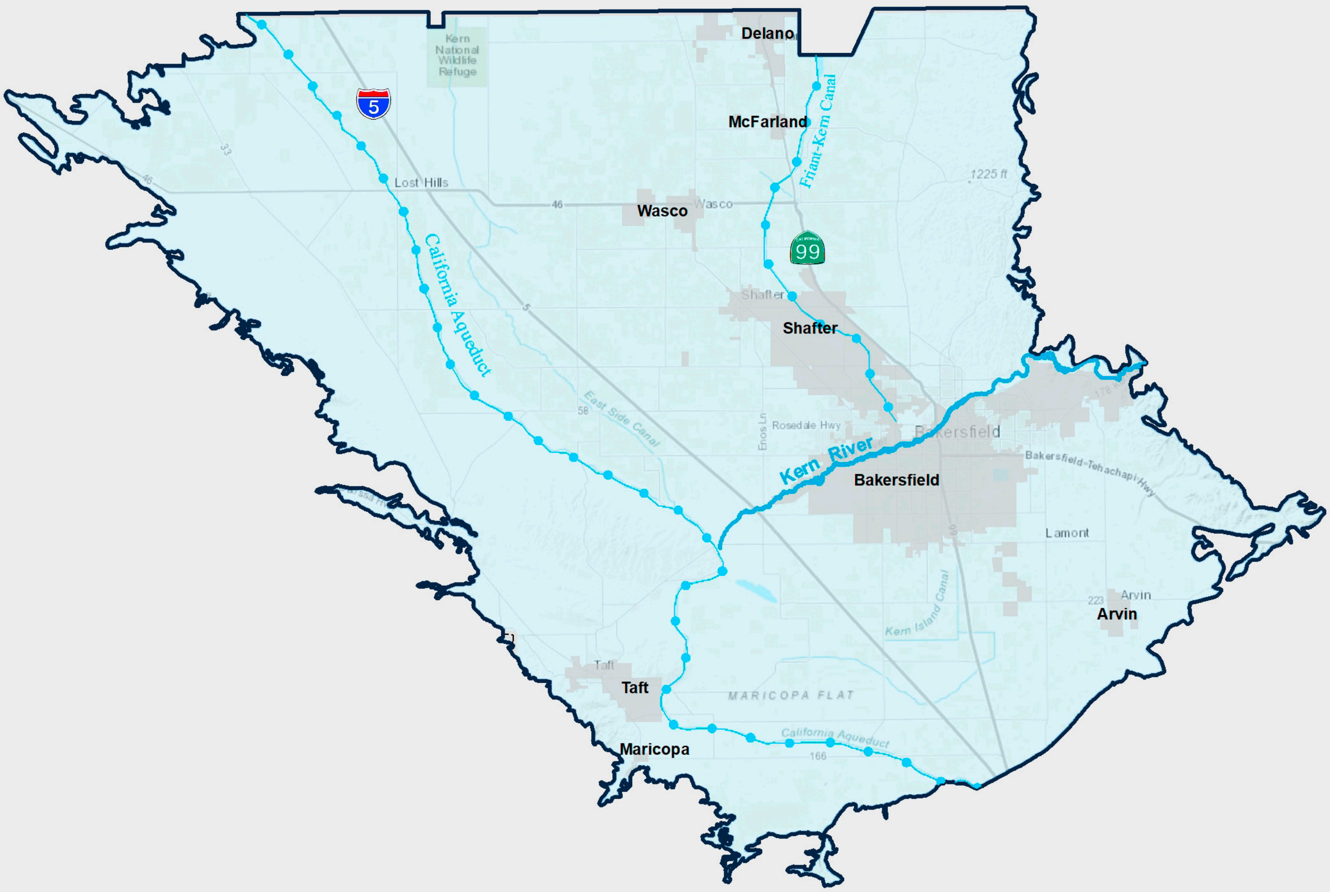
March 2023

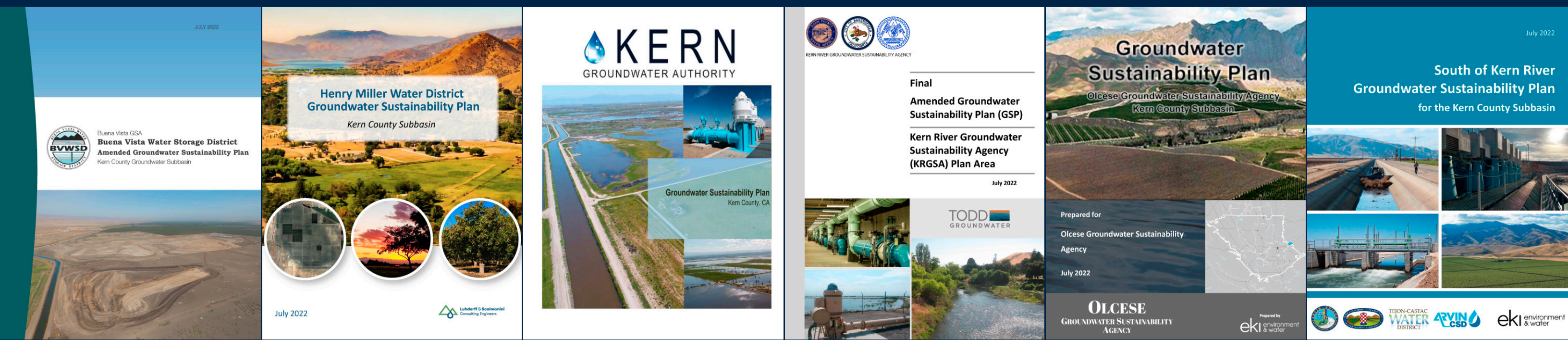
Kern County Subbasin
Groundwater Sustainability Plans

Final

Fourth Annual Report



Water Year 2022



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GROUNDWATER

KERN COUNTY SUBBASIN

GROUNDWATER SUSTAINABILITY AGENCIES

Kern County Subbasin

Basin No. 5-022.14

Groundwater Sustainability Plans (GSPs)

Fourth Annual Report
Water Year 2022

(October 2021 through September 2022)

FINAL

March 31, 2023

TODD GROUNDWATER

2490 Mariner Square Loop, Suite 215
Alameda, CA 94501
510.747.6920
www.toddgroundwater.com

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List of Acronyms

AEWSD	Arvin-Edison Water Storage District
AF	acre feet
AFY	acre feet per year
BCC	Basin Coordination Committee of the Kern County Subbasin
bgs	below ground surface
BMP	Best Management Practices
BVWSD	Buena Vista Water Storage District
CASGEM	California Statewide Groundwater Elevation Monitoring
C2VSim	California Central Valley Groundwater-Surface Water Simulation
C2VSimFG-Kern	California Central Valley Groundwater-Surface Water Simulation Model, Fine-Grid, Kern County Update for the Kern County and White Wolf Subbasin
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
Cawelo WD	Cawelo Water District
CGSA	Cawelo Groundwater Sustainability Agency
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
CVC	Cross Valley Canal
CVP	Central Valley Project
CWD	County Water District
DMS	Data Management System
DWR	Department of Water Resources
ENCSD	East Niles Community Services District
ET	Evapotranspiration
EWMA	Eastside Water Management Area
ft	feet
Greenfield CWD	Greenfield County Water District
GSA	Groundwater Sustainability Agency
GSE	Ground Surface Elevation
GSP	Groundwater Sustainability Plan
HMWD	Henry Miller Water District
ID4	Improvement District 4, Kern County Water Agency
IDC	Independent Demand Calculator

InSAR	Interferometric Synthetic Aperture Radar
ITRC	Irrigation Training and Research Center
IWFM	Integrated Water Flow Model
KCWA	Kern County Water Agency
KDWD	Kern Delta Water District
KFMC	Kern Fan Monitoring Committee
KGA	Kern Groundwater Authority
KRGSA	Kern River Groundwater Sustainability Agency
KTWD	Kern-Tulare Water District
KWB	Kern Water Bank
MA	Management Area
MAP	Management Area Plan
METRIC	Mapping EvapoTranspiration at high Resolution with Internalized Calibration
MNP	Monitoring Network Plan
MO	Measurable Objective
MT	Minimum Threshold
msl	mean sea level
NKWSD	North Kern Water Storage District
MNM	Monitoring Network Module, DWR online SGMA portal
PRISM	Parameter-elevation Relationships on Independent Slopes Model
RRBWSD	Rosedale-Rio Bravo Water Storage District
SGMA	Sustainable Groundwater Management Act
SSJMUD	South San Joaquin Municipal Utilities District
Subbasin	Kern County Subbasin (when capitalized)
SWID	Shafter-Wasco Irrigation District
SWP	State Water Project
SWSD	Semitropic Water Storage District
TCWD	Tejon-Castac Water District
USEPA	United States Environmental Protection Agency
WMA	Water Management Area
WDWA	Westside District Water Authority
WKWD	West Kern Water District
WRMWSD	Wheeler Ridge-Maricopa Water Storage District
WY	Water Year, October 1 through September 30

EXECUTIVE SUMMARY

The Kern County Subbasin (Basin No. 5-022.14) is the largest subbasin in the State, has been designated as critically overdrafted, and is governed by a myriad of water districts, water storage districts, irrigation districts, and municipalities. These agencies manage a complex water supply system, a large portfolio of local and imported water sources, access to flood waters throughout the State, local managed aquifer recharge projects, and numerous large groundwater banking projects, collectively providing both local and State-wide water supply and water quality benefits.

To comply with the Sustainable Groundwater Management Act (SGMA), local agencies are currently organized into seventeen (17) Groundwater Sustainability Agencies (GSAs). These GSAs coordinated to produce six amended Groundwater Sustainability Plans (GSPs) covering the entire Subbasin that were submitted to the Department of Water Resources (DWR) in July 2022. The amended GSPs were submitted in response to a DWR Letter of Determination in January 2022 that identified deficiencies in the original GSPs submitted in January 2020.

Since the submittal of the 2020 GSPs, all of the Subbasin GSAs have coordinated to produce a single comprehensive Annual Report that covers the entire Kern County Subbasin. This Fourth Annual Report demonstrates the collective GSP implementation by all 17 GSAs. **Figure 1** shows the Kern County Subbasin and adjacent subbasins. **Figures 2 and 3** show the current 17 Subbasin GSAs and the areas covered by the six GSPs submitted in July 2022, respectively.

This Fourth Annual Report covers Water Year (WY) 2022, from October 1, 2021 through September 30, 2022, as the reporting period. The purpose of the Annual Report is to provide the required data and analyses to demonstrate that the Kern County Subbasin GSPs are being implemented in a manner that will achieve the sustainability goals that have been developed for the Subbasin and individual GSPs.

Approach

In support of this WY 2022 Annual Report, over 40 agencies have contributed data and information (listed in **Table 1**). Data have been combined and analyzed for use in hydrographs, water level contour maps, and an update of the local C2VSimFG-Kern model. In particular, the C2VSimFG-Kern model provides a technically credible tool to analyze groundwater extractions and changes in groundwater in storage on a basin-wide basis. Various model results are presented from WY 1995 through WY 2022, incorporating the historical period for the GSP water budgets (WY 1995 through WY 2015) and the updated analyses through WY 2022; water year types for that 28-year period are presented on **Figure 6**.

Data templates provided by DWR are employed for consistent reporting of information and data. A narrative progress report on GSP implementation has also been provided by the GSAs and member agencies; those reports are compiled in **Section 7**. In addition to the implementation of the individual GSPs, GSAs and member agencies are also coordinating on a collective effort to accomplish GSP implementation activities on a Subbasin-wide basis, including those documented in the Kern County Subbasin Coordination Agreement. These efforts, led by the Basin Coordination Committee (BCC), are also summarized in **Section 7**.

The data compilation process for this Fourth Annual Report was coordinated with newly developed data-entry templates for water supply and use data developed using the Kern County Subbasin Data Management System (DMS). The project has been funded by a DWR grant under Round 3 of the Sustainable Groundwater Management (SGM) Grant Program (Proposition 68). Subbasin GSAs coordinated and funded the successful grant application.

The Kern County Subbasin GSAs are collectively committed to successful GSP implementation and attainment of Subbasin Sustainability Goals. Substantial compliance with the Annual Report requirements is demonstrated throughout this report, and additional data are currently being collected to address data gaps.

Groundwater Elevations

Groundwater elevations were compiled from wells in the GSP representative monitoring network for the preparation of hydrographs across the Subbasin (**Figure 5**). Available data, including sustainable management criteria, are presented on 198 well hydrographs, compiled in **Appendix A**. The hydrographs are developed within the Subbasin DMS so that the most complete and current groundwater elevations, ground surface elevation, minimum threshold (MT) and measurable objective (MO) are shown on the hydrographs. A public version of the DMS, including the hydrographs from the GSP representative monitoring network, is accessible to Subbasin GSAs and the public through the KGA website.

Data from the SGMA monitoring network were combined with supplemental water level data from the Kern Fan Monitoring Committee and other local monitoring efforts by Kern County Water Agency (KCWA) to prepare groundwater elevation contour maps. Specifically, KCWA developed water level contour maps for Fall 2021 and Spring 2022 for the Primary Principal Aquifer in the Subbasin (**Figures 7** and **8**).

Three additional Principal Aquifers have been identified in four localized areas within the Subbasin as shown on **Figure 9**. Groundwater elevation contour maps for Fall 2021 and Spring 2021 are provided for the Olcese Sand Principal Aquifer on **Figures 10** and **11**, respectively. Groundwater elevations were posted during Fall 2021 and Spring 2022 for the Santa Margarita Principal Aquifer (**Figure 12**). Data were not available for the Upper Aquifer in the north-central portion of the Subbasin during this reporting period. However, the three local Principal Aquifers are represented in the C2VSimFG-Kern local model and grouped together with the Primary Principal Aquifer in the groundwater extraction data and the change in groundwater in storage analyses. The Subbasin GSPs define any water bearing zone within the areal extent and depth interval of an oilfield aquifer exemption as being located outside of the Kern County Subbasin and are, therefore, not included within any of the Principal Aquifers.

Groundwater Extractions

Groundwater extraction data for the Kern County Subbasin were compiled using two methods:

- Directly measured groundwater extraction data collected by local water agencies.
- Estimated groundwater extractions based on land use methods using the IWFM Demand Calculator (IDC) tool developed by DWR (Dogrul, Kadir and Brush, 2017), which is dynamically linked to the C2VSimFG-Kern groundwater model.

IDC employs user-specified evapotranspiration (ET) data that are based on monthly satellite data processed by the Irrigation Training & Research Center (ITRC) at California Polytechnic State University, San Luis Obispo (Howes, 2023). Surface water supplies are incorporated based on measured data and regional precipitation (PRISM); using these collective data sets, IDC calculates the groundwater extraction necessary to meet the crop demand. Urban demands in C2VSimFG-Kern are based on agency-supplied extraction data and/or population and per-capita water demand.

Table ES-1 summarizes the Kern County Subbasin groundwater extractions by water use type and measurement method for WY 2022. Additional details on water use types and groundwater extractions are provided in **Section 3**. **Figure 13** shows the areal distribution of total groundwater extraction volumes over the Subbasin during WY 2022. **Figure 17** graphically presents historical groundwater extractions from WY 1995 through WY 2022.

Table ES-1. Groundwater Extractions in the Kern County Subbasin for Water Year 2022

Groundwater Extraction	Total Groundwater Extractions	Meters Volume	Electrical Records Volume	Land Use Volume	Groundwater Model Volume	Other Methods Volume
Water Use Type	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
Urban	163,032	161,098	0	1,934	0	0
Industrial	0	0	0	0	0	0
Agricultural	1,554,176	382,692	0	1,171,484	0	0
Managed Wetlands	0	0	0	0	0	0
Managed Recharge	520,995	520,995	0	0	0	0
Native Vegetation	0	0	0	0	0	0
Other	105,428	14,022	0	91,406	0	0
Total	2,343,630	1,078,806	0	1,264,824	0	0

Surface Water Supply

For the Kern County Subbasin, surface water supplies are measured directly by local water agencies at the point of diversion from a river, stream or canal using measurement devices and monitoring protocols. Surface water data were collected by measurement devices with a high level of accuracy consistent with relevant standards. Measured surface water data were provided by local agricultural districts, urban water purveyors and city water departments for this Annual Report (see **Table 1**). These surface water supplies are tabulated in **Table ES-2** below. Additional details on surface water supplies are provided in **Section 4**. A map showing surface water supply infrastructure and features in the Subbasin is provided on **Figure 14.**

Table ES-2. Surface Water Supplies in the Kern County Subbasin for Water Year 2022

Surface Water Supply	Surface Water Supply Volume
Surface Water Supply Source	**Acre-ft**
Central Valley Project	144,563
State Water Project	353,716
Colorado River Project	0
Local Supplies	233,851
Local Imported Supplies	41,954
Recycled Water	48,520
Desalination	0
Other Water Source	403
Total Surface Water Supply	823,007

Total Water Use

Based on data and tables in preceding sections, the total water use in the Subbasin is provided by Water Source Type and Water Use Sector on **Tables ES-3** and **ES-4**. Additional details on the tabulation of Total Water Supply and Use are provided in **Section 5**.

Table ES-3. Total Water Use by Source Type, Kern County Subbasin, Water Year 2022

Total Water Use	Total Water Supply by Volume
Water Source Type	**Acre-ft**
Groundwater	2,343,630
Surface Water	774,085
Recycled Water	48,520
Reused Water	403
Other Water Source Type	0
Total Water Supply	3,166,637

Section 5 provides a preliminary assessment of changes in water demand in the Subbasin during the GSP implementation period. The METRIC evapotranspiration (ET) data provided by ITRC (Howes, 2023) shows a notable decline in ET demand during WY 2020 through WY 2022 of 200,000 to 300,000 acre-feet compared to a similar hydrologic period from WY 2014 through 2016 (**Figure 15**). The ongoing Basin Study is currently evaluating potential changes in land use that could account for this decline. In addition, the Subbasin GSAs are currently coordinating several basin-wide management actions to better track and evaluate performance of GSP implementation over time.

The data presented on **Tables ES-1, ES-2, ES-3 and ES-4** are compiled into the data templates provided by DWR and submitted along with this Annual Report for consistent reporting of information and data.

Table ES-4. Total Water Use by Water Use Sector, Kern County Subbasin, Water Year 2022

Total Water Use	Total Water Use Volume
Water Use Sector	**Acre-ft**
Urban	196,974
Industrial	0
Agricultural	2,245,544
Managed Wetland	14,377
Managed Recharge	73,188
Native Vegetation	0
Other Water Use	636,554
Total Water Use	3,166,637

Change in Groundwater in Storage

As required by the GSP regulations, the following figures included in the WY 2022 Annual Report illustrate the changes in groundwater in storage over the Subbasin:

- Graph depicting water year type, groundwater use, the annual and cumulative change in groundwater in storage based on historical data to the greatest extent available, including from January 1, 2015 to the current reporting year.
- Change in groundwater in storage maps for Subbasin Principal Aquifers.

The Subbasin GSAs continue to support the annual updating of the C2VSimFG-Kern local model to assist with the change in groundwater in storage analyses. The model results represent the total change in groundwater in storage for the entire Kern County Subbasin that includes all Subbasin Principal Aquifers.

Figure 16 shows the simulated change in groundwater in storage graph for the Kern County Subbasin over the 28-year period from WY 1995 to WY 2022. The graph includes the annual and cumulative change along with the water year type based on the San Joaquin Valley Index (CDEC, 2023). For WY

2022, a critically dry water year type, the groundwater in storage for the Kern County Subbasin **declined** by 1,740,468 acre-feet (AF).

Figure 18 presents the annual basin-wide change in groundwater in storage map for WY 2022, using the C2VSimFG-Kern model results. The change in groundwater in storage represents the sum of the total inflow components plus the total outflow components. A positive value represents an increase in the volume of groundwater stored in the aquifer that was typified by a rise in groundwater levels whereas a negative represents a decrease in groundwater in storage typified by a decline in groundwater levels.

WY 2022 was rated as a critically dry water year under the San Joaquin Valley Index (CDEC, 2023), and the Kern River Index was 29 percent of average Kern River flows (COB, 2022). As such, widespread low-level declines are observed over most of the Subbasin with some localized areas of minor increases. The change in groundwater in storage is concentrated in the vicinity of the large groundwater banking operations primarily in the center of the Subbasin, representing large volumes of recovery pumping to provide a critical water supply during the extraordinary drought conditions. This pumping recovers water that has already been banked in the groundwater Subbasin in previous years. Groundwater elevations in the banking areas historically fluctuate over a range of 200 feet in response to recharge and recovery operations. These operations lead to highly variable year-to-year change in groundwater in storage. Therefore, the concentrated change in storage in the banking areas is a highly-managed activity that plays a key part in maintaining the groundwater sustainability for the Subbasin.

Change in Groundwater in Storage During GSA Management Period

For this Annual Report, the average annual change in groundwater in storage over the three-year GSA Management period (WYs 2020-2022) is compared to the average from a similar hydrologic period of WYs 2014-2016 prior to GSA management. This preliminary analysis is presented in **Section 6.3** and summarized below in **Table ES-5**. This comparison indicates that the decline in groundwater in storage for drought conditions during the GSA Management period is about 600,000 AFY less than the average decline estimated for the comparable hydrologic period during WYs 2014-2016.

Table ES-5. Change in Groundwater in Storage Comparison of the GSA Management Period to a Comparable Recent Period

Change in Groundwater in Storage	GSA Mgmt. Period WY2020-2022	Comparable Period WY2014-2016	Volumetric Difference	Percent Change
Units	AFY	AFY	AFY	percent
GW Storage Change	-1,309,000	-1,909,000	-600,000	-31%

A comparison of water supply and water use (**Section 5.3**) during these two periods indicates that average annual groundwater pumping was 370,000 AFY less than during WYs 2014-2016 (**Table 8**). Also, the average annual volume of managed aquifer recharge increased by 96,000 acre-feet. The combination of the decreased pumping and increased managed aquifer recharge accounts for about 80% of the difference in the change in groundwater in storage between these two periods.

Both changes to groundwater pumping and managed aquifer recharge are directly related to SGMA implementation. As noted in **Section 5.3**, there are multiple potential factors contributing to the observed changes in water use. However, this preliminary assessment suggests that these water use changes have resulted in a reduced volumetric change in groundwater in storage during the GSA Management period as compared to the similar hydrologic period of WYs 2014-2016. The Subbasin GSAs are currently coordinating on several basin-wide management actions to improve the ability to address data gaps and better calculate water budgets. These projects, summarized in **Section 7.2**, will allow the Subbasin GSAs to better track and evaluate performance of the GSP implementation.

Progress on GSP Implementation

The GSAs and member agencies associated with the six GSPs have provided progress reports on their respective GSP implementation activities for WY 2021. These progress reports provided in **Sections 7.3** through **7.8** are organized by the six GSPs, in alphabetical order for the lead GSA. KGA member agencies that have prepared Management Area Plans are listed in alphabetical order within **Section 7.5**. To facilitate DWR review, a consistent reporting format was established, based on the components listed in the GSP regulations (*§356.2(b)(5)(C)*), as follows:

1) Compliance with Sustainable Management Criteria
    a. GSP Monitoring Activities
    b. Changes in GSP Monitoring Network
    c. Progress in Achieving Interim Milestones
    d. Compliance with Additional Sustainable Management Criteria (including minimum thresholds (MTs) and measurable objectives (MOs))
2) Implementation of Projects and Management Actions
3) Coordination with Stakeholders
4) Summary of Other GSP-related Special Studies or Activities

In brief, all the Subbasin GSAs are in the process of implementing their GSPs, or addressing their data gaps, and are committed to coordination for sustainable groundwater management. Many GSP monitoring networks have been fully implemented; others are planning new monitoring sites. Some networks represent areas where local groundwater conditions do not have a long monitoring history and/or where little groundwater pumping occurs due to undeveloped land use (e.g., rangeland), and naturally poor groundwater quality. These areas have proposed new monitoring locations and/or “Watch Areas” to assess for changes, if any, in current land and groundwater use.

To demonstrate the significant progress that GSAs/member agencies have been making on specific projects and management actions, those activities are briefly summarized in **Table ES-6;** the locations of the narrative that describe these actions in more detail are also provided in **Table ES-6** for reference. Additional information is provided in **Section 7.2** that also includes a summary on the various outreach and coordination activities conducted by the GSAs/member agencies in WY 2022 individual GSAs' management area summaries are provided in **Section 7.3** to **7.8**.

In addition to the implementation of the individual GSPs, GSAs and member agencies are also coordinating on a collective effort to accomplish GSP implementation activities on a Subbasin-wide basis, including those documented in the Kern County Subbasin Coordination Agreement. These efforts, led by the Basin Coordination Committee (BCC), are summarized in **Section 7.1**. These Subbasin wide efforts are summarized below:

- **Coordination on Amended GSPs** - Following the DWR Incomplete Determination letter on January 28, 2022, the Kern County Subbasin GSA and member agency managers met weekly to coordinate corrective actions and prepare Amended GSPs. A Kern Subbasin Amended Coordination Agreement and Amended GSPs were submitted to DWR in July 2022.
- **Coordination on Annual Report Data** - Agencies shared in costs to purchase Subbasin-wide METRIC ET data, available on a monthly basis over the reporting period. Accordingly, this submittal of the Annual Report represents completion of an important GSP implementation measure that demonstrates ongoing coordination on a Subbasin-wide basis.
- **Application of the Kern County Subbasin DMS for Annual Report Preparation** - The Subbasin GSAs are utilizing the web-based DMS to support GSP monitoring and analyses (Coordination Agreement, Appendix 5). In WY 2022, work began on expanding the DMS to include water budget data for the annual report and model updates via the DMS. This expanded capability was implemented in time to support this Annual Report.
- **Coordination on GSP Monitoring Data** - The Subbasin GSAs continue to coordinate for collecting and reporting of GSP monitoring data. Compilation and reporting of the semi-annual monitoring data are now conducted using the DMS.
- **Additions to Subbasin-Wide Monitoring Protocols** - To further support the GSA managers in tracking the Subbasin-wide performance of the GSP monitoring data with respect to their GSP sustainable management criteria, the DMS added a feature to email notifications to alert agency and GSA managers when a MT exceedance occurs. Managers can also use the DMS to track MT exceedances either through online mapping or downloading reports.
- **Successful Grant Application, SGM GSP Implementation Grant Program, Round 1** - The Kern County Subbasin received a $7.6 million Round 1 sustainable groundwater management (SGM) grant for critically overdrafted basins under the Sustainable Groundwater Management (SGM) Grant Program SGMA Implementation grant authorized by the California Budget Act of 2021 and Proposition 68. The grant supports projects that encourage sustainable management of groundwater resources as required by SGMA. The contract between DWR and the representative for the Kern County Subbasin GSAs was signed on August 8, 2022 and includes the following components.
    - **Grant Component: Basin Study** - The Kern County Subbasin Study consists of a systematic, subbasin-wide analysis to address technical data gaps in the hydrogeological conceptual model (HCM), water budgets and model calibration. The

existing C2VSimFG-Kern model will be upgraded to a Kern County Subbasin focused model. The Basin Study will provide the framework for more refined water budget analyses to support ongoing GSP planning and implementation. The results of the Basin Study will support local water managers, policy makers and stakeholders with multiple technical, policy, water rights and legal issues.

- **Grant Component: Evapotranspiration Analysis & Study – Field By Field** - In WY 2022, the Subbasin GSAs worked with Land IQ to expand their ET monitoring service to all irrigated agricultural areas within the Subbasin. Irrigated agriculture represents the largest water use within the Subbasin; this method will improve calculation of ET on a field and crop basis. LandIQ will provide monthly ET data starting in WY 2023.
- **Grant Component: Land Subsidence Investigations and Monitoring** - The Subbasin GSAs supported implementation of a regional land subsidence investigation to improve the land subsidence monitoring program (Coordination Agreement, Appendix 3). This regional effort was developed to supplement the local land subsidence monitoring focused on potential impacts to critical infrastructure of regional importance. The Subbasin GSAs are working in consultation with the United States Geological Survey (USGS) and the Friant Water Authority to plan, design and install an new extensometer device along the Friant-Kern Canal to assess the causes and magnitude of subsidence along this critical regional infrastructure.
- **Grant Component: Monitoring Wells** - Funding to support improvements to existing monitoring network throughout the Kern subbasin by repairing existing monitoring, video water wells for screening, convert existing municipal and/or ag wells to monitoring wells. This will include the ability to video a minimum of 20 water wells for screening, convert existing municipal and/or ag wells to monitoring wells, and repair existing monitoring wells.

Table ES-6. GSP Implementation Summary for WY 2022

GSP	Mgmt Area (Report Section)	Projects	Management Actions
Buena Vista GSP	BVWSD GSA (Section 7.3, 2))	Continued progress on 3 new recharge facilities: 71 acres in escrow, negotiating 30-year lease on 85 acres, meeting regulations for 2,072 ac water bank.	Reduced demand by 2,800 AFY by purchasing land to take out of production.
Henry Miller GSP	Henry Miller WD GSA (Section 7.4, 2))	Optimized recharge and recovery of Pioneer Project banked water including banking and recharge for overdraft correction.	Purchased supplemental water to increase banked supply.
KGA GSP	Cawelo WD GSA (Section 7.5.1, 2))	New water purchase negotiations; worked with landowners on private banking projects; review treatment for recycled produced water; supported Phase 2 of F-K Canal.	Adopted KGA Action Plan for MT Exceedance tracking and response.
	Eastside WMA (Section 7.5.2, 2))	Continued TDS/Nitrate monitoring; construction of aquifer-specific monitoring wells; planning for transducers; planning for surface water capture project.	Cooperating with Basin Study on sustainable yield – will support water transfer credits.
	KCWA Pioneer GSA (Section 7.5.3, 2))	Balanced pumping to mitigate any MT exceedances while continuing sustainable operations.	MA1 – Continued demonstration of maintaining a positive cumulative water
	Kern Water Bank (Section 7.5.4, 2))	Recovered 188,000 AF from banking program in WY 2022. Continued involvement with other GSAs' implementation strategies for local storage (as referenced in Section 7).	Continued operation under Long-term Operations Plan.
	Kern-Tulare WD GSA (Section 7.5.5, 2))	Assisted landowners with metering requirements (90% active irrigation wells metered); worked on CRC Pipeline Project (design 90% complete); FS for 2 new surface reservoirs	Passed Proposition 218 election for extraction charges; groundwater studies ongoing.
	NKWSD and SWID (Section 7.5.6, 2))	Proposition 218 election (in progress) to fund recharge projects (Bell project in construction); CEQA compliance for Landowner Banking Program; completed canal lining.	Coordinated on MT Exceedance Plan; adopted domestic well mitigation plan.
	Rosedale-Rio Bravo GSA (Section 7.5.7, 2))	Completed construction of McCaslin recharge ponds; conducted pilot project for Onyx Ranch water deliveries; CEQA compliance on James recharge project; 60% design regional Kern Fan water bank.	Continued tracking for two demand reductions programs (in-district and white lands.
	Semitropic WSD GSA (Section 7.5.8, 2))	Initiated construction of Leonard Ave. Project; evaluated 1,600 acres for recharge.	MA1: Provided landowner budgets; MA2: Presented Draft tiered pricing for extractions.
	Shafter-Wasco ID 7th Std Annex (Section 7.5.9,2))	Reduced irrigation demand by 1,566 AF through Voluntary Rotational Land Fallowing Program.	Adopted domestic well mitigation plan;
	SSJMUD GSA (Section 7.5.10, 2))	Completed construction of 78-ac Giumarra recharge basin; in Final Design for 75-ac Regan recharge area; continued design/permits for in-district recharge projects and SSJMUD/NKWSD intertie.	Approved domestic well mitigation & MT exceedance plans; Assess consumptive use
	West Kern WD GSA (Section 7.5.11, 2))	Installed 3,401 AMR systems in Automatic Meter Reading Project; Participated in funding and CEQA compliance of Delta Conveyance Facility; Coordinate water supply management for BVARA.	Continued balanced pumping and recharge; coordinated with Basin-wide management.
	WDWA GSA (Section 7.5.12, 2))	Continued monitoring to fill hydrogeologic data gaps from lack of significant groundwater use; continued supplemental water purchases; Feasibility Study for reuse of brackish groundwater.	Progress on management actions combined with Projects (see text to left).
Kern River GSA	Kern River GSA (Section 7.6, 2))	Obtained 4,407 AF transfer water in WAP; Recharged 14,136 AF along KR; used 22,830 AF recycled water; funded Delta Conveyance for 82,946 AF supply; Completed bids for CVC Lining.	Recharged water to benefit GW declines; supported small water system consolidation
Olcese GSA GSP	Olcese GSA (Section 7.7, 2))	Continued assessment of transducer data from to support hydrogeologic studies; developed subsidence monitoring network along OWD canal (included in July 2022 Amended GSP).	Initiated study on vertical hydraulic connection between local aquifer systems.
SOKR GSP	Arvin GSA (Section 7.8.1, 2))	Began construction of Sunset recharge facility; expanded acres for On-Farm Recharge; began construction on pipeline and Eastside Canal intertie with KRGSA; Continued progress on in-lieu banking.	Installed pumping meters at 50 sites; installed wells for arsenic mitigation; WQ sampling.
	Tejon-Castac WD GSA (Section 7.8.2, 2))	Coordinated with AEWSD on converting quarry to reservoir; recharged 202.22 AF of carrot wash water.	Continued management of land use and extraction restrictions under RWMP.
	Wheeler Ridge-Maricopa GSA (Section 7.8.3, 2))	Purchased 14,087 AF of additional SWP water; recovered 52,500 AF banked water; continued funding of Delta Conveyance Project; explored treatment for saline GW to mitigate local pumping.	Retired irrigated lands at new solar generation facility; studied potential assessments.

1 INTRODUCTION

Following the successful submission of five Groundwater Sustainability Plans (GSPs) in January 2020 that covered the entire Kern County Subbasin (Subbasin), the Groundwater Sustainability Agencies (GSAs) and member agencies began GSP implementation. Since that time, all of the Subbasin GSAs have coordinated to produce a single comprehensive Annual Report each year that covers the entire Subbasin in compliance with the Sustainable Groundwater Management Act (SGMA). Three Subbasin-wide annual reports have been submitted previously; this Fourth Annual Report covers Water Year (WY) 2022 and demonstrates the collective implementation of the Subbasin GSPs.

GSA management has now occurred over a three-year period (WY 2020 through WY 2022). Those three years represent a multi-year drought with consecutive critically dry years over the last two years. Although these conditions have resulted in groundwater level declines in the Subbasin, they also have presented the GSAs with an opportunity to adjust groundwater management activities and identify critical local areas.

The Kern County Subbasin (Basin No. 5-022.14) is the largest subbasin in the State, covering more than 2,700 square miles of the southern San Joaquin Valley Groundwater Basin. The Subbasin is bounded by the Kettleman Plain, Tulare Lake, and Tule Subbasins to the north and by the White Wolf Subbasin to the south. A map of the Subbasin and adjacent subbasins is shown in **Figure 1**. The Kern County Subbasin, along with the Tulare Lake, Tule, and eight additional subbasins, has been designated as critically-overdrafted by the Department of Water Resources (DWR).

Kern County Subbasin relies on a diverse portfolio of local and imported surface water supplies managed with flexible and interconnected water conveyance systems. For more than 100 years, conjunctive use has been a cornerstone of local water resources management, and the Subbasin is dominated by both regional and local groundwater banking/managed aquifer recharge projects of both local and state-wide importance.

These Subbasin water resources are managed by a myriad of water districts, water storage districts, irrigation districts, and municipalities. To comply with SGMA, local water agencies originally organized into 11 GSAs that coordinated on five 2020 GSPs that covered the entire Subbasin. Since the submittal of the 2020 GSPs, agencies have re-organized to form an additional six GSAs for a current total of 17 exclusive GSAs in the Subbasin. The 17 GSA areas are shown in **Figure 2**, along with the city limits of local municipalities.

In January 2022, DWR notified the Subbasin that, collectively, the five GSPs were incomplete and provided corrective actions for meeting GSP regulations. Subsequently, the Subbasin GSAs reorganized to amend the five GSPs and prepare one additional GSP to address DWR recommendations; these six amended GSPs were submitted to DWR in July 2022 and also cover the entire Subbasin. DWR recently determined that the six amended GSPs were inadequate to fully address the previous corrective actions; Subbasin GSAs are currently consulting with the State Water Resources Control Board (SWRCB) and DWR, while continuing with coordinated implementation of the six GSPs. **Figure 3** shows the Plan Areas for the current six GSPs in the Subbasin.

As shown on **Figure 3**, the Kern Groundwater Authority (KGA) represents the largest GSP area and consists of nine GSAs including the KGA GSA (**Figure 2**). This KGA GSP represents separate Management Area Plans (MAPs) by individual GSAs and other member agencies of the KGA, which are bound by an "umbrella" GSP that combines the MAPs together. The separate MAPs in the KGA GSP are shown with the other five GSP Plan Areas on **Figure 4**. Collectively, **Figures 2**, **3**, and **4** illustrate the large number of agencies that have coordinated to prepare this GSP Annual Report and implement the six Subbasin GSPs.

Those efforts, including GSP monitoring, analyses of groundwater elevations and water budgets, compliance with sustainable management criteria, progress on implementation of projects and management actions, and other activities, are summarized in this Fourth Annual Report for WY 2022. This Fourth Annual Report demonstrates both coordinated and individual GSA/district progress toward the collective implementation of all six Subbasin GSPs. The location of the 17 GSAs and the six GSP areas are shown on **Figures 2** and **3**, respectively.

This Fourth Annual Report is being prepared under the guidance of Water Code Section 10728 and GSP regulations (in particular, Article 7, §356). The report combines data and information for the entire Kern County Subbasin, as provided by the GSAs that submitted the GSPs and coordinated on the preparation of this report. As such, this Fourth Annual Report is submitted as one comprehensive and coordinated Annual Report that covers the entire Kern County Subbasin.

1.1 PURPOSE OF THE GSP ANNUAL REPORT

The purpose of this Fourth Annual Report for WY 2022 is to demonstrate implementation of the six GSPs in the Kern County Subbasin in a manner that will achieve the sustainability goals. This Fourth Annual Report provides an update on the groundwater conditions for WY 2022 (Reporting Period), and documents continuing progress on GSP implementation.

Data and analyses cover the Reporting Period (October 1, 2021 through September 30, 2022); groundwater elevation hydrographs and the change in groundwater in storage analysis also cover a historical period as required by the regulations. Specifically, these two components are required to use "historical data to the greatest extent available including from January 1, 2015 to the current reporting year." (§356.2 (b)(1)(B) and §356.2 (b)(5)(B)).

1.1.1 Coordinated Submittal

Since the First Annual Report was submitted to DWR April 1, 2020, the Kern County Subbasin GSAs have coordinated on preparation of one combined document for the GSP annual reports. This successful Subbasin-wide coordination continues with the production of this Fourth Annual Report. Various coordination steps taken in development of the Annual Report are summarized below; additional Subbasin-wide coordination activities on GSP implementation are summarized in **Section 7.1**.

1.1.2 Coordinated Historical Data

For the Annual Report analyses that are required to include historical data (i.e., hydrographs and change in groundwater in storage), the Subbasin GSAs are following the same methodology used in the Subbasin GSPs and previous annual reports. In the GSPs, a consistent Subbasin-wide data set with historical data "to the greatest extent available" was developed for the historical and current study period from WY 1995 through WY 2015. This subbasin-wide water budget analysis was conducted over this period using the integrated surface water-groundwater model, C2VSimFG-Kern[1]. This process ensured that the Subbasin uses consistent data and methodologies for the Subbasin-wide water budget analysis as required by GSP regulations.

The First Annual Report updated that model from WY 2016 through WY 2019. Each successive annual report provides updates to the historical data for the preceding water year to support consistent analyses. This Fourth Annual Report updates historical data for the Subbasin through WY 2022.

1.2 BASIN COORDINATION COMMITTEE

As described in the Kern County Subbasin Coordination Agreement (Coordination Agreement), Subbasin GSAs have organized a Basin Coordination Committee (BCC) to provide a forum to coordinate Subbasin GSP implementation. Specifically, the Coordination Agreement states that coordination activities may include "the development, planning, financing, environmental review, permitting, implementation, and long-term monitoring of the multiple GSPs in the Basin, pursuant to SGMA requirements."

Since GSP submittal in January 2020, the BCC has continued to meet and work on various Subbasin-wide activities for GSP implementation including review of any monitoring network changes proposed by the GSAs. During WY 2022, the BCC provided oversight for the response to DWR on the Subbasin Preliminary Determination Letter that the Subbasin GSPs were collectively "incomplete" and required additional correction actions. Amended GSPs and an Amended Coordination Agreement were submitted for the Subbasin in July 2022.

Since that submittal, the BCC has provided oversight on additional projects and management actions envisioned in both the original and amended Coordination Agreement. Subbasin-wide coordinated implementation activities are discussed in more detail in **Section 7.1** *Progress on Subbasin-wide Coordination on GSP Implementation*. Progress on implementing each of the six GSPs, including progress on projects and management actions, is summarized in **Section 7.2**, *Progress on Implementation of the Six Individual GSPs in the Subbasin*.

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[1] Documentation of the local model, along with water budget results, was included as Appendices 2 and 4 of the Subbasin Coordination Agreement.

1.3 APPROACH

Data and analyses for the GSP Annual Report include compilation of water level data; development of hydrographs and groundwater elevation contour maps; tabulation of groundwater extraction, surface water supply, and total water use data; and analysis of changes in groundwater in storage. Data and analyses cover the Reporting Period of WY 2022 except for hydrographs and changes in groundwater in storage, which are presented from WY 1995 through WY 2022.

1.3.1 Data Compilation

Following guidance from Article 7 of the GSP regulations, data were compiled from GSAs, member agencies, and other entities throughout the Subbasin. **Table 1** provides a list of 41 agencies who contributed directly measured or reported data in support of this Annual Report. With the recent completion of key modules in the Kern County Subbasin DMS, agencies were set up with templates to report data directly into the online DMS. This Subbasin-wide DMS was described in detail in the Third Annual Report, submitted to DWR in 2022. Expansion and improvements to the DMS are mentioned throughout this Annual Report and described in **Section 7.1**.

The DMS was also used to generate Subbasin-wide hydrographs for the GSP monitoring networks, using the groundwater elevation data as described in **Section 2**. Metered groundwater extractions, surface water supplies, and water use data were uploaded to the DMS by individual agencies and compiled into the DWR data templates that are reported in **Sections 3**, **4**, and **5**. These data were also incorporated into the C2VSimFG-Kern model update, as described in **Section 1.3.2,** which was used to calculate total groundwater extractions and change in groundwater in storage reported in **Sections 3** and **6**, respectively.

1.3.2 C2VSimFG-Kern Model Update

The Amended Kern County Subbasin Coordination Agreement refers to the local groundwater-surface water model (C2VSimFG-Kern) as the agreed upon method for generating coordinated water budgets for the Kern County Subbasin. Appendices 2 and 4 of the Amended Kern County Subbasin Coordination Agreement include a technical report (Maley and Brush, 2020) on the development and application of C2VSimFG-Kern for these purposes.

C2VSimFG-Kern is based on the C2VSim Fine Grid Public Beta model (C2VSimFG-Beta) that was released by DWR for SGMA support in May 2018. For the 2020 GSPs, the C2VSimFG-Beta input files were revised to incorporate locally derived managed water supply and demand data to better represent the local water budgets for the Kern County Subbasin (Maley and Brush, 2020). To meet the requirements for the Annual Report, C2VSimFG-Kern is updated with new input data following this same methodology to maintain consistency in generating coordinated water budgets.

For this Annual Report model update, WY 2022 data were added to the existing data structure and model input files. In addition, new recovery wells and recharge operations that became operational during the update period were added to the model input. Monthly data were requested and provided by the local agencies through their respective GSA. The monthly data for Kern County Subbasin include:

- Surface water imports and diversions for various uses including agricultural, urban, seasonal refuge, and managed aquifer recharge/groundwater banking.
- Recharge volumes for managed aquifer recharge/groundwater banking operations.
- Measured pumping volumes for managed aquifer recharge/groundwater banking recovery operations for local use and pump-ins to regional aqueducts.
- Urban water supply, both surface water and groundwater, for the larger cities in Kern County Subbasin with emphasis on the Metropolitan Bakersfield Area.
- Stream inflows to the Subbasin for the Kern River and Poso Creek.
- Other locally important water supply or demand data provided by local agencies.

In addition to the agency data in **Table 1**, regional data sets were also updated to provide climatic data sets for the C2VSimFG-Kern update. These data sets include the following:

- Precipitation data were updated using publicly available rainfall data for WY 2022. These data were downloaded from the Oregon State University PRISM Climate Group (PRISM, 2023) web site in March 2023.
- ET rates for Kern County were determined using satellite-based data following the same process used for the original C2VSimFG-Kern development (Maley and Brush, 2020) and for previous annual reports. The ET data were developed by the Irrigation Training & Research Center (ITRC) at California Polytechnic State University, San Luis Obispo (Howes, 2023). ITRC uses a modified Mapping of EvapoTranspiration with Internal Calibration (METRIC) procedure to compute actual evapotranspiration using LandSAT Thematic Mapper data (Howes, 2023).

The agricultural, urban and native vegetation land use areas used the same assumptions as in the projected-future Baseline scenarios for the Kern County Subbasin GSPs (Maley and Brush, 2020). Model input for areas outside of the Kern County Subbasin use data from an analogous water year type. This is the same approach that was used for the projected-future Baseline scenarios for the Kern County Subbasin GSPs (Maley and Brush, 2020).

The 2020 GSP water budgets used WY 1995 to WY 2014 as the historical base period. During this period, C2VSimFG-Kern results show an average annual decline of groundwater in storage of 277,114 AFY. Based on the methodologies used, known data gaps and the availability of historical data, the estimated level of uncertainty of the overall water budget generated by C2VSimFG-Kern is determined to be on the order of 10% to 20% (Maley and Brush, 2020). Notwithstanding these limitations, C2VSimFG-Kern is considered to be the best available information and well-suited as a planning tool to estimate the impacts of the proposed SGMA projects and management actions on groundwater conditions in the Kern County Subbasin.

Table 1. List of Kern County Subbasin Agencies Contributing Data

Agency	Metered Groundwater Extractions	Surface Water Supply	Total Water Use	Groundwater Elevations
Agricultural Water Agencies				
Arvin-Edison WSD	X	X	X	X
Belridge WSD		X	X	X
Berrenda Mesa WD		X	X	X
Buena Vista WSD	X	X	X	X
Cawelo WD	X	X	X	X
Eastside WMA	X	X	X	X
Henry Miller WD	X	X	X	X
Kern Delta WD	X	X	X	X
Kern-Tulare WD	X	X	X	X
Lost Hills WD		X	X	X
North Kern WSD	X	X	X	X
Olcese WD	X	X	X	X
Rosedale-Rio Bravo WSD	X	X	X	X
Rosedale Ranch Improvement District		X	X	
Semitropic WSD	X	X	X	X
Shafter-Wasco ID		X	X	X
7th Standard Annex WMA		X	X	X
Southern San Joaquin MUD		X	X	X
Tejon-Castac WD	X		X	X
Wheeler Ridge-Maricopa WSD	X	X	X	X
Urban Water Agencies				
Arvin CSD	X			
Buttonwillow CWD	X		X	
Cal Water - Bakersfield	X	X	X	X
City of Bakersfield	X	X	X	X
City of Delano	X	X	X	
City of McFarland	X	X	X	
City of Shafter	X	X	X	X
City of Wasco	X	X	X	
East Niles CSD	X	X	X	X
Greenfield CWD	X		X	X
Kern County Water Agency ID4	X	X	X	X
Lamont PUD	X	X	X	X
North of the River Sanitation District	X	X	X	
Oildale MWC	X	X	X	
Vaughn Water Company	X		X	
West Kern WD	X	X	X	X
Other Agencies				
Berrenda Mesa Banking Project	X	X	X	X
County of Kern Parks & Rec. - BVARA	X			
Pioneer Banking Project	X	X	X	X
Kern Water Bank Authority	X	X	X	X
Kern National Wildlife Refuge		X		

The C2VSimFG-Kern water budgets and sustainable yield estimates are based on available data and the current level of model calibration and are considered appropriate to support SGMA planning efforts. C2VSimFG-Kern water budgets are not intended for determination of individual landowner allocations or groundwater rights. Additional technical, policy, and legal analysis, along with stakeholder involvement, is necessary to fully quantify the sustainable and native yields in the Kern County Subbasin.

1.3.3 DWR Data Templates

DWR has provided Microsoft Excel data templates for agencies to report their basin-wide groundwater extraction volumes, measurement methods, surface water supplies, and total water use. DWR requires the GSAs to use these templates to provide for consistent statewide reporting of water use. A description of the data provided for these templates is included in the following sections. These include:

- **Part A. Groundwater Extractions** – Description of groundwater extractions by water use sector data (23 CCR §356.2(b)(2)) is presented in **Section 3**.
- **Part B. Groundwater Extraction Methods** – Description of groundwater extraction measurement methods (23 CCR §356.2(b)(2)) is presented in **Section 3**.
- **Part C. Surface Water Supply** – Description of surface water supply by water source type (23 CCR §356.2(b)(3)) is presented in **Section 4**.
- **Part D. Total Water Use** – Description of total water supply and use (23 CCR §356.2(b)(4)) is presented in **Section 5**.

As part of the submission of this Annual Report, the DWR data templates will be uploaded to the Monitoring Network Module (MNM) on the SGMA Portal, the same system used to upload GSP monitoring data.

1.4 Report Organization

This GSP Annual Report is organized according to the order of topics presented in Article 7 of the GSP regulations. Topics include groundwater elevations (**Section 2**), groundwater extractions (**Section 3**), surface water supply (**Section 4**), total water use (**Section 5**), change in groundwater in storage (**Section 6**), and a narrative description of progress towards GSP implementation (**Section 7**). Groundwater elevation hydrographs are presented in **Appendix A**. Also included are an Executive Summary and general information summarized in this first section.

1.5 Limitations

During WY 2022, the Kern County Subbasin GSAs have made significant progress with GSP implementation and are collectively committed to achieving sustainable groundwater management. Regularly scheduled meetings/webinars are being reinstated by the Basin Coordination Committee (BCC) and other GSA manager groups leading coordinated Basin-wide GSP activities. Substantial compliance with the requirements of the Annual Report is demonstrated throughout this WY 2022 Annual Report.

2 GROUNDWATER ELEVATIONS

This Fourth Annual Report presents the semi-annual monitoring groundwater elevations measured in the GSP Representative Monitoring Wells for WY 2022 (**Figure 5**). These data have been compiled for the Kern County Subbasin through WY 2022 to provide the following required analyses:

- Preparation of water level hydrographs for GSP Representative Monitoring Wells to illustrate long-term trends and fluctuations and to demonstrate compliance relative to sustainable management criteria. The location of GSP Representative Monitoring Wells that had an MT exceedance in WY 2022 are shown symbolically on **Figure 5**.
- Development of water level contour maps for Kern County Subbasin Principal Aquifers, illustrating the seasonal high and seasonal low levels during the Reporting Period of WY 2022 (i.e., Fall 2020 and Spring 2021).

The WY 2022 data were also uploaded to the DWR Monitoring Network Module (MNM) as required in June and December 2022 in compliance with DWR semi-annual reporting requirements (by January 1, 2022 for Fall 2021 water levels and July 1, 2022 for Spring 2022 water levels). These data uploads are now coordinated through the Kern County Subbasin DMS.

2.1 HYDROLOGIC WATER YEAR TYPE

GSP regulations require that hydrographs of groundwater elevations, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage be shown with respect to the water year type representative for the Subbasin (§356.2(b)(1)(B) and §356.2(b)(5)(B). Previous annual reports have included both the San Joaquin Valley Index and the average Kern River April-July runoff to represent the water year type for the Kern County Subbasin. These two indices are maintained in this Fourth Annual Report with modifications and updates as described below and presented on **Figure 6**.

The annual water year type as represented by the San Joaquin Valley Index is shown by the graph on the bottom of **Figure 6**. The San Joaquin Valley index is calculated by DWR as inflow from the Stanislaus, Tuolumne, Merced and San Joaquin Rivers inflow into downstream reservoirs. The WY 2022 San Joaquin Valley Index, calculated by DWR, was 1.56, which is classified as a critically dry water year type (CDEC, 2023). The water year type based on the San Joaquin Valley Index over the historical period from WY 1995 through WY 2022 is shown on **Figure 6**.

The City of Bakersfield calculates the regulated flow, as computed at First Point of Measurement, for the Kern River annual hydrographic reports. This flow rate is also calculated as a percentage of the average long-term flow rate for the Kern River since 1894 for April through July runoff, by calendar year, and by water year. For this Fourth Annual Report, Kern River indices by water year have been updated by the City for WY 1995 through WY 2022 to align with the San Joaquin Valley Index and the Reporting Period (see top graph on **Figure 6**). As shown by the Kern River index for WY2022, the Kern River regulated flow at First Point was only 29 percent of the long-term average (COB, 2022). This index indicates a continuation of the drought conditions that have persisted in the Kern County Subbasin over the last three water years since the submittal of the GSPs and correlate to water level declines across the Subbasin.

A comparison of the San Joaquin Valley and Kern River indices shows relatively good agreement for wet and dry cycles over the historical period from 1995 through 2022. In particular, the recent drought years of 2013, 2014, 2015, 2021, and 2022 represent the five most critically dry years in the period for both the Kern River and the San Joaquin Valley. For both the San Joaquin Valley and Kern River, WY 2015 was the driest on record. The last six years of the period represent two wet years (WY 2017 and WY 2019) and four below normal years (WY 2018, WY 2020, WY 2021 and WY 2022) with WY 2021 and WY 2022 being critically dry years. Since the beginning of the 2012 drought, nine of the last 11 years are characterized by the San Joaquin Valley Index as drought years with one Below Normal (BN), three Dry (D), and five Critically Dry (CD) Water Year Types. For each of those nine years, the Kern River hydrographic reports (COB, 2022) indicated flows at or below 60 percent of its long-term average, with five of those WYs at or below 30 percent (**Figure 6**).

2.2 COORDINATED BASIN-WIDE MONITORING

The Kern County Subbasin GSAs have combined the representative monitoring wells from the six Subbasin GSPs into a Subbasin-wide GSP Representative Monitoring Network as shown on **Figure 5**. Although developed locally, networks were combined to facilitate coordination and evaluation of sustainable management criteria across GSP boundaries and throughout the Subbasin.

The Kern County Subbasin GSAs have also coordinated on monitoring protocols, as documented in each of the Subbasin GSPs and in the executed Coordination Agreement. Monitoring protocols considered Best Management Practices (BMPs), CASGEM[2] monitoring protocols, and protocols from other long-established Kern County Subbasin monitoring programs (e.g., the Kern Fan Monitoring Committee). In consideration of the variable monitoring schedules already developed for existing Subbasin programs, the following time frames were included in the protocols to allow monitoring flexibility for collection of seasonal high and low levels as experienced across this large and complex Subbasin.

- *Collection of water level data between the two approved time frames only:*
  - *January 15th to March 30th representing the seasonal high-water levels.*
  - *September 15th to November 15th representing the seasonal low water levels.*

Some GSP monitoring network wells are measured more frequently, either as part of a separate monitoring program or in compliance with GSP-specific requirements. In addition, groundwater elevation data compiled for the WY 2022 reporting period are incomplete for some wells in the network. Some of these wells were either inaccessible or not measured during the approved time frames. In addition, some of the monitoring wells have been recently installed and/or recently added to the network; as such, some wells do not have available historical water level data.

[2] California Statewide Groundwater Elevation Monitoring (CASGEM) program.

The Subbasin GSAs have recently taken steps to address some of these issues through coordinated management actions and revised monitoring protocols developed as part of the Amended Coordination Agreement and amended GSPs, submitted to DWR in July 2022. For management of inaccessible monitoring wells going forward, GSAs have approved revised monitoring protocols that require GSAs to substitute measurements from a nearby well or evaluate trends in inaccessible wells when a semi-annual measurement is missed. This process was developed to ensure that a missed measurement would not have triggered a local management area exceedance. Details of this coordinated process, along with a description of the revised monitoring protocols, are provided in **Section 7.1**.

Appendix A provides hydrographs for each of the 198 wells in the collective Subbasin GSP Representative Monitoring Network in WY 2022. Hydrographs in **Appendix A** are divided into six sections, one for each of the six GSPs and organized alphabetically by the lead GSA as follows:

- Appendix A1 – Buena Vista WSD GSA
- Appendix A2 – Henry Miller WD GSA
- Appendix A3 – Kern Groundwater Authority GSA
- Appendix A4 – Kern River GSA
- Appendix A5 – Olcese GSA
- Appendix A6 – South of Kern River GSAs

Each hydrograph label includes the following:

- Name of the reporting agency,
- Common local well name,
- DWR Site Code, and
- Graph identification number (Graph ID).

The DWR Site Code provides a link to the well information and water level data already uploaded on the MNM, whereas the local well name allows for easier identification by local agencies. The Graph ID is also included as a well identifier label on each of the hydrographs in **Appendix A** to allow linkage back to **Figure 5**.

2.3 Hydrographs from WY 1995 through WY 2022

Hydrograph development and observations on trends and fluctuations, along with information on compliance with sustainable management criteria, are described below. The groundwater elevation data were used to generate hydrographs for GSP monitoring network wells where Minimum Thresholds (MTs) and Measurable Objectives (MOs) – and, in some cases, interim milestones – have been established. MTs and MOs are provided on each hydrograph in **Appendix A**.

2.3.1 Hydrograph Development

Hydrographs in this Fourth Annual Report are presented for each of the monitoring network wells shown on **Figure 5.** The hydrographs are developed within the Subbasin DMS so that the most complete groundwater elevations, well completion data and MT/MOs are used. The hydrographs are publicly available on the Subbasin DMS (see **Section 7.1.3**).

Almost 200 hydrographs have been developed for this Fourth Annual Report and are presented in a consistent format in **Appendix A**. For each hydrograph, a solid black horizontal line shows the ground surface elevation (GSE), and the MT and MO are represented by orange and green lines, respectively. Groundwater elevation data are shown in blue. As described previously, hydrographs are presented in alphabetical order of the lead GSA for the six GSPs and then alphabetical by monitoring agency; page numbers for each agency's group of hydrographs in the respective section of **Appendix A (Section A1 – Section A6)** are tabulated in **Table 2**.

To comply with GSP regulations, hydrographs include "historical data to the greatest extent available, including from January 1, 2015, to current reporting year" (§356.2(b)(1)(B)). For the Kern County Subbasin, the time period from WY 1995 through WY 2022 was selected based on the 20-year historical study period (WY 1995 – WY 2014) and updated data through the reporting period (WY 2022). Accordingly, the hydrographs show the historical record of measured groundwater elevations of each well within the 28-year period from WY 1995 through WY 2021. Some wells have a long historical record whereas new monitoring wells may only have a limited number of recent measurements. The water year type for this time period uses the San Joaquin Valley Index as illustrated by the bottom graph on **Figure 6**.

Most of the hydrographs represent the Primary Principal Aquifer, composed of the alluvial continental deposits in the Subbasin. However, three local Principal Aquifers in addition to the Primary Principal Aquifer are represented by the following hydrographs in **Appendix A**:

- Six hydrographs prepared by Kern-Tulare Water District (KTWD) for the Santa Margarita Formation (note that KTWD hydrographs also include wells monitored north of the Kern County Subbasin) (see **Appendix A3-20** through **A3-25**)
- Six hydrographs prepared by Eastside Water Management Area (EWMA) for the Santa Margarita Formation and the Olcese Sand (see **Appendix A3-8** through **A3-14**)
- Two hydrographs prepared by Olcese Water District (Olcese WD) for the Olcese Sand (see **Appendix A5-1** through **A5-2**).

In compliance with GSP regulations Article 4, the hydrographs are submitted electronically and labeled with a unique site identification number (Site Code and Local Identifier), monitoring agency, and the GSE. In addition, hydrographs have incorporated the same datum and scaling to the greatest extent practical (§352.4(e)). Some vertical scales are adjusted to allow the GSE, MT, and MO to be displayed.

Table 2. Location of Hydrographs in Appendix A by GSA and Agency

GSP	Reporting Agency	Graph ID (Appendix A)
Buena Vista Water Storage District GSA	Buena Vista Water Storage District GSA	A1-1 to A1-9
Henry Miller Water District GSP	Henry Miller Water District GSA	A2-1 to A2-5
Kern Groundwater Authority GSA	Cawelo Water District GSA	A3-1 to A3-7
Kern Groundwater Authority GSA	Eastside Water Management Area	A3-8 to A3-14
Kern Groundwater Authority GSA	Pioneer GSA	A3-15 to A3-19
Kern Groundwater Authority GSA	Kern Tulare Water District	A3-20 to A3-25
Kern Groundwater Authority GSA	North Kern Water Storage District GSA	A3-26 to A3-35
Kern Groundwater Authority GSA	Rosedale-Rio Bravo Water Storage District	A3-36 to A3-54
Kern Groundwater Authority GSA	Semitropic Water Storage District	A3-55 to A3-67
Kern Groundwater Authority GSA	Shafter-Wasco Irrigation District GSA	A3-68 to A3-77
Kern Groundwater Authority GSA	Southern San Joaquin Municipal Utility District	A3-78 to A3-87
Kern Groundwater Authority GSA	West Kern Water District	A-88 to A-110
Kern Groundwater Authority GSA	Westside District Water Authority	A-111 to A-113
Kern River GSA	Kern River GSA	A4-1 to A4-38
Olcese Water District GSA	Olcese Water District	A5-1 to A5-2
South of Kern River GSAs	Arvin GSA	A6-1 to A6-16
South of Kern River GSAs	Tejon-Castac GSA	A6-17
South of Kern River GSAs	Wheeler Ridge-Maricopa GSA	A6-18 to A6-31

2.3.2 Water Level Trends and Fluctuations

In general, the groundwater elevation trends seen on the hydrographs for the Primary Principal Aquifer (**Appendix A**) are consistent with the water year types illustrated on **Figure 6**. As a result, groundwater elevations generally declined in response to dry conditions in WY 2022; however, these trends vary across the Subbasin.

Historically, groundwater elevation trends in the Subbasin generally show an increase during the wet periods and a decrease during dry periods. This was observed during the wetter years of WYs 1995-1998, WYs 2005-2006, WYs 2010-2011 and the recent wet years of WY 2017 and WY 2019. During these wet years, there was an increase in both natural and managed aquifer recharge accompanied with a rise in groundwater elevations. This increase in groundwater elevations was more pronounced in the areas with managed aquifer recharge and banking operations. Conversely, dry periods have decreased natural recharge and also increased recovery of managed aquifer recharge by groundwater pumping. As expected, groundwater elevations generally declined across the Subbasin during these intervening dry years.

During the extended drought period from WY 2013 through WY 2016, several areas in the Subbasin experienced historic low groundwater elevations. Since that time, drought conditions have persisted with four out of the last six years characterized as below normal, dry, or critically dry, based on both the San Joaquin Valley Index and the Kern River flows (**Figure 6**). After groundwater elevations recovered somewhat during the wet years of WY 2017 and WY 2019, groundwater elevations have continued to decline over the last few years in many areas of the Subbasin (**Figure 6**).

As anticipated, the areas with the largest declines in groundwater elevations in WY 2022 are in the central Subbasin in the vicinity of the Kern Fan banking operations where increased pumping is needed to recover previously recharged groundwater. In the banking areas, groundwater elevations historically fluctuate more than 200 feet from wet to dry years as a result of varying recharge and recovery banking operations (e.g., see hydrograph for the Pioneer GSA on page **A3-19** in **Appendix A**). The groundwater elevations in WY 2022 are consistent with that pattern. This high variability in groundwater elevations is also reflected in the annual change in groundwater in storage maps in the large Kern Fan banking areas (as described in **Section 6**).

In areas farther away from the managed recharge and recovery operations, the groundwater elevations for WY 2020 through 2022 were generally more stable, representing local recharge and pumping conditions that are mostly within the historical range observed in the well. A few areas even indicate increasing groundwater elevations over the past three years. However, with the persistence of drought conditions and two consecutive critically dry years, about 25 percent of the monitoring wells have experienced new historic lows compared to WYs 2015-2016[3]. The exact number of wells with new historic lows is uncertain because many monitoring wells were added to the networks after WYs 2015-

[3] Wells without comparable WY 2015-2016 data were not included in the estimate.

2016 when most historic lows were observed. More information on groundwater elevation trends in the individual GSP areas is provided in **Section 7**.

2.3.3 Compliance with Sustainable Management Criteria

The hydrographs for GSP monitoring network wells illustrate how groundwater elevations compared to their assigned MOs and MTs during the reporting period (**Appendix A**). Note that the water level declines below MTs occurred in some wells prior to the submission of the GSPs and prior to GSP implementation. The location of the GSP Representative Monitoring Wells that exceeded an MT in WY 2022 are shown symbolically on **Figure 5**.

With the persistence of dry conditions since WY 2020, groundwater levels have declined below MTs in 17 of the 198 monitoring wells (less than 10 percent of network wells), mostly focused in the central Subbasin but also scattered across multiple management areas in the Subbasin. In general, the drought declines were anticipated and are being addressed.

The only Management Area Exceedance for WY 2022 occurred in the Urban MA of the KRGSA, covering about five percent of the Kern County Subbasin. The lack of surface water supplies, increase in local pumping, and proximity to large-scale banking recovery pumping resulted in two monitoring wells in the western municipal wellfields falling below MTs for more than three consecutive months. Both wells have recently recovered above or within ten feet of the MTs. This Management Area Exceedance did not cause undesirable results in the Subbasin as defined in the Kern County Subbasin Coordination Agreement.

Discussions of MT exceedances and Management Area Exceedances are provided in the GSAs' and member agencies' GSP Progress Summaries in **Section 7** (introduction in **Section 7.2** and individual progress reports beginning in **Section 7.3**).

2.4 GROUNDWATER ELEVATION CONTOURS FOR SUBBASIN PRINCIPAL AQUIFERS

GSP monitoring network data were supplemented with additional local groundwater elevation data to construct groundwater elevation contour maps for the Principal Aquifers in the Subbasin. Supplemental data include wells monitored by the Kern Fan Monitoring Committee and other available water level data. Kern County Water Agency (KCWA) typically compiles water level data on an annual basis for the Kern Fan Monitoring Committee to monitor conditions in and adjacent to the central Subbasin groundwater banking projects. To provide additional accuracy for water level contour mapping, KCWA has been combining the Kern Fan Monitoring Committee data with other available water level data over time. To support the Kern County Subbasin GSP annual reports, KCWA has been combining these two datasets with the GSP monitoring network data to prepare water level contour maps for the Primary Principal Aquifer, as described in **Section 2.4.1** below.

In addition to the KCWA mapping of the regional Primary Principal Aquifer, groundwater elevation maps were also provided by others for two of the three local Principal Aquifers in the Subbasin. All local Principal Aquifers are much more limited in extent than the Primary Principal Aquifer as shown on **Figure 9**. Specifically, Olcese Water District GSA provided contour maps for the Olcese Sand Principal

Aquifer in the Olcese GSA. KTWD provided groundwater elevations for the local Santa Margarita Principal Aquifer, although data were not yet sufficient to interpret groundwater elevation contours. In addition, data are not available for the remaining local Principal Aquifer area (i.e., Upper Aquifer in the northeast on **Figure 9**). The local agencies are working to address data gaps associated with these local Principal Aquifers. The Subbasin GSAs are coordinating with the comprehensive Basin Study (see **Section 7.1.6**) to address subbasin-wide hydrogeological conceptual model data gaps that will assist with better defining the local Principal Aquifer.

Portions of the Kern County Subbasin overlap active oil fields that have been exempted under the USEPA definition of protected groundwater *(40 CFR §144.3).* An aquifer exemption is an action by USEPA to remove an aquifer or portion of an aquifer from protection as an underground source of drinking water (USDW) under the Safe Drinking Water Act (SDWA) because it does not serve as a source of drinking water either currently or will in the future. An aquifer exemption allows the exempted portion of the aquifer to be used by energy and mining companies for oil or mineral extraction or disposal purposes in compliance with USEPA's (Underground Injection Control) UIC requirements. The Subbasin GSPs define any water bearing zone within the areal extent and depth interval of an aquifer exemption as being located outside of the Kern County Subbasin and, therefore, is not included within any of the Principal Aquifers. The Basin Study is also working to better define the extent of the USEPA-approved exempt aquifers to better integrate this information into the basinwide hydrological conceptual model.

2.4.1 Primary Principal Aquifer

Using the groundwater level monitoring data collected from the Subbasin representative monitoring wells, KCWA prepared groundwater elevation contour maps for the Primary Principal Aquifer, which consists mostly of continental alluvial deposits that extend throughout most of the Subbasin. As mentioned above, KCWA has been responsible for implementation of the Kern Fan Monitoring Committee program and has constructed similar basin-wide groundwater elevation contour maps for decades. Although KCWA has prepared contour maps for both seasonal highs (Spring) and lows (Fall), more data are typically collected in Spring when water levels are less affected by a long irrigation season and more accurately reflect the natural hydrologic conditions in the Subbasin. For this Fourth Annual Report, data were compiled and contoured for both Fall 2021 and Spring 2022, as shown on **Figures 7** and **8**, respectively, to comply with the GSP reporting period of WY 2022. Contours are represented as feet with respect to mean sea level (msl). Negative contours represent feet below msl.

Groundwater elevations are highest along the southeastern boundary of the Subbasin in the Sierra Nevada foothills. The highest groundwater elevations on Figure 7 are along the Kern River (generally above 200 feet msl), which traverses across the central Subbasin from northeast to southwest (see also **Figure 1**). Kern River water infiltrates alluvial deposits in the channel and local unlined canals to recharge the groundwater basin. Groundwater elevations remain relatively high in the central Subbasin but are more variable. Multiple groundwater banking projects store large volumes of recharged water for subsequent recovery in the areas along the Kern River referred to as the Kern Fan area. As reported in the First Annual Report (WY 2019), more than 1,100,000 acre feet (AF) of water were available for managed aquifer recharge, primarily associated with the Kern Fan banking projects, due to relatively wet conditions in WY 2019. In WY 2022, water levels are locally complex in this banking area due to the timing and volumes of recovery pumping from the groundwater banks as a result of the dry conditions during Summer/Fall 2021 (**Figure 7**).

Groundwater elevation contours on **Figure 7** indicate that groundwater flows radially away from the Kern River area. Within several miles, water levels are more than about 50 feet lower compared to levels areas along the river channel. Groundwater elevations continue to decline with distance both north and south of the River. To the south, water levels are generally above 100 feet msl except for two areas to the south and southwest as indicated on **Figure 7**. Groundwater elevations have declined below sea level over most of the northern Subbasin north of the River. The lowest water levels (more than 100 feet below msl) occur in the northwestern Subbasin and along the northern boundary of **Figure 7** near the Subbasin subsurface outflow to adjacent subbasins to the north.

Similar patterns of water levels and groundwater flow directions are indicated for Spring 2022 conditions as shown on **Figure 8**. During this period, water levels in the Kern Fan banking areas remain highly variable with lower groundwater elevations due to concentrated areas of recovery pumping. WY 2022 is characterized by groundwater extraction in the banking areas rather than recharge due to limitations on surface water supplies. Some areas north and south of the Kern River are higher in Spring 2022 (**Figure 8**) than in Fall 2021 (**Figure 7**) due, in part, to the migration of previously recharged water from the Kern River and the Kern Fan banking areas.

Even though Spring conditions generally represent a time of higher water levels, **Figure 8** indicates that groundwater elevations remained below sea level in a similar area of the Subbasin in Spring 2022 as compared to Fall 2021. In addition, measured groundwater elevations in this area are lower in Spring 2022 than in Fall 2021.

2.4.2 Local Principal Aquifers

Although most of the Subbasin production occurs within the Primary Principal Aquifer, three additional Principal Aquifers have been identified in the Subbasin GSPs. Although the exact extents of these three local Principal Aquifers are not well defined, local aquifers have been generally delineated in four areas of the Subbasin as shown on **Figure 9** and listed in **Table 3**. Other localized areas or geologic formations within the Kern County Subbasin with wells that directly provide groundwater for beneficial use, but have not been identified as separate Principal Aquifers, are considered as part of the Primary Principal Aquifer.

As shown on **Figure 9**, three of the local aquifers occur along the northeastern margin of the Subbasin and consist of deeper consolidated units including the Santa Margarita Formation and the Olcese Sand. In those areas, groundwater is produced primarily from the Santa Margarita Formation in KTWD, both the Santa Margarita and Olcese Sand in EWMA, and the Olcese Sand in Olcese WD. In addition, a local Upper Aquifer has been observed mostly within Semitropic WSD in the northern portion of the Subbasin. Water levels in these local principal aquifers are shown on **Figures 10, 11 and 12** and discussed below.

Table 3. Local Principal Aquifers in the Kern County Subbasin

Principal Aquifer	Responsible Agency	Subbasin Area
Olcese Sand	Olcese WD	East, near the Subbasin boundary adjacent to the Kern River
Santa Margarita Formation	Kern-Tulare WD	Northeast
Combined Santa Margarita Formation and Olcese Sand	Eastside WMA	East-Northeast
Upper Aquifer	Semitropic WSD	North-Central

Groundwater elevation contour maps were provided for the Olcese Sand Principal Aquifer by Olcese WD GSA; maps for Fall 2021 and Spring 2022 are presented on **Figures 10** and **11**, respectively. As indicated on **Figure 10**, Fall 2021 groundwater elevations are about 320 feet higher in the Canyon View Ranch Well in the eastern GSA than in wells to the west. A steep hydraulic gradient is evident between the Canyon View Ranch well and the deeper downgradient wells. Groundwater elevations are significantly flatter in Wells #2, #3, and #4. In Spring 2022 (**Figure 11**), groundwater elevations were relatively stable in the Canyon View Ranch Well while water levels rose an average of about 62 feet in other wells. For the Santa Margarita Formation in the northeastern Subbasin, Kern Tulare WD (KTWD) provided groundwater elevations measured in wells from both the previously-implemented CASGEM program as well as the ongoing GSP monitoring network established by KTWD. Groundwater elevations are posted on **Figure 12** for Fall 2021 and Spring 2022. As presented in previous Annual Reports, groundwater elevations both within and north of the Subbasin are posted by Kern-Tulare WD to provide context for the local aquifer that extends to the north (see the Kern County line on **Figure 12**).

As evidenced by the data on **Figure 12**, water levels are variable geographically and not readily conducive to water level contouring. Nonetheless, review of the data shows that water levels rebounded significantly in Spring 2022 compared to Fall 2021. Increases in groundwater elevations for Spring 2022 averaged about 100 feet for the five southern monitoring wells. Even though the increase in groundwater elevations between the two posted measurements for Fall 2021 and Spring 2022 is less in Well 8L1 than in the southern wells (only about nine feet), the overall seasonal fluctuations for that well are similar to the remaining wells (see KTWD hydrographs in **Appendix A3**). The production zone represents a narrow band of Santa Margarita sandstone that is structurally complex. Nonetheless, it provides an important local resource that is being investigated and monitored by KTWD.

As part of the ongoing Basin Study[4] includes a team of hydrogeologists working with local agencies including KTWD on an improved understanding of local principal aquifers in the Subbasin. Similarly, the Basin Study also incorporates information and data from the adjacent Eastside Water Management Area, where production is reported to occur from both the Santa Margarita Formation and Olcese Sand. The Basin Study will further evaluate local groundwater conditions in these local principal aquifers (**Table 3** and **Figure 9**).

In the north central Subbasin, a third local Principal Aquifer has been identified as the Upper Aquifer. This Upper Aquifer has been created by the occurrence of shallow clays that limit downward recharge and locally separate the Upper Aquifer from the Primary Principal Aquifer. Although the Upper Aquifer is not heavily relied on for water supply, the presence of an upper and lower aquifer system is evidenced by differences in water levels observed in the area. Cross sections and maps presented in the Semitropic WSD Management Area Plan (in the KGA GSP) show the water level differences and limited extent of the Upper Aquifer as a local Principal Aquifer. The estimated extent is shown on **Figure 9**.

Groundwater elevations have been mapped previously as part of the Semitropic Groundwater Banking Project Monitoring Committee. Those maps will continue to be available for local planning and use; however, publicly-available groundwater elevations for WY 2022 were not available. Because almost all groundwater production beneath Semitropic WSD occurs in the lower Principal Aquifer (hydraulically connected to the Primary Principal Aquifer), no significant change in groundwater in storage for the Upper Aquifer is expected. Any local change in groundwater in storage will be documented using the C2VSimFG-Kern modeling as part of this Annual Report. As mentioned previously, more information is being generated on all of the local principal aquifers as part of the ongoing Basin Study (see also **Section 7**).

[4] The Basin Study is a Subbasin-wide study of the hydrogeology and hydrology with revisions to the Subbasin integrated water resources C2VSimFG-Kern model, among other technical and outreach components. The study is being coordinated among all of the Subbasin GSAs and incorporates locally available data from Subbasin agencies for an improved understanding of the local principal aquifers. The Study is funded through by a DWR GSP Implementation grant; additional information is provided in **Section 7**.

3 GROUNDWATER EXTRACTIONS

The volume of groundwater extraction in the Kern County Subbasin is provided for WY 2022 per GSP Regulations (23 CCR §356.2(b)(2)). Data presentation follows the DWR data templates that list groundwater extractions by water use sector and identify the method of measurement and accuracy of measurements (**Table 4**). A map of groundwater extractions (**Figure 13**) is provided to illustrate the general location and volume of groundwater extractions in the Kern County Subbasin.

3.1 GROUNDWATER EXTRACTION DATA METHODS

Total groundwater extractions for the Subbasin for WY 2022 have been compiled and summarized for this section. The data were collected using the "best available measurement methods." For the Kern County Subbasin the groundwater extraction data were compiled using two methods:

- Directly measured groundwater extraction data collected by local water agencies.
- Estimated groundwater extractions using the IWFM Demand Calculator (IDC) tool developed by DWR (Dogrul, Kadir and Brush, 2017).

Directly measured groundwater extractions were collected using meters and other appropriate comparable measuring devices by local water agencies (**Table 1**), in accordance with the monitoring protocols of the respective local water agency. These data were compiled and provided by the local water agency to support this Annual Report. These directly measured data were obtained using high-accuracy measuring devices and methodologies (see **Section 3.4**).

The remaining estimated groundwater extractions are based on DWR's IDC tool (Dogrul, Kadir and Brush, 2017) to estimate agricultural, urban and other pumping. IDC is a standalone module used in the IWFM-based C2VSimFG-Kern model that solves the soil moisture balance in the root zone using local soil properties to compute the monthly agricultural and urban water demand for each model element. If water demand is not satisfied with precipitation and applied surface water, the IDC tool calculates the groundwater pumping needed to eliminate any assumed deficit (Dogrul, Kadir and Brush, 2017). The groundwater extraction calculated by IDC is dynamically linked to the C2VSimFG-Kern to provide the overall pumping data for the groundwater model component.

For the Kern County Subbasin, IDC calculates only the groundwater extraction necessary to meet the crop and soil moisture demand after accounting for the contribution from surface water supplies and precipitation. WY 2022 surface water supplies are based on measured data provided by local agencies (**Table 1**), and regional distribution of WY 2022 precipitation is based on data developed by the PRISM Climate Group based at Oregon State University (PRISM, 2023). The determination of agricultural pumping follows the same approach used for the GSP model-derived water budgets (Maley and Brush, 2020).

IDC calculates agricultural demand based on annual crop type distribution mapping from the Kern County Agricultural Commissioner, member agency data and evapotranspiration (ET) rates for twenty irrigated crop types, the urban areas, and the managed seasonal wetlands at the Kern National Wildlife

Refuge. Monthly WY 2022 ET rates were developed by applying the METRIC process to satellite-based data processed at the Irrigation Training & Research Center (ITRC) at California Polytechnic State University, San Luis Obispo (Howes, 2023).

Similarly, urban demands in C2VSimFG-Kern are based on agency supplied information and/or regional population and per-capita water demand. Population information was from projected-future baseline population used for the GSPs (Maley and Brush, 2020). The per-capita water demand was recalculated for the metropolitan Bakersfield area based on water supply data provided by the local water purveyors. For areas outside of the metropolitan Bakersfield area, per-capita water demand is based on urban water management plans and available local water use data. IDC calculates urban water demands for specified urban delivery zones, allocates specified surface water and groundwater supplies to meet these demands, and can optionally pump additional groundwater to satisfy unmet urban (indoor and outdoor) demands in each zone following the same approach as used for the GSP model-derived water budgets (Maley and Brush, 2020).

3.2 Summary Extractions By Subbasin For WY 2022

Using the methods described above, the total groundwater extractions in the Kern County Subbasin for WY 2022 were tabulated. **Table 4** summarizes the Kern County Subbasin groundwater extractions by water use type and measurement method, consistent with the DWR data templates, for WY 2022.

Table 4. Groundwater Extractions in the Kern County Subbasin for WY 2022

Groundwater Extraction	Total Groundwater Extractions	Meters Volume	Electrical Records Volume	Land Use Volume	Groundwater Model Volume	Other Methods Volume
Water Use Type	**Acre-ft**	**Acre-ft**	**Acre-ft**	**Acre-ft**	**Acre-ft**	**Acre-ft**
Urban	163,032	161,098	0	1,934	0	0
Industrial	0	0	0	0	0	0
Agricultural	1,554,176	382,692	0	1,171,484	0	0
Managed Wetlands	0	0	0	0	0	0
Managed Recharge	520,995	520,995	0	0	0	0
Native Vegetation	0	0	0	0	0	0
Other	105,428	14,022	0	91,406	0	0
Total	2,343,630	1,078,806	0	1,264,824	0	0

The data show that 2,343,630 acre-feet of groundwater extractions occurred in WY 2022. For the Kern County Subbasin, the water use sectors are described as follows:

- **Urban** – This category includes groundwater extractions for all urban uses including residential, commercial, municipal, industrial, food processing, oilfield use, landscaping and other uses. Reported data are provided by urban water purveyors with metered data. Non-reported data are derived from land use assumptions in the IDC tool within the C2VSimFG-Kern groundwater model. The total urban groundwater extraction for WY 2022 is 163,032 acre-feet, with most of this based on metered data. Urban pumping accounts for about 7% of the WY 2022 total pumping.

- **Industrial** – Current data do not allow for tabulation of groundwater extraction of industrial groundwater use on a consistent basin-wide basis; therefore, industrial water use is included in the urban water use sector for WY 2022.
- **Agricultural** – These are groundwater extractions for irrigated crops and pasture (including non-district lands). Also included in this category is groundwater used for food processing and dairy operations that is then applied to nearby crops for disposal. Reported data are pumping volumes by local water agencies for agricultural use. Private agricultural pumping is determined using the IDC tool within C2VSimFG-Kern based on the ITRC-METRIC satellite data (Howes, 2023) to determine monthly ET rates. The WY 2022 total agricultural groundwater extraction is 1,554,176 acre-feet, which accounts for about 66% of the total pumping.
- **Managed Wetlands** – The Kern National Wildlife Refuge has historical groundwater use, but currently relies on surface water supplies. No managed wetland groundwater extractions were reported for WY 2022 for the Kern National Wildlife Refuge.
- **Managed Recharge** – This category includes groundwater extractions from local district-managed recharge operations and large groundwater banking projects that go to water sector uses or are returned to the California Aqueduct or Friant-Kern Canal (i.e., "Pump-In") as part of a water exchange. Groundwater recovery pumping amounts by local agencies for use within their jurisdiction for a specific water use are listed on **Table 4** under the appropriate water use sector (e.g., agricultural or urban). The total groundwater extraction for managed recharge recovery, as defined above, is 520,995 acre-feet, which accounts for about 22% of the WY 2022 total pumping.
- **Native Vegetation** – Currently, no groundwater extractions are used for maintaining native vegetation in the Kern County Subbasin.
- **Other Sector** – This category includes groundwater extractions for water use sectors that do not fit within the categories listed above. Examples include groundwater pumping for use in areas adjacent to the Kern County Subbasin, lake level management, and pumping for unspecified or multiple water-use sectors. The total groundwater extraction for other uses in the Kern County Subbasin is 105,428 acre-feet, which accounts for about 4% of the WY 2022 total pumping.

In accordance with 23 CCR §356.2 (b)(2), the user must define the method of measurement (direct or indirect) and the accuracy of measurements. The other criteria required for presenting the groundwater extraction data is by method of measurement. As shown on **Table 4**, the groundwater extractions in the Kern County Subbasin are categorized into two of the methods listed by DWR. These include:

- **Meters** – direct measurement of groundwater extraction collected by local water agencies using meters and other appropriate measurement device. The total groundwater extraction from metered data is 1,078,806 acre-feet which accounts for about 46% of the WY 2022 total pumping.

- **Land Use Calculation** – indirect estimate of groundwater extractions based on land use methods using the IDC tool (Dogrul, Kadir and Brush, 2017), a component of the C2VSimFG-Kern model. The total groundwater extraction based on land use calculations is 1,264,824 acre-feet which accounts for about 54% of the WY 2022 total pumping in the basin.

Groundwater extractions presented here represent the current best estimate of groundwater pumping in the Kern County Subbasin. The use of C2VSimFG-Kern, including the IDC tool, provides a consistent, basin-wide method for estimating the unmeasured pumping in accordance with the Kern County Subbasin Coordination Agreement.

3.3 GROUNDWATER EXTRACTIONS MAP

In accordance with 23 CCR §356.2 (b)(2), this Annual Report includes a map (**Figure 13**) illustrating the general location and volume of groundwater extractions. For WY 2022, a total groundwater extractions map was derived from the simulation results of C2VSimFG-Kern. The specified metered pumping is directly input into C2VSimFG-Kern while the IDC tool estimates the unmeasured portion of agricultural and urban pumping based on land use calculations (Maley and Brush, 2020).

Developing a map showing the distribution of groundwater extraction required accessing the groundwater extraction for each element from the binary output files of model results. The model output is the total volume of groundwater extracted within a model element. Because model elements vary in size, the simulated groundwater extraction rate from C2VSIMFG-Kern was normalized to the rate of acre-feet per square mile. These groundwater extraction rates were then interpolated onto a uniform one-square mile grid superimposed over the Kern County Subbasin. Therefore, the model represents the total pumping per square mile over the groundwater basin included in C2VSimFG-Kern.

Figure 13 shows the distribution of total groundwater extractions over the Kern County Subbasin. Because agricultural pumping accounts for 66% of the total WY 2022 groundwater extractions, the pumping distribution generally corresponds to the distribution of irrigated agriculture. The exception is in the northwestern Subbasin where irrigated agriculture depends solely upon imported surface water supplies due to poor local groundwater quality, which is unsuitable for irrigation. In general, groundwater extraction in the irrigated areas ranges between 250 to 2,000 acre-feet per square mile.

Areas of concentrated pumping are typically associated with groundwater banking recovery operations. The areas where groundwater pumping exceeds 2,000 acre-feet per square mile are located in the vicinity of managed aquifer recharge operations where the pumping is recovering previously “banked” surface water for use.

3.4 PART A AND B DWR DATA TEMPLATES

As part of the Annual Report submittal, DWR requires that a series of Excel spreadsheets be completed to summarize key water supply and use volumes for WY 2022 for the entire Subbasin. For groundwater extraction, DWR requires submittal of two spreadsheets with the Annual Report in accordance with 23 CCR §356.2 (b)(2):

- **Part A. Groundwater Extractions** - groundwater extractions for WY 2022 by water use sector (23 CCR §356.2(b)(2))
- **Part B. Groundwater Extraction Methods** - the volume of groundwater extractions for WY 2022 by different measurement methods (23 CCR §356.2(b)(2)).

Data summarized in **Table 4** follow the Part A and B DWR Template reporting requirements for groundwater extractions and were collected using the best available measurement methods.

The accuracy of measurement is required on the DWR templates. For the Kern County Subbasin, the groundwater extractions are based on either reported metered pumping data or simulation results of the C2VSimFG-Kern model. These data were collected by experienced agency staff from agricultural, urban and county water agencies (**Table 1**) in accordance with their monitoring protocols. The measuring devices used by these agencies are considered to be well maintained and consistently monitored; therefore, reported data meet high accuracy levels in compliance with AWWA (2006, 2012) and other relevant standards. In accordance with these standards, meter accuracy is considered high, ranging between 0% and 5%.

Estimated groundwater extractions are based on simulation results of the IDC tool within C2VSimFG-Kern model. The water balance accuracy of the groundwater model is considered medium, approximately ranging between 10% and 20%. Input data based on metering, as noted above, are assumed to have an accuracy of 0% to 5%. The agricultural pumping, which is the largest component of groundwater extraction, is estimated using the ITRC-METRIC based ET Rates. ITRC (Howes, 2023) lists the accuracy of the ET measurements as ranging from 7% to 10%. Land use is based on Kern County Agricultural Commissioner annual land use data including crop type. Soil properties are based on local soil survey data, which have a higher level of uncertainty. Applying a weighted average of these inputs to the overall water budget produces a relative accuracy between 10% and 20% for the land use calculation for agricultural groundwater extractions.

4 SURFACE WATER SUPPLY

The volume of surface water supplies delivered to the Kern County Subbasin is provided for WY 2022 per GSP Regulations (23 CCR §356.2(b)(3). Data are summarized in a table that follows DWR reporting requirements for surface water supplies by water supply source and identifies the method used to determine the reported volume.

4.1 SURFACE WATER DATA METHODS

Surface water supplies for the Subbasin for WY 2022 were compiled from data collected using the "best available measurement methods." For the Kern County Subbasin, surface water supplies are directly measured by local water agencies at the point of diversion from a river, stream or canal. Water supply from natural sources (e.g., precipitation and natural runoff) are not included in **Section 4**. The contribution of these sources to the basin is included in the calculation of the change in groundwater in storage based on the C2VSimFG-Kern model provided in **Section 6**.

The measured surface water supplies were provided by local agricultural water districts, urban water purveyors and city water departments (**Table 1**) for this Annual Report. These meter data were compiled by local water agencies following their monitoring protocols. Therefore, these data were obtained using a "high accuracy" method consistent with typical accuracy ranges of surface water diversions.

4.2 SURFACE WATER BY SOURCE TYPE

Using the methods described above, the surface water supply by source in the Kern County Subbasin for WY 2022 was tabulated and is summarized in **Table 5**. The water source types are defined in 23 CCR §351 (a-k). The user can identify a different water source type than those predefined by selecting "*other source type*" in the template and providing a description of the source type with the data. **Figure 14** is a map showing the primary surface water supply infrastructure and features in the Kern County Subbasin.

Table 5. Surface Water Supplies in the Kern County Subbasin for WY 2022

Surface Water Supply	Surface Water Supply Volume
Surface Water Supply Source	**Acre-ft**
Central Valley Project	144,563
State Water Project	353,716
Colorado River Project	0
Local Supplies	233,851
Local Imported Supplies	41,954
Recycled Water	48,520
Desalination	0
Other Water Source	403
Total Surface Water Supply	823,007

The data show that 823,007 acre-feet of surface water was supplied to the Kern County Subbasin in WY 2022. Following the DWR templates, the surface water supplies are presented by water source. For the Kern County Subbasin, the water supply sources are described as follows:

- **Central Valley Project (CVP)**: surface water deliveries from the CVP diverted from the Friant-Kern Canal and/or California Aqueduct (westside CVP – Cross Valley Contractors). In WY 2022, 144,563 acre-feet of CVP water were reported as delivered to local agencies, representing about 18% of total surface water supplies.
- **State Water Project (SWP)**: surface water deliveries from the SWP diverted from the California Aqueduct. In WY 2022, 353,716 acre-feet of SWP water were reported as delivered to local agencies, representing about 43% of total surface water supplies.
- **Colorado River Project**: Currently, no surface water from the Colorado River is delivered to the Kern County Subbasin.
- **Local Supplies**: surface water diversions from local surface water sources. The primary local supply is from the Kern River, but also includes other local sources such as Poso Creek and water exchanges. In WY 2022, 233,851 acre-feet of local surface water were reported as delivered to local agencies, representing about 28% of total surface water supplies.
- **Local Imported Supplies:** surface water from local sources imported from areas outside of the Kern County Subbasin. The primary source of local imported water is from treated oilfield produced water[5]. In WY 2022, 41,954 acre-feet of local imported water supplies were delivered, representing about 5% of total surface water supplies.
- **Recycled Water:** wastewater and recovered stormwater that is treated and used for either agriculture or groundwater recharge. In WY 2022, 48,520 acre-feet of recycled water were used, representing about 6% of total surface water supplies.
- **Desalination Water:** poor-quality surface water or groundwater that is treated to levels where it can be used for irrigated agriculture, urban water supply or groundwater recharge. Currently, no desalination water is available in the Kern County Subbasin; however, proposed SGMA projects include this source as a future water supply.
- **Other Water Source**: surface water obtained from sources other than those listed above or from unspecified sources. In WY 2022, 403 acre-feet of local surface water were delivered to the Kern County Subbasin. This is primarily reuse of tailwater or irrigation return flow that re-enters the local surface water system and is then diverted back for irrigated agriculture water supply, representing less than 1% of total surface water supplies.

[5] Produced water is water entrained with the oil and gas produced from hydrocarbon reservoirs. Produced water is primarily used for enhanced oil recovery operations (e.g., water flood, steam injection etc.); however, excess is injected into exempt aquifers. In recent years some produced water, processed at a treatment plant to meet regulatory requirements for beneficial use, is provided to water agencies as local imported surface water derived from outside of the Kern County Subbasin.

The surface water supplies in the Kern County Subbasin vary from year-to-year due to water year type, statewide water demand and operational considerations. WY 2022 was a critically dry year according to the San Joaquin Valley Index; flows on the Kern River were 29% of the long-term average, which is also consistent with critically dry year conditions (**Figure 6**).

4.3 PART C DWR DATA TEMPLATE

As part of the Annual Report submittal, DWR requires that a series of Excel spreadsheets be completed to summarize key water supply and use volumes for WY 2022 for the Subbasin. The volume of surface water reported in the template is by water source type. For the surface water supply, DWR requires submittal of one spreadsheet with the Annual Report in accordance with 23 CCR §356.2 (b)(3):

- **Part C. Surface Water Supply** – the surface water supply for WY 2022 based on quantitative data and listed by water source type (23 CCR §356.2(b)(3)).

Data summarized in **Table 5** follow the Part C DWR Template reporting requirements for surface water supply and were collected using the best available measurement methods.

Measurement of surface water supplies for the Kern County Subbasin includes a variety of methods, but all are considered reliable and accurate. Water agencies typically measure surface water deliveries with a combination of weirs and meters that are read and reported by agency staff. Senate Bill x7-7 (SBx7-7) requires flow measurement devices to be maintained within an acceptable range of accuracy that is defined as a volumetric flow measurement within +/- 12% (§597.3(a)(1))). Weirs and meters used in the Kern County Subbasin conform to the SBx7-7 volumetric accounting standards (ITRC, 2012, USBR, 2001, AWWA 2006, 2012) as documented in local water district agricultural water management plans. Procedures employed by water agencies have been standardized to further reduce potential sources of error to range between 1% to 10% depending on the measurement device. In the Part C template, an error range of 5% to 10% is listed as a conservative assumption for this Annual Report.

5 TOTAL WATER USE

The total water supply and use for the Kern County Subbasin is provided for WY 2022 per GSP Regulations 23 CCR §356.2(b)(4). Data are summarized following the DWR data templates for total water supply and use.

5.1 TOTAL WATER SUPPLY BY SOURCE

The total water supply utilizes the same data compiled for WY 2022 groundwater extractions and surface water supplies as presented in **Section 3** and **4**. The data show a total water use for the Kern County Subbasin of 3,166,637 acre-feet in WY 2022. The total water supply is summarized in **Table 6.** The water supply types shown on **Table 6** are described as follows:

- **Groundwater** includes groundwater extractions for all uses. In WY 2022, the groundwater supply totaled 2,343,630 acre-feet representing about 74% of total supplies in WY 2022.
- **Surface water** includes surface water deliveries for all uses. In WY 2022, the surface water supply totaled 774,085 acre-feet representing about 24% of total water supplies in WY 2022.
- **Recycled water** includes treated wastewater and stormwater for all use. In WY 2022, recycled water supply totaled 48,520 acre-feet representing less than 2% of total water supplies in WY 2022.
- **Reused water** includes reuse of tailwater, or irrigation return flow that re-enters local surface water system and is then diverted back for irrigated agriculture water supply. In WY 2022, reused water supply totaled 403 acre-feet representing less than 0.01% of total water supplies in WY 2022.
- **Other Water Source Type** - No *other* water source type is noted for the Kern County Subbasin.

Table 6. Total Water Supply by Source in the Kern County Subbasin for WY 2022

Total Water Supply	Total Water Supply by Volume
Water Source	**Acre-ft**
Groundwater	2,343,630
Surface Water	774,085
Recycled Water	48,520
Reused Water	403
Other Water Source Type	0
Total Water Supply	3,166,637

In this case, the total surface water supply from **Section 4** that is shown distributed by water source in **Table 5** is presented in **Table 6** distributed by water supply type. The total surface water supply shown on **Table 5** is distributed among surface water, recycled water and reused water on **Table 6**.

5.2 Total Water Use By Water Use Sector

The total water use also utilizes the same data that was compiled for WY 2022 groundwater extractions and surface water supplies presented in **Sections 3** and **4**. In this case, the total urban and agricultural water use is taken from the IDC tool within the C2VSimFG-Kern model. The data show a total water use for the Kern County Subbasin was 3,166,637 acre-feet in WY 2022 as summarized by water use sector in **Table 7**.

Table 7. Total Water Use by Sector in the Kern County Subbasin for WY 2022

Total Water Use	Total Water Use Volume
Water Use Sector	**Acre-ft**
Urban	196,974
Industrial	0
Agricultural	2,245,544
Managed Wetland	14,377
Managed Recharge	73,188
Native Vegetation	0
Other Water Use Type	636,554
Total Water Use	3,166,637

The water use sectors shown on **Table 7** are described as follows:

- **Urban** includes total water use for all urban water uses including residential, commercial, municipal, industrial, landscaping and other uses. In WY 2022, urban water use totaled 196,974 acre-feet, representing about 6% of the total water use.
- **Industrial** includes total water use for industrial use. Current data does not allow for tabulation of industrial water use on a consistent basin-wide basis; therefore, industrial water use is included in the urban water use sector for WY 2022.
- **Agricultural** includes total applied water for all agricultural water uses including consumptive use and return flows. In WY 2022, total applied water for agricultural use totaled 2,245,544 acre-feet, representing about 71% of the total water use.
- **Managed Wetlands** includes total water use for maintaining managed wetlands at the Kern National Wildlife Refuge. In WY 2022, managed wetlands water use totaled 14,377 acre-feet, representing less than 1% of the total water use.
- **Managed Recharge** includes total water use for active recharge at the managed recharge and groundwater banking operations. In WY 2022, managed recharge use totaled 73,188 acre-feet, representing about 2% of the total water use.

- **Native Vegetation** includes total water use for maintaining native vegetation. In WY 2022, no groundwater extractions or surface water deliveries were used on native vegetation.
- **Other Water Use** includes total water use for uses other than those listed above or from unspecified uses. Groundwater recovery pumping from managed recharge operations listed on **Table 3** are also listed here. In WY 2022, Other Water Uses totaled 636,554 acre-feet, representing 19% of the total water use.

5.3 CHANGES IN WATER SUPPLY AND USE DURING GSP IMPLEMENTATION

As the GSP implementation progresses, the Subbasin will be evaluating performance with respect to sustainability. A major performance indicator is the water budget, and the primary tool for evaluating the water budget is the C2VSimFG-Kern model.

Changes in water supply and water use help evaluate performance with respect to sustainability. The annual water supply and water use can vary substantially from year-to-year due to hydrologic water year type, surface water availability and changes in water use. Therefore, it is more informative to compare a multi-year period to a comparable period of similar hydrologic conditions form the 20-year historical base period. For this comparison, the GSA Management period from WYs 2020-2022 is compared to a recent period of similar hydrologic conditions from WYs 2014-2016.

- Hydrologic conditions during the GSA Management period from WYs 2020-2022 is characterized by severe drought. This is demonstrated by the hydrologic water year types (**Section 2.1**) which shows that the San Joaquin Valley Index consists of one dry and two critically dry hydrologic water years (CDEC, 2023). The average Kern River Index for this period is 35% **(Table 6)**.
- WYs 2014-2016 has comparable hydrology conditions that are represented by the San Joaquin Valley Index consisting of one dry and two critically dry hydrologic water years (CDEC, 2023), and an average Kern River Index for this period is 31% **(Table 6)**.

A comparison of the water supply during the GSA Management period with WYs 2014-2016 shows that surface water supplies are relatively low and groundwater use is relatively high for both periods. However, during the GSA Management period the water supply consisted of 379,000 acre-feet less groundwater use but 112,000 acre-feet more surface water use than during WYs 2014-2016 (**Table 8**).

Table 8. Water Supply Comparison of GSA Management and Comparable Recent Period

Water Use Type	GSA Mgmt. Period WY2020-2022	Comparable Period WY2014-2016	Volumetric Difference	Percent Change
Units	AFY	AFY	AFY	percent
Groundwater	2,107,000	2,486,000	-379,000	-15%
Total Surface Water	1,020,000	908,000	112,000	12%
Total Water Source	3,126,000	3,394,000	-267,000	-8%

A comparison of the water use during the GSA Management period with WYs 2014-2016 gives an indication of changes in water use just prior and just after implementation of SGMA. As shown on **Table 9**, there is a large decrease in agricultural water use with the GSA Management period of 319,000 acre-feet less than for WYs 2014-2016. A similar, but smaller, decrease of 18,000 acre-feet is seen in urban water use. In addition, despite the severe drought conditions, about 96,000 acre-feet more managed aquifer recharge occurred compared to WYs 2014-2016. These water use types are those that are most directly influenced by the implementation of SGMA.

Table 9. Water Use Comparison of GSA Management and Comparable Recent Period

Water Use Type	GSA Mgmt. Period WY2020-2022	Comparable Period WY2014-2016	Volumetric Difference	Percent Change
Units	AFY	AFY	AFY	percent
Urban	199,000	217,000	-18,000	-8%
Agricultural	2,211,000	2,530,000	-319,000	-13%
Managed Wetland	16,000	12,000	4,000	31%
Managed Recharge	220,000	124,000	96,000	77%
Bank Recovery and Other Uses	481,000	510,000	-29,000	-6%
Total Water Use	3,127,000	3,394,000	-267,000	-8%

There are multiple potential factors contributing to the observed changes in water use during GSA Management period including water supply availability, economic factors, drought response and pandemic-related issues. However, the Subbasin GSAs also began implementation of their GSP projects and management actions in WY 2020, and the results of these measures would be reflected in the water budget.

Because agriculture is the largest water use within the Subbasin, emphasis will tend to focus on this water use sector. These data indicate that agricultural water use decreased in the Subbasin during the GSA Management period when compared to a similar hydrologic period of WYs 2014-2016. The following provides a preliminary assessment of changes in agricultural water use during the GSP implementation period.

- **Figure 15** shows the ITRC Metric calculated ET demand (Howes, 2023) for the Subbasin from 2013 through 2022. The calculated ET demand for the GSA Management period from WY 2020 through WY 2022 show a notable decrease in ET demand within the Subbasin when compared to the recent hydrologically comparable period from WY 2014 through 2016 .
    - WY 2020 shows a decrease of about 350,000 acre-feet
    - WY 2021 shows a decrease of about 50,000 acre-feet
    - WY 2022 shows a decrease of about 150,000 acre-feet

- The Kern County Agricultural Commissioner provided data (Fankhauser, 2022) that noted a decrease in the permitted agricultural area in WYs 2020 and 2021 of 6% to 9% relative to the average permitted agricultural area during WY 2014 through 2016. This trend is assumed to continue during WY 2022.

The large change in agricultural water use in WY 2020 may reflect a one-time anomaly. As noted above, there are multiple potential factors contributing to the observed changes in agricultural water use. However, these changes may also reflect an increased awareness in sustainability such that growers limited prior practices of relying on groundwater during extended drought periods. Although water use increased in WY 2021 and WY 2022 relative to WY 2020, indications persist of an overall trend of decreased agricultural water usage in the Subbasin.

This is a preliminary assessment of factors contributing to changes in the water supply and use estimates and the Subbasin GSAs during the GSP implementation. The Subbasin GSAs are currently coordinating on several subbasin-wide management actions to improve the ability to determine the ET crop demand, upgrade the C2VSimFG-Kern model and conduct a Basin Study to address data gaps and better calculate water budgets. These projects, summarized in **Section 7.2**, will allow the Subbasin GSAs to better track and evaluate performance of the GSP implementation over time.

5.4 PART D DWR DATA TEMPLATE

As part of the Annual Report, DWR requires completion of a series of Excel spreadsheets that summarize key water supply and use volumes for WY 2022 for the Subbasin. For the total water use, DWR requires that one spreadsheet be submitted in accordance with 23 CCR §356.2 (b)(3):

- **Part D. Total Water Use** – the total water supply by water use type and total water uses by water use sector for the preceding water year (WY 2022) for the entire Kern County Subbasin (23 CCR §356.2(b)(4)).

Data summarized in **Tables 6** and **7** follow the Part D DWR Template reporting requirements for total water supply and use and were collected using the best available measurement methods.

6 CHANGE IN GROUNDWATER IN STORAGE

GSP regulation §356.2(b)(5) requires inclusion of the following maps and graphs in the Annual Report for the entire Kern County Subbasin:

(A) Change in groundwater in storage maps for each principal aquifer in the basin.

(B) A graph depicting water year type, groundwater use, annual change in groundwater in storage, and cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.

This section provides a description of the methodology used to develop the required annual change in groundwater in storage maps and graphs.

6.1 Methodology

The Kern County Subbasin GSAs have coordinated on the approach and documentation (in maps and graphs) of change in groundwater in storage for the entire Subbasin; these were based on the updated C2VSimFG-Kern model results. The Kern County Subbasin Coordination Agreement refers to the local groundwater-surface water model (C2VSimFG-Kern) as the agreed upon method for generating coordinated water budgets for the Kern County Subbasin. C2VSimFG-Kern uses comparable data sets and methodologies over the entire Subbasin that meet the numerous technical requirements for basin-wide coordination in §357.4.

This current approach for continued update and use of the primary DWR modeling tool (with our local Kern County updates for evaluating basin conditions) will maintain consistency of method for presenting the basin-wide change in groundwater in storage. A summary of C2VSimFG-Kern development is provided in **Section 1.3.2**, and additional documentation is available as Appendix 2 and 4 of the Kern County Subbasin Coordination Agreement (Maley and Brush, 2020).

6.2 Graphs of Change in Groundwater in Storage

GSP Regulation §356.2(b)(5)(B) requires that the Annual Report include graphs of the following basin-wide information. The graphs are to include historical data, to the greatest extent available, including from January 1, 2015 to the current reporting year. These graphs are to include the following information:

- Water year type (Wet, Above Normal, Below Normal, Dry, Critically Dry)
- Groundwater use
- Annual change in groundwater in storage
- Cumulative change in groundwater in storage

6.2.1 Change in Groundwater in Storage Graph

Figure 16 shows the simulated change in groundwater in storage graph for the Kern County Subbasin over the 28-year period from WY 1995 through WY 2022. The updated C2VSimFG-Kern results for change in groundwater in storage for the Kern County Subbasin and the water year type based on the San Joaquin Valley Index (CDEC, 2023) are summarized on **Figure 16**.

The variation in the simulated change in groundwater in storage over the historical period generally corresponds with the variation in climatic conditions and surface water supply availability (**Figure 16**). During the periods WY 1995 to WY 1999, WY 2005 to WY 2006 and WY 2011, the groundwater storage volume was stable to increasing; this correlates to the above average rainfall and surface water availability during these times. During the periods WY 2000 to WY 2004, WY 2007 to WY 2010 and WY 2012 to WY 2015, groundwater storage volume decreased, correlated to periods of drought and low surface water availability.

For WY 2022, a critically dry water year type, the groundwater in storage declined by 1,740,468 acre-feet. This is significantly higher than the historical average change in groundwater in storage over the 20-year base period (WYs 1995 through 2014), which was a decline of 277,119 AFY. However, the change reflects the limited surface water supplies and other impacts related to the persistent drought condition in WY 2022 and the occurrence of a second consecutive critically dry year (**Figure 6**).

6.2.2 Groundwater Use Graph

For WY 2022, a critically dry water year type, the Kern County Subbasin had a total groundwater use of 2,343,630 acre-feet, of which 66% was for agricultural use, 8% for urban and industrial use, 22% for groundwater bank recovery[6] and 4% for other uses. Other uses include local lake level management and water use outside of the Subbasin. **Figure 17** shows the simulated groundwater use based on updated C2VSimFG-Kern model results along with the water year type based on the San Joaquin Valley Index (CDEC, 2023). The total groundwater pumping and distribution by water use for WY 2022 is similar to the other recent critically dry years of WY 2013, WY 2014, WY 2015 and WY 2021.

In general, total groundwater pumping in the Kern County Subbasin is about 20% to 30% lower during wet years than during the dry and below normal water year types. This is primarily driven by the availability of surface water for irrigated agriculture during the wet years which led to a decrease to groundwater pumping. Therefore, higher groundwater use is anticipated for a critically dry year such as WY 2022.

Compared to the other recent hydrologically similar period of WY 2014 through WY 2016, agricultural pumping in WY 2022 was about 9% lower. Urban pumping WY 2022 remains slightly lower than in during the historical period due to increased use of surface water and implementation of water

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[6] Recovery pumping associated with groundwater banking extracts local and imported water that was recharged in previous years.

conservation measures. Groundwater pumping for groundwater banking recovery was high in WY 2022, but similar to that for WY 2014 through WY 2016.

6.3 Change in Groundwater in Storage During GSA Management Period

The change in groundwater in storage is an important indicator for evaluating performance with respect to sustainability because it is closely related to the SGMA sustainability indicators. As shown on **Figure 6**, the annual change in groundwater in storage in the Kern County Subbasin can vary substantially from year-to-year due to water year type, statewide imported surface water availability and water use. Therefore, it can be more informative to compare a multi-year period of similar water conditions to a similar hydrologic period in the 20-year base period.

The total change in groundwater in storage over the three-year GSA Management period (WYs 2020-2022) was an average annual decline of 1,309,000 acre-feet per year (**Table 10**). Hydrologic conditions during the GSA Management period have been characterized by severe drought. This is demonstrated by the hydrologic water year types (**Section 2.1**) which shows that the San Joaquin Valley Index consists of one dry and two critically dry hydrologic water years (CDEC, 2023). The average Kern River Index for this period is 35%.

Table 10. Change in Groundwater in Storage Comparison of GSA Management and Comparable Recent Period

Change in Groundwater in Storage	GSA Mgmt. Period WY2020-2022	Comparable Period WY2014-2016	Volumetric Difference	Percent Change
Units	AFY	AFY	AFY	percent
GW Storage Change	-1,309,000	-1,909,000	-600,000	-31%

WYs 2014-2016 have comparable hydrologic conditions to the GSA Management period. This is shown by the San Joaquin Valley as one dry and two critically dry hydrologic water years (CDEC, 2023), and an average Kern River Index for this period is 31% during WYs 2014-2016. The total change in groundwater in storage over WY 2014 through WY 2016 was a decrease of 5,726,501 acre-feet, which is an average annual decline of 1,908,834 acre-feet per year. This comparison indicates that the decline in groundwater in storage for drought conditions during the GSA Management period are significantly less than were experienced during the comparable hydrologic period during WYs 2014-2016.

From the comparison of water supply and water use (**Section 5.3**), during the GSA Management period, average annual groundwater pumping was 370,000 acre-feet less than during WYs 2014-2016 (**Table 8**). Also, the average annual volume of managed aquifer recharge increased by 96,000 acre-feet. The combination of the decreased pumping and increased managed aquifer recharge accounts for about 80% of the difference in the change in groundwater in storage.

Both changes to groundwater pumping and managed aquifer recharge are directly related to SGMA implementation. As noted in **Section 5.3**, there are multiple potential factors contributing to the observed changes in water use. However, this preliminary analysis suggest that changes in water use have resulted reduced the volumetric change in groundwater in storage during the GSA Management period compared to the comparable hydrologic period of WYs 2014-2016.

This is a preliminary assessment of factors contributing to the volumetric change in groundwater in storage during the GSP implementation. The Subbasin GSAs are currently coordinating on several subbasin-wide management actions to improve the ability to determine the ET crop demand, upgrade the C2VSimFG-Kern model and conduct a Basin Study to address data gaps and better calculate water budgets. These projects, summarized in **Section 7.2**, will allow the Subbasin GSAs to better track and evaluate performance of the GSP implementation over time.

6.4 MAP OF CHANGE IN GROUNDWATER IN STORAGE FOR THE SUBBASIN

GSP regulation §356.2(b)(5)(A) requires inclusion in the Annual Report of an annual change in groundwater in storage map. In the Kern County Subbasin, four principal aquifers were defined; however, three of these principal aquifers are small, localized aquifers that currently have limited data. Therefore, the WY 2022 Annual Report presents the change in groundwater in storage for the entire Subbasin rather than separate estimates for each principal aquifer.

6.4.1 WY 2022 Change in Groundwater in Storage Map

The change in groundwater in storage map was developed following a similar process as used for the groundwater extraction map. The C2VSimFG-Kern binary output files were accessed to extract the change in groundwater in storage for each element and model layer. C2VSimFG-Kern output provides the total volume of storage change within a model element for all four model layers. To compensate for the fact that model elements vary in size, the data were normalized to the rate of acre-feet per square mile. The normalized rates were then interpolated onto a uniform one-square mile grid superimposed over the Kern County Subbasin. The map on **Figure 18** shows the C2VSimFG-Kern model results as the total change in groundwater in storage per square mile over the entire Kern County Subbasin.

Figure 18 presents the annual basin-wide change in groundwater in storage map for WY 2022. The change in groundwater in storage represents the sum of the total inflow components plus the total outflow components. A positive value represents an increase in the volume of groundwater stored in the aquifer, which is physically represented as a rise in groundwater levels whereas a negative represents a decrease in groundwater in storage typified by a decline in groundwater levels.

As stated previously, WY 2022 was rated a critically dry water year under the San Joaquin Valley Index (CDEC, 2023), and the Kern River Index was 29% of average Kern River flows (COB, 2022). The largest change in groundwater in storage is concentrated in the center of the Kern County Subbasin in the vicinity of the large groundwater banking operations along the Kern River. Other areas of concentrated groundwater recovery are noted to the north and southeast near those large managed recharge operations. Widespread, but lesser, declines in groundwater in storage are observed over most other areas of the Subbasin. Some limited areas of slight increases are present south of the Kern River along the southeastern corner of the Subbasin.

Figure 18 illustrates how managed recharge and groundwater banking operations produce the most significant localized changes in groundwater in storage due to the magnitude and concentration of such activities. For the critically dry year of WY 2022, these activities are dominated by large volumes of recovery pumping to provide a critical water supply when other surface water supplies are scarce. However, it should be noted that the decline in groundwater in storage associated with the recovery pumping occurs only after similar or larger volumes of surface water have been recharged into the groundwater basin, which has contributed to the overall amount of available groundwater in storage in previous years.

Agricultural and urban areas show lower magnitude annual changes on **Figure 18**, but these are more widespread over the Subbasin. Localized recharge along the major streams and from runoff from the surrounding watersheds is significant in wet years but is diminished during the dry years.

6.4.2 Accuracy of Change in Groundwater in Storage Maps

Using WY 1995 to WY 2014 as the base period, C2VSimFG-Kern results show declining groundwater levels and long-term reduction of groundwater storage, with an average-annual decline in groundwater in storage of 277,114 AFY. An estimated level of uncertainty of the overall water budget was determined to be on the order of 10% to 20% for the historical C2VSimFG-Kern results used in the Kern County Subbasin GSPs (Maley and Brush, 2020). This range is based on a weighted average of the simulation results compared to the relative accuracy of the input values (see **Section 3.4**).

7 PROGRESS ON GSP IMPLEMENTATION

GSP regulations (*§356.2(b)(5)(C)*) require GSAs to describe progress towards implementing a GSP in the Annual Report "including achieving interim milestones, and implementation of projects or management actions." GSPs were originally submitted to DWR in January 2020 and amended in July 2022 in response to the January 2022 determination by DWR that the GSPs were collectively inadequate. Between January and July 2022, a variety of Subbasin-wide coordination activities were conducted to amend the 2020 GSPs. Those activities were detailed in the six GSPs submitted in July 2020; a summary of those Subbasin-wide coordination efforts is provided below. **Section 7.1** also summarizes Subbasin-wide coordination efforts for ongoing GSP implementation of the six GSPs.

This **Section 7** also provides the regulatory-required information on the progress on GSP implementation of the six GSPs in WY 2022. To meet these requirements, GSAs and/or member agencies have provided brief progress reports regarding agency-specific GSP implementation, which are compiled in **Section 7.3** through **Section 7.8** below.

7.1 PROGRESS ON SUBBASIN-WIDE COORDINATION FOR GSP IMPLEMENTATION

The BCC and Subbasin GSAs have coordinated on a variety of Subbasin-wide GSP implementation activities as demonstrated by the accomplishments summarized below.

7.1.1 Coordination on Amended GSPs

Following the DWR Incomplete Determination letter on January 28, 2022, the Kern County Subbasin GSA and member agency managers met weekly to coordinate corrective actions and prepare Amended GSPs. Collectively, the Subbasin managers – in coordination with the BCC – developed consistent terminology and definitions for MA Exceedances and Undesirable Results for widespread use across the Subbasin as required by SGMA. The Subbasin GSAs also developed coordinated revisions to Subbasin monitoring protocols and developed local Management Actions for early response to MT exceedances. A Kern Subbasin Amended Coordination Agreement and Amended GSPs were submitted to DWR in July 2022.

To address a Subbasin-wide deficiency identified by DWR in the January 2022 Determination Letter, the Subbasin identified and coordinated interim sustainable management criteria for land subsidence in the Subbasin. The interim criteria were to be temporary while additional data were collected to address identified scientific data gaps. The interim management criteria were subject to revision in 2025 after collection and review of the needed data. The interim management criteria for regional critical infrastructure were detailed in two whitepapers , one for the Friant-Kern Canal and the other for the California Aqueduct. Both whitepapers were shared and discussed with California Aqueduct Special Program (CASP) prior to inclusion in the revised GSPs.

7.1.2 Coordination on Annual Report Data

As documented in previous sections throughout this Fourth Annual Report, GSAs and associated member agencies in the Subbasin have collaborated and contributed to the technical analyses and the tabulation of water use data presented in this report. More than 40 agencies provided data and information to update the C2VSimFG-Kern local model in support of the Annual Report water budgets. Agencies also shared in costs to purchase Subbasin-wide METRIC ET data from ITRC, available on a monthly basis over the reporting period. Accordingly, this submittal of the Fourth Annual Report represents continued cooperation on an important GSP implementation measure demonstrating ongoing Subbasin-wide coordination. Additional information on this coordinated data compilation effort is provided below.

7.1.3 Application of the Kern County Subbasin DMS for Annual Report Preparation

The data compilation process for this Fourth Annual Report was coordinated with newly developed data-entry templates for water supply and use data developed using the Kern County Subbasin DMS. These agency-specific templates were developed for each of the agencies contributing data to the Annual Report; publicly available data to support the Annual Report were also incorporated when available. Agencies logged into the DMS and completed their agency data templates, which were then transmitted to the technical team developing the Annual Report analyses. This process improved the efficiency of compiling data for the update of the C2VSimFG-Kern local model and other analyses supporting the Annual Report. Although the DMS has been in use for agencies to upload their water level data since Spring 2021 and had been used previously for developing hydrographs, this was the first use of the DMS to fully support the entire Annual Report including water budget updates and GSP implementation progress reports. For context, a brief summary of the DMS and its development process is provided below.

As documented in the previous Third Annual Report for WY 2021, the BCC and Subbasin GSAs coordinated on the development of a customized, web-based DMS to support GSP monitoring and analyses (Coordination Agreement, Appendix 5). The DMS was developed by GEI Consultants, Inc. (GEI) based on their experience in working with DWR on the development of its online SGMA Portal and MNM, as well as their knowledge of Subbasin GSPs, local groundwater conditions, and monitoring data. Additional modules continue to be built as agency managers work through SGMA implementation and identify modules that enable them to better review and coordinate with data management. The project has been funded by a DWR grant under Round 3 of the Sustainable Groundwater Management (SGM) Grant Program (Proposition 68). Subbasin GSAs coordinated and funded the successful grant application.

7.1.4 Coordination on GSP Monitoring Data

The Subbasin GSAs continue to coordinate for collecting and reporting of GSP monitoring data. The Subbasin GSAs perform semi-annual GSP monitoring for groundwater elevations and water quality in accordance with their respective GSPs. Compilation and reporting of the semi-annual monitoring data are now conducted using the DMS.

All semi-annual water level measurements are entered into the Subbasin DMS. These data are reviewed by the GSA managers for accuracy using the DMS mapping and graphing capability to aid in their review. This early quality assurance/quality control (QA/QC) process allows the data to be checked and corrected before submittal to the DMS and MNM. Once approved, data are moved to the public DMS and reported to the SGMA portal. GSP monitoring data were uploaded to the MNM on the SGMA portal in January and July 2022 during WY 2022.

To further support the GSA managers in tracking the basinwide performance of the GSP monitoring data with respect to their GSP sustainability compliance criteria, the DMS added a feature to email notifications were developed to alert agency and GSA managers when a minimum threshold exceedance occurs. Managers can also use the DMS to track minimum threshold exceedances either through online mapping or downloading reports.

7.1.5 Additions to Subbasin-Wide Monitoring Protocols

As part of the 2022 Subbasin-wide coordination efforts to amend the Subbasin GSPs, the GSAs expanded the water level Monitoring Protocols in the Subbasin Coordination Agreement and the Amended GSPs. Specifically, the GSAs determined that some semi-annual measurements were being missed when the representative well was also an active production well. To ensure that a more complete record is collected from all representative monitoring wells, the Subbasin GSAs

If attempts have been made and a measurement cannot be collected from a representative monitoring well during the approved timeframe, one of the following is to occur:

- A measurement from a nearby well with similar water level trends can be used as a proxy.
- If no substitute well is available, the static water level can be estimated based on trending for Spring and Fall levels from the previous four or more bi-annual measurements; estimates are used for purposes of comparing to the established thresholds for each Management Area only.
- If the water level is estimated, the entry must be flagged with a DWR No Measurement Code using the DWR pull-down menu options and described in the Water Level Measurements Comments field as "Estimated groundwater level based on trending for Spring or Fall levels from the previous four or more bi-annual measurements."

If an existing representative monitoring well cannot be measured during two bi-annual timeframes, a plan to replace or repair the well in the monitoring network shall be made prior to the subsequent monitoring period or annual report, whichever occurs first.

7.1.6 Successful Grant Application, SGM GSP Implementation Grant Program, Round 1

The Kern County Subbasin received a Round 1 sustainable groundwater management (SGM) grant for critically overdrafted basin under the Sustainable Groundwater Management (SGM) Grant Program SGMA Implementation grant authorized by the California Budget Act of 2021 and Proposition 68 for projects that encourage sustainable management of groundwater resources that support SGMA. The contract between DWR and the representative for the Kern County Subbasin GSAs was signed on August 8, 2022.

The Work Plan for this grant includes five Components that will develop a more complete understanding of the groundwater subbasin to support long-term sustainable groundwater management. The five components include:

- Component 1: Grant Agreement Administration
- Component 2: Kern County Subbasin – Basin Study
- Component 3: Kern County Subbasin – Evapotranspiration Analysis & Study – Field by Field
- Component 4: Subsidence Investigation and Study - Priority Area #1
- Component 5: New or Converted Monitoring Wells

COMPONENT 1: GRANT ADMINISTRATION

Grant administration supports development of Environmental Information Form, Grant Completion Report, project reports and invoices, and other grant management requirements for the grant.

COMPONENT 2: BASIN STUDY

The Subbasin GSAs are cooperating on the implementation of their recently completed GSPs. Through ongoing coordination meetings, a consensus was reached that an important next step for GSP implementation is to support local decision-makers with comprehensive technical information as they work through the policy, legal and water rights issues. To achieve this objective, the scope of the *Kern County Subbasin Study*, or *Basin Study,* was developed. Work on the Basin Study was initiated in WY 2022 and is planned to provide input to support the upcoming five-year GSP assessment.

The Basin Study project description was developed over the past year and includes input provided during several meetings with Subbasin GSAs, policymakers and stakeholders. Using this input, the general approach for the Basin Study evolved into a systematic, basinwide analysis to address technical data gaps in the hydrogeological conceptual model (HCM), water budgets and model calibration. To make the results of the Basin Study more accessible, a series of GIS maps and geodatabases will be developed. Incorporated in the Basin Study are multiple meetings and technical memoranda to provide opportunities to update progress of the technical work and to answer questions, address comments and receive guidance.

Several management actions are included in the Subbasin GSPs to address data gaps and define goals for GSP implementation. A brief summary of these GSP management actions includes the following:

- Improve the understanding of the groundwater response to the implementation of projects and management actions,

- Support sustainable groundwater Supplies of Disadvantaged and Severely Disadvantaged Communities in order to provide "a safe, clean, affordable, and sufficient water supply to meet the needs of California residents, farms, and businesses."
- Address data gaps in the HCM including details on physical properties, geologic structures and confining clay layers that may affect subsurface flow including areas along the Subbasin margins.
- Address data gaps for basinwide and local water budgets.
- Incorporate locally-derived HCM data from the Subbasin GSPs into the model to better represent subsurface groundwater flow and improve the determination of basinwide and local water budgets.
- Improve model calibration to better simulate the implementation of projects and management actions, relationship to minimum thresholds and measurable objectives (MT/MO) and quantify subsurface flow within and out of the Subbasin.

The Basin Study is needed to support future policy decisions for achieving long-term sustainability of groundwater in the Basin. The goal of the Basin Study is to support multiple aspects of future GSP planning and implementation work by the Subbasin GSAs that will provide multiple benefits for a wide range of communities, water users and stakeholders including Underrepresented Communities. The following discussion provides additional details of the proposed approach (along with a scope of services, schedule, and budget) that demonstrate how the Basin Study will meet this goal.

The Kern County Subbasin Coordination Agreement refers to the local groundwater-surface water model (C2VSimFG-Kern) as the agreed upon method for generating coordinated water budgets for the Kern County Subbasin. The Subbasin GSPs list management actions for the continued use and update of the C2VSimFG-Kern model. The objective is to improve the understanding of groundwater response to the implementation of projects and management actions, (particularly with reference to MTs and MOs), to determine the native yield of the Subbasin, and to assess subsurface flow within and out of the Subbasin.

The emphasis is to better represent local groundwater elevations in the four principal aquifers and provide higher accuracy in simulating changes in groundwater elevations over time. A key objective of the model recalibration is to improve the simulation of groundwater elevations relative to MT/MOs across the Subbasin and provide improved support to long-term GSP implementation planning. The calibrated IWFM-Kern model will produce an updated historical water budget and change in groundwater storage estimates for the Subbasin in preparation of the 2025 GSP updates. To support ongoing GSP implementation, updated projected future water budgets will be run for Baseline and Climate Change scenarios over the 50-year planning and implementation horizon. These scenarios provide a basis of comparison for evaluating proposed sustainability management actions and projects over the SGMA planning and implementation horizon.

COMPONENT 3: EVAPOTRANSPIRATION ANALYSIS & STUDY – FIELD BY FIELD

Irrigated agriculture represents the largest water use within the Subbasin. Currently, agricultural water demands are estimated based on evapotranspiration (ET) rates; therefore, ET needs to be estimated as accurately as possible. Several water districts, representing about 25% of the Subbasin area, use a service provided by Land IQ to calculate ET rates based on satellite remote sensing data on a field-by-field basis.

The Kern County Subbasin plans to expand the service provided by Land IQ for all irrigated agricultural areas within the Subbasin. This will provide a consistent basinwide methodology for calculating ET based on local climatic and cropping data. In WY 2021, the Subbasin GSAs have been working with Land IQ to develop a scope and budget for implementing this program.

The Land IQ approach is to provide instrumentation over the agricultural areas within the Subbasin that are not already instrumented. These stations provide improved calculation of ET on a field and crop basis; field data would subsequently be used for the calibration and validation of ET models using satellite imagery. Stations would be installed in areas where improved ET values would support more accurate groundwater extraction estimates, especially in agricultural areas. Once fully instrumented, basinwide ET rates can then be modeled on a field-by-field basis.

A web tool will be used to relay the results each month to the Subbasin GSAs. All of these spatial results significantly enhance the ability to better understand the overall water balance within the subbasin and comply with necessary regulatory requirements. Because the results will be landscape-wide for the Kern Subbasin, they will serve all communities within the subbasin.

COMPONENT 4: SUBSIDENCE INVESTIGATION AND STUDY – PRIORITY AREA #1

As provided in the Coordination Agreement (Appendix 3), the Subbasin GSAs committed to implementation of a regional land subsidence investigation to improve the land subsidence monitoring program. This regional effort was developed to supplement the local monitoring of land subsidence in each individual GSP and focused on potential impacts to critical infrastructure of regional importance, such as the California Aqueduct and the Friant-Kern Canal. Five areas of interest (AOIs) were identified for further investigation. Currently, the Subbasin GSAs are investigating sources of funding to subsidize efforts to close this data gap at two key AOIs (No. 1 and 3) along the Friant-Kern Canal (FKC) and two key AOIs (No. 2 and 4) along the California Aqueduct (**Figure 1**).

Component 4 consists of purchase, placement, and construction of an extensometer to provide subsidence data along the Friant-Kern Canal (Area of Interest #1). This work is being planned, designed, and implemented in close consultation with the Friant Water Authority and the USGS. Once Component 4 is completed, the data from this extensometer will be able to provide data on the cause and/or activity that is triggering subsidence in this area as well as the actual rate of subsidence. This will assist in working with the extractors (oil or agricultural) around the California Aqueduct and Friant-Kern Canal within the basin to understand how or if their activities of groundwater extractions are contributing to the subsidence. A detailed data analysis in consultation with the USGS will help to strategically placing extensometer which will provide the data necessary to understand and set the Sustainable Management Criteria (SMC) as well as considering the other extraction activities occurring in this basin, such as oil extractions.

Additional subsidence studies will be conducted to further evaluate the causes of subsidence and to help site the monitoring devices for land subsidence that will be installed for this grant and for future monitoring installations. The study will conduct additional InSAR assessment and coordination with scientists at Lawrence Berkeley National Laboratory to better characterize the potential for geomechanical stresses in the Kern Subbasin on critical infrastructure that may be induced by land subsidence.

COMPONENT 5: MONITORING WELLS

Component 5 will improve existing monitoring network throughout the Kern subbasin by repairing existing monitoring, video water wells for screening, convert existing municipal and/or ag wells to monitoring wells. This will include the ability to video a minimum of 20 water wells for screening, convert existing municipal and/or ag wells to monitoring wells, and repair existing monitoring wells.

7.2 Progress on Implementation of the Six Individual GSPs in the Subbasin

To provide consistent information and a reasonable level of effort for the numerous agencies coordinating on this Fourth Annual Report, the outline below has been developed from GSP regulations (§356.2(c)) and used as a guide for the progress report summaries. Responses by each agency are organized around the following topics:

1) Compliance with Sustainable Management Criteria
    a) GSP Monitoring Activities
    b) Changes in GSP Monitoring Network
    c) Progress in Achieving Interim Milestones
    d) Compliance with Additional Sustainable Management Criteria (including minimum thresholds (MTs) and measurable objectives (MOs))
2) Implementation of Projects and Management Actions
3) Coordination with Stakeholders
4) Summary of Other GSP-related Special Studies or Activities

Changes to the GSP monitoring networks are also documented in the individual reports. As required in the Coordination Agreement, the BCC reviewed these changes to better understand how any new sustainable management criteria could impact adjacent monitoring being conducted by others, thereby providing coordinated GSP monitoring on a Subbasin level.

Information regarding compliance with sustainable management criteria has been addressed, in part, through the preparation of hydrographs (which also show MTs and MOs) and compliance with these criteria based on recent water level data, as available. That compliance is summarized herein; as noted in **Section 2**, the compliance hydrographs are provided in **Appendix A**. Hydrographs related to each individual GSP/agency progress report is noted in the associated sections below. Hydrographs in **Appendix A** are organized by the six GSPs (**A1 – A6**) and referred to by page number (**A1-1, A1-2**, etc.).

7.2.1 GSA Project and Management Action Summaries

GSAs/member agencies have provided meaningful narratives that address the most significant progress toward GSP implementation; however, narratives are purposefully concise and do not repeat all details associated with each project or management action in the GSP. The reviewer is referred to a more complete description of each project/management action in the respective GSP.

To demonstrate the significant progress that GSAs/member agencies have been making on specific projects and management actions, those activities are briefly summarized in **Table 11;** the locations of the narrative that describe these actions in more detail are also provide in **Table 11** for reference. Following **Table 8**, a summary is presented on the various outreach and coordination activities conducted by the GSAs/member agencies in WY 2022.

Finally, the individual GSP progress reports are presented in alphabetical order by the lead agency of each of the six GSPs (**Sections 7.3 through 7.8** below). For the KGA GSP, material is presented in alphabetical order for each of the 12 KGA member agencies that provided a separate Management Area Plan for its service area (see **Sections 7.5.1 through 7.5.12** below). Some, but not all, of the KGA member agencies are also separate GSAs.

Table 11. GSP Implementation Summary for WY 2022

GSP	Mgmt Area (Report Section)	Projects	Management Actions
Buena Vista GSP	BVWSD GSA (Section 7.3, 2))	Continued progress on 3 new recharge facilities: 71 acres in escrow, negotiating 30-year lease on 85 acres, meeting regulations for 2,072 ac water bank.	Reduced demand by 2,800 AFY by purchasing land to take out of production.
Henry Miller GSP	Henry Miller WD GSA (Section 7.4, 2))	Optimized recharge and recovery of Pioneer Project banked water including banking and recharge for overdraft correction.	Purchased supplemental water to increase banked supply.
KGA GSP	Cawelo WD GSA (Section 7.5.1, 2))	New water purchase negotiations; worked with landowners on private banking projects; review treatment for recycled produced water; supported Phase 2 of F-K Canal.	Adopted KGA Action Plan for MT Exceedance tracking and response.
	Eastside WMA (Section 7.5.2, 2))	Continued TDS/Nitrate monitoring; construction of aquifer-specific monitoring wells; planning for transducers; planning for surface water capture project.	Cooperating with Basin Study on sustainable yield – will support water transfer credits.
	KCWA Pioneer GSA (Section 7.5.3, 2))	Balanced pumping to mitigate any MT exceedances while continuing sustainable operations.	MA1 – Continued demonstration of maintaining a positive cumulative water
	Kern Water Bank (Section 7.5.4, 2))	Recovered 188,000 AF from banking program in WY 2022. Continued involvement with other GSAs' implementation strategies for local storage (as referenced in Section 7).	Continued operation under Long-term Operations Plan.
	Kern-Tulare WD GSA (Section 7.5.5, 2))	Assisted landowners with metering requirements (90% active irrigation wells metered); worked on CRC Pipeline Project (design 90% complete); FS for 2 new surface reservoirs	Passed Proposition 218 election for extraction charges; groundwater studies ongoing.
	NKWSD and SWID (Section 7.5.6, 2))	Proposition 218 election (in progress) to fund recharge projects (Bell project in construction); CEQA compliance for Landowner Banking Program; completed canal lining.	Coordinated on MT Exceedance Plan; adopted domestic well mitigation plan.
	Rosedale-Rio Bravo GSA (Section 7.5.7, 2))	Completed construction of McCaslin recharge ponds; conducted pilot project for Onyx Ranch water deliveries; CEQA compliance on James recharge project; 60% design regional Kern Fan water bank.	Continued tracking for two demand reductions programs (in-district and white lands.
	Semitropic WSD GSA (Section 7.5.8, 2))	Initiated construction of Leonard Ave. Project; evaluated 1,600 acres for recharge.	MA1: Provided landowner budgets; MA2: Presented Draft tiered pricing for extractions.
	Shafter-Wasco ID 7th Std Annex (Section 7.5.9,2))	Reduced irrigation demand by 1,566 AF through Voluntary Rotational Land Fallowing Program.	Adopted domestic well mitigation plan;
	SSJMUD GSA (Section 7.5.10, 2))	Completed construction of 78-ac Giumarra recharge basin; in Final Design for 75-ac Regan recharge area; continued design/permits for in-district recharge projects and SSJMUD/NKWSD intertie.	Approved domestic well mitigation & MT exceedance plans; Assess consumptive use
	West Kern WD GSA (Section 7.5.11, 2))	Installed 3,401 AMR systems in Automatic Meter Reading Project; Participated in funding and CEQA compliance of Delta Conveyance Facility; Coordinate water supply management for BVARA.	Continued balanced pumping and recharge; coordinated with Basin-wide management.
	WDWA GSA (Section 7.5.12, 2))	Continued monitoring to fill hydrogeologic data gaps from lack of significant groundwater use; continued supplemental water purchases; Feasibility Study for reuse of brackish groundwater.	Progress on management actions combined with Projects (see text to left).
Kern River GSA	Kern River GSA (Section 7.6, 2))	Obtained 4,407 AF transfer water in WAP; Recharged 14,136 AF along KR; used 22,830 AF recycled water; funded Delta Conveyance for 82,946 AF supply; Completed bids for CVC Lining.	Recharged water to benefit GW declines; supported small water system consolidation
Olcese GSA GSP	Olcese GSA (Section 7.7, 2))	Continued assessment of transducer data from to support hydrogeologic studies; developed subsidence monitoring network along OWD canal (included in July 2022 Amended GSP).	Initiated study on vertical hydraulic connection between local aquifer systems.
SOKR GSP	Arvin GSA (Section 7.8.1, 2))	Began construction of Sunset recharge facility; expanded acres for On-Farm Recharge; began construction on pipeline and Eastside Canal intertie with KRGSA; Continued progress on in-lieu banking.	Installed pumping meters at 50 sites; installed wells for arsenic mitigation; WQ sampling.
	Tejon-Castac WD GSA (Section 7.8.2, 2))	Coordinated with AEWSD on converting quarry to reservoir; recharged 202.22 AF of carrot wash water.	Continued management of land use and extraction restrictions under RWMP.
	Wheeler Ridge-Maricopa GSA (Section 7.8.3, 2))	Purchased 14,087 AF of additional SWP water; recovered 52,500 AF banked water; continued funding of Delta Conveyance Project; explored treatment for saline GW to mitigate local pumping.	Retired irrigated lands at new solar generation facility; studied potential assessments.

7.2.2 Outreach and Coordination Activities

As demonstrated by the individual progress reports below, GSAs and member agencies conduct frequent meetings with a wide variety of stakeholders and beneficial users to provide meaningful engagement regarding GSP implementation. All GSAs and member agencies hold regularly-scheduled public meetings of their Board of Directors/City Councils where they address SGMA and GSP-related activities. GSA/member agency websites provide calendars with noticed meetings and agenda. Most GSA/member agency websites also provide resources and information regarding GSP implementation. GSA monitoring data and mapping functions are available to the public on the Subbasin online Data Management System (DMS). In addition to these online tools, agencies also have provided flyers and informational materials on GSP projects and management actions. GSAs and member agencies have also engaged in both coordination meetings and individual communications with non-member agencies in the respective GSA service area and with agencies in adjacent Management Areas.

Finally, as demonstrated in **Section 7.1** and throughout this Annual Report, Subbasin-wide coordination occurs on a regular basis through both the BCC and frequent managers' meetings on a variety of topics including the preparation of this Fourth Annual Report, the ongoing Basin Study, the Subbasin-wide ET Study, monitoring activities, and DMS upgrades. During WY 2022, Subbasin managers held weekly meetings to coordinate responses and corrective actions regarding the 2020 DWR Incomplete Determination Letter, including meetings with personnel from the California Aqueduct Subsidence Program (CASP). The wide variety of meeting types is illustrated by the partial list below of outreach and coordination meetings with stakeholders during WY 2022:

- Regularly-scheduled and noticed Public Board of Directors meetings held by both member agencies and GSAs.
- Informational meetings with landowners, growers, urban water purveyors, small water systems, and other beneficial users of groundwater.
- Coordination meetings with non-member agencies in the GSA.
- Coordination meetings with adjacent Management Areas.
- Coordination meetings with local stakeholders regarding GSP projects, such as local recharge project benefits, metering programs, water distribution rules and regulations, and other activities.
- Outreach associated with the Proposition 218 Process.
- Public access to Online DMS – mapping features and data viewing.
- Coordination meetings on Amended GSPs.
- Outreach and Adoption Hearings for Amended GSPs.
- Outreach and Public Hearings on GSA formation.
- Direct communication between stakeholders and GSA Managers/Directors.

These and other activities associated with GSP implementation are documented in the 19 individual narratives that follow below. Narratives are organized alphabetically by the lead agencies of each of the six GSPs and then by member agencies as applicable.

7.3 Buena Vista Water Storage District GSA

1) Compliance with Sustainable Management Criteria

In WY 2022, BVGSA continued to work to meet its GSP goals and work on Subbasin-wide goals such as grants, reporting, and overall coordination.

a) GSP Monitoring Activities

The network of monitoring wells includes all existing District owned monitoring wells which have been in use for many years. Several of these wells are part of the data collected for the Kern Fan Monitoring Committee's monthly hydrographs. The installation of the network is 100 percent complete. DMW 04 has some bad data from before SGMA. It appears to have been measuring perched water from a piezometer which is why is shows being at and even above ground level. Changes to this data will be made separately from the annual report.

There have been no changes to the GSP Monitoring Networks in WY 2022.

b) Progress in Achieving Interim Milestones

No interim milestones were required or set. WY 2022 water levels dropped due to the severe drought. They were improving following cessation of irrigation, and expectations are that they should continue to improve all through 2023.

c) Compliance with Additional Sustainable Management Criteria

Water levels were still above MOs and MTs during the Reporting Period.

2) Implementation of Projects and Management Actions

BVGSA made progress towards implementing several of its planned GSP Projects in Water Year 2021 as summarized by the following:

- **New Recharge Facility:** The BVWSD/BVGSA have 90 acre project that has still not been used since completion of construction in December 2021. This facility is known as Daley Ranch.
- **New Recharge Facility:** The BVWSD/BVGSA completed construction in 2021 on the Corn Camp Recharge Facility. Staff is working with consultants to get this facility listed as a Federal Water Bank through the NEPA process. This project also has not been used/tested.
- **New Recharge Facility:** The BVWSD/BVGSA continue to work through regulatory hurdles in the development of a 2,072 acre water bank. BVWSD is an 85 percent owner of this project. This project is not in District. The FEIR is close to completion. This project is known as the James Water Bank at McAlister Ranch.

- **Demand Reduction:** In 2022, BVWSD (similar to BVGSA) had no District programs to reduce demand. District growers continued to convert open ground (farmed) into pistachio orchards. This reduces the overall ET in the District in the short term but will increase the demand in the long run. This increase is anticipated in the District's estimates for 2040. The increase may be a little less than anticipated to date.
- **Demand Reduction:** The District has purchased 280 acres in 2021 in addition to the 600 acres of white lands farmland previously taken it out of production. These 700 acres of previously farmed land is still fallow. This land is white land within the KGA. The BVGSA has reduced demand in the KGA by approximately 2800 AF/year by the following of this 700 acres on its 880 acre holding.

3) Coordination with Stakeholders

BVWSD and BVGSA are in ongoing discussions with the Buttonwillow County Water District (CWD) to assess BVWSD groundwater recharge in the vicinity of groundwater wells that supply water to Buttonwillow CWD for use in their community.

4) Summary of Other GSP-related Special Studies or Activities

- BVGSA is coordinating with the KRGSA and KGA to address a minor GSA boundary issues.
- BVGSA continues to participate in the Subbasin-wide coordinated GSP implementation activities as described above in **Section 7.1**.
- BVWSD continues to install its piping system throughout the District. BVWSD has delivered water to its growers through unlined canals for over 140 years. In 2016 the District embarked on an ambitious plan to deliver water via pipelines, in addition to delivering by canals. In 2022 BVWSD installed an additional 11 miles of pipe connecting most of the remaining growers to the pipeline. In a year like 2022 where BVWSD's surface water allocation was about 13,000 ac-ft, or 12% of its demand the pipe was extremely useful. BV would have been unable to deliver any of that amount as canal losses/recharge would have consumed the entire amount. BVWSD recognizes that by bypassing use of unlined canals, additional groundwater recharge will need to be performed to maintain balance.
- BVWSD granted a $300,000 grant to ITRC at Cal Poly San Luis Obispo to study the correlation between groundwater recharge and evaporation. The purpose of the grant is to correlate the data gathered by current satellites with actual ET so that Water Banks can accurately report water into the ground. BVWSD thinks a study of this type is required to keep up with the SGMA mandate of using the best science. Very little science has been developed on this subject despite the millions of acre-feet recharged to the groundwater in Kern County.

  "Open water evapotranspiration (ET) has proven difficult to measure due to variations in water depth, current or flow rates, turbidity, water temperatures, wind, mixing, and seasonality. Cal Poly – Irrigation Training & Research Center (ITRC) has been granted funds to investigate more accurate methodologies to measure open water ET that range from sophisticated instrumentation to a regionally scaled remote sensing model. ITRC's approach uses the Eddy Covariance (EC) technique to directly measure rates of open water ET.

BVWSD proposed this grant funding opportunity to all of the Basin, and Rosedale Rio-Bravo WSD did step up. It was vetoed as a basin wide proposal.

7.4 Henry Miller Water District GSA

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Henry Miller GSA during WY 2022 is summarized as follows:

a) GSP Monitoring Activities

GSP monitoring activities in the Henry Miller GSA during WY 2022 consist of the following actions:

- Groundwater level data for all five monitoring wells was successfully collected in the fall and spring for the annual report to represent the seasonal high and low groundwater levels, in accordance with the recommended protocols for the Subbasin.
- Reduction in groundwater storage data was collected in accordance with the recommended protocols for the Subbasin.
- Water quality samples were successfully collected for the monitoring network in accordance with the recommended protocols for the Subbasin. The samples were analyzed for the constituents listed in the GSP.
- The GSA continues to monitor land subsidence by monitoring California Aqueduct Pools 29 and 30.
- Since interconnected surface water does not exist within the GSA, there were no monitoring activities.

b) Changes in GSP Monitoring Network

There have been no changes to the GSP Monitoring Networks in WY 2022.

c) Progress in Achieving Interim Milestones

- With severe drought conditions in 2022, groundwater level reporting data indicate that water levels for monitoring wells in the GSA are on track with interim milestones in some instances and are deeper than interim milestones in other instances. It is expected that the GSA will achieve its interim milestones over the implementation period as the Kern Subbasin experiences seasons of drought, normal, and above normal hydrologic conditions.
- According to available data, interim milestones for reduction in groundwater storage are on track with interim milestones as set forth in the District's GSP.

- The most recently collected groundwater quality reporting data indicate that water quality constituent levels for monitoring wells in the GSA are on track with interim milestones in some instances and have exceeded interim milestones in other instances. It is expected that the GSA will achieve its interim milestones over the implementation period as the Kern Subbasin experiences seasons of drought, normal, and above normal hydrologic conditions.

- Available land subsidence reporting data indicate that the GSA is complying with the interim milestones as set forth in its GSP.

d) Compliance with Additional Sustainable Management Criteria

- Groundwater level reporting data indicate that the GSA is complying with the sustainability criteria as set forth in its GSP and 2022 seasonal groundwater levels were above MTs in all five GSP monitoring network wells.

- According to available data, the GSA is in compliance with MTs for reduction in groundwater storage as set forth in the District's GSP.

- The most recently collected groundwater quality data indicate that the GSA is complying with the MT sustainability criteria.

- Available land subsidence reporting data indicate that the GSA is complying with the MT sustainability criteria as set forth in its GSP.

2) Implementation of Projects and Management Actions

The GSA's sole project is to optimize the recovery of Pioneer Project banked supplies in dry years. While the GSA has not recovered banked water in the Pioneer Project in recent years, it has delivered significant quantities of surface water to the Pioneer Project for banking and overdraft correction in recent years. The GSA has also taken opportunities to purchase supplemental water supplies to increase its recharge activities for the benefit of its Project. Therefore, the GSA has made considerable strides towards the future implementation of its Project by increasing available supplies that could be used to avoid groundwater overdraft and combat declining groundwater levels in the GSA in future years.

3) Coordination with Stakeholders

SGMA related topics were discussed during the District's Board of Directors meetings throughout the year. Stakeholders evaluated District operations and management to assess and pursue actions that would bring long-term sustainability to the District to comply with SGMA.

4) Summary of Other GSP-related Special Studies or Activities

In order to avoid groundwater overdraft within the District with severe drought conditions in 2022, the District took measures to reduce groundwater pumping primarily through demand reduction through the fallowing of land in coordination with the landowners within the District.

In an effort to reduce net historical groundwater use, the District purchased available overdraft correction (ODC) water supplies from previously recharged surface water from local groundwater banking projects that were credited to the District.

Additionally, District staff engaged with other local entities to discuss both ongoing and new Kern Subbasin groundwater and surface water issues that arose throughout the year.

7.5 KERN GROUNDWATER AUTHORITY (KGA) GSA

As provided in the KGA GSP Umbrella Document, the KGA prepared the GSP representing its member agencies. In addition, 12 agencies prepared their own Plan as a separate chapter of the umbrella document, each relating to its own Management Area. Accordingly, the KGA member agencies provided separate information regarding GSP implementation. That information is arranged in alphabetical order below by each of the 12 member agencies.

7.5.1 Cawelo Water District GSA

1) COMPLIANCE WITH SUSTAINABLE MANAGEMENT CRITERIA

Progress towards compliance with Sustainable Management Criteria in the Cawelo Groundwater Sustainability Agency (**CGSA**) Management Area during WY2022 is summarized below.

a) GSP MONITORING ACTIVITIES

GSP monitoring activities in the CGSA Management Area during WY2022 consist of the following:

- Fall 2021 and Spring 2022 groundwater levels were obtained at all seven (7) representative monitoring wells (**RMWs**).
- The monitoring network is a subset of a preexisting groundwater monitoring network, and groundwater level measurement of the preexisting network occurred in WY2022.
- Groundwater levels are used as a proxy for Reduction in Groundwater Storage in the CGSA Management Area. Fall 2021 and Spring 2022 groundwater levels were obtained at all seven (7) RMWs.
- Water quality samples were collected from all seven (7) monitoring wells in WY2022.
- Groundwater levels are used as a proxy for Land Subsidence in the CGSA Management Area. Fall 2021 and Spring 2022 groundwater levels were obtained at all seven (7) RMWs.

b) CHANGES IN GSP MONITORING NETWORK

CGSA has identified a potential eighth (8th) RMW that is owned by a local small community water system. Due to ongoing COVID-19 and related public health and safety measures, efforts for direct outreach and interaction have been postponed.

c) PROGRESS IN ACHIEVING INTERIM MILESTONES

RMW groundwater level data collected within the CGSA Management Area during WY2022 indicate:

- Fall 2021 and Spring 2022 groundwater elevations continue to fluctuate near or above the 2025 Interim Milestone for each respective RMW.

- Fall 2021 and Spring 2022 groundwater elevations did not exceed their respective Minimum Threshold (**MT**) levels at any of the seven (7) RMWs.

- Groundwater elevations were greater than or near their respective Measurable Objective levels at one (1) RMWs in Fall 2021 and three (3) RMWs in Spring 2022.

RMW water quality data collected within the CGSA Management Area during WY2022 indicate:

- Total dissolved solid (**TDS**) water quality results were less than (i.e., did not exceed) the MT at all RMWs.

d) Compliance with Additional Sustainable Management Criteria

Compliance with additional Sustainable Management Criteria in the CGSA Management Area during WY2022 is detailed below:

- Fall 2021 and Spring 2022 groundwater elevations did not exceed their respective MT levels for Chronic Lowering of Groundwater Levels and Reduction in Groundwater Storage at any of the seven (7) RMWs. Thus, Undesirable Results for Chronic Lowering of Groundwater Levels and Reduction in Groundwater Storage are not occurring in the CGSA Management Area in WY2022.

- Declining groundwater elevations since WY2020 are noted at six of the seven RMW locations. WY2021 and WY2022 were both critically dry water years and declared under a drought emergency by the State of California. These locations will continue to be evaluated in WY2023.

- Fall 2021 and Spring 2022 groundwater elevations did not exceed their respective MT levels for Land Subsidence at any of the seven (7) RMWs .

- Water quality data collected in WY2022 indicate that no MTs were exceeded; thus, Undesirable Results for Degraded Water Quality are not occurring in the CGSA Management Area.

As per the CGSA Revised Groundwater Sustainability Plan (**GSP**) submitted July 2022, the following procedure was developed to address an exceedance of a minimal threshold within CGSA.

- A Management Area Exceedance for the Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage sustainability indicators is triggered when groundwater levels decline below the established MT level in 40% or more of the RMWs over four (4) consecutive bi-annual SGMA required monitoring events; a single MT exceedance is not considered an Undesirable Result. Furthermore, CGSA will utilize the KGA Action Plan Related to Exceedance of Minimum Thresholds for Chronic Lowering of Groundwater to proactively address the MT level exceedance that occurs at any of the RMWs.

- A Management Area Exceedance for the Land Subsidence sustainability indicator is triggered when groundwater levels decline below the established MT level at a single RMW. Because of the uncertainty associated with subsidence, the CGSA will take the following steps:

- Verify if land subsidence is occurring at the locations using DWR InSAR data,

- Assess whether any management area critical infrastructure is being affected by the land subsidence,

- Evaluate whether land subsidence is associated with groundwater pumping or another mechanism.

2) Implementation of Projects and Management Actions

Progress towards implementing planned Projects and Management Actions in the CGSA Management Area includes the following:

- P1 - New Water Supply Purchases
    - Negotiations continue with potential new program partners to purchase water supplies from outside of the Kern Subbasin area.

- P2 - Increase Recharge and Banking Capacity
    - The Cawelo Water District (CWD) Board of Directors approved the Landowner Groundwater Recharge and Banking Project in 2021 that allows for landowners to develop private groundwater recharge facilities increasing recharge and banking capacity within CWD. This provides an opportunity for landowners to bank privately-owned surface water and provides CWD with access to additional recharge and banking facilities (second priority right).
        - CWD is currently working with interested landowners in CWD to develop private recharge and banking projects.

P3 - New Cawelo GSA Banking Partners

- Negotiations continue with potential new groundwater banking partners.

- The CWD Board of Directors approved the Landowner Groundwater Recharge and Banking Project in 2021 that allows for landowners to develop private groundwater recharge facilities increasing recharge and banking capacity within CWD. This provides an opportunity for landowners to bank privately-owned surface water and provides CWD with access to additional recharge and banking facilities (second priority right).

- CWD is currently working with interested landowners in CWD to develop private recharge and banking projects.

<u>P4 - Water Treatment Facilities</u>

- CWD continues to review and discuss potential water treatment facilities/operations to process treated recycled produced water (**RPW**) to a level that is safe for crop irrigation.

<u>P5 - Friant Pipeline Project</u>

- Construction on Phase 1 (pipeline from Famoso Basins to Friant-Kern Canal) was completed December 2021.

- Phase 2 (Friant-Kern Canal turn-in/out structure and pump station) is currently in construction. The construction of the Friant-Kern Canal turn-in/out structure will be substantially completed April 2023 and it is anticipated that construction of the pump station will occur in late 2023.

- To date a total of $7,569,031 has been expended on the project, of which $803,224 was expended in WY2022.

<u>MA 1 - KGA Action Plan</u>

- The CGSA Board of Directors adopted the *KGA Action Plan Related to Exceedance of Minimum Thresholds for Chronic Lowering of Groundwater* and this will be implemented to proactively address MT level exceedances.

3) Coordination with Stakeholders

- The CGSA holds a public Board of Directors meeting every second Thursday of the month. The agenda is posted on the website and public in attendance are invited to participate and discuss agenda items.

- CGSA participates in the regularly scheduled Kern Groundwater Authority (**KGA**) public board meetings and regularly participates in subbasin wide meeting with other GSAs, Management Area Plan (MAP) members, and other agency representatives.

- Coordination with other neighboring MAPs, Eastern Water Management Area (**EWMA**) and Kern-Tulare Water District (**KTWD**), is ongoing to discuss groundwater studies, monitoring, and other joint efforts.

4) Summary of Other GSP-related Special Studies or Activities

CGSA continued to support KGA efforts for the Kern Subbasin Data Management System (**DMS**) planning and development. Additionally, CWD worked closely with the Kern Groundwater Authority (**KGA**), KGA

Management Areas (**MAs**), and other subbasin GSPs/GSAs to coordinate responses and GSP revisions to the DWR Kern Subbasin Incomplete Determination provided January 2022.

CGSA is supporting and actively engaged with the *Kern Subbasin Basin Study*, or *Basin Study*, project to update the basinwide groundwater model. The *Basin Study* consists of a systematic, basinwide analysis to address technical data gaps in the hydrogeological conceptual model (**HCM**), water budgets and model calibration.

7.5.2 Eastside Water Management Area

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Eastside Water Management Area (EWMA) during WY 2022 is summarized as follows:

a) GSP Monitoring Activities

<u>Chronic Lowering of Water Levels:</u> EWMA continues to measure groundwater levels semiannually and groundwater quality annually for seven wells in the RMW network. The EMWA representative network is comprised of the following wells.

- EWMA #04
- EWMA #10
- EWMA #21
- EWMA #23
- EWMA #30
- EWMA #41
- EWMA #49

Water levels in all EWMA RMWs have remained above their MTs. However, due to extreme, ongoing drought conditions, groundwater levels have trended downwards and two of the seven RMWs have water levels above their measurable objectives (MOs).

<u>Reduction in Groundwater in Storage:</u> Per the EWMA MAP, the historical change in groundwater storage is estimated to range from -13,000 to -23,000 AFY. Groundwater levels have remained fairly stable in the EWMA, but further information is needed to determine pumping contributions by aquifer since most wells are perforated across multiple aquifer zones. The method of estimating the change in groundwater storage in the basin is estimated using the C2VSim model which will be updated as part of the basin hydrologic study expected to be completed by the end of 2024. Until the model update is complete the EWMA will continue use the above estimate for change in groundwater storage with the caveat that this estimate will be refined by the upcoming model update.

Water Quality: The EWMA MAP established SMCs for TDS with a MT set at 750 mg/L and a MO of 500 mg/L and no exceedances occurred during WY 2022.

Land Subsidence: No land-based data are known for subsidence within the EWMA. The KGA is developing a remote- sensing land subsidence monitoring program which will generate data for the entire Kern Subbasin. The basin-wide subsidence program is being developed within the context of the basin-wide study which is expected to be completed in 2024. DWR has contracted with TRE Altamira to provide quarterly updates for measurements of vertical ground surface displacement. No material subsidence occurred in the EWMA during WY 2022.

Interconnected Surface Water: Not applicable in the EWMA.

b) Changes in GSP Monitoring Network

Issues with Groundwater Level Measurements at Three (3) Wells

In analyzing groundwater level trends at RMWs, an issue with measurements collected at three of the seven RMW wells (well #s 4, 10, and 41) was identified by Kern Tulare Water District's staff and subsequently investigated by the EWMA. While a wire sounder is typically used to measure groundwater levels by a third-party contractor in the EWMA, three wells had been measured using an acoustic sounder due to complications with using a wire sounder. However, EWMA staff was recently made aware that the acoustic sounder settings were not properly configured, which resulted in inaccurate groundwater level measurements beginning as early as March 2020 EWMA well #s 4, 10, and 41.

Furthermore, during this investigation, it was determined that EWMA well #10 is no longer a suitable monitoring well due to a partially collapsed casing and mudding in the borehole. EWMA used nearby EWMA well #11 as a proxy for EWMA well #10 for the fall 2022 measurement but is currently seeking a replacement well for EWMA well #10. Due to the incorrectly set acoustic sounder, historic measurements in these three wells are not reliable and the EWMA requests that the inaccurate historic measurements be removed from the KGA DMS and DWR's MNM portal. A summary of the issues at each of these three wells and the impacted period is provided in the table below.

Well No.	Issue	Impacted Data Period
4	3rd party contractor used incorrectly set acoustic sounder.	July 2020 through February 2022
10	3rd party contractor recently determined that EWMA well #10 is not a suitable monitoring well due to a likely partially collapsed casing and significant mud in borehole. Nearby EWMA #11 was used as proxy for fall 2022 measurement.	March 2020 through February 2022
41	3rd party contractor noted that wire sounder measurements from March 2020 through September 2020 do not correlate with nearby groundwater levels and an acoustic sounder used from October 2020 through February 2022 which was incorrectly set.	March 2020 through February 2022

Update on DWR TSS Wells

In coordination with adjacent water districts (Cawelo WD and KTWD), EMWA submitted an application for two dedicated monitoring wells near the border of EWMA and Cawelo WD and KTWD. This application was submitted and approved under the DWR Technical Support Services (TSS) program. Data will be shared among these three entities and address data gaps for these areas. While the application was approved, DWR TSS staff indicated program delays due to COVID-19 and operational issues have pushed installation out to 2023 or 2024. Recent discussions with the TSS program manager have not provided a firm date of when this approved project will move forward.

c) Progress in Achieving Interim Milestones

Specific interim milestones were not established in the EWMA MAP due to a lack of historical data for most of the wells in the network. At the time the MAP was produced, insufficient data existed to determine water level trends for most of the wells. EWMA expects specific interim milestones to be established during the 2025 GSP update. However, water level elevations will be compared to SMC to assess progress toward sustainability.

d) Compliance with Additional Sustainable Management Criteria

EWMA established SMCs for groundwater levels and water quality. During WY 2022, no SMC exceedance occurred for groundwater levels or groundwater quality.

2) Implementation of Projects and Management Actions

EWMA made progress towards implementing several of its planned GSP Projects in Water Year 2022 as summarized below:

- **Development of oilfield produced water supplies:** Minimal progress was made on this project during WY 2022. Some planning discussions were held during Board meetings during WY 2022.

- **Investigation of groundwater quality**: Annual monitoring of TDS and nitrates continues to occur.

- **Native Yield Estimation:** No significant efforts were made on this project during WY 2022. However, previously completed hydrogeologic studies by Ken Schmidt & Associates in the EWMA will be incorporated by Todd Groundwater in the basin hydrologic study that will assist in determining the native yield in 2024.

- **Monitor Well Construction:** Construction of aquifer-specific monitoring wells in locations with data gaps, to better understand hydraulic heads and gradients. In coordination with Cawelo WD and KTWD, the EWMA submitted a TSS grant application to drill and construct two dedicated monitoring wells in the EWMA near Hwy 65 to provide information on deeper aquifers. The TSS program was delayed due to operational issues and COVID impacts but are still scheduled to be constructed in 2024.

- **Installation of pressure transducers:** As part of the DWR SGM Round 1 grant, the EWMA requested five (5) transducers. Discussions were held to identify candidate wells for the installation of transducers and this project will likely be completed in WY 2023.

- **Surface runoff capture:** Surface runoff capture and enhanced infiltration in impoundments. Minimal progress was made; planning and high-level legal water rights analysis to occur in 2023.

EWMA has made progress towards implementing several of its planned GSP Management Actions. This progress has included the following:

- **Reduction in Agricultural Water Use:** Reduction of irrigated acreage, or modification of irrigation techniques or crop types to reduce water usage is still being planned. Prior to implementing demand reduction, the sustainable yield needs to be established which is expected to be completed by the end of 2024 via the basin hydrologic study.

- **Groundwater Fees:** No progress was made on a determination to assess fees for groundwater use to encourage reduced pumping or curtailment until the sustainable yield is established following the completion of the basin-wide hydrologic study.

- **Water Transfer Credit System:** Discussions have occurred on establishing a system of transferrable water credits and the EWMA developed an internal sustainable yield policy to be used as the basin develops a basin-wide policy. The native and sustainable yield needs to be established prior to implementation of a water market which is expected to occur by the end of 2024.

3) Coordination with Stakeholders

EWMA membership consists of a volunteer membership of 44 landowners representing roughly 38,300 acres and is governed by a 7-member, landowner-elected Board of Directors. EWMA maintains direct communication with the Board and membership (email and phone) and holds monthly Board meetings that are open to all EWMA members. EWMA maintains good professional relationships with adjacent water districts (Cawelo WD and KTWD). EWMA has held various technical meetings with Cawelo WD and KTWD to discuss groundwater levels, hydrogeologic studies and other coordination items. In addition, EWMA maintains a website where it provides maps of the membership area, the EWMA MAP and information on Board meetings and staff contact information. The EWMA Board and Members have directed staff to begin the process of forming a water district for SGMA purposes. Benefits of forming a water district include the ability to form a GSA and the ability to apply for grants.

4) Summary of Other GSP-related Special Studies or Activities

One important data gap missing in the Kern C2VSim model are the deeper aquifers that many EWMA members rely on for their water supply. These aquifers include the locally productive Santa Margarita, Olcese, and Vedder/Pyramid Hills units. Staff has communicated this model deficiency with Todd

Groundwater and were informed that the model would be updated during the basin hydrologic study expected to be completed by the end of 2024.

7.5.3 Kern County Water Agency - Pioneer GSA

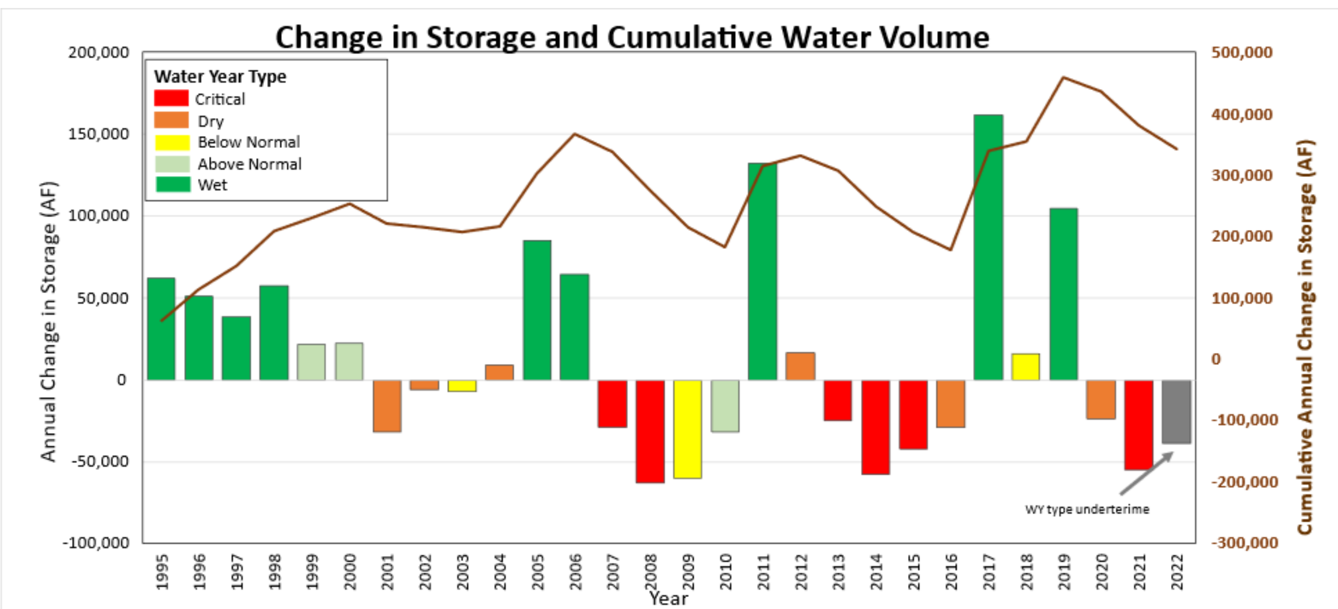
Progress towards compliance with sustainable management criteria in the Kern County Water Agency - Pioneer GSA Management Area during WY 2022 is summarized as follows:

1) Compliance with Sustainable Management Criteria

a) GSP Monitoring Activities

Chronic Lowering of Water Levels: The Pioneer Project records water level data for 42 monitoring and production wells (in the GSA Area). While most of the wells have associated water level data, production well data can be misleading, since measurements can be taken during or after groundwater pumping, which can artificially lower levels below ambient conditions.

Reduction in Groundwater in Storage: The graph provided below in this subsection shows the change in storage volume by year, water type and cumulative annual change in storage volume for the 29-year period from 1994 to 2022 within the Pioneer GSA boundary.



Water Quality: The Pioneer Project collects water quality data from both production and monitoring wells. As part of Pioneer Project operations, water quality is sampled regularly in production wells. Each well is sampled every nine years on a rotational schedule for Title 22 analysis, and data are added to a blending model that forecasts expected water quality results of the blended water that is entering the

SWP from the Pioneer and surrounding projects. Further quarterly water quality sampling is undertaken during extraction/recovery operations on blended water in the CVC and Kern Water Bank Canal to determine efficacy of the model.

Additional water quality sampling for specific constituents occurs on all operating wells during recovery operations and annually on monitoring wells in the Pioneer Project (if accessible). Monitoring wells are sampled for a specified list of constituents and results are shown in the Kern Fan Area Operations and Monitoring Report.

Subsidence Monitoring: Subsidence monitoring for the Pioneer GSA Area includes an extensometer and InSAR remote sensing data. While there are no extensometers in the Pioneer GSA Area, data collected from a DWR- maintained station in the Kern Water Bank will be used in the future, given the extensometer's proximity to the Pioneer GSA Area.

Interconnected Surface Water: Surface water can fall into two categories: natural stream channels and water conveyance infrastructure. The Pioneer GSA Area is bordered to the north by the Central Valley Canal (CVC) and is bisected by the Kern River Canal in the south. Both canals are monitored as part of regular banking activities.

Although the Kern River runs through the middle of two Pioneer GSA Area portions, it is not part of the GSA Area. Therefore, there are no surface water features in the Pioneer GSA Area, and no surface water monitoring is needed.

b) Changes in GSP Monitoring Network

There are no changes to the Pioneer GSA's monitoring network for WY2022.

c) Progress in Achieving Interim Milestones

Interim Milestones were not developed for the Pioneer GSA. The Pioneer Project is a banking program which continues to operate sustainably within the Kern Subbasin, and current water levels are above the Minimum Thresholds.

d) Compliance with Additional Sustainable Management Criteria

Due to drought conditions experienced in California during WY2022, managed recovery occurred in the Pioneer GSA area and one representative well (RMW-048) has fallen just below its minimum threshold level. Despite this exceedance, Undesirable Results conditions as defined in the Chapter and Umbrella GSP have not been experienced. These conditions and operational strategies were anticipated during drought conditions and were incorporated into the methodology used to set thresholds within the Pioneer GSA area. This has allowed the Pioneer GSA to functionally operate primarily within the margin of operational flexibility as described in the submitted Chapter GSP while remaining sustainable through the implementation horizon. Balanced pumping, as described in the Pioneer Chapter GSP, will be used to mitigate and minimize exceedances in the future, but it should be noted that the Pioneer GSA is currently operating sustainably.

2) Implementation of Projects and Management Actions

The Kern County Water Agency - Pioneer GSA Management Area made progress towards implementing several of its planned GSP Projects and Management Actions in Water Year 2022 as summarized by the following:

Management Action 1: Continued balanced pumping and recharge is the standard operating procedure for the Pioneer GSA. Under this management action, pumping has continued to be balanced by recharge activities in the Pioneer GSA Area. Pioneer GSA has continued to closely monitor water that is pumped from the Subbasin and water that recharges the Subbasin with the goal of a balanced groundwater budget over the long term. The Pioneer Project uses a mix of SWP, Kern River and other imported water supplies for groundwater recharge. In the Pioneer GSA Area, the Pioneer Project has a recharge capacity of 302,000 AFY, and a recovery capacity of 68,415 AFY. Recovery capacity is limited by recovery well capacity. KCWA continues to be responsible for management of the Pioneer Project and is the only agency operating groundwater banking and pumping within the Pioneer GSA Area on behalf of the Participants.

To ensure the balance between pumping and recharge, all recharge and recovery in the Pioneer GSA Area is accounted for and metered, including recovery from the Pioneer Project that occurs outside the Pioneer GSA Area boundary. This management action has continued to maintain the balance between recharge and pumping through WY 2022 within normal operational expectations and strategies.

3) Coordination with Stakeholders

As a member of the KGA, the Pioneer GSA has participated in outreach efforts through the KGA. For additional details regarding outreach, please refer to the KGA stakeholder and outreach section.

4) Summary of Other GSP-related Special Studies or Activities

As a member of the KGA, the Pioneer GSA has participated in special studies or activities through the KGA. For additional details regarding special activities, please refer to the KGA special studies or activities section.

7.5.4 Kern Water Bank Authority

The Kern Water Bank (KWB) is a storage program within the Kern Groundwater Authority Groundwater Sustainability Agency (KGAGSA). Although the KWB is not responsible for implementing a GSP, the KWB program is critical to assisting GSAs in achieving sustainable management of the Kern County Subbasin. In addition, the KWB is involved in other agencies GSP implementation strategies as referenced throughout Section 7.1 of this WY 2022 Annual Report; accordingly, this summary of the KWB is provided for context and completeness. KWB members within the Kern County Subbasin include

Improvement District 4 (ID4) of the Kern County Water Agency, Semitropic Water Storage District (SWSD), Tejon-Castac Water District (TCWD), portions of the Westside District Authority (WDWA), and Wheeler Ridge-Maricopa Water Storage District (WRMWSD).

SGMA recognizes the uniqueness of storage programs and their role within a GSA in Water Code Section 10726.2.(b), Which states:

> "... the agency shall not alter another person's or agency's existing groundwater conjunctive use or storage program except upon a finding that the conjunctive use or storage program interferes with implementation of the agency's groundwater sustainability plan." The KGA GSA also recognizes this unique aspect of storage programs within its boundaries with the following provision in its Joint Powers Agreement: "the Authority shall not restrict or otherwise limit the extraction of water stored (whether through direct recharge or in lieu deliveries) in the Kern County Subbasin as a part of any banking or recharge project or program, or otherwise seek to regulate the operation any such project or program..."

With respect to environmental documents, DWR developed extensive mitigation measures, including a long-term operations plan, in an Environmental Impact Report for the continued operations of the KWB that reduces potential groundwater impacts to less-than-significant (DWR, 2016). Importantly, the KWB only recovers water previously stored and cannot contribute to basin overdraft. As indicated above, the KWB program is a critical component of the members' ability to reach sustainability as it provides critical dry-year water that reduces their need to pump groundwater. For more information regarding the benefits the KWB provides toward basin sustainability, see Attachment I6 to the KGAGSP.

1) Compliance with Sustainable Management Criteria

Annual reporting information as listed in the KWBA chapter to the KGA GSP is listed below.

Chronic Lowering of Water Levels
The Joint Operating Committee received one claim related to lowered groundwater levels during the reporting year. Two models used to evaluate the claim indicate KWB activities did not trigger mitigation measures. However, the activities of other members of the Committee did trigger mitigation measures.

Reduction of Groundwater Storage
The Kern Water Bank recovered approximately 188,000 AF in the reporting year. The estimated remaining balance of stored water is 880,000 AF.

Water Quality
- Salt balance summaries are not yet compiled for the year.
- No newly discovered surface contamination sources have been identified for the year.
- Quarterly point of delivery sampling results follow (see table on following page). Note that no downstream samples exceed respective MCLs.
- A DWR Water Quality Assessment of Non-project Turn-ins Technical Memorandum is not yet available for the year.

Subsidence

No incidents of subsidence have been reported by the Kern County Water Agency or the City of Bakersfield for the Cross Valley Canal or Kern River Canal, respectively.

a) GSP Monitoring Activities

Quarterly Sampling Results

Constituent	CVC @ CAA (Tule Elk Bridge)	KWBC Pump-In (Terminus)	Upstream Aqueduct (Tupman Rd.)	Down Stream Aqueduct (Cole's levee)
	Constituent of Concern Sampling 03/10/2022			
Nitrate as N (mg/L)	1.2	0.92	0.54	0.93
Sulfate (mg/L)	23	40	76	39
TDS (mg/L)	180	230	330	230
TOC (mg/L)	ND	ND	1.9	0.52
Arsenic (ug/L)	6.9	7.9	4.2	6.8
Hexavalent Chromium (ug/L)	0.84	1.00	3.1	1.3
Bromide (mg/L)	0.13	0.15	0.34	0.18
Chloride (mg/L)	32	37	100	48
1,2,3-Trichloropropane (ug/L)	0.0017	ND	ND	0.0011
Percholorate (ug/l)	ND	ND	ND	ND
Ortho-Phosphate (mg/L)	ND		ND	ND
	Consituent of Concern Sampling 06/27/2022			
Nitrate as N (mg/L)	0.90	0.085	ND	0.42
Sulfate (mg/L)	31	42	68	55
TDS (mg/L)	190	230	380	310
TOC (mg/L)	ND	0.023	5.0	2.6
Arsenic (ug/L)	7.3	7.6	8.4	5.4
Hexavalent Chromium (ug/L)	0.77	1.1	0.071	0.52
Bromide (mg/L)	0.013	0.15	0.29	0.23
Chloride (mg/L)	34	41	97	70
1,2,3-Trichloropropane (ug/L)	0.0020	ND	ND	ND
Percholorate (ug/l)				
Ortho-Phosphate (mg/L)	ND	ND	ND	ND
	Constituent of Code Sampling 09/28/2022			
Nitrate as N (mg/L)	0.76	0.81	ND	0.49
Sulfate (mg/L)	27	42	55	40
TDS (mg/L)	200	240	360	270
TOC (mg/L)	0.45	0.37	3.8	1.4
Arsenic (ug/L)				
Hexavalent Chromium (ug/L)	1.0	1.2	0.50	0.94
Bromide (mg/L)	0.16	0.15	0.36	0.22
Chloride (mg/L)	40	42	120	65
1,2,3-Trichloropropane (ug/L)	0.0014	ND	ND	ND
Percholorate (ug/l)	ND	ND	ND	ND
Ortho-Phosphate (mg/L)	ND	ND	ND	ND
	Constituent of Code Sampling 12/13/2022			
Nitrate as N (mg/L)	0.83	0.80	1.7	1.3
Sulfate (mg/L)	25	41	99	77
TDS (mg/L)	190	230	430	360
TOC (mg/L)	0.24	0.28	0.56	0.42
Arsenic (ug/L)	11	9.1	5.7	8.2
Hexavalent Chromium (ug/L)	1.1	1.3	4.4	3
Bromide (mg/L)	0.17	0.18	0.52	0.44
Chloride (mg/L)	39	42	130	110
1,2,3-Trichloropropane (ug/L)	0.0010	ND	ND	ND
Percholorate (ug/l)				
Ortho-Phosphate (mg/L)	ND	ND	ND	ND

7.5.5 Kern-Tulare Water District GSA

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Kern-Tulare Water District (KTWD) Management Area during WY 2022 is summarized as follows:

a) GSP Monitoring Activities

KTWD monitors groundwater levels and quality in three aquifers beneath the district: the Continental Deposits, the Santa Margarita Formation, and the Olcese Sands. The primary source of groundwater within KTWD is from the Santa Margarita Formation, which is a confined aquifer that is hydraulically separate from the remainder of the basin.

The District has been monitoring groundwater levels for all three aquifers in 20 wells (11 wells are measured semi- monthly and 9 wells semi-annually). 6 of the wells that monitor groundwater levels in the Santa Margarita were selected as the District's representative monitoring wells. In 2022, the District collected 70 water level measurements for the representative monitoring wells which can be seen on the hydrographs included with the Annual Report. In addition, the District collected 169 water level measurements in the other 14 supplemental wells that include the Continental Deposits and the Olcese Sands.

Groundwater quality data is also collected for all three aquifers from 15 wells within and around the District. Groundwater quality samples are collected during the peak irrigation season when the wells are actively pumping. In 2021, the District collected 8 water quality samples (3 samples represented the Continental Deposits, 3 for the Santa Margarita Formation, and 2 for the Olcese Sands). In 2022, the District collected 3 more water quality samples in the Santa Margarita Formation.

b) Changes in GSP Monitoring Network

In 2020, two adjacent dedicated monitoring wells were completed within the Tule subbasin portion of KTWD and are included as part of the supplemental wells measured semi-annually. One well was completed exclusively in the Continental Deposits and the other in the Santa Margarita Formation. These wells will help fill spatial data gaps and better characterize the groundwater conditions in these primary aquifers.

In 2021, KTWD removed 3 wells from the groundwater quality network: 24S26E24Q1, 25S27E24M2, and 25S27E30D. These wells were removed primarily due to poor construction characteristics for monitoring. 3 wells were also added to the groundwater quality network: 24S26E13H, 25S26E01H, and 25S26E12A2. These wells are located on the District's western edge and were added to better monitor the potential migration of saline water in the Santa Margarita Formation from the west.

No further changes were made to the monitoring network this year. The District intends to revise the representative monitoring network in the 2025 update to include the dedicated monitoring wells and to replace active agricultural wells with inactive agricultural wells converted to monitoring wells. The District may also add wells in the Continental Deposits to its representative monitoring network and develop minimum thresholds and measurable objectives for those wells. The District is currently pursuing DWR Technical Support Services and grant funds to drill more dedicated monitoring wells in the Continental Deposits and Santa Margarita Formation.

c) Progress in Achieving Interim Milestones

As expected for a third consecutive dry year with a limited amount of surface water supply, fall groundwater levels for 2022 were below the 2020 Interim Milestone. The interim milestones and measurable objective established in the District's GSP allowed for operational flexibility and took into consideration seasonal and long-term trends and periods of drought. Groundwater levels were not as low as they were in 2021 and none of the wells reached the minimum threshold. The lowest groundwater elevation collected was still 80 feet above the minimum threshold (-150 feet msl).

The measurable objective for groundwater quality in the Santa Margarita Formation was set at a TDS of 500 mg/L. 2022 samples collected in wells that represent the Santa Margarita Formation all returned TDS values well above the measurable objective, ranging from 260-350 mg/L.

d) Compliance with Additional Sustainable Management Criteria

To date, KTWD has not experienced undesirable results for any of the sustainability indicators. No groundwater levels have exceeded the minimum threshold of -150 ft msl. No groundwater quality samples have exceeded the minimum threshold of 750 mg/L of TDS.

2) Implementation of Projects and Management Actions

Kern-Tulare Water District made progress towards implementing several of its planned GSP Projects and Management Actions in WY 2022 as summarized by the following:

Action 1 - Modify District Pricing Structure: In 2021, the District focused on evaluating the best approach to implement a groundwater charge. The District proposed a Groundwater Extraction Metering Plan and hosted a landowner workshop to receive input on the procedures of groundwater metering. The District elected to measure groundwater pumping by requiring meters on all active groundwater wells within the District. The District amended its Rules and Regulations for the Sale and Distribution of Water to include the new metering requirements and metering standards. The District retained a contractor to inspect all wells within the District for a compliant meter and to assist landowners with installing or modifying meters to meet the District's standards.

In 2022, the District passed a Proposition 218 Election that provided the Board of Directors with the authority to implement a groundwater extraction charge of up to $175 per acre-foot of groundwater pumped within the District. The District continues to assist landowners with groundwater metering compliance and, to date, approximately 90% of active irrigation wells within the District have a meter installed. So far, 75% of the meters meet District's standards and are installed per manufacturer's specifications to ensure accurate meter readings. District staff reads the meters and mails out monthly groundwater extraction information to all landowners with their regular billing statement. The statement reports the metered groundwater pumping for each well and the calculated groundwater pumping based upon ET for each ranch. Currently the groundwater usage is informational, and the Board intends to implement the groundwater charge at a later date.

Action 2 - CRC Pipeline Project: KTWD has continued to pursue the CRC Pipeline Project which would provide an additional produced water supply of about 3,000 AFY. The District recently completed construction of a 684 AF storage reservoir in October of 2020 that would act as the pipeline's terminus. The pipeline design is 90% complete and all environmental permits for the pipeline alignment have been obtained.

Action 3 - In-District Surface Storage: The District is evaluating the feasibility of constructing two surface reservoirs with a total storage capacity of 8,000 AF. If found feasible, the construction of these facilities is not anticipated until 2025-2030.

3) Coordination with Stakeholders

KTWD holds a public Board meeting the second Thursday of every month at 2:30pm. All Board members are landowners within the District and are the elected representatives of the landowners within the District. District staff provides an update on SGMA implementation at each monthly meeting.

In 2021, District staff prepared and distributed additional memos and letters regarding the Groundwater Extraction Metering Plan to involve all landowners and water users in the process. A landowner workshop was specifically hosted on this topic at the September 9, 2021 Board Meeting. Following the Board's adoption of the Amended Rules and Regulations for the Sale and Distribution of Water, the District mailed a notice letter along with a full copy of the new document to all landowners. The District also prepared an informational flyer providing an update on the District's SGMA activities which was mailed out to all landowners and posted on the District's website.

In 2022, the District prepared the Prop. 218 Engineer's Report proposing the implementation of the groundwater charge and presented the report in draft for public review at the District's May Board meeting. In June, the Board adopted the report and District staff mailed letters notifying the landowners of the Engineer's Report and Prop. 218 majority protest hearing. A public hearing was held in August 2022 and the groundwater charge passed with only 396 acres out of 19,790 acres (2%) in protest.

District staff also prepared the 2022 Amended KTWD GSP and presented the revisions in draft for public review at the District's June Board meeting. After receiving public input, District staff made further revisions and the Board adopted the Amended GSP at the District's July Board meeting. The revisions to the GSP were circulated in the District's Board meeting packet that is mailed out to all interested landowners and water users and the completed document was posted to the District's website.

4) Summary of Other GSP-related Special Studies or Activities

<u>Salinity Study for the Santa Margarita Formation and Olcese Sands in the Vicinity of Kern-Tulare Water District (2020):</u> One of the concerns addressed within the KTWD GSP is the potential migration of brackish groundwater in the Santa Margarita Formation from the west which could adversely impact groundwater quality. KTWD and EWMA made a commitment in their GSPs to work together to monitor and manage the potential movement of brackish groundwater from the west. In October 2020, KTWD in coordination with EWMA created a report titled "Salinity Study for the Santa Margarita Formation and Olcese Sands in the Vicinity of Kern-Tulare Water District." The report defines the saltwater interface in the Santa Margarita and Olcese aquifers within the area and proposed additional wells to monitor groundwater quality specifically for TDS. KTWD has been monitoring these additional wells and has seen no indication of an increase in salinity along the western-border of the District.

<u>Supplemental Groundwater Study (2022):</u> Since completion of the GSP, the District has collected additional information to better inform groundwater management and provide updated information for the 2025 GSP. The District prepared a 2022 Supplemental Groundwater Study that provides the best and most recent technical information to assist in a hydrogeologic evaluation for the District and lands to the east. This report was provided to both Kern and Tule subbasin consultants who are performing groundwater modeling and analysis for the 2025 subbasin-wide updates. Topics included in the report were: 1) an updated inventory of all active wells in the study area and identification of the deepest aquifer penetrated by each well; 2) a pumping test at a well adjacent to two monitoring wells to determine aquifer characteristics of the Santa Margarita Formation and the Continental Deposits;

3) an estimation of the porosity of the Santa Margarita Formation; 4) updated hydrographs; 5) updated groundwater quality results and; 6) an evaluation of e-logs from active wells within KTWD to determine the percentage of groundwater pumping from the Santa Margarita Formation and the Continental Deposits.

<u>Distribution System Improvements:</u> The District is currently evaluating its distribution system to identify improvements and funding mechanisms to provide full surface water deliveries to all lands within its service area. Action 1 provides financial incentives for landowners to take deliveries of surface water rather than pump groundwater; however, the District desires to increase the capacity of the distribution systems in order to deliver more surface water and reduce groundwater pumping. The District completed an evaluation of the Northern Distribution Facilities and is beginning to prepare an evaluation of the Southern Distribution Facilities. Distribution System Improvements were not originally included as an Action item in the 2020 GSP but will be added to the 2025 update.

7.5.6 North Kern Water Storage District and Shafter-Wasco Irrigation District

1) COMPLIANCE WITH SUSTAINABLE MANAGEMENT CRITERIA

North Kern Water Storage District and Shafter-Wasco Irrigation District (NKWSD/SWID) have established SMCs for groundwater levels. The objective in this Management Area is to maintain groundwater levels above the Measurable Objective: all Water Year 2022 seasonal measurements complied with this criterion.

a) GSP MONITORING ACTIVITIES

NKWSD and SWID continue to implement the GSP Monitoring Network within their respective Management Area boundaries. The monitoring network is comprised of eight irrigation and seven municipal wells. Water level elevation data was measured and reported for both spring and fall requirements. The districts continue to implement the following monitoring activities to demonstrate compliance with SGMA SMCs.

- Estimate ET at the field level through a system of ground-based monitoring stations in conjunction with available satellite data for both Management Areas.
- Measure surface water deliveries brought into the Management Areas, deliveries to each agricultural turnout, and all groundwater extractions at each of the district's metered groundwater production wells.
- NKWSD conducts an annual subsidence survey along the Friant-Kern Canal and is evaluating the correlation between groundwater levels.

b) CHANGES IN GSP MONITORING NETWORK

- The casing in NKWSD's monitoring well 88-03-009 collapsed in summer 2021. The well was destroyed and replaced. Fall measurements were collected from the newly constructed well.
- In summer 2022, two new Representative Monitoring Wells (RMWs) were added to North Kern's Management Area-2, Rosedale Ranch Improvement District. SMCs were established for groundwater levels, and water level is used as a proxy for water quality and subsidence.
- SMCs for water levels were raised in four of NKWSD's 8 RMWs; and four of SWID's 7 RMWs. NKWSD raised the MO 25-ft and MT 50-ft, and SWID raised the MO for three RMWs 30-feet and one RMW 40-feet and raised the MT for three RMWs 40-feet and one RMW 50-feet.
- An interim MT was established for the Lower Reach of the FKC within the Kern Subbasin. The MO rate is -0.1 feet per year, MT rate of allowable subsidence is -0.2 feet per year, and MT extent is -3.6 feet through the SGMA implementation period (2040).

c) PROGRESS IN ACHIEVING INTERIM MILESTONES

Hydrographs show water levels in NKWSD and SWID have not fallen below the Measurable Objectives or Minimum Thresholds in WY 2022.

- Groundwater elevations are used as a proxy for both groundwater quality and land subsidence. By proxy, the Management Area complies with the interim milestones.

d) COMPLIANCE WITH ADDITIONAL SUSTAINABLE MANAGEMENT CRITERIA

Groundwater levels are used as a proxy for water quality and subsidence. There are no interconnected surface waters in the Kern County Subbasin.

Water Quality
Water quality constituents of concern addressed in the Management Area Plan include arsenic, boron, chloride, dibromochloropropane (DBCP), hexavalent chromium, nitrate, sodium, 1,2,3-trichloropropane (TCP). Samples for each of these constituents of concern are collected within two weeks of seasonal water level measurements to clearly define impacts groundwater levels have on water quality. To date, no unreasonable impacts have been identified as a result of declining or fluctuating groundwater levels. If a correlation develops indicating that declining water levels area causing unmitigated impacts to beneficial users, stakeholders will be consulted, and appropriate corrective actions or mitigation will be considered. Additionally, both NKWSD and SWID actively participate in programs responsible for managing water quality.

Land Subsidence
Subsidence is monitored through CGPS P564 and InSAR data, as well as North Kern's monitoring network along the Friant-Kern Canal. An analysis of the relationship between groundwater levels and measured subsidence was conducted in 2022, with a technical memo attached to the revised Management Area Plan. CGPS station P564 shows relative agreement in the total cumulative subsidence over the same timeframe. NKWSD monitoring network of 13 stations also demonstrates relative agreement between with the InSAR dataset. In Water Year 2022, the TRE Altamira InSAR dataset shows -0.2 to 0.4 feet of subsidence across the management areas.

2) IMPLEMENTATION OF PROJECTS AND MANAGEMENT ACTIONS

The North Kern Water Storage District and Shafter-Wasco Irrigation District Management Area made progress towards implementing several of its planned GSP Projects and Management Actions in Water Year 2022 as summarized by the following:

Management Actions
- **Implement the KGA MT Exceedance Action Plan:** Initiated in summer 2022. No specific implementation actions have been necessary since water levels are maintained above the MO.

- **<u>Coordinate with Existing Water Quality Programs:</u>** Initiated in summer 2022. Both districts active participate in Irrigated Lands Regulatory Program meetings, the Kern Water Alliance meetings (administering the Nitrate Control Program for the Kern Subbasin), maintain active communications with the Cities of Shafter and Wasco, and participate in disadvantaged community outreach through the Poso Creek Regional Water Management Group.

- **<u>Mitigation Program for Potential Impacts to Domestic Wells:</u>** NKWSD and SWID both adopted their proposed Well Mitigation Plan (included with the revised GSP in July 2022) in August 2022. A domestic well survey is being conducted in 2023 to identify the number of vulnerable domestic wells.

- **<u>Refinement of Water Budget Components:</u>** No activity to report for WY 2022. SWID plans to develop water budgets in WY 2023.

Projects

- **<u>Identify potential groundwater recharge sites within Rosedale Ranch</u>:** NKWSD conducted informational and engineering studies to identify potential groundwater recharge sites within Rosedale Ranch. NKWSD is currently working through a Proposition 218 election to fund these recharge projects and the acquisition of additional water supplies.

- **<u>Landowner Groundwater Banking program</u>:** NKWSD has developed a Landowner Groundwater Banking program that provides landowners the opportunity to bank and acquire groundwater credits and provides the district with additional groundwater recharge and banking capacity. An Initial Study/Mitigated Negative Declaration (IS/MND) is complete.

- **<u>Groundwater recharge and recovery programs</u>:** NKWSD continues improvements to conveyance for its groundwater recharge and recovery programs. These improvements include implementation of the Long-Term TCP Mitigation Project and additional expansion of the district's groundwater banking program, improvements to the district's recovery network, and joint projects with neighboring water districts.

- **<u>Lining Calloway Canal</u>:** NKWSD completed concrete lining an additional section of the Calloway Canal and continues the lining project into the district boundary to increase surface water reliability and prevent loss from seepage in the unlined canal. The final segment of canal is expected to be lined in 2024.

- **<u>Oilfield produce water</u>:** NKWSD continues to beneficially use recycled oilfield produced water and explore acquiring additional supplies.

- **<u>Bell Recharge Project</u>:** Construction is in progress on SWID Bell Recharge Project. The project has been fully designed and is currently in construction.

- **<u>Leonard Avenue Conveyance Improvement Project</u>:** SWID completed the Leonard Avenue Conveyance Improvement Project in 2021.

3) Coordination with Stakeholders

SGMA related topics are discussed at each District's Board of Directors monthly meetings. Topics include information on Subbasin-wide activities, progress on management actions, and results of seasonal water level measurements and compliance with the established SMCs. Additional coordination during Water Year 2022 includes:

- Coordination Meeting between SWID and Rosedale-Rio Bravo Water Storage District in April 2022
- Meeting with the Cities of Shafter and Wasco Staff to discuss the 2020 GSP Determination Letter and work in progress to resolve deficiencies in April 2022.
- NKWSD SGMA Committee meeting to update landowners on proposed changes to the Management Area Plan in July 2022.
- Both NKWSD and SWID held special board meetings to adopt the revised Management Area Plan in July

4) Summary of Other GSP-related Special Studies or Activities

No special studies are being conducted exclusively in the NKWSD/SWID Management Areas. However, both districts are actively participating in the Subbasin-wide Basin Study and subsidence studies.

7.5.7 Rosedale-Rio Bravo GSA

As a Kern Groundwater Authority (KGA) member, Rosedale-Rio Bravo Water Storage District (RRBWSD) prepared a Groundwater Sustainability Plan (GSP) Chapter for the KGA GSP covering the Rosedale-Rio Bravo Management Area (RRBMA, Management Area).

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the RRBMA during water year (WY) 2022 is summarized as follows:

a) GSP Monitoring Activities

Chronic Lowering of Water Levels. Groundwater levels were monitored monthly in 19 representative monitoring wells within the Management Area. The wells are a combination of agricultural, domestic, and dedicated monitor wells of known well construction and offer reliable long-term data.

Reduction in Groundwater Storage. A sustainable yield was calculated for the water users in the RRBMA. RRBWSD also prepared an annual operations report including an updated groundwater checkbook balance for 1995-2021.

Groundwater elevations for each Fall measurement cycle were also compared and groundwater storage volume was calculated using RRBWSD's numerical groundwater model.

Water Quality. Groundwater quality was monitored annually in 11 representative monitor wells within the Management Area. The wells are a combination of agricultural, domestic, and dedicated monitor wells of known well construction.

Land Subsidence. Subsidence data was gathered via publicly available InSAR data (provided by DWR for GSP development and implementation) at the five identified monitoring locations. Each monitoring location is near Management Area critical infrastructure throughout the RRBWSD.

Interconnected Surface Water. Not applicable.

b) Changes in GSP Monitoring Network

Chronic Lowering of Water Levels. Groundwater levels were monitored monthly in 19 representative monitoring wells within the management area, no changes were made in the GW levels monitoring network.

Reduction in Groundwater Storage. RRBWSD has no changes in the monitoring network for the Groundwater Storage Calculation.

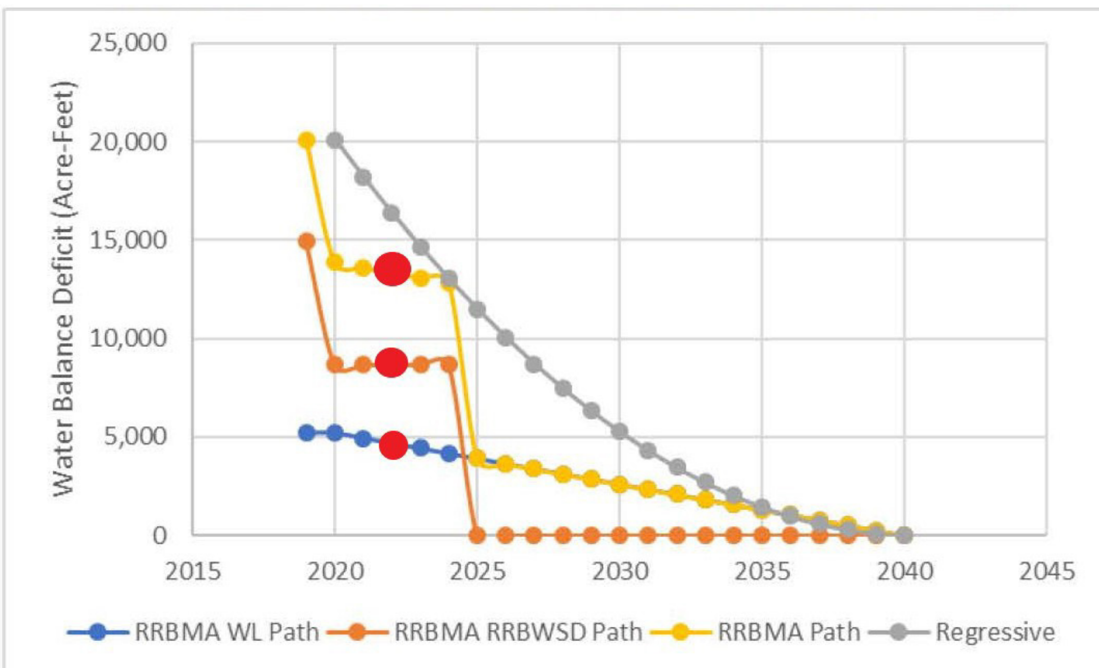
Water Quality. Groundwater quality was monitored annually in 11 representative monitor wells within the management area. The wells were previously hyper-focused on one area of the District and mainly looked at District production wells. To be more representative of all beneficial users in the Management Area, RRBWSD added domestic and municipal wells to the Water Quality monitoring network and spaced the monitoring network uniformly across the RRBMA boundary. The new list of Water Quality wells includes the following: RBG School, Frito-Lay #1, Mayer, Enos, Greeley, Schweikart, Clarisse #2, Brock North, Brock South, Shop, 32N.

Land Subsidence. No change in the Land Subsidence monitoring network. Interconnected Surface Water. Not applicable.

c) Progress in Achieving Interim Milestones

There are three identified interim milestone goals that RRBMA has set in their GSP.

Path to Sustainability. The RRBMA is on its regressive path to sustainability as shown by the red dots on the graph below.



Projects and Management Action Implementation. The RRBMA, as of the end of 2022, has successfully exceeded its 2020 Implementation Milestone by 1,500 AF and has implemented 86% of its 2025 16,800 AF Implementation Milestone goal (see table below).

RRBWSD - GSP Projected Project and Management Action Milestones

Year	Projects (AFY)			Management Actions (AFY)			Total (AFY)		
	Actual	Milestone	Status	Actual	Milestone	Status	Actual	Milestone	Status
2020	6,500	5,000	Complete	1,250	1,250	Complete	7,750	6,250	Complete
2022	**10,500**		**Current**	**1,901**		**Current**	**14,401**		**Current**
2025	TBD	11,500	Not Met	TBD	5,300	Not Met	TBD	16,800	Not Met
2030	TBD	10,000	Not Met	TBD	1,300	Not Met	TBD	11,300	Not Met
2035	TBD	1,000	Not Met	TBD	1,300	Not Met	TBD	2,300	Not Met
2040	TBD	0	Not Met	TBD	1,300	Not Met	TBD	1,300	Not Met

White Land Demand Reduction. White Lands Allowable Imbalance Calculation - As part of the White Land Demand reduction action implementation, demand (AF) is tracked monthly using ET data.

White Lands Allowable Imbalance Calculation

Name	Developed Acres	2020	2021	2022	Sum 2020-2022	Interim Milestone 2020-2024 Total (9.11 Ac-Ft/Ac.)
Landowner A1	118	97	86	154	337	**1,074**
Landowner A2	558	(104)	169	830	895	**5,079**
Landowner A3	60	82	92	138	312	**548**
Landowner A4	44	28	33	70	130	**404**
Landowner A5	315	795	996	1,049	2,839	**2,867**
Landowner A6	318	75	(14)	20	81	**2,895**
Landowner A7	318	244	315	500	1,060	**2,899**
Landowner A8	637	306	(76)	1,007	1,237	**5,805**
Landowner A9	208	(102)	211	(104)	5	**1,899**
Landowner A10	297	874	1,051	1,101	3,026	**2,707**
Landowner A11	371	925	1,034	751	2,710	**3,381**
Landowner A12	58	(9)	(20)	57	28	**525**
Landowner A13	139	110	22	41	174	**1,264**
Total Allowable Imbalance Used	3,441	3,321	3,901	5,614	12,835	
Total Allowable Imbalance (GSP)		6985	6606	6262	19,853	**31,345**

Lands using more than their allowable water during 2020-2024 are shown in red font in the table above.

Supplies are compared based on developed acres and a straight line reduction as seen on the blue line in the "Path to Sustainability" chart above. The District is actively monitoring water use by white land's but the first interim milestone occurs in 2024, when actions may be taken against White

d) Compliance with Additional Sustainable Management Criteria

Chronic Lowering of Water Levels. RRBMA groundwater levels continued to decline as a result of three consecutive dry years. Water levels in the representative monitoring wells (RMWs) declined by 15-20 feet from Fall 2021 to Fall 2022. No exceedances occurred in 2022 within the Management Area. RRBMA will continue to monitor and report the RMWs in accordance with SGMA guidelines.

Reduction in Groundwater Storage. A Sustainable Yield for the Rosedale-Rio Bravo District Lands within the RRBMA is calculated as the sum of Native Yield, Precipitation, and Project Water. A 20-year average is used as a representative long-term average for Management Action implementation purposes. For the 2002-2021 period, Project Water supplies were approximately 66,976 AFY. District Assessed Acres total

39,468 acres, resulting in Project Water of 1.70 AF/acre/yr. The Shafter #5 CIMIS Station's annual average precipitation is 5.04 inches (0.42 ft) or 16,577 AFY. The KGA has allocated a value of

0.15 AF per acre to all developed lands, or 5,920 AFY. The total 20-year average Sustainable Yield for RRBWSD calculates to be 89,473 AFY or 2.27 AF/acre/yr.

RRBWSD prepares an annual operations report including an updated checkbook groundwater balance. For the period of 1995-2021, RRBWSD has a cumulative storage balance of 300,058 AF. In 2021 the overall balance was reduced by about 58,000 AF due to dry hydrology.

Groundwater elevations for each Fall measurement cycle were also compared and groundwater storage volume was calculated using RRBWSD's numerical groundwater model. The model area includes the RRBMA and portions of other neighboring management areas and GSA's. In the model area, based on the Fall 2022 measurement, there was 990,000 AF estimated to be in storage above the RRBMA Minimum Thresholds. The amount of water estimated in storage decreased by 370,000 AF between Fall 2021 and Fall 2022.

Water Quality. The current monitoring wells offer reliable long-term data. Data collection continues but results have not yet been analyzed. Per the GSP, the baseline calculations for the Minimum Thresholds (MT's) and Measurable Objectives (MO's) are complete, with RRBWSD set to collect samples in 2023. To streamline the semiannual data reporting, KGA developed the web-based Data Management System (DMS) for accessing groundwater level and water quality data. Water Quality is a feature that is currently being developed within the DMS.

Land Subsidence. No exceedances occurred in 2022 within the management area. The annual subsidence rate for the five locations (2017-2022) ranged from 0.009 feet to 0.018 feet (or 0.05-0.11 feet in total over six years), which is well below the Minimum Threshold of 0.6 feet over the six-year period.

Interconnected surface water. Not applicable.

2) Implementation of Projects and Management Actions

Project Implementation:
The RRBMA made progress towards implementing several of its planned GSP Projects in Water Year 2022 as summarized by the following:

Enns Basins Improvement Project (McCaslin Ponds): This project was added in 2019 as an adaptive management action and includes a 195-acre project west of Bakersfield to recharge, store, and recover water. RRBWSD completed relevant environmental analysis and applied for grant funding. Subsequent addenda to a previous conjunctive-use EIR were adopted. WaterSmart grants were awarded in 2020 and 2021 towards development and construction. Almond trees were removed from the property in 2021 and construction of recharge ponds and intake was completed in 2022. The design of two Conjunctive-Use banking wells is scheduled for construction in 2022-2023.

Onyx Ranch Project: This project is connected to RRBWSD-owned lands and water rights in the Kern River Valley. The project involves a change in the point of diversion that would bring water supplies to the Kern Subbasin. A Draft EIR was completed and circulated, and the FEIR was certified in January 2021. During 2021, RRBWSD coordinated with the Kern River Interests and initiated a Pilot Project in early 2022 where approximately 1100 AF was delivered for groundwater storage in the Kern Subbasin. Severe drought conditions limited supplies from May through December of 2022. RRBWSD anticipates deliveries will recommence during the winter of 2023.

James Groundwater Storage and Recovery Project: This project is a proposed 2,070-acre project in southwest Bakersfield designed to recharge, store, and recover water to provide a cost-effective and reliable water supply for landowners within RRBWSD. A conceptual design and feasibility analysis was completed in 2019 and awarded grant funding is tentative. The environmental analysis was re-initiated with the distribution of a Notice of Preparation of an EIR in June 2020, distribution of the DEIR in 2022, and certification of the FEIR expected in 2023. The design of an intake from the Kern River to the James Project across the Pioneer Project stands at 30% status.

Kern Fan Groundwater Storage Project: This project would develop a regional water bank in the Kern Fan area to store State Water Project (SWP) Article 21 water when surface water is abundant. The Kern Fan Project's feasibility analysis was completed in March 2020 and an FEIR was certified in December 2020. RRBWSD has commenced permitting and design efforts, now having acquired 350 acres of property for new recharge and recovery. On these properties, recharge improvement plans and specifications stand at 60% with construction expected in 2023-2025. Alternative conveyance routes were also analyzed.

Western Rosedale Lands In-Lieu Service Area Project: This project includes the construction and operation of up to ten miles of water conveyance pipelines, including appurtenant facilities, to provide surface water to agricultural users within a portion of RRBWSD's service area located west of Interstate 5. Project status is shovel ready; feasibility and environmental analysis are complete. No implementation date is known at this time.

Ten Section Project: This project is located in the South of the River Monitoring Area within the RRBMA. A feasibility study of 200+ acre groundwater recharge, storage, and recovery projects is currently underway. No implementation date is known at this time.

The RRBMA made progress toward implementing several of its planned GSP Management Actions in Water Year 2022 as summarized by the following:

Water Charge Demand Reduction: This action is being developed that would be imposed on landowners for the use of water over Native Yield, precipitation, and Project Water. A web-based water budget platform was completed in 2020 and real-time evapotranspiration (ET) data was incorporated in 2021 allowing users the ability to track their water usage for background information. The RRBWSD Board directed staff to change implementation from 2023 to 2024.

RRBWL (White Land) Water Supplies and Demand Imbalance Reduction: This action has been implemented for demand reduction on a linear basis over the planning period of 2020-2040. It is expected that Rosedale-Rio Bravo White Lands would seek to acquire water supplies for in-lieu and direct groundwater recharge via banking agreements with RRBWSD, or others to offset demands. A web-based water budget platform was completed in 2020 to allow users to begin tracking water usage for initial 2020-2024 reduction requirements. Landowners are being regularly updated as to their demands and remaining balances requiring balance by the end of 2024.

RRBWSD 3rd Party Recharge and Storage Program: This action will be developed by RRBWSD for 3rd-party recharge for use in the RRBMA or other downgradient areas in the Kern Subbasin. RRBWSD would offer existing conveyance and recharge facilities in exchange for a portion of the imported water supply and payments of yet-to-be- developed costs and/or fees. RRBWSD executed one such program in 2022 for up to 50,000 AF of groundwater recharge of which RRBWSD would retain 1 AF for every 2 AF stored.

The RRBMA made progress towards implementing several of its planned GSP **Adaptive Management** in Water Year 2022 as summarized by the following:

- To the extent that projects and management actions are unable to prevent undesirable effects that are caused by RRBMA activities, further actions will be evaluated and considered. For example, if either the projects or management actions are unable to produce the projected supplies, or other more cost-effective options are found, the RRBMA may deviate from the actions as described above.

- Because the White Lands are located outside of the political boundaries of RRBWSD, assessment, and water charges are not likely to be imposed unless voluntarily created by those landowners. Currently, there is a contractual relationship where RRBWSD provides certain landowners with SGMA compliance methodology. Compliance with demand reduction management action(s) will initially be voluntary in nature. However, to the extent that a landowner refuses to comply, RRBWSD may terminate the contractual relationship that provides the landowner with SGMA compliance and remove the landowner from the RRBMA. During 2020 and 2022, RRBWSD offered groundwater for transfer from a potential land fallow program. No Rosedale-Rio Bravo White Land participants opted to participate.

3) Coordination with Stakeholders

RRBWSD held monthly Board meetings during all of 2022 which included briefing the Board on SGMA-related activities. Five stakeholder meetings were also held in person at the District's office with a virtual option. RRBWSD provided updates on groundwater monitoring results, plan revisions associated with DWR comments, and implementation of projects and management actions.

4) Summary of Other GSP-related Special Studies or Activities

RRBMA did not engage in any additional GSP-related studies or activities in 2022, beyond the normal operation and management of groundwater and surface water supplies for the benefit of landowners.

7.5.8 Semitropic Water Storage District GSA

In 2022, the Semitropic Water Storage District (SWSD) Groundwater Sustainability Agency (GSA) continued to initiate implementation of its Groundwater Sustainability Plan (GSP), which is included as a Management Area Plan in the Kern Groundwater Authority (KGA) GSP. Based on data provided by SWSD for the Annual SMGA Report, the plan area for SWSD is meeting the Sustainable Management Criteria (SMCs) set in the 2020 GSP. The following summarizes activities for the SWSD GSA during 2022 toward compliance with SGMA.

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the SWSD GSA during WY 2022 is summarized as follows:

a) GSP Monitoring Activities

SWSD GSA continues to collect data from its dedicated SGMA Representative Monitoring Wells (RMW), as well as other wells in its management areas. The District utilizes data from these wells to evaluate changes in groundwater conditions associated with water management activities. During 2022, SWSD GSA collected and reported groundwater elevation for its existing 12 RMWs to the KGA.

Additionally, SWSD conducted annual land use/crop surveys in coordination with ET monitoring performed by Land IQ. Since 2019 there was a steady decrease in irrigated acres and ET volumes over irrigated acres during the monitoring period.

b) Changes in GSP Monitoring Network

There have been no changes to the GSP monitoring network to report for WY 2021. However, the SWSD GSA added two additional monitoring wells to its RMW network in Jan 2023. These two additional RMWs are located in the southern region of the GSA, in SWSD GSA Management Area 2. These RMWs will enable the SWSD GSA to monitor conditions for Groundwater Elevation, Reduction of Groundwater Storage, and Water Quality in this management area and potential interactions with the management areas of neighboring districts.

c) Progress in Achieving Interim Milestones

According to the representative monitoring site hydrographs, updated through 2022, the groundwater levels within the plan are near the Measurable Objectives set in the 2020 GSP. While some groundwater levels are below established interim milestones, they are still within a reasonable variance considering prolonged drought conditions and reduced imported water allocations.

d) Compliance with Additional Sustainable Management Criteria

Per the KGA 2020 GSP, groundwater levels are used as a proxy for both groundwater quality and land subsidence. By proxy, the plan area is meeting its groundwater quality and land subsidence interim milestones.

2) Implementation of Projects and Management Actions

The SWSD GSA made progress towards implementing several of its planned GSP Projects and Management Actions in Water Year 2022 as summarized by the following:

Leonard Avenue System: In 2022, SWSD initiated the construction of the Leonard Avenue System Project.

Enhanced Groundwater Recharge: In 2022, SWSD continues to evaluate subsurface recharge.

Approximately 1,600 acres were evaluated for potential subsurface recharge sites, with 990 acres identified as suitable for development.

Management Action 1 - Landowner Water Budgets: In 2022, SWSD provided individual landowner water budgets and were given opportunity to discuss at two stakeholder meetings held in 2021.

Management Action 2 - Tiered Pricing Structure: In 2022, a draft tiered pricing structure for groundwater extraction was presented to the Board of Directors for consideration and review by stakeholders.

3) Coordination with Stakeholders

SGMA related topics were discussed at each District's Board of Directors meetings throughout 2022. Stakeholders were given the opportunity to evaluate District operations and management to assess and pursue actions toward achieving long-term sustainability and comply with SGMA. The Board of Directors and stakeholders were presented with draft and final content of the 2022 revised KGA GSP and SWSD GSA GSP.

4) Summary of Other GSP-related Special Studies or Activities

The key activity of the SWSD GSA in 2022 was the development of responses to GSP deficiencies identified by DWR and the preparation and submittal of an Amended GSP to DWR with corrective actions. The SWSD GSA amended its 2020 GSP to address those deficiencies specific to SWSD GSA and worked with the KGA and other GSAs in the Kern County Subbasin to address basin-wide coordination issues. SWSD GSA's Amended GSP provides the responses developed specifically for the SWSD GSA deficiencies and those developed by the KGA to better coordinate sustainable management of the groundwater resources throughout the Subbasin. A summary of SWSD GSA's responses to DWR's deficiency comments is provided below.

Deficiency 1:

Corrective Action 1 (a): The Plan's coordination Agreement should be revised to explain how the undesirable results definitions are consistent with the requirements of SGMA and the GSP Regulations, which specify that undesirable results represent effects caused by groundwater conditions throughout the Subbasin. The discussion should include descriptions of how the Plans have utilized the same data and methodologies to define the Subbasin-wide undesirable results and how the Plan has considered the interests of beneficial uses and users of groundwater.

SWSD GSA response: Coordinated undesirable results have been clarified in the revised Appendix 3 of the Kern County Subbasin Coordination agreement and have been incorporated in the amended Section 3 of the SWSD GSA GSP and throughout the document.

Corrective Action 1 (b): Because of the fragmented approach used in the Subbasin that could allow for substantial exceedances of locally defined minimum thresholds over sustained periods of time, the GSAs must commit to comprehensively reporting on the status of minimum threshold exceedances by area in the annual reports and describe how groundwater conditions at or below minimum thresholds may impact beneficial uses and users prior to the occurrence of a formal undesirable result.

SWSD GSA Response: The KGA has adopted the Minimum Threshold Exceedance Policy which is included in the amended SWSD GSA GSP as Appendix E. The Minimum Threshold Exceedance Policy is a proactive approach to identifying and working with management areas to address a single, isolated exceedance. The KGA Well Exceedance Policy has been included in the SWSD GSA GSP as a Management Action (Section 5.2.5). The SWSD GSA has also identified the number of representative Monitoring Wells for each Management Area needed to trigger a Management Area Exceedance (Section 3). Furthermore, the SWSD GSA has identified the percentages of wells by beneficial user category potentially impacted within each Management Area at the Measurable Objective and the Minimum Threshold (Section 3).

Corrective Action 1 (c): The GSAs must adopt clear and consistent terminology to ensure various plans are comparable and reviewable by the GSAs, interested parties, and Department Staff.

SWSD GSA Response: The SWSD GSA has incorporated the consistent terminology developed and agreed to by all GSAs in the Subbasin. Terminology commonly used in the Subbasin GSPs are listed below.

Management Area: Management Areas are areas that will be considered against the determination of an undesirable result at the basin level.

Watch Areas: Areas with no significant groundwater use and no planned groundwater use as documented in a MAP. Watch areas will be monitored for land use changes and groundwater conditions that could change its designation to a "management area" with specified SMCs.

Monitoring Areas: Areas that have significance within a Management Area for monitoring groundwater conditions or impacts to certain beneficial users but are not considered towards the determination of an Undesirable Result.

MT Exceedance: Where a single representative monitoring well exceeds its minimum threshold.

MT Trigger: A management area exceedance is triggered when groundwater levels decline below established MTs in 40% or more of any representative monitoring wells within the management area over four consecutive bi-annual SGMA required monitoring events (Definition for Chronic Lowering of Groundwater).

Management Area Exceedance: Exceeding the MT Trigger (i.e. 40% of wells over four consecutive bi-annual SGMA required monitoring events) within a management area is a "management area exceedance", not an Undesirable Result which is defined at the basin level below.

Undesirable Result: The basin-wide definition unreasonable impacts to beneficial uses and users of groundwater. Should only be referred to as a basin-wide condition and not a management area condition. The equivalent designation at the management area is a "Management Area Exceedance."

Other Department staff recommended revisions:

Map of the entire Subbasin showing each of the GSP area, including management areas and the management areas within the management area plans, associated monitoring zones, etc. that have a locally defined "undesirable result" that can contribute to the Subbasin's undesirable result area-based definitions described in the Coordination Agreement.

SWSD GSA Response: Figure 3-2 and Figure 3-3 of SWSD GSA's Amended GSP have been updated to include consistent descriptions and identification with all Subbasin GSAs.

A comprehensive table or another organized form of identifying each of the areas, the land coverage - both absolutely and as a percentage - of each of those listed areas in comparison to the Subbasin in total.

SWSD GSA Response: See Figure 3-1, Figure 3-2 and Figure 3-3 of SWSD GSA's Amended GSP have been updated to include consistent descriptions and identification with all Subbasin GSAs

In addition to the graphical and tabular representation of the definition of the Subbasin-wide undesirable results, and if the GSAs elect to maintain the percentage of land area definition of undesirable results, the GSAs need to provide a comprehensive description of the groundwater conditions that would lead to localized undesirable results in the GSAs and other management areas which ultimately contribute to the 15 percent or 30 percent of land area criteria.

SWSD GSA Response: See Table 3-1, Figure 3-5 and Table 3-2 of SWSD GSA's Amended GSP have been updated to include consistent descriptions and identification with all Subbasin GSAs.

Additional SWSD GSA Response to Deficiency 1 Comments:
The SWSD GSA collaborated with the KGA to establish a Minimum Threshold Exceedance Policy (SWSD GSA Amended GSP Appendix E), which is a proactive approach to identifying and working with management areas to address a single, isolated exceedance. If correction actions at a single minimum threshold exceedance are unsuccessful, a Management Area Exceedance may be triggered, which could trigger a Subbasin-wide undesirable result. The SWSD GSA with the KGA have developed sustainable management criteria, beyond that required by the SGMA to better address minimum threshold exceedances at a single representative monitoring well or at multiple sites.

All KGA Management Areas used a Well Impact Study to identify beneficial uses and users. SWSD GSA's Amended GSP Section 1 added a consistent description and list of users that actively rely on local groundwater resources and those that can be directly affected by groundwater management, impacts of operating at established measurable objectives, and impacts of exceeding minimum thresholds. SWSD GSA's Amended GSP also included an explanation of data and methodology used to conduct the Well Impact Study and summarizes findings.

Deficiency 2:
Comments specific to SWSD GSA:

The KGA GSP must explain the selection of groundwater level minimum thresholds for the Semitropic Water Storage District management area, including how they represent site-specific levels of depletion that could cause undesirable results and the relationship between this sustainability indicator and other sustainability indicators such as degradation of groundwater quality and subsidence, both of which can be exacerbated by lowering groundwater levels. If minimum thresholds were not set consistent with levels indicating a depletion of supply, the minimum thresholds should be revised accordingly.

The SWSD GSA developed additions descriptions and clarification to its Amended GSP to document the well impact analysis used for determination of impacts to beneficial users present in its three management areas for the lowering of groundwater levels. This analysis included the level of impacts at various levels of performance above the minimum threshold, including the measurable objective. SWSD GSA's Amended GSP includes a thorough analysis of water quality, additional descriptions are included to show the relationship between water quality and groundwater levels.

With regard to the SMC for Reduction of Groundwater Storage, SWSD GSA's Amended GSP provided additional descriptions to clarify the linkage.

While the linkage of groundwater levels to the SMC for subsidence is not as well defined, the SWSD GSA's Amended GSP now includes an expanded discussion, which is also consistent with the Subbasin wide approach to subsidence.

Reconcile Figure 3-1 and Table 3-1 to utilize the same well naming convention so that Department staff and other interested parties may correlate the two.

- The original Figure 3-1 has been updated and is now Figure 3-5 and the original Table 3-1 has been updated and is Table 3-2.

Verify how the subset of wells used in the well impact analysis is representative of wells in the management area. Provide an explanation of the mitigation plan for domestic wells.

- The SWSD GSA developed additional descriptions of the well impact analysis included in SWSD GSA's Amended GSP Section 3 to describe the wells used for the well impact analysis and their representation of the wells within the three SWSD GSA management areas.

- SWSD GSA's Amended GSP Section 5 now includes a Domestic Well Mitigation Program included as Management Action 4. A Tiered Pricing Structure, Management Action2 provides a complimentary funding program to implement the Domestic Well Mitigation Program for the appropriate mitigation of impacts to domestic wells.

All the GSPs must demonstrate the relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the GSA has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.

- The SWSD GSA expanded and provided greater clarification on the relationship between minimum thresholds for each sustainability indicator. Updated and revisions were made throughout the SWSD GSA's Amended GSP

Deficiency 3:

Coordinated sustainable management criteria or assessment of critical infrastructure, present a Subbasin- wide management approach for subsidence, clearly define undesirable results and appropriate MTs and MO's.

The SWSD GSA collaborated with GSAs in the Kern Subbasin to developed coordinated definitions for Subsidence Undesirable Results and Critical Infrastructure as follows:

Undesirable Results: The point at which the amount of inelastic subsidence, if caused by Subbasin groundwater extractions, creates a significant and unreasonable impact to surface land uses or Subbasin critical infrastructure.

Critical Infrastructure: The Subbasin has adopted two classifications for critical infrastructure:

Regional Critical Infrastructure is infrastructure located within the Subbasin that serves multiple areas of the Subbasin and whose loss of significant functionality due to inelastic subsidence, if caused by Subbasin groundwater extractions, would have significant impacts to beneficial users. The Subbasin has collectively determined that the only infrastructure that meets the definition for Regional Critical Infrastructure are the California Aqueduct and the Friant-Kern Canal.

Management Area Critical Infrastructure is infrastructure located within a particular Subbasin Management Area whose loss of significant functionality due to inelastic subsidence if caused by Subbasin groundwater extractions would have significant impacts to beneficial users within that Subbasin Management Area. Each Subbasin Management Area has identified their respective Management Area Critical Infrastructure in their Management Area Plan or individual GSP.

The Kern Subbasin GSPs at the time of the submittals on January 31, 2020, expressed that significant data gaps existed with regard to the differing causes of subsidence that may be unique to each of the five areas of interest identified in the Subbasin. This lack of representative data precluded setting meaningful data-based management objectives for subsidence until additional data was obtained. In the intervening 18 months since submittal of the 2020 GSPs, the Subbasin has made progress in acquiring the data necessary to set sustainable management objectives. This work includes among other things (some completed and other ongoing) two focused subsidence studies and retaining the Lawrence Berkeley National Laboratory (LBNL) to perform a baseline subsidence and Regional Critical Infrastructure status assessment of the Aqueduct and Friant- Kern Canal.

DWR requested that KGA develop interim subsidence Measurable Objectives for Regional Critical Infrastructure. The SWSD GSA collaborated with all GSAs in the Subbasin to establish interim measurable objective and Interim minimum thresholds for the Subbasin Regional Critical Infrastructure, defined as the portions of the Friant Kern Canal and the California Aqueduct within the Subbasin boundaries. The interim minimum thresholds and measurable objectives and the methodologies used to establish these are detailed the 2022 Amended KGA GSP and summarized below.

California Aqueduct

The interim measurable objectives and minimum thresholds for land subsidence for the California Aqueduct are defined as the avoidance of a permanent loss (associated with inelastic subsidence) of conveyance capacity as attributable to subsidence as limited by remaining concrete liner freeboard for a specific Aqueduct Pools. Both the measurable objective and minimum threshold rates of subsidence are calculated and assessed as an average annual rate over a rolling 6-year monitoring period.

Aqueduct Pool	Interim Measurable Objective Rate from 2022-2025 (ft/yr)	Interim Minimum Thresholds Rate from 2022-2025 (ft/yr)
Pool 23 to 32	-0.05	-0.1
Pool 33 to 35	-0.07	-0.15

Friant Kern Canal

The interim measurable objective and minimum thresholds for the entire Lower Reach of the Friant Kern Canal within the Kern Subbasin is defined based on a reported range of average annual rates of subsidence over the last 6 years. Based on information provided by the DWR's California Groundwater Live website, the annual rate of subsidence is presented as a range and measurable objective is set at the average of upper elevations of the subsidence ranges - 0.1 feet/year and the minimum threshold is set as the lower elevations of the subsidence range - 0.2 feet/year

7.5.9 Shafter-Wasco Irrigation District 7th Standard Annexation

The 7th Standard Annex management area, also referred to as Shafter-Wasco Irrigation District (SWID) MA-2, consisted of former "white lands" in the Kern County Subbasin that have been annexed into SWID.

1) Compliance with Sustainable Management Criteria

SMCs have been established for groundwater levels and water quality (arsenic). Groundwater levels are used as a proxy for depletion of groundwater in storage. No SMCs have been set for land subsidence in the 7th Standard Management Area. Seawater Intrusion and Interconnected Surface Waters are not applicable in the Kern Subbasin.

a) GSP Monitoring Activities

7th Standard Annex continues to implement the GSP Monitoring Network, which is comprised of three Representative Monitoring Wells (RMWs). Water level elevation data was measured and reported for both spring and fall requirements, with the exception of one well which was found to be dewatered in fall 2022. A nearby well was used as a proxy for groundwater elevations in the represented area. In addition to groundwater levels, the following monitoring activities are ongoing.

- Field level ET monitoring using Land IQ technology to increase the accuracy of ET and precipitation, and better understand consumptive use of irrigated crops.

b) Changes in GSP Monitoring Network

No changes were made to the monitoring network in Water Year 2022. However, RMW 31J was found to be dewatered during the fall measurement. This well will be replaced with a well that meets the depth requirements, in addition to being accessible and suitable for collecting representative water level measurements.

c) Progress in Achieving Interim Milestones

7th Standard Annex has achieved their goal of 10 percent reduction of the 17,000 AF of overdraft in the first five years of SGMA implementation. During WY 2022, a total of 1,804 AF, or 10.6 percent of the shortfall was reduced through:

- **Increased the recycled water supply** increased use of recycled water supply in 2021 (+186 AF) and 2022 (+52 AF) from North of the River Sanitation District which reduced groundwater use by 238 AF in WY 2022.

- **Land fallowing program** reduced demand in WY 2022 by 1,566 AF.

d) Compliance with Additional Sustainable Management Criteria

Groundwater levels have not declined below the Measurable Objective. No monitoring results are available for water quality or subsidence. At the time of this report, TRE Altamira available data did not cover the 7th Standard Annex management area for WY 2022.

2) Implementation of Projects and Management Actions

Implementation progress in 7th Standard Annex has largely focused on management actions. While projects have been evaluated, implementation is not feasible since there is not sufficient surface water supplies available. The Management Area will be reevaluating proposed projects and will provide an updated list in the 2025 updated plans. Progress towards managements actions include:

- **On-Farm Water Conservation and Participation in Irrigation Scheduling using Remote Sensing:** no progress to date.
- **Voluntary Rotational Land Fallowing Program:** implemented in WY 2021 and have increased use of the program to voluntarily fallow 499 acres in WY 2022. The associated demand reduction was 1,566 AF.
- **Education of Groundwater Use per Acre:** no activity in WY 2022.
- **Well Dewatering Mitigation Program:** domestic well mitigation plan was adopted in WY 2022. No claims have been made to date.
- **Mandatory Pumping Restrictions and/or Land Fallowing**: no progress in WY 2022.

3) Coordination with Stakeholders

The SWID MA-2 manager reported at SWID monthly Board meetings during 2022 and landowner meetings were held in person at the SWIDs office in Wasco on the second Wednesday of each month. Updates on KGA activities and implementation of projects and management actions were provided. Notices to landowners and stakeholders were posted on the SWID general website along with relevant materials and meeting dates.

4) Summary of Other GSP-related Special Studies or Activities

No special studies are being conducted exclusively in the SWID/7th Standard Annex Management Area. However, there is active participation in the Subbasin-wide basin study and subsidence study.

7.5.10 Southern San Joaquin Municipal Utility District GSA

1) Compliance with Sustainable Management Criteria

Southern San Joaquin Municipal Utility District (SSJMUD) established SMCs for groundwater levels. The objective in this Management Area is to maintain groundwater levels above the Measurable Objective (MO): all Water Year 2022 seasonal measurements complied with this criterion. Based on the data provided by SSJMUD and the cities of Delano and McFarland for the 2022 Annual SGMA Report, the plan area covered by the SSJMUD Management Area Plan is meeting the SMC established in the 2020 GSP.

a) GSP Monitoring Activities

SSJMUD continues to implement the GSP Monitoring Network in the district's Management Area. Seven irrigation and two municipal wells serve as RMWs. Water level elevation data was measured and reported for both spring and fall requirements. The district continues to implement the following monitoring activities to demonstrate compliance with SGMA SMCs.

- Estimate ET at the field level through a system of ground-based monitoring stations in conjunction with available satellite data.
- Measure surface water deliveries through each agricultural turnout, and all groundwater extractions at each of the district's production wells.
- Track subsidence monitoring and impacts to the Friant-Kern Canal, as it's identified as regional critical infrastructure.

b) Changes in GSP Monitoring Network

There have been no changes to the GSP monitoring network to report for WY 2022.

c) Progress in Achieving Interim Milestones

Hydrographs show water level have not fallen below the Measurable Objectives or Minimum Thresholds in WY 2022.

- Groundwater elevations are used as a proxy for both groundwater quality and land subsidence. By proxy, the Management Area complies with the interim milestones.

d) Compliance with Additional Sustainable Management Criteria

Groundwater elevations are used as a proxy for both groundwater quality and land subsidence. There are no interconnected surface waters in the Kern County Subbasin.

Water Quality

Water quality samples for constituents of concerns in the Management Area were collected within two weeks of water level measurements to clearly define impacts groundwater levels have on water quality. Out of the nine RMWs, four irrigation wells and two municipal wells have been collected for water quality. The water quality results were compared against water level measurements to determine if there are apparent trends. However, there are not as many water quality results for the irrigation wells as compared to municipal wells. When looking at the irrigation wells, it appears that water levels are slightly decreasing but the trend line is not significant. There is one irrigation well, Well 59, which shows an increase in water levels compared to others. Overall, there does not appear to be enough water quality data to determine any correlations with water levels for irrigation wells.

Water levels in municipal wells show a possible slight decreasing trend, but the trend line is not strong, especially for Delano Well 30. The municipal wells do show an increasing trend in salinity related constituents, such as conductivity, TDS, sulfate, sodium, and chloride. However, there doesn't appear to be a clear correlation between these water quality constituents and water levels. There does not appear to be a correlation between water level and water quality for TCP and nitrate. Monitoring will continue to determine any correlations between water quality and water levels.

Subsidence

SSJMUD monitors subsidence through CGPS station P810 and relies on InSAR data. During Water Year 2022, InSAR data indicates -0.4 to -0.2 feet of subsidence across the district, except the northern area where the lower end of the Tule Subbasin subsidence bowl extends into Kern, specifically into the SSJMUD Management Area. The Management Area continues to study the relationship between groundwater levels and inelastic subsidence.

2) Implementation of Projects and Management Actions

Progress towards implementing projects and management actions in the SSJMUD MA during WY 2022 is summarized as follows:

Management Actions

- **Implement the KGA MT Exceedance Action Plan:** Initiated in summer 2022. No specific implementation actions have been necessary since water levels are maintained above the MO.

- **Mitigation Program for Potential Impacts to Domestic Wells:** SSJMUD's Board of Directors approved a domestic well mitigation plan, which was included with their revised GSP in July 2022. A domestic well survey is being conducted in 2023 to identify the number of vulnerable wells in the Management Area.

- **In-District Allocation Structure/Refinement of Water Budget Components:** SSJMUD consistently evaluates consumptive water use throughout its Management Area. No water use allocations or water budgets have been assigned yet, but the district continues to gather background data to prepare for potential future allocations.

Projects

- **Giumarra Recharge Project:** In 2022, SSJMUD completed construction on the Giumarra recharge Basin, approximately 78 acres.
- **Regan Recharge Project:** In 2022, SSJMUD is almost completed with the final design for the Regan Spreading Grounds, approximately 75 acres.
- **New Recharge Project:** In 2022, SSJMUD continues the preliminary design and environmental permitting on several additional in-district recharge projects.
- **Intertie Project:** The SSJMUD/NKWSD intertie project is continuing with the final design and environmental permitting. The project is estimated to be completed in 2025.

3) Coordination with Stakeholders

SGMA related topics are discussed at each of the district's monthly Board of Directors meetings. Topics include information on Subbasin-wide activities, progress on management actions, and results of seasonal water level measurements and compliance with the established SMCs. Additional coordination includes:

- Meetings with the Cities of Delano and McFarland regarding water supplies and new water users.
- Coordination meetings with neighboring water districts.
- Special board meeting in July 2022 to adopt the revised Management Area Plan.

4) Summary of Other GSP-related Special Studies or Activities

No special studies are being conducted exclusively in the SSJMUD Management Area. However, SSJMUD is actively participating in the Subbasin-wide Basin Study and subsidence studies on the Friant-Kern Canal.

7.5.11 West Kern Water District GSA

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the West Kern Water District (WKWD) Management Area during WY 2022 is summarized as follows:

a) GSP Monitoring Activities

Monitoring frequency for groundwater levels is coordinated Subbasin-wide through the KGA GSP (Umbrella GSP). The Umbrella GSP requires Chapter GSPs to report monitoring twice per year: once between January 15 through March 30 and another between September 15 through November 15. During normal operations, WKWD samples monitoring and production wells on a monthly schedule and has used data collected on this schedule to meet reporting requirements of the Umbrella GSP. WKWD has monitored and will continue to monitor on this schedule to comply with the Umbrella GSP and to provide additional data for GSA planning and monitoring purposes.

The WKWD GSA's groundwater representative monitoring network includes WKWD monitoring wells in its North and South well fields (North Project Management Area and South Project Management Area respectively). In addition, WKWD GSA monitors wells in the Little Santa Maria Valley (LSMV) for purposes described later in this report. The Western Management Area does not have groundwater use and is not monitored by WKWD. The Lake Management Area, more specifically, the Buena Vista Aquatic Recreation Area (BVARA), was identified in the WKWD GSP as a data gap for groundwater level monitoring. BVARA is owned and maintained by Kern County and efforts to coordinate and increase monitoring and data collection at BVARA are underway, as discussed in further detail below.

b) Changes in GSP Monitoring Network

There were no changes to the WKWDs monitoring network during WY 2022.

c) Progress in Achieving Interim Milestones

Groundwater levels for the representative monitoring network are collected during two periods as designated by Subbasin-wide coordination; Fall measurements between September 15 through November 15, and Spring Measurements from January 15 through March 30. Of the 23 representative monitoring network wells, 5 wells are above their MO, 17 well are in the margin of operational flexibility (MoOF) above their minimum thresholds, and one has exceeded its minimum threshold. Of the 17 well in the MoOF, three of those wells did exceed their MT for a short period during the fall of 2022 but have since recovered and no longer exceed the MT. According to the WKWD Chapter GSP Section 5.4 Chronic Lowering of Groundwater Levels, "an undesirable result would occur when the minimum threshold for groundwater levels is exceeded in at least three adjacent management areas that represent at least 15 percent of the Subbasin, or that represent greater than 30 percent of the Subbasin." Current conditions in the representative wells do not indicate or trigger an undesirable result for Chronic Lowering of Groundwater Levels as currently defined. A review of available data suggests that prolonged recovery, due to extended drought conditions, in adjacent groundwater banking projects may be contributing to deeper than anticipated readings. These readings are currently being investigated by WKWD and the WKWD GSA, in coordination with adjacent entities, and any changes or additional flag or notes will be attached the appropriate measurements and reflected in the DMS and future Annual Reports.

d) Compliance with Additional Sustainable Management Criteria

The following subsections provide brief updates and compliance status of the remaining sustainable management criteria.

Groundwater Storage: Groundwater levels are used as a proxy for determining changes in groundwater storage. Therefore, the WKWD GSA has used data collected from its groundwater level monitoring network to monitor changes in storage.

Analysis is conducted on groundwater level data and groundwater levels over the previous year have generally decreased, suggesting a decrease in groundwater storage compared to the previous year's Annual Report. According to the WKWD Chapter GSP Section 5.5 Chronic Lowering of Groundwater Levels, "An undesirable result would occur when the volume of storage (i.e., above the groundwater level minimum thresholds) was depleted to an elevation lower than the groundwater level minimum threshold in at least three adjacent management areas that represent at least 15 percent of the Subbasin or represent greater than 30 percent of the Subbasin (as measured by the acreage of each management area)." Recent groundwater levels for 22 of the 23 representative groundwater monitoring wells were reported above the calculated minimum thresholds, meaning the WKWD GSA is still operating within the identified margin of operational flexibility and an undesirable result, as defined, has not been triggered. Further information regarding modeled storage for the Kern Subbasin is included in the KGA Umbrella GSP Annual Report.

Seawater Intrusion: The GSA area is geographically and geologically isolated from the Pacific Ocean, and any other large source of saline water. As a result, the Kern Subbasin is not at risk for seawater intrusion.

Degraded Groundwater Quality: As discussed in detail in the WKWD Chapter GSP Section 3.5, groundwater quality was relatively consistent throughout the measurement period of 1993-2015, including during the drought period and historically low groundwater levels of 2015. This suggests groundwater quality in the Kern Subbasin within the WKWD GSA does not degrade significantly with changes in groundwater elevations. Therefore, it is reasonable that groundwater levels be used as a proxy for the management of degraded groundwater quality in the WKWD GSA area. Groundwater quality in the WKWD GSA is monitored as required for a community water system by state and local regulations.

Land Subsidence: Currently there are no subsidence monitoring stations in the WKWD GSA area. There is one extensometer one mile north of the North Project Management Areas that is monitored by DWR. InSAR spatial imagery provided by NASA's Jet Propulsion Laboratory is available for the majority of the

Kern Subbasin. The combination of extensometer and InSAR spatial imagery provide data about potential land subsidence in the GSA area.

Land subsidence monitoring was identified as a data gap in the Kern County Subbasin Umbrella GSP and any additional data gathering efforts will be a coordinated effort between all member GSAs. WKWD GSA will continue to participate and coordinate with the KGA, as further described in the Management Actions section below.

Depletions of Interconnected Surface Waters: There is little surface water in the WKWD GSA area. All streams are ephemeral and there are currently no surface stream or river gages in the GSA area. The Kern River flows through a small part of the GSA area only during rare high flow events. The Kern River is also considered fully appropriated.

Due to these natural and legal characteristics, surface water monitoring is not conducted in the GSA area.

2) Implementation of Projects and Management Actions

Several projects and management actions were identified in the WKWD Chapter GSP that will help achieve sustainability goals for the portion of the Kern Subbasin that lies within the WKWD GSA's boundaries. The following subsection briefly describes projects and their implementation status as well as the status of management actions.

Automatic Meter Reading (AMR) Project: WKWD began installing AMR systems for all industrial and outlying customers in 2015. The annual AMR conversion rate is shown below:

- 2015 233 AMR system installations
- 2016 231 AMR system installations
- 2017 161 AMR system installations
- 2018 641 AMR system installations
- 2019 839 AMR system installations
- 2020 434 AMR system installations
- 2021 274 AMR system installations
- 2022 3,401 AMR system installations

From 2015 through 2022, WKWD has installed 6,214 AMR systems on residential and industrial service connections, which represents about 93 percent of WKWD's customers.

To further achieve sustainability goals, WKWD plans to install AMR systems on the remainder of its primarily residential customer meters. This project was initiated prior to the development of the Chapter GSP but directly supports the groundwater management goals of the WKWD GSA and was incorporated into the implementation plan. To off-set costs associated with this project, WKWD submitted a $1.1 million WaterSMART Water and Energy Efficiency Grant application to the Bureau of Reclamation in September 2020; unfortunately, the project was not selected for funding. West Kern will continue to pursue other funding sources as the project progresses.

Participation in Delta Conveyance Facility: The Delta Conveyance Facility (DCF) is intended to address the challenges of pumping water from the Delta by diverting water upstream of the current diversion points and conveying it to existing pump stations for the SWP and the Central Valley Project (CVP). Under current operation, the SWP and CVP are unable to consistently deliver State and federal water contractors their full contract supplies. The Delta Conveyance Facility is intended to address some of the conditions that impact the ability to export water from the Delta.

WKWD will participate in the DCF to increase water supply reliability for its customers. While the exact increase in water supply from the DCF remains uncertain until final design, approvals, and agreements are in place, WKWD anticipates that any water supply benefits from the projects would be allocated in proportion to its level of participation.

The timing and circumstance of implementation of this project is beyond the control of the GSA, because the DCF would be implemented by the State. The U.S. Army Corps of Engineers (USACE) issued a Notice of Intent in August 2020 for the development of an Environmental Impact Report (EIR) and a preliminary cost assessment has been prepared by the Delta Conveyance Design and Construction Authority. In October 2020, the WKWD Board agreed to fund its portion of the planning and environmental review cost for the DCF. The draft EIR for the DFC was released for public review on July 27, 2022. The comment period ended December 16, 2022. The USACE and DWR anticipates response to comments will be released by mid- 2023.

Buena Vista Aquatic Recreation Area (BVARA) Water Supply Management Coordination: The BVARA boundary is in and adjacent to the WKWD GSA area. The 1,585-acre BVARA is home to two manmade lakes, Lake Webb and Lake Evans, boating facilities, playgrounds and volleyball courts, camp sites, and picnic areas. The lakes lie outside of the GSA area but the park facilities such as picnic areas, restrooms, and parking areas are within the GSA area.

Kern County has a contractual obligation to replenish the lake losses and maintain a "minimum pool" elevation to support BVWSD deliveries to its Maples Service area. With only minor diversions for agricultural use, most water from the lakes evaporates with little percolating into the groundwater basin. Kern County pumps groundwater from wells located within the GSA area to supplement losses at the lakes. Supplemental water delivered to the lakes is included in Subbasin's water balance. In 2020, WKWD GSA began measuring depth to water in wells at BVARA. Efforts are currently underway to obtain elevation control for the reference points from Kern County.

Due to uncertainty regarding BVARA water demands and groundwater conditions near the extraction wells at BVARA, this project requires ongoing coordination between the GSA and Kern County to understand BVARA's water management needs and related impacts to the GSA area and Subbasin. WKWD GSA has begun coordination with local stakeholders adjacent to BVARA including Henry Miller WD, Buena Vista WD, KGA, Kern Water Bank Authority, and Kern County to develop an approach for improved management of this area of the Subbasin. Coordination efforts between the WKWD GSA, Kern County, and surrounding local stakeholders will continue into 2022.

Continued Balanced Pumping and Recharge Management Action: Continued balanced pumping and recharge of imported supplies has and will continue to be the operational standard for WKWD. Under this management action, recharge and recovery activity has and will continue to be monitored closely by WKWD to maintain balanced conditions.

Implement Water Shortage Response Plan (WSRP) Management Action: An updated WSRP is incorporated into the WKWD Urban Water Management Plan (UWMP) 2020 Update. The WSRP establishes six levels of response actions to be implemented in times of shortage (Response Level 1 through Response Level 6), with increasing restrictions on water use in response to worsening drought conditions and decreasing available supplies. The policy establishes progressive response levels including regulations to be implemented during times of declared water shortages in order to attain escalating conservation goals. At this time, WKWD has implemented Response Level 1 in response to the Governor's Drought Emergency Order.

Continued Participation in Basin-Wide Coordination Management Action: The WKWD GSA is one of eleven GSAs in the Kern Subbasin. Coordination among these GSAs is necessary for sustainable management of the Subbasin as a whole and has been ongoing during development of the Chapter GSPs. Coordination during GSP development has included regular in-person meetings and calls to discuss sustainability thresholds, potential projects and management actions, plus specific issues and concerns. This management action involves attending KGA manager meetings and coordination meetings which are held monthly, and KGA stakeholder meetings which are held as needed. These meetings, and participation in them, will continue into 2023.

File for Basin Boundary Modification for LSMV Management Action: Basin boundaries define the geographic area included in each groundwater basin. Under SGMA, a process was provided for local agencies to request that DWR revise the boundaries of groundwater basins or subbasins to assist with local governance and control. Requests for modifications can be submitted for either scientific or jurisdictional reasons. Scientific modifications are based on geologic or hydrologic conditions while jurisdictional modifications change boundaries to promote sustainable groundwater management. WKWD GSA will coordinate with local LSMV stakeholders, KGA staff and DWR to determine whether pursuing a basin boundary modification request in 2023 is warranted.

Continued Monitoring and Sustainable Management of LSMV as Part of WKWD Chapter GSP Management Action: As discussed above, water elevation is currently being recorded bi-annually for 20 monitoring wells within the LSMV. This data is reported to the WKWD GSA and will be provided in annual reports for informational purposes.

3) Coordination with Stakeholders

WKWD conducts monthly board meetings where GSP and SGMA related information and updates are provided. These meetings are open to the public and have publicly posted agendas and meeting minutes (https://www.wkwd.org/menus/board-meeting-agendas.html).

4) Summary of Other GSP-related Special Studies or Activities

WKWD GSA continues to coordinate on basin-wide issues related to subsidence, consumptive use (ET) and better understanding the hydrogeologic complexities of the Kern Subbasin.

7.5.12 Westside District Water Authority GSA

In WY 2022, the WDWA GSA began the process to become a Groundwater Sustainability Agency (GSA). The 2023 Annual report will update the status of this application.

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Westside District Water Authority (WDWA) Management Area during WY 2022 is summarized as follows:

a) GSP Monitoring Activities

Groundwater use in the WDWA GSA is primarily limited to blending with State Water Project (SWP) surface water (i.e., Aqueduct water). State surface water is the principal water supply for agriculture in the WDWA GSA. This is because groundwater quality in the WDWA is naturally degraded due to the unique local geology which consists primarily of marine sediments rich in various mineral salts. As a result, wells for SGMA-related groundwater pumping are not numerous. WDWA GSA staff has been actively conducting the collection and analysis of groundwater monitoring and testing data pursuant to the WDWA GSA Chapter Groundwater Sustainability Plan (GSP) Monitoring Network Plan (MNP). As the MNP indicates, there has been a deficiency in groundwater data in the WDWA GSA, due to a lack of representative wells. This is a data gap that the WDWA GSA seeks to fill with identification of existing wells that may be included in the monitoring network, and the installation of purpose-built monitoring wells, provided State grant money is acquired. The KGA will submit a grant application that includes several new monitor wells in the WDWA GSA.

To facilitate the MNP sampling schedule and ensure representative data, WDWA GSA staff has identified the need for additional existing wells for monitoring. In support of this activity, staff is assessing access agreements, and preparing to ground-truth proposed additional monitoring locations to confirm existing well construction details, well casing access and overall well condition. Wells determined to be deficient for the purpose of the MNP will be replaced with the next closest well that meets MNP criteria for representativeness and well condition. Any replacement well location will be detailed in the future Annual Reports along with the technical rationale for the change.

b) Changes in GSP Monitoring Network

The original WDWA GSA monitoring well network included some wells that have since been destroyed, shut down or were found to be not representative of groundwater conditions. As discussed above, the WDWA GSA is working with landowners to find suitable replacement wells.

One well in Northern Lost Hills will be replaced with an adjacent well about 2 miles west, because depth can be monitored electronically, and will provide reliable data for years to come. In southern Belridge, one well was removed because the water quality is so poor that the wells are only used for blending, when surface water supplies are scarce., It was difficult to get a reliable water level measurement from this well due to well construction characteristics. WDWA GSA has submitted additional locations for inclusion in a pending grant application being submitted to the DWR (part of the KGA application). If the grant application is successful, two nested sets (deep and shallow) monitoring wells will be drilled and installed in each member district of the WDWA GSA (total of six nested pairs).

Another well 7106-63, appeared to have a minimum threshold exceedance in WY 2022 based on incomplete data. The MO/MTs for that well (A3-111 herein) were re-set after review by the KGA Board. The rationale for requesting the revision of the MO/MTs for well 7106-63 was that the earlier data was determined to be not representative of SGMA-related beneficial use. The original MTs and MOs for well 7106-63 were based on preliminary CV2Sim model results (i.e., a model simulation). The WDWA GSA now has more accurate groundwater data for well 7106-63 based on measured data and not model simulations. The revised MT for well 7106-63 was reset in early 2023 at 0 feet above mean sea level (MSL) and the MO at 40 feet above MSL.

c) Progress in Achieving Interim Milestones

In addition, the MNP identifies several sentry wells that will be monitored annually in spring and winter for groundwater quality and levels. The purpose of these wells is to fill the data gaps concerning water level and water quality that exist in the WDWA GSA due to the naturally poor groundwater quality. To better align with landowners' operations, groundwater quality sampling going forward will take place shortly before the wells turn on each year in early Spring, and just before they are turned off in late Fall. This will provide the best information regarding the effects of groundwater pumping on water level and water quality. The groundwater quality data is being collected and maintained in the integrated KGA Data Management System (DMS) where it is available to WDWA GSA stakeholders and others. The data will also be presented in the 5-year (i.e., 2025) GSP update.

d) Compliance with Additional Sustainable Management Criteria

The WDWA GSA, as a member of the KGA, participated in the preparation of a whitepaper pertaining to subsidence management criteria for the California Aqueduct. The subject whitepaper was discussed with and submitted to the California Aqueduct Subsidence Project (CASP). Data reviewed included, but was not limited to, INSAR and subsidence studies conducted by the Kern County Subbasin, including a study by the Lawrence Berkley National Laboratory, information provided to the Central Valley Regional Water Quality Control Board (CVRWQCB) by oil operators on the westside, and information in the DWR 2019 Aqueduct Report Based on this information, it was found that the cause of subsidence is complex, and cannot be attributed solely to agriculture pumping, especially between Aqueduct mileposts 195-215. The whitepaper summarized existing knowledge about potential subsidence on the Aqueduct in the westside and proposed an interim monitoring approach for subsidence that would be placed by more definitive MOs/ MTs in 2025 after additional data was collected in consultation with DWR, Lawrence Berkeley National Laboratory and the USGS. Additional studies are now underway.

2) Implementation of Projects and Management Actions

As noted above the WDWA GSA has been actively engaged in assessing and moving forward with the three Management Actions described in its Chapter GSP.

Management Action (MA) #1

Historically, because of the brackish and naturally degraded quality of groundwater in the WDWA GSA, growers have relied almost exclusively on surface water from the Aqueduct for their irrigation needs. Groundwater is used primarily for blending when annual Aqueduct deliveries are less than expected. As a result, there is currently little representative hydrogeologic data in the WDWA GSA. This lack of data represents a significant data gap that must be addressed in order to refine the current understanding of the WDWA GSA Hydrologic Conceptual Model (HCM), including key elements such as native yield/sustainable yield, groundwater elevations, pumping, and changes to groundwater in storage as well as the overall water budget. This important data gap will be filled by implementation of the MNP. The MNP, once fully implemented, will help achieve the following objectives:

- Acquisition of additional representative groundwater elevation data sufficient to assess and document short-term, seasonal, and long-term groundwater trends related to the WDWA GSA, native yield/sustainable yield, proposed sentry MTs/MOs, water budgets, groundwater pumping volumes, groundwater in storage, groundwater elevation, and potential future land subsidence.

- Ability to assess for changes in groundwater storage and conditions relative to identified MOs and MTs; and

- Coordination with adjacent management areas by way of scheduled sampling events, mutually sustainable MTs and MOs, and regularly scheduled status meetings to ensure sustainable outcomes.

MA No.1 was implemented beginning with implementation of the GSP and subsequent acceptance of the MNP. It will directly support WDWA GSA MT/MOs by providing foundational data to monitor and manage adaptive management projects that are designed and implemented to ameliorate the potential for significant reduction of groundwater elevations and groundwater in storage.

Management Action #2

Water resource coordination is a well-established and successful practice of water resource management in the WDWA GSA. Because of the unique and near ubiquitous poor groundwater quality, due to Westside geology, the WDWA GSA meets current demand almost exclusively through surface water from the California Aqueduct. Not all surface water is Table A from the State Water Project. The WDWA GSA and its landowners work cooperatively to facilitate inter- and intra- WDWA GSA supplemental water purchases and trades. In addition, individual landowners work amongst themselves to determine arrangements for supplemental water. These ongoing practices have been assimilated into the Chapter GSP and will be expanded as part of GSP implementation to include cooperation with adjacent Groundwater Management Areas, regarding groundwater quality, supply and elevation data through regular meetings, and the exchange of pertinent groundwater monitoring data, irrigation technology developments and supplemental water demand/supply information. For example, the WDWA GSA and its landowners assess forward looking Dry Year Transfer Programs and work to coordinate MNP groundwater monitoring activities to ensure representative data. Resource coordination meetings and milestones will be described in the upcoming 5-year SGMA Update Report.

Management Action #3

The WDWA GSA has conducted a feasibility study for an innovative water reuse project on the westside that could potentially produce over 10,000 AFY of new water from brackish groundwater and nonconventional resources that are currently not utilized. Preliminary information shows a front-end engineering and design (FEED) report is necessary to further refine project costs. Further assessment is currently underway.

3) Coordination with Stakeholders

The WDWA GSA holds regularly scheduled Board meetings on the first Wednesday of each month at 11 AM that are open and accessible to stakeholders and other interested parties. Board meeting agendas are posted on WDWA GSA's public website (www.westsidedwa.org). Board meetings are accessible remotely by ZOOM for the convenience of stakeholders and the community.

4) Summary of Other GSP-related Special Studies or Activities

WDWA GSA continues to lead and participate in the coordinated Subbasin-wide GSP implementation activities such as analysis of subsidence and development of related science-based MOs/MTs along the California Aqueduct in the westside of Kern County.

7.6 Kern River GSA

1) Compliance with Sustainable Management Criteria

Since the submittal of the original 2020 GSP, the KRGSA has faced a multi-year drought, with the last three consecutive water years characterized as dry or critically dry. Challenges during these drought conditions include scarce surface water supplies, increased ET and irrigation pumping from excessively hot and dry conditions, and the need to increase recovery pumping of banked water as a critical water supply. These conditions led to declining water levels over much of the KRGSA and the Kern County Subbasin.

However, the challenges have also provided an opportunity for the KRGSA to test sustainable management criteria and to learn how best to adjust groundwater management to control local water level declines across the KRGSA Plan Area. Monitoring activities, compliance with sustainable management criteria, and implementation of GSP projects and management actions during this critically dry reporting period are discussed in the following sections.

a) GSP Monitoring Activities

The current KRGSA GSP monitoring network consists of 38 representative monitoring wells (RMWs) distributed across three Management Areas (MAs). These MAs are based on primary land uses and include the Urban MA (approximately 93,350 acres in the northern KRGSA), the Banking MA (approximately 5,045 acres in the western KRGSA), and the Agricultural MA (approximately 134,100 acres in the southern KRGSA). During the reporting period, all 38 RMWs were monitored for groundwater elevations and compared to the MTs for the applicable sustainability indicators. RMWs in the KRGSA are shown on **Figure 5**; the KRGSA monitoring program is summarized below for reference.

<u>Chronic Lowering of Water Levels and Reduction of Groundwater in Storage</u>: All 38 RMWs are used for these two sustainability indicators (see KRGSA Hydrographs in **Appendix A**). Groundwater elevation monitoring was conducted in accordance with the monitoring protocols as provided in the Amended KRGSA GSP and coordinated with other GSAs in the Subbasin.

<u>Water Quality</u>: Water levels in the RMWs are used as a proxy for the Water Quality sustainability indicator to allow for tracking of water quality impacts that could potentially be related to GSA management of groundwater levels based on correlations of groundwater levels and arsenic, the primary constituent of concern as explained in the GSP.

<u>Land Subsidence</u>: Water levels are also used as a proxy for the Land Subsidence sustainability indicator, especially in specified wells in the southern Agricultural MA where historical subsidence has been documented. These groundwater levels are supplemented with InSAR data, which is published annually by DWR and applied as a screening tool for the entire KRGSA. In addition, average InSAR data in 13 square-mile cells are analyzed and reported to the Board annually for tracking of land subsidence rates, including both inside and outside areas of historical subsidence. The KRGSA is also participating in

regional subsidence investigation and monitoring activities in the Subbasin coordinated among all Kern County Subbasin GSAs (see Amended Kern Subbasin Coordination Agreement).

Interconnected surface water and seawater intrusion are not applicable to conditions in the KRGSA, and no monitoring networks are required.

b) Changes in GSP Monitoring Network

No changes to the GSP monitoring network occurred in WY 2022. However, well integrity problems occurred in two wells in WY 2022 that subsequently led to recent changes in the network (in early WY 2023). Because these changes have already been reviewed by the Subbasin Coordination Committee and approved by the KRGSA Board of Directors in February 2023, they are documented below for completeness.

One monitoring well in the Banking MA - RMW-028 - was reported to have a possible casing obstruction in last year's Annual Report for WY 2021. Although the well was monitored in WY 2022, it was subsequently destroyed during land development activities and has been removed from the program. A nearby RMW in the relatively small KRGSA Banking MA (RMW-029) exhibits nearly identical trends and fluctuations as previously measured in the now-destroyed well and is located in the same area of the Banking MA. These data demonstrate that RMW-029 is capable of monitoring groundwater elevations in this area without a new replacement well.

One monitoring well in the Urban MA – RMW-019 – was found to have casing integrity issues that made water level measurements unreliable. A suitable nearby replacement well was selected for additional analysis. Historical water level data dating back to 2015 provided sufficient information for selection of sustainable management criteria. Designated as RMW-019R (for replacement well), this well has been added to the monitoring network to replace RMW-019 and is currently being monitored monthly to match the frequency of other selected wells in the Urban MA.

KRGSA continues to have monitoring challenges with some RMWs that are also active pumping wells. Access is difficult when wells are active and inaccurate measurements of static water levels can occur when wells haven't recovered sufficiently when measured. To partially mitigate these limitations, GSA managers have communicated directly with well owners to coordinate the monitoring schedule with pumping schedules, improving the reliability of monitoring data from some of these RMWs. Other mitigation actions by KRGSA managers are also mentioned in *item 1) d)* below.

c) Progress in Achieving Interim Milestones

KRGSA managers recognized the need for operational flexibility to manage water levels in or adjacent to active production wells while improvements to the monitoring network could be considered. Interim milestones (IMs) were selected in equal 5-year increments to achieve MOs over time. The 5 year interim milestone is designated at 25 percent of the distance from the MT to the MO for each RMW. During WY 2022, more than one-half (about 22 of 38 wells) of the RMWs have groundwater elevations that are already being managed at or above the initial 5-year IM, even during this extended dry period.

d) Compliance with Additional Sustainable Management Criteria

Chronic lowering of Groundwater Levels: As a result of the persistent drought conditions and the second consecutive critically dry water year, water levels generally declined throughout the KRGSA. During the reporting period of WY 2022, eleven RMWs fell below their respective MTs for at least one of the monitoring events (i.e., about 29 percent of the total KRGSA RMWs). Seven of these wells were in the Urban MA and four were in the Agricultural MA. The locations of these KRGSA wells are highlighted in orange on **Figure 5**.

Two wells in the Urban MA (RMW-025 and RMW-032) were below MTs during four consecutive monthly sampling events, resulting in a MA Exceedance. As a result of these exceedances, the GSA managers took steps to determine if local adverse impacts were occurring and to evaluate management actions that could raise local water levels. Since that time, water levels have risen in both wells and are already above the MT in RMW-032. The Urban MA Exceedance, which represents about five percent of the Subbasin, was the only MA Exceedance during WY 2022 and did not trigger undesirable results for the Subbasin as defined in the Amended KRGSA GSP and the Amended Kern Subbasin Coordination Agreement.

A summary of all wells with MT exceedances in the KRGSA during WY 2022 is provided below. The page number for each RMW hydrograph is also referenced (see **Appendix A4** for each hydrograph; all hydrograph locations are highlighted in orange on **Figure 5**). The wells are organized by KRGSA MA, beginning with the northern Urban MA wells followed by the southern Agricultural MA wells. This north-to-south organization facilitates the process of locating these highlighted wells (in orange) on **Figure 5**, which also includes the remaining Subbasin network wells.

KRGSA Urban MA

- **RMW-017** – active production well in the **Urban MA**, labeled **A4-1** on **Figure 5**; hydrograph on p. **A4-1**. This well is in the far northwestern corner of the KRGSA, near active agricultural wells both in the KRGSA and in adjacent MAs. Water levels dipped below the MT in Fall 2021, likely due to local pumping. The well was inaccessible due to its active pumping status in early Spring 2022 (nearby well was used as surrogate data as required by the monitoring protocols). Water levels recovered above the MT by early summer in WY 2022. KRGSA managers have worked with the well owner to access the well between pumping schedules, although it has been difficult to determine how long the pump has been off and how long water levels have had to recover. KRGSA has recently increased monitoring frequency for this well to better track local water levels in this area.

- **RMW-025** - inactive well in the **Urban MA**, labeled **A4-6** on **Figure 5**; hydrograph on p. **A4-6**. The well is located along the western Kern River, adjacent to the Banking MA. Historical water level measurements show this well is influenced by recharge and recovery activities on nearby Kern Fan banking projects. During WY 2022, water levels declined in response to decreased recharge along the Kern River and local recovery operations from nearby groundwater banks. Water levels fell below the MT in May 2022 and continued to decline through the Summer, creating the Urban MA Exceedance. Recent water levels in WY 2023 have recovered close to the MT and are expected to rise above the MT with increasing recharge along the river (in progress).

- **RMW-032** - inactive well in the **Urban MA**, labeled **A4-12** on **Figure 5**; hydrograph on p. **A4-12**. **T**he well is located in the southwestern portion of the Urban MA near local pumping from agricultural wells. Water levels fell below the MT in June 2022 and remained low for several consecutive months, triggering the Urban MA Exceedance. Water levels began to recover in August 2022. Recent water level measurements show groundwater levels have risen above the MT in WY 2023.

- **RMW-211** – inactive well in the **Urban MA**, labeled **A4-34** on **Figure 5**; hydrograph on p. **A4-34**. This well is the in the north-central KRGSA (central Urban MA), southeast of the Kern River, within about 750 feet of two active municipal production wells (Cal Water). Although both semi-annual monitoring events for Fall 2021 and Spring 2022 were above the MT, water levels declined below the MT in Summer 2022. Recent water levels have risen within a few feet of the MT. KRGSA intends to coordinate with Cal Water in the future to redistribute local pumping, when possible, to support local water levels.

- **RMW-213** – inactive well in the **Urban MA**, labeled **A4-30** on **Figure 5**; hydrograph on p. **A4-30**. This well is in the north-central KRGSA (central Urban MA), south of the Kern River (southwest of RMW-211 – see above). This well, like many of the RMWs in the Urban MA, is surrounded by active municipal production wells. Although water levels were above the MT for the semi-annual events in Fall 2021 and Spring 2022, water levels fell below the MT in Summer-Fall 2022. As with the other urban RMWs in this area, increases in summer municipal pumping have led to local declines in this area.

- **RMW-214** – inactive well in the **Urban MA**, labeled **A4-31** on **Figure 5**; hydrograph on p. **A4-31**. This well is in the south-central Urban MA, south of RMW-211 and southeast of RMW-213 (see wells above) and within about one-half mile of multiple active municipal wells. As with other wells in this area, water levels were above the MT during the semi-annual Spring 2022 monitoring event but monthly measurements indicate subsequent declines below the MT with local increases in Summer and Fall pumping in WY 2022.

- **RMW-026** – active production well in the **Urban MA**, labeled **A4-7** on **Figure 5**; hydrograph on p. **A4-7**. This well is in the northeastern KRGSA and has been difficult to schedule monitoring when the well was not pumping. KRGSA managers have worked with the well owner to access the well between pumping schedules, although it has been difficult to determine how long the pump has been off and how long water levels have had to recover. As indicated on the hydrograph, large fluctuations since 2014 indicate more active pumping in this well than in previous years. The KRGSA has recently worked to improve communication with the well owner, and future monitoring is expected to be better-timed between pumping schedules. Although water levels declined below the MT in early 2022, recent water levels have risen above the MT.

KRGSA Agricultural MA

- **RMW-030** - inactive irrigation well in the northeast **Agricultural MA**, labeled **A4-10** on **Figure 5**; hydrograph on p. **A4-10**. This well is within about 1,000 feet of an active irrigation well and in an area with limited surface water sources. Since 2018, groundwater levels have been fluctuating within about four to eight feet above and below the MT. As a result of the last two years of critically dry conditions, water levels have dropped below the MTs. KRGSA has recently been running additional water down the unlined Eastside Canal (about one mile east of RMW-30) to increase local recharge and support future water levels in this area.

- **RMW-034** - active production well in eastern **Agricultural MA**, labeled **A4-13** on **Figure 5**; hydrograph on p. **A4-13**. This active production well is often pumping when field visits are made. Large spikes in water level fluctuations indicate impacts from pumping water levels. As indicated on the hydrograph, local water levels have declined in this area over the last two critically dry years and the Spring 2022 water levels fell nine feet below the MT. This well, along with RMW-217 is near a small water system consolidation project being led by Lamont PUD, which will provide both water level and water quality protection of drinking water supplies in this area, especially for a nearby domestic well owned by El Adobe POA.

- **RMW-217** - active production well in the eastern **Agricultural MA**, labeled **A4-36** on **Figure 5**; hydrograph on p. **A4-36**. The well is located east of RMW-034 (see above) on the eastern edge of the KRGSA near local pumping from both agricultural and small water systems wells. Water levels have steadily declined from 2012 through 2020 and were below the MT prior to GSP adoption. However, recent measurements indicate some improvement of water levels in the area. In addition, as mentioned above, a nearby small water system consolidation project by Lamont PUD is underway in this area to provide drinking water supplies to a private small water system – El Adobe POA.

- **RMW-218** - active production well in the southern **Agricultural MA**, labeled **A4-32** on **Figure 5**; hydrograph on p. **A4-32**. The large fluctuations in this well since 2017 may indicate that groundwater elevations are being influenced by RMW pumping and are not likely representative of static water levels. Fall 2021 and Spring 2022 measurements have fallen below the MT, but other nearby wells do not mirror the magnitude of these water level declines and are above their respective MTs (e.g., see RMW-040, p. **A4-17**).

MA Exceedance and Potential Impacts

The **Urban MA Exceedance** – triggered by four consecutive monthly MT exceedances in RMW-025 and RMW-032 – was assessed to determine if adverse impacts were observed during the time of the MT exceedances. These MTs and the MA Exceedance triggers were selected to protect against both physical impacts to wells in the large municipal wellfields serving Metropolitan Bakersfield, and also to protect against water quality degradation, especially with arsenic concentrations that had been correlated to low water levels. Although assessment activities are continuing, municipal well owners indicated that there have been no significant impacts to municipal wells or water quality related to these water level declines.

However, there has been one dry well reported to KRGSA managers in the Urban MA during the reporting period. That dry well, owned by De Rancho Investors, LLC, was not reported on the DWR domestic well tracking website; rather the well owner worked directly with KRGSA managers. That well served a mobile home community located adjacent to the Cal Water service area; Cal Water is providing a hook up to its municipal system to resolve this issue.

In the **KRGSA Agricultural MA**, two domestic well failures were reported to the DWR Dry Well website in WY 2022 (#19323 and #20585); both of which were located in the central Agricultural MA south and southwest of Greenfield CWD GSA. Although it is difficult to match the available well completion reports to the reported well information online, it appears that both wells were drilled about 60 years ago (1962 and 1963). Wells drilled in this area since the 1980s are generally deeper than the reported total depths of 158 feet and 185 feet for the two dry domestic wells.

Although local water level declines in WY 2022 have since recovered – and are expected to continue to rise with ongoing recharge activities – KRGSA managers will continue to work with local well owners to manage both water levels and water quality, including local recharge and potential redistribution of pumping patterns, where practical. These management activities are summarized below.

Additional GSA Management Activities to Address MT Exceedances: Given the local MT exceedances in the eastern KRGSA (both Urban and Agricultural MAs), the KRGSA managers have been taking proactive steps to determine the issues associated with the MT exceedances and mitigate local declines. Recently, KDWD decided to release additional surface water down the unlined Eastside Canal, which is relatively close to the eastern RMWs with exceedances. In the western Urban MA, the City is currently releasing water through the Kern River Channel, adjacent to RMW-025, which will address the Urban MA Exceedance observed in that well in WY 2022. These actions allow for operational recharge to occur in the open bottom of the river channel and unlined canals to provide benefits to adjacent water levels and wells. Also, as mentioned previously, KRGSA managers are working to coordinate with the well owner's pumping schedules to ensure that representative static water levels can be measured, and pumping water levels do not inadvertently trigger an MT exceedance. Finally, locations of nearby active wells are being researched and recorded in field notes for a better understanding of local impacts. KRGSA managers are planning additional actions if continued monitoring indicates that groundwater levels have not responded to these initial management steps.

The KRGSA – as a participant in the recent KGA SGM grant application for the Subbasin – has applied for grant funding to assist with installation of dedicated monitoring wells to replace some of these active pumping wells. Funding would specifically improve monitoring in disadvantaged communities where many of these pumping RMWs are located.

Land Subsidence: With the persistent drought conditions and consecutive critically dry water years, water levels have declined in some areas of historical subsidence. However, the targeted RMWs in areas of the largest rates of subsidence are all above the MTs. Nonetheless, published InSAR data and a local GPS station in the southeast KRGSA indicate an increase in land subsidence rates during WY 2022 compared to pre-2021 rates. No impacts to local critical infrastructure have been observed. GPS data also indicate some portion of elastic subsidence with land surface rebounds during wet periods; this area will be targeted for additional surface water supplies during the wet conditions of WY 2023. Data will continue to be monitored and KRGSA managers will work to keep water levels above MTs, especially in areas of historical subsidence.

Water Quality: The constituents of concern identified in the GSP are being analyzed for potential water quality degradation in the KRGSA with particular focus in the area of the Urban MA Exceedance. Preliminary data indicate that municipal wells have not significantly increased above historic maximum concentrations during the recent multi-year drought conditions. In addition, municipal water suppliers operate numerous wellhead treatment systems for arsenic and are continuing to rely primarily on those wells for groundwater supply.

As mentioned above, MTs were also exceeded in four RMWs in the Agricultural MA. Water quality in those areas were reviewed to determine if water quality was being impacted by lower water levels locally. To conduct this review, the KRGSA GSP makes best use of numerous existing water quality monitoring programs to track arsenic concentrations, the primary indicator constituent for potential degradation. Data are downloaded annually from the GAMA website. These data indicates that arsenic concentrations are similar or lower compared to WY 2020, even near wells with MT exceedances.

2) Implementation of Projects and Management Actions

The KRGSA continues to make progress on GSP implementation and has already realized benefits from several GSP projects. Progress is also being made on additional projects and management actions as summarized in the information below. The section numbers in the Amended KRGSA GSP that describe the projects and management actions are provided in parentheses by the project/action name for reference.

Water Allocation Plan (WAP) - Kern Delta Water District (see KRGSA GSP Section 7.1.1):
As a direct result of WAP implementation, Kern Delta Water District (KDWD) was able to maximize water supplies during this reporting period by obtaining and actively managing an additional 4,407 AF of transfer water in the District - a supply which would have been previously unavailable before project implementation.

Because of this additional supply, KDWD was able to redirect 831 AF of the 4,407 AF of transfer water to the Eastside canal service area 14 days earlier in the year than is customary. This management action was undertaken to benefit groundwater levels in an area where local declines have occurred during the reporting period. This action will also support local wells during future drought conditions (see also, *item 1) d)* above). During this reporting period, construction of the Arvin-Edison Eastside Canal Intertie

Project was in progress. Once completed, the intertie will provide greater opportunities to introduce additional water supplies to the Eastside Canal throughout the water year. The significance of this capability is to allow both Arvin-Edison Water Storage District and Kern Delta Water District to improve groundwater levels along their borders, which is an area of focus related to SGMA for both districts.

Kern River Optimized Conjunctive Use - City of Bakersfield (see KRGSA GSP Section 7.1.2): During WY 2022, KRGSA continued to implement this conjunctive use project through the member agencies' ongoing water operations and maintenance within the City-owned reaches of the Kern River and canals (see discussion in WY 2020 Annual Report). The total amount of water recharged within the City-owned properties from canals, Kern River, City facilities, and 2,800 Acre Groundwater Recharge Facility amounted to 14,136 AF. This amount represents more recharge than occurred in WY 2021; this additional recharge provides protection for City and Cal Water wells and adds to drinking water supplies for City residents.

***Expand Recycle Water Use in the KRGSA - City of Bakersfield (see KRGSA GSP Section* 7.1.3):** The City of Bakersfield continues to reuse recycled water through its ongoing operations of Wastewater Treatment Plants 2 and 3, reporting 22,830 AF used in WY 2022. Treated effluent from Wastewater Treatment Plant 3 is recycled for multiple purposes, including the application of tertiary treated water for sports park irrigation and the recharge of denitrified water into the groundwater basin via onsite ponds. The City is still in the process of conducting a master study for expanding treatment plant capacity to provide increased recycled water for irrigation of nearby City-owned parks.

Land Use Conversion - Urbanization of Agricultural Lands (see KRGSA GSP Section 7.1.4):
Although this GSP project was originally envisioned for urbanization of agricultural lands, the primary benefit of the land use conversion project is to reduce water demand through changes in land use. To that end, KDWD continues to look for opportunities to acquire properties within KDWD for groundwater recharge projects and to reduce demand by simultaneously taking these properties out of production. Although no land use conversions were documented in Wy 2022, KRGSA continues to track these changes and notes conversions in WY 2023 that are expected to decrease agricultural demand. Those changes will be reported in the WY 2023 Annual Report to be submitted in 2024.

ENCSD Water System Consolidation and Other Small Water System Consolidation Projects (see KRGSA GSP Section 7.1.5):
This project involves consolidation of up to six small water systems into the East Niles Community Service District (ENCSD) to provide a more reliable and high-quality water supply to local disadvantaged communities. At the time of this Annual Report, ENCSD has completed environmental review and is still awaiting State comments on the submitted agreements for the project. As soon as the State responds, ENCSD is ready to execute the agreements and begin project construction.

Additional **small water system consolidation projects** are also being planned in the KRGSA as summarized below.

City Consolidation of two small water systems:
The City of Bakersfield is coordinating with the Division of Drinking Water (DDW), University of Sacramento, and Carollo Engineers regarding consolidation of two small water systems located in underrepresented communities. Specifically, plans are moving forward for consolidation of the South Kern Mutual Water Company and Old River Mutual Water Company into the City's domestic water system for improvements to drinking water quality. As reported in last year's Annual Report, a consolidation engineering report has been completed and additional coordination efforts are ongoing with the DDW.

Lamont PUD Water System Consolidation:
In addition, Lamont Public Utilities District (Lamont PUD) reached a significant milestone with its ongoing consolidation of El Adobe Property Owners Association (El Adobe POA) into the District's water system. The SWRCB announced an award of grant funding through the SAFER program to support key infrastructure including three replacement municipal wells. This grant supports the consolidation of the 80-home community of El Adobe POA, where residents have been waiting nearly a decade for grant support of the consolidation. This grant is the single largest SAFER grant that has been awarded in the program's four-year existence. This project will provide safe and reliable drinking water supply in the POA. Current drinking water quality has been impacted by elevated arsenic concentrations that exceeded MCLs for years prior to GSA management of the area.

Implement Action Plan if Water Levels Fall below MTs (see KRGSA GSP Section 7.2.1):
As documented in item 1)d) above, KRGSA managers are tracking and investigating MT exceedances as they occur in the KRGSA Plan area. Specifically, KRGSA managers have taken steps toward mitigation of potential local water level declines and avoidance of inaccurate static water level measurements in pumping RMWs. Actions include focused operational recharge in nearby canals to manage groundwater levels, coordination of monitoring with well owner pumping schedules, increasing frequency of field visits for tracking RMW pumping, considerations for redistribution of pumping in municipal wellfields, review of permits for new wells, application for grant funding to install dedicated monitoring wells in disadvantaged communities, and other actions.

Implement Groundwater Extraction Reporting Program (see KRGSA GSP Section 7.2.4):
To allow KDWD to better understand local water use and crop demands, the District has invested in an evapotranspiration (ET) analysis program, developed by Land IQ specifically for field conditions in the District. The Land IQ ET system involves a data-driven model for detailed water use estimation. The analysis includes a ground-truthing component, which greatly improves its accuracy. This program, which has been operating since January of 2022, has benefitted the District by providing better identification and quantification of water use and demand. In addition, this allows for indirect estimates of groundwater extraction as the District continues to develop policies and programs to improve groundwater extraction estimation and reporting.

Support California Delta Conveyance Project to Preserve Imported Water Supplies (see KRGSA GSP Section 7.2.5):
ID4 continued funding a share of the Delta Conveyance Project environmental review, planning and design costs at a 100 percent level for 82,946 AF.

Incorporate Climate Change Adaption Strategies (see KRGSA GSP Section 7.2.6):
ID4 developed a 2020 UWMP update that included climate change impacts on the availability of future imported water supplies as provided in DWR's 2019 Delivery Capability Report. The Cross Valley Canal Extension Lining Project - Pool No. 8, was identified in ID4's 2020 UWMP update as an implementation project to increase the reliability of water supplies during dry year conditions and was awarded funding through DWR's Urban and Multi-benefit Drought Relief Grant Program for construction. The public bidding process was completed in WY 2022 and the project will be constructed in WY 2023.

Improve Groundwater Monitoring Network (see KRGSA GSP Section 7.2.8):
As mentioned previously throughout this progress report, the KRGSA managers are making improvements to the current monitoring network. In particular, protocols are being considered to better manage monitoring in actively pumping RMWs. Not only are these wells difficult to access when pumping, but it has also been difficult to determine if water levels have recovered sufficiently after pumps are turned off such that representative static water levels are being measured. Several of the past MT exceedances are in active pumping wells where hydrographs suggest that measurements are being influenced by recent pumping water levels. The objective of the monitoring program is to provide a reasonable representation of water levels in the aquifer rather than to record pumping- influenced water levels in an inefficient production well.

Accordingly, KRGSA managers are taking steps to mitigate these problems, including the following:

- working directly with well owners to coordinate on their operational schedules to access the well during non-pumping periods (e.g., RMW-026),
- increasing measurement frequency to improve measurements of a representative static water level,
- researching data for inactive replacement wells in key areas, and
- applying for grant funds to install dedicated monitoring wells in critical areas.

3) Coordination with Stakeholders

The KRGSA managers have incorporated various methods for interaction with GSP stakeholders. Some of these ongoing efforts are summarized below.

Public Board Meetings: During the reporting period, the KRGSA has continued regular monthly Board meetings that are open to the public and attended by numerous stakeholders in the Subbasin. GPS implementation, including results of the GSP Annual Reports, are presented and discussed in these open meetings. During WY 2022, most meetings were conducted as in-person meetings.

Public Access to Online Data Management System: The KRGSA managers have coordinated with all of the Subbasin GSAs for the development of an online Data Management System (DMS). The system serves as a convenient portal for uploading, storing, viewing, and analyzing GSP data. The portal is open to stakeholders and the public for data viewing and contains a mapping feature that allows the public to see GSA boundaries, locations of monitoring sites, and hydrographs of groundwater elevations throughout the Subbasin.

KRGSA managers continue to communicate with stakeholders by direct communication on a case by case basis, through requested informational meetings, and via grower outreach meetings.

4) Summary of Other GSP-related Special Studies or Activities

Agricultural MA Evapotranspiration (ET) Study: As described in Item 2) above, a program with Land IQ is ongoing for improved estimates of ET in the Agricultural MA. This study supports several of the GSP management actions including the groundwater extraction reporting program.

Isabella Dam Improvement Project: The Isabella Dam improvement project, impacting reservoir storage levels, is substantially complete. Completion of the project allows for filling of the reservoir to unrestricted levels, which will provide greater storage during peak runoff periods. Consequently, those who contract for storage capacity in Isabella Dam, including the City of Bakersfield, will have restored storage capabilities as an additional water management tool that had previously been restricted since 2006.

Additional Studies: The KRGSA continues to coordinate with the Subbasin GSAs on investigations regarding land subsidence and the key studies proposed for grant funding as part of the recent SGM grant application to DWR.

7.7 Olcese Water District GSA

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Olcese GSA during WY 2022 is summarized as follows:

a) GSP Monitoring Activities

Olcese GSA has implemented the GSP Representative Monitoring Network for the Olcese GSA Area through the collection of groundwater level data in Fall 2021 and Spring 2022 from the two wells. These wells also support the Reduction in Groundwater Storage sustainability indicator, by proxy.

In addition, Olcese GSA has also collected groundwater level from additional locations (beyond those in the Representative Monitoring Network) in WY 2022 which are being evaluated as part of local SGMA implementation, as well as information collected by others (e.g., other public water systems, environmental compliance sites, etc.).

b) Changes in Monitoring Network

Groundwater level data collected from wells in the groundwater level Representative Monitoring Network in the Olcese GSA Area in Fall 2021 and Spring 2022 indicate the following:

- Groundwater levels in both RMWs were greater than their respective MTs during both the Fall 2021 and Spring 2022 monitoring events.
- The groundwater level in one RMW was greater than its respective MO during both the Fall 2021 and Spring 2022 monitoring events, and the groundwater level in the other RMW was above its MO in Spring 2022 and below its MO in Fall 2021.

There have been no changes to the GSP Monitoring Network for the Chronic Lowering of Groundwater Levels sustainability indicator in WY 2022. As part of the Amended Olcese GSP submitted in July 2022, the Olcese GSA designated two benchmark survey locations along the Olcese Water District Canal as monitoring points for the Land Subsidence sustainability indicator.

c) Progress in Achieving Interim Milestones

Groundwater level data collected from wells in the groundwater level Representative Monitoring Network in the Olcese GSA Area in Fall 2021 and Spring 2022 indicate the following:

- Groundwater levels in both RMWs were greater than their respective MTs during both the Fall 2021 and Spring 2022 monitoring events.

- The groundwater level in one RMW was greater than its respective MO during both the Fall 2021 and Spring 2022 monitoring events, and the groundwater level in the other RMW was above its MO in Spring 2022 and below its MO in Fall 2021.

d) Compliance with Additional Sustainable Management Criteria

As discussed above, groundwater levels in both RMWs were in compliance with their respective Sustainable Management Criteria (i.e., above MTs) throughout WY 2022. Compliance with Sustainable Management Criteria established for the Land Subsidence sustainability indicator will be evaluated upon collection of benchmark survey elevation data at the two monitoring points established for this indicator as part of the Amended Olcese GSP. This benchmark elevation surveying is planned to occur approximately every five years, and no surveying was conducted during WY 2022. No other sustainability indicators have established MTs within the Olcese GSA Area.

2) Implementation of Projects and Management Actions

Olcese GSA has made progress in WY 2022 towards implementing one of the Projects included in the Olcese GSP:

- **Non-contingent Project #1**: Installation of a shallow monitoring well in the vicinity of Olcese Water District Well #2 for purposes of evaluating potential hydraulic connection between the Olcese Sand Aquifer Unit and the Shallow Alluvium. Olcese GSA installed this well in Summer 2019 and has collected groundwater level monitoring data since Fall 2019, including measurements in Fall 2021 and Spring 2022. Monitoring data was collected manually until November 2020 when a data-logging pressure transducer was installed in the well to collected continuous water level data.

- **Non-contingent Management Action #2:** Conduct a study of the potential hydraulic connection between the Olcese Sand Aquifer Unit and the Shallow Alluvium. The Olcese GSA has begun implementation of its study to assess the degree of hydraulic connection between the shallow alluvium and the Olcese Sand Aquifer Unit (i.e., the principal aquifer underlying the Olcese GSA Area identified in the GSP). The study is based primarily on groundwater level data collected from two wells - one in the shallow alluvium and one in the Olcese Sand Aquifer Unit - using high-frequency data logging transducers. Collection of the transducer-based water level data began in Fall 2020, continued through WY 2022, and is ongoing. Results from the study will be used to inform decisions about sustainable management criteria in the next periodic (5-year) GSP update.

- **Non-contingent Project #3 (from original 2020 Olcese GSP):** Develop a network of subsidence monitoring locations. As discussed above, the Olcese GSA has established a network of subsidence monitoring locations consisting of two benchmark survey locations along the Olcese Water District Canal as part of the Amended Olcese GSP submitted in July 2022. Thus, Olcese GSA has completed implementation of this Project, originally included in the 2020 Olcese GSP, to develop a network of subsidence monitoring locations.

3) Coordination with Stakeholders

Olcese GSA has continued to coordinate with interested stakeholders by holding regular meetings of the Olcese Water District Board of Directors which are open to the public. Such meetings were held in February, May, August and November 2022. Olcese GSA members have also regularly attended inter-basin meetings with members of the other GSAs in the Kern County Subbasin.

4) Summary of Other GSP-related Special Studies or Activities

No other GSP-related special studies or activities were performed in WY 2022 in the Olcese GSA area.

7.8 South of Kern River

7.8.1 Arvin GSA

1) Compliance with Sustainable Management Criteria

On March 2022, the Arvin-Edison Water Storage District (AEWSD) and Arvin Community Services District (ACSD) collectively agreed to leave the Kern Groundwater Authority Groundwater Sustainability Agency (KGA GSA) and form a new Exclusive GSA (i.e., the Arvin GSA) to assume Sustainable Groundwater Management Act (SGMA) responsibilities for their combined service areas within the Kern Subbasin (i.e., the Arvin-Edison Management Area). The Arvin GSA further agreed to resubmit a new Groundwater Sustainability Plan (GSP) in coordination with the Wheeler Ridge-Maricopa GSA and Tejon-Castac Water District GSA (TCWD GSA) for their combined jurisdictional areas within the Kern Subbasin (i.e., the South of Kern River [SOKR] GSP).

The AEWSD Board of Directors is the governing body for the Arvin GSA. The Arvin GSA has approved an agreement with Kern County whereby the County will participate in the Arvin GSA as an additional entity to ensure the GSA's continuing jurisdiction to manage certain lands that are located within its management area but outside of its water storage district boundaries, under SGMA.

The Arvin GSA's progress towards achieving and/or maintaining compliance with Sustainable Management Criteria (SMCs) defined for the Arvin-Edison Management Area in the SOKR GSP during Water Year (WY) 2022 is summarized as follows:

a) GSP Monitoring Activities

During WY 2022, AEWSD implemented its portion of the Arvin GSA SGMA Representative Monitoring Network through the following actions:

- Collection of groundwater level monitoring data: Water levels were measured at all 15 SGMA Water Level Representative Monitoring Wells (RMWs) within AEWSD in Fall 2021 and Spring 2022.
- Collection of ground surface elevation survey data: Land surface elevations were surveyed at all five SGMA Land Subsidence Representative Monitoring Sites in Fall 2021 and Spring 2022
- Collection of groundwater quality monitoring data: Groundwater quality samples were collected at all nine SGMA Water Quality RMWs within AEWSD once during WY 2022.

In addition, ACSD implemented its portion of the Arvin GSA SGMA Representative Monitoring Network in WY 2022 through the following actions:

- Collection of groundwater level RMW data: Water levels were measured at the one SGMA Water Level RMW under ACSD's jurisdiction (ACSD Well #14) in Fall 2021 and Spring 2022.

- Collection of groundwater quality monitoring data: Groundwater quality samples were collected from the one SGMA Water Quality RMW (ACSD Well #14) during seasonal low (10/27/2021) and seasonal high (1/26/2022) periods during WY 2022.

In addition to the above activities related to groundwater level, groundwater quality and land subsidence representative monitoring, AEWSD and ACSD collected additional groundwater level, groundwater quality, and land surface elevation monitoring data from additional locations throughout the Arvin-Edison Management Area in WY 2022 which are being evaluated as part of local SGMA implementation, along with relevant information collected by others.

b) Changes in GSP Monitoring Network

As further described in the SOKR GSP, Water Quality SMCs (i.e., Minimum Thresholds [MTs] and Measurable Objectives [MOs]) for Arsenic were defined at all 10 Water Quality RMWs within the Arvin GSA. Previously Arsenic MTs/MOs were only defined at ACSD Well #14.

There have been no other changes to the Arvin GSA Representative Monitoring Network during WY 2022 with the exception of minor clarifications/corrections related to the development of the Data Management System.

c) Progress in Achieving Interim Milestones

Groundwater level monitoring data collected from the Arvin GSA SGMA Representative Monitoring Network during WY 2022 indicate the following:

Groundwater levels were greater than (i.e., did not exceed) their respective MT levels in 14 of 16 wells measured in Fall 2021 and all 16 wells in Spring 2022. Water Level MT exceedances occurred at wells RMW- 006 (31S29E12M001M) and RMW-009 (31S30E30J001M) during the Fall 2021 monitoring event.

Groundwater levels were greater than or equal to their respective MO levels in 8 of 16 wells measured in Fall 2021 and 9 of 16 wells measured in Spring 2022. The groundwater level monitoring results from WY 2022 indicate that Undesirable Results for Chronic Lowering of Groundwater Levels are not occurring in the Arvin-Edison Management Area.

It is considered an Undesirable Result for Chronic Lowering of Groundwater Levels if Minimum Thresholds are exceeded in 40% or more of the SGMA Water Level RMWs (i.e., 7 out of 16 sites) over four consecutive seasonal measurements (i.e., measurements spanning a total of two years, including two seasonal high groundwater level periods and two seasonal low groundwater level periods).

d) Compliance with Additional Sustainable Management Criteria

Groundwater quality monitoring data collected from the Arvin GSA SGMA Representative Monitoring Network during WY 2022 indicate the following:

- Arsenic concentrations were measured at values lower than the Arsenic MT (i.e., 10 micrograms/Liter [ug/L]) at nine of 10 Water Quality RMW during the WY 2022 monitoring event (May 2022). Arsenic concentrations were measured exactly at the Arsenic MT at RMW-225 (i.e., 30S30E18G001M) during the WY 2022 monitoring event.

The groundwater quality monitoring results from WY 2022 indicate that Undesirable Results for Degraded Water Quality are not occurring in the Arvin-Edison Management Area[7].

Land subsidence monitoring data collected from the Arvin GSA SGMA Representative Monitoring Network during WY 2022 indicate the following:

Cumulative land subsidence since June 2018 has occurred in amounts less than the MT rate and extent defined at all five sites. AEWSD continues to examine the potential cause of subsidence in the vicinity of critical water infrastructure within its Management Area and determine appropriate mitigation actions, if any.

2) Implementation of Projects and Management Actions

AEWSD has made progress towards implementing several of its planned Projects in WY 2022. This progress has included an effort to prioritize and score all of its Projects, but more specifically progress was made on the following:

P/MA #1 AEWSD Sunset Groundwater Recharge Facility. Project construction began and it is anticipated that the project will begin receiving water in the first half of calendar year 2023. AEWSD and Kern Delta Water District entered into an operations and maintenance agreement for the facility.

P/MA #6 On-Farm Recharge. AEWSD has continued development of its initial 2019 Landowner Recharge program through continued outreach and investigation and has increased the total acreage of on-farm recharge in WY 2022. It is anticipated that deliveries of On-Farm recharge will continue in 2023.

P/MA #10 AEWSD Wasteway Basin Improvements. AEWSD continues to seek grant funding for this project.

P/MA #11 Forest Frick Pipeline/KDWD Eastside Canal Intertie. Project construction began and it is anticipated the project will being receiving water in the first half of calendar year 2023.

[7] It is considered an Undesirable Result for Degraded Water Quality if Minimum Thresholds are exceeded in 40% or more of the SGMA Water Quality RMWs (i.e., 4 out of 10 sites) over two consecutive annual SGMA required measurements as a result of groundwater recharge or extraction, such that it cannot be managed to provide drinking water supply (i.e., that treatment or blending is not possible or practicable).

P/MA #14 Conversion of Granite Quarry to Sycamore Reservoir. AEWSD participated in several meetings with Granite Construction, Tejon Ranch Company, and the County of Kern during WY 2022 to discuss the permitting process and next steps for environmental work, if any. Additionally, AEWSD performed a geotechnical study of the quarry and determined that the soils are more than adequate groundwater recharge.

P/MA #17 DiGiorgio Unit In-Lieu Banking Program. AEWSD submitted a USBR WaterSMART Drought Resiliency Project grant application for phase 2 of 5 of the DiGiorgio Unit at $2,000,000 (with a $2,600,000 local cost share). The grant was not awarded. However, AEWSD is moving forward with project design and construction of Phase 2a consisting of a half mile 48" pipeline to serve future phases. Construction is anticipated to be complete in 2023.

P/MA #18 General In-Lieu Banking Program. AEWSD submitted a DWR grant application through the Kern Integrated Regional Water Management Plan to support the construction of the new Frick Unit surface water service area. Final design of the Frick Units is expected to be complete in 2023. Also, AEWSD began design of the new Sandrini Unit, formally called the Tejon Expansion. Development of a potential hybrid in-lieu and temporary water service contract is underway and landowner outreach for the new areas will begin soon.

AEWSD has made progress towards implementing several of its planned Management Actions. This progress has included the following:

P/MA #24 Groundwater Extraction Quantification Method. AEWSD completed installation of groundwater pumping meters at 50 sites under its existing Groundwater Metering grant program to improve estimation of local groundwater use trends within its service area. AEWSD also developed a numerical groundwater flow model for its service area and calibrated it to historical groundwater levels to provide for more accurate estimates of groundwater use, water level, and change in groundwater storage trends within the Arvin-Edison Management Area. AEWSD is currently developing a coupled Decision Support Tool (DST) that will provide a comprehensive mechanism to plan for and evaluate the impacts of ongoing operational and management decisions (e.g., delivery of imported water, groundwater banking and recovery operations) on local groundwater level conditions relative to Water Level SMCs defined for the Arvin GSA in the SOKR GSP.

ACSD has made progress towards implementing several of its planned Projects in WY 2022.

P/MA #28 Emergency 1,2,3-TCP Treatment Well #12 (EPA Replacement CW-1). Well #12 was completed and commissioned in May of 2021. All samples so far have shown no sign of 1,2,3-TCP and Arsenic levels are under the MCL. The well will continue to be sampled on a quarterly basis.

P/MA #29 Arsenic Mitigation Project - Phase II. The Arsenic Mitigation Project Phase II has seen two of the three wells (#16 and #17) completed. Well #18 is waiting on PG&E and its completion has been delayed due to easement issues and COVID-19. Well #18 is expected to be completed by July 2023. All other components of the project have been completed including a 1-million-gallon storage tank with booster station, 15,000 feet of new conveyance pipe, the abandonment of six old well sites, and SCADA implementation for system automation.

3) Coordination with Stakeholders

AEWSD discusses SGMA matters during its regular monthly Board of Directors meetings. In addition, in WY 2022 AEWSD staff participated in the following:

- 50 meetings of the KGA Managers and/or Board of Directors;
- 23 inter-basin meetings with representatives of other GSAs/basins; and
- 25 miscellaneous meetings related to SGMA and groundwater matters with various entities.

ACSD's stakeholder activities include discussion of SGMA matters during its regularly scheduled Board of Directors meetings. In addition, in WY 2022 ACSD staff participated in the following:

- 30 meetings of the KGA Managers and/or Board of Directors;
- 9 inter-basin meetings with representatives of other GSAs/basins; and
- 5 miscellaneous meetings related to SGMA and groundwater matters with other entities.

4) Summary of Other GSP-related Special Studies or Activities

In addition to the above activities related to Projects and Management Actions specifically included in the SOKR GSP, the following SGMA-related studies and activities were conducted in WY 2022:

- Continued analysis of critical water budget components, including agricultural (evapotranspirative) water demands and return flow estimates;
- Continued involvement in review of and comments on various water banking project CEQA documents potentially affecting AEWSD's Central Valley Project / Friant-Kern Canal surface water supplies from the standpoint of both water quantity and water quality concerns;
- Continued participation in water quality studies related to Friant-Kern Canal Reverse Flow/Pump-Back Program;
- Continued participation in Basin-wide initiatives including the Basin Study, DMS development, and the AEM data collection effort;
- Responded to County of Kern requests for GSA review of well permit applications;
- Review of statewide well mitigation policies for development of a local policy;
- Conducted an analysis of well ages to support Sustainability Criteria impacts analysis;
- Developed language for an "Agreement Between Landowner and Arvin Groundwater Sustainability Agency Providing For Confirmation of Consistency With Groundwater Sustainability Plan";

Participated in public awareness initiatives regarding the social benefits of maintaining agricultural economy;

- Assisted Friant Division to effect an exchange of supplies between Millerton Lake and San Luis Reservoir to minimize water supply impact to Friant districts;
- Provided several water supply notification letters to water users to conserve supplies during an extremely dry year;
- Continued to engage in statewide lawsuits involving projects/programs that threaten AEWSD's water supplies;
- Investigated and sought grant funding to expand capacity for an interconnection with neighboring Wheeler- Ridge Maricopa WSD for transfer/exchanges of water supplies;
- Continued to follow and review DWR and SWRCB responses, comments, and decisions regarding SGMA in other basins throughout the state;
- Worked on $25 million bond and finance package for implementing SGMA projects.
- Investigated land repurposing within the District and the DWR LandFlex grant program;
- Researched potential properties to purchase for recharge;
- Increased flow capacity in existing recharge facilities;
- Executed SGMA Implementation Agreement with Wheeler Ridge-Maricopa WSD regarding overlap lands;
- Submitted Drought Resiliency Project Grant application for two new wells and a groundwater model; and
- Amended a memorandum of understanding with ACSD.

7.8.2 Tejon-Castac Water District GSA

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Tejon-Castac Water District (TCWD) GSA Area during WY 2022 is summarized as follows:

a) GSP Monitoring Activities

Tejon-Castac Water District (TCWD) Groundwater Sustainability Agency (GSA) has implemented its GSP (Representative) Monitoring Network in Water Year 2022 through the following actions:

Collection of groundwater level data in Fall 2021 (11/13/2021) and in Spring 2022 (3/29/2022) in the one well in the groundwater level Representative Monitoring Network.

b) Changes in GSP Monitoring Network

There have been no changes to the TCWD GSA Area Monitoring Network in Water Year 2022.

c) Progress in Achieving Interim Milestones

Groundwater levels measured from the one well in the groundwater level Representative Monitoring Network in the TCWD GSA Area during Water Year 2022 were greater than the established Minimum Threshold and below the established Measurable Objective.

d) Compliance with Additional Sustainable Management Criteria

There are no additional sustainable management criteria identified in the TCWD GSA Area.

2) Implementation of Projects and Management Actions

With respect to its planned Projects and Management Actions (P/MAs), TCWD GSA has taken the following steps in Water Year 2022:

Conversion of Granite Quarry to Sycamore Reservoir - In WY 2022, TCWD participated in discussions with Arvin-Edison Water Storage District (AEWSD) and others about this P/MA, regarding the permitting process and next steps for environmental work. This P/MA will be initiated only after operations at the Granite Quarry facility cease, which is anticipated to occur within the next few years.

Recharge of Carrot Wash Water - This P/MA is underway and ongoing. In Water Year 2022, approximately 202.22 acre-feet of carrot wash water were recharged to the groundwater basin under this P/MA.

The TCWD GSA Area is almost entirely covered by and managed under the Tejon Ranch Conservation & Land Use Agreement and associated Ranch Wide Management Plan (RWMP), which includes land use policies and restrictions on groundwater extraction.

3) Coordination with Stakeholders

TCWD GSA has continued to coordinate with interested stakeholders by holding regular meetings of the TCWD Board of Directors which are open to the public. Such meetings were held 6 times in Water Year 2022. Representatives of TCWD have also attended intra-basin meetings with members of the other GSAs in the Kern County Subbasin for purposes of SGMA implementation and coordination.

4) Summary of Other GSP-related Special Studies or Activities

No additional GSP-related special studies or activities were conducted by TCWD in the Kern County Subbasin in Water Year 2022, although TCWD is also a member of the White Wolf Groundwater Sustainability Agency (GSA) in the neighboring White Wolf Subbasin and was an active participant in the development of the White Wolf Groundwater Sustainability Plan. Other SMGA-related activities by

TCWD in the Kern County Subbasin included becoming a GSA for the portion of its service area within the Kern County Subbasin, which went into effect in early 2022, and joint preparation of the South of Kern River (SOKR) GSP, along with the Arvin GSA and Wheeler Ridge-Maricopa GSA.

7.8.3 Wheeler Ridge-Maricopa GSA

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Wheeler Ridge-Maricopa Groundwater Sustainability Agency (WRMGSA) during WY 2022 is summarized as follows:

a) GSP Monitoring Activities

The WRMGSA further implemented its GSP Monitoring Network in Water Year 2022 through the following actions:

- Groundwater levels were observed roughly once per month in 14 wells in the groundwater level Representative Monitoring Network.
- Updated subsidence information were obtained from the Department of Water Resources for 40 benchmark sites that comprise part of the WRMGSA land subsidence Representative Monitoring Network.
- Water samples were collected from four wells in the water quality Representative Monitoring Network that were equipped with pumps and capable of producing water.

In addition to the above activities, WRMGSA collected groundwater level and groundwater quality data from additional monitoring locations and leveraged information collected by others (e.g., other public water systems, environmental compliance sites, etc.).

b) Changes in GSP Monitoring Network

There were no changes to the GSP Monitoring Network during Water Year 2022. Since 2020, however, replacement monitoring well RMW 235R has been sounded in lieu of RMW 235, which was determined to have a collapsed casing.

c) Progress in Achieving Interim Milestones

Trends seen in WRMGSA groundwater level Representative Monitoring Network wells suggest that some progress was made toward achieving interim milestones during Water Year 2022. In summary, groundwater levels in most Representative Monitoring Wells generally fell and rebounded seasonally during this period while remaining above Measurable Objectives. However, two Representative Monitoring Wells (RMWs 232 and 234) continued a pattern that began in 2021, with each well experiencing seasonal summer lows below the Minimum Threshold, then rebounding again in the late summer and finally stabilizing near the Minimum Threshold by the end of the calendar year. At the close of Water Year 2022, RMW 232 and RMW 234 were found to be respectively 43 and 16 feet below their Minimum Threshold, but during the winter of 2022-2023 higher levels were seen, suggesting that these two wells currently may be tracking along an upward trend.

d) Compliance with Additional Sustainable Management Criteria

The WRMGSA obtained updated subsidence information from the Department of Water Resources for 40 benchmark sites that comprise part of the land subsidence Representative Monitoring Network. Within the WRMGSA, Minimum Thresholds and Measurable Objectives for subsidence are stated in terms of an average rate within an entire pool, and on that basis, four out of five Aqueduct pools within the WRMGSA appeared to be stable or subsiding at rates less than their Measurable Objective rates. One pool (Pool 34) did appear to be subsiding at an average rate of about 2.2 inches per year in 2022, which was slightly more than the Minimum Threshold rate of 1.8 inches per year. We also acknowledge that a further 17 individual benchmarks within pools 33 and 35 appeared to be subsiding at rates between 0.9 and 1.8 inches per year, but the average rates for pools 33 and 35 were less than the Measurable Objective rate of 0.9 inches per year.

2) Implementation of Projects and Management Actions

WRMGSA and Wheeler Ridge-Maricopa Water Storage District (WRMWSD) have has made progress towards implementing several of its planned Projects. This progress included the following:

Increase Out-of-District Banking Operations. There were no additional increases in Out-of-District Banking Operations in 2022. However, in 2020 and 2021, WRMWSD did participate in a pair of expansion projects at the Kern Water Bank, in which WRMWSD maintains a 24.03% share. In those recent projects, the Kern Water Bank increased recharge ponds by 1,025 acres and also increased its capacity to divert water from the California Aqueduct by 150 cubic feet per second (cfs).

Purchase Additional Supplies. During Water Year 2022, WRMWSD purchased 14,087 acre-feet of water in addition to its contracted State Water Project supplies for surface delivery within WRMWSD (including both Kern County Subbasin and White Wolf Subbasin lands). Moreover, WRMWSD recovered approximately 52,500 acre-feet of banked water from various banking projects for delivery in WRMWSD.

Desalination Facilities. WRMWSD continued to explore ways to utilize desalination facilities to mitigate localized impacts of pumping in the WRMGSA. To that end, WRMWSD met with certain project proponents and vendors.

"Thru Delta" Facility. WRMWSD continued to fund the planning phase of the Delta Conveyance Project (DCP) in 2022. In 2020, The WRMWSD Board of Directors elected to participate in the planning phase of the Delta Conveyance Project at level of 32% (63,100 acre-feet) of its State Water Project entitlement. Ultimately, participation in the Delta Conveyance Project will allow WRMWSD to firm up access to its existing State Water Project entitlement and will also give WRMWSD access to additional California Aqueduct supplies.

Facility Interconnections with KDWD. WRMWSD, together with KDWD, continued to study possible interconnections that could enable water transfers and exchanges between the two districts, and for that purpose engaged a consultant in 2022.

WRMWSD also made progress towards implementing several of its planned Management Actions. This progress included the following:

Acreage Assessment. WRMSD continued to study and analyze possible acreage assessments or groundwater pumping charges that could both fund future Projects and Management Actions in the WRMGSA and provide financial incentives to limit pumping from the groundwater basin. It is anticipated that analyses will be completed by mid-2023 and that some form of charges will go into effect in 2023.

Land Retirement. During Water Year 2022, construction began on a 300-MW solar generation facility located within District boundaries that will eventually occupy more than 3,400 acres of land. A large portion of these acres were previously farmed but will now be repurposed into solar facilities or mitigation lands for the project, permanently retiring those lands and reducing overall water demand. In addition, a number of smaller solar projects were either proposed or in various stages of construction on former farmlands in 2022.

3) Coordination with Stakeholders

WRMGSA discussed SGMA matters during its normal Board meetings held regularly on the second Wednesday of every month. District staff and Board members also participated in regular KGA Board meetings as well other KGA meetings through July 2022 while the District was still a member of the KGA. Commencing in March 2022, while the South of Kern River (SOKR) Groundwater Sustainability Plan was yet being drafted, District staff and Board members began meeting on a regular schedule with the SOKR GSP group.

4) Summary of Other GSP-related Special Studies or Activities

No other GSP-related special studies or activities occurred in WY 2022.

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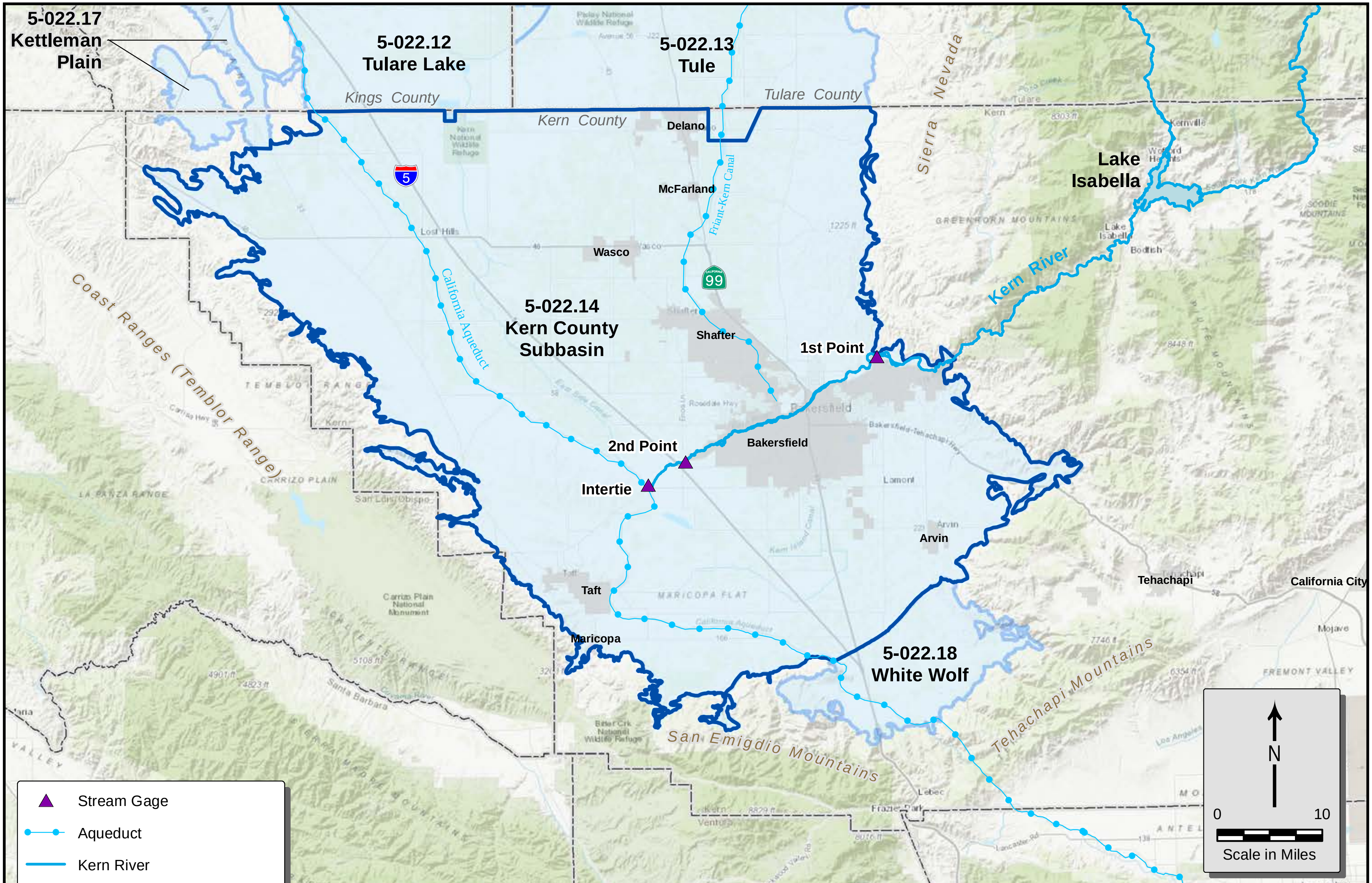
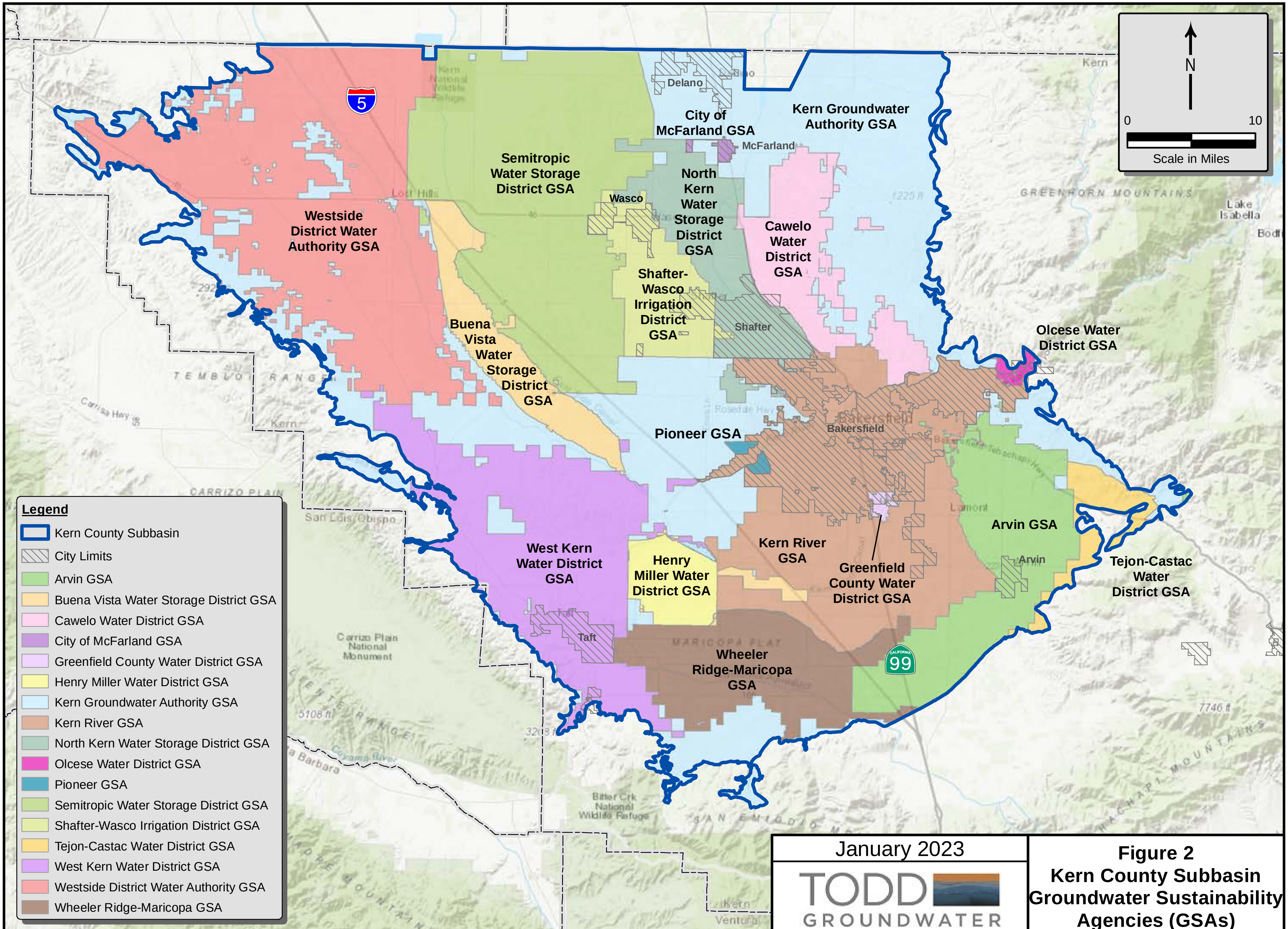
FIGURES



March 2023

TODD GROUNDWATER

Figure 1
Kern County Subbasin



January 2023

Figure 2
Kern County Subbasin Groundwater Sustainability Agencies (GSAs)

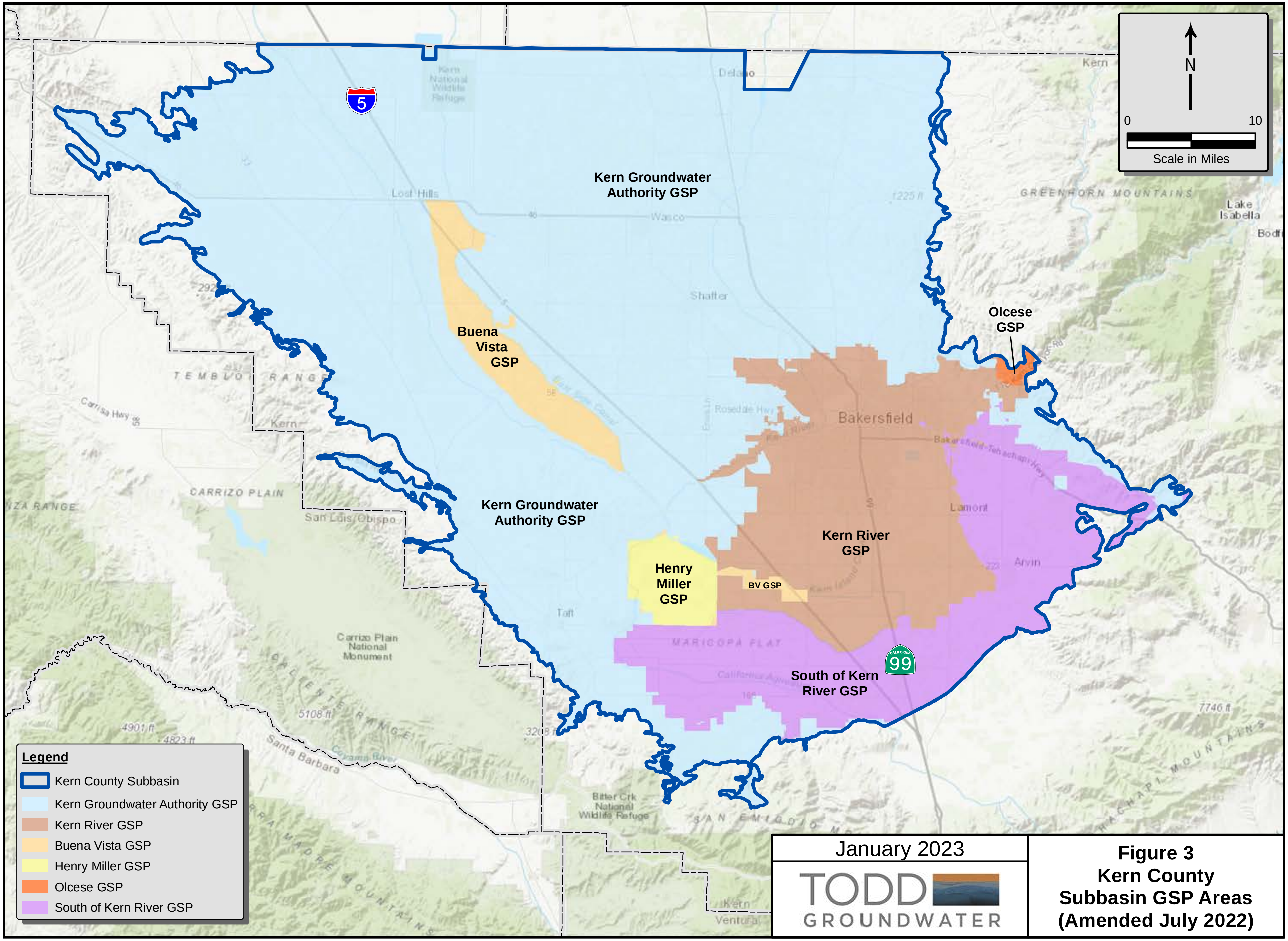


Figure 3
Kern County Subbasin GSP Areas (Amended July 2022)

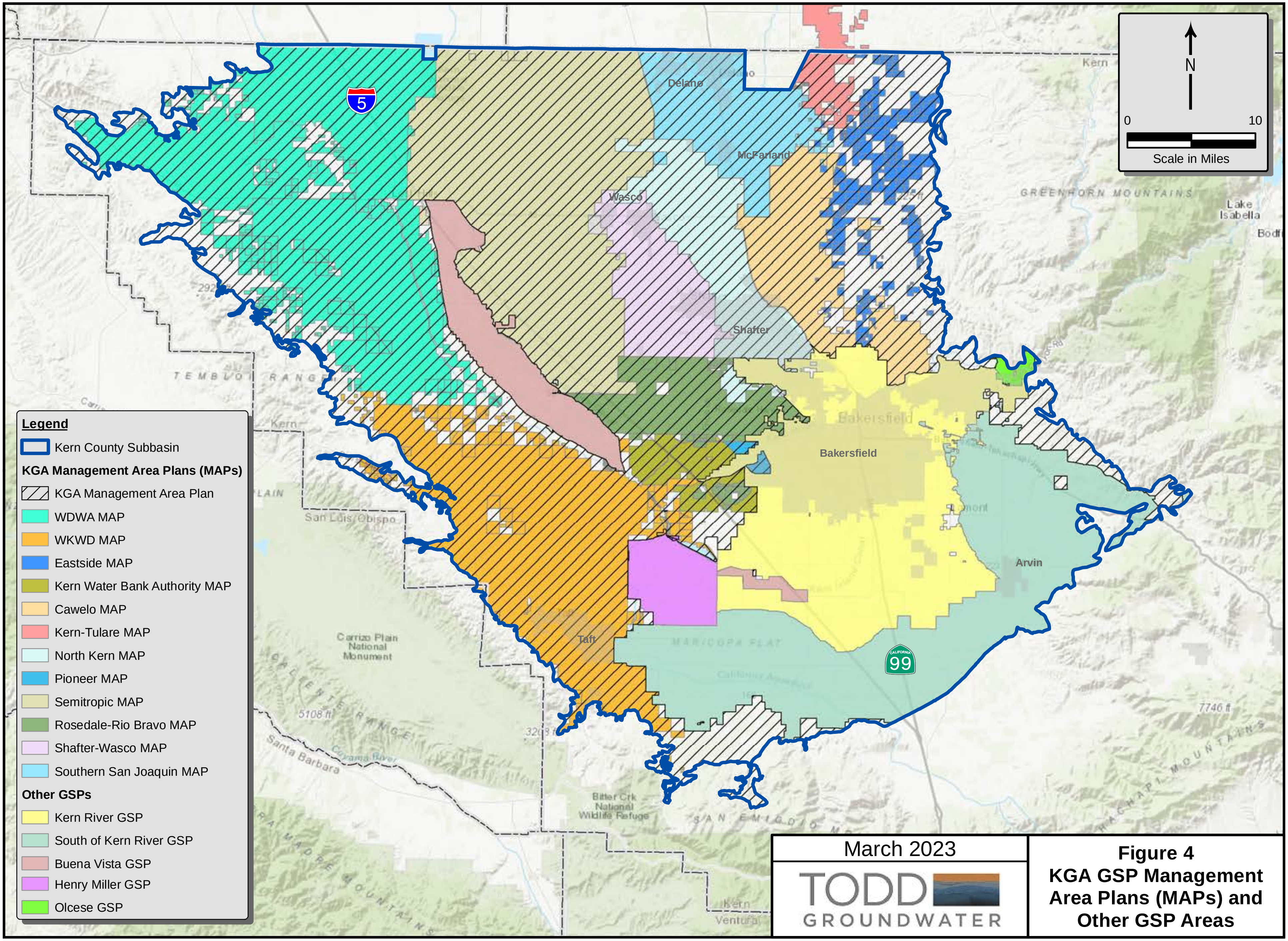
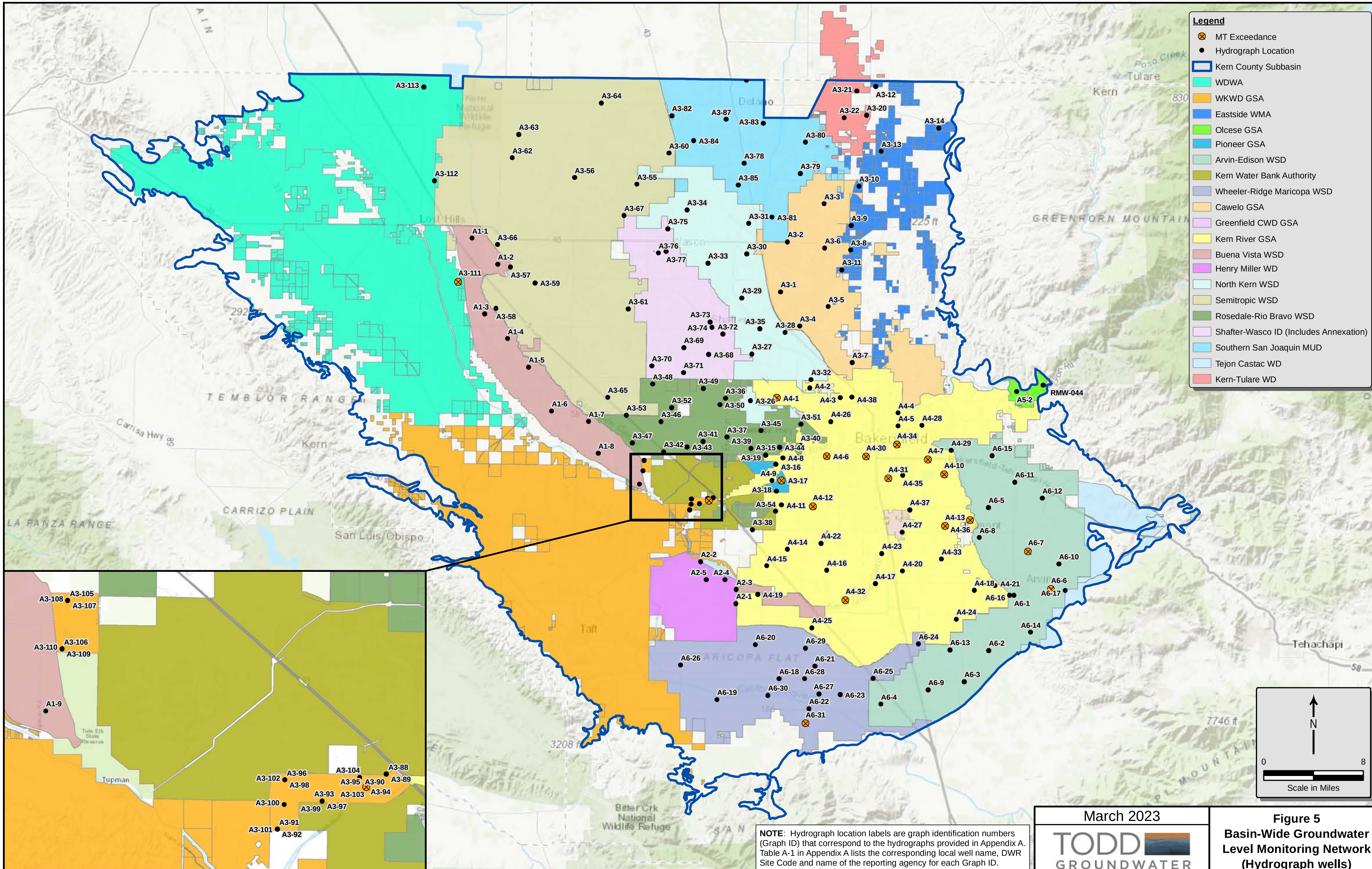
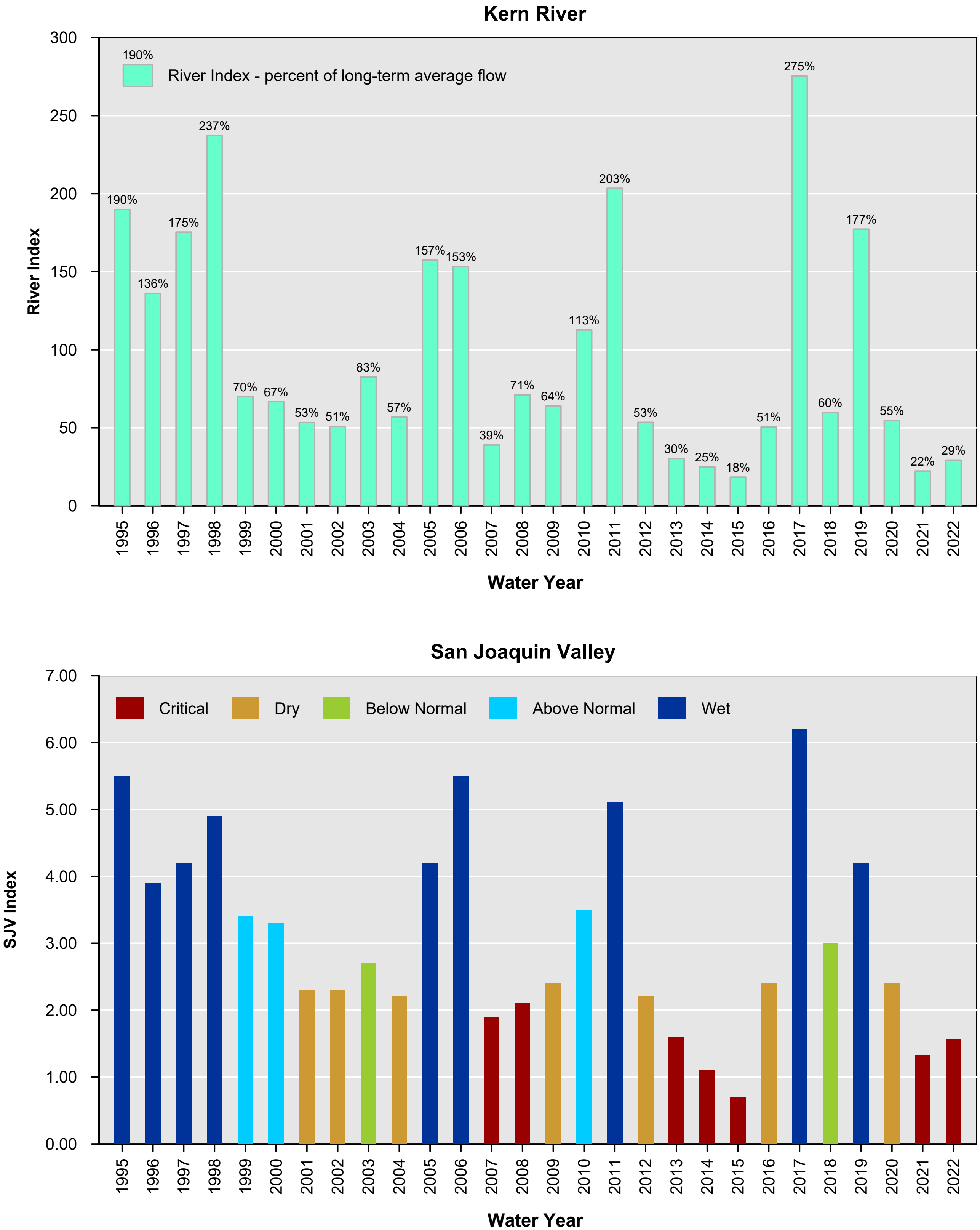


Figure 4
KGA GSP Management Area Plans (MAPs) and Other GSP Areas


Legend
MT Exceedance
Hydrograph Location
Kern County Subbasin
WDWA
WKWD GSA
Eastside WMA
Olcese GSA
Pioneer GSA
Arvin-Edison WSD
Kern Water Bank Authority
Wheeler-Ridge Maricopa WSD
Cawelo GSA
Greenfield CWD GSA
Kern River GSA
Buena Vista WSD
Henry Miller WD
North Kern WSD
Semitropic WSD
Rosedale-Rio Bravo WSD
Shafter-Wasco ID (Includes Annexation)
Southern San Joaquin MUD
Tejon Castac WD
Kern-Tulare WD
N
0
8
Scale in Miles
NOTE: Hydrograph location labels are graph identification numbers (Graph ID) that correspond to the hydrographs provided in Appendix A. Table A-1 in Appendix A lists the corresponding local well name, DWR Site Code and name of the reporting agency for each Graph ID.
March 2023
TODD GROUNDWATER
Figure 5
Basin-Wide Groundwater Level Monitoring Network (Hydrograph wells)



Data Sources:
California Data Exchange Center (CDEC, 2023)
City of Bakersfield, Updated Kern River Indices by WY (received 2/15/2023)

March 2023

TODD GROUNDWATER

Figure 6
Water Year Types, Kern River and San Joaquin Valley Indices, WY 1995-2022

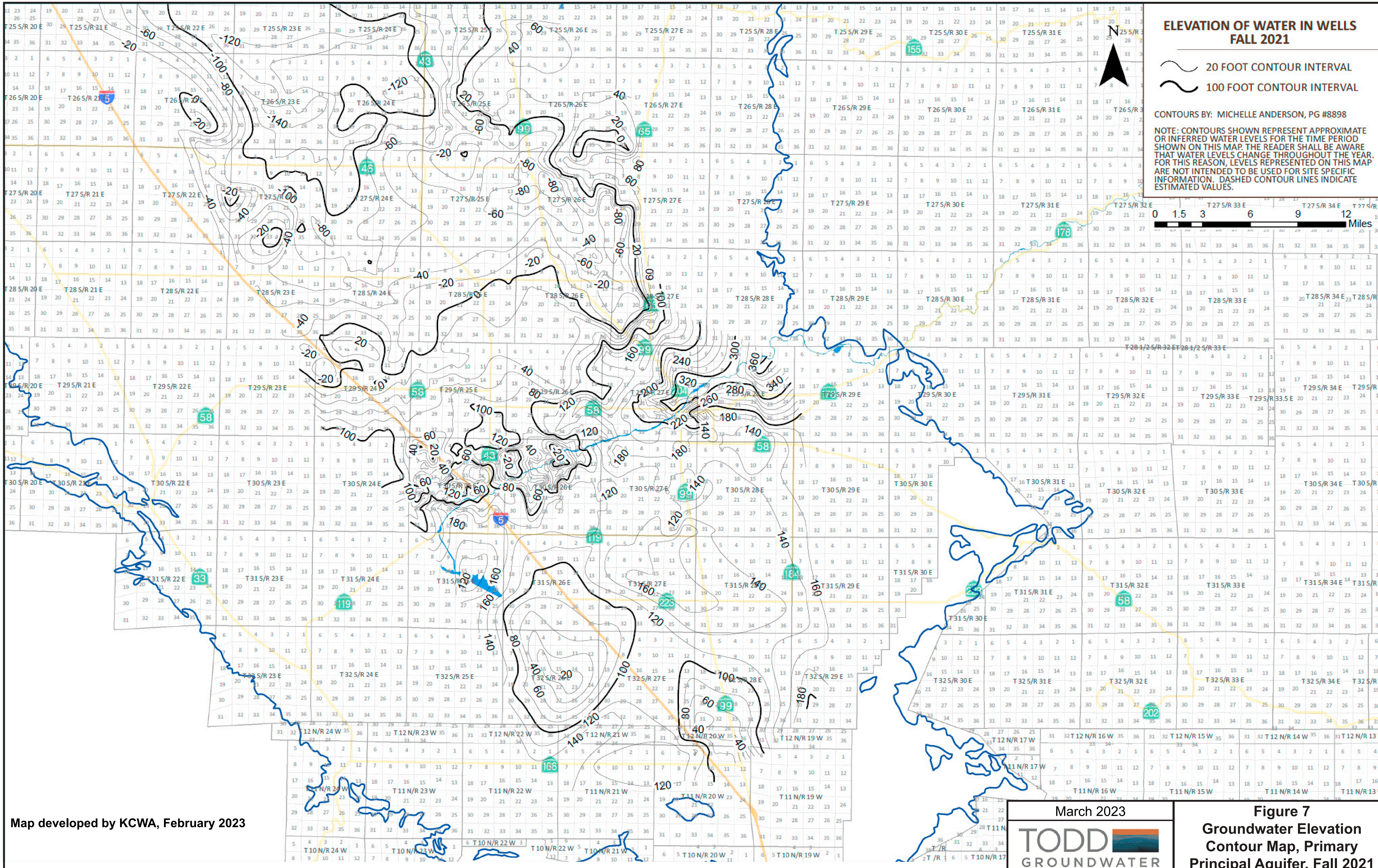


Figure 7
Groundwater Elevation Contour Map, Primary Principal Aquifer, Fall 2021

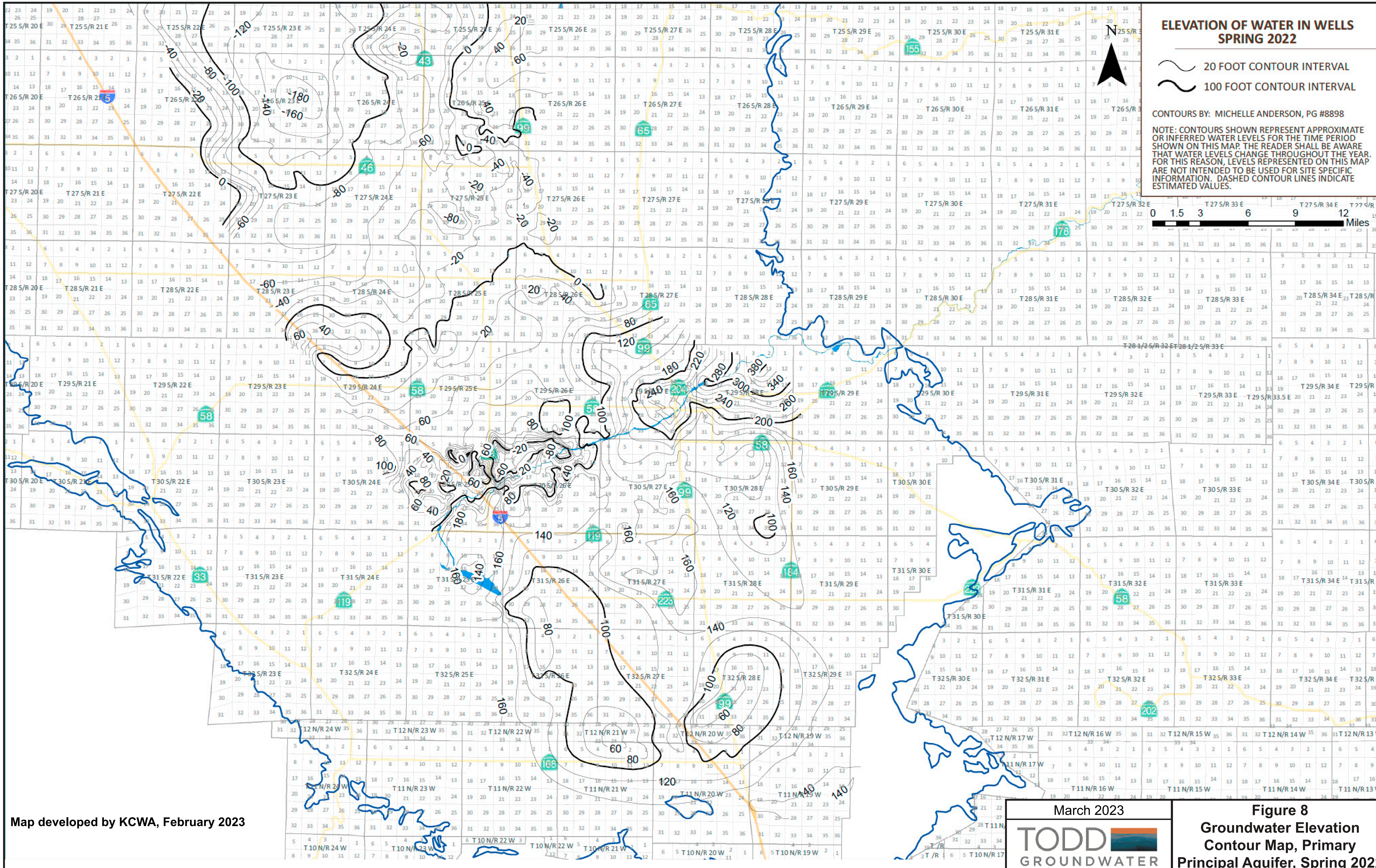


Figure 8
Groundwater Elevation Contour Map, Primary Principal Aquifer, Spring 2022

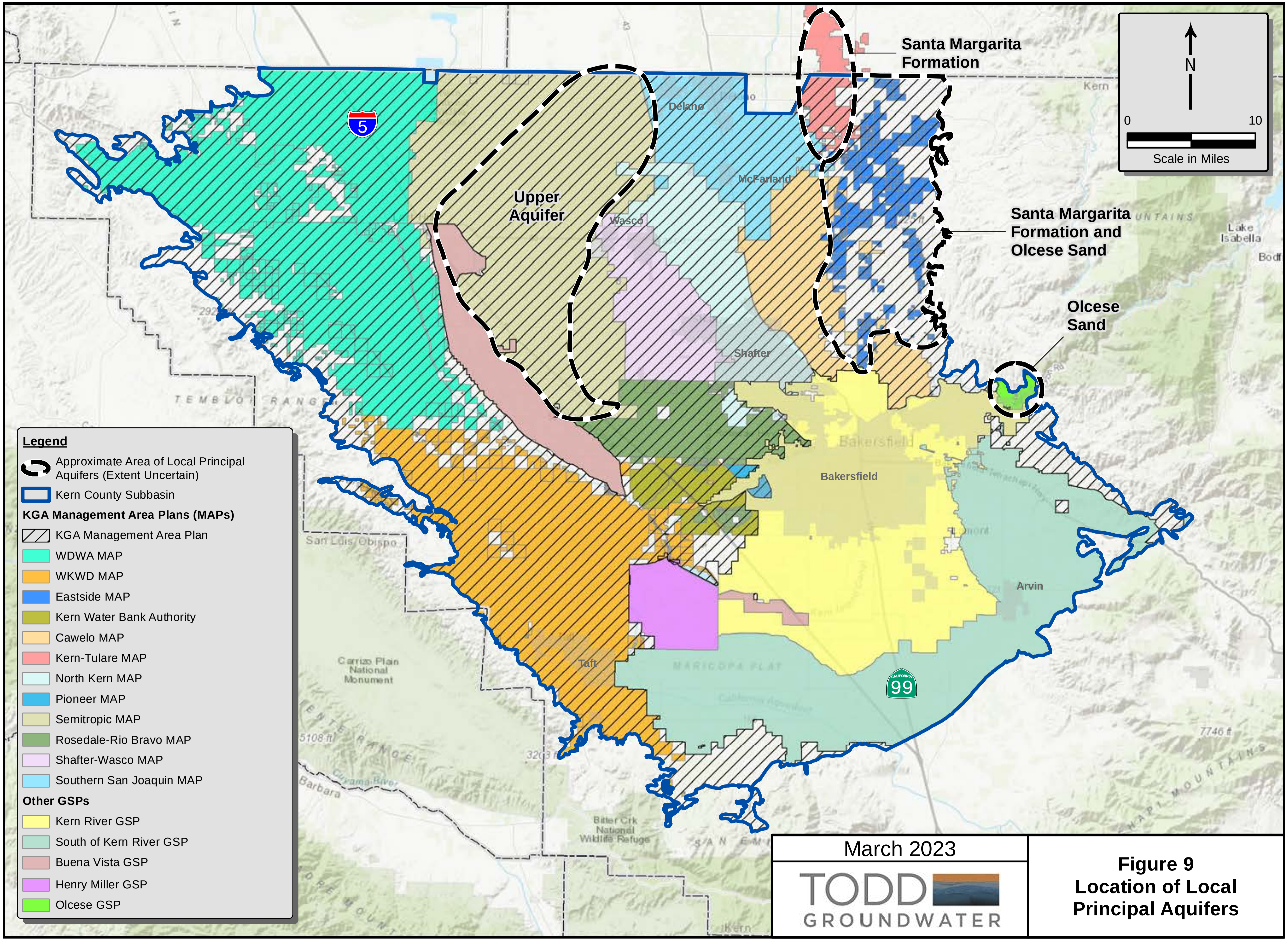
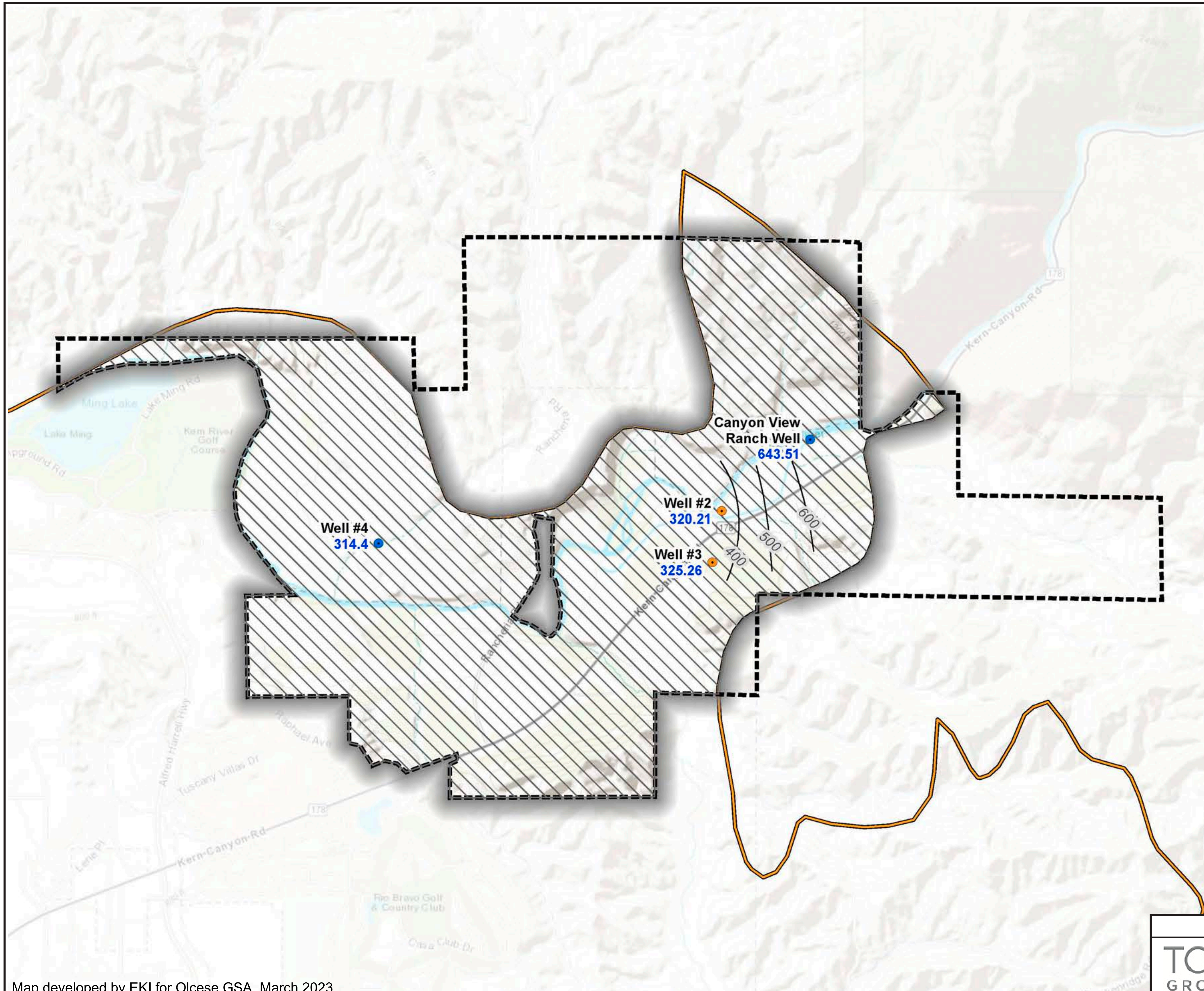


Figure 9
Location of Local Principal Aquifers



Legend

- Olcese Water District
- Olcese Water District GSA
- Kern County Subbasin (DWR 5-022.14)
- GW Level Contour
- GW Level Representative Monitoring Site
- Other GW Level Measurement Location

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
GW = groundwater

Notes

1. All locations are approximate.
2. Groundwater levels measured on 24 September 2021.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 March 2023.

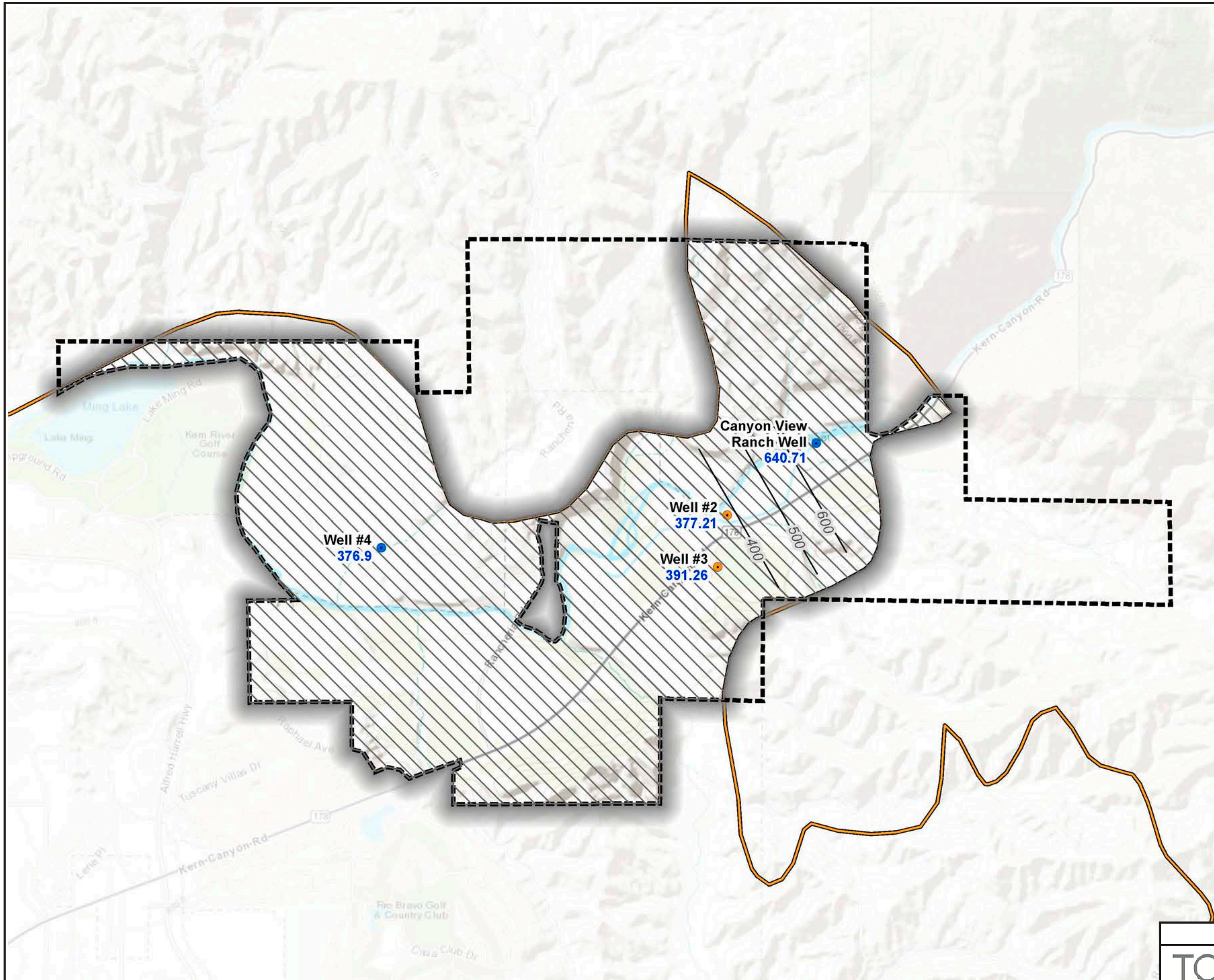
N

0 0.5 1
Miles

March 2023

TODD GROUNDWATER

Figure 10
Groundwater Elevation Contour Map, Olcese Sand Principal Aquifer, Fall 2021



Map developed by EKI for Olcese GSA, March 2023

Legend
- Olcese Water District
- Olcese Water District GSA
- Kern County Subbasin (DWR 5-022.14)
- GW Level Contour
- GW Level Representative Monitoring Site
- Other GW Level Measurement Location

Abbreviations

DWR	=	California Department of Water Resources
GSA	=	Groundwater Sustainability Agency
GW	=	groundwater

Notes
1. All locations are approximate.
2. Groundwater levels measured on 29 March 2022..

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 7 March 2023.

N

0 0.5 1
Miles

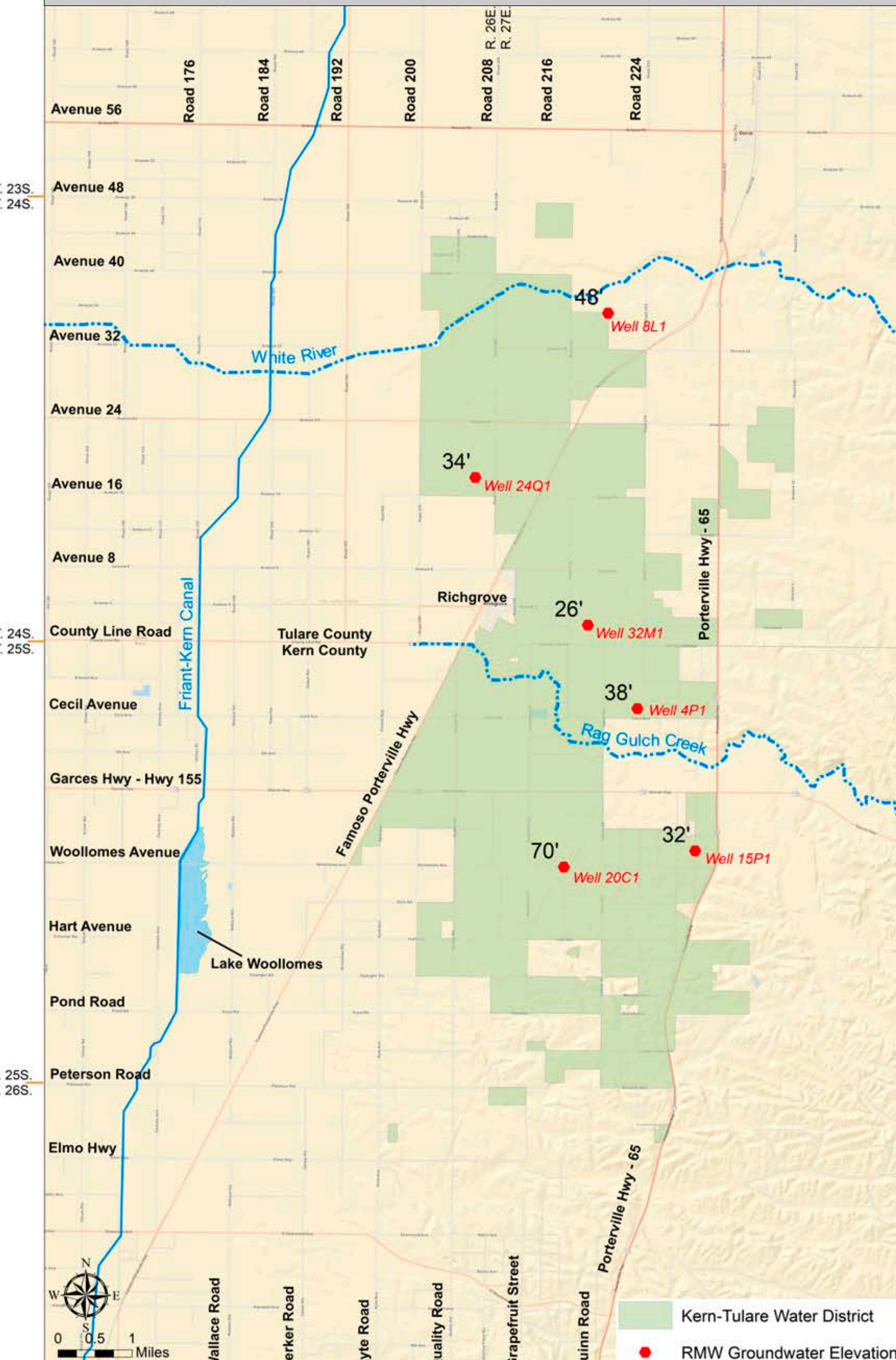
March 2023

TODD GROUNDWATER

Figure 11
Groundwater Elevation Contour Map, Olcese Sand Principal Aquifer, Spring 2022

Fall 2021 Santa Margarita Groundwater Elevations

Spring 2022 Santa Margarita Groundwater Elevations

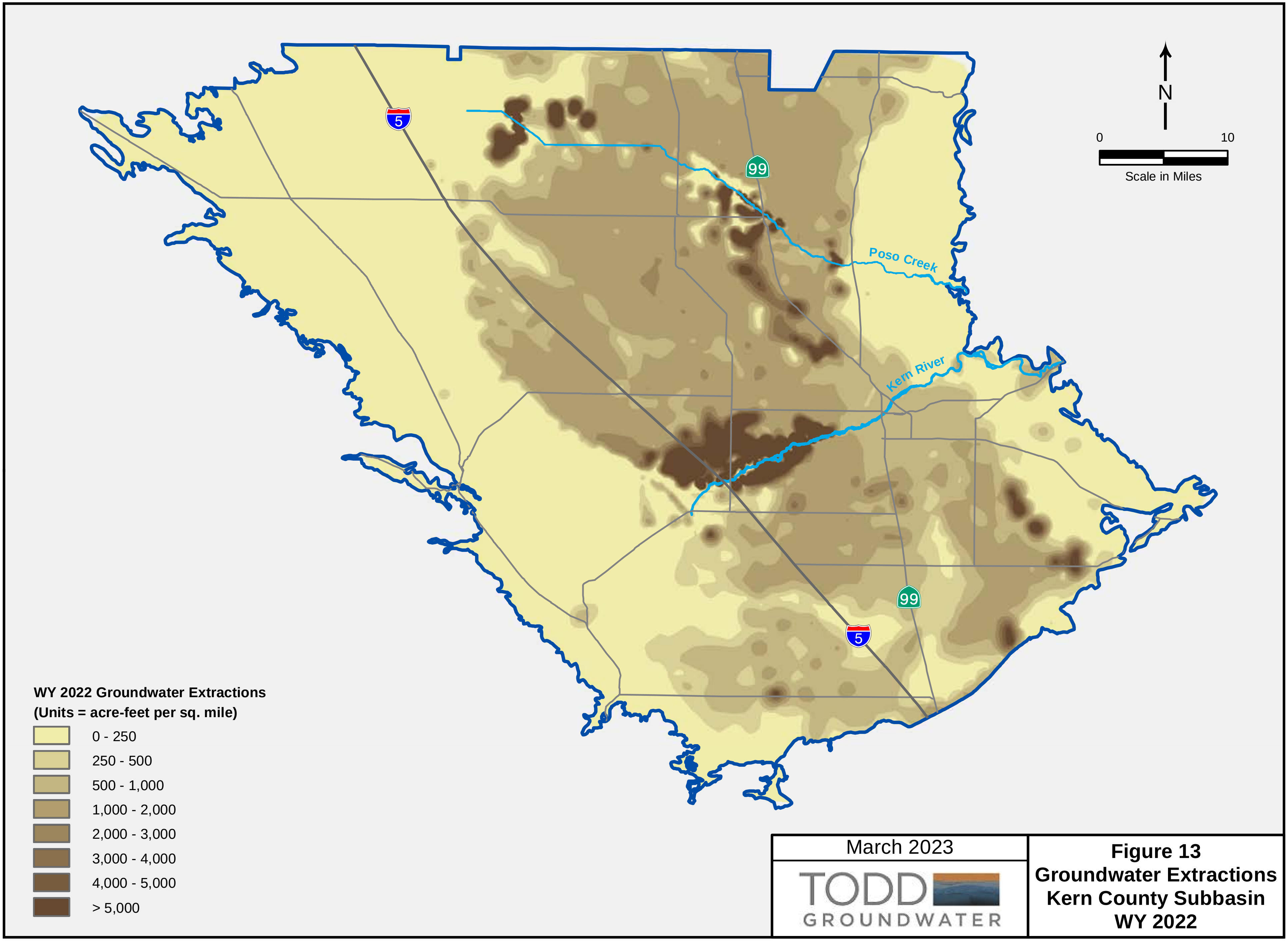


Source:
Kern-Tulare Water District (KTWD),
March 2023.

Figure 12
Groundwater Elevations, Santa Margarita Principal Aquifer, Fall 2021 and Spring 2022

March 2023

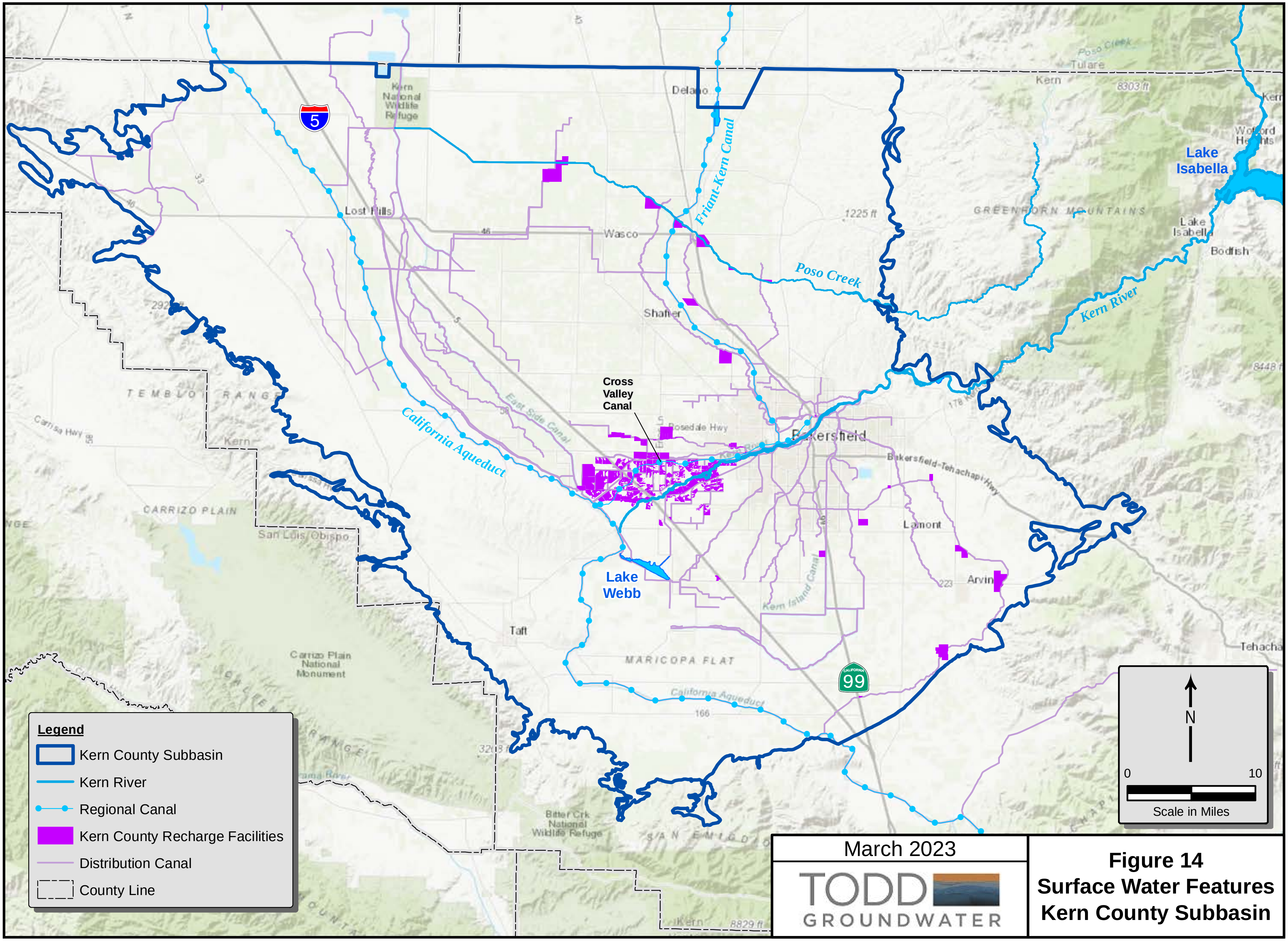
TODD GROUNDWATER



March 2023

TODD GROUNDWATER

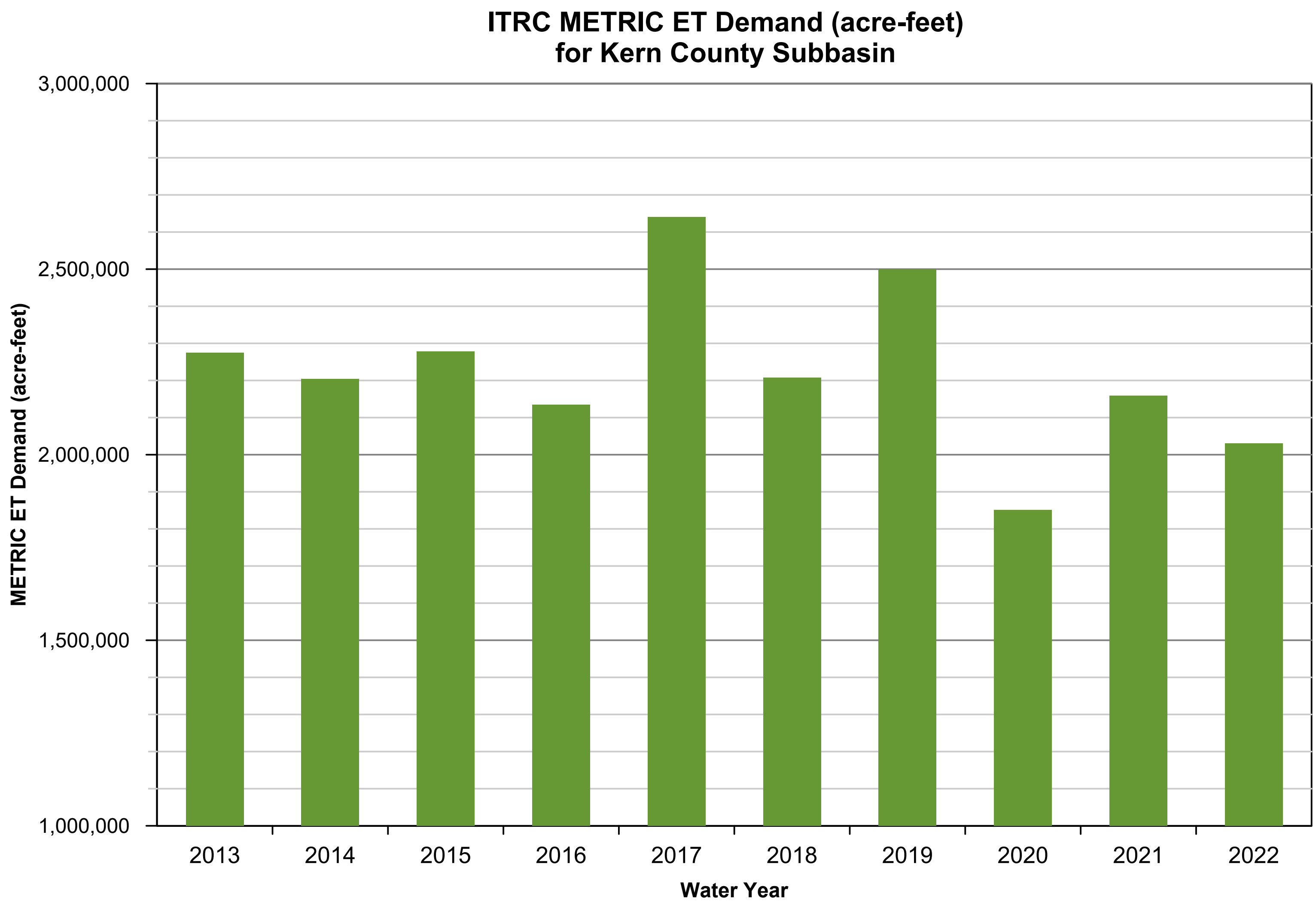
Figure 13
Groundwater Extractions
Kern County Subbasin
WY 2022



March 2023

TODD GROUNDWATER

Figure 14
Surface Water Features
Kern County Subbasin



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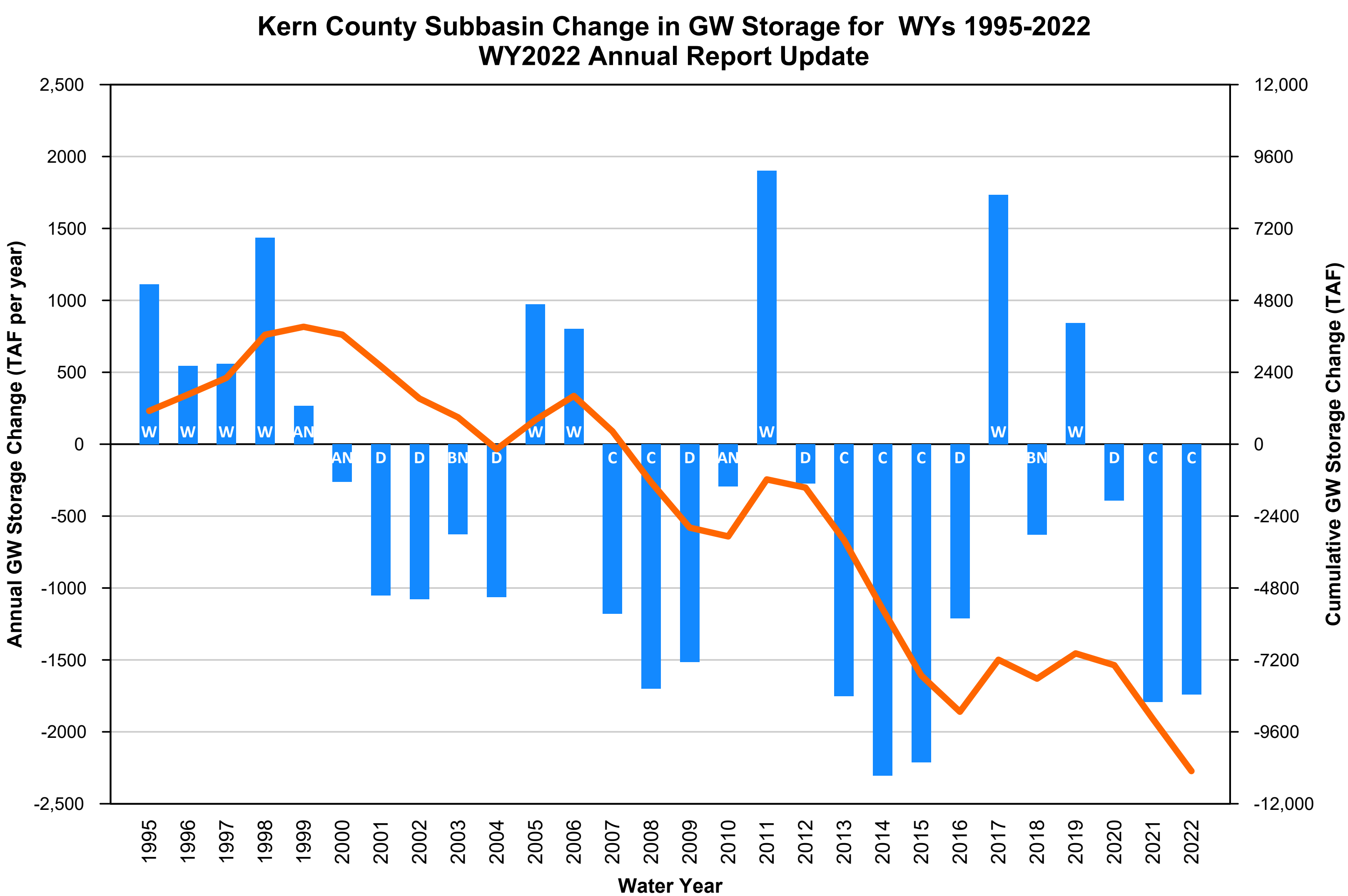
March 2023

TODD GROUNDWATER

Figure 15
ITRC METRIC ET Demand (acre-feet) for Kern County Subbasin



Annual Change in Groundwater Storage (TAF per year)

Cumulative Change in Groundwater Storage (TAF)

W Wet
AN Above Normal
BN Below Normal
D Dry
C Critically Dry

March 2023

TODD GROUNDWATER

Figure 16
Change in Groundwater in Storage
Kern County Subbasin
WY 1995 – WY 2022

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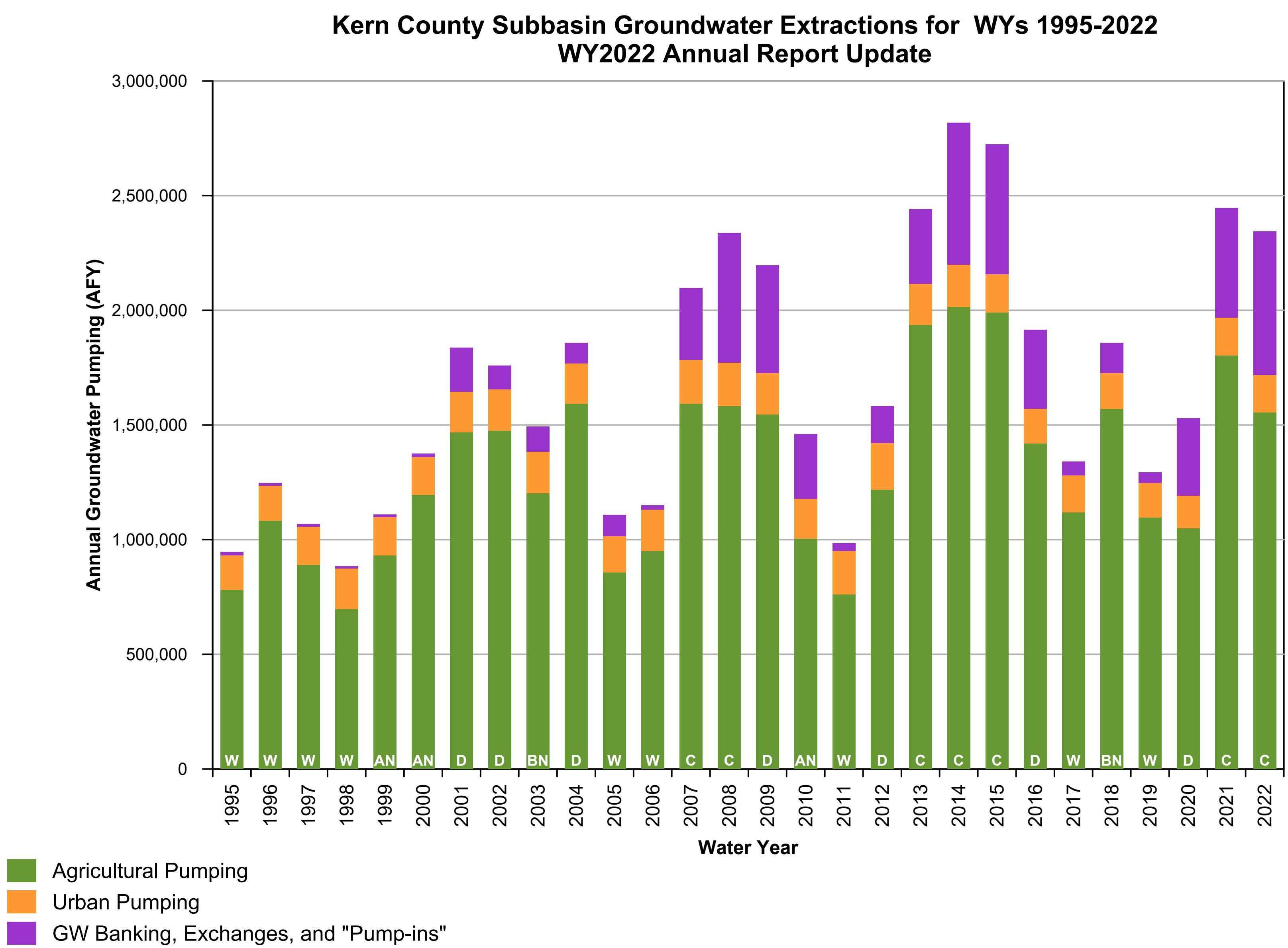


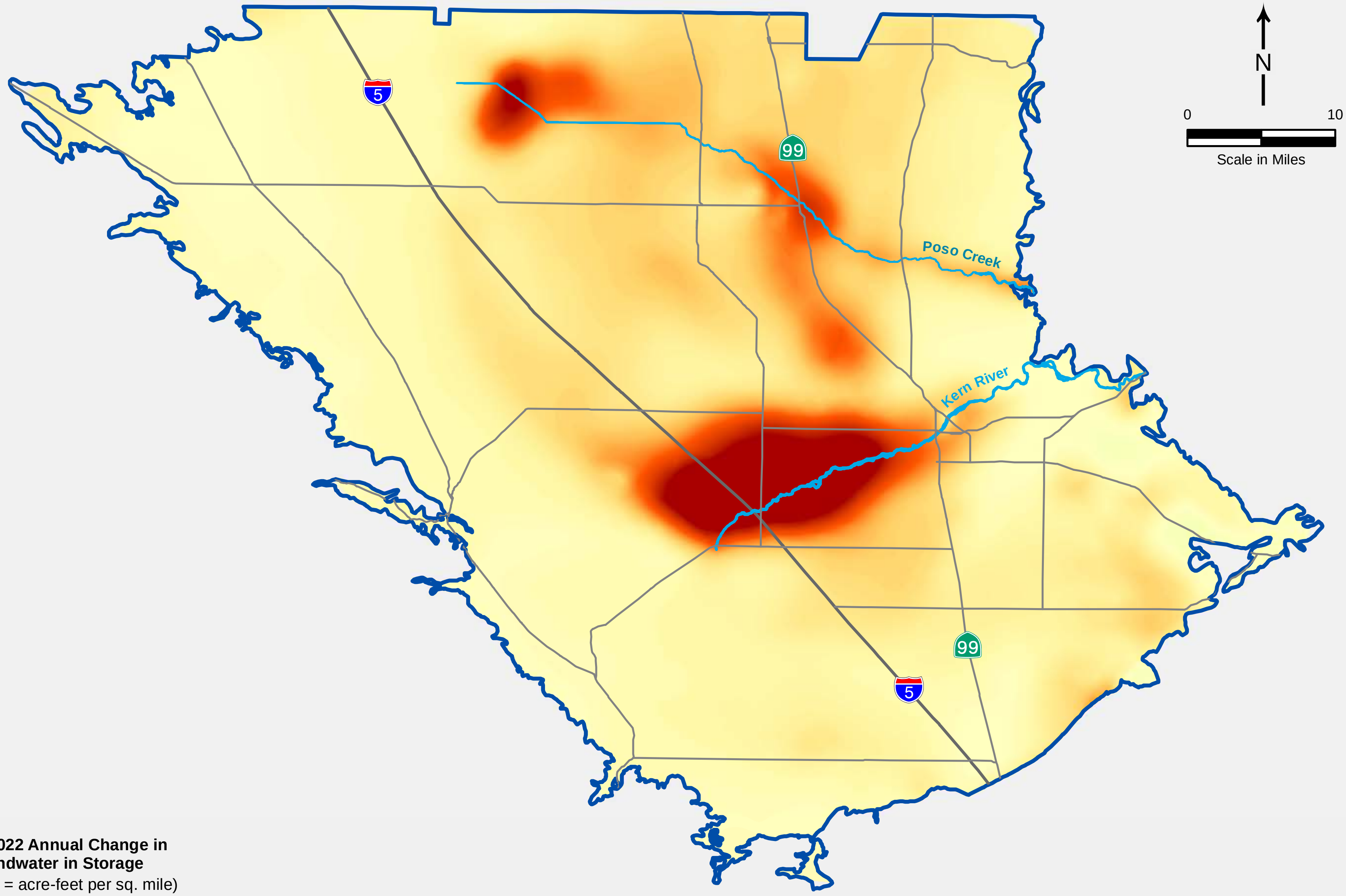
W Wet
AN Above Normal
BN Below Normal
D Dry
C Critically Dry

Path: T:\Projects\Kern 4th ANNUAL REPORT 62317\GRAPHICS\Figure17_Pumping_Chart.gpj

March 2023

TODD GROUNDWATER

Figure 17
Groundwater Extractions
WY 1995 – WY 2022



WY 2022 Annual Change in Groundwater in Storage
(Units = acre-feet per sq. mile)

High : 8000

Low : -4000

March 2023

TODD GROUNDWATER

Figure 18
Change in Groundwater in Storage Kern County Subbasin, WY 2022

APPENDIX A

Hydrographs of Groundwater Elevations

GSP Representative Monitoring Wells

Kern County Subbasin

WY 2022 Annual Report

Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA	WY2022 MT Exceedance
A1-1	DMW01	Buena Vista WSD GSA	356014N1196176W001	Buena Vista GSA	
A1-2	DMW02	Buena Vista WSD GSA	355716N1195808W001	Buena Vista GSA	
A1-3	DMW04	Buena Vista WSD GSA	355137N1195985W001	Buena Vista GSA	
A1-4	DMW05	Buena Vista WSD GSA	354854N1195648W001	Buena Vista GSA	
A1-5	DMW06	Buena Vista WSD GSA	354527N1195347W001	Buena Vista GSA	
A1-6	DMW07	Buena Vista WSD GSA	354021N1195011W001	Buena Vista GSA	
A1-7	DMW08	Buena Vista WSD GSA	353905N1194480W001	Buena Vista GSA	
A1-8	DMW10a	Buena Vista WSD GSA	353536N1194341W001	Buena Vista GSA	
A1-9	DMW12b	Buena Vista WSD GSA	353187N1193747W001	Buena Vista GSA	
A2-1	HMWD #18	Henry Miller WD GSA	351811N1192358W001	Henry Miller GSA	
A2-2	HMWD #20	Henry Miller WD GSA	352294N1192865W001	Henry Miller GSA	
A2-3	HMWD #26	Henry Miller WD GSA	351976N1192358W001	Henry Miller GSA	
A2-4	HMWD #27	Henry Miller WD GSA	352088N1192520W001	Henry Miller GSA	
A2-5	HMWD #28	Henry Miller WD GSA	352086N1192783W001	Henry Miller GSA	
A3-1	Well 33C	Cawelo Water District GSA	355439N1191781W001	KGA GSA	
A3-2	Well 4R	Cawelo Water District GSA	356023N1191690W001	KGA GSA	
A3-3	Well 24R	Cawelo Water District GSA	356469N1191175W001	KGA GSA	
A3-4	Well 11M	Cawelo Water District GSA	355044N1191502W001	KGA GSA	
A3-5	Well 6C	Cawelo Water District GSA	355274N1191100W001	KGA GSA	
A3-6	Well 12H	Cawelo Water District GSA	355954N1191160W001	KGA GSA	
A3-7	Well 28L	Cawelo Water District GSA	356023N1191691W001	KGA GSA	
A3-8	EWMA #21	Eastside Water Management Area	355935N1190787W001	KGA GSA	
A3-9	EWMA #23	Eastside Water Management Area	356220N1190790W001	KGA GSA	
A3-10	EWMA #30	Eastside Water Management Area	356421N1190690W001	KGA GSA	
A3-11	EWMA #41	Eastside Water Management Area	355706N1190911W001	KGA GSA	
A3-12	EWMA #04	Eastside Water Management Area	357840N1190456W001	KGA GSA	
A3-13	EWMA #10	Eastside Water Management Area	357085N1190370W001	KGA GSA	
A3-14	EWMA #49	Eastside Water Management Area	357364N1189549W001	KGA GSA	
A3-15	30S26E04J002M	Pioneer GSA	353434N1191816W001	KGA GSA	
A3-16	30S26E04J003M	Pioneer GSA	353434N1191816W002	KGA GSA	
A3-17	30S26E10P004M	Pioneer GSA	353250N1191739W001	KGA GSA	X

Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA	WY2022 MT Exceedance
A3-18	30S26E15N003M	Pioneer GSA	353123N1191805W001	KGA GSA	
A3-19	30S26E04D003M	Pioneer GSA	353543N1191966W001	KGA GSA	
A3-20	Well 15P1	Kern-Tulare Water District	357503N1190578W001	KGA GSA	
A3-21	Well 4P1	Kern-Tulare Water District	357781N1190720W001	KGA GSA	
A3-22	Well 20C1	Kern-Tulare Water District	357464N1190898W001	KGA GSA	
A3-23	Well 24Q1	Kern-Tulare Water District	358231N1191126W001	KGA GSA	
A3-24	Well 32M1	Kern-Tulare Water District	357944N1190845W001	KGA GSA	
A3-25	Well 8L1	Kern-Tulare Water District	358561N1190806W001	KGA GSA	
A3-26	DW097	North Kern WSD	354172N1192190W001	KGA GSA	
A3-27	3361-62	North Kern WSD	354714N1192174W001	KGA GSA	
A3-28	88-03-009R	North Kern WSD	354970N1191706W001	KGA GSA	
A3-29	88-09-009	North Kern WSD	355364N1192330W001	KGA GSA	
A3-30	88-21-005	North Kern WSD	355878N1192269W001	KGA GSA	
A3-31	88-29-014	North Kern WSD	356232N1192245W001	KGA GSA	
A3-32	99-00-003	North Kern WSD	354424N1191332W001	KGA GSA	
A3-33	99-00-081	North Kern WSD	355764N1192818W001	KGA GSA	
A3-34	99-22-084	North Kern WSD	356380N1193124W001	KGA GSA	
A3-35	Shafter Well 18	North Kern WSD	355010N1192067W001	KGA GSA	
A3-36	RBG School	Rosedale-Rio Bravo WSD	354197N1192544W001	KGA GSA	
A3-37	25M Enos	Rosedale-Rio Bravo WSD	353760N1192498W002	KGA GSA	
A3-38	32N Triple	Rosedale-Rio Bravo WSD	352673N1192138W002	KGA GSA	
A3-39	31H Greeley	Rosedale-Rio Bravo WSD	353618N1192169W001	KGA GSA	
A3-40	35H RRBWSD Shop	Rosedale-Rio Bravo WSD	353620N1191457W002	KGA GSA	
A3-41	27N_Mayer	Rosedale-Rio Bravo WSD	353699N1192856W002	KGA GSA	
A3-42	West I-5	Rosedale-Rio Bravo WSD	353564N1193412W001	KGA GSA	
A3-43	Virgil Bussell	Rosedale-Rio Bravo WSD	353619N1193099W001	KGA GSA	
A3-44	Harvest Ranch	Rosedale-Rio Bravo WSD	353634N1191766W001	KGA GSA	
A3-45	Home Place	Rosedale-Rio Bravo WSD	353824N1192035W001	KGA GSA	
A3-46	Blacco HQ	Rosedale-Rio Bravo WSD	353915N1193454W001	KGA GSA	
A3-47	Parsons	Rosedale-Rio Bravo WSD	353663N1193859W001	KGA GSA	
A3-48	Bushnell	Rosedale-Rio Bravo WSD	354350N1193586W001	KGA GSA	

Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA	WY2022 MT Exceedance
A3-49	L.R. Stout	Rosedale-Rio Bravo WSD	354309N1192859W001	KGA GSA	
A3-50	P. Enns Domestic	Rosedale-Rio Bravo WSD	354121N1192623W001	KGA GSA	
A3-51	Chet Reed	Rosedale-Rio Bravo WSD	353890N1191471W001	KGA GSA	
A3-52	Section 18	Rosedale-Rio Bravo WSD	354090N1193318W001	KGA GSA	
A3-53	Cauzza	Rosedale-Rio Bravo WSD	353986N1193948W001	KGA GSA	
A3-54	28J Triple	Rosedale-Rio Bravo WSD	352889N1191814W001	KGA GSA	
A3-55	S-14B Cluster 2 of 2	Semitropic WSD	356668N1193841W002	KGA GSA	
A3-56	26S-23E-15A1	Semitropic WSD	356736N1194735W001	KGA GSA	
A3-57	S-2	Semitropic WSD	355687N1195623W001	KGA GSA	
A3-58	S-4	Semitropic WSD	355205N1195821W001	KGA GSA	
A3-59	S-5	Semitropic WSD	355506N1195271W001	KGA GSA	
A3-60	S-6	Semitropic WSD	357036N1193392W001	KGA GSA	
A3-61	S-9A Cluster 1 of 2	Semitropic WSD	355219N1193943W001	KGA GSA	
A3-62	S-11	Semitropic WSD	356956N1195623W001	KGA GSA	
A3-63	S-12	Semitropic WSD	357228N1195538W001	KGA GSA	
A3-64	S-13A Cluster 1 of 2	Semitropic WSD	357609N1194366W001	KGA GSA	
A3-65	948L02 Cluster1 of 2	Semitropic WSD	354189N1194216W001	KGA GSA	
A3-66	S-1	Semitropic WSD	355944N1195814W001	KGA GSA	
A3-67	S-8A Cluster 1 of 2	Semitropic WSD	356305N1194021W001	KGA GSA	
A3-68	Shafter Well 15	Shafter-Wasco Irrigation District	354705N1192792W001	KGA GSA	
A3-69	28S/25E-19G	Shafter-Wasco Irrigation District	354779N1193145W001	KGA GSA	
A3-70	28S/24E-35C	Shafter-Wasco Irrigation District	354561N1193595W001	KGA GSA	
A3-71	Well 31J	Shafter-Wasco Irrigation District	354494N1193182W001	KGA GSA	
A3-72	Shafter Well 14	Shafter-Wasco Irrigation District	354943N1192593W001	KGA GSA	
A3-73	Shafter Well 7	Shafter-Wasco Irrigation District	355080N1192777W001	KGA GSA	
A3-74	Shafter Well 12	Shafter-Wasco Irrigation District	355020N1192748W001	KGA GSA	
A3-75	Wasco 12	Shafter-Wasco Irrigation District	356157N1193397W001	KGA GSA	
A3-76	Wasco 8A	Shafter-Wasco Irrigation District	355874N1193523W001	KGA GSA	
A3-77	Wasco 11	Shafter-Wasco Irrigation District	355891N1193417W001	KGA GSA	
A3-78	SSJMUD-42	Southern San Joaquin MUD	356930N1192320W001	KGA GSA	
A3-79	SSJMUD-59	Southern San Joaquin MUD	356820N1191517W001	KGA GSA	

Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA	WY2022 MT Exceedance
A3-80	SSJMUD-62	Southern San Joaquin MUD	357184N1191449W001	KGA GSA	
A3-81	SSJMUD-53	Southern San Joaquin MUD	356307N1191912W001	KGA GSA	
A3-82	SSJMUD-8	Southern San Joaquin MUD	357470N1193360W001	KGA GSA	
A3-83	SSJMUD-14	Southern San Joaquin MUD	357395N1192052W001	KGA GSA	
A3-84	SSJMUD-23	Southern San Joaquin MUD	357185N1193042W001	KGA GSA	
A3-85	McFarland Taylor Ave Well	Southern San Joaquin MUD	356675N1192402W001	KGA GSA	
A3-86	Delano 30	Southern San Joaquin MUD	357898N1192302W001	KGA GSA	
A3-87	Delano 34	Southern San Joaquin MUD	357436N1192587W001	KGA GSA	
A3-88	23M-S	West Kern Water District	353037N1192699W001	KGA GSA	
A3-89	23M-M	West Kern Water District	353037N1192699W002	KGA GSA	
A3-90	23M-D	West Kern Water District	353037N1192699W003	KGA GSA	
A3-91	28E-3-M	West Kern Water District	352895N1193032W002	KGA GSA	
A3-92	28E-D	West Kern Water District	352895N1193032W003	KGA GSA	
A3-93	21R-D	West Kern Water District	352967N1192895W003	KGA GSA	
A3-94	22K-M	West Kern Water District	353005N1192761W002	KGA GSA	
A3-95	22K-D	West Kern Water District	353005N1192761W003	KGA GSA	**X**
A3-96	21L-M	West Kern Water District	353020N1193011W002	KGA GSA	
A3-97	21R-M	West Kern Water District	352967N1192895W002	KGA GSA	
A3-98	21L-S	West Kern Water District	353020N1193011W001	KGA GSA	
A3-99	21R-S	West Kern Water District	352967N1192895W001	KGA GSA	
A3-100	WKWD 7	West Kern Water District	352958N1193011W001	KGA GSA	
A3-101	28E-4-S	West Kern Water District	352895N1193032W001	KGA GSA	
A3-102	21L-D	West Kern Water District	353020N1193011W003	KGA GSA	
A3-103	22K-S	West Kern Water District	353005N1192761W001	KGA GSA	
A3-104	Well 6-04	West Kern Water District	353028N1192780W001	KGA GSA	
A3-105	NWM1-S	West Kern Water District	353464N1193684W004	KGA GSA	
A3-106	NWM2-S	West Kern Water District	353342N1193700W004	KGA GSA	
A3-107	NWM1-M	West Kern Water District	353464N1193684W006	KGA GSA	
A3-108	NWM1-D	West Kern Water District	353464N1193684W007	KGA GSA	
A3-109	NWM2-M	West Kern Water District	353342N1193700W006	KGA GSA	
A3-110	NWM2-D	West Kern Water District	353342N1193700W007	KGA GSA	

Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA	WY2022 MT Exceedance
A3-111	7106-63	Westside District Water Authority	355505N1196368W001	KGA GSA	X
A3-112	S#14	Westside District Water Authority	356675N1196724W001	KGA GSA	
A3-113	7108-66	Westside District Water Authority	357762N1196902W001	KGA GSA	
A4-1	RMW-017	Kern River GSA	354206N1191817W001	Kern River GSA	X
A4-2	RMW-018	Kern River GSA	354344N1191337W001	Kern River GSA	
A4-3	RMW-019	Kern River GSA	354199N1190931W001	Kern River GSA	
A4-4	RMW-020	Kern River GSA	354048N1190102W001	Kern River GSA	
A4-5	RMW-021	Kern River GSA	353898N1190087W001	Kern River GSA	
A4-6	RMW-025	Kern River GSA	353539N1191118W001	Kern River GSA	X
A4-7	RMW-026	Kern River GSA	353512N1189673W001	Kern River GSA	X
A4-8	RMW-028	Kern River GSA	353508N1191723W001	Kern River GSA	
A4-9	RMW-029	Kern River GSA	353247N1191870W001	Kern River GSA	
A4-10	RMW-030	Kern River GSA	353328N1189409W001	Kern River GSA	X
A4-11	RMW-031	Kern River GSA	352964N1191741W003	Kern River GSA	
A4-12	RMW-032	Kern River GSA	352953N1191285W001	Kern River GSA	X
A4-13	RMW-034	Kern River GSA	352747N1189435W001	Kern River GSA	X
A4-14	RMW-35R	Kern River GSA	352450N1191640W001	Kern River GSA	
A4-15	RMW-037	Kern River GSA	352269N1191923W001	Kern River GSA	
A4-16	RMW-038	Kern River GSA	352233N1191281W001	Kern River GSA	
A4-17	RMW-040	Kern River GSA	352083N1190362W001	Kern River GSA	
A4-18	RMW-041	Kern River GSA	352027N1188996W001	Kern River GSA	
A4-19	RMW-042	Kern River GSA	351922N1192052W001	Kern River GSA	
A4-20	RMW-192	Kern River GSA	352220N1190000W001	Kern River GSA	
A4-21	RMW-193	Kern River GSA	352080N1188710W001	Kern River GSA	
A4-22	RMW-195	Kern River GSA	352510N1191160W001	Kern River GSA	
A4-23	RMW-196	Kern River GSA	352410N1190280W001	Kern River GSA	
A4-24	RMW-197	Kern River GSA	351656N1189234W001	Kern River GSA	
A4-25	RMW-200	Kern River GSA	351541N1191289W001	Kern River GSA	
A4-26	RMW-201	Kern River GSA	353941N1191043W001	Kern River GSA	
A4-27	RMW-202	Kern River GSA	352662N1190015W001	Kern River GSA	
A4-28	RMW-210	Kern River GSA	353907N1189752W001	Kern River GSA	

Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA	WY2022 MT Exceedance
A4-29	RMW-212	Kern River GSA	353618N1189334W001	Kern River GSA	
A4-30	RMW-213	Kern River GSA	353536N1190539W001	Kern River GSA	X
A4-31	RMW-214	Kern River GSA	353286N1190221W001	Kern River GSA	X
A4-32	RMW-218	Kern River GSA	351867N1190820W001	Kern River GSA	X
A4-33	RMW-219	Kern River GSA	352389N1189485W001	Kern River GSA	
A4-34	RMW-211	Kern River GSA	353681N1190101W001	Kern River GSA	X
A4-35	RMW-215	Kern River GSA	353325N1190016W001	Kern River GSA	
A4-36	RMW-217	Kern River GSA	352800N1189080W001	Kern River GSA	X
A4-37	RMW-216	Kern River GSA	352924N1189911W001	Kern River GSA	
A4-38	RMW-209	Kern River GSA	354226N1190748W001	Kern River GSA	
A5-1	Canyon View Ranch	Olcese Water District	354386N1188035W002	Olcese GSA	
A5-2	Well #4	Olcese Water District	354310N1188411W002	Olcese GSA	
A6-1	31S29E34A001M	Arvin-Edison WSD	351944N1188423W001	SOKR GSA	
A6-2	32S29E20H001M	Arvin-Edison WSD	351300N1188781W001	SOKR GSA	
A6-3	32S29E31N001M	Arvin-Edison WSD	350931N1189123W001	SOKR GSA	
A6-4	11N20W05J001S	Arvin-Edison WSD	350669N1190295W001	SOKR GSA	
A6-5	30S29E29A001M	Arvin-Edison WSD	352958N1188807W001	SOKR GSA	
A6-6	31S30E30J001M	Arvin-Edison WSD	352017N1187987W001	SOKR GSA	X
A6-7	31S29E12M001M	Arvin-Edison WSD	352452N1188243W001	SOKR GSA	X
A6-8	31S29E05E001M	Arvin-Edison WSD	352605N1188932W001	SOKR GSA	
A6-9	12N20W36G001S	Arvin-Edison WSD	350833N1189632W001	SOKR GSA	
A6-10	31S30E17K001M	Arvin-Edison WSD	352311N1187790W001	SOKR GSA	
A6-11	30S29E11N001M	Arvin-Edison WSD	353269N1188418W001	SOKR GSA	
A6-12	30S30E19E001M	Arvin-Edison WSD	353072N1188037W001	SOKR GSA	
A6-13	32S28E23H001M	Arvin-Edison WSD	351300N1189357W001	SOKR GSA	
A6-14	32S29E12P001M	Arvin-Edison WSD	351522N1188199W001	SOKR GSA	
A6-15	29S29E33N001M	Arvin-Edison WSD	353577N1188771W001	SOKR GSA	
A6-16	ACSD Well #14	Arvin-Edison WSD	351942N1188484W001	SOKR GSA	
A6-17	Caratan Well (RMS-1)	Tejon-Castac Water District	352002N1187698W001	SOKR GSA	
A6-18	32S26E34P001M	Wheeler Ridge-Maricopa WSD	350943N1191736W001	SOKR GSA	
A6-19	11N22W06H001S	Wheeler Ridge-Maricopa WSD	350686N1192609W001	SOKR GSA	

Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

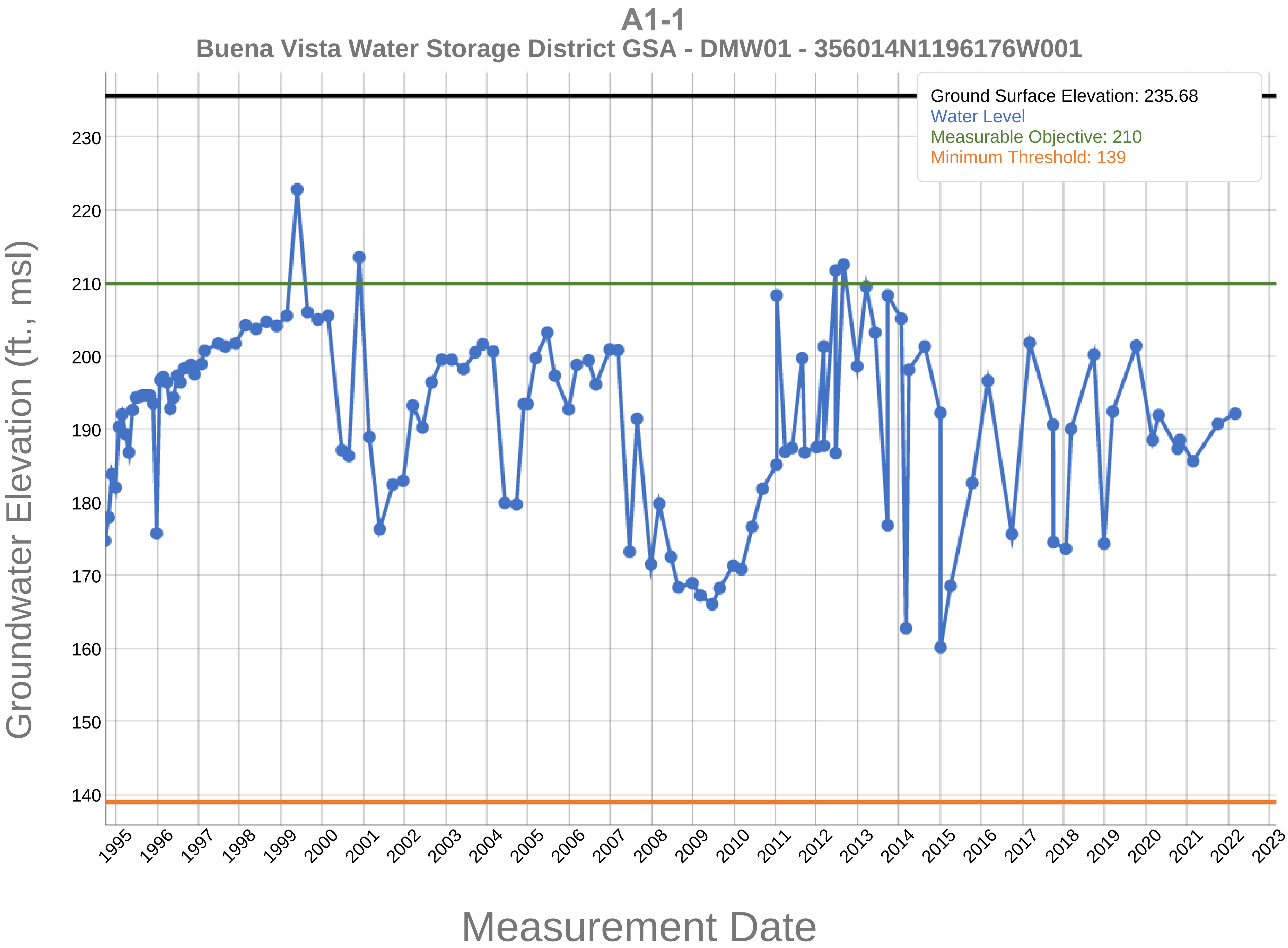
Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA	WY2022 MT Exceedance
A6-20	32S26E20G001M	Wheeler Ridge-Maricopa WSD	351303N1192078W001	SOKR GSA	
A6-21	32S27E30N001M	Wheeler Ridge-Maricopa WSD	351092N1191270W001	SOKR GSA	
A6-22	11N21W09C001S	Wheeler Ridge-Maricopa WSD	350592N1191328W001	SOKR GSA	
A6-23	12N21W35Q001S	Wheeler Ridge-Maricopa WSD	350769N1190871W001	SOKR GSA	
A6-24	32S28E16P001M	Wheeler Ridge-Maricopa WSD	351397N1189767W001	SOKR GSA	
A6-25	32S27E35R001M	Wheeler Ridge-Maricopa WSD	350961N1190435W001	SOKR GSA	
A6-26	32S25E29Q001M	Wheeler Ridge-Maricopa WSD	351083N1193140W001	SOKR GSA	
A6-27	12N21W34N001S	Wheeler Ridge-Maricopa WSD	350772N1191178W001	SOKR GSA	
A6-28	32S26E36P002M	Wheeler Ridge-Maricopa WSD	350947N1191370W001	SOKR GSA	
A6-29	32S26E24K001M	Wheeler Ridge-Maricopa WSD	351304N1191366W001	SOKR GSA	
A6-30	11N22W01D001S	Wheeler Ridge-Maricopa WSD	350750N1191892W001	SOKR GSA	
A6-31	11N21W16E001S	Wheeler Ridge-Maricopa WSD	350428N1191355W001	SOKR GSA	**X**

APPENDIX A1

Hydrographs of Groundwater Elevations

GSP Monitoring Network Wells

Buena Vista WSD GSA


A1-1
Buena Vista Water Storage District GSA - DMW01 - 356014N1196176W001
Ground Surface Elevation: 235.68
Water Level
Measurable Objective: 210
Minimum Threshold: 139
Groundwater Elevation (ft., msl)
Measurement Date
140
150
160
170
180
190
200
210
220
230
1995
1996
1997
1998
1999
2000
2001
2002
2003
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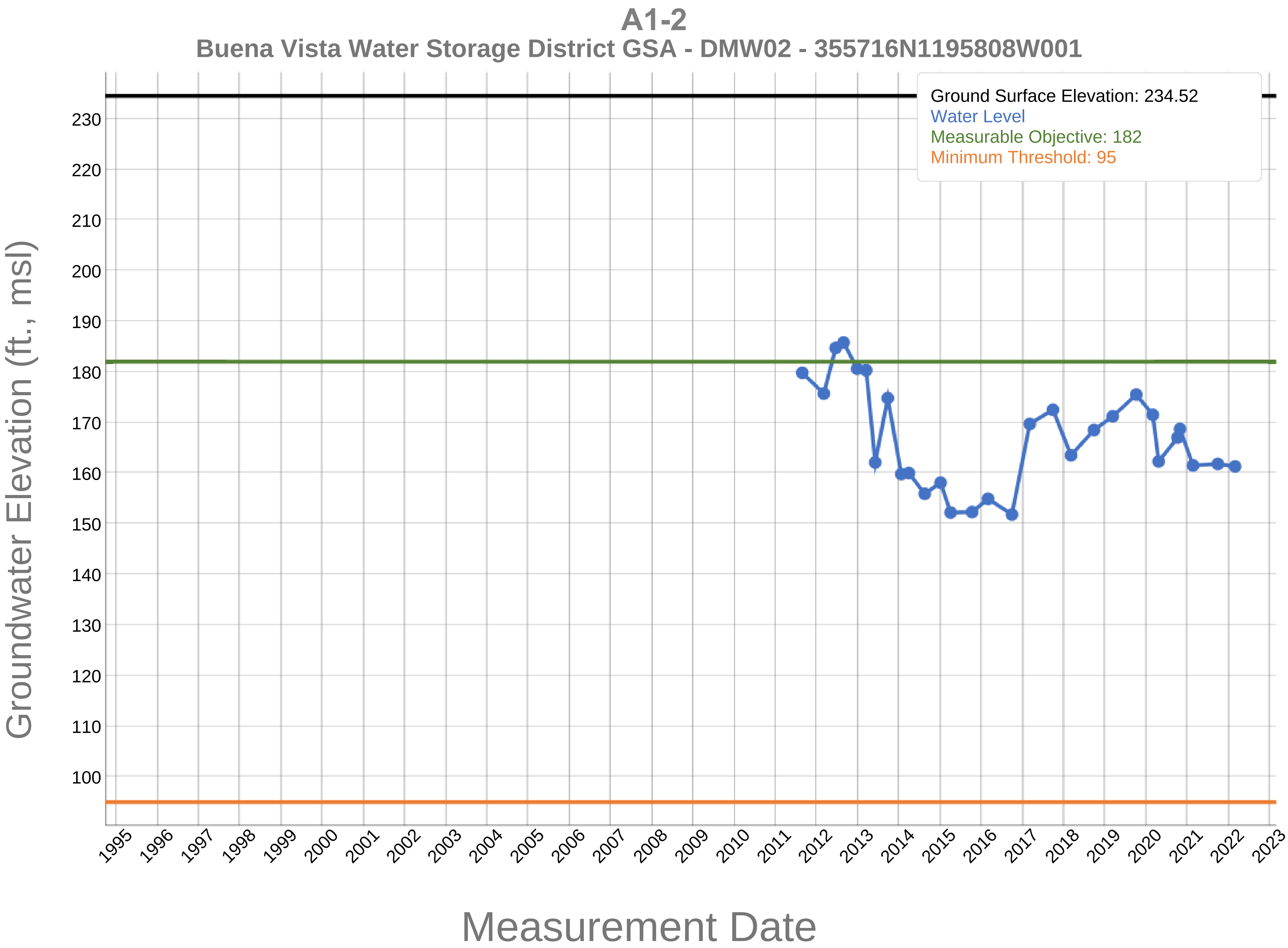
2022
2023



A1-2
Buena Vista Water Storage District GSA - DMW02 - 355716N1195808W001
Ground Surface Elevation: 234.52
Water Level
Measurable Objective: 182
Minimum Threshold: 95
Groundwater Elevation (ft., msl)
230
220
210
200
190
180
170
160
150
140
130
120
110
100
1995
1996
1997
1998
1999
2000
2001
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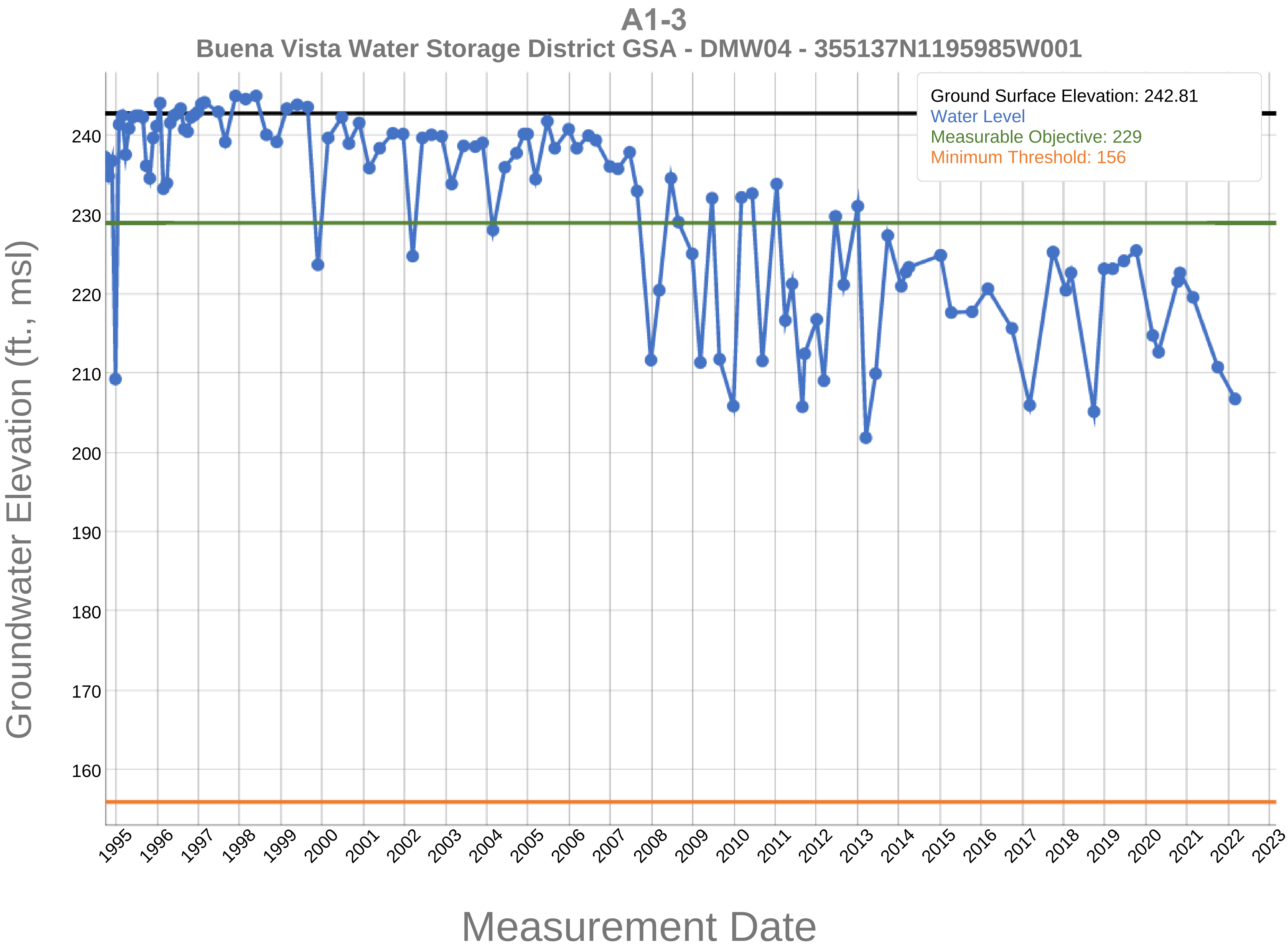
2021
2022
2023
Measurement Date



A1-3
Buena Vista Water Storage District GSA - DMW04 - 355137N1195985W001
Ground Surface Elevation: 242.81
Water Level
Measurable Objective: 229
Minimum Threshold: 156
Groundwater Elevation (ft., msl)
160
170
180
190
200
210
220
230
240
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
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2019
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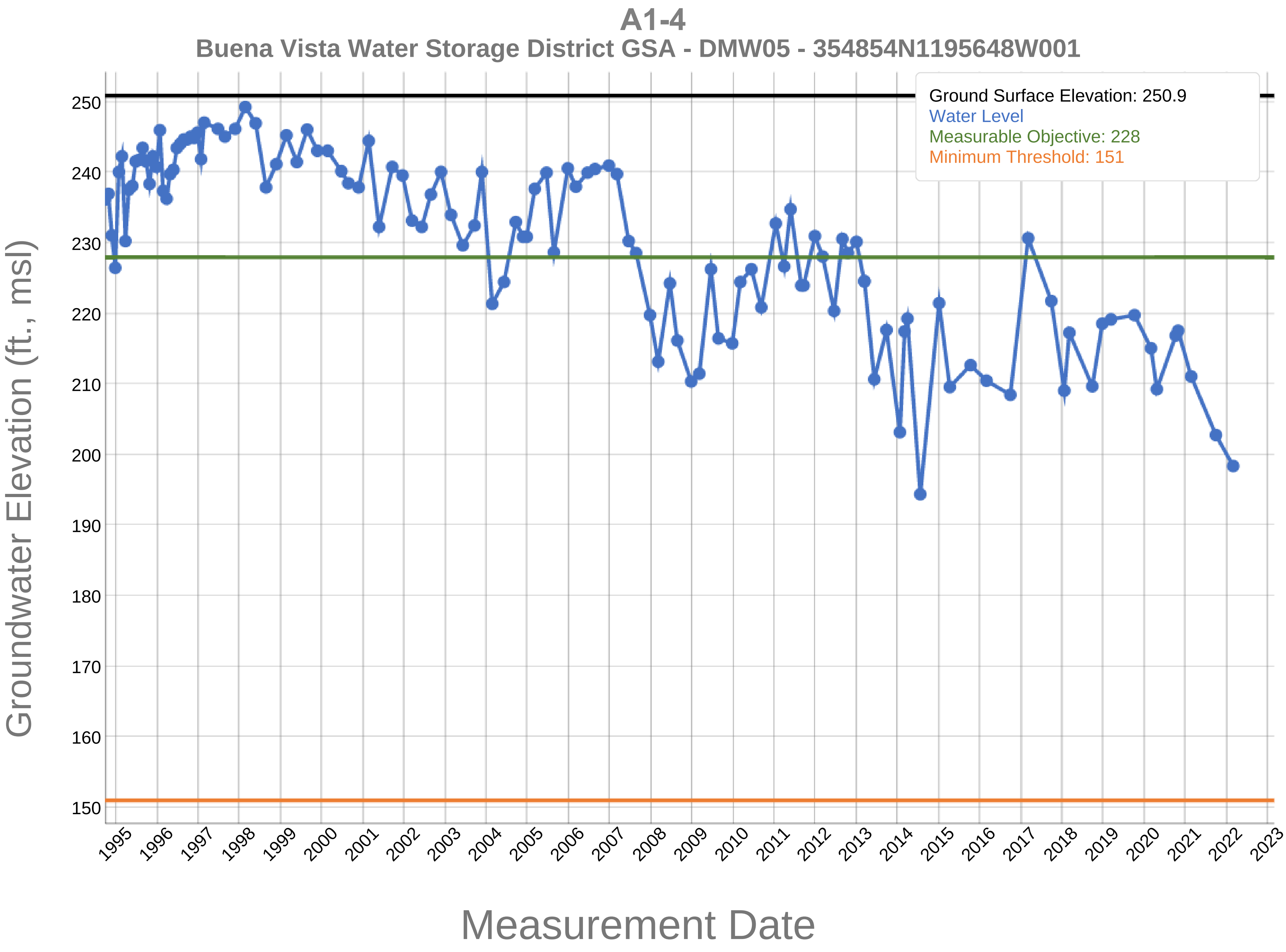
2021
2022
2023
Measurement Date


A1-4
Buena Vista Water Storage District GSA - DMW05 - 354854N1195648W001
Ground Surface Elevation: 250.9
Water Level
Measurable Objective: 228
Minimum Threshold: 151
Groundwater Elevation (ft., msl)
250
240
230
220
210
200
190
180
170
160
150
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
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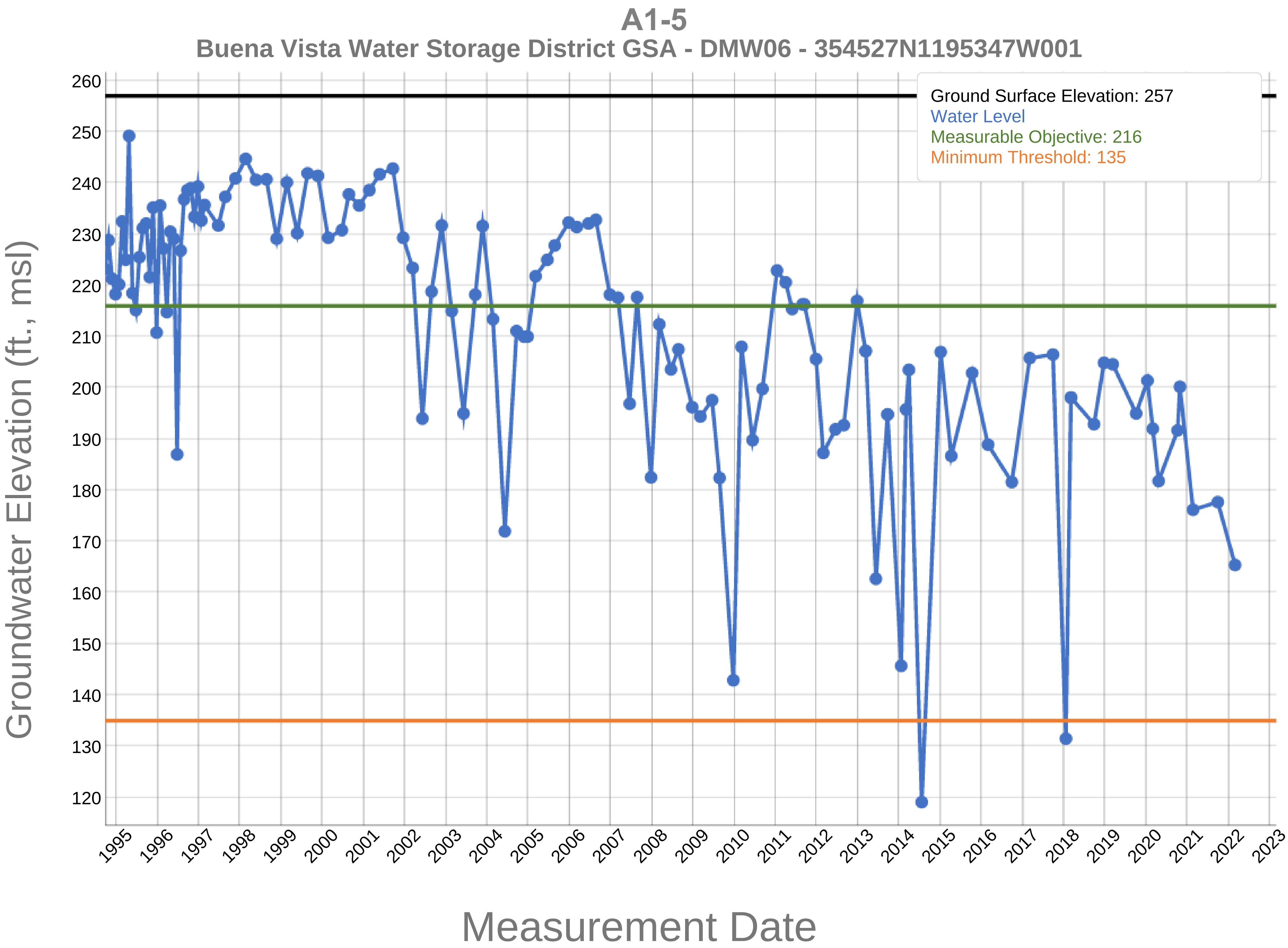
2022
2023
Measurement Date



A1-5
Buena Vista Water Storage District GSA - DMW06 - 354527N1195347W001
Ground Surface Elevation: 257
Water Level
Measurable Objective: 216
Minimum Threshold: 135
Groundwater Elevation (ft., msl)
Measurement Date
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
1995
1996
1997
1998
1999
2000
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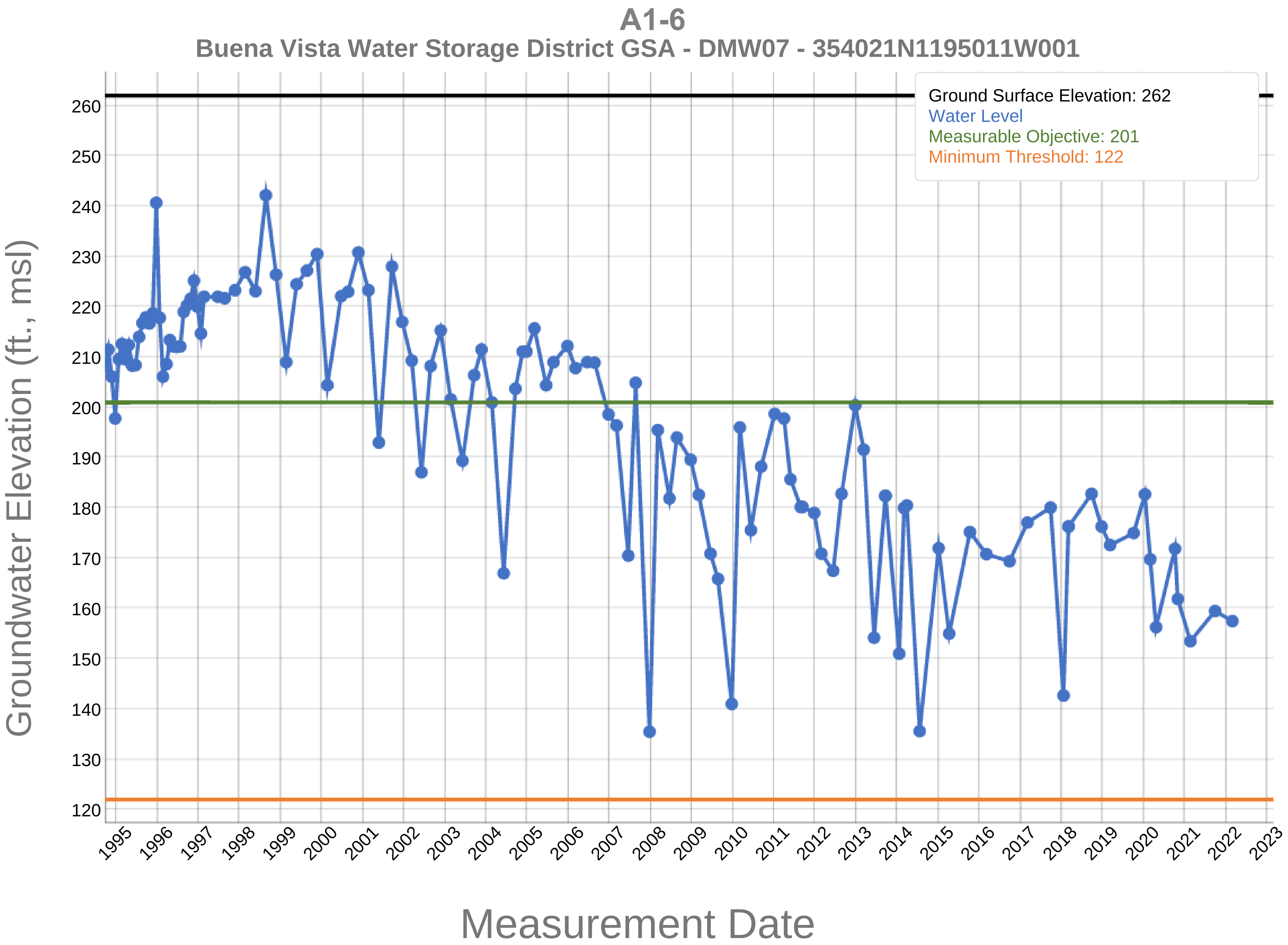

A1-6
Buena Vista Water Storage District GSA - DMW07 - 354021N1195011W001
Ground Surface Elevation: 262
Water Level
Measurable Objective: 201
Minimum Threshold: 122
Groundwater Elevation (ft., msl)
Measurement Date
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
1995
1996
1997
1998
1999
2000
2001
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2003
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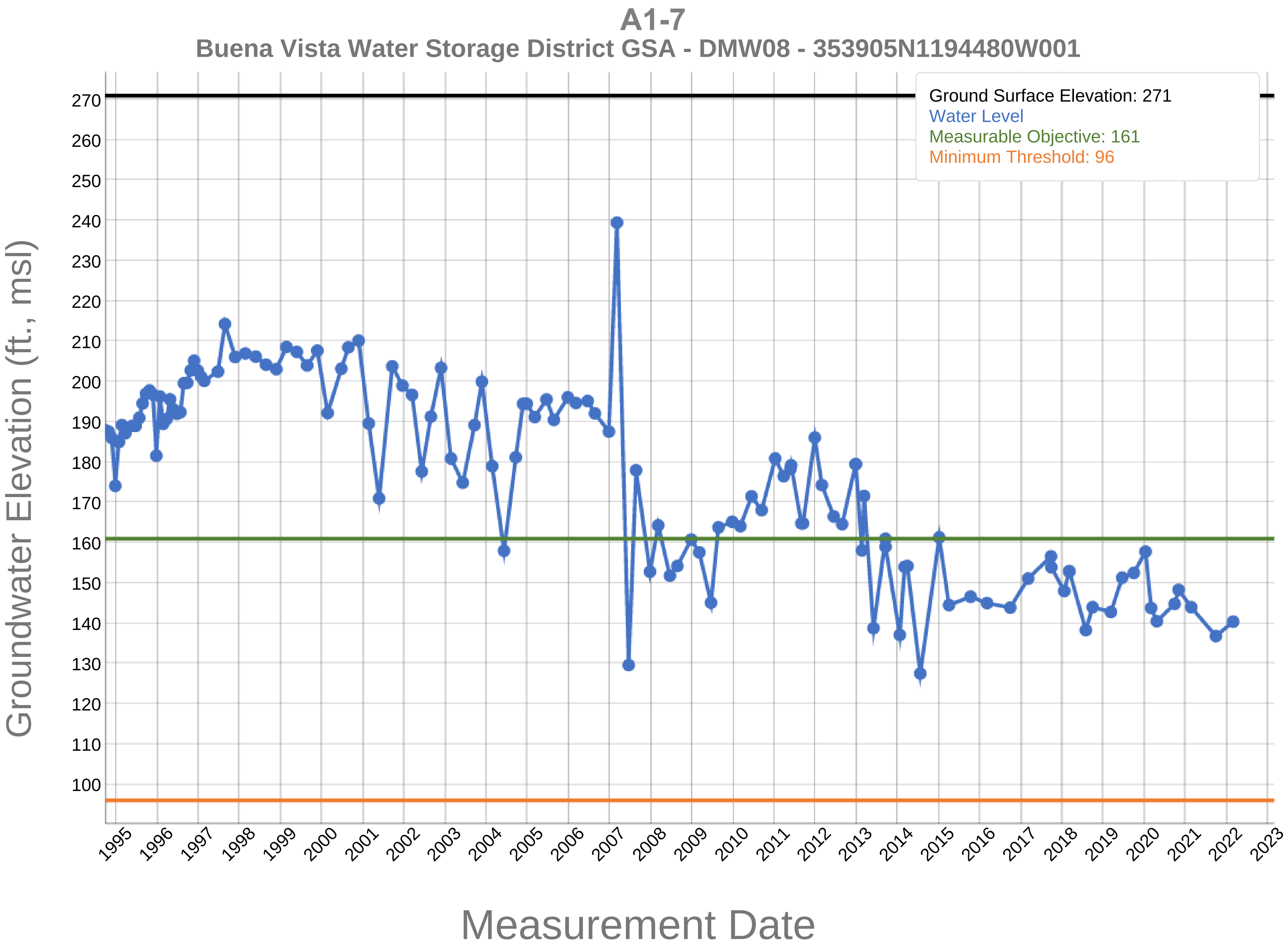
A1-7
Buena Vista Water Storage District GSA - DMW08 - 353905N1194480W001
Ground Surface Elevation: 271
Water Level
Measurable Objective: 161
Minimum Threshold: 96
Groundwater Elevation (ft., msl)
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
1995
1996
1997
1998
1999
2000
2001
2002
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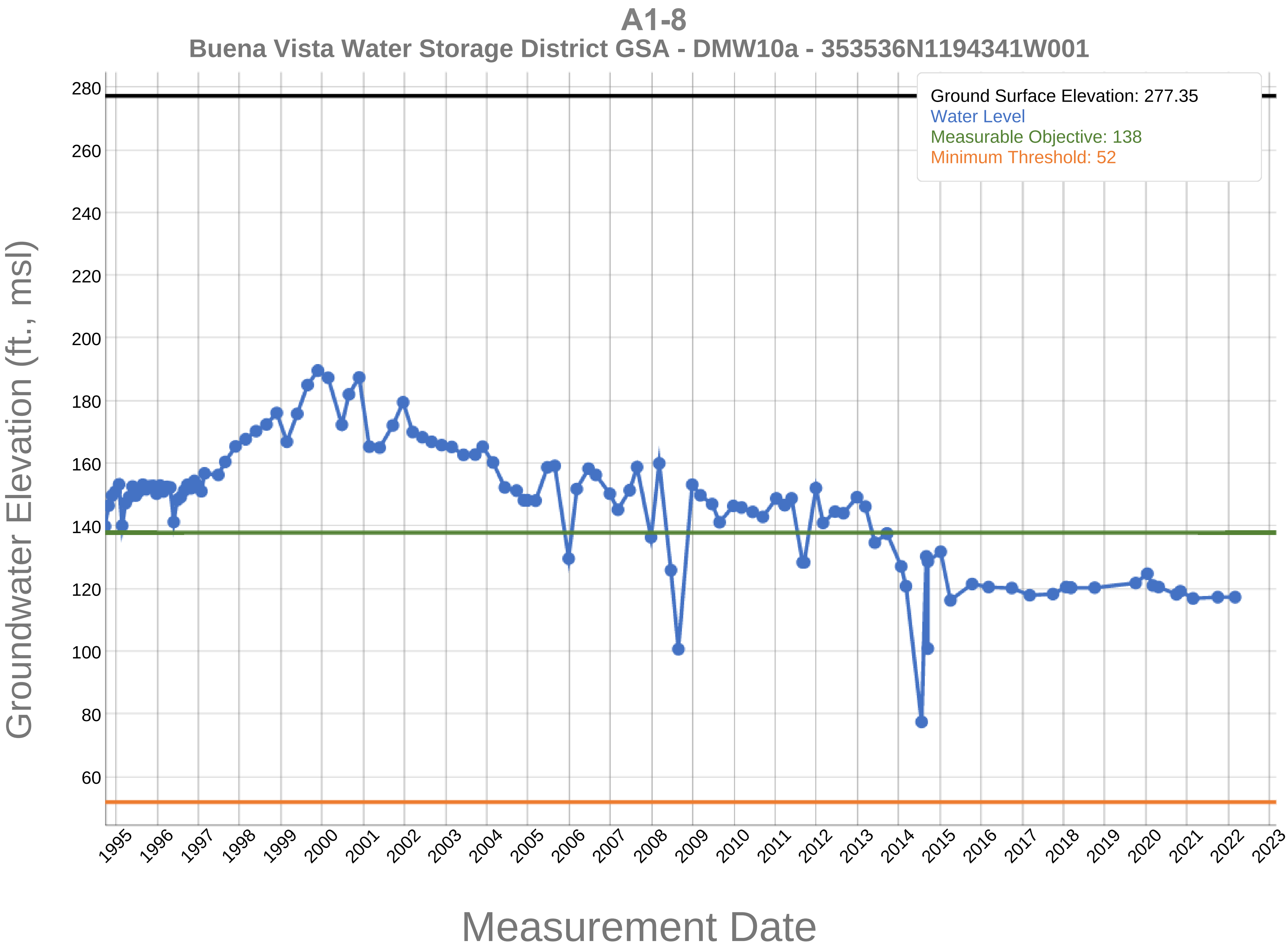
2023
Measurement Date


A1-8
Buena Vista Water Storage District GSA - DMW10a - 353536N1194341W001
Ground Surface Elevation: 277.35
Water Level
Measurable Objective: 138
Minimum Threshold: 52
Groundwater Elevation (ft., msl)
Measurement Date
280
260
240
220
200
180
160
140
120
100
80
60
1995
1996
1997
1998
1999
2000
2001
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2003
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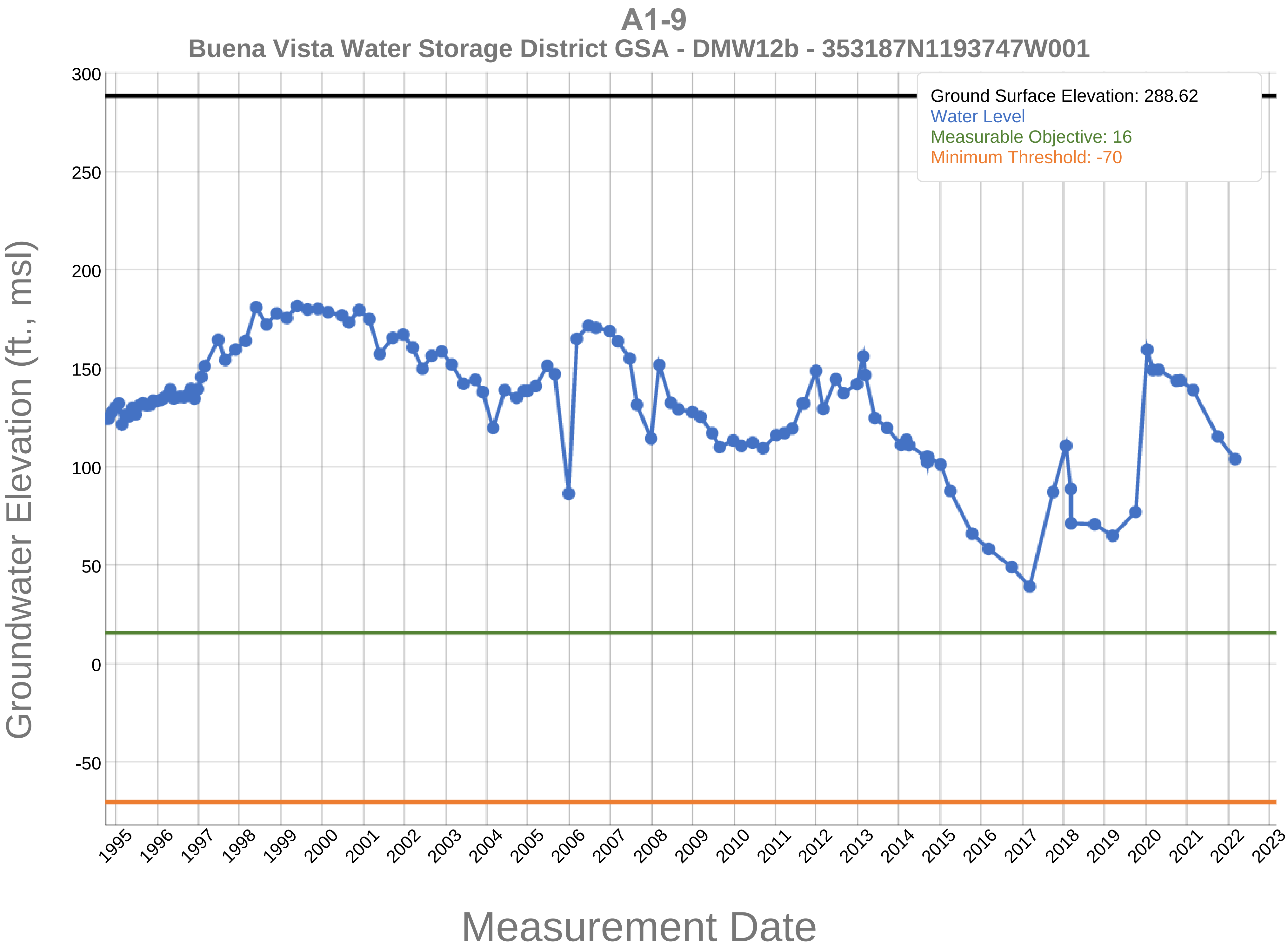
2023



A1-9
Buena Vista Water Storage District GSA - DMW12b - 353187N1193747W001
Ground Surface Elevation: 288.62
Water Level
Measurable Objective: 16
Minimum Threshold: -70
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
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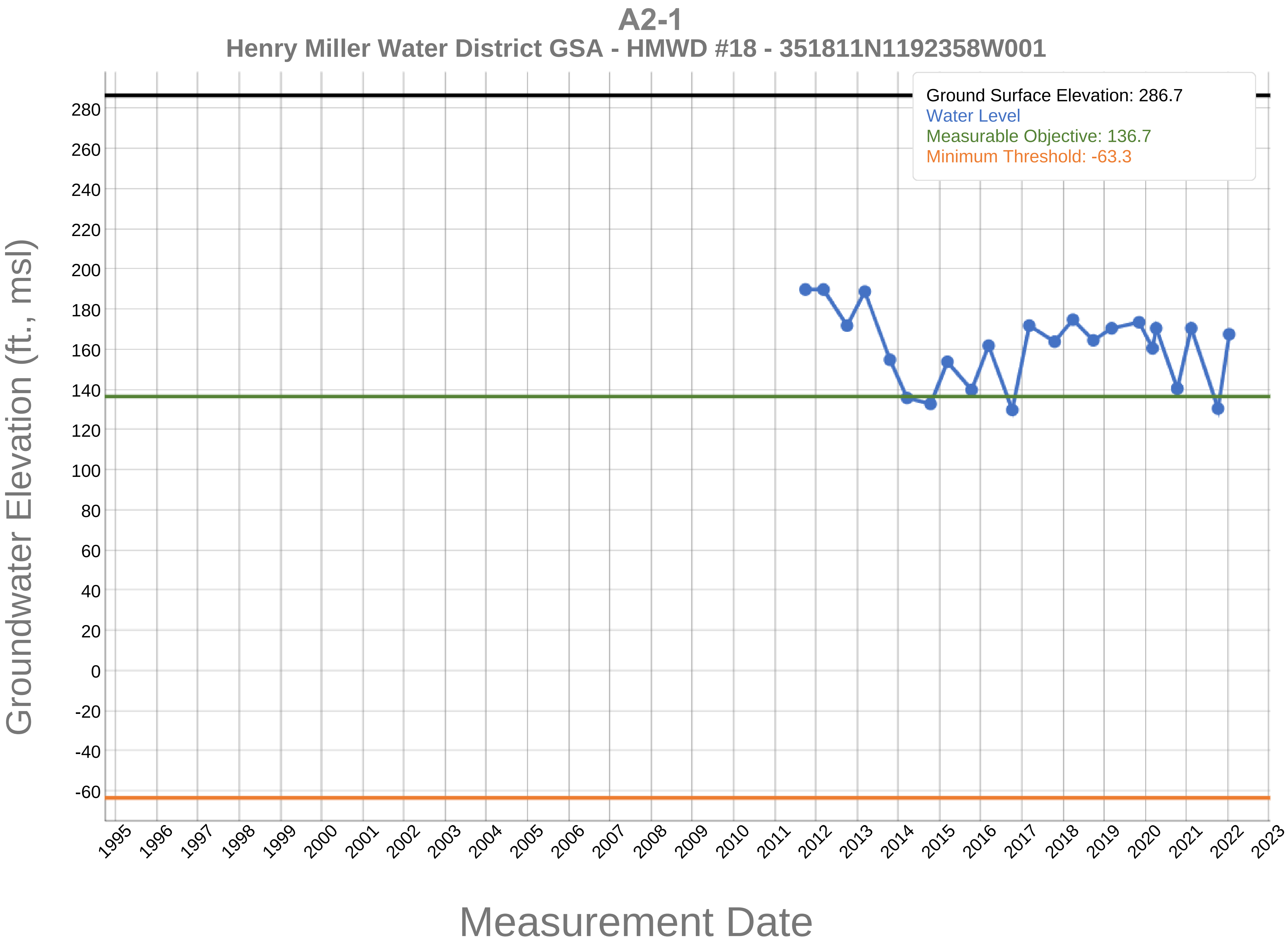
2021
2022
2023
Measurement Date

APPENDIX A2

Hydrographs of Groundwater Elevations

GSP Monitoring Network Wells

Henry Miller WD GSA


A2-1
Henry Miller Water District GSA - HMWD #18 - 351811N1192358W001
Ground Surface Elevation: 286.7
Water Level
Measurable Objective: 136.7
Minimum Threshold: -63.3
Groundwater Elevation (ft., msl)
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
1995
1996
1997
1998
1999
2000
2001
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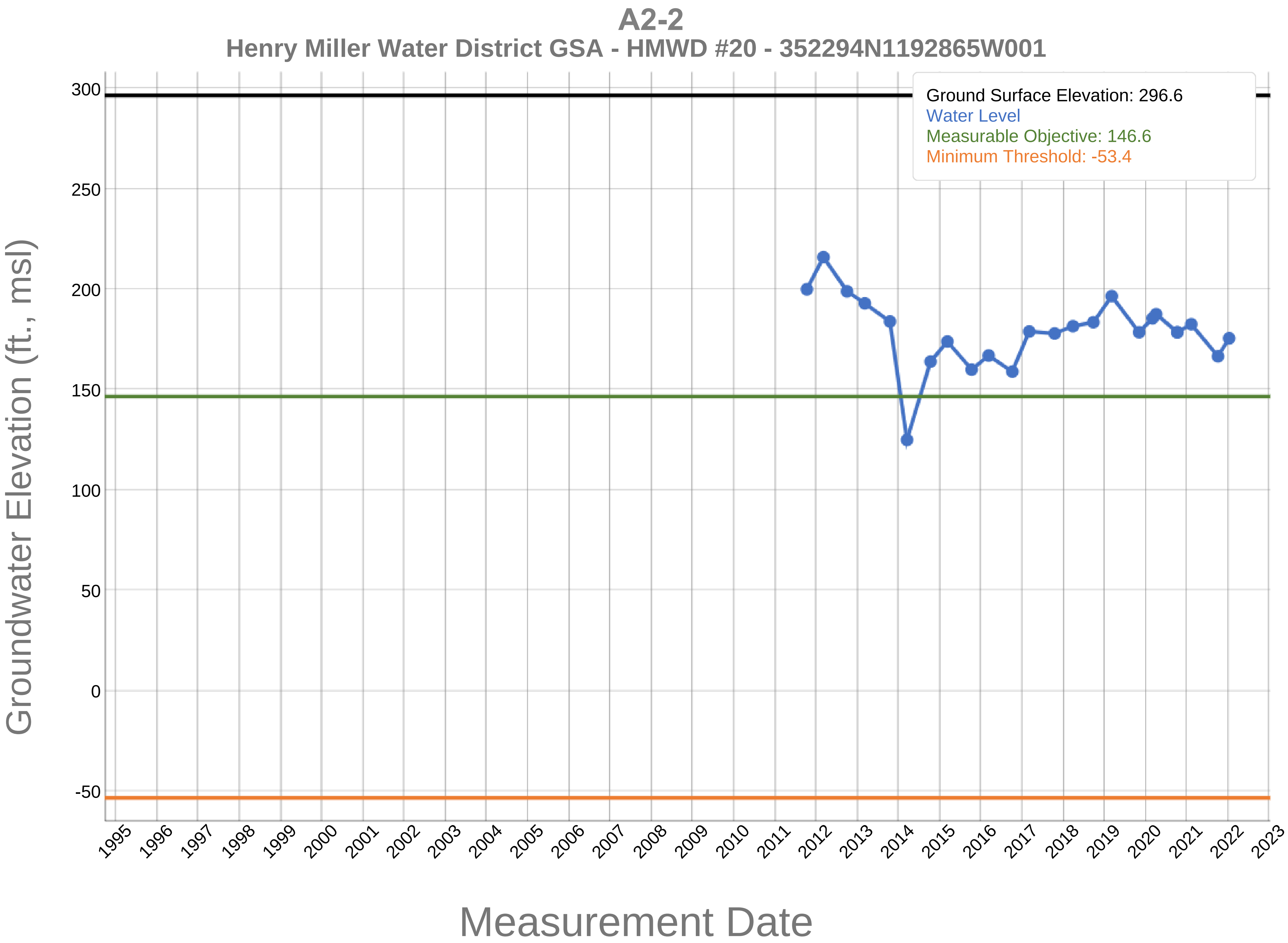
2023
Measurement Date



A2-2
Henry Miller Water District GSA - HMWD #20 - 352294N1192865W001
Ground Surface Elevation: 296.6
Water Level
Measurable Objective: 146.6
Minimum Threshold: -53.4
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
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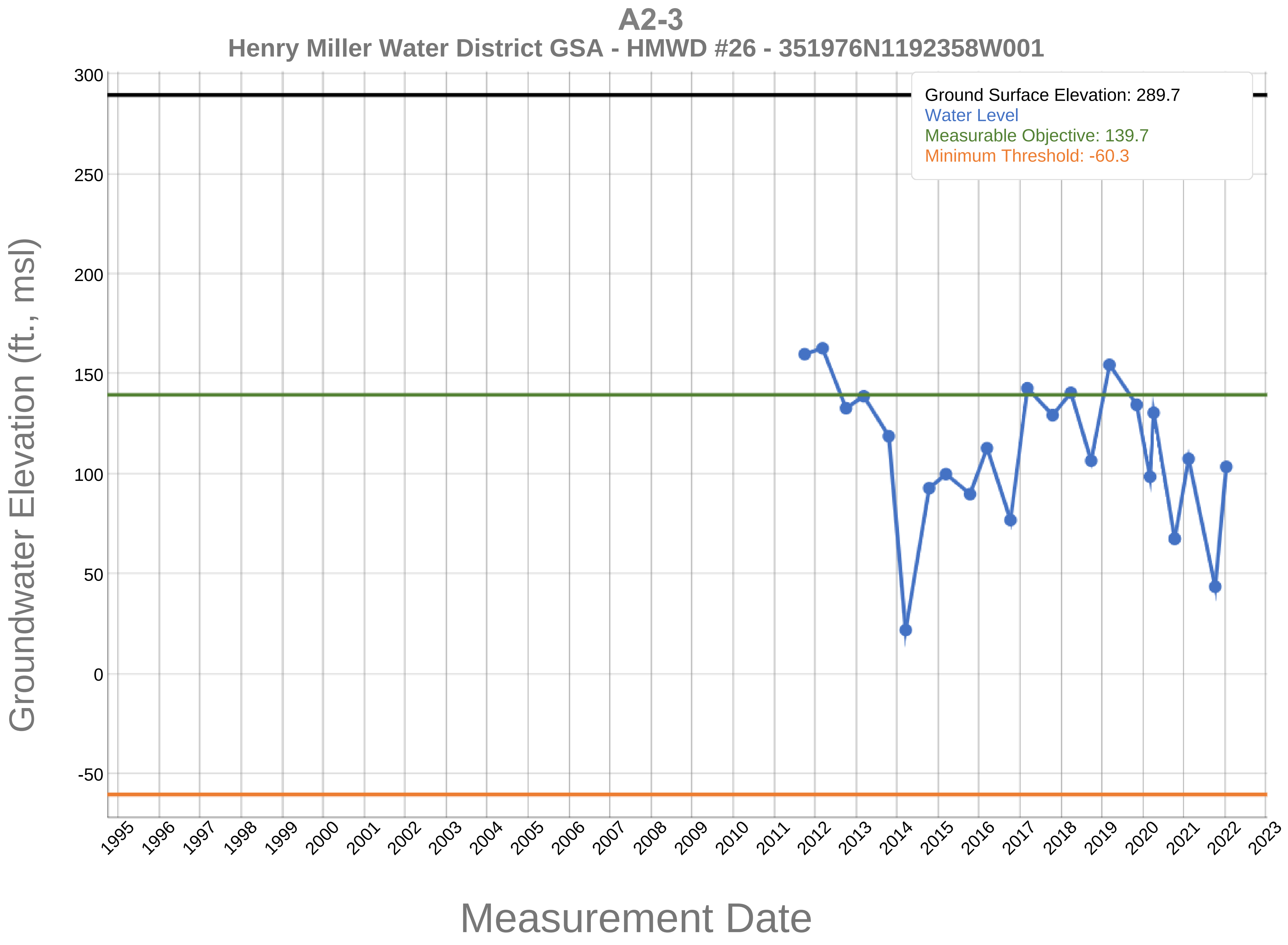
2023
Measurement Date



A2-3
Henry Miller Water District GSA - HMWD #26 - 351976N1192358W001
Ground Surface Elevation: 289.7
Water Level
Measurable Objective: 139.7
Minimum Threshold: -60.3
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
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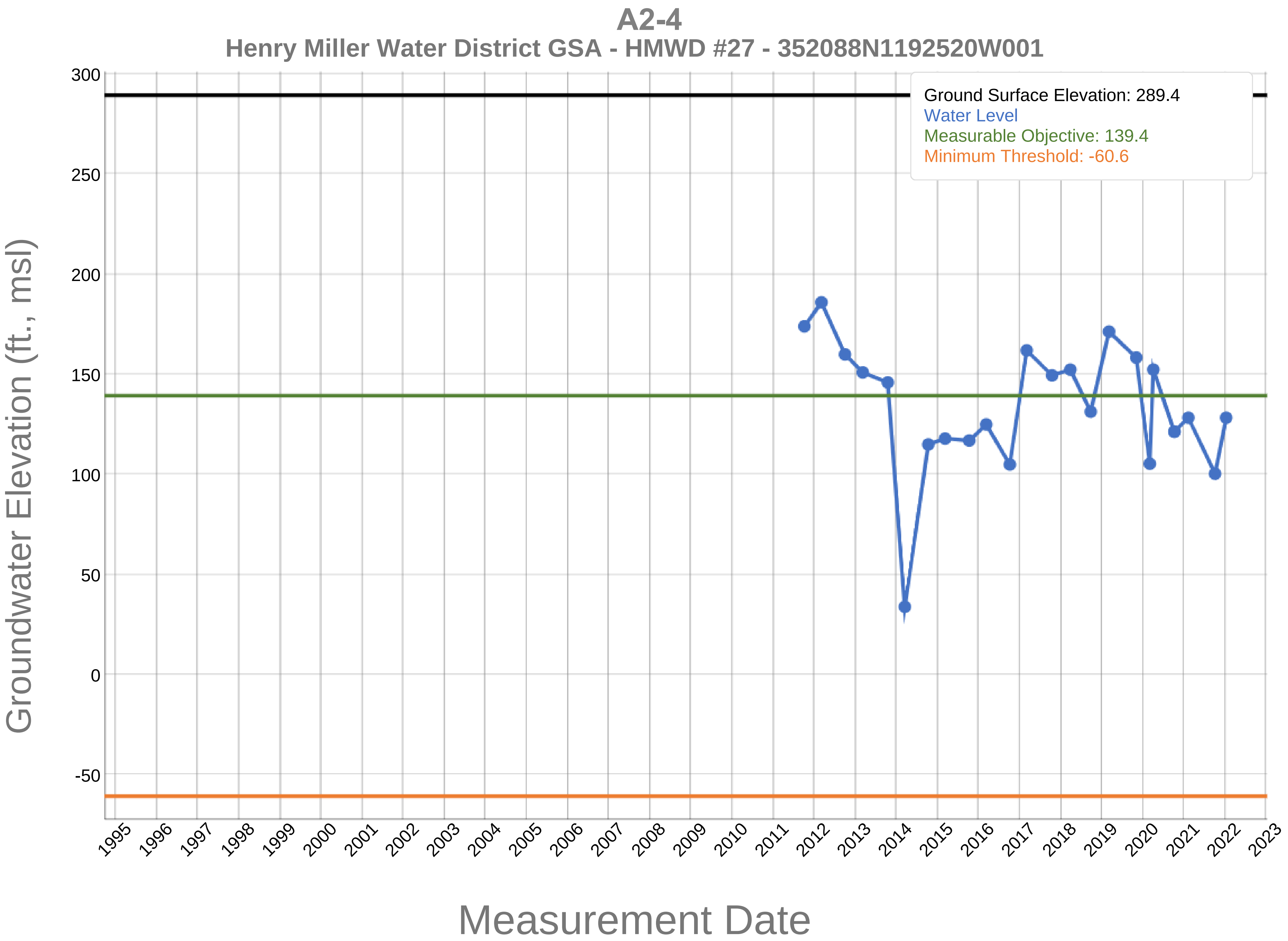
2020
2021
2022
2023
Measurement Date


A2-4
Henry Miller Water District GSA - HMWD #27 - 352088N1192520W001
Ground Surface Elevation: 289.4
Water Level
Measurable Objective: 139.4
Minimum Threshold: -60.6
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
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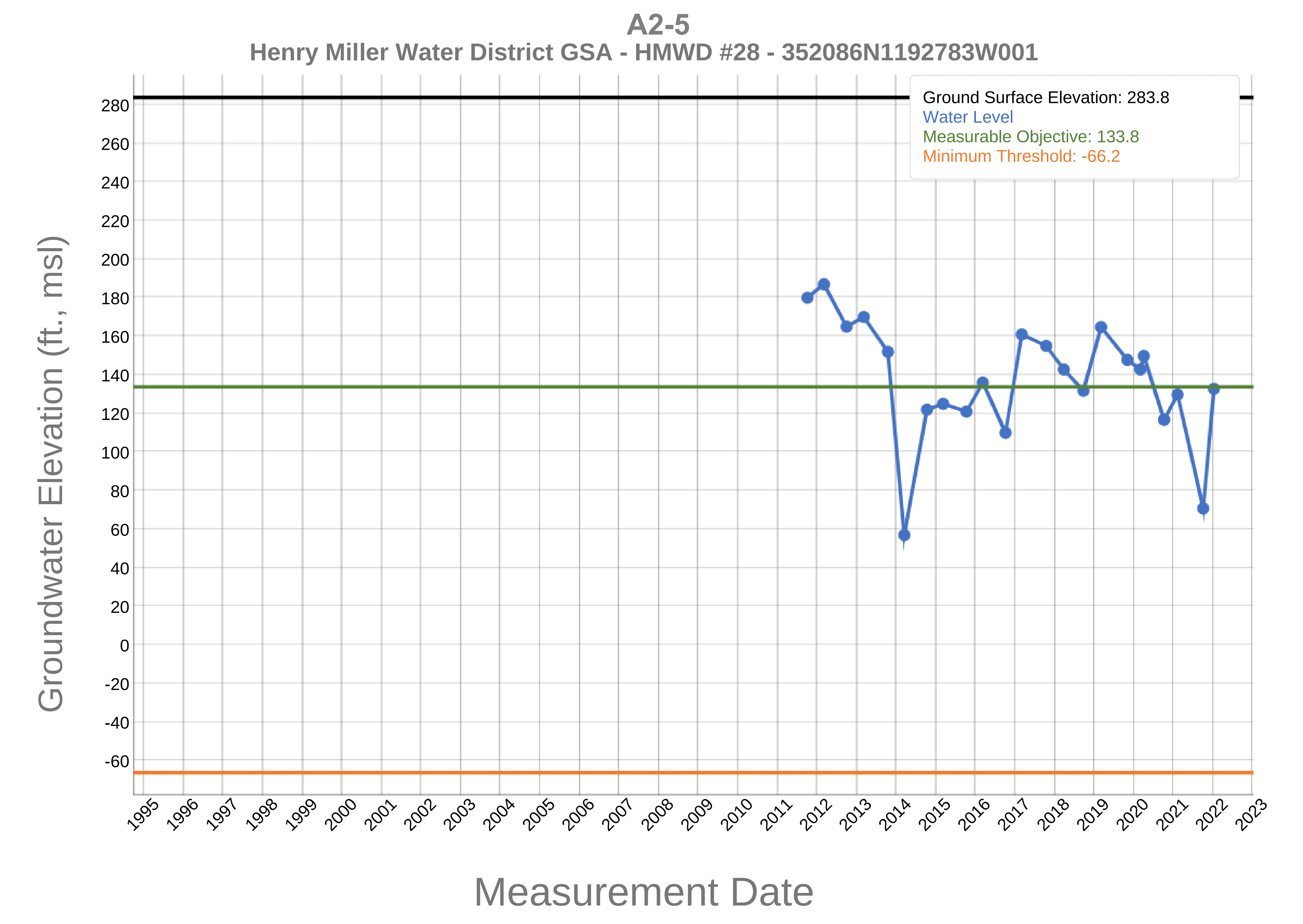
Measurement Date



A2-5
Henry Miller Water District GSA - HMWD #28 - 352086N1192783W001
Ground Surface Elevation: 283.8
Water Level
Measurable Objective: 133.8
Minimum Threshold: -66.2
Groundwater Elevation (ft., msl)
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
1995
1996
1997
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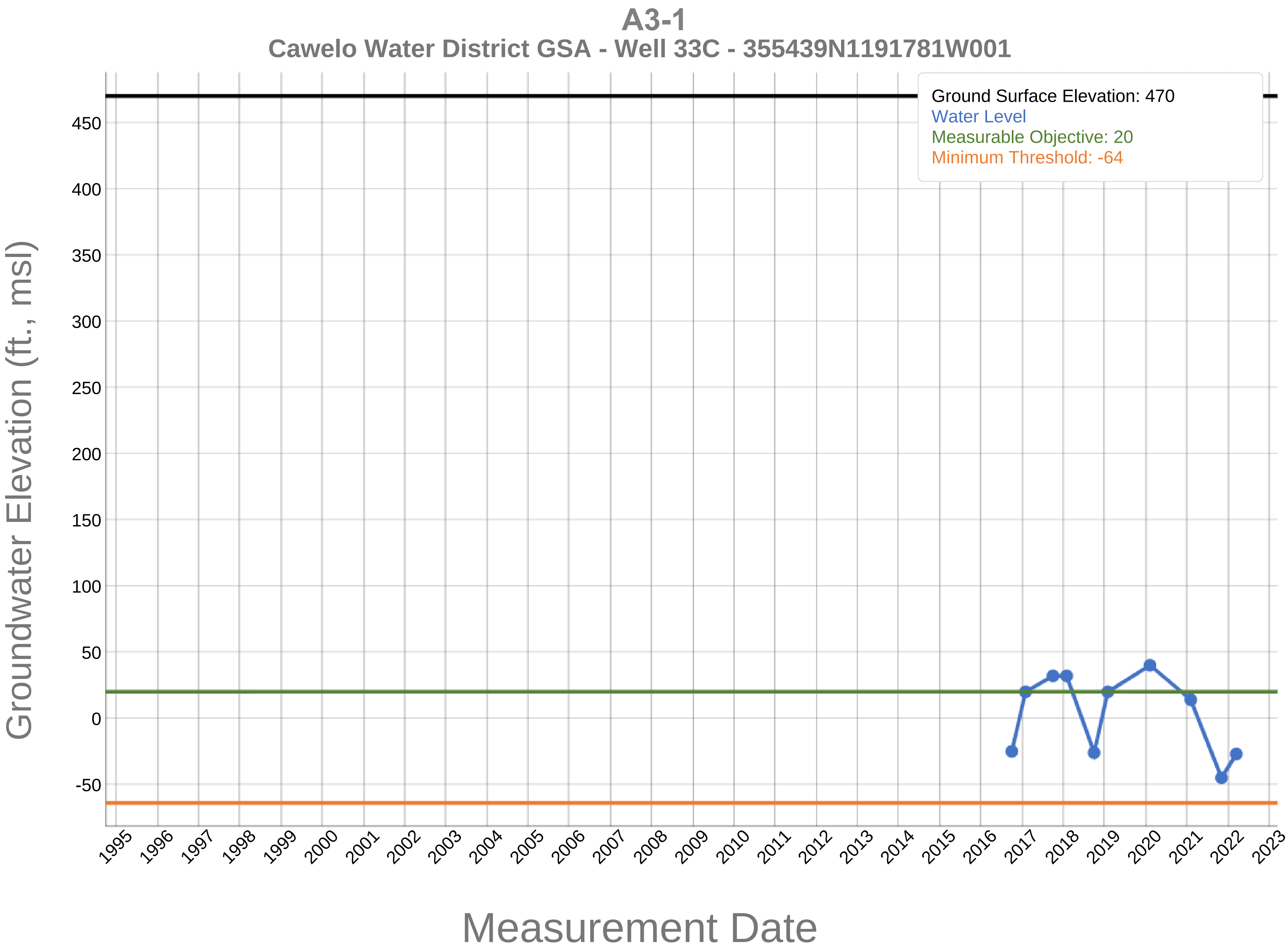
Measurement Date

APPENDIX A3

Hydrographs of Groundwater Elevations

GSP Monitoring Network Wells

Kern Groundwater Authority GSA



A3-1
Cawelo Water District GSA - Well 33C - 355439N1191781W001
Ground Surface Elevation: 470
Water Level
Measurable Objective: 20
Minimum Threshold: -64
Groundwater Elevation (ft., msl)
450
400
350
300
250
200
150
100
50
0
-50
1995
1996
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1998
1999
2000
2001
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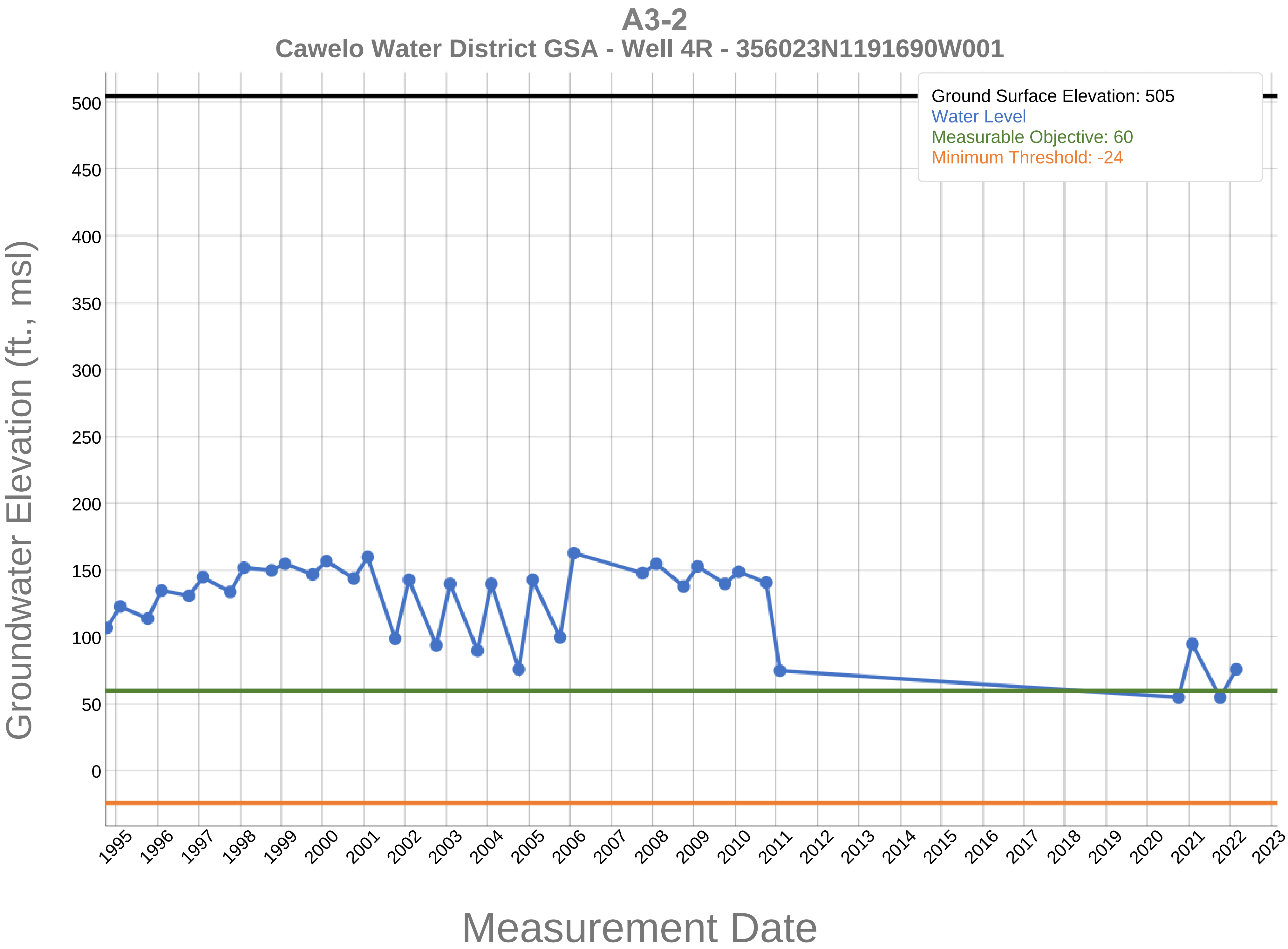
Measurement Date


A3-2
Cawelo Water District GSA - Well 4R - 356023N1191690W001
Ground Surface Elevation: 505
Water Level
Measurable Objective: 60
Minimum Threshold: -24
Groundwater Elevation (ft., msl)
500
450
400
350
300
250
200
150
100
50
0
1995
1996
1997
1998
1999
2000
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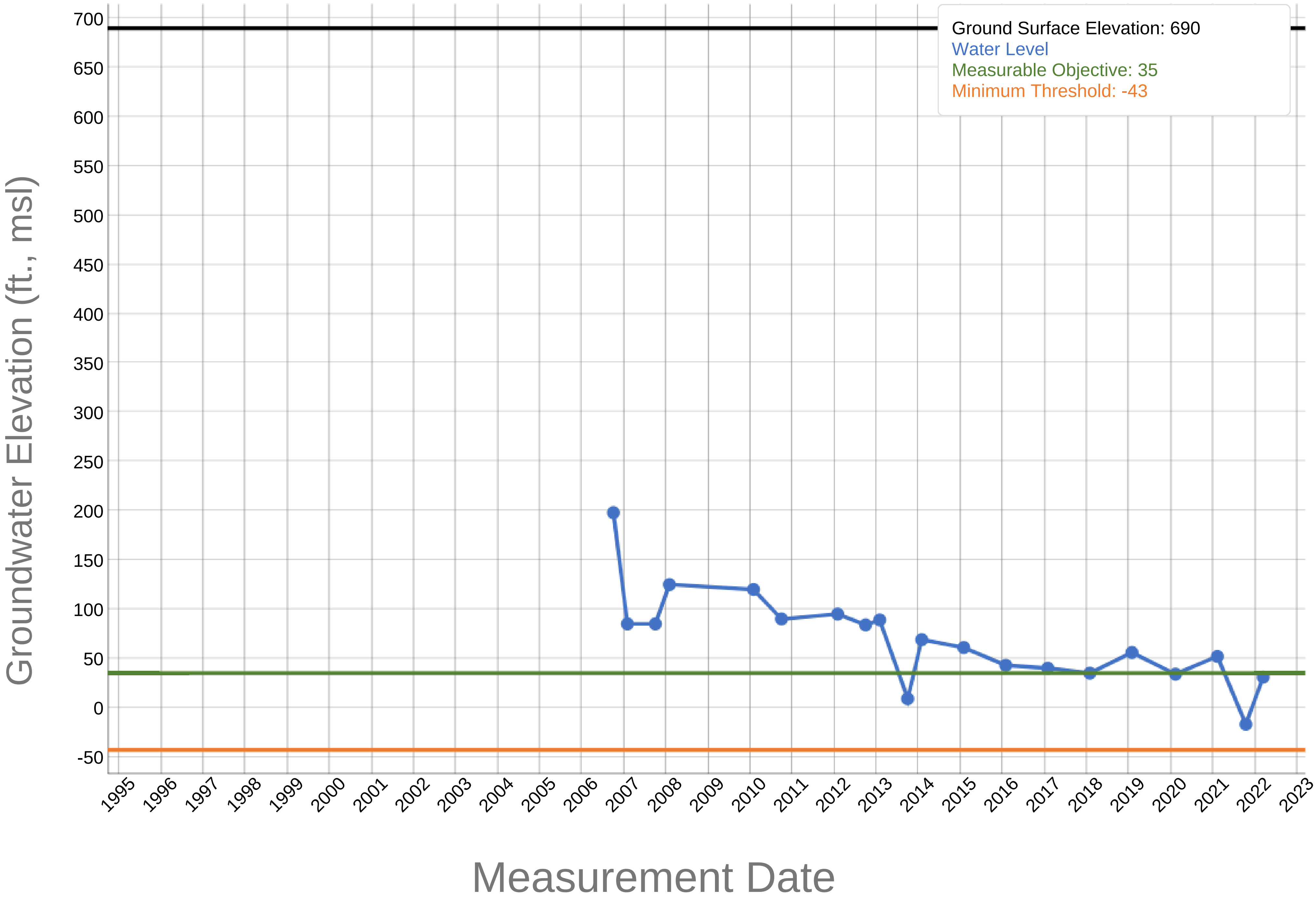
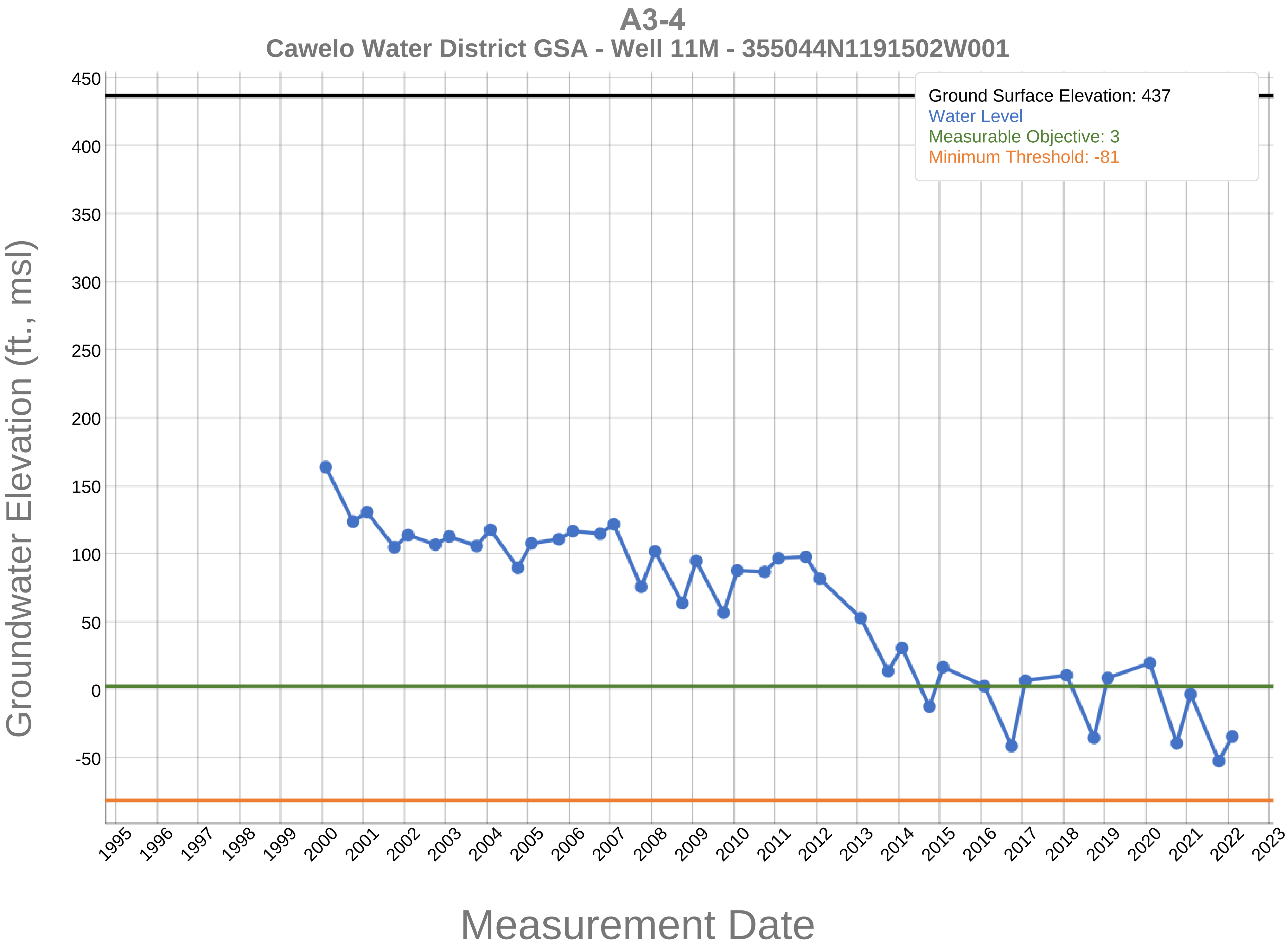
Measurement Date

A3-3

Cawelo Water District GSA - Well 24R - 356469N1191175W001





A3-4
Cawelo Water District GSA - Well 11M - 355044N1191502W001
Ground Surface Elevation: 437
Water Level
Measurable Objective: 3
Minimum Threshold: -81
Groundwater Elevation (ft., msl)
450
400
350
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
2000
2001
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2003
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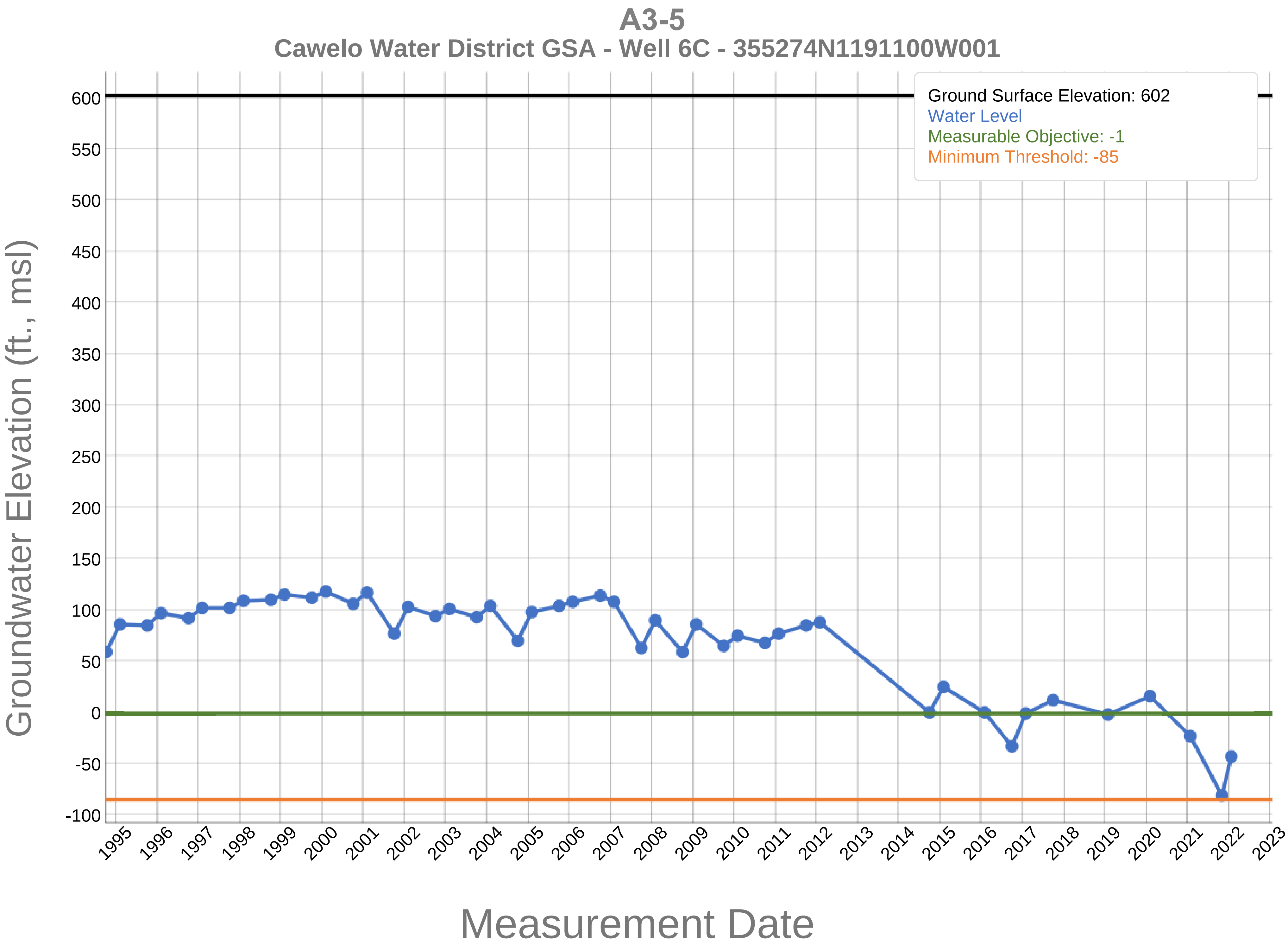
Measurement Date


A3-5
Cawelo Water District GSA - Well 6C - 355274N1191100W001
Ground Surface Elevation: 602
Water Level
Measurable Objective: -1
Minimum Threshold: -85
Groundwater Elevation (ft., msl)
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
1995
1996
1997
1998
1999
2000
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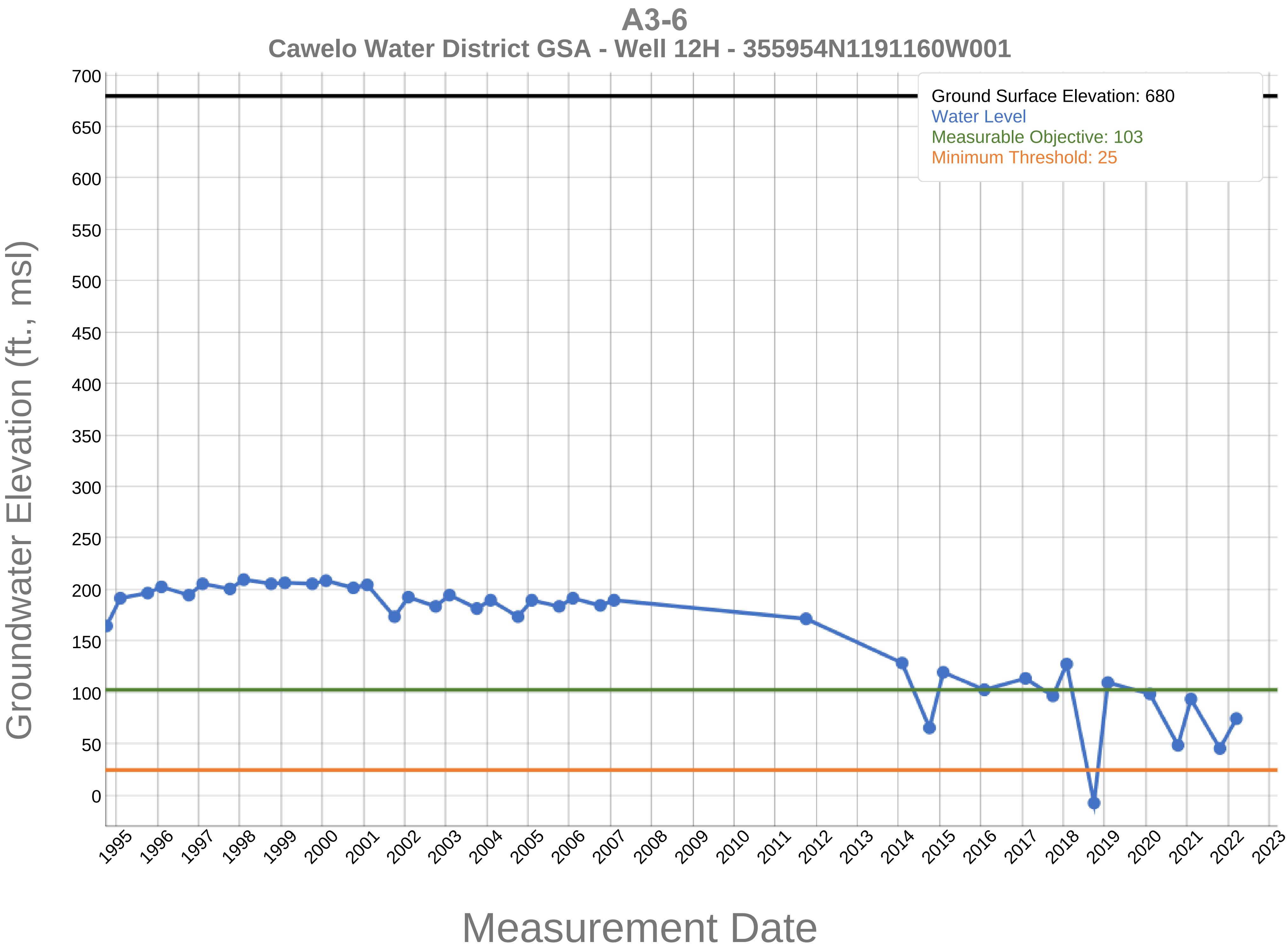
Measurement Date


A3-6
Cawelo Water District GSA - Well 12H - 355954N1191160W001
Ground Surface Elevation: 680
Water Level
Measurable Objective: 103
Minimum Threshold: 25
Groundwater Elevation (ft., msl)
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
1995
1996
1997
1998
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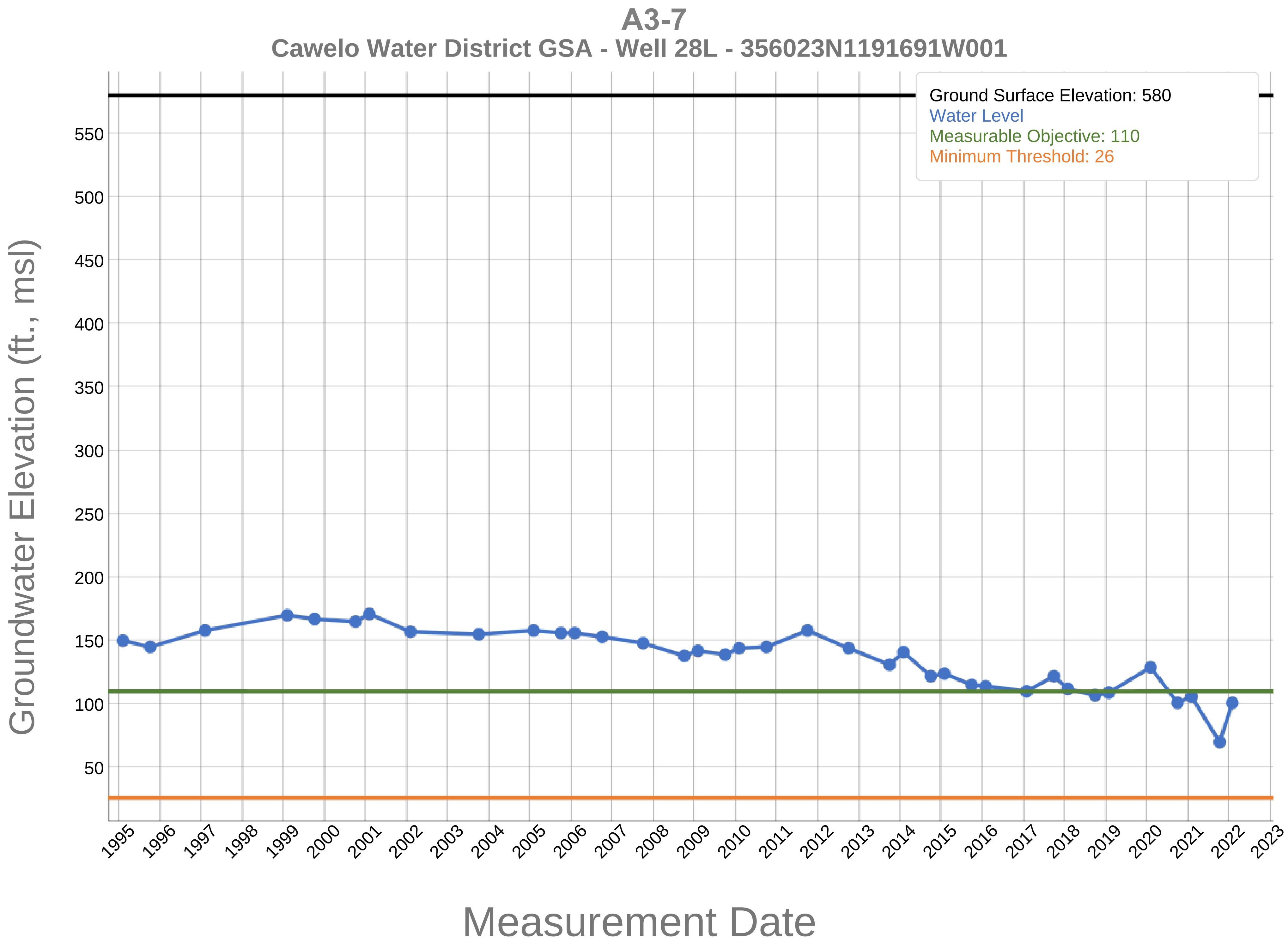
Measurement Date


A3-7
Cawelo Water District GSA - Well 28L - 356023N1191691W001
Ground Surface Elevation: 580
Water Level
Measurable Objective: 110
Minimum Threshold: 26
Groundwater Elevation (ft., msl)
550
500
450
400
350
300
250
200
150
100
50
1995
1996
1997
1998
1999
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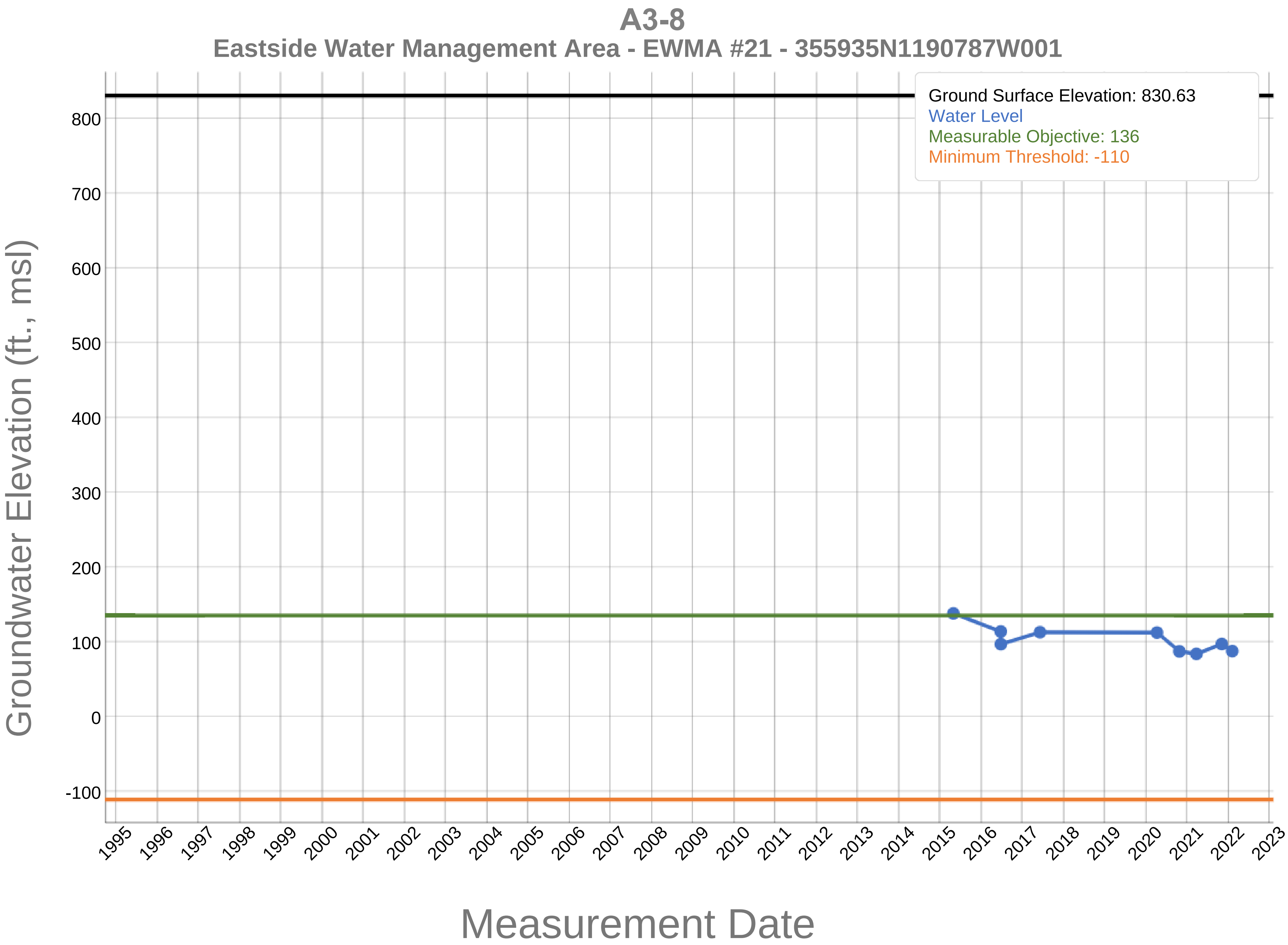
Measurement Date



A3-8
Eastside Water Management Area - EWMA #21 - 355935N1190787W001
Ground Surface Elevation: 830.63
Water Level
Measurable Objective: 136
Minimum Threshold: -110
Groundwater Elevation (ft., msl)
800
700
600
500
400
300
200
100
0
-100
1995
1996
1997
1998
1999
2000
2001
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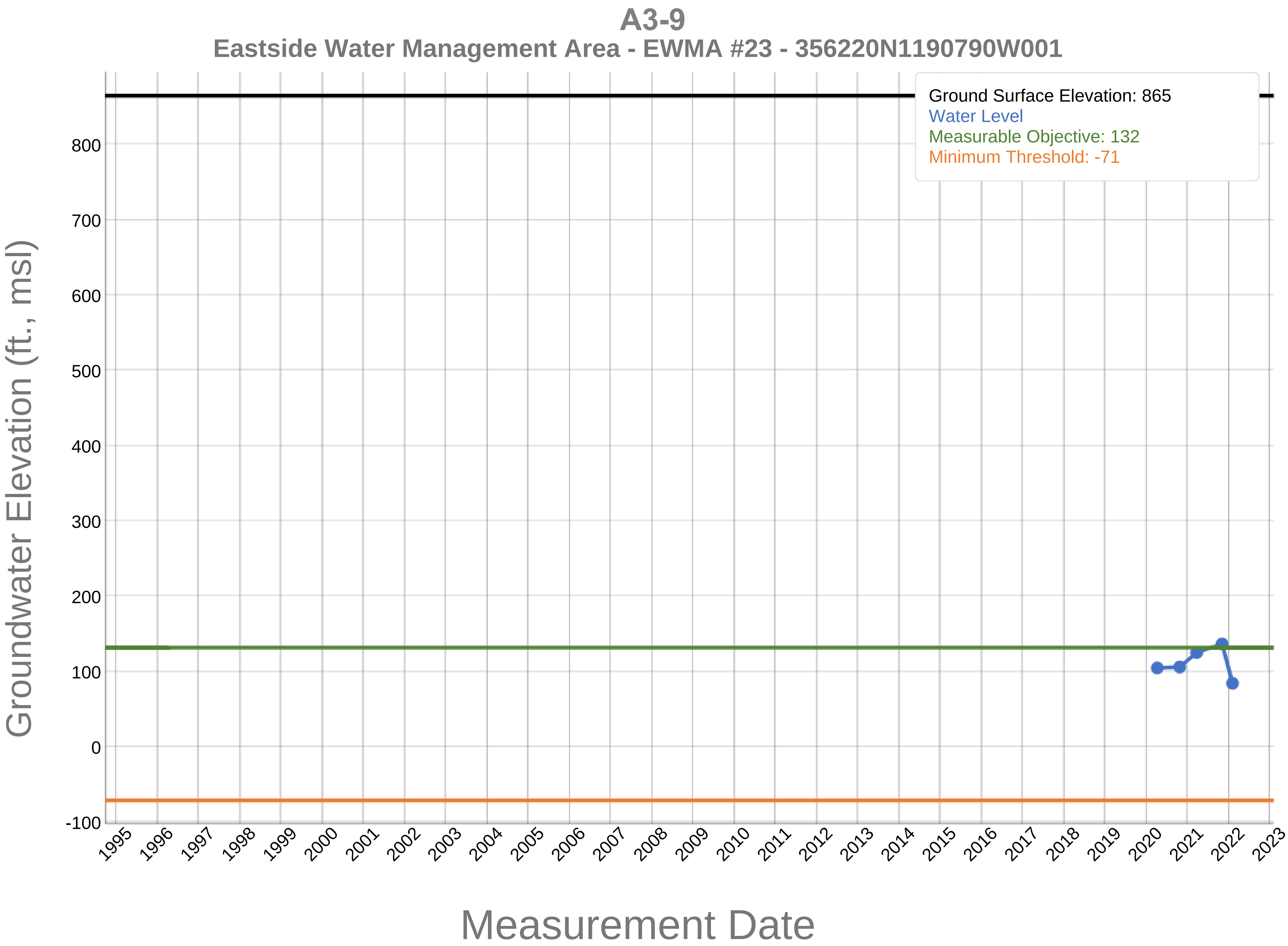
Measurement Date



A3-9
Eastside Water Management Area - EWMA #23 - 356220N1190790W001
Ground Surface Elevation: 865
Water Level
Measurable Objective: 132
Minimum Threshold: -71
Groundwater Elevation (ft., msl)
800
700
600
500
400
300
200
100
0
-100
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
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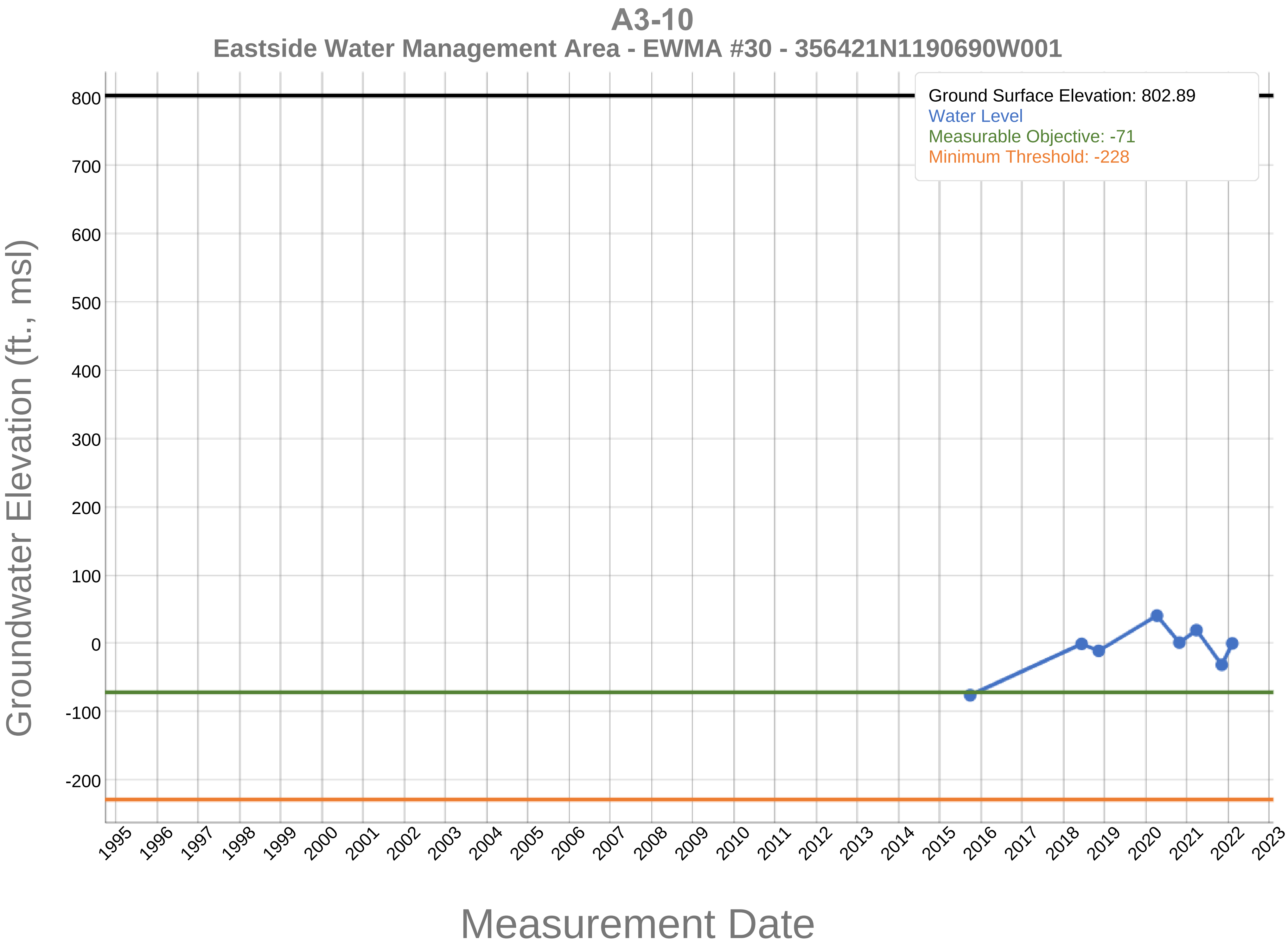
Measurement Date



A3-10
Eastside Water Management Area - EWMA #30 - 356421N1190690W001
Ground Surface Elevation: 802.89
Water Level
Measurable Objective: -71
Minimum Threshold: -228
Groundwater Elevation (ft., msl)
800
700
600
500
400
300
200
100
0
-100
-200
1995
1996
1997
1998
1999
2000
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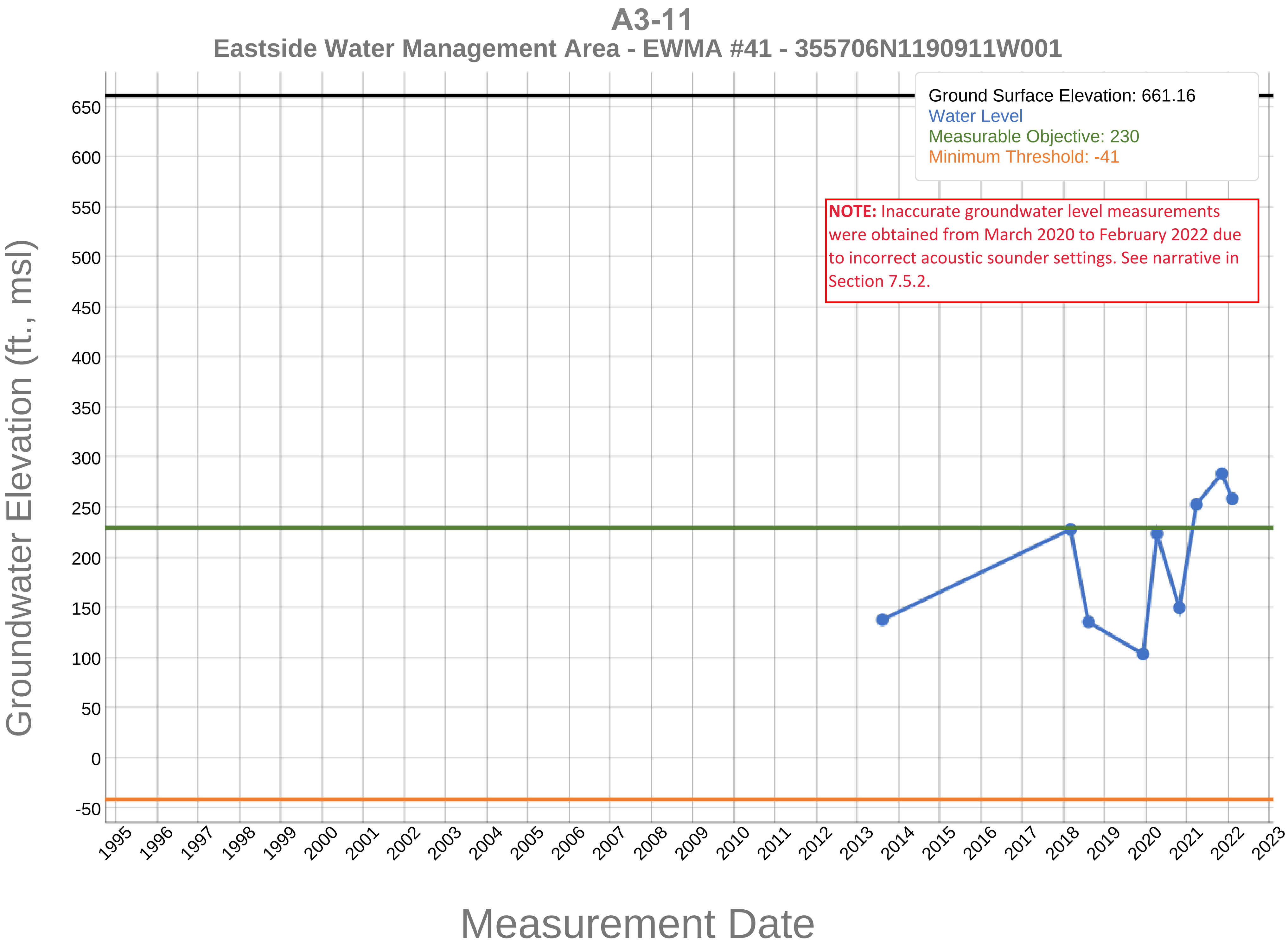
Measurement Date



A3-11
Eastside Water Management Area - EWMA #41 - 355706N1190911W001
Ground Surface Elevation: 661.16
Water Level
Measurable Objective: 230
Minimum Threshold: -41
NOTE: Inaccurate groundwater level measurements were obtained from March 2020 to February 2022 due to incorrect acoustic sounder settings. See narrative in Section 7.5.2.
Groundwater Elevation (ft., msl)
Measurement Date
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
2000
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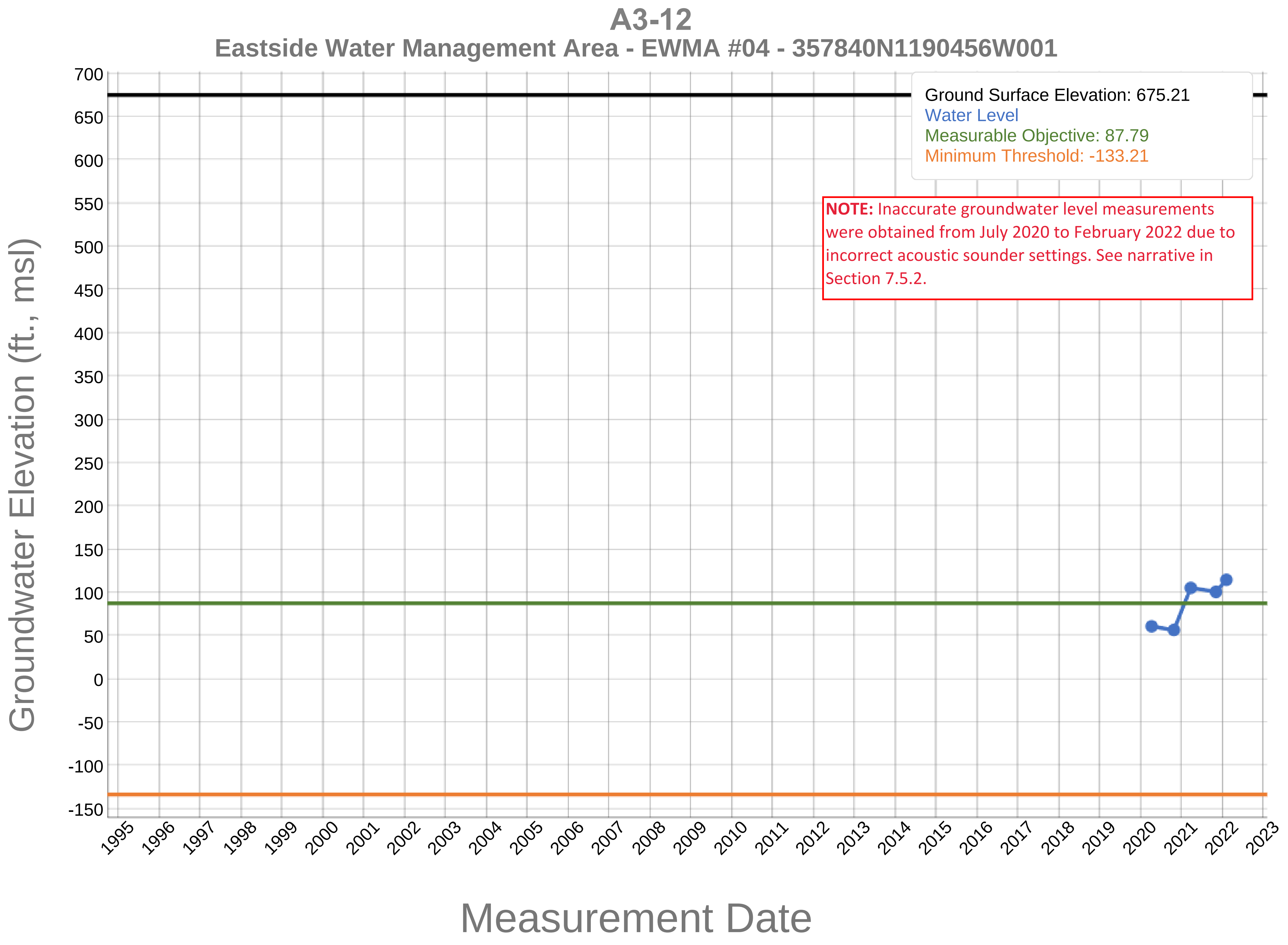

A3-12
Eastside Water Management Area - EWMA #04 - 357840N1190456W001
Ground Surface Elevation: 675.21
Water Level
Measurable Objective: 87.79
Minimum Threshold: -133.21
NOTE: Inaccurate groundwater level measurements were obtained from July 2020 to February 2022 due to incorrect acoustic sounder settings. See narrative in Section 7.5.2.
Groundwater Elevation (ft., msl)
Measurement Date
700
650
600
550
500
450
400
350
300
250
200
150
100
50
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-50
-100
-150
1995
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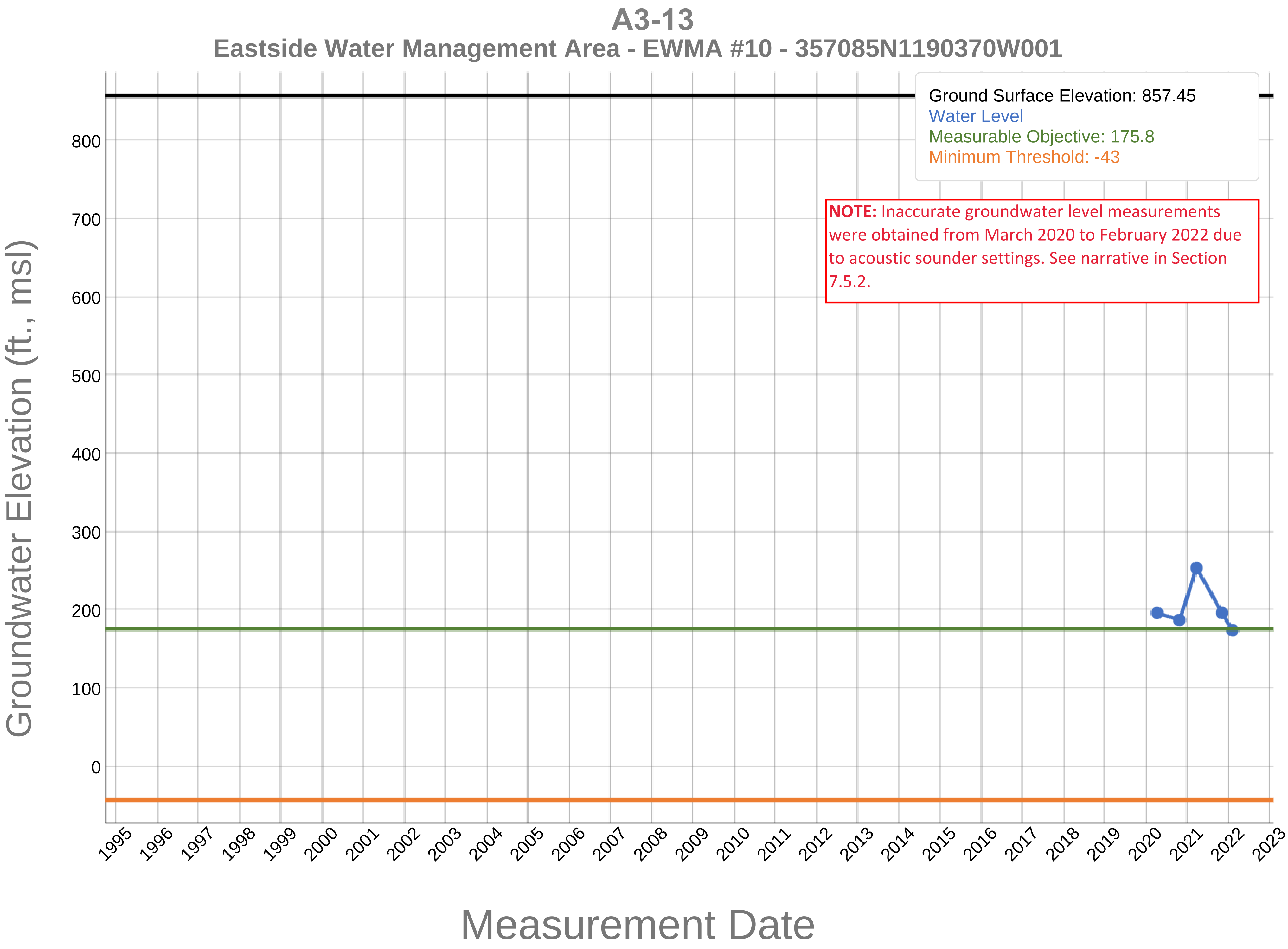
A3-13
Eastside Water Management Area - EWMA #10 - 357085N1190370W001
Ground Surface Elevation: 857.45
Water Level
Measurable Objective: 175.8
Minimum Threshold: -43
NOTE: Inaccurate groundwater level measurements were obtained from March 2020 to February 2022 due to acoustic sounder settings. See narrative in Section 7.5.2.
Groundwater Elevation (ft., msl)
800
700
600
500
400
300
200
100
0
1995
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2000
2001
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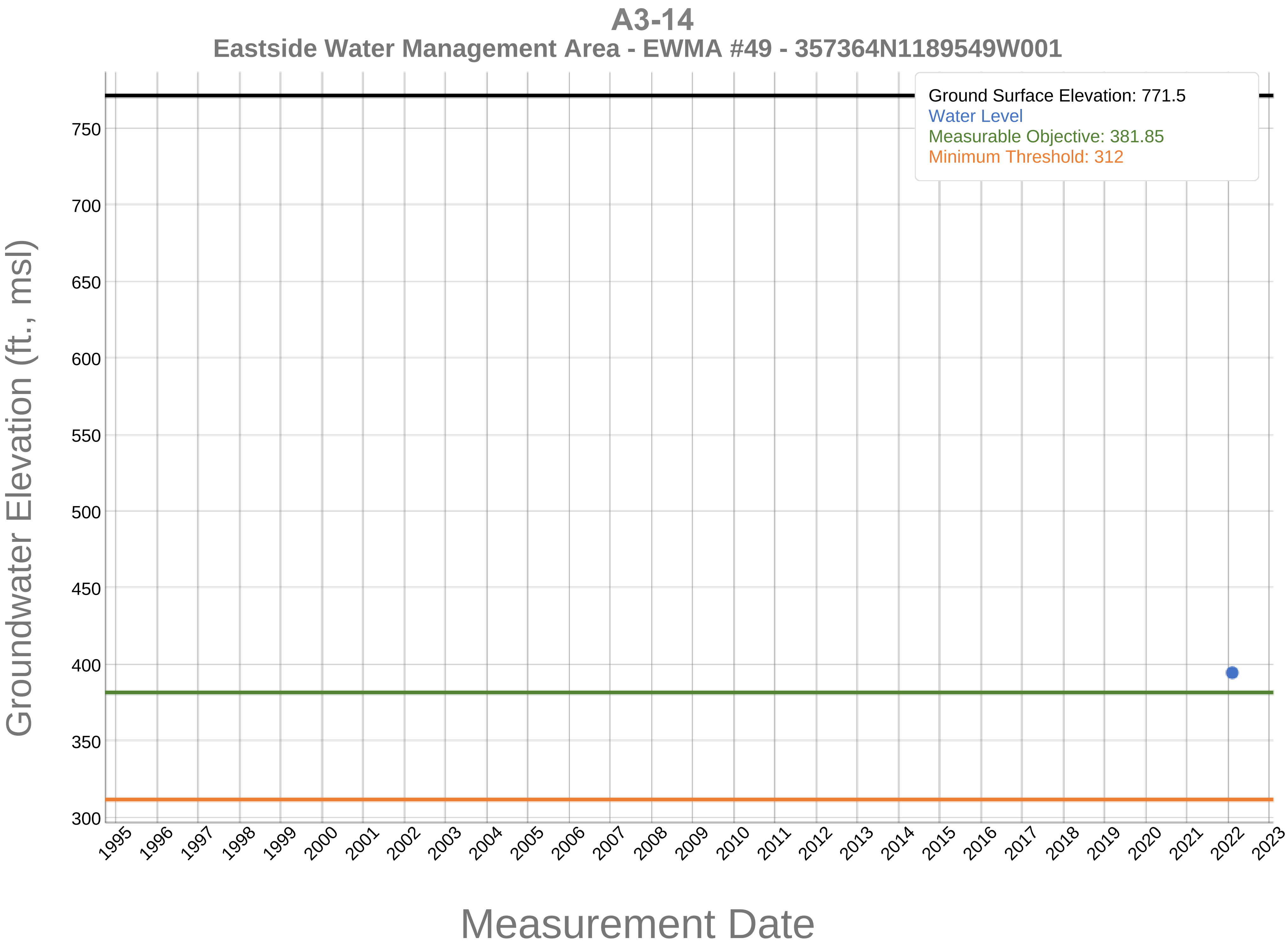
2022
2023
Measurement Date


A3-14
Eastside Water Management Area - EWMA #49 - 357364N1189549W001
Ground Surface Elevation: 771.5
Water Level
Measurable Objective: 381.85
Minimum Threshold: 312
Groundwater Elevation (ft., msl)
750
700
650
600
550
500
450
400
350
300
1995
1996
1997
1998
1999
2000
2001
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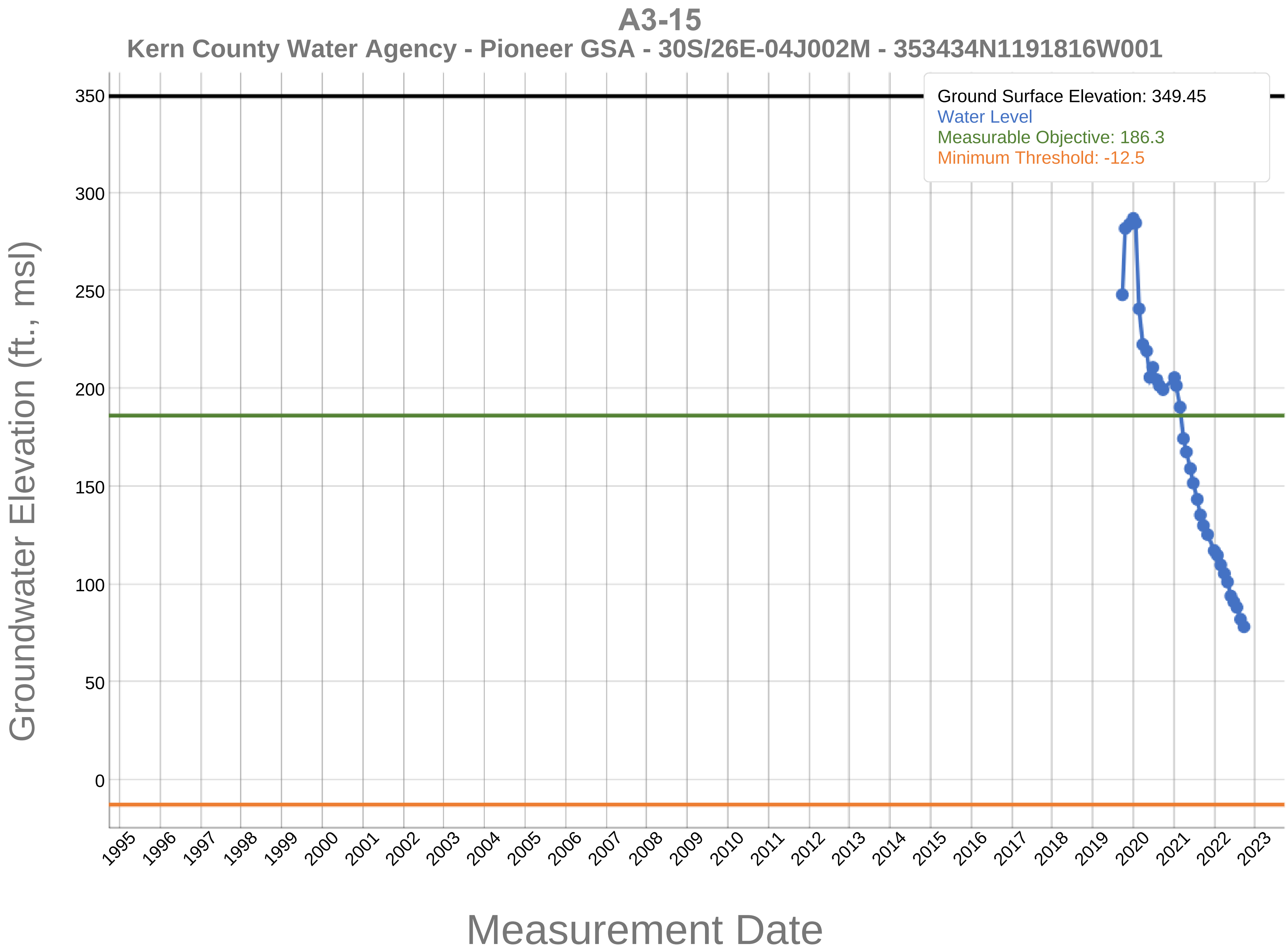
2022
2023
Measurement Date



A3-15
Kern County Water Agency - Pioneer GSA - 30S/26E-04J002M - 353434N1191816W001
Ground Surface Elevation: 349.45
Water Level
Measurable Objective: 186.3
Minimum Threshold: -12.5
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
1995
1996
1997
1998
1999
2000
2001
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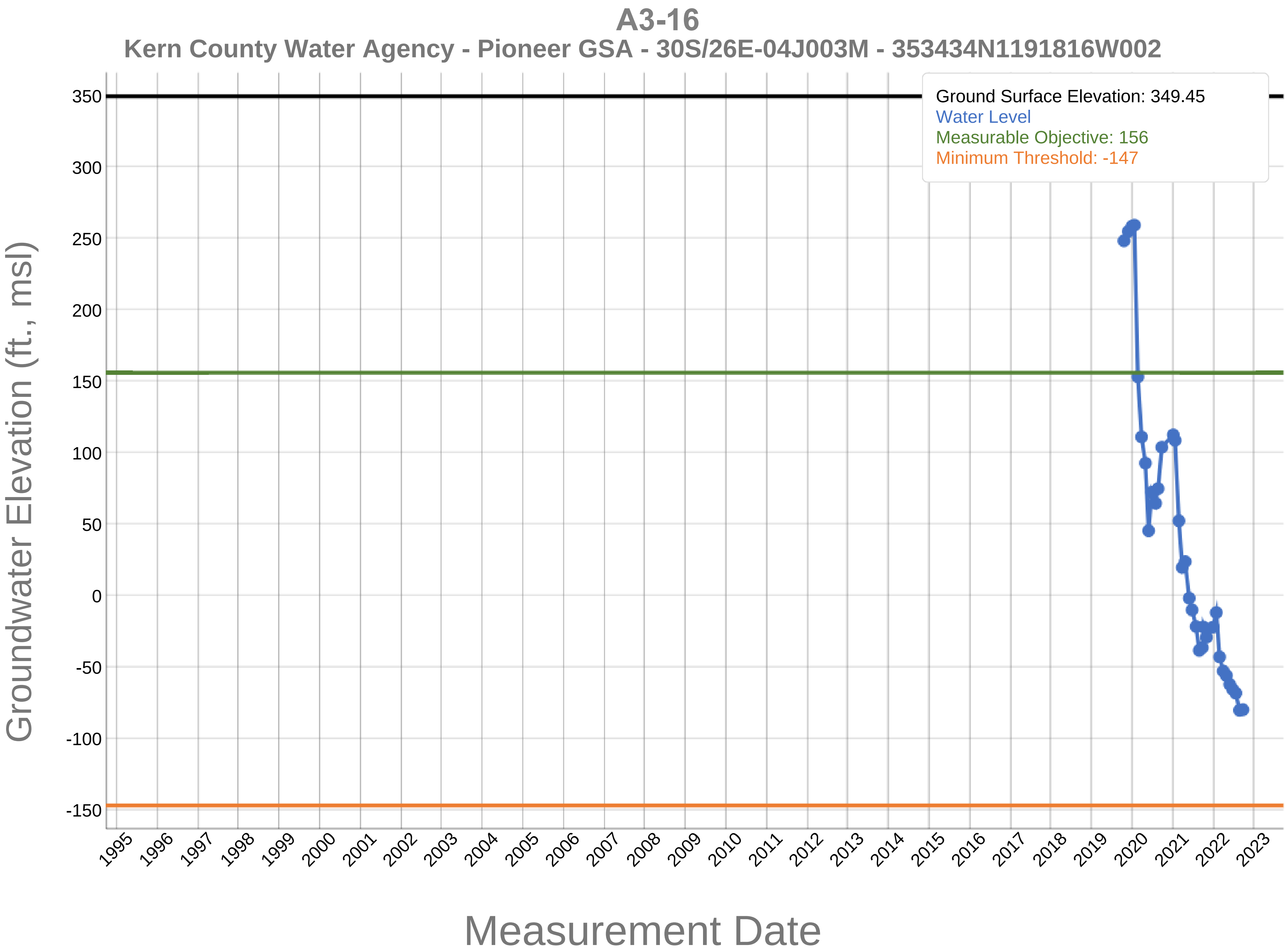
2021
2022
2023
Measurement Date


A3-16
Kern County Water Agency - Pioneer GSA - 30S/26E-04J003M - 353434N1191816W002
Ground Surface Elevation: 349.45
Water Level
Measurable Objective: 156
Minimum Threshold: -147
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
1997
1998
1999
2000
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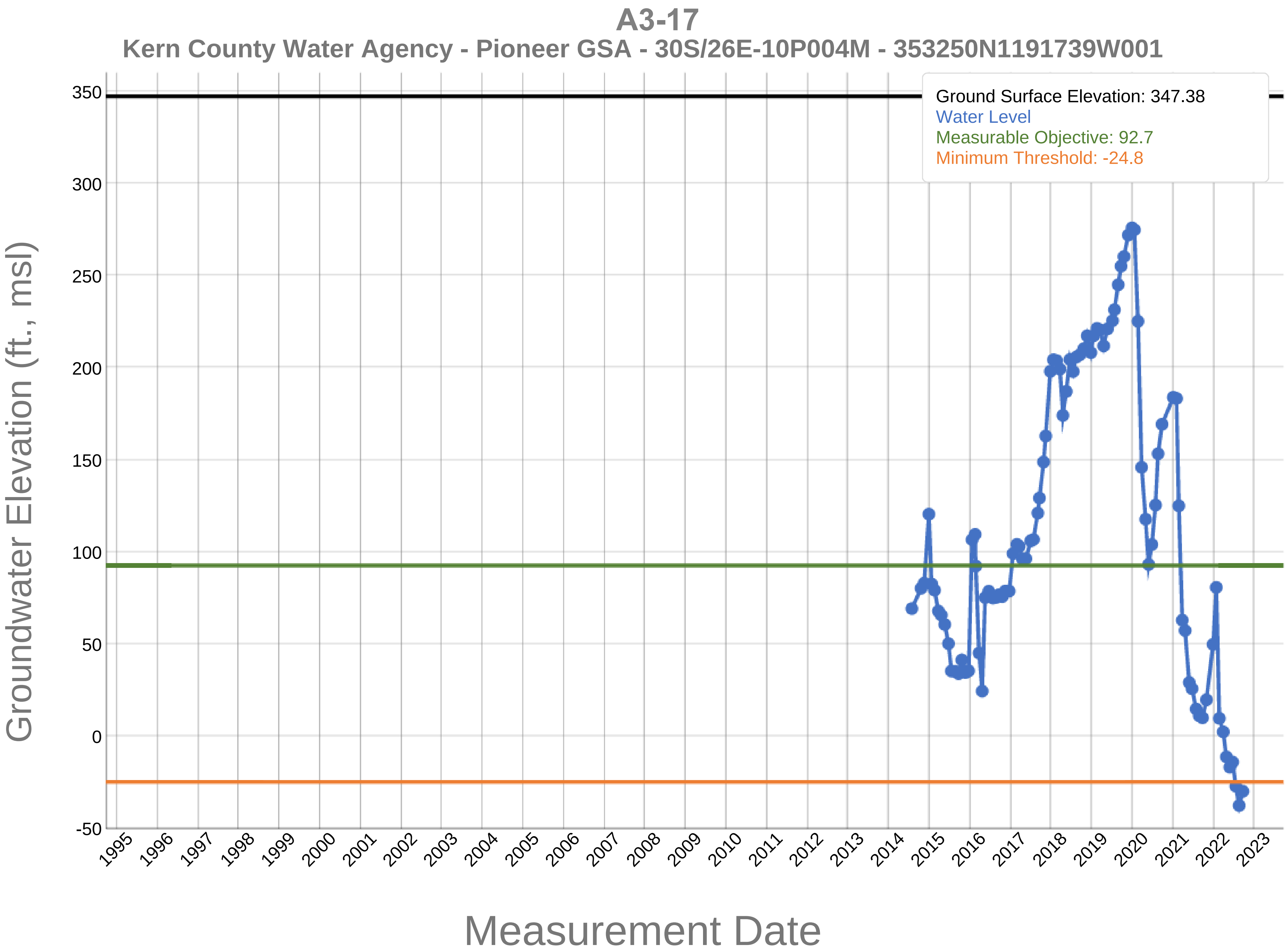
Measurement Date


A3-17
Kern County Water Agency - Pioneer GSA - 30S/26E-10P004M - 353250N1191739W001
Ground Surface Elevation: 347.38
Water Level
Measurable Objective: 92.7
Minimum Threshold: -24.8
Groundwater Elevation (ft., msl)
Measurement Date
350
300
250
200
150
100
50
0
-50
1995
1996
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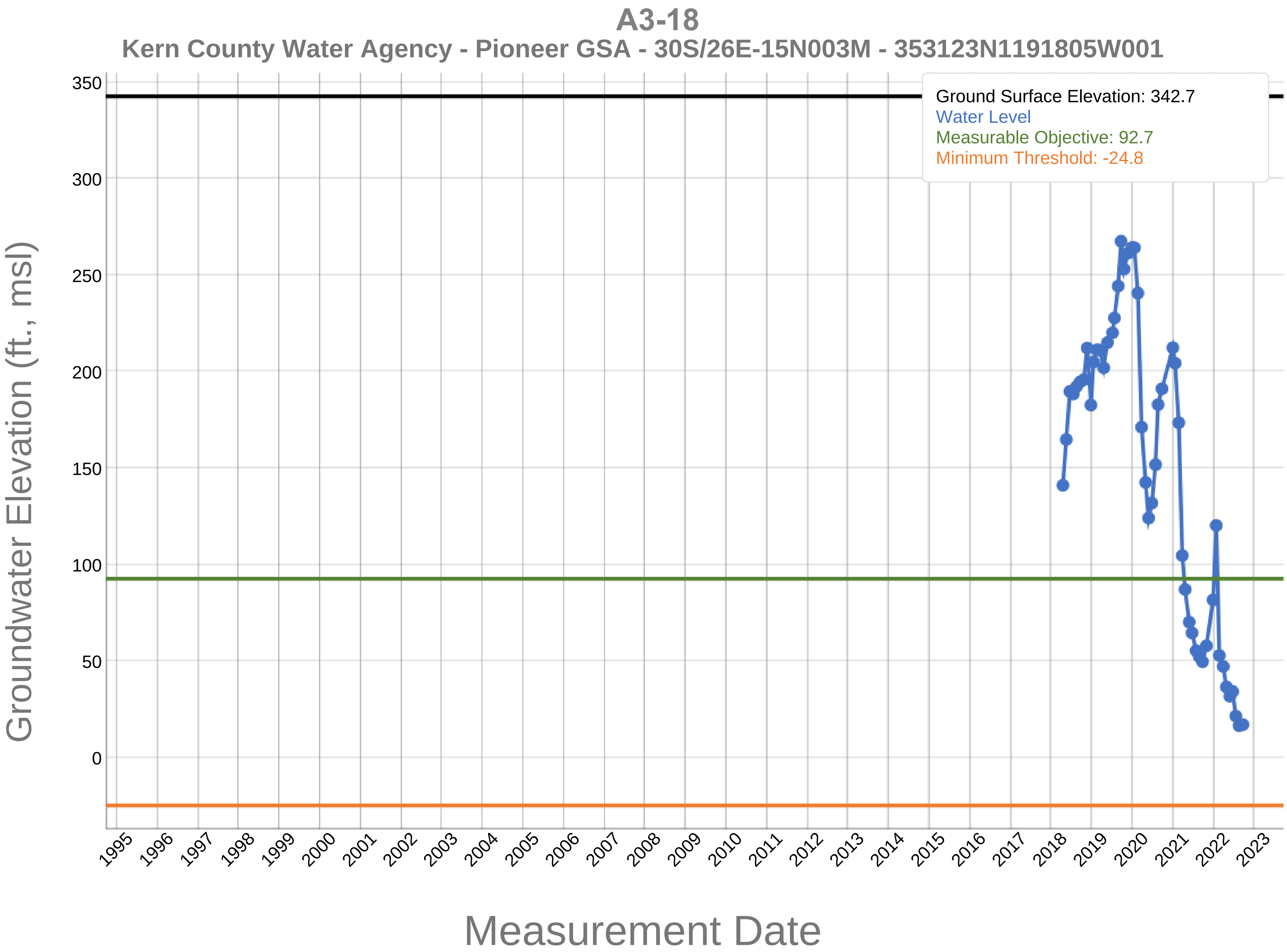
A3-18
Kern County Water Agency - Pioneer GSA - 30S/26E-15N003M - 353123N1191805W001
Ground Surface Elevation: 342.7
Water Level
Measurable Objective: 92.7
Minimum Threshold: -24.8
Groundwater Elevation (ft., msl)
Measurement Date
350
300
250
200
150
100
50
0
1995
1996
1997
1998
1999
2000
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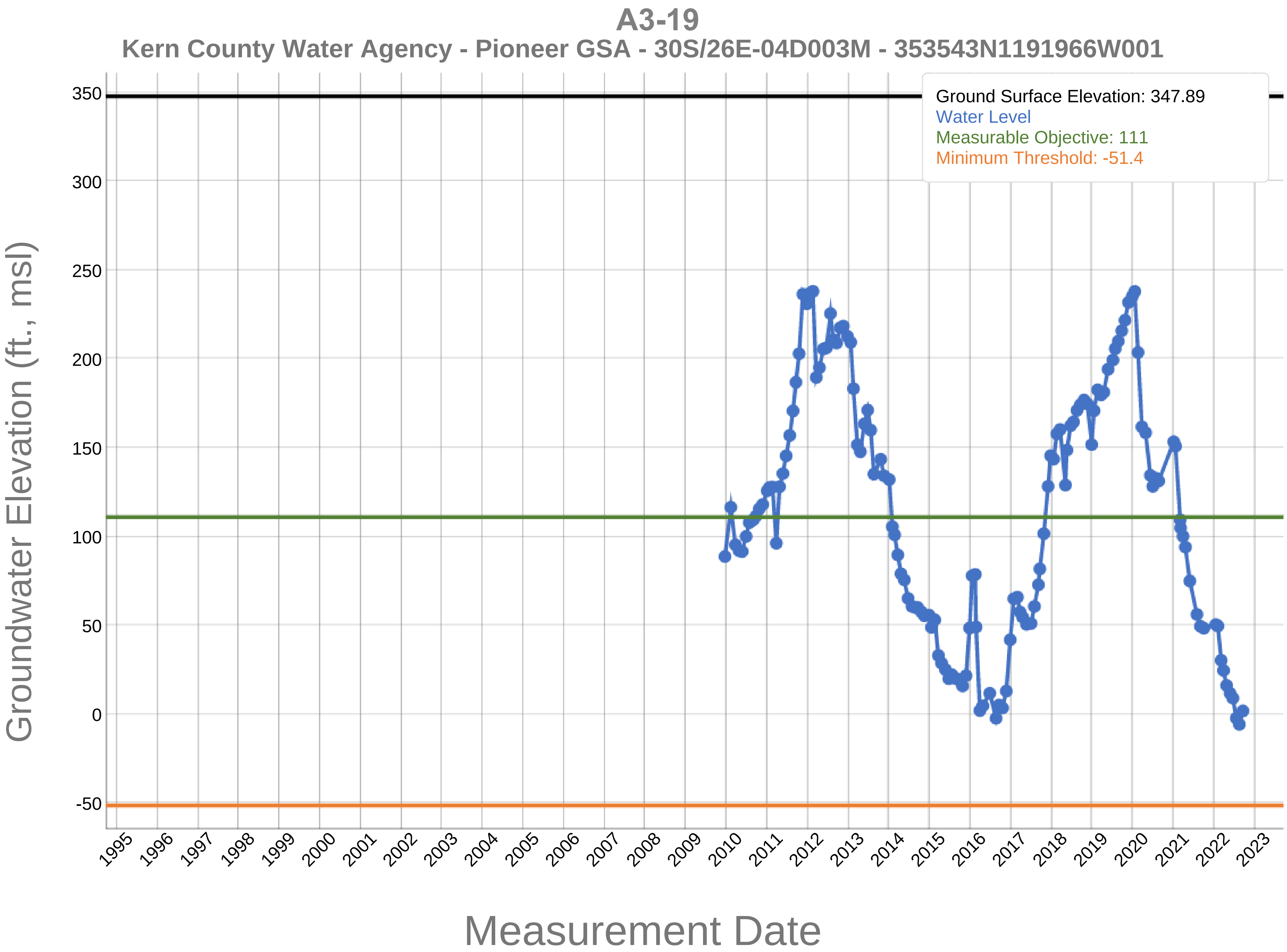

A3-19
Kern County Water Agency - Pioneer GSA - 30S/26E-04D003M - 353543N1191966W001
Ground Surface Elevation: 347.89
Water Level
Measurable Objective: 111
Minimum Threshold: -51.4
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
2000
2001
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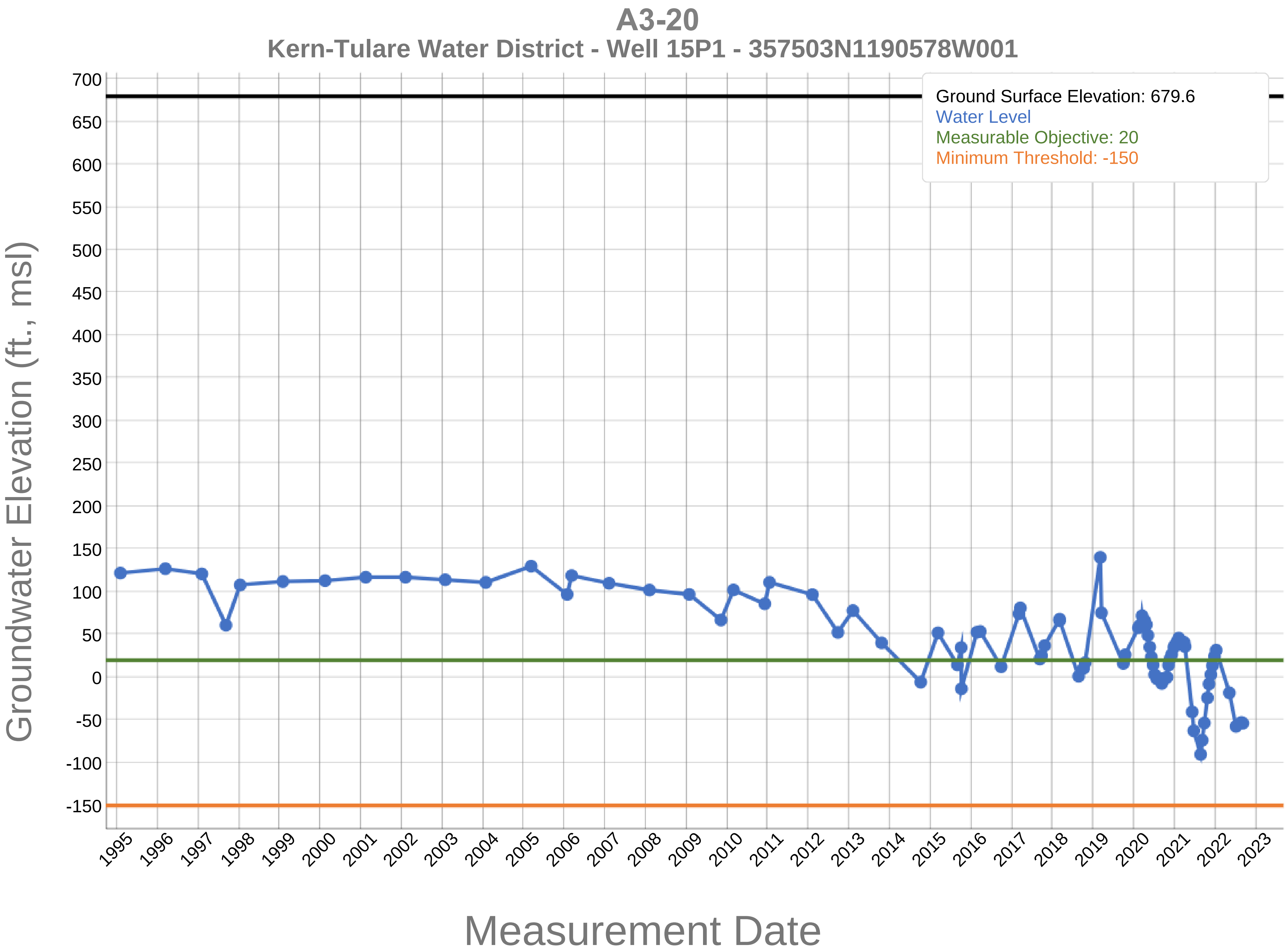
Measurement Date



A3-20
Kern-Tulare Water District - Well 15P1 - 357503N1190578W001
Ground Surface Elevation: 679.6
Water Level
Measurable Objective: 20
Minimum Threshold: -150
Groundwater Elevation (ft., msl)
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
1997
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2022
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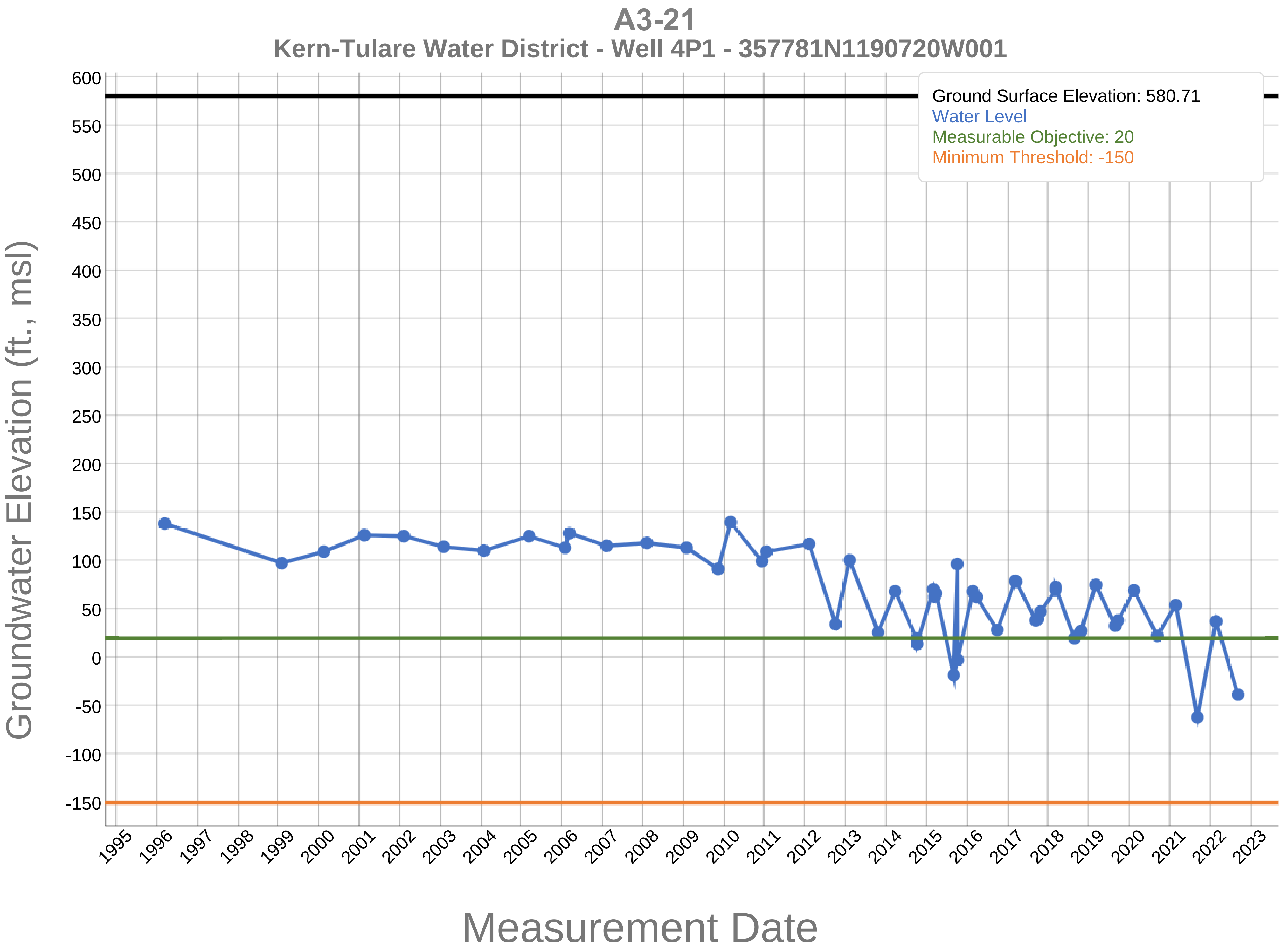
Measurement Date


A3-21
Kern-Tulare Water District - Well 4P1 - 357781N1190720W001
Ground Surface Elevation: 580.71
Water Level
Measurable Objective: 20
Minimum Threshold: -150
Groundwater Elevation (ft., msl)
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
1997
1998
1999
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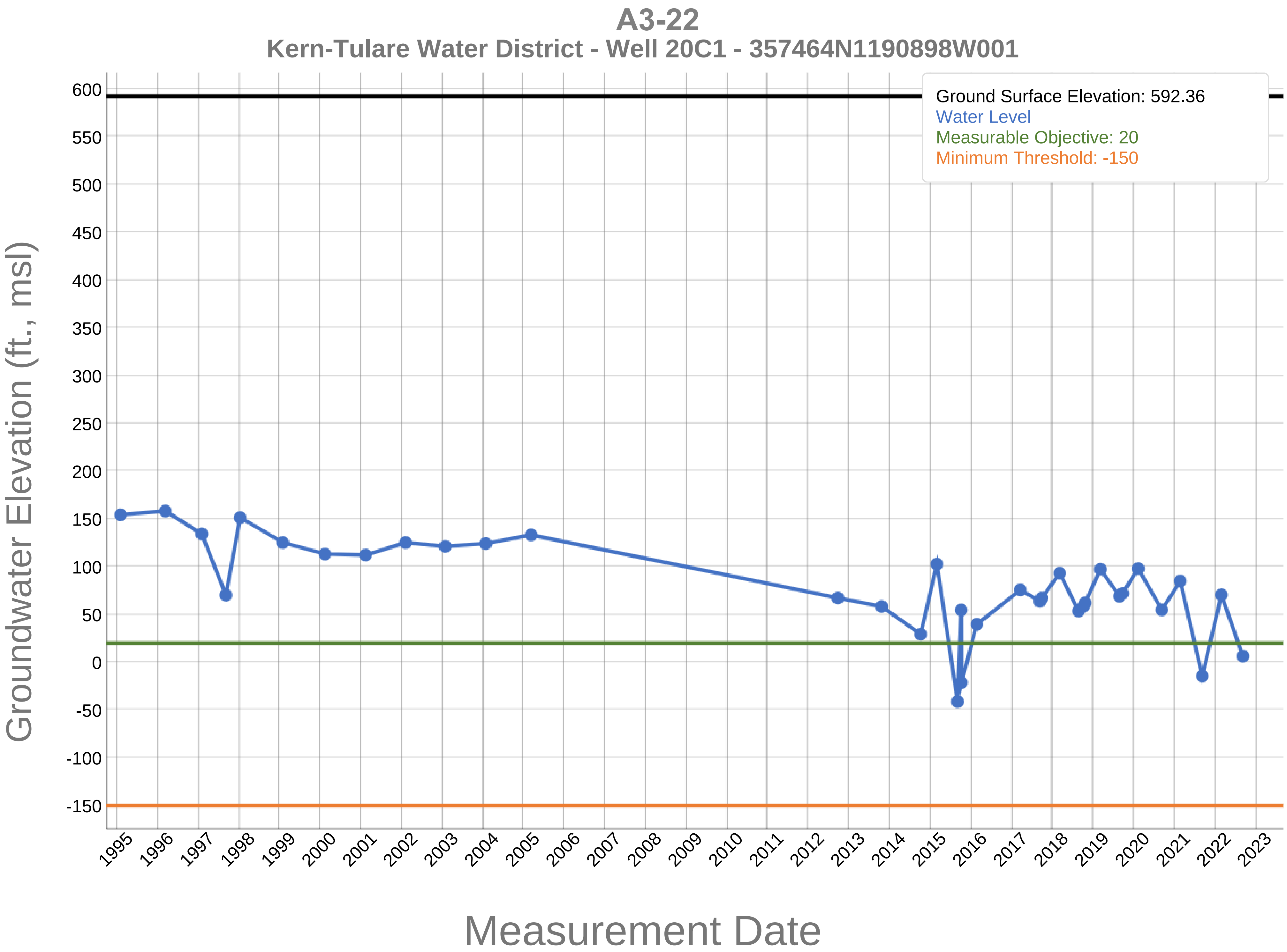
Measurement Date


A3-22
Kern-Tulare Water District - Well 20C1 - 357464N1190898W001
Ground Surface Elevation: 592.36
Water Level
Measurable Objective: 20
Minimum Threshold: -150
Groundwater Elevation (ft., msl)
Measurement Date
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
1997
1998
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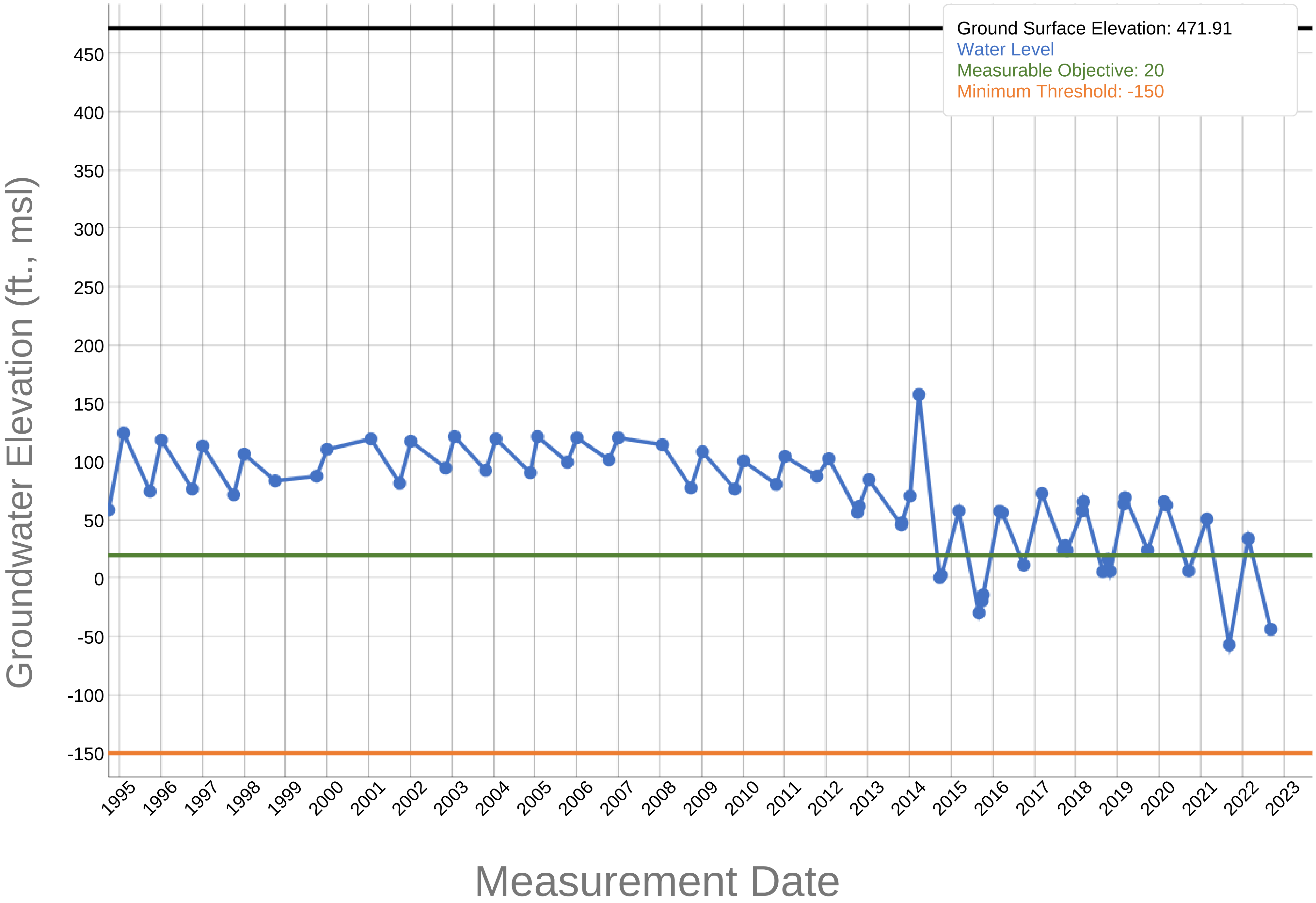
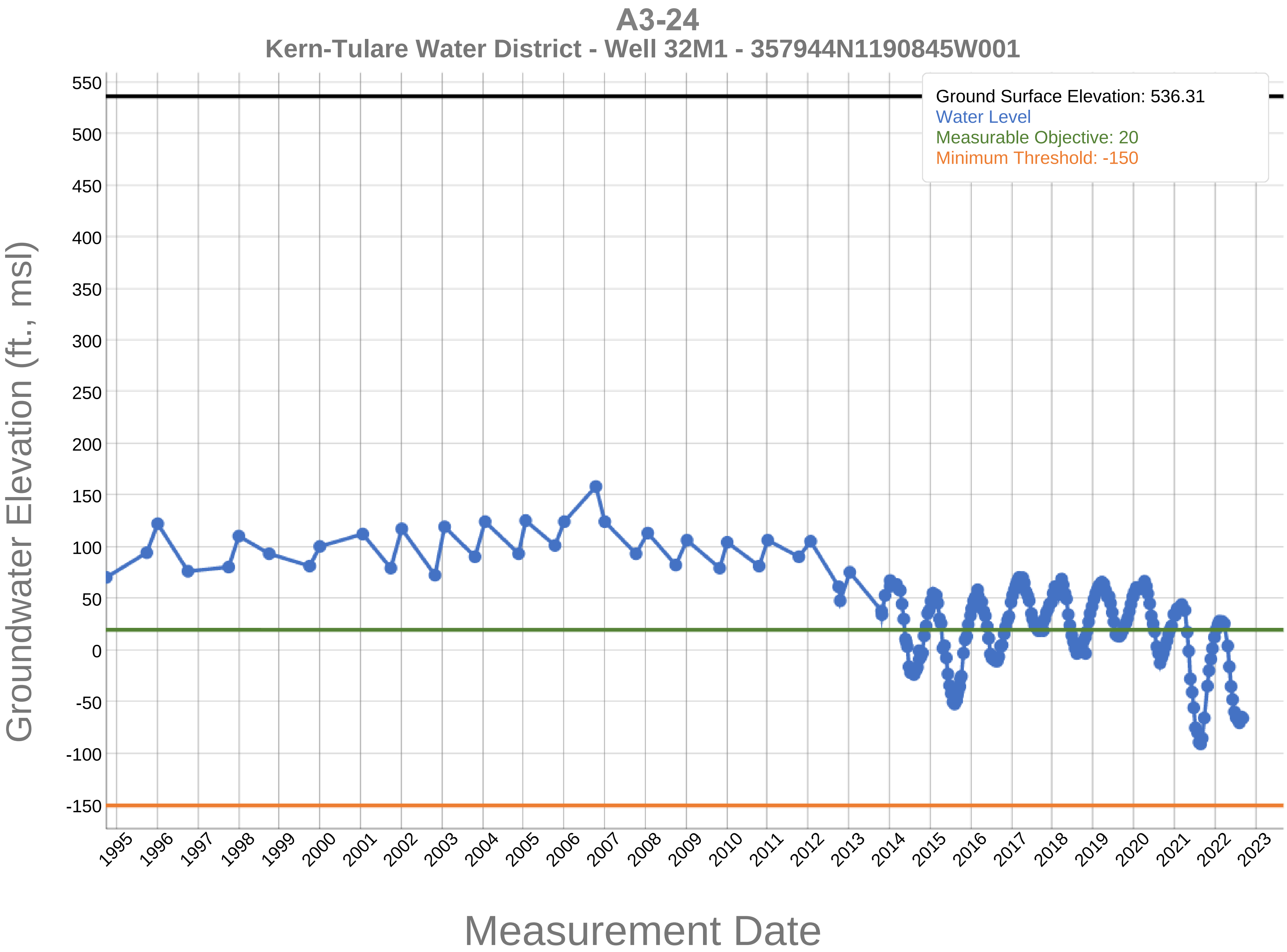
A3-23

Kern-Tulare Water District - Well 24Q1 - 358231N1191126W001




A3-24
Kern-Tulare Water District - Well 32M1 - 357944N1190845W001
Ground Surface Elevation: 536.31
Water Level
Measurable Objective: 20
Minimum Threshold: -150
Groundwater Elevation (ft., msl)
Measurement Date
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
1997
1998
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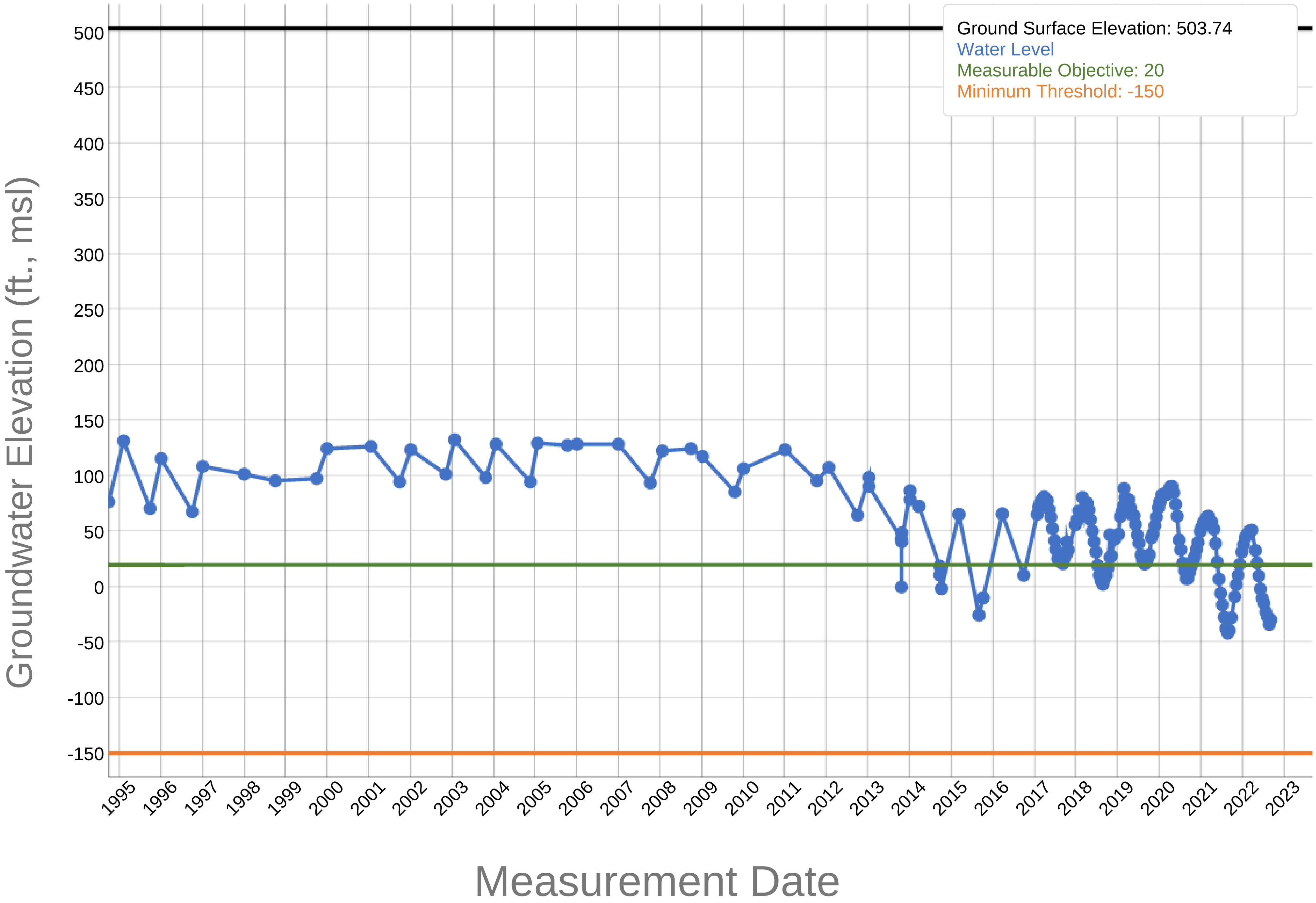
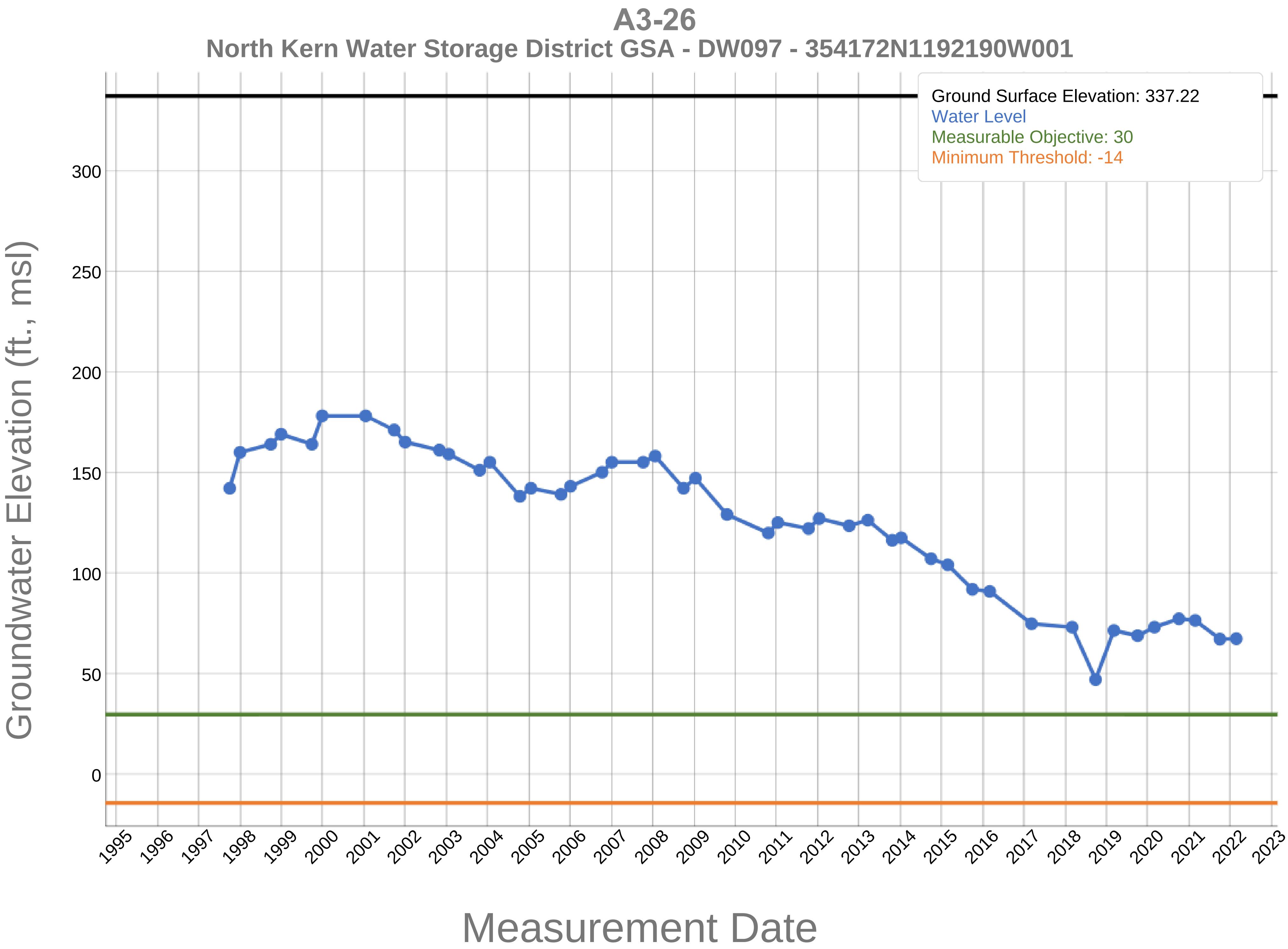
A3-25

Kern-Tulare Water District - Well 8L1 - 358561N1190806W001





A3-26
North Kern Water Storage District GSA - DW097 - 354172N1192190W001
Ground Surface Elevation: 337.22
Water Level
Measurable Objective: 30
Minimum Threshold: -14
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
1995
1996
1997
1998
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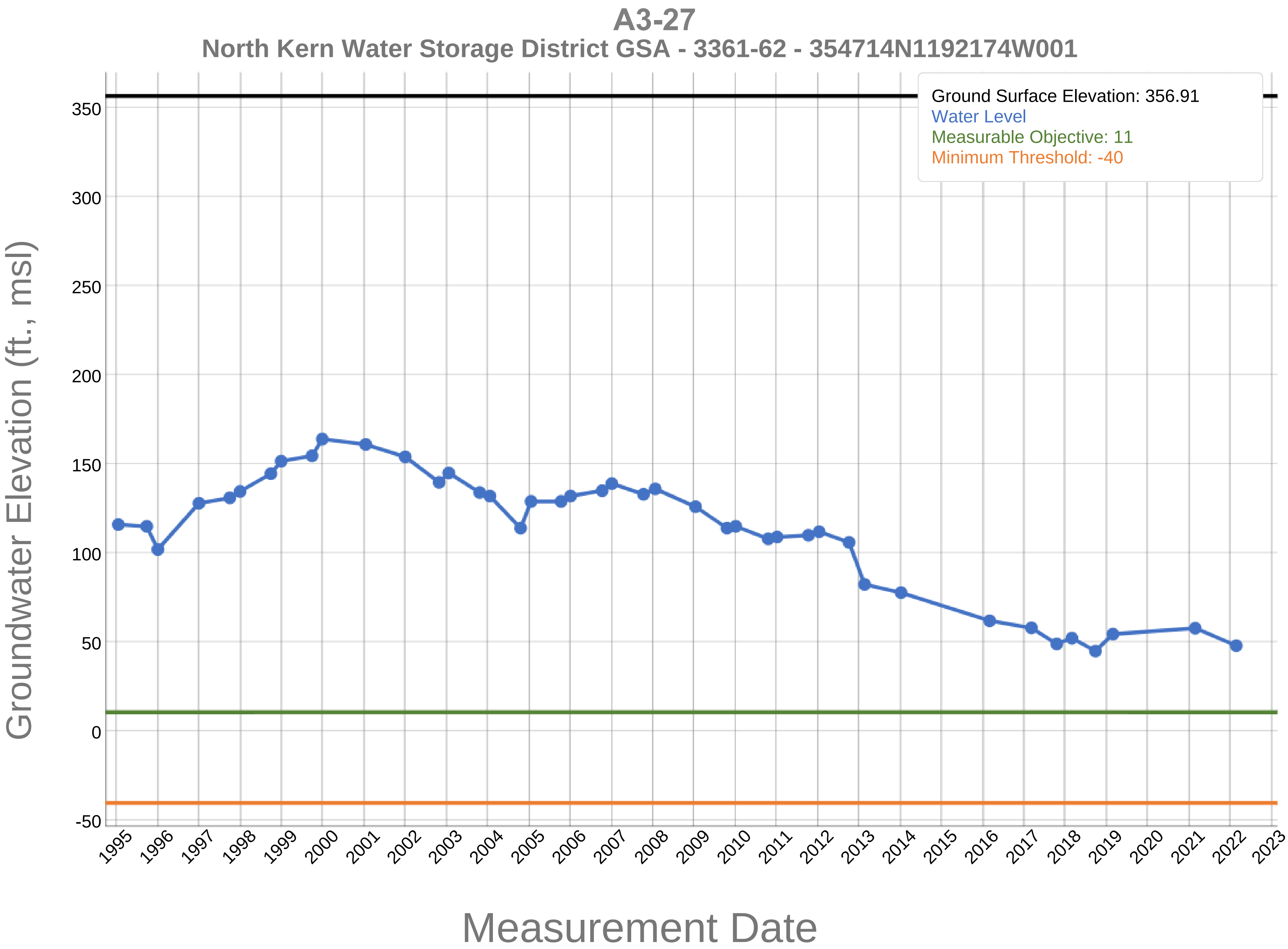
Measurement Date



A3-27
North Kern Water Storage District GSA - 3361-62 - 354714N1192174W001
Ground Surface Elevation: 356.91
Water Level
Measurable Objective: 11
Minimum Threshold: -40
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
1995
1996
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2000
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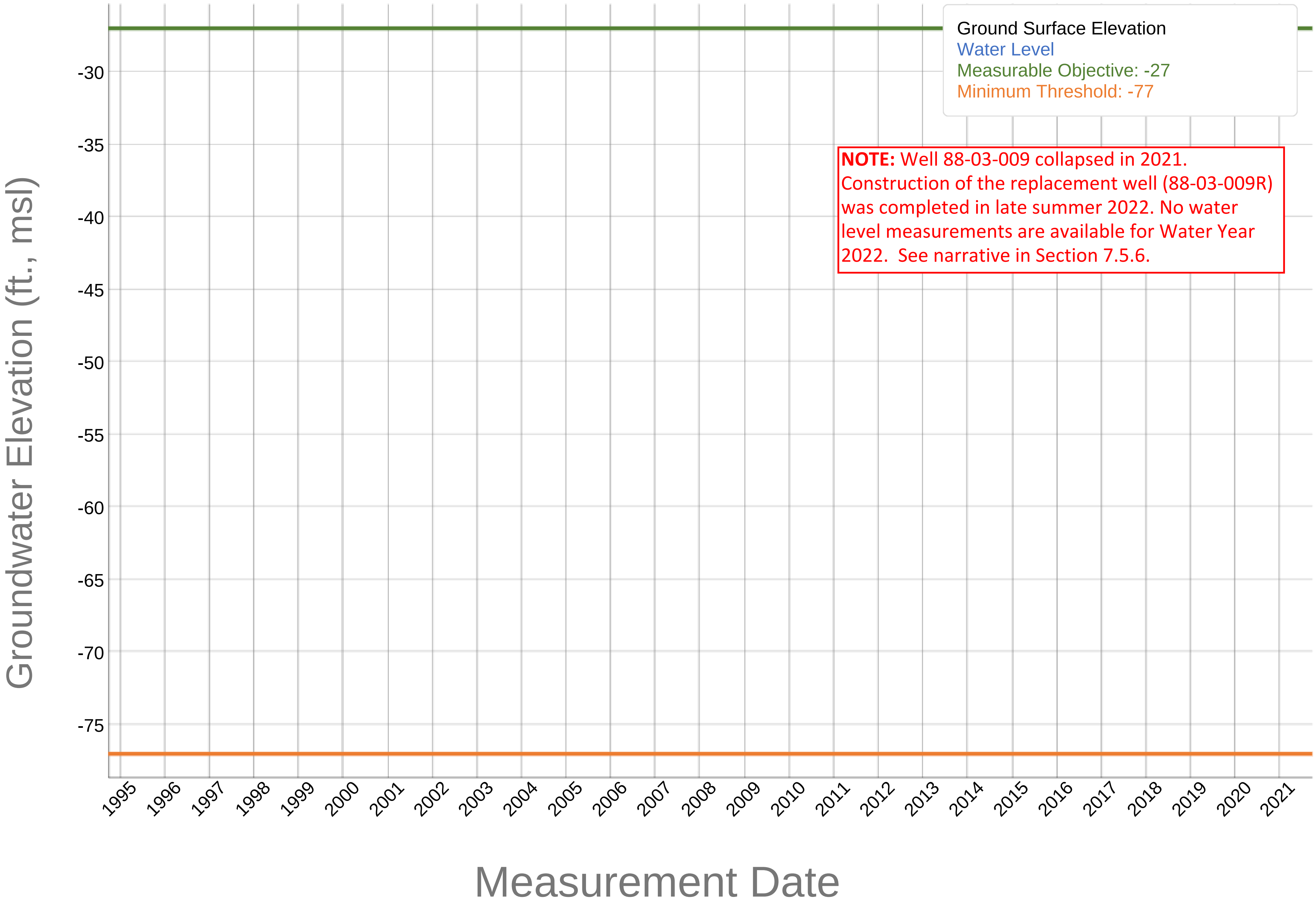
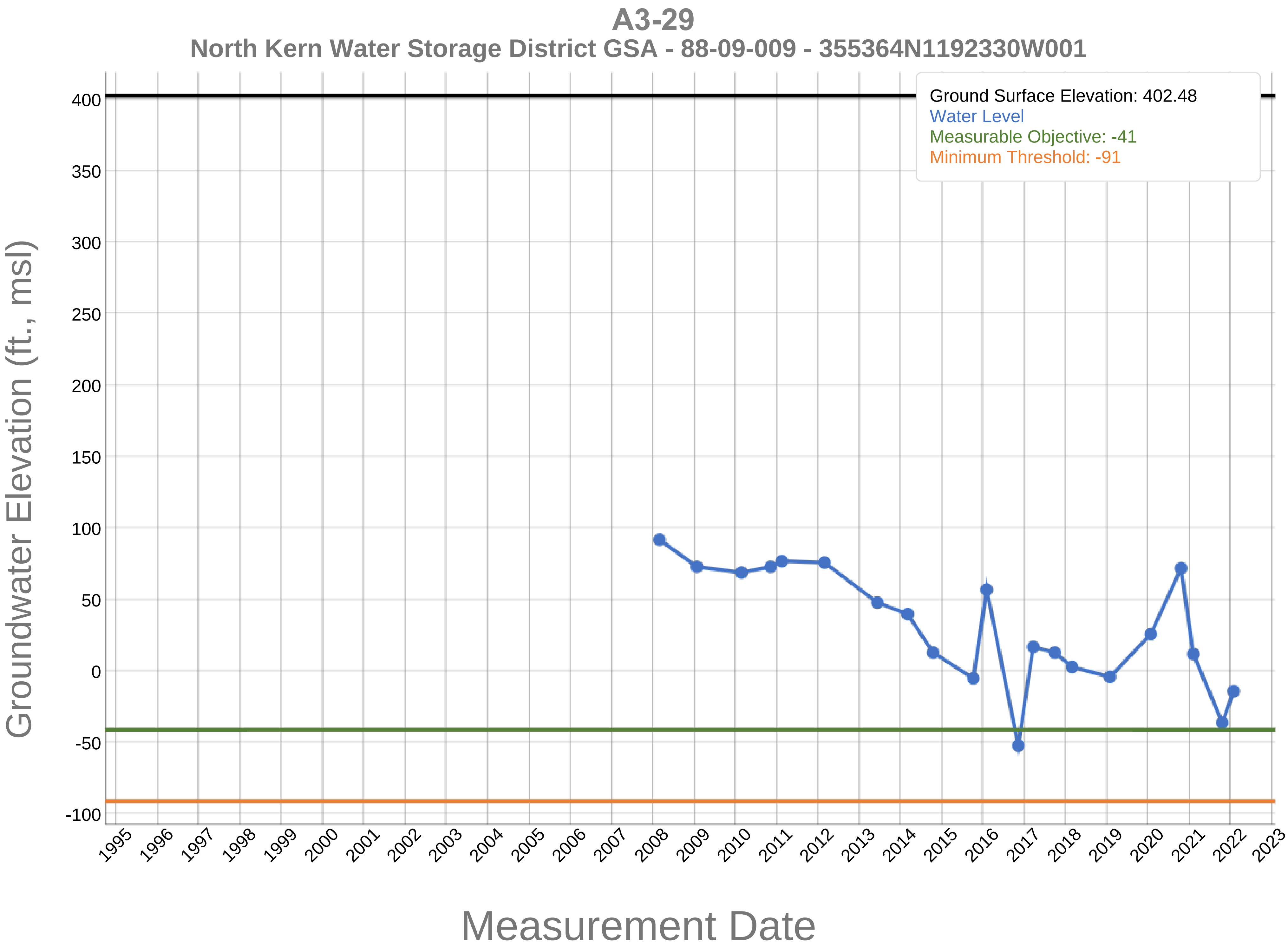
Measurement Date

A3-28

North Kern Water Storage District GSA - 88-03-009R - 354970N1191706W001





A3-29
North Kern Water Storage District GSA - 88-09-009 - 355364N1192330W001
Ground Surface Elevation: 402.48
Water Level
Measurable Objective: -41
Minimum Threshold: -91
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
0
-50
-100
1995
1996
1997
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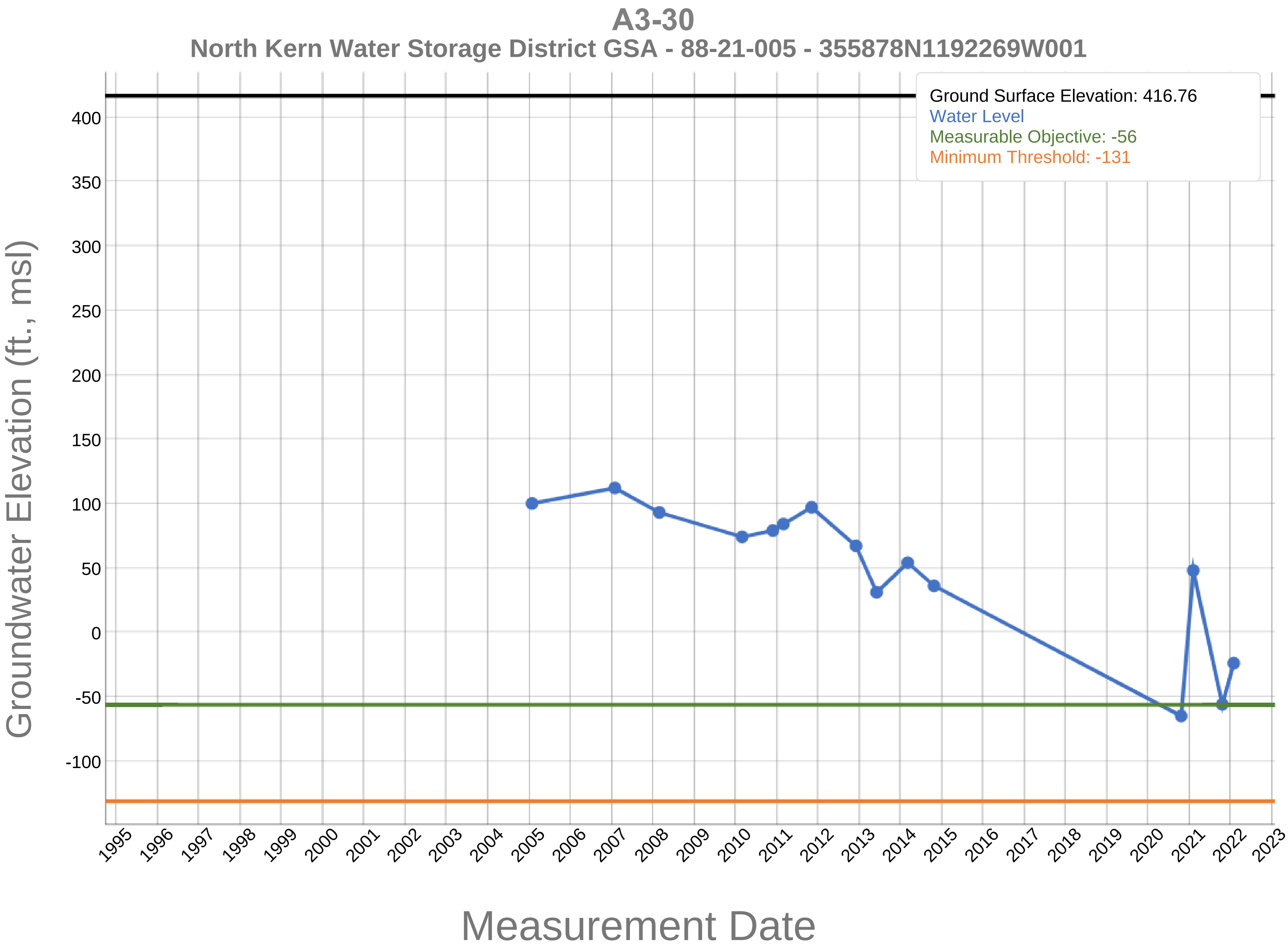
Measurement Date



A3-30
North Kern Water Storage District GSA - 88-21-005 - 355878N1192269W001
Ground Surface Elevation: 416.76
Water Level
Measurable Objective: -56
Minimum Threshold: -131
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
0
-50
-100
1995
1996
1997
1998
1999
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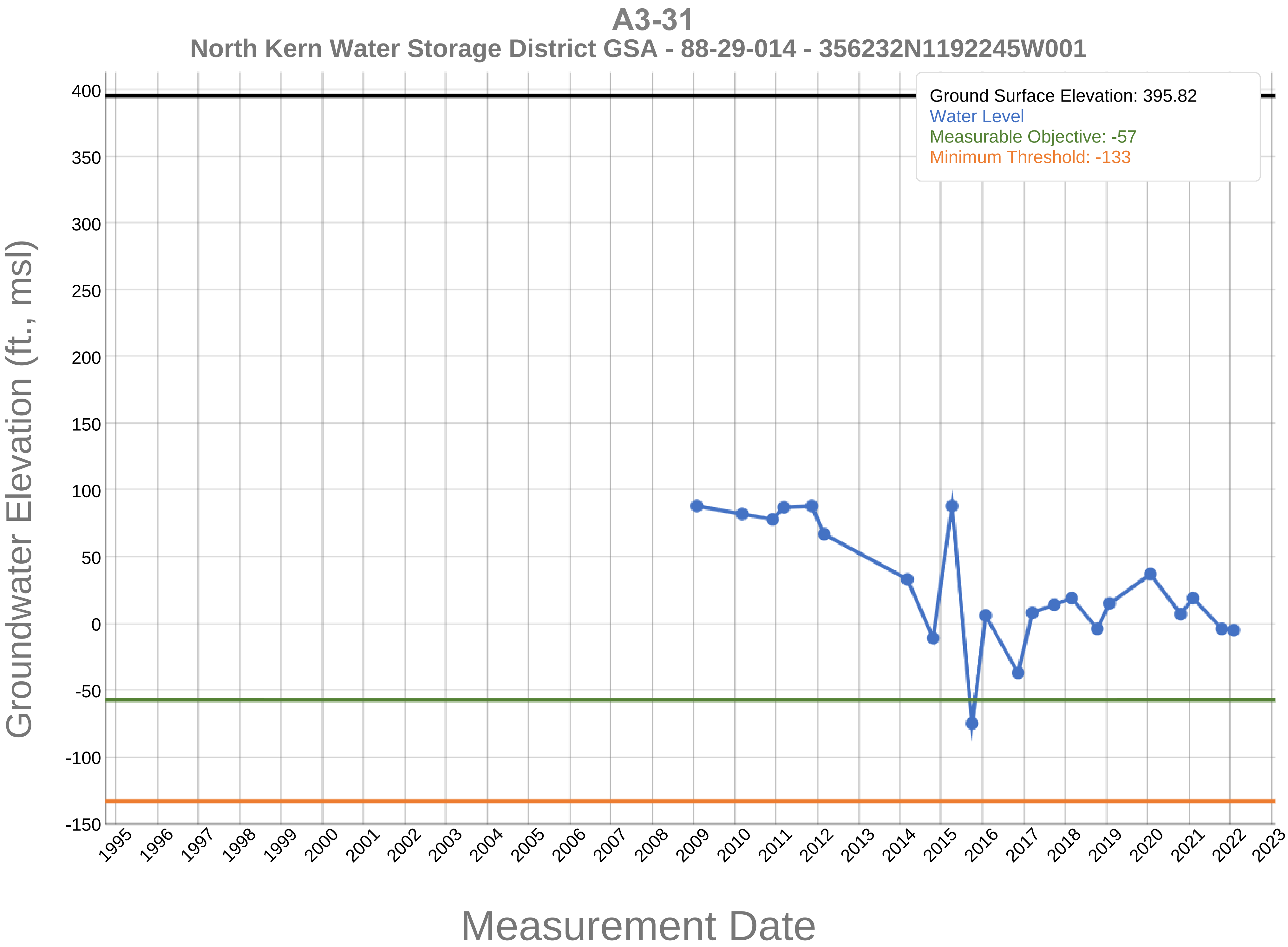
Measurement Date


A3-31
North Kern Water Storage District GSA - 88-29-014 - 356232N1192245W001
Ground Surface Elevation: 395.82
Water Level
Measurable Objective: -57
Minimum Threshold: -133
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
0
-50
-100
-150
1995
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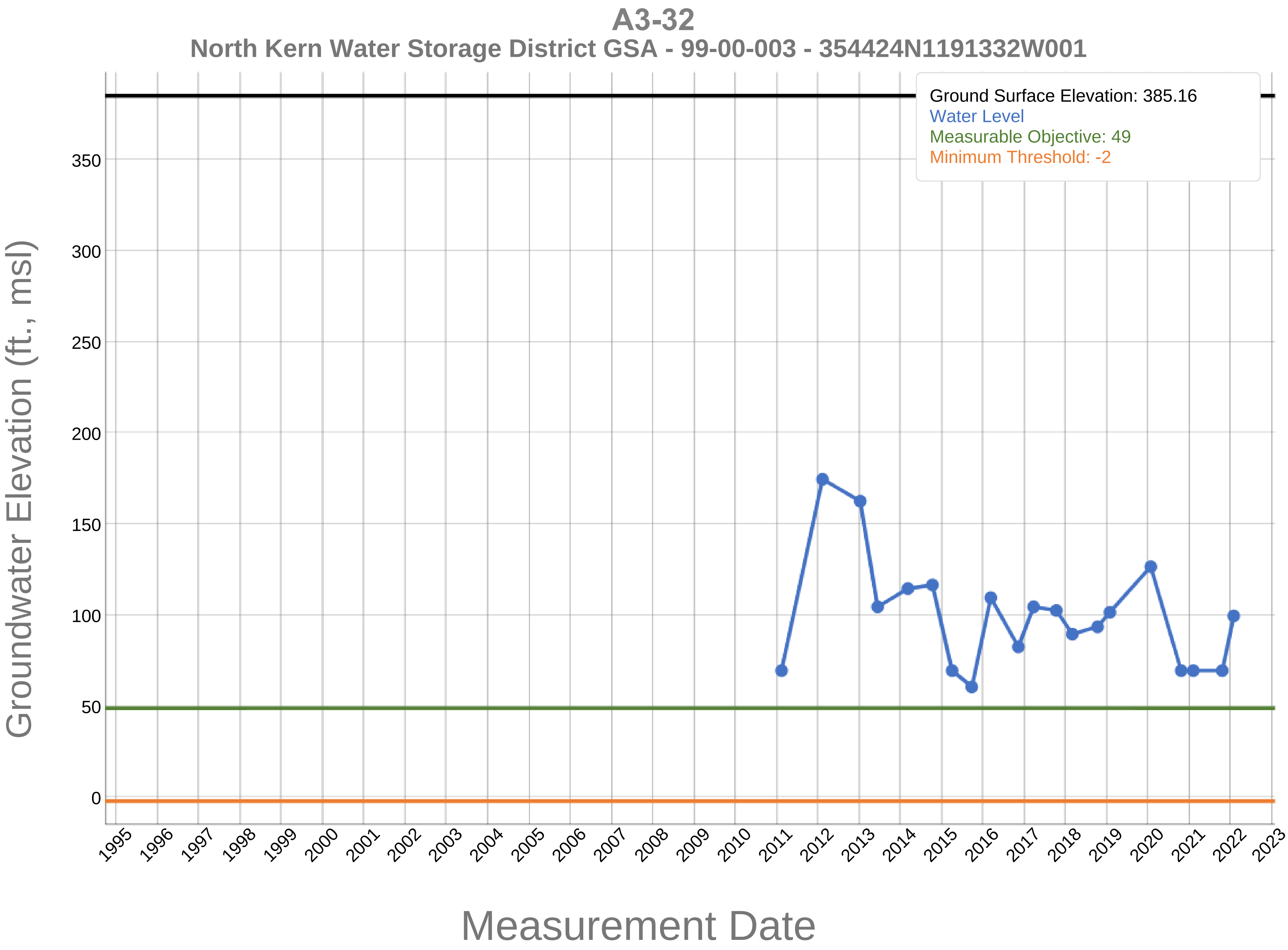
Measurement Date



A3-32
North Kern Water Storage District GSA - 99-00-003 - 354424N1191332W001
Ground Surface Elevation: 385.16
Water Level
Measurable Objective: 49
Minimum Threshold: -2
Groundwater Elevation (ft., msl)
0
50
100
150
200
250
300
350
1995
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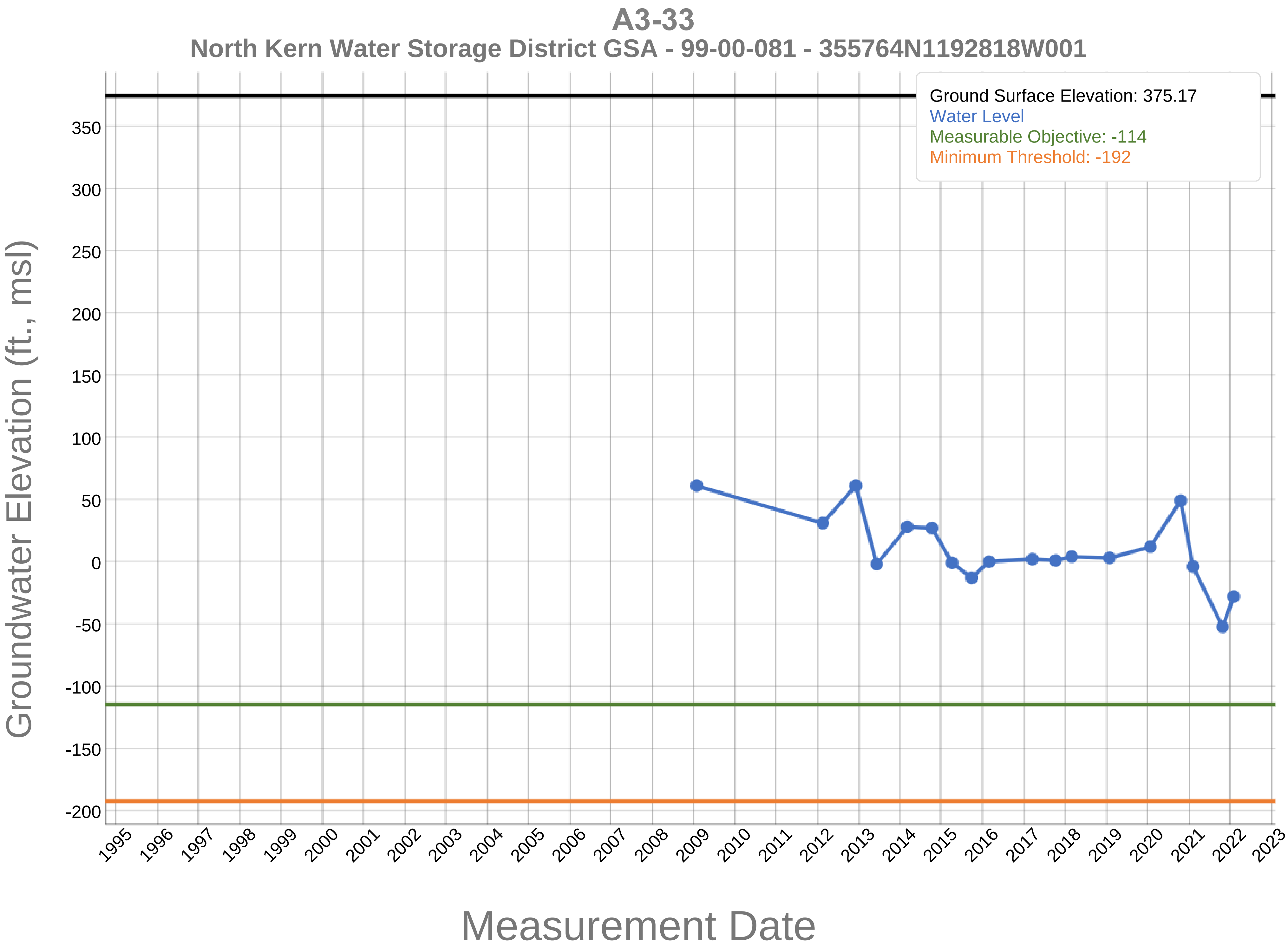
Measurement Date


A3-33
North Kern Water Storage District GSA - 99-00-081 - 355764N1192818W001
Ground Surface Elevation: 375.17
Water Level
Measurable Objective: -114
Minimum Threshold: -192
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
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-50
-100
-150
-200
1995
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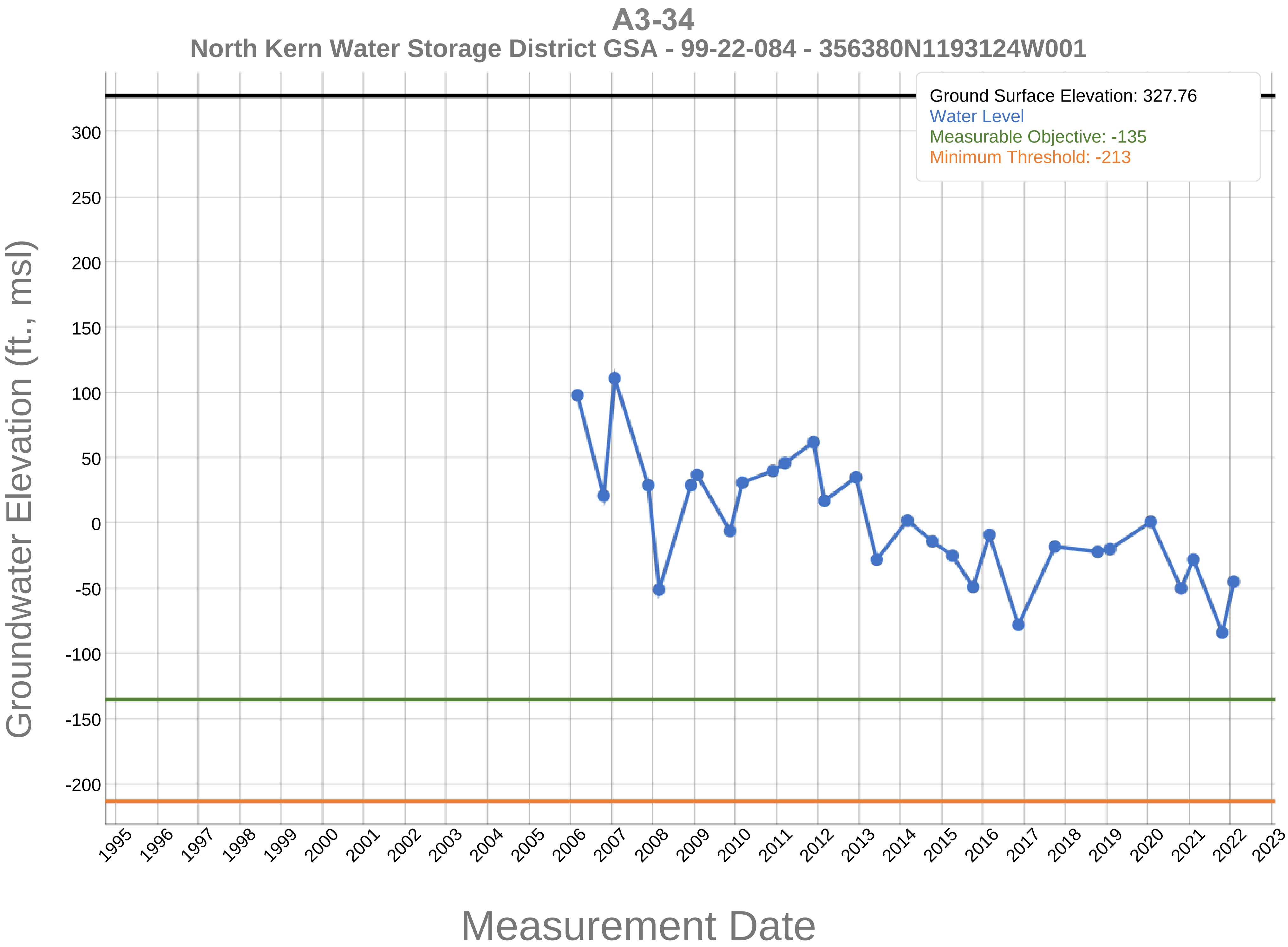
Measurement Date


A3-34
North Kern Water Storage District GSA - 99-22-084 - 356380N1193124W001
Ground Surface Elevation: 327.76
Water Level
Measurable Objective: -135
Minimum Threshold: -213
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
-150
-200
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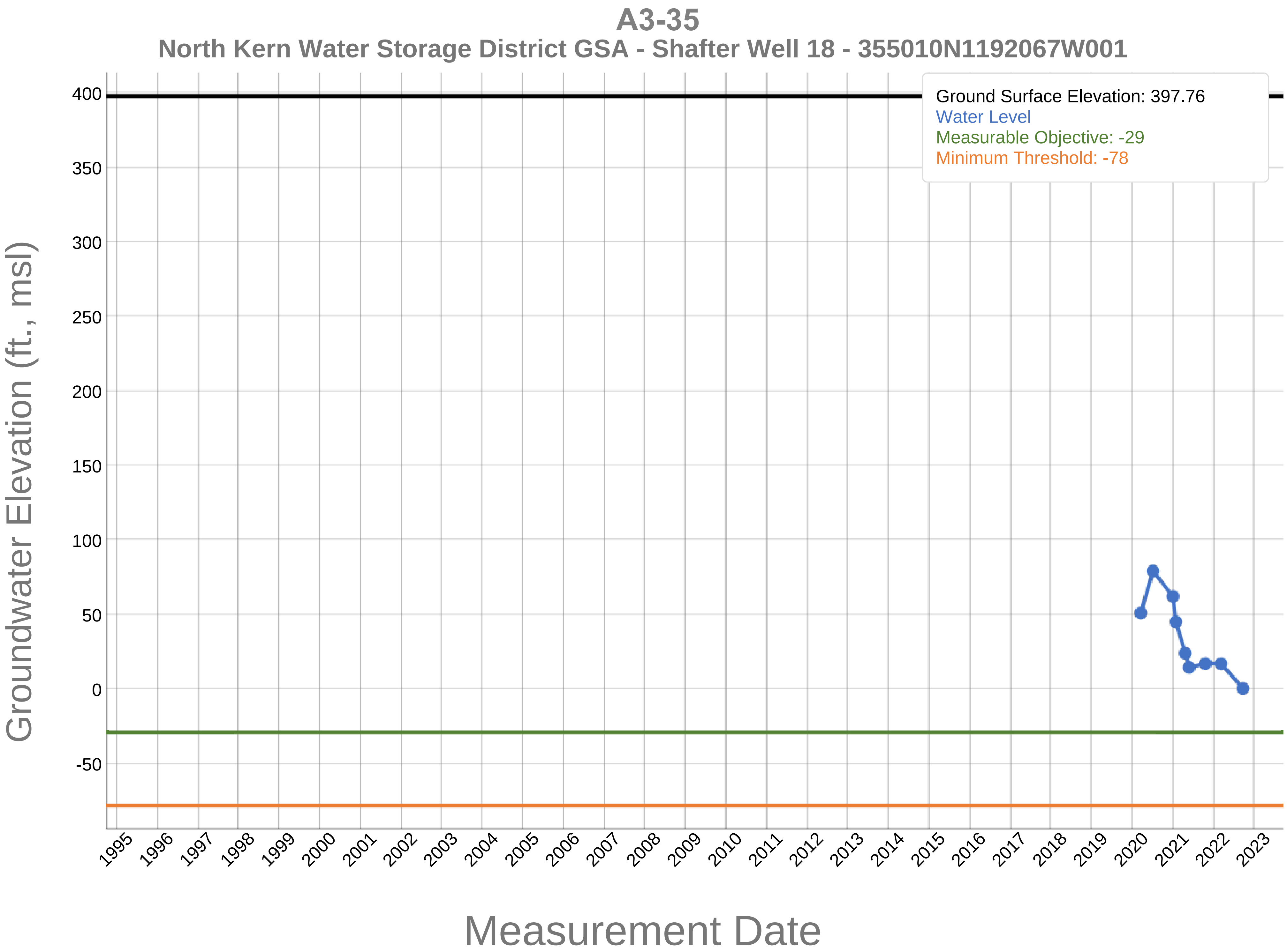
Measurement Date


A3-35
North Kern Water Storage District GSA - Shafter Well 18 - 355010N1192067W001
Ground Surface Elevation: 397.76
Water Level
Measurable Objective: -29
Minimum Threshold: -78
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
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-50
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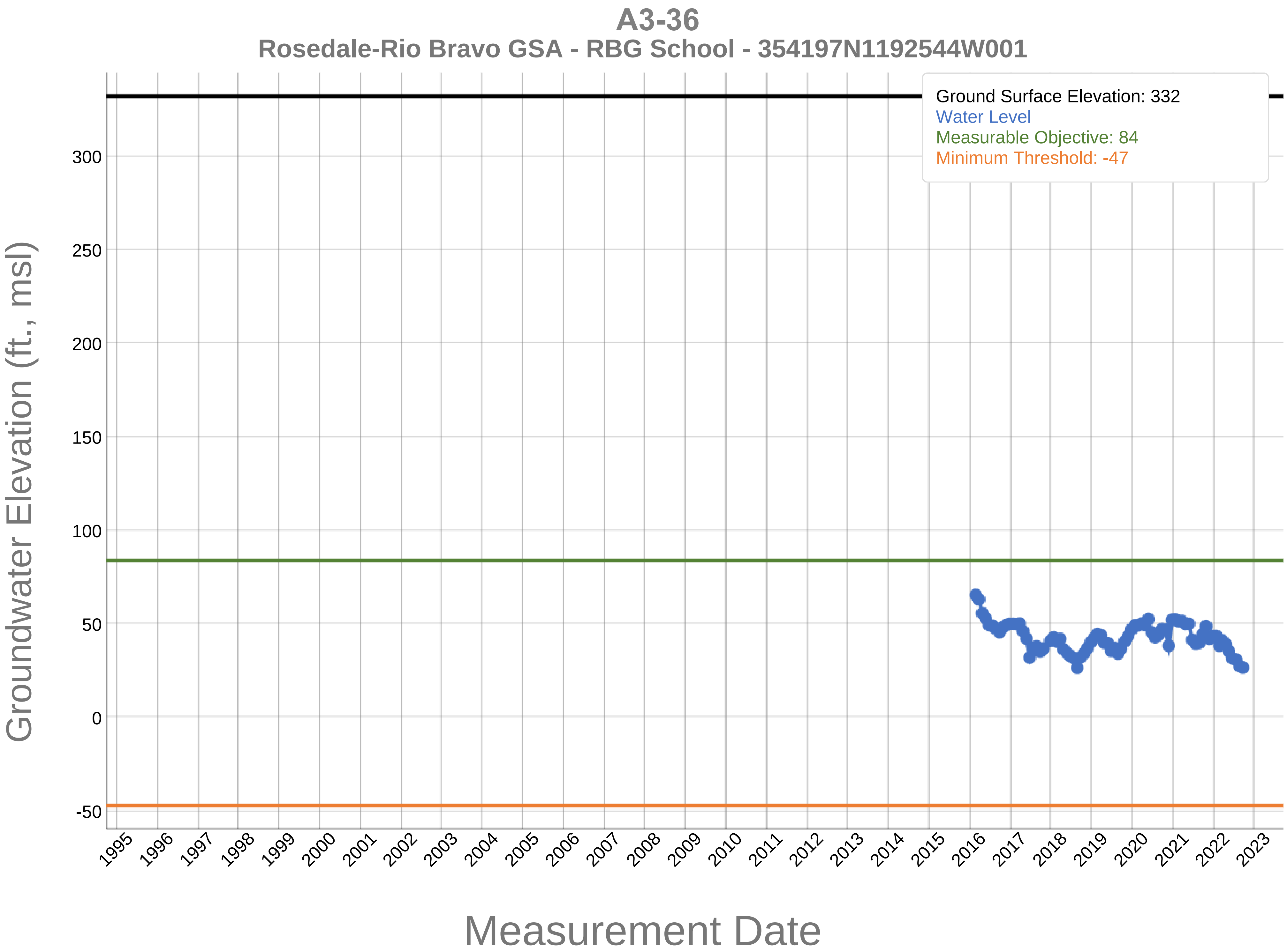
Measurement Date



A3-36
Rosedale-Rio Bravo GSA - RBG School - 354197N1192544W001
Ground Surface Elevation: 332
Water Level
Measurable Objective: 84
Minimum Threshold: -47
Groundwater Elevation (ft., msl)
300
250
200
150
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1995
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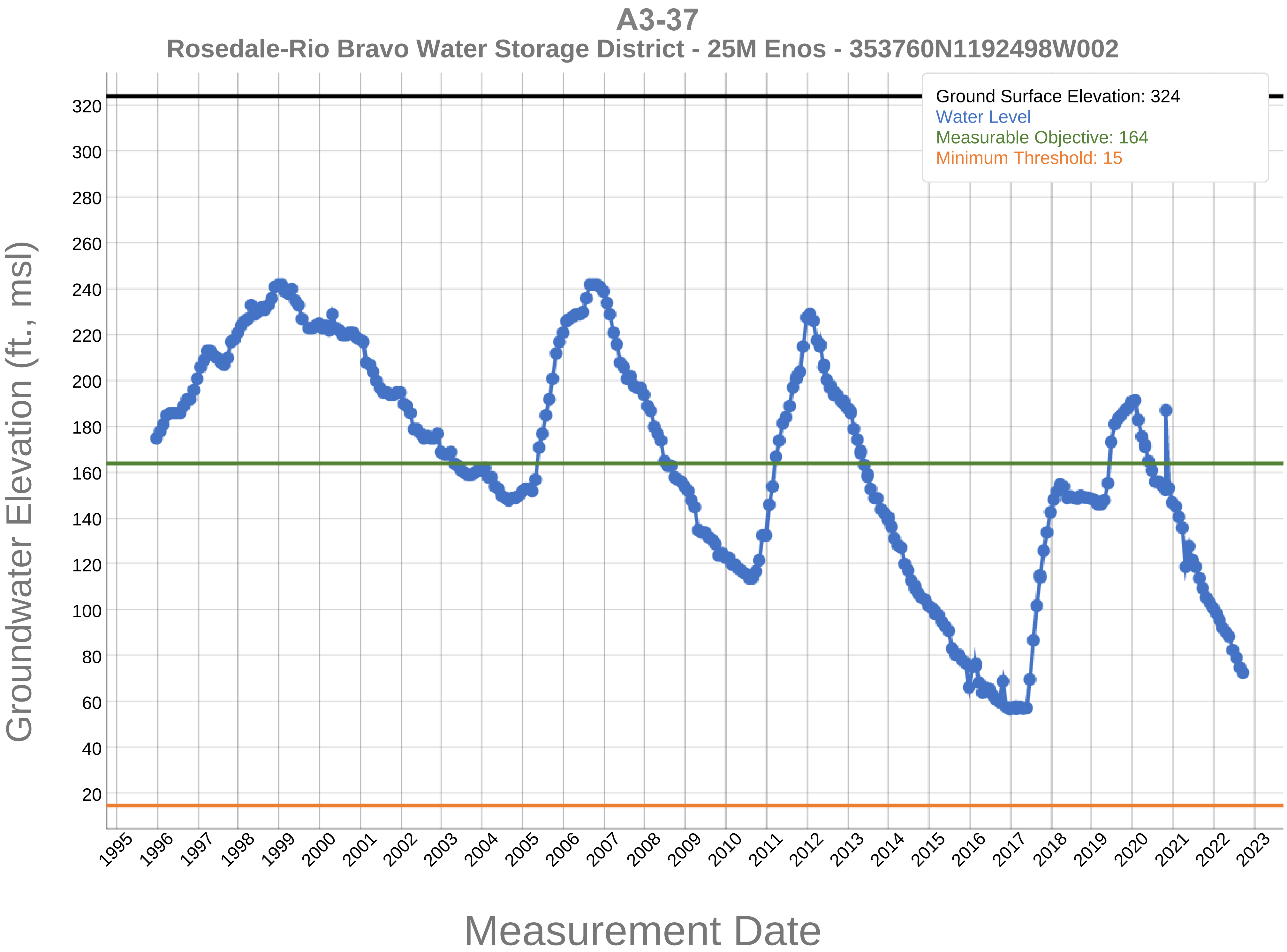
Measurement Date



A3-37
Rosedale-Rio Bravo Water Storage District - 25M Enos - 353760N1192498W002
Ground Surface Elevation: 324
Water Level
Measurable Objective: 164
Minimum Threshold: 15
Groundwater Elevation (ft., msl)
320
300
280
260
240
220
200
180
160
140
120
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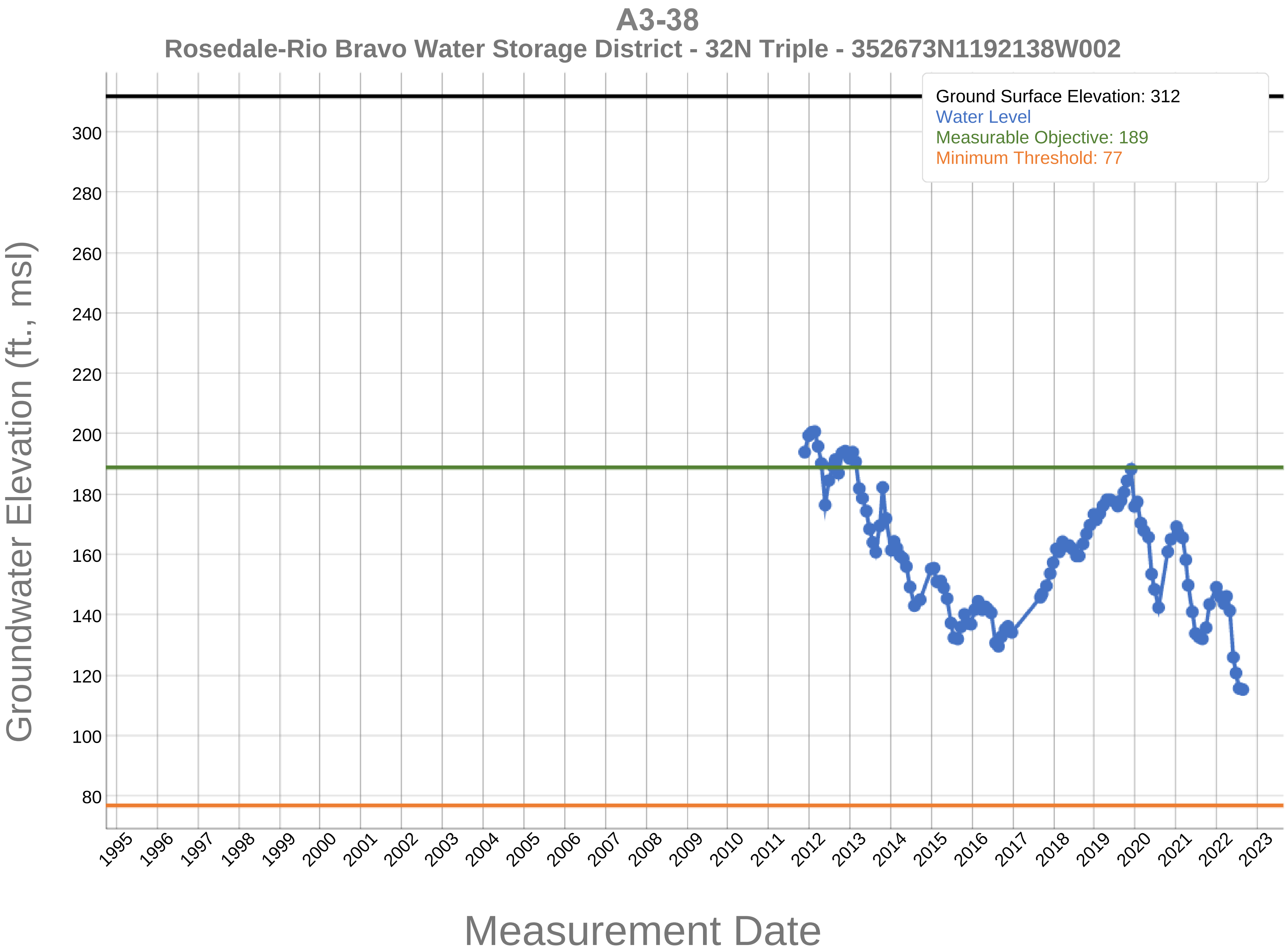
Measurement Date



A3-38
Rosedale-Rio Bravo Water Storage District - 32N Triple - 352673N1192138W002
Ground Surface Elevation: 312
Water Level
Measurable Objective: 189
Minimum Threshold: 77
Groundwater Elevation (ft., msl)
300
280
260
240
220
200
180
160
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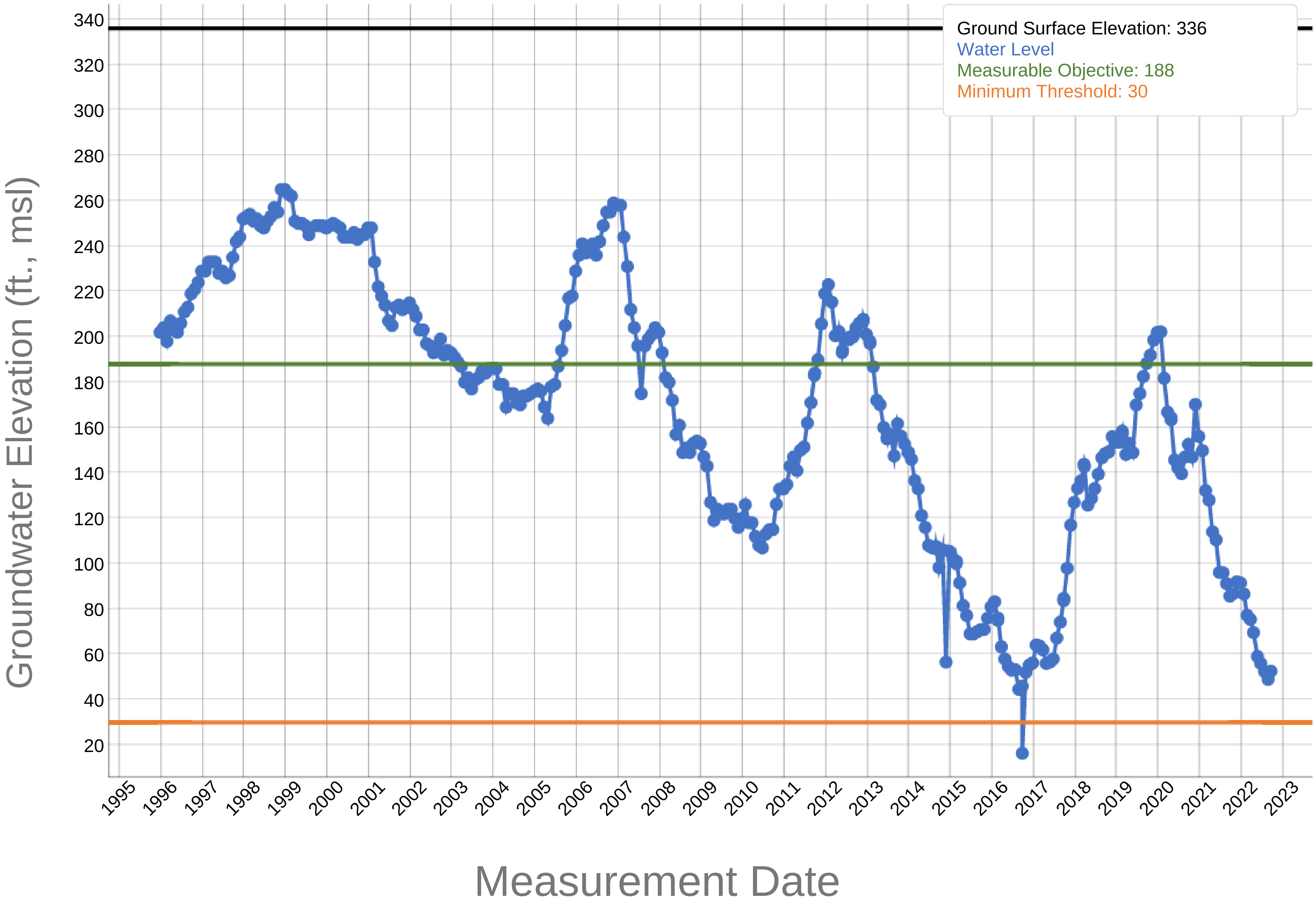
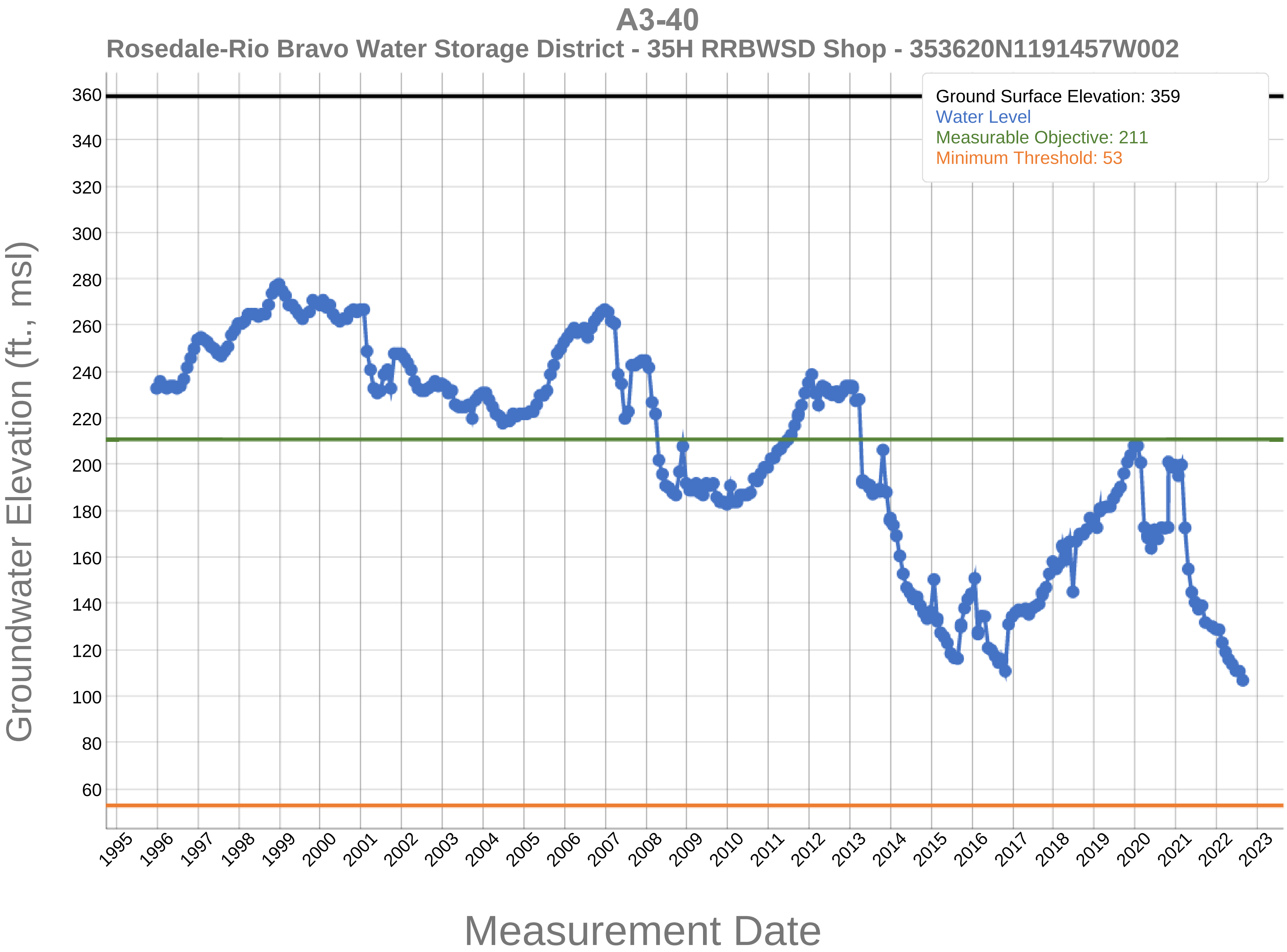
Measurement Date

A3-39

Rosedale-Rio Bravo Water Storage District - 31H Greeley - 353618N1192169W001




A3-40
Rosedale-Rio Bravo Water Storage District - 35H RRBWSD Shop - 353620N1191457W002
Ground Surface Elevation: 359
Water Level
Measurable Objective: 211
Minimum Threshold: 53
Groundwater Elevation (ft., msl)
Measurement Date
360
340
320
300
280
260
240
220
200
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1995
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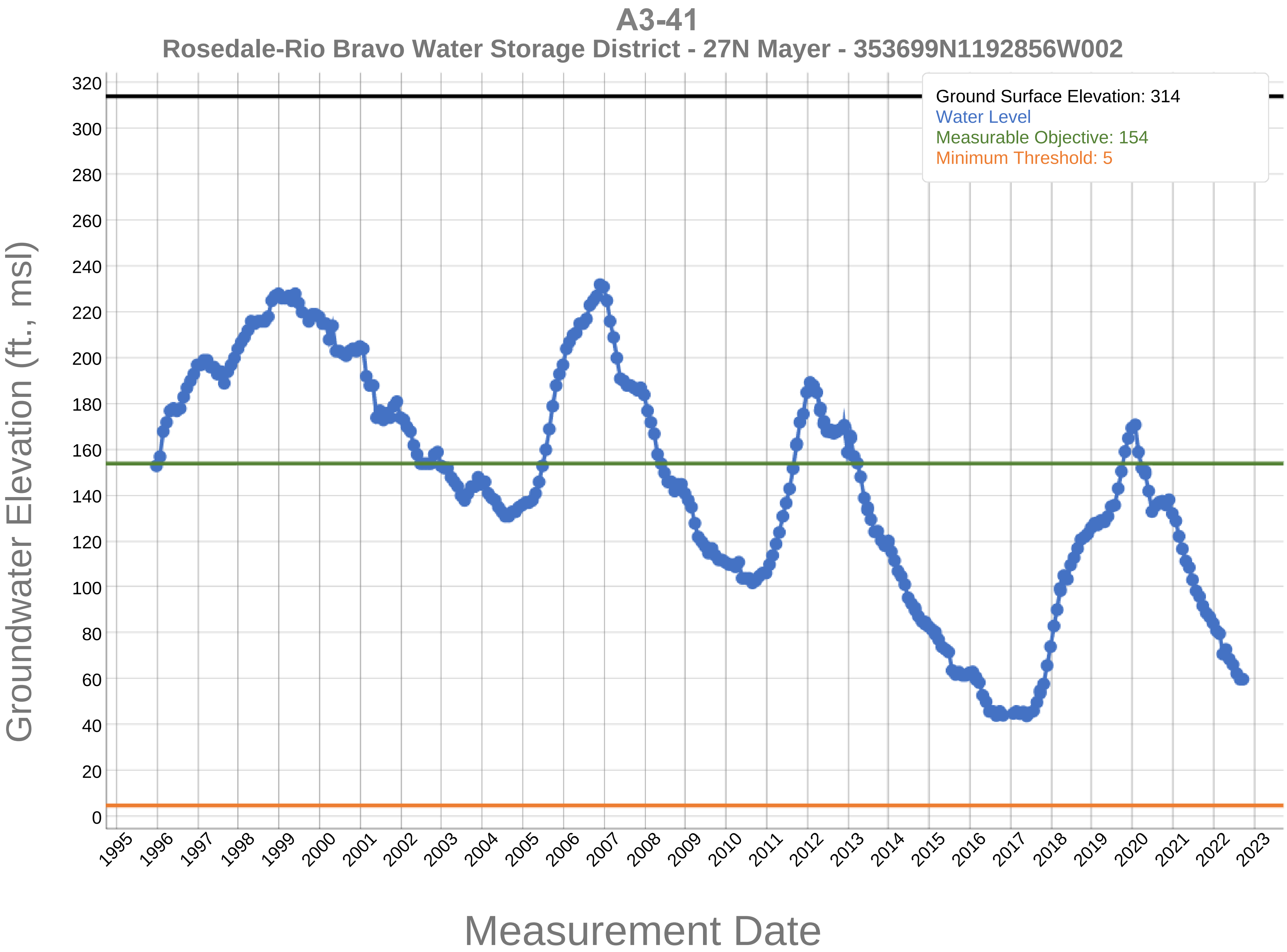

A3-41
Rosedale-Rio Bravo Water Storage District - 27N Mayer - 353699N1192856W002
Ground Surface Elevation: 314
Water Level
Measurable Objective: 154
Minimum Threshold: 5
Groundwater Elevation (ft., msl)
320
300
280
260
240
220
200
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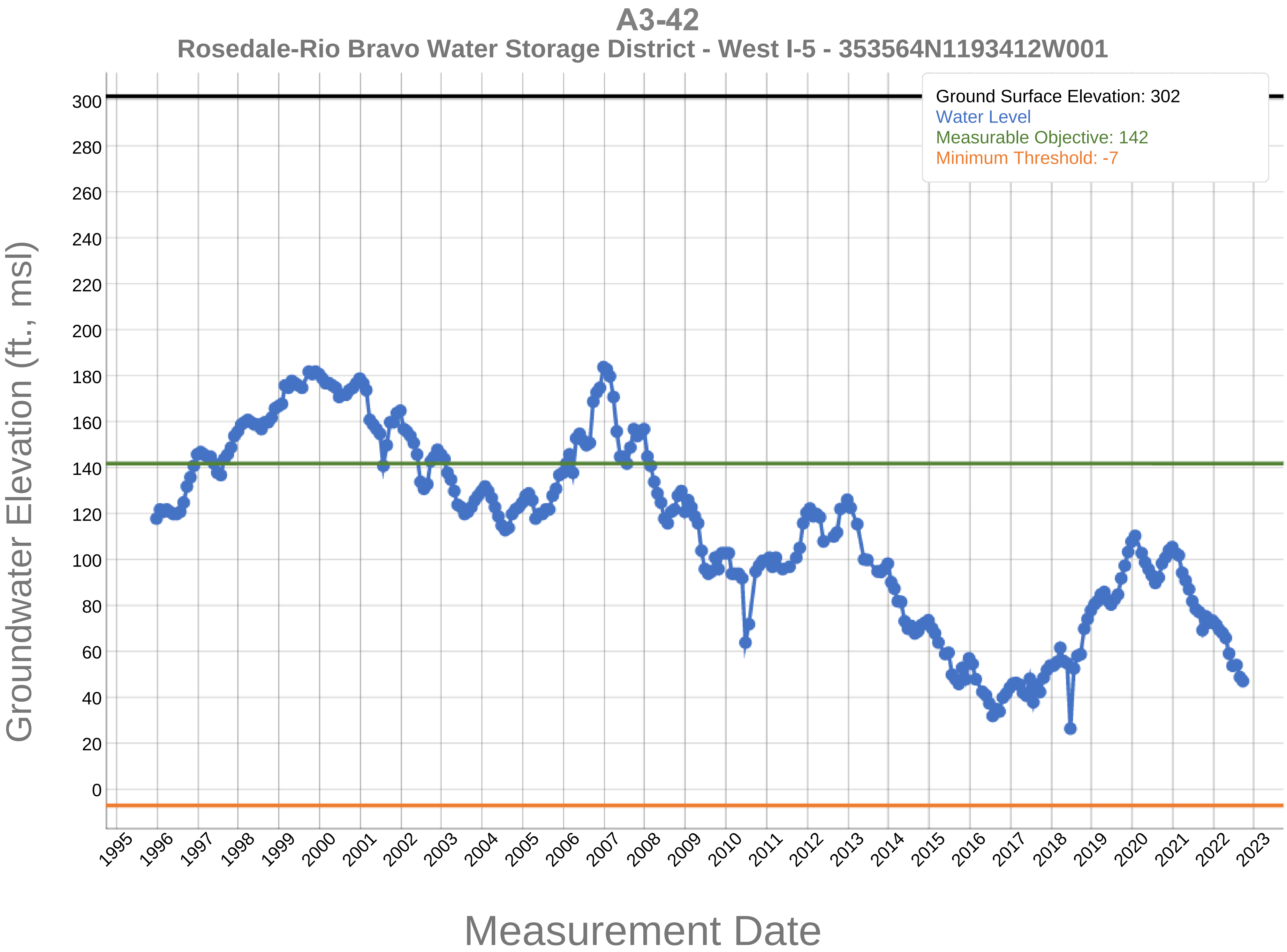
Measurement Date


A3-42
Rosedale-Rio Bravo Water Storage District - West I-5 - 353564N1193412W001
Ground Surface Elevation: 302
Water Level
Measurable Objective: 142
Minimum Threshold: -7
Groundwater Elevation (ft., msl)
300
280
260
240
220
200
180
160
140
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1995
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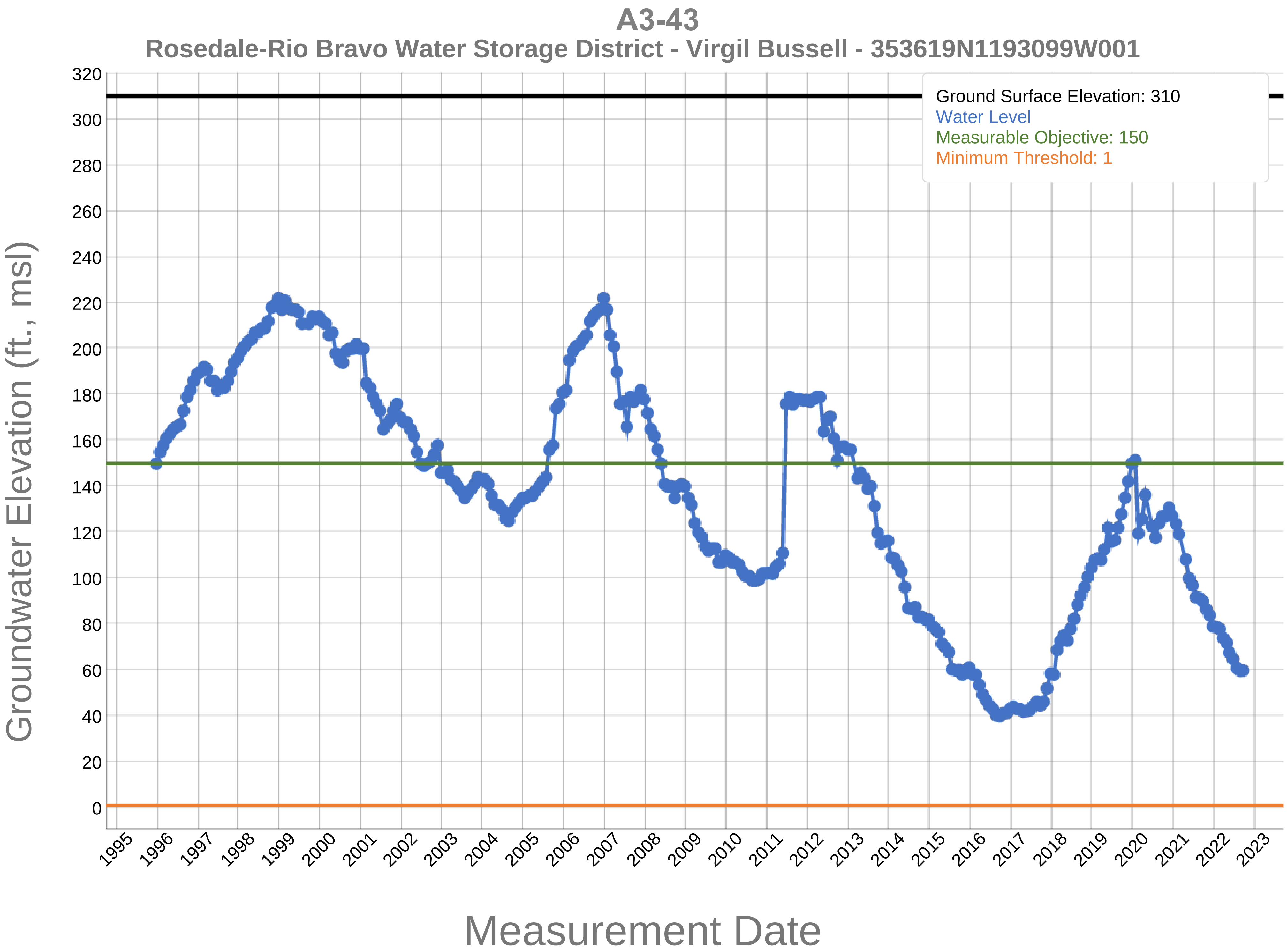
Measurement Date



A3-43
Rosedale-Rio Bravo Water Storage District - Virgil Bussell - 353619N1193099W001
Ground Surface Elevation: 310
Water Level
Measurable Objective: 150
Minimum Threshold: 1
Groundwater Elevation (ft., msl)
Measurement Date
320
300
280
260
240
220
200
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160
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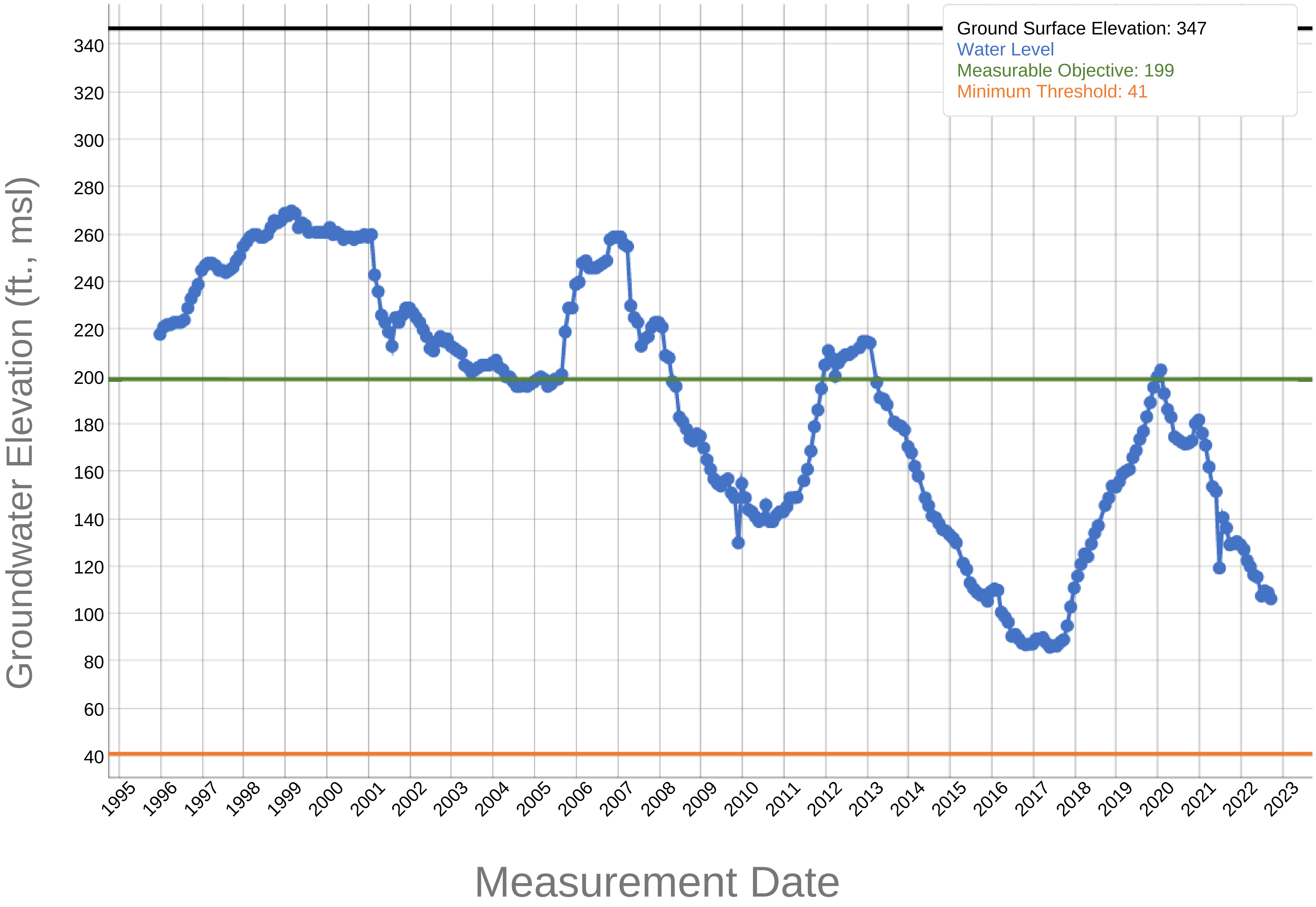
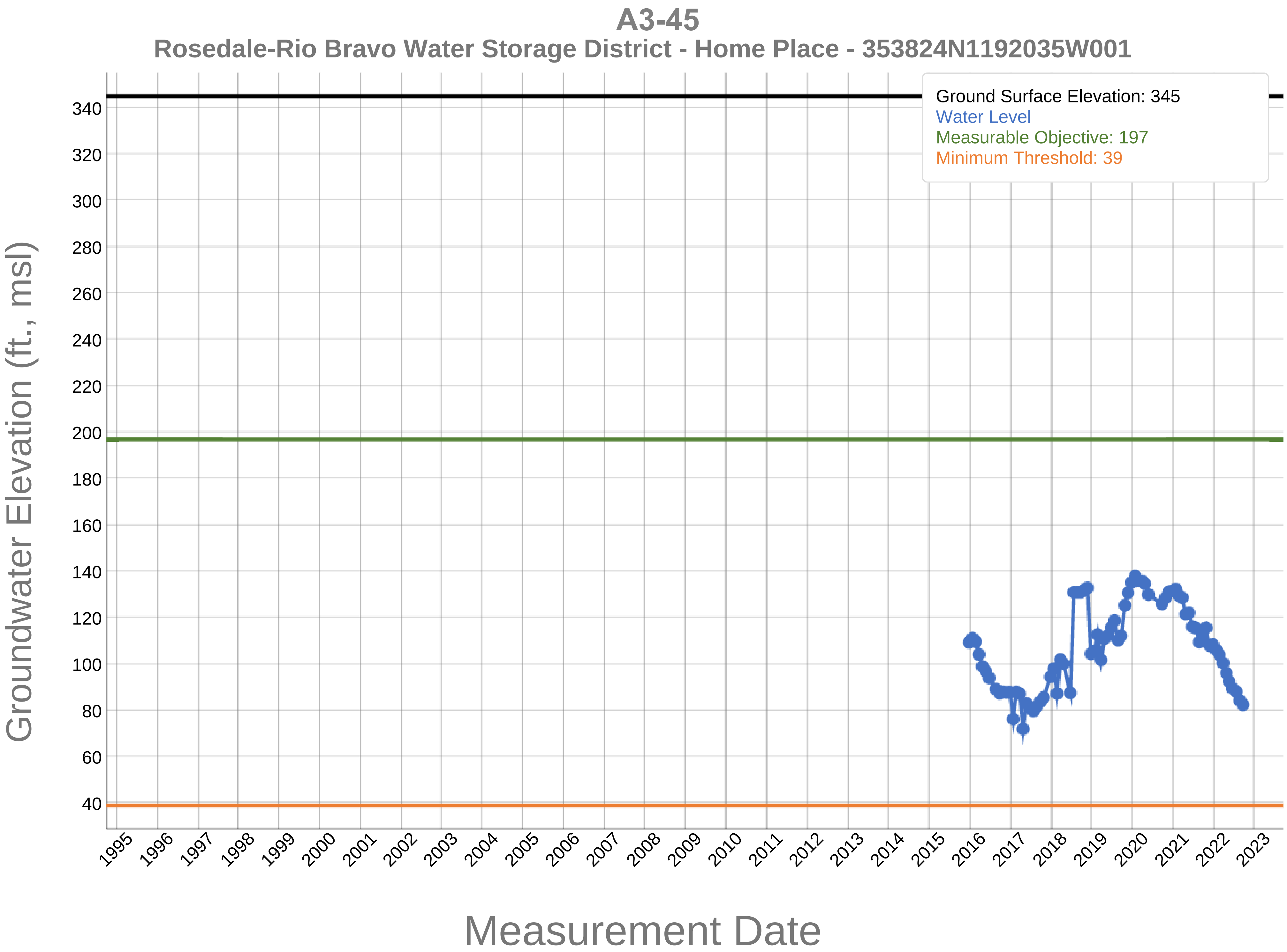
A3-44

Rosedale-Rio Bravo Water Storage District - Harvest Ranch - 353634N1191766W001





A3-45
Rosedale-Rio Bravo Water Storage District - Home Place - 353824N1192035W001
Ground Surface Elevation: 345
Water Level
Measurable Objective: 197
Minimum Threshold: 39
Groundwater Elevation (ft., msl)
340
320
300
280
260
240
220
200
180
160
140
120
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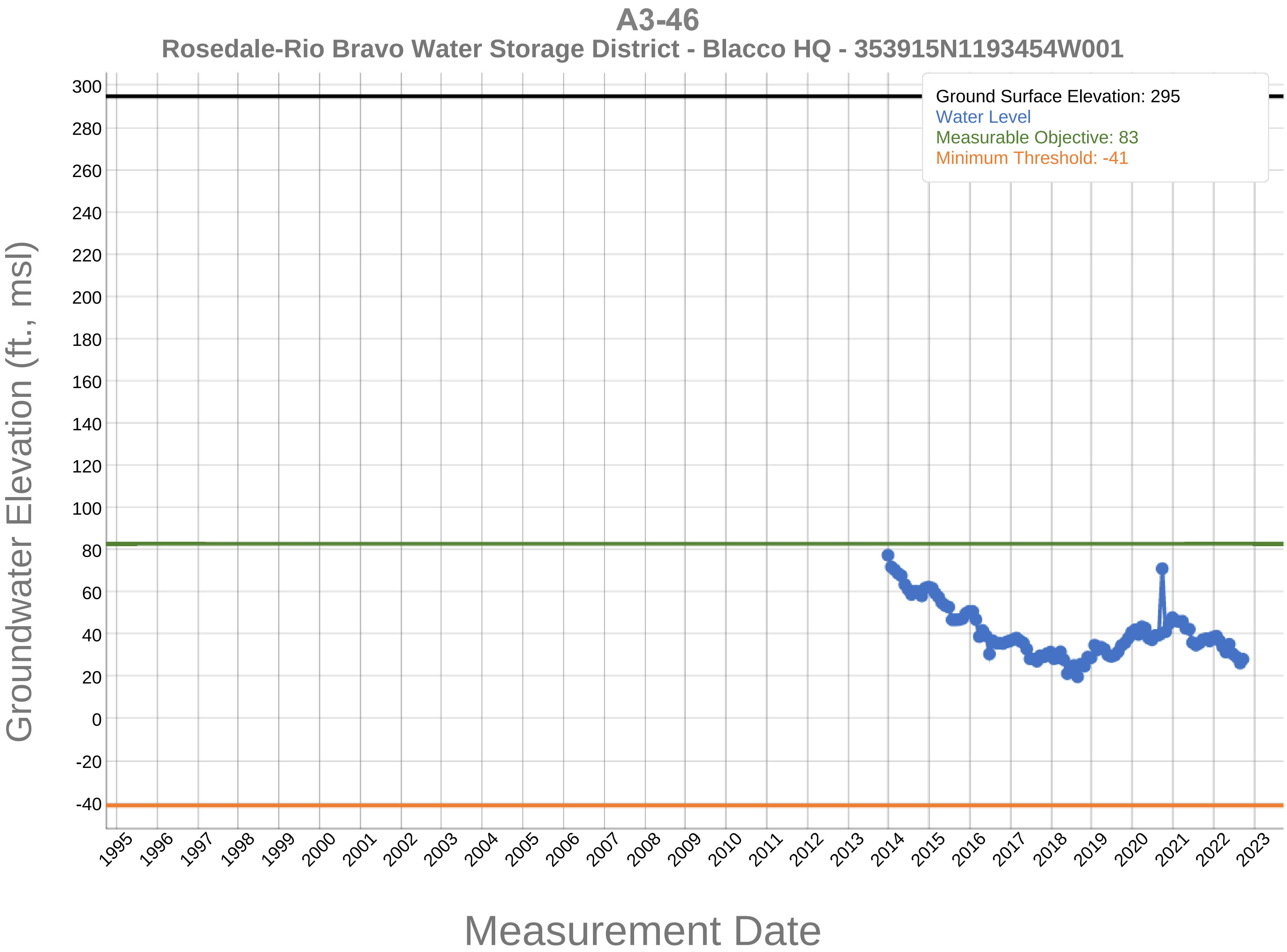
Measurement Date


A3-46
Rosedale-Rio Bravo Water Storage District - Blacco HQ - 353915N1193454W001
Ground Surface Elevation: 295
Water Level
Measurable Objective: 83
Minimum Threshold: -41
Groundwater Elevation (ft., msl)
Measurement Date
300
280
260
240
220
200
180
160
140
120
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80
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-20
-40
1995
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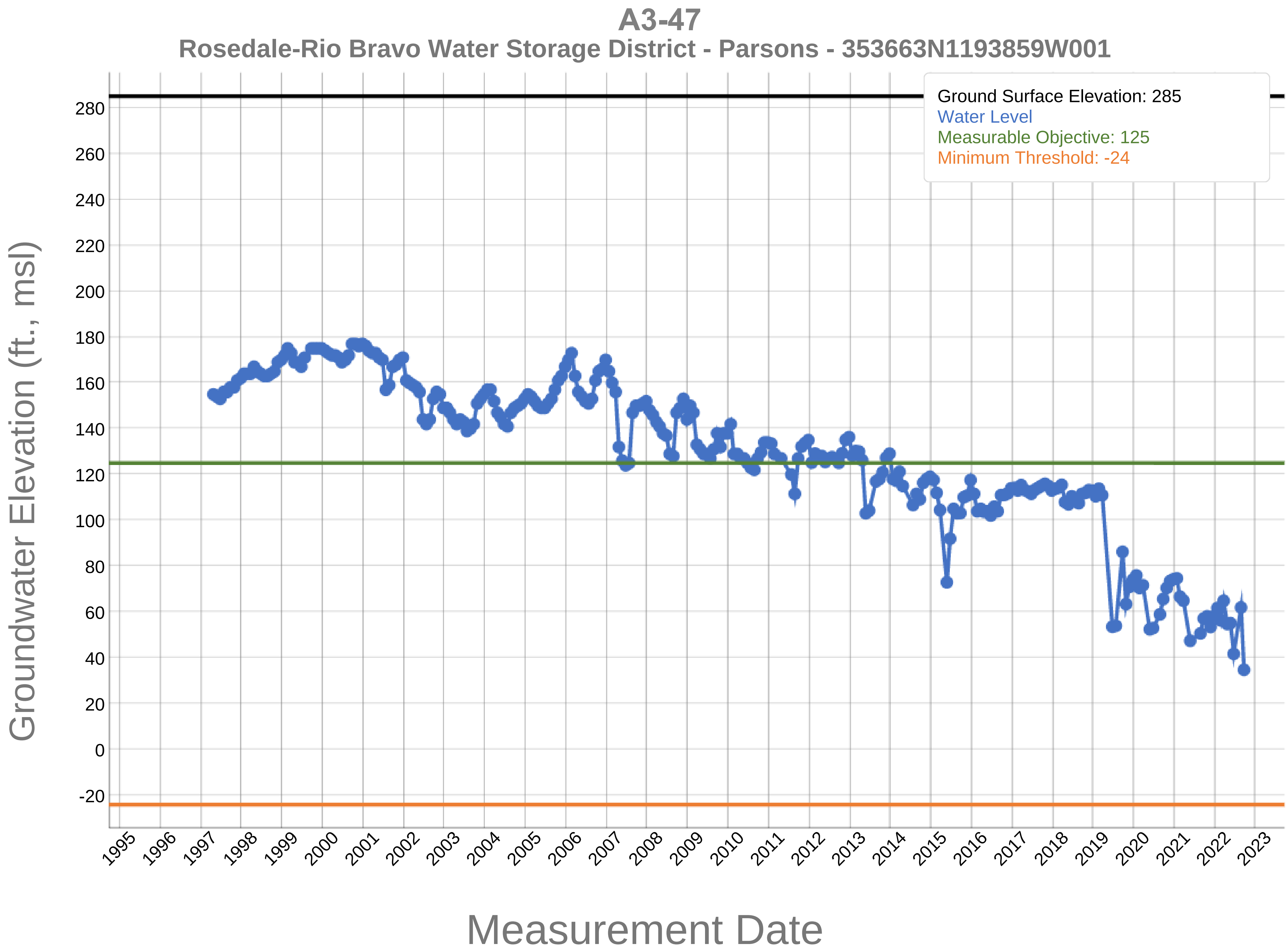
A3-47
Rosedale-Rio Bravo Water Storage District - Parsons - 353663N1193859W001
Ground Surface Elevation: 285
Water Level
Measurable Objective: 125
Minimum Threshold: -24
Groundwater Elevation (ft., msl)
280
260
240
220
200
180
160
140
120
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20
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-20
1995
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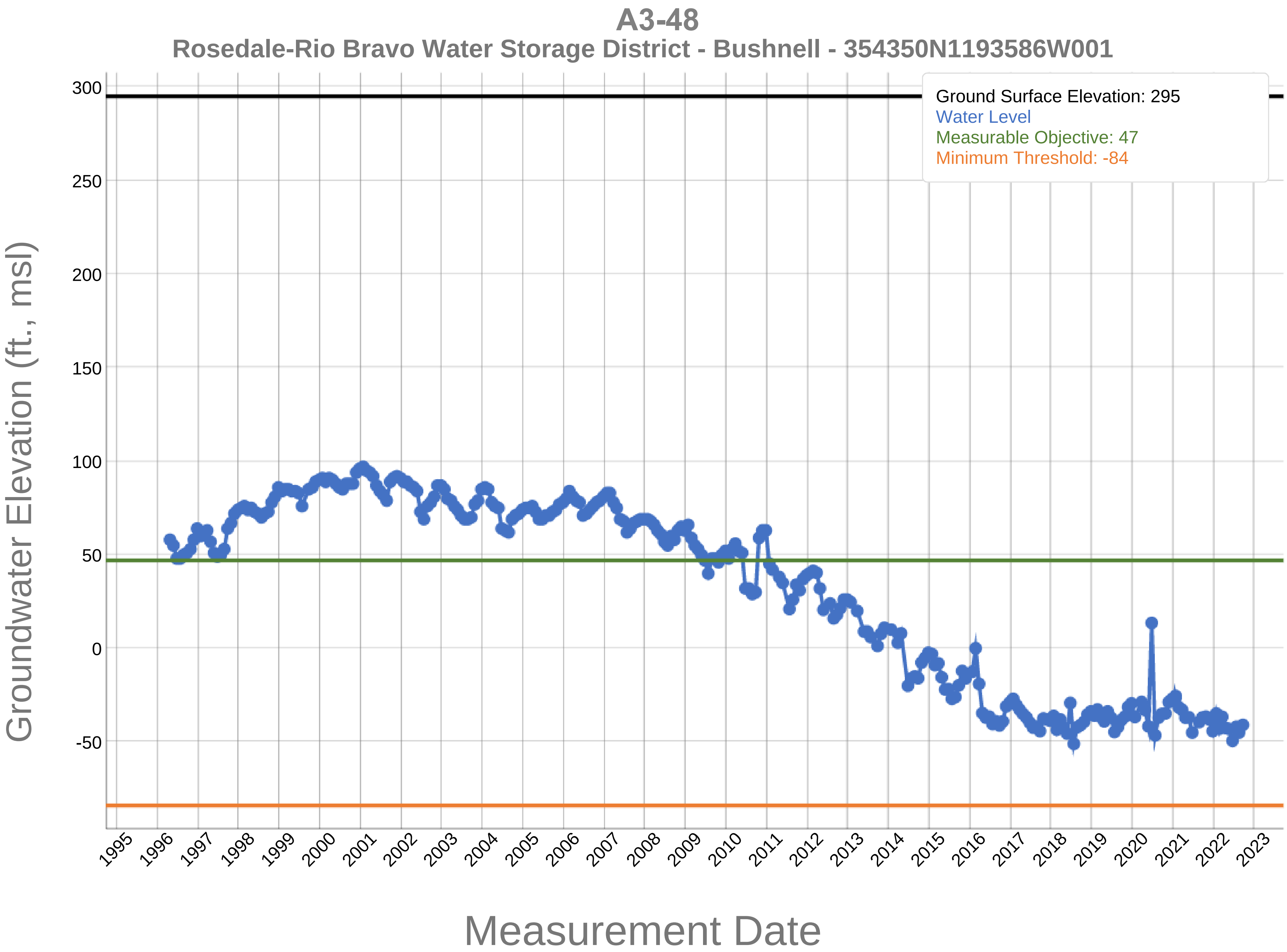
Measurement Date



A3-48
Rosedale-Rio Bravo Water Storage District - Bushnell - 354350N1193586W001
Ground Surface Elevation: 295
Water Level
Measurable Objective: 47
Minimum Threshold: -84
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
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-50
1995
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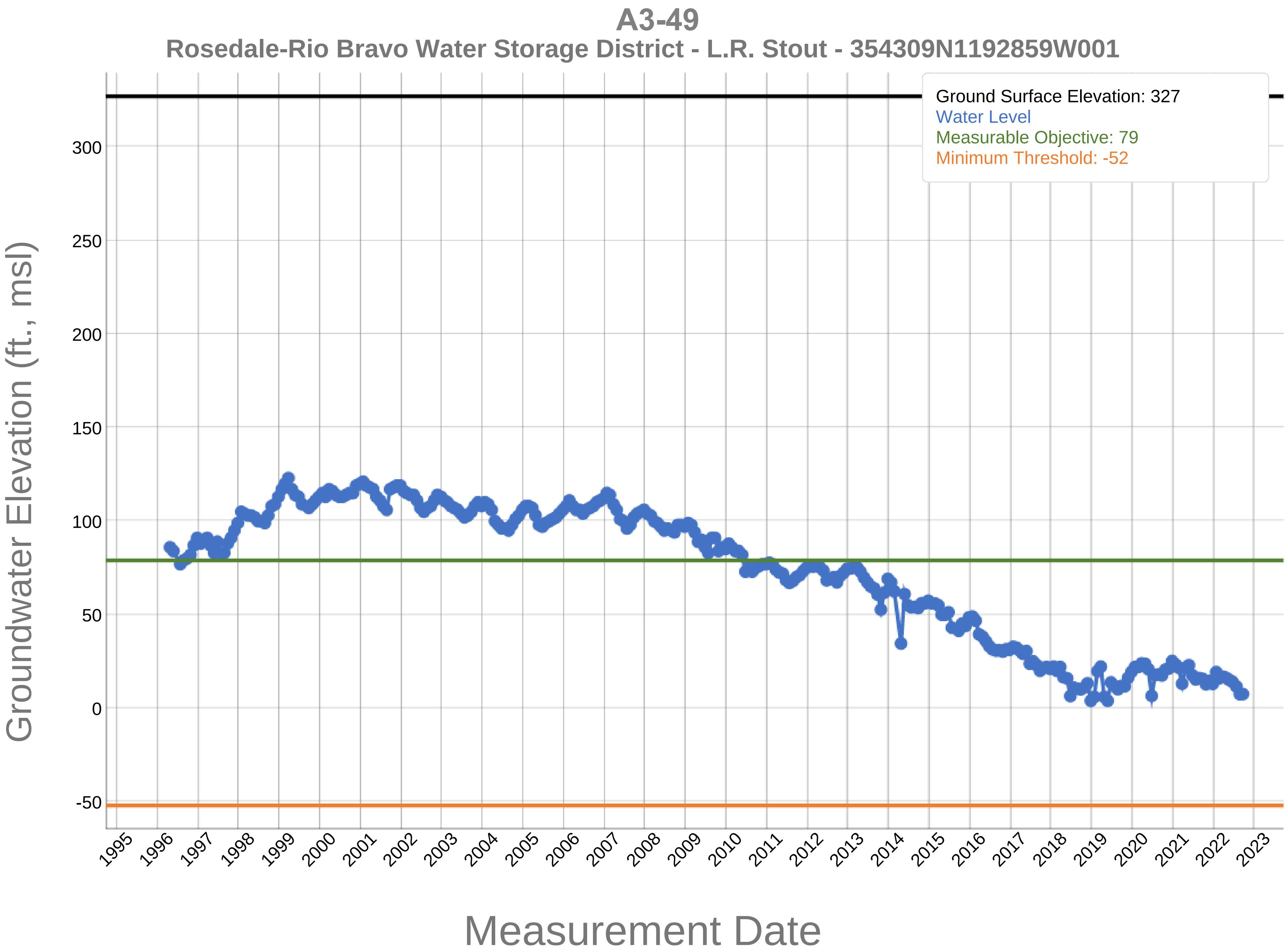
Measurement Date


A3-49
Rosedale-Rio Bravo Water Storage District - L.R. Stout - 354309N1192859W001
Ground Surface Elevation: 327
Water Level
Measurable Objective: 79
Minimum Threshold: -52
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
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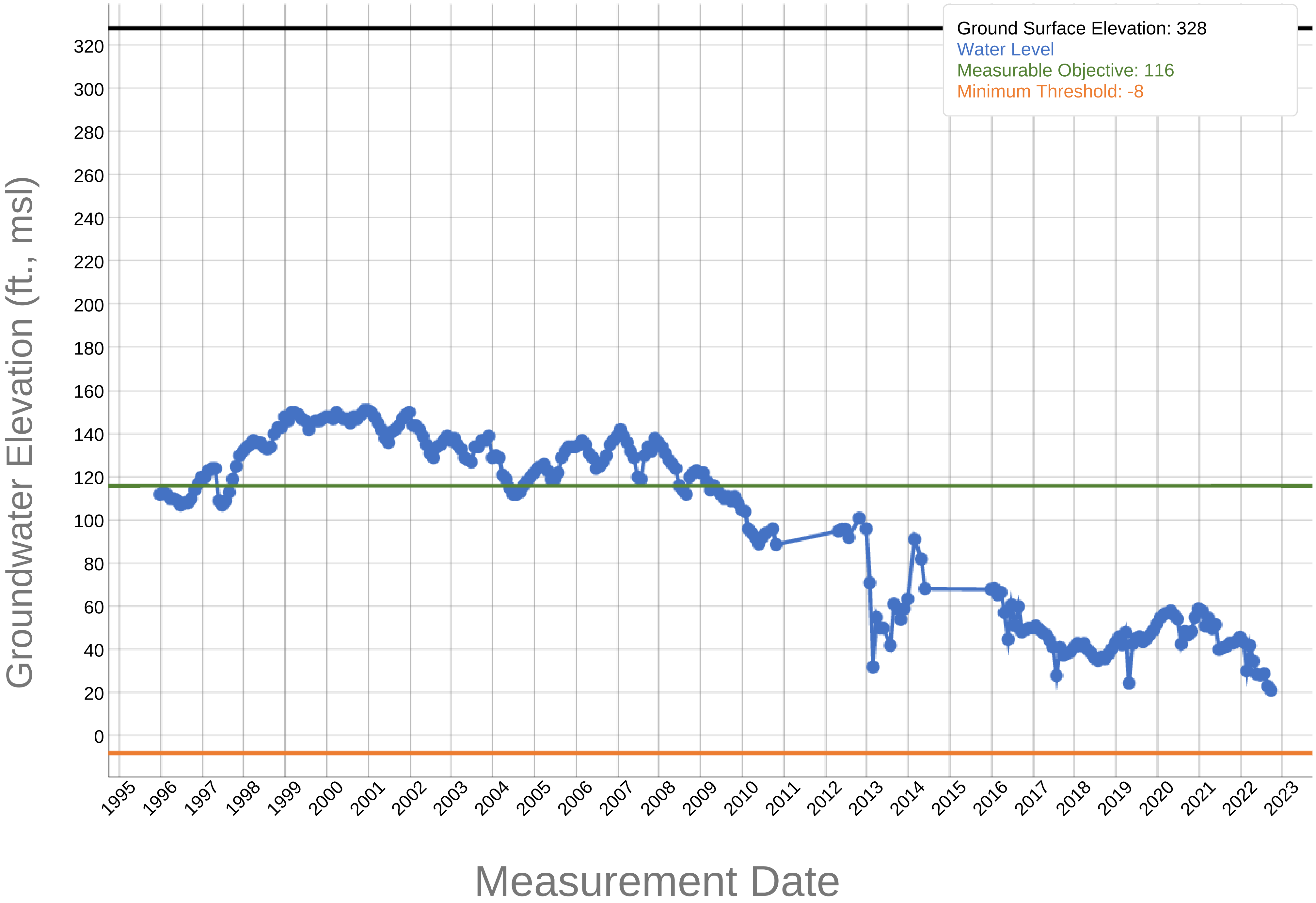
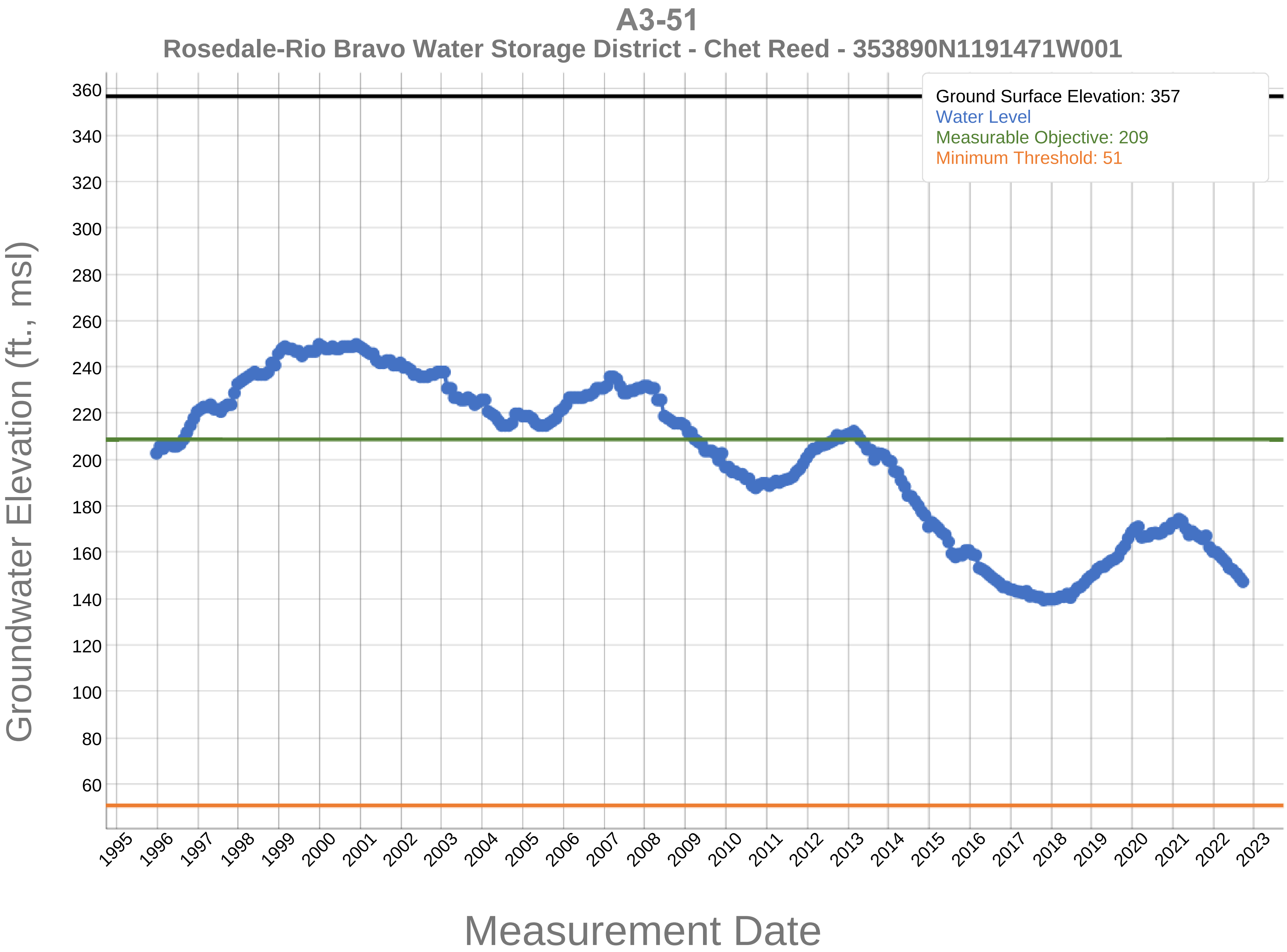
Measurement Date

A3-50

Rosedale-Rio Bravo Water Storage District - P. Enns Domestic - 354121N1192623W001





A3-51
Rosedale-Rio Bravo Water Storage District - Chet Reed - 353890N1191471W001
Ground Surface Elevation: 357
Water Level
Measurable Objective: 209
Minimum Threshold: 51
Groundwater Elevation (ft., msl)
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
1995
1996
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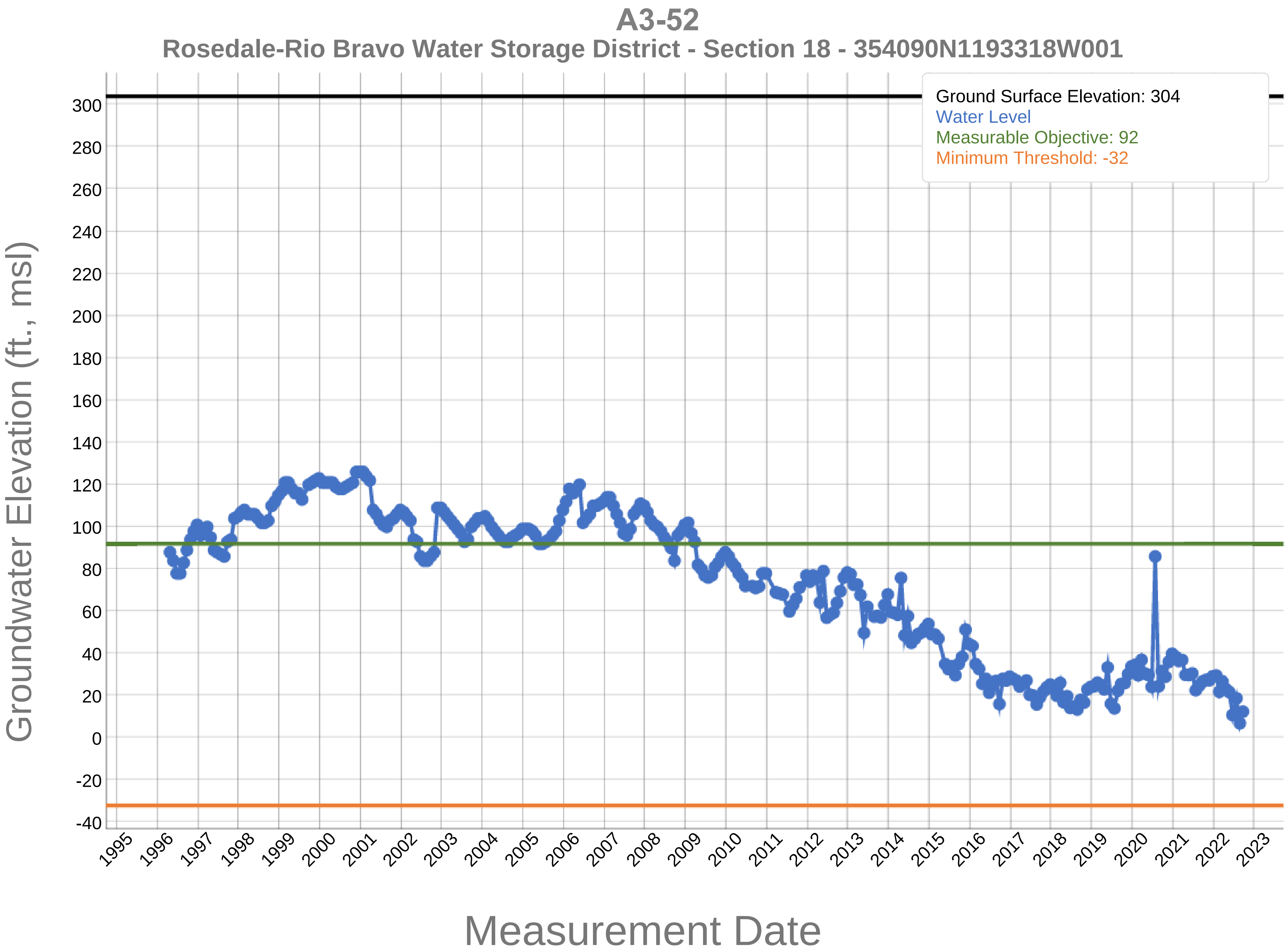
Measurement Date



A3-52
Rosedale-Rio Bravo Water Storage District - Section 18 - 354090N1193318W001
Ground Surface Elevation: 304
Water Level
Measurable Objective: 92
Minimum Threshold: -32
Groundwater Elevation (ft., msl)
300
280
260
240
220
200
180
160
140
120
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60
40
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-20
-40
1995
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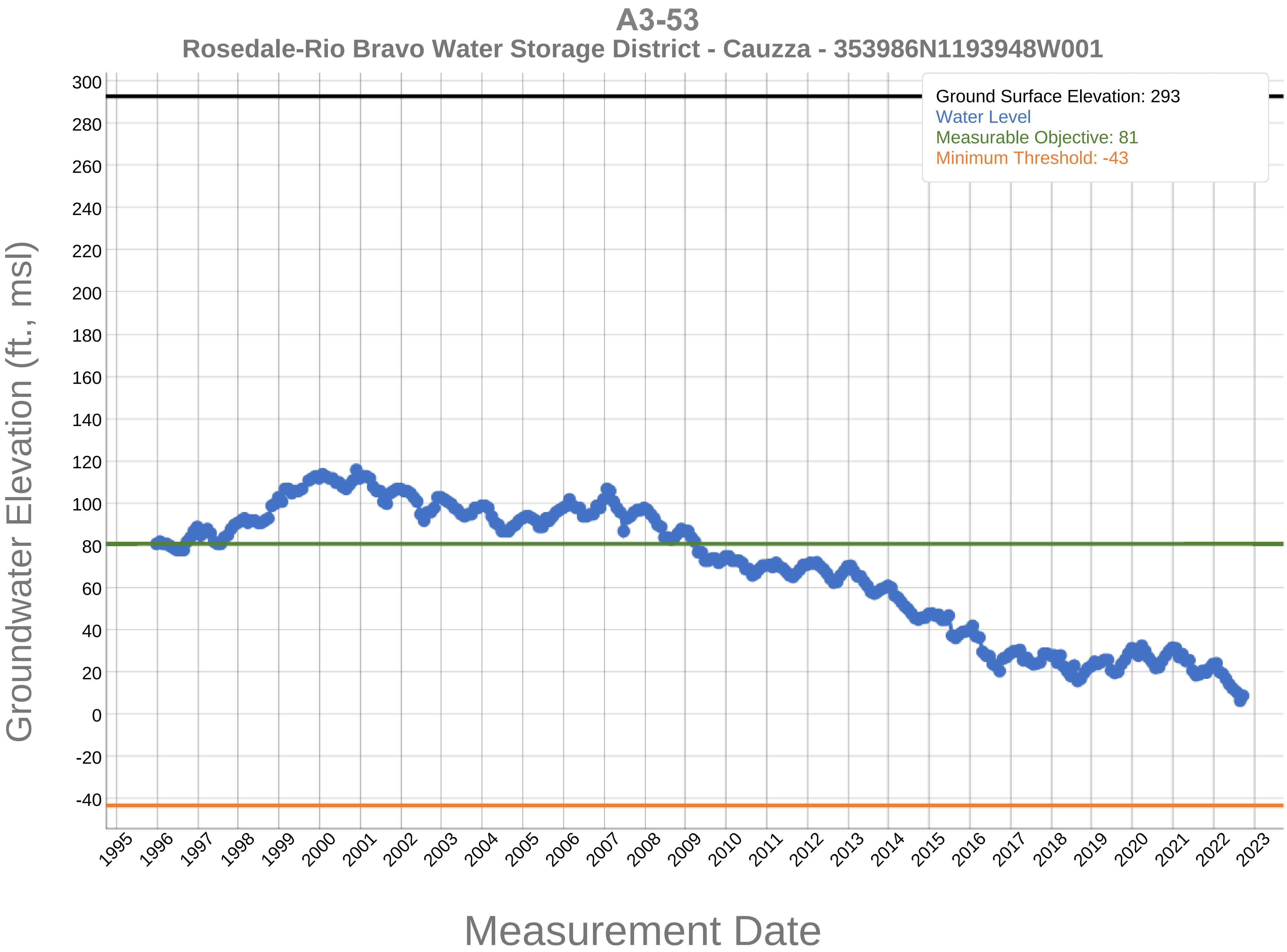
Measurement Date



A3-53
Rosedale-Rio Bravo Water Storage District - Cauzza - 353986N1193948W001
Ground Surface Elevation: 293
Water Level
Measurable Objective: 81
Minimum Threshold: -43
Groundwater Elevation (ft., msl)
300
280
260
240
220
200
180
160
140
120
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-20
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1995
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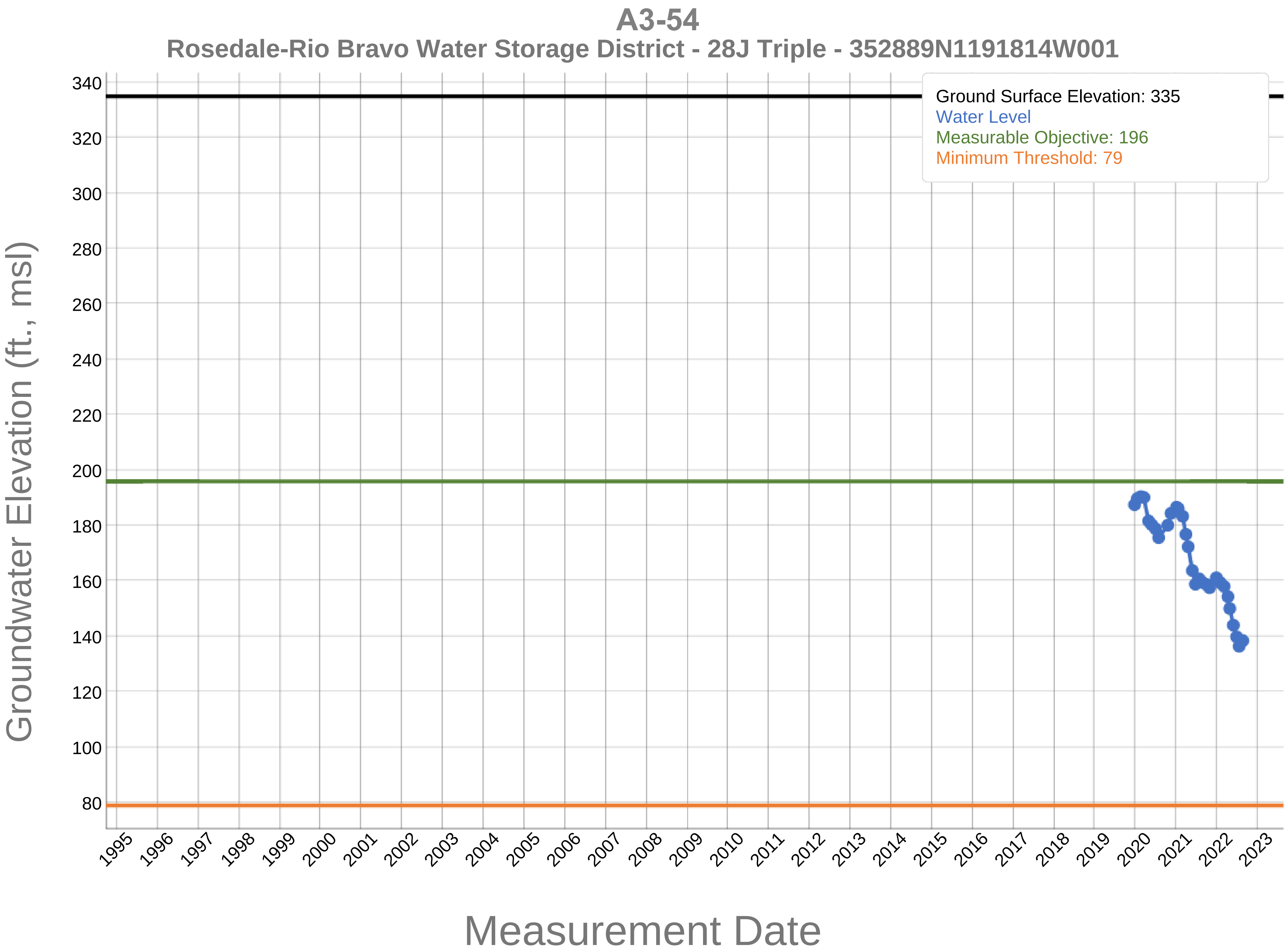
Measurement Date



A3-54
Rosedale-Rio Bravo Water Storage District - 28J Triple - 352889N1191814W001
Ground Surface Elevation: 335
Water Level
Measurable Objective: 196
Minimum Threshold: 79
Groundwater Elevation (ft., msl)
340
320
300
280
260
240
220
200
180
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1995
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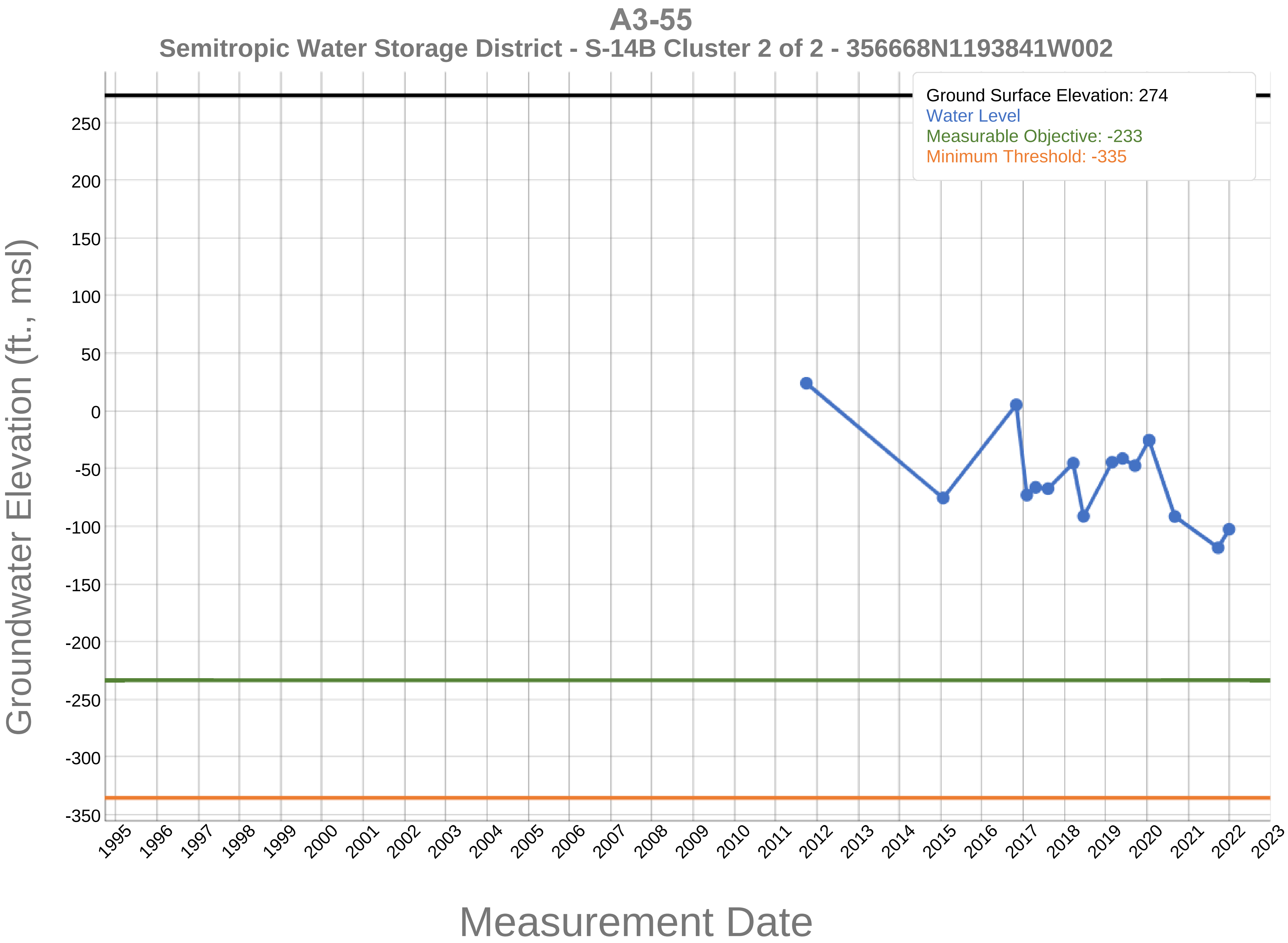
A3-55
Semitropic Water Storage District - S-14B Cluster 2 of 2 - 356668N1193841W002
Ground Surface Elevation: 274
Water Level
Measurable Objective: -233
Minimum Threshold: -335
Groundwater Elevation (ft., msl)
Measurement Date
250
200
150
100
50
0
-50
-100
-150
-200
-250
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-350
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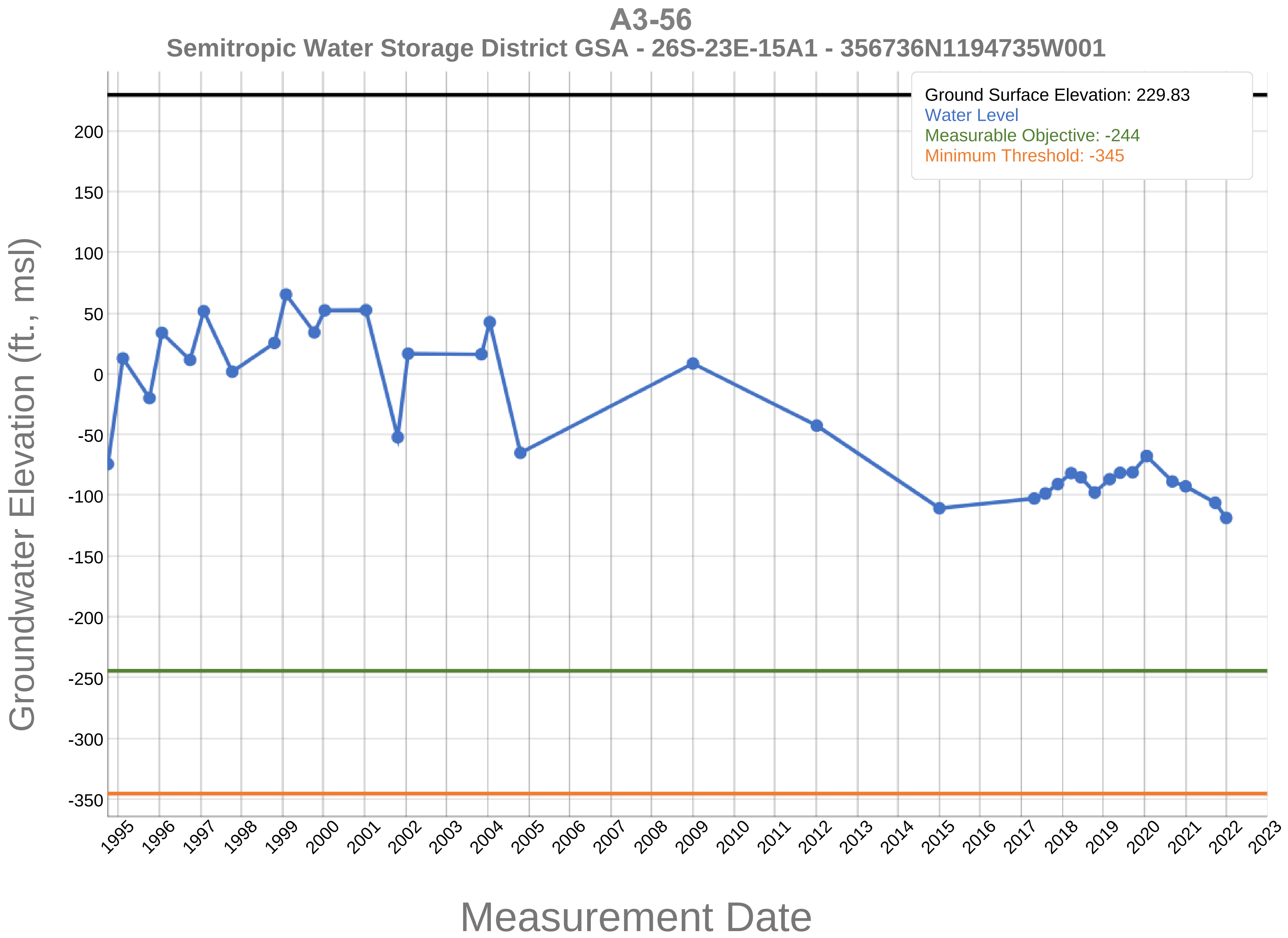
A3-56
Semitropic Water Storage District GSA - 26S-23E-15A1 - 356736N1194735W001
Ground Surface Elevation: 229.83
Water Level
Measurable Objective: -244
Minimum Threshold: -345
Groundwater Elevation (ft., msl)
Measurement Date
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
1995
1996
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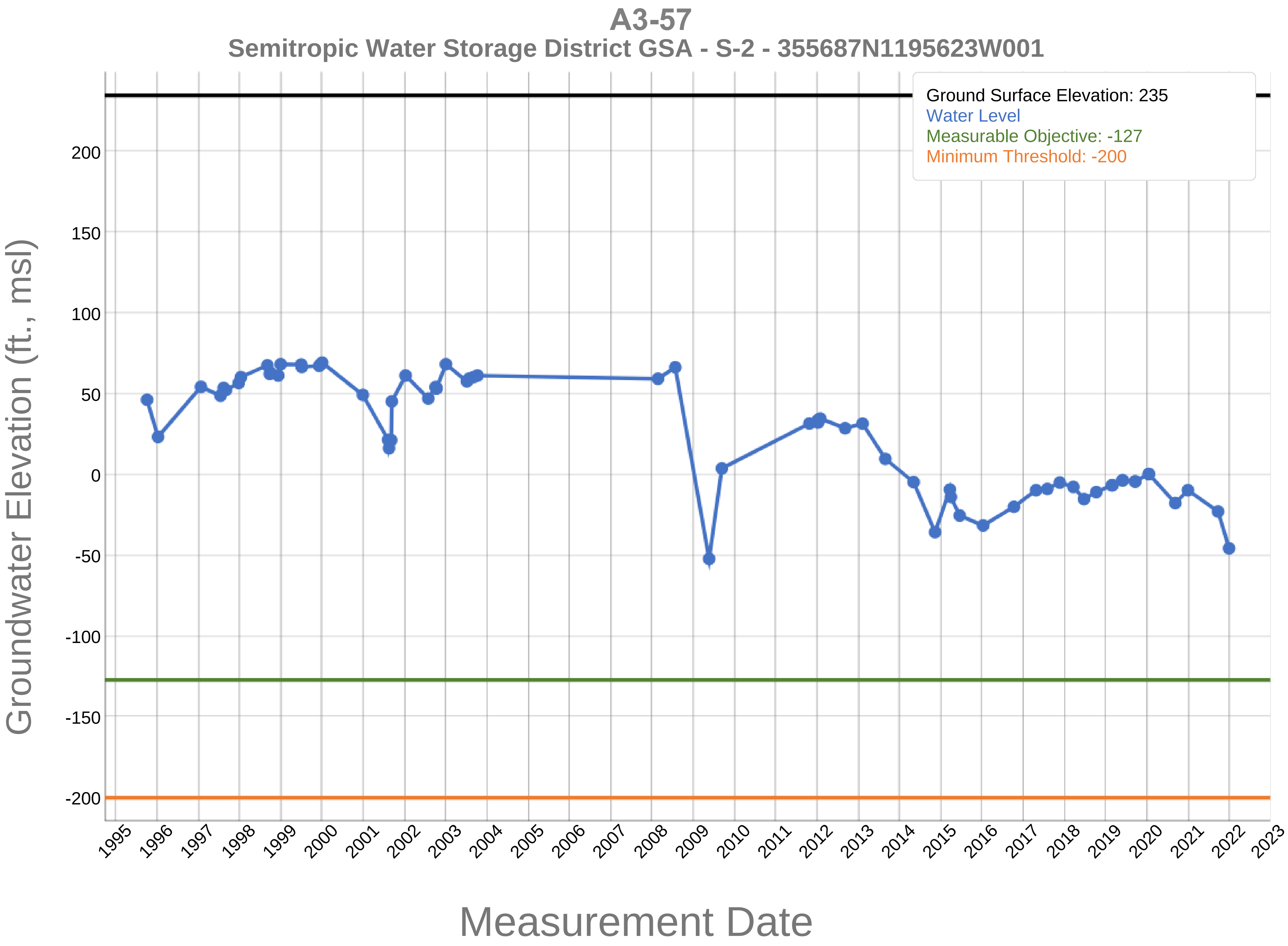
A3-57
Semitropic Water Storage District GSA - S-2 - 355687N1195623W001
Ground Surface Elevation: 235
Water Level
Measurable Objective: -127
Minimum Threshold: -200
Groundwater Elevation (ft., msl)
200
150
100
50
0
-50
-100
-150
-200
1995
1996
1997
1998
1999
2000
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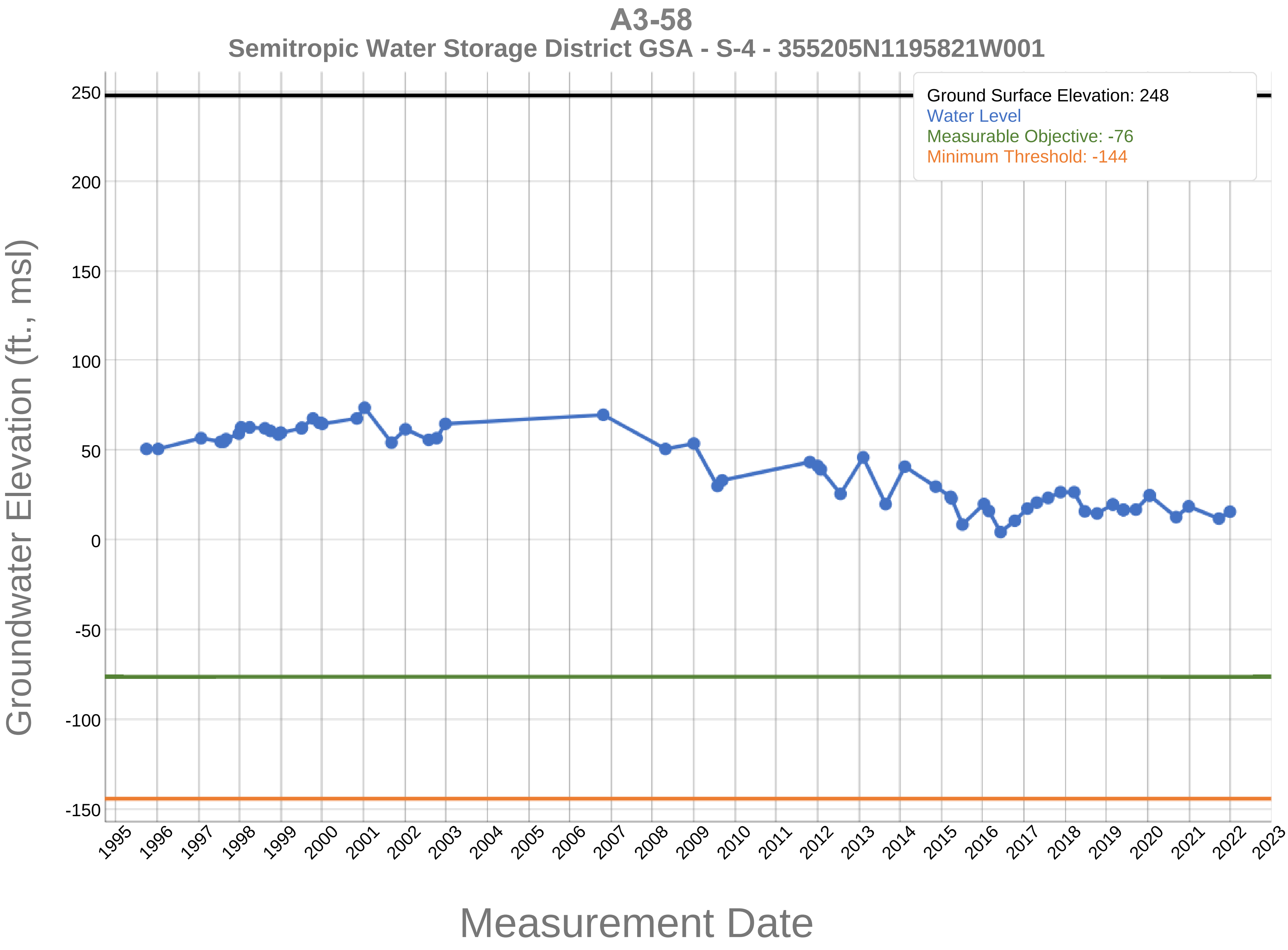
Measurement Date



A3-58
Semitropic Water Storage District GSA - S-4 - 355205N1195821W001
Ground Surface Elevation: 248
Water Level
Measurable Objective: -76
Minimum Threshold: -144
Groundwater Elevation (ft., msl)
250
200
150
100
50
0
-50
-100
-150
1995
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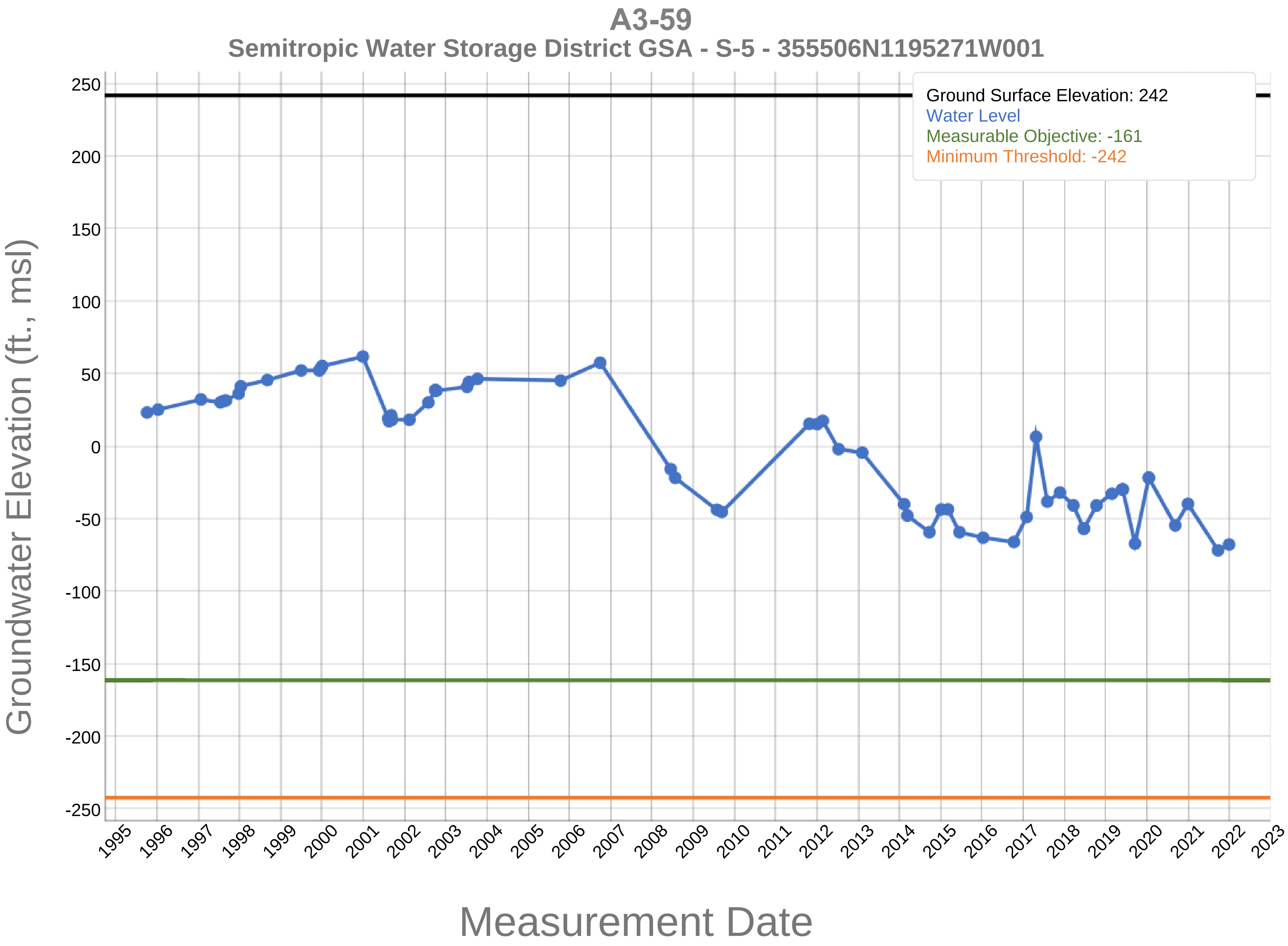
Measurement Date



A3-59
Semitropic Water Storage District GSA - S-5 - 355506N1195271W001
Ground Surface Elevation: 242
Water Level
Measurable Objective: -161
Minimum Threshold: -242
Groundwater Elevation (ft., msl)
Measurement Date
250
200
150
100
50
0
-50
-100
-150
-200
-250
1995
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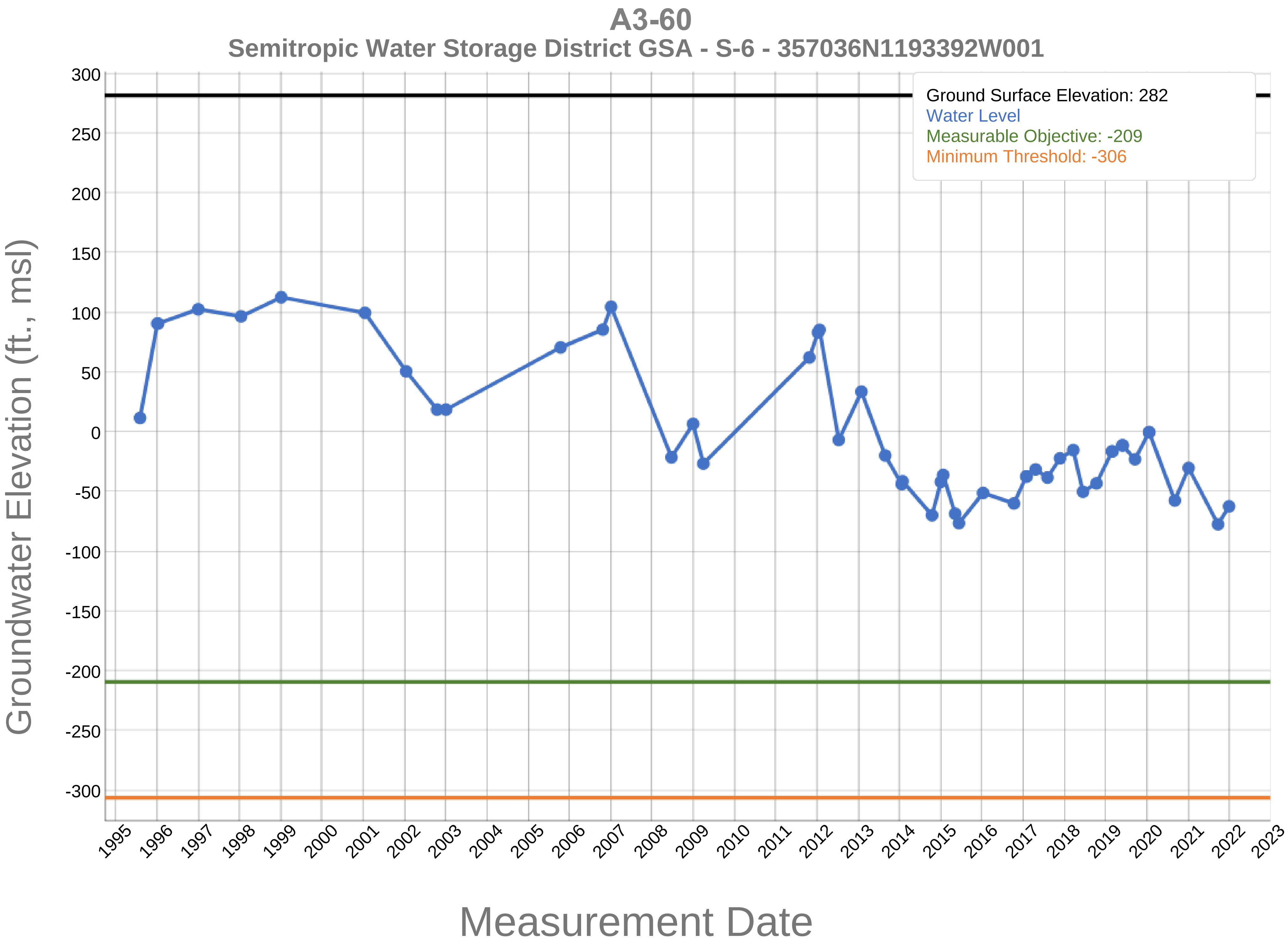
A3-60
Semitropic Water Storage District GSA - S-6 - 357036N1193392W001
Ground Surface Elevation: 282
Water Level
Measurable Objective: -209
Minimum Threshold: -306
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1995
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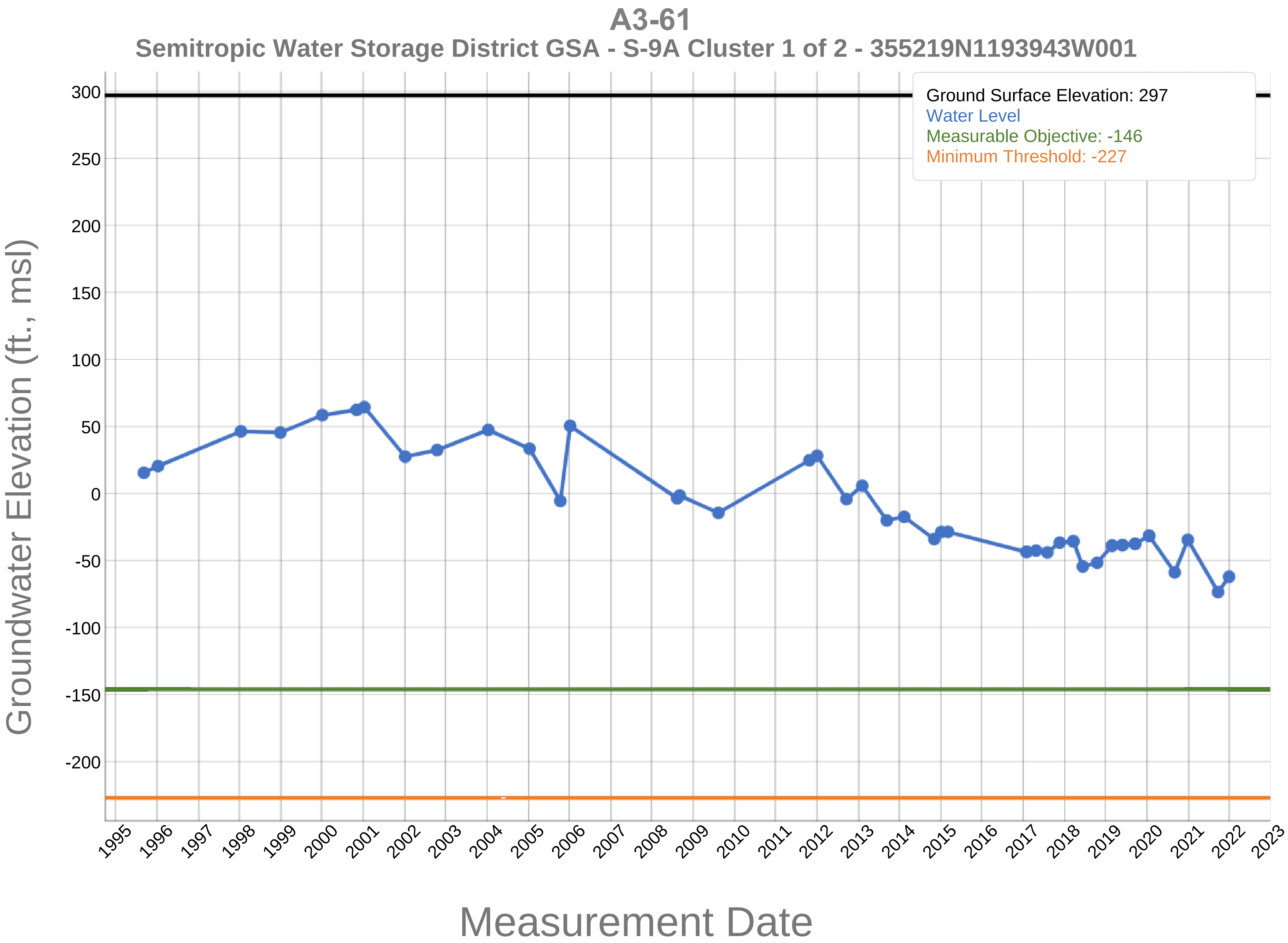
Measurement Date



A3-61
Semitropic Water Storage District GSA - S-9A Cluster 1 of 2 - 355219N1193943W001
Ground Surface Elevation: 297
Water Level
Measurable Objective: -146
Minimum Threshold: -227
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
-150
-200
1995
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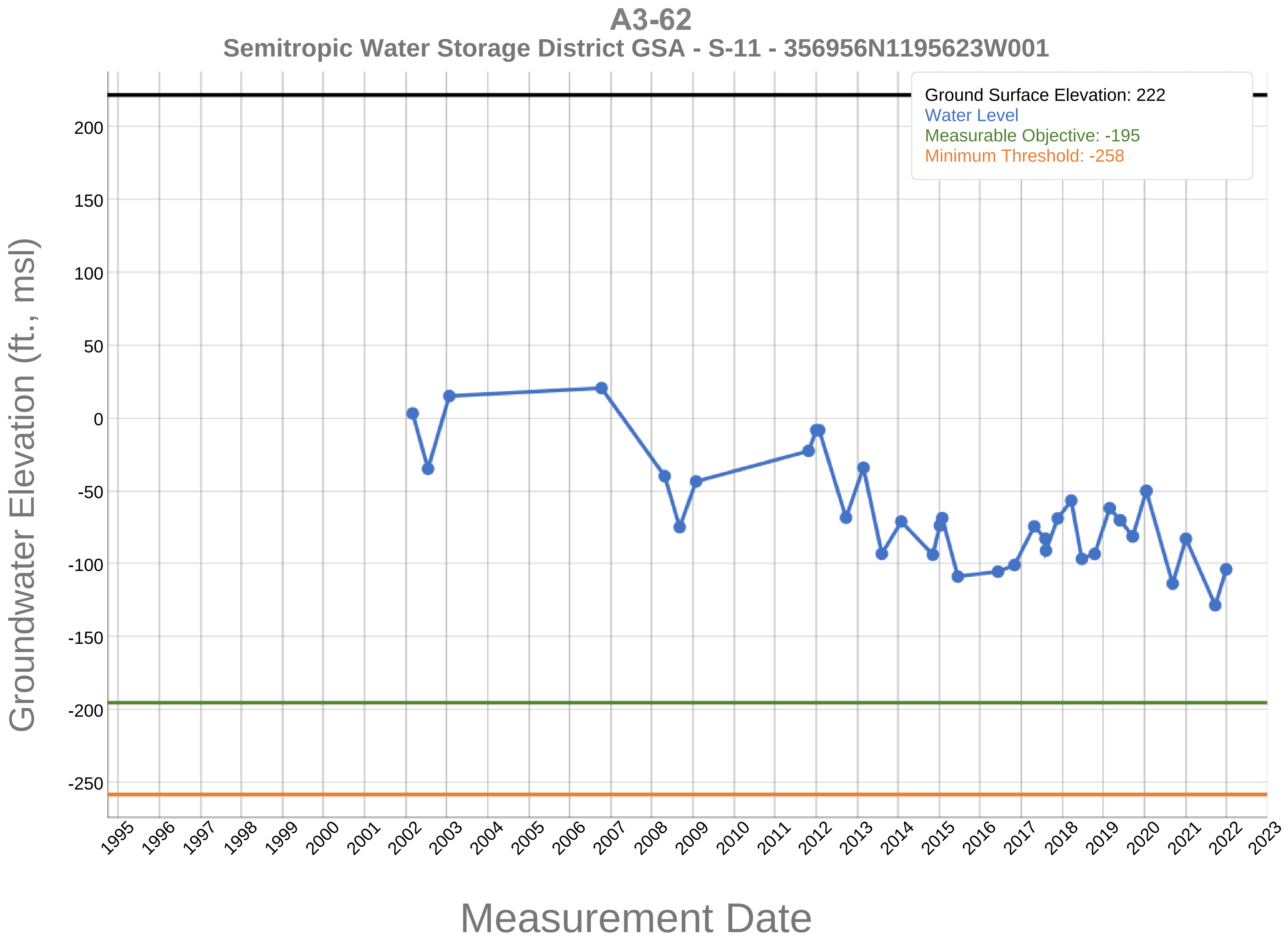
Measurement Date


A3-62
Semitropic Water Storage District GSA - S-11 - 356956N1195623W001
Ground Surface Elevation: 222
Water Level
Measurable Objective: -195
Minimum Threshold: -258
Groundwater Elevation (ft., msl)
200
150
100
50
0
-50
-100
-150
-200
-250
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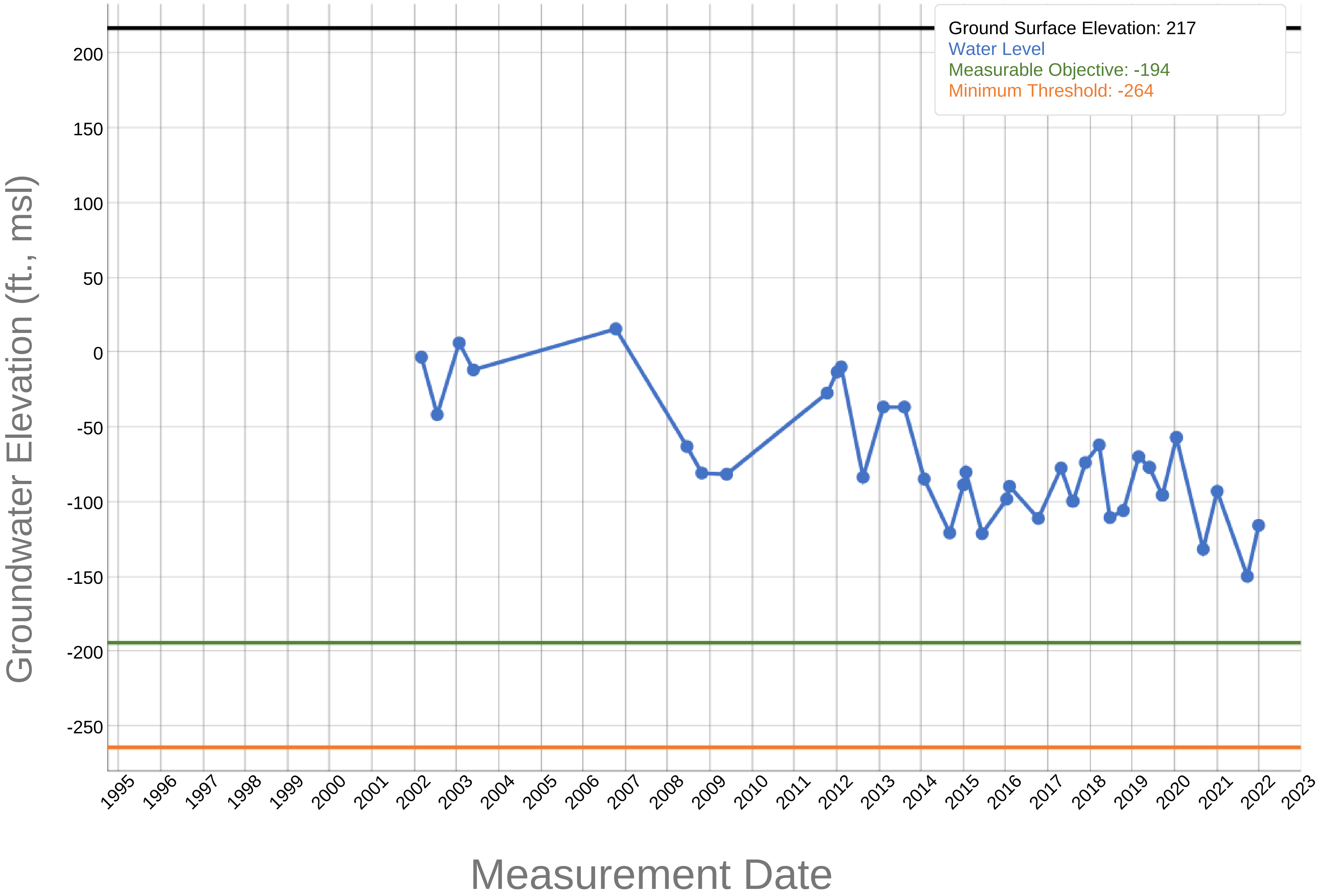
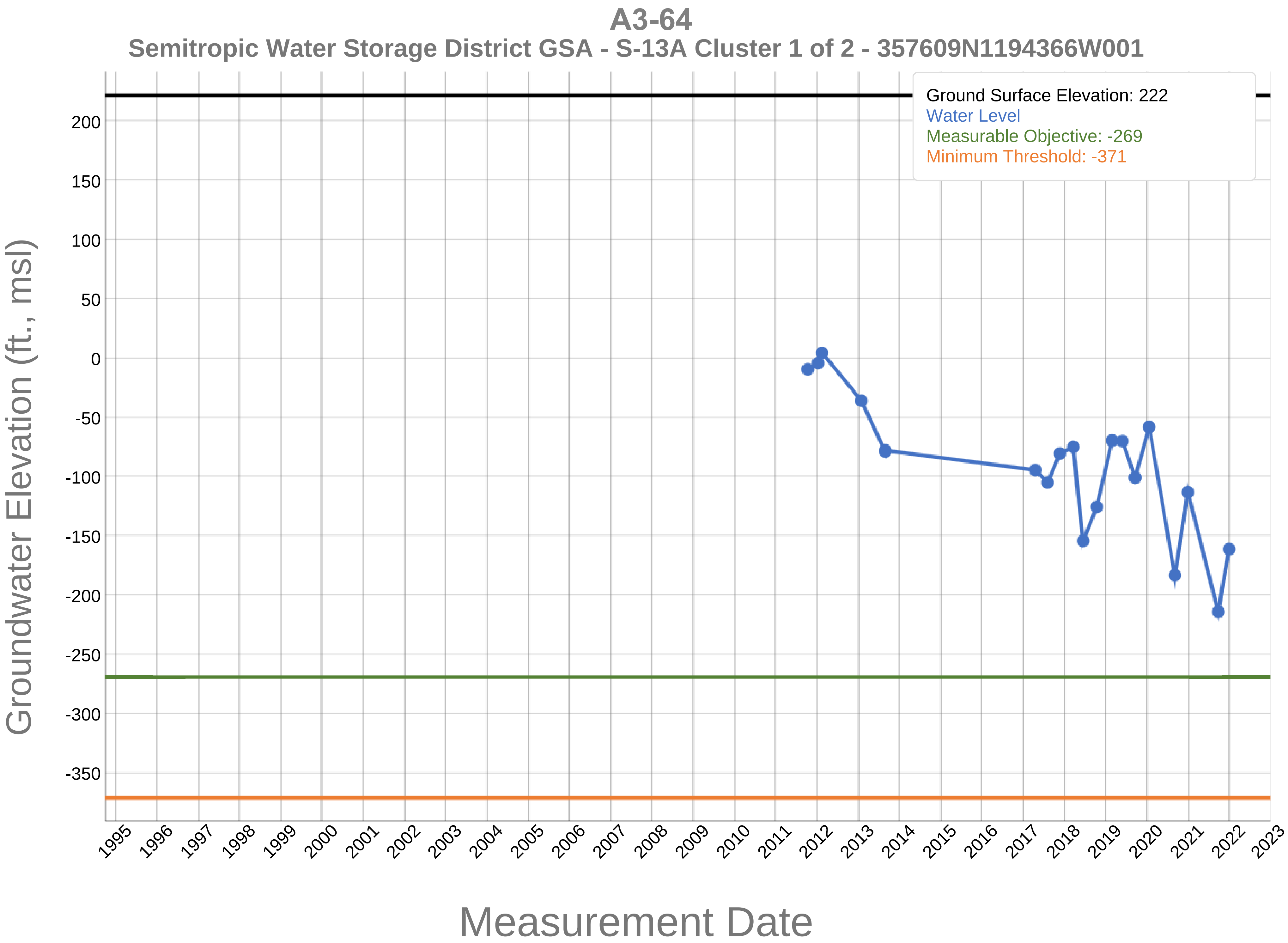
Measurement Date

A3-63
Semitropic Water Storage District GSA - S-12 - 357228N1195538W001




A3-64
Semitropic Water Storage District GSA - S-13A Cluster 1 of 2 - 357609N1194366W001
Ground Surface Elevation: 222
Water Level
Measurable Objective: -269
Minimum Threshold: -371
Groundwater Elevation (ft., msl)
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
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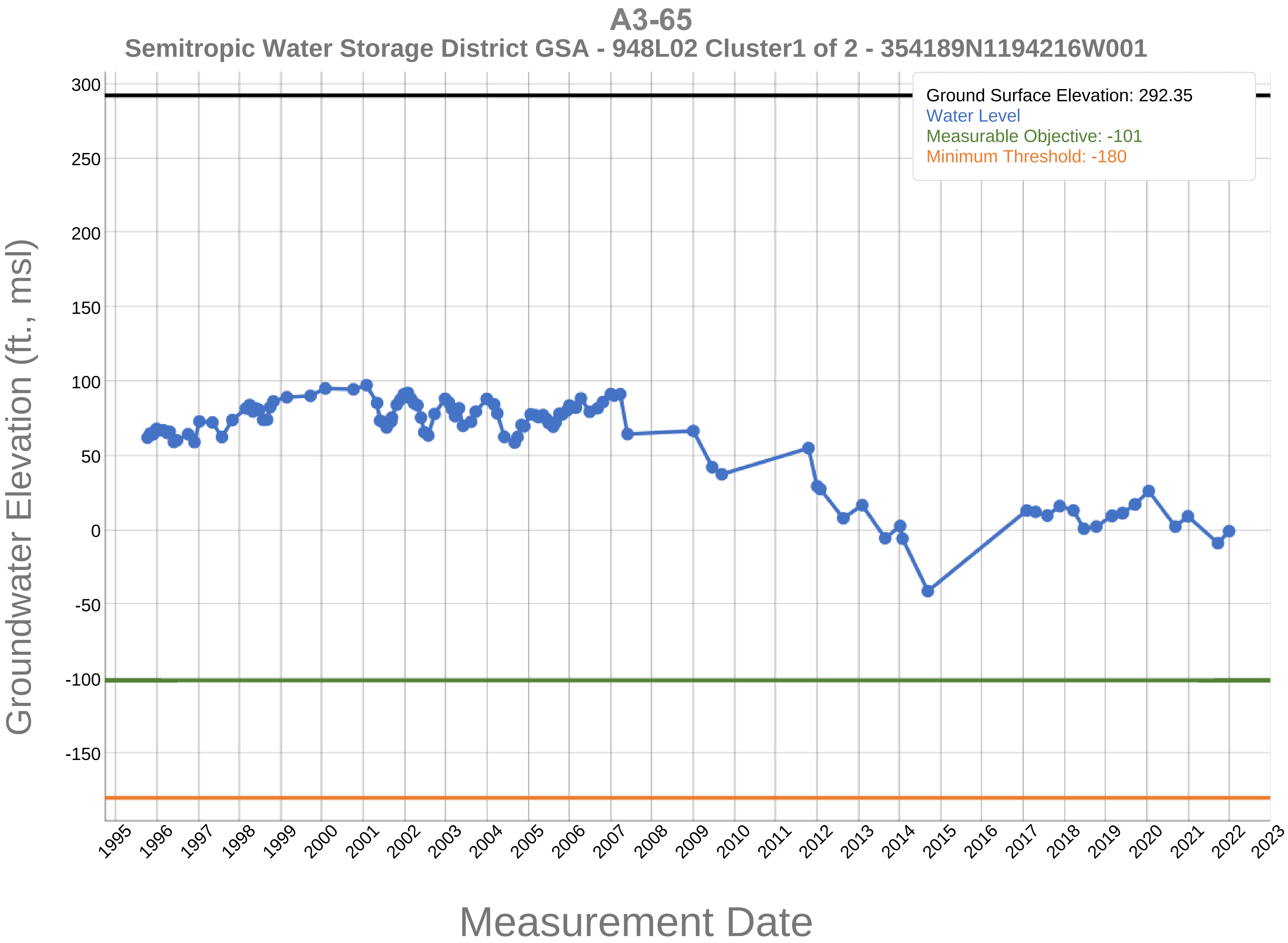
Measurement Date


A3-65
Semitropic Water Storage District GSA - 948L02 Cluster1 of 2 - 354189N1194216W001
Ground Surface Elevation: 292.35
Water Level
Measurable Objective: -101
Minimum Threshold: -180
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
-150
1995
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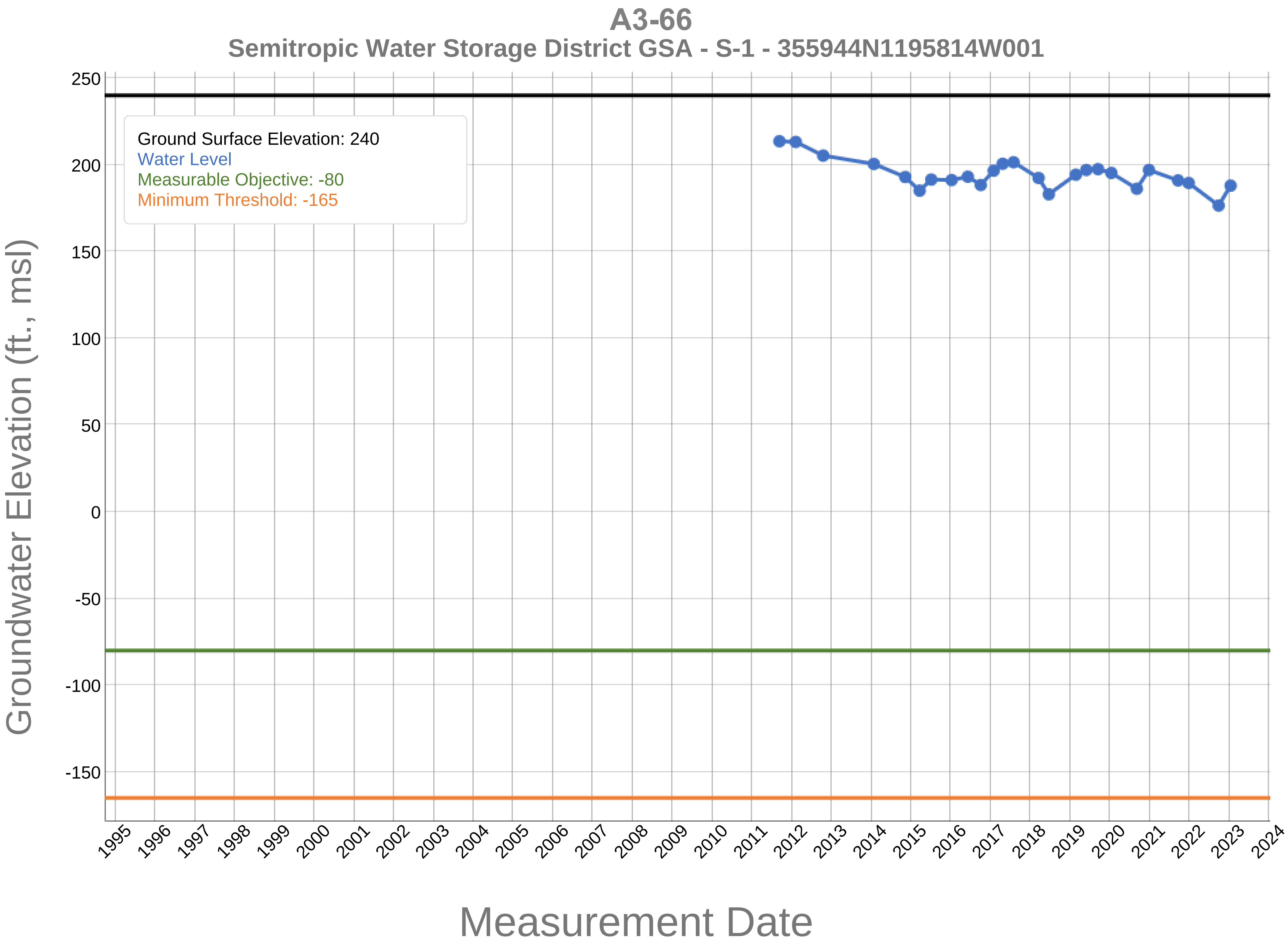
Measurement Date


A3-66
Semitropic Water Storage District GSA - S-1 - 355944N1195814W001
Ground Surface Elevation: 240
Water Level
Measurable Objective: -80
Minimum Threshold: -165
Groundwater Elevation (ft., msl)
250
200
150
100
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-50
-100
-150
1995
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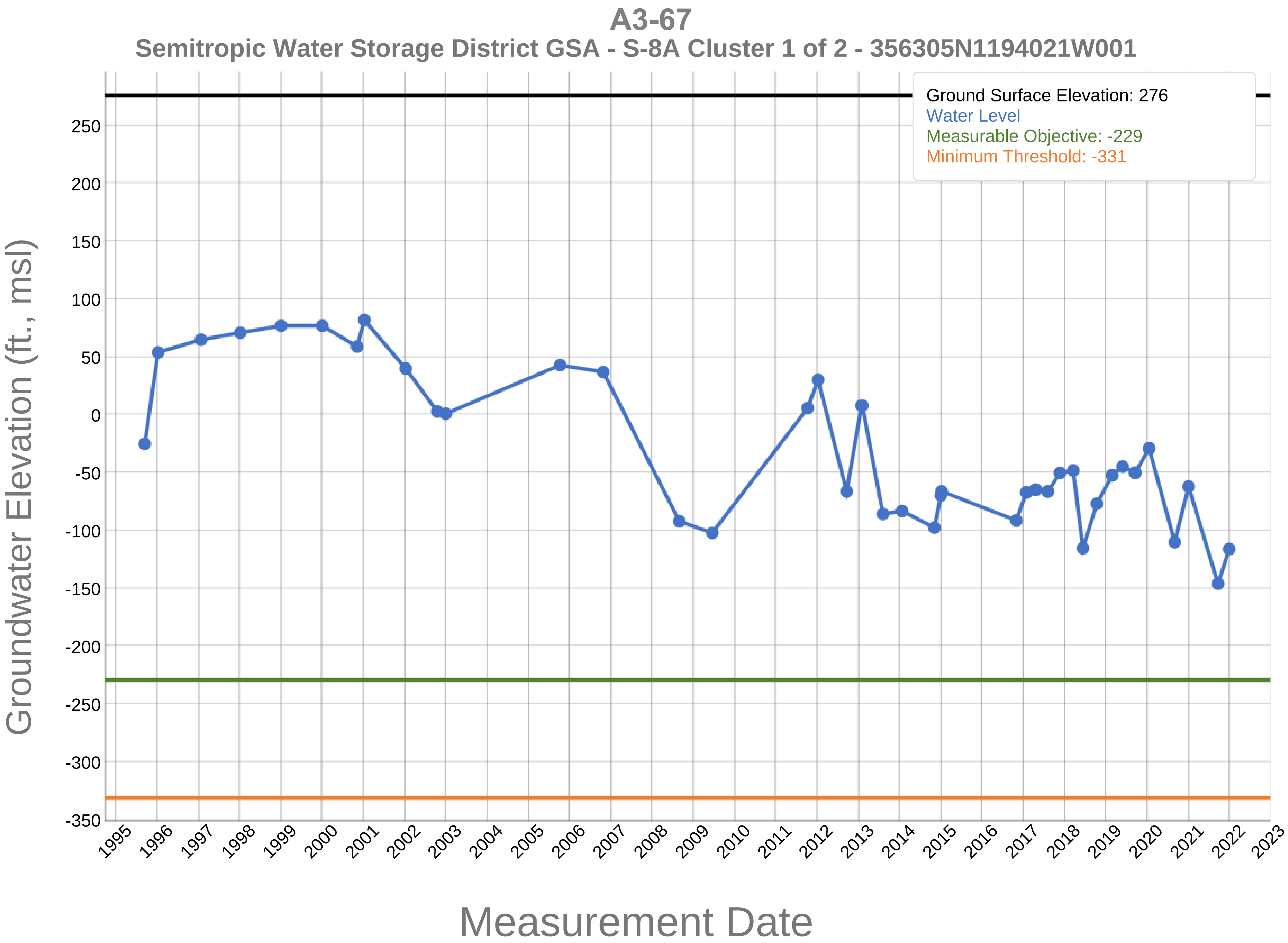
Measurement Date


A3-67
Semitropic Water Storage District GSA - S-8A Cluster 1 of 2 - 356305N1194021W001
Ground Surface Elevation: 276
Water Level
Measurable Objective: -229
Minimum Threshold: -331
Groundwater Elevation (ft., msl)
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
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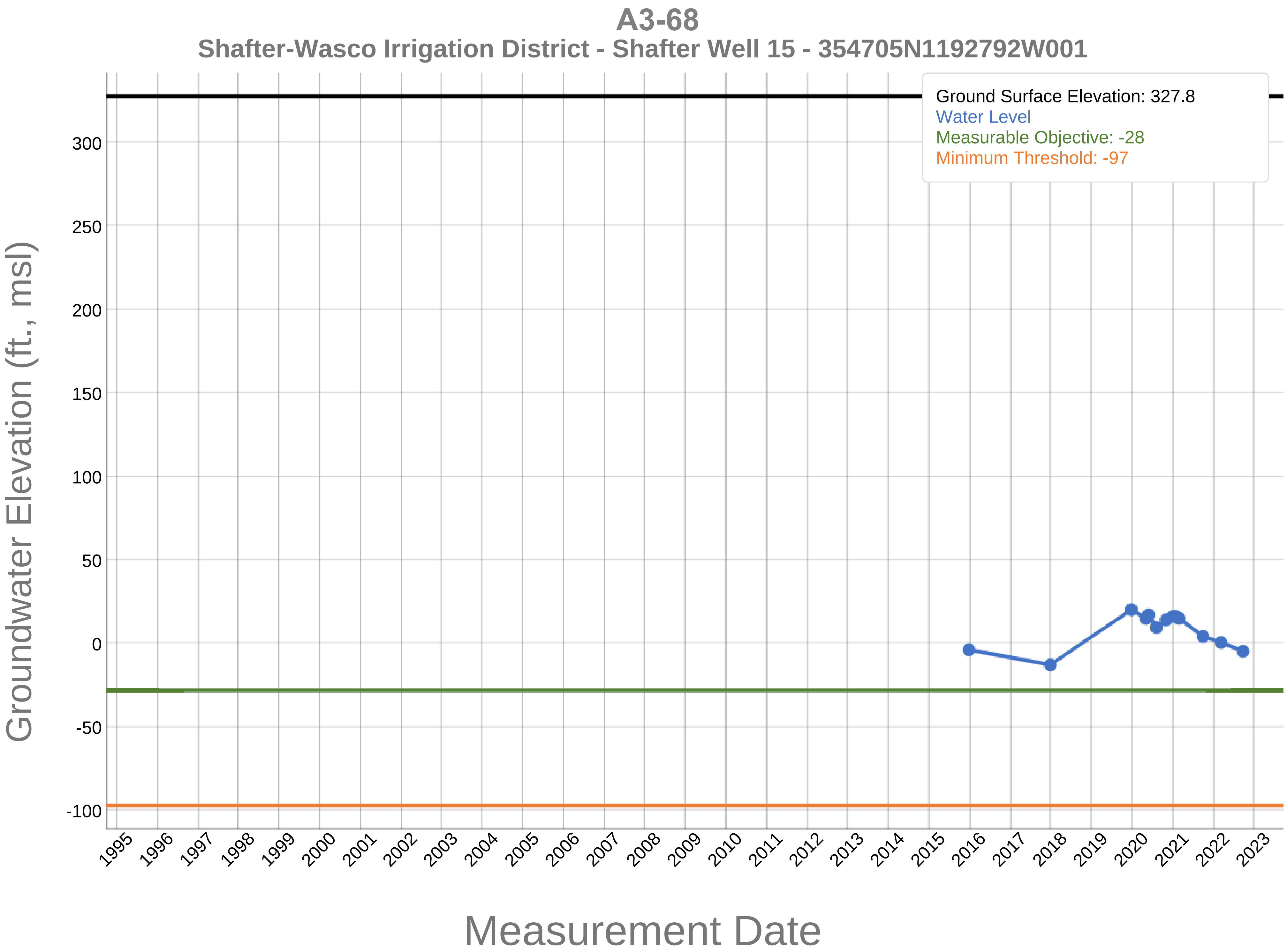
Measurement Date



A3-68
Shafter-Wasco Irrigation District - Shafter Well 15 - 354705N1192792W001
Ground Surface Elevation: 327.8
Water Level
Measurable Objective: -28
Minimum Threshold: -97
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
1995
1996
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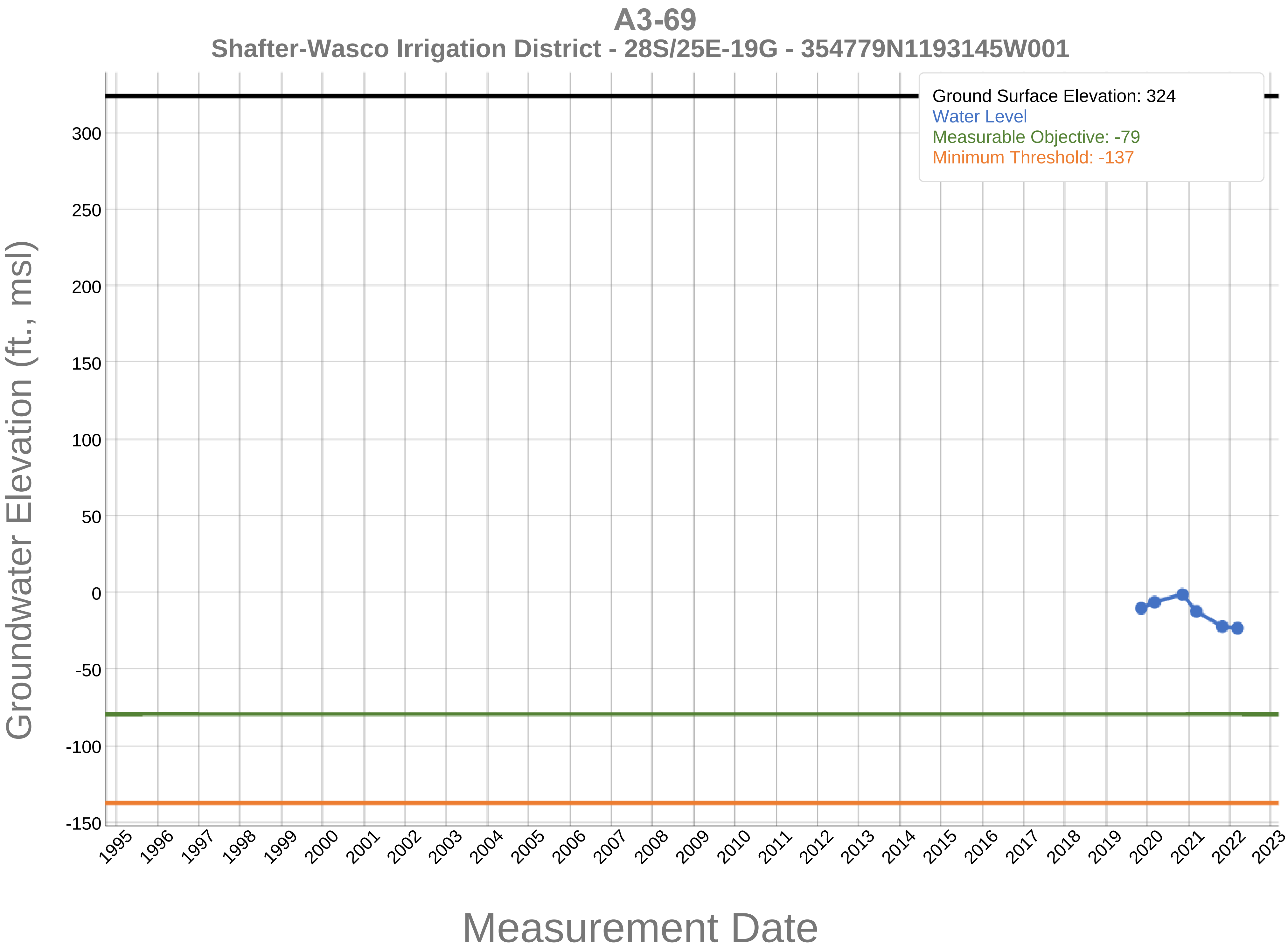
Measurement Date



A3-69
Shafter-Wasco Irrigation District - 28S/25E-19G - 354779N1193145W001
Ground Surface Elevation: 324
Water Level
Measurable Objective: -79
Minimum Threshold: -137
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
-150
1995
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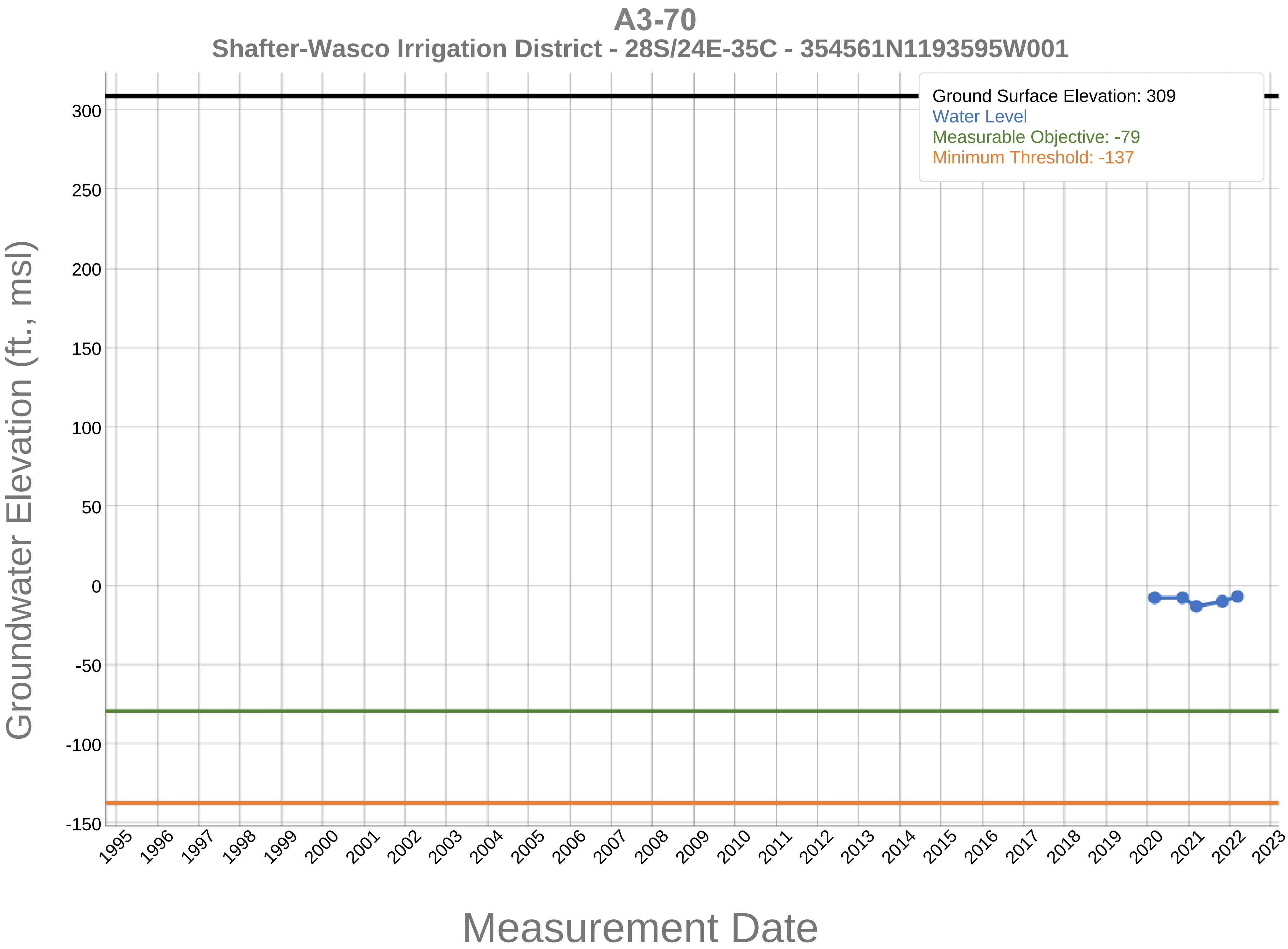
Measurement Date


A3-70
Shafter-Wasco Irrigation District - 28S/24E-35C - 354561N1193595W001
Ground Surface Elevation: 309
Water Level
Measurable Objective: -79
Minimum Threshold: -137
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
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-50
-100
-150
1995
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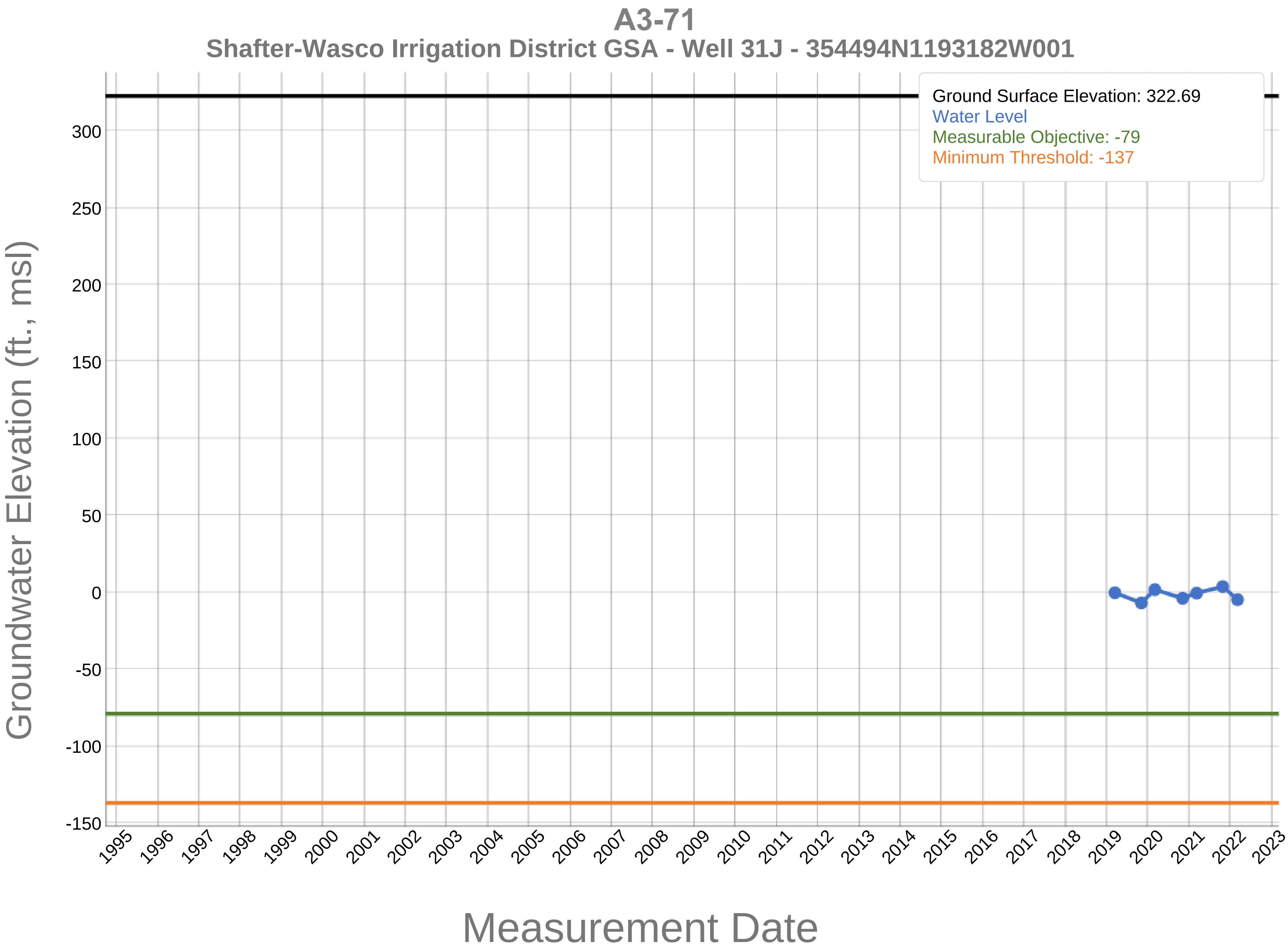
Measurement Date


A3-71
Shafter-Wasco Irrigation District GSA - Well 31J - 354494N1193182W001
Ground Surface Elevation: 322.69
Water Level
Measurable Objective: -79
Minimum Threshold: -137
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
-150
1995
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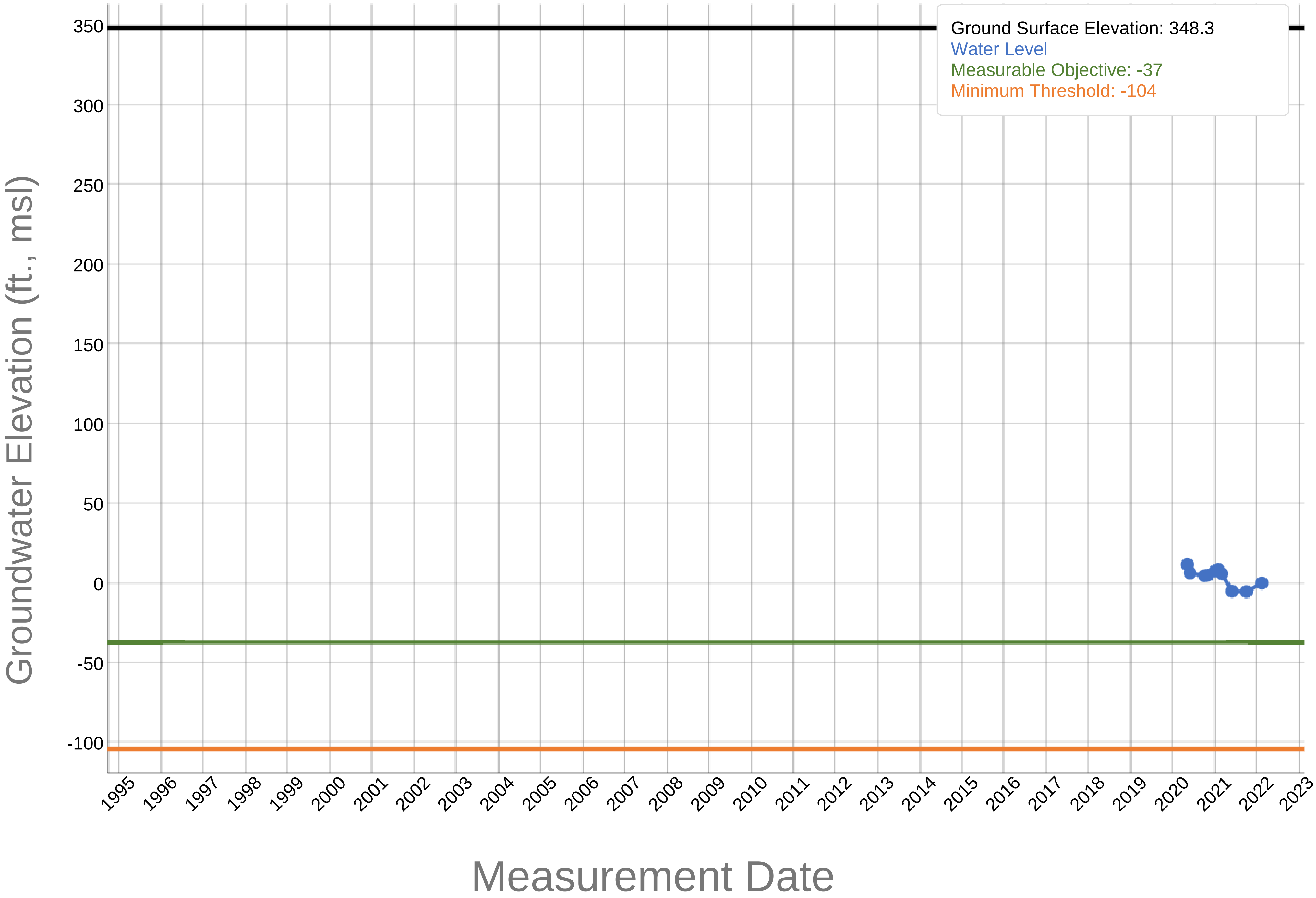
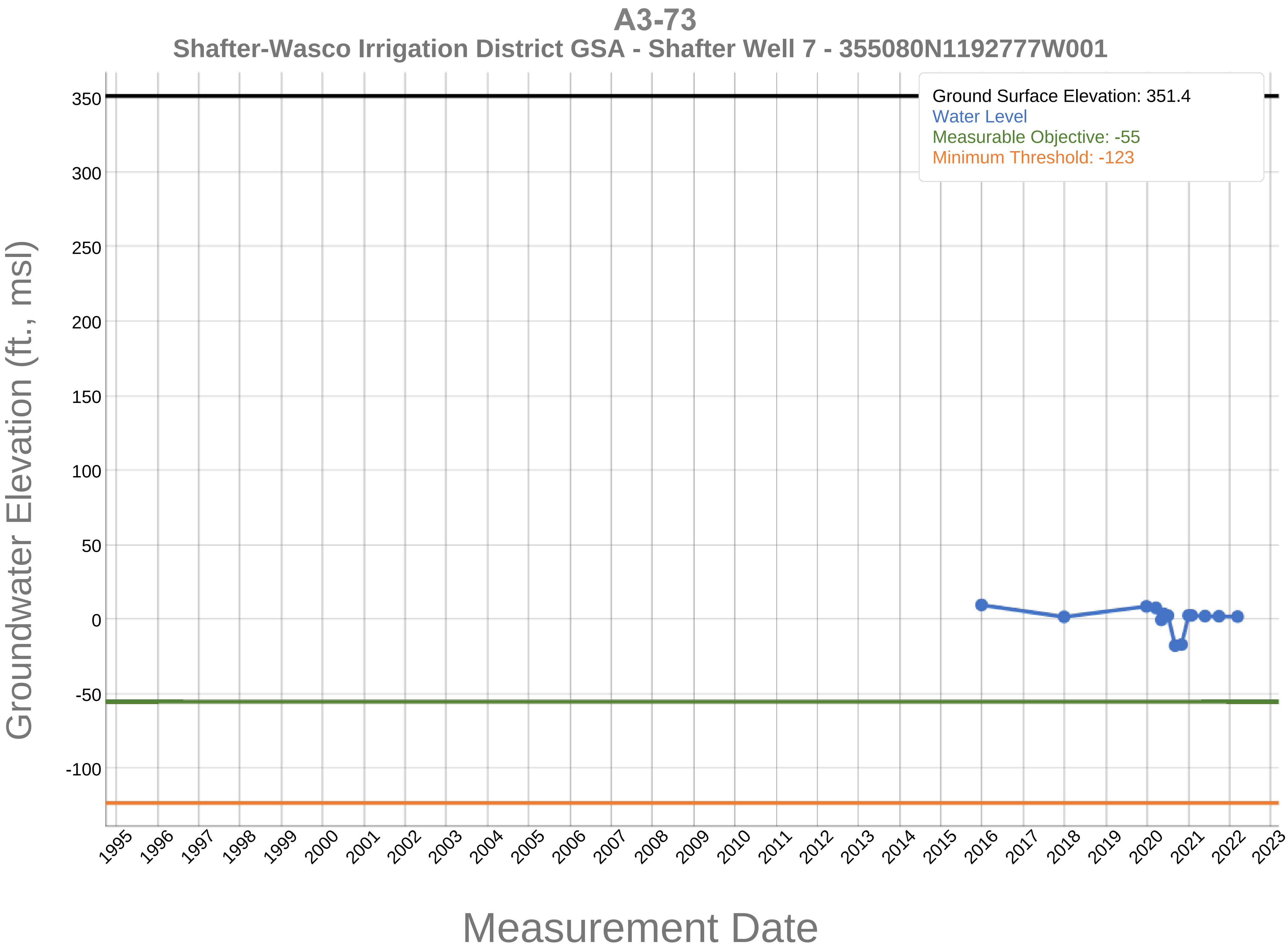
Measurement Date

A3-72

Shafter-Wasco Irrigation District GSA - Shafter Well 14 - 354943N1192593W001




A3-73
Shafter-Wasco Irrigation District GSA - Shafter Well 7 - 355080N1192777W001
Ground Surface Elevation: 351.4
Water Level
Measurable Objective: -55
Minimum Threshold: -123
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
1995
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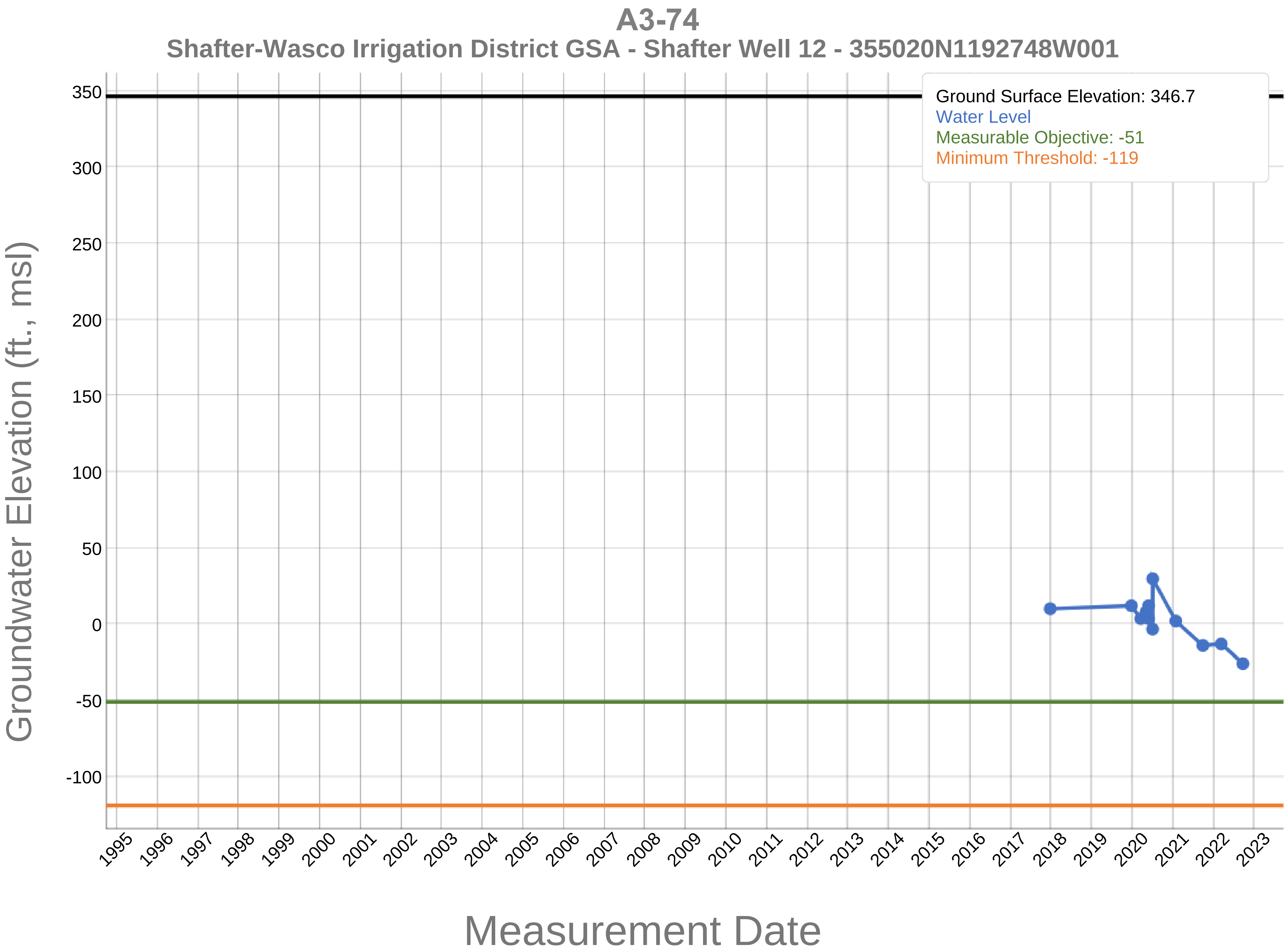
Measurement Date


A3-74
Shafter-Wasco Irrigation District GSA - Shafter Well 12 - 355020N1192748W001
Ground Surface Elevation: 346.7
Water Level
Measurable Objective: -51
Minimum Threshold: -119
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
1995
1996
1997
1998
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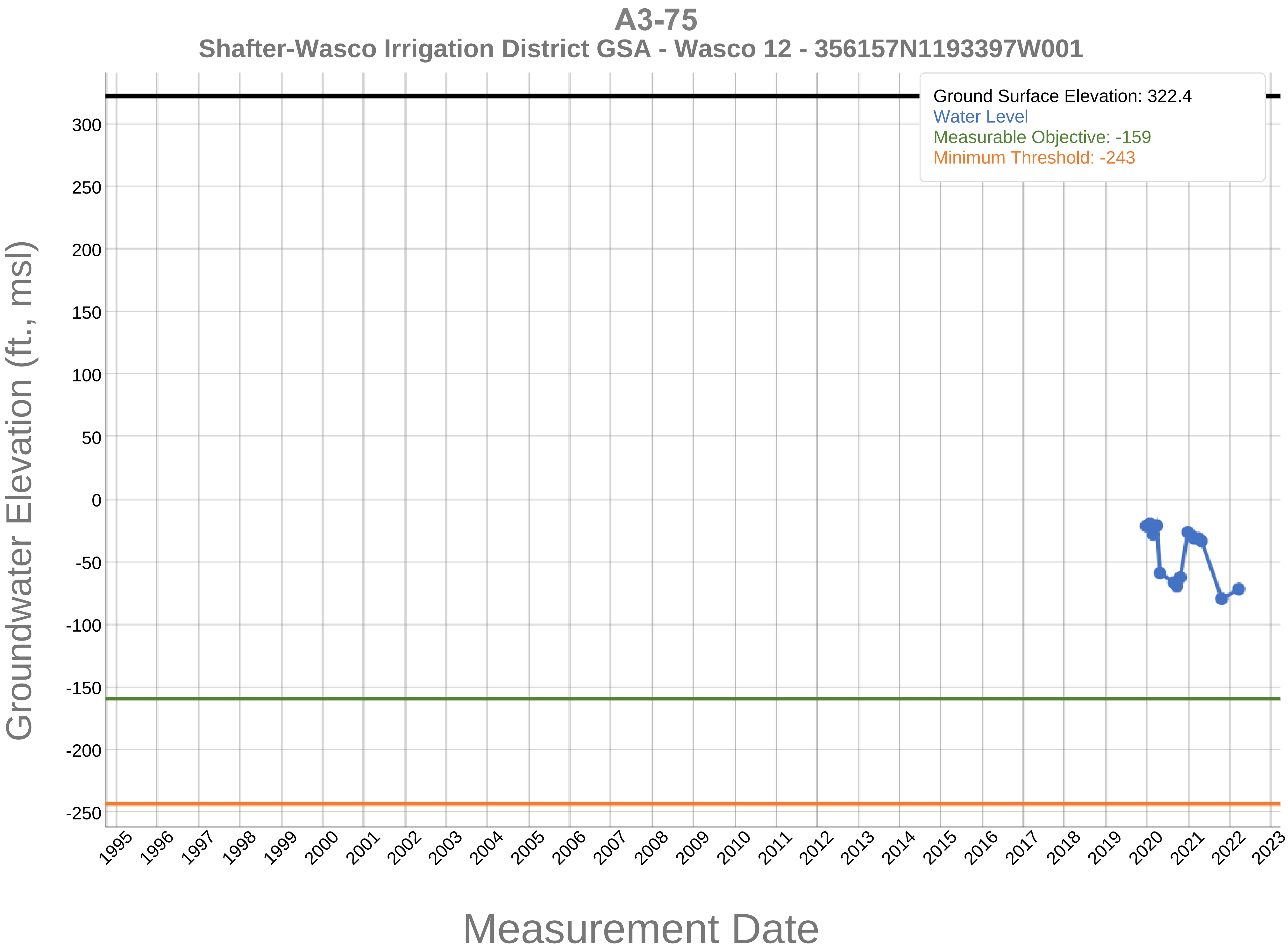
Measurement Date



A3-75
Shafter-Wasco Irrigation District GSA - Wasco 12 - 356157N1193397W001
Ground Surface Elevation: 322.4
Water Level
Measurable Objective: -159
Minimum Threshold: -243
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
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-50
-100
-150
-200
-250
1995
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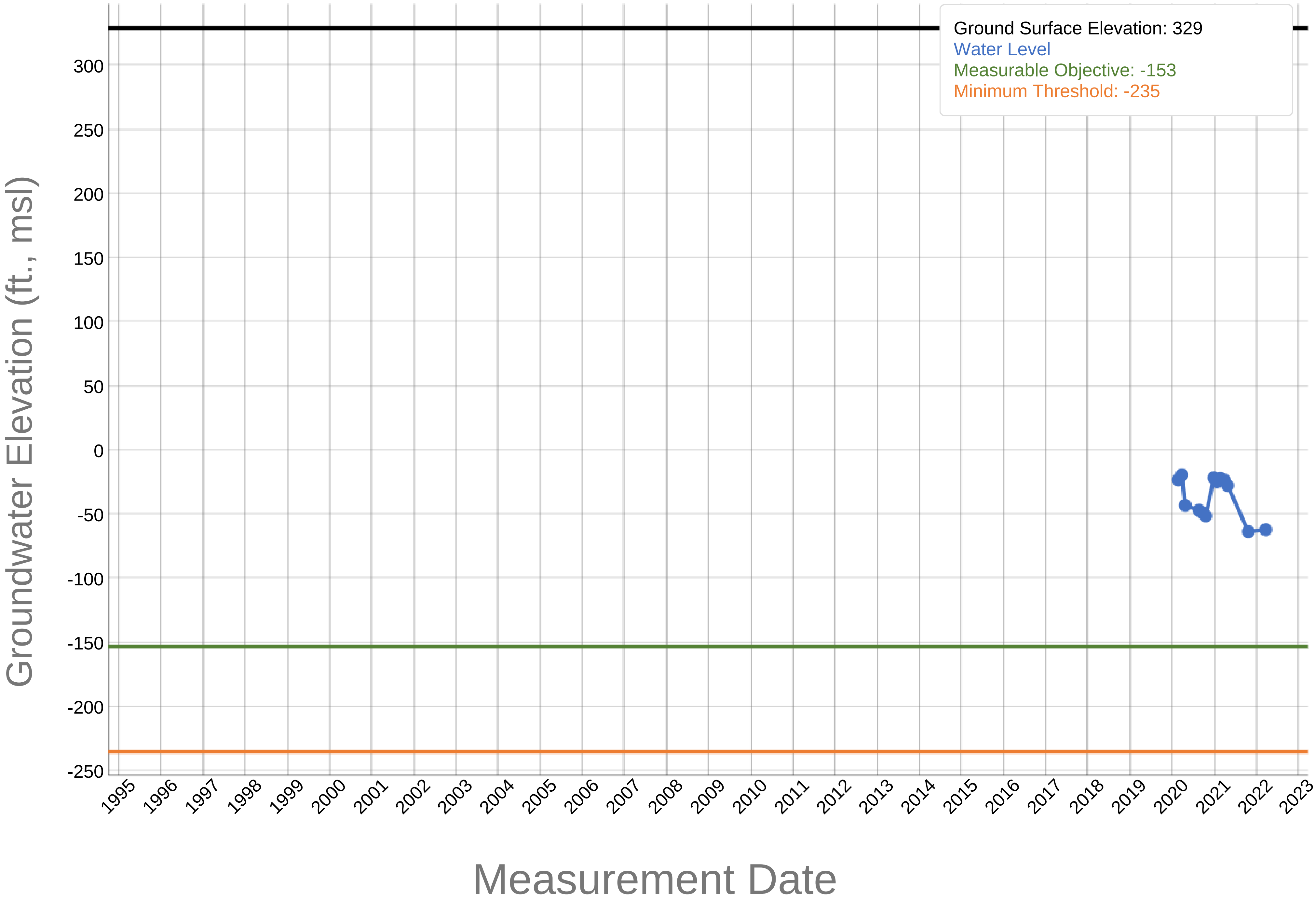
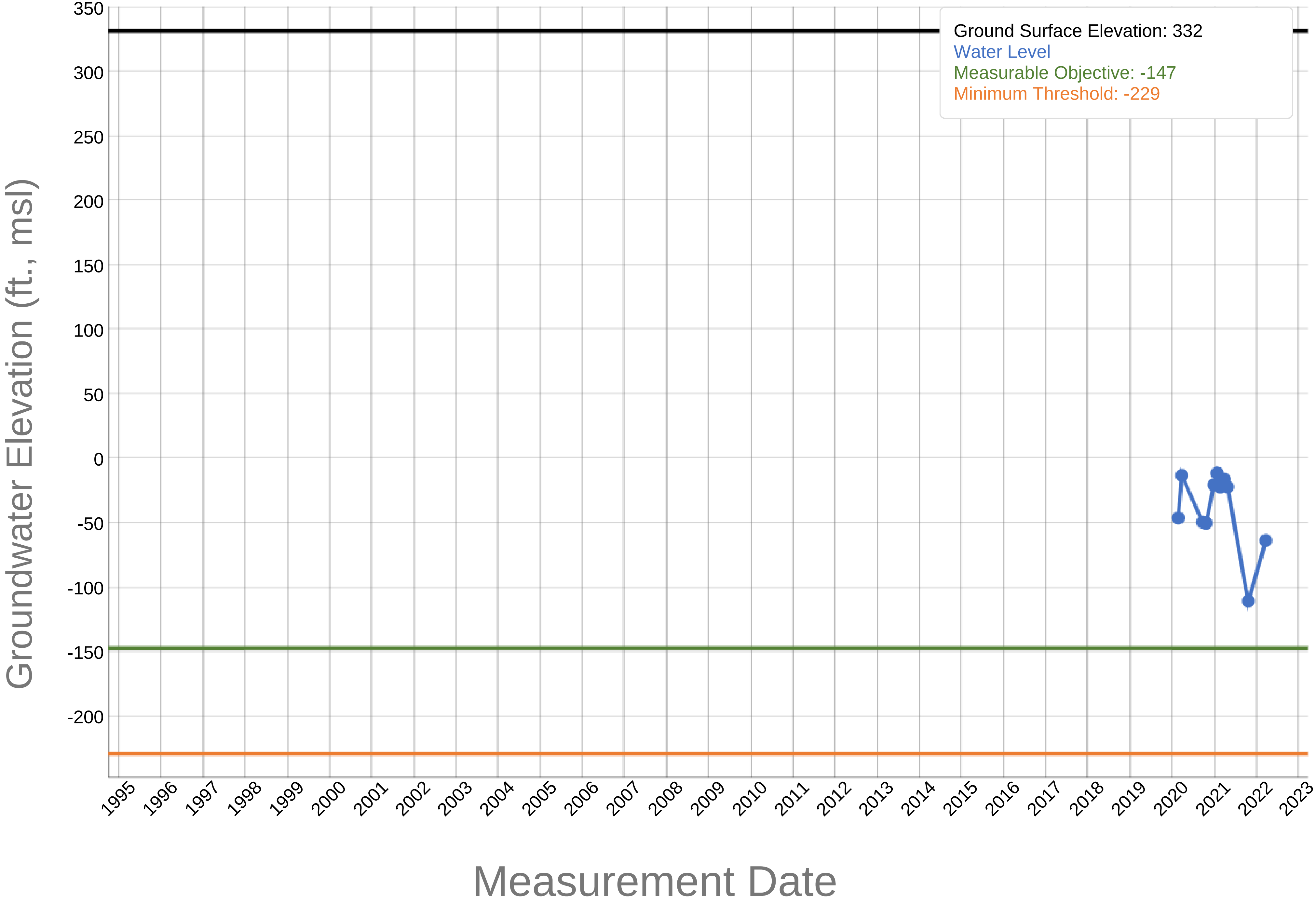
Measurement Date

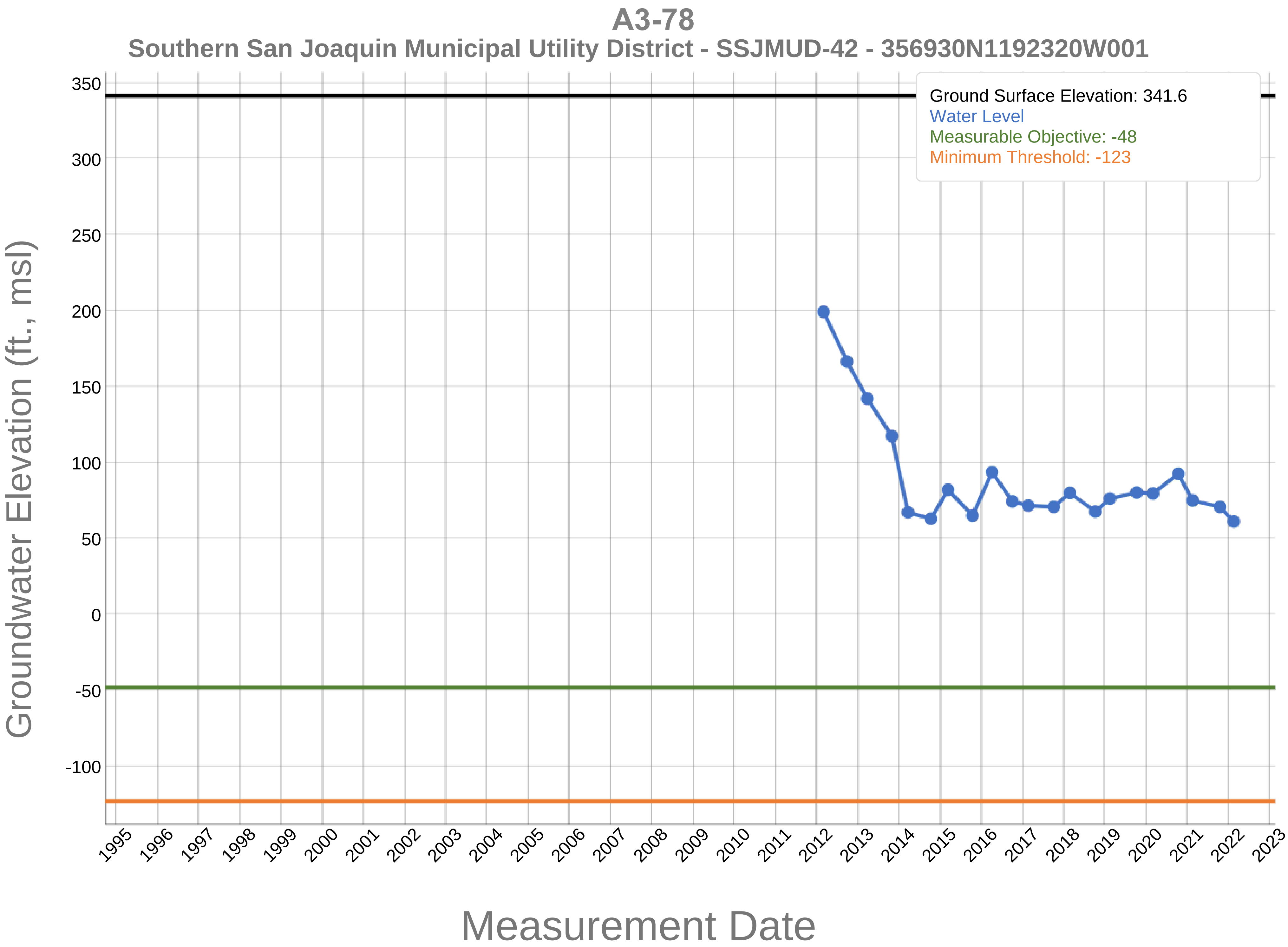
A3-76

Shafter-Wasco Irrigation District GSA - Wasco 8A - 355874N1193523W001



A3-77
Shafter-Wasco Irrigation District GSA - Wasco 11 - 355891N1193417W001




A3-78
Southern San Joaquin Municipal Utility District - SSJMUD-42 - 356930N1192320W001
Ground Surface Elevation: 341.6
Water Level
Measurable Objective: -48
Minimum Threshold: -123
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
1995
1996
1997
1998
1999
2000
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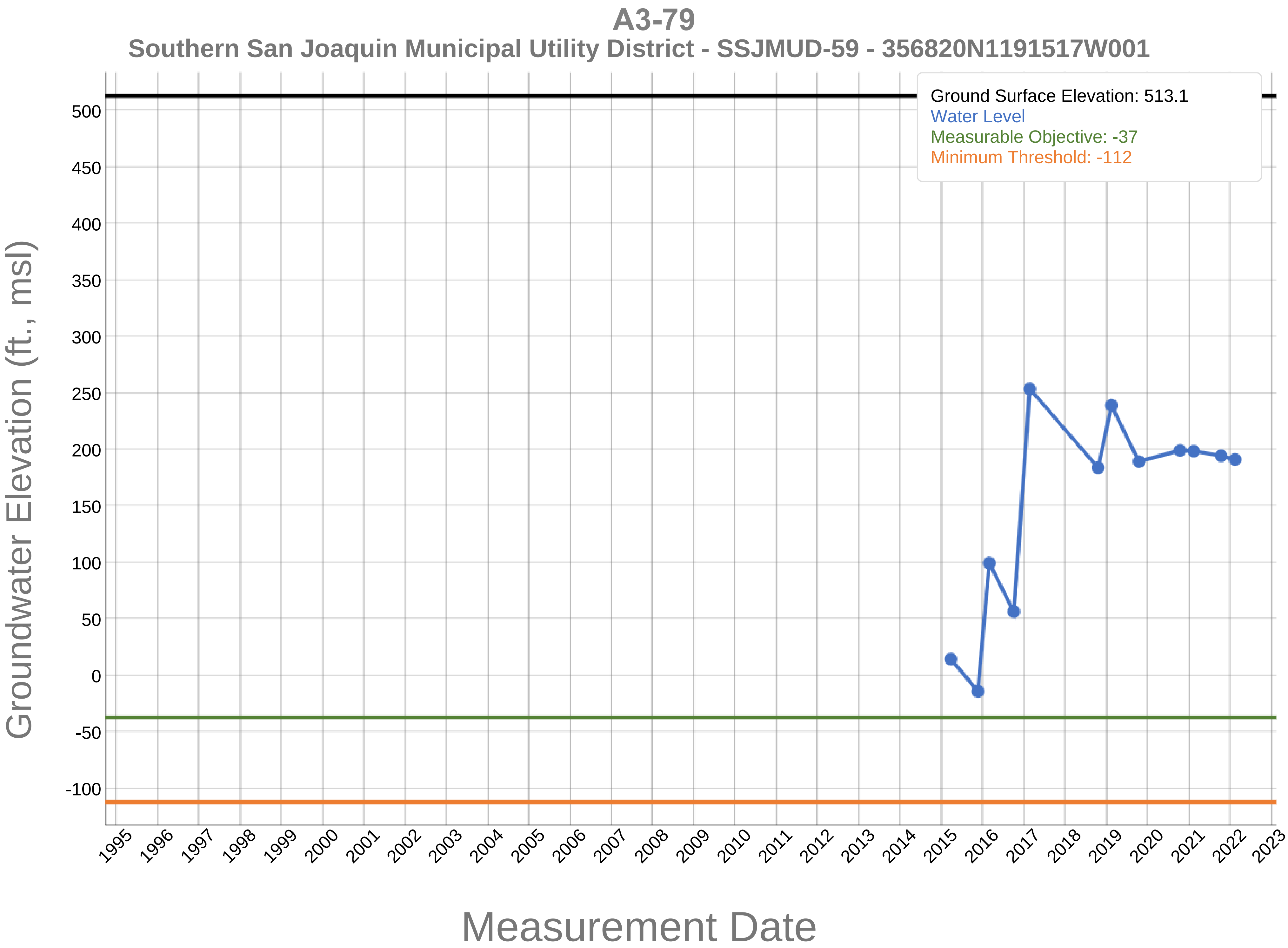
Measurement Date


A3-79
Southern San Joaquin Municipal Utility District - SSJMUD-59 - 356820N1191517W001
Ground Surface Elevation: 513.1
Water Level
Measurable Objective: -37
Minimum Threshold: -112
Groundwater Elevation (ft., msl)
500
450
400
350
300
250
200
150
100
50
0
-50
-100
1995
1996
1997
1998
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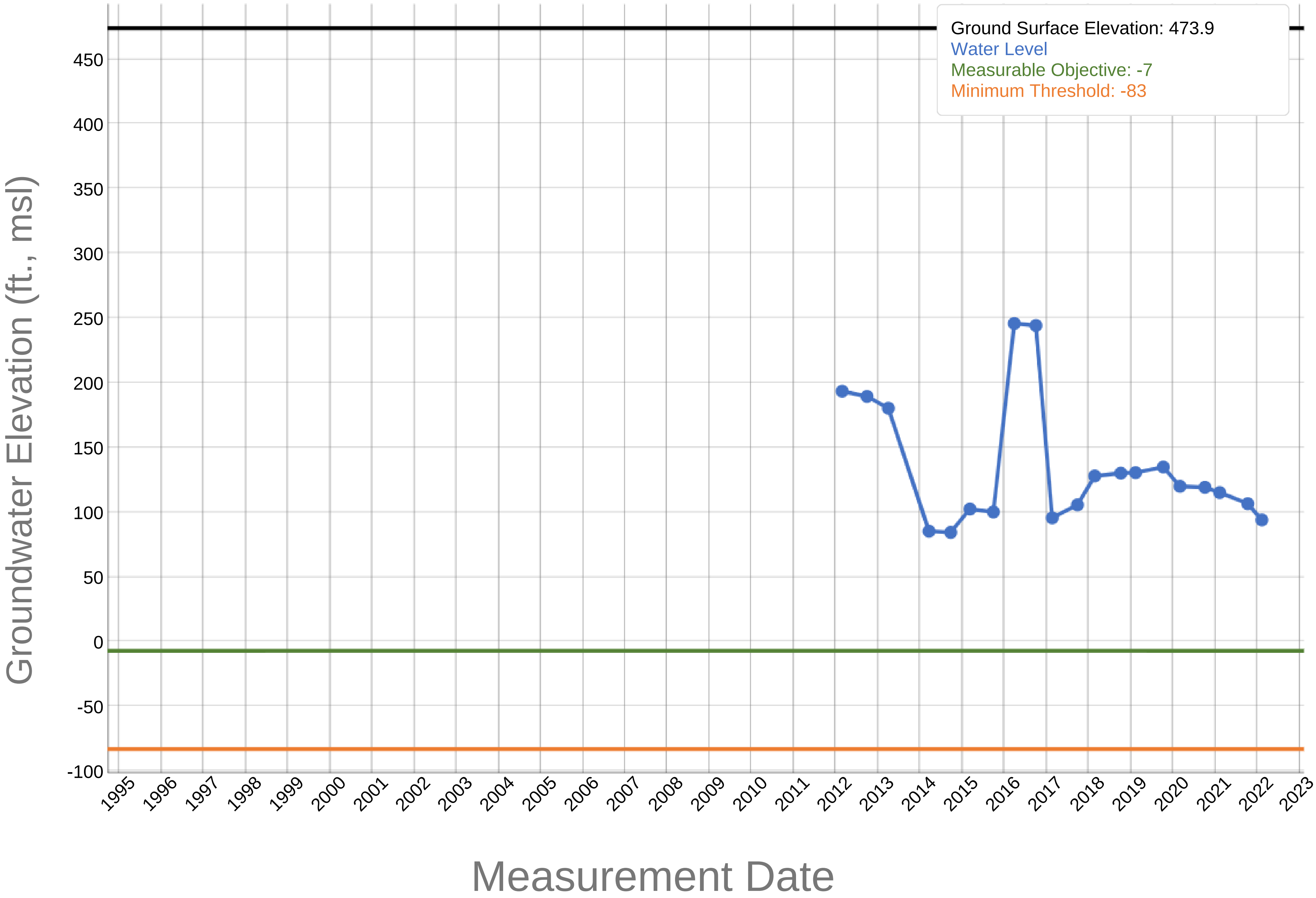
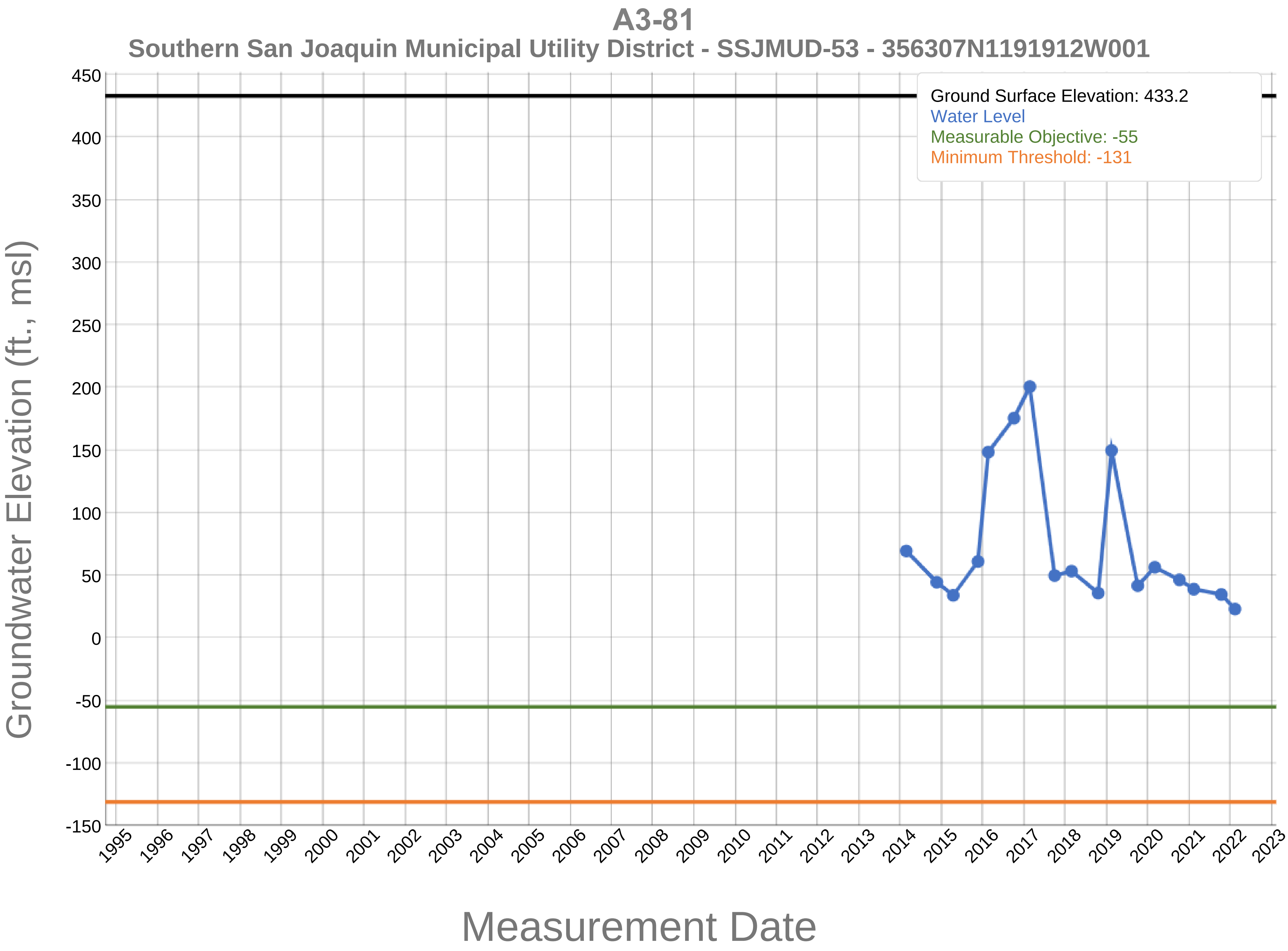
Measurement Date

A3-80

Southern San Joaquin Municipal Utility District - SSJMUD-62 - 357184N1191449W001





A3-81
Southern San Joaquin Municipal Utility District - SSJMUD-53 - 356307N1191912W001
Ground Surface Elevation: 433.2
Water Level
Measurable Objective: -55
Minimum Threshold: -131
Groundwater Elevation (ft., msl)
450
400
350
300
250
200
150
100
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-50
-100
-150
1995
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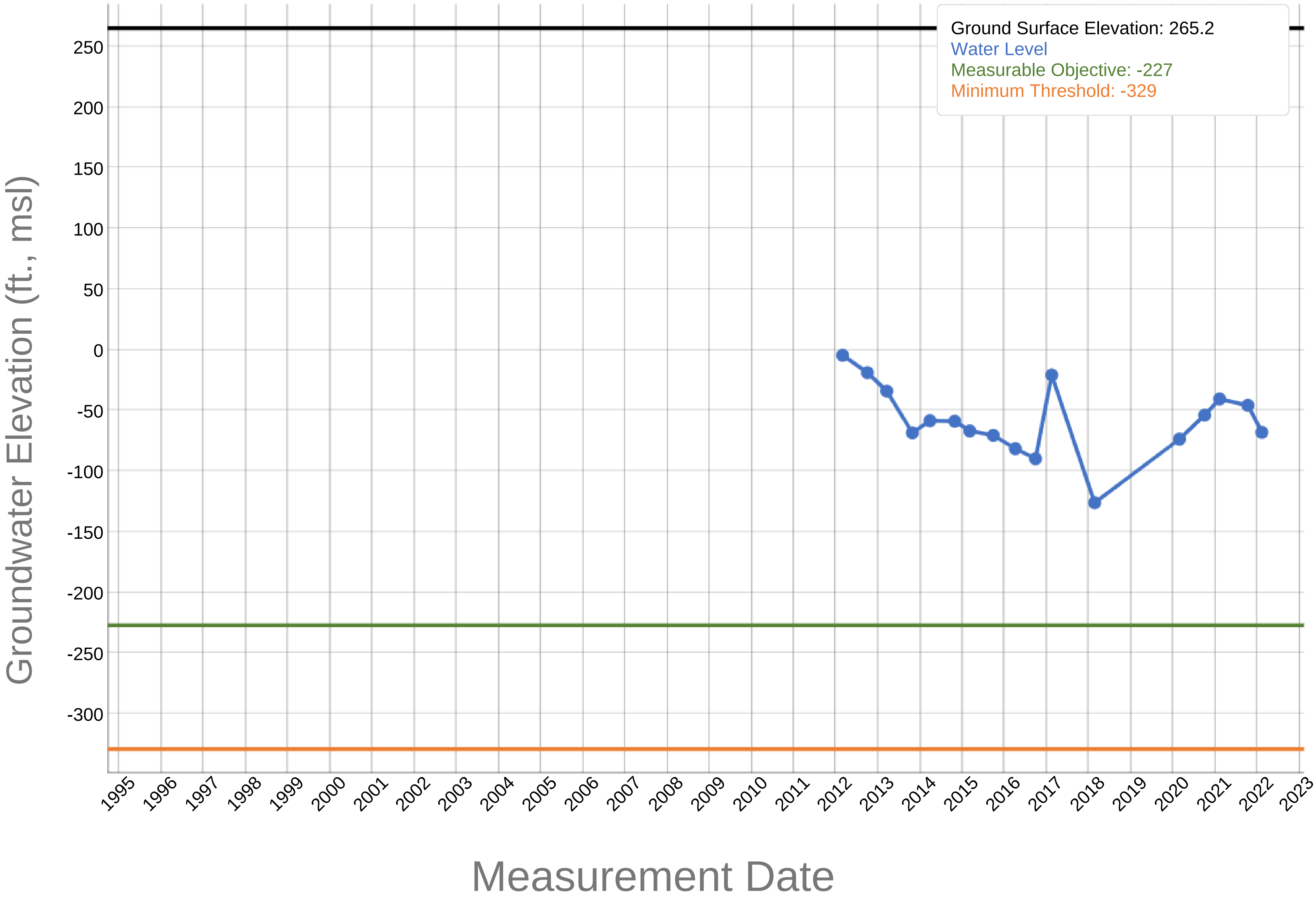
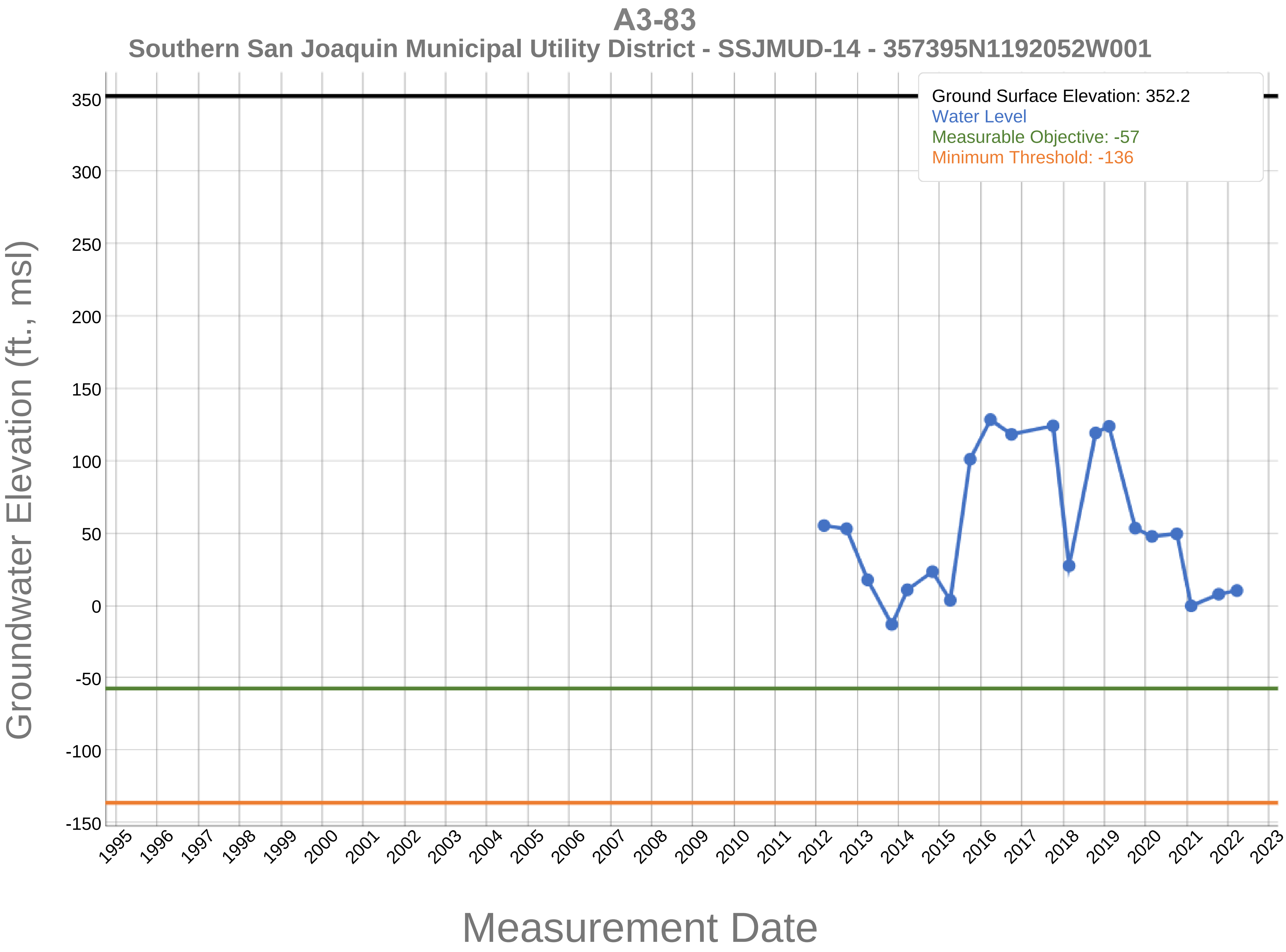
Measurement Date

A3-82

Southern San Joaquin Municipal Utility District - SSJMUD-8 - 357470N1193360W001




A3-83
Southern San Joaquin Municipal Utility District - SSJMUD-14 - 357395N1192052W001
Ground Surface Elevation: 352.2
Water Level
Measurable Objective: -57
Minimum Threshold: -136
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
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-50
-100
-150
1995
1996
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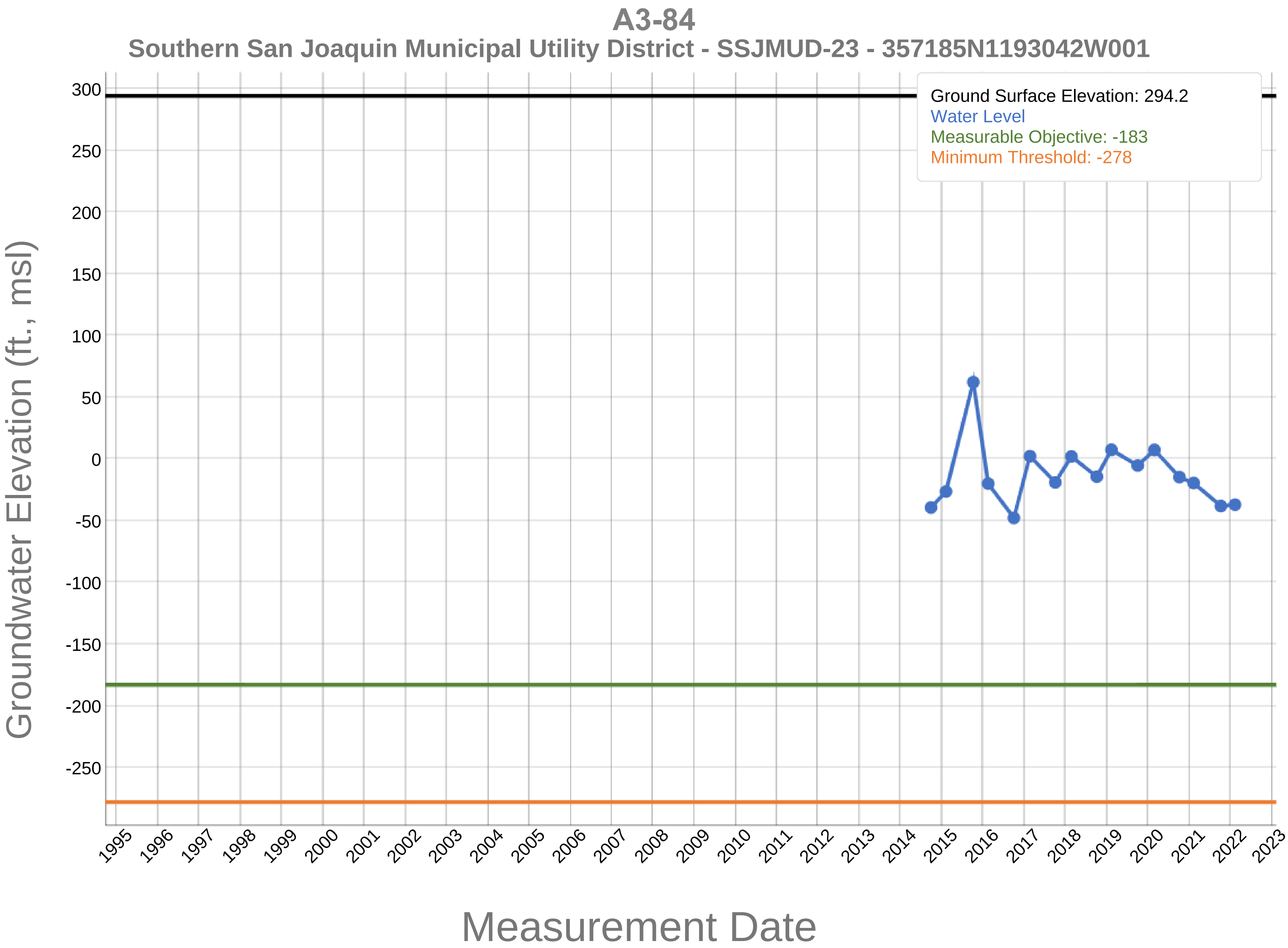
Measurement Date


A3-84
Southern San Joaquin Municipal Utility District - SSJMUD-23 - 357185N1193042W001
Ground Surface Elevation: 294.2
Water Level
Measurable Objective: -183
Minimum Threshold: -278
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
1995
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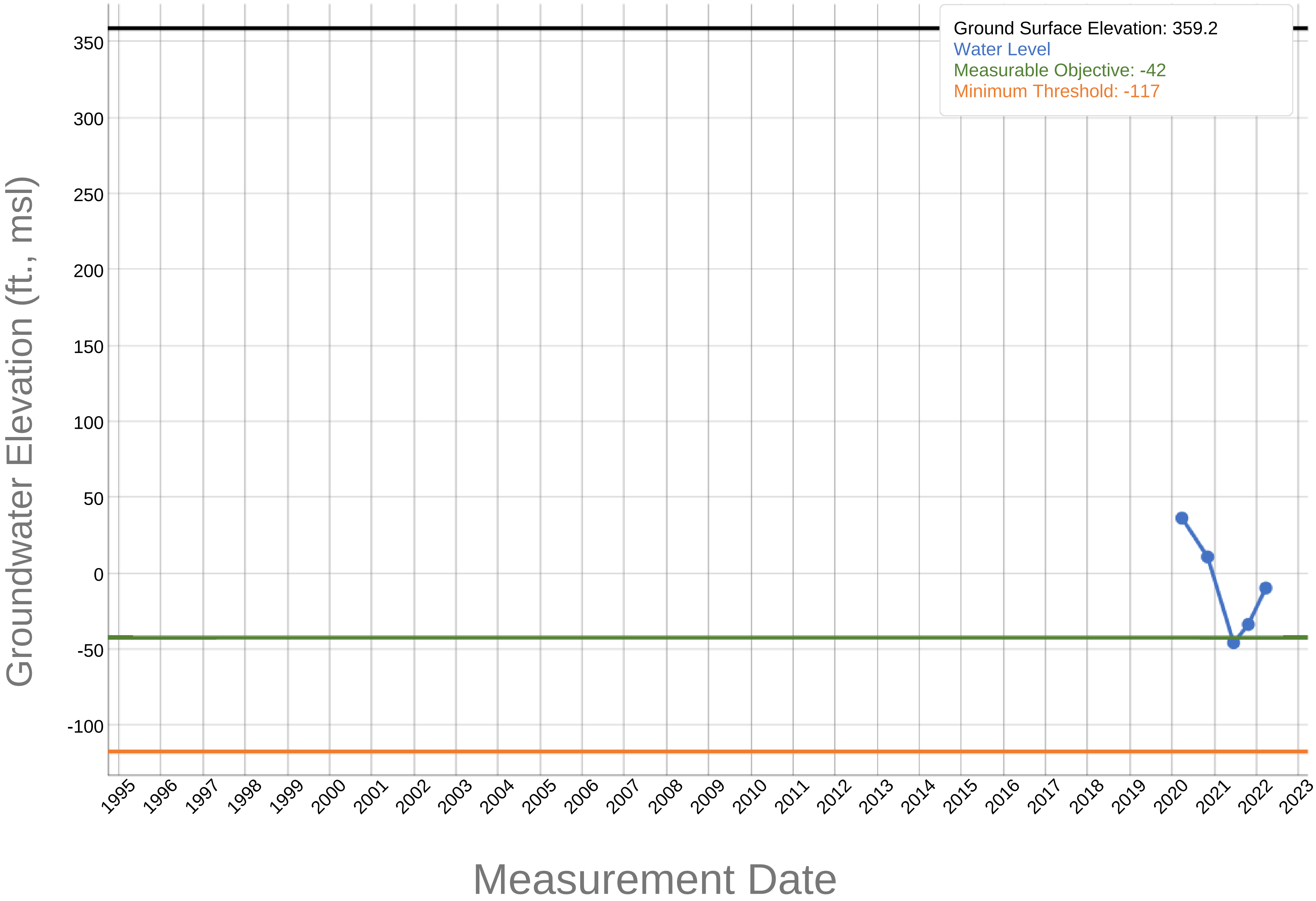
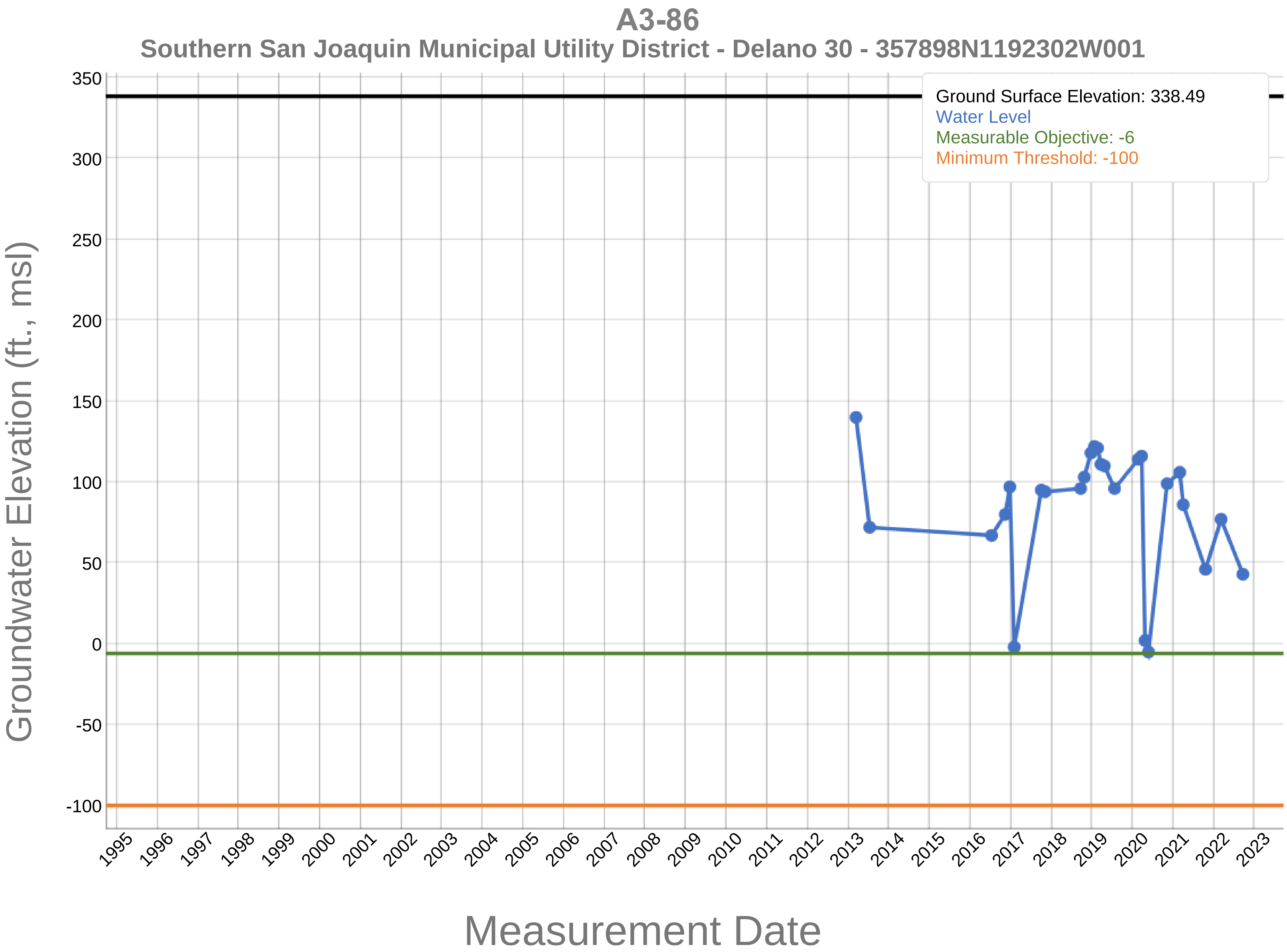
Measurement Date

A3-85

Southern San Joaquin Municipal Utility District - McFarland Taylor Ave Well - 356675N1192402W001




A3-86
Southern San Joaquin Municipal Utility District - Delano 30 - 357898N1192302W001
Ground Surface Elevation: 338.49
Water Level
Measurable Objective: -6
Minimum Threshold: -100
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
1995
1996
1997
1998
1999
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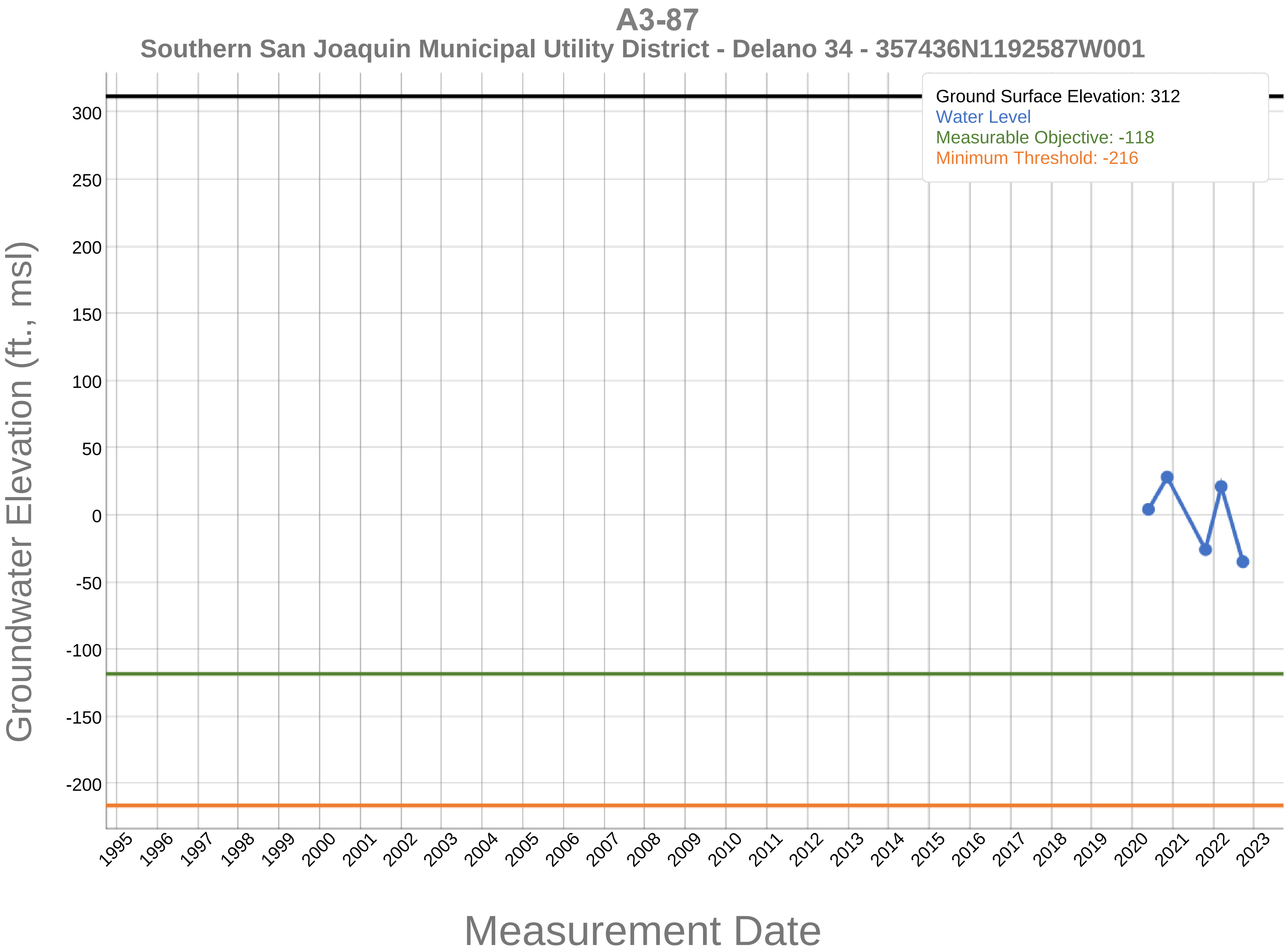
Measurement Date


A3-87
Southern San Joaquin Municipal Utility District - Delano 34 - 357436N1192587W001
Ground Surface Elevation: 312
Water Level
Measurable Objective: -118
Minimum Threshold: -216
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
-150
-200
1995
1996
1997
1998
1999
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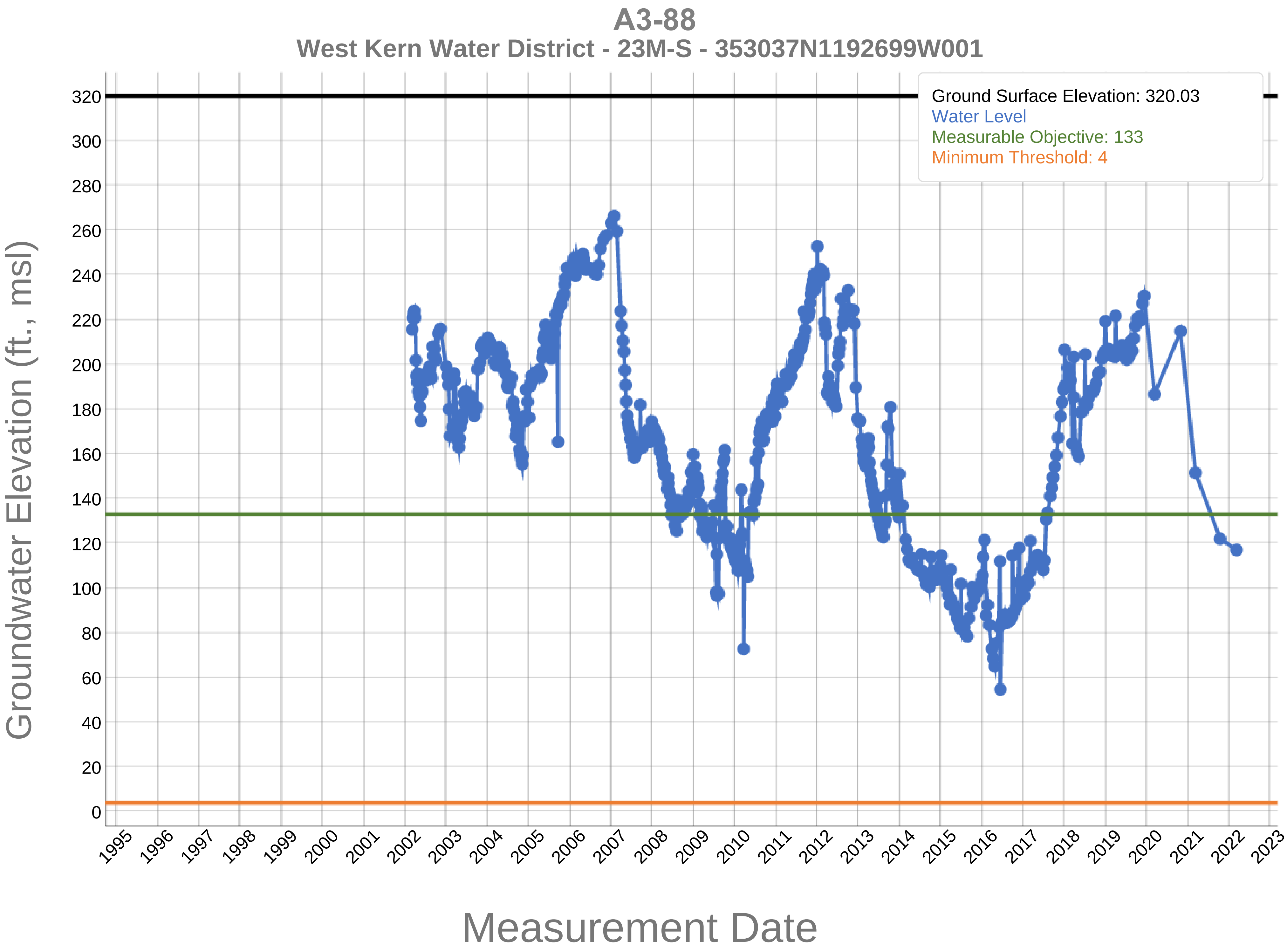
Measurement Date



A3-88
West Kern Water District - 23M-S - 353037N1192699W001
Ground Surface Elevation: 320.03
Water Level
Measurable Objective: 133
Minimum Threshold: 4
Groundwater Elevation (ft., msl)
Measurement Date
0
20
40
60
80
100
120
140
160
180
200
220
240
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300
320
1995
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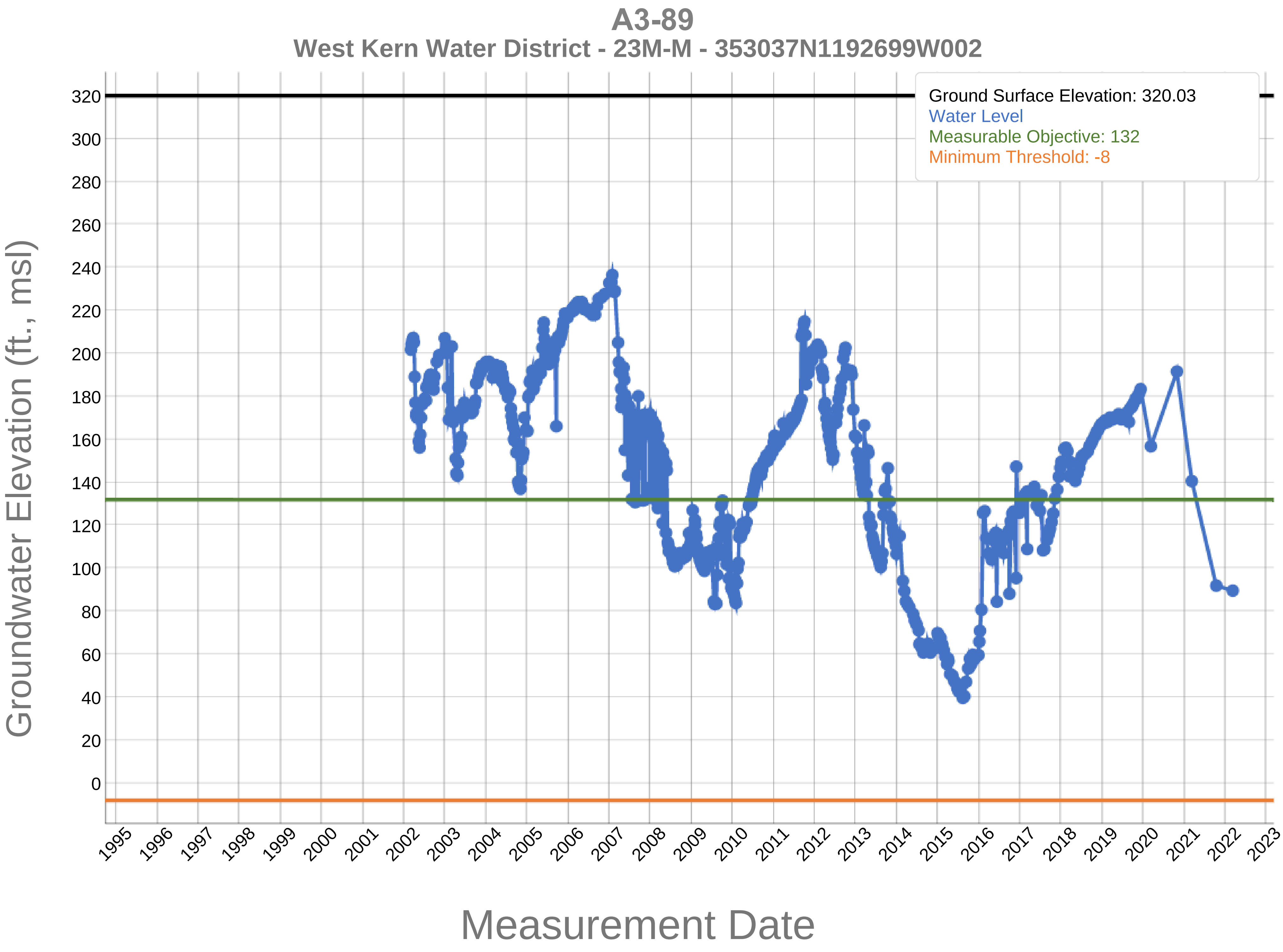
A3-89
West Kern Water District - 23M-M - 353037N1192699W002
Ground Surface Elevation: 320.03
Water Level
Measurable Objective: 132
Minimum Threshold: -8
Groundwater Elevation (ft., msl)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
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320
1995
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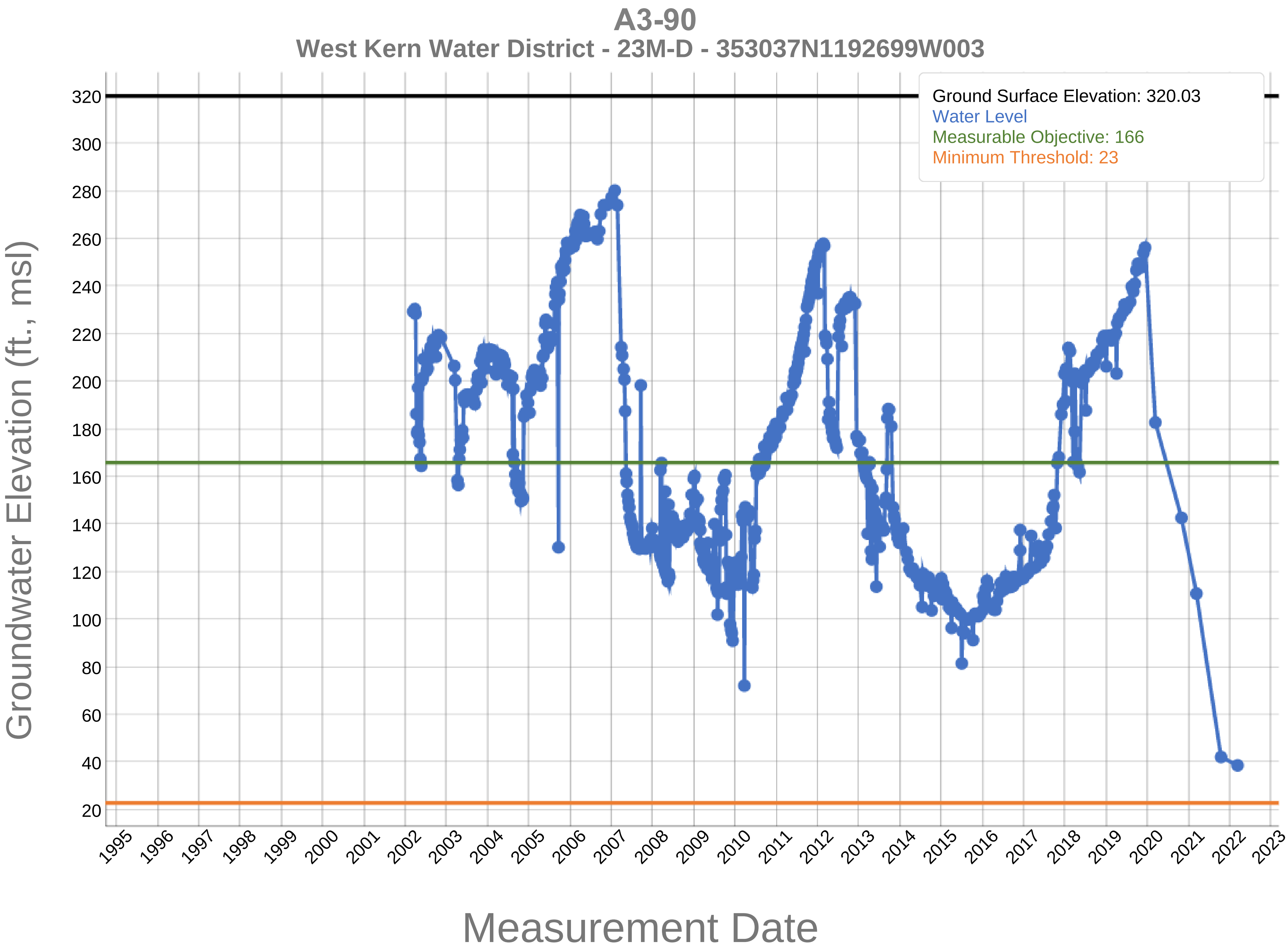
Measurement Date



A3-90
West Kern Water District - 23M-D - 353037N1192699W003
Ground Surface Elevation: 320.03
Water Level
Measurable Objective: 166
Minimum Threshold: 23
Groundwater Elevation (ft., msl)
Measurement Date
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
1995
1996
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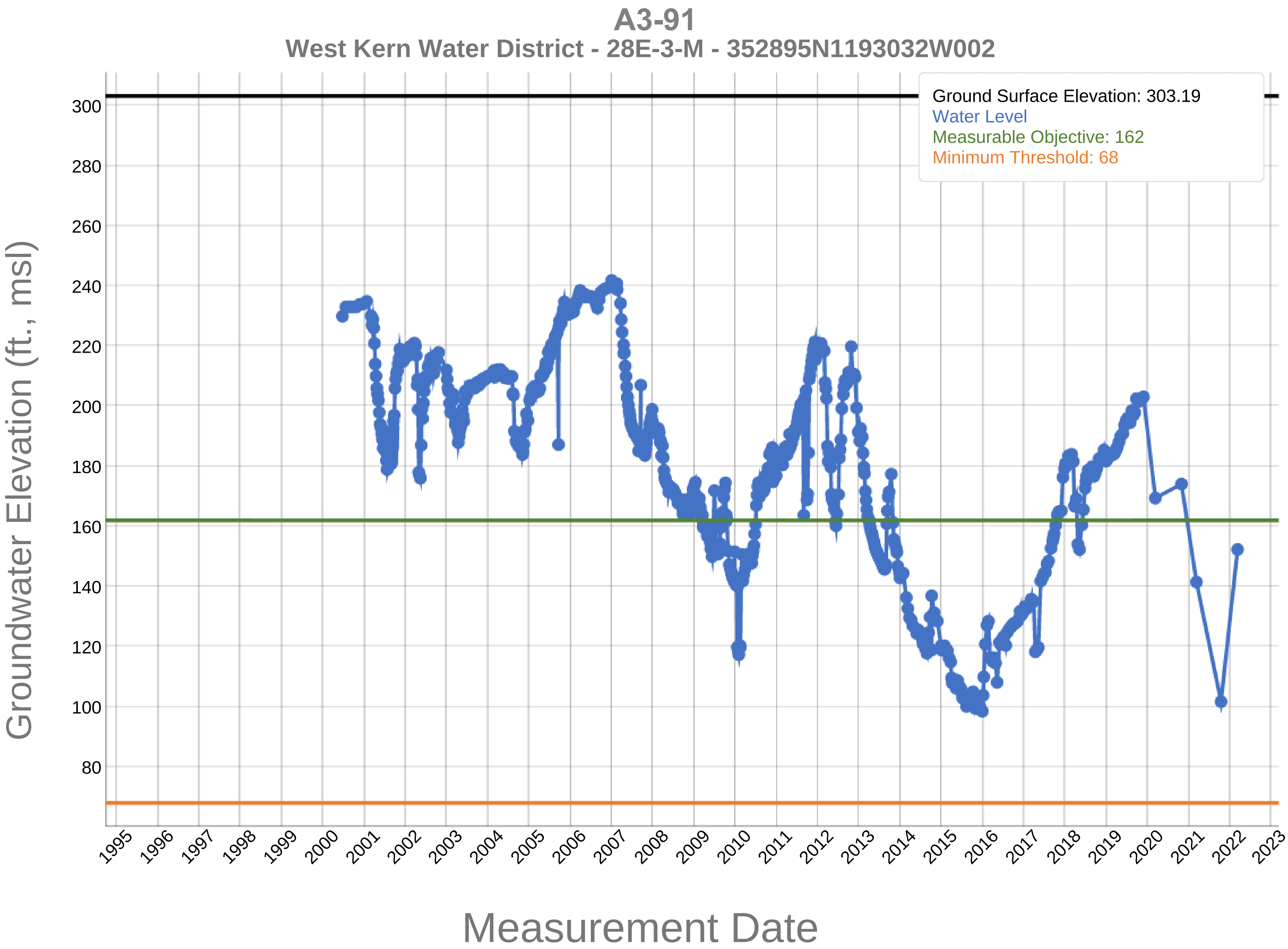
A3-91
West Kern Water District - 28E-3-M - 352895N1193032W002
Ground Surface Elevation: 303.19
Water Level
Measurable Objective: 162
Minimum Threshold: 68
Groundwater Elevation (ft., msl)
300
280
260
240
220
200
180
160
140
120
100
80
Measurement Date
1995
1996
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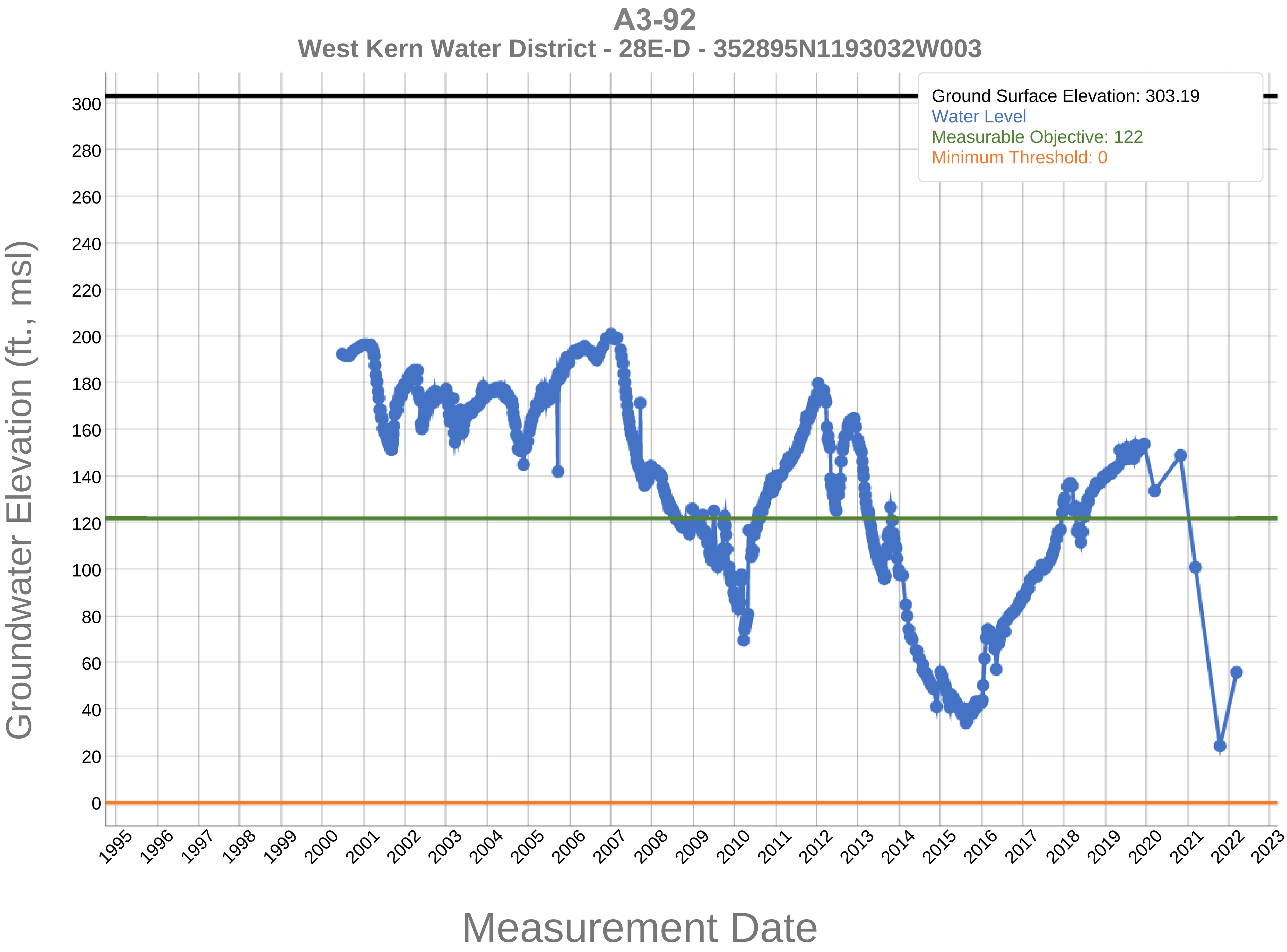

A3-92
West Kern Water District - 28E-D - 352895N1193032W003
Ground Surface Elevation: 303.19
Water Level
Measurable Objective: 122
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
300
280
260
240
220
200
180
160
140
120
100
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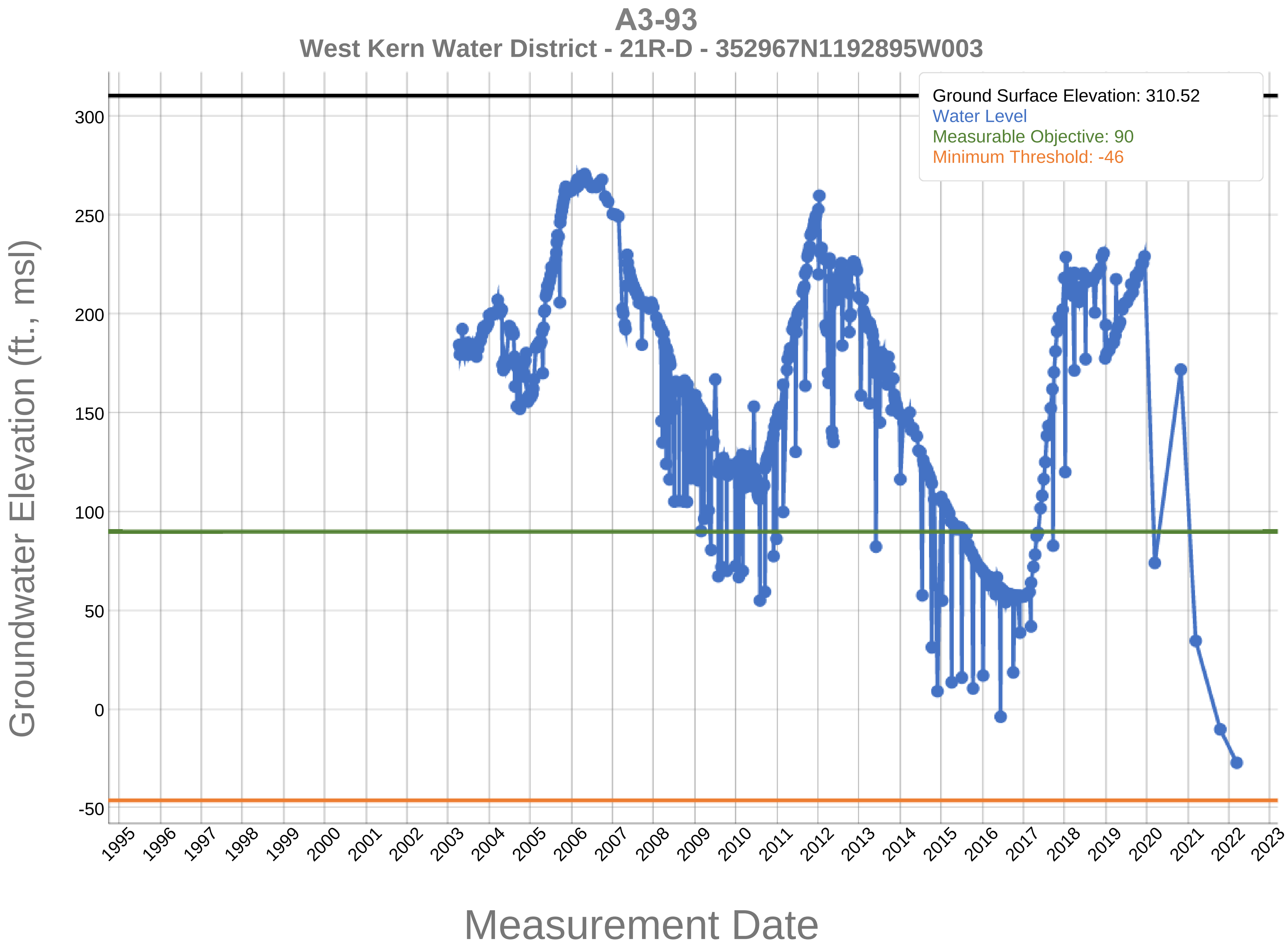
Measurement Date


A3-93
West Kern Water District - 21R-D - 352967N1192895W003
Ground Surface Elevation: 310.52
Water Level
Measurable Objective: 90
Minimum Threshold: -46
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
1996
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1999
2000
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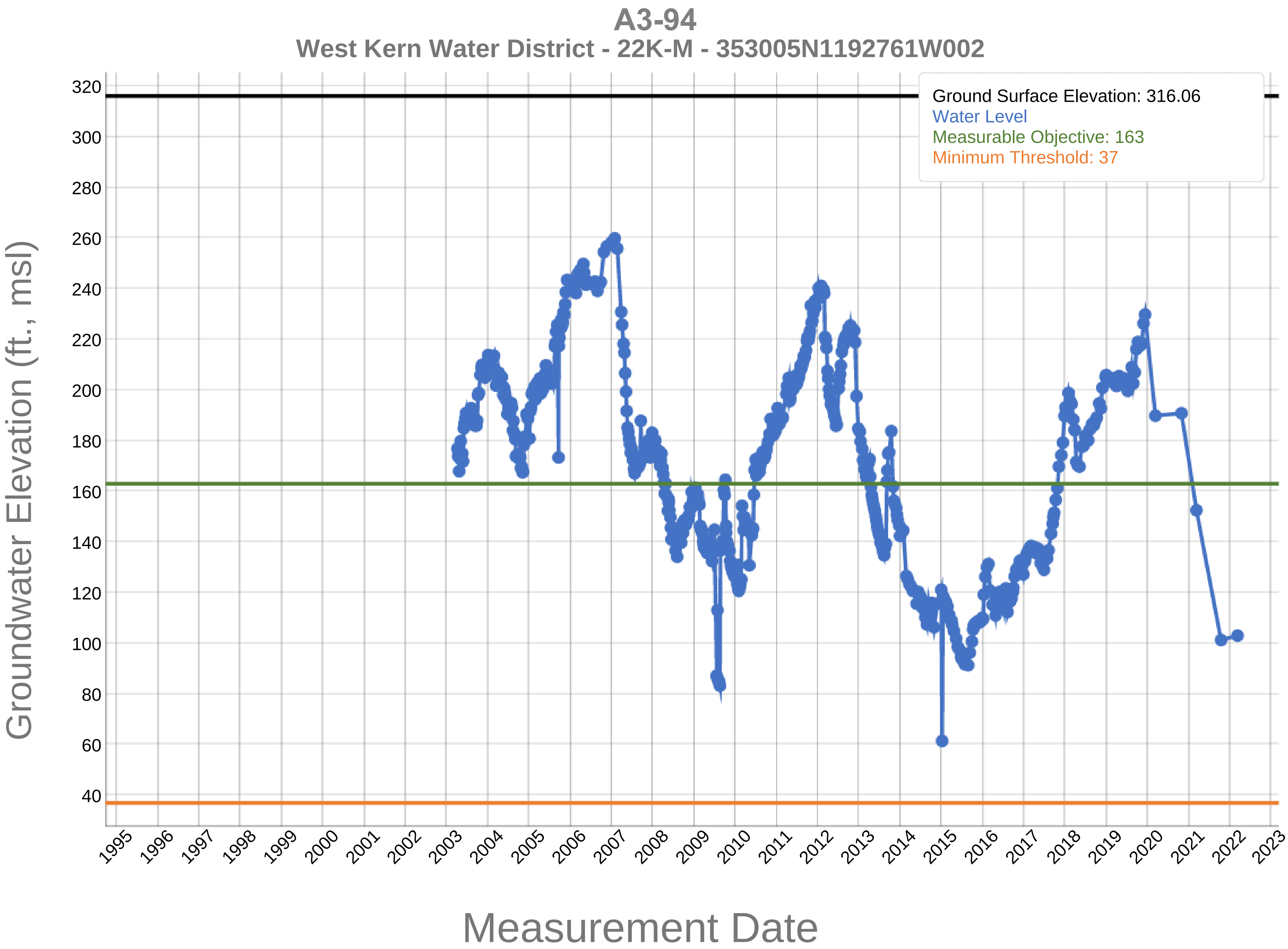
Measurement Date


A3-94
West Kern Water District - 22K-M - 353005N1192761W002
Ground Surface Elevation: 316.06
Water Level
Measurable Objective: 163
Minimum Threshold: 37
Groundwater Elevation (ft., msl)
Measurement Date
320
300
280
260
240
220
200
180
160
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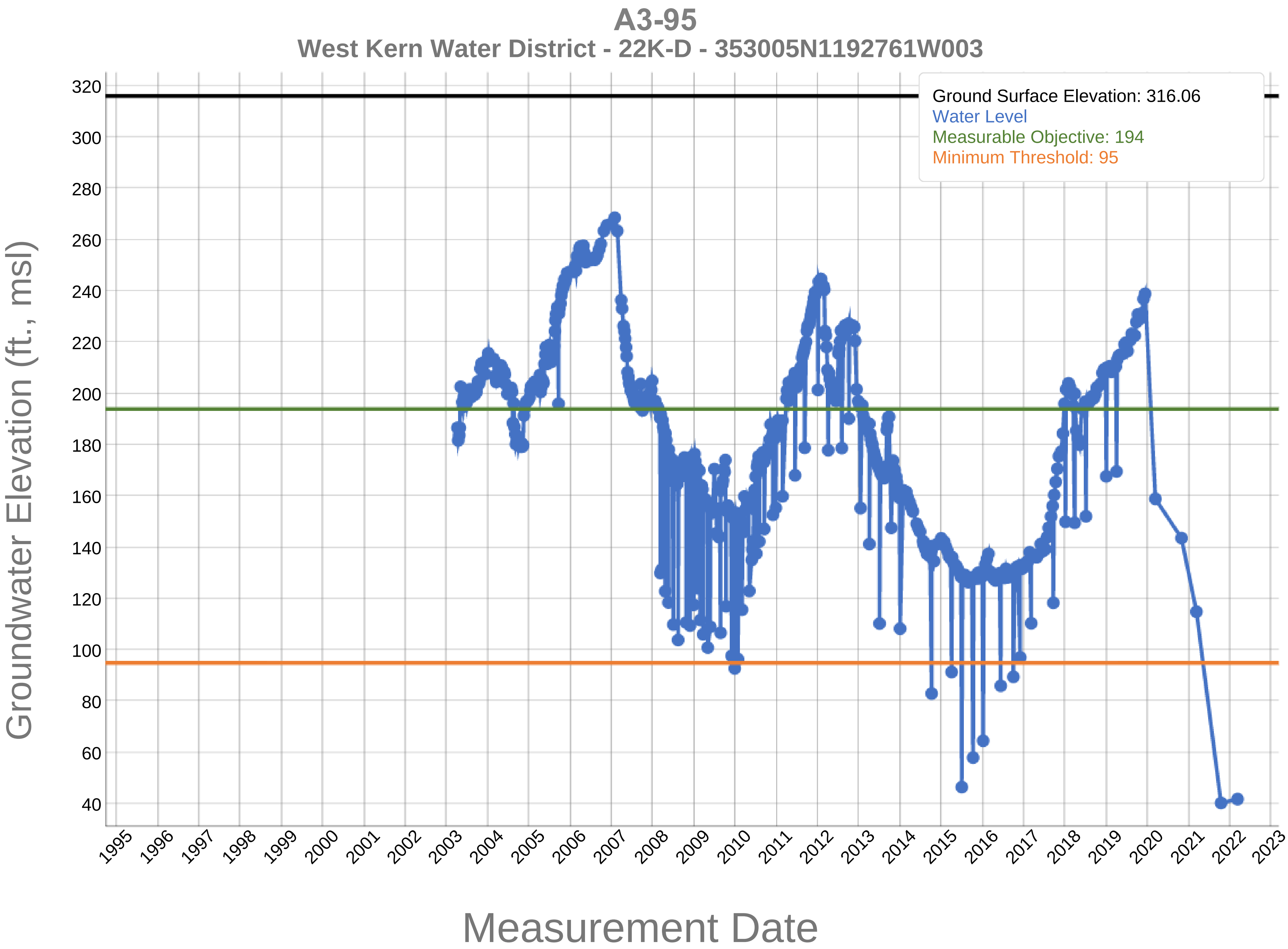

A3-95
West Kern Water District - 22K-D - 353005N1192761W003
Ground Surface Elevation: 316.06
Water Level
Measurable Objective: 194
Minimum Threshold: 95
Groundwater Elevation (ft., msl)
Measurement Date
320
300
280
260
240
220
200
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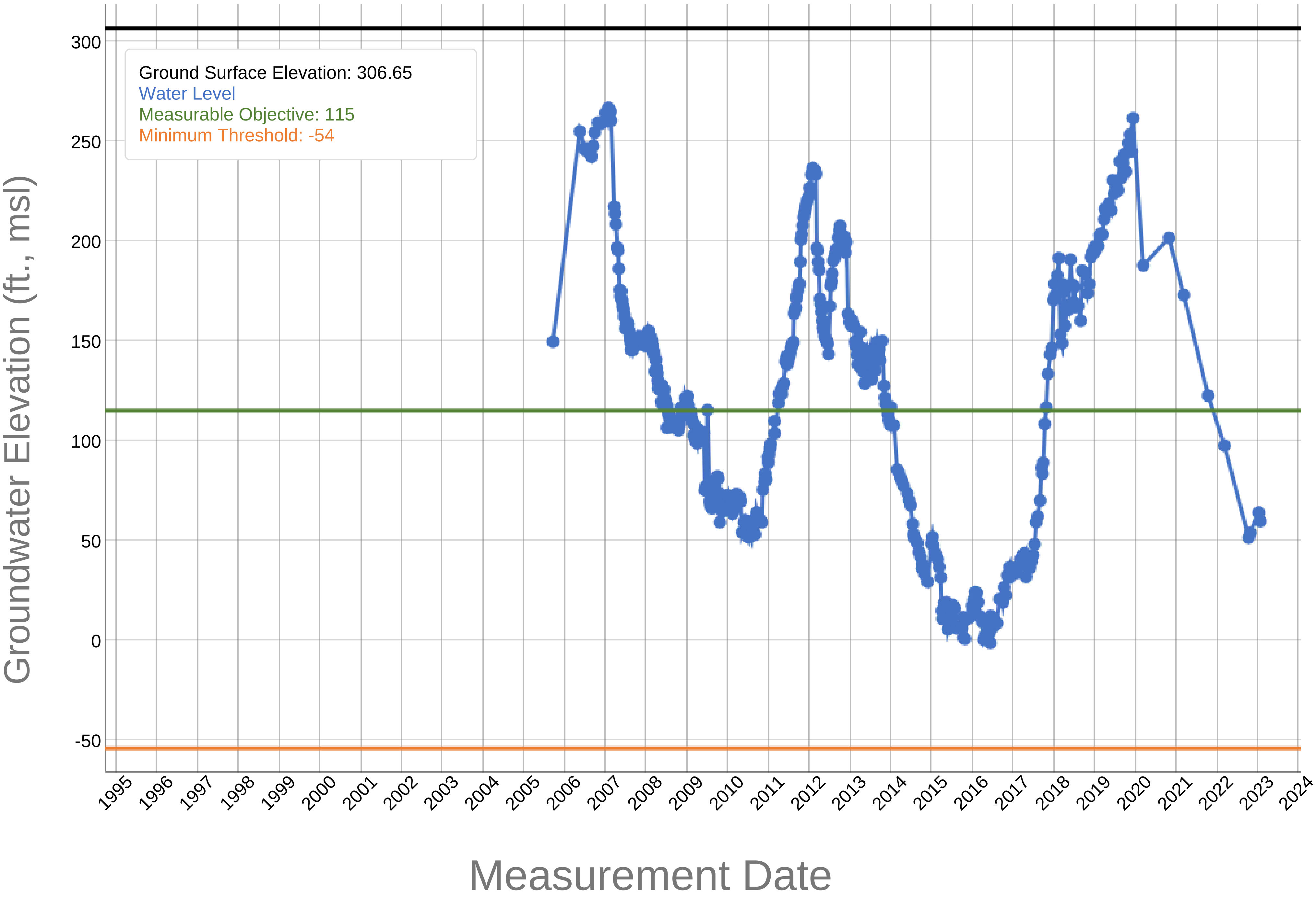
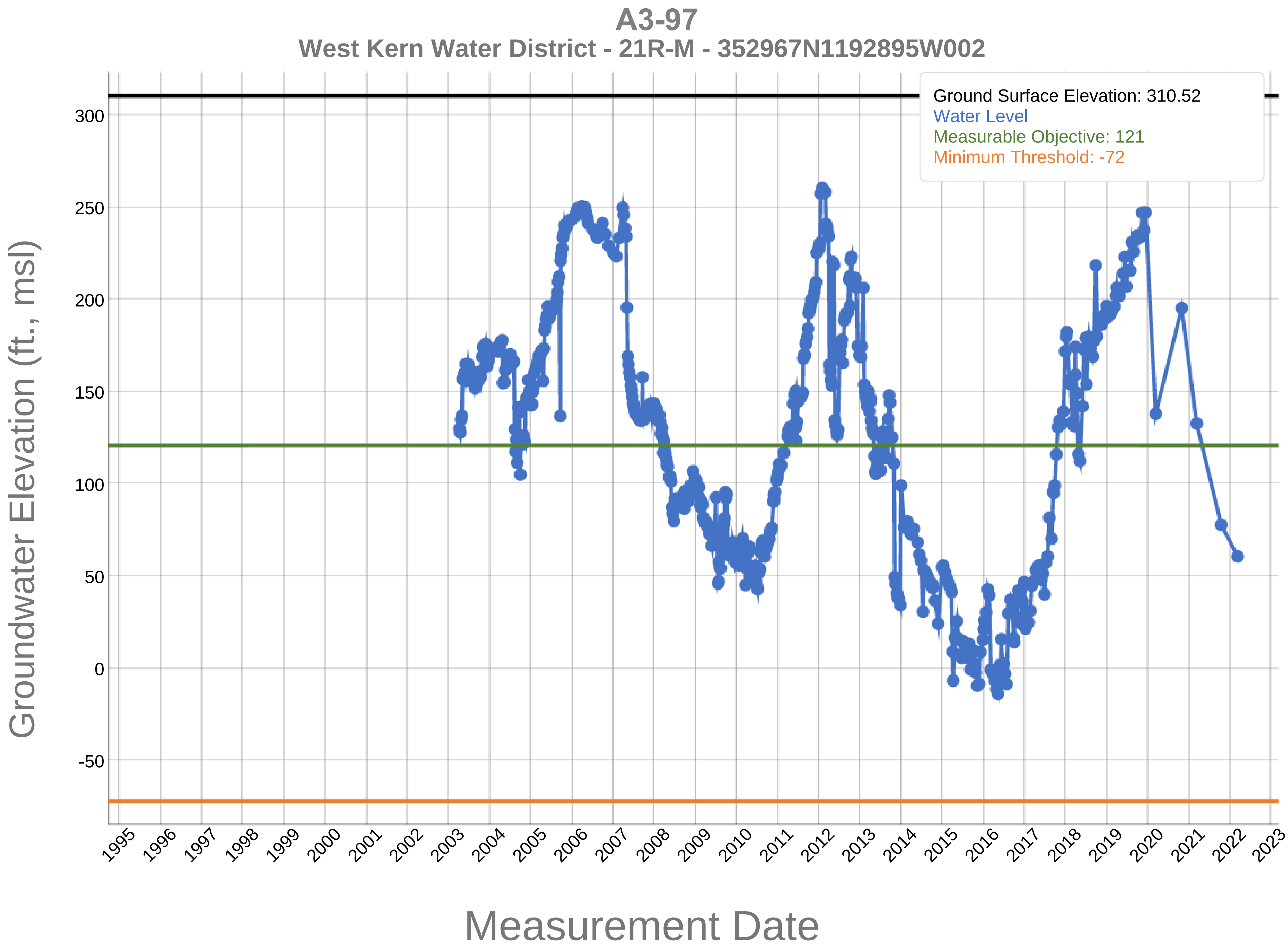
A3-96

West Kern Water District - 21L-M - 353020N1193011W002





A3-97
West Kern Water District - 21R-M - 352967N1192895W002
Ground Surface Elevation: 310.52
Water Level
Measurable Objective: 121
Minimum Threshold: -72
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
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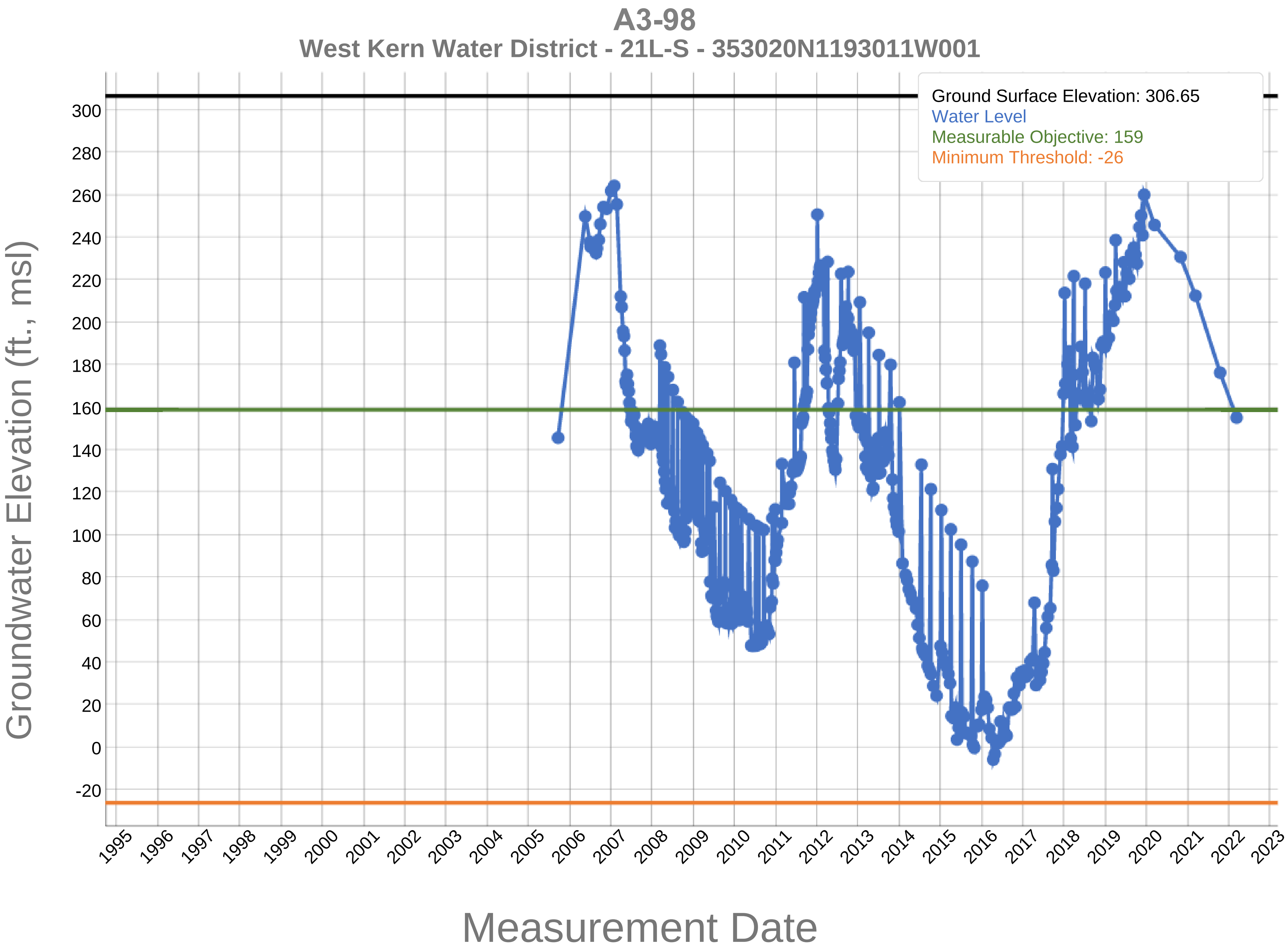
Measurement Date


A3-98
West Kern Water District - 21L-S - 353020N1193011W001
Ground Surface Elevation: 306.65
Water Level
Measurable Objective: 159
Minimum Threshold: -26
Groundwater Elevation (ft., msl)
-20
0
20
40
60
80
100
120
140
160
180
200
220
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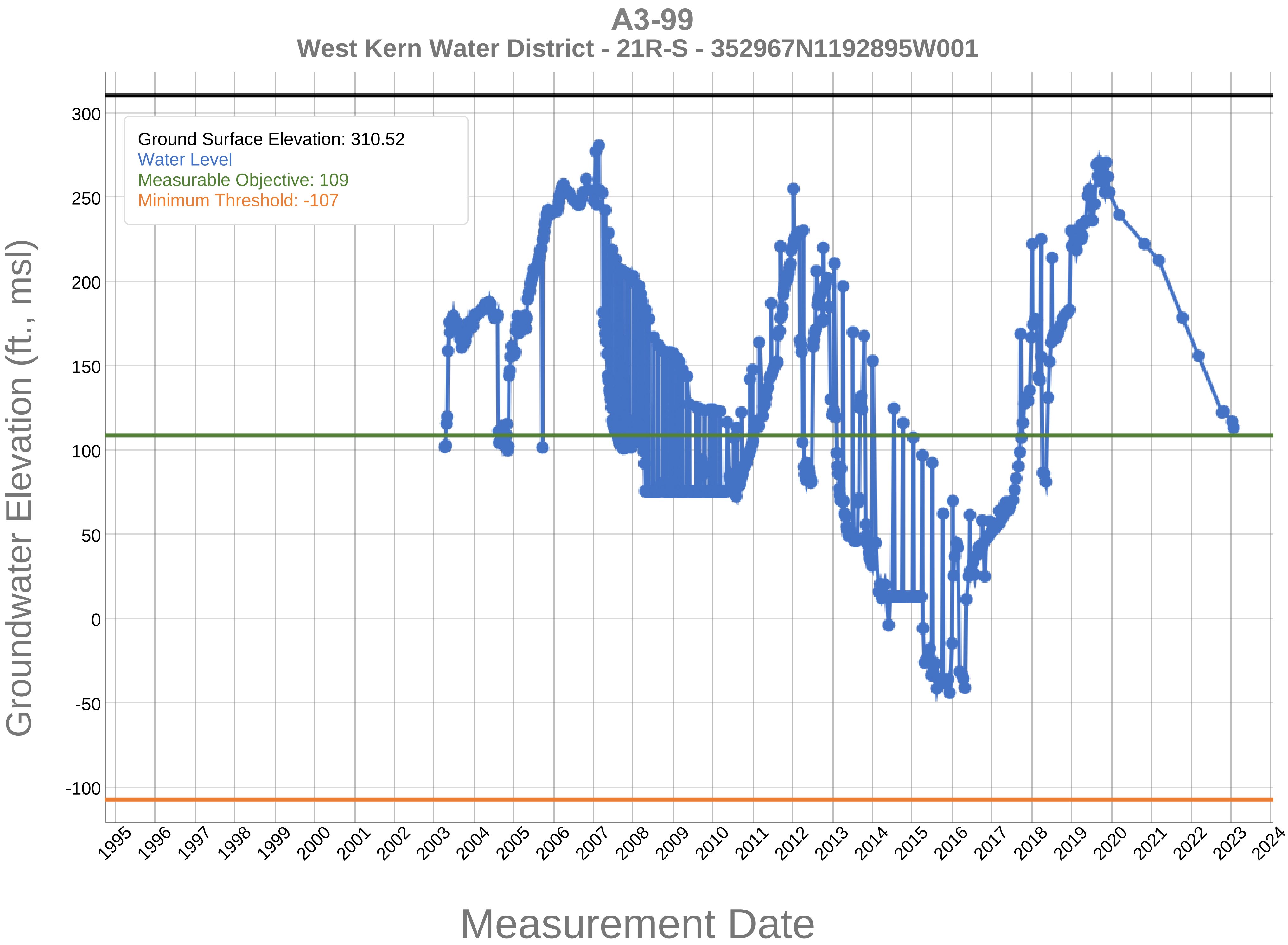
Measurement Date



A3-99
West Kern Water District - 21R-S - 352967N1192895W001
Ground Surface Elevation: 310.52
Water Level
Measurable Objective: 109
Minimum Threshold: -107
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
1995
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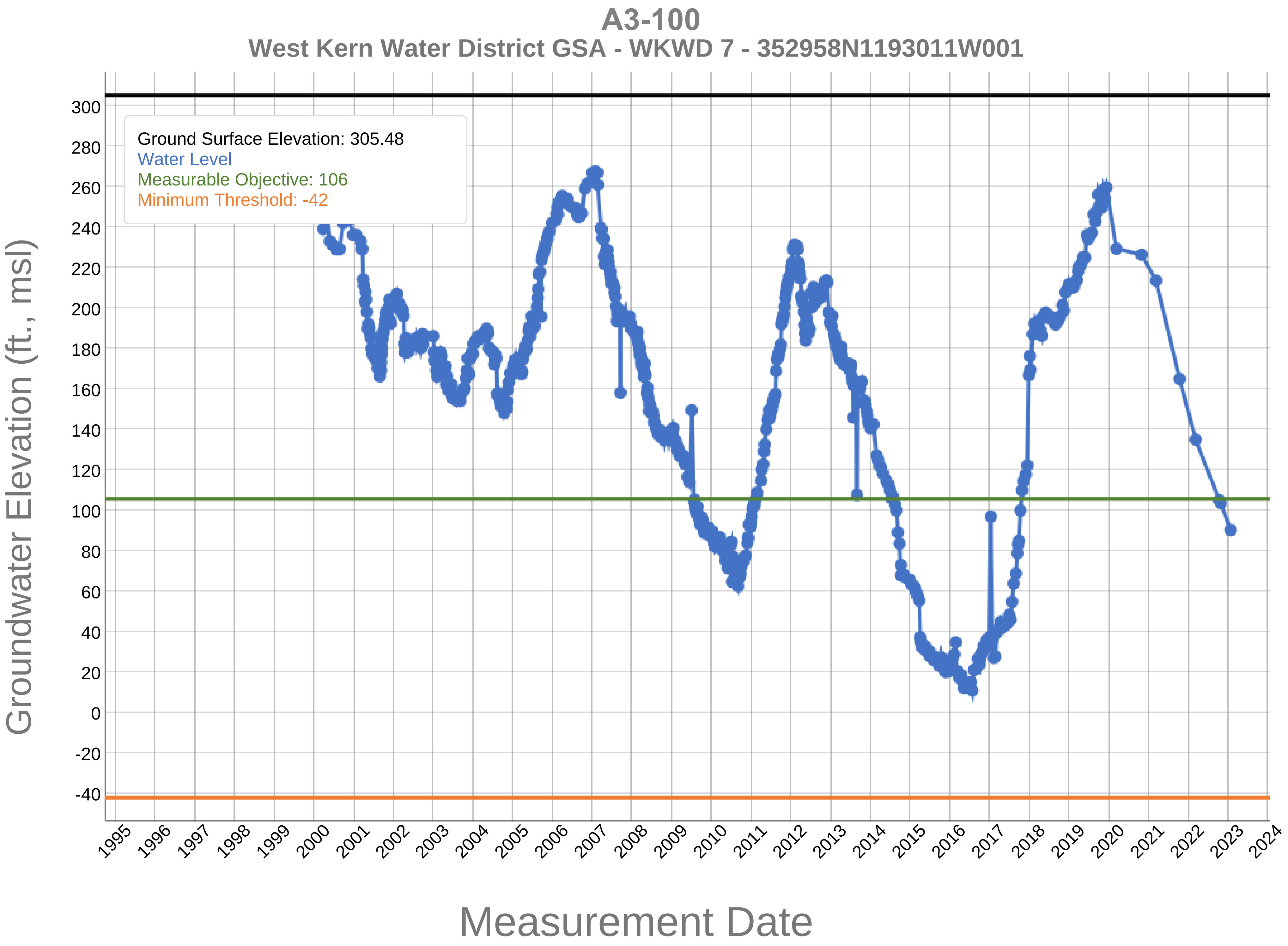
Measurement Date



A3-100
West Kern Water District GSA - WKWD 7 - 352958N1193011W001
Ground Surface Elevation: 305.48
Water Level
Measurable Objective: 106
Minimum Threshold: -42
Groundwater Elevation (ft., msl)
300
280
260
240
220
200
180
160
140
120
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60
40
20
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-20
-40
1995
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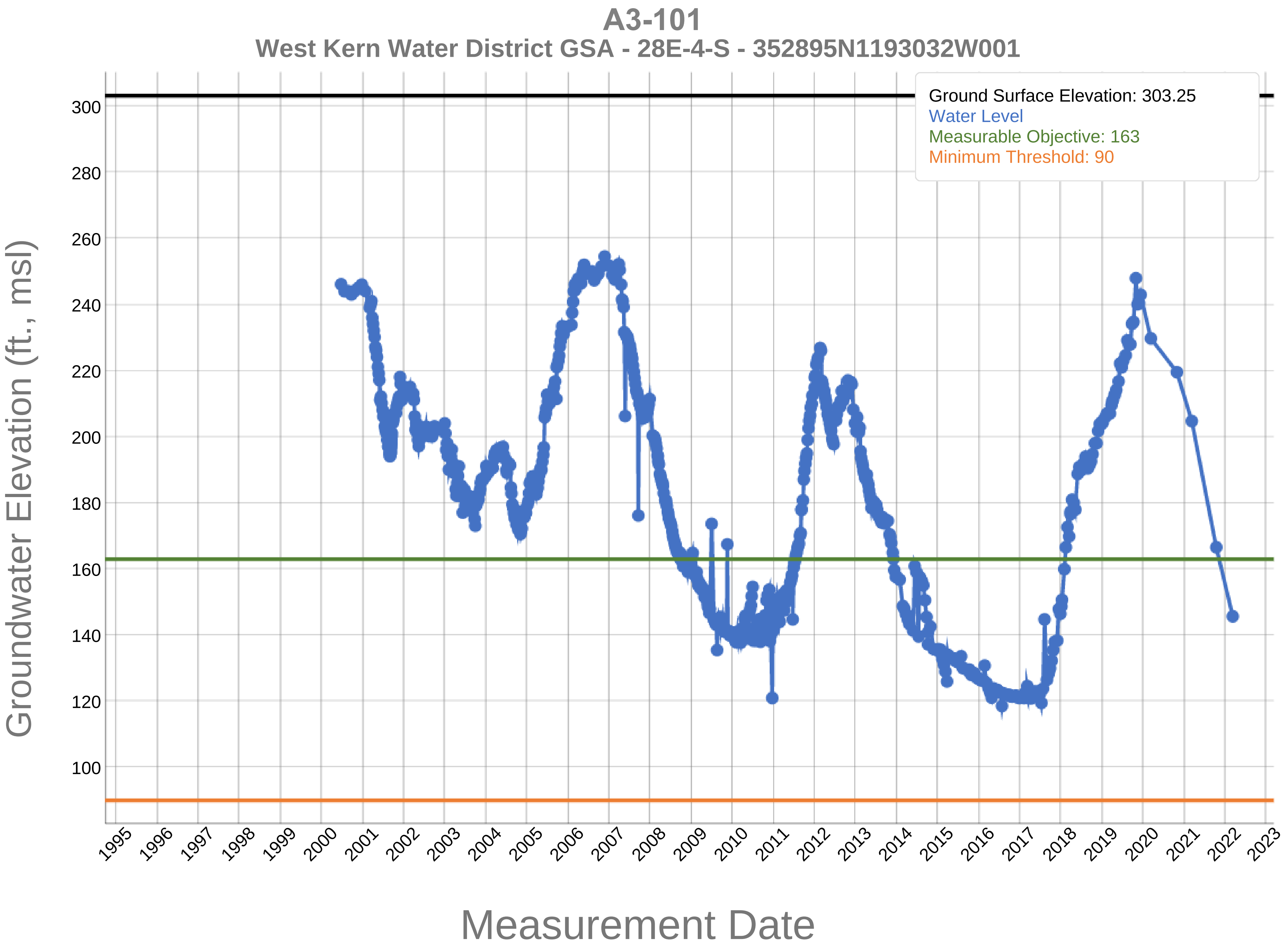
Measurement Date


A3-101
West Kern Water District GSA - 28E-4-S - 352895N1193032W001
Ground Surface Elevation: 303.25
Water Level
Measurable Objective: 163
Minimum Threshold: 90
Groundwater Elevation (ft., msl)
300
280
260
240
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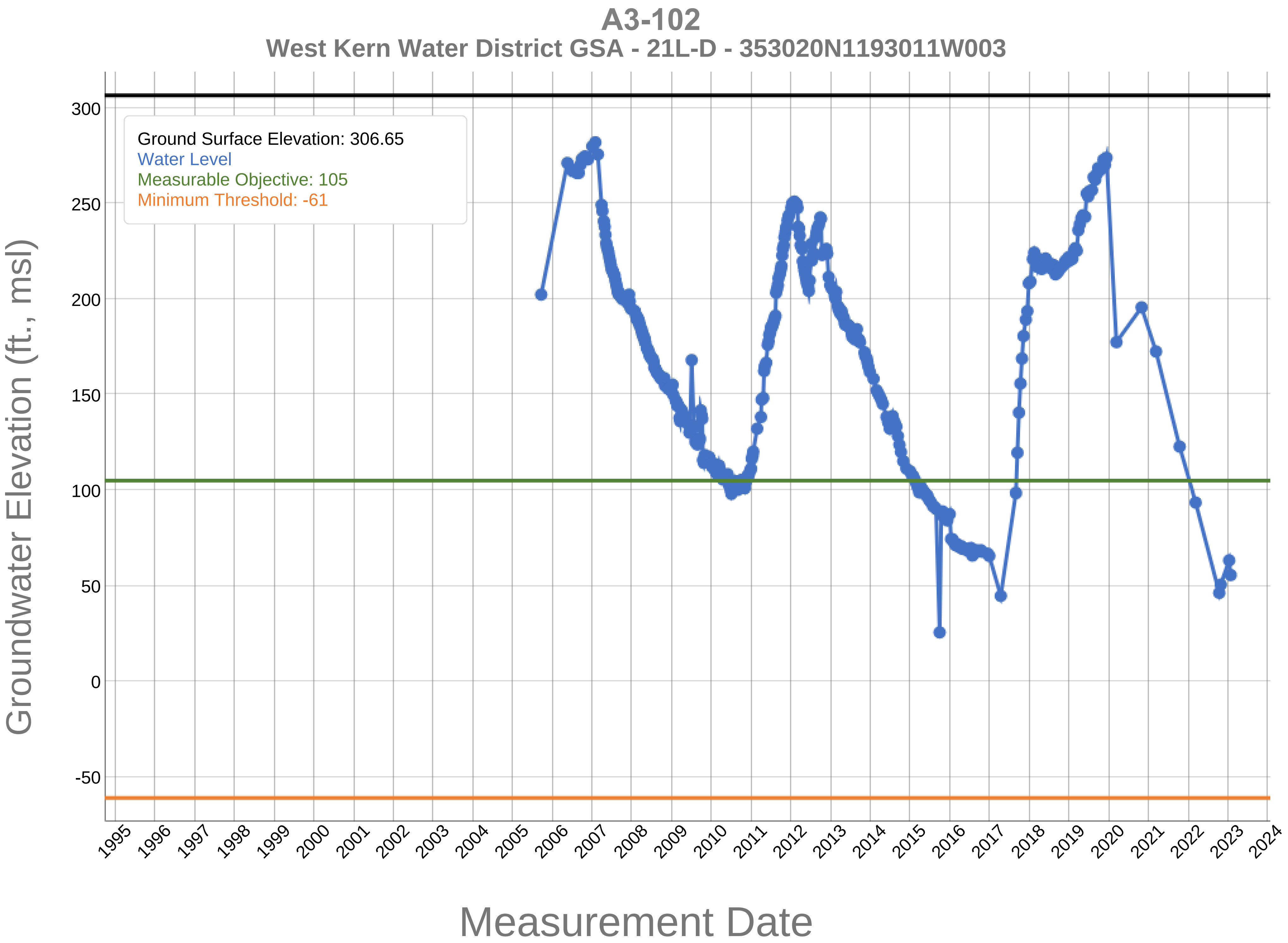
Measurement Date



A3-102
West Kern Water District GSA - 21L-D - 353020N1193011W003
Ground Surface Elevation: 306.65
Water Level
Measurable Objective: 105
Minimum Threshold: -61
Groundwater Elevation (ft., msl)
300
250
200
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100
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-50
1995
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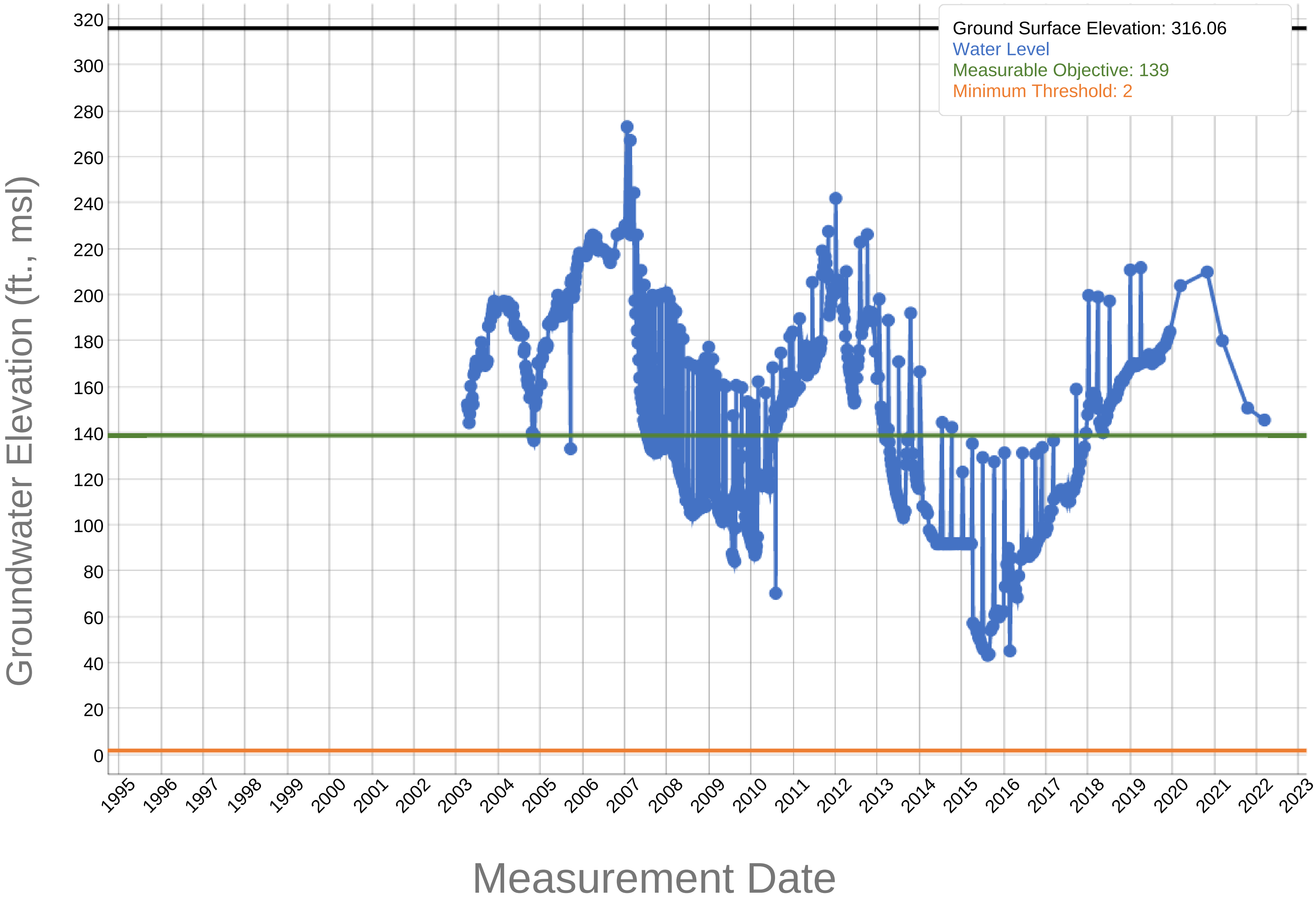
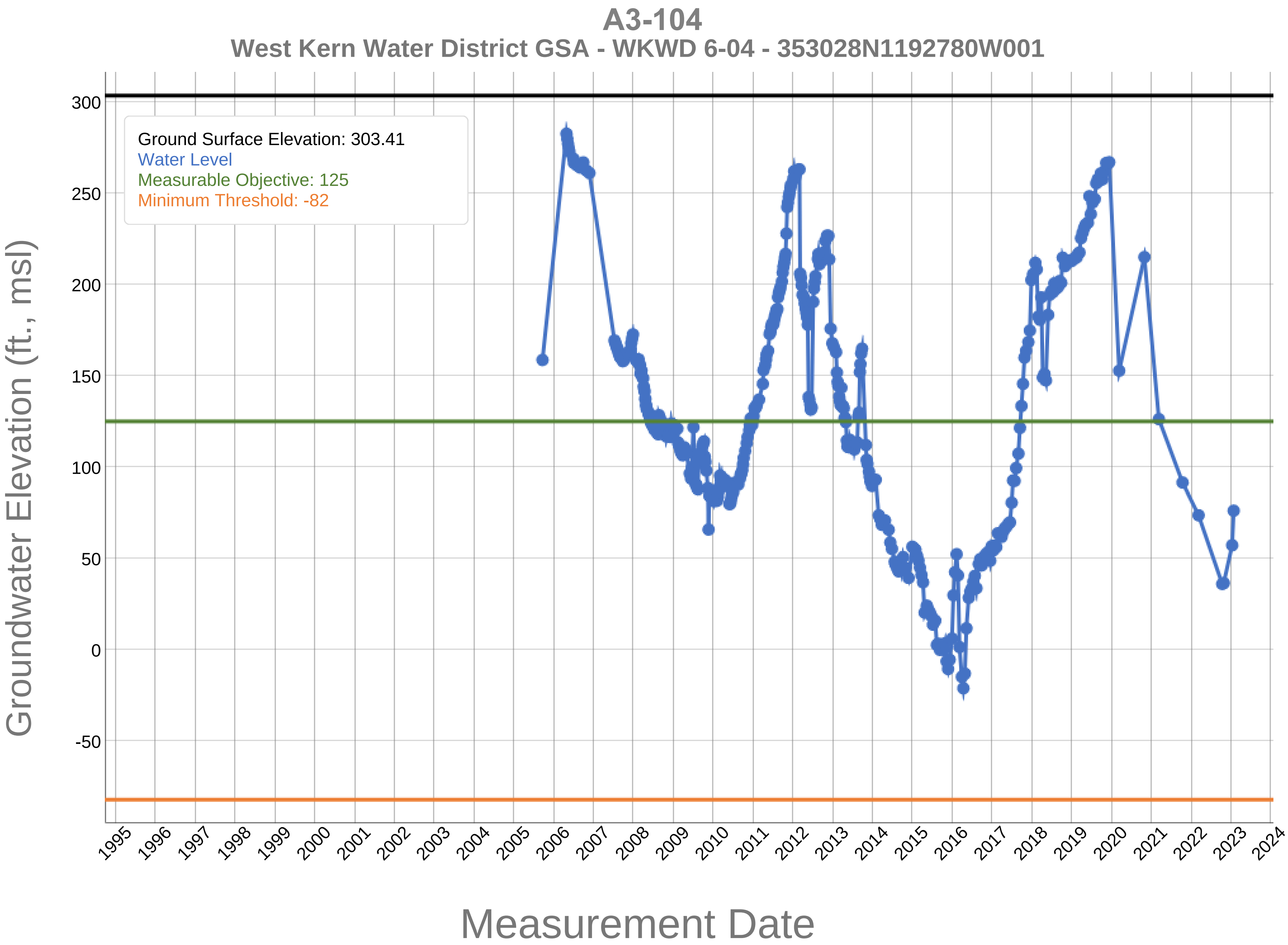
Measurement Date

A3-103

West Kern Water District GSA - 22K-S - 353005N1192761W001




A3-104
West Kern Water District GSA - WKWD 6-04 - 353028N1192780W001
Ground Surface Elevation: 303.41
Water Level
Measurable Objective: 125
Minimum Threshold: -82
Groundwater Elevation (ft., msl)
Measurement Date
300
250
200
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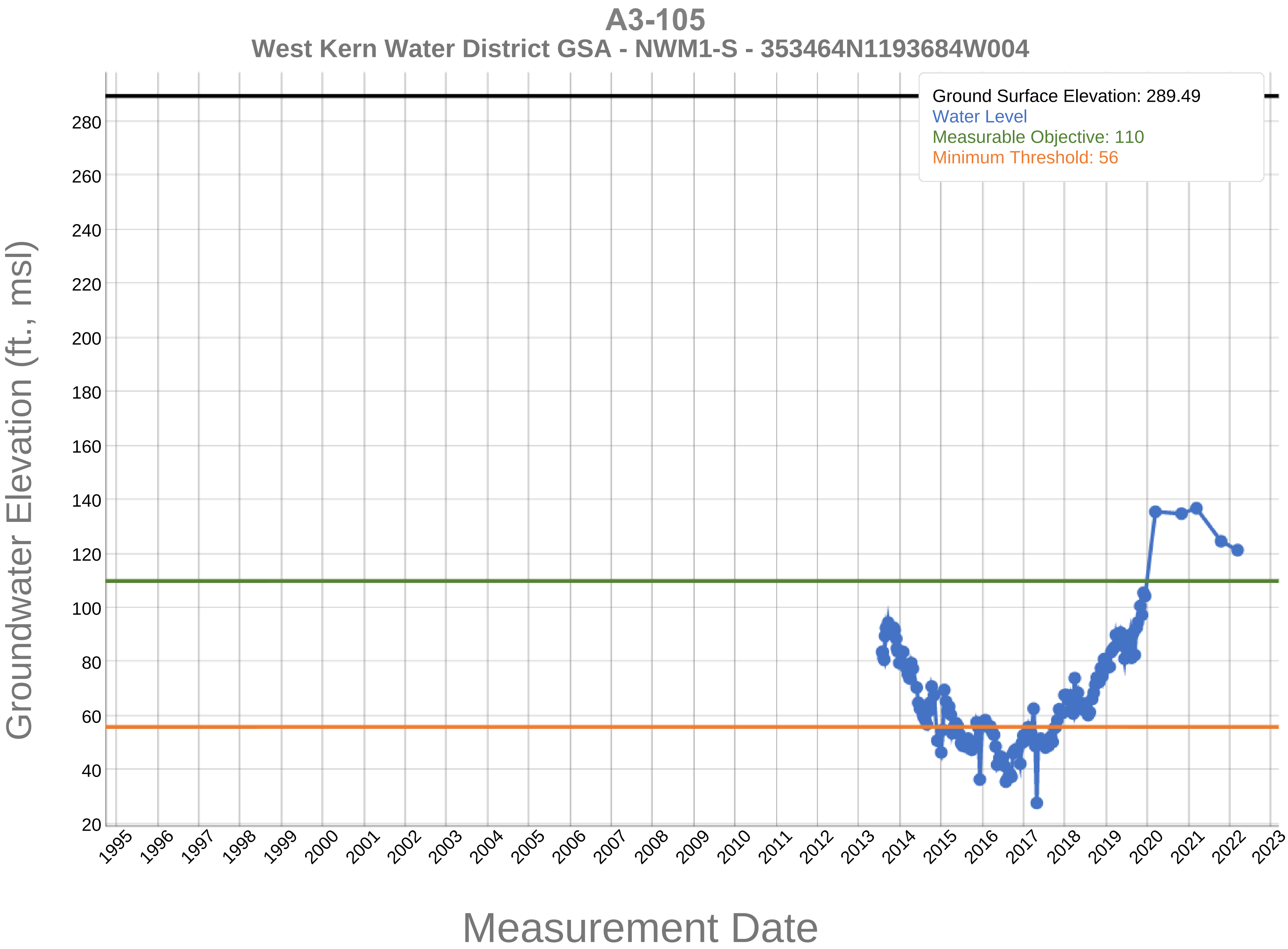
A3-105
West Kern Water District GSA - NWM1-S - 353464N1193684W004
Ground Surface Elevation: 289.49
Water Level
Measurable Objective: 110
Minimum Threshold: 56
Groundwater Elevation (ft., msl)
Measurement Date
280
260
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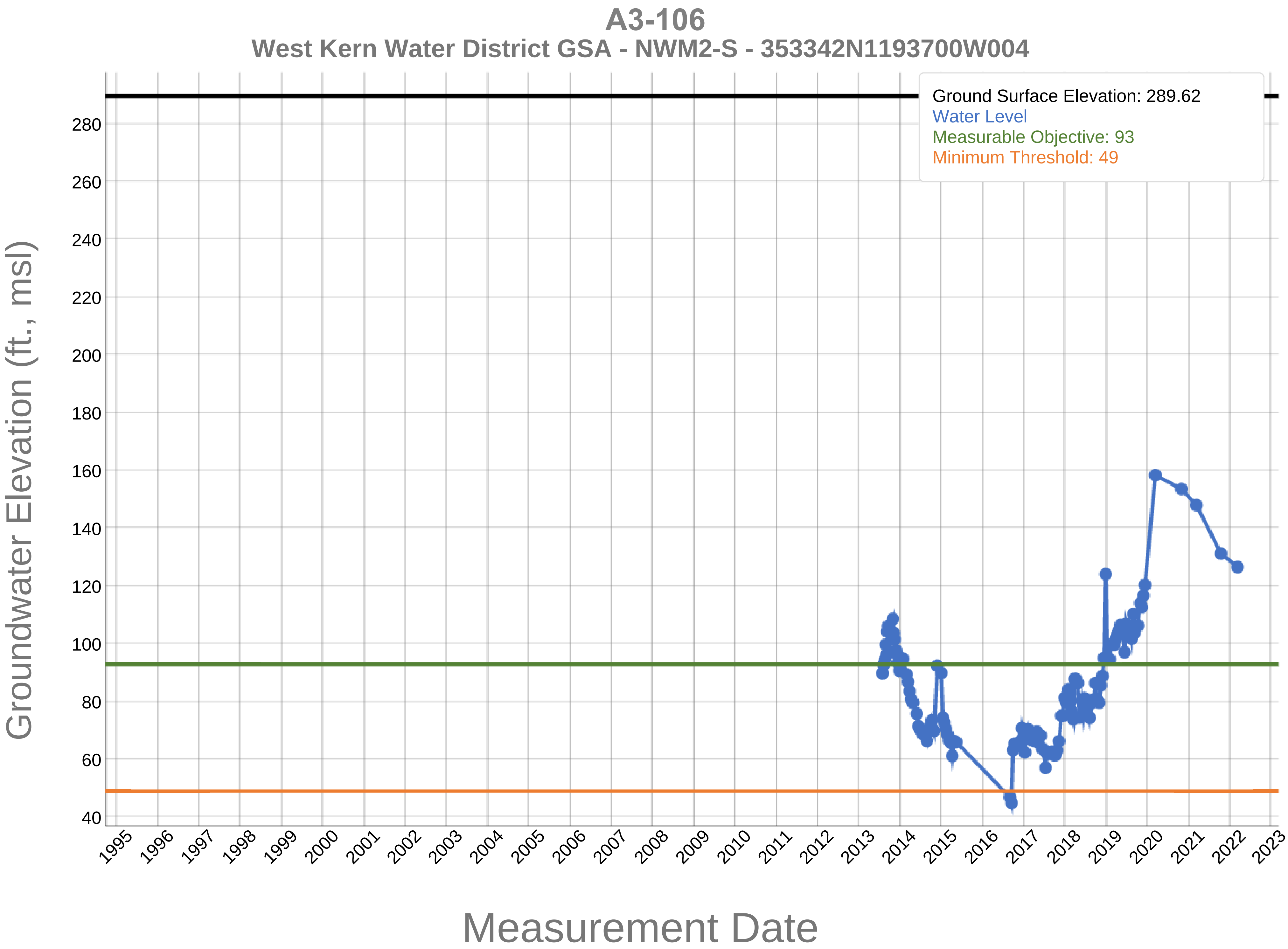
A3-106
West Kern Water District GSA - NWM2-S - 353342N1193700W004
Ground Surface Elevation: 289.62
Water Level
Measurable Objective: 93
Minimum Threshold: 49
Groundwater Elevation (ft., msl)
Measurement Date
280
260
240
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200
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1995
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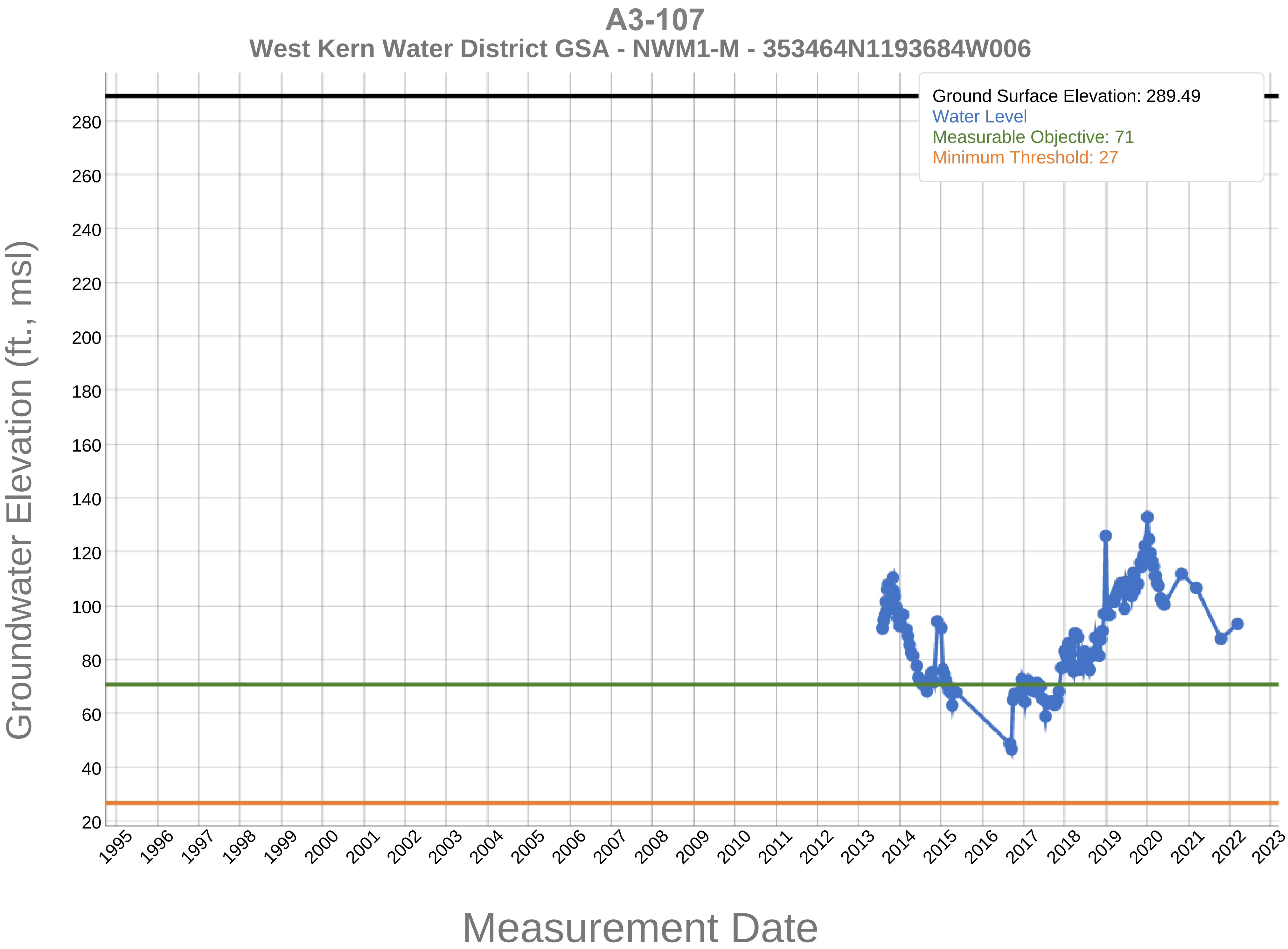
A3-107
West Kern Water District GSA - NWM1-M - 353464N1193684W006
Ground Surface Elevation: 289.49
Water Level
Measurable Objective: 71
Minimum Threshold: 27
Groundwater Elevation (ft., msl)
Measurement Date
20
40
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100
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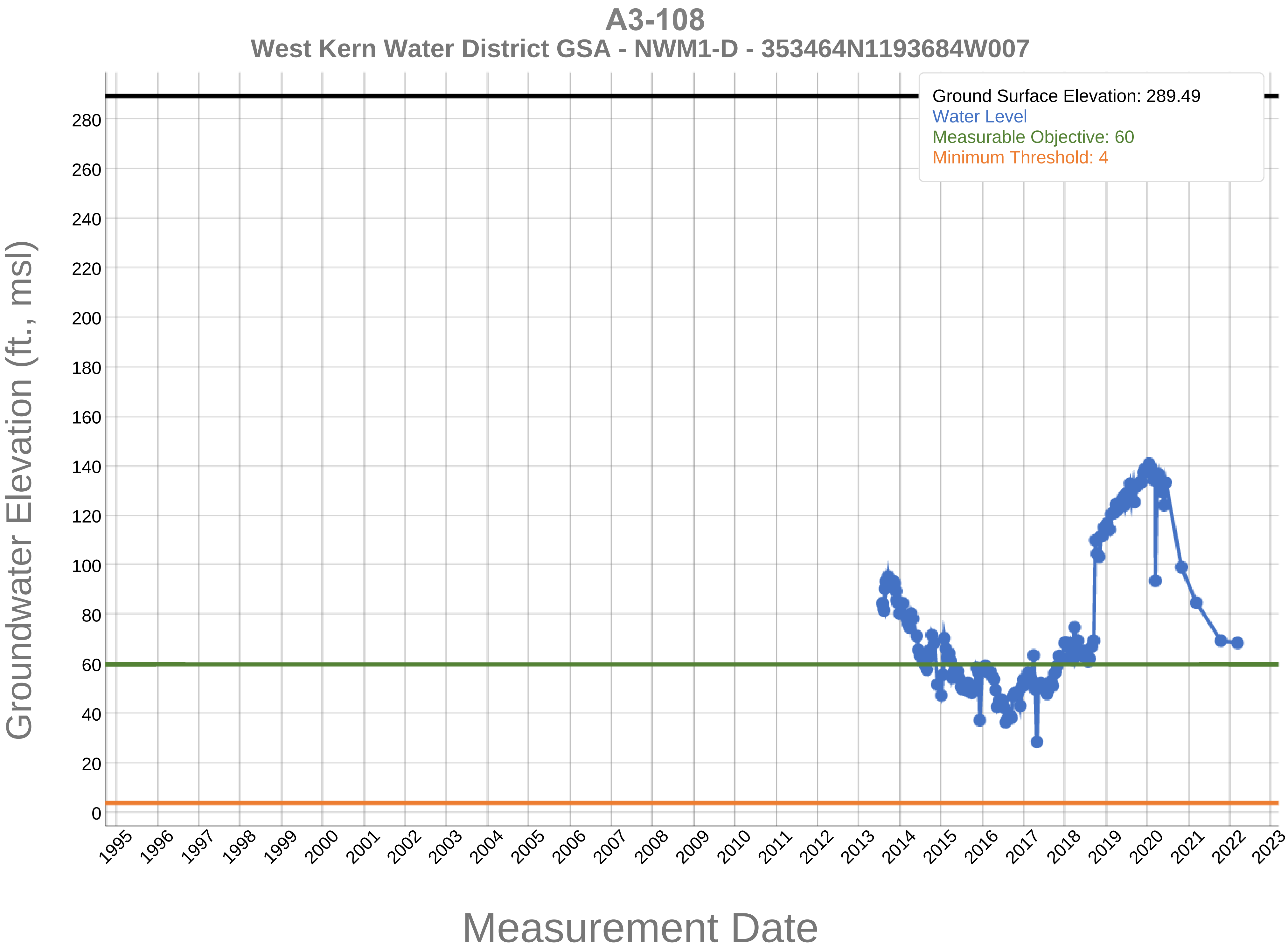
A3-108
West Kern Water District GSA - NWM1-D - 353464N1193684W007
Ground Surface Elevation: 289.49
Water Level
Measurable Objective: 60
Minimum Threshold: 4
Groundwater Elevation (ft., msl)
Measurement Date
0
20
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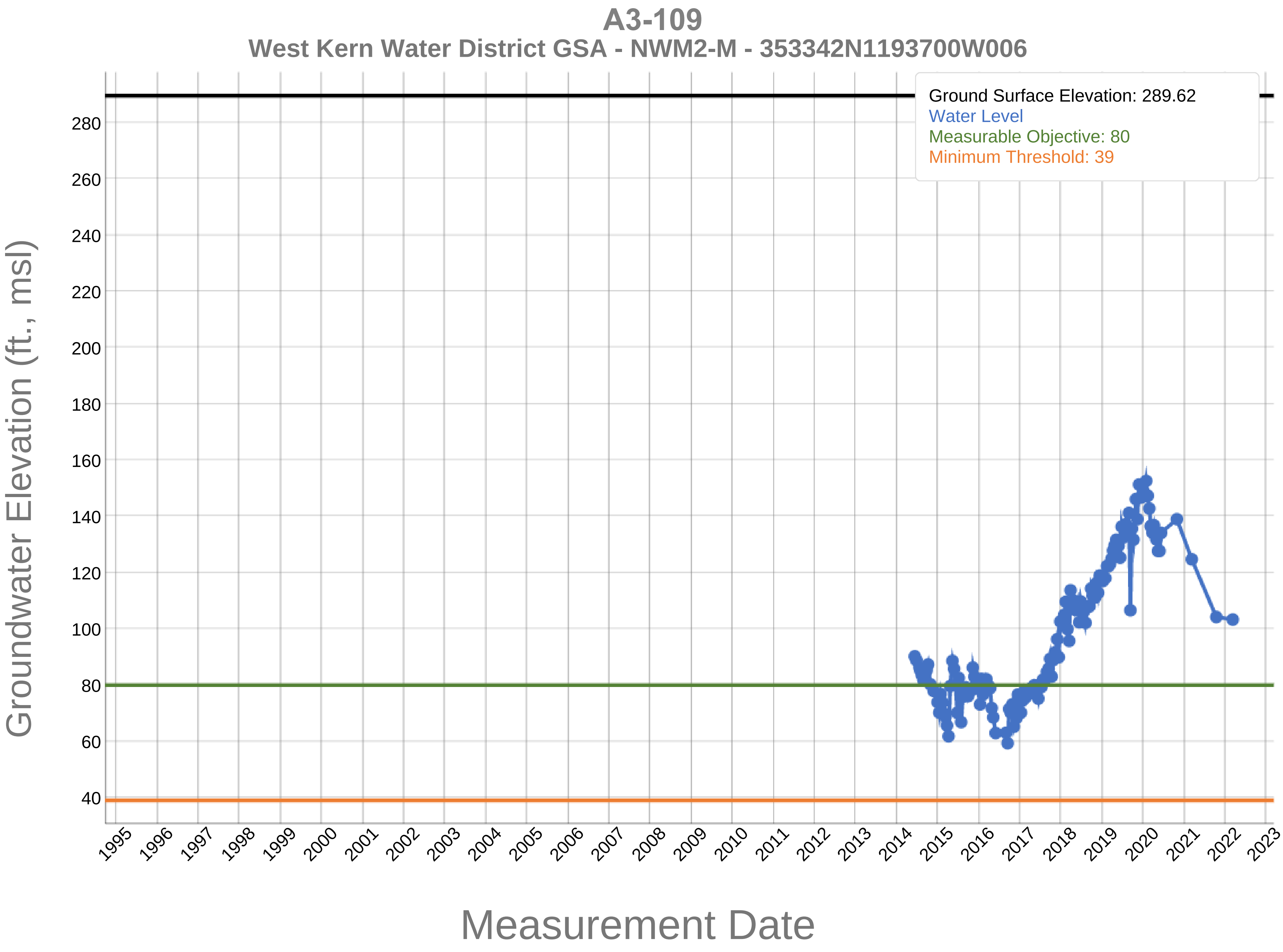

A3-109
West Kern Water District GSA - NWM2-M - 353342N1193700W006
Ground Surface Elevation: 289.62
Water Level
Measurable Objective: 80
Minimum Threshold: 39
Groundwater Elevation (ft., msl)
280
260
240
220
200
180
160
140
120
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1995
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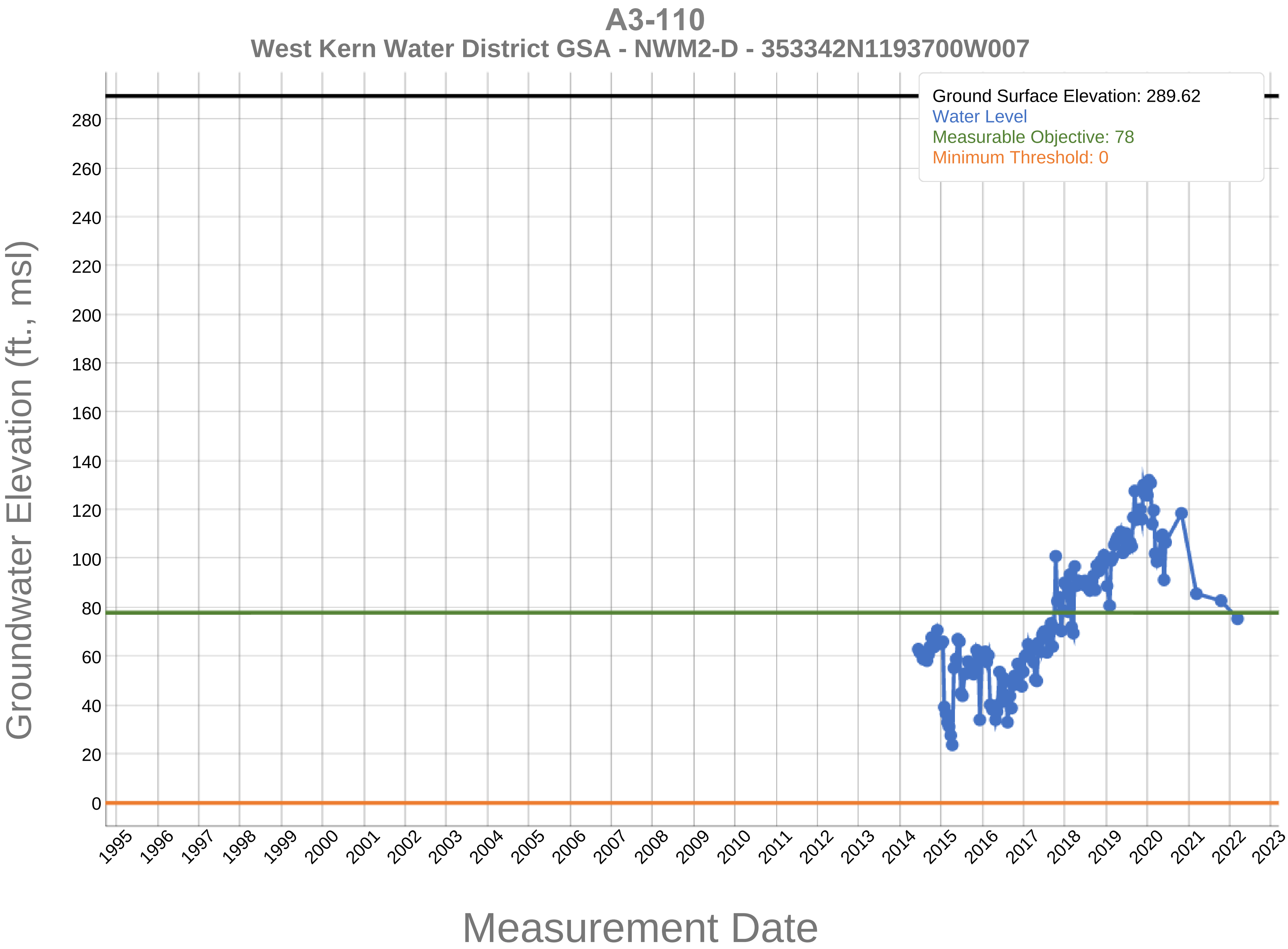
Measurement Date



A3-110
West Kern Water District GSA - NWM2-D - 353342N1193700W007
Ground Surface Elevation: 289.62
Water Level
Measurable Objective: 78
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
280
260
240
220
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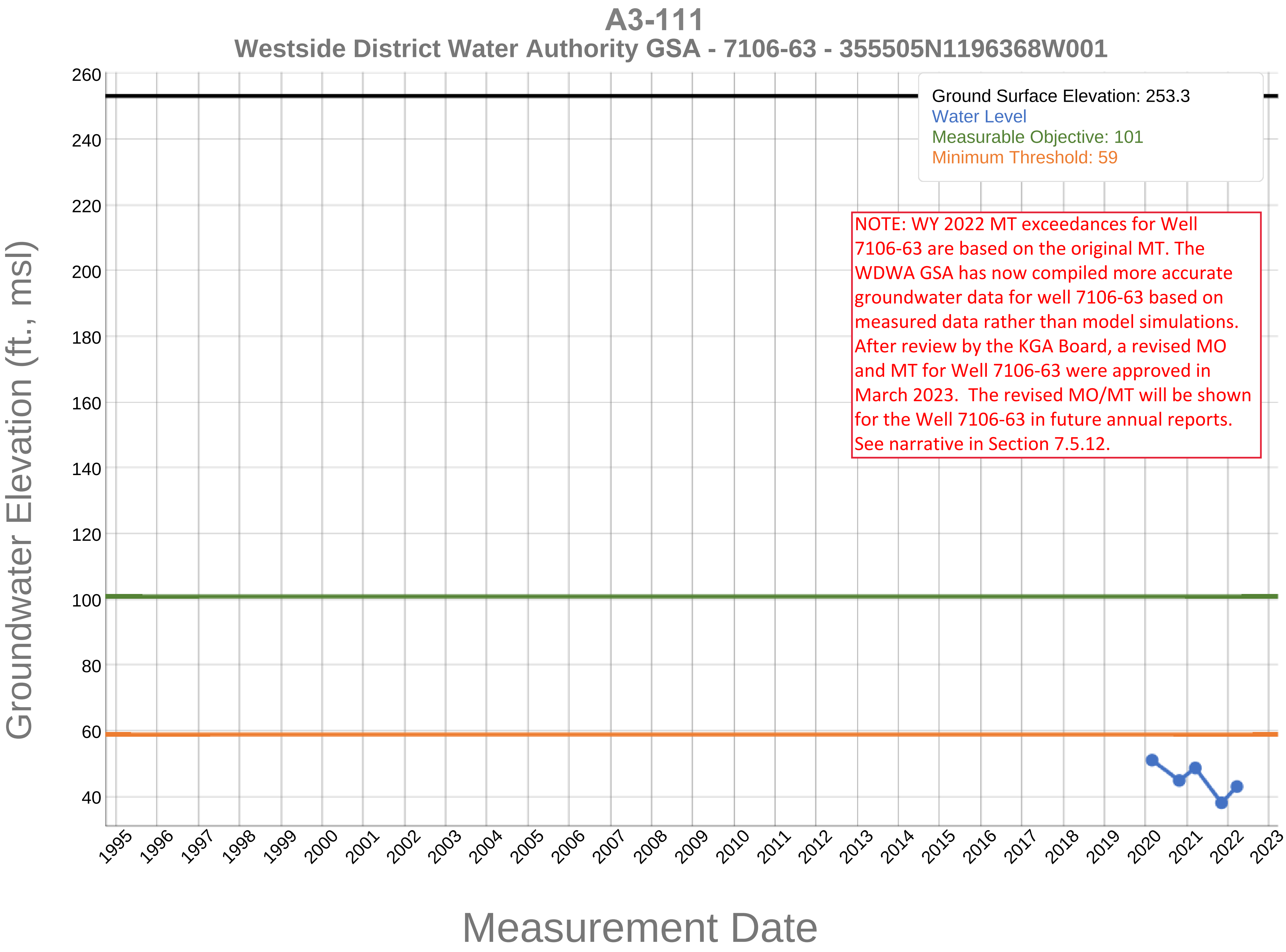
Measurement Date



A3-111
Westside District Water Authority GSA - 7106-63 - 355505N1196368W001
Ground Surface Elevation: 253.3
Water Level
Measurable Objective: 101
Minimum Threshold: 59
NOTE: WY 2022 MT exceedances for Well 7106-63 are based on the original MT. The WDWA GSA has now compiled more accurate groundwater data for well 7106-63 based on measured data rather than model simulations. After review by the KGA Board, a revised MO and MT for Well 7106-63 were approved in March 2023. The revised MO/MT will be shown for the Well 7106-63 in future annual reports. See narrative in Section 7.5.12.
Groundwater Elevation (ft., msl)
260
240
220
200
180
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140
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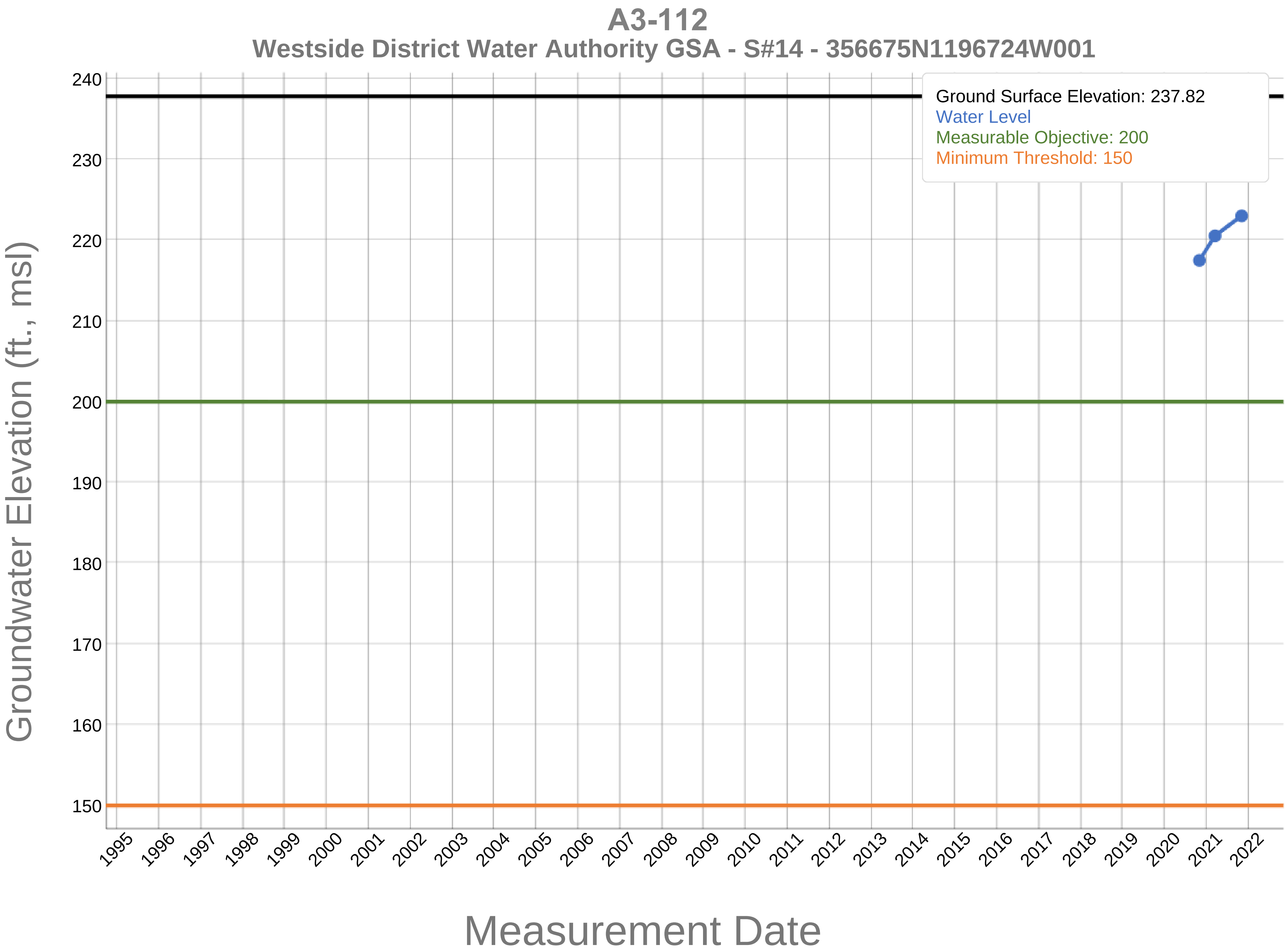
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Measurement Date



A3-112
Westside District Water Authority GSA - S#14 - 356675N1196724W001
Ground Surface Elevation: 237.82
Water Level
Measurable Objective: 200
Minimum Threshold: 150
Groundwater Elevation (ft., msl)
240
230
220
210
200
190
180
170
160
150
1995
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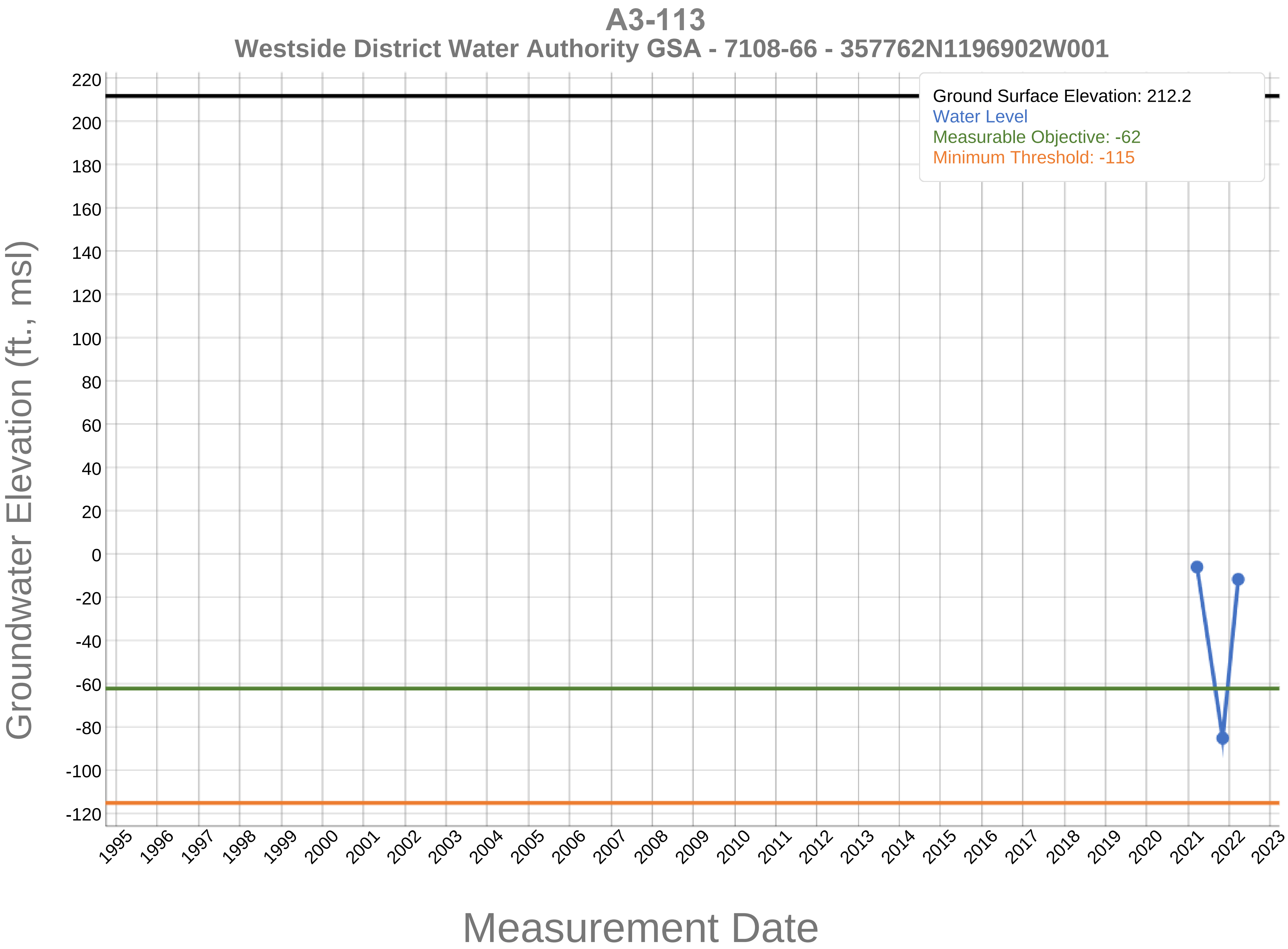
Measurement Date


A3-113
Westside District Water Authority GSA - 7108-66 - 357762N1196902W001
Ground Surface Elevation: 212.2
Water Level
Measurable Objective: -62
Minimum Threshold: -115
Groundwater Elevation (ft., msl)
220
200
180
160
140
120
100
80
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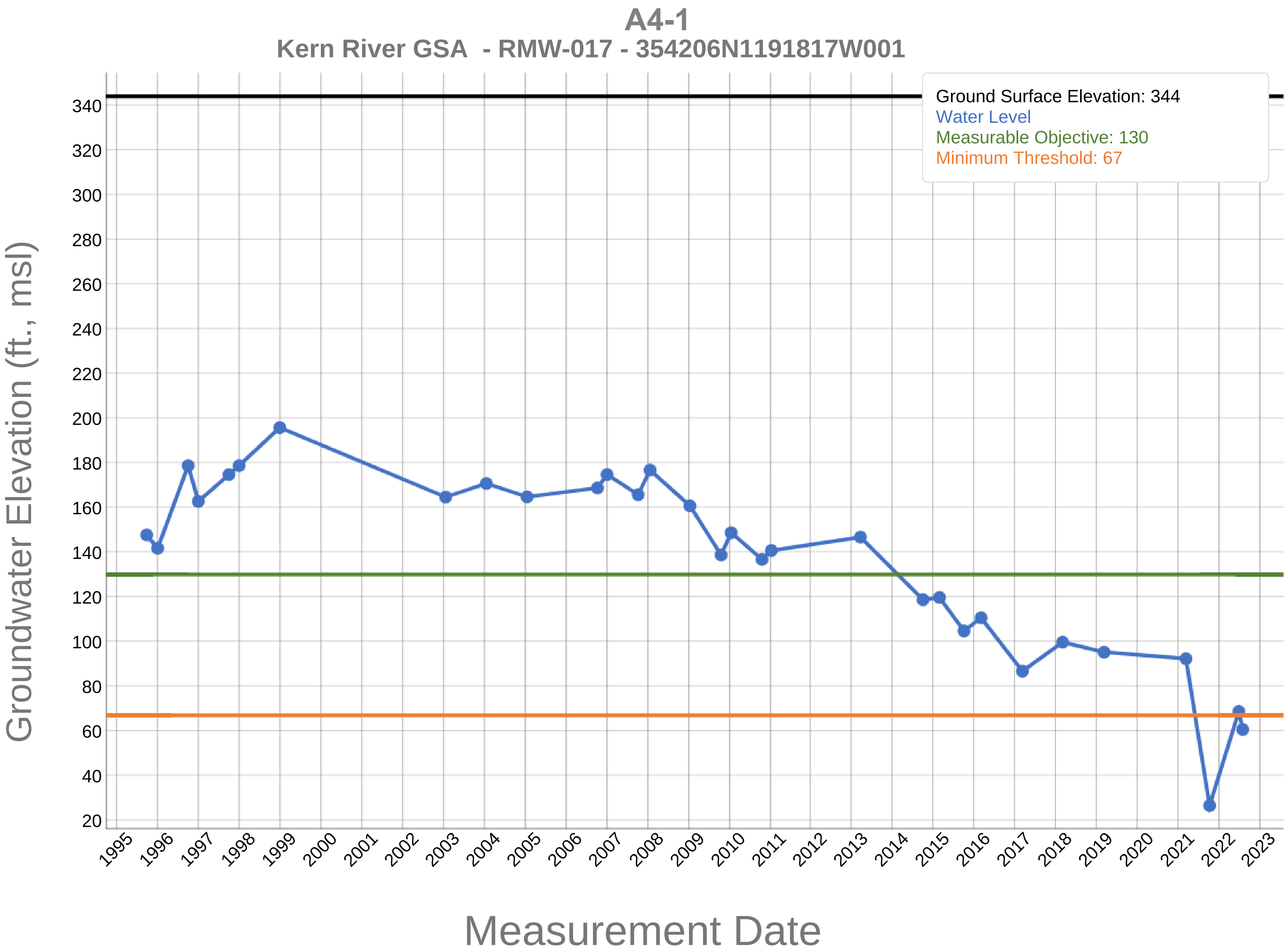
Measurement Date

APPENDIX A4

Hydrographs of Groundwater Elevations

GSP Monitoring Network Wells

Kern River GSA


A4-1
Kern River GSA - RMW-017 - 354206N1191817W001
Ground Surface Elevation: 344
Water Level
Measurable Objective: 130
Minimum Threshold: 67
Groundwater Elevation (ft., msl)
340
320
300
280
260
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220
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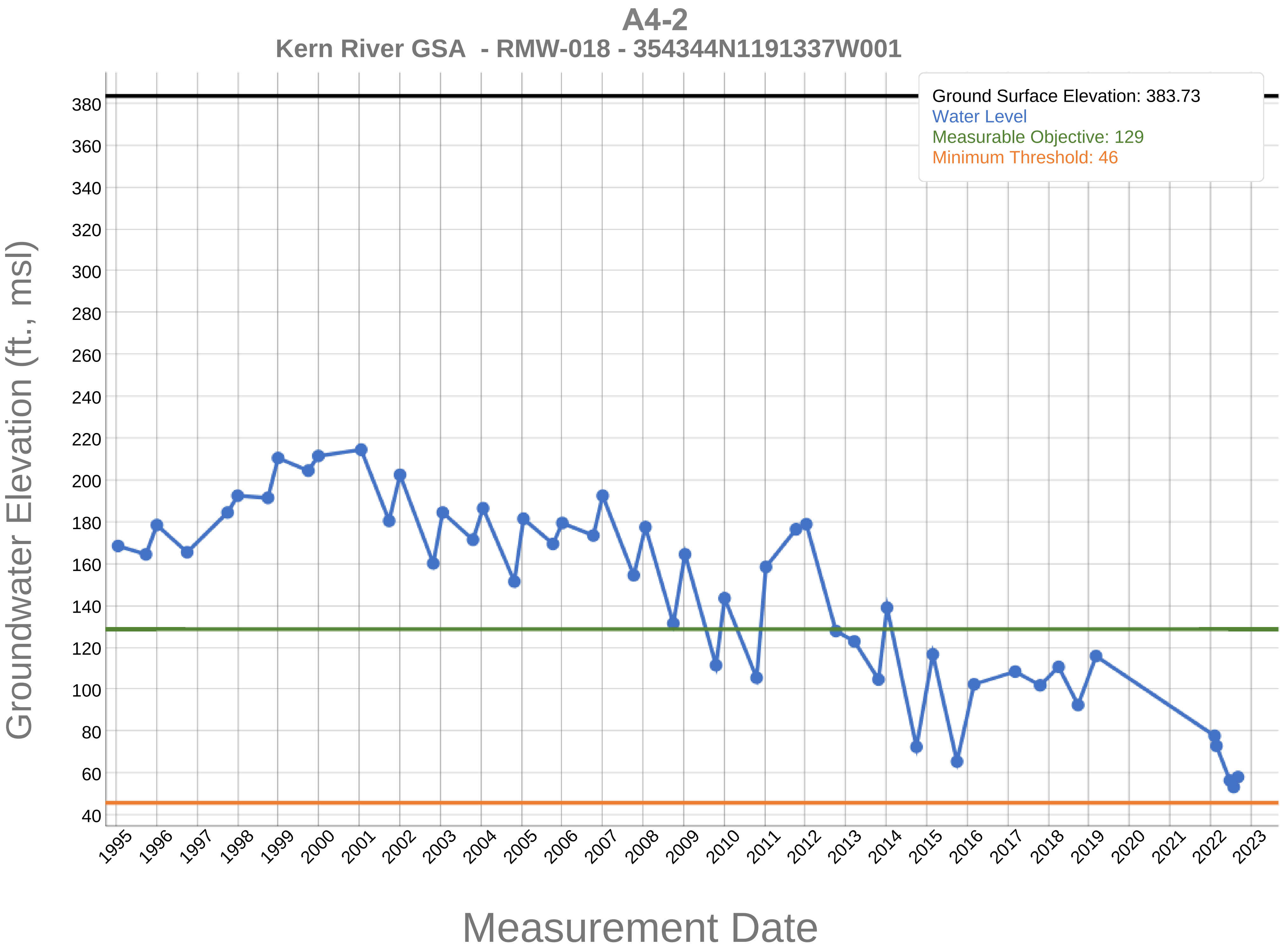
A4-2
Kern River GSA - RMW-018 - 354344N1191337W001
Ground Surface Elevation: 383.73
Water Level
Measurable Objective: 129
Minimum Threshold: 46
Groundwater Elevation (ft., msl)
380
360
340
320
300
280
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220
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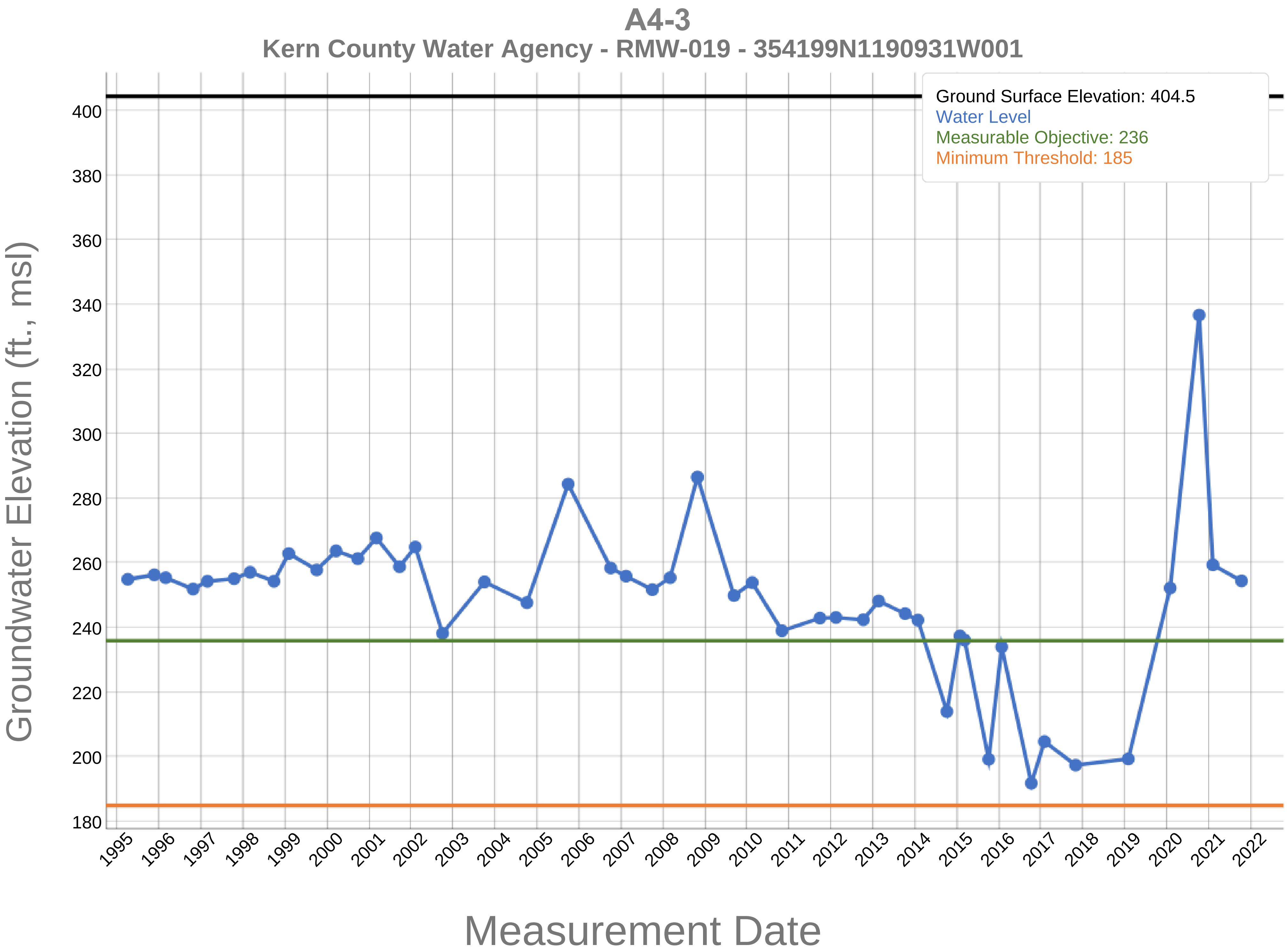

A4-3
Kern County Water Agency - RMW-019 - 354199N1190931W001
Ground Surface Elevation: 404.5
Water Level
Measurable Objective: 236
Minimum Threshold: 185
Groundwater Elevation (ft., msl)
400
380
360
340
320
300
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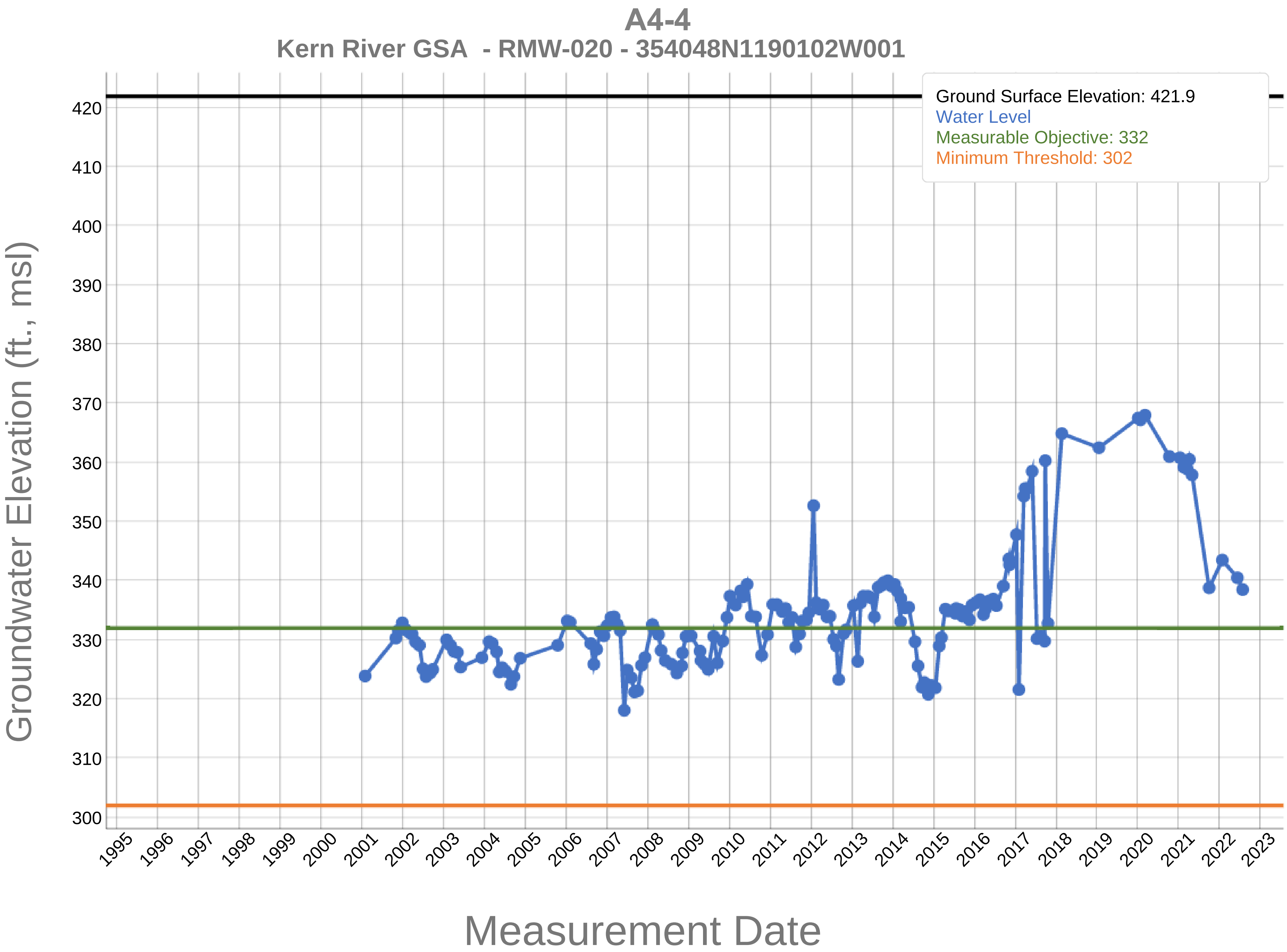
A4-4
Kern River GSA - RMW-020 - 354048N1190102W001
Ground Surface Elevation: 421.9
Water Level
Measurable Objective: 332
Minimum Threshold: 302
Groundwater Elevation (ft., msl)
300
310
320
330
340
350
360
370
380
390
400
410
420
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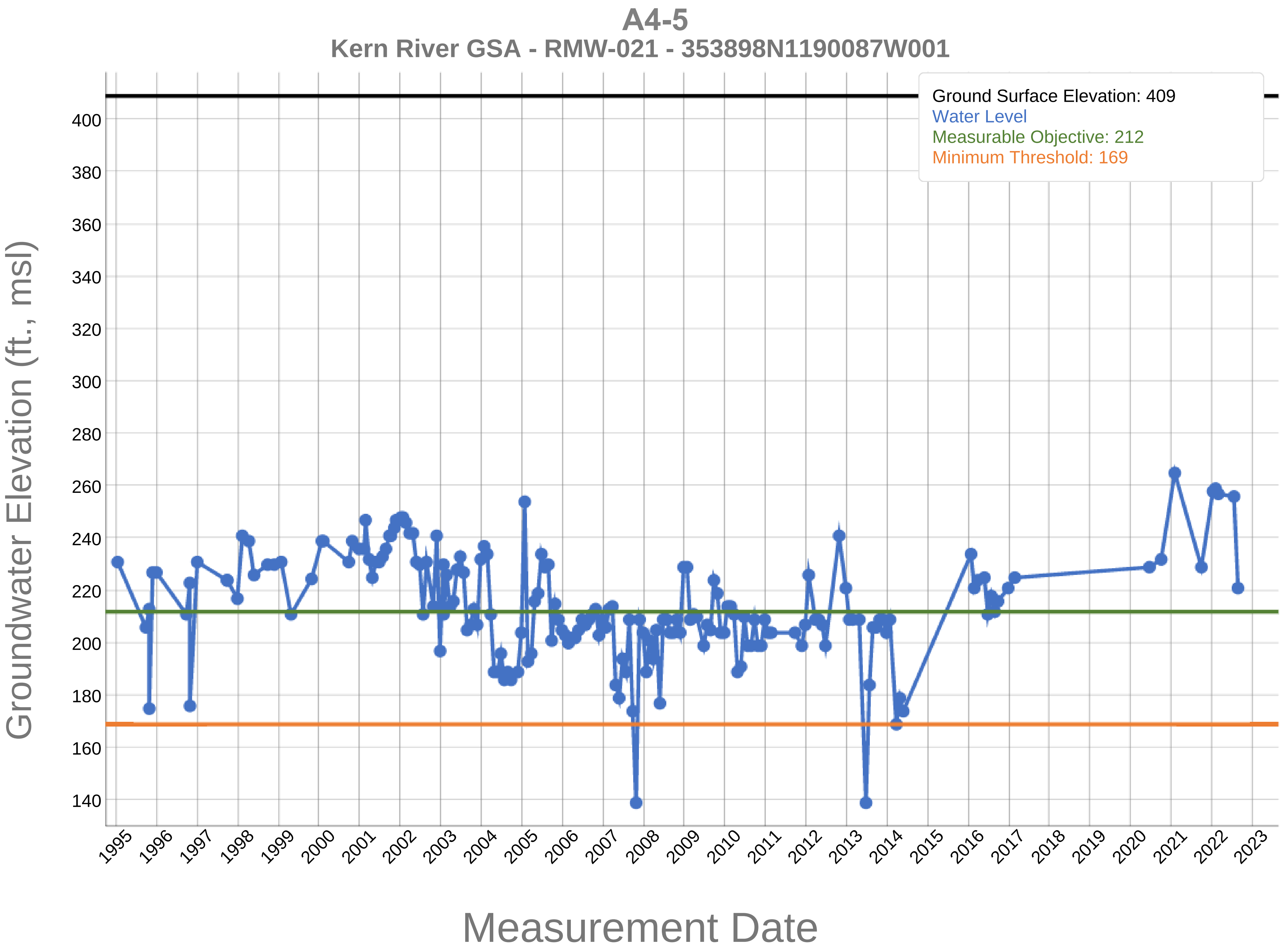
A4-5
Kern River GSA - RMW-021 - 353898N1190087W001
Ground Surface Elevation: 409
Water Level
Measurable Objective: 212
Minimum Threshold: 169
Groundwater Elevation (ft., msl)
400
380
360
340
320
300
280
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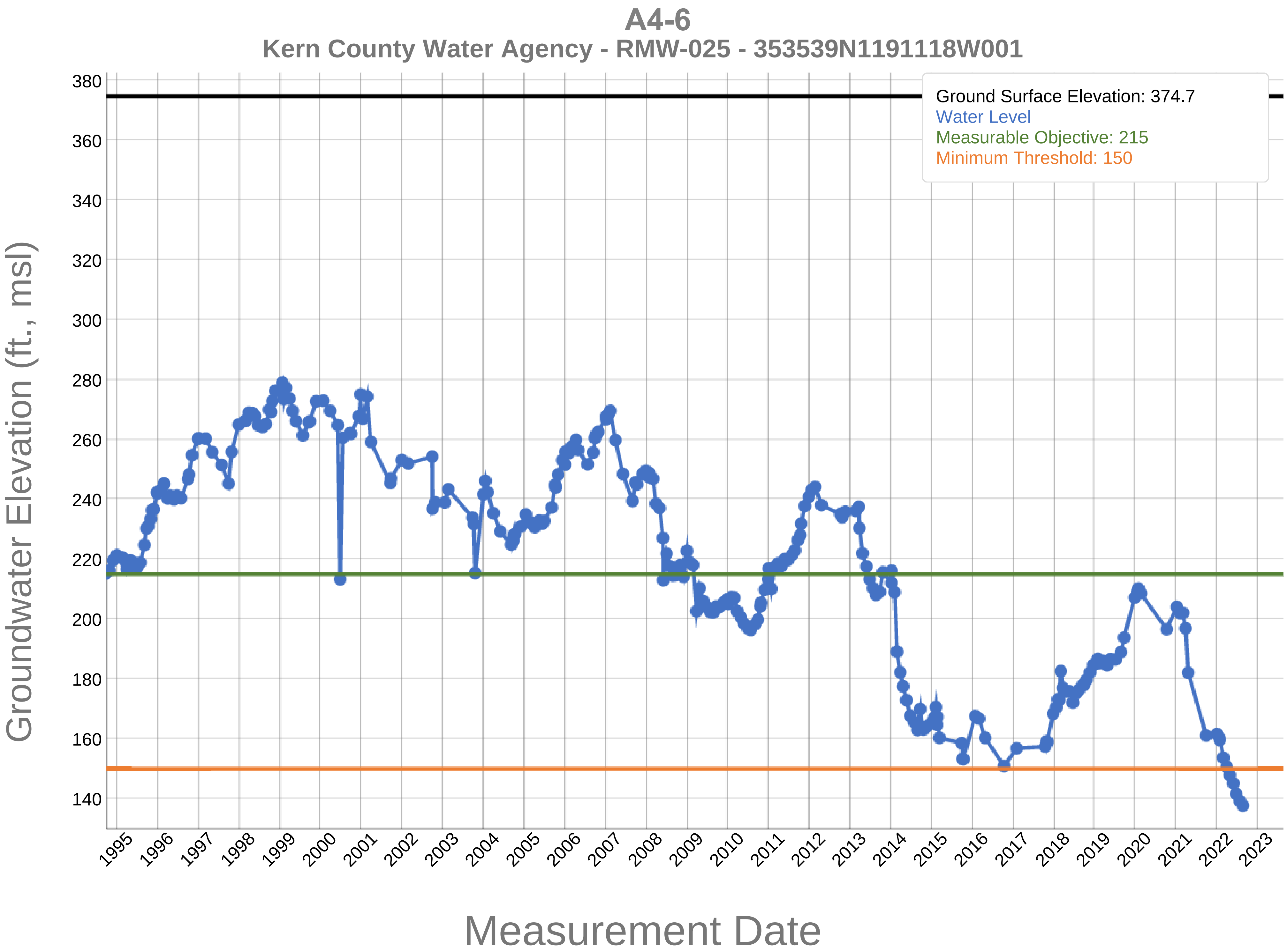
Measurement Date



A4-6
Kern County Water Agency - RMW-025 - 353539N1191118W001
Ground Surface Elevation: 374.7
Water Level
Measurable Objective: 215
Minimum Threshold: 150
Groundwater Elevation (ft., msl)
380
360
340
320
300
280
260
240
220
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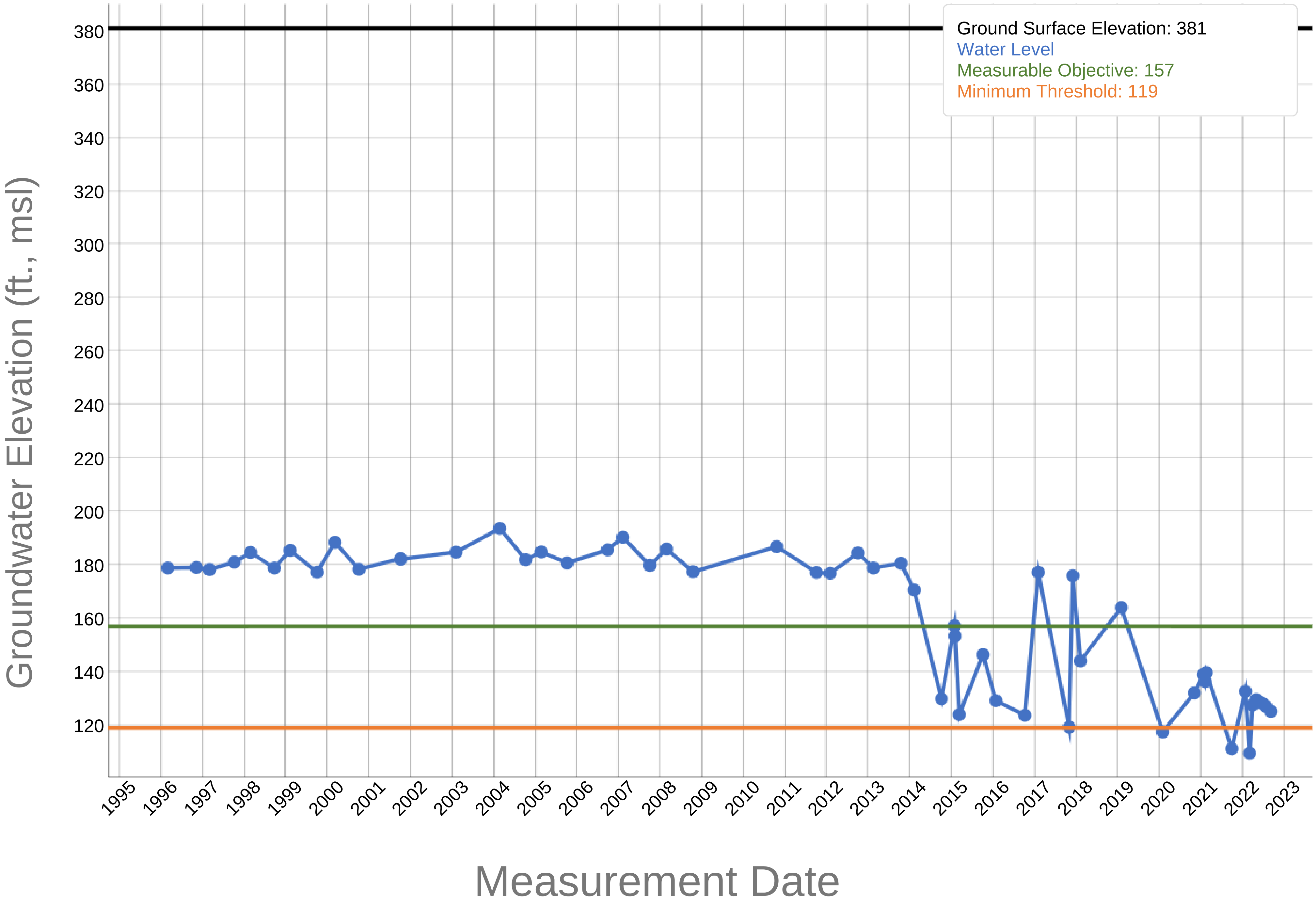
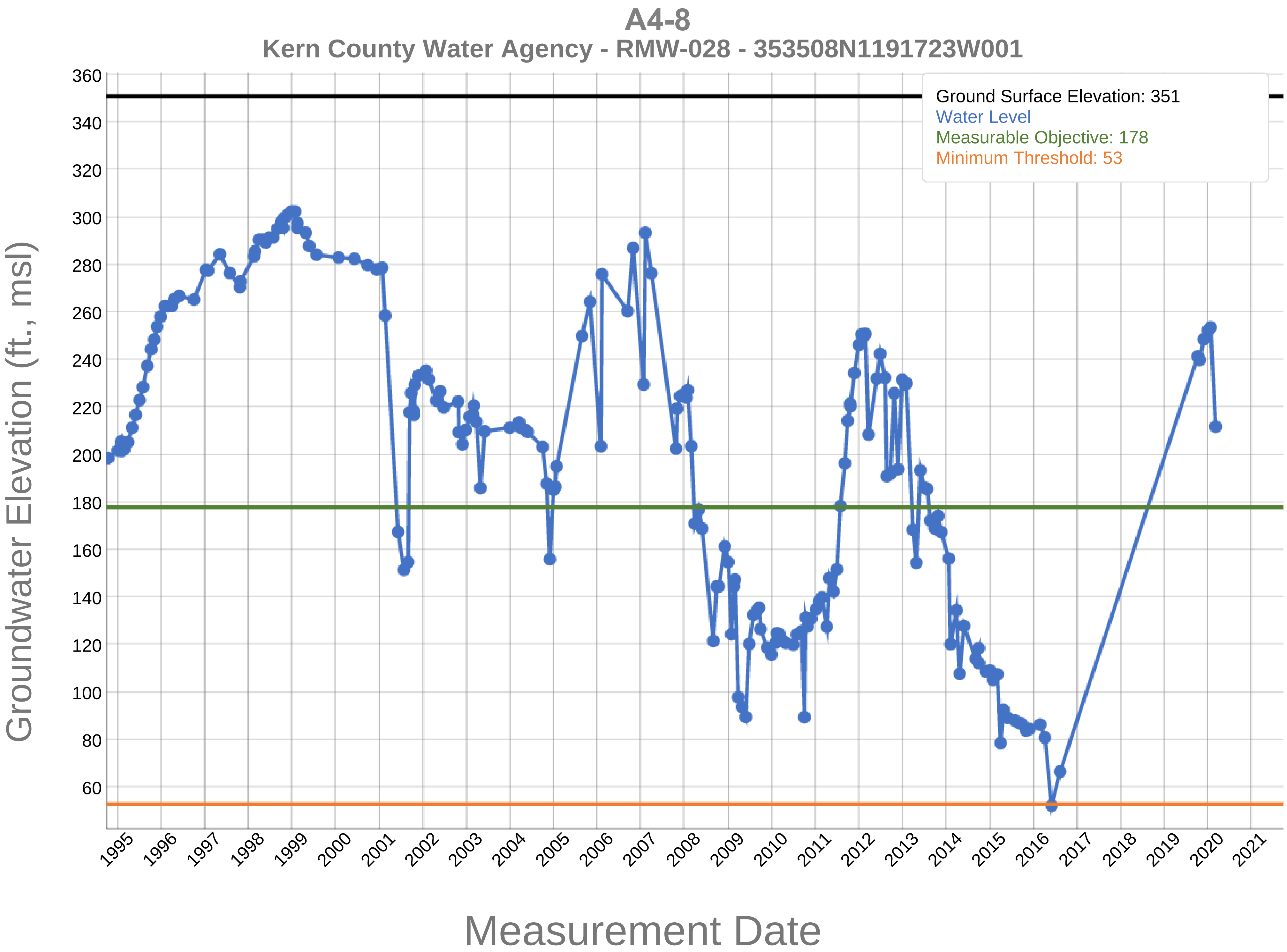
Measurement Date

A4-7

Kern River GSA - RMW-026 - 353512N1189673W001




A4-8
Kern County Water Agency - RMW-028 - 353508N1191723W001
Ground Surface Elevation: 351
Water Level
Measurable Objective: 178
Minimum Threshold: 53
Groundwater Elevation (ft., msl)
360
340
320
300
280
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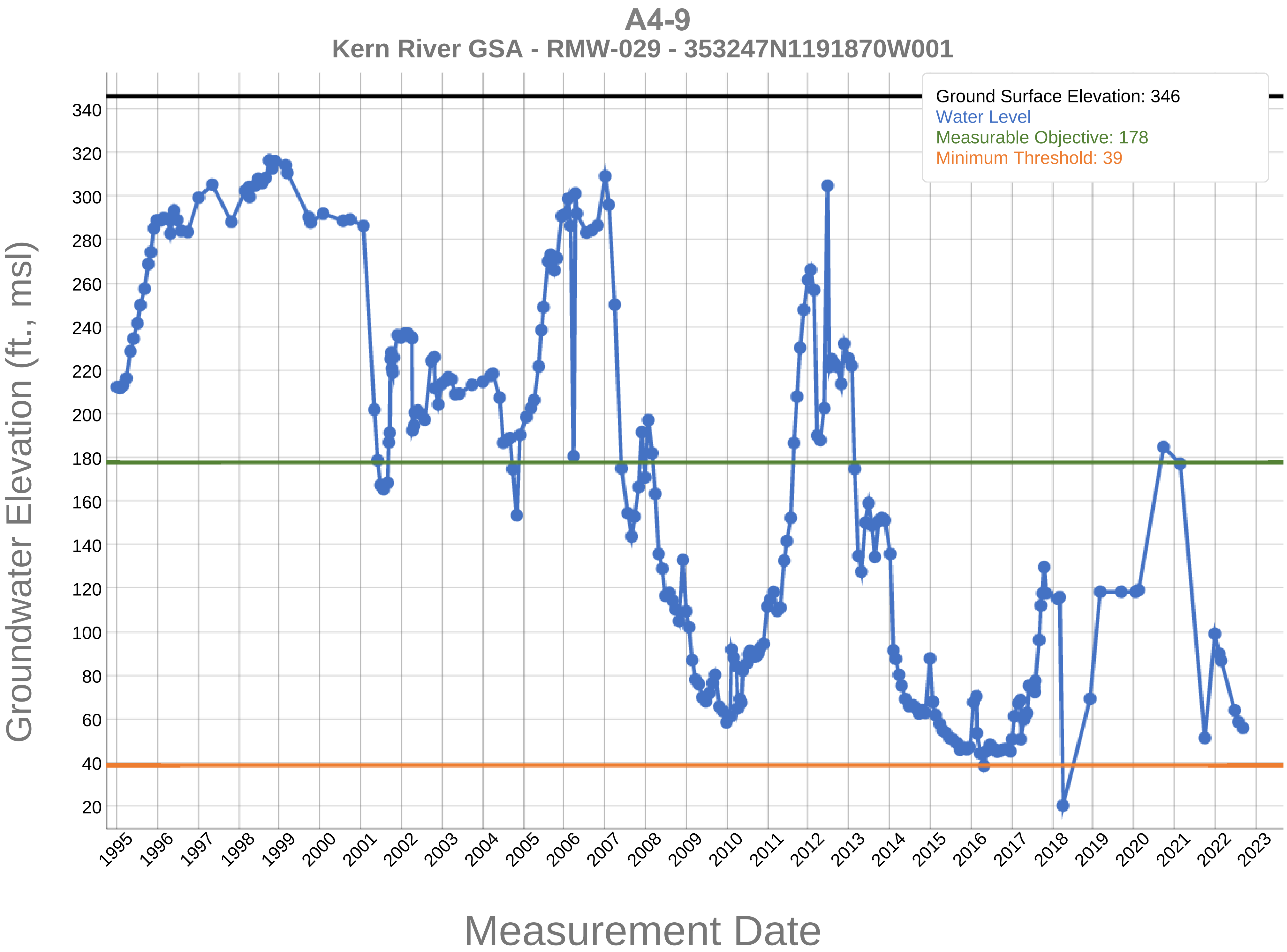
Measurement Date



A4-9
Kern River GSA - RMW-029 - 353247N1191870W001
Ground Surface Elevation: 346
Water Level
Measurable Objective: 178
Minimum Threshold: 39
Groundwater Elevation (ft., msl)
340
320
300
280
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220
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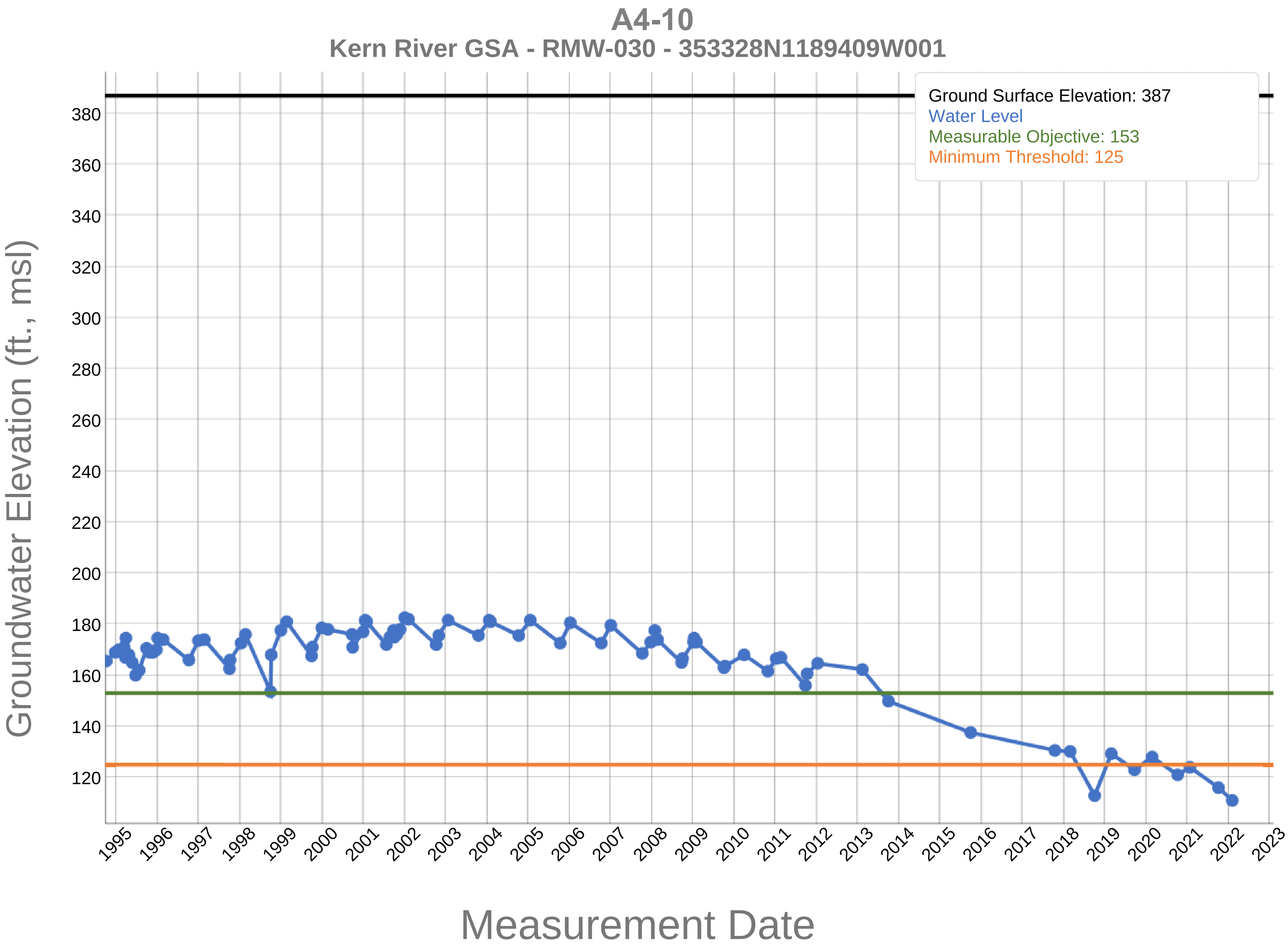
Measurement Date


A4-10
Kern River GSA - RMW-030 - 353328N1189409W001
Ground Surface Elevation: 387
Water Level
Measurable Objective: 153
Minimum Threshold: 125
Groundwater Elevation (ft., msl)
380
360
340
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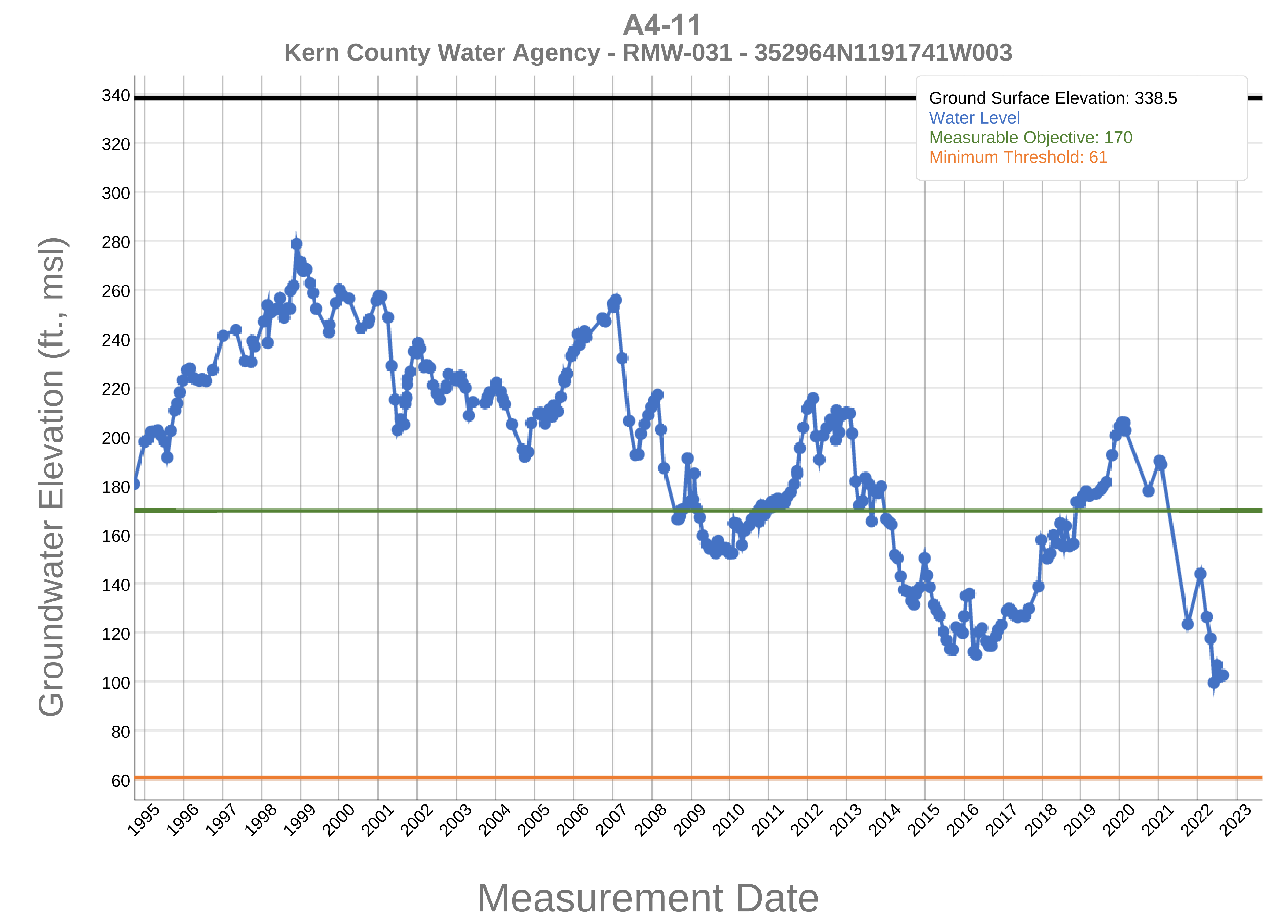

A4-11
Kern County Water Agency - RMW-031 - 352964N1191741W003
Ground Surface Elevation: 338.5
Water Level
Measurable Objective: 170
Minimum Threshold: 61
Groundwater Elevation (ft., msl)
340
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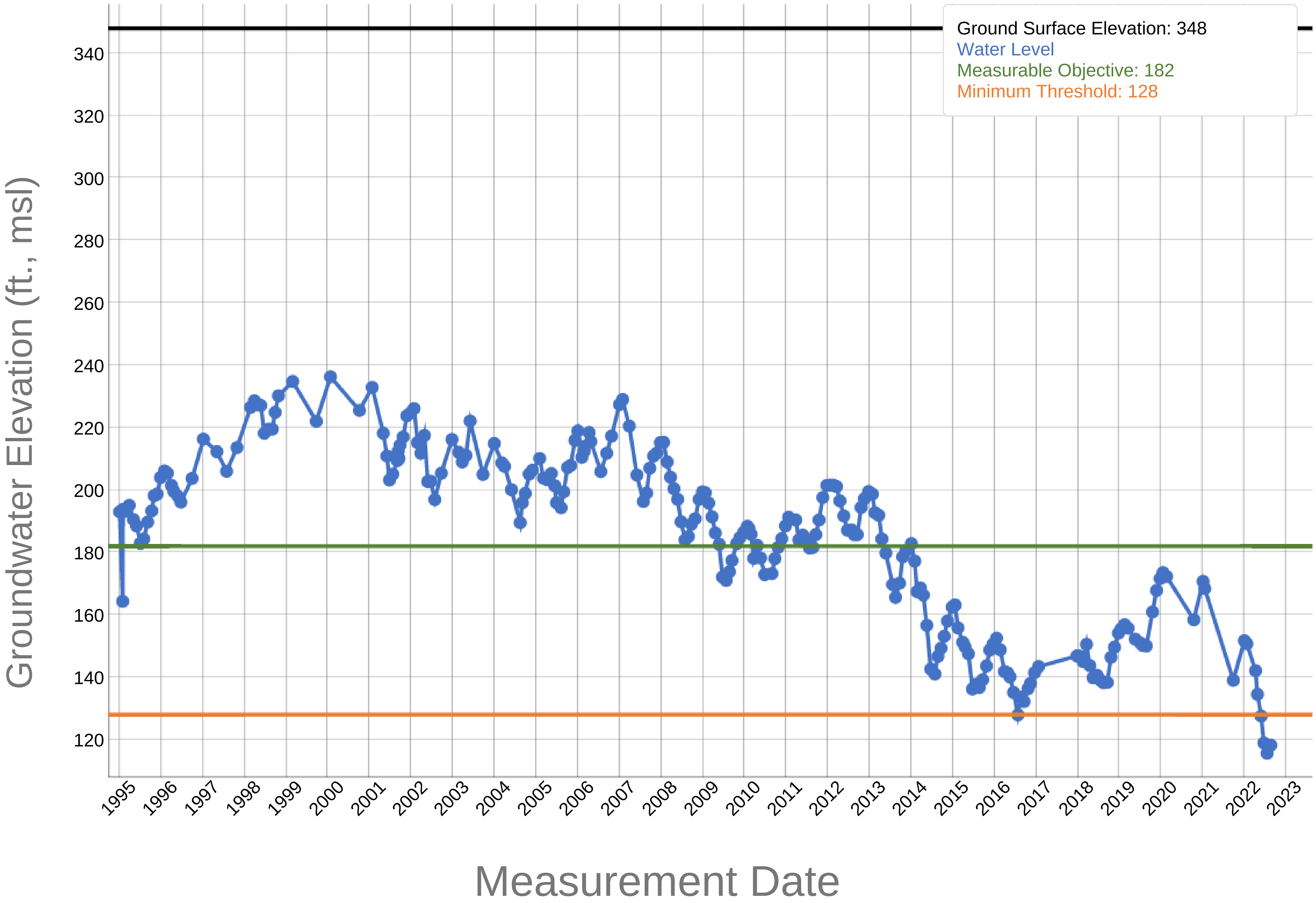
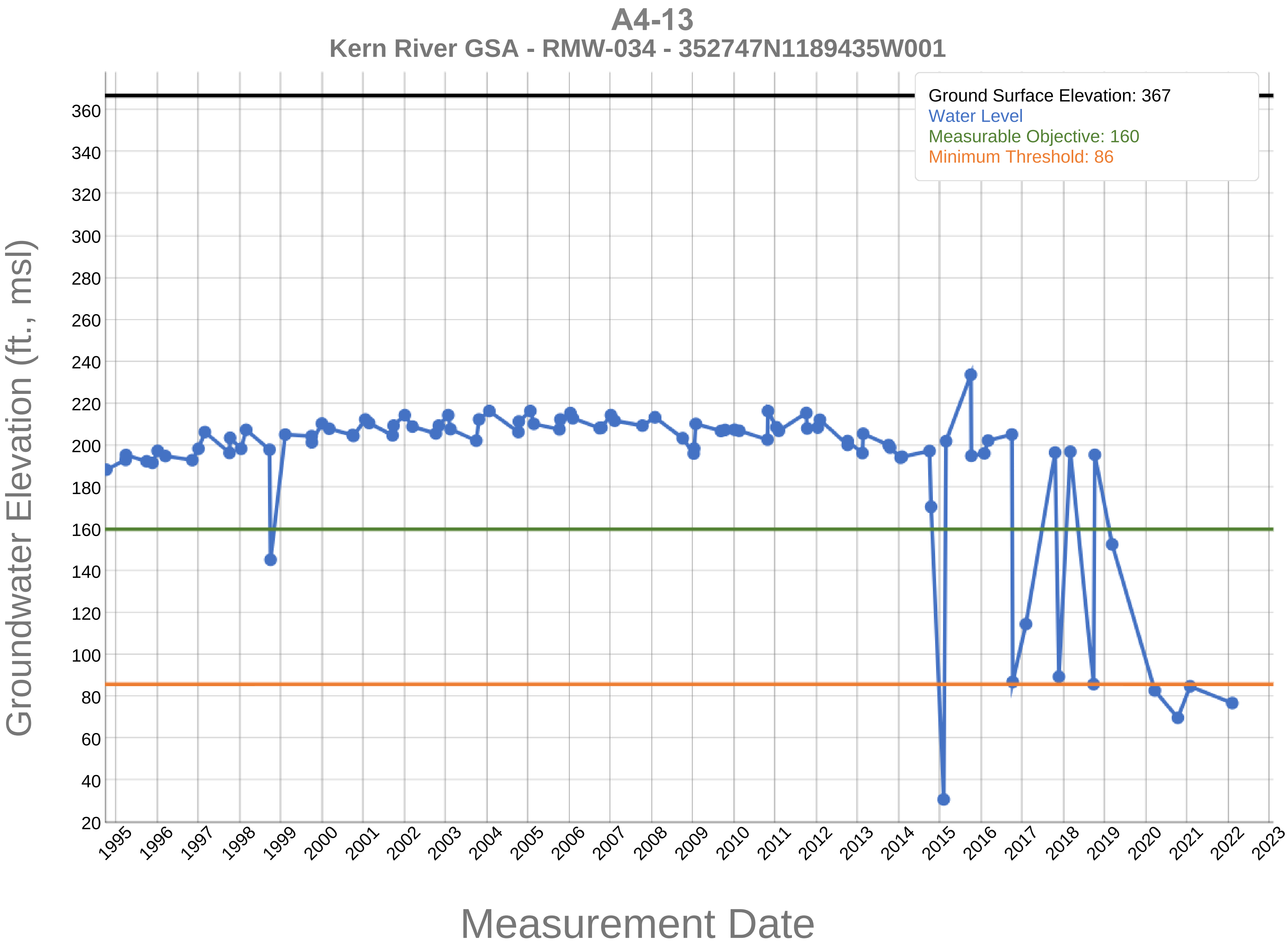
Measurement Date

A4-12

Kern County Water Agency - RMW-032 - 352953N1191285W001





A4-13
Kern River GSA - RMW-034 - 352747N1189435W001
Ground Surface Elevation: 367
Water Level
Measurable Objective: 160
Minimum Threshold: 86
Groundwater Elevation (ft., msl)
Measurement Date
360
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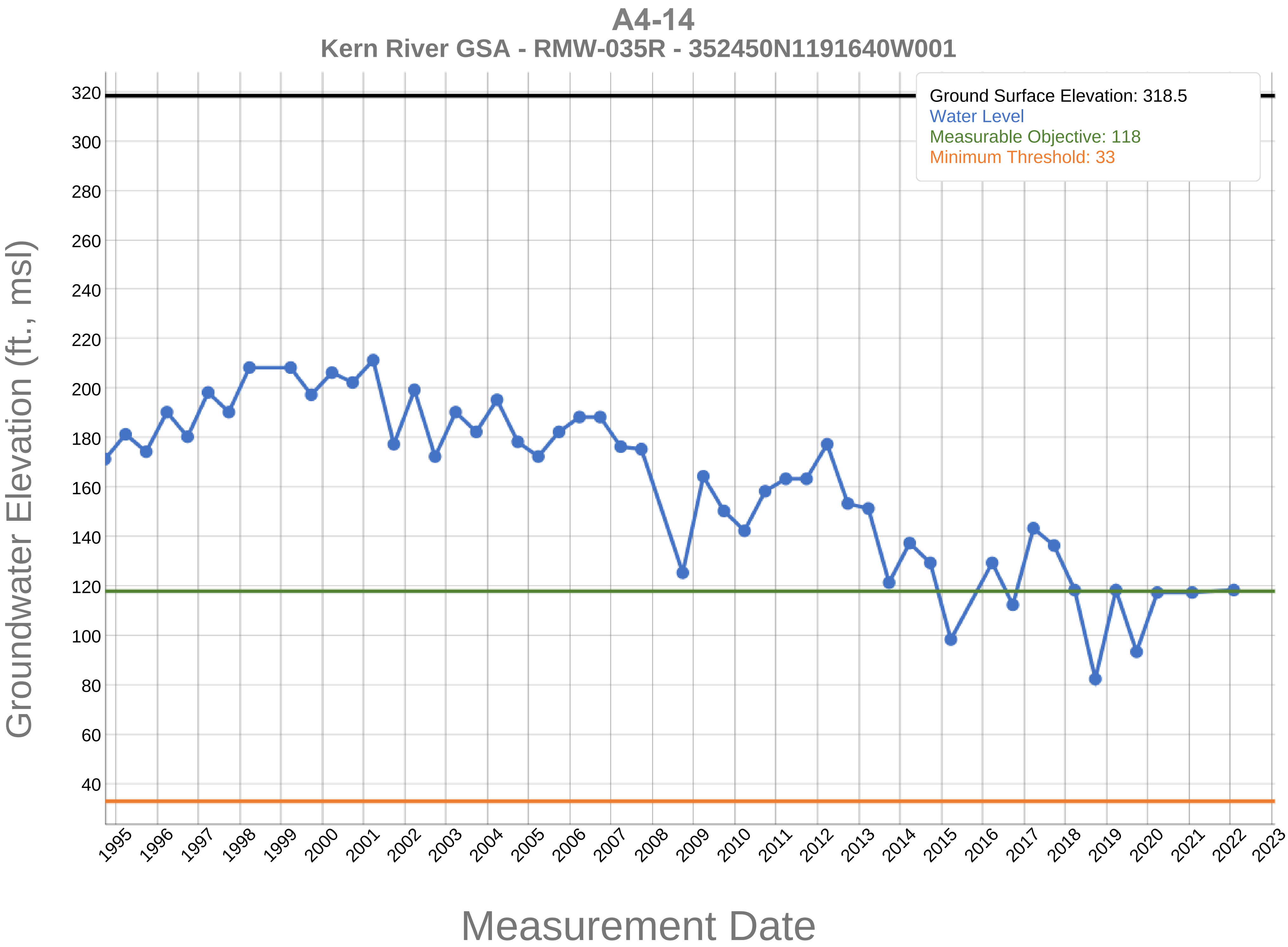
A4-14
Kern River GSA - RMW-035R - 352450N1191640W001
Ground Surface Elevation: 318.5
Water Level
Measurable Objective: 118
Minimum Threshold: 33
Groundwater Elevation (ft., msl)
Measurement Date
320
300
280
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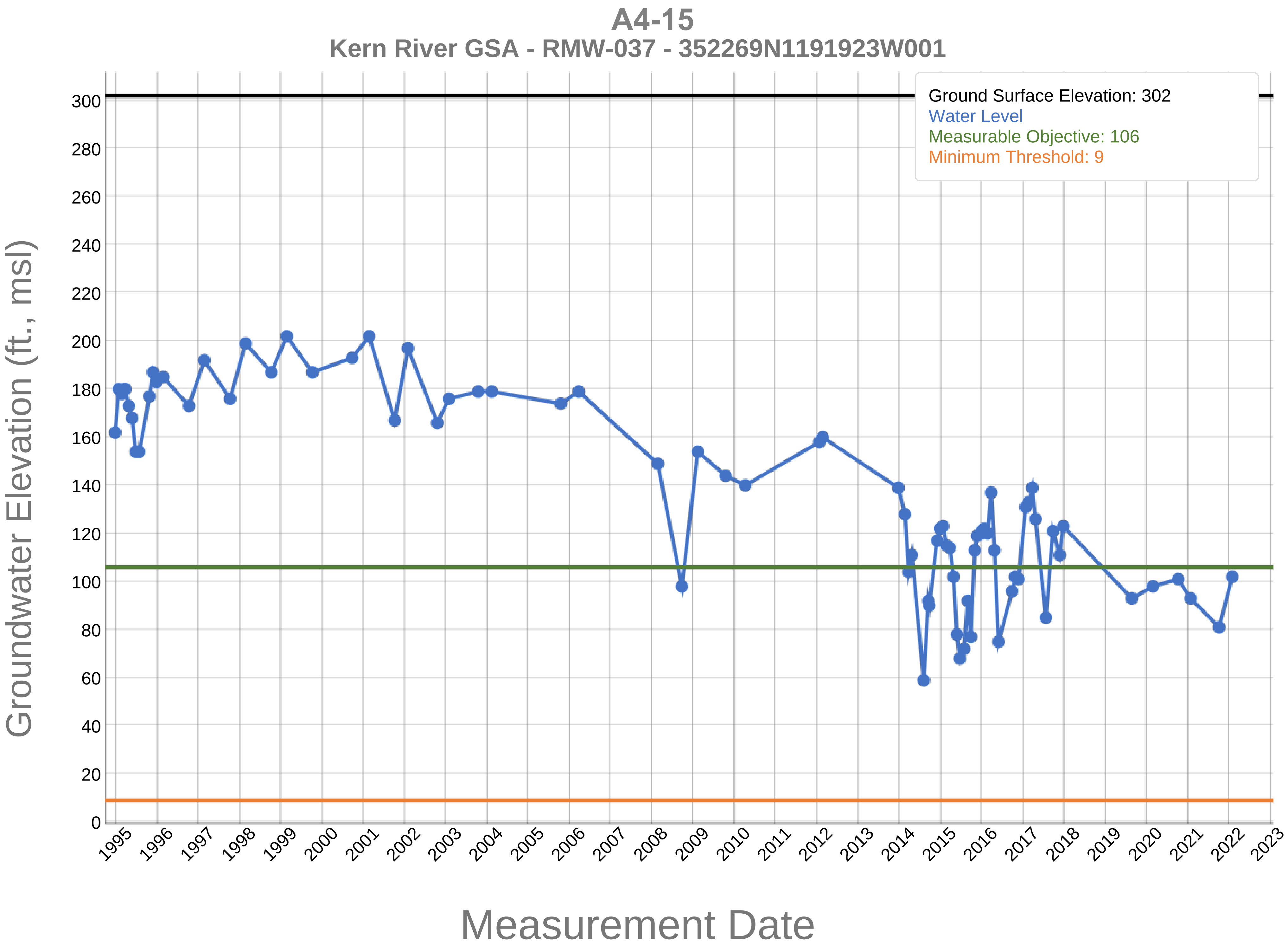
A4-15
Kern River GSA - RMW-037 - 352269N1191923W001
Ground Surface Elevation: 302
Water Level
Measurable Objective: 106
Minimum Threshold: 9
Groundwater Elevation (ft., msl)
Measurement Date
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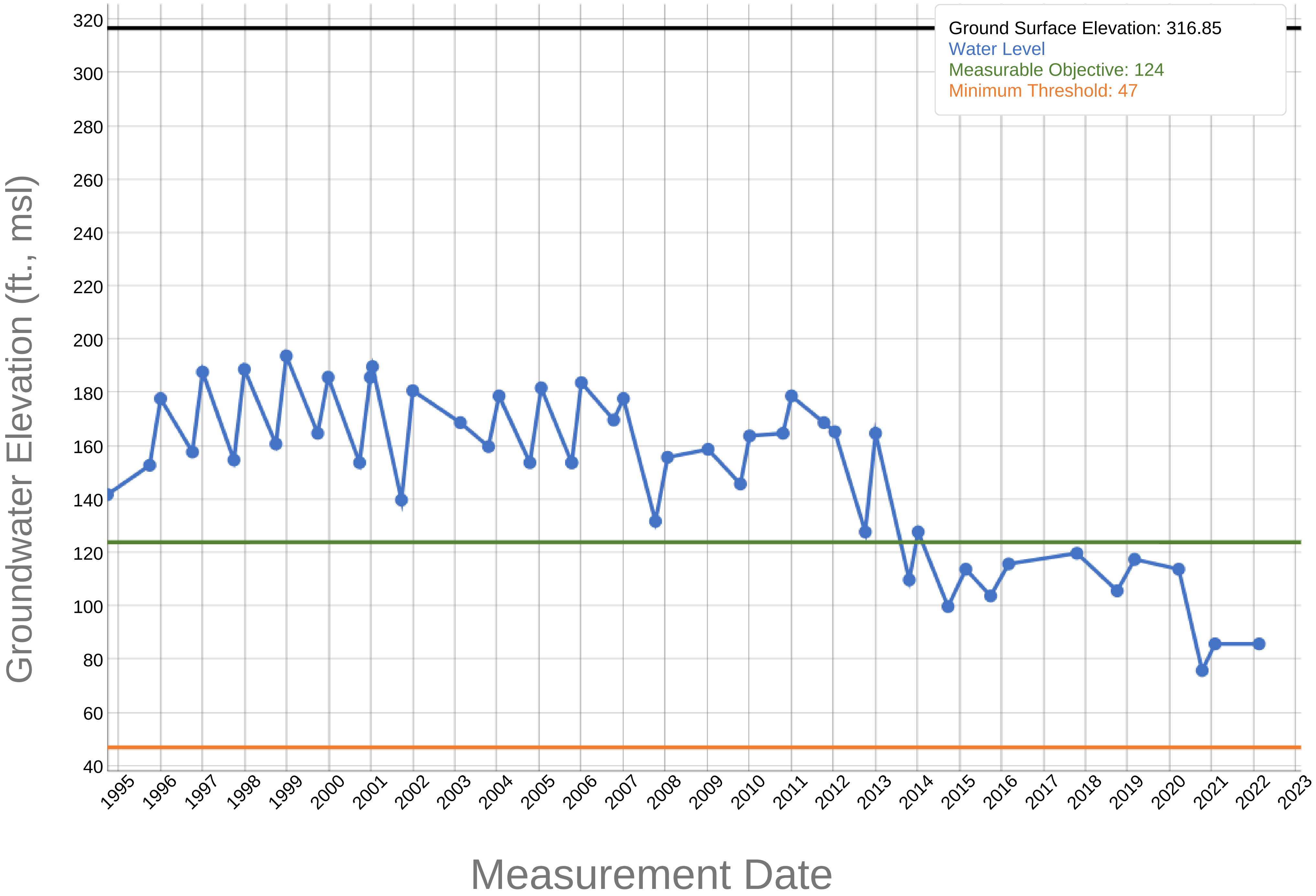
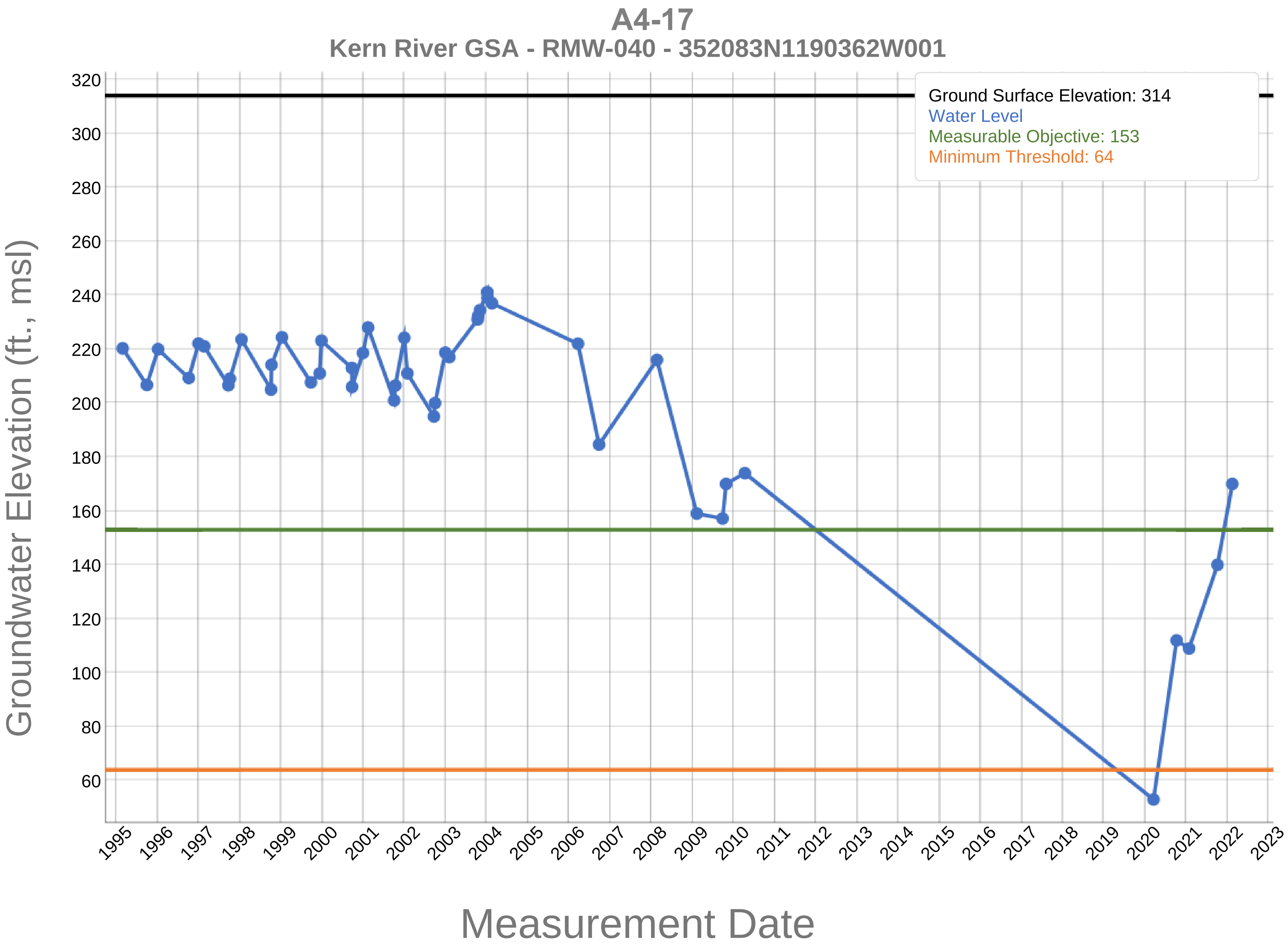
A4-16

Kern River GSA - RMW-038 - 352233N1191281W001





A4-17
Kern River GSA - RMW-040 - 352083N1190362W001
Ground Surface Elevation: 314
Water Level
Measurable Objective: 153
Minimum Threshold: 64
Groundwater Elevation (ft., msl)
Measurement Date
320
300
280
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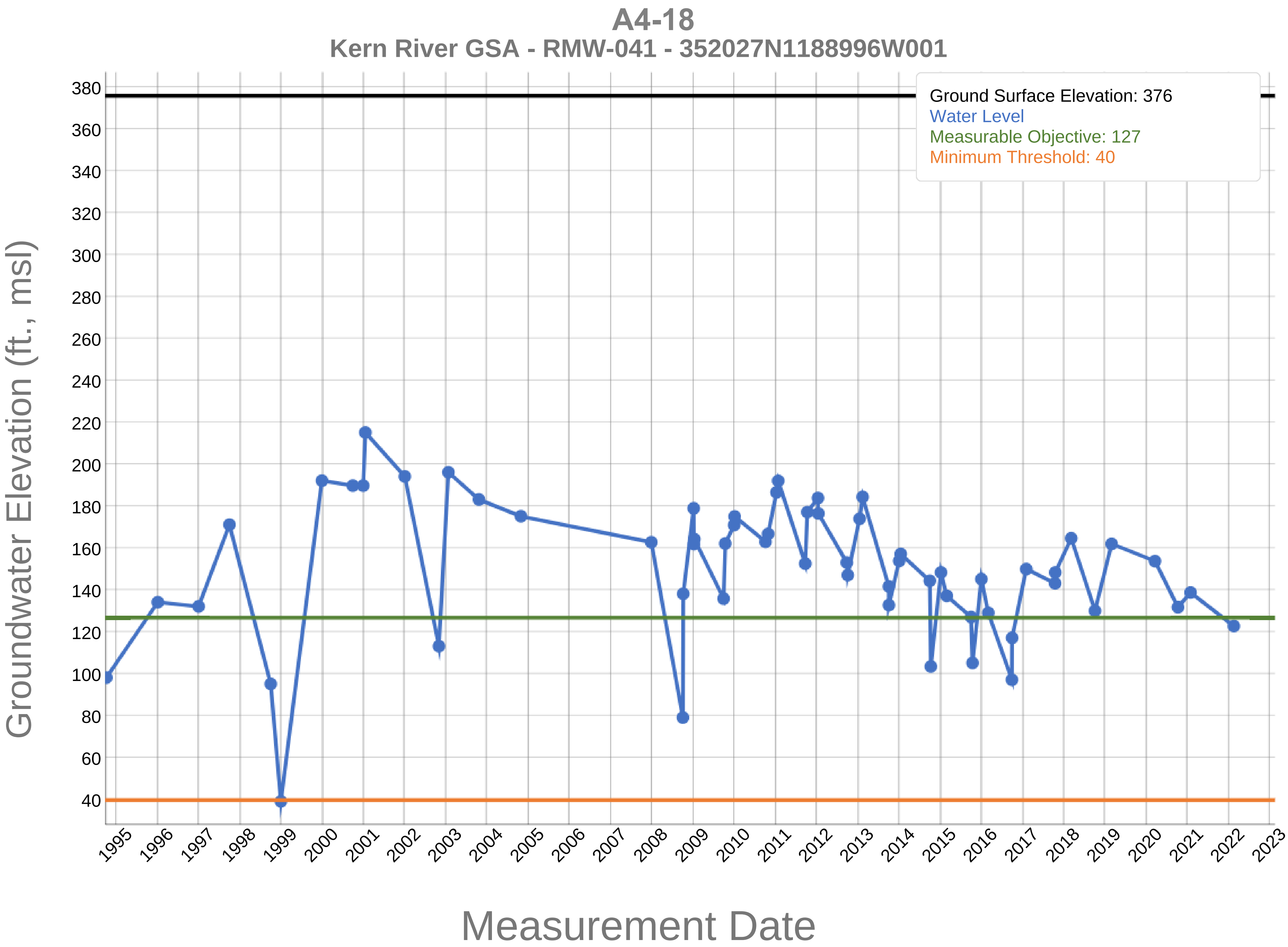
A4-18
Kern River GSA - RMW-041 - 352027N1188996W001
Ground Surface Elevation: 376
Water Level
Measurable Objective: 127
Minimum Threshold: 40
Groundwater Elevation (ft., msl)
Measurement Date
380
360
340
320
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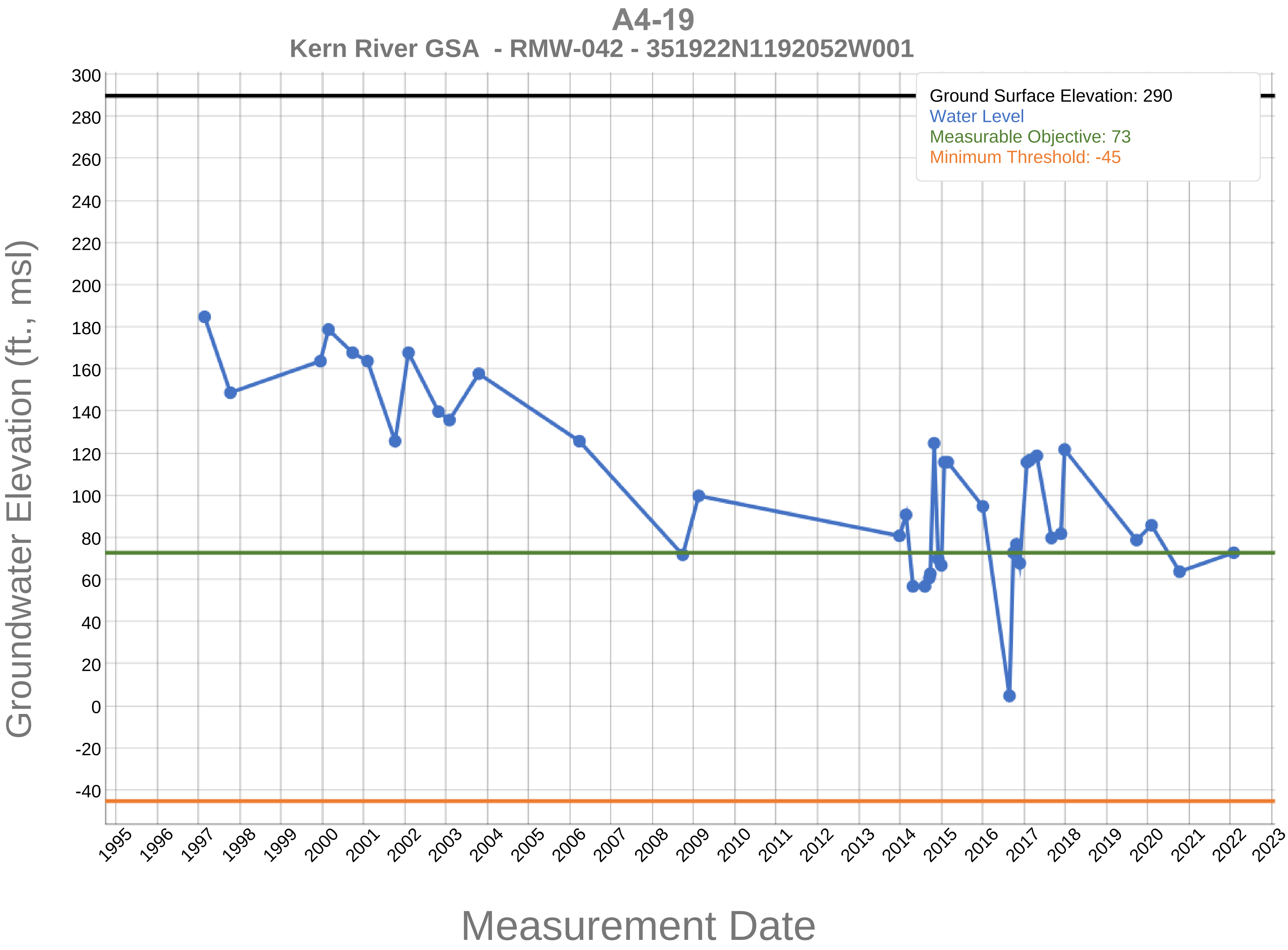
A4-19
Kern River GSA - RMW-042 - 351922N1192052W001
Ground Surface Elevation: 290
Water Level
Measurable Objective: 73
Minimum Threshold: -45
Groundwater Elevation (ft., msl)
Measurement Date
300
280
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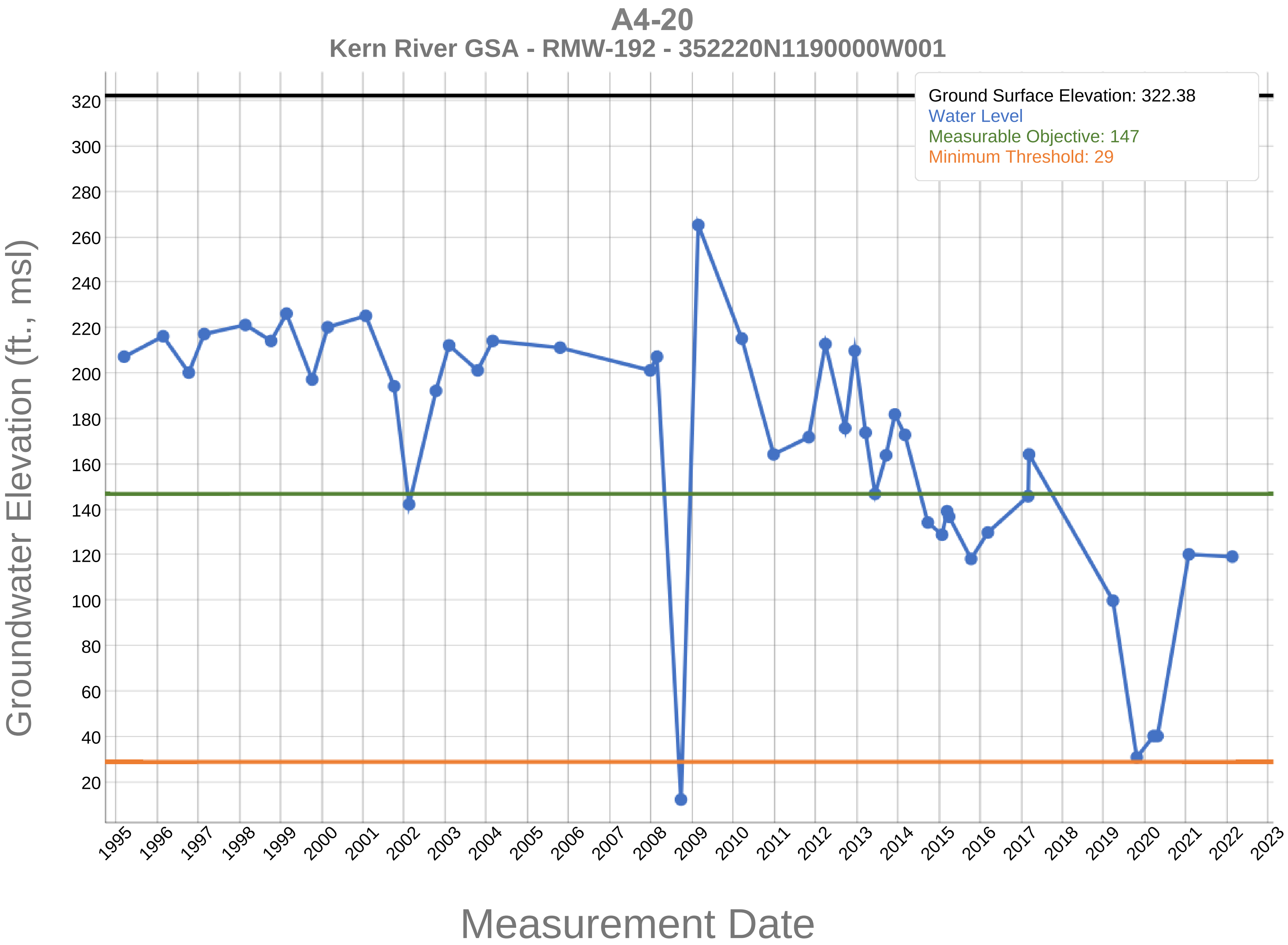
A4-20
Kern River GSA - RMW-192 - 352220N1190000W001
Ground Surface Elevation: 322.38
Water Level
Measurable Objective: 147
Minimum Threshold: 29
Groundwater Elevation (ft., msl)
Measurement Date
320
300
280
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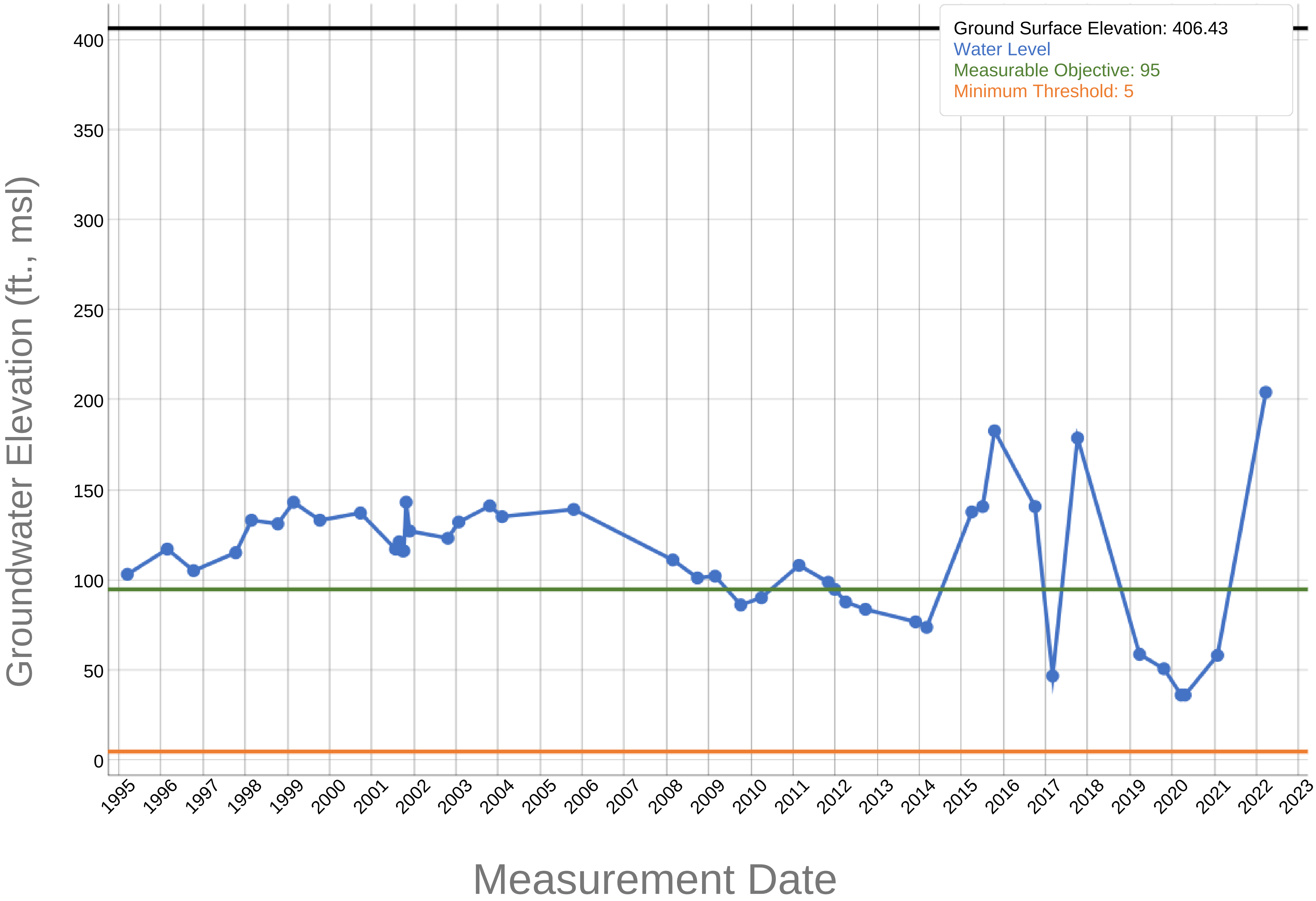
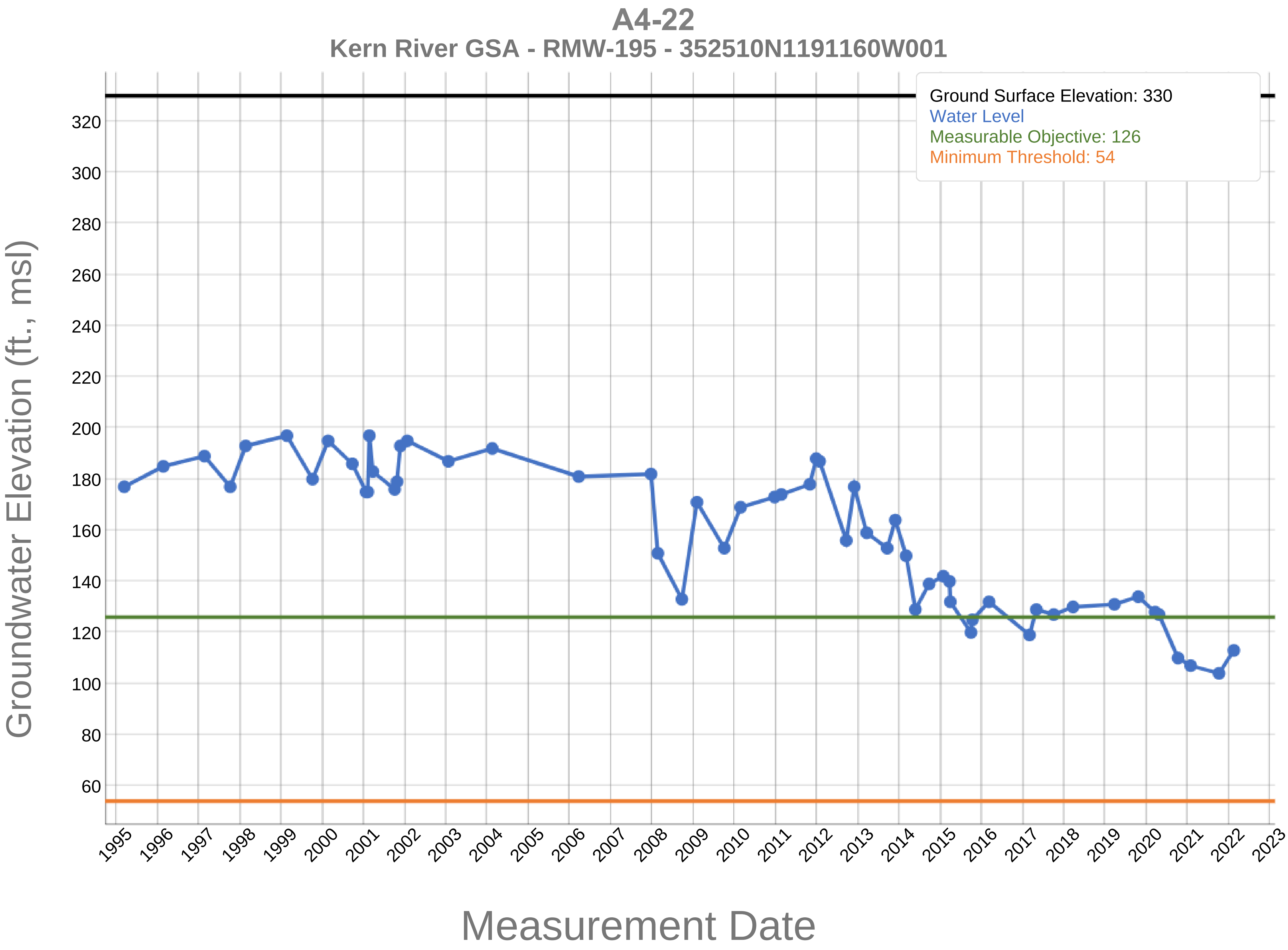
A4-21

Kern River GSA - RMW-193 - 352080N1188710W001




A4-22
Kern River GSA - RMW-195 - 352510N1191160W001
Ground Surface Elevation: 330
Water Level
Measurable Objective: 126
Minimum Threshold: 54
Groundwater Elevation (ft., msl)
320
300
280
260
240
220
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1995
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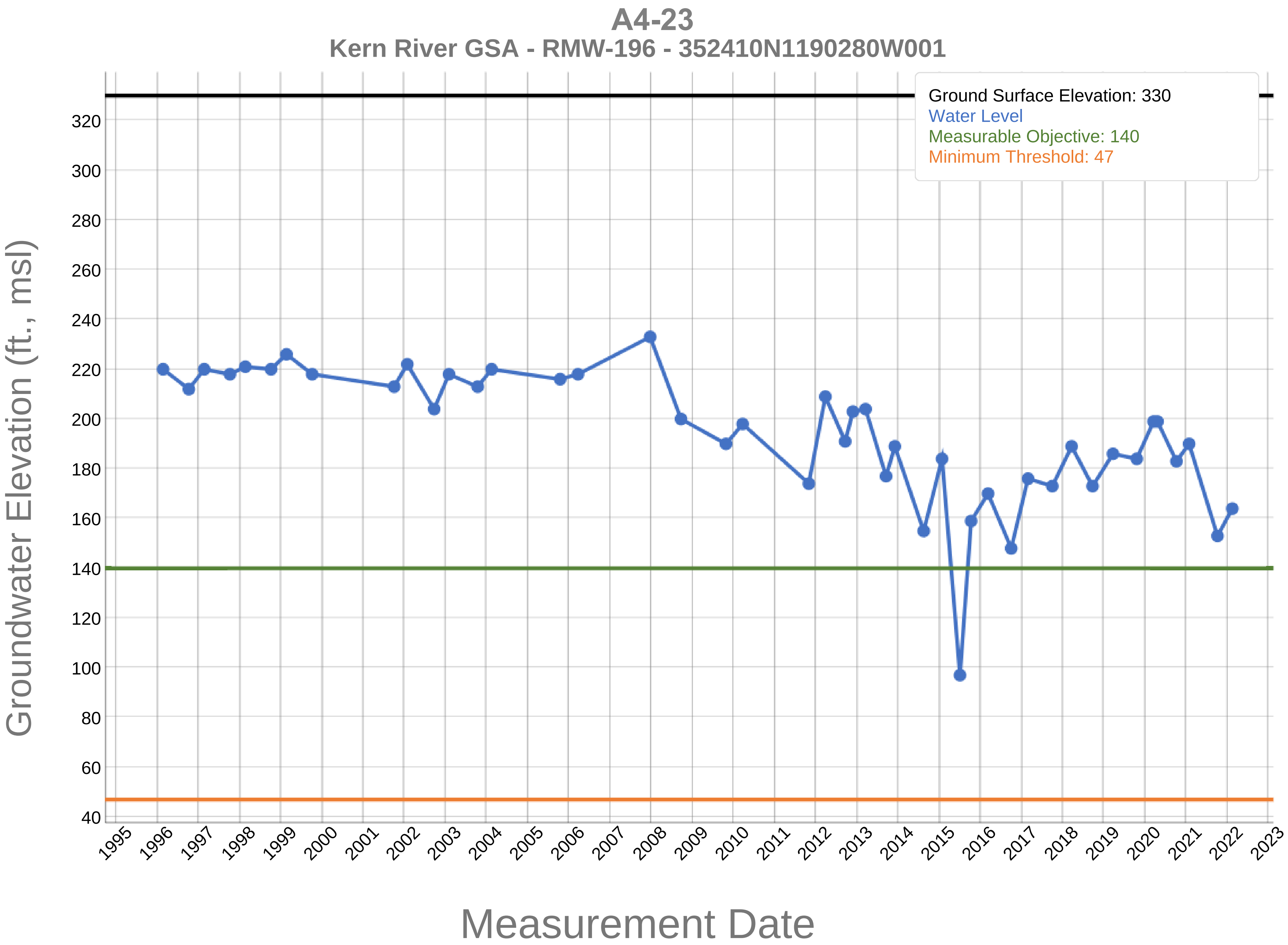
Measurement Date


A4-23
Kern River GSA - RMW-196 - 352410N1190280W001
Ground Surface Elevation: 330
Water Level
Measurable Objective: 140
Minimum Threshold: 47
Groundwater Elevation (ft., msl)
Measurement Date
40
60
80
100
120
140
160
180
200
220
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260
280
300
320
1995
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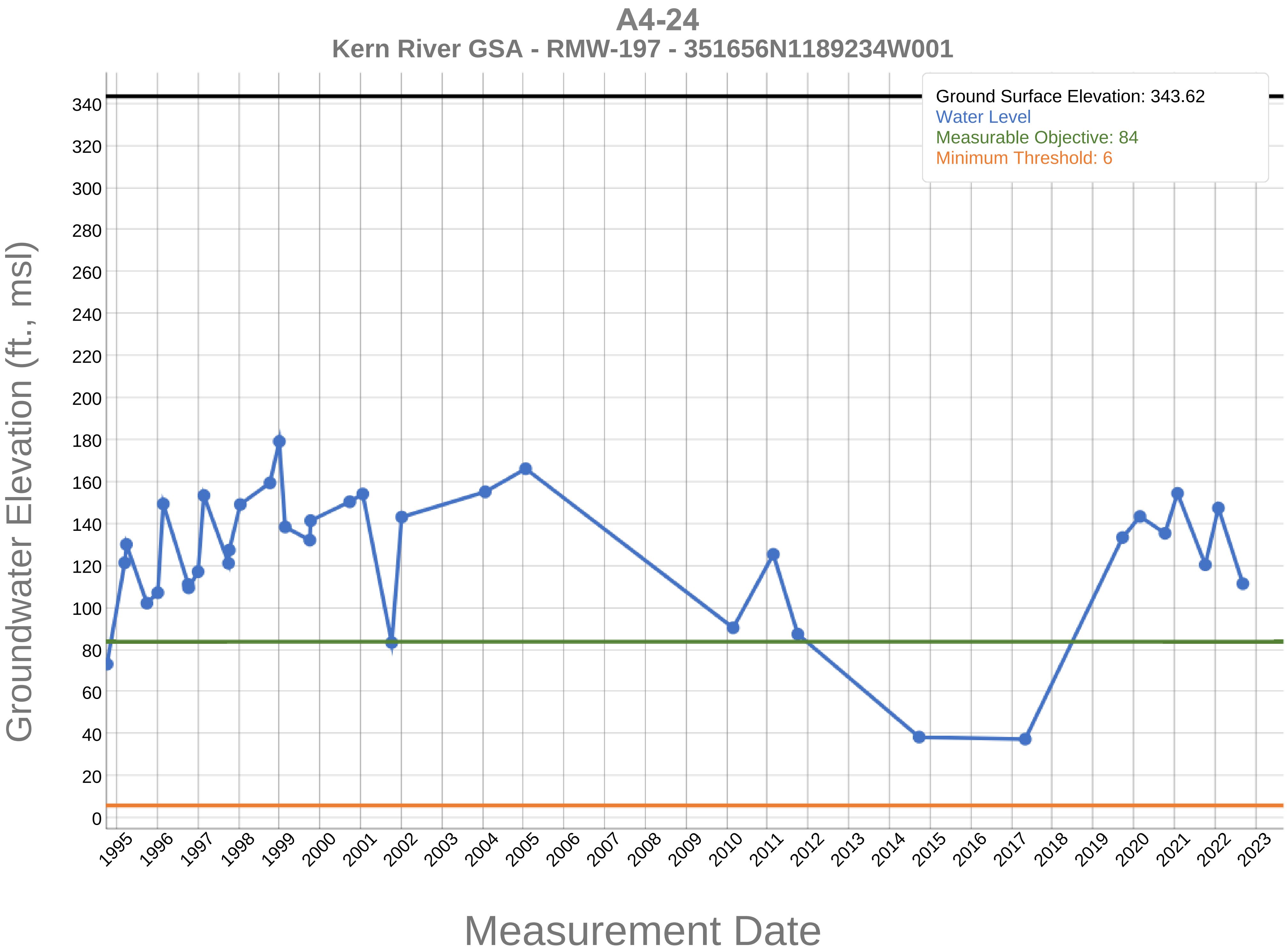
A4-24
Kern River GSA - RMW-197 - 351656N1189234W001
Ground Surface Elevation: 343.62
Water Level
Measurable Objective: 84
Minimum Threshold: 6
Groundwater Elevation (ft., msl)
Measurement Date
0
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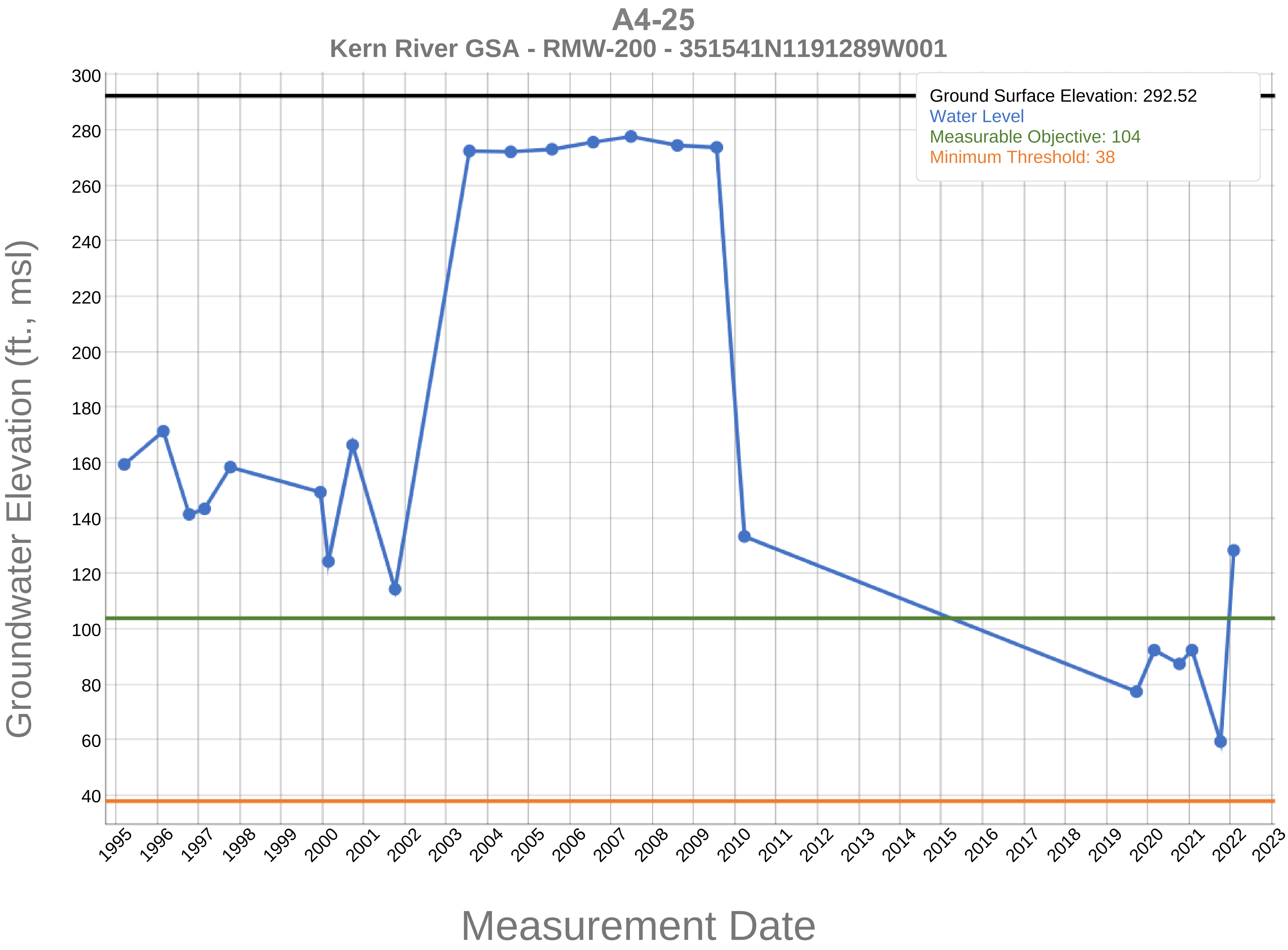

A4-25
Kern River GSA - RMW-200 - 351541N1191289W001
Ground Surface Elevation: 292.52
Water Level
Measurable Objective: 104
Minimum Threshold: 38
Groundwater Elevation (ft., msl)
300
280
260
240
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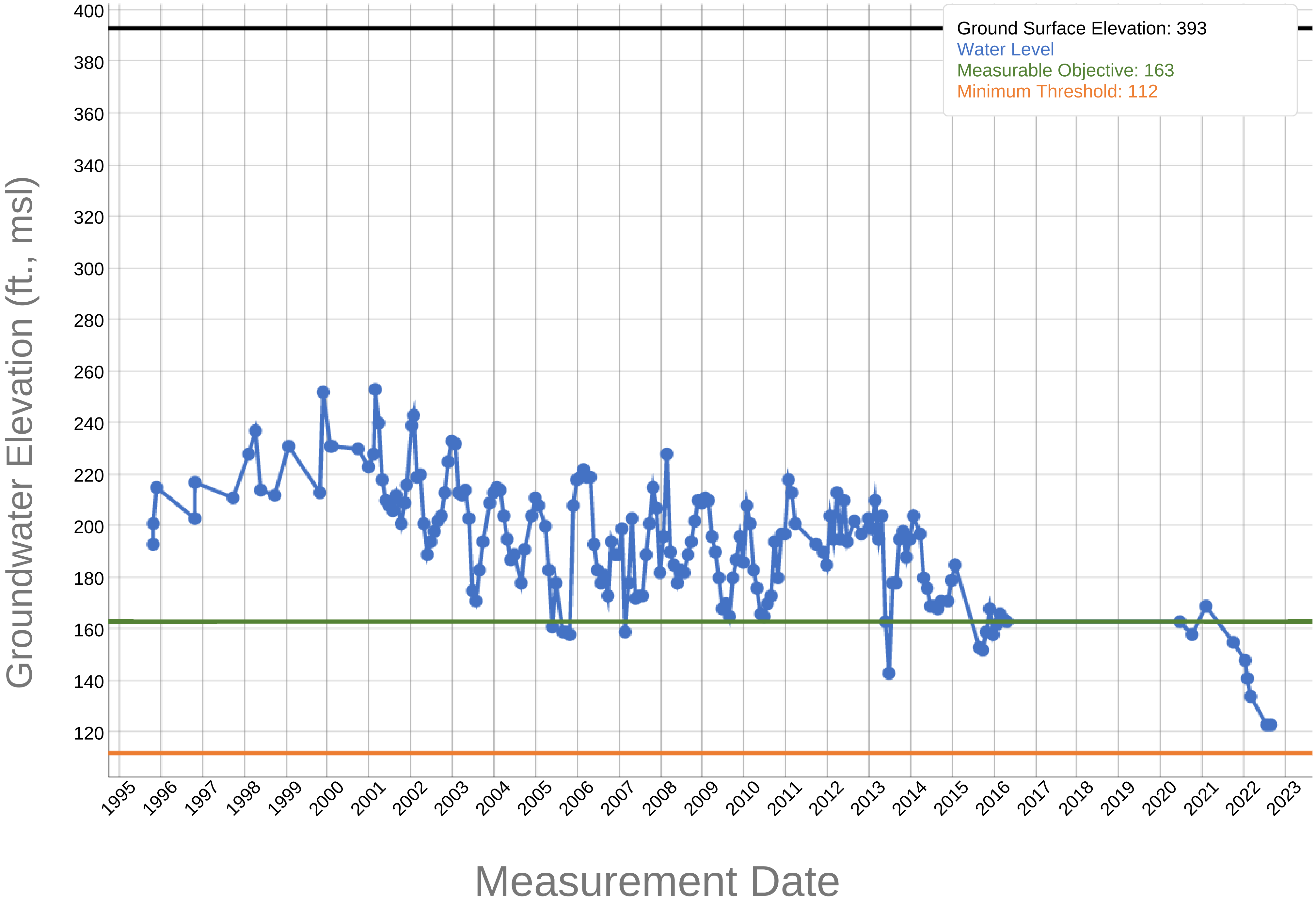
Measurement Date

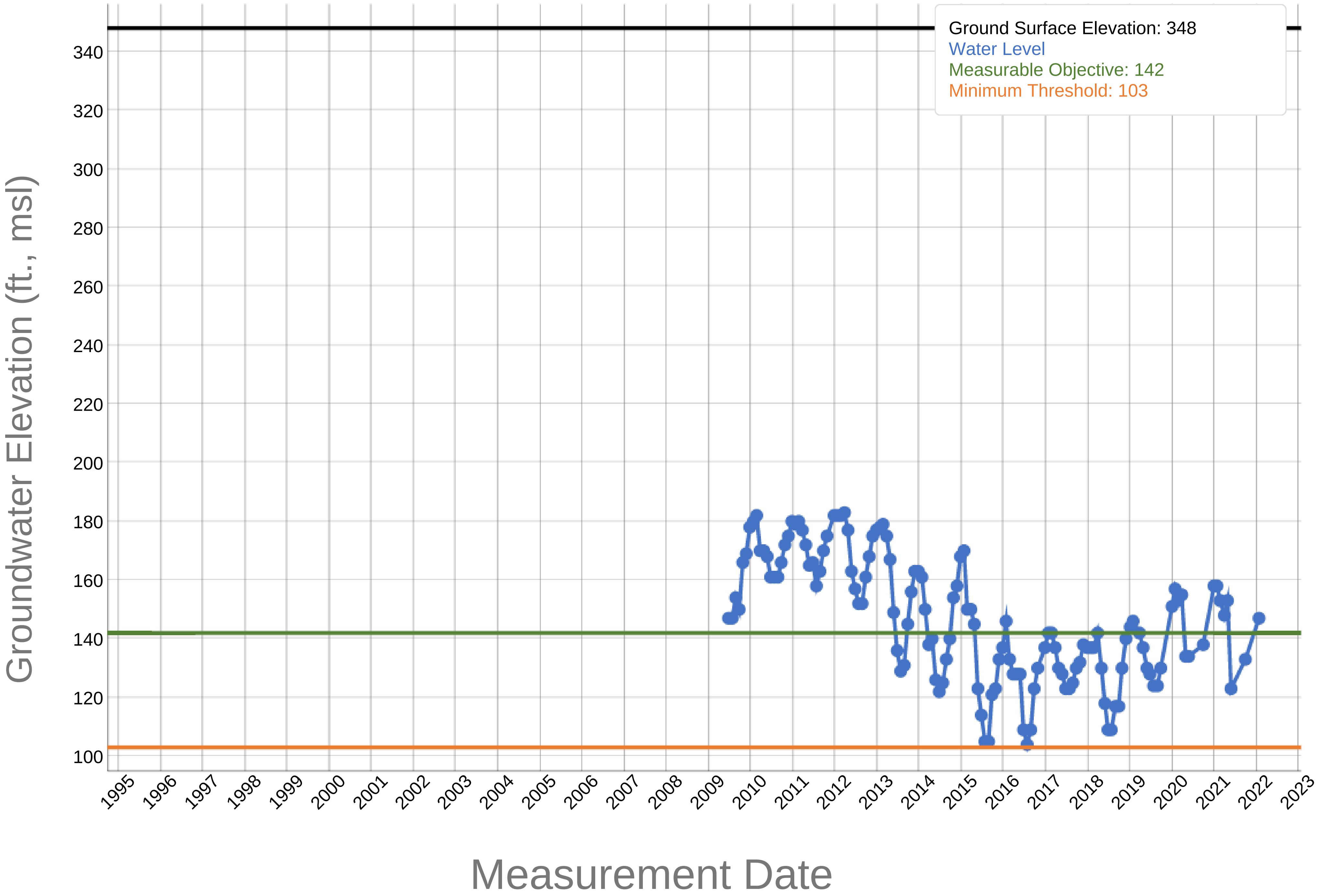
A4-26

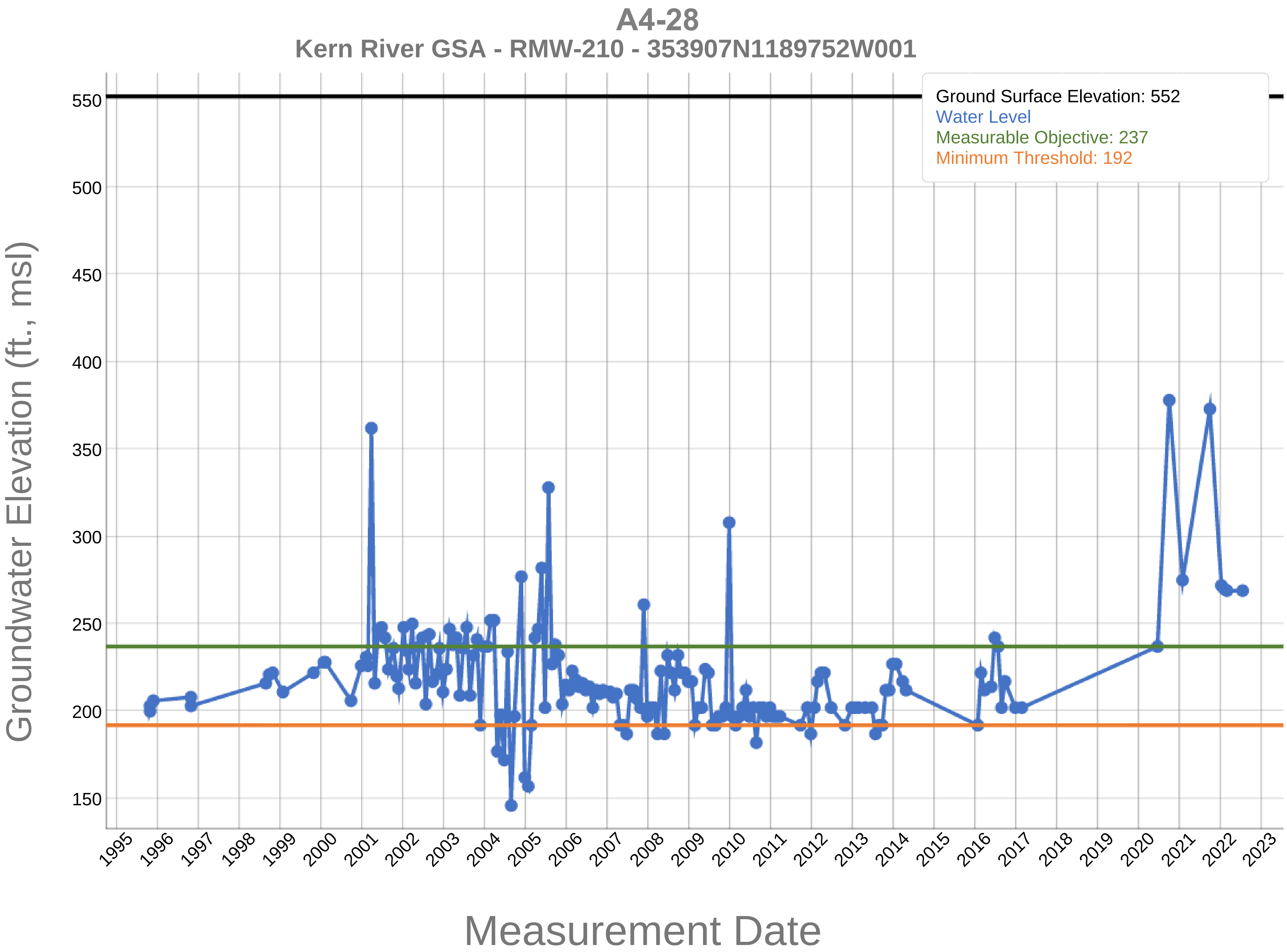
Kern River GSA - RMW-201 - 353941N1191043W001



A4-27

Kern River GSA - RMW-202 - 352662N1190015W001




A4-28
Kern River GSA - RMW-210 - 353907N1189752W001
Ground Surface Elevation: 552
Water Level
Measurable Objective: 237
Minimum Threshold: 192
Groundwater Elevation (ft., msl)
550
500
450
400
350
300
250
200
150
1995
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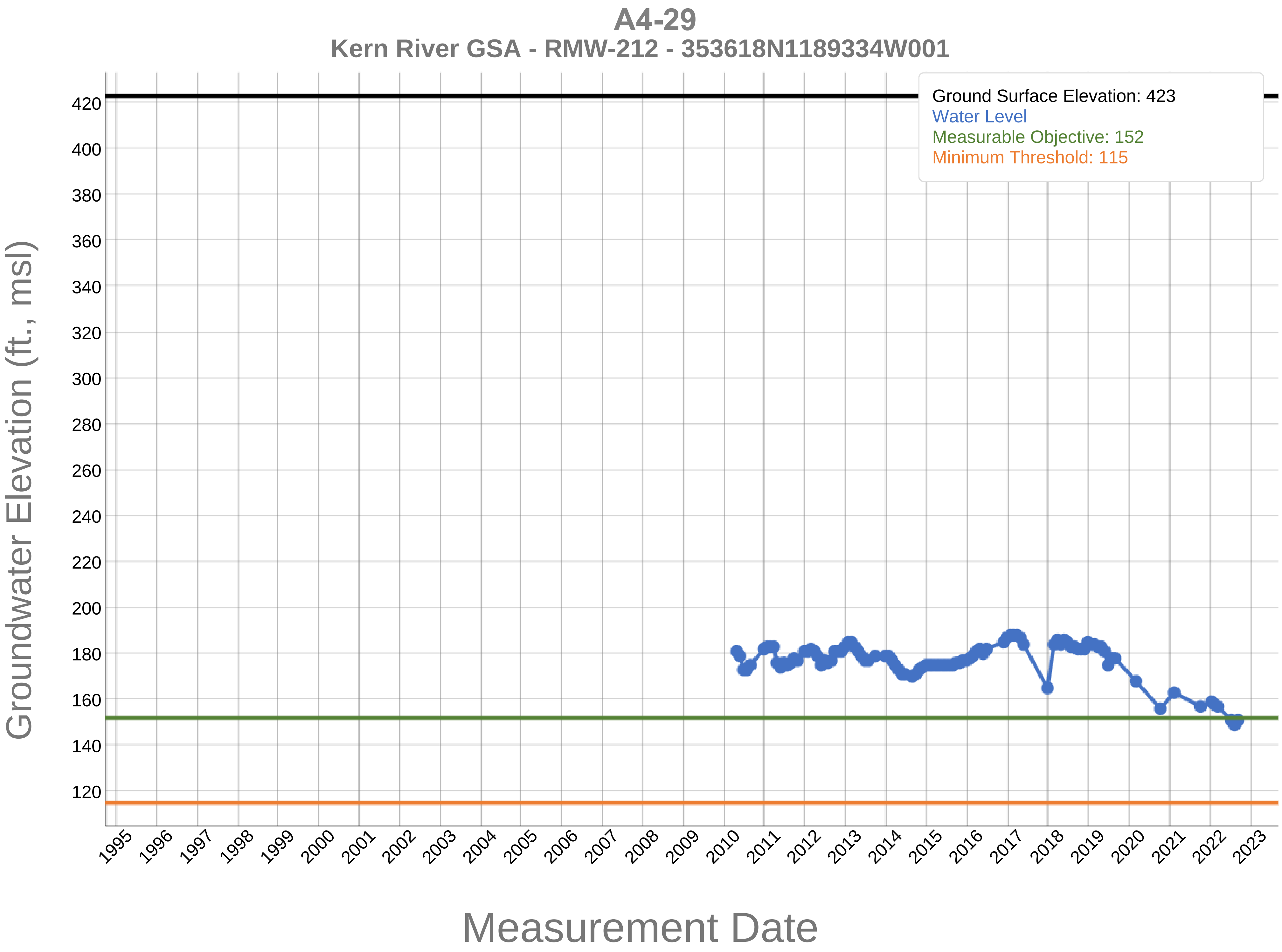
Measurement Date



A4-29
Kern River GSA - RMW-212 - 353618N1189334W001
Ground Surface Elevation: 423
Water Level
Measurable Objective: 152
Minimum Threshold: 115
Groundwater Elevation (ft., msl)
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
1995
1996
1997
1998
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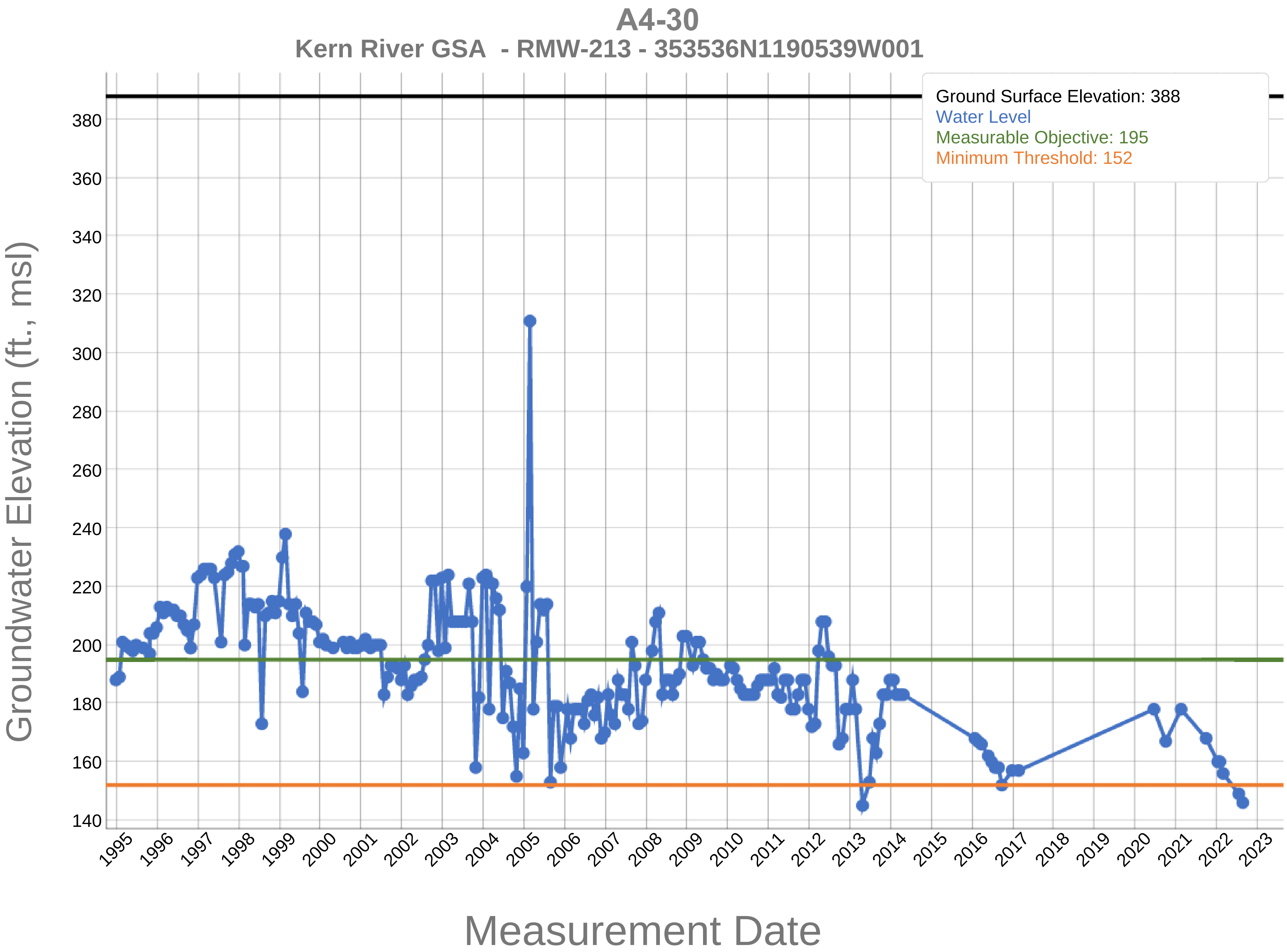
Measurement Date



A4-30
Kern River GSA - RMW-213 - 353536N1190539W001
Ground Surface Elevation: 388
Water Level
Measurable Objective: 195
Minimum Threshold: 152
Groundwater Elevation (ft., msl)
380
360
340
320
300
280
260
240
220
200
180
160
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1995
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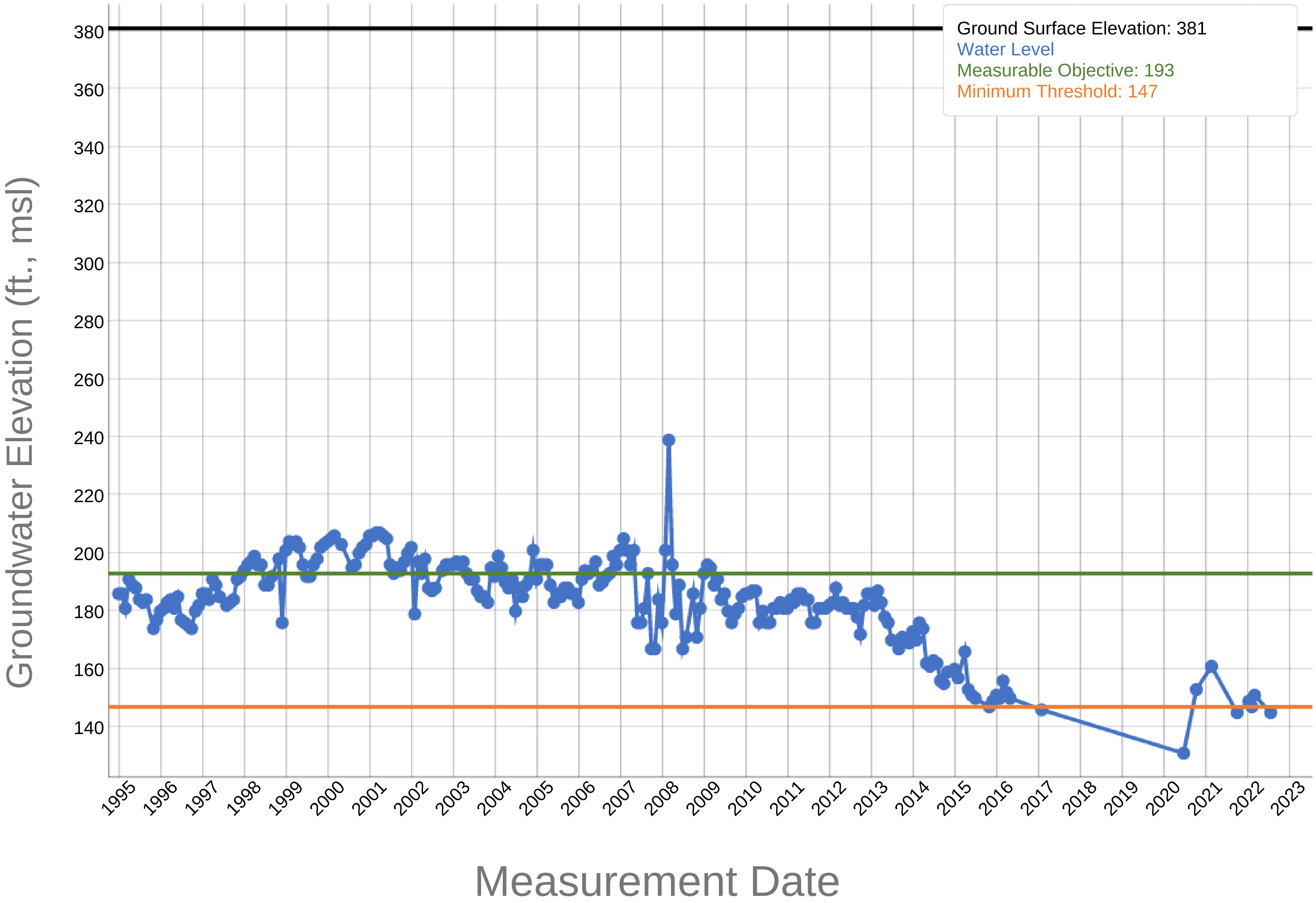
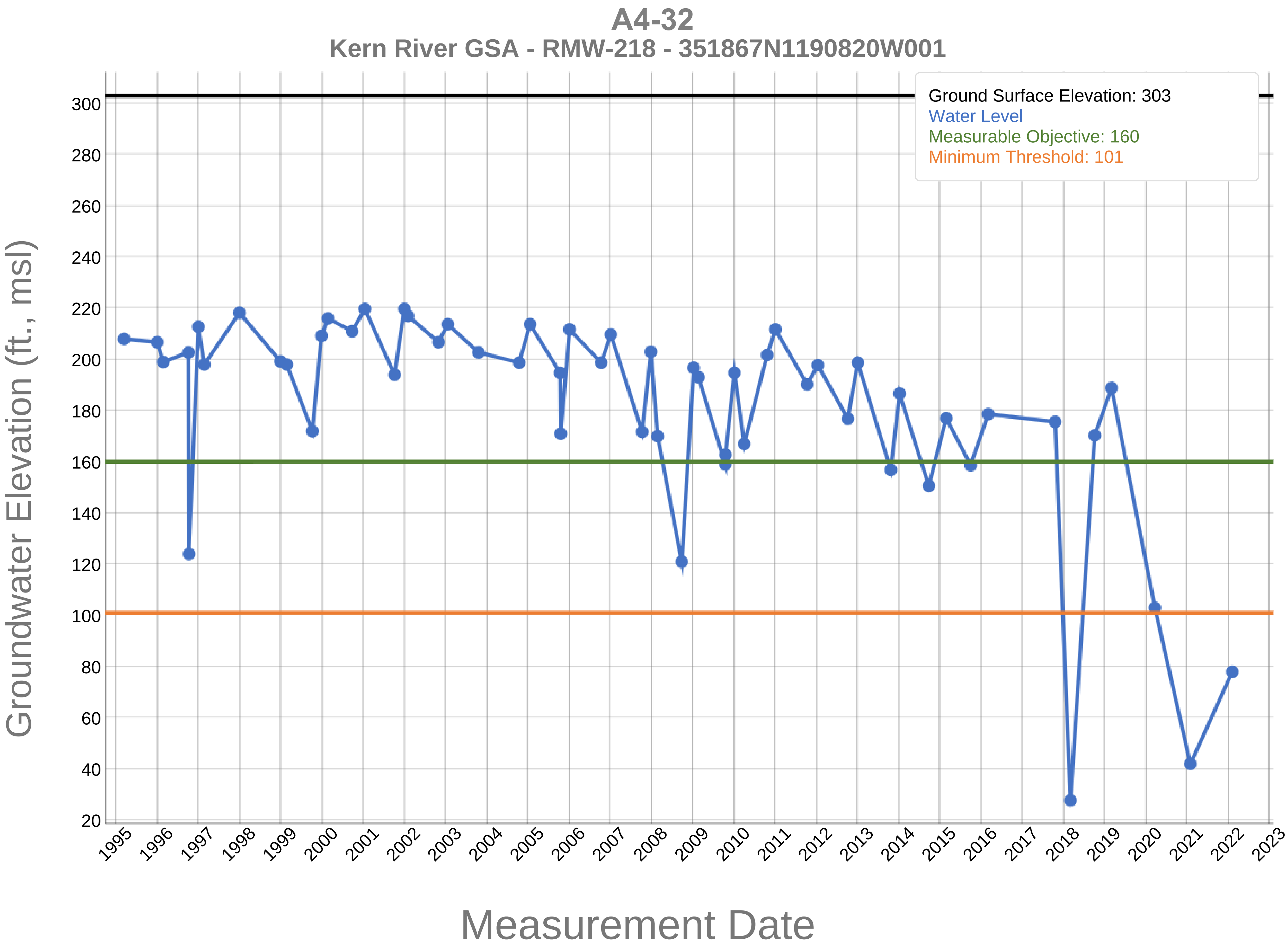
Measurement Date

A4-31

Kern River GSA - RMW-214 - 353286N1190221W001




A4-32
Kern River GSA - RMW-218 - 351867N1190820W001
Ground Surface Elevation: 303
Water Level
Measurable Objective: 160
Minimum Threshold: 101
Groundwater Elevation (ft., msl)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
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1995
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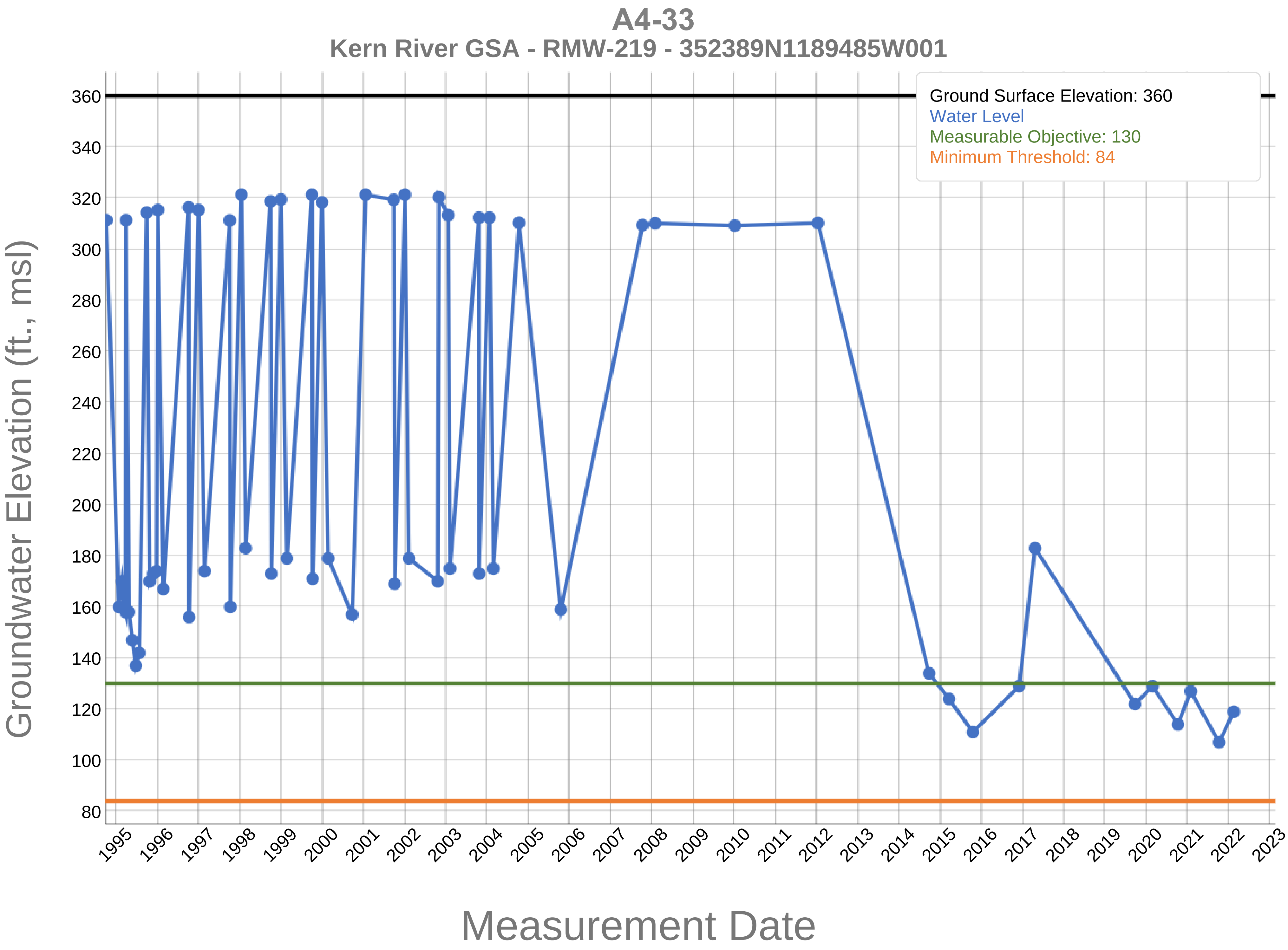
Measurement Date



A4-33
Kern River GSA - RMW-219 - 352389N1189485W001
Ground Surface Elevation: 360
Water Level
Measurable Objective: 130
Minimum Threshold: 84
Groundwater Elevation (ft., msl)
Measurement Date
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
1995
1996
1997
1998
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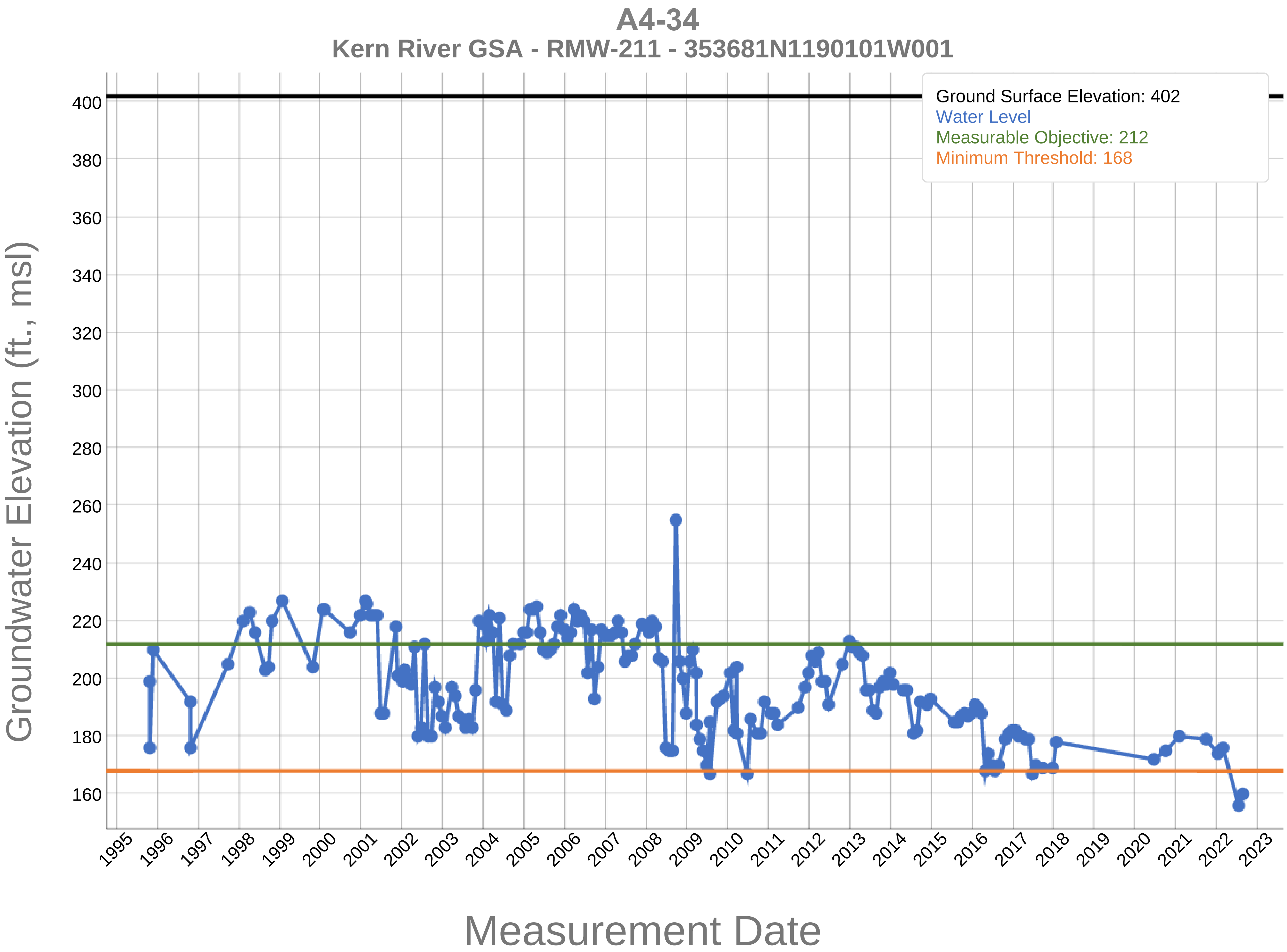
A4-34
Kern River GSA - RMW-211 - 353681N1190101W001
Ground Surface Elevation: 402
Water Level
Measurable Objective: 212
Minimum Threshold: 168
Groundwater Elevation (ft., msl)
160
180
200
220
240
260
280
300
320
340
360
380
400
1995
1996
1997
1998
1999
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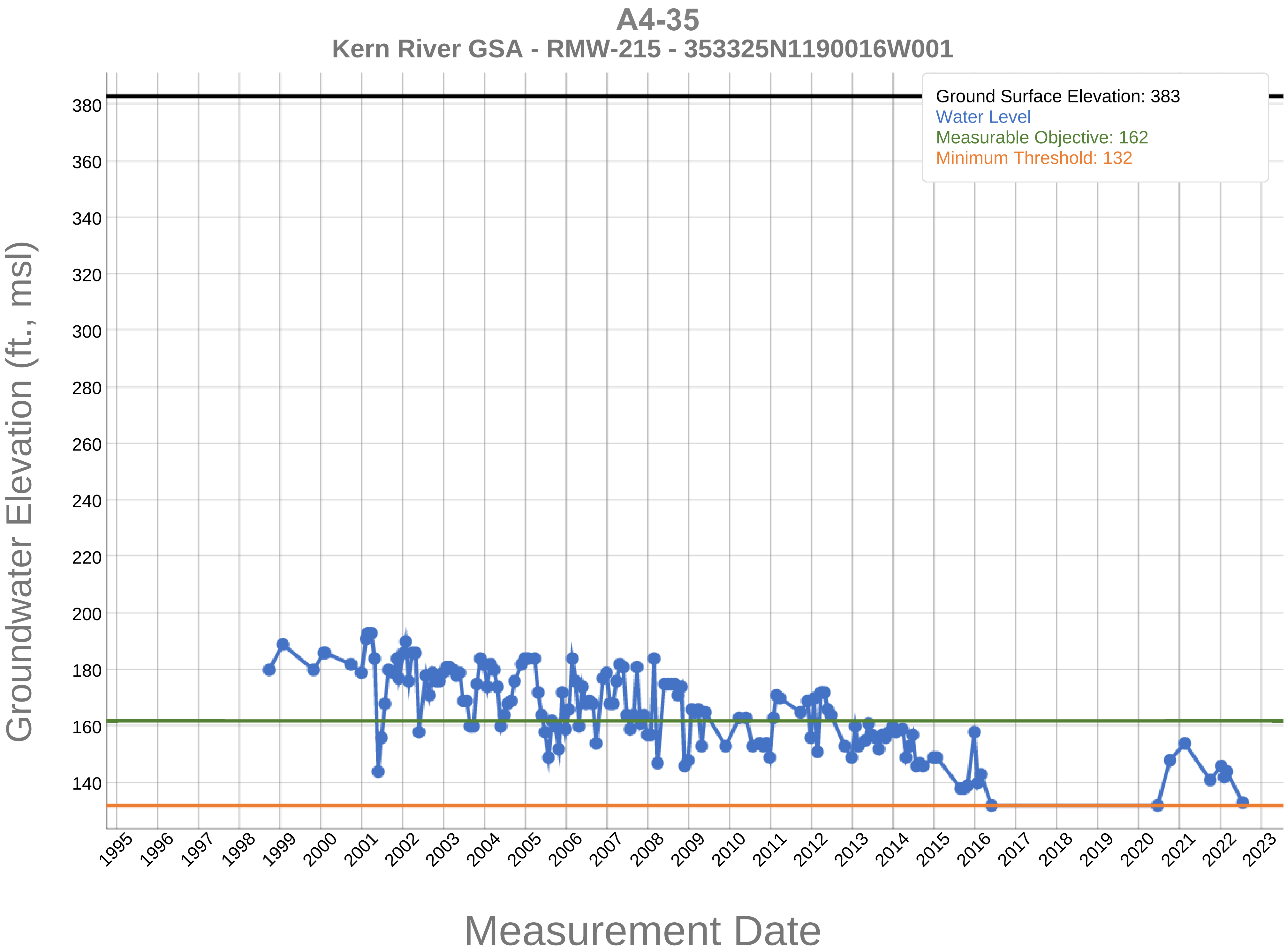
Measurement Date



A4-35
Kern River GSA - RMW-215 - 353325N1190016W001
Ground Surface Elevation: 383
Water Level
Measurable Objective: 162
Minimum Threshold: 132
Groundwater Elevation (ft., msl)
380
360
340
320
300
280
260
240
220
200
180
160
140
1995
1996
1997
1998
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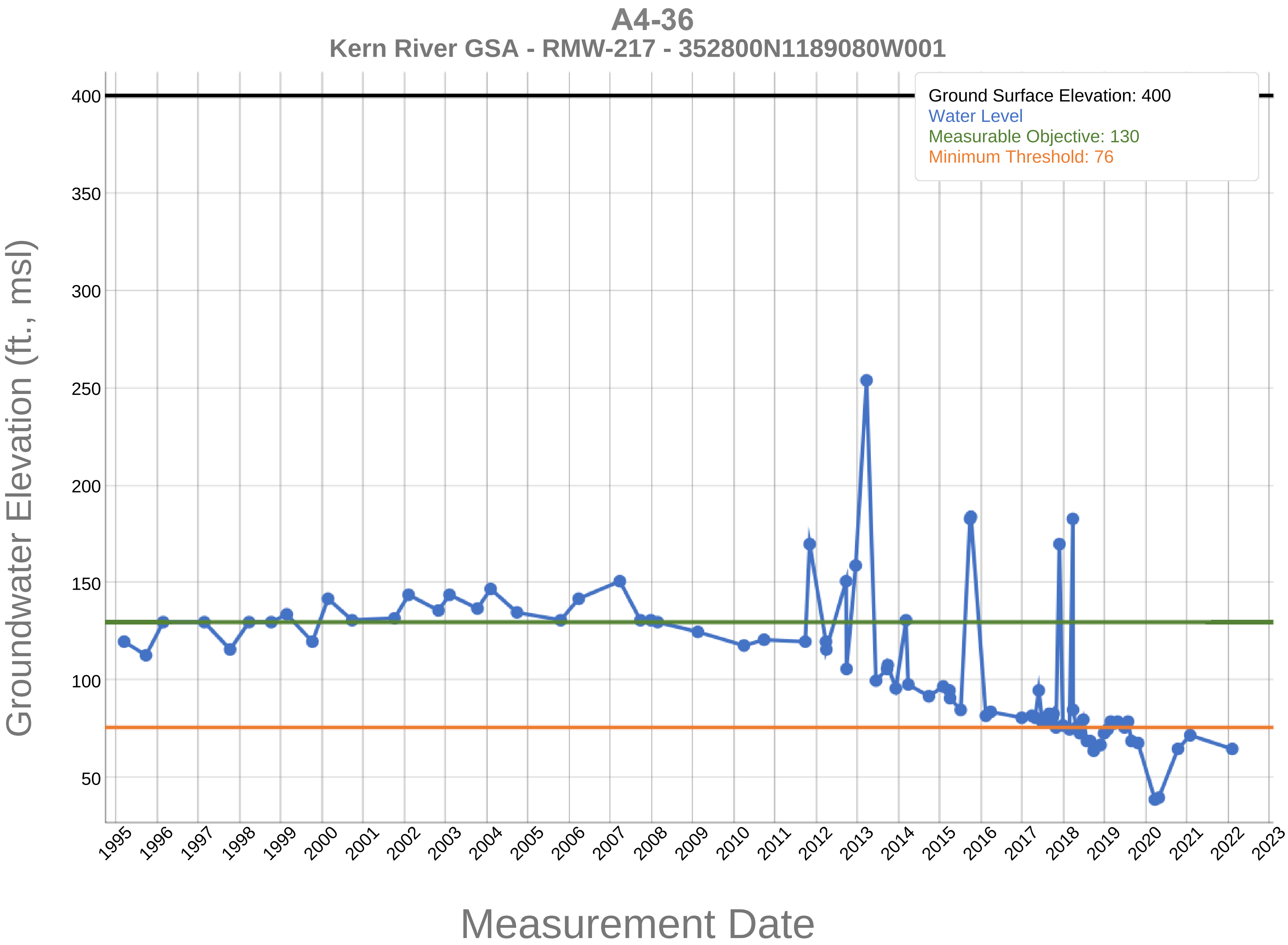
Measurement Date



A4-36
Kern River GSA - RMW-217 - 352800N1189080W001
Ground Surface Elevation: 400
Water Level
Measurable Objective: 130
Minimum Threshold: 76
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
1995
1996
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1999
2000
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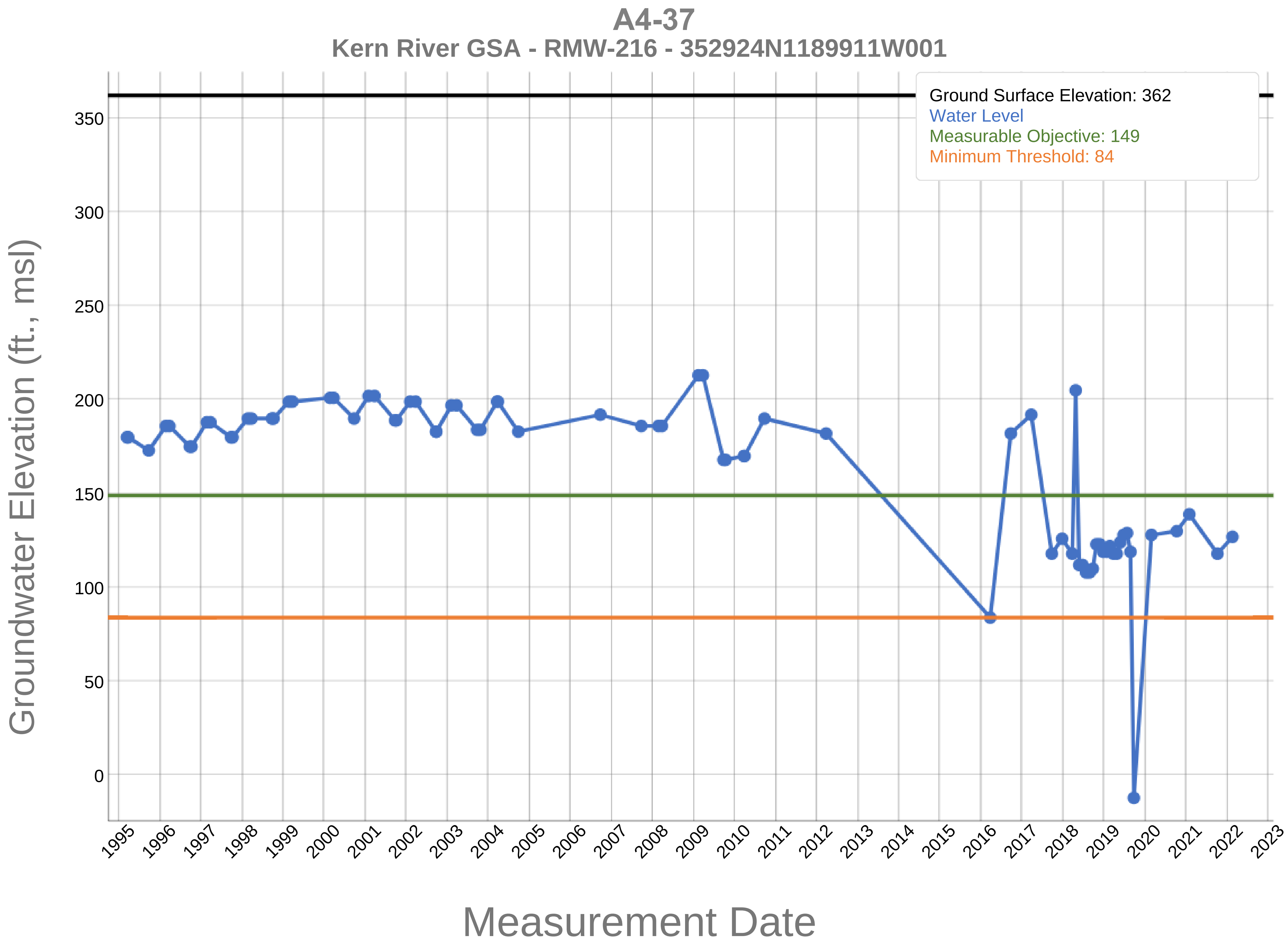
Measurement Date



A4-37
Kern River GSA - RMW-216 - 352924N1189911W001
Ground Surface Elevation: 362
Water Level
Measurable Objective: 149
Minimum Threshold: 84
Groundwater Elevation (ft., msl)
Measurement Date
0
50
100
150
200
250
300
350
1995
1996
1997
1998
1999
2000
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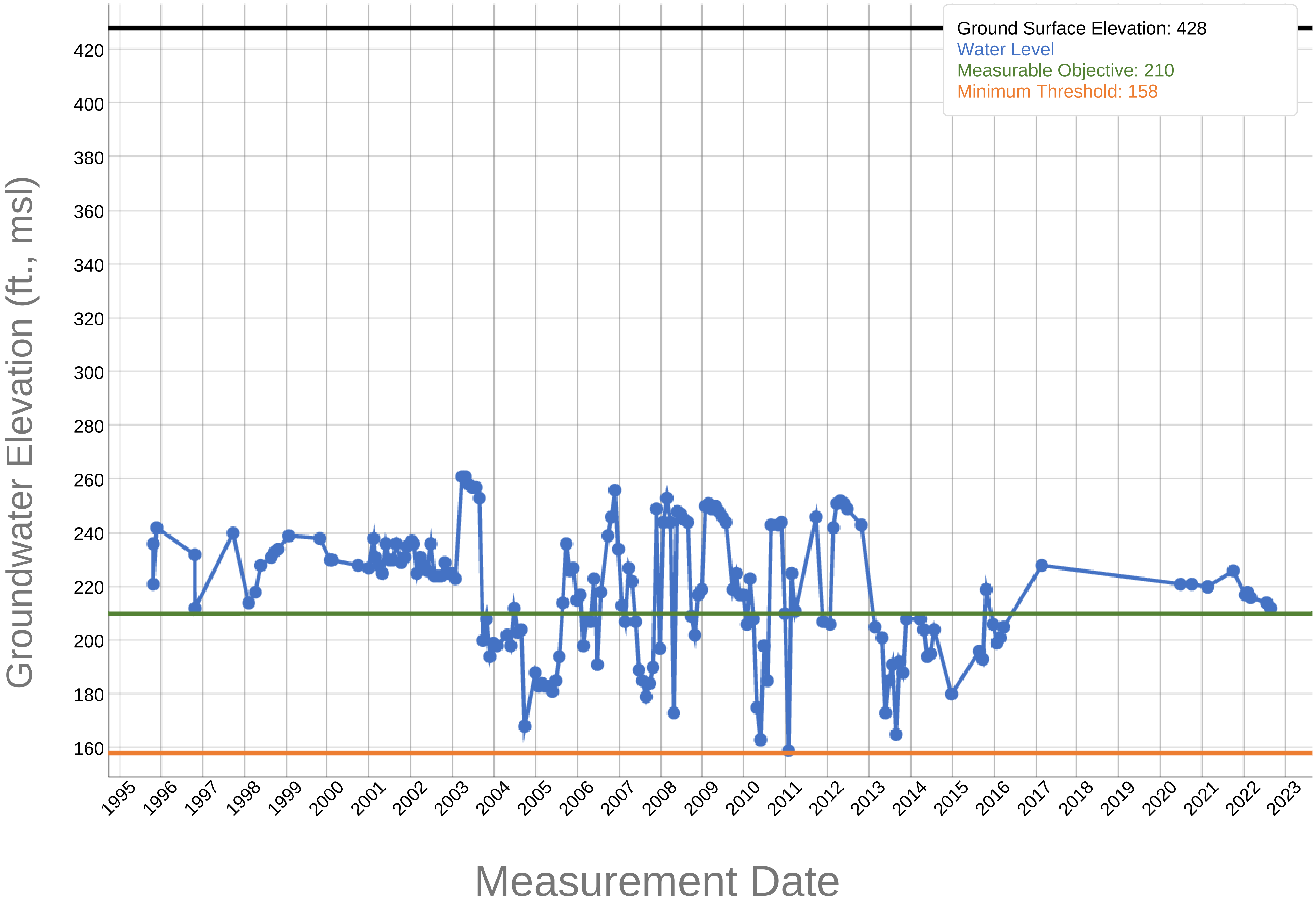
A4-38

Kern River GSA - RMW-209 - 354226N1190748W001

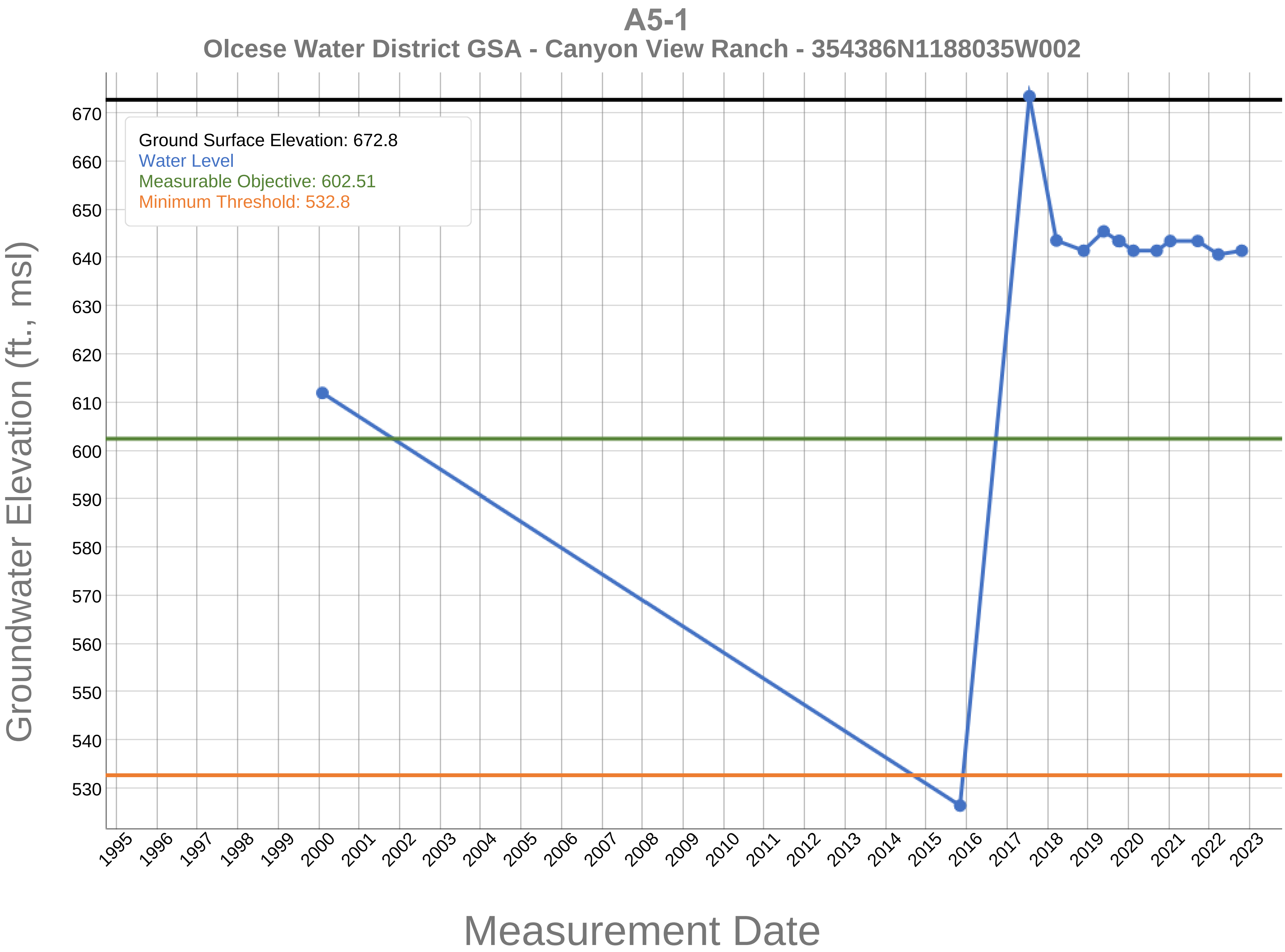


APPENDIX A5

Hydrographs of Groundwater Elevations

GSP Monitoring Network Wells

Olcese Water District GSA


A5-1
Olcese Water District GSA - Canyon View Ranch - 354386N1188035W002
Ground Surface Elevation: 672.8
Water Level
Measurable Objective: 602.51
Minimum Threshold: 532.8
Groundwater Elevation (ft., msl)
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
1995
1996
1997
1998
1999
2000
2001
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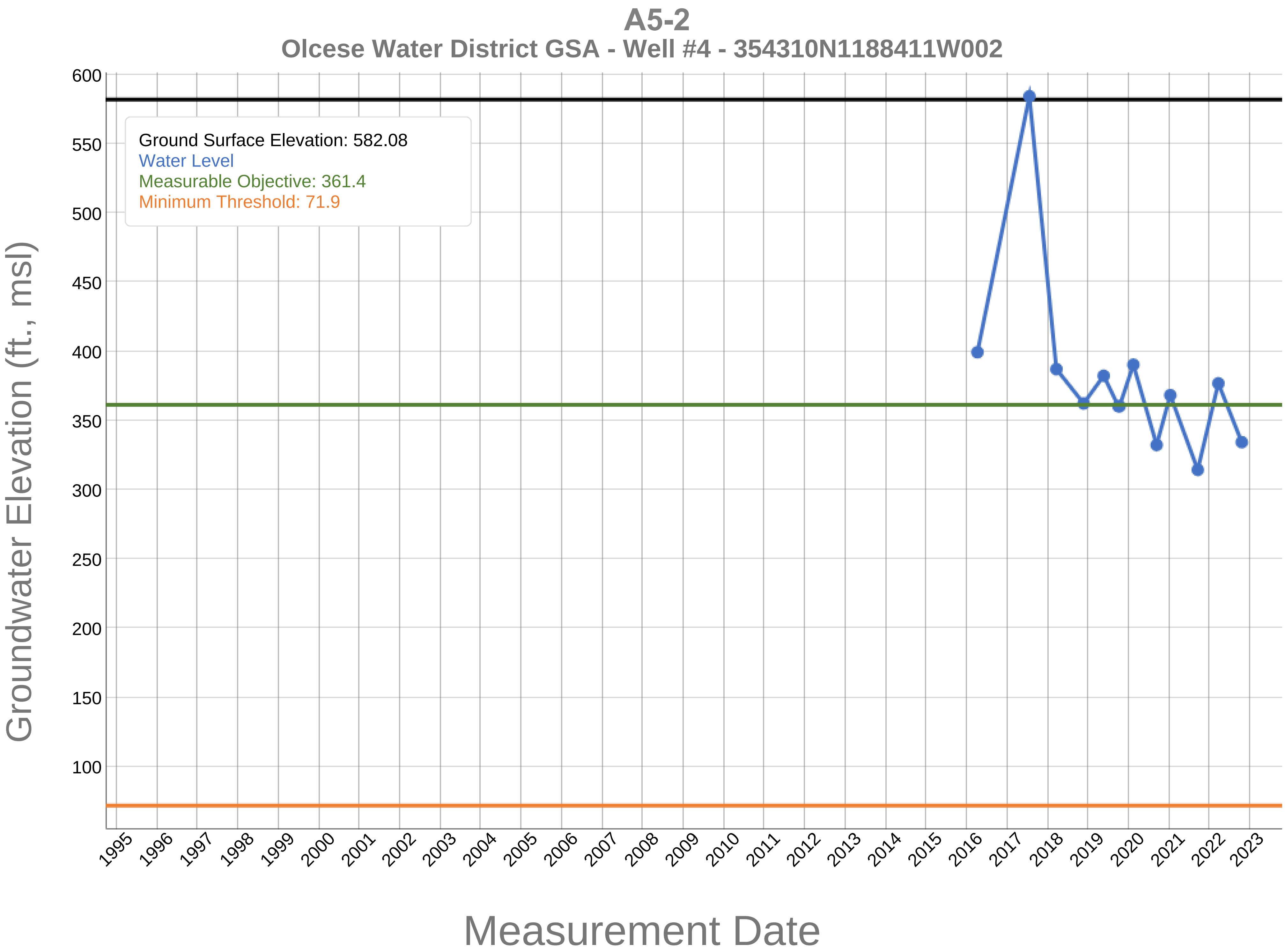
Measurement Date


A5-2
Olcese Water District GSA - Well #4 - 354310N1188411W002
Ground Surface Elevation: 582.08
Water Level
Measurable Objective: 361.4
Minimum Threshold: 71.9
Groundwater Elevation (ft., msl)
600
550
500
450
400
350
300
250
200
150
100
1995
1996
1997
1998
1999
2000
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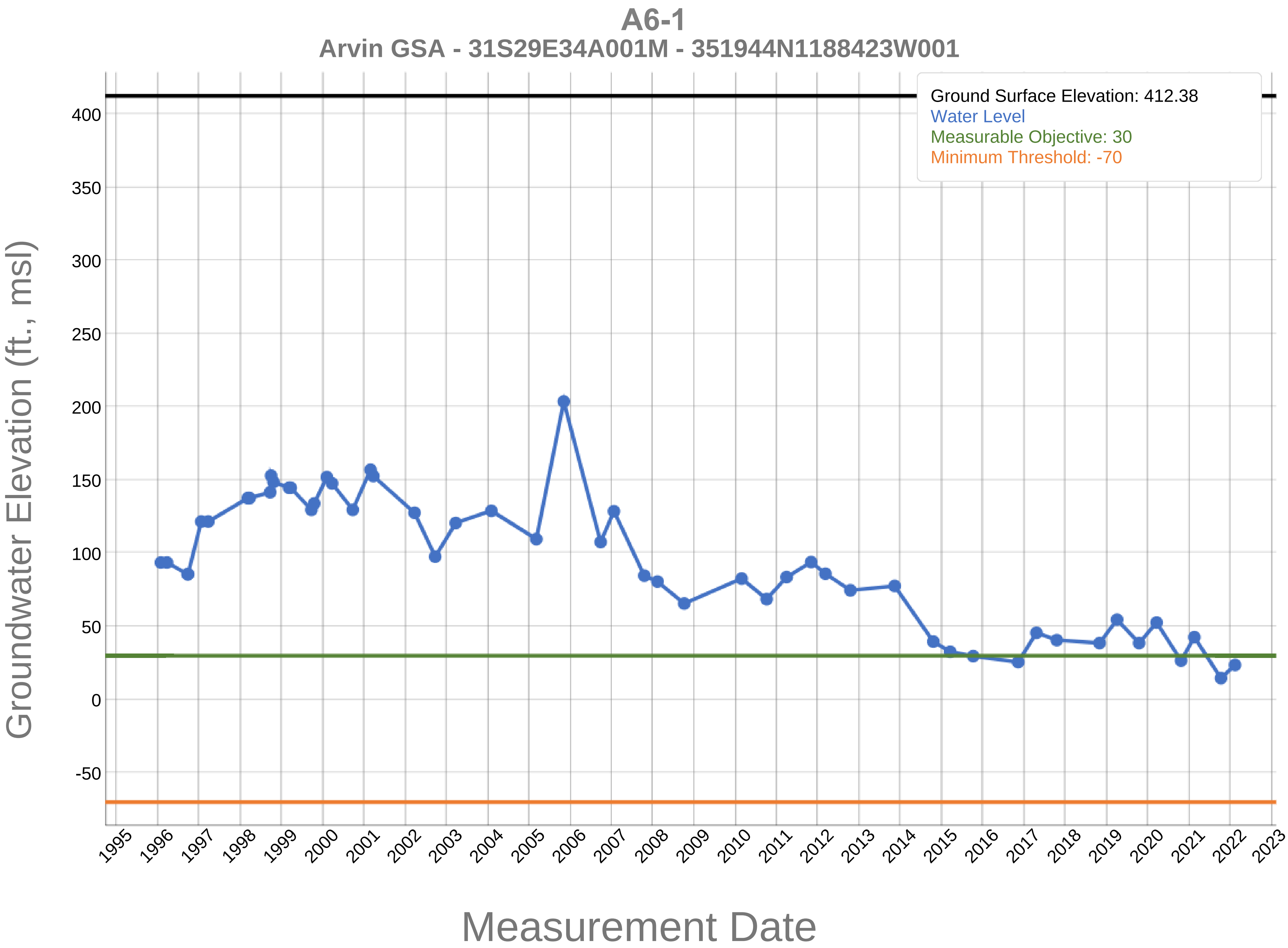
Measurement Date

APPENDIX A6

Hydrographs of Groundwater Elevations

GSP Monitoring Network Wells

South of Kern River GSAs



A6-1
Arvin GSA - 31S29E34A001M - 351944N1188423W001
Ground Surface Elevation: 412.38
Water Level
Measurable Objective: 30
Minimum Threshold: -70
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
2000
2001
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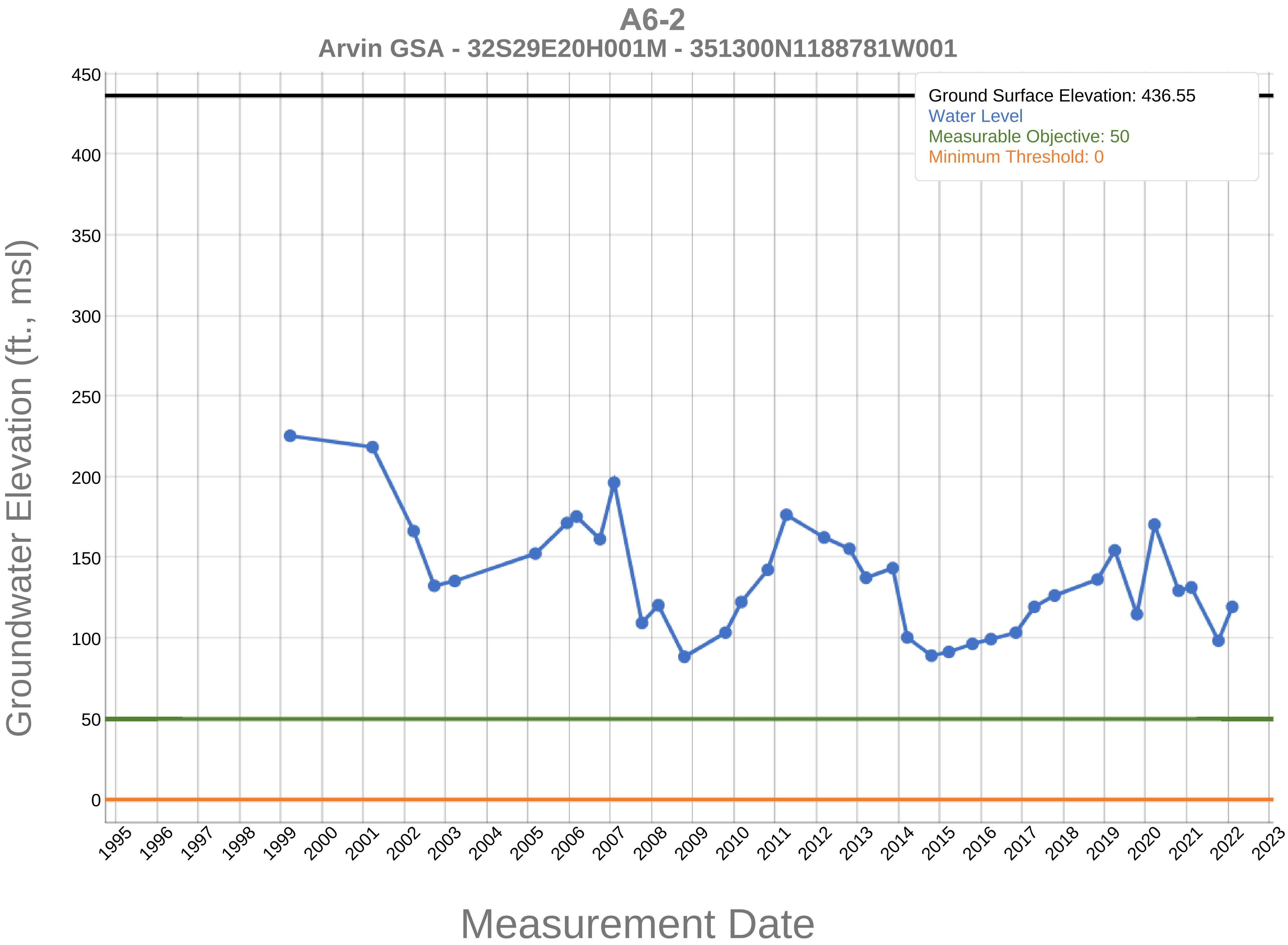
Measurement Date



A6-2
Arvin GSA - 32S29E20H001M - 351300N1188781W001
Ground Surface Elevation: 436.55
Water Level
Measurable Objective: 50
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
Measurement Date
450
400
350
300
250
200
150
100
50
0
1995
1996
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1998
1999
2000
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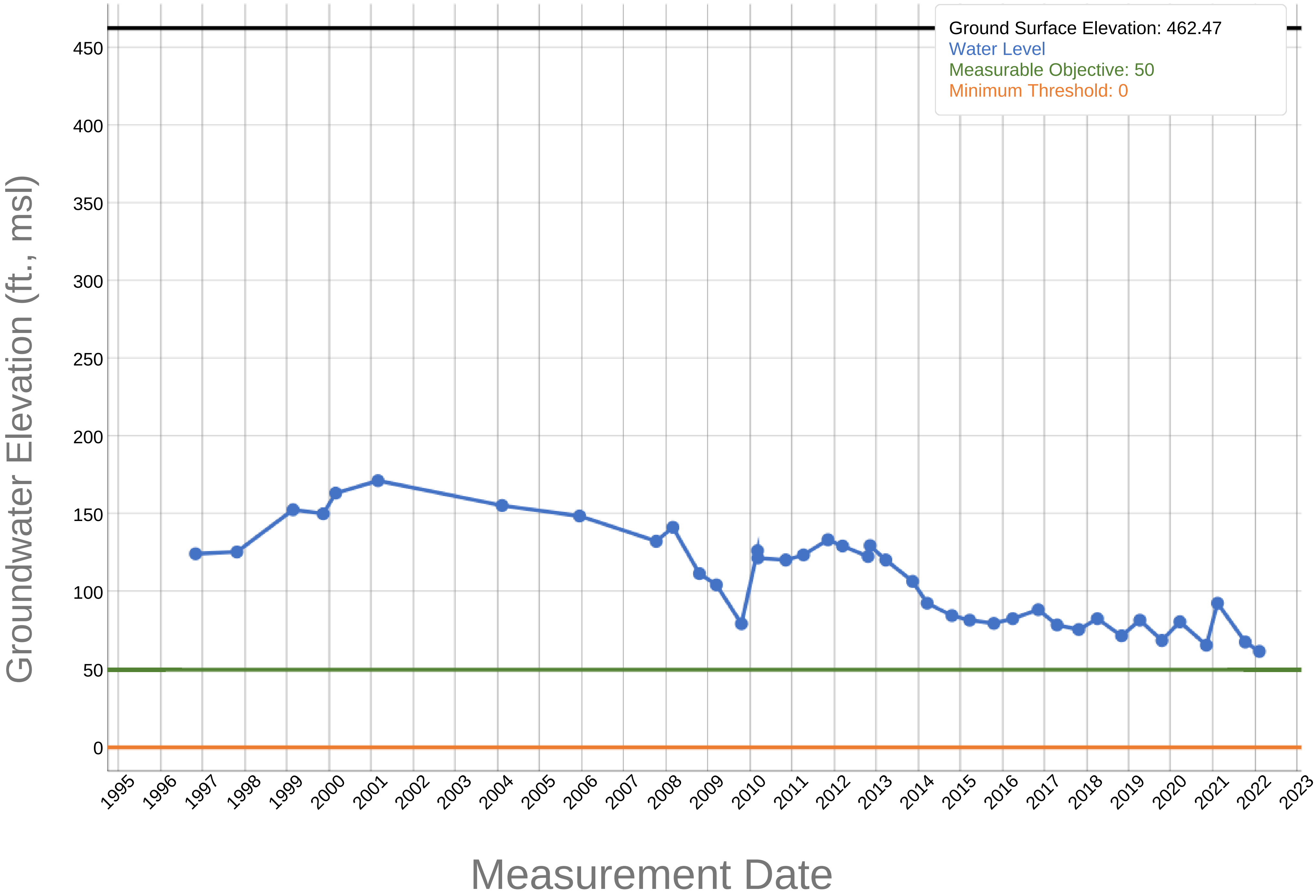
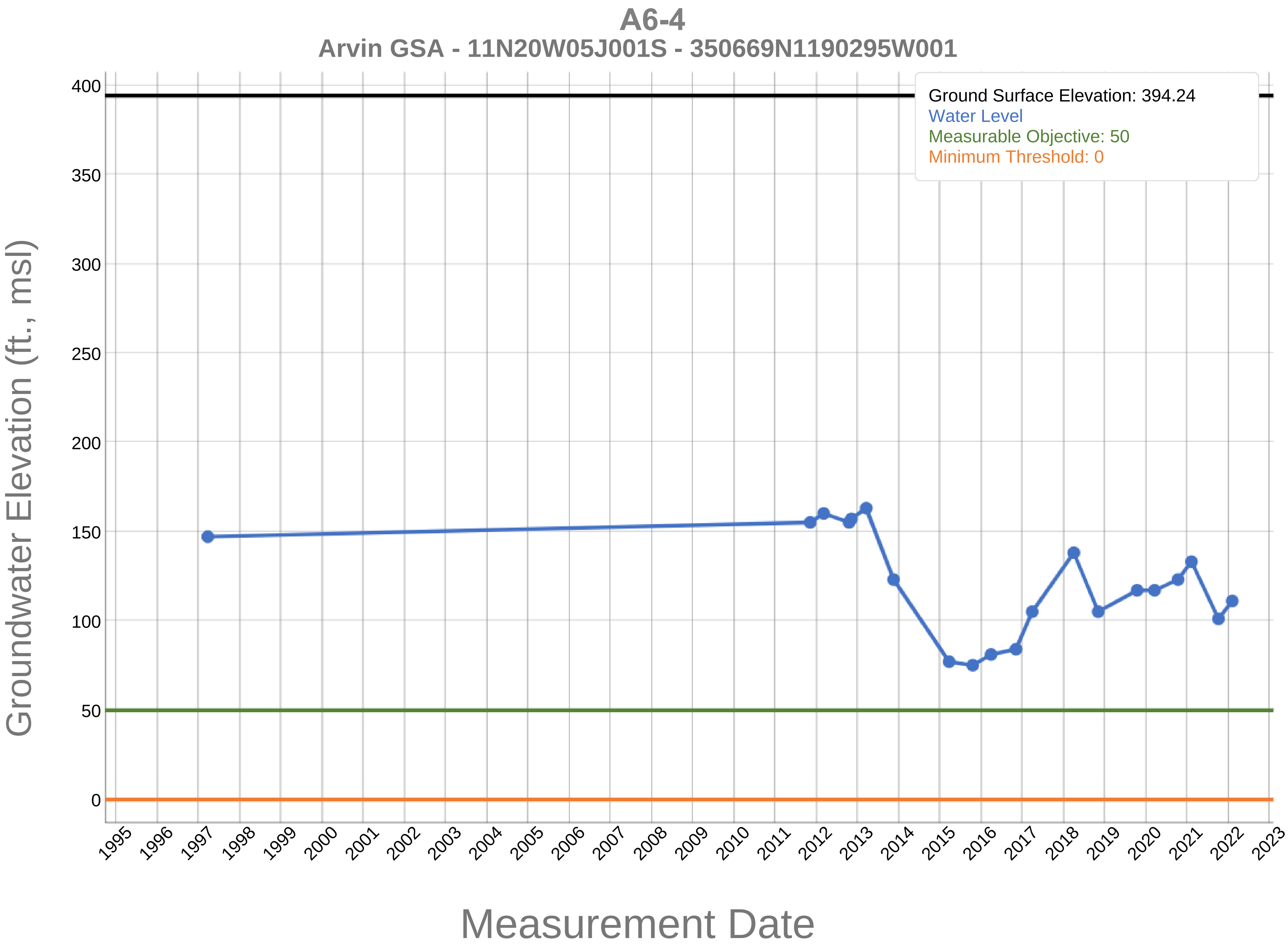
A6-3
Arvin GSA - 32S29E31N001M - 350931N1189123W001




A6-4
Arvin GSA - 11N20W05J001S - 350669N1190295W001
Ground Surface Elevation: 394.24
Water Level
Measurable Objective: 50
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
0
50
100
150
200
250
300
350
400
1995
1996
1997
1998
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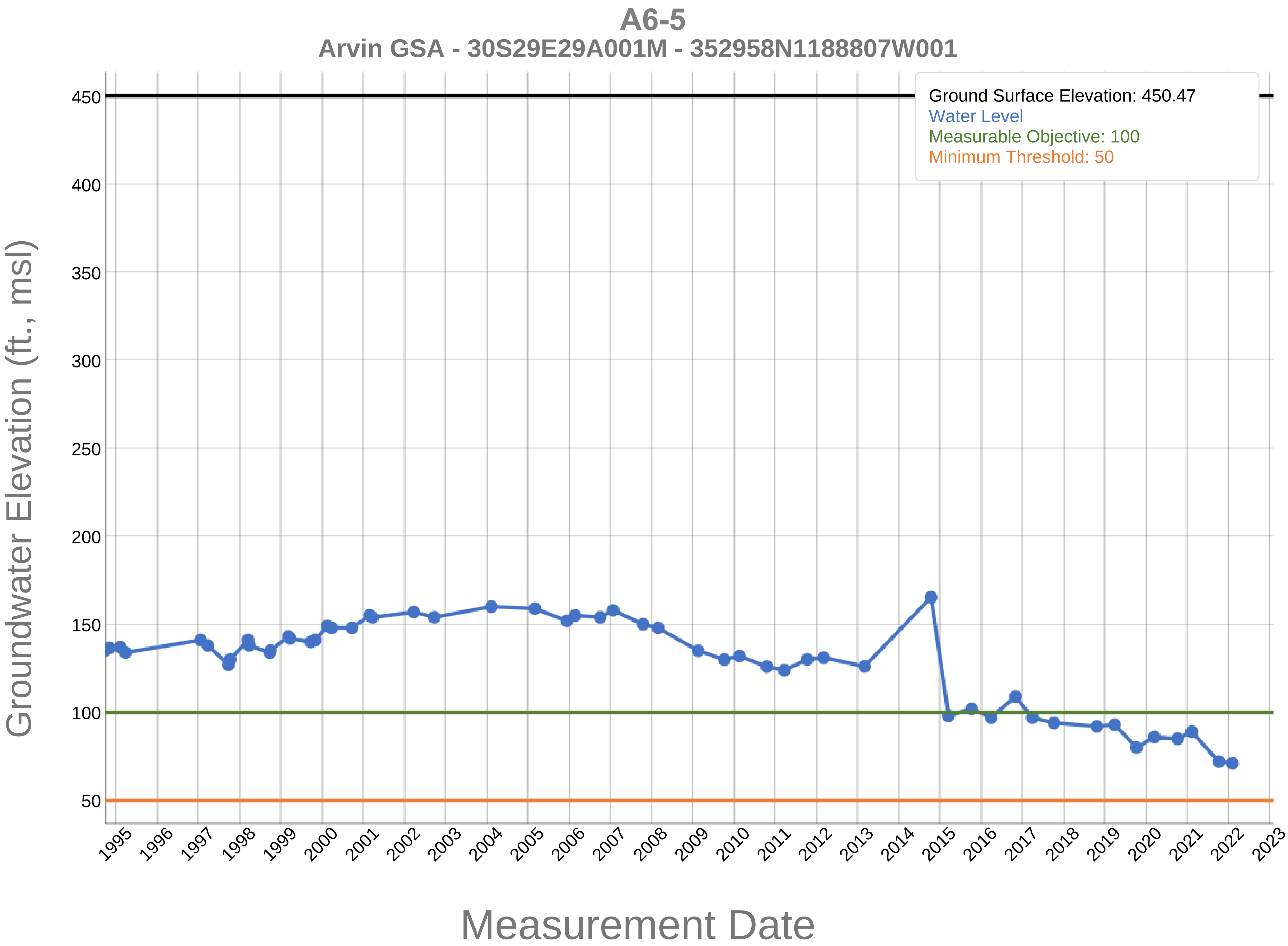
Measurement Date


A6-5
Arvin GSA - 30S29E29A001M - 352958N1188807W001
Ground Surface Elevation: 450.47
Water Level
Measurable Objective: 100
Minimum Threshold: 50
Groundwater Elevation (ft., msl)
450
400
350
300
250
200
150
100
50
1995
1996
1997
1998
1999
2000
2001
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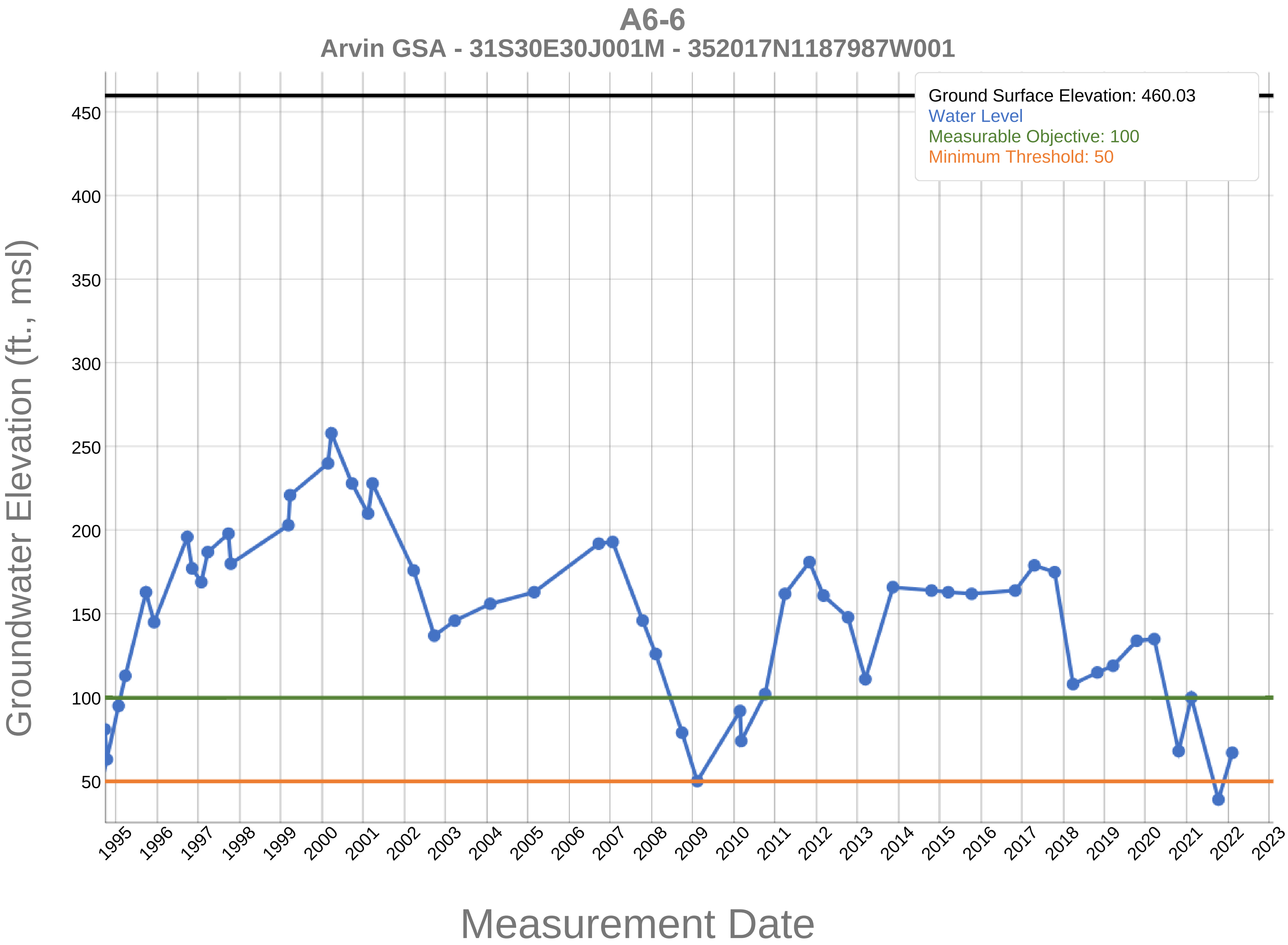
Measurement Date


A6-6
Arvin GSA - 31S30E30J001M - 352017N1187987W001
Ground Surface Elevation: 460.03
Water Level
Measurable Objective: 100
Minimum Threshold: 50
Groundwater Elevation (ft., msl)
450
400
350
300
250
200
150
100
50
1995
1996
1997
1998
1999
2000
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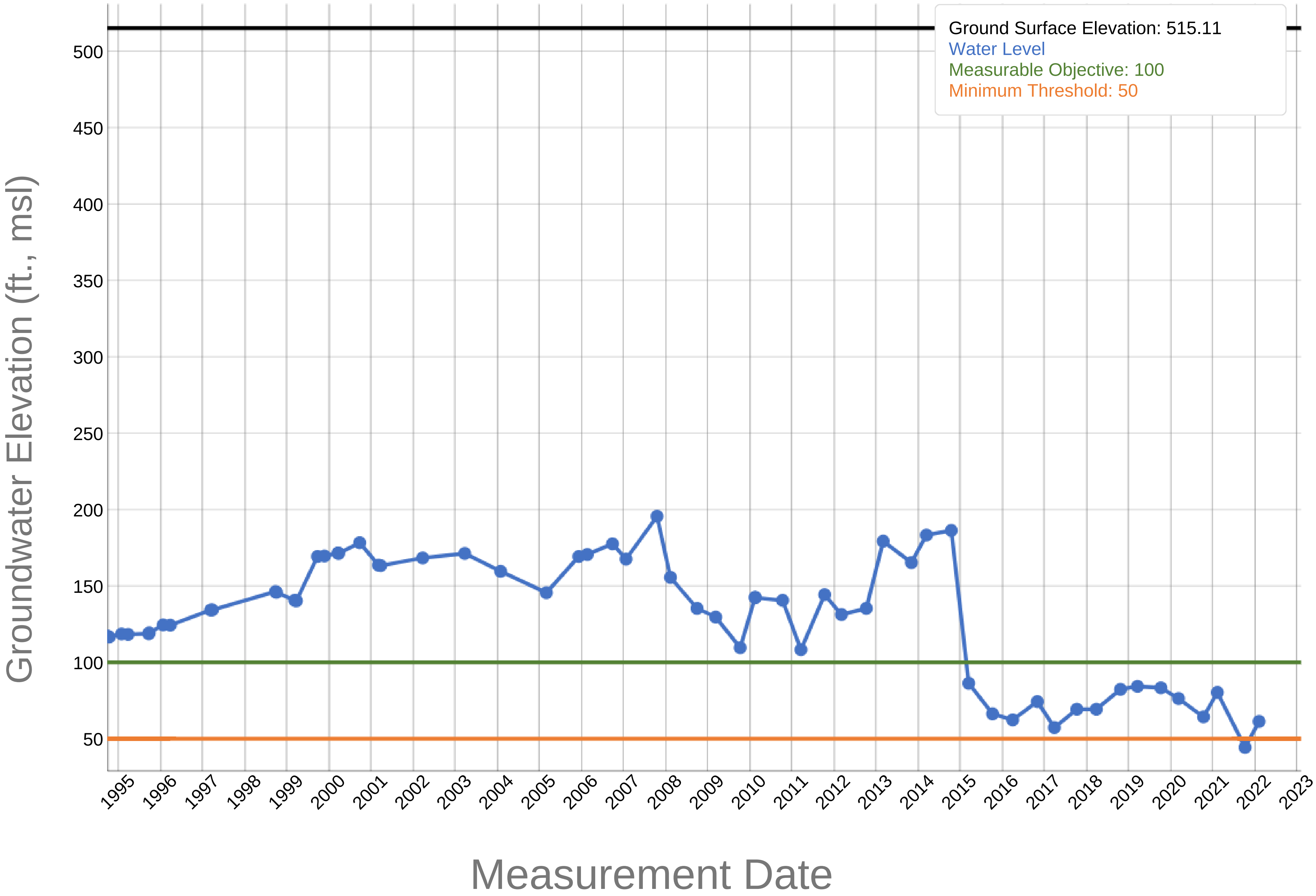
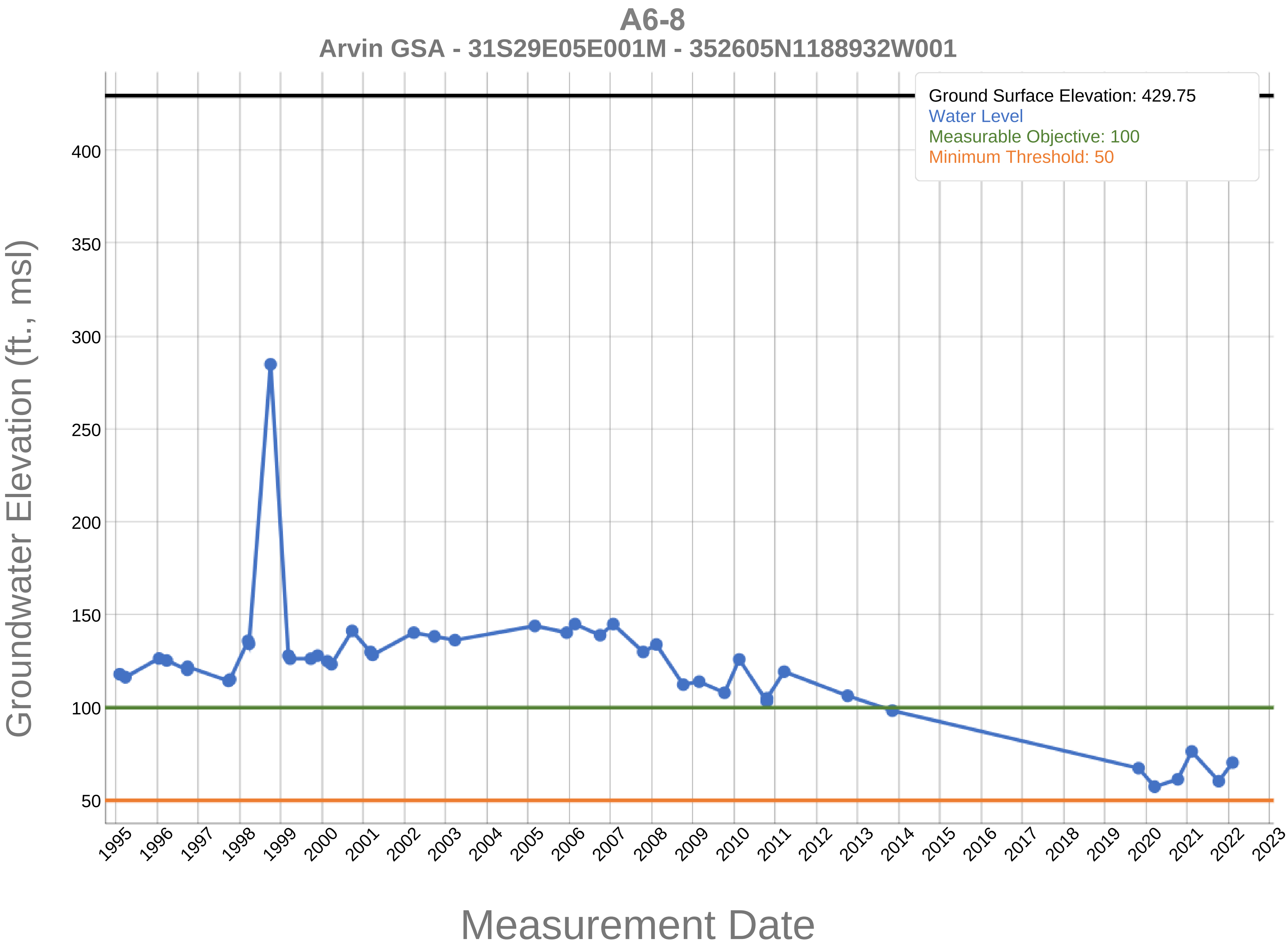
Measurement Date

A6-7

Arvin GSA - 31S29E12M001M - 352452N1188243W001




A6-8
Arvin GSA - 31S29E05E001M - 352605N1188932W001
Ground Surface Elevation: 429.75
Water Level
Measurable Objective: 100
Minimum Threshold: 50
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
1995
1996
1997
1998
1999
2000
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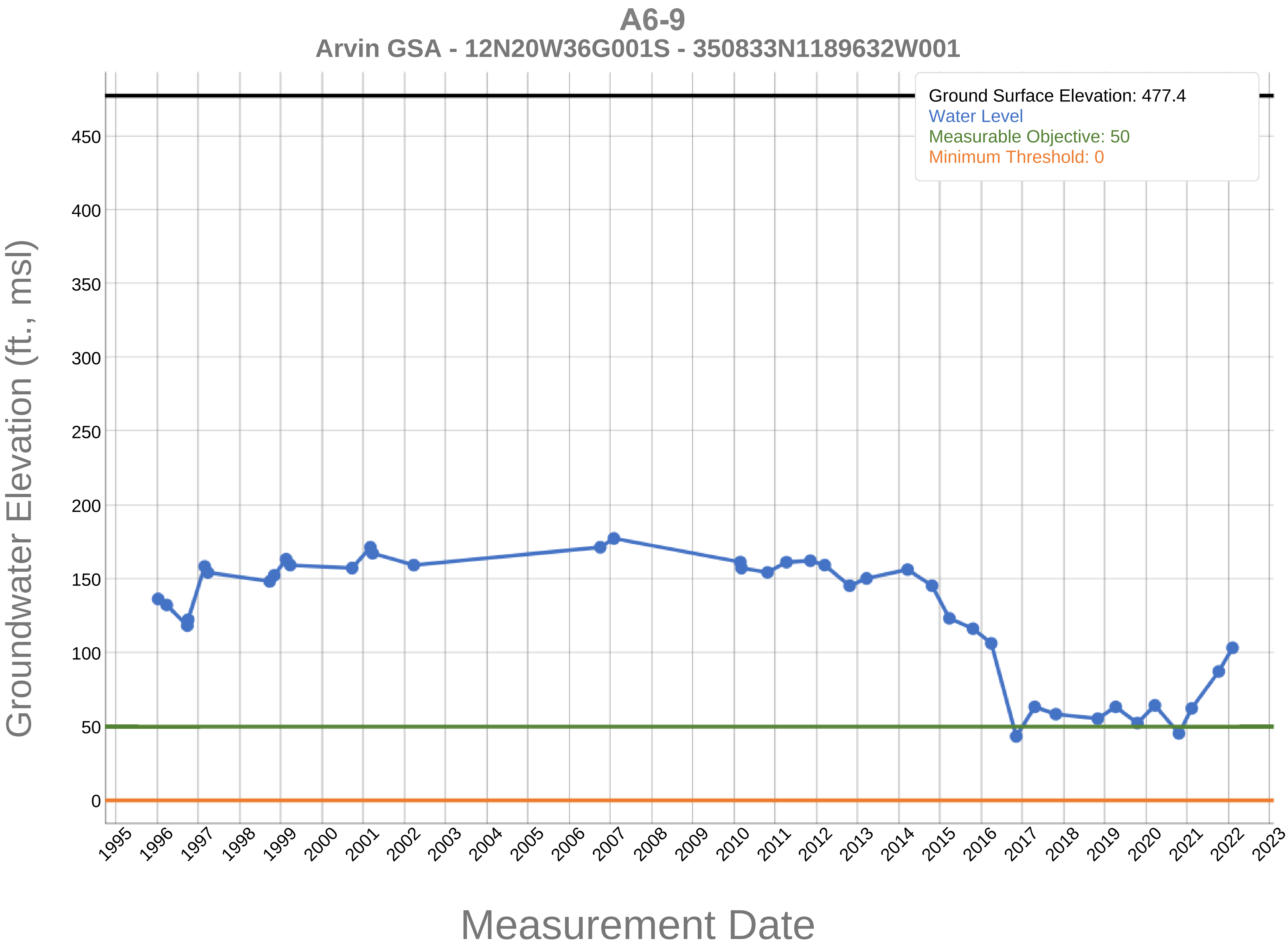
Measurement Date


A6-9
Arvin GSA - 12N20W36G001S - 350833N1189632W001
Ground Surface Elevation: 477.4
Water Level
Measurable Objective: 50
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
0
50
100
150
200
250
300
350
400
450
1995
1996
1997
1998
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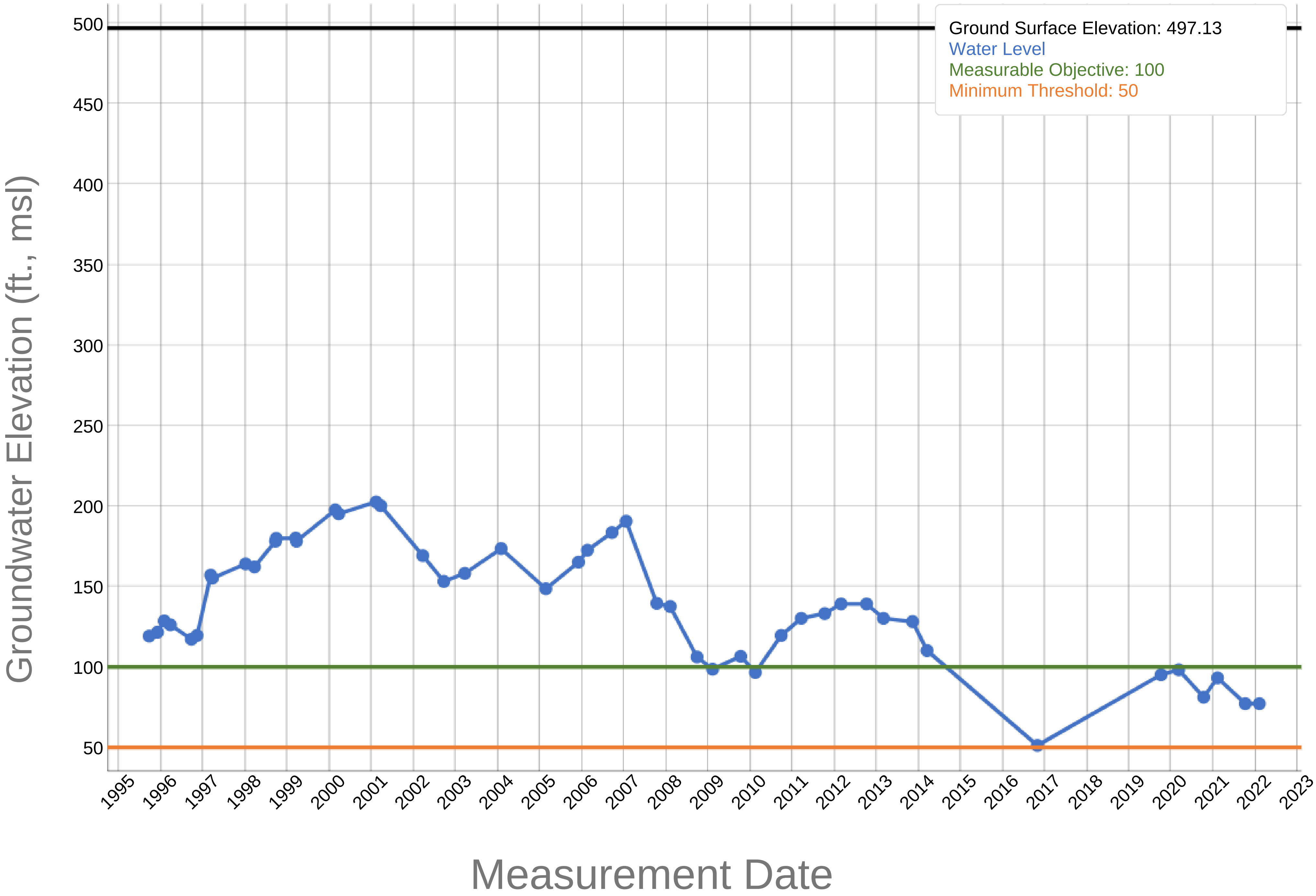
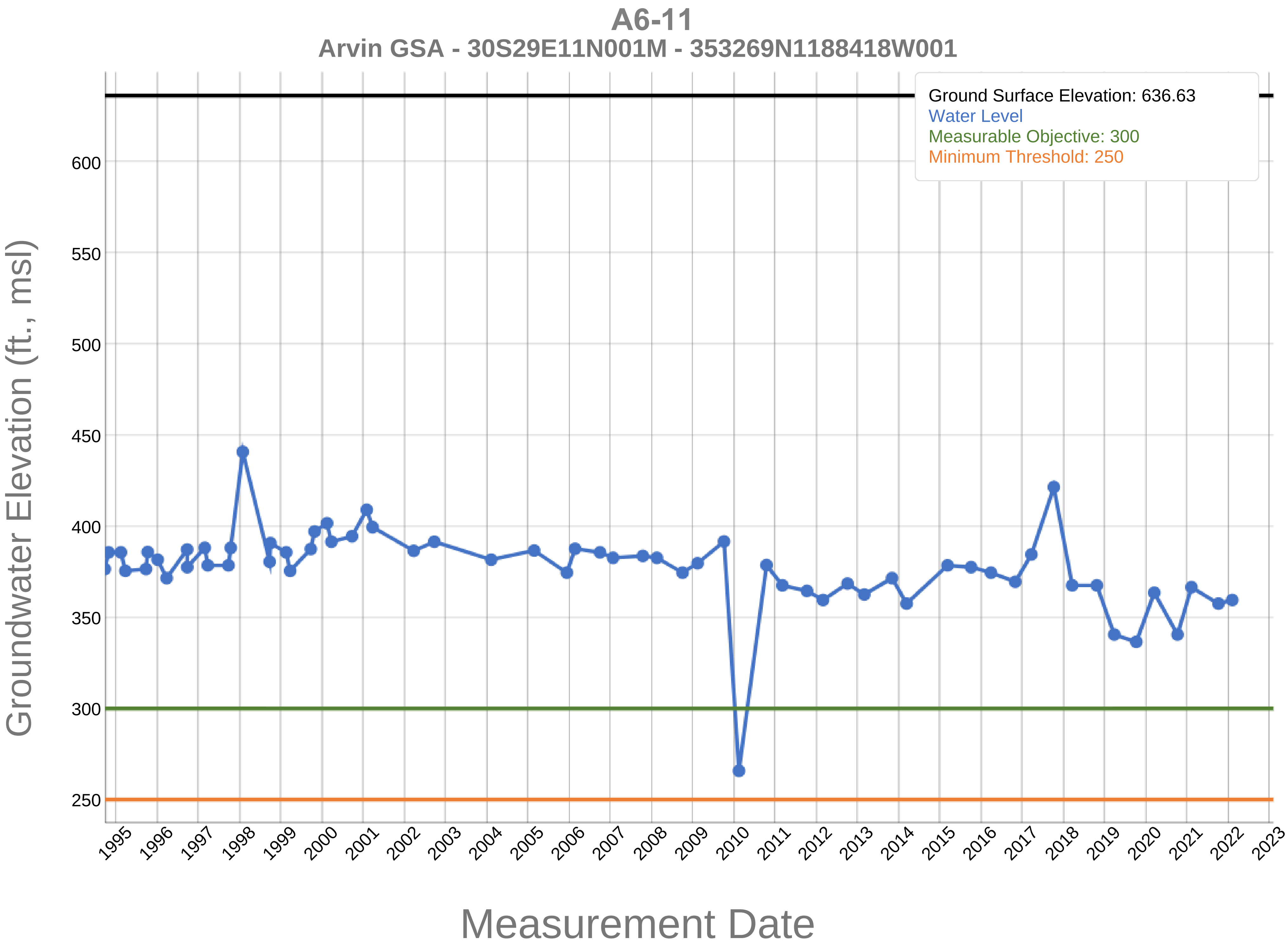
Measurement Date

A6-10

Arvin GSA - 31S30E17K001M - 352311N1187790W001




A6-11
Arvin GSA - 30S29E11N001M - 353269N1188418W001
Ground Surface Elevation: 636.63
Water Level
Measurable Objective: 300
Minimum Threshold: 250
Groundwater Elevation (ft., msl)
600
550
500
450
400
350
300
250
1995
1996
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1999
2000
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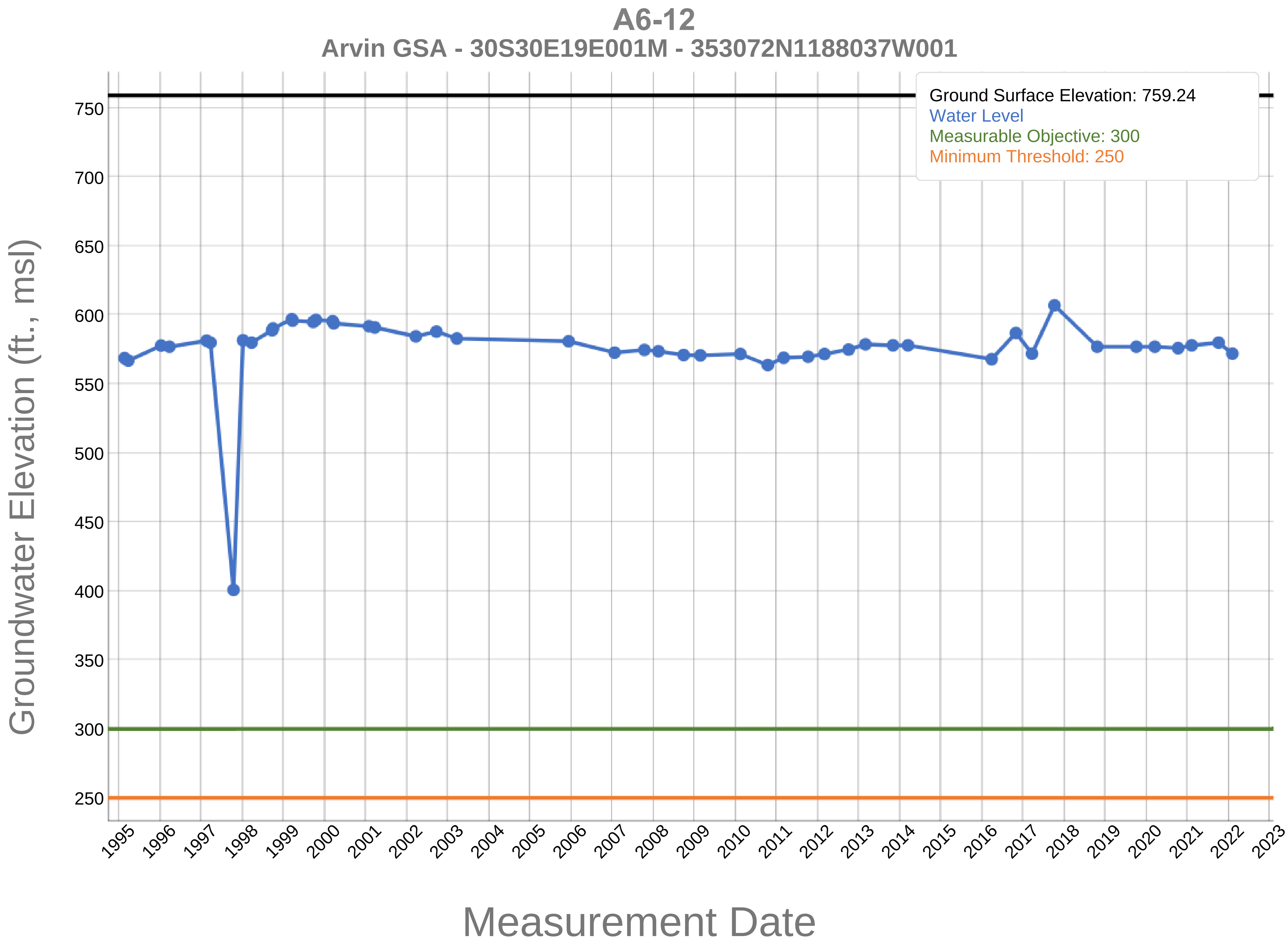
Measurement Date



A6-12
Arvin GSA - 30S30E19E001M - 353072N1188037W001
Ground Surface Elevation: 759.24
Water Level
Measurable Objective: 300
Minimum Threshold: 250
Groundwater Elevation (ft., msl)
750
700
650
600
550
500
450
400
350
300
250
1995
1996
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1999
2000
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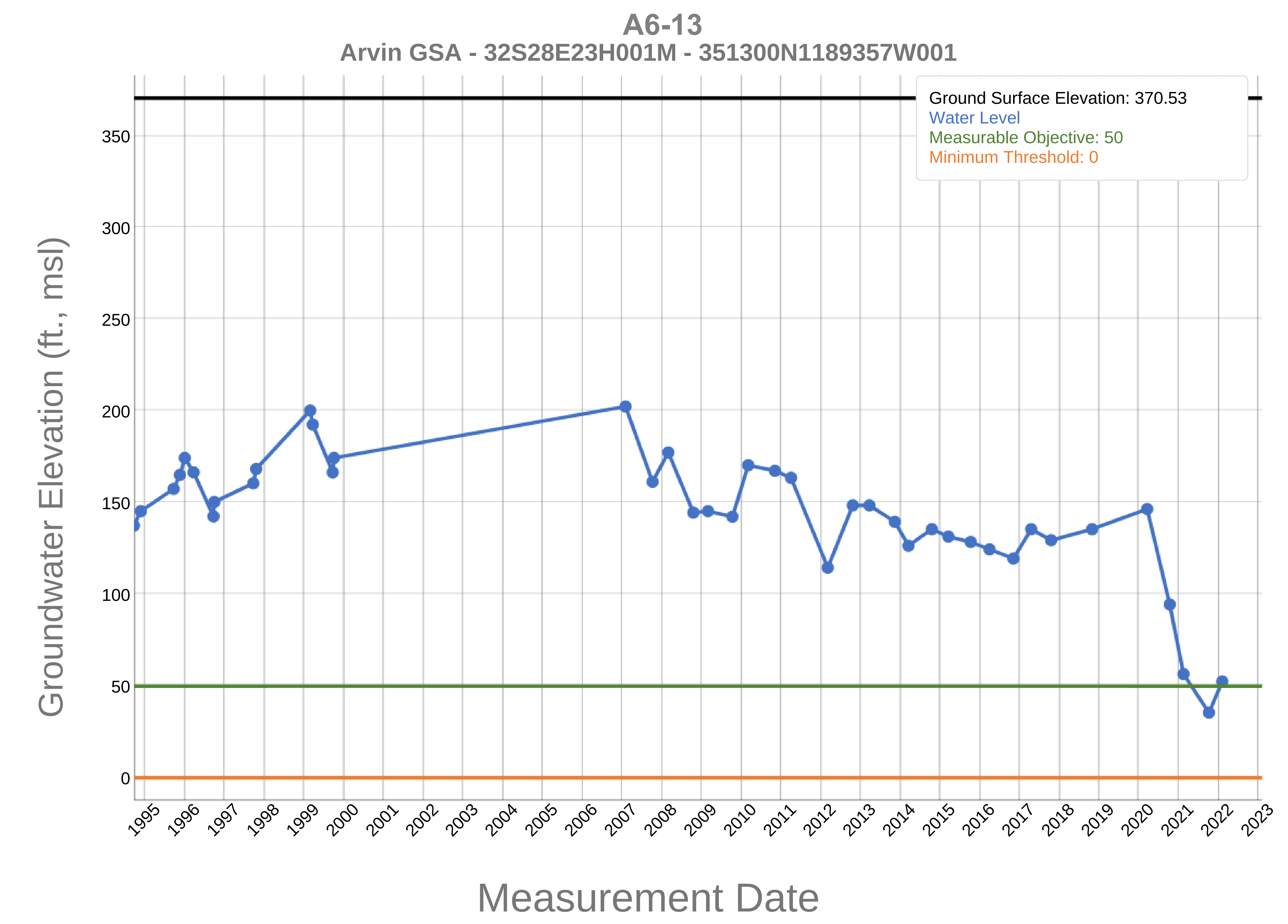
Measurement Date



A6-13
Arvin GSA - 32S28E23H001M - 351300N1189357W001
Ground Surface Elevation: 370.53
Water Level
Measurable Objective: 50
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
1995
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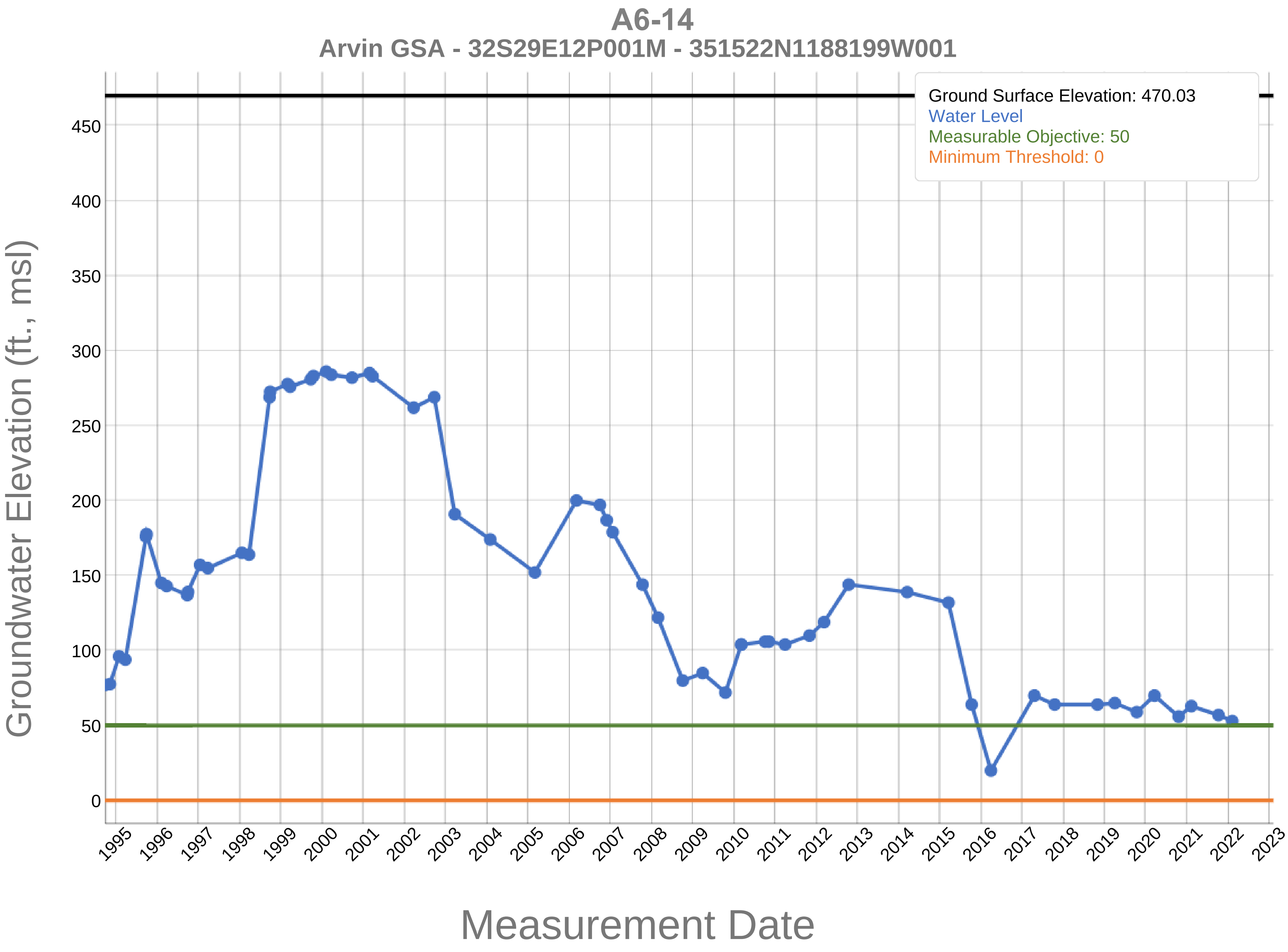
Measurement Date



A6-14
Arvin GSA - 32S29E12P001M - 351522N1188199W001
Ground Surface Elevation: 470.03
Water Level
Measurable Objective: 50
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
0
50
100
150
200
250
300
350
400
450
1995
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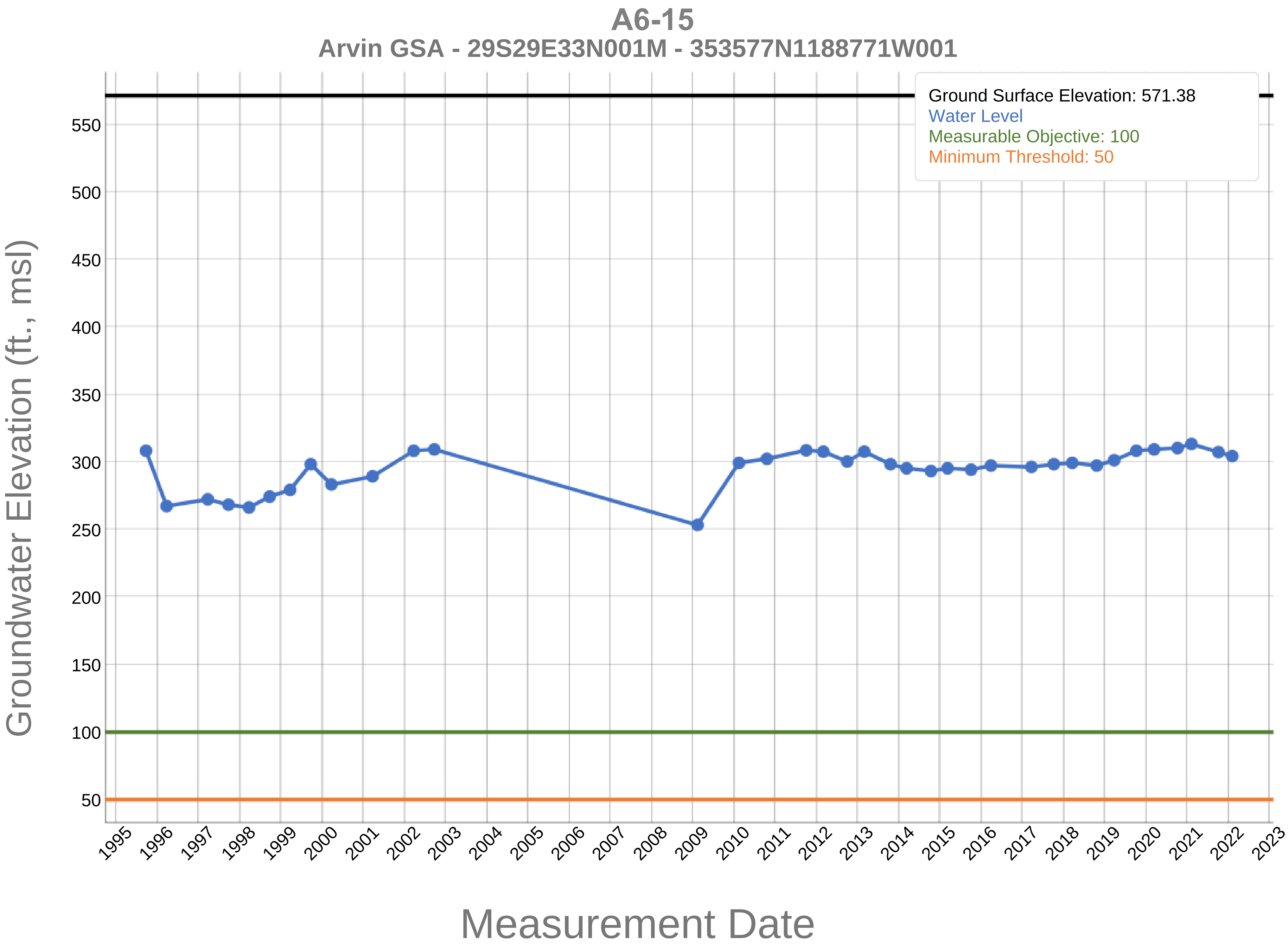
Measurement Date


A6-15
Arvin GSA - 29S29E33N001M - 353577N1188771W001
Ground Surface Elevation: 571.38
Water Level
Measurable Objective: 100
Minimum Threshold: 50
Groundwater Elevation (ft., msl)
550
500
450
400
350
300
250
200
150
100
50
1995
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1999
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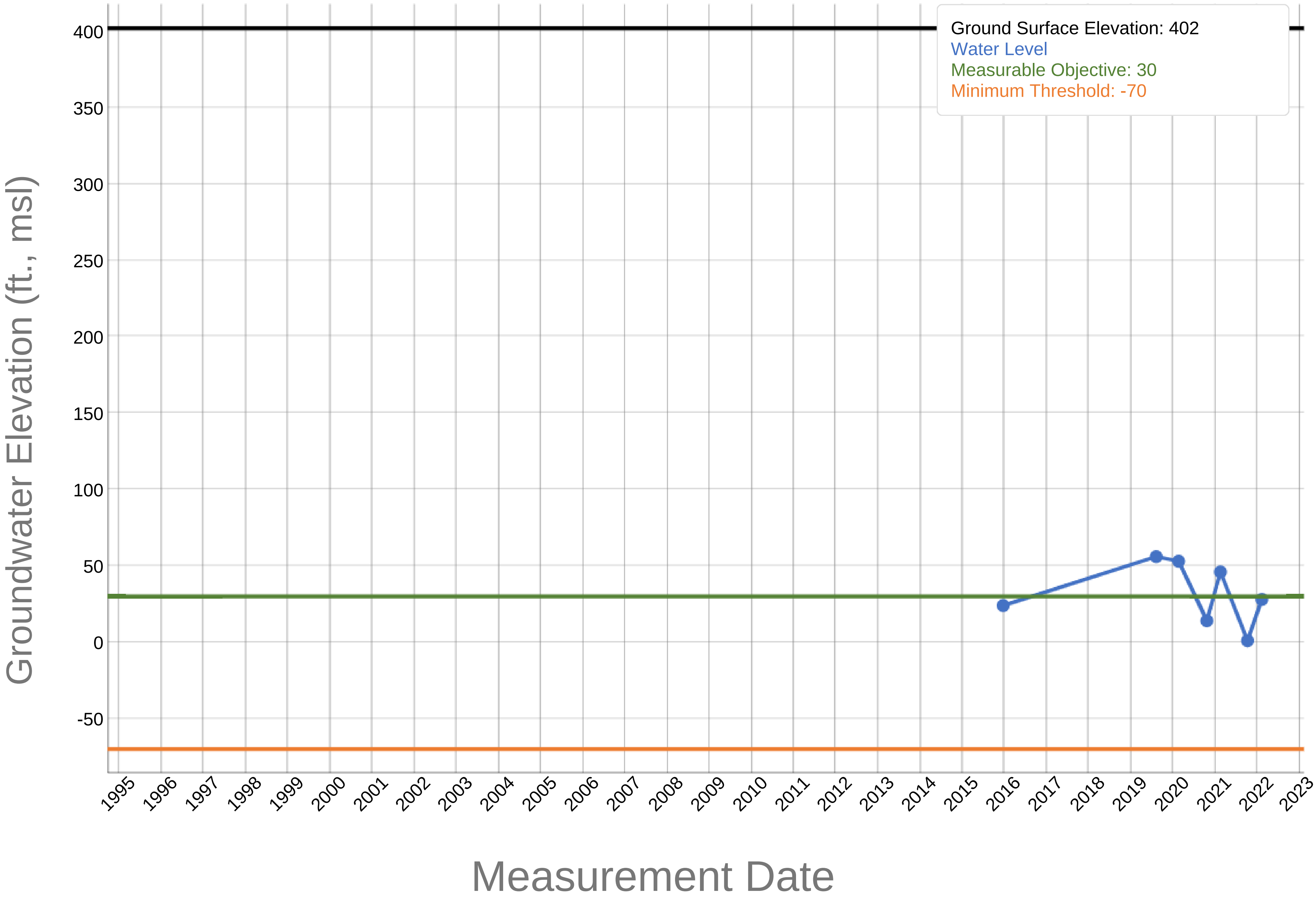
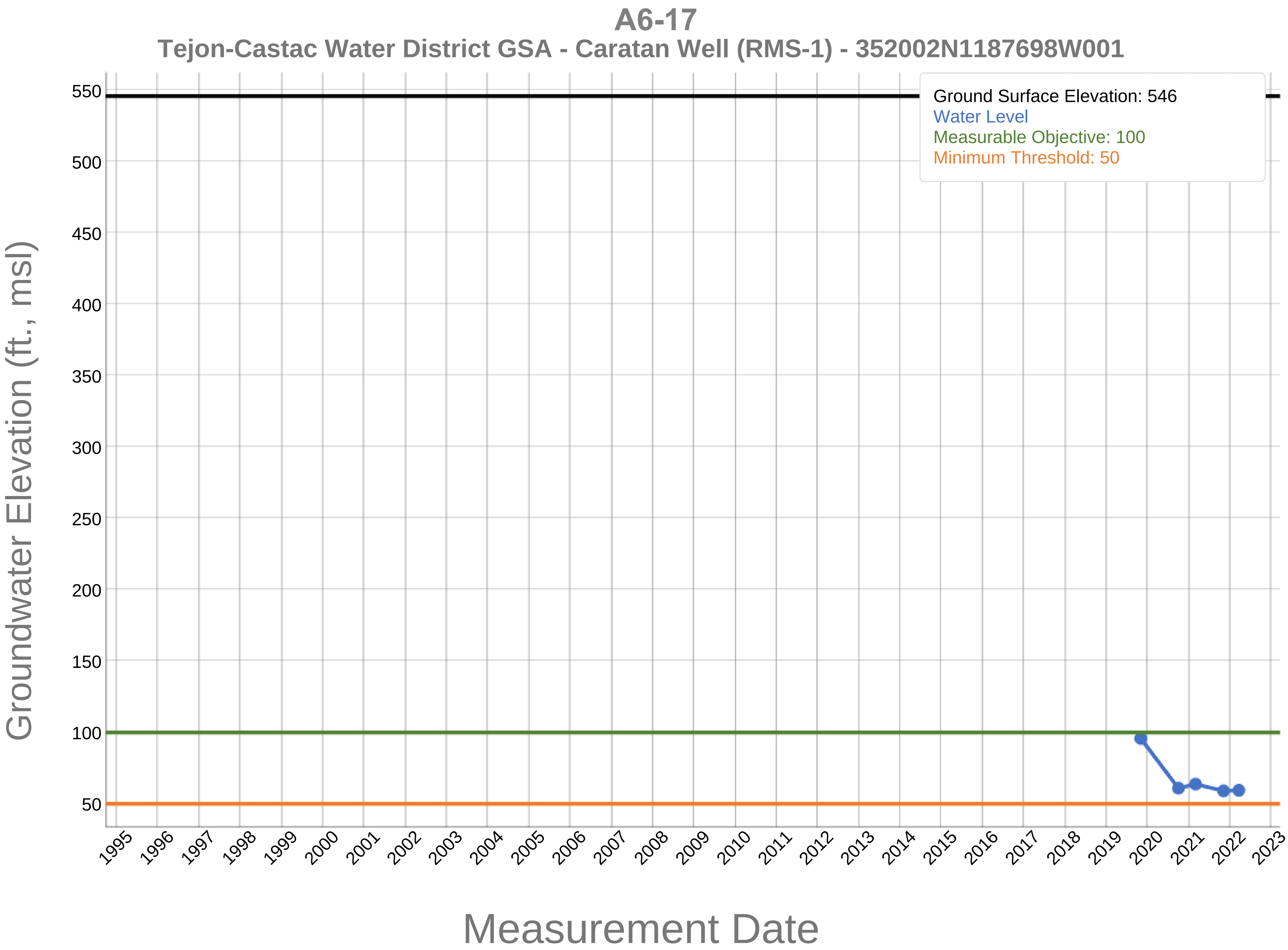
Measurement Date

A6-16

Arvin GSA - ACSD Well #14 - 351942N1188484W001




A6-17
Tejon-Castac Water District GSA - Caratan Well (RMS-1) - 352002N1187698W001
Ground Surface Elevation: 546
Water Level
Measurable Objective: 100
Minimum Threshold: 50
Groundwater Elevation (ft., msl)
550
500
450
400
350
300
250
200
150
100
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1995
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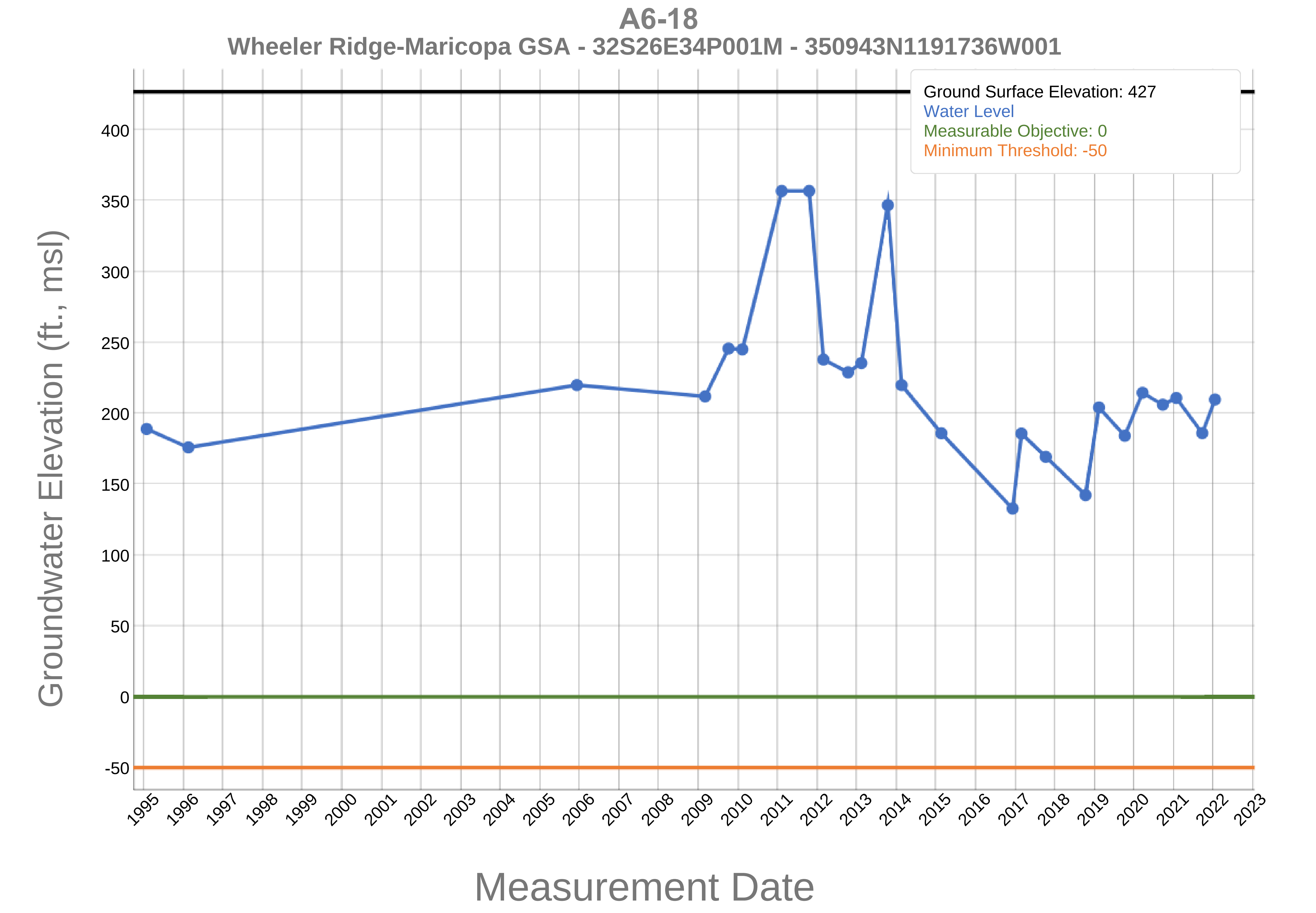
Measurement Date



A6-18
Wheeler Ridge-Maricopa GSA - 32S26E34P001M - 350943N1191736W001
Ground Surface Elevation: 427
Water Level
Measurable Objective: 0
Minimum Threshold: -50
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
0
-50
1995
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1999
2000
2001
2002
2003
2004
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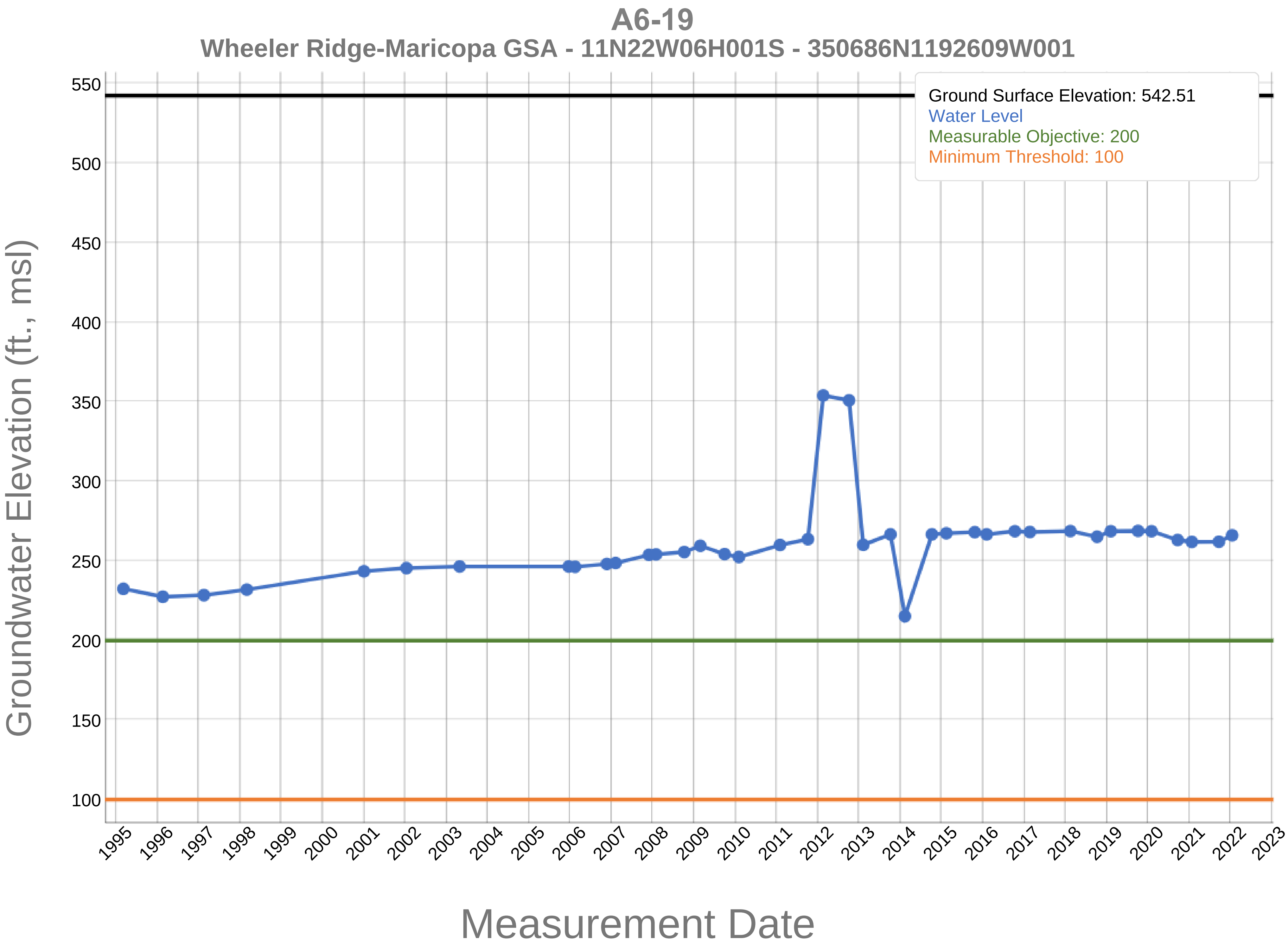
2023
Measurement Date


A6-19
Wheeler Ridge-Maricopa GSA - 11N22W06H001S - 350686N1192609W001
Ground Surface Elevation: 542.51
Water Level
Measurable Objective: 200
Minimum Threshold: 100
Groundwater Elevation (ft., msl)
Measurement Date
550
500
450
400
350
300
250
200
150
100
1995
1996
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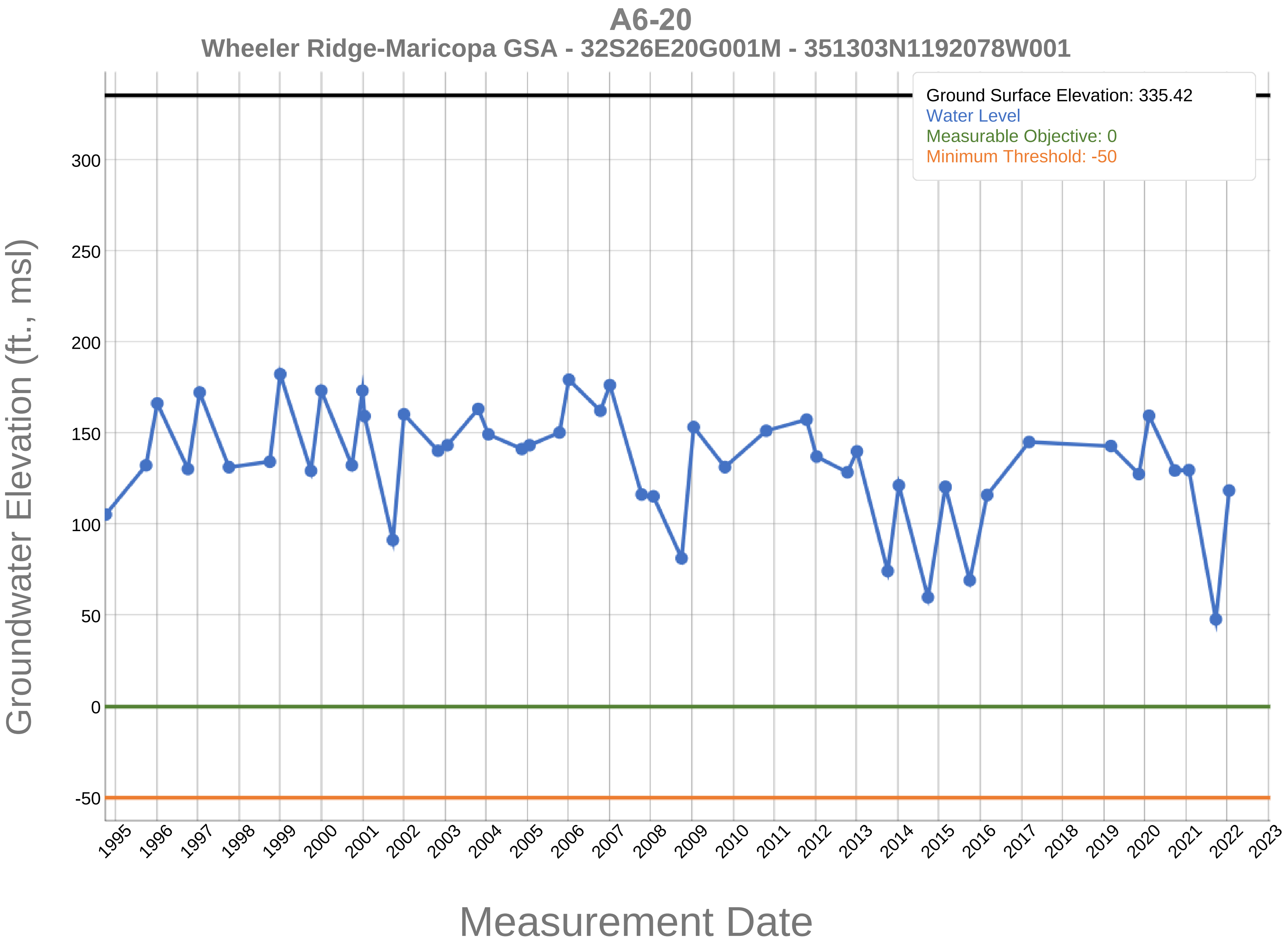
A6-20
Wheeler Ridge-Maricopa GSA - 32S26E20G001M - 351303N1192078W001
Ground Surface Elevation: 335.42
Water Level
Measurable Objective: 0
Minimum Threshold: -50
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
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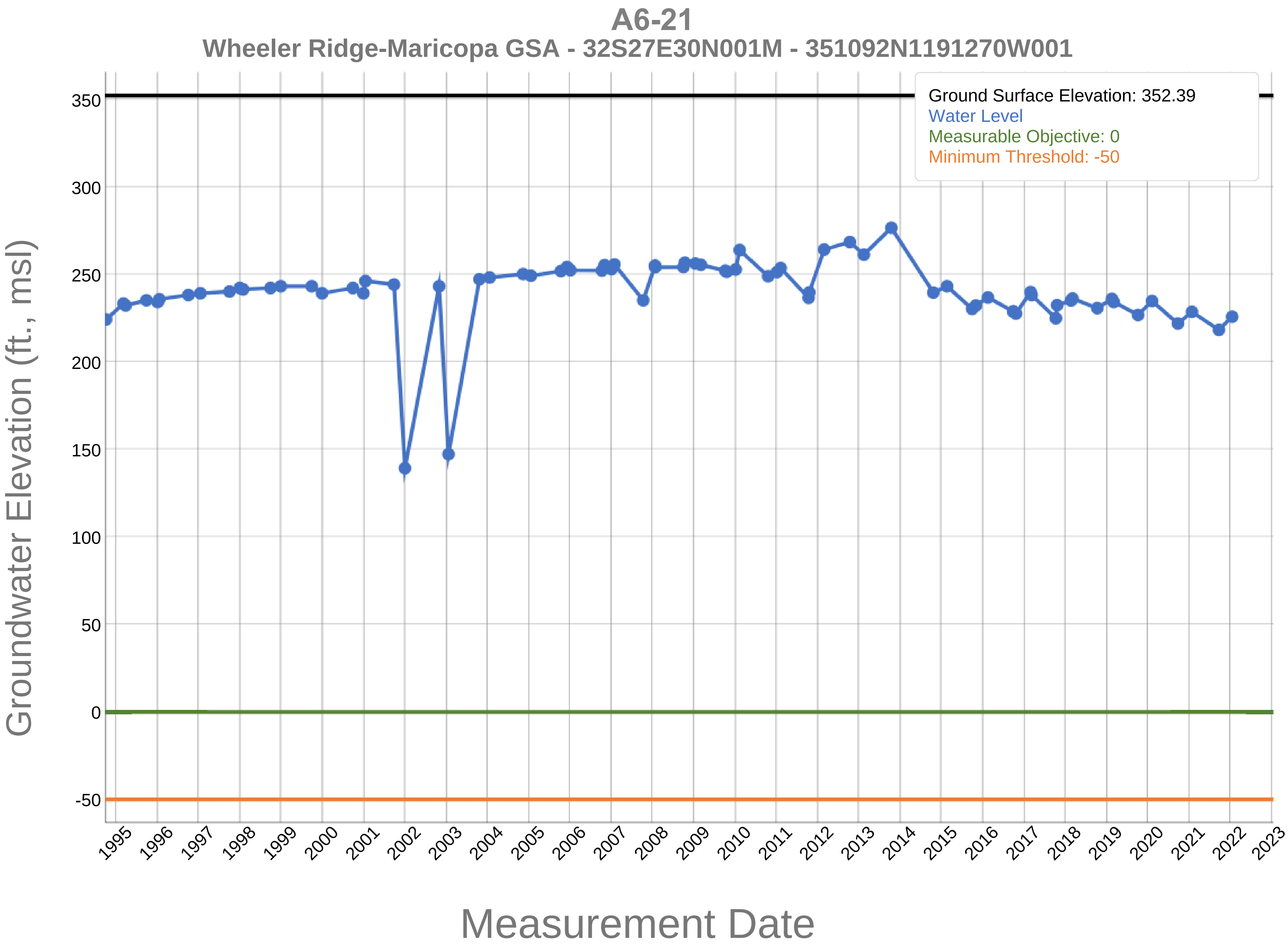
2022
2023
Measurement Date



A6-21
Wheeler Ridge-Maricopa GSA - 32S27E30N001M - 351092N1191270W001
Ground Surface Elevation: 352.39
Water Level
Measurable Objective: 0
Minimum Threshold: -50
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
1995
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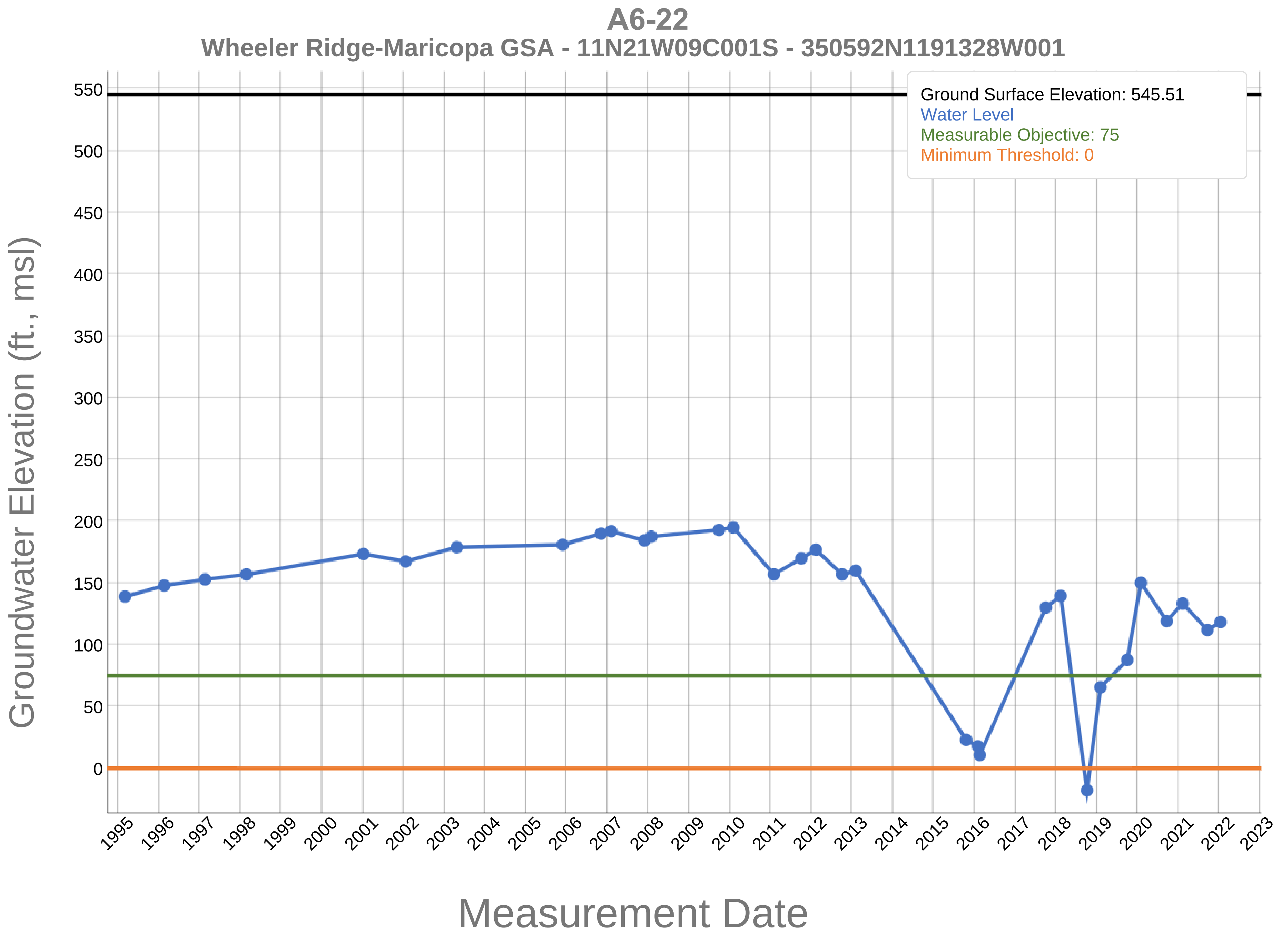
Measurement Date


A6-22
Wheeler Ridge-Maricopa GSA - 11N21W09C001S - 350592N1191328W001
Ground Surface Elevation: 545.51
Water Level
Measurable Objective: 75
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
550
500
450
400
350
300
250
200
150
100
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0
1995
1996
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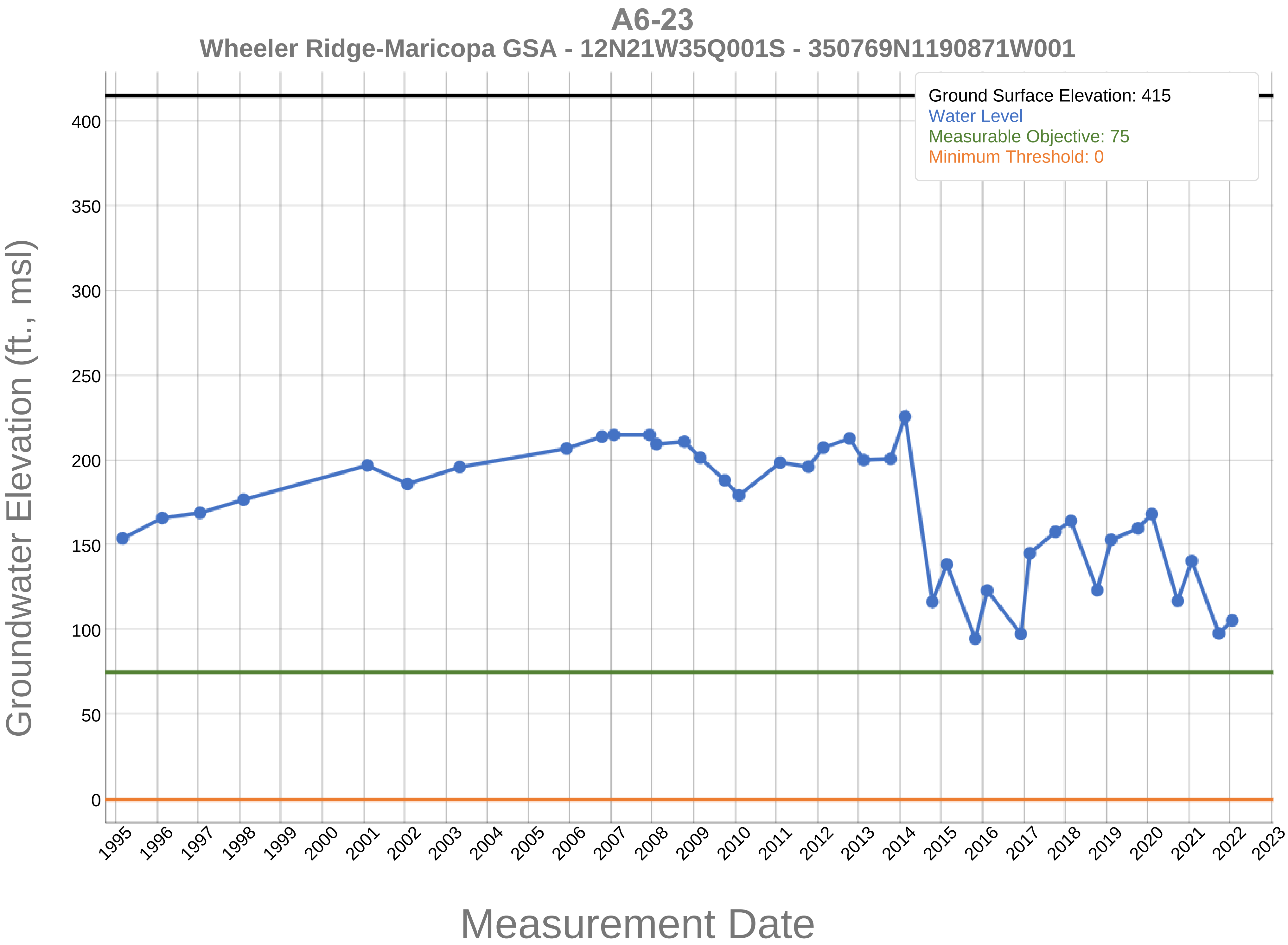
Measurement Date


A6-23
Wheeler Ridge-Maricopa GSA - 12N21W35Q001S - 350769N1190871W001
Ground Surface Elevation: 415
Water Level
Measurable Objective: 75
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
0
50
100
150
200
250
300
350
400
1995
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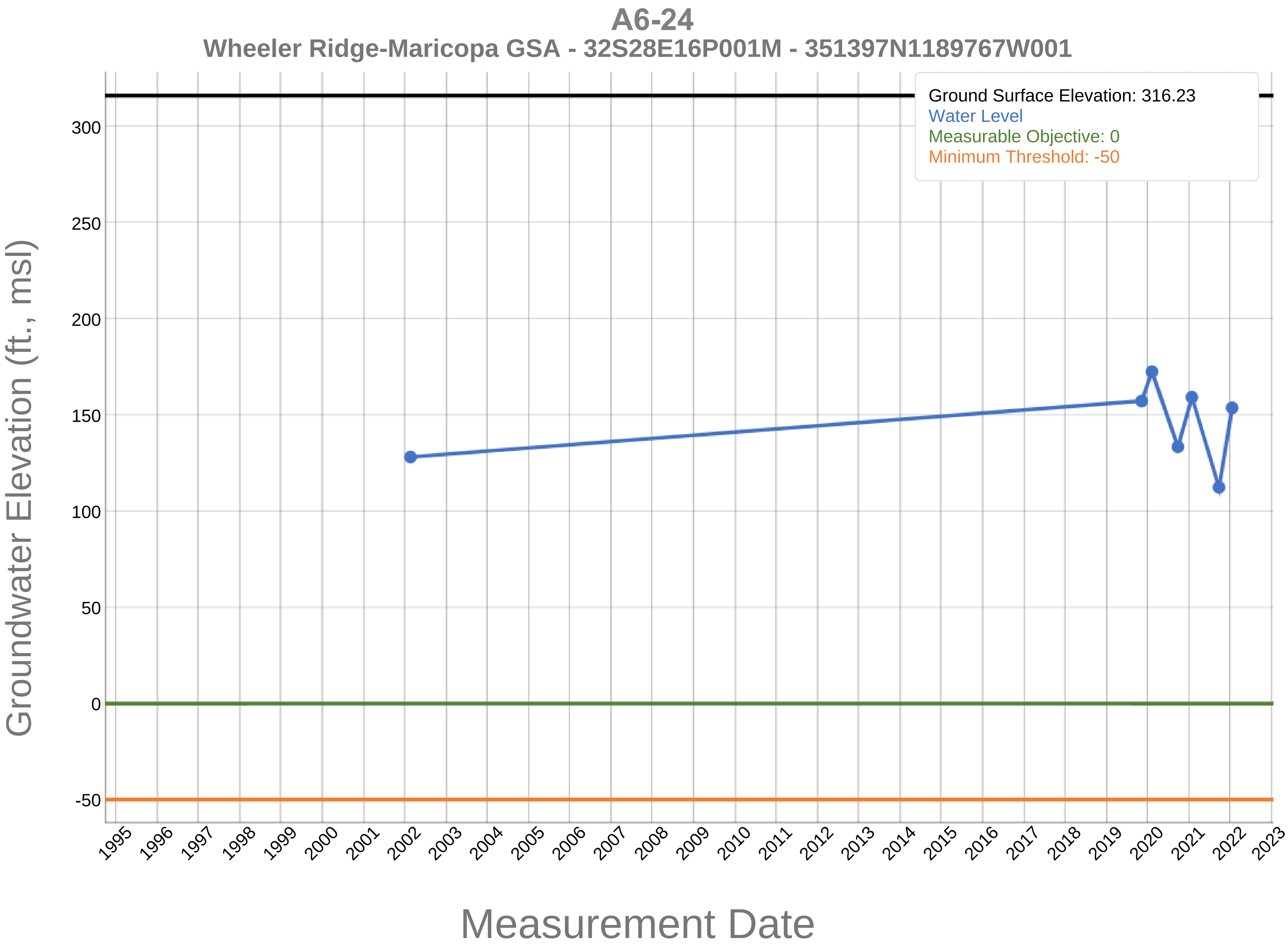
Measurement Date


A6-24
Wheeler Ridge-Maricopa GSA - 32S28E16P001M - 351397N1189767W001
Ground Surface Elevation: 316.23
Water Level
Measurable Objective: 0
Minimum Threshold: -50
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
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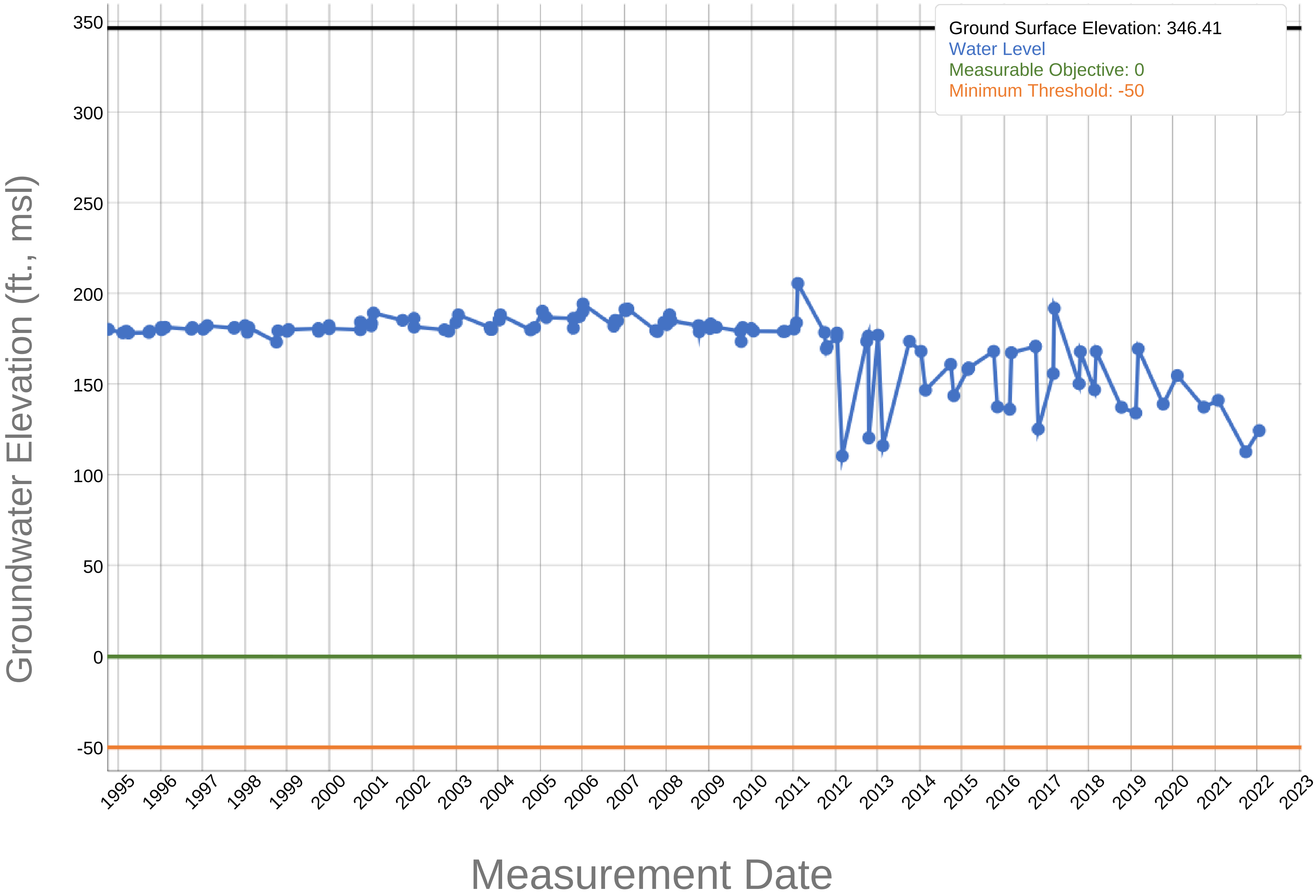
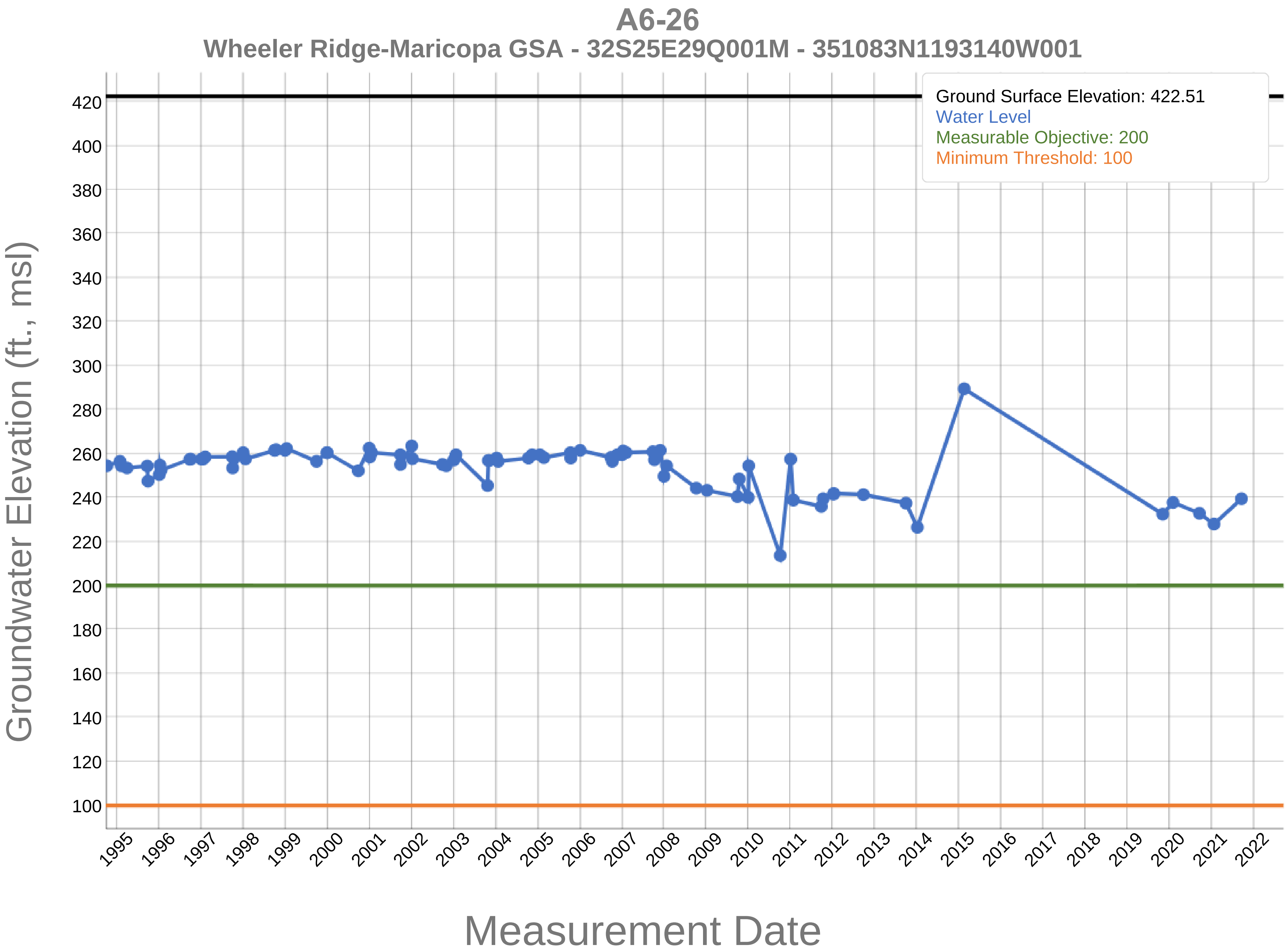
Measurement Date

A6-25

Wheeler Ridge-Maricopa GSA - 32S27E35R001M - 350961N1190435W001




A6-26
Wheeler Ridge-Maricopa GSA - 32S25E29Q001M - 351083N1193140W001
Ground Surface Elevation: 422.51
Water Level
Measurable Objective: 200
Minimum Threshold: 100
Groundwater Elevation (ft., msl)
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
1995
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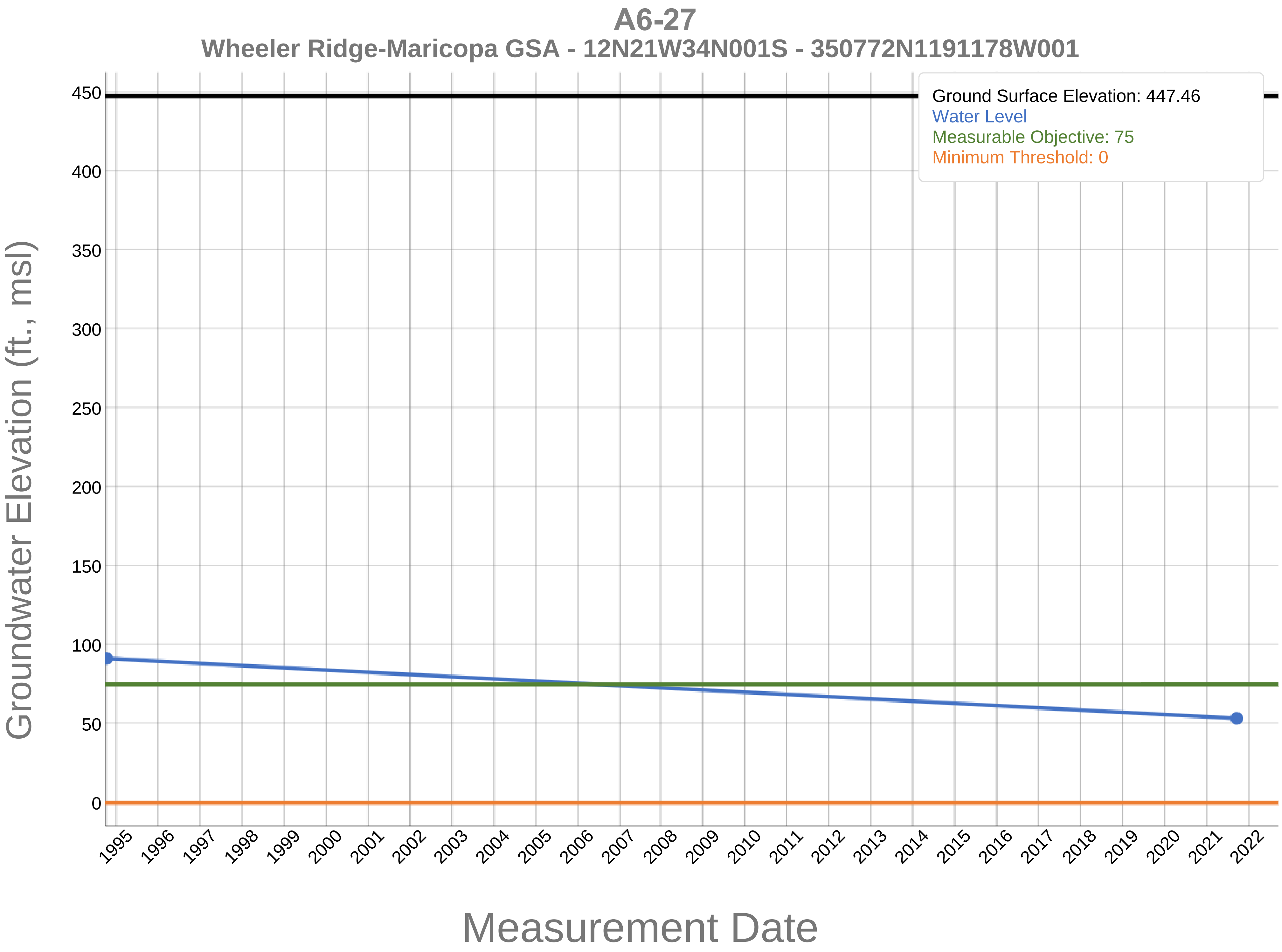
Measurement Date


A6-27
Wheeler Ridge-Maricopa GSA - 12N21W34N001S - 350772N1191178W001
Ground Surface Elevation: 447.46
Water Level
Measurable Objective: 75
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
Measurement Date
0
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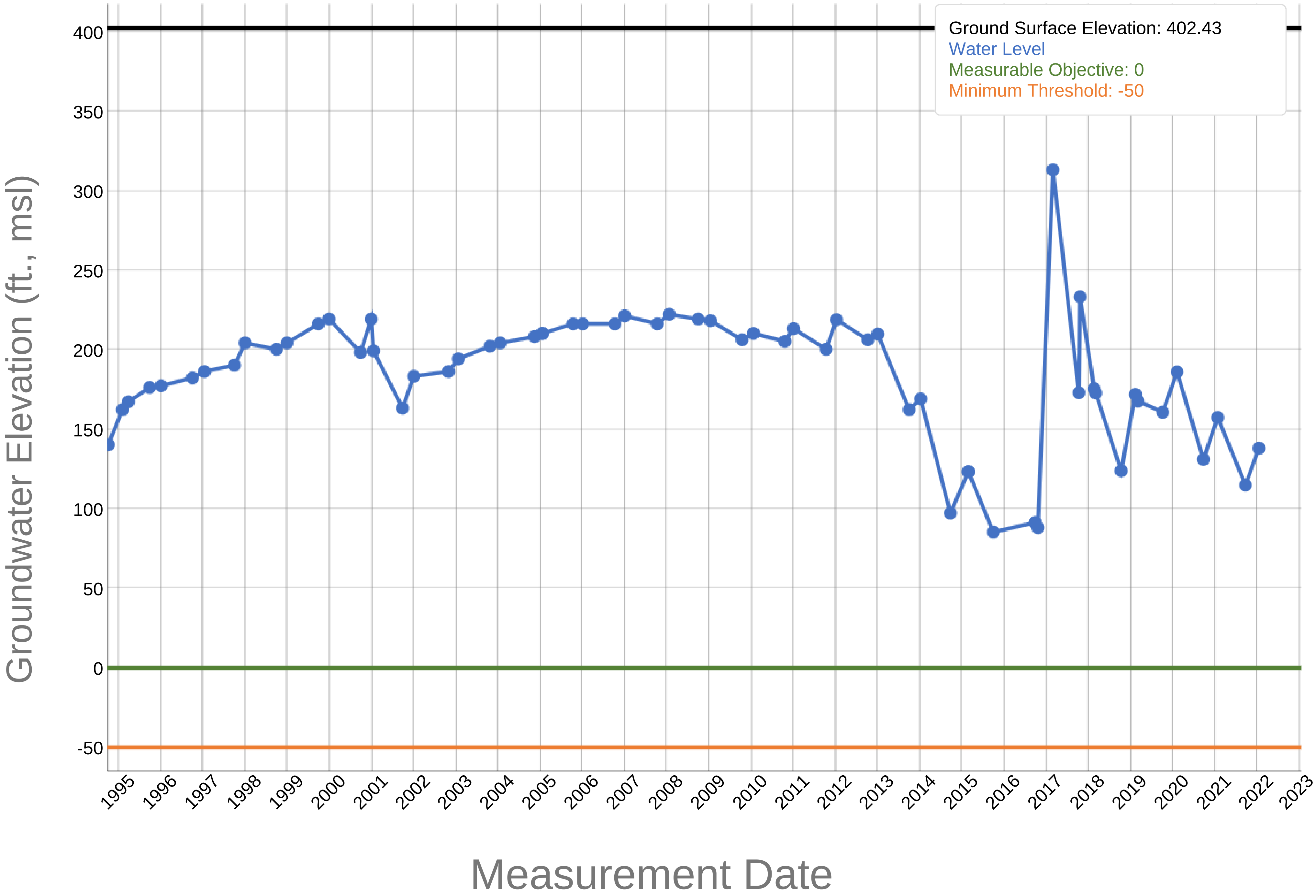
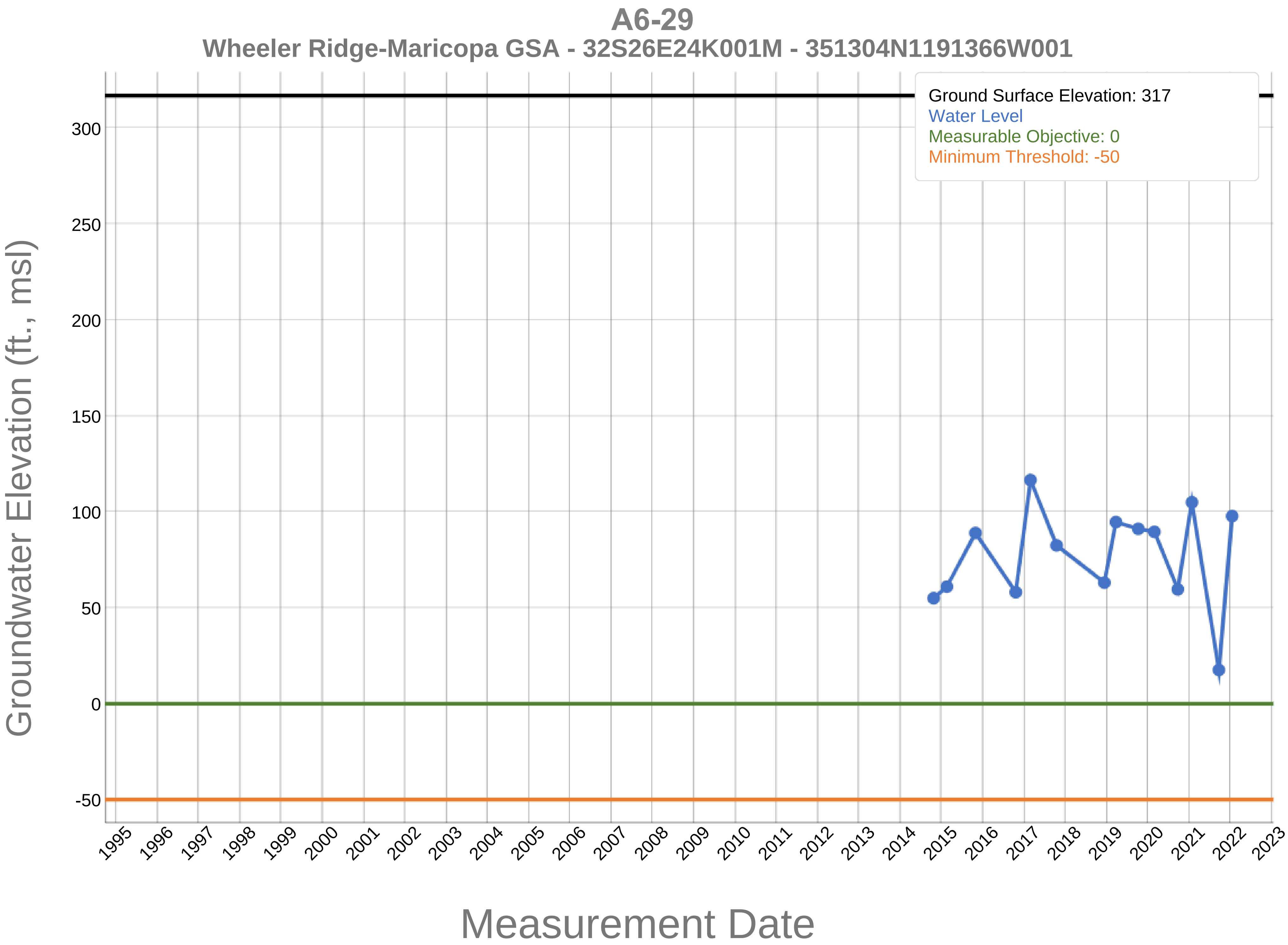
A6-28

Wheeler Ridge-Maricopa GSA - 32S26E36P002M - 350947N1191370W001




A6-29
Wheeler Ridge-Maricopa GSA - 32S26E24K001M - 351304N1191366W001
Ground Surface Elevation: 317
Water Level
Measurable Objective: 0
Minimum Threshold: -50
Groundwater Elevation (ft., msl)
300
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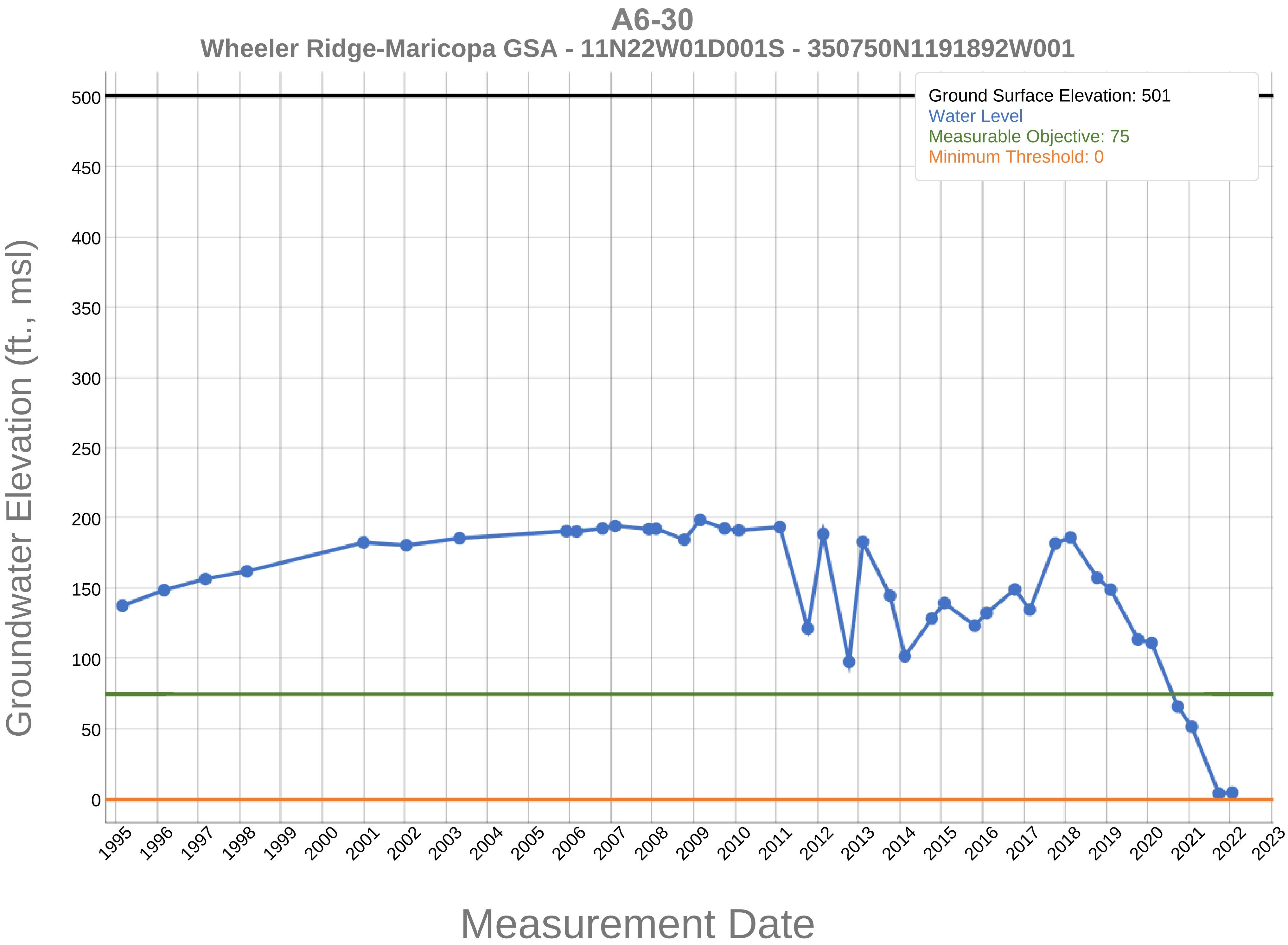
Measurement Date


A6-30
Wheeler Ridge-Maricopa GSA - 11N22W01D001S - 350750N1191892W001
Ground Surface Elevation: 501
Water Level
Measurable Objective: 75
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
500
450
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350
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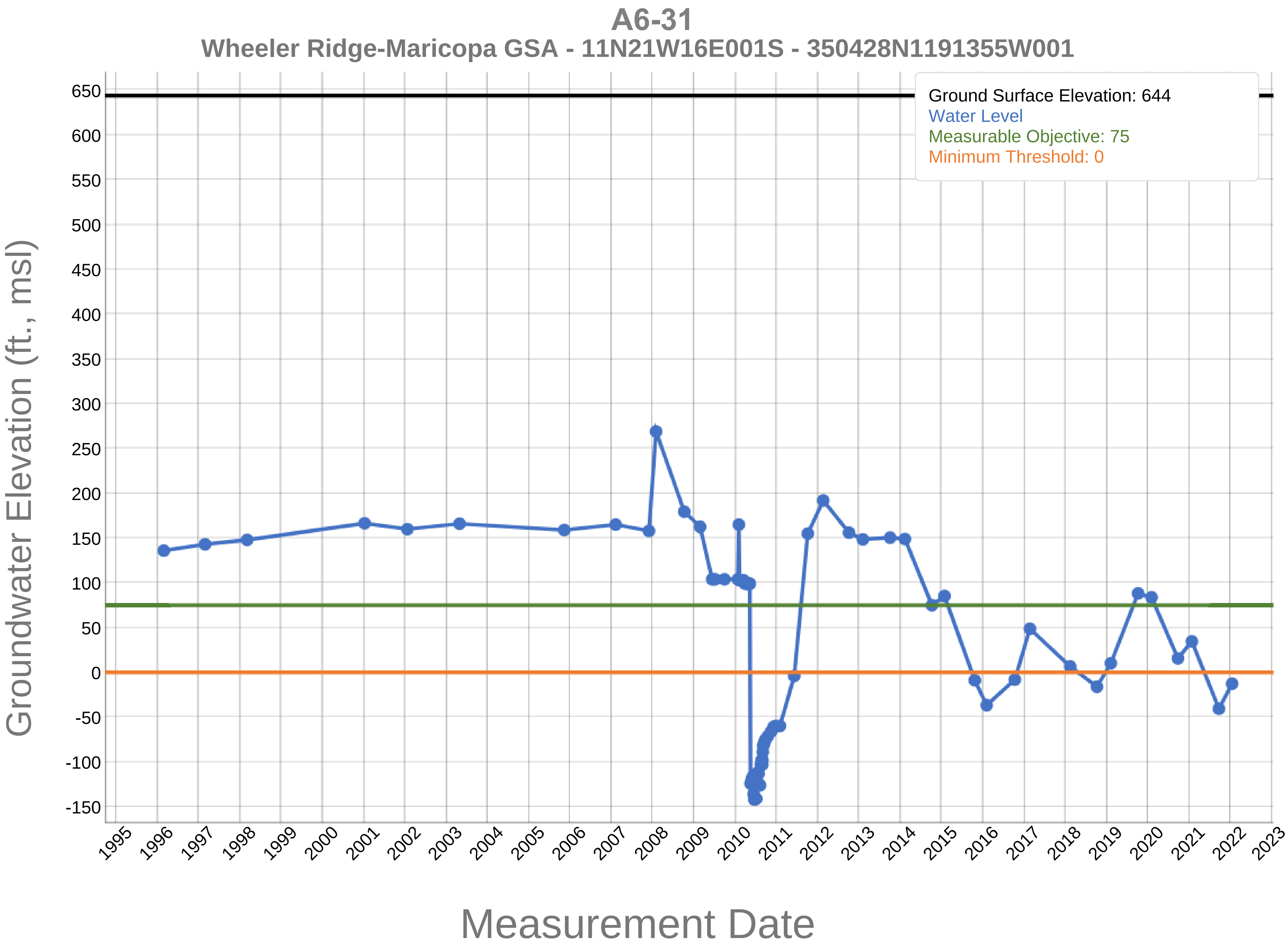
Measurement Date



A6-31
Wheeler Ridge-Maricopa GSA - 11N21W16E001S - 350428N1191355W001
Ground Surface Elevation: 644
Water Level
Measurable Objective: 75
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
650
600
550
500
450
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350
300
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200
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-50
-100
-150
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Measurement Date




TODD
GROUNDWATER