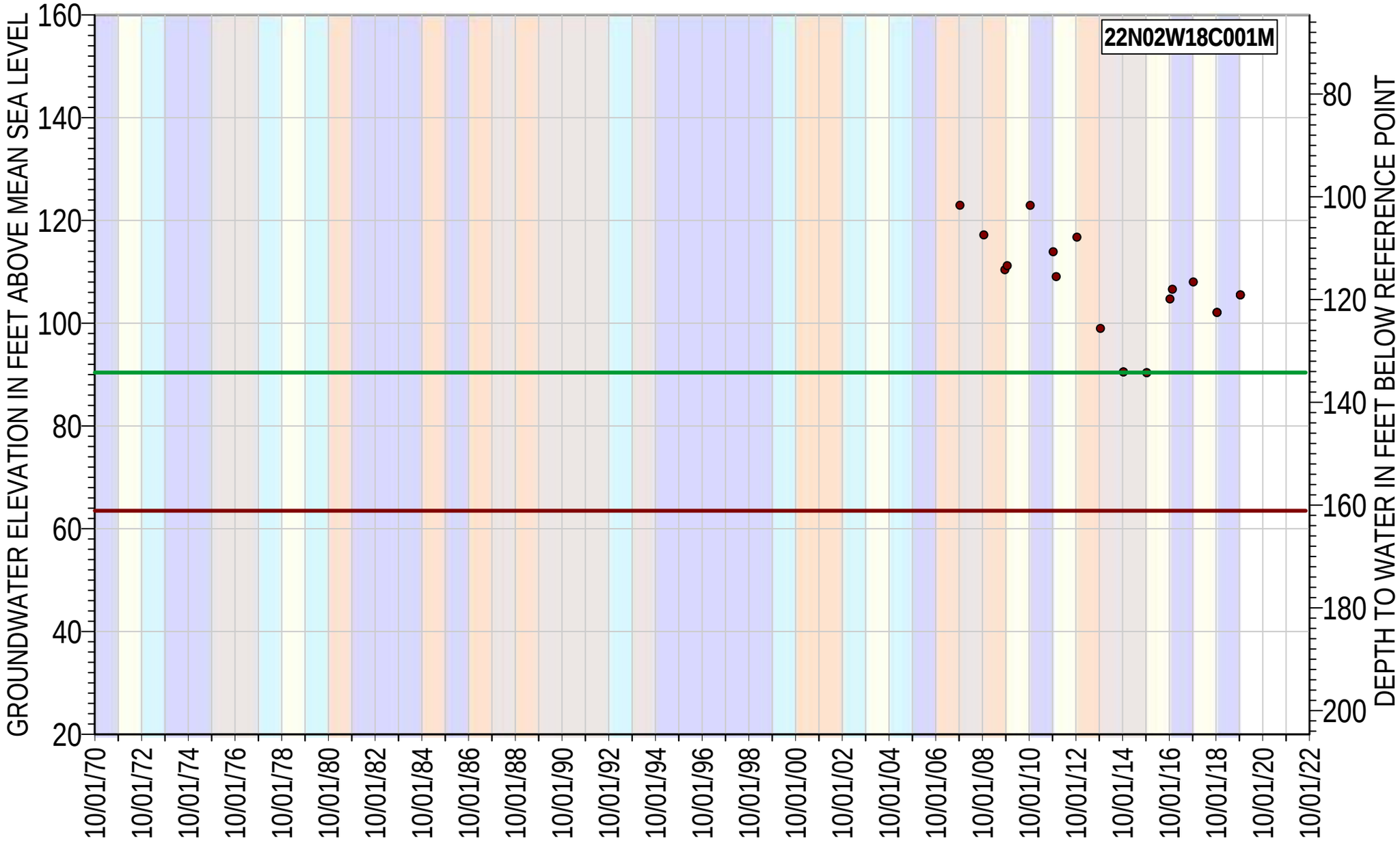
Minimum Threshold

Reference Point Elevation= 192.2 ft AMSL
Well Type: Observation
Total Depth: 258 ft bgs
Well Screen Interval= 210 - 220 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





22N02W18C001M Fall Groundwater Elevation

Measurable Objective

Minimum Threshold

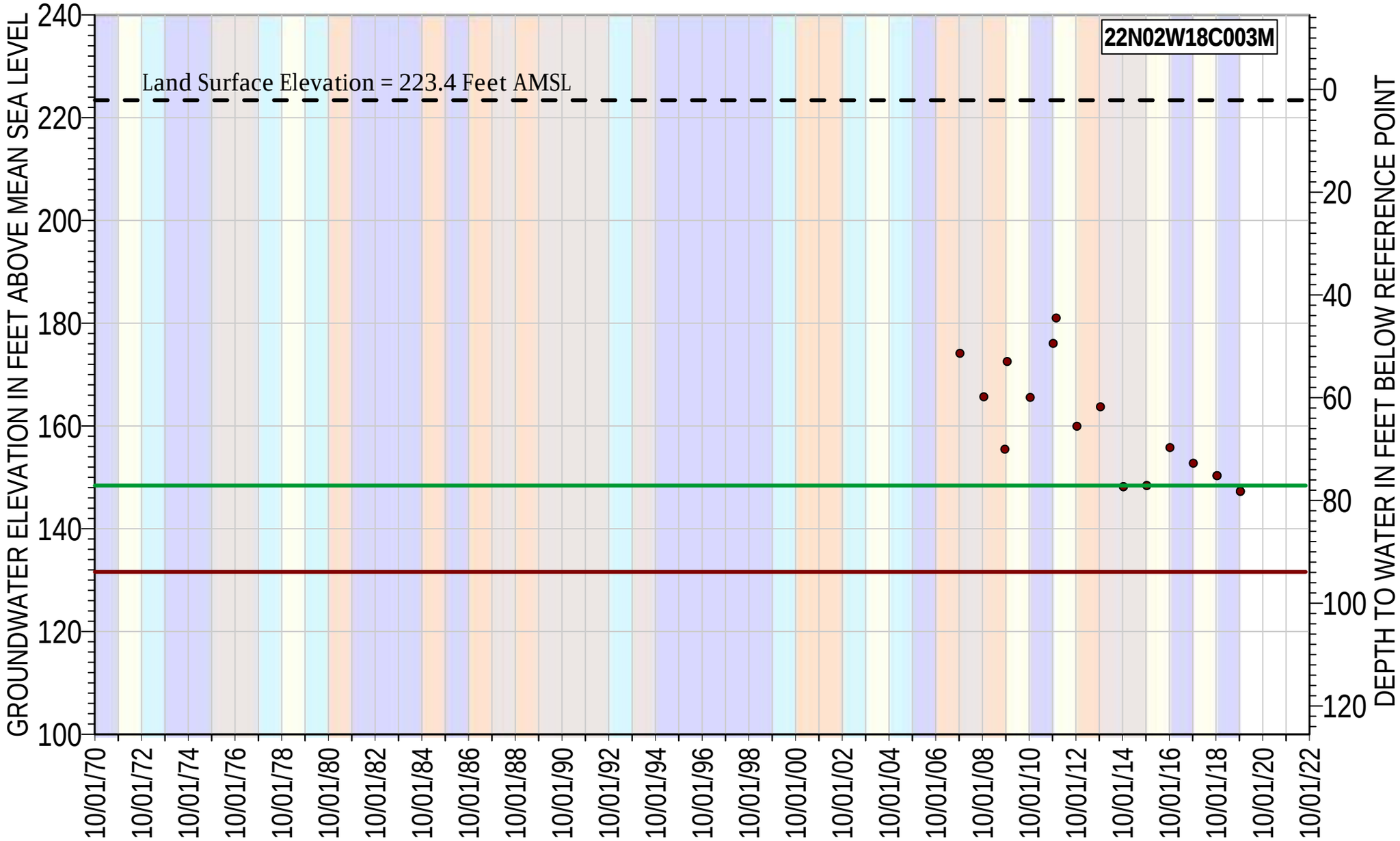
Reference Point Elevation= 224.6 ft AMSL
Well Type: Observation
Total Depth: 1062 ft bgs
Well Screen Interval= 841 - 1029 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



Slight Declining Trend



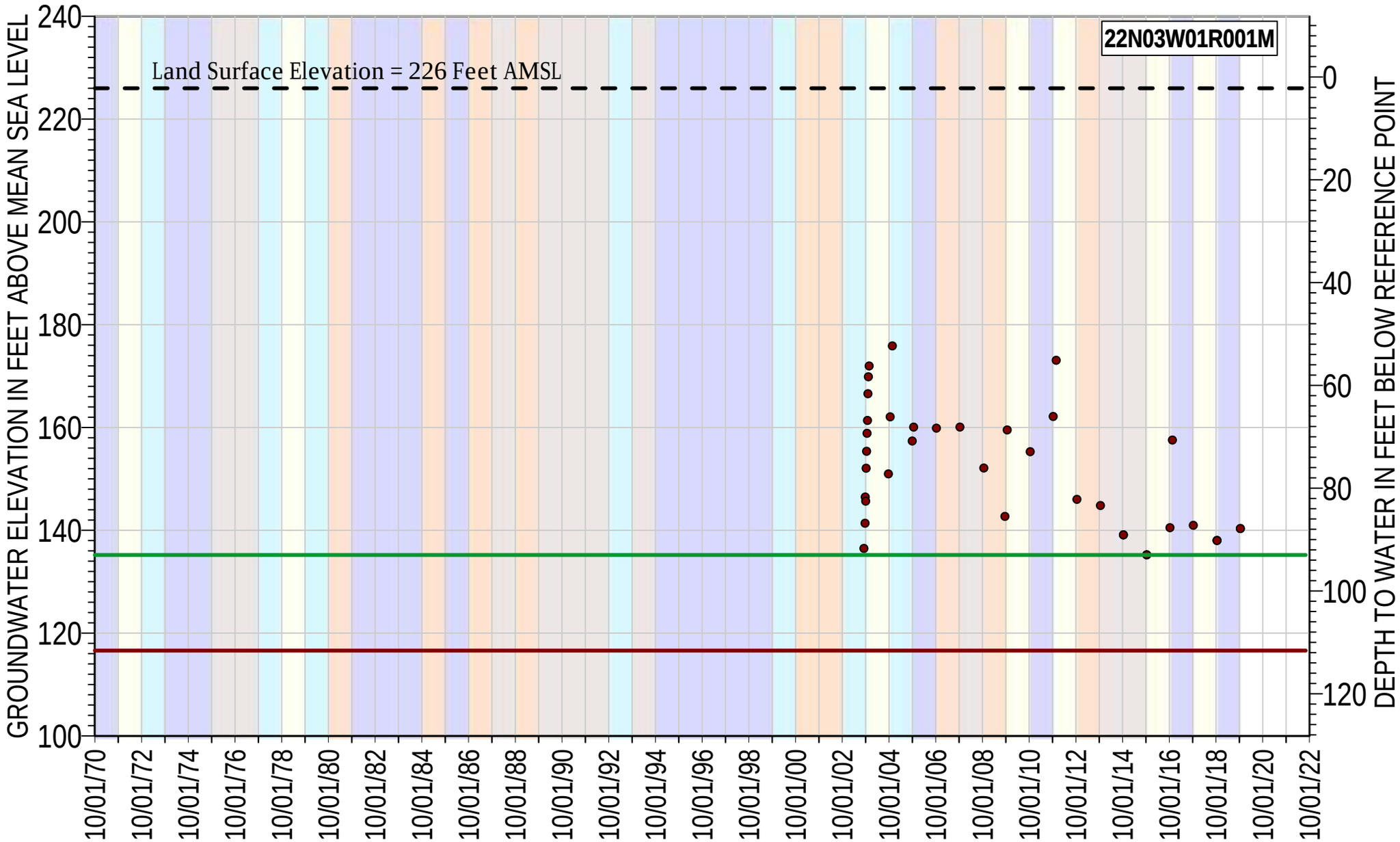
22N02W18C003M Fall Groundwater Elevation
Land Surface Elevation
Measurable Objective
Minimum Threshold

Reference Point Elevation= 225.5 ft AMSL
Well Type: Observation
Total Depth: 188 ft bgs
Well Screen Interval= 165 - 175 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





22N03W01R001M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

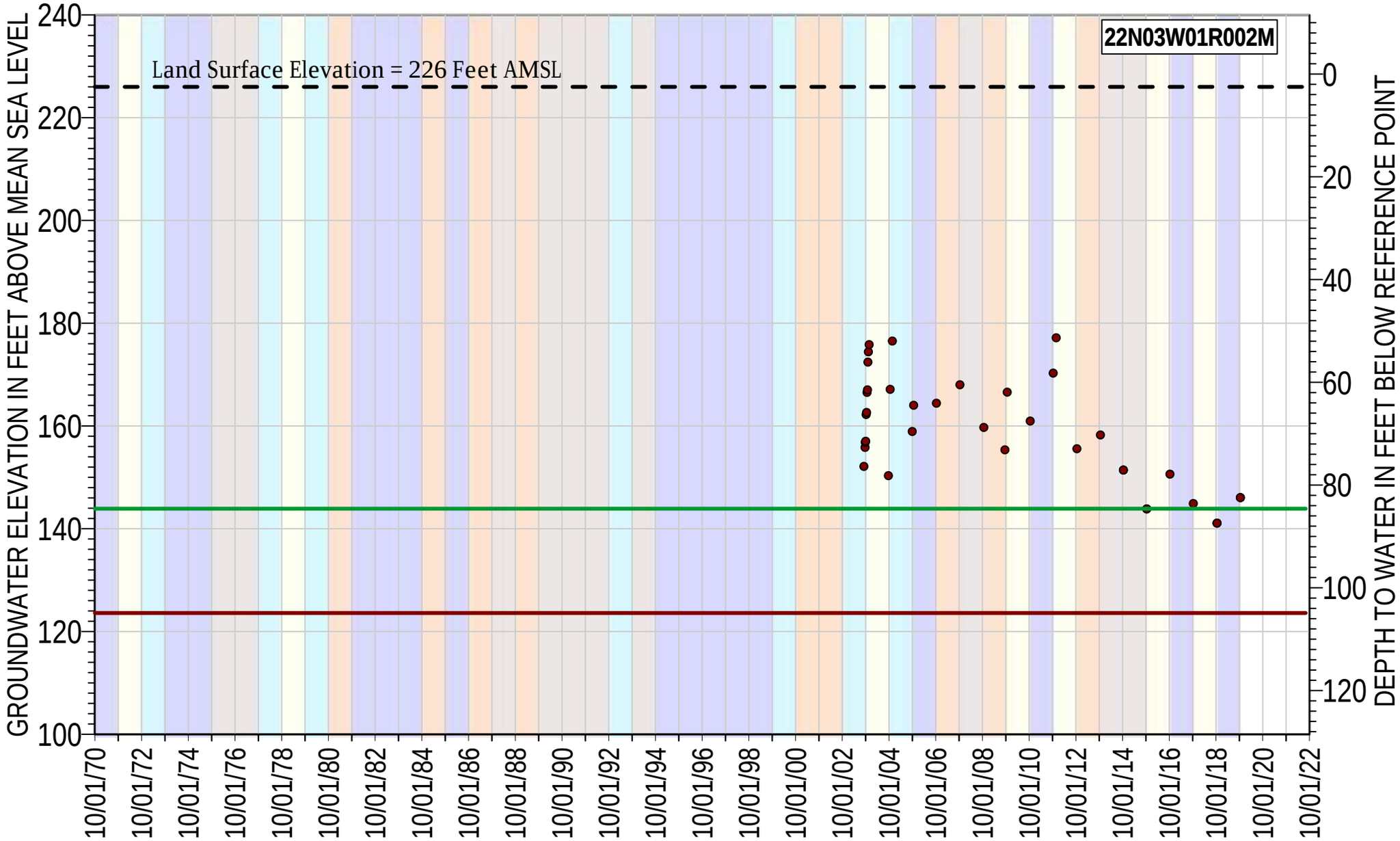
Minimum Threshold

Reference Point Elevation= 228.2 ft AMSL
Well Type: Observation
Total Depth: 515 ft bgs
Well Screen Interval= 470 - 480 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





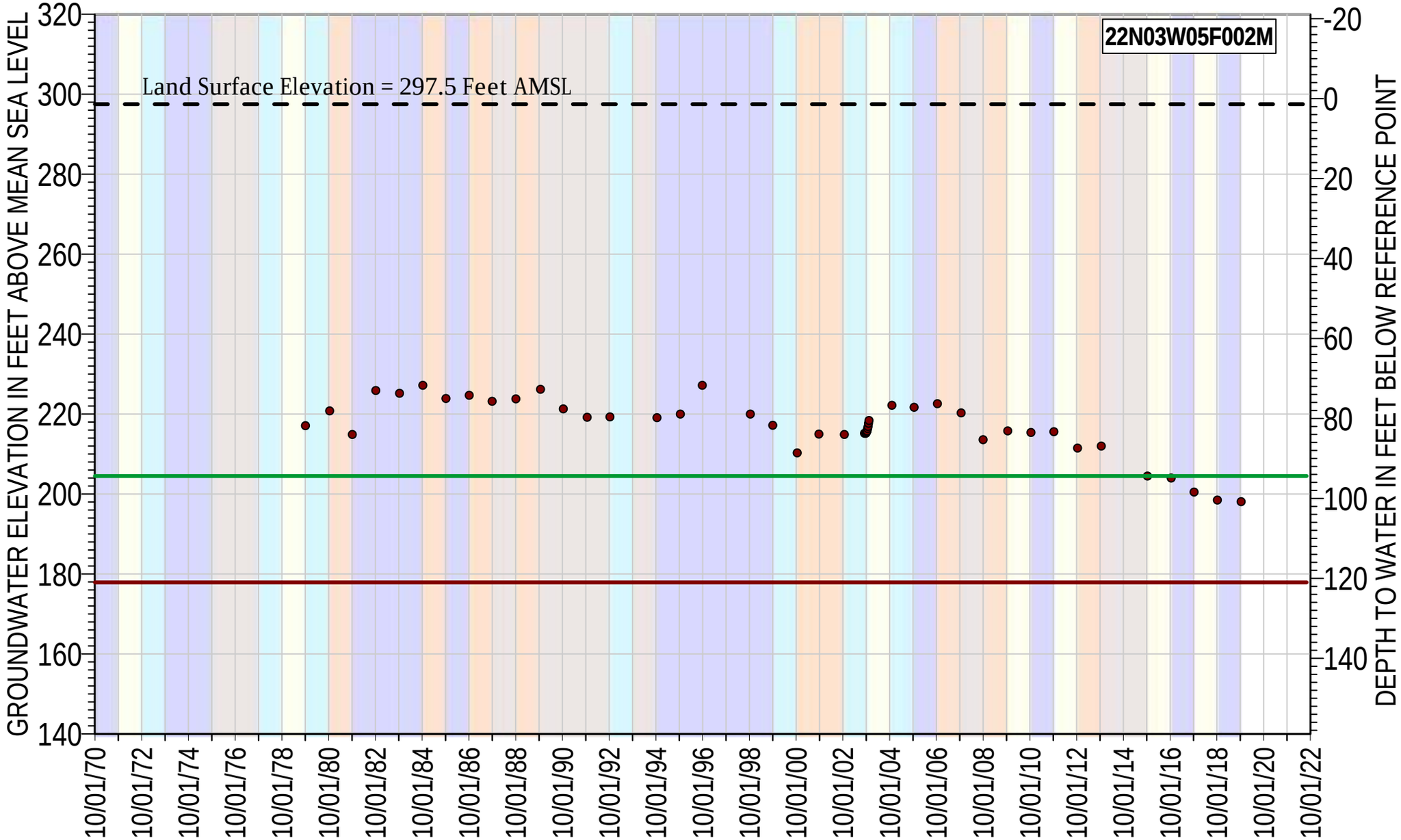
22N03W01R002M Fall Groundwater Elevation
Land Surface Elevation
Measurable Objective
Minimum Threshold

Reference Point Elevation= 228.5 ft AMSL
Well Type: Observation
Total Depth: 314 ft bgs
Well Screen Interval= 270 - 280 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





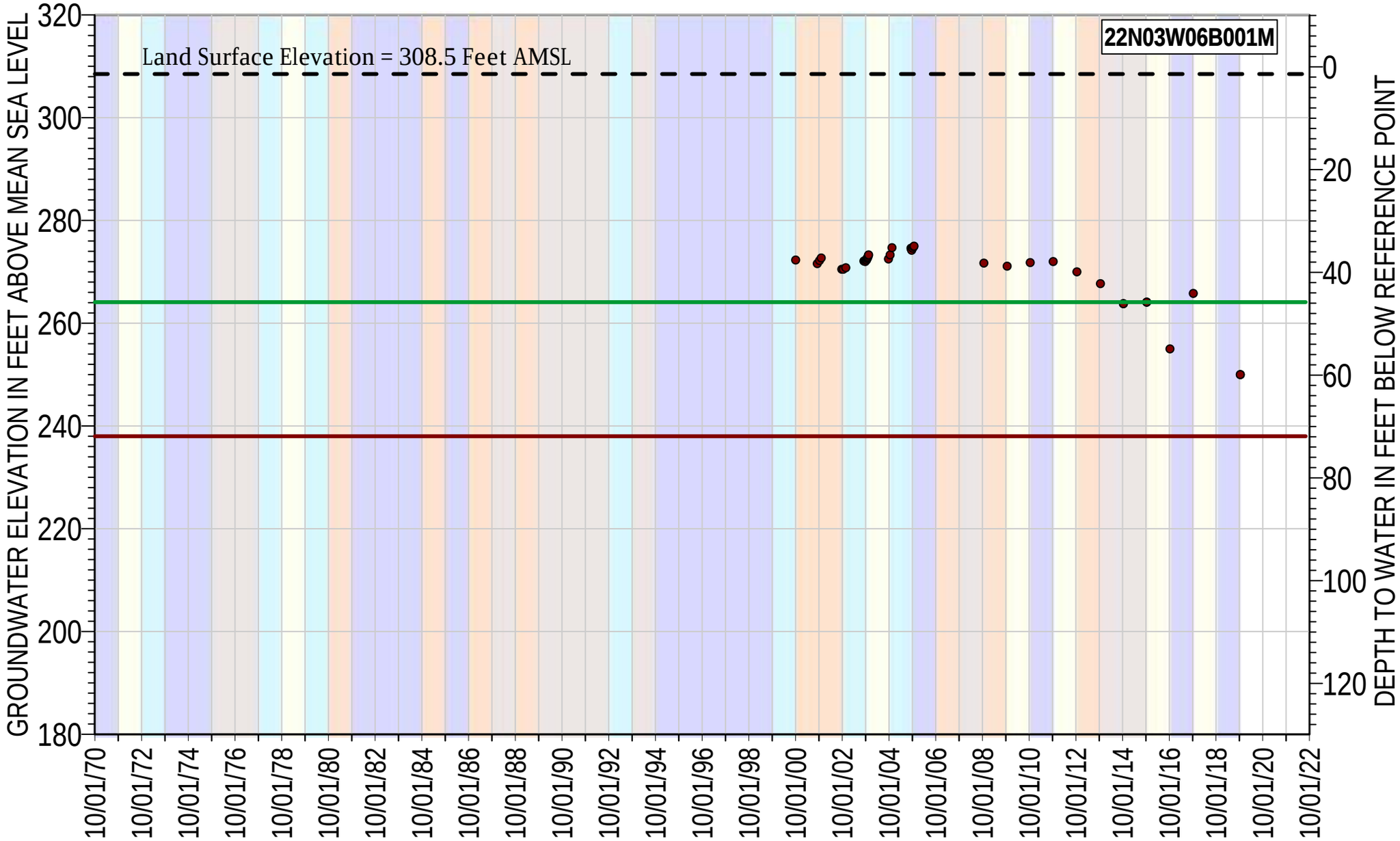
22N03W05F002M Fall Groundwater Elevation
Land Surface Elevation
Measurable Objective
Minimum Threshold

Reference Point Elevation= 298.9 ft AMSL
Well Type: Irrigation
Total Depth: 218 ft bgs
Well Screen Interval= 188 - 218 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





22N03W06B001M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

Minimum Threshold

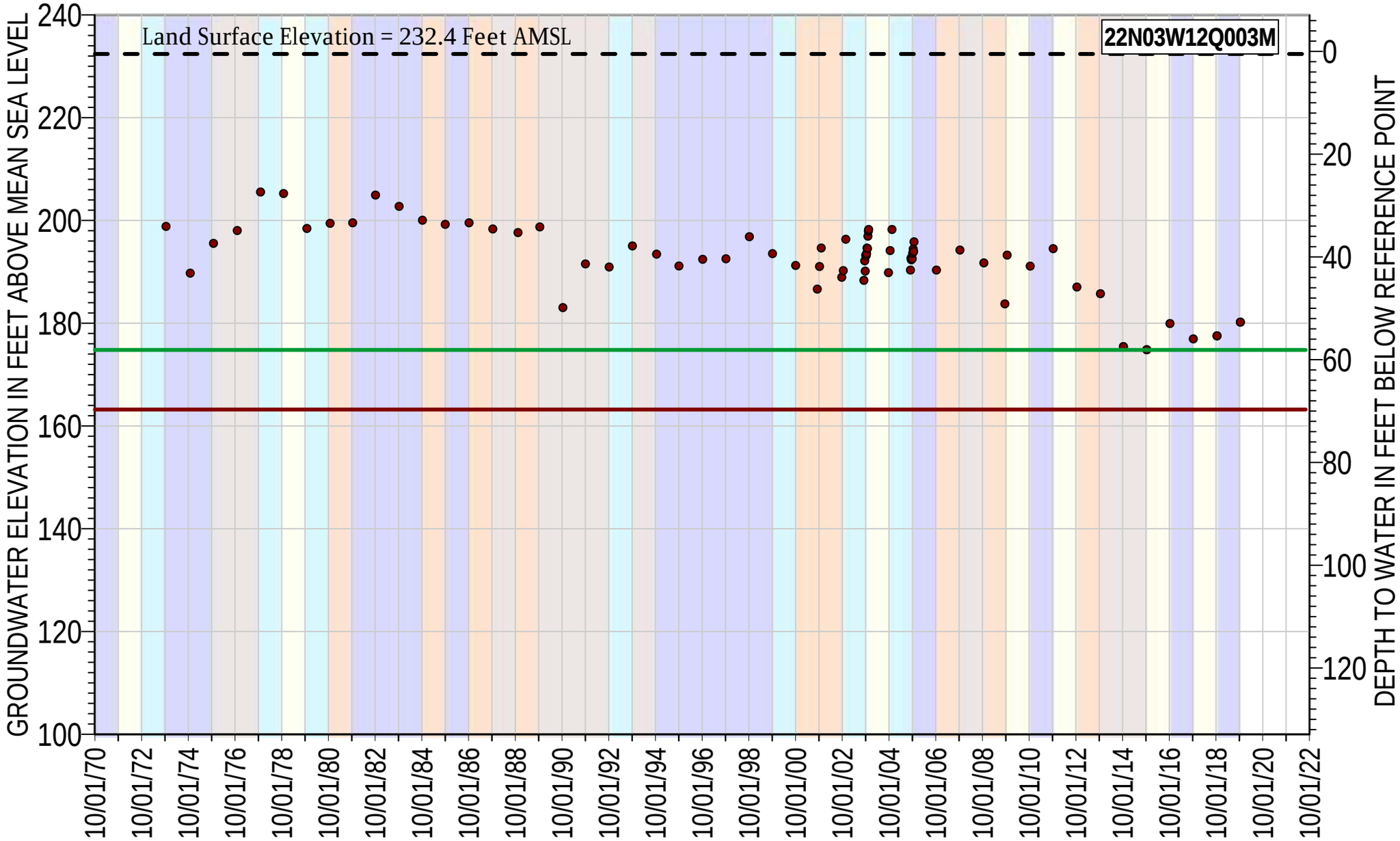
Reference Point Elevation= 309.9 ft AMSL
Well Type: Domestic
Total Depth: 210 ft bgs
Well Screen Interval= 195 - 210 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



Slight Declining Trend



22N03W12Q003M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

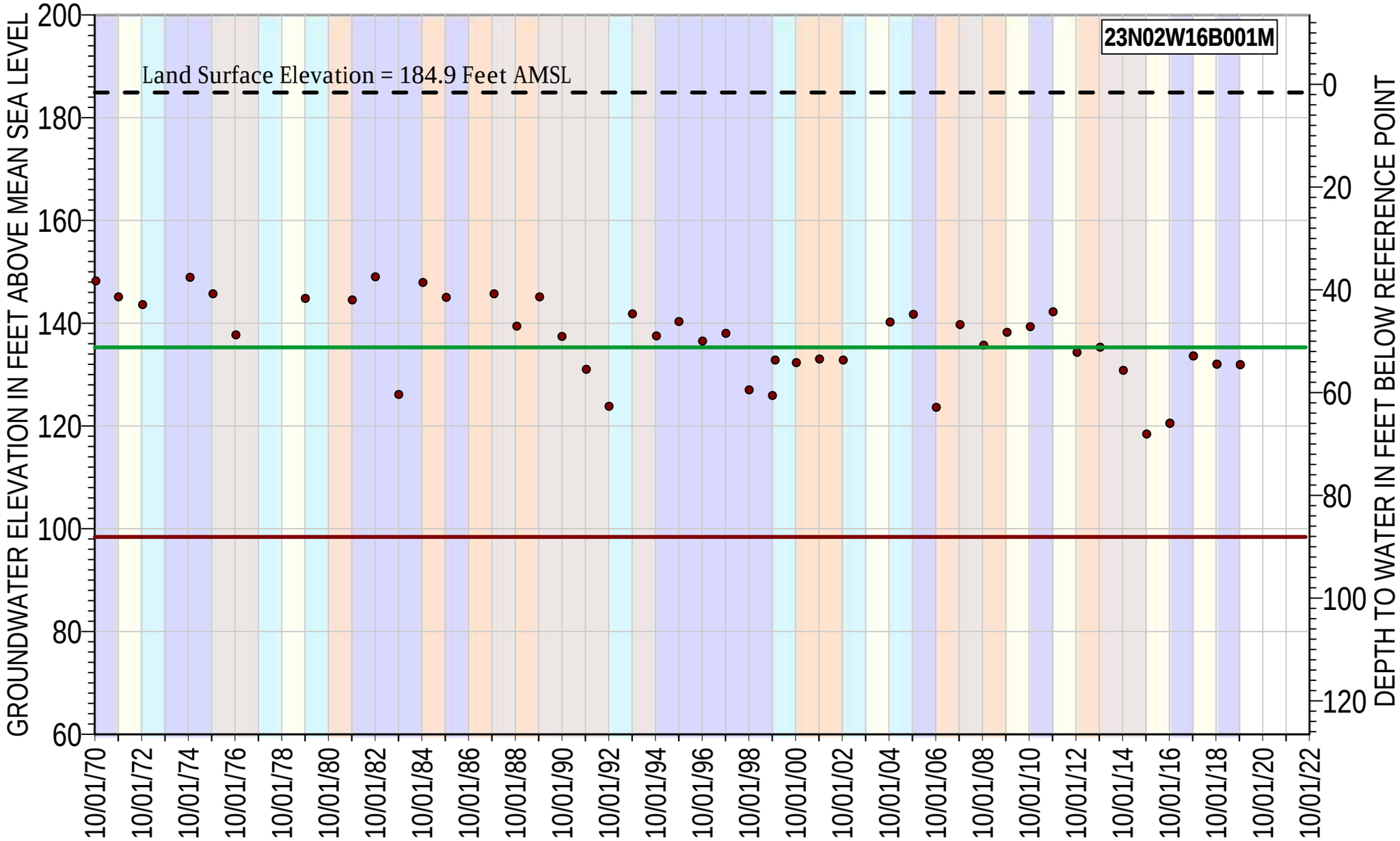
Minimum Threshold

Reference Point Elevation= 232.9 ft AMSL
Well Type: Domestic
Total Depth: 124 ft bgs
Well Screen Interval= 112 - 123 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





23N02W16B001M Fall Groundwater Elevation

Land Surface Elevation

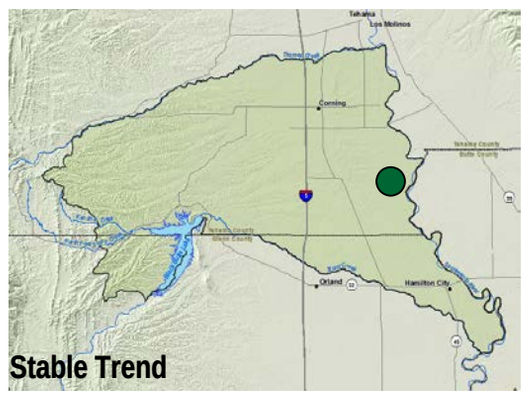
Measurable Objective

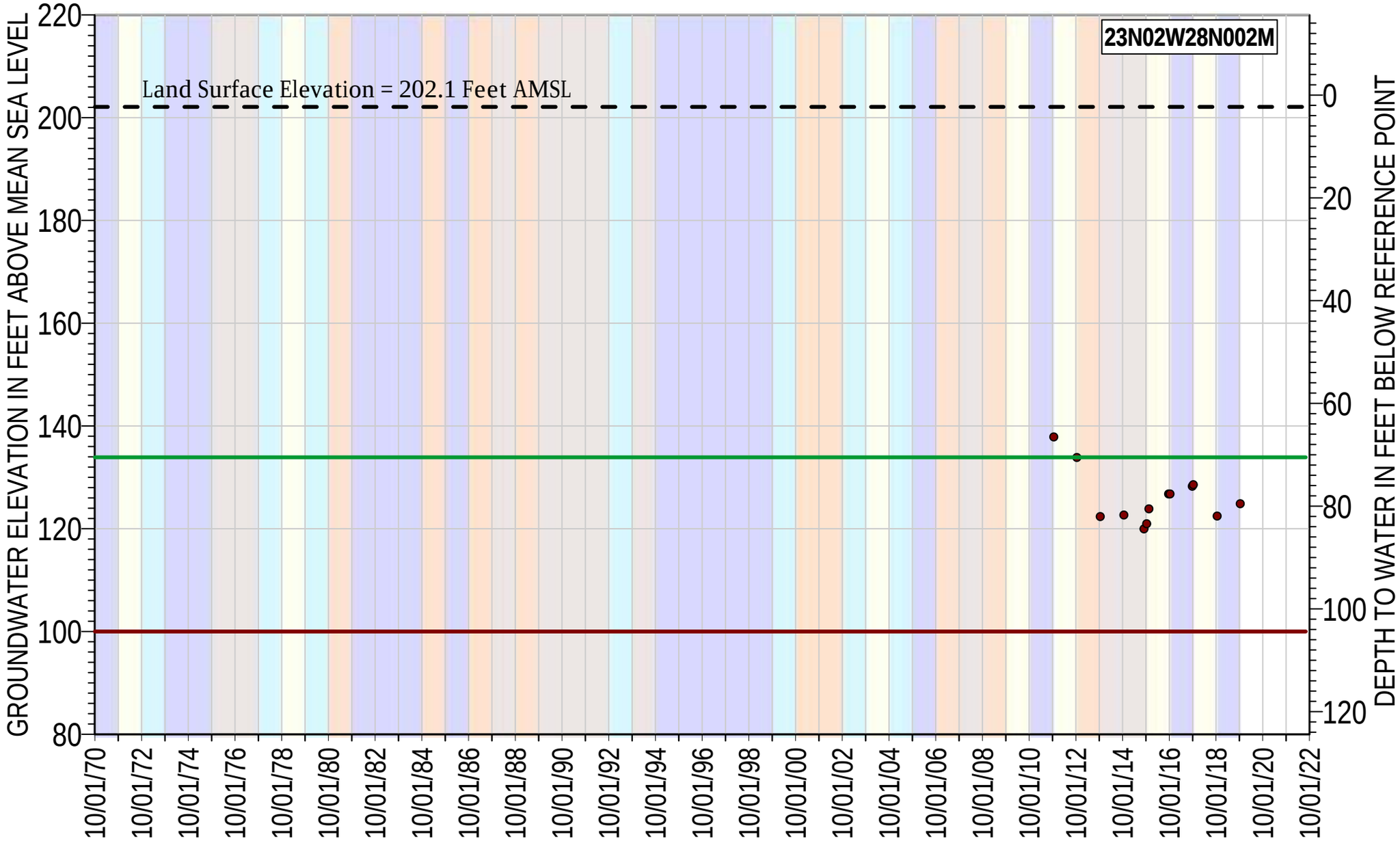
Minimum Threshold

Reference Point Elevation= 186.5 ft AMSL
Well Type: Irrigation
Total Depth: 120 ft bgs
Well Screen Interval= 100 - 120 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





23N02W28N002M Fall Groundwater Elevation

Land Surface Elevation

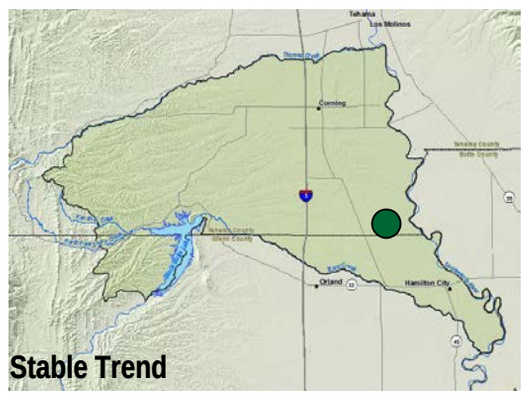
Measurable Objective

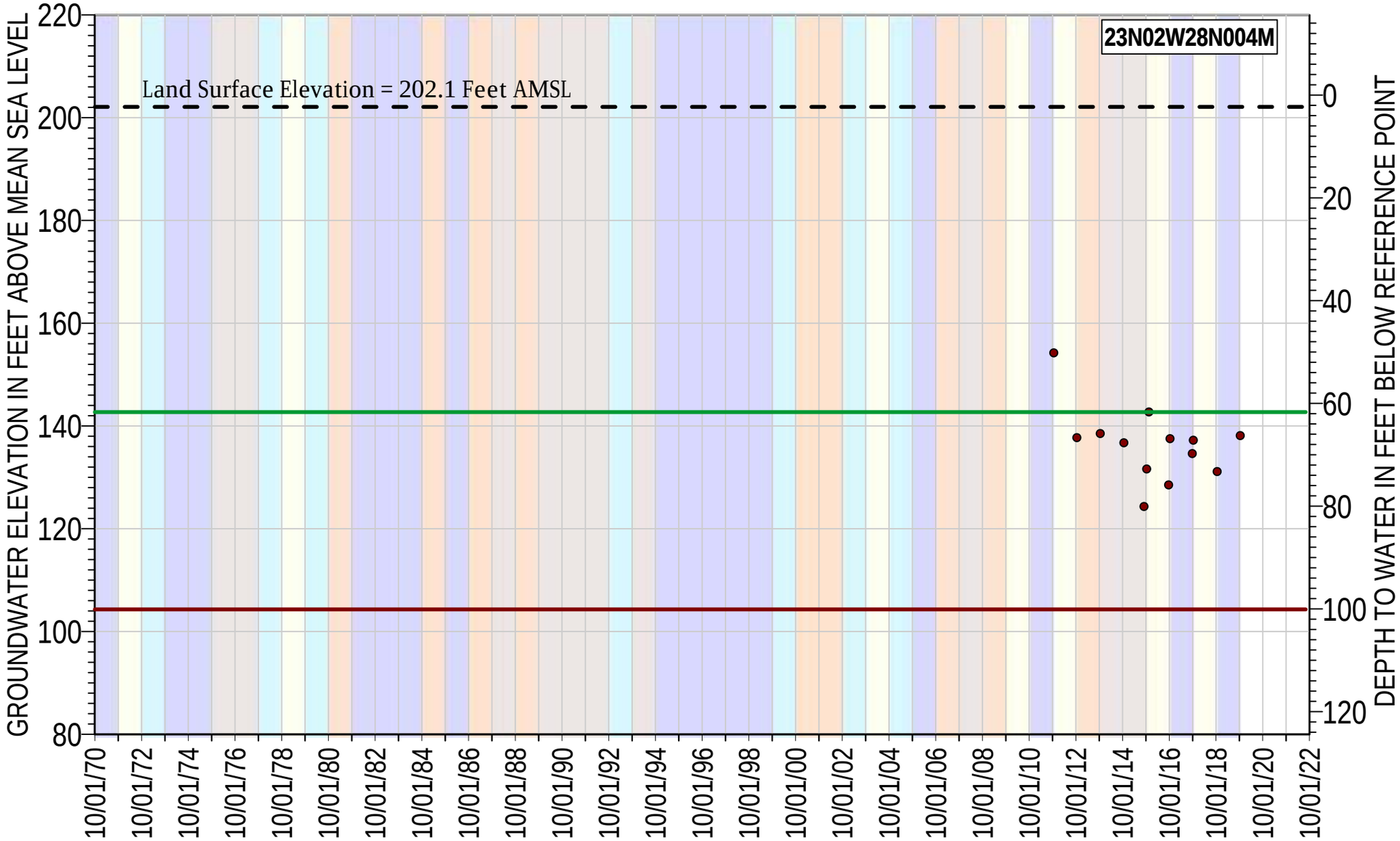
Minimum Threshold

Reference Point Elevation= 204.4 ft AMSL
Well Type: Observation
Total Depth: 580 ft bgs
Well Screen Interval= 550 - 570 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





23N02W28N004M Fall Groundwater Elevation

Land Surface Elevation

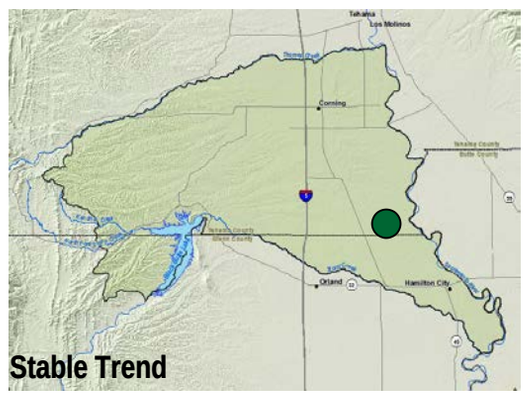
Measurable Objective

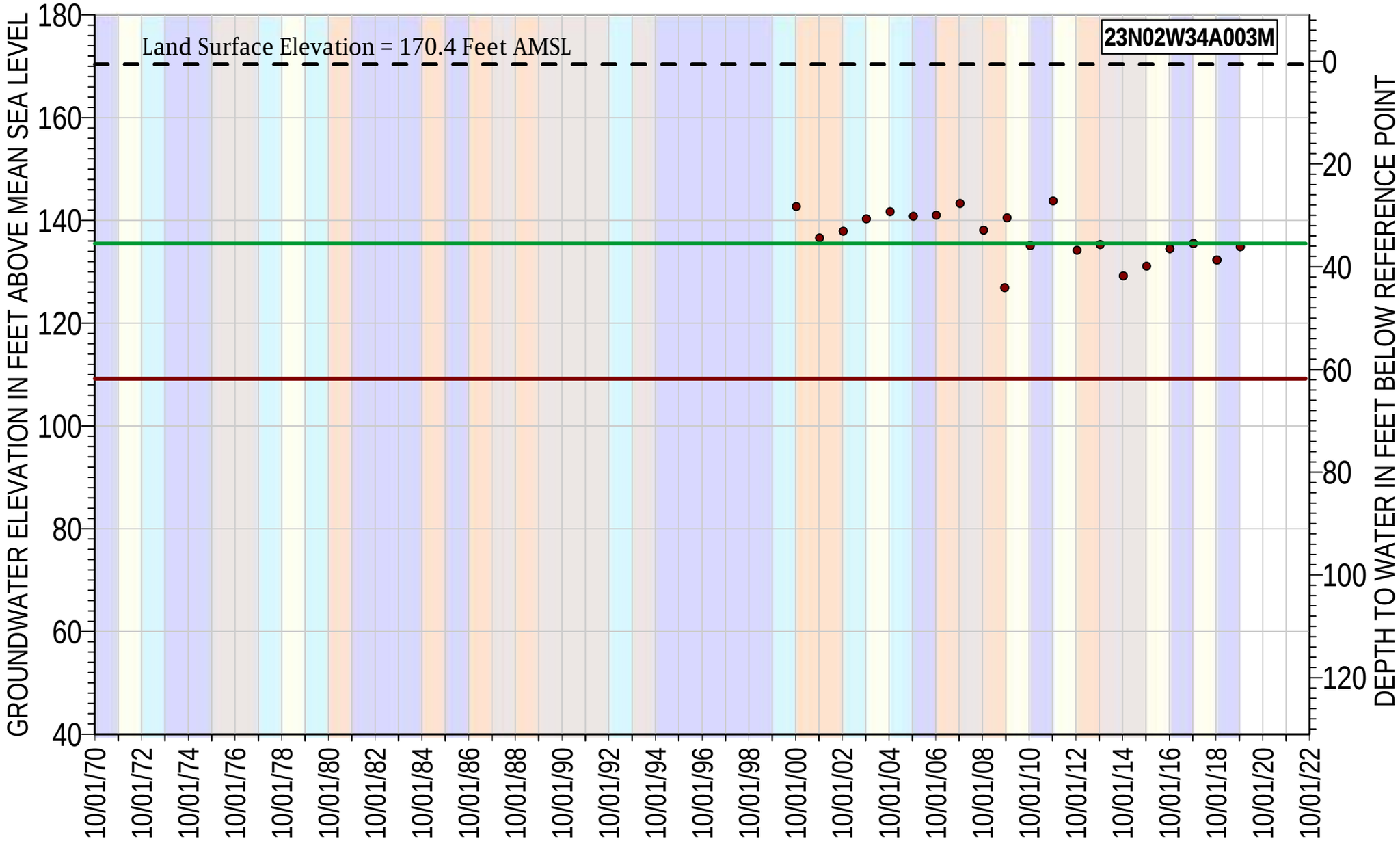
Minimum Threshold

Reference Point Elevation= 204.4 ft AMSL
Well Type: Observation
Total Depth: 205 ft bgs
Well Screen Interval= 100 - 170 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





23N02W34A003M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

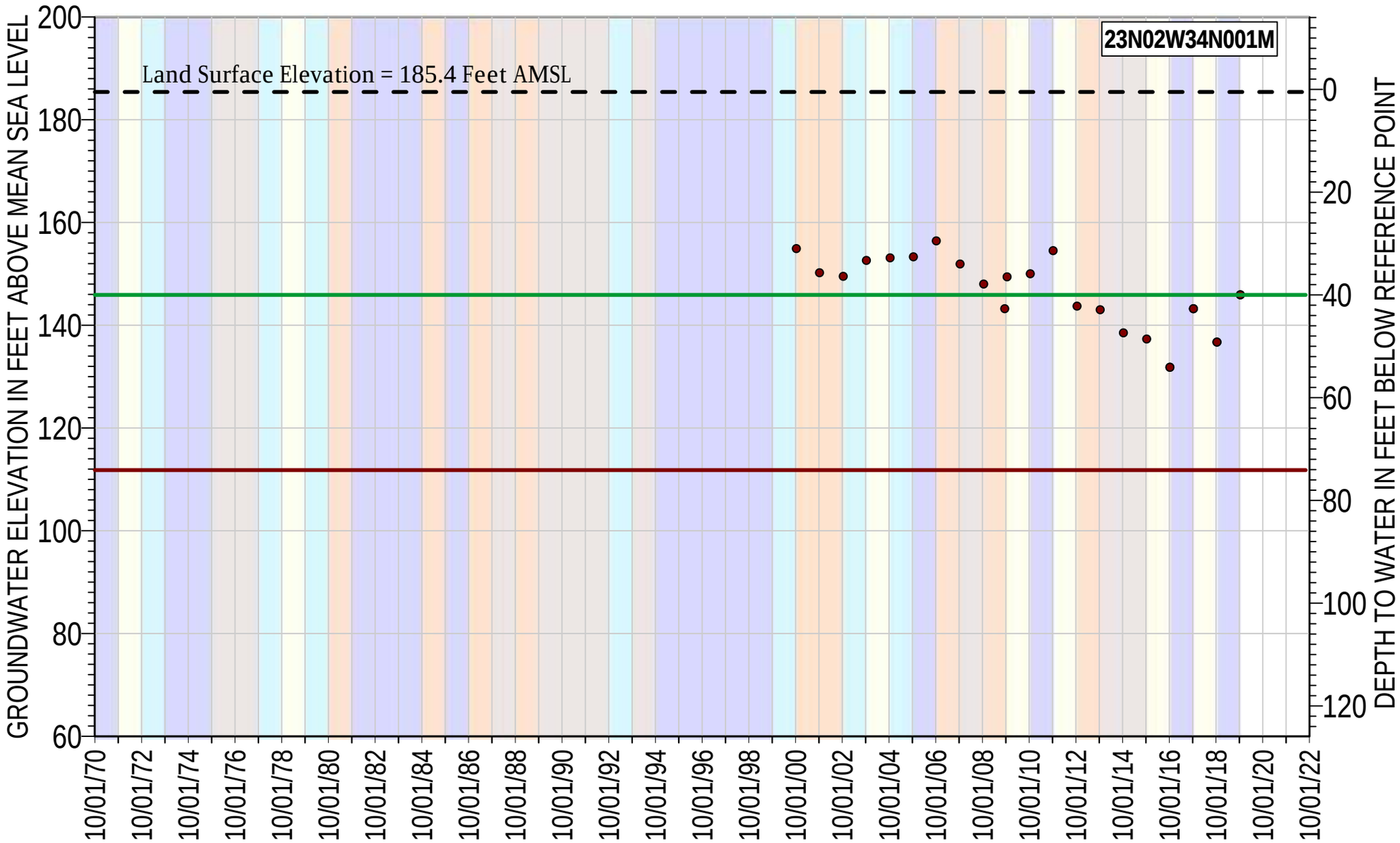
Minimum Threshold

Reference Point Elevation= 171 ft AMSL
Well Type: Irrigation
Total Depth: 125 ft bgs
Well Screen Interval= 104 - 124 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





23N02W34N001M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

Minimum Threshold

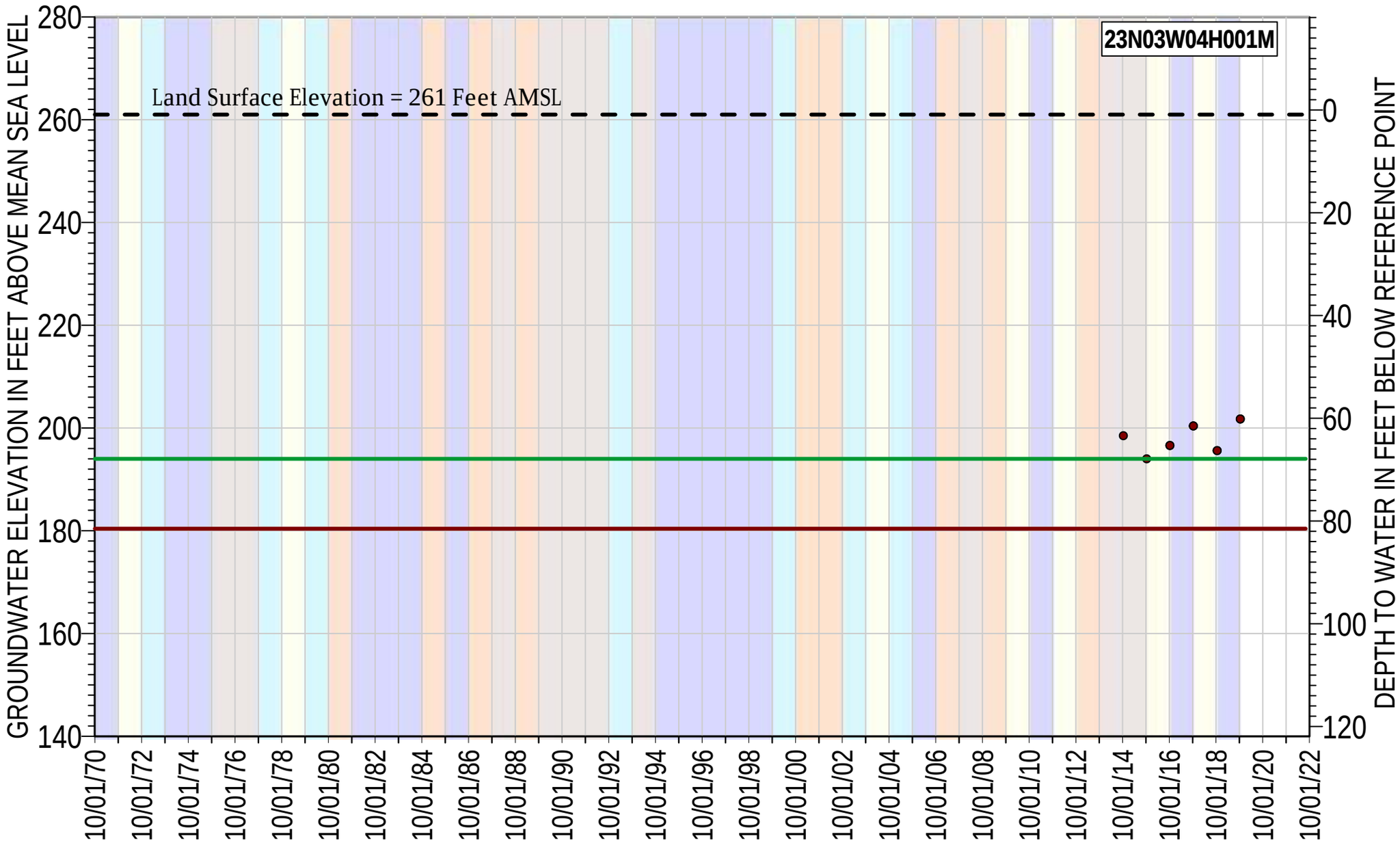
Reference Point Elevation= 185.9 ft AMSL
Well Type: Industrial
Total Depth: 100 ft bgs
Well Screen Interval= 70 - 100 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



Stable Trend

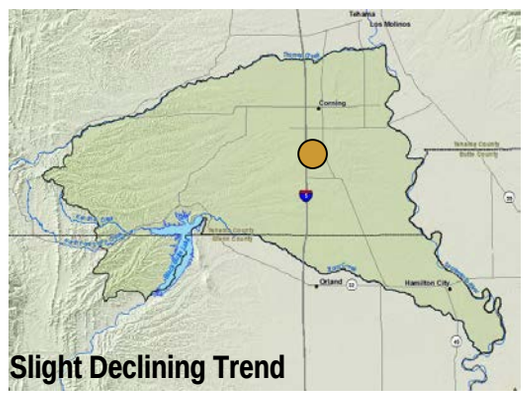


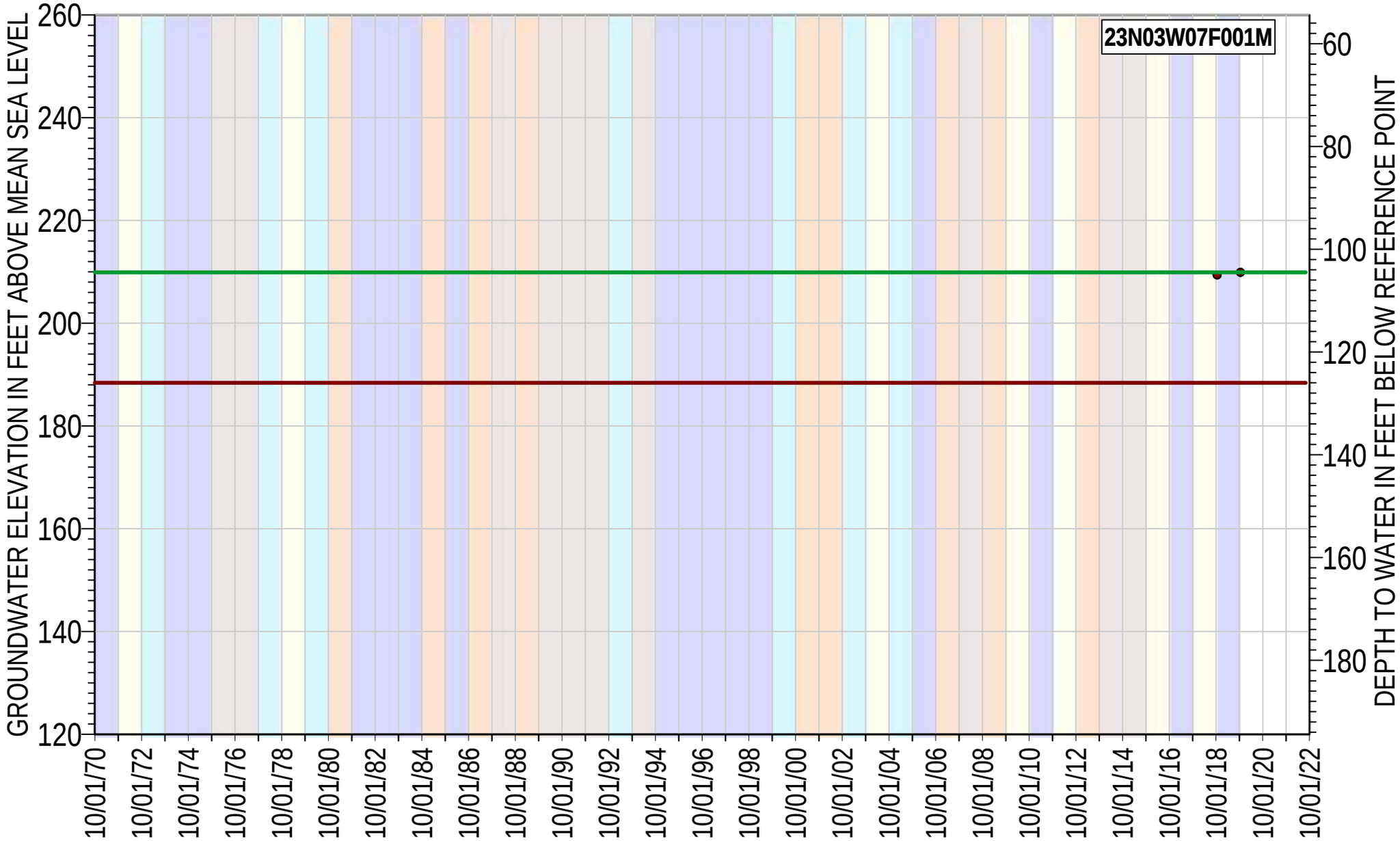
23N03W04H001M Fall Groundwater Elevation
Land Surface Elevation
Measurable Objective
Minimum Threshold

Reference Point Elevation= 261.9 ft AMSL
Well Type: Irrigation
Total Depth: 270 ft bgs
Well Screen Interval= 200 - 270 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





23N03W07F001M Fall Groundwater Elevation
Measurable Objective
Minimum Threshold

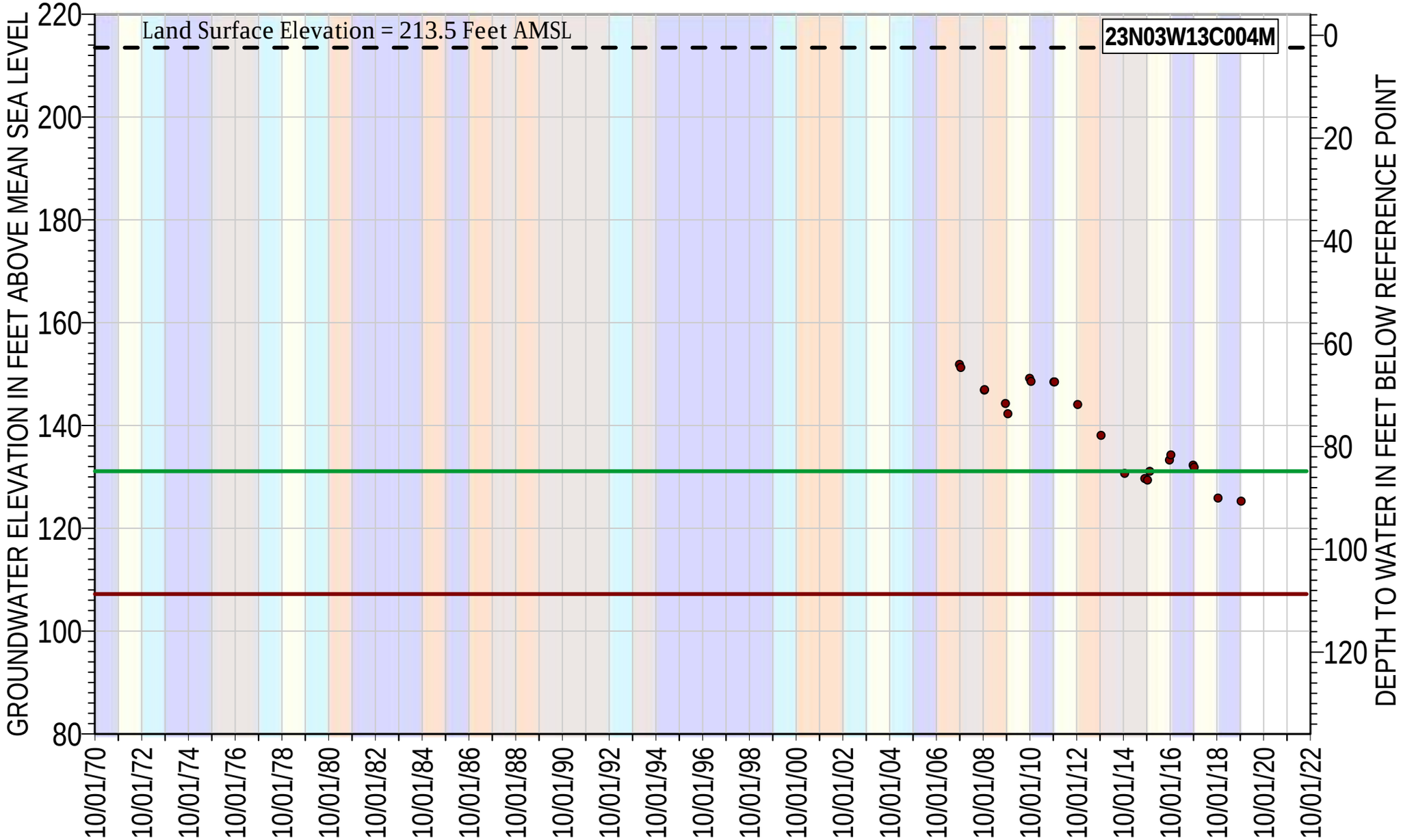
Reference Point Elevation= 314.4 ft AMSL
Well Type: Irrigation
Total Depth: 790 ft bgs
Well Screen Interval= 240 - 790 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



**Note: Insufficient Data - MO defined using 2016-2019 max*



23N03W13C004M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

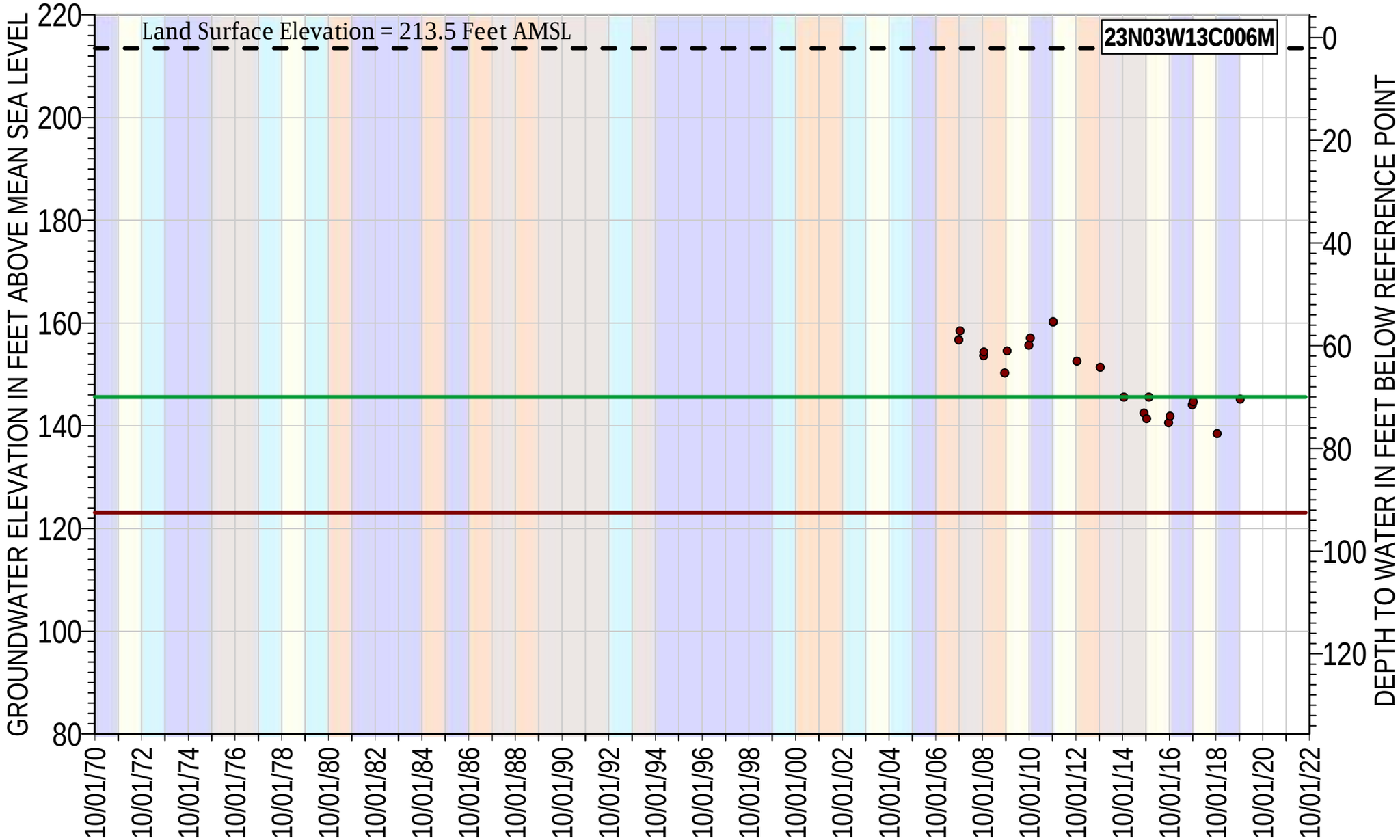
Minimum Threshold

Reference Point Elevation= 215.9 ft AMSL
Well Type: Observation
Total Depth: 835 ft bgs
Well Screen Interval= 815 - 825 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





23N03W13C006M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

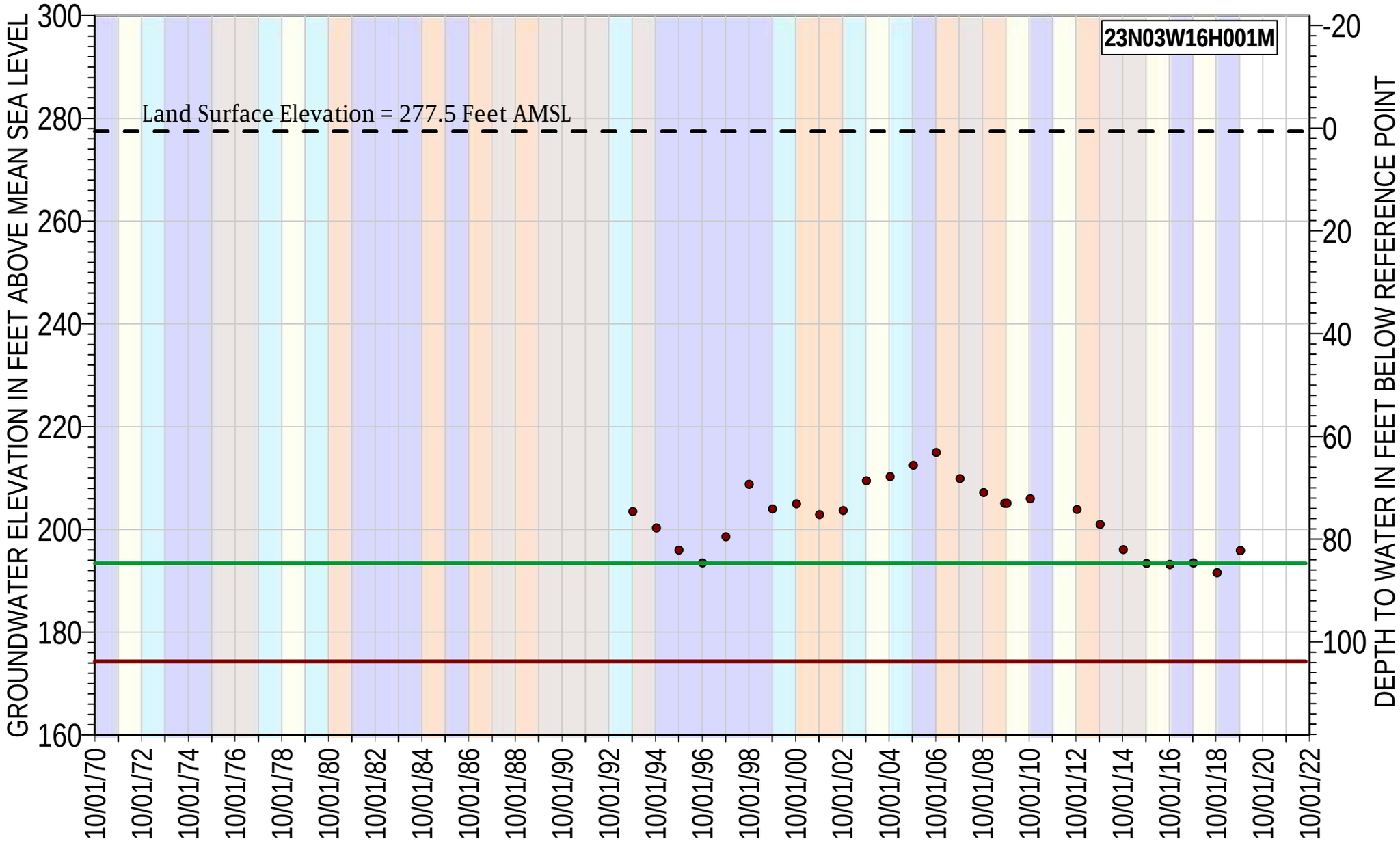
Minimum Threshold

Reference Point Elevation= 215.6 ft AMSL
Well Type: Observation
Total Depth: 182 ft bgs
Well Screen Interval= 95 - 135 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





23N03W16H001M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

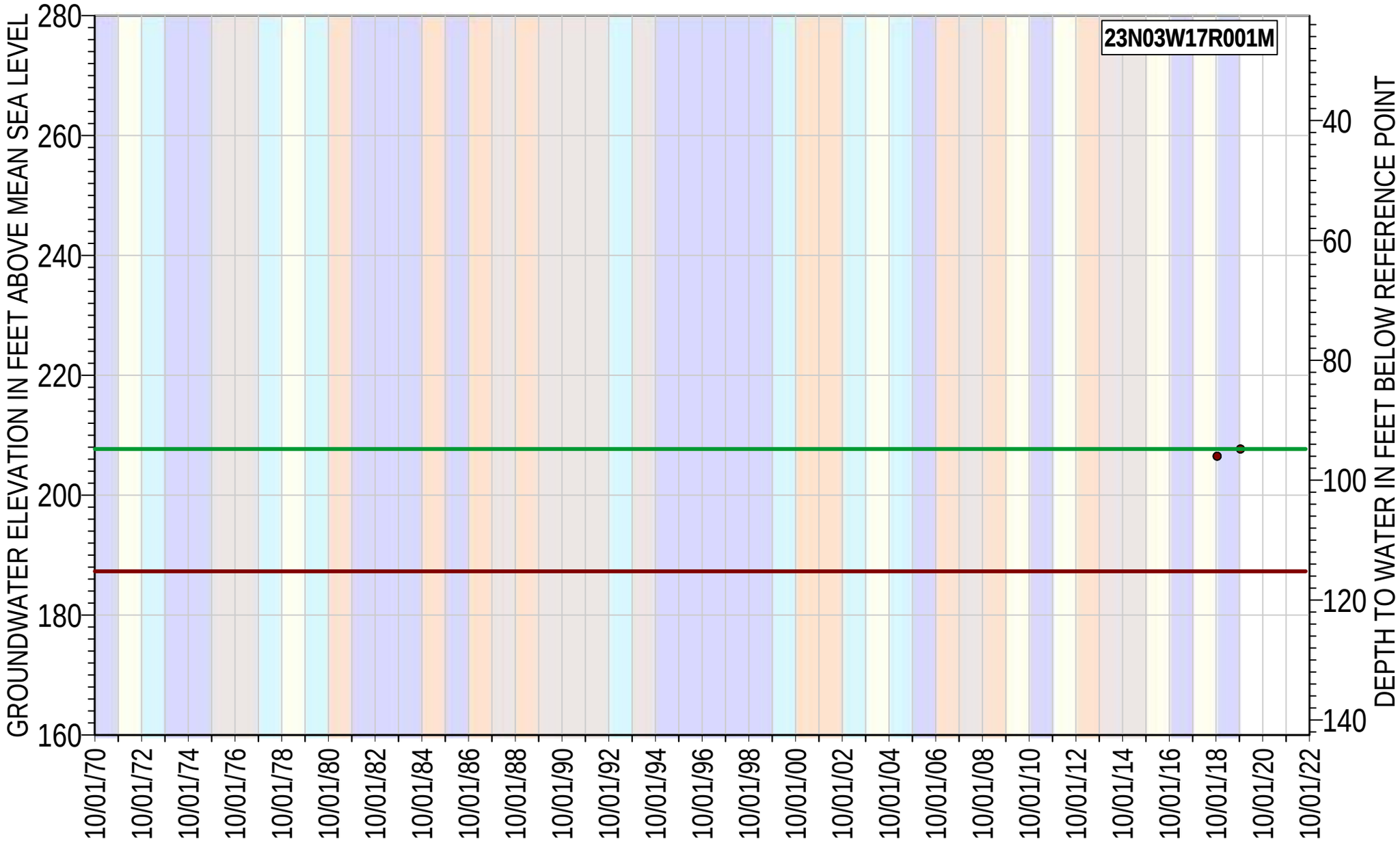
Minimum Threshold

Reference Point Elevation= 278.1 ft AMSL
Well Type: Domestic
Total Depth: 150 ft bgs
Well Screen Interval= 144 - 150 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





23N03W17R001M Fall Groundwater Elevation

Measurable Objective

Minimum Threshold

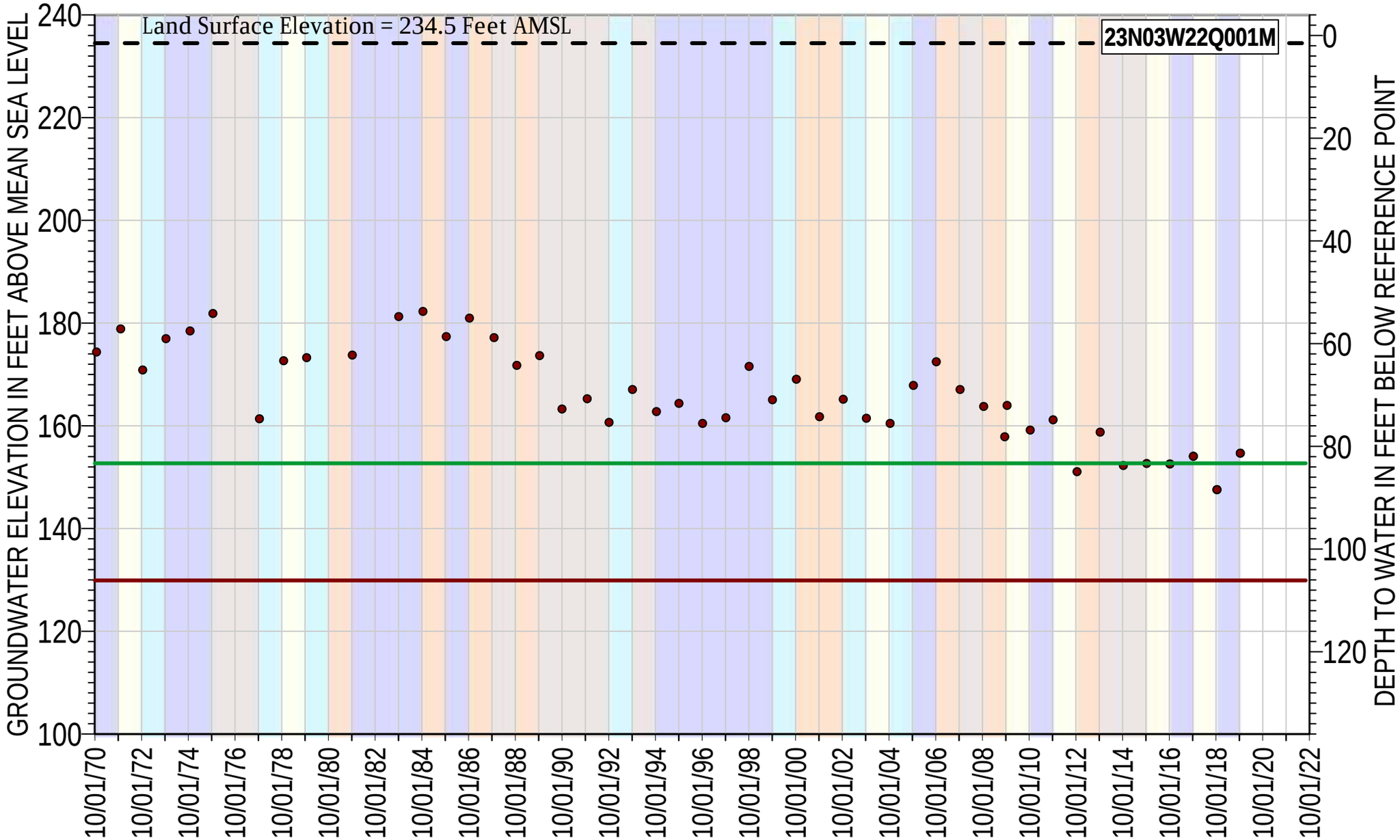
Reference Point Elevation= 302.5 ft AMSL
Well Type: Irrigation
Total Depth: 720 ft bgs
Well Screen Interval= 360 - 720 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



**Note: Insufficient Data - MO defined using 2016-2019 max*



23N03W22Q001M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

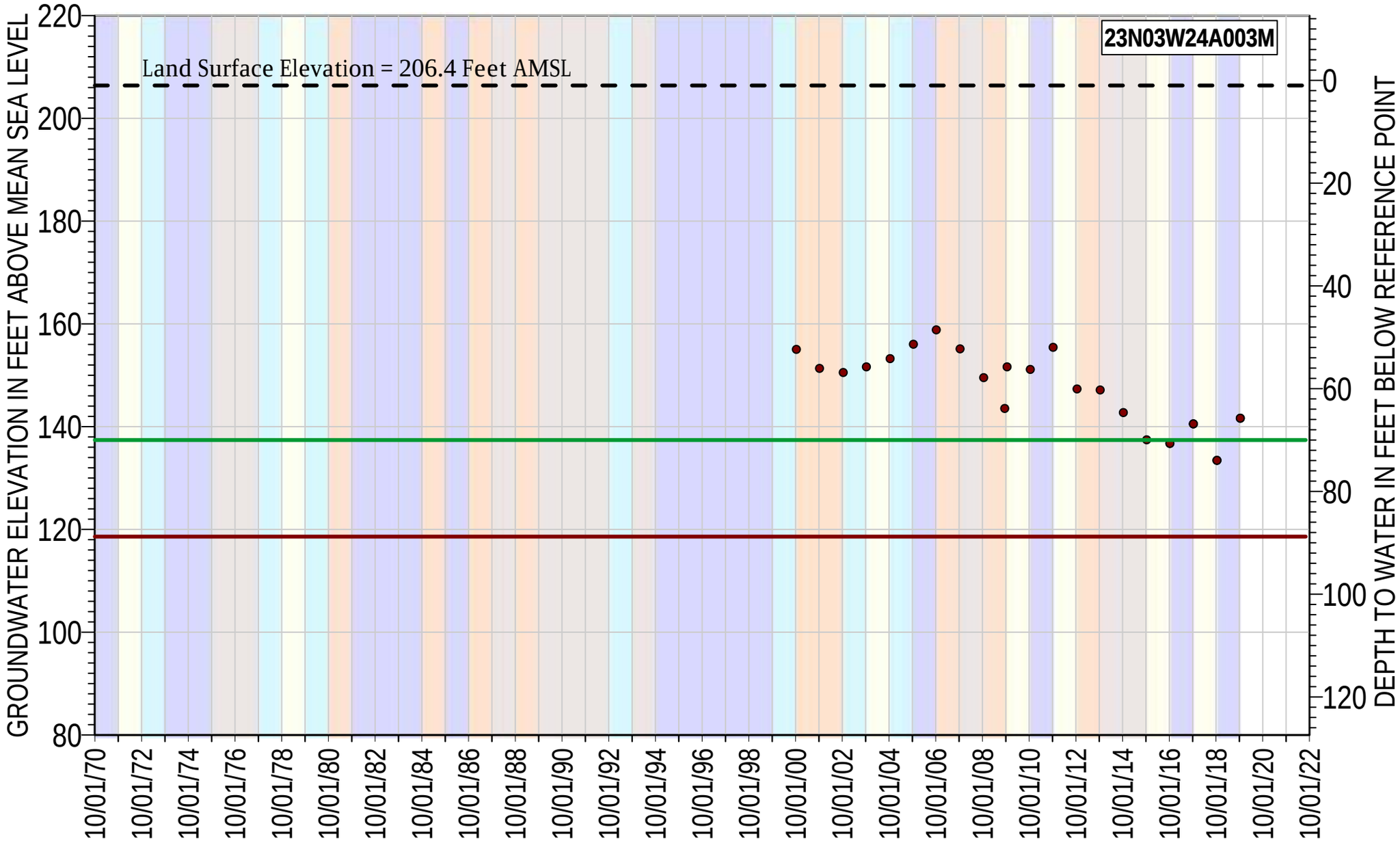
Minimum Threshold

Reference Point Elevation= 236 ft AMSL
Well Type: Irrigation
Total Depth: 380 ft bgs
Well Screen Interval= Unknown ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





23N03W24A003M Fall Groundwater Elevation

Land Surface Elevation

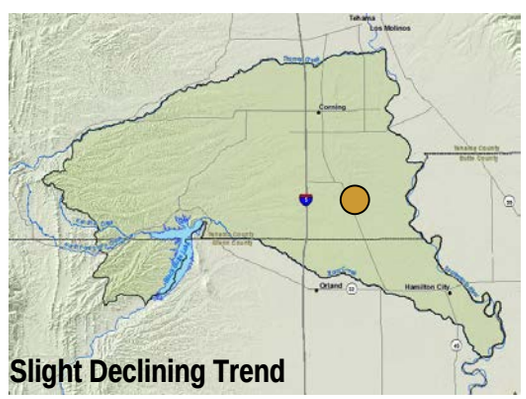
Measurable Objective

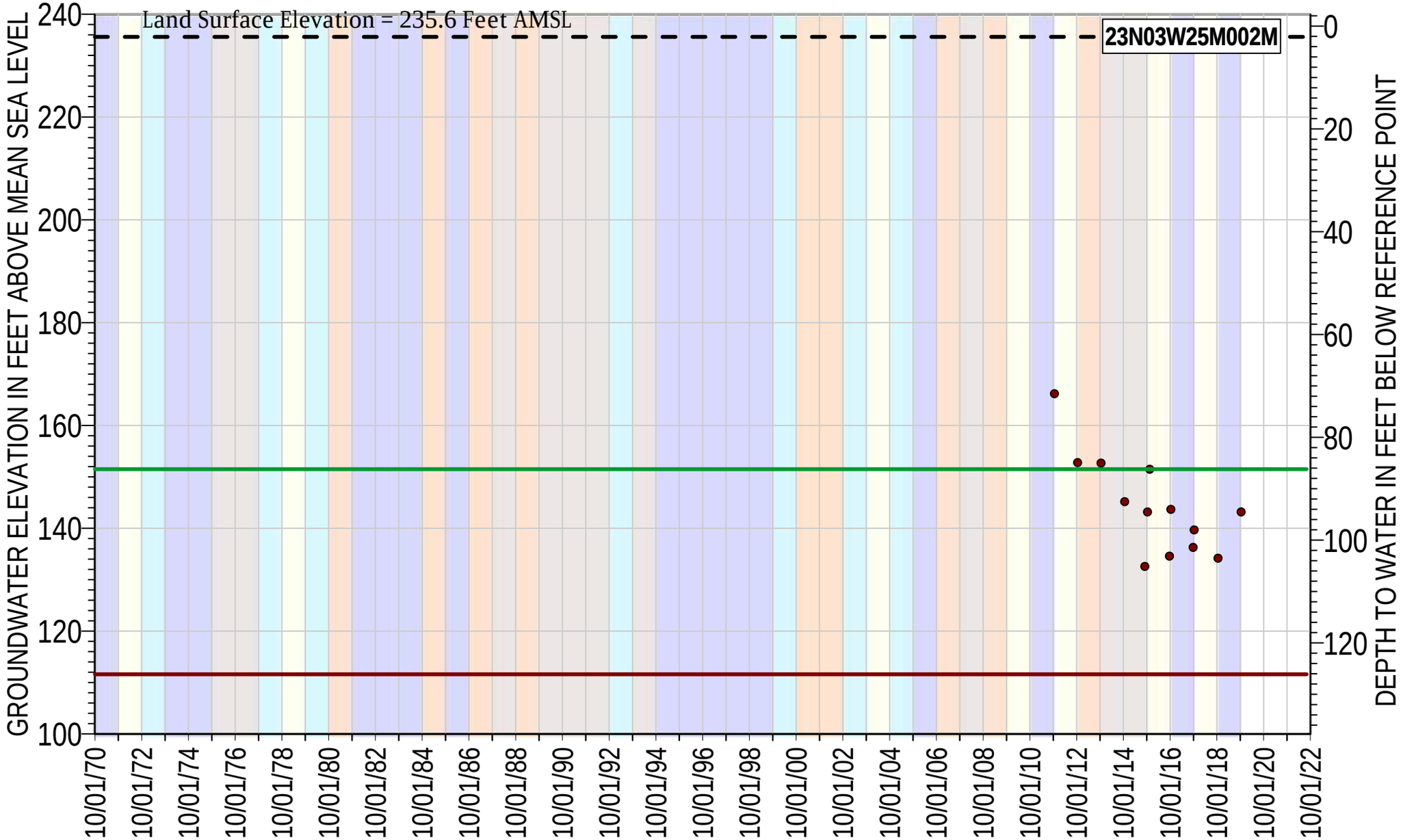
Minimum Threshold

Reference Point Elevation= 207.4 ft AMSL
Well Type: Domestic
Total Depth: 199 ft bgs
Well Screen Interval= 180 - 199 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





23N03W25M002M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

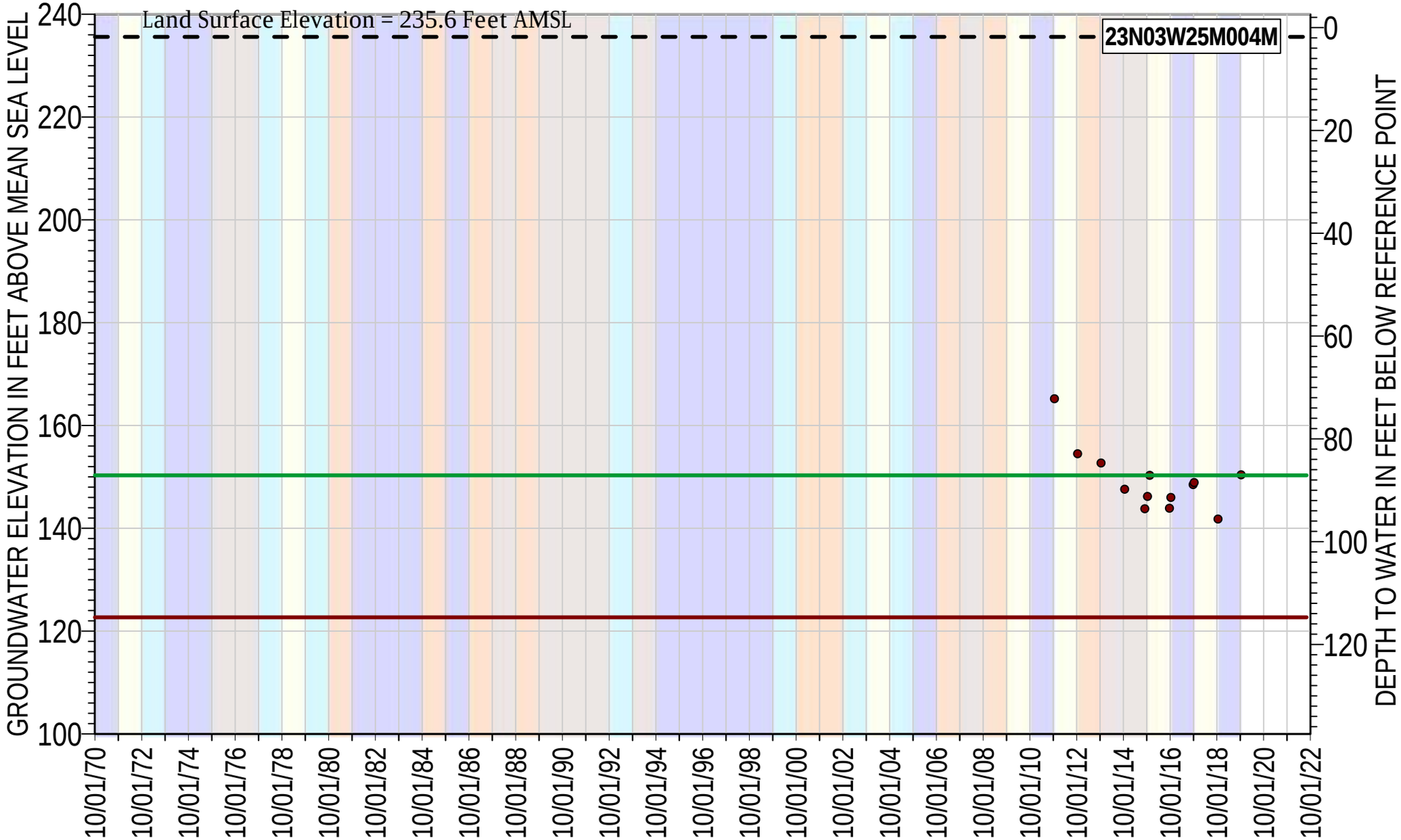
Minimum Threshold

Reference Point Elevation= 237.7 ft AMSL
Well Type: Observation
Total Depth: 513 ft bgs
Well Screen Interval= 470 - 500 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





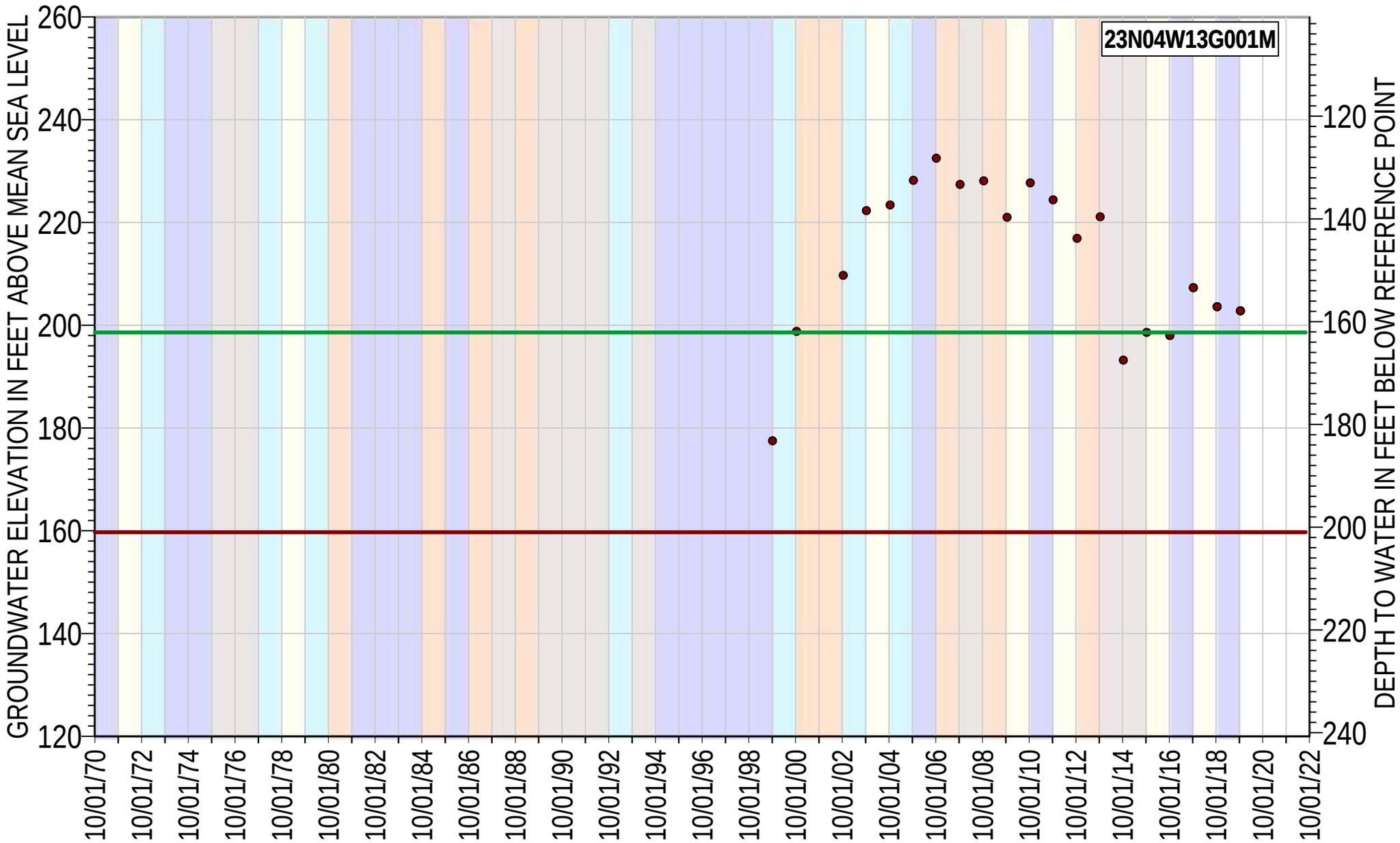
23N03W25M004M Fall Groundwater Elevation
Land Surface Elevation
Measurable Objective
Minimum Threshold

Reference Point Elevation= 237.4 ft AMSL
Well Type: Observation
Total Depth: 155 ft bgs
Well Screen Interval= 120 - 130 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





23N04W13G001M Fall Groundwater Elevation

Measurable Objective

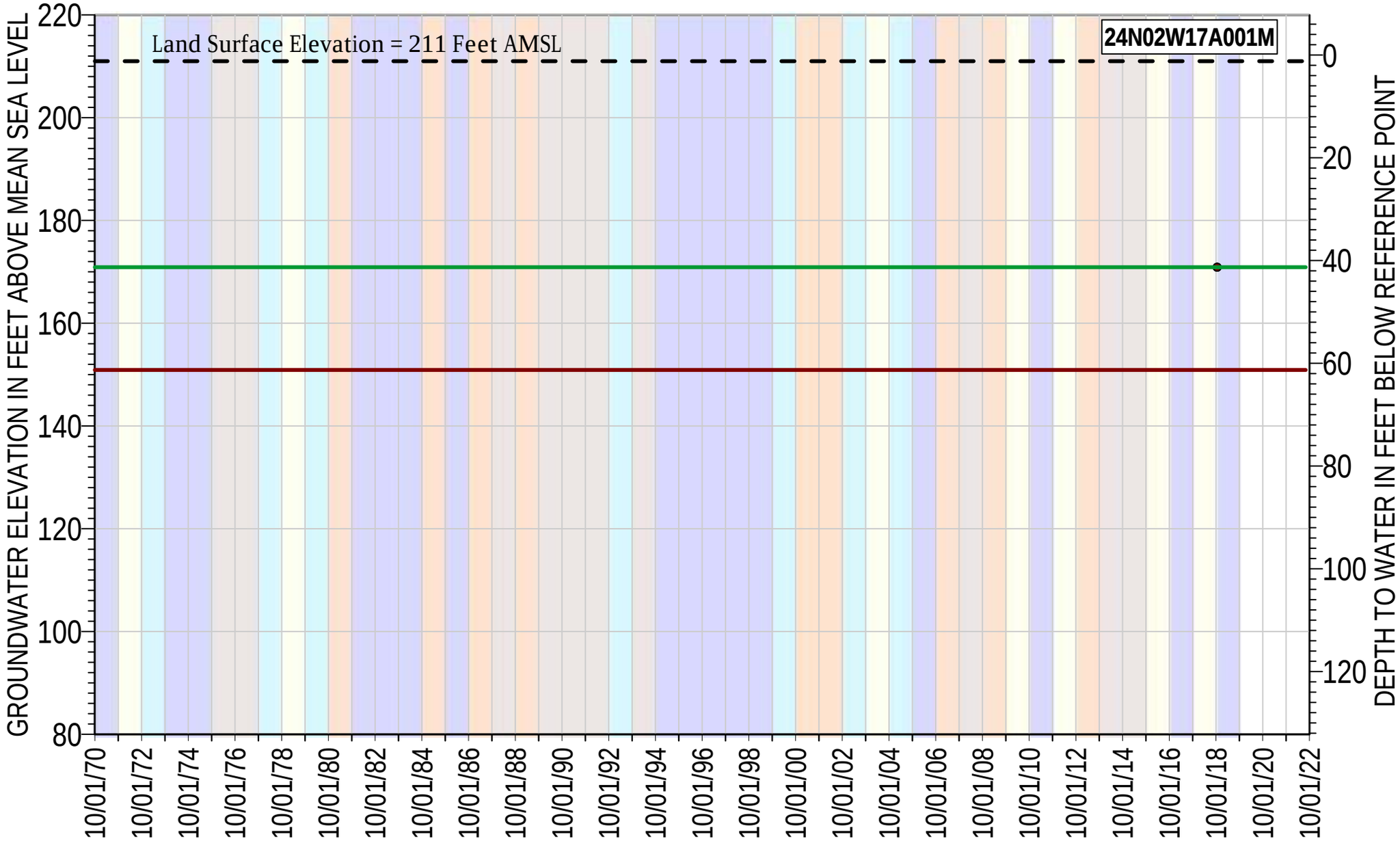
Minimum Threshold

Reference Point Elevation= 360.7 ft AMSL
Well Type: Irrigation
Total Depth: 560 ft bgs
Well Screen Interval= Unknown ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



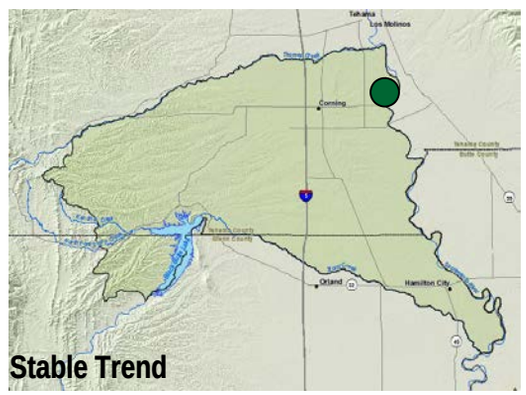


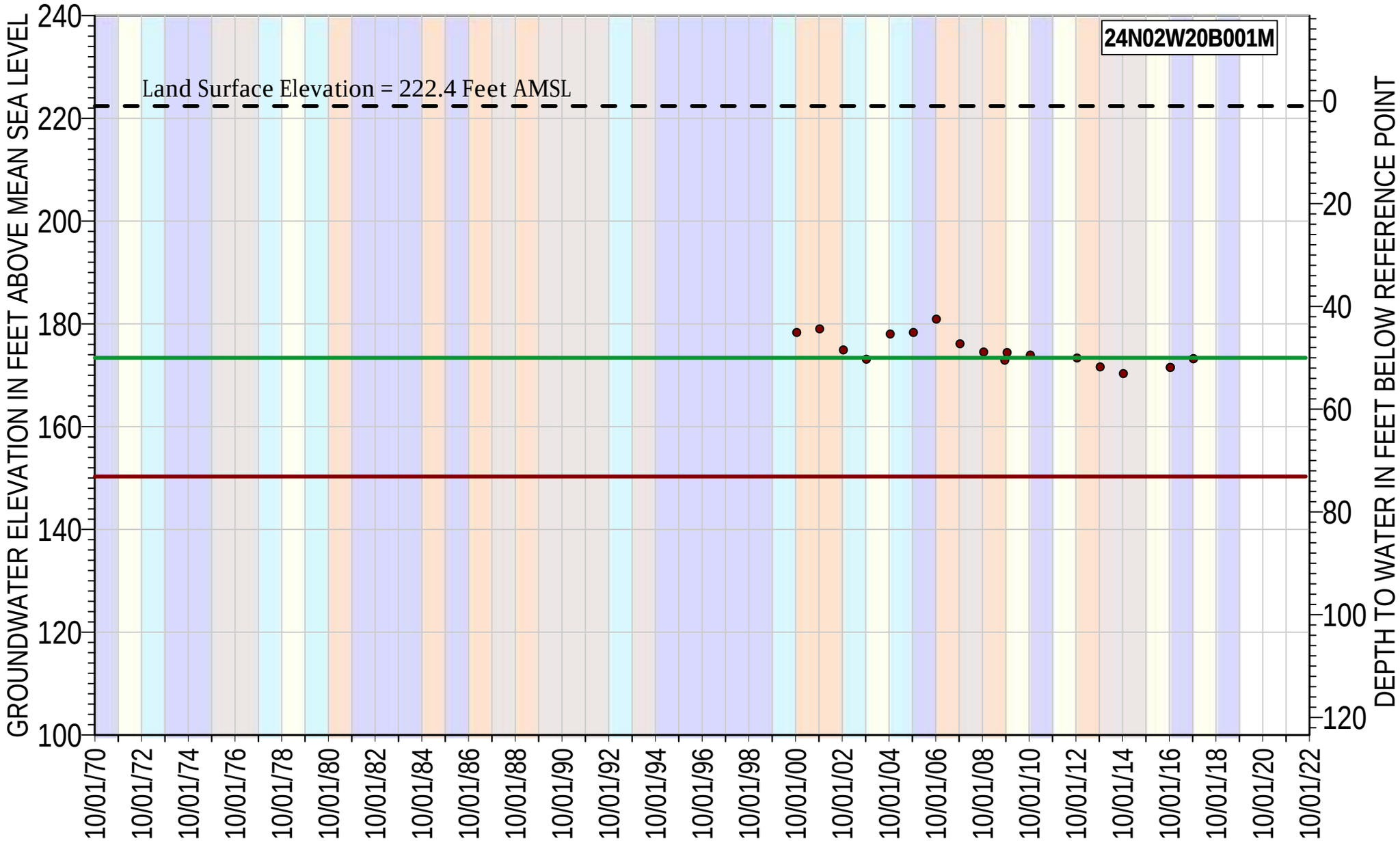
24N02W17A001M Fall Groundwater Elevation
Land Surface Elevation
Measurable Objective
Minimum Threshold

Reference Point Elevation= 212.2 ft AMSL
Well Type: Domestic
Total Depth: 140 ft bgs
Well Screen Interval= 120 - 140 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



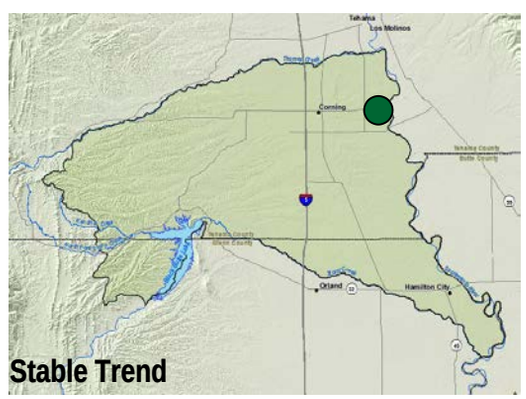


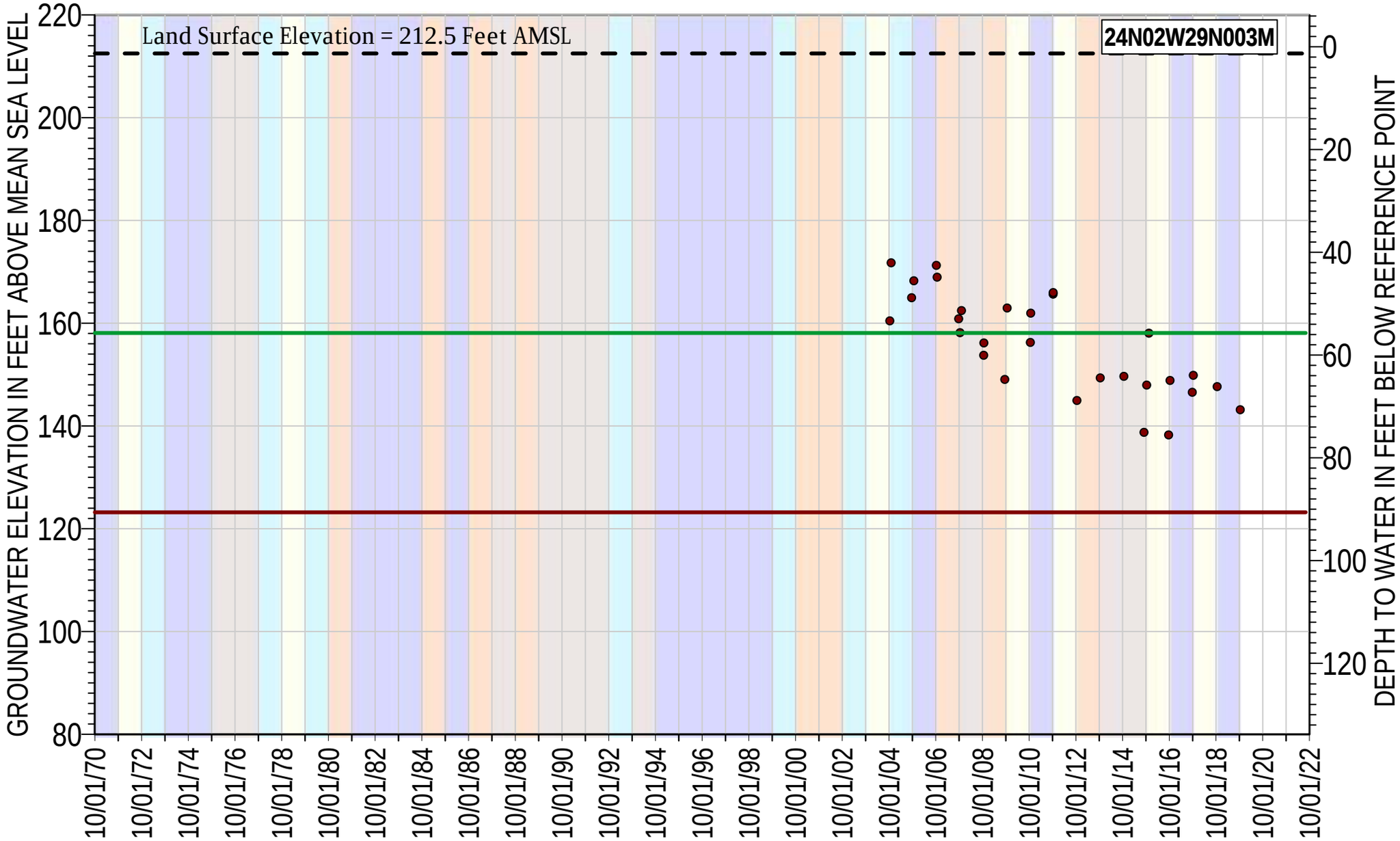
24N02W20B001M Fall Groundwater Elevation
Land Surface Elevation
Measurable Objective
Minimum Threshold

Reference Point Elevation= 223.4 ft AMSL
Well Type: Domestic
Total Depth: 120 ft bgs
Well Screen Interval= 100 - 120 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





24N02W29N003M Fall Groundwater Elevation

Land Surface Elevation

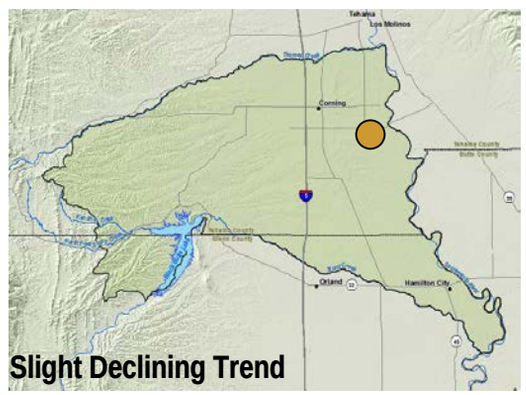
Measurable Objective

Minimum Threshold

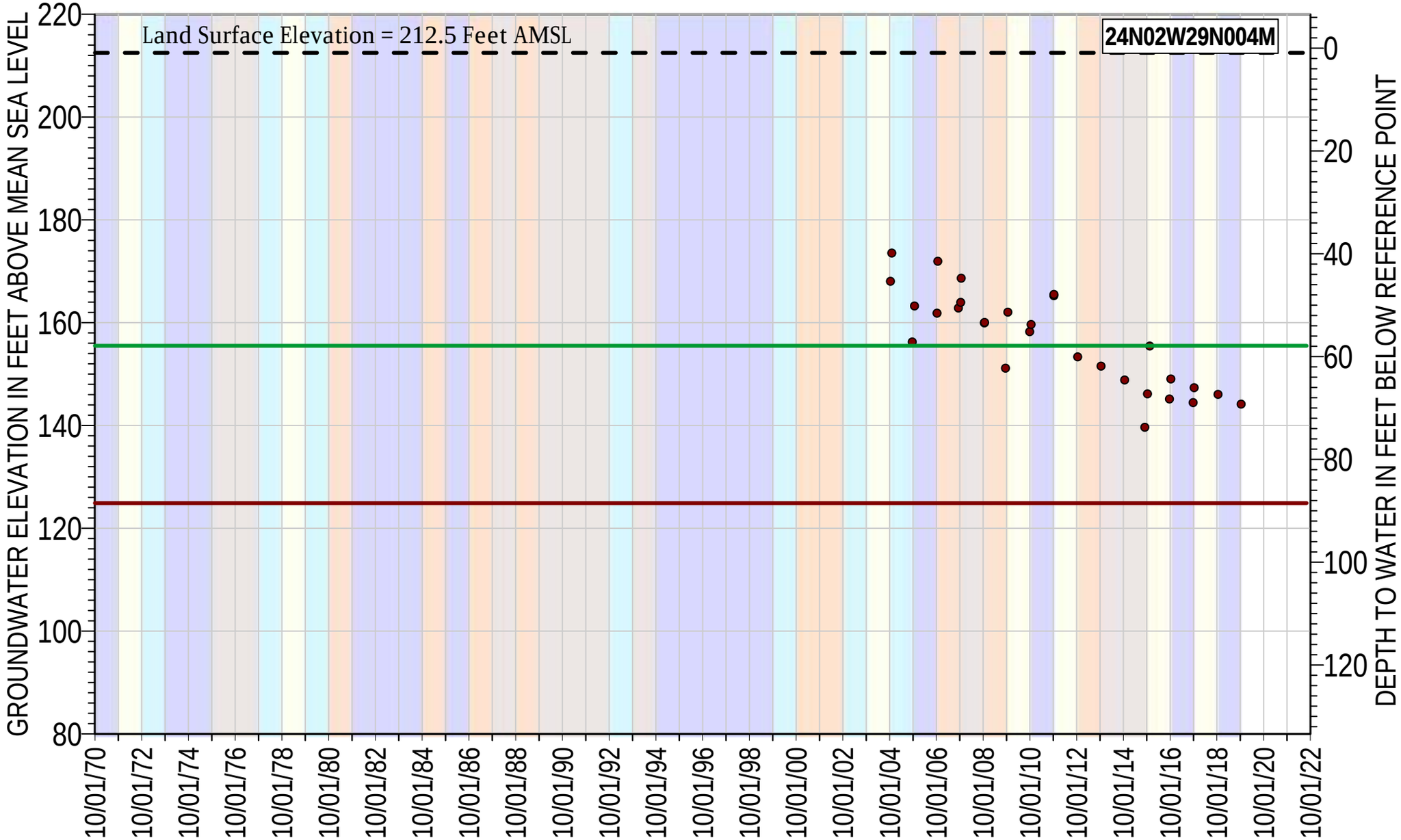
Reference Point Elevation= 213.8 ft AMSL
Well Type: Observation
Total Depth: 388 ft bgs
Well Screen Interval= 200 - 290 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



Slight Declining Trend



24N02W29N004M Fall Groundwater Elevation

Land Surface Elevation

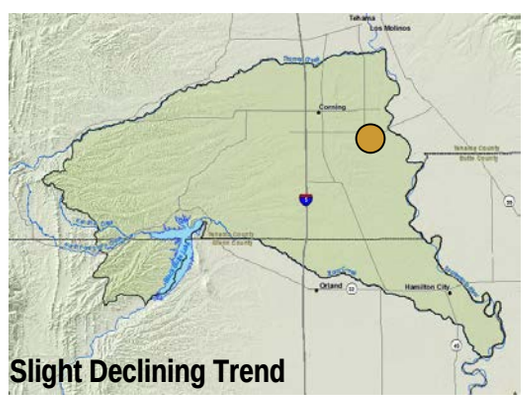
Measurable Objective

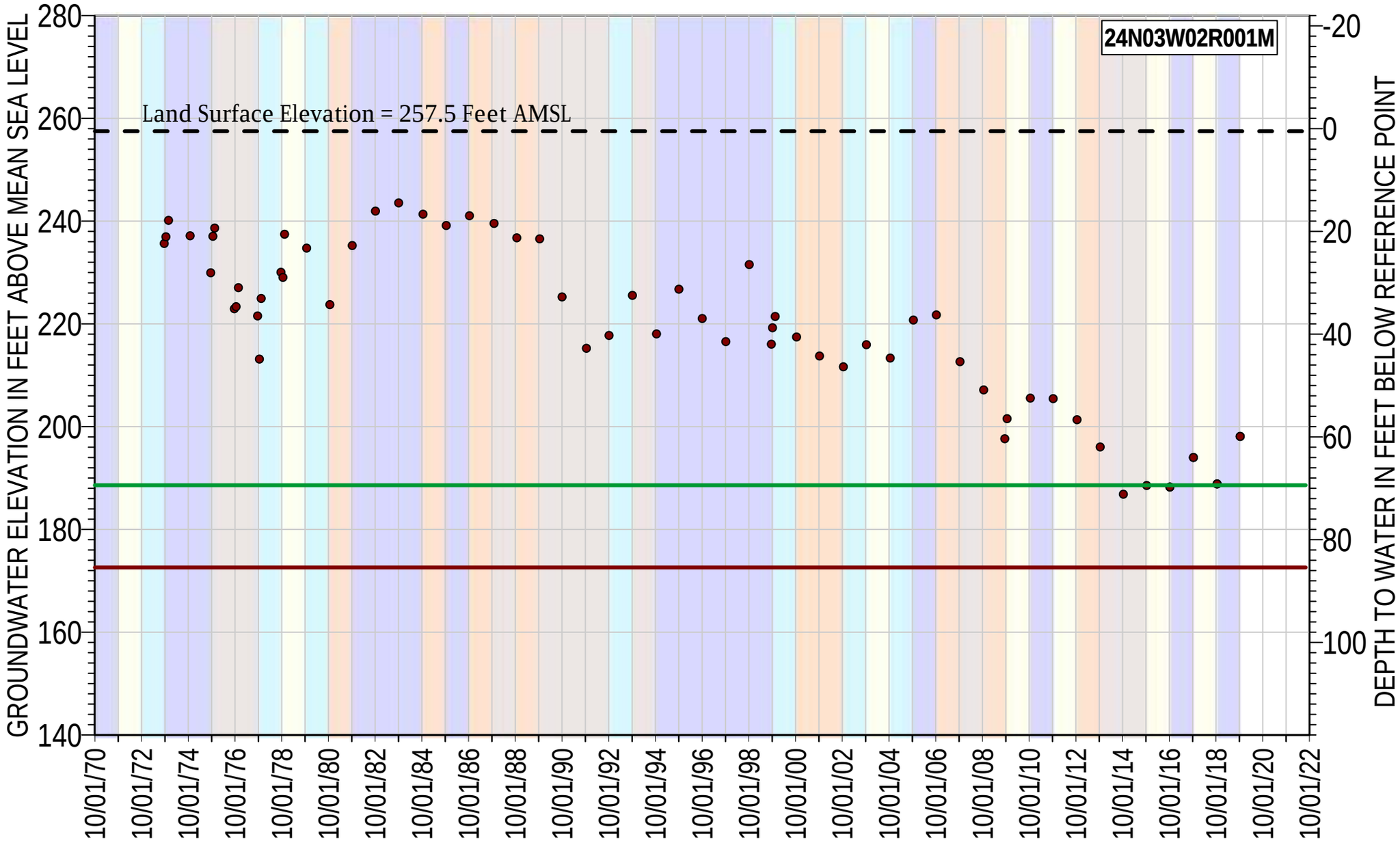
Minimum Threshold

Reference Point Elevation= 213.4 ft AMSL
Well Type: Observation
Total Depth: 741 ft bgs
Well Screen Interval= 590 - 710 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





24N03W02R001M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

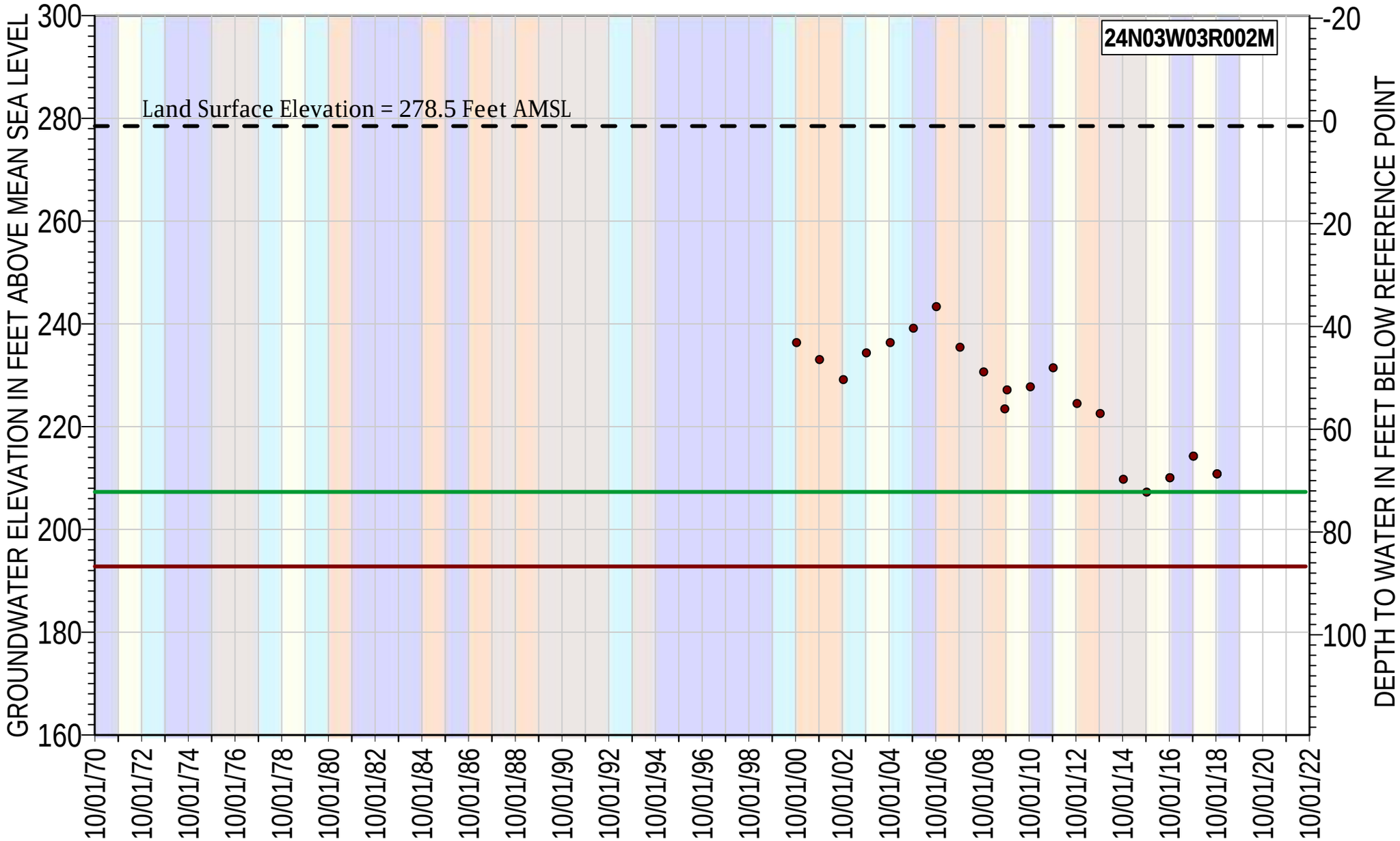
Minimum Threshold

Reference Point Elevation= 258 ft AMSL
Well Type: Domestic
Total Depth: 270 ft bgs
Well Screen Interval= Unknown ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





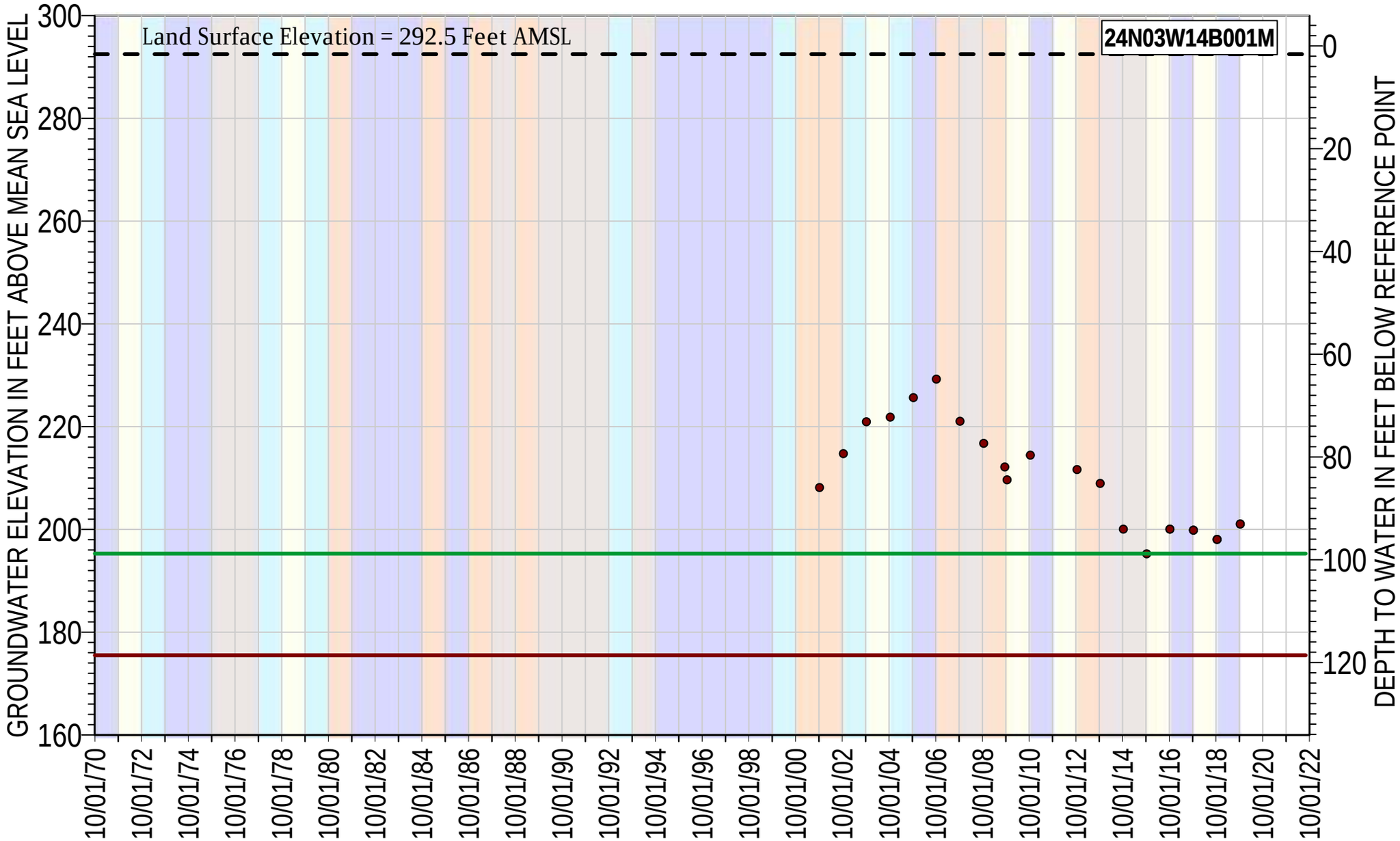
24N03W03R002M Fall Groundwater Elevation
Land Surface Elevation
Measurable Objective
Minimum Threshold

Reference Point Elevation= 279.5 ft AMSL
Well Type: Domestic
Total Depth: 132 ft bgs
Well Screen Interval= 112 - 132 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





24N03W14B001M Fall Groundwater Elevation

Land Surface Elevation

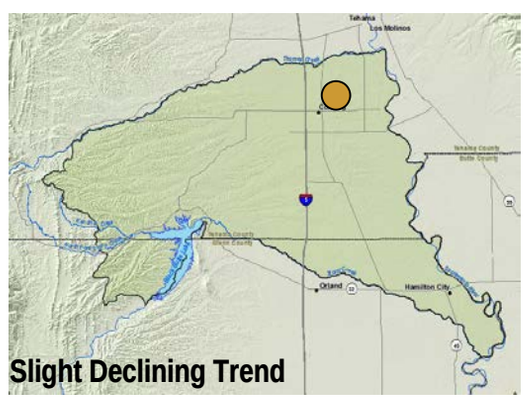
Measurable Objective

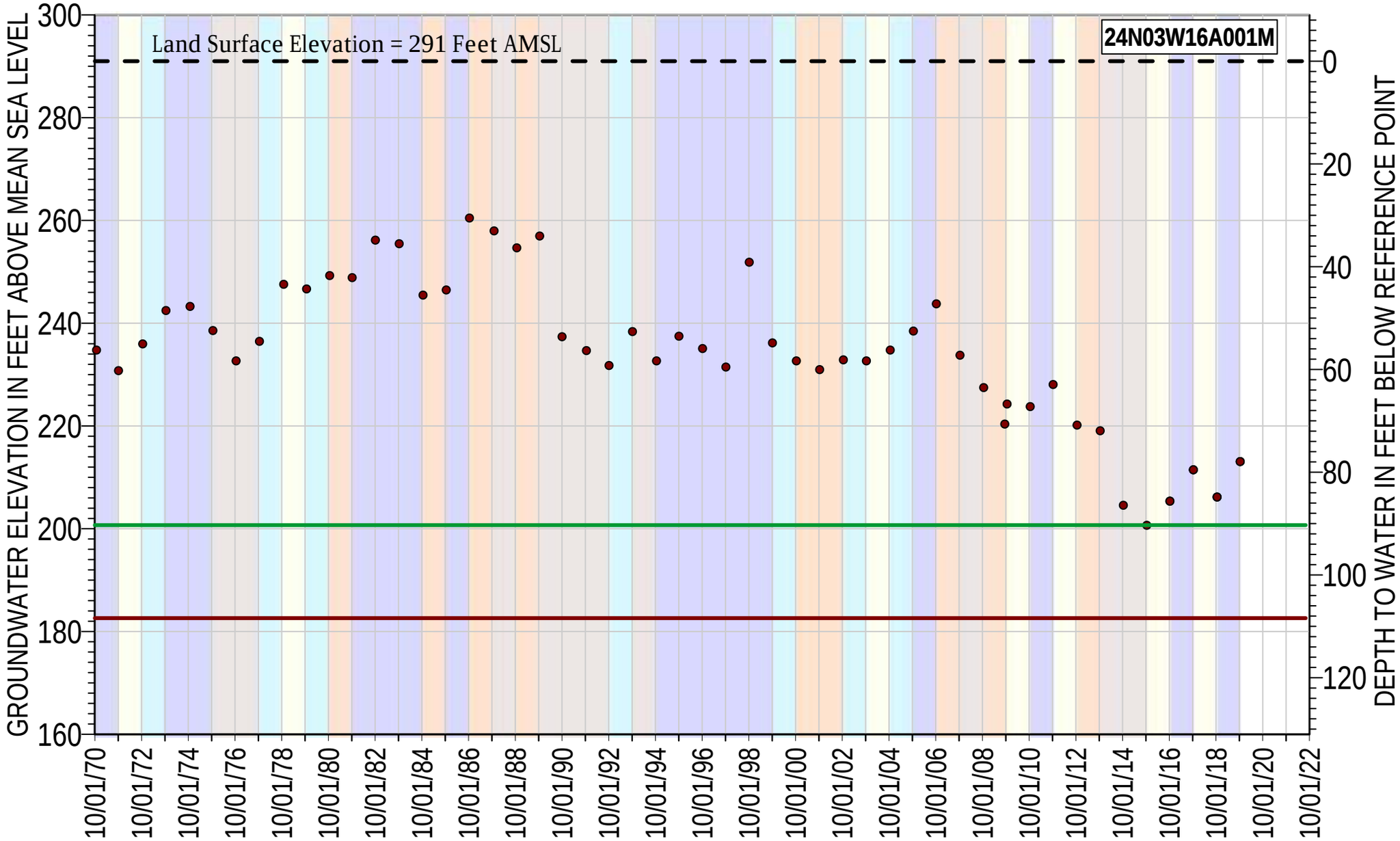
Minimum Threshold

Reference Point Elevation= 294.1 ft AMSL
Well Type: Industrial
Total Depth: 140 ft bgs
Well Screen Interval= 130 - 140 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





24N03W16A001M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

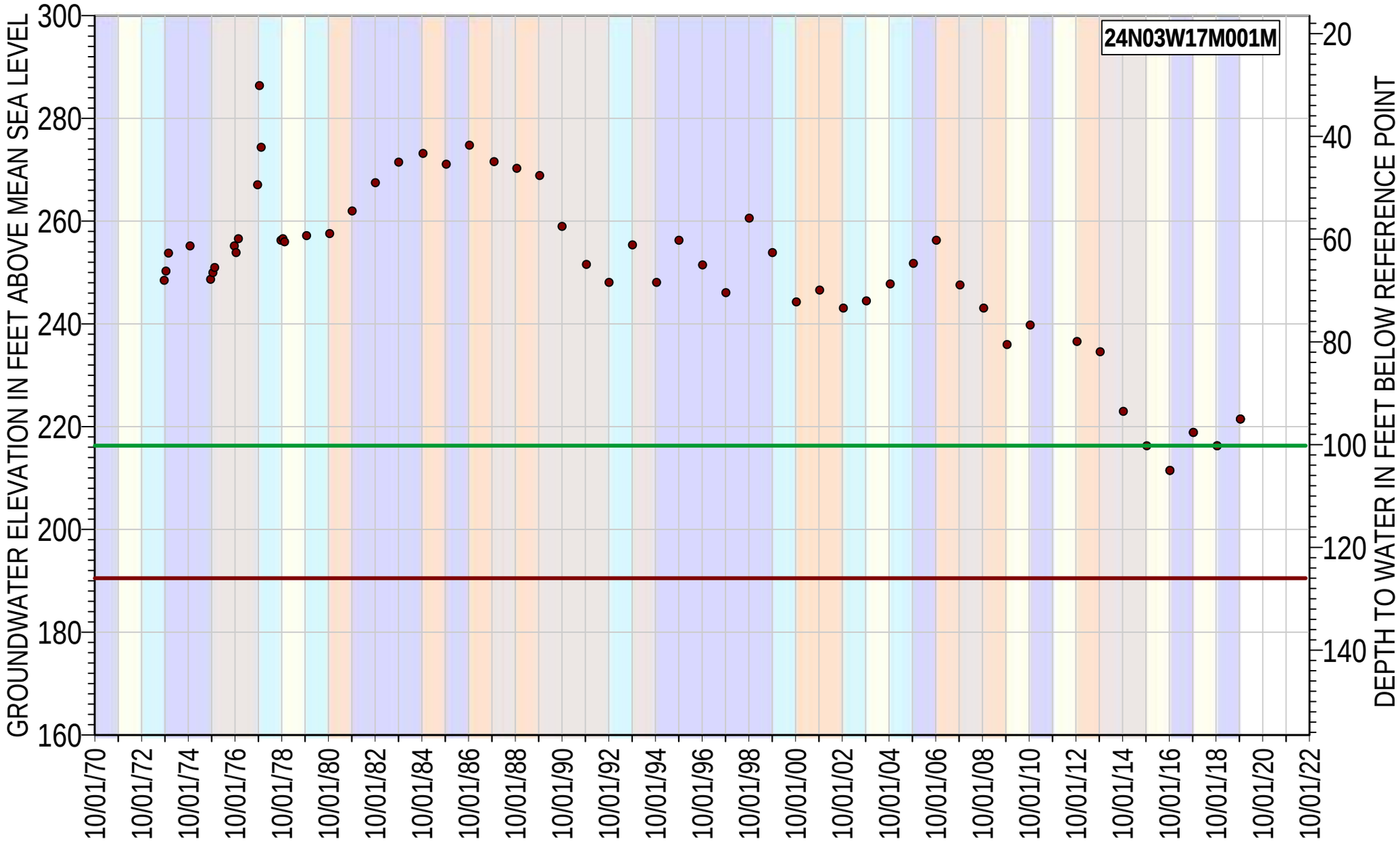
Minimum Threshold

Reference Point Elevation= 291 ft AMSL
Well Type: Irrigation
Total Depth: 195 ft bgs
Well Screen Interval= 85 - 195 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





24N03W17M001M Fall Groundwater Elevation

Measurable Objective

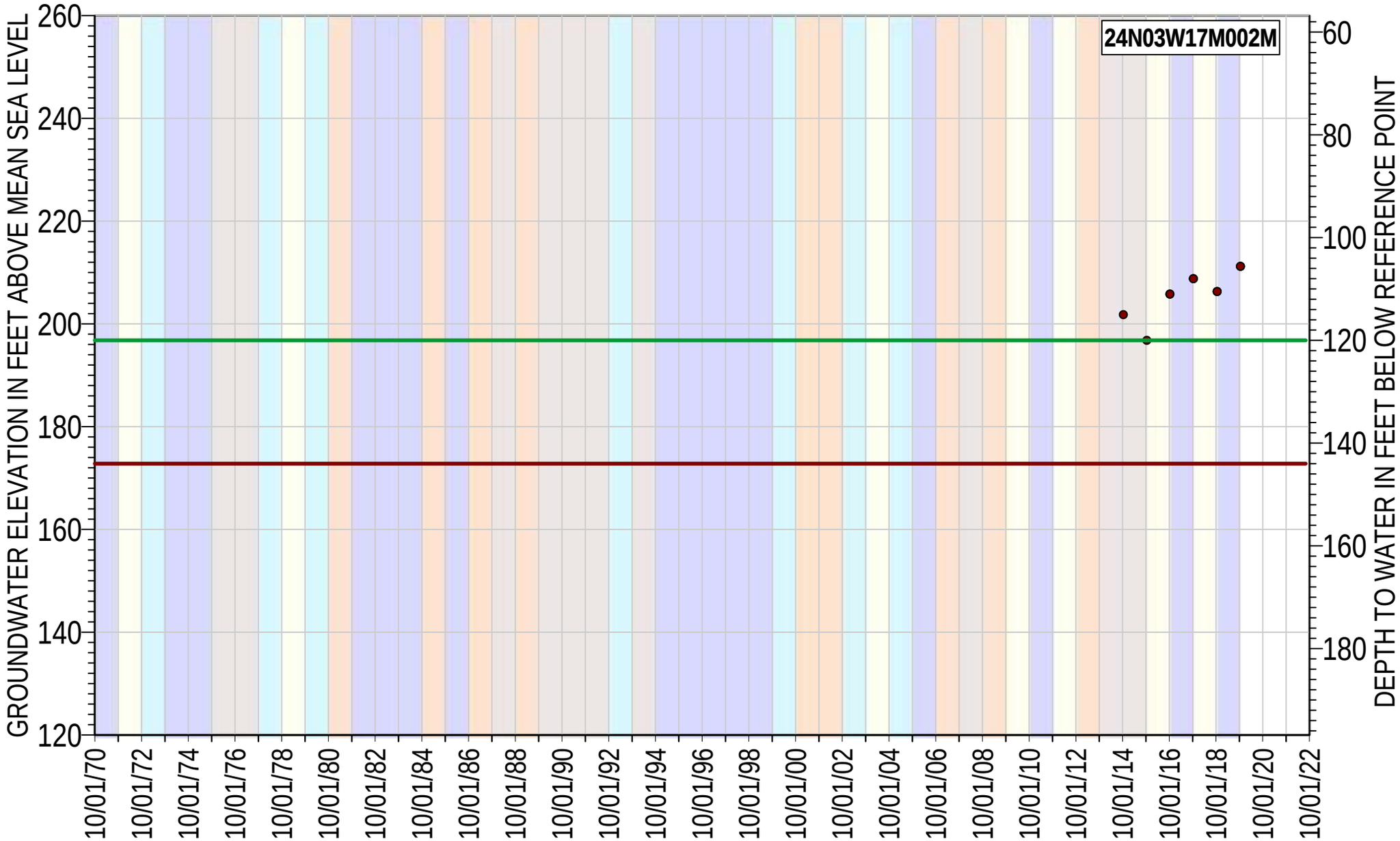
Minimum Threshold

Reference Point Elevation= 316.5 ft AMSL
Well Type: Domestic
Total Depth: 108 ft bgs
Well Screen Interval= 100 - 108 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





24N03W17M002M Fall Groundwater Elevation

Measurable Objective

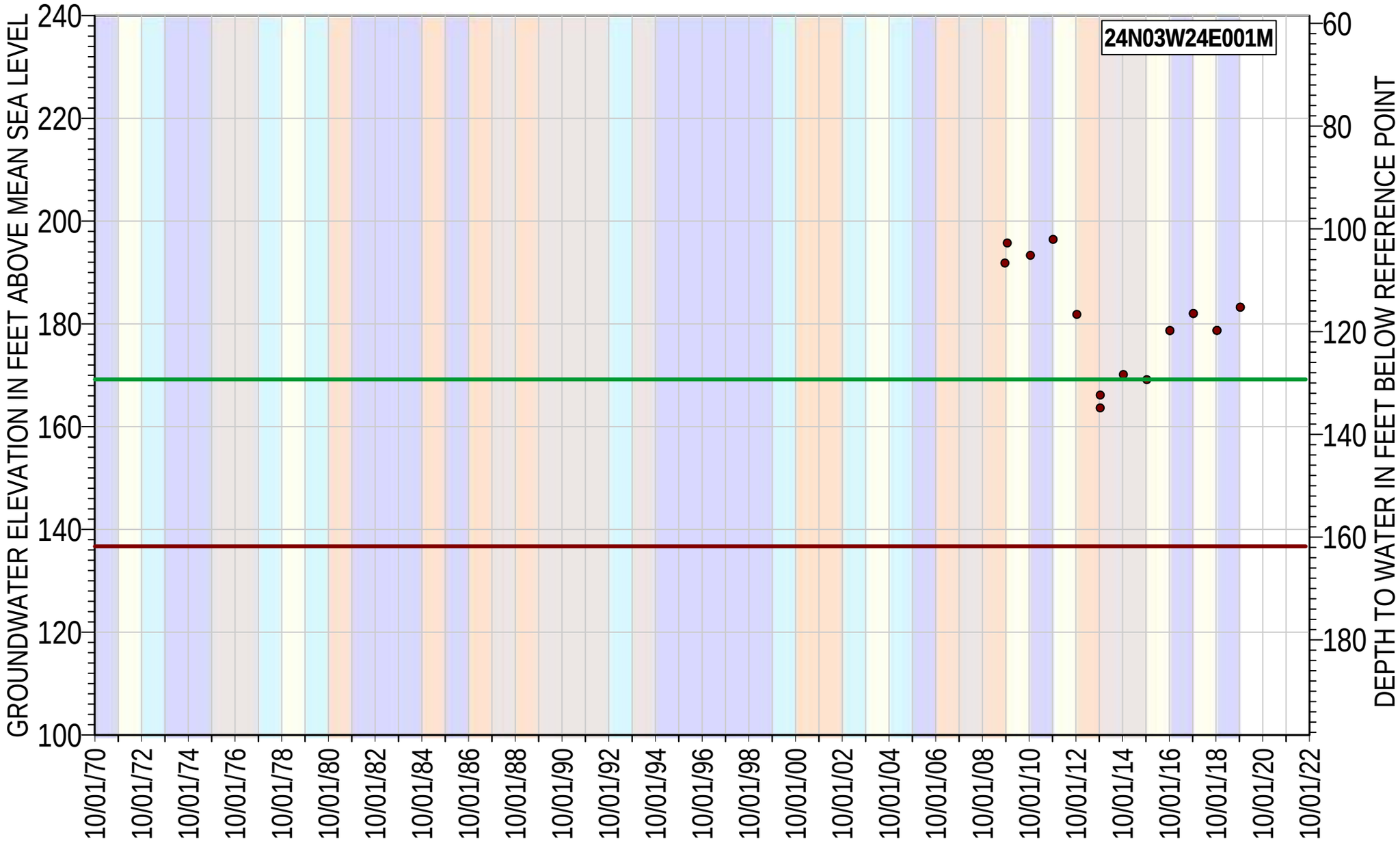
Minimum Threshold

Reference Point Elevation= 316.8 ft AMSL
Well Type: Irrigation
Total Depth: 505 ft bgs
Well Screen Interval= 315 - 495 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





24N03W24E001M Fall Groundwater Elevation

Measurable Objective

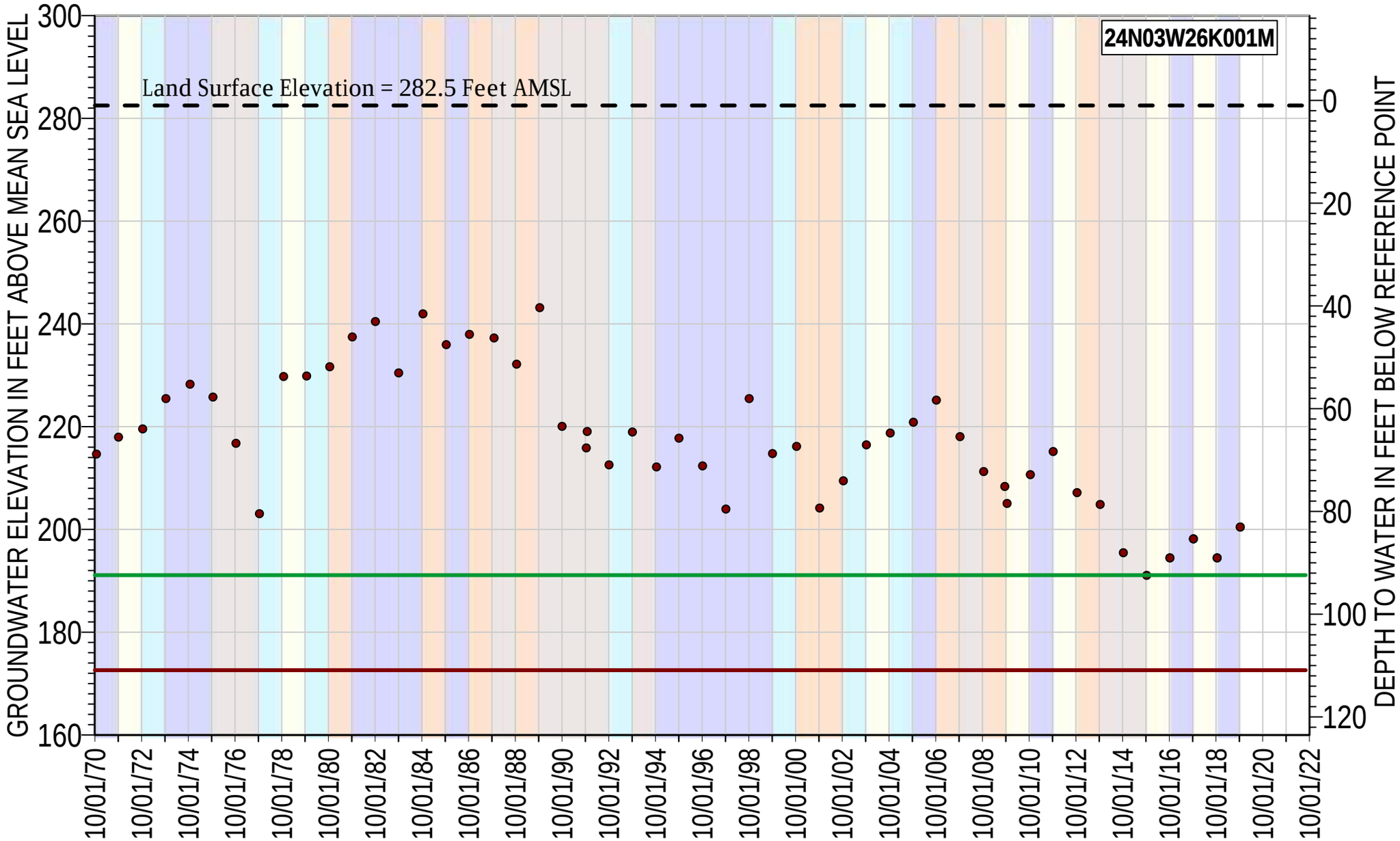
Minimum Threshold

Reference Point Elevation= 298.5 ft AMSL
Well Type: Domestic
Total Depth: 224 ft bgs
Well Screen Interval= 212 - 220 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





24N03W26K001M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

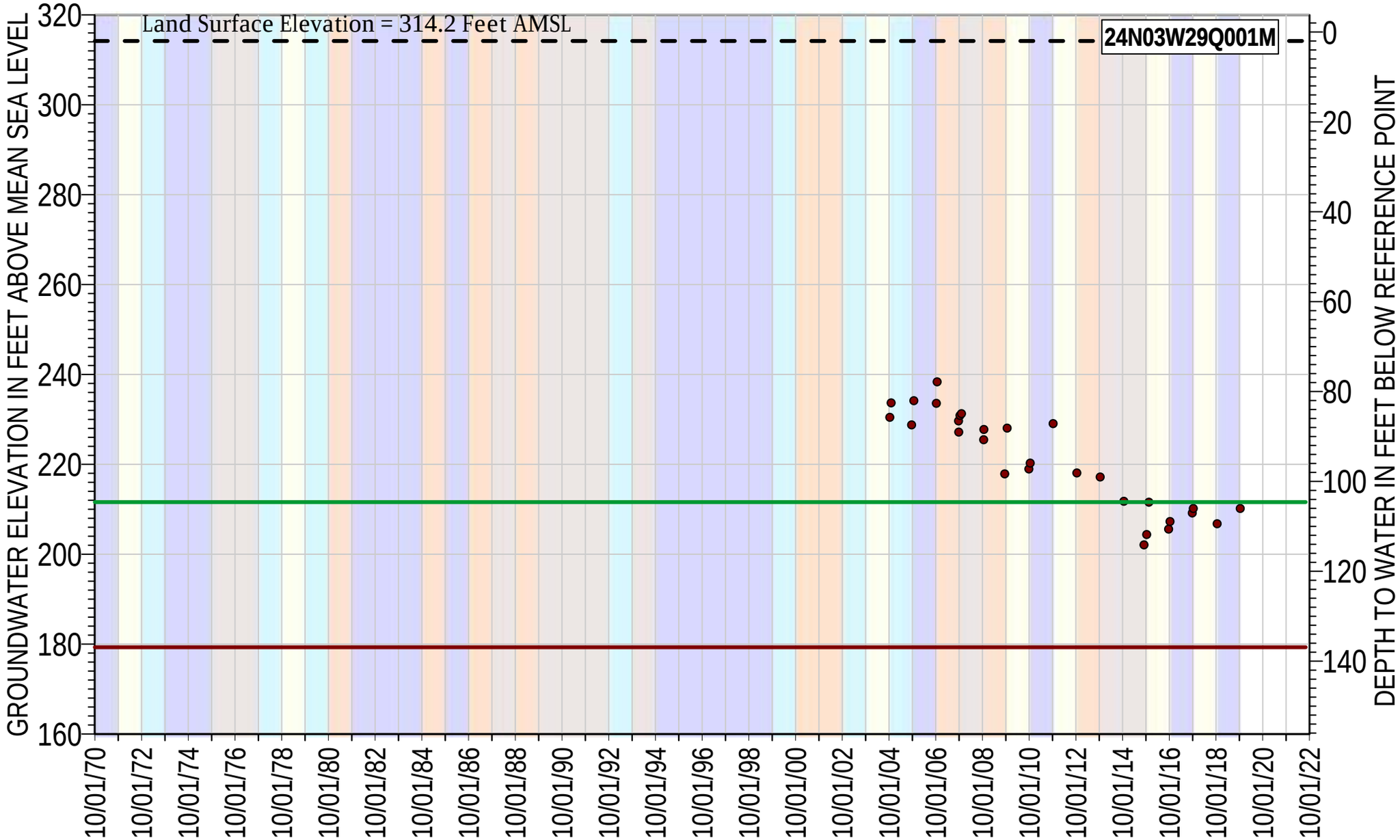
Minimum Threshold

Reference Point Elevation= 283.5 ft AMSL
Well Type: Irrigation
Total Depth: 245 ft bgs
Well Screen Interval= 103 - 175 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





24N03W29Q001M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

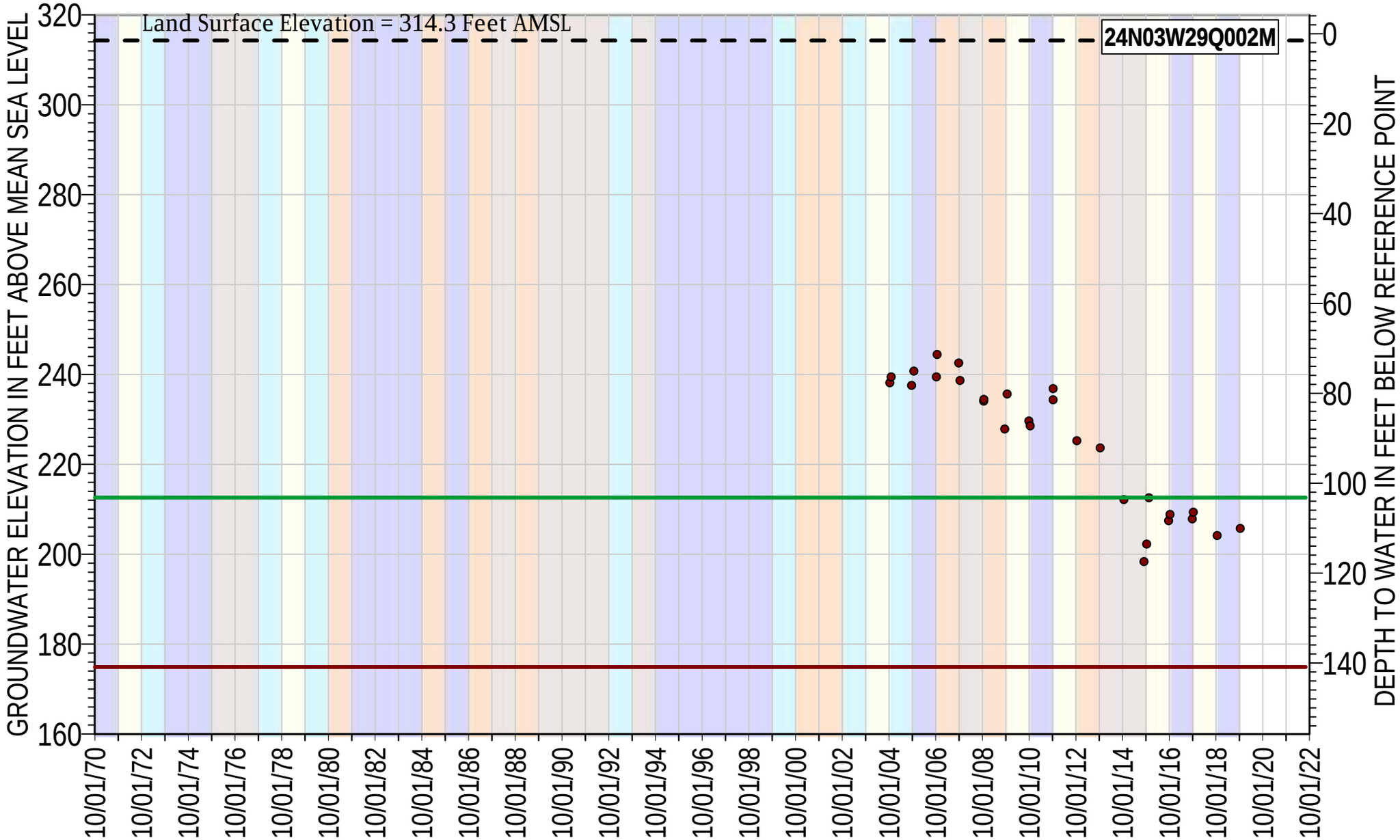
Minimum Threshold

Reference Point Elevation= 316.2 ft AMSL
Well Type: Observation
Total Depth: 372 ft bgs
Well Screen Interval= 130 - 360 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





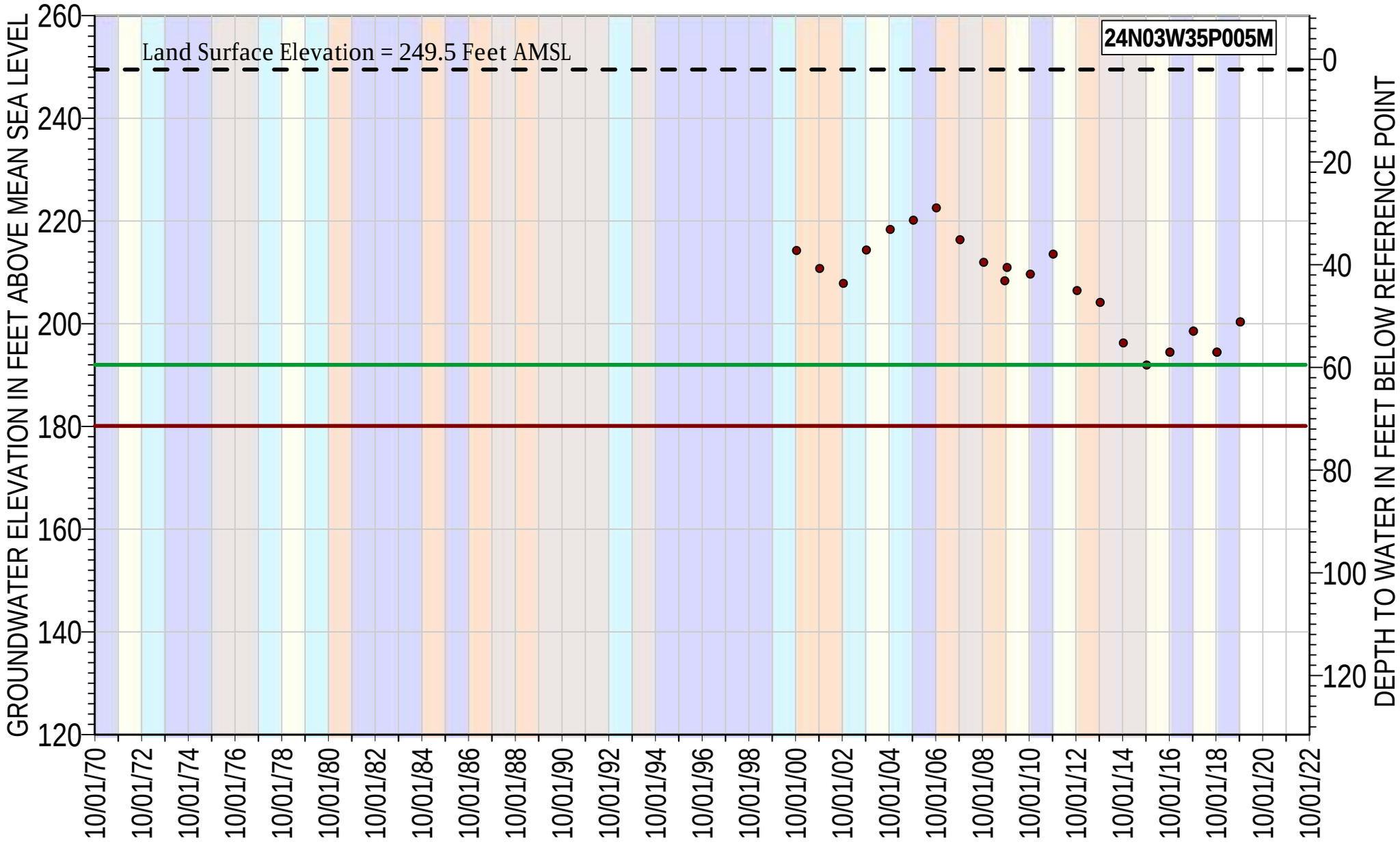
- 24N03W29Q002M Fall Groundwater Elevation
- Land Surface Elevation
- Measurable Objective
- Minimum Threshold

Reference Point Elevation= 315.8 ft AMSL
Well Type: Observation
Total Depth: 575 ft bgs
Well Screen Interval= 490 - 550 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





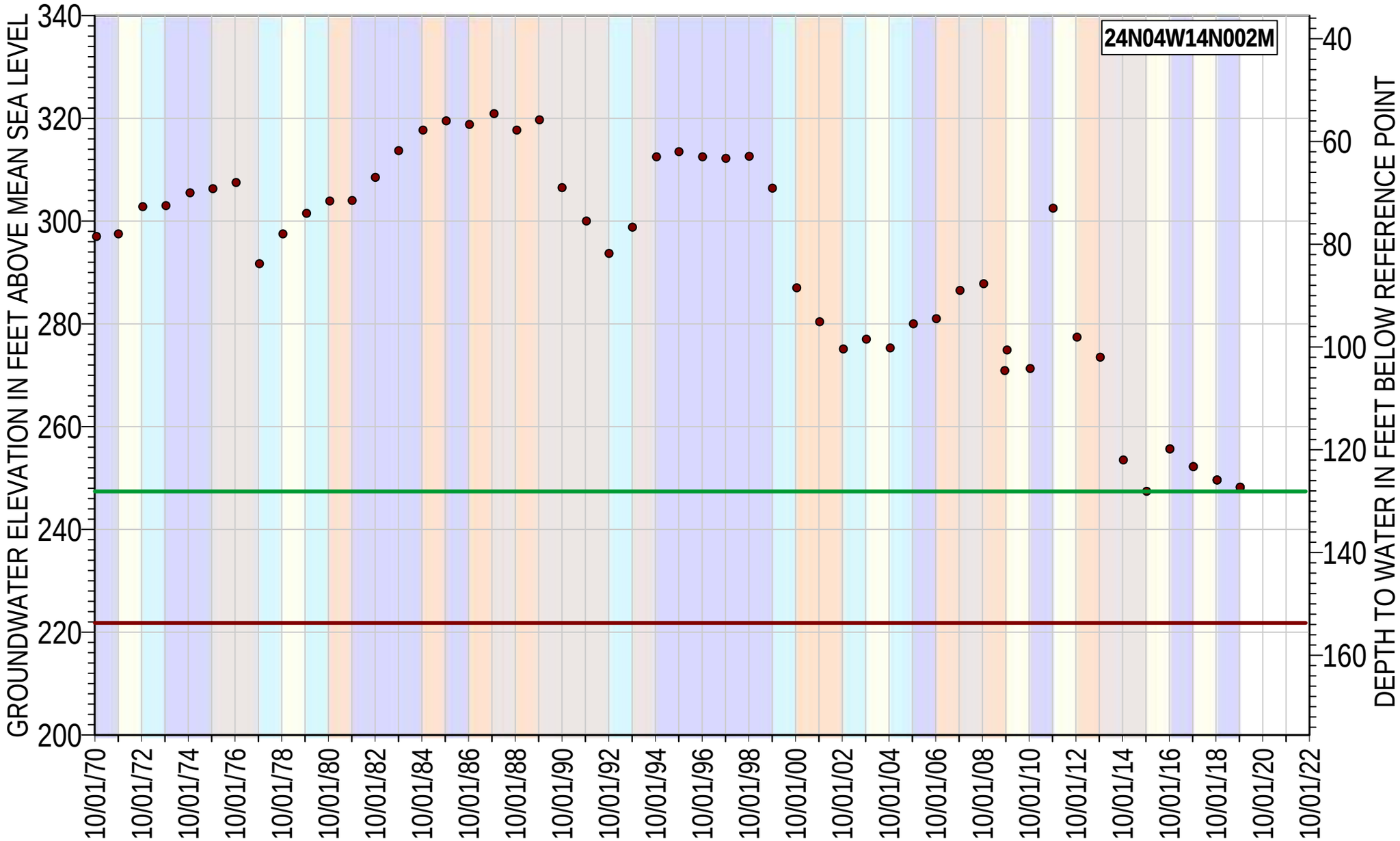
- 24N03W35P005M Fall Groundwater Elevation
- Land Surface Elevation
- Measurable Objective
- Minimum Threshold

Reference Point Elevation= 251.5 ft AMSL
Well Type: Domestic
Total Depth: 120 ft bgs
Well Screen Interval= 100 - 120 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





24N04W14N002M Fall Groundwater Elevation

Measurable Objective

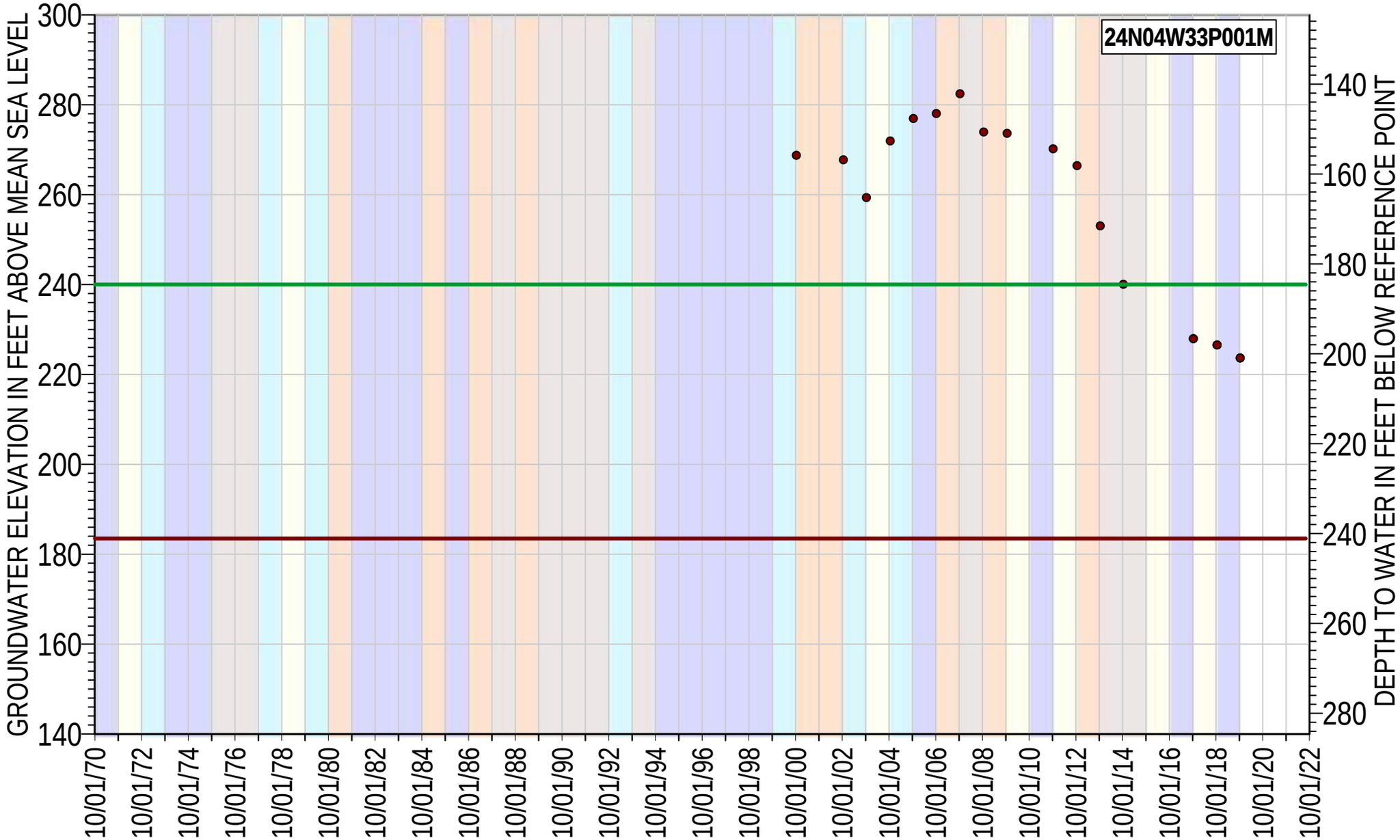
Minimum Threshold

Reference Point Elevation= 375.5 ft AMSL
Well Type: Domestic
Total Depth: 180 ft bgs
Well Screen Interval= Unknown ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





24N04W33P001M Fall Groundwater Elevation

Measurable Objective

Minimum Threshold

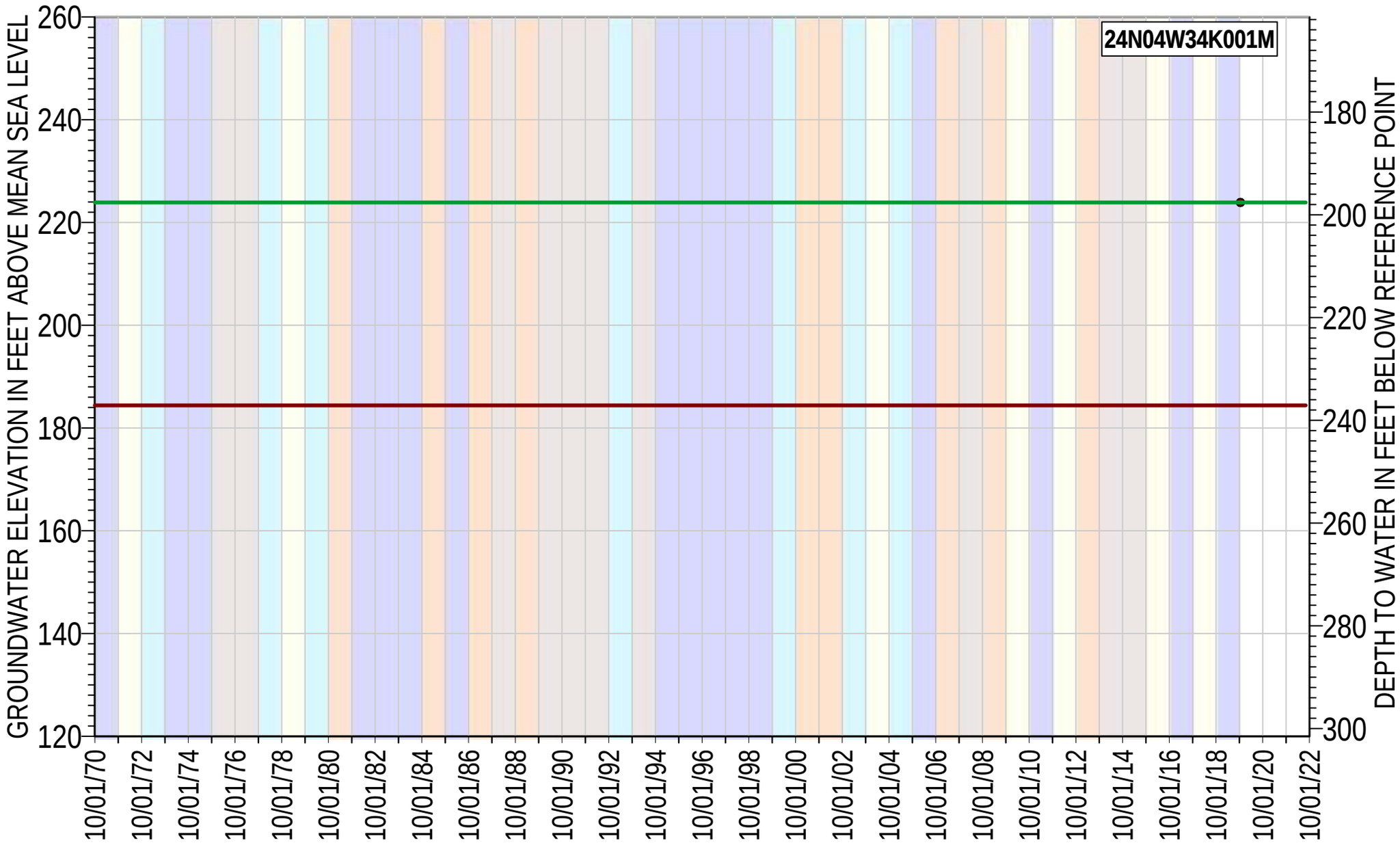
Reference Point Elevation= 424.6 ft AMSL
Well Type: Irrigation
Total Depth: 780 ft bgs
Well Screen Interval= 250 - 780 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



**Note: Insufficient Data - MO defined using 2014 max*



24N04W34K001M Fall Groundwater Elevation

Measurable Objective

Minimum Threshold

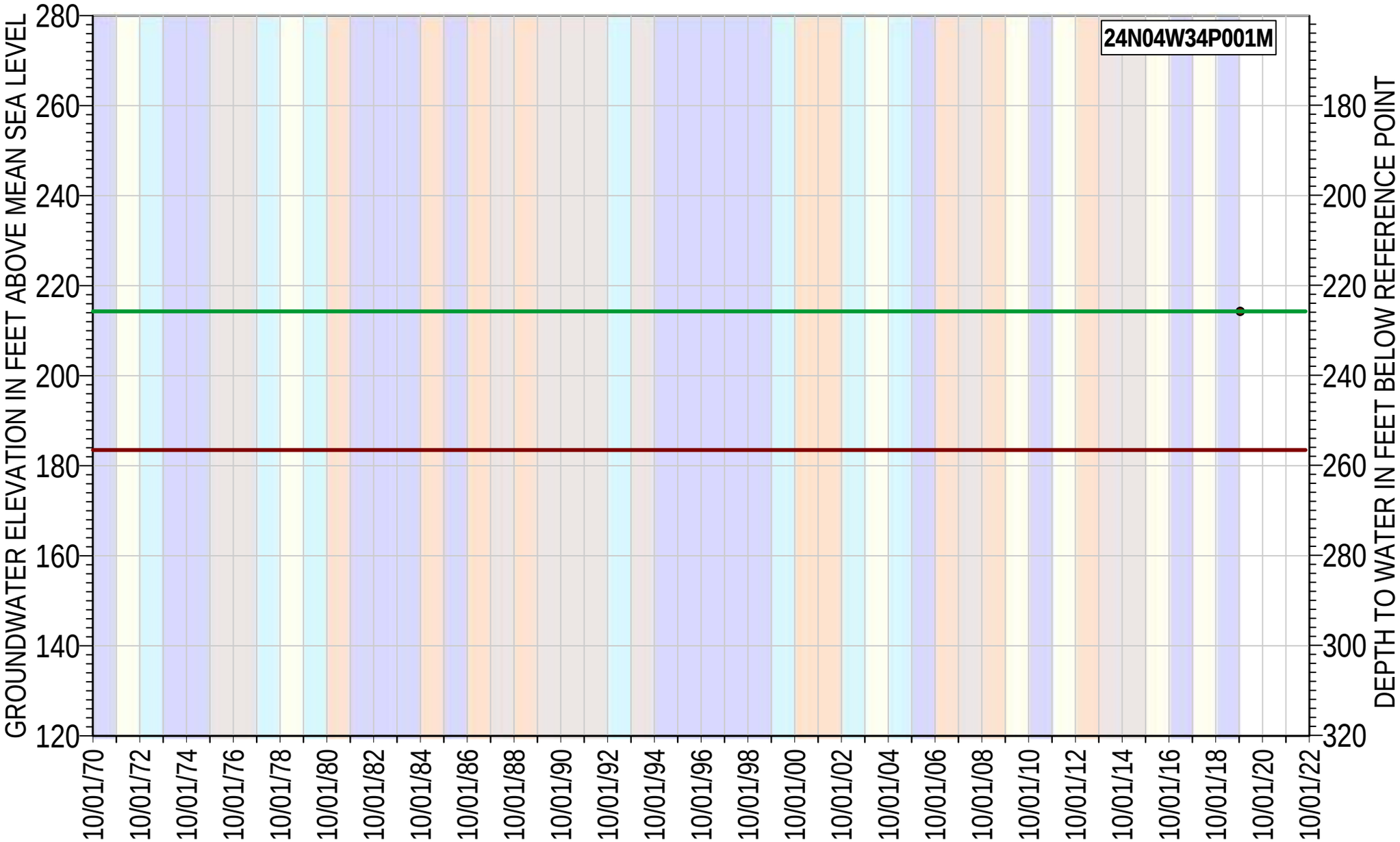
Reference Point Elevation= 421.5 ft AMSL
Well Type: Irrigation
Total Depth: 750 ft bgs
Well Screen Interval= 310 - 750 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



**Note: Insufficient Data - MO defined using 2016-2019 max*



24N04W34P001M Fall Groundwater Elevation

Measurable Objective

Minimum Threshold

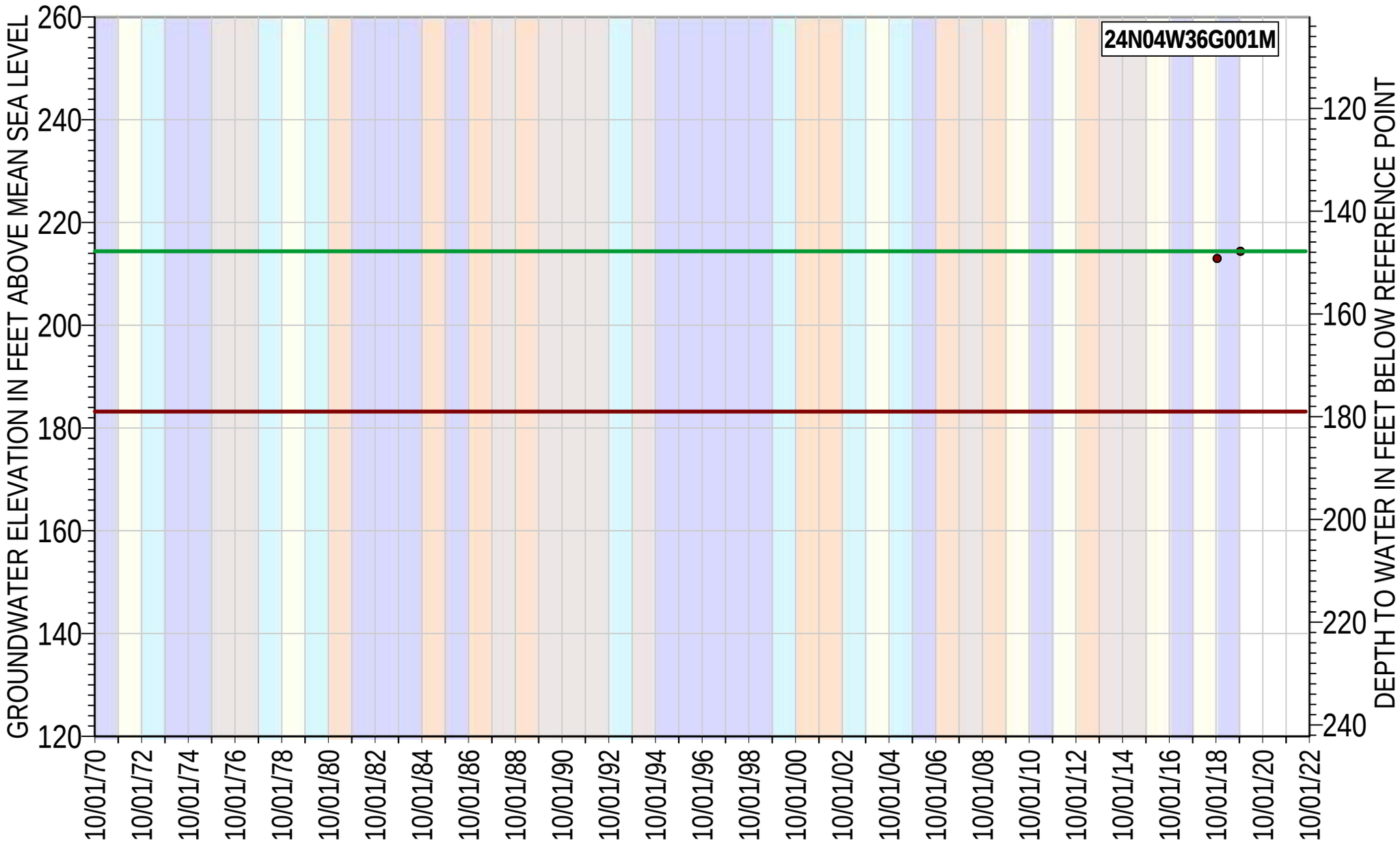
Reference Point Elevation= 440.1 ft AMSL
Well Type: Irrigation
Total Depth: 535 ft bgs
Well Screen Interval= 290 - 475 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



**Note: Insufficient Data - MO defined using 2016-2019 max*



24N04W36G001M Fall Groundwater Elevation

Measurable Objective

Minimum Threshold

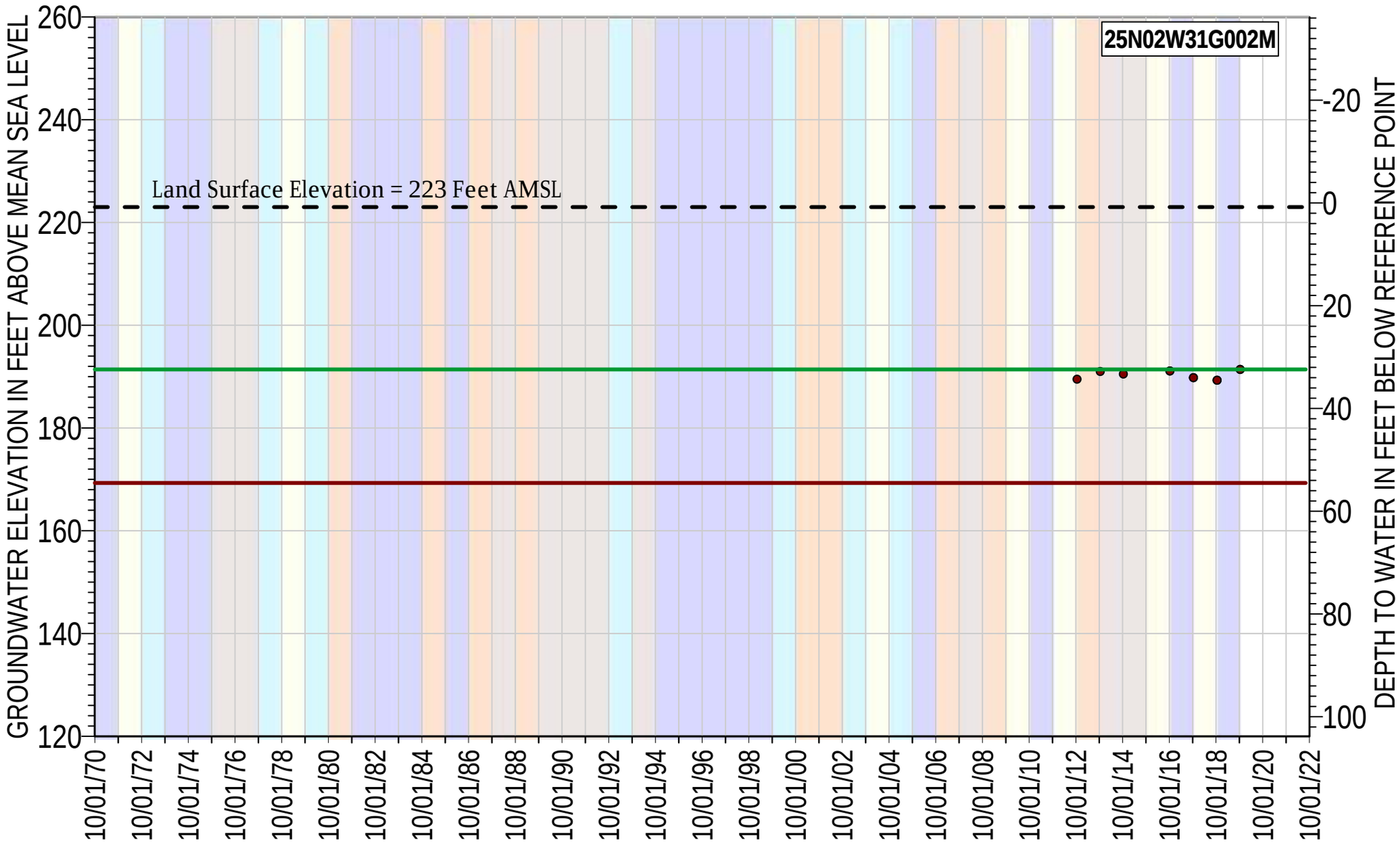
Reference Point Elevation= 362.2 ft AMSL
Well Type: Irrigation
Total Depth: 750 ft bgs
Well Screen Interval= 320 - 750 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	



**Note: Insufficient Data - MO defined using 2016-2019 max*



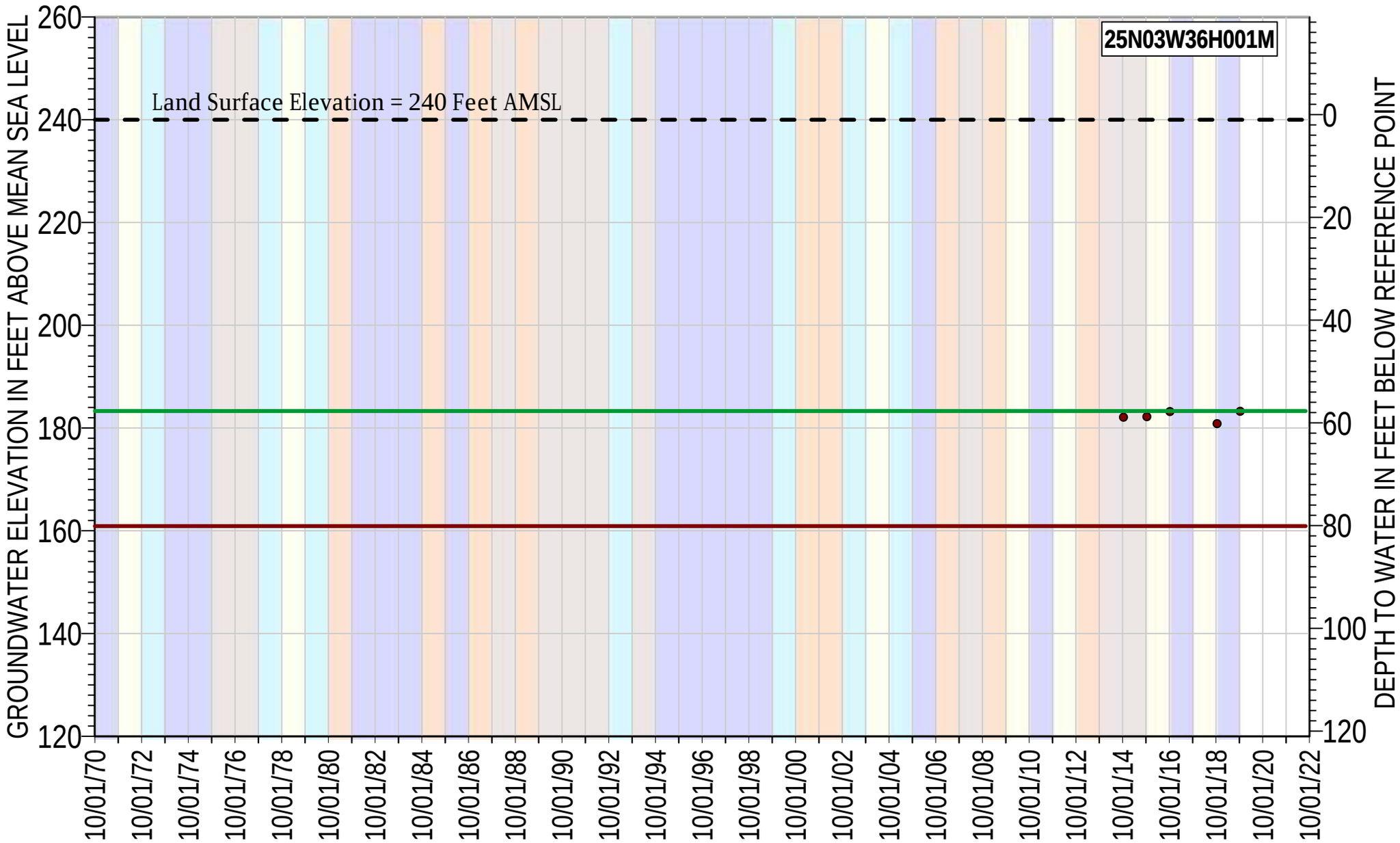
25N02W31G002M Fall Groundwater Elevation
Land Surface Elevation
Measurable Objective
Minimum Threshold

Reference Point Elevation= 223.8 ft AMSL
Well Type: Irrigation
Total Depth: 115 ft bgs
Well Screen Interval= 93 - 113 ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	





25N03W36H001M Fall Groundwater Elevation

Land Surface Elevation

Measurable Objective

Minimum Threshold

Reference Point Elevation= 241 ft AMSL
Well Type: Irrigation
Total Depth: 524 ft bgs
Well Screen Interval= Unknown ft bgs

Water Year Classification

Wet	Dry
Above Normal	Critically Dry
Below Normal	

