Cuyama Valley Groundwater Basin

Groundwater Sustainability Plan

Appendices

Prepared by:

December 2019

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Chapter 1 Appendices

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Chapter 1
Appendix A

Preparation Checklist
for Groundwater Sustainability Plan Submittal

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SGMA Regulations Section	Water Code Section	Requirement	Description	Relevant GSP Section
Article 3. Technical and Reporting Standards				
352.2		Monitoring Protocols	• Monitoring protocols adopted by the GSA for data collection and management • Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin	Chapter 4, *Monitoring Networks* in Appendix A, *Monitoring Protocols for Groundwater Level Monitoring Network*
Article 5. Plan Contents, Subarticle 1. Administrative Information				
354.4		General Information	• Executive Summary • List of references and technical studies	• Executive Summary • References section of each Chapter
354.6		Agency Information	• GSA mailing address • Organization and management structure • Contact information of Plan Manager • Legal authority of GSA • Estimate of implementation costs	• Chapter 1, *Agency Information, Plan Area and Communication* in Section 1.1, *Introduction and Agency Information* • Chapter 8, *Implementation Plan*
354.8(a)	10727.2(a)(4)	Map(s)	• Area covered by GSP • Adjudicated areas, other agencies within the basin, and areas covered by an Alternative • Jurisdictional boundaries of federal or State land • Existing land use designations • Density of wells per square mile	Chapter 1, *Agency Information, Plan Area and Communication* in Section 1.2, *Plan Area*
354.8(b)		Description of the Plan Area	• Summary of jurisdictional areas and other features	Chapter 1, *Agency Information, Plan Area and Communication* in Section 1.2, *Plan Area*
354.8(c) 354.8(d) 354.8(e)	10727.2(g)	Water Resource Monitoring and Management Programs	• Description of water resources monitoring and management programs • Description of how the monitoring networks of those plans will be incorporated into the GSP • Description of how those plans may limit operational flexibility in the basin • Description of conjunctive use programs	Chapter 1, *Agency Information, Plan Area and Communication* in Section 1.2, *Plan Area* Chapter 4, *Monitoring Networks*
354.8(f)	10727.2(g)	Land Use Elements or Topic Categories of Applicable General Plans	• Summary of general plans and other land use plans • Description of how implementation of the GSP may change water demands or affect achievement of sustainability and how the GSP addresses those effects • Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans • Summary of the process for permitting new or replacement wells in the basin • Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	Chapter 1, *Agency Information, Plan Area and Communication* in Section 1.2, *Plan Area*
354.8(g)	10727.4	Additional GSP Contents	**Description of Actions related to:**	Chapter 1, *Agency Information, Plan Area and*

SGMA Regulations Section	Water Code Section	Requirement	Description	Relevant GSP Section
			• Control of saline water intrusion • Wellhead protection • Migration of contaminated groundwater • Well abandonment and well destruction program • Replenishment of groundwater extractions • Conjunctive use and underground storage • Well construction policies • Addressing groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects • Efficient water management practices • Relationships with State and federal regulatory agencies • Review of land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity • Impacts on groundwater dependent ecosystems	*Communication* in Section 1.2, *Plan Area* in Table 1-2: *Plan Elements from Plan Elements from CWC Section 10727.4*
354.10		Notice and Communication	• Description of beneficial uses and users • List of public meetings • GSP comments and responses • Decision-making process • Public engagement • Encouraging active involvement • Informing the public on GSP implementation progress	Chapter 1, *Agency Information, Plan Area and Communication* in Section 1.3, *Notice and Communication*
Article 5. Plan Contents, Subarticle 2. Basin Setting				
354.14		Hydrogeologic Conceptual Model	• Description of the Hydrogeologic Conceptual Model • Two scaled cross-sections • Map(s) of physical characteristics: topographic information, surficial geology, soil characteristics, surface water bodies, source and point of delivery for imported water supplies	Chapter 2, *Basin Settings* in Section 2.1, *Hydrogeologic Conceptual Model*
354.14(c)(4)	10727.2(a)(5)	Map of Recharge Areas	• Map delineating existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas	Chapter 2, *Basin Settings* in Section 2.1.9, *Topography, Surface Water, and Recharge*
	10727.2(d)(4)	Recharge Areas	• Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	Chapter 2, *Basin Settings* in Section 2.1.9, *Topography, Surface Water, and Recharge*
354.16	10727.2(a)(1) 10727.2(a)(2)	Current and Historical Groundwater Conditions	• Groundwater elevation data • Estimate of groundwater storage • Seawater intrusion conditions • Groundwater quality issues	Chapter 2, *Basin Settings* in Section 2.2, *Groundwater Conditions*

SGMA Regulations Section	Water Code Section	Requirement	Description	Relevant GSP Section
			• Land subsidence conditions • Identification of interconnected surface water systems • Identification of groundwater-dependent ecosystems	
354.18	10727.2(a)(3)	Water Budget Information	• Description of inflows, outflows, and change in storage • Quantification of overdraft • Estimate of sustainable yield • Quantification of current, historical, and projected water budgets	Chapter 2, *Basin Settings* in Section 2.3, *Water Budget*
	10727.2(d)(5)	Surface Water Supply	• Description of surface water supply used or available for use for groundwater recharge or in-lieu use	Chapter 2, *Basin Settings* in Section 2.3, *Water Budget*
354.20		Management Areas	• Reason for creation of each management area • Minimum thresholds and measurable objectives for each management area • Level of monitoring and analysis • Explanation of how management of management areas will not cause undesirable results outside the management area • Description of management areas	• Chapter 4, *Monitoring Networks* • Chapter 5, *Minimum Thresholds, Measurable Objectives, and Interim Milestones* • Chapter 7, *Projects and Management Actions* in Section 7.2, *Management Areas*
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria				
354.24		Sustainability Goal	• Description of the sustainability goal	Chapter 3, *Undesirable Results* in Section 3.1, *Sustainability Goal*
354.26		Undesirable Results	• Description of undesirable results • Cause of groundwater conditions that would lead to undesirable results • Criteria used to define undesirable results for each sustainability indicator • Potential effects of undesirable results on beneficial uses and users of groundwater	Chapter 3, *Undesirable Results*
354.28	10727.2(d)(1) 10727.2(d)(2)	Minimum Thresholds	• Description of each minimum threshold and how they were established for each sustainability indicator • Relationship for each sustainability indicator • Description of how selection of the minimum threshold may affect beneficial uses and users of groundwater • Standards related to sustainability indicators • How each minimum threshold will be quantitatively measured	Chapter 5, *Minimum Thresholds, Measurable Objectives, and Interim Milestones*
354.30	10727.2(b)(1) 10727.2(b)(2) 10727.2(d)(1) 10727.2(d)(2)	Measurable Objectives	• Description of establishment of the measureable objectives for each sustainability indicator • Description of how a reasonable margin of safety was established for each measureable objective • Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones	Chapter 5, *Minimum Thresholds, Measurable Objectives, and Interim Milestones*

SGMA Regulations Section	Water Code Section	Requirement	Description	Relevant GSP Section
Article 5. Plan Contents, Subarticle 4. Monitoring Networks				
354.34	10727.2(d)(1) 10727.2(d)(2) 10727.2(e) 10727.2(f)	Monitoring Networks	• Description of monitoring network • Description of monitoring network objectives • Description of how the monitoring network is designed to: demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features; estimate the change in annual groundwater in storage; monitor seawater intrusion; determine groundwater quality trends; identify the rate and extent of land subsidence; and calculate depletions of surface water caused by groundwater extractions • Description of how the monitoring network provides adequate coverage of Sustainability Indicators • Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends • Scientific rational (or reason) for site selection • Consistency with data and reporting standards • Corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone • Location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used • Description of technical standards, data collection methods, and other procedures or protocols to ensure comparable data and methodologies	Chapter 4, *Monitoring Networks*
354.36		Representative Monitoring	• Description of representative sites • Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators • Adequate evidence demonstrating site reflects general conditions in the area	Chapter 4, *Monitoring Networks*
354.38		Assessment and Improvement of Monitoring Network	• Review and evaluation of the monitoring network • Identification and description of data gaps • Description of steps to fill data gaps • Description of monitoring frequency and density of sites	Chapter 4, *Monitoring Networks*
Article 5. Plan Contents, Subarticle 5. Projects and Management Actions				
354.44		Projects and Management Actions	• Description of projects and management actions that will help achieve the basin's sustainability goal • Measurable objective that is expected to benefit from each project and management action • Circumstances for implementation • Public noticing • Permitting and regulatory process • Time-table for initiation and completion, and the accrual of expected benefits • Expected benefits and how they will be evaluated • How the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that	Chapter 7, *Projects and Management Actions*

SGMA Regulations Section	Water Code Section	Requirement	Description	Relevant GSP Section
			water shall be included. • Legal authority required • Estimated costs and plans to meet those costs • Management of groundwater extractions and recharge	
354.44(b)(2)	10727.2(d)(3)		• Overdraft mitigation projects and management actions	Chapter 7, *Projects and Management Actions*
Article 8. Interagency Agreements				
357.4	10727.6	Coordination Agreements - Shall be submitted to the Department together with the GSPs for the basin and, if approved, shall become part of the GSP for each participating Agency.	**Coordination Agreements shall describe the following:** • A point of contact • Responsibilities of each Agency • Procedures for the timely exchange of information between Agencies • Procedures for resolving conflicts between Agencies • How the Agencies have used the same data and methodologies to coordinate GSPs • How the GSPs implemented together satisfy the requirements of SGMA • Process for submitting all Plans, Plan amendments, supporting information, all monitoring data and other pertinent information, along with annual reports and periodic evaluations • A coordinated data management system for the basin • Coordination agreements shall identify adjudicated areas within the basin, and any local agencies that have adopted an Alternative that has been accepted by the Department	The Cuyama Valley Groundwater Basin does not need a coordination agreement because the basin is using a single GSP.

Chapter 1
Appendix B

Notification of Intent to Develop a Groundwater Sustainability Plan

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CUYAMA BASIN GROUNDWATER SUSTAINABILITY AGENCY

1901 Royal Oaks Drive, Suite 200 Sacramento, California 95815
December 1, 2017

Trevor Joseph, GGM Section Chief
STATE OF CALIFORNIA
Department of Water Resources
P.O. Box 94236
Sacramento, CA 94236

Subject: Notification of Intent to Develop a Groundwater Sustainable Plan (GSP)

Dear Mr. Joseph:

Pursuant to California Water Code Section 10727.8 and California Code of Regulations Section 353.6, the Department of Water Resources (DWR) is hereby given notice that the Cuyama Basin Groundwater Sustainability Agency (CBGSA) intends to commence with the development of a Groundwater Sustainability Plan (GSP). The CBGSA will have a single coordination agreement compliant with Section 10727.6.

The CBGSA Board of Directors (BOD) meetings are held regularly the first Wednesday of every month at the Family Resource Center, 4689 CA-166, New Cuyama, CA 93254. Special Board meetings will be held as needed and noticed through the website and local posting. The public is encouraged to attend and participate in the GSP development and implementation process.

Additionally, the CBGSA has formed a Standing Advisory Committee (SAC) comprised of members falling within the categories of interested persons or representatives of interested entities as described in the Sustainable Groundwater Management Act (SGMA). The SAC will specifically engage on issues related to GSP preparation and implementation. The SAC may also be involved in other outreach efforts to encourage participation from diverse social, cultural, and economic elements of the population in development and implementation of a GSP. The SAC is a public meeting and interested parties are encouraged to attend. The SAC meetings are held the Thursday immediately before the Board of Directors monthly session.

Meeting notices and materials are posted online on the Santa Barbara County website at http://www.countyofsb.org/pwd/gsa.sbc and at the Family Resource Center, 4689 CA-166, New Cuyama, CA 93254.

The CBGSA looks forward to working collaboratively with DWR on developing and implementing a GSP. Should DWR have any questions about this notice, please contact Jim Beck by email at jbeck@hgcpm.com or by phone at (661) 333-7091.

Sincerely,

Jim Beck, CBGSA Executive Director

Chapter 1
Appendix C

Notice of Decision to Form a Groundwater Sustainability Agency

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RESOLUTION OF THE
BOARD OF DIRECTORS OF
THE CUYAMA BASIN WATER DISTRICT

RESOLUTION TO PARTICIPATE IN THE FORMATION OF A GROUNDWATER SUSTAINABILITY AGENCY PURSUANT TO THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT FOR THE CUYAMA VALLEY GROUNDWATER BASIN	)))))))))	**RESOLUTION NO. 2017-003**

WHEREAS, the California legislature passed a statewide framework for sustainable groundwater management, known as the Sustainable Groundwater Management Act (California Water Code § 10720 *et seq.)* as amended, which became effective January 1, 2015; and

WHEREAS, pursuant to the Sustainable Groundwater Management Act (SGMA), sustainable groundwater management is intended to occur pursuant to Groundwater Sustainability Plans (GSP) that are created and adopted by local Groundwater Sustainability Agencies (GSA); and

WHEREAS, pursuant to Water Code §10723(a), a Local Agency or combination of Local Agencies, as defined in Water Code §10721(n), may decide to become or form a Groundwater Sustainably Agency; and

WHEREAS, the Cuyama Basin Water District, Santa Barbara County Water Agency, the County of San Luis Obispo, the County of Ventura, the County of Kern, and Cuyama Community Services District are "Local Agencies" as defined in Water Code §10721(n), and collectively include all of the lands within the Basin; and

WHEREAS, the Cuyama Basin Water District was formed in part to provide a vehicle for landowners in the Cuyama Valley Groundwater Basin to directly participate in the SGMA process; and

WHEREAS, the District desires to form a Groundwater Sustainability Agency in conjunction with the Cuyama Basin Water District, the County of San Luis Obispo, the County of Ventura, the County of Kern, and Cuyama Community Services District, and which may include at a later time other Local Agencies and other legally authorized entities; and

WHEREAS, a notice of a public hearing to consider whether the District should elect to become a GSA for the basin in conjunction with the Local Agencies listed above was timely published in the Santa Barbara News Press, San Luis Obispo Star and Ventura County Star pursuant to California Government Code §6066; and

WHEREAS, the District held a public hearing on May 22, 2017, in Ventura, San Luis

Obispo and Santa Barbara Counties, to consider election to become a GSA for a portion of the Basin; and

NOW, THEREFORE, BE IT RESOLVED AS FOLLOWS: that the Board of Directors of the Cuyama Basin Water District declares and directs as follows:

1. That the Board of Directors of the District herein decides to form a Groundwater Sustainability Agency in conjunction with the County of Santa Barbara, the County of San Luis Obispo, the County of Ventura, the County of Kern and Cuyama Community Services District known as the Cuyama Basin Groundwater Sustainability Agency (Agency), and which shall have all the powers granted to a groundwater sustainability agency pursuant to the Sustainable Groundwater Management Act.

2. That the Agency hereby created shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans, as required by California Water Code §10723.2.

3. That the Agency hereby created shall establish and maintain a list of persons interested in receiving notices regarding plan preparation, meeting announcements, and availability of draft plans, maps,. and other relevant documents, as required by California Water Code
§10723.4.

4. That the President of the Board of Directors of the District shall be authorized to execute a Joint Exercise of Powers Agreement with the County of Santa Barbara, the County of San Luis Obispo, the County of Ventura, the County of Kern, and Cuyama Community Services District, and cause notice to be given to the California Department of Water Resources of the decision of the Board of Directors of the District in conjunction with the County of Santa Barbara, County of San Luis Obispo, the County of Ventura, the County of Kern, and Cuyama Community Services District to create the above referenced Groundwater Sustainability Agency.

5. As provided by said Joint Exercise of Powers Agreement, each of the Directors of the District are designated as a Director of the Agency, and General Manager, Matt Klinchuch is hereby appointed as an alternate, if any Director is absent from a meeting of the Agency, and Board Secretary, Brad DeBranch is appointed as a second alternate, if any Director is absent from a meeting of the Agency, subject to modification by the Board of Directors from time to time.

PASSED, APPROVED, AND ADOPTED by the Board of Directors of the Cuyama Basin Water District, on this 22nd day of May, 2017, by the following vote:

AYES: Directors Albano, Bracken, Cappello, Wooster & Yurosek

NAYS: None

ABSENT: None

ABSTAIN: None

SECRETARY'S CERTIFICATE

I, BRAD DEBRANCH, Secretary of the Cuyama Basin Water District, do hereby certify that the foregoing is a full, true and correct copy of the Resolution of the Board of Directors of the Cuyama Basin Water District, duly and regularly adopted by the Board of Directors of the Cuyama Basin Water District in all respects as required by law and the Bylaws of the Cuyama Basin Water District, on this 22nd day of May, 2017, by the consent in writing of all members of the Board of Directors of the Cuyama Basin Water District to the adoption of said resolution.

BRAD DEBRANCH, Secretary

A RESOLUTION OF THE BOARD OF DIRECTORS OF
THE CUYAMA COMMUNITY SERVICES DISTRICT
TOWN SITE OF NEW CUYAMA
STATE OF CALIFORNIA

RESOLUTION TO PARTICIPATE IN THE FORMATION OF A GROUNDWATER SUSTAINABILITY AGENCY PURSUANT TO THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT FOR THE CUYAMA COMMUNITY SERVICES DISTRICT AREA OF THE CUYAMA VALLEY GROUNDWATER BASIN	**RESOLUTION NO. 17-2**

WHEREAS, the California legislature passed a statewide framework for sustainable groundwater management, known as the Sustainable Groundwater Management Act (California Water Code § 10720 *et seq.*) as amended, which became effective January 1, 2015; and

WHEREAS, pursuant to the Sustainable Groundwater Management Act (SGMA), sustainable groundwater management is intended to occur pursuant to Groundwater Sustainability Plans (GSP) that are created and adopted by local Groundwater Sustainability Agencies (GSA); and

WHEREAS, pursuant to Water Code §10723(a), a Local Agency or combination of Local Agencies, as defined in Water Code §10721(n), may decide to become or form a Groundwater Sustainability Agency; and

WHEREAS, the Santa Barbara County Water Agency, the Cuyama Basin Water District, the Cuyama Community Services District, the County of San Luis Obispo, the County of Ventura, and the County of Kern are "Local Agencies" as defined in Water Code §10721(n), and collectively include all of the lands within the Basin; and

WHEREAS, the Cuyama Community Services District desires to form a Groundwater Sustainability Agency in conjunction with the Cuyama Basin Water District, the Santa Barbara County Water Agency, the County of San Luis Obispo, the County of Ventura, and the County of Kern, and which may include at a later time other Local Agencies and other legally authorized entities; and

WHEREAS, a notice of a public hearing to consider whether the District should elect to become a GSA for a portion of the basin was published in the Santa Maria Times and Bakersfield Californian press pursuant to California Government Code §6066; and

WHEREAS, the Cuyama Community Services District held a public hearing on May 23, 2017 to consider election to become a GSA for a portion of the basin; and

NOW, THEREFORE, BE IT RESOLVED AS FOLLOWS: that the Board of Directors of the Cuyama Community Services District declares and directs as follows:

1. That the Board of Directors of the Cuyama Community Services District herein decides to form a Groundwater Sustainability Agency in conjunction with the Cuyama Basin Water District, the Santa Barbara County Water Agency, the County of San Luis Obispo, the County of Ventura, and the County of Kern, known as the Cuyama Basin Groundwater Sustainability Agency (Agency), and which shall have all the powers granted to a groundwater sustainability agency pursuant to the Sustainable Groundwater Management Act.

2. That the Agency hereby created shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans, as required by California Water Code §10723.2.

3. That the Agency hereby created shall establish and maintain a list of persons interested in receiving notices regarding plan preparation, meeting announcements, and availability of draft plans, maps, and other relevant documents, as required by California Water Code §10723.4.

4. That the Chair of the Board of Directors of the Cuyama Community Services District shall be authorized to execute a Joint Exercise of Powers Agreement with the Cuyama Basin Water District, the Santa Barbara County Water Agency, the County of San Luis Obispo, the County of Ventura, and the County of Kern, and cause notice to be given to the California Department of Water Resources of the decision of the Board of Directors of the Cuyama Community Services District in conjunction with the Cuyama Basin Water District, Santa Barbara County Water Agency, the County of San Luis Obispo, the County of Ventura, and the County of Kern to create the above referenced Groundwater Sustainability Agency.

PASSED, APPROVED, AND ADOPTED by the Board of Directors of the Cuyama Community Services District, Town Site of New Cuyama, State of California, on this 23rd day of May, 2017 by the following vote:

AYES:	F. Paul Chounet John Coats Malcolm Ricci Deborah Williams
NAYS:	None
ABSENT:	Linda Proeber

ABSTAIN: None

ACCEPTED AND AGREED:
CUYAMA COMMUNITY SERVICES DISTRICT

By:____________________________
Malcolm Ricci, Chair, Board of Directors

By:____________________________
F. Paul Chounet, Vice Chair, Board of Directors

ATTEST:
VIVIAN VICKERY,
OFFICE ADMINISTRATOR/BOARD SECRETARY
Cuyama Community Services District

By:____________________________
Board Secretary

County of Santa Barbara
BOARD OF SUPERVISORS
Minute Order

May 9, 2017

Present: 5 - Supervisor Williams, Supervisor Wolf, Supervisor Hartmann, Supervisor Adam, and Supervisor Lavagnino

PUBLIC WORKS, BOARD OF DIRECTORS, WATER AGENCY File Reference No. 17-00341

RE: HEARING - Consider recommendations regarding Cuyama Valley Groundwater Basin Groundwater Sustainability Agency Formation, First and Fifth Districts, as follows:
(EST. TIME: 1 HR.)

Acting as the Board of Directors, Water Agency:

a) Approve and authorize the Chair to execute the "Joint Exercise of Powers Agreement, Cuyama Basin Groundwater Sustainability Agency" to form a Groundwater Sustainability Agency in the Cuyama Valley Groundwater Basin;

b) Adopt the Resolution entitled "Resolution to Participate in the Formation of a Groundwater Sustainability Agency Pursuant to the Sustainable Groundwater Management Act for the Cuyama Valley Groundwater Basin";

c) Appoint by Resolution Supervisor Das Williams as a Director of the Groundwater Sustainability Agency, with Chief of Staff Darcel Elliot as an alternate;

d) Appoint by Resolution Fifth District Chief of Staff Cory Bantilan as a Director of the Groundwater Sustainability Agency, with an alternate to be designated by Mr. Bantilan; and

e) Determine that the proposed actions are not a project under the California Environmental Quality Act, pursuant to Guidelines Section 15378(b) (5), organization or administrative activities that will not result in a direct or indirect physical change in the environment.

COUNTY EXECUTIVE OFFICER'S RECOMMENDATION: APPROVE

County of Santa Barbara
BOARD OF SUPERVISORS
Minute Order

May 9, 2017

Received and filed staff presentation and conducted public hearing.

A motion was made by Supervisor Williams, seconded by Supervisor Lavagnino, that this matter be acted on as follows:

a) Approved; Chair to execute;

b) Adopted;

RESOLUTION NO. 17-97

c) and d) Adopted, amended as follows:

Appoint by Resolution Fifth District Chief of Staff Cory Bantilan as a Director of the Groundwater Sustainability Agency, with Supervisor Lavagnino as an alternate.

RESOLUTION NO. 17-98

e) Approved.

The motion carried by the following vote:

Ayes:	4 -	Supervisor Williams, Supervisor Wolf, Supervisor Hartmann, and Supervisor Lavagnino
Recused:	1 -	Supervisor Adam

RESOLUTION OF THE
BOARD OF DIRECTORS OF THE SANTA BARBARA COUNTY WATER AGENCY
STATE OF CALIFORNIA

RESOLUTION TO PARTICIPATE IN THE FORMATION OF A GROUNDWATER SUSTAINABILITY AGENCY PURSUANT TO THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT FOR THE CUYAMA VALLEY GROUNDWATER BASIN	)	**RESOLUTION NO.** 17-97

WHEREAS, the California legislature passed a statewide framework for sustainable groundwater management, known as the Sustainable Groundwater Management Act (California Water Code § 10720 *et seq.*) as amended, which became effective January 1, 2015; and

WHEREAS, pursuant to the Sustainable Groundwater Management Act (SGMA), sustainable groundwater management is intended to occur pursuant to Groundwater Sustainability Plans (GSP) that are created and adopted by local Groundwater Sustainability Agencies (GSA); and

WHEREAS, pursuant to Water Code §10723(a), a Local Agency or combination of Local Agencies, as defined in Water Code §10721(n), may decide to become or form a Groundwater Sustainably Agency; and

WHEREAS, the Santa Barbara County Water Agency, the Cuyama Basin Water District, Cuyama Community Services District, the County of San Luis Obispo, the County of Ventura, and the County of Kern are "Local Agencies" as defined in Water Code §10721(n), and collectively include all of the lands within the Basin; and

WHEREAS, the Santa Barbara County Water Agency desires to form a Groundwater Sustainability Agency in conjunction with the Cuyama Basin Water District, Cuyama Community Services District, the County of San Luis Obispo, the County of Ventura, and the County of Kern, and which may include at a later time other Local Agencies and other legally authorized entities; and

WHEREAS, a notice of a public hearing to consider whether the County should elect to become a GSA for the basin in conjunction with the Local Agencies listed above was published in the Santa Maria Times and Santa Barbara News Press pursuant to California Government Code §6066; and

WHEREAS, the County Water Agency held a public hearing on May 9, 2017 to consider election to become a GSA for a portion of the basin; and

NOW, THEREFORE, BE IT RESOLVED AS FOLLOWS: that the Board of Directors of the Santa Barbara County Water Agency declares and directs as follows:

1. That the Board of Directors of the Santa Barbara County Water Agency herein decides to form a Groundwater Sustainability Agency in conjunction with the Cuyama Basin Water District, Cuyama Community Services District, the County of San Luis Obispo, the County of Ventura, and the County of Kern, known as the Cuyama Basin Groundwater Sustainability Agency (Agency), and which shall have all the powers granted to a groundwater sustainability agency pursuant to the Sustainable Groundwater Management Act.

2. That the Agency hereby created shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans, as required by California Water Code §10723.2.

3. That the Agency hereby created shall establish and maintain a list of persons interested in receiving notices regarding plan preparation, meeting announcements, and availability of draft plans, maps,. and other relevant documents, as required by California Water Code §10723.4.

4. That the Chair of the Board of Directors of the Santa Barbara County Water Agency shall be authorized to execute a Joint Exercise of Powers Agreement with the Cuyama Basin Water District, Cuyama Community Services District, the County of San Luis Obispo, the County of Ventura, and the County of Kern, and cause notice to be given to the California Department of Water Resources of the decision of the Board of Directors of the Santa Barbara County Water Agency in conjunction with the Cuyama Basin Water District, Cuyama Community Services District, the County of San Luis Obispo, the County of Ventura, and the County of Kern to create the above referenced Groundwater Sustainability Agency.

PASSED, APPROVED, AND ADOPTED by the Board of Directors of the Santa Barbara County Water Agency, State of California, on this 9th day of May, 2017 by the following vote:

AYES: Supervisors Williams, Wolf, Hartmann, and Lavagnino

NAYS: None

ABSENT: None

ABSTAIN: None

RECUSED: Supervisor Adam

ATTEST:
MONA MIYASATO,
COUNTY EXECUTIVE OFFICER
Ex Officio Clerk of the Board Directors
of the Santa Barbara County Water Agency

By: ______________________
Deputy

APPROVED AS TO FORM:
MICHAEL C. GHIZZONI
COUNTY COUNSEL

By: ______________________
Deputy

ACCEPTED AND AGREED:
SANTA BARBARA COUNTY WATER AGENCY

By: ______________________
Joan Hartmann, Chair, Board of Directors

#1

RESOLUTION OF THE
BOARD OF DIRECTORS OF THE SANTA BARBARA COUNTY WATER AGENCY
STATE OF CALIFORNIA

RESOLUTION TO APPOINT DIRECTORS AND ALTERNATES TO THE CUYAMA BASIN GROUNDWATER SUSTAINABILITY AGENCY BOARD OF DIRECTORS PURSUANT TO THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT FOR THE CUYAMA VALLEY GROUNDWATER BASIN	**RESOLUTION NO.** 17-98

WHEREAS, the California legislature passed a statewide framework for sustainable groundwater management, known as the Sustainable Groundwater Management Act (California Water Code § 10720 *et seq.*) as amended, which became effective January 1, 2015; and

WHEREAS, the Santa Barbara County Water Agency (County Water Agency) is entering into a Joint Powers Agreement to form the Cuyama Basin Groundwater Sustainability Agency in conjunction with the Cuyama Basin Water District, Cuyama Community Services District, the County of San Luis Obispo, the County of Ventura, and the County of Kern, and which may include at a later time other Local Agencies and other legally authorized entities; and

WHEREAS, the Joint Powers Agreement for the Cuyama Basin Groundwater Sustainability Agency specifies that the County Water Agency shall appoint two Directors and their two alternates, each of whom shall be an elected official or member of management; and

WHEREAS, the Cuyama Valley Groundwater Basin lies within the County of Santa Barbara's First and Fifth Supervisorial Districts; and

NOW, THEREFORE, BE IT RESOLVED AS FOLLOWS: that the Board of Directors of the Santa Barbara County Water Agency declares and directs as follows:

1. That the Board of Directors of the Santa Barbara County Water Agency hereby appoints First District Supervisor Das Williams as a Director of the Cuyama Basin Groundwater Sustainability Agency, and appoints First District Chief of Staff Darcel Elliot as an Alternate Director.

2. That the Board of Directors of the Santa Barbara County Water Agency hereby appoints Fifth District Chief of Staff Cory Bantilan as a Director of the Cuyama Basin Groundwater Sustainability Agency, and appoints Fifth District Supervisor Steve Lavagnino as an Alternate Director of the Cuyama Basin Groundwater Sustainability Agency.

PASSED, APPROVED, AND ADOPTED by the Board of Directors of the Santa Barbara County Water Agency, State of California, on this 9th day of May, 2017 by the following vote:

AYES: Supervisors Williams, Wolf, Hartmann, and Lavagnino

NAYS: None

ABSENT: None

ABSTAIN: None

RECUSED: None

ATTEST:
MONA MIYASATO,
COUNTY EXECUTIVE OFFICER
Ex Officio Clerk of the Board Directors
of the Santa Barbara County Water Agency

By: ____________________
Deputy

ACCEPTED AND AGREED:
SANTA BARBARA COUNTY WATER AGENCY

By: ____________________
Joan Hartmann, Chair, Board of Directors

APPROVED AS TO FORM:
MICHAEL C. GHIZZONI
COUNTY COUNSEL

By: ____________________
Deputy

IN THE BOARD OF SUPERVISORS

County of San Luis Obispo, State of California

Tuesday, May 23, 2017

PRESENT: Supervisors Bruce S. Gibson, Adam Hill, Lynn Compton, Debbie Arnold, and Chairperson John Peschong

ABSENT: None

RESOLUTION NO. 2017-145

RESOLUTION APPROVING THE JOINT EXERCISE OF POWERS AGREEMENT CREATING A JOINT POWERS AGENCY (JPA) TO SERVE AS THE CUYAMA BASIN GROUNDWATER SUSTAINABILITY AGENCY, APPOINTING THE DIRECTOR AND ALTERNATE DIRECTOR REPRESENTING THE COUNTY OF SAN LUIS OBISPO TO THE JPA BOARD OF DIRECTORS, AND FINDING THAT THE PROJECT IS EXEMPT FROM SECTION 21000 *ET SEQ.* OF THE CALIFORNIA PUBLIC RESOURCES CODE (CEQA)

The following Resolution is hereby offered and read:

WHEREAS, in 2014, the California Legislature adopted, and the Governor signed into law, three bills (SB 1168, AB 1739, and SB 1319) collectively referred to as the Sustainable Groundwater Management Act (SGMA) (Water Code §§ 10720 *et seq.*), that became effective on January 1, 2015, and that have been subsequently amended; and

WHEREAS, the intent of SGMA, as set forth in Water Code Section 10720.1, is to provide for the sustainable management of groundwater basins at a local level by providing local groundwater agencies with the authority, and technical and financial assistance necessary, to sustainably manage groundwater; and

WHEREAS, SGMA requires the formation of Groundwater Sustainability Agencies (GSAs) for the purpose of achieving groundwater sustainability through the adoption and implementation of Groundwater Sustainability Plans (GSPs) for all medium and high priority basins as designated by the California Department of Water Resources (DWR); and

WHEREAS, SGMA requires that a local agency or a collection of agencies through a joint powers agreement or memorandum of agreement decide to become a single GSA or that multiple local agencies decide to each become a GSA for all medium and high priority basins on or before June 30, 2017 and that the GSA or GSAs for basins DWR has designated as "subject to critical conditions of overdraft" develop a GSP or coordinated GSPs on or before January 31, 2020; and

WHEREAS, the Cuyama Valley Groundwater Basin (Basin) has been designated by DWR as a medium priority basin subject to critical conditions of overdraft; and

WHEREAS, the County of San Luis Obispo, the Santa Barbara County Water Agency, the County of Ventura, the County of Kern, the Cuyama Basin Water District, and the Cuyama Community Services District are each a "local agency" within the Basin as defined in Water Code Section 10721(n), and thus are eligible to collectively form a GSA for the Basin through a joint powers agreement under the authority of Water Code Section 10723.6(a) (collectively, Local Agencies or Members); and

WHEREAS, the Local Agencies have determined that management of the Basin will best be achieved through the creation of a joint powers agency (JPA) to serve as the GSA for the Basin pursuant to the terms and conditions set forth in the Joint Exercise of Powers Agreement attached hereto as Exhibit A and incorporated herein (Joint Powers Agreement); and

WHEREAS, Article 3.1 of the Joint Powers Agreement provides that the JPA is a public entity separate from the Members and shall be known as the Cuyama Basin Groundwater Sustainability Agency; and

WHEREAS, Article 7.1 of the Joint Powers Agreement provides that the JPA shall be governed by a board of eleven (11) directors (JPA Board) comprised of representatives from each of the six (6) Members; and

WHEREAS, Article 7.2 of the Joint Powers Agreement provides that the directors and alternate directors representing each Member shall be appointed by the governing body of the Member with the exception that all five (5) Cuyama Basin Water District Board members shall serve as directors on the JPA Board; and

WHEREAS, the Members are committed to the sustainable management of groundwater within the Basin and intend to consider the interests of all beneficial users and uses of groundwater within the Basin through establishment of an advisory committee as more specifically set forth in Article 8 of the Joint Powers Agreement; and

WHEREAS, Article 5.2 of the Joint Powers Agreement acknowledges that SGMA expressly reserves certain powers and authorities to and preserves certain powers and authorities of cities and counties, including, without limitation, the issuance of permits for the construction, modification or abandonment of groundwater wells, land use planning and groundwater management pursuant to city and county police powers in a manner that is not in conflict with the GSP; and

WHEREAS, the County of San Luis Obispo published a notice of public hearing consistent with the requirements contained within Water Code Section 10723(b); and

WHEREAS, the Board of Supervisors conducted such a public hearing on May 23, 2017.

NOW, THEREFORE, BE IT RESOLVED AND ORDERED by the Board of Supervisors of the County of San Luis Obispo, State of California, that:

Section 1: The foregoing recitals are true and correct and are incorporated herein by reference.

Section 2: The County of San Luis Obispo hereby decides to participate in and jointly form the JPA known as the Cuyama Basin Groundwater Sustainability Agency, the boundaries of which are depicted in Exhibit B attached hereto and incorporated herein, to serve as the GSA for the Basin by approving and authorizing the Chairperson of the Board of Supervisors to execute the Joint Powers Agreement.

Section 3: The Director of Public Works of the County of San Luis Obispo, or designee, is hereby authorized and directed to submit notice of adoption of this Resolution in addition to all other information required by SGMA, including but not limited to, all information required by Water Code Section 10723.8, to the Santa Barbara County Water Agency in accordance with Article 3.2 of the Joint Powers Agreement and/or to DWR, and to support the JPA's development and maintenance of an interested persons list as described in Water Code Section 10723.4 and a list of interested parties as described in Water Code Section 10723.8(a)(4).

Section 4: The Director of Public Works of the County of San Luis Obispo, or designee, is hereby authorized to take such other and further actions as may be necessary to administer the County of San Luis Obispo's participation in the Joint Powers Agreement as set forth therein.

Section 5: The Board of Supervisors finds that the adoption of this Resolution is exempt from the requirements of the California Environmental Quality Act (Public Resources Code §§ 21000 et seq.) (CEQA) pursuant to Section 15061(b)(3) of the CEQA Guidelines.

Section 6: The Environmental Coordinator of the County of San Luis Obispo is hereby directed to file a Notice of Exemption in accordance with the provisions of CEQA.

Section 7: The Board of Supervisors hereby appoints the District 4 Supervisor, Lynn Compton, as the director and the District 5 Supervisor, Debbie Arnold, as the alternate director to represent the County on the JPA Board.

Upon motion of Supervisor Compton, seconded by Supervisor Arnold, and on the following roll call vote, to wit:

AYES: Supervisor Compton, Arnold, Gibson, Hill and Chairperson Peschong
NOES: None
ABSENT: None
ABSTAINING: None

the foregoing Resolution is hereby adopted on the 23rd day of May, 2017.

John Peschong
Chairperson of the Board of Supervisors

ATTEST:

TOMMY GONG
Clerk of the Board of Supervisors

By: Annette Ramirez
Deputy Clerk

[SEAL]

APPROVED AS TO FORM AND LEGAL EFFECT:

RITA L. NEAL
County Counsel

By: /s/ Erica Stuckey
Deputy County Counsel

Dated: May 10, 2017

L:\Water Resources\2017\May\BOS\Cuyama Basin GSA Formation\Cuyama GSA rsl per eas.docxCB.mj

STATE OF CALIFORNIA,)
) ss.
COUNTY OF SAN LUIS OBISPO)

I, Tommy Gong, County Clerk and ex-officio Clerk of the Board of Supervisors, in and for the County of San Luis Obispo, State of California, do hereby certify the foregoing to be a full, true and correct copy of an order made by the Board of Supervisors, as the same appears spread upon their minute book.

WITNESS my hand and the seal of said Board of Supervisors, affixed this 23rd day of May, 2017.

Tommy Gong
County Clerk and Ex-Officio Clerk
of the Board of Supervisors

(SEAL)

By: [signature]
Deputy Clerk

JOINT EXERCISE OF POWERS AGREEMENT
CUYAMA BASIN GROUNDWATER SUSTAINABILITY AGENCY

This Joint Exercise of Powers Agreement ("Agreement") is made and entered into as of MAY 23, 2017 ("Effective Date"), by and between the Cuyama Basin Water District ("CBWD"), the Cuyama Community Services District ("CCSD"), the County of Kern ("Kern"), the County of San Luis Obispo ("San Luis Obispo"), the Santa Barbara County Water Agency ("Santa Barbara"), and the County of Ventura ("Ventura"), also each referred to individually as "Member" and collectively as "Members," for the purposes of forming a joint powers agency to serve as the groundwater sustainability agency for the Cuyama Valley Groundwater Basin. This joint powers agency shall hereinafter be known as the Cuyama Basin Groundwater Sustainability Agency ("CBGSA" or "GSA").

RECITALS

A. WHEREAS, the Sustainable Groundwater Management Act of 2014 ("SGMA"), Water Code §§ 10720 *et seq.*, requires the formation of groundwater sustainability agencies to manage medium and high priority basins by June 30, 2017, and the adoption of groundwater sustainability plans ("GSP") by January 31, 2020 for high and medium priority basins that are subject to conditions of critical overdraft; and

B. WHEREAS, the Cuyama Valley Groundwater Basin (also referred to as the "Cuyama Groundwater Basin"), as identified and defined by the California Department of Water Resources (DWR) in Bulletin 118 (as Basin 3-13), has been designated by DWR as a medium priority basin subject to conditions of critical overdraft; and

C. WHEREAS, all Members to this Agreement are local agencies, as defined in SGMA, located within the Cuyama Groundwater Basin and duly organized and existing under the laws of the State of California; and

D. WHEREAS, pursuant to SGMA, specifically Water Code § 10723.6, and the Joint Exercise of Powers Act, Government Code §§ 6500 *et seq.*, the Members are authorized to create a joint powers agency to jointly exercise any power common to the Members together with such powers as are expressly set forth in the Joint Exercise of Powers Act and in SGMA upon successfully becoming a GSA for the Cuyama Groundwater Basin; and

E. WHEREAS, in accordance with Water Code § 10723(b), all members have held a public hearing regarding entering into this Agreement and complied with the noticing provisions in SGMA; and

F. WHEREAS, the Members desire to create a joint powers authority to sustainably manage the Cuyama Groundwater Basin as required by SGMA.

NOW, THEREFORE, in consideration of the terms, conditions, and covenants contained herein, the Members hereby agree as follows:

ARTICLE 1
INCORPORATION OF RECITALS

1.1 The foregoing recitals are true and correct and are incorporated herein by reference.

ARTICLE 2
DEFINITIONS

The following terms shall have the following meanings for purposes of this Agreement:

2.1 "Agreement" means this Joint Exercise of Powers Agreement forming the Cuyama Basin Groundwater Sustainability Agency over the Cuyama Valley Groundwater Basin.

2.2 "Basin" means the Cuyama Valley Groundwater Basin, also referred to as the Cuyama Groundwater Basin, as identified and defined by DWR in Bulletin 118 (as Basin 3-13) as of the Effective Date or as modified pursuant to Water Code Section 10722.2.

2.3 "Bulletin 118" means DWR's report entitled "California Groundwater: Bulletin 118" updated in 2016, and as it may be subsequently updated or revised in accordance with Water Code § 12924.

2.4 "Board of Directors" or "Board" means the governing body of the GSA as established by Article 7 (Board of Directors) of this Agreement.

2.5 "CBGSA" or "GSA" means the Cuyama Basin Groundwater Sustainability Agency formed as a separate entity through this Agreement.

2.6 "Director(s)" and "Alternate Director(s)" means a director or alternate director appointed by a Member pursuant to Articles 7.2 (Appointment of Directors) and 7.3 (Alternate Directors) of this Agreement.

2.7 "DWR" means the California Department of Water Resources.

2.8 "GSP" means a Groundwater Sustainability Plan, as defined by SGMA in Water Code §§ 10727 *et seq.*

2.9 "Joint Exercise of Powers Act" means Government Code §§ 6500, *et seq.*, as may be amended from time to time.

2.10 "Member(s)" means a local agency eligible under SGMA to be a groundwater sustainability agency and included in Article 6.1 (Members) of this Agreement or any local agency that becomes a new member pursuant to Article 6.2 (New Members) of this Agreement.

2.11 "Officer(s)" means the Chair, Vice Chair, Secretary, Auditor or Treasurer of the GSA to be appointed by the Board of Directors pursuant to Article 9.2 (Appointment of Officers) of this Agreement.

2.12 "SGMA" means the Sustainable Groundwater Management Act, Water Code §§ 10720 *et seq.*, as may be amended from time to time.

2.13 "State" means the State of California.

ARTICLE 3
CREATION OF THE GSA

3.1 Creation of a Joint Powers Agency. There is hereby created pursuant to the Joint Exercise of Powers Act, Government Code §§ 6500 *et seq.*, and SGMA, Water Code §§ 10720 *et seq.*, a joint powers agency, which will be a public entity separate from the Members to this Agreement, and shall be known as the Cuyama Basin Groundwater Sustainability Agency ("CBGSA" or "GSA"). The boundaries of the CBGSA shall be coterminous with the boundaries of the Basin as determined by DWR in Bulletin 118 or as modified by DWR pursuant to Water Code Section 10722.2.

3.2 Notices. Within 30 days after the Effective Date of this Agreement, and after any amendment hereto, Santa Barbara, on behalf of the GSA, or the GSA, shall cause a notice of this Agreement or amendment to be prepared and filed with the office of the California Secretary of State containing the information required by Government Code § 6503.5. Within 30 days after the Effective Date of this Agreement, Santa Barbara, on behalf of the GSA, shall cause a statement of the information concerning the GSA, required by Government Code § 53051, to be filed with the office of the California Secretary of State and with the County Clerk for the County of Santa Barbara, and any other County in which the GSA maintains an office, setting forth the facts required to be stated pursuant to Government Code § 53051(a). Within 30 days after the Effective Date of this Agreement, Santa Barbara, on behalf of the GSA, shall inform DWR of each Parties' decision and intent to undertake sustainable groundwater management within the Basin through the GSA in accordance with Water Code § 10723.8.

3.3 Purpose of the CBGSA. The purpose of the CBGSA is to implement and comply with SGMA in the Cuyama Valley Groundwater Basin by serving as the Basin's groundwater sustainability agency, developing, adopting, and implementing a GSP for the Basin, and sustainably managing the Basin pursuant to SGMA.

ARTICLE 4
TERM

4.1 This Agreement shall become effective on the date on which the last Member listed in Article 6.1 (Members) signs this Agreement ("Effective Date"), after which notices shall be filed in accordance with Article 3.2 (Notices). This Agreement shall remain in effect until terminated pursuant to the provisions of Article 17 (Withdrawal of Members) of this Agreement.

ARTICLE 5
POWERS

5.1 The GSA shall possess the power in its own name to exercise any and all common powers of its Members reasonably necessary for the GSA to implement the purposes of SGMA and for no other purpose, together with such other powers as are expressly set forth in the Joint Exercise of Powers Act and in SGMA subject to the limitations set forth therein.

5.2 SGMA expressly reserves certain powers and authorities to and preserves certain powers and authorities of cities and counties, including, without limitation, the issuance of permits for the construction, modification or abandonment of groundwater wells, land use planning and groundwater management pursuant to city and county police powers in a manner that is not in conflict with the GSP. The Directors representing the counties of San Luis Obispo, Kern and Ventura do not have the ability to authorize the GSA to exercise or infringe upon any such reserved powers and authorities, without the GSA first seeking and receiving authorization by formal action of the Boards of Supervisors. Furthermore, this Agreement shall not be interpreted as limiting or ceding any such reserved or preserved powers and authorities. In addition, to the extent that a Member other than a county independently possesses any of the powers or authorities expressly preserved by SGMA, the GSA does not have the ability or authority to exercise or infringe on such preserved powers and/or authorities of such Member without the GSA first seeking and receiving authorization from such Member's governing board, unless specifically enumerated in this Agreement.

5.3 For purposes of Government Code § 6509, the powers of the GSA shall be exercised subject to the restrictions upon the manner of exercising such powers as are imposed on the Cuyama Basin Water District, and in the event of the withdrawal of the Cuyama Basin Water District as a Member under this Agreement, then the manner of exercising the GSA's powers shall be exercised subject to those restrictions imposed on the Cuyama Community Services District.

5.4 As required by Water Code § 10723.2, the GSA shall consider the interests of all beneficial uses and users of groundwater in the Basin, as well as those responsible for implementing the GSP. Additionally, as set forth in Water Code § 10720.5(a), any GSP adopted pursuant to this Agreement shall be consistent with

Section 2 of Article X of the California Constitution. Nothing in this Agreement modifies the rights or priorities to use or store groundwater consistent with Section 2 of Article X of the California Constitution, with the exception that no extraction of groundwater between January 1, 2015 and the date the GSP is adopted may be used as evidence of, or to establish or defend against, any claim of prescription. Likewise, as set forth in Water Code § 10720.5(b), nothing in this Agreement or any GSP adopted pursuant to this Agreement determines or alters surface water rights or groundwater rights under common law or any provision of law that determines or grants surface water rights.

5.5 The GSA may define within the GSP one or more management areas within the Basin in accordance with 23 CCR § 354.20.

ARTICLE 6
MEMBERSHIP

6.1 Members. The Members of the GSA shall be:

(a) Cuyama Basin Water District;

(b) Cuyama Community Services District;

(c) County of Kern;

(d) County of San Luis Obispo;

(e) Santa Barbara County Water Agency; and

(f) County of Ventura

as long as they have not, pursuant to the provisions hereof, withdrawn from this Agreement.

6.2 New Members. Any local agency, as defined by SGMA, that is not a Member on the Effective Date of this Agreement may become a Member upon all of the following:

(a) The approval of the Board of Directors as specified in Article 12.3 (Decisions of the Board);

(b) Amendment of the Agreement in accordance with Article 18.2 (Amendments to Agreement); and

(c) Payment of a pro rata share of all previously incurred costs that the Board of Directors determines have resulted in benefit to the local agency, and are appropriate for assessment on the local agency.

ARTICLE 7
BOARD OF DIRECTORS

7.1 Formation of the Board of Directors. The GSA shall be governed by a Board of Directors ("Board"). The Board shall consist of eleven (11) Directors consisting of representatives from each of the Members identified in Article 6.1 (Members) as follows:

(a) Five (5) Directors representing CBWD;

(b) One (1) Director representing CCSD;

(c) One (1) Director representing Kern;

(d) One (1) Director representing San Luis Obispo;

(e) Two (2) Directors representing Santa Barbara; and

(f) One (1) Director representing Ventura.

7.2 Appointment of Directors. The Directors shall be appointed by the governing body of the Members as follows:

(a) The Directors representing CBWD shall be the Directors of CBWD's Board of Directors, provided if the CBWD Board is ever expanded, then CBWD's Board will appoint the five Directors from CBWD's Board representing CBWD by resolution of CBWD's Board.

(b) The Director representing CCSD shall be appointed by resolution of the CCSD's Board of Directors.

(c) The Director representing Kern shall be appointed by resolution of Kern's Board of Supervisors.

(d) The Director representing San Luis Obispo shall be appointed by resolution of San Luis Obispo's Board of Supervisors.

(e) The Directors representing Santa Barbara shall be appointed by resolution of Santa Barbara's Board of Directors.

(f) The Director representing Ventura shall be appointed by resolution of Ventura's Board of Supervisors.

Subject to Article 7.2 each Director shall be an elected official or member of management of the Member.

7.3 Alternate Directors. Each Director shall have one Alternate to act as a substitute Director for that Director. All Alternates shall be appointed in the same manner as set forth in Article 7.2 (Appointment of Directors). Alternate Directors shall not vote or participate in any deliberations of the Board unless appearing as a substitute for a Director due to absence or conflict of interest. If the Director is not present, or if the Director has a conflict of interest which precludes participation by the Director in any decision-making process of the Board, the Alternate Director appointed to act in his/her place shall assume all rights of the Director, and shall have the authority to act in his/her absence, including casting votes on matters before the Board. An Alternate Director shall be an elected official or member of management of the Member.

7.4 Requirements. Each Director and Alternate Director shall be appointed by resolution as noted in Article 7.2 (Appointment of Directors). Directors and Alternate Directors shall serve at the pleasure of the governing body of the Member that appointed him/her. No individual Director may be removed except by the vote of the governing body of the Member that appointed him/her.

7.5 Vacancies. Upon the vacancy of a Director, the Alternate Director shall serve as Director until a new Director is appointed as set forth in Article 7.2 (Appointment of Directors). Members shall submit any changes in Director or Alternate Director positions to the Board or Executive Director by providing a copy of the executed resolution.

7.6 Duties of the Board of Directors. The business and affairs of the GSA, and all of its powers, including without limitation all powers set forth in Article 5 (Powers), are reserved to and shall be exercised by and through the Board of Directors, except as may be expressly delegated to the Executive Director or others pursuant to this Agreement, Bylaws, GSP, or by specific action of the Board of Directors.

7.7 Director Compensation. No Director shall be compensated by the GSA for preparation for or attendance at meetings of the Board or meetings of any committee created by the Board. Nothing in this Article is intended to prohibit a Member from compensating its representatives on the Board or on a committee for attending such meetings.

ARTICLE 8
ADVISORY COMMITTEES

8.1 Standing Advisory Committee. A Standing Advisory Committee is hereby established as a group of representatives to advise the GSA, and shall be appointed by the Board.

(a) Purpose. The Standing Advisory Committee shall advise the Board concerning, where legally appropriate, implementation of SGMA in the Basin and review the GSP before it is approved by the Board.

(b) Membership. The composition of and appointments to the Standing Advisory Committee shall be determined by the Board.

(c) Brown Act. All Meetings of the Standing Advisory Committee, including special meetings, shall be noticed, held, and conducted in accordance with the Ralph M. Brown Act (Government Code §§ 54950 *et seq.*).

(d) Compensation. No Advisory Committee member shall be compensated by the GSA for preparation for or attendance at meetings of the Board or at any committee created by the Board.

8.2 Additional Advisory Committees. The Board may from time to time appoint one or more additional advisory committees or establish standing or ad hoc committees to assist in carrying out the purposes and objectives of the GSA. The Board shall determine the purpose and need for such committees and the necessary qualifications for individuals appointed to them. No committee member shall be compensated by the GSA for preparation for or attendance at meetings of the Board or at any committee created by the Board.

ARTICLE 9
OFFICERS

9.1 Officers. Officers of the GSA shall be a Chair, Vice Chair, Secretary, Auditor and Treasurer. Additional officers may be appointed by the Board as it deems necessary.

(a) Chair. The Chair shall preside at all meetings of the Board of Directors.

(b) Vice Chair. The Vice Chair shall exercise all powers of the Chair in the Chair's absence or inability to act.

(c) Secretary. The Secretary shall keep minutes of the Board of Director meetings.

(d) Auditor and Treasurer. The Treasurer and Auditor shall perform such duties and responsibilities specified in Government Code §§ 6505.5 and 6505.6.

9.2 Appointment of Officers. Officers shall be elected annually by, and serve at the pleasure of, the Board of Directors. Officers shall be elected at the first Board meeting, and thereafter at the first Board meeting following January 1st of each year. A Director appointed by Santa Barbara shall be designated as the Chair Pro Tem to preside at the initial meeting of the Board until a Chair is elected by the Board. An Officer may serve for multiple consecutive terms, with no term limit. Any Officer may resign at any time upon written notice to the Board, and may be removed and replaced by the Board. Notwithstanding the foregoing, the Treasurer and Auditor shall be appointed in the manner specified in Government Code §§ 6505.5 and 6505.6. Until such time as the Board determines otherwise, the GSA's Treasurer shall be the Treasurer of Santa Barbara.

9.3 Principal Office. The principal office of the GSA shall be established by the Board of Directors, and may thereafter be changed by the Board.

ARTICLE 10
EXECUTIVE DIRECTOR

10.1 Appointment. The Board may appoint an Executive Director or other designated manager ("Executive Director") of the GSA, who may, but need not be, an officer, employee, or representative of one of the Members.

10.2 Compensation. The Executive Director's compensation shall be determined by the Board.

10.3 Duties. The Executive Director shall serve at the pleasure of the Board and shall be responsible to the Board for the property and efficient administration of the GSA. The Executive Director shall have the powers designated by the Board, or otherwise as set forth in the Bylaws.

10.4 Termination. The Executive Director shall serve until he/she resigns or the Board terminates his/her appointment.

ARTICLE 11
GSA DIRECTOR MEETINGS

11.1 Initial Meeting. The initial meeting of the GSA Board of Directors shall be called by Santa Barbara and held within the boundaries of the Basin, within sixty (60) days of the Effective Date of this Agreement.

11.2 Time and Place. The Board of Directors shall meet at least quarterly, at a date, time and place set by the Board within the Basin, and at such other times as may be determined by the Board. Meetings may be held via teleconferencing to the extent allowed by law and teleconferenced meetings shall be conducted in accordance with the Ralph M. Brown Act (Government Code §§ 54950 *et seq.*).

11.3 Special Meetings. Special meetings of the Board of Directors may be called by the Chair or by a simple majority of Directors, in accordance with the Ralph M. Brown Act (Government Code §§ 54950 *et seq.*).

11.4 Conduct. All meetings of the Board of Directors, including special meetings, shall be noticed, held, and conducted in accordance with the Ralph M. Brown Act (Government Code §§ 54950 *et seq.*).

11.5 Local Conflict of Interest Code. The Board of Directors shall adopt a local conflict of interest code pursuant to the provisions of the Political Reform Act of 1974 (Government Code §§ 81000 *et seq.*).

ARTICLE 12
VOTING

12.1 Quorum. A quorum of any meeting of the Board of Directors shall consist of a majority of the Directors. In the absence of a quorum, any meeting of the Directors may be adjourned by a vote of the simple majority of Directors present, but no other business may be transacted.

12.2 Director Votes. Voting by the Board of Directors shall be made on the basis of one vote for each Director weighted as follows:

(a) Directors representing CBWD- each Director's vote shall be weighted by 6.667%;

(b) Director representing CCSD- Director's vote shall be weighted by 11.111%;

(c) Director representing Kern- Director's vote shall be weighted by 11.111%;

(d) Director representing San Luis Obispo- Director's vote shall be weighted by 11.111%;

(e) Directors representing Santa Barbara- each Director's vote shall be weighted by 11.111%; and

(f) Director representing Ventura- Director's vote shall be weighted by 11.111%.

A Director, or an Alternate Director when acting in the absence of his/her Director, may vote on all matters of GSA business unless disqualified.

12.3 Decisions of the Board.

(a) Majority Approval. Except as otherwise specified in this Agreement, all decisions of the Board of Directors shall require the affirmative vote of more than 50% of the weighted vote total in accordance with Article 12.2, provided that if a Director is disqualified from voting on a matter before the Board because of a conflict of interest and no Alternate Director is present in the Director's place or if the Alternate Director is also disqualified because of a conflict of interest, that Director shall be excluded from the calculation of the total number of Directors that constitute a majority.

(b) Supermajority Approval. Notwithstanding the foregoing, 75% of the weighted vote total in accordance with Article 12.2 shall be required to approve any of the following: (i) the annual budget; (ii) the GSP for the Basin and any substantive amendment thereto; (iii) any stipulation to resolve litigation; (iv) addition of new Members pursuant to Article 6.2 (New Members); (v) establishment and levying any fee, charge or assessment; (vi) adoption or amendment of Bylaws; or (vii) selection of consultant to prepare the GSP.

ARTICLE 13
BYLAWS

13.1 The Board of Directors may approve and amend, as needed, bylaws for the GSA.

ARTICLE 14
ACCOUNTING PRACTICES

14.1 General. The Board of Directors shall establish and maintain such funds and accounts as may be required by generally accepted public agency accounting practices. The GSA shall maintain strict accountability of all funds and a report of all receipts and disbursements of the GSA. The GSA shall hire an independent auditor to audit its funds and accounts as required by law.

14.2 Fiscal Year. Unless the Board of Directors decides otherwise, the fiscal year for the GSA shall run from July 1st to June 30th.

14.3 Records. The books and records of the GSA shall be open to inspection by the Members.

ARTICLE 15
BUDGET AND EXPENSES

15.1 Budget. The Board of Directors shall adopt an annual budget for the GSA.

15.2 GSA Funding and Contributions.

(a) For the purpose of funding the expenses and ongoing operations of the GSA, the Board of Directors shall maintain a funding account in connection with the annual budget process.

(b) The GSA shall pursue and apply for grants and/or loans to fund a portion of the cost of developing and implementing the GSP as the Board shall direct.

(c) The Board of Directors may fund the GSA and the GSP as provided in SGMA at Water Code § 10730 *et seq.*, from voluntary Member contributions, and/or from any other means allowable by law.

15.3 Return of Contributions. In accordance with Government Code § 6512.1, repayment or return to the Members of all or any part of any contributions made by Members and any revenues by the GSA may be directed by the Board of Directors at such time and upon such terms as the Board of Directors may decide; provided that (1) any return of contributions shall be made in proportion to the contributions paid by each Member to the GSA, and (2) any capital contribution paid by a Member voluntarily, and without obligation to make such capital contribution pursuant to Article 15.2 (GSA Funding and Contributions), shall be returned to the contributing Member, together with accrued interest at the annual rate published as the yield of the Local Agency Investment Fund administered by the California State Treasurer, before any other return of contributions to the Members is made. The GSA shall hold title to all funds and property acquired by the GSA during the term of this Agreement.

15.4 Issuance of Indebtedness. The GSA may issue bonds, notes or other forms of indebtedness, provided such issuance is approved at a meeting of the Board of Directors by 100% of the weighted vote total in accordance with Article 12.2.

ARTICLE 16
LIABILITIES

16.1 Liability. In accordance with Government Code § 6507, the debts, liabilities and obligations of the GSA shall be the debts, liabilities and obligations of the GSA alone, and not the Members.

16.2 Indemnity. The GSA, and those persons, agencies and instrumentalities used by it to perform the function authorized herein, whether by contract, employment or otherwise shall be exclusively liable for any injuries, costs, claims, liabilities, damages or whatever kind arising from or related to activities of the GSA. The GSA agrees to indemnify, defend and hold harmless each Member, their respective governing boards, officers, officials, representatives, agents and employees from and against any and all claims, suits, actions, arbitration proceedings, administrative proceedings, regulatory proceedings, losses, damages, judgments, expenses or costs, including but not limited to attorney's fees, and/or liabilities arising out of or attributable to the GSA or this Agreement ("Claims").

Funds of the GSA may be used to defend, indemnify, and hold harmless the GSA, each Member, each Director and Alternate Director, and any officers, officials, agents or employees of the GSA for their actions taken within the course and scope of their duties while acting on behalf of the GSA against any such Claims.

The Members do not intend hereby to be obligated either jointly or severally for the debts, liabilities, obligations or Claims of the GSA, except as may be specifically provided for in Government Code § 895.2. Provided, however, if any Member(s) of the GSA are, under such applicable law, held liable for the acts or omissions of the GSA, such parties shall be entitled to contribution from the other Members so that after said contributions each Member shall bear an equal share of such liability.

16.3 Insurance. The GSA shall procure appropriate policies of insurance providing coverage to the GSA and its Directors, officers and employees for general liability, errors and omissions, property, workers compensation, and any other coverage the Board deems appropriate. Such policies shall name the Members as additional insureds.

ARTICLE 17
WITHDRAWAL OF MEMBERS

17.1 Unilateral Withdrawal. Any Member may unilaterally withdraw from this Agreement without causing or requiring termination of this Agreement, effective upon sixty (60) days written notice to the Executive Director and all other Members.

17.2 Rescission or Termination of GSA. This Agreement may be rescinded and the GSA terminated by unanimous written consent of all Members, except during the outstanding term of any GSA indebtedness.

17.3 Effect of Withdrawal or Termination. Upon termination of this Agreement or unilateral withdrawal, a Member shall remain obligated to pay its share of all liabilities and obligations of the GSA required of the Member pursuant to terms of this Agreement, but only to the extent that the liabilities and obligations were incurred or accrued prior to the effective date of such termination or withdrawal and are the individual Member's liabilities and obligations as opposed to the GSA's obligation and liabilities in accordance with Article 16. Any Member who withdraws from the GSA shall have no right to participate in the business and affairs of the GSA or to exercise any rights of a Member under this Agreement or the Joint Exercise of Powers Act, and shall not share in distributions from the GSA. Notwithstanding the foregoing, nothing contained in this Article 17.3 shall be construed as prohibiting a Member that has withdrawn from the GSA to become a separate groundwater sustainability agency within its jurisdiction.

17.4 Return of Contribution. Upon termination of this Agreement, where there will be a successor public entity which will carry on the functions of the GSA and assume its assets, the assets of the GSA shall be transferred to the successor public entity. If there is no successor public entity which will carry on the functions of the GSA, then any surplus money on-hand shall be returned to the Members in proportion to their contributions made. The Board of Directors shall first offer any property, works, rights and interests of the GSA for sale to the Members on terms and conditions determined by the Board of Directors. If no such sale to Members is consummated, the Board of

Directors shall offer the property, works, rights, and interest of the GSA for sale to any non-member for good and adequate consideration. The net proceeds from any sale shall be distributed among the Members in proportion to their contributions made.

ARTICLE 18
MISCELLANEOUS PROVISIONS

18.1 Notices. Notices to a Member shall be sufficient if delivered to the clerk or secretary of the respective Member's governing board or at such other address or to such other person that the Member may designate in accordance with this Article. Delivery may be accomplished by personal delivery or with postage prepaid by first class mail, registered or certified mail or express courier.

18.2 Amendments to Agreement. This Agreement may be amended or modified at any time only by subsequent written agreement approved and executed by all of the Members.

18.3 Agreement Complete. The foregoing constitutes the full and complete Agreement of the Members. This Agreement supersedes all prior agreements and understandings, whether in writing or oral, related to the subject matter of this Agreement that are not set forth in writing herein.

18.4 Severability. Should any part, term or provision of this Agreement be decided by a court of competent jurisdiction to be illegal or in conflict with any applicable federal law or any law of the State of California, or otherwise be rendered unenforceable or ineffectual, the validity of the remaining parts, terms, or provisions hereof shall not be affected thereby, provided however, that if the remaining parts, terms, or provisions do not comply with the Joint Exercise of Powers Act, this Agreement shall terminate.

18.5 Withdrawal by Operation of Law. Should the participation of any Member to this Agreement be decided by the courts to be illegal or in excess of that Member's authority or in conflict with any law, the validity of the Agreement as to the remaining Members shall not be affected thereby.

18.6 Assignment. The rights and duties of the Members may not be assigned or delegated without the written consent of all other Members. Any attempt to assign or delegate such rights or duties in contravention of this Agreement shall be null and void.

18.7 Binding on Successors. This Agreement shall inure to the benefit of, and be binding upon, the successors of the Members.

18.8 Dispute Resolution. In the event that any dispute arises among the Members relating to this Agreement, the Members shall attempt in good faith to resolve the controversy through informal means. If the Members cannot agree upon a resolution of the controversy, the dispute may be submitted to mediation prior to commencement of any legal action, if agreed to by all Members. The mediation shall be no more than a full day (unless agreed otherwise among the Members) and the cost of mediation shall be paid in equal proportion among the Members.

18.9 Counterparts. This Agreement may be executed in counterparts, each of which shall be deemed an original and together shall constitute one and the same instrument.

18.10 Singular Includes Plural. Whenever used in this Agreement, the singular form of any term includes the plural form and the plural form includes the singular form.

18.11 Member Authorization. The governing bodies of the Members have each authorized execution of this Agreement and all signatories to this Agreement warrant and represent that they have the power and authority to enter into this Agreement in the names, titles and capacities stated herein and on behalf of the Members.

18.12 No Third Party Beneficiary. Except as expressly set forth herein, this Agreement is not intended to benefit any person or entity not a party hereto.

IN WITNESS WHEREOF, the Members have executed this Agreement to be effective on the date executed by the last Member as noted on Page 1.

ATTEST:
Clerk of the District

By: ______________________
Deputy Clerk

Address:

CUYAMA BASIN WATER DISTRICT:

By: ______________________
Chair, Board of Directors

Date: ______________________

ATTEST:
Clerk of the Board

By: ______________________
Deputy Clerk

Address:

CUYAMA COMMUNITY SERVICE DISTRICT:

By: ______________________
Chair, Board of Directors

Date: ______________________

ATTEST:
Clerk of the Board

By: ______________________
Secretary

Address:

COUNTY OF KERN:

By: ______________________
Chair, Board of Supervisors

Date: ______________________

ATTEST:
Clerk of the Board

By: ______________________
Deputy Clerk

Address:

COUNTY OF SAN LUIS OBISPO:

By: ______________________
Chair, Board of Supervisors

Date: ______________________

APPROVED AS TO LEGAL FORM AND EFFECT
Rita L. Neal
County Counsel

By: [signature] 5-2-2017
Deputy County Counsel

ATTEST:
Mona Miyasato
County Executive Officer
Clerk of the Board, Ex Officio Clerk of
the Santa Barbara County Water Agency

By: ______________________________
Deputy Clerk

Address:

SANTA BARBARA COUNTY WATER AGENCY:

By: ______________________________
Joan Hartmann, Chair
Board of Directors

Date: ______________________________

RECOMMENDED FOR APPROVAL:
Santa Barbara County Water Agency

By: ______________________________
Scott D. McGolpin
Public Works Director

APPROVED AS TO FORM:
Risk Management
Ray Aromatorio, ARM, AIC

By: ______________________________
Risk Management

APPROVED AS TO FORM:

Michael C. Ghizzoni
County Counsel

By: ______________________________
Deputy County Counsel

APPROVED AS TO ACCOUNTING FORM:
Theodore A. Fallati, CPA
Auditor-Controller

By: ______________________________
Deputy

ATTEST:
Clerk of the Board

By: ______________________________
Secretary

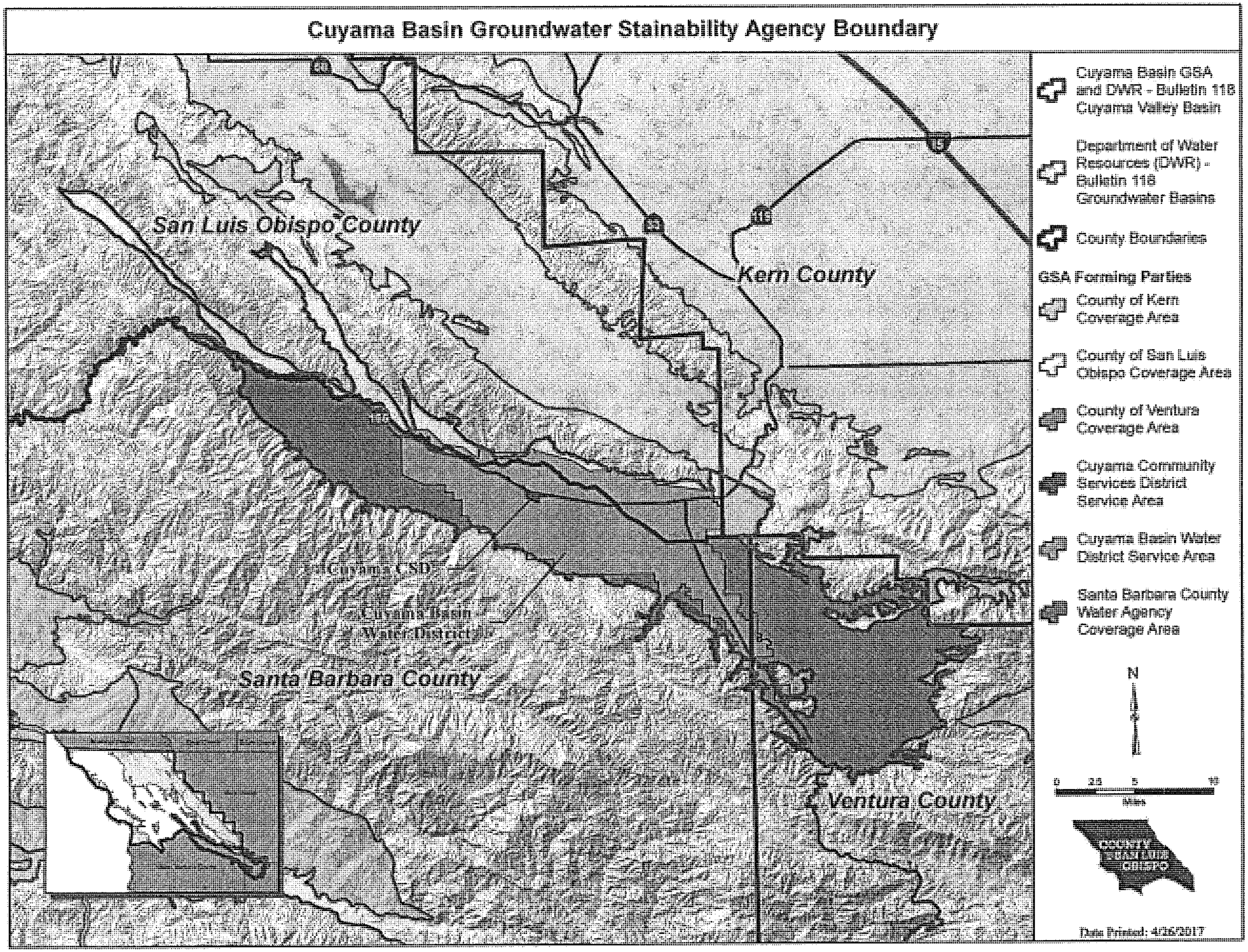
Address:

COUNTY OF VENTURA:

By: ______________________________
Chair, Board of Supervisors

Date: ______________________________

EXHIBIT B



Cuyama Basin Groundwater Stainability Agency Boundary
San Luis Obispo County
Kern County
Cuyama CSD
Cuyama Basin
Water District
Santa Barbara County
Ventura County
Cuyama Basin GSA and DWR - Bulletin 118 Cuyama Valley Basin
Department of Water Resources (DWR) - Bulletin 118 Groundwater Basins
County Boundaries
GSA Forming Parties
County of Kern Coverage Area
County of San Luis Obispo Coverage Area
County of Ventura Coverage Area
Cuyama Community Services District Service Area
Cuyama Basin Water District Service Area
Santa Barbara County Water Agency Coverage Area
N
0 2.5 5 10
Miles
COUNTY OF SAN LUIS OBISPO
Date Printed: 4/26/2017

BOARD MINUTES
BOARD OF SUPERVISORS, COUNTY OF VENTURA, STATE OF CALIFORNIA

SUPERVISORS STEVE BENNETT, LINDA PARKS,
KELLY LONG, PETER C. FOY AND JOHN C. ZARAGOZA
June 6, 2017 at 2:30 p.m.

Public Hearing Regarding a Joint Powers Agreement to Form a Groundwater Sustainability Agency to Manage the Cuyama Valley Groundwater Basin; Adoption of the Resolution Authorizing the County to Enter a Joint Powers Agreement Creating the Cuyama Basin Groundwater Sustainability Agency and Appointment of a Director and Alternate Director of the Cuyama Basin Groundwater Sustainability Agency. (Public Works Agency)

(X) All Board members are present.

(X) The Board holds a public hearing.

(X) The following persons are heard: Glenn Shephard, Byron Albano, and Jeff Pratt.

(X) The following document is submitted to the Board for consideration:
(X) Exhibit 2 - Cuyama Valley Basin Maps

(X) Upon motion of Supervisor Bennett, seconded by Supervisor Parks, and duly carried, the Board hereby approves recommendations and appoints Glenn Shephard as the Director and Arne Anselm as the Alternate Director.

I hereby certify that the annexed instrument is a true and correct copy of the document which is on file in this office.
Dated: 6/7/17
MICHAEL POWERS
Clerk of the Board of Supervisors
County of Ventura, State of California
By: Lori Gaines
Deputy Clerk of the Board

By: ______
Brian Palmer
Chief Deputy Clerk of the Board

Item #28
6/06/17

RESOLUTION NO. 17-060

RESOLUTION OF THE BOARD OF SUPERVISORS OF THE COUNTY OF VENTURA AUTHORIZING EXECUTION OF JOINT POWERS AGREEMENT TO CREATE THE CUYAMA BASIN GROUNDWATER SUSTAINABILITY AGENCY AND APPOINTING DIRECTOR(S) TO CBGSA BOARD

WHEREAS, California enacted the Sustainable Groundwater Management Act of 2014 (California Water Code § 10720 et seq., SGMA), which authorizes local agencies to manage groundwater in a sustainable fashion; and

WHEREAS, pursuant to the SGMA, sustainable groundwater management is intended to occur pursuant to Groundwater Sustainability Plans (GSP) that are created and adopted by local Groundwater Sustainability Agencies (GSA); and

WHEREAS, pursuant to Water Code §10723(a), a Local Agency or combination of Local Agencies, as defined in Water Code §10721(n), may decide to become or form a Groundwater Sustainably Agency; and

WHEREAS, the Cuyama Basin Water District, the Cuyama Community Services District, the County of Kern, the County of San Luis Obispo, the Santa Barbara County Water Agency, and the County of Ventura (Member Agencies) are Local Agencies as defined by the Water Code and wish to enter into the attached proposed Joint Exercise of P owers Agreement (JPA) to create the Cuyama Basin Groundwater Sustainability Agency (CBGSA or GSA) to manage all of the Cuyama Valley Groundwater Basin (basin number 4-3-13 in the California Department of Water Resources CASGEM groundwater basin system (Basin);

WHEREAS, the JPA requires the governing board of the County of Ventura to appoint a Director to the CBGSA Board of Directors;

WHEREAS, a notice of a public hearing to consider whether the County should enter into this JPA Agreement to form the Cuyama Basin Groundwater Sustainability Agency to manage this Basin was duly published pursuant to the requirements of California Government Code §6066; and

WHEREAS, the County held a public hearing on June 6, 2017 to consider whether to enter into the JPA to form the Cuyama Basin GSA to manage all of this Basin;

NOW, THEREFORE, BE IT RESOLVED that the Ventura County Board of Supervisors hereby:

1. Approves the attached JPA to form the Cuyama Basin GSA (Exhibit 1) and authorizes the Chair to execute the JPA on behalf of the County of Ventura;

2. Declares the County's commitment, as a Member Agency to the GSA, to assist the GSA in considering the interests of all beneficial uses and users

of groundwater, as well as those responsible for implementing groundwater sustainability plans, as required by California Water Code §10723.2.

3. Declares the County's commitment, as a Member Agency to the GSA, to assist the GSA in establishing and maintaining a list of persons interested in receiving notices regarding plan preparation, meeting announcements, and availability of draft plans, maps, and other relevant documents, as required by California Water Code §10723.4; and

4. Hereby appoints Glenn Shephard as a Director, and appoints Arne Anselm as an Alternate Director, to the Cuyama Groundwater Sustainability Agency Board of Directors to represent the interests of the County of Ventura on the CBGSA Board.

Upon motion of Supervisor Bennett, seconded by Supervisor Parks, and duly carried, the Board hereby approves and adopts this resolution on the 6th day of June, 2017.

Chair, Board of Supervisors
County of Ventura

ATTEST:

Michael Powers,
Clerk of the Board of Supervisors
County of Ventura, State of California.

By: ______________________
Deputy Clerk of the Board

COUNTY OF VENTURA ★ CALIFORNIA ★

BEFORE THE BOARD OF SUPERVISORS
COUNTY OF KERN, STATE OF CALIFORNIA

In the matter of: Resolution No. 2017-108

RESOLUTION ELECTING TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY FOR A PORTION OF THE CUYAMA GROUNDWATER BASIN

I, KATHLEEN KRAUSE, Clerk of the Board of Supervisors of the County of Kern, do certify that the following resolution, on motion of Supervisor Couch, seconded by Supervisor Gleason, was duly passed and adopted by the Board of Supervisors at an official meeting this 23rd day of May, 2017, by the following vote:

AYES: Gleason, Scrivner, Maggard, Couch, Perez

NOES: None

ABSENT: None

KATHLEEN KRAUSE
Clerk of the Board of Supervisors
County of Kern, State of California

Deputy Clerk

RESOLUTION

Section 1. WHEREAS:

(a) The comprehensive groundwater legislation referred to as the "Sustainable Groundwater Management Act" (SGMA) was signed into law on September 16, 2014 with an effective date of January 1, 2015, and codified at California Water Code sections 10720 *et seq.*; and

(b) The stated purpose of SGMA, as set forth in California Water Code Section 10720.1, is to provide for the sustainable management of groundwater basins, and subbasins, as defined by the California Department of Water Resources at a local level by providing local water supply, water management and land use agencies with the authority and technical and financial assistance necessary to sustainably manage groundwater; and

(c) SGMA further provides for and anticipates that eligible local agencies overlying basins that are designated by California Department of Water Resources (DWR) as "high or medium priority" will form Groundwater Sustainable Agencies ("GSAs") for the purpose of achieving groundwater sustainability through the adoption and implementation of Groundwater Sustainability Plans ("GSPs"); and

(d) Water Code section 10723(a) authorizes local agencies with water supply, water management or local land use responsibilities, or a combination of those local agencies, overlying a groundwater basin to elect to become a GSA; and

(e) The County of Kern falls within the SGMA definition of local agency and it overlies the entirety of the unadjudicated groundwater subbasin known as Cuyama Groundwater Basin (Basin).

(f) The Basin, which is defined in DWR Bulletin 118 as Basin No. 3-13, has been designated as a high priority basin in critical overdraft; and

(g) Many of the express powers set forth in SGMA were previously held exclusively by the County through its constitutionally granted policy power over groundwater and as such the ability of a local water purveyor to now also exercise these powers through the formation of a GSA is a significant expansion of the authorities granted to local water purveyors. Prior to SGMA, the powers and authorities afforded to a of a local water purveyor were expressly set forth, and limited by, the purveyor's enabling act; and

(h) SGMA anticipates and expressly provides the statutory authorities for GSAs to operate as enterprise funds through the imposition of fees on those that are benefited by the GSA's operations. As such, any initial outlay of general funds by the County may be recouped once the GSA is formed; and

(i) SGMA does not allow a local agency to impose fees or regulatory requirements on activities that are outside of the boundaries of the local agency and therefore in order to ensure uniformity in the implementation of SGMA and its effects on all lands within the Basin the County of Kern should elect to become a GSA or be a member of all GSA's in the Basin; and

(j) Water Code section 10735.2(a) provides that the State Board may designate the Basin as probationary if any portion of the Basin is not covered by a GSA before June 30, 2017; and

(k) Staff has reviewed this matter and determined that this matter is exempt from further CEQA review pursuant CEQA Guideline section 15061(b)(3) because it can be seen with certainty that there is no possibility that the activity in question may have a significant effect on the environment and CEQA Guideline section 15378(b)(5) because the matter is an organizational activity that will not result in a direct or indirect physical change in the environment; and

(l) As required by Water Code section 10723(b), the notice of public hearing to consider this election to become a GSA for the Basin was published pursuant to Government Code section 6066 in the Bakersfield Californian; and

(m) On May 9, 2017, the Board of Supervisors approved a Joint Powers Authority (JPA) Agreement with the Cuyama Basin Groundwater Sustainability Agency; and

(n) All members to the JPA Agreement are local agencies, as defined in SMGA, located within the Basin and duly organized and existing under the laws of the State of California; and

(o) On May 23, 2017, the Board of Supervisors properly held the noticed public hearing required by Water Code section 10723(b) at 2:00 p.m. in the Board of Supervisors Chambers.

Section 2. IT IS RESOLVED by the Board of Supervisors of the County of Kern, State of California, as follows:

1. This Board finds that the recited facts are true and that it has the jurisdiction to consider, approve, and adopt this Resolution.

2. This Board incorporates and makes all the findings recommended by staff, whether verbally or in their written reports.

3. This Board finds and determines that the applicable provisions of the California Environmental Quality Act of 1970 ("CEQA"), the State CEQA Guidelines, and the Kern County Guidelines have been observed in conjunction with the hearing and the considerations of this matter and it is exempt from further CEQA review pursuant Sections 15061(b)(3) and 15378(b)(5).

4. As set forth in the DWR's Groundwater Sustainability Agency Frequently Asked Questions dated January 7, 2016, the GSA formed by the County of Kern shall consider the desires of other eligible agencies to join this GSA or form other GSA's with the participation and membership of the County of Kern.

5. As required by Water Code section 10723.2, the GSA formed by the County of Kern shall consider the interests of all beneficial uses and users of groundwater, as well as those that are responsible for implementing groundwater sustainability plans.

6. As required by Water Code section 10723.4, the GSA shall establish and maintain a list of all persons interested in receiving notices regarding the GSP preparation, meetings, announcements, and the availability of draft plans, maps and other relevant documents.

7. Staff is directed to ensure that the notice of GSA formation, and all supporting documentation, is submitted to California Department of Water Resources by no later than June 30, 2017.

8. Staff is further authorized and directed to engage in discussions with other qualified local agencies that wish to be a part of the GSA established herein.

9. The Clerk of this Board shall cause a Notice of Exemption to be filed with the County Clerk.

10. The Clerk of this Board shall transmit copies of this Resolution to the following:

Planning and Natural Resources
County Counsel

Cuyama Basin Water District
c/o Cuyama Valley Family Resources Center
4689 Hwy 166
New Cuyama, CA 93254

COPIES FURNISHED:
See above
6/2/2017 (TI)

Chapter 1
Appendix D

Groundwater Sustainability Plan
Summary of Public Comments and Responses

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APPENDIX D
GROUNDWATER SUSTAINABILITY PLAN
COMMENTS AND RESPONSES

This appendix documents public input about the Cuyama Basin Groundwater Sustainability Agency's (CBGSA's) Groundwater Sustainability Plan (GSP) and their responses. Input was received in the following ways:

- At CBGSA Board and Standing Advisory Committee (SAC) meetings
- At community workshops
- Comments sent directly to the CBGSA
- Comments made on the draft GSP chapters or sections that were provided for public comment prior to release of the final draft GSP. These are shown in Attachment 1.
- Comments made by technical staff and consultants on Technical Forum conference calls. These are shown in Attachment 2.

Public Comments and Responses at CBGSA and SAC Meetings

Questions and responses noted below are from the minutes of the CBGSA Board meetings, joint meetings of the CBGSA Board and SAC meetings. Complete minutes for these meetings are available online at www.cuyamabasin.org.

CBGSA Board Meetings

Questions and answers recorded in the minutes for CBGSA Board meetings are listed below in chronological order, from oldest to newest.

April 4, 2018

Question: How recent is the collected data? Why do we not go back to the USGS sites for data?

Answer: Woodard & Curran have all of the data that the Santa Barbara County Water Resources Agency and USGS had.

Question: Has someone been hired to go out and collect that data proactively?

Answer: The more data received, the better.

Question: What about data consistency? How will it be vetted for accuracy?

Answer: A request for data was sent out to the four counties, CBWD, and CCSD. Wells on different sides of a geological fault will be looked at to determine if that data is valid.

Question: Will Woodard & Curran report the data that is not used?

Answer: Woodard & Curran plan on doing that.

May 2, 2018

The minutes for this meeting included no questions from the public.

July 11, 2018

Question: Clarify the review period of the GSA plans by DWR?

Answer: DWR will begin reviewing the plans in 2020, and it may take up to two years to complete the review period.

Question: What will the GSAs be doing while the GPSs are being reviewed?

Answer: The GSAs may begin implementing GSP programs.

Question: Can Woodard & Curran identify who is making comments from the technical forum?

Answer: Woodard & Curran can do this.

August 1, 2018

Question: How do the groundwater level maps correlate to the USGS studies since they do not show the same drops (in groundwater levels).

Answer: The graph represents a different time frame.

Question: How well does the USGS data compare?

Answer: It compares very well and is represented in the model. The current integrated water flow model (IWFM) that Woodard & Curran are using is very good.

Question: Will the stakeholders be informed of the Board and SACs definition of sustainability?

Answer: This information is coming. The sustainability goals and criteria will be developed and available in the September to November time period. The CBGSA Board has not been presented with the criteria for drafting their definition of sustainability, and this composition will be drafted in the fall.

September 5, 2018

Question: Will the public comments made on parts of the draft GSP sections be seen by the SAC.

Answer: All of the comments received by Woodard & Curran will be compiled so the SAC will see everyone's comments.

October 3, 2018

Question: When will the Groundwater Dependent Ecosystems (GDE) be developed?

Answer: In a month or two.

Question: If the CBGSA chose not to have management areas, would they still need boundaries for thresholds?

Answer: Boundaries would still be required.

November 7, 2018

Question: If some wells exceed their thresholds in the same area but are less than the required percentage triggering State intervention, will this trigger anything.

Answer: No.

Question: Are there enough monitoring wells in each area to set thresholds?

Answer: We are working with the data we have. Splitting up the western area will reduce the amount of data and will result in dubious results.

January 9, 2019

The minutes for this meeting included no questions from the public.

February 6, 2019

The minutes for this meeting included no questions from the public.

Joint Meetings of the CBGSA Board and SAC

Questions and answers recorded in the minutes at joint meetings of the CBGSA Board and SAC are listed below in chronological order, from oldest to newest.

February 7, 2018

The minutes for this meeting included no questions from the public.

March 7, 2018

The minutes for this meeting included no questions from the public.

June 6, 2018

The minutes for this meeting included no questions from the public.

February 13, 2018

Question: How can you set minimum thresholds and measurable objectives without the water budget as you would have to go back and redo those numbers if they do not match with the water budget.

Answer: You do not have to resubmit the GSP but update the annual report.

March 6, 2018

Minutes for this meeting were not available as of this writing.

SAC Meetings

Questions and answers recorded in the minutes for SAC meetings are listed below in chronological order, from oldest to newest.

March 1, 2018

Question: Will the GSP team stay until the conclusion of the Spanish workshop at 8:30 pm?

Answer: The GSP consultants will remain for both the English and Spanish language workshops.

Question: Why is an efficient surface interface option a benefit with the IWFM model when Cuyama Valley does not have surface water.

Answer: The Cuyama Valley does have surface water in different forms. The groundwater basin is recharged through surface streams (and upstream fingerlings), as well as irrigation percolation.

March 29, 2018

Question: Is the data going into the model going to be shared publicly?

Answer: Yes, either on the CBGSA website or through DWR's SGMA portal website.

Question: When are the minimum thresholds and measurable objectives determined.

Answer: They will be determined after the conceptual model is developed.

April 26, 2018

Question: Is ground truthing is being done on the data.

Answer: The technical team confirmed that they are spending significant time to do this.

May 31, 2018

Question: Is the GSA aware of the IRWM grant to the Cuyama Community Services District (CCSD)?

Answer: The GSA is aware of the grant.

Question: Will reports be available on the GSA website for public review?

Answer: Yes.

Question: Why is the baseline shown as January 1, 2015?

Answer: The baseline is the ending point for data collection that was provided by DWR.

Question: What is the timeframe for deciding WMAs?

Answer: By the end of summer. The modeling results will assist in determining if WMAs exist.

Question: Who will determine the financial component of achieving measurable objectives.

Answer: The SAC will determine the financial component, and Woodard & Curran will develop a portfolio of options to achieve the measurable objectives the group decides on. Potential projects and management actions for meeting measurable objectives will be discussed in the near future.

Question: Why doesn't the SAC have data for pumping levels?

Answer: Landowners do not always like to provide pumping levels. Woodard & Curran will estimate pumping levels. The lack of pumping data could be a data gap that is identified in the GSP and that the GSA should formulate ways to improve this data going forward.

Question: Will climate change be factored into the GSP?

Answer: Yes, DWR will provide climate data for this variable.

June 28, 2018

Question: Aren't groundwater pumping numbers a critical component of verifying the model?

Answer: The GSA can decide pumping limits, but DWR does not require any pumping data.

Question: If groundwater dependent vegetation is negatively impacted by water diversions, these areas should be monitored. Can the SAC put a caveat in the GSP to add monitoring areas that are not currently monitored if changes in the water use occur?

Answer: This is something that can be updated during the 5-year update cycle or during the annual review of the monitoring data.

Question: Can the next CBGSA newsletter explain the difference between monitoring wells and the monitoring network.

Answer: Yes.

Question: Are community members unaware of their current pumping rates, how will they know if they go over their limit?

Answer: It will be determined how landowners will report on their data.

Question: How will the definition of sustainability be decided?

Answer: The CBGSA Board will develop the definition with stakeholder input.

July 26, 2018

Question: Where will the water budgets for the ten recent years be coming from and when will they be available?

Answer: The water budgets will be developed by the numerical model, and the initial results are anticipated to be available at the September 5, 2018 meeting.

Question: Under SGMA, does the water budget take climate change into account?

Answer: Yes, it will.

Question: How big of an area will be reported on?

Answer: Woodard & Curran will report potentially on four areas. The CBGSA Board will determine this number.

Question: What is the typical range that the regional scale is based on? Is there a standard range?

Answer: It is based on irrigation efficiency. It is a general range, but the number will be updated in the model to be specific for Cuyama.

Question: Will there ever be a number on all the wells detailing what is being pumped or will it be estimated?

Answer: That decision will be made as the implementation plan is developed. There are several ways to calculate future use, one way being satellite imagery like evapotranspiration. The California DWR will accept pump meters and satellite imagery that can calibrate appropriately. If pumping meters are used, they will need to be installed during the implementation period starting in 2020.

Question: If in five years from now, if the GSP is not being achieved, how precise is the data to point out where we are missing the mark, and can it be pinpointed to the 40-acre grid.

Answer: The actual evapotranspiration modeling is on a 30 meter by 30-meter pixel; therefore, the cropping pattern should be fairly visible and accurate.

Question: Will the urban demand estimate factors in the efficiency and age of the system?

Answer: It will.

Question: Will the data from the 12 wells provided by Grapevine Capital be included?

Answer: Woodard & Curran will confirm this.

Question: Will Woodard & Curran study storage loss based on subsidence? Do11 inches equate to lost storage? Does the model does not incorporate subsidence?

Answer: Not sure. We need to get further information.

August 30, 2018

Question: For domestic water use, how would the model be used for areas not in the Cuyama Community Services District.

Answer: The model will be based on estimated using recent census information that is being developed.

Question: Can you clarify the1967-2017 date range for the model, is the model going to go back that far?

Answer: The model is looking at 50 years of data for precipitation and resulting runoff and recharge.

Question: Has Woodard & Curran looked into moving groundwater from plentiful areas to areas that are lacking?

Answer: We will investigate this.

Question: Are some of the wells are drilled below the groundwater basin as Grapevine Capital said they have drilled their wells to bedrock.

Answer: This question will need to be answered by Grapevine Capital.

September 27, 2018

Question: Why is the Cuyama Community Services District (CCSD) was listed as a management area?

Answer: It is shown for jurisdictional reasons.

Question: Who makes the final decision on management areas. Will the interests of New Cuyama be impacted?

Answer: The CBGSA Board.

Question: Can subsidence can affect storage differently in areas that are a mixture of sand and clay?

Answer: There is not a lot of space being lost in those areas.

November 1, 2018

Question: Does Woodard & Curran think Tritium and the age of water is an issue?

Answer: No, since the Sustainable Groundwater Management Act (SGMA) is about regional water management and the Tritium study focuses on a few localized wells. The presence of Tritium does not mean deep well percolation is not occurring.

Question: Is the Vadose zone being tracked?

Answer: Woodard & Curran has not tracked the Vadose zone because it is very expensive, and those costs could be avoided by tracking groundwater levels.

Question: Why was five years of storage was chosen for the Margin of Operational Flexibility?

Answer: Five years is the approximate length of a drought period; however, this is a

subjective value that can be changed.

Question: Is the same rationale is needed for every representative well?

Answer: No and that is why they are looking at suggesting the use of management areas.

Question: Can the minimum threshold be set based on how much water is in each well?

Answer: That is possible. Using the "shallowest well method" for setting minimum thresholds does not work as well in canyons or areas with elevation changes.

Question: Is there a potential that the GSP can be produced by 2020 without management actions?

Answer: Management actions will be addressed in the GSP.

Question: What minimum thresholds will be applied to each representative well?

Answer: Woodard & Curran will present recommended thresholds for the SAC to review, which will ultimately go to the CBGSA Board for approval.

November 29, 2018

Question: When discussing minimum threshold numbers, how was the 20 percent number was decided on for the range? Is it an industry standard?

Answer: It is a value based on professional experience.

Question: Would the California DWR approve a minimum threshold of 100 percent of range.

Answer: Yes, because it does not cause undesirable results and it would not dewater wells in that area.

Question: Was this (rational options for the central region of the basin) applied to some wells that have a steeper drop.

Answer: The example (Opti Well 421) is actually a fairly steep drop but does not appear that way due to the hydrograph scaling.

Question: How does setting thresholds in the Cuyama Basin affect overdraft?

Answer: Regardless of where the minimum thresholds are set, they must not go down and need to flatten out. In explaining the differences between the threshold options, if you believe there are no undesirable results in the central region, you likely want to keep the minimum threshold low, however, if you think there have been, you likely want to keep it higher.

Question: When can minimum thresholds be changed?

Answer: DWR requires updates every five years, but the GSA can update yearly.

January 8, 2019

No questions from the public were noted in the minutes for this meeting.

January 31, 2019

Question: Has Woodard & Curran discussed implementing mini rainfall models in the different regions (of the Cuyama Basin)?

Answer: Woodard & Curran are using 30-40 sub-watersheds, and each one simulates the inflows and outflows for each section of the Cuyama Basin.

Question: Did the average annual precipitation come from a database or the model?

Answer: It came from the PRISM database which is actual data that is extrapolated.

Question: How did the applied water value change from the December 3, 2018 community workshop?

Answer: The December 3 value was a very rough first cut and improvements have been made to the model since them.

Question: What do the terms appropriative and correlative rights relate to?

Answer: They apply to surface water and groundwater rights. Appropriative rights are based on historic use, and correlative rights determine rights in groundwater based on ownership of land. Prescriptive rights are obtained through the adverse possession of someone else's water rights.

Question: Has the option to only allocate pumping in the problem areas been considered?

Answer: This can be done, but it can be difficult to determine the fringe of impacts. More than one allocation can be created.

Public Input and Response Received at Community Workshop

From March 2018 through May 2019, six community workshops were held in both English and Spanish. At the request of the Spanish-speaking community, the Spanish language workshops were held in a separate room at the same time and location as the English language workshops. The following summarizes the questions asked and the responses provided at each workshop.

March 7, 2018, Community Workshops

Two community workshops, one in English and one in Spanish, were held on March 7, 2018, in New Cuyama, CA. Questions received, and the responses provided are grouped below by workshop topic.

Topic 1 – Sustainable Groundwater Management Act and Groundwater Sustainability Plan

Question: Aren't the solutions for the Cuyama Basin groundwater problem simply more rain and less use? What other options do we have?

Answer: The GSP will include projects and management actions to assist the Cuyama Basin in reaching sustainability by 2040. The projects and management actions will potentially include actions to reduce pumping and projects to increase water supplies.

Question: How many aquifers are there in the Cuyama Basin?

Answer: The available data from the USGS indicated that the Basin included three aquifers.

Question: What do the concepts of Measurable Objectives, Minimum Thresholds, and Interim Milestones mean?

Answer: Each of these SGMA-related terms were further clarified in accordance with SGMA definitions.

Question: What is the difference between Minimum Threshold and Measurable Objective?

Answer: The minimum threshold is the value below which undesirable results occur. The Measurable objective is a specific, quantifiable goal for Basin conditions.

Question: Under SGMA, is there a timetable requirement for meeting the Minimum Threshold?

Answer: By 2040.

Question: If we create a reasonable GSP that is accepted by DWR, what happens if there are droughts that result in failure to meet the objective?

Answer: The GSP includes an implementation plan that will drive the monitoring program. Every five years update to the GSP is required. The monitoring for undesirable results will allow the GSA to know if the GSP is on track or not and can work with the GSA Board and DWR to make adjustments to the GSP as needed. The intent is to look at long-term sustainability and set minimum thresholds that allow for fluctuations that may occur as a result of droughts.

Question: There are naturally occurring calcium and magnesium levels in the water; how are these addressed under SGMA?

Answer: The GSP address constituents that are shown to have a causal nexus between potential GSP actions and constituent concentrations.

Question: Who evaluates the GSP and who reports to DWR?

Answer: DWR will evaluate the GSP. The GSA staff will respond to inquiries about the GSP from DWR.

Question: If the GSP is a "living" document, with interim reporting milestones, then can the plan be adjusted or changed?

Answer: Yes. The GSP will be updated every five years. Adjustments will be proposed as needed.

Question: SGMA requires the identification of projects and management actions; most of the examples shown won't work; what options will be available for the Cuyama Basin?

Answer: In a few months, the GSP team will have more information to present workable projects and management actions for consideration for inclusion in the GSP.

Topic 2 – Data for Use in the Hydrologic Model

Question: What public data are being used to develop the plan?

Answer: Public data is being accessed from the four counties with jurisdiction in the Cuyama Basin, U.S. Geological Survey, California Data Exchange Center, National Oceanic and Atmospheric Administration, California Statewide Groundwater Elevation Monitoring, and others.

Question: What data will the team use from private wells?

Answer: Well construction information and historical groundwater levels

Question: How will the team be filling in the data gaps?

Answer: The team is collecting any available data from wells in the basin and developing a proposed plan for establishing a robust monitoring network to fill data gaps.

Question: How will the team validate the data?

Answer: A comparison will be made between private landowner data and publicly available data.

Question: How will the team address discrepancies?

Answer: Data that appears to be anomalous when compared to the overall dataset will be removed for purposes of the technical analysis.

Question: What does relevant timeframe mean (referring to a statement that the team is collecting data for the relevant timeframe)?

Answer: The team is using the period from 1995 to 2015 to validate the groundwater model.

Question: What will future pumping allocations be based on, a 20- to 30-year historical amount?

Answer: There are several approaches for allocating groundwater pumping, which will be discussed as part of projects and management actions.

Question: What is the difference, for the effectiveness of the model, if the team receives generic water data versus specific data from basin growers/farmers/ranchers (referring to a prior statement about the availability of data from private sources)?

Answer: Specific numeral data is more useful for model development.

Question: Will the team accept water data from growers/farmers/ranchers that USGS did not include in their study?

Answer: Yes.

Question: Will the team use the monitoring data that USGS is still gathering?

Answer: Yes. All data that is provided by June 2018 will be used in development of the GSP.

Question: Does the team know the pumping capacity for the production wells identified?

Answer: No. Groundwater pumping is estimated based on crop types and water demand for those crops, rather than on pumping capacity.

Topic 3 – Cuyama Basin Plan Area Description Elements

Question: For the geology, will the team use core samples to validate the geology?

Answer: No, that would be costly. The team is using available published geologic reports.

Question: Can the team get the changes in land use from satellite imagery? For land use changes since 2014, Sunrise Olive Ranch, on the road to Ventucopa, should be included. Since 2014, more than the normal amount of land has been fallowed due to drought conditions.

Answer: Yes. Data that was provided on current land uses will be incorporated into modeling analyses for current and projected conditions.

Question: Will the team refer to the same geographic zones as USGS did: Ventucopa Uplands Zone, Main Basin Zone, and Foothill Zone?

Answer: Geographic regions will be developed for relevancy to the GSP.

Question: Has there been subsidence from oil pumping? USGS says there has been no subsidence at Russell Ranch.

Answer: There is no evidence of subsidence in that area.

Question: Is there a different evapotranspiration rate for the valley portion of the basin?

Answer: The model calculates the evapotranspiration based on the data provided by the Irrigation Training & Research Center at Cal Poly San Luis Obispo.

Question: Who is paying for this?

Answer: Funds from the four counties that have jurisdiction in the Cuyama Basin along with state grant funds.

Question: On the CBGSA Board of Directors, there are five representatives from the Cuyama Basin Water District (CBWD) and only one from the Cuyama Community Services District. Does CBWD pay more?

Answer: Yes, the CBGSA Board has developed a cost allocation formula for the participating entities.

Question: What can New Cuyama residents do to stop the decline in groundwater use? Water consumption is minimal now with people using bottled water; irrigation is limited. People are doing their part. What else could the community do?

Answer: Continue to provide input to the development and implementation of a balanced GSP for the Cuyama Basin.

Question: Water bills are very high; how will this project affect the water bills?

Answer: The GSP does not address the cost of water for the community. The GSP will consider projects, such as a new well for New Cuyama.

Question: What will be the economic impact on agriculture and jobs in the community? What are the impacts of potential changes in water use?

Answer: The economic impacts on agriculture are not yet known. As the GSP development progresses, more information about the pumping allocations will better inform options for sustainability.

Discussion about Existing Basin Conditions

The workshop included an interactive discussion that focused on individual ranchers/farmers talking about their observations and experiences with water in different geographic areas in the Cuyama Basin. Attendees discussed their experience with water in distinct geographic areas of the Cuyama Basin including Upper Ventucopa (Apache Canyon), Lower Ventucopa, the foothills of the central portion of the basin, the valley floor, and Cottonwood Canyon/northwest basin. The information provided a better understanding of the changes in water levels and pumping capacities over time as well as the importance of understanding the influence of fault lines on the aquifer.

June 6, 2018, Community Workshops

Two community workshops, one in English and one in Spanish, were held on June 6, 2018, in New Cuyama, CA. Questions received, and the responses provided are grouped below by workshop topic.

Topic 1 – Overview of Physical Conditions of the Cuyama Basin

Question: What happens if the Cuyama Basin does not reach the minimum threshold by 2040?

Answer: The Cuyama Basin GSP is reviewed every five years, from 2020 to 2040, and adjustments to the GSP would be made if progress toward the minimum threshold is not occurring.

Question: How will the existing water quality contamination, specifically from salinity and arsenic, be addressed in the GSP?

Answer: These are described in the groundwater conditions section of the GSP.

Question: How can water quality help understand the flows and barriers of groundwater and help with the geologic modeling?

Answer: Water quality can be significantly different on one side or another of a groundwater barrier that impedes or diverts groundwater flows, so water quality analyses can help identify barriers and how groundwater flows. However, water quality testing can be expensive, so it should be considered carefully.

Question: Can you define groundwater plumes?

Answer: Plumes are areas of contamination that can move through and spread in groundwater. Plume fronts determine the direction and speed of spreading contamination.

Question: What is the depth to groundwater levels on the three Cuyama Basin hydrogeology layers?

Answer: In the center of the Cuyama Basin, the deepest groundwater level is at 1,000 feet; followed by the middle layer at 800 feet; followed by the top layer at 600 feet.

Question: Regarding the two faults (Russell Fault and Rehoboth Fault), why are they of such interest?

Answer: The two faults are of interest because there is less recorded data regarding the faults and how these faults generally affect groundwater flows. The published studies are not consistent regarding the impact of faults on water flow.

Question: Is more research going to be done on Santa Barbara Canyon fault and its effect on the aquifer?

Answer: The existing published data is consistent for Santa Barbara Canyon fault, so it is a low priority for further research at this time.

Question: What is the significance of "basement" rock?

Answer: Basement rock is a catch-all term for rock formations that generally do not hold water and are a barrier to water movement. If you consider the basin a bathtub filled with sand and water, the basement rock is the porcelain bathtub. In some cases, the rock can be fractured, which allows some movement of water through basement rock.

Question: Do we know if the "bathtub" or basement rock leaks?

Answer: Most basement rock in most basins does leak, but that cannot be measured. The model includes this as an estimate.

Question: On the ground surface and groundwater elevation profile, does it consider the sides of the river as opposed to just the river end-to-end? Have you done anything to look at the sides of the Cuyama Valley? Are you identifying water-bearing layers of wells?

Answer: The groundwater conditions section of the GSP considers the sides of the river, i.e., how the groundwater levels change from the edges of the Cuyama Basin to the Cuyama River. The next phase of work looks at the data to estimate the elevation contours and use existing reports to understand groundwater movement. USGS looked at groundwater layers. They found them not to be consistent from well to well. Over time, the Cuyama River has deposited fine sand and coarse rocks in varied ways in the Cuyama Valley.

Question: Have you given thought to water management areas based on the hydrology and geology?

Answer: Water management areas are a possible consideration, based on the hydrology and geology. However, there is no decision at this time; there is more work to be done. Management areas are going to be discussed at future meetings.

Question: Are you looking at well logs to identify geologic layers?

Answer: Yes, if provided.

Question: When was the last USGS study done?

Answer: The latest data from the USGS study was 2014. More recent data is being used to understand current conditions.

Question: How and when will data gaps be addressed? Before and after the draft plan?

Answer: While developing the GSP, the unknowns are documented. Moving forward, data gaps are addressed as more data is gathered. Activities to address data gaps and reduce uncertainty will be included in the GSP and used to refine the GSP at the 5-year updates.

Topic 2 – Sustainability and Role of Water in the Future of Cuyama Basin

Following a general introduction about sustainability and what it means in SGMA, the following question asked of participants *What does sustainability of the Cuyama Valley mean for you?* The responses are summarized below:

Balanced Water Use: Balance water use among all water users to allow everyone (farms and residential) to remain in the Cuyama Basin. Water needs to be balanced, and water needs to be used wisely by all users. The water table is replenished and fills to levels that do not fall to dangerous levels even in drought.

Economic Productivity and Stability: Current Perspectives: Without water, how can we survive and maintain our livelihood? The community is already subject to greater impacts now with the high cost of water ($160 to $200 per household per month) and the water contamination (salinity and arsenic) that has come as a result of the increase in farming. The farmers/ranchers can pack up and leave the area if they want to, leaving the community with no jobs and no community; the people in the community can’t just pick up and leave.

Future Perspectives: Water and jobs are directly connected. The Cuyama economy should continue to grow. Economic productivity and quality of life are necessary. Solutions to water issues have to be economical. Cuyama needs an economy that keeps people employed. Water use by homes is negligible compared to agriculture. Access to affordable quality water is the only thing that can support people and the economy in the Cuyama Valley.

Water Equality: Need to fix the current water inequality in the future. (people have bad water with salinity and arsenic, and farmers pump all day). Regulate the amount of farming and irrigating so that residents can have clean water, affordable water. Water needs to be used wisely by all users. All water users must evaluate their use and determine where they can cut back – individuals must have enough water to maintain good health, and large and small farms must evaluate their use and change their practices to be more conservation oriented.

Local Ecology: We would like to see more plant growth along the riverbed and improvement to local ecology (e.g., trees). Utilize trees for windbreaks. Restore habitats for migratory birds as well as insects and wild animals.

Farming Management Practices: Farms have to change how they do business. Consider crop shift and value-added processing. Grow crops that are more permanent to reduce tilling and soil drying. Maintain the dry rangeland that is sustainable in parts of the valley. Farmers need to change what they are growing to use water more wisely. Use hedge-rows around fields. Rebuilding soil for moisture retention (no-till and cover crop).

Water Delivery Infrastructure: The Community Services District pumps break, the wells go down now; this didn't happen 5 to 10 years ago.

Water Quality: The water has not been drinkable for at least 28 years (number of years the speaker has lived near the intersection of 166 and 33). The water is better at Maricopa, so they go there to get water. Three to four times per year the water is brown. The salinity has gotten worse. The people need better water sources in the future, with no salinity. Better drinking water, some wells not drinkable, total dissolved solids. Increased salinity from overdrafting on large farms leads to more overdrafting to remediate the problem which leads to dust and poor air quality.

Groundwater Depth: 10 years ago, when there were fewer farms, the depth to water was okay. Now with more farms, the water depths are worse – have to drill deeper now to find water. Depth to water was bad during the drought, but it is even worse now since even more farming (North Fork Vineyard) has come into the Valley. Need to stop wells from going dry.

Additional Comments: Sustainability means the return of environmental and groundwater conditions to rates that were previous to the adverse effects taking place. Sustainability means improving water quality, the reverse of land subsidence, and decreasing well depths. Sustainability is maximizing resources and increasing quality of life for members of the community. Sustainability is not just water, rebuild soils in the area. Sustainability means survival of the community and wildlife through drought periods, that mega-farming is not expanded beyond current levels, and no additional residential development. Sustainability means that people, animals, and crops must be able to survive without using more water than is replenished in an average year; this requires re-evaluation of current practices. The water connection to the natural and human environment is essential – e.g., water retention can support natural and human communities. The future has to be different – we are at a change point. Consider that there are longer cycles of wet and dry in the future. Re-establish reservoirs. Use a 60-year cycle to accommodate for a full wet and dry cycle of the Pacific Decadal Oscillation (we entered a wet cycle in 2014).

The next question asked of participants was, Water is important for the future of the Cuyama Valley. What do you see as important challenges or undesirable effects for the future of water in the Cuyama Valley for the following:

- Water and jobs
- Water and community/households
- Water and small farms
- Water and large farms
- Water and natural resources
- Water and the economy

Water and Jobs: The water used for farming is okay, but the water for the community is still bad. Jobs go if the water goes. We want water for all – a balanced approach. We want to keep jobs in the Valley for people that live here. For homeowners, the value of the homes will drop drastically if there is no water and no jobs. With most farms, worker housing has been removed causing families with children to move away, which has impacted the schools. Family housing needs to be addressed. Affordable, quality water supports jobs. The only jobs are farming jobs, so some people live here, but don't work here. Need increased population to work at both small and large farms – keep the money in the Valley.

Water and Community: Water of good quality must be available for people and animals at an affordable price. Cuyama Community Services District (CCSD) needs to provide safe and affordable water. Are the problems with the town water (low pressure, salinity, brown color at times, arsenic, unreliable delivery system) because of the nearby over-pumping? Can there be a way not to pump at all within a certain proximity to the town? We want water for the community pool, for community recreation. Grimmway should pay the CCSD water bills, which are between $160 and $200 a month. Increasing arsenic, salinity, and carcinogens. The town well is drying, need functioning wells in town. Don't want to have to decide between washing clothes or taking a shower like it is now in New Cuyama. Need to educate children now about how to use water wisely, how to conserve water. With most farms, worker housing has been removed causing families with children to move away which has impacted the schools. Family housing needs to be addressed. Groundwater pumping could turn the Cuyama Basin into a desert, making homes impossible to sell, making it impossible to move elsewhere.

Water and Small Farms: Many small farms are gone now. Generational farming is phasing out. Small farms have been and continue to be affected because as the water is deeper; farmers can't afford to drill deeper while the big farms can. Deeper wells to reach water makes more expense for the small farmer; this is not sustainable. A bad impact would be that the community and small farms are unfairly punished for the negligence of the responsible parties of the negative effects. Small farms need to be protected from wells going dry and crops going dry.

Water and Big Farms: No Water = No Jobs. Bad water quality impacts crops negatively – the crops will not be as good. Big farms should operate sustainably with the amount of water to keep water use balanced for everyone. Farming needs to reevaluate water use and crop choice. Can farmers grow crops that use less water? Regulate the water, so farmers change what they are growing. Big farms don't care about how much water they use, and they don't care about the community. They have the money to drill new wells. They have the money to pick up and leave; the people don't. Large farms operated by industrial ag-corporations appear to be blind to the damage that they do to the environment and the community. Shrink industrial agriculture by at least 50 percent. Wells are going dry, crops going dry. Agriculture must pay for water based on the actual amount that they use.

Water and Natural Resources: Chemicals are being sprayed onto the crops and then going into the groundwater. If there is no water, big agriculture leaves, and they leave a polluted dustbowl full of the sprayed chemicals. Air quality is bad because of big agriculture operations. Animals like deer and rabbits will be left with no water. There are fewer deer and rabbits now probably because they've been eating and drinking the sprayed chemicals. If there is no clean water for animals, then there will be no animals. Need diversity of species. Build organic matter into the soil. Forty-five years ago, streams ran year-round, not just as torrents after rains. With a sustainable water table, the streams could run again. Over pumping has already destroyed much of the natural environment that drew people here years ago. Sustaining riparian areas, supporting wildlife habitat.

Water and Economy: Cost of water needs to be affordable. Economic stability through boom and bust. We want affordable water. Affordability of well drilling to depth. Economic impact: agriculture and urban – need to connect with uses. It is undesirable for long-term management if the whole valley is treated the same. We need a diversified economy; we are over-reliant on certain industries. Changes in farming practices are important to the economy. If the GSP fails, there will be no economic stability.

General Undesirable Results: Everyone will get less water. It is a closed system. What if the Groundwater Sustainability Plan doesn't get the outcomes we want? Well infrastructure is old and falling apart, which contributes to poor water quality. Groundwater pumping could limit access to water for the community. Land subsidence could be a problem that leads to infrastructure issues, less recharge for children to take on business and have a positive experience in Cuyama.

September 5, 2018, Community Workshops

Two community workshops (English and Spanish), were held on September 5, 2018, in New Cuyama, CA. Questions received, and the responses provided are grouped below by workshop topic.

Topic 1 – Modeling Cuyama Basin Groundwater Conditions

Question: Explain primary and secondary axes and what are the Average Annual Volume numbers on slide 26, Groundwater Budget: Basin-Wide.

Answer: The left axis shows the groundwater gains (e.g., recharge) and losses (e.g., pumping) each year. The right axis depicts the cumulative change in groundwater storage, as shown with the black line on the graph. The average annual volumes are the estimated average annual gains or losses from the groundwater basin, as calculated by the model.

Question: The numbers shown as model results today are not calibrated, right? The community should not assume the numbers fully depict the historical conditions or trends.

Answer: Yes, the model is not yet fully calibrated; the numbers are preliminary and are likely to change.

Question: When mentioning domestic use, the population you used was in the thousands?

Answer: No, the estimated population for the Community Services District is approximately 800. This estimate will be updated with new information when available.

Question: The point is there is a downward trend in groundwater storage, and the point is to figure out how to get it not to go down? It looks like we are down 200 feet, but the water budget graph makes it look like there is the same amount of water coming in as is going out.

Answer: The annual water budget is balanced on the graph by the amount of change in water storage (purple). Most years, there is a decline in water storage.

Question: What is the definition of “developed land?”

Answer: Anything with agricultural and urban use on it.

Question: Why is evapotranspiration the only thing used to estimate pumping demand and not direct evaporation from spray irrigation or ponded water?

Answer: Evapotranspiration includes estimates for direct evaporation.

Question: Is there a way to measure/monitor deep percolation?

Answer: There is no easy way to measure that.

Question: On most of the graphs on slide 28, the actual groundwater levels look like they are deeper than what the model has estimated.

Answer: Yes, the model still needs to be calibrated to develop closer alignment between modeled results and actual measurements. The team is working in the next several months to understand local irrigation practices better and calibrate the model.

Question: There may be different depths of screens in wells that could affect the well depth monitoring that the model has not captured. How hard is it to go back in and add layers for well?

Answer: If we have data on it, then it can be added, but we do not want to break up existing layers into sublayers just to “brute force” the model.

Question: How is the pumping value calculated when the pumps do not have meters on them?

Answer: We estimate the pumping demand based on domestic and agricultural uses and calculate pumping amounts based on those needs.

Question: Plants need water in the ground, and there is water above ground, puddling, etc. How is this water considered in the model calculations?

Answer: We capture the total irrigation water demand through the evapotranspiration calculations, which included direct evaporation.

Question: How is climate change incorporated into this model?

Answer: The CBGSP team will include scenarios that estimate future changes resulting from climate change (e.g., changing rainfall patterns, increased irrigation demand).

Question: Does the model take into account the changes in the basin as it narrows? It may be more than the model currently covers.

Answer: We have implemented what the USGS implemented in their model for the shape of the basin, based on well logs (water and oil) and satellite data.

Question: Recently the Government proposed selling leases for oil drilling (federal land in the foothills). Oil operations could use additional groundwater, particularly if fracking is involved. How would that be considered?

Answer: Future water demands in the Cuyama Basin can be considered. We can look into how likely additional pumping from the Cuyama Basin would be.

Question: Is 90 percent irrigation efficiency realistic?

Answer: Irrigation efficiency is based on evapotranspiration and not on other irrigation practices. The CBGSP team will further clarify these calculations.

Question: How do subsidence and the loss of storage due to subsidence fit into the model?

Answer: There are no simple, cost-effective ways to model subsidence. Subsidence and the potential loss of storage are discussed and addressed in the GSP.

Question: How do you estimate and calibrate surface water flows if there are no good surface water gauges in the basin.

Answer: The land surface component of the model simulates surface water flows based on available precipitation, soil, and land use datasets. Then we compare the results with the available streamflow observations to make adjustments.

Question: Did the USGS study include surface flow in their model?

Answer: USGS has limited information about surface flows, which the team is reviewing and comparing.

Question: How are you looking at groundwater dependent ecosystems (GDEs) and all the wildlife that depends on that.

Answer: We have a biologist who is reviewing and checking available data regarding groundwater dependent ecosystems in the basin. A memo summarizing the findings will be prepared.

Question: How does the model take into consideration how some wells have declined, and others have remained relatively stable?

Answer: The model calculates water budget and elevation levels for each cell in the model based on the conditions in that cell. The calibration effort is getting the calculations to replicate real-world measurement.

Question: With so many factors calculated in the model, it is important to understand the level of certainty that underlies the factors and model results. Can that uncertainty be quantified?

Answer: The GSP includes a discussion of uncertainty and recommendations for reducing uncertainty in the future.

Question: The presenter asked for information about the causes for the Cuyama Community Services District groundwater levels to drop after 2011. The commenter noted that this was the year that Duncan Family Farms started farming irrigated land near the CCSD well – could there be a correlation?

Answer: There may be a connection. This will be investigated as part of numerical model calibration.

Question: I'd like to know the implications of water being removed from the older alluvium (beneath the aquitard) and being put into the newer alluvium (above the aquitard)? It is called "deep percolation" in the model but it different/distinct from that water not being pumped and remaining in the deep alluvium.

Answer: This is not likely to significantly affect the overall groundwater budget.

Question: How does the pumping in one area affect others (cone of depression)? Does the heavy agricultural pumping make domestic wells have to be deeper? Who should bear these consequences if this occurs?

Answer: If groundwater levels fall below minimum thresholds, the Board will determine the proper action to make in response.

Question: Cuyama Community Services District had two wells. One went out of service a couple of years ago. I am wondering if your model is using data from two different wells?

Answer: The numerical model assumes that pumping for the CCSD is taken from the remaining well.

Question: What sustainable options are you exploring? How can the options you are currently presenting be viable? Are you addressing a model for "sustainability" by proposing a pipeline? How does that make sense?

Answer: A pipeline is an example of a project that might be considered to help the Cuyama Basin become sustainable by 2040. Some projects and management actions will be presented later in the GSP development process for further consideration and evaluation.

Question: Are there underground river flows (data) available?

Answer: This type of data is not available. However, subsurface flows are estimated by the numerical model.

Topic 2 – Potential Management Actions and Projects for the Cuyama Basin

Question: Are cattle positive or negative in terms of water use? Can they be used to manage vegetation in rangeland?

Answer: This is not likely to have a significant effect on the overall Basin water budget.

Question: How do we evaluate the sustainability of whatever project(s) we consider when some options may draw water from other basins?

Answer: The options considered should help sustain the Cuyama Basin; the CBGSA Board and Standing Advisory Committee may consider many factors in evaluating options.

Question: Do the projects need to be suggested now? And implemented by 2020? Or do they get implemented later?

Answer: The GSP includes an evaluation of potential actions and an implementation plan for the most viable approaches. The projects and management actions do not have to be implemented by 2020.

Question: Are we trying to reach 2015 levels? Or are we leveling off whenever we level off in 2040?

Answer: There is no mandate to meet 2015 levels. The thresholds and objectives will define what the projects and management actions need to achieve.

Question: Given that we are in critical overdraft, have we been in contact with DWR? They implied that levels could not change from now.

Answer: The Cuyama Basin is not required to return to 2015 groundwater levels. The requirement is that the basin achieves sustainability, which the GSP will define for this basin.

Question: Explain the glide path. How is it used; is this to help predict the future?

Answer: The glide path is included to establish a predictable plan for how and when the basin might achieve more sustainable conditions.

Question: Is there a way, when considering purchasing water, to evaluate how demands and supplies and price may change over time? Can price changes be accounted for in a 20-year purchase plan?

Answer: Evaluation for the inclusion in the GSP includes estimated costs for the projects and management actions considered.

Question: How would funds would be raised to buy that water?

Answer: The GSP implementation plan will describe how management actions and projects could be funded.

Question: What can be learned from other GSAs?

Answer: The team is reviewing ideas being considered by other GSAs.

Question: What can we do as a community to counter these changes (climate change, loss of EPA regulations, changes in government and legislation) to allow ourselves to flourish?

Answer: The GSP will include modeling for climate change.

Question: The options (for management actions and projects) do not make sense in terms of what is sustainable. What options are you considering that are regenerative options for water supply?

Answer: Reuse options may be considered by local landowners in response to pumping allocations.

Topic 3 – Concepts for Management Areas

Question: Can we use a combination of those management areas?

Answer: Yes. The GSA could decide to combine concepts or use a different approach not developed yet.

Question: The blue areas shown (high groundwater levels) are traditionally grazing lands that use very little water, so why manage them?

Answer: The Board could decide to establish management areas only in areas where groundwater management is needed.

Question: Why do we have so much area that is outside of the main part of the basin? Why don't we change the basin boundary?

Answer: Boundary modifications could be considered, but the rules specify when DWR will consider changes.

Question: Do we need management areas? It's hard to set them if we don't know what they can and cannot do.

Answer: This presentation is a preliminary presentation of concepts. Having no management areas is also an option. The GSP team will provide additional information about what can and can’t be accomplished with management areas at a future workshop.

Question: Could the GSP set management areas based on data gaps, with the purpose of not necessarily setting thresholds and just trying to figure out what to do there?

Answer: It is possible, but generally, management areas are to help set thresholds and to organize and implement management actions and projects.

Question: Another data point would be rainfall in the foothills, can you establish management areas by rainfall patterns?

Answer: It is possible, but generally, management areas are to help set thresholds and to organize and implement management actions and projects.

Question: What standard are federal lands under in terms of water use? Are there regulations they must comply with?

Answer: The federal government is not bound by state law.

Question: If there have been grapes planted at the west end of the basin and the basin was in overdraft before that, who decides for final water cutbacks.

Answer: The GSA Board will decide on the management actions, projects, and implementation plan.

Question: Can you accomplish results without management areas?

Answer: Yes, management areas are not required. The GSA is the managing and implementing agency, with or without management areas.

December 3, 2018, Community Workshops

Two community workshops (English and Spanish), were held on December 3, 2018, in New Cuyama, CA. Questions received, and the responses provided are grouped below by workshop topic.

Topic 1 – Sustainability Thresholds

Question: How does the water budget relate to the minimum thresholds?

Answer: The water budget and minimum thresholds are not directly related. The water budget doesn't influence what is established as minimum thresholds. The water budget and numerical model are used to guide projects and management actions so that the Cuyama Basin will be sustainable within 20 years and be above the minimum thresholds.

Question: When in the water budget analysis are the topography of the Cuyama Basin and recharge areas considered?

Answer: The topography of the Cuyama Basin is considered in the water budget and numerical model, which considers the collection of surface water and infiltration to the groundwater. The identification of potential recharge areas is a part of the development of projects and management actions to increase water supplies in the basin.

Question: When setting minimum thresholds, why allow further decline of the groundwater levels? How is that sustainability? If minimum thresholds are set below 2015 levels and allow further decline, then how do we get balance? Don't we have to get the water budget in balance?

Answer: The setting of minimum thresholds is designed so that, as a whole, the Cuyama Basin avoids undesirable results. Undesirable results adversely affect beneficial uses of groundwater – in some portions of the basins, groundwater levels can decline without causing further undesirable results, and the minimum thresholds reflect this.

Question: Are there actual undesirable results that can be related to the proposed minimum thresholds in the different threshold regions? What are we trying to prevent the setting of the minimum thresholds? Have the undesirable results that are to be avoided been defined for each region?

Answer: Part of the rationale for setting minimum thresholds by regions within the basin is to indicate when a given threshold region might be approaching an undesirable result. Potential undesirable results have not been identified by region at this time. Five undesirable results apply in the Cuyama Basin as defined by SGMA: reduction of groundwater storage, land subsidence, chronic lowering of groundwater levels, depletion of interconnected surface water, degraded water quality).

Question: How connected is the groundwater between the threshold regions?

Answer: Groundwater flow varies among the threshold regions based on the geology, but generally, the groundwater is connected between the regions.

Question: Are additional monitoring wells planned?

Answer: Yes, a monitoring network is established that includes new monitoring wells in areas that require additional data.

Question: Explain what you mean by "establish range of operation in the groundwater basin."

Answer: On slide #30, "Why Minimum Thresholds" three reasons were given: Required by SGMA, establish range of operation in the groundwater basin, and protect other groundwater pumpers. The second reason "establish range of operation in the groundwater basin" is referring to setting a range of groundwater levels to allow for groundwater pumping through wet and dry periods.

Question: Did the technical team working on the model consult with other agencies and surrounding counties for data?

Answer: Yes, data was collected from several agencies including DWR, U.S. Geological Survey, the counties of Kern, Santa Barbara, San Luis Obispo, and Ventura, and others.

Question: What do you mean when you say, "protect access to groundwater for the Cuyama Community Services District?"

Answer: This is a good example of how minimum thresholds can help identify when an undesirable result might occur, such as dewatering the CCSD well. The CCSD access to groundwater should be protected as it is an existing groundwater user.

Question: When will there be a new well for the Cuyama Community Services District (CCSD)?

Answer: A new CCSD well will be evaluated as a possible project in the GSP. It will be up to the CBGSA Board to decide on the actions that protect groundwater users.

Question: Does the CBGSA submit the GSP and then find funding for projects and management actions such as a new well for the CCSD?

Answer: Part of the evaluation of projects and management actions will be identifying potential funding sources for projects, including grants and/or local funding by the GSA and groundwater pumpers.

Question: Isn't it a contradiction to say that we can allow wells to be drilled deeper such a new CCSD well while working to achieve sustainability in the Cuyama Basin?

Answer: Interim period between 2020 to 2040, while projects and management actions are being implemented, it is possible that groundwater levels will continue to decline, which may warrant new wells to maintain access for groundwater pumpers.

Question: Do other GSPs have more or less monitoring wells than in the Cuyama Basin?

Answer: It varies. Each groundwater basin is developing monitoring wells and the right number to provide a basin-wide measurement of sustainability.

Question: How do you update the GSP every 5-years; what does that look like?

Answer: During the five years, everything is monitored and assessed. The update is a chance to relook at conditions with new and better information, refine and update sustainability thresholds, check-in on how project and management actions are doing, and determine if new projects or actions are justified or needed.

Question: What is an example of a management action that is implemented, and then needs to be changed or modified during the 5-year GSP update process?

Answer: For example, new monitoring wells will be installed around the faults. During the 5-year update, it may be learned that more monitoring wells are needed to further understand the conditions. Another example would be where a recharge project was implemented with good results, and a decision might be made to expand it.

Question: If a goal is to increase water supplies, how will that be done?

Answer: The team will be evaluating projects and management actions, which is a topic for future workshops.

Question: As the GSP is updated every 5-years, will the actions get stricter to achieve sustainability by 2040?

Answer: The GSP contemplates phased implementation of projects and management actions as well as water allocations. The 5-year updates may show that more projects and management actions are needed if progress toward sustainability by 2040 is not matching expectations.

Question: For the rationale that sets the minimum threshold at 2015, is the idea then that the well doesn't go below that level even without undesirable results?

Answer: This is still to be determined. The team will use rationales selected with input from the community, SAC, and the CBGSA Board to develop specific minimum thresholds for each threshold region and interim milestones. In some cases, the interim milestones may go below 2015 levels with the goal of recovering by 2040.

Question: How do threshold regions or rationales relate to the existing 30 percent overdraft?

Answer: The rationales are intended to develop the minimum thresholds to monitor against undesirable results. 30 percent represents the over-pumping across the entire basin. Projects and management actions are developed to address over-pumping.

Question: 20 thousand acre-feet (TAF) must be cut back, but how can that happen if we keep declining groundwater levels?

Answer: There will be a transition period between now and 2040, during this time there may be further lowering of groundwater levels, but the overall intent of the plan is to get the basin in balance by 2040 and beyond. Beyond 2040, inputs have to match the outputs.

Question: Groundwater levels must flatten completely to be sustainable; is that rationale correct?

Answer: Sustainability boils down to two things: inputs must match outputs, and undesirable results must be avoided. The inputs must match the outputs on a long-term average, not each year, so there may still be fluctuations in groundwater levels.

Topic 2 – Numerical Model Update and Initial Water Budgets

Question: What direction does groundwater flow?

Answer: Like surface water, groundwater movement in an unconfined aquifer is dictated by gravity – it flows downhill. Groundwater flows from areas of higher hydraulic head to areas of lower hydraulic head. In the Cuyama Basin, that is generally from the south to the north, and from the east to the west.

Question: How much water is an acre-foot?

Answer: An acre-foot of water is 43,560 cubic feet, or to 325,851 U.S. gallons, enough water to cover a football field with a foot of water.

Question: How does the model calculate deep percolation?

Answer: The model calculates deep percolation as the potential quantity of recharge to an aquifer. Recharge is the amount of water leaving the active root zone (deep percolation). Recharge is derived from precipitation, irrigation, evapotranspiration, and soil hydraulic properties.

Question: How does the water budget change in different parts of the Cuyama Basin?

Answer: The water budget is developed for the entire Cuyama Basin.

Question: What is the total groundwater depletion in the Cuyama Basin over the past 20 years?

Answer: Since 1995, the total decline in basin storage is approximately 400,000 acre-feet.

Question: Was the age of the wells recorded?

Answer: The monitoring well data that was collected had a wide variation in its level of detail. Some wells had an installation date, and some did not.

Question: How does the plugging of well screens affect groundwater level readings?

Answer: If monitoring well screens are plugged, it is less likely that measurements in the well will represent conditions near the well.

Question: Is the model developed enough to depict the size of storage or what is left in storage?

Answer: The total amount of storage in the basin is unknown because there is uncertainty about the depth of the groundwater basin throughout the whole area.

Question: How does the model calculate evapotranspiration?

Answer: The model calculates the evapotranspiration based on the data provided by the Irrigation Training & Research Center at Cal Poly San Luis Obispo.

Question: How much water is nature using?

Answer: Native vegetation consumptive use is approximately 182,000 acre-feet per year out of a basin-wide total of about 223,000 acre-feet.

Question: How much water is left after native plants and agriculture?

Answer: Deep percolation to the groundwater is approximately 32,000 acre-feet per year and 11,000 acre-feet per year is runoff.

Question: Have you forecasted full groundwater depletion?

Answer: No. The GSP is looking at how to get the basin back in balance, not how long it would take to use all the water in the basin.

Question: What about groundwater dependent ecosystems, are they taken into account in the model?

Answer: Groundwater dependent ecosystems are not represented directly in the model; instead their water consumption is lumped in with other native vegetation.

Question: What influences the groundwater ranges?

Answer: Location, geologic conditions, topography, precipitation, and several other factors.

Question: What about groundwater quality, is that addressed in the GSP?

Answer: Salinity is included in the GSP.

Question: Is climate change included in the model?

Answer: There will be projected hydrologic conditions under a climate change scenario provided by DWR.

Question: What does "reconstructed stream flows" mean? Isn't it an estimate?

Answer: Streamflows leaving the Cuyama Basin are estimated using the reconstructed historical precipitation data.

Question: When looking at earlier studies conducted in the Cuyama Basin, how do they compare with the model and the resulting water budgets?

Answer: The results are not directly comparable because no previous model covered the entire Cuyama Basin.

Question: If the model can calculate storage loss, how much is left, how close to empty are we?

Answer: The total amount of water stored in the basin is unknown due to uncertainties in the depth of the basin. The GSP is looking at how to get the basin back in balance, not how long it would take to use all the water in the basin.

Question: What science can show what happens to deep percolation when the vadose zone is 500 feet of empty, de-watered dry zone above the groundwater level but below the land use? Where in California has this ever been studied? What procedure can predict this? What certainty exists as to whether the deep percolation ever makes it back down to usable groundwater?

Answer: The lowering of groundwater levels at very high rates has a significant impact on the recharge of deeper aquifers when a thick clay layer exists. As a result of lower pressures, the pore space between the clay particles get smaller and slow the vertical flow. Without such thick clay layers, the most significant impact is the delay in time for the recharge occurrence to reach saturated groundwater level rather than the volume.

March 6, 2019 Community Workshops

Two community workshops, one in English and one in Spanish, were held on March 6, 2019, in New Cuyama, CA. Questions received, and the responses provided are grouped below by workshop topic.

Topic 1 – SGMA Background and GSP Development Overview

There were no questions.

Topic 2 – Cuyama Basin Water Budget

Question: What is the sustainable yield of the Cuyama Basin?

Answer: Total sustainable yield in the Basin is about 21 thousand-acre-feet (taf)

Question: The concept of regions is confusing because the conceptual model is detailed while the defined regions are fairly blocky. How defined will be boundaries of these regions be?

Answer: The CBGSA previously approved regions to be used for developing groundwater level thresholds; however, these regions will not be used as Management Areas. As determined by the CBGSA Board, management area boundaries will be estimated using numerical modeling results.

Question: Is the Ventucopa Management Area set in the town? What is the Ventucopa Area?

Answer: On March 6, 2019, the Board approved using preliminary Management Areas defined by groundwater level changes estimated by the Cuyama Basin numerical model of greater than 2 feet per year.

Question: When will the model runs that include Climate Change be available?

Answer: Modeling results that incorporate climate change will be shown at the April CBGSA Board meeting.

Question: Is climate change included in the model?

Answer: Not yet, but the model will be run with climate change assumptions provided by DWR.

Question: Why is the word “draft” on a number of the slides?

Answer: The analysis is not quite completed so the word draft was added where appropriate.

Question: What is the “Woodward & Curran technical team”?

Answer: This is the consultant team developing the GSP for the Cuyama Basin under contract with the CBGSA.

Question: In New Cuyama, how far down is the water?

Answer: The well is about 800 feet deep and the groundwater level is around 200 feet deep.

Question: Will the water quality improve if the aquifer is recharged?

Answer: We don’t know.

Topic 3 – Projects and Management Actions

Question: The pumping reduction numbers seem high? I am not convinced by the pumping reductions-only scenario. There are roughly 16,000 irrigated acres, 3 feet = 8,000 acres. Half of those taken out = balanced.

Answer: The projected pumping reductions needed to reach sustainability reflect the best estimate of the numerical model given the current available information. The model is not perfect as there are data gaps. It should be noted that the required pumping reduction will be greater than the projected overdraft. Need to take into consideration the reduction from deep percolation.

Question: Will taking crops out of production (fallowing land) be a primary tool to become sustainable?

Answer: Yes.

Question: If the Department of Water Resources (DWR) will take 2 years to review the GSP, what happens in those 2 years?

Answer: The assumption is that the Cuyama Basin GSP will be implemented on the schedule submitted with the GSP. The DWR will have to review annual reports as well.

Question: Who is paying to implement projects?

Answer: The CBGSA Board will have to determine this and the funding strategy is likely to be reflective of a philosophy that the costs should be paid by the beneficiaries.

Question: Has cloud seeding been tried over the Cuyama Basin?

Answer: No, but it has been used in Santa Barbara County and other locations.

Question: Is there a risk of toxicity for fruits and nuts that are being grown?

Answer: There is no significant toxic effects as measured thus far.

Question: What is the history of cloud seeding? How long has this technique been used and monitored for toxicity? Has toxicity been measured?

Answer: Cloud seeding has been performed over many decades in many watersheds across California. For example, cloud seeding has been utilized in the Kern River area for over 30 years. These other basins have not experienced major issues with toxicity.

Question: How to test effectiveness (of cloud seeding)?

Answer: Once cloud seeding is implemented, it is difficult to estimate exactly how much additional precipitation results because there is no opportunity to test with and without conditions for the same year.

Question: Someone did a master's thesis on Cottonwood Canyon runoff potential. Did Woodward & Curran use information from canyons that run when there is over 1 inch of rain?

Answer: The model simulates water flows from the canyons. The Woodward and Curran team would be glad to look at the person's master's thesis.

Question: Do cost estimates include annual costs?

Answer: The cost estimates include both implementation and annual costs.

Question: Since the Central Region is so overdrafted, would those in the Central Region pay for potential projects?

Answer: Most likely project costs would be paid by those landowners who derive the greatest benefit.

Question: Silting has shutdown projects in Ventucopa, could this be a big issue here?

Answer: Yes.

Question: Have you considered streambed restoration to slow water? Sounds like the natural function of a stream is being described.

Answer: There is a component of natural recharge, but the concept of stormwater capture is to divert water than would otherwise be lost downstream due to high flows in the river.

Question: Can you increase seepage in the river bottom?

Answer: This would need to be studied to assess the benefits and whether there would be any negative environmental impacts.

Questions: Do you have to do projects?

Answer: SGMA requires that sustainability be reached, and projects can help bring the Cuyama Basin into balance by 2040. You don't have to do projects, but it is prudent because every acre of farming that you lose has an economic impact associated with it.

Question: If pumping increases outside of the Central Region and Ventucopa Area, could more management areas be created?

Answer: Yes.

Question: Currently, there is not much requirement to measure your water use, with the GSP will there be required metering?

Answer: Not for those with private wells using less than 2 acre-feet per year, but metering may be required in other locations—the exact mechanism for tracking water use still needs to be determined by the CBGSA Board.

Question: Why are the groundwater conditions in the Central region and the Ventucopa area so different.

Answer: The Central Region has more pumping and the Ventucopa area has more recharge; additionally, wells in Ventucopa are much shallower than those in the Central region.

Question: How will the new community wells be paid for?

Answer: We hope to get grant funds.

Question: With cloud seeding, how do you measure for toxicity?

Answer: Toxicity has not been a problem in other areas using cloud seeding.

Question: If the projects proposed do not work, then what happens?

Answer: Pumping would have to be further reduced.

Question: Which is implemented first, is it projects followed by pumping reductions?

Answer: Pumping reductions would be implemented first followed by projects.

Question: Is there information on every well in the Cuyama Basin? If not, why not?

Answer: No. Not every well was added to the State's database.

Question: How soon will monitoring start, is there a deadline for when it must begin?

Answer: There is not a specific schedule. Developing the detailed monitoring network and monitoring plan will be part of the initial work to be done.

Question: The Cuyama Community Services District (CCSD) well is not impacting the Cuyama Basin like agricultural pumping is, right?

Answer: Correct.

Topic 4 – GSP Implementation Plan

Question: Do less aggressive pumping reductions mean lower levels of groundwater?

Answer: Yes, less aggressive pumping reductions would result in lower groundwater levels initially; however, the CBGSA will need to bring levels above the minimum thresholds approved by the CBGSA Board by 2040.

Question: Are the monitoring wells new wells or converted ag production wells?

Answer: Both.

Question: What is an assessment?

Answer: SGMA gives GSA's the authority to implement assessments which will likely be property assessments based on acreage, or they could be based on something else. The CBGSA Board of Directors will decide the strategy. An assessment that includes pumping is a likely component of any future assessment.

Question: How are the socio-economic impacts being evaluated? With pumping reductions by the large ag growers, looking at the socio-economic impacts is crucial.

Answer: An economic assessment will be performed prior to any project or pumping allocation implementation.

Question: Can the CBGSA staff talk to the large employers in the Cuyama Basin and ask them to encourage their employees to be involved as this process continues to go forward over the coming years? The employees don't seem to know about what is needed to achieve sustainability in the Cuyama Basin. The employers and employees need to be encouraged to talk about what is coming.

Answer: The GSA has an active outreach process that is designed to try to include as many local residents in the process as possible.

Written Comments Received at March 6 Workshops

- It seems that an aggressive implementation of pumping reductions would be best for keeping the native ecological balance in the riparian areas with the least loss of the rich natural areas that provide quality of life for the inhabitants of the region.
- The pumping reductions might mean financial loss for some, but most of the financial gain from the use of the valley's water does not stay in the valley to provide benefits for the local population, but rather it goes to communities outside of the valley.
- Can a program to educate/provide more efficient irrigation systems like improved water delivery equipment or means to reduce evaporation be developed?
- Is there a way to use a little less technical language and simplify things by using more general terms with more diagrams? Some of the text slides need simplification.

May 1, 2019 Community Workshops

Two community workshops, one in English and one in Spanish, were held on May 1, 2019, in New Cuyama, California. The following is a summary of comments received at the workshops, and comments are grouped by topic. Responses to these comments are in Attachment D-1.

Summary of Comments Received Regarding the Draft GSP

Regarding **SGMA**, the GSP should include the following:

- Clarification that the development and implementation of the GSP is a government mandate under SGMA, but implementation will be paid for by landowners in the Cuyama Basin.
- Clarification that SGMA was not enacted to improve water quality or increase water flows.
- Explain what happens if the GSP fails -- what does state control look like?

Regarding **economic analysis and impacts**, the GSP should include the following:

- Economic impact analysis.
- Explanation of economic impacts from the groundwater cutbacks. The cutbacks could destroy the entire Valley's economy. The economic analysis needs to address the fact that the people who live in the Cuyama Basin work on the agricultural lands or support those that do.
- Explanation of how the economic impacts will be addressed as an offer on a ranch was withdrawn after the need for an 80 percent reduction in pumping was announced.
- Detailed plan for the cost for implementation taking into account that if the costs are put on the smaller landowners, they will go out of business. Protection for small landowners from unreasonable costs.

Regarding **implementation costs and funding**, the GSP should include the following:

- Define who is paying for what, what are the costs to residents.
- Explanation of how the disadvantaged communities in the Cuyama Basin can afford to continue this effort, year after year at $1 million plus per year.
- Consideration that when identifying funding for implementation, given that the Cuyama Basin is so severely overdrafted, decreasing water consumption will severely impact the finances of all those in the Basin whose livelihood depends on water use. Sacramento needs to find a way to pay for changes required by the GSP for the benefit all of California.
- Appropriate agencies should be seeking grant funding now for implementation.
- Information about how long grants will be available.
- Provide funding for houses that have to drill deeper for groundwater.

Regarding the **water model and data**, the GSP should include the following:

- Data gathering methods that are consistently updated so there is a consistent view provided.
- Explanation of why long-term economic decisions are being made on uncertain groundwater modeling.
- Explanation that decisions are being made based on model results without a clear understanding of how wrong the predictions might be. There are ways to quantitatively express the uncertainty in the model, and this should be included. Every model has uncertainty.
- Clarification of the quantitative sensitivity analysis (of the model) to identify parameters that have an outsized effect on hydraulic heads and overdraft/water balance.
- Clarification of uncertainty inputs (to the model) in terms of the range of probably outcomes.
- What the three biggest data gaps in the model are.
- More information that validates if new groundwater users are impacting Cuyama Basin groundwater or not.
- Account for domestic water use.

Regarding the **Russell Fault**, the GSP should include the following:

- Clarification of whether the Russell Fault restricts groundwater flow or if that is still “up in the air.”
- Additional studies to validate if the fault is in fact restricting groundwater movement.

Regarding **minimum thresholds/interim milestones**, the GSP should include the following:

- Explanation as to why minimum thresholds are set too low to achieve sustainability before the groundwater is further severely depleted.
- Improved explanation of the interim milestones. They should be set higher than the minimum thresholds.

- Clarification of the minimum thresholds and undesirable results in Chapter 3 – setting the percentage of wells that fall below minimum threshold at 30 percent is a problem if all wells in a management area go below the minimum threshold yet do not exceed the 30 percent measure for determining undesirable results.
- Explanation of why the minimum thresholds do not protect for continual overdraft.
- Explanation of why the interim milestones are set the same as the minimum thresholds. What happened to the margin of operational flexibility, this GSP is looking to do nothing better than the very worst that is acceptable.

Regarding the **glide path**, the GSP should include the following:

- Better clarification of the glide path.
- Setting reasonable undesirable results that reflect the glide path.
- Connection of undesirable results to the glide path.
- Consideration of starting the pumping allocations/reductions sooner than 2023.
- Implementation of the allocation plan by 2038.

Regarding the **monitoring network**, the GSP should include the following:

- Data gathering methods that are consistently updated so there is a consistent view provided.
- Agreement that the counties will play an active role in the monitoring network.
- Validation that the monitoring network is truly representative.
- Water quality monitoring so it can be dealt with, include water quality planning.
- Standardization of monitoring wells.
- Monitoring wells are not representative of local production.
- Better monitoring network and stream gauges.
- Who pays for the new groundwater monitoring wells?

Regarding **water quality monitoring**, the GSP should include the following:

- Monitoring of other water quality constituents that are of great concern for human and animal consumption, such as nitrates, arsenic, etc. Explain why total dissolved solids (TDS) are the only constituent considered. To avoid the consequences of water quality getting worse as pumping continues, more than just TDS should be monitored.
- Track groundwater quality with age date of multiple constituents.
- Water quality data from other agencies; it already exists.
- Explanation of why all wells cannot be monitored.

Regarding **environmental issues**, the GSP should include the following:

- Planning for potential for degradation of the environment (e.g., increased dust due to fallowing of land during implementation).
- Further analysis of the potential for destruction of native habitat, which is already occurring.
- Increased effort to protect groundwater-dependent ecosystems (GDEs).
- Protection for GDEs – The GSP does not recognize, quantify, or protect GDEs and it should. Basin overdraft has dried up most of the GDEs, the GSP must protect those that remain.

Regarding **water conservation**, the GSP should include the followng:

- Information about conservation by all groundwater users in the Cuyama Basin. All water users in the Cuyama Basin need to be encouraged to change their water use practices. Growers need to be encouraged to change to crops that use less groundwater, change watering systems to conserve more groundwater, let some fields remain unplanted. Private citizens should be encouraged to greatly reduce their water waste, i.e. showering, hand washing dishes, watering gardens.
- Clarification that if residents conserve water use, their bills do not go down.
- Clarification about the GSA’s role in recommending growers grow a different crop that uses less water.

Regarding **pumping allocations**, the GSP should include the following:

- Allocation methodology that provides equity among all groundwater users.
- Allocation methodology that is basin-wide.
- Protections for residential groundwater users.
- Definition of and exclusion of de minimis groundwater users from being subject to GSP implementation.
- Information/determination of how the CBGSA will treat a well that is used for irrigation and residential use.
- Information/determination of how the CBGSA will treat new well water users.
- Address the vulnerability of areas to new wells and/or increased pumping where there is no allocation planned currently.

Regarding **projects**, the GSP should include the follwoing:

- What are the impacts and risks associated with cloud seeding?

Regarding **future well drilling**, the GSP should include:

- Explanation of how future well drilling will be addressed.
- Discussion of a possible moratorium on well drilling permits issued by the counties.
- Confirmation that it is a requirement for all new wells to be reported to the CBGSA.

Other comments received at the workshops are summarized below.

- Fees set by the CBGSA will go toward the five-year reporting requirements.
- “Analysis paralysis” could keep the CBGSA Board from taking action.
- There needs to be a commitment on the part of the CBGSA Board to implement the GSP instead of business as usual.
- We were told that the CBGSA Board members do not care – this is worrisome.
- During CBGSA Board meetings, the board members need to listen rather than being on their smartphones during the meetings.
- There needs to be transparency by all parties during GSP implementation.
- Long-term implementation should engage the upcoming generation.
- Ensure that the GSP works for (1) groundwater levels, (2) water quality, and (3) allows for an adequate environment in the Cuyama Basin.
- Better trust that the pumpers will cooperate, report and pay.
- This is the eighth groundwater report done in the Cuyama Basin. We have known about the overdraft problem for the last 50 years. This is nothing new. How are we going to change business as usual behavior? If this plan is not improved drastically, we will know SGMA to mean same old groundwater mining activities.

Comments Made Directly to the CBGSA

The following letter was received by the CBGSA via email on March 3, 2019, and is quoted below.

OPEN LETTER TO CBGSA

If any entity was to craft a responsible long term business plan which relied on one key input or commodity naturally present but limited, in the region of operation, common sense would stress the *fact,* if the key commodity, commonly called a resource, was limited and would maintain it at the highest possible level to insure a viable business. If responsibly envisioned, this would require, among other things, taking into account patterns and trends regarding the limitation, continual degradation, and increased extraction expense of that input. It would make less sense to argue over the fine points of the remaining commodity and one's allotment within a narrow speculative margin than to plan and do everything possible to use with greatest efficiency and to augment through whatever means possible that key commodity. One must ask, to be blunt, what are the real objectives and contradictions behind CBGSP word play, and actual resource conservation and business as usual?

In the present example, there is a consortium of interests (Cuyama Basin Water District) determined to implement a probable short-to-medium-range plan that prefers to maximize output (capital) at the expense of adequate or perhaps even minimum maintenance of the commodity. This is at odds with the stated purpose of the GSP. This convoluted approach is justified by a perception of a-right-by-law of the dominant users, without acknowledgement of any responsibility to maintain the commodity and the fact that the depletion of it has had considerable adverse impacts on the region's character and potential long term availability for other users.

The science of and historical concern with the issue of water extraction in the Cuyama Valley Basin point to ongoing degradation by agricultural industry on a scale beyond the available water commodity in this basin. The patterns of verifiable depletion were just beginning to be noted in the 1951 USGS study. The basin had been essentially in equilibrium until 1946, a date that coincided with the arrival of electricity to the valley. By 1970, USGS reported that the estimated cumulative dewatering was in the range of 400,000 acre feet for the Basin.

The County of Santa Barbara's own studies at ten year intervals indicated by 1987 the total annual water demand in the basin was between 48,882 and 48,982 acre feet. Beyond a number of recommendations for grower conservation and a tax incentive proposal that never materialized, nothing more was done by agency action and the can was kicked further down the road. By the inception of the most recent USGS study in 2008, the county's water agency, taking all previous reports as more or less accurate, determined that the basin had already irrecoverably lost an estimated 1,500,000 acre feet in addition to the ongoing overdraft per year.

Pumping cost has motivated increased irrigation efficiency and production of less demanding crops since the late 1980's, and diminished the annual deficit to the 30,000 range that is currently being debated as the Groundwater "Sustainability" Plan is being formed. Still, and most importantly, every partisan in this issue does acknowledge a significant annual water deficit, yet among the consortium of major extractors there is no intention to diminish pumping to a level that would stabilize the water commodity in the basin. Instead the intention appears to be to drag out the maximum possible output (pursuing maximum capital return on basically "free" water). Thus the real preferred plan and expectation is to misrepresent the situation as much as the current legislation allows. This, at least in theory, is poor business practice from any perspective. In the short term, the major extractor beneficiaries seek to avoid full responsibility and continue production to the fullest possible extent while the irreversible desertification of the valley continues.

This myopic misuse of the groundwater of California is what SGMA intends to counter. Each of the groundwater basins in the State has unique conditions that require real and forthright solutions. In the Cuyama Basin, the excessive extraction of a sole source commodity is particularly irresponsible and damaging to the individuals and communities that call the valley's basin their home, to the future generations who will have to live with less of that much-needed commodity, and to the grace and modest bounty of a natural landscape that has already suffered irreparable damage from agriculture. It is long past time for a groundwater recovery plan that runs counter to the normal business bottom line, and takes an honest look at a bigger reality.

Most Sincerely,

John Mackenzie

Former Vice-Chairman CCSD

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Proposed Response
1	1.1	2	1	This document will...	Comment: Would imagine this sentence isn't necessary in the final GSP?	This is correct, the sentence will be removed from final GSP
2	1.3	1	3	The Basin also encompasses...	Comment: Since referencing the creeks, it would be helpful to label creeks like Fig 1-14	Creek labels will be added to Figure 1-1
3	1.3	3	4	The San Joaquin Valley Basin...	Comment: Figure spells 'Potero'	Spelling will be corrected in the Figure
4	1.3	5	1	Figure 1-5 shows...	Comment: Why is [Figure 1-5] this map at a differentn scale than the others?	The scale of Figure 1-5 will be modified to show full basin.
5	1.3	5	1	The CBWD covers...	Insert: "...west of Wells Creek to # miles east of the intersection of...."	Comment accepted.
6	1.3	6	1	Figure 1-6 and 1-7...	Comment "Figure 1-6": If data in this figure is all from the Counties, why say DWR land survey?	The figure depicts land use resulting from surveys performed by DWR
7	1.3	6	1	Figure 1-6 and 1-7...	Comment "... 2014...": How is the Grapevine Capital land use going to be included in this effort?	These figures depict historical land use from before the Grapevine Capital development. For modeling purposes, assumptions about current and future land use will include the Grapevine Capital development as well as other recent changes in land use.
8	1.3	6	---	Crops are generally...	Text Edits ". Crops are generally rotated regularly, and some agricultural area is idle. ~~, but a~~Areas that are in active agricultural use produce are primarily miscellaneous truck crops, carrots, potatoes and sweet potatoes, miscellaneous grains and hay, and grapes. Various other crop types are produced in the Basin as well, such as fruit and nut trees, though at smaller production scales.	Comment accepted.
9	1.3	7	4	Much of the surface water...	Comment "figure.": Color scheme between the legend and map appear to be different. Some irrigated lands appear to not have a water use	The current background map shows land uses that were not present in 2014. The background map will be replaced to avoid color confusion.
10	1.3	8	1	Figure 1-9...	Comment "average depth": Would median be a better indicator per square mile?	DWR provides average values, and average is the common statistical representation of groundwater depths
11	1.3	9	1	Figure 1-10...	Comment "10": Is there potential for this figure to change if more data comes in by 5/31? Legend in figure still says 'Domestic' instead of Production	Applicable data provided on or before 5/31/2018 will be incorporated, if possible, in to the groundwater model. However, this data may not be incorporated into this Plan Area figure. The figure's legend will be updated to say "Domestic" in place of "Production".
12	1.3	9	1	Figure 1-10...	Comment "density": Suggest using a different color spectrum, i.e. 'cool to hot' as the density goes up	Comment accepted.
13	1.3	9	1	Figure 1-10...	Comment "average depth": Would median be a better metric?	DWR provides average values, and average is the common statistical representation of groundwater depths
14	1.3	10	2	The Basin contains...	Comment "three": Really only 3? CCSD only has 1 well?	The information represented in Figure 1-11 is what is included in DWR's well completion report database, which contains information on the majority of wells drilled after 1947. However, some wells may not have been reported to DWR (potentially up to 30%), and therefore are not included in the database or this summary.
15	1.3	11	3	The Los Padres National...	Insert: "... then runs outside the Basin's western and southern boundary...	Comment accepted
16	1.3	12	1	Figure 1-13...	Comment "13": Why is Santa Maria watershed more prominent than Cuyama?	The Figure will be modified to make the Cuyama watershed more prominent.
17	1.3	12	1	Figure 1-13...	Comment "part of the Cuyama Basin's northeastern arm located in the Estrella River Basin.": Should add some discussion/explanation why Cuyama Basin doesn't receive water from watersheds on the west side	A sentence will be added to the paragraph that explains why this area does not flow into the Cuyama Basin.
18	1.3	12	3	The figure also identifies...	Comment "... figure also identifies the various other groundwater basins...": Seval of these aren't shown in the map	This sentence will be removed as this figure is not intended to show groundwater basins.
19	1.4	1	4	The USGS has two active...	Comment "deactivated gages": Discuss history coverage of deactivated gages	The text will be modified to discuss the deactivated USGS gages
20	1.4	2	4	and another gage...	Comment "and another gage downstream of the watershed but above Twitchell reservoir on the Cuyama River.": What?	This sentence will be revised for clarity
21	1.5	1	2	Existing groundwater monitoring...	Comment "Existing groundwater monitoring programs in the Basin collect data on groundwater elevation, groundwater quality and subsidence at varying temporal frequencies": Should have a figure(s) to help with the discussion in this section and following sub-sections. Figures may also help identify data gaps	Figures depicting existing groundwater monitoring wells will be included in the Monitoring Network section of the GSP.
22	1.5.1	8	5	Full construction information...	Comment "Full construction information is not available for voluntary wells because SBCWA does not have permission to release available construction information.": Is this still valid? Thought there were on-going conversations on these.	W&C will follow up with Matt Young of Santa Barbara County to verify this information
23	1.5.1	8	6	This known data gap...	Comment "Monitoring Plan": SBCWA's monitorng plan?	This discussion of data gaps will be removed from this section of the GSP and added to the Monitoring Network section of the GSP
24	1.5.1	8	bullets	Spatial gaps...	Comment "• Spatial gaps in the northwestern and southeastern areas of the Santa Barbara County portion of the Basin. • Data gaps in the area north of Highway 166 and in the center of the Basin between Bell and Kirschenmann Roads. ": Figures would be helpful	This discussion of data gaps will be removed from this section of the GSP and added to the Monitoring Network section of the GSP
25	1.5.1	9	bullet	Horizontal spatial gap...	Comment "at least one well per 10 square miles": Should focus on this more and or earlier. Could help develop gaps and projects for monitoring wells going forward	This discussion of data gaps will be removed from this section of the GSP and added to the Monitoring Network section of the GSP
26	1.5.2	0	heading		Comment on heading 1.5.2: Figures showing the temporal and spatial availability of the data would help facilitate discussion and also highlight the gaps and needs moving forward	A figure showing this information will be inlcuded in the Monitoring Network section of the GSP

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27	1.5.2	5	3	In the Cuyama basin...	Comment ", six DDW": Are these not public? That would be more than three portrayed earlier	W&C will review the information and determine if any of these wells need to be categorized as public wells
28	1.5.3	1	2	There are no known...	Comment "no known extensometers": Are these different than the stations mentioned in the following paragraph?	Yes, all current subsidence monitoring stations within the basin use GPS.
29	1.5.7	0	heading		Comment on heading 1.7: Recommend discussing in same order from section to section. Previous section went SB, SLO, Ventura, Kern. This section goes Kern, SLO, SB, Ventura.	The order of the subsections in 1.7 will be reordered and corrected
30	1.8	1	bullet (g)	Well Construction policies	Comment: Will this cover how well permits are granted or denied for new or replacement wells going forward?	No, this section of the GSP documents current well permitting programs. Potential changes to these programs could be considered in the Project and Management Actions section of the GSP.
31	1.9	0	heading		Comment on heading: Are these all cited in text?	Yes
32	1.3	3	4	To the southwest...	Comment "To the southwest, and more distant from the Cuyama Basin, are the Santa Maria, San Antonio Creek Valley and Santa Ynez River Valley Basins, which are located about 10 to 15 miles southwest of the Cuyama Basin.": The distance to these other basins is not accurate. San Antonio Creek is at least 35 miles away as the crow flies, and much futher by highway. The Santa Ynez basin is even further.	Text will be modified for clarity
33	1.3	6	1	Figure 1-6 and 1-7...	Comment on whole paragraph: - These maps do not show range land which dominate the western area of the valley and should be included as an agricultural land use. - Recent agricultural land development is not included which are significant increases in relation to groundwater use in the Basin: specifically the 870 acres of vineyard planted in the western portion of the Basin; and the intensive olive cropping along Hwy 33 are not included. If the map cannot be updated to 2016, then these additions/changes should at least be mentioned in the narrative. - Potatoes and sweet potatoes are not grown at any scale any longer, making it pretty clear that the crop types the report refers to are based on old data. Hay, which is a rain-fed crop, is hardly farmed anymore. However, alfalfa, which is an intensively irrigated crop, and was a cause of the early overdrafting, is still grown along Highway 33. A drive across the Valley today shows large plantings of beets, broccoli, garlic and salad greens, along with carrots.	Land use for additional years, including 2016, is currently being processed and will be shown in the next revision of the Plan Area document. These land use datasets only show irrigated agricultural lands and therefore do not include non-irrigated range and pasture land. However, water use from these other land areas will be accounted for in the numerical model and water budget as part of the GSP.
34	1.3	11	3	The Los Padres National...	Comment "The Los Padres National Forest covers most of the Basin's northwestern arm, then runs outside the Basin's western boundary, where it enters the Basin again and covers most of the Basin east of Ventucopa": Los Padres National Forest also is the boudanry and part of the watershed for the entire southern component of the Basin. A watershed focus should be used since these arms, even though they are located outside the physical basin itself, are feeder streams into the basin.	Comment noted. Figure 1-13 shows the portions of the Los Padres National Forest that run off into the Cuyama Basin.
35	1.4	1-2	3	The Only CDEC gages...	Comment "The only CDEC gages in the Cuyama River watershed are at Lake Twitchell which is downstream of the Cuyama Basin. The USGS has two active gages that capture flows in the Cuyama River watershed upstream of Lake Twitchell... Although neither of these stream gages is located within the Cuyama Basin, they can be used to monitor the inflow and outflow of surface water through the Basin.": The gages located near Twitchell Reservoir are only partially fed by stream flow from the upper basin. Multiple tributaries flow into the Cuyama River to the west of the Basin. Some of these streams include: Miranda Pines Creek, Alamo Creek, and many other smaller creeks. A drive along Highway 166 from the western end of the Basin at Rock Creek to Twitchell Reservoir shows multiple cases of creeks or washes with riparian vegetation (Sycamore, Cottonwood, Willows, etc.) leading into the Cuyama River, all indications of significant groundwater movement. Thus, we question how accurate a reading these gages would provide for stream flow exiting the Cuyama Basin as defined by Bulletin 118.	Comment noted. Figure 1-14 shows the portion of the watershed upstream of Twitchell Reservoir that flows into the Cuyama River within and downstream of the Cuyama Groundwater Basin, as well as the location of gage 1136800. As part of developing the water budget, W&C will estimate the portion of the gage 1136800 flow that originated from the Cuyama Basin area.
36	General Comment				Comment: Is this the section where past studies of groundwater in the Cuyama Basin would be mentioned? If so, we recommend including this summary chart of past studies prepared by Dennis Gibbs, Yulalona Hydrology, as part of a report for Santa Barbara Pistachio Company, December 7, 2017. We feel that the Plan Description should more clearly summarize the historic overdraft of the groundwater in the Basin that has been documented for many decades. This really should be the starting point for any future management plan. 	These will be discussed in the Water Budget section of the GSP

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37	General Comment				Comment: We also question if oil wells and pumping have been examined in terms of potential water use. It is known that water must be injected into some oils wells to aid in the oil extraction process. Is there any of this going on, have water wells been drilled to supply this water, and if so, how much water is being used?	This will be addressed in the Water Budget section of the GSP. No information has been provided for the water use for oil production.
38	General Comment				Comment: We also believe that the report should include a list of all the new water wells that have been drilled and put into operation in the Basin since the passage of SGMA, including where they are, how much water they can pump, and for what crops they will be used. A lot of water development and water use changes have occurred in the Basin in the past 3-4 years.	Recently installed groundwater wells will be included in the well database developed for the GSP if information is provided for them. However, these will not be identified separately.
39	1.2	1	2	It is beneath the Cuyama...	Comment "It is beneath the Cuyama Valley, which is bounded by the Caliente Range to the northwest and the Sierra Madre Mountains to the southeast": these 2 ranges should be shown on the figure.	Labels for these ranges will be added to Figure 1-1.
40	1.3	1	4	The Basin also encompasses...	Comment "Wells Creek": not labeled on figure	Creek labels will be added to Figure 1-1
41	1.3	1	4	The Basin also encompasses...	Comment "Quatal Canyon drainage": not labeled on figure	Creek labels will be added to Figure 1-1
42	1.3	1	4	The Basin also encompasses...	Comment "Cuyama Creek": not labeled on figure	Creek labels will be added to Figure 1-1
43	1.3	2	1	Figure 1-2...	Comment "CBGSA": not mentioned in legend	The legend will be updated to note the CBGSA boundary
44	1.3	4	7	Its jurisdictional coverage...	Edits "Ventura County ~~encompasses~~ has jurisdiction over the southeastern area of the Basin (covering 120 square miles), including the area east of Ventucopa."	Comment accepted
45	1.3	6	3	Crops are generally...	Edits "~~Crops are generally generally~~ there is regular rotation of crops~~ rotated regularly, and~~with some agricultural area ~~is~~ left idle~~, but~~. ~~areas~~ Areas that are in active agricultural use produce primarily miscellaneous truck crops, carrots, potatoes and sweet potatoes, miscellaneous grains and hay, and grapes. Various other crop types are produced in the Basin as well, though at smaller production scales.	Comment accepted
46	1.3	10	Figure 1-10		Comment on Figure: Legend has Township & Range with Domestic Wells but figure is production wells density	The legend will be updated to say "Domestic" in place of "Production"
47	1.3	10	1	Figure 1-10...	Comment: define production well	Definition will be added to the text for "Production", "Domestic" and "Public" wells
48	1.3	11	Figure 1-11		Comment on Figure: Legend has Township & Range with Domestic Wells but figure is production wells density	The legend will be updated to say "Domestic" in place of "Public"
49	1.3	11	2	The Basin contains...	Comment: Which well is this? Our database does not show a municpal well in Cuyama Basin	DWR's well completion database shows a public well at this location. Initial research suggests that this well is located at a fire station, but this has not been confirmed.
50	1.3	12	3	The Los Padres National...	Edits: The Los Padres National Forest covers most of the Basin's northwestern arm, then runs just outside the Basin's western boundary~~, where it enters the Basin again and covers most of the Basin~~ until the Forest boundary turns east at about~~east of~~ Ventucopa where it covers the southern part of the basin. A portion of the Basin north of Ventucopa, as well as an area nearby that is immediately outside the Basin, is designated as the Bitter Creek National Wildlife Refuge. The Bureau of Land Management (BLM) has jurisdiction over a large area ~~that runs~~ outside the Basin, and along the Basin's northern boundary~~, and covers~~including small parts of the Basin north of the Cuyama River. Most of the northeastern arm of the Basin is designated as State Lands.	Comment accepted
51	1.3	13	1	Figure 1-13...	Comment on figure: Where is the Cuyama Watershed on the figure? Needs to be more obvious. It would also be helpful if the areas of different colors were included in the legend	The Figure will be modified to make the Cuyama watershed more prominent.
52	1.3	13	after 2		Comment on last comment/insertion: Figure would be more helpful if it did not include all the extra basins. Also, are they basins or watersheds. Ventura is labeled at the bottom but that's not the county boundary or the Cuyama basin boundary)	This sentence will be removed as this figure is not intended to show groundwater basins.
53	1.4	1	1	Existing groundwater monitoring...	Edits: "Existing surface water monitoring in the Cuyama Basin is extremely limited. ~~Existing s~~Surface water monitoring in the basin is limited to DWR's California Data Exchange Center (CDEC) program, and monitoring performed by the United States Geological Survey (USGS). The only CDEC gage~~s~~ in the Cuyama River watershed ~~are~~ is at Lake Twitchell which is downstream of the Cuyama Basin . The USGS has two active gages that capture flows in the Cuyama River watershed upstream of Lake Twitchell, as well as four deactivated gages (Figure 1-14). "	Comment accepted
54	1.4	1			Comment on Figure showing Twitchell: Not clear where this is on the map	A label will be added for Twitchell Reservoir on Figure 1-14
55	1.4	1			Comment on Figure 1-14: Are the gages that are labeled on the figure only the USGS gages? What is the area with the diagonal lines?	Yes, the figure only shows USGS gages. There are no other surface flow gages within the basin. As described in the legend, the hatched area shows the portion of the Cuyama River Watershed that contributes to the Cuyama River downstream of the Cuyama Valley Groundwater Basin

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56	1.4	2			Edits: "The two active gages include one gage on the Cuyama River downstream of the Basin (ID #11136800), which is located just upstream of Lake Twitchell. This gage has 58 years ~~recorded years~~ of recorded streamflow measurements from 1959 to 2017. The other active gage is south of the city of Ventucopa along Santa Barbara Canyon Creek (ID #11136600) and has seven ~~recorded~~ years of recorded streamflow measurements ranging from 2010 to 2017. and another gage downstream of the watershed but above Twitchell reservoir on the Cuyama River. Although neither of these stream gages is located within the Cuyama Basin, they can be used to monitor the inflow and outflow of surface water through the Basin.	Comments accepted
57	1.4	2			Comment "The two active gages...": USGS?	Yes, the document will be clarified to be clear that these are USGS gages
58	1.4	2			Comment "The other active gage is south of the city of Ventucopa...": town not labeled on map. Also Ventucopa has been called a community, a town and not a city in this report	A label will be added for Ventucopa to Figure 1-14. The document will be update to consistently refer to Ventucopa as a "town"
59	1.4	2			Comment "and another gage downstream of the watershed but above Twitchell reservoir on the Cuyama River.": ???	Text will be modified for clarity
60	1.5.1	1	2	Data is submitted...	Comment: What is SBCWA?	SBCWA was previously spelled out in Section 1.3
61	1.5.1	3	4	Wells were montiored...	Edits "~~Wells were monitored in 2017, with most~~ Most of the wells that were monitored in ~~being~~ 2017 have been monitored since 2008, although a few have measurements dating back to 1983.	Comment accepted
62	1.5.1	7	6	Full Construction information...	Comment: construction information is no longer confidential	W&C will follow up with Matt Young of Santa Barbara County to verify this information
63	1.7			Addition, last paragraph of 1.7	Insertion "**Ventura County Plan's Update** The County of Ventura is working on a comprehensive update to its General Plan for the first time in almost 30 years. The County's current General Plan expires in 2020 and it has not been comprehensively updated since 1988. Since that time, there have been many important changes to state law that dictate what issues must be included in a general plan. As a part of the General Plan Update, the existing elements may be reorganized and the County will develop three additional elements to address issues related to agriculture, economic development, and water. The General Plan Update will also incorporate the topics of health and climate change. "	Insertion accepted
64				Figure 1-11	Comment: Figure 1-11 shows public wells with a public well at the south end of the basin. We don't have a municipal well in Cuyama Basin in our database.	DWR's well completion database shows a public well at this location. Initial research suggests that this well is located at a fire station, but this has not been confirmed.
65					Comment: • The two wells that are being reported to the CASGEM program are not the two described in section 1.5.1 Groundwater Elevation Monitoring, Ventura County Watershed Protection District CASGEM Monitoring Plan (page 20). The well Ventura reports are: o 07N24W13C03S has been monitored since at least April 1989, and we have a well completion report on it so we do have construction information. o 07N23W16R01S has been monitored since at least March 1972. We do not have a well completion report so no well construction information. Our database has the well depth as 73 feet but I don't know where the information came from. Casing diameter is 10 inches.	This section will be reviewed and clarified
66					Comment: There is not map that shows the wells they are using for water elevation or water quality data.	This information will be provided in the Monitoring Network section of the GSP
67					Comment on Figure 1-12, Fed and state lands: The state lands in the n/w should be labeled "Carrizo plain ecological reserve" as the wildlife sustainability issues will be important.	Carrizo Plains Ecological Reserve will be added to Figure 1-12 where the map label "State Lands" is currently located
68	1.6.2				Comment: The San Luis Obispo 2014 IRWM Plan presents a comprehensive water resources management approach to managing the region's water resources, focusing on strategies to improve the sustainability of current and future needs of San Luis Obispo County (County of San Luis Obispo, 2014), see note below. • Note that the IRWM Plan was heavily based on the 2012 Master Water Report -- https://slocountywater.org/site/Frequent%20Downloads/Master%20Water%20Plan/	A sentence will be added to Section 1.6.2 to note that the IRWM Plan Update was based on the 2012 Master Water Report.
69	1.2				Comment: Add labels on figure for Caliente Range and Sierra Madre Mountains	Labels for these ranges will ba added to Figure 1-1.
70	1.3				Comment: combine Figure 1-1 and 1-2?	Creek labels will be added to Figure 1-1
71	1.3				Label Wells Creek, Santa Barbara Creek, Quatal Canyon, and Cuyama Creek on Figure 1-1	Creek labels will be added to Figure 1-1
72	1.3	2	3	The CBGSA was created..	Edit: Remove "E" from "JEPA"	W&C will confirm the correct acryonym.

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73	1.3				Comment on Figure 1-2: Figure 1-4 shows County Boundaries? Figure 1-2 Not Needed Combined w/ Figure 1-1.	The Figures have been organized to clearly show compliance with SGMA requirements and therefore, the contents and numbering of each figure will not change.
74	1.3	3		Figure 1-3 shows...	Comment on entire paragraph: P. 3 coss draft 2018 SGMA Prioritization. High Priority	Figure 1-3 will be updated to reflect the new prioritization of the Cuyama Valley Groundwater Basin
75	1.3	4			Comment on Figure 1-4: Move to Figure 1-2A	The Figures have been organized to clearly show compliance with SGMA requirements and therefore, the contents and numbering of each figure will not change.
76	1.3	5			Comment on Figure 1-5: Figure 1-2b	The Figures have been organized to clearly show compliance with SGMA requirements and therefore, the contents and numbering of each figure will not change.
77	1.3	6			Comment on Figure 1-6 and 1-7: Show all Ag? Cattle Grazing, pastures, and federal and state land. From Landuse. New Figure?	These land use datasets only show irrigated agricultural lands and therefore do not include non-irrigated range and pasture land. However, water use from these other land areas will be accounted for in the numerical model and water budget as part of the GSP. Federal and State Lands are shown in Figure 1-12.
78	1.3	7		Figure 1-8 shows...	Comment on whole paragraph: Capture all ag? Any diminimis users?	These land use datasets only show irrigated agricultural lands and therefore do not include non-irrigated range and pasture land. However, water use from these other land areas will be accounted for in the numerical model and water budget as part of the GSP.
79	1.3	7		Figure 1-8 shows...	Comment "Pastureland, which may not be...": Can you add this infor? New figure?	These land use datasets only show irrigated agricultural lands and therefore do not include non-irrigated range and pasture land. However, water use from these other land areas will be accounted for in the numerical model and water budget as part of the GSP.
80	1.3	8		The number in each...	Comment at end of paragraph": Add table QAQC discuss. This data is the Figure 13 head to follow	A table is not necessary to represent this information
81	1.3	between 8 and 9			Comment: Geology and well screen level?	Geology information will be provided in the HCM section of the GSP. Screen interval data is not widely available.
82	1.3	9		Figure 1-10 shows...	Comment on paragraph: QAQC discuss	Language will be added to describe the reliablility and completeness of DWR well information.
83	1.3			Figure 1-1	Comments: - add "creeks" to make the label "streams/creeks" - label from page 1 - if showing parcels/ ag areas show the entire basin.	Creek labels will be added to Figure 1-1. Background imagery will be revised to provide more clarity.
84	1.3			Figure 1-2...	Comment: - Combine w/ Figure 1-1 - Too busy w/ all the roads	Background imagery will be revised to provide more clarity. The Figures have been organized to clearly show compliance with SGMA requirements and therefore, the contents and numbering of each figure will not change.
85	1.3			Figure 1-4	Comment: Figure 1-2?	The Figures have been organized to clearly show compliance with SGMA requirements and therefore, the contents and numbering of each figure will not change.
86	1.3			Figure 1-5	Comment: Suggest using entire Basin Scale? Instead of 200 median	The scale of Figure 1-5 will be modified to show full basin.
87	1.3			Figure 1-3	Comment on Medium or all Priorities: Still correct> Draft 2018 SGMA Plan is High	Figure 1-3 will be updated to reflect the new prioritization of the Cuyama Valley Groundwater Basin
88	1.3			Figure 1-6	Comment: Does this include Harvard? All ag?	Land use for additional years, including 2016, is currently being processed and will be shown in the next revision of the plan area document. These land use datasets only show irrigated agricultural lands and therefore do not include non-irrigated range and pasture land. However, water use from these other land areas will be accounted for in the numerical model and water budget as part of the GSP.
89	1.3			Figure 1-7	Comments: - Move state and federal land use figures to ag land use to another figure - show all ag?	Figure 1-12 does not show land use but rather the boundaries of State and Federal lands. Land use for additional years, including 2016, is currently being processed and will be shown in the next revision of the plan area document. These land use datasets only show irrigated agricultural lands and therefore do not include non-irrigated range and pasture land. However, water use from these other land areas will be accounted for in the numerical model and water budget as part of the GSP.

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90	1.3			Figure 1-8	Comments: - show all ag? - Any de minimis users?	Land use for additional years, including 2016, is currently being processed and will be shown in the next revision of the plan area document. These land use datasets only show irrigated agricultural lands and therefore do not include non-irrigated range and pasture land. However, water use from these other land areas will be accounted for in the numerical model and water budget as part of the GSP. De minimis user data is not availble.
91	1.3			Figure 1-9	Edit to legend: Remove "Township & Range with" to just make it "Domestic Wells"	"Number of Domestic Wells by Township and Range" will be used in Figure 1-9, and similar changes will be made to Figures 1-10 and 1-11.
92	1.3			Figure 1-10	Edit to legend: Remove "Township & Range with" and change to "Production" to just make it "Production Wells"	"Number of Domestic Wells by Township and Range" will be used in Figure 1-9, and similar changes will be made to Figures 1-10 and 1-11.
93	1.3			Figure 1-11	Comment: - Google show all ag? - Cicled well with "280" and called it "Strange"	Background imagery will be revised to provide more clarity. The Figures have been organized to clearly show compliance with SGMA requirements and therefore, the contents and numbering of each figure will not change.
94	1.3			Figure 1-11	Edit to legend: Remove "Township & Range with" to just make it "Domestic Wells"	"Number of Domestic Wells by Township and Range" will be used in Figure 1-9, and similar changes will be made to Figures 1-10 and 1-11.
95	1.3				General comment, might be for Figure 1-10 and 1-11?: Well Screen level? Geology?	Geology information will be provided in the HCM section of the GSP. Screen interval data is not widely availble. Screen interaval information is not currently availble for most wells. Text will be updated to reflecty why screen levels are not included
96	1.3			Figure 1-12 and 1-13	Comment: Suggest move up ahead or behind Ag land use on or before.	The Figures have been organized to clearly show compliance with SGMA requirements and therefore, the contents and numbering of each figure will not change.
97	1.4	1			Comment: Approximate amount?	This is described in the subsequent paragraph.
98	1.4	2			Comment: How is this data QA/QC?	The USGS performs QA/QC on their data prior to posting.
99	1.5	1			Comment: When was the CCSD and CBWD formed?	This information will be added to the paragraph that references Figure 1-5
100	1.5	1			Comment "There are 101 wells...: Approximate?	References to the numbers of wells will be removed from this seciton and discussed in the Monitoring Network section of the GSP along with appropriate figures
101	1.5	1			Comment: Figures?	Figures will be added to the Monitroing Network section of the GSP
102	1.5.1	2	1	SLOFC&WCD has...	Insertion: "has two CASGEM wells in the service area..."	Comment accepted
103	1.5.1	4	4	Wells were monitored in 2017...	Comment on "with most being monitored isnce 2008.": Revise, awkward.	Sentence will be revised for clarity
104	1.5.1	4			Comment: Tables/figures?	This section of the GSP describes the program in general terms. More details will be provided in the Monitoring Network section of the GSP
105	1.5.1	5			Comment: Table/figures.	This section of the GSP describes the program in general terms. More detailes will be provided in the Monitoring Network section of the GSP
106	1.5.1	6			Comment: SLO County so the well is mentioned previously and these wells are voluntary	Monitoring programs often overlap which is why the wells are mentioned multiple times
107	1.5.1	9			Comment on paragraph header: Volunteer Program for SLO	Comment noted. No change needed
108	1.5.1	9			Comment on "One well is screened in the Younger Alluvium....": Go over Geolog of Basin. Does not fit?	Geology references will be removed from this section of the GSP and will be included in the HCM section of the GSP
109	1.5.2	1	5 and 6	Constituents most frequently...	Comment: General minerals? Nitrates?	Comment noted. No change needed
110	1.5.2	5			Comment on whole paragraph: Add new requirement for ILRP order. Title I to Title III	Comment noted. This level of detail is not needed in the GSP document.
111	1.5.3				Comment on Placeholder for other USGS Subsidence Monitoring: CORS stations if in area?	This will be updated during the development of the Monitoring Network section of the GSP.
112	1.7				Comment on Section: Need to State GSA's goal then how each Plan Aligns w/ them.	The text will be modified so as to not state or imply that the GSA is adopting goals from the General Plan.
113	1.7.1	1			Comment: GSA Board should decide?	The text will be modified so as to not state or imply that the GSA is adopting goals from the General Plan.
114	1.7.1	3			Comment/edit: Remove last sentence starting with "Due to the complementary nature...." GSA decides. Should b a combo of all General Plans	The text will be modified so as to not state or imply that the GSA is adopting goals from the General Plan.
115	1.7.1	4	2	Given the small portion of the...	Comment/edit: Remove "...and the GSP's alignment wit hthe Genral Plan's goals" Goals need to be vbetted with GSA Board and Public.	The text will be modified so as to not state or imply that the GSA is adopting goals from the General Plan.
116	1.7.2.	3rd to last Paragraph			Comment on last sentence: Need to vett goasl w/ GSA Board and Public	The text will be modified so as to not state or imply that the GSA is adopting goals from the General Plan.

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117	1.3				Comment: This section uses a variety of indexes to describe the Basin but misses others. Numerous secondary streams flow into the valley and contribute to the flow of the Cuyama River but only a couple are mentioned. What about Cottonwood, Aliso, Branch, Salisbury, Ballenger, Burgees, Apache and Reyes Creeks. And what can be done to monitor the sometimes significant contribution these creeks have to the basin. The lack of surface water flow monitoring on any of these secondary stream is a potentially problem for developing a water budget or model. Also no mention is made about the variety of surface water features other then streams and rivers. Cuyama is notorious for its Seeps, Springs, Wetland meadows and Cienegas. There are Federal and State agencies which have wetland tracking maps for these Groundwater Dependent Ecosystems and they characterize a significant portion of the valley. There should be a map representing these wetlands and a monitoring program to understand their conditions.	The streams and other surface water features shown on the figures will be revisited when the surface water modeling approach for the GSP is developed. A map will be developed that shows the wetlands contained in state and federal databases.
118	1.3			Figure 1-5	Comment: Figure 1-5 is at an unnecessarily odd scale and it would be helpful to see it combined with Figure 1-4 so as to see which county is responsible for the parts of the Basin which are outside of the Water District.	The scale of Figure 1-5 will be modified to show full basin. The Figures have been organized to clearly show compliance with SGMA requirements and therefore, the contents and numbering of each figure will not change.
119	1.3			Figures 1-6 and 1-7	Comment: Figures 1-6 & 1-7 regard land use changes up to 2014, however significant changes have happened across the valley with regards to land use and crop changes. How can the changes at Harvard Vineyard, Sunridge Nursery, Duncan Farm, Sunrise Olive, the Solar Farm and others be accounted for as they all are recent major land use changes on a large portion of the valley?	Land use for additional years, including 2016, is currently being processed and will be shown in the next revision of the Plan Area document. These land use datasets only show irrigated agricultural lands and therefore do not include non-irrigated range and pasture land. However, water use from these other land areas will be accounted for in the numerical model and water budget as part of the GSP.
120	1.3			Figure 1-8	Comment: Figure 1-8 is incorrect or miss-keyed. Some Irrigated lands are unmarked and no lands are irrigated by surface water as appear to be indicated on the map by the wrong color key.	The current background map shows land uses that were not present in 2014. The background map will be replaced to avoid color confusion.
121	1.5				Comment: The section on existing monitoring of surface water is telling in its brevity. There are not enough flow gauges to make real measurements. This will be a critical issue with the water budget and model development.	Comment noted. For the water budget development, flows will be estimated using precipitation records
122	General Comment				Comment: No mention is made of historic Groundwater use or of the many studies made of the Basin. It seems relevant to present the history of peer reviewed studies and the commonality of all their conclusions; mainly historic & chronic overdraft. Summary of all modern Hydrologic Analyses of the Cuyama Groundwater Basin Year Agency Overdraft Method 2014 USGS-SBCWA 34,500 AF/y Finite Difference Model 2009 UCSB Bren School 30,500 AF/y Mass Balance 1998 CDWR 14,600 AF/y Specific Yield 1992 SBCWA 28,000 AF/y Mass Balance 1988 CRCD 30,300 AF/y Mass Balance 1977 SBCWA 38,000 AF/y Mass Balance 1970 USGS 21,000 AF/y Mass Balance 1951 USGS "Steady State" Observations	These will be discussed in the Water Budget section of the GSP
123	1.4	2	4	and another gage...	Comment: Sentence structure issue	The text will be modified for clarity
124	1.4	2	5	Although neither of...	Comment: 11136600 is within the DWR GW Basin Boundary	The text will be modified for clarity
125	1.4	2	5	Although neither of...	Comment: May be misleading when considering the development of a GSP and monitoring inflow and outflow from Basin. 11136800 is 15 miles downstream with a fairly large contributing watershed above it and outside the basin. Then again, suppose it's better than nothing at all.	The usefulness of this gage for monitoring will be assessed when the surface water monitoring approach is developed. No change needed for this document.
126	1.5	1		There are 101 wells...	Comment: A general NWIS datapull has double this number of wells with historic data. Possible referring to active program?	Groundwater level data is currently being assessed and the records of wells with historical data will be confirmed. References to the numbers of wells will be removed from this seciton and discussed in the Monitoring Network section of the GSP.
127	1.5	1		There are 101 wells...	Comment: Monitored by whom? USGS and SBCWA and the water district?	The agencies that perform the monitoring are described in the sections below.
128	1.5.1	1	1	Data is submitted to the WDL from ... Santa Barba County Flood Contrl and Water Conservation District...	Comment: Not that I'm aware of. We (WA) do provide data to DWR for the CASGEM program only. Probably what they're referring to here.-although there's a CASGEM section below. I have a feeling that DWR may mine data from the NWIS webpage.	The discussion on the entities who perform monitoring will be reviewed and clarified
129	1.5.1	3	2	The USGS provides historical data for 48 wells from 1946 to 2009...	Comment: ????????????? Also what makes me think DWR pulled data out of NWIS. Discrete values in NWIS are coded CA042 for for Flood Control. The WA submits CASGEM and voluntary CASGEM data for wells to DWR. USGS has never directly provided data to DWR.	The discussion on the entities who perform monitoring will be reviewed and clarified

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130	1.5.1	4	2	In the Cuyama Basin, there are 23 wells...	Comment: ?? Historically there are 200+	Groundwater level data is currently being assessed and the records of wells with historical data will be confirmed. References to the numbers of wells will be removed from this seciton and discussed in the Monitoring Network section of the GSP.
131	1.5.1	4	3	Wells are monitored by the USGS in SBFC&WCD's...	Comment: Water Agency Program	The discussion on the entities who perform monitoring will be reviewed and clarified
132	1.5.1	4	3	...with most being monitored since 2008...	Comment: Ignoring historic data set	Groundwater level data is currently being assessed and the records of wells with historical data will be confirmed.
133	1.5.1	4	3	...back to 1983	Comment: And earlier	Groundwater level data is currently being assessed and the records of wells with historical data will be confirmed.
134	1.5.1	4	3	Groundwater level measurements at these wells are taken approximately once per quarter	Comment: Only during the study	Groundwater level data is currently being assessed and the records of wells with historical data will be confirmed.

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1	2.1	Global			I understand that this draft does not yet constitute the complete Basin Setting Description, but of the three requirements of an HCM by CDWR, I find this draft addresses only the first item comprehensively. 1. An understanding of the general physical characteristics related to regional hydrology, land use, geology and geologic structure, water quality, principal aquifers, and principal aquitards of the basin setting; 2. A context to develop water budgets, mathematical (analytical or numerical) models, and monitoring networks; 3. A tool for stakeholder outreach and communication.	The GSP will use the HCM for guiding water budget development and HCM components will be elaborated upon during outreach activities.
2	2.1	Global			In order to facilitate and serve as the basis for the development, construction, and application of a mathematical (analytical or numerical) model and water budget, more narrative would be needed regarding the sources of recharge, and the consumptive use by existing native rangeland and phreatophyte vegetation, as well as a better description of the complexity of the "cascading basin" that results from hydrogeologic barriers that separate the Ventucopa Uplands from the Main Zone, the Main Zone from the Cottonwood subarea and the Cottonwood subarea from the Santa Maria Groundwater Basin. The suggested base period does not span one or more of the major climatic cycles know as the Pacific Decadal Oscillation (PDO), nor does it include the major period of dewatering of the basin in the 1970's & 1980's when much of the groundwater storage was lost. (see USGS, Cuyama Valley, California Hydrologic Study: An Assessment of Water Availability)	This will be addressed in later chapters.
3	2.1	Global			In order to better serve as a tool for stakeholder outreach and communication it would be necessary to more adequately "provide often highly-technical information in a format more easily understood to aid in stakeholder outreach and communication of the basin characteristics to local water users" (DWR). This should include a graphic three dimensional interpretation of the Basin characteristics. "The breadth and level of detail of the basin conditions should be sufficient to capture long-term changes in groundwater behavior" (DWR). I find there to be a deficiency of detail in this regard. I will provide examples in the specific comments below.	3D graphic will be included in the Basin Model and Water Budget section. There is a general deficiency in detail about Cuyama geology.
4	2.1	Global			Data Gaps that are not mentioned include information about: - Santa Barbara Canyon Fault - pumpage data - Stream-flow gauge on the Cuyama River - Seasonal land use practices like frost protection and drench leaching for salinity, varieties of irrigation methods, multiple cropping's in the same year on the same field - Discrepancies between where water is extracted and where it is applied such as the well at Bell and Foothill roads that pumps groundwater for several miles eastward across the Rehoboth Fault	The Data Gaps section of the HCM has been updated. Some of these items will be addressed in the Groundwater Conditions section.
5	2.1	Global			Subsidence data is not mentioned	Subsidence will be discussed in the Groundwater Conditions Section
6	2.1	Global			There is no Groundwater Elevation Contour Map	Groundwater elevation contour maps will be presented in the Groundwater Conditions Section
7	2.1.10	Global			Not all of these citations are from published sources that are considered Peer Reviewed Journals. There should be a consistent citation format that could make that distinction. How will QC/QA be addressed? Some USGS citations are incorrect. The format is inconsistent and some citations are missing. Here are a few examples: Deeds, D.A., Kulongoski, J.T., Mühle, J., Weiss, R.F., 2015, Tectonic activity as a significant source of crustal tetrafluoromethane emissions to the atmosphere: Observations in groundwaters along the San Andreas Fault: Earth and Planetary Science Letters, Vol. 15, pp. 163-172. (https://doi.org/10.1016/j.epsl.2014.12.016) Everett. R.R., Hanson, R.T., and Sweetkind, D.S., 2011, Kirschenmann Road multi-well monitoring site, Cuyama Valley, California Hydrologic Study: An Assessment of Water Availability, Fact Sheet 2014-3075, 2014 Cuyama Valley, Santa Barbara County, California: U.S. Geological Survey Open-File Report 2011-1292, 4 p. (http://pubs.usgs.gov/of/2011/1292/) Everett, R.R., Gibbs, D.R., Hanson, R.T., Sweetkind, D.S., Brandt, J.T., Falk, S.E. and Harich, C.R., 2013, Geology, water-quality, hydrology, and geomechanics of the Cuyama Valley groundwater basin, California, 2008–12: U.S. Geological Survey Scientific Investigations Report 2013–5108, 62 p. Gibbs, D., 2010, Cuyama Groundwater Basin: Department of Public Works, Santa Barbara County, 8 p. Hanson, R.T., Flint, L.E., Faunt, C.C., Gibbs, D.R., and Schmid, W., 2014, Hydrologic models and analysis of water availability in Cuyama Valley, California: U.S Geological Survey Scientific Investigations Report 2014–5150, 150 p., http://dx.doi.org/10.3133/sir20145150. Hanson, R.T., and Sweetkind, D.S., 2014, Water Availability in Cuyama Valley, California: U.S. Geological Survey Fact Sheet FS2014-3075 4p. Hanson, R.T., Boyce, S.E., Schmid, Wolfgang, Hughes, J.D., Mehl, S.M., Leake, S.A., Maddock, Thomas, III, and Niswonger, R.G., 2014, MODFLOW-One-Water Hydrologic Flow Model (OWHM): U.S. Geological Survey Techniques and Methods 6-A51, 122 p. (http://pubs.usgs.gov/tm/tm6a51/) Parsons, M.C., Kulongoski, J.T., and Belitz, Kenneth 2014, Status and understanding of groundwater quality in the South Coast Interior groundwater basins, 2008—California GAMA Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2014–5023, 68 p., http://dx.doi.org/10.3133/sir20145023. Mathany, T.M., Kulongski, J.T., Ray, M.C., and Belitz, Kenneth, 2009, Groundwater-quality data in the South Coast Interior Basins study unit, 2008: Results from the California GAMA program: U.S. Geological Survey Data Series 463, 82 p. Available at http://pubs.usgs.gov/ds/463. Sweetkind, D.S., Faunt, C.C., and Hanson, R.T., 2013, Construction of 3-D geologic framework and textural models for Cuyama Valley groundwater basin, California: U.S. Geological Survey Scientific Investigations Report 2013–5127, 46 p.	The reference list was reviewed and updated.

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8	2.1.10				I understand the great pressure that the Woodard & Curran team is under to satisfy the statutory deadlines presented by SGMA. This is a complex and convoluted Basin a long way from Sacramento and under these circumstances information is hard to acquire and verify with ground truthing given the time constraints. For those of us living and working in Cuyama this is more than a little frustrating. However, this document is meant to provide a current and historical picture of groundwater dynamics in a conceptual framework that can be used to understand the issues as they relate to a sustainable future. As such it needs some additional data and narratives. A 3D graphic is missing. A description of the changes to GDEs, water quality & availability due to groundwater extraction in recent history is needed. How, why and for how long has Cuyama been considered a critically over-drafted basin?	Please note that this is only one section of many that is devoted to describing groundwater conditions in the Basin. The 3D graphic (and model) will be discussed in Section 4 (Basin Model and Water Budget) The Groundwater Conditions Section will discuss: GDEs Water quality Groundwater availability Historical groundwater storage & use
9	2.1.3	Global			It would be very helpful to maintain some consistent descriptive format. Some formation descriptions lack important information that is provided for the others. In particular their water bearing relevance to the Basin or its boundaries and to the model itself would be good to include in each formation description. Some do, some don't.	The inconsistency in description formats, particularly for the faults, is a result of the discrepancies in the amount of data and reports. Some faults are well studied and have numerous resources to cite while others (like the Morales fault) lack information.
10	2.1.4	3	6	The syncline has folded water and non-water bearing formations...	Descriptions of structural features (i.e. faults & synclines) should be more consistent in format with more reference to their relevance to the hydrology in general. For example if the Cuyama Syncline "is favorable to the transmission of water from the southeast end of the valley" why would it then have "no pronounced effect on the occurrence of groundwater in the basin"? The syncline near Santa Barbara Canyon Fault has little or no description of its relevance to groundwater movement. If its occurrence is significant but its relevance is unknown this should be noted as a data gap for further investigation.	Noted. Will discuss details of tectonic features in Data Gap section.
11	2.1.4	10	1	Due to the lack of a consensus as to	I appreciate the last paragraph of the Russell Fault description for its acknowledgment of the known-unknowns of this formation with respect to its permeability to groundwater flow. This honesty is refreshing and should be encouraged elsewhere. It is at least as important to identify what we don't know as to acknowledge what we do.	Noted.
12	2.1.4	18	5	The fault is considered a barrier to	What is the significance of the Santa Barbara Canyon Fault being a barrier to groundwater flow? "The SBCF was not represented as a barrier to flow in the younger alluvium in the model cells that represent the Cuyama River channel in the CUVHM"(D.Gibbs). How might this impact the Model or Budget? What more would we need to know about the fault to adequately address the management decisions to come? How can we discover what it is we need to know?	The USGS in 2013 also concluded that the SBCF was a barrier to groundwater flow: "Relatively small amount of vertical offset in the SBCF indicates changes in water levels across the fault documented in previous studies are perhaps the result of distinct fault-zone properties rather than juxtaposition of units of differing water-transmitting ability" (USGS, 2013a).
13	2.1.4	20	1	The Morales fault is a 30-mile....	The Morales Fault is used as the northern boundary of the Basin but very little is mentioned as to its type, or hydrologic permeability. Is its only relevance and justification for being a boundary that it was used as such in the bulletin 118?	Because the Morales Fault bounds the basin sediments and basement rocks. Basement rocks are impermeable. Impermeable rocks are a basin boundary.
14	2.1.4	last paragraph	4	The presence of these non-aquifer materials in this area....	As for the outcrops of bed rock in the western part of the Basin; how can we quantify that the outcrops "likely restricts groundwater movement by limiting the extent of permeable materials in this portion of the basin"? Again, how can we learn what we need to know to understand this impact on the model and water budget as a whole?	The characteristics of the formations in the outcrops indicate that they are non-water bearing. They could be further studied with well installation and pump testing to improve understanding of their permeability.
15	2.1.5	2			Not all of the faults being used to set the Basin's Lateral Boundaries have been described as impermeable to groundwater flow. Is it important to provide any supporting science behind the Bulletin 118 delineation? Might there be some issues here like the fingers that are in the Basin but outside of the watershed and boundary faults that may or may not constitute barriers to groundwater flow?	Because the faults bound the basin sediments and basement rocks. Basement rocks are impermeable. Impermeable rocks are a basin boundary.
16	2.1.5	5	1	The bottom of the Cuyama Basin...	Please cite the claim "the bottom of the Cuyama Basin is generally defined by the base of the upper member of the Morales Formation".	A citation has been added.
17	2.1.5	Global			Be consistent when referring to the aquifer. It is defined as ending at the upper member of the Morales Formation but throughout the section the entire Morales Formation is referenced as the aquifer	A sentence has been added at the beginning of the section clarifying that when referring to the aquifer, we are referring to alluvium layers through the top of the Morales Formation.
18	2.1.6	1	5	There are no major stratigraphic....	How can you claim "There are no major stratigraphic aquitards or barriers to groundwater movement, amongst the alluvium and the Morales Formation", and then describe those formations as "consisting of interbedded layers of sand and gravel and thick beds [of] clay ranging from 1 to 36 ft."? That 2nd description defines an aquitard and is evidenced by the many "exceptions of locally perched aquifers resulting from clays in the formations." These clays and aquitards have profound effects on the lateral and vertical movement of groundwater within the Aquifers. I cannot believe that "the aquifer is considered to be continuous and unconfined" in the presence of so many thick clay layers! How can this inconsistence be reconciled?	There are no continuous clay layers that cover a large area of the Basin in the reviewed literature. Individual clay lenses are not considered a regional aquitard. The extent and nature of clay lenses is not well understood in Cuyama and could be investigated as a data gap.
19	2.1.6	9	3	Using aquifer tests from 63 wells...	This is also evidenced by the "estimates of horizontal hydraulic conductivity ranging from 1.5 to 28 feet per day (ft/d)". That's quite a range to be considered unconfined, and would render the average and/or median values to be statistically irrelevant. The wide ranges in the estimates for all the Aquifer Properties show the great variability of groundwater movement within the aquifers due to these aquitards. How will the mathematical model and the budget handle this kind of spatial differentiation?	Discussion of model and water budget methodology will be discussed in the Water Budget & Basin Model Sections
20	2.1.6	Figure 2-12			This map shows that there are no Aquifer Test Wells anywhere in the Ventucopa Uplands south of the SBCF. This data gap contributes to a lack of understanding of the Ventucopa area, the region responsible for most of the groundwater recharge into the main basin. Similar data gaps exist for Cottonwood area west of the Russell Fault. How will these gaps be addressed before developing the Model and Budget?	How aquifer tests (or lack thereof) will be used in the groundwater model will be described in the Basin Model section. The limited amount of conductivity data will be identified as a data gap that can potentially filled by studies at the direction of the GSA in the future.
21	2.1.6	Figures 2-8 to 2-11			These cross sections need a legend and should trace the current & historic groundwater levels similar to the way the USGS did with their cross sections. The cross sections should also indicate where one intersects another and should show the locations of the major faults and synclines as they intersect these sections as shown in the USGS charts of the same cross sections. If these cross sections are from the USGS Study why are they redacted and without citations?	The cross sections have been updated.
22	2.1.7				No reference is made of the USGS GAMA reports and related sampling. No discussion of age dating, tritium isotopes, or trace metals. Can the historical data from Singer and Swarzenski (1970) be compared to the more current data by Hanson et al (2013) as part of the USGS Cuyama studies and the GAMA project to provide the relevant water quality trends? Why is the age dating data ignored as it relates to poor water quality and the lack of recent recharge?	Additional discussion of water quality (including historical water quality and age dating) is discussed in the Groundwater Conditions section.

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23	2.1.8	3			The USGS Geochemistry and isotope dating indicate little to no recharge in the Cuyama Main Basin. Deep percolation of artificial recharge from inefficient irrigation practices is additionally hampered by clay layers, distance to the zone of saturation and compaction due to dewatering and subsidence. Consequently looking at soil properties from the SAGBI database may not be representative of the subsurface properties that potentially control recharge and runoff. How can this potentially high margin of error be verified?	If a groundwater recharge program is selected by the GSA, further study will need to be conducted as part of the program.
24	2.1.8	3			No mention is made of the many Groundwater Dependent Ecosystems; springs, seeps and wetland meadows. Historical evidence should be presented and current conditions quantified for these groundwater discharge areas. How or where will they be presented?	GDEs will be discussed in the Groundwater Conditions section. Available spring reference material was presented in Figure 2-16.
25	2.1.8	3 & 4		Surface Water Bodies & Areas of Recharge	A more complete description of the surface water activities, with regards to runoff & recharge throughout the basin is needed.	Surface water (including runoff and recharge) will be discussed in further detail in the Water Budget section.
26	2.1.8	3 & 4		Surface Water Bodies & Areas of Recharge	How can we evaluate and determine the volume or rate of surface water depletion as it relates to groundwater extraction? An evaluation of the uncertainties and the margins of error within the data sets and HCM components will be needed before any assumptions can be made by using them in the Model or Budget.	Surface water will be discussed in further detail in the Water Budget section.
27	2.1.8	Figure 2-16			This map does not reflect the "approximately 25 miles of the eastern portion of the Cuyama River [that] is categorized as a wetland by the U.S. Fish & Wildlife Service's National Wetlands Inventory". Where is that data being presented? What about the remaining 75% of the valley including the river channel and rangelands? How will recharge be calculated for the majority of the Basin?	Recharge will be discussed in the Water Budget Section. Wetlands will be further discussed in Groundwater Conditions.
28	2.1.8	Figure 2-15			This map and the supporting text do not include many of the major contributing drainages that we have been talking about: Apache Canyon, Ballinger Canyon, Salisbury Creek, Branch Canyon, Alisos Canyon and Cottonwood Canyon. There are also many artificial standing bodies of water pumped from the groundwater that are used for irrigation, frost protection and salinity abatement. They should be adequately described as part of the HCM. How will these surface waters be routed into the groundwater Model and the Water Budget?	A location map will be developed, surface water is a part of the water budget.
29	2.1	Global			Does is meet the requirements for SGMA and help address the DWR BMP's: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_HCM_Final_2016-12-23.pdf	The GSP will be compliant with Regulations and will consider the BMPs, as appropriate.
30	2.1.1				Suggestion labeling all the faults mentioned or approximate location on a separate figure. Cuyama is complex and a visual map would help.	Please see Figure 2-6
31	2.1.2				Suggestion labeling all the faults mentioned or approximate location on a separate figure. Cuyama is complex and a visual map would help.	Please see Figure 2-6
32	2.1.2				Label ranges that are mentioned in the text.	Please see Figure 2-1
33	2.1.6	Figure 2-12			I suggested adding another figure and showing the location of the areas with Bulletin 118	The Basin boundary has been overlain over the USGS map
34	2.1.3	Figure 2-3			Add timeline scale under Epoch, such as Holocene approx. 11,700 years	A timeline scale has been added to Figure 2-3
35	2.1.6	Figures 2-9 to Figure 2-11			Figures 2-9 to 2-11: Add legend: formation type, location markers to help the public, fault names, etc.... Please discuss what these figures mean.	These cross sections have been removed. Revised versions will be included in a later draft.
36	2.1.3	4	4	The older alluvium is	Label on map (TTRF & GRF)	Please see Figure 2-6
37	2.1.3	6	8	The Morales Formation	Label on map - Cuyama Badlands	Please see Figure 2-2
38	2.1.3	8	2	Layers of volcanic ash	Label on map - Caliente	Follow-up. May consider labeling geologic units on the figure.
39	2.1.3	Figure 2-2			Label on map - La Panza and Sierra Madre ranges	No change made to map because these ranges are located outside of the Basin.
40	2.1.3	Figure 2-2			Label on map - Cuyama Badlands and La Panza Range	No change made to map because these ranges are located outside of the Basin.
41	2.1.4	22	3	Outcrops of basement	Suggest to add a footnote to help explain to the public what this is.	The text has been revised.
42	2.1.4	8	1	The highest yielding wells	Not sure if this is for the main basin or basin wide, I suggest clarifying it up front. If basin -wide add the methodology and/or assumptions of how this is projected to the entire basin, such as hydraulic conductivity is from 63 wells in one basin section, so how does this reflect the entire basin with all of the differing geology: faults, formations, and etc...	A description of conductivity that is available currently has been added.
43	2.1.4	12	2	Using aquifer tests from 63 wells...	How was this determine, maybe showing the formula to explain in a footnote?	This is referenced from USGS, 2013c who did not reference their calculations
44	2.1.4	12	6	Wells screened in both	Similar to older alluvium, I suggest adding an explanation for the similarity.	This is a USGS, 2013c interpretation and was made by them, based on their work.
45	2.1.4	12	7	Using groundwater level	values are highest in the central portion of the valley and decline to the west because (geology/faults, etc.....)	The text has been revised for clarification
46	2.1.7	4	2	In 2013, the USGS	Suggest adding a footnote to define the primary and secondary MCL's for the public.	The text has been revised for clarification
47	2.1.8	Figure 2-15			Add recharge and discharge map with labels, seeps, and etc.	Springs and seeps are mapped in Figure 2-16
48	2.1.8	5	Global	Areas of Recharge	Add water budget	This will be discussed in the Water Budget section
49	2.1.3	Figure 2-2			So, essentially the only map we have of the basin formations is from T. Dibblee?	No. Multiple maps were reviewed during HCM development. The Dibblee map was selected for the figure due to its robust detail.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
50	2.1.4	8	3	Water bearing units on the western	What does this mean: "Water bearing units on the western (upthrown) side of the Russell fault are thinner than the water bearing units to the east of the Russell fault due to this uplift"?	The fault has offset deposits so that one side is thicker than the other.
51	2.1.4	14	6	Evidence of the faults and their no-flow boundaries	The Singer reported that water was slow to replenish along the faults - was based on what?	The Singer report did not state why.
52	2.1.4	Figure 2-6			Will consideration be given to minor faults?	Where data is available regarding the nature of faults, they are/will be considered in the GSP.
53	2.1.5	Figure 2-8			Yes, this map was released in June 2012 but some notation should be made of when it was drawn. So this is the best map you have? What do the colors represent? It is highly likely that this map was drawn even before the basin boundaries were established. So this is the best information and most recent info available?	Multiple maps were reviewed during HCM development. The Dibblee map was selected for figure use due to its robust detail. The legend from Figure 2-2 was added to Figure 2-8.
54	2.1.5	Figures 2-9 - 2-11			Are these maps a continuation of Figure 2-8? It is unclear how these maps relate.	These cross sections have been removed. Revised versions will be included in a later draft.
55	2.1.8	6	3	SAGBI provides an index for groundwater recharge for....	The info from the Soil Ag Groundwater Banking Index seem rather unnecessary in an area where an annual rainfall rarely is enough to reach past plant roots, unless you plan on collecting flood water which I thought had already been examined by Twitchell.	Aquifer recharge options will be considered as part of the Actions and Projects evaluation.
56	2.1.4	20	2	The Morales thrust fault *as* a dip of approximately	I know what a dip is - does this mean 30 degrees?	Text is revised to state "The Morales thrust fault has a dip of approximately 30 degrees."
57	Global				We already have subsidence, which means that certain areas will not recharge. So how is water getting below those compacted levels to recharge the aquifers the deep wells are drawing from? It would seem that the water that does not run off the surface or is absorbed by the plants would run downhill on top of the impermeable layers, i.e. in a generally westward pattern away from Cuyama Valley, NOT down into the aquifer.	Noted. No change needed to HCM.
58	Global				What is the definition of "successful implementation of the GSP." Population growth in the rest of the county has nothing to do with population growth in Cuyama Valley unless some small, non-polluting company decided to move here and create employment for local people. That appears to be unlikely unless the county has a plan to attract people who want to live here, rather than extractive Big Ag commuters. With 35 students in the high school this coming year, we're certainly not going to attract families any time soon.	Successful implementation of the GSP is determined by the GSA with input from the stakeholder advisory committee and local stakeholders.
59	pg. 5				pg. 5 - Does Old Cuyama no longer have a well?	Unknown.
60	2	2	1	Hydrogeologic Conceptual Model	The "Best Management Practices (BMP) for the Sustainable Management of Groundwater: Hydrological Conceptual Model" document fundamentals indicate that a HCM can be used for "stakeholder outreach and communication". Without clear explanations, a glossary, definitions, clear citations, the document in its current form has limited use in stakeholder outreach and communication. Further, the BMP document recommends that the HCM for a basin's GSP should include a 3-D model of the basin. The draft HCM for the Cuyama Basin does not include such a model.	The GSP will be compliant with Regulations and will consider the BMPs, as appropriate.
61	2.1	Global			All data submitted by non-public entities should be noted assuch and flaggedin the HCM and throughout the final GSP. Their contributions (data, input, maps, quotes) to the GSP should be noted as provided by entities that are affiliated with a private interest in the valley. Further, the HCM and the GSP should contain a listof all non-publicagencies that have submitted data, with notations on their affiliations. Specifically, Cleath-Harris is affiliated with the North Fork property; EKI is affiliated with the Cuyama Basin Water District.	Data and knowledge about the geology in this Basin is deficient in details. Any available data or reports were reviewed and formally cited if used.
62	2.1	Global			All maps and charts that do not include data from the current 850 acres of North Fork planting should be flagged and noted as not including the current planting and wells drilled.	The HCM is limited to geology. Comment noted for other sections.
63	2.1.4	4	1	There is a syncline in the western	It should be noted that this information has not been verified through independent review and has been provided by an entity affiliated with a grower that has vested interest in outcomes that may result from including this information in the HCM and the GSP.	Comment noted. A link to the referenced document has been provided in the references section of the HCM section.
64	2.1.4	6	1	The Russell fault is a subsurface	According to Sweetkind et al., the Russell Oil Field is located at the western edge of the valley, not "in the center of the main basin". If the location is referring to "center" on a north-south axis, please state as such.	The text has been revised.
65	2.1.4	21	1	A fault located southwest of the Russell	Refer to #1 above. This material appears to have been provided by Cleath-Harris. Please include citation, and flag that this information has not been verified by an independent, public entity.	Comment noted. A link to the referenced document has been provided in the references section of the HCM section.
66	2.1.5	4	2	The lower member of the Morales Formation is composed of clay..	As noted in 2.1.10 References of the Draft HCM, the Cleath-Harris study "Groundwater Investigations and Development, North Fork Ranch, Cuyama, California" did not appear to address the main basin. Is this citation correct? Or should an earlier reference be cited?	Citation has been revised.
67	2.1.6	10	3	The dewatered alluvium has an average specific yield of 15 percent	The wide ranges of specific yield appear to be problematic in estimating an average specific yield of 15%. Please note how these wide range will be addressed.	How conductivity reference information will be used in the groundwater model will be described in the Basin Model section.
68	2.1.6	10	3	The dewatered alluvium has an average specific yield of 15 percent	Please explain why the HCM refers to a specific yield cited in 1970, yet, as written, seems to imply that the average specific yield is correlated to data noted by the USGS 35 years later. If this is a sound hydrogeological practice, please elaborate	Properties of the subsurface geology do not change over time, because subsurface materials (sand, silt, rock) do not move.

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69	2.1.7	4	1	In 2013, the USGS collected groundwater from 39 wells and two...	Before submitting the GSP, these readings should be updated at minimum to 2018, five years following the initial readings, and that these readings should be taken at regular intervals going forward. Please state in the text how and when these readings will be updated.	Additional groundwater quality information will be included in the Groundwater Conditions section. A field study on groundwater quality could be chosen by the GSA as a plan action. GSP development does not include field work due to budget and time constraints.
70	2.1.7	5		Groundwater is used primarily for irrigation.	This statement should be updated to include the North Fork plantings. Further, in section 4€ of the GSP emergency Regulations (https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GSP_Emergency_Regulations.pdf), pg. 14 states that the HCM shall include the following regarding the aquifer/aquitards: "Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply." While not 'primary' use, the description above does not include domestic and municipal use by the CCSD.	The statement has been revised to also discuss domestic and municipal uses and add a statement regarding irrigation in the west, along the river.
71	2.1.10				An additional suggested reference is "Tertiary Tectonics and Sedimentation in the Cuyama Basin, San Luis Obispo, Santa Barbara, and Ventura Counties, California, Book 59, April 1988" http://www.worldcat.org/title/tertiary-tectonics-and-sedimentation-in-the-cuyama-basin-san-luis-obispo-santa-barbara-and-ventura-counties-california/oclc/19296307	Noted. We will review this document.
72	2.1.2	Figure 2-1			This figure states that faults were obtained from the Dept of Conservation webpage yet there are many faults on the figure which are not part of the interactive map. If there are other sources for the faults they should be listed.	Second source of fault information was added to figure.
73	2.1.4	9	4	In 2015, the USGS identified the Russell fault as a barrier to flow...	This is not accurate. The fault was used as a no-flow boundary for the sake of model computation. It was never identified as a barrier; in fact, it is identified in the publications as not being a barrier to groundwater flow. The wording in this instance is misleading needs to be reconsidered.	The USGS has contradicted itself in its characterization of the Russell fault across multiple reports.
74	2.1.4	9	5	Based on the conclusions of the...	My observation is that this ["Standing moisture near the fault.."] is all Green Canyon flow from Caliente Ranch	Noted. No change needed to HCM.
75	2.1.4	9	6	In addition, Cleath-Harris....	This document should be made available for review by members of the Technical Forum	Comment noted. A link to the referenced document has been provided in the references section of the HCM section.
76	2.1.4	9	1		Is this illustrated in Figure 2-6?	Yes, the fault is shown in Figure 2-6.
77	2.1.6	4	2	The recent and younger alluvium is the primary source of groundwater...	Appears to be referencing much older publications when younger alluvium actually was the primary source of groundwater on the western side of the basin. Now there are 850 acres of vineyard and wells as deep as 900 feet. (primary pumping wells ranging from 450 to 730 feet).	Noted. No change needed to HCM.
78	2.1.6	Figures 2-9 to 2-11			Figures 2-9 through 2-11 need a legend, showing what formation each unit represents.	These cross sections have been removed. Revised versions will be included in a later draft.
79	2.1.8	3	5	Peak flows through the Cuyama River	Reference to peak flows. What gage and where is it? Upstream Ventucopa gage (period of record?) or downstream Buckhorn gage 15+ miles outside of the basin?	Gages were shown in the Plan Area section and more surface water data will be part of the Water Budget Section.
80	2.1.4	Global			This looks very good to me. I applaud the choice to verify fault barriers to water flow by well monitoring and not to rely on theoretical modelling of the geology. The modelling that has been done is understandably biased by the interests of a major user who has also employed two of the consultant firms listed as having modelled these faults and their impacts. This needs to be publicly disclosed in the interest of transparency.	Noted. No change needed to HCM.
81	2.1.4	Figure 2-6			Fault maps on pages 6 and 16 show the Whiterock/Russell Fault zone as a broken line, which does not match the continuous lines used on the maps.conservation.ca.gov (referenced source) or the map on page 13 or Dibblee's map on page 20.	The Russell fault line on a map is indicative of the fault's general area. The figure is revised to show a continuous line.
82	2.1.6	Figures 2-9 to 2-11			Pages 24 and 25: Cross-section A-A' crosses the bedrock high's mapped by Dibblee and DeLong, which are shown on page 20. The page 25 interpretation incorrectly leaves bedrock far below the surface. If this cross section was meant to cross the river bed, it is not based on available data as permeable sediments average only the top 50 feet below the surface across this section of the fault zone.	These cross sections have been removed. Revised versions will be included in a later draft.
83	2.1.3	2	6	The deposits thicken to the east; typically ranging from 5 to 50 feet...	The younger and recent alluvium are the principal water-bearing formations in the Cuyama Basin. Since the alluvium is so much thinner on the western portion of the valley, would this not imply that the actual amount of stored groundwater would be much less, and that any calculations (for example the estimate of the amount of water in the Cottonwood sub-area where Harvard's vineyard is located) of how much actual groundwater is available needs to be verified?	Water budget details will be prepared in the Water Budget Section.
84	2.1.3	6	7	In 1970, Singer and Swarzenski reported the Morales Formation....	It is unclear to what extent and which faults are being called into question as limiting the lateral extent of the Morales Formation. For some faults there is good data on this limiting effect, and on others it is unclear or disputed (for example the Russell Fault), and for others, how much depth of the Morales Formation there might be over some of the more inactive faults.	Noted. No change needed to HCM.
85	2.1.3	12	3	To the east, the Vaqueros Formation grades into the lower	What about the so-called Vaqueros outcrop near the confluence of Cottonwood Creek? There is no evidence that this outcrop is part of a continuous below-ground formation, or an isolated uplifted portion of the formation that is now independent of the below ground material.	Noted. No change needed to HCM.
86	2.1.3	Figure 2-3			The figure seems to represent the upper member of the Morales Formation to only be made up of gravel conglomerate. Our understanding is that it is actually layered sediments that include gravel, but also layers of silt, clay, and sand, more like the lower member. Is this true?	Noted. Sedimentary rock is typically deposited in layers.

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87	2.1.4	5	1	There is a syncline in the western portion of the basin.......	This citation is from unpublished, non-peer reviewed work produced for a stakeholder with specific interests. If this information is to be part of the HCM it needs to be made publicly available and peer reviewed, or stated that it is not.	Comment noted. A link to the referenced document has been provided in the references section of the HCM section.
88	2.1.4	5	2	The full extent of this syncline....	Presence or absence of this extension needs to be ground-truthed.	Field study could be chosen by the GSA as a plan action to fill data gaps. GSP development does not include field work due to budget and time constraints.
89	2.1.4	9	5	Based on the conclusions of the USGS, Dudek stated that the fault...	It should be noted that DWR rejected the boundary modification based on conflicting scientific evidence that claims that the Russell Fault is buried under at least 1000 feet of Lower and Upper Alluvium and Morales Formation, all of which are water bearing and probably allowing permeability at the Fault. This should be mentioned in the HCM draft.	Discussion of the DWR's rejection of the basin boundary modification has been added to the text.
90	2.1.4	9	6	In addition, Cleath-Harris determined that the..	For all information submitted by Cleath-Harris: This is cited from unpublished, non-peer reviewed work produced for a stakeholder with specific interests. It is also in conflict with the previous comment we make above.	Comment noted. A link to the referenced document has been provided in the references section of the HCM section.
91	2.1.4	9	1	The Russell fault has been analyzed	Furthercomment on Russell Fault: The fault has been inactive for 4 million years and since then has had 1000 feet of deposition of Morales formation on top of it of which several strata are water bearing. Agricultural wells on both sides of the fault are less than 1000 feet deep. Hence, there is a high likelihood of water movement in both directions above the fault. (Citation: Yeats, R.S., J.A. Calhoun, B.B. Nevins, H.F. Schwing, and H.M. Spitz. 1989. Russell Fault: Early Strike-Slip Fault of the California Coast Ranges. The American Association of Petroleum Geologists Bulletin. Vol. 73 (9): 1089-1102.) Therefore we agree with the conclusion for further investigating that needs to include the strata on top of the Fault. This could be an appropriate area for more test wells.	Noted. We will review this document.
92	2.1.4	21	1	A fault located southwest of the Russell fault runs southeast....	This is lacking a citation.	Text as been revised to include a citation
93	2.1.4	21	1	A fault located southwest of the Russell fault runs southeast....	Please include: There is no evidence that this Fault is a barrier of water flow from south to north and no evidence that it prevents water use in the north from impacting wells to the south, especially in the Cottonwood Canyon area.	Preexisting reports disagree about the fault's nature and the fault's characteristics to flow are considered a data gap.
94	2.1.4	Figure 2-7			Is this figure included in the draft? What is the source of this figure?	Yes, Figure 2-7 is included in the draft - data sources are listed in the top left corner.
95	2.1.4	last paragraph	4	The presence of these non-aquifer materials in this area....	There is no hydrologic data to back this up, so it is important to not infer any attributes of permeability.	The characteristics of the formations in the outcrops indicate that they are non-water bearing. They could be further studied with well installation and pump testing to improve understanding of their permeability.
96	2.1.5	5	2	The lower member of the Morales Formation is composed of clay....	If Cleath-Harris is citing work done by other authors, those authors should be cited as the original source of the information. Also, since the cited Cleath-Harris study is an unpublished, private report prepared for stakeholders with interests in access to water in the Cuyama Valley, it needs public vetting and validation from other experts in the field before being given any weight in the HCM.	Noted. This document will be made publicly available.
97	2.1.5	5	4	The top of the Morales Formation...	This infers that everything above 750 feet at a minimum is potentially water bearing sediments. Is this correct?	The Morales Formation thickness is variable.
98	2.1.6	9	3	Using aquifer tests from 63 wells...	Does this vary seasonally and/or from wet year to dry year?	Conductivity is not connected to above ground seasons.
99	2.1.6	10	4	The USGS estimated the specific...	It is not clear what these yield numbers mean. Are they a percent? Why is the value for dewatered alluvium a percentage, and the ranges for recent alluvium not listed as percentages? How does the dewatered yield relate to these ranges?	Text has been revised for consistency.
100	2.1.6	Figures 2-9 to 2-11			Comment: What is A-A', B-B', C-C'. It would be helpful for the figures to have captions. Where are the faults on these sections and the differentiation between upper and lower Morales?	These cross sections have been removed. Revised versions will be included in a later draft.
101	2.1.6	Global			Within this section there is no mention of aquitards. It is important to know about aquitard presence especially clay layers in the Morales since they can significantly restrict water movement.	There are no continuous clay layers that cover a large area of the Basin in the reviewed literature. Individual clay lenses are not considered a regional aquitard. The extent and nature of clay lenses is not well understood in Cuyama and could be investigated as a data gap.
102	2.1.6 & 2.1.7	Figures 2-12 & 2-13			It would be helpful to clarify what the boundary line is in these figures. It appears to exclude the western portion of the Basin. If the drawn boundaries are not aligned with Bulletin 118 boundaries, can that be overlayed?	Basin boundary has been overlain over the USGS map
103	2.1.6 & 2.1.7	Figures 2-12 & 2-13			Water quality sites appear to be lacking in both the western and eastern portion of the Basin.	Noted. There is very limited data in these areas.

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104	2.1.7	4	1	In 2013, the USGS collected groundwater from 39 wells and two...	All of these constituents need to be monitored over time, especially nitrates. Since one of the proposals for increasing recharge rates is through percolation through ag land use, these soils which will most likely continue to increase nitrate levels even from organic farming.	Additional groundwater quality information will be included in the Groundwater Conditions section. A field study on groundwater quality could be chosen by the GSA as a plan action. GSP development does not include field work due to budget and time constraints.
105	2.1.7	5	2	The majority of agricultural activity	This statement does not take into account the new intensive viticulture in the western portion of the Basin.	The text has been revised to include western area.
106	2.1.8	3	3	The river is perennial with most dry seasons	Based on historic records of streamflow we know that year-round surface flow has become rare, especially in dry years. Even in normal years, the Cuyama River no longer has surface flow all year. The loss of riparian vegetation is a good indication of the reduction of perennial streamflow. We think this change should be mentioned.	Surface water flows will be discussed as part of the historical Water Budget.
107	2.1.8	3	5	There are approximately four main....	Wells Creek should be changed to Aliso Creek	Wells Creek has been renamed Aliso Canyon Creek
108	2.1.8	4	2	Downstream on the Cuyama River	Twitchell Reservoir is completely dry in most summers and completely dry all year during drought years, demonstrating how limited surface stream flow is for the entire Cuyama River. This should also be included.	Surface water flows will be discussed as part of the historical Water Budget.
109	2.1.8	Figure 2-15			Wells Creek should be changed to Aliso Creek	Wells Creek has been renamed Aliso Canyon Creek
110	2.1.2	4	5	Thrust and compression continued..	Comment: Thrusting reactivated older faults, particularly in the western basin. The upper and lower Morales are unconformable (percom with E&B Natural Resources and Ellis 1994), visible in seismic lines available in Ellis 1994 thesis. Lower Morales is fine grained, and generally predates or dates to very early compressive stage. The low gradient in the system leads to deposition of finer grain size material. As compression begins/continues you get first uplift and erosion (the unconformity) followed by coarser-grained deposition of Upper Morales as slopes increase (mountain range rise). Upper Morales often shows some degree of angular unconformity as well. Studies have also looked at composition and sources of gravels in Morales (Ellis 1993,???) which help firm up this timing. The western valley shows extensive Morales deformation, particularly echelon folding as was noted by Nevins, 1983, Schwing 1984, Calhoun 1985.	Comment noted. Thank you. No change needed in HCM.
111	2.1.3	4	5	Older alluvium is typically 400...	Comment: Western area is more gypsiferous than east of Russell. Add citation/description from DeLong of this unit for western area as cited paper does not address this area. See also Hill 1958.	Comment accepted. Description from DeLong and Hill, etc. has been reviewed and incorporated as appropriate.
112	2.1.3	6	4	The contact between the upper...	Comment: Older alluvium is much thinner than this in the Western Valley (much less than 100' typically). The USGS 2013a report did not address the western valley. When using this report to address generalized conditions for the valley, generalizations are often not applicable west of the Russell fault (out of the report study area). This means that if this source is used, western valley needs to be addressed separately.	Comment accepted.
113	2.1.3	6	4	The Morales is massively bedded...	Comment: This paper is East of the Russell fault only. There are areas in the western basin where Morales is less than this, particularly near the western boundary.	Comment accepted. Text has been revised per the USGS report extent.
114	2.1.3	9	6	The formation underlies the....	Comment: Unconformably underlies the Morales Formation (unconformity reported by Hill et al. 1958). Other marine units unconformably underlie Morales Fm. in the western area as well based on Dibblee, Hill, DeLong, etc..	Comment accepted. Description from DeLong and Hill, etc. has been reviewed and incorporated as appropriate.
115	2.1.3	--	Figure 2-3	--	Comment: Should be an unconformity between Upper and Lower Morales. In most of the valley this unconformity is buried. It is not highly apparent in well logs, but is very obvious in seismic sections. As most papers have addressed only well log data, this is not widely reported. See seismic sections for the Eastern Valley (in Ellis 1994).	Comment accepted. Description of upper/lower Morales unconformity and reference has been added to the text per Ellis 1994.
116	2.1.4	4	2	The full extent of this syncline....	Comment: Dibblee mapped back in the 1940's and 1950's in this area, John Minch did the editing and digitization around and after Dibblee's death in 2004. Minch is the editor, not the mapper.	Comment accepted. Citation has been edited to refer only to Dibblee.
117	2.1.4	8	3	The USGS in 2013 studied the fault...	Comment: InSAR report notes that deformation did not extend far enough west to be truncated by fault (insufficient data). They concluded without data. This is an important caveat to this statement.	Comment noted. Thank you. No change needed in HCM.
118	2.1.4	23	3	Figure 2-7 shows an overlay....	Edit: "Figure 2-7shows an overlay.." (space needed)	Comment accepted.
119	2.1.4	12	4	The Whiterock fault is a barrier...	Comment: This fault forms part of the boundary to the basin but also extends under the basin (under the Cuyama River and Highway 166) (see Yates et al 1989, Calhoun 1985, Schwing 1984, Nevins 1983. This portion of the white rock (along with the TTRF and GRF) help to impede N-S infiltration of river water into the main (central) basin east of the Russell fault. This should not be neglected in either the HCM or the groundwater model.	Comment noted. References have been reviewed regarding Whiterock fault.
120	2.1.4	23	5	As shown in Figure 2-7, Outcrops	Comment: It is important to note that these outcrops occur west of the area in Figure 2-7 as well (See mouth of Cottonwood Canyon, and other areas mapped by Dibblee). They are very common in the entire western basin, but have not been well mapped or well structurally constrained. The focus has been in the area terrace mapped by DeLong as this is pretty much the best data available. It is not comprehensive.	Comment noted. Thank you. No change needed in HCM.
121	2.1.4	17	6	The USGS in 2013 also concluded...	Comment: Oil well data across this fault (See Ellis 1994 and others) addresses this as well including structure and offset.	Comment accepted.
122	2.1.4	8	7	EKI reviewed the USGS's work in...	Comment: Except at the river, alluvium is above the water table along the fault. This can clearly be seen in mapping of the area. Only the Morales Formation need be truncated for this to be a barrier to flow. The river channel is a spill point between the east and west subbasins.	Comment noted. Thank you. No change needed in HCM.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
123	2.1.4	--	Figure 2-6	--	Comment: This map does not show the Russell fault as continuous across the Valley. To my knowledge, every published geologic map of the area does: USGS 2013, Dibblee, DeLong, Smith and Jennings, Jennings and Strand, Yates et al, Vedder and Repenning, English, Singer and Swarzenski, Upson and Worts. 18 miles of offset along this fault does not occur without a continuous fault plane. When one of the key issues in the valley is both the continuity and offset of this fault to ignore well established maps on the continuity of the fault (all the way across the valley, no gaps) will lead to a LOT of misunderstandings. I realize this is likely a GIS translation issue, but another GIS shapefile which shows the continuous fault across the valley should to be used.	Comment accepted. Data from Ellis 1994 has been reviewed and incorporated as appropriate.
124	2.1.4	--	Figure 2-6	--	Comment: Work in Ellis 1994 pulls the SBCF into Ballinger Canyon and establishes a minimum degree of offset. This line should extend further east.	comment accepted
125	2.1.4	4	Heading	Syncline in the Northwestern....	Formatting Edit: Move header onto next page	comment accepted
126	2.1.6	10	7	The highest values in the Morales...	Comment: Most of the fault discussions in the technical forums have suggested to dealing with faults using a reduction in conductivity. How will this by resolved both in the model and in the conceptual model given that the values would be expected to deviate significantly from average, and given limited pump test data. Hydraulic conductivity across fault zones is an important issue.	Model development will be discussed in the Basin Model section.
127	2.1.6	--	Figure 2-9	--	Comment: There is a major difference between surface mapping (Dibblee and others) and this section line. See annotation (below).	The figure has been reviewed and updated.
128	2.1.7	2	7	Along the eastern edge of the...	Comment: Again, this does not reflect TDS conditions in the western basin which show a sharp change across the Russell fault based on historic data (the USGS water quality series that was used to develop Singer and Swarzenski circa 1965-1970). If you are going to cite this study then you should look at the data the USGS collected in the western area (same time span) that shows the quality shift and address both the cross fault quality change and more broadly conditions in the west. Water quality (both historic and current) across the Russell fault is a KEY discussion point in the basin as it is a metric for helping to define both potential subbasins and management areas.	Comment noted. Groundwater quality will be discussed further in the Geologic Conditions section.
129	2.1.1	1	1	The basin is located at the south...	Edit: "...north of the Western Transverse Ranges (Figure 2-1~~Figure2-1~~)	Comment accepted
130	2.1.2	5	1	Following a period of orogeny...	Comment: Suggest adding general ranges of time in Ma after epoch names	Noted. Text has been revised to include ranges of time in Ma.
131	2.1.2	5	2	This period also correlated...	Edit: "This period also correlated with two transgressive-regressive cycles, when the sea advanced and retreated over the area that is now Cuyama Basin".	Comment accepted
132	2.1.2	6	3	The transition to a predominately...	Edit: "The transition to a predominantely...."	Comment accepted
133	2.1.3	1	5	The Cuyama Valley Groundwater...	Edit: "....nonmarine deposits of Pliocene to Pleistocene age unconformably over~~laying~~ consolidated marine and nonmarine sedimentary rocks of late Cretaceous to middle Cenozoic age on top of ~~overlaying~~ Mesozoic....."	Comment accepted
134	2.1.3	5	1	The Paso Robles Formation part...	Edit: The Paso Robles Formation is part of the Quaternary....	Comment accepted
135	2.1.3	2	2	Recent alluvium is active fluvial...	Edit: "Recent alluvium is active fluvial channel deposits associated with the Cuyama River and other active channels." Suggest header "Stratigraphic Units Within the Main Cuyama Basin Aquifer"	Comment accepted
136	2.1.3	5	2	It is identified by an unconformity...	Comment: How identified? Unconformity is at top of unit? Bottom of unit?	Comment accepted
137	2.1.3	5	3	The Paso Roble Formation is a gray..	Edit: The Paso Robles Formation is a gray, crudely bedded alluvial gravel derived from Miocene rocks and basement rocks of western San Emigdio Mountains east of the San Andreas Fault	Comment accepted
138	2.1.3	1	5	A generalized stratigraphic...	Edit: "...of the Valley is ~~mapped in~~ shown on Figure 2-3."(space needed)	Comment accepted
139	2.1.3	6	--	Morales Formation	Comment: Suggest breaking Morales into separate paragraphs for Upper Morales and Lower Morales, then separate by header "Stratigraphic Units Below the Main Cuyama Basin Aquifer"	Comment accepted.
140	2.1.3	--	Figure 2-2	--	Comments on Figure: - Suggest marking intervals of young alluvium - Morales Formation as "Cuyama Basin aquifer" or something similar and everything below the Morales Formation as "Bedrock (below groundwater basin" or similar - Younger Alluvium - Pliocene highlighted - confirm the unconformity is Pliocene aged	Comment accepted.
141	2.1.3	--	Figure 2-4	--	Comments on Figure: - A-A' does not match USGS (2013a) - B-B' is not discussed in text - Confusing. "Study Area boundary is not the same as the Basin Boundary - the basin is the focus of the study."	Comment noted. Bulletin 118 Basin boundary has been added for context.
142	2.1.4	5	1	There is a syncline in the western...	Edit: "...that roughly follows a west-northwest (WNW)	Text has been edited to remove (NW) acronym after west-northwest and move to the first instance of northwest.
143	2.1.4	etween 14 & 1	1	The South Cuyama Fault.....	Comment: Missing header format: South Cuyama Fault	Comment accepted
144	2.1.4	1	2	Major Faults and synclines are...	Edit: Major ~~F~~faults and synclines are...	Comment accepted
145	2.1.4	13	2	The fault dips southwest by north...	Comment: Wide variation in orientation? Or does it just dip mostly NE?	The text has been revised.

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146	2.1.4	19	2	The Morales fault is a 30-mile....	Comment & Edit: The Morales thrust has a dip of approximately 30 degrees and has a large amount of offset." Unclear. Suggest "...dips approximately 30 degrees north, and has been mapped with offsets of approximately XXXX feet (reference, date)..."	Comment accepted.
147	2.1.4	14	5	Both faults are considered to be....	Comment on Figure: Turkey Trap Ridge, Graveyard Ridge, and Santa Barbara Canyon Faults should be clearly differentiated as likely barriers to GW flow on the structural map.	Comment noted. Thank you. No change needed in HCM.
148	2.1.4	9	7	EKI reviewed the USGS's work in...	Comment: EKI (2017) concluded that the Russell Fault as implemented in the CUVHM was not consistent with its characterization in the USGS study. We did not make the conclusion you stated. Instead, we recommended further investigation of the hydraulic properties of the fault.	Comment accepted.
149	2.1.4	--	Figure 2-6	--	Comments on Figure: In the Legend - - Remove "reverse faults"; no reverse faults shown in map - Explain SBCF, TTRF, GRF - Show plunge direction on syncline - Use different linetype, halo, or other graphic means to represent faults considered to be GW flow barriers.	Comment accepted.
150	2.1.5	5	3	The top of the Morales Formation...	Comment: Suggest a map of depth to basin bottom or basin/aquifer thickness	Comment noted. Thank you. No change needed in HCM.
151	2.1.6	2	6	Cross sections were created...	Comment: Need better description of the relationship between basin & model layering.	Model layering is described in the model development portion of the report
152	2.1.6	4	3	In the west, younger alluvium...	Edit: "...thick beds ~~up~~ of clay (ranging from 1 to 36 ft. thick)..." Comment: 36-ft thick beds of clay sounds like at least a local aquitard, which contradicts assertion of no aquitards on previous page.	There are no continuous clay layers that cover a large area of the Basin in the reviewed literature. Individual clay lenses are not considered a regional aquitard. The extent and nature of clay lenses is not well understood in Cuyama and could be investigated as a data gap.
153	2.1.6	6	5	In most regions of the basin, the....	Comment: "...of the basin, the top of the saturated zone (the water table) is either..." (or just use water table alone)	Comment accepted. Text is revised to "...of the basin, the top of the saturated zone (the water table) is either..."
154	2.1.6	7	5	In the east and southeastern...	Comment: This section is the first time water transmitting properties are mentioned. It seems contradictory to state properties are "not well defined," yet the hydraulic conductivity "varies greatly laterally and with depth."	Comment noted. Thank you. No change needed in HCM.
155	2.1.6	12	2	Using aquifer tests from 63 wells...	Comment: The distribution of test locations is limited, and wells with data are not located "across the valley."	Comment accepted. Text is revised to state "Using aquifer tests from 63 wells ~~across~~ located primarily in the central portion of the valley."
156	2.1.6	12	6	Data from the 51 wells were not....	Comment: What 51 wells? Different from the 63 wells discussed above?	Comment accepted. The text is revised to "63 wells."
157	2.1.6	12	7	Using groundwater level contours...	Comment: Transmissivity exhibits spatial variability. "Fluctuate" conveys oscillation with time.	Comment accepted.
158	2.1.6	--	--	--	Comments on Figure: - Absolutely nothing on east side? So no hydraulic data for Morales Fm? Or are wells available W of Russell Fault with P/T data? - Need to show data from west of Russell Fault. - Show DWR Basin Boundary as overlay on all maps to avoid confusion. Especially maps from USGS (2013).	The DWR Boundary has been overlayed on the figure. Detailed data on this Basin is not widely available and not widely, spatially distributed.
159	2.1.7	--	--	--	Comment: Suggest point or post maps of WQ data for TDS, Cl, B, NO3. Include symbolization to identify shallow, moderate, deep well data where available. May help to identify both horizontal and vertical data gaps.	Comment noted. Groundwater quality is further discussed in Groundwater Conditions.
160	2.1.8	3	5	Peak flows through the Cuyama...	Comment: suggest mentioning the period of record.	Comment accepted
161	2.1.8	5	2	The basin is comprised mostly of...	Edit: "...comprised mostly of fine- to coa~~u~~rse-loamy soils..."	Comment accepted
162	2.1.8	7	2	Approximately 25 miles of the...	Comment: Wetlands are typically discharge areas - they are GW fed. What is going on here (what is feeding the wetland - perennial SW flows)? The wetlands should be shown on a map.	Citation from US Fish & Wildlife wass incorrectly located and has been removed.
163	2.1.8	8	5	SAGBI data shown in figure Figure...	Edit: "SAGBI data shown in ~~figure~~ Figure 2-16~~8: Recharge Areas, Seeps, and Springs~~..."	Comment accepted
164	2.1.8	9	3	Figure 2-18 shows the location of....	Edit: "Figure 2-1~~8~~6 shows the location..."	Comment accepted
165	2.1.8	9	3	The springs shown in Figure 2-18...	Edit: "The springs shown in Figure 2-1~~8~~6 shows the location..."	Comment accepted
166	2.1.8	9	3	The springs shown in Figure 2-18...	Comments on Areas of Recharge Section: - Where is the discussion of inflows and outflows and system dynamics? - Conceptual 3-D block diagram is needed, in fact it is critical for supporting outreach activities. - Missing land use - processing it is part of IDC work and is surely available. - Groundwater Elevation map - USGS provides for part of the basin.	Comment noted. These items will be discussed in the Groundwater Conditions and Water Budget sections.
167	2.1.8	--	--	--	Comment: Section describes topography, surface water, soil, and recharge potential but not sources of recharge....Include description of sources of recharge?	Comment noted. The amount of recharge will discussed in the Water Budget section.
168	2.1.8	--	Figure 2-16	--	Comment on Figure: Incomplete per 23 CCR §354.14 (d) - need to graphically show recharge areas in addition to these SAGBI soil data. More data available at https://gis.water.ca.gov/app/NCDatasetViewer/	Comment noted. The link is to GDE data, which is discussed in Groundwater Conditions section.
169	General Comment				Comment: Need to develop 3D cartoon diagram, conceptual components of water budget. Not all water budget components are identified, e.g. river relationship to GW, others.	Comment noted. Water Budget components are discussed in the Water Budget section.
170	General Comment				Comment: Need to mention uses of GW, inflows, outflows; main basin outflow is pumping.	Comment noted. Water Budget components are discussed in the Water Budget section.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
171	General Comment				Comment: Spatial component of hydraulic properties is not presented. Same for water level measurement density and water quality data density. Suggest maps showing these data densities or gaps.	Comment noted. Groundwater Conditions components are discussed in the Groundwater Conditions section.
172	General Comment				Comment: Statement re no imported water?	Comment accepted.
173	2.1.2	5	5	The Paso Robles Formation is sandwiched...	Edit: "....it rests ~~uncomforably~~ unconformably below the older alluvium...."	Comment accepted.
174	2.1.2	--	Figure 2-1	--	Comments on Figure: The label for the Santa Ynez Fault appears to have been misspelled ("Yenez"), "Transerverse Ranges" is misspelled (Transverse)	Comment accepted. Figure 2-2 has been revised.
175	2.1.4	11	4	The USGS determined the fault to...	Comment: Subsidence is mentioned in discussion of the Rehoboth Fault as a barrier to GW flow, then it is never mentioned again. Has subsidence been documented in the Basin? Is it potentially problematic? Consider including a brief paragraph discussing subsidence later in the GW conditions discussion.	Comment noted. Subsidence will be discussed further in the Groundwater Conditions section of the GSP.
176	2.1.4	last paragrap	6	The presence of these non-aquifer...	Comment: "The presence of these non-aquifer materials in this area likely *restricts GW movement...*". I'm not sure I agree with this statement. Does an island of bedrock in an alluvial aquifer restrict GW flow? The GW flows around it, correct? When I think restricting flow, I think of faults, barriers, etc. This seems to include a debatable statement where it isn't necessary. Consider simplifying to the "presence of these non-aquifer materials in this area limits the extent of permeable materials in this portion of the basin."	Comment accepted.
177	2.1.4	--	Figure 2-6	--	Comment: If possible, provide direction arrows for strike-slip faults and up/down symbols for normal faults.	Comment accepted
178	2.1.5	3	2	The Cuyama and Carrizo Plain...	Comment: Consider including the neighboring basins (Carrizo Plain too) on one of the figures.	Comment noted. A map of the Cuyama Basin and neighboring subbasins was developed and included in the Plan Area section, please see Figure 1-3.
179	2.1.6	8	5	In the east and southeastern parts of...	Edit: "...where the Morales Formation ~~outcrops~~ crops out, the formation..."	Comment accepted
180	2.1.6	--	Figure 2-9 Figure 2-10 Figure 2-11	--	Comment: Include legend identifying strata depicted in cross sections.	Comment accepted.
181	2.1.7	2	3	With the exception of spikes in nitrate..	Comment: This is an overly broad statement: "...groundwater quality is...typical of alluvial basins." What is typical of alluvial basins? TDS here is pretty high, not typical of the alluvial basins I have worked in to date.	Comment accepted.
182	2.1.7	3	2	Marine rocks produce brackish water...	Comment: This is an overly broad statement: "Marine rocks produce brackish water..." Maybe these marine rocks produce brackish water, and if so, identify the specific formations that produce brackish water here, but there are plenty of marine rocks that don't produce brackish water.	Comment noted. Citation is a direct quote from author.
183	2.1.7	4	7	Nitrate concentrations ranged from...	Edit: "....to 45.3 mg/L, exceeding the ~~S~~MCL (10 mg/L) in...." Nitrate is a primary standard with an MCL, not a secondary standard with SMCL.	Comment accepted.
184	2.1.7	#1 -3	--	--	Comment: Strongly suggest including a map with groundwater level hydrographs, along the lines of the attached figure for SLO Basin. You discuss historic groundwater quality, but no historic groundwater levels. This is the crux of the biscuit and why the basin is in critical overdraft. A figure with hydrographs can communicate at a glance areas that have significant declines and areas that do not.	Comment noted. Groundwater levels are discussed in the Groundwater Conditions section.
185	2.1.4	9	1	The Russell fault has been...	The InSAR data is only an indicator that a combination of factors were not present to create differential deformation across the fault. These factors include large enough water-level declines to cause deformation along with a fault the can truncate the transmission of those declines across the fault. Although the InSAR images show no obvious differential deformation there is no evidence that it is still not a barrier to or partial barrier to groundwater flow and that the water level declines in proximity to the fault and on either side of the fault were enough to cause a signal of 10mm or more of deformation to be seen in InSAR image (which is the lower resolution when differencing radar reflection images as InSAR). The Russell Fault was treated as a no flow boundary in all layers except for just one cell in the youngest alluvium (layer 1) and a pair of cells in the Morales and Older alluvium directly below the Cuyama River in the Greek Ranch. So the Russell Fault was treated as a flow boundary in the CUVHM model with the concept of potential re-incised channels that could allow some groundwater underflow directly beneath the Cuyama River. "MiniVibe" seismic profiles across the fault on both sides of the River with short receiver spacing's (<1 meter spacing) would probably be needed to better determine the structural integrity and geometry of this potential flow barrier and fault in all three geologic units. The truncation of the geologic units is also indicated by Sweetkind and others (2013). The EKI conclusion is suspect as the hydraulic gradients are generally unknown in the recent alluvium and may well be closer to perpendicular to the river except near the river channel.	Comment noted. Reference provided was inaccurate, correct reference is USGS, 2013c. On pg. 55 the USGS states "Similar to the other faults, the Russell fault did not appear to be acting as a barrier to groundwater flow. " The text has been updated to include this statement.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
186	2.1.4	11	4	The USGS determined the fault to...	Comment: The Rehoboth Fault was treated as an HFB barrier in the younger, older alluvium and Morales in the CUVHM.	Comment noted. Will review CUVHM literature regarding Rehoboth Fault.
187	2.1.4	18	5	The fault is considered a barrier...	Comment: The Santa Barbara Canyon Fault was not represented as a barrier to flow in the younger alluvium in the model cells that represented the Cuyama River channel in the CUVHM.	Comment accepted. Data from Ellis 1994 will be reviewed and incorporated as appropriate.
188	2.1.4				Comment: The entire Cottonwood area is poorly defined including potential faults that could be groundwater flow barriers that are not shown on maps, described, and are not implemented in the new model.	Comment noted. Data and reports on this area are sparse, and details in this area will be noted as a data gap.
189	2.1.4		Figure 2-6		Comment on Figure: Missing faults such as Russell and Santa Barbara Canyon Faults as well as others in the Cottonwood area. These are likely transform faults that create flow barriers along with the other normal and thrust faults in the Cuyama Valley.	Comment noted. Russell fault and Santa Barbara Canyon Fault (SBCF) are shown on Figure 2-6. acronyms have been defined on this figure
190	2.1.5	2	1	The Cuyama Basin is geologically..	Comment: Lateral boundaries lack information from USGS studies and research drilling in Cuyama Valley	Comment noted. Thank you. No change needed in HCM.
191	2.1.6	1			Comment: What aquitards? There is no mention of them or physical data to support such a discussion	Comment noted, The 5th sentence of Section 2.1.6 notes that "There are no major stratigraphic aquitards or barriers to groundwater movement..."
192	2.1.6	3	2	Rocks older than the upper....	Comment: Need citation on "rocks older than the Morales...."	Comment accepted. Text has been revised to include reference to USGS, 2013a.
193	2.1.6	8	5	In the east and southeastern...	Comment: Most of it is far above the zone of saturation	Comment noted. Thank you. No change needed in HCM.
194	2.1.6	11	7	The highest values in the Morales...	Comment: Not sure the statement about yields on the west end is accurate...perhaps different in 1970 when there was more saturated thickness.	Comment noted. Thank you. No change needed in HCM.
195	2.1.6	11	3	The dewatered alluvium has an....	Comment: Specific yields from the 1998 CDWR work states 10-15% used in calibration. Please reference properly. USGS had additional estimates from their Tech files and was published in Everett and others (2013).	Comment noted. Text has been revised
196	2.1.6				Comment: Do not use information from USGS studies	Comment noted. Thank you. No change needed in HCM.
197	2.1.7	5	1	The Cuyama Valley is known for...	Comment: Aquifer use section does not give reference for claim that this is one of the most productive agricultural regions in Southern California. Groundwater has also been used in support of oil-well drilling and secondary recovery techniques.	Comment accepted.
198	2.1.7	#1-4			Comment: Water quality section did not reference the USGS GAMA reports and related sampling. No discussion of age dating, tritium isotopes, trace metals. The citations from Singer & Swarzenski (1970) are interesting] but the section Recent Groundwater Quality uses little to none of the water chemistry, water quality or isotope geochemistry published by the USGS as part of the Cuyama studies and the GAMA project.	Comment noted. Groundwater quality, including discussion of GAMA data will be further discussed in the Groundwater Conditions section.
199	2.1.8	3	5	There are approximately four main..	Comment: Missing/misstating major drainages: should have Upper Cuyama, Rancho Nuevo, Apache Canyon, Berges Canyon, Quatal Canyon, Ballinger Canyon, Santa Barbara Canyon, Branch Canyon, Alisos Canyon, and Cottonwood, as well as the Cuyama River	Comment noted. The GSP identifies the main sources that feed the Cuyama River, only select streams were listed.
200	2.1.8	4	1	No standing bodies of water....	Comment: Surface water bodies section does not catalogue the man-made ponds used as storage for irrigation water	Comment noted. Man-made ponds could be inventoried as a GSP implementation action item.
201	2.1.9	1	1	HCM data gaps are present in the...	Comment: Several Data Gaps not mentioned including pumpage data, annual-seasonal land use and irrigation methods, linkages between where water is extracted and where it is applied for irrigation such as the well at Bell and Foothill roads that pumps groundwater which is transported miles eastward to the main zone across the Rehoboth Fault. Subsidence data is not mentioned and additional streamflow data such as reactivating the gage on the Cuyama River is a huge data gap.	Comment noted. Water Budget components are discussed in the Water Budget section.
202	General Comment				General comment: The report seems more like a compendium of compiled information rather than a "conceptual model." There is no discussion of routing surface waters into the Cuyama GW Basin nor a discussion of how the different components of the Integrated Water Flow Model will work together to synthesize accurate output numbers	Comment noted. Groundater conditions components, water budget components, and the groundwater model will be discussed in the appropriate upcoming sections.
203	General Comment				Comment: Use of Kellogg should be done with caution as our understanding is that this work was largely a compilation of previous studies and had limited field verifications. We recommend that you check with Kellogg before using any of his maps.	Comment noted. Thank you. No change needed in HCM.
204	General Comment				Comment: HCM report uses and cites old reports such as Upson et al. and Singer et al a lot but does not use much of the information from any of the USGS reports Hanson et al. and somare are not even cited such as the USGS Kirschenmann Road Monitoring well site Open File Report.	Comment noted. Thank you. No change needed in HCM.
205	References				Comment: Some USGS citations are incorrect, the format is inconsistent and some references are missing.	The references have been reviewed and updated.

Cuyama Basin Groundwater Conditions September Draft
Summary of Public Comments and Responses
November 19, 2018

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1	General	N/A	N/A	N/A	The text is overtly understated regarding significante conditions depicted with conclusive data sets & trends.There is a need to "state the obvious" when viewing conclusive data sets.	Comment noted. No change required in document.
2	General	N/A	N/A	N/A	No historical baseline is established for the discussion of measurable objectives. The contextual perspective of past or current conditions is not generally available. The uncertainty of this will not be helped when a algorithm generates it in the model.	Comment noted. No change required in document.
3	General	N/A	N/A	N/A	Data Gaps are recognized as a significant challenge to fully understanding the groundwater conditions and drive a higher degree of uncertainty when making assumptions & conclusions	
4	2.2	1	N/A	Bullets # 4,5 & 6 of 7	Three intended objectives outlined in the first paragraph of section 2.2, have not been addressed	As noted in the document, these sections are under development and will be available in a future version of this section.
5	2.2.1	N/A	N/A	Fig. 2.2-1	Landmarks - Caliente Range - Ventucopa Uplands (Badlands) - Apache Canyon	Caliente Range and Apache Canyon have been added to Figure 2.2-1. Ventucopa Uplands are not specifically discussed in this section.
6	2.2.3	N/A	N/A	Fig. 2.2-16 to18	If the screening intervals and perforation depths of these three multi completion wells are know and presented here, then why are they not in the Opti DMS?	This information will be added to the Opti DMS for these well locations
7	2.2.3	N/A	N/A	Fig. 2.2-19	Text should explain that the blue arrows indicate the direction of the downward horizontal groundwater flow. These arrows are helpful and should be used in other Groundwater Contour maps.	The text referring to this figure has been updated. There are no other figures in this section for which these arrows would be appropriate.
8	2.2.3	N/A	N/A	Fig. 2.2-20	Illustrates a classic example of a Bullseye depression. Speak to the significance of these conditions. Speak also to the Data Gaps representing the missing northeast area, near the intersections of 166 & 33. How big or deep is the zone of depression?	Comment noted. The document notes that the depth to water is up to 600 feet deep.
9	2.2.4	1	N/A	Bullet #1	Storage loss is a significant groundwater condition that should be measurable, but we are going to model it first. The cart is before the horse!	While changes in groundwater storage can be inferred from changes in groundwater levels, storage quantities cannot be directly measured with the available data. The numerical model will provide the best available estimate of groundwater storage.
10	2.2.6	2	1	Subsidence	Subsidence at a rate of > 0.5" / year should not be dismissed or diminished by comparison to the collapse of the San Joaquin. This is a critical Data Gap with only one monitor site in the central basin. It may or may not be anomalous without anything to compare it to	Comment noted. The need for additional subsidence monitoring is discussed in the Monitoring Networks section.
11	2.2.7 Literature Review	8	1	The USGS reported the following	The USGS, SBCWA & the GAMA data files all indicate constituante levels (TDS, Nitrate, Sulfate, & Arsenic) above MCL in the central basin implicating a causal nexus with localized excessive groundwater extraction.	Comment noted. The data is insufficient to make a definitive conclusion about the relationship between groundwater extraction and water quality.
12	2.2.7	5	2	Toward the northeast end of the basin...	The available data is inconclusive in establishing any trends in conditions over time, stable or otherwise. How can we quantify a minimum threshold and how can we monitor this causal nexus between groundwater extraction & groundwater quality degradation?	Comment noted. The data is insufficient to make a definitive conclusion about the relationship between groundwater extraction and water quality.
13	2.2.7	N/A	N/A	Groundwater Quality	Available groundwater age & temperature data should be used to help determine flow rates over faults, intermixing of aquifer layers, and recharge rates of deep percolation.The response to this same comment on the Draft HCM was that it would be presented in this section of the GSP. What section will it be in next?	As discussed at the November 1 SAC meeting,
14	2.2.8	N/A	N/A	InterconnectedSurface Water Systems	When this section is developed it should additionally include the following: 1.)Consideration of the causal nexus between declines in ephemeral and intermittent streams, and SGMA related activities. 2.)Estimates of the ecological services and emergent benefits of interconnected surface water systems. 3.)Literature Review of the historic loss of the riparian habitats through the valley. 4.)Consider potentials for river channel modification to slow, spread & sink stream discharge for enhanced recharge.	Comment noted. This will be taken into consideration when this section is developed.
15	2.2.9	N/A	N/A	Groundwater Dependent Ecosystems	When this section is developed it should additionally include the following: 1.)Estimates of Evapotranspiration needs of existing GDEs and the stream discharge requirements to satisfy their dependance. 2.)Assessment of the Beneficial Uses and emergent benefits of the biology associated with the GDEs. 3) Consider the causal nexus of desertification and the loss of native wetland habitats due to SGMA related activities. 4)Consideration of enhancing GDEs to facilitate stormwater capture and recharge by the reduction of flash runoff	Comment noted. This will be taken into consideration when this section is developed.
16	2.2.10	N/A	N/A	Data Gaps	Recognised Data Gaps include: 1) Recent groundwater level & quality data in the Ventucopa upland & river corridor, 2) Historical groundwater data from the Cottonwood subarea. 3) More multi-completion wells in the main basin to better understand the zone of depression. 4) Data for Groundwater elevations in the north and west of the basin. 5) Well Completion Data with perforation intervals. Available from down hole video logging. 6) More CGPS Subsidence monitors in the main basin. 7) Current Groundwater quality data basin wide. 8) Surface water flow gauges on the Cuyama in the Basin, at bridges on Hwy 33 in Ventucopa uplands and Hwy 166 in the central basin. 9) Data concerning GDEs in the basin.	Comment noted. This will be taken into consideration when this section is developed.
17	2.2.10	N/A	N/A	Data Gaps	Major Data Gaps continue to generate the concern for the uncertainty of any conclusions made from the assumptions needed to develop a numerical model. Greater uncertainty requires a more conservative approach to model assumptions.	Comment noted. No change required in document.
18	General	N/A	N/A	N/A	In its current form, the draft GWC chapter is incomplete relative to 23 CCR §354.16 because several GWC elements identified above (groundwater storage changes, interconnected surface water systems, and groundwater dependent ecosystems) are included in the chapter only as placeholders and are not complete	Comment noted. No change required in document.
19	2.2.2 GW Hydrographs 2.2.3 GW Contours	N/A	N/A	N/A	The GWC chapter does not adequately reference the hydrogeologic conceptual model (HCM). The discussion of groundwater contour figures lacks any mention of the hydraulic effect of faults. For instance, the HCM documents that SBCF is a barrier to groundwater flow. This significant fact should be used to interpret water level observations ("Groundwater Hydrographs" [2.2.2]; "Groundwater Contours" [2.2.3]).	Comment noted. No change required in document.
20	2.2.2 GW Hydrographs 2.2.3 Vertical Gradients 2.2.3 GW Contours	N/A	N/A	N/A	The GWC chapter does not adequately reference the hydrogeologic conceptual model (HCM). Similarly, the HCM discusses varying hydraulic conductivities between the younger alluvium, older alluvium, and Morales Formation. The effects of hydrostratigraphy should be considered in discussions of vertical gradients, hydrograph comparisons, and groundwater elevation contours ("Groundwater Hydrographs" [2.2.2]; "Vertical Gradients" [2.2.3]; "Groundwater Contours" [2.2.3]).	Comment noted. No change required in document.
21	2.2.3			1947 to 1966 Groundwater Trends	The chapter cites results from the outdated CUVHM model. Cited CUVHM results ("1947 to 1966 Groundwater Trends" [2.2.3]) may be unreliable and obsolete given that WC is developing a new model.	Comment noted. Even after development of the updated model, data from the USGS study will still be a primary source of information for the earlier period from 1947-1966.

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22	Figures 2.2-11 to 2.2-15				Hydrograph figures lack organization and their interpretation is insufficiently clear (2.2-11 to - 15). Partial overlap and repetition of hydrographs make the figures confusing. Figures should be revised so that each one exclusively covers a portion of the basin with unique hydrographs. Well 620 should be discussed under "central portion" because it is north of SBCF and follows the pattern of decline in that region. South of the fault to the Ventucopa area is showing a largely consistent picture of long-term steady elevations (Wells 40, 41, 85) with the exception of decline in Well 62 since the 1990s. The area of decline in the western portion of the basin extends to Well 70, just west of Bitter Creek. Regarding the statement that "all monitoring wells in [the central portion of the basin] show consistent declines, consider that Well 28 has elevations leveling off in the 1990s and then starting to recover in the 2000s.	The figure and text have been made consistent. Title corrected.
23	2.2.3				Referenced hydrographs are missing, or more useful selections are available. Hydrographs for Wells 40, 316, and 640 are discussed in the text but not included in the figures. Consider adding hydrographs for Wells 70, 107, 110, 112, and 114, because they have significantly long data records, fill spatial gaps, and preserve the variation in water level trends observed in the basin. Consider removing hydrographs for Wells 108, 121, 571, 830, 840, and 846 because their data records are too short to reveal much about water level trends.	The figure and text have been made consistent. Title corrected.
24	2.2.3 GW Hydrographs			Groundwater levels followed	The GWC chapter contains unsupported statements. The statement, "Groundwater levels followed climactic patterns" ("Groundwater Hydrographs" [2.2.3]) is ambiguous. If it refers to cycles of wet and dry years, a hyetograph of monthly or annual rainfall totals should be included to support it.	Comment noted. No change required in document.
25	2.2.7 Data Analysis			The spikes of TDS	The GWC chapter contains unsupported statements. The statement, "The spikes of TDS increases correspond with Cuyama River flow events" ("Data Analysis" [(2.2.7]) should be supported by showing a river hydrograph on the same plot.	Figures showing the climactic variability will be included in the Water Budgets section.
26	2.2.1 Useful Terminology 2.2.3 Vertical Gradients				Wells that are screened in different intervals are not differentiated. In two mentions of wells having different depths ("Useful Terminology" [2.2.1], "Vertical Gradients" [2.2.3]), language should be precise that perforations are at different depth intervals.	Comment noted. No change required in document.
27	2.2.3 Vertical Gradients				Improvements are needed in vertical gradient hydrographs and interpretation ("Vertical Gradients" [2.2.3]). The hydrographs should have finer x-axis label resolution than annual, because seasonality is discussed in the document. Regarding their interpretation, hydrographs that behave similarly lend themselves into being grouped by geographic subareas when possible. This type of grouping is one consideration when defining potential groundwater management areas. It is therefore important that these assessments accurately represent the data. Uncertainty must be clearly communicated by (for example) use of hydrographs which reflect the variability observed in a spatial grouping. Some specific examples include:	The scale of the hydrographs have been modified to show greater vertical detail
28	2.2.3 Vertical Gradients				a. (CVFR) "There is no vertical gradient." At the scale of the hydrograph figure, we cannot discern whether there is no gradient or a small gradient.	The scale of the hydrographs have been modified to show greater vertical detail
29	2.2.3 Vertical Gradients				b. (CVBR) We cannot dismiss the contribution of horizontal recharge; the CVFR site shows the basin is not vertically driven, at least not everywhere. Also, given the depth to water it is speculative to conclude vertical recharge exceeds horizontal. Furthermore, the hydrographs show "shallow" wells are influenced by seasonal conditions just as much as "deep" wells.	The text has been revised for clarity.
30	2.2.3 Vertical Gradients				c. (CVKR) "The hydrograph of the four completions shows that at the deeper completions are slightly lower than the shallower completions in the spring at each completion, and deeper completions are generally lower in the summer and fall." This statement seems to say groundwater levels decrease with depth in the in the spring, summer, and fall. Why is winter excluded—no measurements?	The text has been revised for clarity.
31	2.2.3 Vertical Gradients				d.(CVKR) "This likely indicates that...the vertical gradient is significantly smaller at this location in the spring measurements." Or does it indicate that there is no vertical gradient during unpumped conditions?	The text has been revised for clarity.
32	2.2.3 Appendix Y				Errors and overgeneralizations exist in the mapped groundwater elevation contours (including Appendix Y). The text analyzing the contour figures (including in the appendices) contains interpretive errors ("Groundwater Contours" [2.2.3]). For instance, "In the southeastern portion of the basin near Ventucopa, groundwater is mostly between 100 and 150 feet bgs" should be "between 150 and 200 feet bgs."	The text has been revised for clarity.
33	2.2.3 Appendix Y				The same discussions of contour maps in Appendix Y seem to be reused for each season/map, ignoring or smoothing over distinctions between them. For example, an area of low groundwater elevation is described as "northeast of...Cuyama" for Figures Y-1, -3, -5, and -7, yet the figures show that area shifting between the north and northwest of Cuyama.	The text has been revised for clarity.
34	2.2.3 Appendix Y				In several instances, "groundwater levels rising" should be replaced with "depth to water decreasing" because the topic is DTW contours. Contour labels on Figure Y-4 neither match values posted on wells nor represent a 50-ft contour interval.	Figure Y-4 has been corrected.
35	2.2.3 Appendix Y				Explanation of the maps should specify that they "improve understanding of recent horizontal trends in the basin." The inferred contours are unnecessary, speculative, and often seem to be physically unreasonable. The small contour interval relative to low well density causes several occurrences of a "target" effect, where a single well drives the appearance of a dramatic groundwater mound (like a "bullseye"). In some cases, the actual cause of the large head differential appears to be the SBCF. Larger contour intervals would decrease this effect.	Due to the regional nature and large topographic and groundwater depth ranges in the Cuyama Basin, the 50 foot contour interval was chosen to capture trends while not ignoring conditions that are shallower than 100 feet. Like many presentation figure decisions, this one is a compromise. No change made to contour maps.
36	2.2.7 Data Analysis				Explanation of water quality constituents is needed. An explanation of why TDS, nitrate, and arsenic are selected for mapping and discussion would be helpful ("Data Analysis" [2.2.7]).	These consituents were selected because they were identified as being of interest during the stakeholder process. Very limited data is available for analysis of other constituents.
37	2.2.7 Data Analysis				An incorrect Nitrate MCL is cited. The nitrate MCL is cited as 5 mg/L ("Data Analysis" [2.2.7]). It actually is 10 mg/L as N.	The MCL value has been corrected
38	Figure 2.2-25				Consistent time scales in Figure 2.2-25 should be used for clarity. The plot time scales are inconsistent, which makes interpretation unnecessarily difficult.	The time scales on the plots have been set to allow readers to clearly see the data.

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39	Appendix X				The hydrograph appendix contains errors and omissions. Many wells are symbolized in the map but not labeled. Many wells labeled in the map do not have hydrographs included. Data axis label intervals are inconsistent (one year vs. three years). For Wells 90 and 639, the y-axis minimum is too high.	Wells symbolized in the maps incorporated into Appendix X incorporate all "OPTI Wells." These includes both groundwater level monitoring and groundwater quality wells that are included in the source datasets. This means that some wells on the map will not have a hydrograph associated with them. Additionally, some of the wells may overlap one another so closely that GIS is unable to automate every well number label on the map. These limitations are not affected in the online DMS, but Appendix X is intended to provide as much information as reasonable in print form. Hydrograph label axis intervals are automated. Labels still effectively show GWE and DTW. The Y-axis in the hydrographs have been adjusted to show all data in wells 90 and 639.
40	Appendix Z			This loss of aquifer	The subsidence appendix requires further explanation. Regarding the statement, "This loss of aquifer is limited to the water that was stored in the compressed clays, and storage capacity lost is limited to the water that was stored in clays that were compressed" ("How Subsidence Occurs"), what does WC intend to communicate regarding the difference between loss of aquifer and loss of storage capacity? Aren't they effectively the same thing?	The text has been revised for clarity.
41	2.2 GW Conditions	1	1	The groundwater conditions section	Chapter scope. The statement, "The groundwater conditions section is intended to...Define measurable objectives to maintain or improve specified groundwater conditions" ("Groundwater Conditions" [2.2]) is more accurately worded in the following paragraph: "The groundwater conditions described in this section...are used elsewhere in the GSP to define measurable objectives."	The text has been revised for clarity.
42	2.2.1 Useful Terminology				Terms not used in the document. Two defined terms ("Useful Terminology" [2.2.1]) are not used elsewhere in the document, and their purposes should be stated: "historical high groundwater elevation" and "historical low groundwater elevation."	These definitions have been removed from the section.
43	Figures 2.2-1 & 2.2-2				Map symbology. Figure 2.2-1 has non-intuitive and inconsistent symbology. Purple lines and points represent an eclectic set of "landmarks". All the canyons are labeled, but most of the creeks are not. Bitter Creek is referenced many times in this document, but it is not shown on any subsequent figures. In Figure 2.2-2, Bitter Creek and SBCF are mentioned in the text discussion but not shown on the figure.	Comment noted. The purpose of Figure 2.2-1 is to show the locations of elected landmarks in the Basin to assist in discussion of conditions in the section. It is not necessary to repeat each landmark in subsequent figures.
44	2.2.3 GW Hydrographs			In the western area	Unclear sentences. There are several incomplete and/or confusing sentences in the document. "In the western area west of Bitter Creek are near the surface near the Cuyama river, and deeper below ground to the south, uphill from the river, and have been generally stable since 1966" ("Groundwater Hydrographs" [2.2.3]).	The text has been revised for clarity.
45	2.2.3 Vertical Gradients			The hydrograph of the four completions	Unclear sentences. There are several incomplete and/or confusing sentences in the document. "The hydrograph of the four completions shows that at the deeper completions are slightly lower than the shallower completions in the spring at each completion, and deeper completions are generally lower in the summer and fall" ("Vertical Gradients" [2.2.3]).	The text has been revised for clarity.
46	2.2.3 GW Countours			Measurements from wells of different	Unclear sentences. There are several incomplete and/or confusing sentences in the document. "Measurements from wells of different depths are representative of conditions at that location and there are no vertical gradients" should say "...assumes there are no vertical gradients" ("Groundwater Contours" [2.2.3]).	The text has been revised for clarity.
47	2.2.7 Data Analysis			TDS in the central portion	Unclear sentences. There are several incomplete and/or confusing sentences in the document. "TDS in the central portion of the basin" ("Data Analysis" [2.2.7]).	The text has been revised for clarity.
48	2.2.7 Data Analysis			The chart for Well 85	Unclear sentences. There are several incomplete and/or confusing sentences in the document. "The chart for Well 85 at the intersection of Quatal Canyon and the Cuyama River is generally below 800 mg/L TDS with spikes of TDS increases" ("Data Analysis" [2.2.7]).	The text has been revised for clarity.
49	Appendix Z			[Subsidence is] not restricted	Unclear sentences. There are several incomplete and/or confusing sentences in the document. "[Subsidence is] not restricted in rate, magnitude, or area involved" (Appendix Z).	The text has been revised for clarity.
50	2.2.7 Reference and Data Collection				Links and sources identical. Two different DWR data source links ("Reference and Data Collection" [(2.2.7]) share the same web address.	The link for the CNRA dataset has been updated.
51	General	N/A	N/A	N/A	It seems that there has been no examination of faults/aquitards down stream (West) from the basin border. While it is acknowledged that the GSA has no authority beyond the defined basin, it would seem that knowing what the further extent of pooled ground water is present and where/why that water is held back would be important for making management decisions in that segment of the basin. It may well be that the basin's western limit was drawn for exactly to account for this but that does not seem to be clearly spelled out.	Comment noted. This is outside of the scope of the GSP.
52	Figure 2.2-1				On Figure 2.2-1 the location of the Russell Ranch Oil Field is not too accurate....it is also wrong on OPTI ID (Jane to send Brian a map).	Russell Ranch Oil Field has been removed from the figure.
53	Appendix X				In the hydrographs (appendix X), many of the wells on our place are no longer there. It is misleading because some wells were drilled, tested once and that was it. I guess they give info about water depth.	The maps and data in Appendix X are intended to show the groundwater level information that is available historically in the Basin. Because of this, many wells that no longer exist will be included.
54	Figures Y-4 & Y-6				Just based on what I know the stats were on our wells, it looks like Figures Y-4 and Y-6 are over-generalized. Some places we saw differences and some places the Wells didn't fluctuate all.	Comment noted. The contour maps represent estimates based on the available information in each period.
55	General				On all maps, in every section, please show the major faults and major streams as landmarks for easier location of what is being shown on the specific map.	This represents too much detail for most maps in the section. Figure 2.2-1 is intended to provide geographic locations of features for reference.

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56	General				Age dating of water is an important component of groundwater conditions since it indicates sources and recharge. Any claim for surface recharge of the groundwater needs to be validated by tritium analysis.	This is incorrect. Tritium analysis can provide some useful information about groundwater recharge, but is not a conclusive method for determining whether surface recharge has occurred.
57	General				The Cuyama Basin needs dedicated test wells at critical locations in order to better understand groundwater availability and movement	Comment noted. Potential locations of new monitoring wells is discussed in the Monitoring Networks section.
58	2.2.3 GW Trends				While the maps clearly show the decades-long downward trend of the central basin (Figure 2.2-7), the narrative just mentions specifics and does not give enough of a full watershed overview of how there are records since 1950 of extraction without replenishment which has created a record of a severe downward trend of approximately 500 feet over 6+ decades. This overview is key to establishing minimum thresholds for the GSP since this downward trend needs to stop with no continued depletion. We recommend adding a summation overview to this section.	Comment noted. This level of detail is not needed in this section.
59	2.2.4 Change in GW Storage				The determination of groundwater storage from the model seems backwards, since the model is highly dependent on how much water there is to pump. Isn't there data available to inform the groundwater storage available in certain areas? Without such data the accuracy of the model seems much more uncertain.	The model provides the best estimate currently available of the quantity of groundwater storage available.
60	2.2.6 Land Subsidence				Any subsidence can negatively affect groundwater storage. The very limited measurements to date don't adequately determine if current subsidence has been occurring for a long period of time or is just beginning. This creates a data gap that adds more uncertainty to the model and therefore more monitoring sites are needed to determine both rates and extent of subsidence.	Comment noted. The need for additional subsidence monitoring is discussed in the Monitoring Networks section.
61	2.2.7 GW Quality				This section on groundwater quality reports on various constituents' historical conditions, but does not develop a foundation for a baseline for future monitoring nor identify what constituents are recommended for monitoring.	Monitoring is addressed in the Monitoring Networks section. There is not enough existing historical data to 'establish a baseline' in this basin.
62	2.2.7 GW Quality				In reviewing the information in this section, plus in discussing this in meetings as well as with the CCSD and other hydrologists involved in monitoring wells in the Cuyama Basin, we would recommend that current baselines be established for TDS, nitrate levels, and specific heavy metals such as arsenic relevant to different areas of the basin	What is a 'baseline' for TDS, arsenic, nitrates and metals? This is not a term typically used in conjunction with water quality
63	2.2.7 GW Quality				Monitoring be established that relates depth of groundwater extraction to constituents present and monitors for changes over time. Water quality analysis should also include tritium analysis to determine the age dating of water and verify if recharge from the surface is occurring.	The relationship between depth to groundwater and the concentration of water quality constituents is not known in this basin due to limited groundwater quality monitoring information - therefore - the relation between depth and constituent concentration cannot be developed accurately, and is a data gap that should be filled during GSP implementation
64	2.2.7 GW Quality				How will nitrogen loading from both agricultural applications and groundwater use be monitored?	GSAs do not have authority toregulate agricultural fertilizer practices - therefore, the GSA will not be monitoring them.
65	2.2.7 GW Quality				How will arsenic induction by extraction of ancient water be monitored?	It won't be performed as a part of the initial GSP - the relationship between depth to groundwater and the concentration of water quality consituents (like arsenic) is not known at this time. The GSA board may decide to establish an arsenic monitoring program as part of GSP implementation and expansion of the water quality monitoring grid, but existing monitoring is erratic, spatially inaedquate and not useful for this purpose.
66	2.2.7 GW Quality				Does CCSD have a time series of arsenic level in their wells to see if changes have occurred?	The CCSD has not provided water quality data
67	2.2.8 Interconnected Surface Water Systems				This section will also need a historical component of surface water loss through looking at riparian habitats.	Comment noted. Historical information on surface water loss is not available except through model estimates.
68	2.2.9 GDE				A response to the study being conducted by a consulting biologist: this study should be done when GDEs are most biologically active and engage ground-truthing by accessing local knowledge of the different areas of the Basin.	Comment noted.
69	2.2.10 Data Gaps				Throughout this section data gaps are referred to, but are not listed here. The fact that there are so many data gaps in this section is very disconcerting, since most of these gaps provide critical data to inform the model. Not having these data introduces greater uncertainty in the validity of the model.	Comment noted. The model will be developed based on the best available information that is currently available, but can be updated in the future.
70	Ch 2 Intro	1	1	This document includes the	It looks like some the GSP regulations for § 354.8 is missing or maybe part of another chapter. Other GSP Regulations seem to be included but not listed.	As noted, this is just one section that will satisfy the requirements of § 354.8
71	2.2.1 Useful Terminology	N/A	N/A	MCL – Maximum Contaminant	Suggest defining the Primary and Secondary MCL which is discussed in the document, but not defined.	These terms are not used in the document.
72	2.2.2 GW Elevation Data Processing	Bullet list	N/A	N/A	Please verify if any wells are duplicates and/or reported to multiple agencies?	This was performed prior to development of the section.

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73	2.2.2 GW Elevation Data Processing	2	2	Data collected also included	Please clarify the meaning of "questionable measurement code"	This information is provided by monitoring agencies to indicate when conditions at a well effect the quality of a measurement. This level of detail is not needed in this document.
74	Figure 2.2-2 & 2.2-4	N/A	N/A	N/A	Please label [Bitter Creek] on figure.	The location of Bitter Creek is shown in Figure 2.2-1
75	2.2.1 Useful Terminology	N/A	N/A	Figure 2.2-1	Add faults to acronym list (missing GRF and TTRF)	These have been added to the acronyms list
76	Figure 2.2-2	N/A	N/A	N/A	Suggest removing the word Earlier from figure and adding actual years, if possible	This change is not needed as the purpose of this figure is to highlight wells with recently measured data.
77	General	N/A	N/A	N/A	Suggest showing State and Federal lands on all of the figures. This may help the public understand why some areas have no wells or water quality data.	These are shown on the figures in the Plan Area section.
78	General	N/A	N/A	N/A	Suggest adding stream/creek names to all figures that mentioned streams/creeks in the description of the figure.	The stream names have been added to Figure 2.2-1
79	Figure 2.2-3	N/A	N/A		Suggest adding on figure abbrev. or defining terms in the description of Figure 2.2-3 for CVKR, CVFR, CVBR	These are names that are provided for the wells. We assume they are abreviations, but have not come across definitions, and thus cannot provide that information.
80	Figure 2.2-5	N/A	N/A		Suggest - Label on figure (Russell Ranch Oilfields, Cottonwood Canyon, & Aliso Canyon)	These are labeled on Figure 2.2-1
81	Figure 2.2-11	Bullet list	N/A		Round Springs Canyon, near Ozena Fire Station & Springs Canyon, near Ozena Fire Station - Please label on figures.	These are labeled on Figure 2.2-1
82	2.2.3 GW Hydrographs			Figure 2.2-12 shows	Suggest stating your interpretation of why this area is having a quick recovery (for example - stream influence provides recharge to this basin area / fault/ etc.), if known or is additional investigation required?	Comment noted. This is beyond the scope of this section.
83	2.2.3 GW Hydrographs			Near Ventucopa, hydrographs for Wells 85	Suggest defining climatic patterns.	Figures showing the climactic variability will be included in the Water Budgets section.
84	Figure 2.2-12			The hydrograph for Well 40	Missing: Suggest adding well hydrograph to the Figure 2.2-12. (for wells 40 & 316)	The text has been revised for clarity.
85	2.2.3 GW Hydrographs	9	2	The hydrographs in this area show consistent	Suggest adding your interpretation of why this area shows consistent decline and little to no responses, if known or is additional investigation required?	Comment noted. This is beyond the scope of this section.
86	Figure 2.2-14	10	3	Levels remain lowered along	Missing: Suggest adding well hydrograph to the Figure 2.2-14. (well 640)	The text has been revised for clarity.
87	2.2.3 GW Hydrographs	10	4	Groundwater levels are higher to the west	Suggest adding your interpretation of why this area shows consistent decline, if known or is additional investigation required?	Comment noted. This is beyond the scope of this section.
88	Figure 2.2-15	N/A	N/A		Please define GSE and WSE – located on hydrographs	These have been added to the acronyms list
89	2.2.3 Vertical Gradients	Bullet list	N/A	CVFR is comprosed of four completion	Please clarify term "completion". Is this a cluster of monitoring wells?	A sentence has been added to the section to define "multiple completion well"
90	2.2.3 Vertical Gradients	Bullet lists	N/A	N/A	Suggest showing the map location for CVFR, CVBR, and CVKR if possible.	The locations of these wells are shown in Figure 2.2-3
91	2.2.3 GW Countours	Bullet List	N/A	Due to the limited spatial amount	Please explain more of the process to generate the contours in this section or in an appendix, number of wells used, etc.	Comment noted. Additional information is not needed.
92	2.2.3 GW Countours			The contour maps are not indicative	Suggest adding: do not account for topography ***or faults***. A short discussion on faults would be helpful to the public with the groundwater contours.	The faults are discussed in detail in the GCM section.
93	Figure 2.2-20				Bitter Creek - Place label on figure	This is labeled on Figure 2.2-1
94	2.2.3 GW Countours			Contour maps for spring 2017	Suggest explaining the difference between the years from all of these figures, to help the public understand what they are reviewing.	The text has been added to the document.
95	Figure Y-1, Y-3, Y-5, Y-7				Suggest adding groundwater flow arrows to the figure	Groundwater flow arrows have been added to these figures
96	Figure Y-1				Ozena fire station - place label on figure	This is labeled on Figure 2.2-1
97	2.2.3 GW Countours			The contour map shows a steep	The contour map shows a steep gradient ***north*** of - Suggest verifying the direction	The text has been revised for clarity.
98	2.2.6 Land Subsidence	N/A	N/A	N/A	Suggest showing and discussing the entire basin area, as well as showing the three stations (P521, OZST, and BCWR) on a figure with graphs, if possible.	The current figure shows all 3 station locations. The data for P521 is shown because it is the most relevant.
99	2.2.7 Data Analysis	2	2	In 1966, TDS was above the MCL	Please list and discuss all of the secondary MCL standards for TDS (500 mg/L; 1,000 mg/L and 1,500 mg/L) and why 1,500 mg/L is being recommended.	Comment noted. No change needed.
100	Figure 2.2-23	N/A	N/A	N/A	Place label on figure (Ozena Fire Station, Santa Barbara Canyon, and upper Quatal Canyon)	These are labeled on Figure 2.2-1
101	2.2.7 Data Analysis			In the 2011-2018 period, TDS was	In the 2011-2018 period, TDS was above the **MCL** in over 50% of measurements. - Suggest listing which MCL standard?	Comment noted. No change needed.
102	Figure 2.2-24	N/A	N/A		Place label on figure (Quatal Canyon, and along the Cuyama River between Cottonwood Canyon and Schoolhouse Canyon)	These are labeled on Figure 2.2-1
103	Figure 2.2-25	N/A	N/A		Place label on figure (Quatal Canyon)	This is labeled on Figure 2.2-1

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104	2.2.7 Data Analysis			Figure 2.2-26 shows that the	Figure 2.2 26 shows that data collected in 1966 was below the MCL of 5 mg/L throughout the basin, with **some measurements** above the **MCL** in the central portion of the basin where irrigated agriculture was operating Suggest adding number of samples: ## samples out of ### total samples & Suggest adding the primary MCL for nitrates to be consistent with the rest of the page	Nitrate MCL has been corrected to 10 mg/L
105	2.2.7 Data Analysis			Figure 2.2-27 shows that the	Figure 2.2 27 shows that data collected over this period **was generally** below the **MCL**, with two measurements that were over 20 mg/L. Suggest adding number of samples: ## samples out of ### total samples & Suggest adding the primary MCL for nitrates to be consistent with the rest of the page	Nitrate MCL has been corrected to 10 mg/L
106	2.2.7 Data Analysis			Figure 2.2-28 shows that the	Figure 2.2 28 shows arsenic measurements from 2008-2018. Data was not available prior to this time period in significant amounts. Figure 2.2 28 shows arsenic measurements **were below** the MCL of 10 ug/L where data was available. Suggest adding number of samples, ## samples out of ### total samples	Text has been revised for clarity.
107	Figure 2.2-31				Place label on figure (Ballinger, Quatal, and Apache Canyons)	These are labeled on Figure 2.2-1
108	2.2.7 Literature Review	Bullet List		97% of samples had concentrations greater than	Is this the MCL for each concentration? If so, please add the MCL in the bullet point	These are not the MCL. No change needed.
109	General				This section as a whole requires significant revision. The description of wells needs to be revised to be clear what entity conducted the monitoring, not what database W&C gathered the data from. For a discussion of SBCWA monitoring programs in the basin, the SBCWA contract with the USGS, and its relationship to CASGEM, please contact Matt Scrudato. This section contains minimal analysis of groundwater conditions, just reporting of selected hydrographs, with little explanation or interpretation. The water quality section is confusingly structured and incomplete. Finally, although we understand the time sensitivities in preparing the GSP by spring 2019, it would save reviewers quite a bit of time if a technical editor or senior W&C staff member reviewed these sections prior to distribution.	The section has been revised for clarity.
110	General				Most of the wells in the basin are not dedicated monitoring wells, but are frequently described in this section as such.	Text has been revised for clarity.
111	2.2.1 Useful Terminology	Bullet list		There are two versions of contour maps	Consider breaking identification of gw elevation and depth to water info out into a separate bullet point. GW elevation and depth to water are not just used on contour maps, they are used in hydrographs as well.	Text has been revised for clarity.
112	General				Please change "collected" to "compiled" throughout this section. It is potentially confusing to the reader to describe gathering data from various sources as collecting data. Typically collecting well data refers to taking measurements	Text has been revised for clarity.
113	2.2.2 GW Elevation Data Processing	1	1	Groundwater well information and	"collected from **local stakeholders**" - These appear to be included in the 8 major sources.	Text has been revised for clarity.
114	2.2.2 GW Elevation Data Processing	Bullet List		Well and groundwater elevation data were	Was data collected from the CSD? If so, include in list.	No data was collected from the CSD
115	2.2.2 GW Elevation Data Processing	Bullet List		list of data	Include references for publically available data sources; Any available info on data validation, and collection would be useful for these.	References are included in the Data Management GSP section
116	2.2.2 GW Elevation Data Processing			Data collected included well information	Data accuracy section is needed. What standards/protocols are each of these data collection entities following? How is ground surface elevation being determined. DGPS like the original USGS model? Off a map with +/-20 foot accuracy? Please elaborate.	This has been addressed in a footnote.
117	Figure 2.2-2 & 2.2-3				Figures should be titled differently. These are not DWR wells. They are wells with data pulled from the DWR database. The DWR database I assume is CASGEM, which was ultimately collected by SBCWA/USGS. The database that Woodard and Curran compiled the data from is ultimately less important than how it was gathered. Need to make distinction in the title (which is different on the actual figure) of what this is supposed to show. Where they got the data and/or who collected it? Actual title on figure says "DWR Wells" which is not an accurate statement.	Figure titles have been revised for clarity.
118	2.2.2 GW Elevation Data Processing			Roughly half of the wells from DWR's database	Please provide context for why this is important in the text. "measured in 17-18 is mentioned throughout without context. This is a plan that will be issued in 2020. Why 17-18 is the focus needs to be explained.	Text has been revised for clarity.
119	2.2.2 GW Elevation Data Processing			Data collected from the DWR	This is confusing. Data was perhaps collected by Woddard and Curren from DWR, but the data was not collected by DWR. Clarify data received (how / where did they locate the data) vs collected (who and how collected.	Text has been revised for clarity.
120	2.2.2 GW Elevation Data Processing			Data collected from the DWR	"one measurement in the spring, and one measurement in the fall " - If this refers to the CASGEM wells this is not entirely true – most wells monitored 1xyear with a few 2xyear	Text has been revised for clarity.
121	Figure 2.2-3				This list of wells is mostly accurate, but is missing some wells like Spanish Ranch on far west end.	Wells included in Figure 2.2-3 have been reviewed and it has been confirmed that the Figure includes all well data provided by the USGS
122	2.2.2 GW Elevation Data Processing			Data collected from USGS has been typically measured bi-annually	Not entirely true. And there is data overlap here with CASGEM program. Again, describe SBCWA/USGS monitoring program.	Text has been revised for clarity.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
123	2.2.2 GW Elevation Data Processing			Santa Barbara wells are concentrated in the western portion	This does not include all wells monitored by the County. The County does not own these wells, and monitors far more than just these wells.	The maps show the wells and data that had been provided as of June 2018.
124	2.2.2 GW Elevation Data Processing			Data collected from the counties	"measured bi-annually" - Currently making quarterly measurements. Appear to be missing wells. Were a few select wells chosen?	Text has been revised for clarity.
125	Figure 2.2-4				Missing a few. Difficult to determine how many. At some point need to should describe why/how these are different from DWR/CASGEM and USGS program. For example, Matt Scrudato is monitoring in the west end because there is a lack of data in that area – something SBCWA agreed to do to help with GSP development.	The maps show the wells and data that had been provided as of June 2018.
126	2.2.2 GW Elevation Data Processing				Need to add a section somewhere that describes QA/QC process, who does it (USGS, SBCWA), who doesn't (Bolthouse/Grimmway/Grapevine), and why.	This has been addressed in a footnote.
127	2.2.2 GW Elevation Data Processing			The locations of SBCWA well data are located	What is the difference between these wells and the wells referenced in Figure 2.2-4? SBCWA should be taken off Figure 2.2-5 for several reasons (we don't own the wells shown, we're not a private company, we're not ag, etc). All of wells measured by Matt Scrudato should be in Figure 2,2-4	Wells included in these figures have been reviewed and it has been confirmed that the Figure 2.2-4 includes all well data provided by the SBCWA and that Figure 2.2-5 includes all well data provided by private landowners.
128	2.2.2 GW Elevation Data Processing			The locations of SBCWA	"The locations of SBCWA well data are located **west of Cottonwood Canyon**" - West of Aliso Canyon would be more accurate	Text has been revised for clarity.
129	2.2.2 GW Elevation Data Processing			The date of measurement varies significantly by year.	Explain why this is important as context for the reader.	Text has been revised for clarity.
130	2.2.2 GW Elevation Data Processing				"Data provided by Grapevine Capital Partners is **bi-annual** " - quarterly	Text has been revised for clarity.
131	Figure 2.2-7				This graph is more confusing than helpful. Please reomve. Well locations are already identified previously and hydrographs are better described in later sections. The need for this statement and graph appears to be validation for the quality of water level data provided by Grimway and Bolthouse. This should be done in a separate data validation section. Please remove the statement "accurate measurements" from this paragraph. At best, the statement can note that data "match ing tracking historical trends within a 4-mile area", but in no way should refer to these data as "accurate measurements". Then again, what is the definition of an "accurate measurement"? The USGS states that discrete water level measurements made with graduated steel or electric tapes are accurate to 0.01 foot. What standard is Woodard & Curran using? If this graph is kept in the document, the graph should start in about year 1977 when there is a comparison between the data sets. The data prior to this is irrelevant. It is not clear which well relates to which line on the graph. 1.Were there any wells which were monitored by BOTH Grimway/Bolthouse and the USGS where data can be compared for a single location? Are these all the Grimway/Bolthouse wells where data are available or only a select few? 2.DWR are not collecting well data in Cuyama	The figure is included because of interest expressed during public meetings regarding how data provided by private landowners compares with data provided by public agencies. The text describing the figure has been revised for clarity.
132	2.2.2 GW Elevation Data Processing			Figure 2.2-7 shows a comparison of data	Need context to explain why this comparison is being done.	Text has been revised for clarity.
133	2.2.2 GW Elevation Data Processing			Figure 2.2-8 shows a comparison of data	Need context to explain why this comparison is being done.	Text has been revised for clarity.
134	Figure 2.2-8				The need for this statement and graph appears to be validation for the quality of water level data provided by Grapevine Capital Partners. Please remove both the discussion (page 2.2-11) and the graph as these data illustrates nothing at all. 1.Two of the Santa Barbara County wells are not even part of the network. I don't even think these wells exist in the Valley. It is unclear where these data came from. 2.You appear to be comparing very shallow wells to a 6 of the 12 deep production wells. 3.Are these discrete static water level measurements used for the Grapevine data or select points from the continuous 5-minute data sets? SBCWA has been making periodic discrete water level measurements at the 12 productions wells on the Harvard property. A comparison of 26 measurements shows differences between discrete water level and computed water levels ranging from -47.9 feet to 150.36 feet. These are large outliers when compared to all the measurements, but would be a better indication of the data quality (see chart below). SBCWA has measurements from 9/2018 to compare as well. There would be some variation of only a few feet in this comparison based on equipment PSI (most likely higher PSI being used due to large level changes and therefor reduced accuracy), MP elevation choice, computation procedures, etc. Please contact Matt Scrudato to discuss specifics.	The figure is included because of interest expressed during public meetings regarding how data provided by private landowners compares with data provided by public agencies. The text describing the figure has been revised for clarity.
135	2.2.2 GW Elevation Data Processing			A long term comparison is not possible	The wells are in different locations, what value does this provide?	The figure is included because of interest expressed during public meetings regarding how data provided by private landowners compares with data provided by public agencies. The text describing the figure has been revised for clarity.

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136	Figure 2.2-5				Again, misleading title here vs. actual figure which states "Owners and Operating Entities" SBCWA does not own or operate the wells assigned to us in this graph. We only own and maintain CVFR, CVKR, and CVBR. Further this map does not include most of the wells measured by the SBCWA	The figure title has been revised for clarity
137	2.2.3 GW Trends				This section needs major reorganization. There is a time based section, then a number of other sections without a designated timeframe. Also, the wording in this section needs a thorough review by a technical editor.	The text has been revised for clarity.
138	2.2.3 1947 to 1966 GW Trends			1947 to 1966 Groundwater Trends	Hydrographs illustrated are all through 2018. Are you trying to differentiate between times or is the next section a separate concept? If so, there needs to be discussion on more current trends following 1966.	The text has been revised for clarity.
139	2.2.3 GW Hydrographs			Groundwater Hydrographs	This is confusing. The previous section is about a specific time period. If this is 1966-present you should say so.	The text has been revised for clarity.
140	2.2.3 GW Hydrographs			Groundwater hydrographs were developed to provide indicators	What indicators? Don't the hydrographs just show trends?	The text has been revised for clarity.
141	2.2.3 GW Hydrographs			Hydrographs for all monitoring wells with elevation	There can be a big difference between a monitoring well and a well that is being monitored. Be more clear.	The text has been revised for clarity.
142	Appendix X				Comments on Appendix X: 1)Some graphs extrapolate off the hydrograph – is this in error or is there a data point(s) not shown? 2)Similarly, some graphs don't show any data points. 3)Scale issues 4)No need for one per page, consider 4 5)Hydrographs don't identify data source, who and how collected and whether data has been QA/QC. Consider adding an index of all wells, like a lookup table, with OPTI number, USGS number, and well number owner/operator uses, etc.	1) This has been fixed by increasing vertical scale 2) Some OPTI wells only have groundwater quality data associated with them. Because there are so many wells, a hydrograph was made for every OPTI well; therefore some do not have level data. 3) This has been addressed in #1. The graph scales were selected to show the depth to water of all wells on the same scale. 4)One figure per page allows greate detail to be seen in the graphs, as some have a significant amount of data points. 5) This information is available through OPTI for those who would like to review it.
143	2.2.3 GW Hydrographs			Figure 2.2-11 shows Hydrographs in different portions	Please describe in the text why these wells were chosen. Are they representative of the areas?	The text and figure have been revised for clarity.
144	2.2.3 GW Hydrographs	Bullet list		In the area southeast of Round Springs Canyon	Please edit for clarity and grammar. Also, if you are going to describe the hydrographs, you should describe all of them If they want to generalize then make the graph mimic these areas, pick 5 representative hydrographs. Right now there are 7 on the Figure which looks cluttered.	The text has been revised for clarity.
145	Figure 2.2-11				Bitter Creek area - Illustrate on map as a reference	This is labeled on Figure 2.2-1
146	2.2.3 GW Hydrographs			Figure 2.2-12 shows selected hydrographs	Why is this section in a different format than the previous. Please make consistent.	Comment noted. No change needed.
147	Figure 2.2-12				Well 40 & 316 - where? Not shown in map	The text has been revised for clarity.
148	2.2.3 GW Hydrographs			Figure 2.2-13 shows hydrographs of discontinued monitoring wells	Then need to explain why they were selected.	The text has been revised for clarity.
149	General				Stick with one descriptor – either elevation or depth to water. Mixing elevation and depth to water is confusing to the reader.	The section consistently discusses depth to water
150	Figure 2.2-14				Well 640 - where? Not shown in map	The text has been revised for clarity.
151	2.2.3 GW Hydrographs			Figure 2.2-15 shows hydrographs of monitoring wells	The discussion on west end hydrographs and the related Figure 2.2-15 is misleading. Continuous data sets from the 12 wells indicate water levels drops as large as 100 feet in CHG-14 since data collection started in June 2017. This well is the extreme, where other production wells on Harvard vineyard property show water level drops of 25-50 feet. The trends indicate the yearly hydrologic minimum continues to drop.	Wells shown in Figure 2.2-15 show a range of conditions in the western edge of the Basin. OPTI Well 840 shows conditions see in part of the Basin.

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152	2.2.3 GW Hydrographs			Hydrographs for wells 571 and 108	Earlier discrete data located in NWIS.	Well 571 (USGS Code 345847119534901) only has two measurements as shown in the hydrograph (https://groundwaterwatch.usgs.gov/AWLSites.asp?S=345847119534901&ncd=) Well 108 has 8 measurements. Individual points are difficult to destinguish due to hydrograph size, but the hydrograph is correct.
153	Figure 2.2-11				Suggest illustrating hydrographs using same scale / minimize white space for all Figures in this section	All hydrographs on each figure are the same scale
154	Figure 2.2-12 & 2.2-13				Actual Figure has typo in title Also for all Figures in this section, suggest only showing hydrographs referred to in text.	The figure and text have been made consistent. Title corrected.
155	2.2.3 Vertical Gradients			Knowledge about vertical gradients is required by regulation	Please cite the regulation for the reader.	The text has been revised for clarity.
156	2.2.3 Vertical Gradients			Figure 2.2-16 shows the combined hydrograph	State that these wells were installed by USGS as part of the Cuyama Valley Water Availability Study in cooperation with the SBCWA. Multiple completion wells are owned by SBCWA.	This text has been added.
157	Figure 2.2-16, 2.2-17, 2.2-18				The data used to determine there is no vertical gradient as illustrated in the figure 2.2-16 (page 2.2-27) appear to be discrete measurements. At times, there were only two discrete measurements in a year with the remainder of the year interpolated. This is not enough data for an elevation comparison. The USGS used continuous 15-minute unit value data for this nested well and concluded the following (from page 39, Scientific Investigations Report 2013-5108) CVFR.....did show similar seasonal and longer-term changes. Similar to CVKR and CVBR, the vertical hydraulic gradients were upward during the winter months and reversed to downward gradients during the irrigation season; however the gradients at the CVFR site were notably smaller. USGS conclusion supported by water chemistry samples showing increased tritium with depth which may result from younger water from shallow sytem. Woodard & Curran should review the full continuous data set prior to making a conclusion about vertical gradients. Data are available on NWIS. This is data for 3B2- https://nwis.waterdata.usgs.gov/ca/nwis/uv?cb_72019=on&format=gif_default&site_no=345351119323102&period=&begin_date=2010-09-04&end_date=2012-09-01 1.The scale used in these graphs (2.2-16, 17 and 18) mask the trends and makes any analysis impossible. Please change the graph scale for all three graphs (2.2-16-18). 2.The x-axis date scale for Figures 2.2-16 and 17 follow an unusual interval. Is this done for any specific reason (see figure below)? A graph with a scale that masks everything that is happening. A 600 ft axis for a graph with an 80 ft range.	Available Continuous Data has been added. Continuous data is only available from 7/21/201 through 11/28/2012 as it has been "Approved." All other "Provisional" data is only available in summary form, which is the data that was being shown in the hydrograph. Newly added continuous data follows the trend that was already shown on hydrograph.
158	2.2.3 GW Countours			Groundwater contour maps were prepared for	Where is 2016	The hydrograph periods were selected to show the change over the most recent period of 3 years for which data was available in the Spring (from 2015 to 2018) and from the Fall (from 2014 to 2017). Therefore, a figure for 2016 was not necessary.
159	2.2.3 GW Countours			These years were selected	Explain in the text the importance of this date in relation to SGMA. Why? Explain. I may have missed this in earlier sections but are they choosing Jan 1 2015 as their baseline?	The text has been revised for clarity.
160	2.2.3 GW Countours			Each contour map is contoured at	Labels and symbols should be obvious on the map without having to describe in the text	Comment noted. No change needed.
161	2.2.3 GW Countours			Due to the limited temporal amount	Non-pumping and static measurements? What was the selection of wells based on? It appears wells are missing.	The maps are based on available data during the period in question.
162	2.2.3 GW Countours			These assumptions make the contours	Explain in the text which wells aree used and why? Howe was data interpolated?	The maps are based on available data during the period in question.
163	Figure 2.2-19				Correct typo in text on lower right of map - "limitated"	The figure has been corrected.
164	Appendix Y				Where are contour maps for 2016?	The hydrograph periods were selected to show the change over the most recent period of 3 years for which data was available in the Spring (from 2015 to 2018) and from the Fall (from 2014 to 2017). Therefore, a figure for 2016 was not necessary.
165	2.2.3 GW Countours				These descriptions are not useful with the maps in the appendix. The descriptions should be with the maps, either here in the text or back in the appendix.	Comment noted. No change needed.

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166	2.2.3 GW Countours			Figure Y-1 through Figure Y-8	Explain reason for changes in seasonal contours.	Comment noted. No change needed.
167	2.2.4 Change in GW Storage			Change in groundwater storage for the last 10 years	Why 10?	SGMA requires 10 years of data for historical water budgets
168	2.2.6 Land Subsidence				The paper mentions that the USGS determined 0.2 feet of subsidence in 10 years. This appears to be the change in daily land surface elevation starting in about May 2007 (0.00 mm) and ending in April 2012 (-68mm). This would be a 5-year period of record for analysis. The full 12 year period of record from 2000-2012 is 0.4 feet of subsidence and the 10-years mentioned in the W&C paper (2000-2010) is 0.26 feet of subsidence. Woodard&Curran used data from 1999 to 2018 to determine 1 foot of subsidence. The brief and general summary of the USGS data and analysis from SIR 2013-5108 does not seem to correlate to what is written in this paper. Please expand on the first paragraph related to the USGS data. This will help the reader determine what was completed prior to your analysis of these data.	The subsidence estimate in the first paragraph has been corrected.
169	Appendix Z				Appendix Z adds little value to the document, appears to be at least partly taken directly from Wikipedia, only focuses on subsidence effects on agriculture, and appears to have been written prior to W&C contracting with the GSA. It is unclear why this was included in the document. Background educational materials data on, e.g., water level data collection, water quality, and other topics is not provided, so why provide this for subsidence. Please delete.	Comment noted. The appendix is included because some readers are interested in this content.
170	2.2.7 GW Quality				A summary of the conclusions drawn about water quality would be very useful. As written, the section is quite disjointed. There is a smattering of data analysis, and review of other studies, but no conclusions about what groundwater quality conditions are in various regions of the basin. There is no explanation of why constituents were selected for analysis. The literature review might be better placed before the data analysis to provide context.	Some additional explanation has been added, including an explanation has been added for why these constituents were included.
171	2.2.7 Reference and Data Collection				Why was age dating data not considered in this analysis and discussion? Why no data from the CSD? Does this (USGS) include NWIS?	The CSD did not provide water quality data. Age dating does not provide information on water quality conditions in the data. The USGS data does include NWIS.
172	2.2.7 Reference and Data Collection			Data used in reference studies was not generally available	This is not correct. ALL data used in USGS and SBCWA studies (3 out of the 4 referenced in this section) are available and are therefore represented in the data.	The text has been revised for clarity.
173	2.2.7 Data Analysis			Collected data was analyzed for TDS, nitrate, and arsenic	Explain in the text why only these constituents were selected. Explain for the lay reader what the possible sources of these constituents are	The text has been revised for clarity.
174	2.2.7 Data Analysis			Figure 2.2-24 shows TDS of groundwater	Note: Additional data for west end collected July 2018 will be available soon.	Comment noted. Due to budget and schedule constraints, data provided after June 2018 will not be incorporated into the current version of the plan.
175	2.2.7 Data Analysis			Multiple years of collected data were used	Where is the comparison? Figure 2.2-23 (1966 data) shows high (>2000mgL) TDS for wells on west end N of river. These are very shallow and recharged by the river. Figure 2.2-24 shows wells directly S of river with low TDS. These are new deep wells. They shouldn't be compared as the same unit. The map aludes to the fact that they are. That possibly the quality has improved	The text does not make a direct comparison because there is insufficient data to make specific conclusions regarding how TDS may have changed over time.
176	Figure 2.2-25				Include a line showing the MCL on the figure	MCL lines have been added to the figure.
177	2.2.7 Data Analysis			Figure 2.2 28 shows arsenic measurements	USGS data indicate 4 of the 33 wells were >10 Only 25 wells used in this study. Why the discrepancy and why were the 4 wells with >10 not used? Please elaborate on data selection used for this analysis.	The text and figure have been reviewed and updated.
178	2.2.7 Data Analysis			Figure 2.2-28 shows arsenic measurements	What about the CSD? They treat for arsenic.	The CSD did not provide any arsenic data.
179	2.2.7 Data Analysis			Figure 2.2-29 shows that most of these sites	Describe for the reader what this means – leaks from storage tanks?	The text has been revised for clarity.
180	2.2.7 Literature Review	1	1	In 1970, Singer and Swarzenski reported	"TDS was as high as 1,500 to 1,800 mg/L TDS" - contradicts following sentence; "and higher (3,000-6,000 mg/L) in wells " - This is much higher than the first sentence says.	The text has been revised for clarity.
181	2.2.7 Literature Review	1		They state that the high TDS is generated	"water from marine rocks" - Confusing if you don't identify them geologically	Comment noted. No change needed.
182	2.2.7 Literature Review	2		The study identified that specific conductance	In the text, please provide context for why this is important and what this means in the context of groundwater quality.	The text has been revised for clarity.
183	2.2.7 Literature Review			In 2013, USGS reported	Please discuss any vertical gradients in constituent concentrations in the multicompletion wells.	The text and figure have been reviewed and updated.

Cuyama Basin Monitoring Networks Chapter
Summary of Public Comments and Responses
January 25, 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1	General				The Monitoring Networks spatial density around the faults of interest is insufficient.	Comment noted. These areas have been included in the groundwater level data gaps.
2	General - Well Data with Completion reports				The insufficient Quality Control / Quality Assurance compounds the uncertainty due to the scarcity of data.	Comment noted. Monitoring protocols will be set up to ensure consistent QA/QC for monitoring in the future.
3	General (Well ID #)				Will any cross reference table for well ID#s be made available?	This can be provided separate from the document.
4	Global (Salinity)				Please use the term TDS	The text has been changed to note at first usage that salinity is measured in TDS
5	General				The MN must asses all causal nexus between groundwater quality and groundwater extraction, such as constituents migrating into areas with lower pressure heads due to heavy groundwater extraction.	Comment noted. This can be accomplished in the implementation phase by filling in the monitoring data gaps.
6	4.2 Basin Conditions (Pg. 4-11)			Fig 4-2 Combined Hydrograph	The text should clearly articulate that groundwater elevations have declined consistently over 500' since pumping started in 1947.	The text has been revised for clarity.
7	4.3 Existing Monitoring Used (Pg. 4-13)				Other wells that have been monitored by DWR - CASGEM, USGS and/or The Ventura County Watershed Protection District (VCWPD) in the Ventucopa Uplands river corridor should be reconcidered for selection as a monitoring site for the GSP.	Comment noted. Additional wells can be added during the GSP implementation phase.
8	Table 4-5: Cuyama Basin VCWPD Wells (Pg. 4-22)				Table is mislabeled as; Number of SLOCFC&WCD wells	The table has been corrected.
9	Table 4-9: Cuyama Basin NWQMC, USGS, IRLP Water Quality Monitoring Sites (Pg. 4-29)				The texts suggests "The NWQMC database provides data on 47 water quality monitoring sites", but the table indicated there are 176 sites.	The text has been revised for clarity.
10	GAMA / DWR (Pg. 4-31)			age dating and groundwater movement trending	If freshwater recharge is assumed to be happening, then where is it going if not into the productive wells of the area?	Comment noted. This is not relevant to the Monitoring Network section.
11	4.3.5 Surface Water Monitoring (Pg. 4-37)			Fig 4-14	Not one stream gauge exists on the Cuyama River within the basin. Can we get a Plan to fill this Data Gap? Flow Gauges at the 3 bridges over the Cuyama?	This will be discussed in Section 4.10 when it is developed.
12	4.5.5 Representative Monitoring (Fig 4-16 thru Fig 4-18)				The major Data Gaps area in Fig 4-18 are also the fault zones of interest and the likely boundaries to proposed Management Areas (or Threshold Regions). What is the plan to solve this uncertainty?	This will need to be addressed during the GSP implementation phase.
13	4.6 Groundwater Storage Monitoring Network (Pg. 4-53)				All of the data gaps for the groundwater level monitoring network will now compound the uncertainty of the Groundwater Storage calculations. How will calculations made from uncertain data be verfied for QA/QC?	Monitoring protocols will be set up to ensure consistent procedures for monitoring in the future.
14	4.8 Degraded Groundwater Quality Monitoring Network (Pg. 4-53)				The best available science suggests a causal nexus between SGMA related activities like groundwater extraction and the migrations of constituents into areas with lower pressure heads due to unsustainable extraction.(See Appendix A, page 21-29) Boron, Arsenic & Nitrites should be monitored along with age dating to determine the movement of bodies of groundwater and the rates of any freshwater recharge.	The text has been revised to describe the rationale for establishing the monitoring network only for salinity.
15	4.9 Land Subsidence Monitoring Network (Pg. 4-60)				Is it possible to use other avaliable technologies (like InSAR to match the USGS data set) while we wait for more CGPS installations to come online?	The can be explored by the GSA during the GSP implementation phase.
16	4.9.5 Monitoring Protocols (Pg. 4-62)			"New stations will require downloading the data as equipment storage..."	Garbled english!	The text has been revised for clarity.
17	4.10 Depletions of Interconnected Surface Water Monitoring Network (Pg. 4-64)				The last of the Cuyama River Cottonwood trees stand as testament to the depletion of interconnected surface waters. Try to count them before their dead limbs crack and fall to the dry sands of their former wetlands.	Comment noted. No change needed in the Monitoring Network section.
18	Pg. 4-22				On page 4-22 the first line of the table is incorrect (not SLOCFC&WCD)). It should read VCWPD wells.	The table has been corrected.
19	Figure 4-7				The map in Figure 4-7 the title for VC wells in the legend for VCWPD should be more descriptive - Ventura County Watershed Protection District database wells to be consistent with the other maps.	The figure title has been changed.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
20	Intro			This section was prepared to meet the requirements	Consider listing the GSP regulations for this chapter	The regulation has been added.
21	4.2 Monitoring Networks Obj.	1	1	This section describes the Cuyama	Consider adding a comment or footnote on seawater intrusion to reinforce why it is not being monitored.	This is discussed in the Undesirable Results GSP Section.
22	4.2.1 Basin Conditions Relevant	2	3	There are no major stratigraphic aquitards or	Suggest clarifying this sentence. The basin has faults, maybe adding a figure of the Morales Formation.	The text has been revised for clarity. A figure of the Morales Formation is shown in the HCM Section.
23	4.2.1 Basin Conditions Relevant	2	4	The aquifer ranges from	Consider adding the top and bottom basin range.	The text has been revised for clarity.
24	4.2.1 Basin Conditions Relevant	3	1	The largest groundwater	Suggest adding a table of the entire basin for land use, square miles, and percentage, such urban, rural, open space, and etc.	This is discussed in the Plan Area section.
25	4.2.1 Basin Conditions Relevant	4	2	Generally, groundwater elevations	Consider quantifying the decrease in years, such as ... decreasing by approximately XX ft from the 1940s and 1950s to the present	The text has been revised for clarity.
26	4.2.1 Basin Conditions Relevant	4	2	Generally, groundwater elevations	Suggest verifying if the figure is missing.	The figure is included in the GSP section.
27	4.3.1 Groundwater Level Monitoring	4	1	CASGEM allows locally	Editorial: "CASGEM allows ~~locally~~ local agencies to be designated"	The text has been revised for clarity.
28	4.3.1 Groundwater Level Monitoring			There are currently six CASGEM	Clarification - The two SLO County CASGEM wells are volunteer wells (County agreement with private owner)	The text has been revised for clarity.
29	Figure 4-3			Cuyama Basin DWR/CASGEM Wells	Suggest adding the Federal and State areas to the monitoring network to help show why groundwater wells are not located in several basin areas.	These are shown in the Plan Area section and are not needed in this section.
30	Table 4-2			Cuyama Basin USGS Well Statistics	Suggest verifying if duplicate wells exist between all agencies, such as County, DWR, and USGS.	This is addressed in Section 4.3.2
31	Figure 4-4			Cuyama Basin USGS Wells	Suggest adding the Federal and State areas to the monitoring network to help show why groundwater wells are not located in several basin areas.	These are shown in the Plan Area section and are not needed in this section.
32	Table 4-3			Cuyama Basin SBCWA Well Statistics	Suggest verifying if duplicate wells exist between all agencies, such as County, DWR, and USGS.	This is addressed in Section 4.3.2
33	Figure 4-5			Cuyama Basin SBCWA Managed Wells	Suggest adding the Federal and State areas to the monitoring network to help show why groundwater wells are not located in several basin areas.	These are shown in the Plan Area section and are not needed in this section.
34	4.3.1 GW Level Monitoring - SLO	1	2	SLOCFC&WCD also reports the data for	SLO County – the two CASGEM wells are in the County's volunteer program (agreement between the County and owner). If using these 2 wells in the GSP, the CBGSA will need agreements with the owners.	Comment noted. Agreements can be sought during the GSP implementation phase.
35	Figure 4-6			Cuyama Basin SLOCFC&WCD Wells	Suggest adding the Federal and State areas to the monitoring network to help show why groundwater wells are not located in several basin areas.	This is addressed in Section 4.3.2
36	Figure 4-7			Cuyama Basin VCWPD Wells	Suggest adding the Federal and State areas to the monitoring network to help show why groundwater wells are not located in several basin areas.	This is addressed in Section 4.3.2
37	Figure 4-8			Cuyama Basin Community Services District Wells	Suggest adding the Federal and State areas to the monitoring network to help show why groundwater wells are not located in several basin areas.	This is addressed in Section 4.3.2
38	Figure 4-9			Cuyama Basin Private Landowner Wells	Suggest adding the Federal and State areas to the monitoring network to help show why groundwater wells are not located in several basin areas.	This is addressed in Section 4.3.2
39	4.3.3 GW Quality Monitoring - NWQMC	2	3	Initial water quality data for the Cuyama	Could this data be leveraged for the GSP? If so, please add the regulations pertaining to the IIRLP, such as water quality sampling.	This is included in the monitoring network. Regulations for IRLP progam can be found here: https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/
40	Multiple figures			Cuyama Basin NWQMC, USGS, IRLP Water Quality Monitoring Sites	Suggest adding the Federal and State areas to the monitoring network to help show why groundwater wells are not located in several basin areas.	These are shown in the Plan Area section and are not needed in this section.
41	4.3.3 GW Quality Monitoring - Private Landowners	1	1	Private landowners within the	Consider verifying if these owners are in the IRLP, included in GAMA?	Comment noted. This can be done during the GSP implementation phase.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
42	4.4 Monitoring Rationales	1	2	Monitoring networks in the Cuyama GSP	Suggest adding – "Cuyama Basin GSP"	The text has been revised for clarity.
43	4.4 Monitoring Rationales	3	2	The schedule and costs associated	Suggest adding –a period "GSP."	The text has been revised for clarity.
44	Table 4.13			Number of Wells Selected for Monitoring Network	SBCWA - Suggesting verifying that well are not being counted twice between agencies and verifying that the programs are continuing, if leverage existing programs	The table has been updated to note that the total does not equal the sum of the rows due to wells being duplicated in multiple databases.
45	Table 4.13			Number of Wells Selected for Monitoring Network	SLOCFC&WCD - Clarification - The two SLO County CASGEM wells are volunteer wells (County agreement with owner), not monitoring wells. The CBGSA will need agreements with the well owners for additional sampling beyond CASGEM	Comment noted. No change needed to text.
46	4.5.3 Monitoring Frequency	5	1	The Basin is an unconfined aquifer	Where did the 5 inches per year come from?	"5-inches" is based on values provided in Table 4-14, which is from the *Monitoring Networks and Identification of Data Gaps Best Mangement Practices.* " 5-inches" refers to the quantitative value of annual recharge. This value is output from the model, which currently models an annual recharge of # inches. Although this value is subject to change based on model calibration efforts, it is not expect to increase above 5-inches per year.
47	4.5.3 Monitoring Frequency	5	2	Based on the data in Table 4-14	Suggest that the CBGSA Board review the consultant economic benefit cost analysis on monthly, quarterly, and semi-annual groundwater sampling to determine what is feasible? Suggest the Consultant reviews the sampling timeframe with the CBGSA Board.	Comment noted. The specific time frame will need to be selected by the CBGSA Board going forward.
48	4.5.4 Spatial Density	3		Based on Hopkins well density	Suggest adding reference	The reference has been added to the text.
49	4.5.4 Spatial Density	3		Based on Heath	Suggest adding reference	The reference has been added to the text in the section and to the references at the end of the section.
50	4.5.6 GW Level Monitoring Network	1	1	The Groundwater Level Monitoring Network	Suggesting verifying that well are not being counted twice between agencies and verifying that the programs are continuing, if leverage existing programs.	Entities with current monitoring programs were attempted to be contacted. Of those that responded to our inqueries, most were non-committal with the continuation of their programs, however, this non-committal response was a result of not knowing specifics about the wells in Cuyama and not wanting to be responsible for missinformation. This is also why criteria for inclusion in the monitoring network is so broad. In the event some wells are discontinued, it is the hope that other wells will be able to provide sufficient data. If this is not the case, the GSA will have to determine if additional wells will need to be constructed. A review of the monitoirng network was conducted and no duplicates were found. Wells that appear in Figure 4-17: Cuyama GW Basin Groundwater level and Storage Monitoring Network Wells that have multiple labels for what appears to be the same site are actually multi-completion (aka multi-depth) wells. Each individual casing is considered an independent well due to the output of GWL measurements. Note: Due to revisions to the Monitoring Network and Representative Wells through Board direction, the Table and List of wells has been updated.
51	4.5.6 GW Level Monitoring Network	1	1	The Groundwater Level Monitoring Network	Does the CBGSA have to form agreements with the well owners for volunteer programs?	Yes, this will need to be done going forward during the GSP implementation phase.
52	4.5.6 GW Level Monitoring Network	3	1	The proposed monitoring frequency	Suggest that the CBGSA Board review the consultant economic benefit cost analysis on monthly, quarterly, and semi-annual groundwater sampling to determine what is feasible? Suggest the Consultant reviews the sampling timeframe with the CBGSA Board.	Comment noted. The specific time frame will need to be selected by the CBGSA Board going forward.
53	Appendix K	1	1	General	Suggesting verifying that this follows SGMA GSP protocols.	Appendix K is *Best Management Practices for the Sustainable Management of Groundwater Monitoring Protocols, Standards, and Sites* published by DWR and provided on the SGMA website.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
54	4.5.8 Data Gaps	3	1	Well construction information is not	Suggesting verifying if there is a SGMA GSP standard for well construction. If so, does this monitoring network meet these standards?	Article 3, Section 352.4, (c) describes the standards to apply to the wells. Although it outlines the information that should be included under Part (1), Part (2) states that either the GSA create a schedule for acquiring the necessary information, or describe why the information is not necessary to undersand and manage groundwater in the basin. Due to the extremely limited amount of data within the Cuyama Basin, an attempt to use all valuable data was made. To understand the limitations of the data, the Tiering System was utlized and discussed within the section. Additionally, within Project and Management Actions, there will be additional information about pursuing projects to obtain additional well information.
55	4.5.9 Plan to fill data gaps	3	3	New wells drilled by DWR's	Suggest updating this section when DWR approves the TSS for new wells	Comment noted. This will be considered if DWR approves the TSS before completion of the GSP.
56	4.8 Degraded GW Quality	1	1	Due to the relationship of undesirable	This needs to be vetted by the CBGSA Board for any constituent to be monitored and sampled. Is sampling for salinity meeting SGMA GSP regulations? Suggest providing a discuss of why other constituent are not being monitored	The text has been revised to describe the rationale for establishing the monitoring network only for salinity.
57	4.8.2 Monitoring Sites Selected	1	4	Note that due to duplication of wells	Consider updating the table (4-17) with the correct values.	The table has been updated.
58	4.8.3 Monitoring Frequency	2	3	The Basin, in coordination	This needs to be vetted by the CBGSA Board for any constituent to be monitored, sampled, and frequency of sampling.	Comment noted. The specific time frame will need to be selected by the CBGSA Board going forward.
59	4.8.6 GW Quality Monitoring Network	1	3	All 64 wells are representative	Suggest verifying if these are duplicate wells and if leveraging data from existing programs to verify that the program is continuing.	Comment noted. This will be done during the implementation phase going forward.
60	4.8.8 Data Gaps	4	3	All management entities are	Suggest verifying that this assumption is true	The text has been revised for clarity.
61	4.8.9 Plan to fill data gaps	3	2	Downhole video logging	Suggest verifying that you can perform downhole video logging in existing wells with casings.	This will be verified as specific wells are identified for video logging by the DWR TSS.
62	4.9.7 Plan to fill data gaps	1	3	Although there are multiple	Suggest reviewing the pros/cons and cost associated with recommendation	The rationale for this recommendation is provided in the text.
63	General				It is quite difficult to determine the appropriateness of the proposed monitoring network without know what the management areas will be. Suggest revising/recirculating once they have been identified.	Comment noted. This can be considered by the GSA Board.
64	Figure 4.1			Well completion diagram	Depth to Bottom of Well should/could be reworded to match the what is written under useful terms - Total Well Depth	Updated Figure
65	4.1 Useful Terms			Subsidence (refer to appendix Z	Suggest deleting appendix Z for reasons described in comments to Groundwater Conditions Section	Comment noted. The appendix is included because some readers are interested in this content.
66	4.2.1 Basin Conditions Relevant	2	3	There are no major stratigraphic aquitards	Fault lines?	The text has been revised for clarity.
67	4.2.1 Basin Conditions Relevant	2		The aquifer ranges from 10's to 100's of feet	Not a very useful, give #s.	Specific values are unavailble in this summary sentence. Therefore, numbers have been removed. For details on aquifer thickness, refer to the HCM section.
68	4.2.1 Basin Conditions Relevant	2		Median reported hydraulic	Median or a range?	Median, as shown in Table 2.1-1.
69	4.2.1 Basin Conditions Relevant	2		Figure 2.1-2 shows the extent	Do we have that?	This figure is in the HCM section.
70	4.2.1 Basin Conditions Relevant	3		Based on the most recent data from 2016,	Sentence is somewhat confusing.	The text has been revised for clarity.
71	Figure 4-2			Central Basin with Combined	Label wells on map	The figure has too many wells to effectively label them.
72	4.3 Existing Monitoring Used	1	1	This section discusses current groundwater	As mentioned in comments to the groundwater conditions section, this is a list of databases from which W&C pulled data, it is not a list of monitoring programs.	The text has been revised for clarity.
73	4.3.1 Groundwater Level Monitoring				I like how each monitoring entity is mentioned in a separate section below. A general summary of how these data were collected should be included for each entitry to include information such as: 1-protocols 2-accuracy 3-equipment used 4-QA/QC	Users can refer to the metadata provided by each data source for this information. This level of detail is not needed in this GSP section.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
74	4.3.1 Groundwater Level Monitoring - DWR, Statewide...			CASGEM Wells – Wells with well	Many of the voluntary wells have publically available well construction info. This distinction is not correct.	The text has been revised for clarity.
75	4.3.1 Groundwater Level Monitoring - DWR, Statewide...			Most wells were measured on a semi-annual	This is not correct, most wells are measured annually. Some were measured semi-annually during the USGS study.	The text has been revised for clarity.
76	Table 4-1			Summary Statistics for CASGEM Wells	No CASGEM program in 1946. It started in 2000. No big deal. These wells are now CASGEM.	The table header has been revised for clarity.
77	Figure 4-3			Cuyama Basin DWR/CASGEM	As commented on the groundwater conditions section, these are not DWR wells.	The figure title has been changed.
78	4.3.1 Groundwater Level Monitoring - USGS	5	1	USGS has approximately 25 approved	Needs to be much clearer. USGS doesn't "have" these wells. They happen to appear in the USGS database.	The text has been revised for clarity.
79	Table 4.2			Cuyama Basin USGS Well Statistics	# of provisional wells - This is unclear. There may be some provisional data from the last few months that re currently not approved. Standard to approve data within 150 days. This statement leads one to believe that these data are not useable.	The distinction between provisional and approved USGS wells has been removed.
80	Figure 4-4			Cuyama Basin USGS Wells	These are not USGS wells. They are wells that are in the USGS database.	The text has been revised for clarity.
81	4.3.1 Groundwater Level Monitoring - SBCWA	1	1	The Santa Barbara County Water Agency (SBCWA) manages	Summary of SBCWA monitoring programs: USGS network for entire basin was 32 wells. •About 14 of these 32 wells are overlapped on the west-end with our quarterly network. •Our quarterly network is 36 wells but could be considered as large as 47 if we want to count the Harvard production wells which they self-monitor and we periodically verify. •Mandatory CASGEM is 3 and Voluntary CASGEM is 13. These are also part of the USGS total of 32 wells. • The USGS has stopped monitoring wells in the basin.The entire network we will start to monitor will be about 52 in total (or 63 if we want to consider the 11 Harvard production wells).	Text and Table has been updated
82	4.3.1 Groundwater Level Monitoring - SBCWA	1	3	Many of these wells are included in the DWR	I didn't see any in the DWR database. Some are in NWIS. Important to clarify that wells may be in database and maps, but our data for the last couple of years is not located in the database.	Unecessary detail removed from document
83	Table 4-3			Number of SBCWA-wells	29 should be 55	Numbers reflect data provided by SBCWA. Numbers have been updated to reflect this.
84	Table 4-3			Number of SBCWA wells included in the Monitoring Network	30 is ?	Numbers have been updated.
85	Figure 4-5			Cuyama Basin SBCWA	As mentioned, this does not include all the wells monitored by SBCWA	Figure has been updated
86	4.3.1 Groundwater Level Monitoring - Private Landowners	1	1	Private landowners within the Basin	Nearly all the wells mentioned previously are owned and "managed" by private landowners. The terminology is very confusing.	The text has been revised for clarity.
87	4.3.1 Groundwater Level Monitoring - Private Landowners	1	3	Summary statistics for these	Are these private wells that are measured by USGS, Ventura, SLO, and SBCWA? Or are these overlap wells found in separate databases? Hard to tell without shapefiles. If there are 99 wells measured by private landowners, there would a serious issue with data quality and accuracy and should not be the foundation of the model.	The text has been clarified to note that these are additional wells beyond those included in the previously described datasets.
88	4.3.2 Overlapping and Duplicate Data	2	1	Duplicates were identified and then	Were similar MP elevations, accuracy standards, and methodology used?	Well data was not altered during this duplicate identification processing. Sources were either combined (i.e. one source had GSE and another had RPE) or the source with the more accurate information was utilized (i.e. once dsource only had ID and general coordinates whereas another may have had well construction info and general coordinates). Sources where there were conflicting data, such as Well Depth, were addressed one by one and researched and professional determination was made. All elevation values were ultimately corrected using a singular DEM dataset to standardize all elevation values.

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89	Table 4-8			MSC column	Explain how Local Name is different from Name? Explain how is USGS ID different from MSC?	Some wells had two names. For example, OPTI Well 834 has a state well number, a well name of "Mustang Production" and local well name of "Spanish WM-1". In an effort to include as much well information as possible "two" well name categories were included. The USGS ID and MSC are two unique identification serial numbers. For example, OPTI well 134 has a SWN of 07N23W20M001S and a USGS Site Code of 344115119202001.
90	Table 4-8			SBCWA row	The table needs to include all SBCWA-monitored wells, which includes all of the CASGEM Wells in the basin within SB County.	Data provided by the SBCWA in indivudal spreadsheets did not include CASGEM ID, and thus a check mark was not included in the CASGEM ID column for the SBCWA row in Table 4-8. Table 4-8 is intended to show what information was included in the orginal data provided to W&C to illistrate the necessity of finding duplicates and data processing. Although those wells may have CASGEM IDs, these were associated with the wells during data processing.
91	Table 4-8			Managing Entity column	Change heading to Database	The heading has been changed to "Data Maintaining Entity"
92	4.3.3 GW Quality Monitoring	1	1	This section discusses existing groundwater	Confusingly worded – the programs were "collected"?	The text has been revised for clarity.
93	4.3.3 GW Quality Monitoring - NWQMC				Why is NWIS not mentioned?extensive water quality data available.	The data downloaded form the NWQMC includes NWIS data. The text has been revised for clarification.
94	4.3.3 GW Quality Monitoring - NWQMC				What sample constituents and parameters?	Text has been editted for clarity.
95	4.3.3 GW Quality Monitoring - NWQMC	2	3	IRLP was initiated in 2003	Are these data collected by the landowner? Explain in text who does this data collection?	Who collects this data is unknown and not included in the data provided by the management enetities
96	Table 4-9			Median period of record	Is this accurate?	Yes. A considereable number of sites only took 1-2 samples during a single year.
97	4.3.3 GW Quality Monitoring - GAMA/DWR				Explain in text what sample constituents and parameters.	Clarification has been added to the text, detail about consituents was not added due to nexus of causality in water qualty result.
98	4.3.3 GW Quality Monitoring - GAMA/DWR			Earliest measurement date year	GAMA started in 2000 Many of these data are historic USGS data from NWIS. The database W&C pulled the data from is not indicative of what program or agency collected the data.	While this comment is correct, the intent of this section is to summarize the data that is available, and was downloaded, and could be downloaded, from each of these sources and to show the processes W&C took to processes and collect data for the Cuyama Basin.
99	4.3.3 GW Quality Monitoring - Ventura County Watershed				Need to add a section on the CSD.	A new section has been added to include data provided by the CSD.
100	4.3.3 GW Quality Monitoring - Ventura County Watershed				What sample constituents and parameters?	Clarification has been added to the text, detail about consituents was not added due to nexus of causality in water qualty result.
101	4.3.3 GW Quality Monitoring - Private Landowners				What sample constituents and parameters?	The text addresses that only TDS is utlized by this data source.
102	4.3.4 Subsidence Monitoring			Appendix Z, a subsidence white	As commented on groundwater conditions section, suggest deleting this white paper.	Comment noted. The appendix is included because some readers are interested in this content.
103	4.3.5 Surface Water Monitoring				Perhaps assess whether there is more needed? Where?	This will be addressed in Section 4.10
104	4.4 Monitoring Rationales	2	1	The monitoring networks were	Be specific - levels? Storage?	The text has been revised for clarity.
105	4.5.2 Monitoring Wells Selected for Monitoring Network				SBCWA knows of currently available wells to fill these data gaps for monitoring. Also, a few wells, which are also currently available, should be monitored in the Ventucopa Uplands and east uplands. We don't need the network density here, but maintaining a baseline dataset is important. It is unwise to completely overlook these areas because there's currently little to no and use. Please contact Matt Scrudato for information on wells available	Comment noted. In the GSP implementation phase, the GSA should coordinate with SBCWA staff to identify appropriate wells to fill data gaps.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
106	4.5.2 Monitoring Wells Selected for Monitoring Network	2	1	Tier 1 encompasses wells with the most	Are there any in the Basin? None show up on the figure	No, there are no Tier 1 wells in the Basin.
107	4.5.2 Monitoring Wells Selected for Monitoring Network			Table 4-13 & following paragraph	This is not useful and unnecessarily confusing due to the overlap between the top three monitoring groups. The database that W&C found the well in is irrelevant.	The paragraph has been removed.
108	Figure 4-16			Cuyama Basin Groundwater Level and Storage Monitoring	No Tier 1 Wells?	No, there are no Tier 1 wells in the Basin.
109	4.5.3 Monitoring Frequency	5	1	The Basin is an unconfined aquifer	Large withdrawals are not consistent across the basin. Mention where the large withdrawals occur.	The text has been revised for clarity.
110	4.5.3 Monitoring Frequency	5	2	Based on the data in Table 4-14	If there are management areas, may not need monthly monitoring this across all areas. A good reason to wait until MAs jave been decided.	Comment noted. This can potentially be updated in the Public Draft if the GSA Board provides direction on management areas.
111	4.5.4 Spatial Density				Should be done by management area.	The monitoring wells correspond to the wells used to develop threholds, which have been selected by threshold region.
112	4.5.4 Spatial Density	1	5	Monitoring wells in close proximity	Many of the wells in the basin are themselves pumped. There are very few dedicated monitoring wells.	Comment noted. No change needed to text.
113	4.5.5 Representative Monitoring				The GSA will need access agreements with private landowners to monitor nearly all of these wells. These ability to get these agreements may drastically alter which wells are selected.	Comment noted. No change needed to text.
114	4.5.5 Representative Monitoring			Monitoring Well – Other wells are	"Supplemental wells" may be a less confusing description.	The text has been changed accordingly.
115	4.5.5 Representative Monitoring			Adequate Spatial Distribution – Representative monitoring	Awkward phrasing, please restate for clarity	The text has been revised for clarity.
116	4.5.6 GW Level Monitoring Network	1	1	The Groundwater Level Monitoring Network is comprised	Sum of Table 4.13 is 151 wells. Not useful.	Paragraph was removed.
117	Table 4-16			Column: Managing Agency as of 2018	These are not the managing agency. This is the database W&C pulled the data from	The column has been renamed "Data Mantaining Agency"
118	Table 4-16			OPTI ID	Add Bittercreek. Appears to be a discrepancy between managing agency mentioned here and monitoring agency mentioned on the OPTI webpage.	We are unclear what "Add Bittercreek" means. With more clarification, we can make a change in the Public Draft.
119	Table 4-16			2* SB County	This well appears to be located in Ventura in OPTI	Table has been updated
120	Table 4-16			105 - confidential	This data is published in NWIS. Not confidential. Depth of well 600 feet. Depth of hole 750 feet.	The table has been updated.
121	Table 4-16			109	Plots in the ocean near Channel Islands.	Data provided to W&C was plotted in the Ocean. This well has been removed, and and the correct well/lat/long was added to the network as OPTI Well 833
122	Table 4-16			120	Collapsed well. Not a good choice.	Data provided to W&C did not indicate the well was collapsed. Instances like recent collapses that happened after data collection will be addressed in the GSP implementation phase.
123	Figure 4-17			Groundwater Level and Storage Representative	Big data gaps in this map. SBCWA can assist in providing better spatial coverage.	Comment noted. In the GSP implementation phase, the GSA should coordinate with SBCWA staff to identify appropriate wells to fill data gaps.
124	4.5.7 Monitoring Protocols	1	1		LSD accuracy standard? What is the required accuracy for the WL data? May want to refer to USGS publication Groundwater Technical Procedures of the USGS if this is the required standard. https://pubs.er.usgs.gov/publication/tm1A1	As mentioned before about Appendix K (*Best Management Practices for the Sustainable Management of Groundwater Monitoring Protocols, Standards, and Sites)* the GSP cites DWRs published material for sampling protocols.
125	4.5.7 Monitoring Protocols	1	1	Monitoring protocols for the groundwater	The attached appendix is titled Appendix A.	The text has been revised for clarity.
126	4.5.8 Data Gaps	1	1	Groundwater levels monitoring data gaps	awk - delete sentence and 2 bullet points below	The text has been revised for clarity.
127	4.5.9 Plan to fill data gaps	2	1	The CBGSA has already been	Provide context (Proposition 1, etc)	The text has been revised for clarity.

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128	4.5.9 Plan to fill data gaps	2	2	This task includes identification	Explain where? Why? What will this illustrate and how will it help? Better than discrete monthly measurements?	The text has been revised for clarity.
129	4.5.9 Plan to fill data gaps	3	1	DWR provides Technical Support Services (TSS) to	This needs context and has no basin-specific info.	The text has been revised for clarity.
130	Figure 4-18			Groundwater Levels Monitoring Network	See Figures 4.10 and 4-4. There appear to be wells available to fill data gaps. CVCR6 RRU1 and 2	Comment noted. W&C will coordinate with SBCWA staff to identify appropriate wells to fill data gaps.
131	4.8 Degraded GW Quality	1	1	Due to the relationship of undesirable	Elaborate. This need a lot more justification. Why only salinity? What is the standard? What would cause this to change? No other parameters needed at all?	The text has been revised to describe the rationale for establishing the monitoring network only for salinity.
132	4.8.2 Monitoring Sites Selected				Too many in North Fork. Large data gaps. No west end monitoring? Poor distribution when other wells are available.	The monitoring network identified in the document only includes wells that are currently being monitored for salinity. Wells for filling the data gaps identified in the document will be idenfied in the future during GSP implementation.
133	4.8.2 Monitoring Sites Selected	1	4	Note that due to duplication of wells	Why show this if there are overlaps? What value does it add?	It identifies the role that these entities currently play in managing and maintaining water quality data in the Basin.
134	4.8.3 Monitoring Frequency	1	1	Monitoring agencies such the USGS	USGS always in July, except during the recent basin study. They collect these samples for the SBCWA. The SBCWA will likely discontinue this program once the GSP is submitted.	Text has been editted for clarity. Text reflects the conversation with USGS staff and W&C.
135	4.8.3 Monitoring Frequency	1		Monitoring agencies such the USGS (entire paragraph)	This is irrelevant. Explain what the GSA is going to do first, then explain how it will leverage samples collected by other agencies.	The text has been revised for clarity.
136	4.8.3 Monitoring Frequency	2	2	The Basin, in coordination with partnering	This should come first	The text has been revised for clarity.
137	4.8.3 Monitoring Frequency	2	2	Representative wells, those with sufficient	Not necessary, it was already stated that all are representative wells.	The text has been revised for clarity.
138	Table 4-18			Managing Agency as of 2018	See previous comment.	The text has been revised for clarity.
139	Table 4-18			Department of Water Resources	Wells 710-758 are DWR. This managing agency should stay consistent and use DWR.	The table has been revised for clarity.
140	Table 4-18			Last Measurement Date	Many of these are from the USGS Study, not part of a regular monitoring program. There is no "managing entity as of 2018".	"Managing entity" has been changed to "Data Maintaining Agency"
141	4.8.7 Monitoring Protocols			Existing groundwater quality monitoring	Irrelevant. GSA will be establishing its own network and using its own protocols. Existing programs may not continue.	The text has been revised for clarity.
142	4.8.8 Data Gaps	3		Additional information about how	Use the three wells completed at different depths.	Comment noted. This can be considered during the GSP implementation phase.
143	4.8.8 Data Gaps	4	1	The entire Basin is identified as	??? The basin is the data gap?? Please restate to explain what data is missing.	The text has been revised for clarity.
144	4.8.9 Plan to fill data gaps	1	1	The CBGSA will fill the temporal	Explain (DWR's TSS program. to perform downhole logging....)	The text has been revised for clarity.
145	Figure 4-20				Wells are available. SBCWA can help find them. SBCWA are actually measuring them and collecting water quality samples.	Comment noted. The GSA can coordinate with SBCWA to incorporate these wells during the GSP implementation phase.
146	4.9.3 Monitoring Frequency	1	1	Subsidence monitoring frequencies should capture	State clearly in the beginning of the section what the GSA will do.	The text has been revised for clarity.
147	4.9.4 Spatial Density	1	1	The current spatial density of subsidence	With 2 stations within the basin as mentioned in 4.9-2?	Yes, this is based on the 2 stations currently in the Basin.
148	Figure 4-21			Current Subsidence Monitoring	Legend does not include symbols for the sites.	Stations are labeled on map, and thus are not needed in the legend.

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149	4.9.5 Monitoring Protocols				Is there equipment calibration needed? There needs to be a written standard. This needs to be elaborated on. There are some standards already developed which may be useful as a guide and reference. These are as follows: (for GNSS surveys) USGS- https://pubs.usgs.gov/tm/11d1/tm11-D1.pdf NOAA https://www.ngs.noaa.gov/PUBS_LIB/NGS-58.html https://www.ngs.noaa.gov/PUBS_LIB/NGS592008069FINAL2.pdf USGS reports have information about "future monitoring" which may be a useful reference when establishing the standards and protocols. Here's an example: https://pubs.usgs.gov/sir/2014/5075/pdf/sir2014-5075.pdf	Comment noted. This can be considered during the GSP implementation phase.
150	4.9.5 Monitoring Protocols	2	1	Data should be saved on	Where? Central databse?	The text has been revised for clarity.
151	4.9.7 Plan to fill data gaps				Should we create a baseline dataset set now since it may take time to establish permanent sites? DGPS biannually?	Comment noted. This can be considered during the GSP implementation phase.
152	4.9.7 Plan to fill data gaps	2	1	Theses stations can be managed	Why USGS? Are they running the current stations or have we determined that they will do this monitoring? If so, M Sneed (USGS) should elaborate on the protocols and methodology.	Comment noted. This can be considered during the GSP implementation phase.
153	General				Representativeness of wells for water level monitoring. Wells used within a monitoring network must not only meet standards for sufficient well construction and monitoring data, they also must be representative of local hydrogeologic conditions. "The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area." [§ 354.36(c)]. The process for selecting candidate wells for the water level Monitoring Network is explained based on well construction and monitoring frequency criteria, but the chapter is unclear on how selected wells were determined to be representative of certain areas of the basin.	Comment noted. These factors can be considered when the monitoring network is finalized during the GSP implementation phase.
154	General				Representativeness of wells for water quality monitoring. The process used to select wells as representative for water quality monitoring also is not transparent. All available wells apparently were included in the water quality Monitoring Network, but this section (e.g., Page 4-54) lacks discussion of basin groundwater quality characteristics. A Piper diagram with data from all wells, or maps with well-by-well Stiff diagrams could highlight spatial differences (and redundancies) in water quality. If only TDS data are available, a figure showing side-by-side historical TDS data boxplots for all wells would allow identification of wells with statistically-distinct (or redundant) historical data.	Comment noted. The available water quality data is discussed in the Groundwater Conditions chapter. This level of detail is not needed in this chapter.
155	General				General determination process. In general, a systematic process for selecting representative wells is not discussed. The basis used to identify the various wells as representative is not clear.	The criteria used to select representative monitoring wells are given in Section 4.5.5
156	General				Optimization. It also is unclear whether an effort was made to simplify the network to increase efficiency, and reduce cost (i.e., have the same wells be used for water levels, water quality monitoring, etc). The chapter needs a discussion of network optimization, including (a) coordination of monitoring with other agencies or entities to potentially share costs and eliminate redundant monitoring, and (b) identification of clustering and spatial redundancy within the network, via comparison of water level, well construction, and water quality data (see preceding comment #2), to eliminate wells that are not both unique and representative.	Comment noted. This can be addressed when the monitoring network is finalized during the GSP implementation phase.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
157	General				Clustering effects. The potential effect of data clustering on conclusions drawn from parts of the network with very high well densities also is not discussed. The well density discussion needs to consider the potential effects of data clustering on conclusions drawn from aggregation of water level data. For example, if Undesirable Results are defined as a certain percentage of monitoring network wells experiencing water levels below their Minimum Thresholds, clustering of wells through intentional "selection of additional wells in heavily pumped areas" may artificially magnify the apparent portion of the basin affected, increasing the likelihood of it being judged as out of compliance with sustainability criteria.	Comment noted. This can be addressed when the monitoring network is finalized during the GSP implementation phase.
158	General				Sustainability Criteria. The Monitoring Network section does not include "quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site", as required [§354.34 (g)(3)]. We understand that these sustainability criteria are currently under development, and anticipate that, when final, the appropriate values will be incorporated into this chapter.	This will be provided in the Sustainability Thresholds GSP chapter.
159	General				Data gaps. Discussion of plans to fill data gaps is very general, with no description of "steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites." [§354.38 (d)]. Regulations specify that each GSA identify data gaps wherever the basin does not contain (a) a sufficient number of monitoring sites, (b) does not monitor sites at a sufficient frequency, or (c) utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the agency. There is no reason therefore to create minimum well acceptance standards to match what is currently available, and instead criteria should emphasize the capacity to reliably monitor and track basin efforts to maintain sustainability.	Comment noted. The specific plan to fill data gaps will be developed during the GSP implementation phase.
160	General				Acquisition of wells to meet network deficiencies. Regulations regarding minimum requirements for monitoring network wells state "If an Agency relies on wells that lack casing perforations, borehole depth, or total well depth information to monitor groundwater conditions as part of a Plan, the Agency shall describe a schedule for acquiring monitoring wells with the necessary information, or demonstrate to the Department that such information is not necessary to understand and manage groundwater in the basin." [§352.4]. Additionally, DWR's Best Management Practices #2 – Monitoring Networks & Identification of Data Gaps states that agricultural or municipal wells may be used in place of monitoring wells, but that "If not using a dedicated monitoring well, the GSA must provide a rationale and a schedule for acquiring one." The Monitoring Network section does not assert that the information available for existing wells is adequate to understand the basin, nor does it support or refute the need for a rationale and schedule for acquiring monitoring wells.	Comment noted. This can be addressed when the monitoring network is finalized during the GSP implementation phase.
161	General				Access for future monitoring. DWR's Best Management Practices #2 – Monitoring Networks & Identification of Data Gaps also states, "Monitoring wells should be secured by a long-term access agreement to ensure year-round site access." No discussion is provided in the Monitoring Network section regarding negotiation goals or procedures to ensure access to wells on private property for monitoring in the future.	Comment noted. This can be addressed when the monitoring network is finalized during the GSP implementation phase.
162	General				Implementation. Explanation of how the Monitoring Network will be developed and implemented is deferred to a later GSP section (Projects and Management Actions), although it is required in the Monitoring Network section [§354.34(b)].	This can be revisited for the Public Draft version of this section when the implentation section is available

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163	General				Areas with known data gaps. Very few wells were selected for the Monitoring Network within the southeastern part of the basin (near and upstream of Ventucopa). Ventura County Watershed Protection District maintains 51 wells in the area (Table 4-11, Figure 4-12), and private landowners have indicated they provided data to WC for additional wells in this area. It may be useful to reconsider inclusion of some of these wells into the network, to obtain better representation in this area of the basin. A pre-existing well with known construction data and some measurements is preferable to nothing, as long as the well is in acceptable condition.	Additional wells have been added to the monitoring network in these region.
164	General				Field confirmation of selected Network wells. Anecdotally, some older historically gauged wells under consideration for inclusion within the network may have failed, allowing annular or aquifer materials into the casing, and altering their effective screened intervals. We recommend field-confirmation of total depths and general condition of wells selected for the network, particularly in areas of sparse well data density where each well represents large areas of the basin.	Comment noted. This can be addressed when the monitoring network is finalized during the GSP implementation phase.
165	General				Surface water monitoring. Discussion of interconnected surface water monitoring is deferred until after numerical modeling is complete.	Comment noted.
166	Pg. 4-14				Places where the relationships between sets of wells and databases is confusing: The distinction between California State Groundwater Elevation Monitoring (CASGEM) and other Department of Water Resources (DWR) wells is confusing. The text refers to Figure 4-3 as CASGEM wells, but the map labels say "DWR Database Wells." There appear to be 222 wells on the map, not 113. Terminology between text, table, and figure is inconsistent.	The text has been revised for clarity.
167	Pg. 4-28				Places where the relationships between sets of wells and databases is confusing: "IRLP [sic] water quality measurements are sampled from surface locations." Why are Irrigated Lands Regulatory Program (ILRP) sites included in the groundwater quality database (see label and caption for Figure 4-10)? It is unclear whether all the sites in Table 4-9 are groundwater sites.	ILRP stations were utlized in the quality monitoring because surface flows within the basin, except during signifincantly high flow events, percolate into the groundwater system. These water qulaity measurements may be useful to provide information to the GSA as to the quality of water that enters the groundwater system.
168	Pg. 4-29				Places where the relationships between sets of wells and databases is confusing: The relationship between databases from ILRP, California Environmental Data Exchange Network (CEDEN), U.S. Geological Survey (USGS), and National Water Quality Monitoring Council (NWQMC) is confusing. We suggest clarifying this point, perhaps using a Venn diagram or a similar graphic.	The text has been revised for clarity.
169	Pg. 4-40				Monitoring network selection issues: Proposed Monitoring Network tiers reflect priorities in the following order: (i) recent data, (ii) frequent data, (iii) known construction information. This is reasonable if monitoring is limited only to acquisition of data from existing programs. However, if the network is selected to meet SGMA requirements and monitor specifically for the GSA, then construction information and future well access is more important than frequency of past measurements and (to an extent) more important than the date of the most recent measurement. Additionally, no discussion was provided of data by which the wells were determined to be representative of the basin.	There is not adequate information on well construction and well access to base well selection on these criteria. These will need to be considered as the monitoring program is developed during the GSP implementation phase.
170	Pg. 4-35				Monitoring network selection issues: How were private landowner TDS values obtained? What was the context of the monitoring? Will landowners be enlisted to continue monitoring? How will this be accomplished if so?	Comment noted. This can be addressed when the monitoring network is finalized during the GSP implementation phase.
171	Pg. 4-45				Monitoring network selection issues: "Wells with multiple depths..." The vertical distribution of representative wells is not discussed. It appears here as a goal, but there is no indication of the depth distribution of the representative network.	Criteria Updated.
172	Pg. 4-53				Monitoring network selection issues: "...Established to monitor for salinity." What about other constituents from the groundwater conditions GSP chapter?	The text has been revised to describe the rationale for establishing the monitoring network only for salinity.

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173	Pg. 4-53				Monitoring network selection issues: "...Unlikely to be monitored again by that monitoring agency." Will the GSA rely on the agencies to continue monitoring? Will the GSA attempt to share monitoring activity with the agency, ensure the network is monitored through their own funding?	Comment noted. This can be addressed when the monitoring network is finalized during the GSP implementation phase.
174	Pg. 4-58				Monitoring network selection issues: "Well/measurement depths for three-dimensional constituent mapping." Was this considered in the section discussing groundwater level data gaps?	Not directly. We anticipate that the GSA will first need to focus on filling spatial data gaps in the monitoring network.
175	Pg. 4-37				Text issues: Section 4.3.4 discusses CGPS stations on Figure 2.2-22. The Monitoring Networks section needs its own figure showing subsidence monitoring stations, including CGPS stations. Also, on the same page an unreferenced "subsidence white paper" is attributed to Appendix Z, which likely is a placeholder. The paper needs a complete reference.	The figure in Chapter 2 is sufficient. The white paper is an appendix to the Groundwater Conditions chapter - the reference has been revised for clarity.
176	Pg. 4-39				Text issues: Section 4.5.1, discussing Management Areas, may be out of date. Several other sections discussing Management Areas also may no longer be accurate.	This section will be developed when the Board provides direction on management areas in the Basin.
177	Pg. 4-62				Text issues: The subsidence monitoring network section should at least mention critical or subcritical infrastructure likely to be affected by subsidence. If none exists, it may be helpful to state this and cite as the reason that limited subsidence monitoring will be required.	The data gaps section identifies areas that may be critically affected by subsidence.
178	Pg. 4-18				Table issues: Shouldn't "Number of SBCWA wells included in the Monitoring Network" be less than "Number of SBCWA wells"? The distinction between these categories is unclear. There is no discussion of why some are included, and others are not.	The text has been revised for clarity.
179	Pg. 4-24				Table issues: CCSD well table shows two wells with longest period of record 37 years and median 11 years. This is not possible given only two wells.	Table has been updated
180	Pg. 4-47 - 4-49				Table issues: Suggest adding a table number and identification on each page of the multi-page table.	The table format has been revised
181	General				Figure issues: When map figure discussions in the text name geographic features, those features should be shown and labeled on the map (e.g., Pages 4-14, 4-18).	The text has been revised for clarity.
182	Figure 4-2				Figure issues: Are all the hydrograph wells within this oval? Why focus on such a small part of the basin? This cannot be the extent of agriculture. Wells shown on hydrographs should be labeled on the map.	Yes. A single area was selected for presentation purposes as using all wells within the central basin would create a hydrograph that would not be useful or legible.
183	Figure 4-15				Figure issues: As discussed above, the selection scheme values a monthly monitoring record over knowledge of critical well construction data (screened or perforated interval). We rather suggest swapping the criteria for Tier 2 and Tier 3. Also, text explaining the criteria for each tier needs to be increased in size for readability.	Suggestion noted but not included. Every well with data from 2017-2018 was included in the montioring network regaurdless of well construciton information or frequency of measurement.
184	Figure 4-17				Figure issues: Faults should be included on this figure (and on most if not all water level monitoring network figures), especially since they were discussed in the monitoring well selection rationale.	Faults have been added to 4-16 and 4-17
185	Figure 4-19				Figure issues: What are "Non-Groundwater Quality Monitoring Network Wells"? This should be explained in the text.	Wells have been removed from figure.
186	Figure 4-20				Figure issues: This map distinguishes between Representative Wells and Active Groundwater Quality Monitoring Network Wells. The text says that all water quality network wells are representative wells.	Figurue and text has been updated.
187	Pg. 4-20				Misc/Minor: "East of Highway 33" should be "west of Highway 33."	This has been fixed.
188	Figure 4-2				Misc/Minor: Data series labels on the plot should be clearer or larger.	This has been fixed.
189	Pg. 4-26				Misc/Minor: "Landowners have provided data on 99 wells." Needs discussion of how the data were requested and obtained.	The text has been revised for clarity.
190	Pg. 4-28				Misc/Minor: Throughout the document, Irrigated Lands Regulatory Program is abbreviated as "IRLP" rather than "ILRP."	This has been fixed.
191	Pg. 4-44				Misc/Minor: "Proximity to other prominent features such as faults..." Based on this statement it is unclear - should monitoring wells be near or far from faults?	The text has been revised for clarity.

Cuyama Basin DMS
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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
	Comments on DMS Section					
1	General				The GSP chapter and DMS appear to fulfill the basic requirements of GSP Regulation § 352.6 - Data Management System.	Comment noted. No change required in document.
2	Table 6-2				All data types within the DMS are listed in Table 6-2, but it is unclear which data are minimum required information (e.g., latitude and longitude) and which are optional parameters (e.g., casing perforations).	The table and text have been revised to indicate required fields.
3	6.3	3	2	In many cases ...	The chapter states "In many cases, there were discrepancies between ground surface elevation (GSE) of the well from different sources. In these cases, the ground surface elevation of the well was updated using the USGS digital elevation model." This might cause problems with calculation of water-level elevations, as the USGS DEM is less precise than surveyed GSE values, and based on a 30 meter by 30 meter horizontal resolution. DEM elevation values are interpolated and averaged within each model element. The use of DEM elevation data could affect assumed groundwater flow directions in areas with shallow groundwater gradients. More information should be provided to demonstrate the adequacy of this approach over evaluating and selecting the most likely of the elevations published in original data sources for the wells. At the least, wells with groundwater elevations calculated using DEM values should be flagged clearly in hydrographs, piezometric surface maps, and other interpretations.	Comment noted. The data used in the model can be re-evaulated in the future as the monitoring network is implemented and more data is available.
4	General				For "more detailed" instructions on DMS use, the user is referred to a sparse one-page user guide. Some pertinent details of user interaction and function limits could be provided, for example restrictions on data downloads for review of well construction details.	Comment noted. The Opti User Guide is a 17 page user manual for data managers and is provided separately from the 1 page Opti Quick Start Guide. The User Guide will be linked to the DMS Section upon finalization.
5	6.2.1 User and Data Access...			Private data is monitoring data...	Please clarify, it is unclear if private data can be edited by ANY private user. Also, how is this performed? For example, is the private data associated to the user type with parcel/well id	The text has been revised for clarity. Sites (wells, gages, etc.) and their associated data (whether private, shared, or published) may only be edited by Administrators and Power Users associated with the Managing Entity.
6	6.2.2 Data Entry and Validation	1	3	The data is validated using...	Please clarify -Who is performing and verifying the quality control checks?	The text has been revised for clarity. The system runs some validation checks to alert users to potential data quality issues. The data is validated by the Managing Entity's Administrators or Power Users.
7	6.2.2 Data Entry and Validation - Data Collection...	1	2	In the Data Entry tool, new sites may be added by...	Please explain who is verify the data entry? Is the data being flagged as new, so it can be reviewed later by the GSA Board?	The text has been revised for clarity to match the existing conditions. If process changes are required for GSA Board review, the DMS can be configured to meet those needs during the implementation phase.
8	6.2.2 Data Entry and Validation - Monitoring Data...			Quality Flag	Please explain the term "Quality Flag" and how is it used and by whom	The text has been revised for clarity. Quality flags are associated with individual measurements and include quality assurance descriptions (e.g., "Pumping", "Can't get tape in casing", etc.). The quality flags should be documented by the person taking the measurement.
9	6.2.2 Data Entry and Validation - Data Validation	3	2	Users may access partially completed...	Consider adding a note to the bottom of the page to reference that this is a partially completed import validation, in case of data discrepancies.	The text has been revised for clarity. Partially completed logs are currently identified as incomplete in the DMS import logs.
10	6.3 Data Included in the Data...	2		Groundwater Elevation (2 parameters)...	Please list these parameters. The GSA Board may need this information to resolve any data discrepancies. Can the list of parameters grow?	The text has been revised to list parameters. The list of parameters can grow as the needs of the GSA change over time.
11	6.2 Functionality of the Data...	2	3	For more detailed instructions on ...	Provide a hyperlink to the user's guide here	Comment noted. Hyperlink will be included upon finalizing and posting the User Guide.
12	6.2.2 Data Entry and Validation	1	1	To encourage agency and user participation...	This possibly helps maintain consistency but how do these tools improve data quality? Data quality is a function of training, following protocols, and equipment calibrations combined to create defensible data. It even mentions below in Data Validation that these data may not be accurate.	Comment noted. The text has been revised for clarity.
	Comments on topics separate from the DMS Section					
13	General				Clustering effects. The potential effect of data clustering on conclusions drawn from parts of the network with very high well densities also is not discussed. The well density discussion needs to consider the potential effects of data clustering on conclusions drawn from aggregation of water level data. For example, if Undesirable Results are defined as a certain percentage of monitoring network wells experiencing water levels below their Minimum Thresholds, clustering of wells through intentional "selection of additional wells in heavily pumped areas" may artificially magnify the apparent portion of the basin affected, increasing the likelihood of it being judged as out of compliance with sustainability criteria.	This was accounted for in the selection of wells included in the Representative Monitoring Network, and will be addressed in the Sustainability Thresholds GSP section.
14	General				A number of properties including well construction details and measuring-point (MP) and ground surface (GS) elevations cannot be queried in the public "Opti" interface. Some of the data can be viewed on a well-by-well basis, but the use of tables and queries is very limited. This lack of transparency makes quantitative evaluation by outside parties difficult.	Comment noted. No change required in document. Will evaluate as enhancements to Opti query tool during implementation phase.
15	General				Queries seem to hang without producing consistent results depending on the browser used to access the website. For example, the Opti system seems to produce better results using Google Chrome than Mozilla Firefox, and Microsoft Internet Explorer is stated as not compatible at all.	Comment noted. No change required in document. Will evaluate Opti query tool performance.

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16	General				A few queries to test the site's functions revealed some potential structural problems with the DMS. In one example, a query for all wells with Managing Agency = Cuyama Basin GSA returns an extensive list of wells but when the data are downloaded to an Excel format file, only subsidence data for two sites (not wells, apparently) are produced. In another example, a query for Reference ET > 0 appears to be coded into the menu system but running the query produces no records.	Could not reproduce results described. A query for all wells with Managing Entity = "Cuyama Basin GSA" and subsequent Excel export produced expected results. More information is needed to try and identify the issue described. The system is coded for more data types (e.g., Reference ET) than are currently collected for future expansion of data efforts.
17	6.2 Functionality of the Data...				Please clarify - Does the GSA need agreements with well owner for the information they are supplying? For example, if someone is adding a new well to the DMS, can the board use the well data in their monitoring network? What is the GSA process to approve a new groundwater well for the DMS?	These issues will be addressed during the GSP implementation phase.
18	6.2.1 User and Data Access...				Please clarify - Does the DMS track what data was changed and by what user?	The data record and user associated with measurement data entry/modification is stored in the DMS but not currently viewable in the tabular data output.
19	6.2.1 User and Data Access...			System Administrator users manage,,,	Please clarify - Who is the system administrator? Does the GSA need to designate someone?	Currently, the Consultant team is the System Administrator. The GSA can designate a System Administrator as desired.
20	6.2.1 User and Data Access...			The Cuyama Basin GSA is...	Please clarify term "Cuyama Basin GSA" – Do you mean GSA Board members, Executive Director, or both? Do you need the Board to address this and list who is the managing entity(ies)?	It is currently the Executive Director and GSA consultants. The GSA Board will decide on the appropriate party for managing the DMS in the future.
21	Table 6-2			Data Collection Site Information	Is there a way to rank the groundwater well locations/elevations on accuracy? For example, rank (1) – accurate with little risk to location/ elevation to rank 3 – not as accurate, considering surveying the groundwater well to verify location/elevation	That ranking does not currently exist in the DMS, but can be added is needed during the implementation phase.
22	6.2.2 Data Entry and Validation - Monitoring Data...	1	1	Monitoring data including but not limited to...	Would Land Use data be included in this data set?	Land use is currently not included in this dataset. Additional data needs can be evaluated and potentially included during the implementation phase.
23	6.2.2 Data Entry and Validation - Data Validation				To help address data questions, is there a column to note who revised or entered the data?	The data record and user associated with measurement data entry/modification is stored in the DMS but not currently viewable in the tabular data output.
24	6.2.2 Data Entry and Validation - Data Validation	1	2	The entities that maintain the monitoring data...	Who will keep the DMS maintained and updated?	DMS maintenance and update will be determined by the Cuyama Subbasin GSA Board.
25	6.2.2 Data Entry and Validation - Data Validation	1	2	The entities that maintain the monitoring data...	Please list all assumptions made for the database, such as locations of each well and how they were verified, such as by a GPS survey, lats/logs, google maps, and etc. Consider approaching the GSA Board with a disclaimer on the DMS for data and accuracy.	Comment noted. A disclaimer window has been added upon logging into the DMS.
26	6.2.2 Data Entry and Validation - Data Validation	2	1	Upon saving the data in the data entry interface...	Can the GSA Board increase the list of data validation checks?	Comment noted. No change required in document. Will work with Cuyama Subbasin GSA to evaluate need for additional data validation checks during implementation phase.
27	6.2.3 Visualization and Analysis	1	1	Transparent visualization and analysis	Can it be incorporated into their own DMS system?	There are many options for integrating different DMS systems and functionalities. These options and the exact requirement would need to be identified and evaluated for inclusion during the implementation phase.
28	6.3 Data Included in the Data...	5	2	Using the DMS data viewing capabilities...	Consider asking the GSA Board, if they would like a list of recommendations to this chapter, such as below. 6.4 RECOMMENDATIONS Recommendation to survey each groundwater well, as discussed on Page 7 of the DWR BMP Groundwater Monitoring Protocols, Standards, and Sites Best Management Practice, December 2016. •The elevation of the Reference Point (RP) on the well casing of each well must be surveyed to the North American Vertical Datum of 1988 (NAVD88), or a local datum that can be converted to NAVD88. The elevation of the RP must be accurate to within 0.5 foot. It is preferable for the RP elevation to be accurate to 0.1 foot or less.	Comment noted. This can be addressed by the GSA Board during the implementation phase.
29	General				The Data Management System has been developing with steady improvements being made over time. However, several issues with functionality and the need for more complete data inputs still persist. The wells in the Monitoring Network are not in a viewable layer. And a search by State ID #s is not cross referenced with the Opti ID #s, challenging the users ability to find a particular well.	Comment noted. The DMS will be updated to display wells in the Monitoring Network once the Monitoring Network has been finalized. State Well Numbers and Opti IDs (Site Name) are cross referenced in the Site List. Consultant team will evaluate updating the Query tool to reflect the cross reference and update functionality as needed during the implementation phase.

Cuyama Basin DMS
Summary of Public Comments and Responses
January 25, 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
30	6.2.2 Data Entry and Validation, page 6-2				Although some of the critically important data has be entered, many of the data parameters on table 6-2 are completely blank throughout the DMS. The fields that are most important to understanding the aquifer a particular well might represent is the depth and casing perforation intervals. None of this is available in Opti, yet. I'm told much of this data is in W&C's hands, but are not able to be input due to time & budget. Why can't the wells selected for the Groundwater Level Monitoring Network be viewed as a subset or a seperate layer? Same for any of the other sites in the Monitoring Network? Which wells are the representative Groundwater Quality Monitoring wells? If "The data is validated using a number of quality control checks prior to inclusion in the DMS." What are the QC/QA checks? As we move forward, in order to help promote user confidence in the data stored and published in the DMS, some ground truthing and well site canvassing will be required by a licensed hydrogeologist to verify and complete the understanding of the Monitoring Network wells and their data.	Comments noted. Additional data may be added during the implementation phase. The DMS will be updated to display wells in the Monitoring Network once the Monitoring Network has been finalized. The QC/QA checks performed by the DMS are listed in Section 6.2.2 and include: • Duplicate measurements: The database checks for duplicate entries based on the unique combination of site, data type, date, and measurement value. • Inaccurate measurements: The database compares data measurements against historical data for the site and flags entries that are outside the historical minimum and maximum values. • Incorrect data entry: Data field entries are checked for correct data type, e.g., number fields do not include text, date fields contain dates, etc.
31	6.2.4 Query and Reporting, page 6-5				The query tool does not allow a well to be searched by the various other ID#s like the State Well ID, USGS Code, or CASGEM ID, even when this data is present. This is unnecessarily cumbersome. A cross reference table should be made available if the DMS can't search for it. The Analysis Tools and the toolbox mentioned sounds very helpful but it is not part of the DMS. Will the DMS ever actually offer any of these analysis tools, including contouring, total water budget visualization, and management area tracking?	Enhancements to the Query tool will be evaluated and implemented as needed during the plan implementation phase. The tools discussed in the DMS section of the GSP are currently available for non-public users. Access will be granted for Monitoring Entities and their associated users to these tools. Additional tools will be made available as needed during the implementation phase.
32	6.1 Overview of the Cuyama Basin....	2	3	The site may be accessed here:	Where will this site ultimately reside? It shouldn't be in the system of W&C, nor should their name be part of this URL. Does the GSA own the DMS and will it have access once W&C's contract ends?	To be determined by the Cuyama Subbasin GSA Board. W&C can direct the DMS to a domain of the GSA's choosing.
33	6.2.2 Data Entry and Validation - Data Collection...	1	2	In the Data Entry tool, new sites may be added by...	May not want to provide access to create new sites to too many users. This could create issues with overlap.	Comment noted. Access will be determined by Cuyama Subbasin GSA Board.
34	6.2.2 Data Entry and Validation - Data Collection...	1	3	Existing sites may be updated using the Edit Site...	A feature should be added (similar to the CASGEM portal) which automatically tracks ALL edits to data and site information to include date/time/user/edit.	Comment noted. Will evaluate feasibility and address during implementation phase.
35	6.2.2 Data Entry and Validation - Data Collection...	2	1	The information that is collected for sites...	Many of these items could use additional clarification for the user and entity inputting these data. Examples include.......... 1)-Lat/Long-accuracy and how was the information obtained. Cell phone, GPS, DGPS, etc. NAD27 or NAD83, or.......? 2)-Accuracy of GSE and how was the information obtained? NAVD29 or NAVD88 or....?	Comment noted. Will evaluate feasibility and address during implementation phase.
36	6.2.2 Data Entry and Validation - Monitoring Data...				Can we add a function to upload photos and measurement field notes? Storing this original data and viewing changes to the well head over many years will be useful. I can't tell if these are options, but additional things to add to this list are...... 1)-Time of measurement. 2)-Status (pumping, nearby pumping, dry, flowing, etc) 3)-Accuracy of measurement 4)-Equipment used to make the measurement (steel tape, electric tape, etc.) and was this equipment calibrated? Calibration paperwork should be loaded to this data portal for reference. 5)-Things noted in Supplemental Info are mentioned in Table 6.2 and linked to the well. These shouldn't be changed during measurements unless the reference point changed as a result of breaking or modification.	Comment noted. Will evaluate feasibility and address during implementation phase.
37	6.2.2 Data Entry and Validation - Data Validation	1	1	Quality control helps ensure the integrity....	Data validation is a huge issue in the basin, but we understand this section is strictly related to the DMS. Possibly a footnote explaining this issue with data quality should be provided to the user. Possibly verification/statement that certain protocols were followed when making the measurement? Additionally, data quality can be better verified by adding entries which.......... 1)-indicate data accuracy (0.01 ft, 0.1 ft, 0.5 ft, to the nearest foot, etc). 2)-equipment calibration 3)-where two consecutive measurements completed? 4)-availability of field notes	Comment noted. Will evaluate feasibility and address during implementation phase.
38	6.2.2 Data Entry and Validation - Data Validation	2		Inaccurate measurements: The database...	Many of the historical data were collected by private entities with no QA/Q processes in place. In addition, in a declining basin, one would expect to continually see entries outside the historical minimum values.	Comment noted. No change required in document.
39	6.2.2 Data Entry and Validation - Data Validation	3	3	This allows a second person to also access the...	There should be confirmation that 2 individuals reviewed these data. Possibly an option for a second user to login and initial that the data have been visually confirmed.	Comment noted. Will evaluate feasibility and address during implementation phase.
40	General				Where there are multiple data sources for one site that the most negative data be assumed as the most accurate pending implementation of the monitoring system	Comment noted. Will evaluate feasibility and address during implementation phase.

Cuyama Basin Water Budget Section
Summary of Public Comments and Responses
April 22, 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1	2.3.4 Water Budget…Current and Projected	1		Because there is no basis to assume any changes in Cuyama Basin	Consider adding projects to the projected water budget.	The Water Budget section on sustainable yield now includes an analyses that incorporates potential projects.
2	General Comments				"As defined by the Groundwater Sustainability Plan (GSP) regulations promulgated by the California Department of Water Resources (DWR), the water budgets section is intended to quantify the following: (5) If overdraft conditions occur, a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions." These are the only two times the word "overdraft" is used in this whole chapter, yet the data indicates that of the 60 TAF extracted every year from the Cuyama Groundwater Basin for agriculture, 23 to 26 TAF of it is in excess of available recharge, otherwise known as "overdraft". That's 44% overdraft, almost ½ the amount that is being extracted. That is before climate change or GDEs are factored into the budget. Yet there is not one mention of the word overdraft! Change in Storage is an unclear euphemism that must be qualified with another disassociating term, such as positive/negative or gain/loss. In a basin that is designated by DWR as critically overdrafted, the GSP should not be hiding the problem behind misleading terminology that downplays the issue. Call it by its real name; Overdraft.	A note has been added that reduction in storage is overdraft.
3	2.3.5 Water Budget Estimates				The terms used for the components of the surface and groundwater budgets should be clearly defined in a Useful Terms section. What is specifically meant by these terms and how are they calculated,estimated or measured; Evapotranspiration, Deep Percolation, Applied Water, Runoff, Stream Seepage, Subsurface inflow, Reduction in storage	A Useful Terms section has been added
4	2.3.6 Historical Water Budget			The Basin average annual historical groundwater budget has greater	This sounds like chronic overdraft. To accurately quantify it would be to compare it to the total pumping demand. 23 TAF/Y has no reference to the basin as a whole. 44% overdraft is a quantification. The decision makers who are charged with balancing this basin are not well served when the problem is not clearly stated.	Required pumping reductions to eliminate overdraft are now quantified in the sustainable yield section.
5	2.3.7 Current and Projected Water Budget				The water budget considers native vegetation within the surface water system of the water budget. Native vegetation evapotranspiration (174,000 AFY) is a significant portion (60%) of the average annual surface water budget. Because the section of the report related to Groundwater Dependent Ecosystems is not yet available for review, it is unknown if some portion of the native vegetation could be utilizing groundwater as its water source. It is also recognized that this is one of the many real data gaps, as this Basin's hydrologic connection to the native ecosystems is poorly understood. The Project of Rangeland Management fits in here with a possible win/win between ecological services and a water Budget. Fire, as a management strategy for maintaining a more mature natural ecosystem, can augment groundwater recharge in the main basin. Where is the Data Gap section to help refine this understanding to help improving these Thresholds into the future.	GDEs are now discussed in the Groundwater Conditions section. The rangeland management project is not included in the GSP per direction from the Board
6	2.3.7 Current and Projected Water Budget				The text incorrectly identifies Figure 2.3-9 and Figure 2.3-10 as historical when they are current and projected numbers. The text also fails to quantify the overdraft of 42% by only stating that the "budget has greater outflows than inflows, leading to an average annual decrease in groundwater storage of 25,000 AF" By presenting only the value of the imbalance, the degree of overdraft is not conveyed and the severity of the situation is avoided and misrepresented. This is an unacceptable disservice to contextual understanding, which misleads and decontextualized the situation to decision-makers and stakeholders.	The text has been corrected. Required pumping reductions to eliminate overdraft are now quantified in the sustainable yield section.
7	Table 2.3-4: Current and Projected				What is meant by these Water Year Types? How many inches of rain per type of water year? This table could be informative if it had more reference or context. What is the % of normal or average?	Water year types were developed for the Cuyama Basin based on historical Basin precipitation.
8	2.3.8 Sustainable Yield Estimate				DWR requires an estimate of sustainable yield for the basin. Why is this incomplete? This section can be developed without the projects and management actions modeling analysis. Why not estimate the Sustainable Yield for the baseline condition before projects and management actions? Some amount less than the sum of Deep Percolation + Stream Seepage + Subsurface Inflow would be a Sustainable Yield. That's < 35,000 AF or 56% of currant pumping. Quantify what we do already know.	Sustainable yield information is now included in the section.
9	General Comments				It is disingenuous to present alarming data without reference or context for the understanding of its severity. DWR requires the quantification of the overdraft. W&C has not only failed to clearly quantify the degree of overdraft, but they refrained from even using the term at all. For the sake of stakeholder understanding and effective decision making it is critical that all information is presented in full context. Complex issues need their significance and their implications explained clearly.	A note has been added that reduction in storage is overdraft.
10	2.3.1 Water Budget Information	3			It would be useful to be more specific which regulations are binding than the entire California Code of Regulations.	A footnote has been added as suggested below.
11	Figure 2.3-2				Please double-check the cumulative departure calculations. Based on visual inspection, the calculations appears to be off in places (e.g., 2003 received 12 inches below average precip, but the cumulative departure only drops about 8 inches)	The figure has been updated
12	2.3.4 Water Budget…Current and Projected	1		This baseline uses current land and water use	This is not accurate based on previously presented information in the Technical Forum. It was previously understood that you are varying assumed land use going forward to match historical changes in annual crops.	The text has been revised for clarity.
13	General Comments				There does not appear to be a placeholder for a projected groundwater budget considering climate change.	A section on climate change has been added.
14	2.3.1 Water Budget Information	3		In this document, consistent with the	Suggest citing in footnote: California Code of Regulations, Title 23. Waters, Division 2. Department of Water Resources, Chapter 1.5. Groundwater Management, Subchapter 2. Groundwater Sustainability Plans	This has been added.
15	Figure 2.3-2				Align and standardize vertical scales to allow direct comparison for a given year or set of years.	The figure has been updated

Cuyama Basin Water Budget Section
Summary of Public Comments and Responses
April 22, 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
16	General Comments				The IWFM was calibrated for the period 1995-2015. The historical budget is for the period 1998-2017. Presumably the 2016 and 2017 periods are predicted by the model. Where is the post audit of those results?	These can be made available to the Tech Forum members
17	2.3.4 Water Budget…Historical	1	2	The hydrologic period of 1998	This results in cumulative removal of 18 inches of water relative to the long-term average.	Comment noted. No change required in document.
18	2.3.5 Water Budget Estimates			The following components are included in the groundwater budget	Are spring flows negligible/ignored?	Spring flows are negligible compared to the overall water budget.
19	Table 2.3-2			Average Annual Land Surface Water Budget	Incorporate "20-yr" and "50-yr" in table title	These have been added as footnotes to the table
20	Table 2.3-3			Average Annual Land Surface Water Budget	Move tables closer to text where they are discussed.	The section has been re-formatted
21	Table 2.3-4			"Runoff" cell	Is this flow out of the basin?	Yes
22	Table 2.3-3			Cell with 25,000 value in 3rd column for Deep Percolation	Rounding error? Why not 26,000 AFY as with land surface deep percolation?	Yes, this difference is due to ronding.
23	Figure 2.3.4			Historical Land Surface Water Budget	Need to be rigorous about land surface and groundwater budgets; do not refer to basin budget components.	The text has been revised as recommended.
24	2.3.6 Historical Water Budget			The Basin experiences about 285,000 AF	"Basin" - The unsaturated soil zone, not the basin; groundwater is part of the basin water budget.	The text has been revised as recommended.
25	2.3.6 Historical Water Budget			The Basin experiences about 285,000 AF	"inflows" - Land surface inflows	The text has been revised as recommended.
26	2.3.6 Historical Water Budget			About 225,000 AFY is consumed as evapotranspiration	These amounts make sense?	Yes, the evapotranspiration estimates are reasonable given the available land use data. The stream seepage and deep percolation estimates are reasonable given the data that is available.

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses
April 22, 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1	5.1 Useful Terms			Sustainability Goals – The culmination	The definitions are almost verbatim from the regs but could use some translation for a general audience, esp Sustainability Goals	To make sure that we are consistent with the Regulations, we have kept the definitions as is.
2	5.2.1 Threshold Regions…Southeastern Threshold			The northern boundary of this region is the narrows at the Cuyama river,	"and the eastern boundary" - You mean western boundary?	Although correct, the intention was to say the "eastern" because to the west of the boundary of the Basin and to the west is the Badlands Management Area. The intention was to destinguish the boundary between the two management areas.
3	5.2.1 Threshold Regions…Eastern Threshold			The Eastern Threshold Region lies just east of the central part of the	…lies just southeast?	Text has been updated
4	5.2.1 Threshold Regions…Eastern Threshold			Hydrographs in this region indicate that groundwater	Mention other aspects of Eastern Region: More variability in water levels? Locally important shallow production wells?	Text has been updated to provide more clarity to destinguish this region from the Central Region by discussing differences in water level. Also mentioned in this section is the Santa Barabara Canyon Fault, which is discussed in more detail in the HCM.
5	5.2.1 Threshold Regions…Western Threshold			The eastern boundary is defined by the Russell Fault,	Brief explanation of which land uses are differentiated	Text has been updated
6	5.2.1 Threshold Regions…Northwestern Threshold			The southeastern border was drawn to differentiate between the	Suggest "southern border" or border with the western region"; also, which land uses differentiated?	Text has been updated
7	Figure 5-1: Cuyama GW Basin Level			Map	Suggest text callout labels on the map to make it easier to tell which region is which	The figure has been updated
8	Figure 5-1: Cuyama GW Basin Level			Map	Change Legend to say "Representative well with OPTI well ID number"	The figure is clear enough without this change.
9	5.2.2 Minimum Thresholds…Southeastern Threshold			Placeholder for IM calculation	Show and reference example hydrograph (use real one) with example of trend and MT & MO calculation	Since the document has been changed to make all IMs equal to MTs, this is not needed
10	5.2.2 Minimum Thresholds…Southeastern Threshold			Levels will be measured using	An embedded table to summarize monitoring frequency would be useful	Monitoring frequency is discussed in the Monitoring Networks chapter
11	5.2.2 Minimum Thresholds…Eastern Threshold			The MT for this region intends to protect	Suggest combined hydrograph with multiple wells to illustrate trend	Hydrographs with thresholds are provided in an appendix
12	5.2.2 Minimum Thresholds…Eastern Threshold			This 20% of the range was then added below	State period of historical range used (1995-2014, or entire range of data?)	Updated text for clarity
13	5.2.2 Minimum Thresholds…Eastern Threshold			The MT values calculated by the two methods were then compared, and	Update method of setting MT & MO per 3/6/2019 GSA Board Meeting	Text has been updated. Board provided final approval for update to MTs and MOs at the 4/5/2019 meeting
14	5.2.2 Minimum Thresholds…Central Threshold			If no measurement was taken during this 4-month period	State period used to evaluate range	Updated text for clarity
15	5.2.2 Minimum Thresholds…Western Threshold			The MT was calculated by taking the difference between the total well depth and the value closest to mid-February, 2018	2018 or 2015? Explain reason for change in assumed baseline	Updated text for clarity
16	5.2.2 Minimum Thresholds…Northwestern Threshold			This value was then set as the MT.	In other words, an allowable loss of 15% of the estimated saturated thickness of the aquifer was proposed.	This is correct.

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses
April 22, 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
17	Table 5-1 - Representative Monitoring			2030 IM	IM???	IM = Interim Milestone
18	Table 5-1 - Representative Monitoring	OPTI well 77, Final MO 400			How do the MT's agree across the Basin? Table shows significant difference in parameter ranges in different Threshold Regions. Are we going to have some agreement across the Basin or will it bust? The Central Region has a range of 600 feet, Western 130 feet, and Eastern 70 feet.	Thresholds have been calculated to be protective of certain areas of the Basin and the conditions within those portions of the Basin while also considering beneficial uses of GW. In other regions, they have been calculated to achieve sustainability over the planning horizon. While threshold levels may differ across regions, these thresholds will 1) help move the
19	Table 5-1 - Representative Monitoring	OPTI well 324, Final MT 311			Suggest using a contour or symbolic post map to illustrate overall basin MTs and MOs. May show some discontinuities that you will want to address in the text.	Spatial density of wells may not be sufficient to provide a map that is accurate to represent the MOs across the entire basin. When more data is available, this may be an option.
20	5.3 Reduction in Groundwater	2	1	Reduction of groundwater storage is not a concern for the Basin	I kinda thought this was the main concern, actually. Might want to re-word this a little. Maybe something like "Separate monitoring of groundwater storage changes apart from groundwater levels is not proposed..."	Text has been updated for clarity
21	5.3 Reduction in Groundwater	3	1	Second, because the primary aquifer in the Basin is not confined	Storage also is linear with water levels in confined systems, you just have a much smaller storage coefficient.	Comment noted. No change needed.
22	5.5 Degraded Water Quality	3	1	Because the undesirable result for degraded water quality	Suggest clarifying this. Maybe "Because undesirable water quality results are defined under SGMA only as those chemical constituents which are influenced by SGMA-related groundwater management activities, not all chemicals of concern in Cuyama Basin groundwater will be monitored or regulated by the GSA. Total dissolved solids (TDS) will..."	Text has been updated for clarity
23	Table 5-2: MOs	Table		MO column	Suggest making a symbolic post map, color "heat map" or contours to illustrate the basin as a whole, or maybe by threshold region, even though you aren't using those for WQ. Still people have gotten used to them and now think along those lines.	Spatial density of wells may not be sufficient to provide a map that is accurate to represent the MOs across the entire basin. When more data is available, this may be an option.
24	5.6.3 Minimum Thresholds	1	1	Because current subsidence rates are not believed to be significant and	P521 is outside the basin. VCST is in the basin.	Updated text for clarity
25	5.6.3 Minimum Thresholds	2	2	Thus, the MO for subsidence is set for zero	Isn't CUHS subsidence ~11 inches? More than zero...	Text has been updated for clarity. Although approximatly 295 mm of subsidence has occurred in the last 14.5 years (estimated by taking -5mm around mid 2002 ti -300 around Jan 2017), the rate of subisdence has been about 0.8 inches per year.
26	5.7 Depletions of Interconnected	2	2	In January 1, 2015 surface flows infiltrated into the groundwater	Are you talking about a single 1-day flood event? This sentence is unclear if you are describing general conditions or a specific event.	Updated the text for clarity
27	5.7 Depletions of Interconnected	2		Conditions have not changed since January 1, 2015	How does this correspond to the water budget showing significant surface water outflows?	Updated the text for clarity
28	General Comment				No explanation is offered for the absence of Interim Milestones. How and when will these be calculated? Placeholders for these important sustainability goals represent a critical gap in this chapter and need some explanation as to the timing and process for their completion.	The updated draft sets all IMs for water levels and water qualities to equal MTs
29	General Comment				Minimum Thresholds for the Eastern Region are being reconsidered and adjusted by the GSA and are not accurately reflected in this draft for review.	Text has been updated. Board provided final approval for update to MTs and MOs at the 4/5/2019 meeting
30	General Comment				The sustainability criteria of subsidence, loss of storage, water quality and the depletion of interconnected surface waters are underemphasized to the point of misrepresenting the undesirable results that are currently being experienced by beneficial users and uses other than agriculture in the basin.	Comment noted. No change needed.
31	General Comment				There is a dismissive approach to addressing the undesirable results of the Sustainability Criteria and to the setting of MTs. All the available data indicates conditions of overdraft in the basin but many MTs allow for continued declines in groundwater elevations and groundwater quality. The perspective towards sustainability appears to be coming from the viewpoint of the commercial agricultural beneficial user and dismissive of the needs of others, such as domestic and environmental users. Many water quality issues are avoided, such as arsenic and nitrates and domestic supply needs. Subsidence is dismissed and increasingly tolerated. Interconnected surface waters and GDEs are assumed to be irrelevant without the responsibility for protection. This is unexceptable to this stakeholder and I would hope and expect that the DWR would agree	Comment noted. No change needed.
32	5.2 Chronic Lowering				Of the six Threshold Regions that were defined for specific MT/MO/IMs, only two specifically note protection of environmental uses: Southeastern Threshold Region, and Eastern Threshold Region. However, W&C has defined likely GDEs in the Northwestern region and parts of the Central region. Without the associated maps and GDE report, it was unclear if these wells with MTs and MOs are protective of these likely GDEs. Most MTs/MOs in these wells (Table 5-1) are really deep; a few wells have MTs < 100ft and MOs <50 ft. It would be important for be able see where those wells overlay with the potential GDEs (both original NC dataset potential GDEs and the W&C likely GDEs). How is it demonstrated that the lowering of groundwater levels with these thresholds won't adversely impact these beneficial uses?	Well locations relative to GDEs can be assessed when Monitoring Network data gaps are addressed during the GSP implementation phase.

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses
April 22, 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
33	5.2.1 Threshold Regions				This subsection does not discuss the strategies used to calculate the MOs, MTs, and Milestones for each Threshold Region, as stated in the text, but only describe the characteristics and location of the regions. Strategies are presented in subsection 5.2.2.	Text has been updated for clarity
34	5.2.2 Minimum Thresholds…Southeastern Threshold				The MT is intended to be "protective of domestic, private, public, and environmental uses", yet for one of the only two monitoring wells in this region the MT is set only one foot above the bottom of the well (Opti well #2). How is that being protective?	MT is set at levels determined and approved by the GSA Board. If levels drop below MTs, the Board can take action in the future.
35	5.2.2 Minimum Thresholds…Eastern Threshold				It has been noted that these rationales do not work well for this region and that the monitoring wells are not representative of the wells in this region. The rationales for this region need to be reconsidered by the GSA and then this subsection rewritten before review.	Text has been updated. Board provided final approval for update to MTs and MOs at the 4/5/2019 meeting
36	5.2.2 Minimum Thresholds…Western Threshold				This sentence makes no sense; "This would allow users in this Threshold Region to utilize their groundwater supply without increasing the risk of running a dry well beyond acceptable limits, and this methodology is responsive to the variety of conditions and well depths in this region." A well running dry would surely constitute an Undesirable Result.	Text has been updated for clarity
37	5.2.2 Minimum Thresholds…Western Threshold				OPTI Well 474 is not in this region, why is it mentioned here?	Well 474 is in the western region
38	5.2.2 Minimum Thresholds…Northwestern Threshold				Very little publicly verified information is available for this region which until recently had never been developed for irrigation. Only two years of data exists from the new wells in the region. How was the "total average saturated thickness for the primary storage area of the region" determined with any validity? With such limited historical data available, how was 50 feet determined to be 5 years of storage? Local landowner input is suspect to be biased in the interest of their recent commercial development and is therefore questionable at best. In the case of such uncertainty it seems imprudent and risky to set MTs so far below current conditions in a critically overdrafted basin. Were the "Far-west Northwestern" wells put into a newly designated Threshold Region, moved into the "Western" region, or just "reclassified" because the rational is inappropriate? Is this an appropriate solution? This was never discussed by the SAC or GSA.	Information about this region was provided in two memorandums emailed to the Cuyama mailing list on 12/13/2018. The GSA Board was able to take this information into account when setting MTs for this region.
39	5.3 Reduction in Groundwater				Reduction of groundwater storage is certainly a concern for the Basin for obvious reasons. A lack of sufficient monitoring data in several areas of the Basin (western, northwestern, far west northwestern, eastern, and southeastern) inadequately represent conditions of groundwater storage. Chronic groundwater elevation declines in many areas of the Basin indicate significant reduction in storage. The historic and current condition of overdraft (-26 TAF/Y) has reduced groundwater storage in the basin by well over 1,000,000 AF, and is projected to continue until some substantial changes are made to the management of this resource. The reduction of groundwater storage caused by continued overdraft is an undesirable result experienced by every beneficial user in the basin	The text has been revised to just note that direct measurement of storage is not needed, while removing reference to storage not being a concern.
40	5.5 Degraded Water Quality				Because of the causal nexus between excessive groundwater extraction and degrading groundwater quality, the GSA is responsible for monitoring the changes in concentrations of any constituent that would represent an undesirable degradation of water quality due to groundwater extraction. These include Arsenic, Nitrates and TDS. Limiting the GSP to monitoring TDS alone is not sufficient and does not satisfy the requirements of SGMA with regards to monitoring groundwater quality.	Direction was provided by the GSA Board (through approval of the Monitoring Networks GSP section) to only include TDS for monitoring and sustainability in the GSP. As stated in the text, other contamination sites are regulated by the RWQC, nitrates are unde the jurisdiction of the ILRP, and the GSA does not possess land use authroity to incluence fertlizer use. Additionally, Arsenic occurs at specific depths in the Basin and is not managed a the GSA regional scale.
41	5.5.3 Minimum Thresholds				TDS levels in the groundwater detrimentally impact the agricultural economy of the Basin because crops like potatoes, beets and leafy greens, formerly a much larger part of local production, are no longer commercially viable. Carrots may tolerate the high TDS, but they suffer in quality, taste and sweetness. It should be noted that to defend poor water quality and tasteless produce does not serve the local agricultural economy well and the GSP should not include this sort of language. Further, there is no mention made of the undesirable effect experienced by domestic and livestock users due to the poor water quality. It should be noted that carrot production is not the only beneficial user of groundwater in the basin. Disadvantaged communities in the valley are not well resourced to treat drinking water sources or redrill domestic wells.	High TDS in the Basin, as stated in the text (Sustainability Thresholds Sectio nand Groundwater Conditions) is naturally occuring within the Basin. The GSA has voted to monitor TDS, but may only influece TDS concentrations through groundwater levels, through additional inputs. These inputs travel through highly saline rock, contributing to additional TDS in the groundwater. Per SGMA regulations, the GSA is also only required to maintain water quality conditions that exist as of January 1, 2015. The GSA may choose to refine these thresholds later as more data is collected.
42	Table 5-2: MOs				How is it that all the Interim Milestones set for TDS have progressively higher concentrations over time? For example Opti well 99, with a MT of 1562, has an IM of 1490 - 1508 mg/L for 2025, 1490 - 1526 mg/L for 2030, and 1490 - 1544 mg/L for 2035. This appears to be getting worse not better! Why is it that many wells in the table (all of the last 17) have MO the same as the MTs, with IMs that have no range or change? For example; Opti well 845 has an MO of 1250 and an MT of 1250, and all three IMs are 1250 - 1250 mg/L. This data table implies worsening TDS concentrations over time and needs further clarification.	Interim Milestone calculations have been updated such that IMs equal the MTs at all intervals.
43	5.6 Subsidence				With the current accelerating rate of subsidence of approximately 0.5 inches per year, what is the rationale of a MT of 2 inches per year? This is far too permissive and clearly allows for up to 10 inches of collapse in 5 years at four time the current rate. Ground surface instability and associated storage loss of this caliber is not achieving sustainability and would constitute a significant undesirable result. There needs to be a clearer explanation of why this undesirable result is allowable	No undesirable result has been identified for subsidence of up to 2 inches per year
44	5.7 Depletions of Interconnected				Riparian habitat and phreatophytes in the Cuyama River have been drying up and dying since long before January 1, 2015, as groundwater levels decline and the river bank storage is lost. Conditions continue to degrade with the depletion of interconnected surface water as less of the river experiences surface flows due to declining groundwater elevations. Deforestation and riparian habitat loss is an undesirable result due to the adverse effects of continued overdraft. Groundwater dependent ecosystems are similarly adversely impacted by this undesirable result. SGMA requires GSAs to identify, quantify and manage these beneficial uses to avoid any undesirable results. This GSP fails to recognize that requirement or manage for these undesirable results.	Comment noted. Please review the GDE report for additoinaly information.
45	5.7 Depletions of Interconnected				Without the baseline information in the Groundwater Conditions, especially in the newly developed Northwestern region, it is difficult to justify the decision to allow for the continued decline of groundwater levels with these MT/MO.	Comment noted. The MTs and MOs reflect the values approved by the Board.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
46	5.2.1 Threshold Region... Southeastern Threshold				I believe it is inaccurate to describe this Region as having groundwater levels that are "generally high in this area, with levels around 50 feet or less below the ground surface which indicates that this region is likely in a 'full' condition." If the GSP is going to characterize this region like that, then it needs to point out that it is based on limited history from two wells in the southern headlands half of the region, and that little or no data exists for the areas north toward the narrows. Data does, however, exist, and I think it should inform our understanding and description of the region. At the request of staff, I have twice sent 3rd party documentation in the form of various well drilling reports as well as additional information about the significant fluctuations in static water levels that have occurred historically within this region. Those documents , well videos and air-line measurements show that static water levels in this region have fluctuated significantly during drought periods to at least as low as 108' bgs. I believe there needs to be a recognition of the historical fluctuation of water levels in this region, and that this section should include something like the following wording: "Groundwater is generally high in this area with levels around 100 feet or less below ground surface. Groundwater levels in this region are subject to significant declines during drought periods but have typically recovered to within 50' or less of ground surface during historically wet periods."	Text has been updated to add additional language.
47	5.2.1 Threshold Region...Eastern Threshold				The Eastern Threshold Region description should include a little more information: It only mentions conditions during the past 20 years, whereas our understanding of the reliability and availability of water in this region relates to a much longer time horizon. Our historical modeling is informed by 50 years of data, and I think we should at least descriptively recognize what's happened in this region over a longer history. I think we should include wording to the effect that "Hydrographs in this region indicate that groundwater levels have ranged widely and repeatedly over the past 50 years. Hydrographs in the Ventucopa area indicate that groundwater levels have been, in general, declining for the past 20 years.	Example is OPTI Well 85. Text has been updated for clarity.
48	5.2.2 Minimum Thresholds…Southeastern Threshold				Although the charts and thresholds are all good, I believe the threshold description rationale is in error. It reverses the use of the terms MO and MT.	Text has been updated to correct this error.
49	5.2.2 Minimum Thresholds…Southeastern Threshold	2	1	The MT for the Southeastern Threshold Region…	It should read: "The MO for Southeastern Region…."	Text has been edited
50	5.2.2 Minimum Thresholds…Southeastern Threshold	3	1	To provide an operational flexibility range, the…	Sentence should read "To provide an operational flexibility range, the MT was calculated by adding 5-years of groundwater storage to the MO."	Text has been edited
51	5.5.3 Minimum Thresholds				The section seems to say that the TDS levels in the water need to be better measured and understood, and that we can't do much about them, and they're not necessarily impacting the economy that much, but then goes on to set Minimum Thresholds at very strict levels sometimes just above a recent historical level. At least some of the OPTI wells in the DMS have very limited data associated with the TDS, or even just two data points, sometimes with the same date (OPTI 83) and have a falsely narrow range of readings. Under the MT formula, this results in an exceptionally strict MT such as in OPTI 83 where the MT is set at just 6 ppm over the only reading on the well which was August of 2011. TDS levels vary broadly over short distances, and can vary significantly from year to year. My own sampling results show TDS results varying by as much as 800 ppm from one well to the next and by similar amounts on an individual well over time. If water quality readings that violate MTs will be an issue, then I believe the proposed MTs should be rethought and not expressed in terms of historical ranges, but rather as a percentage factor over recent values.	Comment noted. The Board can reassess the thresholds in the future as more data is collected.
52	5.1 Useful Terms	Final			Typo in use of MI instead of IM.	Text has been updated
53	5.2.1 Threshold Regions	1		These conditions are influenced by geographic…	This sentence is confusing and needs revision	Text has been updated
54	5.2.1 Threshold Regions…Southeastern Threshold				Typo "southeaster"	Text has been updated
55	5.2.1 Threshold Regions…Southeastern Threshold				Describing groundwater levels is sufficient, no need to editorialize about "full" condition", or at least state that it is currently in a full condition.	Text has been updated
56	5.2.1 Threshold Regions…Central Threshold			Hydrographs in this region indicate that groundwater levels have been…	Should note that the levels have been substantially declining, or give a sense of the average rate of decline.	Comment noted. This is shown in the Groundwater Conditions section.
57	5.2.1 Threshold Regions…Western Threshold				Mention types of land use to distinguish it from NW Region Also, describing groundwater levels is sufficient, no need to editorialize about "full" condition", or at least state that it is currently in a full condition.	Text has been updated

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
58	5.2.1 Threshold Regions…Northwestern Threshold			The Northwestern Threshold Region is the bottom of the Cuyama…	Please be more specific and revise to something like: " The Northwestern Threshold Region is at the western edge of the Cuyama Basin and has undergone changes in land use from grazing to irrigated crops over the past 4 years." Also, describing groundwater levels is sufficient, no need to editorialize about "full" condition", or at least state that it is currently in a full condition.	Text has been updated
59	5.2.1 Threshold Regions…Badlands Threshold			There is no monitoring in this region, and this	Revise to "… and no sustainability criteria were developed for this region."	Text has been updated
60	5.2.2 Minimum Thresholds	General Comment			MTs were established for wells, not regions. So the text should state that MTs were calculated for wells in a given region.	Text has been updated
61	5.2.2 Minimum Thresholds	General Comment			Include additional reasoning why the various threshold rationales were chosen.	Comment noted. This will be included in the Undesirable Results Narrative.
62	5.2.2 Minimum Thresholds…Central Threshold			The MT for the Central Threshold Region	Typo "The MT for the Central Threshold Region was calculated by taking finding…"	Text has been updated
63	5.2.2 Minimum Thresholds…Central Threshold			OPTI Wells 74, 103, 114, 568, 609, and	Please explain the reason for this in the text (e.g., "Because OPTI Wells 74, 103, 114, 568, 609, and 615 did not have sufficient measurements…")	The text has been updated. These wells did not have measurements to within the specified time range to represent January 1, 2015 conditions and thus utlized a linear trendline to extroplate and estimated value.
64	5.2.2 Minimum Thresholds…Western Threshold			OPTI Well 474 utilizes a modified MO calculation	Please explain why in the text.	Text has been updated
65	5.3 Reduction in Groundwater	2		Reduction of groundwater storage is not a concern for the Basin for two reasons.	Reduction of groundwater storage may be able to measured using levels as a proxy, but it is inaccurate to say that it is not a concern. Even areas that may be currently "full" may suffer reductions in groundwater storage going forward. Suggest deleting this discussion.	The text has been revised to just note that direct measurement of storage is not needed, while removing reference to storage not being a concern.
66	5.5 Degraded Water Quality	3		Because the undesirable result for degraded	Explain in text why TDS will be monitored. Current discussion is only about constituents not to be monitored.	Text has been updated
67	5.5 Degraded Water Quality	3		Arsenic occurs at specific depths in the basin, but the location	If arsenic increases with depth, then managing declines in groundwater levels would manage arsenic concentrations.	Text has been updated
68	5.5.3 Minimum Thresholds	3	1	Due to these factors the MT for representative well sites are set	Please give an example of how this is calculated with an example well for clarity in the text. Also provide the calculations in Table 5.2 or in an appendix. Columns with the total range and the 90th percentile of measurements would be useful.	Text and Table has been updated
69	Table 5-2: MOs				Table should state that these concentrations are for TDS. Include units for MO and MT as they are for the IMs. For ease of table reading, could move units to the header.	Table has been updated
70	5.6.2 Representative Monitoring				It's not just water-related infrastructure that is impacted by land subsidence. It can be roads, bridges, etc.	Text has been updated
71	Figure 5-4				Needs to be referenced	Text has been updated
72	5.7 Depletions of Interconnected	2	2	In January 1, 2015 surface flows infiltrated into the groundwater	This statement, and this whole section is confusing and should be revised. I think that the intent is to say that there has been no change in surface water depletion since 2015, but the wording is quite awkward and would not be coherent to a reader without significant background knowledge.	Text has been updated
73	General Comment				In general, the Central Coast Water Board recommends that the number of chemical constituents included in the Minimum Thresholds (MT), Measurable Objectives (MO), and Interim Milestones (IM) be increased. The Central Coast Water Board agrees that MTs, MOs and IMs should be established for total dissolved solids (TDS), however, including only that single constituent is insufficient for determining whether a groundwater basin is being managed sustainably with respect to water quality or for determining if undesirable results are being addressed. Land use in the Cuyama Valley is dominated by commercial agriculture, an industry that utilizes a variety of chemicals and practices that pose threats to groundwater quality. Therefore, the Central Coast Water Board recommends expanding the list of chemical constituents in the MT, MO, and IM to include nitrate, arsenic, and major dissolved ions. The reasoning for this recommendation is described in detail below.	Direction was provided by the GSA Board (through approval of the Monitoring Networks GSP section) to only include TDS for monitoring and sustainability in the GSP. Therefore, this Section will only include water quality sustainability indicators for TDS, unless alternate direction is provided by the Board.

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74	General Comment				Nitrate: Nitrate contamination of groundwater from agricultural activities is widely documented in the Central Coast region, including within the Cuyama Valley. Approximately 9% of on-farm domestic wells in the Cuyama Valley exceed the human health standard for nitrate concentration in drinking water1. The draft chapter states that the Cuyama Valley groundwater sustainability agency (GSA) does not have the authority to influence fertilizer use, and we are not suggesting the GSA should undertake such a regulatory role. However, the GSPs are required to implement thresholds and monitoring that can identify when undesirable results are occurring. Given the current impairment from nitrate in the basin and ongoing agricultural activity, it is appropriate to require thresholds and monitoring for nitrate in the Cuyama Valley groundwater basin. Nitrate monitoring is not unusual in agriculturally-dominated basins; for example, the Salinas Valley GSA is recommending an expanded suite of chemical constituents for its thresholds and monitoring. The recommendation in their most recent draft includes up to 25 different chemical constituents, including nitrate and arsenic. Finally, we recommend that nitrate be reported as nitrogen (nitrate as N), because this convention allows for easy comparison and summation (e.g., calculation of total nitrogen).	Direction was provided by the GSA Board (through approval of the Monitoring Networks GSP section) to only include TDS for monitoring and sustainability in the GSP. Therefore, this Section will only include water quality sustainability indicators for TDS, unless alternate direction is provided by the Board.
75	General Comment				Arsenic: Arsenic is a toxic chemical compound that occurs naturally in relatively high concentrations in many of the sediments that form California groundwater basins, including those of the Central Coast. Groundwater data from the Water Board's GeoTracker GAMA website indicates that 12% of the wells in the Cuyama Valley groundwater basin exceed the maximum contaminant level (MCL) for arsenic in drinking water. The highest concentration recorded in the basin occurred in 2011 and was more than six times greater than the MCL. Furthermore, recent studies in the Central Valley of California and the Mekong Delta in Thailand have demonstrated that ground subsidence associated with groundwater over-pumping can mobilize arsenic by 'squeezing' it out of subsurface clay layers. The resulting mobilized arsenic can then enter groundwater and increase arsenic concentrations in nearby water supply wells. Because there is documented overdraft and subsidence in the Cuyama Valley, there is the potential risk of anthropogenically-induced arsenic contamination of groundwater due to arsenic mobilization from clay layers in the Cuyama Valley basin. Lastly, in addition to sediment related sources, arsenic is a component in many pesticides commonly used on various crops. These factors suggest that arsenic should be included in the MTs, MOs, and IMs for the Cuyama Valley basin.	Direction was provided by the GSA Board (through approval of the Monitoring Networks GSP section) to only include TDS for monitoring and sustainability in the GSP. Therefore, this Section will only include water quality sustainability indicators for TDS, unless alternate direction is provided by the Board.
76	General Comment				Major Dissolved Ions: Major dissolved cation and anion composition in groundwater reflects the source of recharge water, lithological and hydrological properties of the aquifer, groundwater residence time, and chemical processes within the aquifer. As such, major dissolved ions are valuable for identifying different groundwater types (via Piper or Stiff diagrams) and for "fingerprinting" source water from individual wells. In addition, ionic charge balance provides quality assurance that all the major ions are actually included in the analysis and that TDS concentrations are accurate. Finally, collection and analysis of major dissolved ion samples is easy and inexpensive, and the cost of the analysis is well worth the data provided, particularly if the well is already being sampled for other constituents.	Direction was provided by the GSA Board (through approval of the Monitoring Networks GSP section) to only include TDS for monitoring and sustainability in the GSP. Therefore, this Section will only include water quality sustainability indicators for TDS, unless alternate direction is provided by the Board.
77	5.1 Useful Terms				Suggest that the GSA Board is aware that the representative wells are theoretical until an agreement between the GSA and well owner is executed. Does the Consultant have a list of other potential representative wells in case a well is not operational, or an agreement cannot be executed?	All the wells that could be used as representatives wells are included, and thus no alternative list is available. The text has been updated for clarity
78	5.2.1 Threshold Regions…Southeastern Threshold	1	1	The Southeaster Threshold Region	Spelling	Text has been updated
79	5.2.1 Threshold Regions…Southeastern Threshold	1	2	Groundwater is generally high	Consider adding a timeframe or date to when this area was defined as full.	Text has been edited for clarity
80	5.2.1 Threshold Regions…Southeastern Threshold	1	3	The northern boundary of this region is the	Consider defining all four boundary directions for the Southeastern Threshold Region.	Text has been updated
81	5.2.1 Threshold Regions…Eastern Threshold	1	4	The northern boundary of this region	Consider defining all four boundary directions for the Eastern Threshold Region.	Text has been updated
82	5.2.1 Threshold Regions…Central Threshold	1	3	The south-eastern boundary is defined by	Consider defining all four boundary directions for the Central Threshold Region.	Text has been updated
83	5.2.1 Threshold Regions…Western Threshold	1	1	The Western Threshold Region is characterized	Consider adding a timeframe or date to when this area was defined as full.	The text has been updated.
84	5.2.1 Threshold Regions…Western Threshold	1	3	The eastern boundary is defined by	Consider defining all four boundary directions for the Western Threshold Region.	Text has been updated
85	5.2.1 Threshold Regions…Northwestern Threshold	1	2	Hydrographs in this portion of the	Consider adding a timeframe or date to when this area was defined as full.	The text has been updated.
86	5.2.1 Threshold Regions…Northwestern Threshold	1	3	The southeastern border was drawn to	Consider defining all four boundary directions for the Northwestern Threshold Region.	Text has been updated
87	5.2.1 Threshold Regions…Eastern Threshold	1	3	The northern boundary of this region is	Consider defining all four boundary directions for the Eastern Threshold Region.	Text has been updated

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
88	5.2.1 Threshold Regions…Central Threshold	1	3	The south-eastern boundary	Consider defining all four boundary directions for the Central Threshold Region.	Text has been updated
89	5.2.1 Threshold Regions…Western Threshold			The Western Threshold Region is characterized	Consider adding a timeframe or date to when this area was defined as full.	The text has been updated.
90	5.2.1 Threshold Regions…Western Threshold			The eastern boundary is defined by the	Consider defining all four boundary directions for the Western Threshold Region.	Text has been updated
91	5.2.1 Threshold Regions…Northwestern Threshold	1	2	Hydrographs in this portion of the Basin	Consider adding a timeframe or date to when this area was defined as full.	The text has been updated.
92	5.2.1 Threshold Regions…Northwestern Threshold	1	3	The southeastern border	Consider defining all four boundary directions for the Northwestern Threshold Region.	Text has been updated
93	5.2.1 Threshold Regions…Badlands Threshold	1	2	There are few active wells and little	Consider removing the word little and adding an estimated value of groundwater from the groundwater model.	The text has been edited.
94	5.2.1 Threshold Regions…Badlands Threshold	1	3	There is no monitoring in this region	Consider defining the geology of the Badlands area, such as adding Ballinger, Quatal, and Apache Canyons. This will help explain why this area has few active wells	This is in the HCM section.
95	5.2.2 Minimum Threhsolds	1	1		Consider adding a summary of why each region may have a different MT and MO.	This information is provided in the text
96	5.2.2 Minimum Thresholds…Southeastern Threshold				Consider adding a hydrograph figure to help explain each threshold region for MO & MT.	Hydrographs with thresholds are provided in an appendix
97	5.2.2 Minimum Thresholds…Eastern Threshold				Consider adding a hydrograph figure to help explain each threshold region for MO & MT.	Hydrographs with thresholds are provided in an appendix
98	5.2.2 Minimum Thresholds…Central Threshold				Consider adding a hydrograph figure to help explain each threshold region for MO & MT.	Hydrographs with thresholds are provided in an appendix
99	5.2.2 Minimum Thresholds…Western Threshold				Consider adding a hydrograph figure to help explain each threshold region for MO & MT.	Hydrographs with thresholds are provided in an appendix
100	5.2.2 Minimum Thresholds…Northwestern Threshold				Consider adding a hydrograph figure to help explain each threshold region for MO & MT.	Hydrographs with thresholds are provided in an appendix
101	5.2.2 Minimum Thresholds…Badlands Threshold			The Badlands Threshold Region has no	Page 5-8 states that the area has few active wells, please clarify or correct.	Text has been updated
102	5.2.3 Selected Minimum Thresholds				Consider adding a summary table for MO / MT, such as the one shown in the GSA Board agenda packet on March 6th.	Summary table is provided - Table 5-1
103	5.5.3 Minimum Thresholds	2	3	Much of the crops grown	Consider referencing the crop types or adding a figure on crop types to support this statement.	This information would be inlcuded in the plan in the Basin Settings section
104	General Comment				Consider adding adaptive management as a section in this chapter to provide flexibility to the GSA Board for MO, MT, and interim milestones. Revisions to the MO, MT, and interim milestones could be based on the data collected and analyzed from the GSP monitoring and overall plan effectiveness.	Addaptive management will be included in the Projects and managmeent action section.
105	Refernces			California Department of Water Resources (DWR),	Wrong agency?	Text has been updated
106	Refernces			rrigated Land Regulatory Program (IRLP),	Correction - ILRP	Text has been updated

Cuyama Basin Placeholder Sections
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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1	1.2.8 Plan Elements from CWC Section 10727.4	1	1	The plan elements from...	Suggest revising language in 1.2.8 - first sentence	The text has been revised
2	2.2.4 Change in Groundwater Storage	1	5	The color of bar...	Consider revising the river name	The year type index has been clarified.
3	2.2.10 Data Gaps	1			Consider adding a table on all the data gaps mentioned below in 2.2.10, including data gaps required by DWR GSP regulations.	This is not needed
5	General				Overdraft continues to be hidden within confusing language. Clarity with this issue is paramount and should not be at all ambiguous.	The text has been revised to note that negative change in storage is overdraft
6	General				Some shake up in classifying GDEs has made two unrealistic elimination of either 56% or 82% potential GDEs.	Comment noted. A more detailed analysis of GDEs can be performed during implementation if the Board chooses to do so.
7	General				Additional Data Gaps for the Groundwater Conditions we noted.	The data gaps section has been edited.
8	General				Due to the absence of any stream gauges in the Cuyama in the basin the model is calculating all the amounts and the relationships between the surface and groundwater. This interpreted Interconnectivity of surface waters with the groundwater in not well reflected from the model onto the Figure. More inter-relativity in the presentation is needed.	Comment noted.
9	2.1.10 Hydrogeologic Conceptual Model Data Gaps				It has been recognized that the interconnectivity between Groundwater and surface water is poorly understood, and represents a significant Data Gap in the HCM and throughout this GSP. Many historic seeps, springs and wetlands indicate a complex cascading basin in the three main aquifers with perched groundwater elevations on top of clay layered aquitards. This affects the Groundwater Dependent Ecosystems across the basin and needs further understanding.	Comment noted. A more detailed analysis of GDEs can be performed during implementation if the Board chooses to do so.
10	2.2.4 Change in Groundwater Storage	1	4	Average annual use over the twenty-year period was...	The text does not express the degree or severity of the overdraft. The sentence is incorrect and misinforming. It does not even use the euphemism "change in storage", the word "use" should read "overdraft".	The text has been revised to note that negative change in storage is overdraft
11	2.2.4 Change in Groundwater Storage	1	1	Historical change in storage in the Cuyama Basin...	The text does not express the degree or severity of the overdraft. In this sentence, at least the first "change in storage" could be replaced for clarity with "overdraft". At the very least quantify it as "negative change in storage".	The text has been revised to note that negative change in storage is overdraft
12	2.2.4 Change in Groundwater Storage				The water year type should be correlated to a Cuyama Basin type of water year, not the central valley. Please define what is designated by the water year type as a percent of deviation from an average or normal year.	The year type index has been clarified.
13	2.2.8 Interconnected Surface Water Systems				Is this the same Appendix X as the GDE Report Appendix X?	The text has been revised to clarify that this is referring to the IWFM model appendix.
14	2.2.8 Interconnected Surface Water Systems				Presumably, the Cuyama Basin IWFM Model can be used to analyze groundwater interactions between all the surface water flows in the Basin. Figure 2.2 only represents the Cuyama River, and four of the creeks. Are these the only reaches being analyzed from the model? And can we get more analysis of this data? Show amounts and percentages of gain and loss by reach.	While runoff from all watersheds is simulated in the model, these are the only reaches explicitly simulated as creeks in the model.
15	2.2.8 Interconnected Surface Water Systems				As is noted in the Section 4-10 below, this modeling is being done without any stream gauge data points, because there are no stream gauges, yet.	Comment noted.
16	Table 2-1				This table needs a couple of additional rows on the bottom for Totals & Averages by Reach. This would illustrate the patterns better than the Total column does and it would be helpful to overlay on Figure 2-2 (which needs relabeling). Range of data and the % of Total would also be informative additional rows to this chart	An average annual row has been added.
17	2.2.9 Groundwater Dependent Ecosystems				How and why did we go from reducing to 497 acres from the 2700 acres of GDEs in the DWR's Natural Communities Commonly Associated with Groundwater (NCCAG) dataset, to these 123 "probable GDEs" and 275 "probable non-GDEs"? What happened to acreage? It is not reasonable to eliminate such a large % (82% & 56% respectively) of possible GDE acres from a desktop analysis of aerial imagery and such little field study (1 & ½ days and only six discreet sites). All of the GDEs up Santa Barbara Canyon are on public land and are full of seeps, springs & wetlands. You just have to walk in to verify them, not drive. Why are they classified as non-GDEs? Figure 2-5 misspelled "Likely Wetlands" and shows no discernable wetlands at all. This report drastically underrepresents the remaining GDEs and risks the continued loss of this important beneficial use of the groundwater resources.	Comment noted. A more detailed analysis of GDEs can be performed during implementation if the Board chooses to do so.
18	2.2.9 Groundwater Dependent Ecosystems	2	2	The NCCAG dataset was compiled by the Nature Conservancy...	Is this true? I thought it was CWDR. The text and Figure 2-3 should credit DWR, not The Nature Conservancy. And that is all the more reason to ground truth verify the data before tossing it out	The text has been revised.
19	2.2.10 Data Gaps				Additional Data Gaps in the Groundwater Conditions include the following: All the major faults are not well understood with regard to the degree they represent a barrier to flow and at what depth below the surface.	The data gaps section has been edited.
20	2.2.10 Data Gaps				Additional Data Gaps in the Groundwater Conditions include the following: The wells in the database and in the Monitoring Network are not well known and must be canvassed to verify well depth, perforation interval and current status.	The data gaps section has been edited.
21	2.2.10 Data Gaps				Additional Data Gaps in the Groundwater Conditions include the following: The size of the Basin with regard to groundwater in storage is not well known and after 40 years of chronic overdraft and the loss of over 1 MAF, what remains in storage?	The data gaps section has been edited.

Cuyama Basin Placeholder Sections
Summary of Public Comments and Responses
April 22, 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
22	4.10 Depletions of Interconnected Surface Water Monitoring Network			Monitoring Networks for depletions of surface water cannot ...	It is appreciated by this reviewer that the lack of any surface water gage stations on the Cuyama River in the Basin is recognized as an impediment to accurate modeling. No amount of numeric estimating can make up for the lack of real data points. When can we see these new stream gages installed?	Comment noted.
23	Appendix X				This Technical Memorandum could have been more informative with a brief Publication Review. Historical reference with field verification and local experience would have yielded different conclusions. With only six actual field sites visited, this was not a significant field verification and the aerial imagery analysis was inadequate to identify the many existing GDEs that were disqualified in this report.	Comment noted. A more detailed analysis of GDEs can be performed during implementation if the Board chooses to do so.

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses - General
December 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1					Transparency of decision making during implementation of the Plan: The Draft Plan could be improved with a clear description of how, moving forward, there will be transparency in implementation and decision making.	The CBGSA Board of Directors holds responsibility for plan implementation. Decisions about implementation and funding will occur through publicly noticed board meetings. Groundwater monitoring data will be available publicly through the CBGSA data management system.
2					Develop a 20-year GSP implementation timeline, including individualized pumping management plans, detailed incentives for sustainable management, and enforcement measures to ensure compliance.	During the first five years of implementation, the CBGSA will develop and approve the groundwater pumping allocations and the enforcement measures, consistent with their authorities under SGMA.
3					Include soil health and soil conservation tools as Best Management Practices in the GSP, including cover cropping, mulch application, and other well document NRCS conservation practices.	Soil and water conservation measures are available from many sources to all water users in the Cuyama Basin. The GSP does not include these as required actions for water users. The water management tools included groundwater pumping allocations, which will be implemented over the next five years.
4					Include a reference list of State and Federal funding programs to assist land managers in adopting groundwater Best Management Practices, including the CA Healthy Soils Program (HSP), the State Water Efficiency and Enhancement Program (SWEEP), the NRCS Environmental Quality Incentives Program (EQIP) and the USDA Farm Bill Funding.	The CBGSA and the Cuyama Basin Water District may make this information available to water users during implementation to assist water users subject to pumping allocations.
5					SGMA, the GSP should include: Clarification that the development and implementation of the GSP is a government mandate under SGMA, but implementation will be paid for by landowners in the Cuyama Basin.	The development of the GSP has been funded by a grant from the Department of Water Resources and local matching funds from the 6 local organizations represented on the CBGSA board (counties, water district, and community services district). The CBGSA board continues to discuss costs funding approaches for implementing the GSP.
6					SGMA, the GSP should include: Clarification that SGMA was not enacted to improve water quality or increase water flows.	The SGMA requirements for achieving sustainability for the Cuyama Basin are described in the GSP, in the Checklist included as an Appendix to Chapter 1, which lists the requirements specified by DWR. Additional discussion of this topic could be held with the GSA Board
7					SGMA, the GSP should include: Explain what happens if the GSP fails -- what does state control look like?	While SGMA and the GSP resulations provide general information on what would happen if the GSP fails, there are many uncertainties regarding that outcome. Therefore, it would not be helpful to include this in the GSP document, but this topic can be discussed in future GSA meetings
8					Economic Analysis & Impacts, the GSP should include:Economic impact analysis.	An economic analysis will be performed and the results will be presented to the Board
9					Economic Analysis & Impacts, the GSP should include:Explanation of economic impacts from the groundwater cutbacks. The cutbacks could destroy the entire Valley's economy. The economic analysis needs to address the fact that the people who live in the Cuyama Basin work on the agricultural lands or support those that do.	An economic analysis will be performed and the results will be presented to the Board
10					Economic Analysis & Impacts, the GSP should include: Explanation of how the economic impacts will be addressed as an offer on a ranch was withdrawn after the need for an 80% reduction in pumping was announced.	An economic analysis will be performed and the results will be presented to the Board
11					Economic Analysis & Impacts, the GSP should include:Detailed plan for the cost for implementation taking into account that if the costs are put on the smaller landowners, they will go out of business. Protection for small landowners from unreasonable costs.	The CBGSA board continues to discuss costs and funding approaches for implementing the GSP.
12					Implementation Costs and Funding, the GSP should include: Define who is paying for what, what are the costs to residents.	The CBGSA board continues to discuss costs and funding approaches for implementing the GSP.
13					Implementation Costs and Funding, the GSP should include: Explanation of how the disadvantaged communities in the Cuyama Basin can afford to continue this effort, year after year at $1 million plus per year.	The CBGSA board continues to discuss costs and funding approaches for implementing the GSP.
14					Implementation Costs and Funding, the GSP should include: Consideration that when identifying funding for implementation, given that the Cuyama Basin is so severely overdrafted, decreasing water consumption will severely impact the finances of all those in the Basin whose livelihood depends on water use. Sacramento needs to find a way to pay for changes required by the GSP for the benefit all of California.	The CBGSA board continues to discuss costs and funding approaches for implementing the GSP, including potential state grants.
15					Implementation Costs and Funding, the GSP should include: Appropriate agencies should be seeking grant funding now for implementation.	The CBGSA board continues to discuss costs and funding approaches for implementing the GSP, including potential state grants.
16					Implementation Costs and Funding, the GSP should include: Information about how long grants will be available.	This information is not available as it is unknown what future grant opportunities will be available.
17					Implementation Costs and Funding, the GSP should include: Provide funding for houses that have to drill deeper for groundwater.	The groundwater monitoring and minimum thresholds for groundwater levels included in the GSP are intended to protect water users. During the first five years of implementation, additional monitoring and pumping information will improve understanding of what will be needed to maintain groundwater levels.
18					Model/Data, the GSP should include: Data gathering methods that are consistently updated so there is a consistent view provided.	Data collection methods will be developed during GSP implementation.
19					Model/Data, the GSP should include: Explanation of why long-term economic decisions are being made on uncertain groundwater modeling.	The groundwater model is the best available information on Basin groundwater conditions. Implementing the GSP will adapt to new information and updated modeling forecasts as pumping allocations are implemented.
20					Model/Data, the GSP should include: Explanation that decisions are being made based on model results without a clear understanding of how wrong the predictions might be. There are ways to quantitatively express the uncertainty in the model, and this should be included. Every model has uncertainty.	Uncertainty information has been added to Chapter 2 and to Appendix C.
21					Model/Data, the GSP should include: Clarification of the quantitative sensitivity analysis (of the model) to identify parameters that have an outsized effect on hydraulic heads and overdraft/water balance.	Uncertainty information has been added to Chapter 2 and to Appendix C.
22					Model/Data, the GSP should include: Clarification of uncertainty inputs (to the model) in terms of the range of probably outcomes.	Uncertainty information has been added to Chapter 2 and to Appendix C.

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses - General
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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
23					Model/Data, the GSP should include: What the three biggest data gaps in the model are.	Model data gaps are described in Appendix C.
24					Model/Data, the GSP should include: More information that validates if new groundwater users are impacting Cuyama Basin groundwater or not.	The numerical modeling includes all current groundwater users.
25					Model/Data, the GSP should include: Account for domestic water use.	Domestic water use is included in the numerical model.
26					Russell Fault, the GSP should include: Clarification of whether the Russell fault restricts groundwater flow or if that is still "up in the air."	The best available information on this issue is presented in Chapter 2. Understanding of the Russell Fault will improve as additional information is gathered during GSP implementation.
27					Russell Fault, the GSP should include: Additional studies to validate if the fault is in fact restricting groundwater movement.	The best available information on this issue is presented in Chapter 2. Understanding of the Russell Fault will improve as additional information is gathered during GSP implementation.
28					Minimum Thresholds/Interim Milestones, the GSP should include: Explanation as to why Minimum Thresholds are set too low to achieve sustainability before the groundwater is further severely depleted.	The groundwater monitoring and minimum thresholds for groundwater levels included in the GSP are intended to protect water users. During the first five years of implementation, additional monitoring and pumping information will improve understanding of what will be needed to maintain groundwater levels.
29					Minimum Thresholds/Interim Milestones, the GSP should include: Improved explanation of the interim milestones. They should be set higher than the minimum thresholds.	Interim Milestones have been adjusted per direction from the CBGSA Board
30					Minimum Thresholds/Interim Milestones, the GSP should include: Clarification of the Minimum Thresholds and Undesirable Results in Chapter 3 – setting the percentage of wells that fall below minimum threshold at 30% is a problem if all wells in a management area go below the minimum threshold yet do not exceed the 30% measure for determining undesirable results.	This issue was discussed at the CBGSA Board meeting on 6/5/2019, where the Board determined to maintein the 30% of wells criteria.
31					Minimum Thresholds/Interim Milestones, the GSP should include: Explanation of why the minimum thresholds do not protect for continual overdraft.	The minimum thresholds do limit future overdraft potential in the Basin.
32					Minimum Thresholds/Interim Milestones, the GSP should include: Explanation of why the interim milestones are set the same as the minimum thresholds. What happened to the MoOF (margin of operational flexibility), this GSP is looking to do nothing better than the very worst that is acceptable.	Interim Milestones have been adjusted per direction from the CBGSA Board
33					Glide Path, the GSP should include: Better clarification of the glide path.	The glide path describes the progressive implementation of pumping allocations to bring the Basin into balance. During the first five years of implementation, additional monitoring and pumping information will improve understanding of necessary pumping allocations and the glide path.
34					Glide Path, the GSP should include: Setting reasonable Undesirable Results that reflect the glide path.	The GSP reflects minimum thresholds and a glide path that were determined by the GSA Board
35					Glide Path, the GSP should include: Connection of Undesirable Results to the glide path.	The GSP reflects minimum thresholds and a glide path that were determined by the GSA Board
36					Glide Path, the GSP should include: Consideration of starting the pumping allocations/reductions sooner than 2023.	The schedule for pumping allocations in the plan was determined by the GSA Board, considering the time needed to establish allocation and pumping monitoring procedures.
37					Glide Path, the GSP should include: Implementation of the allocation plan by 2038.	The glide path relfects pumping allocations to achieve basin balance by 2038.
38					Monitoring Network, the GSP should include: Data gathering methods that are consistently updated so there is a consistent view provided.	GSP implementation includes five year updates of the GSP to incorporate improved monitoring and reporting.
39					Monitoring Network, the GSP should include: Agreement that the counties will play an active role in the monitoring network.	The counties are represented on the CBGSA board and have played an active role in monitoring and data collection.
40					Monitoring Network, the GSP should include: Validation that the monitoring network is truly representative.	The CBGSA will expand and review the monitoring network through the first five years of implementation.
41					Monitoring Network, the GSP should include: Water quality monitoring so it can be dealt with, include water quality planning.	The CBGSA will implement monitoring for total dissolved solids to identify if groundwater pumping is altering groundwater quality.
42					Monitoring Network, the GSP should include: Standardization of monitoring wells.	The CBGSA will expand and review the monitoring network through the first five years of implementation.
43					Monitoring Network, the GSP should include: Monitoring wells are not representative of local production.	The CBGSA will expand and review the monitoring network through the first five years of implementation.
44					Monitoring Network, the GSP should include: Better monitoring network and stream gauges.	The CBGSA will expand and review the monitoring network through the first five years of implementation.
45					Monitoring Network, the GSP should include: Who pays for the new groundwater monitoring wells?	Options for financing are included in Chapter 8. The CBGSA board continues to discuss costs and funding approaches for implementing the GSP.
46					Water Quality Monitoring, the GSP should include: Monitoring of other water quality constituents that are of great concern for human and animal consumption, such as nitrates, arsenic, etc. Explain why TDS (total dissolved solids) are the only constituent considered. To avoid the consequences of water quality getting worse as pumping continues, more than just TDS should be monitored.	The rationale for TDS monitoring for water quality is described in Chapter 4.
47					Water Quality Monitoring, the GSP should include: Track groundwater quality with age date of multiple constituents.	The monitoring plan does not include constituents related to age dating of water because this is not required by SGMA. This could be added if desired by the CBGSA Board.
48					Water Quality Monitoring, the GSP should include: Water quality data from other agencies; it already exists.	The GSA can utilize data collected by other agencies in decision making going forward.
49					Water Quality Monitoring, the GSP should include: Explanation of why all wells cannot be monitored.	Monitoring all wells is cost prohibitive
50					Environment, the GSP should include: Planning for potential for degradation of the environment, e.g., increased dust due to fallowing of land during implementation.	Additional monitoring of groundwater dependent ecosystems is included in the implementation plan.

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses - General
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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
51					Environment, the GSP should include: Further analysis of the potential for destruction of native habitat, which is already occurring.	Additional monitoring of groundwater dependent ecosystems is included in the implementation plan.
52					Environment, the GSP should include: Increased effort to protect Groundwater Dependent Ecosystems (GDEs).	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs can potentially be added in the future at the direction of the CBGSA Board.
53					Environment, the GSP should include: Protection for GDEs -- The GSP does not recognize, quantify, or protect GDEs and it should. Basin overdraft has dried up most of the GDEs, the GSP must protect those that remain.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs can potentially be added in the future at the direction of the CBGSA Board.
54					Water Conservation, the GSP should include: Information about conservation by all groundwater users in the Cuyama Basin. All water users in the Cuyama Basin need to be encouraged to change their water use practices. Growers need to be encouraged to change to crops that use less groundwater, change watering systems to conserve more groundwater, let some fields remain unplanted. Private citizens should be encouraged to greatly reduce their water waste, i.e. showering, hand washing dishes, watering gardens.	Water conservation measures can be considered by private landowners in response to pumping allocations. Water conservation measures are available from many sources to all water users in the Cuyama Basin.
55					Water Conservation, the GSP should include: Clarification that if residents conserve water use, their bills do not go down.	Residential water use is a very small proportion of groundwater pumping in the Basin. Mechanisms for GSP funding will be determined during GSP implementation.
56					Water Conservation, the GSP should include: Clarification about the GSA's role in recommending growers grow a different crop that uses less water.	Changes in crop mix can be considered by private landowners in response to pumping allocations.
57					Allocations, the GSP should include: Allocation methodology that provides equity among all groundwater users.	The CBGSA will develop the allocation methodology in the first three years of GSP implementation.
58					Allocations, the GSP should include: Allocation methodology that is basin-wide.	The CBGSA will develop the allocation methodology in the first three years of GSP implementation. Currently, per Board Direction areas outside of the management areas are not given allocations. However, allocations for other parts of the Basin could be implemented if desired by the Board.
59					Allocations, the GSP should include: Protections for residential groundwater users.	The specifics for how pumping allocations will be implemented will be determined during the first three years of GSP implementation.
60					Allocations, the GSP should include: Definition of and exclusion of "de minimus" groundwater users from being subject to GSP implementation.	The Board has not provided specific direction on de minimis users. This will be determined during GSP implementation. Under SGMA, the GSA can establish pumping allocations for de minimus users (pumping of less than 2 acre-feet per year for residential use), but cannot require monitoing of pumping.
61					Allocations, the GSP should include: Information/determination of how the CBGSA will treat a well that is used for irrigation and residential use.	The specifics for how pumping allocations will be implemented will be determined during GSP implementation.
62					Allocations, the GSP should include: Information/determination of how the CBGSA will treat new well water users.	Water Code section 10725.6 authorizes a GSA to require registration of a well within its management area. Additionally, section 10726.4(a)(2) authorizes a GSA to control pumping by regulating, limiting, or suspending extractions from individual wells or extractions from wells in the aggregate, construction of new groundwater wells, enlargement of existing wells, or reactivation of abandoned groundwater wells, or otherwise establishing groundwater extraction allocations. However, that same subsection provides that any limitation on pumping by a GSA shall not be construed to be a final determination of rights to pump groundwater. So whatever controls on pumping a GSA implements needs to address current and projected conditions, and be adaptive over the life of the GSP. The GSA will need to decide as data is developed and the model is refined which of these tools should be employed and for how long.
63					Allocations, the GSP should include: Address the vulnerability of areas to new wells and/or increased pumping where there is no allocation planned currently.	The CBGSA will develop the allocation methodology in the first three years of GSP implementation. Currently, per Board Direction areas outside of the management areas are not given allocations. However, allocations for other parts of the Basin could be implemented if desired by the Board.
64					Projects, the GSP should include: What are the impacts and risks associated with cloud seeding?	This is discussed in Chapter 7
65					Future Well Drilling, the GSP should include: Explanation of how future well drilling will be addressed.	Water Code section 10725.6 authorizes a GSA to require registration of a well within its management area. Additionally, section 10726.4(a)(2) authorizes a GSA to control pumping by regulating, limiting, or suspending extractions from individual wells or extractions from wells in the aggregate, construction of new groundwater wells, enlargement of existing wells, or reactivation of abandoned groundwater wells, or otherwise establishing groundwater extraction allocations. However, that same subsection provides that any limitation on pumping by a GSA shall not be construed to be a final determination of rights to pump groundwater. So whatever controls on pumping a GSA implements needs to address current and projected conditions, and be adaptive over the life of the GSP. The GSA will need to decide as data is developed and the model is refined which of these tools should be employed and for how long.

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses - General
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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
66					Future Well Drilling, the GSP should include: Discussion of a possible moratorium on well drilling permits issued by the counties.	Water Code section 10725.6 authorizes a GSA to require registration of a well within its management area. Additionally, section 10726.4(a)(2) authorizes a GSA to control pumping by regulating, limiting, or suspending extractions from individual wells or extractions from wells in the aggregate, construction of new groundwater wells, enlargement of existing wells, or reactivation of abandoned groundwater wells, or otherwise establishing groundwater extraction allocations. However, that same subsection provides that any limitation on pumping by a GSA shall not be construed to be a final determination of rights to pump groundwater. So whatever controls on pumping a GSA implements needs to address current and projected conditions, and be adaptive over the life of the GSP. The GSA will need to decide as data is developed and the model is refined which of these tools should be employed and for how long.
67					Future Well Drilling, the GSP should include: Confirmation that it is a requirement for all new wells to be reported to the CBGSA.	Water Code section 10725.6 authorizes a GSA to require registration of a well within its management area. Additionally, section 10726.4(a)(2) authorizes a GSA to control pumping by regulating, limiting, or suspending extractions from individual wells or extractions from wells in the aggregate, construction of new groundwater wells, enlargement of existing wells, or reactivation of abandoned groundwater wells, or otherwise establishing groundwater extraction allocations. However, that same subsection provides that any limitation on pumping by a GSA shall not be construed to be a final determination of rights to pump groundwater. So whatever controls on pumping a GSA implements needs to address current and projected conditions, and be adaptive over the life of the GSP. The GSA will need to decide as data is developed and the model is refined which of these tools should be employed and for how long.
68					Process/Other: Fees set by the CBGSA will go toward the 5-year reporting requirements.	This can be considered during GSP implementation
69					Process/Other: "Analysis paralysis" could keep the CBGSA Board from taking action.	Comment noted.
70					Process/Other: There needs to be a commitment on the part of the CBGSA Board to implement the GSP instead of business as usual.	Comment noted.
71					Process/Other: We were told that the CBGSA Board members do not care – this is worrisome.	Comment noted.
72					Process/Other: During CBGSA Board meetings, the board members need to listen rather than being on their smartphones during the meetings.	Comment noted.
73					Process/Other: There needs to be transparency by all parties during GSP implementation.	The CBGSA Board of Directors holds responsibility for plan implementation. Decisions about implementation and funding will occur through publicly noticed board meetings. Groundwater monitoring data will be available publicly through the CBGSA data management system.
74					Process/Other: Long-term implementation should engage the upcoming generation.	Comment noted.
75					Process/Other: Ensure that the GSP works for (1) groundwater levels, (2) water quality, and (3) allows for an adequate environment in the Cuyama Basin.	Comment noted.
76					Process/Other: Better trust that the pumpers will cooperate, report and pay.	Comment noted.
77					Process/Other: This is the 8th groundwater report done in the Cuyama Basin. We have known about the overdraft problem for the last 50 years. This is nothing new. How are we going to change business as usual behavior? If this plan is not improved drastically, we will know SGMA to mean Same old Groundwater Mining Activities.	Comment noted.
78					This is now a single document, and should be better integrated. Along those lines, please include a cover page for the GSP. Please include be a glossary and acronym list for the GSP as a whole, rather than chapter by chapter. Finally, the chapter introductions declaring the chapter to be a part of the GSP are no longer necessary.	These changes have been made to the document.
79					Overall any statement or description that is about the Central Basin Area needs to be identified as such not the entire CBGSA, it is misleading and disingenuous to the reader of the report and plan.	The discussion of water budgets and groundwater in the GSP focuses on the entire basin because that is what is required by SGMA. Discussion of regional differences within the Basin are included in many sections of the GSP, which make clear that the primary issues are in the Central Basin.

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80					First, as mentioned in the last meeting, it is our hope that water allocation will be based on water/acre rather than historical usage. This not only se ems more fair but incentivises careful use while some are watering a lot in hopes it will be based on historical usage. Second, we want assurances that once water allocations are in place there would be a plan for redistribution of water if some ranches left or shut down. This is opposed to just adding this to further restriction of water in the Cuyama Valley. Our Story: We adopted twin boys who have special needs from SLO county 22 ye ars ago. We bought land and built a home 12 years ago here in the Valley. We planted 35 acres of Pastaccio trees 3 years ago. We are careful wi th our water irrigation. However, the demands for those trees will increase over the next few years. We have put all our funds and retirement into t his property and the trees were to be our support on retirement in the next few years as well as support for our kids. When we heard about the wat er restrictions we accepted an offer on our property that was below it's value. We would then have left California in order to financial suevive. The n the "80 percent" restriction was announced. The next day the offer was withdrawn. Now we are trying to find a way to survive, save our ranch, pl an for our future with all the controls and associated costs that are coming. Dave is a Civil Engineer, who worked for SB county, is is now working on Bakersfield. Karen is a Physical Therapist at Marian Reginal Medical Center in Santa Maria. We hire locals and teens when we need help. Thes e water restrictions may destroy our future finances and leave our two young men to be cared for by government sources. I was told that someone on the board said they do not care about the impact this plan may have on ranchers. Every family has a story. Most are not big money ranchers but hard working individual ranches. Please consider the best plan to help sustain the valley and not just the water reserves.	The specifics for how pumping allocations will be implemented will be determined during GSP implementation.
81					The Cuyama Basin is a relatively poor region financially. To cut back water usage and at the same time financially support an agency (the GSA) to implement the GSP will be a great financial strain. The GSP does not successfully address the problem of how it will financially implement the GSP over the next 20 years. In the interest of real change for the benefit of the Cuyama Region and California as a whole, I would suggest that the state offer financial assistance to the Cuyama Basin so that a refined GSP, when finally adopted, can be successfully implemented.	The CBGSA board continues to discuss costs and funding approaches for implementing the GSP, including potential state grants.
82					We the SMVWCD were formed under the “New” California Water Code, and specifically designed to investigate, identify, develop solutions and maintain a balanced conveyance to Recharge Groundwater and conducts the primary Flood Control component in concert with the other Sister Elements that manage the other Elements, that serve the water users of the Santa Maria basin (3-012). SMVWCD is the operator of record, paid the original loan off in 2007 making Twitchell Dam (TD) a transitional Facility, we have been the only operator of this facility and remain accountable and in communication within our chain of Command and Communication. Recent changes have been the Adjudication of Twitchell Yield making those waters a primary component and should be central to the foundation of your Project. Our District should have been considered and central to your Formation, Mission and Continuing Operation. Adding SMVWCD to your active mailing list will go a long way to keeping us informed. “Other Water Partners” should be added to your mailings as to keeping all parties informed and keep you in compliance with all “Necessary Parties” having ownership in the waters a.k.a of Twitchell Yield (TY). SMVWCD does not own or use water, it's our task to Operate the TD Facility, Manage Inflows, Cuyama and other inflows, report and take action to maintain “the Proper Function and Flow of the TY they only conveyance of water from TD is through the DWR Diversion under the “use of water”, the only acceptable extraction is from a water well. Water Users of the Santa Maria Basin (3-012 and interconnected sub-basins) have shared the surface and sub-surface flows from the Cuyama Basin (3-013) and beyond to and including the Watershed beyond 3-013 forever, the “Project Area” of the subject GSP is the Primary Water Supply for everyone up and downstream from your Project. It would be an understatement to say we collect just the benefits that come with the surface and sub-surface water flows that gravitate to the Pacific Ocean. We have accumulated many millions of yards of sediment from the Cuyama Valley and Federal Properties. The SMVWCD was formed after a long process that started in the 1920’s by a dedicated group of Community Members, Elected and Appointed Members that used 1928, 29 and 1930 Water Law that is the foundation to the now named California Water Code. to create an Agency A.K.A. SMVWCD in 1936, to help develop laws and processes to finance and bring under control the flows of the Cuyama River at Twitchell Reservoir (you call it Twitchell Lake) in 1954. Much the same path as any other water user. Our operation predates yours and the conditions of the Adjudication further alters water use of “Twitchell Yield” We at SMVWCD thank you for the great document and look forward its development and implementation. The SMVWCD along with the Water Users and Purveyors in our Basin along with the South Santa Barbara County Agencies support the “Weather Modification Process” to “supplement” Cuyama and Huasna River meteoric flow into Twitchell and all the other water storage Reservoirs. SMVWCD uses a Diversion Permit to directly recharge the groundwater in Basin 3-012 and beyond, this is the Primary water supply many water users that your document fails to recognize.	The discussion of stormwater capture in Chapter 7 notes the need to consider downstream water rights.
83					I haven't read the Draft GSP but I hope the water table in the Cuyama valley rises. One thing I notice when I ride my bike past the farms is that sometimes there are sprinklers blasting full water in the middle of a hot summer day and it seems that a lot of this water evaporates before it even touches the ground. Here's what I recommend: Hire a person or company that knows how to install efficient irrigation systems and make the farmers install these systems. The State of California would be wise to help farmers pay for these efficient irrigation systems. Also, if this hasn't already happened, put a meter on all wells in the Cuyama valley to measure the volume of water being pulled out of the ground by farmers, charge the farmers a nominal fee based upon usage, and give this money to Cuyama Community Services District to help pay for their water operation.	During the first five years of implementation, the CBGSA will develop and approve the groundwater pumping allocations and monitoring and enforcement measures, consistent with their authorities under SGMA.

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84					...I wanted to presence a number of shortcomings with the Draft GSP. I want to start by saying that I live in a place (Quail Springs) whose impact on our spring has been positive, as more and more water flows each year since our arrival and the banishment of the grazing operations that had deforested the spring and drained the wetland. This is an example of a human impact that has not been negative or neutral but rather positive. We as humans have the power to continue doing harm by being an extractive force or we can be regenerative and live with an ethic of fair share for all, including the voiceless. How can farming continue given this new water budget? This would seem to imply, to the industrial carrot farmers of this valley, a change that would be incompatible with their financial interests. This is far from the case. There are examples in this valley of dry farmed grapes and olives, whose sale is earning a high desert premium, and whose water usage per acre is little to nothing once the crops are established (the result of which is also carbon sink and healthier soils as opposed to the tilling operation that most ofthese farmers employ year after year). This feels like a win for all involved, it just requires that farmers turn away from crops with unsustainable irrigation requirements towards perennial crops like goji berries, grapes, olives, jujubes, pistachios etc that can earn more money per acre and will at the same time be in accordance with the 2040 plan for sustainability (of which little sustenance has been heard). Innovation is key - the ecosystem of people, plants, animals, and soil in this valley cannot afford more groundwater mining in this area. Their lives depend on a change toward a more regenerative usage of groundwater. As the rest of California looks to the Cuyama Valley as an example, we must keep in mind our grandchildren and the communities of flora and fauna 100 years from now and beyong that depend on our actions today.	The specifics for how pumping allocations will be implemented will be determined during GSP implementation. Changes in crop mix can be considered by private landowners in response to pumping allocations.
85					The GSP does not specify a plan or roadmap to achieve Sustainability with in the 20 year timeline; No Pumping Management plan, No plan to achieve the “Glide Path” approach to significant reductions, No Funding mechanism, No Incentives or Enforcements for compliance. No “nuts and bolts”...This Plan still needs the major components of a roadmap to achieving sustainability.	The specifics for how pumping allocations will be implemented will be determined during GSP implementation.
86					Filling the Data Gaps need urgent attention during the first few years: Better Representation in the Monitoring Wells, Understanding the major Faults in the basin , Installation of Stream flow gauges on the bridges, More than one Subsidence monitor, and there is no recognition or monitoring for the loss of wetlands, seeps, springs and surface flow.	Additional information will be developed during GSP implementation as the Monitoring Network is developed.
87					There is no plan to ever strive for the Measurable Objectives. No Interim Milestones were set above the Minimum Thresholds, some of which are below current conditions. This GSP appears to be tolerant of further dewatering with no achievable drought buffer and no recovery of the historic losses of groundwater from storage.	The Interim Milestones have been revised per direction by the GSA Board
88					Groundwater Quality is of enormous importance to the Cuyama community. It is widely known that the water quality is poor in the Cuyama Valley, and will only worsen with continued overdraft. Not enough is known about the sources and flow rates of groundwater in the basin. Arsenic, Boron, Nitrates and Ions should be studied to help inform the Hydrologic Model and protect from any further Undesirable Results.	Comment noted.
89					This Plan does not adequately address the desertification of the Basin as an Undesirable Result of groundwater overdraft. The declines of Interconnected Surface water with Groundwater and the resulting losses of Groundwater Dependent Ecosystems is a trend that must reverse. More data and protections are needed to ensure the vitality of the environmental beneficial users.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs can potentially be added in the future at the direction of the CBGSA Board.
90					This GSP is a reasonable compilation of the many published reports on Cuyama Groundwater in the last 50 years. Analysis of the geology and available monitoring data is sufficiently addressed to present the current conditions of overdraft in the Basin. However, the lack of sufficient time and/or money has been repeatedly used to excuse the lack of sufficient policy development and implementation directives to achieve Sustainability. Very little new and revealing data was developed for this Plan, as little if any on-the-ground evaluations or investigations were involved. This Plan does not contain the ways and means to achieve the necessary reduction of groundwater use of 50 to 67%. No Allocations, restrictions, incentives or fee assessments are presented. No well canvassing or ground truthing, no field tests, no installation of monitoring facilities, no additional measurements were made. The Economic analysis, which was suggested would contain crop evaluations, employment analysis, land value considerations and other stakeholder impacts, is inexplicable omitted. No Sustainability Goal was ever discussed at the SAC or GSA level to help build consensus on the goal of this whole Plan. There was no discussion about Undesirable Results that were pre-existing in 2015. Data Gaps continue to drive up the Model uncertainty and hamper GSA decision making. No connection has been made between the setting of Minimum Thresholds and basin-wide Sustainability or the connection to the “glide slope” approach to pumping restrictions. As vice-chair of the Standing Advisory Committee, I am grateful for all the very hard and time consuming work that has been put into the document. We have come a long way, under acknowledged constraints, and limitations. This GSP clearly conveys the need for urgent action, but fails to provide a viable Implementation Plan to take that action. This is good work done, but the job is not yet done.	The specifics for how pumping allocations will be implemented will be determined during GSP implementation. An economic analysis will be performed and presented to the GSA Board. The SAC and CBGSA discussed and revised the sustainability goal at the May 30 and June 5 meetings. Other comments are addressed as specific comments in each chapter.

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91					In general, the Central Coast Water Board recommends that the number of chemical constituents included in the Minimum Thresholds (MT), Measurable Objectives (MO), and Interim Milestones (IM) be increased. The Central Coast Water Board agrees that MTs, MOs and IMs should be established for total dissolved solids (TDS), however, including only that single constituent is insufficient for determining whether a groundwater basin is being managed sustainably with respect to water quality or for determining if undesirable results are being addressed. Land use in the Cuyama Valley is dominated by commercial agriculture, an industry that utilizes a variety of chemicals and practices that pose threats to groundwater quality. Therefore, the Central Coast Water Board recommends expanding the list of chemical constituents in the MT, MO, and IM to include nitrate, arsenic, and major dissolved ions. The reasoning for this recommendation is described in detail below.	The rationale for why monitoring for just TDS in the Basin is provided in the Monitoring chapter. Based on this rationale, direction was provided by the GSA Board (through approval of the Monitoring Networks GSP section) to include only TDS for monitoring and sustainability in the GSP. Therefore, the Monitoring and sustainability chapters will only include water quality sustainability indicators for TDS, unless alternate direction is provided by the Board.
92					The Central Coast Water Board recommends expanding the list of chemical constituents in the MT, MO, and IM to include nitrate: Nitrate contamination of groundwater from agricultural activities is widely documented in the Central Coast region, including within the Cuyama Valley. Approximately 9% of on-farm domestic wells in the Cuyama Valley exceed the human health standard for nitrate concentration in drinking water1. The draft chapter states that the Cuyama Valley groundwater sustainability agency (GSA) does not have the authority to influence fertilizer use, and we are not suggesting the GSA should undertake such a regulatory role. However, the GSPs are required to implement thresholds and monitoring that can identify when undesirable results are occurring. Given the current impairment from nitrate in the basin and ongoing agricultural activity, it is appropriate to require thresholds and monitoring for nitrate in the Cuyama Valley groundwater basin. Nitrate monitoring is not unusual in agriculturally-dominated basins; for example, the Salinas Valley GSA is recommending an expanded suite of chemical constituents for its thresholds and monitoring. The recommendation in their most recent draft includes up to 25 different chemical constituents, including nitrate and arsenic2. Finally, we recommend that nitrate be reported as nitrogen (nitrate as N), because this convention allows for easy comparison and summation (e.g., calculation of total nitrogen).	The rationale for why monitoring for just TDS in the Basin is provided in the Monitoring chapter. Based on this rationale, direction was provided by the GSA Board (through approval of the Monitoring Networks GSP section) to include only TDS for monitoring and sustainability in the GSP. Therefore, the Monitoring and sustainability chapters will only include water quality sustainability indicators for TDS, unless alternate direction is provided by the Board.
93					The Central Coast Water Board recommends expanding the list of chemical constituents in the MT, MO, and IM to include arsenic: Arsenic is a toxic chemical compound that occurs naturally in relatively high concentrations in many of the sediments that form California groundwater basins, including those of the Central Coast. Groundwater data from the Water Board's GeoTracker GAMA3 website indicates that 12% of the wells in the Cuyama Valley groundwater basin exceed the maximum contaminant level (MCL) for arsenic in drinking water. The highest concentration recorded in the basin occurred in 2011 and was more than six times greater than the MCL. Furthermore, recent studies in the Central Valley of California4 and the Mekong Delta in Thailand5 have demonstrated that ground subsidence associated with groundwater over-pumping can mobilize arsenic by 'squeezing' it out of subsurface clay layers. The resulting mobilized arsenic can then enter groundwater and increase arsenic concentrations in nearby water supply wells. Because there is documented overdraft and subsidence in the Cuyama Valley, there is the potential risk of anthropogenically-induced arsenic contamination of groundwater due to arsenic mobilization from clay layers in the Cuyama Valley basin. Lastly, in addition to sediment-related sources, arsenic is a component in many pesticides commonly used on various crops. These factors suggest that arsenic should be included in the MTs, MOs, and IMs for the Cuyama Valley basin.	The rationale for why monitoring for just TDS in the Basin is provided in the Monitoring chapter. Based on this rationale, direction was provided by the GSA Board (through approval of the Monitoring Networks GSP section) to include only TDS for monitoring and sustainability in the GSP. Therefore, the Monitoring and sustainability chapters will only include water quality sustainability indicators for TDS, unless alternate direction is provided by the Board.
94					The Central Coast Water Board recommends expanding the list of chemical constituents in the MT, MO, and IM to include major dissolved ions: Major dissolved cation and anion composition in groundwater reflects the source of recharge water, lithological and hydrological properties of the aquifer, groundwater residence time, and chemical processes within the aquifer. As such, major dissolved ions are valuable for identifying different groundwater types (via Piper or Stiff diagrams) and for "fingerprinting" source water from individual wells. In addition, ionic charge balance provides quality assurance that all the major ions are actually included in the analysis and that TDS concentrations are accurate. Finally, collection and analysis of major dissolved ion samples is easy and inexpensive, and the cost of the analysis is well worth the data provided, particularly if the well is already being sampled for other constituents.	The rationale for why monitoring for just TDS in the Basin is provided in the Monitoring chapter. Based on this rationale, direction was provided by the GSA Board (through approval of the Monitoring Networks GSP section) to include only TDS for monitoring and sustainability in the GSP. Therefore, the Monitoring and sustainability chapters will only include water quality sustainability indicators for TDS, unless alternate direction is provided by the Board.
95	Ch 7 P. 69-70				In particular, these comments concern the proposal to enhance Cuyama Basin groundwater yield through the diversion and off-stream recharge of stormwater flows in the Cuyama River (Draft GSP, Ch. 7, pp. 69-70.) Any new use of Cuyama River flows will be subject to senior downstream water rights. The potential yield and benefits of any such project for the Cuyama Basin may be severely limited. Twitchell Reservoir is licensed by the State of California to capture Cuyama River stormwater flows for subsequent release and recharge of the Santa Maria Groundwater Basin (see attached License for Diversion and Use of Water #10416 issued by the State Water Resources Control Board). In most years, the entire stormwater flow of the Cuyama River is captured in Twitchell Reservoir. Any proposed new use of the flows of the Cuyama River will be conditioned to have no impact on the operation of Twitchell Reservoir. Given this constraint, it may be infeasible to develop any new off stream recharge program dependent upon Cuyama River flows. (attached: License for Diversion and Use of Water #10416)	The discussion of stormwater capture in Chapter 7 notes the need to consider downstream water rights.
97	General				The GSP proposes three funding mechanisms to fund planning efforts — fees based upon water usage, fees based upon acreage within the Basin, or a combination of the two. Fees based upon water use is the most defensible method for funding planning efforts given that current and historical water use patterns are the primary drivers of Cuyama Basin overdraft conditions.	The CBGSA board continues to discuss costs and funding approaches for implementing the GSP.
98					The GSP does not specify a plan or roadmap to achieve Sustainability with in the 20 year timeline; No Pumping Management plan, No plan to achieve the "Glide Path" approach to significant reductions, No Funding mechanism, No Incentives or Enforcements for compliance. No "nuts and bolts".	The specifics for how pumping allocations will be implemented will be determined during GSP implementation. The CBGSA board continues to discuss costs and funding approaches for implementing the GSP.
99					Filling the Data Gaps need urgent attention during the first few years: Better Representation in the Monitoring Wells, Understanding the major Faults in the basin , Installation of Stream flow gauges on the bridges, More than one Subsidence monitor, and there is no recognition or monitoring for the loss of wetlands, seeps, springs and surface flow.	Additional information will be developed during GSP implementation as the Monitoring Network is developed.
100					There is no plan to ever strive for the Measurable Objectives. No Interim Milestones were set above the Minimum Thresholds, some of which are below current conditions. This GSP appears to be tolerant of further dewatering with no achievable drought buffer and no recovery of the historic losses of groundwater from storage.	The Interim Milestones have been revised per direction by the GSA Board

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101					Groundwater Quality is of enormous importance to the Cuyama community. It is widely known that the water quality is poor in the Cuyama Valley, and will only worsen with continued overdraft. Not enough is known about the sources and flow rates of groundwater in the basin. Arsenic, Boron, Nitrates and Ions should be studied to help inform the Hydrologic Model and protect from any further Undesirable Results.	Direction was provided by the GSA Board (through approval of the Monitoring Networks GSP section) to only include TDS for monitoring and sustainability in the GSP. Therefore, this Section will only include water quality sustainability indicators for TDS, unless alternate direction is provided by the Board.
102					This Plan does not adequately address the desertification of the Basin as an Undesirable Result of groundwater overdraft. The declines of Interconnected Surface water with Groundwater and the resulting losses of Groundwater Dependent Ecosystems is a trend that must reverse. More data and protections are needed to ensure the vitality of the environmental beneficial users.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs can potentially be added in the future at the direction of the CBGSA Board.
103					We ask your Board to ensure that any and all CBGSA funding would exclude any imposition of fees or assessments based on acreage or parcels. SGMA law regulates groundwater extraction, not land use. Non-irrigated rangeland acres do not contribute to Basin overdraft. Proposition 218 requires that assessments, fees or taxes levied on property must provide a direct and special benefit to that property. We urge your Board to prepare a simple GSP chapter with a self- monitoring area for the rangeland-level groundwater users that confirms they will continue to be permitted by right, including domestic wells for rural housing, stock water wells, and landscaping around rural housing. The property owners within the Self-Monitoring area would not need to sign any agreements, lending simplicity and cost- effectiveness to the Plan.	The CBGSA board continues to discuss costs and funding approaches for implementing the GSP.
104					Another critical issue of concern is the Draft Plan's proposal for cloud seeding to enhance rainfall. Cloud seeding within the proposed target area as shown in Figure ES-12 would create a rain shadow of drought for those of us Kern County landowners whose property lies directly north and east of the target area. The Los Padres National Forest is the significant property within the resulting rain shadow – after five years of drought the forest is a tinder box waiting to explode, without artificial rain manipulation making it worse. Cloud seeding also raises serious concerns about chemical residue and subsequent toxic exposure to humans and livestock as well as contamination of water. We believe that the many risks and costs associated with cloud seeding far outweigh any predicted benefit. We respectfully request that you remove the cloud seeding proposal from the plan. Capturing high stormwater flows in the Cuyama River and diverting it to recharge basins is the logical and less controversial alternative.	As noted in Chapter 7, additional study will be performed on cloud seeding prior to implementation
105					The California Legislature clearly states that SGMA is intended to "enhance local management of groundwater." Therefore, we recognize that the CBGSA is allowed the discretion and flexibility to craft its non-irrigated, non-districted portion of the SGMA plan to meet the needs of grazing properties, like ours, which many of us believe have been erroneously included.	The specifics for how pumping allocations will be implemented will be determined during GSP implementation.
106					Many comments made during the development of the CBGSPd were not recognized or adopted. The Cuyama "technical forum group" (TFG) met monthly by telephone, but it was made clear by WC representatives that the TFG would not serve as "advisory committee" during the process and development of the GSP and comments would only be selectively addressed.	Comment noted.
107					Previous water investigations of the CGB have indicated an overdraft or imbalance of between approximately 15,000 to 30,000 Acre Feet per Year. These studies have been completed by CDWR, the United States Geological Survey (USGS), the Santa Barbara County Water Agency (SBCWA) and the United States Department of Agriculture (USDA). The studies by the USGS and SBCWA have been peer reviewed and published and are available on-line. Based on the peer reviewed and published Studies the median imbalance is approximately 27,000 Acre Feet per Year. All recent and published studies indicate the imbalance to come from the Main or Central Zone, as denoted by both the USGS (2011) and Woodard and Curran Consultants (2019).	Comment noted.
108					Hydrographs, water level trends and analyses in the Ventucopa Area show a seasonal depression separated by the Santa Barbara Canyon Fault Barrier where static water levels quickly move from near 100 feet below ground surface (bgs) to near 650 feet bgs. In this regards, the Santa Barbara Canyon Fault Boundary needs to be more closely examined.	The best available information on this issue is presented in Chapter 2. Understanding of the Santa Barbara Canyon Fault will improve as additional information is gathered during GSP implementation.
109					Recent data from the far western area of the Cuyama Basin, otherwise denoted the Cottonwood Subarea indicate a shallow and non-recharged area since the Cuyama River became ephemeral in the 1960's and 1970's, when multiple yearly cuttings of Alfalfa were realized, and rejected recharge from the Cuyama Basin ceased. During development of the CBGSP, some overlying extractors in the Cottonwood Subarea have informally requested an "exclusion" from the Sustainable Groundwater Management Act (SGMA) to be able to further lower groundwater levels than they were in January 2015, outside the essence of SGMA.	Comment noted.
110					Saltwater intrusion in the Cuyama Valley/Basin is not an issue. Several Faults and Mountainous Barriers stretching from New Cuyama to near Twitchell Reservoir create a barrier to salt water intrusion. Water emanating from the Cuyama Basin is very hard, as most of the geological formations are marine in origin. Total Dissolved Solids by itself is not a good water quality indicator for the Basin, due to background concentrations, and periodic full schedule nutrient sampling needs to be addressed during the CBGSP implementation period.	Direction was provided by the GSA Board (through approval of the Monitoring Networks GSP section) to only include TDS for monitoring and sustainability in the GSP. Therefore, this Section will only include water quality sustainability indicators for TDS, unless alternate direction is provided by the Board.
111					The chronic lowing of groundwater levels, degradation of water quality due to "concentration" (over usage), and loss of GDE's is significant in the Cuyama Basin and needs to immediately be considered as any part of the CBGSP.	These issues are addressed in the GSP.
112					Recognized as one of the first developed Sustainable Groundwater Management Act (SGMA) Plans (GSP), the Cuyama Basin must be examined closely, as well as any objectives included in the plan to alleviate and address overdraft and imbalance. We see no dedicated resolve in the CBGSPd to alleviate imbalance. That would include pumping reductions or projects to augment recharge: Rainfall/Snowpack augmentation, off channel retention and/or percolation, Channel projects to increase direct percolation of stream seepage, or most importantly in the eyes of Yulalona Hydrology LLC Rangeland Management. Since the early 1990's the United States Forest Service (USFS) has neglected prescription burning in California, which has led to the most costly and destructive wildfires in California's history, including, but not limited to, the Zaca, La Brea, Thomas Fires and Camp Fires.	All of these actions were considered during CBGSA Board meetings. Pumping reductings, precipitation enhancement and stormwater capture have been included in the GSP in Chapter 7.
113					Previous studies and collected data indicate that the majority (near 75%) of the recharge to the CGB derive from the Ventucopa Corridor, from near the Santa Barbara Canyon Fault to Frazier Park, the uppermost part of the Watershed. Differing rainfall patterns and snow melt affect the runoff in the Cuyama River Watershed, sometimes combined, resulting in outlier peak flows such as in 1998 and 2005 when California Highway 166 washed out and lives were lost.	Additional analysis can be performed during GSP implementation.

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114					It is important to note that the Cuyama River Watershed and Drainage is very large; it drains 90 square miles in the upper watershed at Ozena, 866 square miles at USGS Gauging Station Cuyama River below Buckhorn Canyon 11136800 (NWIS Portal, 2019) and 1135 square miles to Twitchell Reservoir (USBR Portal, 2019). It is also important to note that the Cuyama River is not gauged between the inlet (Ozena) and the Outlet (USGS Gauging Station Cuyama River below Buckhorn Canyon 11136800) requiring losses or gains to the CGB to be estimated. This serves as a “data gap” that needs to be addressed during implementation of the CBGSP.	Discussion of the surface water stream gauges is included in Chapter 1.
115					The term “deep percolation” as part of the most recent study conducted by Woodard and Curran has been debated, but ignored in comments made during development of the CBGSP. Data from previous chemical analyses has indicated “ancient” (tens of thousand years old or older) water being produced out of the Main or Central Zone of the Basin (GAMA, 2007), with no traces of any anthropogenic tracers, such as, but not limited to, tritium. Certainly there is some stream seepage and direct percolation of rainfall as a part of “infiltration”, but no recent evidence suggests any of this infiltration makes it through the vadose zone. This could be further examined utilizing piezometers and should be noted as another “data gap”.	Additional analysis can be performed during GSP implementation.
116					During the 2007-2014 USGS-SBCWA collaborative study, hydrologic technicians and analysts were asked to no longer access Grimmway and Bolthouse properties (by Grimmway and Bolthouse representatives), including monitoring wells in in section 10N-25W sections 21 and 23 (based on the San Bernardino Baseline and Meridian). This study was initiated by Santa Barbara County Supervisor Joe Centeno, concerned about water usage in the Cuyama Valley, far pre dating SGMA. It is interesting that in 2017-18 “private” data (CBGSPd, figure 4-9) has been submitted from these large agricultural companies, with no oversight, quality assurance or control. It should also be noted that the USGS and SBCWA have recorded data from these areas during the 1970’s to 2007, which are still helpful when calibrating simulations.	As discussed in Chapter 2, the reasonableness of private landowner data was assessed through comparison with USGS and DWR well data.
117					The 1997 Santa Maria Basin litigation, Santa Maria Valley Water Conservation District versus the City of Santa Maria, et al (consolidated for all legal purposes) (1-97-CV-770214) did not adequately address upstream (Cuyama River and Watershed) water rights, leaving the issue of Cascading Basins unresolved.	The discussion of stormwater capture in Chapter 7 notes the need to consider downstream water rights.
118					In the Cuyama Groundwater Basin (CBG), data gaps have been realized by analysts from multiple agencies working on water budgets. The fact that large agricultural entities have not acted in good faith since 2007 to produce adequate records of pumpage and static drawdown, combined with limited scientific peer reviewed data of the interactions between the Main or Central Zone with both the Ventucopa Uplands and Cottonwood Subarea, demonstrate the need for a “deep” (1200’ bgs minimum) “depth dependent” monitoring well in Section 21 or 23 to adequately derive hydraulic properties of the deep older alluvium and Morales Formation.	The CBGSA will expand and review the monitoring network through the first five years of implementation.
119					Climatic Fluctuations are addressed as Appendix C of this memorandum to the Hallmark Group pertaining to Water Availability of the Cuyama Groundwater Basin. With the addition of Methane and Carbon from the melting permafrost (Sigmov, 2019), coupled with Carbon Dioxide being liberated from the Oceans (Goodridge, 2018) the CDWR tools for evaluating climate change are inadequate.	The GSP climate change analysis was prepared consistent with SGMA guidance from the Department of Water Resources. The GSA can consider additional climate change analyses during GSP implementation if desired.
120		General			Comment: As written, the CBGSP does not describe an actual Sustainability Goal for the Cuyama Basin and the steps to achieve that goal. Further, the Draft CBGSP does not explicit name a sustainable yield for the Basin, although the concept has been discussed at CBGSA meetings and mentioned in Chapter Two of the CBGSA. Essential elements of a concrete, achievable plan have not been established, as mandated by the Final GSP Emergency Regulations. Source: “354.24 Sustainability Goal: The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.” Source: “354.30. Measurable Objectives (e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.	Chapter 3 includes a sustainability goal approved by the CBGSA Board. Undesirable results statements are also provided in Chapter 3, with minimim thresholds and measurable objectives provided in Chapter 5.
121		General			The Draft CBGSP was developed over nearly two years of meetings and chapter review. However, several essential elements of the Plan were developed by the plan development consultants out of the public view and without any review, input or vote from the CBGSA or the Standing Advisory Committee. These sections were first presented to the SBGSA, the SAC in the text of the Draft CBGSA. These include: Setting a 30% Threshold for all five Undesirable Results in the Basin, without scientific evidence or justification Setting all Interim Milestones for Groundwater Levels to be identical with all Minimum Thresholds. Setting Minimum Thresholds for: Groundwater Quality Subsidence Interconnected surface water Setting a Sustainability Goal for the Cuyama Basin and pre- existing Undesirable Results. This approach is unacceptable and runs counter to the claim that the process encouraged “input, discussion, and questions from both the CBGSA Board of Directors and SAC members as well as public audience members (Draft CBGSP, Chapter One, P. 58, 1.3.5). On what are arguably the most important elements of the Plan, no “input, discussion, and questions” were encourage or elicited from the CBGSA, the SAC or the public. Recommendation: These critical sections require further review by the CBGSA, the SAC and the public.	All of these issues have either been discussed in CBGSA Board meetings or included in draft Chapters that were previously reviewed and commented on.
122		General			The process that the CBGSA undertook to apply for a DWR Technical Support Services grant to fund the drilling of three much-needed new monitoring wells was discontinued halfway through the process, without notification to the CBGSA, the Standing Advisory Committee or the public. Apparently the initial grant application was submitted, the second portion of the grant application process was not completed and funding three essential wells to expand the Cuyama Basin’s monitoring network and fill critical data gaps was not successfully secured. No public statement or explanation has been issued regarding this decision, with all decisions made behind closed doors.	Comment noted.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1					This section is the most likely to be read by stakeholders and interested members of the public, and contains confusing wording and organization. It could use a thorough read-through by an editor for clarity.	Comment noted. It has been reviewed by a technical editor
2	P. ES-2				The basin setting map does not show most of the features described in the Basin Setting section, and does not have a legend for the various color GW basins. The name of the basin in the map (Cuyama Valley) is different than the name of the basin used in the document (Cuyama). Recommend revising.	The figure has been replaced
3	P. ES-3				The Existing Groundwater Conditions section of the ES should focus on more groundwater levels rather than water quality, as water quality is not the primary issue in the basin. The summary should discuss the various regions within the basin, rather than getting into the specific concentrations of water quality constituents. Also, Figure ES-4 is not illustrative of existing conditions in the basin and doesn't belong in the ES; a set of representative hydrographs may be more useful.	The section has been revised
4	P. ES-4	1	Final		Please revise the description of water quality as "not good". Possibilities include "poor", "degraded", or "impaired". Also, suggest splitting the sentence up for clarity.	The text has been revised
5	P. ES-4	Last			"The lowering of groundwater levels has corresponded with degradation of groundwater quality, and particularly levels of TDS." Add the word "elevated" or "increased" before TDS.	The text has been revised
6	P. ES-4	Last			Also, suggest removing the editorial word word "minor" from the second sentence. The specific amount of measures subsidence could be stated to make the sentence more clear.	The text has been revised
7	P. ES-7	3			"Since there are no projected changes in land use or population in the Basin, the projected annual decline in groundwater storage is estimated to be the same as under current conditions." Please revise to "Assuming no changes in land use or population in the Basin, the projected annual decline in groundwater storage is estimated to be the same as under current conditions."	The text has been revised
8	P. ES-7				Suggest moving the description of the modeling in the second to last paragraph further up in this section for clarity.	The text has been revised
9	P. ES-7	Last			Suggest changing "annual water budget of minus 25,000 acre-feet…" to "overdraft of 25,000 acre-feet".	The text has been revised
10	P. ES-9				The "summary of existing wells" table should be removed from the ES. It is not relevant to the plan going forward, and the numbers in it are misleading without explanation. The description of existing monitoring is also not particularly useful in the ES. Suggest replacing with a description of the proposed monitoring plan (number of wells, frequency of monitoring, etc.).	The table has been changed.
11	P. ES-11				Please edit the first paragraph for clarity. "Projects that increase water supply" are management actions, not some separate category.	The terminology used in the ES is consistent with Chapter 7
12	P. ES-11				There are three separate places where it is stated that the reductions will be reevaluated.	The current version of the ES only states this once.
13					TDS Section - This section needs to be rewritten for clarity and appropriate descriptions. This states that there is a California water quality standard the is exceeded but does not say for what? Drinking water? Most water is used for agriculture this comparison does not have merit. Overall using the TDS measurements and stating that there 'high' levels only has meaning if it is in relationship to a use of the water, without showing a use it is has no meaning and is ambiguous. Since TDS in any particular situation can not be fixed' why is this being used? How will it be defined as an Undesirable outcome?	Comment noted. The text has been revised to note that the MCL is for drinking water
14					Groundwater Graph is misleading, it seems to represent the Entire CBGSA area, but is really just for the central area.	The graph is showing data for the entire Basin (consistent with the scale of data reporting in Chapter 2). It is noted in the text that the central basin contains most of the overdraft in the Basin.
15					The subsidence statement needs clarification, this seems like speculation, do you know why this occurred and do you know if it has contributed in any way to any other 'undesirable' situations, this is stated as reality, also, the actual measurement is insignificant and could have occurred simply because the school put to much water on the ground and caused the soil to settle, ground squirrels, gophers...	The sentence has been revised
16		Last paragraph			Water Budget: Move last paragraph to the opening paragraph/statements, Add "Central Part" to all references to "Basin". This is written as if the entire CBGSA is in in crisis, very misleading.	The data reported is for the entire basin, not just for the central basin. This is consistent with the scale of data reporting in Chapter 2. The regional differences are noted in the last paragraph.
17					Projects and Management Actions: Should state Central Area Basin or in Proposed Central Area Basin	The text nodes that projects will be in the Central Basin where appropriate
18					Funding: Statement that the funding will be borne by the Landowners is an assumption that needs to be clarified, nothing has been established or determined.	The sentence has been revised
19	ES-3	Final			The San Emigdio Mountains lie along the eastern edge of the basin, the Calient Range lies along the northern edge (maybe northeastern edge), this is unclear	The figure has been replaced
20	ES-1			Although current analysis indicates groundwater pumping …	Acknowledges additional data and review of model are needed. What are the "additional efforts to confirm the level of pumping reduction required to achieve sustainability"… "as outlined"? What section & page?	This is noted in the Water Budget section of Chapter 2
21	ES-2 Figure ES-3				Fig. ES-3 could use an inset map to show location in California	The figure has been replaced
22	ES-4			Figure ES-5 is a graph showing …	Suggest "…showing **modeled** annual and cumulative long-term reduction…"	The text has been revised
23	ES-6				Summarize how "5-year drought buffer" was calculated or estimated	The sentence has been revised
24	ES-7			Analysis of the Basin as a whole shows that much…	The basin must be considered as a whole. The Central basin is downgradient of other areas of the basin. Groundwater flow from the western and southeastern areas into the Central basin is being intercepted, cutting off water that historically has helped to reduce drawdown effects of pumping in the Central basin.	Comment noted. While the ES mostly discusses conditions over the entire Basin, it is still appropriate to discuss regional differences.
25	ES-11			The exact amount of required…	Acknowledges the effects of uncertainty in predicted overdraft, but suggest a more explicit discussion of uncertainty.	Comment noted. Uncertainty discussion has been added to Chapter 2. The ES text notes that the amount of pumping reductions may be revised as additional evaluations are performed in the future.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
26	ES-13 Fig. ES-14				Add small well location symbols to the Management Area figure, so the reader can get an idea of the spatial basis of projected drawdown contours. Since no pumping reductions are required outside of the drawdown-defined Mgmt Areas, whether a well is in or out is a big deal for landowners in terms of their costs. Consider classifying wells as in or out within the OPTI system.	The OPTI well database contains monitoring wells, not production wells. Location data on many production wells is not available and therefore it would be misleading to put them on the map.
27	ES-15 Fig. ES-16				Suggest enlarging Fig. ES-16 for readability.	The text has been enlarged
28	General			Interim Milestone?	Question: What happened to Interim Milestones?	Interim Milestones are shown in Chapter 5 (and adjusted per Board direction), but are not needed in the ES
29	P. ES.3			Groundwater quality in the Basin is variable…	Comment: This Groundwater Quality section makes all the valid points for the need to monitor more than just TDS, and then it fails to mention that the Plan will only monitor TDS.	The text has been revised to be consistent with Board direction
30	P. ES.6 & P. ES.9			these representative wells and subsidence…	Comment: The text fails to mention that the Monitoring Network has significant Data Gaps. No Stream Gauges or Piezometers, only one Subsidence meter in the center, no Fault characterization. Addition: Mention Data Gaps, even if only just a little. How will this GSP measure for subsidence in the center of the cone of depression? How will this GSP evaluate stream flow/groundwater interactions? How will this GSP know if pumping is causing Arsenic or Boron laden waters to migrate into the cone of depression?	The text has been revised to note that there are data gaps in the monitoring network
31	P. ES.6			In general, measurable objectives were established…	Question: If there is no planed intention or Interim Milestones toward the Measurable Objective, how can they serve as a drought buffer? What part of this GSP aims to achieve the MO? Comment: It would be pure luck or maybe a freak coincidence to ever get back up to the Measurable Objective. The Sustainability Goal is simply to not exceed the Minimum Thresholds, which will be a big lift as it is.	Interim Milestones are shown in Chapter 5 (and adjusted per Board direction), but are not needed in the ES
32	P. ES.13 Figure ES-14			the yellow, orange and red areas indicating areas …	Correction: The red areas actually indicate groundwater elevation declines in excess of 7 feet of per year, not just 4. Without a legend on Fig. ES.14 this text is inaccurate and an underrepresentation of the significance of the problem areas.	The text has been revised
33		P. 2, 3rd paragraph		The Draft GSP outlines…	Addition of the clarification word "basinwide": Although current analysis indicates groundwater pumping reductions on the order of 50 to 67 percent basinwide may be required to achieve sustainability, additional efforts are required to confirm the level of pumping reduction required to achieve sustainability	This has been added.
34		P. 2, 3rd paragraph		The Draft GSP outlines…	Comment: The "additional efforts … required to confirm level of pumping…" referred to in this sentence should include the approximately 30% of wells in the valley that have not been identified or from which data has been collected. Source, Draft CBGSP, Chapter One, P. 13, 1.2.2	Comment noted. This can be considered in GSP implementation, but this level of detail is not needed in the ES
35	P. 4	Existing groundwater conditions			Question: What is the source of the detailed water quality information, specifically the levels of constituents?	This is in the Groundwater Conditions section of Chapter 2
36	P. 8	Water budgets, 1st paragraph			Addition: To clarify the Basin's condition historically, this sentence should be amended (with text in red) to read: "The Basin has been in an overdraft condition for many years. Overdraft conditions in the Basin were first documented in the 1950s, and the DWR has identified the Basin to be in "critical overdraft" since 1980.	It is noted in the first paragraph of the ES that the basin is in critical overdraft
37	P. 8	Water budgets, 3rd & 4th paragraphs			Addition: Please include a clear explanation of sustainable yield, a critical element of the CBGSP, in this section. While explained in Chapter Two, the Sustainable Yield belongs in the Executive Summary as well to illuminate the extent of the overdraft and the task ahead to reach sustainability.	The Basin sustainable yield is shown in Figure ES-8
38	P. 10	Monitoring Network, Summary of Existing Monitoring Wells			Question/Comment: This table is confusing. The Executive Summary indicates on P. 7 that that there are 61 representative wells. Yet this table (titled Summary of Existing Monitoring Wells) seems to indicate that there are 222 existing monitoring wells (222 Total number of DWR and CASGEM wells). Please clarify.	The table has been replaced
39	P. 13	Last Paragraph			Question/Comment: This paragraph refers to the very misleading inclusion of GSA projects that "these include installing new wells to secure reliability of water supply to residents of Ventucopa, Cuyama and New Cuyama." What is the GSA's role in these projects? P. 12 of the Executive Summary, states that funding for three new community wells is the responsibility of the communities. In Chapter 8, (P. 6, 1.1, Fig 8-1), states that oversight, permitting, installation and operation of the wells is the responsibility of the communities. So if funding, installation and operation of these wells is the responsibility of the communities, why are they included in the GSP at all? They do not appear to be projects of the CBGSP. Please clarify.	Financing options for these projects are included in Chapter 8. Financing does not need to be provided directly by the GSA for the projects to be included in the GSP.
40	P. 15	3rd bullet point			Change: Basn is misspelled	This has been fixed.
41	P. 16	Figure ES-16			Change: In the footnote to the overall schedule of activities (*Represents Management Area Activities), please text to read: "Represents Activities that will take place in any currently identified management area, or area that may be identified in the future."	The footnote text has been revised
42	P. 17	1st paragraph		For budgetary purposes, the …	Correction: Chapter 8 (P. 9, last paragraph) notes this figure as $1.3 million per year.	This has been corrected.
43	P. 17	General			Addition: As an Executive Summary document that will be more widely read than the full CBGSP, it seems prudent to include a brief summary of the consequences of not implementing this plan, and thereby not achieving sustainability.	While SGMA and the GSP resulations provide general information on what would happen if the GSP fails, there are many uncertainties regarding that outcome. Therefore, it would not be helpful to include this in the GSP document, but this topic can be discussed in future GSA meetings
44	ES-2 Public Meeting Figure			"Public Meeting" table	reference table in text + table caption, such Table ES-1 Number of Public Meetings	A reference has been added to the text
45	ES-2			The strategy incorporated monthly CBGSA…	Discuss table in text, such Table ES-1 Number of Public Meetings shows the number of....	A reference has been added to the text

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46	ES-3			The United States Geologocal	spelling - Geological	This has been fixed.
47	ES-3			Concentrations of boron at up to…	Consider adding the secondary MCLs for chloride and boron	References to these constituents have been removed as they are not discussed in detail in the main document.
48	ES-3			Consider adding the range of years instead of many years.	Consider adding the range of years instead of many years.	The sentence following this one notes that overdraft conditions have been documented since the 1950's
49	ES-3			These values exceed the California…	The statement needs clarification, please add the secondary MCL and define what a secondary MCL is. For example, secondary MCLs address aesthetic issues related to taste, odor, or appearance of the water and are not related to health effects, although elevated TDS concentrations in water can damage crops, affect plant growth, and damage municipal and industrial equipment.	The sentence has been revised to note that this is the secondary MCL.
50	ES-7			The Basin has been in overdraft…	Consider deleting this sentence since already mentioned earlier in report	The sentence has been removed.
51	ES-9			Figure ES-9: Groundwater	Consider removing the bullet point and increasing the figure size to read the legend	The figure has been enlarged.
52	ES-14			In 2023, monitoring in 2023…	Consider deleting "in 2023" (repeated)	This has been corrected.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1	1.2.4		2	"Local agencies such as the CCSD and"	CCSD does in fact test groundwater quality every six months and has for years according to employees and contractors involved.	The sentence has been removed
2	1.3.1		2nd bullet		Here you say CCSD does monitor and report groundwater elevations	The sentence in 1.2.4 has been removed
3	1.3.4			"The CBGSA Board appointed the"	Look at language RE: SAC. Not true. Delete "primary." During discussions there was never any intent that the SAC would be the "primary" body for providing advice. The GSA is equally interested in comments from the public no matter in what venue the comments are received. Advice and input primarily comes from Woodard & Curran.	The text has been revised
4	1.3.1				Benefits - Beneficial Users: The first statement is very broad. There has not been anything that describes the benefits to water users in the areas that are Not in the problem area of the Central Area, assuming that the area can be remedied, this has No benefit to any other area, especially the Western and North Western areas where the water comes from the water shed in the mountains to the south and Not from the water shed from the East (as per your presentations and data)	This section is intended to describe beneficial users of groundwater in the Basin, not just those that benefit from the GSP projects and actions.
5	P. 1.1 Sec. 1.1			Introduction and Agency Information: List of GSA members	Addition: Alternate Members and Affiliations should also be listed here.	These have been added
6	P. 1.2 Sec. 1.1.2			Management Structure: SAC members	Addition: As designated by the GSA, the SAC is a 9-member committee and a vacancy will hopefully be filled soon.	The text has been revised to note that the 9th SAC position is currently vacant.
7	P. 1.7 Sec. 1.2.2			Plan Area Setting: "However, some wells may not have been reported to DWR …	Question: How does the GSP plan to account for the 30% of total wells that were not reported to the DWR? Addition: These well should be investigated and considered for inclusion in the Monitoring Network as Representative wells.	This will be considered during GSP implementation.
8	P. 1.21 & 1.22 Figure 1-15 & Figure 1-16			Production Well Density & Domestic Well Density	Addition: These wells should be characterized as De minimis, domestic, industrial, rangeland or irrigation users and must also be identified and incorporated in density mapping. Question: How does this GSP define "de minimus"? Source: Final GSP Emergency Regulations, Section 354.8(a) " (5) The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information."	These figures depict data from DWR's Well Completion Report database, which is currently the best available information. This could be potentially updated during GSP implementation.
9	P. 1.26 Sec. 1.2.3 Table 1.1			Deactivated stream gages	Addition: Please provide a discussion of the challenge to long term monitoring of stream flow. How critical is this data gap. Suggestion: Install flow gauge on all brides over the Cuyama River (only 3) and major drainages, ASAP.	Text has been added.
10	P. 1.45 Sec. 1.3.1			Holders of overlying groundwater rights, including agricultural users ...	Question: Are there industrial users and industrial wells in the Cuyama Basin? Should they be identified here and in the DMS as such?	Industrial users are not included in the GSP because they do not have a net consumption of water.
11	P. 1.45 Sec, 1.3.1			Disadvantaged communities: There are two disadvantaged communities …	Correction: The communities of New Cuyama and Ventucopa have been designated as Disadvantaged Communities; the community of Cuyama has been designated as a Severely Disadvantaged Community. Source: https://gis.water.ca.gov/app/dacs/	The text has been revised to add Ventucopa
12	P. 1.45 Sec, 1.3.1			Potential interests that are not present in the Cuyama Basin…	Question: What is the definition of an "Environmental User of Groundwater"? Would this include GDEs? Would this include Wildlife habitat and its connectivity? Would this include the beneficial uses such as fishing, birding, swimming and living, all of which depend on groundwater?	Environmental users have been added to the list of users present in the Basin
13	P. 1.50 Sec. 1.3.4			On June 30, 2017, the CBGSA Board …	Addition: Please describe the proportional hybrid weighted voting by CBGSA members, including the criteria requiring a supermajority, as stipulated by the Joint Powers Agreement which governs the CBGSA's authorities.	This has been added
14	P. 56 Sec. 1.3.4			In March 2018, the CBGSA Board expanded the SAC membership …	Comment: The inclusion and active participation of the Hispanic community in the development and implementation of this GSP is critical. Action: Appoint and maintain a full 9 seat SAC with at least 2 Hispanic members	The text in section 1.1.2 has been revised to note that the 9th SAC position is currently vacant.
15	P. 1.51 Sec. 1.3.5			Community input was encouraged …	Comment: Community input was extremely limited at all CBGSA meetings. Time constraints and the need to "keep moving on" were often used to discourage community input at the public GSA meetings.	Comment noted. The text has been revised.
16	P. 1.52 Sec. 1.3.5			The input was also used to develop context and content for CBGSA meetings…	Change: The word, "contend" should be "content"	The text has been revised.

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17	P. 1.53 Sec. 1.3.5			The GSP's list of projects was revised …	Correction: The GSP only offers encouragement in support for, but not construction of any new wells. This appears responsive to the disadvantaged community public comment & real needs while doing and committing to nothing. This GSP only proposes to support the idea of grant funding to construct new wells.	Comment noted. No change needed as the sentence is accurate in that these projects are included in the GSP project list in Chapter 7.
18	P. 5			Acronyms list	Addition: GDE Groundwater Dependent Ecosystems SAC Standing Advisory Committee SBCWA Santa Barbara County Water Agency	These have been added.
19	P. 7			1.1 Introduction and Agency Information: List of GSA members	Addition: As alternates frequently attend meetings, they (and their affiliations) should also be listed here.	These have been added.
20	P. 7			1.1 Introduction and Agency Information	Addition: Section 354.6 of the Final GSP Emergency Regulations includes the following requirement: "(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs." This item is not included in the Appendix A Checklist, nor is it outlined in Chapter 1, Section 1.1. Question: Will the CBGSP be considered incomplete without this information? Should the Draft CBGSP have included a placeholder notation here? Source: Final GSP Emergency Regulations	This is discussed in Chapter 8
21	P. 8			1.1.2 Management Structure: SAC members	Addition: Please include the existence of one vacant seat in the 9-member committee.	The text has been revised to note that the 9th SAC position is currently vacant.
22	P. 9			Information presented in Figures 1-15…	Question: How does the CBGSP plan to account for the 30% of total wells that were not reported to the DWR?	These figures depict data from DWR's Well Completion Report database, which is currently the best available information. This could be potentially updated during GSP implementation.
23	P. 27 & 28			Figure 1-15: Production Well Density Figure 1-16: Domestic Well Density	Addition: De minimis users must also be identified and incorporated in density mapping. How does the CBGSP define "de minimis" user? Is it consistent with the State Water Board's definition? The State Water Board Fact Sheet issued in March 2017 "De minimis Extractors: SGMA defines a de minimis extractor as "a person who extracts, for domestic purposes, two-acre feet or less per year." A person who extracts two acre-feet or less per year for a non-domestic purpose is not considered a de minimis extractor. Domestic purposes do not include commercial activities. A person who extracts more than two acre-feet per year from a parcel is not a de minimis user. De minimis users are exempt from reporting in unmanaged areas. However, the State Water Board may require de minimis extractors to report in a probationary basin if necessary. The emergency regulation clarifies how the term "domestic purposes" will be interpreted when determining if an extractor is de minimis. The Final GSP Emergency Regulations, Section 354.8(a) indicate that the CBGSA must show "(5) The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information."	These figures depict data from DWR's Well Completion Report database, which is currently the best available information. De minimis users could be potentially be identified and included during GSP implementation.
24	P. 32, 1.2.3			Deactivated stream gages	Addition: Response to public comment #19 (P. 167) requesting explanation of the deactivation of 4 stream gages, was "The text will be modified to discuss the deactivated USGS gages." No discussion appears in the Draft CBGSA. Please provide discussion of the deactivated USGS gages.	Information on these gages is provided in Table 1-1
25	P. 50, 1.2.7			Element (1) (i) Efficient water management practices, as defined in Section 10902, for the delivery of water and water conservation methods to improve the efficiency of water use.	Change: Location: Cuyama Basin Irrigation District. Does this exist? Was this supposed to be the Cuyama Basin Water District? And if so, please explain the CBWD's role in " Efficient water management practices, as defined in Section 10902, for the delivery of water and water conservation methods to improve the efficiency of water use."	It was been corrected to say Cuyama Basin Water District. As the representative of many landowners in the Basin, it is expected that the CBWD would play a role in implementation of potential water conservation measures.
26	P. 51, 1.3.1			Beneficial Users and Users of Groundwater	Question: Are there industrial users and industrial wells in the Cuyama Basin and have those been included in the Draft CBGSP?	Industrial users are not included in the GSP because they do not have a net consumption of water.
27	P. 51, 1.3.1			Disadvantaged communities: There are two disadvantaged communities in ...	Correction: The communities of New Cuyama and Ventucopa have been designated as Disadvantaged Communities; the community of Cuyama has been designated as a Severely Disadvantaged Community. Source: https://gis.water.ca.gov/app/dacs/	The text has been revised to add Ventucopa
28	P. 56, 1.3.4			GSA Decision Making Process	Addition: Please add a discussion of the proportional voting by CBGSA members, including the criteria by which specific votes require a supermajority, as stipulated by the Joint Powers Agreement which governs the CBGSA's authorities.	This has been added

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29	P. 56, 1.3.4			In March 2018, the CBGSA Board expanded …	Comment: This change was made at the insistence of the public and at the unanimous request of the full Standing Advisory Committee, due the lack of representation of the Hispanic community, as required by the Final GSP Emergency Regulations. Since the resignation of one Hispanic SAC member in December 2018, the CBGSA has delayed replacing that committee member for five months, a critical omission during the final phase of development of the GSP. Reasons have included cost and timing. CBGSA staff quoted an estimate of $913 to initiate and complete the process of selecting a replacement. It can be accurately stated that the 11-member SBGSA and the original 7- member SAC, had no Hispanic representation at all. In the 23 months that the GSP has been in formal development, during 10 of those months, 2 members of the Hispanic community were included on the SAC, during 5 of those months 1 member of the Hispanic community has been included. In a community that is roughly 50% Hispanic, this cannot be even remotely considered to be appropriately representative of the demographics of the community. Section 354.10 (d)(3)of the Final GSP Emergency Regulations states that the GSP must provide "A description of how the Agency encourages the active involvement of diverse social, cultural and economic elements of the population within the basin." Aside from translation of meeting announcements, newsletters, and the Draft GSP Executive Summary into Spanish, and holding workshops in Spanish, the community engagement process has not actively engaged with the Hispanic or the disadvantaged community. In fact, for all SBGSA and SAC meetings, unpaid volunteer interpreters have provided live interpretation, utilizing equipment on loan from the local school district.	Comment noted. Actions taken to outreach to the Spanish community are described in Sections 1.3.6 and 1.3.7
30	P. 57, 1.3.5			Community input was encouraged and received …	Comment: Community input was extremely limited at all CBGSA meetings. The Board Chair and Vice Chair were extremely brusque with the public on multiple occasions and did not permit public comment, even when the public used the required comment process. On multiple occasions, requests for comment were rejected citing time restrictions, claimed irrelevancy, or that the process was "moving on". On several occasions, one comment or question may have been permitted from members of the public, but follow-up questions or comments were not permitted. Additionally, following the established board procedure, with public comment following board discussion, even after subsequent additional board discussion, with additional issues raised, public comment was not permitted on the additional issues raised. Further, on at least one occasion, the Board Chair and Vice Chair permitted a SBGSA Director to speak harshly to staff and a member of the public. This conduct is not consistent with the claim "Community input was encouraged and received at all CBGSA meetings."	Comment noted. The text has been revised.
31	P. 58, 1.3.5			How Public Comment Was Used….	Change: 1st paragraph, "contend" should be "content"	The text has been revised.
32	P. 58, 1.3.5			All CBGSA-hosted public meetings…	Comment: This statement is a misrepresentation of the actual circumstances. See Comments #13 & 14 above. Additionally, the public was NOT encouraged to provided input or discussion at CBGSA meetings. The public was permitted to ask one question, perhaps two, but NO discussion was permitted. However, at meetings of the Standing Advisory Committee and at Public Workshops, the public was encouraged to provide input, engage in discussion and ask questions.	Comment noted. The text has been revised.
33	P. 59, 1.3.5			The GSP's list of projects was revised to include	Correction: "The GSP's list of projects was revised to include support for construction of new wells for these communities." The GSP did not propose to construct or finance the construction of these wells. It proposes to help seek grant funding to construct new wells.	Comment noted. No change needed as the sentence is accurate that these projects are included in the GSP project list in Chapter 7.
34	P. 135			The SAC will determine the financial component...	Change: Should the highlighted text (SAC) read "GSA"?	The text has been revised.
35	1.3.1				Department believes that beneficial uses, such as fish and wildlife preservation and enhancement, GDEs and other plant and animal species that depend on interconnected surface waters occur within the Cuyama Basin [Water Code §10727.4(l), Title 23 California Code of Regulations §§ 666 and 354.26(b)(3)]. GDEs can rely on groundwater for some or all its requirements, relying on multiple water sources simultaneously and at different temporal/spatial scales (e.g., precipitation, river water, reservoir water, soil moisture in the vadose zone, groundwater, applied water, treated wastewater effluent, urban stormwater, irrigated return flow). Several sensitive species known to occur within the Basin that should be considered in the GSP as beneficial users and are vulnerable to groundwater pumping impacts include (but not limited to): California red-legged frog (Rana draytonii); tricolored blackbird (Agelaius tricolor); western spadefoot (Spea hammondii), southwestern pond turtle; (Actinemys pallida; yet\ow warbler (Setophaga petechia); Arroyo chub Gila orcuttii); least Bell's vireo (Vireo bellii pUSIllus); and willow flycatcher (Empidonax traillii) [see Natural Communities Commonly Associated with Groundwater dataset (NC Dataset) located at https://gis.water.ca .qov/app/NCDatasetViewer/].	Environmental users have been added to the list of users present in the Basin
36				Prep. Checklist - Article 5 - 354.4 "List of references and..."	References are not in the executive summary, but listed in each chapter	The table has been revised
37				Prep. Checklist - Article 5 - 354.6 "Estimate of implementation…"	Consider adding Chapter 8, which list the estimated cost.	The table has been revised
38				Description of how those plans may limit....	Please check to see if this is mentioned in Chapter 4 (maybe Chapter 5).	The table has been revised
39				Summary of the process for…	Please verify that it is in Chapter 1.	A sentence has been added to Chapter 1 regarding the permitting process for new wells.
40				Prep. Checklist - Article 5 - 354.8(g)	Please verify that all of these item are in Chapter 8. It seems that some of these items are briefly mentioned in Chapter 1.	The table has been revised

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41				Prep. Checklist - Article 5 - 354.10	Please verify that the items are in Chapter 8. It seems that some of these items are briefly mentioned in Chapter 1.	The table has been revised
42				Prep. Checklist - Article 5 - 10727.2(d)(4)	Please verify, some of these items are in Ch 2.1 (reference to Ch 7 in 2.3)	The table has been revised
43				Prep. Checklist - Article 5 - 354.20	Please check to see if a few of these items are discussed in Chapter 7	The table has been revised
44	1.1.3			Per Section 10723.8(a) of the	Consider adding to whom the notice was given to.	This has been added
45	1.2.1			Consider defining water yielding capacity	Consider defining water yielding capacity	Don't need to provide a definition since this is a direct quote from a DWR document
46	1.2.4			Consider defining temporal frequencies	Consider defining temporal frequencies	A definition is not needed for this
47	P. 1-45 & 1-46				[Checklist item #1]: Significant science-based sources indicate that environmental users of groundwater, known as groundwater dependent ecosystems (GDEs), as well as other species that depend on interconnected surface waters, exist in Cuyama Basin and therefore should be identified and described. For any species that are no longer present in the basin, please provide scientific rationale and data to support this claim. The information on environmental users in the Cuyama basin is readily available and includes the data and data sources. Please refer to the following: • Natural Communities Commonly Associated with Groundwater dataset (NC Dataset), which is provided by the Department of Water Resources and identifies potential GDEs https://gis.water.ca.gov/app/NCDatasetViewer/ • In Fall 2018, The Nature Conservancy sent a list of freshwater species located in the Cuyama Basin, which is included as Attachment C of this letter. Please take particular note of the species with protected status. • In addition to identifying and describing environmental beneficial users, SGMA requires that beneficial users be considered throughout the plan. The Nature Conservancy has identified each part of the GSP with this requirement. That list is available here: https://groundwaterresourcehub.org/importance-of-gdes/provisions- related-to-groundwater-dependent-ecosystems-in-the-groundwater-s. Please ensure that environmental beneficial users are addressed accordingly throughout the plan.	Comment noted. Environmental users have been added to the list of users present in the Basin
48	P. 1.57 Appendix A GSP Regulations			Missing or only selected items	Question: Why do many items in this Appendix differ with GSP Regulations list? Some are edited, or omitted? Consistency here with the regulations seems critical. Source: Final GSP Emergency Regulations	The Table in the appendix is based on the Preparation Checklist provided by DWR. The only change is the addition of the column noting the relevant GSP Section for each row. Additional detail on the requirements is not needed.
49	P. 65, Appendix A GSP Regulations Section 352.2			Monitoring protocols that are designed to detect changes …	Question: Where does highlighted text ("and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin") appear in the Final GSP Emergency regulations section 352.2? This highlighted text is not included in the regulations. Please provide the source for the highlighted text. 352.2 states: "Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows: Monitoring protocols shall be developed according to best management practices. The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department, or may adopt similar monitoring protocols that will yield comparable data. Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary. Note: Authority cited: Section 10733.2, Water Code. Reference: Sections 10727.2, 10728.2, 10729, and 10733.2, Water Code.	The Table in the appendix is based on the Preparation Checklist provided by DWR. The only change is the addition of the column noting the relevant GSP Section for each row. Additional detail on the requirements is not needed.
50	P. 65, Appendix A GSP Regulations Section 352.2			Missing text	Addition: Please include: (c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary. Source: Final GSP Emergency Regulations	The Table in the appendix is based on the Preparation Checklist provided by DWR. The only change is the addition of the column noting the relevant GSP Section for each row. Additional detail on the requirements is not needed.
51	P. 65, Appendix A GSP Regulations Section 352.4			Missing text	Addition: Please include: 352.4. Data and Reporting Standards This section provides significant guidance on what must be included in the GSP and wholly missing from this appendix. Source: Final GSP Emergency Regulations	The Table in the appendix is based on the Preparation Checklist provided by DWR. The only change is the addition of the column noting the relevant GSP Section for each row. Additional detail on the requirements is not needed.
52	P. 65, Appendix A GSP Regulations Section 354.6			Estimate of implementation costs Chapter 1 Section 1.1 Introduction and Agency Information	Addition: Section 354.6 includes the following requirement: "(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs." This item is not included in the Appendix A Checklist, nor is it outlined in Chapter 1, Section 1.1. Will the plan be considered incomplete without this information? Should the Draft GSP have included a placeholder notation here? Source: Final GSP Emergency Regulations	The Table in the appendix is based on the Preparation Checklist provided by DWR. The only change is the addition of the column noting the relevant GSP Section for each row. Additional detail on the requirements is not needed.
53	P. 65, Appendix A GSP Regulations Section 354.8(a)			Bullet point #4: Existing land use designations	Should read: "Existing land use designations and the identification of water use sector and water source type." Source: Final GSP Emergency Regulations 354.8(a)(4)	The Table in the appendix is based on the Preparation Checklist provided by DWR. The only change is the addition of the column noting the relevant GSP Section for each row. Additional detail on the requirements is not needed.
54	P. 65, Appendix A GSP Regulations Section 354.8(a)			Bullet point # 5 "Density of wells per square mile….	Add: "including de minimis extractors"	The Table in the appendix is based on the Preparation Checklist provided by DWR. The only change is the addition of the column noting the relevant GSP Section for each row. Additional detail on the requirements is not needed.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "…	Comment	Response to Comment
55	P. 67, Appendix A GSP Regulations Section 354.8(g) Water Code Section 10727.4			Bullet point #2: Wellhead protection	Should read: Wellhead protection areas *and recharge areas.* Source: CA Water Code §10727.4 (2017)	The Table in the appendix is based on the Preparation Checklist provided by DWR. The only change is the addition of the column noting the relevant GSP Section for each row. Additional detail on the requirements is not needed.
56	P. 67, Appendix A GSP Regulations Section 354.10			Bullet point #6 Encouraging active involvement	Should read: (d)(3): A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin Source: Final GSP Emergency Regulations	The Table in the appendix is based on the Preparation Checklist provided by DWR. The only change is the addition of the column noting the relevant GSP Section for each row. Additional detail on the requirements is not needed.
57	P. 68, Appendix A GSP Regulations Section 354.14			Missing or only selected items	Change: Many items in the Final GSP Emergency Regulations Section 354.14 are missing from Appendix A. Please revise to include all items. Source: Final GSP Emergency Regulations	The Table in the appendix is based on the Preparation Checklist provided by DWR. The only change is the addition of the column noting the relevant GSP Section for each row. Additional detail on the requirements is not needed.
58	P. 71, Appendix A GSP Regulations Section 354.30			Bullet #3 "Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones"	This is incomplete. Please include a more complete description of measureable objectives and interim milestones. 354.30 (a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon. 354.30 (e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon. Source: Final GSP Emergency Regulations	The Table in the appendix is based on the Preparation Checklist provided by DWR. The only change is the addition of the column noting the relevant GSP Section for each row. Additional detail on the requirements is not needed.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1					Groundwater dependent ecosystems: The Plan has a gap concerning GDEs in the Basin that should be addressed in terms of impact and actions under the Plan.	Comment noted. Actions for GDEs can potentially be added in the future at the direction of the CBGSA Board.
2					This chapter would be a good place to introduce and make the case for the threshold regions and present conditions by region. Also, the groundwater level decline figures presented in Chapter 7 would be helpfully introduced here. The executive summary cites a water budget for the Central Management area of 25,000 acre-feet per year of overdraft, but that is not in this section at all. Overall, this chapter needs to be better tied in with the rest of the document.	Per expressed desire by the CBGSA Board, water budget numbers are only shown for the complete Basin, not for sub-regions. The reference to the Central Basin overdraft in the Executive Summary has been removed.
3	P. 2-38, Figure 2-10				Where are these two westernmost PGE wells? This doesn't look right. The one near the river looks like the Cal Trans well and the other looks like the Caliente Ranch well (private)	This data was pulled from the USGS report *Geology, Water-Quality, Hydrology, and Geomechanics of the Cuyama Valley Groundwater Basin* , California, 2008–12 < https://pubs.usgs.gov/sir/2013/5108/>. Based on the data provided in this report, these wells were sampled by PG&E.
4	P. 2-43			The majority of agricultural activity occurs"	Just delete "near the north fork." There is no "north fork." North Fork Cattle Co. was formed in 1970 in San Juan Capistrano and just happened to buy and own property west of the Russell Fault at one time	The text has been revised
5	P. 2-117				Reach 8-School House Cyn. Creek: On figure 2-61 Reach 8 is on the wrong place. You have labeled it School House Cyn Creek but it is actually Aliso Cyn. Should 8 be changed or should the map be changed?	The text has been revised to say Aliso Canyon Creek
6	2.2.8				Interconnected Surface Water Systems: This section seems incomplete. At least some mention should be made that these are only selected surface water systems. There are other creeks that run longer than those mentioned and surely Branch Creek and Salisbury Cyn are worth mentioning if only due to the frequency of their flooding	The text has been modified to note that these are the stream reaches that are explicitly simulated in the numerical model.
7	2.2.9			Groundwater occuring near the ground surface	GDEs: what is that supposed to mean? I object to 1) how this data was collected and 2) that a great deal of it is based on supposition and 3) your unwillingness to come out and state such. What exactly are "remote sending techniques"? Why on Figure 2-63 do you use TNC identified potential GDE wetlands and TNC identified potential GDE vegetation? Why not use the wetlands and vegetation areas identified in the NCD dataset which appears to be much more accurate and complete? Furthermore, I was unable to find any site that could identify the 123 probably GDE's on the 275 probable non-GDE's in the Basin. Additionally, it is never actually admitted the no one ever looked at the sites for this data. Your biologist came to California, came to the Cuyama Valley, but not much effort was made to access the most important ecosystems on the ground. Academic white wash. In your technical you state "the field study was conducted only on publicly accessible lands." Then you say "Field observations were ,ade pm MCCAG-mapped seeps springs..." inderring that these areas were observed which they weren't as most of them are on private ground or are inaccessible.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs can potentially be added in the future at the direction of the CBGSA Board.
8	2.2.10			"The Cuyama River is not guaged"	DATA GAP. Third bullet point. That's not even possible. This is enough to invalidate this entire GSP. According to your Appendix C to Ch 2 P. C-7, "the USGS has two active gages that record flows in the Cuyama River watershed upstream of the Lake Twitchell. These include one gage on the Cuyama River downstream of the basin (ID 11136800) which is located just upstream of Lake Twitchell. "The other active gage is south of the city of Ventucopa..." The watershed for Twitchell Reservoir includes a much larger area than the Cuyama Basin. Any estimate from their stream guage would have to be modeled for areas of flow and results would only be an estimate.	The bullet has been revised to note that available precipitation data was used in addition to downstream surface flow records to estimate flows in the Basin
9					As regards Groundwater Dependent Ecosystems - GDE's: The Nature Conservancy recognized 2000 acres of GDE's in the Cuyama Basin. The GSP reduced that area to 500 acres, based on a biologist spending a day and a half on a computer, never visiting the sights. The GDE's are where the native plants, animals, birds and the pollinators still thrive because of the availability of nature springs and seeps. They provide a vision of how more of the land would look in its recovery. The GDE's need to be protected from further degradation. I feel that the present GSP does not recognize their importance.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs can potentially be added in the future at the direction of the CBGSA Board.
10	P. 2-14 Figure 2-3				The Upper and Lower Morales are unconformable (Seismic Lines-Ellis 1994)-Figure does not convey this, and text does not reflect this. This unconformity is the basis for delineating these two units for most seismic work within the valley	We are unable to find the unconformity between the Upper and Lower Morales Formation in Seismic Lines-Ellis 1994. This section can be updated with more information during the 2025 GSP update.
11	P. 2-52 Figure 2-21				South Cuyama Oilfield does not reflect CA DOGGR oilfield shape/location	The figure has been revised.
12	P. 2-61 Figure 2-26				Russell fault is not continuous across the valley, published field maps (Dibblee, Nevins, Schwing, DeLong) show this fault to be continuous across valley.Fault has 18+ miles of lateral displacement and should be continuous	The representation of the fault in the figure has been revised.
13	P. 2-88 Figure 2-43				Russell fault is not continuous across the valley, published field maps (Dibblee, Nevins, Schwing, DeLong) show this fault to be continuous across valley.Fault has 18+ miles of lateral displacement and should be continuous	The representation of the fault in the figure has been revised.
14	P. 2-90 Figure 2-44				Russell fault is not continuous across the valley, published field maps (Dibblee, Nevins, Schwing, DeLong) show this fault to be continuous across valley.Fault has 18+ miles of lateral displacement and should be continuous	The representation of the fault in the figure has been revised.
15	P. 2-91 Figure 2-45				Russell fault is not continuous across the valley, published field maps (Dibblee, Nevins, Schwing, DeLong) show this fault to be continuous across valley.Fault has 18+ miles of lateral displacement and should be continuous	The representation of the fault in the figure has been revised.
16	P. 2-94 Figure 2-46				Russell fault is not continuous across the valley, published field maps (Dibblee, Nevins, Schwing, DeLong) show this fault to be continuous across valley.Fault has 18+ miles of lateral displacement and should be continuous	The representation of the fault in the figure has been revised.
17	P. 2-96 Figure 2-47				Russell fault is not continuous across the valley, published field maps (Dibblee, Nevins, Schwing, DeLong) show this fault to be continuous across valley.Fault has 18+ miles of lateral displacement and should be continuous	The representation of the fault in the figure has been revised.
18	P. 2-97 Figure 2-48				Russell fault is not continuous across the valley, published field maps (Dibblee, Nevins, Schwing, DeLong) show this fault to be continuous across valley.Fault has 18+ miles of lateral displacement and should be continuous	The representation of the fault in the figure has been revised.
19	P. 2-33			In general, conductivity is highest near the center of the Basin…	What is the basis for this conclusion? Show maps of data to confirm this conclusion and relate finding to previous work (e.g., USGS texture analysis). The distribution of aquifer properties influences the distribution of model-calculated water levels and groundwater storage declines, which are the basis for defining Management Areas and pumping allocations.	The center of the Basin near the streambed is made up primarlily of younger alluvium, which is generally associated with higher conductivity.
20	P. 2-125			The Cuyama River is not gaged …	What parameters are most influential on these flows and model-calculated recharge from river leakage?	Text has been added to Appendix C to discuss these parameters.

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21	P. 2-125			Faults are not well understood with regard to the …	What does model testing show regarding the sensitivity of model-calculated water level and storage changes to the conductivity of these faults?	The calibrated numerical model shows limited flows occuring across these faults. This can be re-evaluated in the future when more data is available.
22	P. 2-28			shows the outcrops of bedrock near the Russell Fault …	Beginning of sentence is missing something.	The text has been corrected
23	P. 2-51			Figure 2-22 shows major faults …	Should be Figure 2-21.	The text has been corrected
24	P. 2-52				Faults shown are not consistent with faults shown on Figure 2-8 and those represented in the model.	This figure is not intended to show all of the faults in the Basin
25	P. 2-125			The Cuyama River is not gaged …	What does model sensitivity testing show regarding these features?	Text has been added to Appendix C to discuss these parameters.
26	P. 2.8 to 2.9			Piper diagrams are useful for understanding…	Suggestion: Please list these terms alphabetically. Addition: This Plan should use Piper diagrams from a full schedule of constituents to better understand basis recharge dynamics. Not just TDS alone.	Comment noted. These have been re-ordered alphabetically
27	P. 2.32 Sec. 2.1.7			DWR's Groundwater Glossary defines an aquifer as…	Question: How does DWR define an Aquitard? Question: What "field tests" were performed as part of this study effort? Or is all this interpreted from the USGS and other published study? Was there any new ground truthing done in this study?	This has been added to the text.
28	P. , 2.45 Figure 2.17			Surface Water	Addition: Please include major drainages of Ballinger Canyon, Branch Wash & Cottonwood Canyon. Upper Cuyama is misnamed and should be "Reyes" Creek.	The figure has been revised.
29	P. 2.52 Figure 2.21			Cuyama Basin Landmarks	Corrections: Burges Canyon is misspelled and Bitter Creek is misnamed and should be Branch Wash	Burges Canyon label has been updated. The "Bitter Creek" label is what is utilizez in the National Hydrologic Data Set shapefile. According to USGS Topo maps, Branch Wash is actually just east of the Bitter Creek line and is therefore correctly labeled.
30	P. 2.53, Sec. 2.2.1			Useful Terms	Suggestion: Please list these terms in alphabetical order.	These have been re-ordered alphabetically
31	P. 2.74 Figure 2.36 thru 2.38			Vertical Gradients	Comment: These multiple depth compilation wells are of great importance in determining vertical gradients. However since 2014, CVKR, CVBR and CVFR are missing the high (winter) and low (summer) measurements making the interpretation of vertical gradients less accurate. Suggestion: Return to quarterly monitoring ASAP. Addition: Install several more of these types of well for monitoring the Vertical Gradient around the major Faults; SBCF & Russell Faults.	Comment noted. This can be considered during GSP implementation.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "…	Comment	Response to Comment
32	P. 2.81 Sec. 2.2.3 Fig. 2.39			The gradient increases in the vicinity of the SBCF and flows to an area of …	Comment: This map actually shows that the groundwater under the bridge of 166 has reversed gradient and is flowing southeast, 180* opposite of streamflow and topographic gradient. Suggestion: Text should point this phenomenon out for the significances it represents. A 600' deep cone of depression is more than just an area of lowered elevations. Addition: The title of Figure 2.39 should include "Groundwater Flow Direction"	The text has been revised. No change needed to the Figure as Groundwater Flow Direction is noted in the legend.
33	P. 2.99 Sec. 2.2.4			Average annual use over the 20-year period was -23,076 acre-feet.	Correction: The word "use" is incorrect and should be "overdraft".	The text has been revised
34	P. 2.99 Sec. 2.2.4 Figure 2.49			Cuyama Groundwater Storage by Year, Water Year Type, and Cumulative Water Volume	Comment: This chart shows 1 million AF lost from storage over the last 20 years! What about the previous 20 years? Question: How much more storage will be lost before sustainability in 2040? What Undesirable Results does this GSP recognize because of this historic overdraft?	Comment noted. The undesirable results definitions in the GSP are tools to measure future Basin conditions, not past conditions.
35	P. 2.103 Sec 2.2.7			DWR GeoTracker California Groundwater Ambient …	Comment: This GAMA report is referenced for TDS, but does not discuss any of the other conclusive evidence by way of the age dating and "fingerprinting" water by source. The lack of any tritium indicates there is no recent recharge and groundwater production is sourcing fossil water, over 30 thousand years old. Addition: Fully utilize GAMA for groundwater quality understanding and protection. Continue to collect similar data moving forward.	Comment noted. This can be considered in the future if direction is provided by the GSA Board.
36	P. 2.117 Sec. 2.2.8 Fig. 2.61 Table 2.2			Stream Reaches Used in Cuyama Groundwater Model…	Comment: This attempt to depict the interconnectivity of surface water is much appreciated, yet it could be improved with some clarifications and additions. Question: How were the reaches determined? Why not Apache? Why Schoolhouse and not Cottonwood? Addition: Please add to Figure 2.61 the values of average annual gain or loss by Reach from Table 2.2.	The text has been modified to note that these are the stream reaches that are explicitly simulated in the numerical model.
37	P. 2.126 Sec. 2.3				Suggestion: Please list these terms in alphabetical order.	Comment noted. These have been re-ordered alphabetically
38	P. 2.132 Sec. 2.3 Table 2.4 & 2.5				Comment: The Model and the Budget do not take into consideration the effect of more than 500' of dewatered vadose zone. This can drastically affect the calculation for "Deep Percolation" from precipitation and applied water. Age dating shows no recent recharge. (See comment 23) Question: How is deep percolation through the vadose assumed and justified as recharge? What data disputes GAMA's lack of recharge?	Comment noted. The numerical model can potentially be revised in the future as additional data is available.
39	P. 2.146 Sec 2.3 Table 2.7				Comment: It is great to know a number for sustainable yield but this plan lacks a means of getting there! Question: If the sustainable yield for the basin is 20 TAF, what is the Plan for reducing pumping by 55 to 67%?	This is discussed in Chapter 7. Specifics can be determined during GSP implementation.
40	2.1.6				The GSP should provide more information on groundwater extraction well depths throughout the basin including how it compares with the depth of the Morales geologic formation. Wells that extend outside the vertical limits of the basin should be included within the SGMA regulations. Well depth should be included in the determination of the basin bottom to capture such occurrences.	Data was not available to perform these analyses in advance of the GSP. Additional detail can potentially be added as additional data is collected in the future.
41	2.1.7				The GSP identifies that the aquifer is unconfined and continuous, except for locally perched clay aquifers. These perched water resources can provide essential habitat and sustenance for various wildlife species including plants, aquatic animals and migratory refugia for avian species. To enhance the effectiveness and utility of the GSP, CDFW requests the following information be included: a) Identify where perched aquifers exist with in the basin and describe, by each aquifer, if they: 1) are being used by domestic shallow wells; 2) support GDEs; and, 3) have interactions with surface water. b) Document the characteristics of each perched aquifer, including thickness, porosity, hydraulic conductivity, and vertical gradients to more recent alluvium aquifers.	Data was not available to perform these analyses in advance of the GSP. Additional detail can potentially be added as additional data is collected in the future.
42	2.1.7				As described in Section 2.1.7, the GSP identifies that the aquifer is unconfined and continuous, except for locally perched clay aquifers. The model results appear to support that the entire river is an interconnected surface water system [23 CCR §351(o)]; therefore, GDEs that exist within the basin rely more on availability and health of the aquifer. The GSP should include additional information on annual average stream depletion by reach (see Table 2-2), including identifying losing and gaining segments.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs can potentially be added in the future at the direction of the CBGSA Board.
43	2.2.9				Section 2.2.9 does not adequately identify GDEs within the Basin. Mapping GDEs and other beneficial uses/users is an essential component in the consideration, development and implementation of GSPs (Water Code §10723.2) and in assessing if conditions are having potential effects on beneficial uses and users of groundwater. GSAs must also include sustainable management criteria and monitoring to detect adverse impacts. CDFW believes the elimination of a large portion of the data pertaining to GDEs may have been premature. We recommend that best scientific data on depth to groundwater be included in the analysis of interconnected surface waters before any data is excluded. Other data should include (but not be limited to): USGS mapped springs/seep and comparing recent groundwater level contours to vegetation root zones. In addition, relying solely on soils information is not recommended. For example, the presence of sandy, dry, and friable soils, does not mean that existing plant species do not rely on groundwater for some portion of their life cycle. Capillary fringe associated with root networks from native plants could be accessing groundwater from deeper depths. In addition, restoration projects that provide direct benefits to sensitive riparian resources, such as slowing river velocities during high flow events which benefits the Cuyama Basin by allowing for increased surface water infiltration into the subsurface aquifer, should be identified as GDEs and mapped in the GSP. Beneficial use in the form of future riparian enhancement projects should be included in the GSP.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs and other environmental benefits can potentially be added in the future at the direction of the CBGSA Board.

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44					The Department has documented populations of several sensitive species on the restoration site and these species should be listed as beneficial users of groundwater. They are all vulnerable to groundwater pumping impacts and include California red-legged frog (Rana draytonii), tricolored blackbird (Agelaius tricolor), western spadefoot (Spea hammondii), southwestern pond turtle (Actinemys pallida), yellow warbler (Setophaga petechia), Arroyo chub (Gila orcuttii), and California roach (Lavinia symmetricus). All of these species have benefitted from the restoration project which may eventually provide habitat for the state listed least Bell's vireo (Vireo bellii pusillus) and willow flycatcher (Empidonax traillii). The importance of the restoration site is reflected in Figure 2- 63 which shows a high density of GDE elements in the northwestern corner of the Basin. Beneficial use in the form of future riparian enhancement projects should be included in the GSP.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs and other environmental benefits can potentially be added in the future at the direction of the CBGSA Board.
45	2.3			The change in the annual volume	Please elaborate on if you are also using drought and wet years?	This is described when water budget numbers are presented in subsequent sections.
46	2.3 P. 2-126			Figure 2-64 presents	Please verify if the right figure is in the text. The listed figure and text description are not matching for Figure 2-64.	The figure reference has been corrected
47	2.3 P. 2-126			Domestic water use is the volume	Please clarify what non-potable water is being used in Cuyama Basin for Domestic Water Use (such as is related to collecting rain water for irrigation)?	This information is not currently available.
48	P. 2-127			Figure 2-65:.	Please fix format (extras colon or period).	This has been corrected.
49	P. 2-128			The cumulative departure of the…	Consider revising sentence for clarity, " ...The cumulative departure of the spatially averaged of the rainfall..."	The text has been revised.
50	P. 2-132			The estimated average annual water budgets...	Please verify the right table numbers are in the text. The listed tables and text description are not matching for Tables 2-3 and 2-4.	The table references have been corrected.
51	Table 2-6			Water Year Type	Consider adding more information on water year type, maybe a note under the Table 2-6 to clarify.	The water year types are defined in a footnote on the previous page.
52	P. 2-31				[Checklist item #2]: It is currently unclear how existing well depths compare with the depth of the upper member of the Morales Formation. According to DWR's Hydrogeologic Conceptual Model BMP3, "the definable bottom of the basin should be at least as deep as the deepest groundwater extractions". Thus, groundwater extraction well depth data should also be included in the determination of the basin bottom. This will prevent the possibility of extractors with wells deeper than the basin boundary from claiming exemption of SGMA due to their well residing outside the vertical extent of the basin boundary.	Data was not available to perform these analyses in advance of the GSP. Additional detail can potentially be added as additional data is collected in the future.
53	P. 2-32				[Checklist item #3]: In paragraph 1, "The aquifer is considered to be continuous and unconfined with the exception of locally perched aquifers resulting from clays in the formation". Please provide more details on: • the location of perched aquifers • whether perched aquifers are being used by domestic shallow wells, GDEs and/or are potentially interacting with surface water • the vertical gradients between the perched aquifers and the recent and younger alluvium aquifers • other aquifer characteristics that may be known (e.g., perched aquifer thickness, porosity, hydraulic conductivity)	Comment noted. Additional detail can potentially be added in future versions of the GSP as additional data is collected in the future.
54	P. 2-117				[Checklist item #4]: The model results are demonstrating that the entire river is an interconnected surface water system ("surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted" 23 CCR §351(o)). Based on the annual average stream depletion by reach (Table 2-2), it appears that losing and gaining reaches of the Cuyama can be mapped. Please distinguish the gaining and losing reaches. The data provides seems to indicate: o Gaining: Reach 1, Reach 3, Reach 6, Reach 8, Reach 9. o Losing: Reach 2, Reach 4, Reach 5, Reach 7	Data was not available to perform these analyses in advance of the GSP. Additional detail can potentially be added as additional data is collected in the future.
55	P. 2-121				SGMA requires that all beneficial uses and users, including GDEs, be considered in the development and implementation of GSPs (Water Code §10723.2). The GSP Regulations include specific requirements to identify (map) GDEs and consider them when determining whether groundwater conditions are having potential effects on beneficial uses and users. SGMA also requires an assessment of whether sustainable management criteria (including minimum thresholds and measurable objectives) may cause adverse impacts to beneficial uses, including GDEs, and that monitoring networks are designed to detect such impacts. Therefore, mapping GDEs is a critical first step for incorporating environmental considerations into GSPs. [Checklist item #7]: • It appears that the preliminary desktop analysis, completed by Woodard & Curran and documented in Appendix D of the draft GSP, resulted an excessive elimination – totaling two-thirds – of the NC dataset polygons mapped in the Cuyama Basin. In particular, the methods and field verification approach described in the draft GSP failed take groundwater levels into consideration. SGMA defines GDEs as "ecological communities and species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface". We recommend that depth to groundwater contour maps are used to verify whether a connection to groundwater exists for polygons in the NC Dataset. Please refer to Appendix D of this letter for best practices for using groundwater data to verify a connection to groundwater.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs and other environmental benefits can potentially be added in the future at the direction of the CBGSA Board.
56	Figure 2-64				[Checklist items #8 & 9]: Decisions to remove, keep, or add polygons from the NC dataset into a basin GDE map should be based on best available science in a manner that promotes transparency and accountability with stakeholders. Any polygons that are removed, added, or kept should be inventoried in the submitted shapefile to DWR, and mapped in the plan. We recommend revising Figure 2-64 to reflect these requirements.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs and other environmental benefits can potentially be added in the future at the direction of the CBGSA Board.

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57					[Checklist item #10]: Groundwater conditions within GDEs should be briefly described within the portion of the Basin Setting Section where GDEs are being identified. Please refer to Attachment E of this letter for details on a new, free online tool that enables groundwater sustainability agencies to assess historical and current trends of growth and moisture content in vegetation using 35 years of satellite imagery for all of the polygons in the NC dataset.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs and other environmental benefits can potentially be added in the future at the direction of the CBGSA Board.
58					[Checklist item #16]: Not all GDEs are created equal. Some GDEs may contain legally protected species or ecologically rich communities, whereas other GDEs may be highly degraded with little conservation value. Including a description of the types of species (protected status, native versus non-native), habitat, and environmental beneficial uses (see Worksheet 2, p.74 of GDE Guidance Document) can be helpful in assigning an ecological value to the GDEs. Identifying an ecological value of each GDE can help prioritize limited resources when considering GDEs as well as prioritizing legally protected species or habitat that may need special consideration when setting sustainable management criteria.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs and other environmental benefits can potentially be added in the future at the direction of the CBGSA Board.
59	Appendix D				Appendix D lists assessment of aerial photography as a means of assessing GDE, but does not document which datasets were used for this effort making it difficult to reproduce/assess this effort.	Section 2.2.9 notes that the biologist assessed the NCCAG dataset available through the SGMA data portal at https://gis.water.ca.gov/app/NCDatasetViewer/
60	P. 2.221 Sec. 2.2.9 Appendix D			Groundwater Dependent Ecosystems	Comment: The elimination of ⅔ of the proballe GDEs from the NCCAG dataset by using remote sensing techniques and very few in-field site inspections is inadequate to identify GDEs or determine whether sustainable management activities may cause adverse impacts to GDEs.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs can potentially be added in the future at the direction of the CBGSA Board.
61	Appendix D				More specific comments related to the desktop analysis approach (as described in Appendix D of the GSP) include: • Inundation visible on aerial imagery – This method is inappropriate because it is not possible to know whether surface water is connected with groundwater by visually inspecting it with aerial imagery. For example, in some cases surface water can be completely disconnected from groundwater, so in this scenario this approach would falsely suggest that NC dataset polygons are connected to groundwater. Similarly, if surface water is not present, this method would also falsely suggest that NC dataset polygons are not connected to groundwater if plant communities and the species they support are accessing groundwater beneath the surface. This method also fails to account for the fact that GDEs can rely on groundwater for some or all its water requirements, which in California often vary by season, and depend on the availability of alternative water sources (e.g., precipitation, river water, reservoir water, soil moisture in the vadose zone, groundwater, applied water, treated wastewater effluent, urban stormwater, irrigated return flow). oIf aerial imagery is to be used, a range of dates should be selected to reflect the California's Mediterranean climate, seasonal variations and water year types. oPhreatophytes (groundwater-dependent vegetation) often rely on groundwater that is occurring near the ground surface via their rooting network. Because these sources of groundwater are not detectable using aerial imagery, the images should be compared with contoured groundwater levels to determine whether groundwater levels are close enough to vegetation root zones. oWe suggest the methods be revised and clarified accordingly. • Saturation visible on aerial imagery could indicate many different conditions, including standing water or saturated soils that may be ephemeral, intermittent, or permanent in nature. To help verify what the images actually indicate, this method should be coupled with more advanced remote sensing methods. Please clarify if this was the case. • Dense riparian and/or wetland vegetation visible on aerial imagery can help identify potential GDEs but is not an appropriate method to screen for whether a polygon is supported by groundwater and in fact a GDE. The presence of sparse vegetation also does not preclude the possibility that vegetation are using groundwater. Many desert and semi-arid environments with sparse vegetation can still be groundwater dependent ecosystems.	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs can potentially be added in the future at the direction of the CBGSA Board.
62	Appendix D				More specific comments related to the GDE field validation approach (as described in Appendix D of the draft GSP): • The removal of Probable Non-GDE 1 and Probable Non-GDE 2 was based on the presence of sandy, dry, and friable soils was not scientifically justified. The presence of this soil type does not preclude the possibility that the dominant plant species observed are reliant on groundwater at depths below the earth surface. For example, a rooting depth of 13 feet has been observed for Ericameria nauseosa and >4 feet for Eriogonum fasiculatum, and the capillary fringe associated with those rooting networks could be accessing groundwater from deeper depths, depending on the hydraulic conductivity of the substratum. For more rooting depth data, please refer to TNC's global rooting depth database, available at: https://groundwaterresourcehub.org/gde-tools/gde-rooting-depths-database-for- gdes/	The analysis and discussion of GDEs in the GSP was developed to satisfy SGMA requirements as they relate to GDEs. The GSP recommends piezometers to monitor for groundwater levels in the vicinity of critical GDEs. Additional analysis of GDEs and actions for GDEs can potentially be added in the future at the direction of the CBGSA Board.
63	Item 4 Conclusions P.4			The Cuyama Valley Groundwater basin is…	Further comments on GDEs TM: delete "oil and gas exploration and production, ranching." Was this even written by Woodard & Curran? Shame on you. You have not been listening to all those hours of public comments. Ranching, i.e. grazing, is a de minimis user of water. Delete ranching. The oil and gas industry in the valley is a de mimimus user of water. Delete oil and gas industry.	The text has been revised
64	Figure 3				Further comments on GDEs TM: Including this area map and not including the other GDE NCCAG area maps is highly misleading. Your photos are so few as to be misleading.	Comment noted. Additional analysis can potentially be performed on GDEs in the future.
65	C-3			The Technical Forum held 14 monthly conference calls over …	Model files not provided for review until 2/18/19 - late in the process.	Comment noted.

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66	C-4			CBWRM Development	There should be a discussion of the range of aquifer parameters used in the model and how they compare to measured values. Include figures showing the distribution by layer. Hydraulic conductivity values used in the model are lower than those reported by the USGS for the Morales formation (layer 3). The calculated groundwater-storage decline within Management Areas is sensitive to the specified values of hydraulic conductivity. Hence, the recommended pumping allocations are sensitive to hydraulic conductivity.	Ranges of aquifer parameters have been added to the uncertainty section. Additional information can be added in the future as more data becomes available.
67	C-4			The CBWRM historical model simulates Basin hydrologic …	Why were daily time step selected? Does data support daily time steps? Version provided for review runs only through September 30, 2015.	A daily time step was selected to allow for simulation of the highly variable surface water hydrology in the Basin.
68	C-4			CBWRM Development	No discussion of aquifer properties, no map of aquifer properties, no comparison to measured values. Basin Setting indicates that subsidence has occurred in the basin. Should subsidence be included in the model, especially for future scenarios with continued WL decline?	Subsidence could be considered in future versions of the model.
69	C-7			The hydrologic conditions of these small watersheds used to estimate the subsurface and surface flows are...	Inflow from the small watersheds is an important component of the basin water budget. How were small watershed parameters determined? What data were used to constrain these parameters and calibrate/verify small watershed flow? More importantly, how did uncertainty in these parameters influence model-calculated water budgets and the calculated decline in groundwater storage? Was inflow from small watersheds only applied to layer 1? Why? Was the water budget and model-calculated decline in groundwater storage influenced by the lack of recharge to the deeper layers?	The text has been revised.
70	C-7			CBWRM Grid Cuyama Water District boundary	There are some areas where the element edges don't follow the CBWD boundary.	Comment noted.
71	C-7			...and to contain relatively finer resolution along rivers, which …	Mesh size doesn't appear to be finer along several stream reaches. Finer elements seem to be along faults more than some of the stream reaches.	Comment noted. Not all stream reaches are explicitly simulated in the model.
72	C-7			...and surface flows are represented using parameters…	How were these parameters determined? How was flow from the small watersheds calibrated/verified?	The text has been revised.
73	C-8			The average annual precipitation ….	Calibration period (1995-2017) was relatively wet compared to long-term average (1967-2017).	Comment noted.
74	C-8			Attachment 1 describes the…	Labeled as Attachment C-2 in document.	This has been corrected.
75	C-9 Figure C-2			Cuyama Valley Groundwater Basin IWFM …	Faults shown are not consistent with faults in the model.	The figure has been updated
76	C-11 Figure C-3				It would be helpful to show precipitation for small watersheds to illustrate the variability in precipitation in these watersheds and its influence on the water budgets.	A table of average annual precip for each watershed has been added to the figure
77	C-15			Spatial land use data were used to specify …	How was existing data used to interpolate land use for years with no data?	Private landowner data was provided and used for every year in the calibration period. This represented most of the irrigated land area in the Basin. In other parts of the Basin, data from the closest available year was used for years when data wasn't available.
78	C-15			2014 and 2016 data that were…	2016 LandIQ data not shown on cited DWR Land Use Viewer	Comment noted. LandIQ has completed 2016 land use data for DWR, but the data has not yet been posted to DWR's land use viewer. It is expectd to be posted by the end of 2019.
79	C-15			2000, 2003, 2006, 2009, 2012 data	Labeled as Attachment C-1 in document.	This has been corrected.
80	C-15			The projected annual land use	This needs more explanation.	Additional detail has been added.
81	C-17			The RSRZ Model is driven by the Landsat …	This is the only discussion of the RSRZ model. More explanation on the model and how crop coefficients were developed is needed. Crop coefficients are a key component in estimating crop demand and, therefore, pumping demand and ultimately groundwater storage decline.	An attachment has been added with additional information on how crop evapotranspiration was determined. The acronym RSRZ has been removed from the document.
82	C-17			The reference evapotranspiration	Labeled as Attachment C-1 in document.	This has been corrected.
83	C-17			In the CBWRM, ET represents the net	ET is flux from the land surface/root zone to the atmosphere.	Comment noted. This is consistent with the text currently in the document.
84	C-18			CBWRM Layering	The unsaturated zone not represented in the model, and the existing configuration assumes deep percolation from the root zone reaches the water table instantaneously. This is not reasonable given the substantial depth to the water table in substantial portions of the basin. Model results will be sensitive to the time lag between infiltration/deep percolation and interception by the water table. An explanation is needed to justify ignoring the time-lag effect of the unsaturated zone.	Inadequate information was available on unsaturated zone parameters to effectively calibrate the time-lag effect. This can be modified in future versions of the model when more data is available.

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85	C-18			CBWRM Layering - The CBWRM subsurface	Provide maps of layer extents and general statistics on layer thicknesses.	New figures have been included to show the layer extents and thicknesses
86	C-22			This assumption, however, results in the use of first …	Did uncertainty/errors in the transients represented by the "start-up" initial heads dissipate during the "first few years?" Did analysts confirm errors did not influence model calibration and the resulting calculation of groundwater storage declines?	Yes, comparison of simulated groundwater levels with observed values confirmed that initial heads did not affect the calculation of groundwater storage declines.
87	C-22			As discussed in the previous section	Was inflow from small watersheds only applied to layer 1 rather than the deeper layers? Why?	The text has been revised.
88	C-22			Therefore, the model calibration period	Calibration time period inconsistent with statement on page C-24.	The calibration period on page C-22 has been corrected.
89	C-23			Calibrate Water Demands estimates for agricultural…	What data were used for calibration of water demand? Water demand is a key factor influencing groundwater pumping and the magnitude of estimated pumping allocations required to achieve "sustainable" conditions.	An attachment has been added with additional information on how crop evapotranspiration was determined. The acronym RSRZ has been removed from the document.
90	C-24			Due to uncertainty in the initial conditions…	The calibration period reported here is inconsistent with a previous statement of calibration period (1998-2015) on page C-22.	The calibration period on page C-22 has been corrected.
91	C-24			The calibrated IDC was used to	Inconsistent with daily time steps in model.	Comment noted. The monthly time step was adequate for IDC calibration.
92	C-24			The flows from this gage were	How were stream flows adjusted to estimate flow at downstream end of basin?	Additional text has been added on the small watershed computations.
93	C-25			During this step of the calibration	What data was used to calibrate the water budget? What constraints were placed on the water budget calibration?	Water budget calibration was based on a general understanding of flows in the Cuyama Basin (as reflected in the HCM) and on ensuring internal consistency of CBWRM results, spatially and temporally.
94	C-26			Outflows: Groundwater pumping	GW budget shows there is outflow from GW to the streams (stream gains).	This has been corrected.
95	C-28			Within the CBWRM, 139 wells	Far fewer than 139 wells visible on the map.	The figure has been updated
96	C-29			The goal of groundwater level	How was the reasonable range determined? There is no discussion of the range of aquifer parameters and how they compare to measured values. Hydraulic conductivity values used in the model are lower than those reported by the USGS for the Morales formation (layer 3)	A comparison of CBWRM and USGS hydraulic conductivity values has been added to the uncertainty section. Other parameter values are based on measured values or values in the literature.
97	C-29 Figure/Table C-16 and C-17			Figures C-16 and C-17 show a	What do figures look like with reasonable changes to aquifer properties?	Versions of these figures with a range of aquifer parameters were presented at the June 5 Board meeting.
98	C-31			To incorporate the uncertainty that originates from various …	Describe the ensembles of perturbed simulations. More information is needed on uncertainty/sensitivity analysis. Which parameters (IDC, small watershed, and groundwater) were evaluated and which were the most/least sensitive? A thorough sensitivity evaluation will provide a range of plausible groundwater storage declines and provide flexibility in determining Management Actions need to reach sustainability.	Additional information has been provided in the Uncertainty Assessment section.
99	C-31			Uncertainty Assessment	Need more information on uncertainty/sensitivity analysis. Which parameters were most/least sensitive for both GW and IDC parameters.	Additional information has been provided in the Uncertainty Assessment section.
100	C-32			GSP stakeholder and Technical Forum have reviewed model development and ...	The Tech Forum did not receive the model files for review until 18 February 2019. The model development was essentially complete at this point. EKI's brief review of the model identified potential issues of concern such as a lack of agreement between measured and modeled aquifer properties and a lack of sensitivity testing and reporting. Simple sensitivity tests performed by EKI showed that hydraulic conductivity values have a significant influence on groundwater storage changes in the Management Areas. As a member of the Tech Forum, EKI did not make the statement that the CBRWM is a "strong analytical tool," nor do we recall hearing a consensus for this statement during any Tech Forum meeting. EKI's position has been that it is a reasonable tool to use given substantial limitations in the data available and compressed schedule to develop the model. However, it is critical that results from model implementation ("using" the tool) include characterizing model uncertainty (in other words, quantify how wrong the result might be).	Comment noted. The text has been revised. Additional uncertainty results have been added to the uncertainty assessment section.
101	C-33			The following recommended actions would support …	Perform a post-audit on the model. A post- audit evaluates how model predictions using actual "future" climate and water availability conditions compare to measured conditions, and results from the comparisons provide insight into the strengths and weaknesses of the HCM and model parameter values.	The text has been revised.
102	C-33			These include eastern art of the basin	Misspelled word	This has been corrected.
103	Attachment C-1 ; 1			The most common land use in the Cuyama	Is native veg the most common land use?	The text has been revised.

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104	Attachment C-1 ; 2 Table 1			SUMMARY OF DATA SOURCES	Was Cropscape data considered when developing land use information?	Yes, Cropscape was found to be inadequate in the Cuyama Basin region.
105	Attachment C-1 ; 2			Since then, Land IQ has completed statewide	2016 LandIQ data not shown on DWR land use viewer.	Comment noted. LandIQ has completed 2016 land use data for DWR, but the data has not yet been posted to DWR's land use viewer. It is expectd to be posted by the end of 2019.
106	Attachment C-1 ; 5			SUMMARY OF CROP MAPPING RESULTS	How was land use estimated for years in which no data are available?	Private landowner data was provided and used for every year in the calibration period. In other parts of the Basin, data from the closest available year was used for years when data wasn't available.
107	Attachment C-1 ; 6			SURFACE ENERGY BALANCE	How does the RSRZ model described in the main text come into play here?	An attachment has been added with additional information on how crop evapotranspiration was determined. The acronym RSRZ has been removed from the document.
108	Attachment C-1 ; 10			Crop variety and irrigation methods	Figure C-12 shows that there may be declining ag water demand. That is contradictory to this statement. Is total crop acreage declining?	Crop acreage declined from 2012-2015 but increased in 2016.
109	Attachment C-2 ; C-1			...for the Eastern San Joaquin Groundwater Sustainability Plan.	Wrong GSP identified.	This has been corrected.
110	Attachment C-2 ; C-1			Guidance for Climate change…	Missing text?	This has been corrected.
111	Attachment C-3			Groundwater Level Hydrographs	Why are hydrographs included for wells with no data? These can't be used as a calibration well.	The attachment has been revised to remove wells without observed data
112	Attachment C-3			Groundwater Level Hydrographs	Include map showing wells with hydrographs.	This is shown on the updated Figure C-15.
113	Attachment C-3			Groundwater Level Hydrographs	Model layer is not identified on hydrographs. Does simulated WL differ by layer at these sites?	The model does not show significant deviation between different model layers in most areas of the Basin. Differences in results can be seen in the model data files provided to Technical Forum members.

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1	3.3				Overall, the statements at the end of each sub-section that the Basin is "not in an undesirable condition" does not mesh with the reality that the Basin has been designated as critically overdrafted and groundwater levels been in decline for decades. The statement at the end of each section should be revised to more clearly and specifically state that the Basin does not currently meet the specific technical criteria for having an undesirable result.	The text has been revised
2	p. 3-6	3rd from bottom			The percentage of wells would most usefully be applied by threshold region, rather than basin-wide.	The CBGSA Board determined to use a Basin-wide standard.
3	3.3.4				This section does not contain a description of the undesirable result for degraded water quality. It is a direct copy of the section on groundwater levels.	Text has been corrected.
4	3.3.5				It seems unnecessary to use the 30% number from previous sections if there are only two stations. It would be clearer to state that if one of the sites exceeds the threshold an undesirable result would occur. Also, the 2 inches per year threshold has not been discussed by the GSA Board.	The percentage is included so that it will still be valid if additional stations are added in the future. The 2 inches per year criteria can be adjusted if directed by the Board.
5	General			Undesirable Results	Comment: This Chapter was first previewed and public comments was made in August of 2018. Those comments, W&C's responses and these revisions were not presented until now in this final public draft. There are substantial policy considerations in this chapter that have never come before the SAC or the GSA in the 10 months of developing this section. Given this timeline I find it very odd that it was never presented for public consideration. Question: What happened to public input?	Comment noted. A review of initial comments indicated that a revised draft would not be helpful until it could be released in combination with the chapter on sustainability thresholds.
6	General			Undesirable Results	Comment: My comment from last summer remains unaddressed; The data clearly indicates 50 years of chronic overdraft with a historic loss of over 1,000,000 AF of storage, more than 400' of groundwater level declines, subsidence rates of approximately 0.8 inches per year, the total loss of the annual Cuyama River surface water base flow, and the desertification of the many GDEs across the basin. This Plan does not accurately present today's conditions. Question: How can this Plan justify not recognizing pre-existing, chronic & persistent Undesirable Results today if not back in 2015?	The chapter reflects undesirable results as defined by minimum threshold levels approved for each sustainability indicator by the GSA Board.
7	P. 3.5 Sec. 3.1			To maintain a viable groundwater resource for the beneficial …	Question: Is this Goal #1 of more items? What is a "viable groundwater resource" in reference to wells going dry, declining GDEs and Interconnected Surface waters, or domestic drinking water quality? Addition: The Sustainability Goal should include aims to achieve MOs and determine whether or not any historic conditions are recognized as Undesirable.	The Sustainability Goal has been updated per direction from the CBGSA Board.
8	P. 3-5, Sec. 3.2			Undesirable Results are defined for use in SGMA …	Comment: All of the Undesirable Results Statements describe current Cuyama conditions as of 2015. Suggestion: This plan must recognize the historic impact of chronic overdraft for the perspective of how very out of balance the situation has been and for how long. Cuyama has pre-existing Undesirable Conditions, why must this be overlooked in the GSP?	The chapter reflects undesirable results as defined by minimum threshold levels approved for each sustainability indicator by the GSA Board.
9	Sec. 3.3 Global			The Undesirable Result for the chronic lowering of groundwater levels is considered …	Comment: The decision to set the Identification Threshold at 30% was never discussed at the SAC or GSA or had public comments reviewed & responded to by W&C. Issues include: Monitoring wells are not adequately representative, nor do they have the spatial density to accurately reflect groundwater conditions in many parts of the basin. The Management Area in the Central part of the basin, where most of the overdraft is occurring, contains only 15 Representative wells. There are no Monitoring Wells in the Ventucopa Management Area. (In response to Brenton's email below, I have created two quick maps. There are 15 GW Level Representative Wells within the Management Areas - 15 in the Central and 0 in the Ventucopa Area. Additionally, there are 15 GW Quality Representative Wells within the Management Areas - 15 in the Central and 0 in the Ventucopa Area. -Micah Micah Eggleton Environmental Planner and Scientist Woodard & Curran) Even if 100 percent the monitoring wells in all the currently overdrafted parts of the basin were to fall below their Minimum Thresholds, no Undesirable Results would be identified by this GSP. Question: What criteria was used to justify this critical decision? Or must we just assume that we can not call the current conditions a problem, due to statutory enforcement? Change: The Identification Threshold of 25% Basin wide or maybe 50% if by Region, is a more realistic criteria to define undesirable results for the Management Areas likely to be experiencing them.	The Basin-wide 30% criteria was confirmed by the CBGSA Board
10	Global			Potential Effects of Undesirable Results: All Indicators	Comment: The current Cuyama conditions represent all the potential Undesirable Results such as de-watering of existing groundwater infrastructure (Ventucopa townsite well is dry), adversely affected groundwater dependent ecosystems (mostly dead already), caused changes in irrigation practices, crops grown, and adversely affected property values. Additionally, these Undesirable Results have adversely affected domestic and municipal uses, including uses in disadvantaged communities, which rely on groundwater in the Basin. Suggestion: If the best SGMA and this GSP can do is to avoid any additional Undesirable Results (2015?) from occurring then the Plan must at least be honest about the current conditions to begin with.	The chapter reflects undesirable results as defined by minimum threshold levels approved for each sustainability indicator by the GSA Board. Historical changes in conditions are shown in Chapter 2.
11	P. 3-11, Sec. 3.3.4			The Undesirable Result for the chronic …	Correction: The text should read Degraded Water Quality, not chronic lowering of groundwater levels. Suggestion: This GSP must establishing minimum thresholds for groundwater levels that are protective of GDEs across the basin. Data Gaps must be filled to know this information.	Text has been corrected. The chapter reflects undesirable results as defined by minimum threshold levels approved for each sustainability indicator by the GSA Board.
12	P. 3.11 Sec. 3.3.5			Chapter 5 discussed how minimum thresholds were …	Delete: The word "is". Comment: When and by what criteria were minimum thresholds set for anything other than groundwater levels?	Text has been corrected. Thresholds for sustainability indicators other than groundwater levels were included in a previous version of Chapter 5 that was reviewed and commented on.
13	P. 3-11 Sec. 3.3.6			Because measurements show that levels are not in …	Question: What proxy groundwater measurements show that River flow levels are not in an undesirable condition or that depletion of interconnected surface water is not in an undesirable condition? No such conclusive data exist to make that claim. No gauges, no wetland monitors, no shallow riverside monitoring. Facts on the ground are that the river does not flow like it did not long ago, and the dying Cottonwoods speak to the recent depletions of surface water and degraded Groundwater Dependent Ecosystems. Suggestion: State the data gap issues and try not to speculate that everything is fine when there is no evidence to support that claim, and plenty to refute it.. Historically, flowing springs were found along the trace of faults that parallel Graveyard and Turkey Trap Ridges in the main basin. (Singer and Swarzenski USGS 1970) It is not possible to define "significant and unreasonable adverse impacts" without knowing what is being impacted.	The current definition reflects the best understanding given currently available data. The undesirable results definitions for depletion of interconnected surface can be updated when better data is available.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
14	P. 6-9			Identification of Undesirable Results for Chronic Lowering of Groundwater Levels…	Comment: The decision to set the Identification Threshold at 30% for all five Sustainability Indicators was never discussed or had public comments reviewed and responded to by W&C. Issues include: Monitoring wells are not adequately representative, nor do they have the spatial density to accurately reflect groundwater conditions in many parts of the basin. The Management Area in the Central part of the basin, where most of the overdraft is occurring, contains only 15 Representative wells, and there are no Monitoring Wells in the Ventucopa Management Area. Even if all the monitoring wells in all the currently overdrafted parts of the basin were to fall below their Minimum Thresholds, no Undesirable Results would be identified by this GSP. Question: Who made this policy decision as it never came to the SAC or GSA? Or must we just assume that we cannot call the current conditions a problem, due to statutory enforcement?	The Basin-wide 30% criteria was confirmed by the CBGSA Board
15	P. 3-11 Section 3.3.4			The Undesirable Result for the chronic…	Change: The text should read Degraded Water Quality, not chronic lowering of groundwater levels.	Text has been corrected.
16	P. 3-11 Section 3.3.6			Because measurements show that levels …	Question: What proxy groundwater measurements show that River flow levels are not in an undesirable condition or that depletion of interconnected surface water is not in an undesirable condition? No such conclusive data exist to make that claim. No gauges, no wetland monitors, no shallow riverside monitoring. Facts on the ground are that the river does not flow like it did not long ago, and the dying Cottonwoods speak to the recent depletions of surface water and degraded Groundwater Dependent Ecosystems. Suggestion: Recognize the already-occurring depletion of surface water, state the current issue accurately, including issues with data gaps, and present an outline of how the CBGSA plans to remedy the gaps and reach Measureable Objectives for Depletions of Interconnected Surface Water.	The current definition reflects the best understanding given currently available data. The undesirable results definitions for depletion of interconnected surface can be updated when better data is available.
17	P. 3-11 Section 3.3.5			Chapter 5 discussed how minimum thresholds were selected is. The minimum…	Delete: The word "is". Comment: When and how were minimum thresholds set for this Sustainability Indicator?	Text has been corrected. Thresholds for indicators other than groundwater levels were included in a previous version of Chapter 5 that was reviewed and commented on.
18	P. 3-26			The Russell fault offsets the top of bedrock by as much as 1,500 feet (Nevins, 1982), …	Comment: We concur. Our understanding is the Russell Fault has been inactive for millions of years and is most likely overlaying by permeable layers of older and more recent alluvium that are at least 1000 feet thick. Recommendation: Pump tests and water quality studies need to be done on both sides of the fault.	These recommendations can be considered during GSP implementation.
19	P. 3-30			A fault located southwest of the Russell fault runs southeast to northwest and is located…	Recommendation: Field study is needed as a test of the existence and importance of this "unnamed fault" to verify the existence of any Santa Margarita formation (e.g., by finding sandstone with marine fossils). Otherwise this is probably permeable Morales Formation.	These recommendations can be considered during GSP implementation.
20	P. 3-5			This chapter is a key component of the Cuyama Basin	Consider revising sentence for clarity - "This chapter is a key component of the Cuyama Basin Groundwater Sustainability Agency's (CBGSA's) Groundwater Sustainability Plan (GSP), as other GSP components must be developed to set quantitative thresholds on monitoring points that indicate where Undesirable Results might occur on the monitoring network, and to shape the monitoring network to detect Undesirable Results. "	Text has been revised for clarity.
21	P. 3-9			By setting minimum thresholds on shallow…	Please clarify sentence, slightly confusing - "By setting minimum thresholds on shallow groundwater wells near surface water, this gradient is managed, and in turn, depletions of interconnected surface water are managed."	Text has been revised for clarity.
22	P. 3-9			Increased depletions could result in…	Consider adding a figure to help explain and clarify this sentence - "Increased depletions could result in lowering of groundwater elevations in shallow aquifers near surface water courses, which changes the hydraulic gradient between the water surface elevation in the surface water course and the groundwater elevation, resulting in an increase in depletion."	Text has been revised for clarity.
23	P. 3-10			Using the method identified above…	Consider revising this section in this GSP or adding language as an option to be revisited in the DWR interim update in 2025 with an updated numerical model. This undesirable results should be modeled with different percentages (such as 20%, 25%, and 30%) in different basin areas and scenarios (such as drought) with projected groundwater recovery time.	Undesirable results determinations are made using monitoring data, not with the numerical model. The Basin-wide 30% criteria was confirmed by the CBGSA Board
24	P. 3-11			Chapter 5 discussed how minimum…	Please clarify sentence	Text has been revised for clarity.
25	P. 3-11			The Undesirable Result for land subsidence…	Consider adding how many sites are in the Basin.	This is already included.

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses - Chapter 3
December 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "…	Comment	Response to Comment
26	P. 3-6 and 3-10				[Checklist items #26-42]: • Identification of Undesirable Results – significant adverse impacts to GDEs can occur if 30% of representative monitoring wells fall below their minimum groundwater elevation thresholds for two consecutive years. The proposed approach could work if management areas were established to "identify different minimum thresholds, measurable objectives, monitoring, or projects and management actions based on differences in water use sector, water source type, geology, aquifer characteristics, or other factors" [23 CCR §351(r)]. But, as it is written now, significant and unreasonable adverse impacts to GDEs could occur if the exceedance of minimum thresholds disproportionately occurs in representative monitoring wells close to GDEs (e.g., 3 out of the 60 wells minimum thresholds are exceeded for 3 years are causing adverse impacts to GDEs, but because the definition of undesirable results (18 out of 60 wells) is not met, there is no formal recognition that undesirable results are occurring). We recommend that groundwater levels that are protective of GDEs be considered when establishing minimum thresholds for groundwater levels across the basin. Please refer to Step 2 of GDEs under SGMA: Guidance for Preparing GSPs1 for more details.	The chapter reflects undesirable results as defined by minimum threshold levels approved for each sustainability indicator by the GSA Board.
27	P. 3-9				[Checklist items #26-42]: •Under the Potential Effects of Undesirable Results subsection, "If depletions of interconnected surface water were to reach Undesirable Results, groundwater dependent ecosystems could be affected" should also include potential effects on environmental surface water users, land uses (e.g., fishing/hunting, hiking, boating), and property interests (e.g., privately and publicly protected conservation lands and open spaces, including wildlife refuges, parks, and natural preserves) [23 CCR §354.26(b)(3)]. Please also provide more details on how these various beneficial users could be adversely affected. SGMA also requires that depletions of interconnected surface water also consider adverse impacts on beneficial uses of surface water [23 CCR 354.28(6)].	The chapter reflects undesirable results as defined by minimum threshold levels approved for each sustainability indicator by the GSA Board using the information that is currently available. They can be revised in the future if additional information is developed.
28	P. 3-9				• In addition to identifying GDEs in the basin, The Nature Conservancy recommends identifying beneficial users of surface water, which include environmental users. This is a critical step, as it is impossible to define "significant and unreasonable adverse impacts" without knowing what is being impacted, nor is possible to monitor ISWs in a way that can "identify adverse impacts on beneficial uses of surface water" [23 CCR §354.34(c)(6)(D)]. For your convenience, we've provided a list of freshwater species within the boundary of the Cuyama Basin in Attachment C. Our hope is that this information will help your GSA better evaluate and monitor the impacts of groundwater management on environmental beneficial users of surface water. We recommend that after identifying which freshwater species exist in your basin, especially federal and state listed species, that you contact staff at the Department of Fish and Wildlife (DFW), United States Fish and Wildlife Service (USFWS) and/or National Marine Fisheries Services (NMFS) to obtain their input on the groundwater and surface water needs of the organisms on the freshwater species list, and how best to monitor them. Because effects to plants and animals are difficult and sometimes impossible to reverse, we recommend erring on the side of caution to preserve sufficient groundwater conditions to sustain GDEs and ISWs.	The chapter reflects undesirable results as defined by minimum threshold levels approved for each sustainability indicator by the GSA Board using the information that is currently available. They can be revised in the future if additional information is developed.
29	P. 3-9				• Please also provide more details on when, where, and how groundwater changes can adversely affect these various beneficial users. Are there particular species, with legal protection, that already have known thresholds that need special consideration? The more specific the definition of what an adverse impact to beneficial users of groundwater and surface water looks like, the easier it is to quantify minimum thresholds, measurable objectives, and interim milestones that are protective of that definition.	The chapter reflects undesirable results as defined by minimum threshold levels approved for each sustainability indicator by the GSA Board using the information that is currently available. They can be revised in the future if additional information is developed.
30	P. 3-11				[Checklist items #26-42]: • There is a typo, Section 3.1.6 is actually intended to reference Section 3.2.6.	The text has been corrected.
31	P. 3-11				• Please be more specific on what measurements were used to show that groundwater gradients along interconnected surface water bodies in the Cuyama basin are not in an undesirable condition. How were these gradients determined?	The current definition reflects the best understanding given currently available data. The undesirable results definitions for depletion of interconnected surface can be updated when better data is available.
32	P. 3-11				• Analysis of Interconnected Surface Waters in Section 2.2.8, particularly Table 2.2, demonstrate that depletions of interconnected surface water are occurring, meaning that adverse impacts to beneficial uses and users could be occurring. Thus, it is inadequate to state that "depletion of interconnected surface water is not identified to be in an undesirable condition" without evaluating potential effects to beneficial users.	The chapter reflects undesirable results as defined by minimum threshold levels approved for each sustainability indicator by the GSA Board using the information that is currently available. They can be revised in the future if additional information is developed.
33	Appendix A			TABLE: Cuyama Basin Groundwater Sustainability	The first Undesirable Result listed in the first row of the first column of the table Framework for Developing Sustainable Management Criteria, is adverse impacts to the viability of agriculture and the agricultural economy. If that is Undesirable Result #1 as indicated, then pumping reduction recommendations must be conservative with respect to their potential impact to the agricultural economy, especially in the first few years, until enough data can be collected and analyzed to determine whether or not modeled water level declines are overpredicted, underpredicted, or something in between. The potential effects of uncertainty on predicted groundwater elevations and storage depletion should be acknowledged and clearly presented, and predicted values of water levels and groundwater storage volumes should be presented as ranges of likely outcomes rather than single values, or time series.	The pumping reduction schedule was determined by the CBGSA Board. Uncertainty information is presented in Chapter 2 and in the modeling appendix.
34	Appendix A			Framework for Developing Sustainable Management Criteria	The framework seems to suggest that the conditions in 2015 were considered the in setting of thresholds, yet most MT are below that and some MO are lower than 2015. Question: How were the conditions in 2015 considered? And is it acceptable to not plan on ever recovering to those conditions?	The MTs developed by the CBGSA Board were defined relative to 2015 groundwater elevations. SGMA does not require that groundwater elevations are returned to 2015 levels.
35	P. 3-9, Section 3.2.6			Potential causes of undesirable results for depletions of interconnected surface water…	What leads you to believe this? For the most part groundwater production has not occurred in the shallowest zones. Furthermore, you imply the connection of surface water and groundwater occurs only in shallow zones which I would question.	The text has been revised.

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses - Chapter 4
December 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "…	Comment	Response to Comment
1					Monitoring system: The Plan could be improved by recognizing that the wells selected for the monitoring system are not necessarily representative. Over time, and with more data, hopefully the Plan will improve the selection of wells that are truly representative. Moreover, it is more logical to have a monitoring system specifically for the Central Basin, separate from the other management areas, since this is the most critical part of the whole Basin.	The monitoring network will be reviewed during GSP implementation to confirm the inclusion of wells recommended in the plan and to add additional wells to close data gaps.
2	4.8				This section should better explain for the reader what is meant by the term "causal nexus" and why there is causal nexus between salinity and GSA actions. If arsenic is primarily found at depth, and maintaining water levels is the primary management responsibility of the GSA, it would appear that there is a causal nexus between arsenic and GSA actions.	The text has been revised.
3	P. 4-13, 4-15, 4-17, etc.			Headers describing agencies contributing data	Suggest spell out headers for general public readability such as done for header on p. 4-6: ("DWR, Statewide Dataset/California Statewide Groundwater Elevation Monitoring (CASGEM)").	This correction has been made.
4	General				Suggestion: All water wells designated as "monitoring wells" should be thoroughly canvassed and characterized and that data should be in the DMS.	This can be considered as an augmentation to the DMS in the future.
5	P. V.			Acronyms	Addition: OPTI DMS	DMS has been added.
6	P. 4.2 and 4.3			4.1.1 Well-Related Terms…	Suggestion: It would be helpful to list the terms in alphabetical order	This correction has been made.
7	P. 4.21 Sec. 4.3			Private landowners in the Basin…	Question: Who measures the "private" wells and what methods and QC/QA protocols are used?	This data was provided by private landowners in the Basin. While QA/QC protocols were not provided for past monitoring, they will be specified for future monitoring during GSP implementation.
8	P. 4.23 Sec. 4.3.2			Many of the data sources used to compile and create the Cuyama...	Addition: There should be a OPTI – State Well Number (SWN) searchable cross reference in the DMS	This can be considered as an augmentation to the DMS in the future.
9	P. 4.24 and 4.25, P. 4.30 and 4.31 Sec. 4.3.3			Groundwater Quality Monitoring:	Addition: The VCWPD Groundwater Quality Monitoring sites should be distinguished between "active" and "historical"	Specific information about which sites are active is not available.
10	P. 4.44 to 4.47 Table 4.5			Wells included in the Groundwater Levels and Storage Monitoring Network	Addition: This table should have SWN's and should distinguish if it is "representative" or "supplemental".	This is not necessary as the representative wells are identified in Chapter 5.
11	P. 4.49 Sec. 4.5.7 & Sec. 4.5.8			As of Draft GSP publication…	Comment: Along with proper canvassing, no thorough effort was made to acquire and input construction information on all representative wells, which can be obtained from owners, permitting agency, CDWR, the driller – or manual sounding for depth. Suggestion: This investigative canvassing and data entry needs to be completed early on during implementation. Question: What happened to the TSS grant for new depth dependent monitoring wells & Stream gauge flow meters and down hole video logging? This was supposed to have happened over a year ago.	This can be considered during GSP implementation.
12	P. 4.52 Sec. 4.8			Furthermore, unlike with salinity, there is no evidence …	Comment: I disagree with this statement about arsenic. Overpumping the aquifer can induce arsenic laden "ancient" water to migrate into the cone of depression. Change: The second instance of the word "salinity", in this sentence should be changed to "nitrates" or "Boron" or almost anything else that is being ignored.	The sentence has been corrected.
13	P. 4.52 Sec. 4.8			Degraded Groundwater Quality Monitoring Network:	Addition: The GSP should define a "schedule" of constituents to be sampled annually or periodically.	This will be developed during GSP implementation.
14	P. 4.52 Sec. 4.8			Degraded Groundwater Quality Monitoring Network:	Comment: The "background" TDS in the Cuyama drainage is very high, thus on its own does not serve as an ample signal for Groundwater Quality trends. Addition: In order to monitor Groundwater Quality this GSP must sample more than just TDS.	Comment noted.
15	P. 4.55 to 4.57 Table 4-7			Wells Included in the Groundwater Quality Monitoring Network:	Addition: This Table should cross reference OPTI to SWN	This cannot be easily accomplished with the table format. The SWN numbers can be easily found in OPTI
16	P. 4.60 Sec. 4.8.8			Well construction for existing salinity sampling efforts …	Question: What good is it to pull Water Quality samples from unknown depths? Addition: Collect and input this data into the DMS and Model early on in Implementation.	This can be considered during GSP implementation.
17	P. 4.62 Sec. 4.8.9			Plan to Fill Data Gaps:	Addition: For the sake of greater Basin understanding this GSP needs to monitor for more than just TDS.	Comment noted.

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses - Chapter 4
December 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
18	P. 4.68 Sec. 4.10			The minimum threshold established for depletions of interconnected…	Comment: There are no stream gauges on the Cuyama inside the basin, no shallow wells near the river or piezometers to monitor GDEs. This GSP does not adequately identify or quantify the depletions of interconnected surface waters. Question: How can you quantify what you have not located and have no way to measure? Addition: This GSP needs a description of whether hydrological data are spatially and temporally sufficient to monitor groundwater conditions for each GDE unit.Also needed is a description of how impacts to GDEs and environmental surface water users, will be monitored and which monitoring methods will be used in conjunction with hydrologic data to evaluate cause-and-effect relationships with groundwater conditions.	The section on GDEs in Chapter 2 has been updated to note that piezometers are needed to monitor GDEs.
19	P. 4-15			SLOCFC&WCD also reports theses	Grammar	The text has been corrected.
20	P. 4-42 & 4-43				[Checklist items #43-45]: •Please identify which representative monitoring wells are capable of monitoring groundwater level conditions that can impact environmental beneficial users of groundwater (i.e., GDEs) and of surface water (e.g., freshwater aquatic species). Refer to Best Practice #4 in Attachment D to this letter for technical guidance.	This can be considered during GSP implementation.
21	P. 4-10				•The improvement of numerical model accuracy for the estimation of interconnected surface waters should also include the installation of clustered or nested wells and the installation of shallow monitoring wells around GDEs and the Cuyama River to resolve data gaps that were identified in Section 2.2.10: oThe Cuyama River is not gaged inside the Cuyama Basin, so flows of the river in the Basin have been estimated based on measurements at downstream gages. oVertical gradients in the majority of the Basin are not understood due to the lack of wells with completions of different depths located near each other. oGDEs could be evaluated in greater detail oInformation about many of the wells in the Basin is incomplete, and additional information is needed regarding well depths, perforation intervals and current status. oDue to sporadic monitoring by a variety of monitoring entities, a long period of record of monitoring groundwater levels does not exist in many areas in the Basin.	Additional information will be developed as the monitoring network is developed during GSP implementation.
22	P. 4-10				•Please identify appropriate biological indicators that can be used to monitor potential impacts to environmental beneficial users due to groundwater conditions. Refer to Appendix E of this letter for an overview of a free, new online tool for monitoring the health of GDEs over time.	This can be considered during GSP implementation.
23	Figure 4-3				This map shows certain wells monitored for which DWR has no access. Interesting. Is data from other agencies sent to DWR for this dataset?	Yes, the DWR database includes data provided to DWR from other agencies and private landowners.
24	Page 4-28			Number of measurement sites	This # refers to CCSD water quality data measurements. At 1.2.4 you state that "local agencies sucas CCSD … do not conduct routine monitoring" yet you can see they test every 6 months it would seem.	The sentence in 1.2.4 has been removed.
25	4.3.5			Surface water monitoring	P. 2-125 states flows of the river have been based on measurements at downstream gagues, then at Appendix C-7 gauge ID 11136800 is cited. Gere 4.3.5 admits this gauge receives non-basin water in addition to basin water.	It is noted in Appendix C that the flows on this gage were adjusted to estimate flows at the downstream boundary of the basin.
26	4.8				For whatever reason, the water quality in the Cuyama Basin is poor. Perhaps connected with the years of severe overdraft. The GSP is only required to deal with the problem of salinity. I would like to suggest that the GSA be required to coordinate with the agency responsible for other issues of water quality to help solve the real problem of water quality for the local residents. State support for this would be very beneficial.	Comment noted.

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses - Chapter 5
December 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1	5.2.2 (p. 5-8)			"Monitoring in this threshold region indicates"	We agree with establishing the Western Region as separate from the Northwest Region and establishing a Minimum Threshold for representative wells "to protect the water levels from declining significantly, while allowing beneficial and surface uses of the groundwater and protection of current well infrastructure." We especially appreciate the concern shown to monitor and protect our wells in relation to the major change in water use over the past three years in what is identified as the Northwest Region.	Comment noted.
2	Figure 5.1				This map shows that 10 representative wells have been selected for the Western Region. We are concerned that only 3 if the 10 representative wells are in Cottonwood Canyon, especially since the GSP says "levels varied significantly depending on where representative wells were in the region" (p. 5-8). Cottonwood Canyon is where most of the domestic dwellings and full-time residents live in this region. Of the 3 wells in Cottonwood Canyon, 2 are directly on Cottonwood Creek. These two wells will be impacted by the year-round flow. We suggest that one of the two more wells from Cottonwood Canyon be added to the representative wells that can represent the variation of groundwater flow in the Western Region. Santa Barbara County has been monitoring several more wells in Cottonwood Canyon that could be added to the database.	Additional wells can be considered during GSP implementation.
3	Table 5-1 (p. 5-13)				Shows the Minimum Thresholds, Measurable Objectives, and Interim Milestones for each of the wells in the Monitoring Network. The 3 wells identified in the Cottonwood Canyon area, all have Minimum Thresholds (MT) that are lower than the current groundwater level by 10-60 feet. (#117 MT is 10 feet below the current groundwater level; #118 is over 60 feet below current groundwater level; #571 is over 20 below current groundwater level).Our wells have held steady through over five years of drought. We don't think that by having a MT that will allow water levels to decrease will protect our wells. We are especially concerned that the Interim Milestones are set over the next 15 years at the level of the MT> This means the goal for the representative wells in the Western Region and specifically Cottonwood Canyon is to have our well levels go down. We suggest instead, the Measurable Objective, which is set at actual current groundwater levels, be used for the Interim Milestones in our region.	Interim Milestones have been revised per Board direction.
4					The minimum threshold established by the GSP: The minimum thresholds as established by the GSP are based on the groundwater levels as existed in 2015. Over more than 50 years before 2015, various studies have shown that the groundwater usage had exceeded the amount recovered each year. So the groundwater level in 2015 was already extremely over-drafted. I understand that the various studies did not include data from a number of properties because some property owners or leasers would not share that information. Nevertheless, basing the minimum thresholds on 2015 data means that by 2020, "sustainability" would be groundwater levels no better than in the year 2015--extremely over-drafted.	The minimum thresholds reflect those approved by the GSA Board.
5	P. 5-7			Eastern Threshold Region: "The MT	Explain rationale why MTs in the Eastern TR were set 35% below 2015 water levels, but MTs in the Central TR were set 20% below 2015 water levels.	A sentence has been added to the Eastern Region section
6	P. 5-7, 5-8			Central TR: "For Opti Wells 74, 103, 114, 568, 609, and 615, a modified… Western TR: "Opti Well 474 ...and include Opti Wells 830, 831, 832, 833, 834, 835, and 836.	Explain rationale for why the method of sustainability criteria calculation was modified for these particular wells.	The text has been updated to probide additional clarification on these wells.
7	P. 5-9				Suggest compiling a summary table of MO, MT, and IM methods and rationales by Threshold Region for comparison and discussion.	This was presented during the GSA Board meeting where the rationales were discussed.
8	P. 5-11 Table 5-1				Screen bottom for Opti well 72 not consistent with information in other tables.	The table has been corrected.
9	P. 5-18			…the MT [for TDS] for representative	Using a threshold value for TDS at the 90th percentile of the historical range could quickly become problematic, especially in wells with increasing TDS trend. Most wells are >90% of their threshold (MT) value, and almost all wells are above their MO. Suggest using a method similar to that used for water level MTs, where generally a constant was subtracted (added in the case of WQ MTs) from the minimum (or the 2015 data). Do the WL and TDS values correlate? Are WLs a potential proxy for TDS in certain Threshold Regions?	The Board can consider adjusting MT levels in the future if conditions warrant it.
10	P. 5-23			Subsidence is expected to be	Subsidence in most cases is permanent and irreversible. Setting the MO to zero overly constrains the basin. Some subsidence can be tolerated without noticeable effects - a few inches over 20 years should not be considered significant and unreasonable. There are many faults in the basin, and tectonic forces are very active in the region. How will the GSA separate measured changes in ground surface into SGMA-related subsidence versus movement due to faulting?	The Board can consider adjusting MT levels in the future if conditions warrant it.
11	General Comment			the Basin's representative sites will also have IMs...	Comment: No IM calculations were made for any representative wells. All IM are simply set the same as the MT. As a result, IMs will in no way help to measure progress toward sustainability over the GSP's planning horizon. The MOs & IMs have no actionable significance in this Plan? The SAC and GSA never discussed this being the goal. Question: Who decided the goal was only to minimizing the exceedance of MTs between now and 2040, and who chose not to move toward the MOs or any Sustainability Goal greater than the MTs? Addition: Set IM at 33% intervals in the MoOF for a goal of the MO. That would seem to be DWRs intent.	The IMs have been adjusted based on Board direction.
12	P. 5.1 Sec. 5.1			Useful Terms	Comment: Please list these terms alphabetically	This change has been made.
13	P. 5-6 Sec. 5.2.2			The MT was calculated by taking…	Comment: Conditions in 2015 may have somehow been considered but in the case of the Central Region and the Eastern Region they were overlooked and forgotten. 20 to 35% of range below 2015 for MTs. The Western and Northwestern did not use 2015 for calculating any thresholds at all. Question: How did DWR expect 2015 conditions to be considered, as a baseline for sustainability or just a benchmark to measure down from?	The document reflects direction provided by the GSA Board.

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses - Chapter 5
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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "…	Comment	Response to Comment
14	P. 5-8			Monitoring in this threshold region indicates levels …	Comment: Groundwater level declines were noted with in two years of establishing the new agriculture in the area (North Fork Vineyard), yet the MT was set to allow the water levels to continue declining significantly. The criteria for the MTs in this region was suggested by property owner's unproven science for determining the region's total average saturated thickness for the primary storage area. That is speculation not science. QC/QA Question: Given the unproven geology of this region, how was this done? By who? And why would that be a defensible justification for lowering groundwater levels in a critically overdrafted basin? By what QC/QA was this determination established?	The document reflects direction provided by the GSA Board.
15	P. 5-15 Sec. 5.5			degraded water quality is a result stemming …	Comment: There are several undesirable results stemming from a causal nexus between groundwater pumping & water quality. Not just TDS. Suggestion: Monitor & track changes in other constituents like Arsenic , Nitrites, Boron and Ions to better understand recharge rates and sources. Question: Can the GSP monitor various constituents without having to set MTs?	The document reflects direction provided by the GSA Board.
16	P. 5-16			In the case of arsenic, all of the high concentration measurements …	Comment: This is within the range of pumping and the recharge is horizontal flow coming in from adjacent ancient water high in these constituents of concern. More than 30% of the MN wells pump from below 700'. (See Table 5.2 on P. 5.19) Suggestion: Monitor for a wider spectrum of constituents including arsenic, for Water Quality such as was used in CDWRs GAMA program for improving our understanding of recharge rates and sources.	The document reflects direction provided by the GSA Board.
17	P. 5-18 Sec. 5.5.3			It should be noted however, that TDS levels in…	Comment: Many of the crops grown in the Basin, including carrots, are adversely affected by the kinds of salts in the Cuyama Basin, resulting in lower yields of lower quality carrots and other row crops, or else acidification inputs are necessary. Undrinkable water adversely affects domestic and livestock uses. The agricultural economy is not the only factor to consider. Delete: This editorializing is not factual or necessary and should be deleted.	The sentence has been revised to be less definitive.
18	P. 5-22 Sec. 5.6.3			Because current subsidence rates (approximately …	Comment: With only one monitoring site on the edge of the central problem area, very little is known about basin wide subsidence issues or their effect on ground water storage. Suggestion: Please justify the 2 inches MT better and prioritize filling the data gap.	The Board can consider adjusting MT levels in the future if conditions warrant it. The data gap is identified in Chapter 4.
19	P. 5.23 Sec. 5.6.2			storage losses are small enough they may be considered superficial.	Comment: Compressed clays and collapsed aluvium may in fact significantly decrease "deep percolation" through the 600' of dry vadose zone. Question: Please justify how you can consider these consequences are superficial?	Text has been revised.
20	P. 5-26			Conditions have not changed since January 1, 2015, and surface flows	Comment: It may be true that the Cuyama River is as dry as it was in 2015, but infiltration into a 600' thick vadose zone is questionably available for use by local phreatophytes. Suggestion: Address the effects of that much dry alluvium on recharge and deep percolation. The GSP can not overlook the vadose zone in this basin of complex cascading hydrogeology.	This can potentially be evaluated further in the future.
21	P. 9			Recent historical data and hydrographs in this portion	Comment: This statement appears to be based on data provided by the landowner of this parcel. This data has not been peer reviewed or verified by any other source. Without qualified, third-party review by an entity that does not have a conflict of interest in the production of this data, the "recent historical data and hydrographs" cited cannot be considered unprejudiced scientific evidence and should not be the basis of the statement that this portion of the Basin is "likely currently in a full condition". Recommendation: Delete this statement, or amend to read "Recent historical data and hydrographs in this portion of the Basin indicate suggest that this portion is may currently be in a full condition. The CBGSA will conduct a third-party review of this data to verify this assumption."	A comparison of private landowner and DWR/USGS data is shown in Chapter 2 that demonstrates consistency between them.
22	P. 10, 11, 12, 13			IMs were set to equal the MT in all incremental years between 2020 and 2040. This reflects a policy goal of minimizing the exceedance of MTs between now and 2040. As a result, IMs will be a way to measure progress toward sustainability over the GSP's planning horizon.	Comment: This paragraph appears in 5 of the 6 descriptions of Threshold Regions, as rationales for setting MTs, MOs and IMs. This policy was not discussed or vetted by the CBGSA and no logical or scientific support for this policy was presented to the CBGSA, nor is such evidence included in the Draft CBGSP. As described in this text and as seen in table 5- 1, the IMs set for every monitoring well make no attempt to approach the MO previously set for each well and appear to dismiss the notion of Measurable Objectives completely. If this policy is adopted, why were Measurable Objectives set for any region at all? Per SGMA regulations, this policy is unacceptable and must be changed or substantiated with verifiable science. The Final GSP Emergency Regulations state: "355.4 When evaluating whether a Plan is likely to achieve the sustainability goal for the basin, the Department shall consider the following: (1) Whether the assumptions, criteria, findings, and objectives, including the sustainability goal, undesirable results, minimum thresholds, measurable objectives, and interim milestones are reasonable and supported by the best available information and best available science." Source: Final GSP Emergency Regulations, Section 355.4 (1) Recommendation: Present a review of this policy decision, supported by science, to the CBGSA, as well as an analysis of the impact this policy will have on reaching Measurable Objectives and the sustainability goal for the Basin. Change: Missing word in last sentence: "be"	Interim Milestones have been revised per Board direction.
23	P. 18-19 Table 5-1				Correction: The identification of a "Far-West Northwestern region" has not been adopted by a vote of the CBGSA and does not appear on any maps. The locations of these wells is not indicated anywhere else in the GSP. Please correct.	They are described as such in the text on page 5-8 and were discussed in this way at the Board meeting.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "…	Comment	Response to Comment
24	P. 19 Section 5.3	2		Direct measurement of the reduction of groundwater storage in the Basin is not needed because monitoring in several areas of the Basin (i.e., the western, eastern, and portions of the north facing slope of the Cuyama Valley near the center of the Basin) indicate that those regions are likely near, or at full conditions	Question: Please clarify the location of the highlighted section (portions of the north facing slope of the Cuyama Valley near the center of the Basin) referred to as "portions of the north facing slope of the Cuyama Valley near the center of the Basin". This seems to contradict the data that indicates that the center of the Basin is not "likely near, or at full conditions."	The text says areas "near the center of the Basin", not in the center of the Basin
25	P. 19 Section 5.5	1		The undesirable result for degraded water quality is a result stemming from a causal …	Comment: This is not an accurate statement. The CBGSA did not vote to only consider "the undesirable result for degraded water quality is a result stemming from a causal nexus between SGMA-related groundwater quantity management activities." No such vote was proposed or taken. This is an assumption made by the plan consultant. SGMA regulations do not stipulate a "causal nexus" argument for establishing undesirable results for degraded water quality. Further, the Final GSP Emergency Regulations state: "354.28. Minimum Thresholds (c)(4) In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin." Nowhere in the 354.28 subsection are GSAs permitted to determine and solely address water quality conditions that the CBGSA deems to have a so-called "causal nexus" with groundwater pumping. Further, a recent Stanford University study recently established a causal nexus between overpumping and arsenic levels in groundwater, which refutes the opposite claim in the Draft CBGSP. Recommendation: Without further data, monitoring, and a basis in scientific evidence, the CBGSA should not rule out setting undesirable results, MTs, MOs and IMs for all constituents that impact water quality in the Basin, in particular arsenic. Further, per the Final GSP Emergency Regulations, the CBGSA must "consider local, state, and federal water quality standards applicable to the basin" when determining the Undesirable Results, MOs, MTs and IMs relative to water quality throughout the Basin. Please provide proof that "local, state, and federal water quality standards" have been considered in the CBGSP's plan to prevent Undesirable Results for the Sustainability Indicator Degraded Water Quality. Please provide scientific, peer-reviewed evidence for the inclusion or exclusion of any constituent in the CBGSP's plan to prevent Undesirable Results for the Sustainability Indicator Degraded Water Quality.	The current plan for water quality in the GSP satisfies DWR requirements. This can be changed if direction is provided by the GSA Board.
26	P. 19-20 Section 5.5			The SGMA regulations specify that, "minimum thresholds for degraded...	Comment: This section offers an incomplete quotation of the relevant statute. The full subsection reads: "354.28 (c)(4) Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. *In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin."* (highlight added) In the Cuyama Basin, arsenic has long been an issue, so much so that the CCSD maintains an arsenic treatment plant to reach safe levels for arsenic for drinking water. The argument that there is no "causal nexus" between groundwater pumping and arsenic levels in the aquifer is not grounded in data or science. The Central Coast Regional Water Quality Control Board recommended that the GSP monitor for TDS, nitrates, arsenic and major dissolved ions, the latter to facilitate accurate readings. Recommendation: Follow the Central Coast Regional Water Quality Control Board's recommendations for constituents that should be included in determining and preventing undesirable results for the Cuyama Basin.	The current plan for water quality in the GSP satisfies DWR requirements. This can be changed if direction is provided by the GSA Board.
27	P. 19 Section 5.5.3			It should be noted however, that TDS levels in groundwater do not…	Comment: The GSP will govern groundwater use in the Cuyama Basin for the next 20 years, and possibly beyond. Due to water allocations and the potential for changes in crop patterns, this sentence may not be relevant in future years. Additionally, as SGMA requires that all beneficial users and uses are considered in determining and preventing undesirable results, the effect that TDS levels have on current crops and agricultural interests is not the only impact that should be considered. TDS levels affect domestic wells, drinking water and Groundwater Dependent Ecosystems. Recommendation: Strike this sentence or include a scientific analysis that observes the impact of TDS levels on all beneficial users and uses.	The sentence has been revised to be less definitive.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "…	Comment	Response to Comment
28	P. 22, 5.5.3			GSP regulations require GSAs to avoid undesirable results by 2040…	Comment: This statement is misleading and suggests that "meeting or exceeding the MT is required by SGMA" but that reaching a Measureable Objective is not also required by SGMA. This is not the case. The regulations state the following: "Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds." (Source: Final GSP Emergency Regulations 354.30) Therefore, by definition, measurable objectives are distinct from minimum thresholds; minimum thresholds are to be avoided and measurable objectives are to be reached, through the application of interim milestones. Nowhere in the regulations does it state that interim milestones can be set as the same value as minimum thresholds. In fact, interim milestones must be set to demonstrate that a GSP includes a plan to achieve measurable objectives. Further, the Final GSP Emergency Regulations state that monitoring networks must "Demonstrate progress toward achieving measurable objectives described in the Plan."(354.34 (b)(1) How can the CBGSP demonstrate "progress toward achieving measurable objectives" if minimum thresholds and interim milestones to reach measurable objectives are considered one in the same? The regulations also state that the DWR will consider the following in evaluating the GSP: "(1) Whether the assumptions, criteria, findings, and objectives, including the sustainability goal, undesirable results, minimum thresholds, measurable objectives, and interim milestones are reasonable and supported by the best available information and best available science." It seems unlikely that the DWR will conclude that completely ignoring measurable objectives and equating minimum thresholds with interim milestones is supported by "the best available information and best available science." (Final GSP Emergency Regulations 355.4. Criteria for Plan Evaluation)	The IMs have been adjusted based on Board direction.
29	P. 27 & 28			Because current subsidence rates (approximately 0.8 inches per year)…	Comment: By setting the minimum threshold for subsidence across the Basin at 2 inches per year, and by not setting interim milestones to reach a measurable objective of zero, the CBGSP is not complying with SGMA regulations. No plan is identified that will actually bring the subsidence level to zero. Further, by setting the MT at 2 inches per year, as written, the CBGSP could potentially allow 40 inches of land subsidence by 2040, without consequence. Recommendation: Reduce the MT for subsidence to one inch per year, and set interim milestones to reach zero subsidence by 2040 as required by SGMA.	The Board can consider adjusting MT levels in the future if conditions warrant it.
30	General Comment			Interim Milestones	SGMA regulations state as follows: § 354.30. Measurable Objectives (e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, *including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective* , in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon. Comment: Throughout Chapter 5 Minimum Threshold is used for Interim Milestones. Measurable Objectives are not incorporated at all for any of the sustainability goals even when the MT brings the indicator lower than its current status. The goal is not just to stop lowering the water levels, but to bring them back up to the measurable objective. Furthermore, if the IMs are set to the MTs, the plan does not provide a safety net for the Basin in times of drought. Recommendation: Set interim milestones to incorporate Measurable Objectives.	The IMs have been adjusted based on Board direction.
31	General Comment			Sustainability Goals, Sustainable Yield	§ 354.24 Sustainability Goal: The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, *a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield* , and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon. Comment: There is no correlation made in Chapter 5 between Minimum Thresholds, Measureable Objectives, Interim Milestones and how the Basin will reach it sustainable yield.	Projects and actions to achieve the Sustainability Goal are described in Chapter 7.
32	P. 5-8 Section 5.2			map of representative wells by Threshold Region	Comment: Western Region: Of the 10 representative wells identified in the Western Region, only 3 are in the main rural residential area, Cottonwood Canyon. Of the 3 in Cottonwood Canyon, 2 are located on Cottonwood Creek which benefit from year-round subsurface flow and seasonal surface flow. There are more wells in this area being monitored by Santa Barbara County that would more fully represent this area. Recommendation: Refer to Santa Barbara County Water Agency for their recommendation on wells to be monitored.	Additional wells can be considered during GSP implementation.
33	P. 5-3			The northern boundary of this region is the narrows at the Cuyama River…	Recommendation: Since this boundary borders on federal lands, recommend this be mentioned in the description.	Text has been revised.
34	P. 5-5			This part of the Basin has agricultural pumping	Comment: During summertime when there is the greatest agricultural pumping in this region, domestic wells go dry and water has to be trucked in. Recommendation: The above should be incorporated in the description.	This is discussed in section 5.2.2
35	P. 5-9			Recent historical data and hydrographs …	Comment: The Northwestern Region was in a full condition prior to intensive pumping began in 2016. It is now not only no longer in "full condition," but is also dropping. Recommendation: This should be clarified in the description.	Insufficient data is available to know if recent changes in groundwater elevations are tempory or reflect a long-term change.
36	P. 10 Section 5.2.2			IMs were set to equal the MT in all incremental years between 2020…	Comment: This is the same IMs used throughout the chapter. For the Eastern Region this sets the Milestones at staying near the bottom of some of the representative wells. This is not an acceptable goal for an area that includes an identified Management Area in the Basin. Recommendation: Set IMs for this region that aims to reach the Measurable Objective.	The IMs have been adjusted based on Board direction.
37	P. 11 Section 5.2.2			"IMs were set to equal the MT …	Comment: Same IM statement was used as above. The IM here should at least be set to the glide path and include the cutbacks to start in early 2023.	The IMs have been adjusted based on Board direction.
38	P. 12 Section 5.2.2			"The MT was calculated by taking the difference between the …	Comment: Why should this region's MT go below Feb 2018 when these wells have held steady on groundwater through 6 years of drought? The MT could be set at the 2015 levels, which was the 4th year of drought.	The document reflects direction provided by the GSA Board.

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39	P. 12 Section 5.2.2			IMs were set to equal the MT in…	Comment: Interim Milestones are set over the next 15 years at the level of the MT. This means the goal for the representative wells in the Western Region is for them to go down. Recommendation: Instead we recommend using the Measurable Objective, which is set at actual current groundwater levels, be used for the Interim Milestones in this region.	The IMs have been adjusted based on Board direction.
40	P. 12 Section 5.2.2			Due to these hydrologic conditions, the MT was set to protect	Comments: in the NW region, the MT in this region allows many wells to draw down an additional 20 feet, in some cases more than an additional 100 feet. Does that mean the IM for the Northwest region is to have a target of lowering the ground level every 5 years? Recommendation: to use the Measurable Objectives for the IMs in the Northwest Region.	The document reflects direction provided by the GSA Board.
41	P. 19 Section 5.3			Direct measurement of the reduction of	Comment: This provides an inappropriate description of the Basin. The eastern area, specifically the Ventucopa area, as described in other areas of Chapter 5, has shown consistent trends toward depletion over the last 20 years. If these areas are full, then it is very likely that GDE's would be negatively impacted if the MT is set at the lower levels than they are now.	The text has been revised for clarity.
42	P. 19 Section 5.5			Salinity (measured as total dissolved solids	Comment: It is not sufficient to measure only TDS. There are multiple agencies monitoring various constituents and there is pumping taking place at greater than 700 feet. Recommendation: Incorporate and continue groundwater quality measurements from other agencies (eg. CCSD, the Counties, Central Coast Water Board) into the GSP including so that an overall assessment of groundwater quality can be done at regular intervals.	This can be considered during GSP implementation.
43	P. 5-22 Section 5.5.3			TDS does not have a primary maximum	Comment: This section proposes that the only constituent being measured be TDS and in all cases, due to its natural occurrence in the groundwater, it be allowed to exceed California Division of Drinking Water and USEPA secondary standard. Thus, since TDS is not being held to conventional standards and since no other constituents are being monitored, there is virtually no water quality sustainability goals being set in the GSP. Question: Are any of the identified wells used for drinking water or located near drinking water wells? If so, what standards should these wells be monitored for? Recommendation: Identify wells near drinking water wells and separate them out for specific monitoring.	This can be considered during GSP implementation.
44	Table 5-2. p. 5.23				Comment: Of the 63 wells listed only 4 are below the 500 mg/L for the Maximum Measurement Value. 32 (more than 50%) are above 1500 mg/L for the Maximum Measurement Value. In all cases except 1 the MT is set higher or equal to that well's Maximum Measurement Value. The 1 exception is well #703 which has the highest reading for MMV: 4500mg/L and a MT of 4096.8 Would you want your child to drink this water?	This can be changed if direction is provided by the GSA Board.
45	5.6.3			the primary influence within the Basin	Comment: Why if it's 0.8 inches now are we giving latitude to go to 2 inches? How does this translate to loss in storage? Loss of groundwater storage is not even mentioned. Yet wasn't there a significant decrease at the CVHS site? This is not mentioned in the narrative, but the graph p. 5.29 shows a drop of 300 mm (apx 1 foot) between August 99 and 2017. At earlier SAC meetings it was proposed that more monitoring sites would be installed. Recommendation: Have the MT be at the current level of 0.8 inches and install additional monitoring sites in the Basin to establish a representative reading. Provide an estimate of storage loss that occurs with a subsidence of 0.8 inches.	This can be changed if direction is provided by the GSA Board.
46	5.7			Because current Basin conditions have	Comment: The Northwest region of the Basin has shown depletion since 1/1/15 when it was at a surface groundwater level. Thus depletion in this area could impact GDEs. As represented in the groundwater level section of this chapter, the MTs for many of the representative wells in this area are set at a level that would impact GDEs thus these MTs will not "act to maintain depletions of interconnected surface water…" In addition, it was proposed during SAC and GSA meetings that peziometers would be set up to monitor GDEs, but there is no mention of this in the plan. Recommendation: If the objective is to use groundwater levels to monitor, use the Measurable Objectives for the NW region which are either at current groundwater level or below.	The section on GDEs in Chapter 2 has been updated to note that piezometers are needed to monitor GDEs.
47	P. 5.6			This reflects a policy goal of minimizing the exceedance of MTs between now and 2040	Consider verifying this approach (Minimum Thresholds = Interim Milestones) with DWR.	The IMs have been adjusted based on Board direction.
48	P. 5.7			This reflects a policy goal of minimizing the exceedance of MTs	Consider verifying this approach with DWR.	The IMs have been adjusted based on Board direction.
49	P. 5.7			As a result, IMs will a way	Consider verifying this approach with DWR.	The IMs have been adjusted based on Board direction.
50	P. 5.7			This reflects a policy goal of minimizing the exeedance	Consider verifying this approach with DWR.	The IMs have been adjusted based on Board direction.
51	P. 5.8			Monitoring in this threshold region indicates levels …	As similar to the other regions text, please verify and add language if this is protective for domestic pumpers.	Text has been revised..
52	P. 5.8			These wellls have total depths that is shallower	These wells were reclassified into the Western Threshold Region MOs and MTs, but located within the Northwestern Threshold Regions; please discuss why these wells (Opti Wells 830, 831, 832, 833, 834, 835, and 836) will not be impacted by the Northwestern Threshold Region MTs and MOs.	As discussed in the monitoring networks chapter, potential impacts will be detected by the Monitoring Network so they can be addressed by the CBGSA Board
53	P. 5.9			This relfects a policy goal of minimizing	Consider verifying this approach with DWR.	The IMs have been adjusted based on Board direction.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "…	Comment	Response to Comment
54	P. 5.18			For this reason, the IMs for 2025...	Consider verifying this approach with DWR.	The IMs have been adjusted based on Board direction.
55	P. 5.24			Subsidence rates will be measured…	Please remove extra period	This has been corrected.
56	P. 5-6 thru 5-9				· Selecting thresholds by using groundwater elevation measurements closest to (but not before) January 1, 2015 is inadequate for identifying minimum thresholds or measurable objectives. Relying solely on the SGMA benchmark date (January 1, 2015) or any other single point in time to characterize groundwater conditions fails to capture the seasonal and interannual variability typical of California's climate. Hydrology is not static. Measurable objectives are intended to be set with enough operational flexibility to permit seasonal and interannual fluctuations that occur in California. We recommend that you consider using a baseline approach to better capture seasonality and water year types.	Using January 1, 2015 as a reference point is acceptable for development of the GSP MOs and IMs.
57	P. 5-6 thru 5-9				• January 1, 2015 was at the height of California's historic drought, a period of time that was characterized by adverse impacts to domestic well owners (e.g., dry wells), GDEs (e.g., water stress impacts on growth, reproduction, and even mortality due to lack of groundwater), and surface water users (e.g., lower streamflows). The onus is on the GSAs to determine whether groundwater conditions (due to groundwater pumping) exacerbated impacts to these beneficial users. And if so, to recognize these impacts and establish thresholds and measurable objectives that can avoid adverse impacts to beneficial users caused by groundwater in all water year types.	Using January 1, 2015 as a reference point is acceptable for development of the GSP MOs and IMs.
58	P. 5-6 thru 5-9				· While total well depth information is helpful in considering adverse impacts to beneficial users of groundwater (e.g., domestic, irrigation, and municipal wells), it fails to consider adverse impacts to GDEs and environmental beneficial users of surface water in interconnected surface waters. Environmental beneficial users of groundwater need to be considered when establishing measurable thresholds, measurable objectives, and interim milestones. Please refer to Step 2 of GDEs under SGMA: Guidance for Preparing GSPs1 for how this can be accomplished.	Comment noted.
59	P. 5-6 thru 5-9				· Please describe any differences between the selected minimum threshold and state, federal, or local standards relevant to the species or habitats residing in GDEs, as required [23 CCR §354.28 (b)(5)].	No differences have been identified.
60	P. 5-27				· It is highly doubtful that January 1, 2015 surface water conditions can be considered "normal" (2nd sentence in 2nd paragraph), please provide data to back this claim. January 1, 2015 was at the height of California's historic drought, a period of time that was characterized by adverse impacts to domestic well owners (e.g., dry wells), GDEs (e.g., water stress impacts on growth, reproduction, and even mortality due to lack of groundwater), and surface water users (e.g., lower streamflows).	Using January 1, 2015 as a reference point is acceptable for development of the GSP MOs and IMs.
61	P. 5-27				· Please provide more data and an elaborated description on how current basin conditions have not varied from January 1, 2015 conditions.	This can potentially be added as more data is available in the future.
62	P. 5-27				· Even if current basin conditions may not have varied from January 1, 2015, the onus is on the GSAs to determine whether groundwater conditions are causing any adverse impacts to beneficial users. And if so, to recognize these impacts and establish thresholds and measurable objectives that can avoid adverse impacts to beneficial users caused by groundwater in all water year types.	This will be performed through monitoring during GSP implementation.
63	P. 5-27				• According to Table 2-2 in the Draft GSP, 5994 AF of surface water was depleted in 2017. Please investigate whether these depletions in surface water are adversely impacting instream flow conditions and groundwater levels in riparian areas for environmental beneficial users, especially legally protected species.	Data does not currently exist to assess this, but it could potentially be assessed in the future.
64	P. 5-27				• Please describe any differences between the selected minimum threshold and state, federal, or local standards relevant to the species or habitats residing in GDEs or aquatic ecosystems dependent on interconnected surface waters [23 CCR §354.28 (b)(5)].	Data does not currently exist to assess this, but it could potentially be assessed in the future.
65	5.19 Appendix A			Hydrographs of Representative Wells	Comment: It is helpful to group the wells by threshold region to get a better understanding of the impact of MTs in each region. The region-based analysis of the compilation of hydrographs shows the following: There are no wells in the entire Basin where the MT is set to bring the GWL above current GWL. The identified management area of the Central Region, where the most critical overdraft is and almost all of the wells have a downward trend, has most of its wells' MTs set with a goal of keeping them at the GWL where they are now. Most of the Western region wells, which are characterized as domestic or rangeland wells (i.e. shallow), have MTs 20 feet below current GWL. While the map of representative wells (p.5.8) does not separate a NW and FarNW region, Table 5.1 (p.5.17) does. Looking at the map, it appears that the wells located in the Far NW region would generally be ranch and rangeland wells while the Northwestern wells are the recently drilled wells used for irrigating the newly planted vineyard. Almost all of the wells in the Western, Northwest and Far Northwest regions have MTs set at least 20 feet below current GWL.	The wells are organized by OPTI Well number to make them easy to find.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1	Entire Document				Very little information in this document specific to Cuyama DMS. Most of this document could apply to any basin where the Opti system has been used.	Comment noted.
2	P. 6-3			As the needs of the Cuyama Basin	Can the GSA re-configure/maintain the DMS in the future or does W-C have to do it?	The CBGSA will have the ability to choose how to update the DMS in the future.
3	P. 6-8			6.3 Data Included in the DMS	Provide some statistics on data in the DMS. Number of wells, average depth, number of wells having perforation data, WL data, WQ data, etc.	The text has been revised to report the number of wells and the number of those that have historical GWL and TDS measurements.
4	P. 6-10			In many cases, there were discrepancies	Was it automatically assumed that DEM is more accurate than GSE identified in the other sources?	No, the DEM was used just so that all well measurements could be compared by the same benchmark.
5	General			OPTI	Comment: Well identification and locations are hard to correlate with other standardized ID system like the State Well ID. Suggestion: A searchable cross reference table with State Well ID # would be very helpful. Correction: All the depth to groundwater charts in OPTI DMS are upside down compared to the groundwater elevation chart. It now looks like the depth to water is improving while groundwater levels are declining. Is this the way this GSP will fix everything?	The depth to groundwater charts have been corrected. Other DMS updates can be considered during GSP implementation.
6	P. 6.4 Sec. 6.2.2 Table 6.2			Table 6-2 lists the information that is collected …	Comment: Of the almost 40 fields of information on this table, less than 10 are entered for any well site. Of concern are the construction info, well depth and perforation Intervals and the status or classification(abandoned, domestic, agricultural,etc.). Addition: This investigative Data collection and entry must be prioritized early in Implementation and loaded into the OPTI DMS.	Additional data entry can be considered during GSP implementation.

Cuyama Basin Sustainability Section
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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1					Management areas: The Plan notes that the Central Basin and part of Ventucopa are critically overdrafted, and are a major focus for sustainability. I am concerned that the other areas of the basin may therefore continue to use water in a less than sustainable fashion. The Plan should be clear about the need for all parts of the basin to be closely monitored to ensure sustainable use practices are effected.	This is addressed in the Monitoring Networks Chapter.
2					Projects: While the scale of the problem in the Basin is staggering, the Plan should explore practices and technologies that can help improve efficiencies of water use.	The GSA cannot regulate water use efficiency practices under SGMA
3					The cloud seeding project appears to have inconsistent numbers in terms of number of AF (pg 16 has 1500 AF annually over 50 yrs, while pg 17 has 4200 AF), so please explain the difference.	The text has been corrected.
4					Pumping Allocations: The Plan should indicate how diminimus users in the basin will be defined, and if they will have allocations. Also, the Plan does not address how additional acres brought into irrigation will affect allocations. It may also be important to consider more strict considerations by CBGSA counties for approving new ag wells in this highly deficit basin.	The specifics for pumping allocations will be determined during GSP implementation.
5	P. 7-5	2			Please clarify what happens to areas with more than 2 feet of overdraft over a given timeframe going forward. For example if an area is shown to have a decrease >2ft/year over X number of years, it would be designated as a management area.	The text has been clarified that the 2 feet of overdraft standard is based on numerical modeling, not monitoring levels. While this approach has been used to develop the current management area boundaries, it has not been determined whether the same method would be used in a future update.
6	P. 7-5	2			"While the Cuyama Community Service District (CCSD) service area also has modeled overdraft exceeding 2 feet, it is not included in the management area." Please briefly explain why it was not included for the reader.	The text has been modified.
7	P. 7-9	Table 7-2			please define what would constitute "groundwater levels decrease sufficiently". This is an item that should be discussed by the GSA Board.	The text has been revised to reflect Board direction on adaptive management
8	7.5				A figure showing cumulative change in storage with and without pumping reductions as implemented along the proposed glide path (similar to Figure 7-3) would be useful for the reader.	Since we did not do a model simulation of the glide path, model results are not available to develop a similar figure.
9	7.5.2				Please change "is intending to implement pumping allocations" to "will implement pumping allocations".	The text has been changed.
10	P. 7-28				"Native sustainable yield". This would be good to include in a master glossary of key terms.	The text has been changed.
11	P. 7-31				Adaptive Management Triggers should be discussed by the GSA Board. This section would also be a good place to include policy about areas demonstrating >2 feet/year decline over a given period.	The text has been revised to reflect Board direction on adaptive management
12	P. 7-5			The CBGSA has designated two areas in the Basin as …	On what basis was the criteria of 2 feet selected? For example, why would 1 foot or 3 feet not be equally acceptable? Why is the Management Area based on a model-calculated water level decline rather than something like land and/or water use conditions (well density, crop density, high water demand crops, etc.) which have much less uncertainty and are not influenced by model errors. For example, the area where model-calculated water level decline is > 2 feet is sensitive to modeled aquifer property values. For example, using the historical run and considering the entire model domain, the area where drawdown is > 2 ft increased from 17,300 acres to 18,100 acres after increasing the modeled hydraulic conductivity in layer 3 by a factor of 10. This increases the total area outside the Water District with a modeled drawdown greater than 2 ft, so it has the effect of shifting the boundary of the Management Area.	This crteria was set by the GSA Board, but could be changed if the Board provides different direction.
13	P. 7-27 Section 7.5.2				Was the relationship between pumping changes in areas outside the Central Basin and the benefit of Central Basin Management Area pumping allocations assessed? Specifically, was it verified that pumping increases in any of the areas outside the Central Basin have no effect on management actions implemented in the Central Basin? A more conservative approach would employ pumping allocations Was the relationship between pumping changes in areas outside the Central Basin and the benefit of Central Basin Management Area pumping allocations assessed? Specifically, was it verified that pumping increases in any of the areas outside the Central Basin have no effect on management actions implemented in the Central Basin? A more conservative approach would employ pumping allocations in the Central Basin and specify no further pumping increases allowed in areas outside the Central Basin MA unless it can be verified the additional pumping will not negatively impact the benefits from Central Basin allocations.	Pumping allocations outside the management areas can be considered in a future update of the GSP.
14	P. 7-28			Because pumping allocations would only be imposed on users …	This does not account for recharge to the Central Basin that originates outside the Central Basin. Subsurface flow from areas outside the CBWD is sensitive to changes in aquifer parameters.	This could be evaluated in greater detail when morer data is available in the future.
15	P. 7-28			To the extent feasible, the CBGSA would determine …	Is a groundwater user that has been pumping for 1 year given the same priority as a user that has been pumping for 20-years or longer?	The text has been revised to be less definitive. The exact method to determine historical use will be determined during GSP implementation.
16	P. 7-30			CBGSA has the authority to develop a pumping allocation …	What about the impact of CBGSA enforced pumping allocations on groundwater rights?	Pumping allocations do not affect groundwater rights, just the quantity of water that water rights holders are able to pump.
17	P. 7-28			The CBGSA anticipates that…	Shouldn't the new supplies be added to the available supply for those users who paid for the new supply?	The text has been revised
18	P. 7-7 Table 7-1			Adaptive Management	Adaptive Management should be done routinely with the aim of verifying the expected benefit from pumpage reductions and adjusting the glide path accordingly.	The adaptive management section reflects direction provided by the Board. This is not included in the adaptive management policies specified by the Board. The Board can choose to adjust the glide path as additional data is available in the future.
19	P. 7-29 Figure 7-4				The glide path does not account for uncertainty or provide flexibility to manage the basin adaptively.	The GSA Board can choose to adjust the glide path as additional data is available in the future.
20	P. 7-31				What happens if the benefit to groundwater storage exceeds the expected benefit for the actual pumpage reduction? Will the pumping allocations be increased accordingly?	Adaptive management language has been revised per direction from the GSA Board.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
21	P. 7-5			The CBGSA has designated two areas	Why was 2 feet selected? Why not 3, 4, etc? Why base it on an area of water level decline rather than an area of defined land use (for example, well density, crop density, high water demand crops, etc.)	This crteria was set by the GSA Board, but could be changed if the Board provides different direction.
22	P. 7-5			The remaining areas in the Basin are	What scenario was used to come to this conclusion?	This was concluded from results of the 50-year Baseline simulation.
23	P. 7-7 Table 7-1			Adaptive Management	Adaptive Management should be done routinely with the aim of verifying the expected benefit from pumpage reductions and adjusting the glide path accordingly.	This is not included in the adaptive management policies specified in the GSP. The Board can choose to adjust the glide path as additional data is available in the future.
24	P. 7-28			Because pumping allocations would	Does not account for recharge to the Central Basin that originates outside the Central Basin.	This is accounted for in the model simulation used to estimate required pumping reductions.
25	P. 7-28			To the extent feasible, the CBGSA	This may be inconsistent with SGMA's intent to have no effect on existing water rights, including overlying rights.	The text has been revised to be less definitive. The exact method to determine historical use will be determined during GSP implementation.
26	P. 7-31			Adaptive Management	What happens if the benefit to groundwater storage exceeds expectations for the actual pumpage reduction (i.e., what if water levels recover faster, or to a higher elevation than expected)?	The GSA Board can choose to adjust the glide path as additional data is available in the future.
27	P. 7.6 Sec. 7.2			Figure 7-1 - Cuyama GW Basin CBGSA Management Areas	Addition: Please show the Foothill and Bell Roads as an background layer for "proximity"	The figure has been updated.
28	P. 7.6			Figure 7-1 - Cuyama GW Basin CBGSA Management Areas	Addition: The Santa Barbara Canyon Fault needs to be examined more definitively to fill data gaps.	No change needed in document.
29	P. 7.16 Sec. 7.4.2			"This project would target cloud …	Addition: Text needs a citation for the statement of 10% increase in precipitation	This is the average of the 5-15% range cited in the paragraph above.
30	P. 7.22 Sec. 7.4.4			This management action would include…	Comment: It is agreed that the disadvantaged communities of Cuyama Valley need resilience and reliability for their domestic supply. It is good to consider the opportunities, like it's good to wish for luck. Question: What would this look like? Grant writing or well wishing?	Potential financing options are discussed in Chapter 8.
31	P. 7.28 Sec. 7.5.2			A specific approach for allocation of pumping volumes among…	Question: So if groundwater users must decrease pumping by approximately 67 percent, and we have not determined a way to do that, what is the Plan?	This will be determined during GSP implementation.
32	P. 7.29 Sec. 7.5.2 Figure 7-4			Glide Path for Central Basin Management Area Groundwater Pumping Reductions	Comment: The Timeline for Implementation or "glide slope" is a big expectation. Question: How are we going to accomplish this logistically or financially? What is the Plan?	This will be determined during GSP implementation.
33	Global Comment				Recommendation: Due to the overdraft determined by the model, and the need to reduce it, it is recommended that a moratorium on new wells be instituted in the Cuyama Valley until a proper allocation system is developed and implemented. Otherwise, the overdraft will only worsen.	Water Code section 10725.6 authorizes a GSA to require registration of a well within its management area. Additionally, section 10726.4(a)(2) authorizes a GSA to control pumping by regulating, limiting, or suspending extractions from individual wells or extractions from wells in the aggregate, construction of new groundwater wells, enlargement of existing wells, or reactivation of abandoned groundwater wells, or otherwise establishing groundwater extraction allocations. However, that same subsection provides that any limitation on pumping by a GSA shall not be construed to be a final determination of rights to pump groundwater. So whatever controls on pumping a GSA implements needs to address current and projected conditions, and be adaptive over the life of the GSP. The GSA will need to decide as data is developed and the model is refined which of these tools should be employed and for how long.
34	7.5.1 P.7.25			The small population of…	Comment: This statement does not make sense since it seems to focus only on the population that lives in the valley, not the agricultural firms that own or lease the land that is farmed, and definitely have the economic resources to fund projects – especially when their operations stand to gain the most from management actions that are designed to increase recharge	No change needed in document.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "…	Comment	Response to Comment
35	7.5.1 P.7.25			management actions "could affect the economic health of the region and on local agricultural industry. It would also consider the projected changes to the region's land uses and population and whether implementation of these projects would support projected and planned growth,"	Comment: No studies have been done on what the actual drivers are of economic health in the valley, especially for the resident population, and how connected they are to groundwater conditions. All groundwater studies done leading up to this GSP have focused on water use by the big agricultural interests, who obviously stand to suffer economic impact when groundwater use is reduced, but nothing is known regarding impacts on residents in the valley, especially disadvantaged communities. Part of the issue is related to impacts on jobs in the valley, and part is related to impacts of domestic wells and water supplies of "de minimis users (which have not yet been defined). Recommendation: The economic analysis must go beyond the large agricultural interests and include impact on local residents as well as the impact on industry and residents in the Basin if water use continues without change during the next 5-20 years.	An economic analysis of the effects of GSP actions on the Basin will be conducted soon.
36	7.5.2 P. 7.27			Comment is on this whole section	Comment: This section supposedly addresses setting limits on pumping, however the only real comment that says reduction is needed is in the first paragraph that says "pumping must be reduced 67% if the basin in to come into balance" (where pumping equals recharge). From there on the focus is on allocation, and without any actual pumpage data, there currently is no way to determine if pumpage reduction takes place. Even the use of the term "allocation" seems to be incorrect, since the reduction in overdraft is not about how much water users should get, but really about how much they should cut back. Pumping "reductions" would be the more proper terminology. Recommendation: Data is needed regarding recharge by aging the water to determine if recharge is happening and, if so, the rate of recharge. Then a more accurate rate of pumping reduction can occur.	This will be determined during GSP implementation.
37	7.5.2 P. 7.27			Outlined here is a framework for how CBGSA would develop and implement …	Comment: The issue comes up again as well as to why only the Central Basin Management Area is going to receive "allocations" – aka. pumping reductions, when the entire Basin is considered in critical overdraft. Is the <2ft drop in groundwater levels an enforceable limit to groundwater drop? Will MT's be enforceable limits to how low water levels can go? Should the rest of the Basin be allowed to continue to pump without limits? Recommendation: Develop a framework that shows the interconnectivity in the Basin between the different parts of the Basin as a whole watershed so that impacts of pumping in one part of the Basin can be connected to other parts of the Basin.	The GSA Board has not specified pumping allocations for areas outside of the management areas.
38	7.5.2 P. 7.28			The required decreases in pumping volumes…	Comment: This entire section seems like it is just pushing off the inevitable need to reduce pumping. Implementation of reductions will not take place before 2023, and the process for setting up "allocations" and pumping reductions seems vague and uncertain at this time, that it is really not a Plan. Meanwhile, groundwater levels will continue to drop since pumpage will not change. In fact, despite the fact that SGMA and DWR require a Plan to be submitted for how sustainability of groundwater in the Cuyama Basin will be achieved, this section basically says work will begin on some kind of plan after this GSP is submitted. Other than the Glide Path for % reductions over 20 years, there are no elements of what the plan will be, how it will be funded, and who will enforce it. Recommendation: This is an incomplete plan. It needs to have these components added before 2022. Recommend the GSA have as a priority developing these components and submitting the to DWR for review.	This will be determined during GSP implementation.
39	7.2			While the Cuyama Community…	Consider discussing why the CCSD is not included in the management area.	Additional text has been added.
40	7.4				Consider adding a new project for updating the numerical modeling to help address the uncertainties in the current model. The update to the numerical model should include new monitoring data prior to the DWR interim GSP milestone in 2025 or 2030. This project would need to be discussed in the Chapter 7 Management Actions and Chapter 8 Implementations with associated cost and description.	This can be considered by the GSA Board in the future.
41	7.4			Projects included in this GSP	Consider adding on a volunteer basis to member agencies - "... member agencies on a volunteer basis...."	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
42	P. 7-13			If pursued, the CBGSA anticipates…	Consider adding on a volunteer basis to member agencies - "...one of its member agencies on a volunteer basis."	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
43	P. 7-13			Once a preferred alternative	Consider adding on a volunteer basis to member agencies- "...one of its member agencies on a volunteer basis."	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
44	P. 7-13			As public water supply agencies, any	Consider text revisions text - "As a public agency, any CBGSA members (on a volunteer basis) has authority to implement the project once land is acquired and applicable permits are secured."	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
45	P. 7-16			If a precipitation enhancement…	Consider verifying with Santa Barbara on the the existing permits/EIR, and expanding on the existing SBCWA program (vague language).	This would be determined during GSP implementation
46	P. 7-18			The project would be implemented	Consider adding "one of the member agencies of the CBGSA on a volunteer basis."	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
47	P. 7-20				Consider adding the following language, if the project is not removed by the GSA Board: "…The current assumption is that any project using direct recharge through recharge basins will be initiated and owned by the County or GSA Board. This assumption results prevents private ownership of recharged groundwater from these projects, allowing all recharged groundwater to be available to all groundwater pumpers…"	This limitation has not been approved by the CBGSA Board

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48	P. 7-20 - 7-23				Cross out all of section 7.4.3	This is contrary to Board direction. As noted, this action would only be taken in combination with flood/stormwater capture.
49	P. 7-22			Changes to stormwater capture	Pending GSA Board action on this item, please clarify this sentence if the project is not removed - "Changes to stormwater capture and recharge facilities that may result from this feasibility study would receive CEQA and NEPA coverage under those facilities' environmental documentation. " Also, would permit revisions be required by the other facilities, such as Twitchell Reservoir?	As noted, additional study would be required prior to implementation of this action.
50	P. 7-23			In addition to a well drilling permit…	Consider adding the name of the County	This has been added.
51	P. 7-25			In total, these improvements	Consider adding "....approximately $1,175,000. Projects are funded by the CCSD and VWSC."	Financing options are discussed in Chapter 8.
52	7.5 P. 7-25				Please add a discussion (if direct by the GSA Board) or option on De Minimis Groundwater Users, such as below. De minimis groundwater users are not currently regulated under this GSP. Growth of de minimis groundwater extractors could warrant regulated use in this GSP in the future. Growth will be monitored and reevaluated periodically.	The Board has not provided specific direction on de minimis users. This will be determined during GSP implementation.
53	7.5 P. 7-25			Water management actions are generally	Consider adding on a volunteer basis to member agencies - "... member agencies on a volunteer basis..."	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
54	7.5.2 P. 7-27			No pumping allocations would	Please discuss why Ventucopa Management Area is not performing the reduction in pumping.	The text has been revised
55	7.5.2 P. 7-27			CCSD would be provided allocations	Please define the historical use for CCSD and why the CCSD is not performing the reduction in pumping.	The rationale for not including the CCSD in a management area has been added to section 7.2
56	P. 7-28			Develop Allocations	Considering creating a list of potential plans/studies for the GSA Board to take future action on, such as remote sensing, pumping allocation plan, calculating native sustainable yield for only the Central Basin Management Area, Rate assessment, and etc.	This will be determined during GSP implementation.
57	P. 7-30			Successful implementation would…	Consider adding on a volunteer basis to member agencies - "...member agencies on a volunteer basis."	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
58	P. 7-30			Mechanisms for enforcement	Consider adding - "...CBGSA or member agencies on a volunteer basis."	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
59	7-6 P. 7-31			Adaptive Management	Consider defining and expanding Adaptive Management for the GSA Board, such as the purpose of the Adaptive Management is to provide the final "check and balance" for the GSP to ensure that the overall objectives of the groundwater basin are being met. Adaptive Management is also used to provide guidance on the overall effectiveness of the GSP and to provide a tool with which to modify the programs to better meet the overall Basin objectives.	Adaptive management language has been revised per direction from the GSA Board.
60	7-6 P. 7-31			Pumping reductions are more than 5…	Consider defining how the 5% is being calculated, such as from the numerical model	This will be determined during GSP implementation.
61	7-6 P. 7-31			If the Basin is within the Margin of	Consider defining how the 10% is being calculated, such as from the numerical model	This will be determined during GSP implementation.
62	P. 7-18			Implementation of this project would…	Automated High Output Ground Seeding System (AHOGS)	This has been added.
63	P. 7-19			This studied evaluated…	Change "studied" to "study"	The text has been revised
64	P. 7-19			"Cloud seeding has been conducted…	Change to "…in portions of Santa Barbara County…"	The text has been revised
65					The glide path to sustainability: Because the minimum thresholds are based on 2015 data, they allow continued high usage of water with only a gradual decrease of usage over each five year period until 2020, when groundwater levelswould have become "sustainable" at the 2015 level. This would mean that groundwater will continue to be depleted as has been the case now for years--until 2020. This seems to be almost business as usual. I recognize that the profits of agriculture in the area and therefore the tax profits of the state from agriculture are a real consideration; but the future of 'life' in the Cuyama Basin-- for native plants, animals, birds, and pollinators and for ordinary people and small farmers requires change that does not allow further depletion of the groundwater for the next 21 years.	The glide path reflects the direction of the CBGSA Board. The Board can consider revising the glide path in the future.
66	7.1				•Please describe how the projects described in this chapter and their benefits will help "maintain a viable groundwater resource for the beneficial use of people and the environment" as stated in the sustainability goal for the Cuyama Basin.	This is reflected in the project descriptions.
67	7.4.1			Flood and stormwater capture	Spefics should be included about how Twitchell Reservoir makes this project infeasible or why wou will be able to overcoe that. Twitchell Reservoir holds less than 200,000 AF and water is used to replenish downstream basin.	As noted in the chapter, this will be determined through additional study during GSP implementation.
68	7.4.2			Precipitation enhancement	This analysis does not address the concernts of organic producers that were raised at GSP meetings nor has it ever addressed the issue of rain shadow where enhancing rain in one area creates drought in another. This should be addressed.	As noted in the chapter, these will be addressed additional study during GSP implementation.
69					The plan should consider logical, affordable and easily implemented projectes such as removing certain trees in the river bottom which are invasive species and which use (reportedly) up to 250 gallons of water per day.	Additional actions can be considered and studied during GSP implementation.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
1					Cost of Plan implementation: The proposed Projects and Management Actions are extremely costly, particularly when you consider the very sparsely populated basin, the disadvantaged status of the community, and the scale of the problem. The economic analysis should highlight this in more detail, but it begs the question of how realistic are any of the proposed projects that at first analysis, provide only minimal increases in water availability and stability.	All projects would be evaluated in greater detail prior to implementation.
2	P. 8.9, Section 8.4.9				Coordination regarding Twitchell would most likely be with the Twitchell Management Authority and Santa Maria Valley Water Conservation District. The Santa Maria basin is in the process of DWR reprioritization to "Very Low" priority, removing SGMA requirements, and the Santa Maria Fringe GSA in Santa Barbara County is likely to be dissolved.	No change needed to document as the existing paragraph is accurate.
3	P. 8.4 Sec. 8.2.1			the CBGSA will develop a financing plan that will include one or more of the following financing approaches….	Comment: Pumping Fee or Assessments, Allocations or Restrictions. There may be plenty of ways to approach this difficult policy implementation, but this GSP make no determination how it will be done. Question: Does the Implementation Plan simply intend to come up with a plan of how to implement pumping reductions goals? A Plan to make a plan!	As noted, this will be determined during GSP implementation.
4	P. 5, 1.1			Adaptive management	Addition: Please define the term "adaptive management"	This is discussed in Chapter 7.
5	P. 6, 1.1, Fig 8-1			Implementation Schedule	Change: Figure 8-1 is not adequately labeled. The section spanning years is not labeled at all and the items in the column Task Name do not correspond to any of the items in the timeline. Please present this timeline in a more understandable format.	The figure is using a standard Microsoft Project schedule format. Task descriptions for local communities projects have been updated to more closely match the descriptions in Chapter 2.
6	P. 6, 1.1, Fig 8-1			Implementation Schedule	Question: It appears that under Project Implementation, Task 4, drilling new wells for CCSD and for Ventucopa is suggested. These processes are described in Chapter 7, with estimated costs. However, verbally in SAC and GSA meetings, this task is not suggesting that the GSA pay for the drilling of these wells, but instead would support writing grants to obtain the funds for these wells. The 2019-20 Budget Draft, as presented in the GSA packet on May 1, 2019, includes $40,000 for Grant Proposals and $15,000 for Grant Administration. Yet it is unclear if those items will be allocated for seeking grants to pay for these two wells, or seeking grants to fund the GSA and GSP implementation. Please add language to this task and to Chapter 7 that clarifies the GSA's actual involvement in these two projects. From the Implementation Schedule and in Chapter 7, the language is very misleading and does not accurately reflect what has been said verbally in public meetings.	Financing options for these projects are included in Table 8-2. Financing does not need to be provided directly by the GSA for the projects to be included in the GSP.
7	P. 7, 1.1, Fig 8-1			Implementation Schedule	Question: It appears that under Management Action Implementation, Task 2, "Determine Sustainable Yield" will be completed by January 2021. However the Final GSP Emergency Regulations indicate that Sustainable Yield is required to be included in the GSP, which must be finalized by January 2020. Source: Final GSP Emergency Regulations, Section 354.8 (b)(7)	This line has been removed from the schedule. Sustainable yield is described in Chapter 2.
8	P. 9, 8.2.1			2nd bullet point: Stakeholder/Board engagement: *Quarterly* Stakeholder Advisory Committee (SAC) meetings, bimonthly CBGSA Board meetings, bi-monthly calls with the CBGSA Board ad-hoc committees, and semi-annual public workshops	Change: Change Quarterly Stakeholder Advisory Committee (SAC) meetings to Bi- Monthly to reflect the schedule proposed in the May 1 meeting of the CBGSA.	This has been changed.
9	P. 11, Table 8-2			Project 4: Improve reliability of Water Supplies for Local Communities	Delete: Given the current lack of financial resources at the CCSD and VWSC, it is highly unlikely that CCSD and VWSC Operating Costs could be used to finance the drilling of these wells. These two potential funding sources should be removed from this list. It should be clearly noted that the CBGSA has no intention of paying for these wells and proposing them as a project of the CBGSA and including them in the Draft GSP is extremely misleading.	This is listed as one potential financing source. Table 8-2 shows the potential financing options for these projects. Financing does not need to be provided directly by the GSA for the projects to be included in the GSP.
10	P. 11, Table 8-2			Mention of "Member Agencies" as Responsible Entity or Potential Funding Source	Delete: Including any mention of "Member Agencies" is extremely misleading and runs counter to the vote taken by the SBGSA on April 3, 2019 that did not approve Member Agencies, namely the CBWD, to be the responsible Entity or Potential Funding Source for implementation of the plan. To be consistent with the CBGSA's vote, please remove all instances of "Member Agencies" from Table 8-2. Source: 2019-05-01-CBGSA-Board-Packet-public-1.pdf, P. 11	Since the financing mechanisms for these projects and actions have not been determined, CBGSA member agencies continue to be a potential financing option
11	P. 12, 8.3.2			Basin Conditions	Addition: Unless specified as part of the identified monitoring network, groundwater levels should also be reported on the 20 piezometers proposed to be installed to monitor GDEs across the valley. Please add Groundwater Elevation Data from piezometer network as a separate bullet point.	The section on GDEs in Chapter 2 has been revised to note the need for piezometers to monitor levels for GDEs.
12	8.1.1 P. 8-1			Adaptive management would only be	Consider defining and expanding Adaptive Management, such as the purpose of the Adaptive Management is to provide the final "check and balance" for the GSP to ensure that the overall objectives of the groundwater basin are being met. Adaptive Management is also used to provide guidance on the overall effectiveness of the GSP and to provide a tool with which to modify the programs to better meet the overall Basin objectives.	Adaptive management is described in Chapter 7 and reflects direction from the GSA Board.

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Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
13	Table 8-1			Project 3 cost	Correction $600 - $2,800 (missing hyphen)	This has been corrected.
14	Table 8-1			Project 4: Basin-Wide Economic…	Does this include data for the rate assessment?	No. As described in Chapter 7, this will be an economic analysis of the projects and management actions included in the GSP.
15	Table 8-1			$75,000 annually for fiscal years…	Please clarify activity/estimated cost to justify the cost. This seems like the same work effort as the annual report and Five-Year GSP updates.	Activities associated with this item are described in the text following the table. These are all distinct work efforts. A more detailed scope and cost estimate will be developed when the GSA issues a task order for completion of these tasks.
16	Table 8-1			$155,000 annually for FYs...	Please clarify activity/estimated cost to justify the cost. This seems like the same data and work effort as above.	Activities associated with this item are described in the text following the table. These are all distinct work efforts. A more detailed scope and cost estimate will be developed when the GSA issues a task order for completion of these tasks.
17	Table 8-1			Additional costs during initial years…	Please clarify activity/estimated cost to justify the cost. This seems like the same data and work effort as above.	Activities associated with this item are described in the text following the table. These are all distinct work efforts. A more detailed scope and cost estimate will be developed when the GSA issues a task order for completion of these tasks.
18	Table 8-1			$800,000 every five years …	Please clarify activity/estimated cost to justify the cost. This seems like the same data and work effort as above.	Activities associated with this item are described in the text following the table. These are all distinct work efforts. A more detailed scope and cost estimate will be developed when the GSA issues a task order for completion of these tasks.
19	8.2.1 P. 8-4			Stakeholder and Board Engagement	Update per direction by the GSA Board, May 1st meeting	This has been corrected.
20	8.2.1 P. 8-4			CBGSA operations are partially	Consider adding "...member agencies volunteer funding.	The text has been revised.
21	8.2.1 P. 8-4			Although ongoing operation of	Consider revising the sentence and adding something similar to the CBGSA member agencies to fund the start-up CBGSA administrative cost on a volunteer basis until the CBGSA funding is in place.	The text has been revised.
22	P. 8-5			During development of a financing plan, the	Consider adding a discussion on a option to exclude De Minimis Groundwater Users from the GSP. If excluded by the GSA Board then maybe stating De minimis groundwater users are not currently regulated under this GSP. Growth of de minimis groundwater extractors could warrant regulated use in this GSP in the future. Growth will be monitored and reevaluated periodically.	The Board has not provided specific direction on de minimis users. This will be determined during GSP implementation.
23	P. 8-5			Combination of fees and assessments	Consider adding a sentence on a option to exclude De Minimis Groundwater Users from the GSP.	The Board has not provided specific direction on de minimis users. This will be determined during GSP implementation.
24	P. 8-5			Pumping fees: Pumping fees would	Consider adding a sentence on a option to exclude De Minimis Groundwater Users from the GSP.	The Board has not provided specific direction on de minimis users. This will be determined during GSP implementation.
25	P. 8-5			Assessments: Assessments would charge a	Consider adding a sentence on a option to exclude De Minimis Groundwater Users from the GSP.	The Board has not provided specific direction on de minimis users. This will be determined during GSP implementation.
26	Table 8-2			Potential Financing column, Project 1 Feasibility Study	Consider adding CBGSA Member Agencies (Volunteer)	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
27	Table 8-2			Responsible Entity column, Project 1 Project Implementation	Consider adding CBGSA Member Agencies (Volunteer)	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
28	Table 8-2			Potential Financing column, Project 1 Project Implementation	Consider adding CBGSA Member Agencies (Volunteer)	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
29	Table 8-2			Potential Financing column, Project 2 Feasability Study	Consider adding CBGSA Member Agencies (Volunteer)	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
30	Table 8-2			Responsible Entity column, Project 2 Project Implementation	Consider adding CBGSA Member Agencies (Volunteer)	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
31	Table 8-2			Potential Financing column, Project 2 Project Implenentation	Consider adding CBGSA Member Agencies (Volunteer)	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
32	Table 8-2			Responsible Entity column, Management Action 2 - Enforcement	Consider adding CBGSA Member Agencies (Volunteer)	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4

Cuyama Basin Sustainability Section
Summary of Public Comments and Responses - Chapter 8
December 2019

Comment #	Section	Section Paragraph #	Paragraph's Sentence #	Sentence Starts with, "...	Comment	Response to Comment
33	Table 8-2			Potential Financing column, Management Action 2 - Enforcement	Consider adding CBGSA Member Agencies (Volunteer)	A note that member agencies would participate on a voluntary basis has been added to the introduction to section 7.4
34	8.4.1 P. 8-8			If any of the adaptive…	Please expand and clarify adaptive management triggers, see comment in Section 7.6	Adaptive management is described in Chapter 7 and has been updated per direction from the GSA Board.
35	8.4.1 P. 8-8			If any of the adaptive…	Please add what chapter/section the adaptive management process is described. If this section is not included please add the discussion or options.	Adaptive management is described in Chapter 7. A reference is not needed here.
36	Table 8-1			Implementation costs	The Cuyama Valley does not have the resources to pay these costs. Many of these costs were never discussed with the GSA. $46 million for flood and stormwater capture? Board engagement $195,000 annually? $40,000 for an annual financial statement? These items and many others are totally unreasonable and came from the consultants who wrote the plan and not from the GSA.	Some adjustments to the cost estimates have been made following discussion with the CBGSA budget ad-hoc committee. The costs currently in the document are a reasonable estimate of what is required to meet SGMA requirements.
37	P. 8-5			Assessments	The Board (GSA) decided that amounts "$5-$8 per acre per year" would be removed from the plan. Also when this was presented to the board (GSA) it said de minimis users would not be charged and grazing would be used as an example of a de minimis user.	References to cost ranges have been reemoved.
38	General				When it comes to costs and assessments much of this chapter has been written by Woodard & Curran before any consultation with the Board. Decisions have not been made and it is premature to include them as part of the plan at this point.	Because the Board has not determined a policy, Section 8.2.1 notes that a financing plan will be developed by the CBGSA going forward. The section on costs has been revised to note that the cost estimates may be revised as more information is available during GSP implementation.
39					The GSP proposes three funding mechanisms to fund planning efforts: 1) fees based upon water usage; 2) fees based upon acreage within the Basin; or 3) a combination approach. CDFW believes that fees based upon water use is the most reasonable considering that current and historical water use patterns appear to be the main cause of overdraft conditions. The historic use and growth of agriculture, including wineries and legal cannabis cultivation, will continue to place demand on groundwater within the Cuyama Basin.	Comment noted.

Chapter 2 Appendices

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Chapter 2
Appendix A

Cuyama Valley Groundwater Basin Hydrographs

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OPTI Well 2 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3659 ft.
WSE Max = 3692 ft.
Well Depth = 73 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3730
3710
3690
3670
3650
3630
3610
3590
3570
3550
3530
3510
3490
3470
3450
3430
3410
3390
3370
3350
3330
3310
3290
3270
3250
3230
3210
3190
3170
3150
3130
3110
3090
3070
3050
3030
3010
2990
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160
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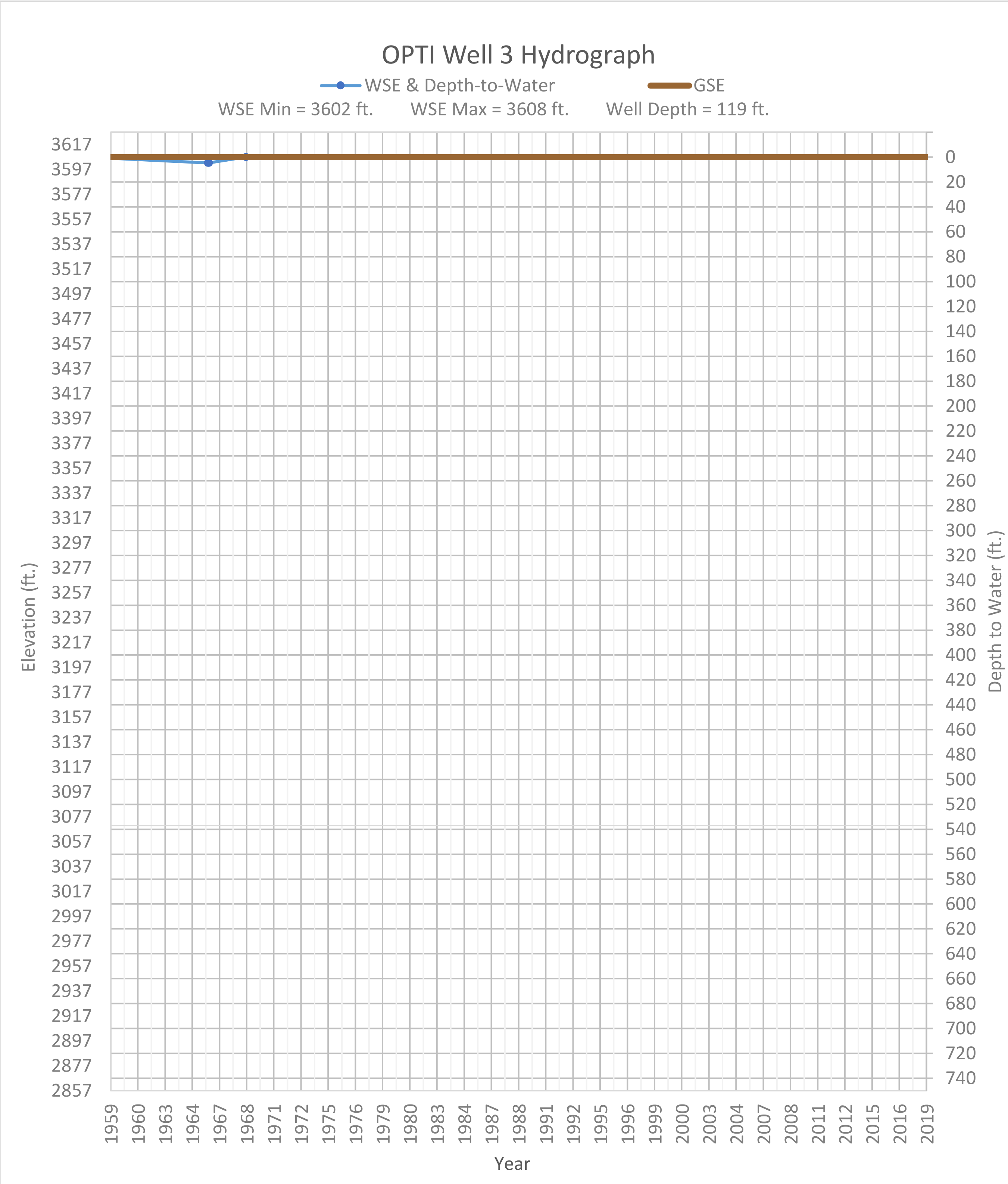
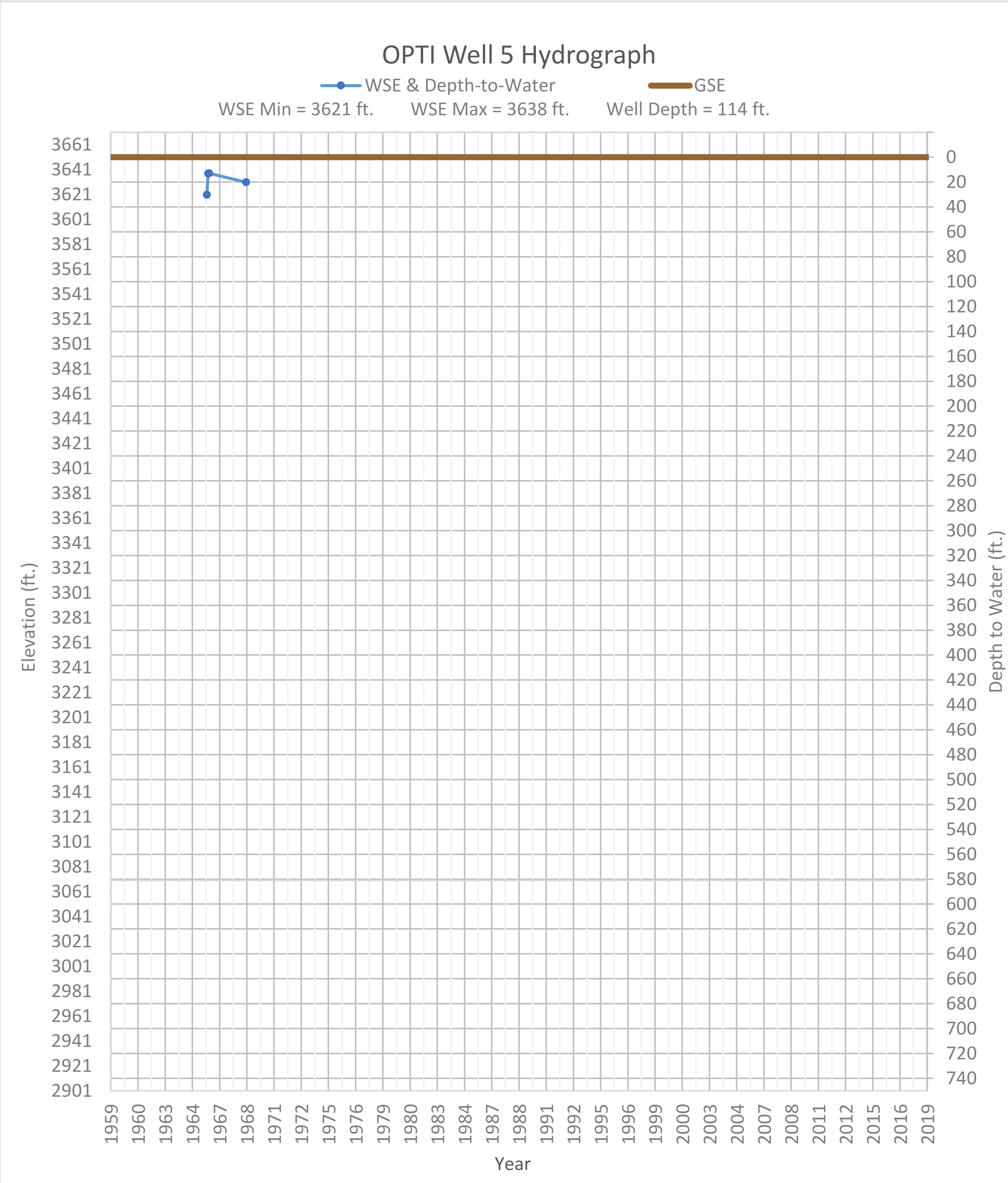
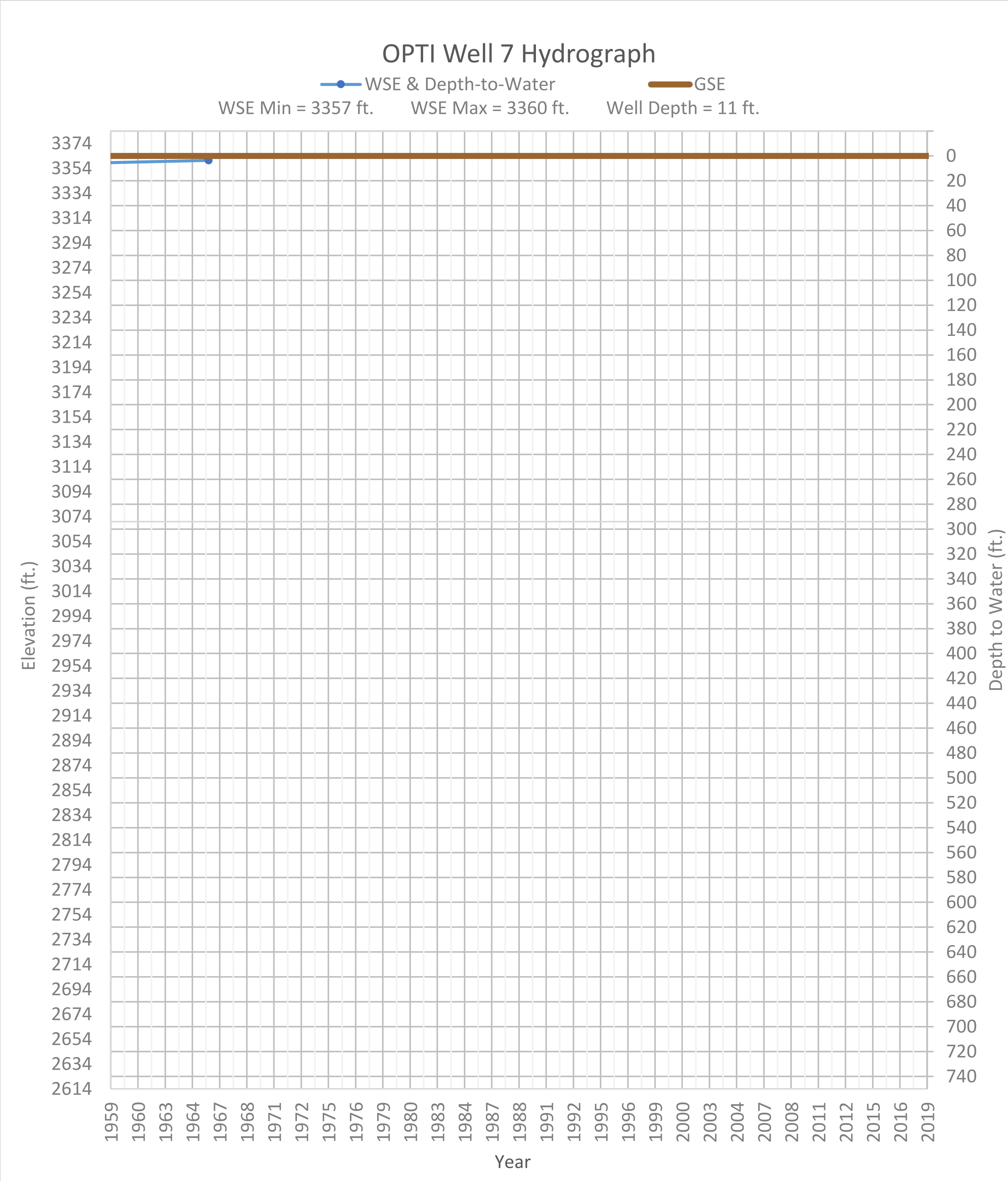

OPTI Well 3 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3602 ft.
WSE Max = 3608 ft.
Well Depth = 119 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

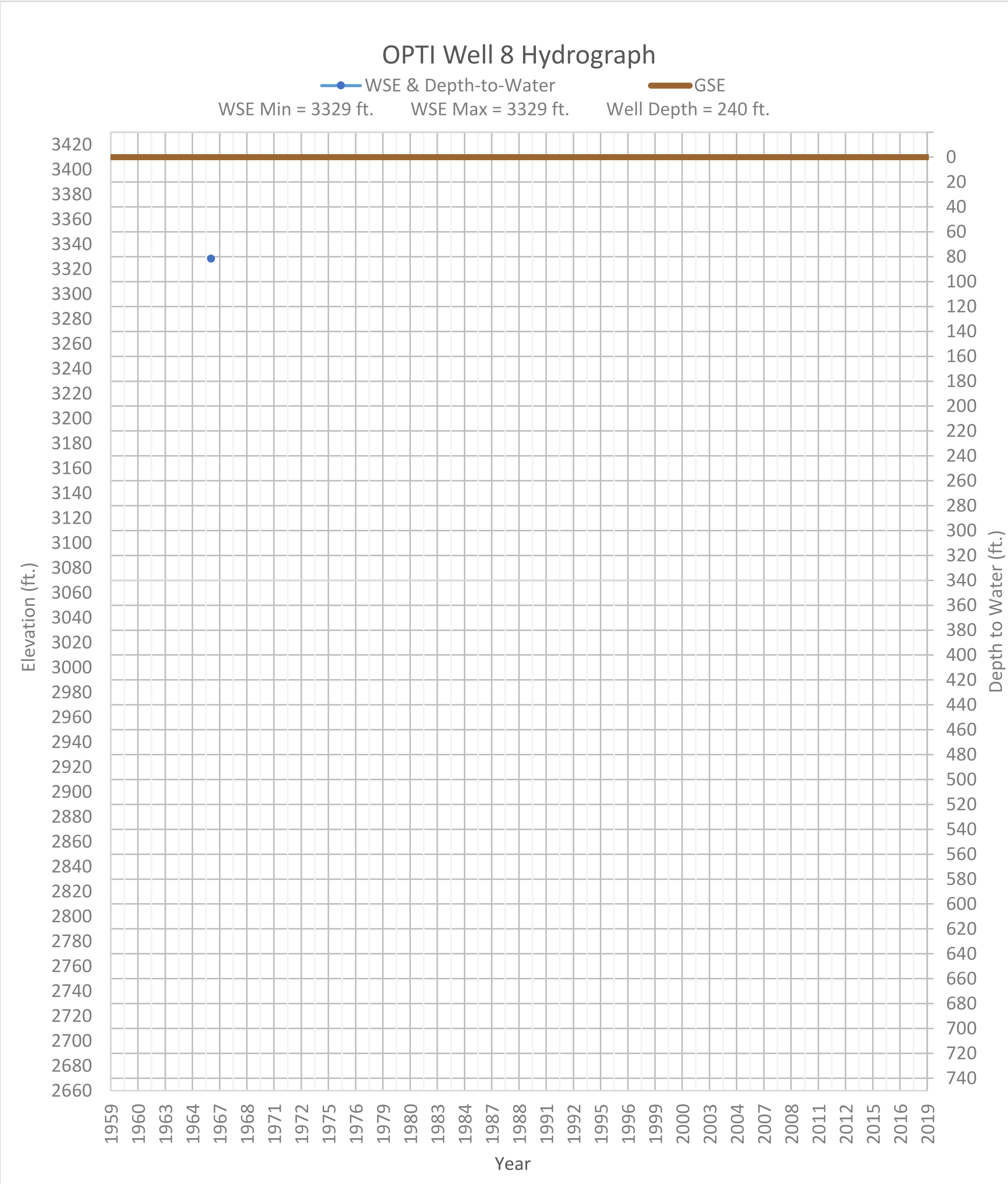


OPTI Well 5 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3621 ft.
WSE Max = 3638 ft.
Well Depth = 114 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 6 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3778 ft.
WSE Max = 3808 ft.
Well Depth = 96 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 7 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3357 ft.
WSE Max = 3360 ft.
Well Depth = 11 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 8 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3329 ft.
WSE Max = 3329 ft.
Well Depth = 240 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3420
3400
3380
3360
3340
3320
3300
3280
3260
3240
3220
3200
3180
3160
3140
3120
3100
3080
3060
3040
3020
3000
2980
2960
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2820
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2780
2760
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2720
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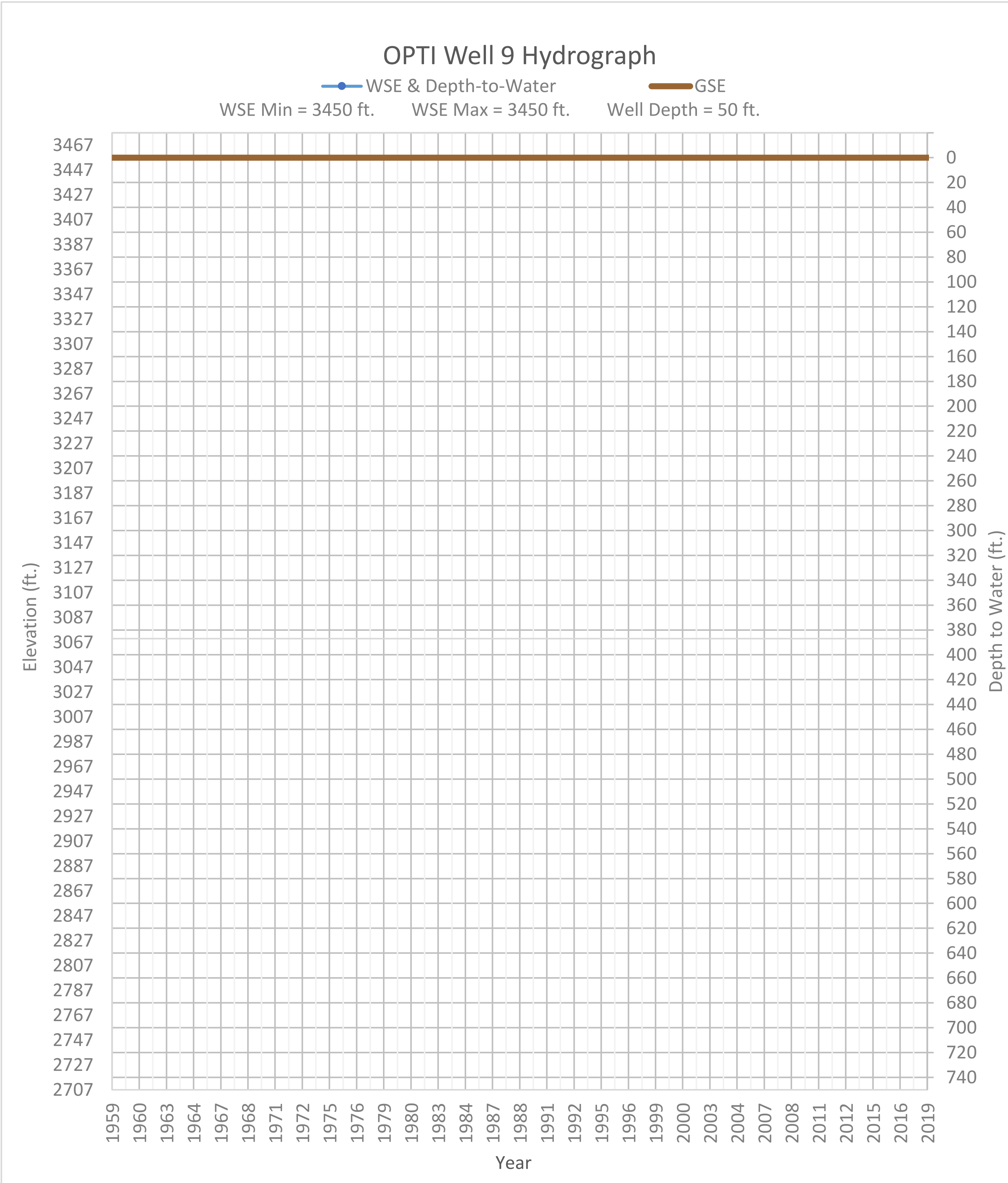

OPTI Well 9 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3450 ft.
WSE Max = 3450 ft.
Well Depth = 50 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3467
3447
3427
3407
3387
3367
3347
3327
3307
3287
3267
3247
3227
3207
3187
3167
3147
3127
3107
3087
3067
3047
3027
3007
2987
2967
2947
2927
2907
2887
2867
2847
2827
2807
2787
2767
2747
2727
2707
0
20
40
60
80
100
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140
160
180
200
220
240
260
280
300
320
340
360
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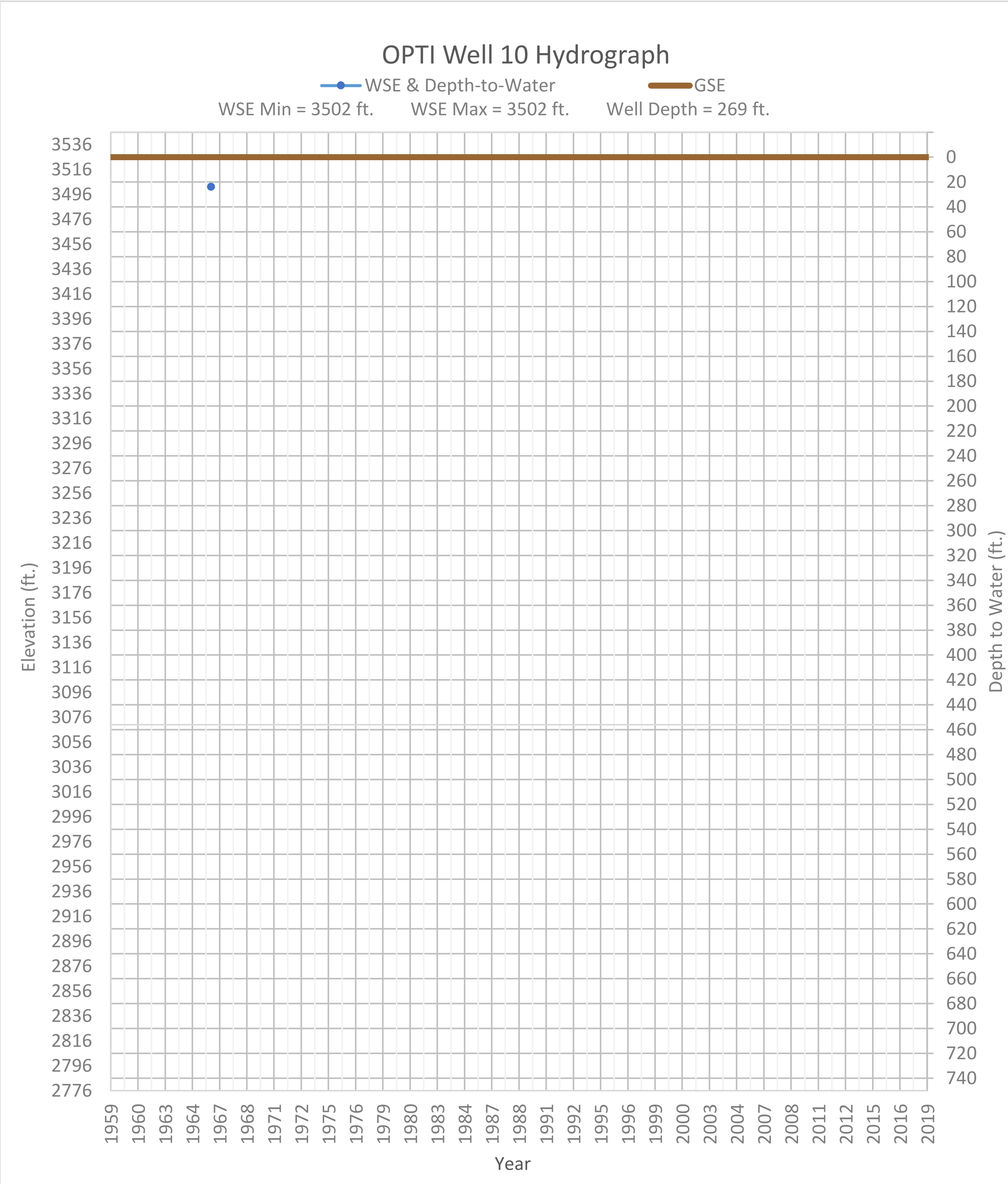
OPTI Well 10 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3502 ft.
WSE Max = 3502 ft.
Well Depth = 269 ft.
Elevation (ft.)
3536
3516
3496
3476
3456
3436
3416
3396
3376
3356
3336
3316
3296
3276
3256
3236
3216
3196
3176
3156
3136
3116
3096
3076
3056
3036
3016
2996
2976
2956
2936
2916
2896
2876
2856
2836
2816
2796
2776
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
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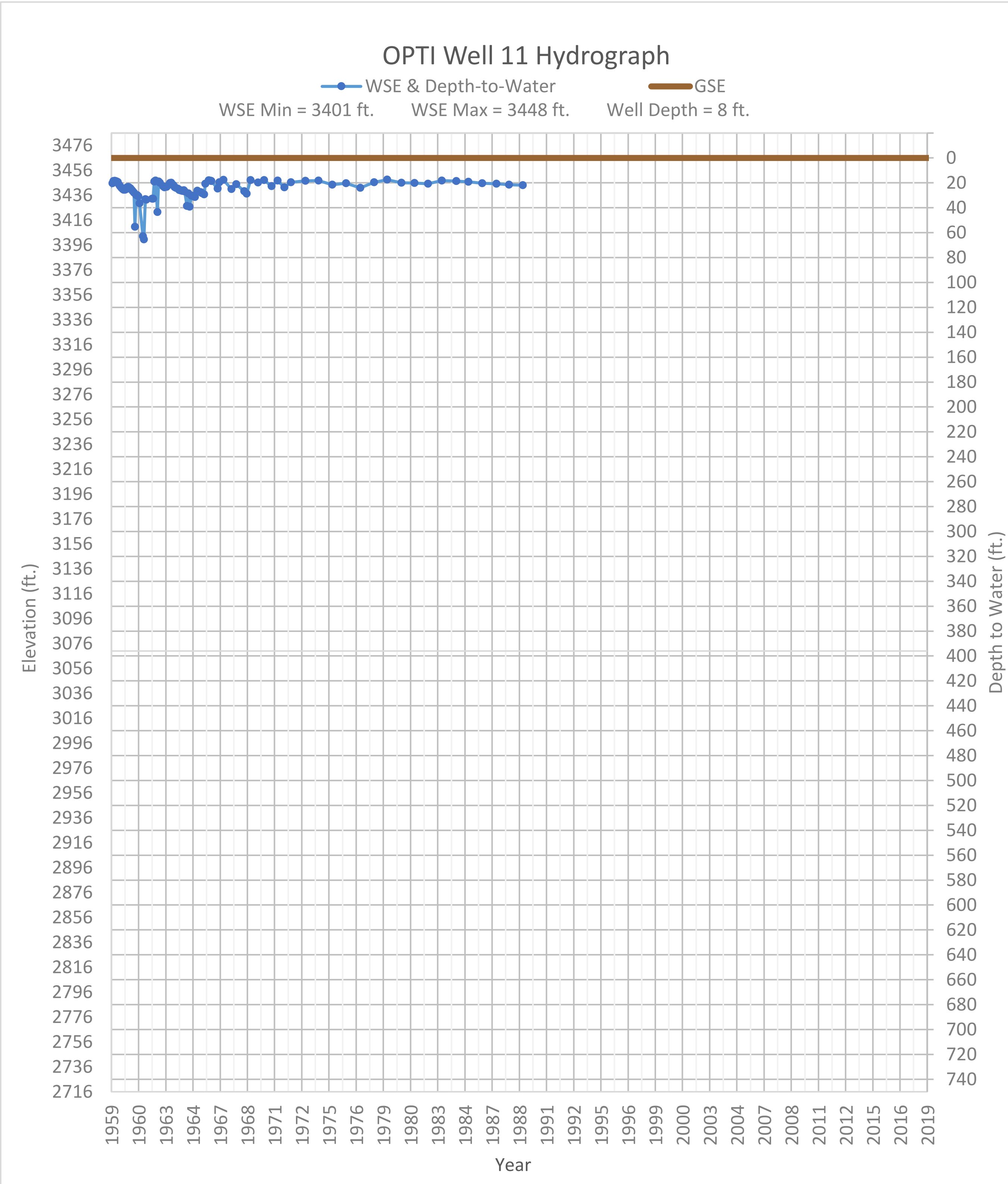
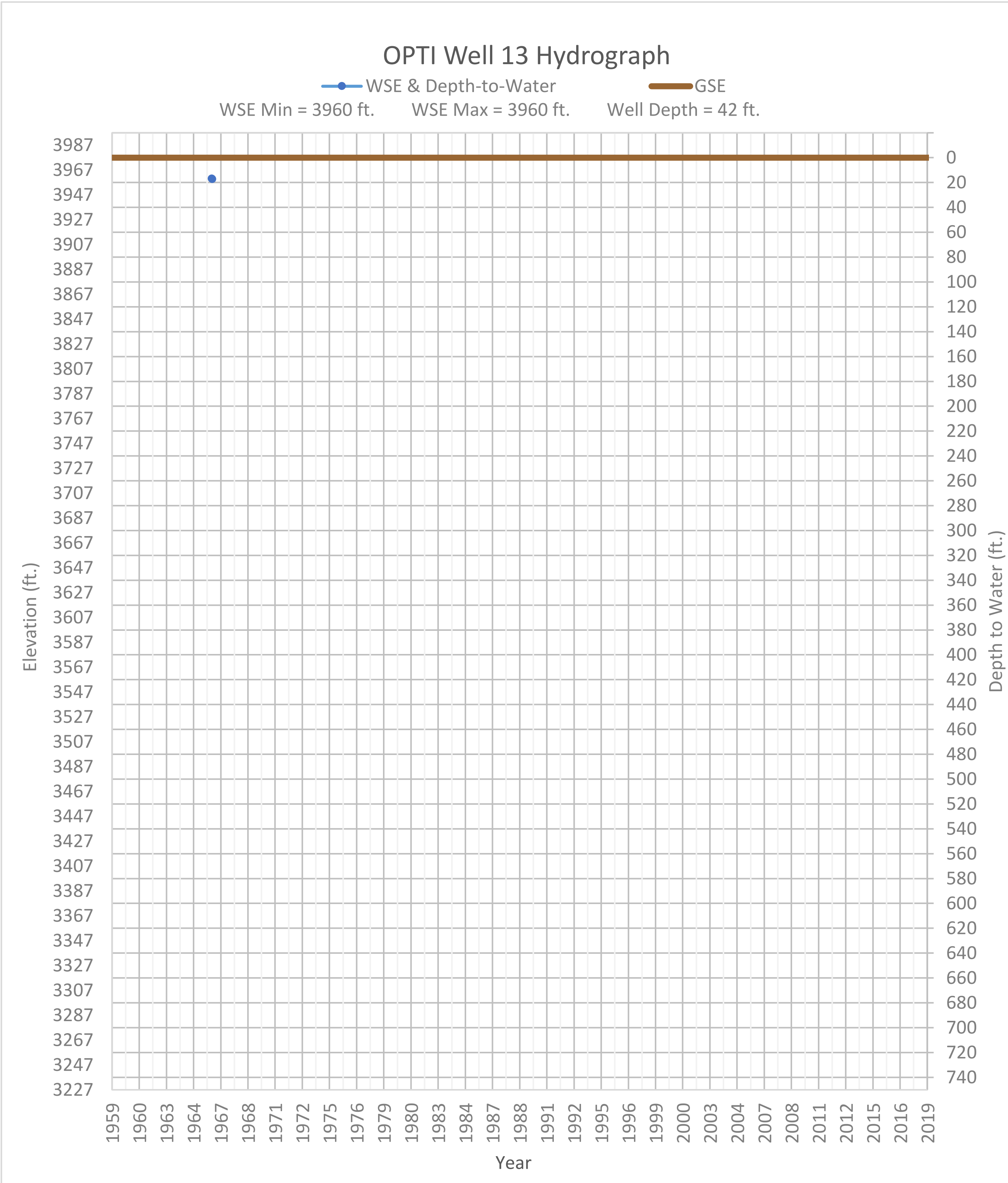


OPTI Well 11 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3401 ft.
WSE Max = 3448 ft.
Well Depth = 8 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 13 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3960 ft.
WSE Max = 3960 ft.
Well Depth = 42 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3987
3967
3947
3927
3907
3887
3867
3847
3827
3807
3787
3767
3747
3727
3707
3687
3667
3647
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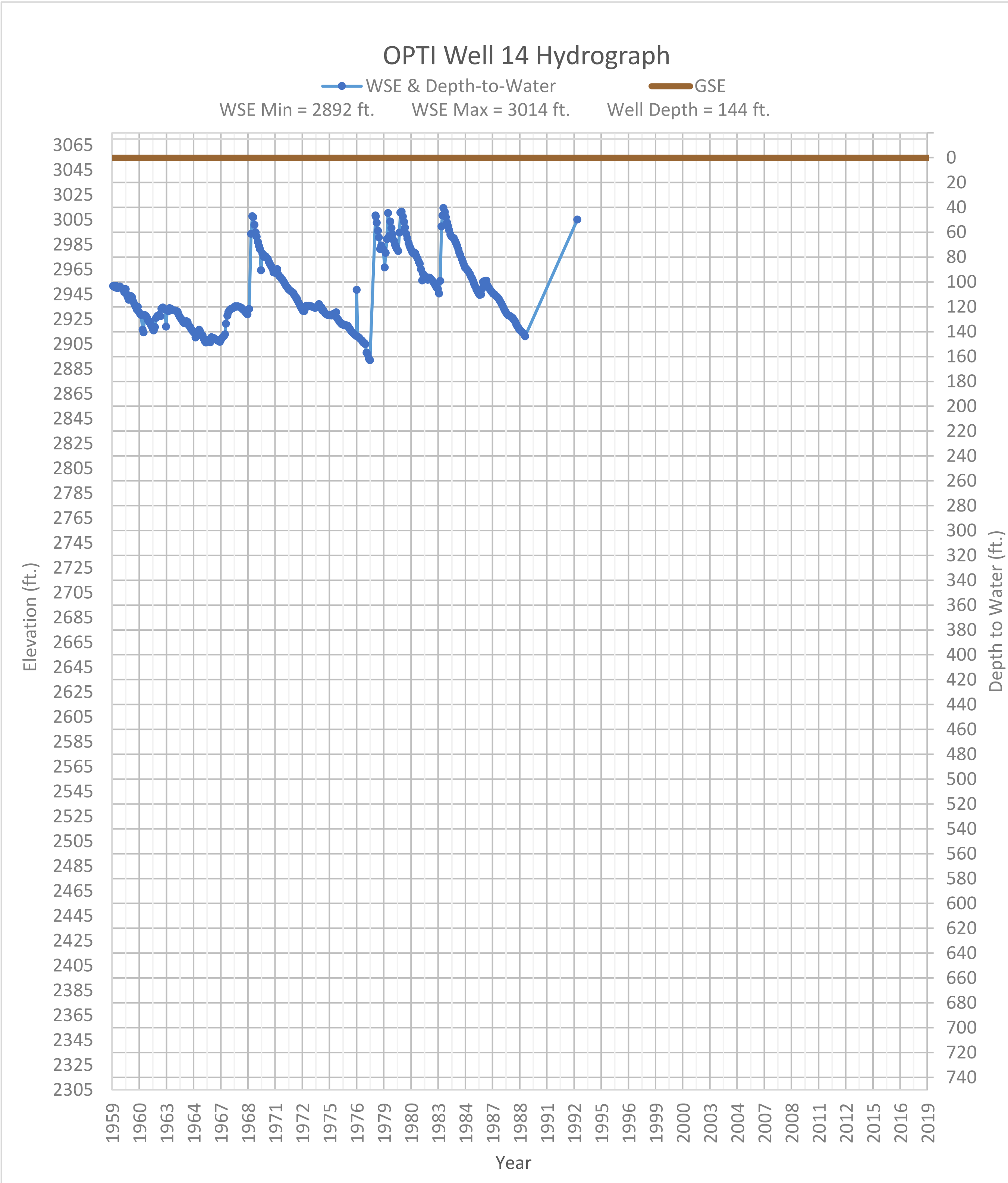

OPTI Well 14 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2892 ft.
WSE Max = 3014 ft.
Well Depth = 144 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3065
3045
3025
3005
2985
2965
2945
2925
2905
2885
2865
2845
2825
2805
2785
2765
2745
2725
2705
2685
2665
2645
2625
2605
2585
2565
2545
2525
2505
2485
2465
2445
2425
2405
2385
2365
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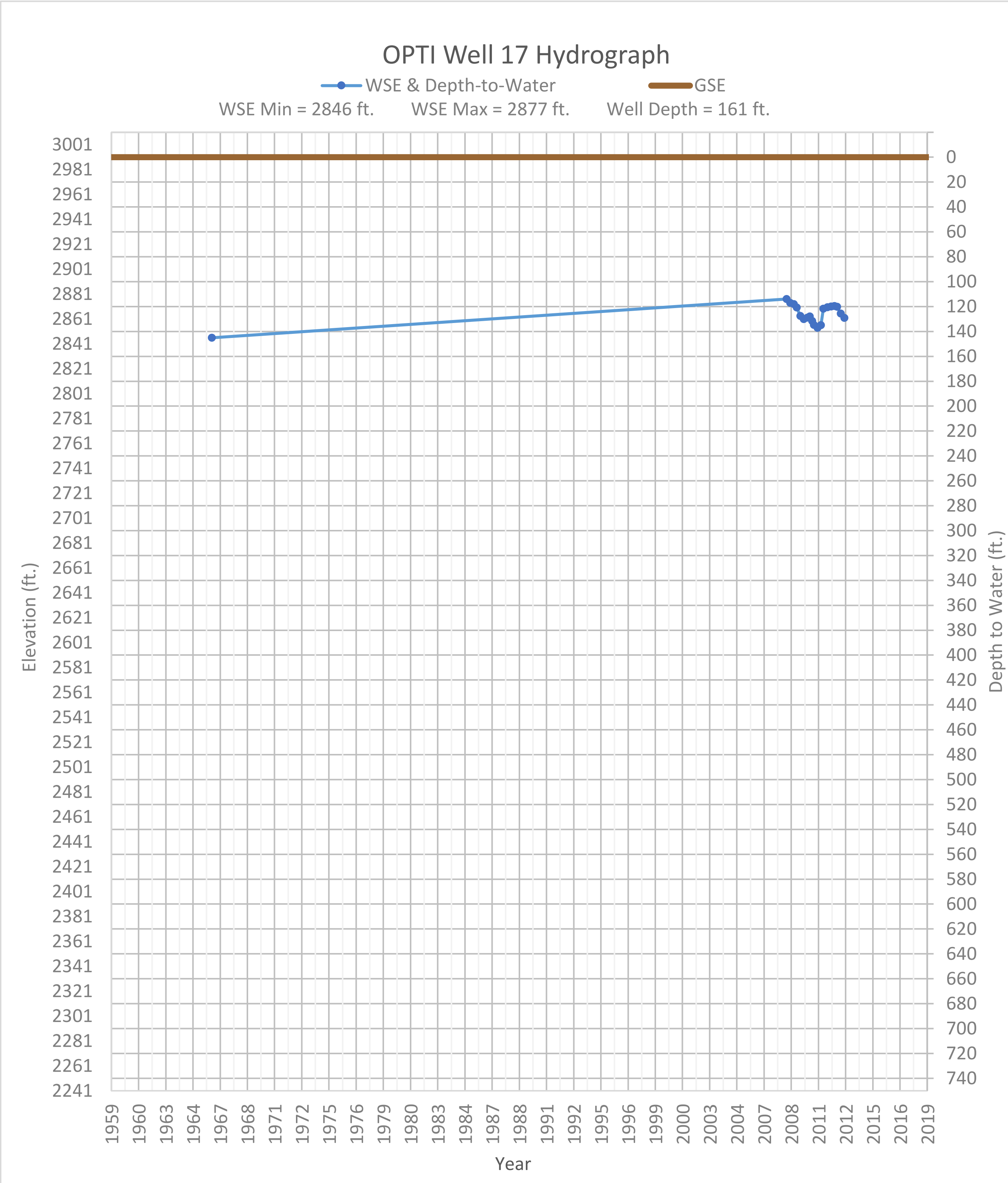
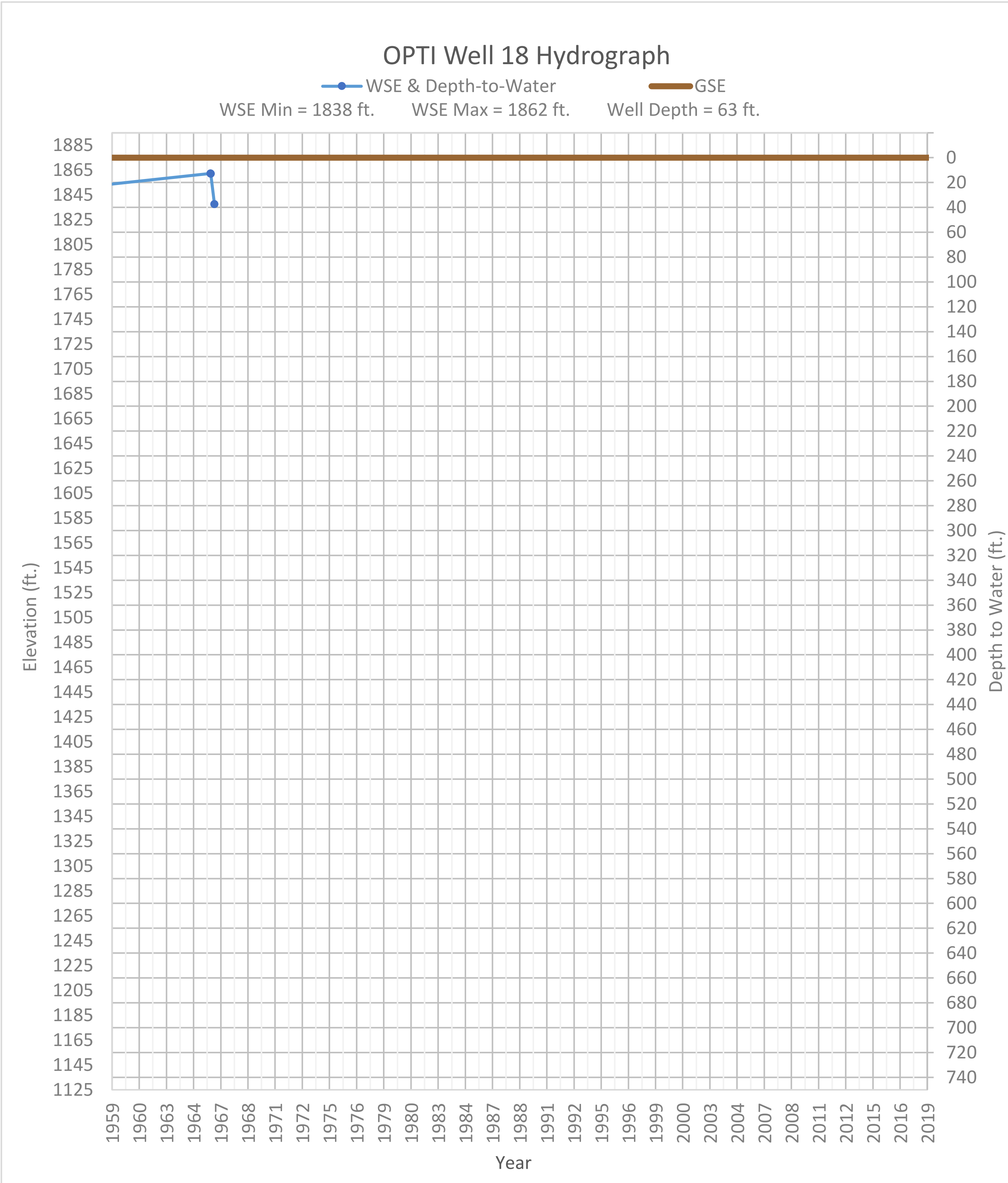
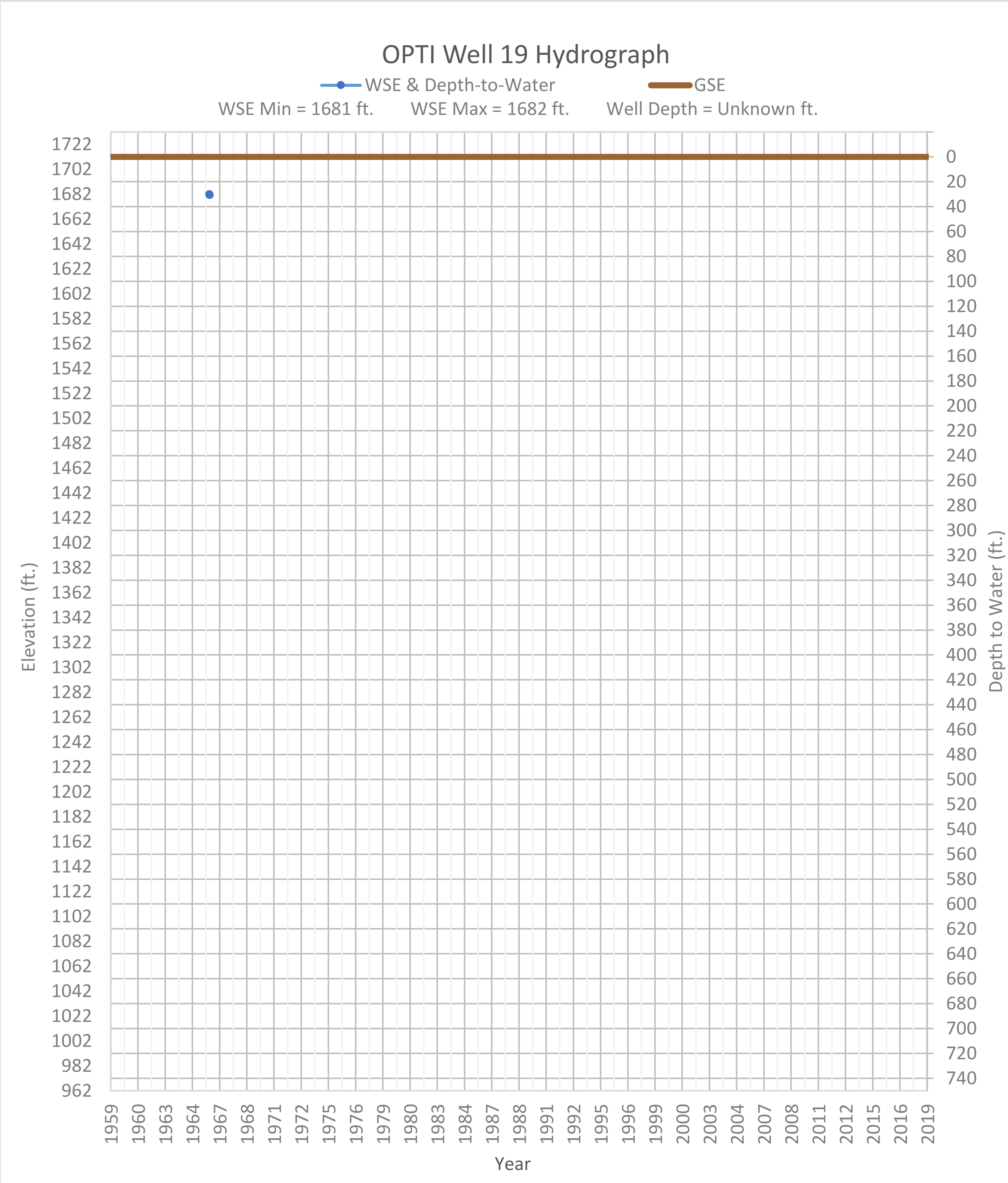


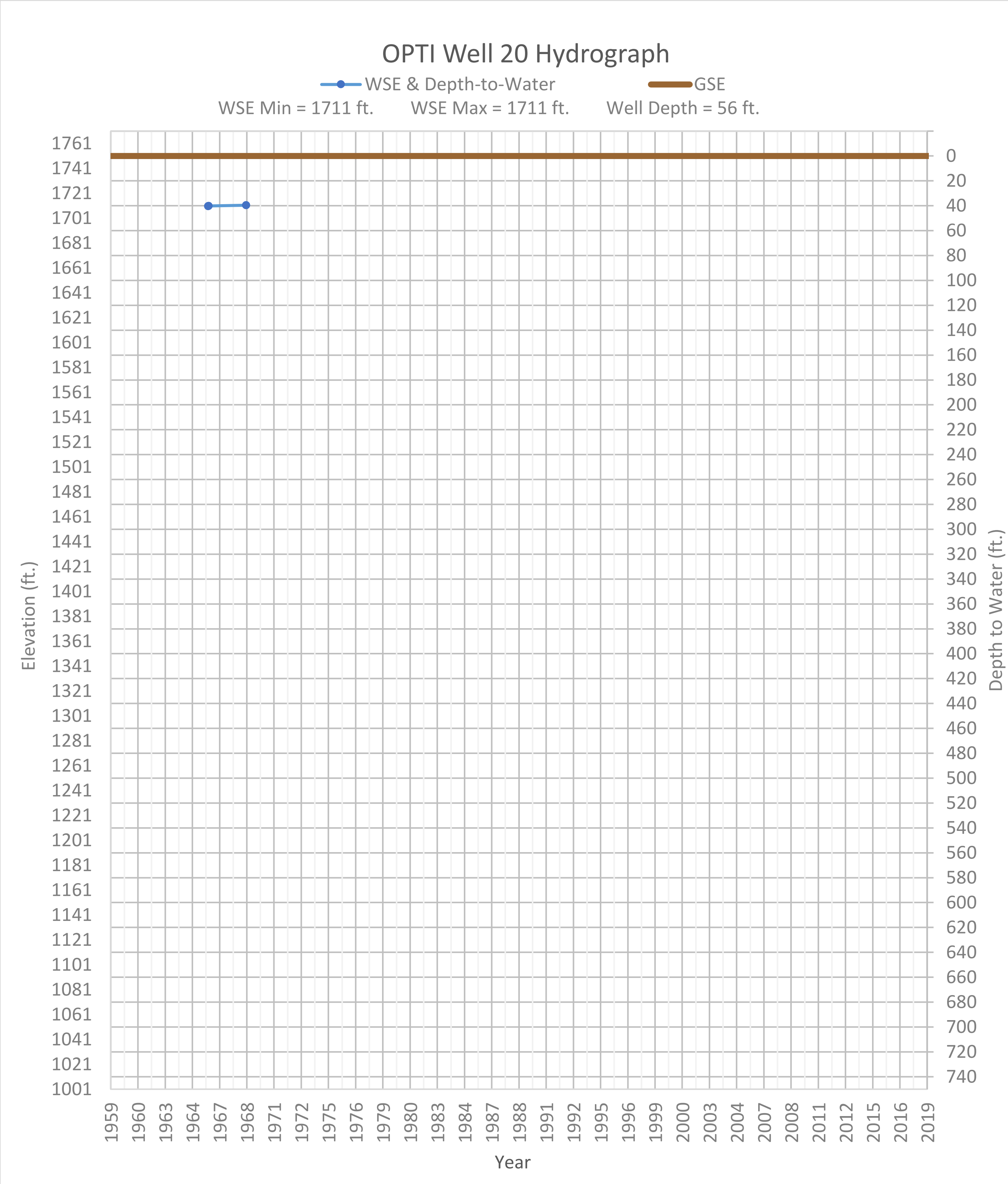
OPTI Well 17 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2846 ft.
WSE Max = 2877 ft.
Well Depth = 161 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



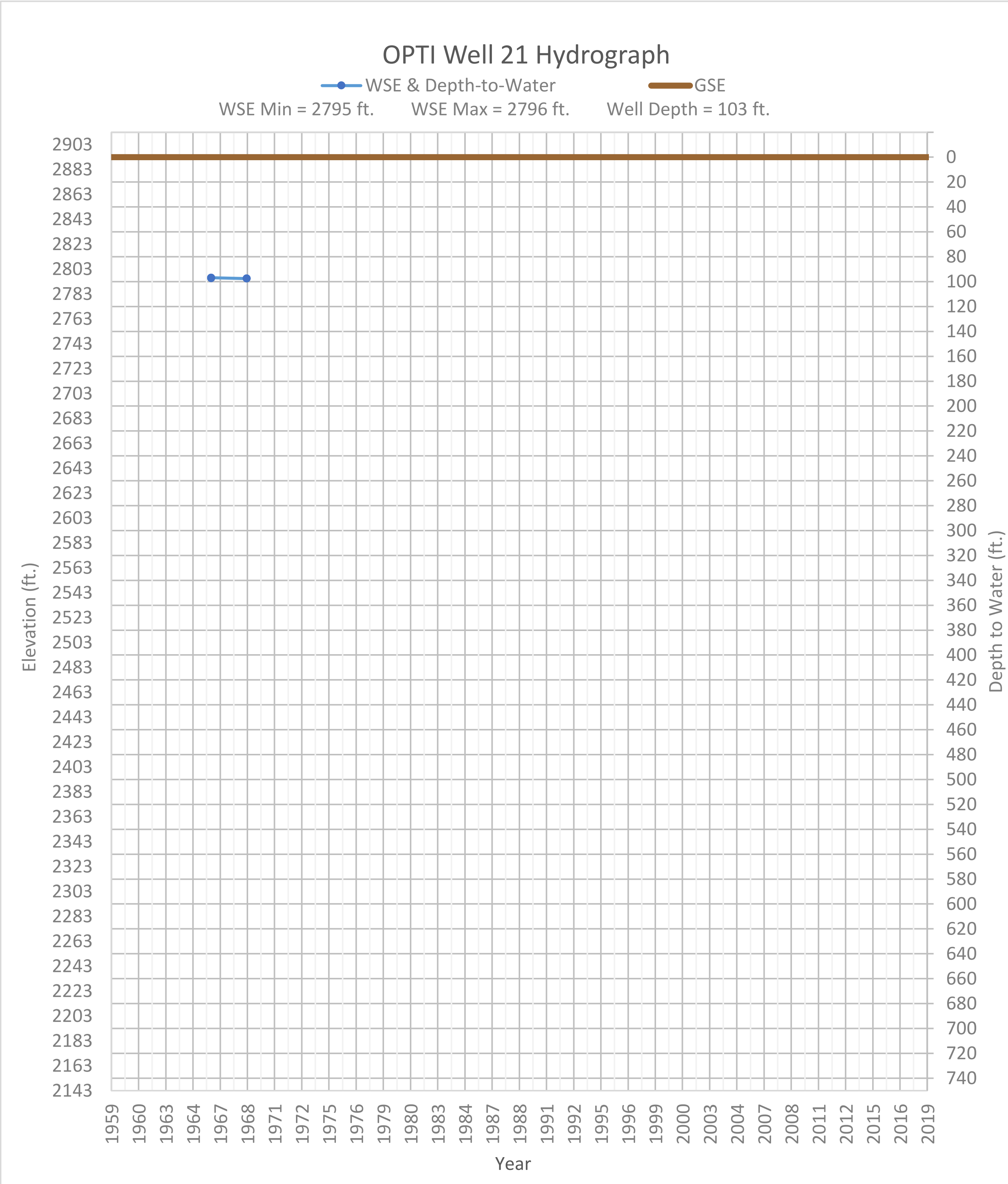
OPTI Well 18 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1838 ft.
WSE Max = 1862 ft.
Well Depth = 63 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 19 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1681 ft.
WSE Max = 1682 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 20 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1711 ft.
WSE Max = 1711 ft.
Well Depth = 56 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 21 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2795 ft.
WSE Max = 2796 ft.
Well Depth = 103 ft.
Elevation (ft.)
2903
2883
2863
2843
2823
2803
2783
2763
2743
2723
2703
2683
2663
2643
2623
2603
2583
2563
2543
2523
2503
2483
2463
2443
2423
2403
2383
2363
2343
2323
2303
2283
2263
2243
2223
2203
2183
2163
2143
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
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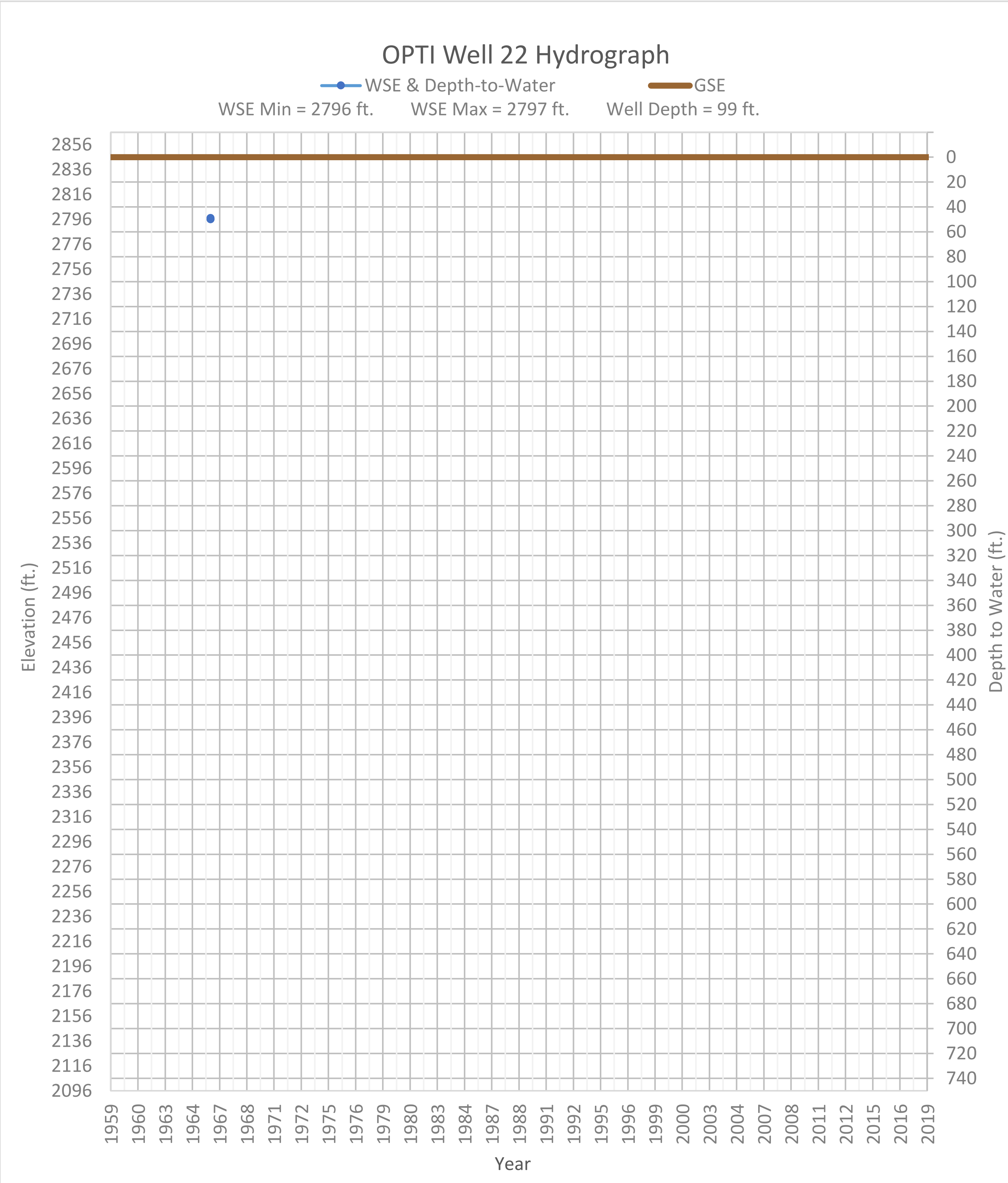
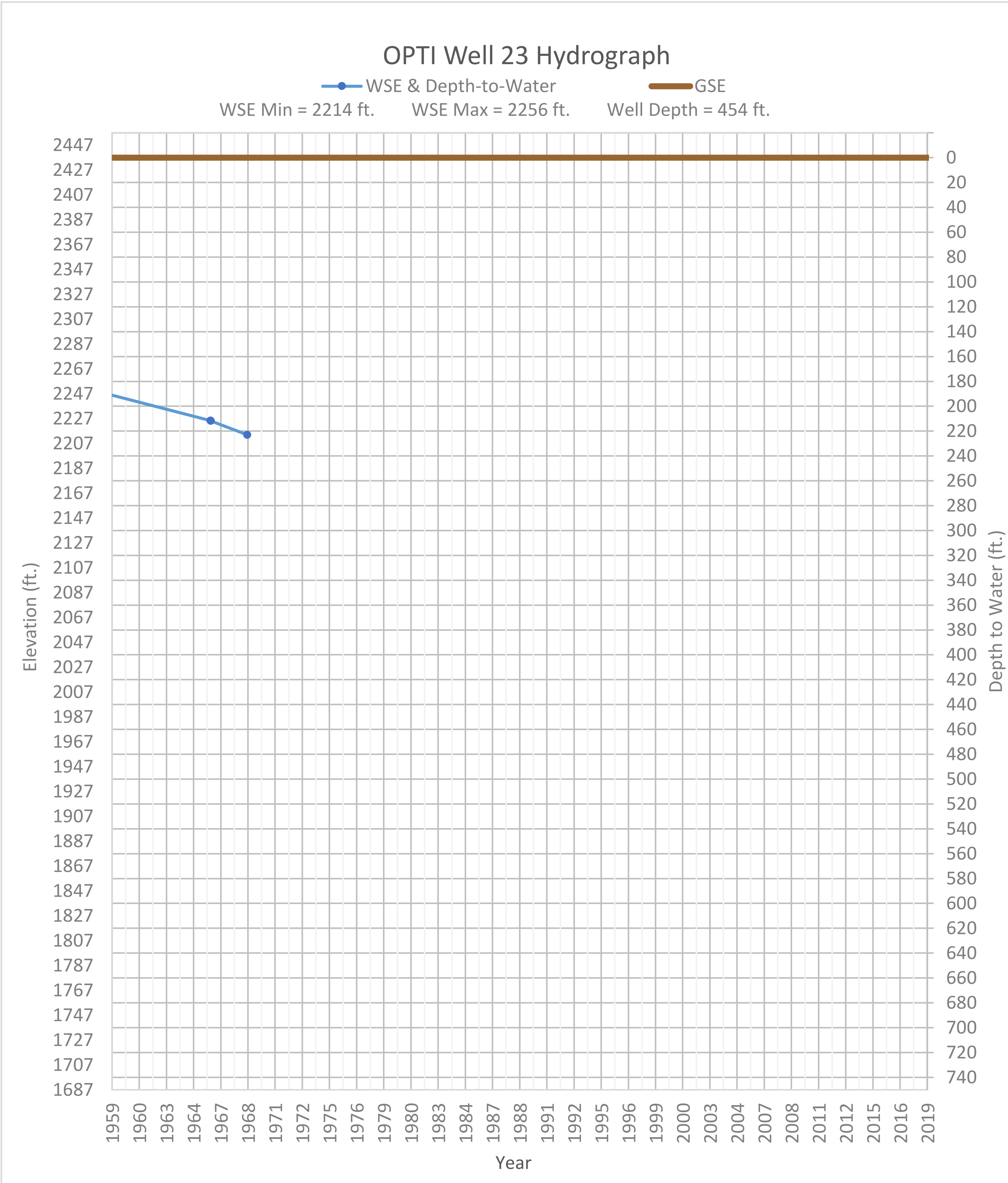
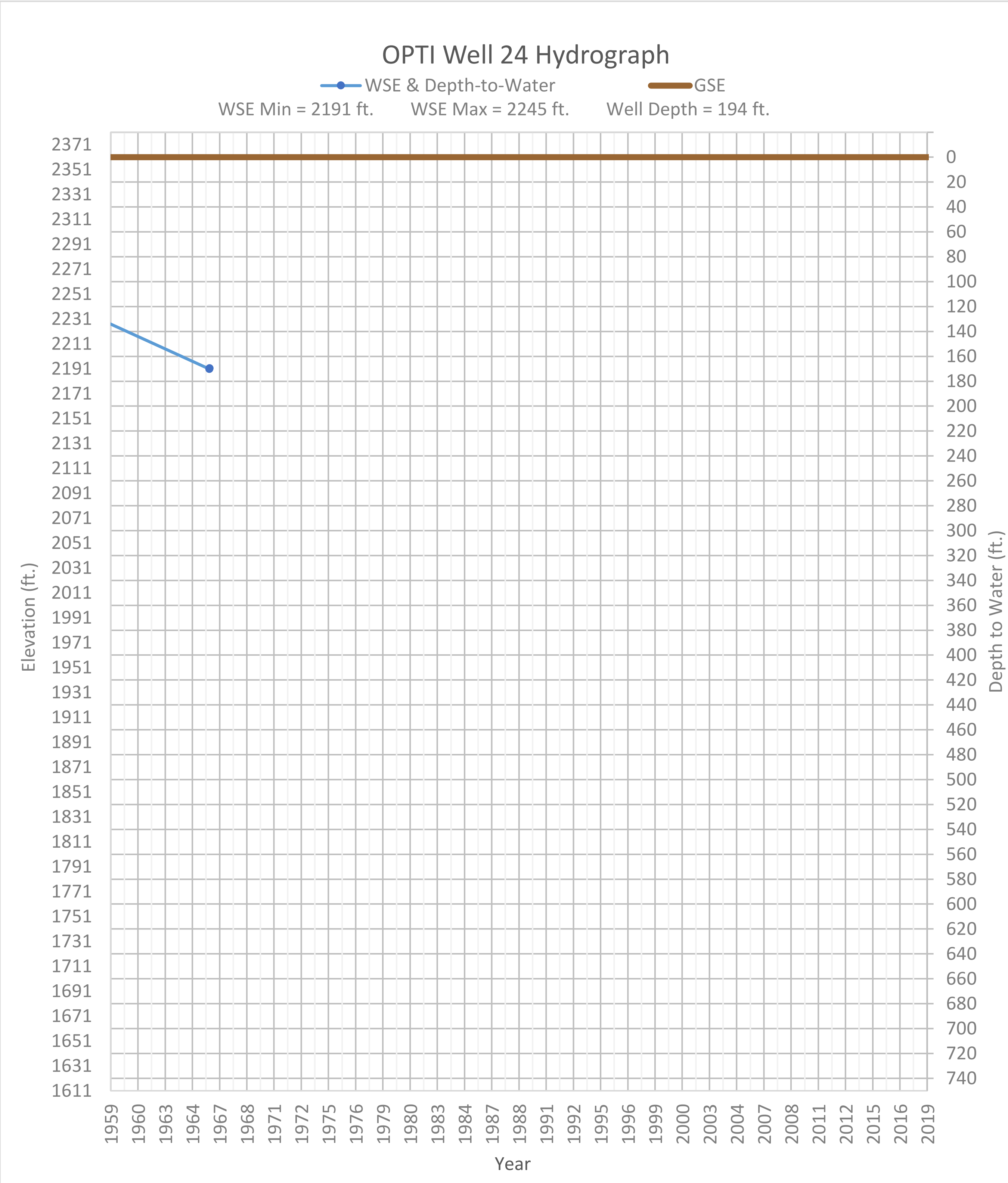


OPTI Well 22 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2796 ft.
WSE Max = 2797 ft.
Well Depth = 99 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 23 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2214 ft.
WSE Max = 2256 ft.
Well Depth = 454 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 24 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2191 ft.
WSE Max = 2245 ft.
Well Depth = 194 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2371
2351
2331
2311
2291
2271
2251
2231
2211
2191
2171
2151
2131
2111
2091
2071
2051
2031
2011
1991
1971
1951
1931
1911
1891
1871
1851
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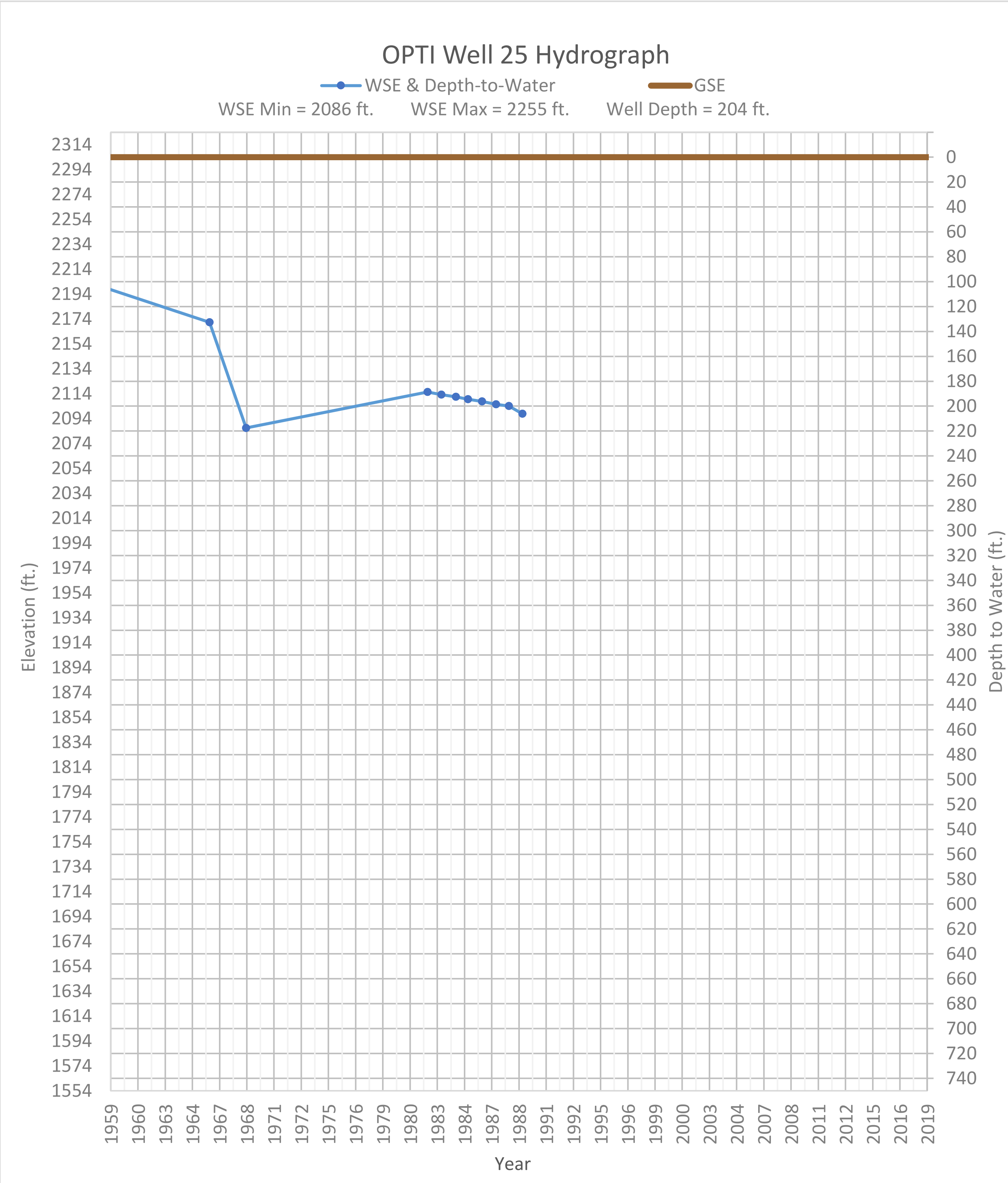
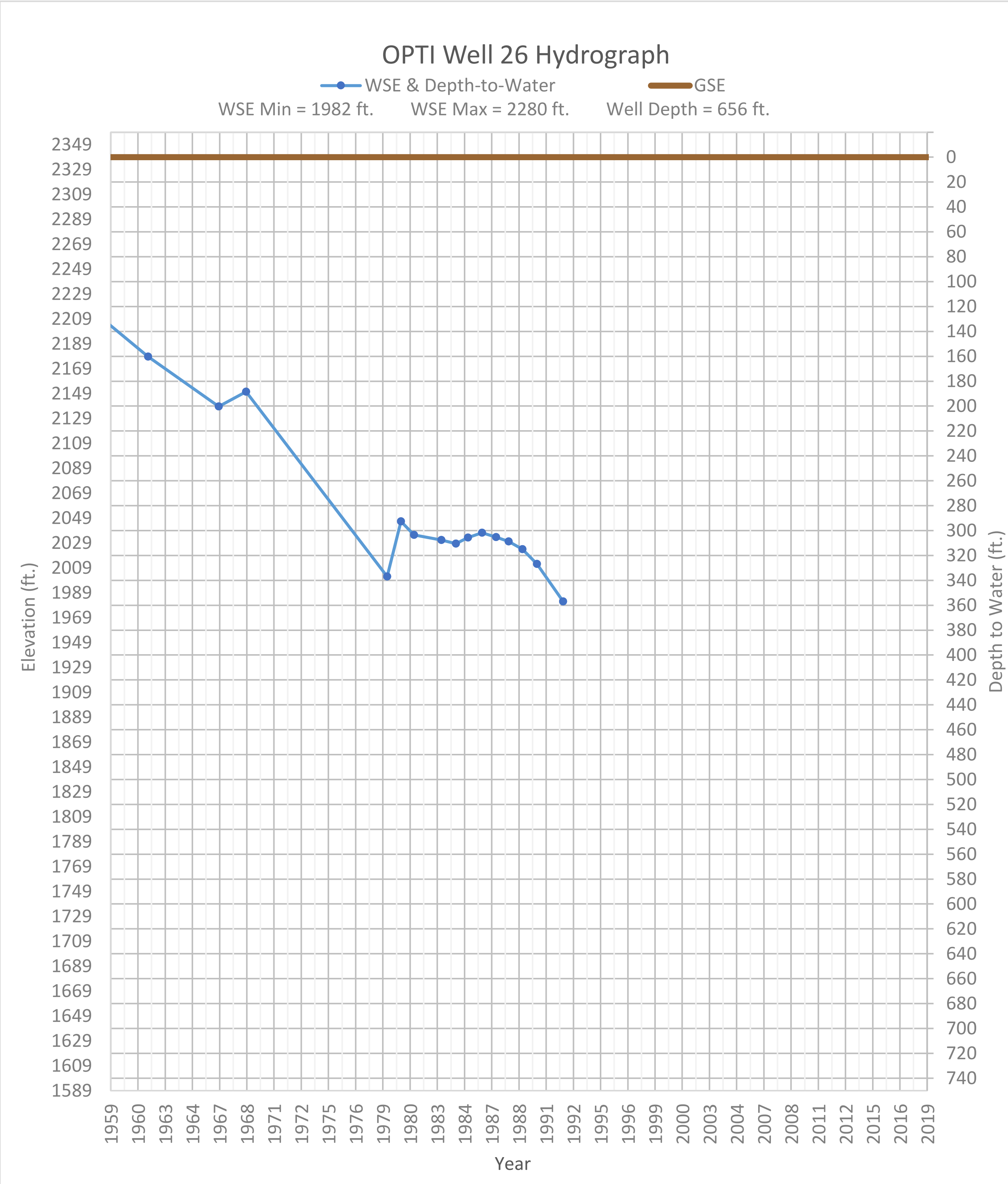

OPTI Well 25 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2086 ft.
WSE Max = 2255 ft.
Well Depth = 204 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 26 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1982 ft.
WSE Max = 2280 ft.
Well Depth = 656 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2349
2329
2309
2289
2269
2249
2229
2209
2189
2169
2149
2129
2109
2089
2069
2049
2029
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1989
1969
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1909
1889
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1609
1589
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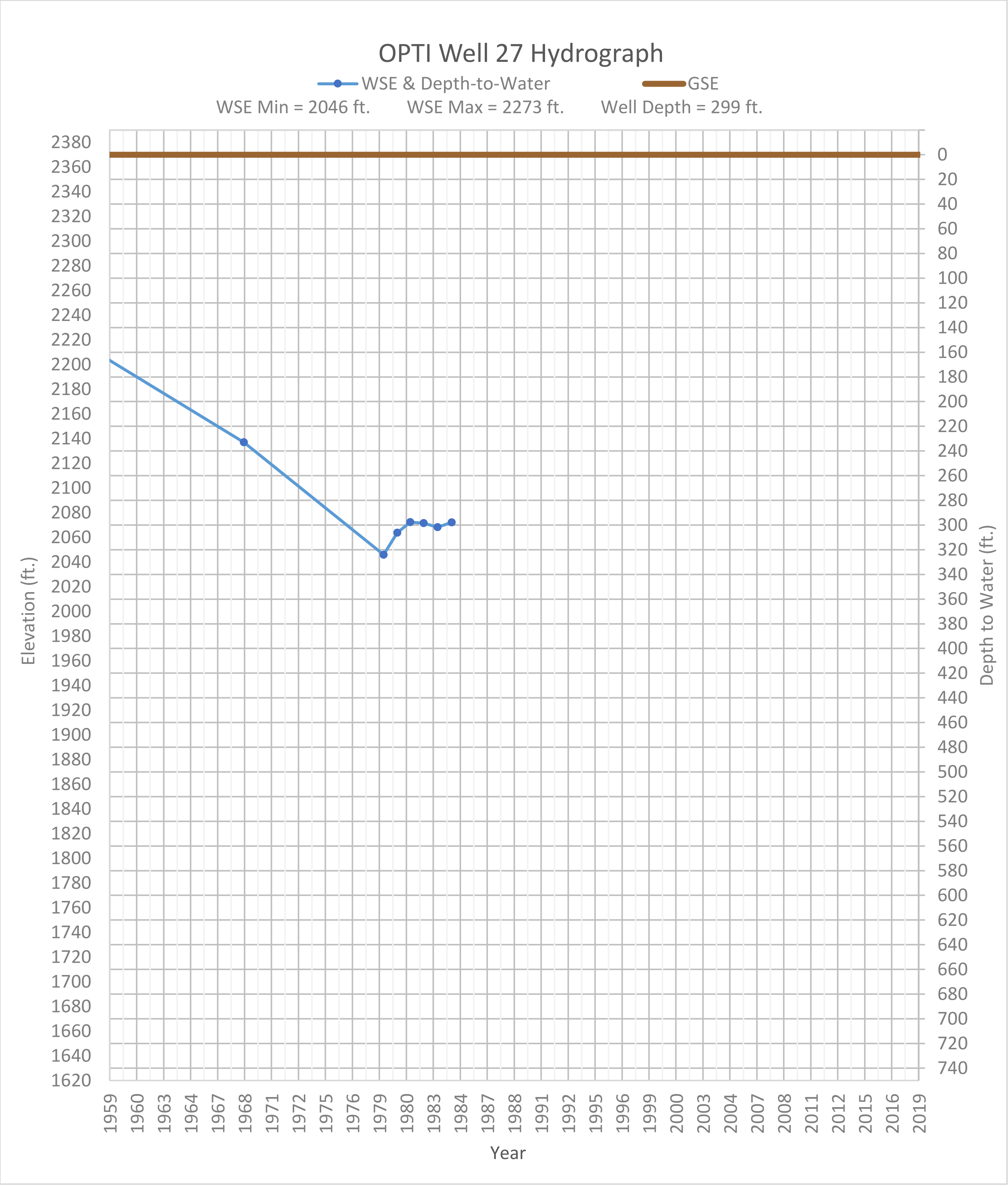
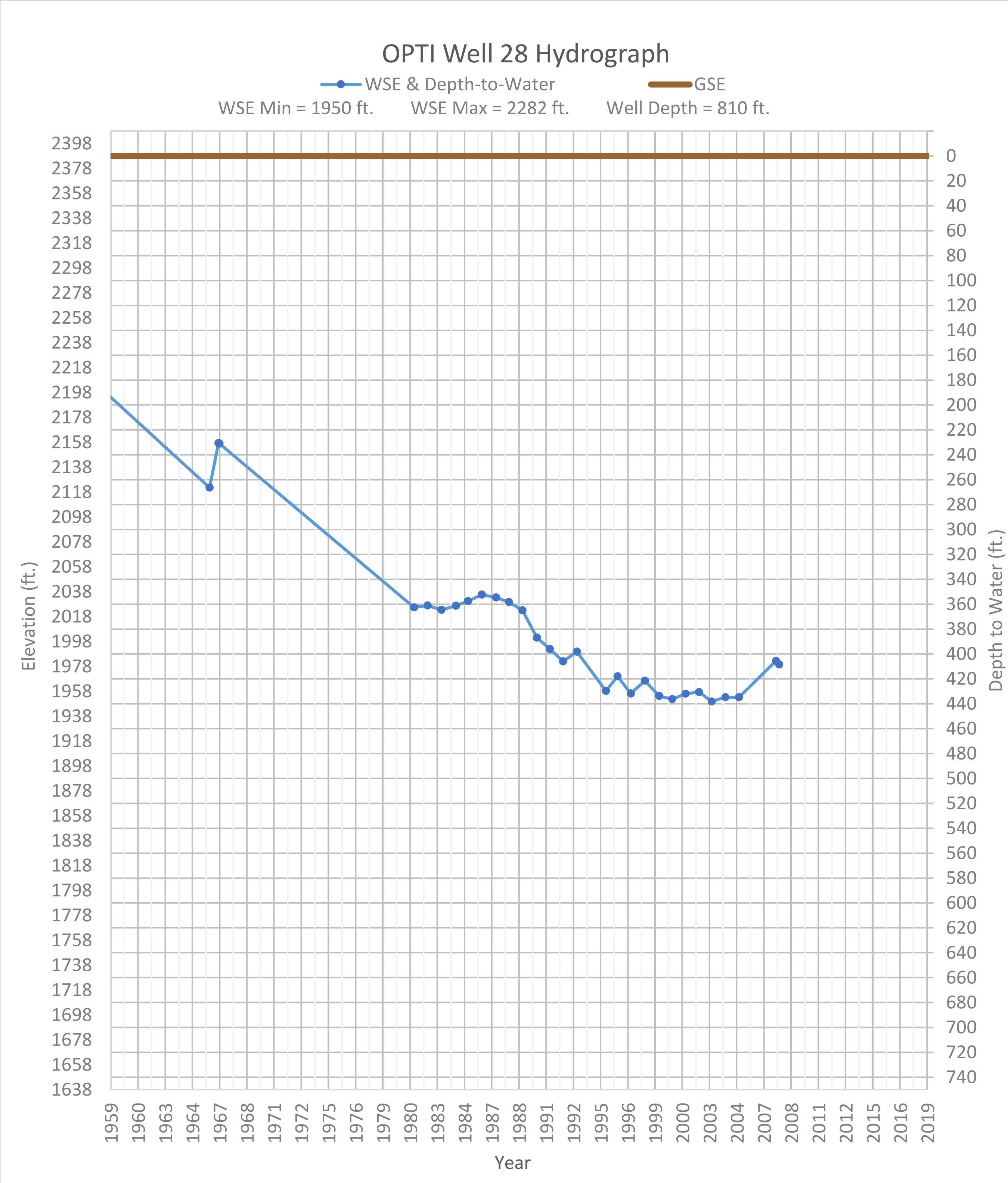
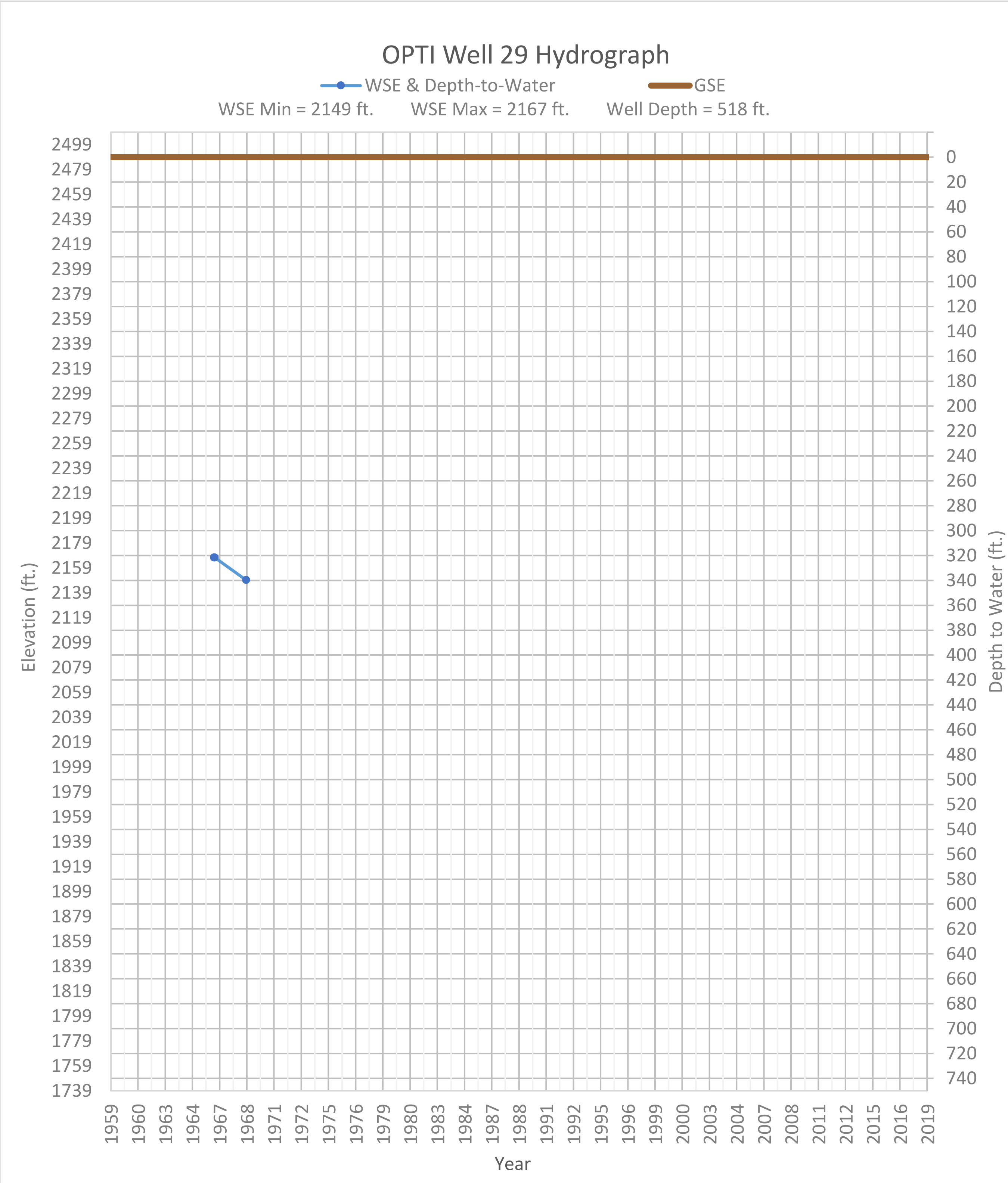
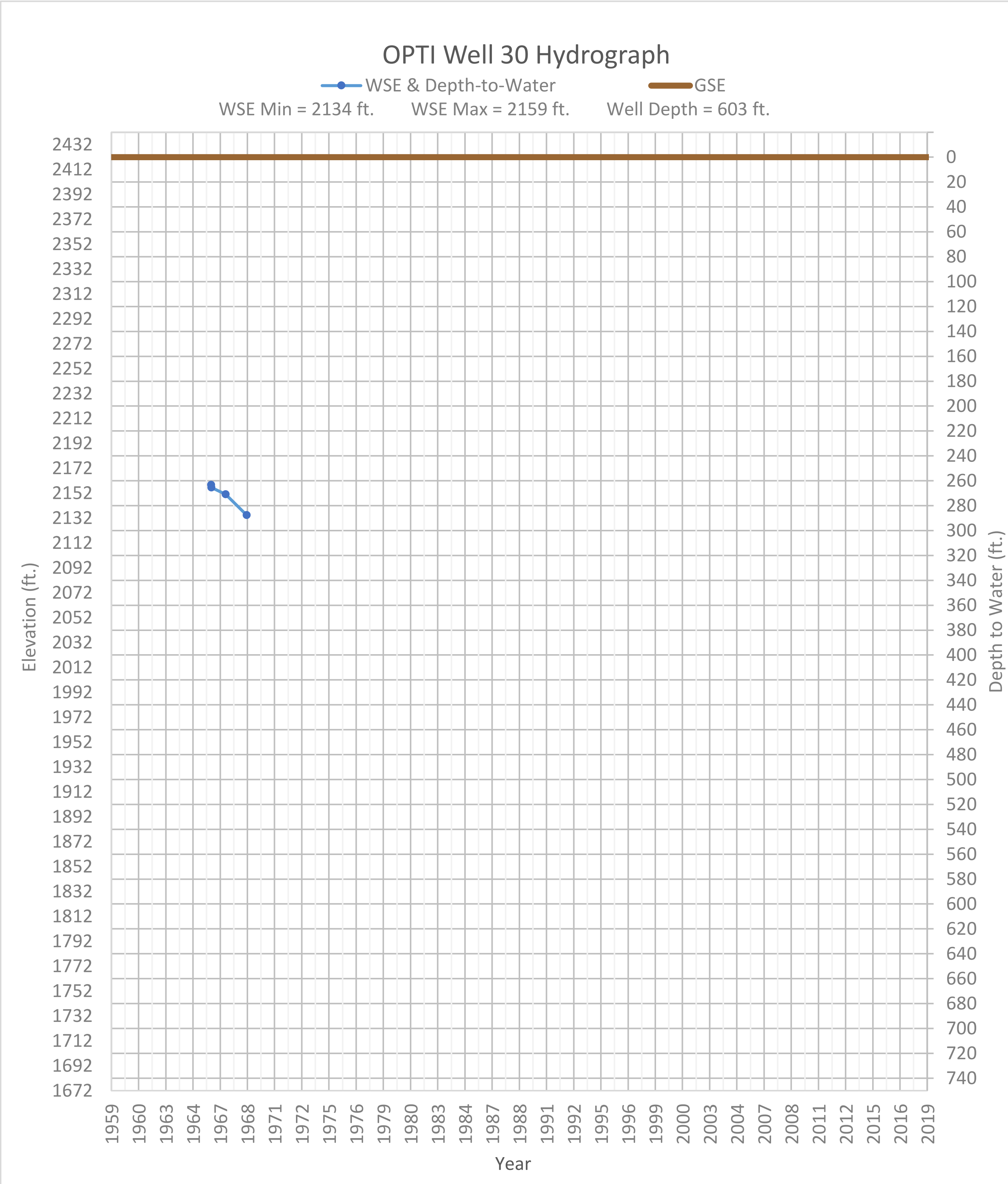

OPTI Well 27 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2046 ft.
WSE Max = 2273 ft.
Well Depth = 299 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 28 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1950 ft.
WSE Max = 2282 ft.
Well Depth = 810 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 29 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2149 ft.
WSE Max = 2167 ft.
Well Depth = 518 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 30 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2134 ft.
WSE Max = 2159 ft.
Well Depth = 603 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2432
2412
2392
2372
2352
2332
2312
2292
2272
2252
2232
2212
2192
2172
2152
2132
2112
2092
2072
2052
2032
2012
1992
1972
1952
1932
1912
1892
1872
1852
1832
1812
1792
1772
1752
1732
1712
1692
1672
0
20
40
60
80
100
120
140
160
180
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220
240
260
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380
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1959
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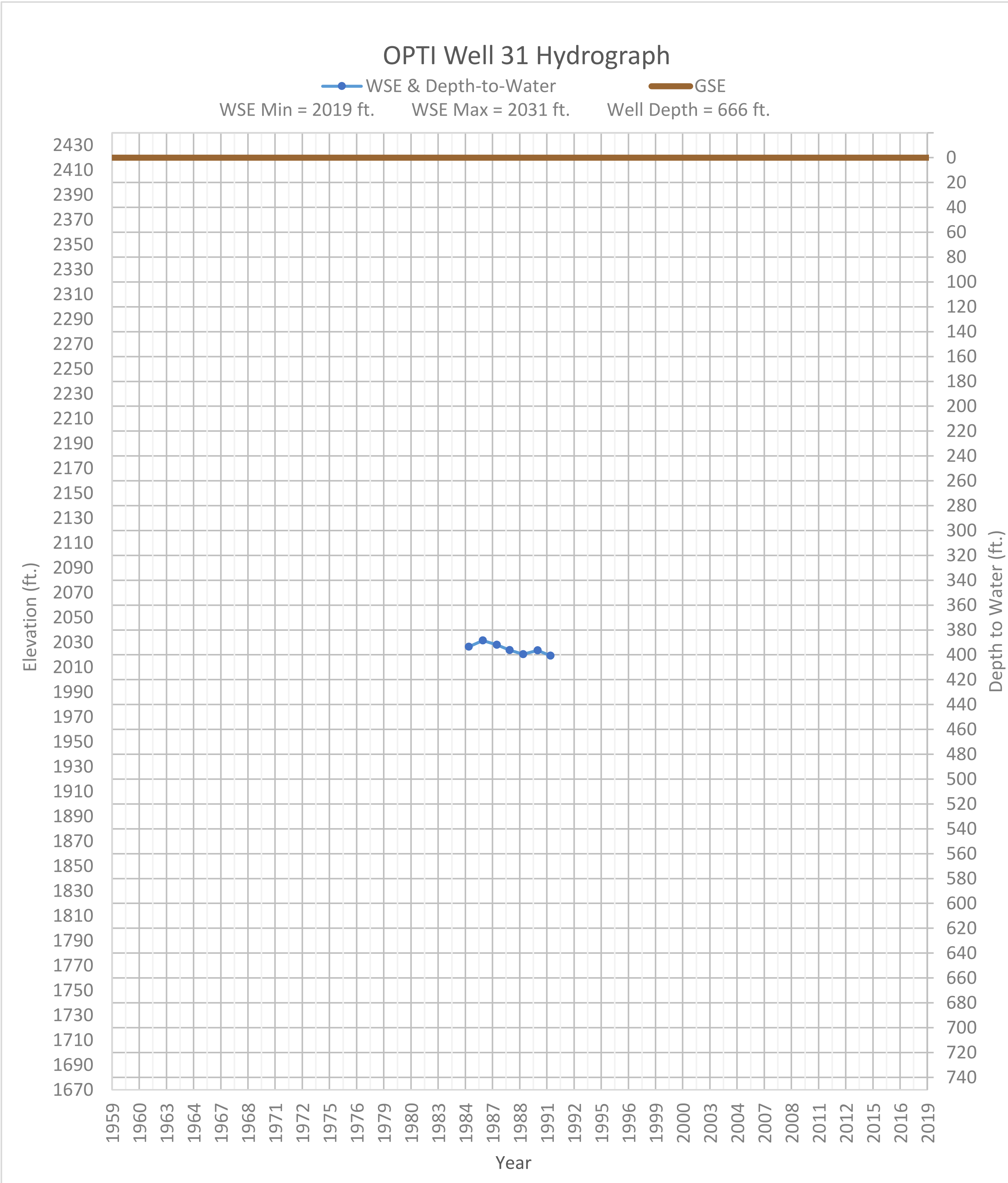
2011
2012
2015
2016
2019


OPTI Well 31 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2019 ft.
WSE Max = 2031 ft.
Well Depth = 666 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2430
2410
2390
2370
2350
2330
2310
2290
2270
2250
2230
2210
2190
2170
2150
2130
2110
2090
2070
2050
2030
2010
1990
1970
1950
1930
1910
1890
1870
1850
1830
1810
1790
1770
1750
1730
1710
1690
1670
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
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540
560
580
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620
640
660
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1959
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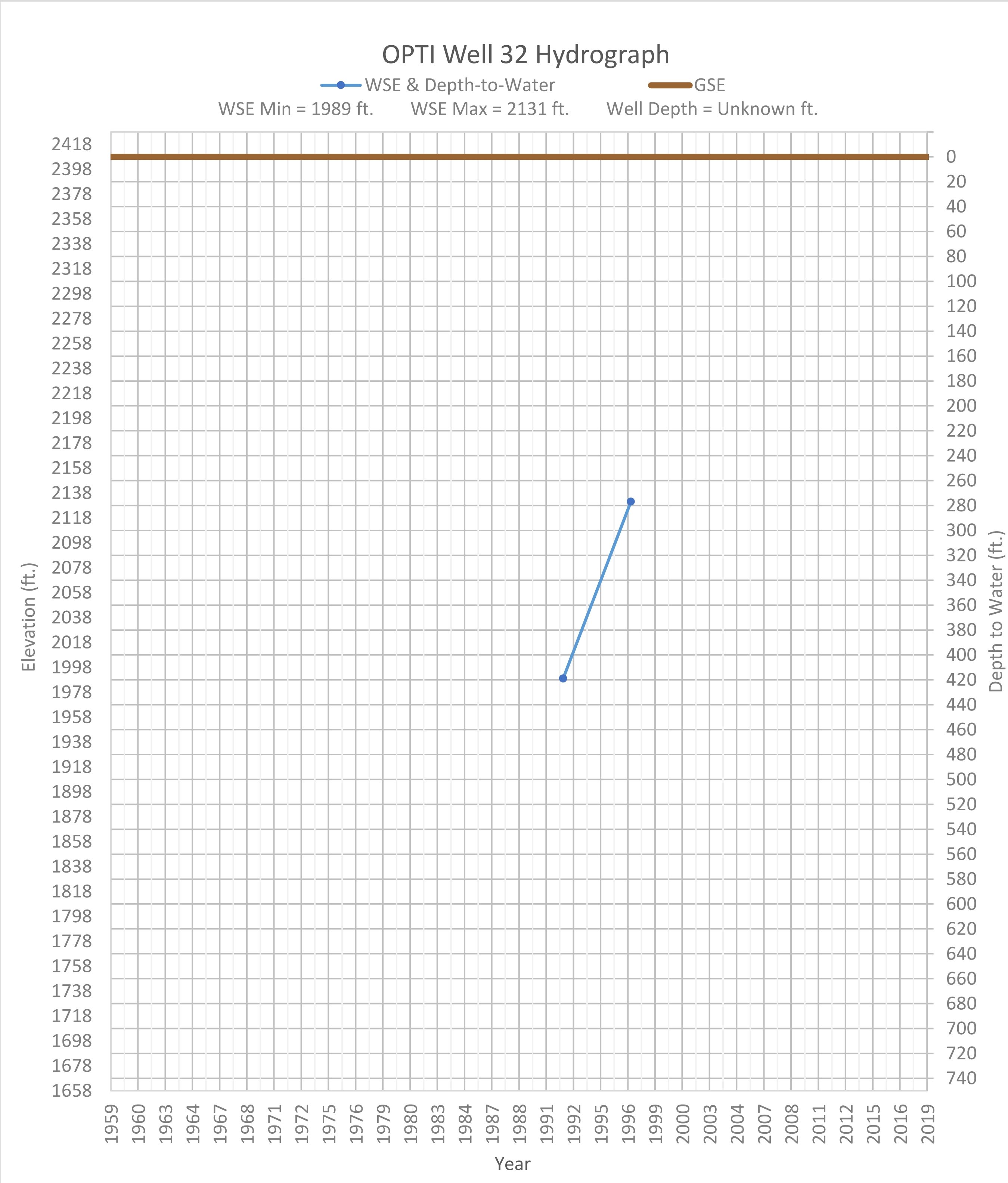
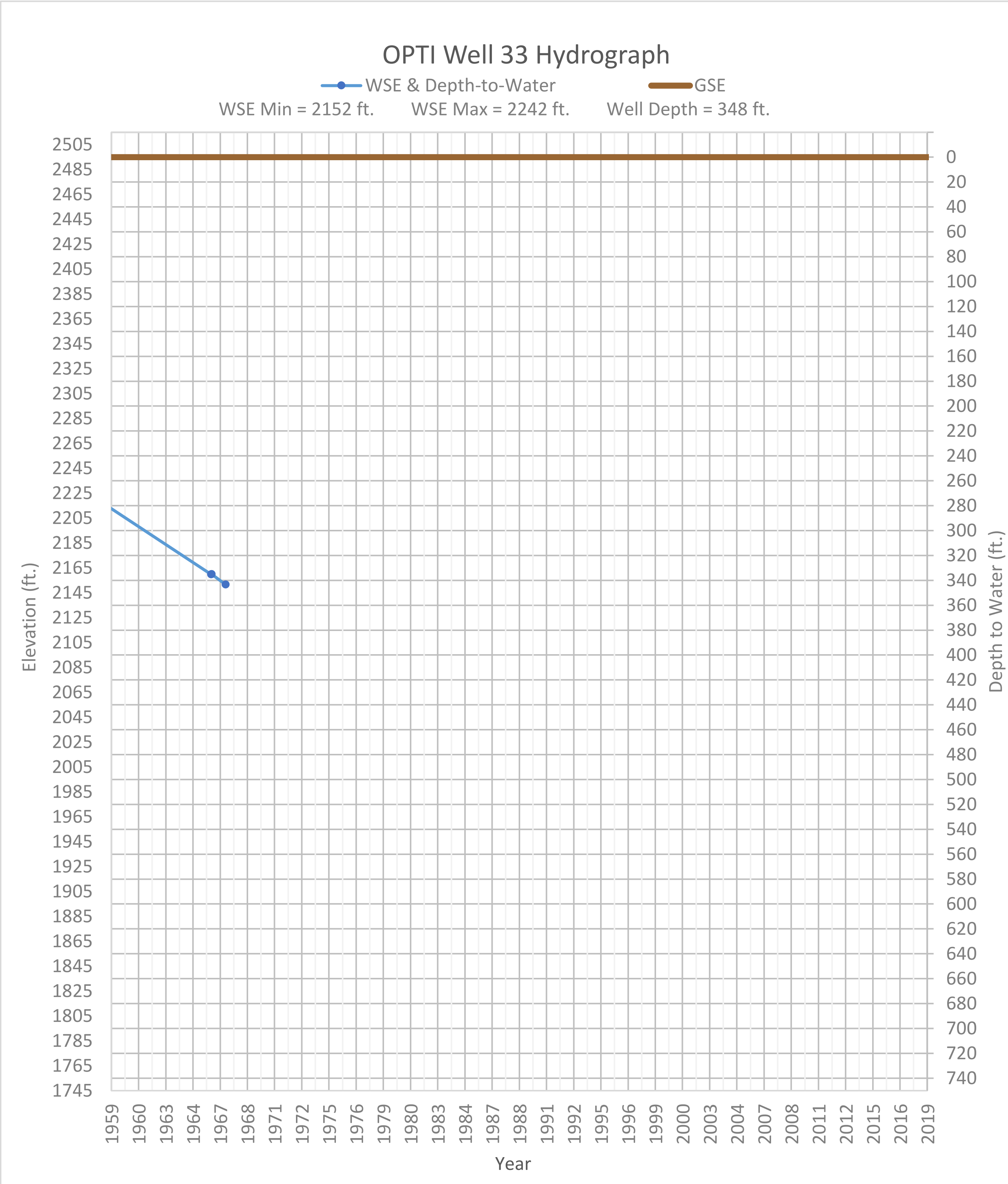
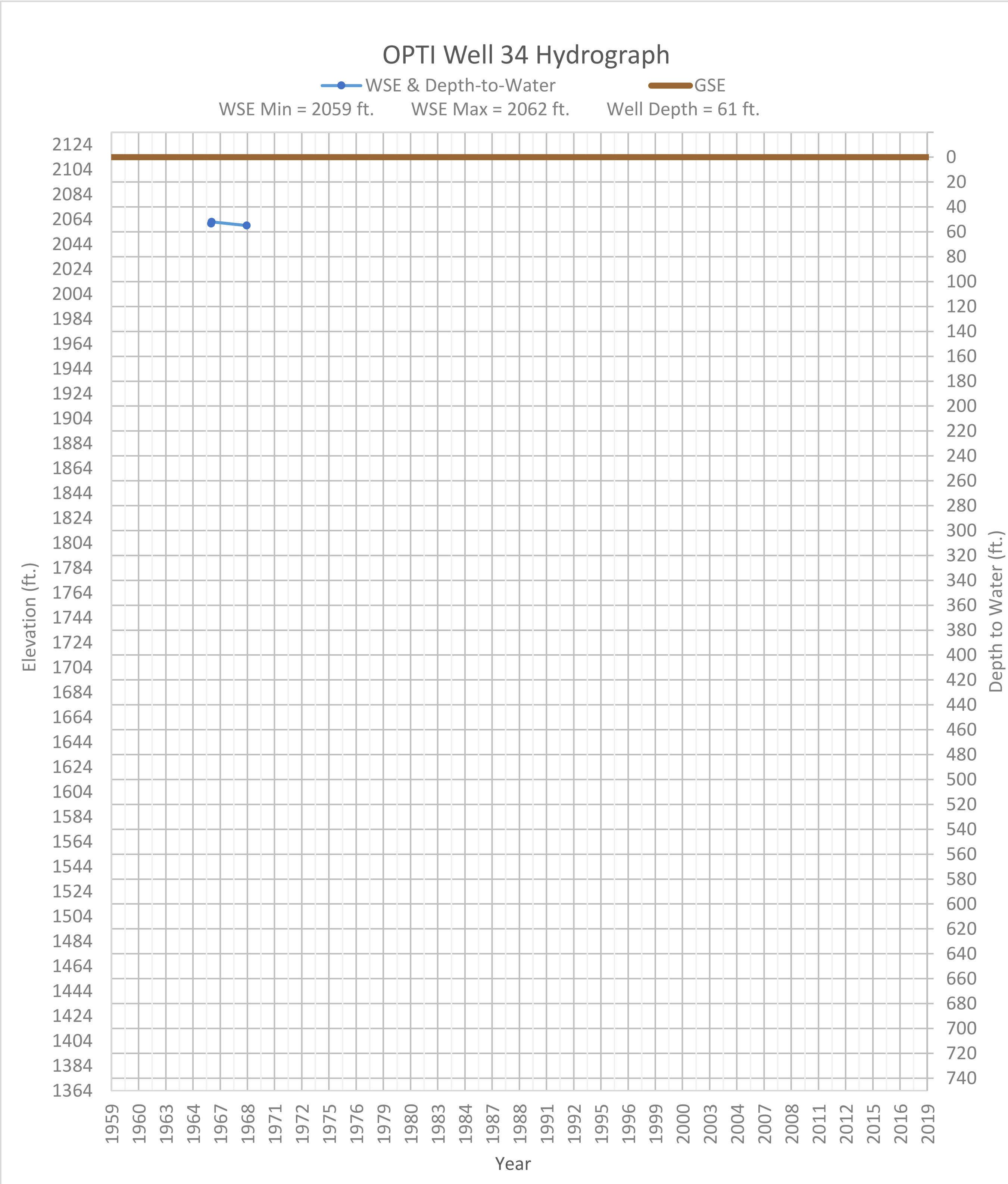
2011
2012
2015
2016
2019



OPTI Well 32 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1989 ft.
WSE Max = 2131 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 33 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2152 ft.
WSE Max = 2242 ft.
Well Depth = 348 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 34 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2059 ft.
WSE Max = 2062 ft.
Well Depth = 61 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2124
2104
2084
2064
2044
2024
2004
1984
1964
1944
1924
1904
1884
1864
1844
1824
1804
1784
1764
1744
1724
1704
1684
1664
1644
1624
1604
1584
1564
1544
1524
1504
1484
1464
1444
1424
1404
1384
1364
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80
100
120
140
160
180
200
220
240
260
280
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340
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380
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420
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460
480
500
520
540
560
580
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640
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680
700
720
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1959
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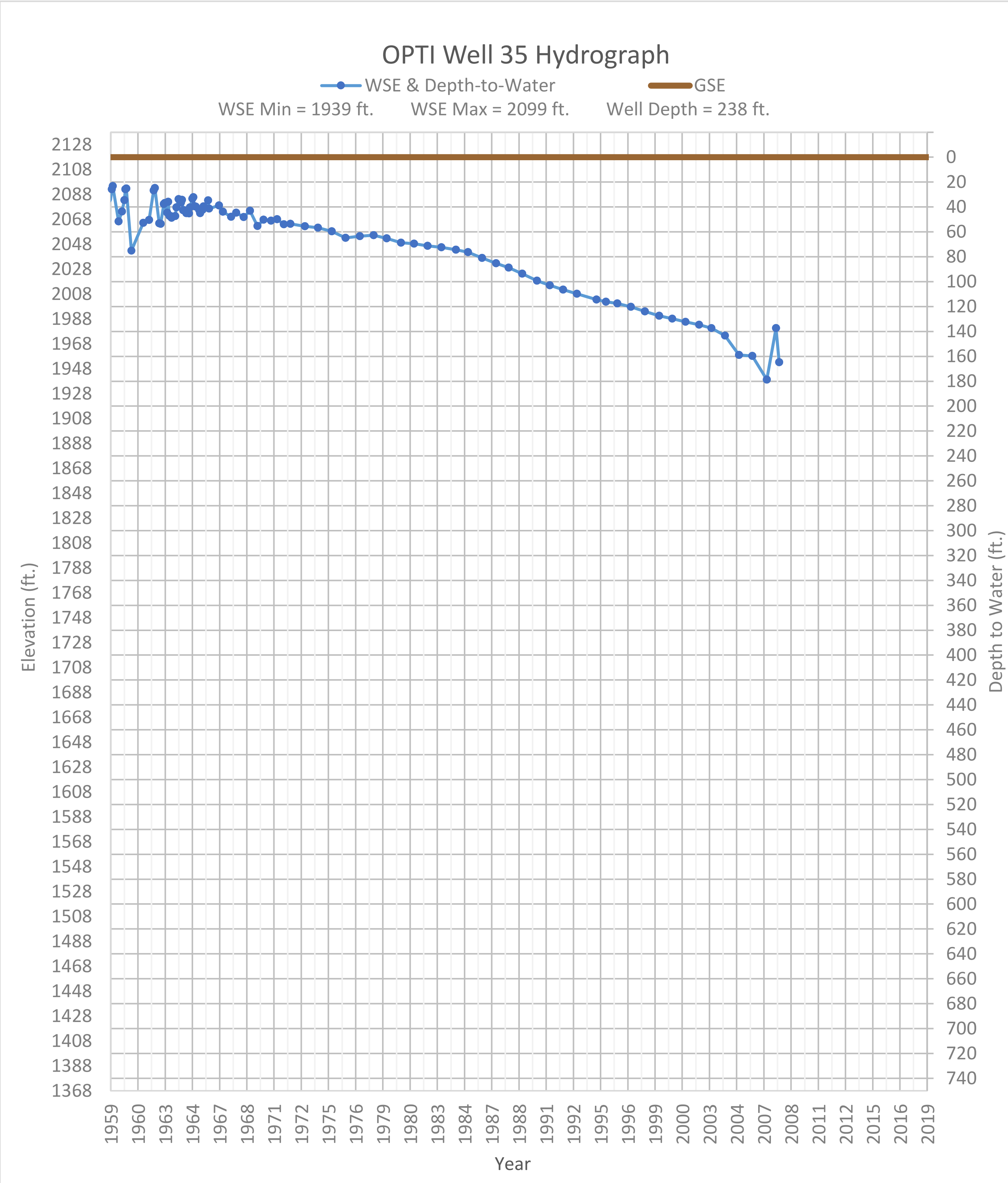
OPTI Well 35 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1939 ft.
WSE Max = 2099 ft.
Well Depth = 238 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2128
2108
2088
2068
2048
2028
2008
1988
1968
1948
1928
1908
1888
1868
1848
1828
1808
1788
1768
1748
1728
1708
1688
1668
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1628
1608
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1568
1548
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1468
1448
1428
1408
1388
1368
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120
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160
180
200
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1959
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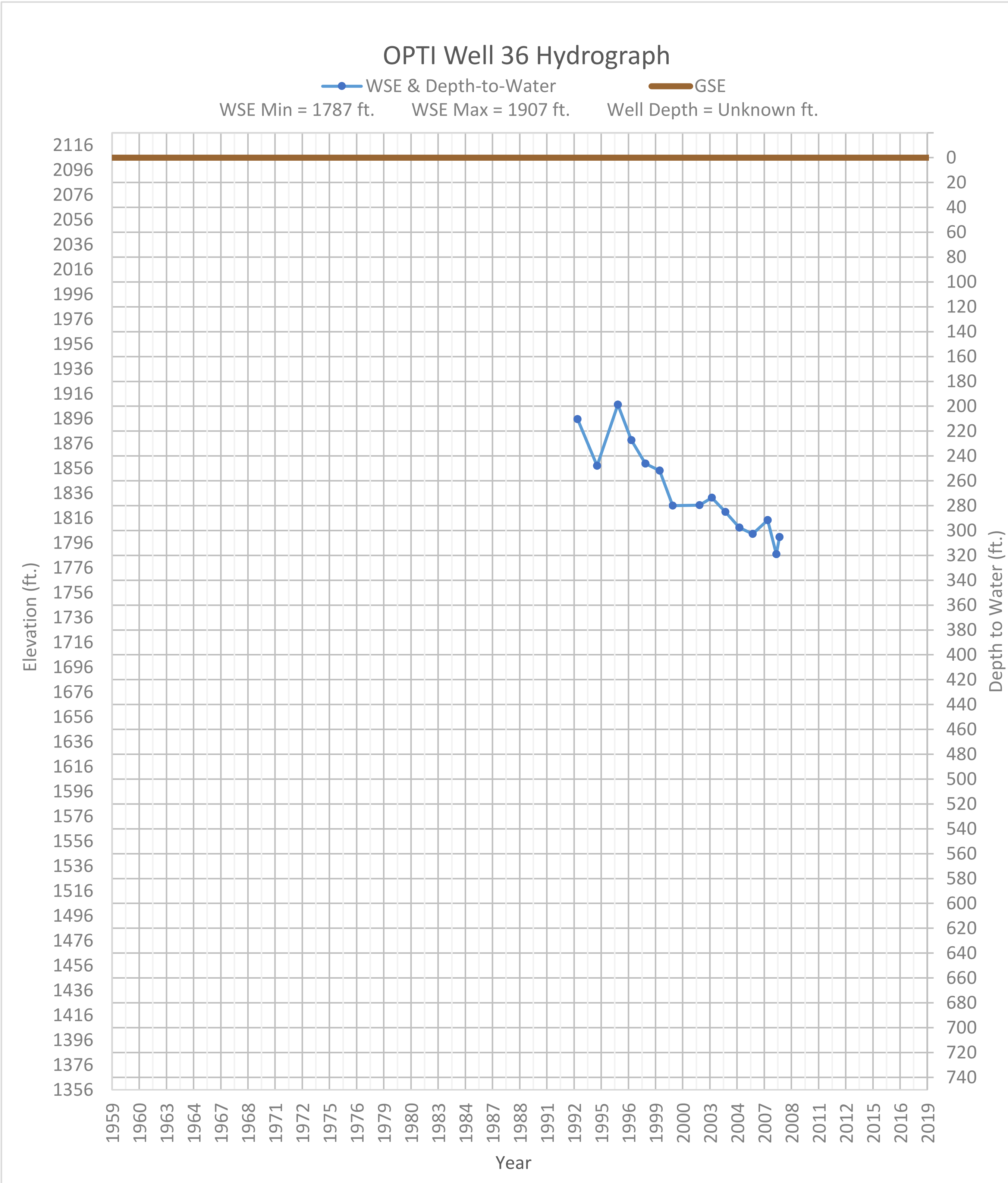
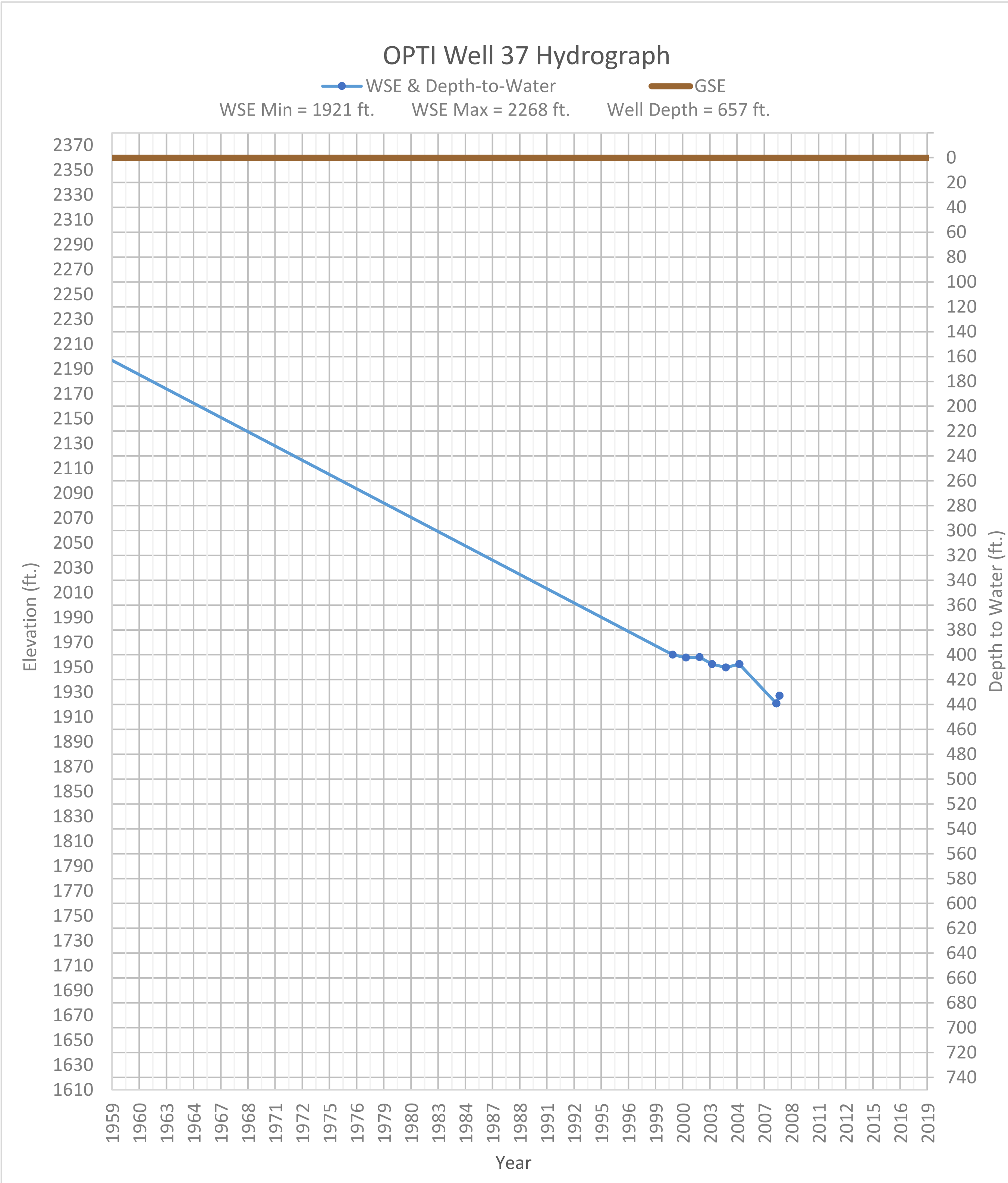
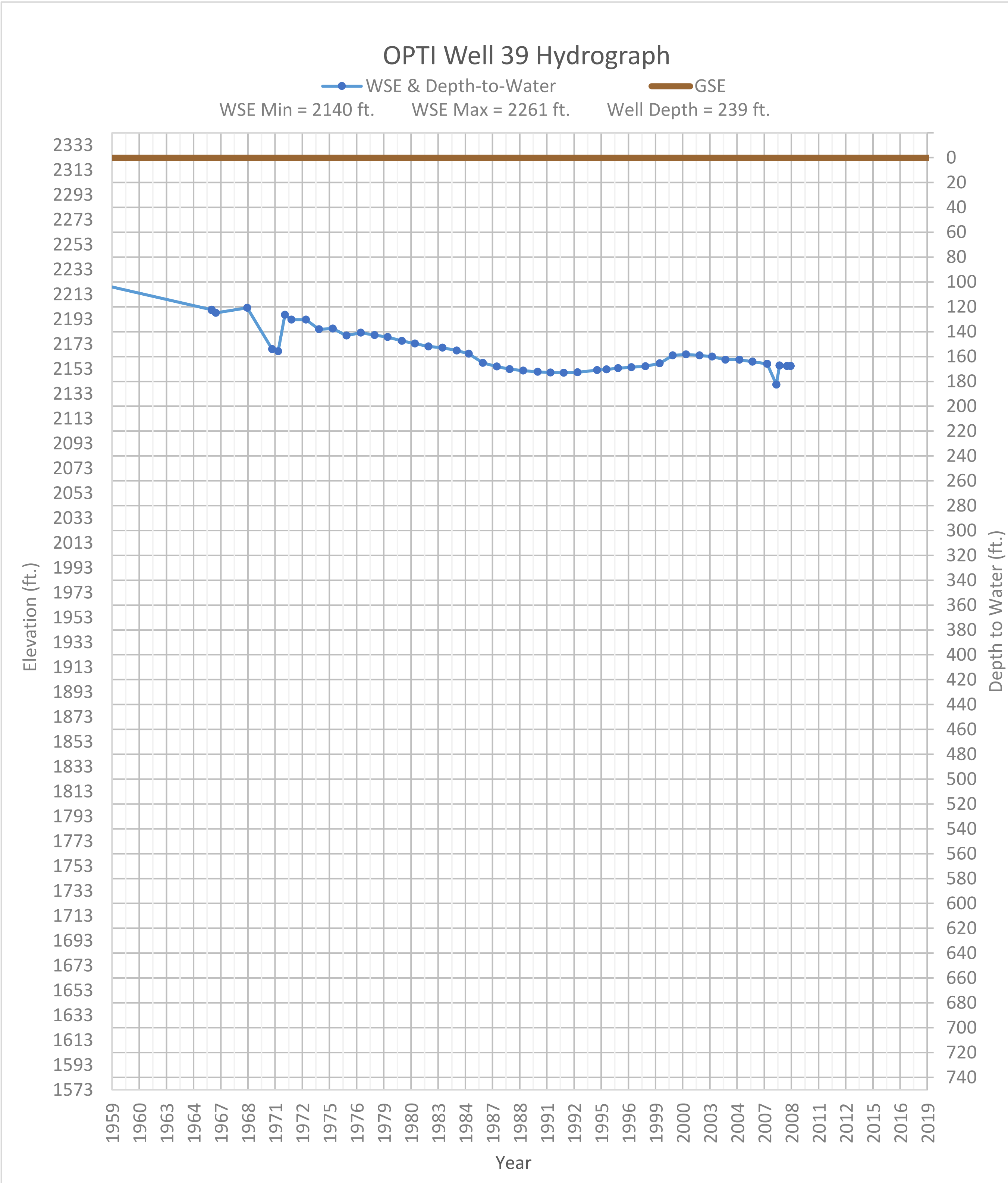
2019



OPTI Well 36 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1787 ft.
WSE Max = 1907 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 37 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1921 ft.
WSE Max = 2268 ft.
Well Depth = 657 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 38 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1917 ft.
WSE Max = 2239 ft.
Well Depth = 450 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 39 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2140 ft.
WSE Max = 2261 ft.
Well Depth = 239 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2333
2313
2293
2273
2253
2233
2213
2193
2173
2153
2133
2113
2093
2073
2053
2033
2013
1993
1973
1953
1933
1913
1893
1873
1853
1833
1813
1793
1773
1753
1733
1713
1693
1673
1653
1633
1613
1593
1573
0
20
40
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80
100
120
140
160
180
200
220
240
260
280
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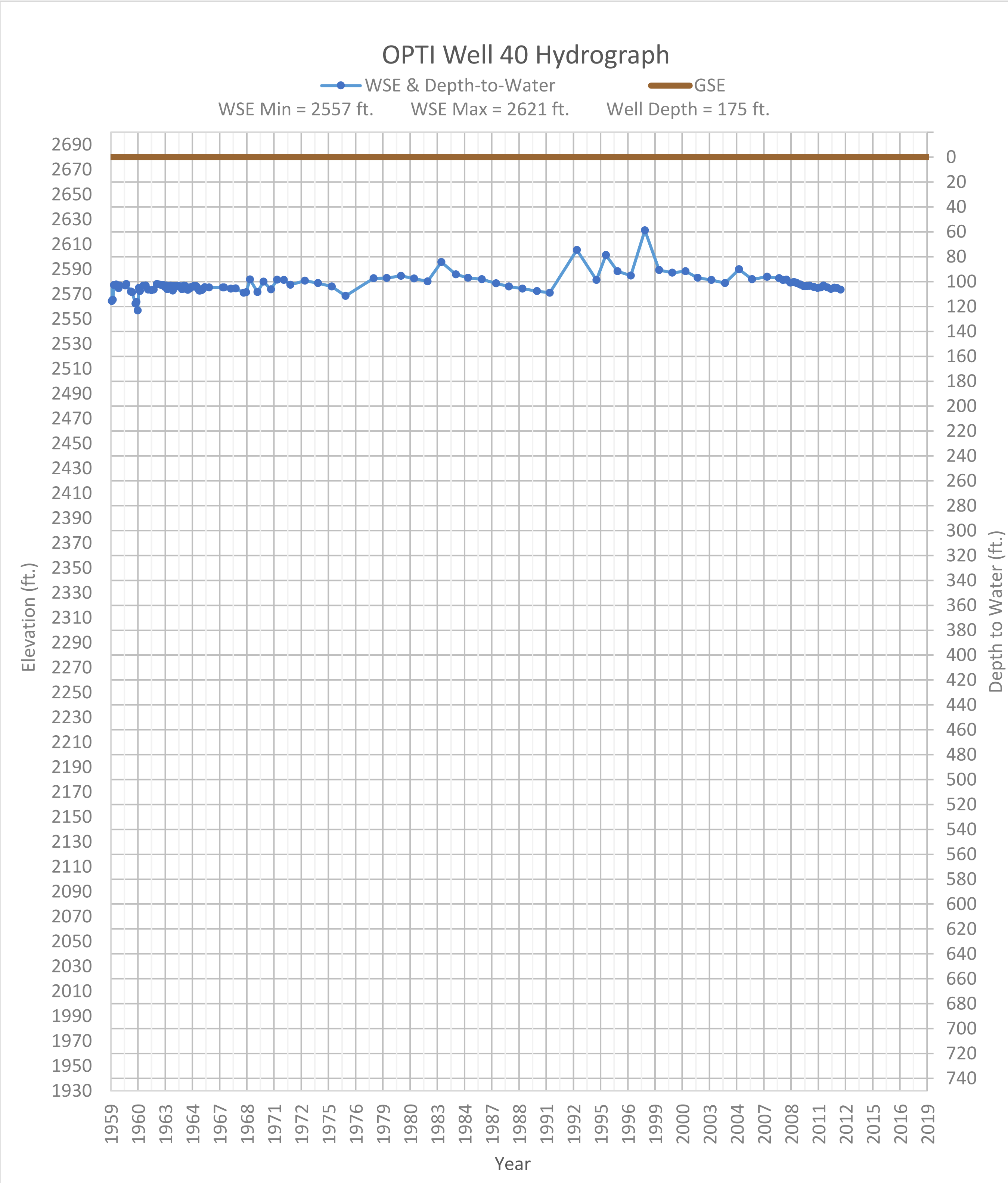
OPTI Well 40 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2557 ft.
WSE Max = 2621 ft.
Well Depth = 175 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2690
2670
2650
2630
2610
2590
2570
2550
2530
2510
2490
2470
2450
2430
2410
2390
2370
2350
2330
2310
2290
2270
2250
2230
2210
2190
2170
2150
2130
2110
2090
2070
2050
2030
2010
1990
1970
1950
1930
0
20
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120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
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520
540
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640
660
680
700
720
740
1959
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2011
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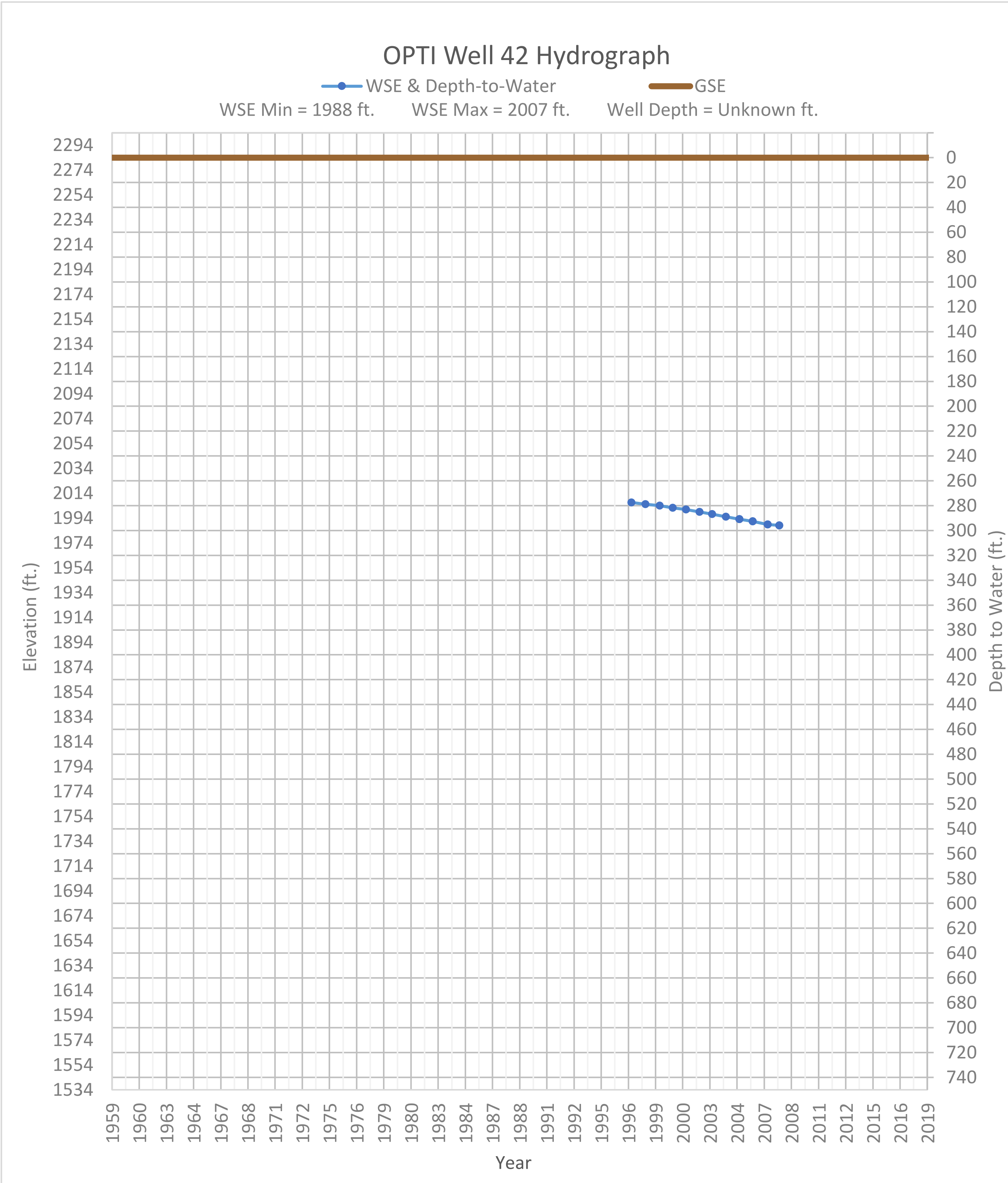
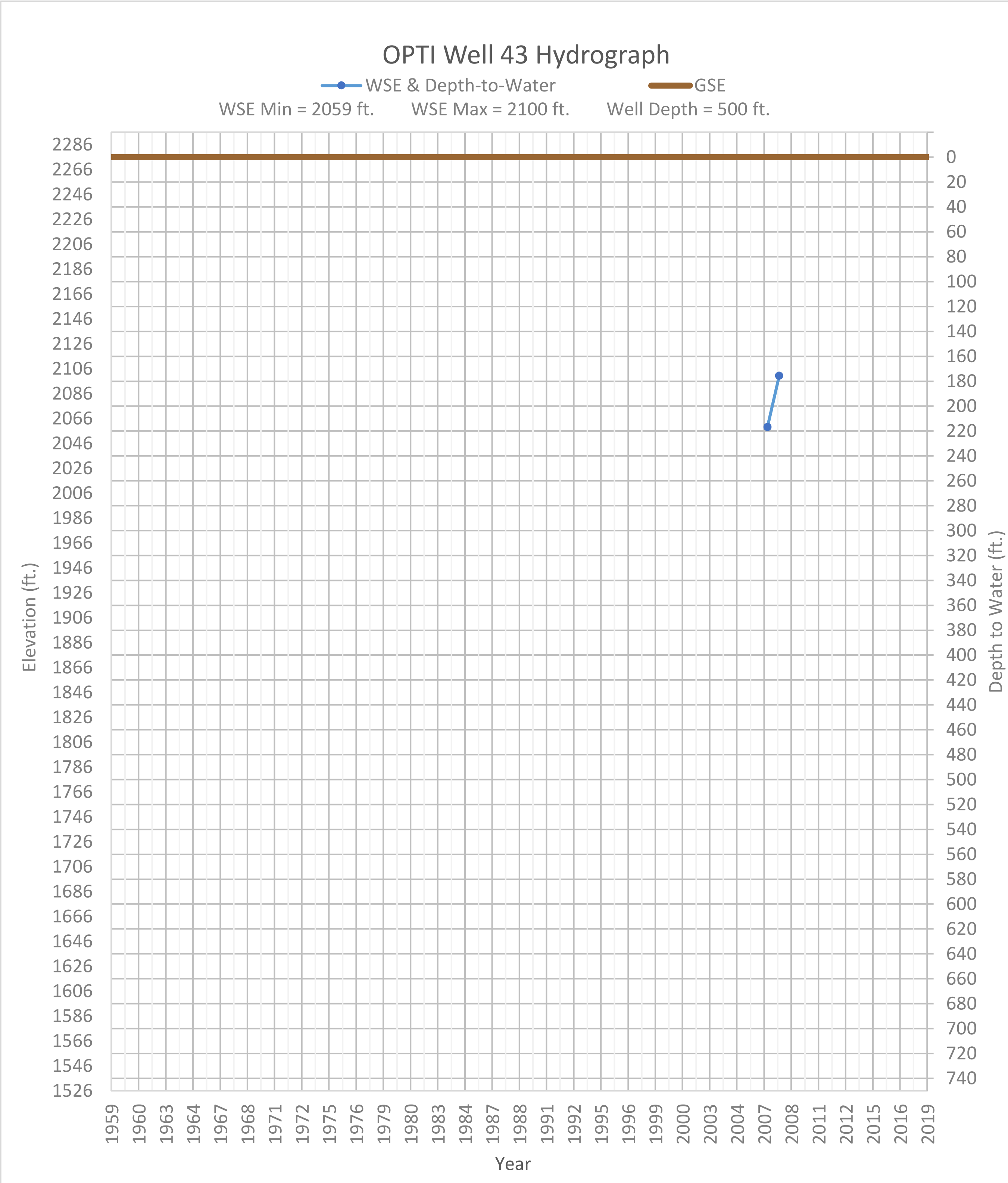
2016
2019


OPTI Well 41 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2743 ft.
WSE Max = 2799 ft.
Well Depth = 95 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 42 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1988 ft.
WSE Max = 2007 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 43 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2059 ft.
WSE Max = 2100 ft.
Well Depth = 500 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
1786
1766
1746
1726
1706
1686
1666
1646
1626
1606
1586
1566
1546
1526
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
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420
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460
480
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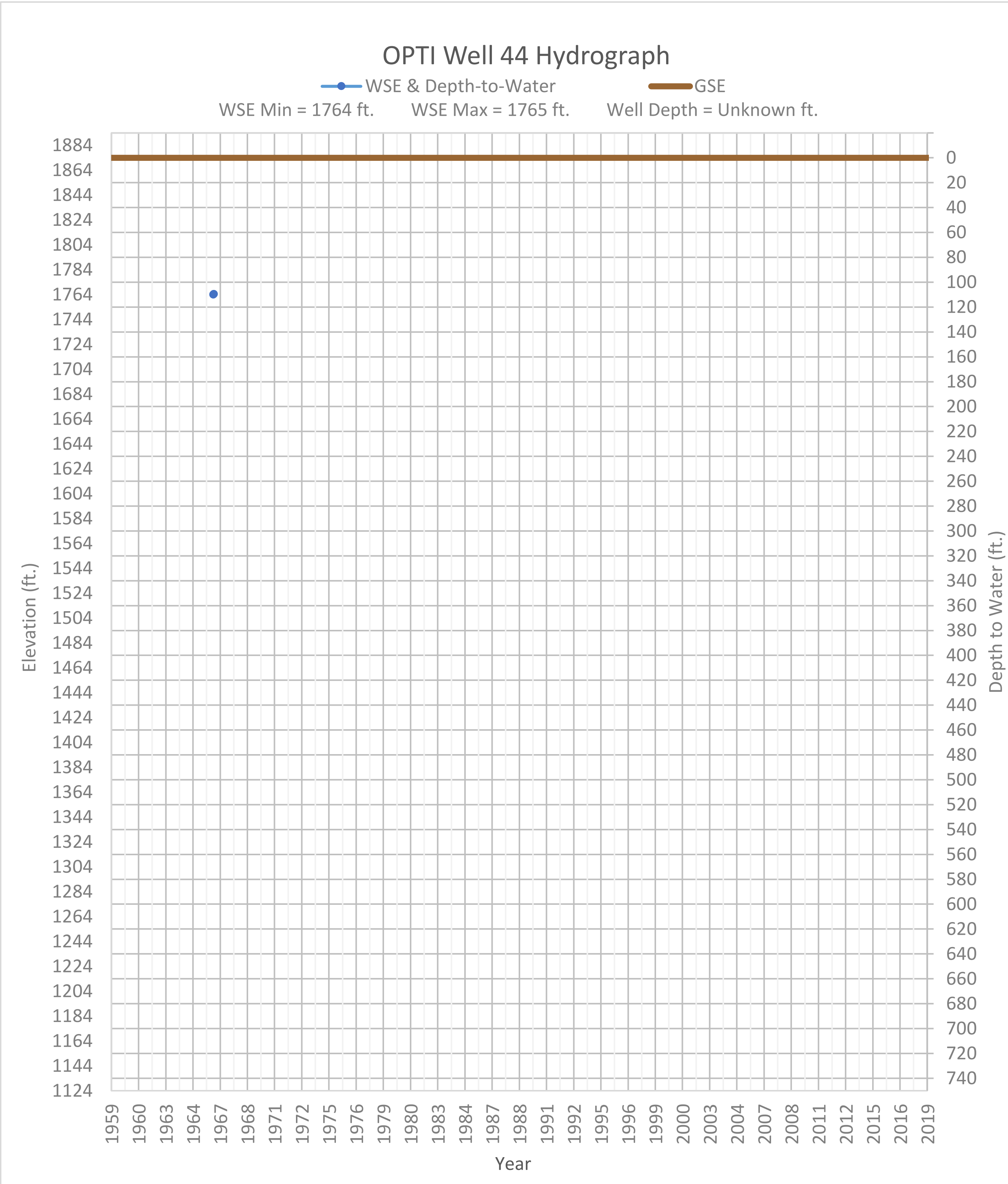
2016
2019



OPTI Well 44 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1764 ft.
WSE Max = 1765 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1884
1864
1844
1824
1804
1784
1764
1744
1724
1704
1684
1664
1644
1624
1604
1584
1564
1544
1524
1504
1484
1464
1444
1424
1404
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1344
1324
1304
1284
1264
1244
1224
1204
1184
1164
1144
1124
0
20
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80
100
120
140
160
180
200
220
240
260
280
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320
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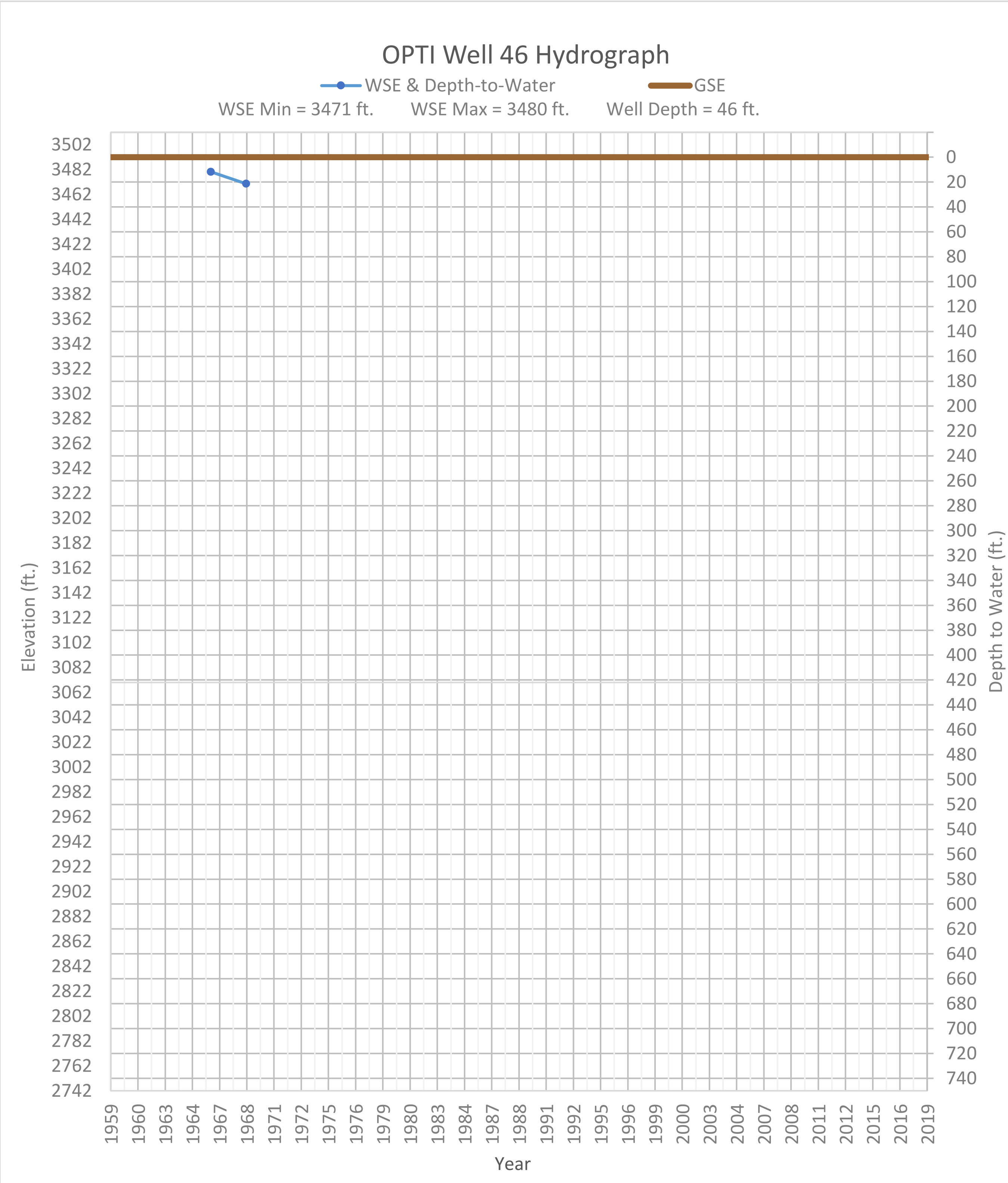
2019



OPTI Well 46 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3471 ft.
WSE Max = 3480 ft.
Well Depth = 46 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3502
3482
3462
3442
3422
3402
3382
3362
3342
3322
3302
3282
3262
3242
3222
3202
3182
3162
3142
3122
3102
3082
3062
3042
3022
3002
2982
2962
2942
2922
2902
2882
2862
2842
2822
2802
2782
2762
2742
0
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60
80
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160
180
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1959
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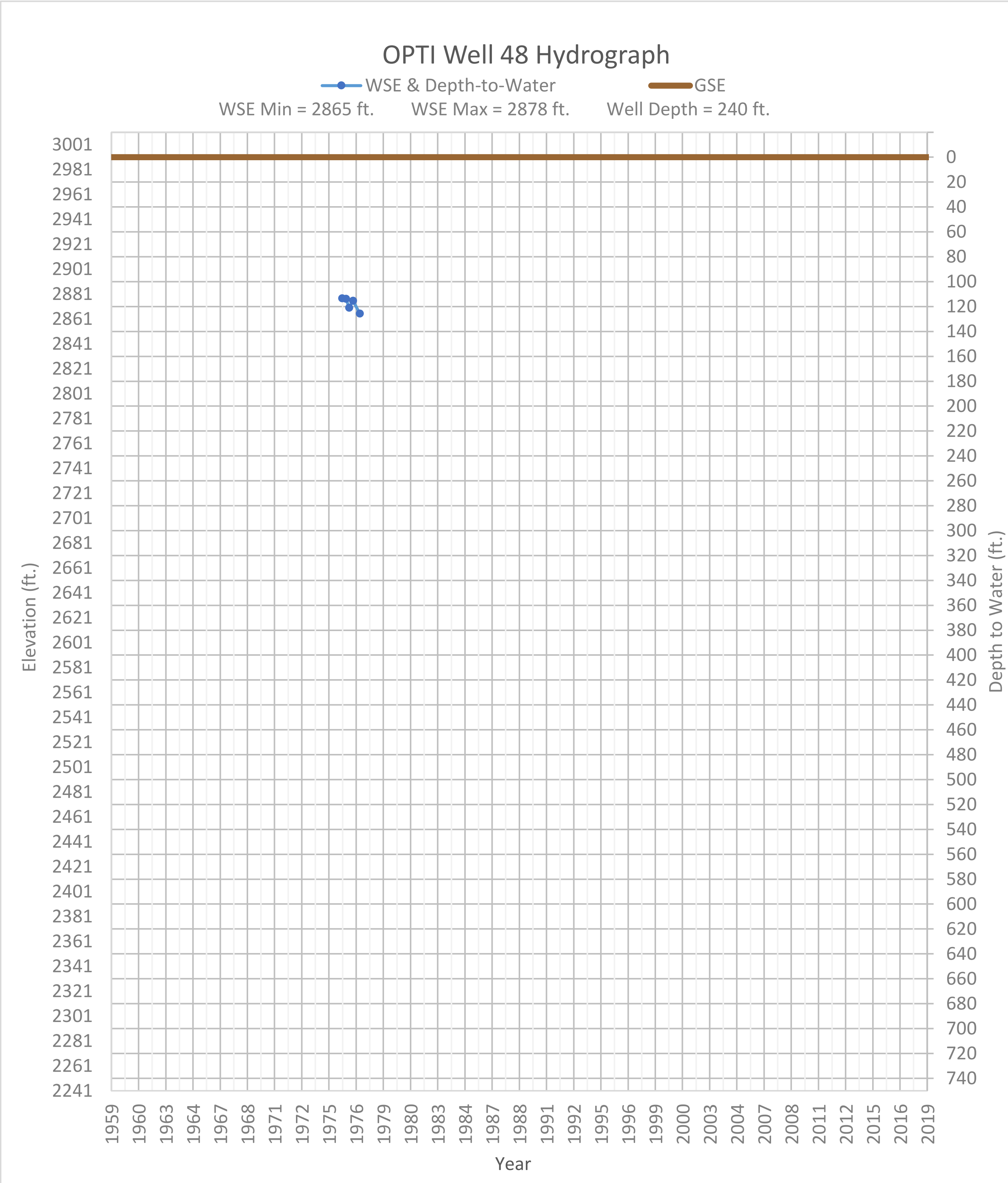
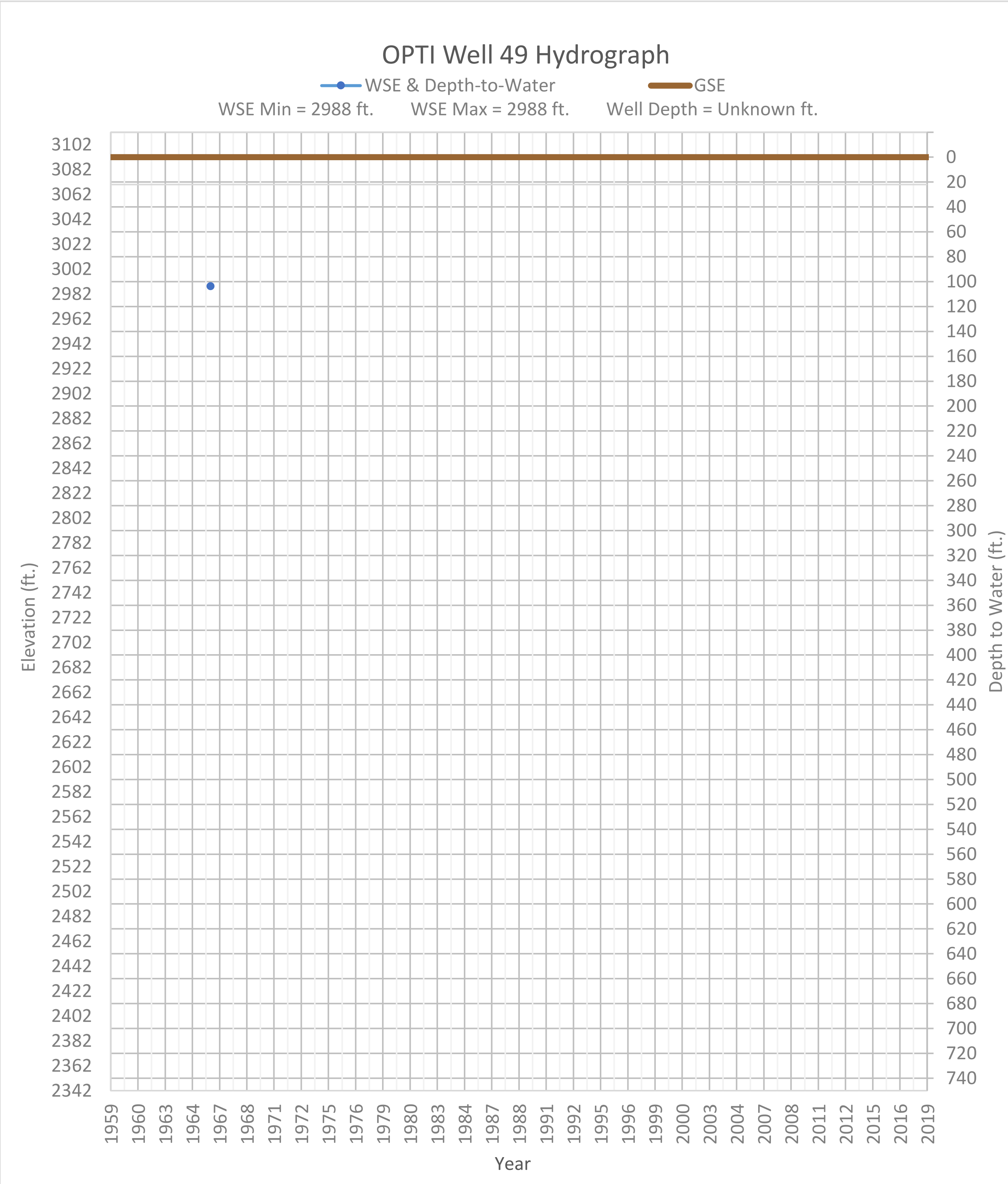
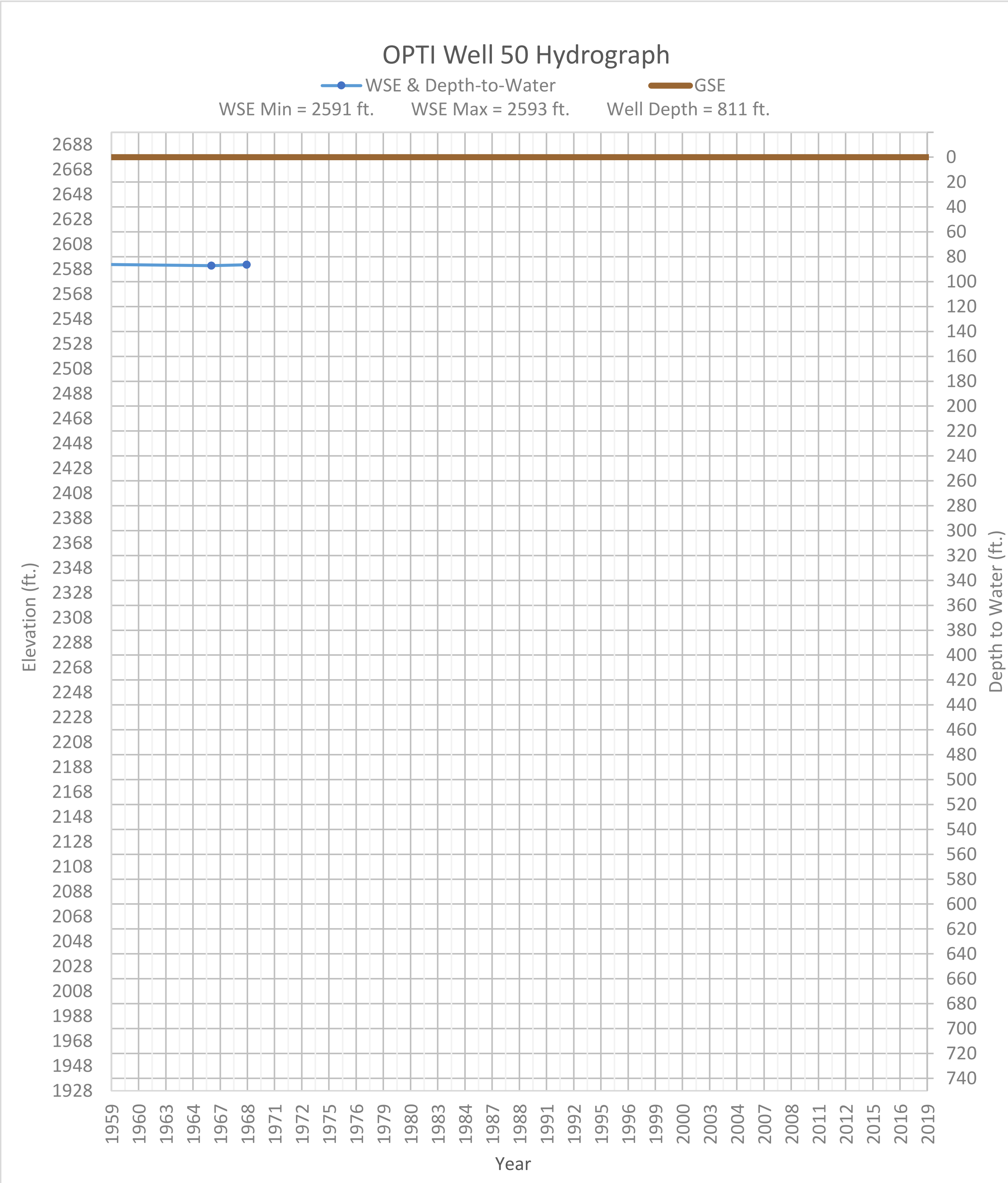
2015
2016
2019


OPTI Well 48 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2865 ft.
WSE Max = 2878 ft.
Well Depth = 240 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 49 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2988 ft.
WSE Max = 2988 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 50 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2591 ft.
WSE Max = 2593 ft.
Well Depth = 811 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2688
2668
2648
2628
2608
2588
2568
2548
2528
2508
2488
2468
2448
2428
2408
2388
2368
2348
2328
2308
2288
2268
2248
2228
2208
2188
2168
2148
2128
2108
2088
2068
2048
2028
2008
1988
1968
1948
1928
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
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1959
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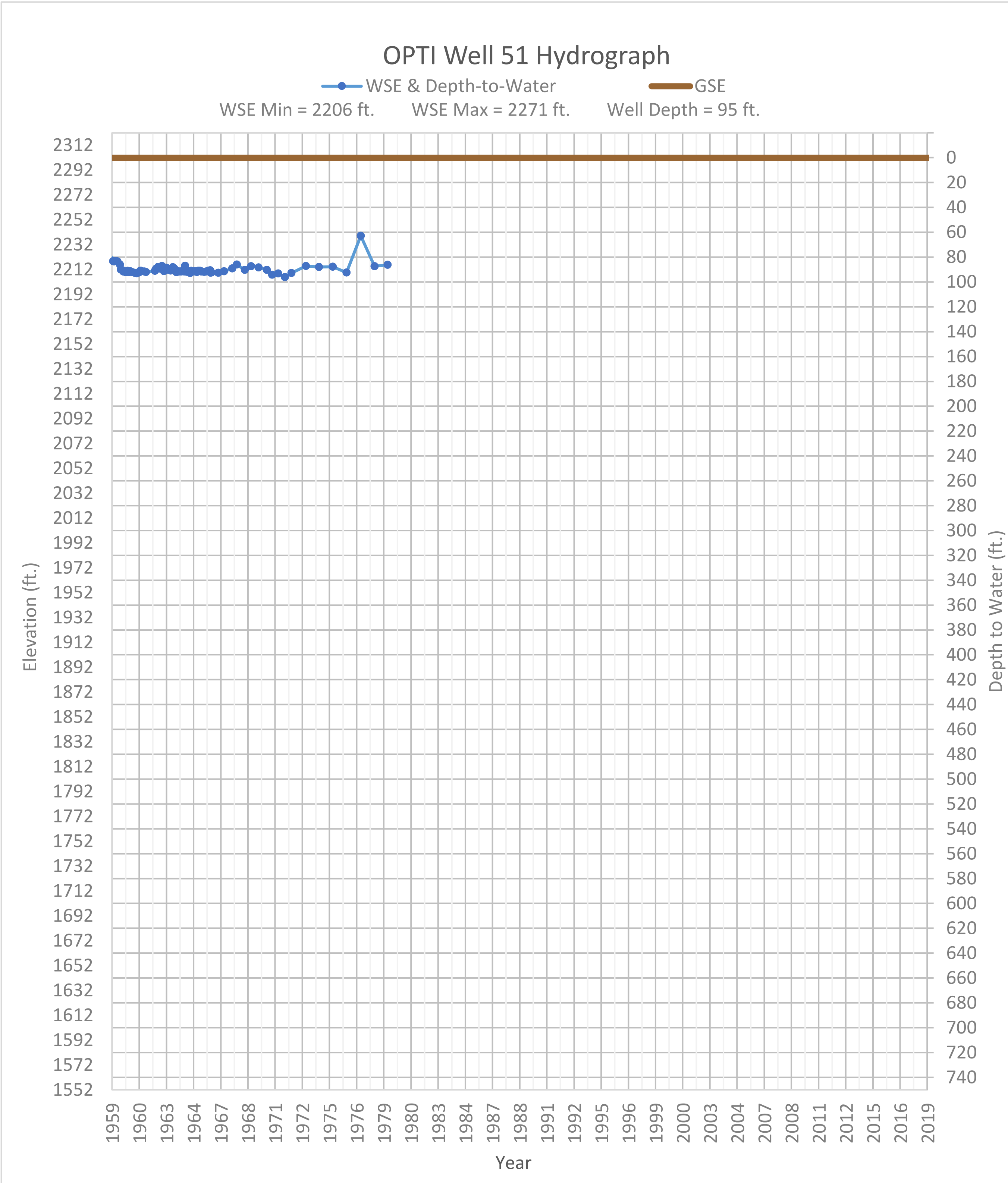
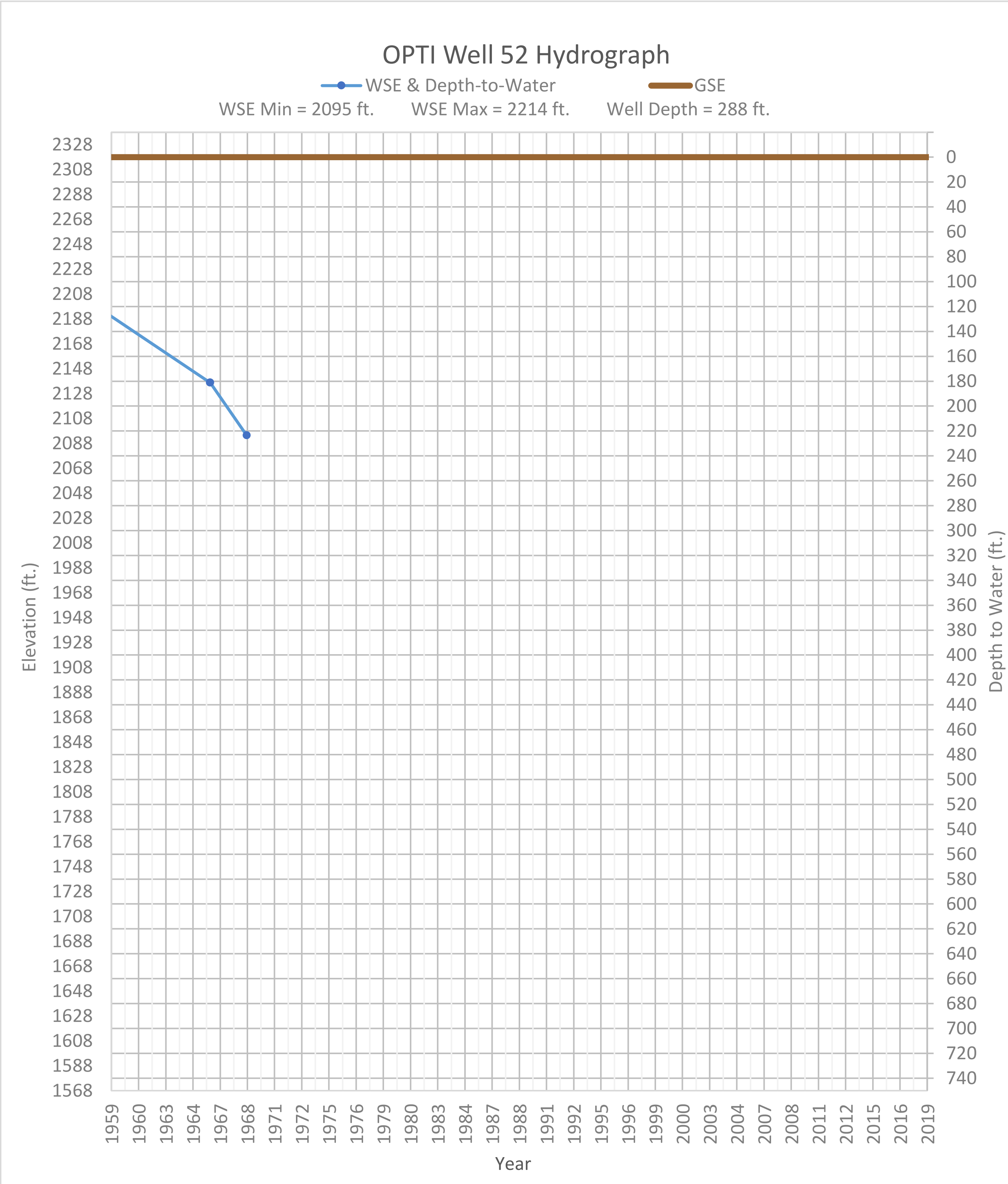
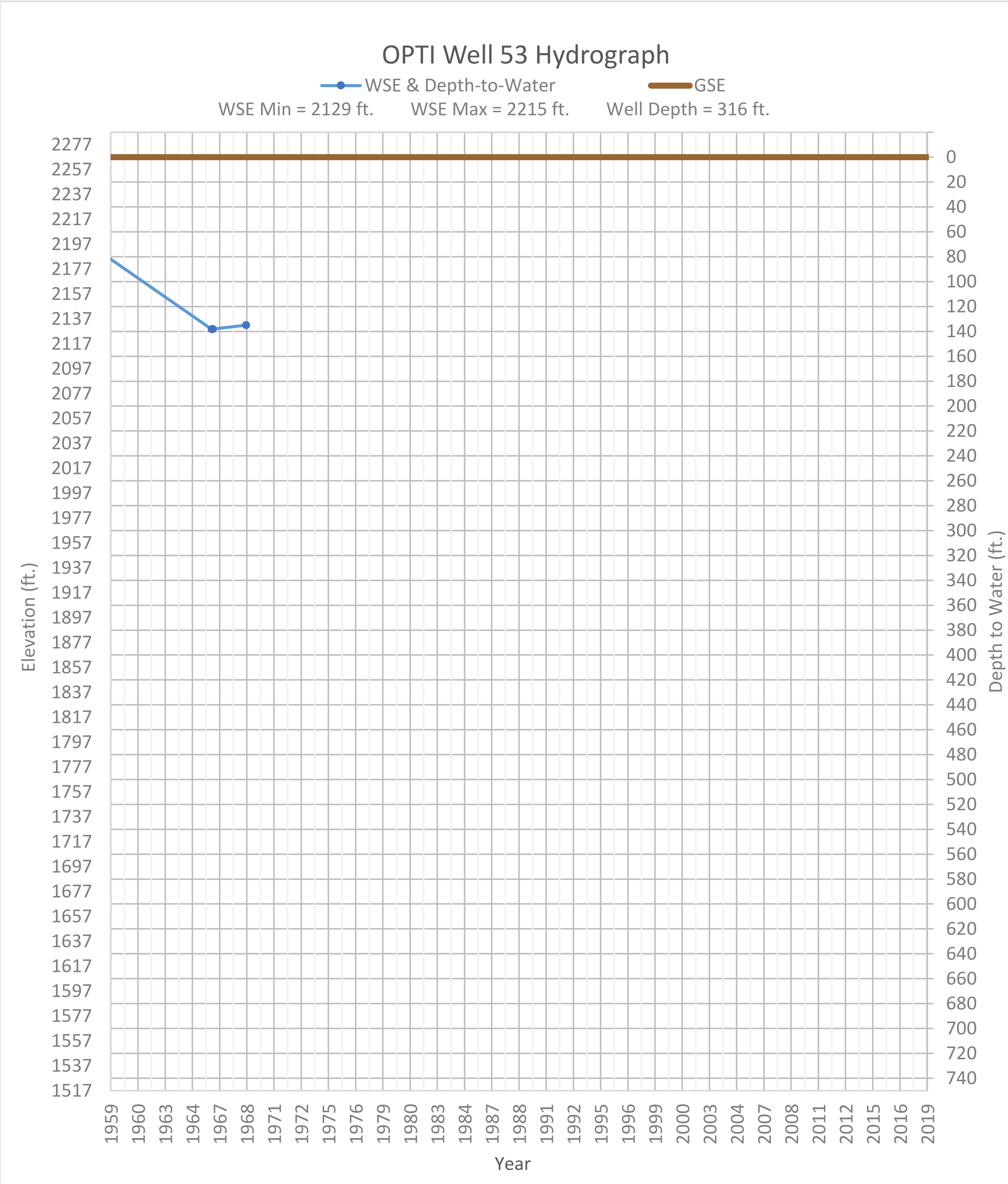


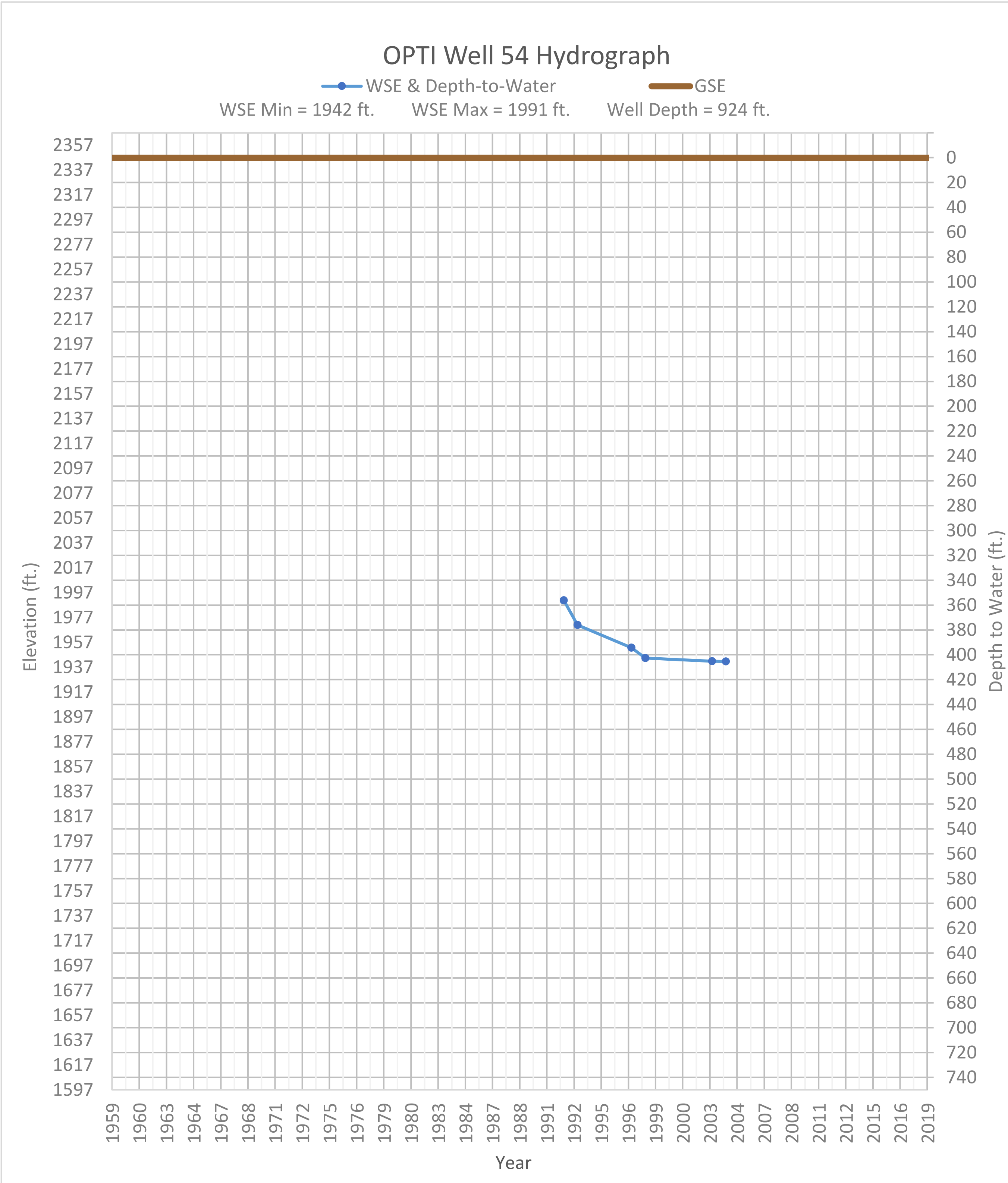
OPTI Well 51 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2206 ft.
WSE Max = 2271 ft.
Well Depth = 95 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

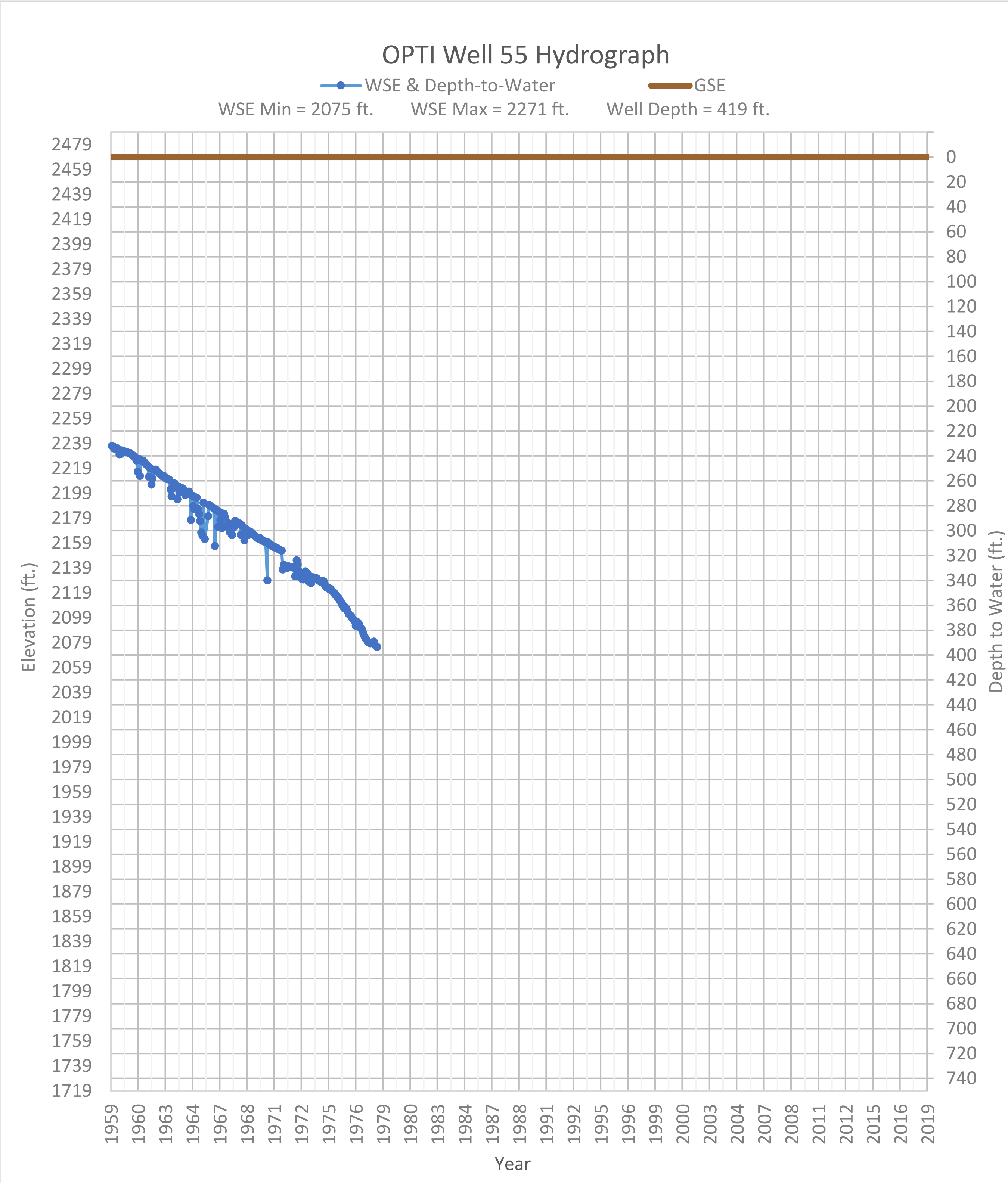


OPTI Well 52 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2095 ft.
WSE Max = 2214 ft.
Well Depth = 288 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

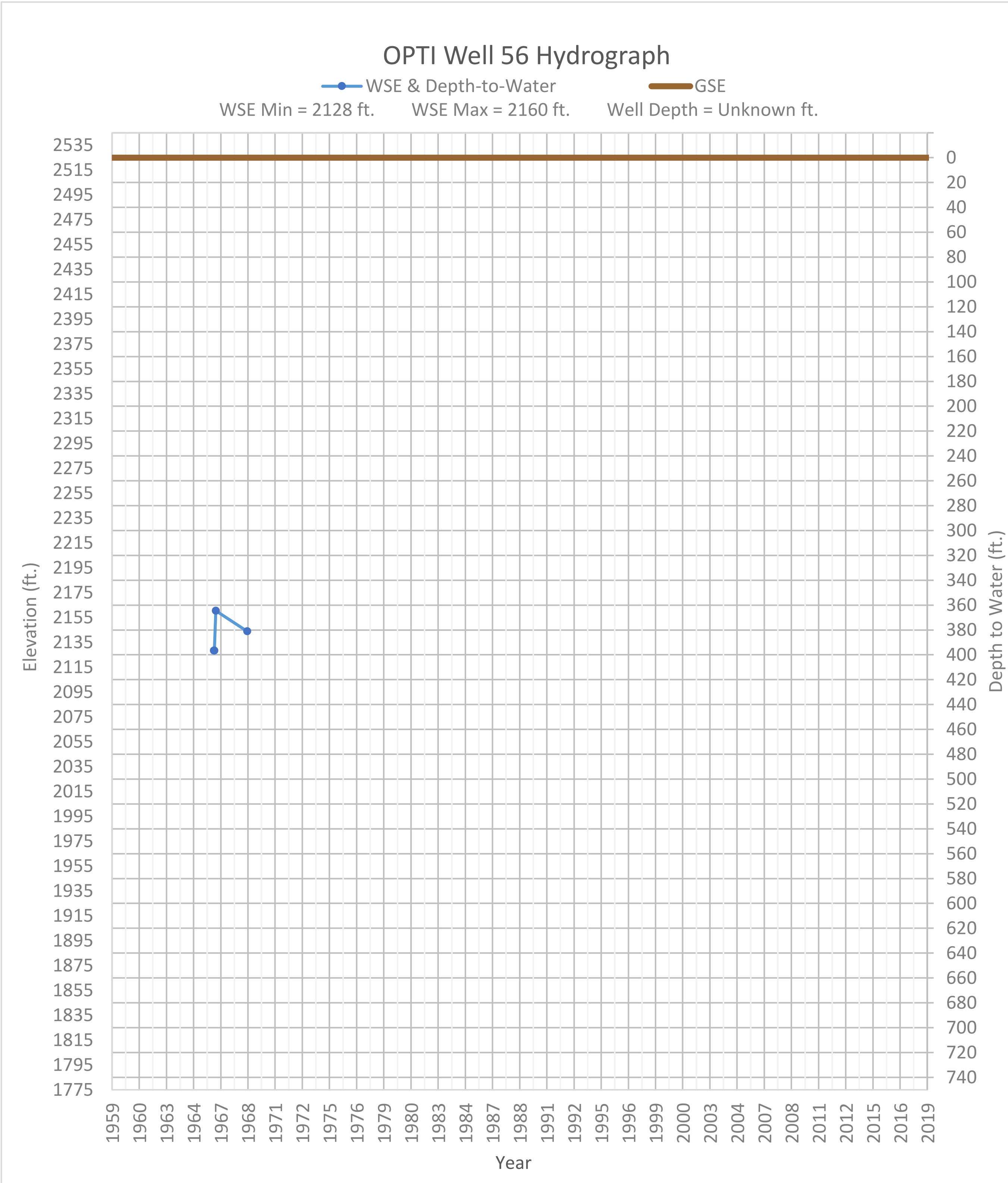


OPTI Well 53 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2129 ft.
WSE Max = 2215 ft.
Well Depth = 316 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2277 2257 2237 2217 2197 2177 2157 2137 2117 2097 2077 2057 2037 2017 1997 1977 1957 1937 1917 1897 1877 1857 1837 1817 1797 1777 1757 1737 1717 1697 1677 1657 1637 1617 1597 1577 1557 1537 1517
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500 520 540 560 580 600 620 640 660 680 700 720 740
1959 1960 1963 1964 1967 1968 1971 1972 1975 1976 1979 1980 1983 1984 1987 1988 1991 1992 1995 1996 1999 2000 2003 2004 2007 2008 2011 2012 2015 2016 2019

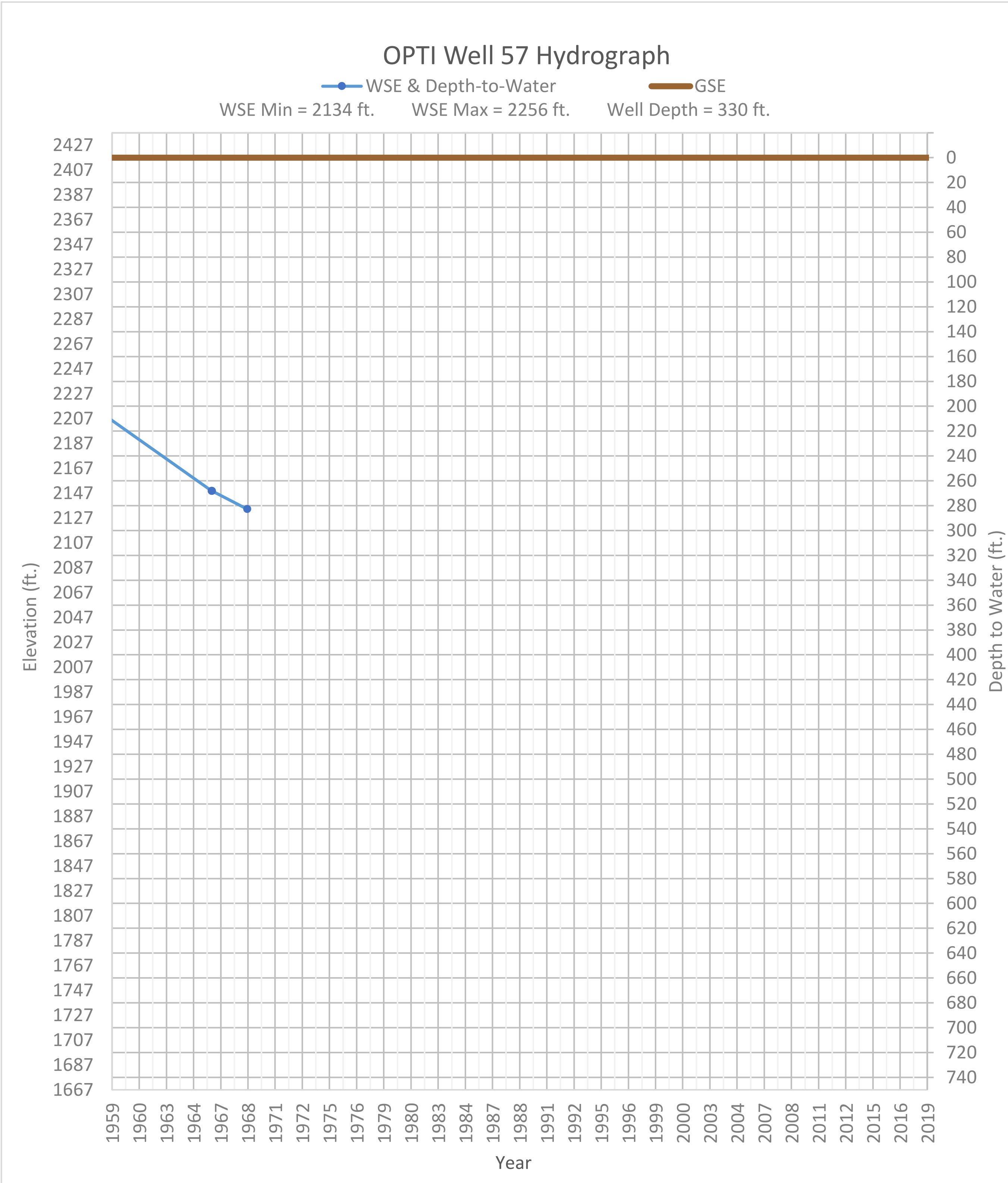

OPTI Well 54 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1942 ft.
WSE Max = 1991 ft.
Well Depth = 924 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



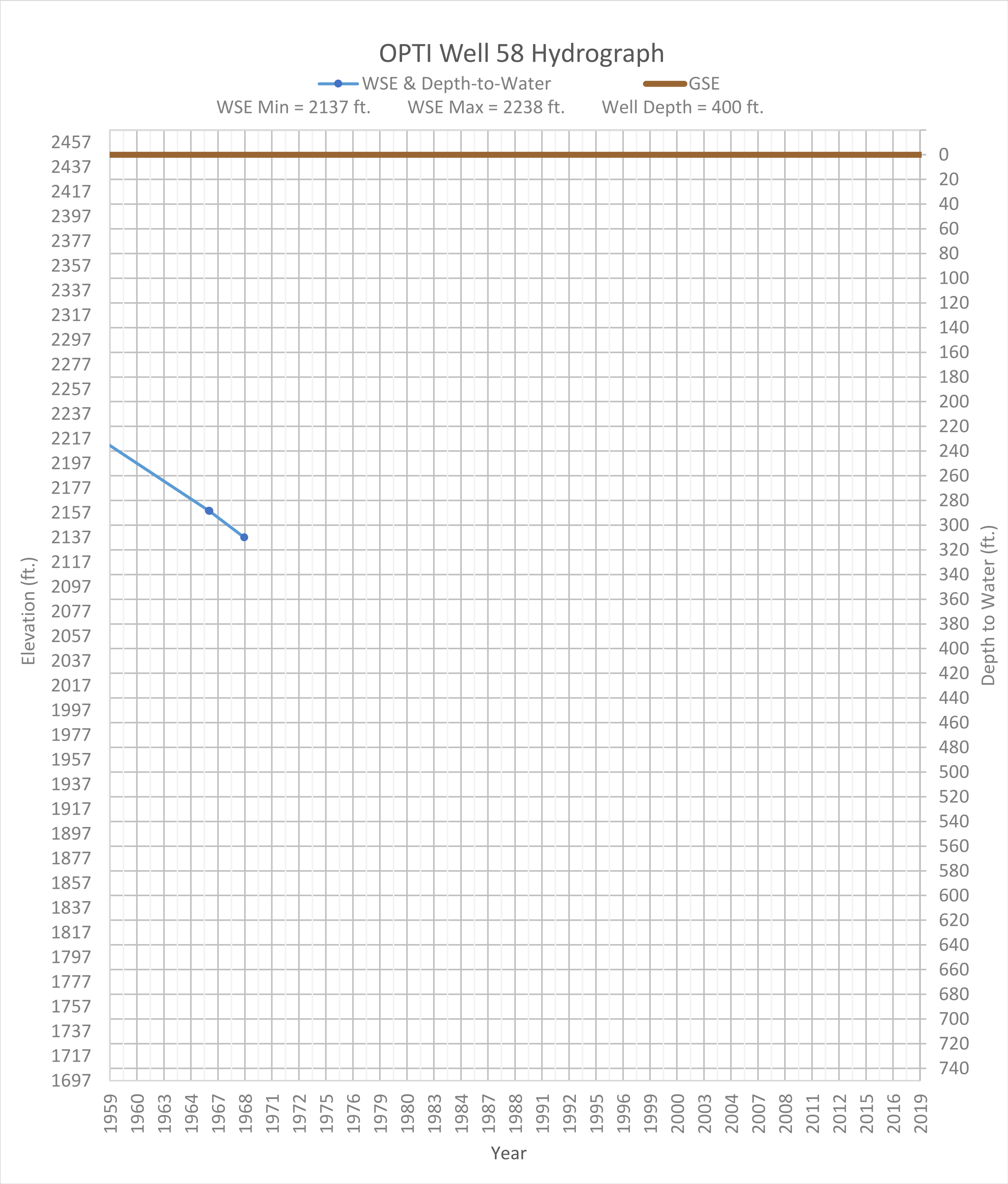
OPTI Well 55 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2075 ft.
WSE Max = 2271 ft.
Well Depth = 419 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 56 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2128 ft.
WSE Max = 2160 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year

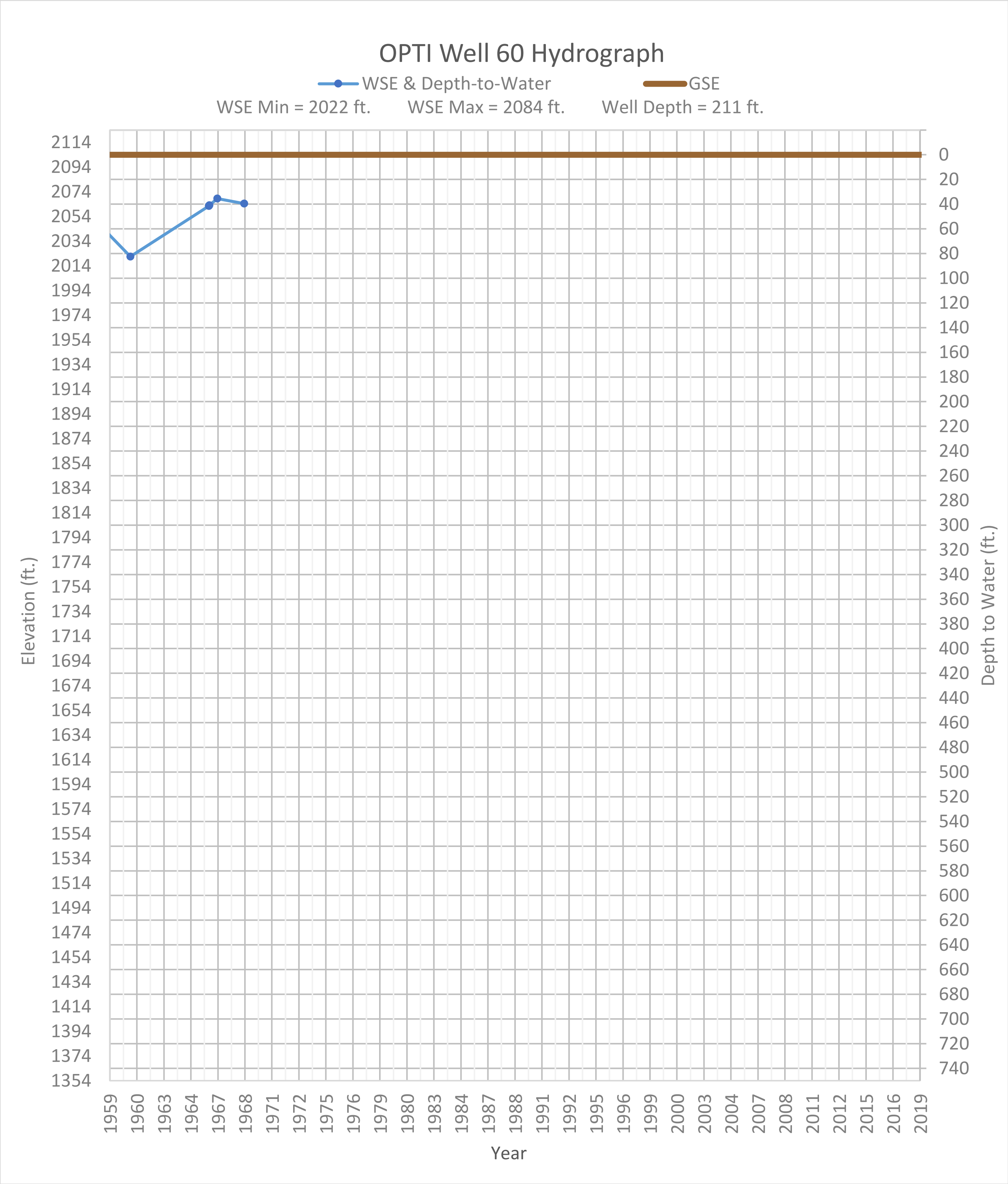


OPTI Well 57 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2134 ft.
WSE Max = 2256 ft.
Well Depth = 330 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



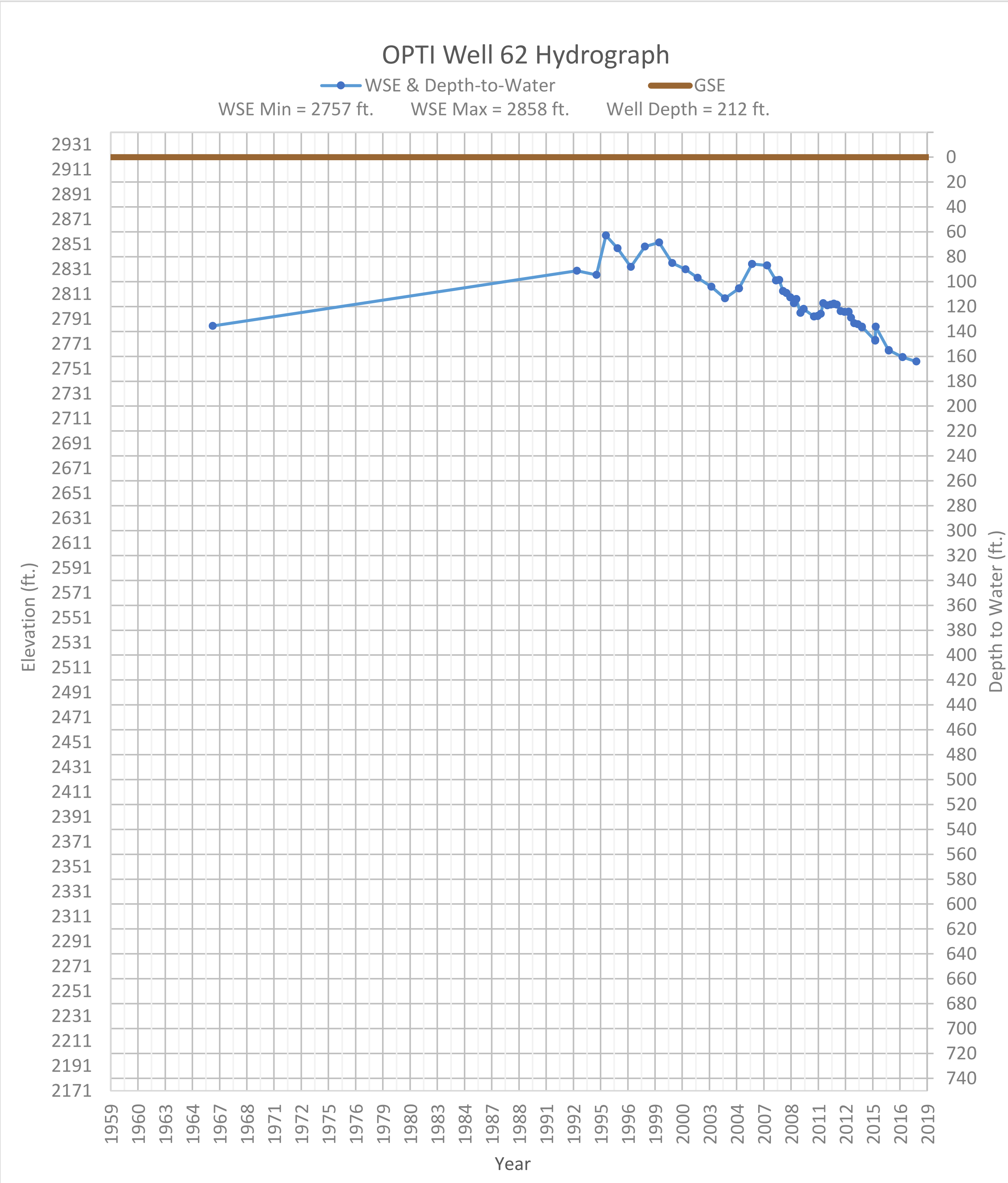
OPTI Well 58 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2137 ft.
WSE Max = 2238 ft.
Well Depth = 400 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 59 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2087 ft.
WSE Max = 2095 ft.
Well Depth = 65 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

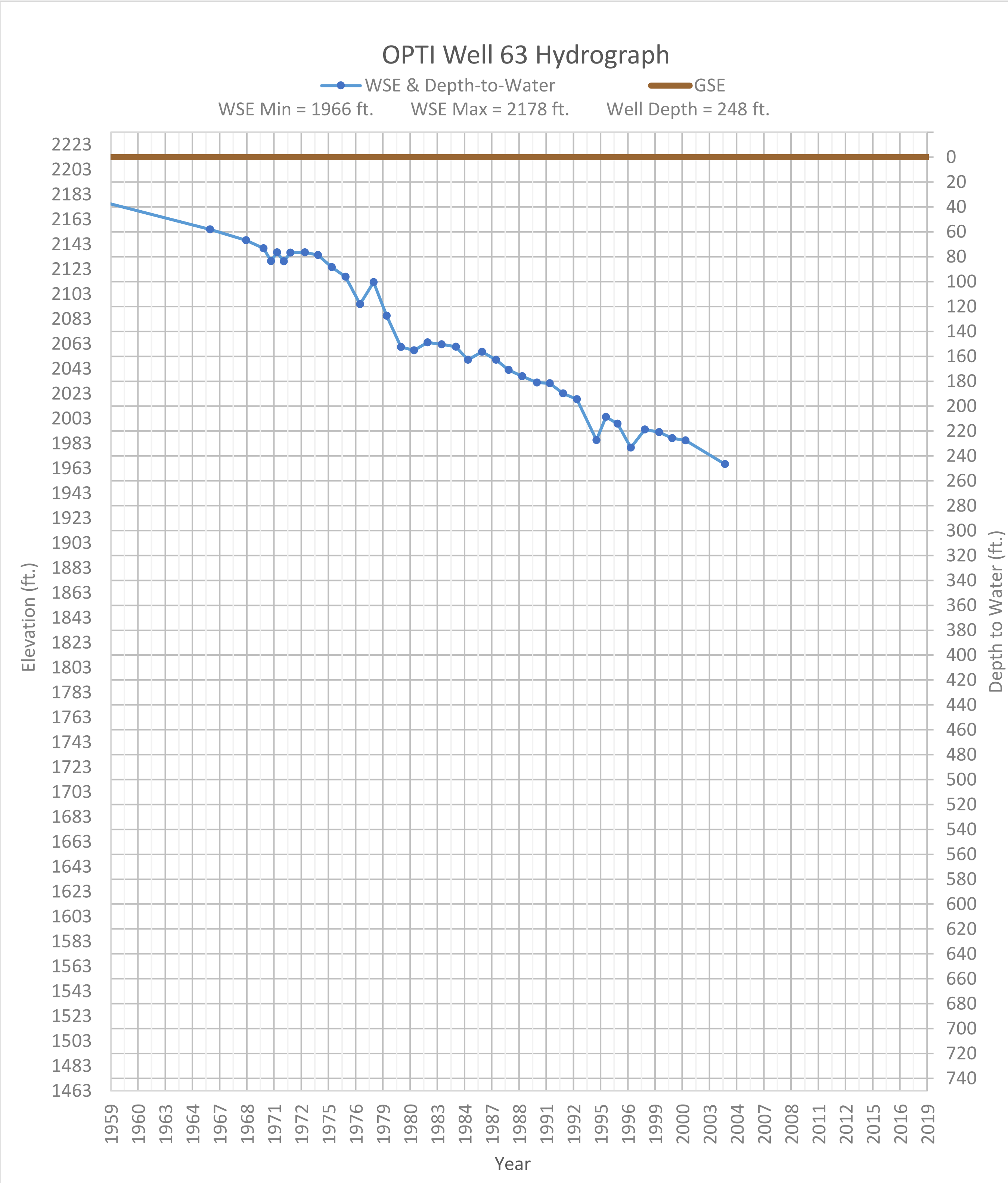


OPTI Well 60 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2022 ft.
WSE Max = 2084 ft.
Well Depth = 211 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 61 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3593 ft.
WSE Max = 3664 ft.
Well Depth = 357 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

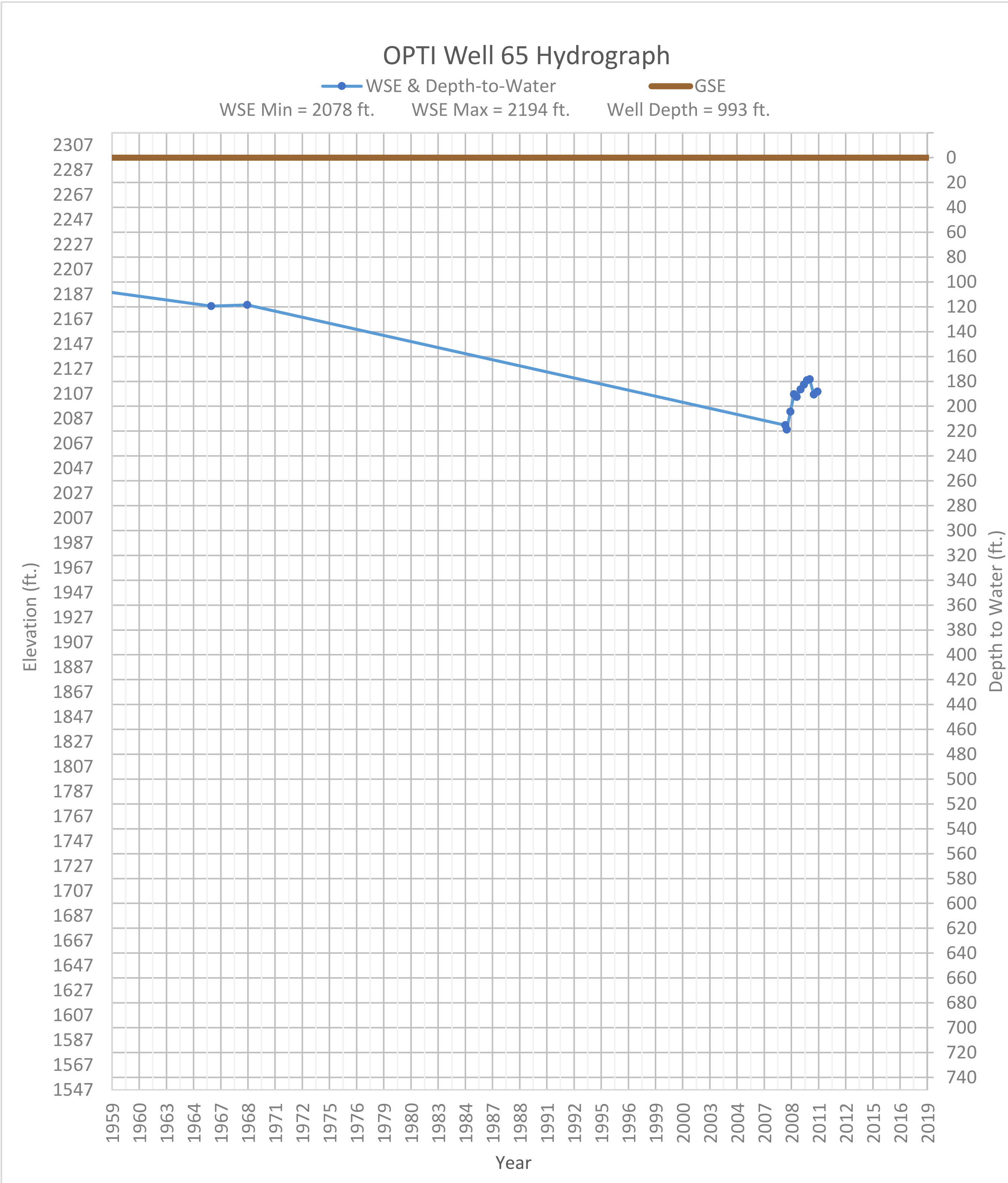


OPTI Well 62 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2757 ft.
WSE Max = 2858 ft.
Well Depth = 212 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 63 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1966 ft.
WSE Max = 2178 ft.
Well Depth = 248 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 64 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1980 ft.
WSE Max = 2098 ft.
Well Depth = 1004 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 65 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2078 ft.
WSE Max = 2194 ft.
Well Depth = 993 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2307
2287
2267
2247
2227
2207
2187
2167
2147
2127
2107
2087
2067
2047
2027
2007
1987
1967
1947
1927
1907
1887
1867
1847
1827
1807
1787
1767
1747
1727
1707
1687
1667
1647
1627
1607
1587
1567
1547
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100
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160
180
200
220
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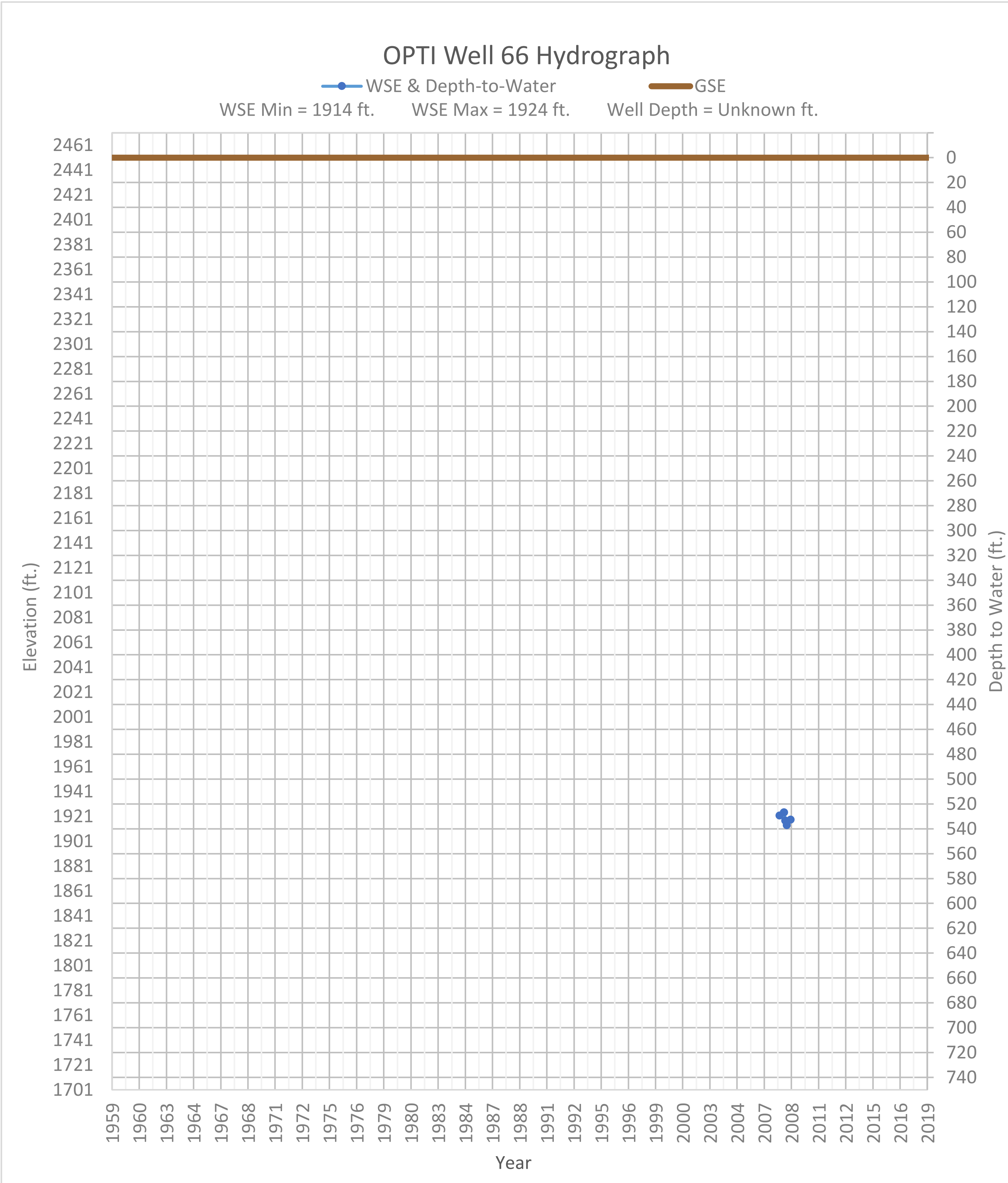

OPTI Well 66 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1914 ft.
WSE Max = 1924 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2461
2441
2421
2401
2381
2361
2341
2321
2301
2281
2261
2241
2221
2201
2181
2161
2141
2121
2101
2081
2061
2041
2021
2001
1981
1961
1941
1921
1901
1881
1861
1841
1821
1801
1781
1761
1741
1721
1701
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
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420
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460
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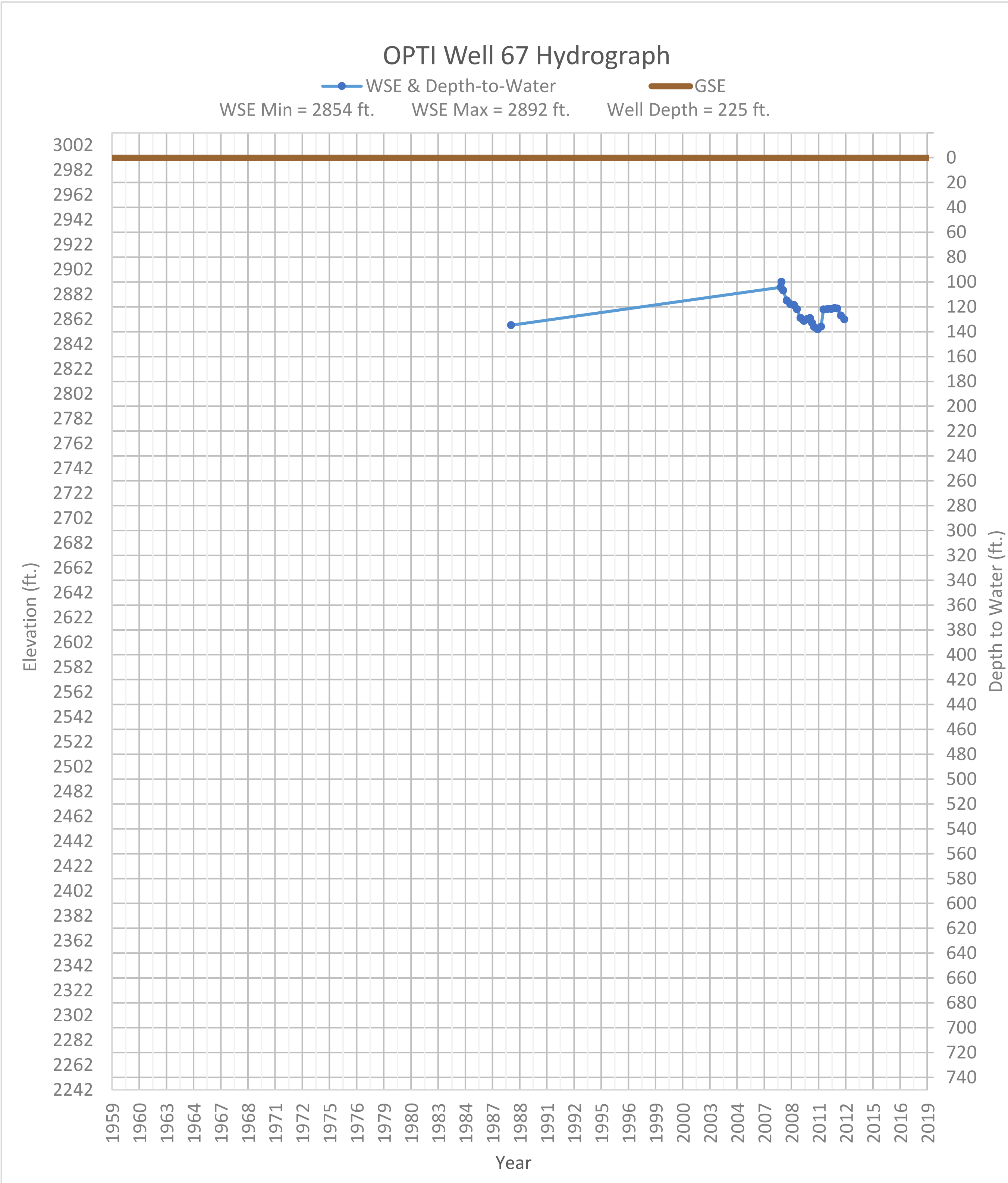

OPTI Well 67 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2854 ft.
WSE Max = 2892 ft.
Well Depth = 225 ft.
Elevation (ft.)
3002
2982
2962
2942
2922
2902
2882
2862
2842
2822
2802
2782
2762
2742
2722
2702
2682
2662
2642
2622
2602
2582
2562
2542
2522
2502
2482
2462
2442
2422
2402
2382
2362
2342
2322
2302
2282
2262
2242
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
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560
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640
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700
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740
Year
1959
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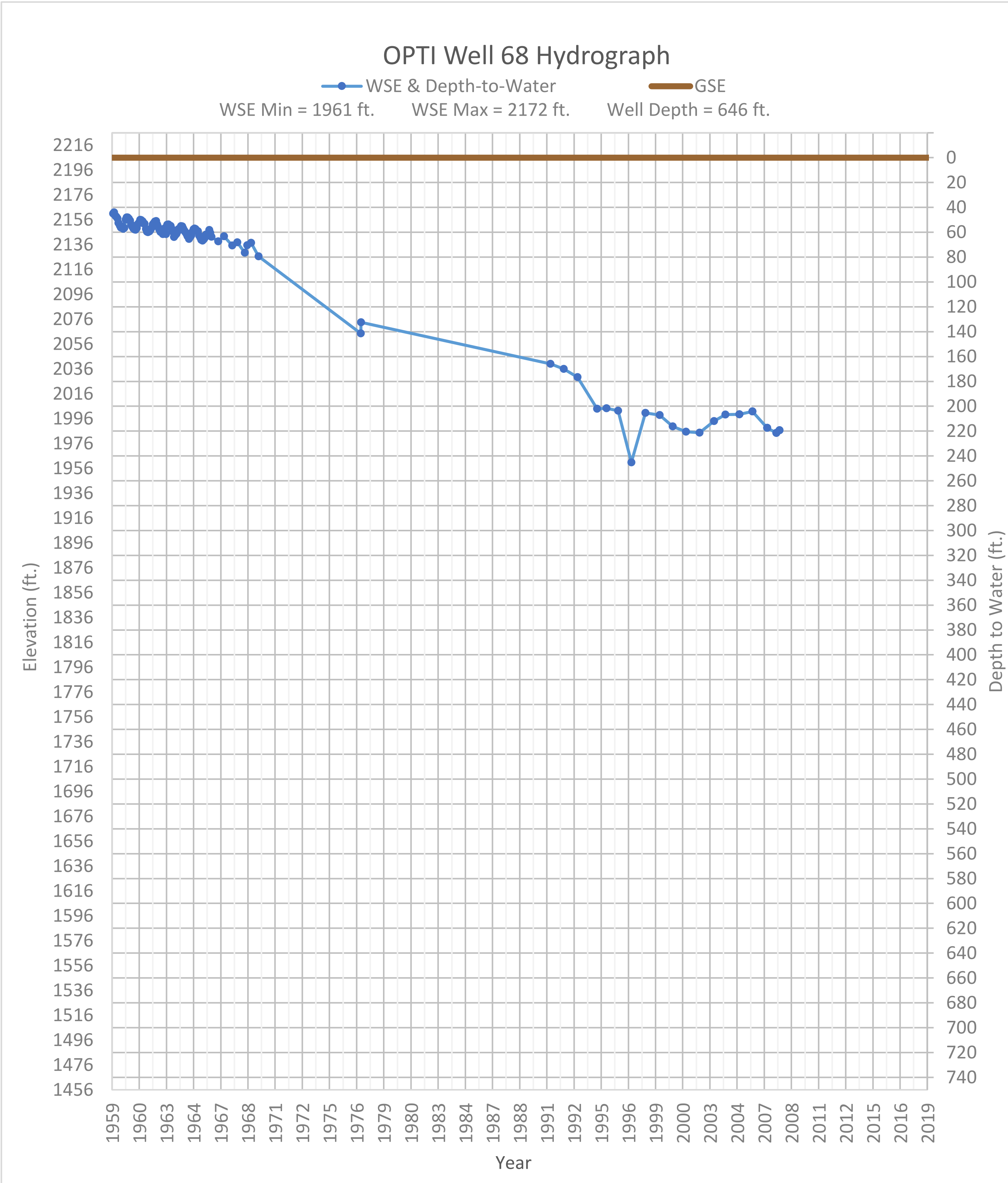
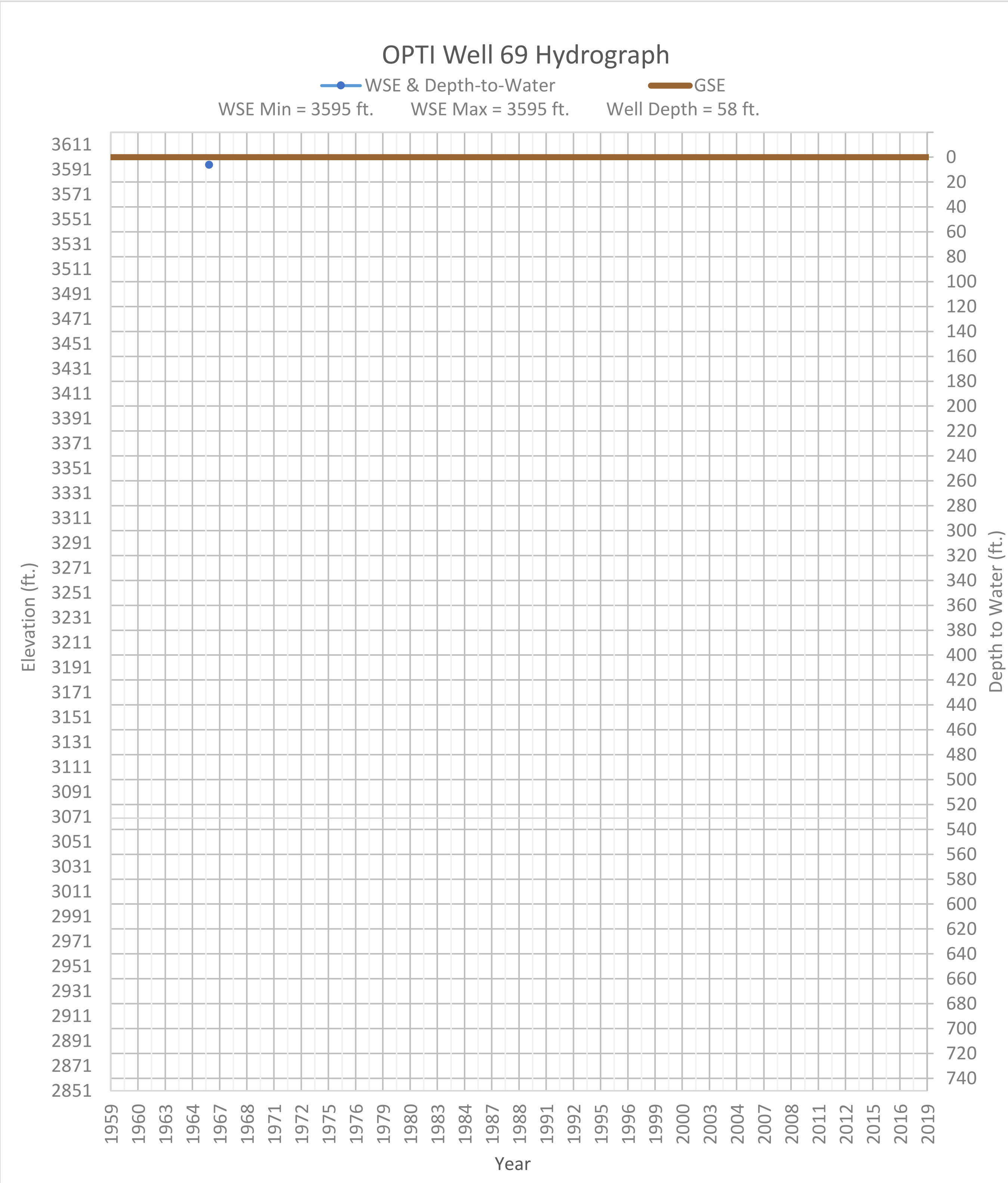
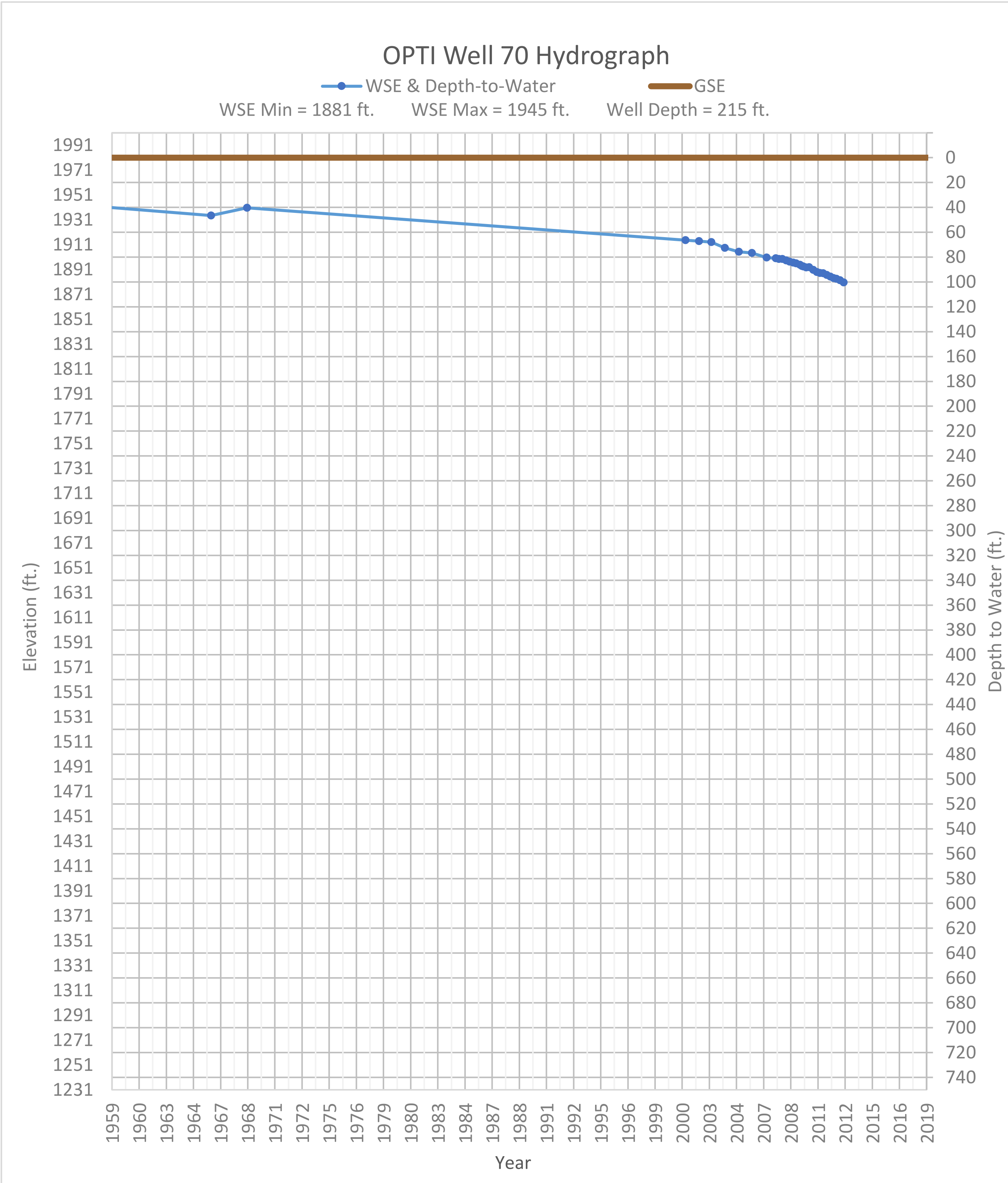
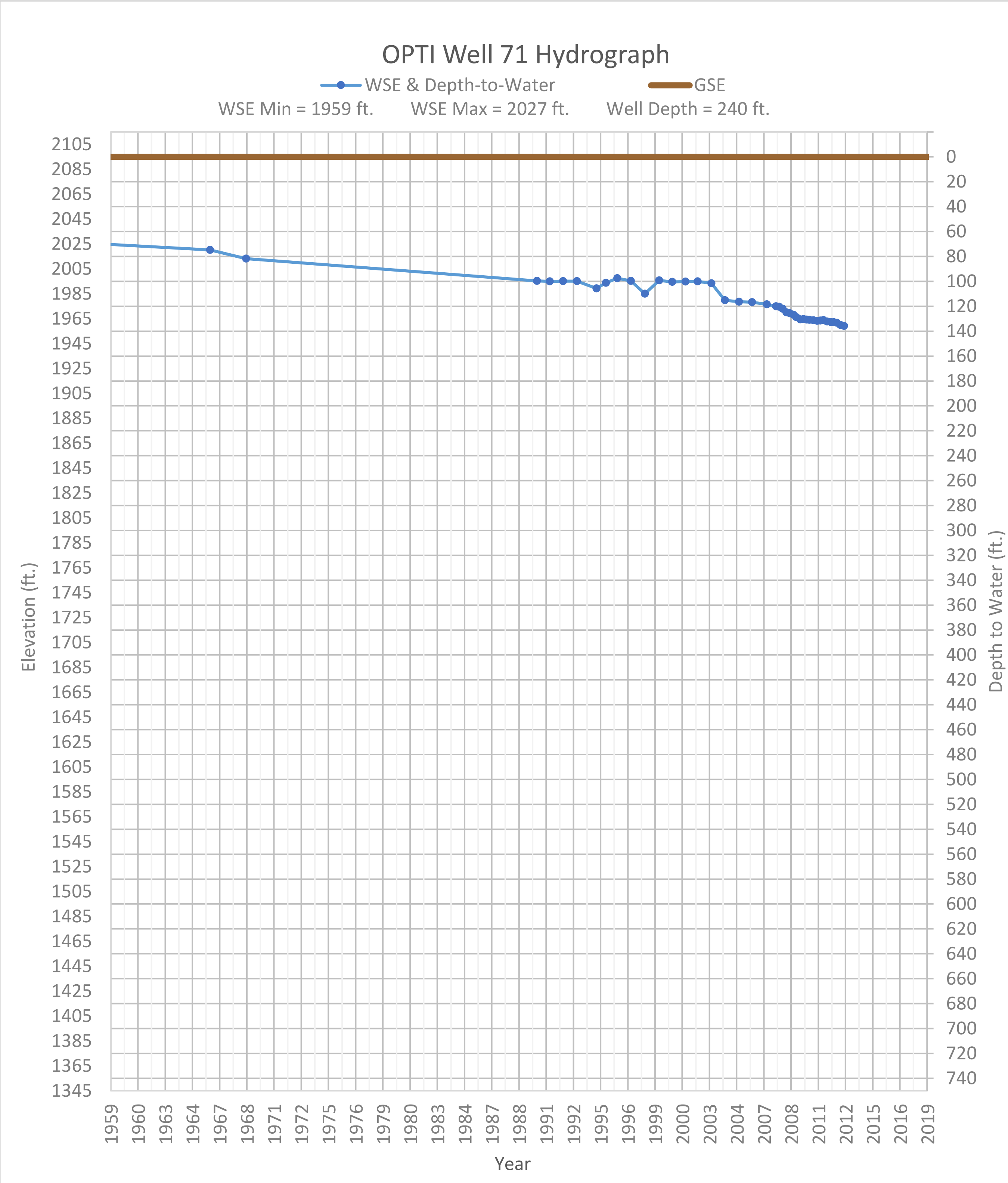

OPTI Well 68 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1961 ft.
WSE Max = 2172 ft.
Well Depth = 646 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 69 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3595 ft.
WSE Max = 3595 ft.
Well Depth = 58 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 70 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1881 ft.
WSE Max = 1945 ft.
Well Depth = 215 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 71 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1959 ft.
WSE Max = 2027 ft.
Well Depth = 240 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2105
2085
2065
2045
2025
2005
1985
1965
1945
1925
1905
1885
1865
1845
1825
1805
1785
1765
1745
1725
1705
1685
1665
1645
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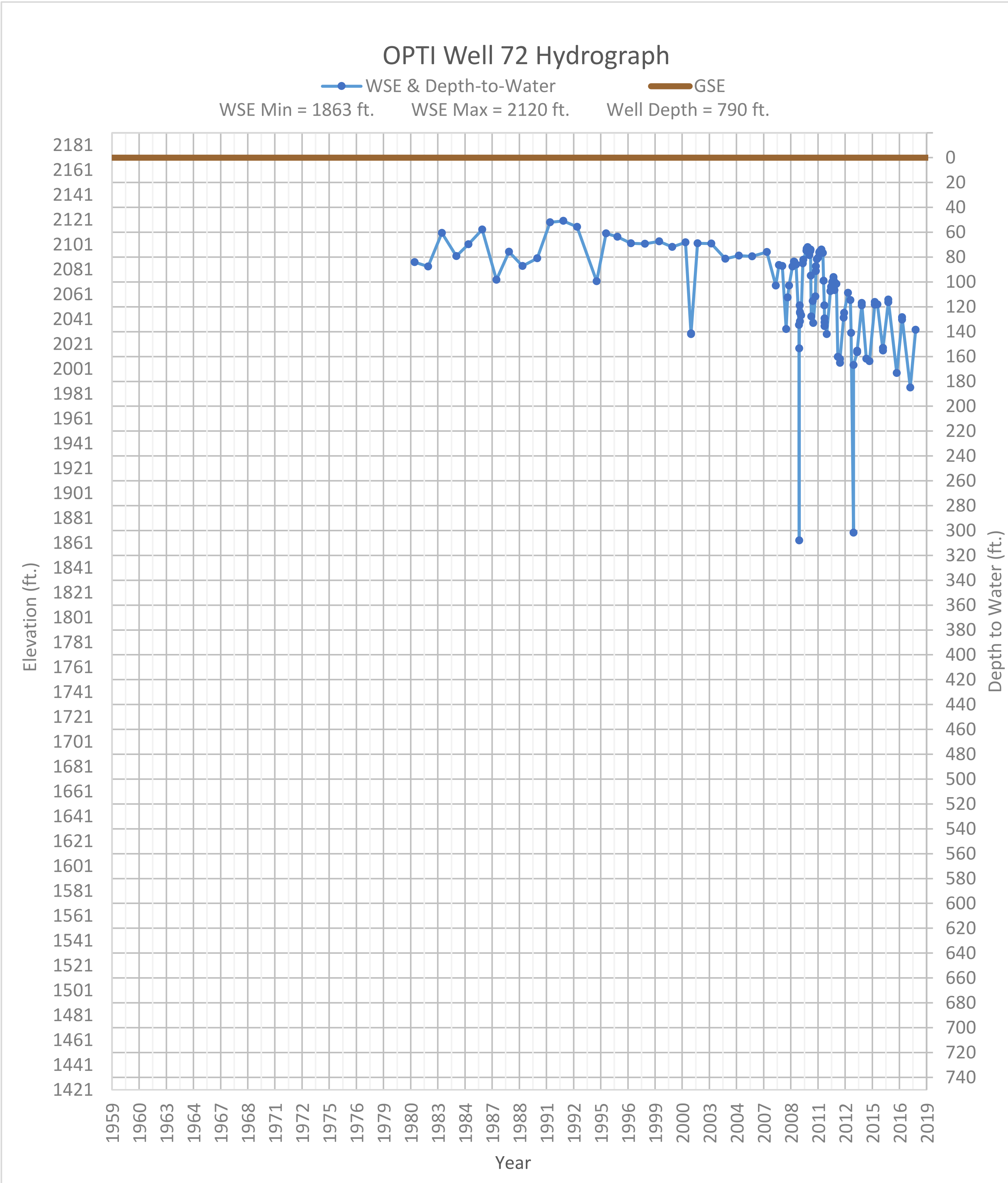
OPTI Well 72 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1863 ft.
WSE Max = 2120 ft.
Well Depth = 790 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2181
2161
2141
2121
2101
2081
2061
2041
2021
2001
1981
1961
1941
1921
1901
1881
1861
1841
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1801
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1621
1601
1581
1561
1541
1521
1501
1481
1461
1441
1421
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80
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160
180
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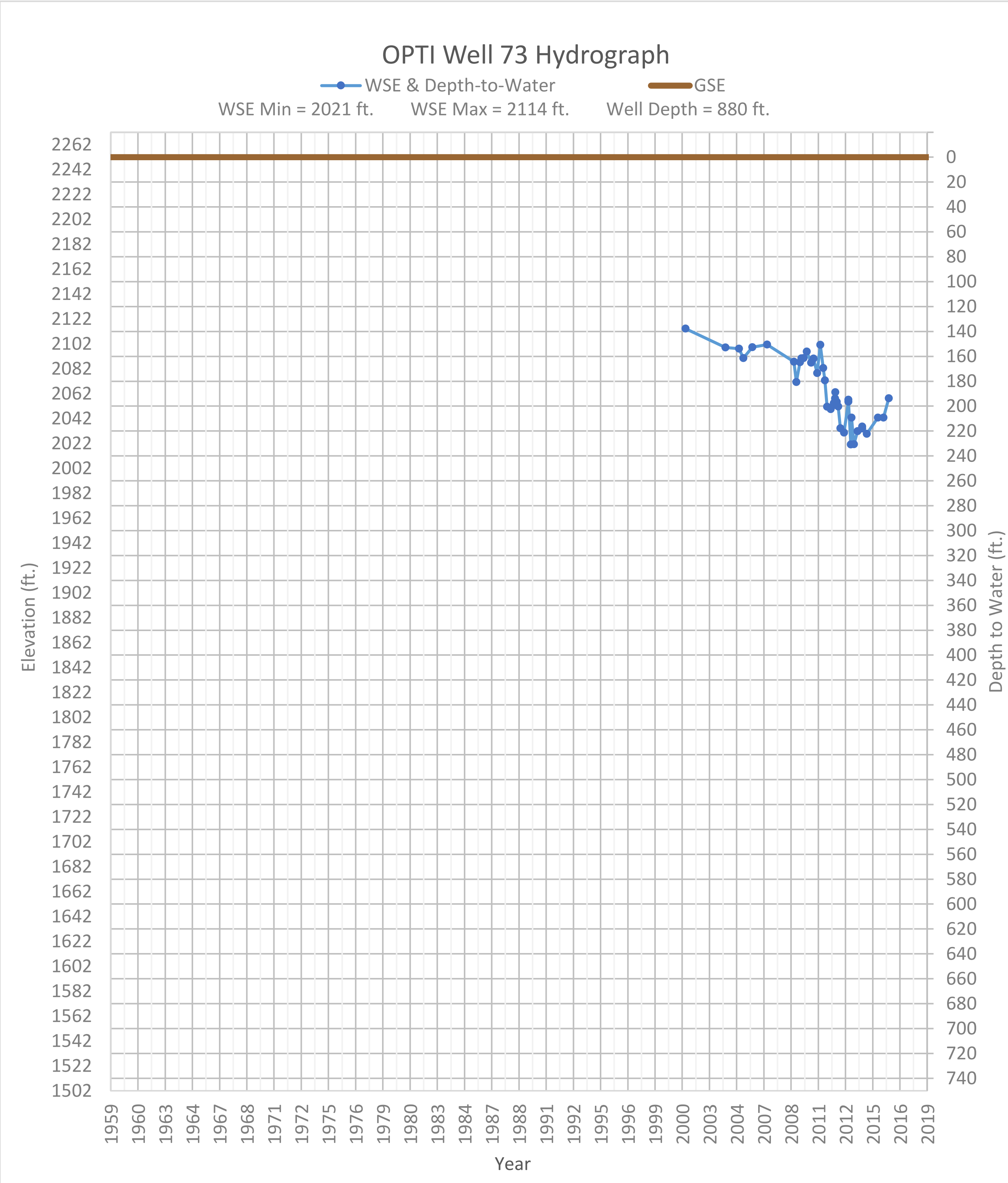
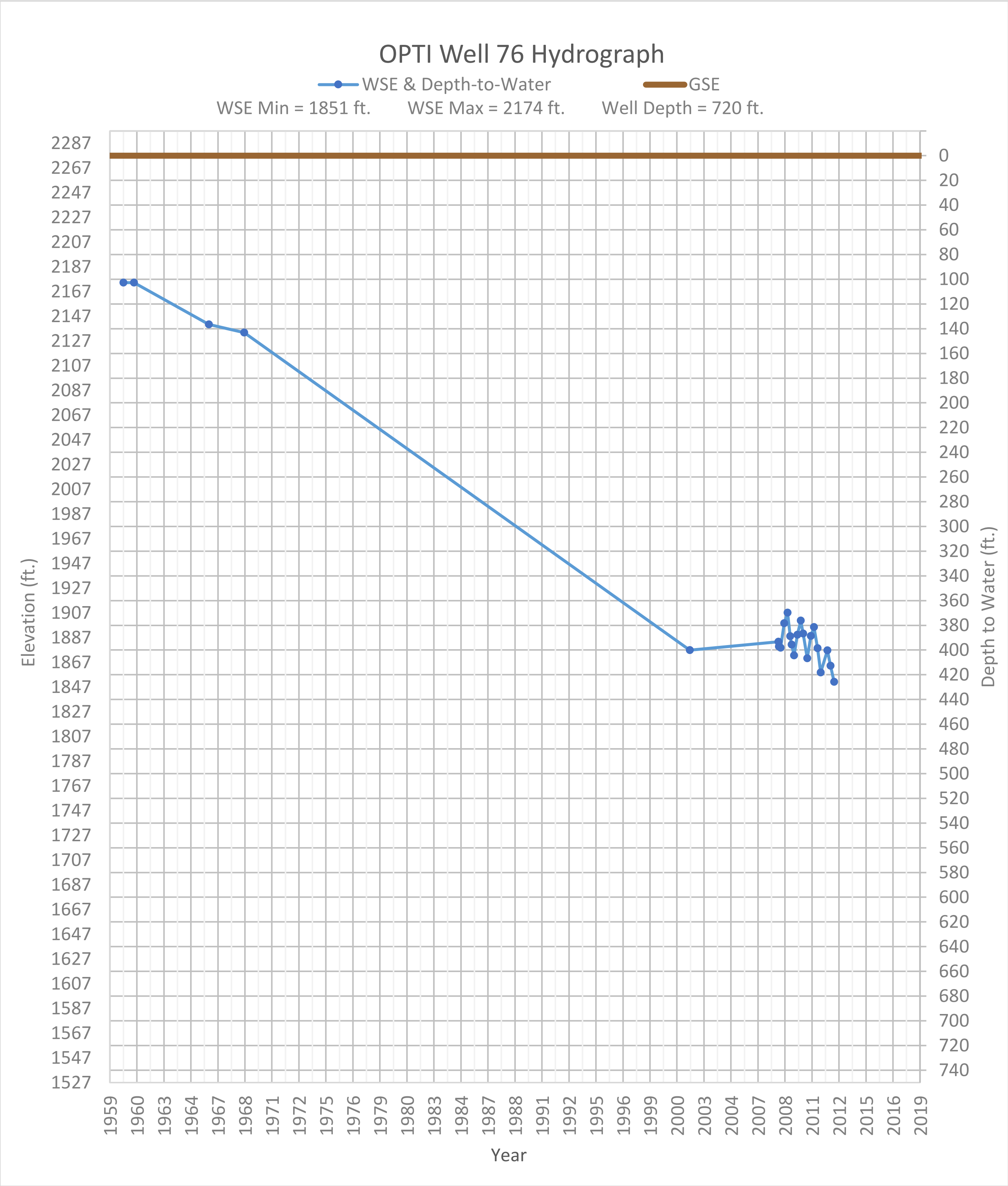


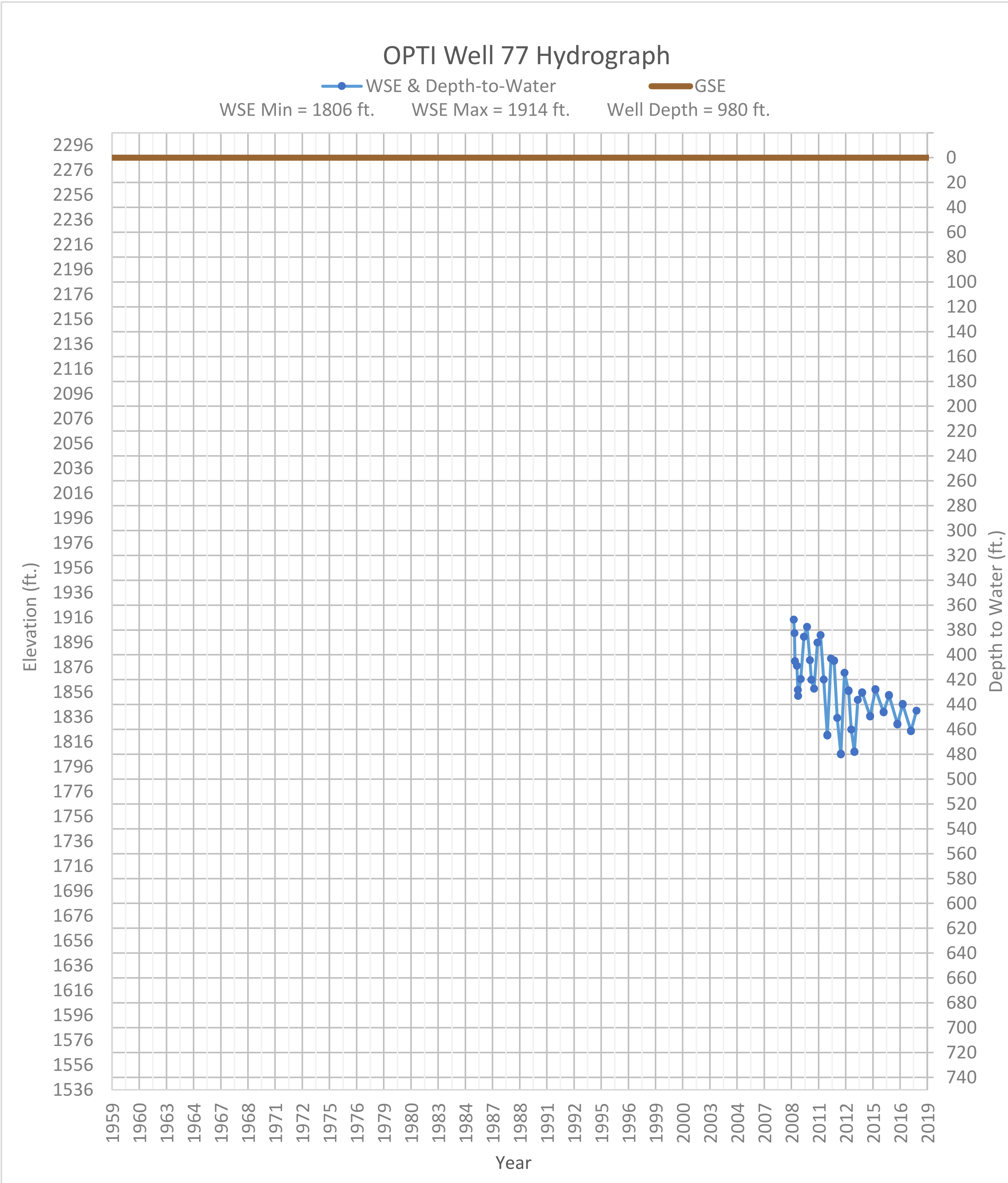
OPTI Well 73 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2021 ft.
WSE Max = 2114 ft.
Well Depth = 880 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 74 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1882 ft.
WSE Max = 1986 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year

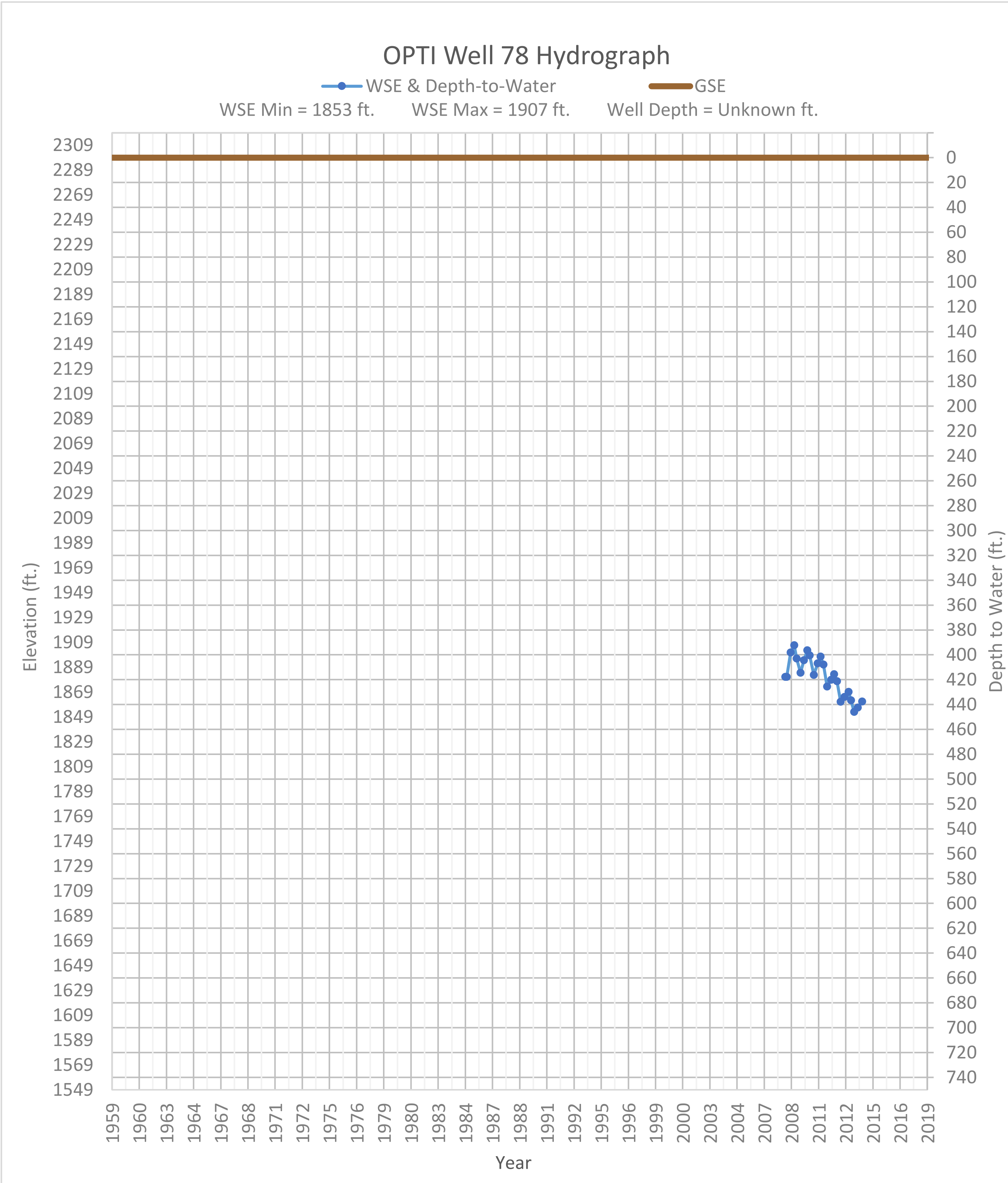

OPTI Well 75 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1912 ft.
WSE Max = 2089 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



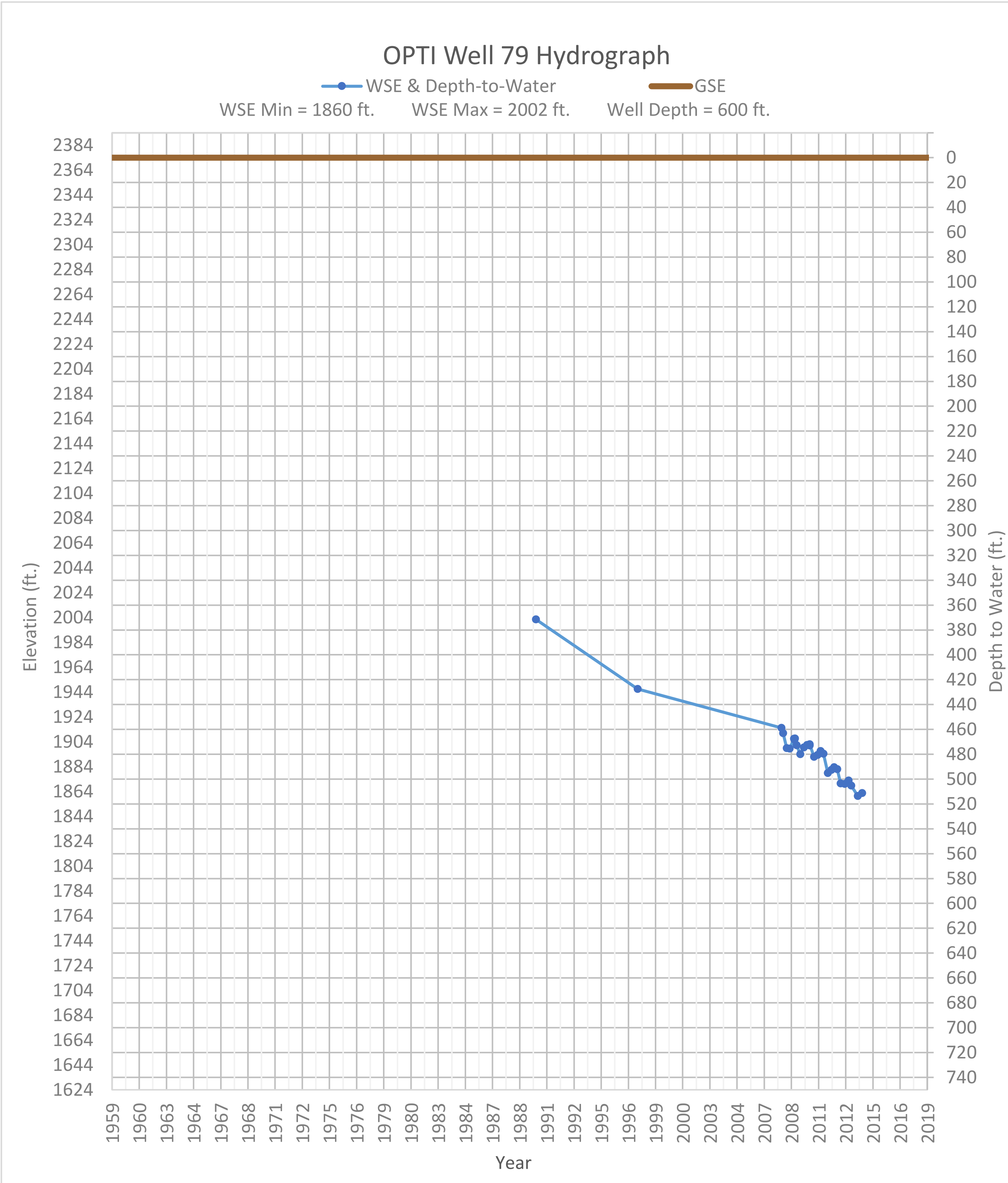
OPTI Well 76 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1851 ft.
WSE Max = 2174 ft.
Well Depth = 720 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

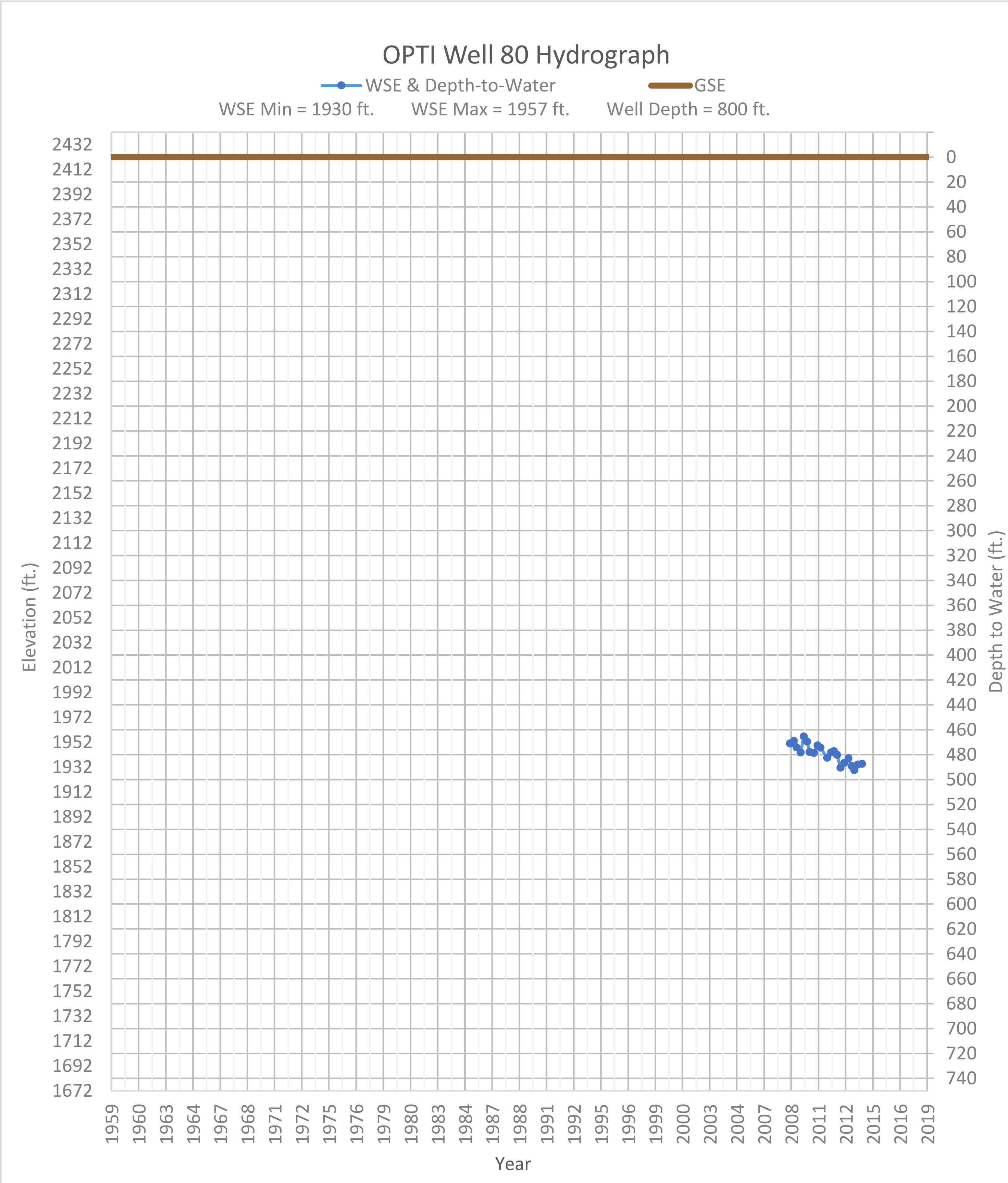


OPTI Well 77 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1806 ft.
WSE Max = 1914 ft.
Well Depth = 980 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

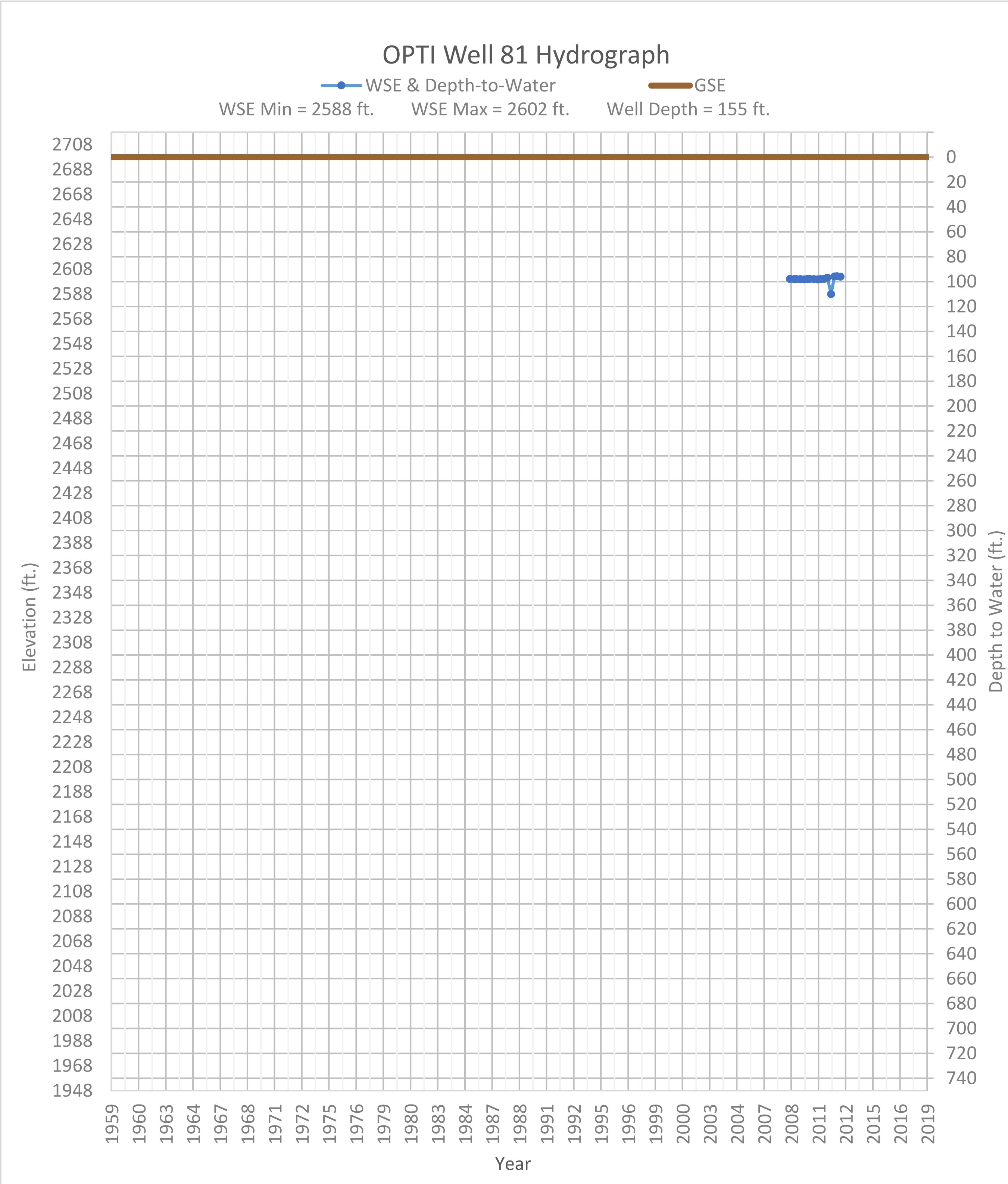


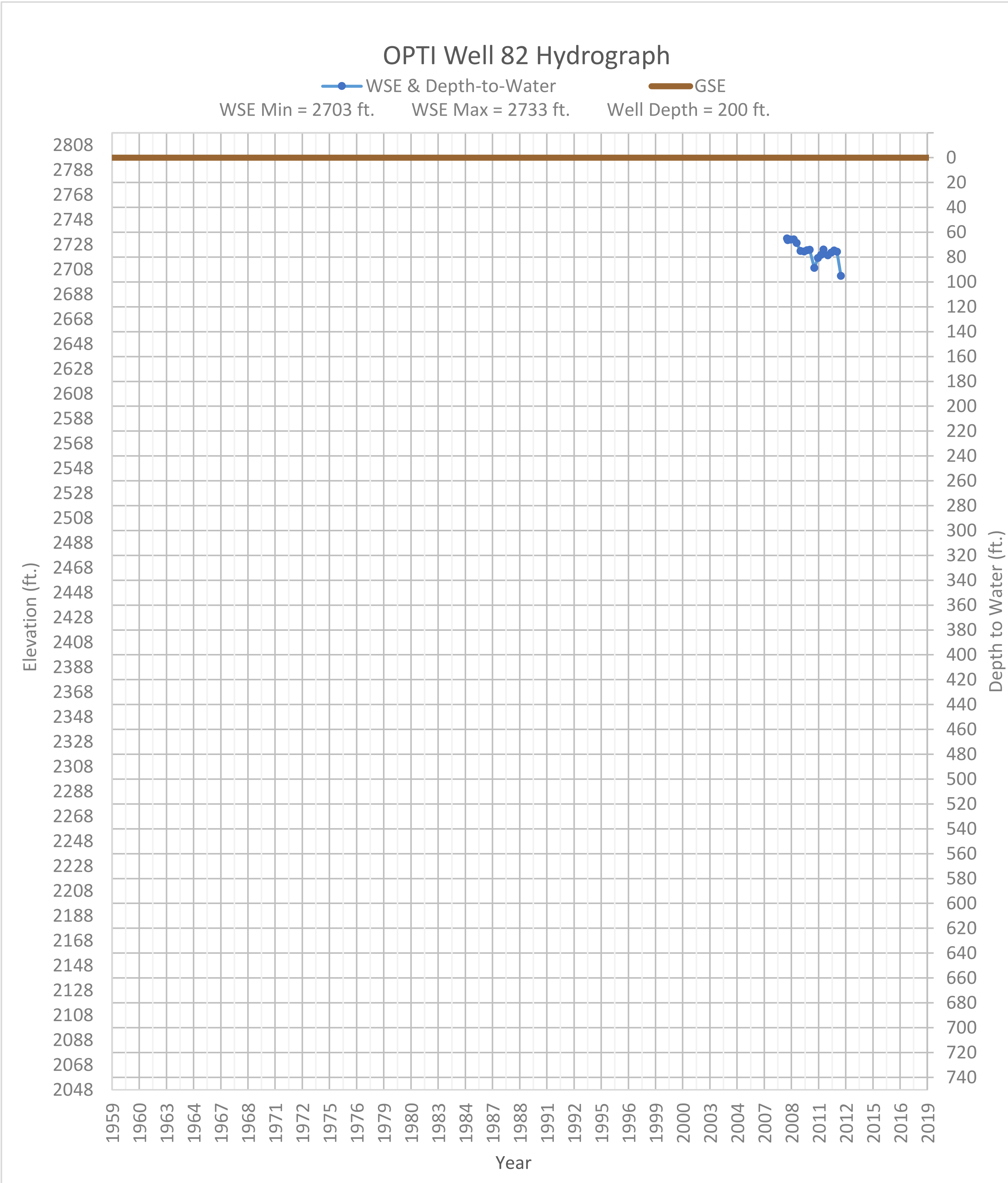
OPTI Well 78 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1853 ft.
WSE Max = 1907 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 79 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1860 ft.
WSE Max = 2002 ft.
Well Depth = 600 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 80 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1930 ft.
WSE Max = 1957 ft.
Well Depth = 800 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 81 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2588 ft.
WSE Max = 2602 ft.
Well Depth = 155 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 82 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2703 ft.
WSE Max = 2733 ft.
Well Depth = 200 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2808
2788
2768
2748
2728
2708
2688
2668
2648
2628
2608
2588
2568
2548
2528
2508
2488
2468
2448
2428
2408
2388
2368
2348
2328
2308
2288
2268
2248
2228
2208
2188
2168
2148
2128
2108
2088
2068
2048
0
20
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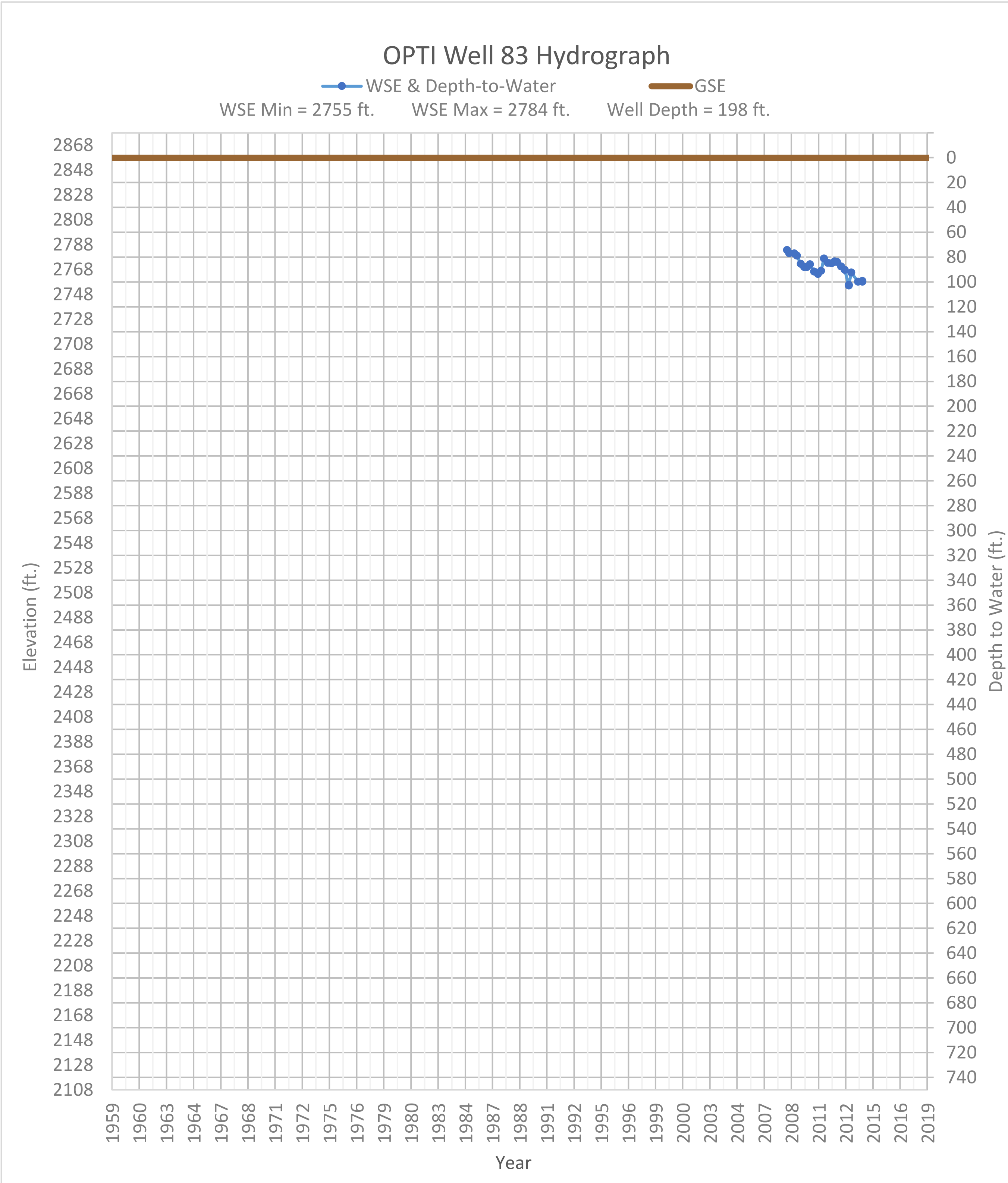
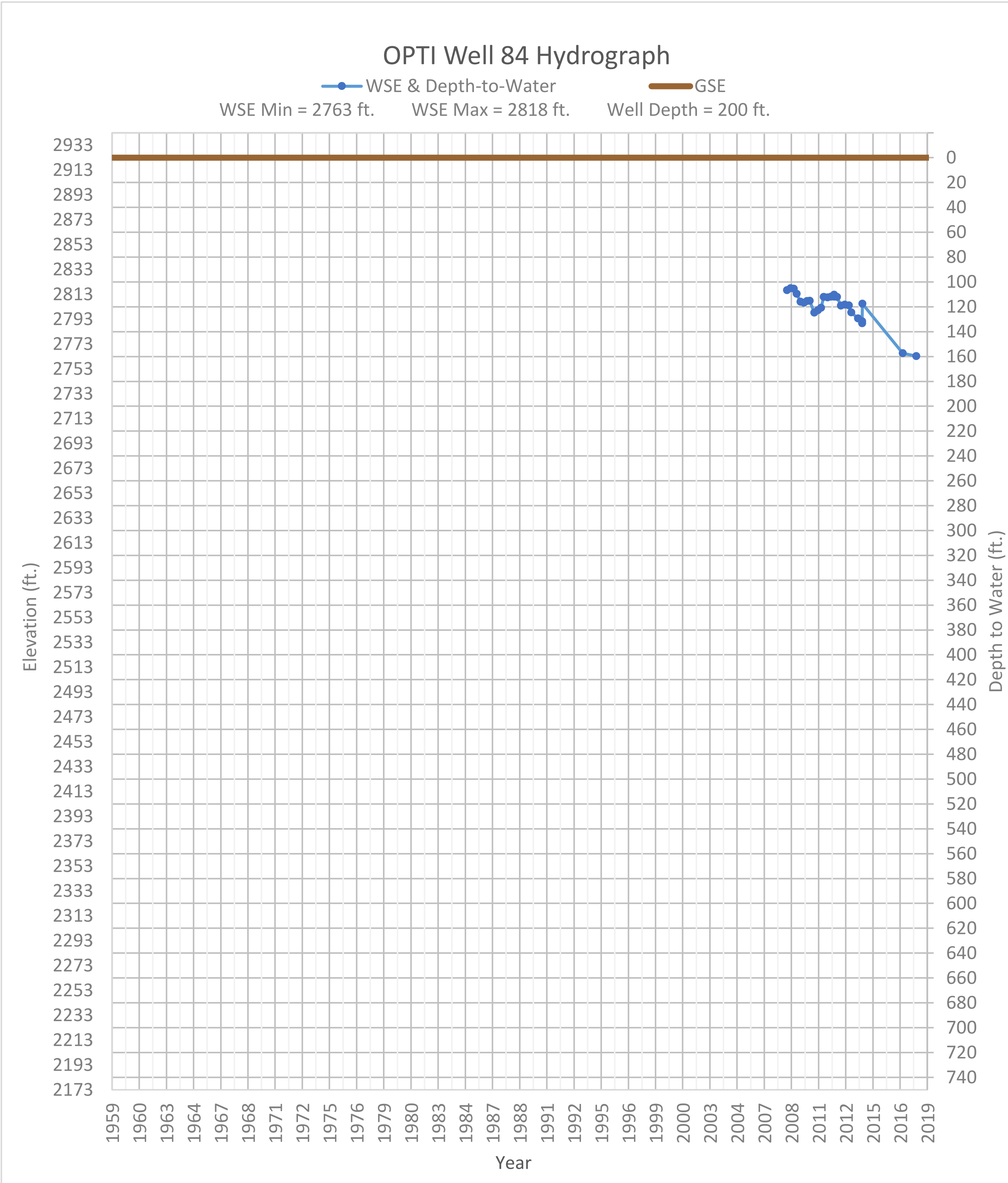


OPTI Well 83 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2755 ft.
WSE Max = 2784 ft.
Well Depth = 198 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 84 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2763 ft.
WSE Max = 2818 ft.
Well Depth = 200 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2933
2913
2893
2873
2853
2833
2813
2793
2773
2753
2733
2713
2693
2673
2653
2633
2613
2593
2573
2553
2533
2513
2493
2473
2453
2433
2413
2393
2373
2353
2333
2313
2293
2273
2253
2233
2213
2193
2173
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
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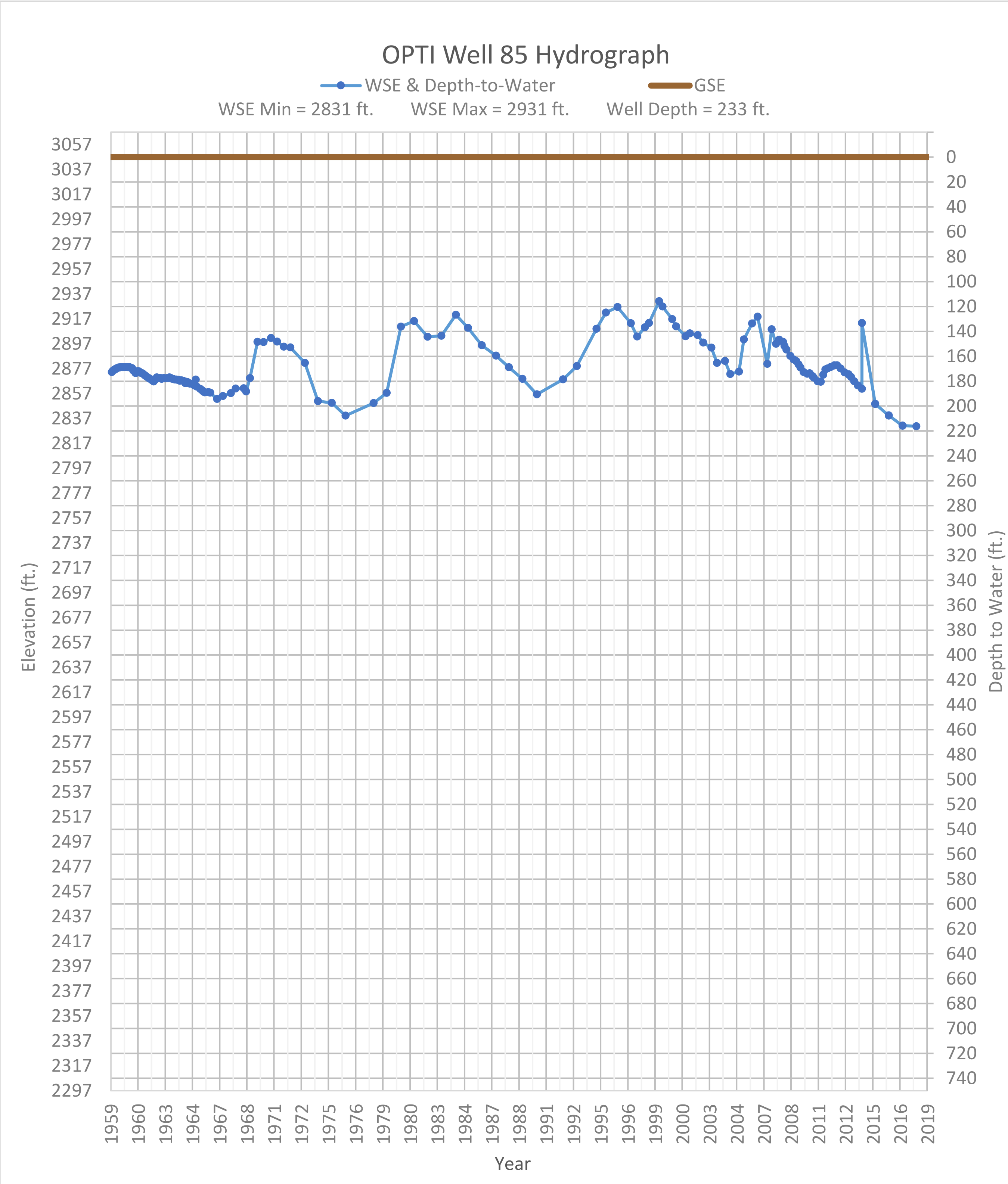
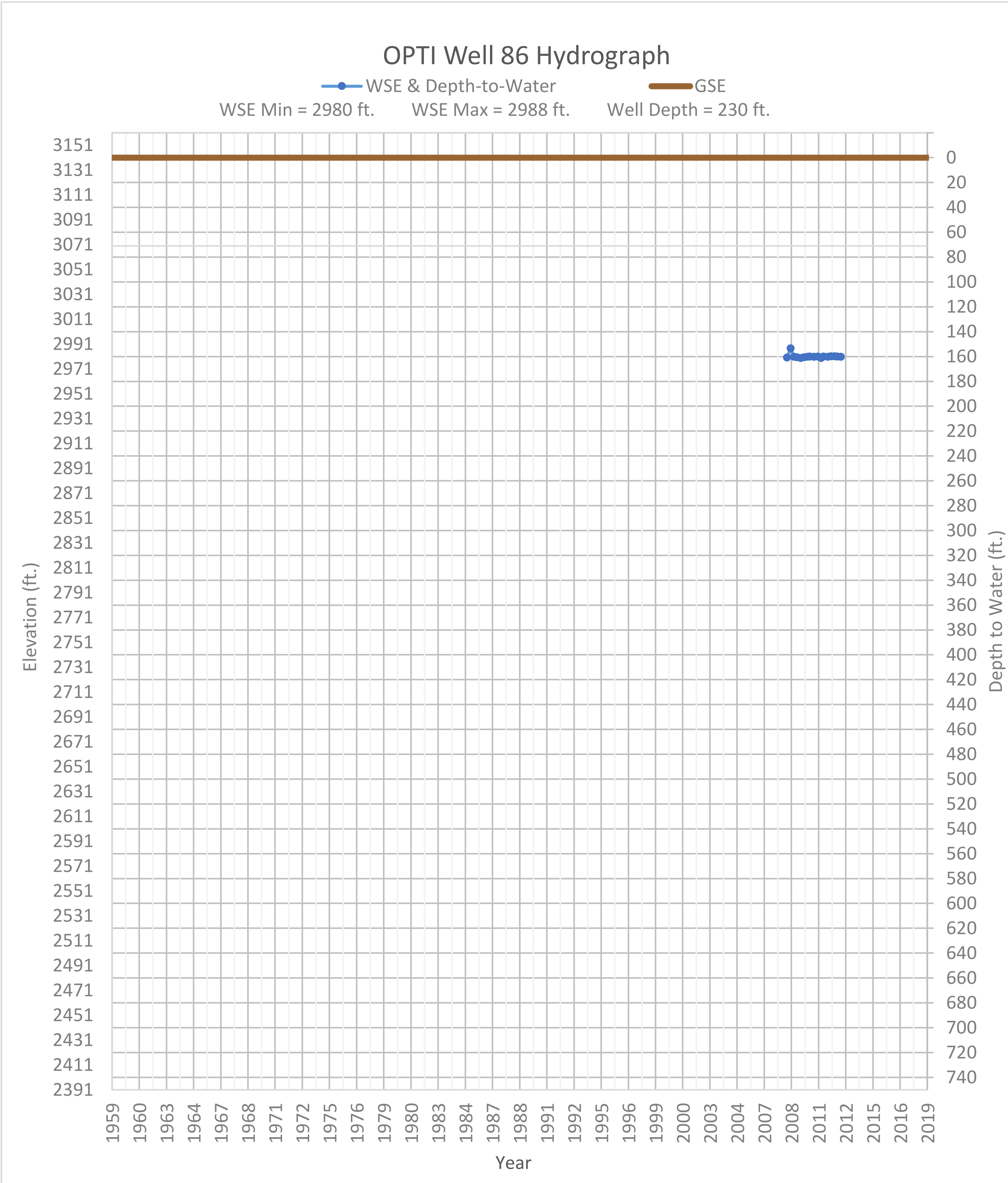
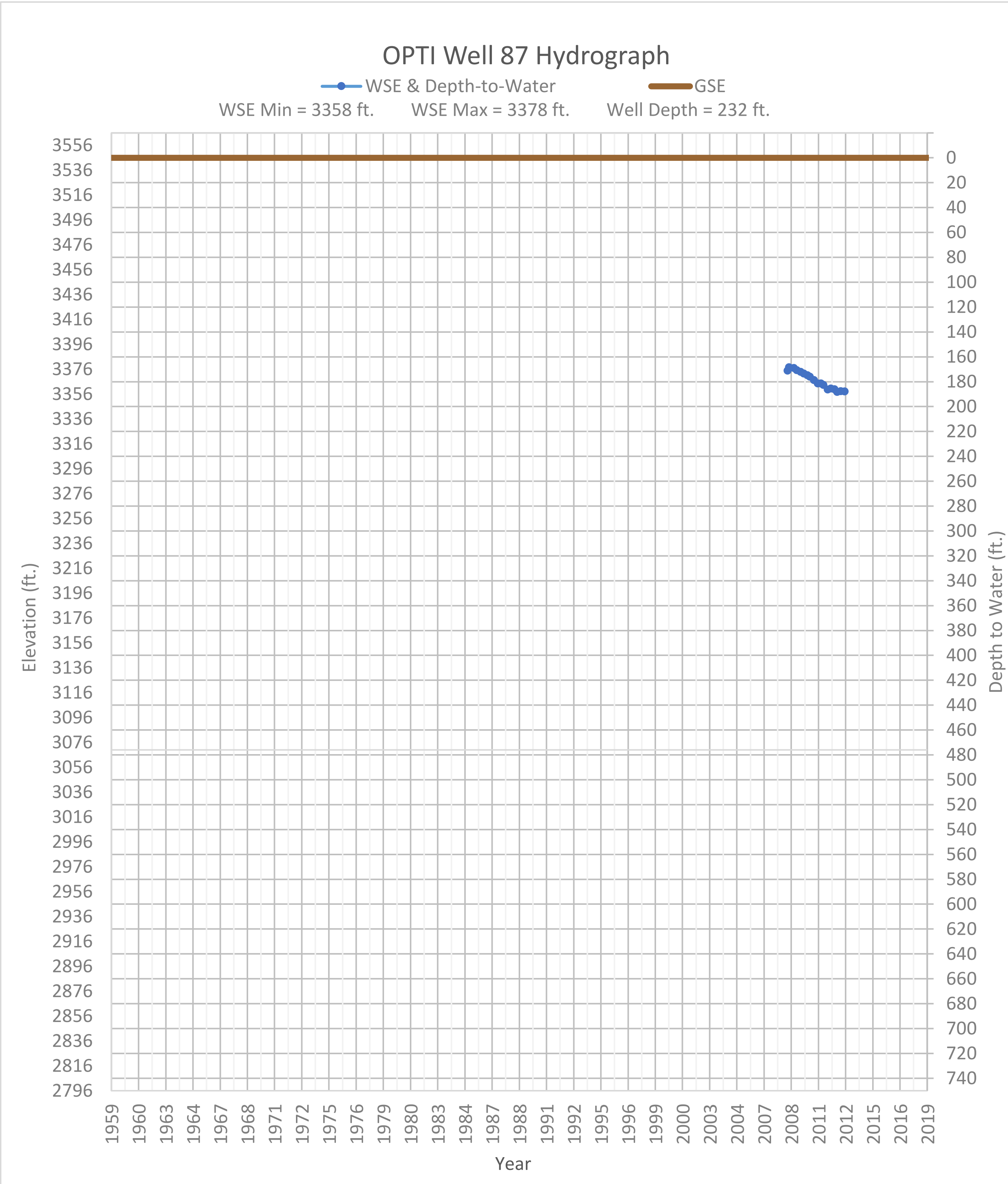


OPTI Well 85 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2831 ft.
WSE Max = 2931 ft.
Well Depth = 233 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 86 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2980 ft.
WSE Max = 2988 ft.
Well Depth = 230 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 87 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3358 ft.
WSE Max = 3378 ft.
Well Depth = 232 ft.
Elevation (ft.)
3556
3536
3516
3496
3476
3456
3436
3416
3396
3376
3356
3336
3316
3296
3276
3256
3236
3216
3196
3176
3156
3136
3116
3096
3076
3056
3036
3016
2996
2976
2956
2936
2916
2896
2876
2856
2836
2816
2796
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
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380
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460
480
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600
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640
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680
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720
740
Year
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2011
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2015
2016
2019


OPTI Well 88 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3276 ft.
WSE Max = 3322 ft.
Well Depth = 400 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3559
3539
3519
3499
3479
3459
3439
3419
3399
3379
3359
3339
3319
3299
3279
3259
3239
3219
3199
3179
3159
3139
3119
3099
3079
3059
3039
3019
2999
2979
2959
2939
2919
2899
2879
2859
2839
2819
2799
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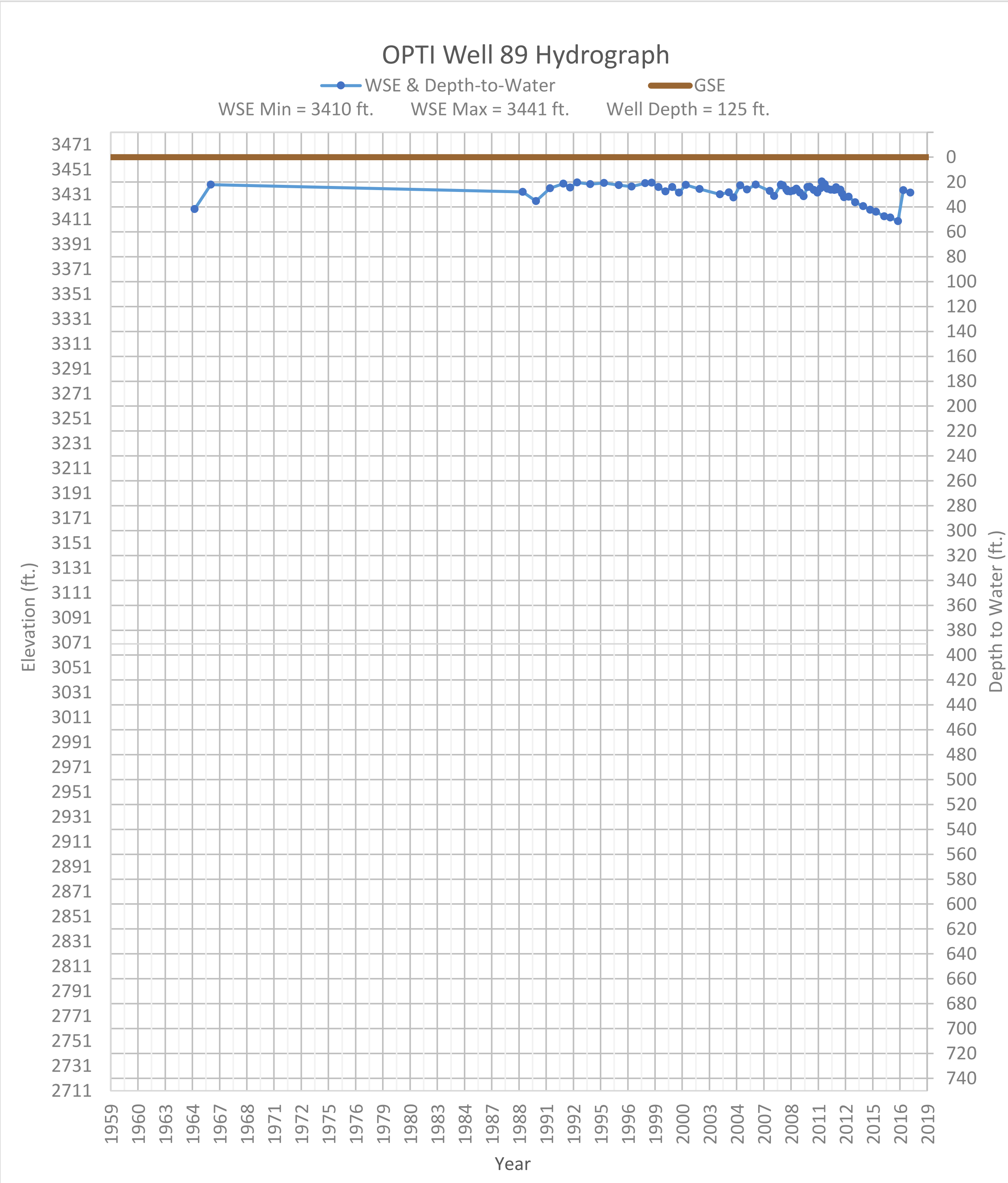
2016
2019


OPTI Well 89 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3410 ft.
WSE Max = 3441 ft.
Well Depth = 125 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3471
3451
3431
3411
3391
3371
3351
3331
3311
3291
3271
3251
3231
3211
3191
3171
3151
3131
3111
3091
3071
3051
3031
3011
2991
2971
2951
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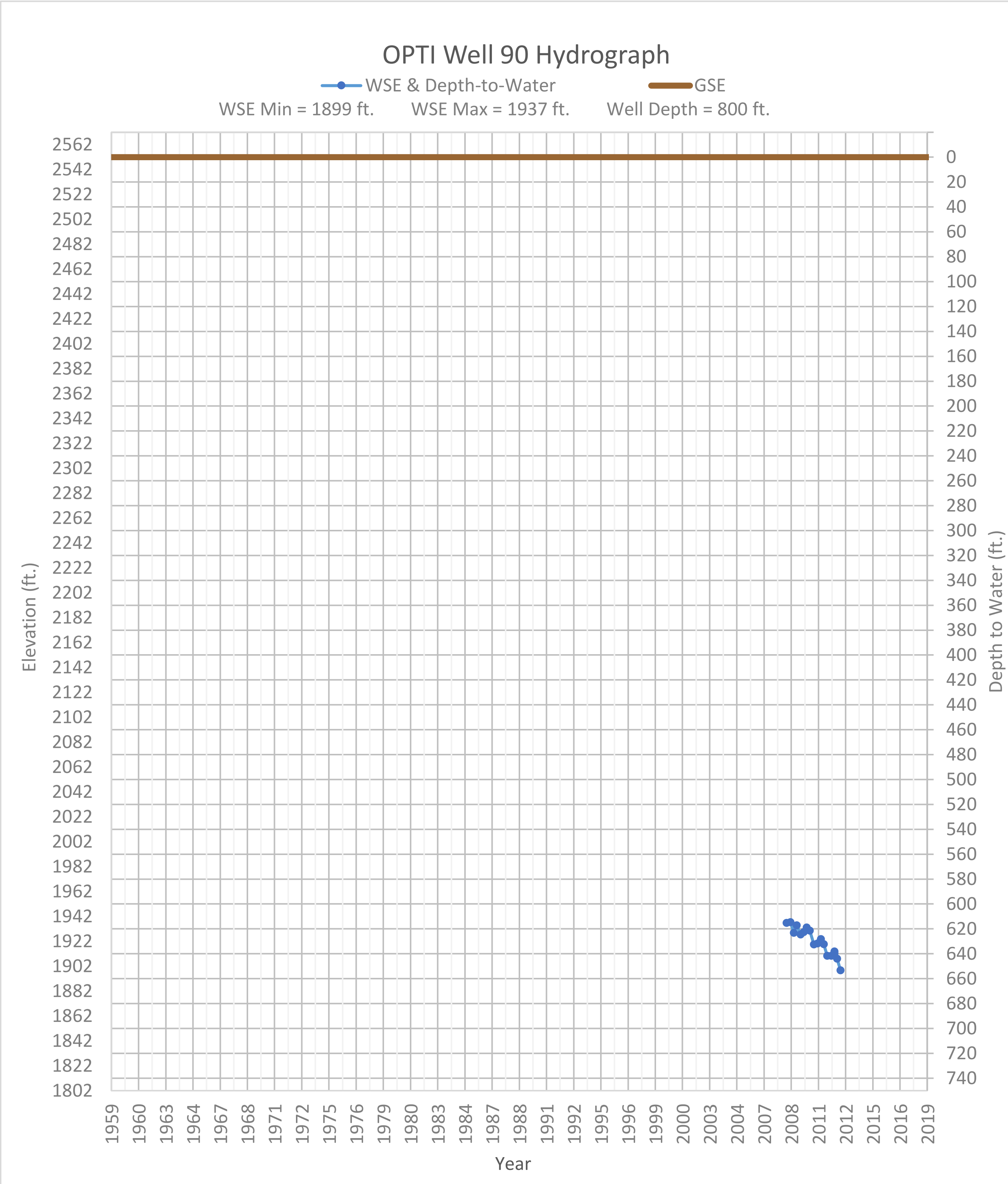
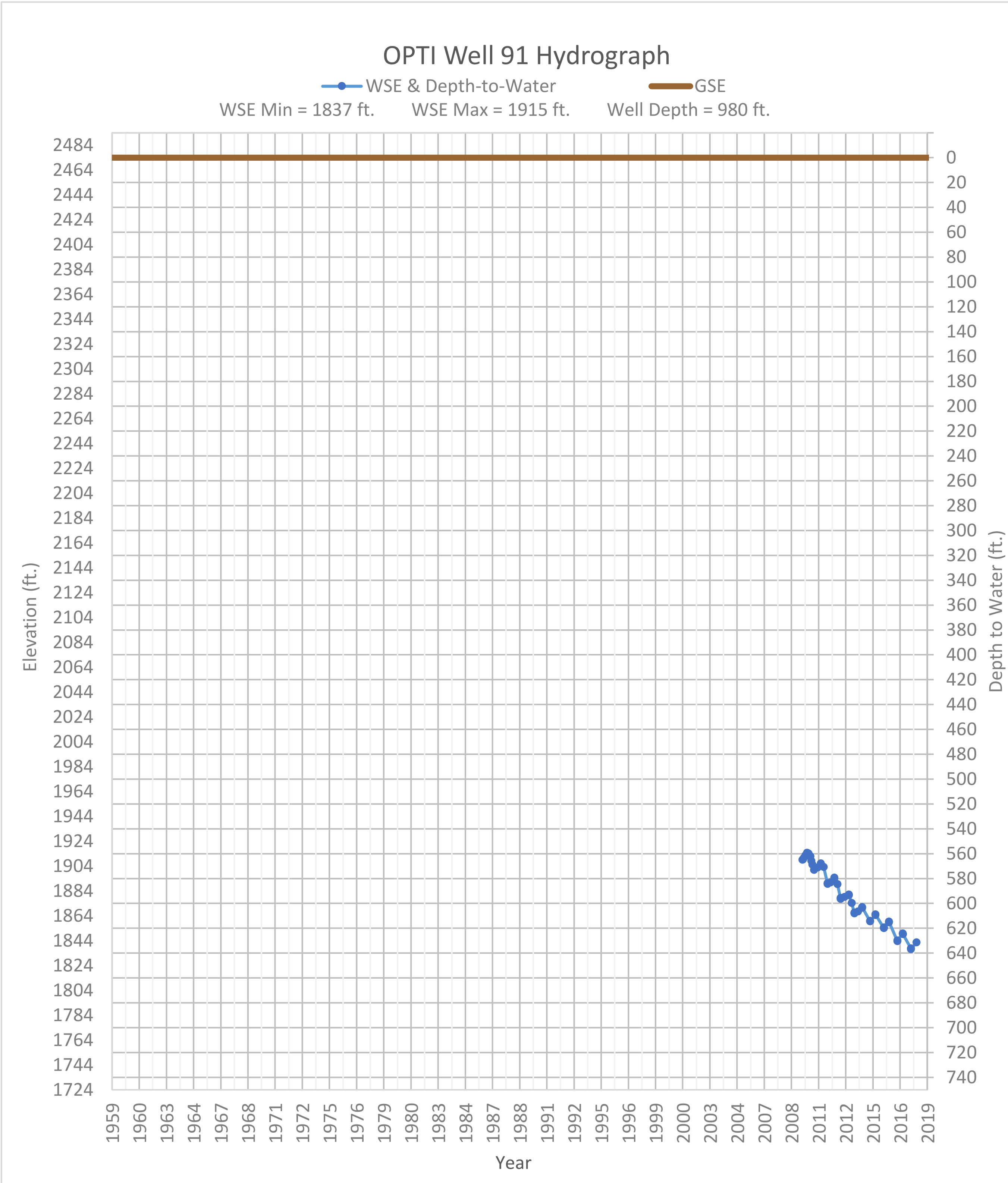
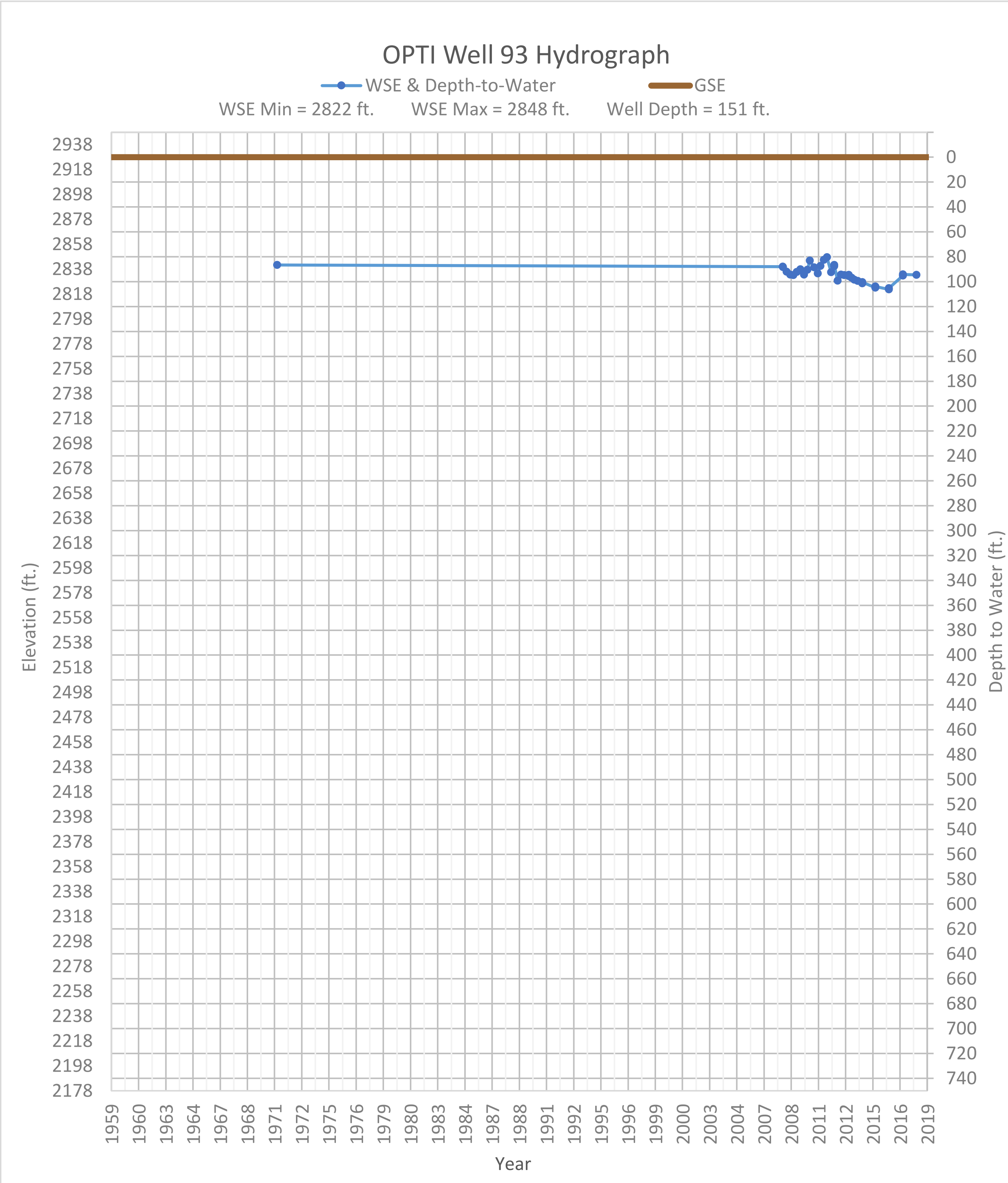


OPTI Well 90 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1899 ft.
WSE Max = 1937 ft.
Well Depth = 800 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 91 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1837 ft.
WSE Max = 1915 ft.
Well Depth = 980 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 92 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2530 ft.
WSE Max = 2577 ft.
Well Depth = 230 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 93 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2822 ft.
WSE Max = 2848 ft.
Well Depth = 151 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2938
2918
2898
2878
2858
2838
2818
2798
2778
2758
2738
2718
2698
2678
2658
2638
2618
2598
2578
2558
2538
2518
2498
2478
2458
2438
2418
2398
2378
2358
2338
2318
2298
2278
2258
2238
2218
2198
2178
0
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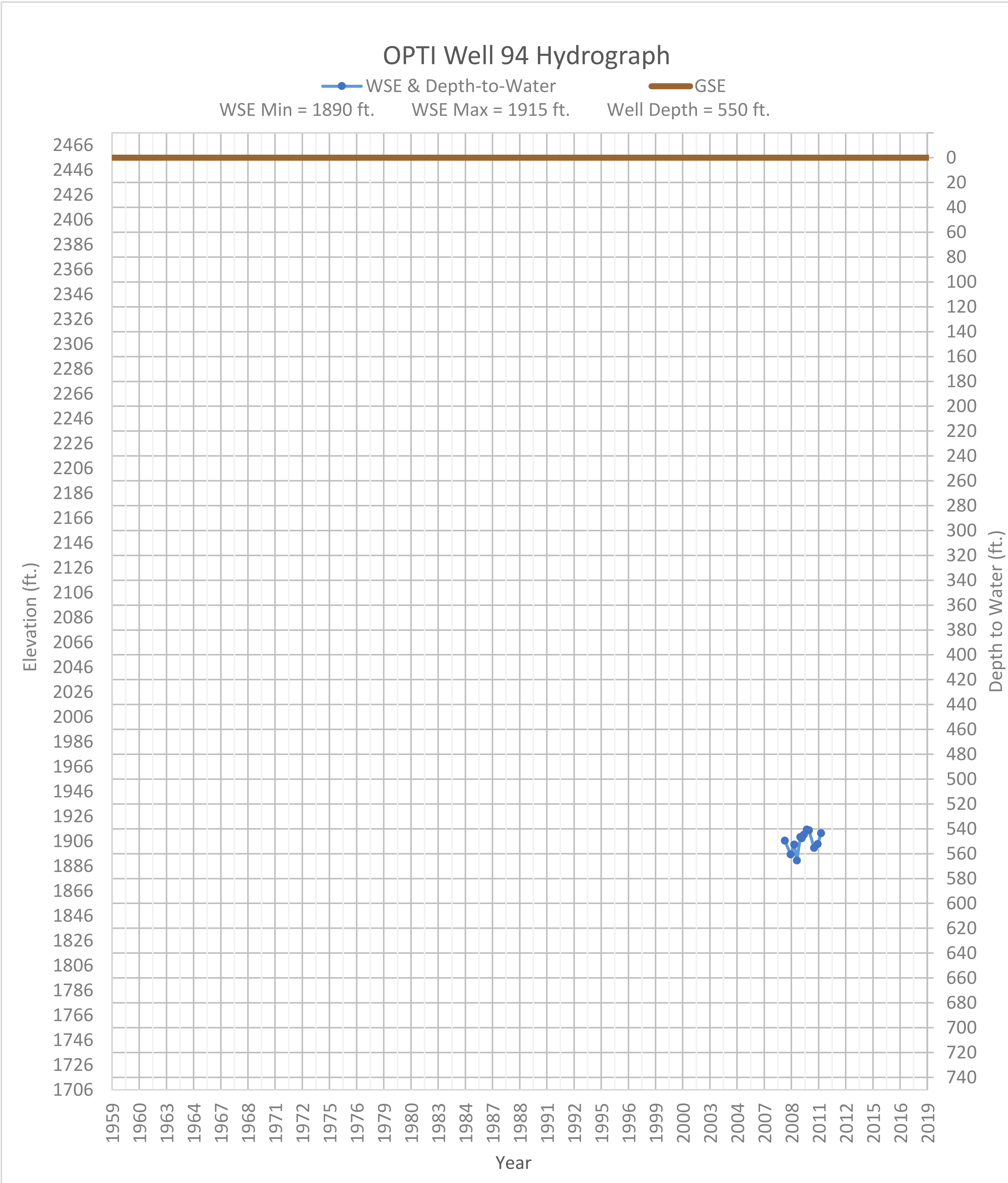

OPTI Well 94 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1890 ft.
WSE Max = 1915 ft.
Well Depth = 550 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2466
2446
2426
2406
2386
2366
2346
2326
2306
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
1786
1766
1746
1726
1706
0
20
40
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80
100
120
140
160
180
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260
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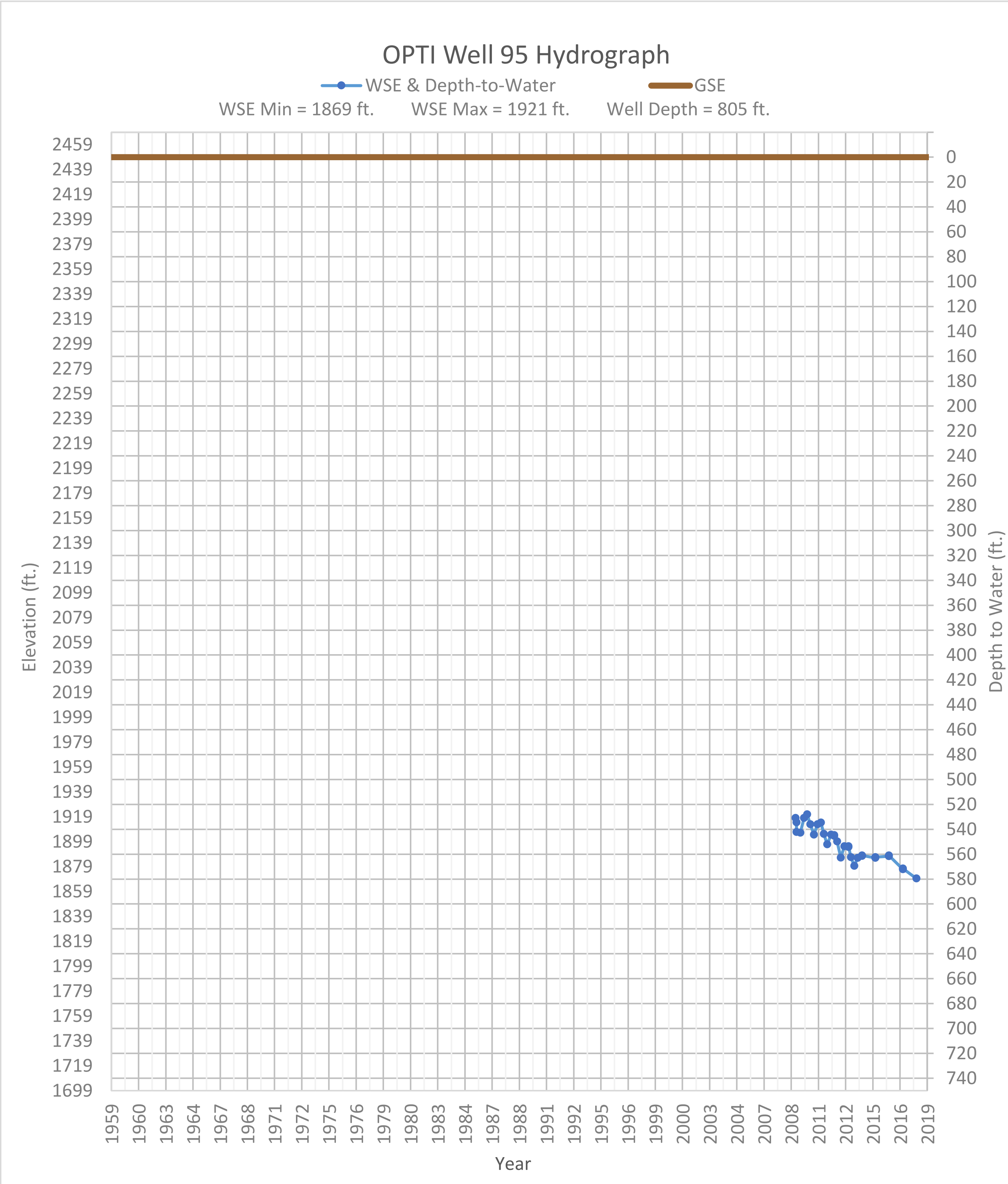
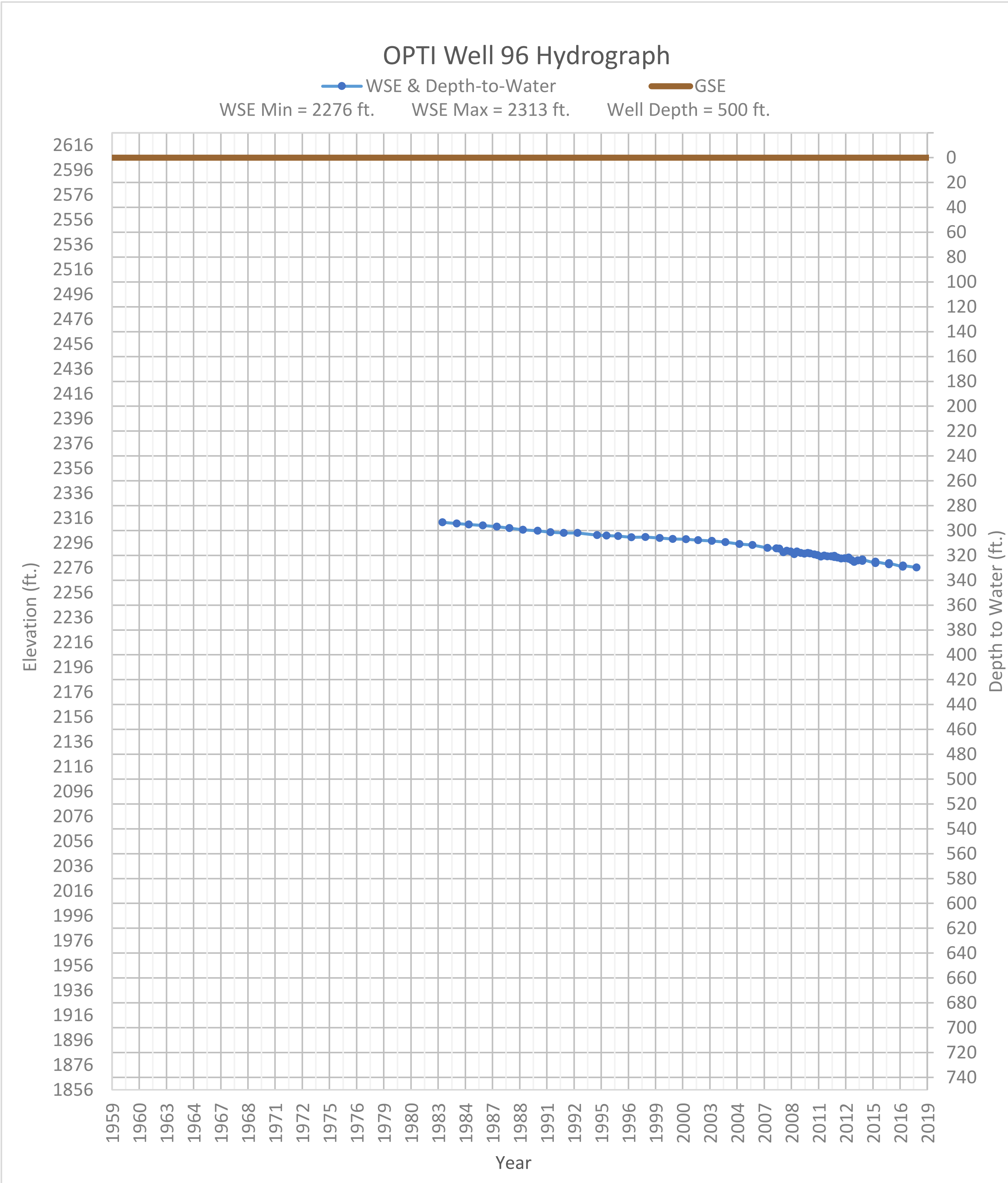


OPTI Well 95 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1869 ft.
WSE Max = 1921 ft.
Well Depth = 805 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 96 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2276 ft.
WSE Max = 2313 ft.
Well Depth = 500 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2616
2596
2576
2556
2536
2516
2496
2476
2456
2436
2416
2396
2376
2356
2336
2316
2296
2276
2256
2236
2216
2196
2176
2156
2136
2116
2096
2076
2056
2036
2016
1996
1976
1956
1936
1916
1896
1876
1856
0
20
40
60
80
100
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140
160
180
200
220
240
260
280
300
320
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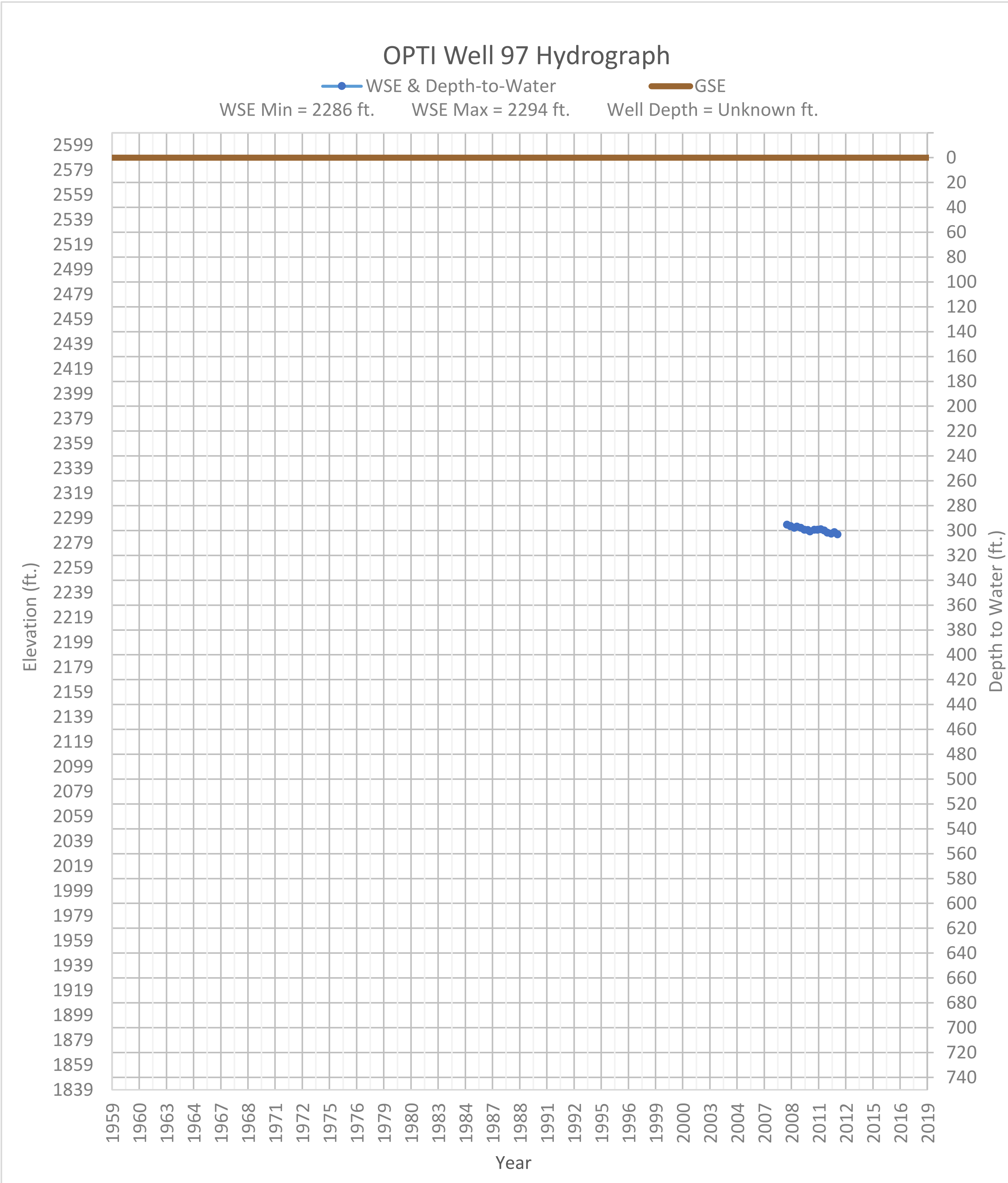
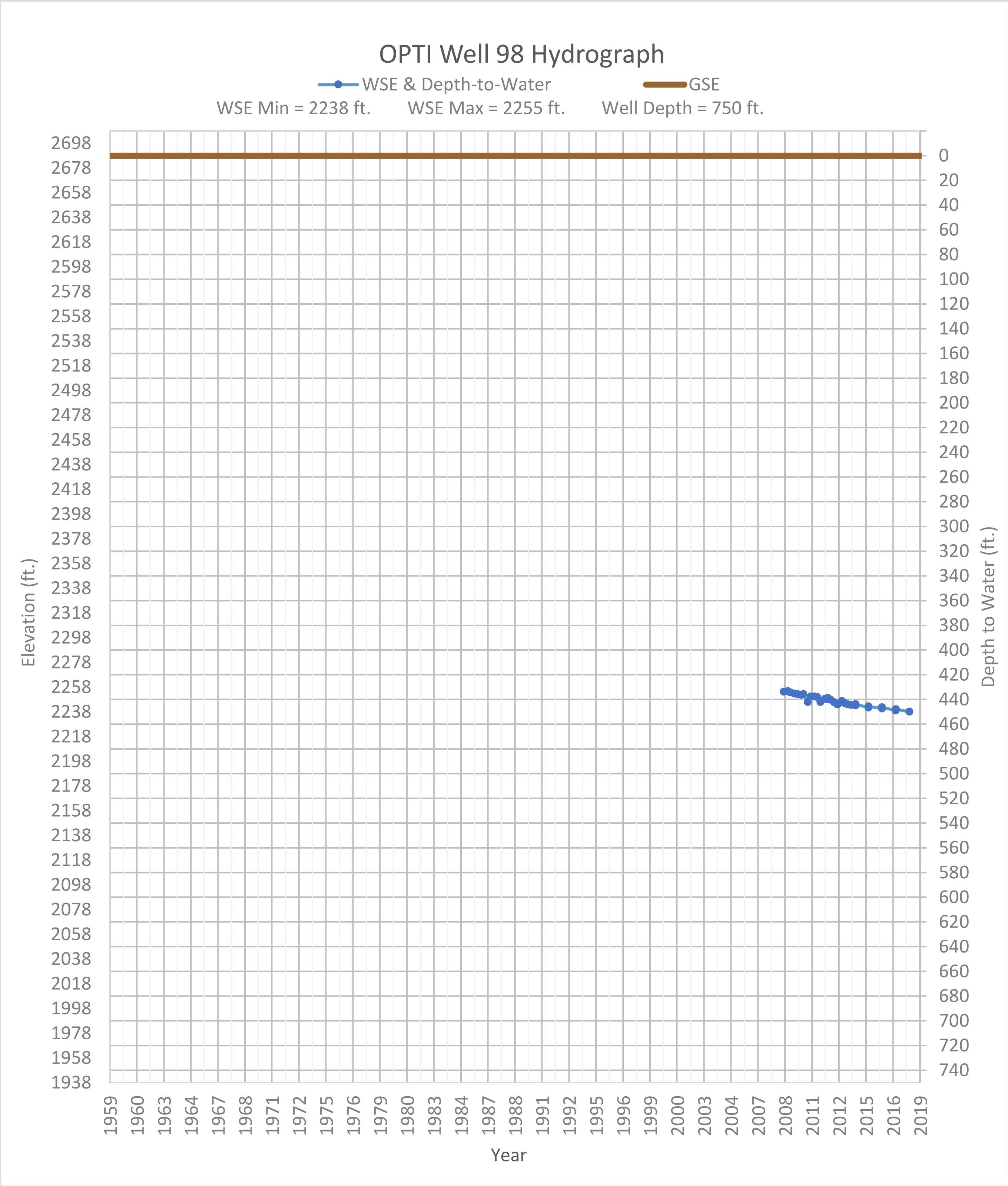
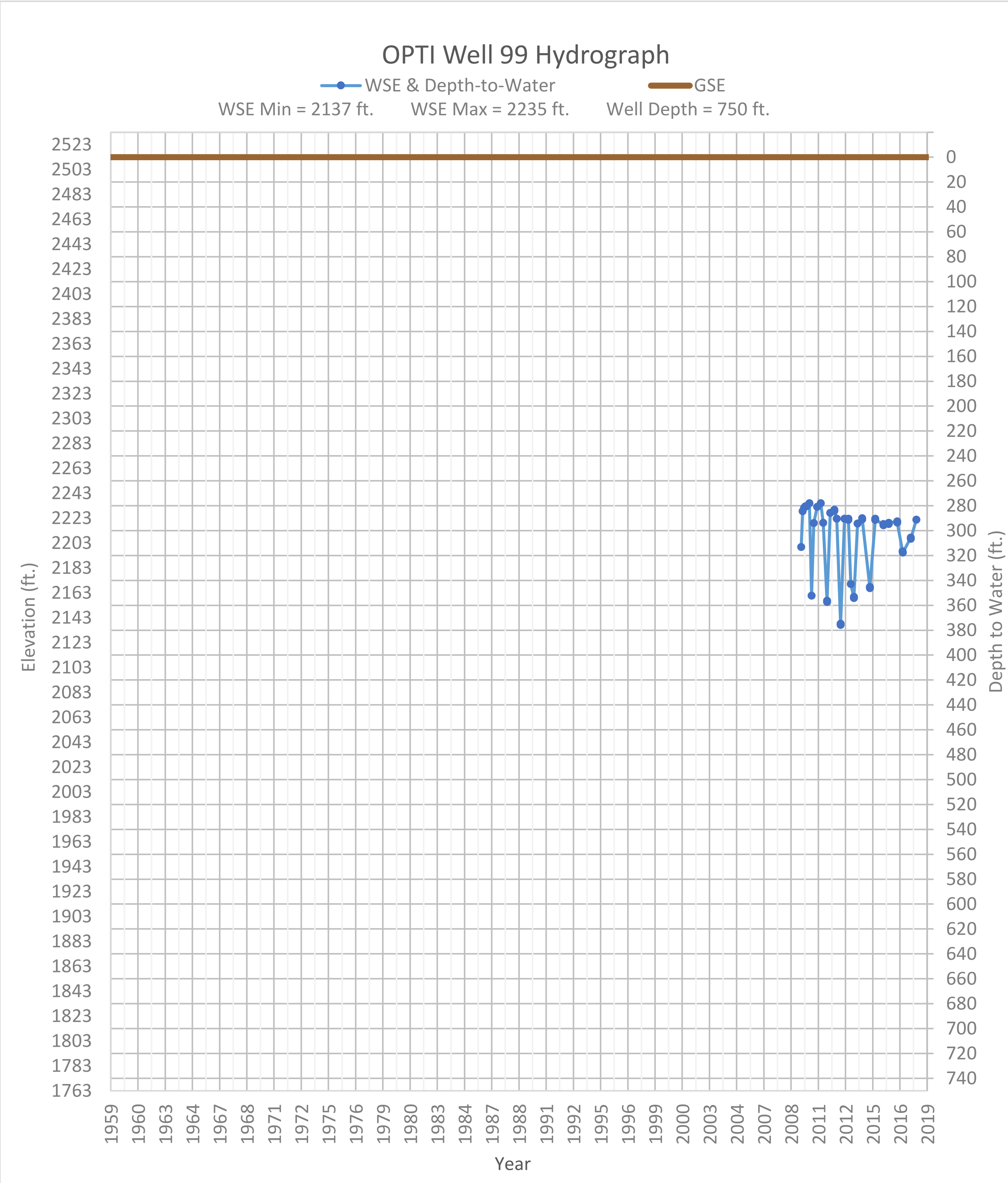


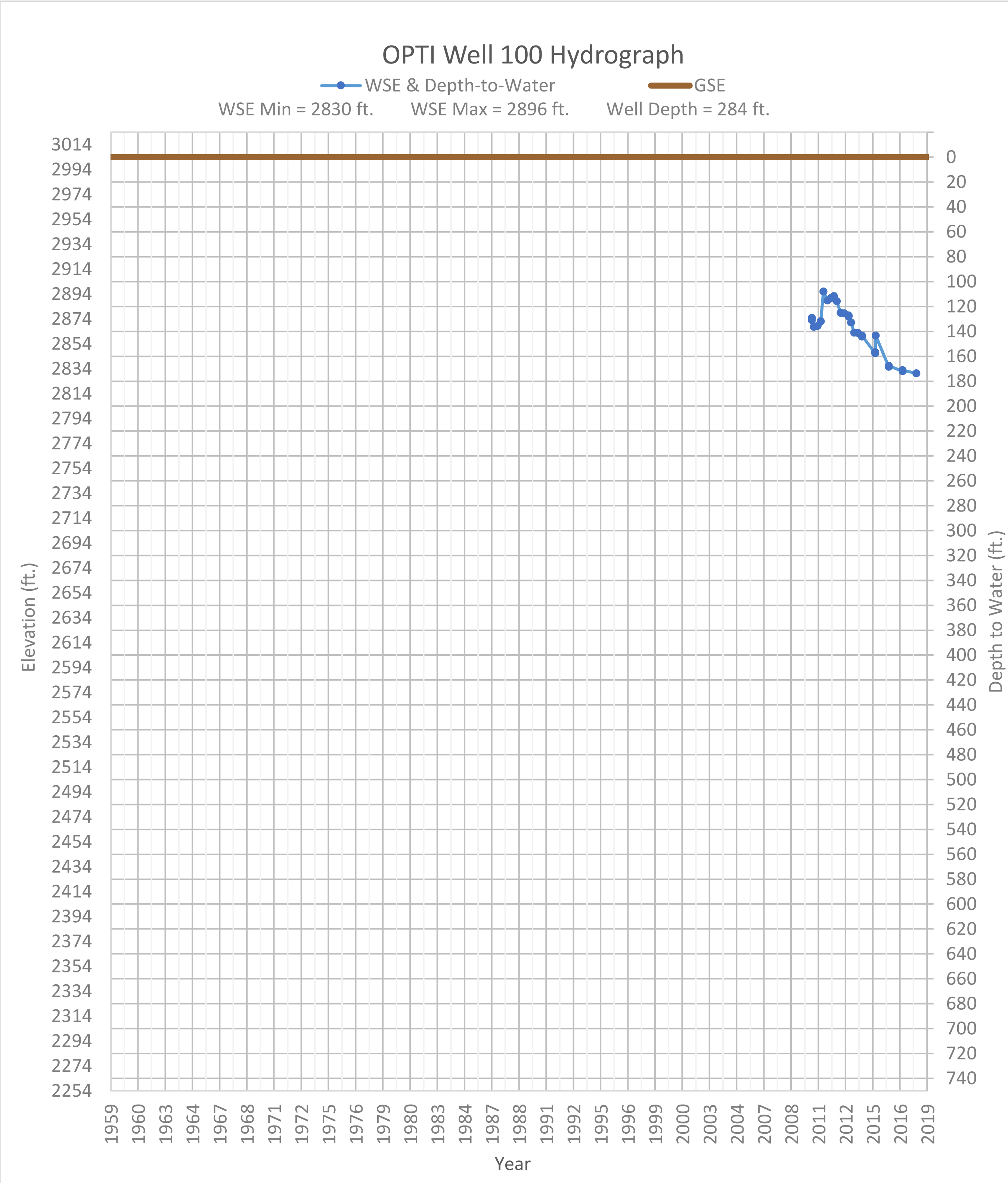
OPTI Well 97 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2286 ft.
WSE Max = 2294 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year

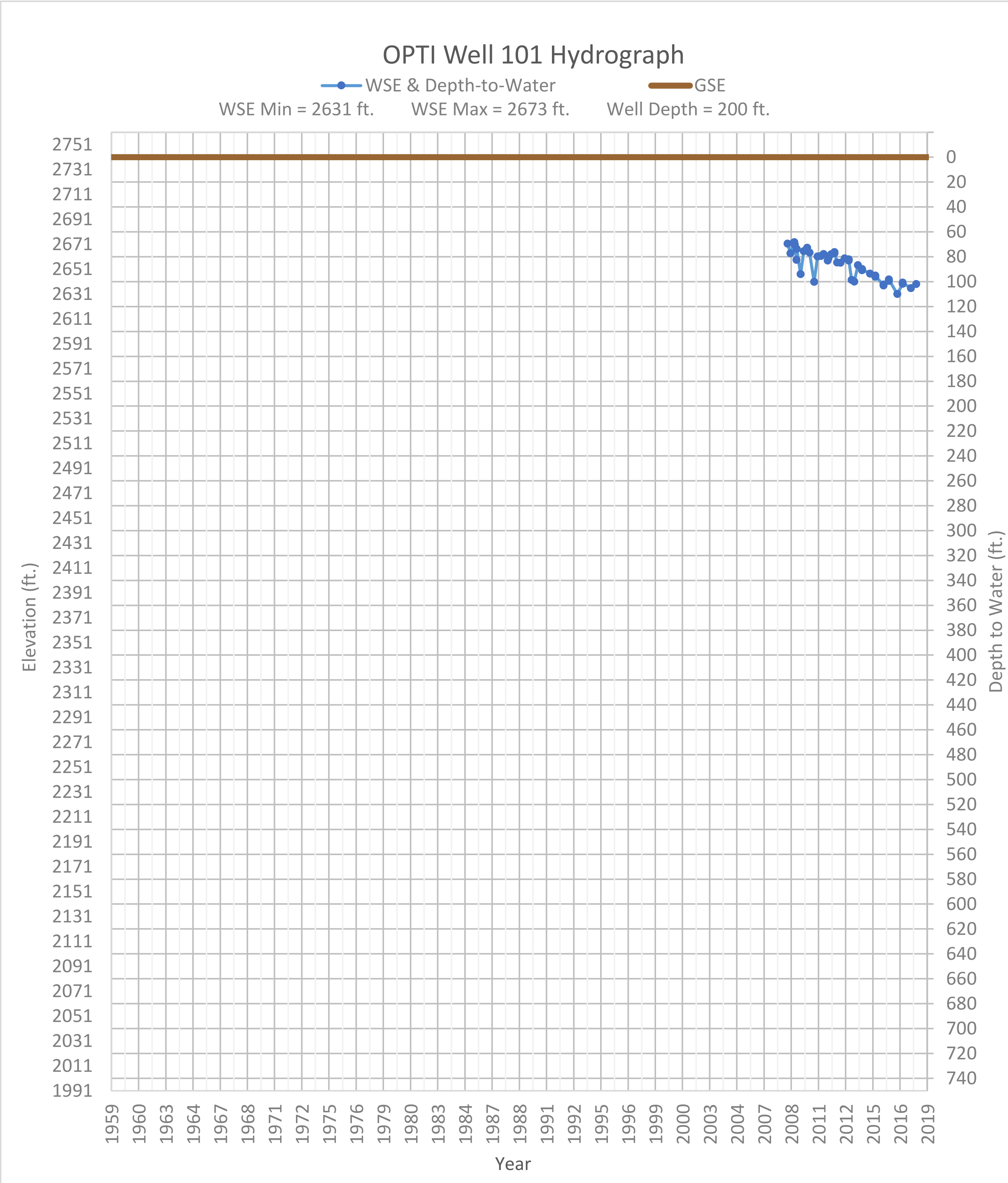


OPTI Well 98 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2238 ft.
WSE Max = 2255 ft.
Well Depth = 750 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 99 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2137 ft.
WSE Max = 2235 ft.
Well Depth = 750 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 100 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2830 ft.
WSE Max = 2896 ft.
Well Depth = 284 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 101 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2631 ft.
WSE Max = 2673 ft.
Well Depth = 200 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2751
2731
2711
2691
2671
2651
2631
2611
2591
2571
2551
2531
2511
2491
2471
2451
2431
2411
2391
2371
2351
2331
2311
2291
2271
2251
2231
2211
2191
2171
2151
2131
2111
2091
2071
2051
2031
2011
1991
0
20
40
60
80
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120
140
160
180
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220
240
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2011
2012
2015
2016
2019


OPTI Well 102 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1802 ft.
WSE Max = 1861 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2056
2036
2016
1996
1976
1956
1936
1916
1896
1876
1856
1836
1816
1796
1776
1756
1736
1716
1696
1676
1656
1636
1616
1596
1576
1556
1536
1516
1496
1476
1456
1436
1416
1396
1376
1356
1336
1316
1296
0
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80
100
120
140
160
180
200
220
240
260
280
300
320
340
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2016
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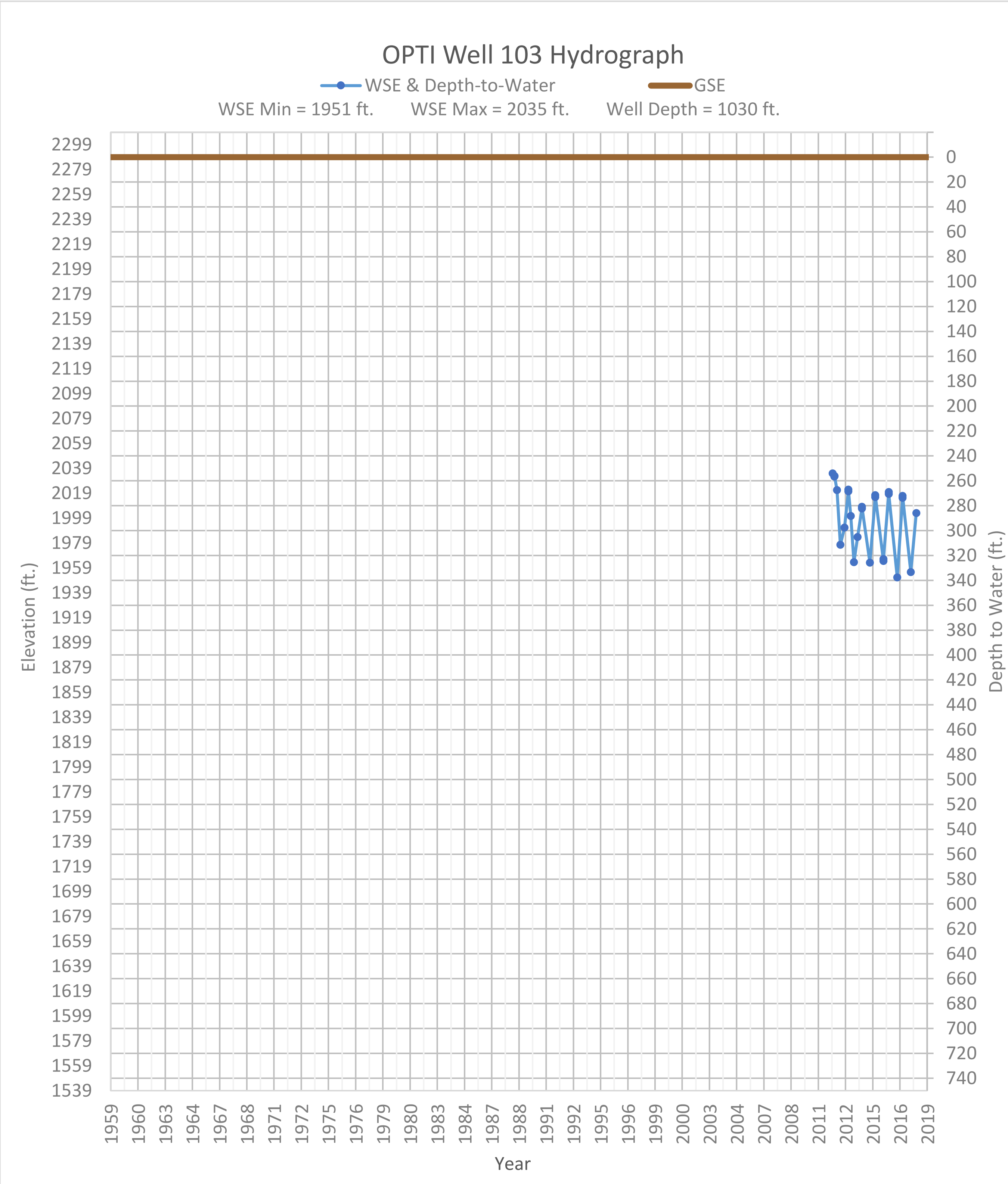
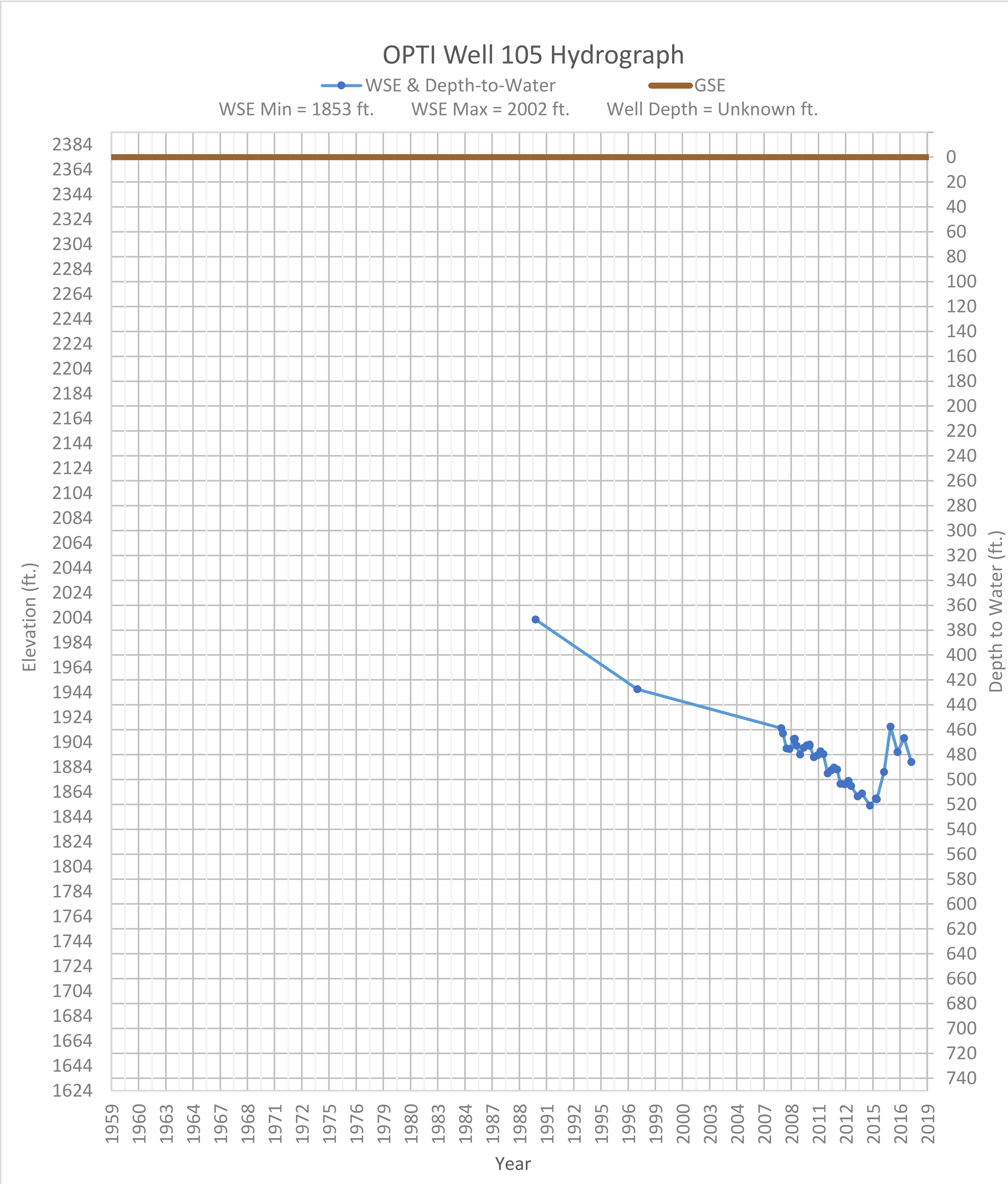
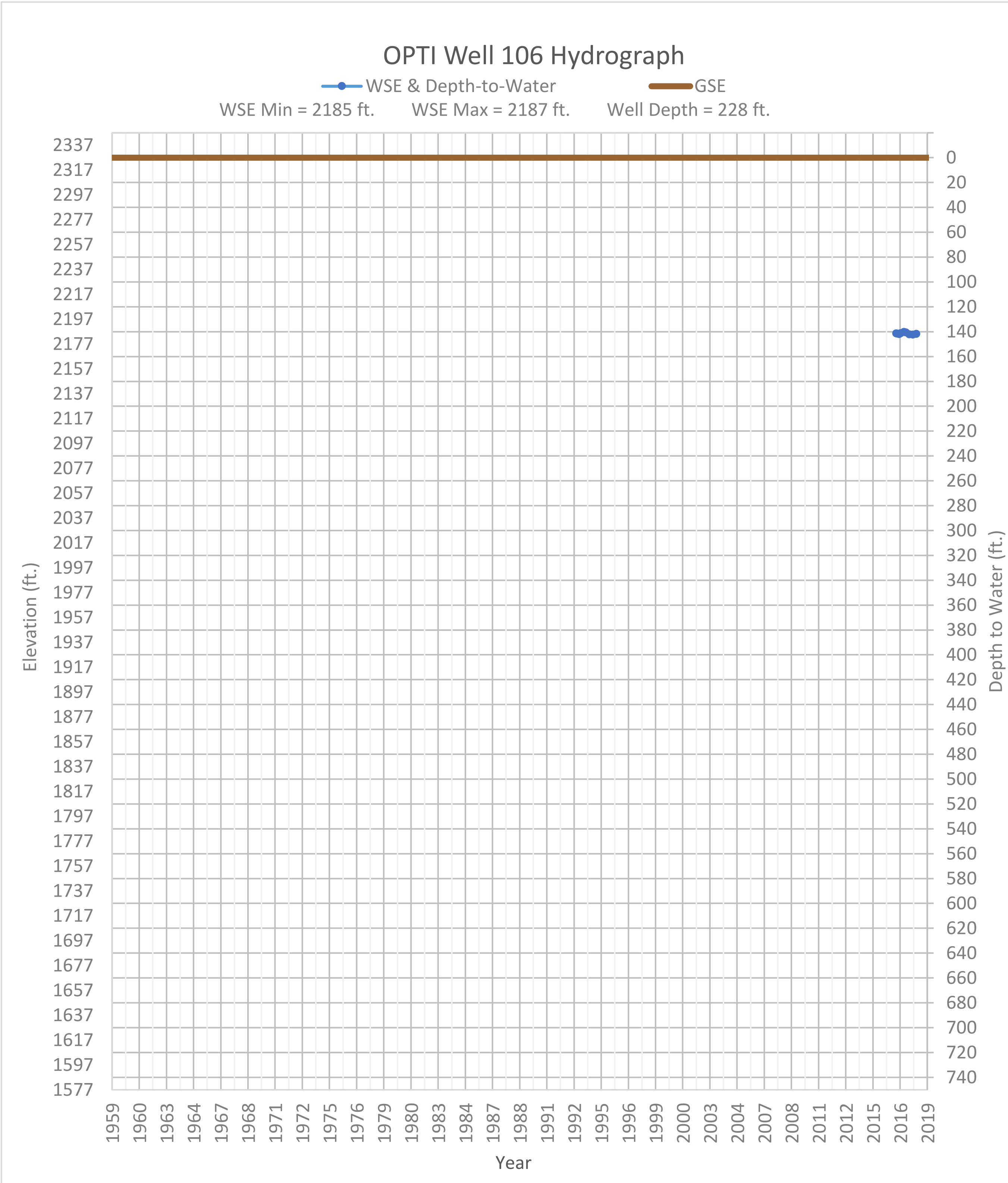


OPTI Well 103 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1951 ft.
WSE Max = 2035 ft.
Well Depth = 1030 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 104 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1837 ft.
WSE Max = 1907 ft.
Well Depth = 640 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 105 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1853 ft.
WSE Max = 2002 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 106 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2185 ft.
WSE Max = 2187 ft.
Well Depth = 228 ft.
Elevation (ft.)
2337
2317
2297
2277
2257
2237
2217
2197
2177
2157
2137
2117
2097
2077
2057
2037
2017
1997
1977
1957
1937
1917
1897
1877
1857
1837
1817
1797
1777
1757
1737
1717
1697
1677
1657
1637
1617
1597
1577
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
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420
440
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560
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Year
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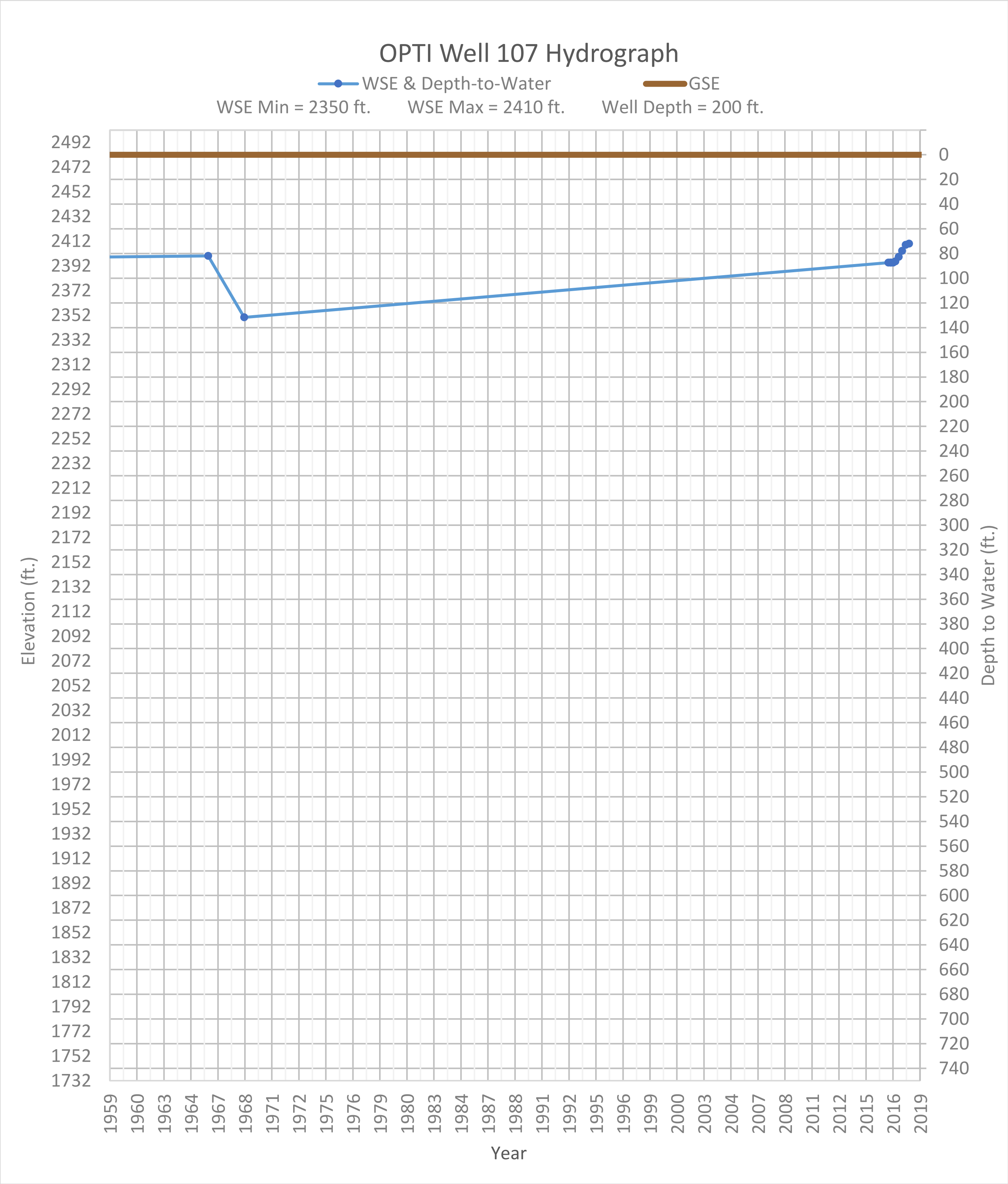
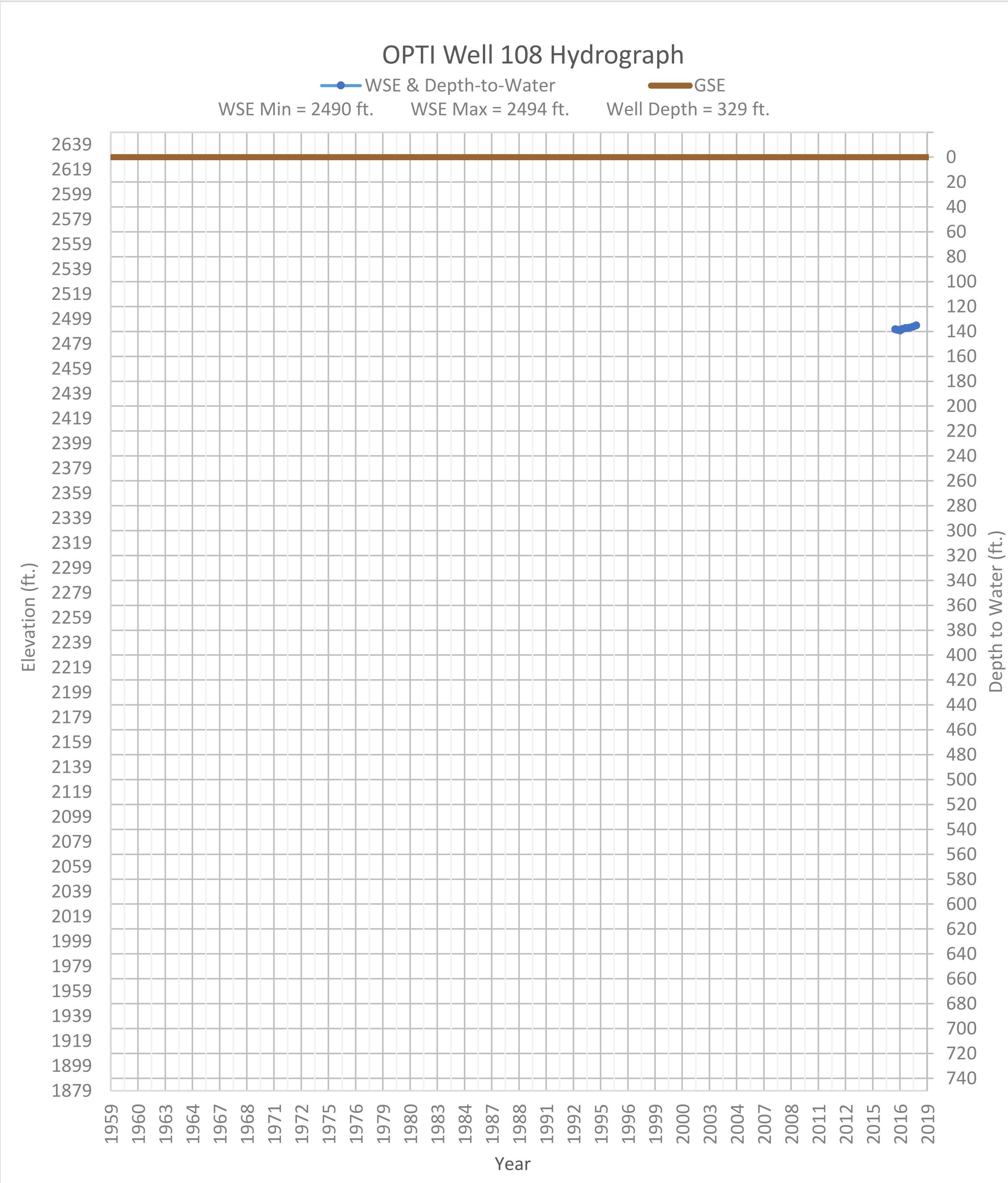


OPTI Well 107 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2350 ft.
WSE Max = 2410 ft.
Well Depth = 200 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 108 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2490 ft.
WSE Max = 2494 ft.
Well Depth = 329 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2639
2619
2599
2579
2559
2539
2519
2499
2479
2459
2439
2419
2399
2379
2359
2339
2319
2299
2279
2259
2239
2219
2199
2179
2159
2139
2119
2099
2079
2059
2039
2019
1999
1979
1959
1939
1919
1899
1879
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200
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280
300
320
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360
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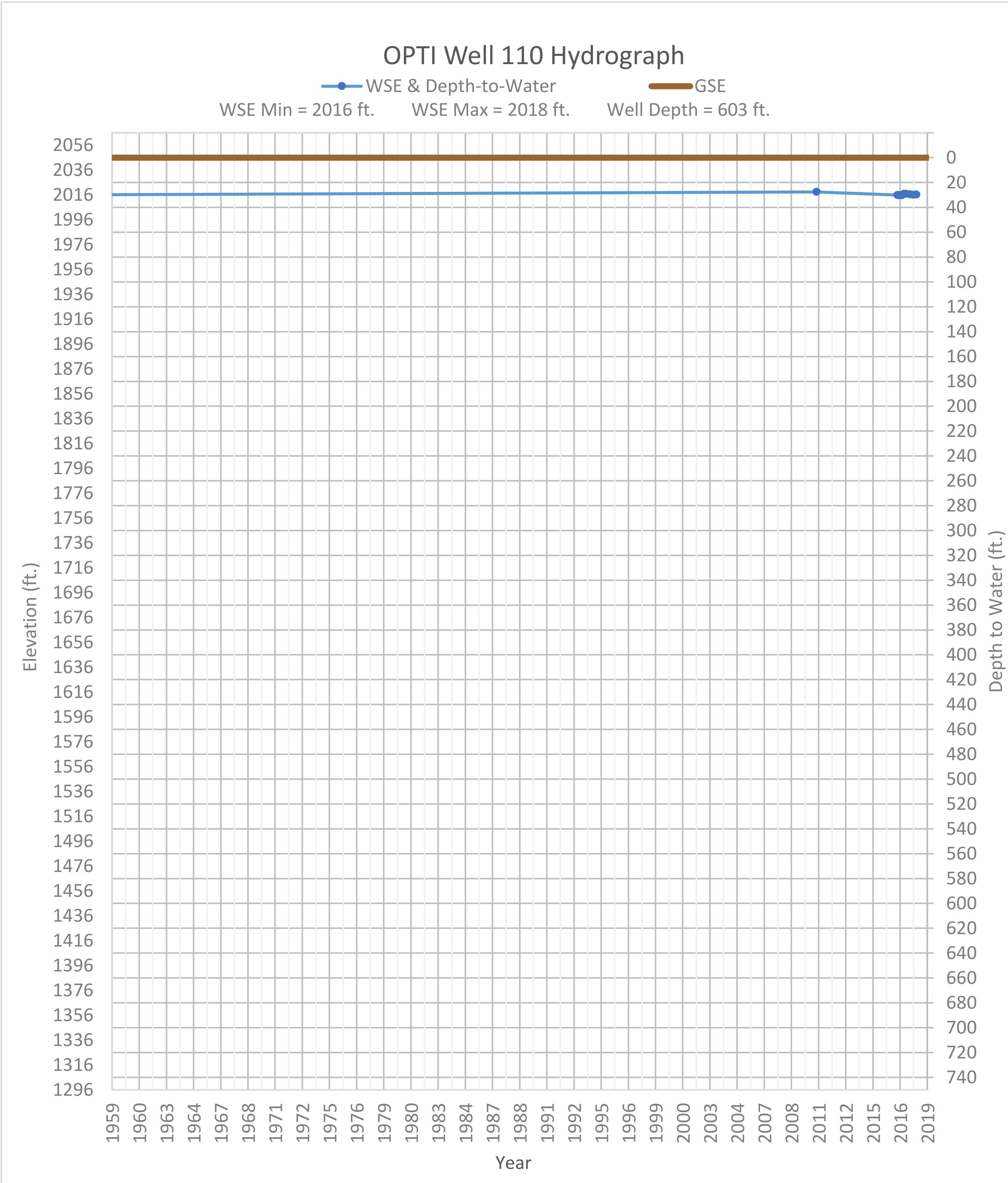
OPTI Well 110 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2016 ft.
WSE Max = 2018 ft.
Well Depth = 603 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2056
2036
2016
1996
1976
1956
1936
1916
1896
1876
1856
1836
1816
1796
1776
1756
1736
1716
1696
1676
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1296
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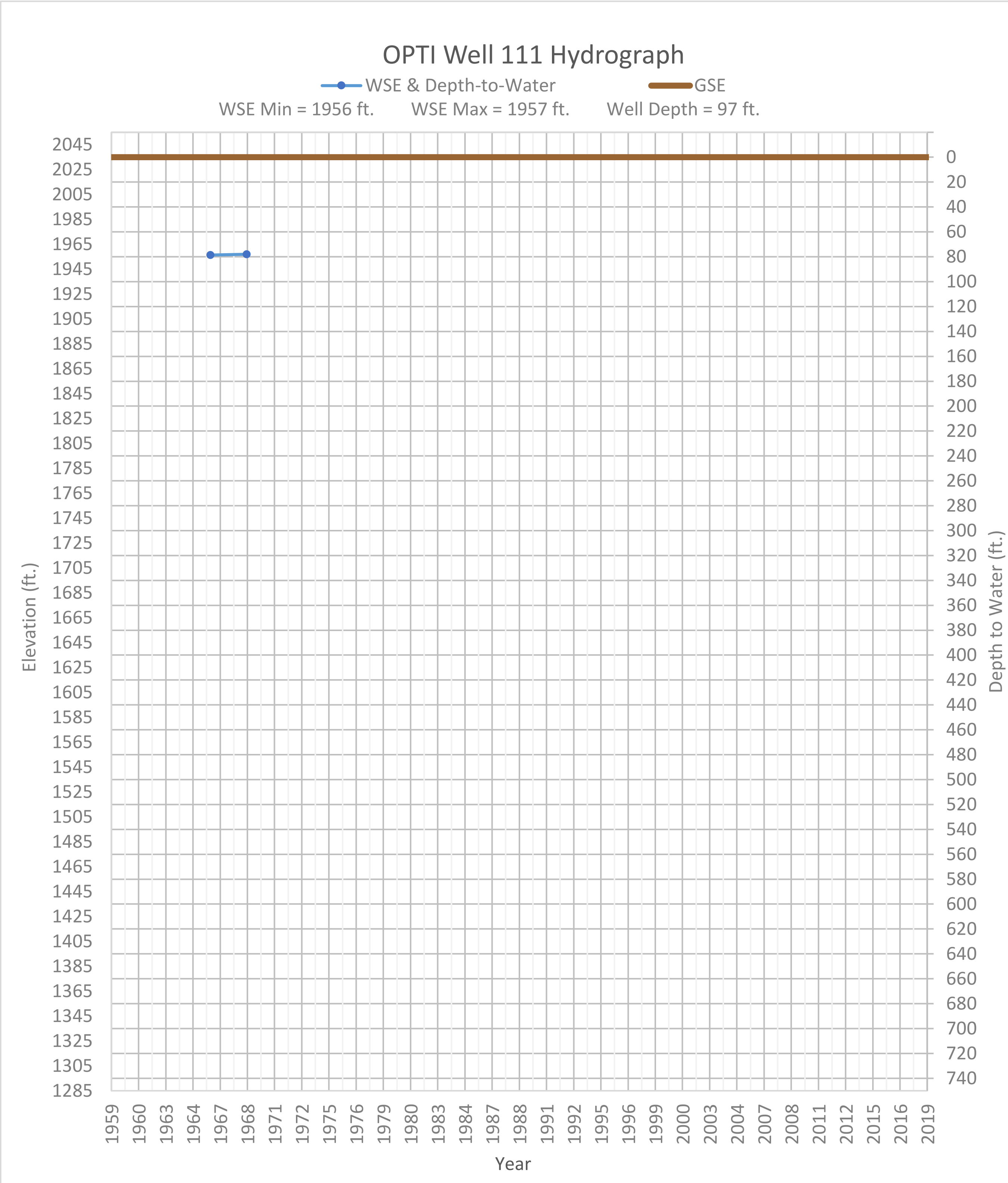
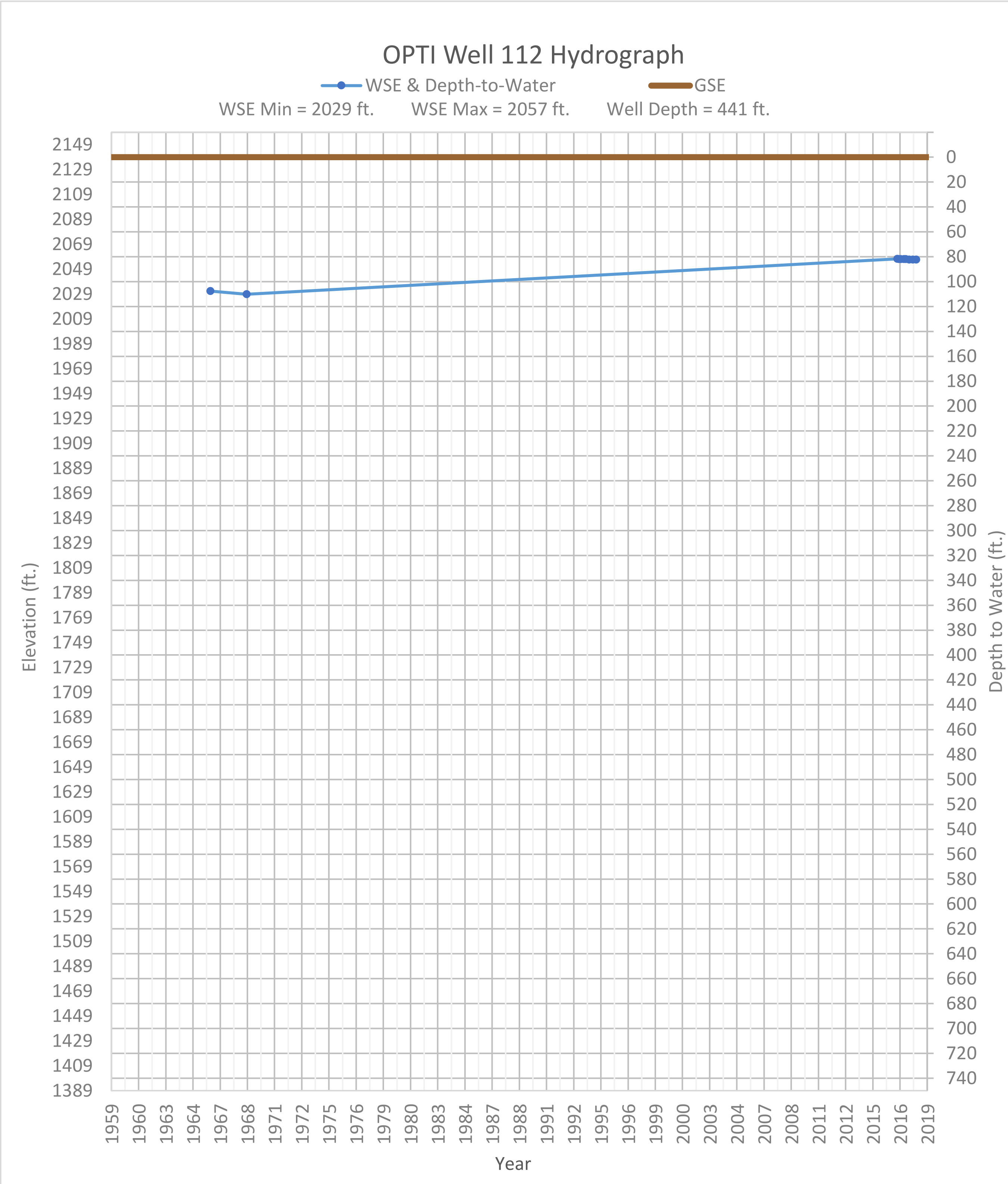


OPTI Well 111 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1956 ft.
WSE Max = 1957 ft.
Well Depth = 97 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 112 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2029 ft.
WSE Max = 2057 ft.
Well Depth = 441 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2149
2129
2109
2089
2069
2049
2029
2009
1989
1969
1949
1929
1909
1889
1869
1849
1829
1809
1789
1769
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1709
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1489
1469
1449
1429
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1389
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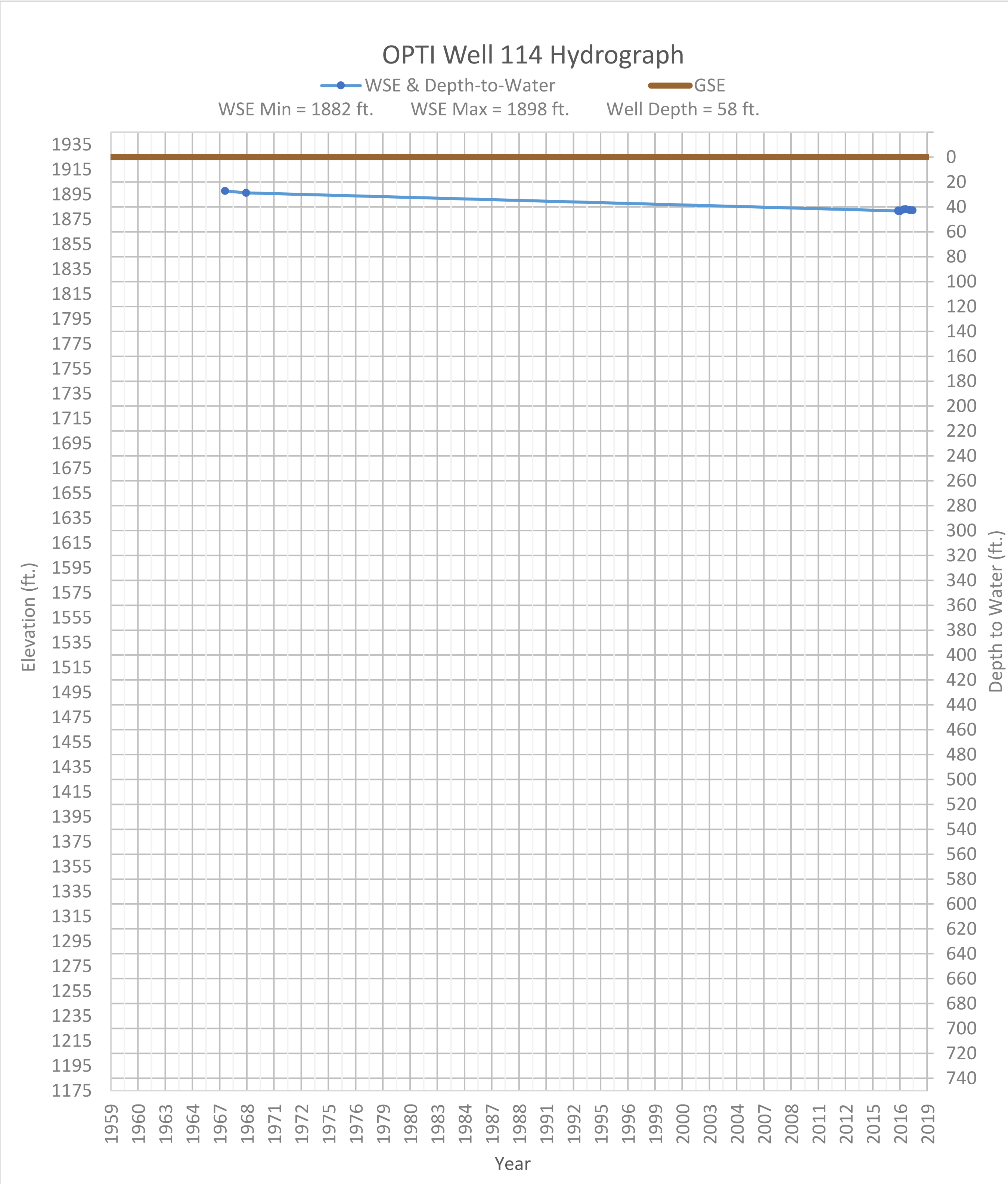

OPTI Well 114 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1882 ft.
WSE Max = 1898 ft.
Well Depth = 58 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1935
1915
1895
1875
1855
1835
1815
1795
1775
1755
1735
1715
1695
1675
1655
1635
1615
1595
1575
1555
1535
1515
1495
1475
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1375
1355
1335
1315
1295
1275
1255
1235
1215
1195
1175
0
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40
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80
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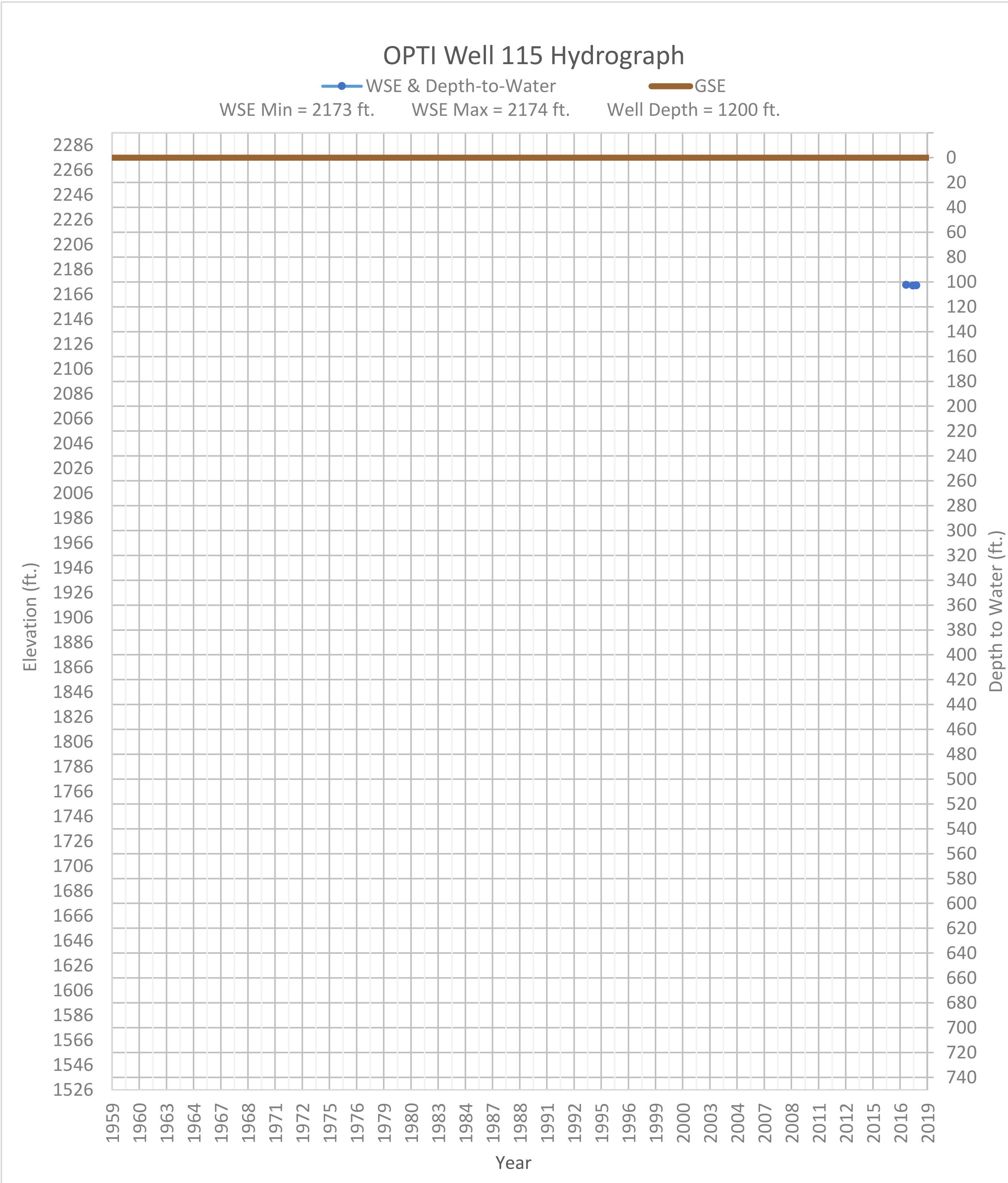
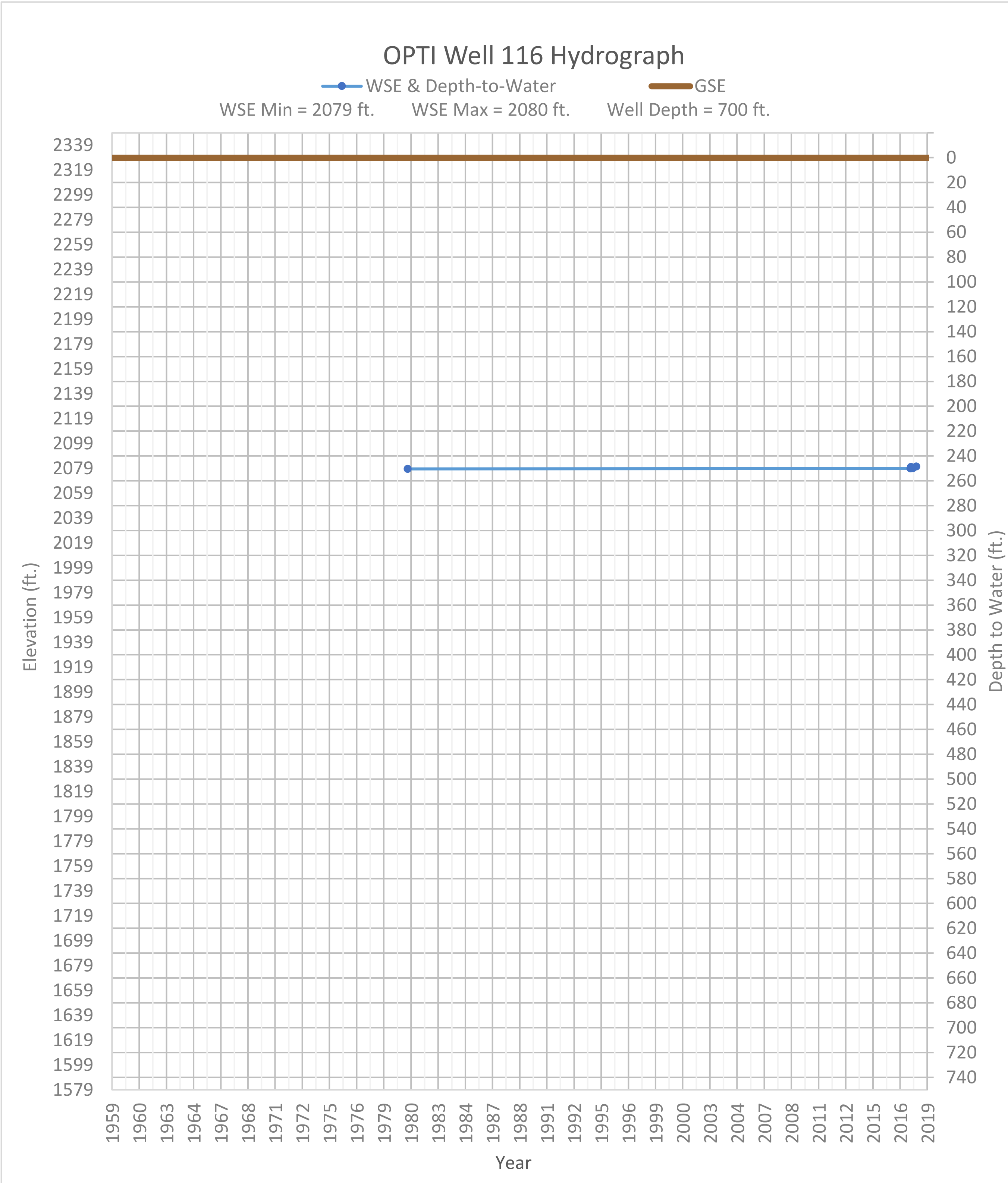


OPTI Well 115 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2173 ft.
WSE Max = 2174 ft.
Well Depth = 1200 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 116 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2079 ft.
WSE Max = 2080 ft.
Well Depth = 700 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2339
2319
2299
2279
2259
2239
2219
2199
2179
2159
2139
2119
2099
2079
2059
2039
2019
1999
1979
1959
1939
1919
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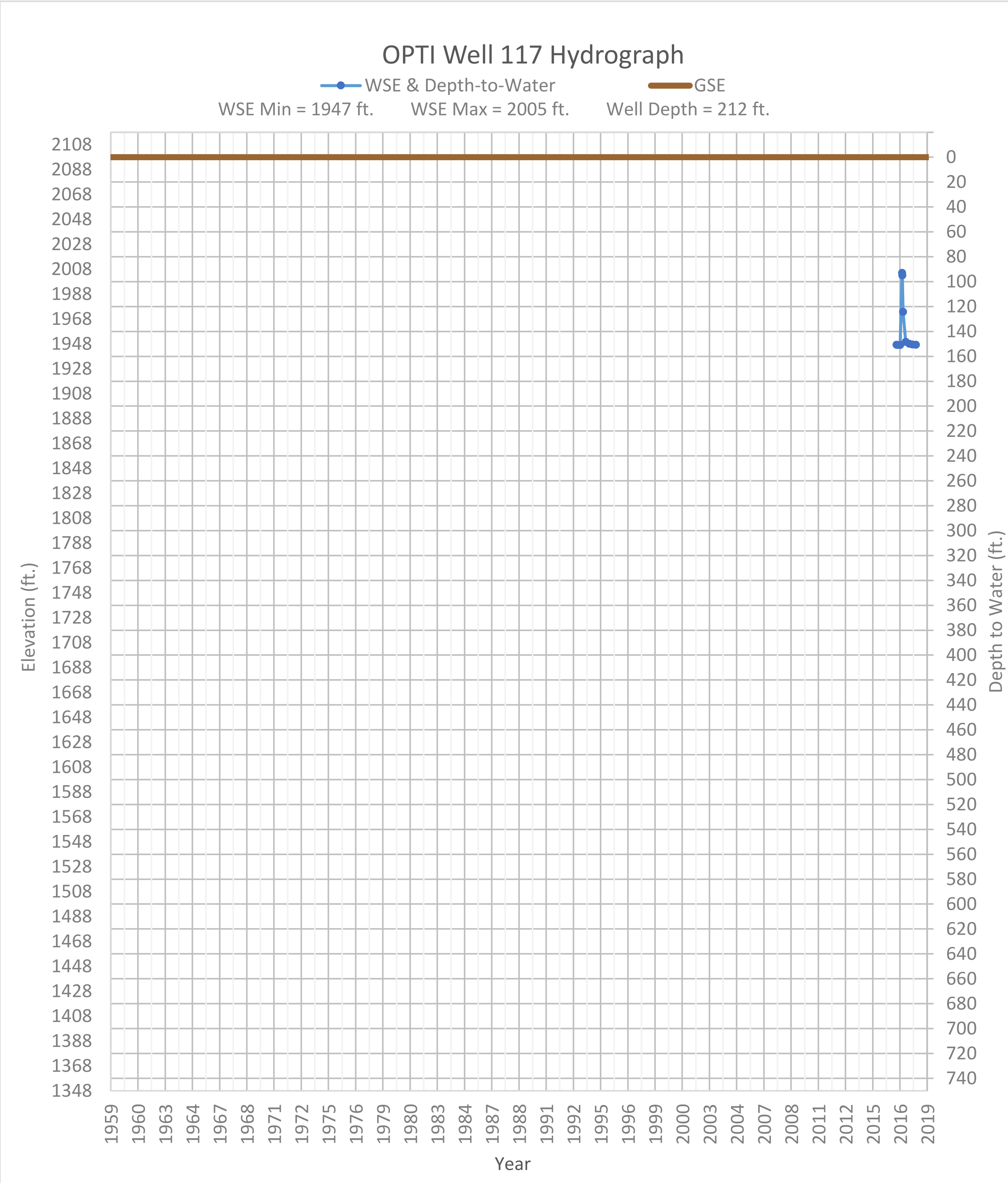
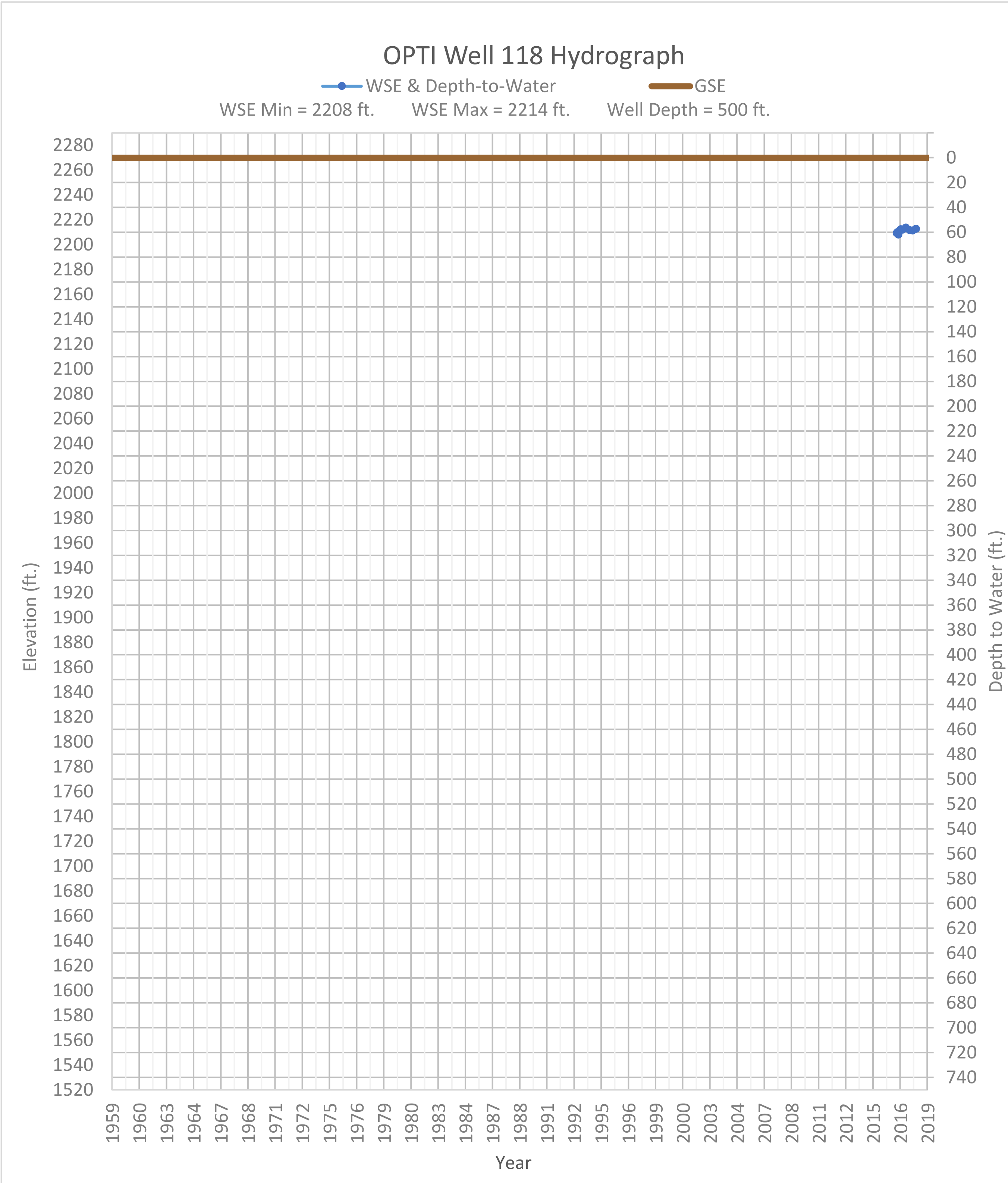


OPTI Well 117 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1947 ft.
WSE Max = 2005 ft.
Well Depth = 212 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 118 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2208 ft.
WSE Max = 2214 ft.
Well Depth = 500 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1959
1960
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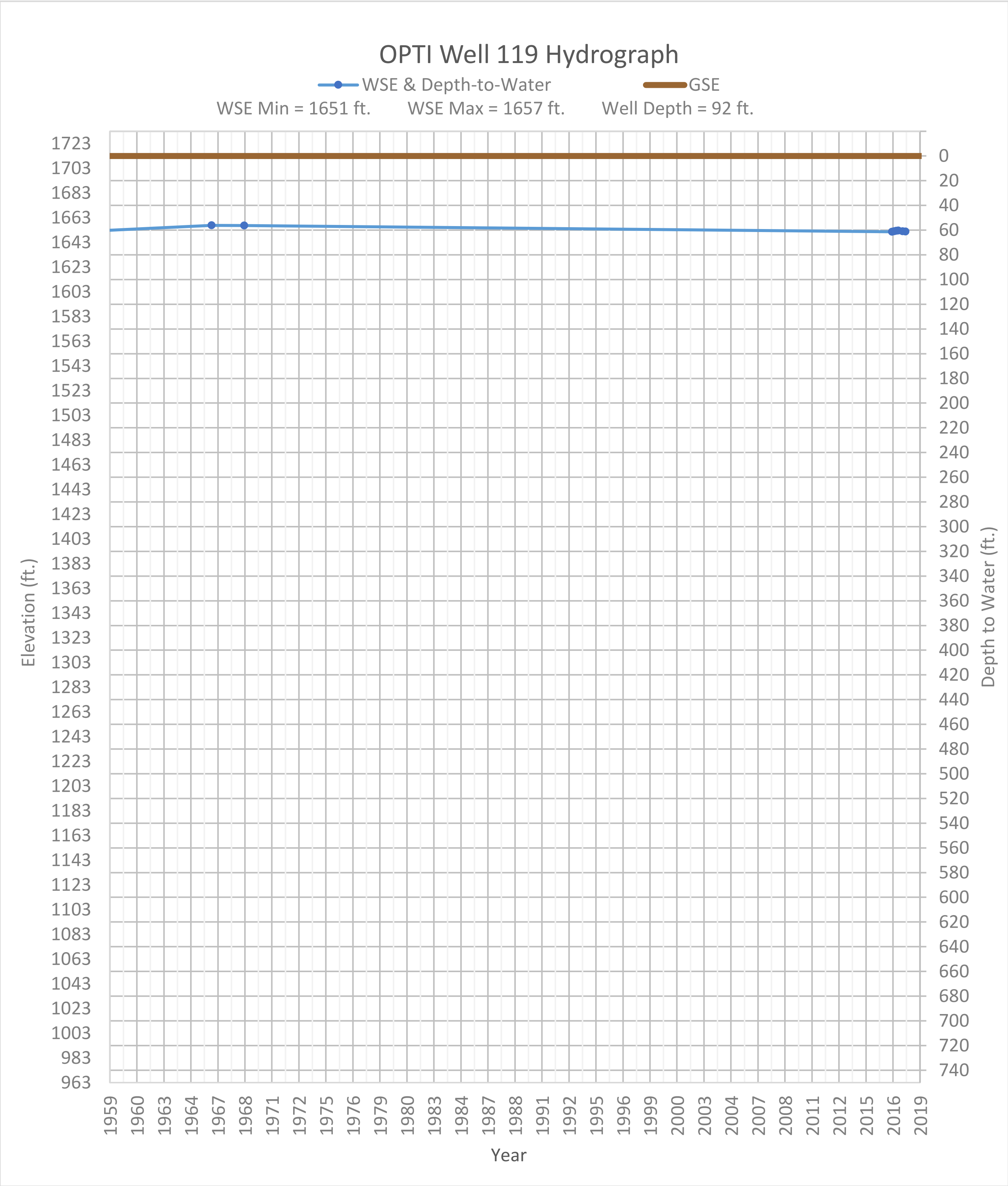
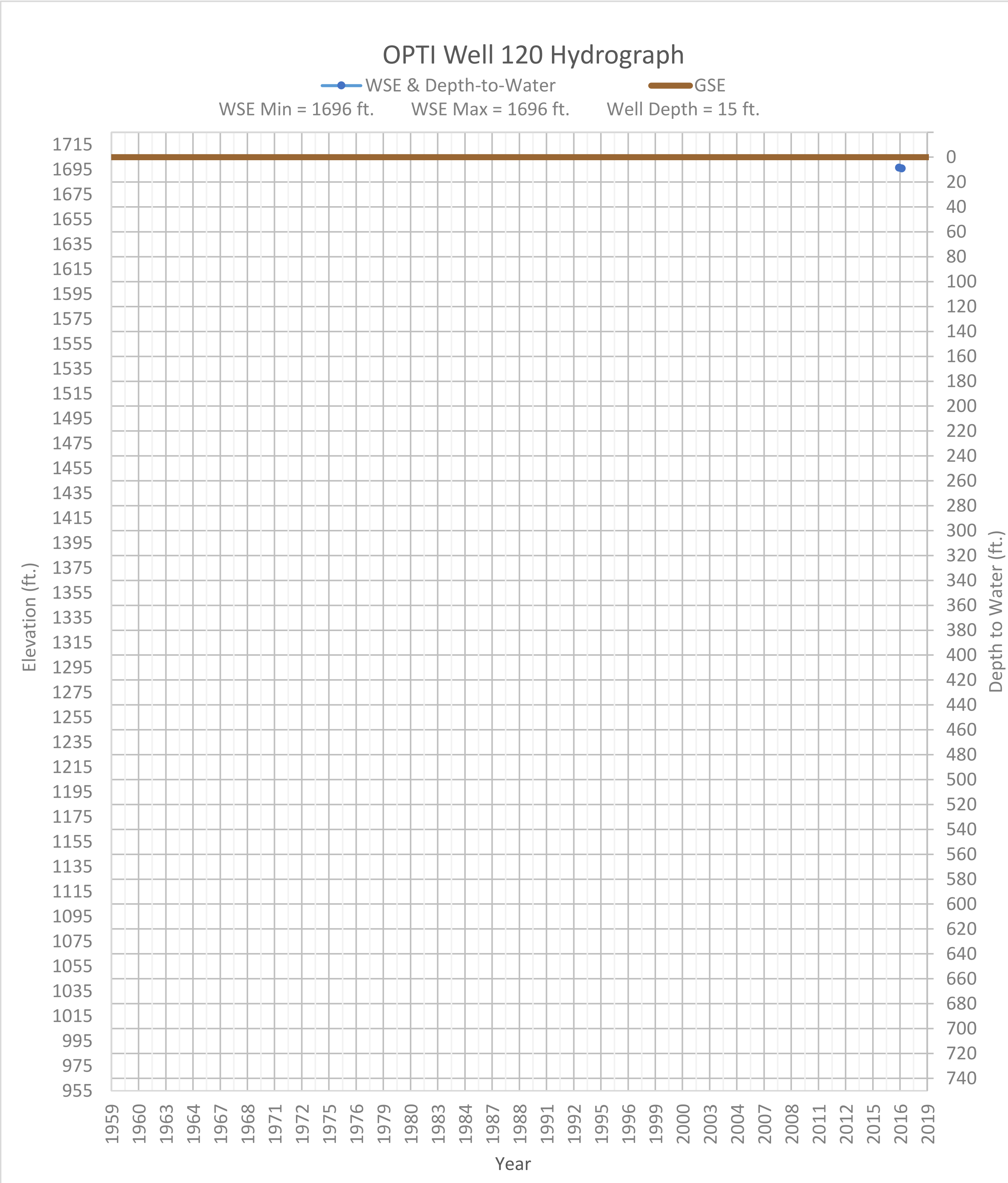

OPTI Well 119 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1651 ft.
WSE Max = 1657 ft.
Well Depth = 92 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 120 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1696 ft.
WSE Max = 1696 ft.
Well Depth = 15 ft.
Elevation (ft.)
1715
1695
1675
1655
1635
1615
1595
1575
1555
1535
1515
1495
1475
1455
1435
1415
1395
1375
1355
1335
1315
1295
1275
1255
1235
1215
1195
1175
1155
1135
1115
1095
1075
1055
1035
1015
995
975
955
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
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700
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2015
2016
2019
Year


OPTI Well 121 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1916 ft.
WSE Max = 1927 ft.
Well Depth = 98 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1994
1974
1954
1934
1914
1894
1874
1854
1834
1814
1794
1774
1754
1734
1714
1694
1674
1654
1634
1614
1594
1574
1554
1534
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1234
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220
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2011
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2015
2016
2019


OPTI Well 122 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2063 ft.
WSE Max = 2101 ft.
Well Depth = 63 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2139
2119
2099
2079
2059
2039
2019
1999
1979
1959
1939
1919
1899
1879
1859
1839
1819
1799
1779
1759
1739
1719
1699
1679
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1539
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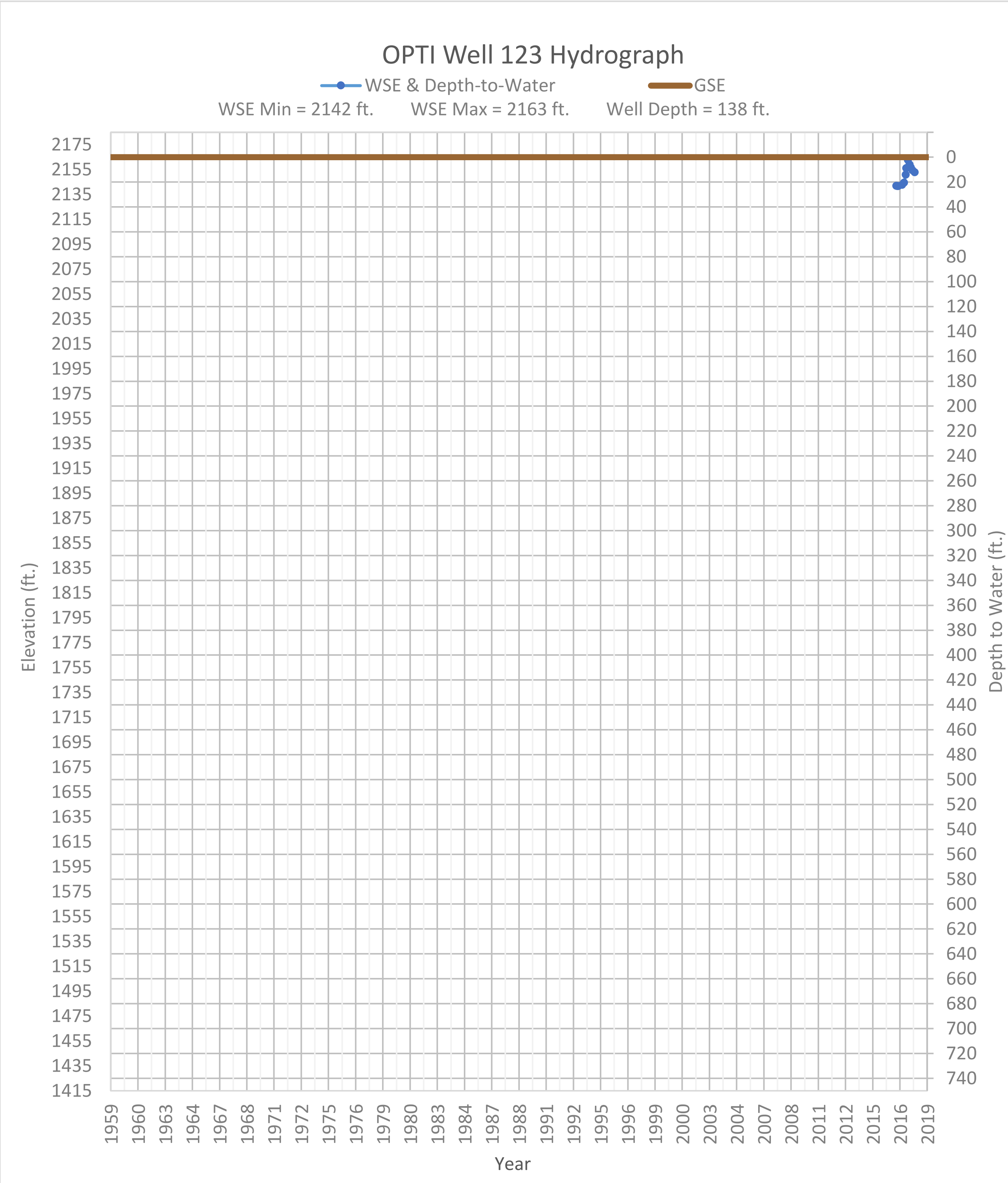
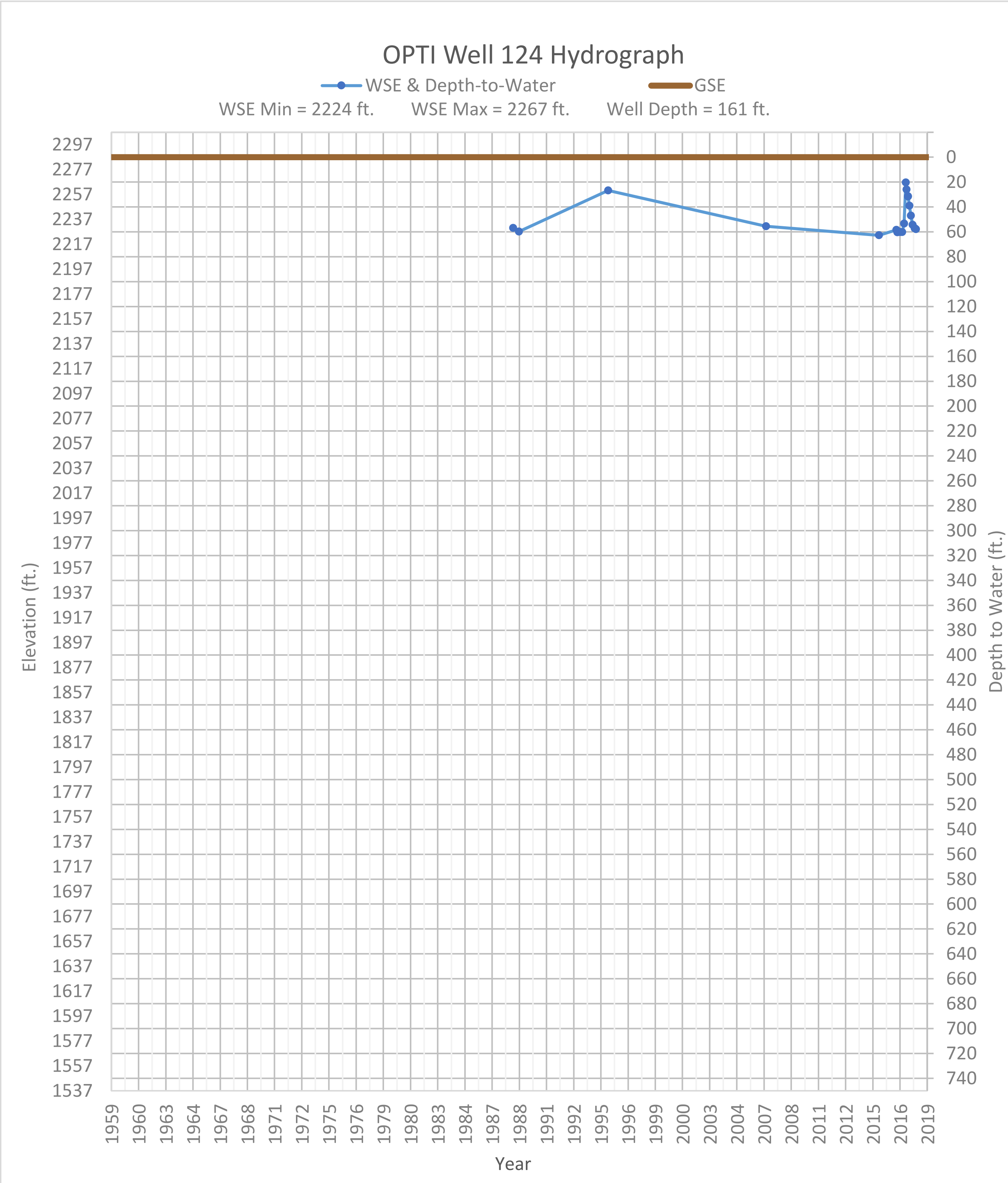


OPTI Well 123 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2142 ft.
WSE Max = 2163 ft.
Well Depth = 138 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 124 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2224 ft.
WSE Max = 2267 ft.
Well Depth = 161 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2297
2277
2257
2237
2217
2197
2177
2157
2137
2117
2097
2077
2057
2037
2017
1997
1977
1957
1937
1917
1897
1877
1857
1837
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1797
1777
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1697
1677
1657
1637
1617
1597
1577
1557
1537
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160
180
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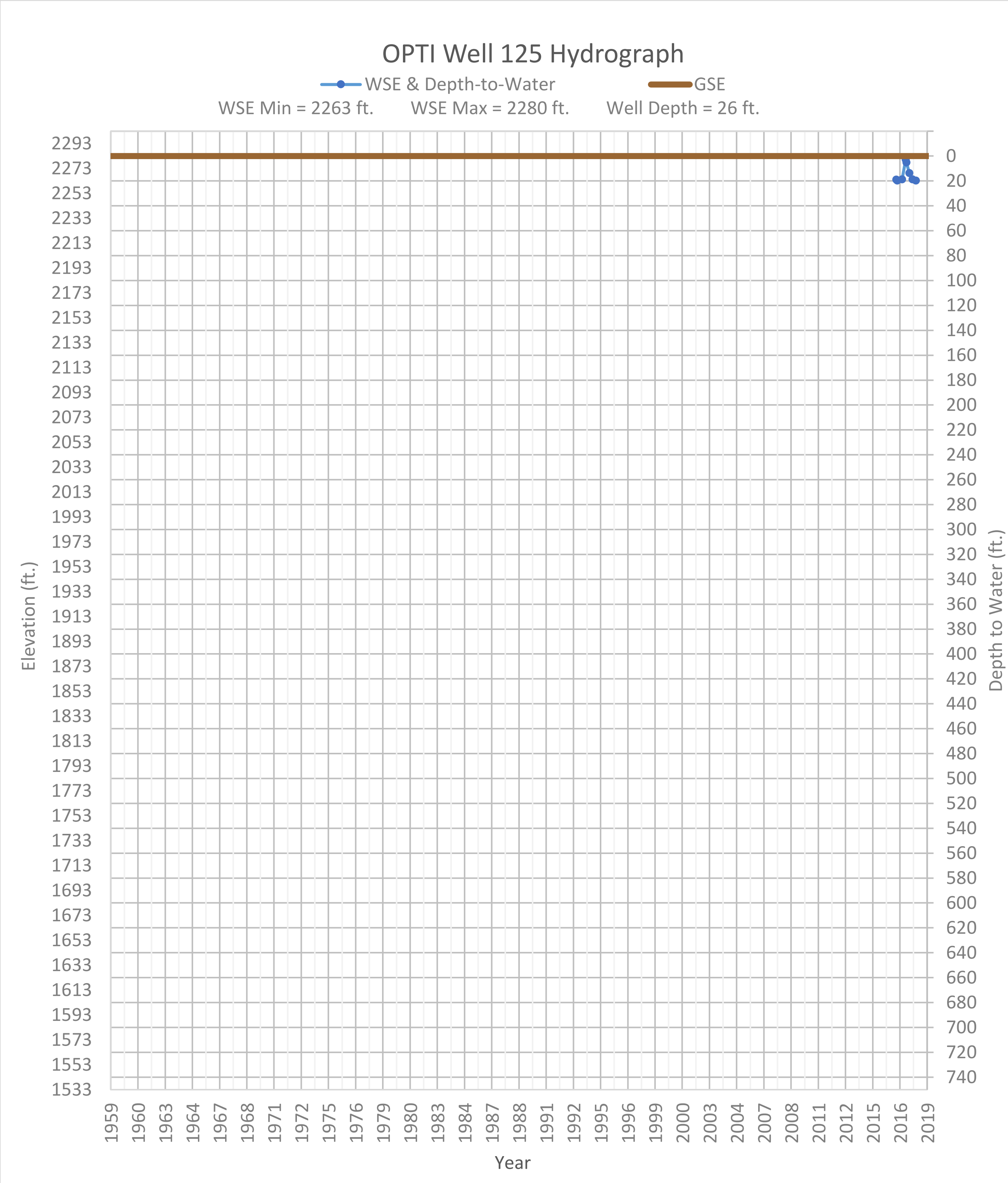

OPTI Well 125 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2263 ft.
WSE Max = 2280 ft.
Well Depth = 26 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 127 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2328 ft.
WSE Max = 2345 ft.
Well Depth = 100 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2374
2354
2334
2314
2294
2274
2254
2234
2214
2194
2174
2154
2134
2114
2094
2074
2054
2034
2014
1994
1974
1954
1934
1914
1894
1874
1854
1834
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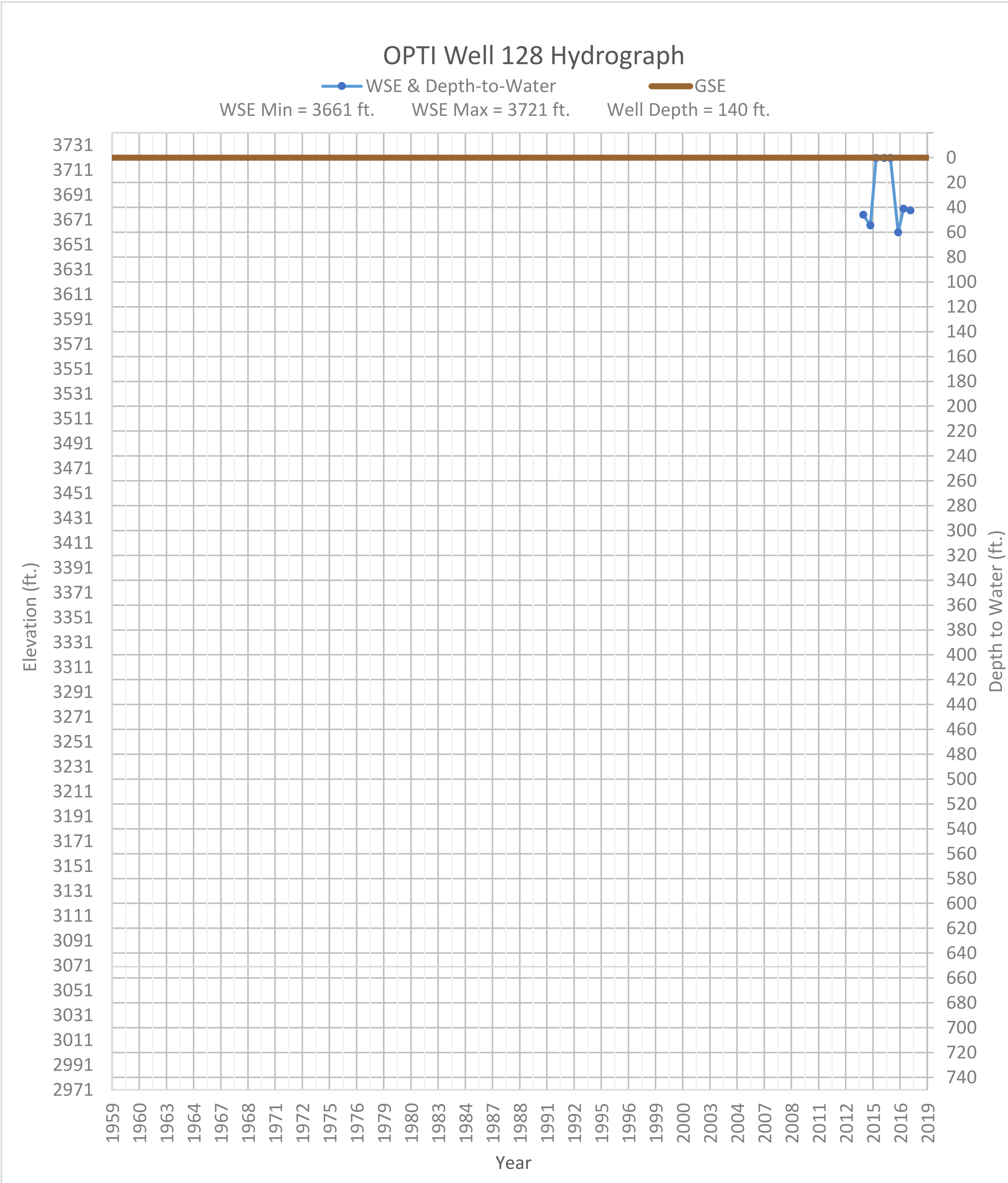
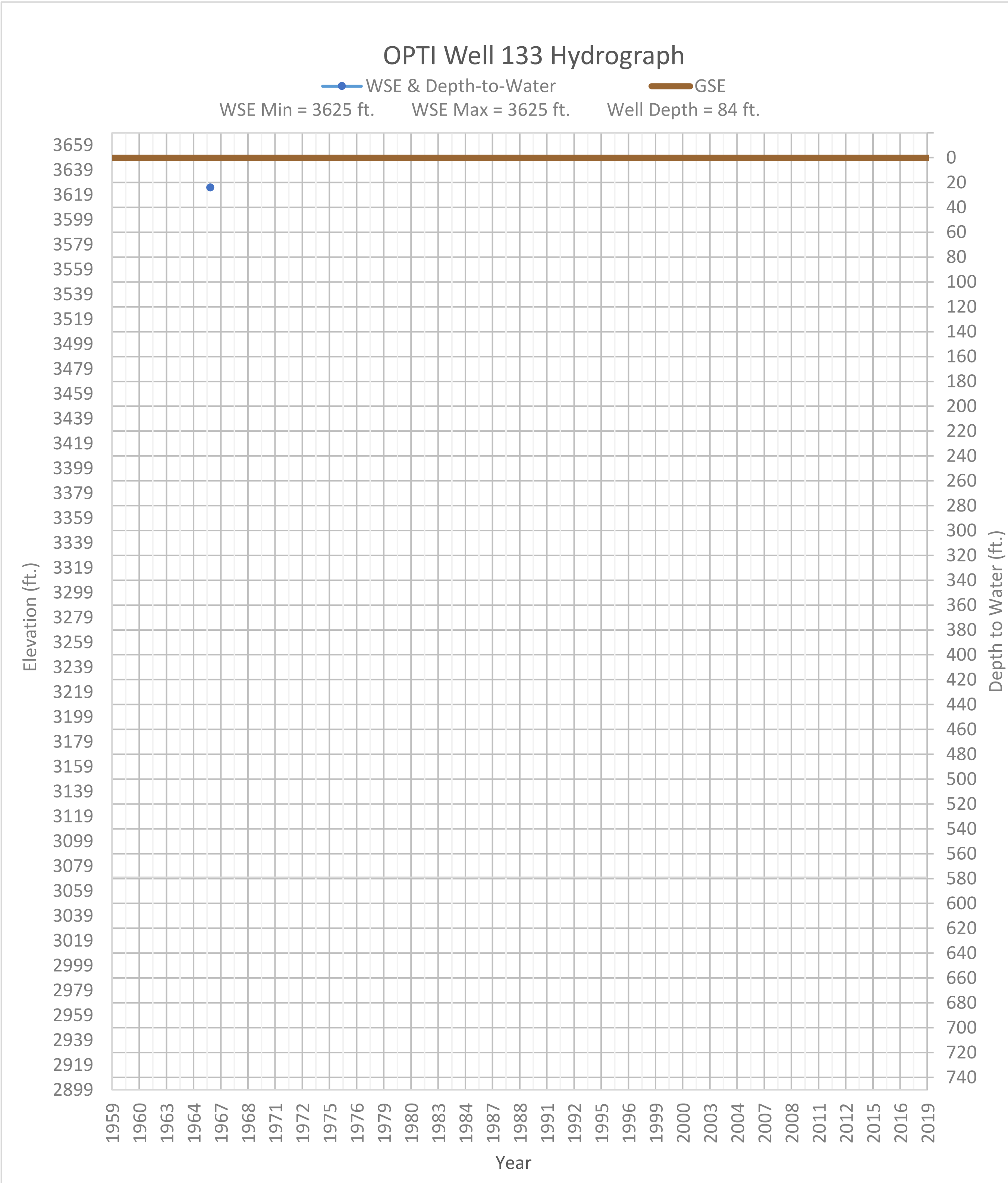


OPTI Well 128 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3661 ft.
WSE Max = 3721 ft.
Well Depth = 140 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 133 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3625 ft.
WSE Max = 3625 ft.
Well Depth = 84 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3659
3639
3619
3599
3579
3559
3539
3519
3499
3479
3459
3439
3419
3399
3379
3359
3339
3319
3299
3279
3259
3239
3219
3199
3179
3159
3139
3119
3099
3079
3059
3039
3019
2999
2979
2959
2939
2919
2899
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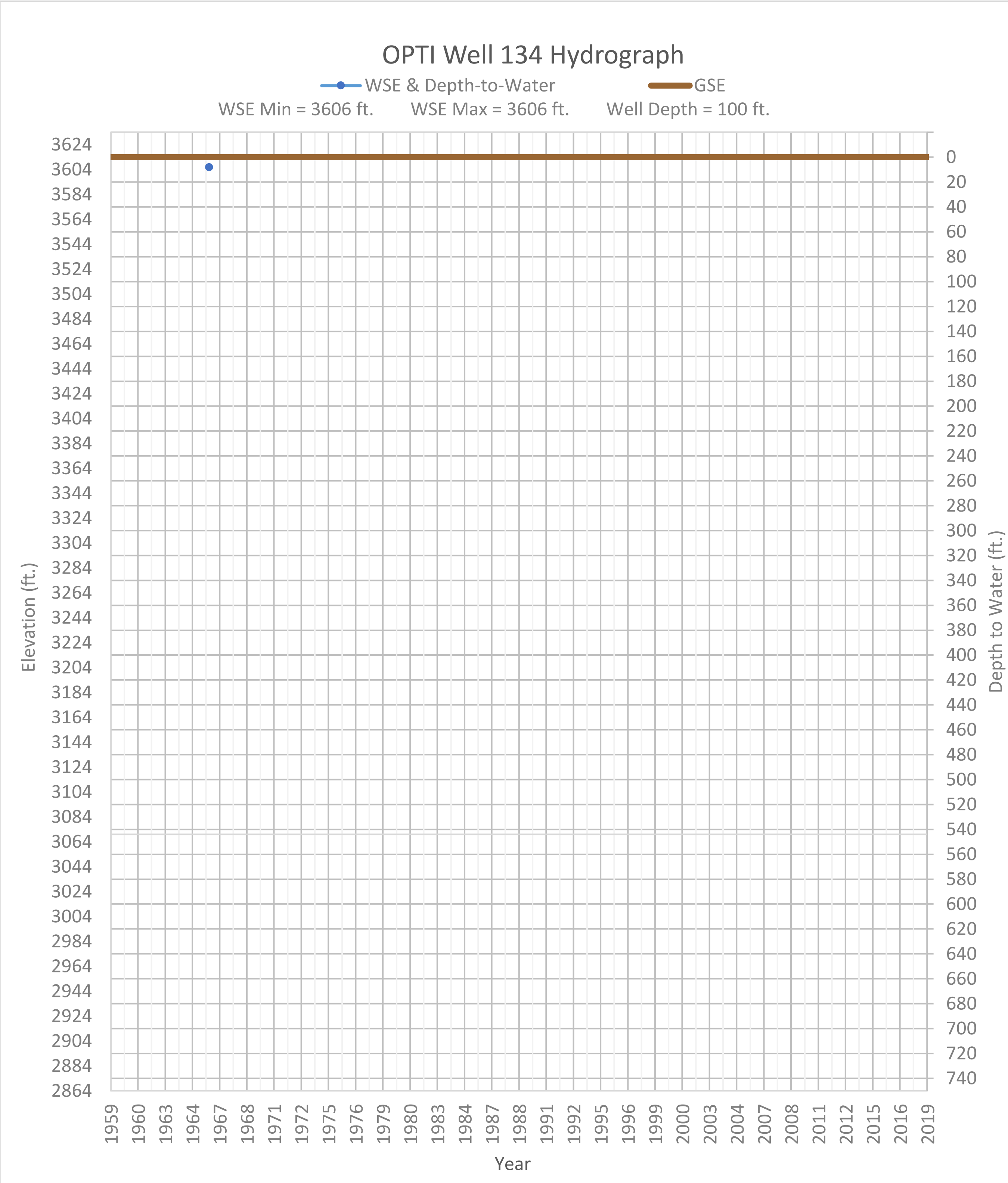
OPTI Well 134 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3606 ft.
WSE Max = 3606 ft.
Well Depth = 100 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3624
3604
3584
3564
3544
3524
3504
3484
3464
3444
3424
3404
3384
3364
3344
3324
3304
3284
3264
3244
3224
3204
3184
3164
3144
3124
3104
3084
3064
3044
3024
3004
2984
2964
2944
2924
2904
2884
2864
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240
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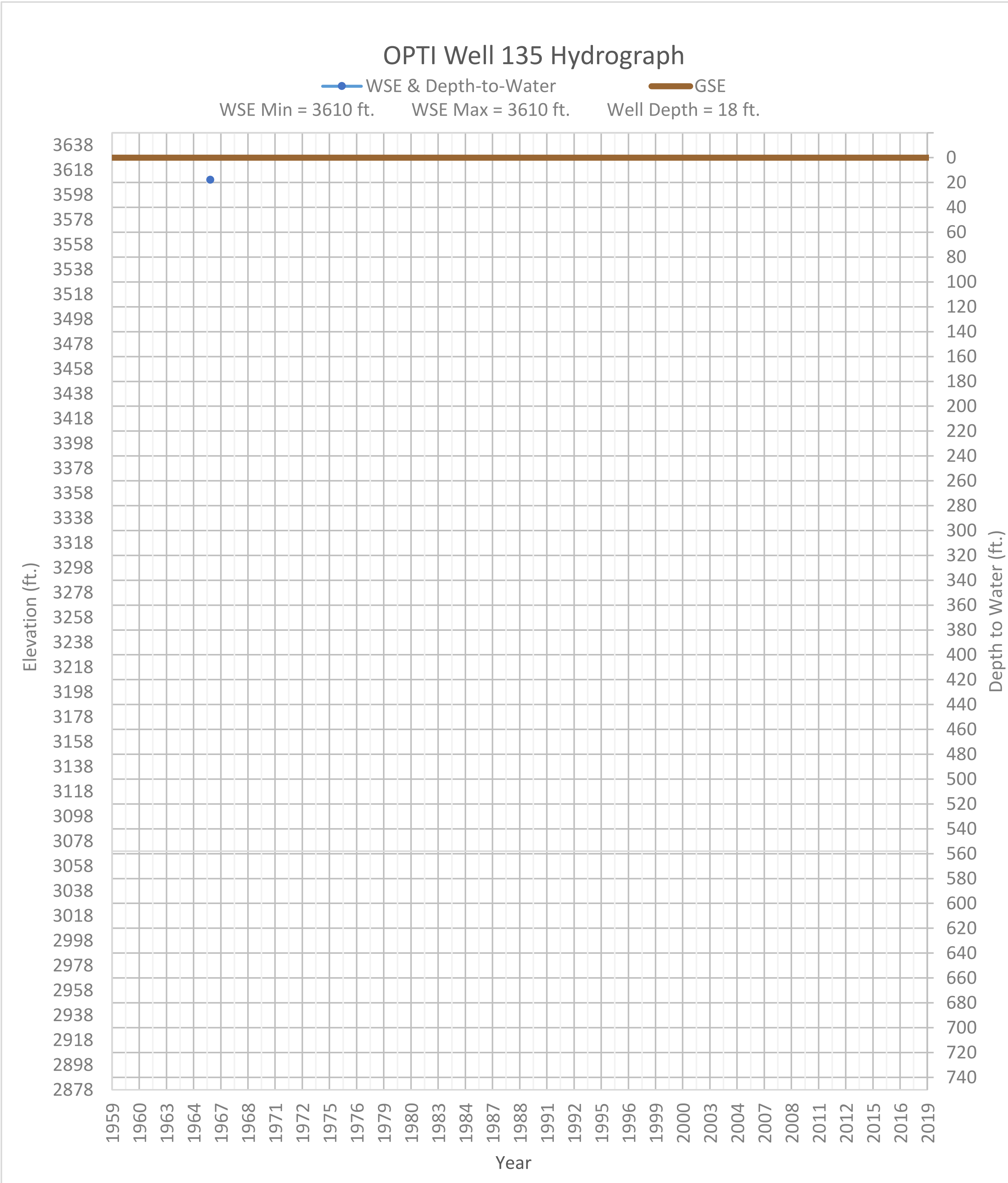
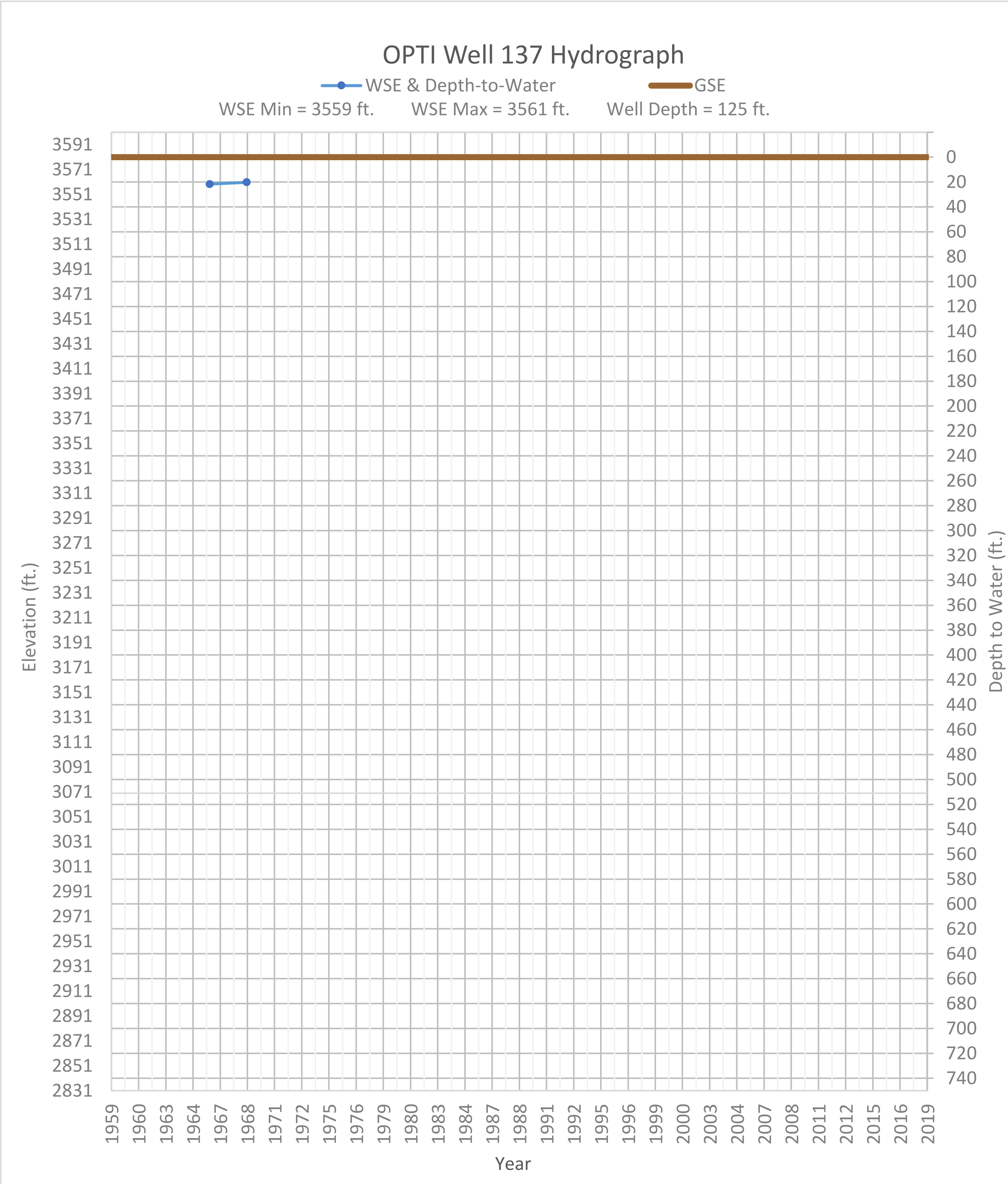
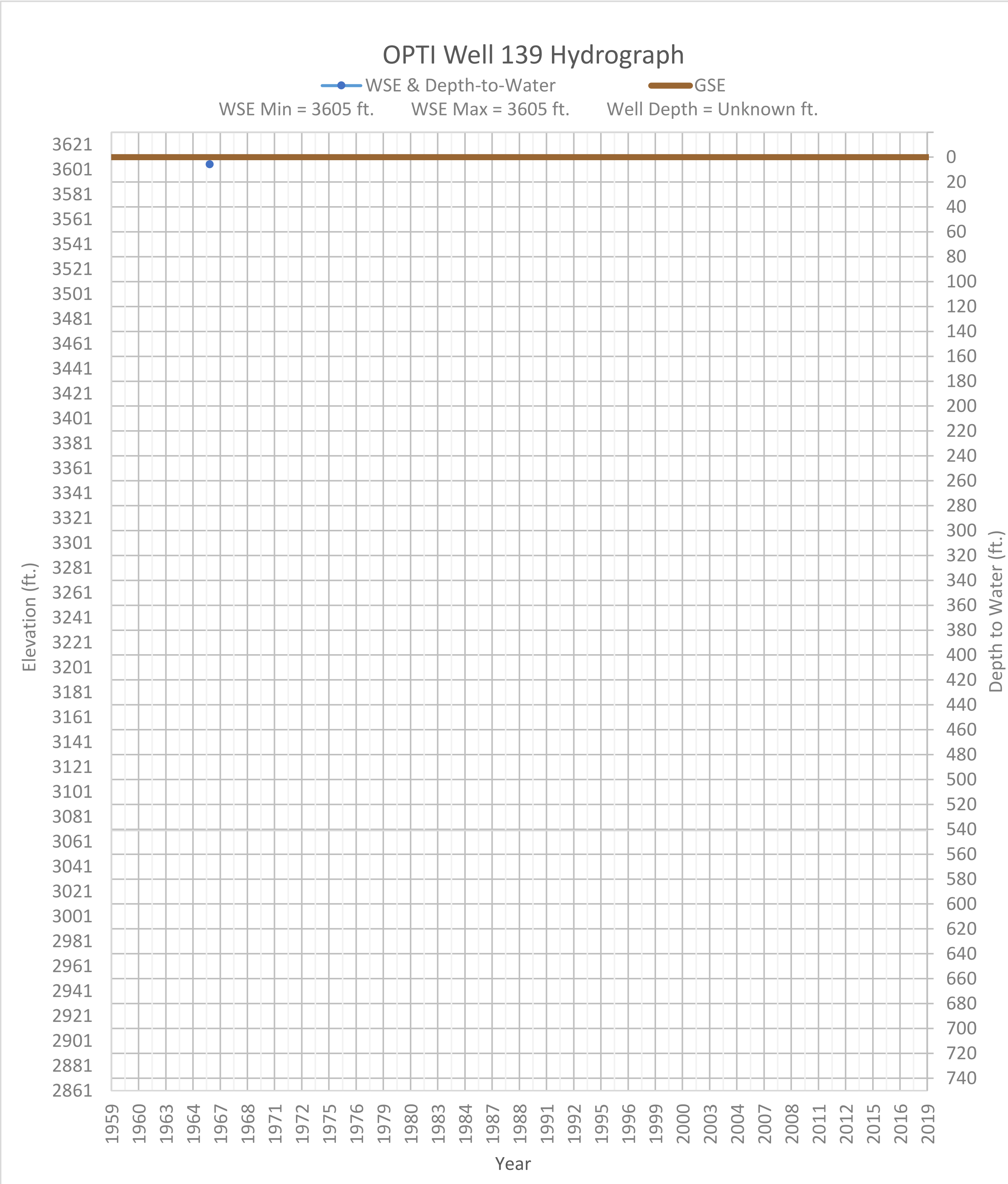


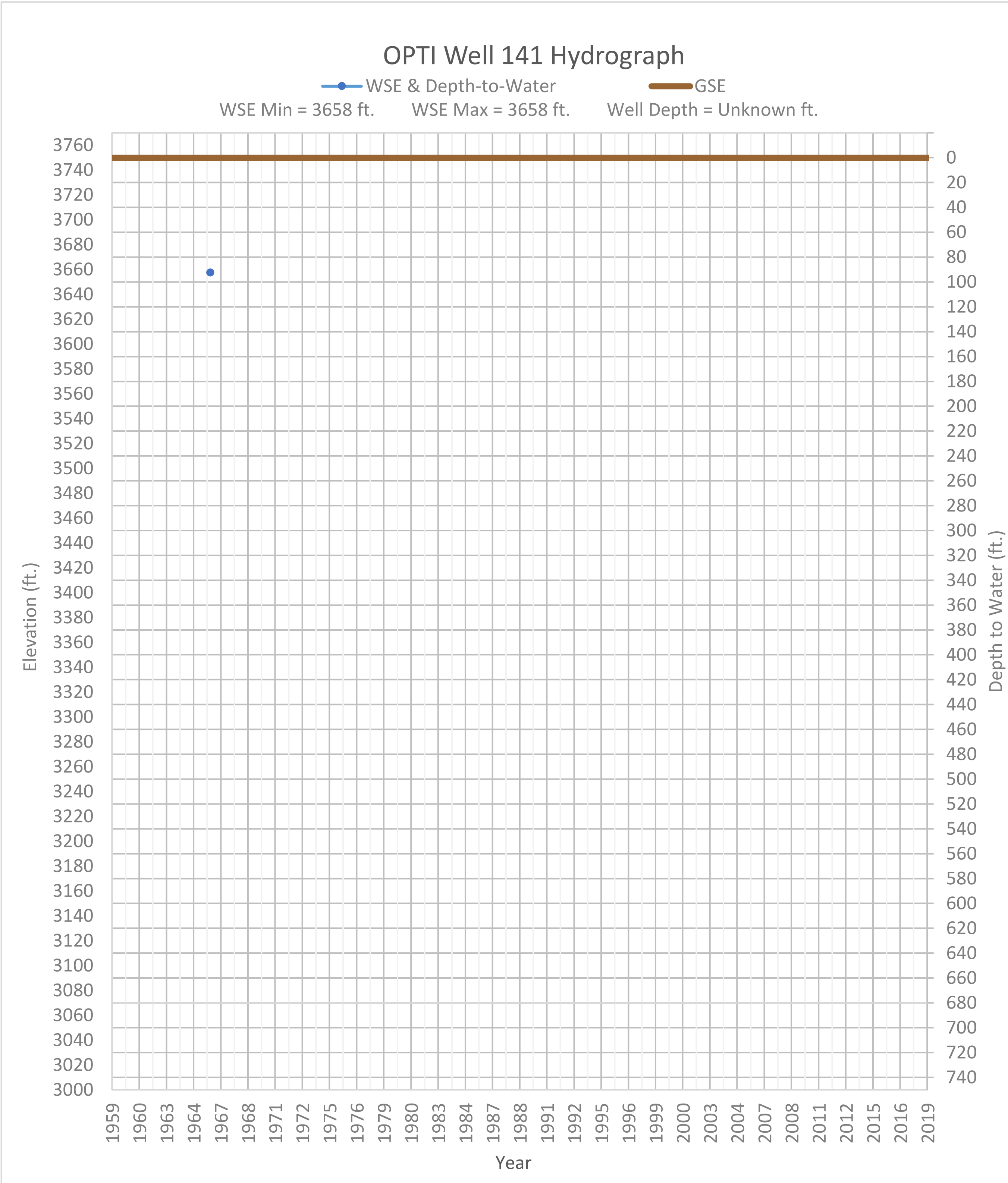
OPTI Well 135 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3610 ft.
WSE Max = 3610 ft.
Well Depth = 18 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



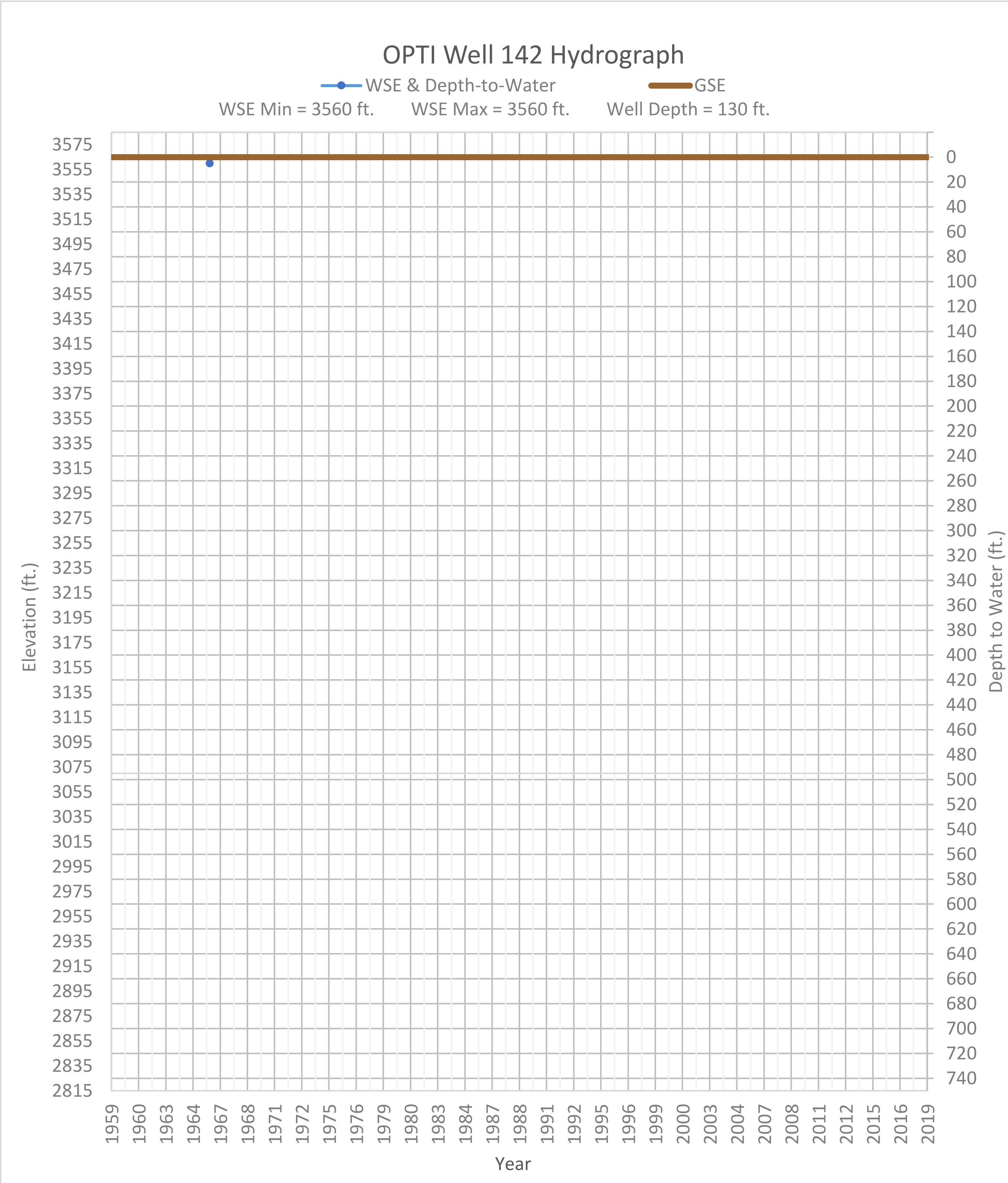
OPTI Well 137 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3559 ft.
WSE Max = 3561 ft.
Well Depth = 125 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

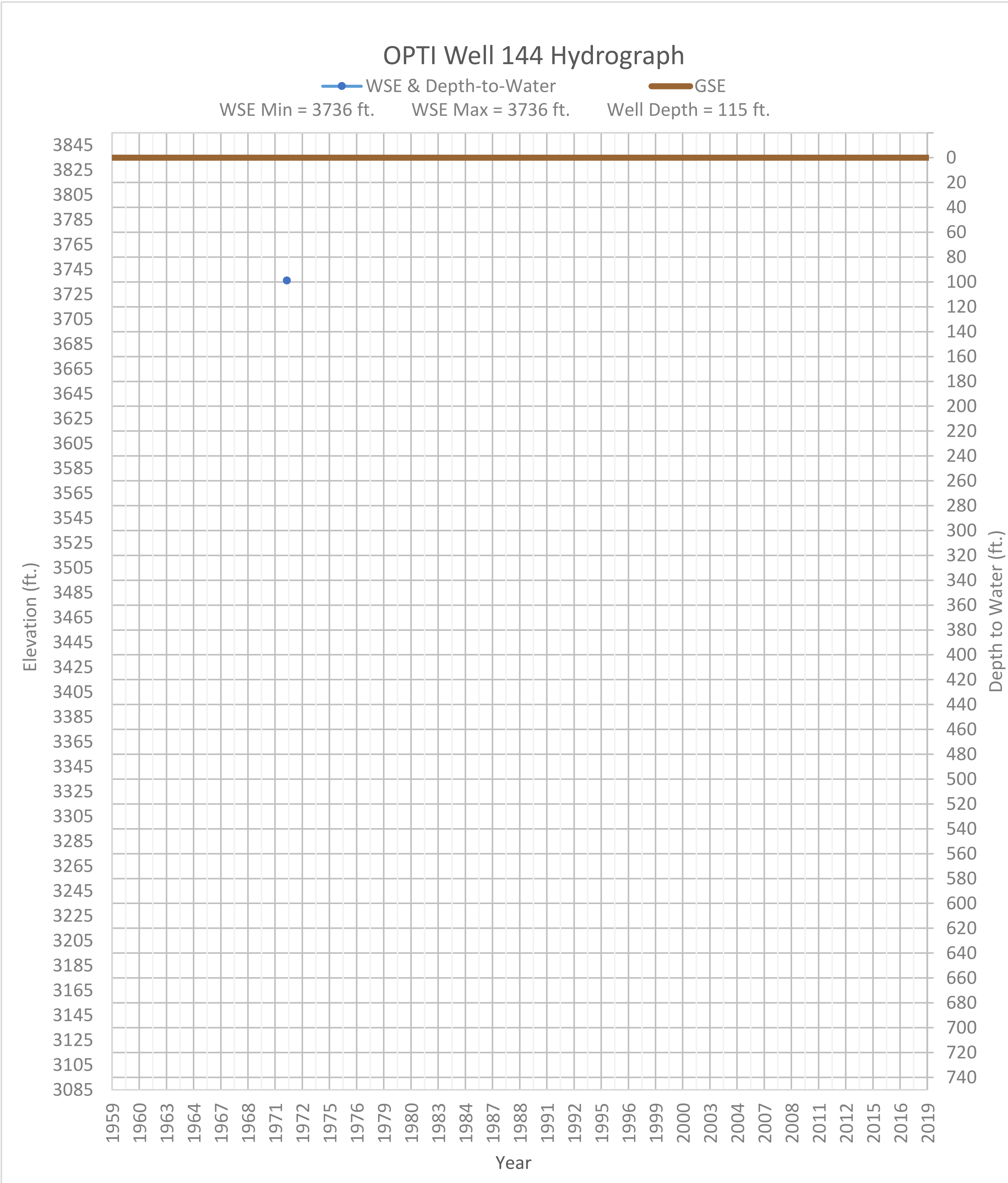


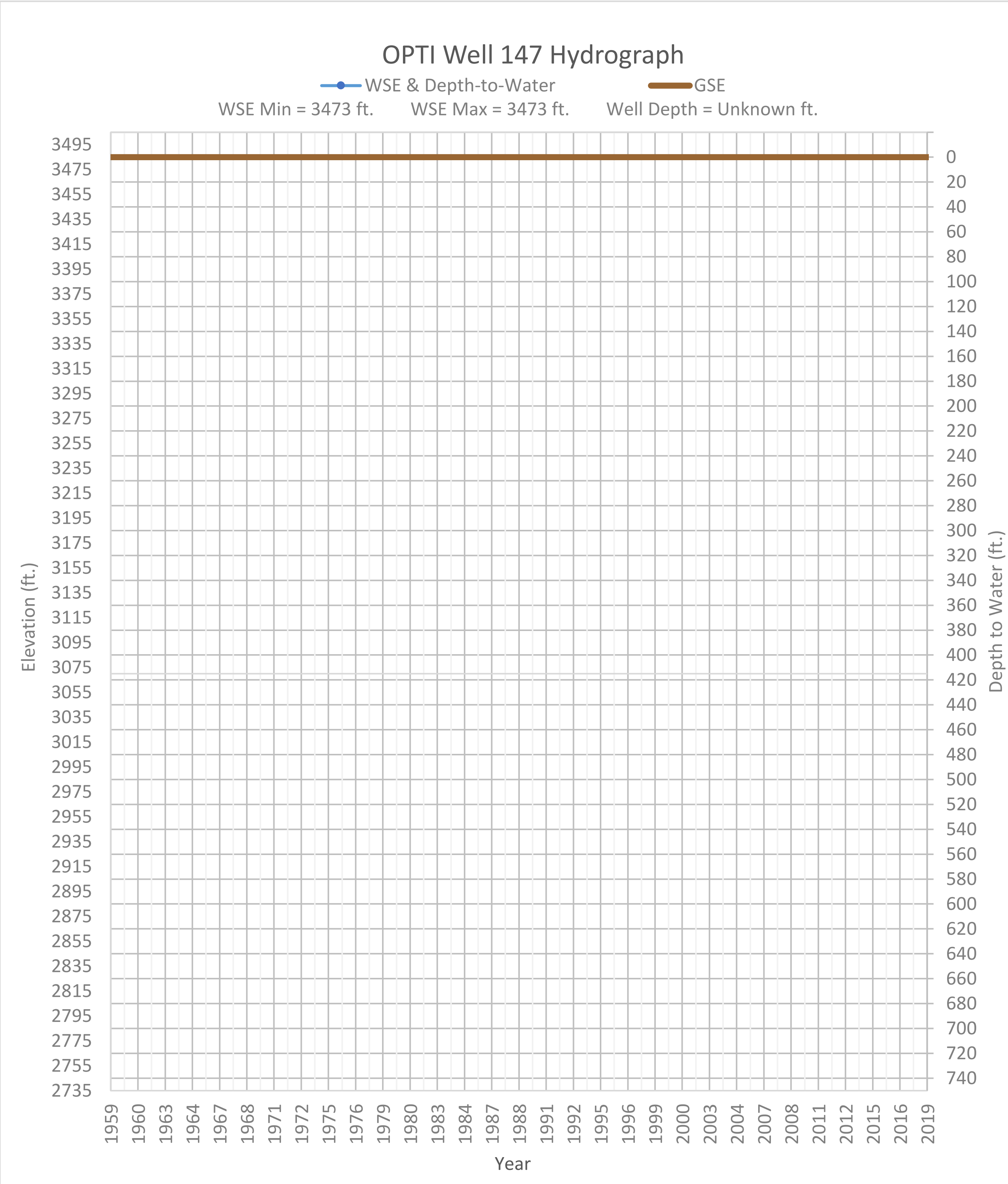
OPTI Well 139 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3605 ft.
WSE Max = 3605 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



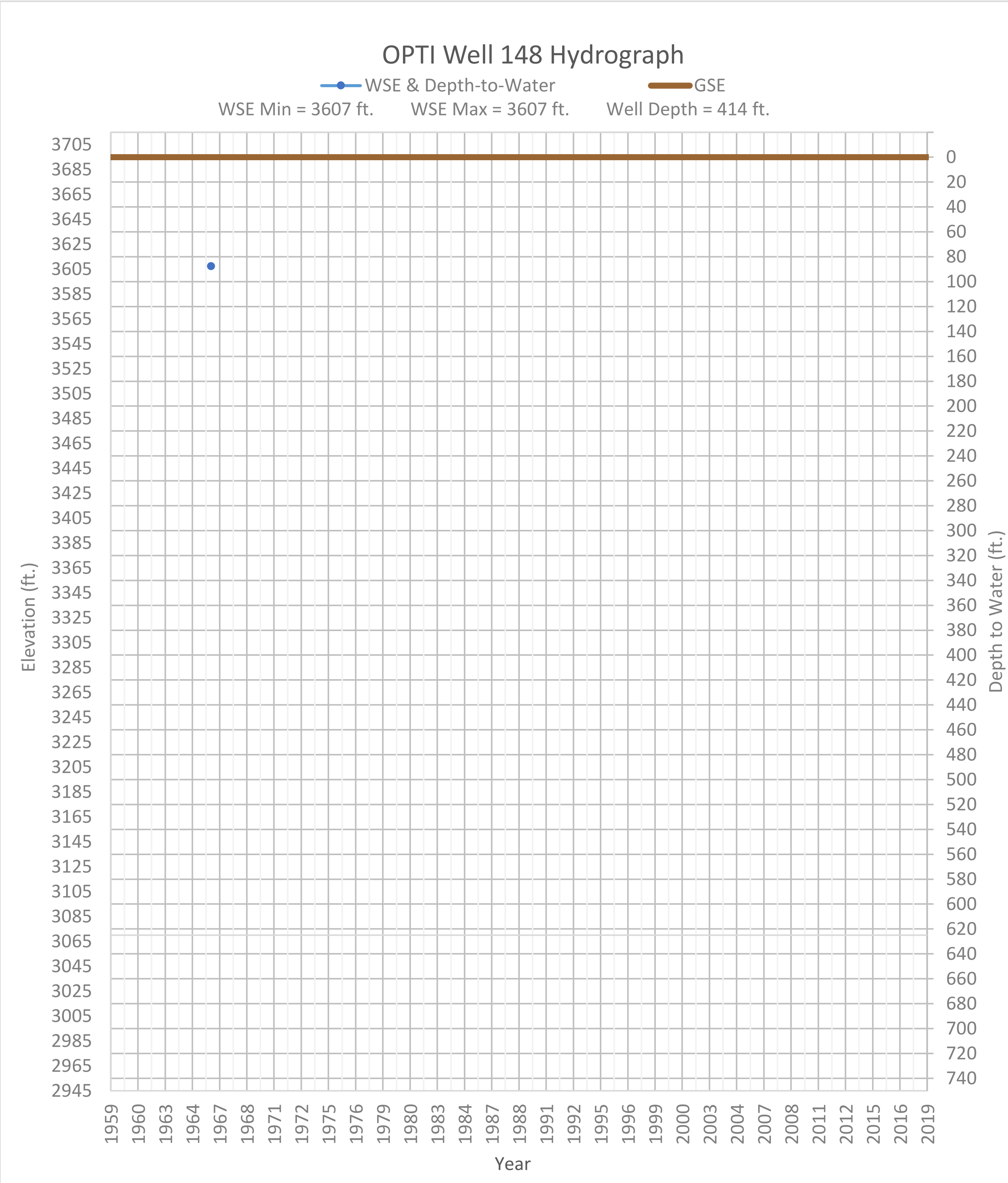
OPTI Well 141 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3658 ft.
WSE Max = 3658 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 142 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3560 ft.
WSE Max = 3560 ft.
Well Depth = 130 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

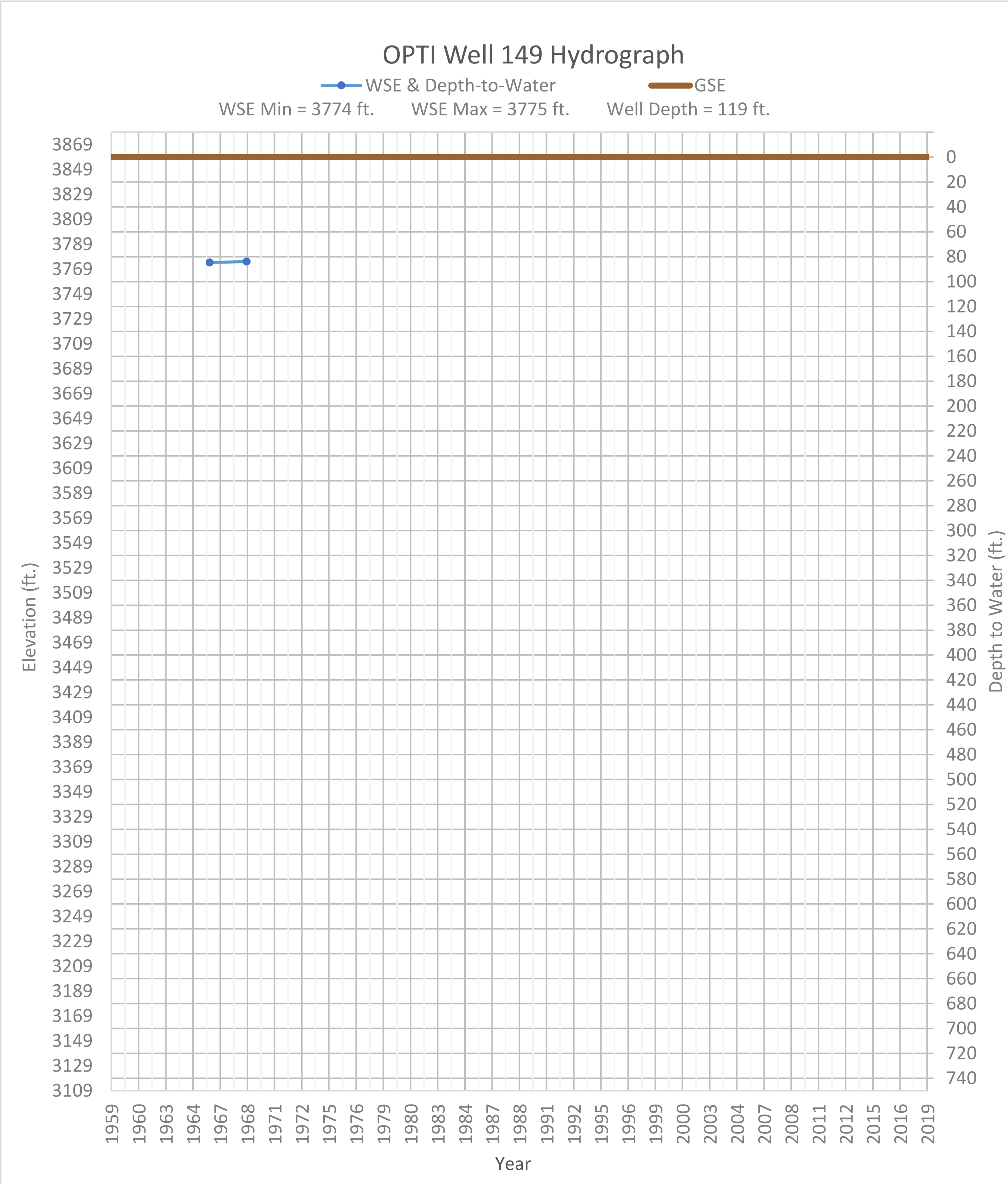

OPTI Well 144 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3736 ft.
WSE Max = 3736 ft.
Well Depth = 115 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3845 3825 3805 3785 3765 3745 3725 3705 3685 3665 3645 3625 3605 3585 3565 3545 3525 3505 3485 3465 3445 3425 3405 3385 3365 3345 3325 3305 3285 3265 3245 3225 3205 3185 3165 3145 3125 3105 3085
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500 520 540 560 580 600 620 640 660 680 700 720 740
1959 1960 1963 1964 1967 1968 1971 1972 1975 1976 1979 1980 1983 1984 1987 1988 1991 1992 1995 1996 1999 2000 2003 2004 2007 2008 2011 2012 2015 2016 2019



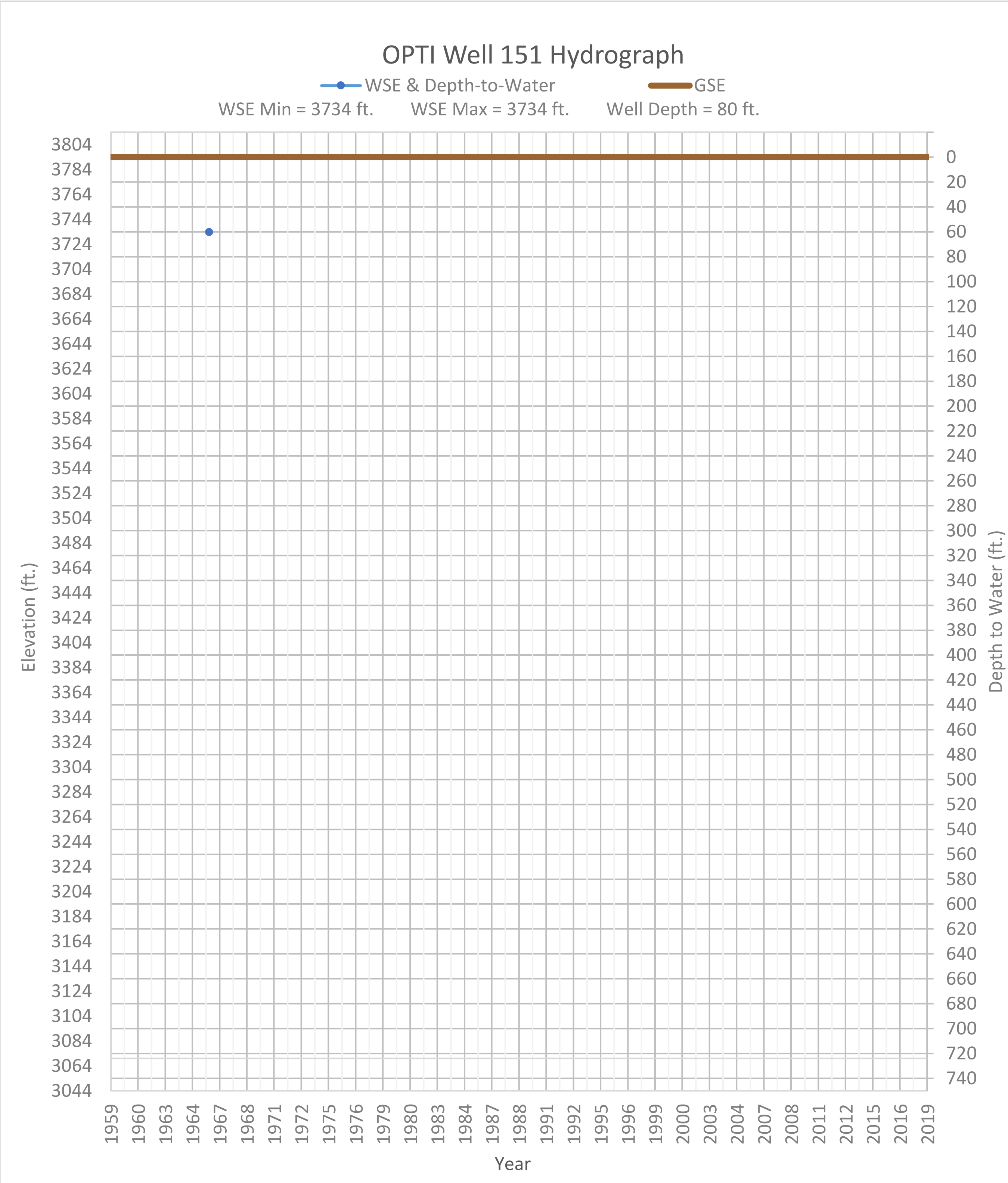
OPTI Well 147 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3473 ft.
WSE Max = 3473 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 148 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3607 ft.
WSE Max = 3607 ft.
Well Depth = 414 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 149 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3774 ft.
WSE Max = 3775 ft.
Well Depth = 119 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 151 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3734 ft.
WSE Max = 3734 ft.
Well Depth = 80 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3804
3784
3764
3744
3724
3704
3684
3664
3644
3624
3604
3584
3564
3544
3524
3504
3484
3464
3444
3424
3404
3384
3364
3344
3324
3304
3284
3264
3244
3224
3204
3184
3164
3144
3124
3104
3084
3064
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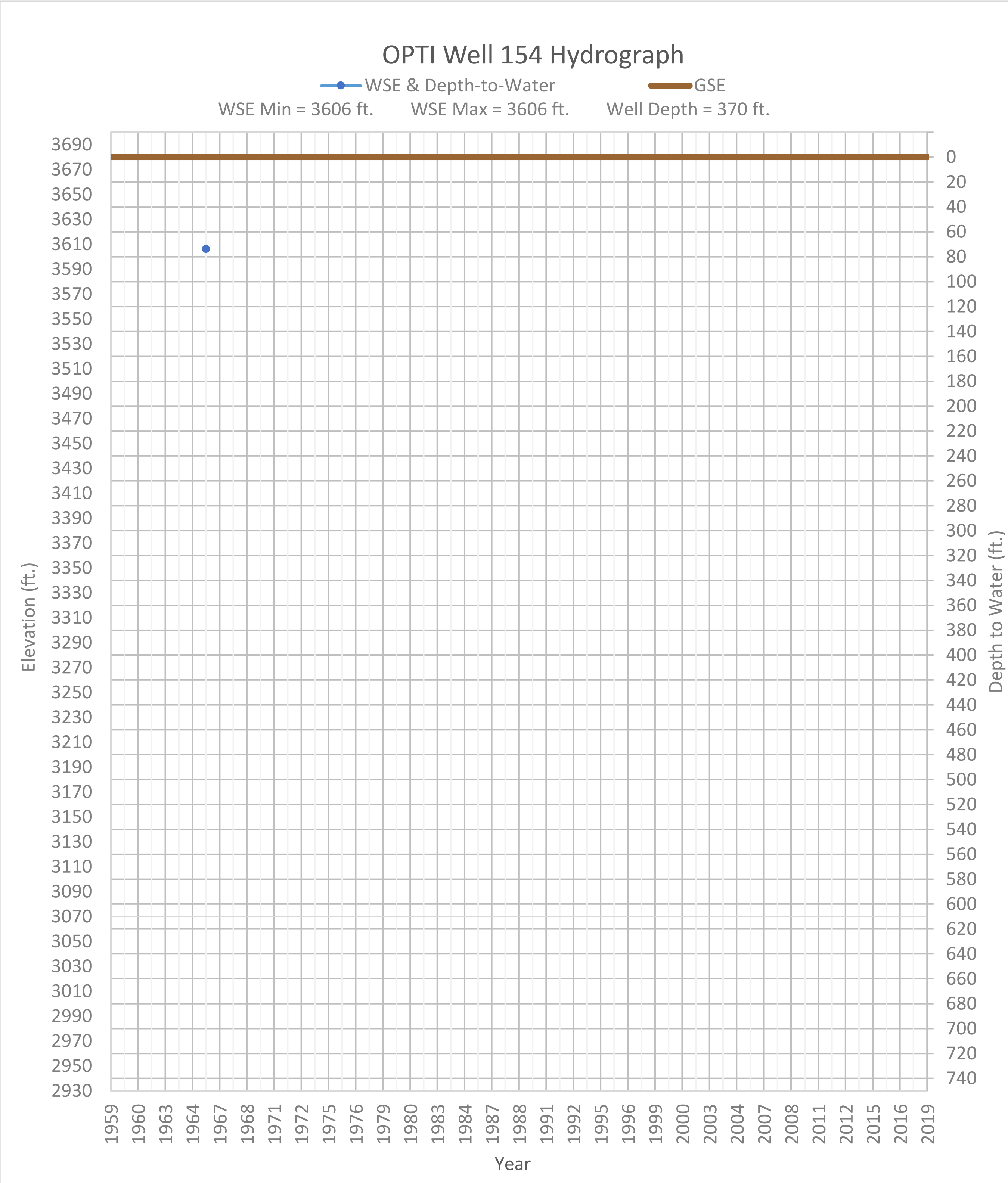
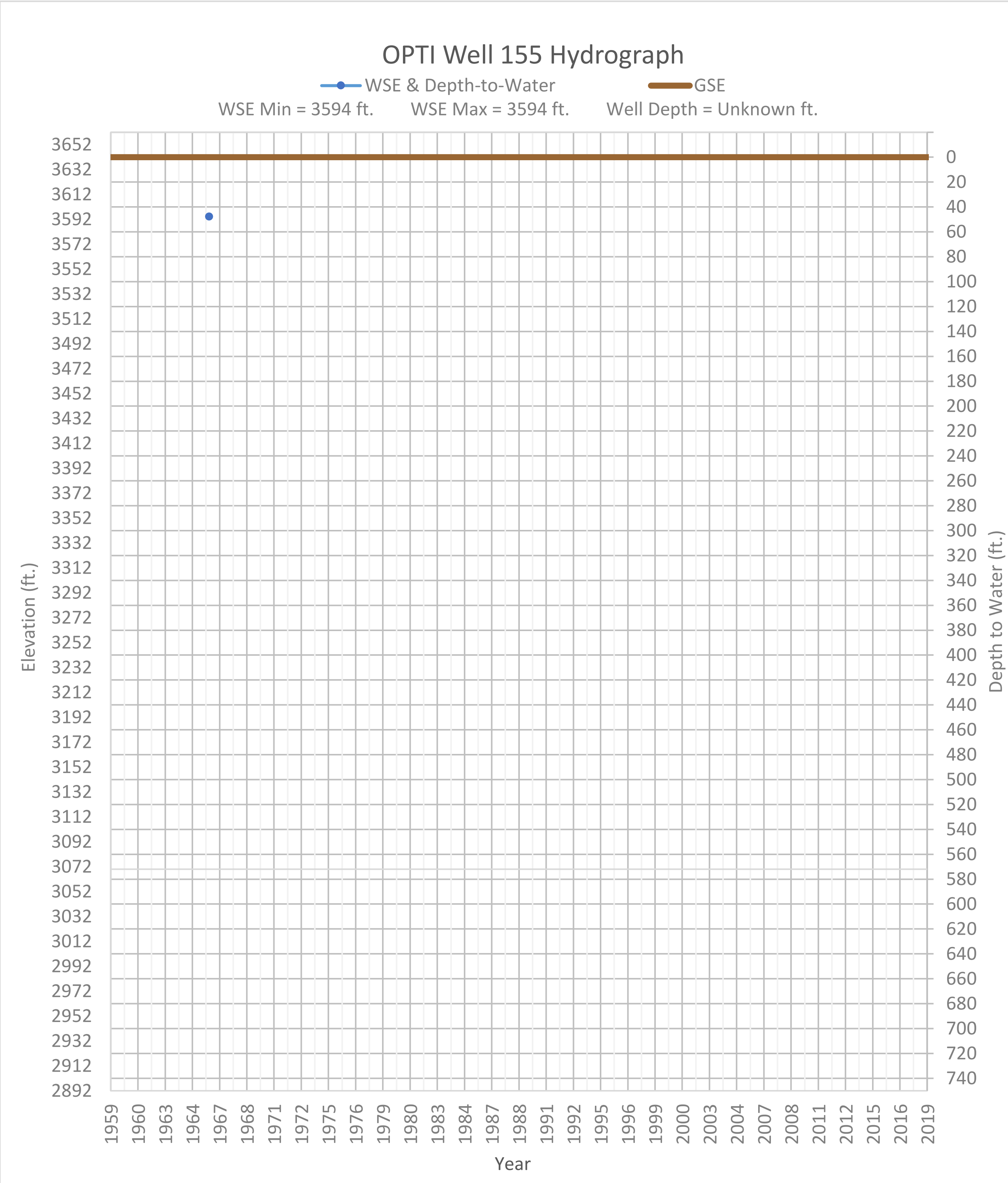
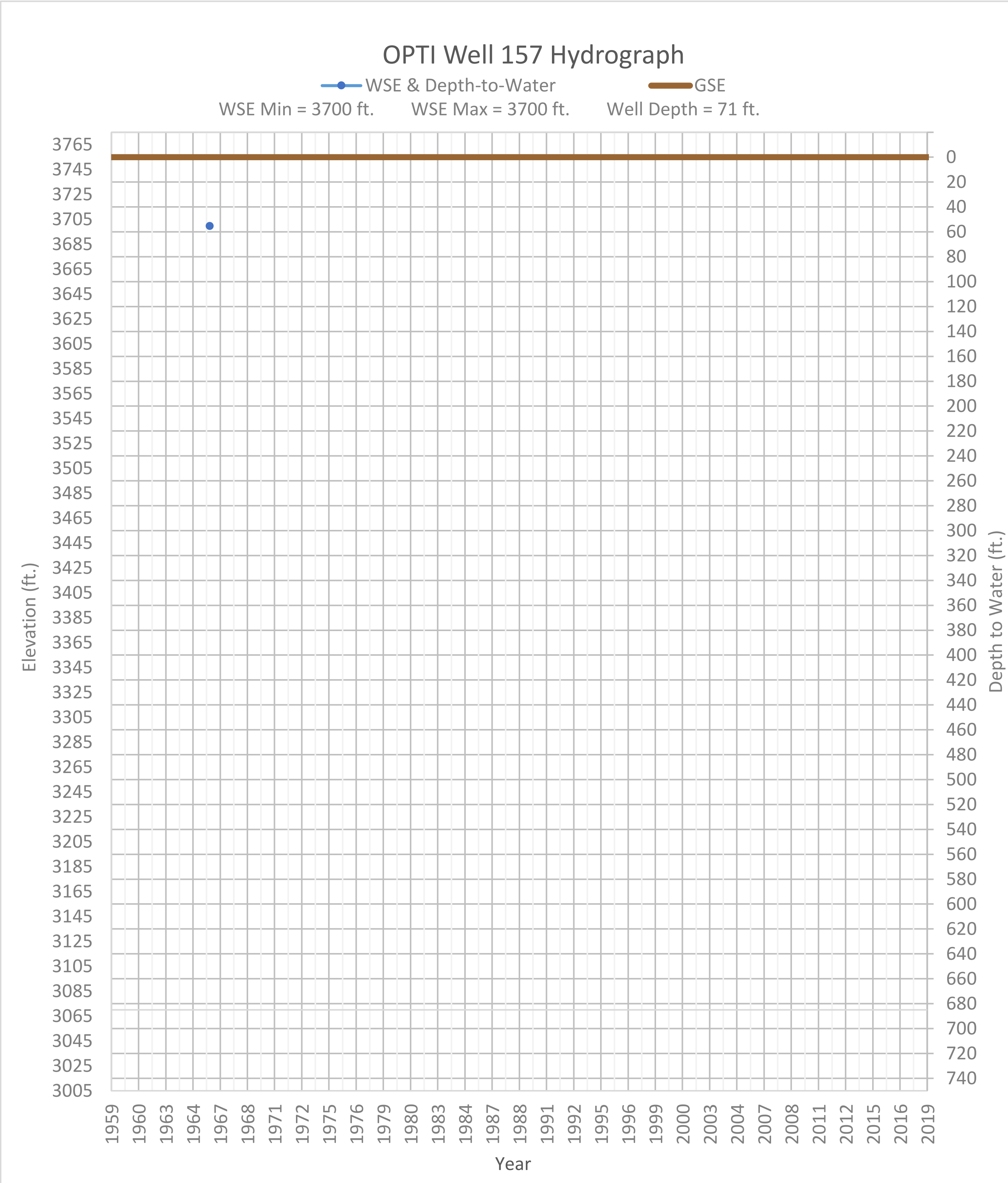


OPTI Well 154 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3606 ft.
WSE Max = 3606 ft.
Well Depth = 370 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

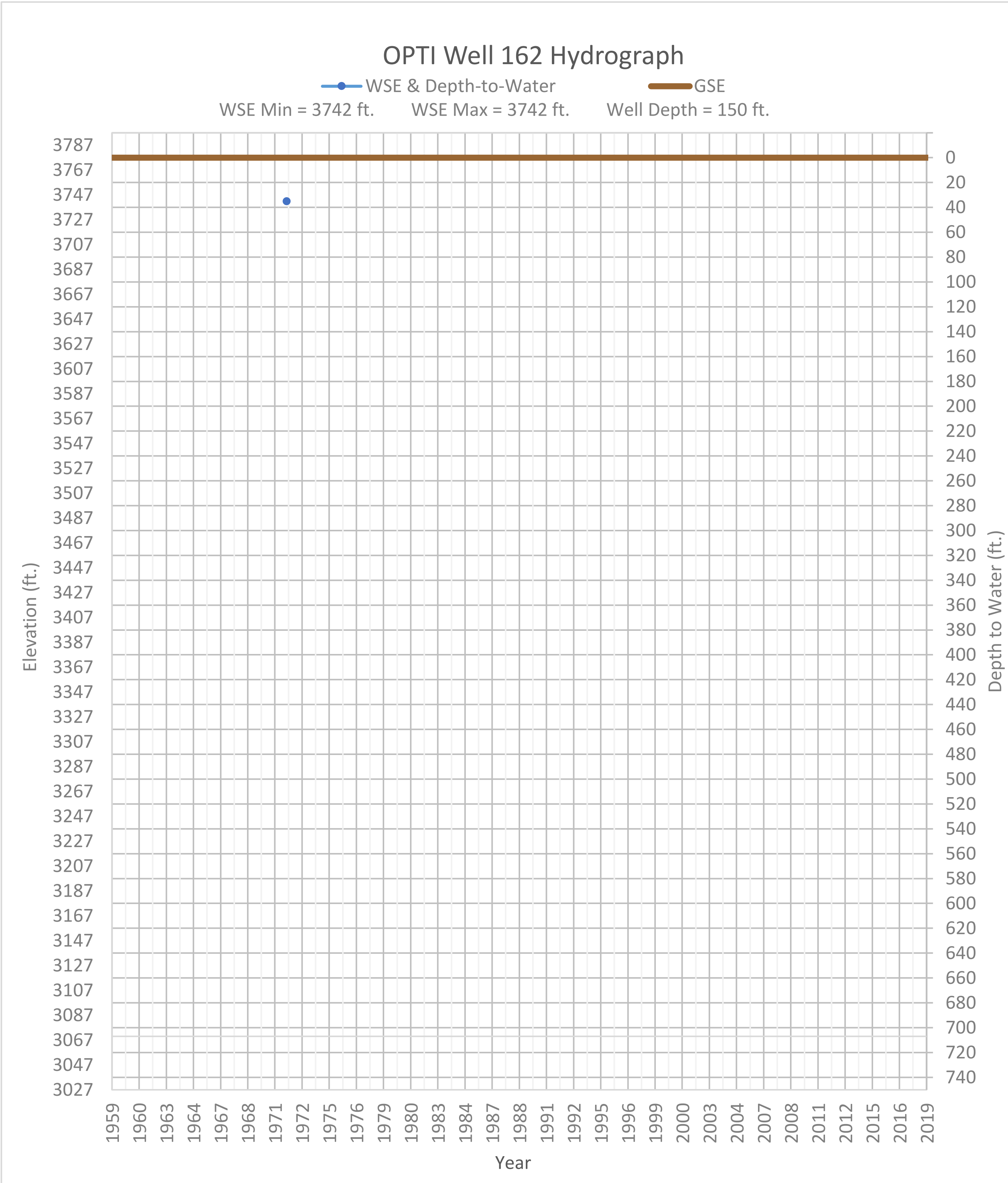


OPTI Well 155 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3594 ft.
WSE Max = 3594 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year

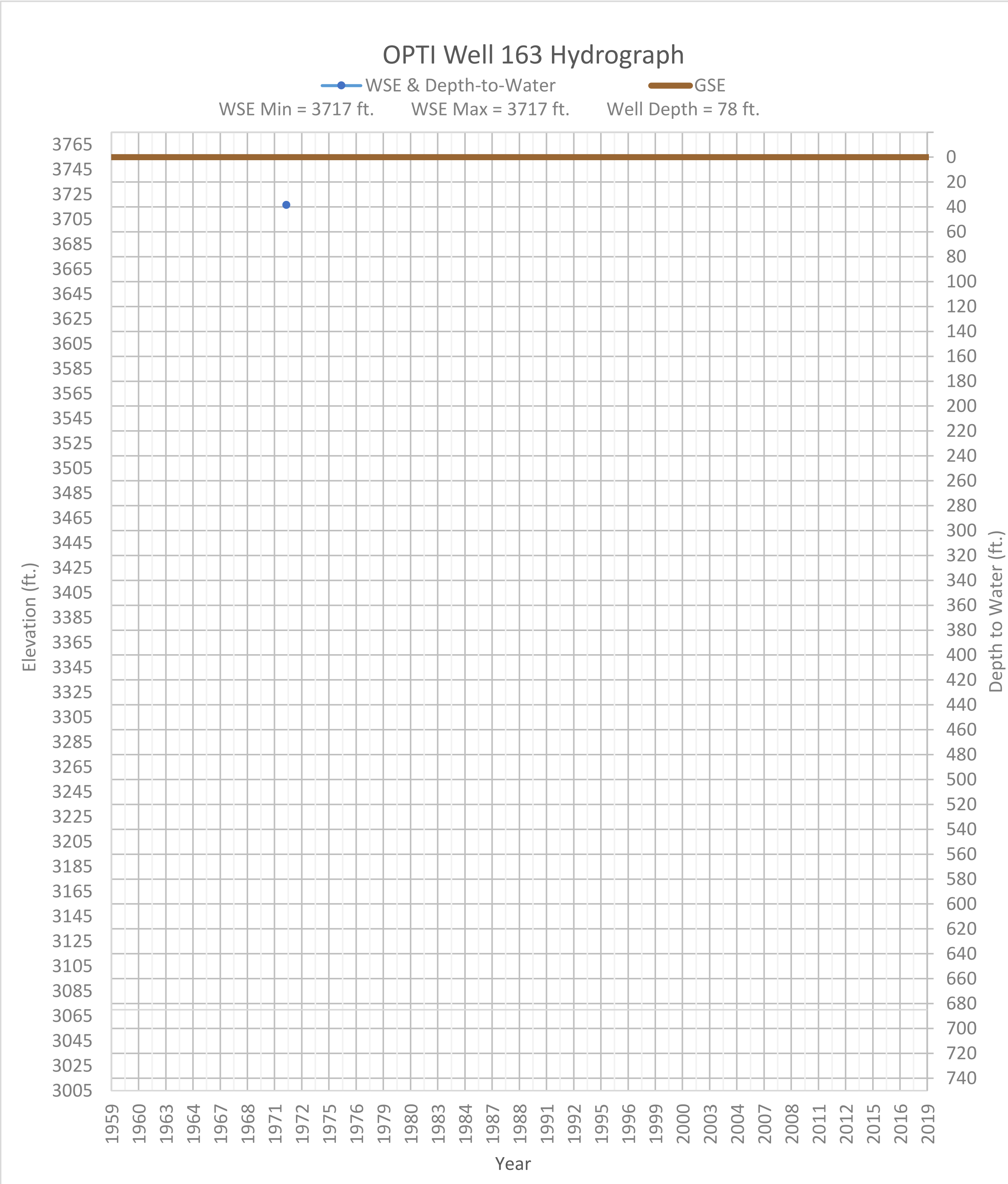


OPTI Well 157 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3700 ft.
WSE Max = 3700 ft.
Well Depth = 71 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 159 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3687 ft.
WSE Max = 3692 ft.
Well Depth = 64 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 162 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3742 ft.
WSE Max = 3742 ft.
Well Depth = 150 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 163 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3717 ft.
WSE Max = 3717 ft.
Well Depth = 78 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3765
3745
3725
3705
3685
3665
3645
3625
3605
3585
3565
3545
3525
3505
3485
3465
3445
3425
3405
3385
3365
3345
3325
3305
3285
3265
3245
3225
3205
3185
3165
3145
3125
3105
3085
3065
3045
3025
3005
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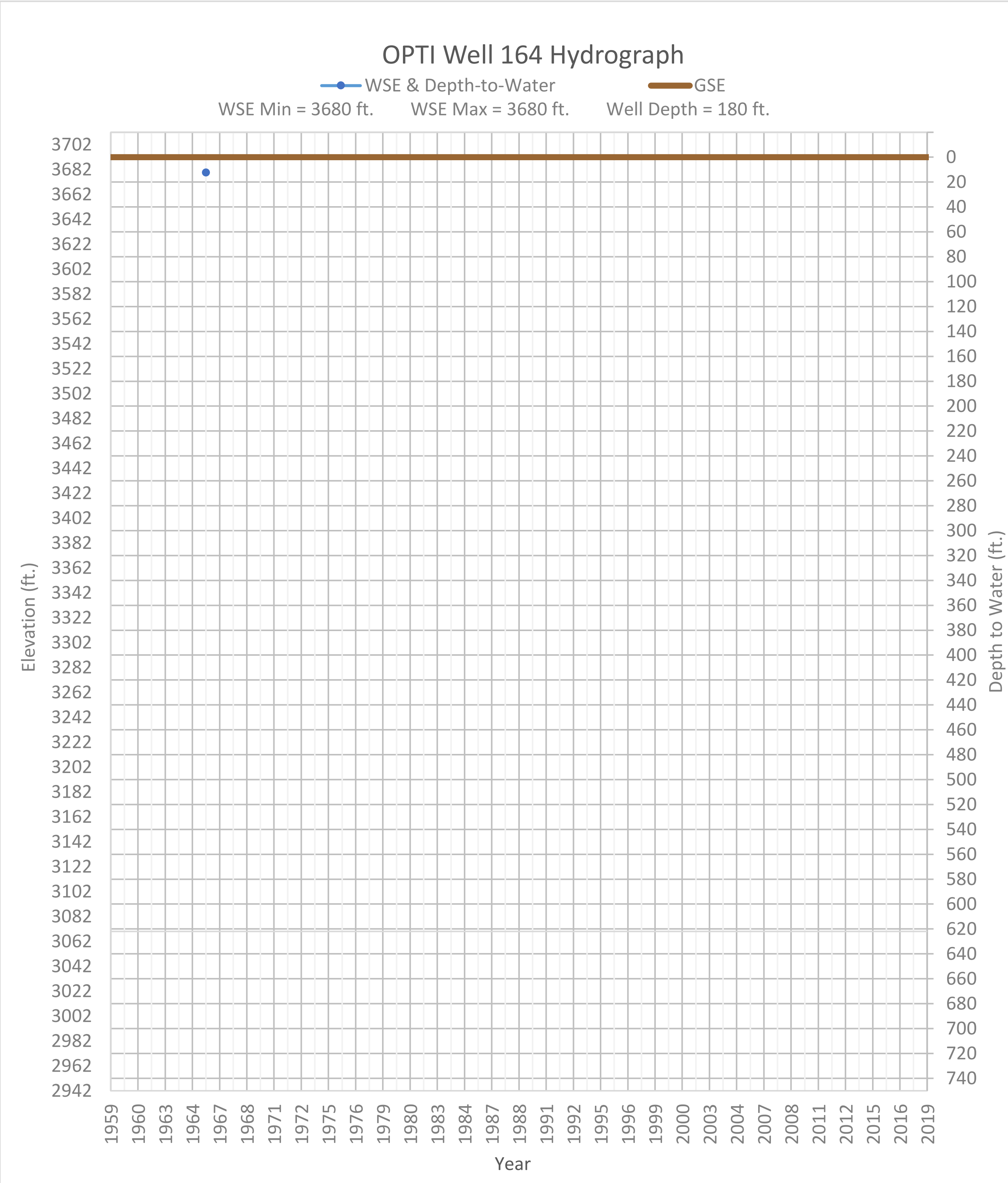

OPTI Well 164 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3680 ft.
WSE Max = 3680 ft.
Well Depth = 180 ft.
Elevation (ft.)
3702
3682
3662
3642
3622
3602
3582
3562
3542
3522
3502
3482
3462
3442
3422
3402
3382
3362
3342
3322
3302
3282
3262
3242
3222
3202
3182
3162
3142
3122
3102
3082
3062
3042
3022
3002
2982
2962
2942
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
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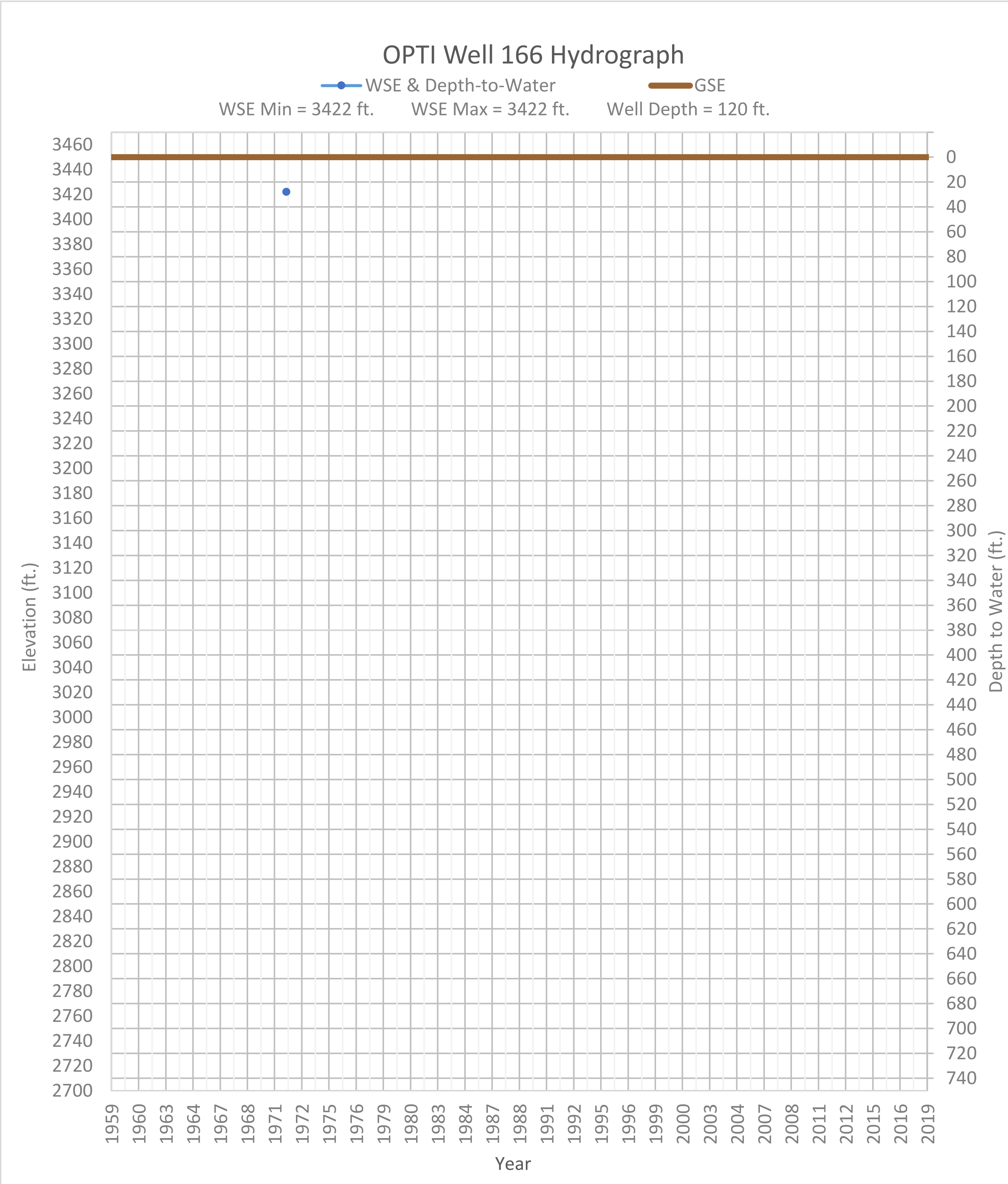
2019
Year


OPTI Well 166 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3422 ft.
WSE Max = 3422 ft.
Well Depth = 120 ft.
Elevation (ft.)
3460
3440
3420
3400
3380
3360
3340
3320
3300
3280
3260
3240
3220
3200
3180
3160
3140
3120
3100
3080
3060
3040
3020
3000
2980
2960
2940
2920
2900
2880
2860
2840
2820
2800
2780
2760
2740
2720
2700
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
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Year
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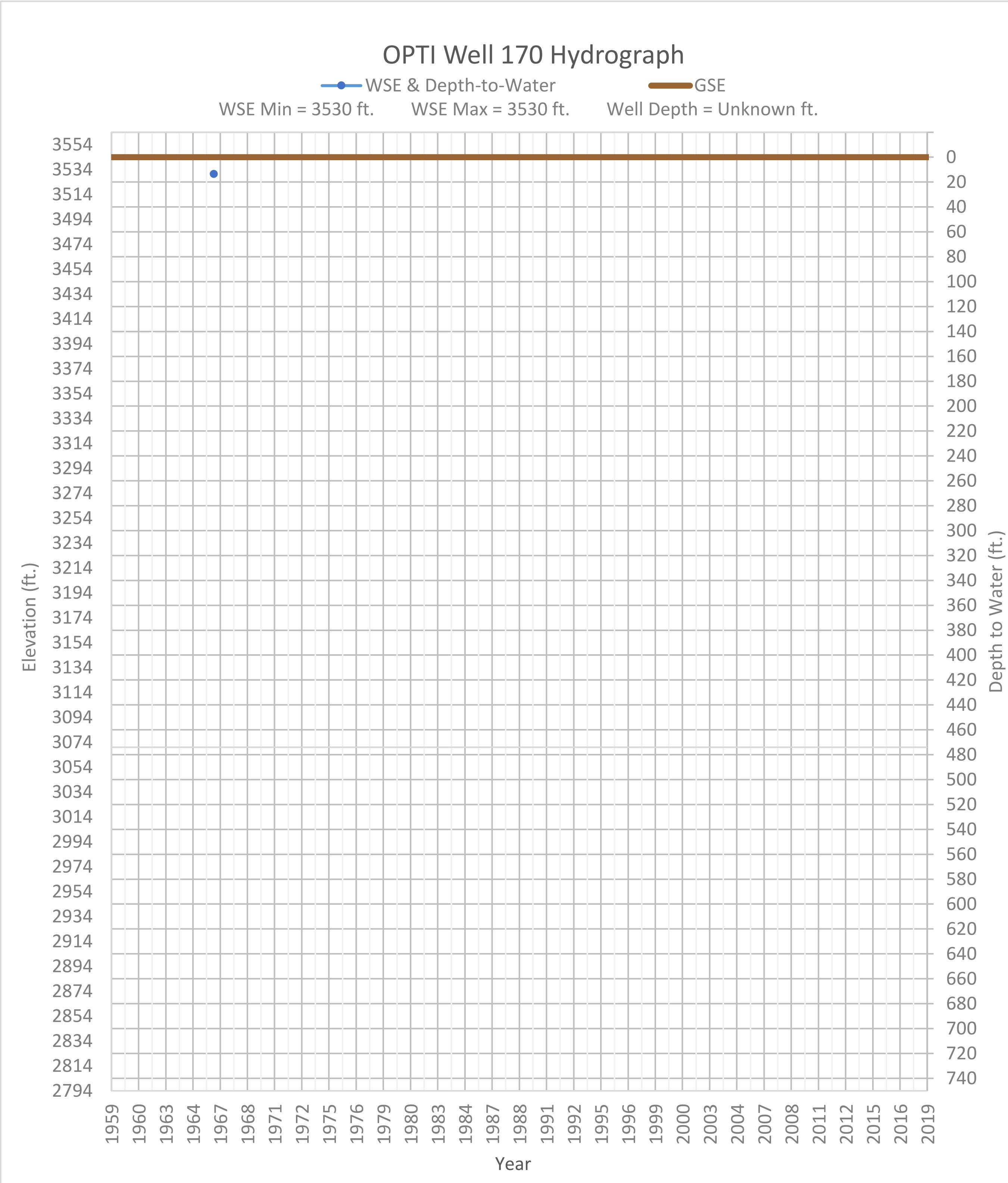

OPTI Well 170 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3530 ft.
WSE Max = 3530 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3554
3534
3514
3494
3474
3454
3434
3414
3394
3374
3354
3334
3314
3294
3274
3254
3234
3214
3194
3174
3154
3134
3114
3094
3074
3054
3034
3014
2994
2974
2954
2934
2914
2894
2874
2854
2834
2814
2794
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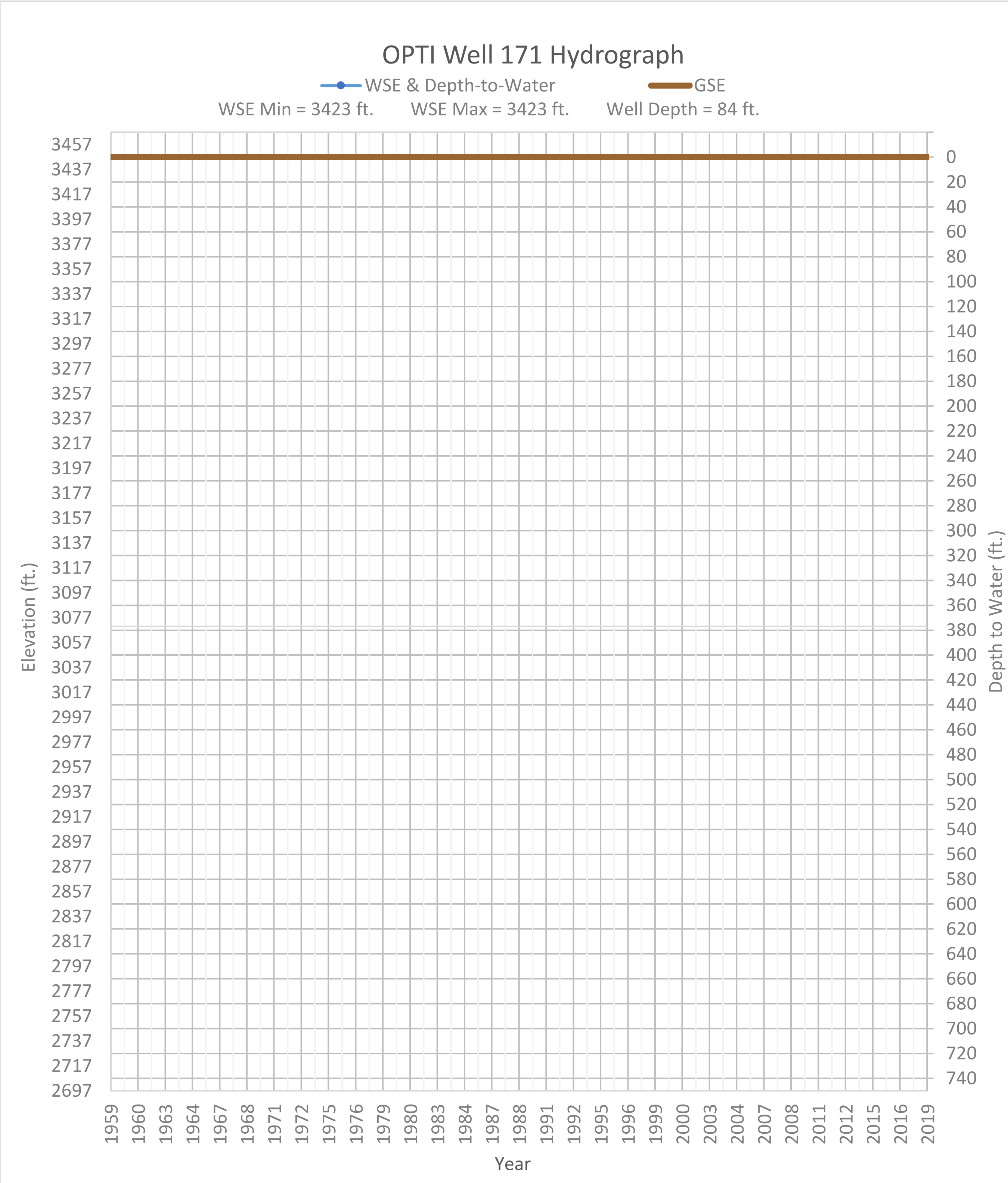
OPTI Well 171 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3423 ft.
WSE Max = 3423 ft.
Well Depth = 84 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3457
3437
3417
3397
3377
3357
3337
3317
3297
3277
3257
3237
3217
3197
3177
3157
3137
3117
3097
3077
3057
3037
3017
2997
2977
2957
2937
2917
2897
2877
2857
2837
2817
2797
2777
2757
2737
2717
2697
0
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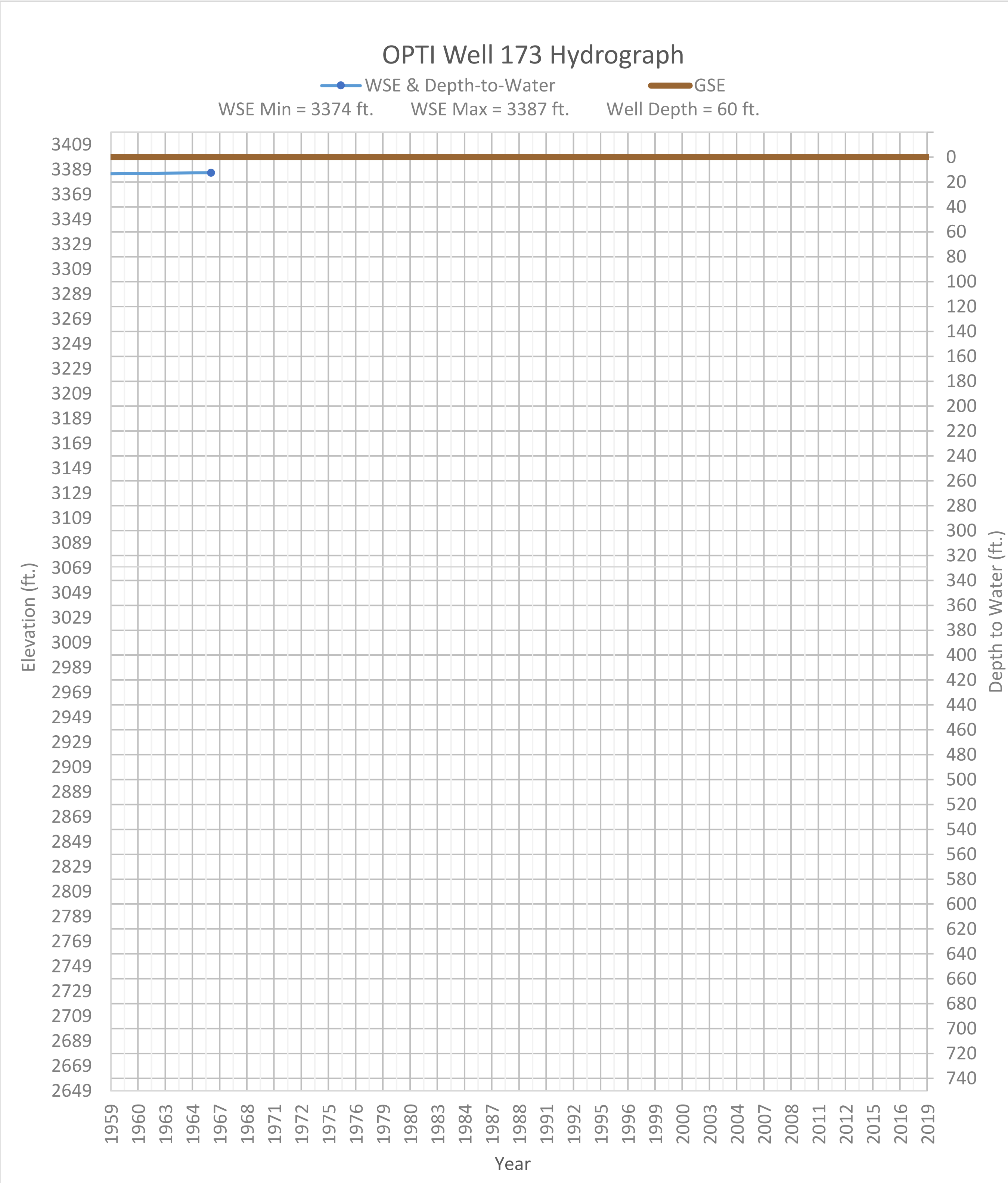

OPTI Well 173 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3374 ft.
WSE Max = 3387 ft.
Well Depth = 60 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3409
3389
3369
3349
3329
3309
3289
3269
3249
3229
3209
3189
3169
3149
3129
3109
3089
3069
3049
3029
3009
2989
2969
2949
2929
2909
2889
2869
2849
2829
2809
2789
2769
2749
2729
2709
2689
2669
2649
0
20
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60
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120
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160
180
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220
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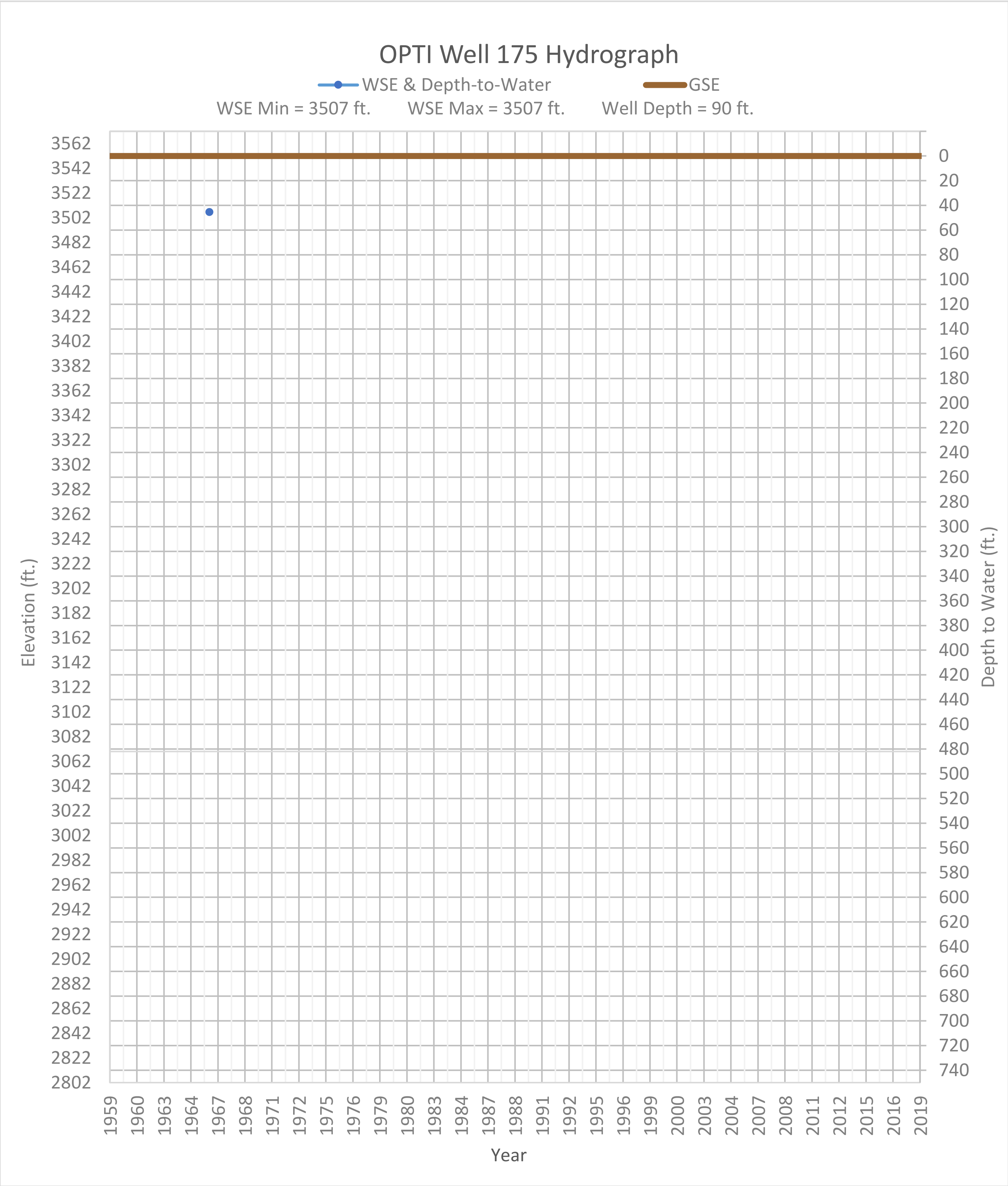
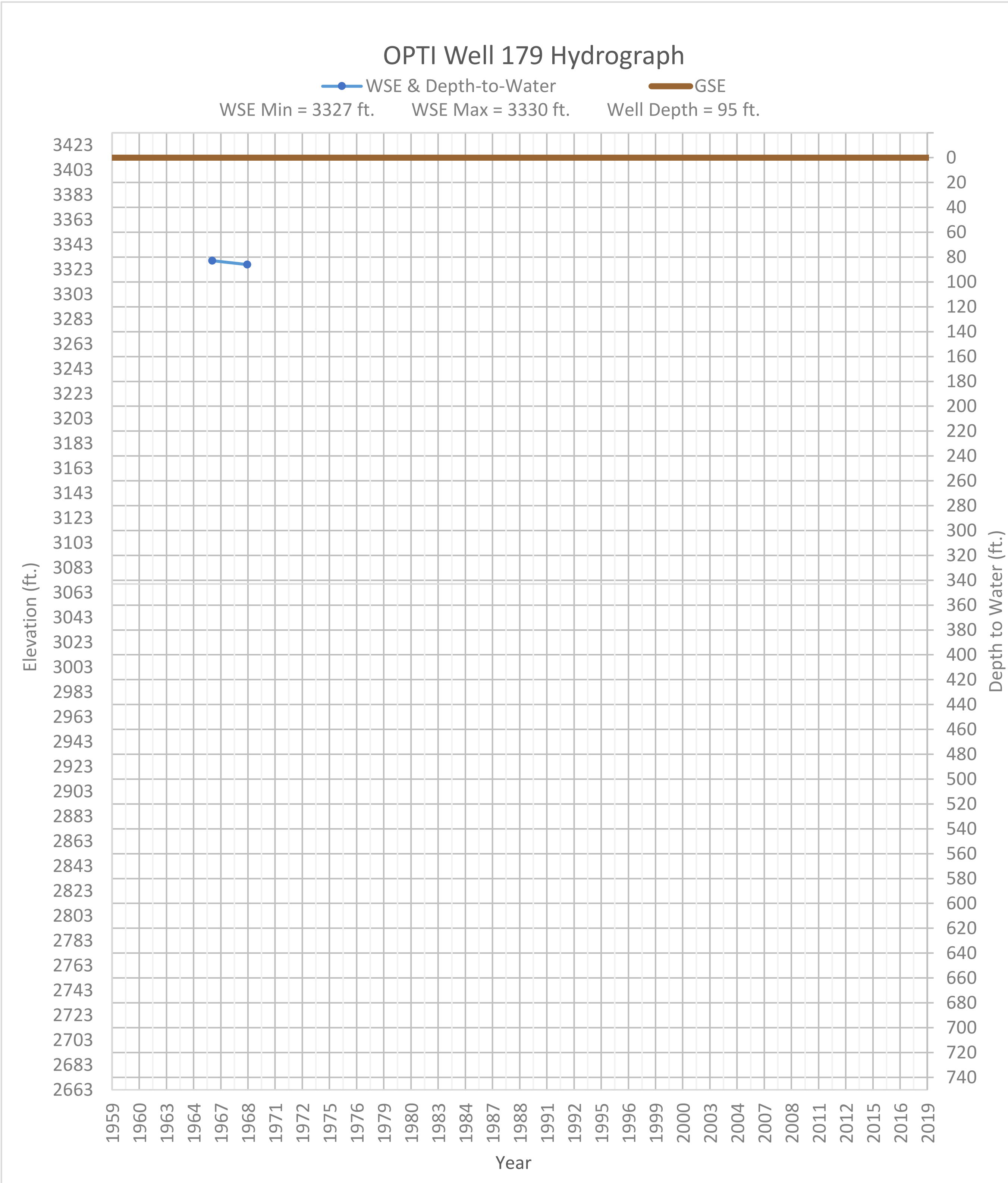
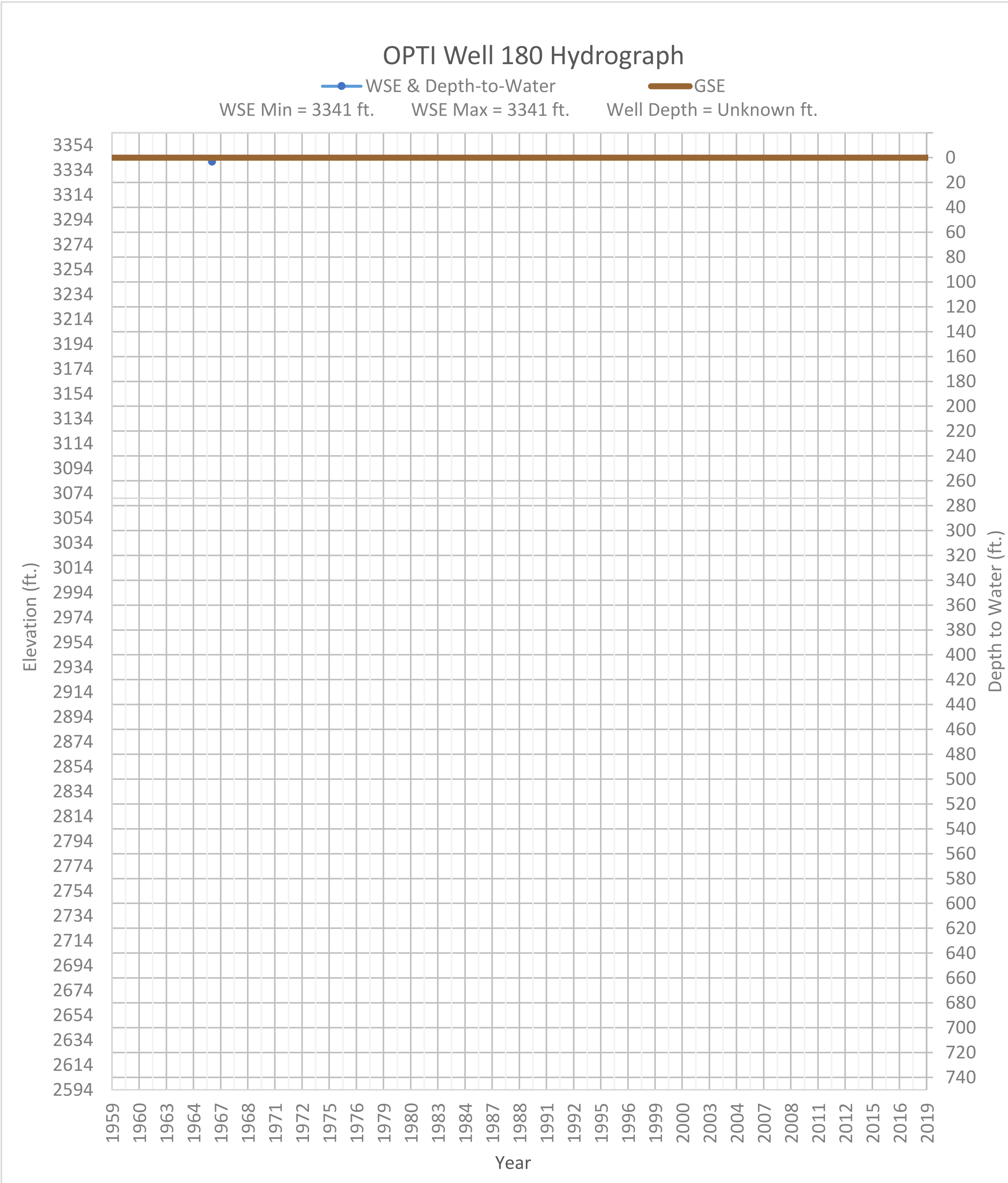
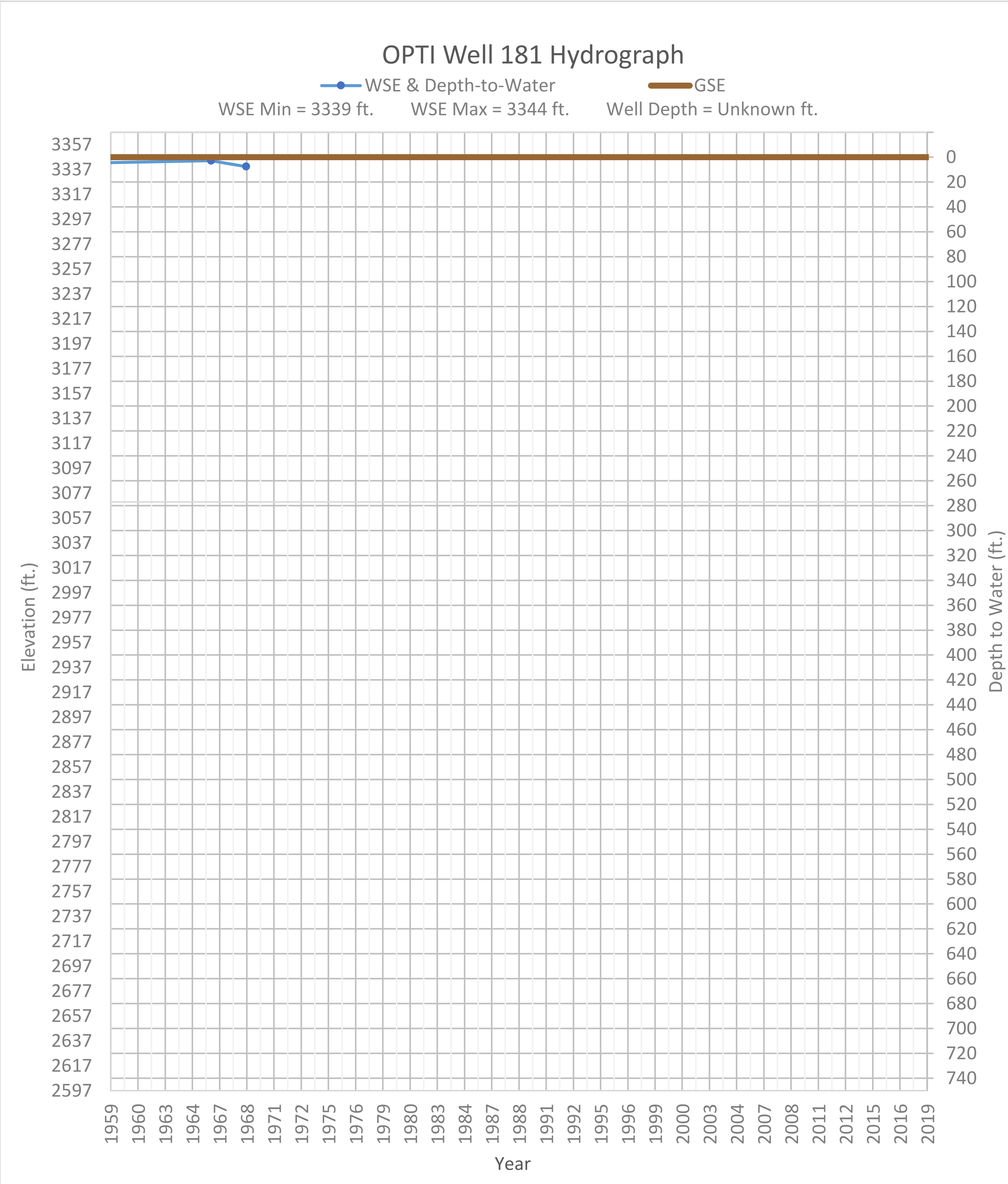


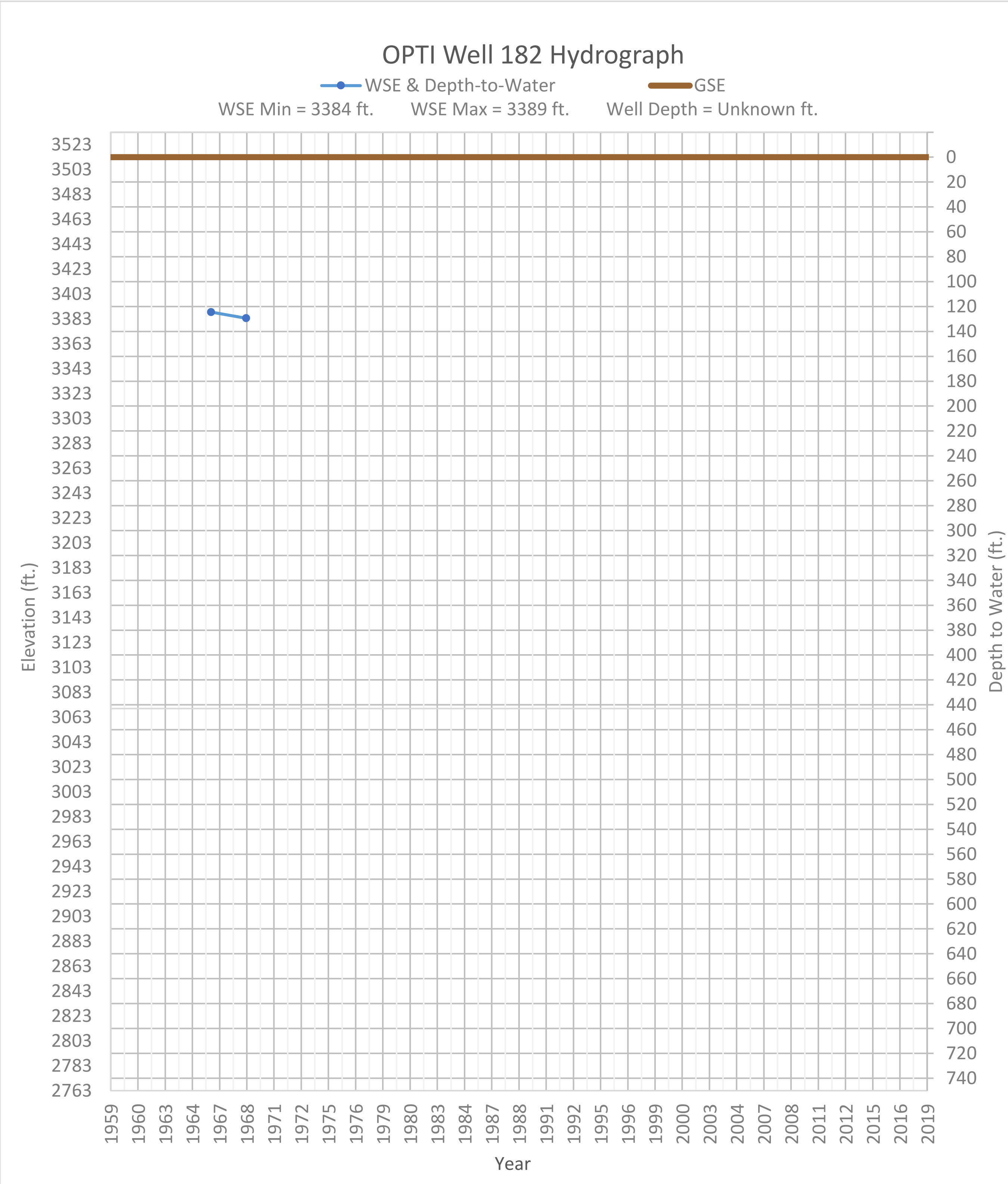
OPTI Well 175 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3507 ft.
WSE Max = 3507 ft.
Well Depth = 90 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 179 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3327 ft.
WSE Max = 3330 ft.
Well Depth = 95 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

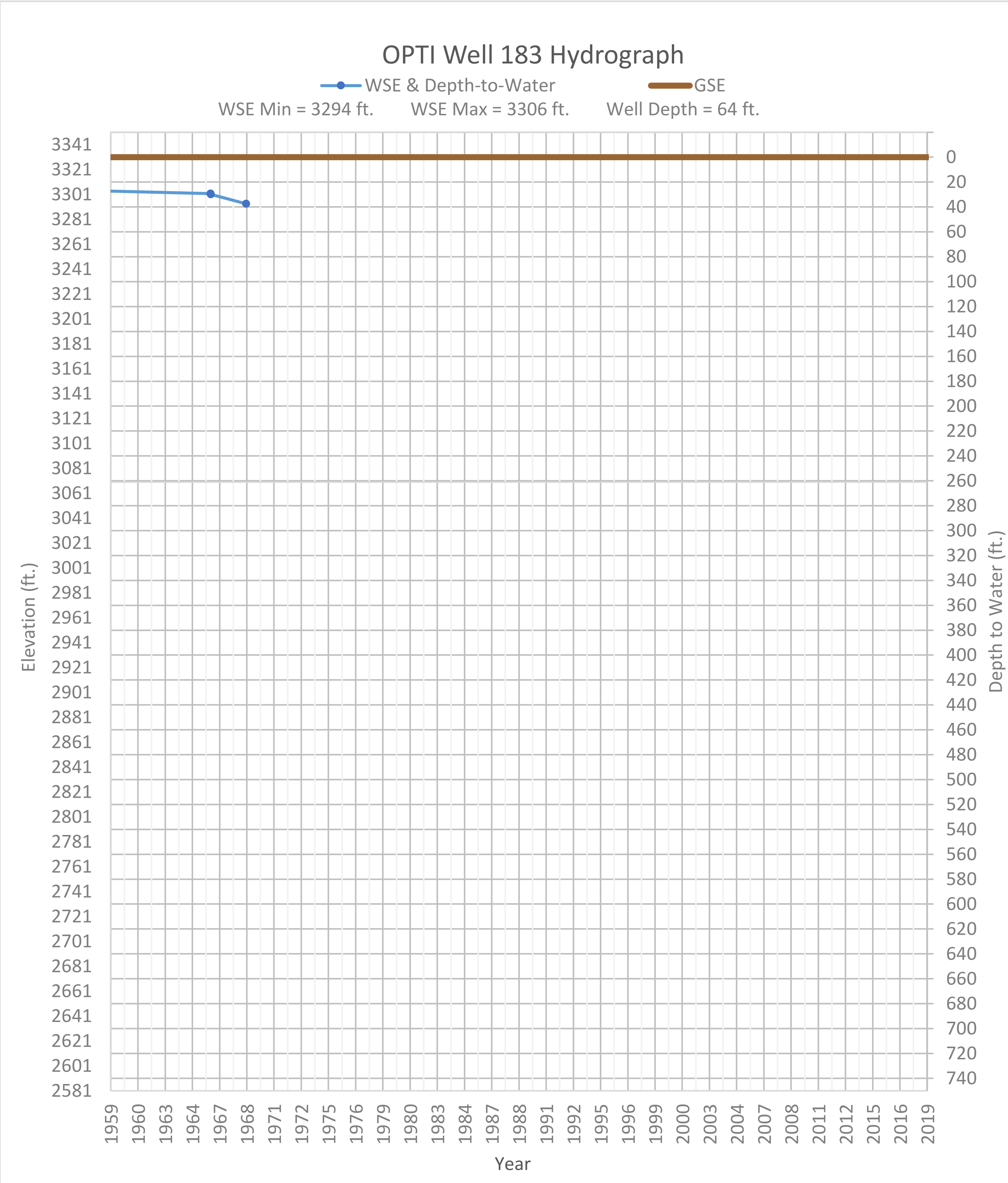

OPTI Well 180 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3341 ft.
WSE Max = 3341 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



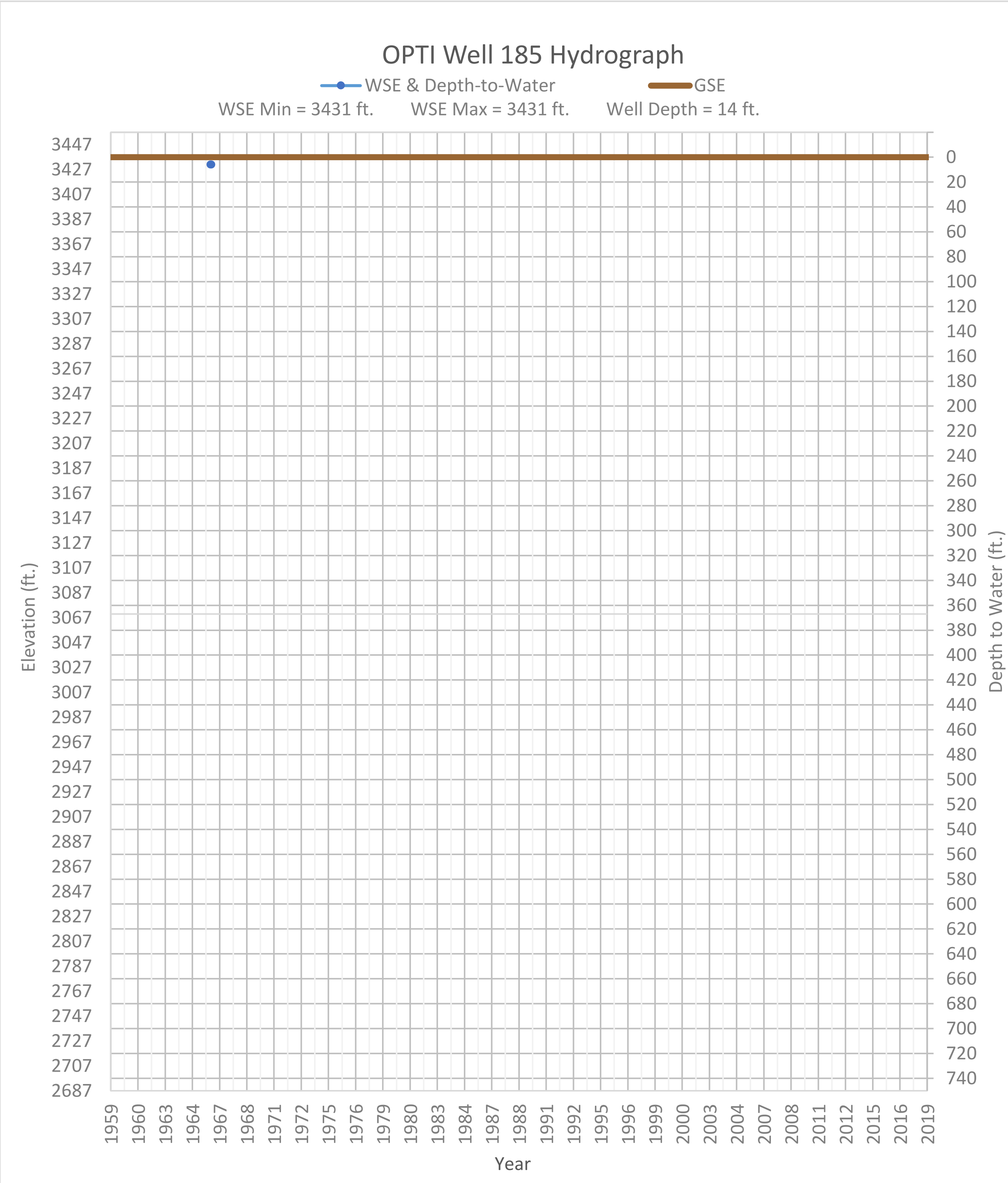
OPTI Well 181 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3339 ft.
WSE Max = 3344 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 182 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3384 ft.
WSE Max = 3389 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 183 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3294 ft.
WSE Max = 3306 ft.
Well Depth = 64 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 185 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3431 ft.
WSE Max = 3431 ft.
Well Depth = 14 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3447
3427
3407
3387
3367
3347
3327
3307
3287
3267
3247
3227
3207
3187
3167
3147
3127
3107
3087
3067
3047
3027
3007
2987
2967
2947
2927
2907
2887
2867
2847
2827
2807
2787
2767
2747
2727
2707
2687
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
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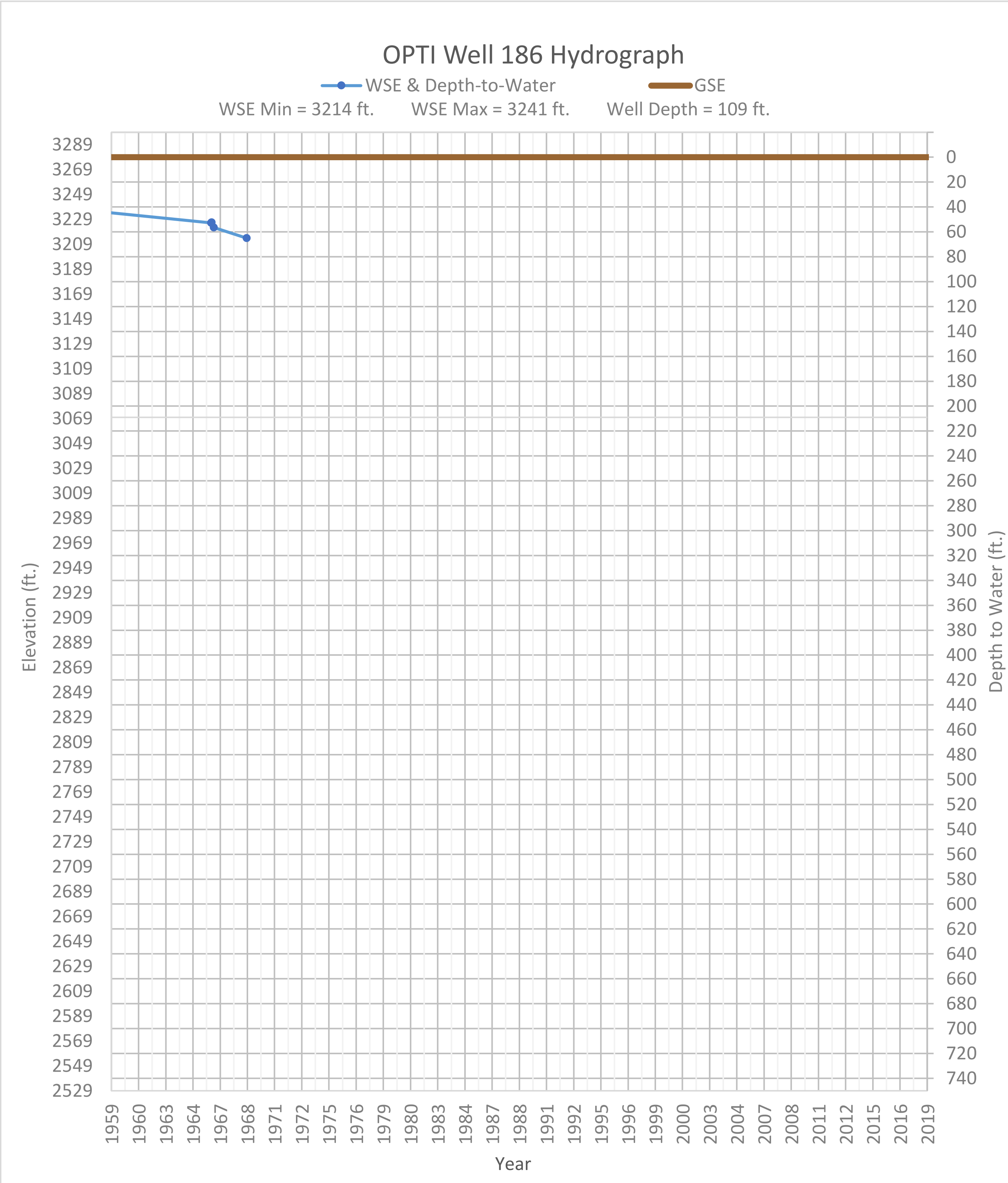
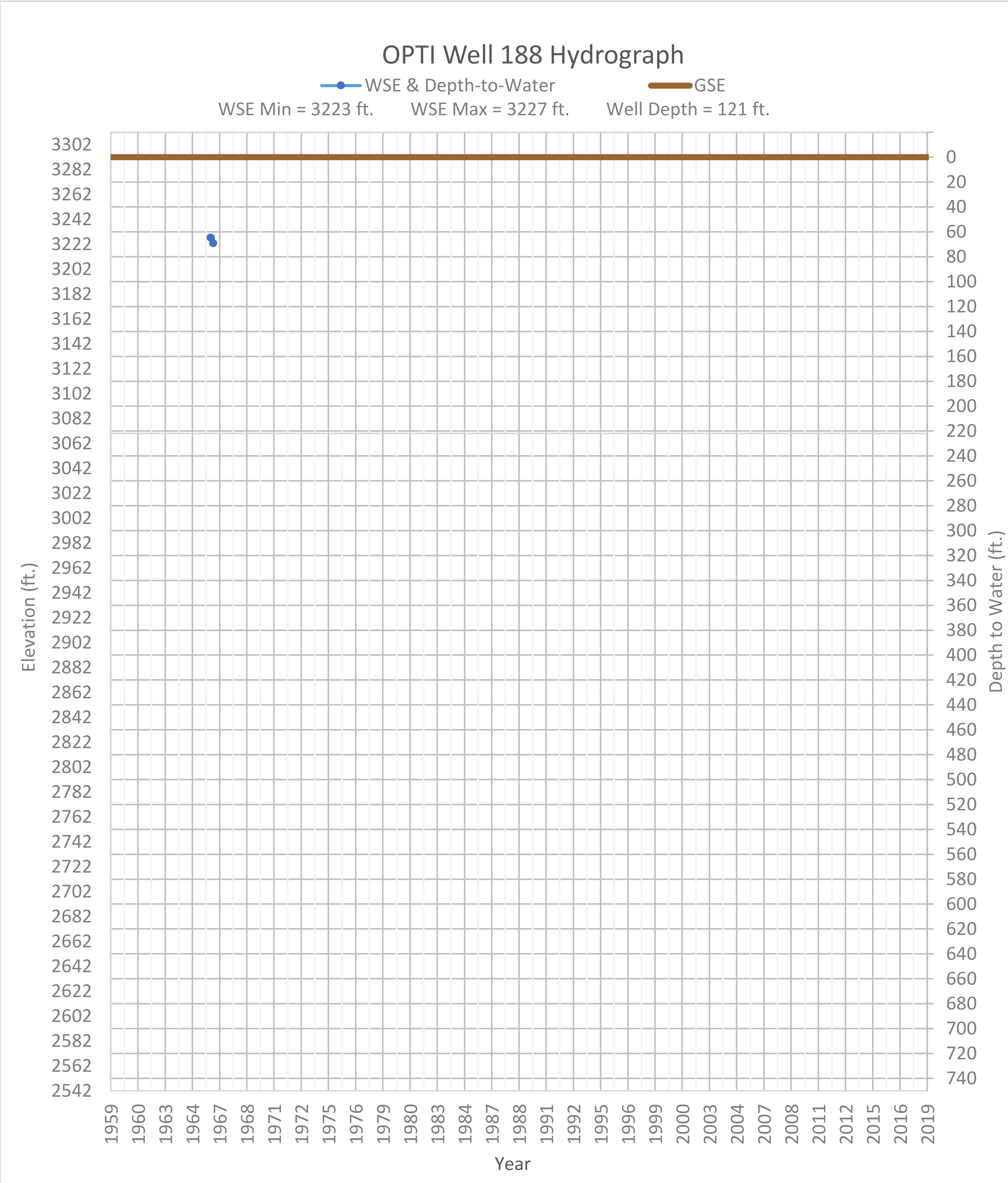
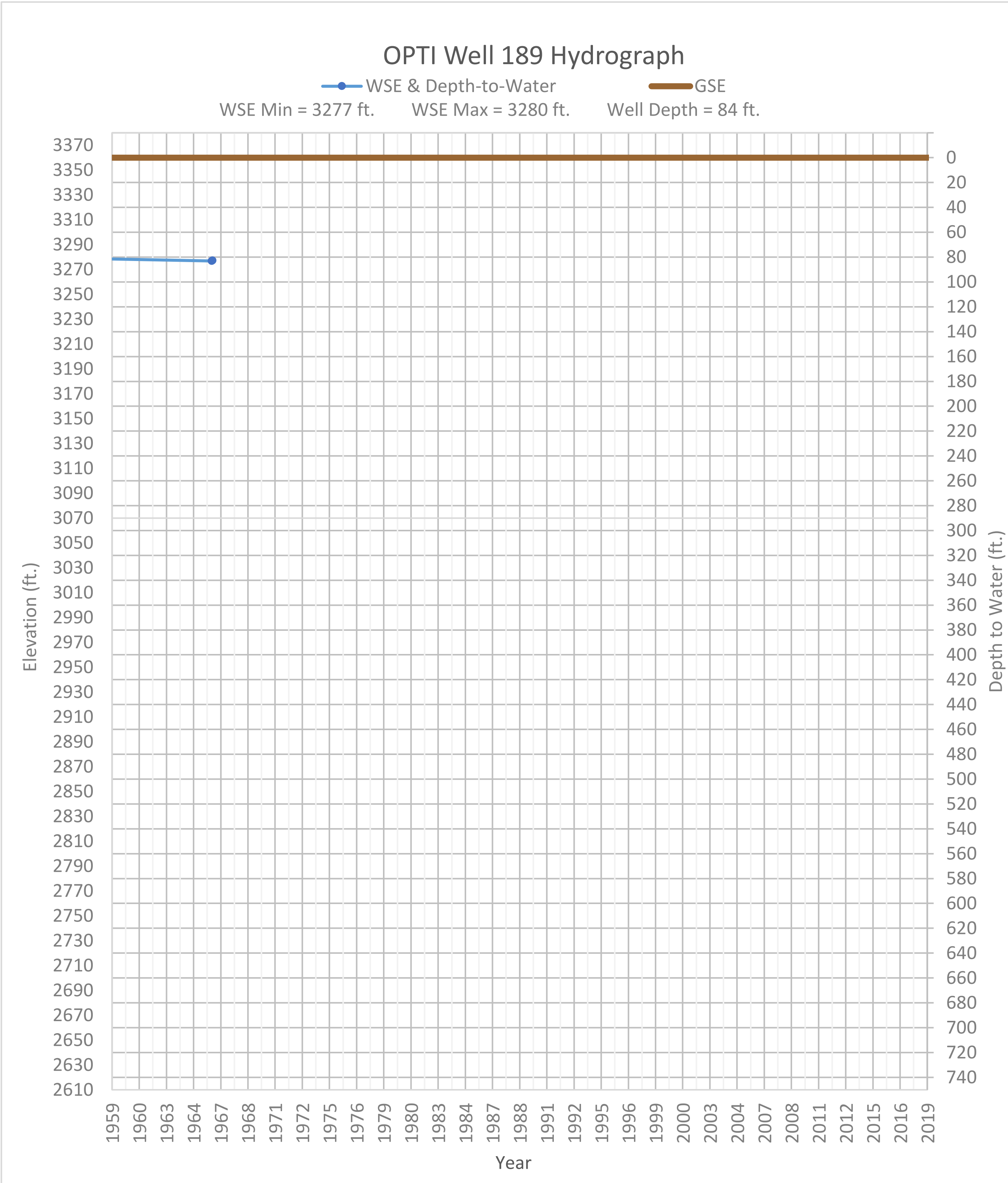
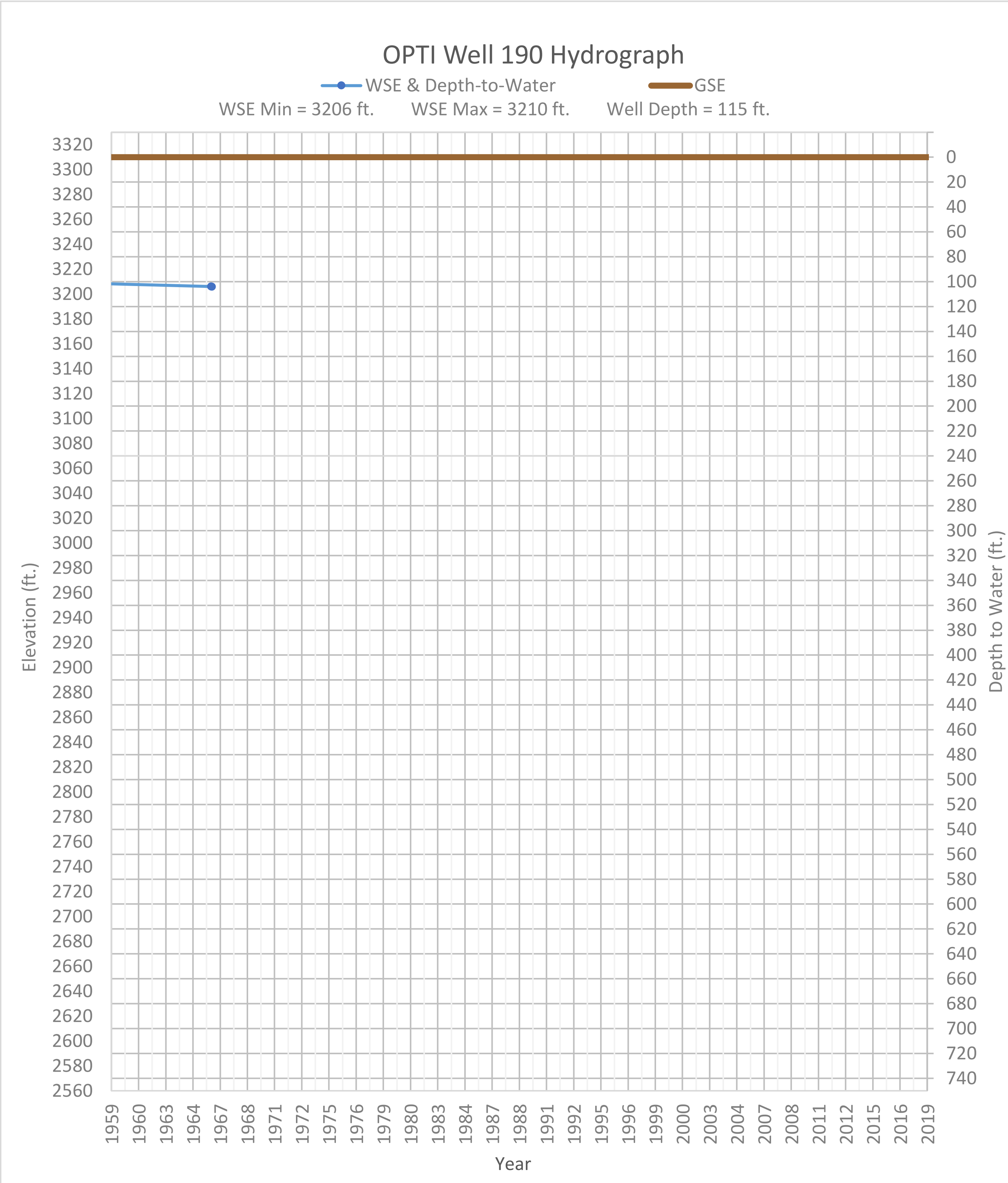

OPTI Well 186 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3214 ft.
WSE Max = 3241 ft.
Well Depth = 109 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

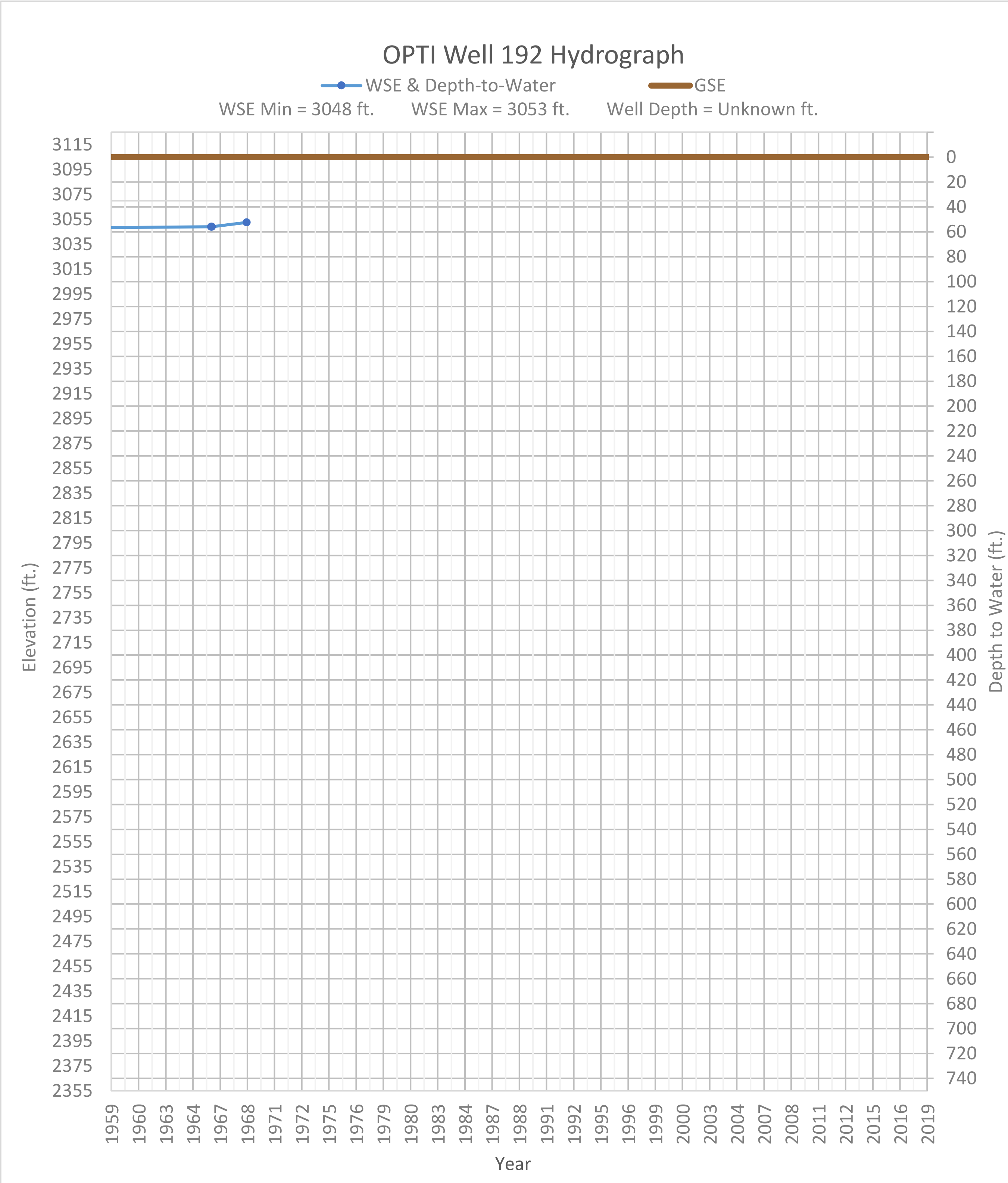

OPTI Well 188 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3223 ft.
WSE Max = 3227 ft.
Well Depth = 121 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

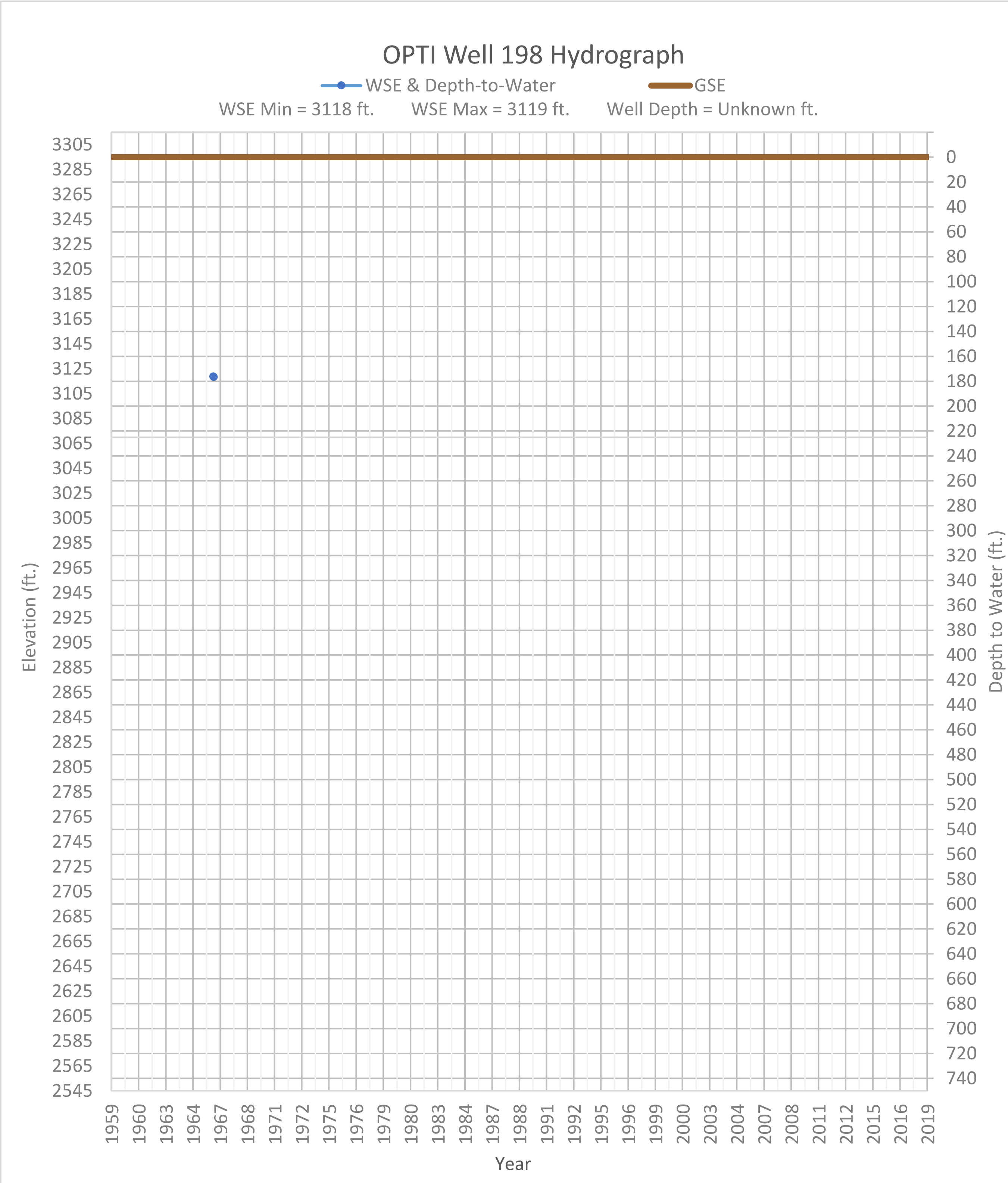


OPTI Well 189 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3277 ft.
WSE Max = 3280 ft.
Well Depth = 84 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 190 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3206 ft.
WSE Max = 3210 ft.
Well Depth = 115 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 192 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3048 ft.
WSE Max = 3053 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 198 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3118 ft.
WSE Max = 3119 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3305
3285
3265
3245
3225
3205
3185
3165
3145
3125
3105
3085
3065
3045
3025
3005
2985
2965
2945
2925
2905
2885
2865
2845
2825
2805
2785
2765
2745
2725
2705
2685
2665
2645
2625
2605
2585
2565
2545
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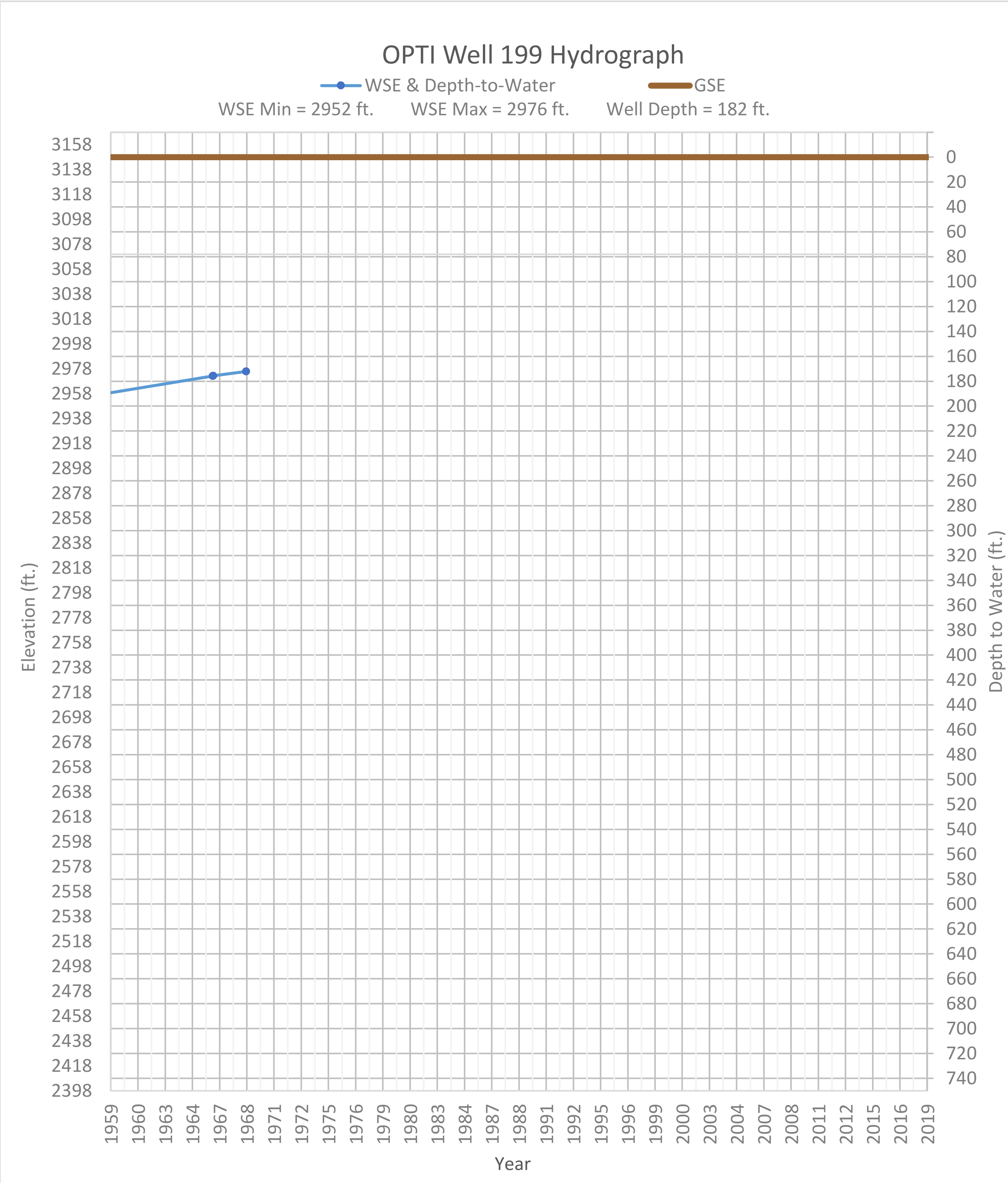
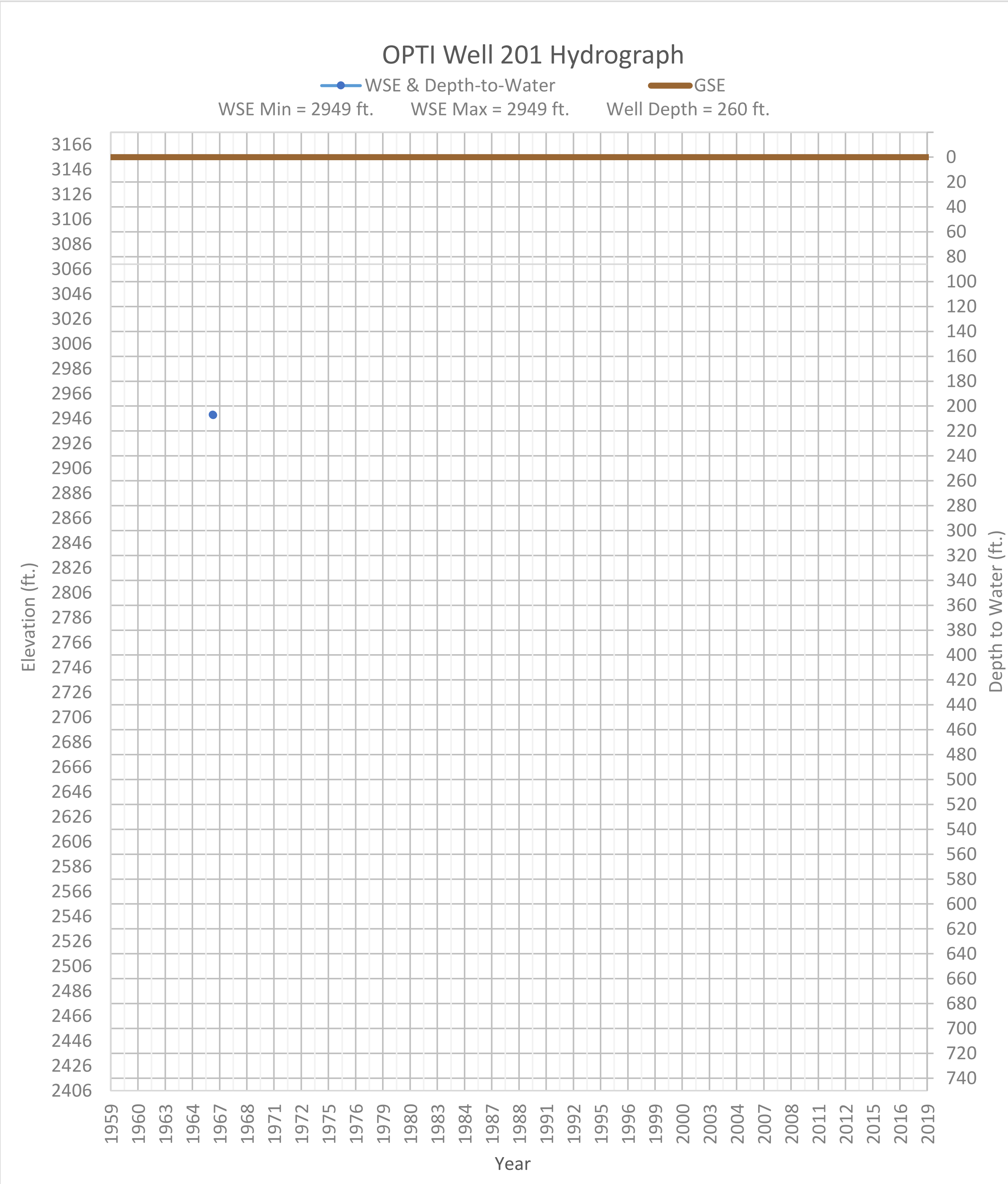
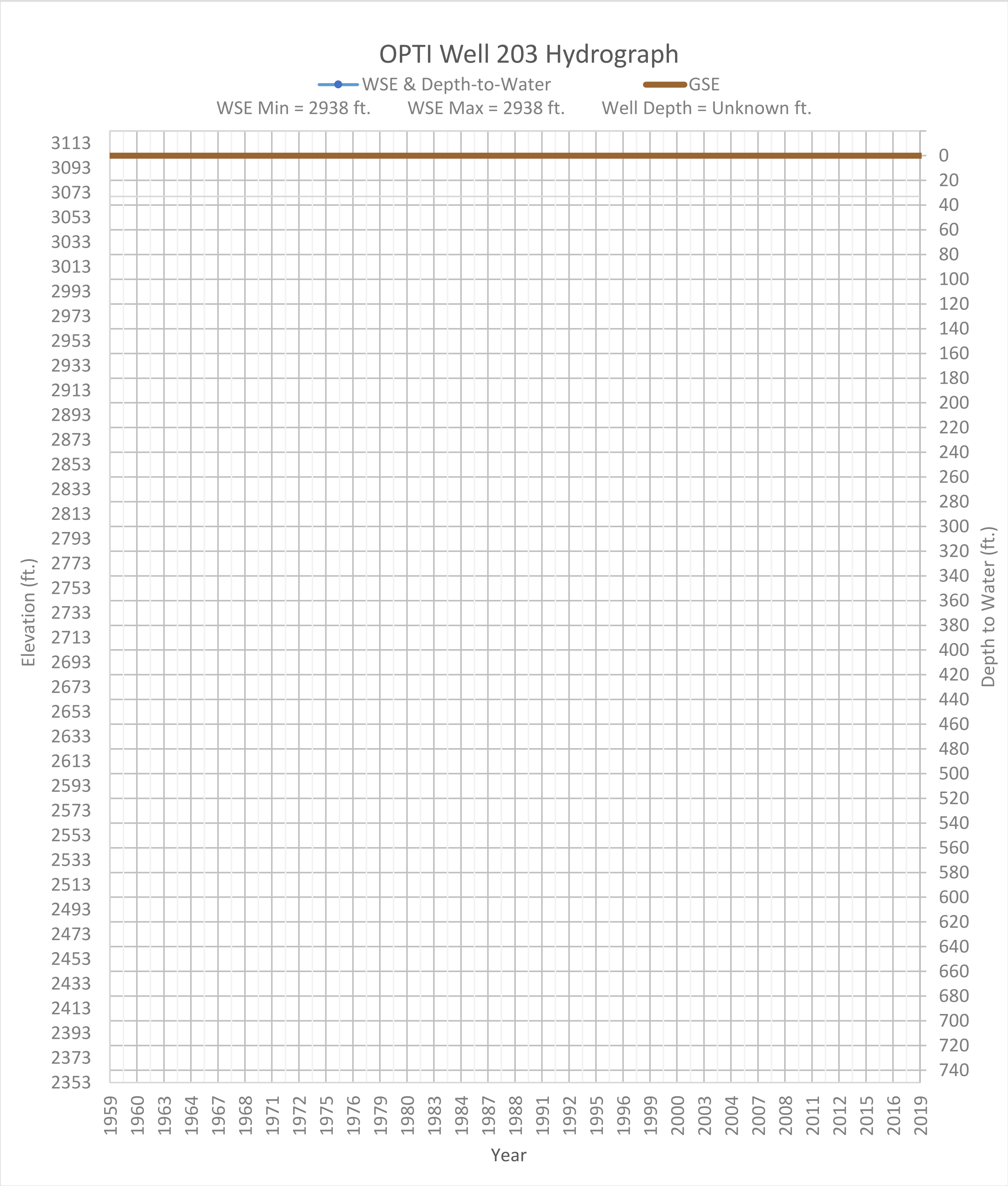
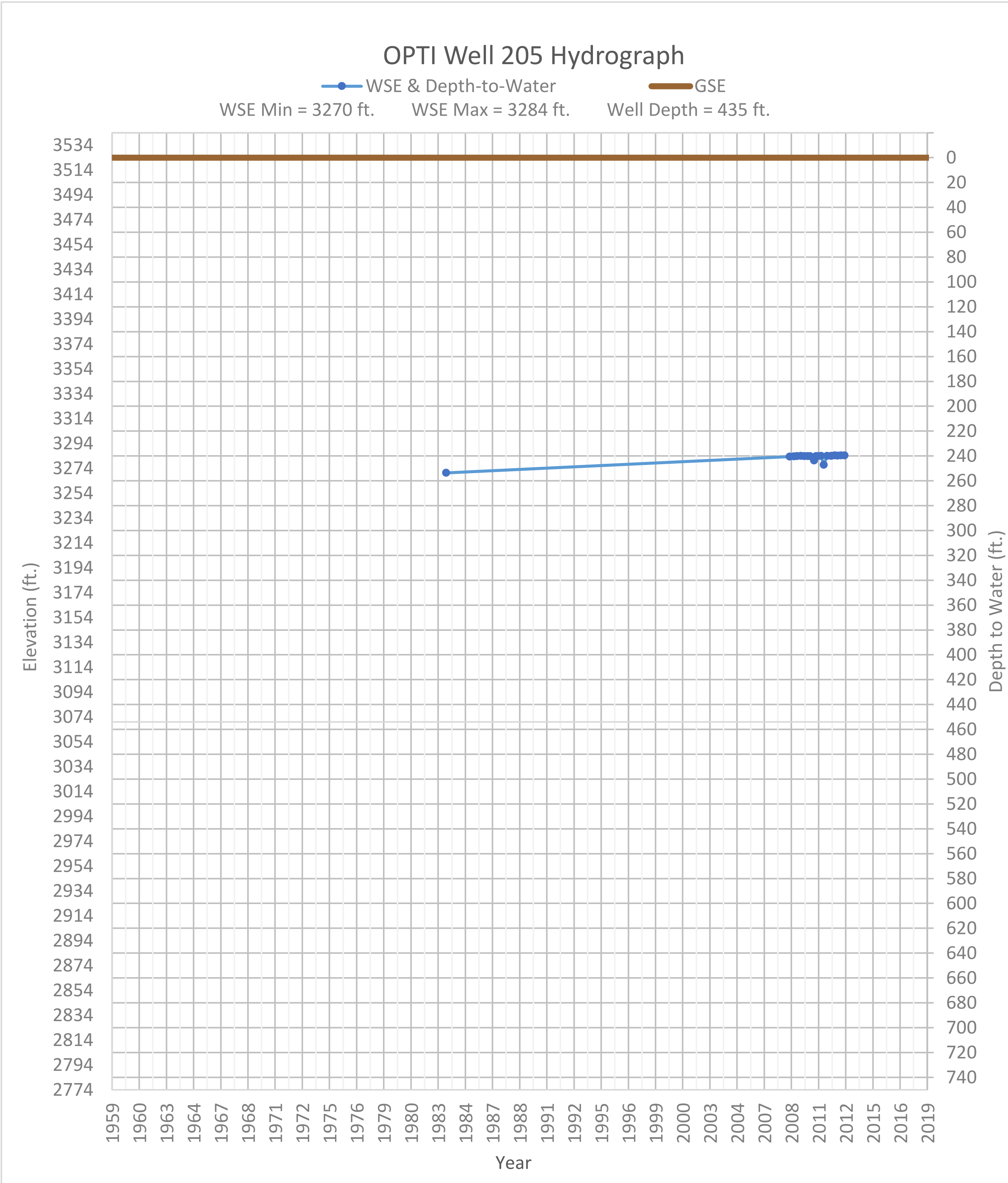


OPTI Well 199 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2952 ft.
WSE Max = 2976 ft.
Well Depth = 182 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 201 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2949 ft.
WSE Max = 2949 ft.
Well Depth = 260 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 203 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2938 ft.
WSE Max = 2938 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 205 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3270 ft.
WSE Max = 3284 ft.
Well Depth = 435 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3534
3514
3494
3474
3454
3434
3414
3394
3374
3354
3334
3314
3294
3274
3254
3234
3214
3194
3174
3154
3134
3114
3094
3074
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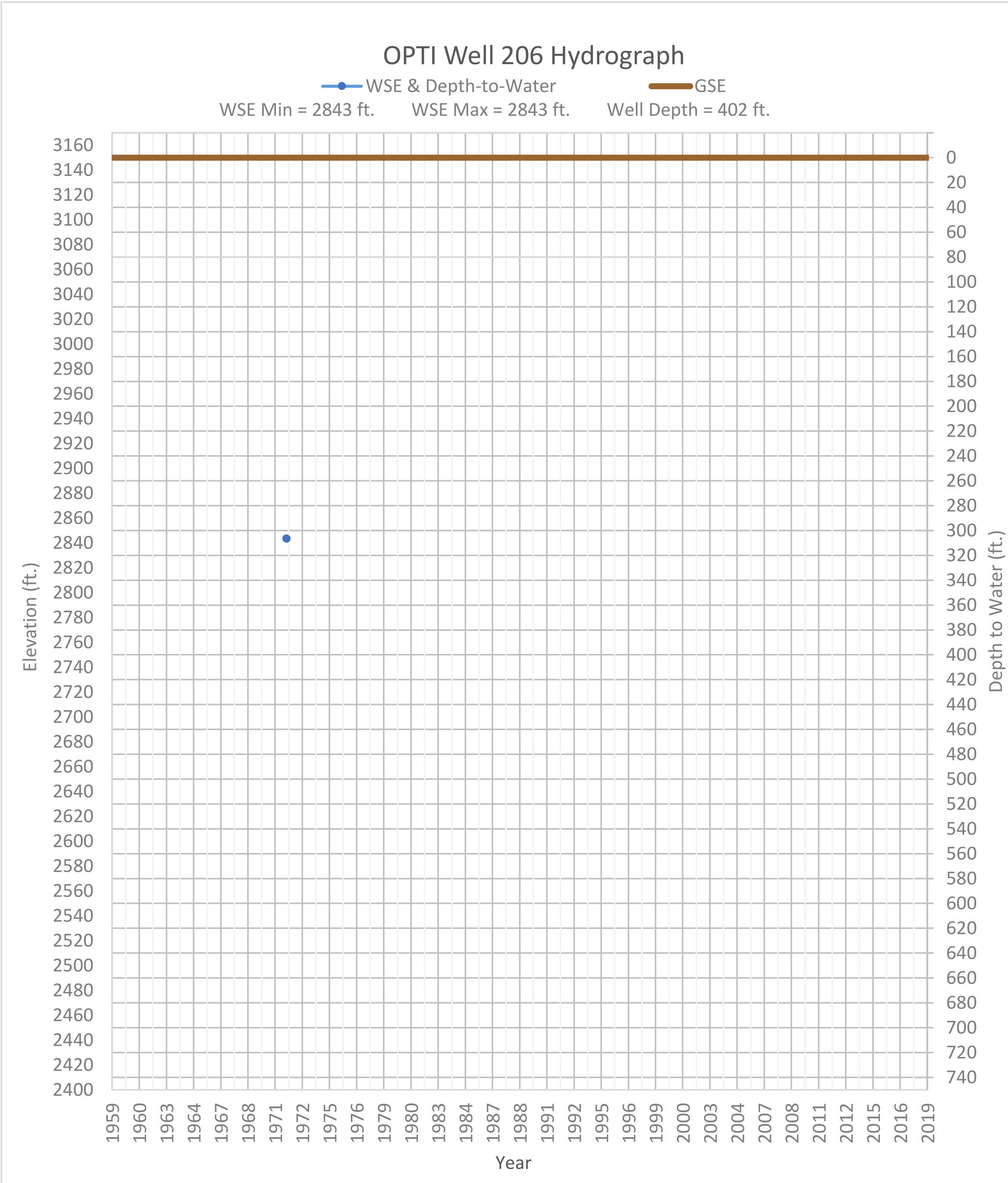
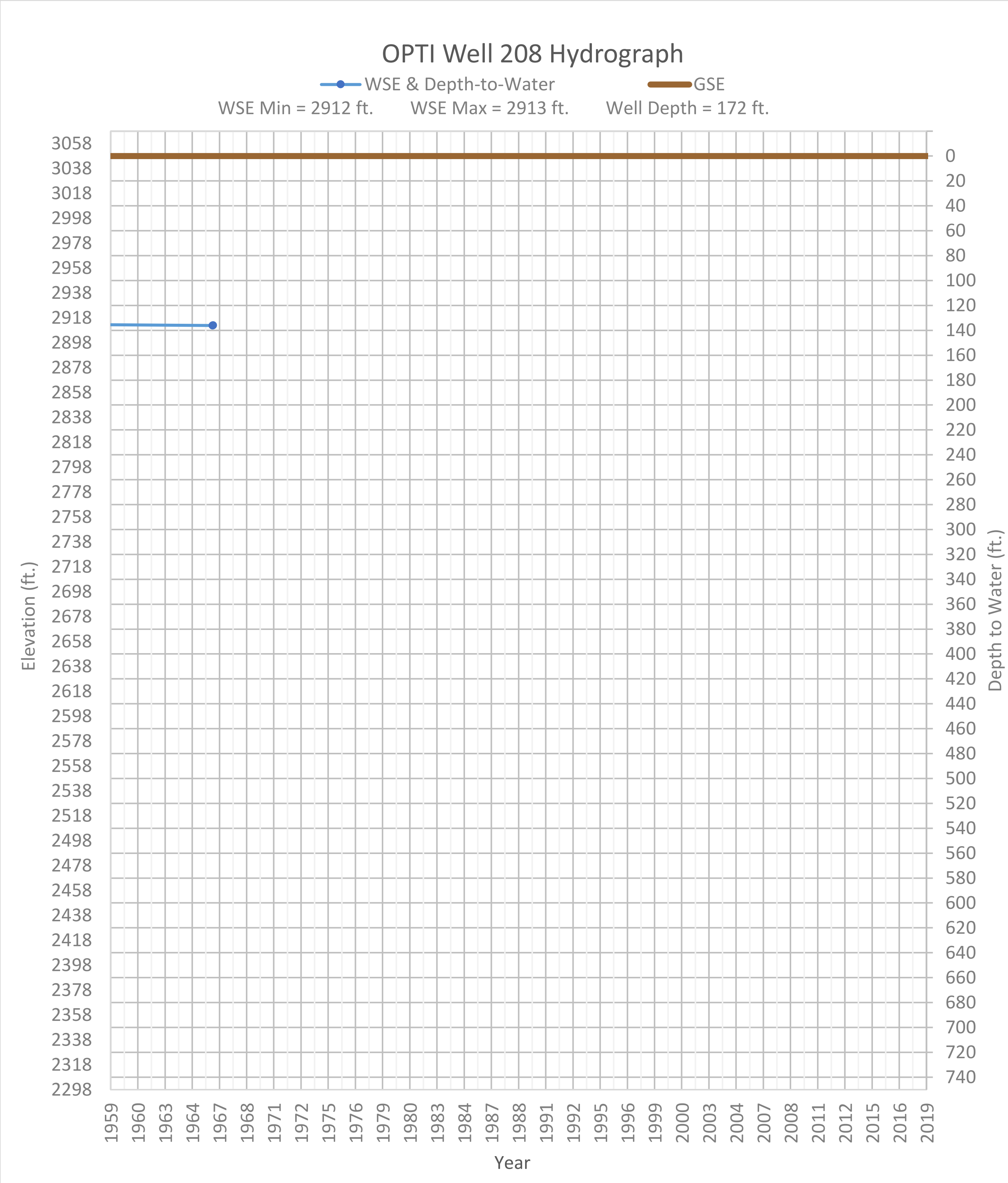
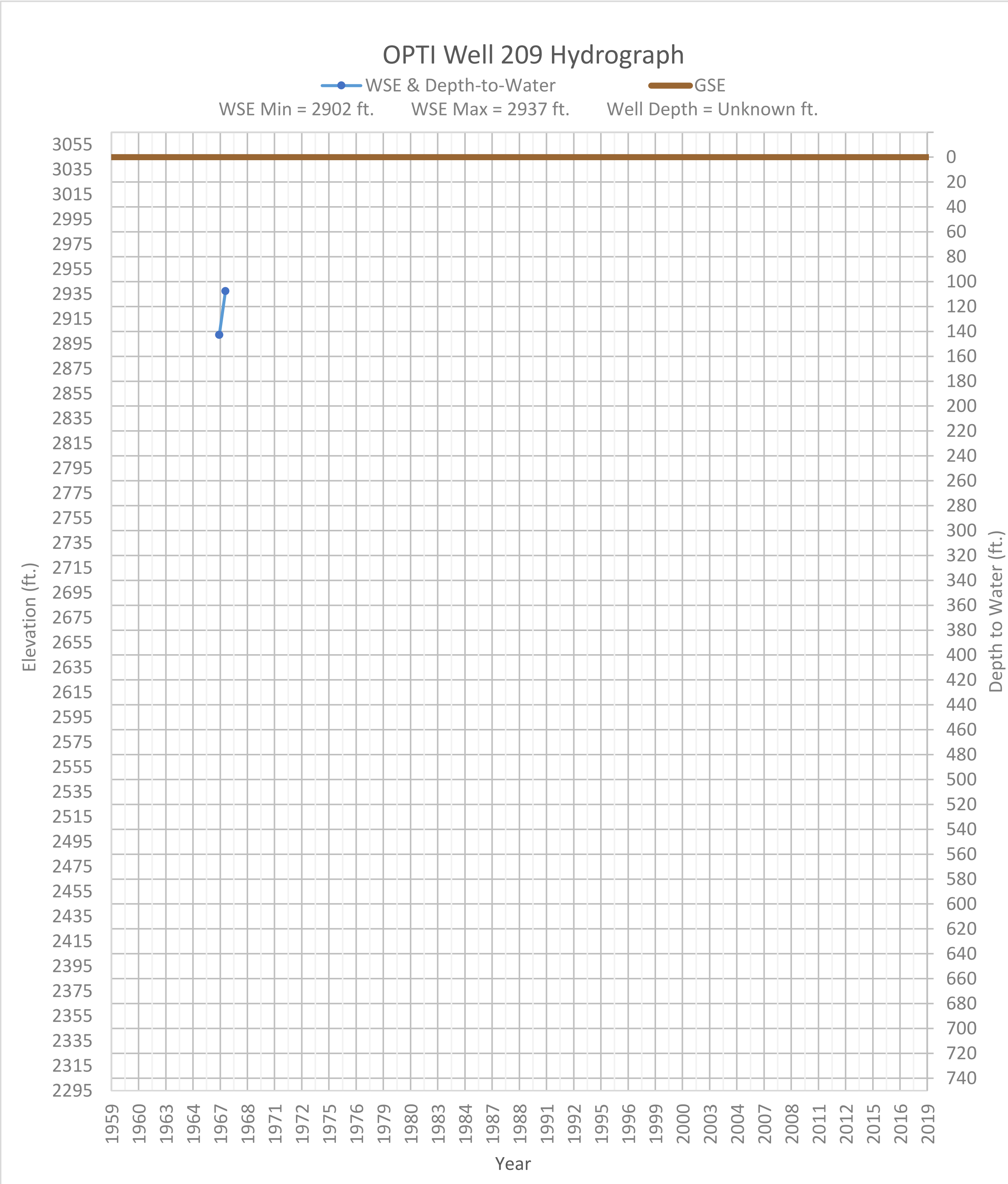
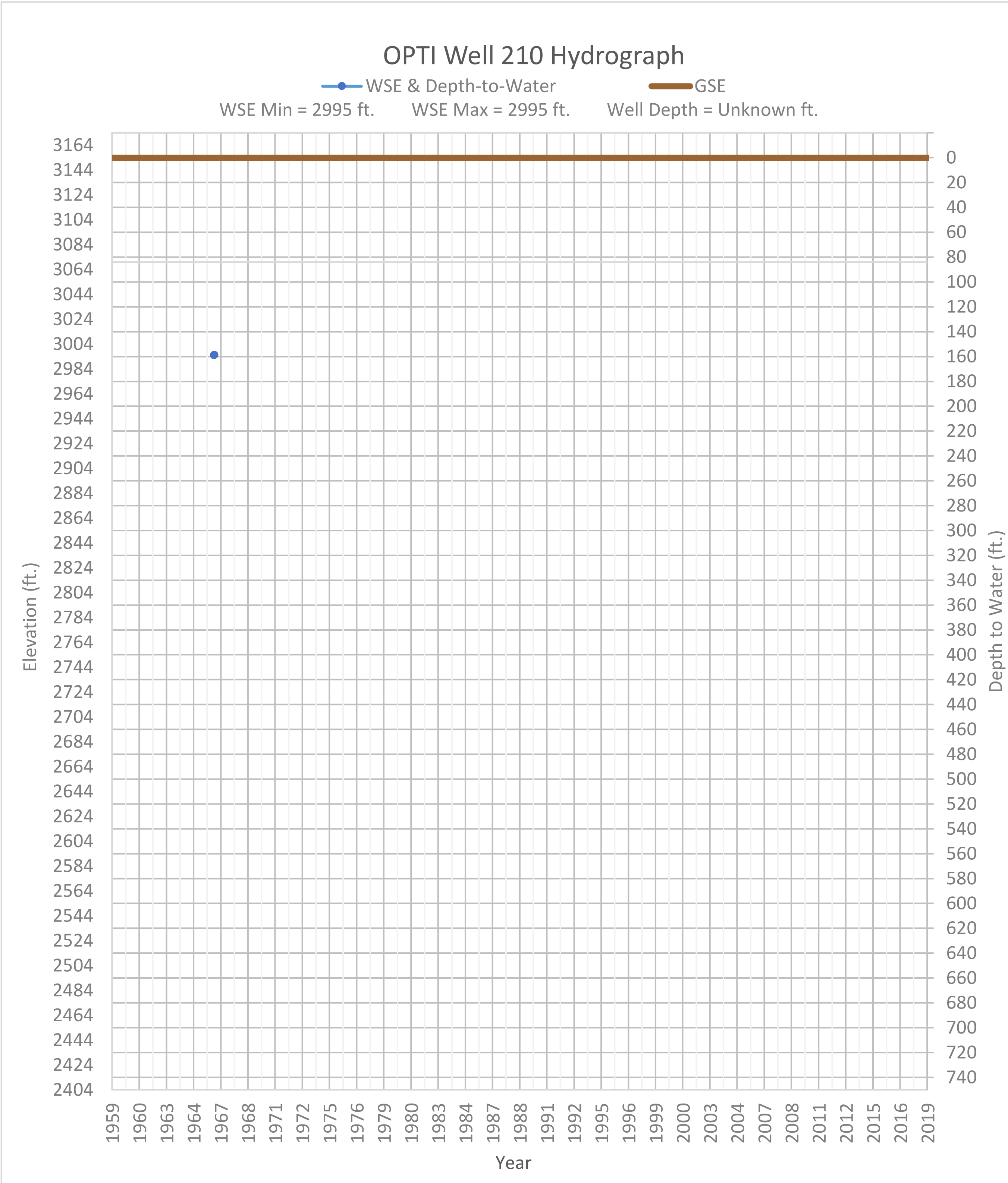

OPTI Well 206 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2843 ft.
WSE Max = 2843 ft.
Well Depth = 402 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 208 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2912 ft.
WSE Max = 2913 ft.
Well Depth = 172 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 209 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2902 ft.
WSE Max = 2937 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 210 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2995 ft.
WSE Max = 2995 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3164
3144
3124
3104
3084
3064
3044
3024
3004
2984
2964
2944
2924
2904
2884
2864
2844
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2804
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2584
2564
2544
2524
2504
2484
2464
2444
2424
2404
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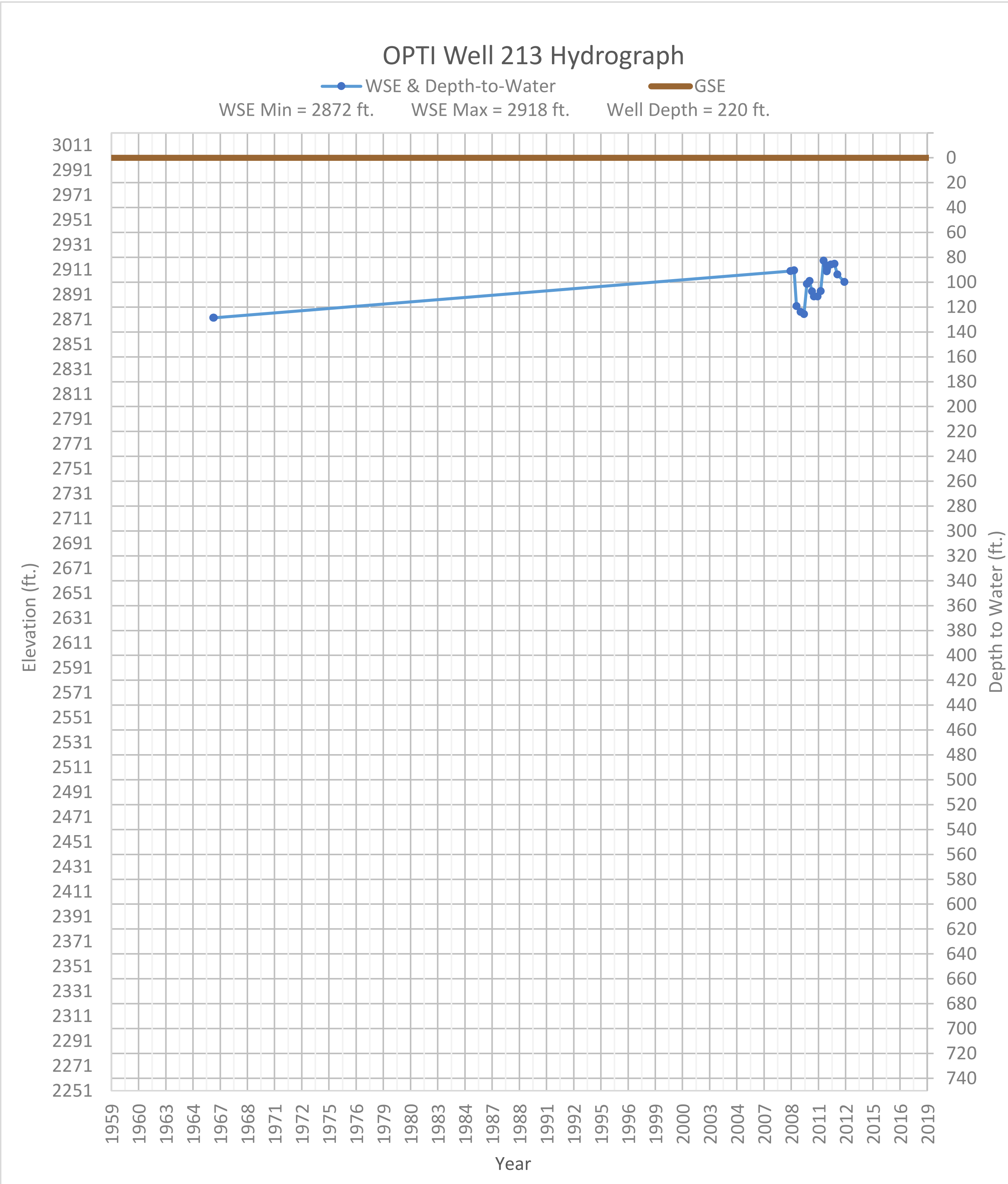
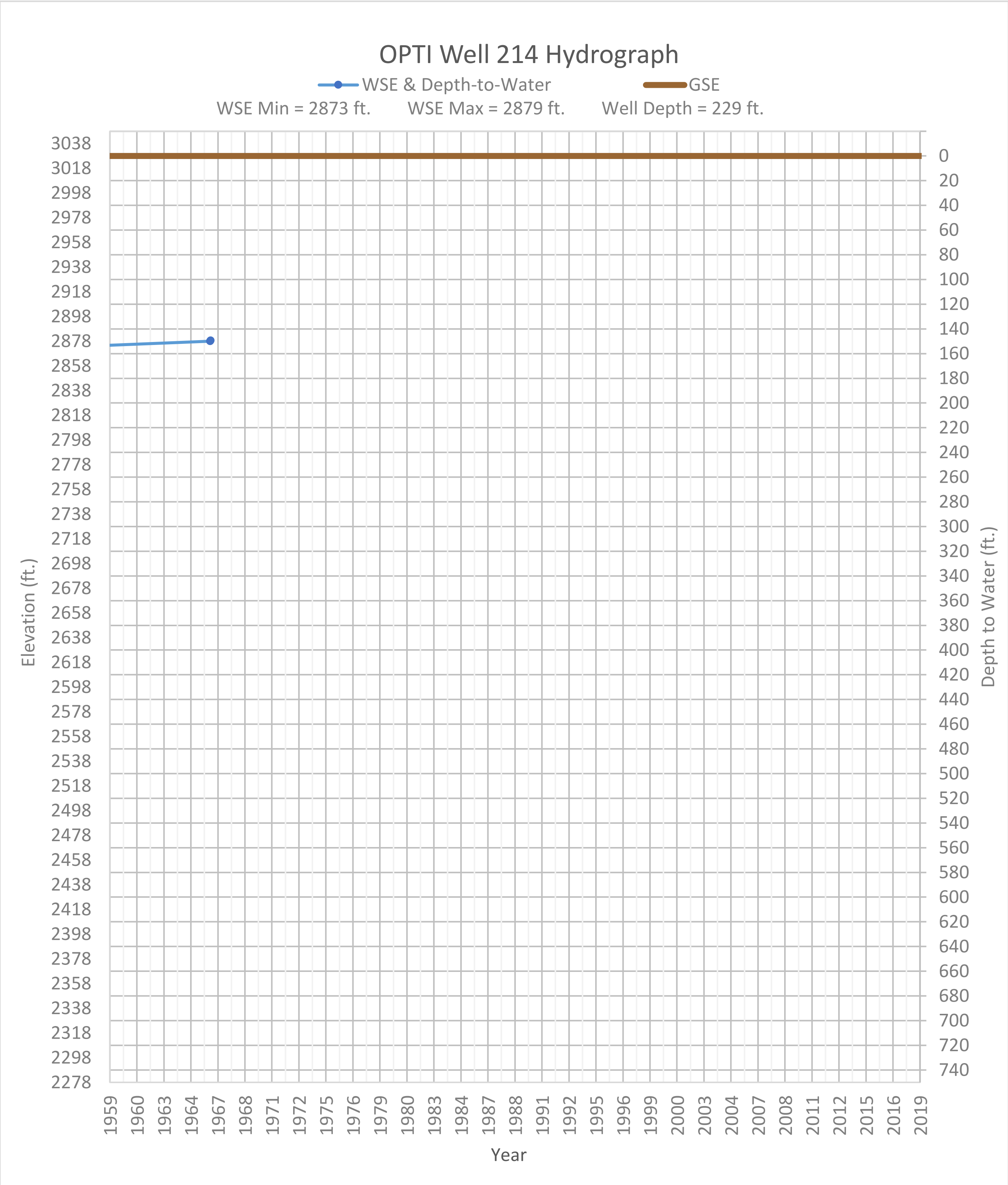
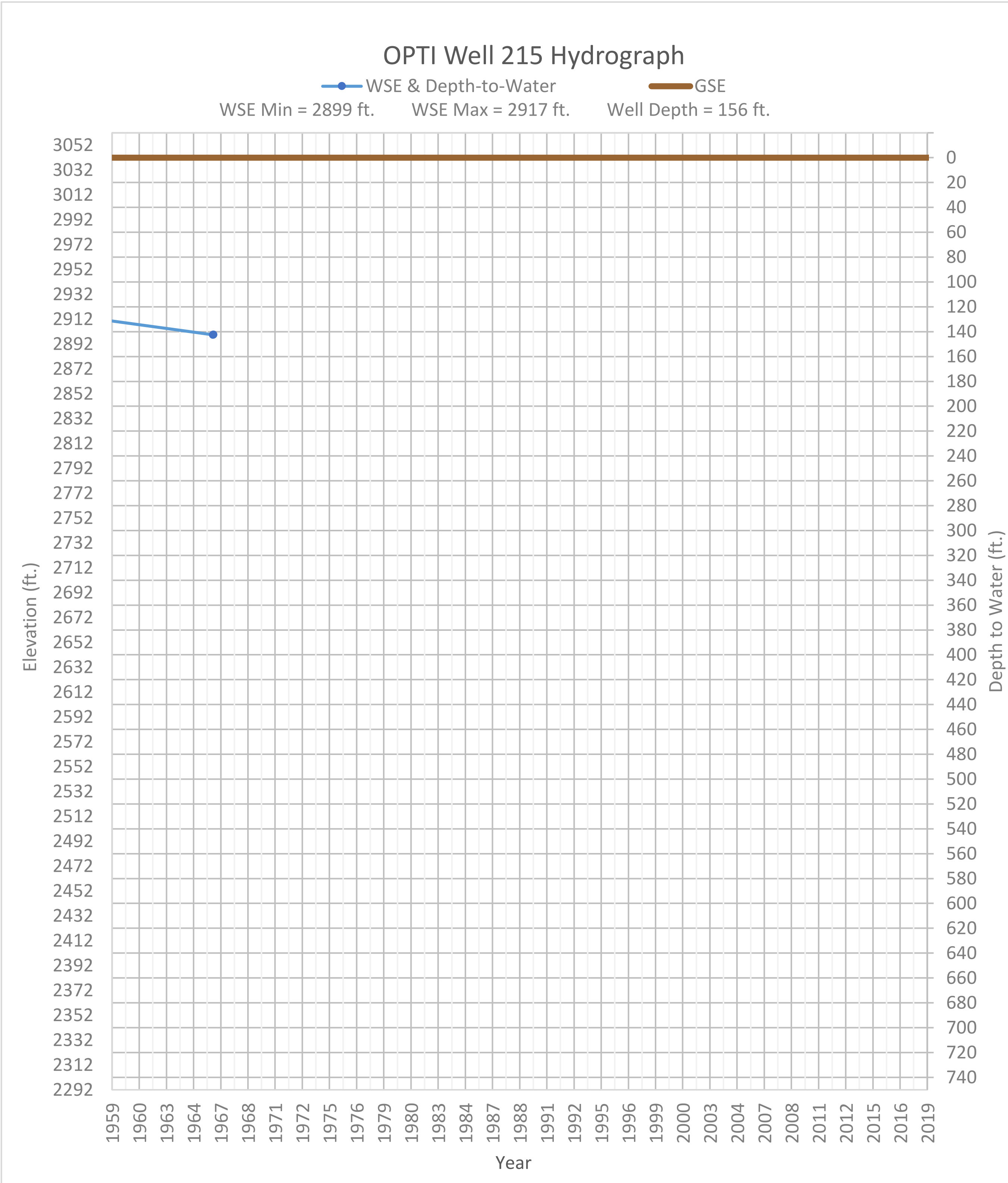


OPTI Well 213 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2872 ft.
WSE Max = 2918 ft.
Well Depth = 220 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 214 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2873 ft.
WSE Max = 2879 ft.
Well Depth = 229 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 215 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2899 ft.
WSE Max = 2917 ft.
Well Depth = 156 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3052
3032
3012
2992
2972
2952
2932
2912
2892
2872
2852
2832
2812
2792
2772
2752
2732
2712
2692
2672
2652
2632
2612
2592
2572
2552
2532
2512
2492
2472
2452
2432
2412
2392
2372
2352
2332
2312
2292
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
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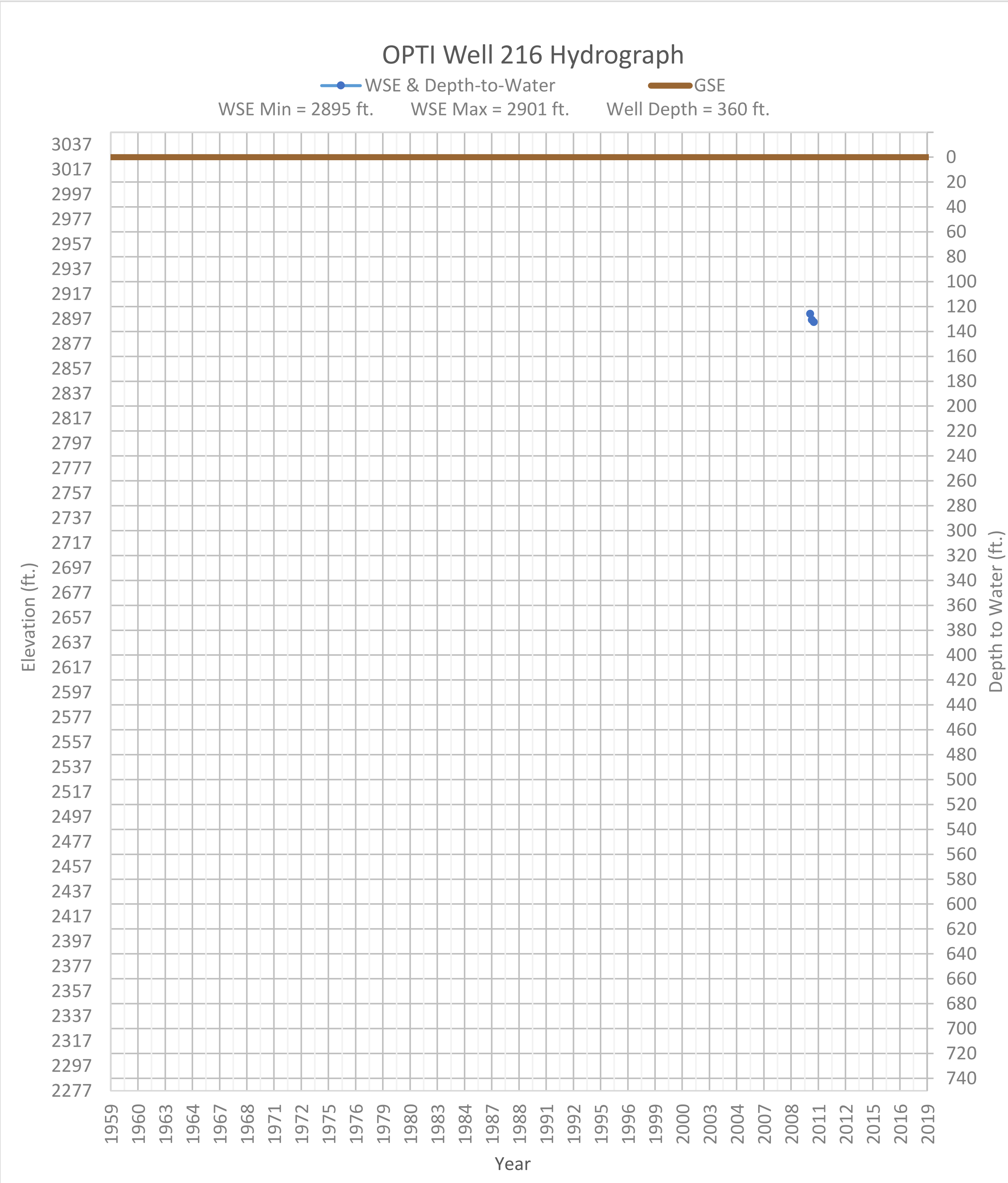
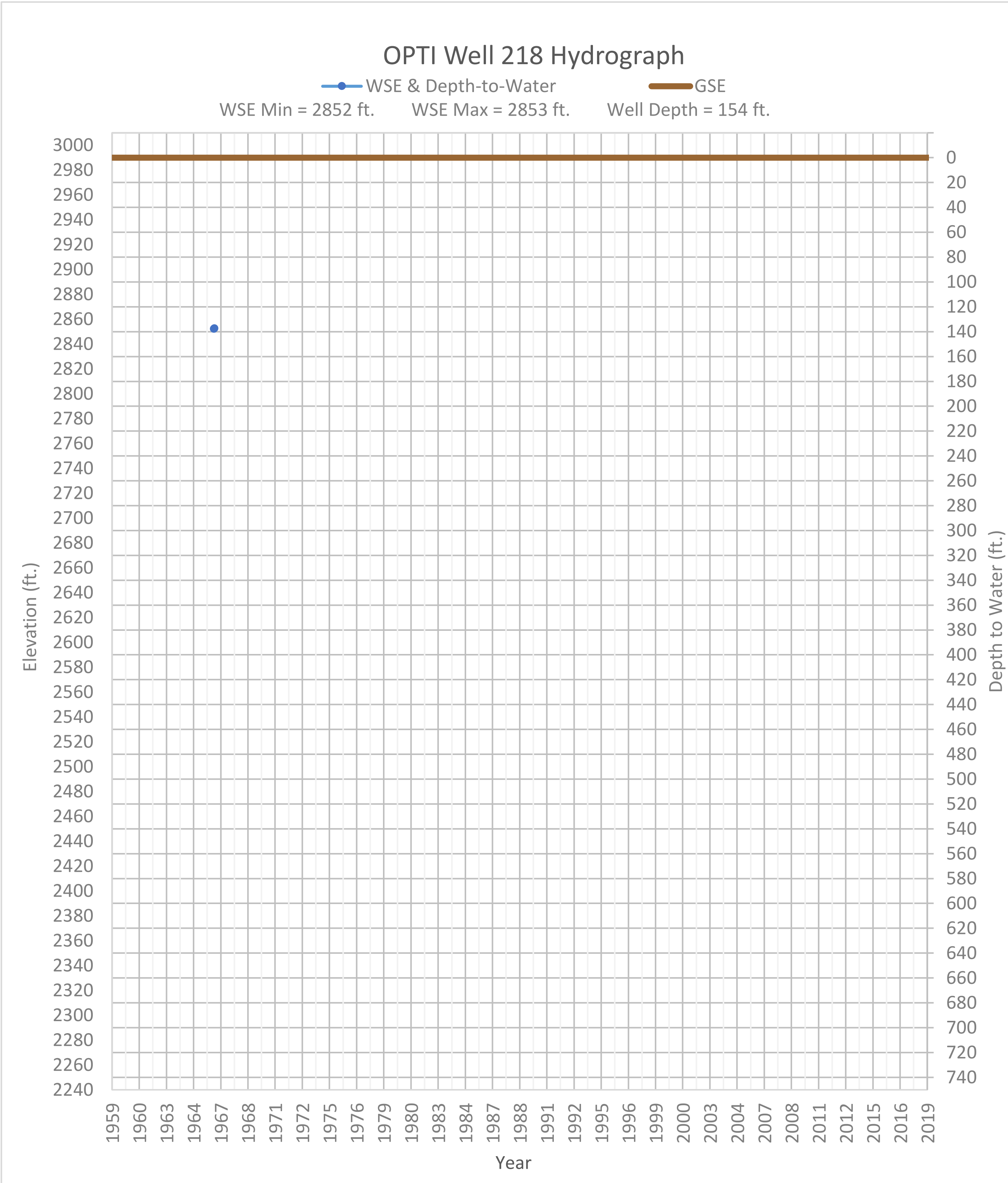
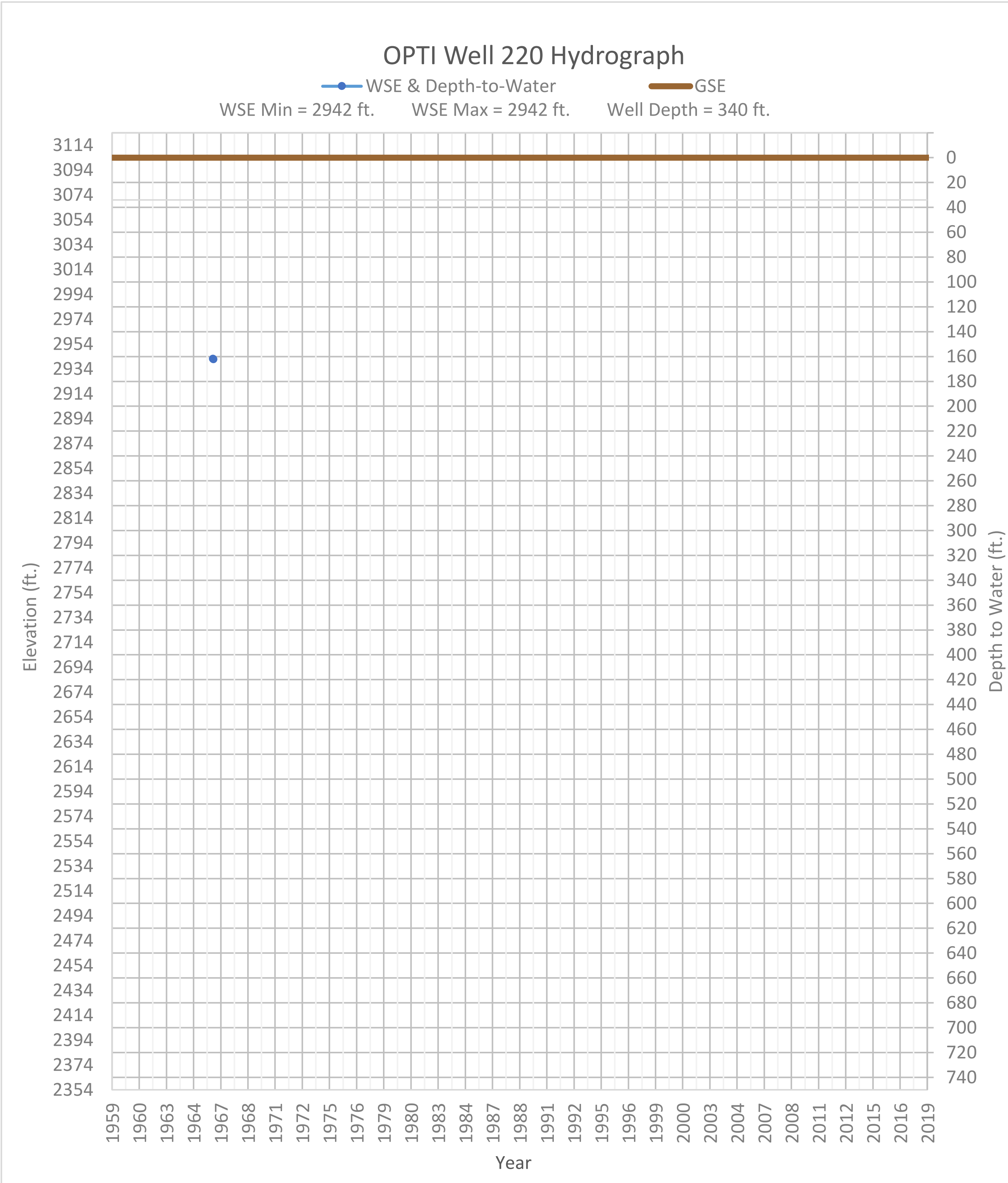
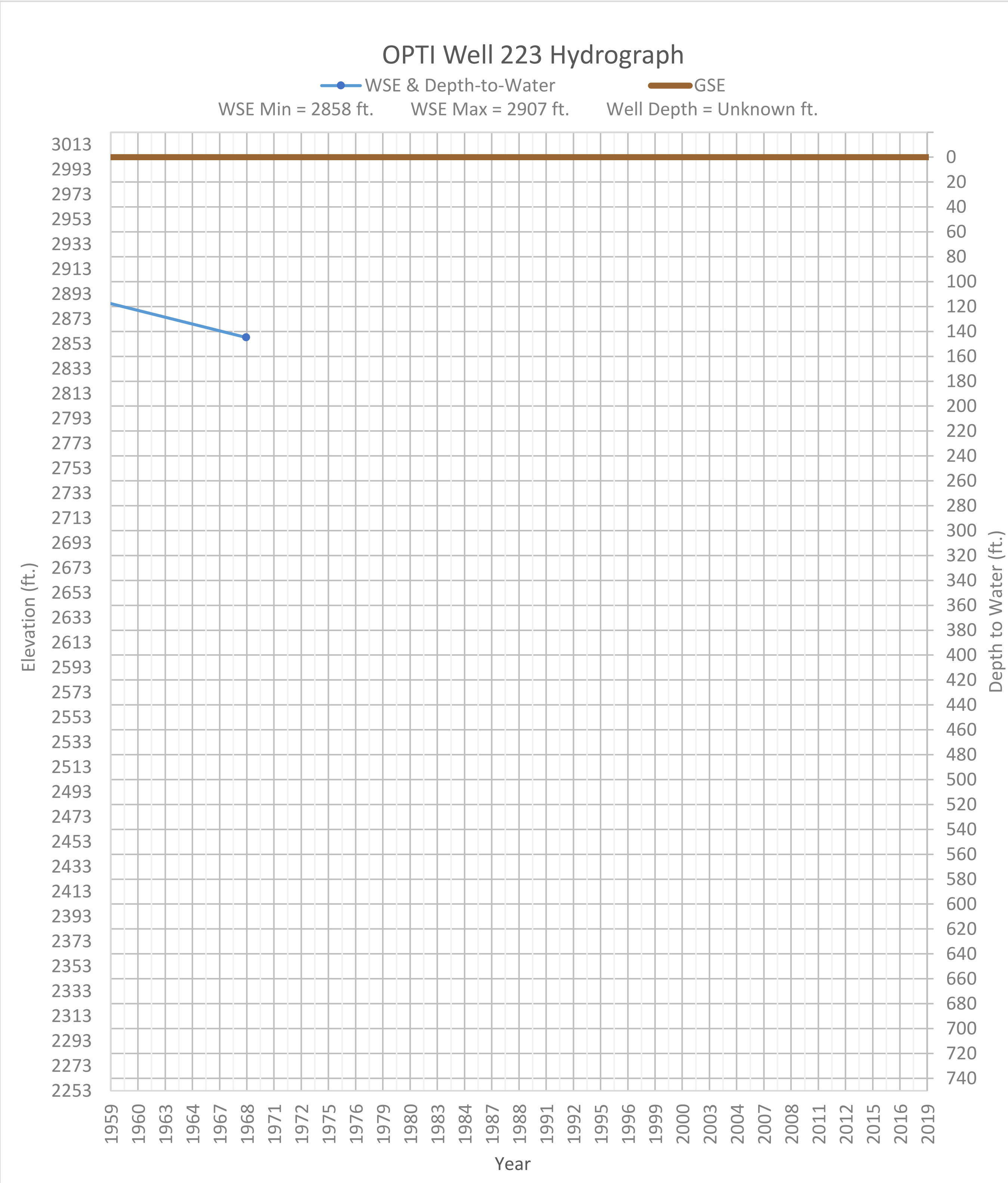

OPTI Well 216 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2895 ft.
WSE Max = 2901 ft.
Well Depth = 360 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

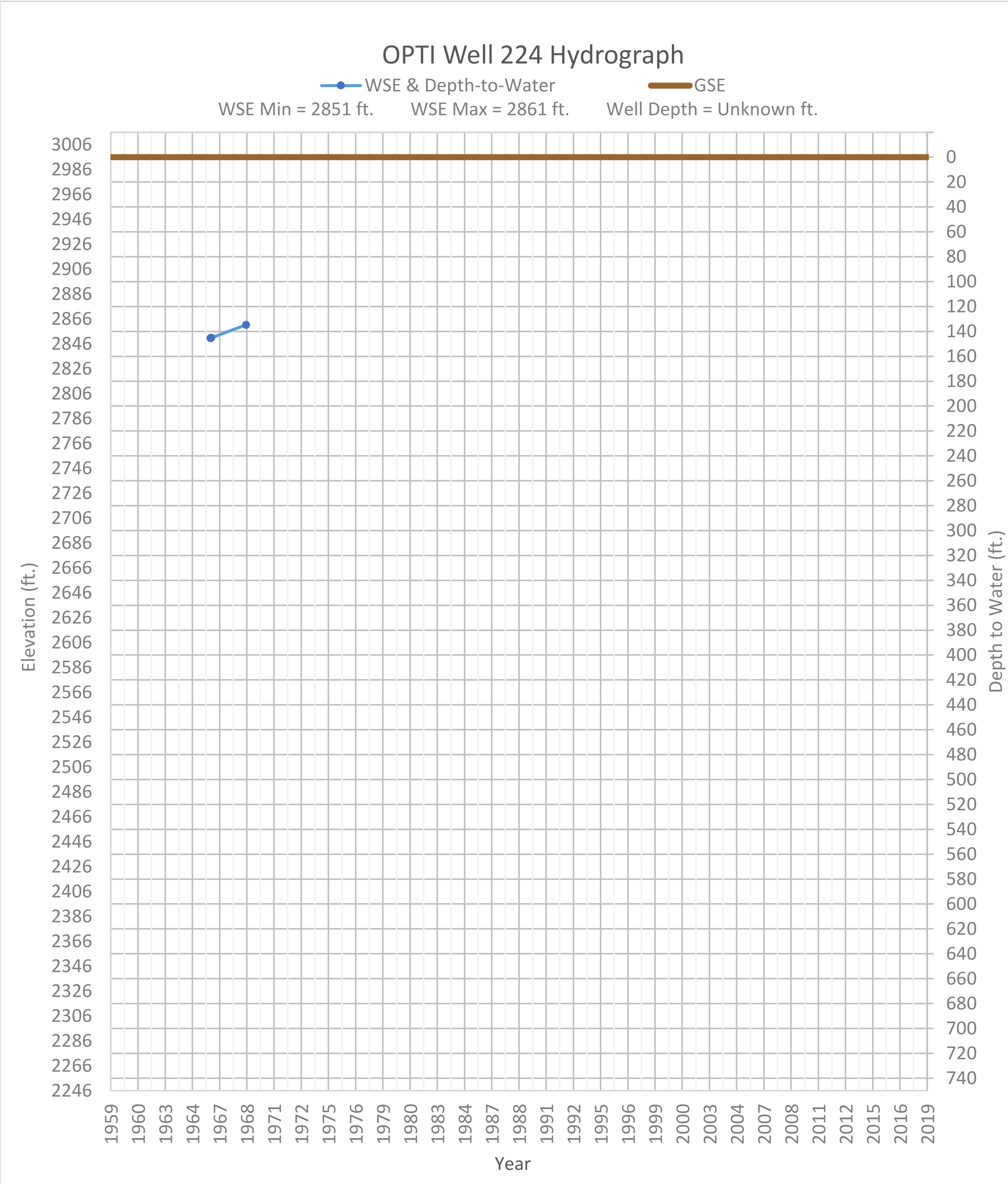


OPTI Well 218 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2852 ft.
WSE Max = 2853 ft.
Well Depth = 154 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 220 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2942 ft.
WSE Max = 2942 ft.
Well Depth = 340 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 223 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2858 ft.
WSE Max = 2907 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 224 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2851 ft.
WSE Max = 2861 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
3006
2986
2966
2946
2926
2906
2886
2866
2846
2826
2806
2786
2766
2746
2726
2706
2686
2666
2646
2626
2606
2586
2566
2546
2526
2506
2486
2466
2446
2426
2406
2386
2366
2346
2326
2306
2286
2266
2246
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
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640
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680
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1959
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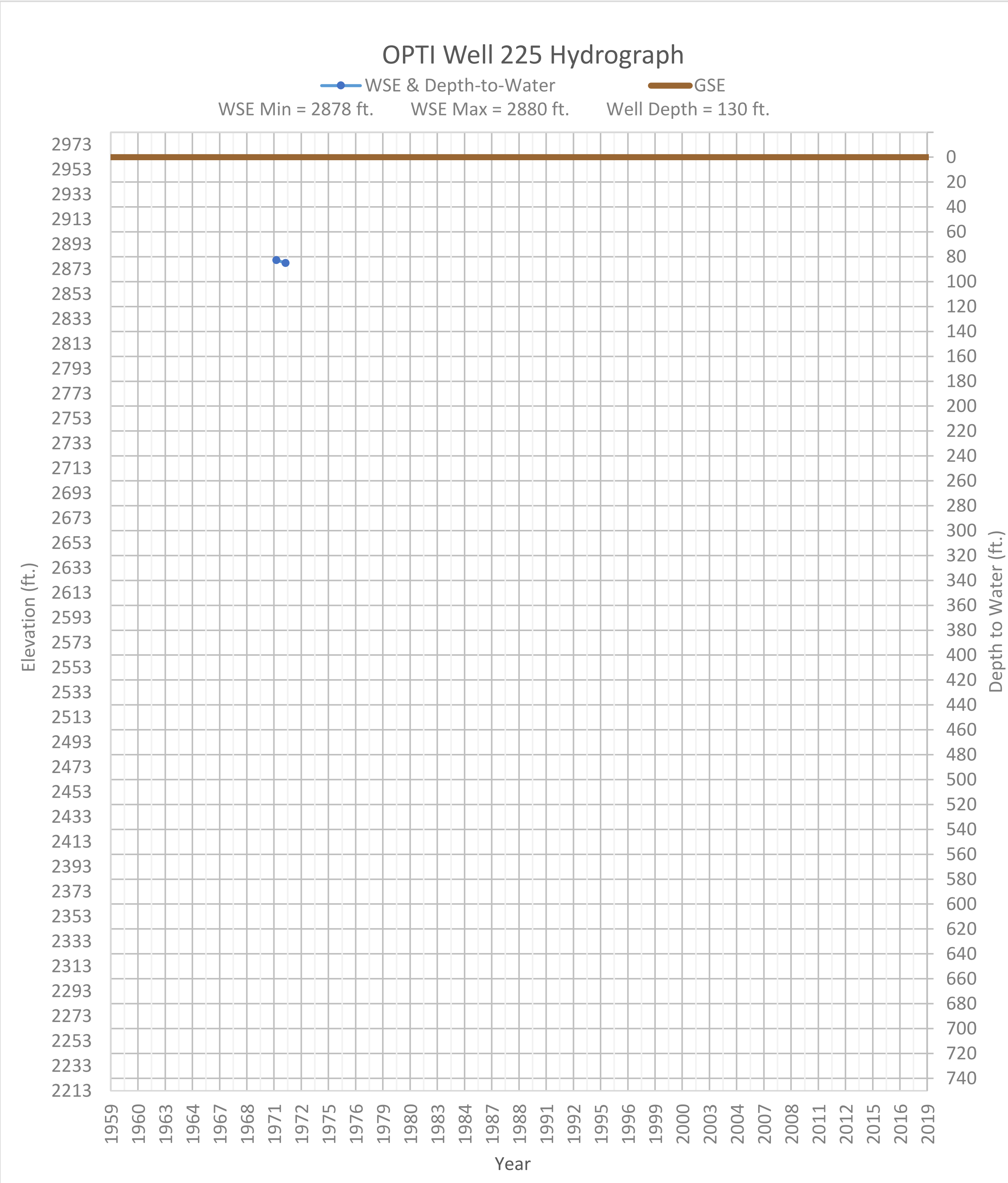
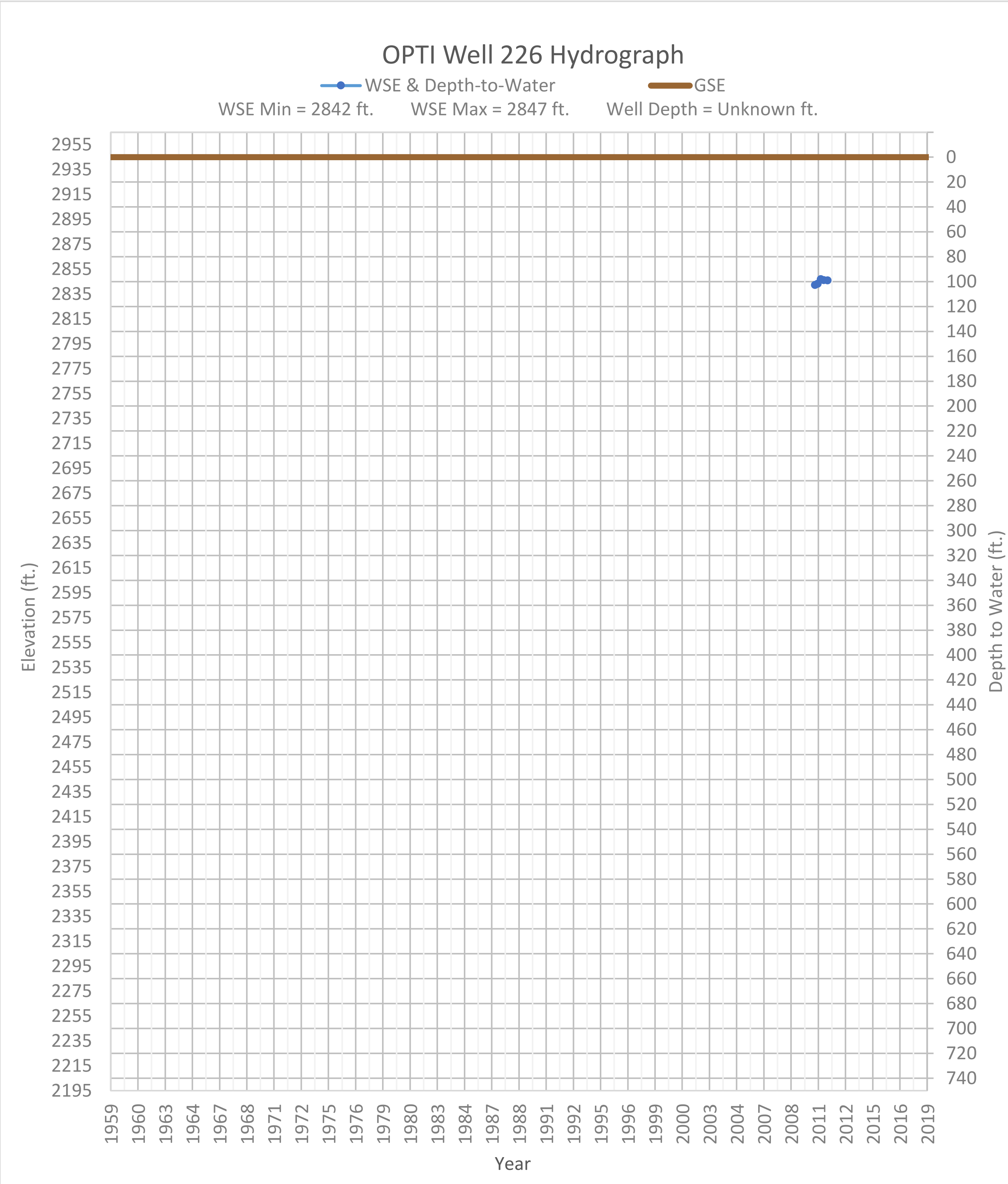


OPTI Well 225 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2878 ft.
WSE Max = 2880 ft.
Well Depth = 130 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 226 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2842 ft.
WSE Max = 2847 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2955
2935
2915
2895
2875
2855
2835
2815
2795
2775
2755
2735
2715
2695
2675
2655
2635
2615
2595
2575
2555
2535
2515
2495
2475
2455
2435
2415
2395
2375
2355
2335
2315
2295
2275
2255
2235
2215
2195
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720
740
1959
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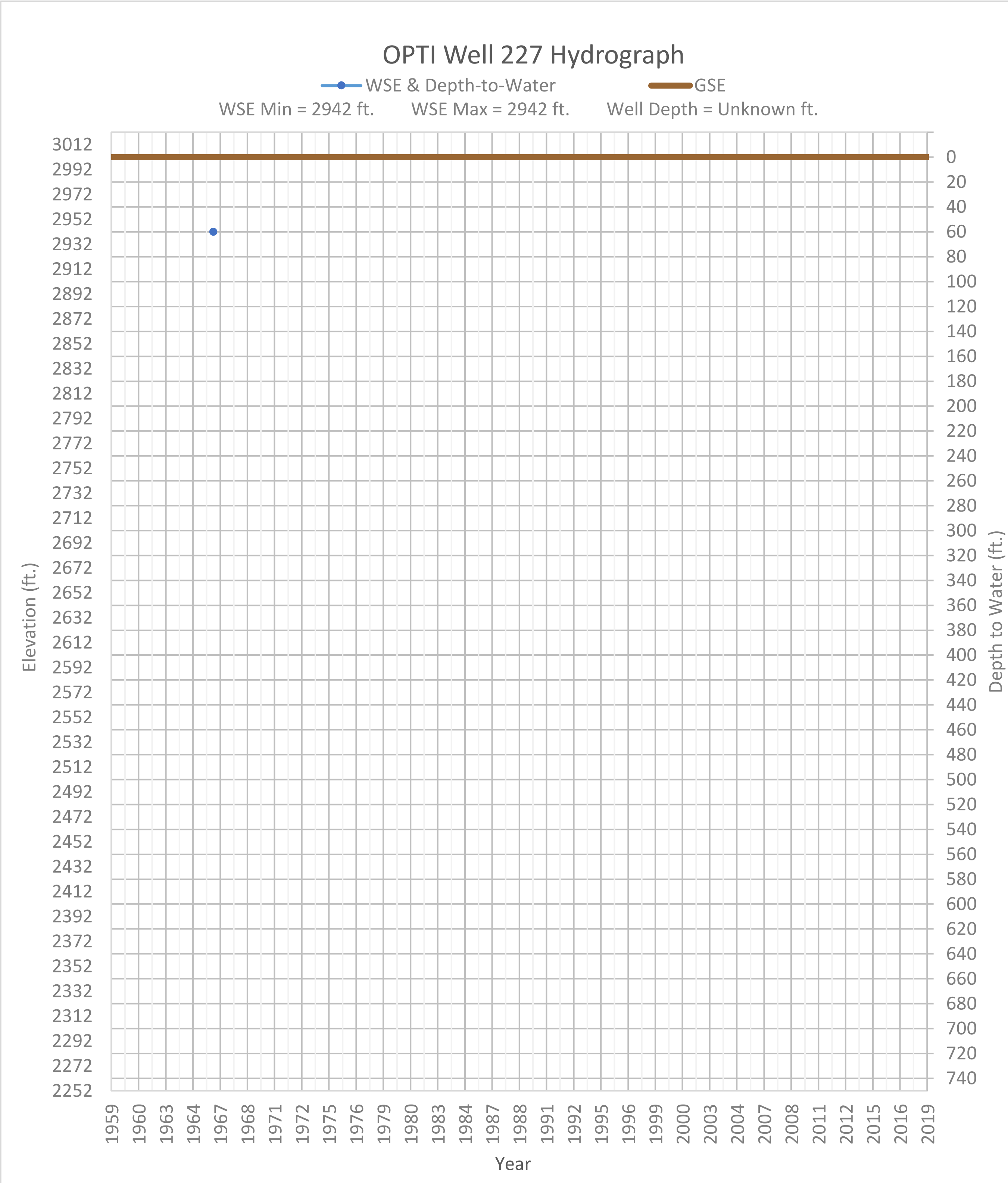
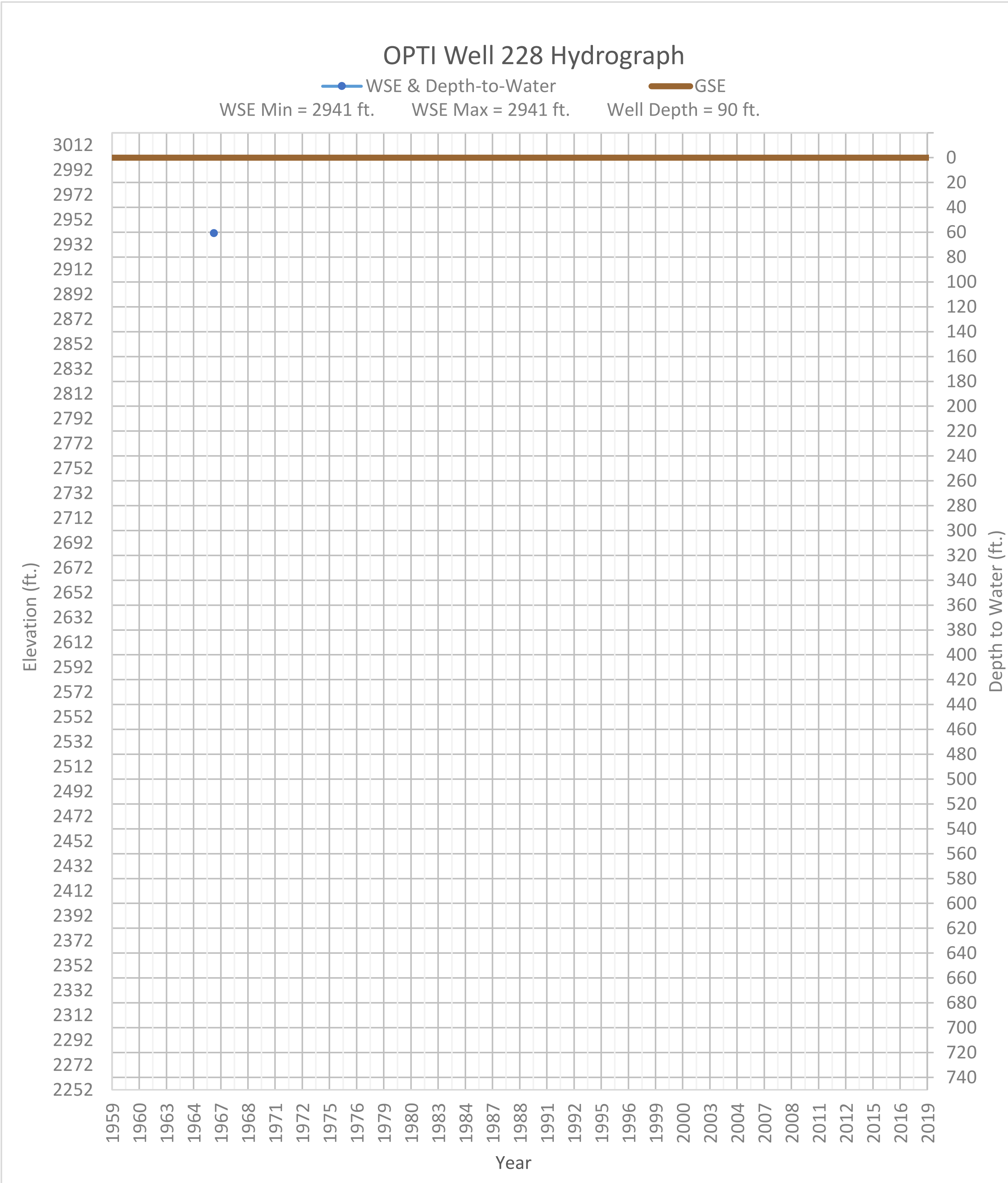
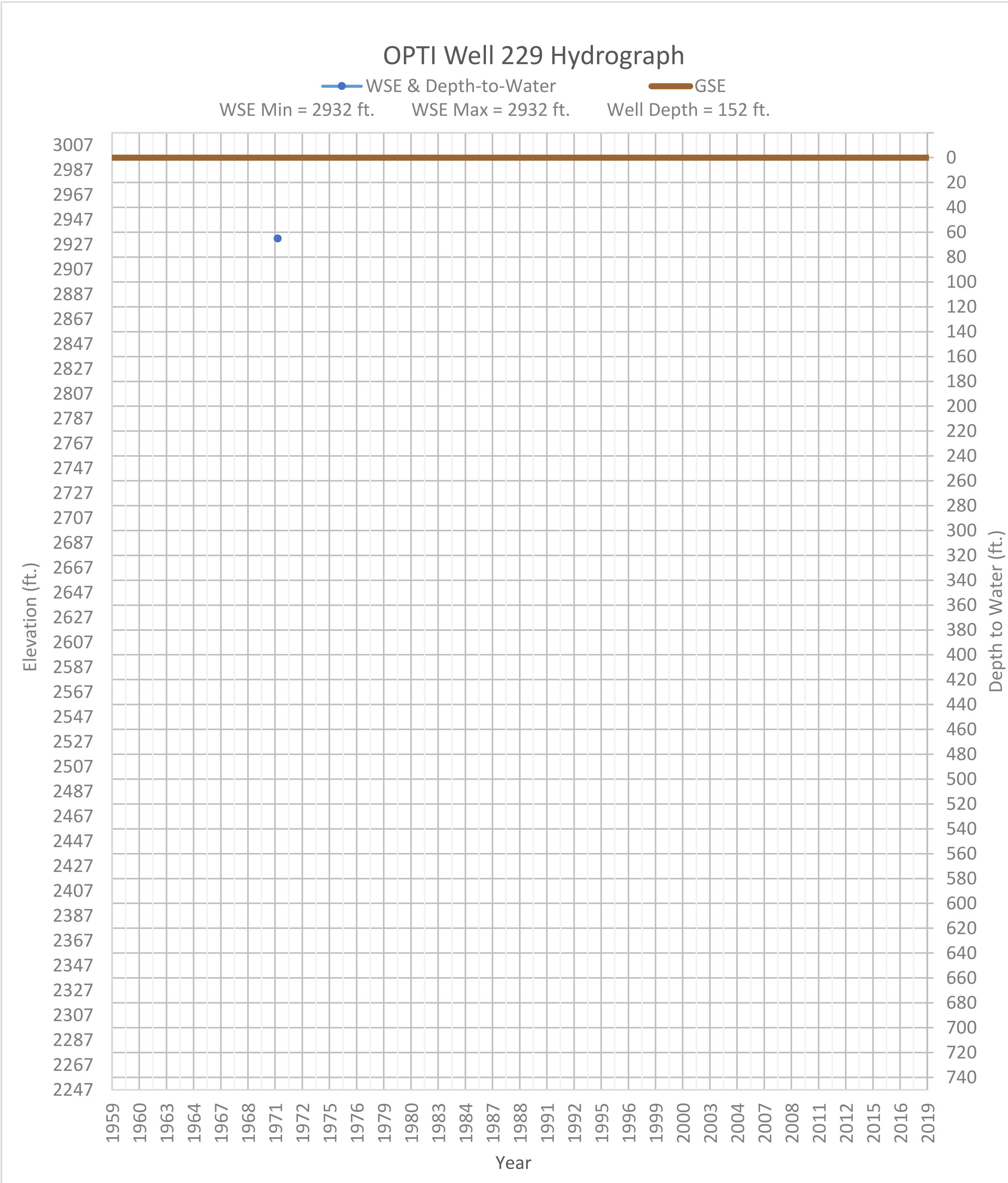
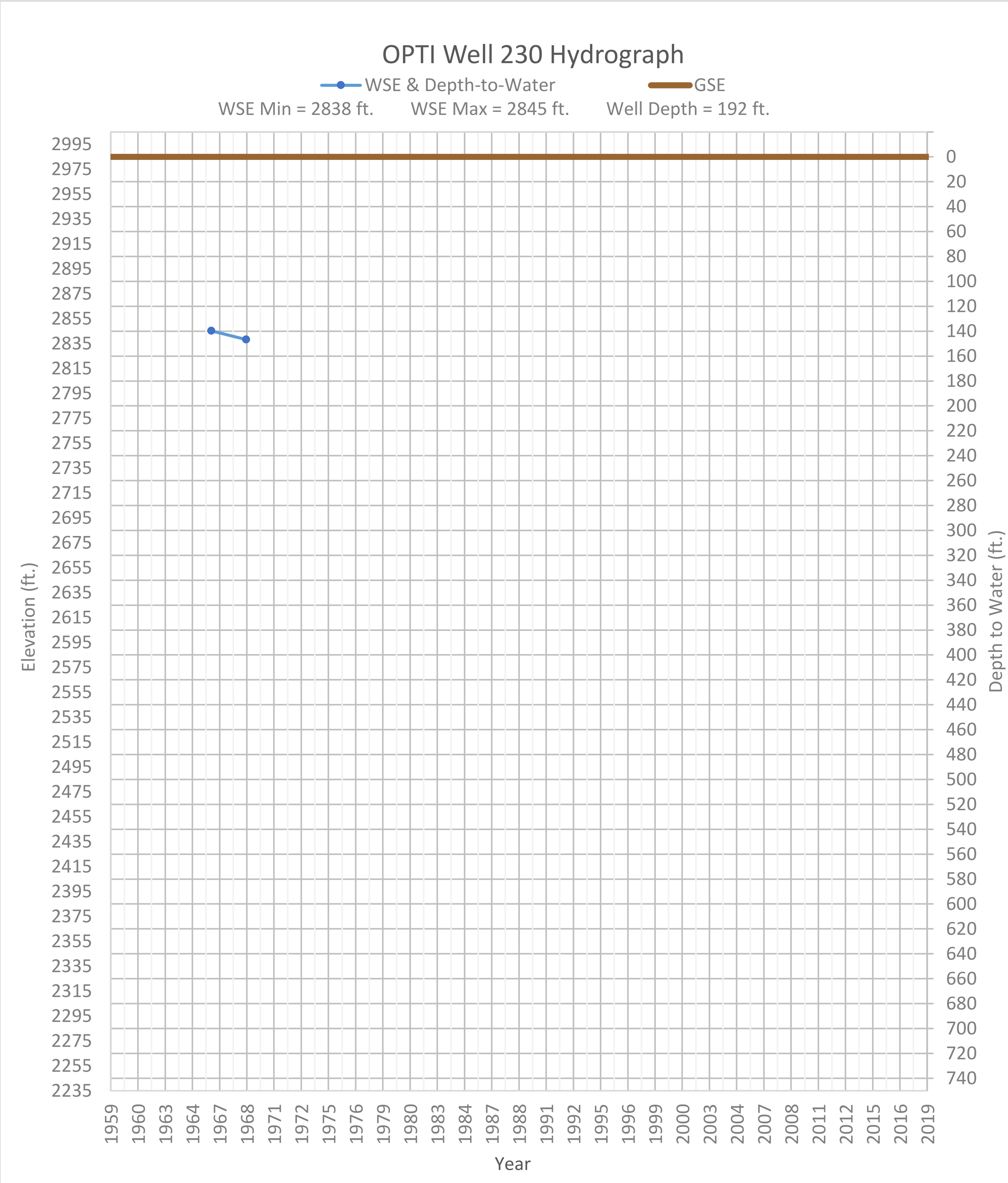
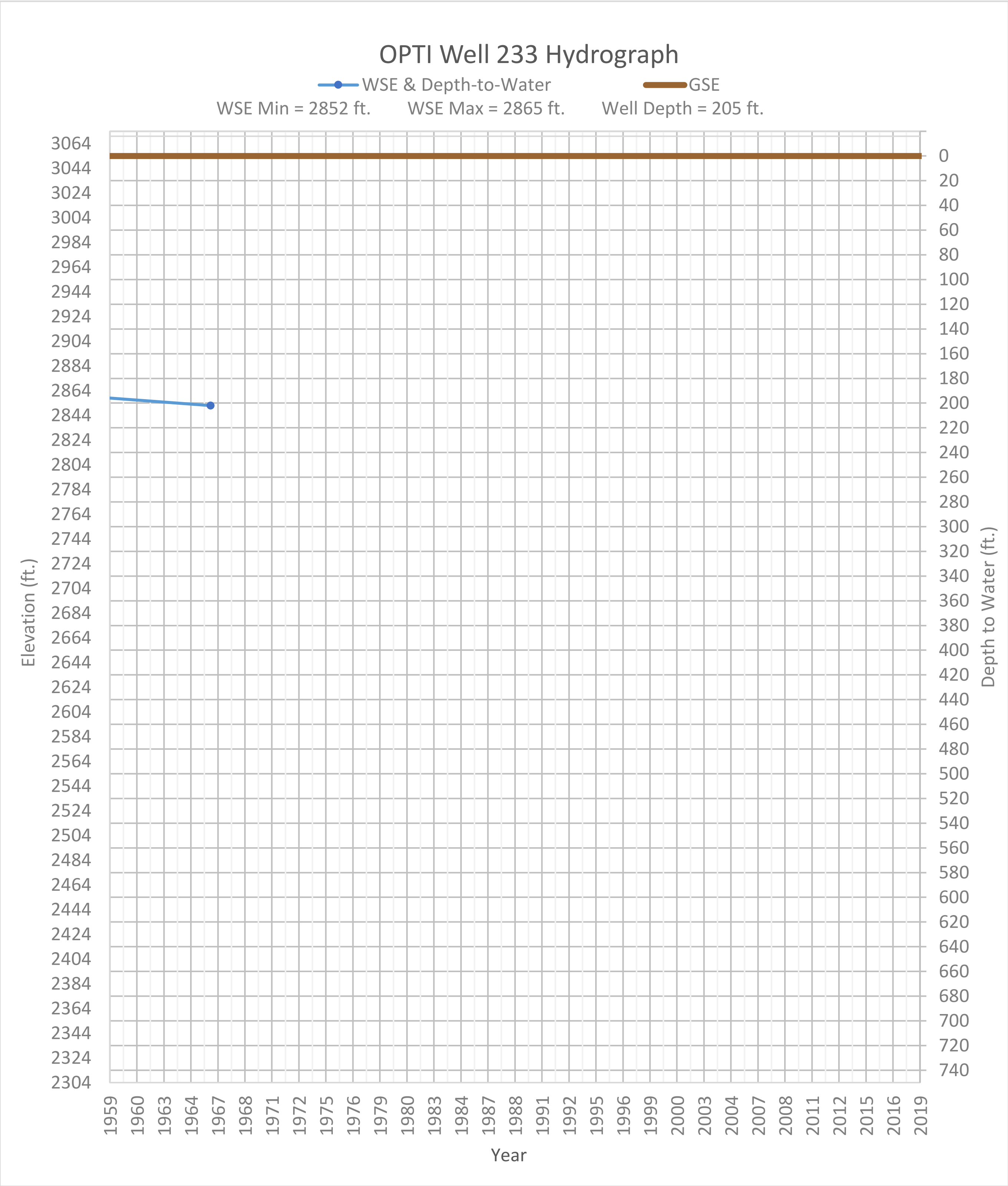
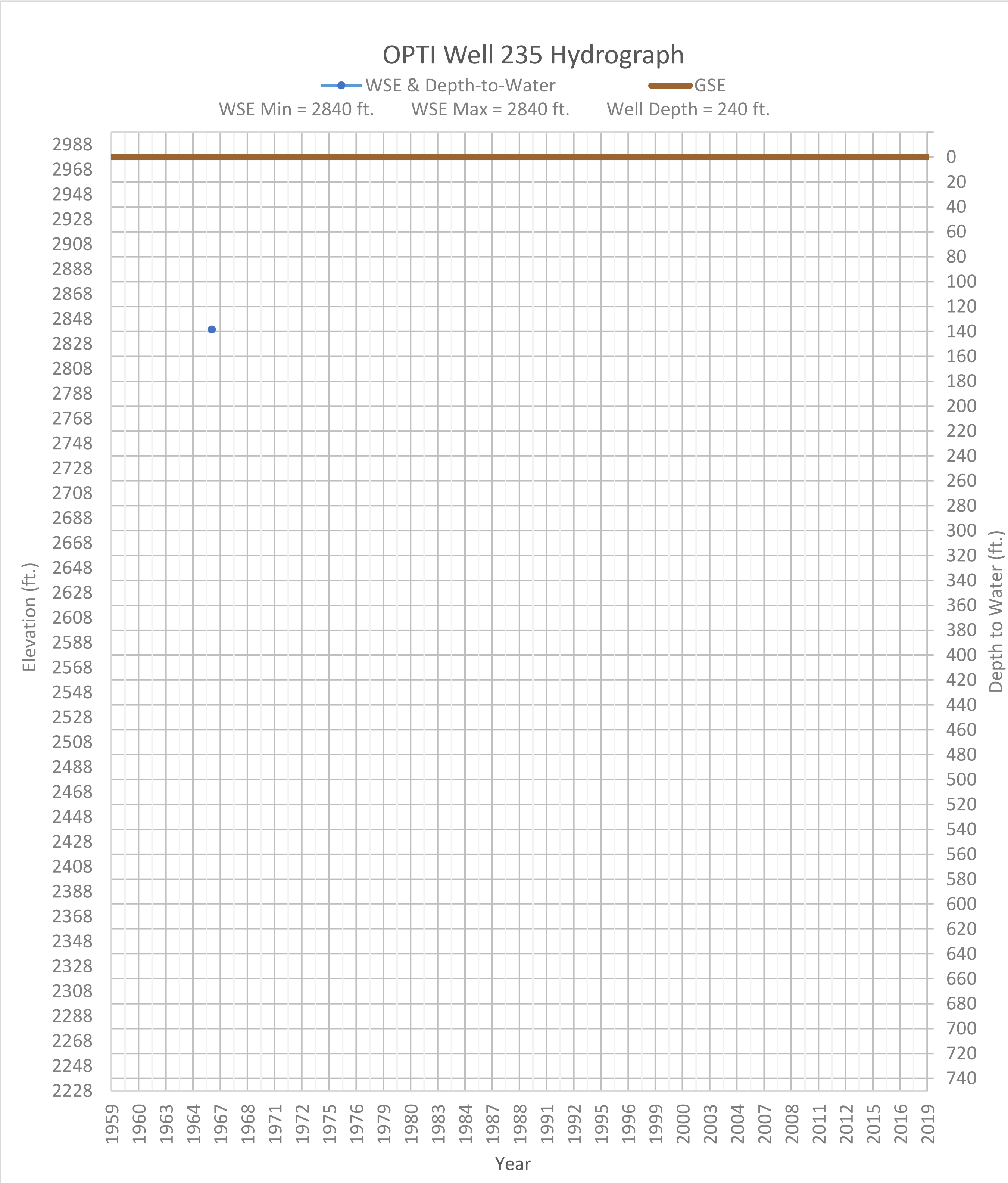

OPTI Well 227 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2942 ft.
WSE Max = 2942 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 228 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2941 ft.
WSE Max = 2941 ft.
Well Depth = 90 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

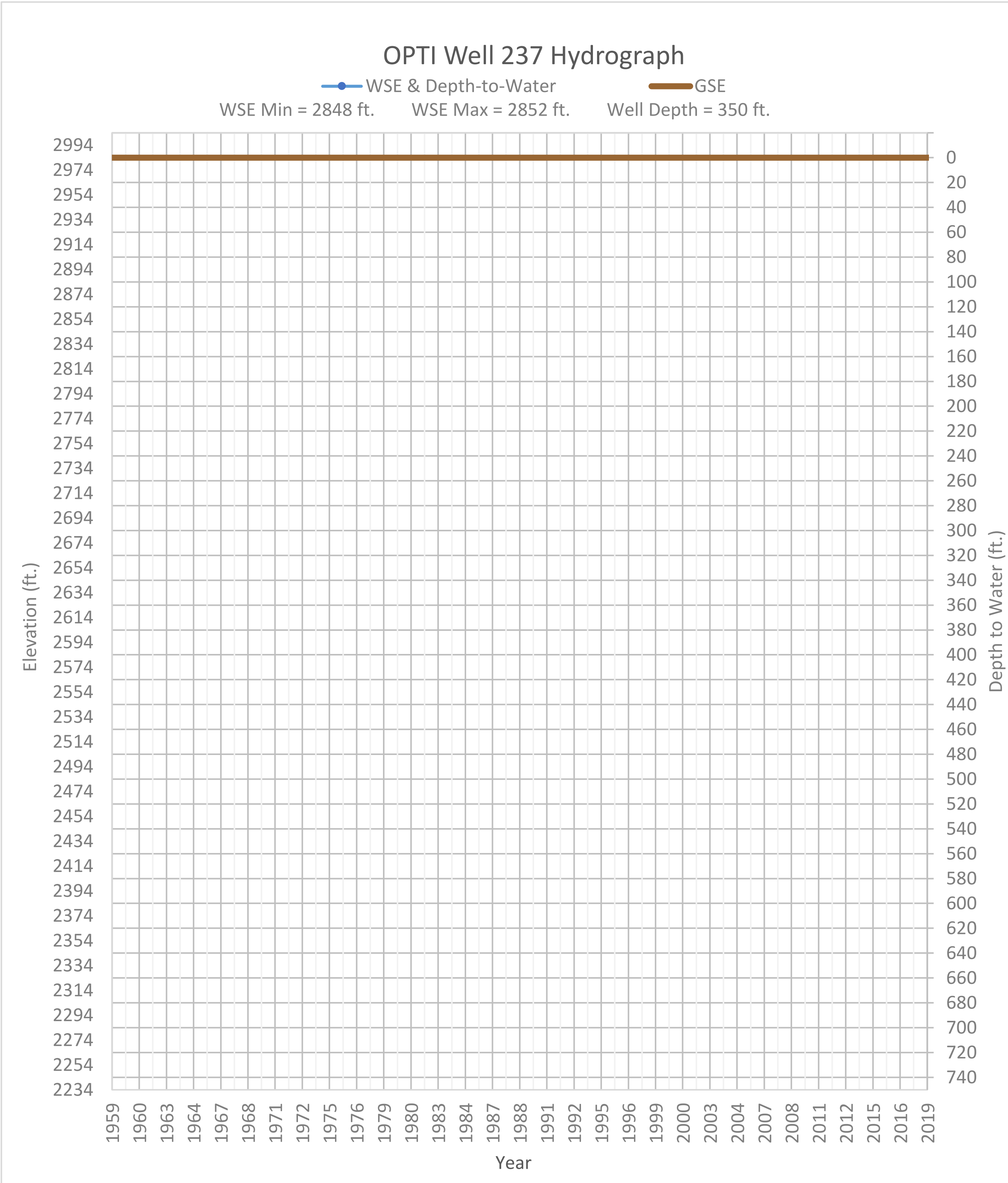

OPTI Well 229 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2932 ft.
WSE Max = 2932 ft.
Well Depth = 152 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 230 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2838 ft.
WSE Max = 2845 ft.
Well Depth = 192 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 233 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2852 ft.
WSE Max = 2865 ft.
Well Depth = 205 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 235 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2840 ft.
WSE Max = 2840 ft.
Well Depth = 240 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 237 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2848 ft.
WSE Max = 2852 ft.
Well Depth = 350 ft.
Elevation (ft.)
2994
2974
2954
2934
2914
2894
2874
2854
2834
2814
2794
2774
2754
2734
2714
2694
2674
2654
2634
2614
2594
2574
2554
2534
2514
2494
2474
2454
2434
2414
2394
2374
2354
2334
2314
2294
2274
2254
2234
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720
740
Year
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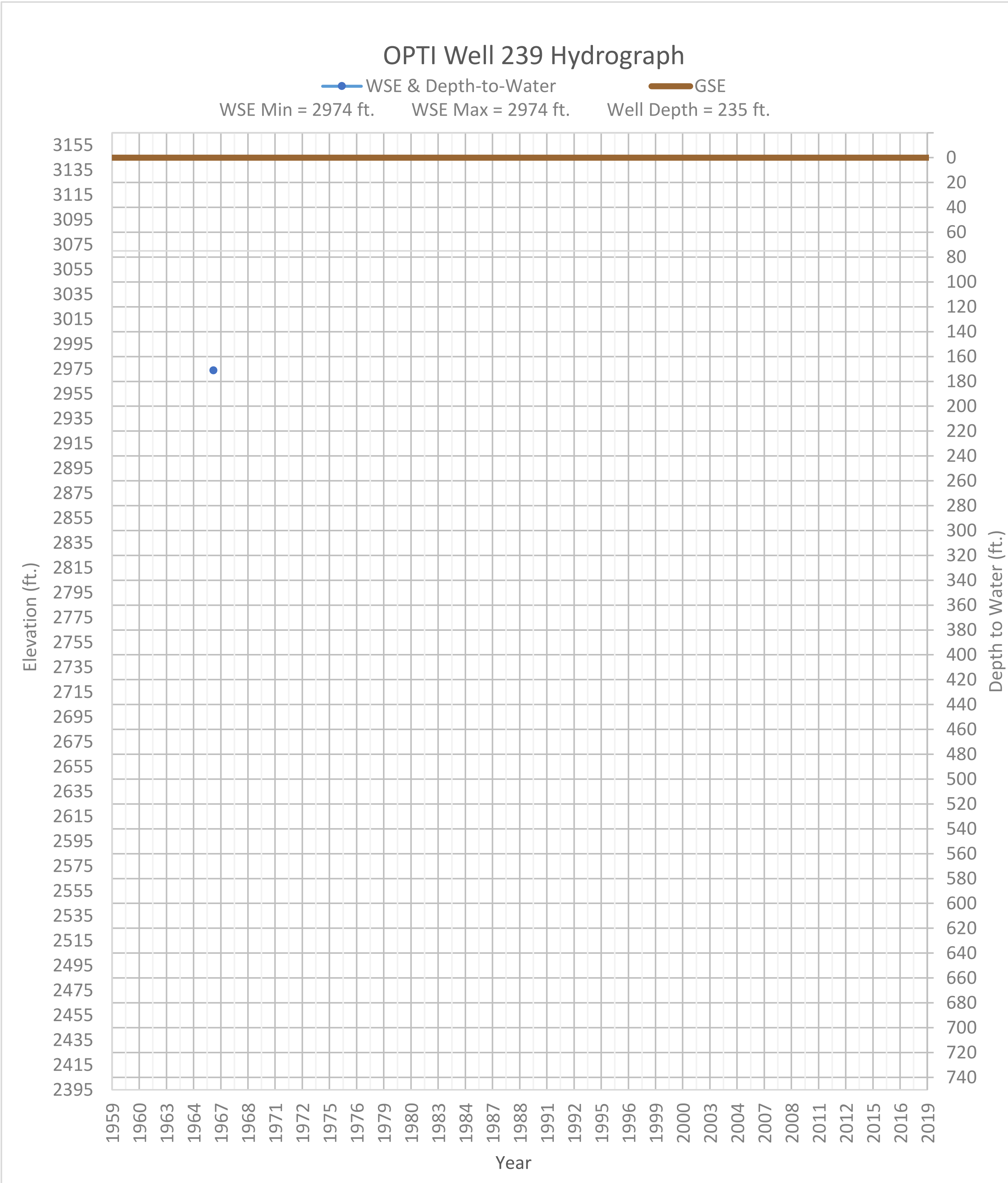
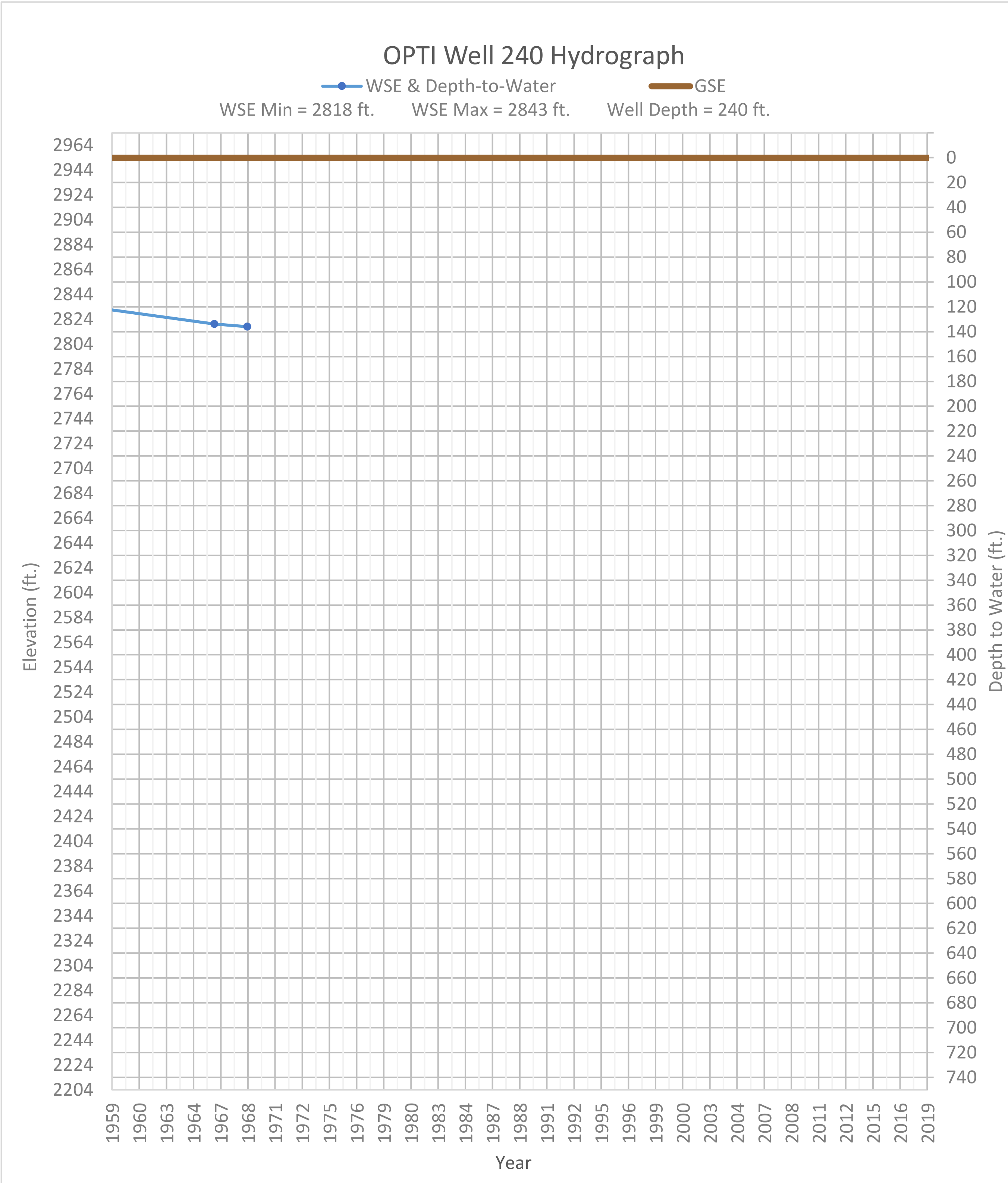
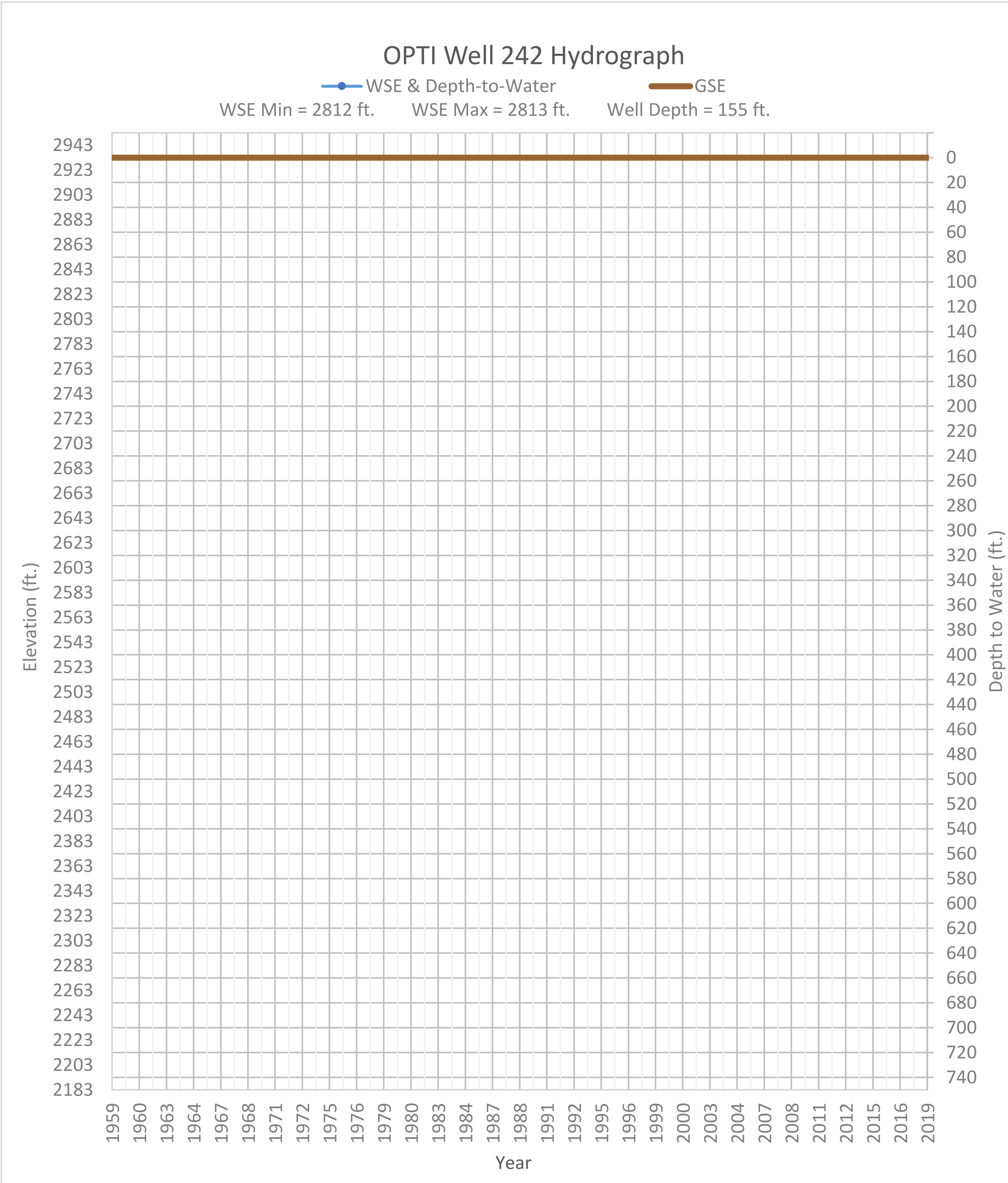


OPTI Well 239 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2974 ft.
WSE Max = 2974 ft.
Well Depth = 235 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 240 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2818 ft.
WSE Max = 2843 ft.
Well Depth = 240 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 242 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2812 ft.
WSE Max = 2813 ft.
Well Depth = 155 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2943
2923
2903
2883
2863
2843
2823
2803
2783
2763
2743
2723
2703
2683
2663
2643
2623
2603
2583
2563
2543
2523
2503
2483
2463
2443
2423
2403
2383
2363
2343
2323
2303
2283
2263
2243
2223
2203
2183
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
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460
480
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540
560
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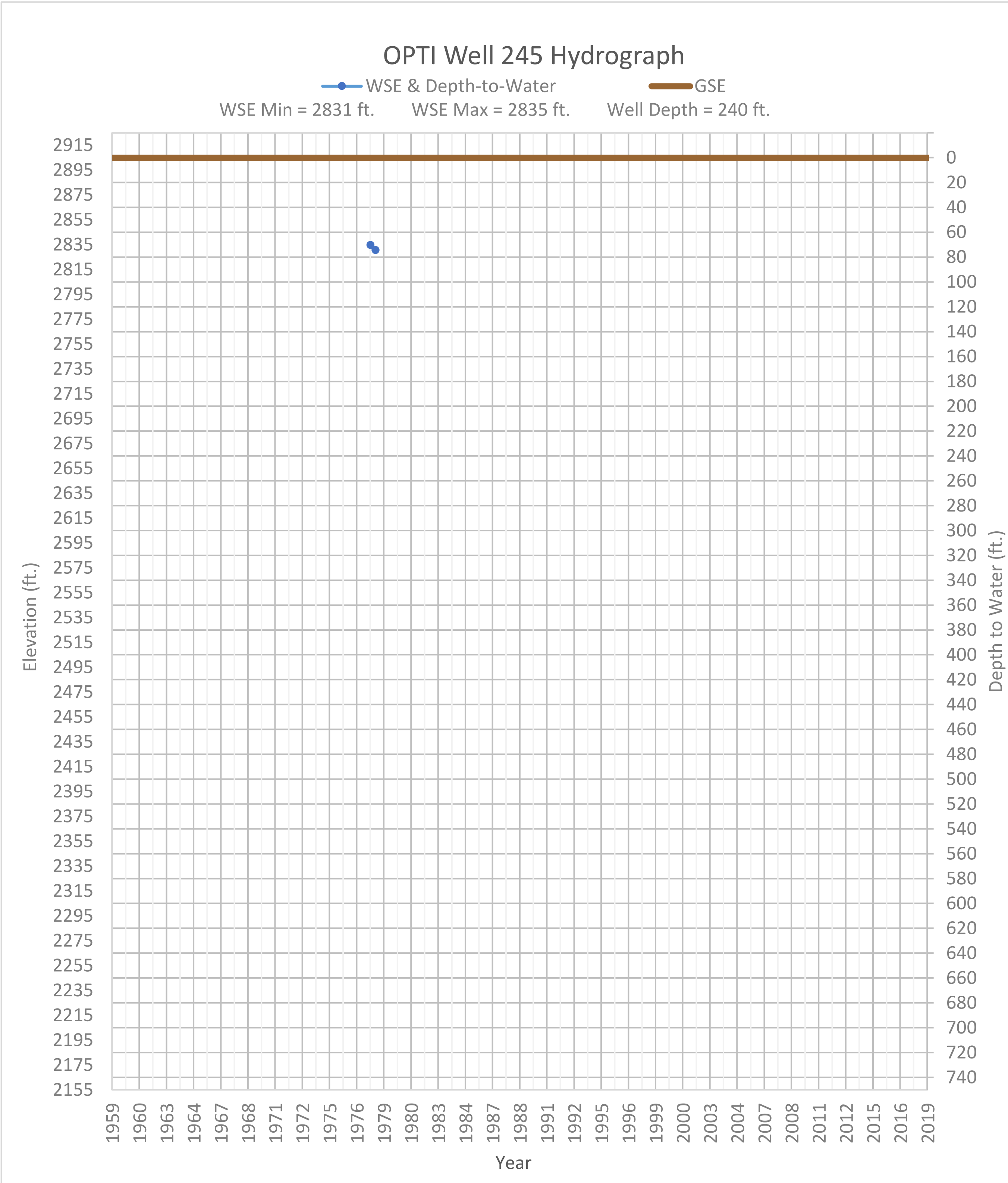
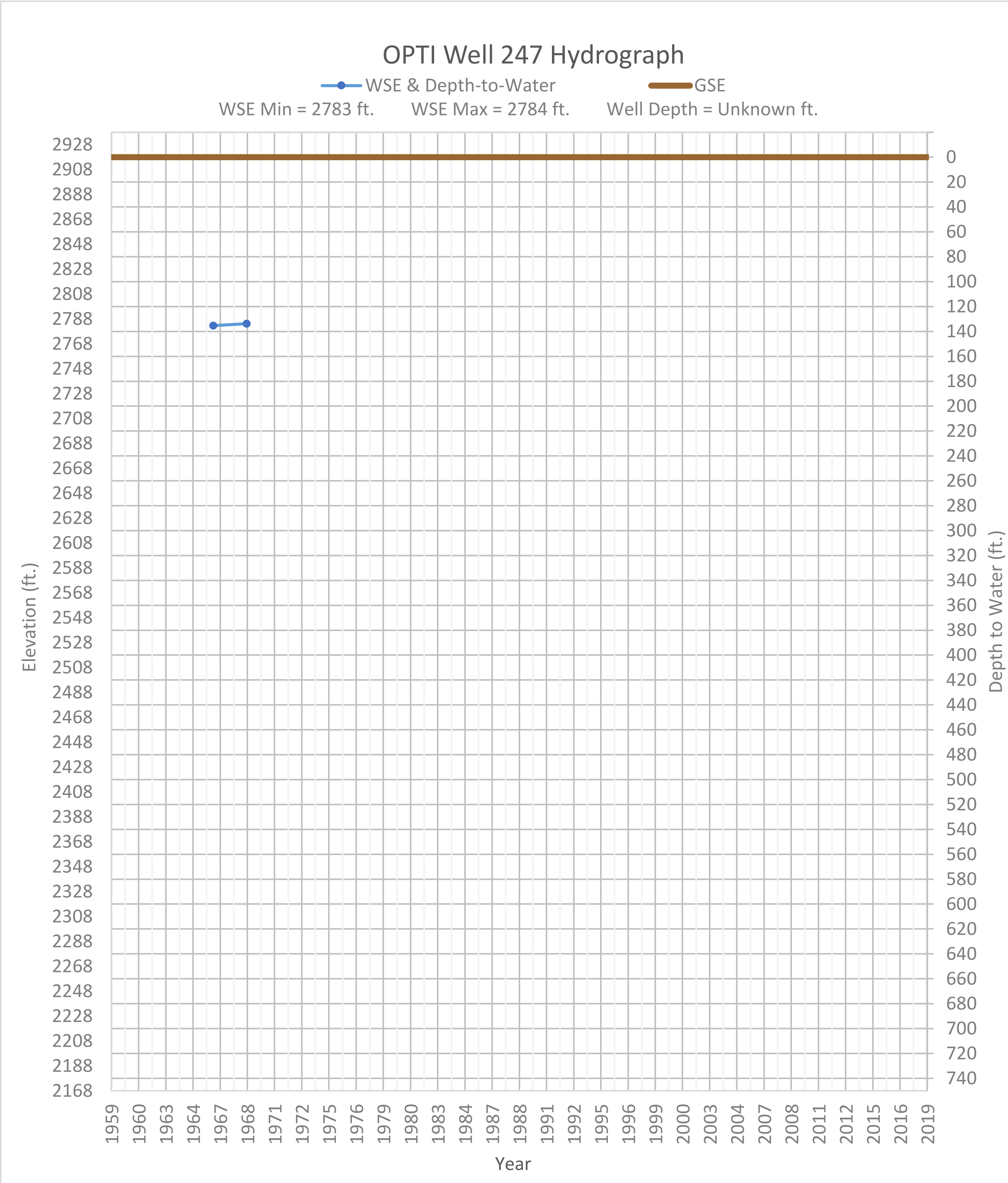


OPTI Well 245 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2831 ft.
WSE Max = 2835 ft.
Well Depth = 240 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 247 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2783 ft.
WSE Max = 2784 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2928
2908
2888
2868
2848
2828
2808
2788
2768
2748
2728
2708
2688
2668
2648
2628
2608
2588
2568
2548
2528
2508
2488
2468
2448
2428
2408
2388
2368
2348
2328
2308
2288
2268
2248
2228
2208
2188
2168
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
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420
440
460
480
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520
540
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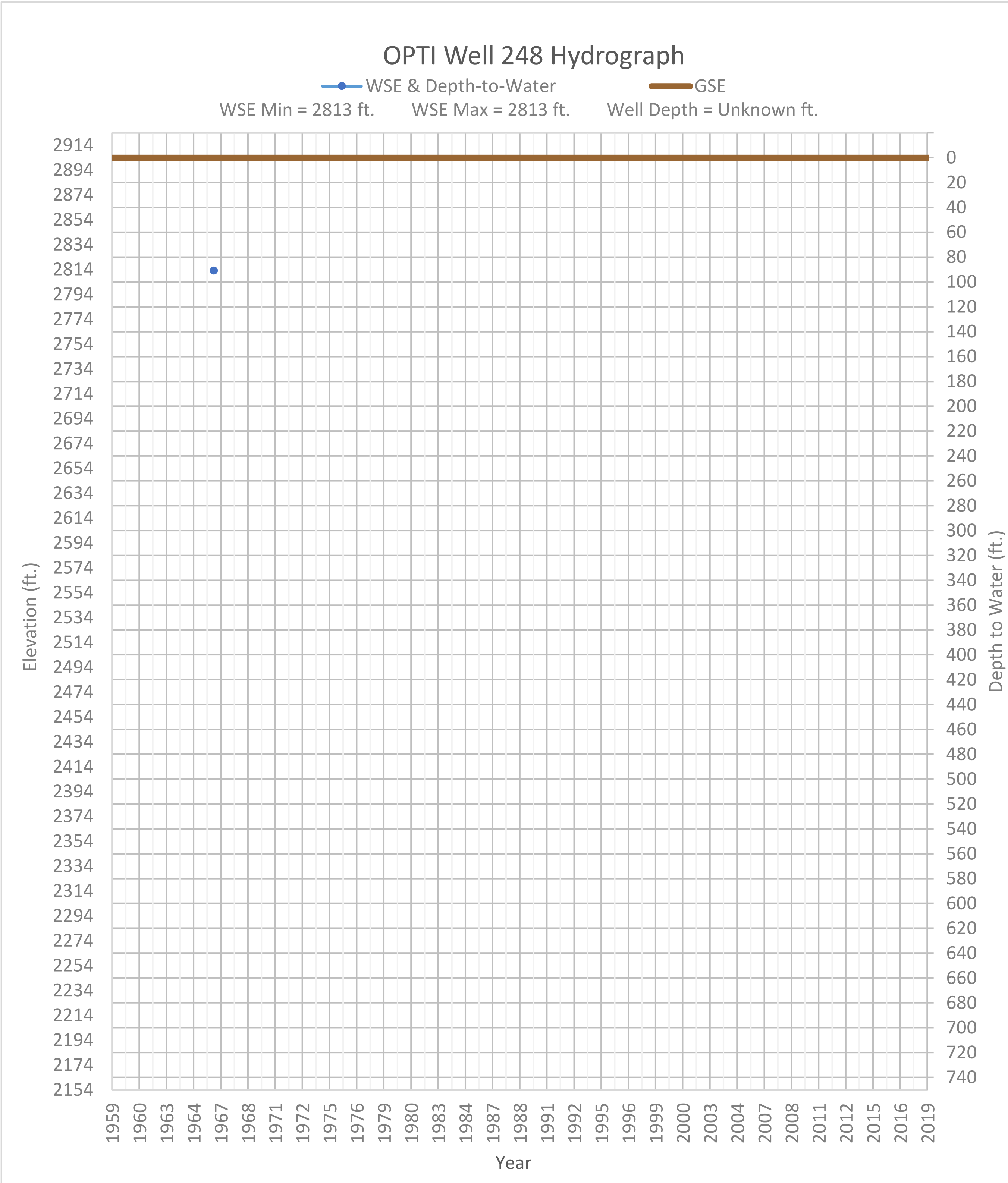
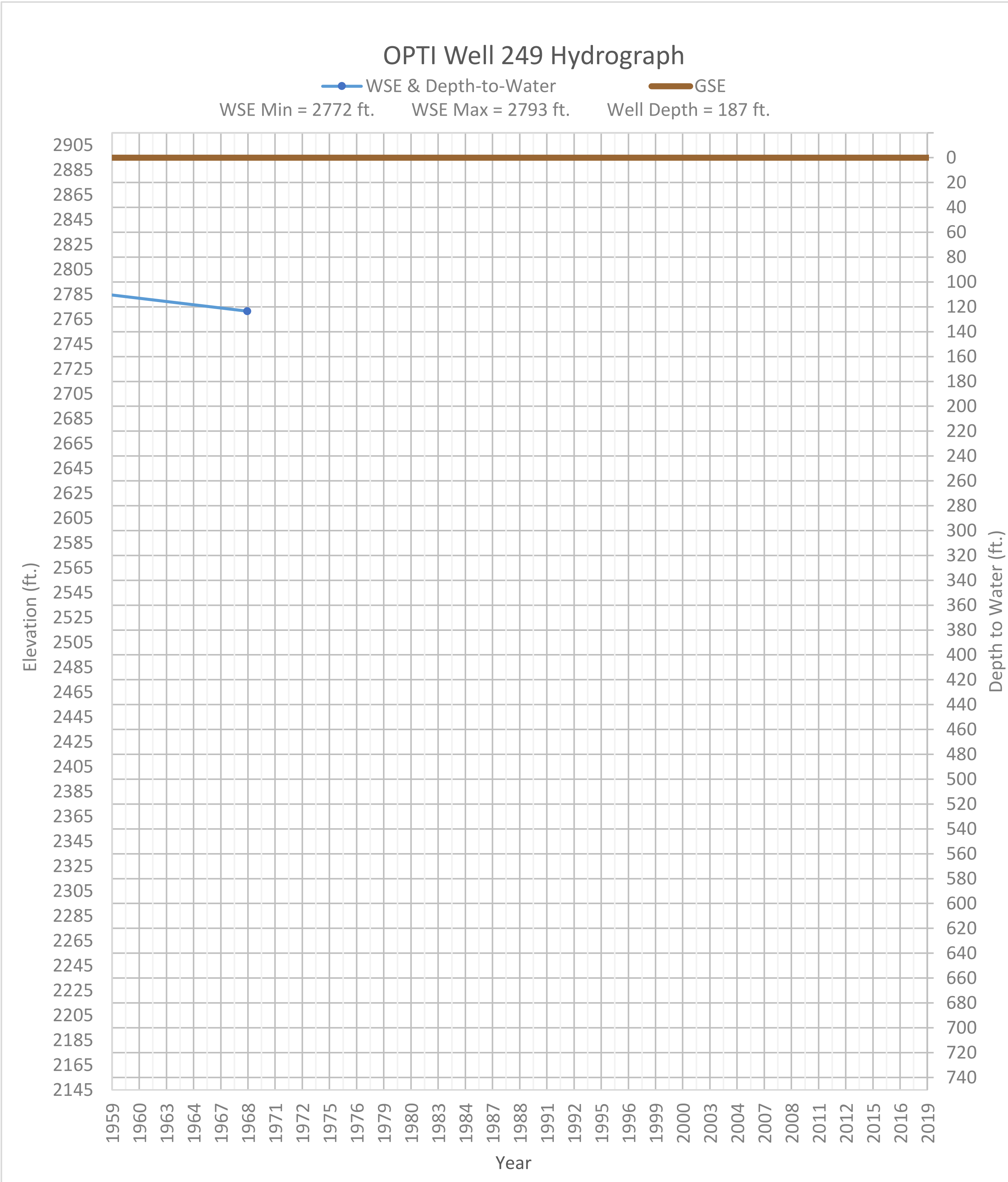


OPTI Well 248 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2813 ft.
WSE Max = 2813 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 249 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2772 ft.
WSE Max = 2793 ft.
Well Depth = 187 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2905
2885
2865
2845
2825
2805
2785
2765
2745
2725
2705
2685
2665
2645
2625
2605
2585
2565
2545
2525
2505
2485
2465
2445
2425
2405
2385
2365
2345
2325
2305
2285
2265
2245
2225
2205
2185
2165
2145
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720
740
1959
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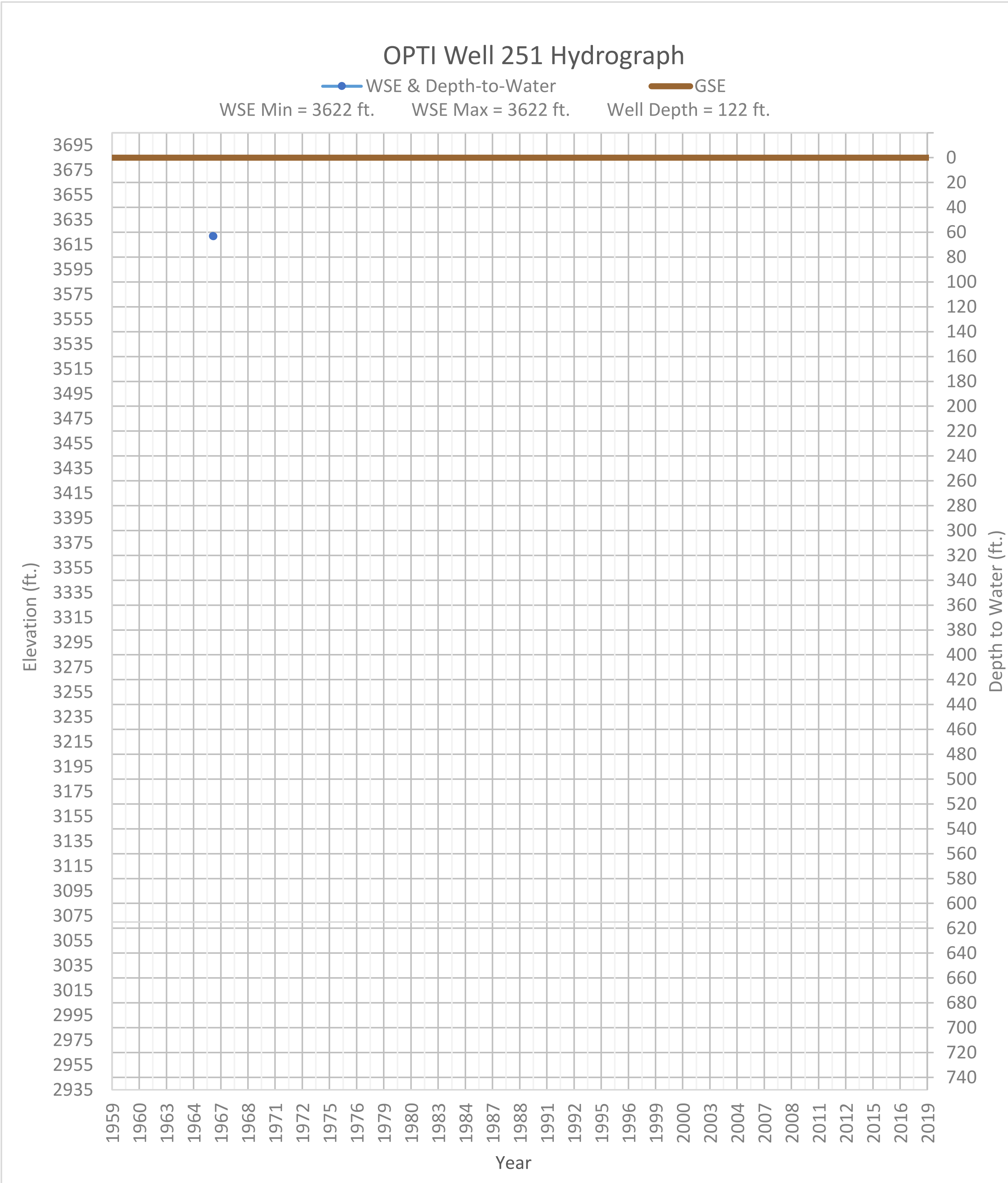
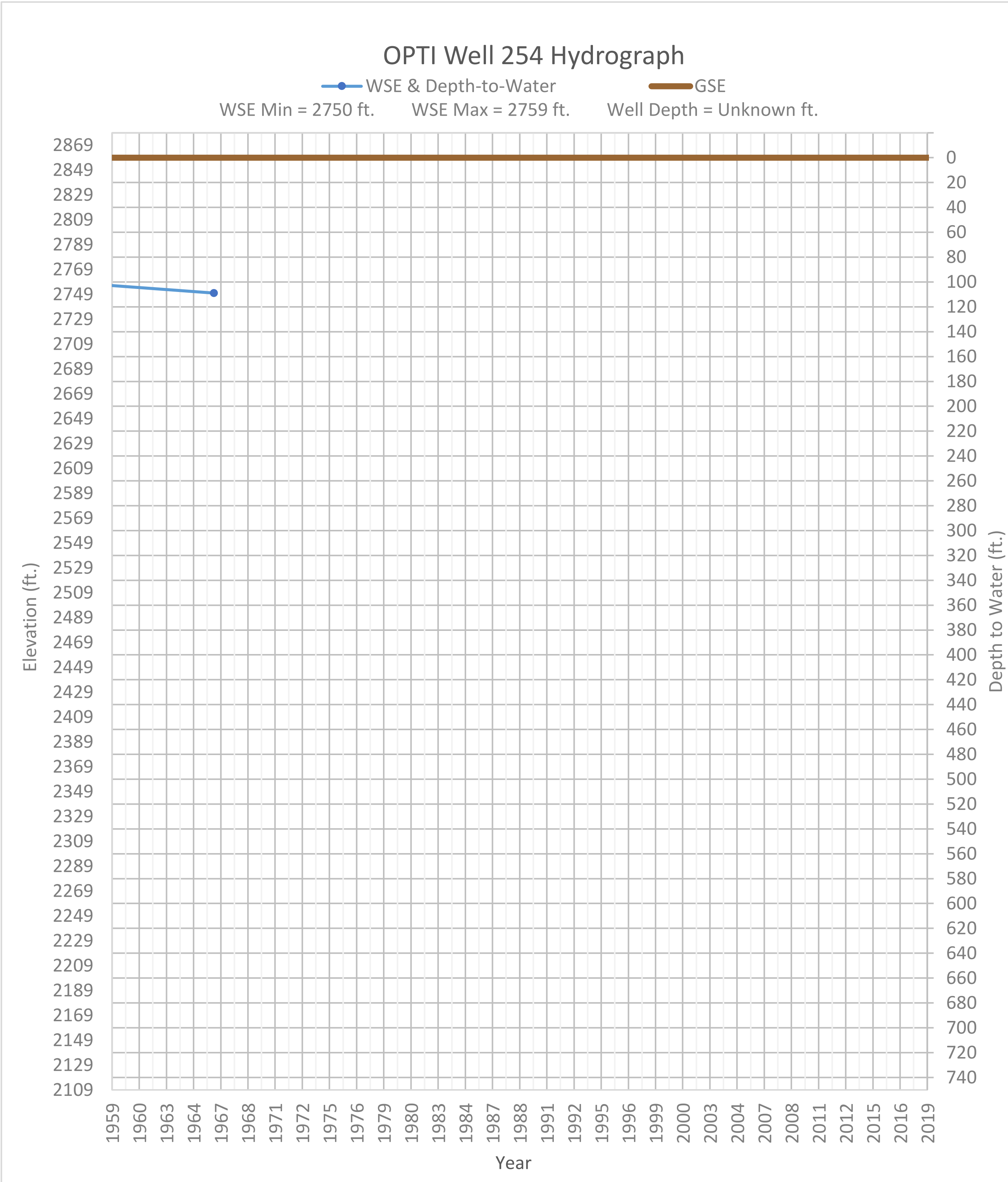
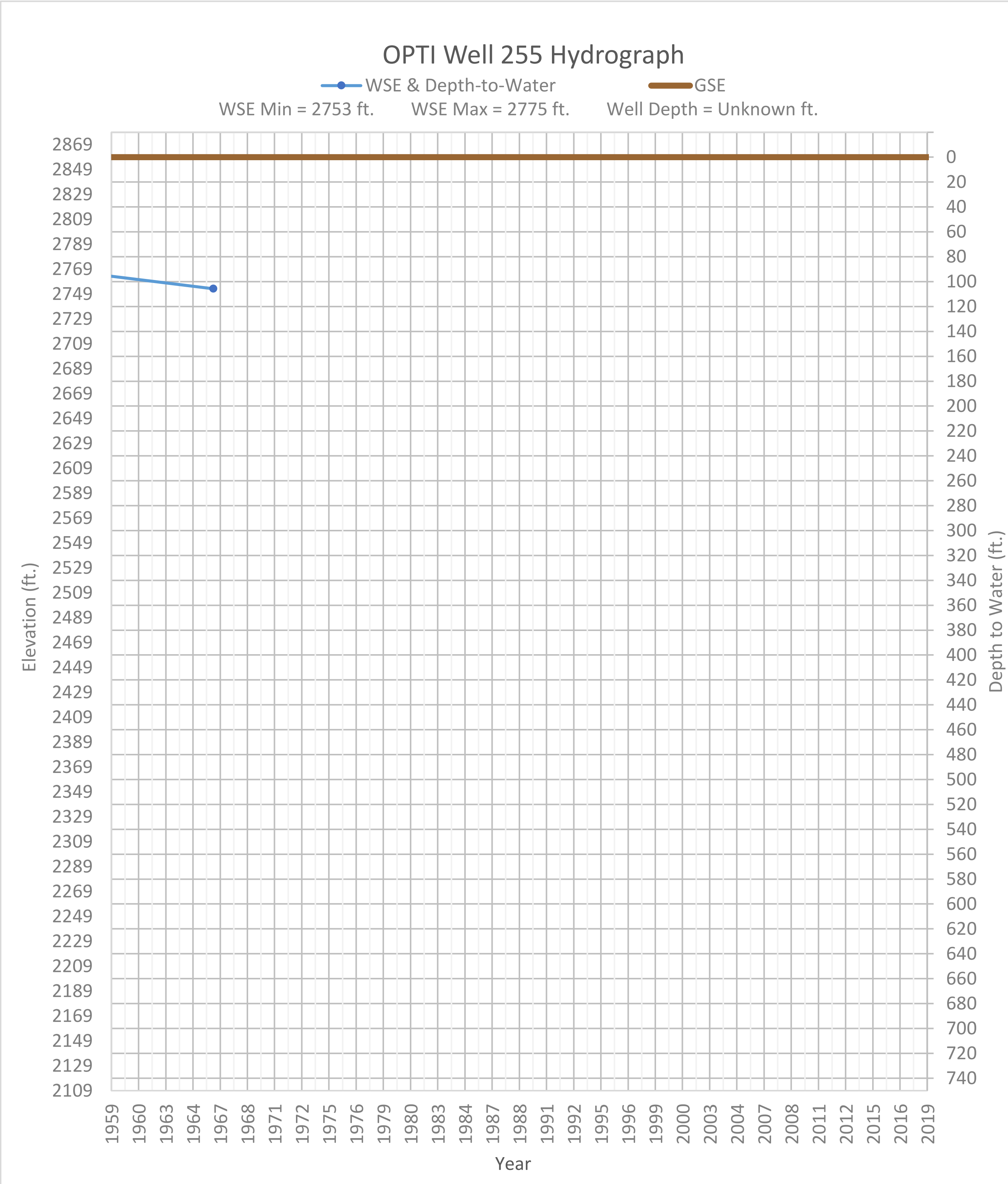
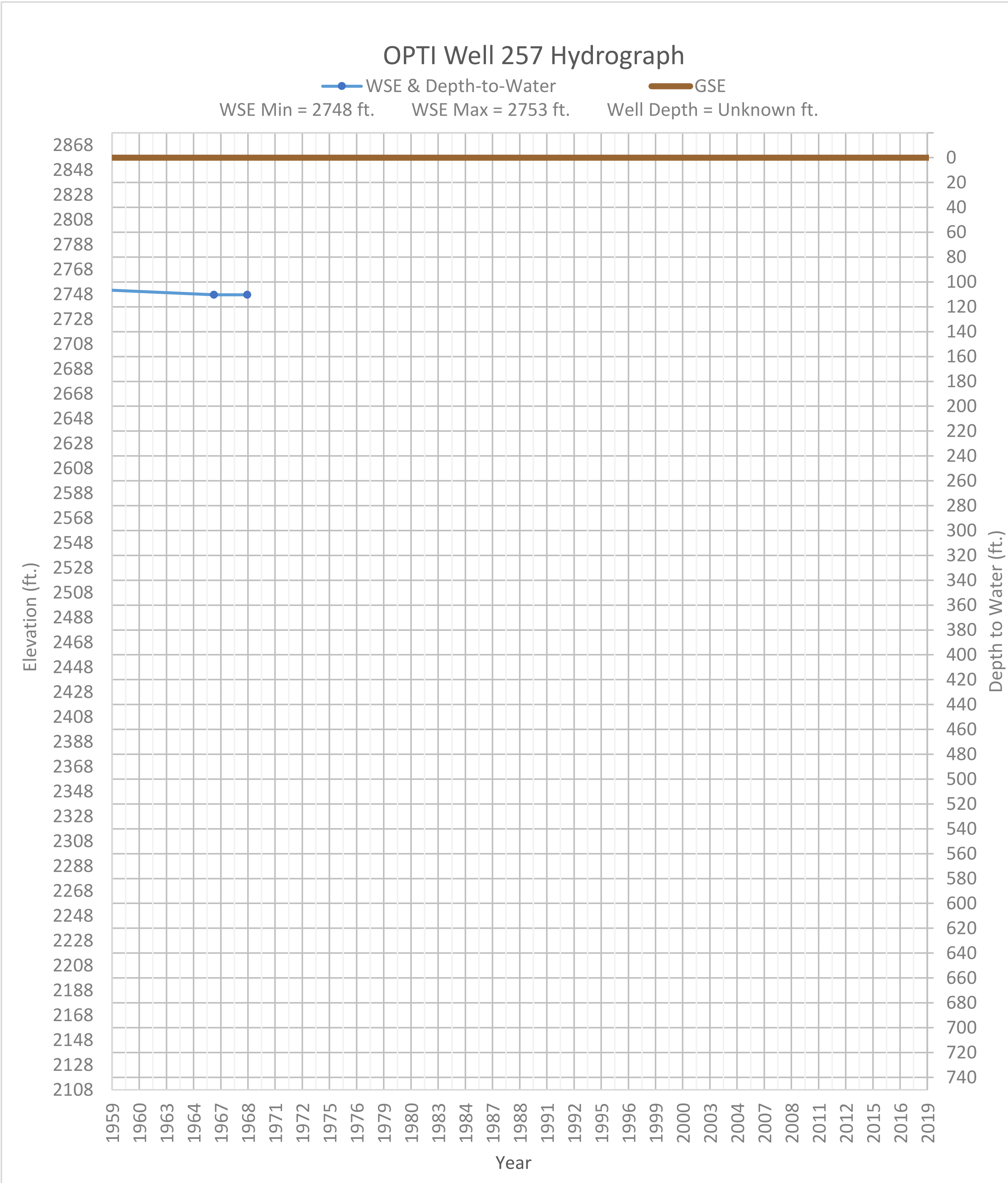


OPTI Well 251 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3622 ft.
WSE Max = 3622 ft.
Well Depth = 122 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

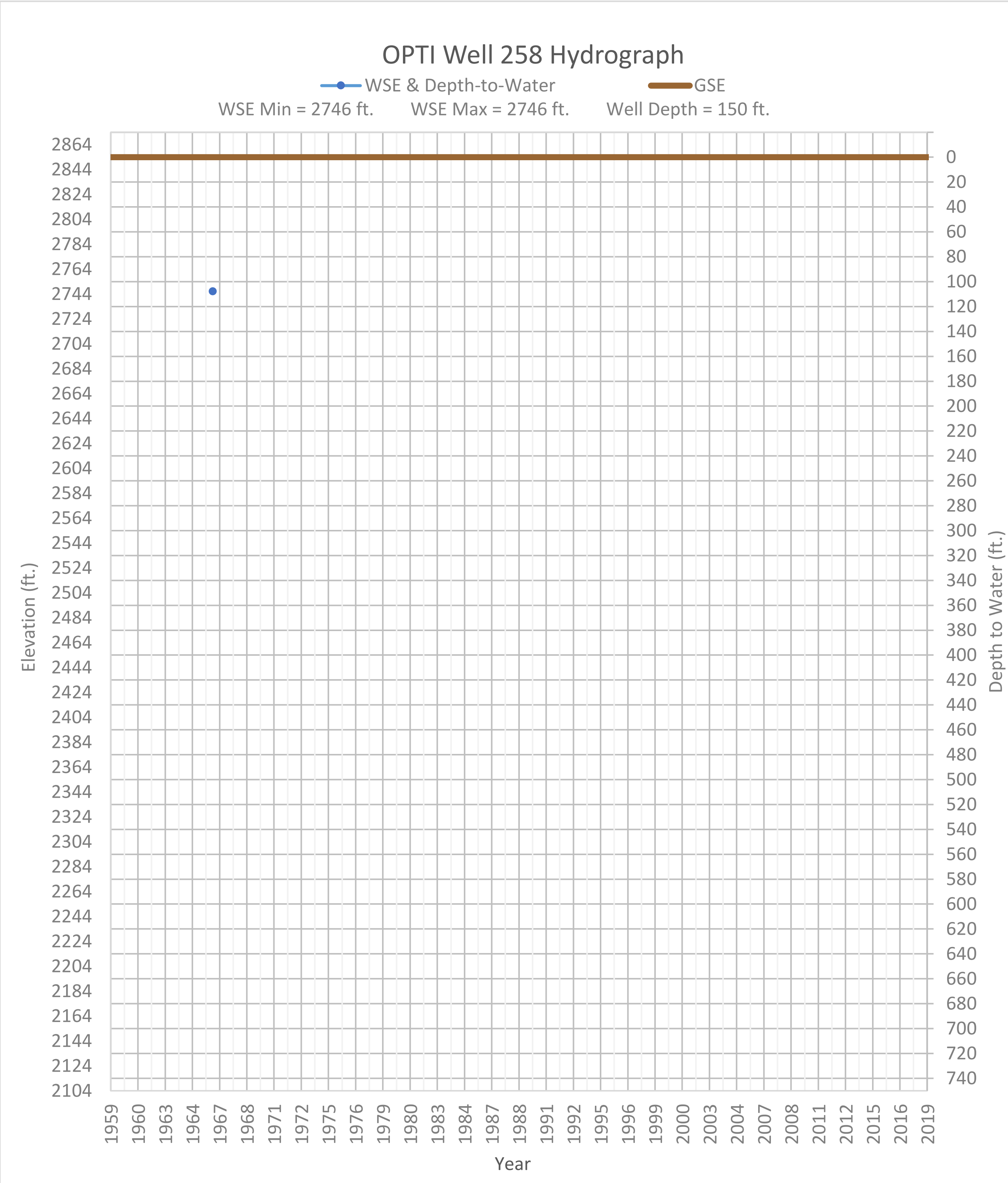

OPTI Well 254 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2750 ft.
WSE Max = 2759 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 255 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2753 ft.
WSE Max = 2775 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 257 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2748 ft.
WSE Max = 2753 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 258 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2746 ft.
WSE Max = 2746 ft.
Well Depth = 150 ft.
Elevation (ft.)
2864
2844
2824
2804
2784
2764
2744
2724
2704
2684
2664
2644
2624
2604
2584
2564
2544
2524
2504
2484
2464
2444
2424
2404
2384
2364
2344
2324
2304
2284
2264
2244
2224
2204
2184
2164
2144
2124
2104
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
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1959
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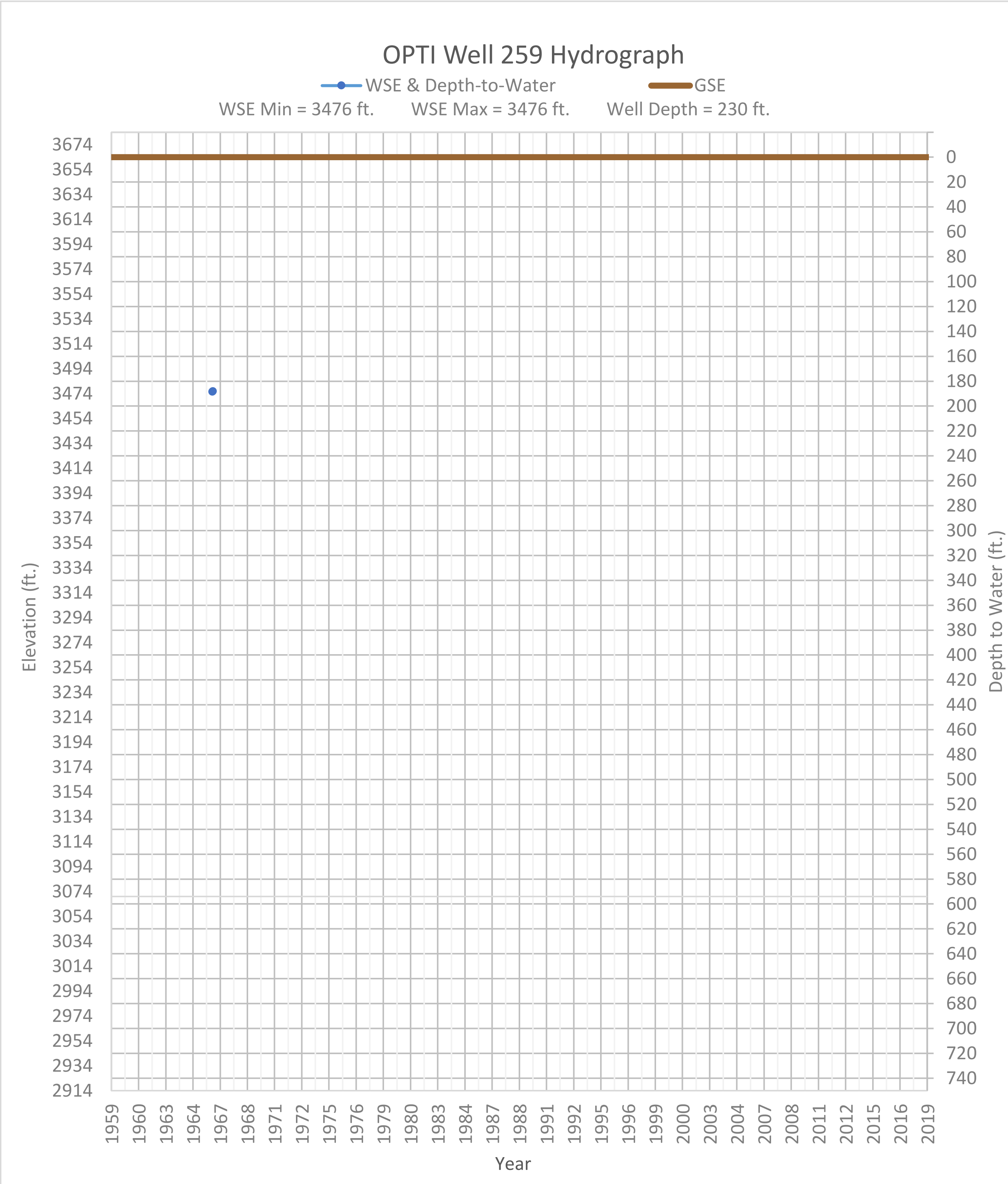
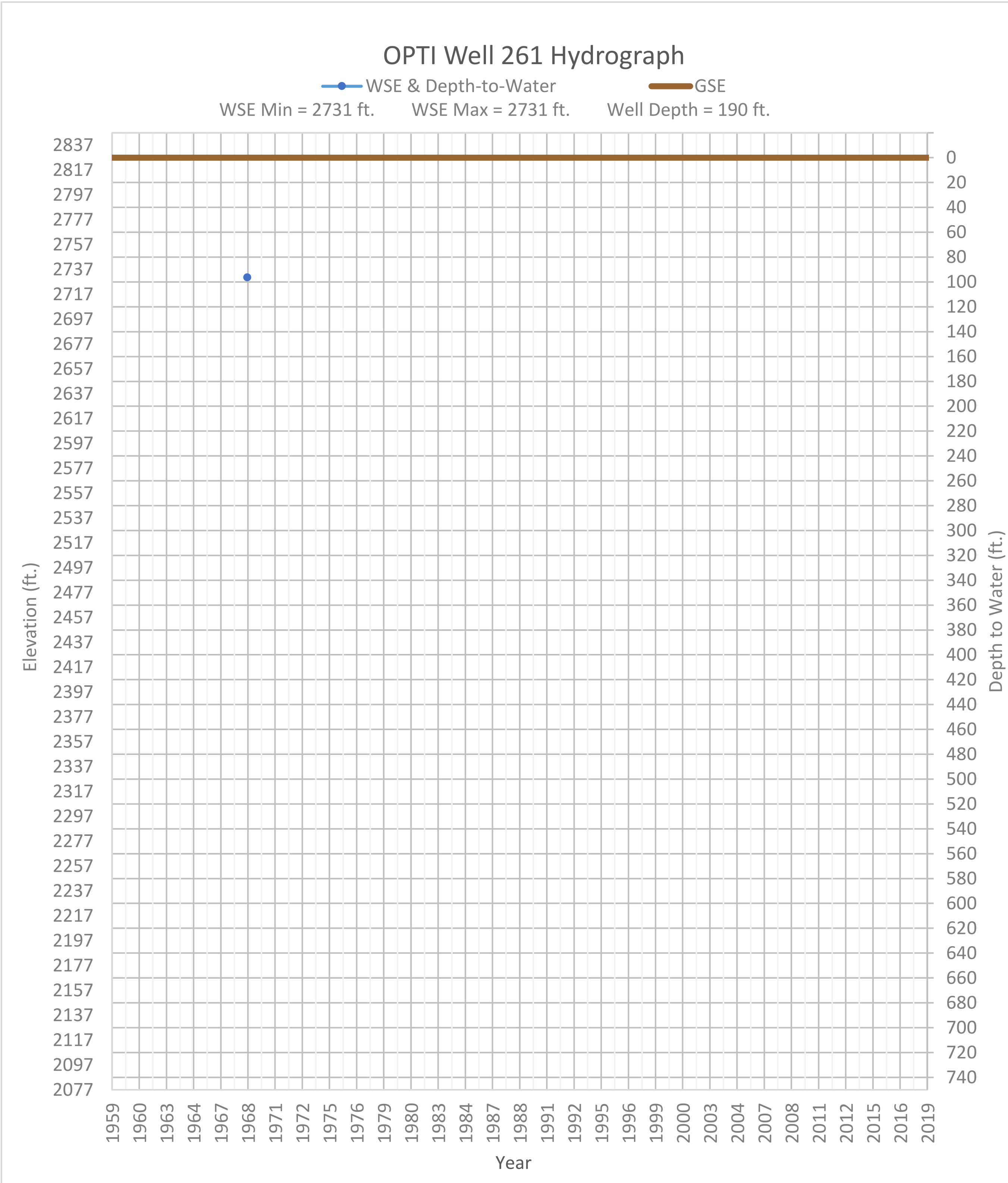
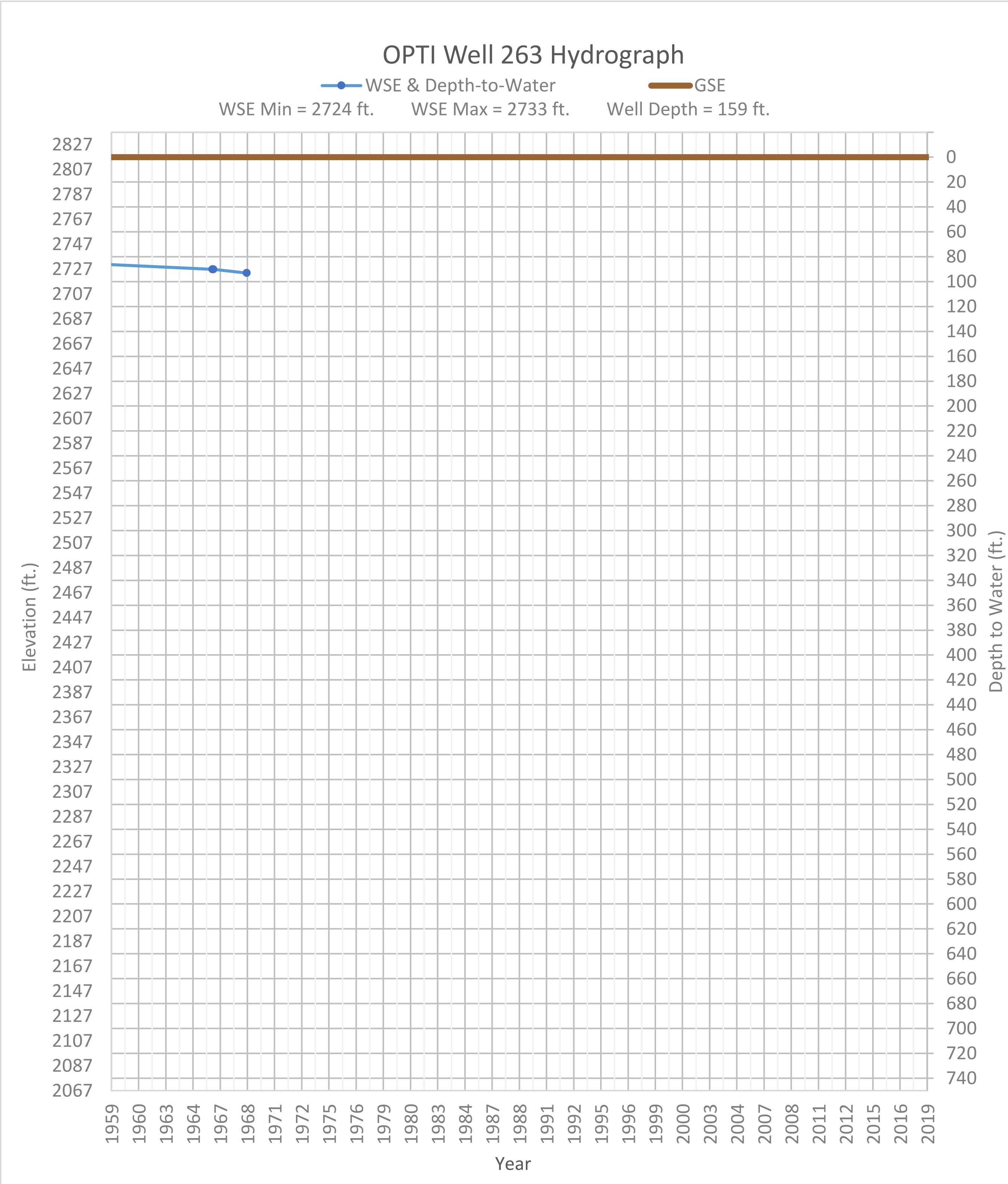
Year



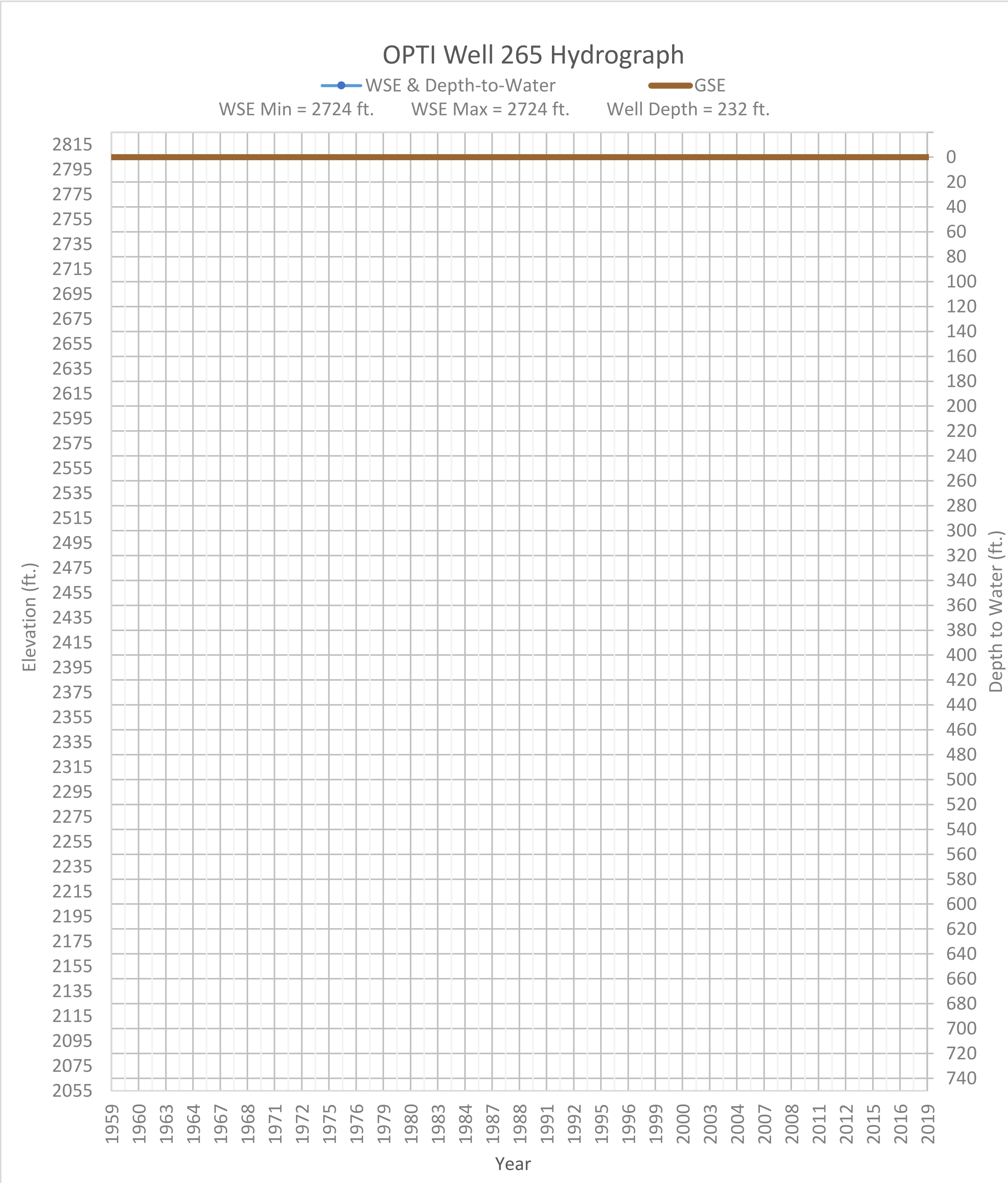
OPTI Well 259 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3476 ft.
WSE Max = 3476 ft.
Well Depth = 230 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



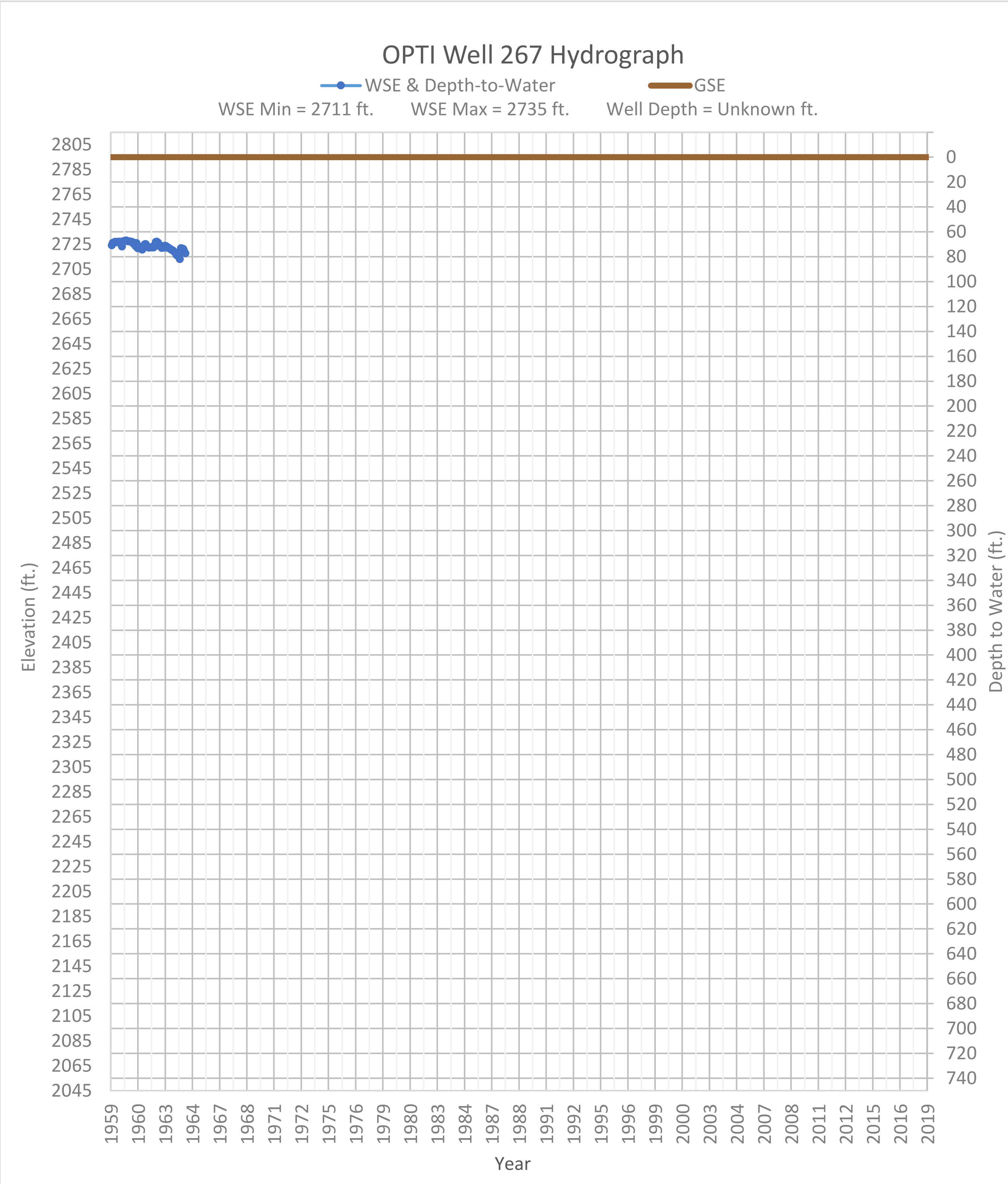
OPTI Well 261 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2731 ft.
WSE Max = 2731 ft.
Well Depth = 190 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 263 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2724 ft.
WSE Max = 2733 ft.
Well Depth = 159 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 265 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2724 ft.
WSE Max = 2724 ft.
Well Depth = 232 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 267 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2711 ft.
WSE Max = 2735 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2805
2785
2765
2745
2725
2705
2685
2665
2645
2625
2605
2585
2565
2545
2525
2505
2485
2465
2445
2425
2405
2385
2365
2345
2325
2305
2285
2265
2245
2225
2205
2185
2165
2145
2125
2105
2085
2065
2045
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
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620
640
660
680
700
720
740
1959
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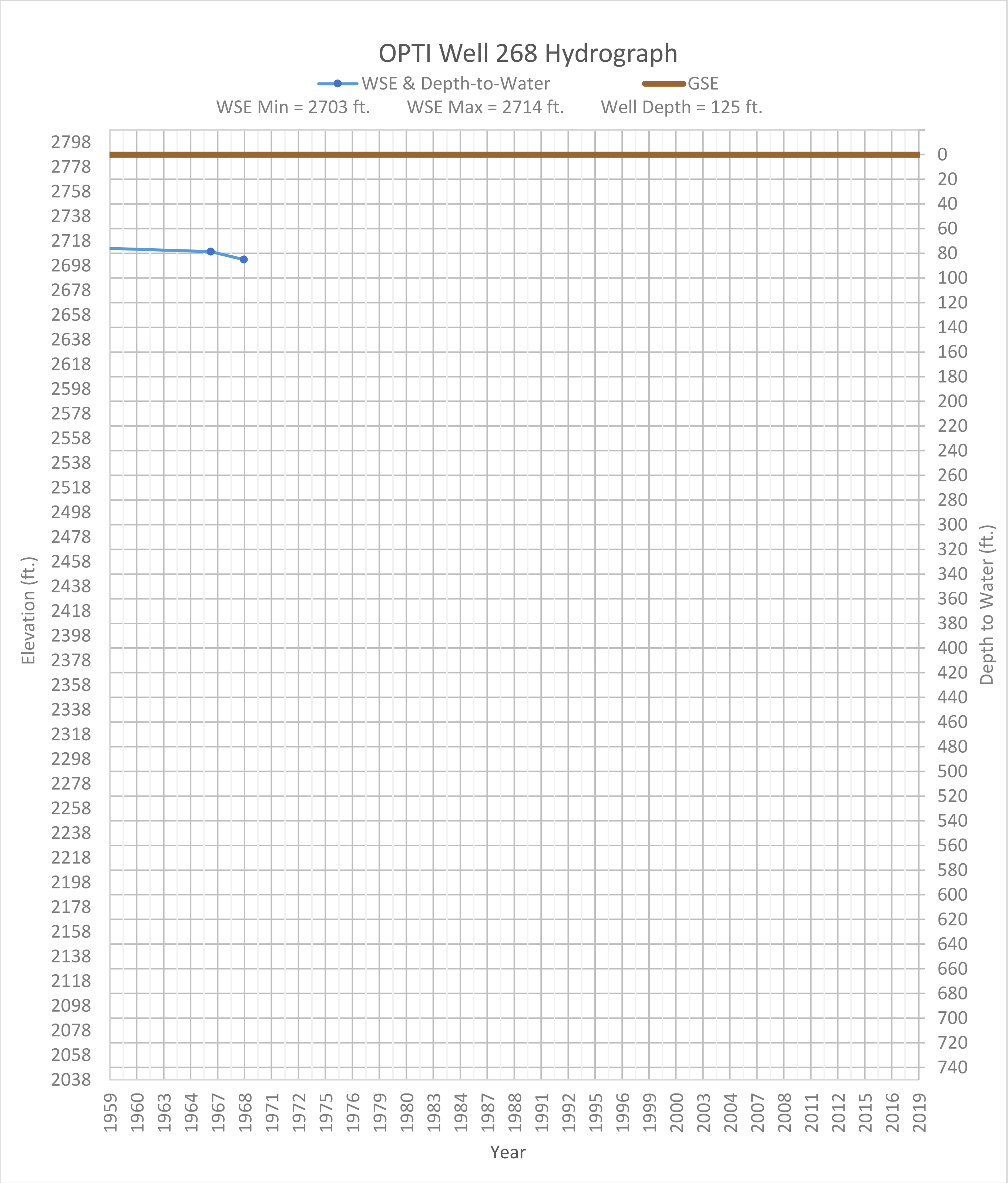
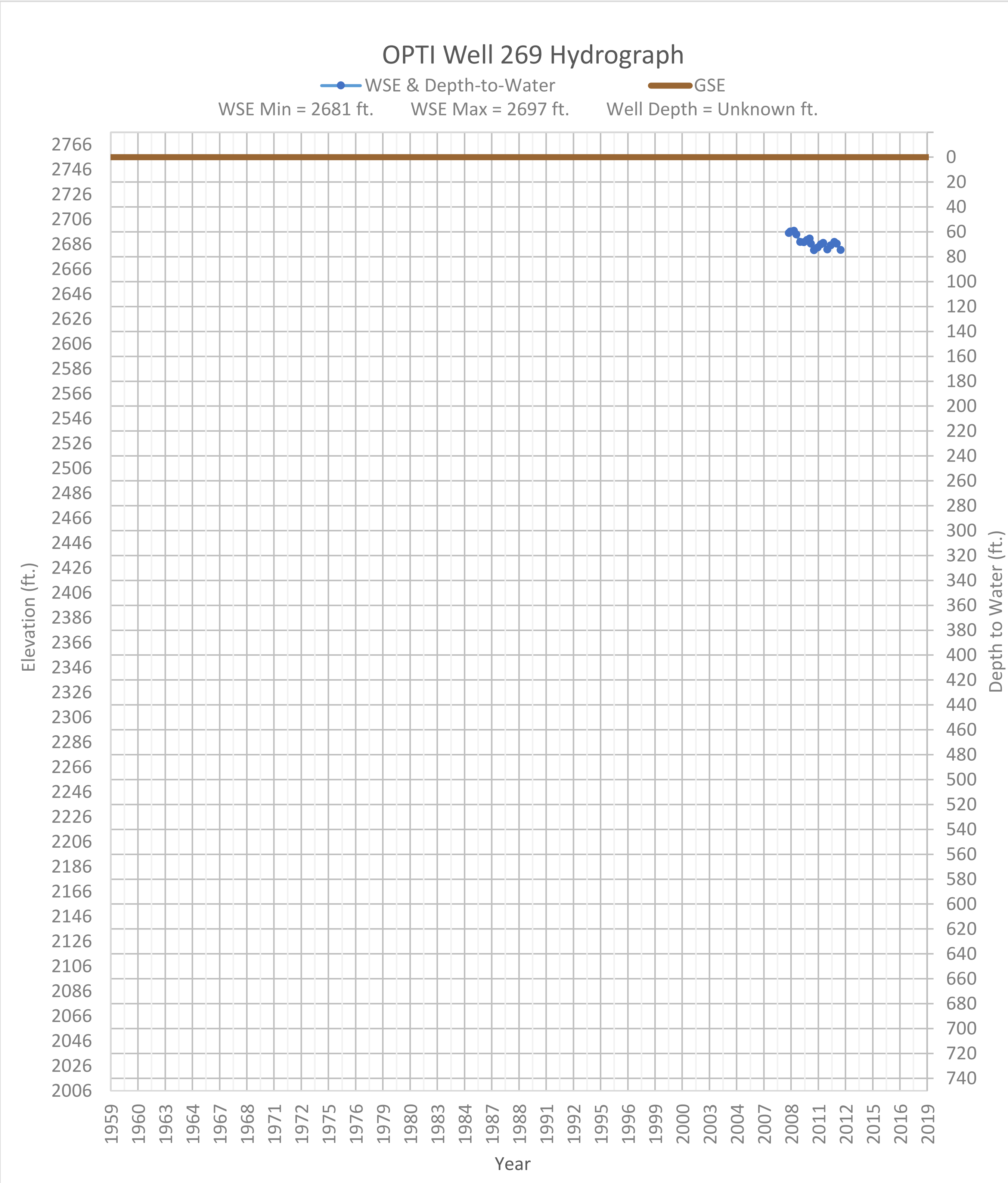
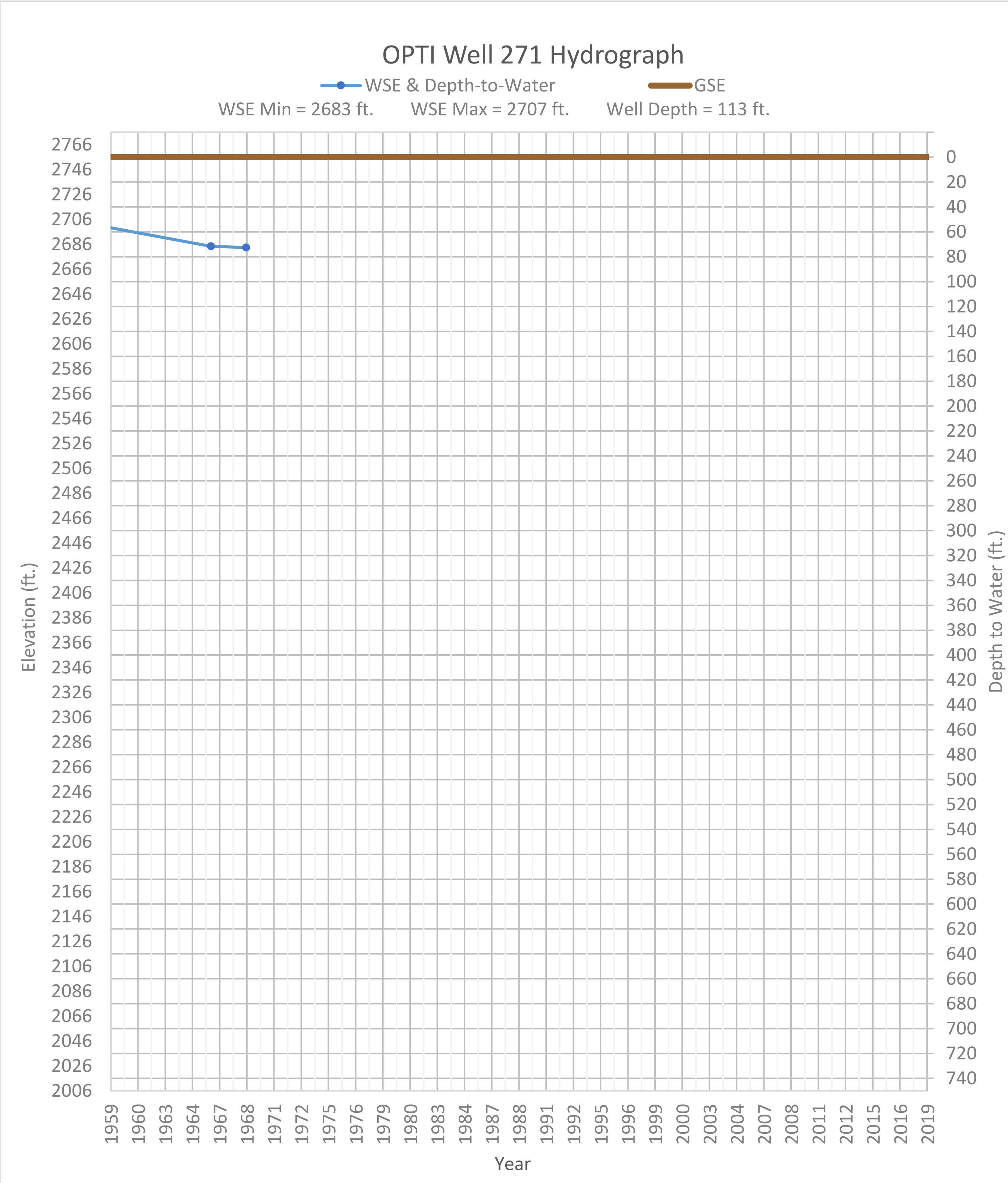
2019



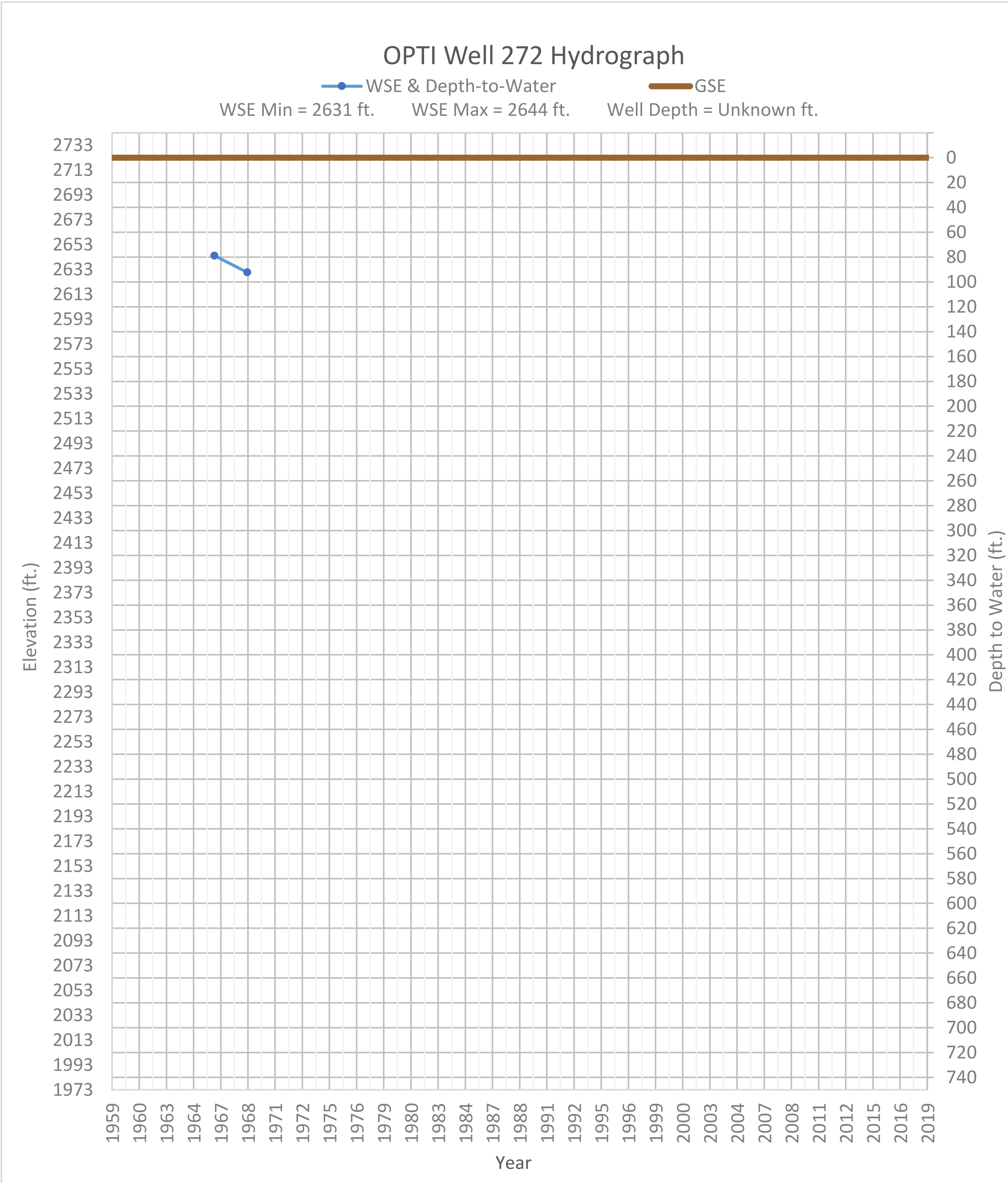
OPTI Well 268 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2703 ft.
WSE Max = 2714 ft.
Well Depth = 125 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

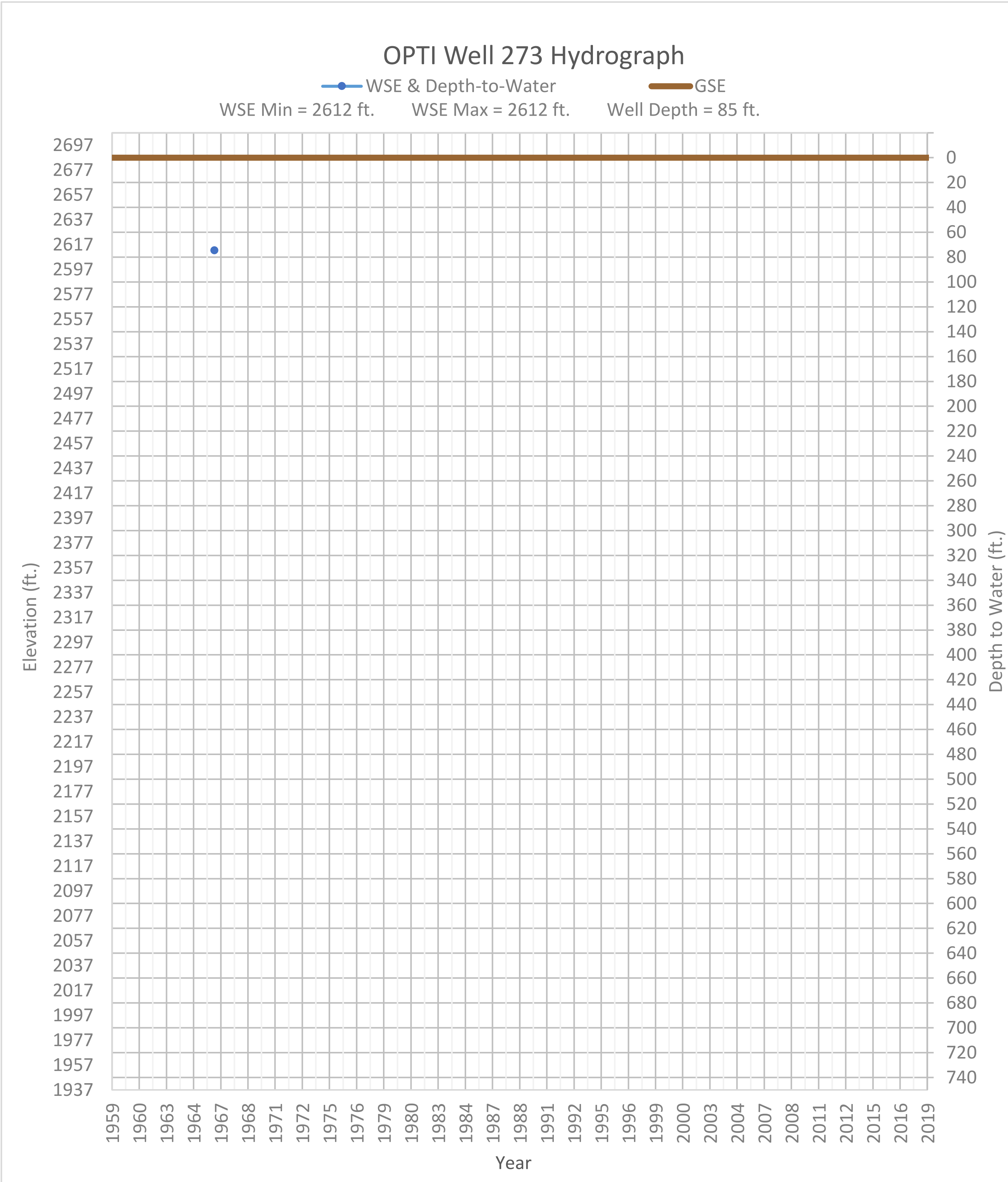


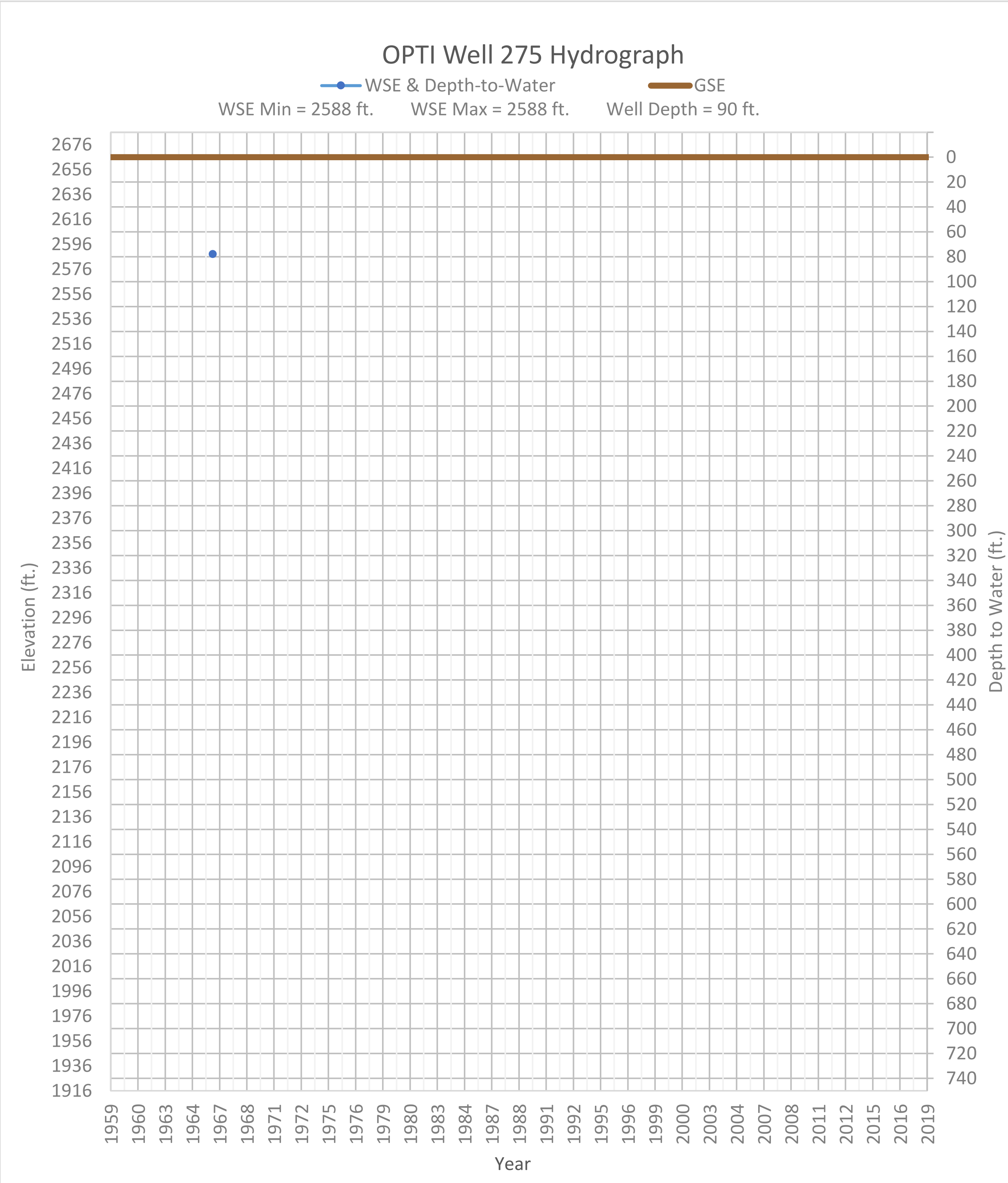
OPTI Well 269 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2681 ft.
WSE Max = 2697 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



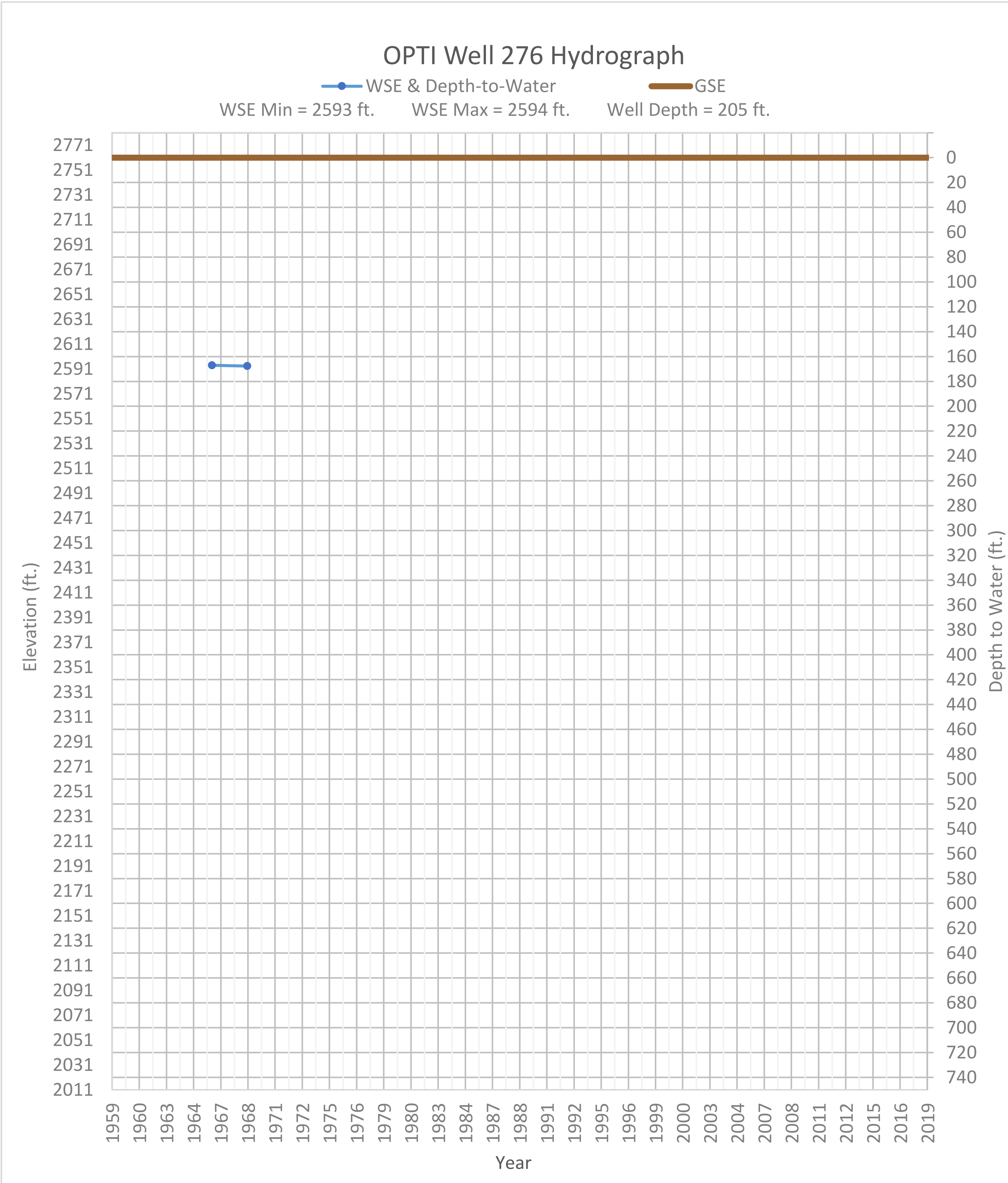
OPTI Well 271 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2683 ft.
WSE Max = 2707 ft.
Well Depth = 113 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 272 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2631 ft.
WSE Max = 2644 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year

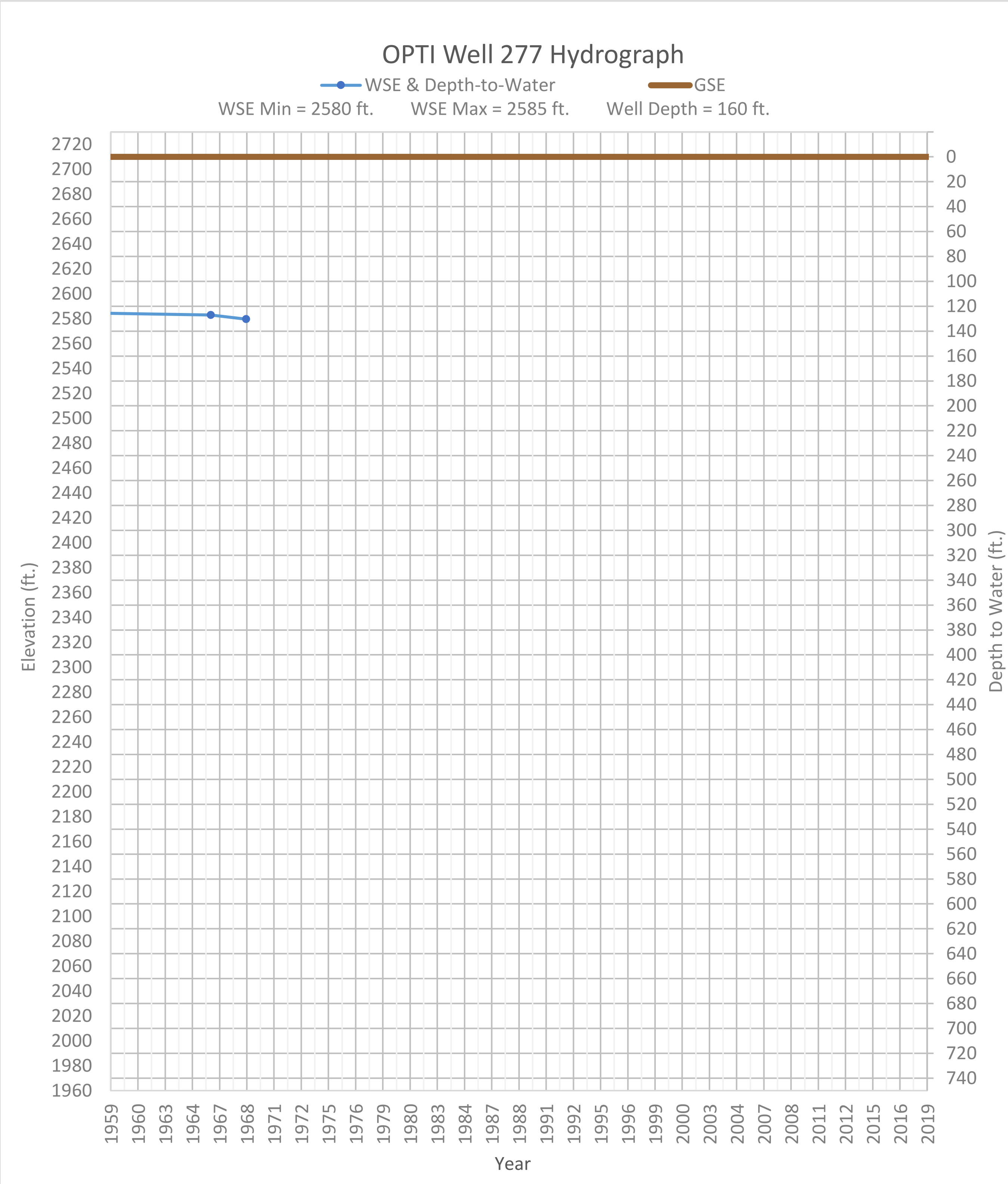

OPTI Well 273 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2612 ft.
WSE Max = 2612 ft.
Well Depth = 85 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

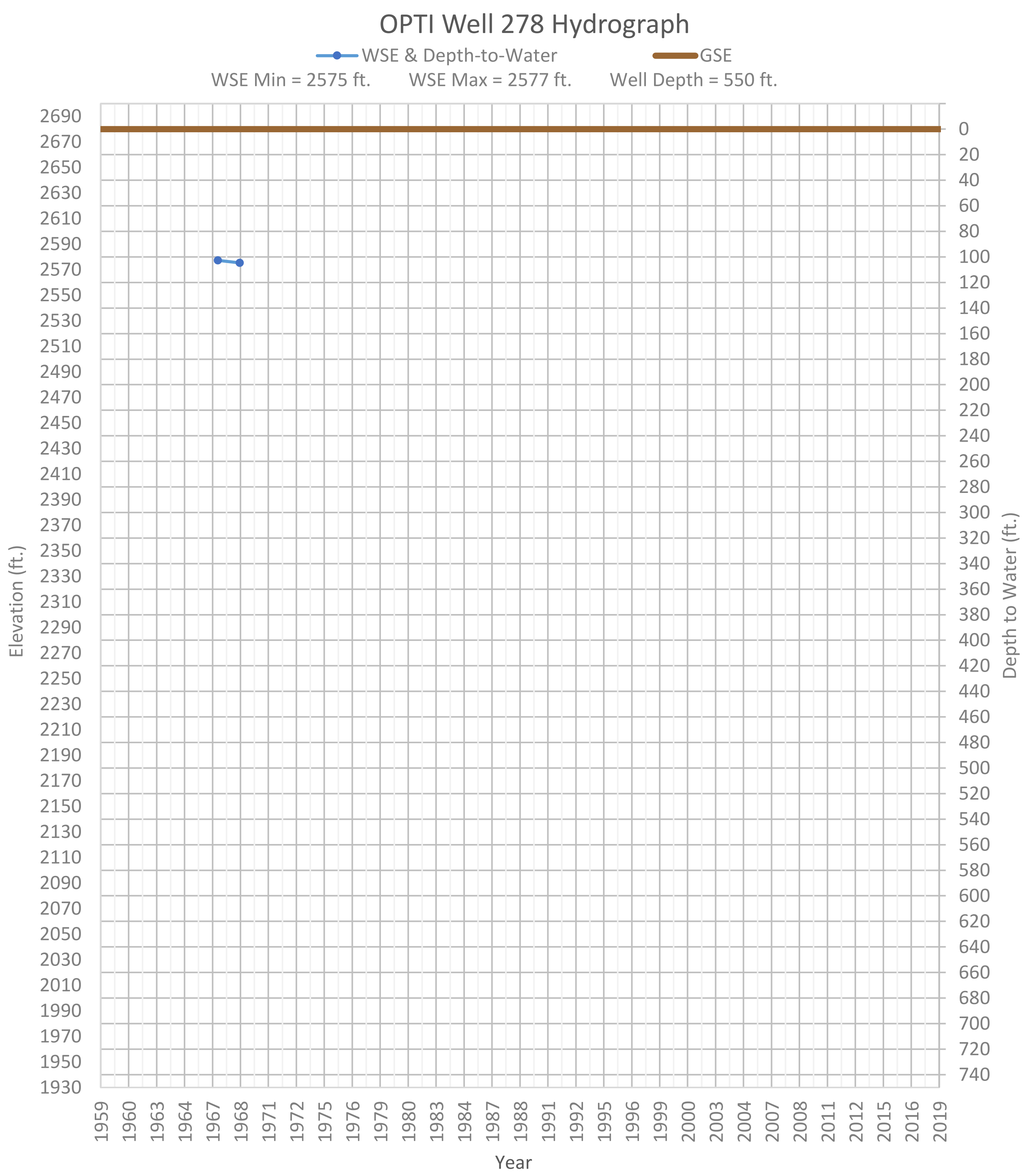


OPTI Well 275 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2588 ft.
WSE Max = 2588 ft.
Well Depth = 90 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

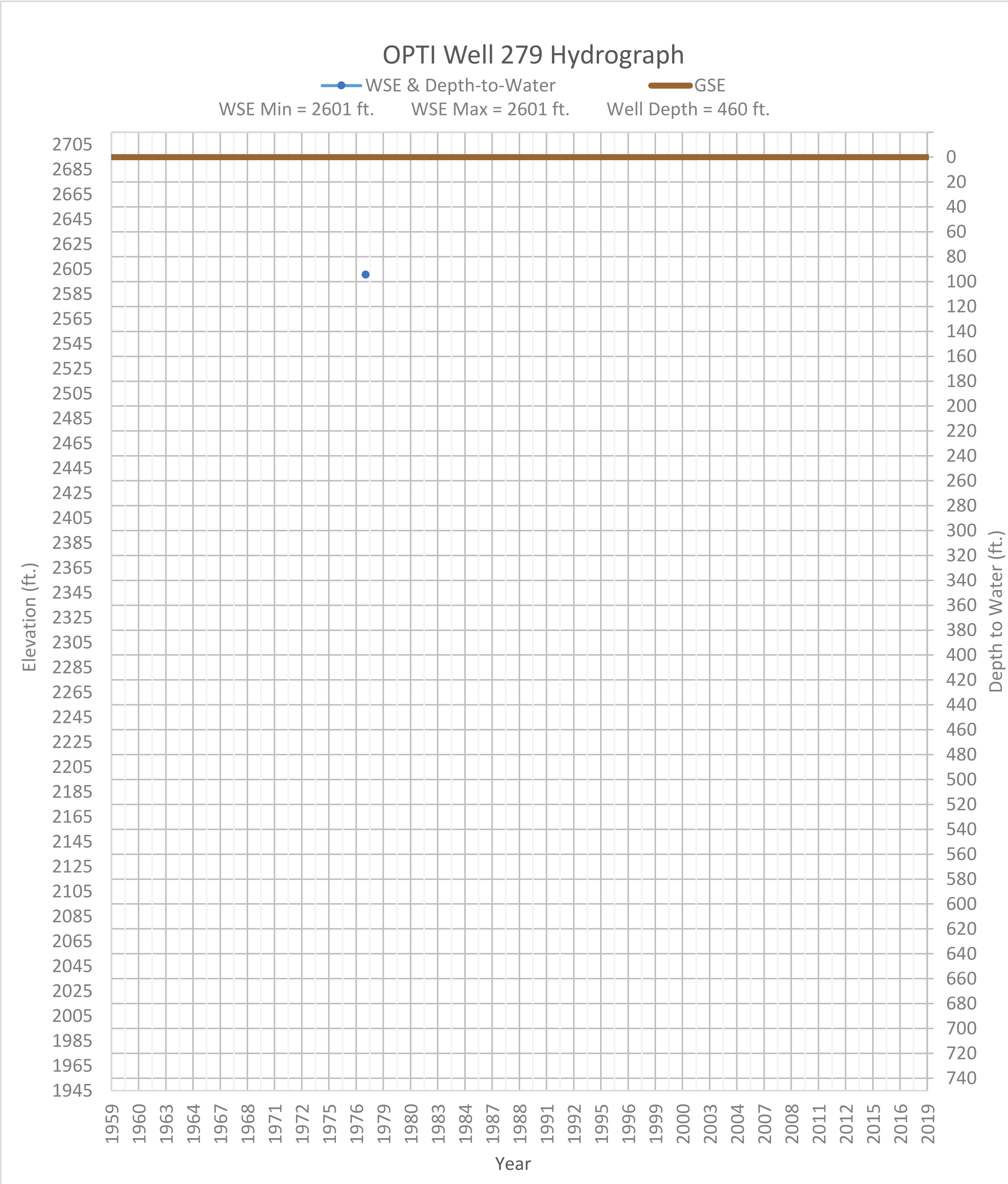


OPTI Well 276 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2593 ft.
WSE Max = 2594 ft.
Well Depth = 205 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

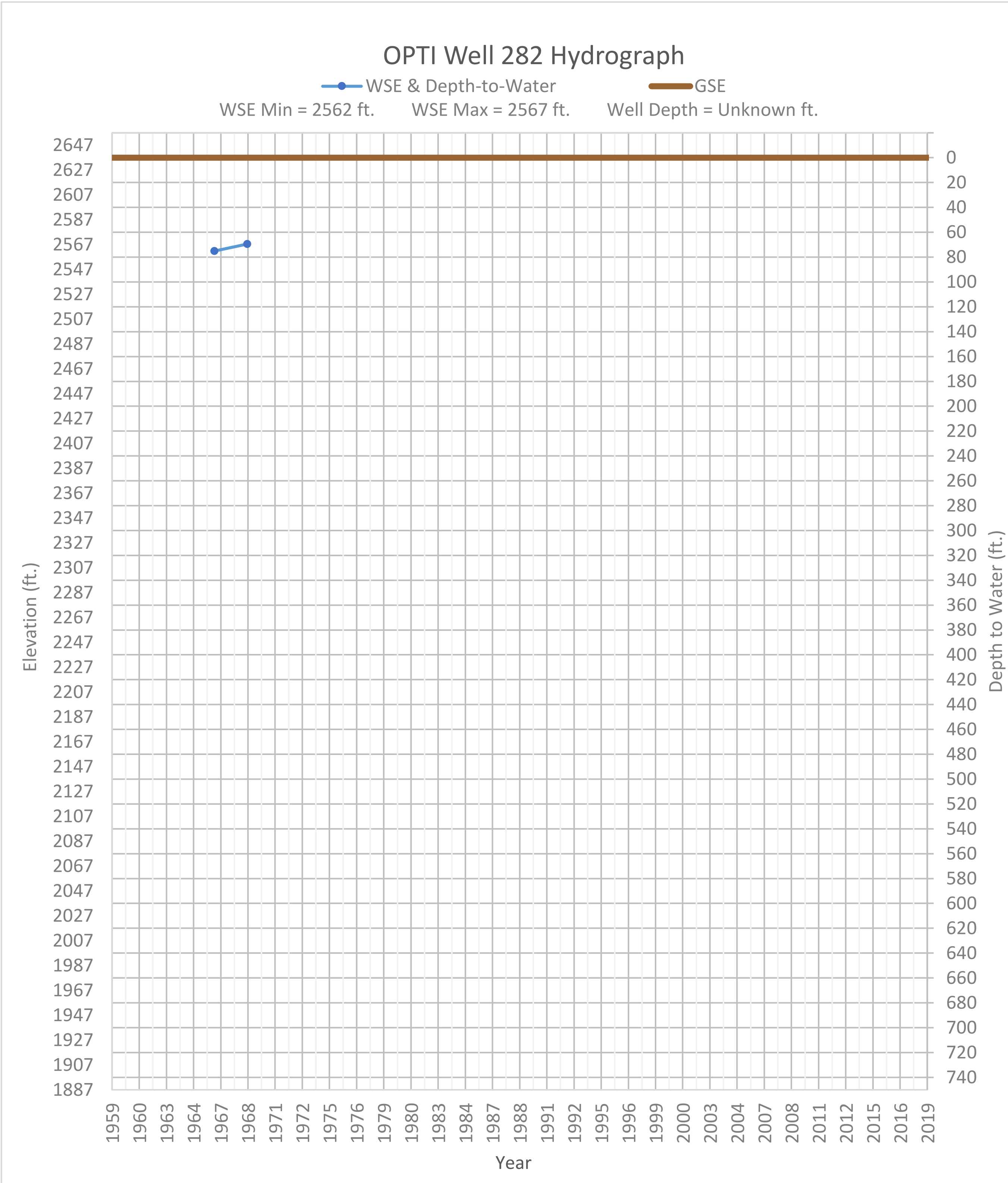

OPTI Well 277 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2580 ft.
WSE Max = 2585 ft.
Well Depth = 160 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

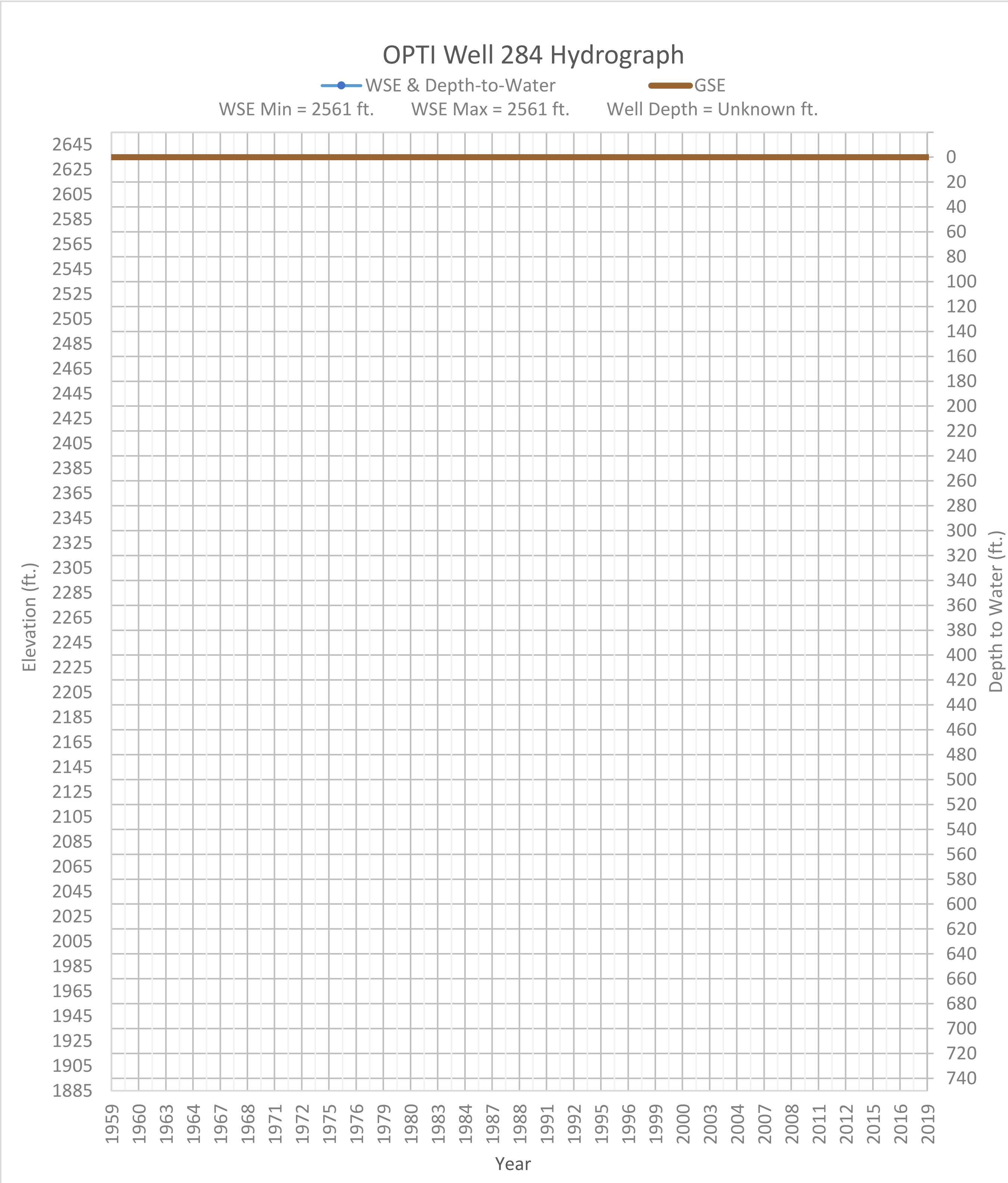


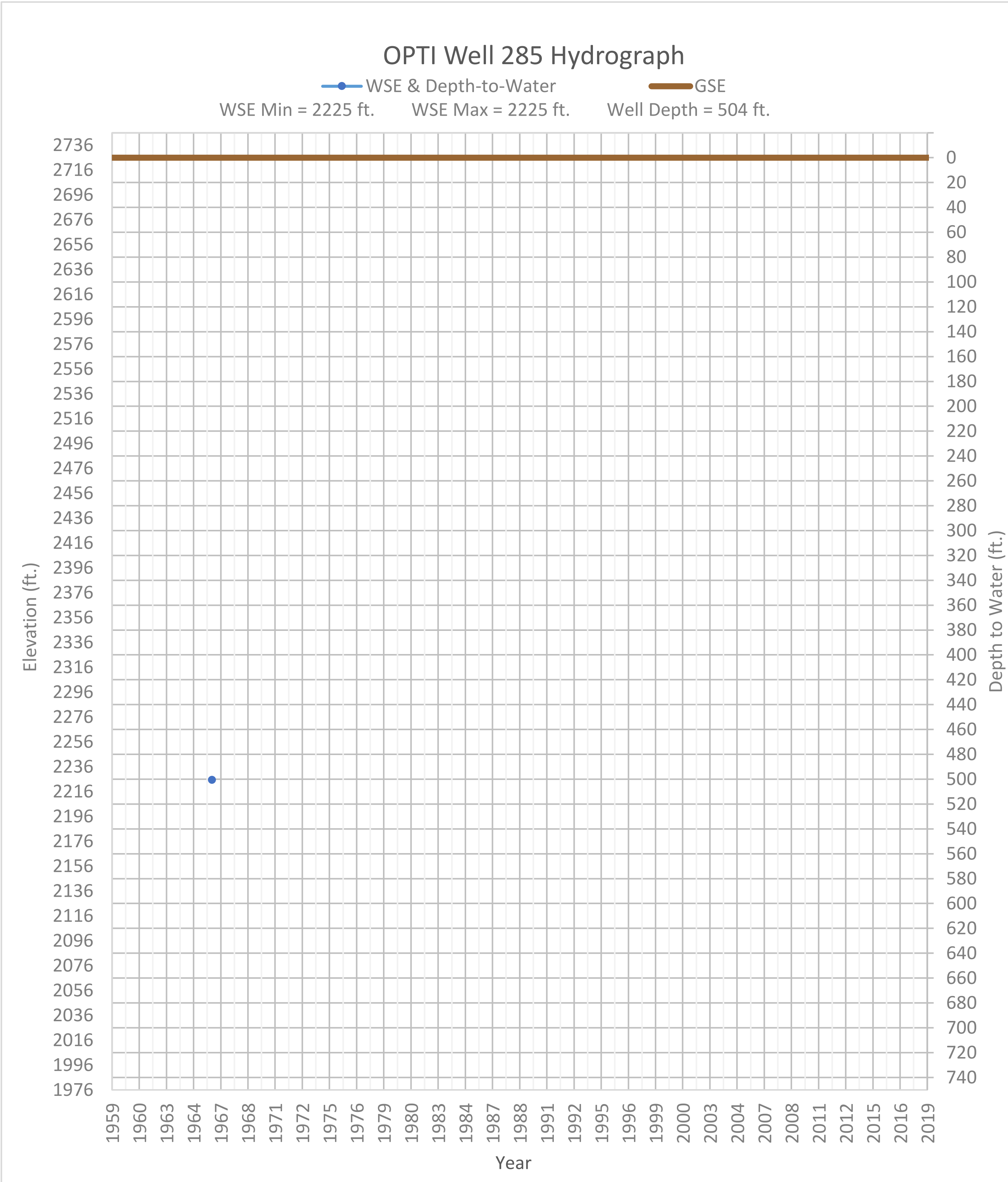
OPTI Well 278 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2575 ft.
WSE Max = 2577 ft.
Well Depth = 550 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



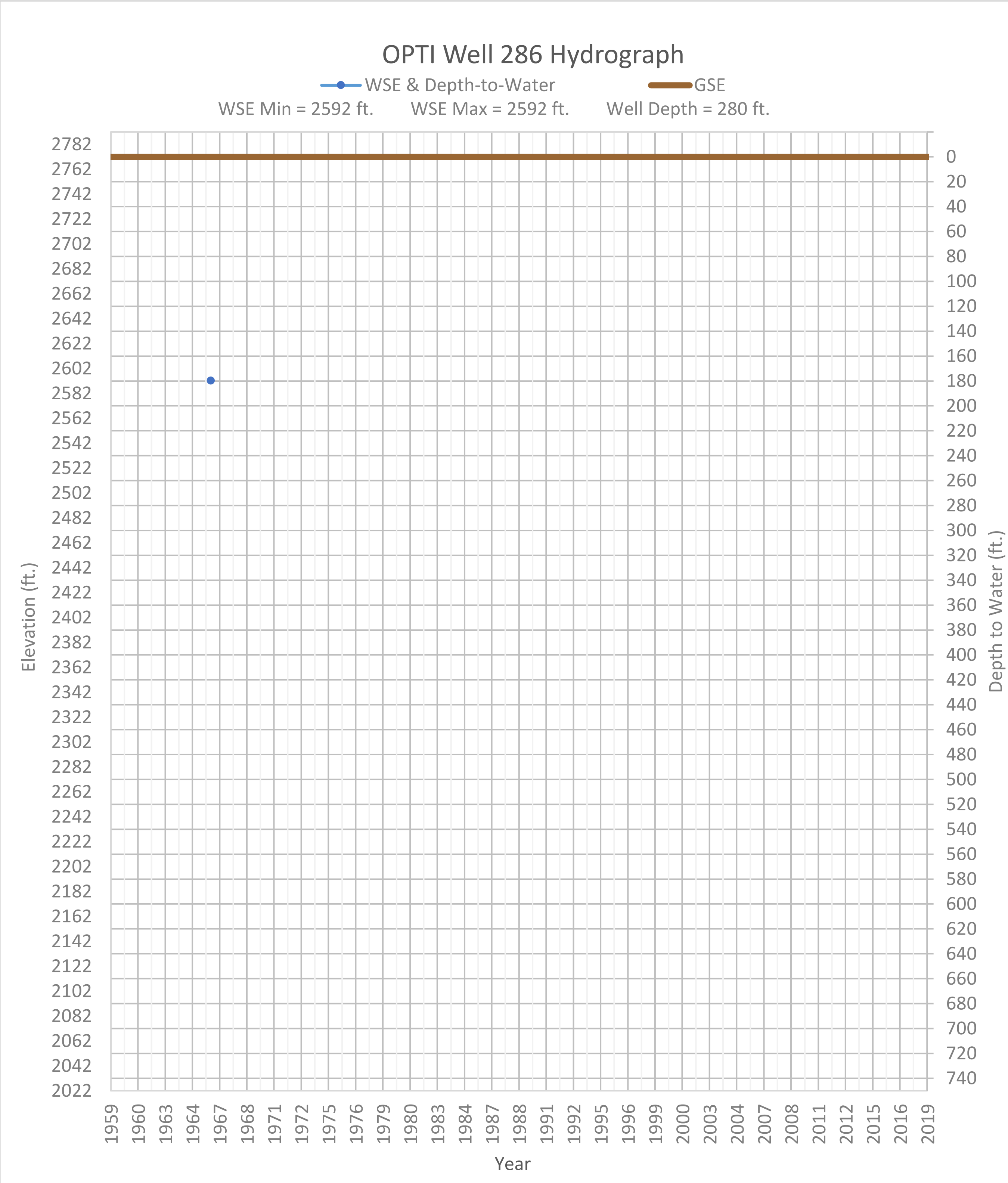
OPTI Well 279 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2601 ft.
WSE Max = 2601 ft.
Well Depth = 460 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 282 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2562 ft.
WSE Max = 2567 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year

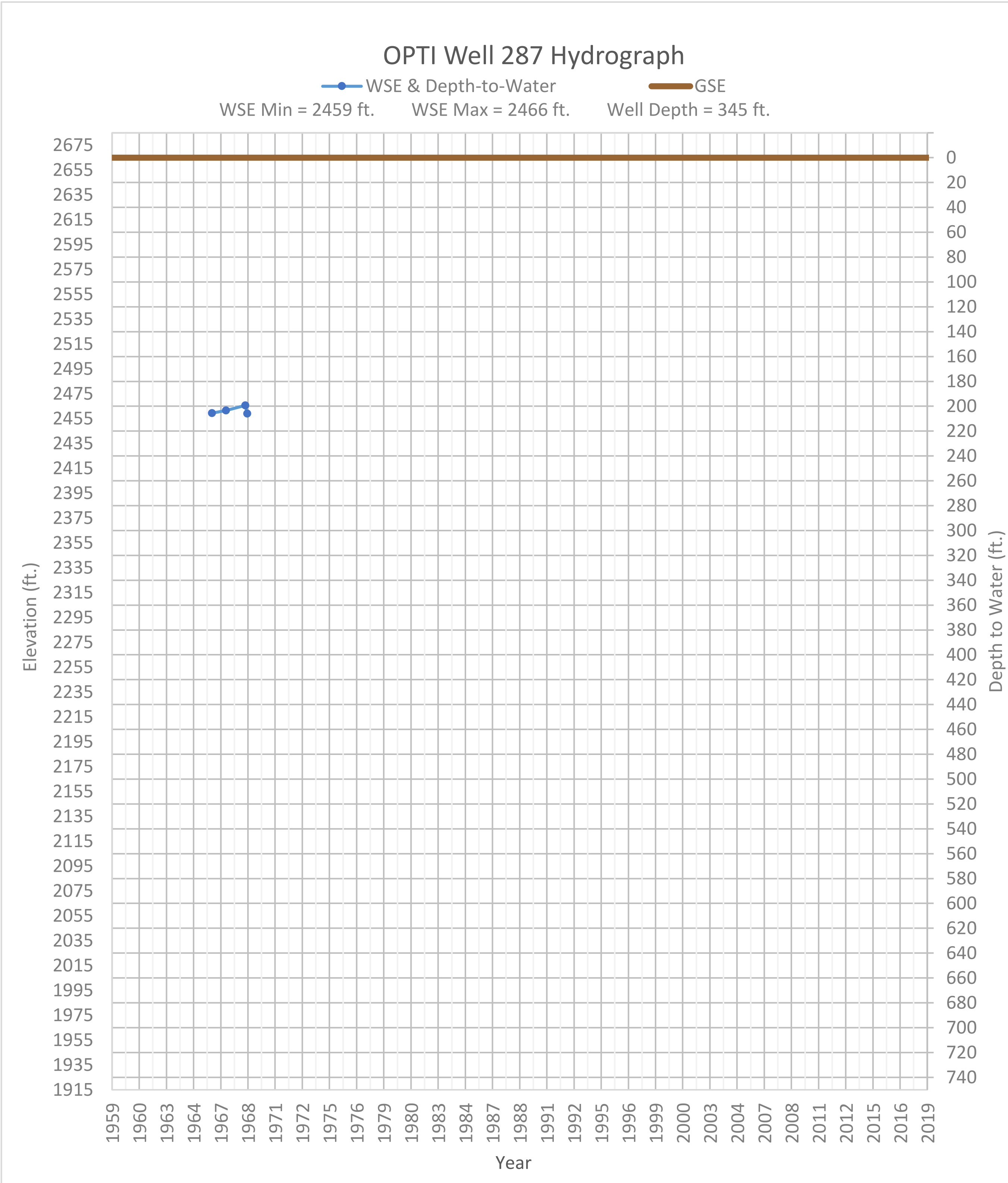

OPTI Well 284 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2561 ft.
WSE Max = 2561 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



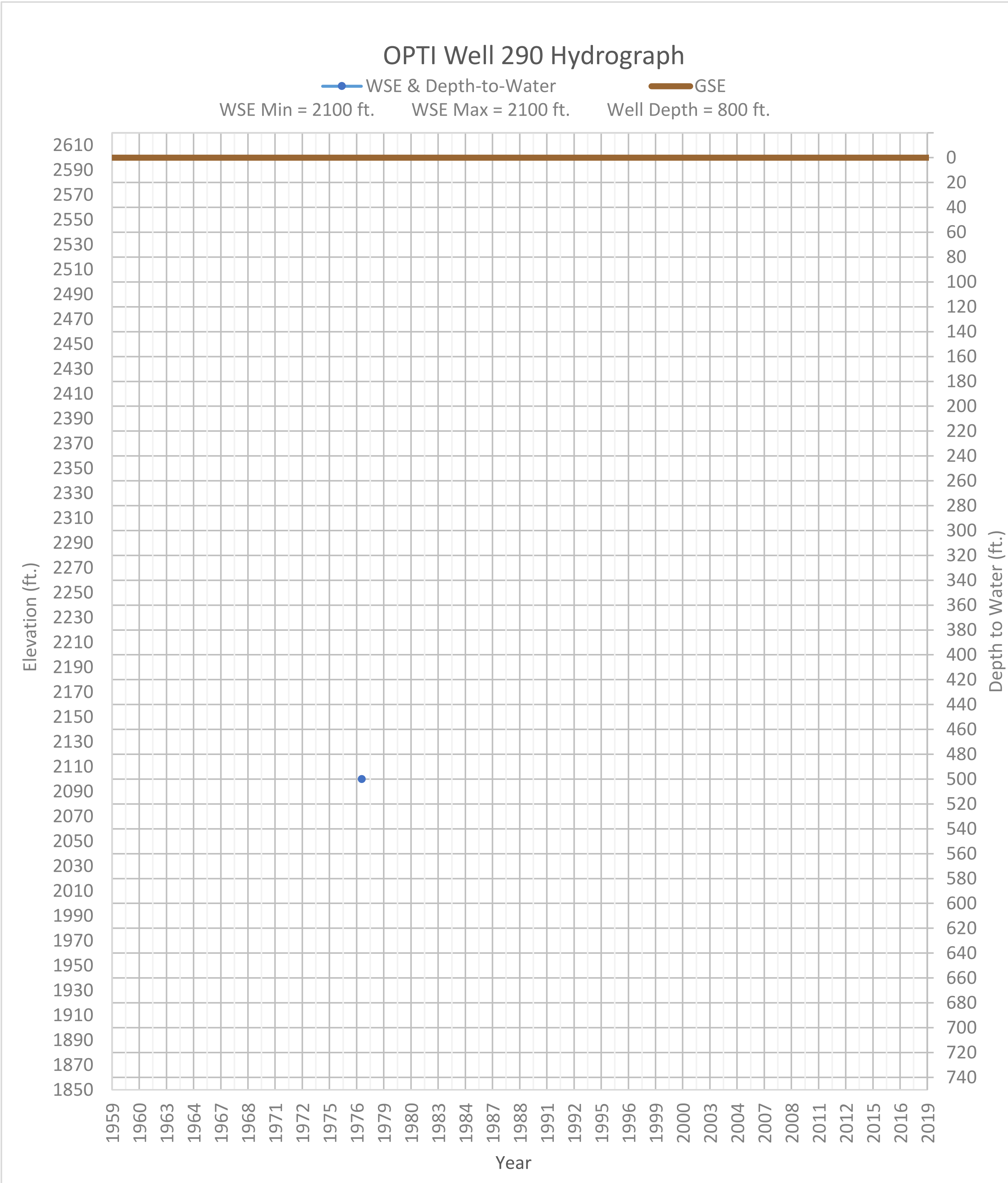
OPTI Well 285 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2225 ft.
WSE Max = 2225 ft.
Well Depth = 504 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

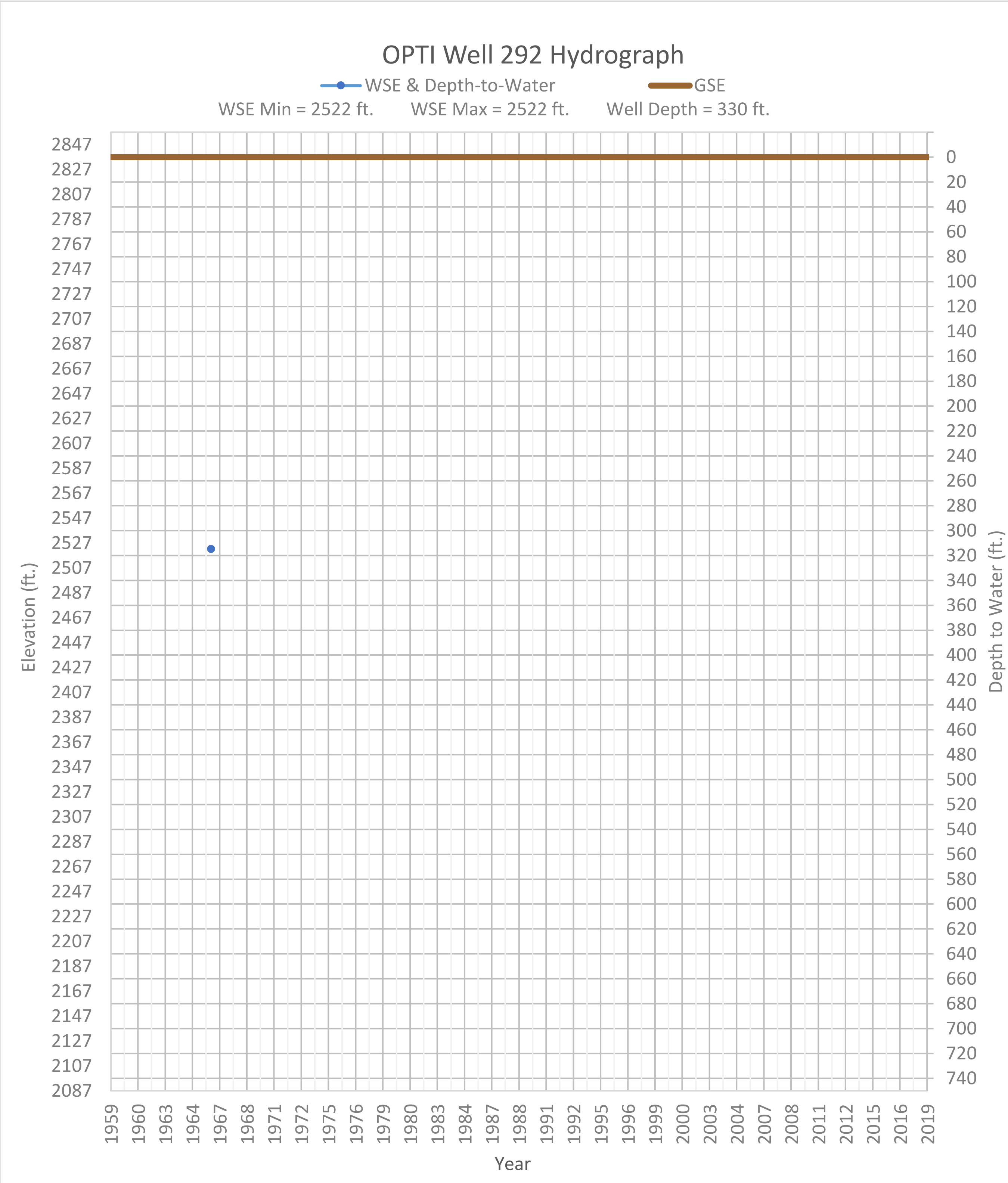


OPTI Well 286 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2592 ft.
WSE Max = 2592 ft.
Well Depth = 280 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

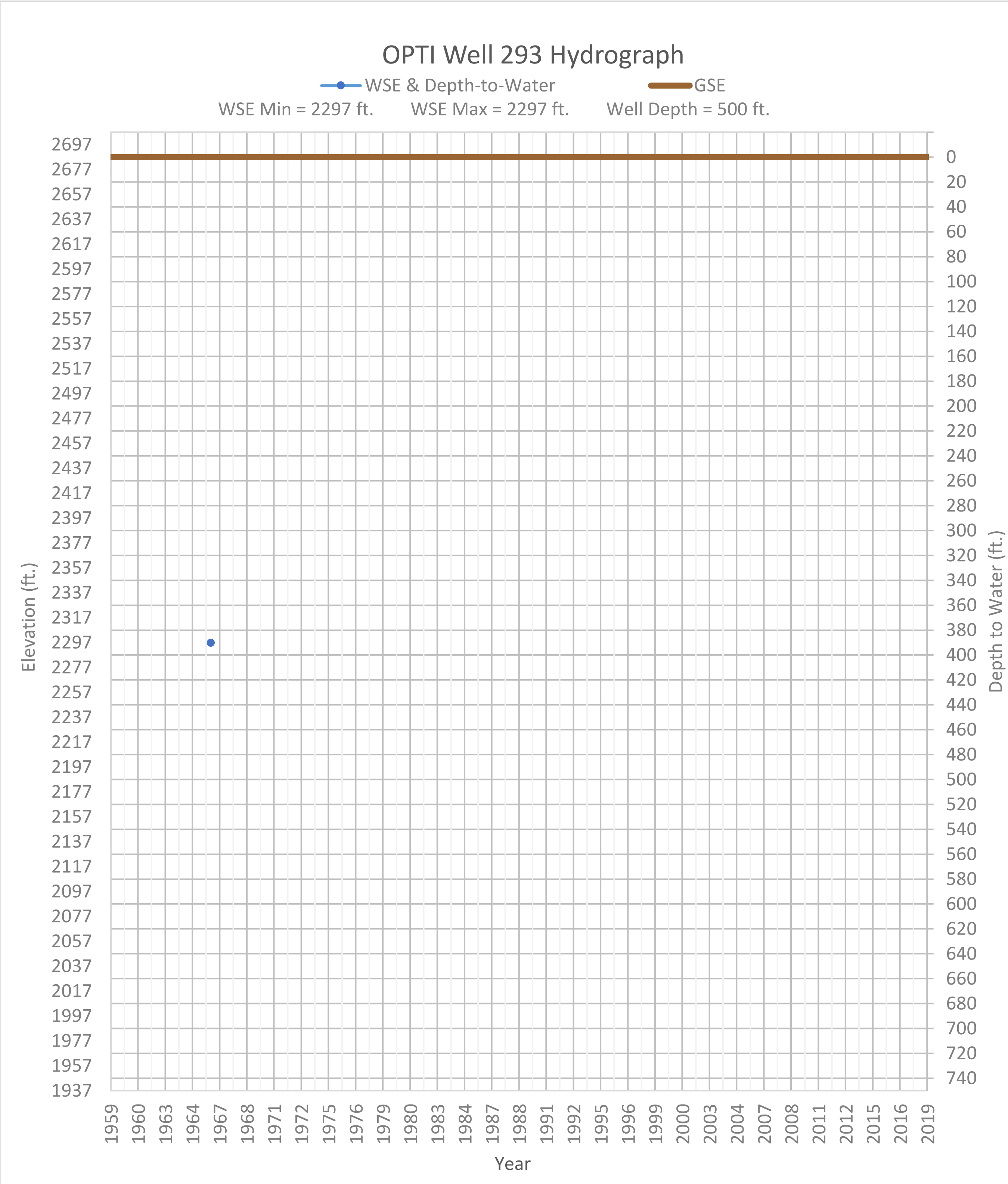


OPTI Well 287 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2459 ft.
WSE Max = 2466 ft.
Well Depth = 345 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

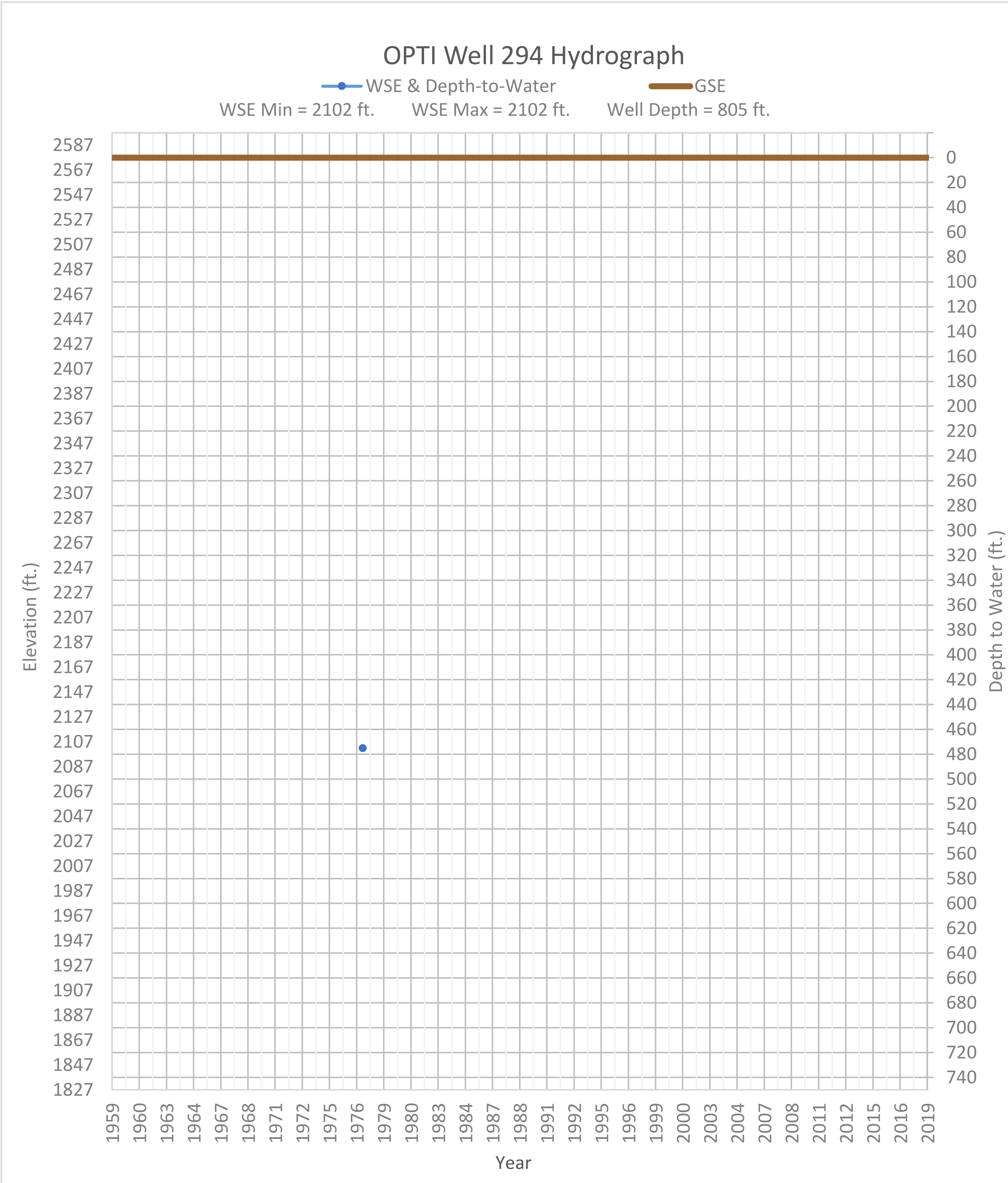

OPTI Well 290 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2100 ft.
WSE Max = 2100 ft.
Well Depth = 800 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 292 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2522 ft.
WSE Max = 2522 ft.
Well Depth = 330 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 293 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2297 ft.
WSE Max = 2297 ft.
Well Depth = 500 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 294 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2102 ft.
WSE Max = 2102 ft.
Well Depth = 805 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2587
2567
2547
2527
2507
2487
2467
2447
2427
2407
2387
2367
2347
2327
2307
2287
2267
2247
2227
2207
2187
2167
2147
2127
2107
2087
2067
2047
2027
2007
1987
1967
1947
1927
1907
1887
1867
1847
1827
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720
740
1959
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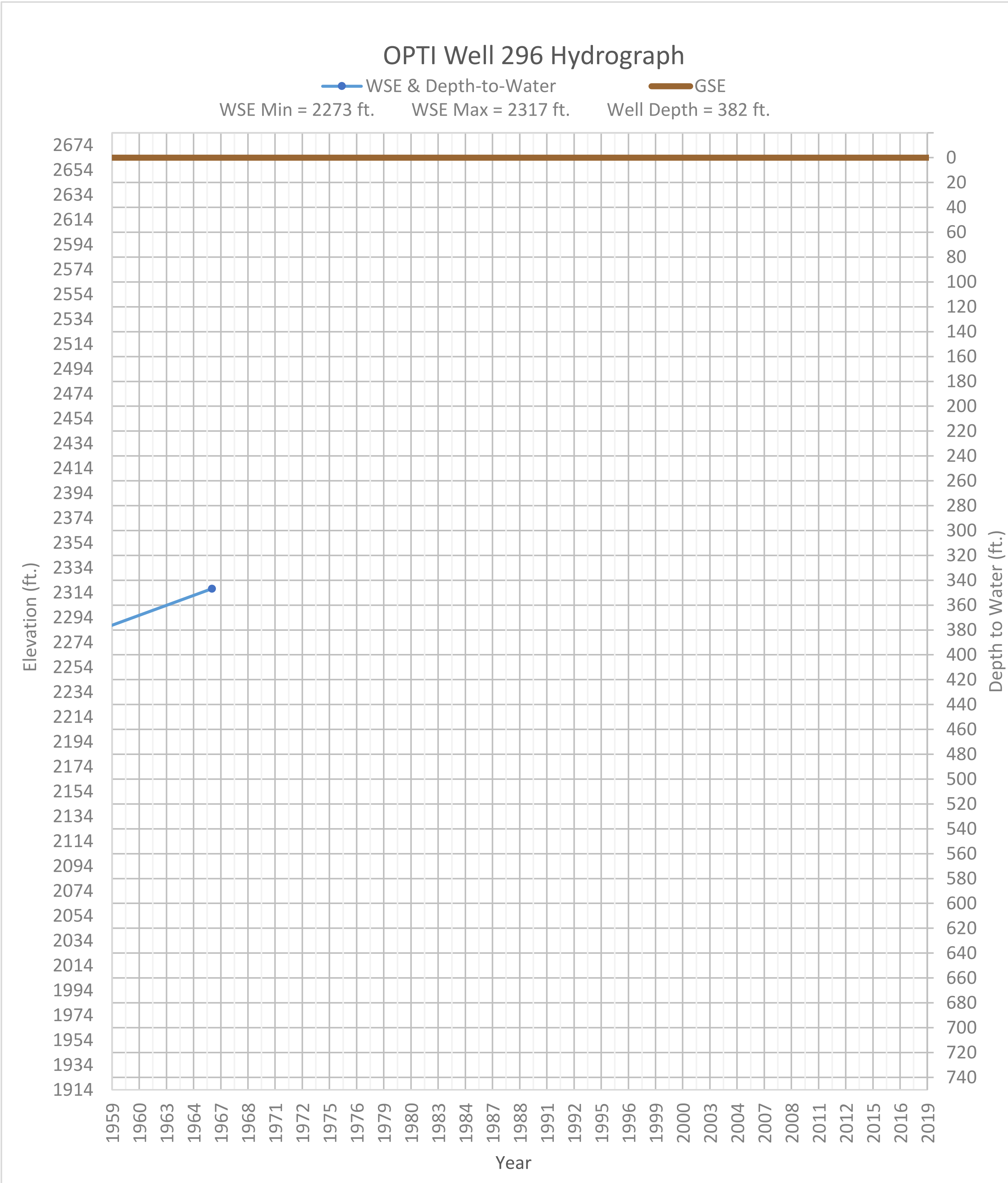
2012
2015
2016
2019



OPTI Well 296 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2273 ft.
WSE Max = 2317 ft.
Well Depth = 382 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2674
2654
2634
2614
2594
2574
2554
2534
2514
2494
2474
2454
2434
2414
2394
2374
2354
2334
2314
2294
2274
2254
2234
2214
2194
2174
2154
2134
2114
2094
2074
2054
2034
2014
1994
1974
1954
1934
1914
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720
740
1959
1960
1963
1964
1967
1968
1971
1972
1975
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2008
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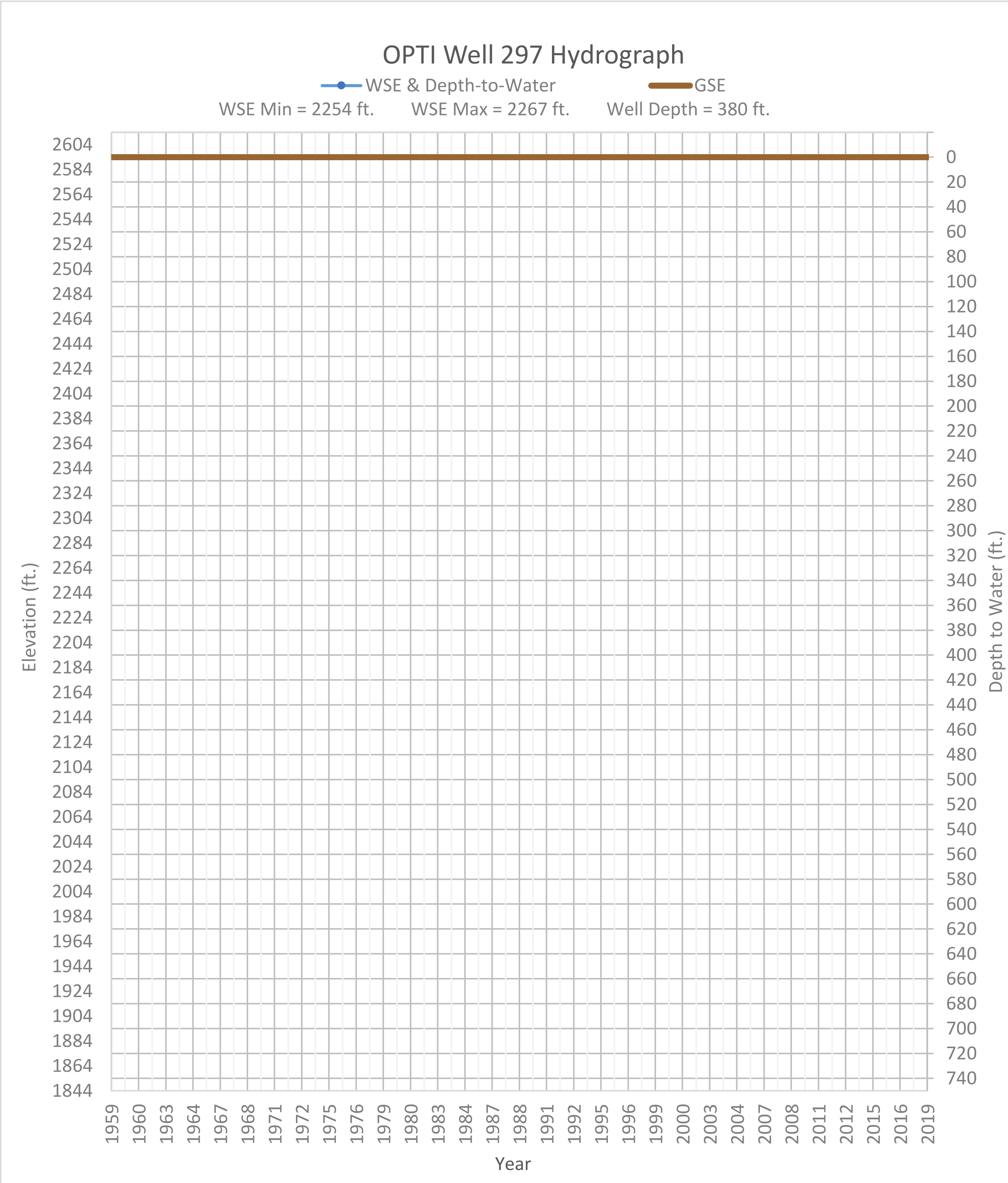
2012
2015
2016
2019


OPTI Well 297 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2254 ft.
WSE Max = 2267 ft.
Well Depth = 380 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2604
2584
2564
2544
2524
2504
2484
2464
2444
2424
2404
2384
2364
2344
2324
2304
2284
2264
2244
2224
2204
2184
2164
2144
2124
2104
2084
2064
2044
2024
2004
1984
1964
1944
1924
1904
1884
1864
1844
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
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680
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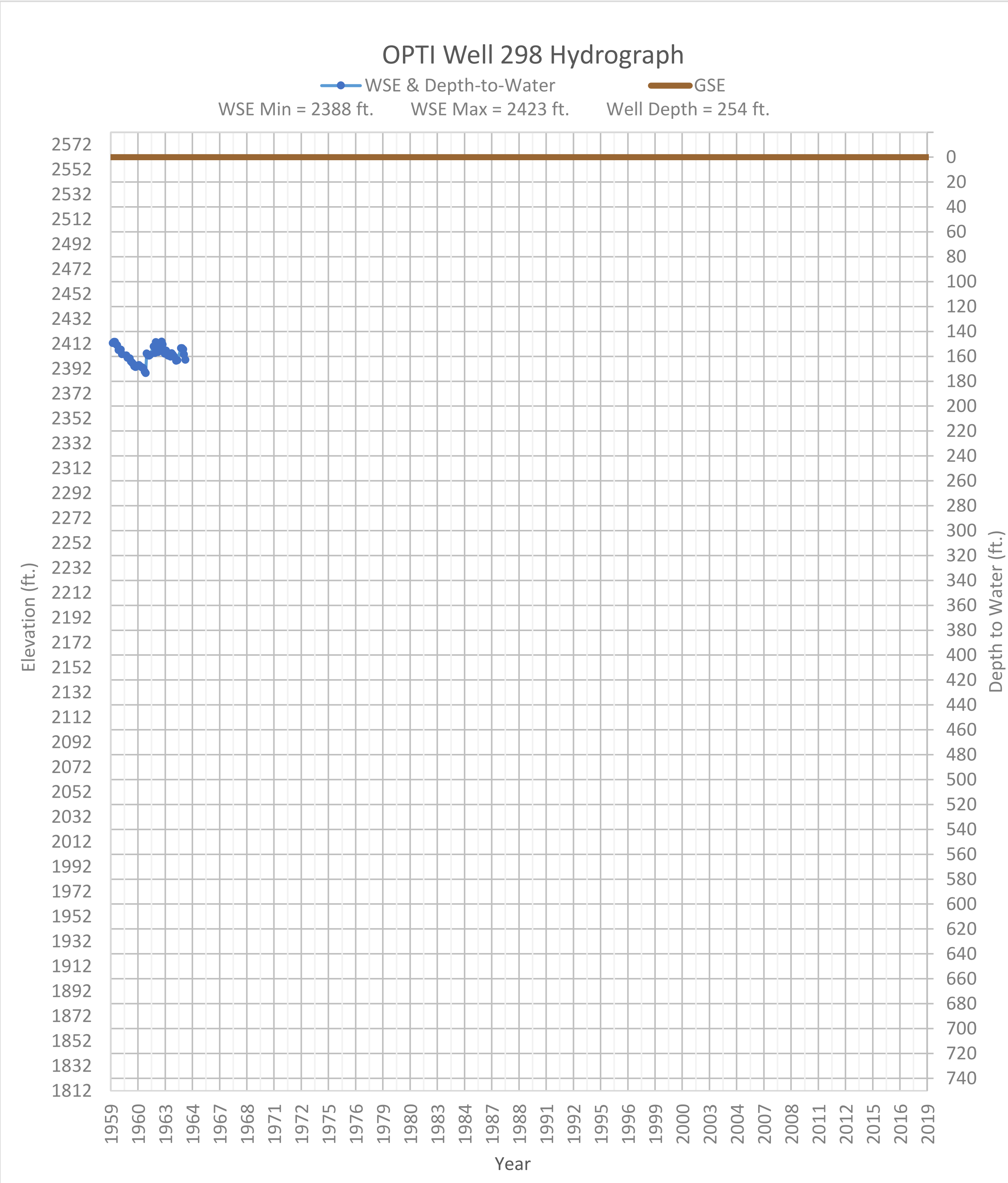
2012
2015
2016
2019



OPTI Well 298 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2388 ft.
WSE Max = 2423 ft.
Well Depth = 254 ft.
Elevation (ft.)
2572
2552
2532
2512
2492
2472
2452
2432
2412
2392
2372
2352
2332
2312
2292
2272
2252
2232
2212
2192
2172
2152
2132
2112
2092
2072
2052
2032
2012
1992
1972
1952
1932
1912
1892
1872
1852
1832
1812
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720
740
Year
1959
1960
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1964
1967
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1971
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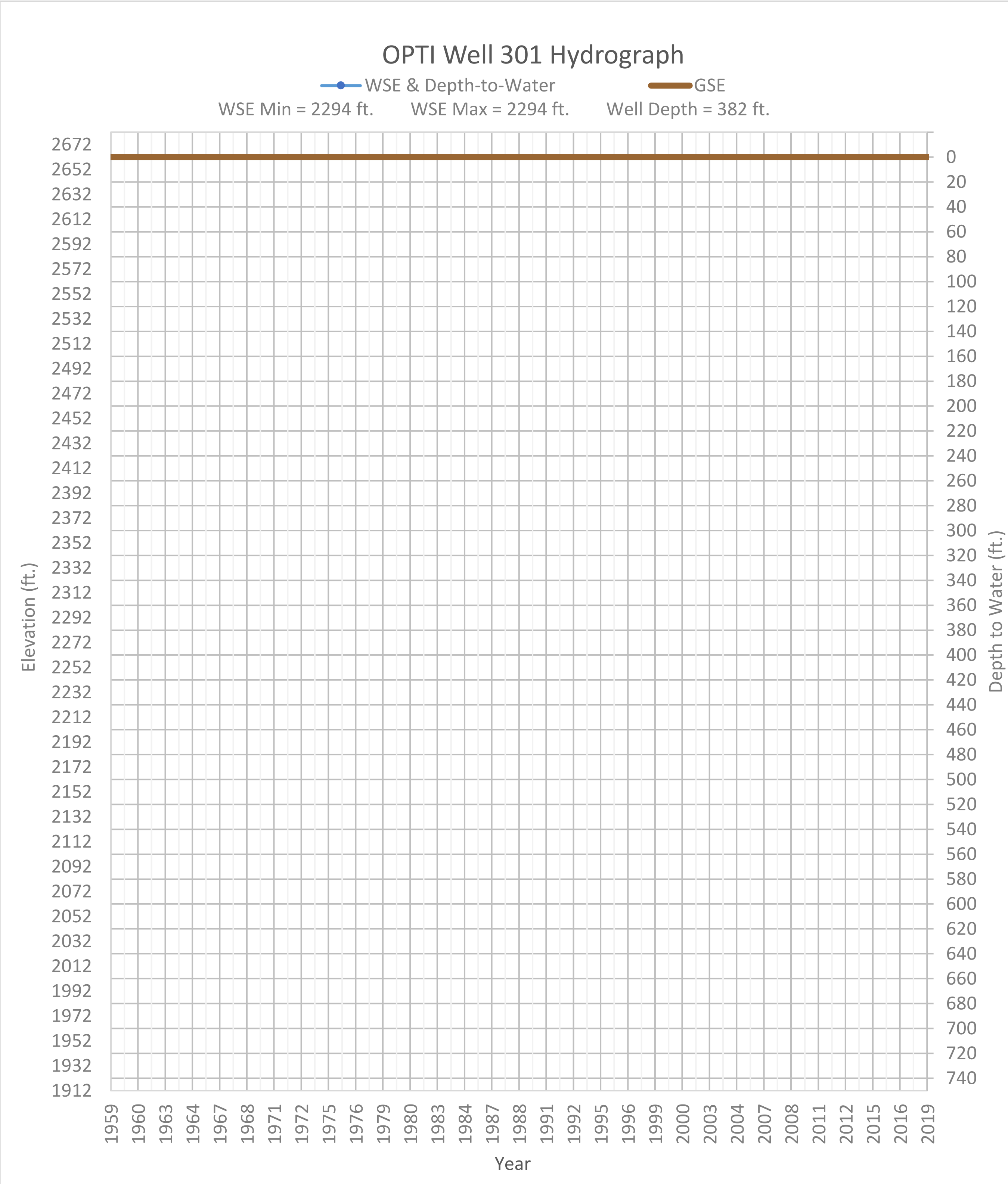
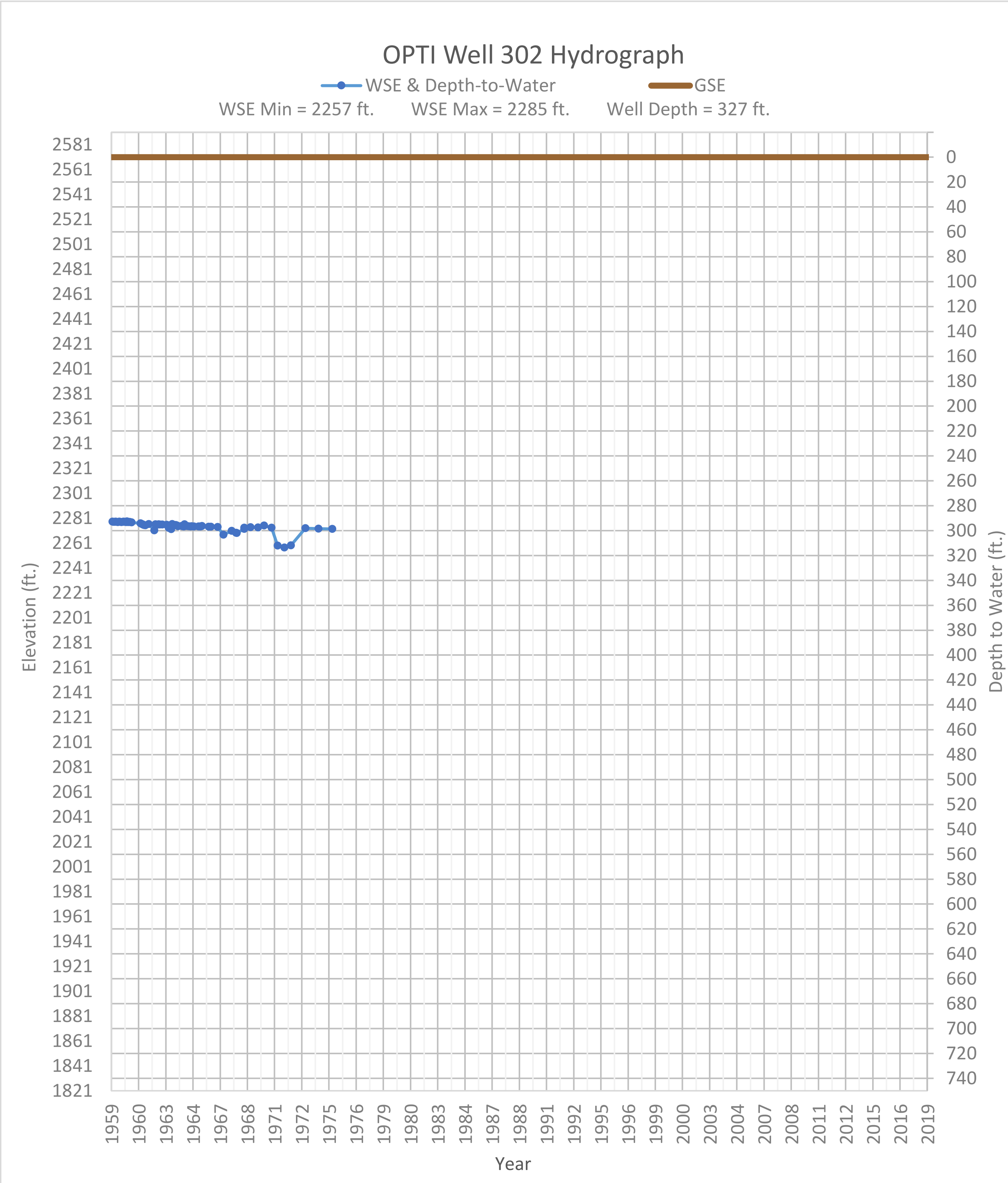
2016
2019



OPTI Well 301 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2294 ft.
WSE Max = 2294 ft.
Well Depth = 382 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 302 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2257 ft.
WSE Max = 2285 ft.
Well Depth = 327 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2581
2561
2541
2521
2501
2481
2461
2441
2421
2401
2381
2361
2341
2321
2301
2281
2261
2241
2221
2201
2181
2161
2141
2121
2101
2081
2061
2041
2021
2001
1981
1961
1941
1921
1901
1881
1861
1841
1821
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720
740
1959
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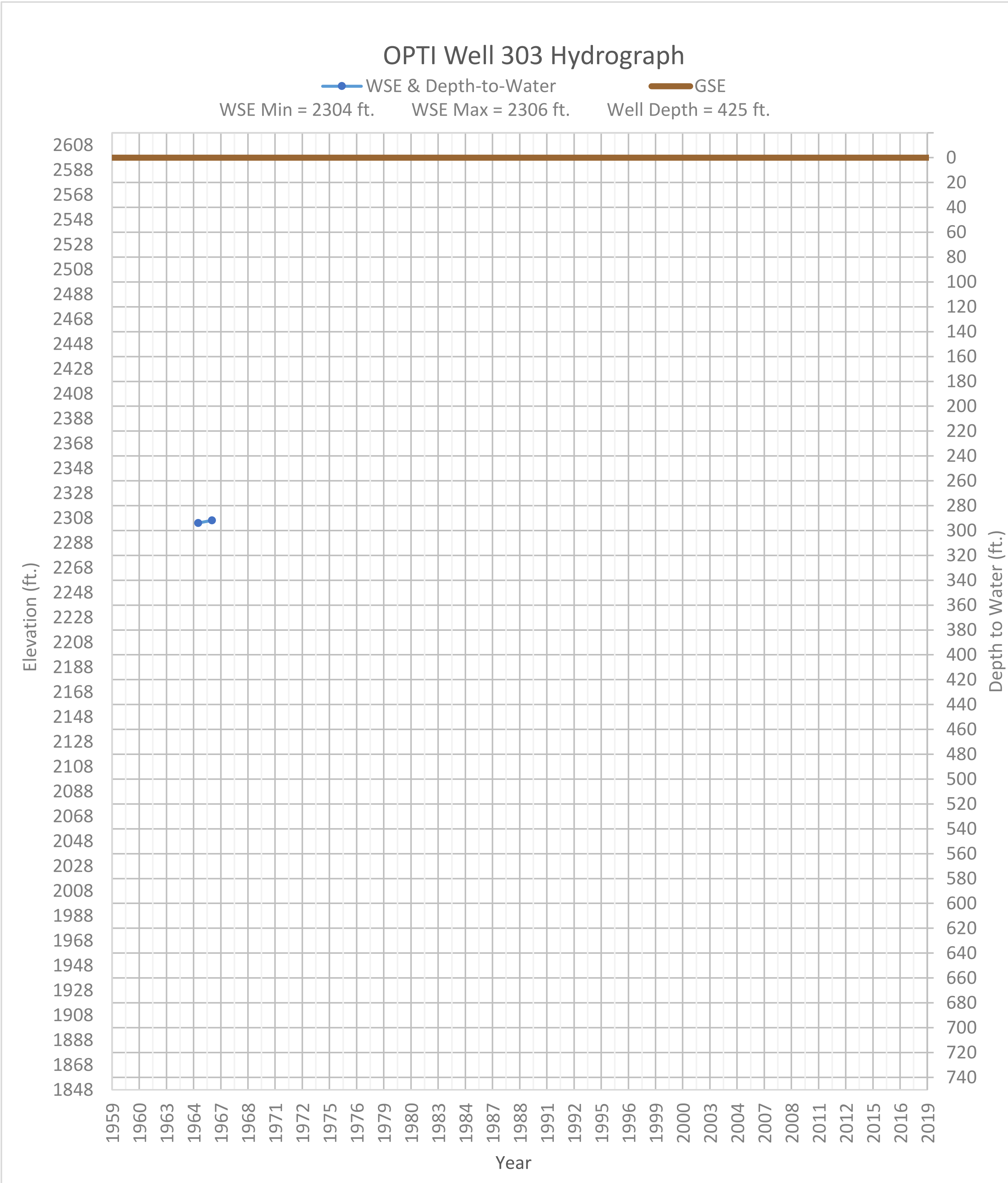
2016
2019



OPTI Well 303 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2304 ft.
WSE Max = 2306 ft.
Well Depth = 425 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 307 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2288 ft.
WSE Max = 2606 ft.
Well Depth = 322 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2616
2596
2576
2556
2536
2516
2496
2476
2456
2436
2416
2396
2376
2356
2336
2316
2296
2276
2256
2236
2216
2196
2176
2156
2136
2116
2096
2076
2056
2036
2016
1996
1976
1956
1936
1916
1896
1876
1856
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
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460
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540
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620
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740
1959
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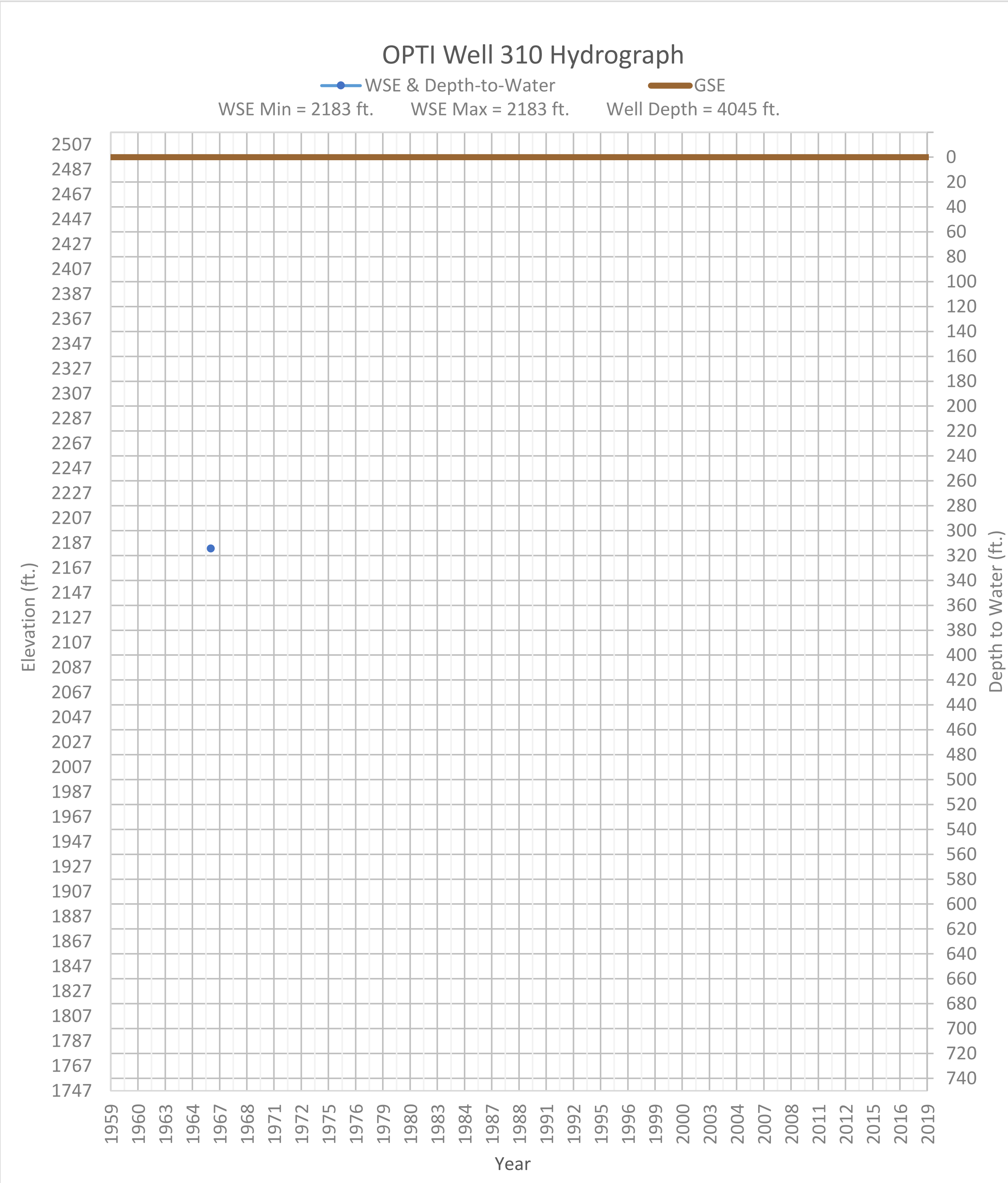
2016
2019


OPTI Well 310 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2183 ft.
WSE Max = 2183 ft.
Well Depth = 4045 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2507
2487
2467
2447
2427
2407
2387
2367
2347
2327
2307
2287
2267
2247
2227
2207
2187
2167
2147
2127
2107
2087
2067
2047
2027
2007
1987
1967
1947
1927
1907
1887
1867
1847
1827
1807
1787
1767
1747
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
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680
700
720
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1959
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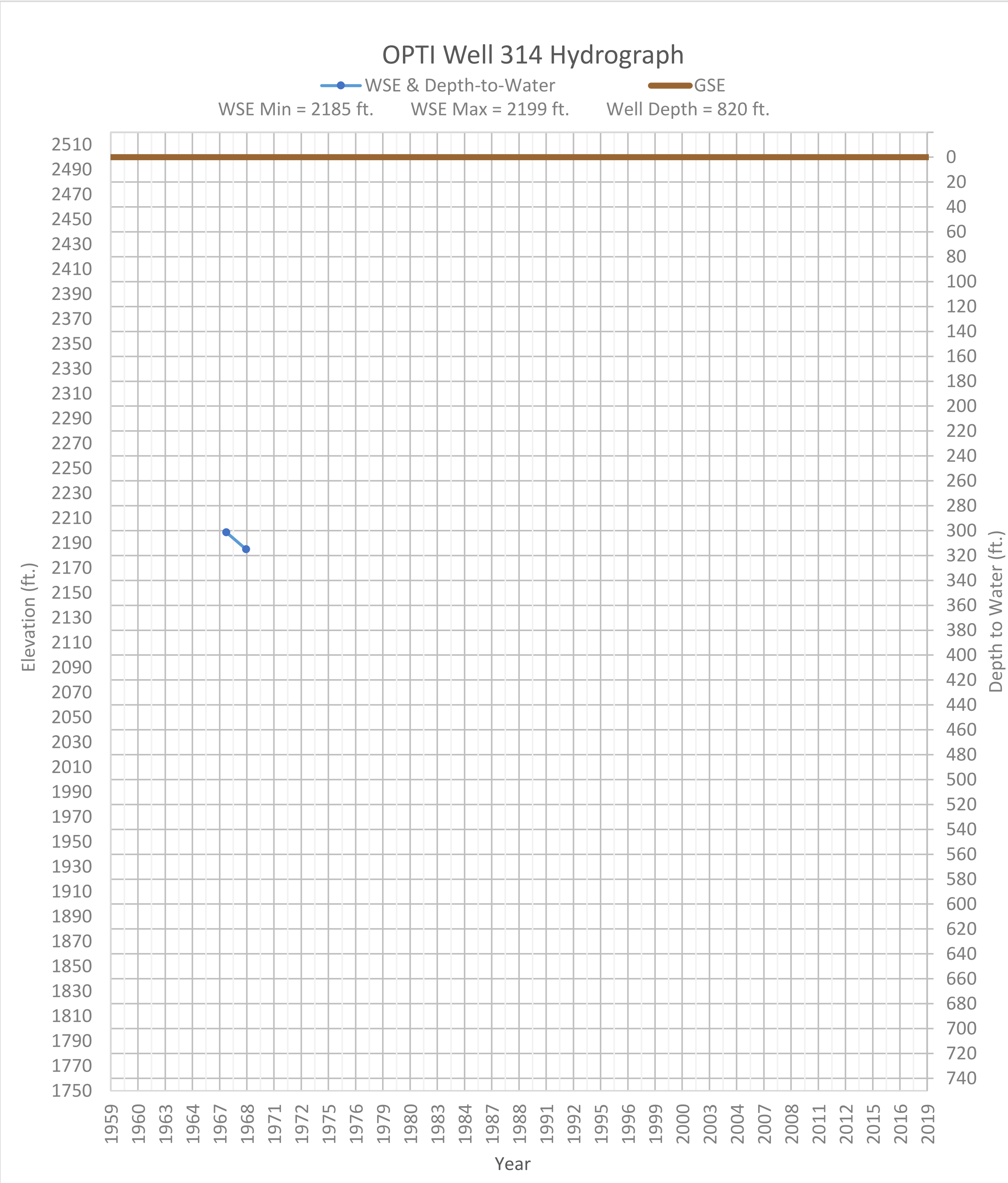
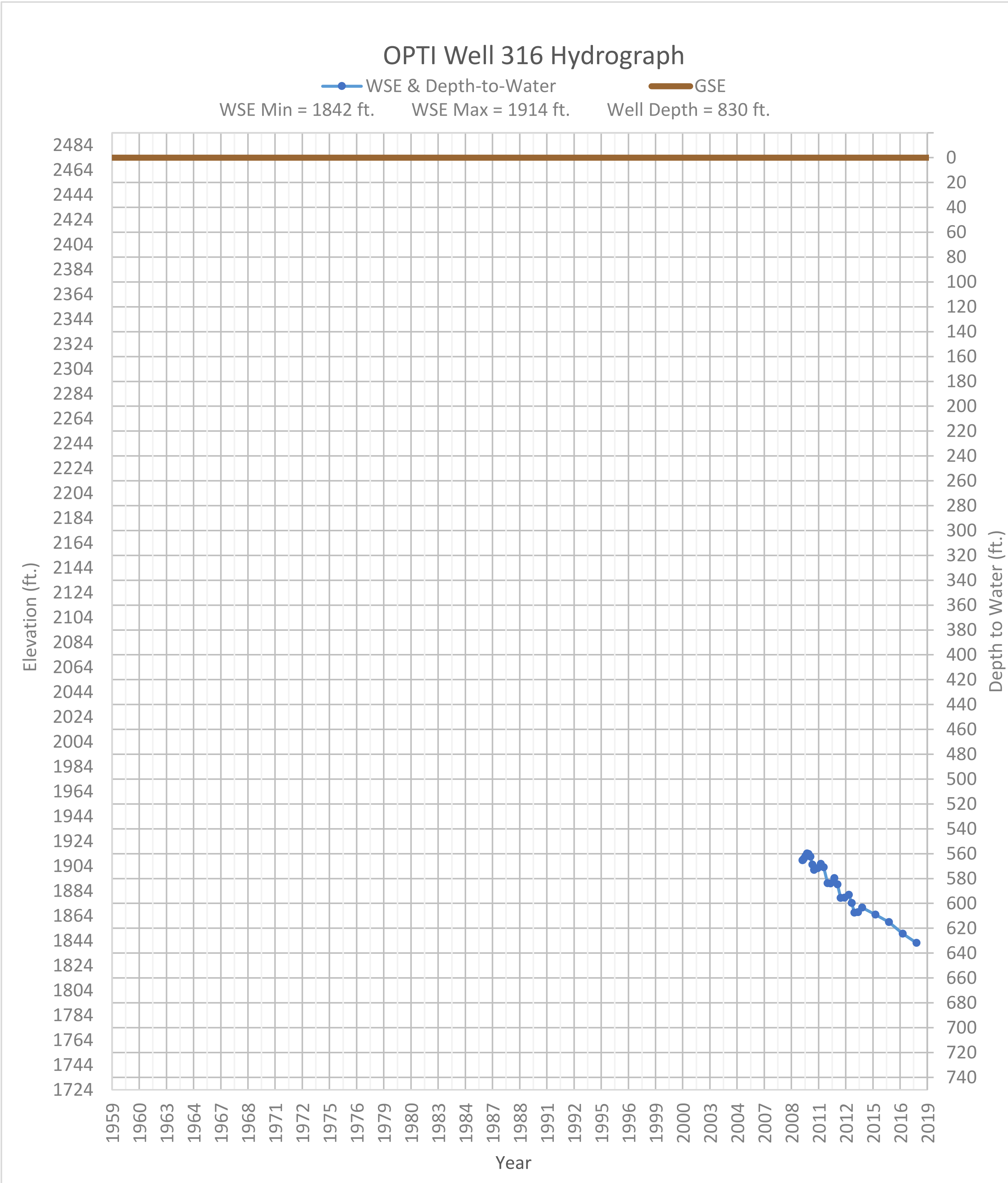
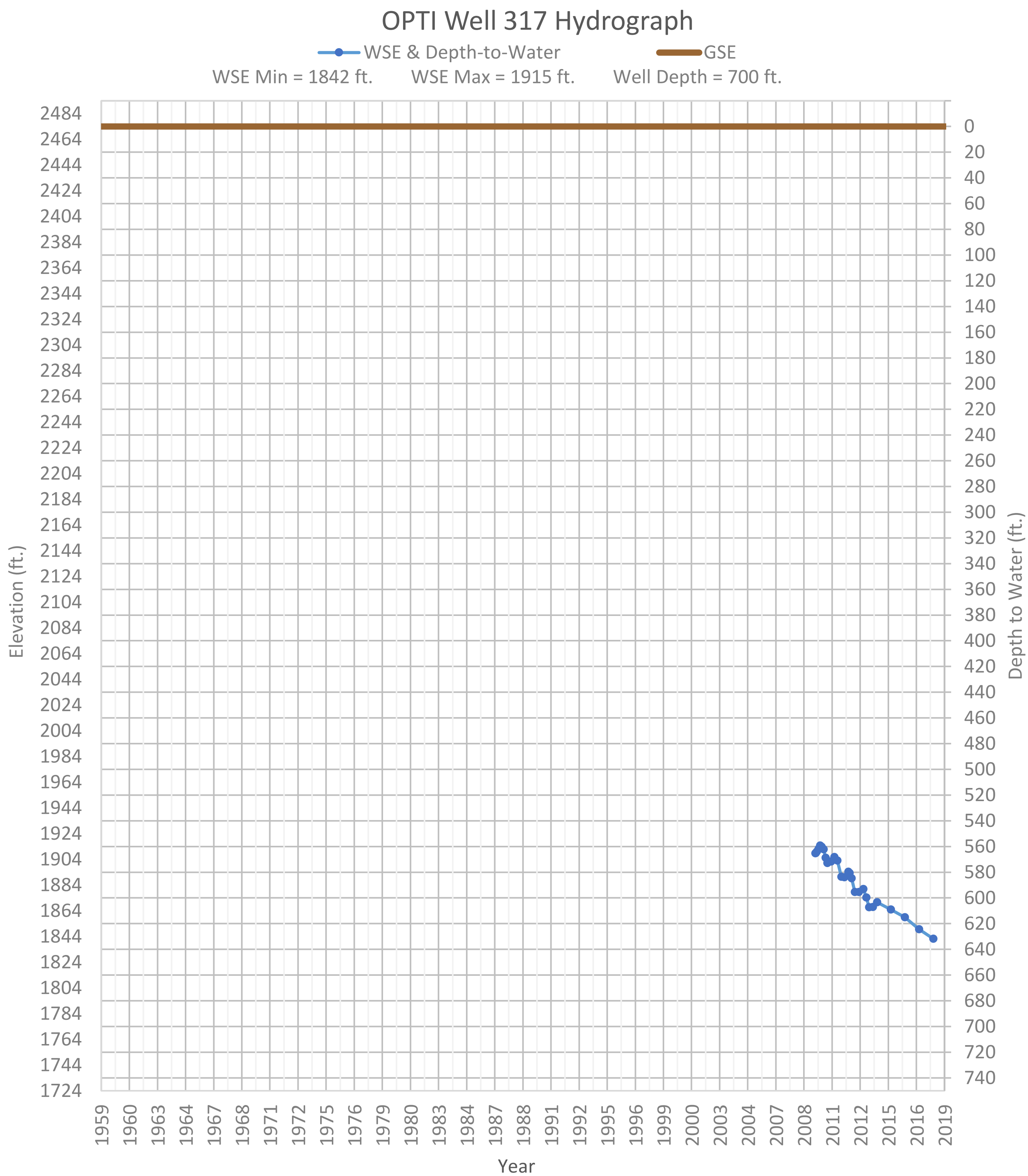
2012
2015
2016
2019



OPTI Well 314 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2185 ft.
WSE Max = 2199 ft.
Well Depth = 820 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 316 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1842 ft.
WSE Max = 1914 ft.
Well Depth = 830 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 317 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1842 ft.
WSE Max = 1915 ft.
Well Depth = 700 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2484
2464
2444
2424
2404
2384
2364
2344
2324
2304
2284
2264
2244
2224
2204
2184
2164
2144
2124
2104
2084
2064
2044
2024
2004
1984
1964
1944
1924
1904
1884
1864
1844
1824
1804
1784
1764
1744
1724
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20
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80
100
120
140
160
180
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220
240
260
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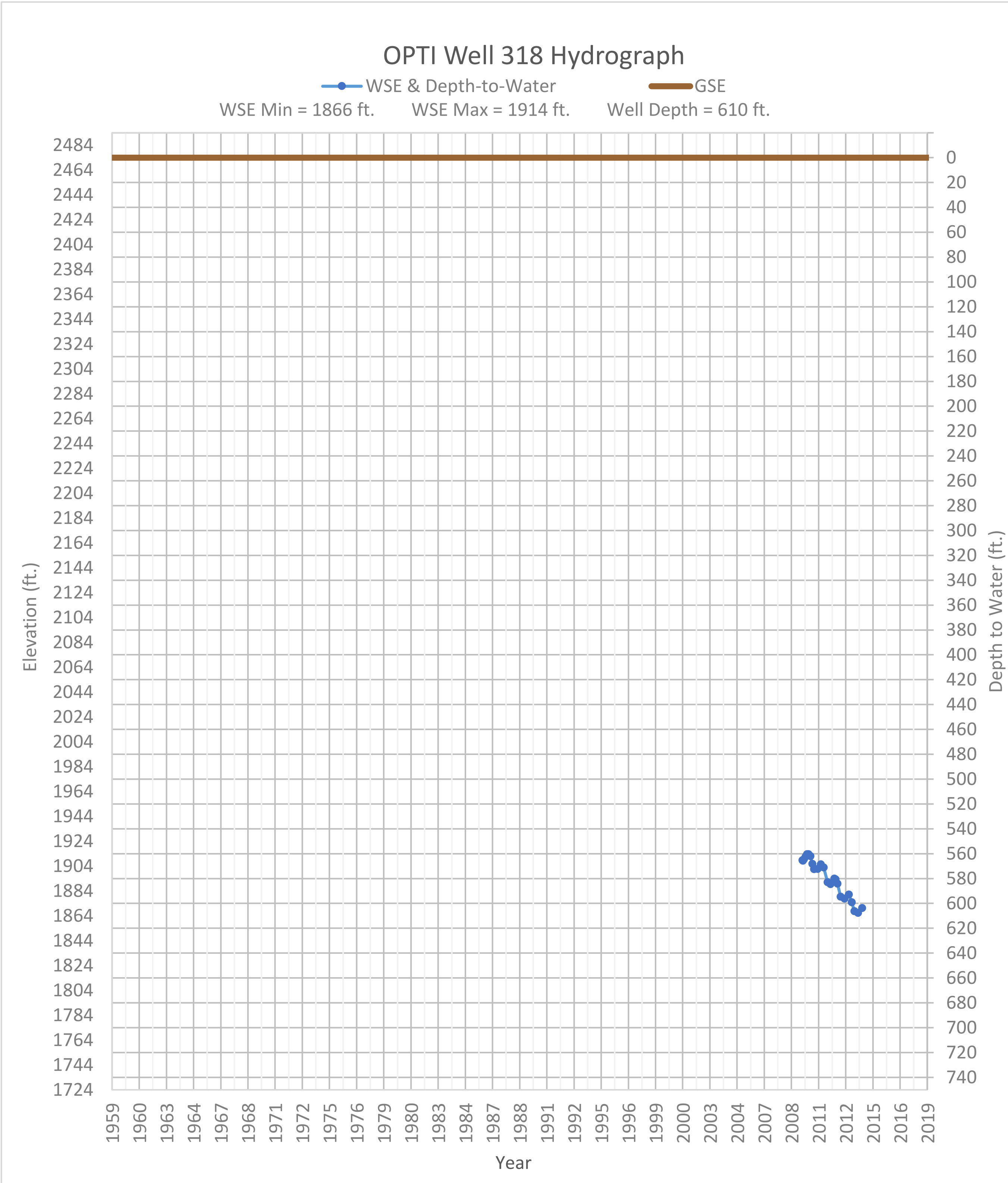
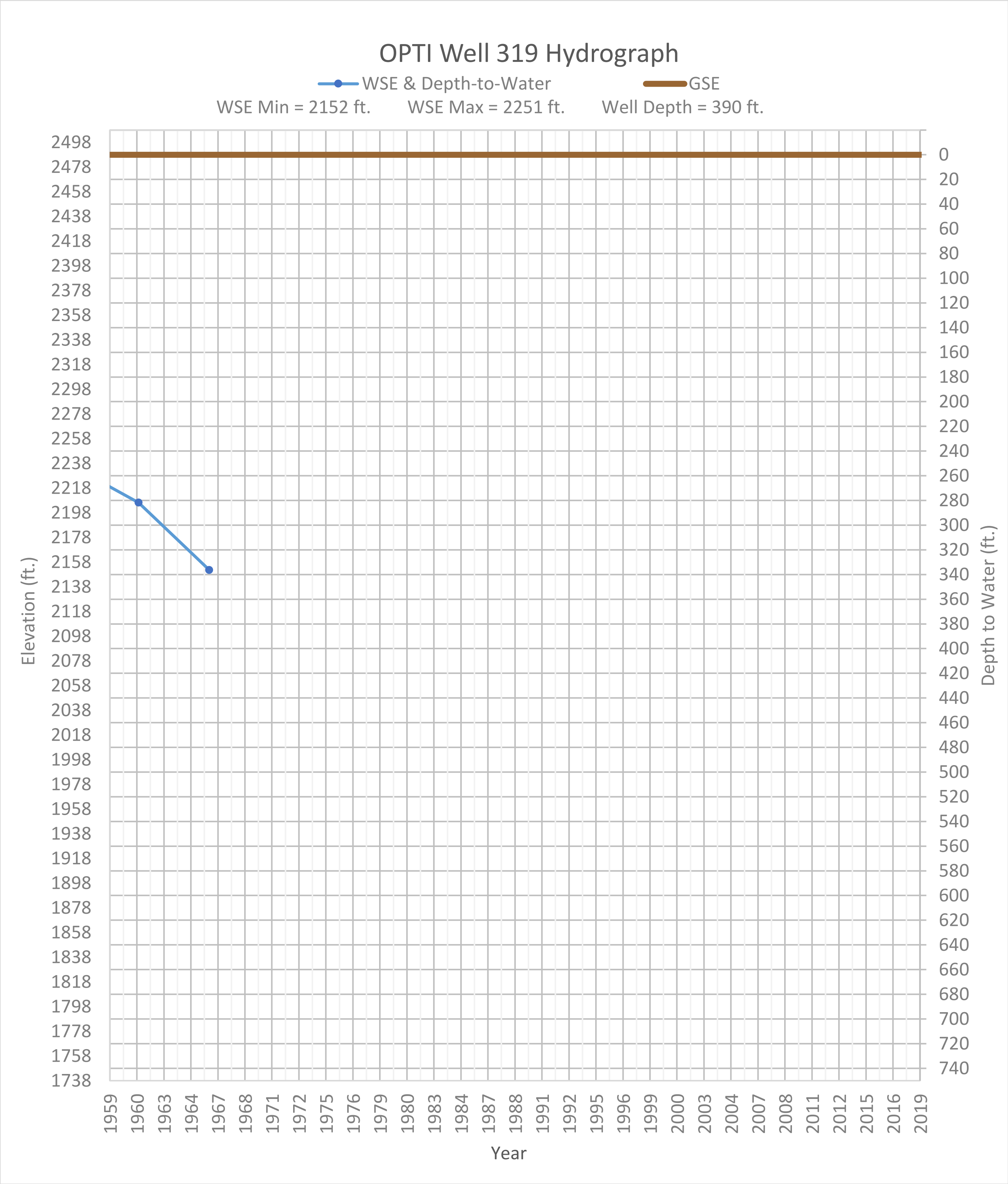
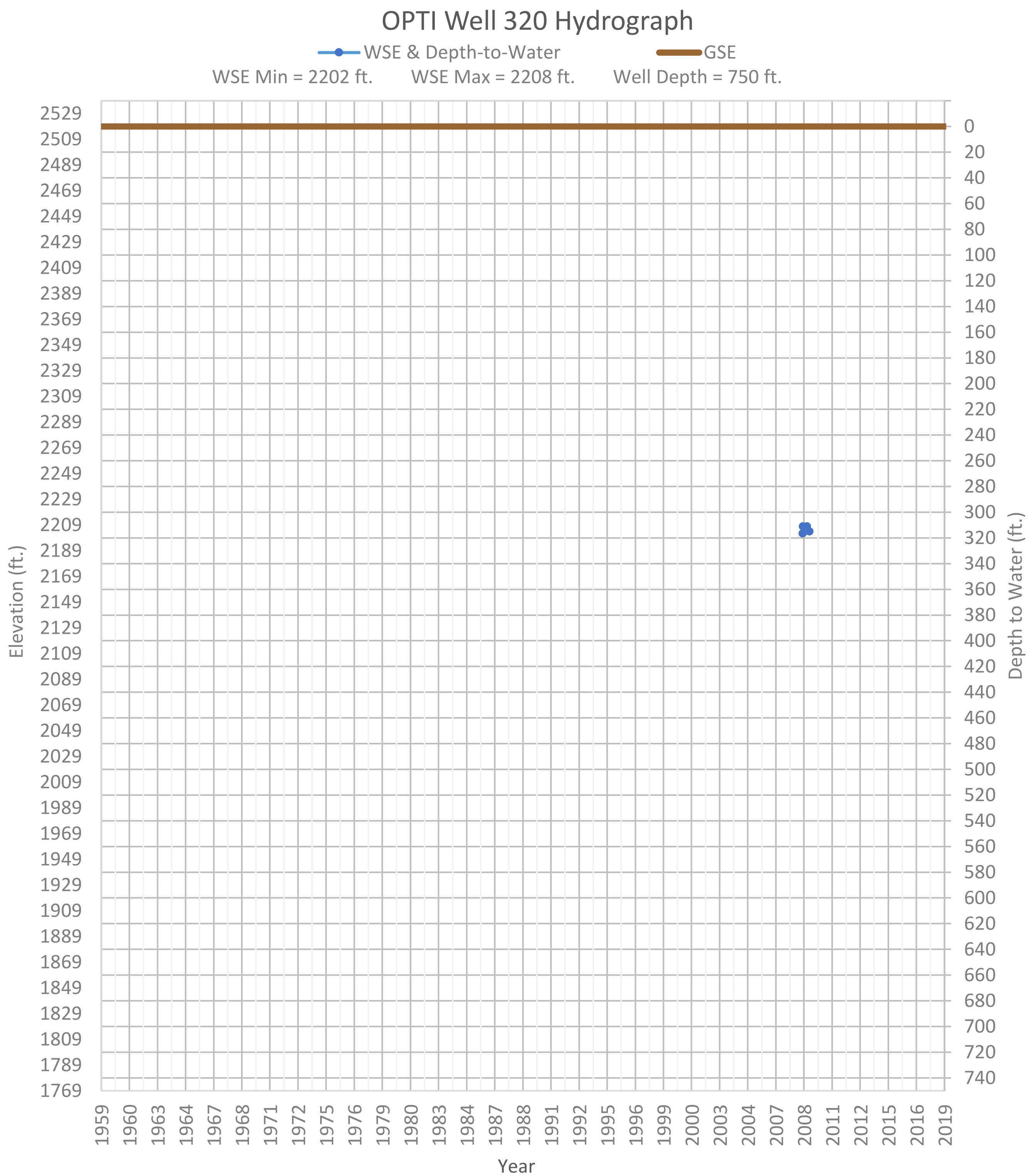
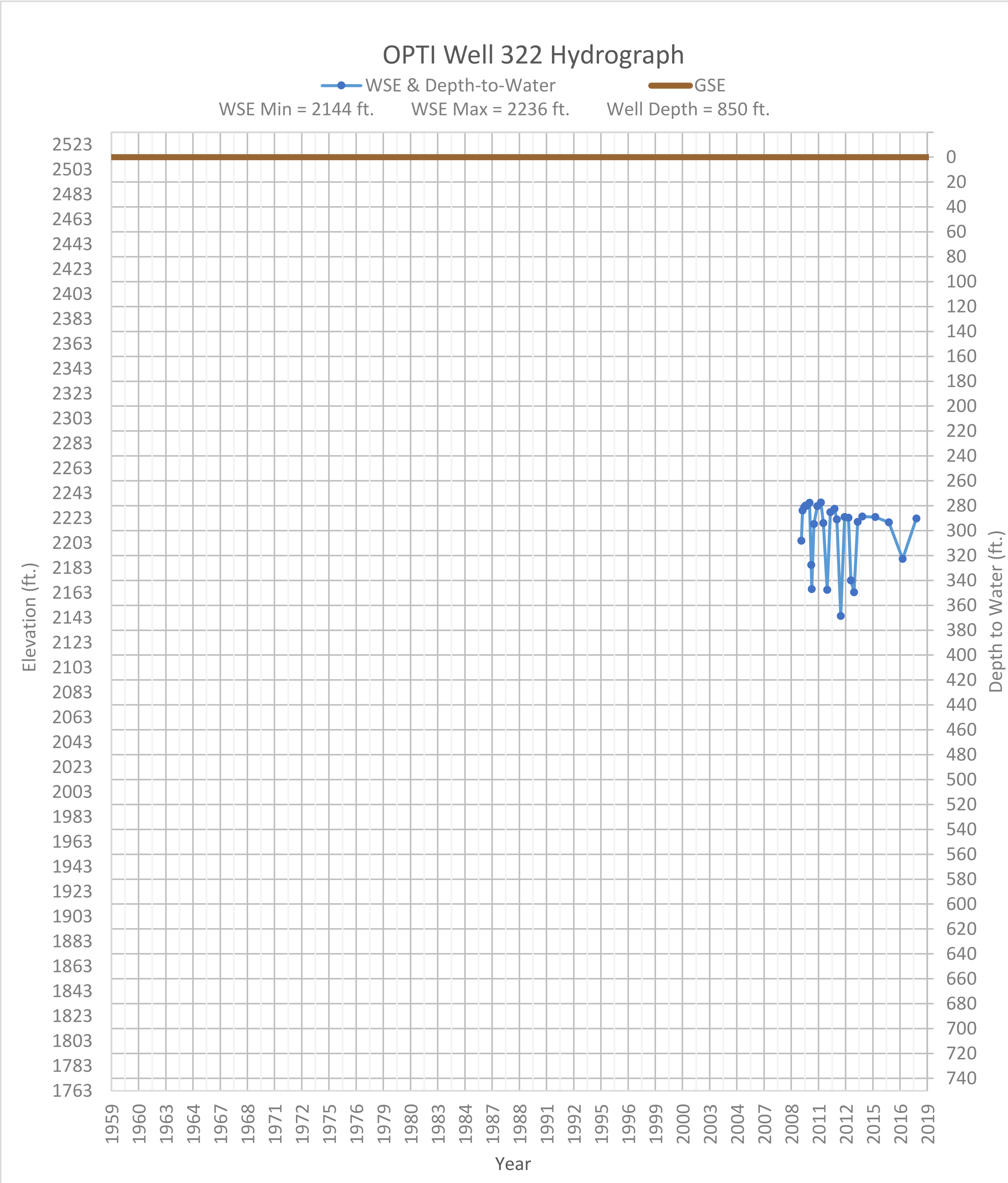


OPTI Well 318 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1866 ft.
WSE Max = 1914 ft.
Well Depth = 610 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 319 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2152 ft.
WSE Max = 2251 ft.
Well Depth = 390 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 320 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2202 ft.
WSE Max = 2208 ft.
Well Depth = 750 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 322 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2144 ft.
WSE Max = 2236 ft.
Well Depth = 850 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2523
2503
2483
2463
2443
2423
2403
2383
2363
2343
2323
2303
2283
2263
2243
2223
2203
2183
2163
2143
2123
2103
2083
2063
2043
2023
2003
1983
1963
1943
1923
1903
1883
1863
1843
1823
1803
1783
1763
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
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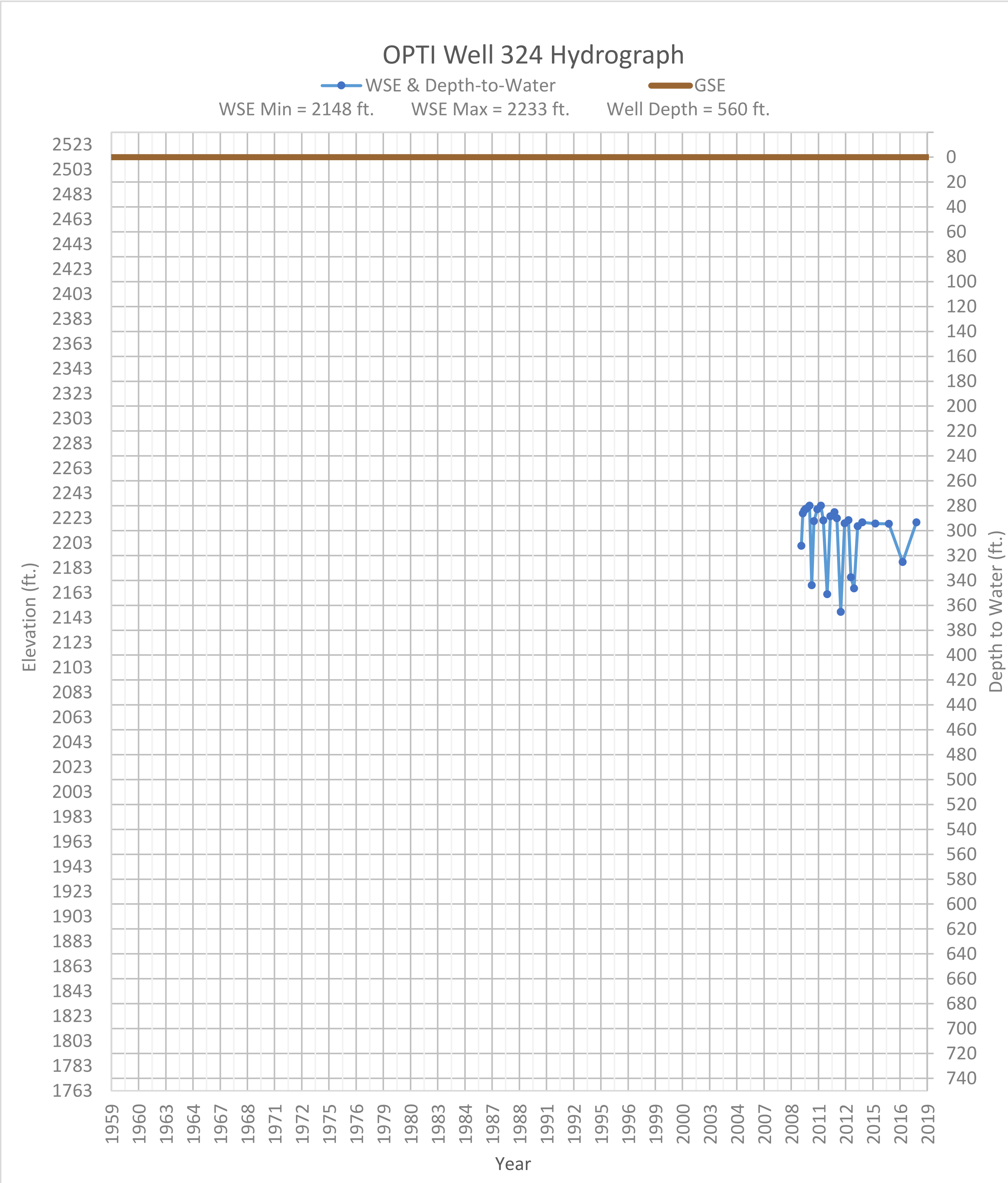
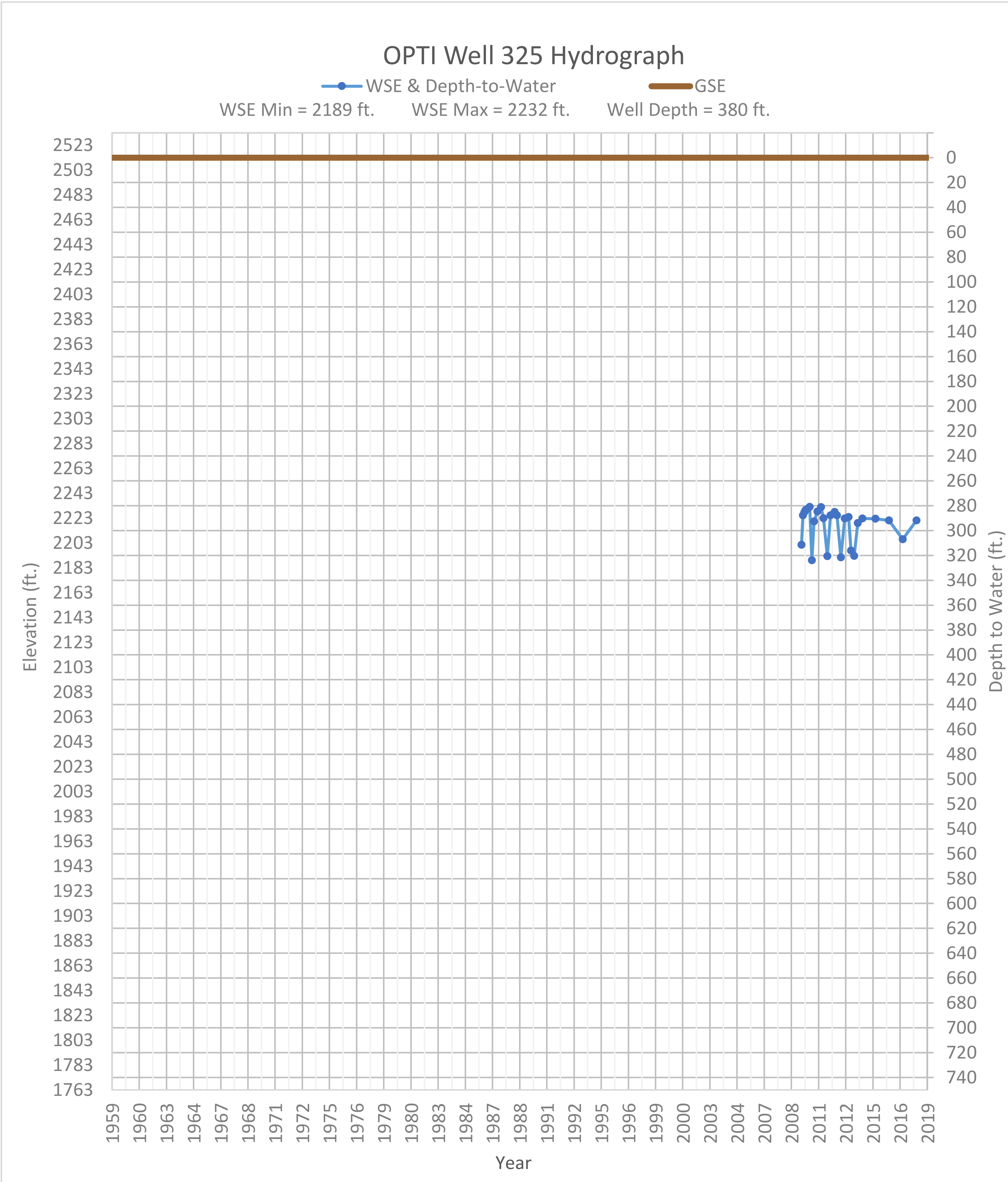


OPTI Well 324 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2148 ft.
WSE Max = 2233 ft.
Well Depth = 560 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 325 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2189 ft.
WSE Max = 2232 ft.
Well Depth = 380 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2523
2503
2483
2463
2443
2423
2403
2383
2363
2343
2323
2303
2283
2263
2243
2223
2203
2183
2163
2143
2123
2103
2083
2063
2043
2023
2003
1983
1963
1943
1923
1903
1883
1863
1843
1823
1803
1783
1763
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
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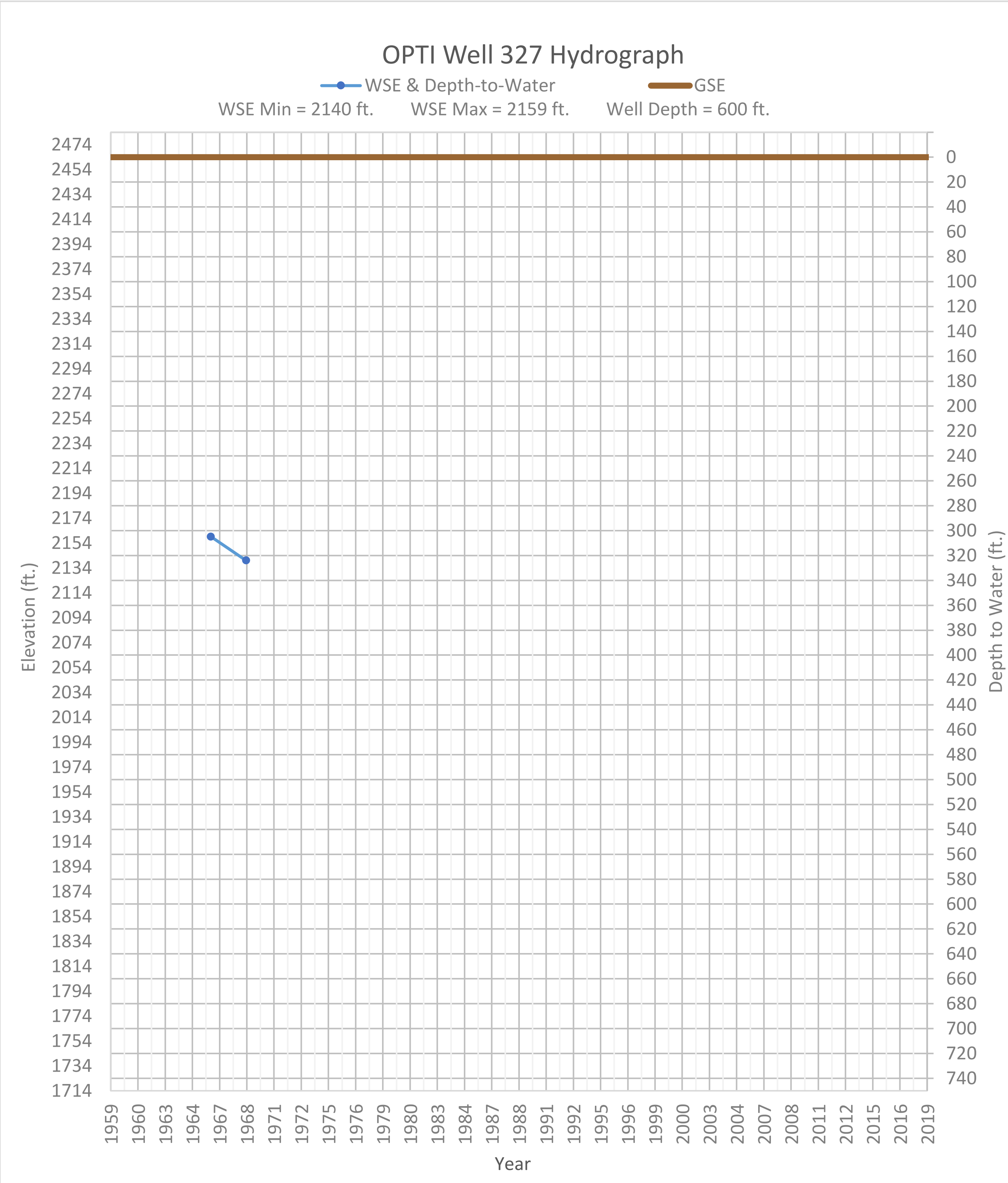
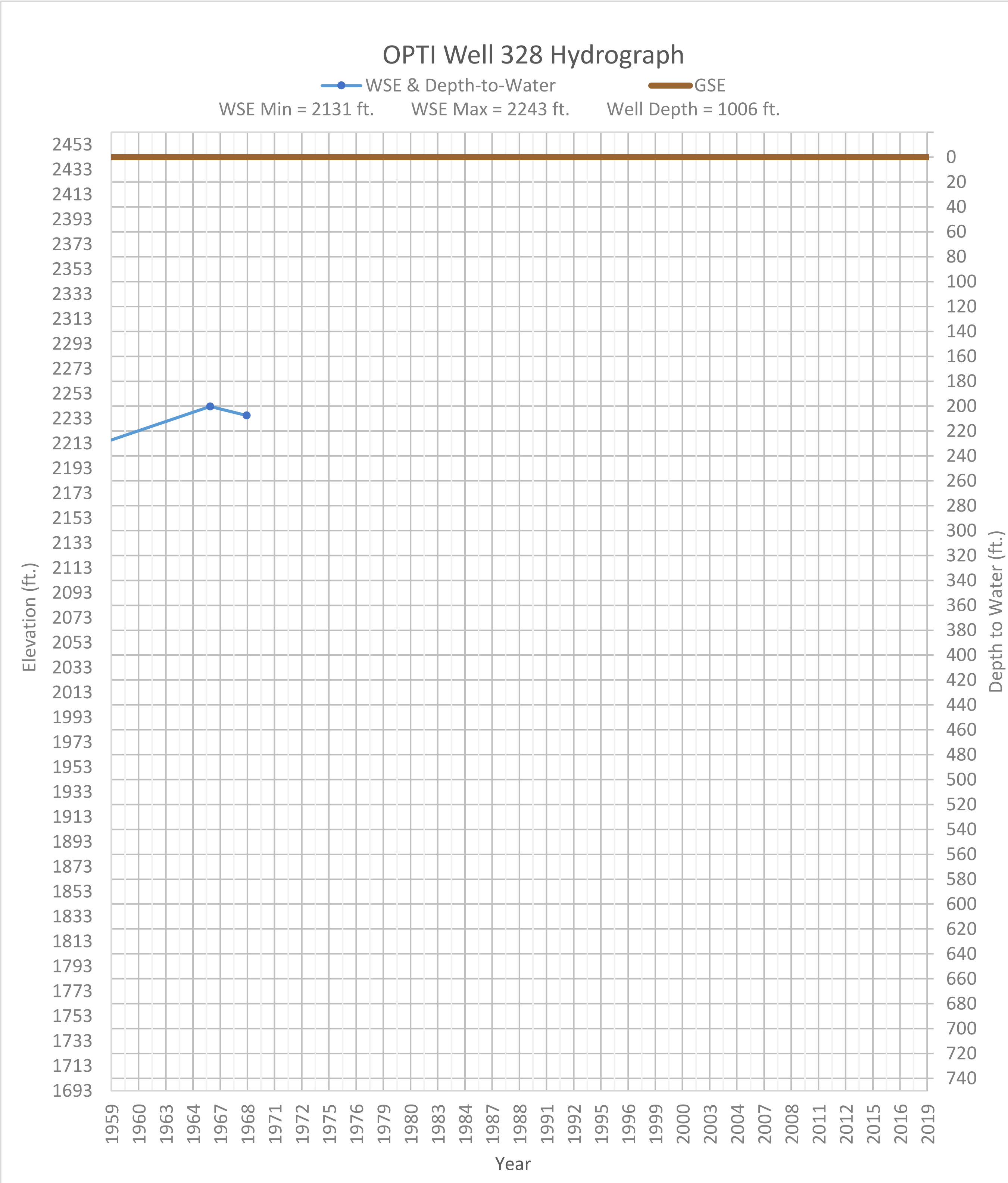
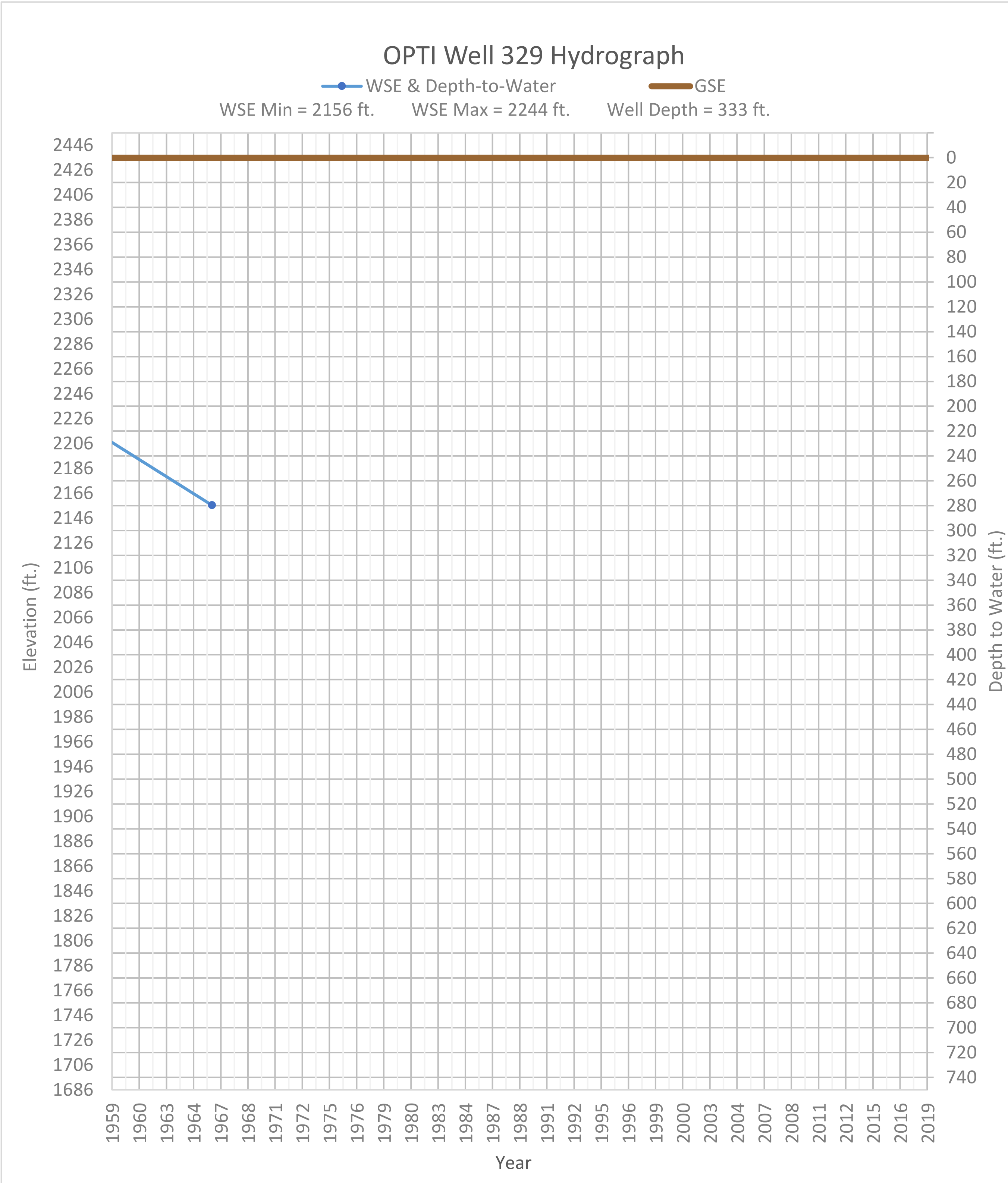

OPTI Well 327 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2140 ft.
WSE Max = 2159 ft.
Well Depth = 600 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 328 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2131 ft.
WSE Max = 2243 ft.
Well Depth = 1006 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 329 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2156 ft.
WSE Max = 2244 ft.
Well Depth = 333 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2446
2426
2406
2386
2366
2346
2326
2306
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
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1826
1806
1786
1766
1746
1726
1706
1686
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40
60
80
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120
140
160
180
200
220
240
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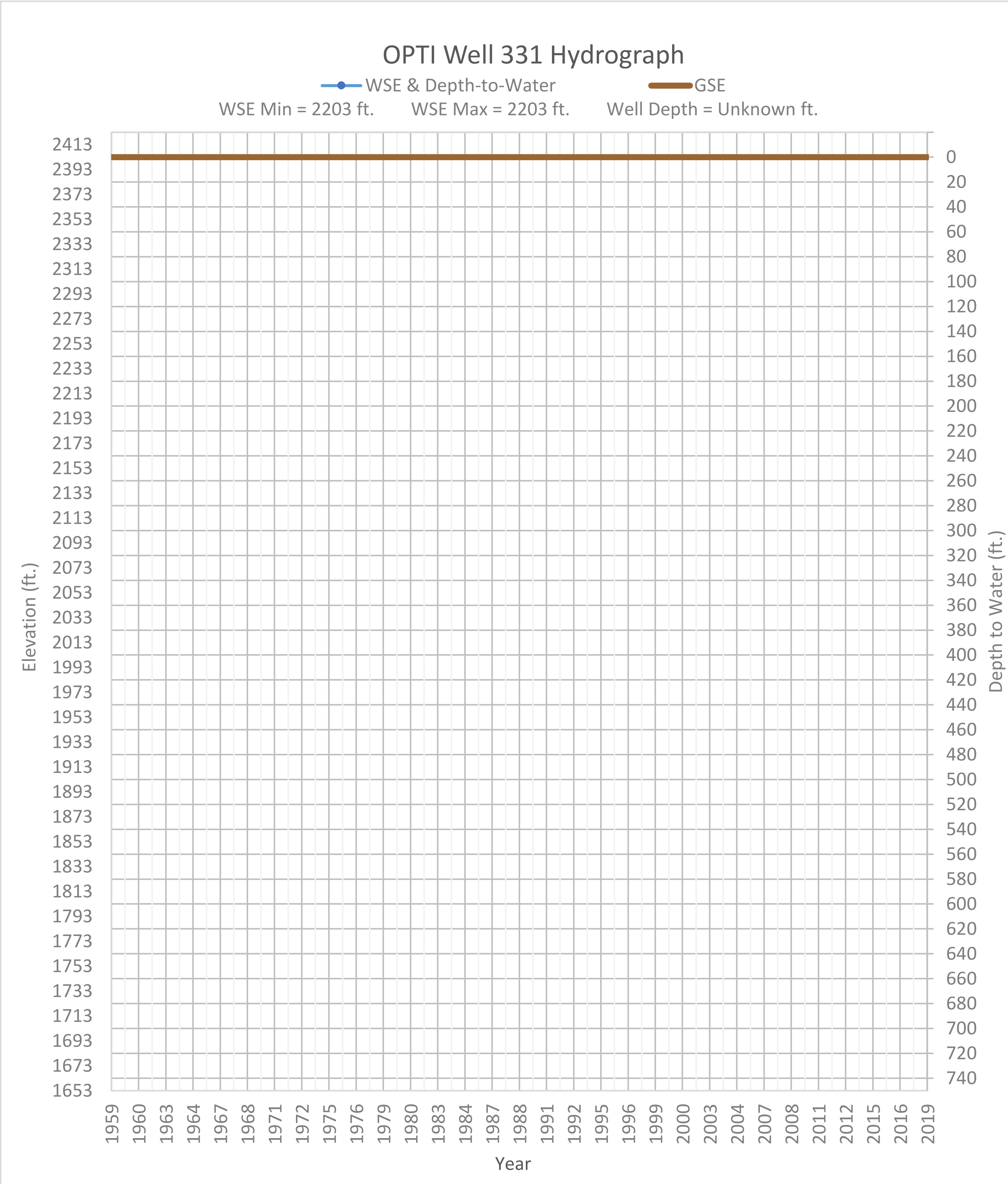
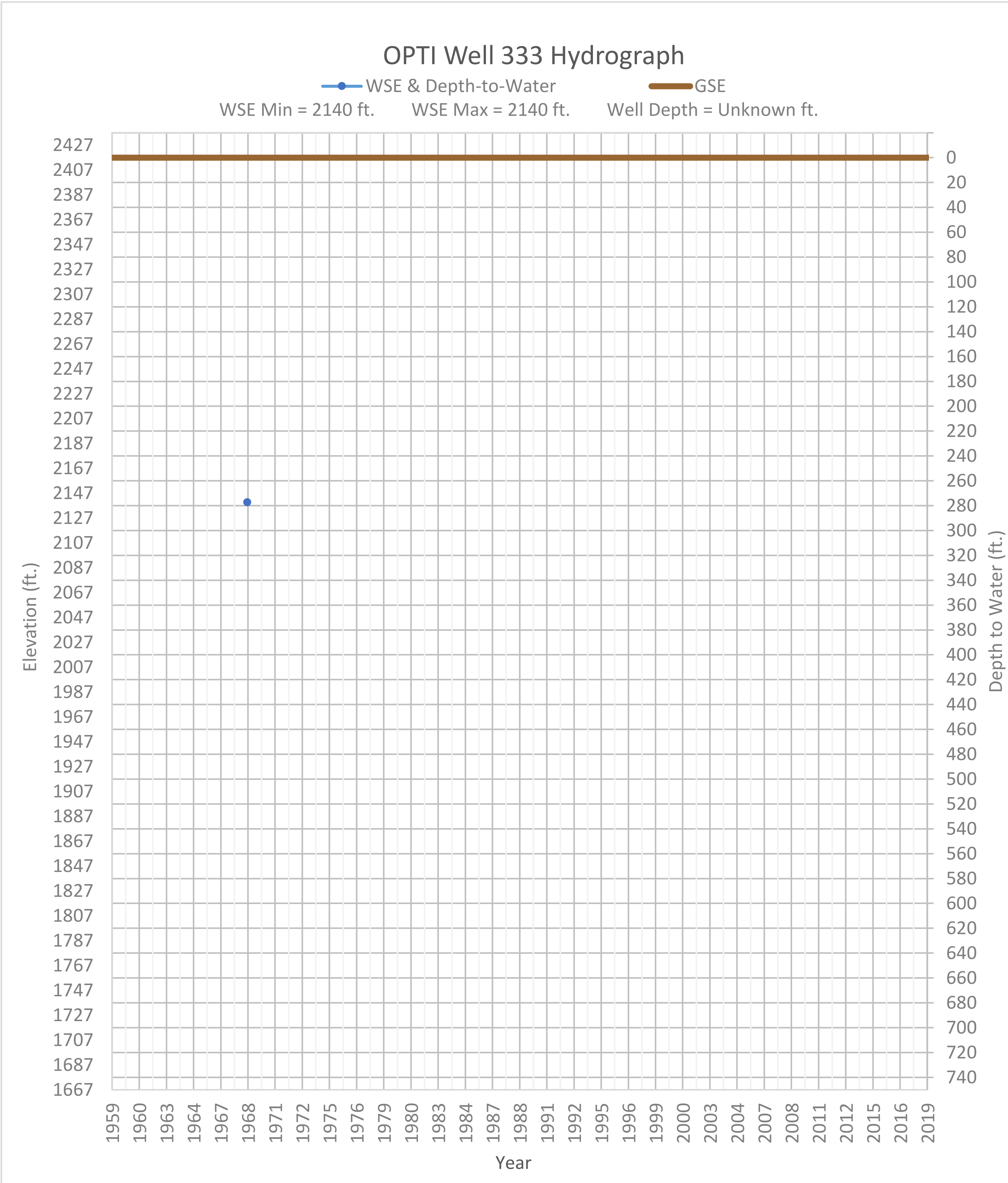
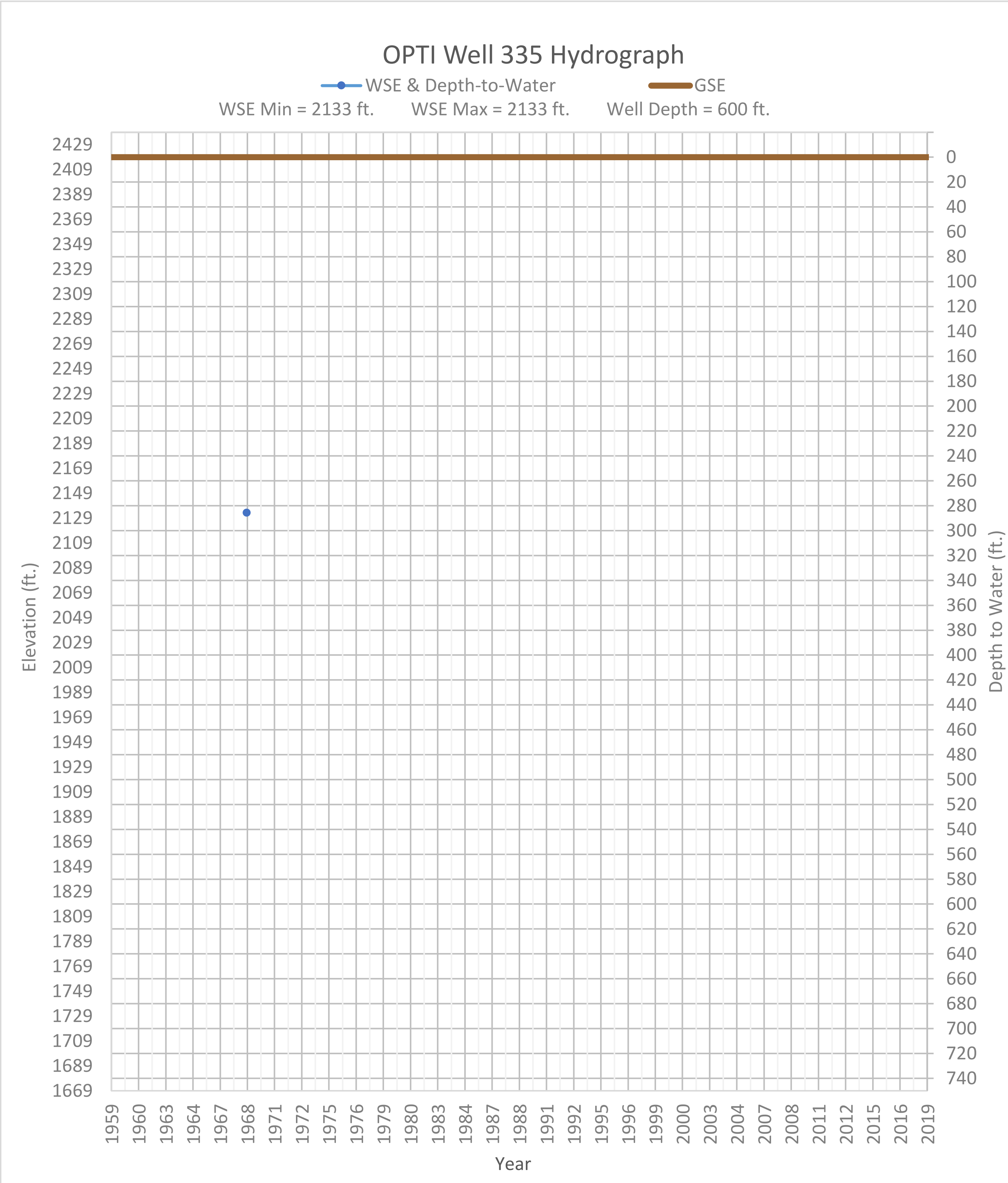
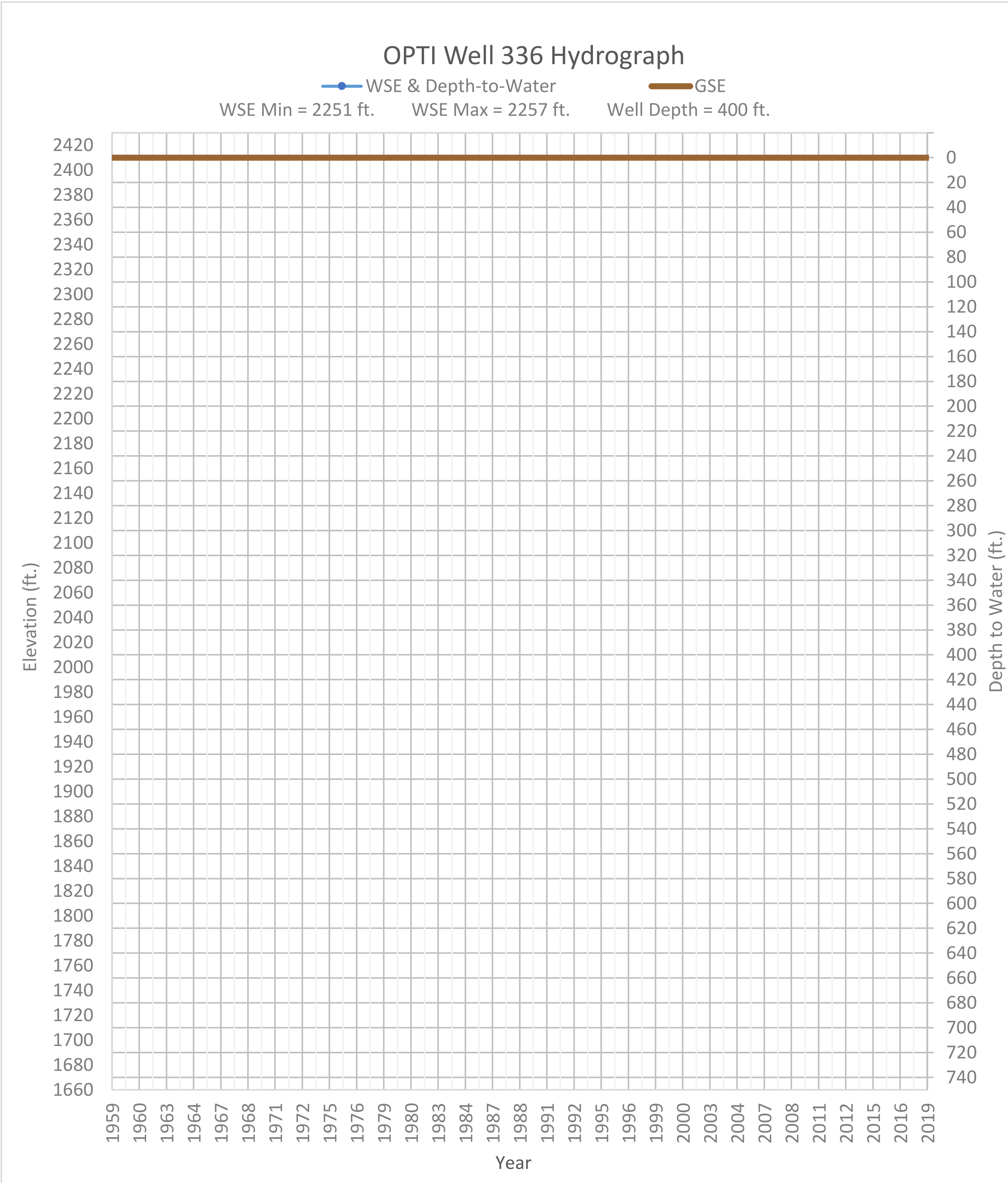


OPTI Well 331 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2203 ft.
WSE Max = 2203 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year

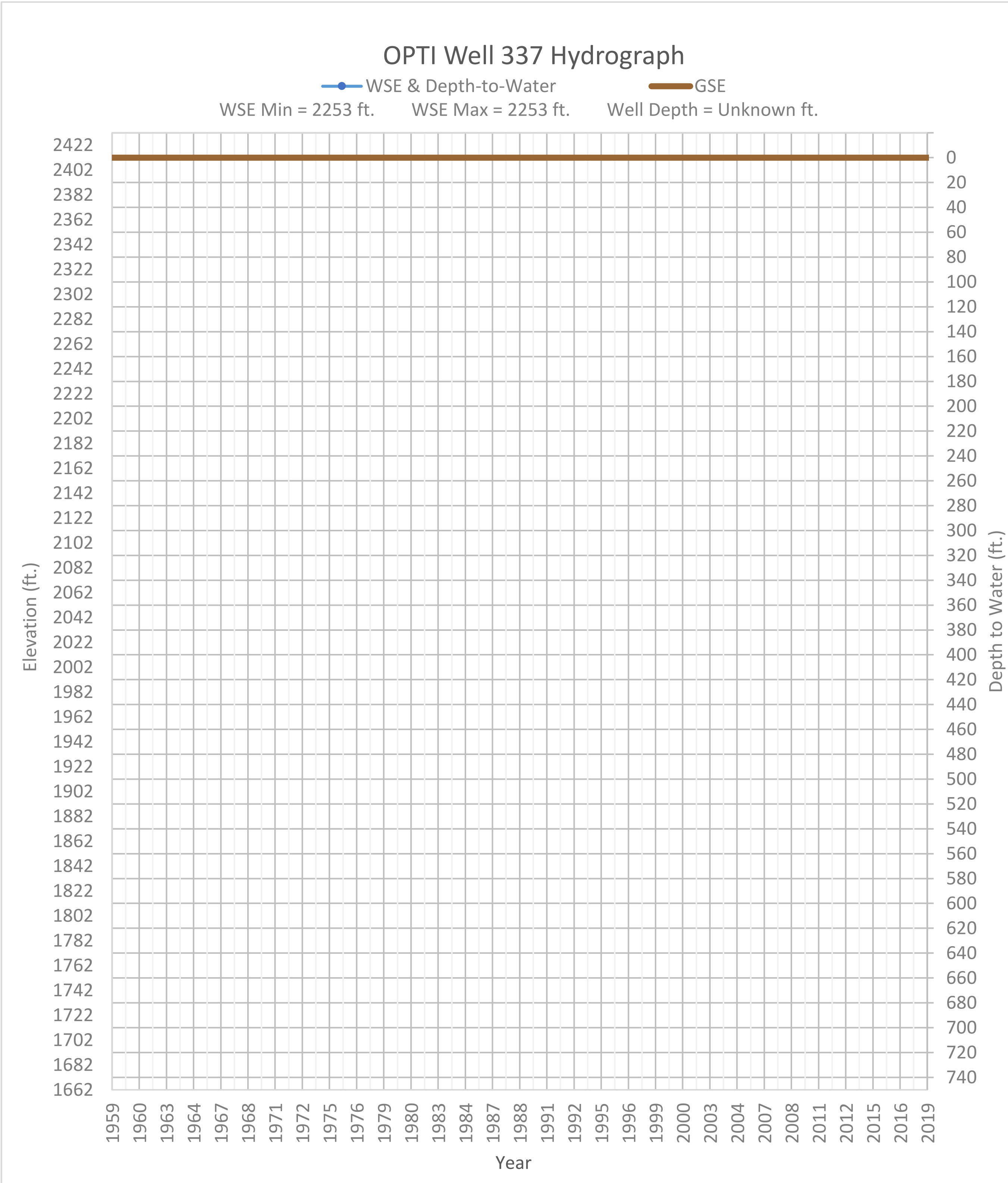

OPTI Well 333 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2140 ft.
WSE Max = 2140 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



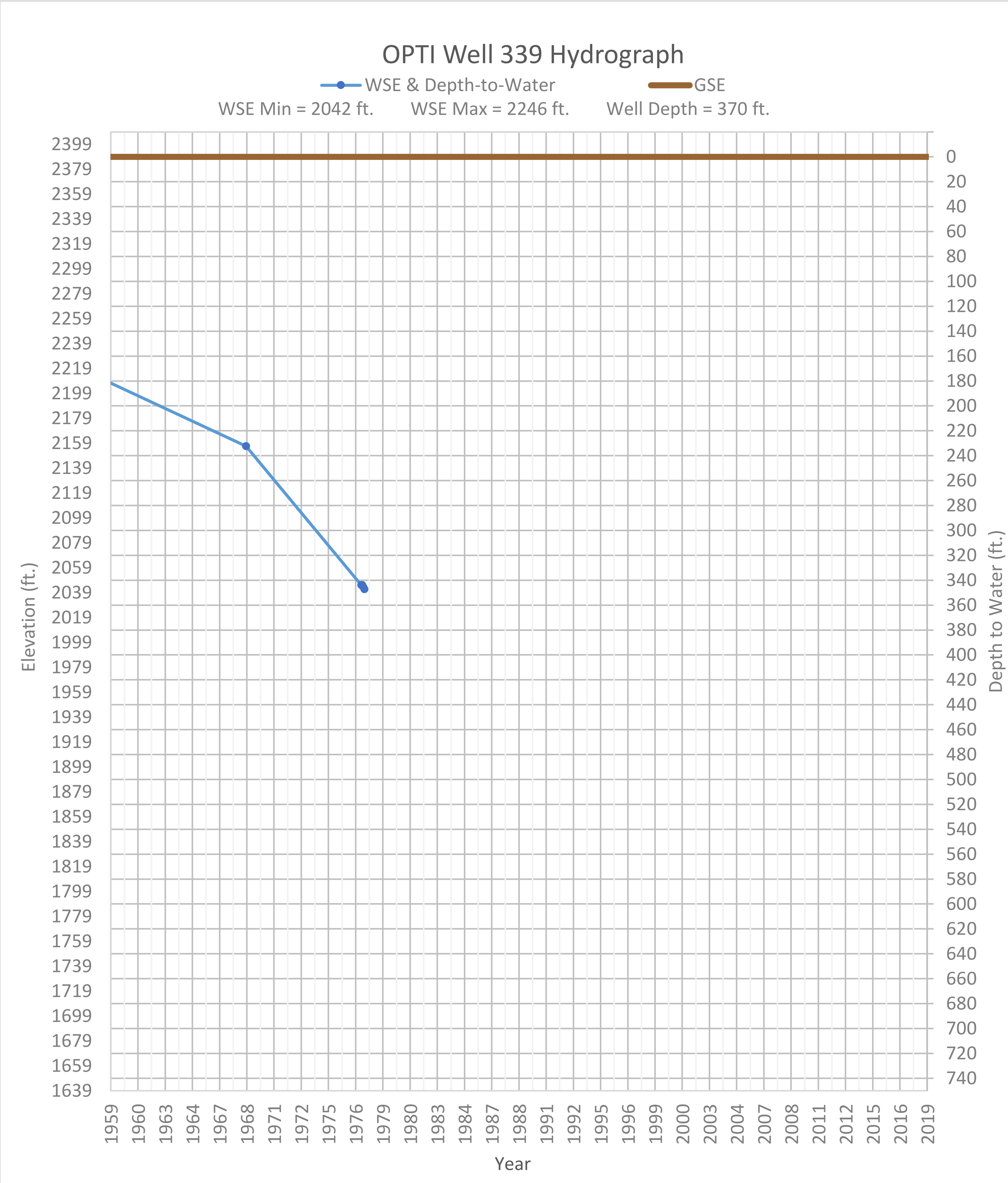
OPTI Well 335 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2133 ft.
WSE Max = 2133 ft.
Well Depth = 600 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



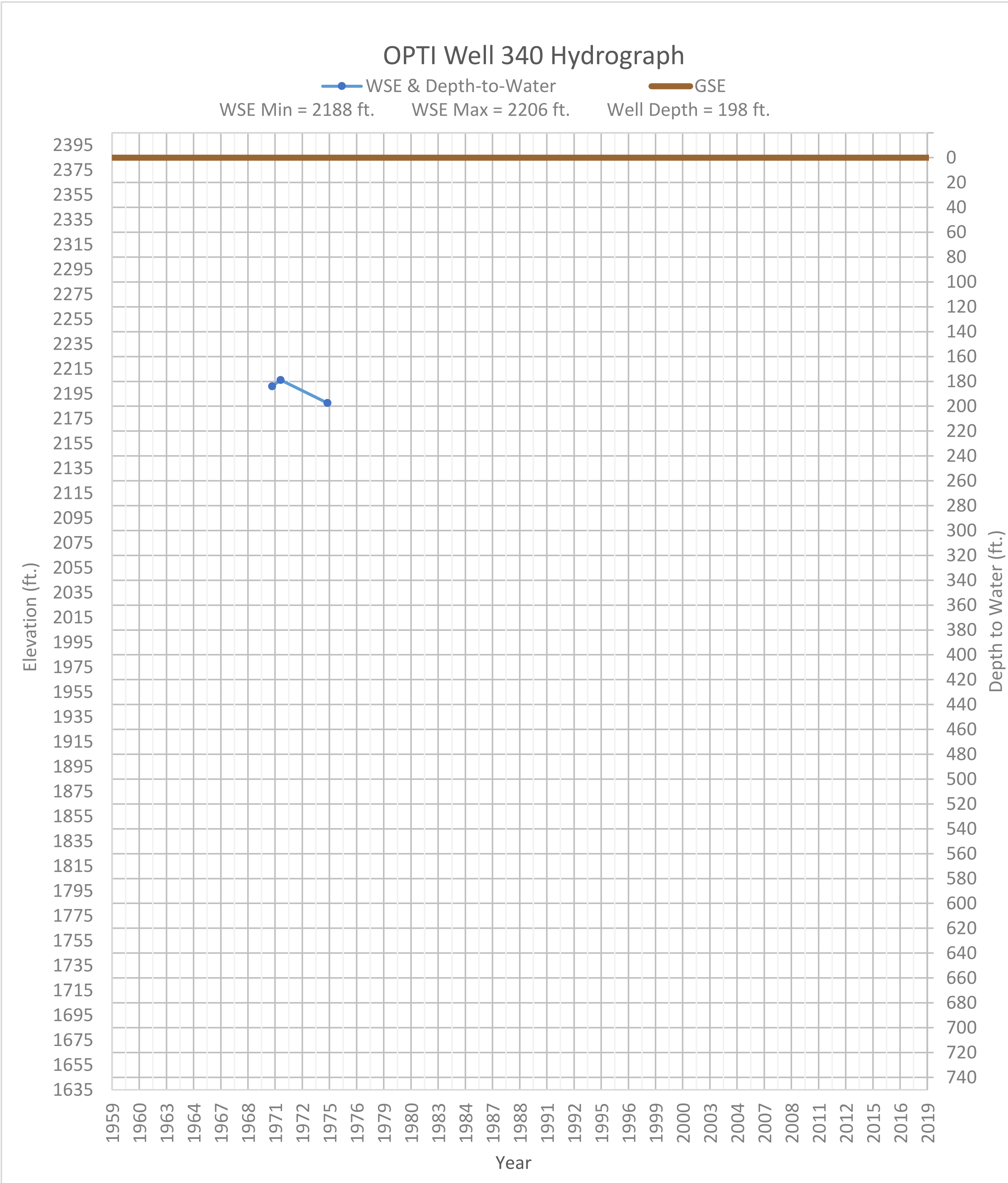
OPTI Well 336 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2251 ft.
WSE Max = 2257 ft.
Well Depth = 400 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



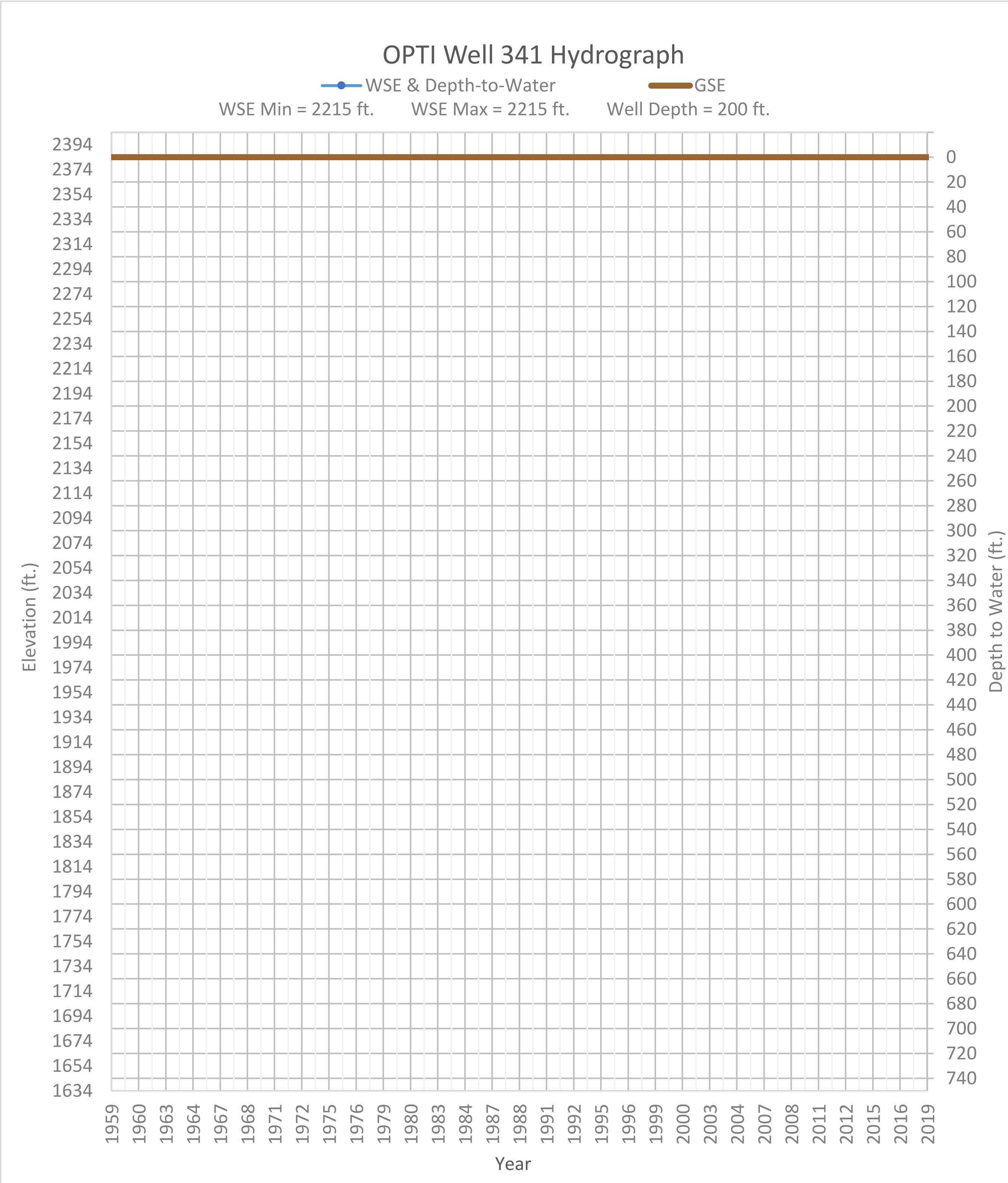
OPTI Well 337 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2253 ft.
WSE Max = 2253 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year

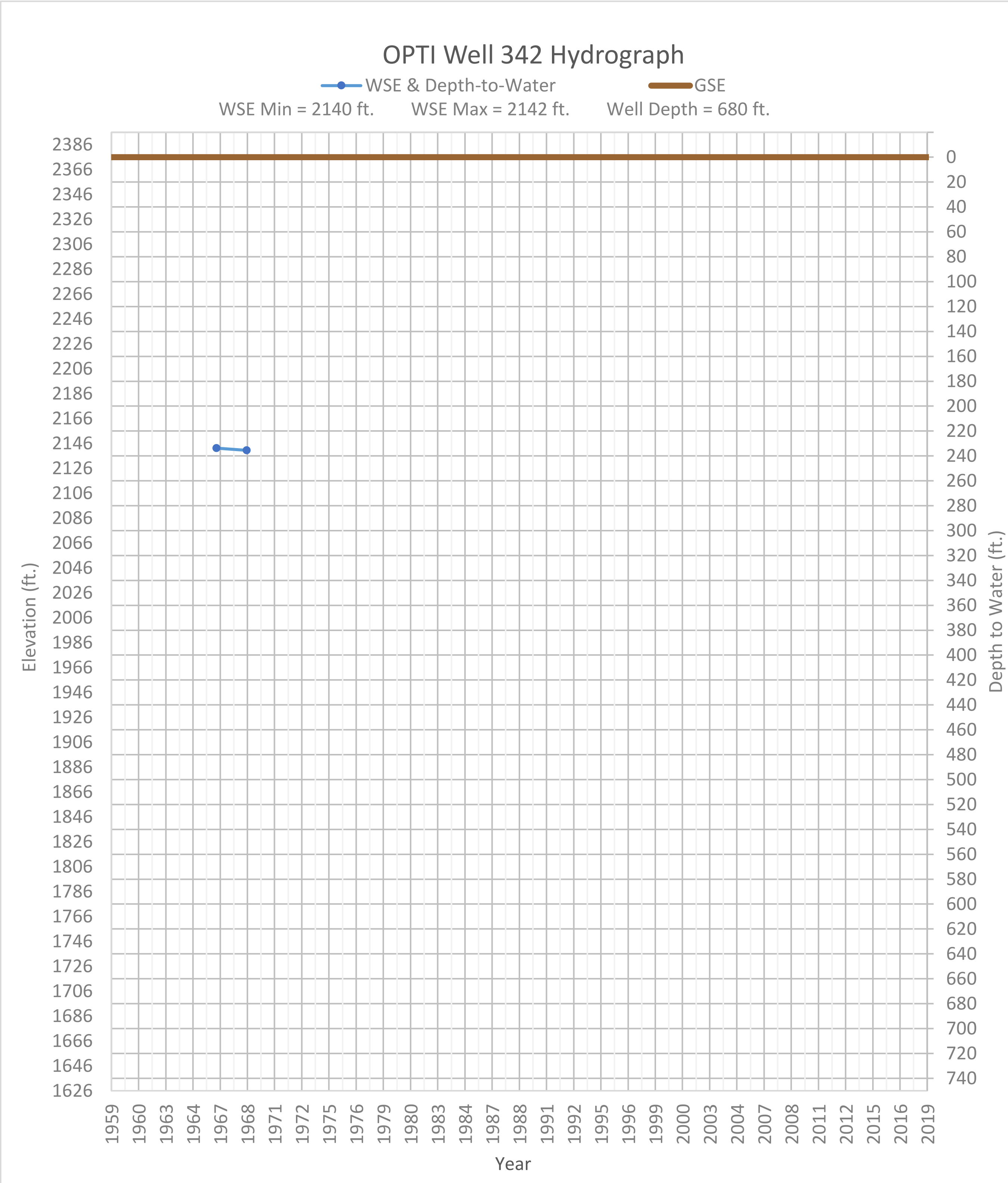


OPTI Well 339 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2042 ft.
WSE Max = 2246 ft.
Well Depth = 370 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 340 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2188 ft.
WSE Max = 2206 ft.
Well Depth = 198 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 341 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2215 ft.
WSE Max = 2215 ft.
Well Depth = 200 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 342 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2140 ft.
WSE Max = 2142 ft.
Well Depth = 680 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2386
2366
2346
2326
2306
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
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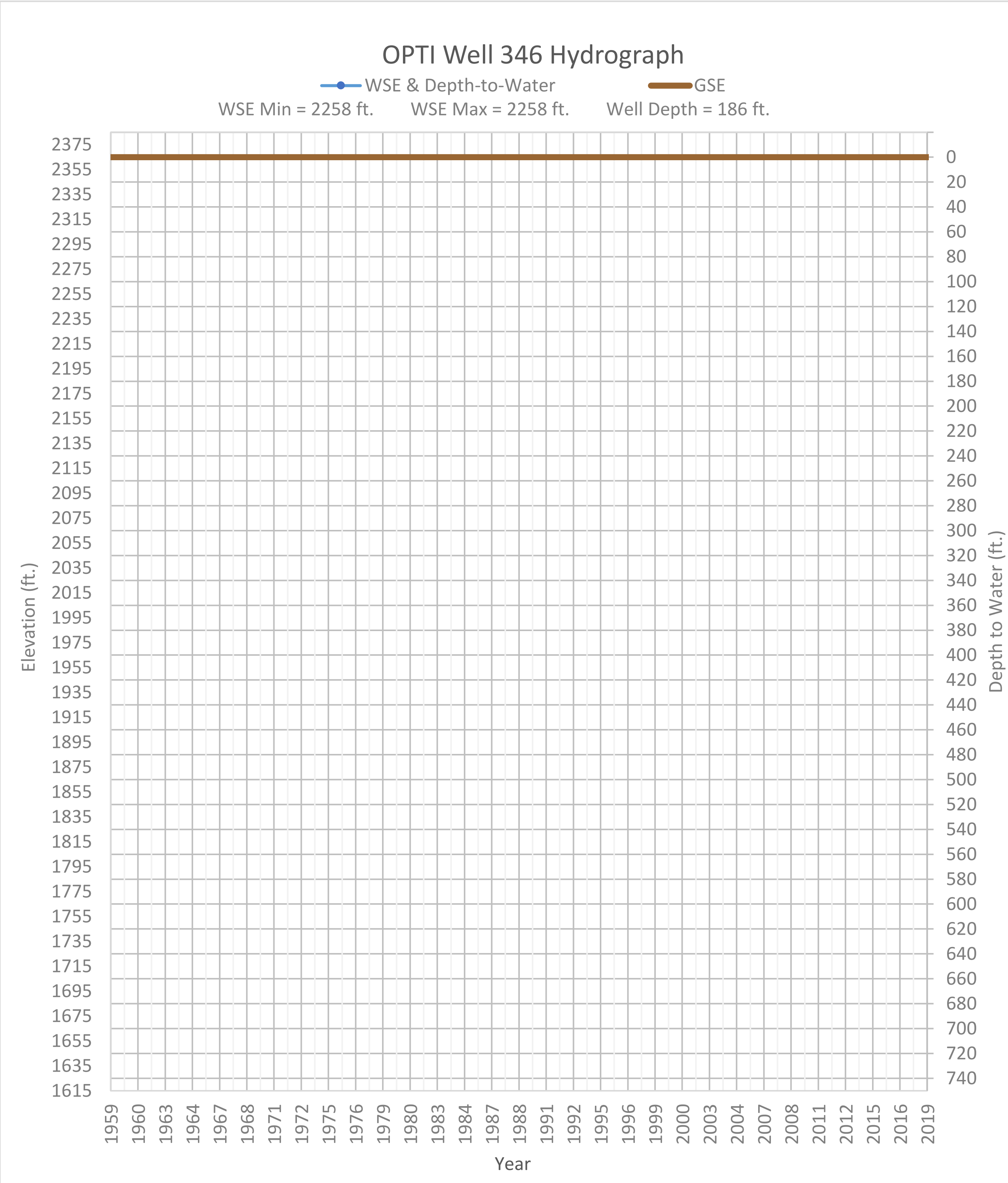
OPTI Well 346 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2258 ft.
WSE Max = 2258 ft.
Well Depth = 186 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2375
2355
2335
2315
2295
2275
2255
2235
2215
2195
2175
2155
2135
2115
2095
2075
2055
2035
2015
1995
1975
1955
1935
1915
1895
1875
1855
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1715
1695
1675
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1615
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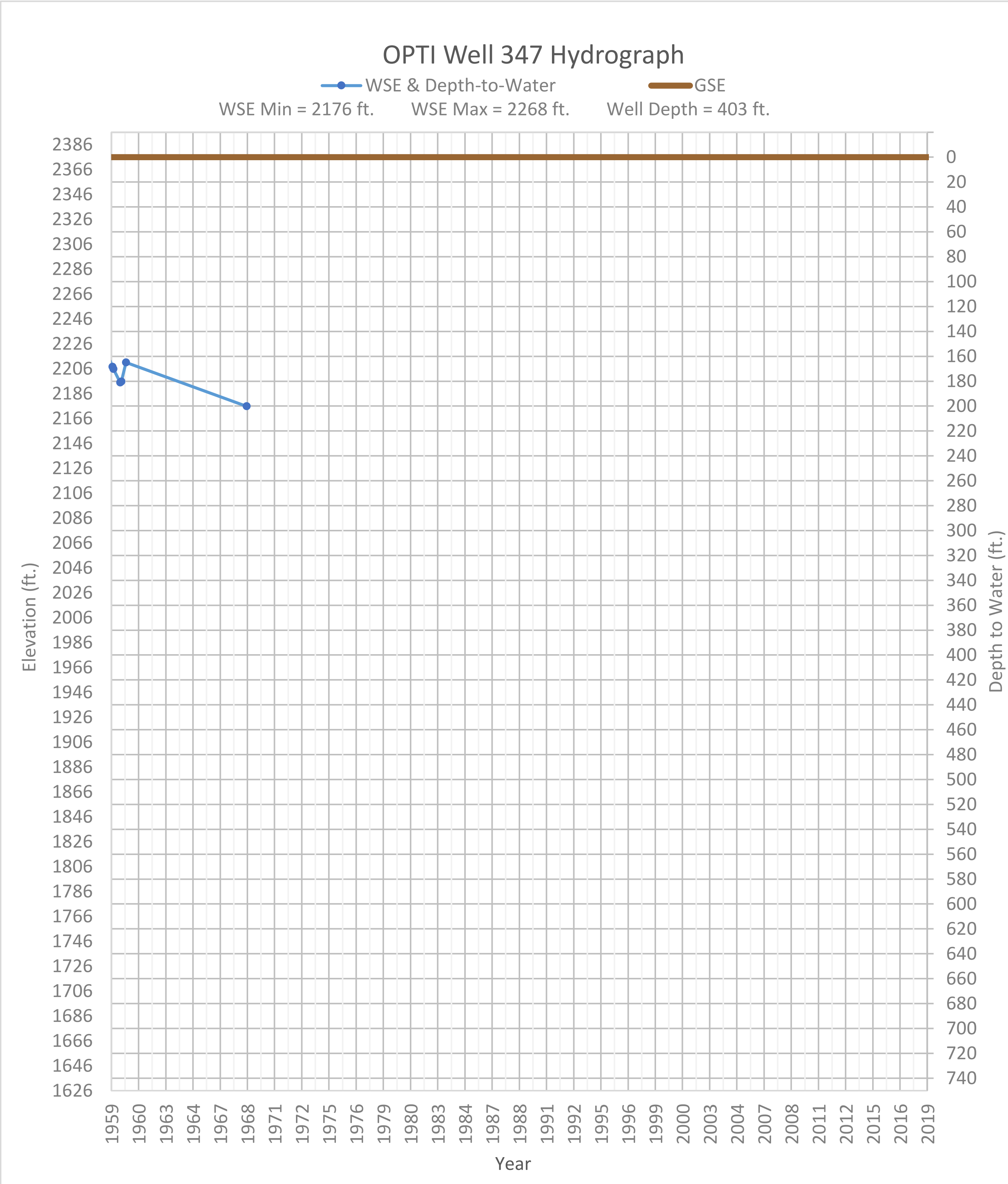
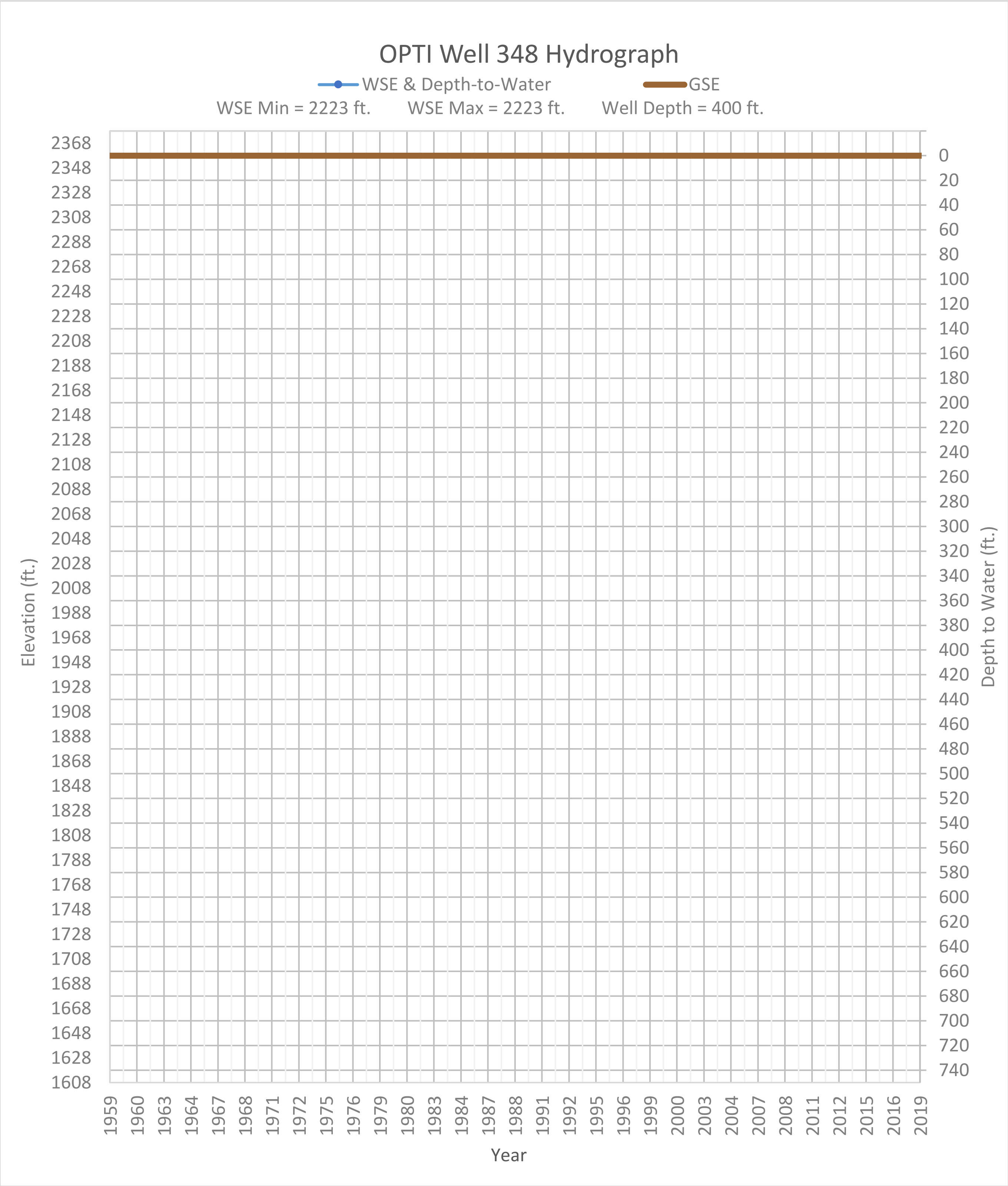
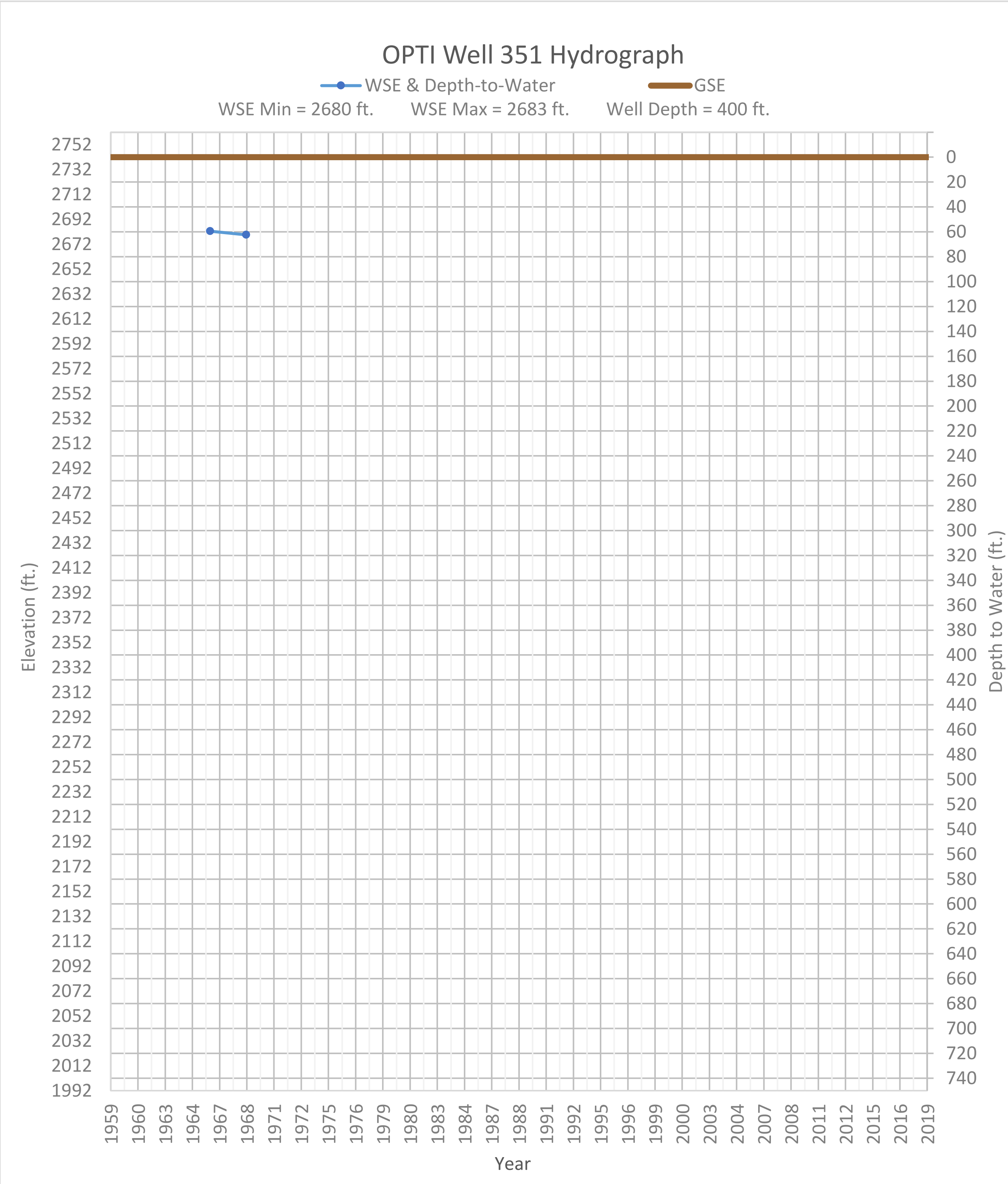


OPTI Well 347 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2176 ft.
WSE Max = 2268 ft.
Well Depth = 403 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 348 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2223 ft.
WSE Max = 2223 ft.
Well Depth = 400 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 351 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2680 ft.
WSE Max = 2683 ft.
Well Depth = 400 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2752
2732
2712
2692
2672
2652
2632
2612
2592
2572
2552
2532
2512
2492
2472
2452
2432
2412
2392
2372
2352
2332
2312
2292
2272
2252
2232
2212
2192
2172
2152
2132
2112
2092
2072
2052
2032
2012
1992
0
20
40
60
80
100
120
140
160
180
200
220
240
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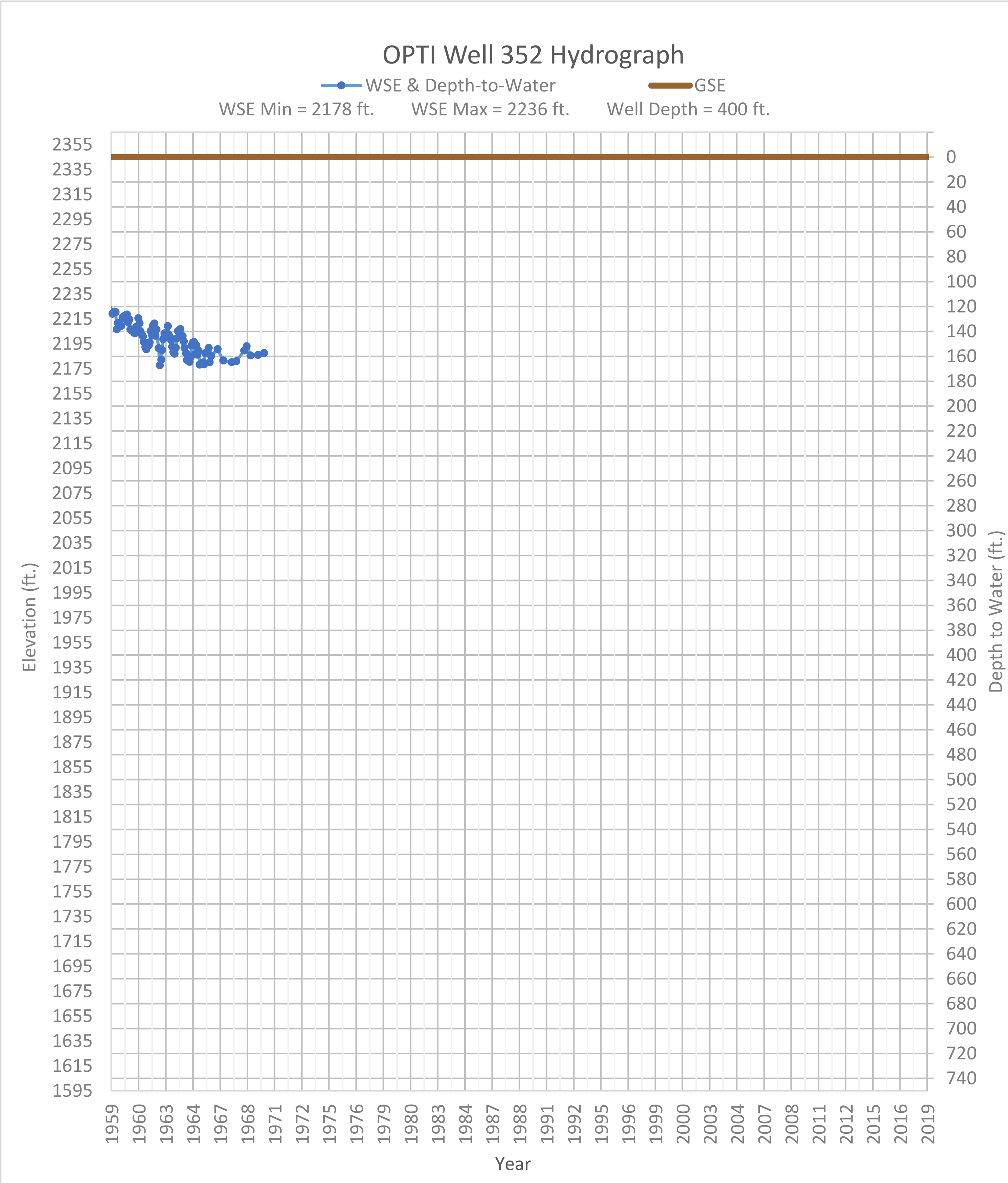
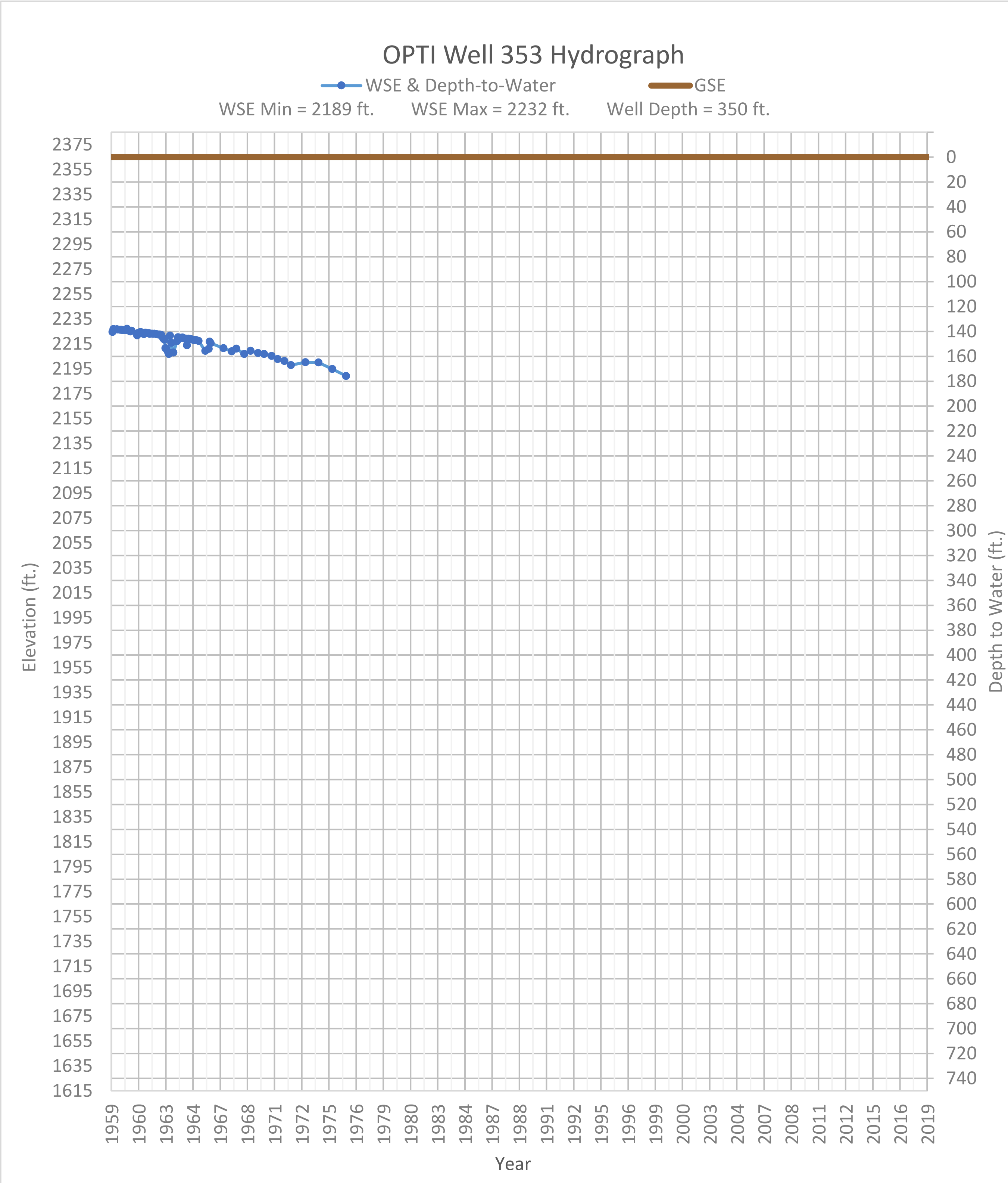
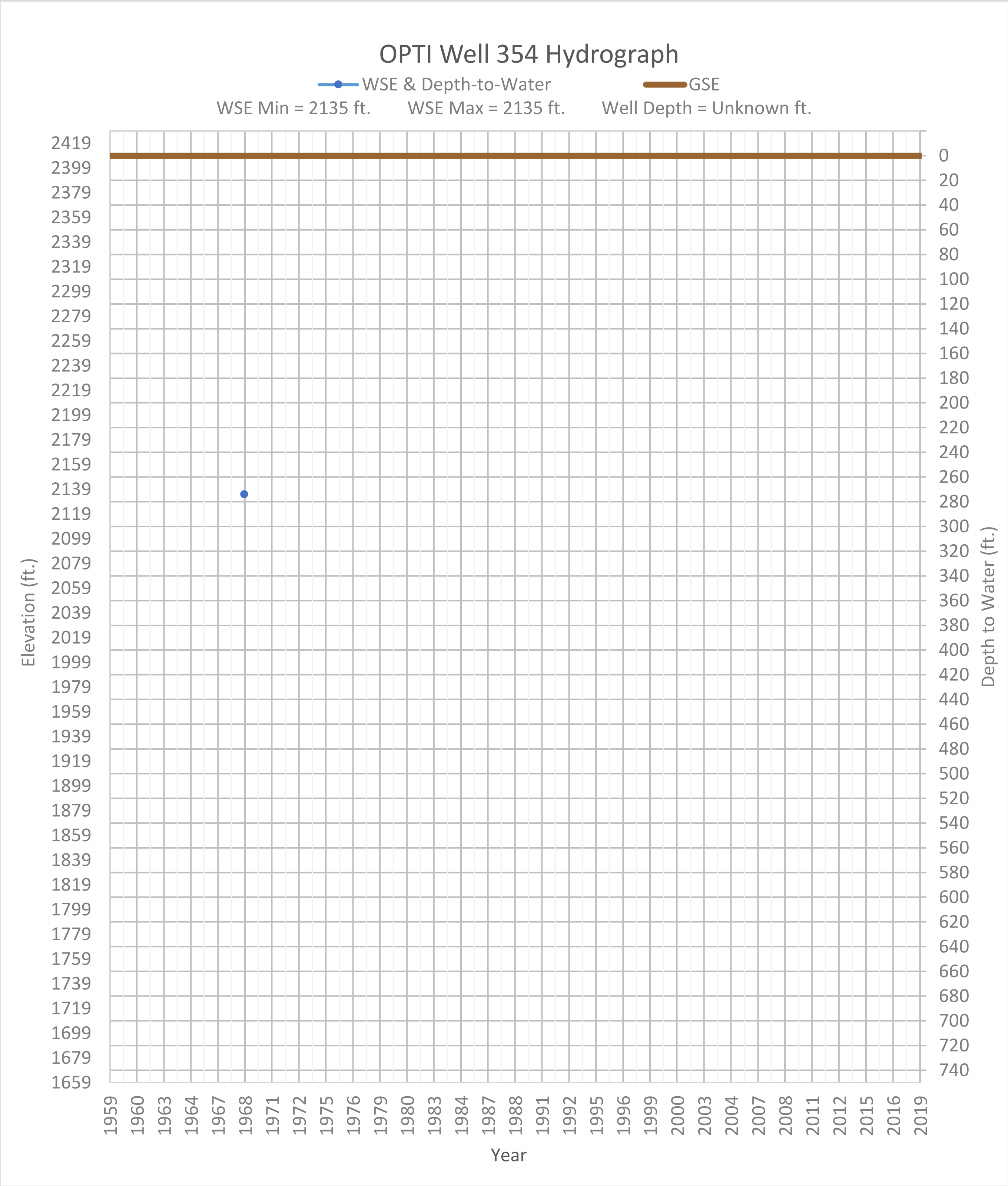
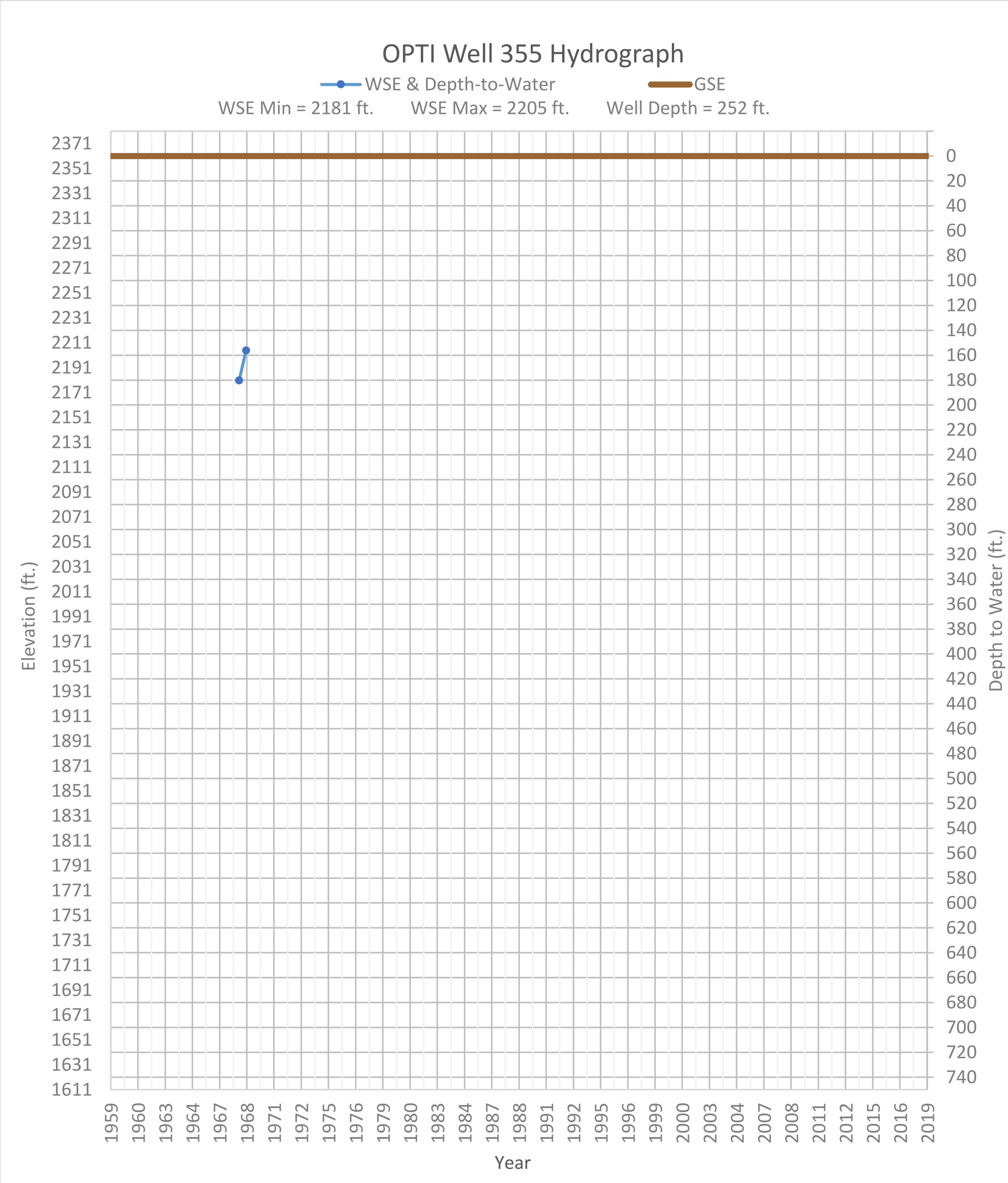

OPTI Well 352 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2178 ft.
WSE Max = 2236 ft.
Well Depth = 400 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



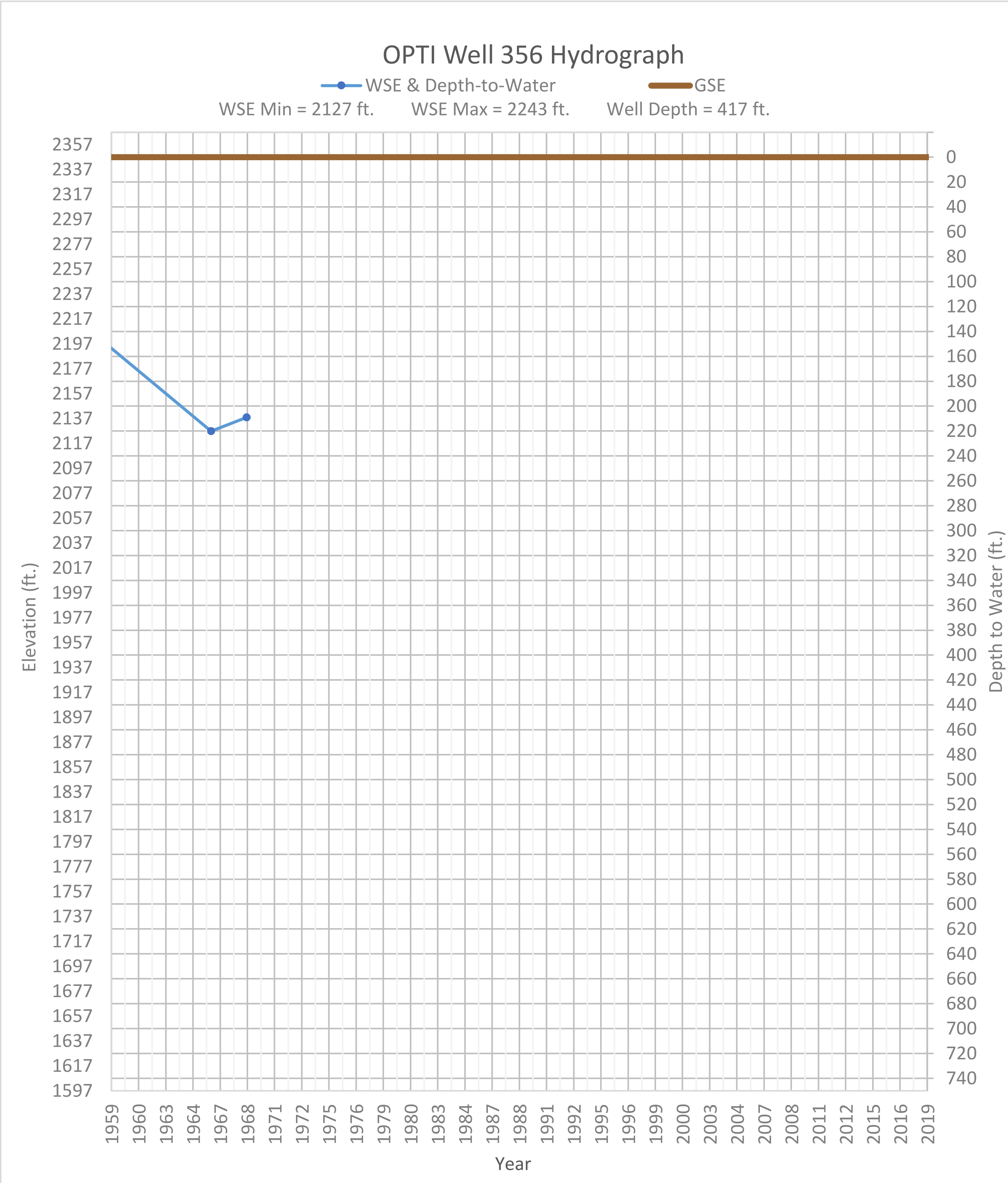
OPTI Well 353 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2189 ft.
WSE Max = 2232 ft.
Well Depth = 350 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



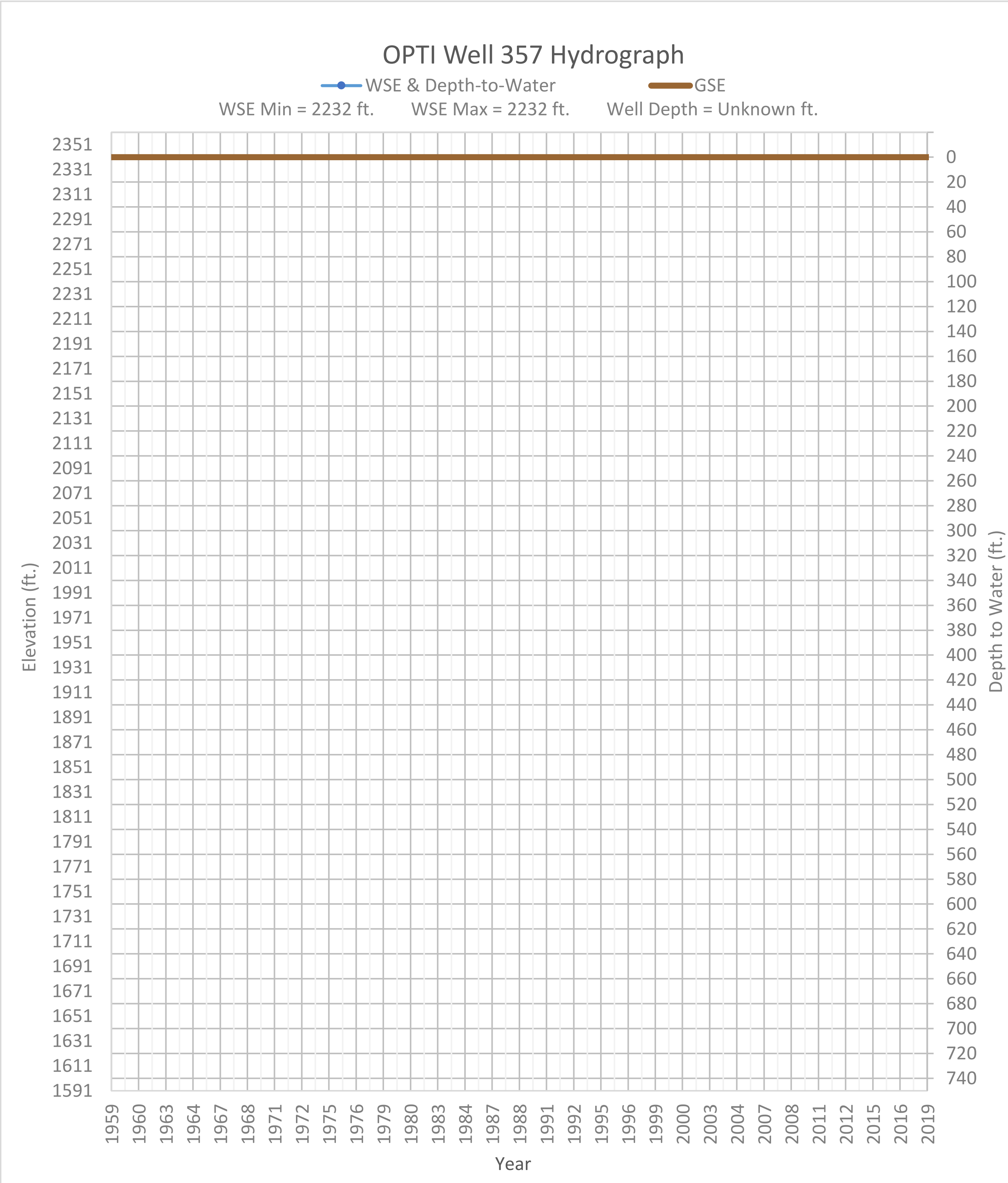
OPTI Well 354 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2135 ft.
WSE Max = 2135 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



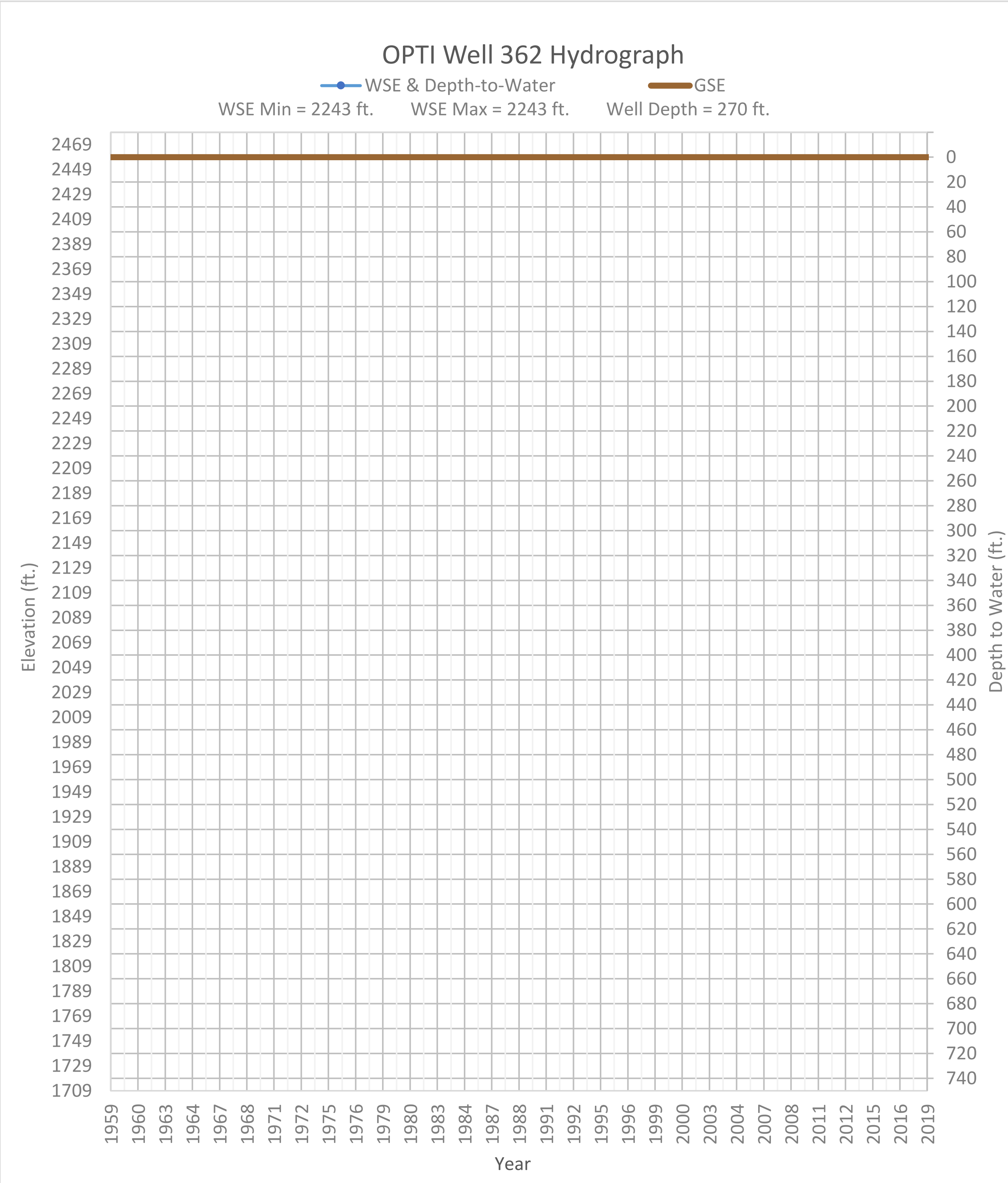
OPTI Well 355 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2181 ft.
WSE Max = 2205 ft.
Well Depth = 252 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 356 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2127 ft.
WSE Max = 2243 ft.
Well Depth = 417 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 357 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2232 ft.
WSE Max = 2232 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 362 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2243 ft.
WSE Max = 2243 ft.
Well Depth = 270 ft.
Elevation (ft.)
2469
2449
2429
2409
2389
2369
2349
2329
2309
2289
2269
2249
2229
2209
2189
2169
2149
2129
2109
2089
2069
2049
2029
2009
1989
1969
1949
1929
1909
1889
1869
1849
1829
1809
1789
1769
1749
1729
1709
Depth to Water (ft.)
0
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40
60
80
100
120
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160
180
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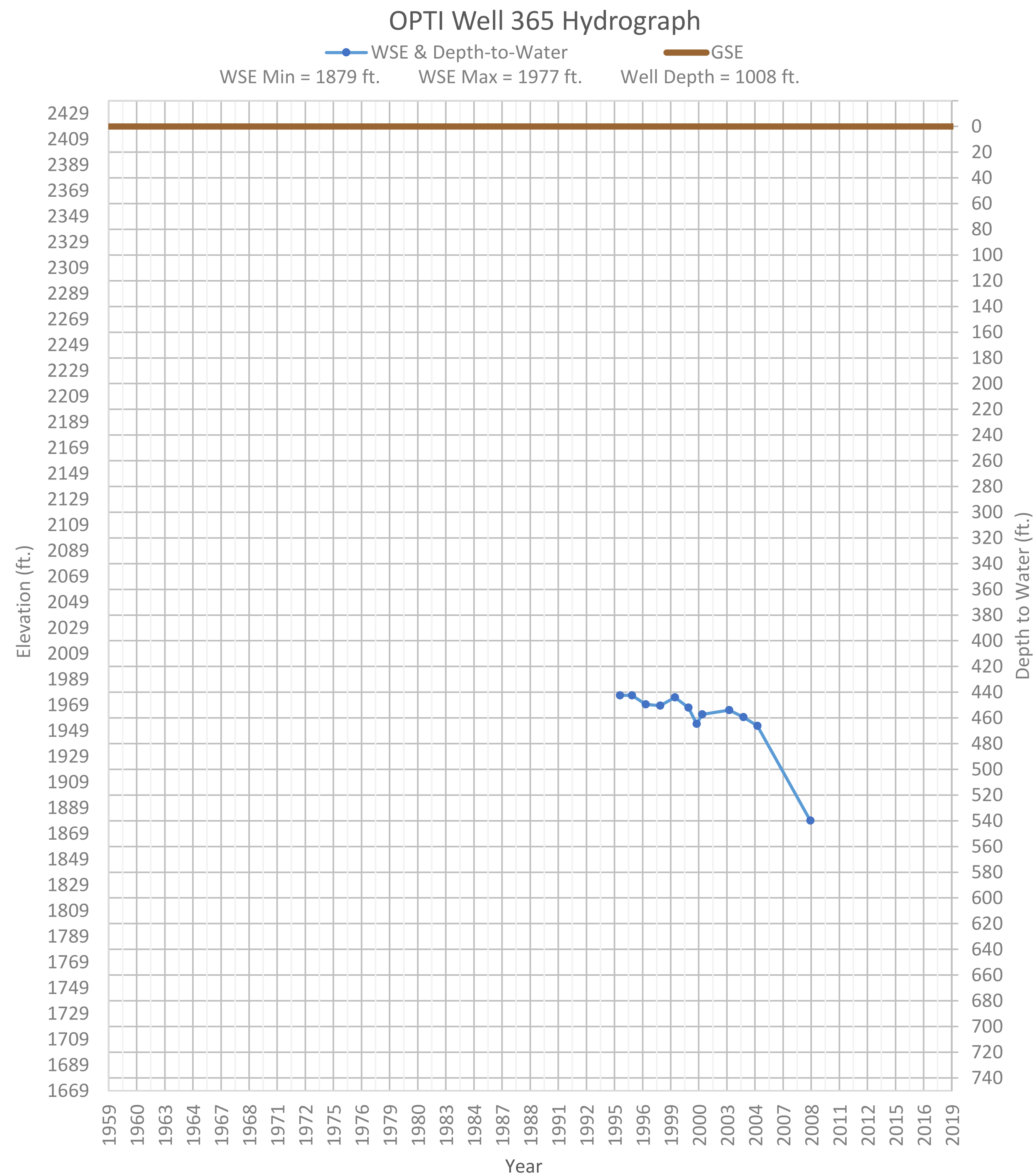
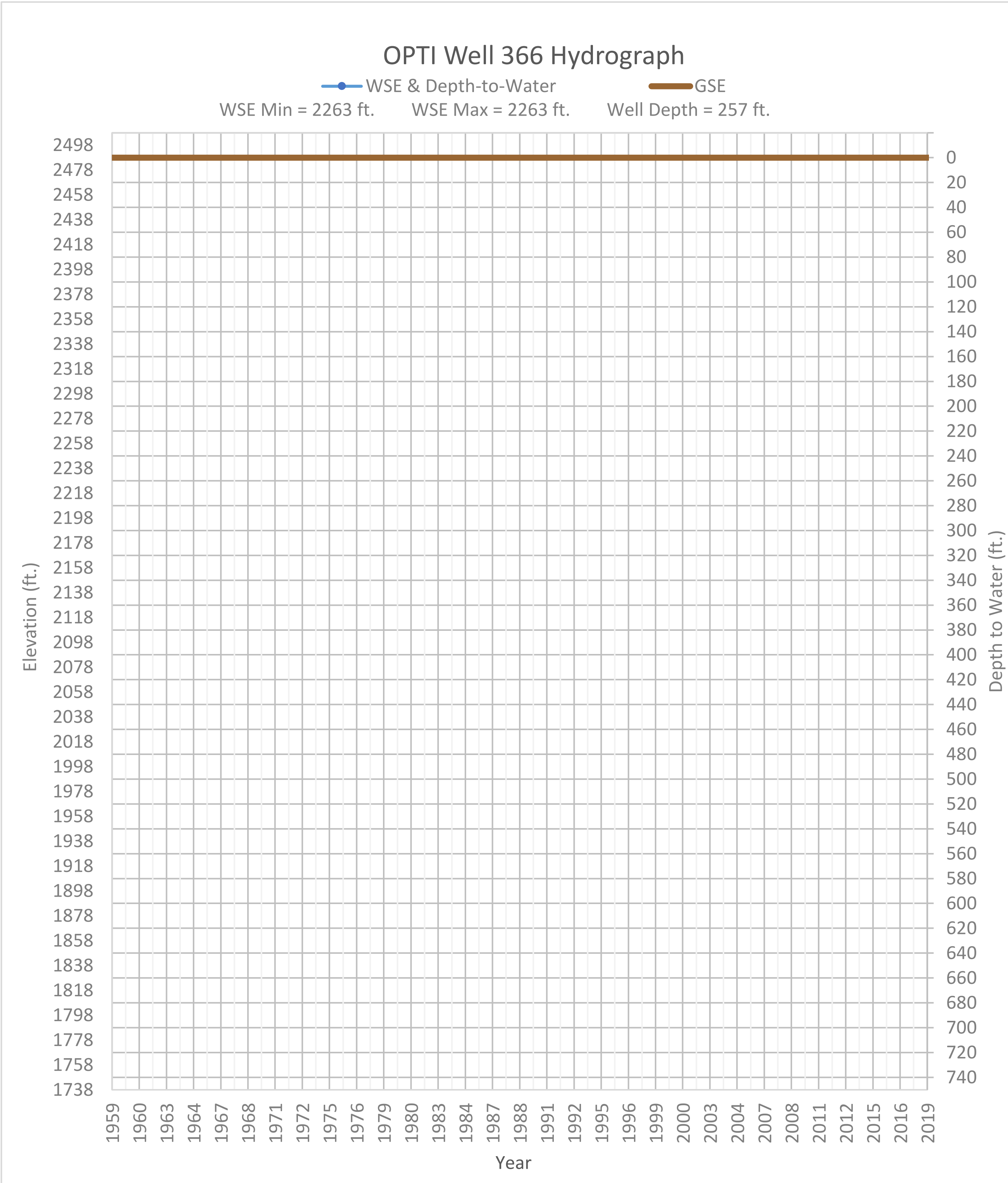
2019



OPTI Well 365 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1879 ft.
WSE Max = 1977 ft.
Well Depth = 1008 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 366 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2263 ft.
WSE Max = 2263 ft.
Well Depth = 257 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2498
2478
2458
2438
2418
2398
2378
2358
2338
2318
2298
2278
2258
2238
2218
2198
2178
2158
2138
2118
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1978
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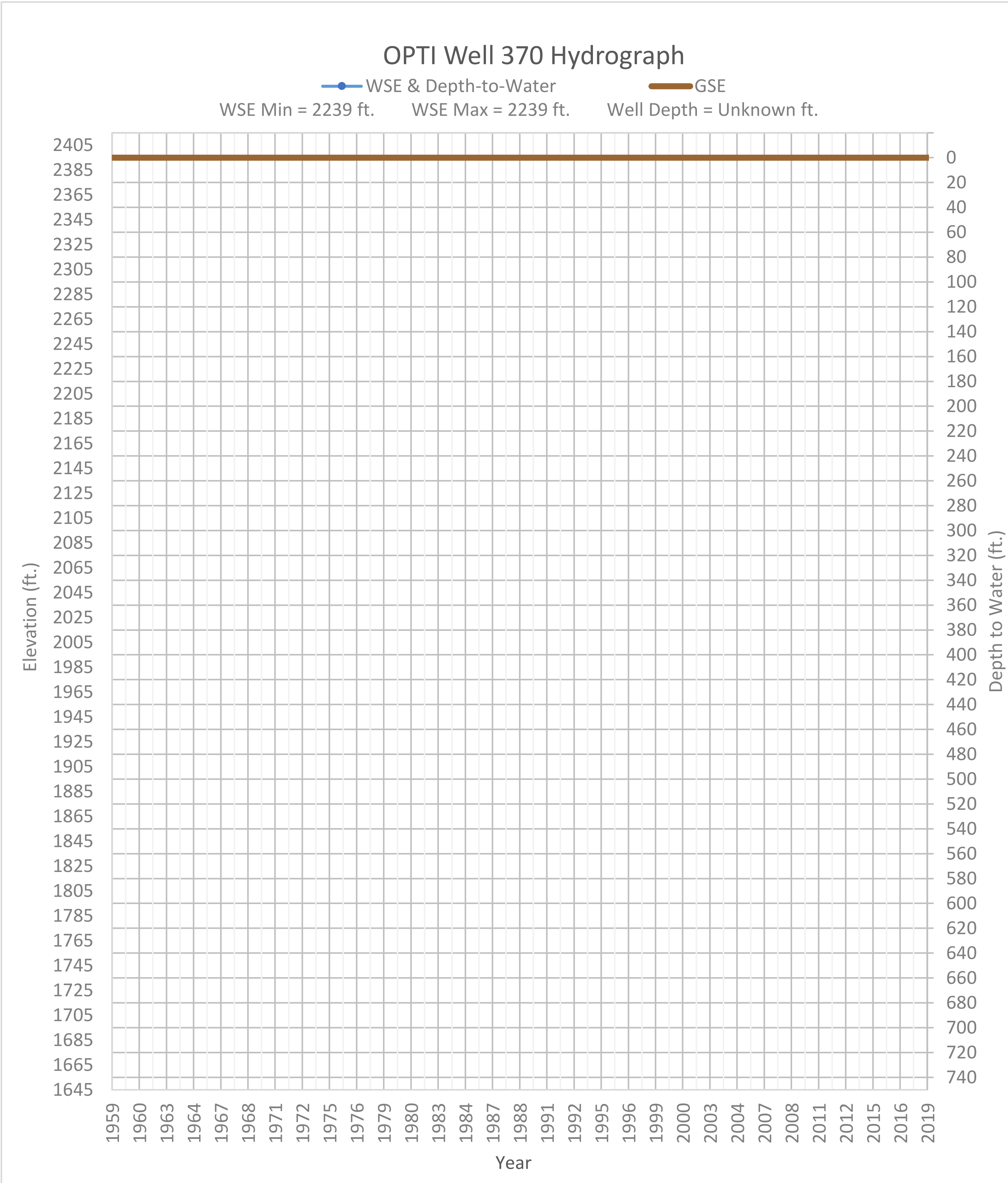

OPTI Well 370 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2239 ft.
WSE Max = 2239 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2405
2385
2365
2345
2325
2305
2285
2265
2245
2225
2205
2185
2165
2145
2125
2105
2085
2065
2045
2025
2005
1985
1965
1945
1925
1905
1885
1865
1845
1825
1805
1785
1765
1745
1725
1705
1685
1665
1645
0
20
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80
100
120
140
160
180
200
220
240
260
280
300
320
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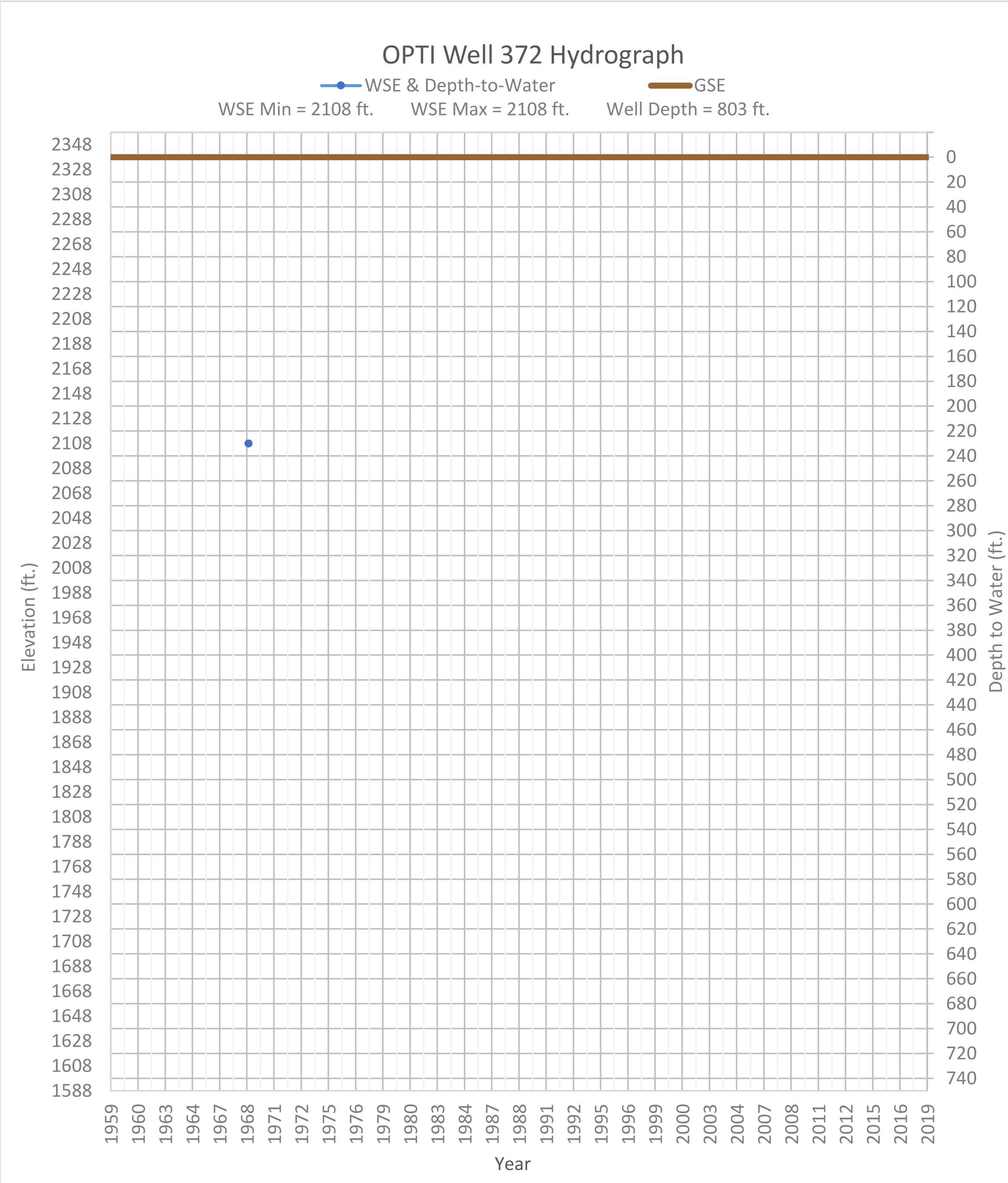
OPTI Well 372 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2108 ft.
WSE Max = 2108 ft.
Well Depth = 803 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2348
2328
2308
2288
2268
2248
2228
2208
2188
2168
2148
2128
2108
2088
2068
2048
2028
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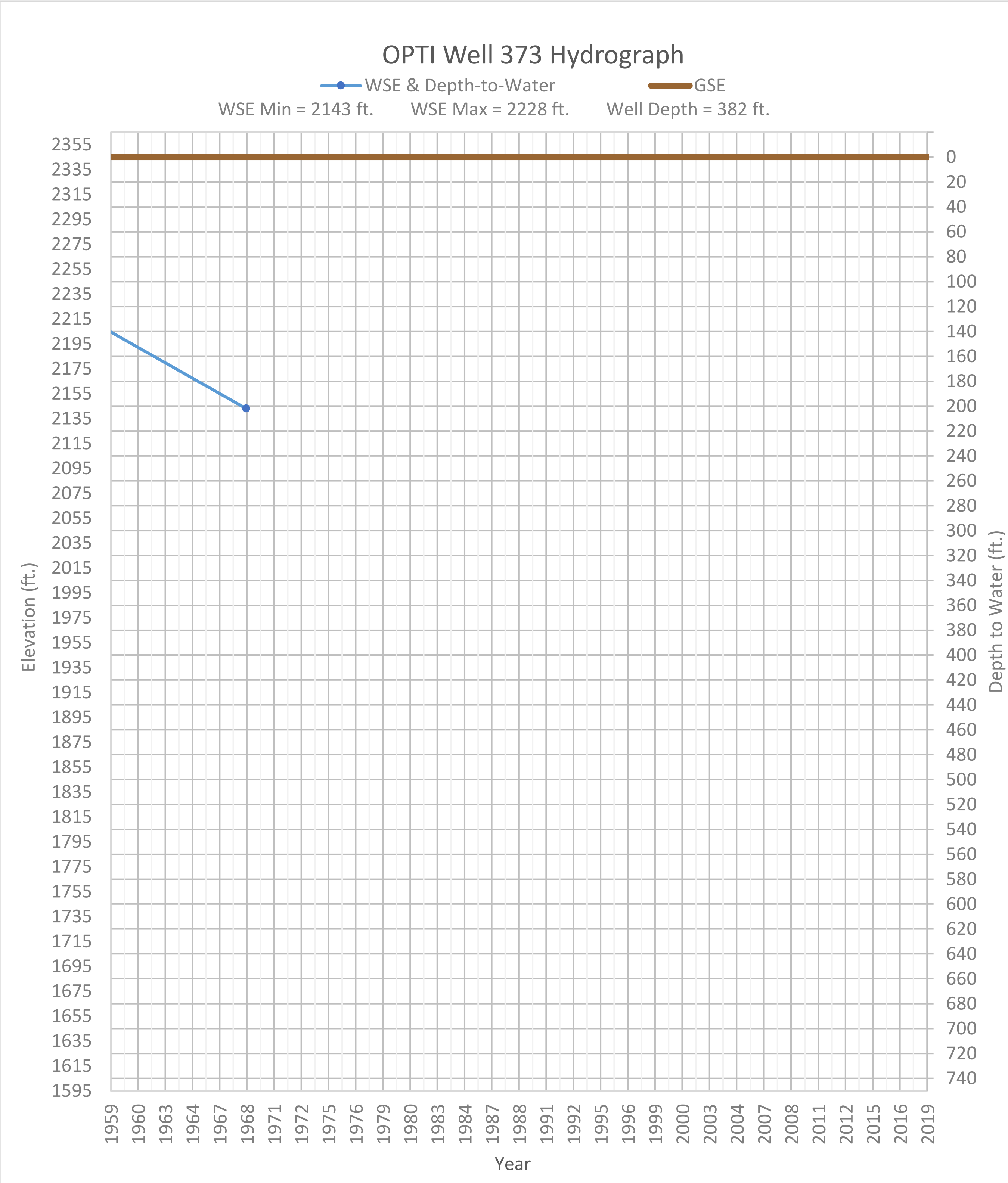
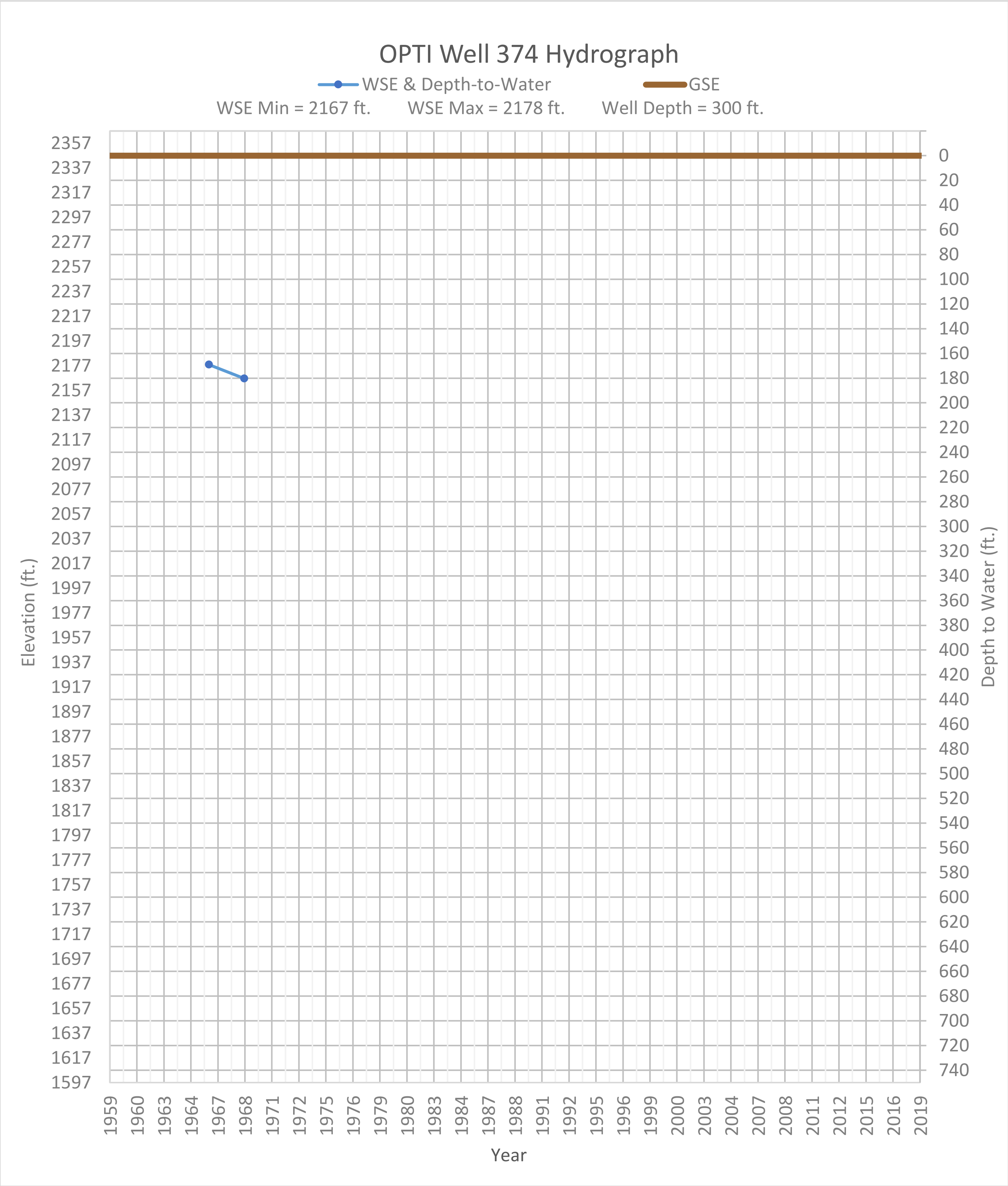
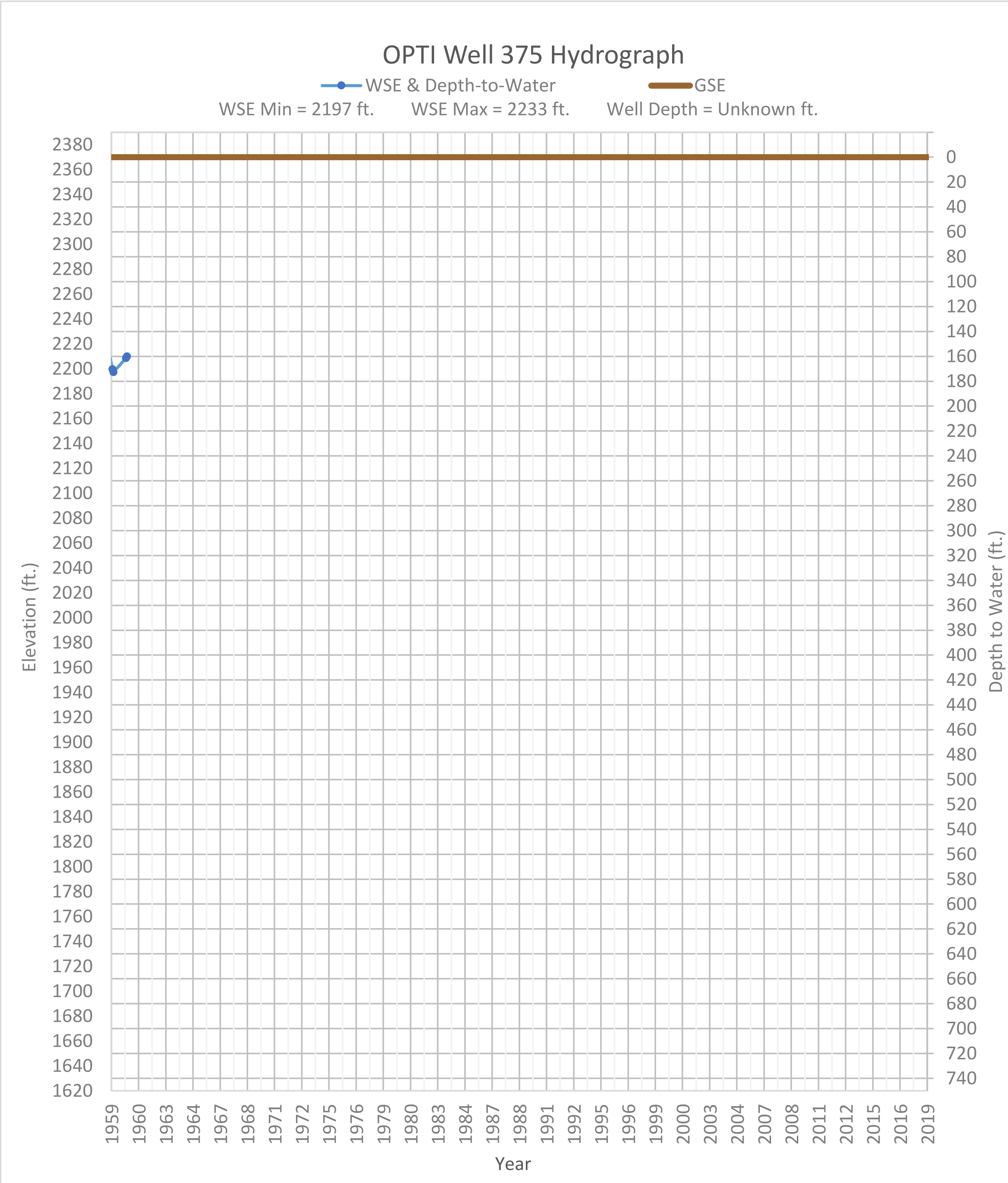
2016
2019

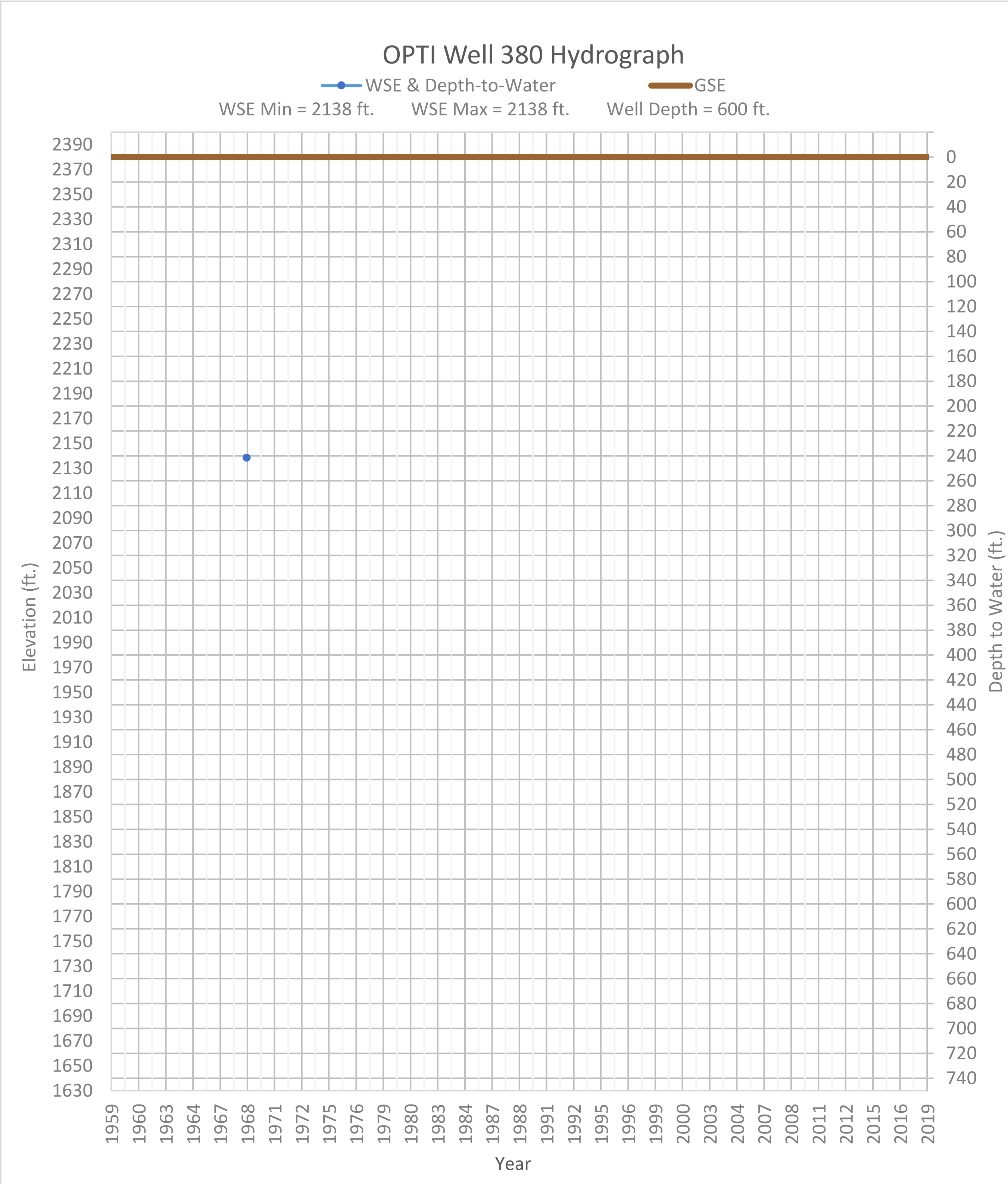


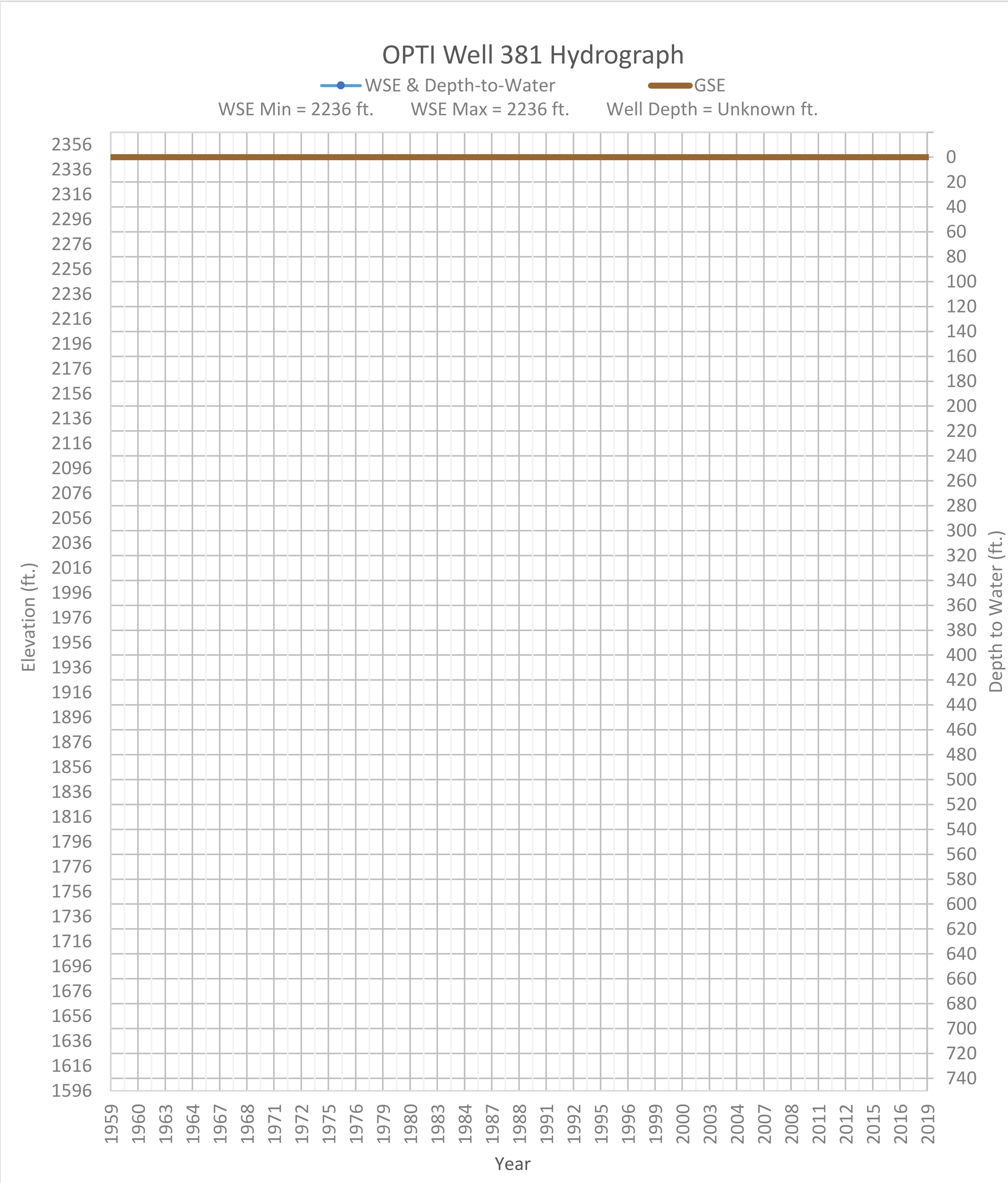
OPTI Well 373 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2143 ft.
WSE Max = 2228 ft.
Well Depth = 382 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 374 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2167 ft.
WSE Max = 2178 ft.
Well Depth = 300 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 375 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2197 ft.
WSE Max = 2233 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 380 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2138 ft.
WSE Max = 2138 ft.
Well Depth = 600 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 381 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2236 ft.
WSE Max = 2236 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2356
2336
2316
2296
2276
2256
2236
2216
2196
2176
2156
2136
2116
2096
2076
2056
2036
2016
1996
1976
1956
1936
1916
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1676
1656
1636
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1596
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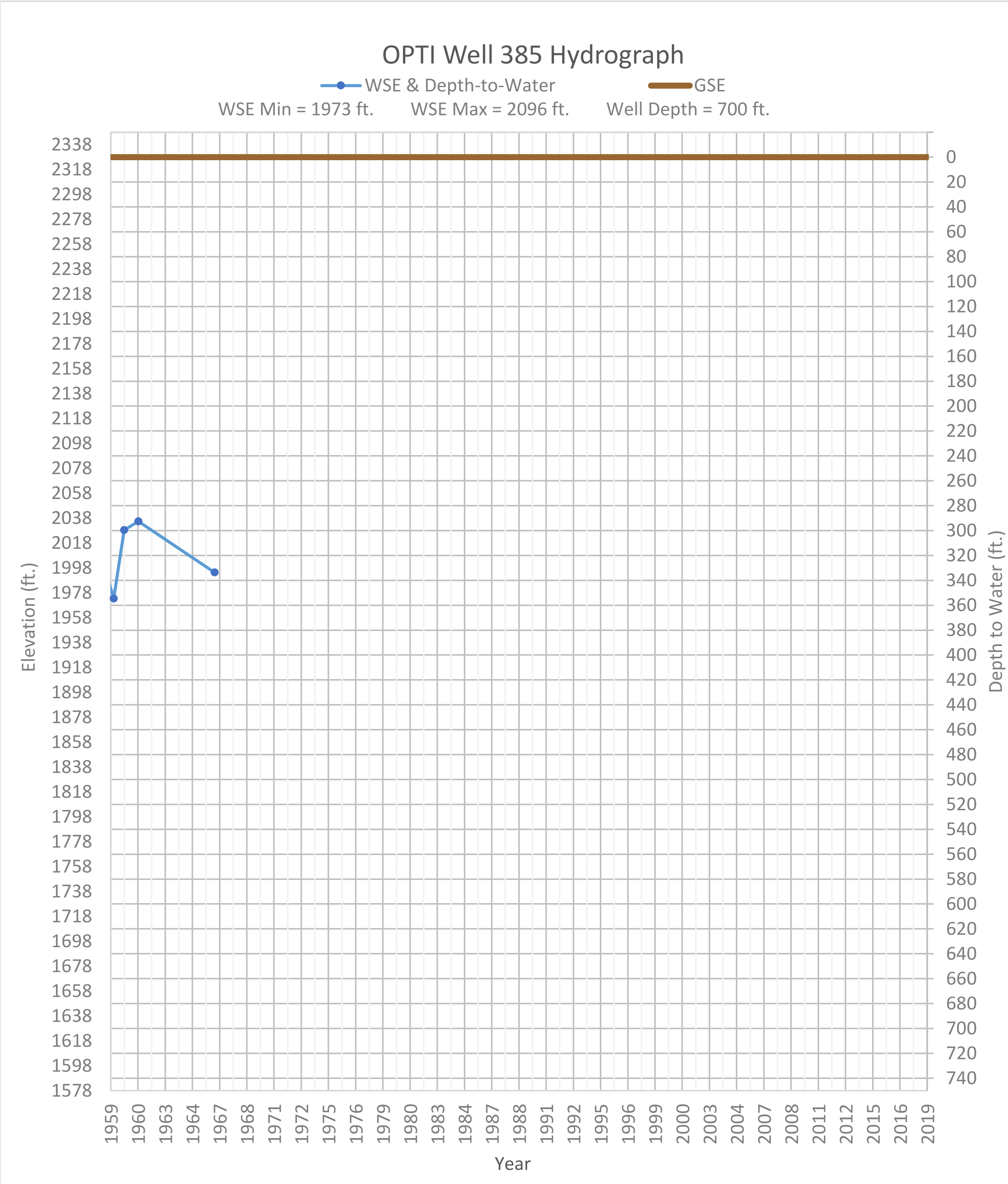

OPTI Well 385 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1973 ft.
WSE Max = 2096 ft.
Well Depth = 700 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2338
2318
2298
2278
2258
2238
2218
2198
2178
2158
2138
2118
2098
2078
2058
2038
2018
1998
1978
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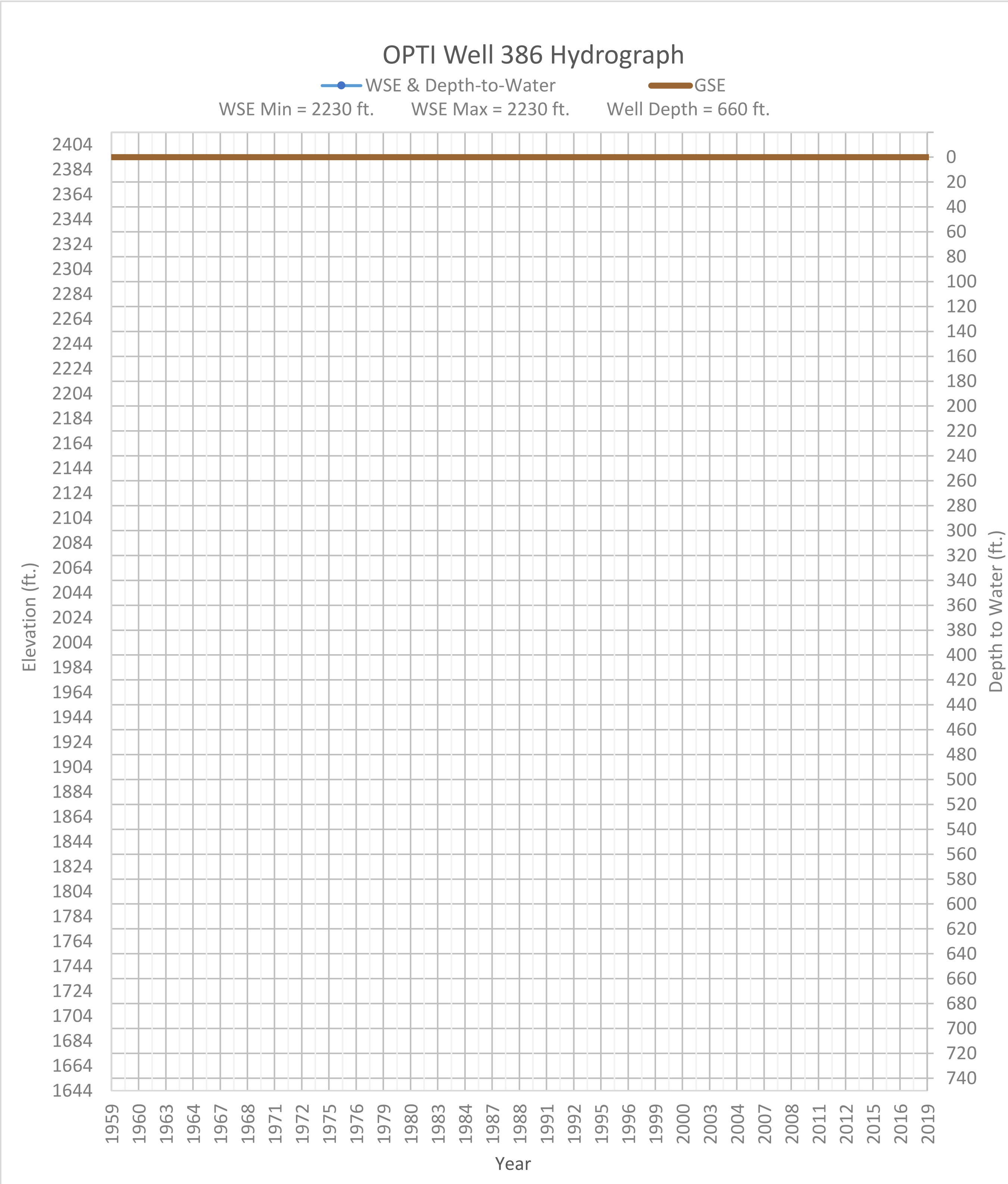
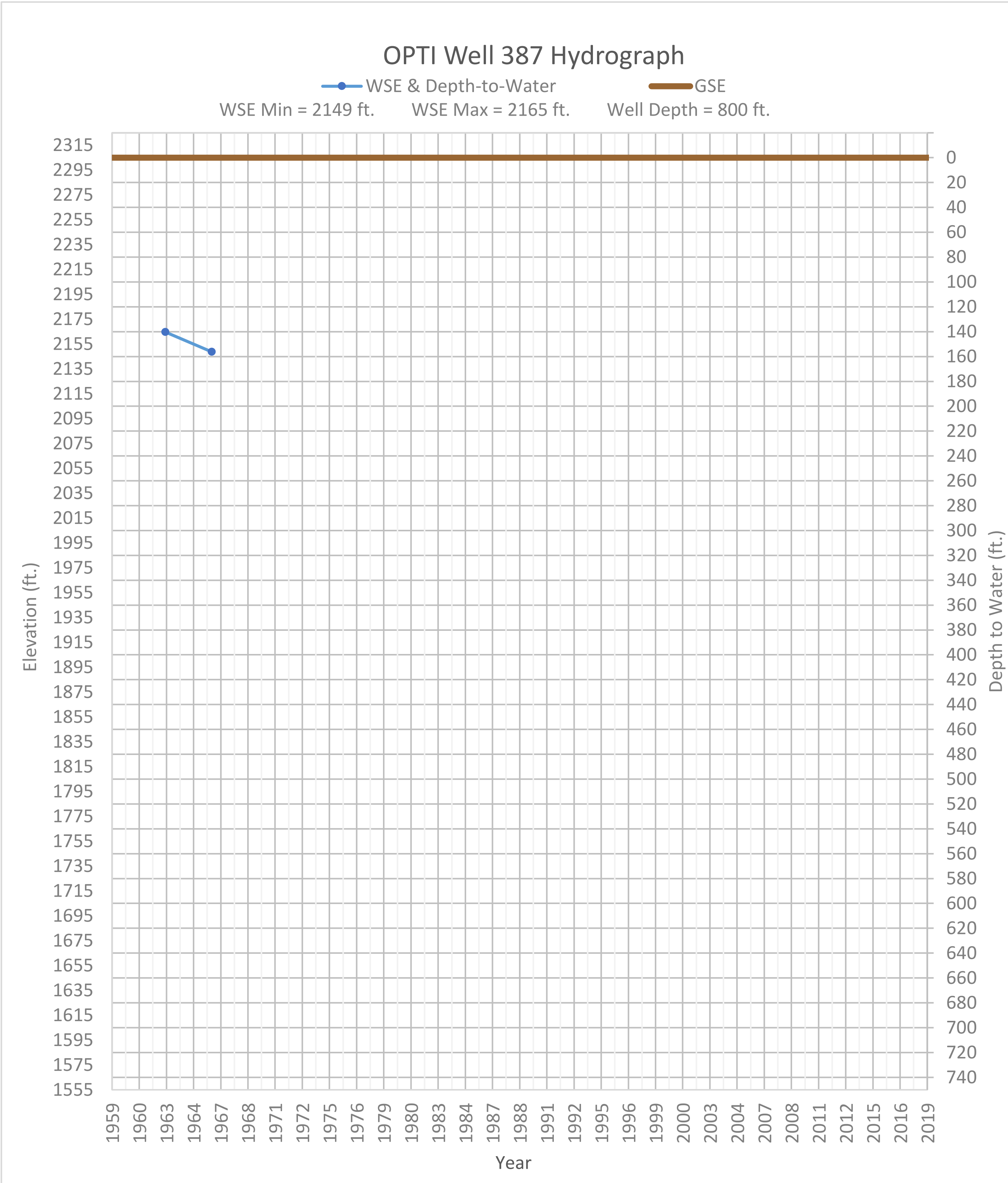
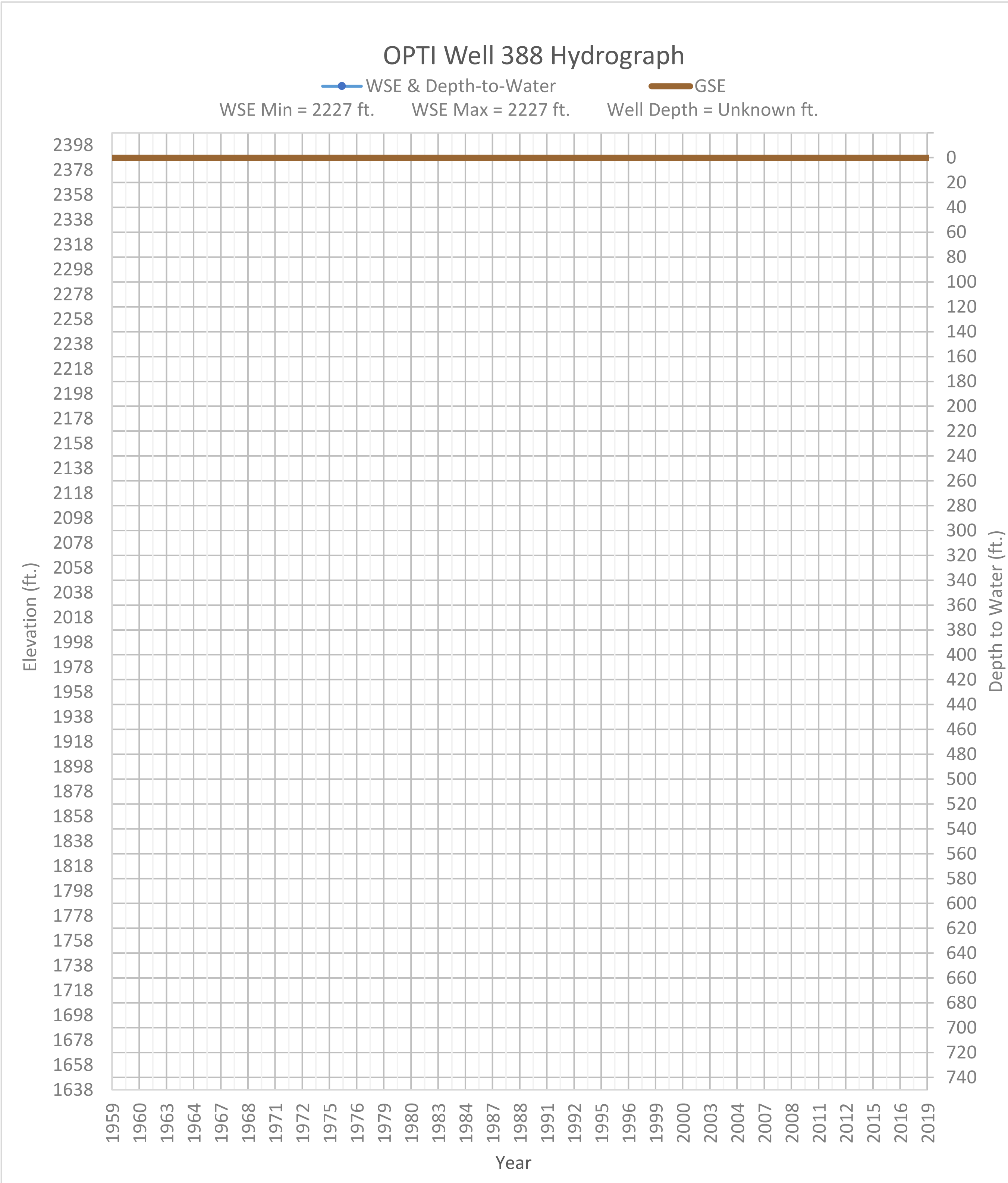
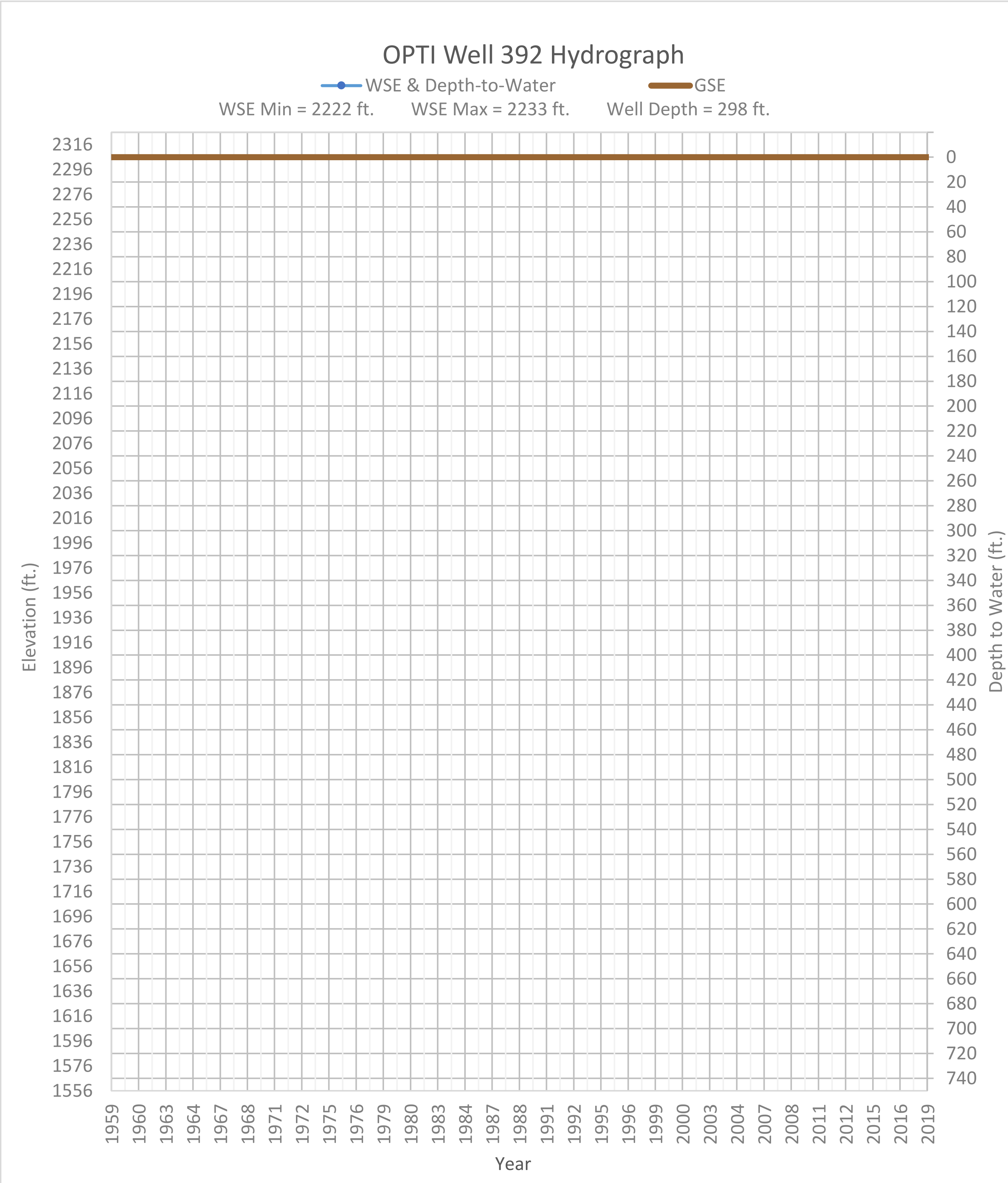

OPTI Well 386 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2230 ft.
WSE Max = 2230 ft.
Well Depth = 660 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2404 2384 2364 2344 2324 2304 2284 2264 2244 2224 2204 2184 2164 2144 2124 2104 2084 2064 2044 2024 2004 1984 1964 1944 1924 1904 1884 1864 1844 1824 1804 1784 1764 1744 1724 1704 1684 1664 1644
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500 520 540 560 580 600 620 640 660 680 700 720 740
1959 1960 1963 1964 1967 1968 1971 1972 1975 1976 1979 1980 1983 1984 1987 1988 1991 1992 1995 1996 1999 2000 2003 2004 2007 2008 2011 2012 2015 2016 2019

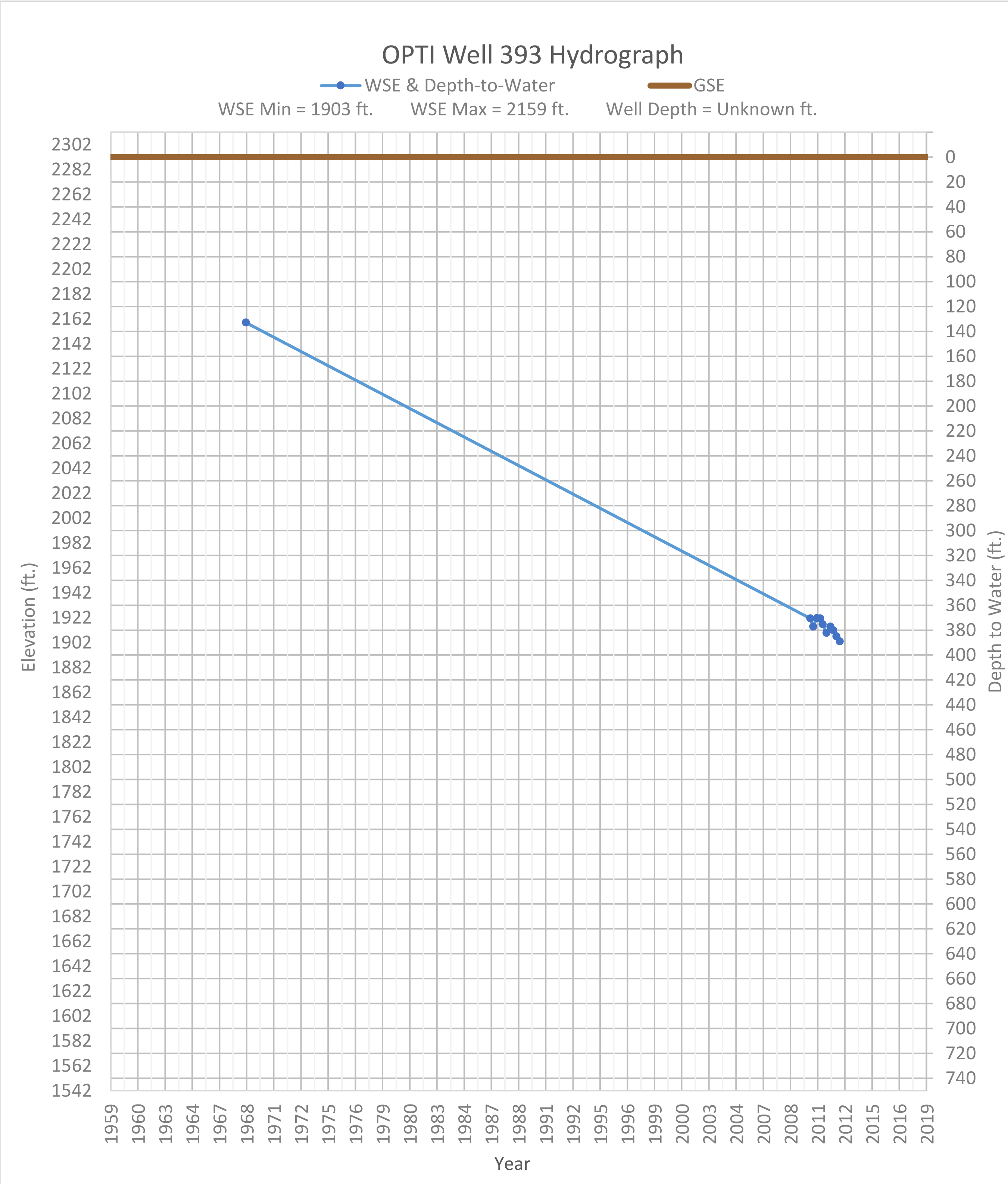


OPTI Well 387 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2149 ft.
WSE Max = 2165 ft.
Well Depth = 800 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

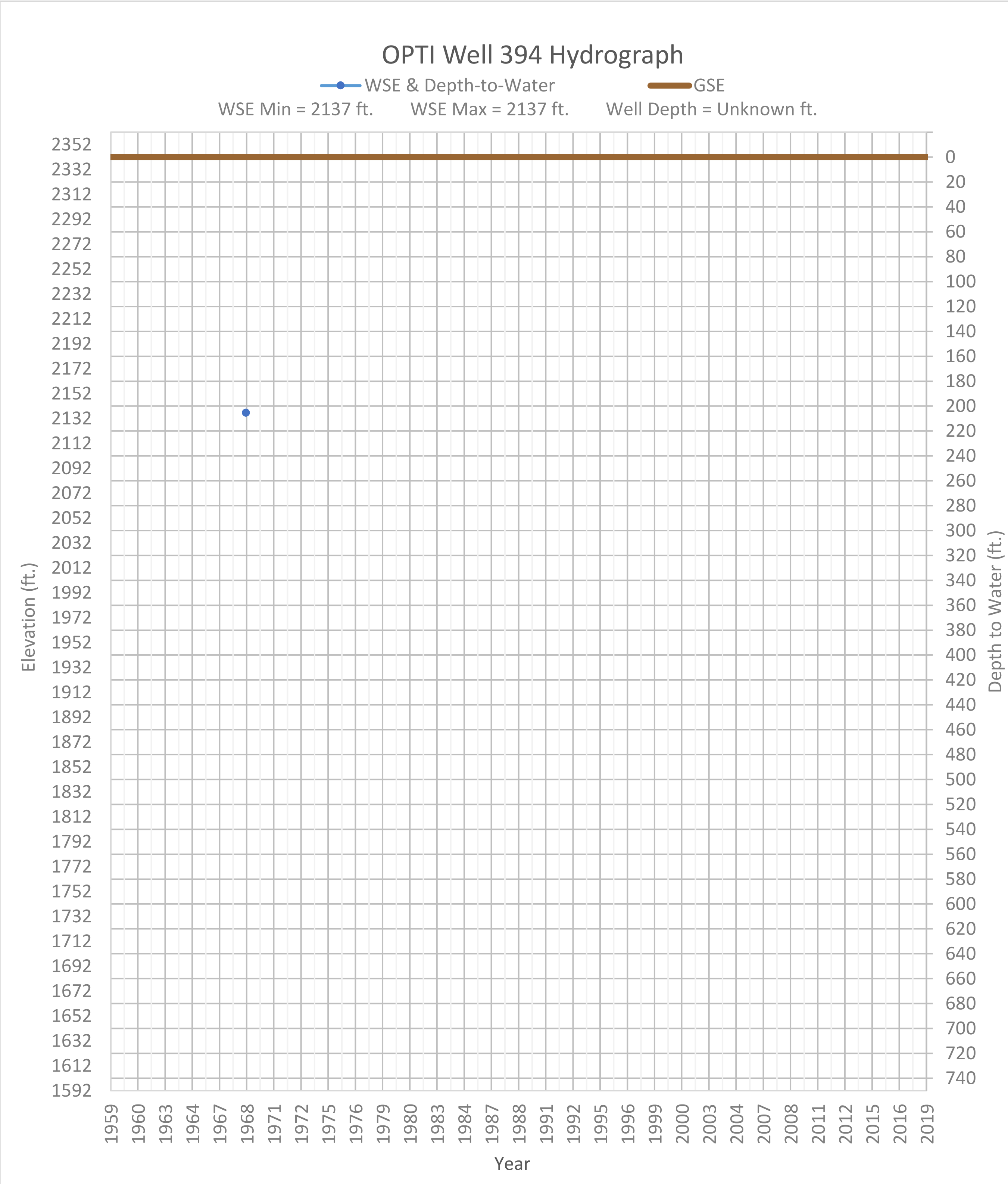


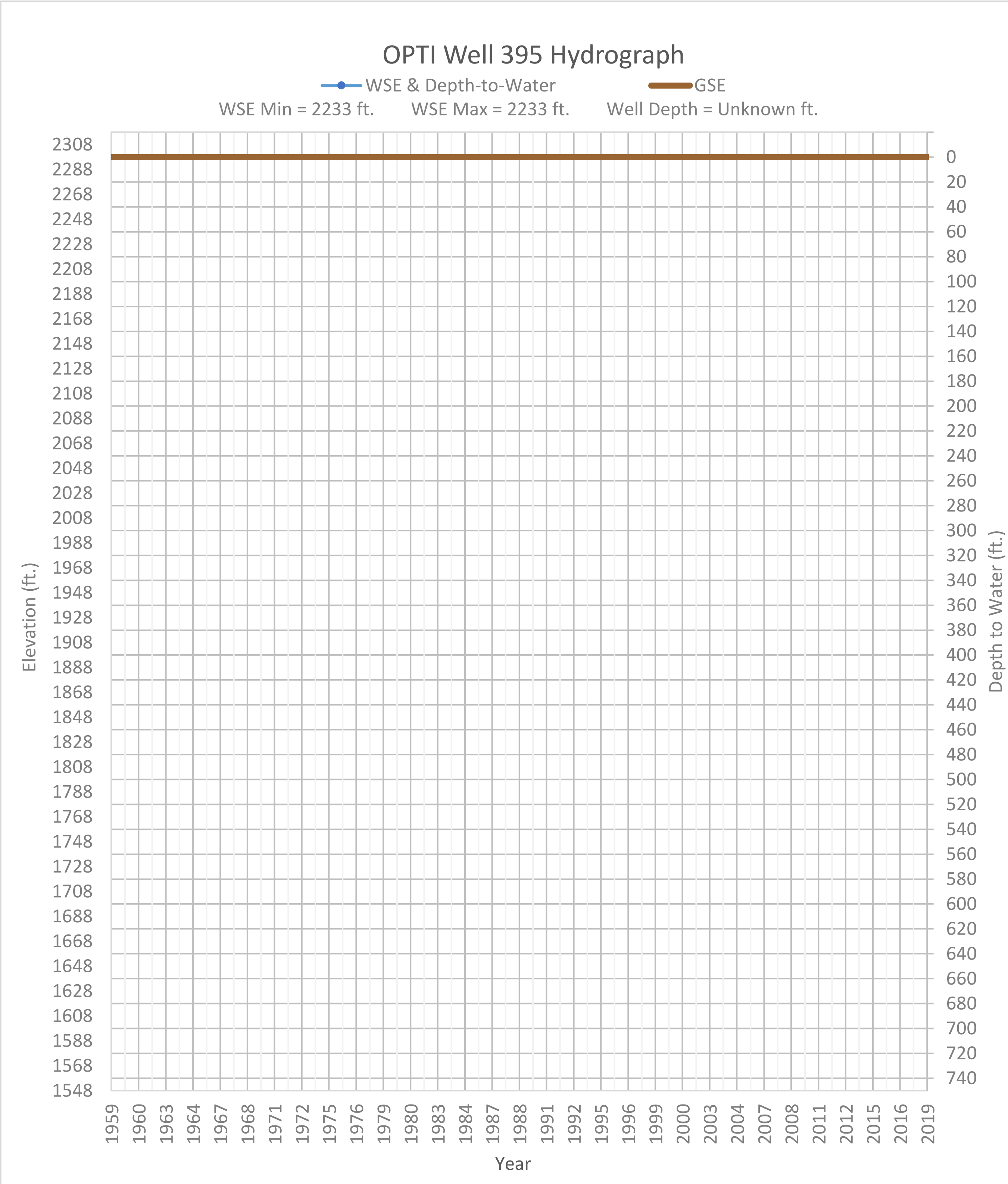
OPTI Well 388 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2227 ft.
WSE Max = 2227 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 392 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2222 ft.
WSE Max = 2233 ft.
Well Depth = 298 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 393 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1903 ft.
WSE Max = 2159 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 394 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2137 ft.
WSE Max = 2137 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 395 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2233 ft.
WSE Max = 2233 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2308
2288
2268
2248
2228
2208
2188
2168
2148
2128
2108
2088
2068
2048
2028
2008
1988
1968
1948
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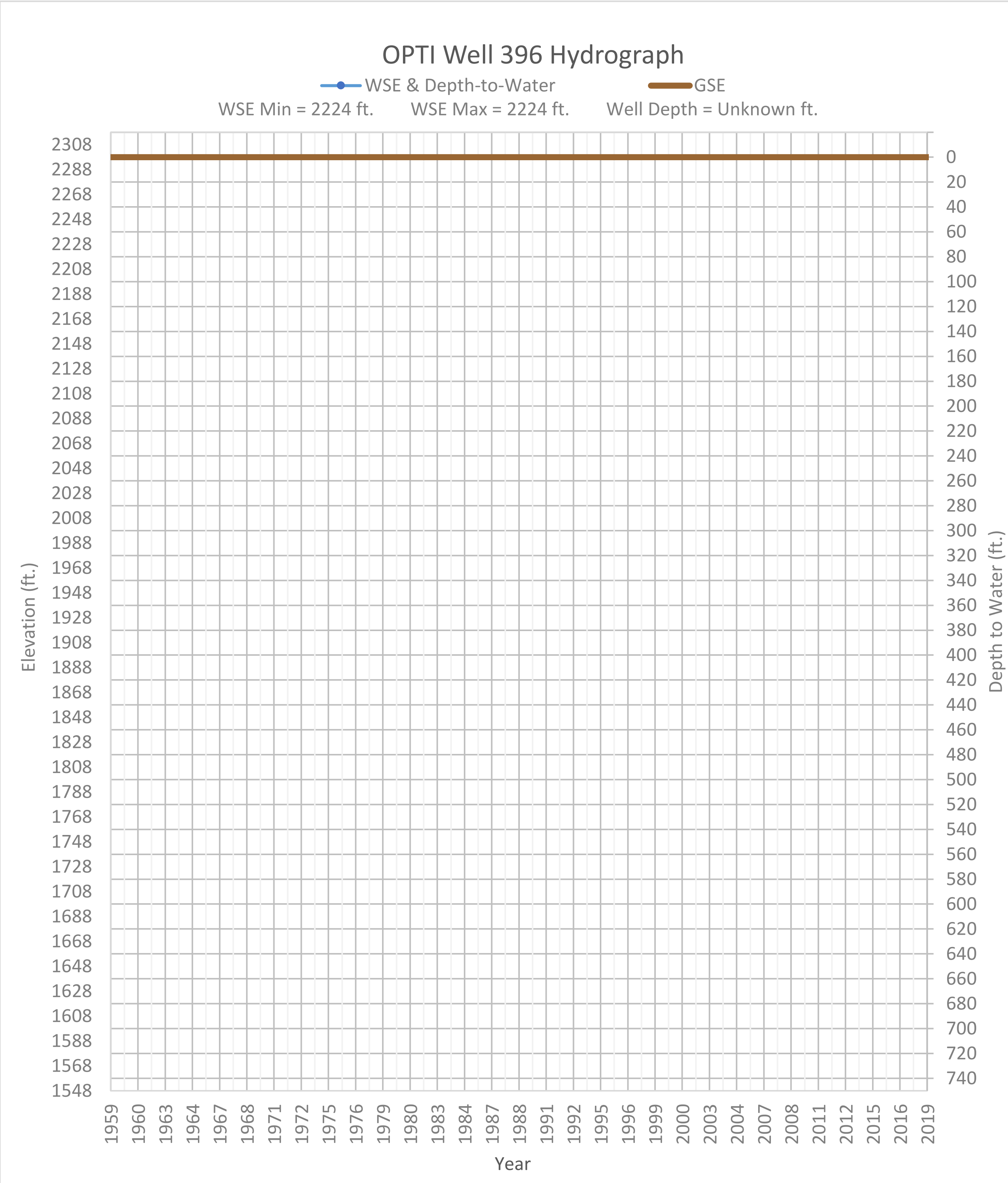
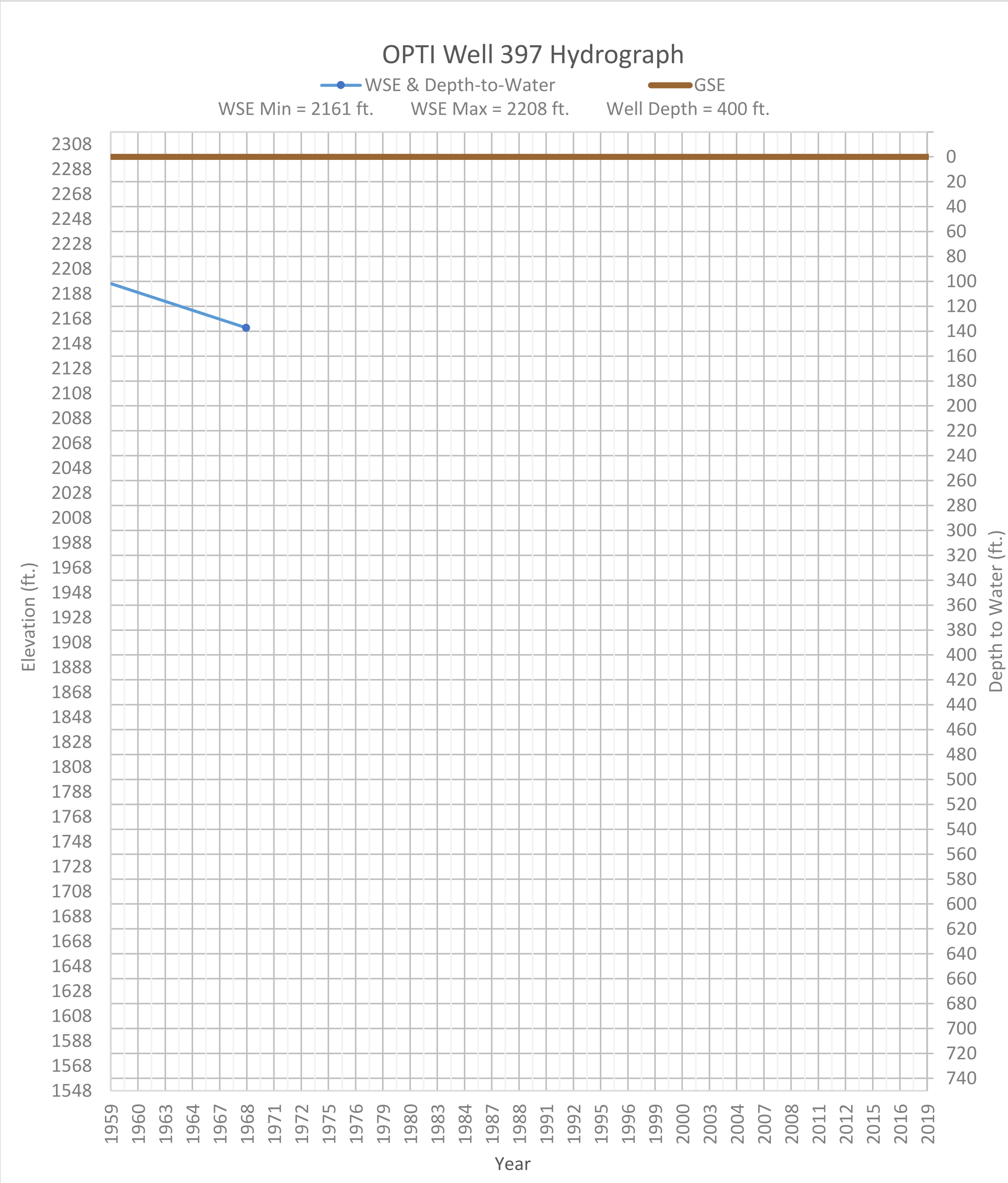

OPTI Well 396 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2224 ft.
WSE Max = 2224 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 397 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2161 ft.
WSE Max = 2208 ft.
Well Depth = 400 ft.
Elevation (ft.)
2308
2288
2268
2248
2228
2208
2188
2168
2148
2128
2108
2088
2068
2048
2028
2008
1988
1968
1948
1928
1908
1888
1868
1848
1828
1808
1788
1768
1748
1728
1708
1688
1668
1648
1628
1608
1588
1568
1548
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
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Year
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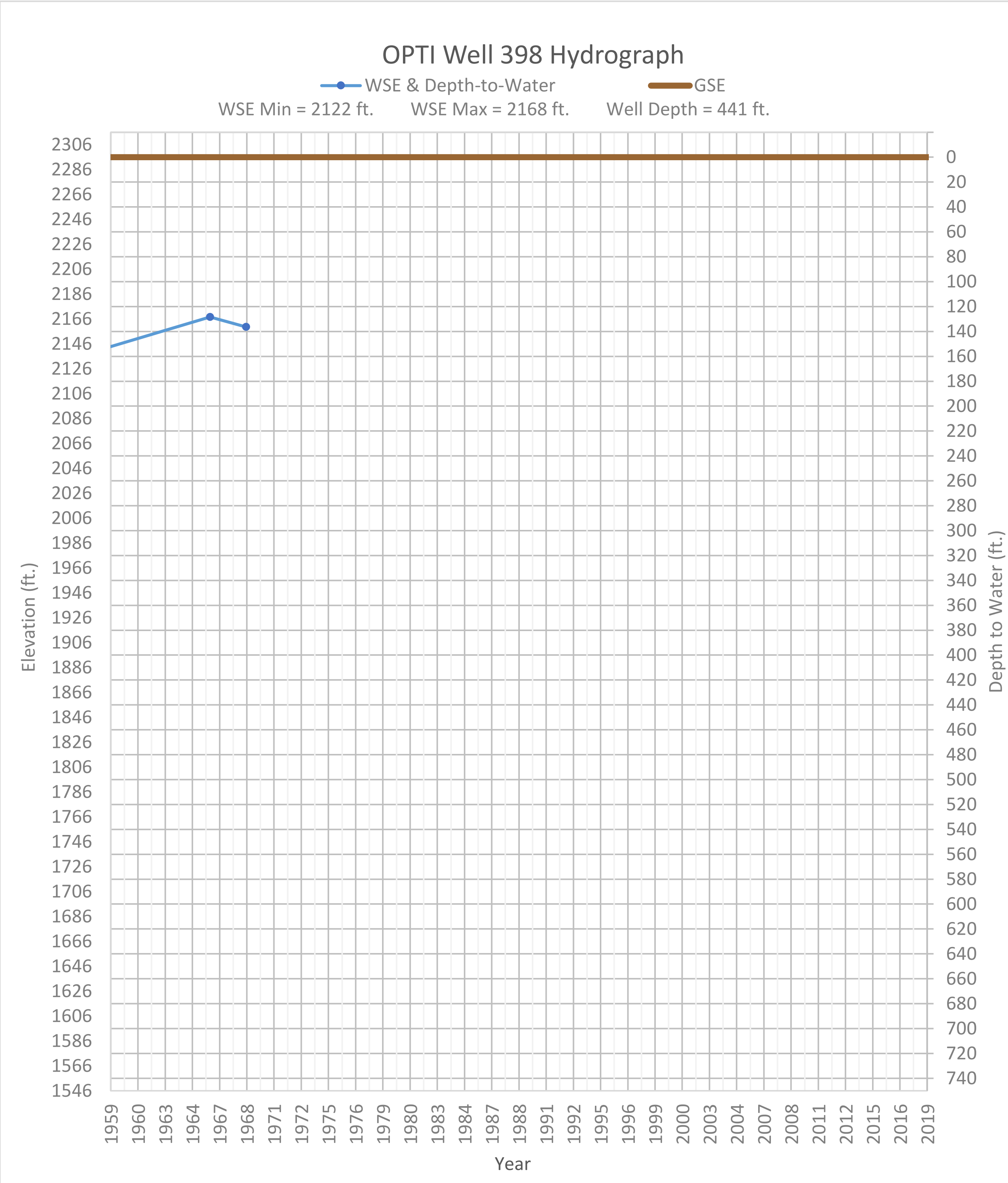
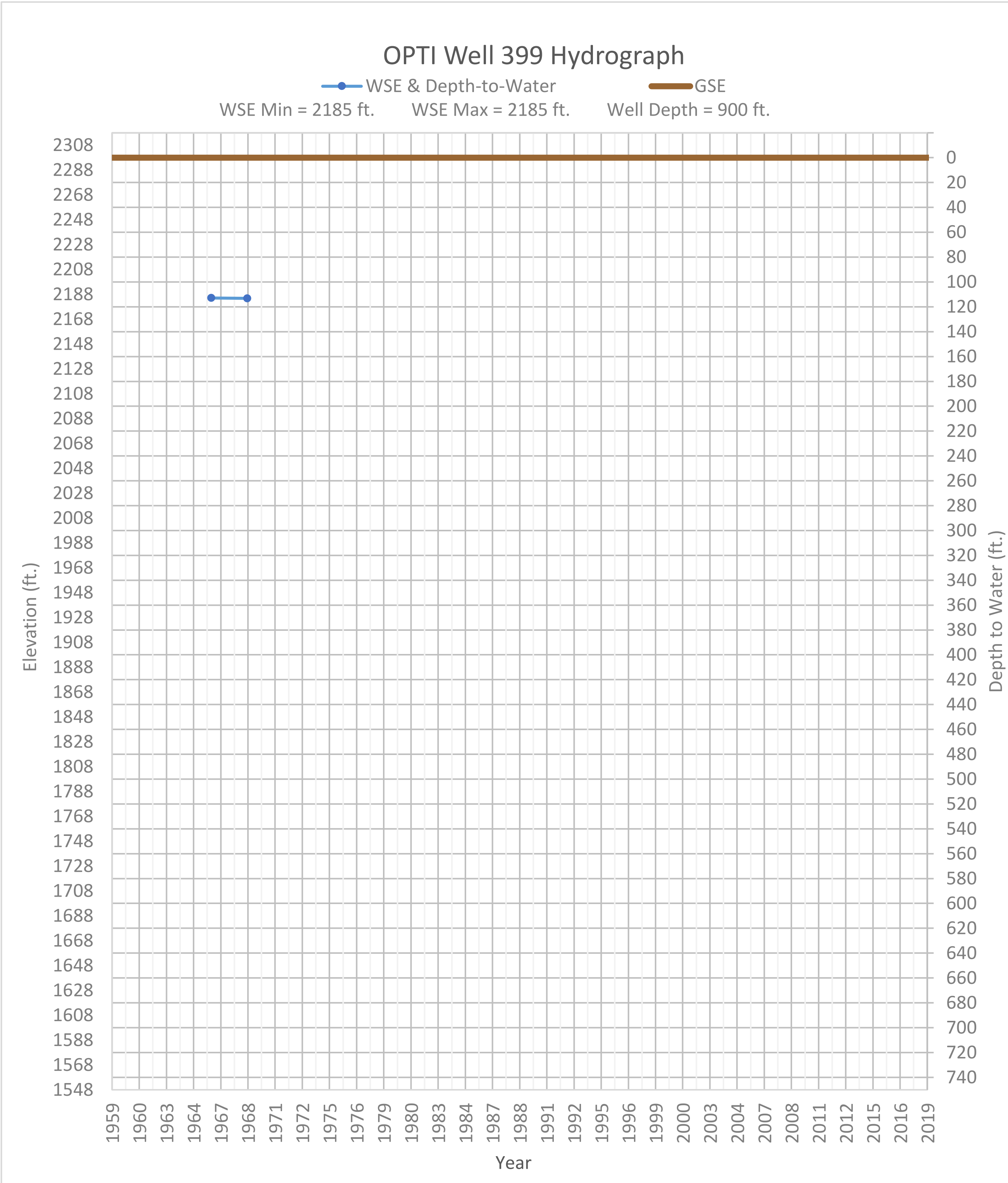
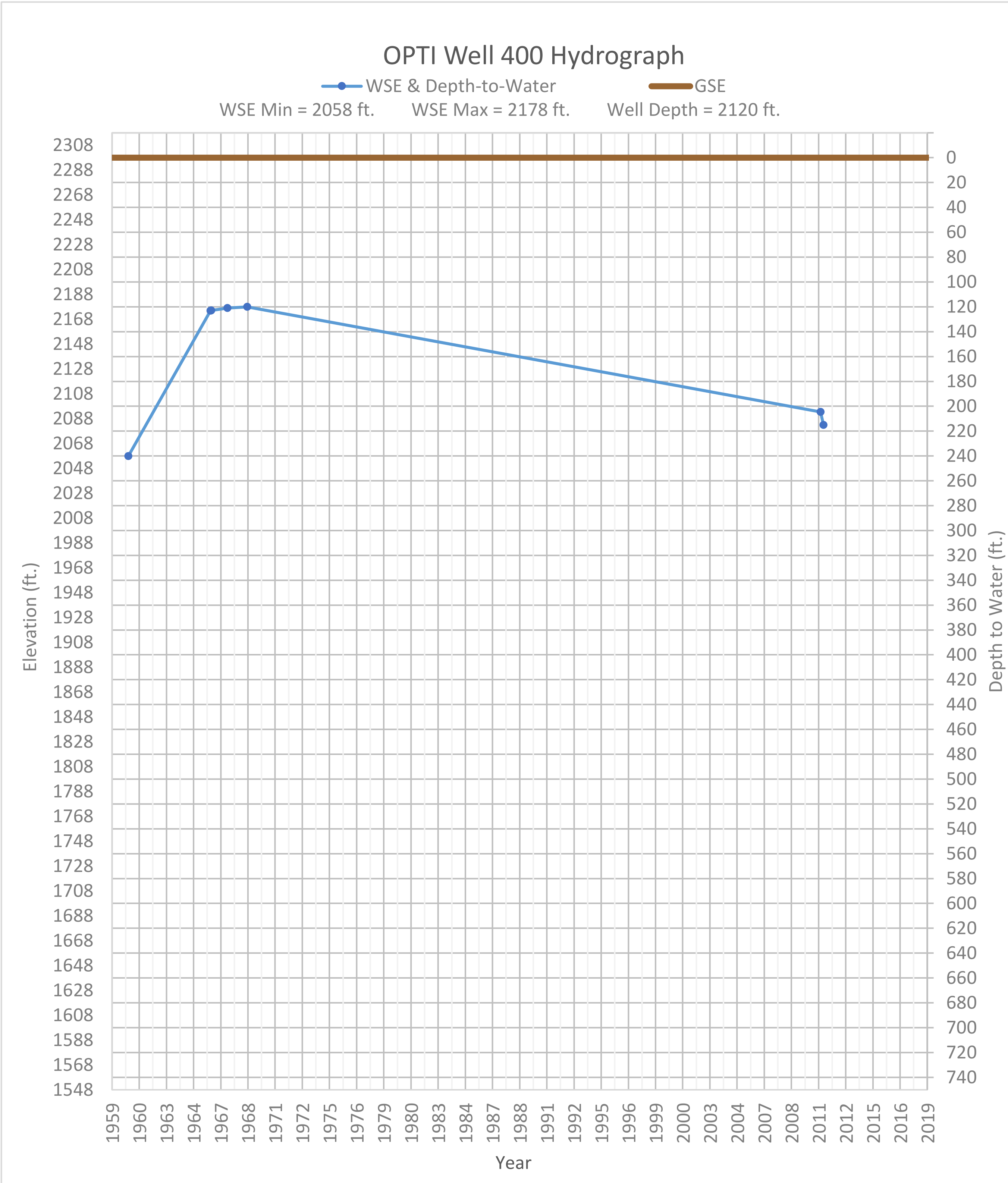


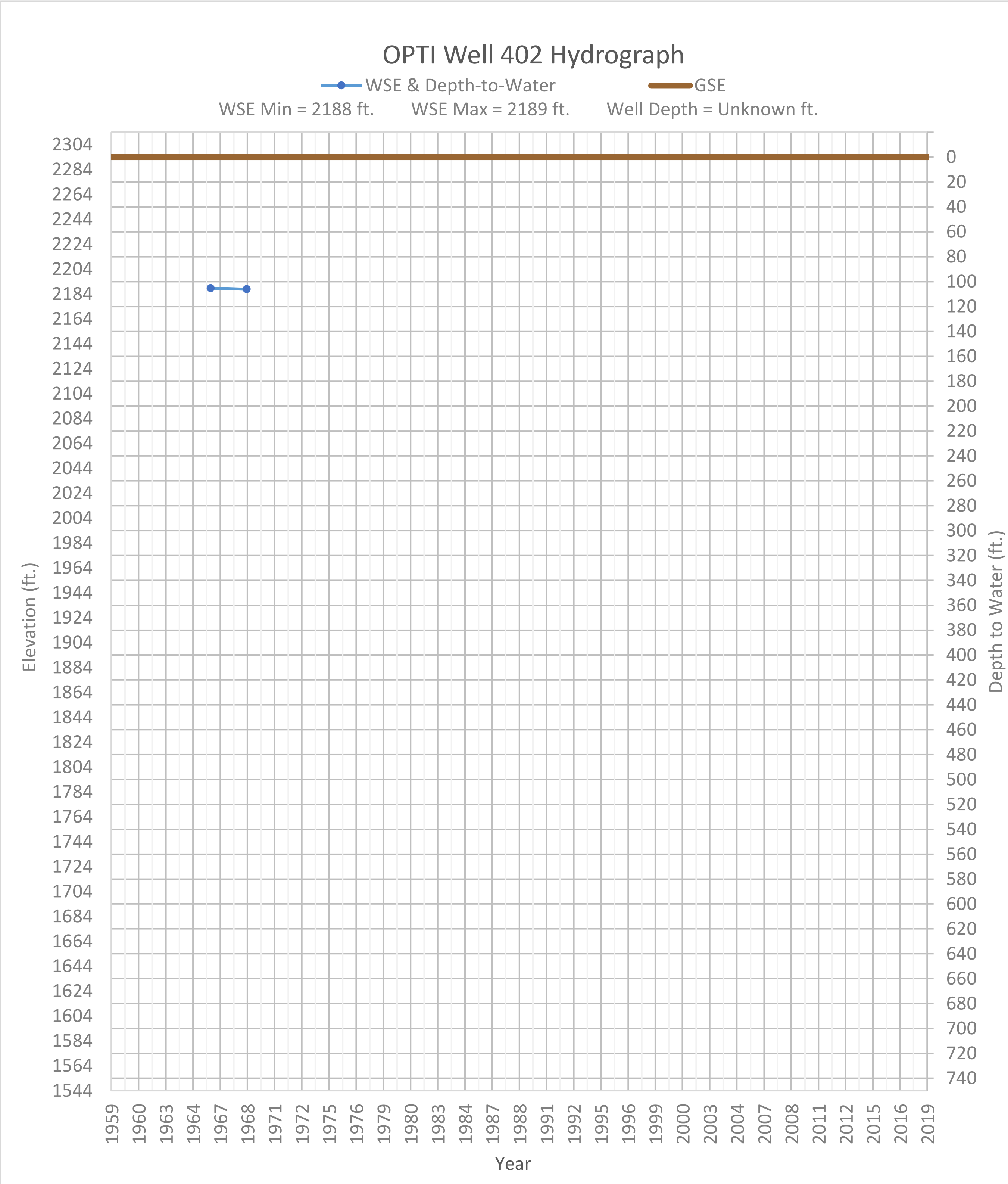
OPTI Well 398 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2122 ft.
WSE Max = 2168 ft.
Well Depth = 441 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



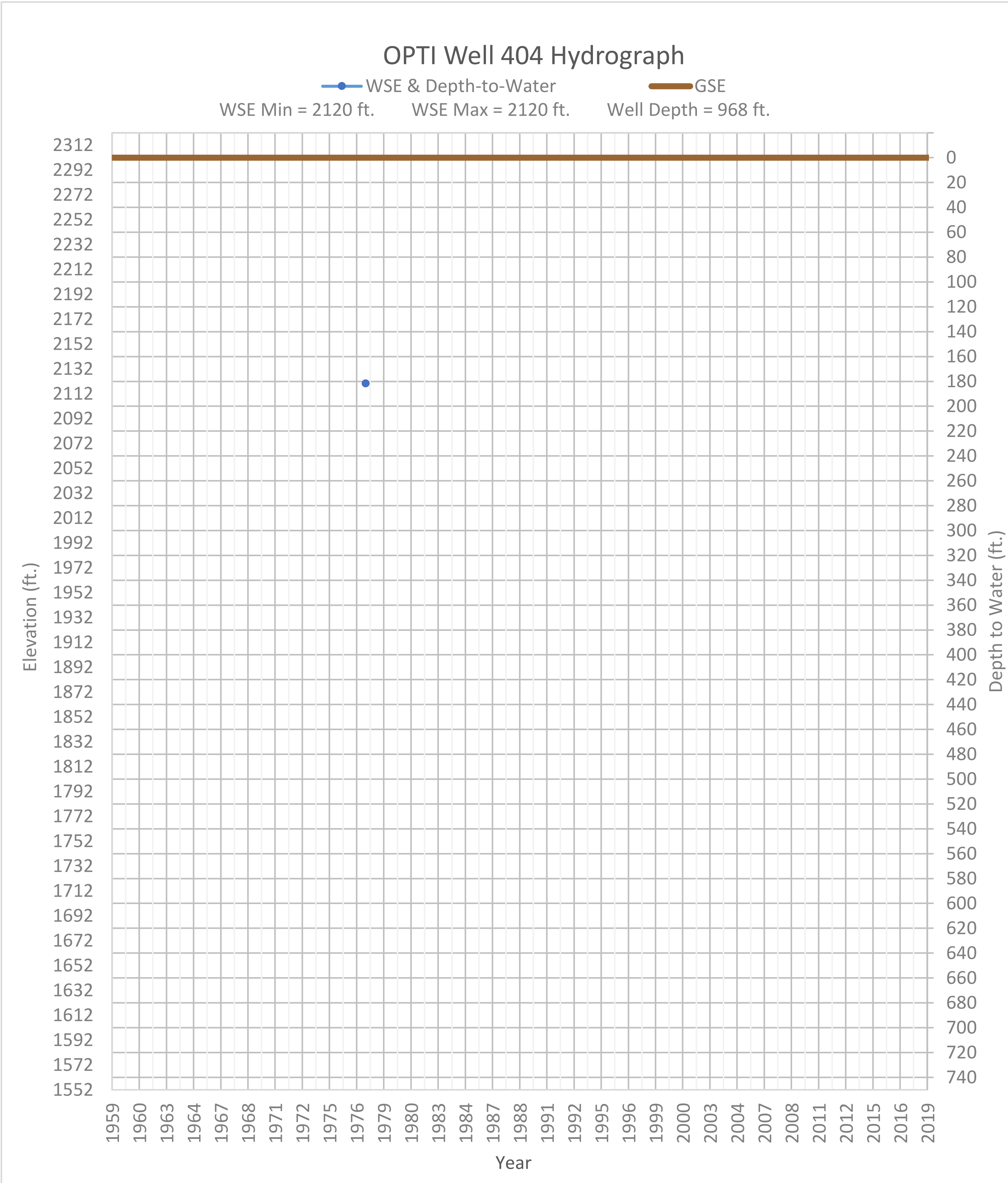
OPTI Well 399 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2185 ft.
WSE Max = 2185 ft.
Well Depth = 900 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2308 2288 2268 2248 2228 2208 2188 2168 2148 2128 2108 2088 2068 2048 2028 2008 1988 1968 1948 1928 1908 1888 1868 1848 1828 1808 1788 1768 1748 1728 1708 1688 1668 1648 1628 1608 1588 1568 1548
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500 520 540 560 580 600 620 640 660 680 700 720 740
1959 1960 1963 1964 1967 1968 1971 1972 1975 1976 1979 1980 1983 1984 1987 1988 1991 1992 1995 1996 1999 2000 2003 2004 2007 2008 2011 2012 2015 2016 2019



OPTI Well 400 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2058 ft.
WSE Max = 2178 ft.
Well Depth = 2120 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 402 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2188 ft.
WSE Max = 2189 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 404 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2120 ft.
WSE Max = 2120 ft.
Well Depth = 968 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2312
2292
2272
2252
2232
2212
2192
2172
2152
2132
2112
2092
2072
2052
2032
2012
1992
1972
1952
1932
1912
1892
1872
1852
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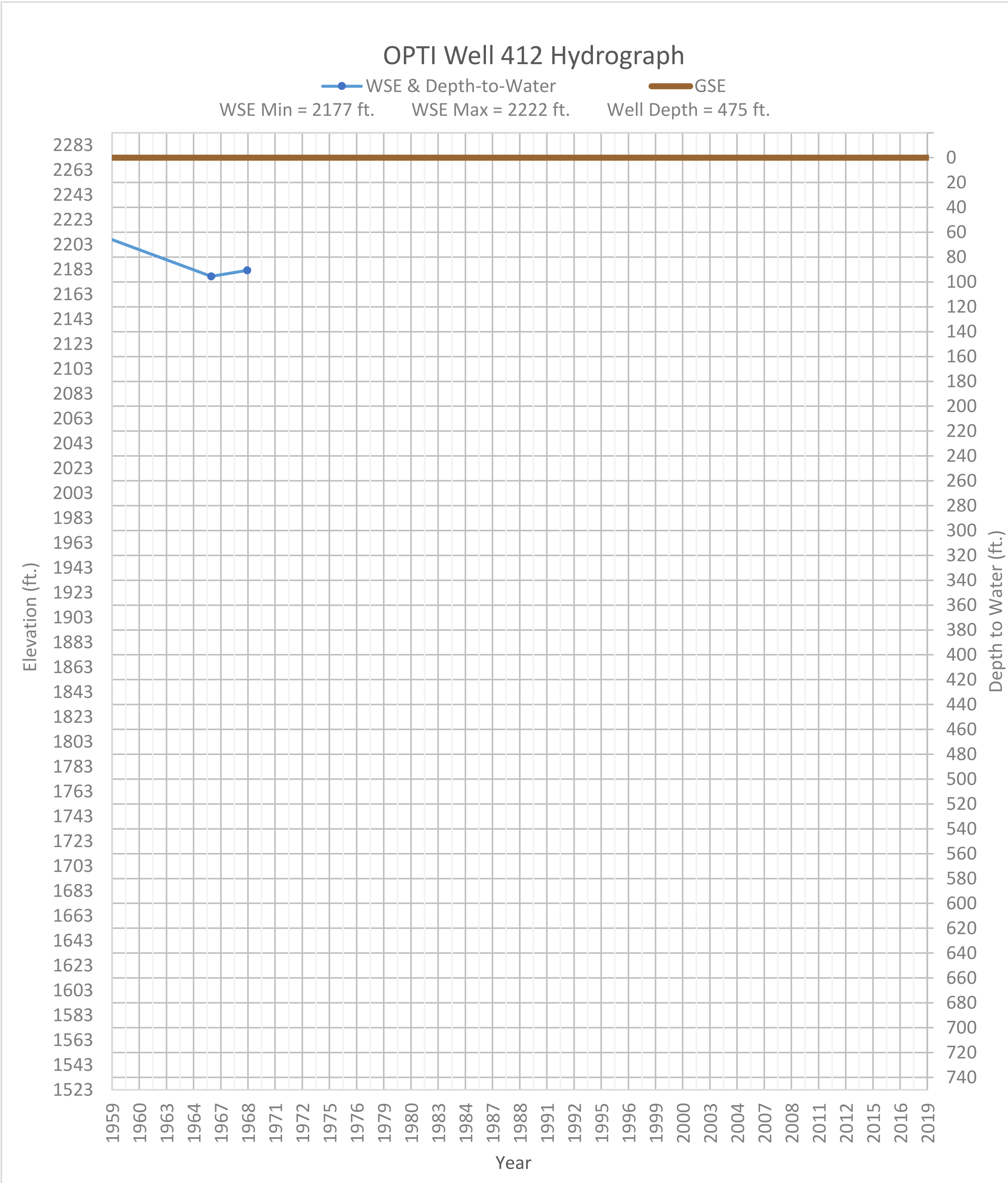
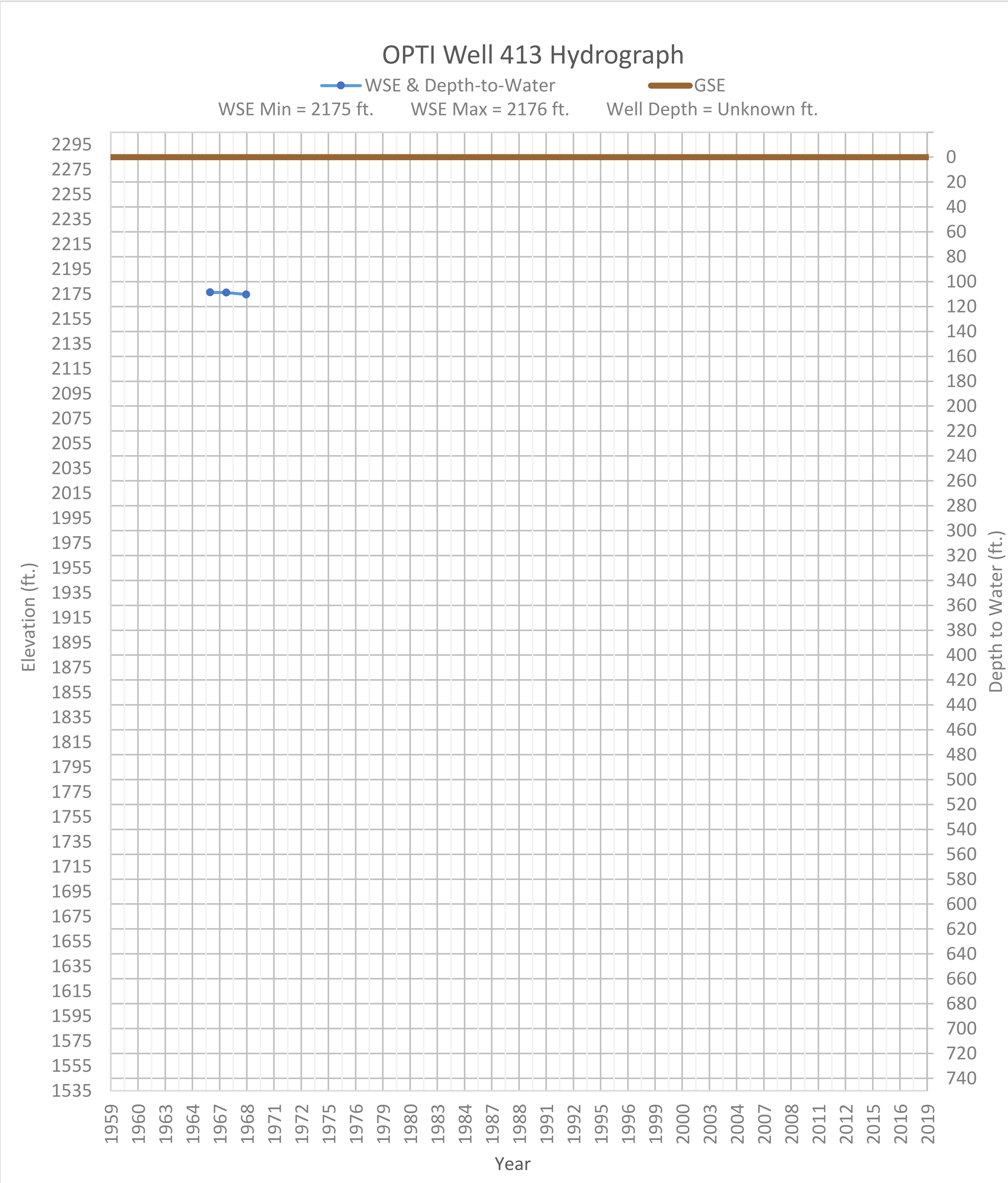
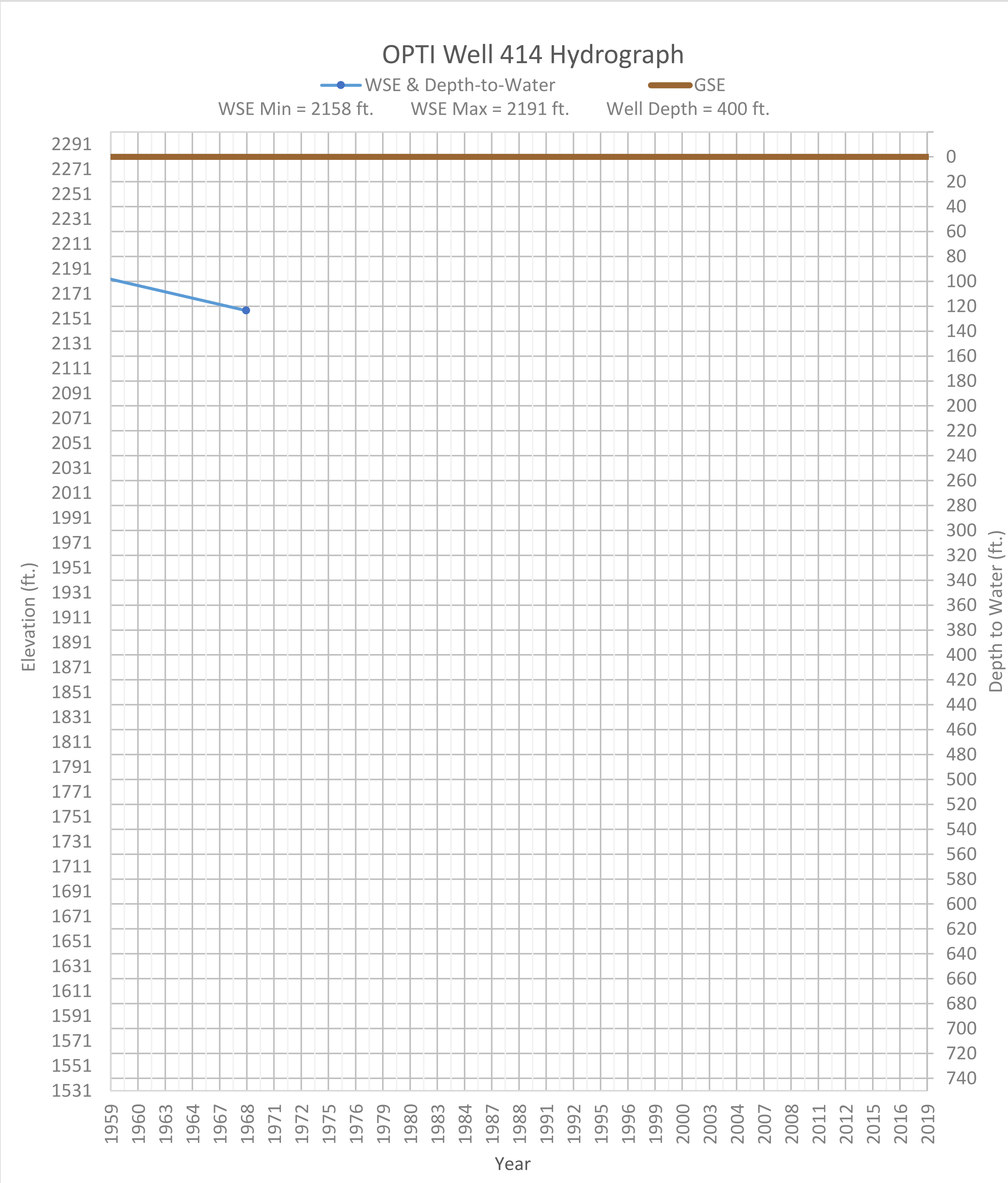


OPTI Well 412 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2177 ft.
WSE Max = 2222 ft.
Well Depth = 475 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 413 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2175 ft.
WSE Max = 2176 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 414 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2158 ft.
WSE Max = 2191 ft.
Well Depth = 400 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2291
2271
2251
2231
2211
2191
2171
2151
2131
2111
2091
2071
2051
2031
2011
1991
1971
1951
1931
1911
1891
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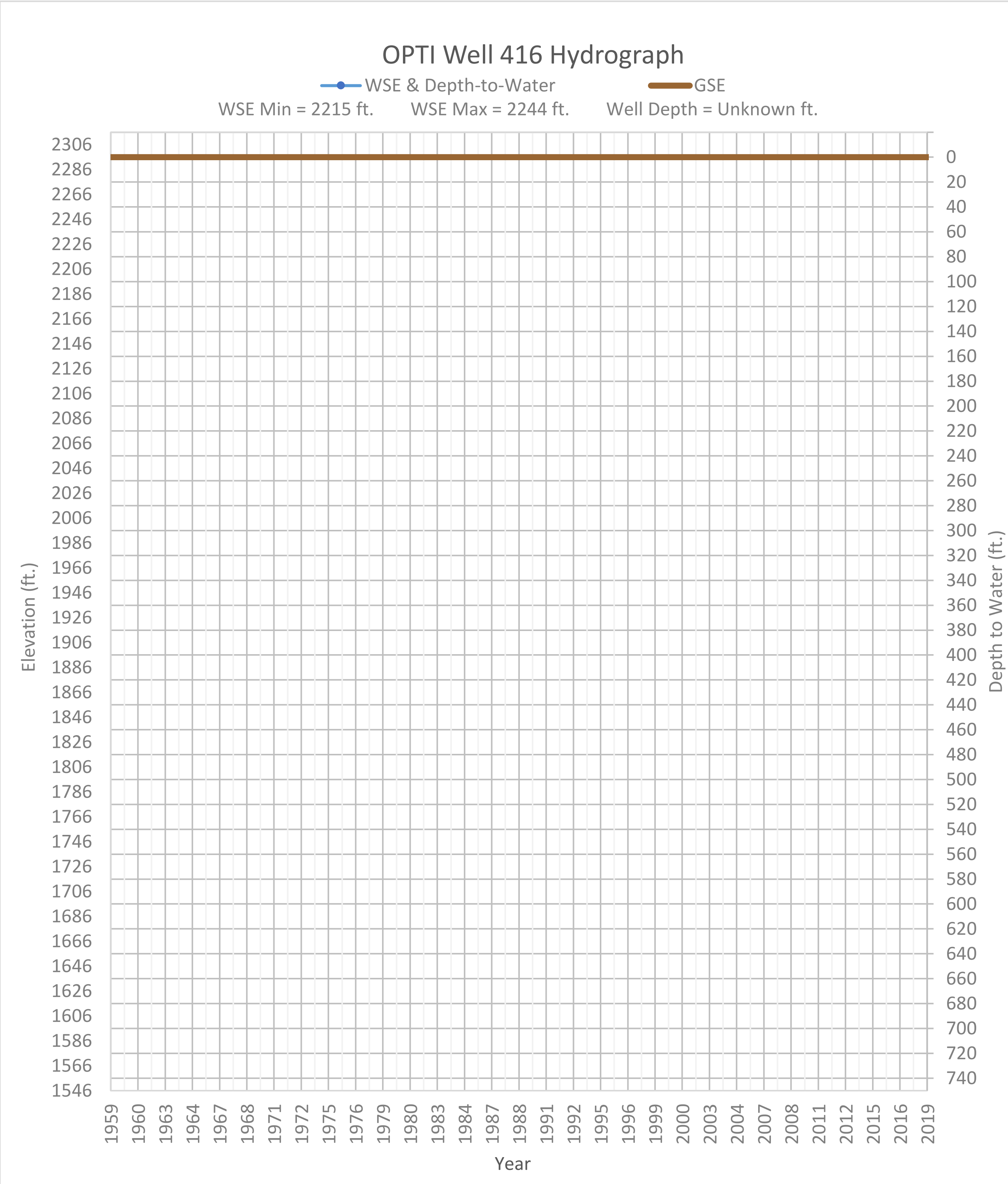
2016
2019



OPTI Well 416 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2215 ft.
WSE Max = 2244 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2306
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
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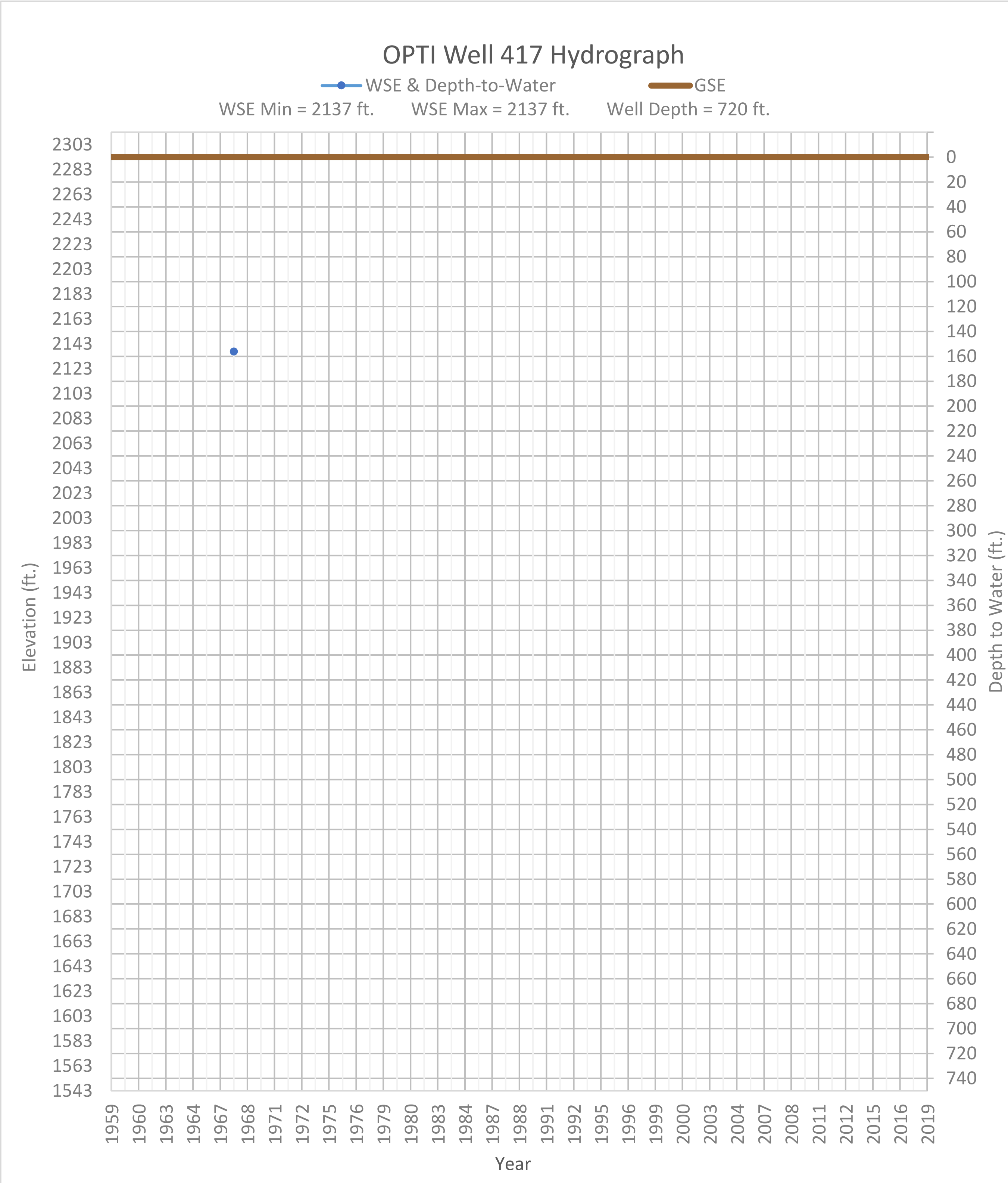

OPTI Well 417 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2137 ft.
WSE Max = 2137 ft.
Well Depth = 720 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2303
2283
2263
2243
2223
2203
2183
2163
2143
2123
2103
2083
2063
2043
2023
2003
1983
1963
1943
1923
1903
1883
1863
1843
1823
1803
1783
1763
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1723
1703
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1623
1603
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1543
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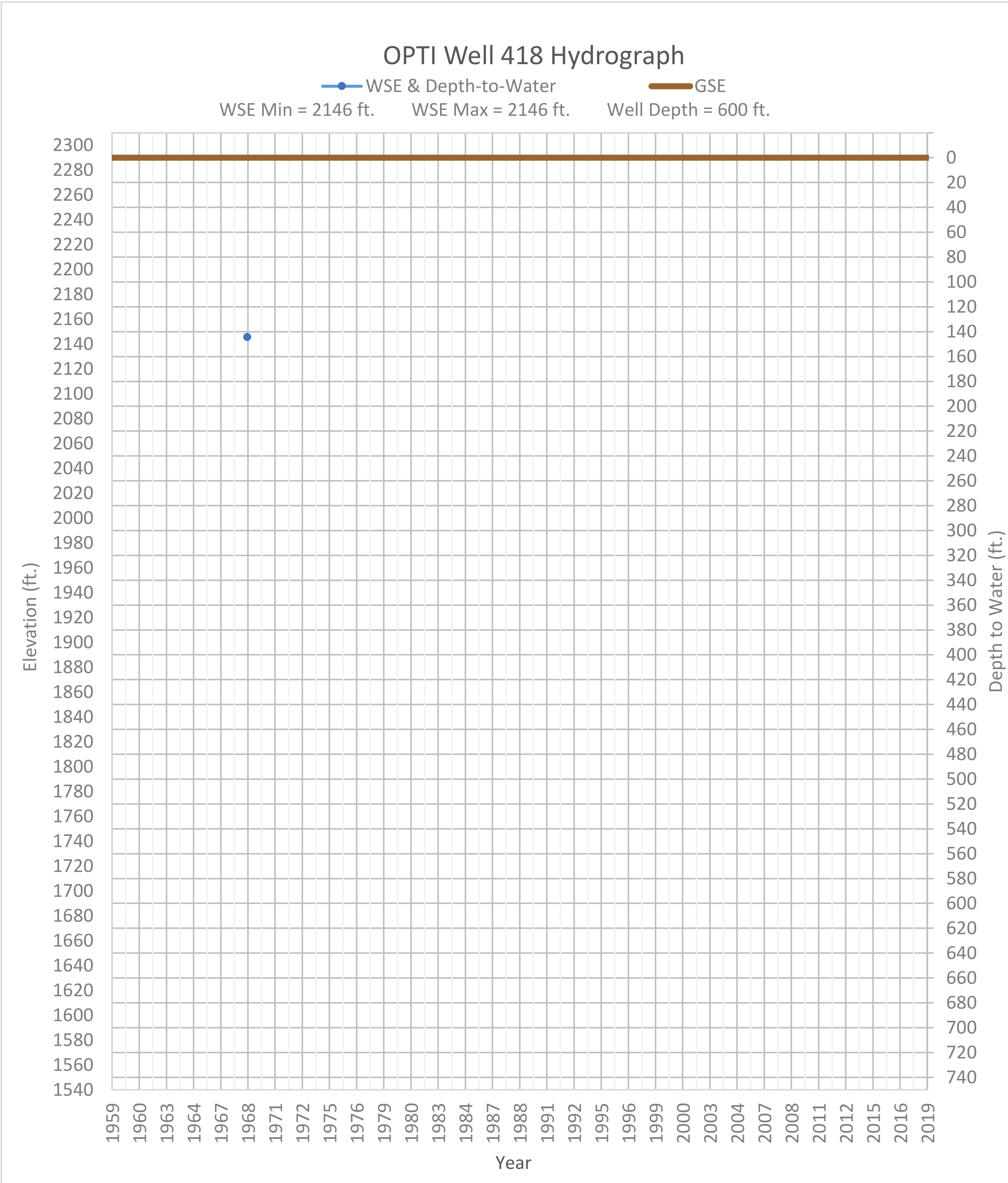
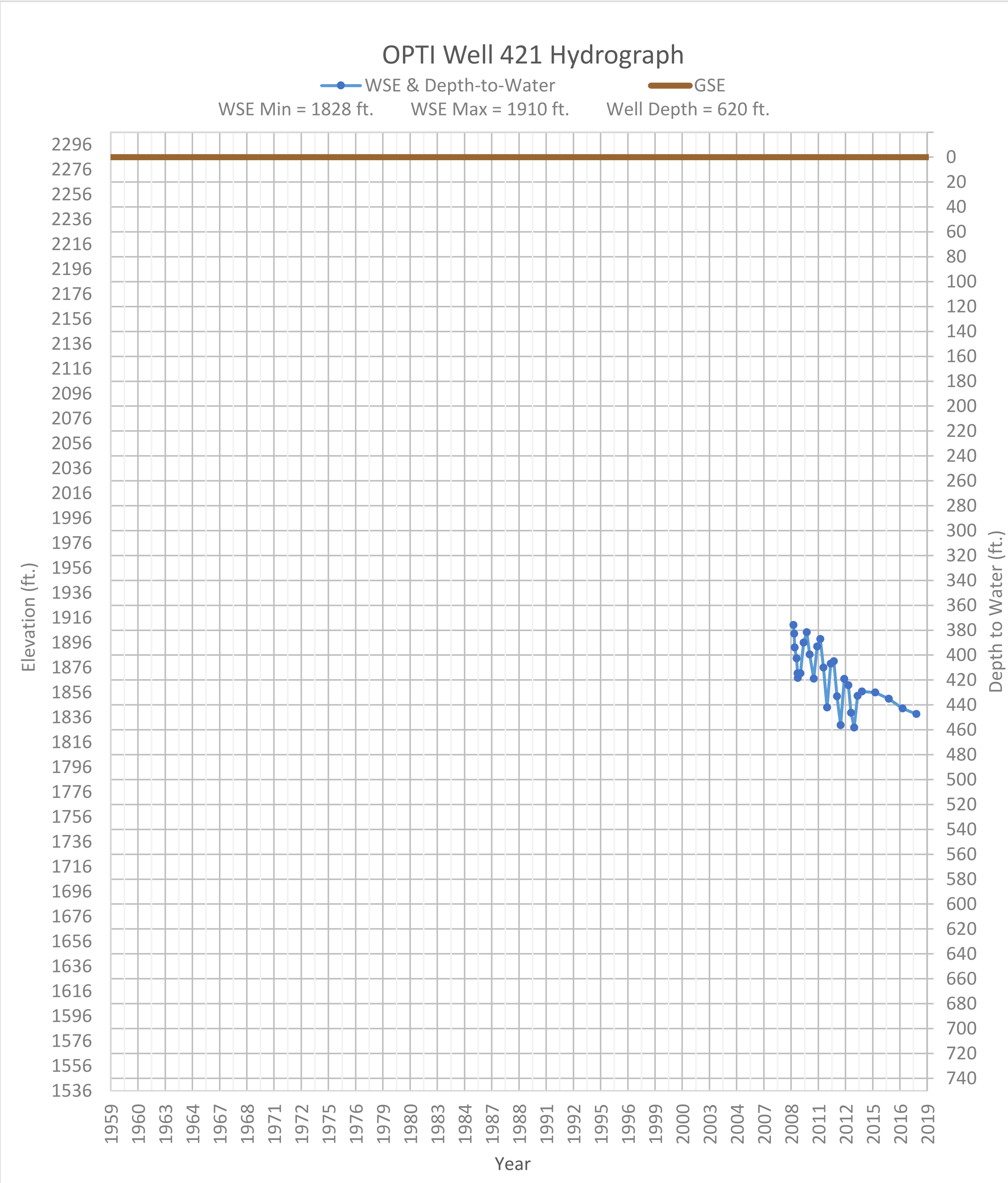


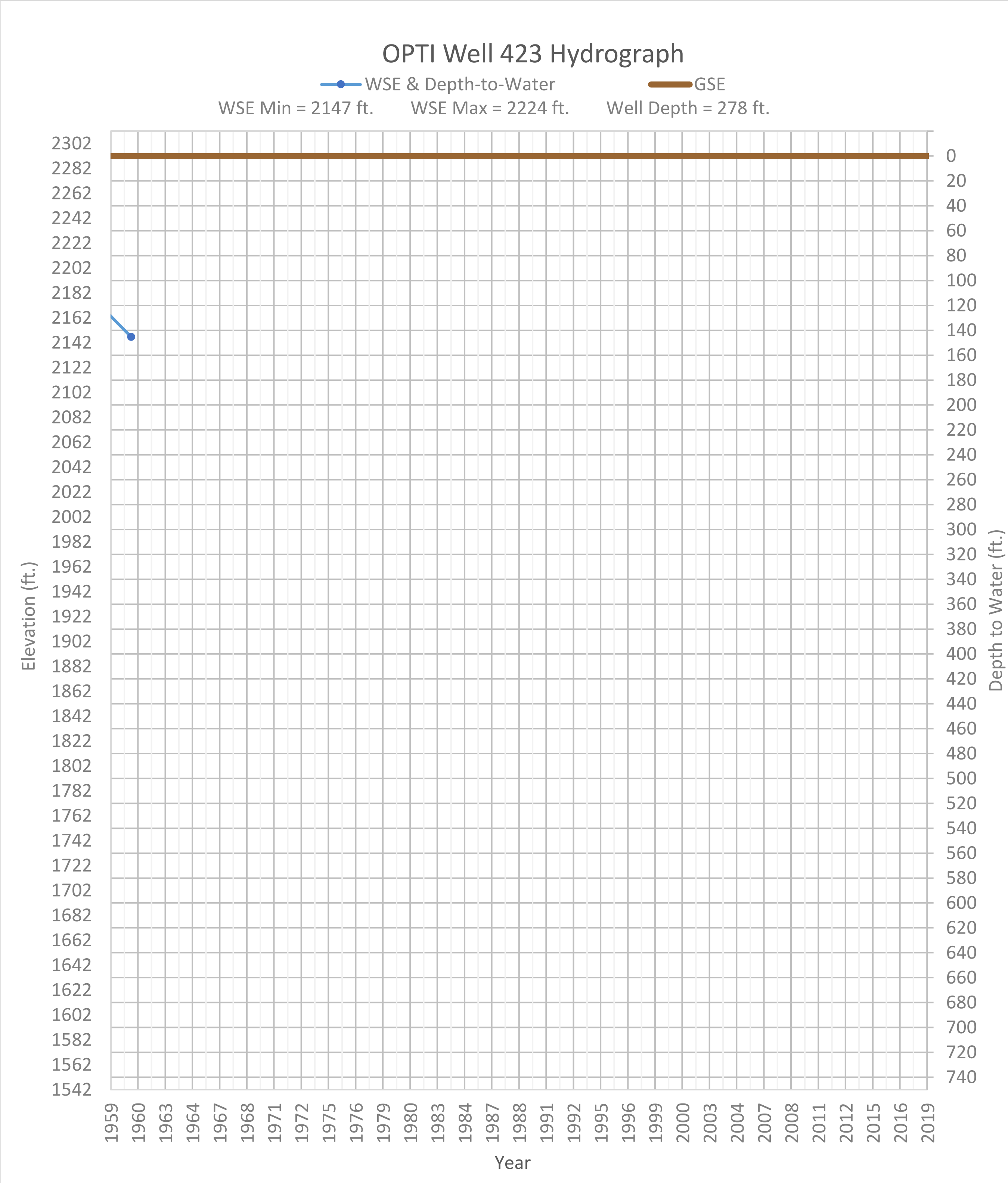
OPTI Well 418 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2146 ft.
WSE Max = 2146 ft.
Well Depth = 600 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 420 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1809 ft.
WSE Max = 1913 ft.
Well Depth = 780 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

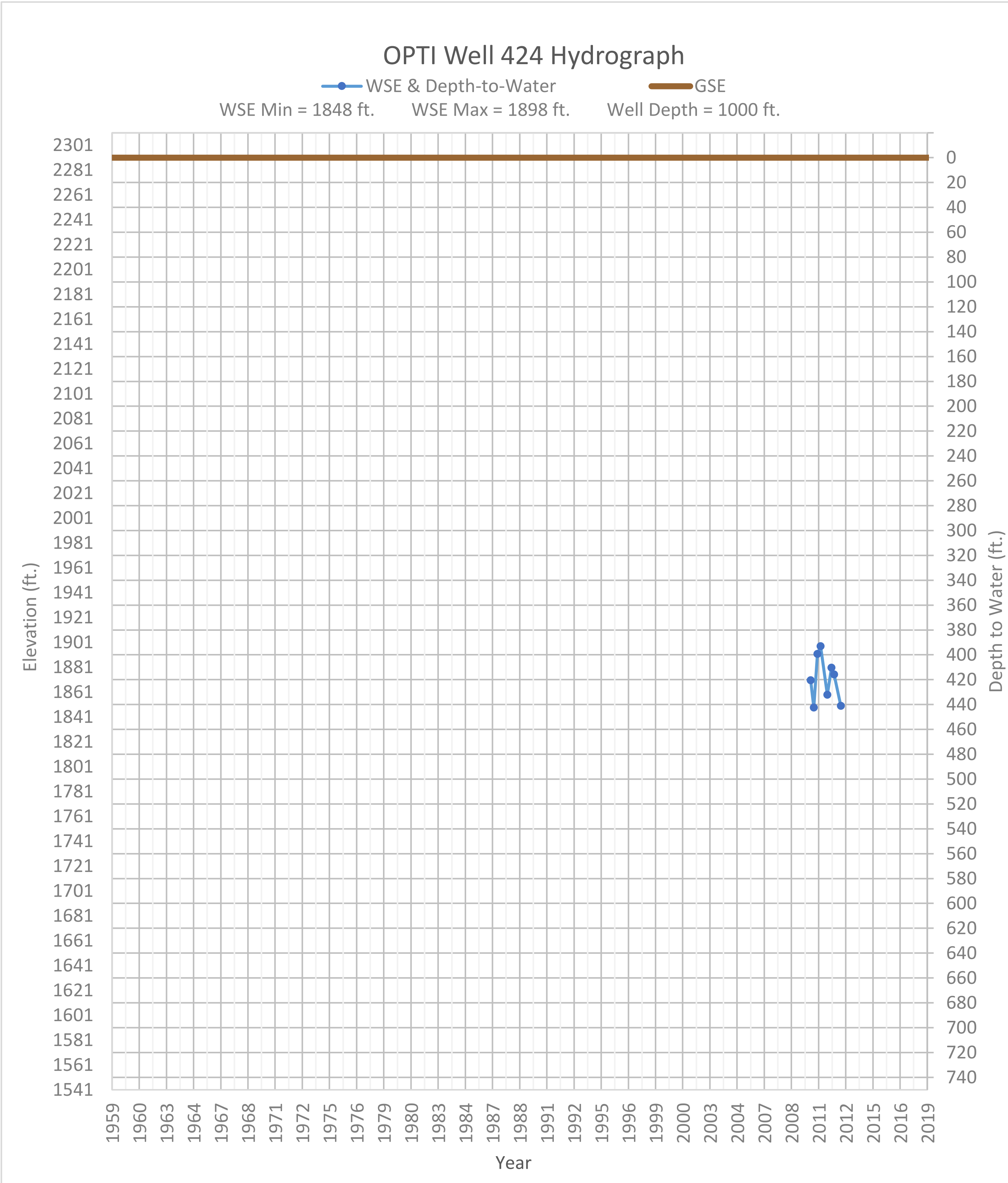


OPTI Well 421 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1828 ft.
WSE Max = 1910 ft.
Well Depth = 620 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 422 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1838 ft.
WSE Max = 1909 ft.
Well Depth = 460 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 423 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2147 ft.
WSE Max = 2224 ft.
Well Depth = 278 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 424 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1848 ft.
WSE Max = 1898 ft.
Well Depth = 1000 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2301
2281
2261
2241
2221
2201
2181
2161
2141
2121
2101
2081
2061
2041
2021
2001
1981
1961
1941
1921
1901
1881
1861
1841
1821
1801
1781
1761
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1721
1701
1681
1661
1641
1621
1601
1581
1561
1541
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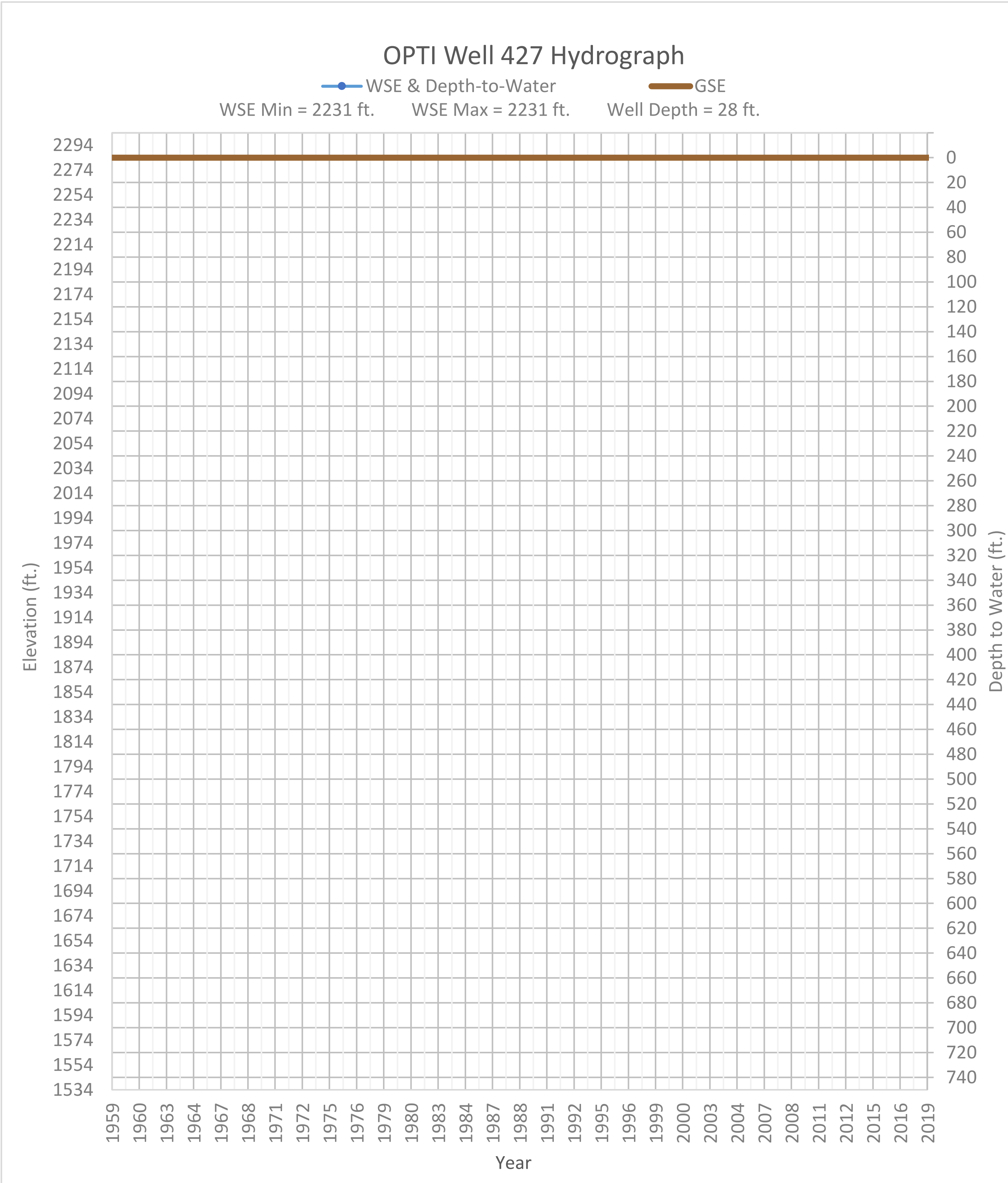
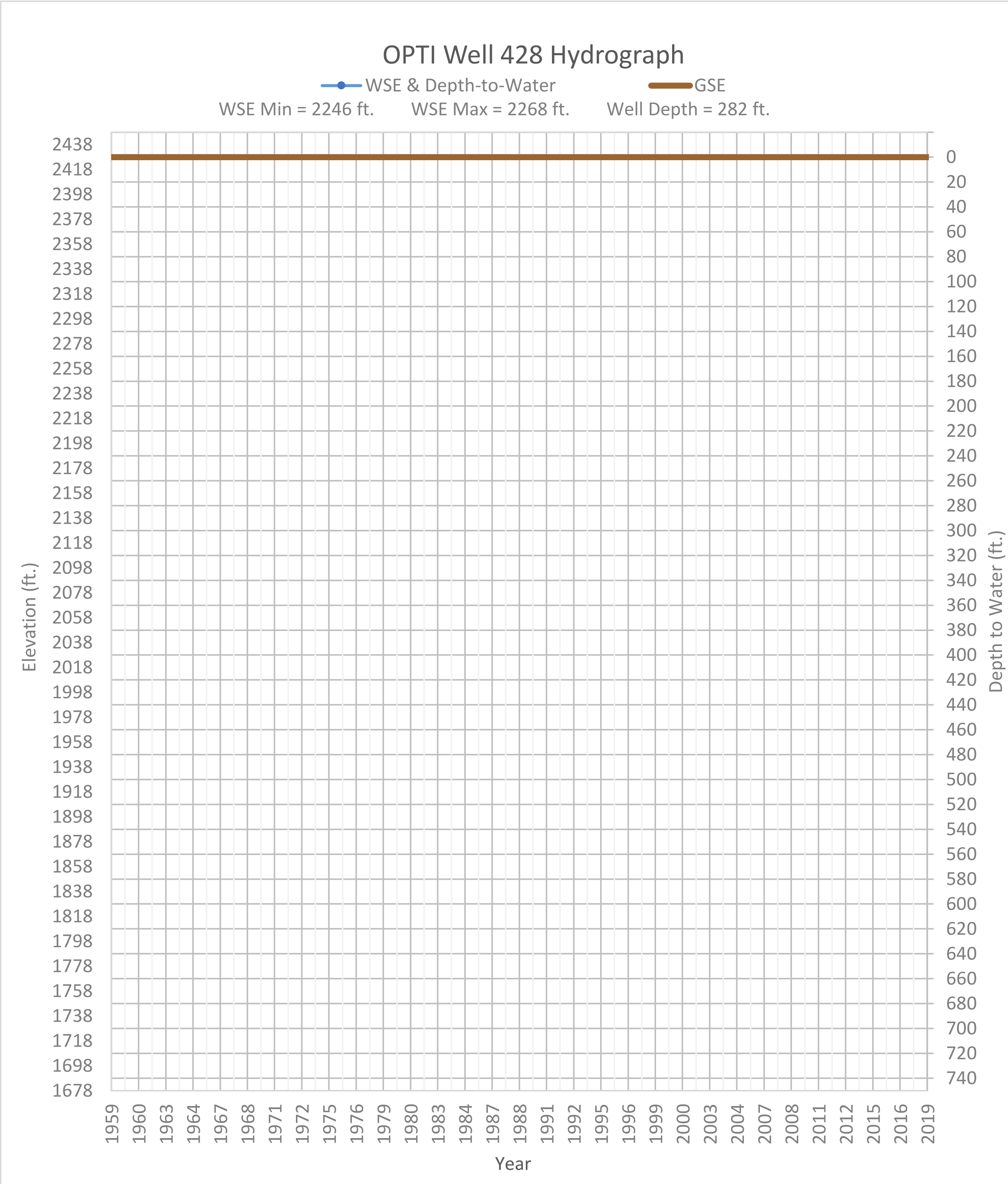
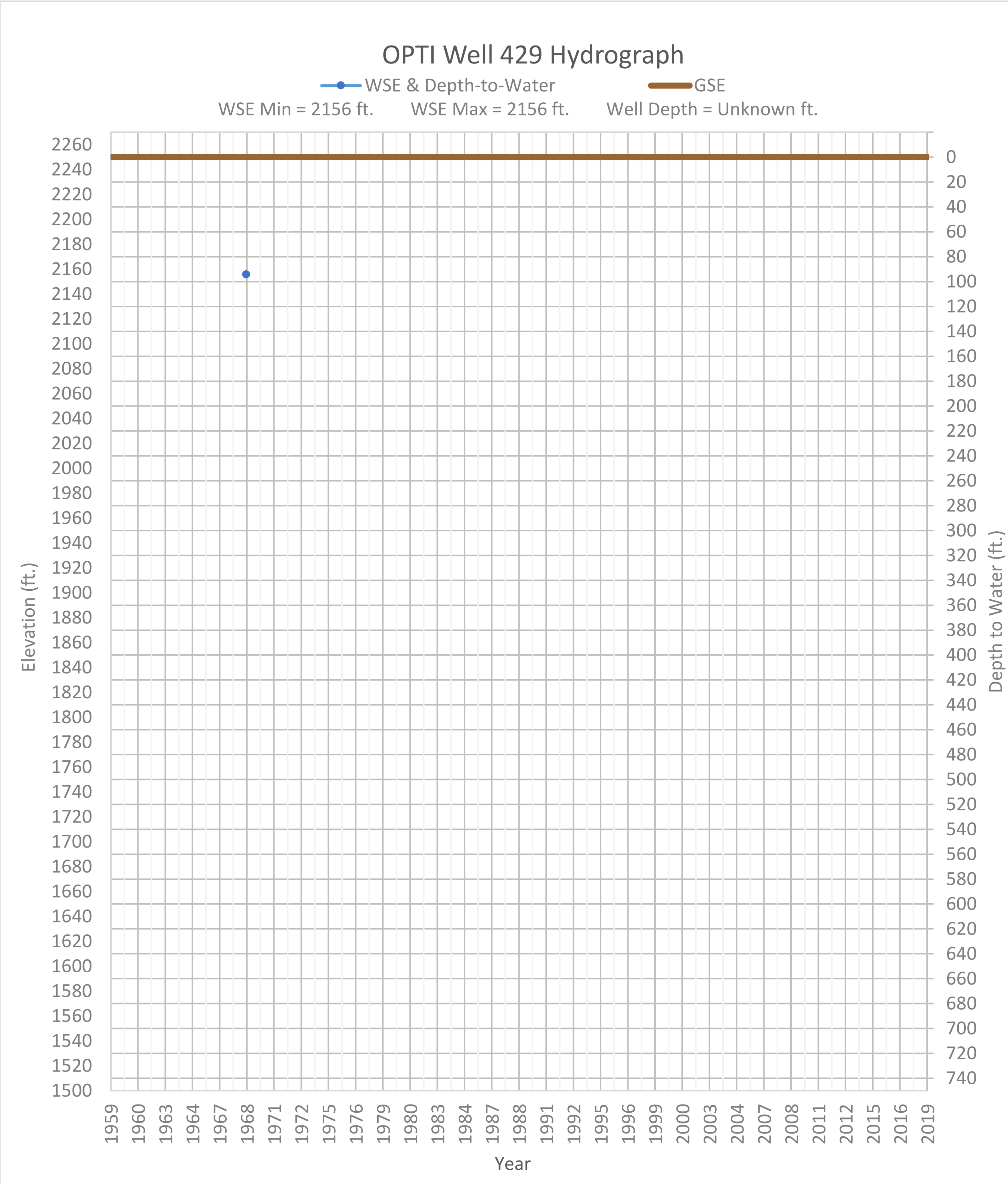


OPTI Well 427 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2231 ft.
WSE Max = 2231 ft.
Well Depth = 28 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 428 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2246 ft.
WSE Max = 2268 ft.
Well Depth = 282 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 429 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2156 ft.
WSE Max = 2156 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2260
2240
2220
2200
2180
2160
2140
2120
2100
2080
2060
2040
2020
2000
1980
1960
1940
1920
1900
1880
1860
1840
1820
1800
1780
1760
1740
1720
1700
1680
1660
1640
1620
1600
1580
1560
1540
1520
1500
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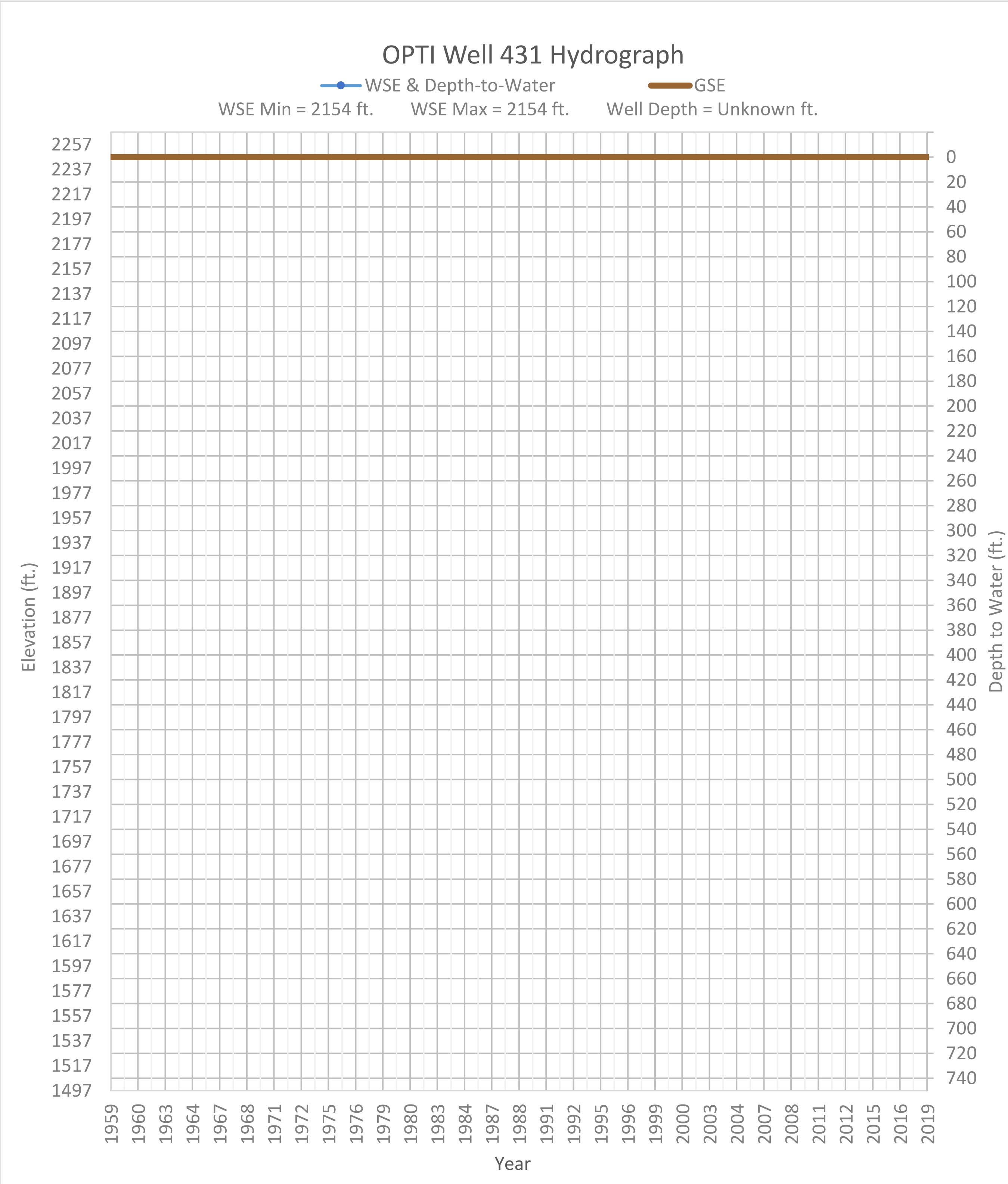
OPTI Well 431 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2154 ft.
WSE Max = 2154 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2257
2237
2217
2197
2177
2157
2137
2117
2097
2077
2057
2037
2017
1997
1977
1957
1937
1917
1897
1877
1857
1837
1817
1797
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1637
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1577
1557
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1517
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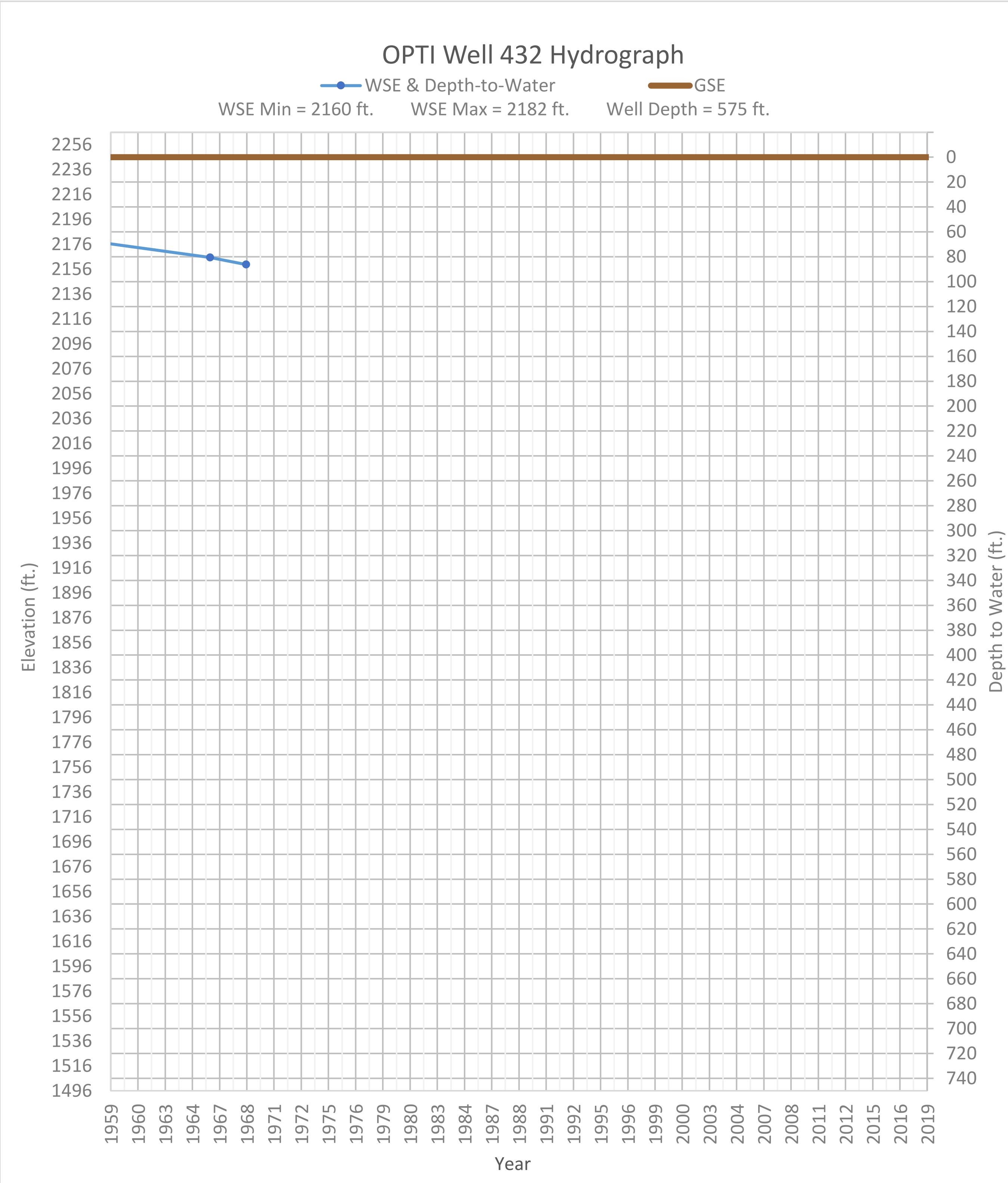
OPTI Well 432 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2160 ft.
WSE Max = 2182 ft.
Well Depth = 575 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2256
2236
2216
2196
2176
2156
2136
2116
2096
2076
2056
2036
2016
1996
1976
1956
1936
1916
1896
1876
1856
1836
1816
1796
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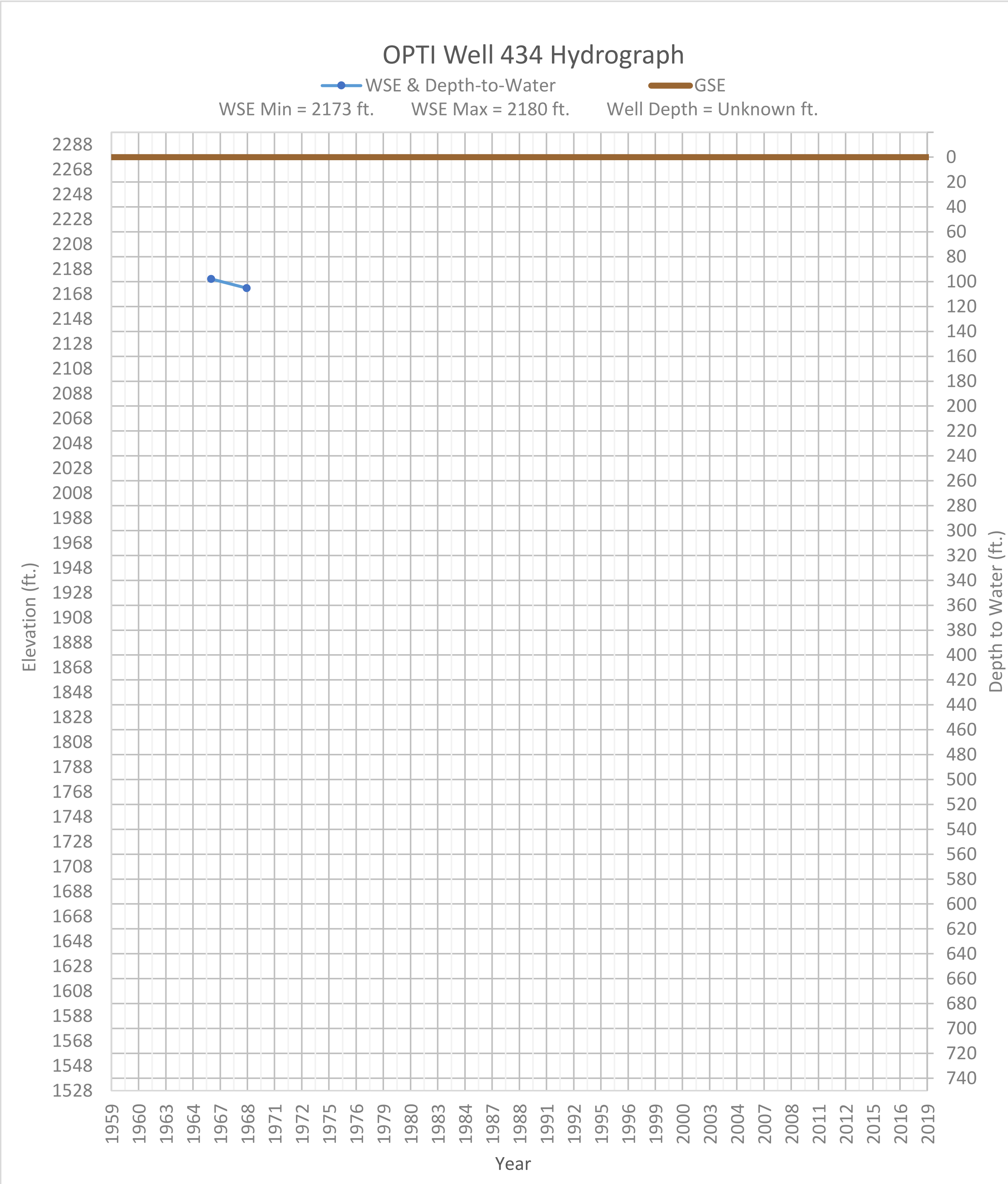
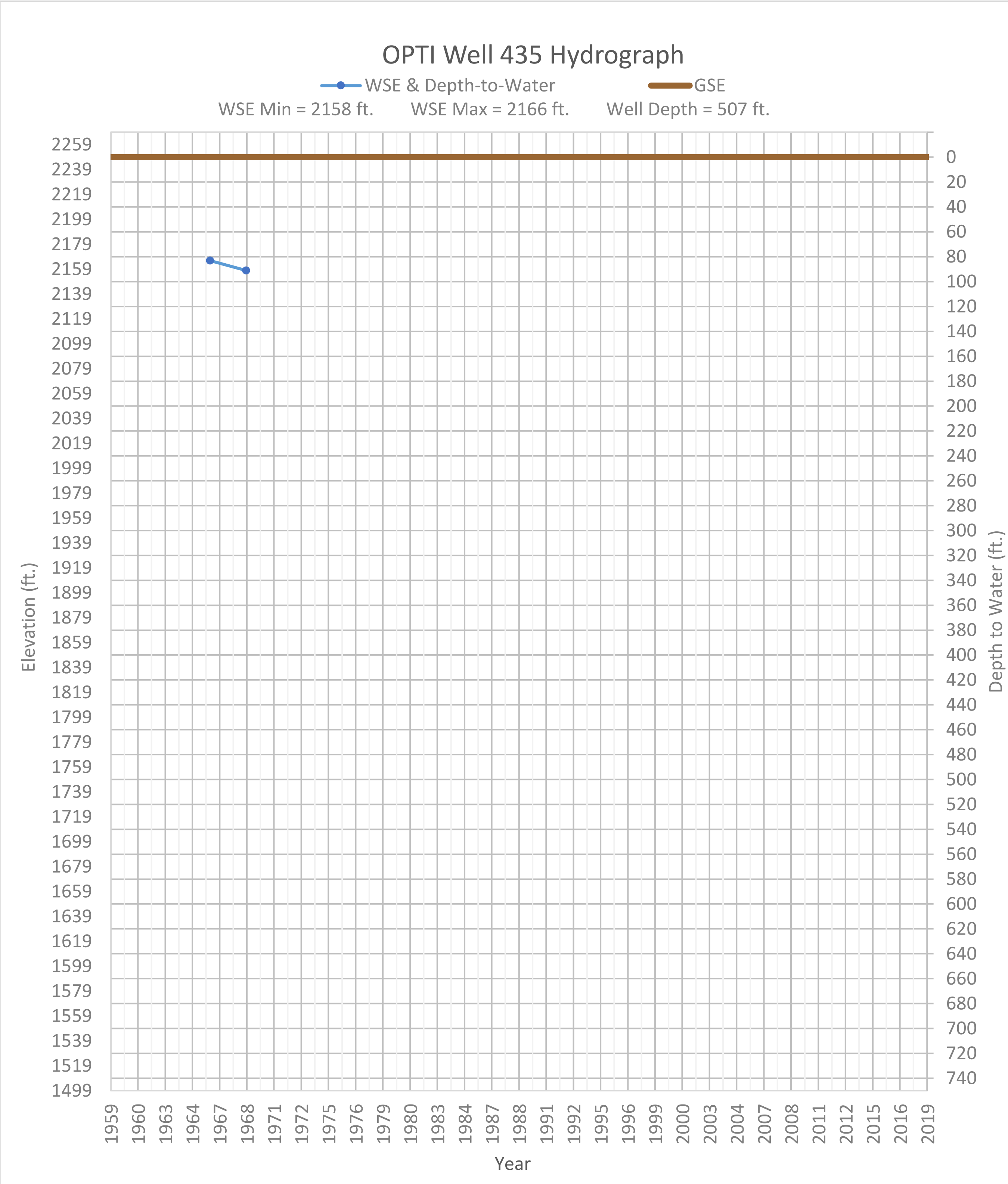


OPTI Well 434 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2173 ft.
WSE Max = 2180 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 435 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2158 ft.
WSE Max = 2166 ft.
Well Depth = 507 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2259
2239
2219
2199
2179
2159
2139
2119
2099
2079
2059
2039
2019
1999
1979
1959
1939
1919
1899
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1859
1839
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1599
1579
1559
1539
1519
1499
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2016
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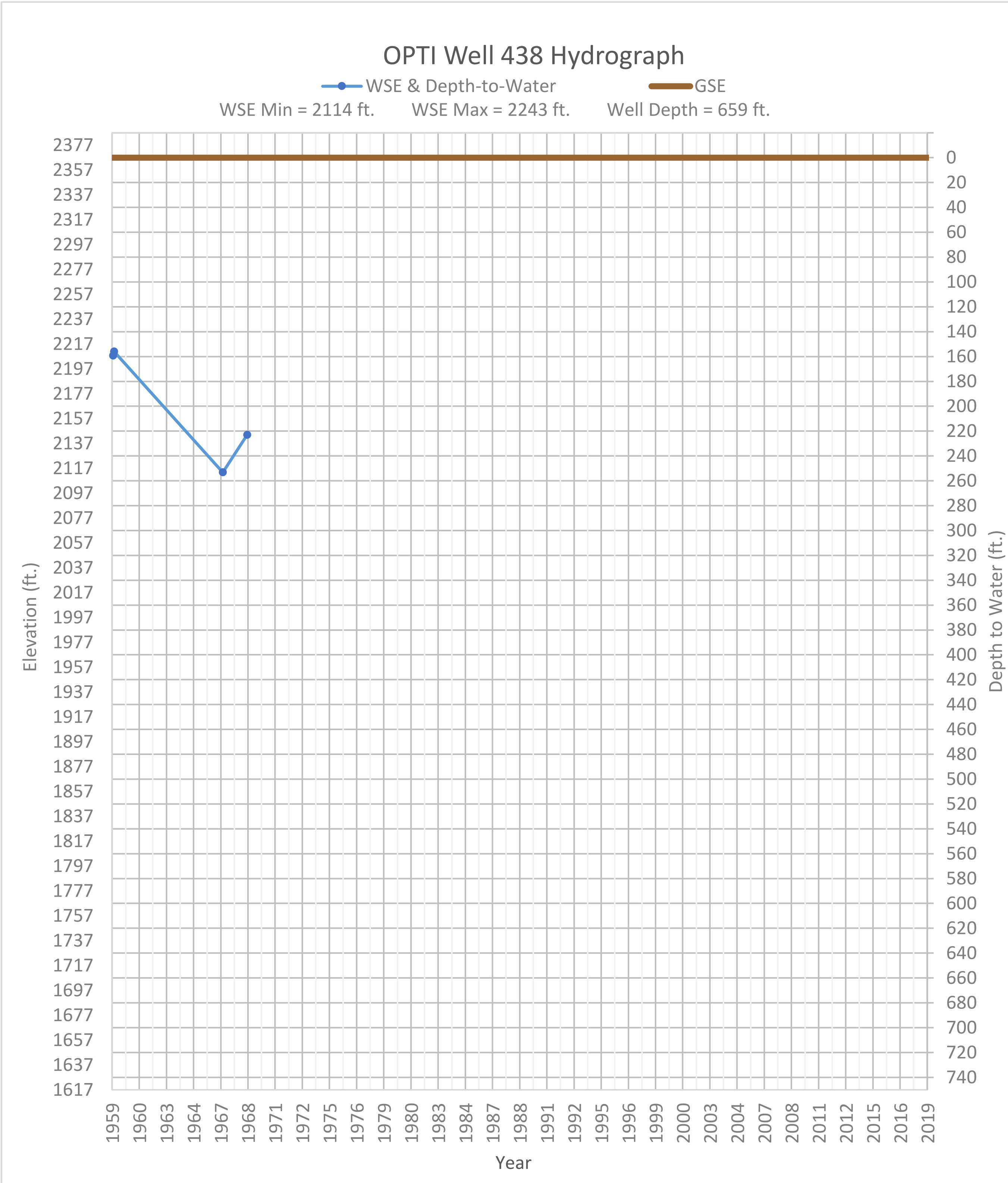
OPTI Well 438 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2114 ft.
WSE Max = 2243 ft.
Well Depth = 659 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2377
2357
2337
2317
2297
2277
2257
2237
2217
2197
2177
2157
2137
2117
2097
2077
2057
2037
2017
1997
1977
1957
1937
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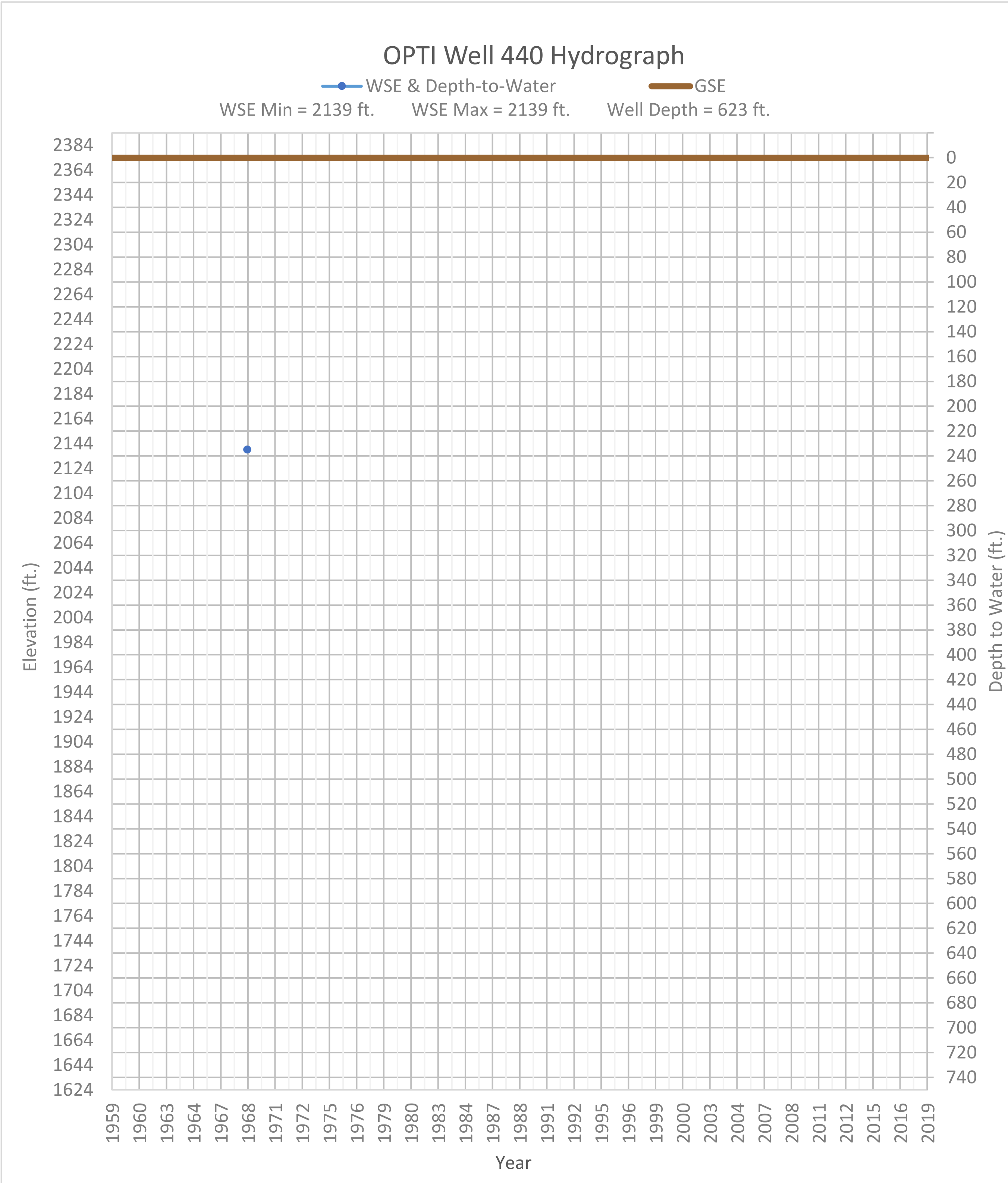
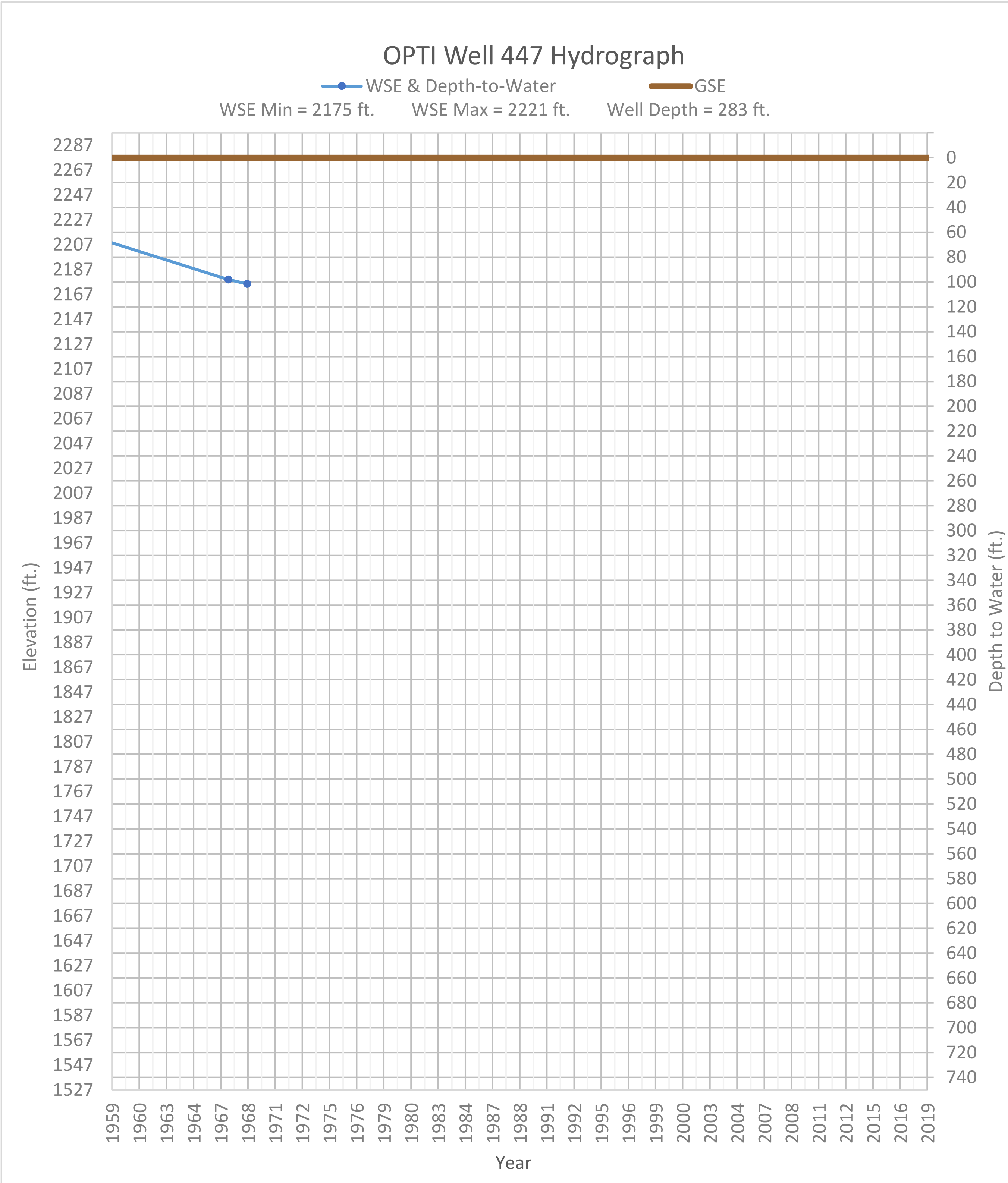
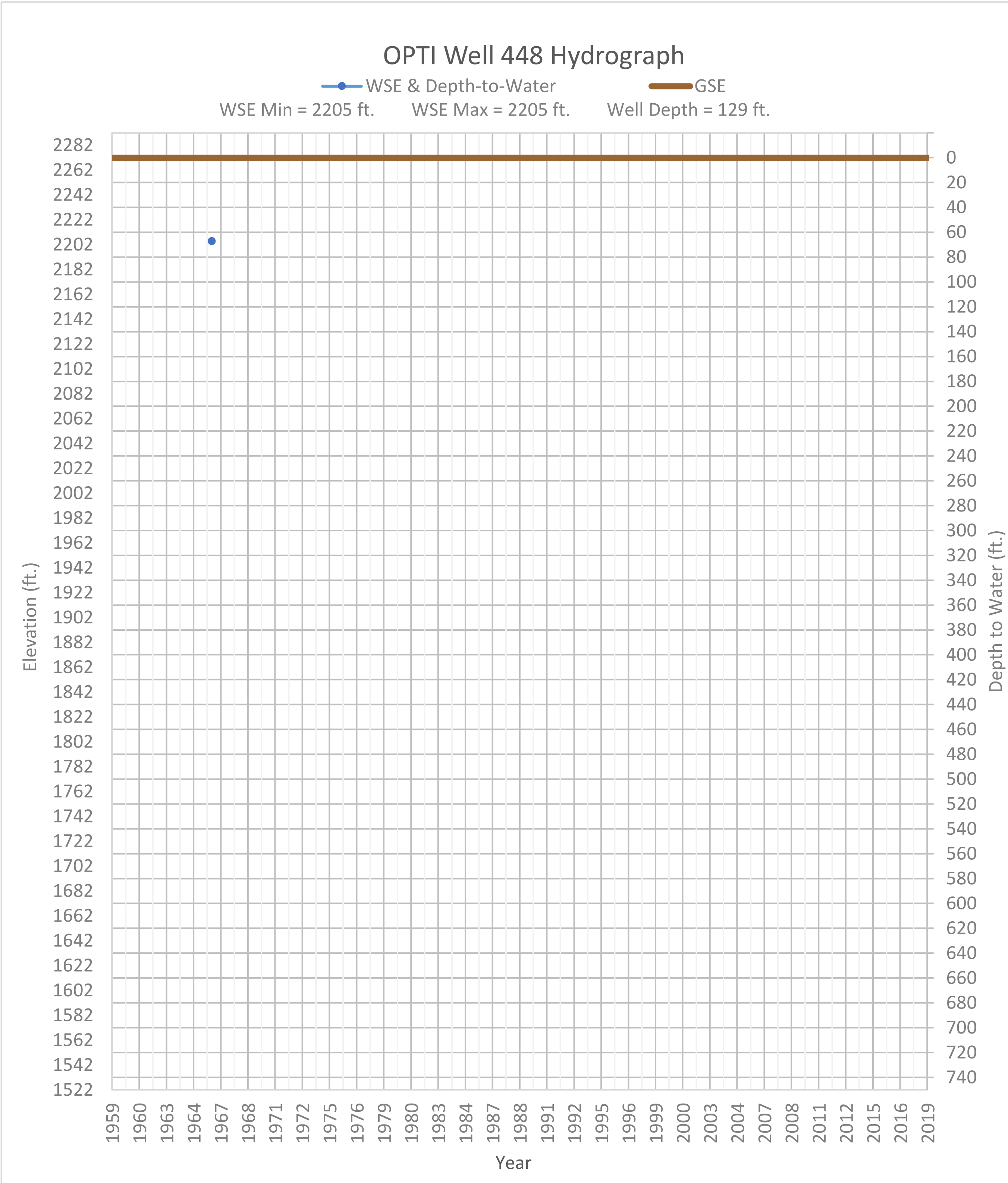

OPTI Well 440 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2139 ft.
WSE Max = 2139 ft.
Well Depth = 623 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 447 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2175 ft.
WSE Max = 2221 ft.
Well Depth = 283 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 448 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2205 ft.
WSE Max = 2205 ft.
Well Depth = 129 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2282
2262
2242
2222
2202
2182
2162
2142
2122
2102
2082
2062
2042
2022
2002
1982
1962
1942
1922
1902
1882
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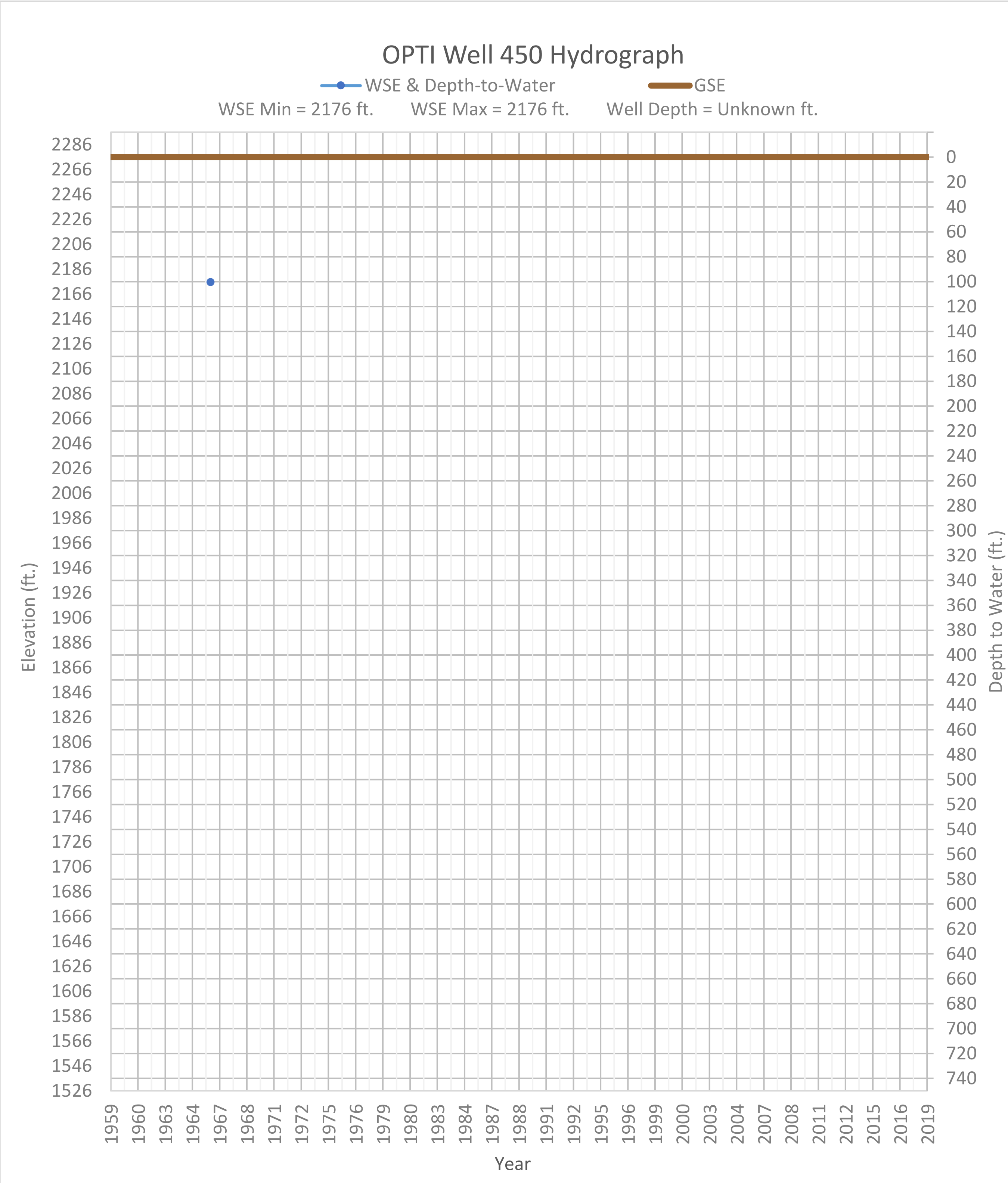

OPTI Well 450 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2176 ft.
WSE Max = 2176 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
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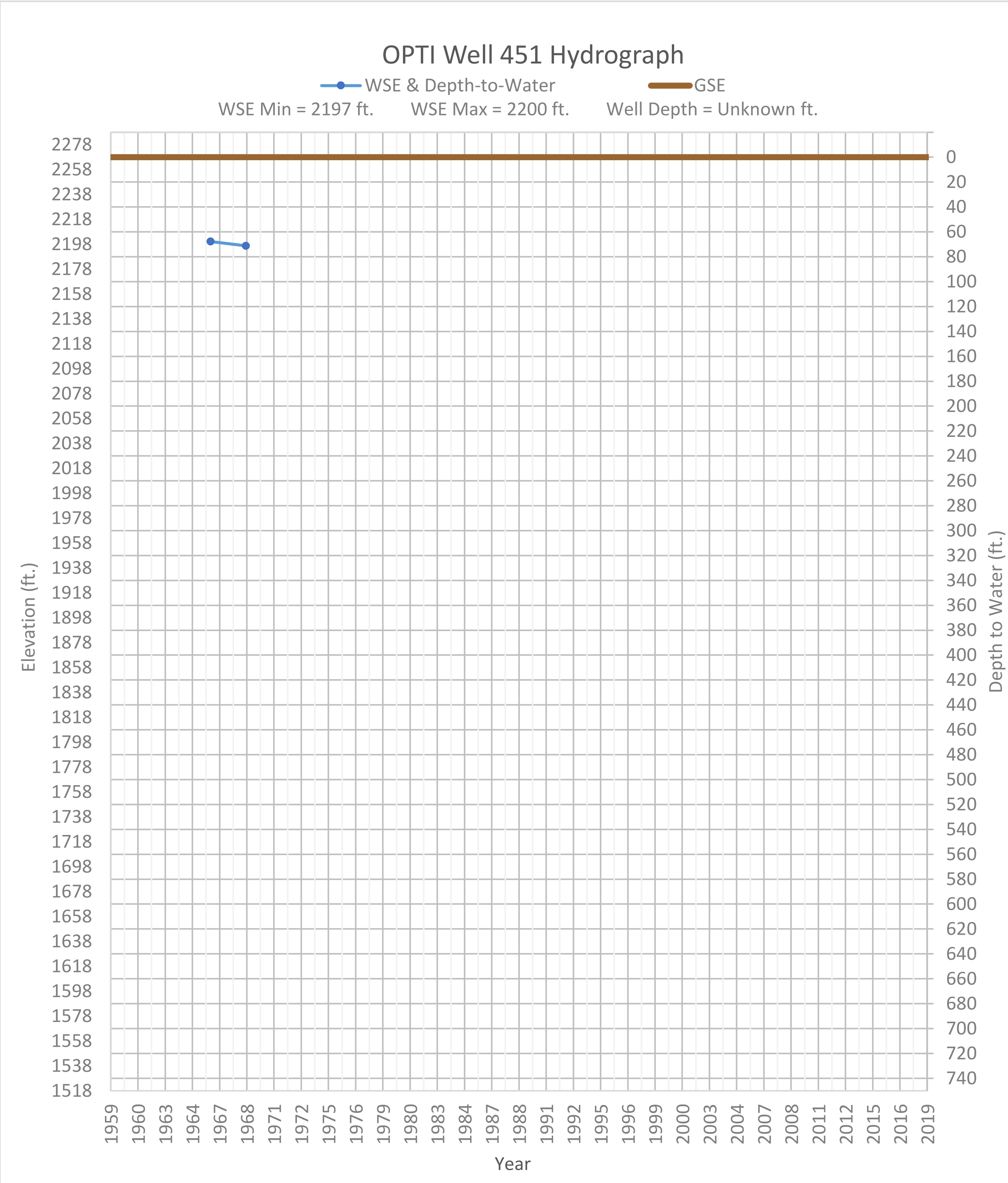
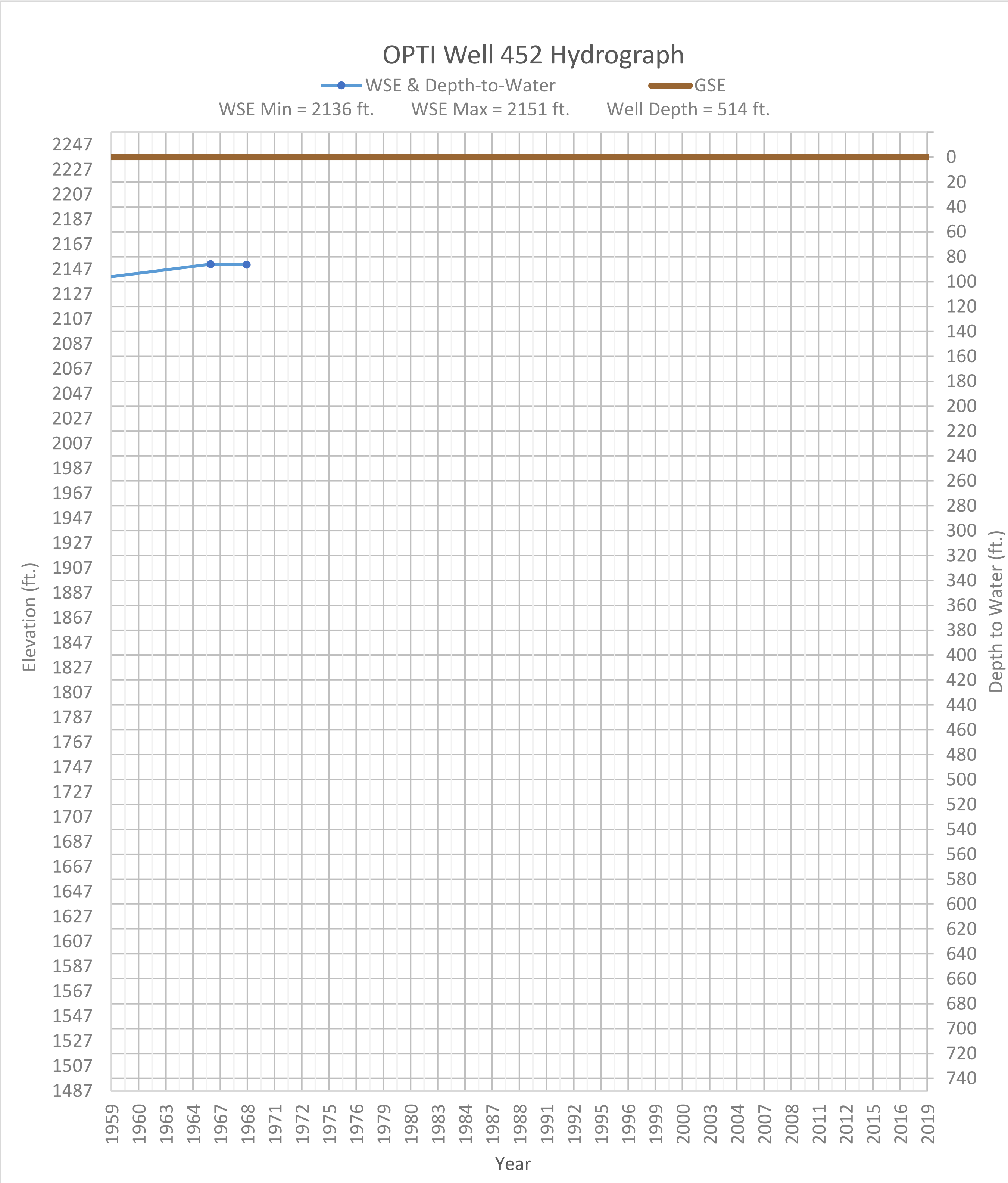


OPTI Well 451 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2197 ft.
WSE Max = 2200 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 452 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2136 ft.
WSE Max = 2151 ft.
Well Depth = 514 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2247
2227
2207
2187
2167
2147
2127
2107
2087
2067
2047
2027
2007
1987
1967
1947
1927
1907
1887
1867
1847
1827
1807
1787
1767
1747
1727
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1687
1667
1647
1627
1607
1587
1567
1547
1527
1507
1487
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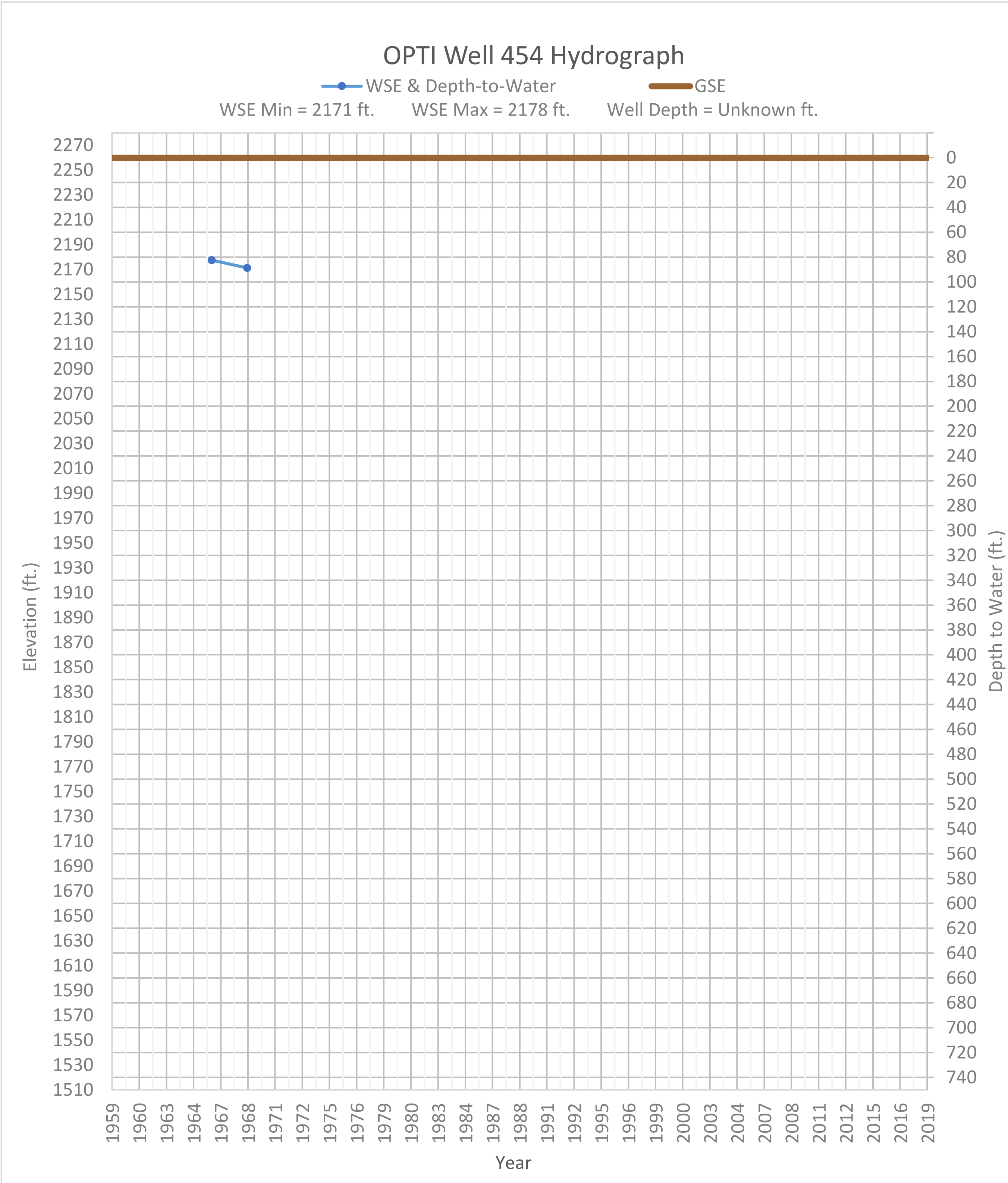
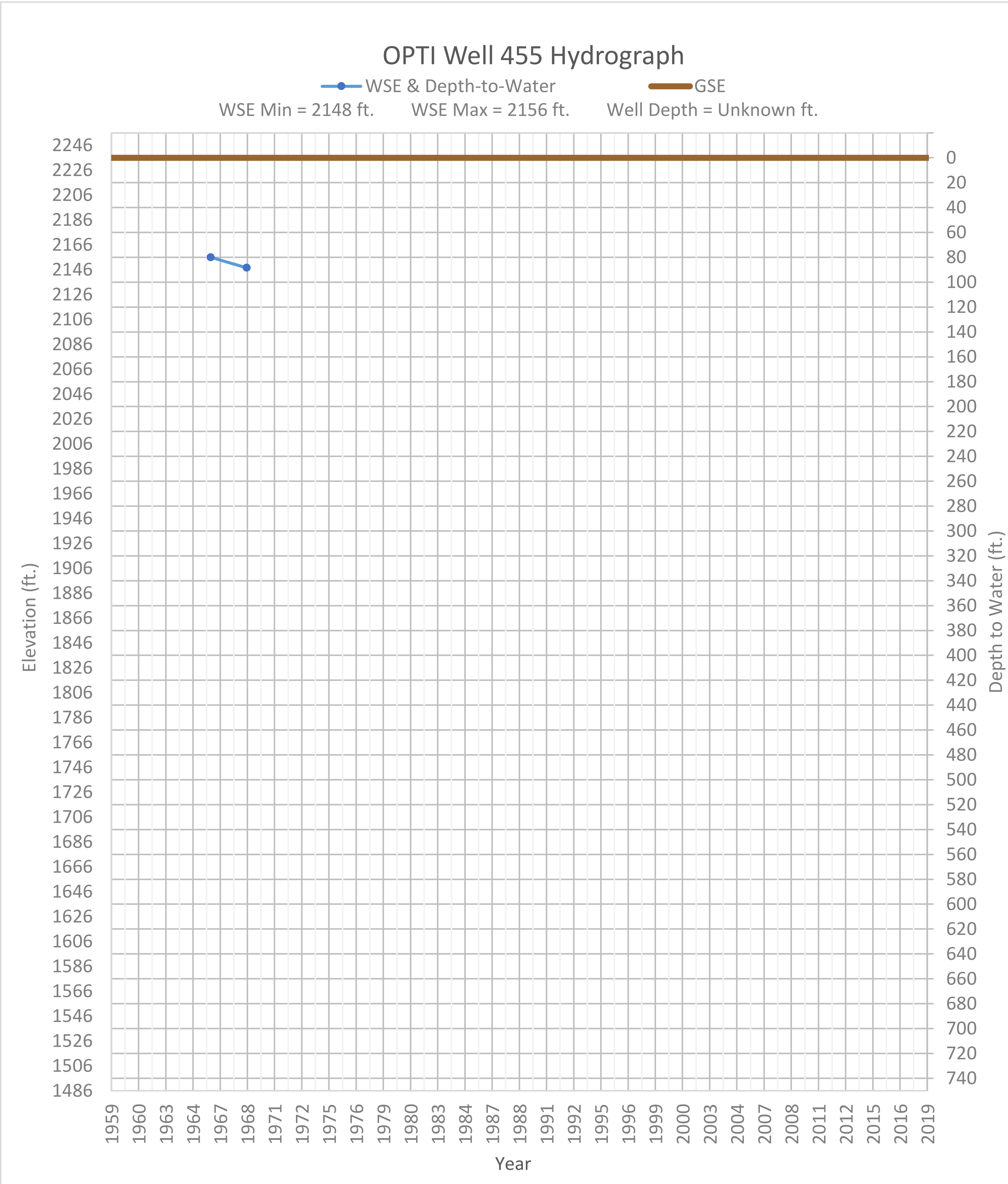
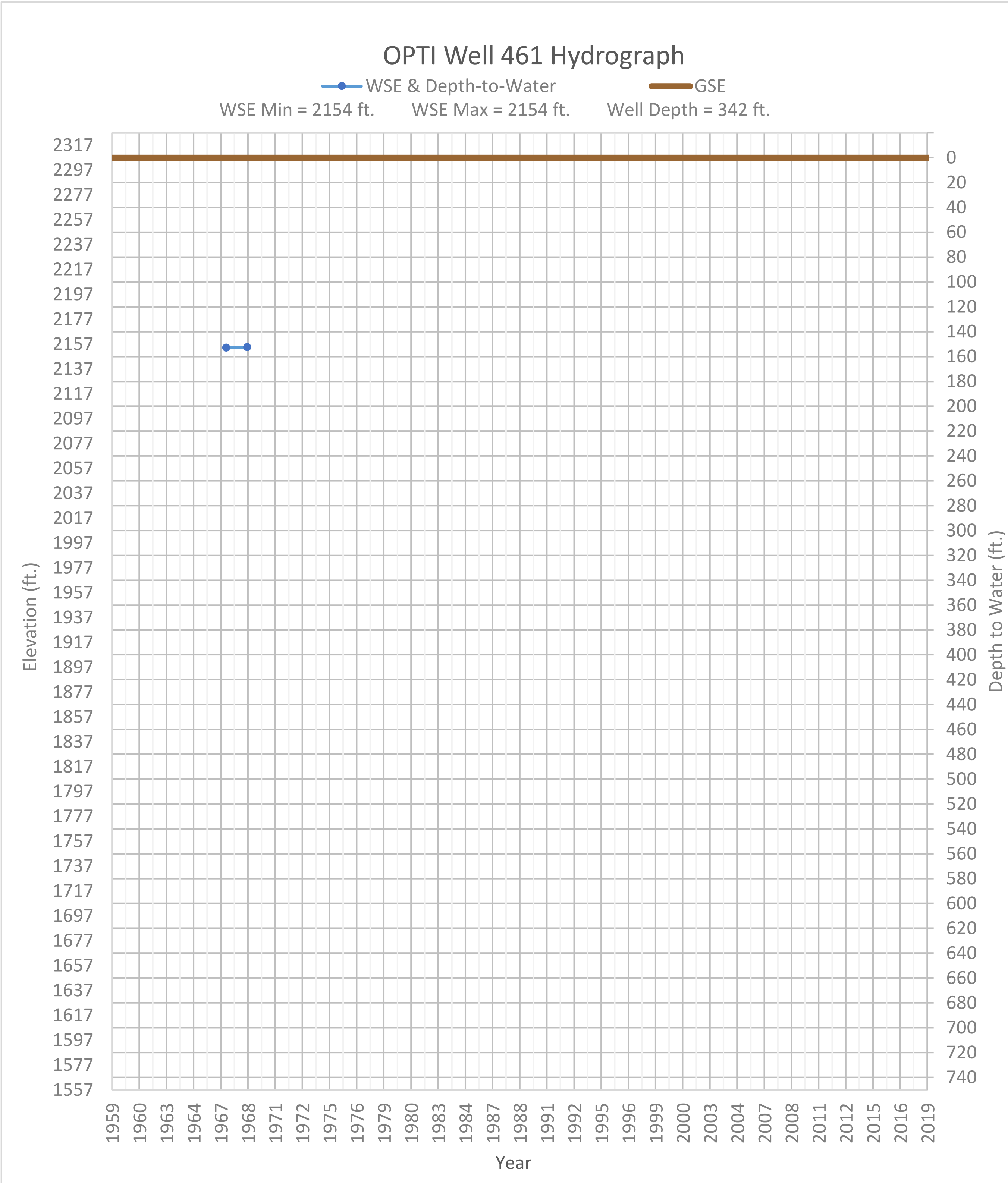


OPTI Well 454 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2171 ft.
WSE Max = 2178 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 455 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2148 ft.
WSE Max = 2156 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 461 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2154 ft.
WSE Max = 2154 ft.
Well Depth = 342 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2317
2297
2277
2257
2237
2217
2197
2177
2157
2137
2117
2097
2077
2057
2037
2017
1997
1977
1957
1937
1917
1897
1877
1857
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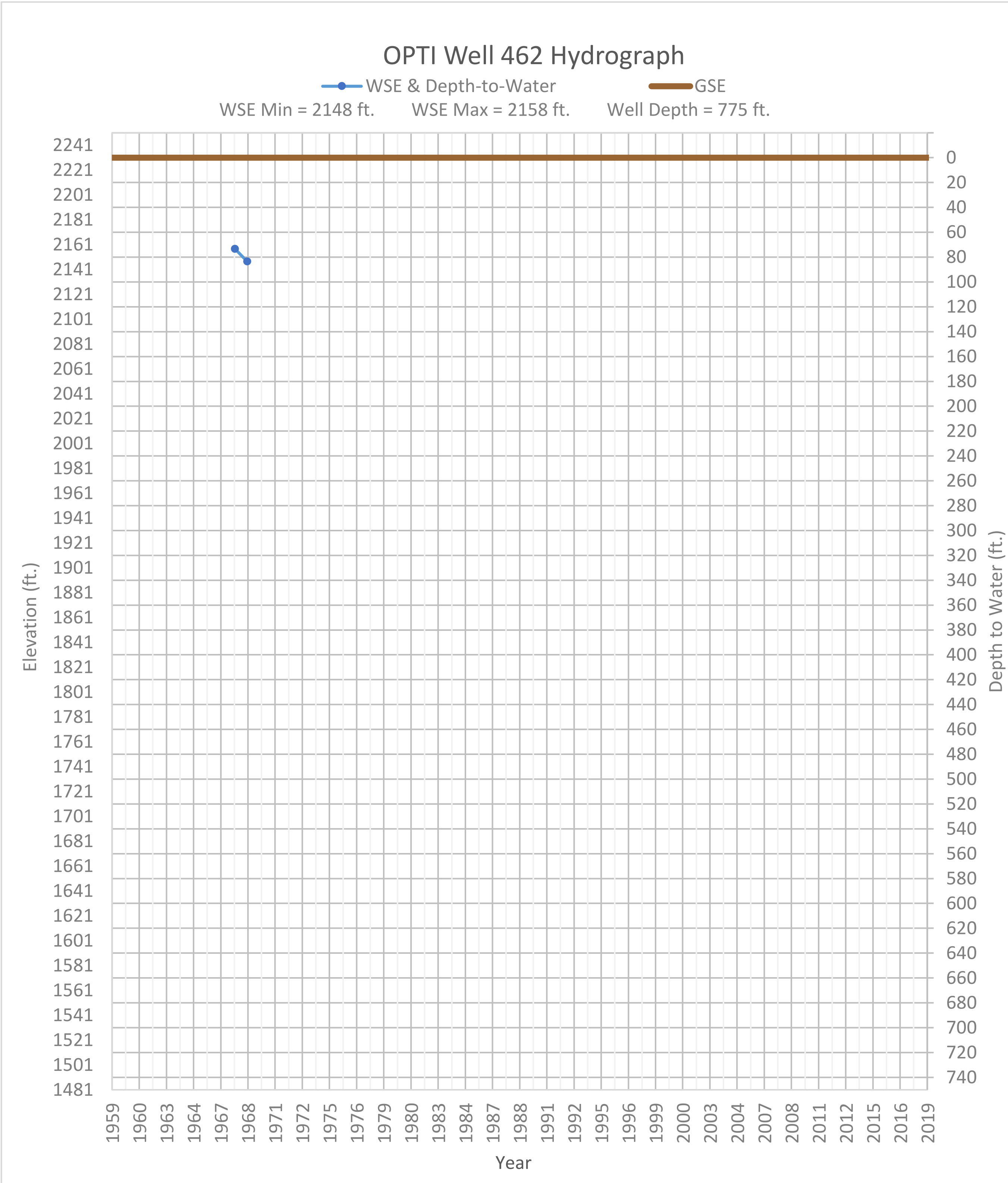
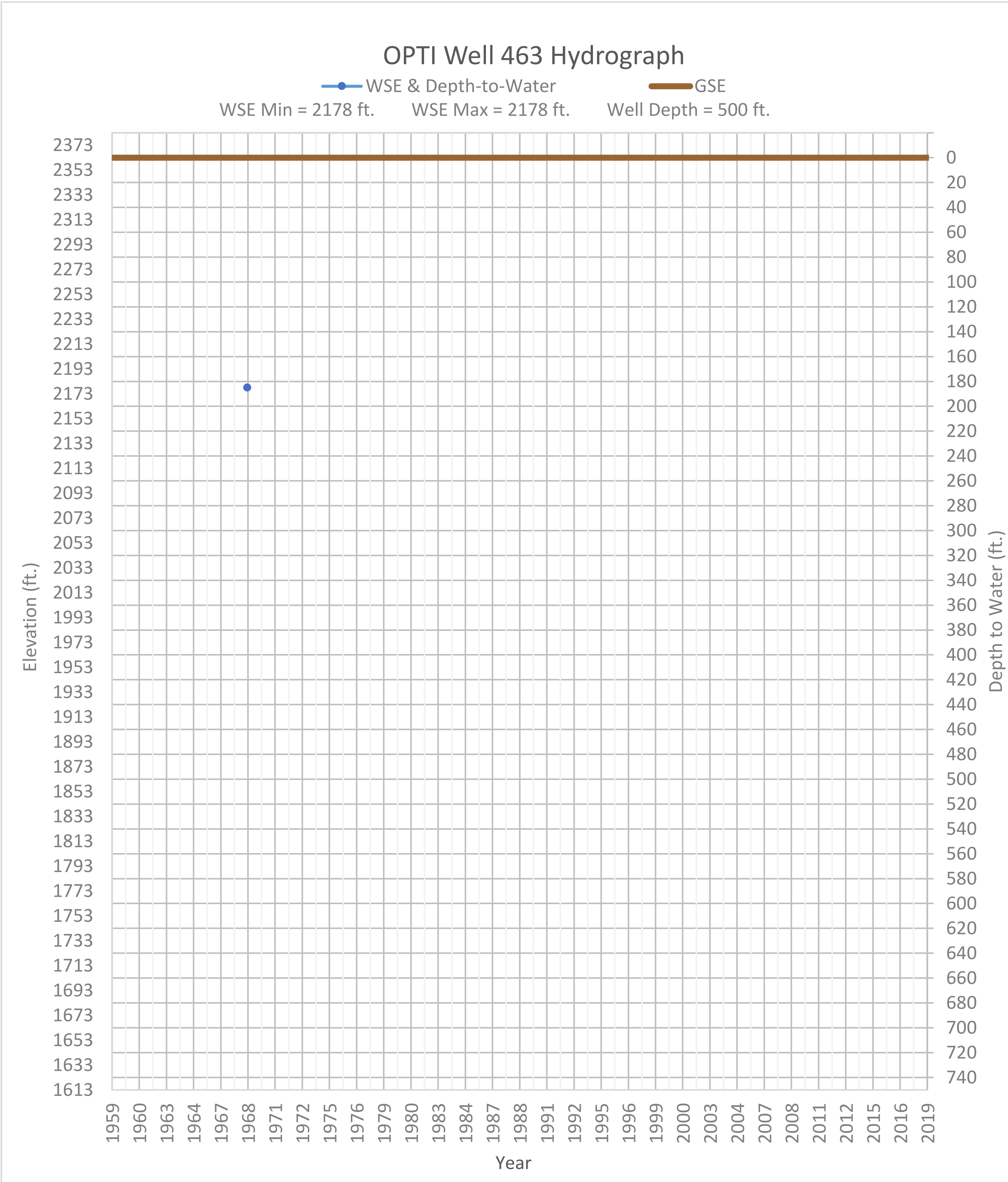
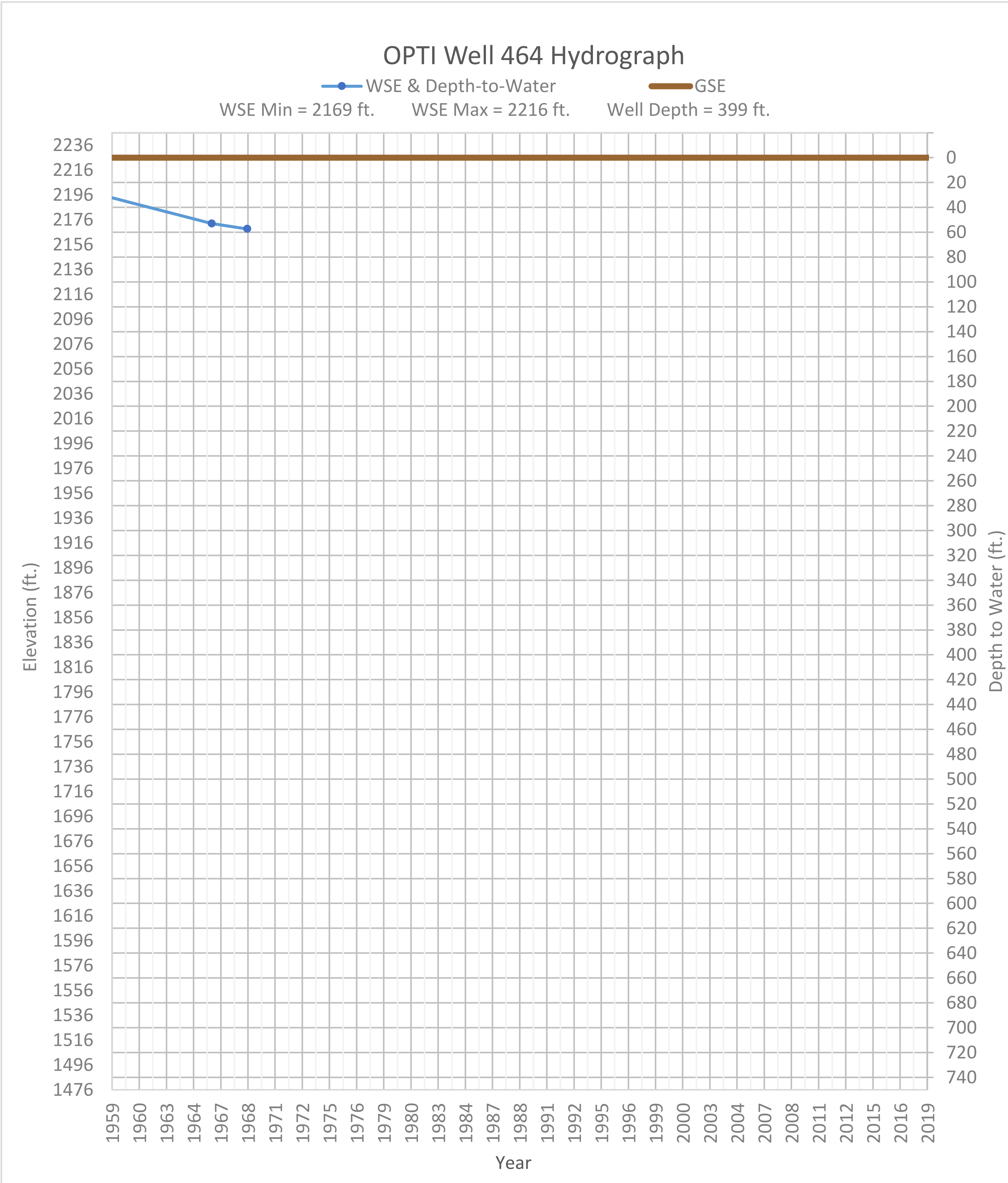
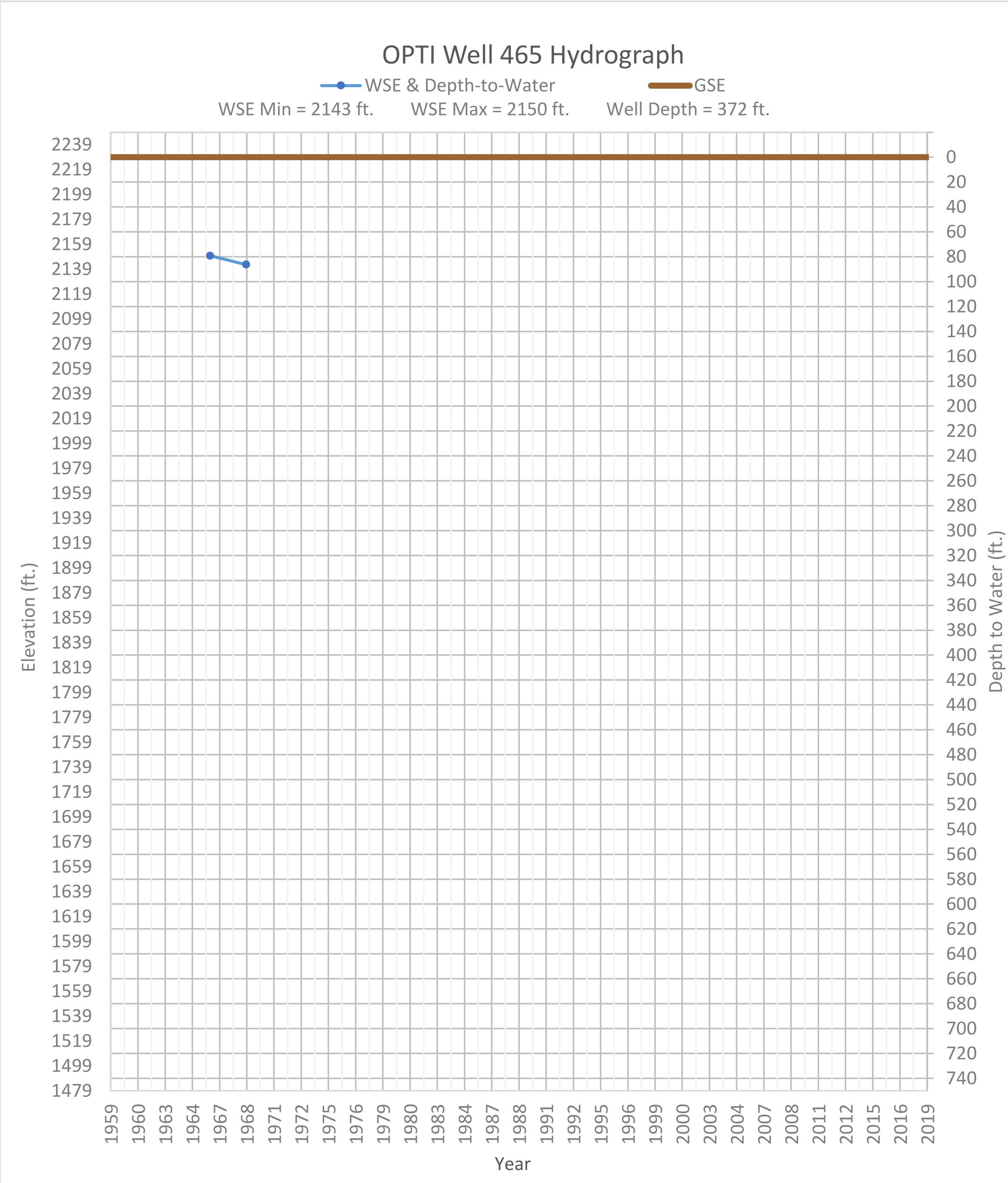


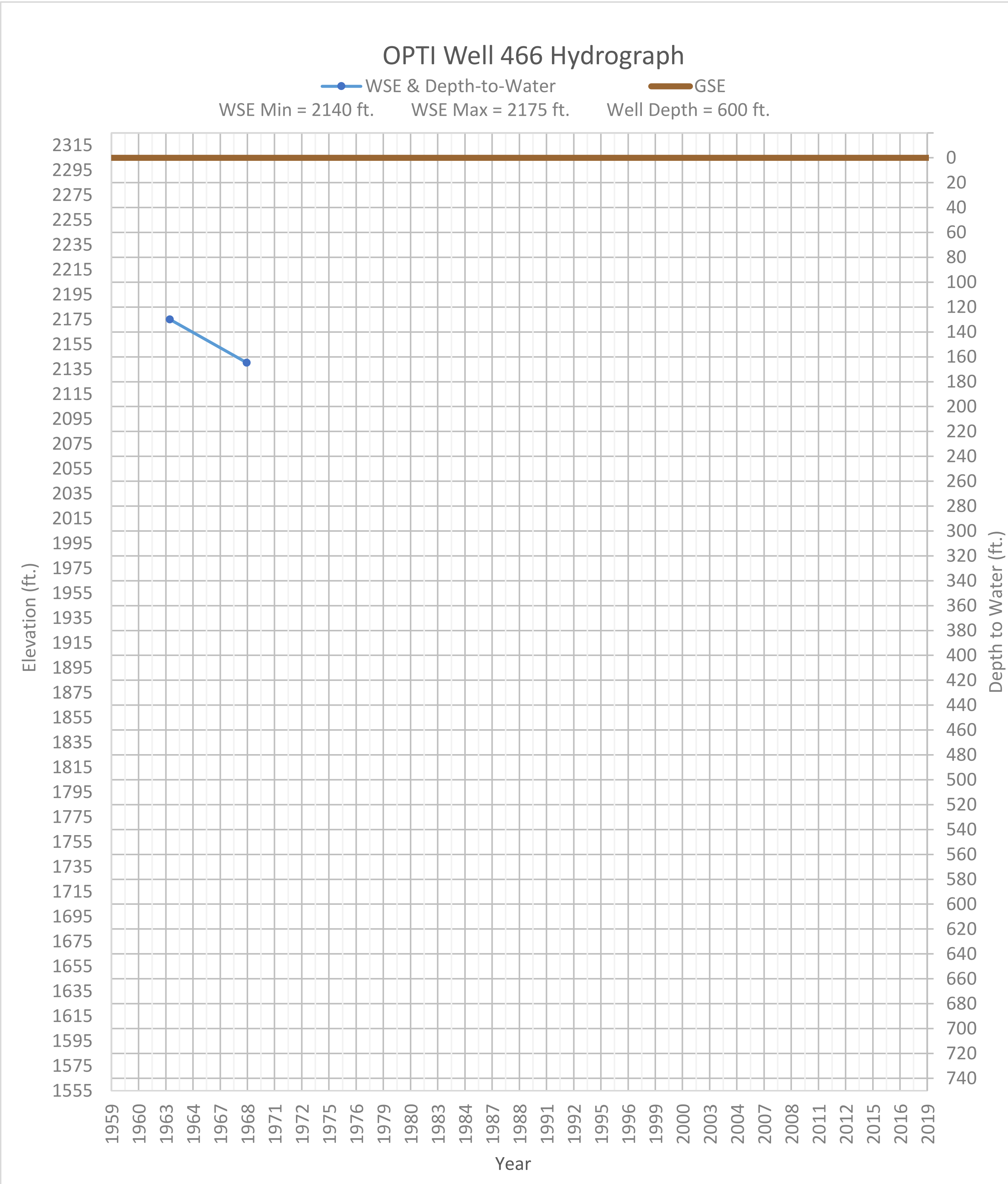
OPTI Well 462 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2148 ft.
WSE Max = 2158 ft.
Well Depth = 775 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 463 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2178 ft.
WSE Max = 2178 ft.
Well Depth = 500 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

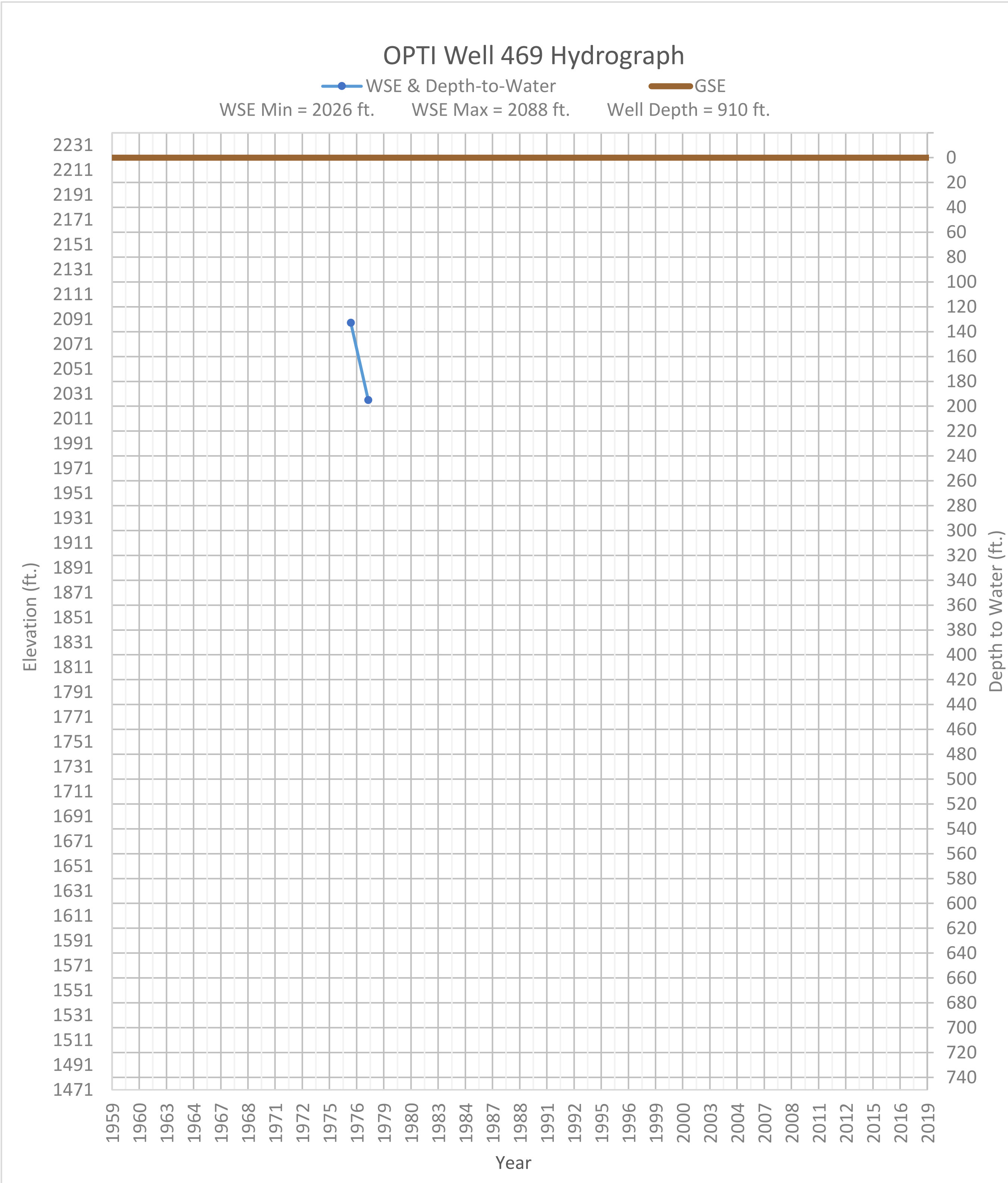


OPTI Well 464 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2169 ft.
WSE Max = 2216 ft.
Well Depth = 399 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

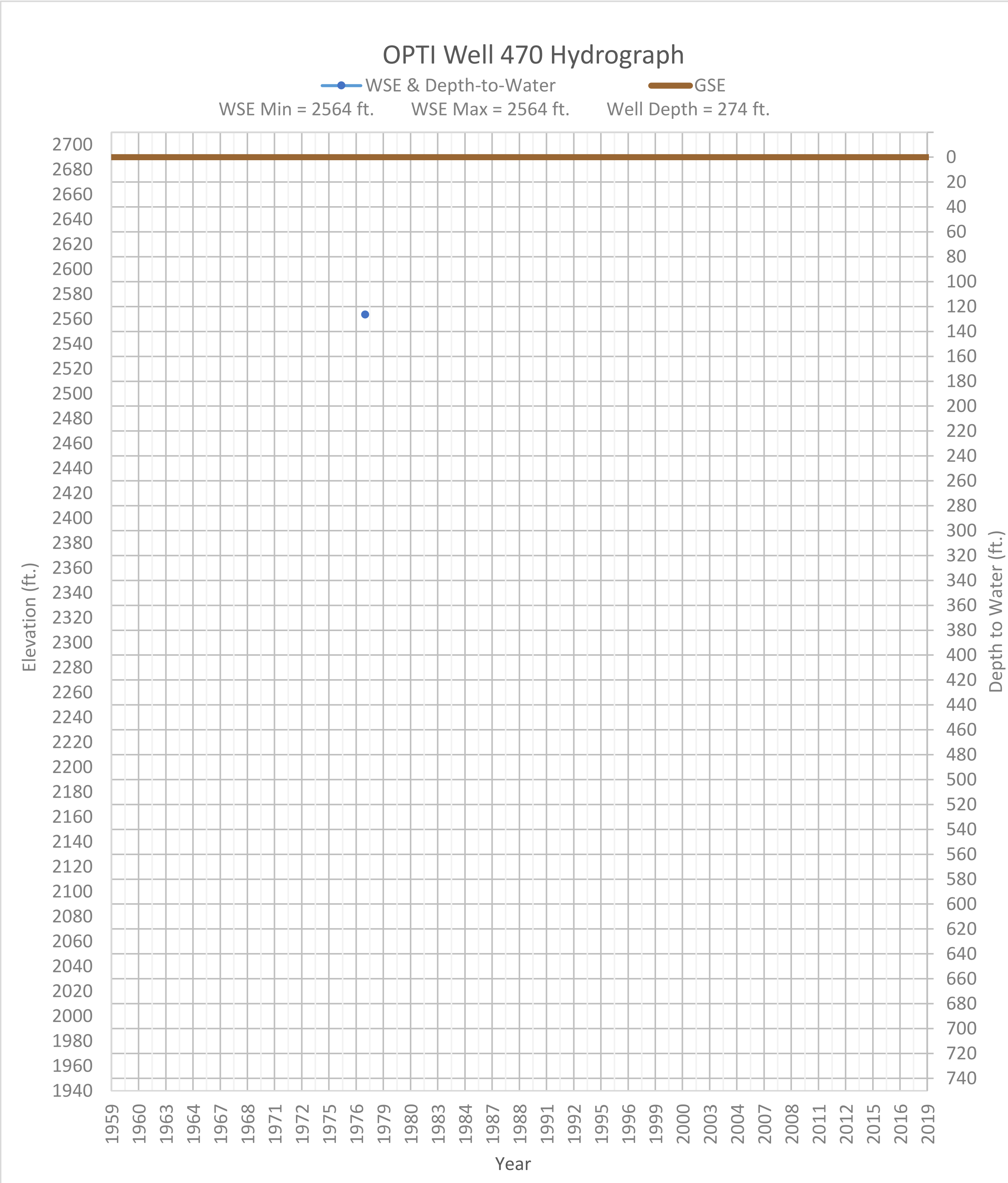

OPTI Well 465 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2143 ft.
WSE Max = 2150 ft.
Well Depth = 372 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

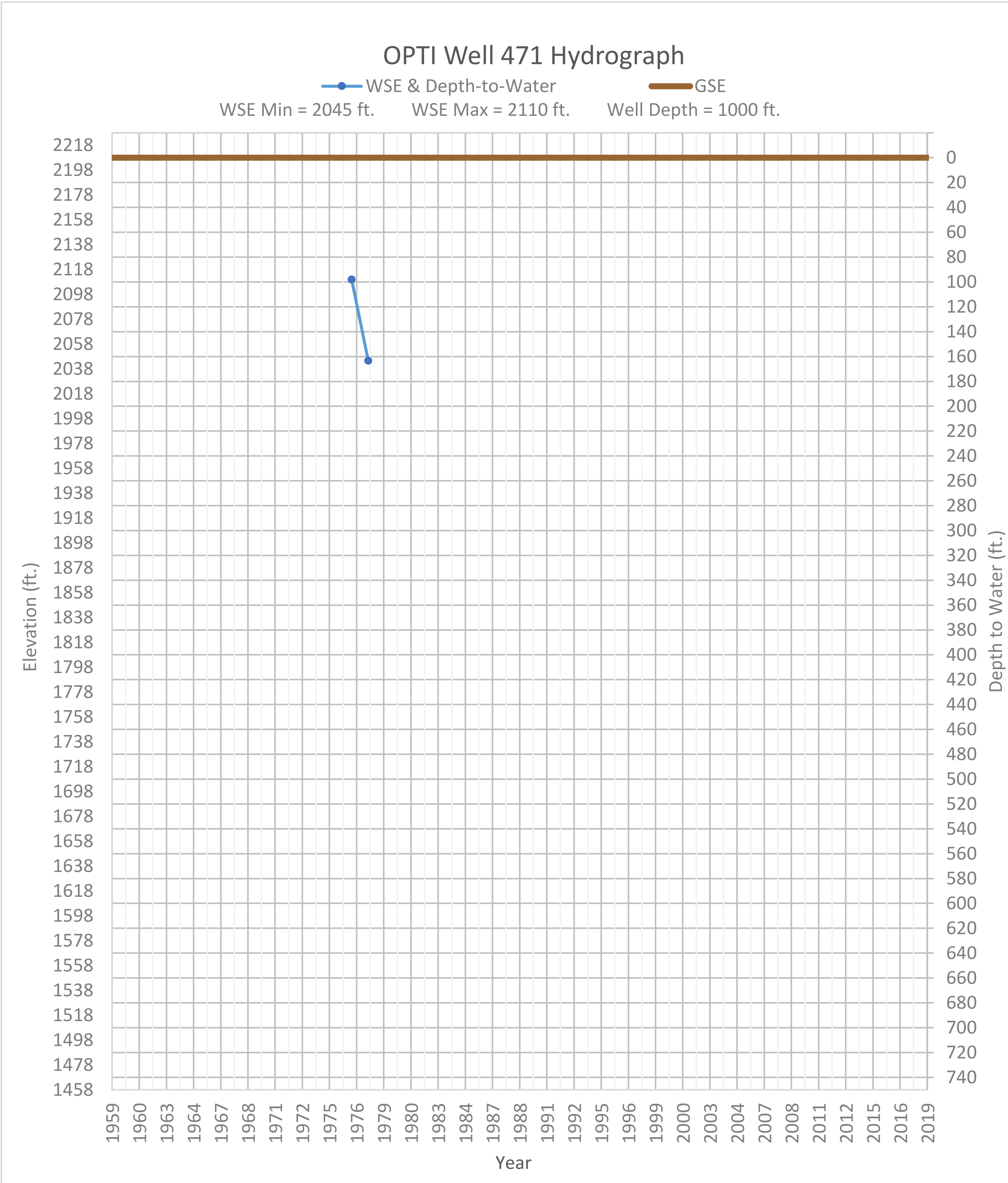


OPTI Well 466 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2140 ft.
WSE Max = 2175 ft.
Well Depth = 600 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 469 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2026 ft.
WSE Max = 2088 ft.
Well Depth = 910 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 470 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2564 ft.
WSE Max = 2564 ft.
Well Depth = 274 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 471 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2045 ft.
WSE Max = 2110 ft.
Well Depth = 1000 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2218
2198
2178
2158
2138
2118
2098
2078
2058
2038
2018
1998
1978
1958
1938
1918
1898
1878
1858
1838
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1638
1618
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1578
1558
1538
1518
1498
1478
1458
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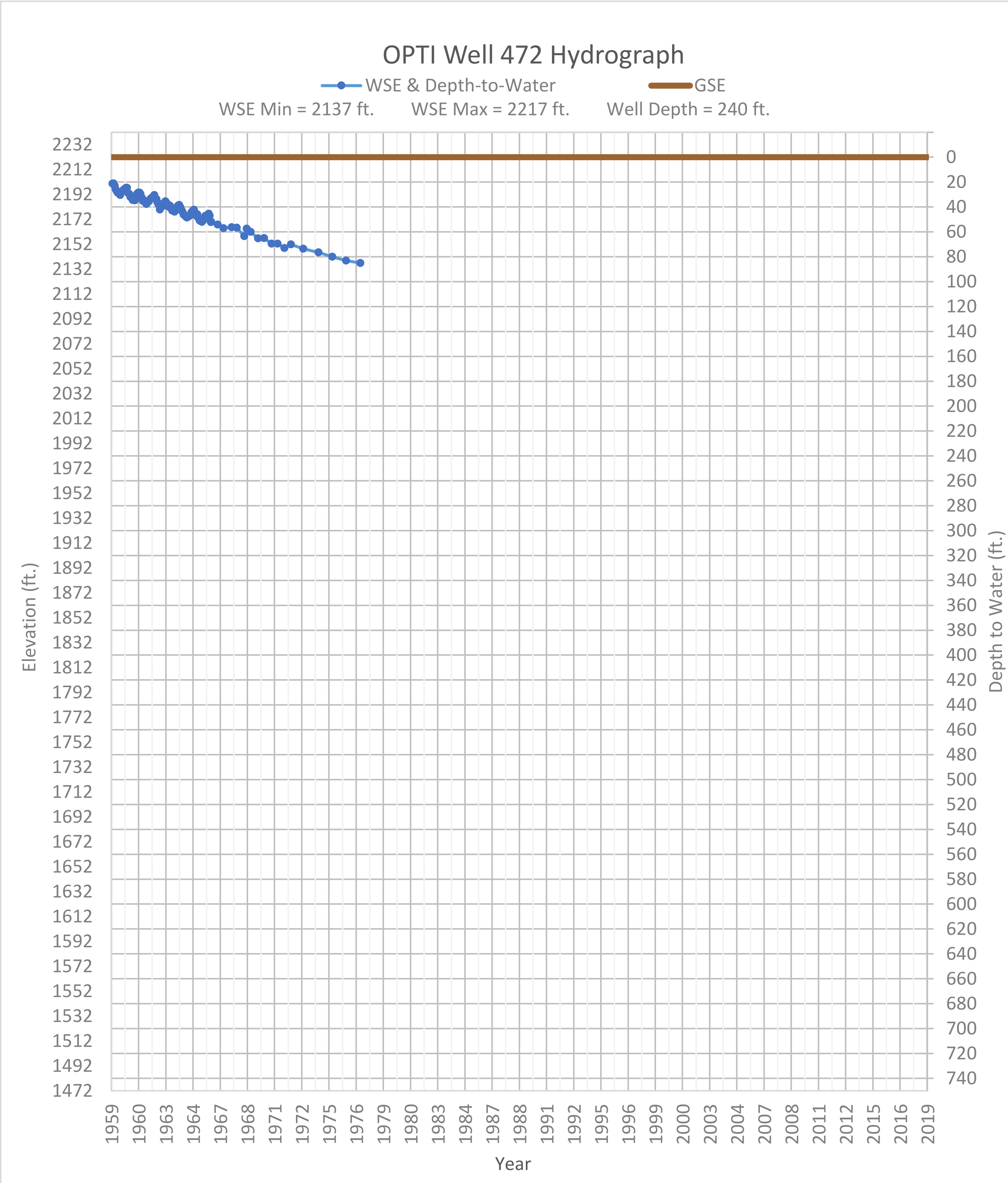
OPTI Well 472 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2137 ft.
WSE Max = 2217 ft.
Well Depth = 240 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2232
2212
2192
2172
2152
2132
2112
2092
2072
2052
2032
2012
1992
1972
1952
1932
1912
1892
1872
1852
1832
1812
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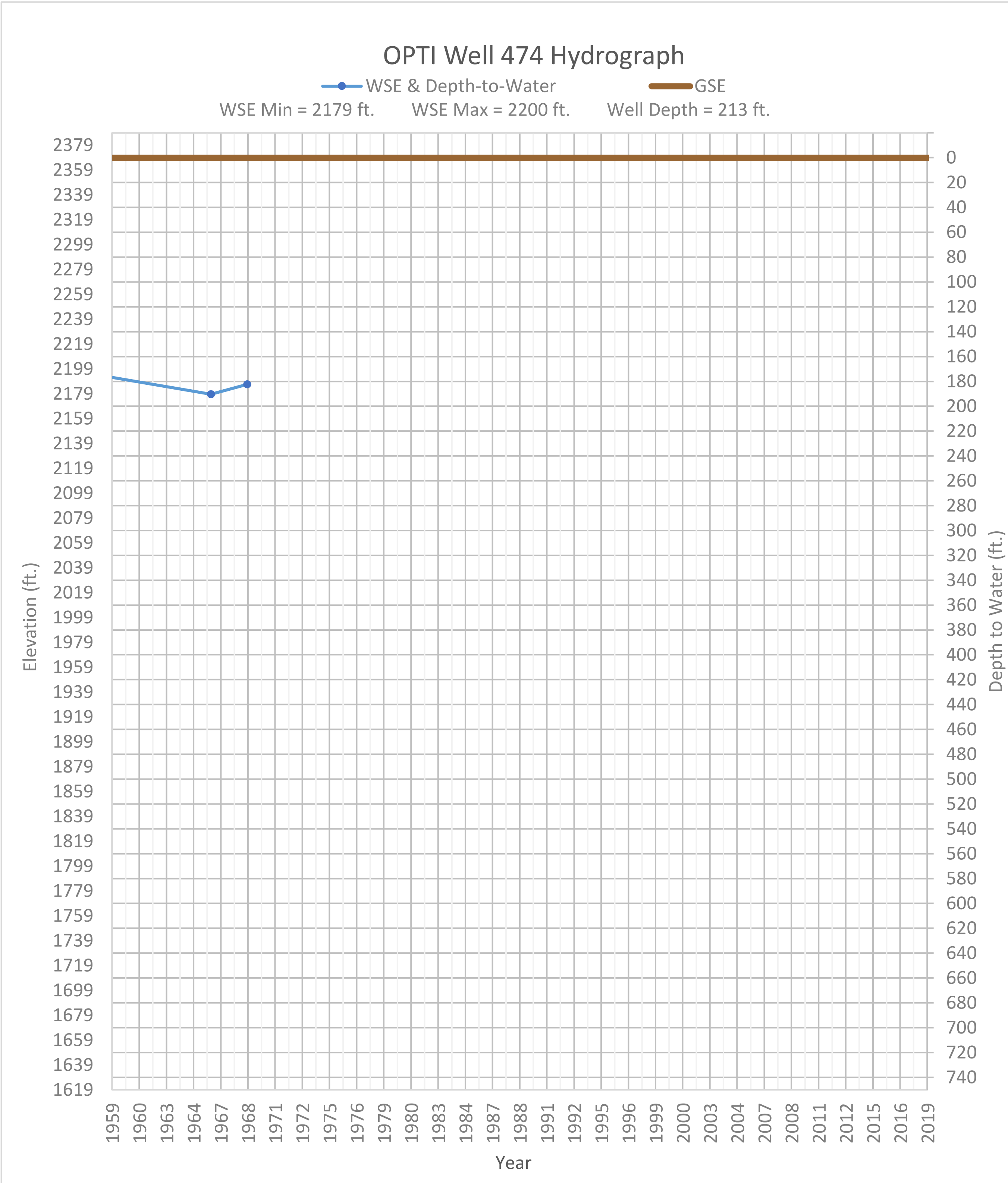
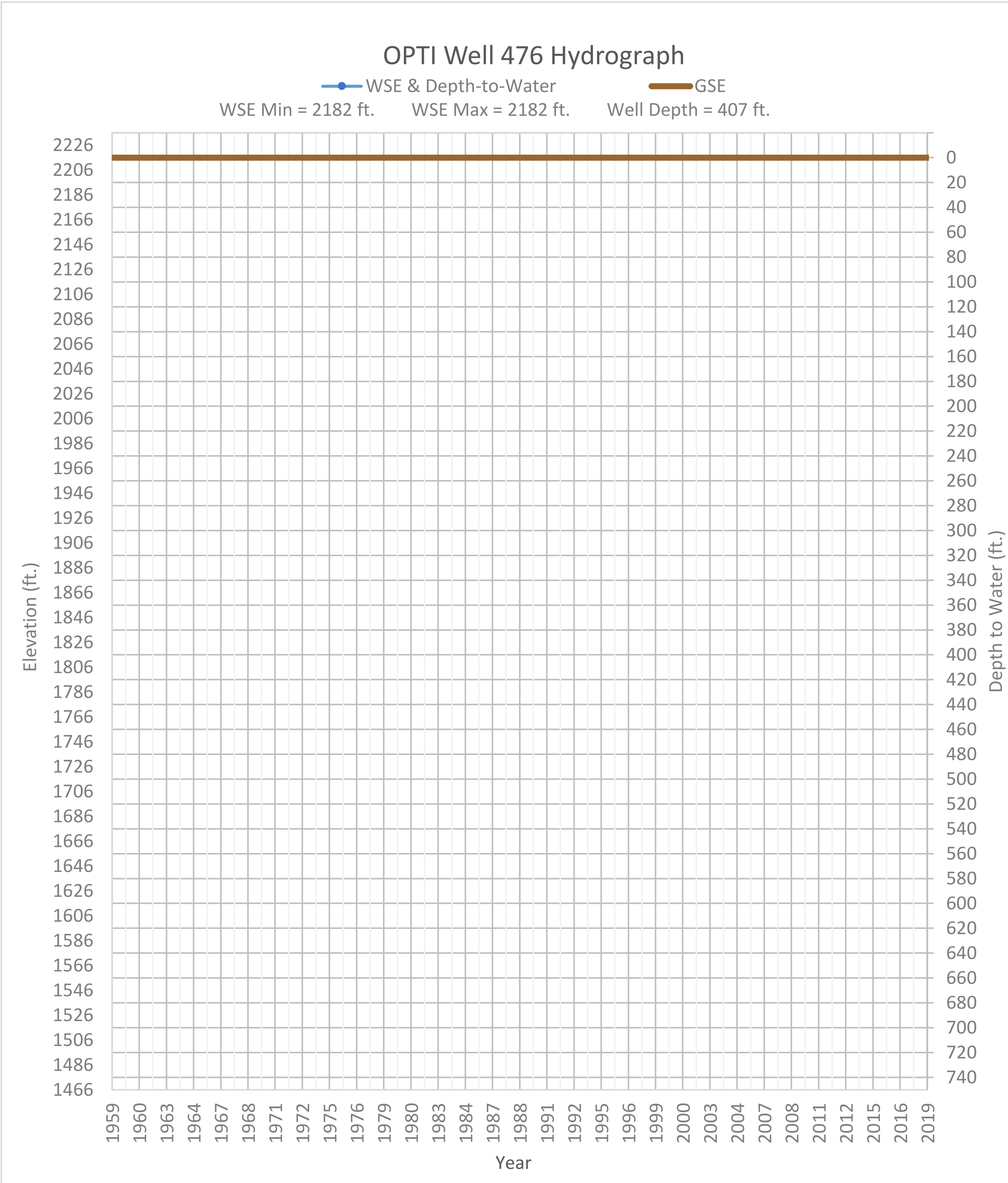


OPTI Well 474 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2179 ft.
WSE Max = 2200 ft.
Well Depth = 213 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 476 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2182 ft.
WSE Max = 2182 ft.
Well Depth = 407 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
1786
1766
1746
1726
1706
1686
1666
1646
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1566
1546
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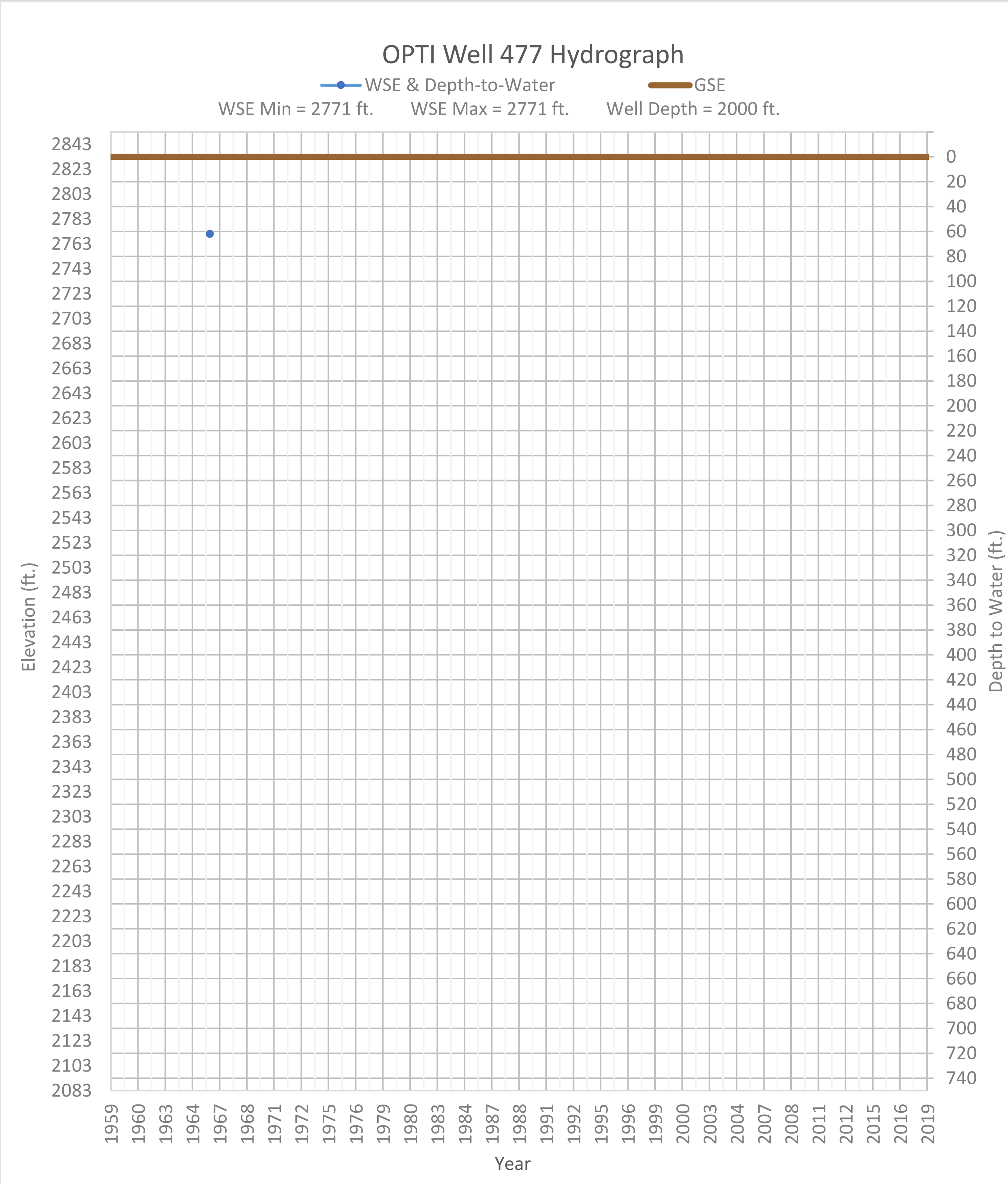

OPTI Well 477 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2771 ft.
WSE Max = 2771 ft.
Well Depth = 2000 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 478 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2046 ft.
WSE Max = 2100 ft.
Well Depth = 350 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2178
2158
2138
2118
2098
2078
2058
2038
2018
1998
1978
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1918
1898
1878
1858
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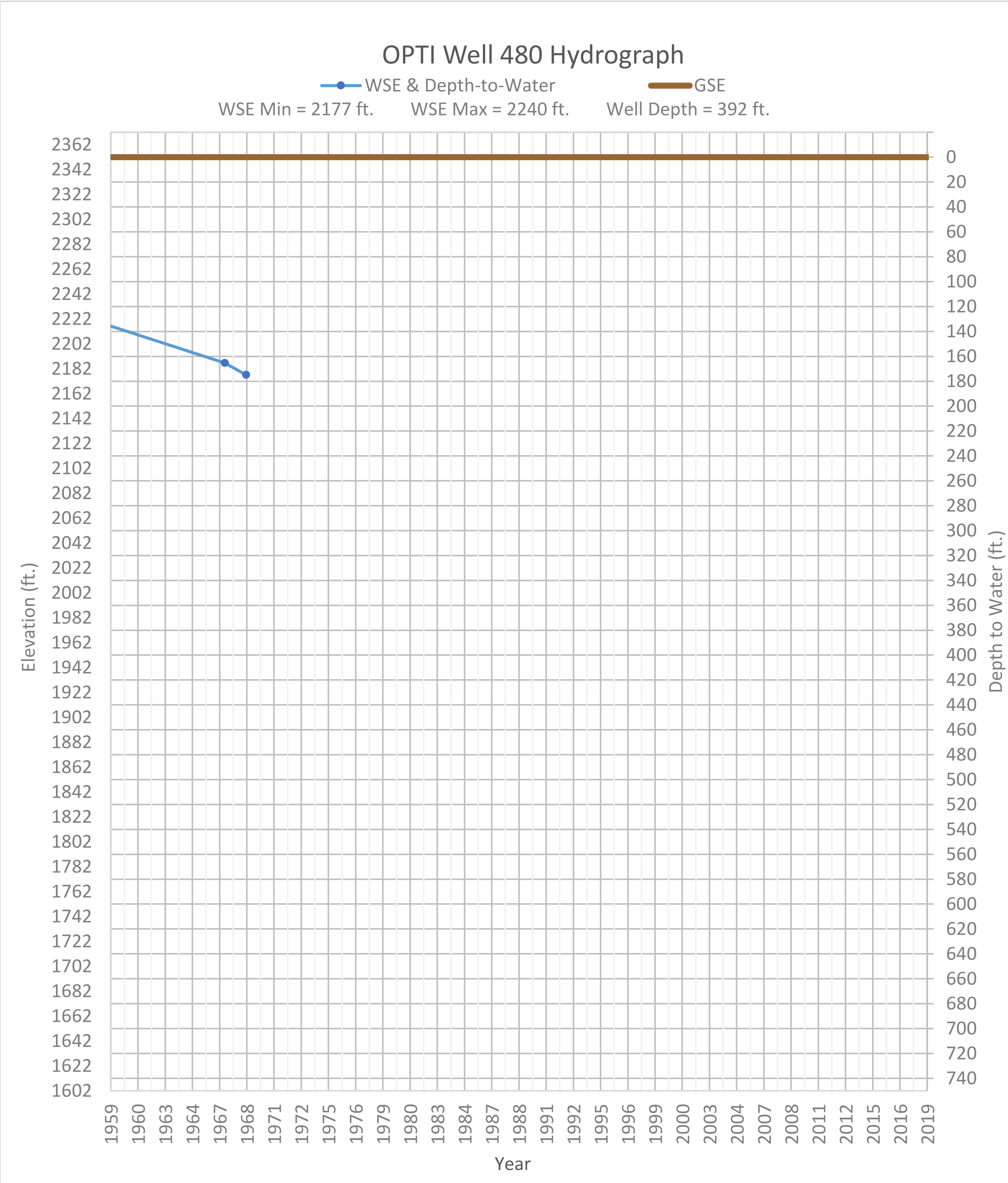
OPTI Well 480 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2177 ft.
WSE Max = 2240 ft.
Well Depth = 392 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2362
2342
2322
2302
2282
2262
2242
2222
2202
2182
2162
2142
2122
2102
2082
2062
2042
2022
2002
1982
1962
1942
1922
1902
1882
1862
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1822
1802
1782
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1742
1722
1702
1682
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1602
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2011
2012
2015
2016
2019


OPTI Well 482 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2037 ft.
WSE Max = 2123 ft.
Well Depth = 508 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2209
2189
2169
2149
2129
2109
2089
2069
2049
2029
2009
1989
1969
1949
1929
1909
1889
1869
1849
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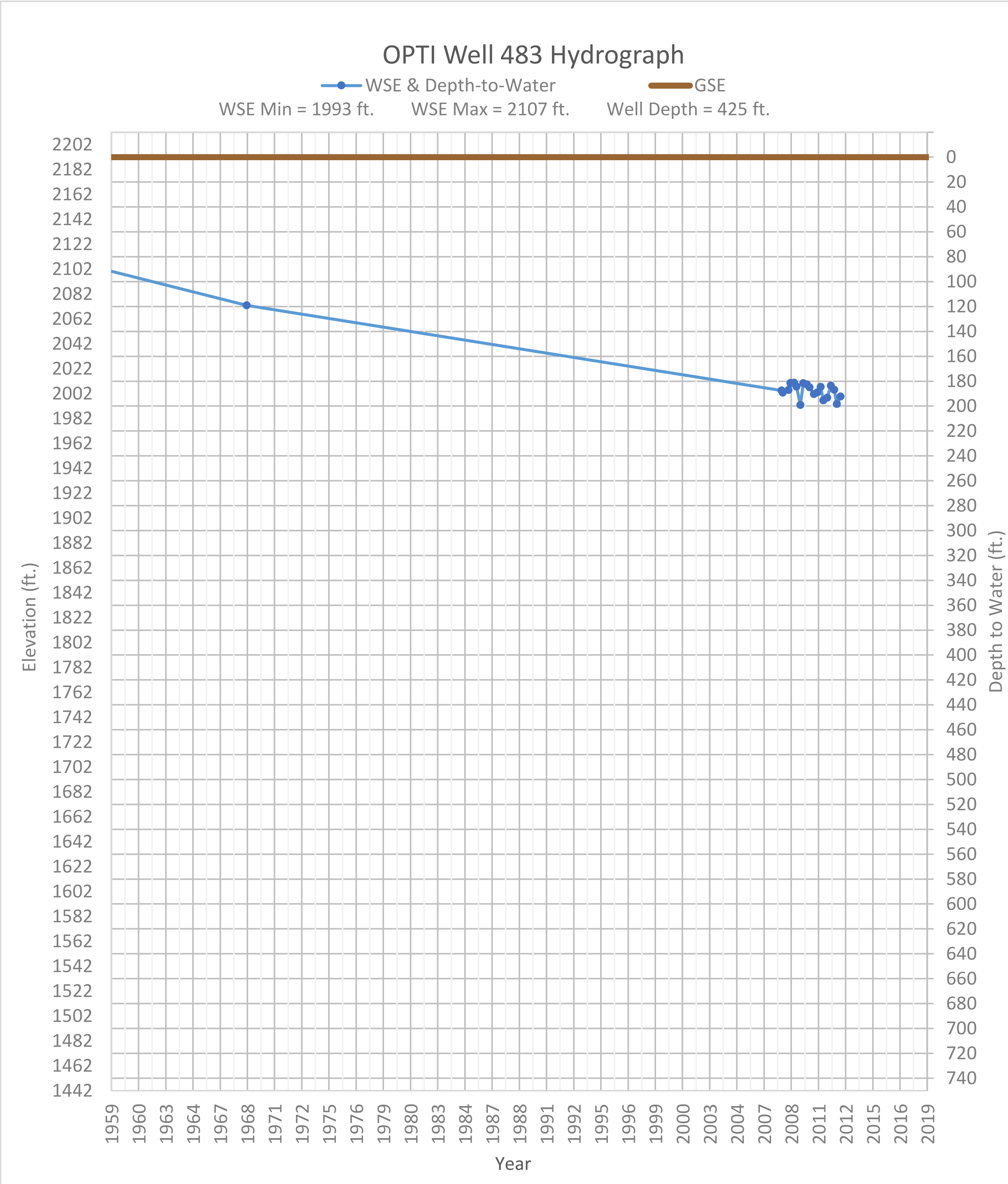
OPTI Well 483 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1993 ft.
WSE Max = 2107 ft.
Well Depth = 425 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 484 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2027 ft.
WSE Max = 2122 ft.
Well Depth = 465 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2195
2175
2155
2135
2115
2095
2075
2055
2035
2015
1995
1975
1955
1935
1915
1895
1875
1855
1835
1815
1795
1775
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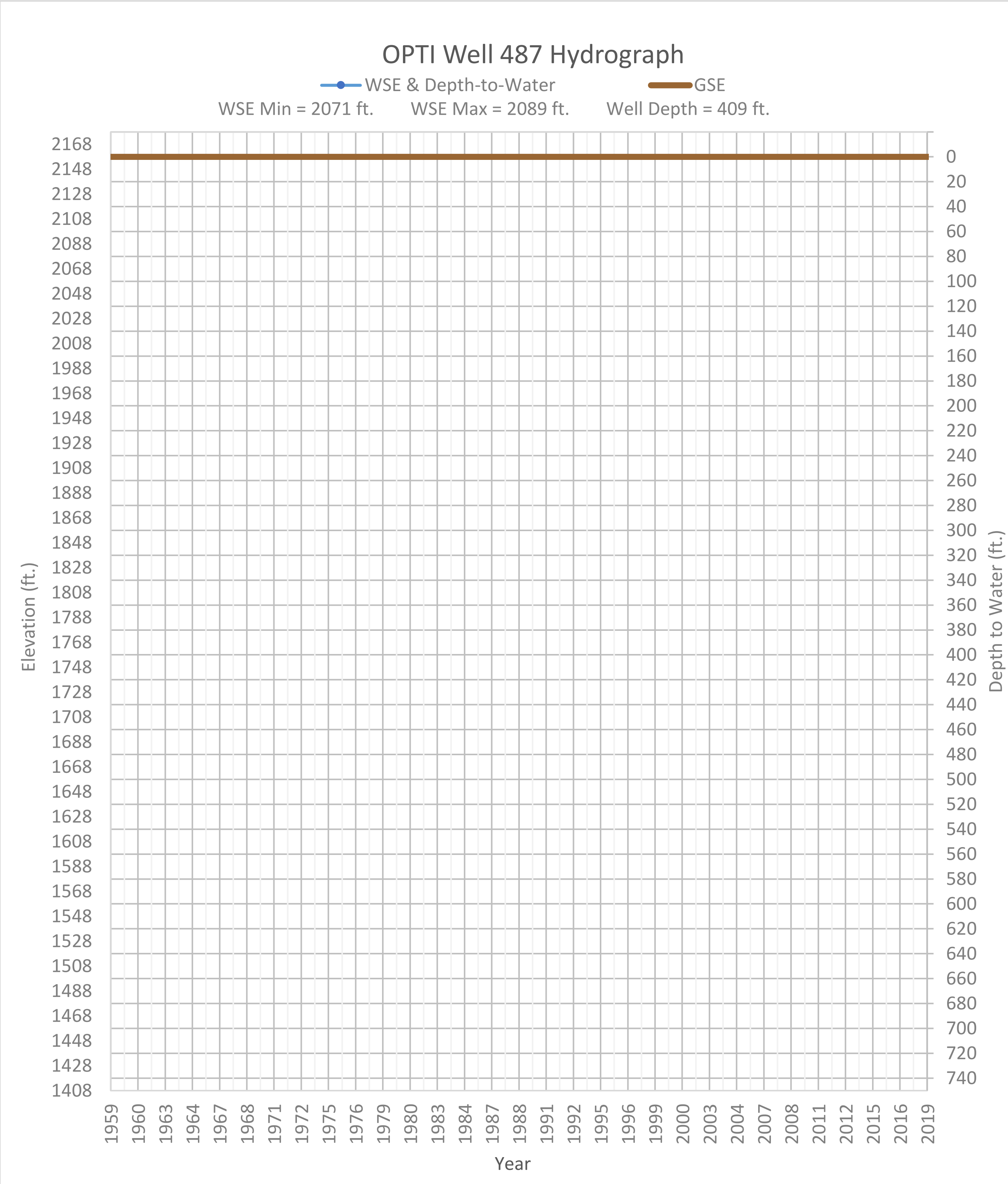
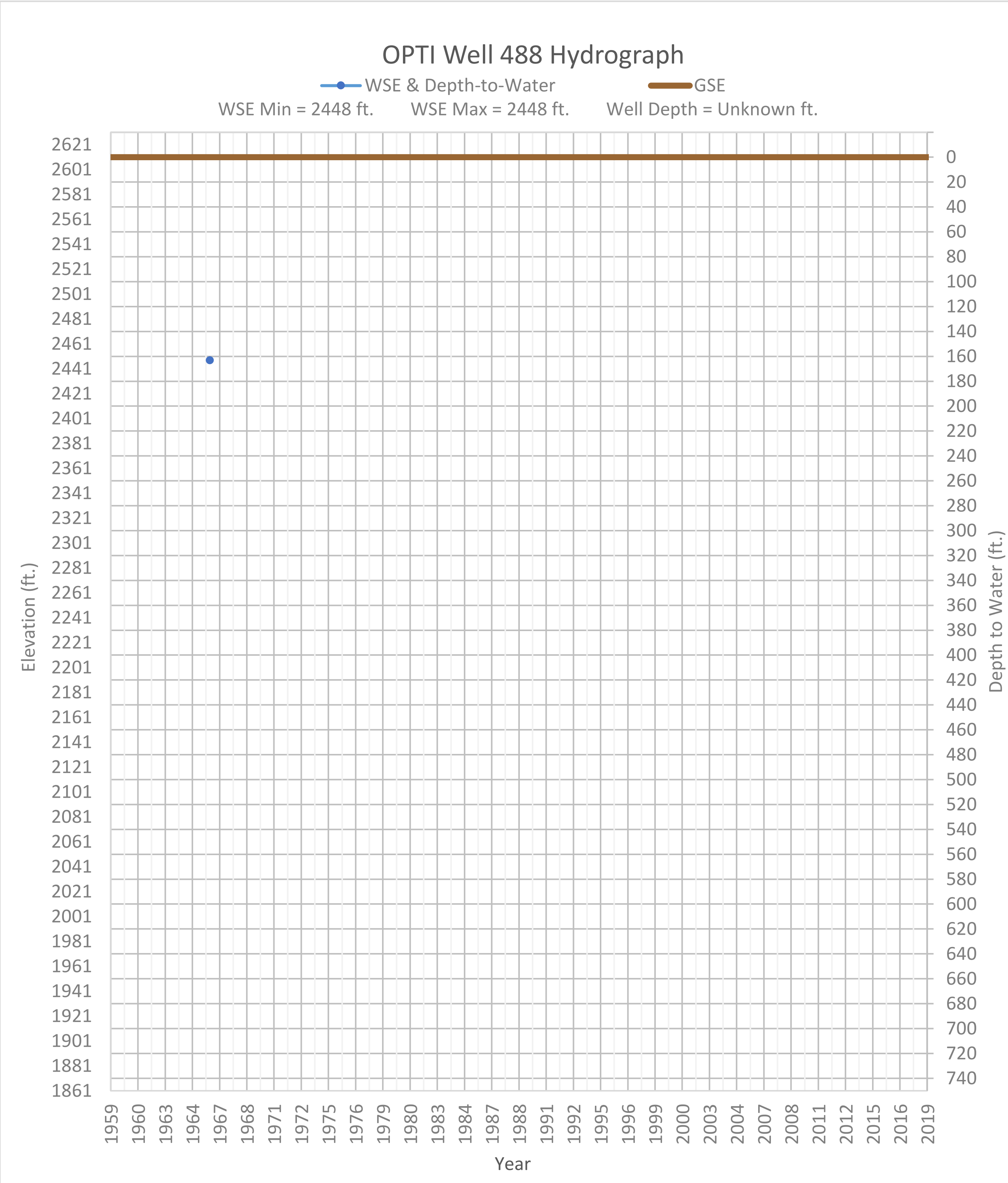
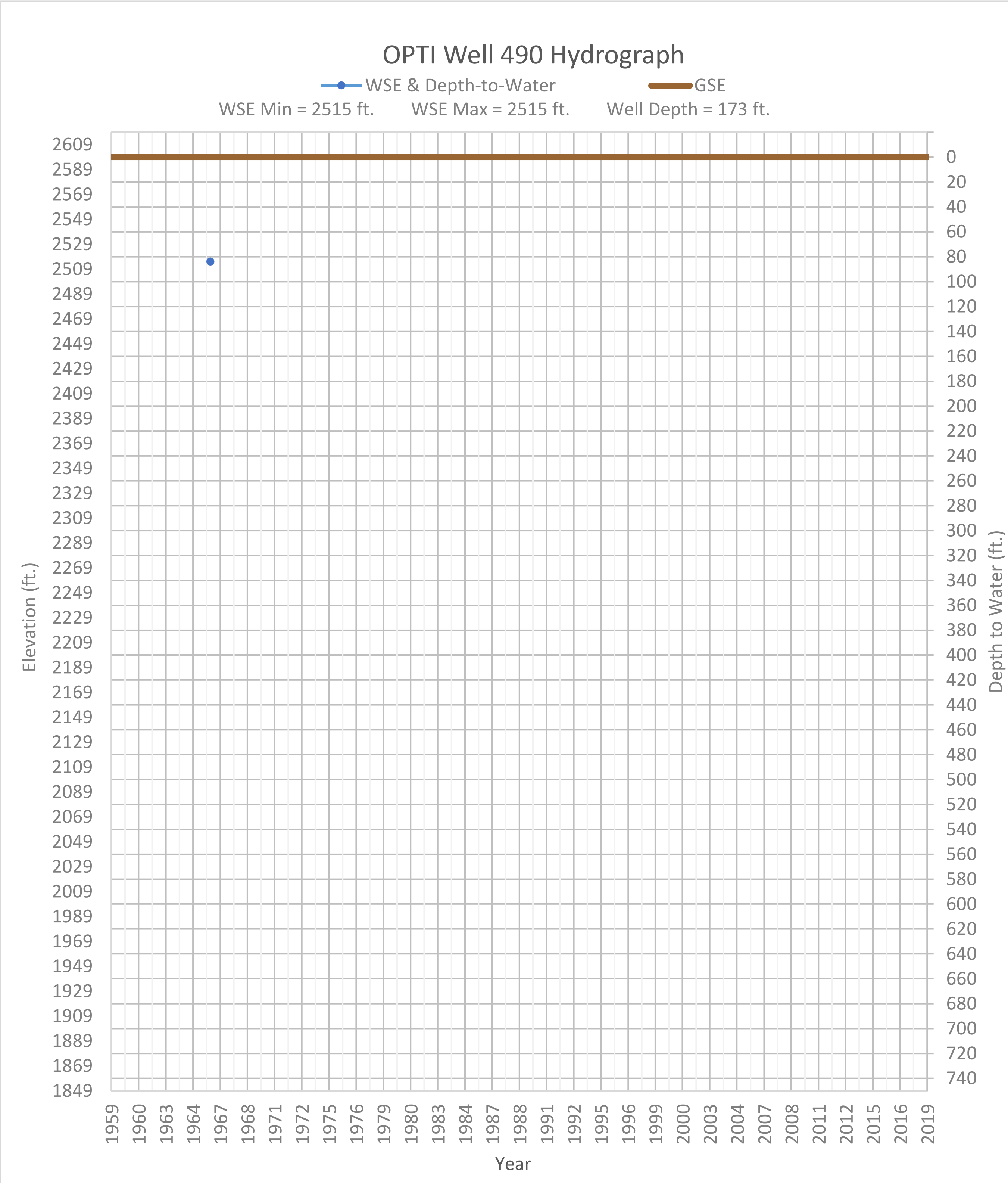


OPTI Well 487 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2071 ft.
WSE Max = 2089 ft.
Well Depth = 409 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 488 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2448 ft.
WSE Max = 2448 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 490 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2515 ft.
WSE Max = 2515 ft.
Well Depth = 173 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2609
2589
2569
2549
2529
2509
2489
2469
2449
2429
2409
2389
2369
2349
2329
2309
2289
2269
2249
2229
2209
2189
2169
2149
2129
2109
2089
2069
2049
2029
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1889
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1849
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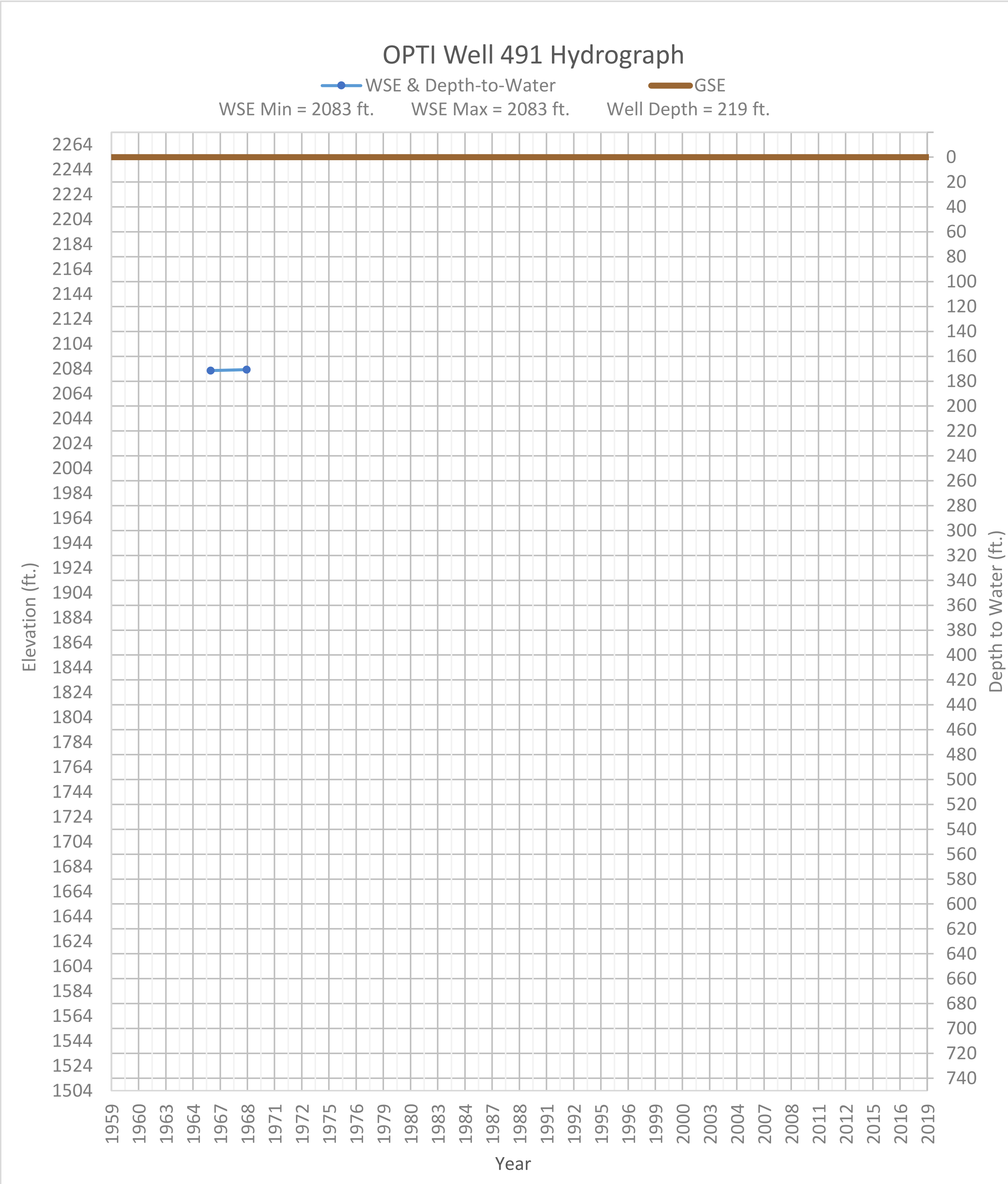
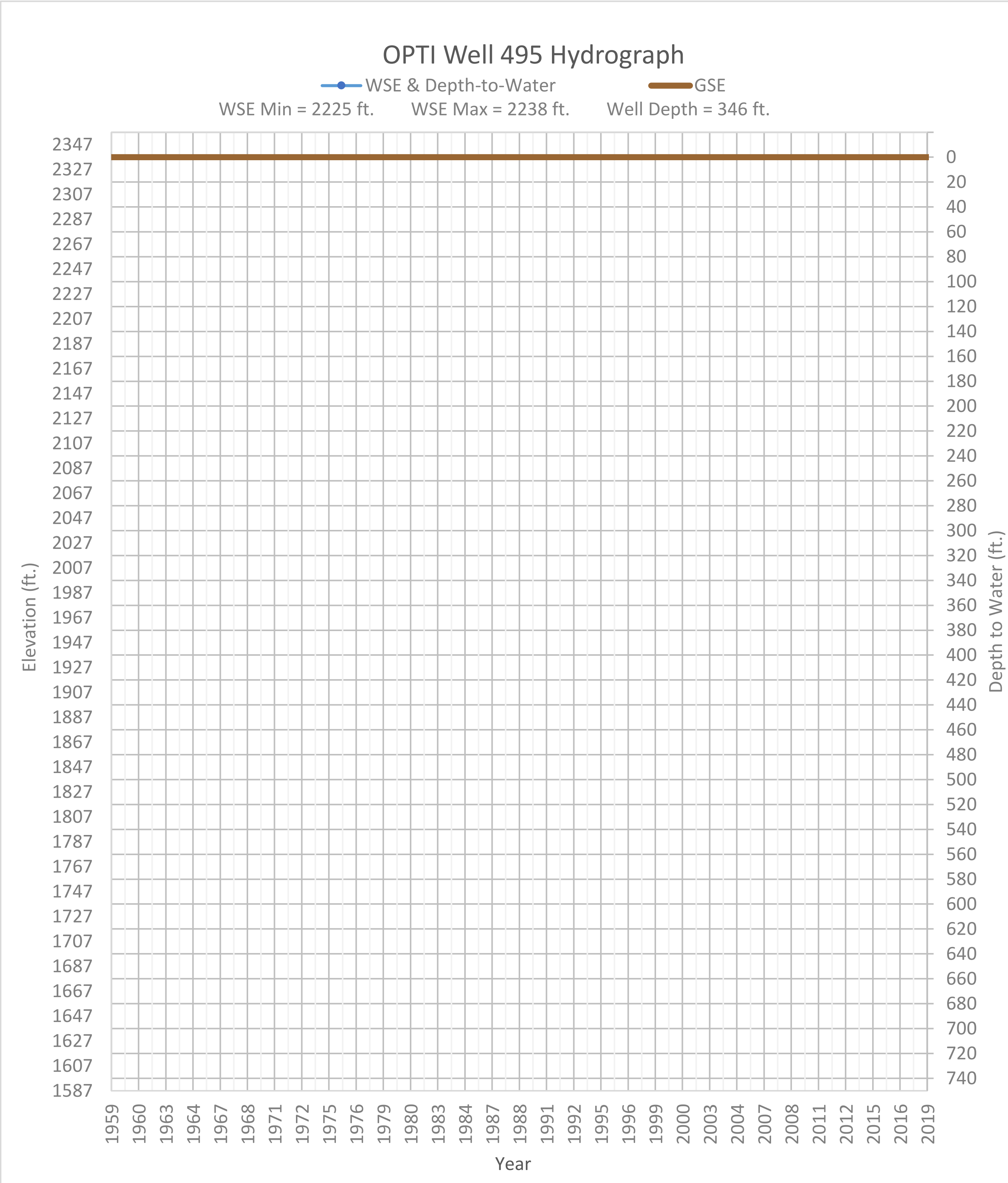


OPTI Well 491 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2083 ft.
WSE Max = 2083 ft.
Well Depth = 219 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 495 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2225 ft.
WSE Max = 2238 ft.
Well Depth = 346 ft.
Elevation (ft.)
2347
2327
2307
2287
2267
2247
2227
2207
2187
2167
2147
2127
2107
2087
2067
2047
2027
2007
1987
1967
1947
1927
1907
1887
1867
1847
1827
1807
1787
1767
1747
1727
1707
1687
1667
1647
1627
1607
1587
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
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380
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560
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Year
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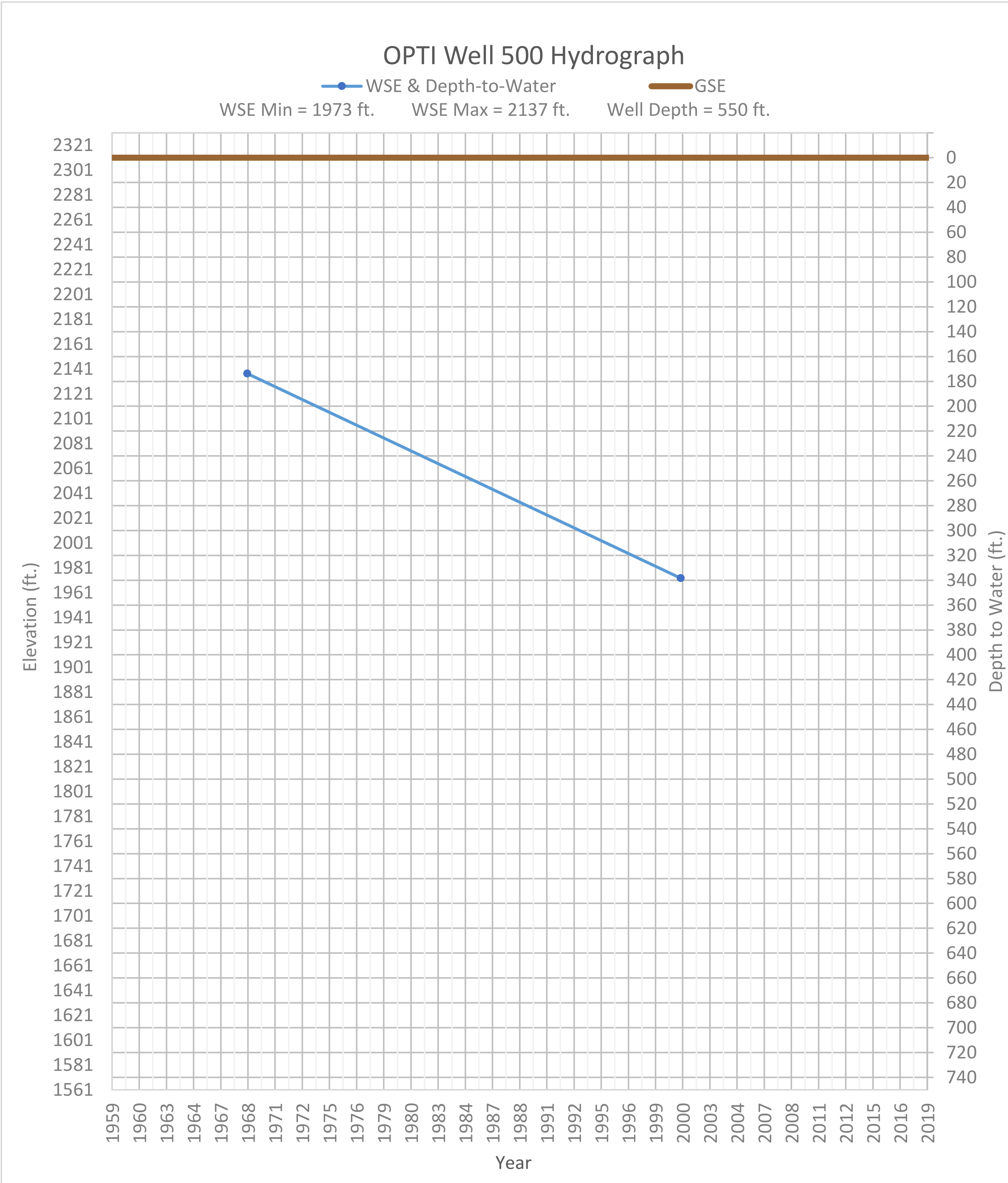
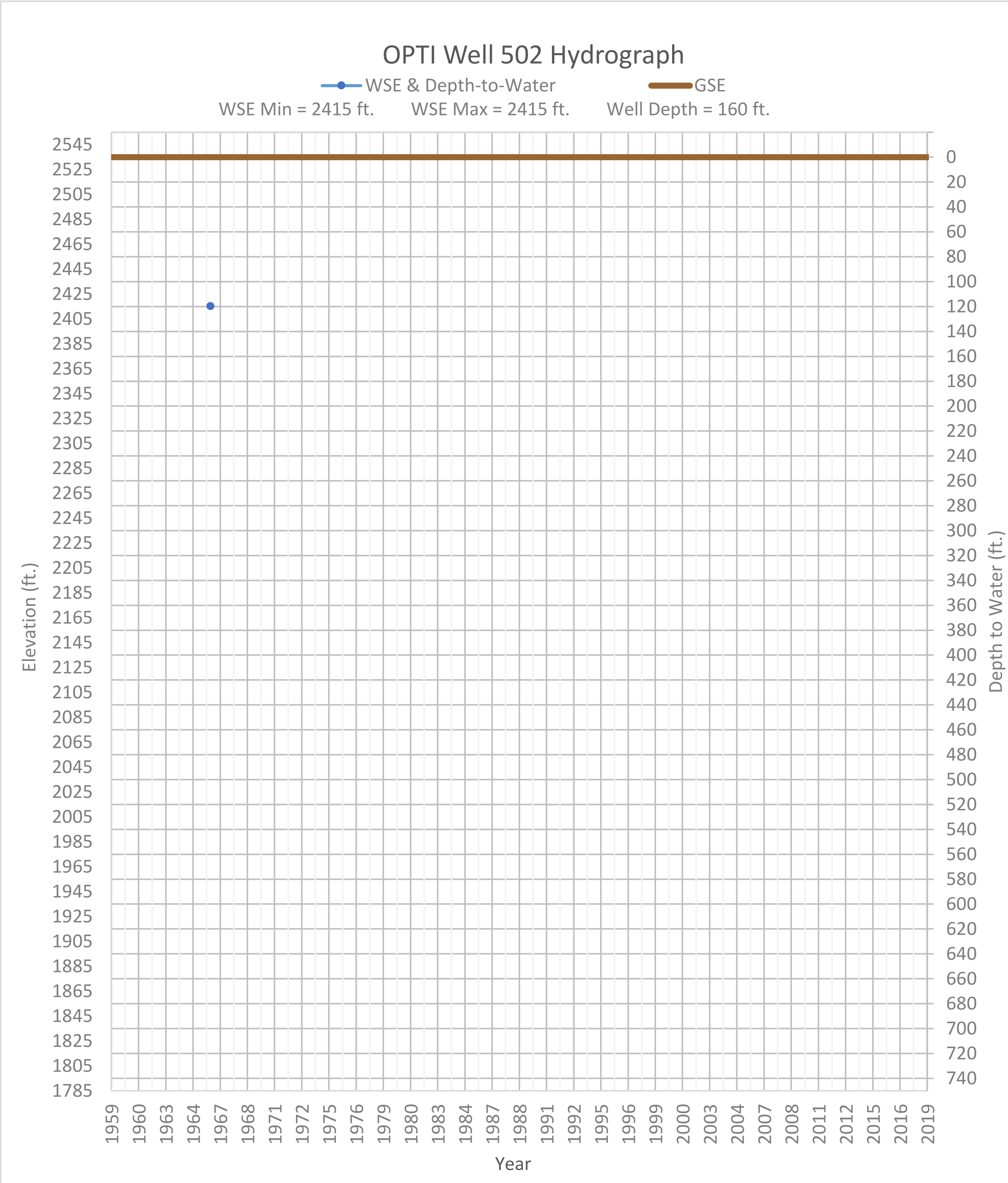
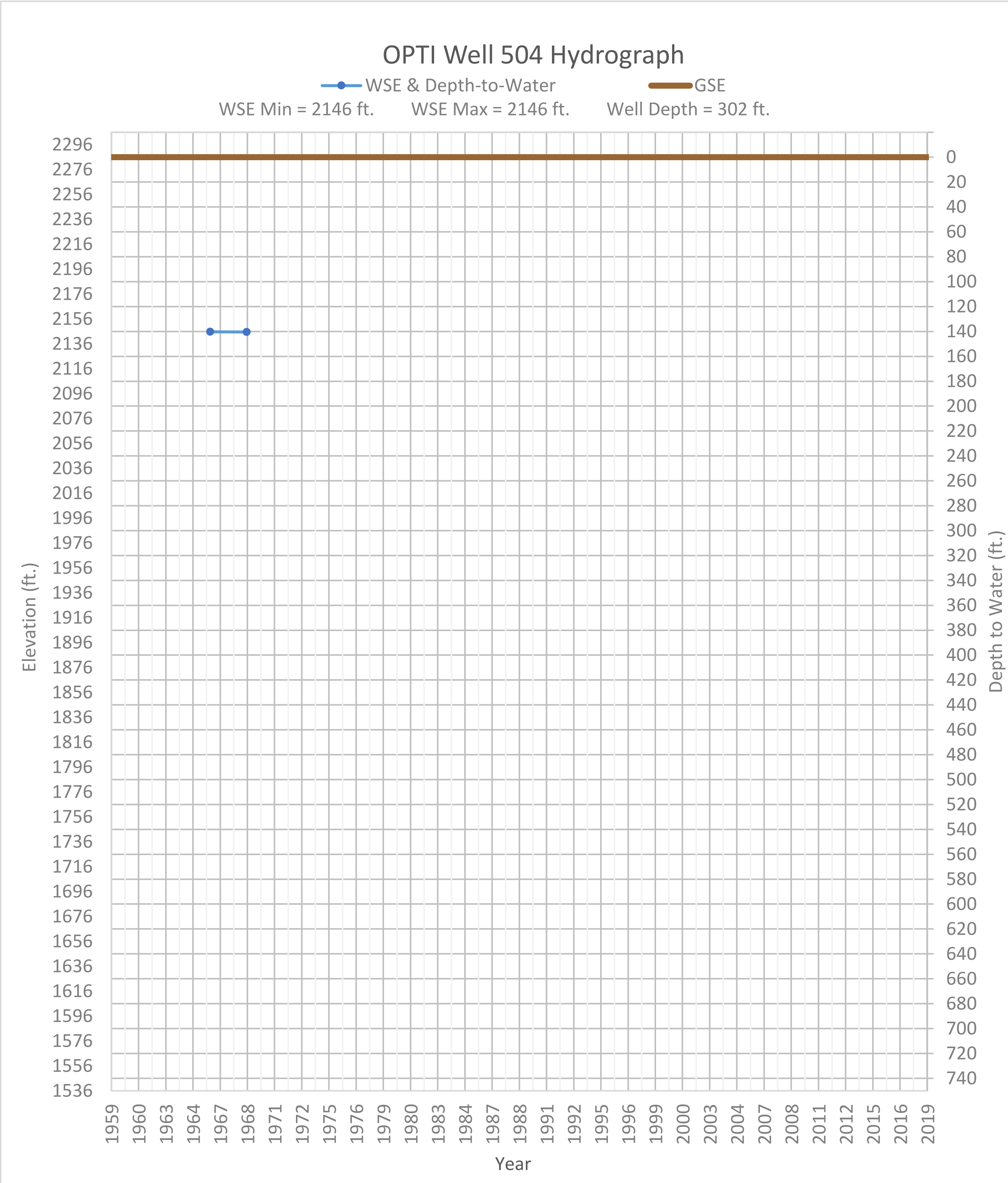


OPTI Well 500 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1973 ft.
WSE Max = 2137 ft.
Well Depth = 550 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 502 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2415 ft.
WSE Max = 2415 ft.
Well Depth = 160 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 504 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2146 ft.
WSE Max = 2146 ft.
Well Depth = 302 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2296
2276
2256
2236
2216
2196
2176
2156
2136
2116
2096
2076
2056
2036
2016
1996
1976
1956
1936
1916
1896
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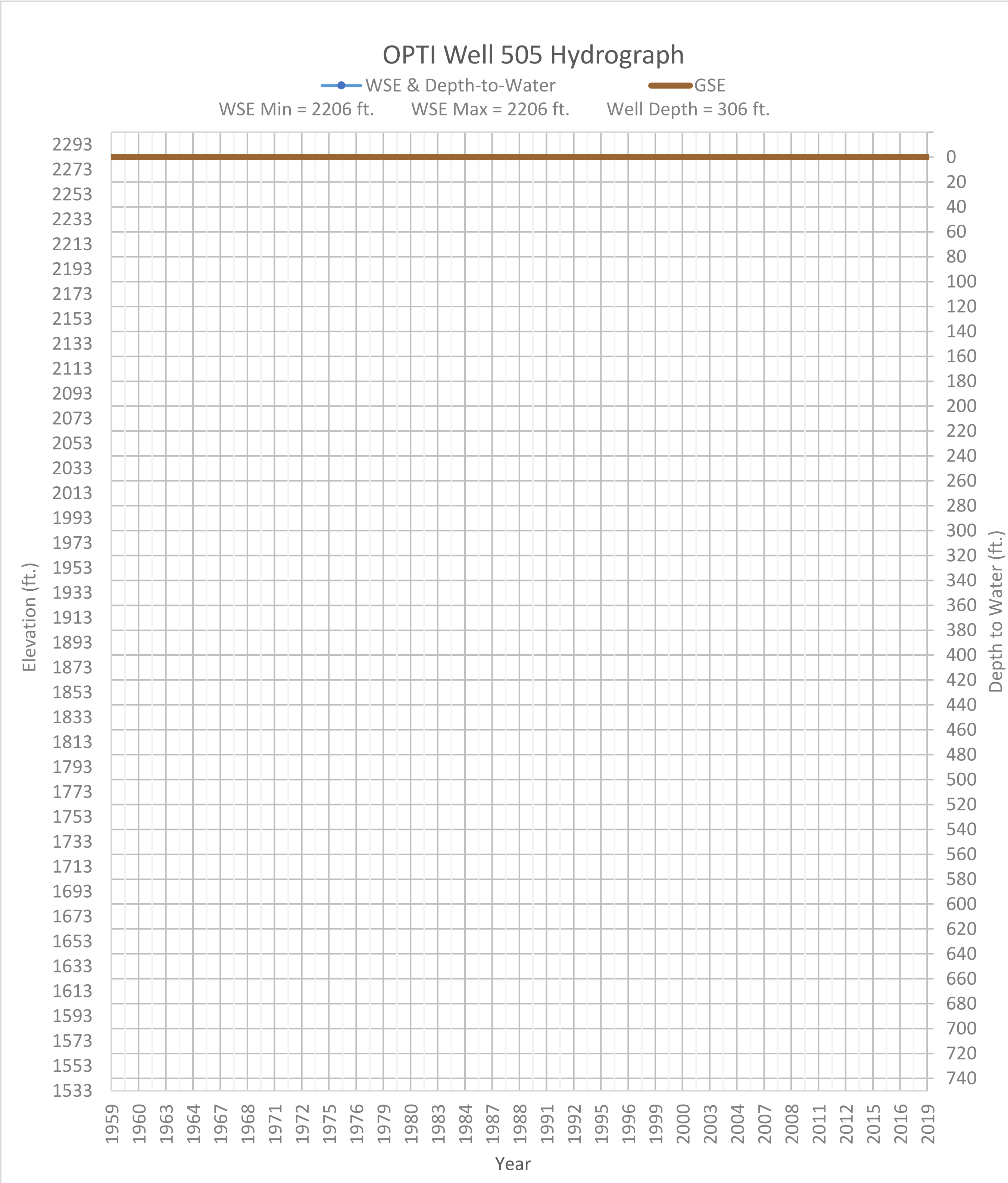
OPTI Well 505 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2206 ft.
WSE Max = 2206 ft.
Well Depth = 306 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2293
2273
2253
2233
2213
2193
2173
2153
2133
2113
2093
2073
2053
2033
2013
1993
1973
1953
1933
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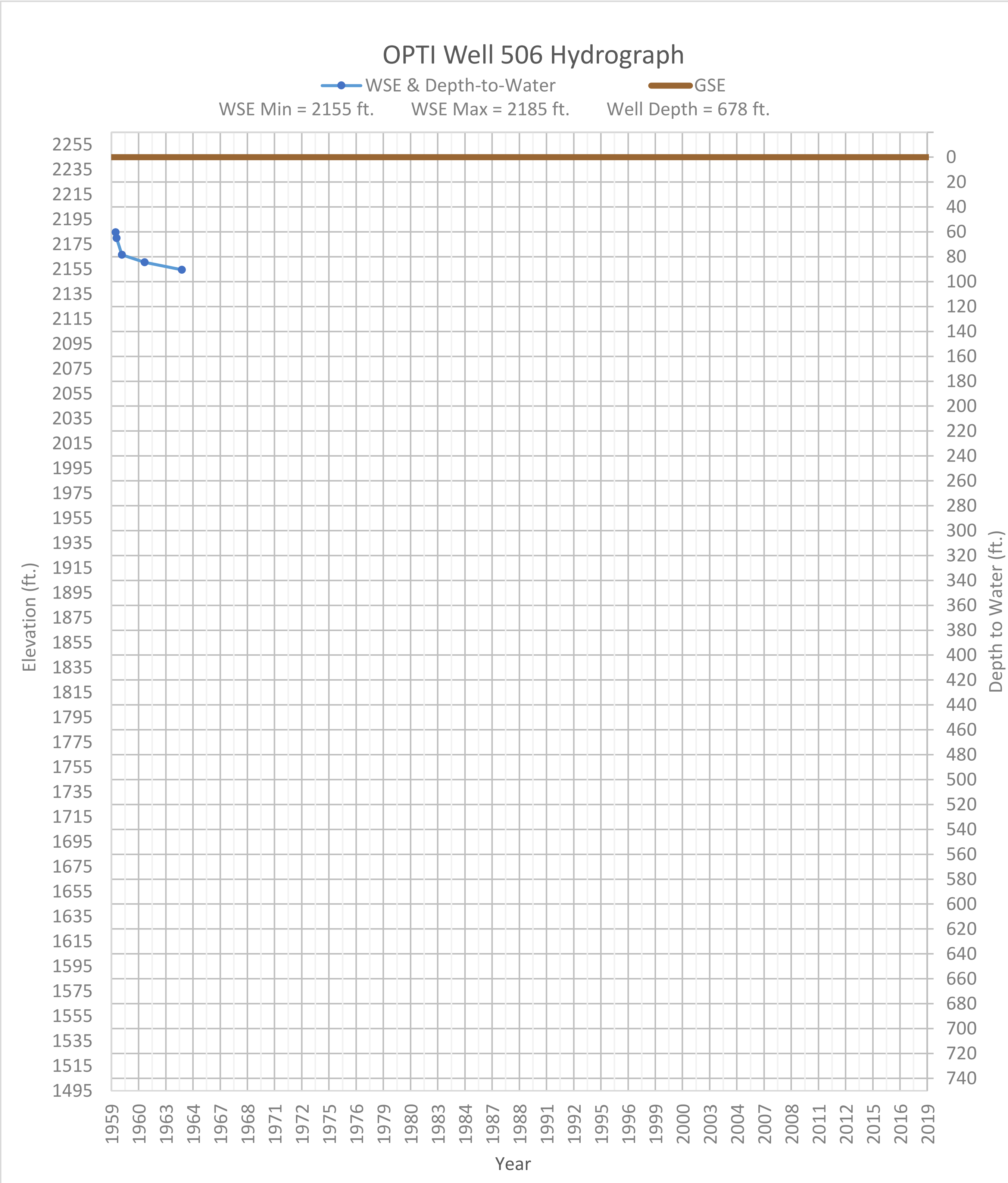
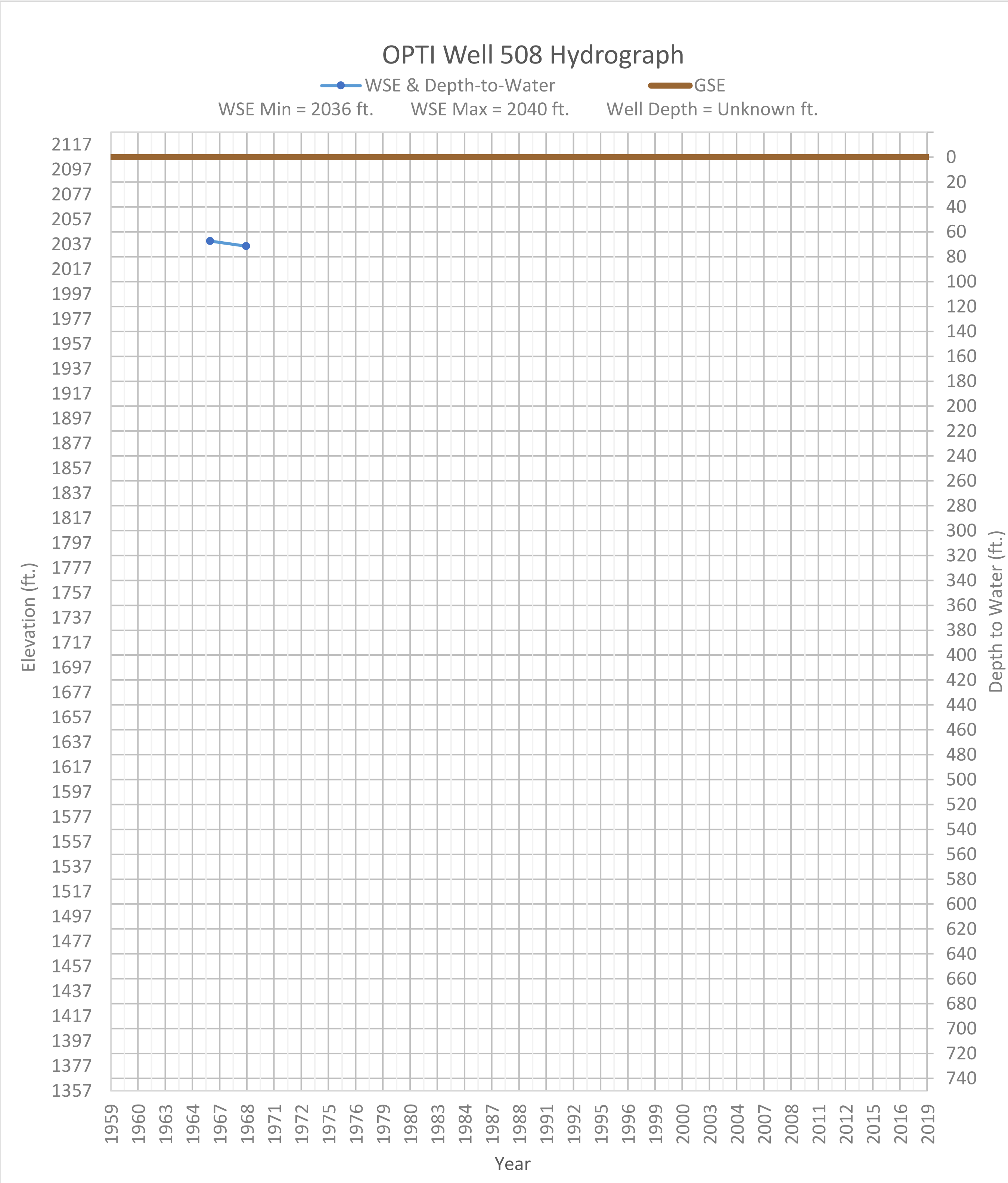

OPTI Well 506 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2155 ft.
WSE Max = 2185 ft.
Well Depth = 678 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 508 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2036 ft.
WSE Max = 2040 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2117
2097
2077
2057
2037
2017
1997
1977
1957
1937
1917
1897
1877
1857
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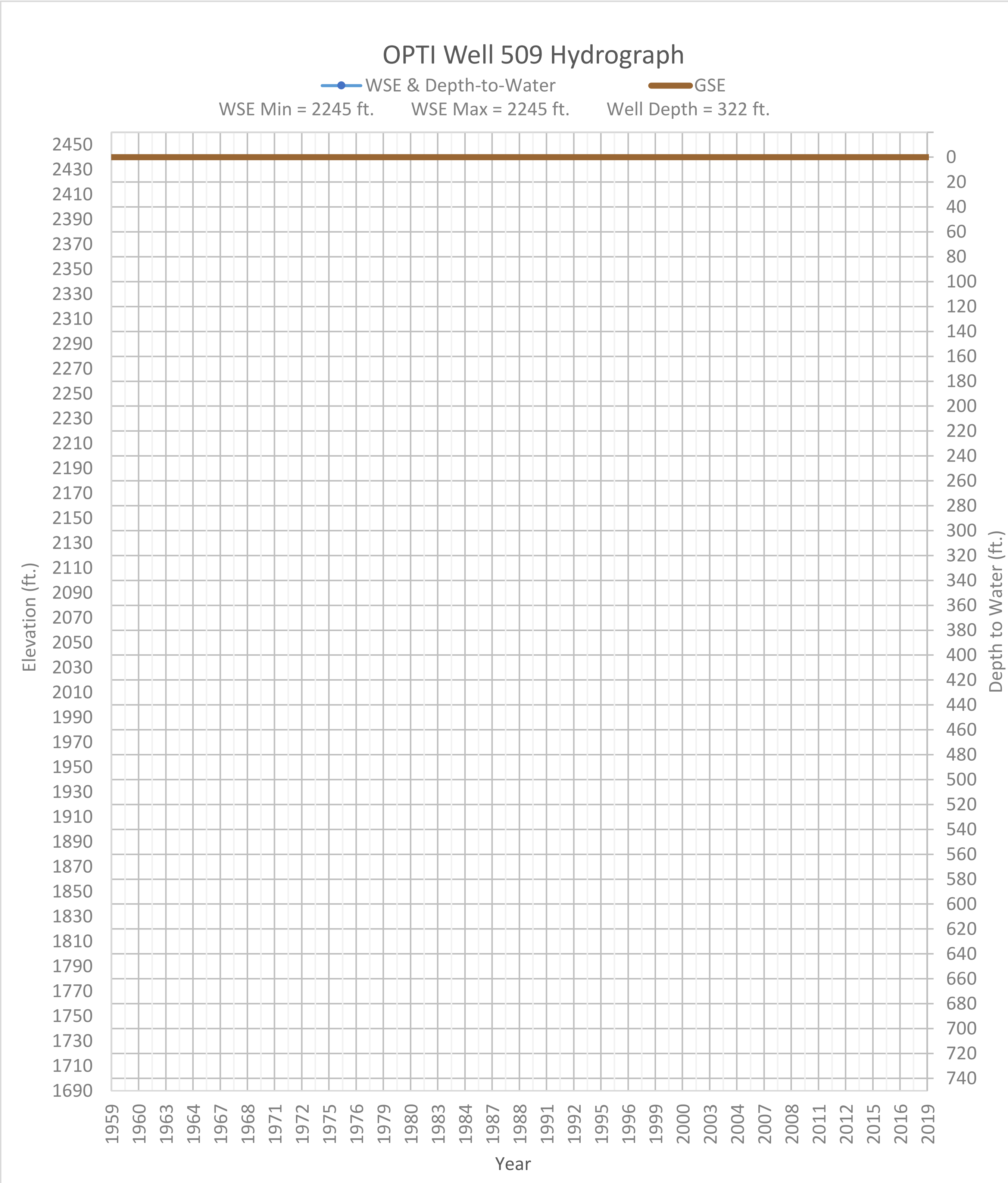

OPTI Well 509 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2245 ft.
WSE Max = 2245 ft.
Well Depth = 322 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2450
2430
2410
2390
2370
2350
2330
2310
2290
2270
2250
2230
2210
2190
2170
2150
2130
2110
2090
2070
2050
2030
2010
1990
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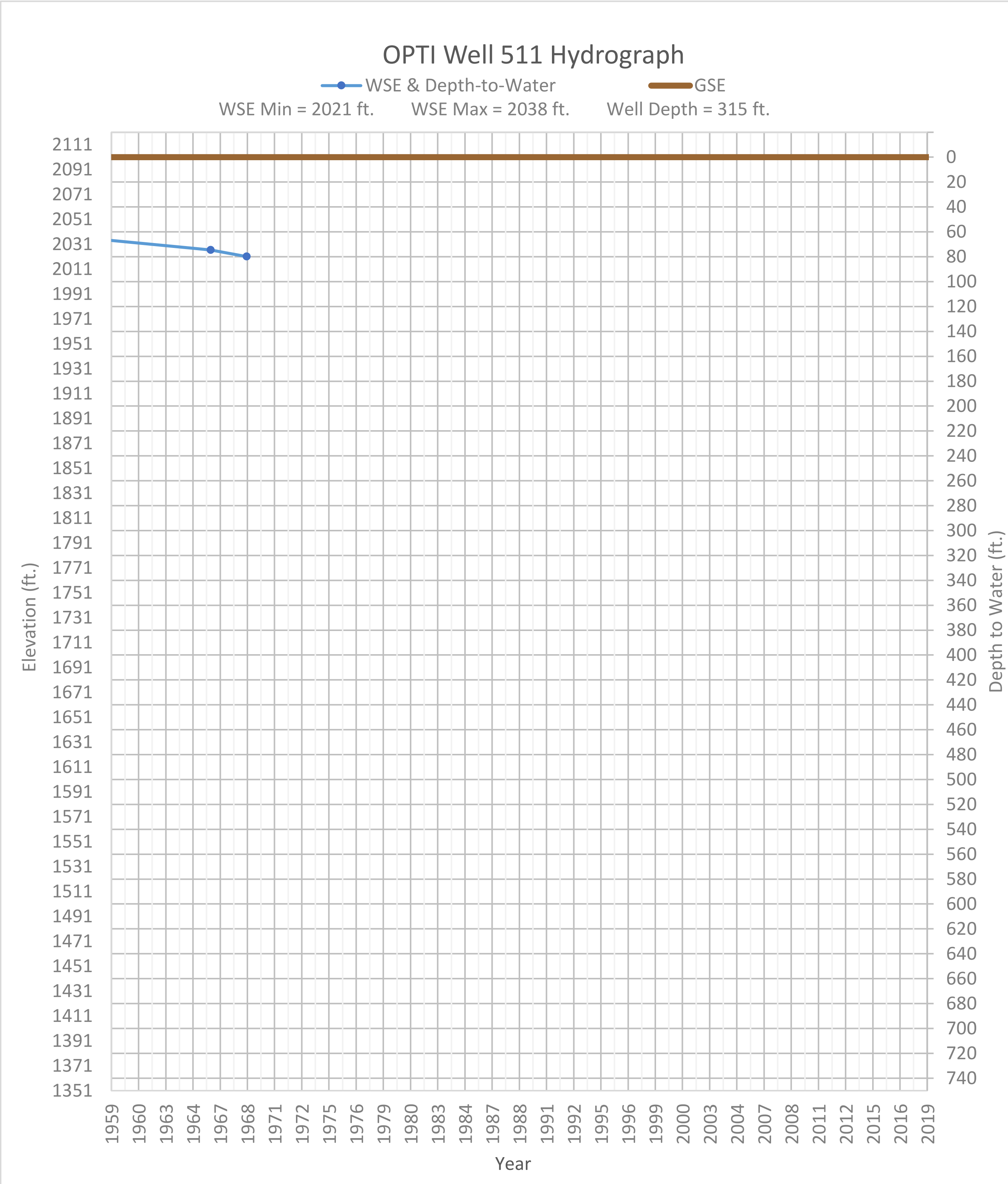
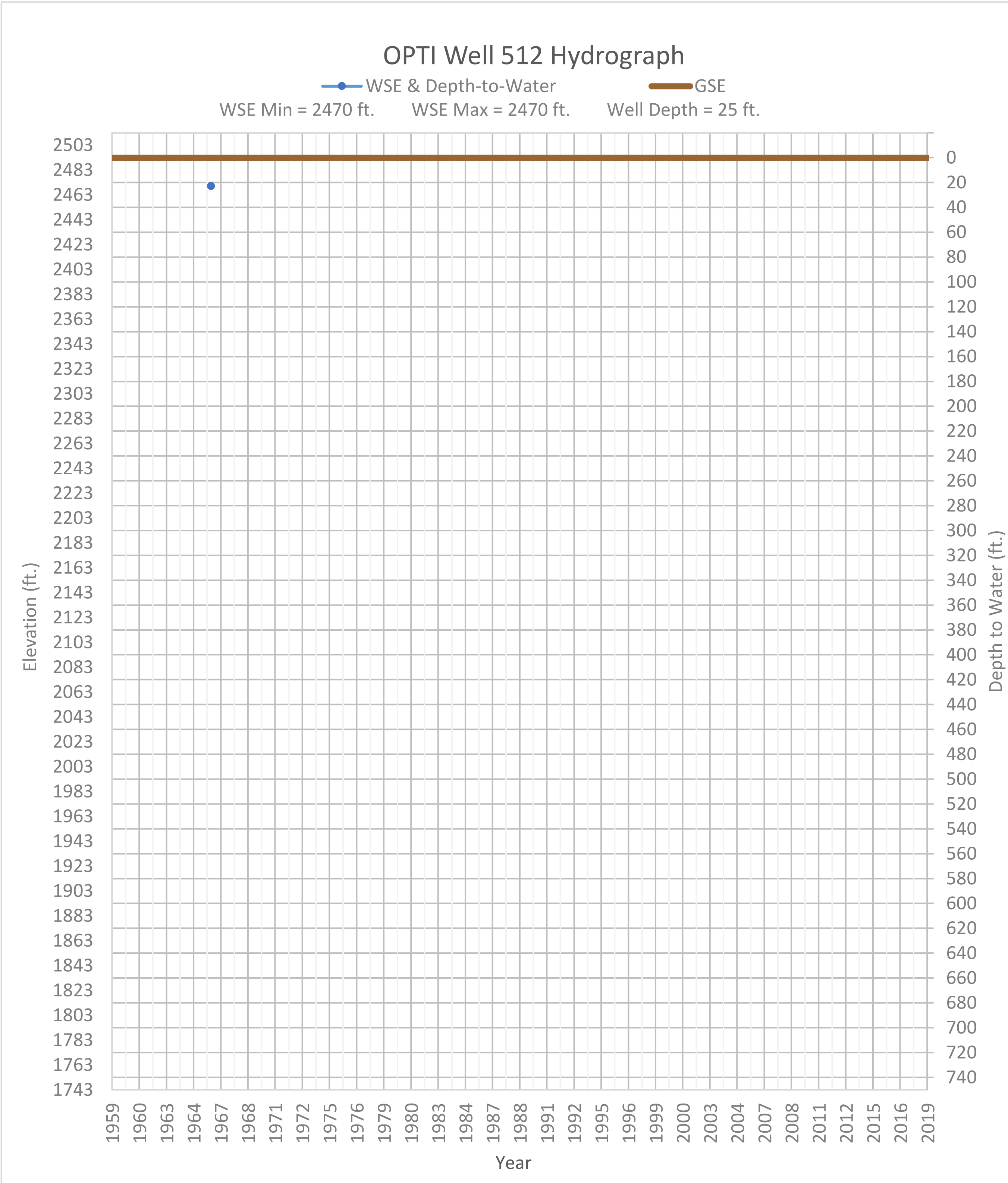

OPTI Well 511 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2021 ft.
WSE Max = 2038 ft.
Well Depth = 315 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 512 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2470 ft.
WSE Max = 2470 ft.
Well Depth = 25 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2503
2483
2463
2443
2423
2403
2383
2363
2343
2323
2303
2283
2263
2243
2223
2203
2183
2163
2143
2123
2103
2083
2063
2043
2023
2003
1983
1963
1943
1923
1903
1883
1863
1843
1823
1803
1783
1763
1743
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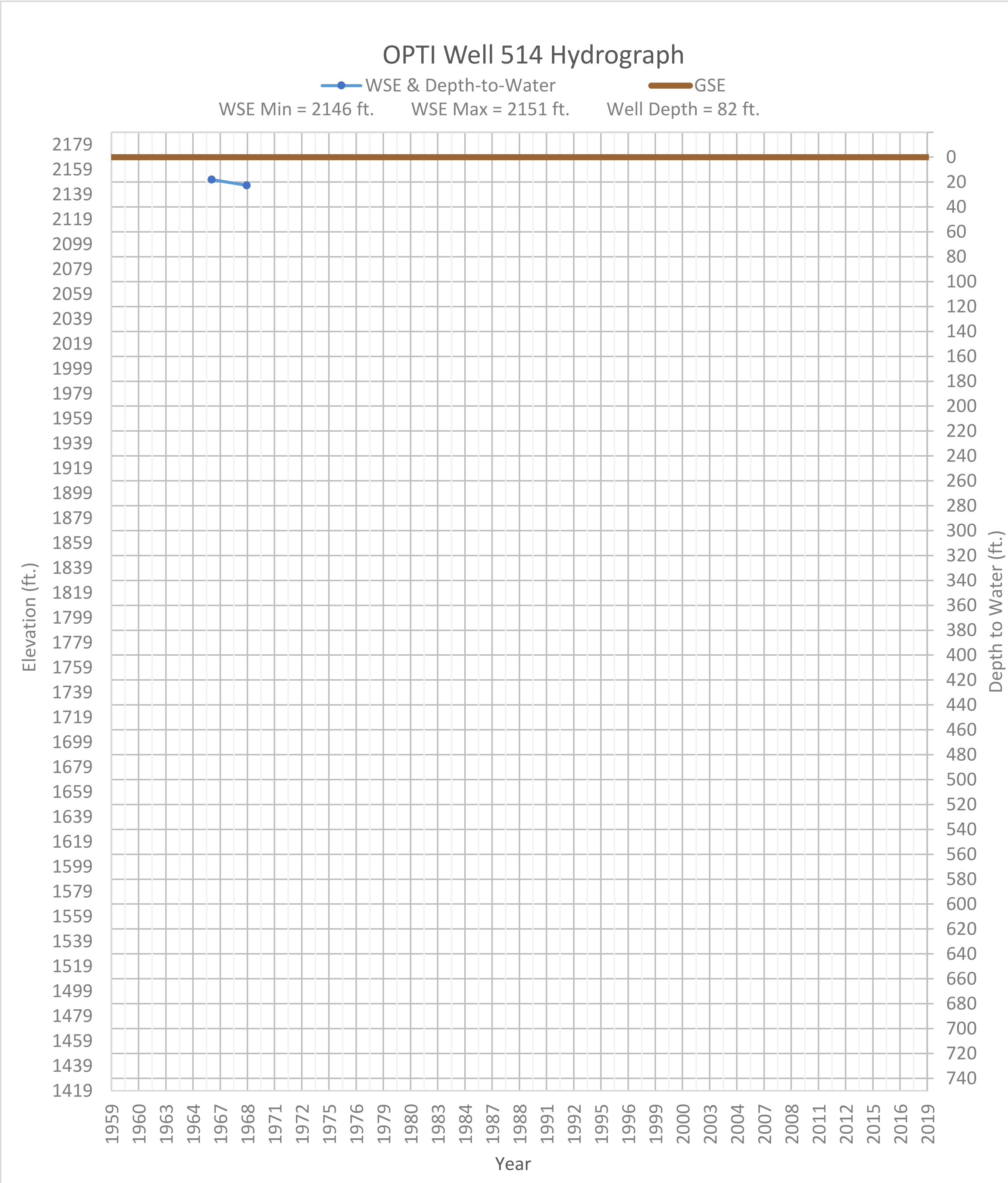

OPTI Well 514 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2146 ft.
WSE Max = 2151 ft.
Well Depth = 82 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2179
2159
2139
2119
2099
2079
2059
2039
2019
1999
1979
1959
1939
1919
1899
1879
1859
1839
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1579
1559
1539
1519
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1459
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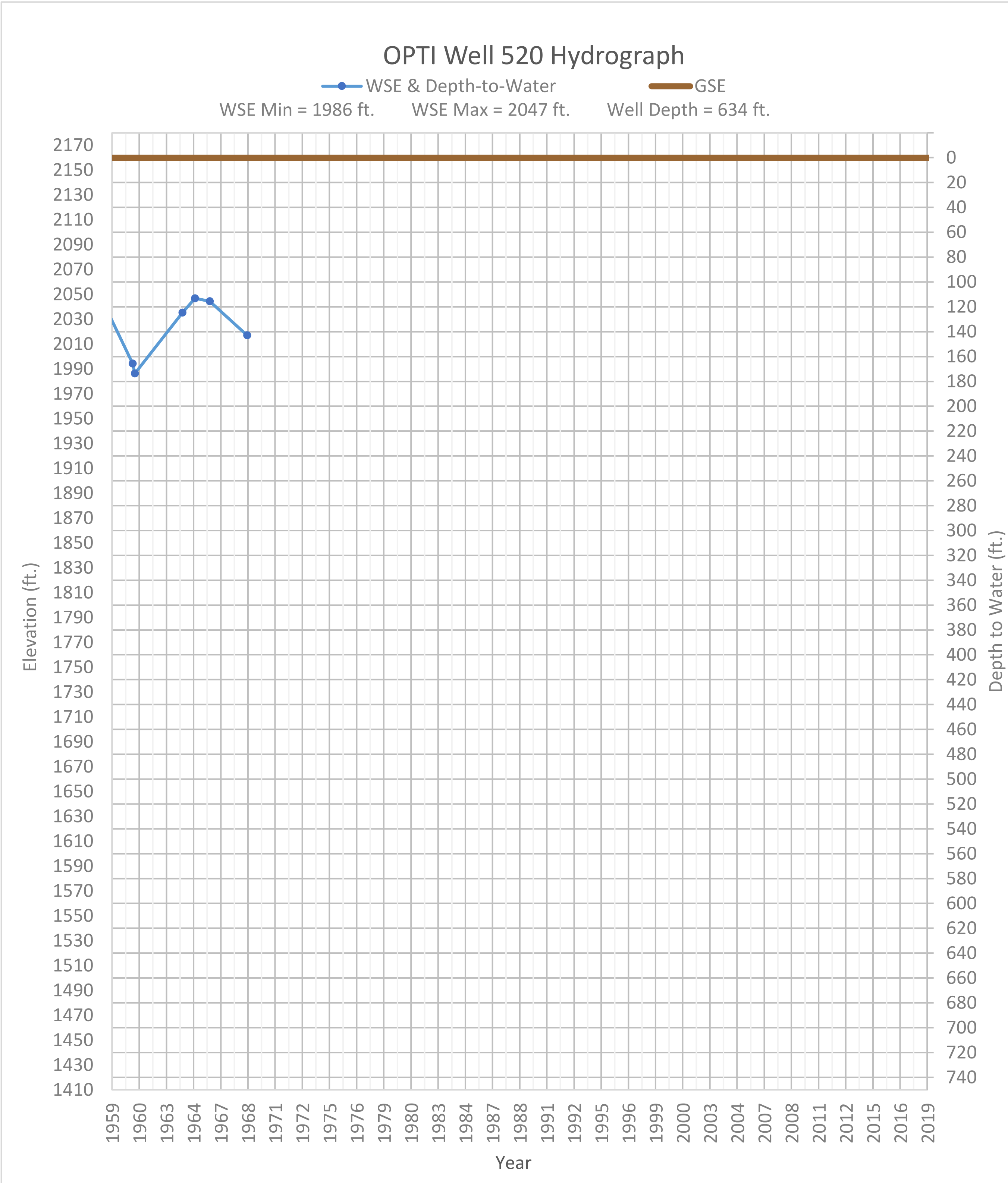
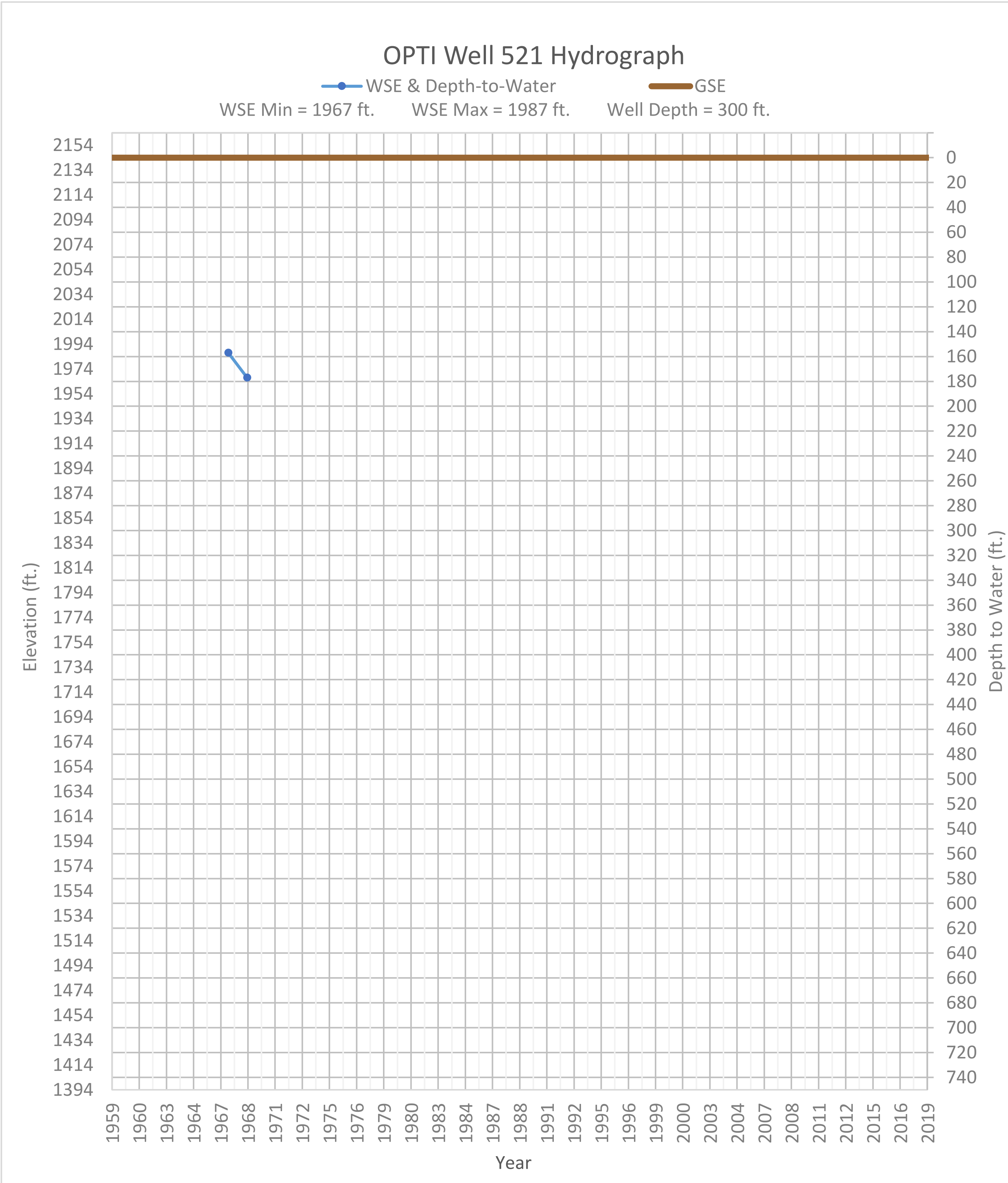
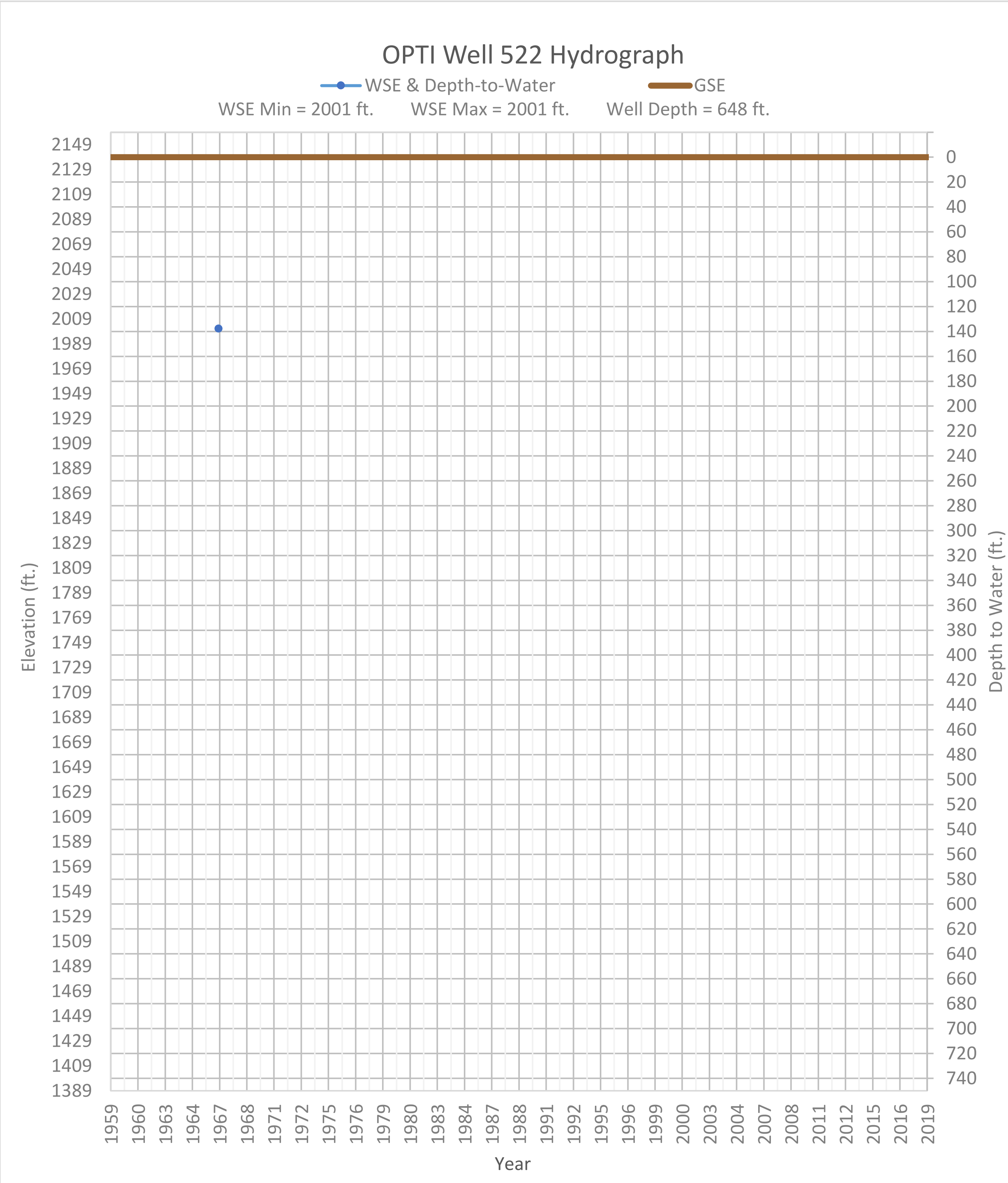
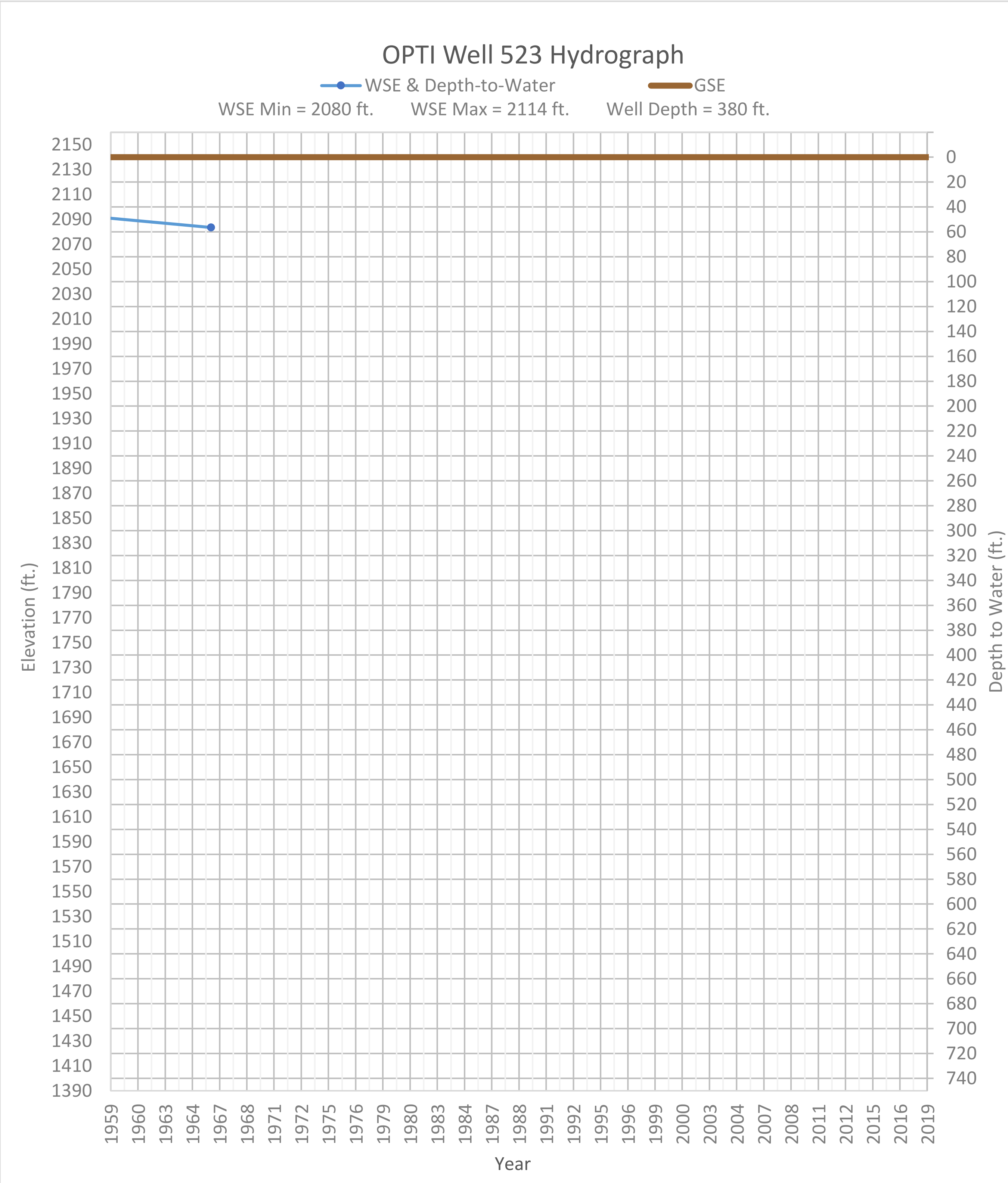


OPTI Well 520 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1986 ft.
WSE Max = 2047 ft.
Well Depth = 634 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 521 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1967 ft.
WSE Max = 1987 ft.
Well Depth = 300 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 522 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2001 ft.
WSE Max = 2001 ft.
Well Depth = 648 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 523 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2080 ft.
WSE Max = 2114 ft.
Well Depth = 380 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2150
2130
2110
2090
2070
2050
2030
2010
1990
1970
1950
1930
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1890
1870
1850
1830
1810
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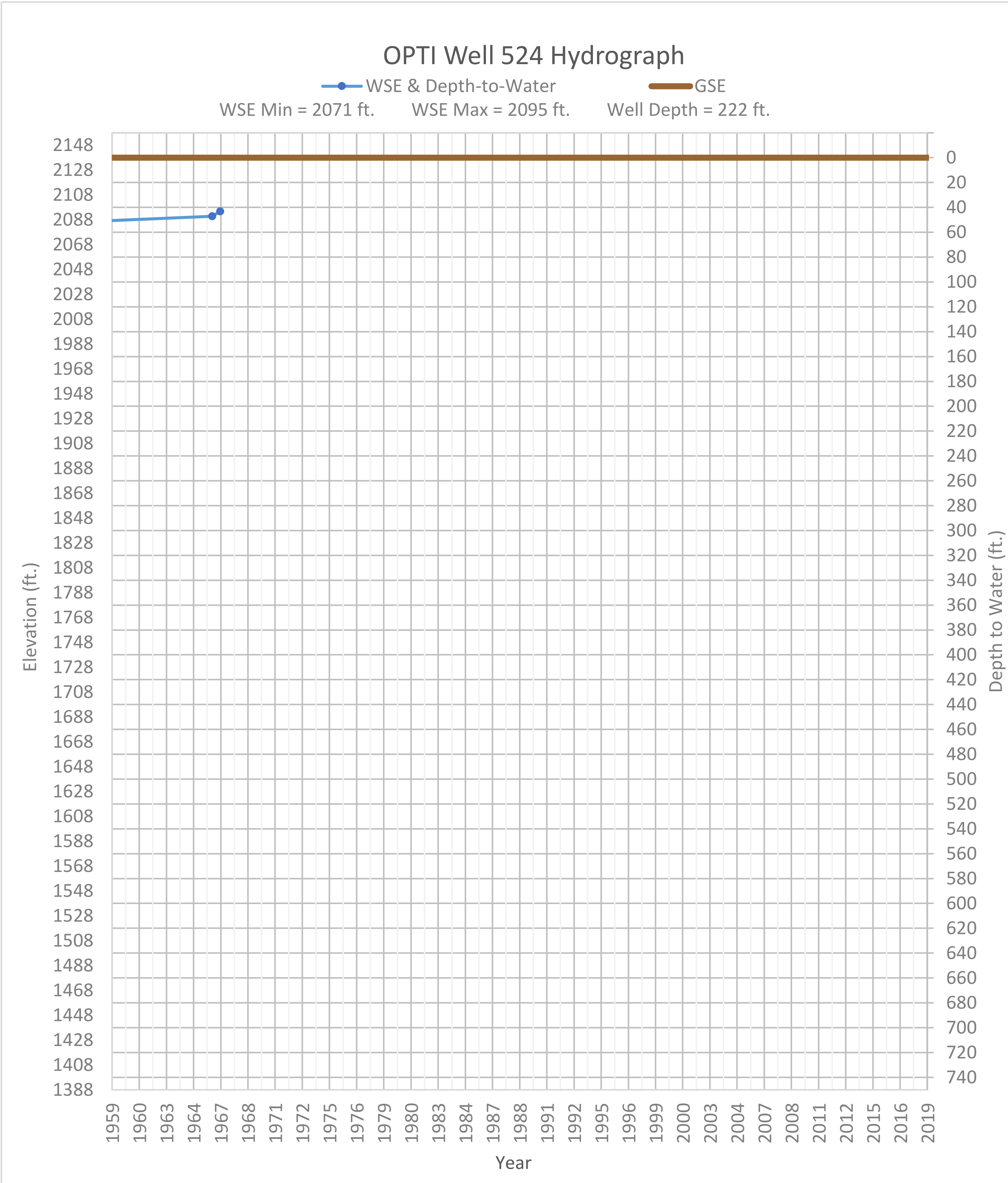
OPTI Well 524 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2071 ft.
WSE Max = 2095 ft.
Well Depth = 222 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2148
2128
2108
2088
2068
2048
2028
2008
1988
1968
1948
1928
1908
1888
1868
1848
1828
1808
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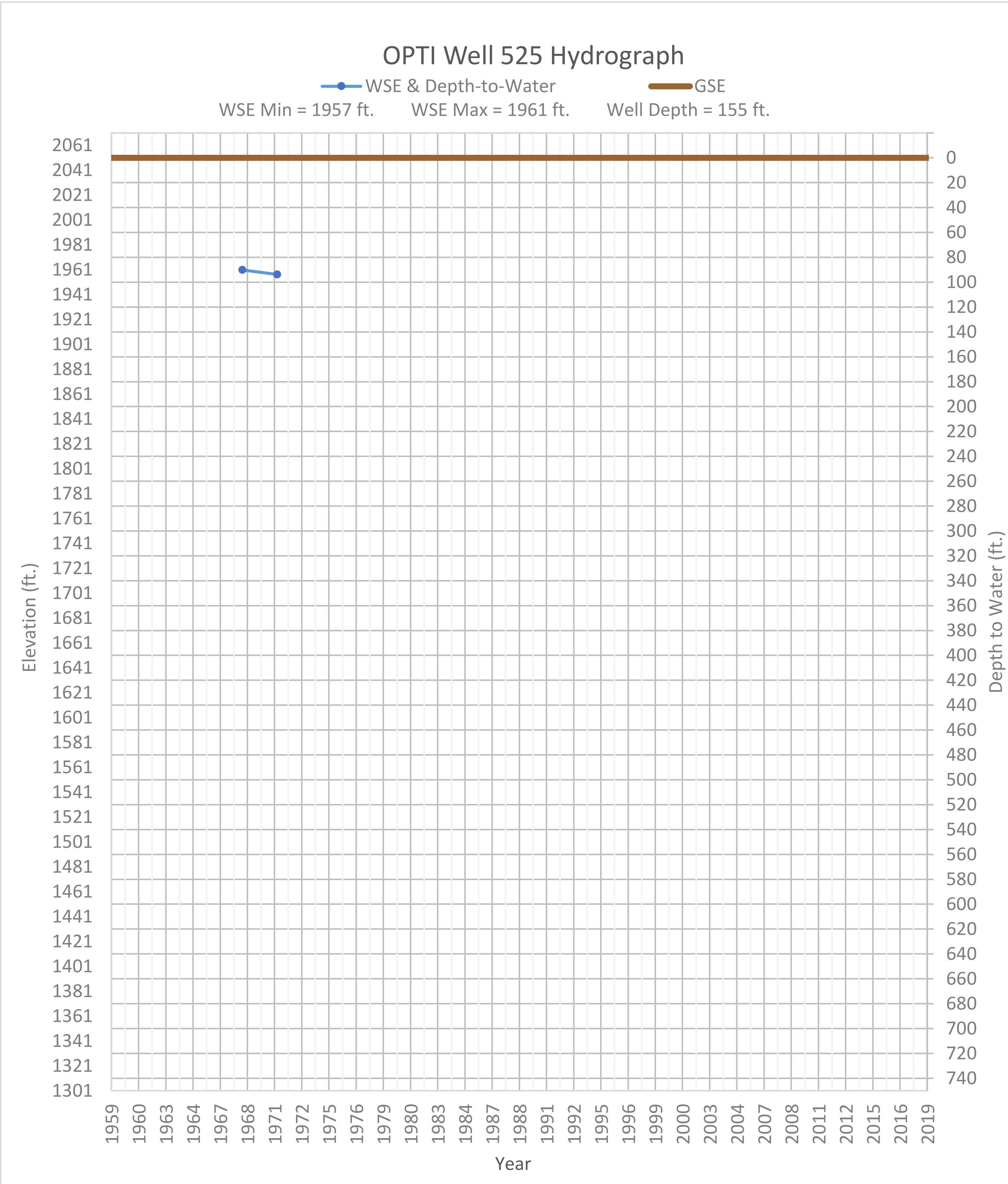

OPTI Well 525 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1957 ft.
WSE Max = 1961 ft.
Well Depth = 155 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2061
2041
2021
2001
1981
1961
1941
1921
1901
1881
1861
1841
1821
1801
1781
1761
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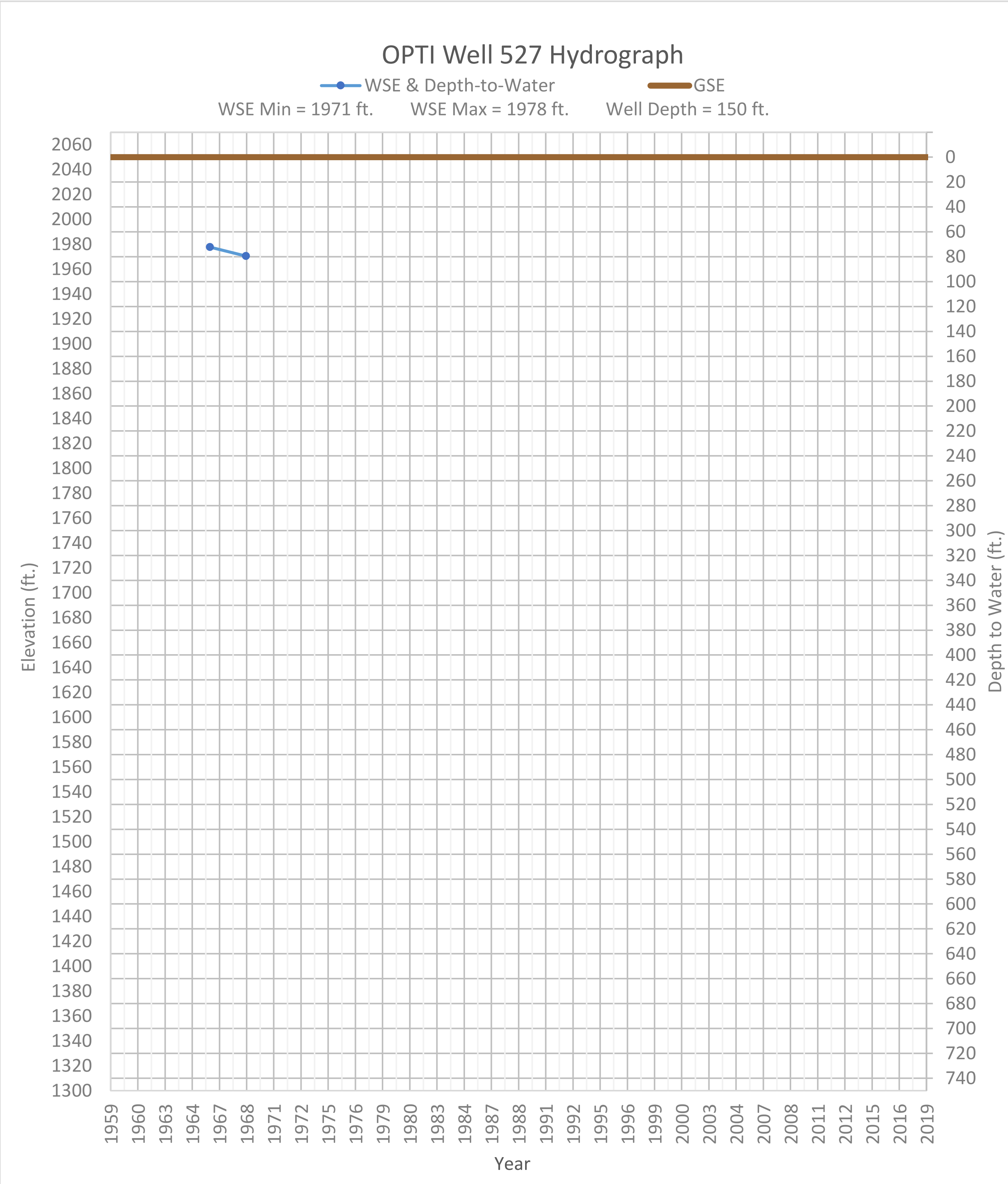
OPTI Well 527 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1971 ft.
WSE Max = 1978 ft.
Well Depth = 150 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2060
2040
2020
2000
1980
1960
1940
1920
1900
1880
1860
1840
1820
1800
1780
1760
1740
1720
1700
1680
1660
1640
1620
1600
1580
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1540
1520
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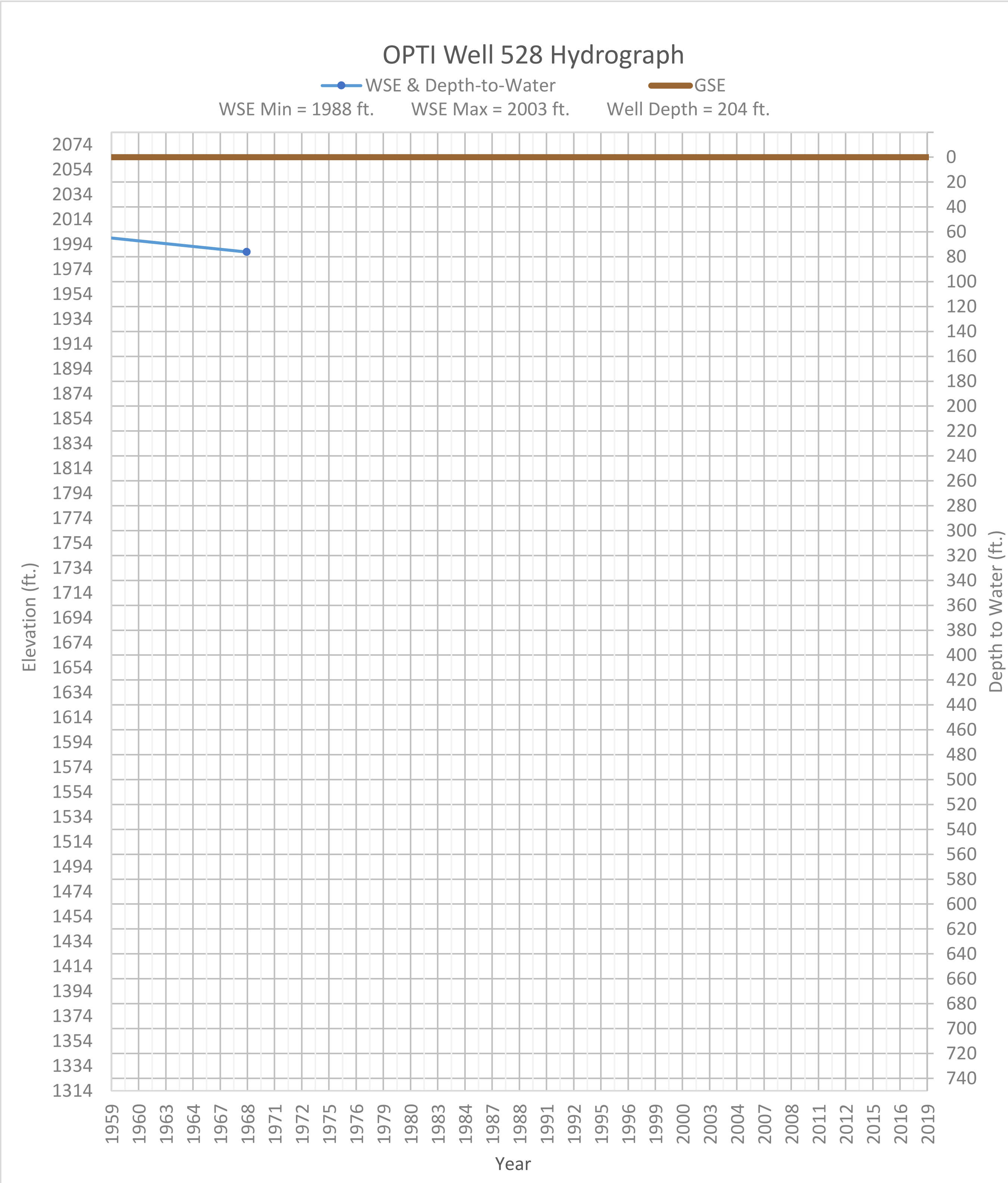
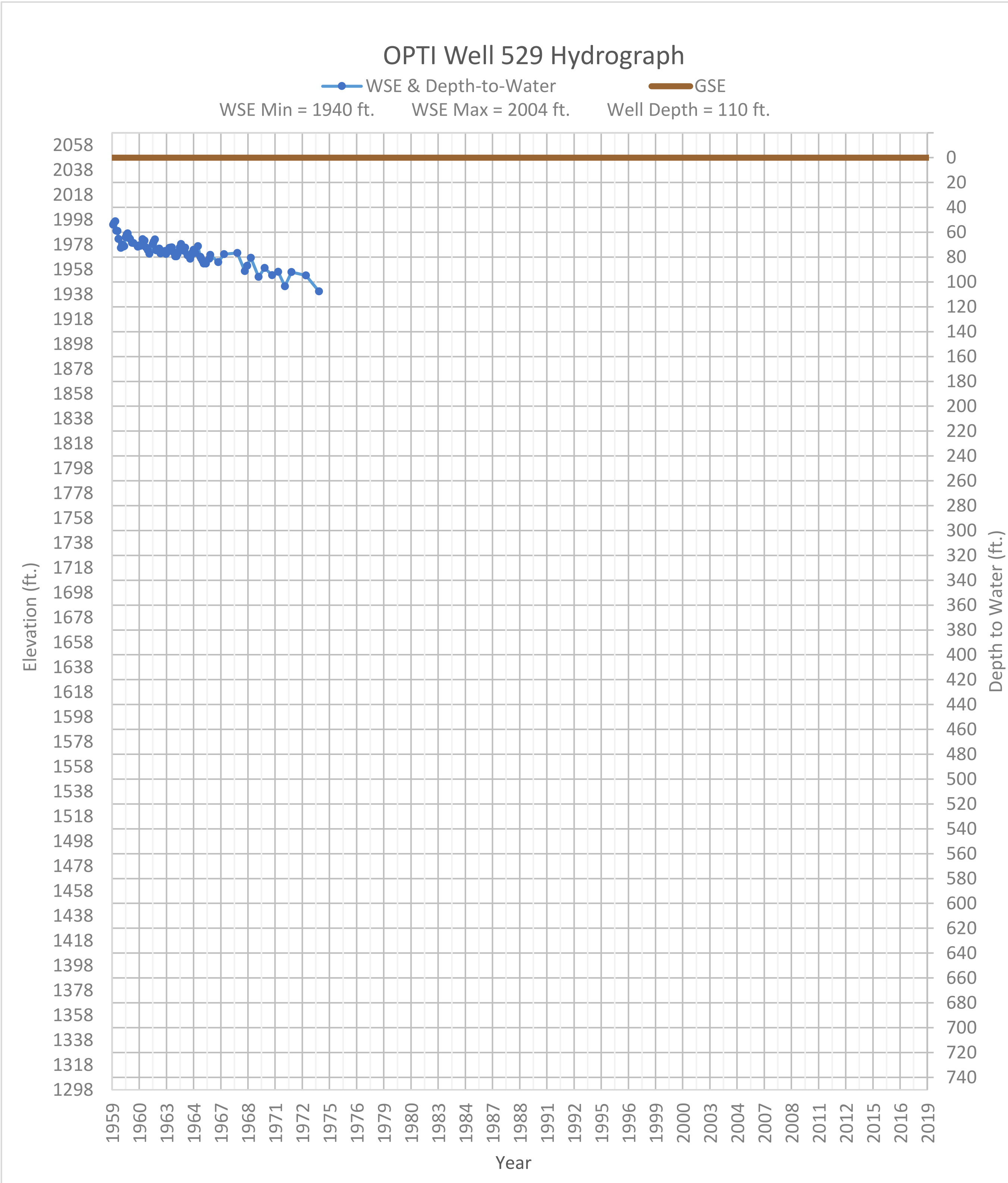


OPTI Well 528 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1988 ft.
WSE Max = 2003 ft.
Well Depth = 204 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 529 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1940 ft.
WSE Max = 2004 ft.
Well Depth = 110 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2058
2038
2018
1998
1978
1958
1938
1918
1898
1878
1858
1838
1818
1798
1778
1758
1738
1718
1698
1678
1658
1638
1618
1598
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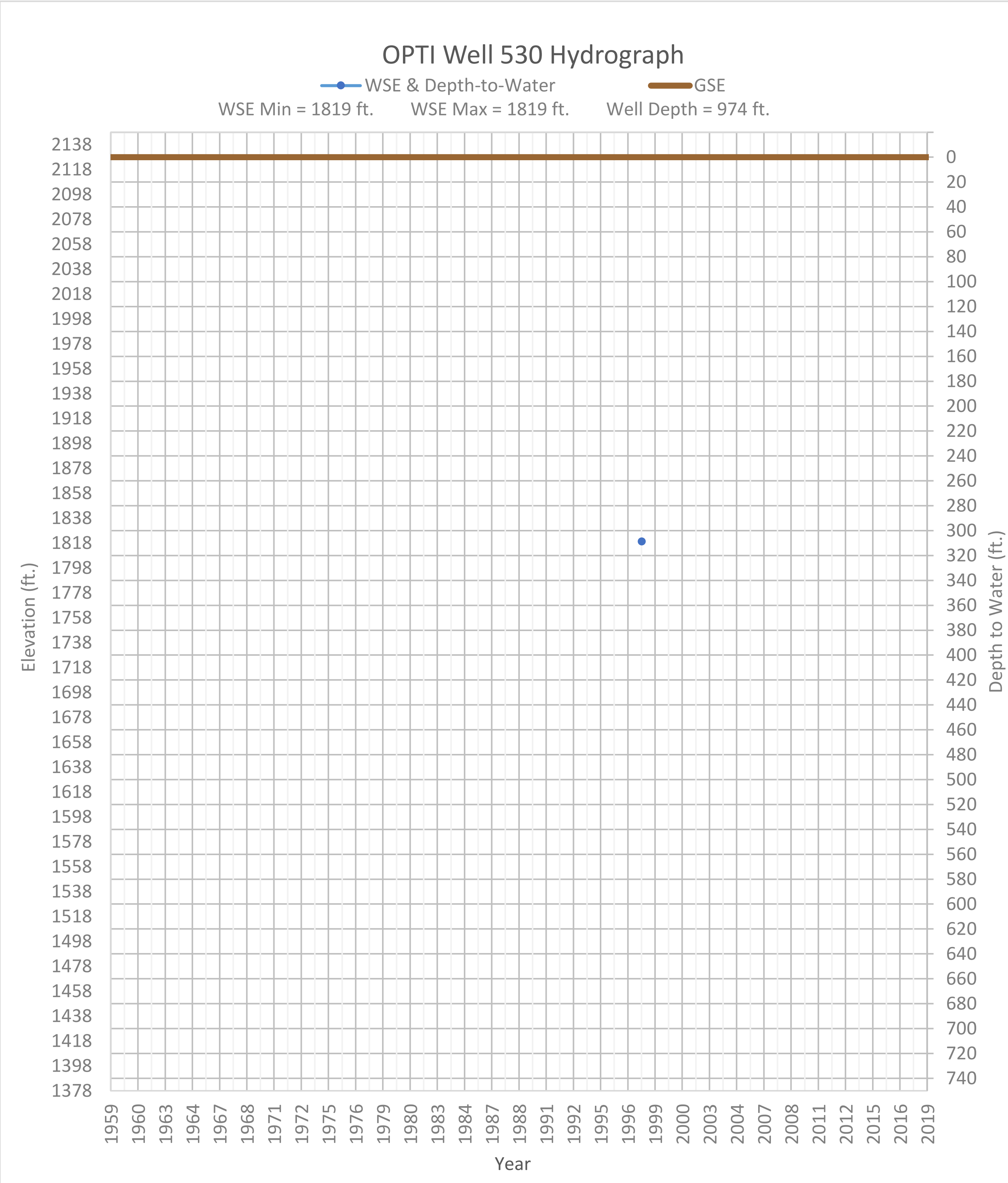
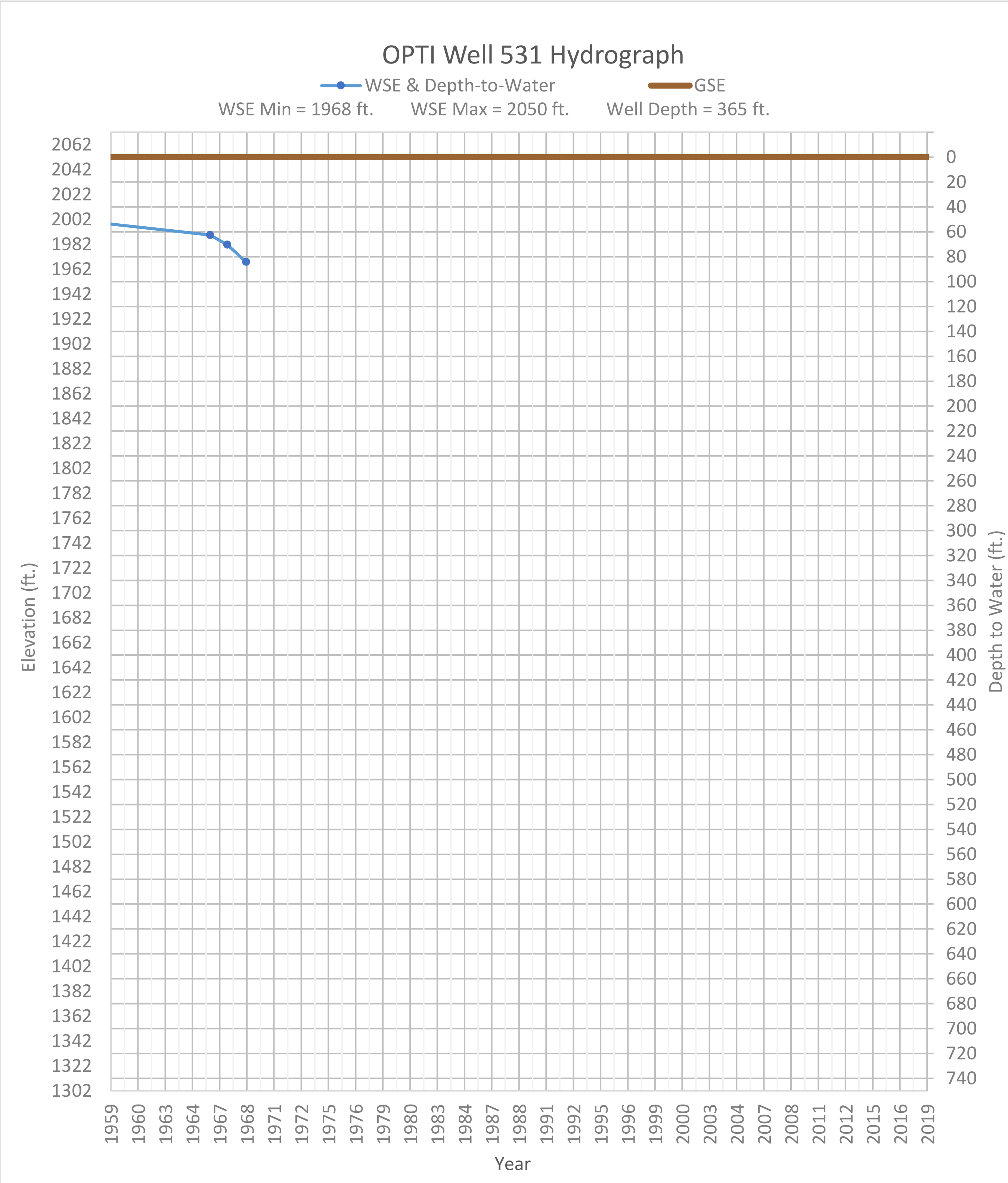


OPTI Well 530 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1819 ft.
WSE Max = 1819 ft.
Well Depth = 974 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 531 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1968 ft.
WSE Max = 2050 ft.
Well Depth = 365 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2062
2042
2022
2002
1982
1962
1942
1922
1902
1882
1862
1842
1822
1802
1782
1762
1742
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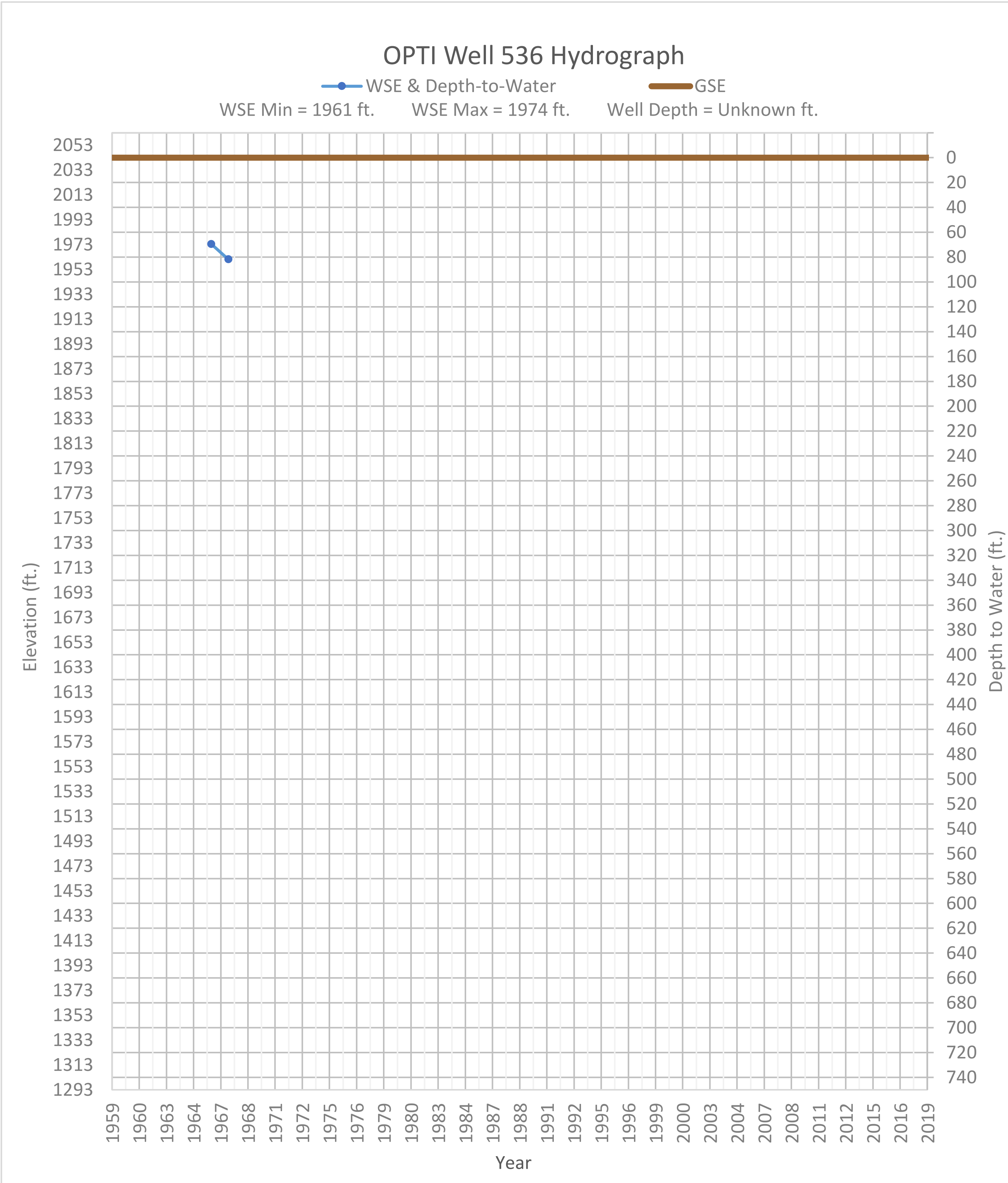
OPTI Well 536 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1961 ft.
WSE Max = 1974 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2053
2033
2013
1993
1973
1953
1933
1913
1893
1873
1853
1833
1813
1793
1773
1753
1733
1713
1693
1673
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1633
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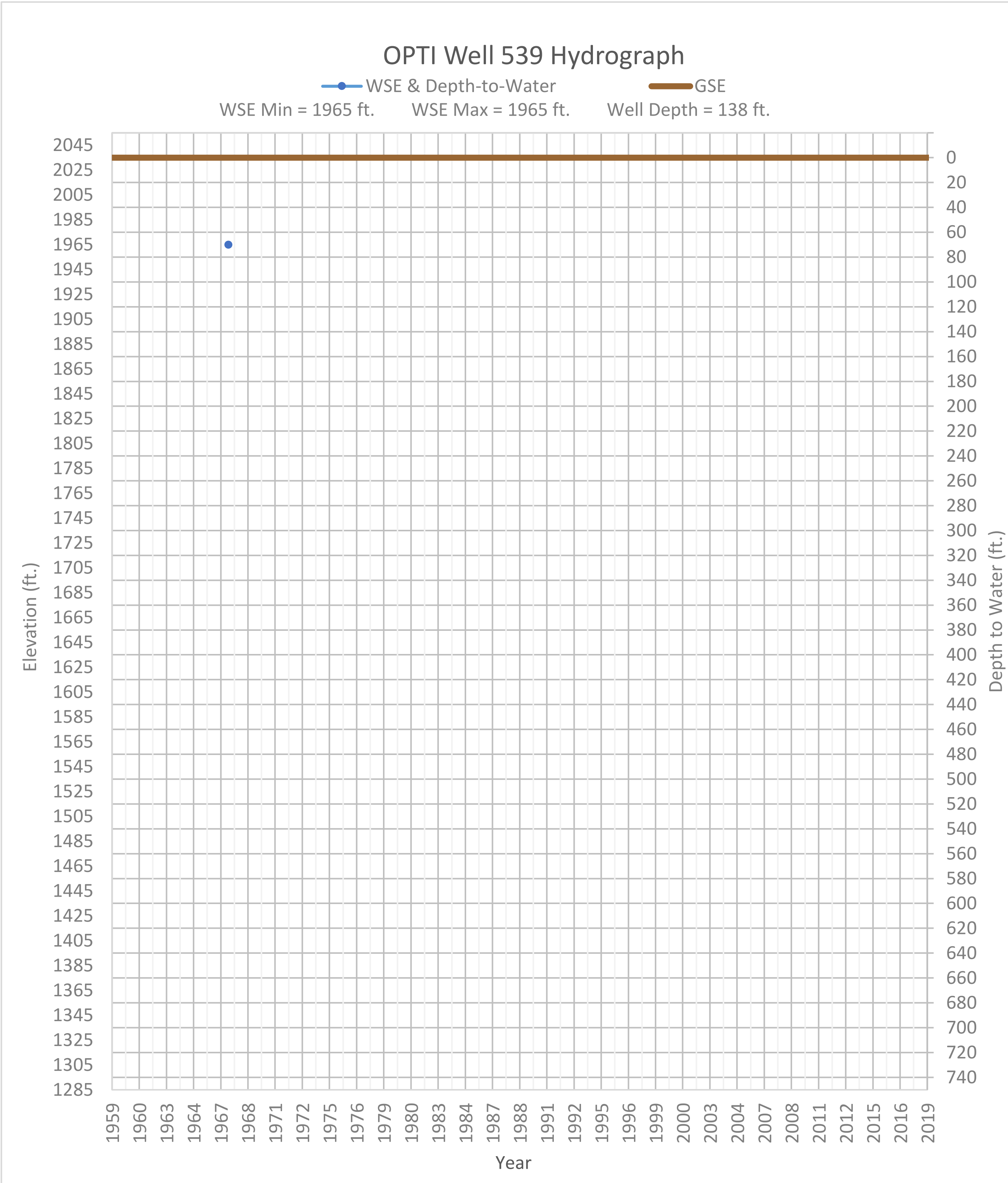
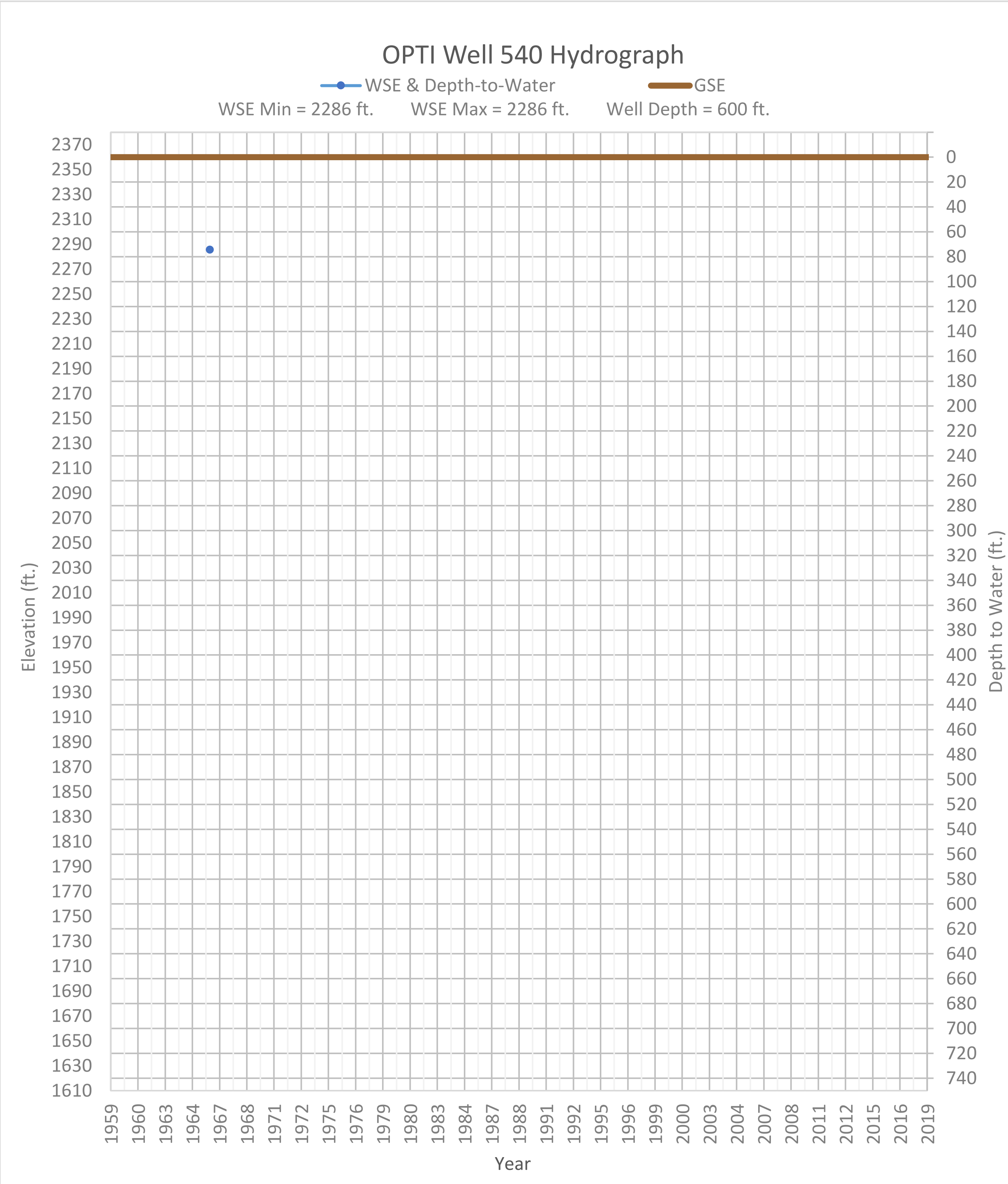
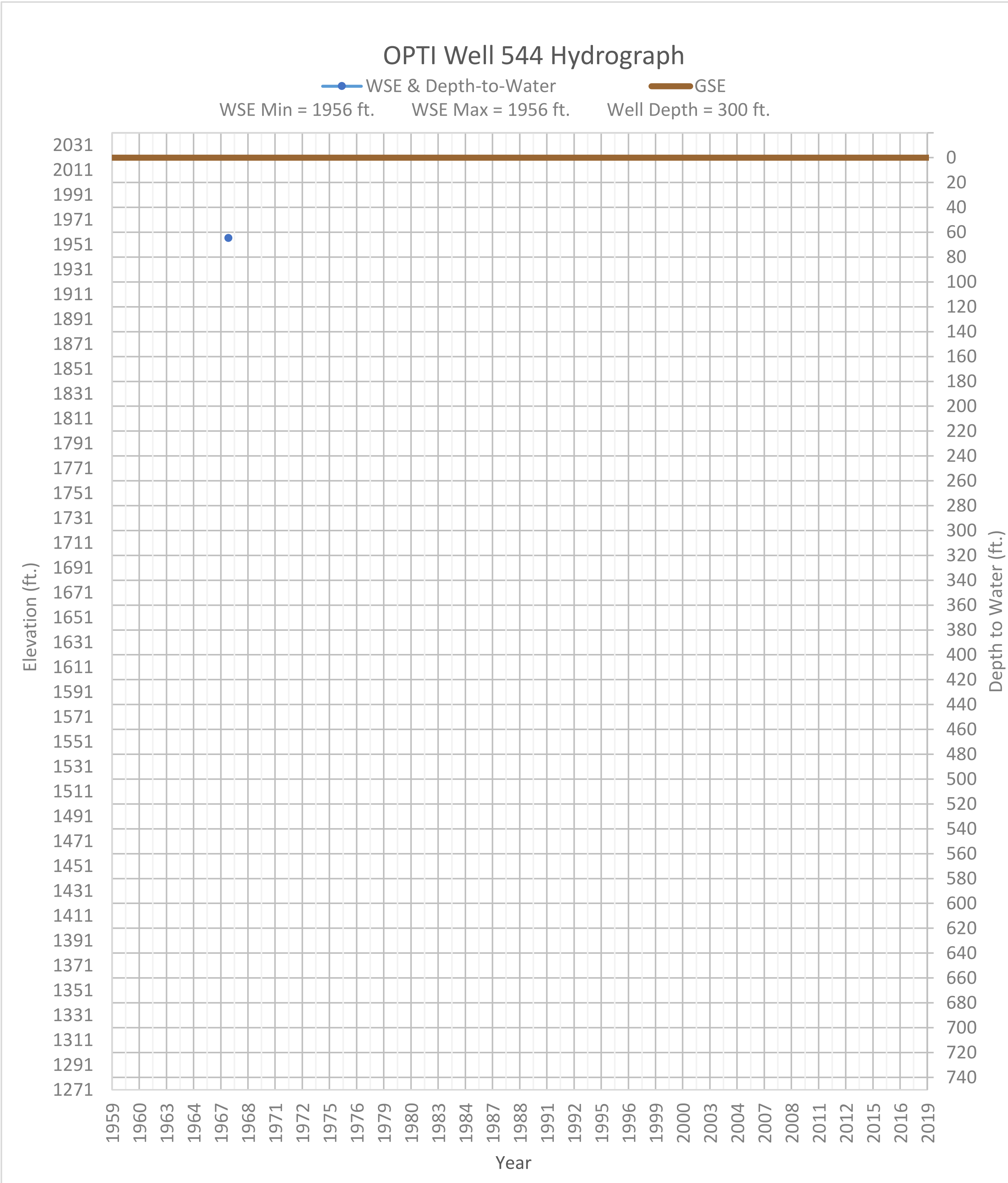


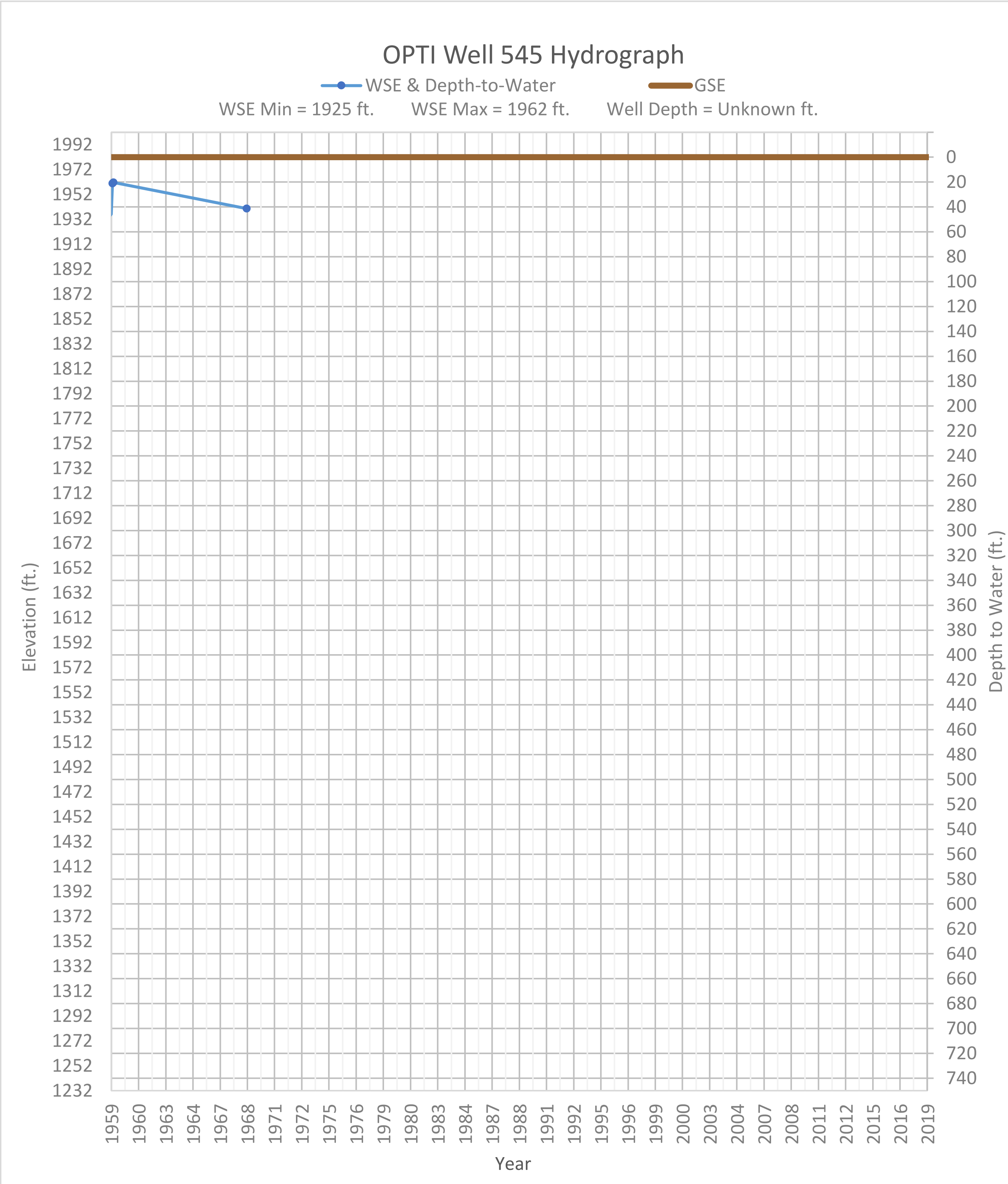
OPTI Well 539 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1965 ft.
WSE Max = 1965 ft.
Well Depth = 138 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 540 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2286 ft.
WSE Max = 2286 ft.
Well Depth = 600 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 544 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1956 ft.
WSE Max = 1956 ft.
Well Depth = 300 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 545 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1925 ft.
WSE Max = 1962 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1992
1972
1952
1932
1912
1892
1872
1852
1832
1812
1792
1772
1752
1732
1712
1692
1672
1652
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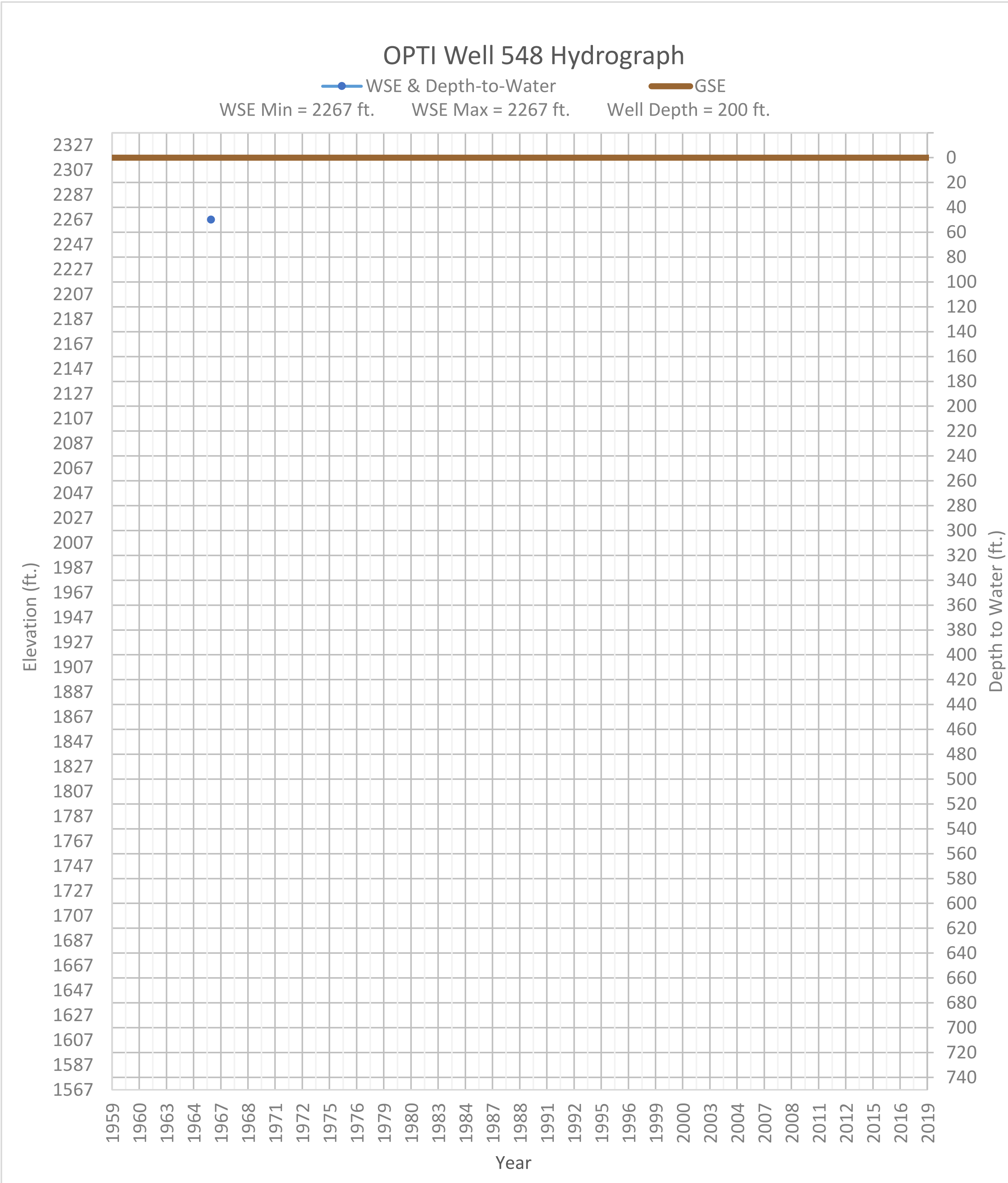
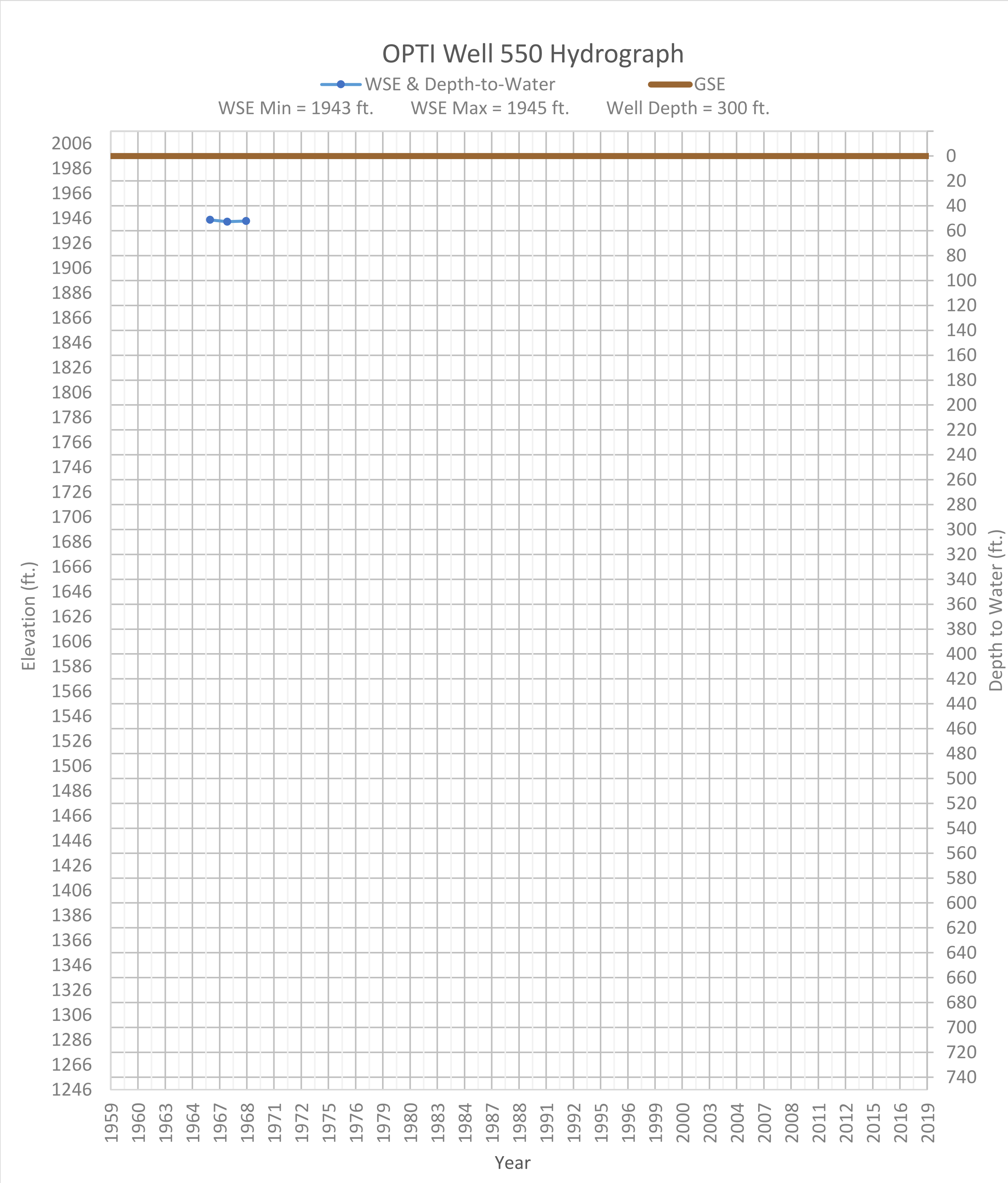
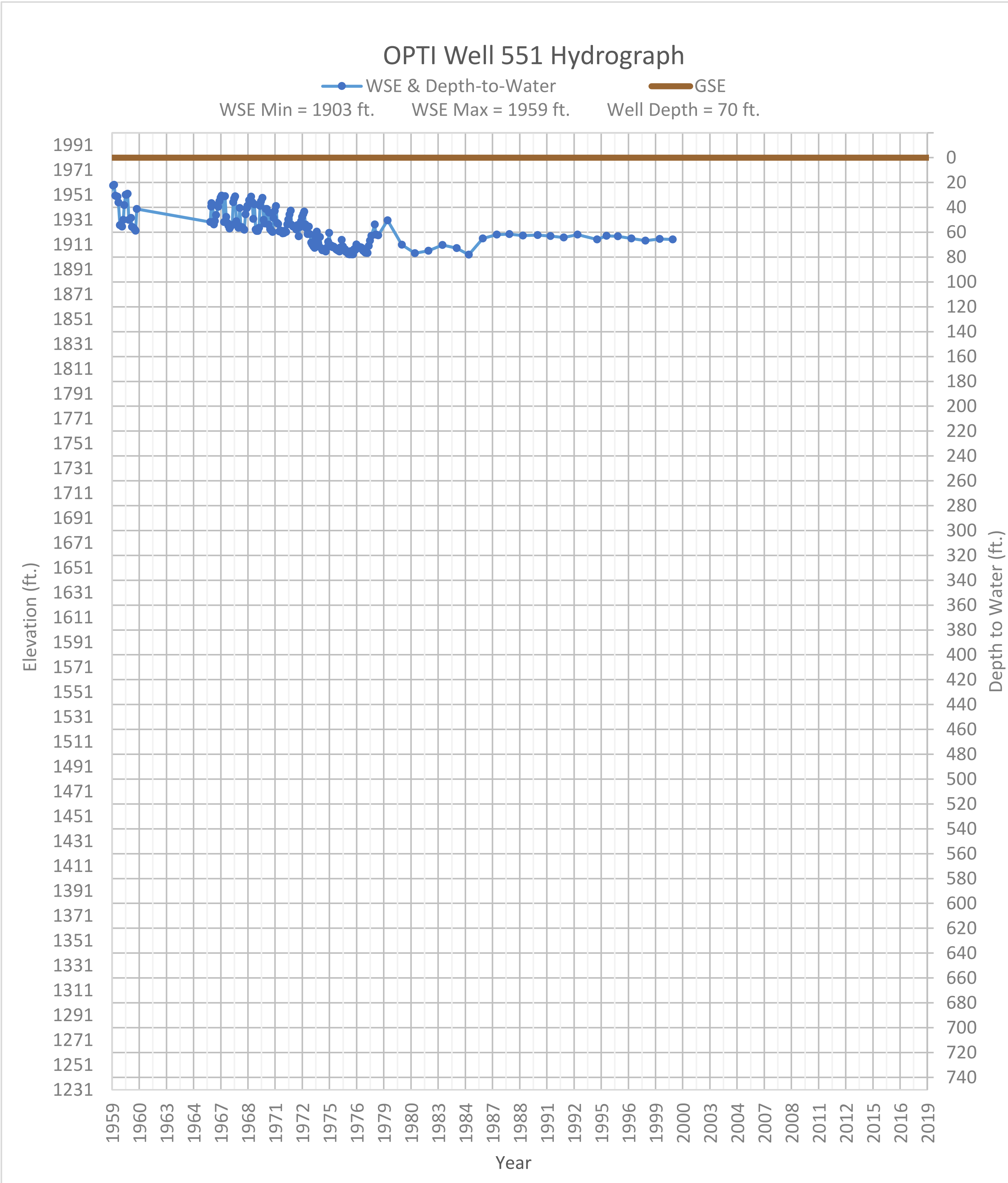


OPTI Well 548 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2267 ft.
WSE Max = 2267 ft.
Well Depth = 200 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 550 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1943 ft.
WSE Max = 1945 ft.
Well Depth = 300 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 551 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1903 ft.
WSE Max = 1959 ft.
Well Depth = 70 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1991
1971
1951
1931
1911
1891
1871
1851
1831
1811
1791
1771
1751
1731
1711
1691
1671
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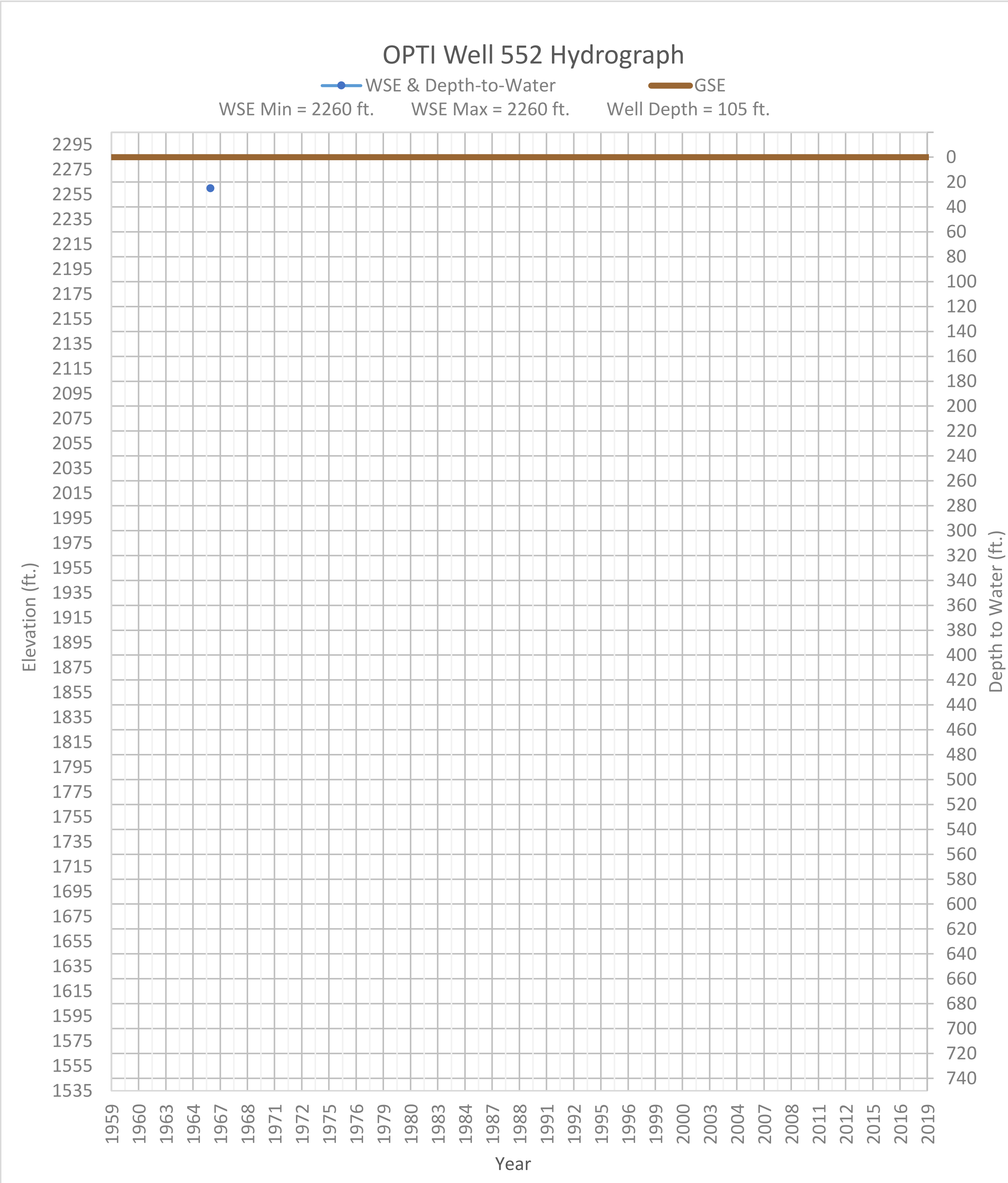
OPTI Well 552 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2260 ft.
WSE Max = 2260 ft.
Well Depth = 105 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 554 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1879 ft.
WSE Max = 1947 ft.
Well Depth = 378 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1976
1956
1936
1916
1896
1876
1856
1836
1816
1796
1776
1756
1736
1716
1696
1676
1656
1636
1616
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OPTI Well 557 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1939 ft.
WSE Max = 1942 ft.
Well Depth = 300 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1996
1976
1956
1936
1916
1896
1876
1856
1836
1816
1796
1776
1756
1736
1716
1696
1676
1656
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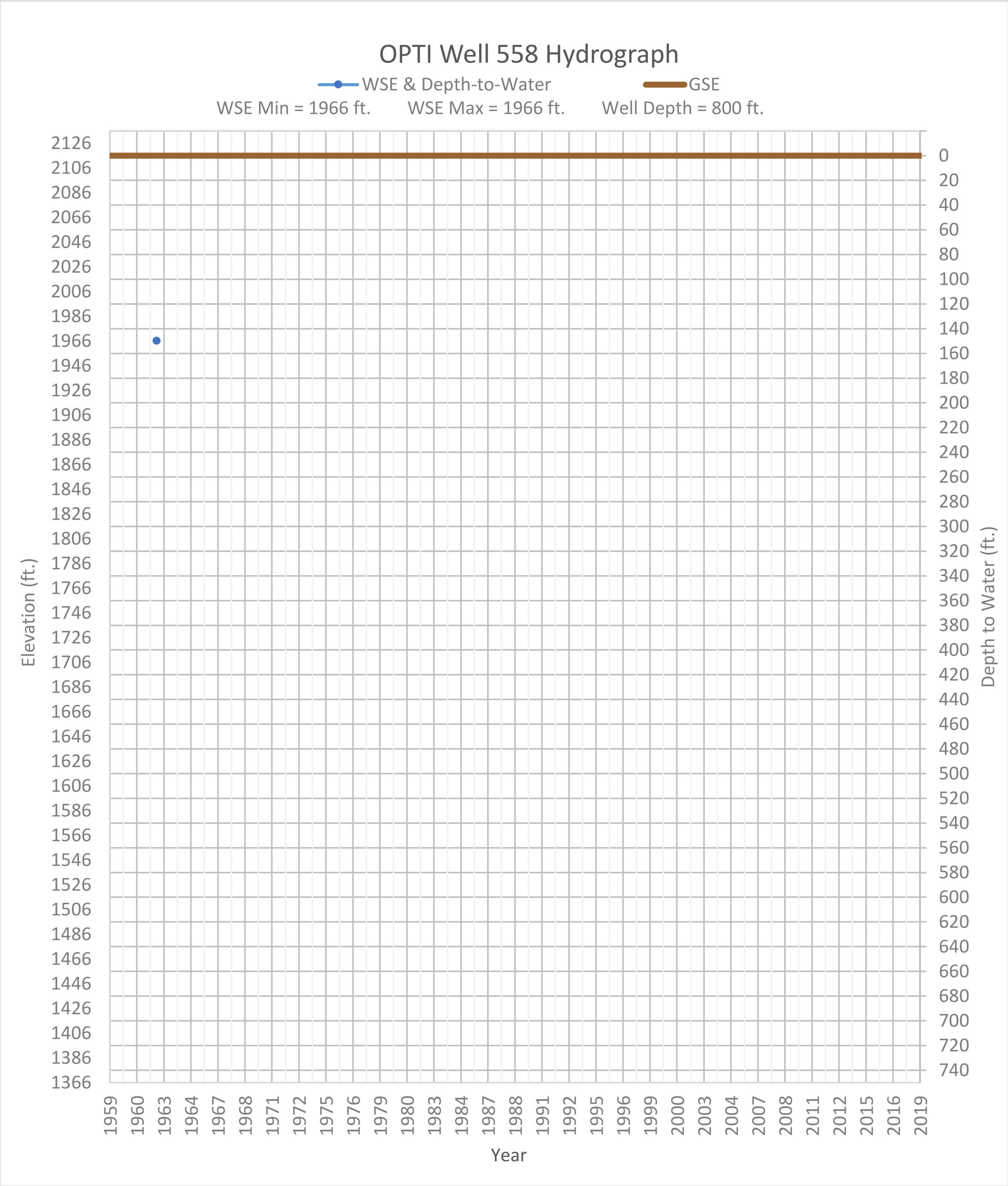
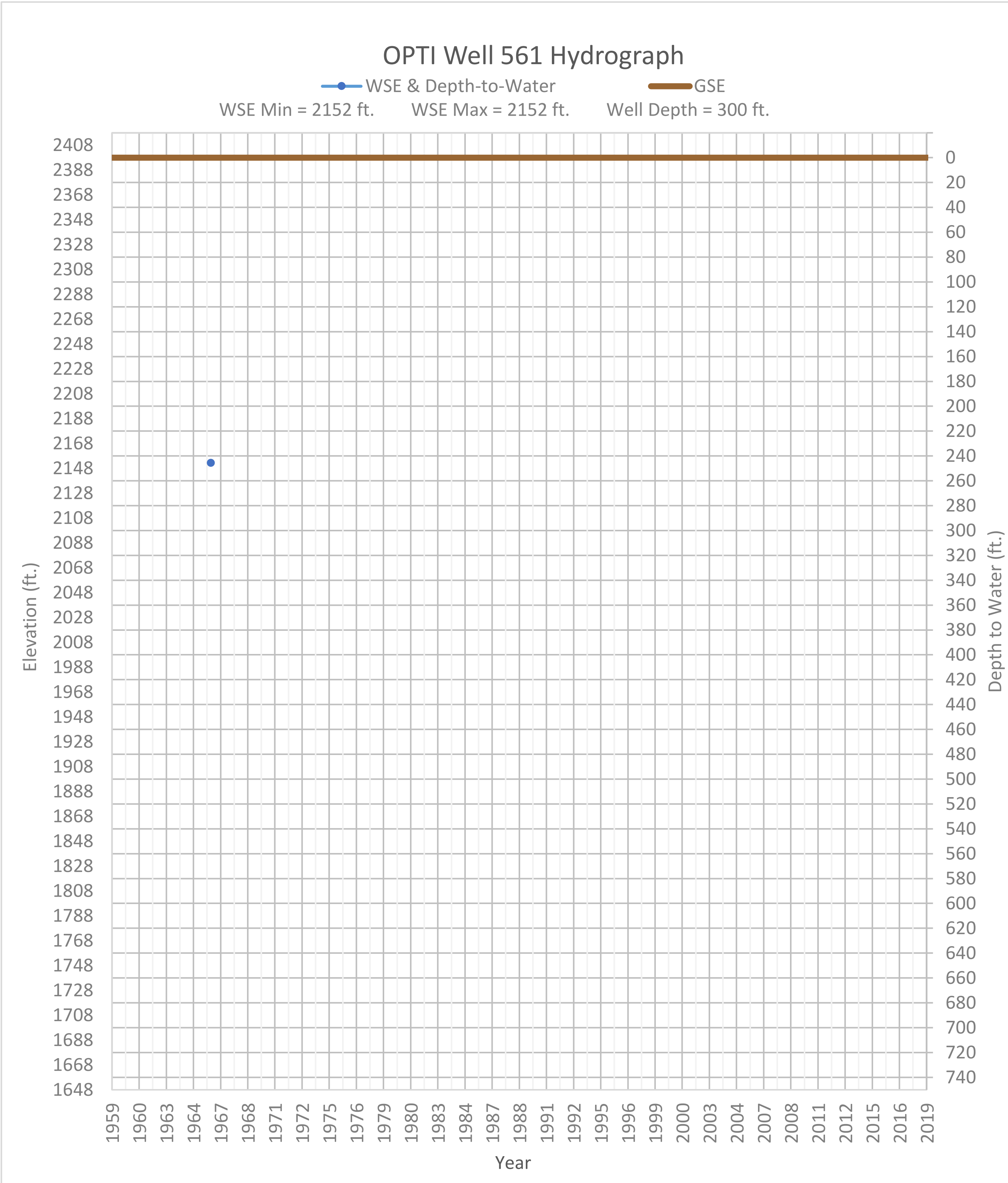

OPTI Well 558 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1966 ft.
WSE Max = 1966 ft.
Well Depth = 800 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 561 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2152 ft.
WSE Max = 2152 ft.
Well Depth = 300 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2408
2388
2368
2348
2328
2308
2288
2268
2248
2228
2208
2188
2168
2148
2128
2108
2088
2068
2048
2028
2008
1988
1968
1948
1928
1908
1888
1868
1848
1828
1808
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1728
1708
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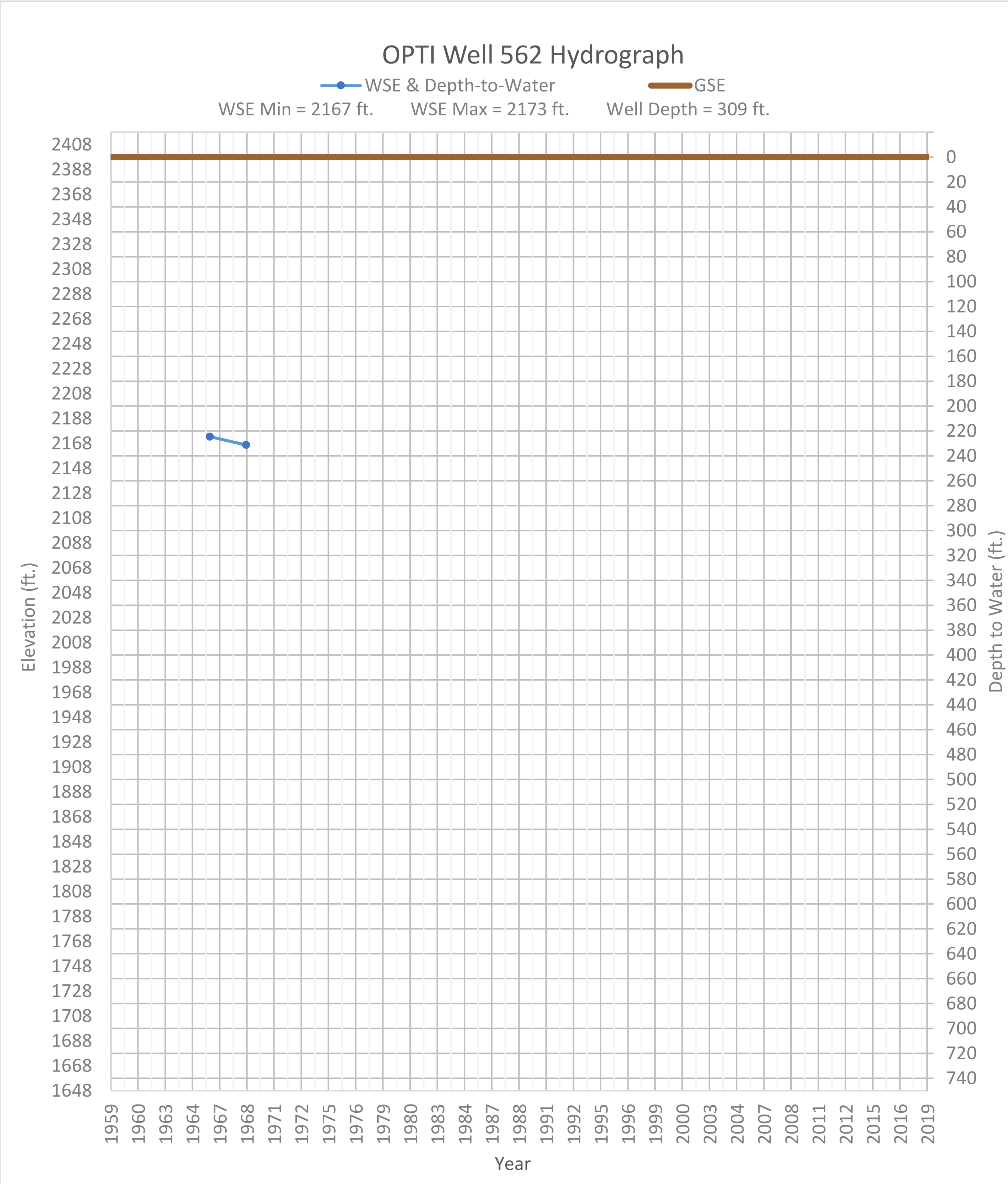
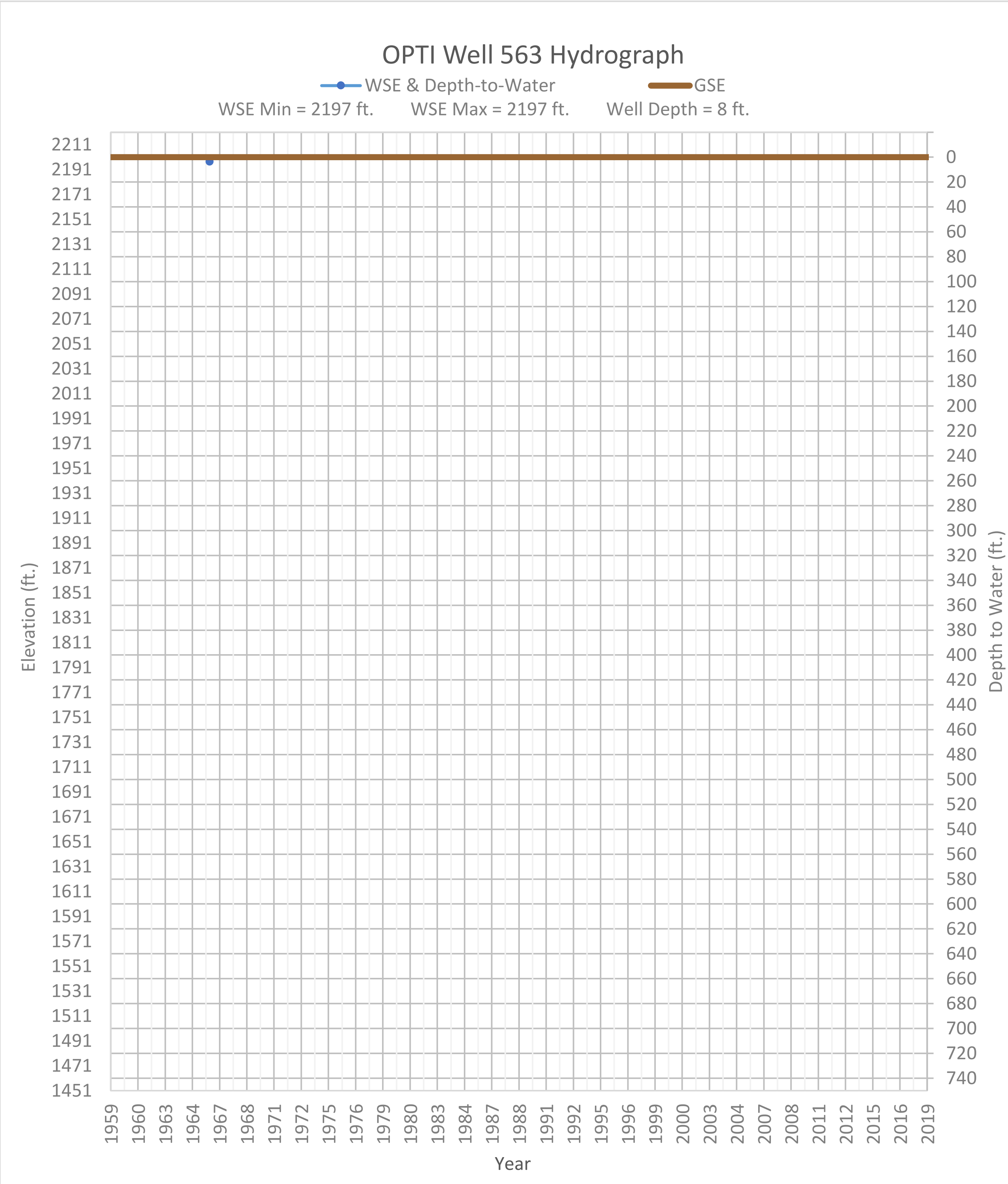


OPTI Well 562 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2167 ft.
WSE Max = 2173 ft.
Well Depth = 309 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 563 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2197 ft.
WSE Max = 2197 ft.
Well Depth = 8 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2211
2191
2171
2151
2131
2111
2091
2071
2051
2031
2011
1991
1971
1951
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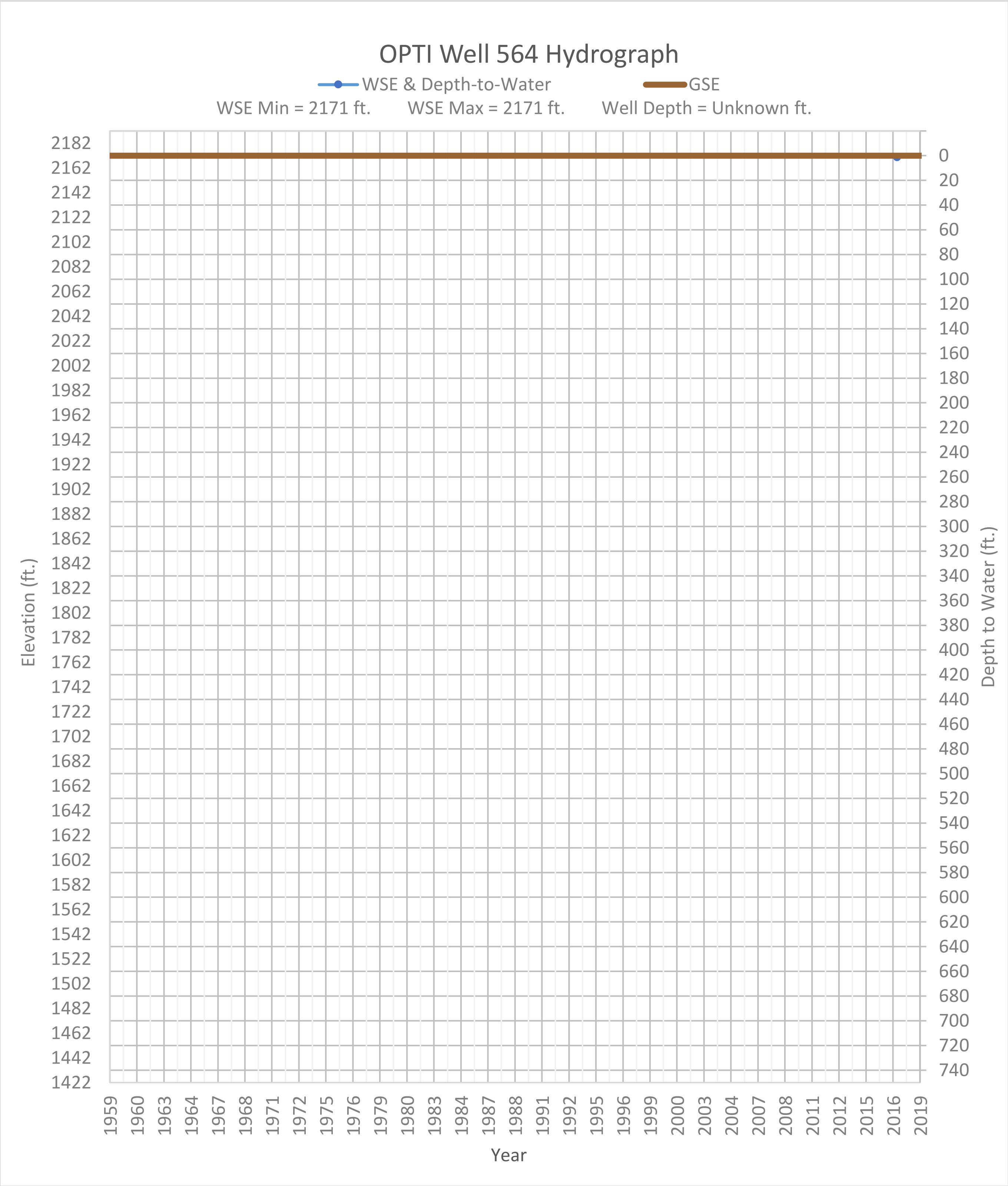

OPTI Well 564 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2171 ft.
WSE Max = 2171 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2182
2162
2142
2122
2102
2082
2062
2042
2022
2002
1982
1962
1942
1922
1902
1882
1862
1842
1822
1802
1782
1762
1742
1722
1702
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1662
1642
1622
1602
1582
1562
1542
1522
1502
1482
1462
1442
1422
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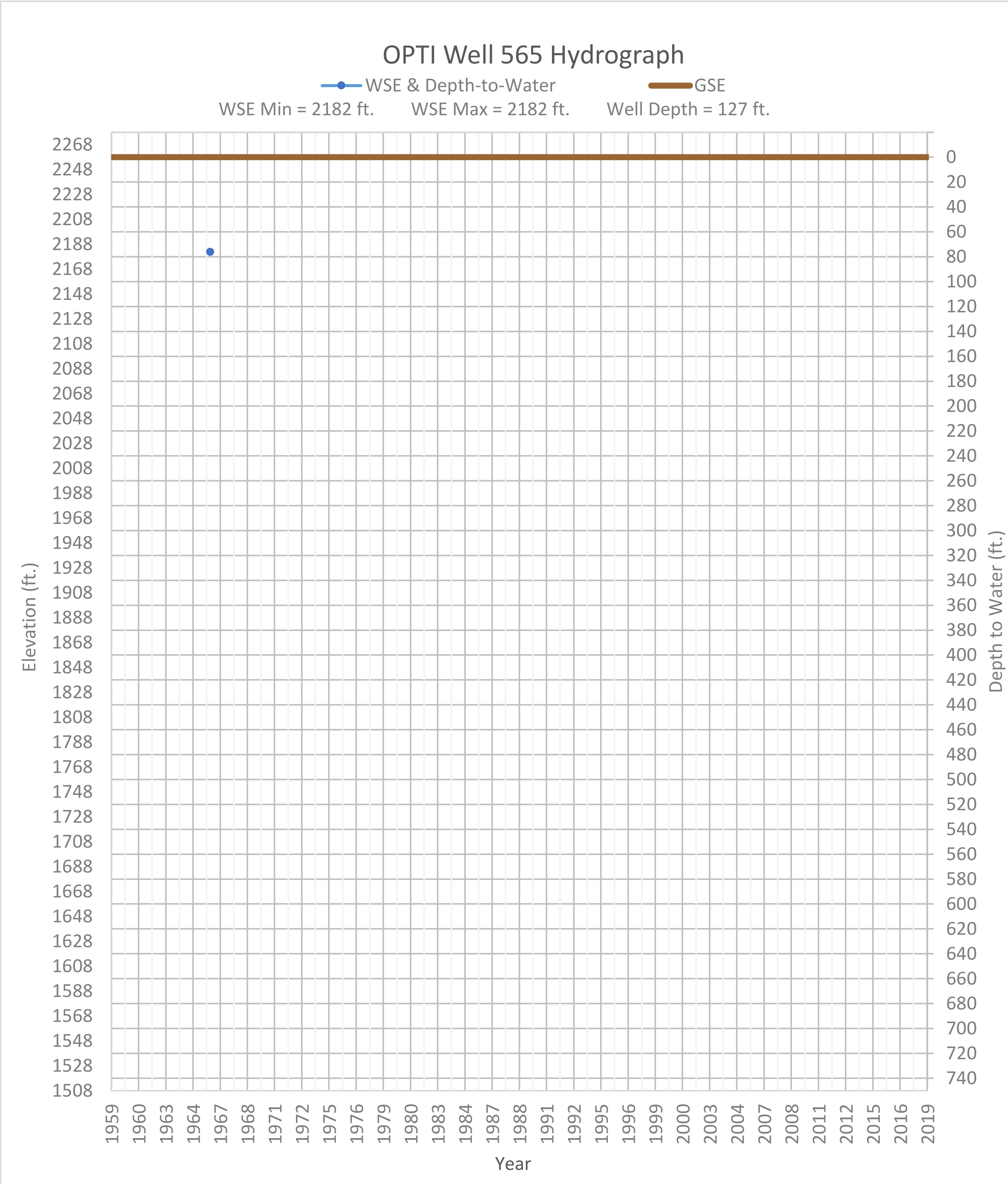
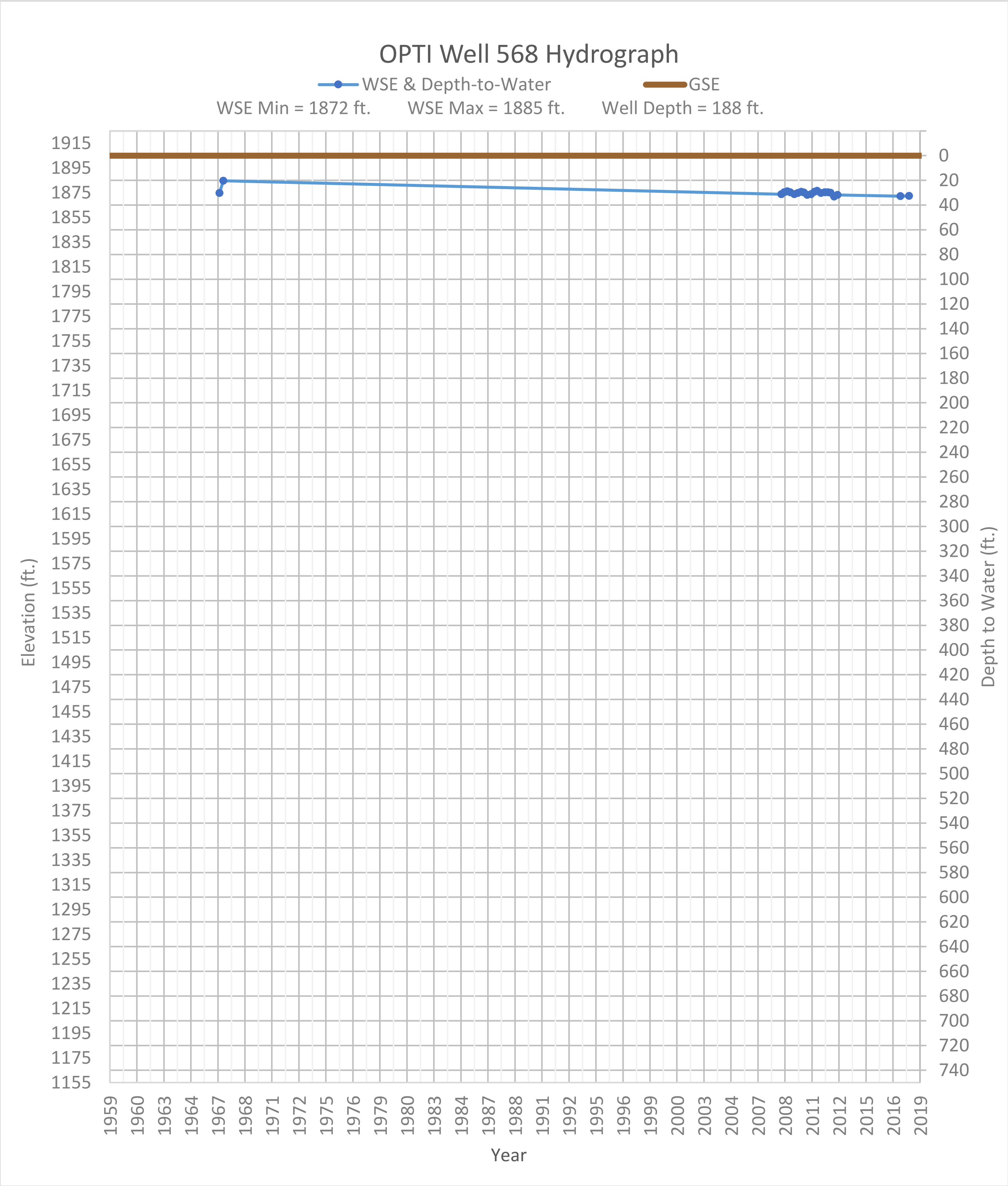
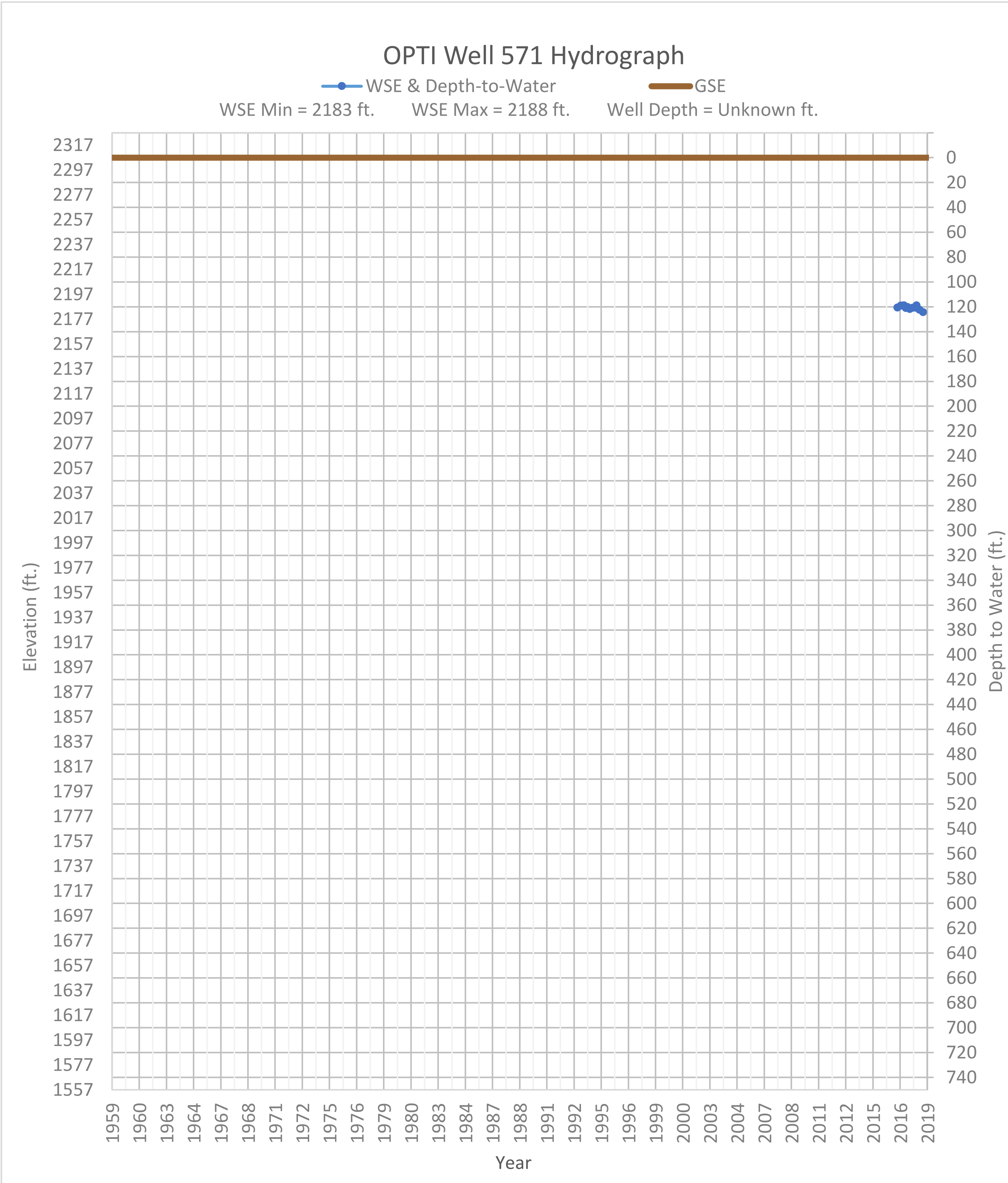


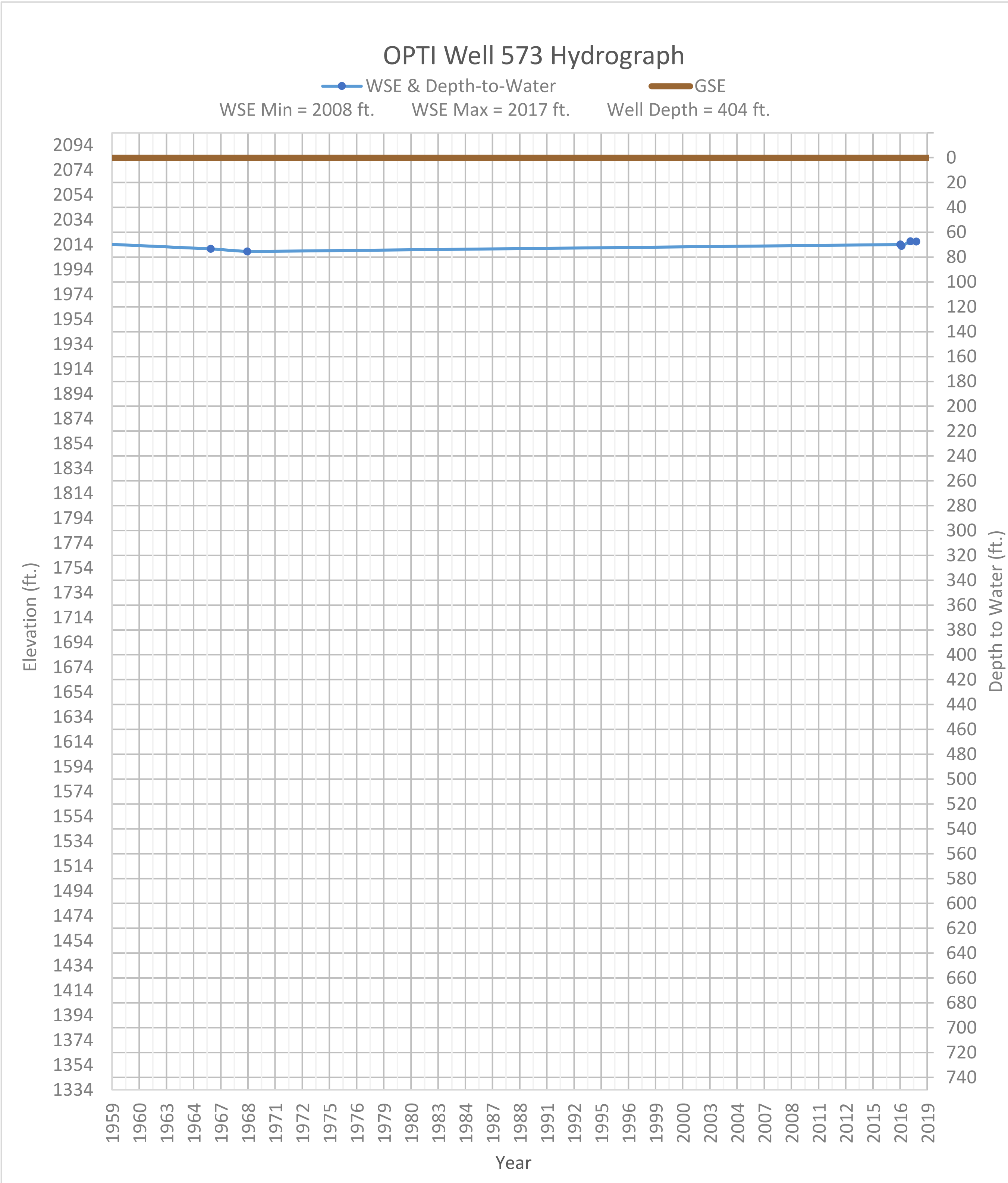
OPTI Well 565 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2182 ft.
WSE Max = 2182 ft.
Well Depth = 127 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



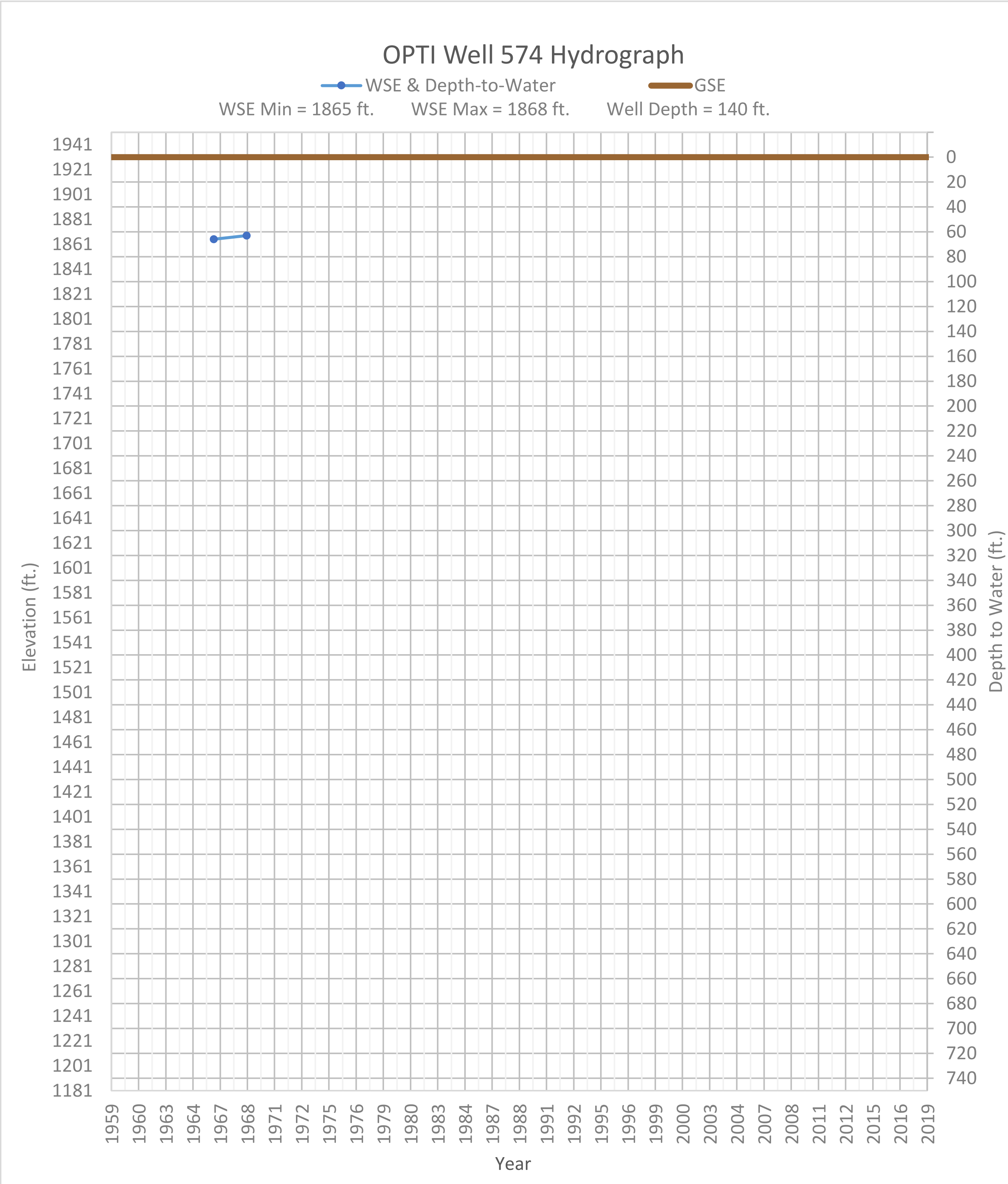
OPTI Well 568 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1872 ft.
WSE Max = 1885 ft.
Well Depth = 188 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



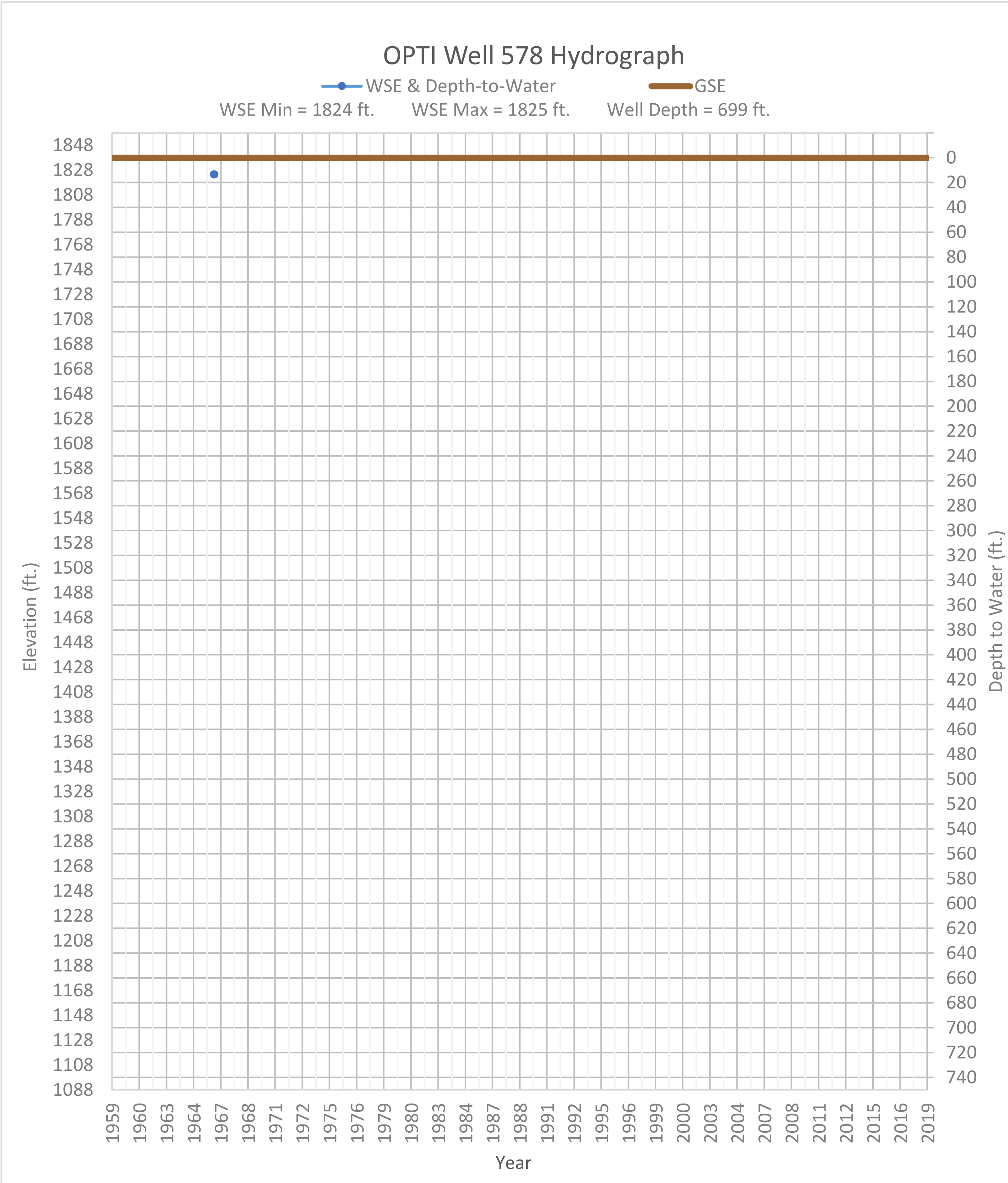
OPTI Well 571 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2183 ft.
WSE Max = 2188 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



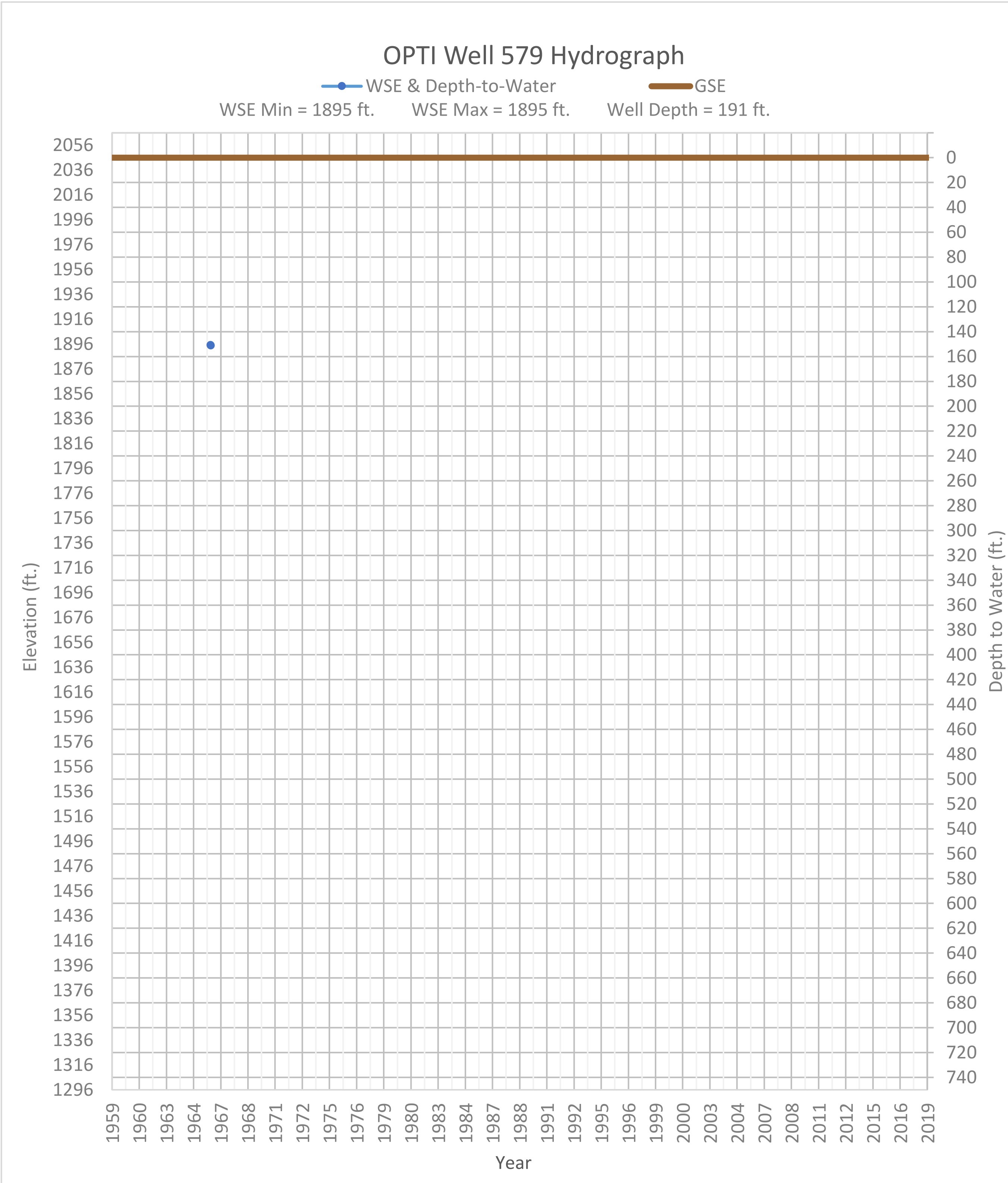
OPTI Well 573 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2008 ft.
WSE Max = 2017 ft.
Well Depth = 404 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



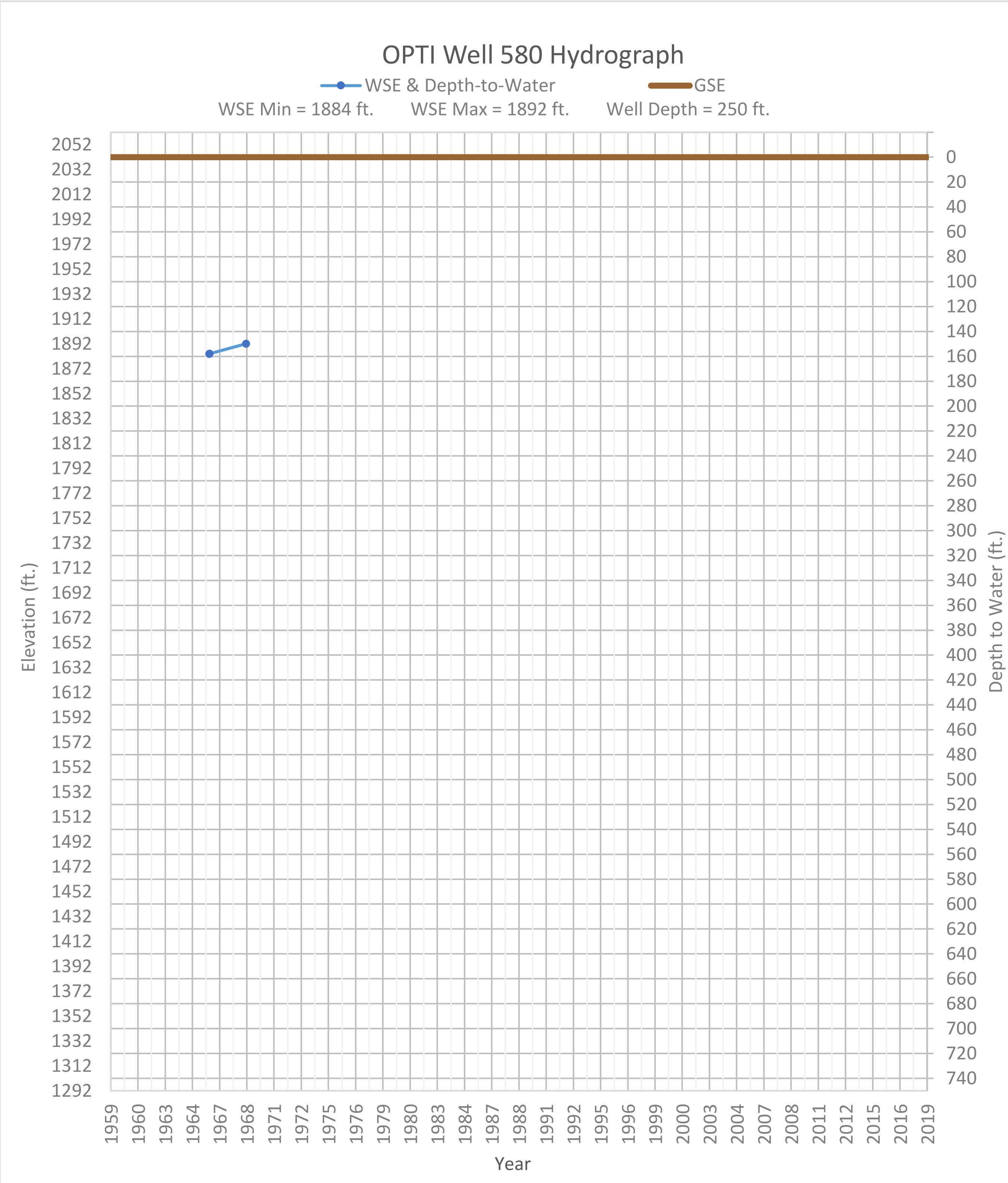
OPTI Well 574 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1865 ft.
WSE Max = 1868 ft.
Well Depth = 140 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



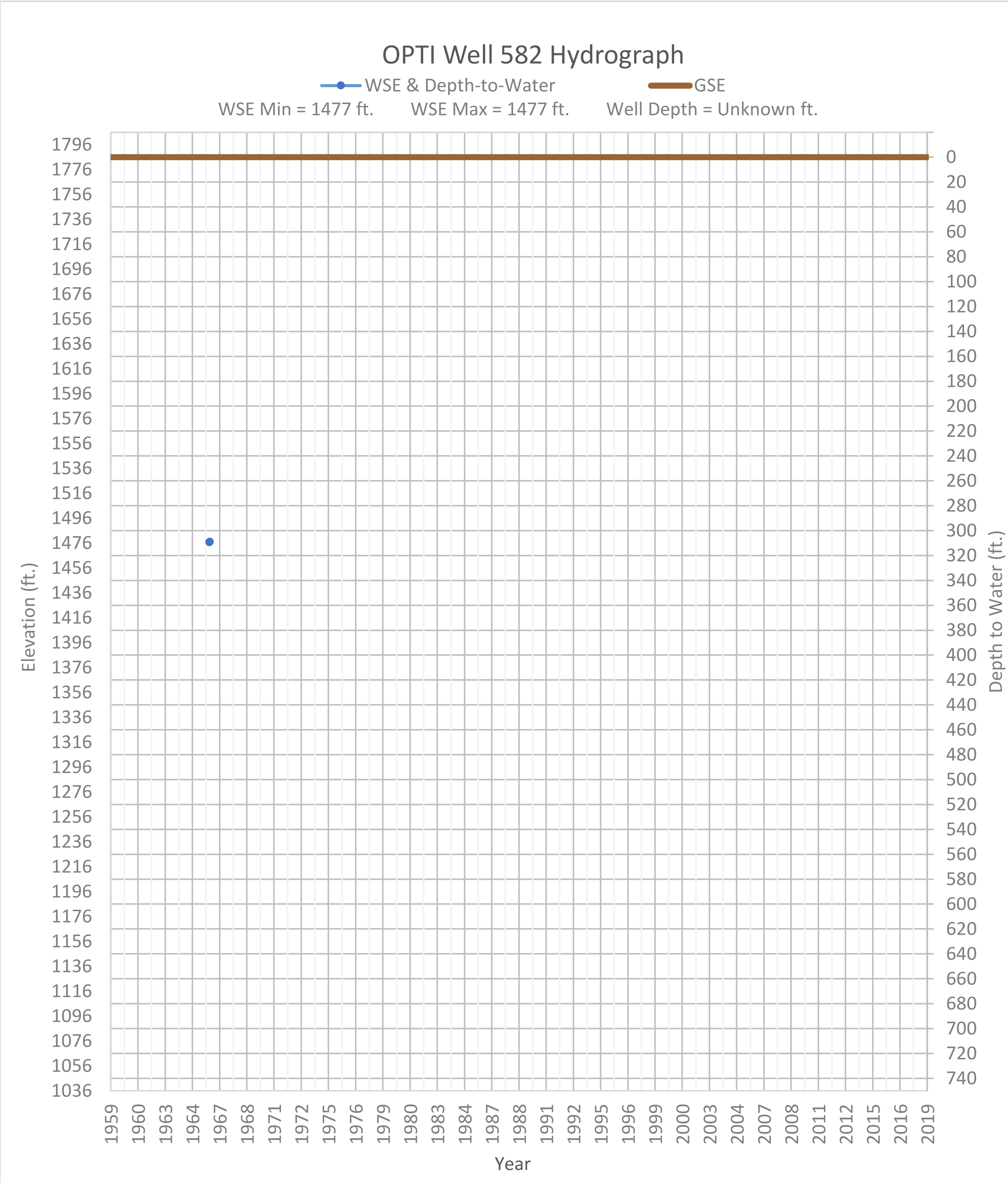
OPTI Well 578 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1824 ft.
WSE Max = 1825 ft.
Well Depth = 699 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 579 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1895 ft.
WSE Max = 1895 ft.
Well Depth = 191 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 580 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1884 ft.
WSE Max = 1892 ft.
Well Depth = 250 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 582 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1477 ft.
WSE Max = 1477 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1796
1776
1756
1736
1716
1696
1676
1656
1636
1616
1596
1576
1556
1536
1516
1496
1476
1456
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1376
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1196
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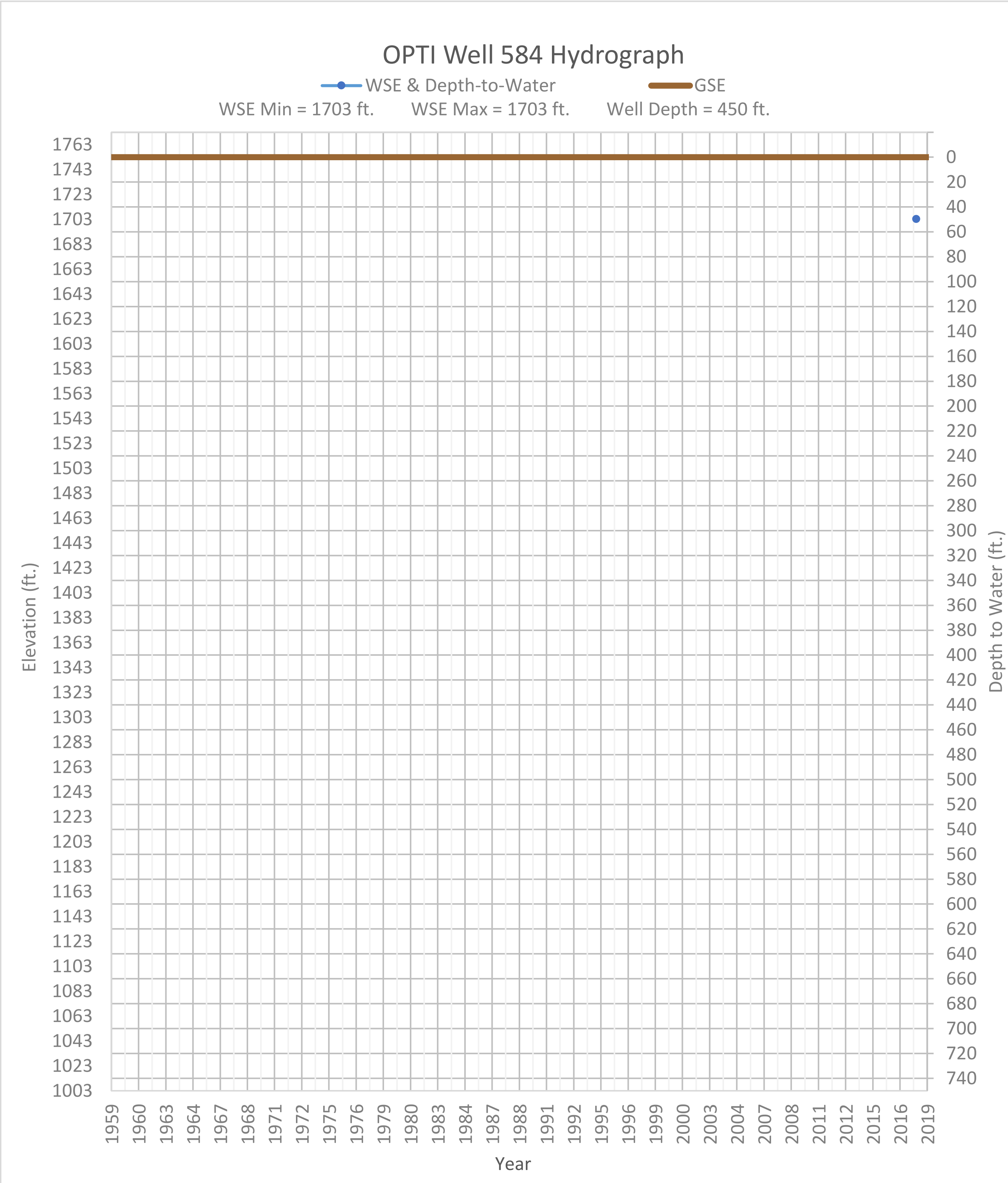
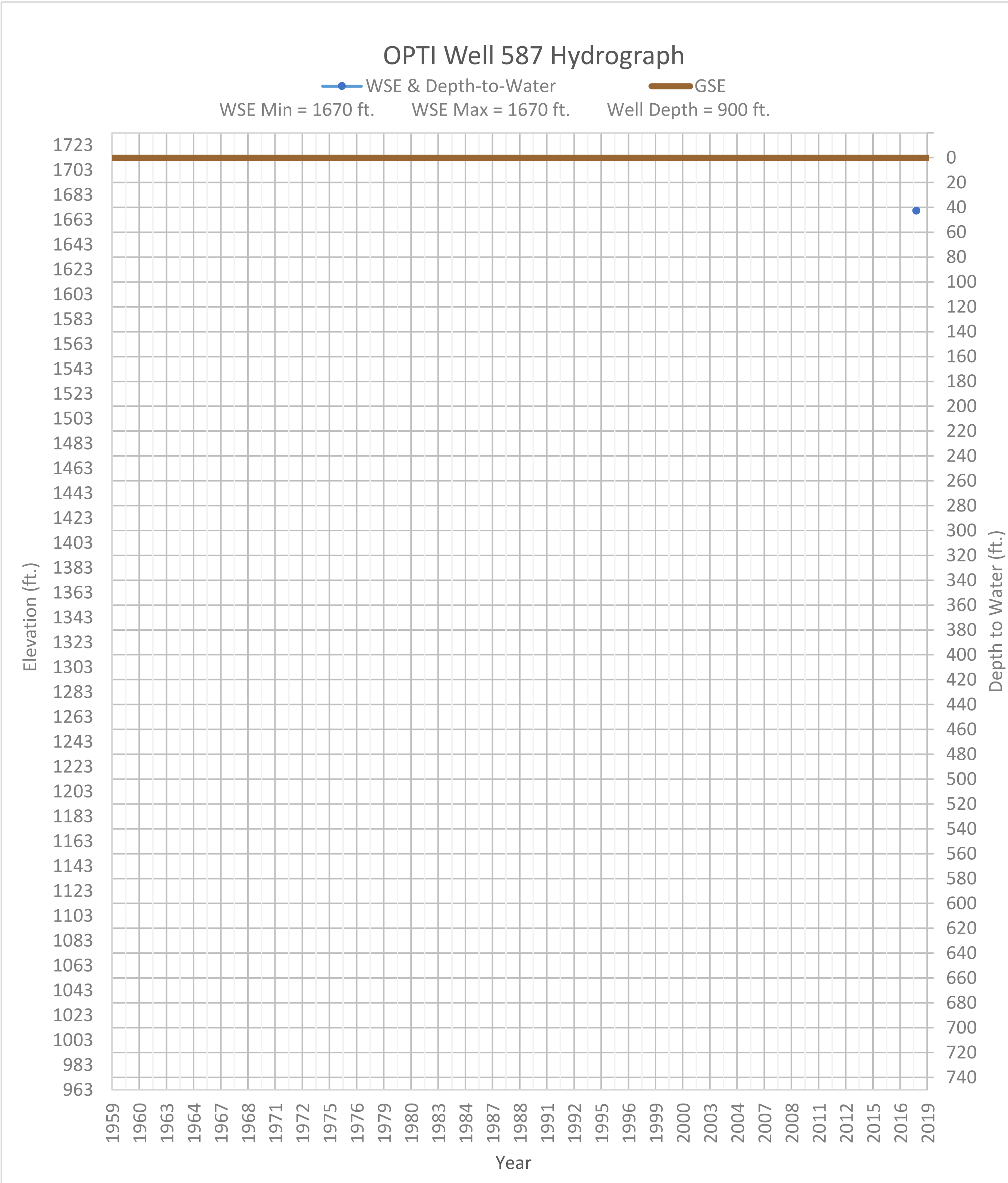


OPTI Well 584 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1703 ft.
WSE Max = 1703 ft.
Well Depth = 450 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 587 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1670 ft.
WSE Max = 1670 ft.
Well Depth = 900 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1723
1703
1683
1663
1643
1623
1603
1583
1563
1543
1523
1503
1483
1463
1443
1423
1403
1383
1363
1343
1323
1303
1283
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1183
1163
1143
1123
1103
1083
1063
1043
1023
1003
983
963
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100
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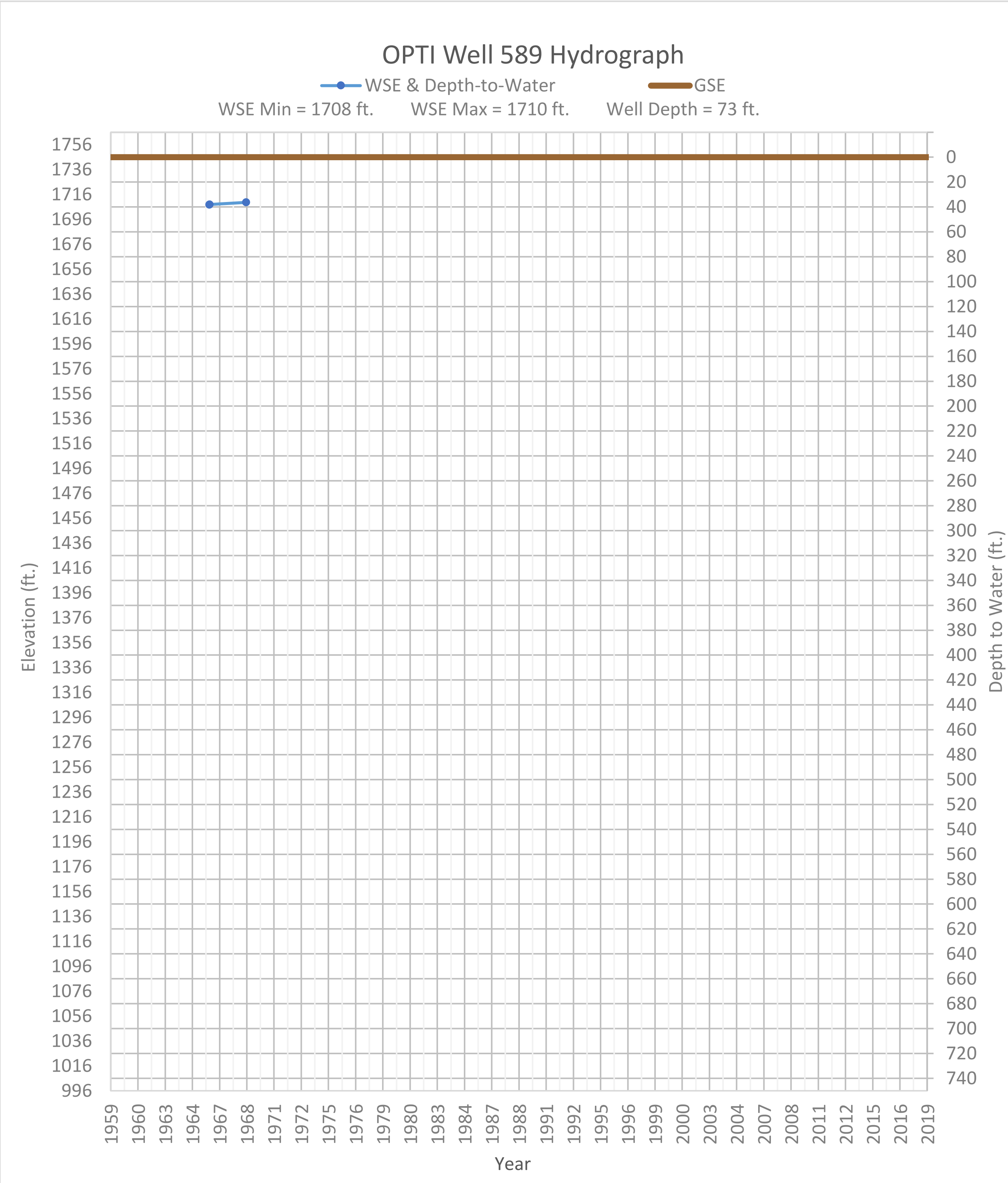
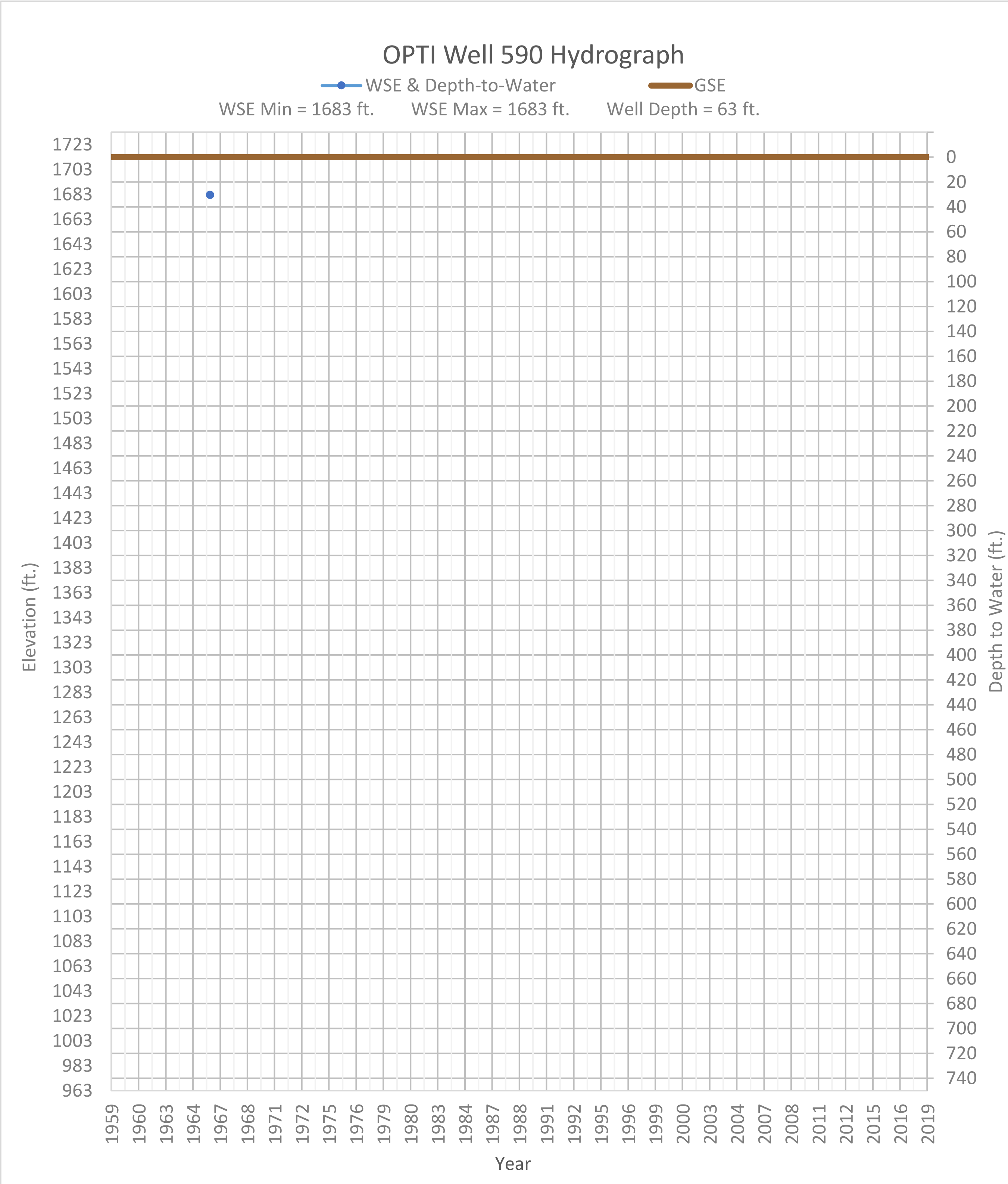
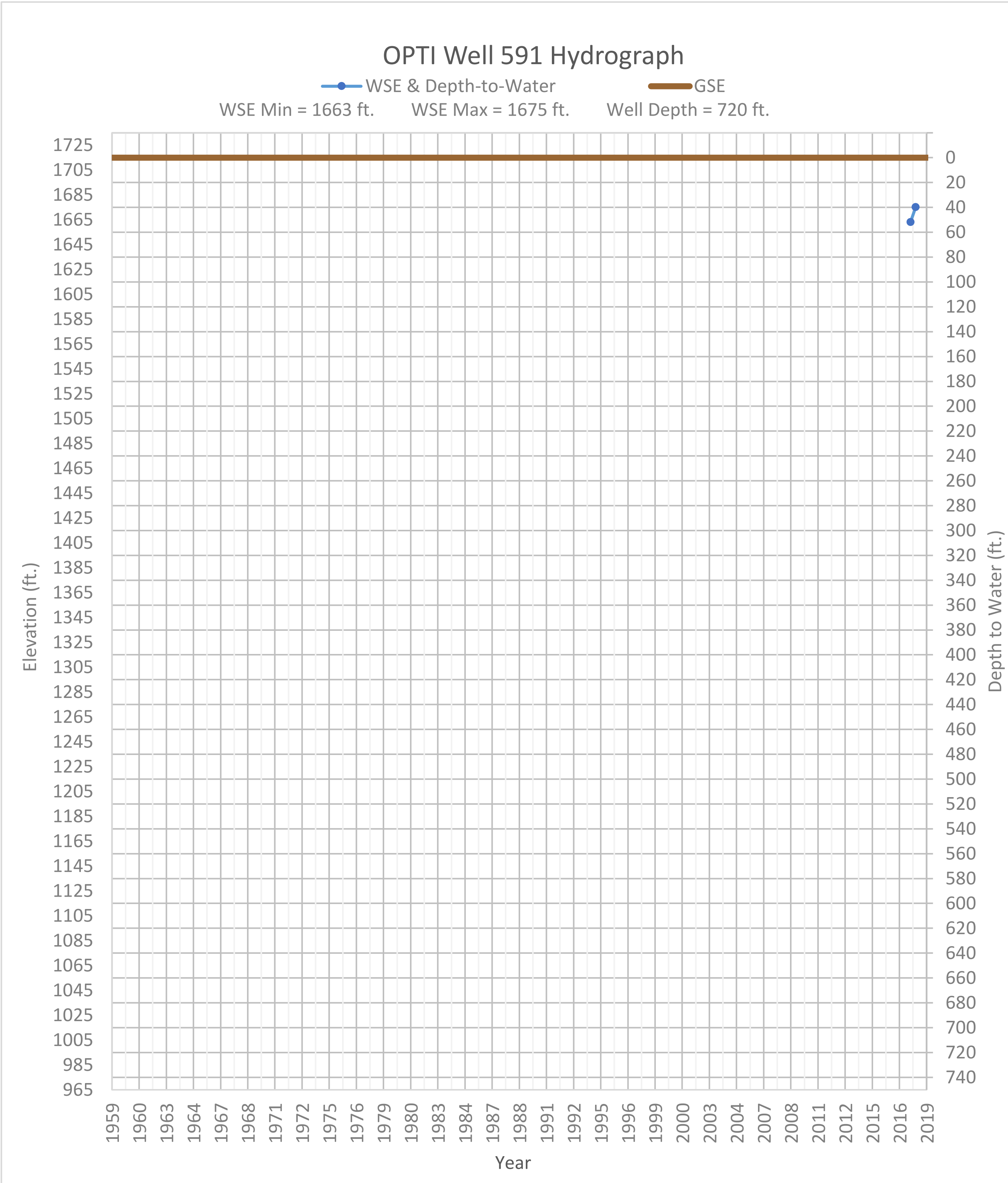
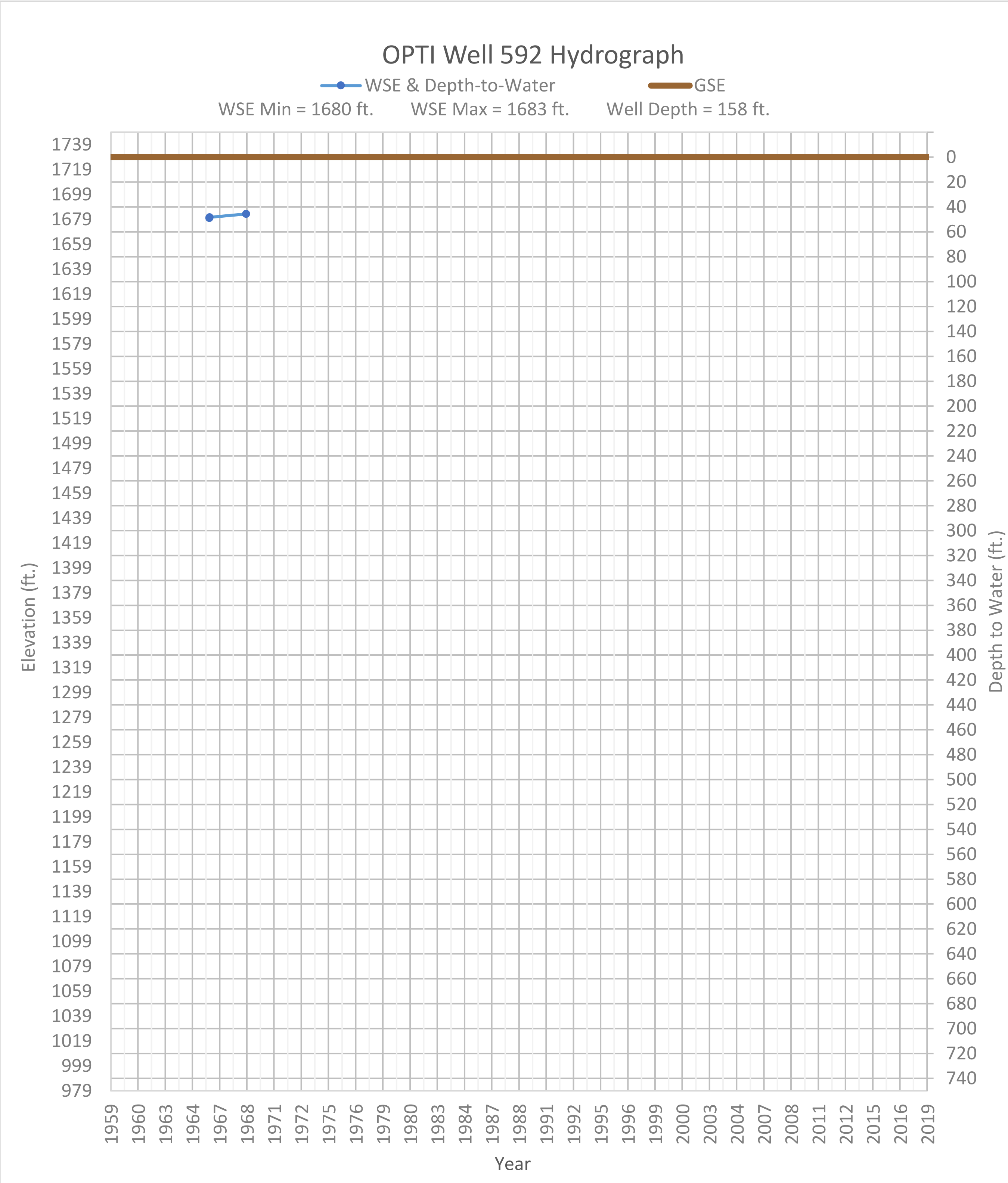


OPTI Well 589 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1708 ft.
WSE Max = 1710 ft.
Well Depth = 73 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

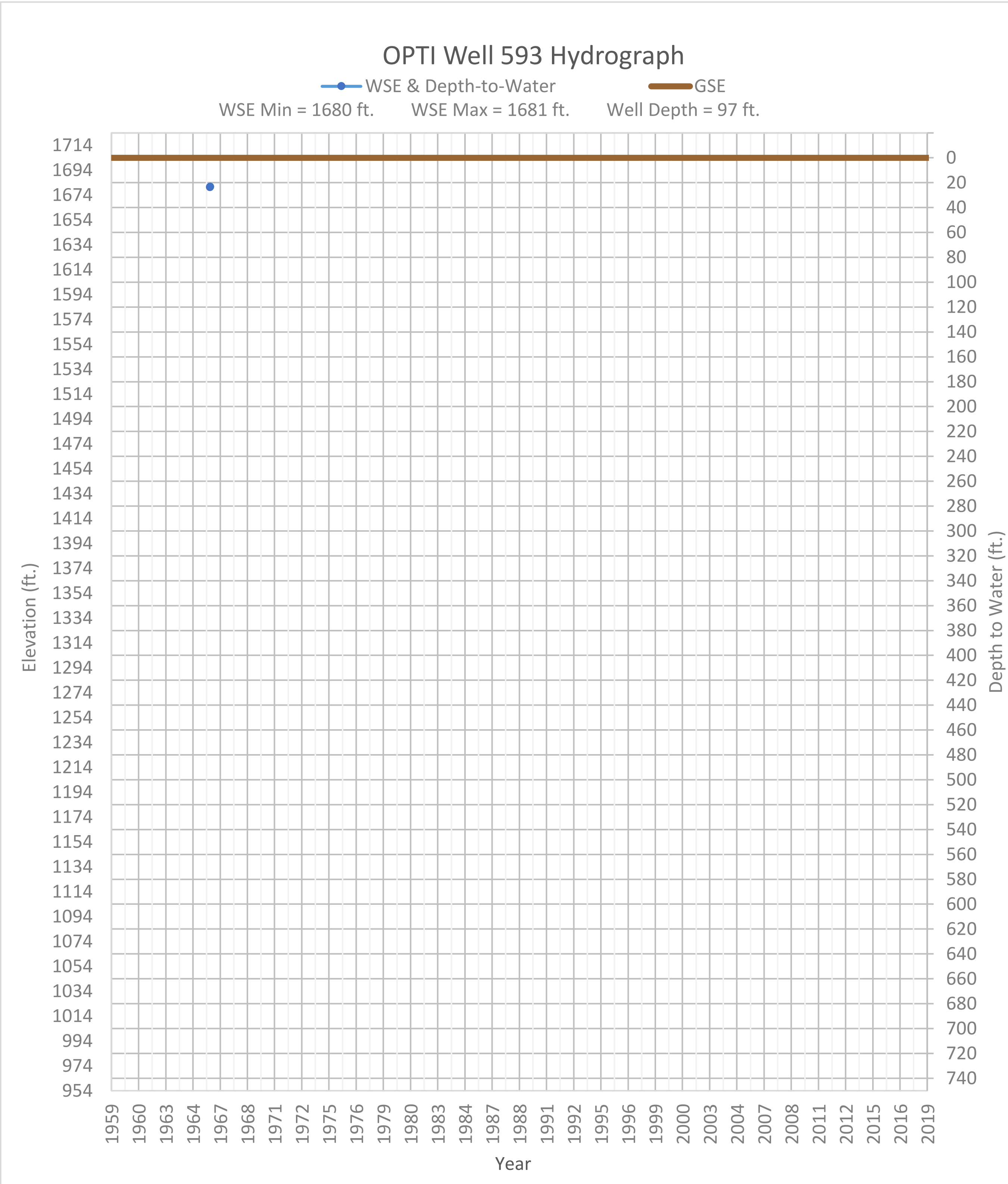

OPTI Well 590 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1683 ft.
WSE Max = 1683 ft.
Well Depth = 63 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



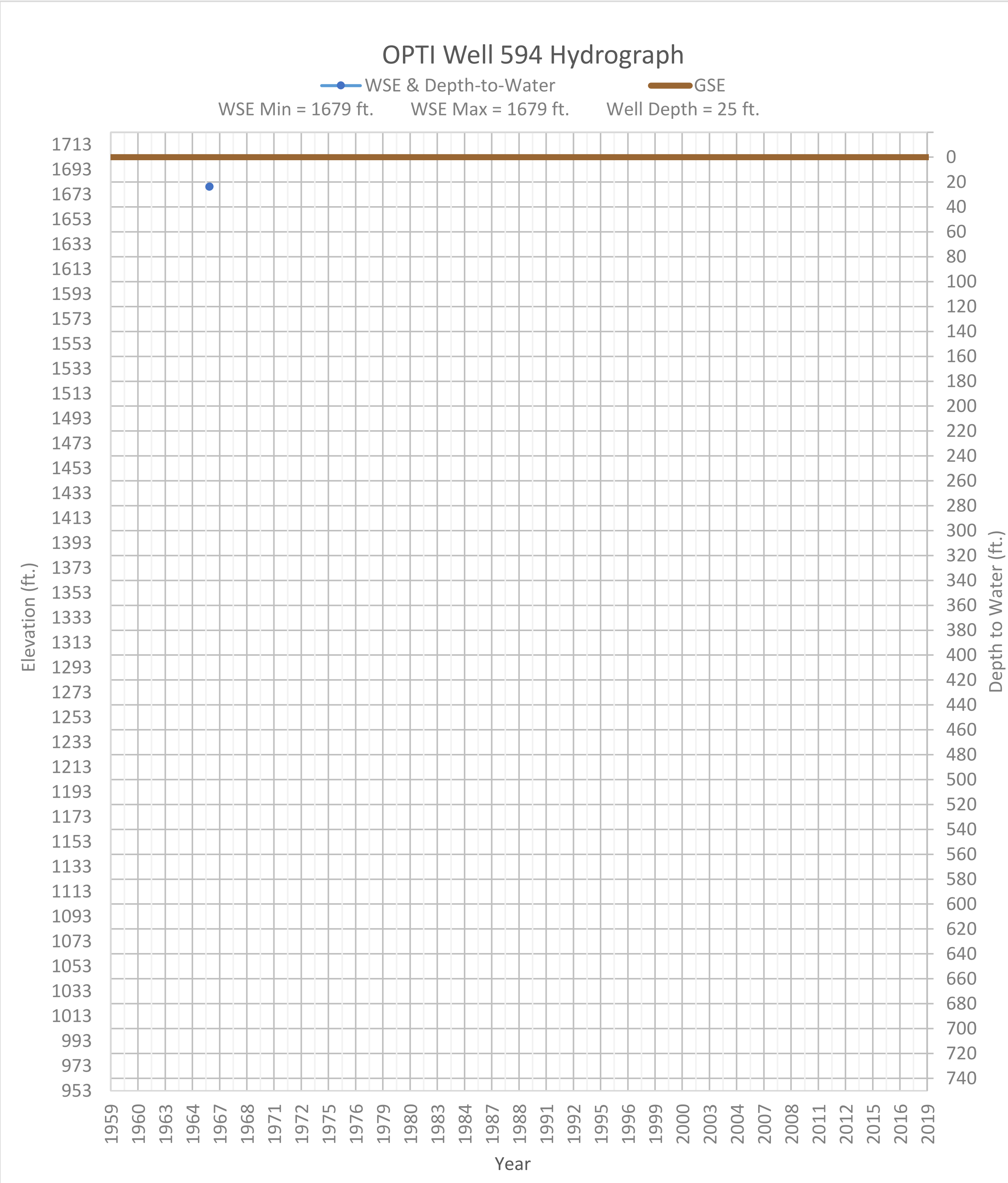
OPTI Well 591 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1663 ft.
WSE Max = 1675 ft.
Well Depth = 720 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

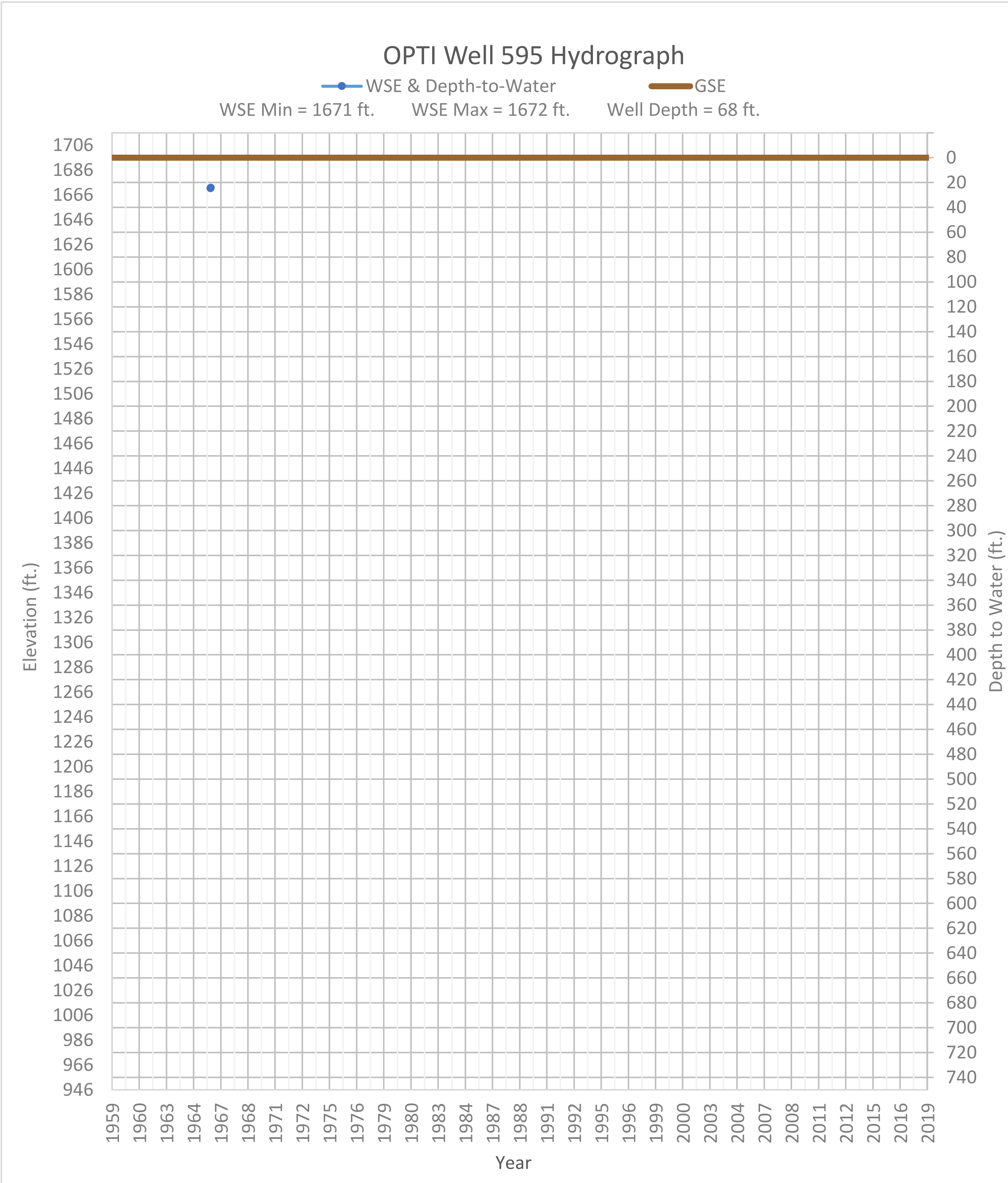


OPTI Well 592 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1680 ft.
WSE Max = 1683 ft.
Well Depth = 158 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 593 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1680 ft.
WSE Max = 1681 ft.
Well Depth = 97 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 594 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1679 ft.
WSE Max = 1679 ft.
Well Depth = 25 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 595 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1671 ft.
WSE Max = 1672 ft.
Well Depth = 68 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1706
1686
1666
1646
1626
1606
1586
1566
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1486
1466
1446
1426
1406
1386
1366
1346
1326
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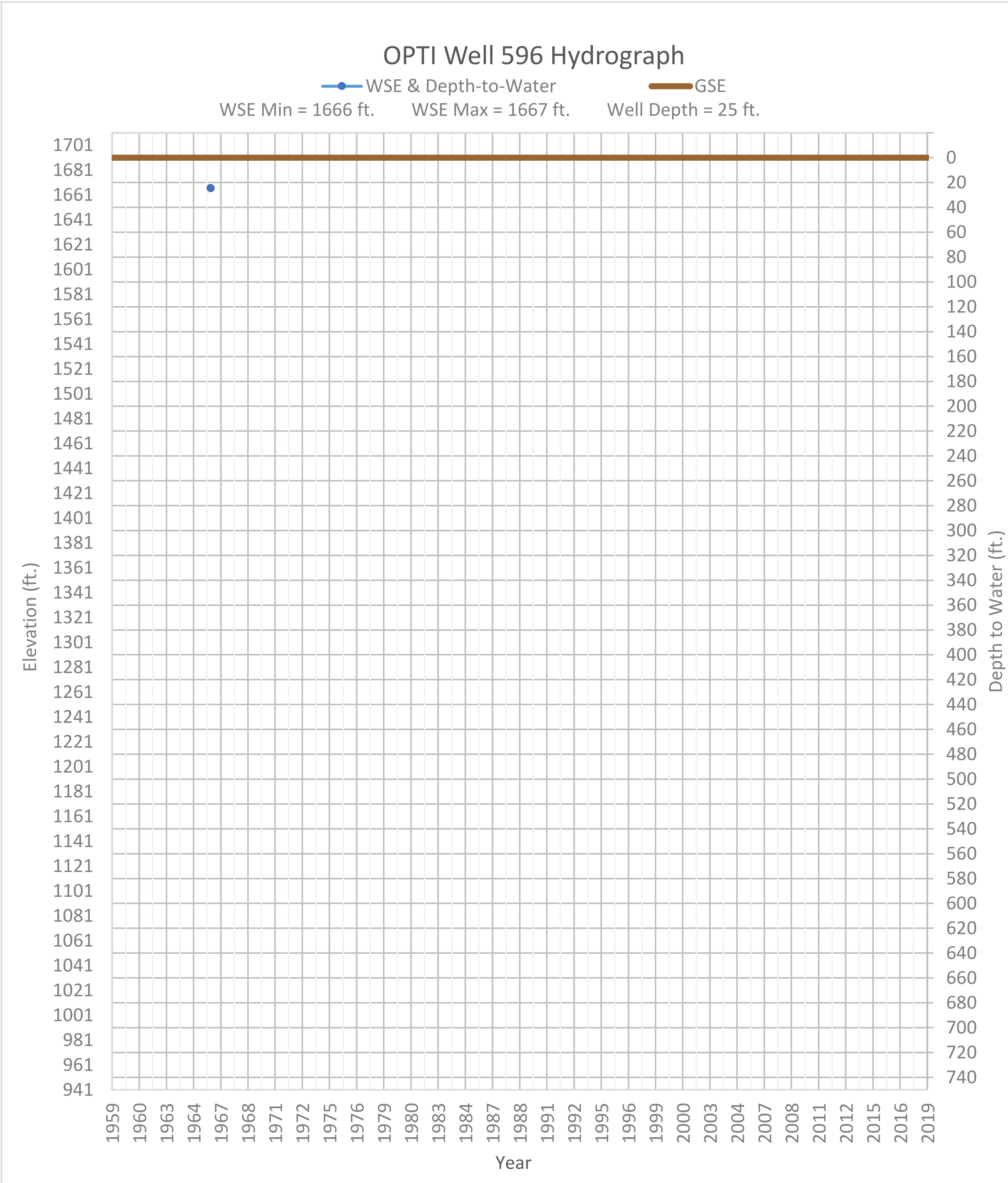
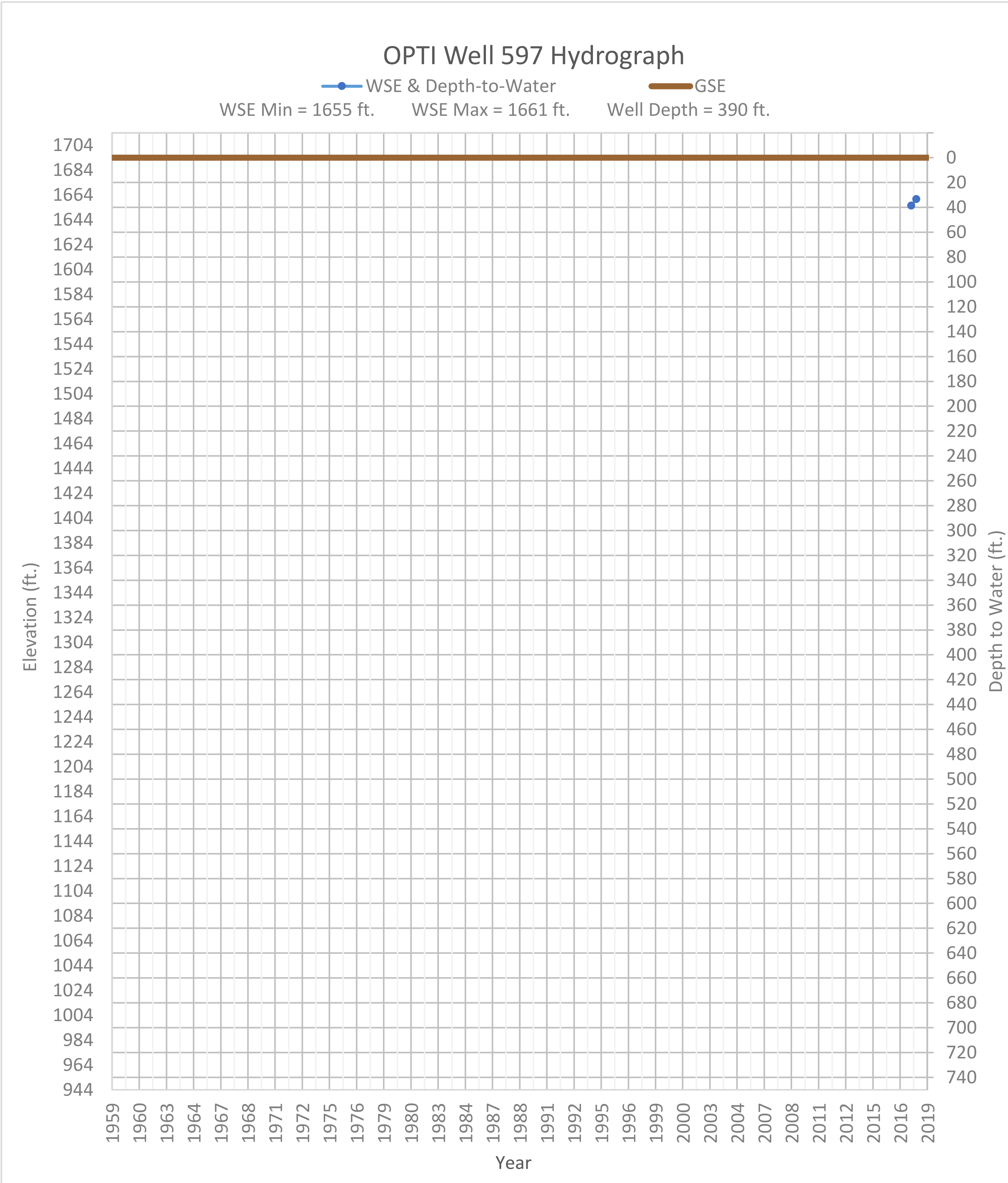


OPTI Well 596 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1666 ft.
WSE Max = 1667 ft.
Well Depth = 25 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 597 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1655 ft.
WSE Max = 1661 ft.
Well Depth = 390 ft.
Elevation (ft.)
1704
1684
1664
1644
1624
1604
1584
1564
1544
1524
1504
1484
1464
1444
1424
1404
1384
1364
1344
1324
1304
1284
1264
1244
1224
1204
1184
1164
1144
1124
1104
1084
1064
1044
1024
1004
984
964
944
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
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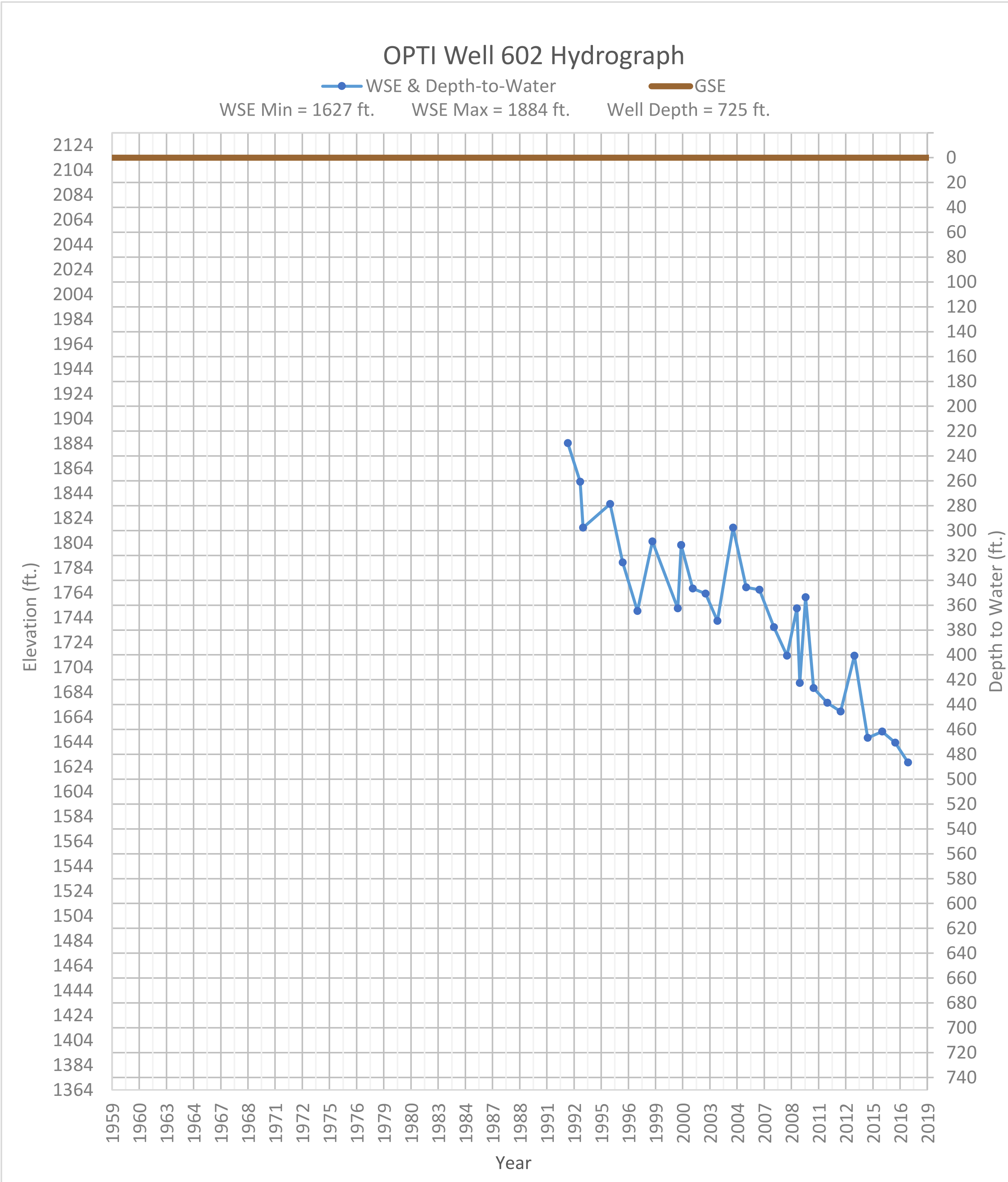
OPTI Well 601 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1640 ft.
WSE Max = 2056 ft.
Well Depth = 723 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 602 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1627 ft.
WSE Max = 1884 ft.
Well Depth = 725 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2124
2104
2084
2064
2044
2024
2004
1984
1964
1944
1924
1904
1884
1864
1844
1824
1804
1784
1764
1744
1724
1704
1684
1664
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1524
1504
1484
1464
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1384
1364
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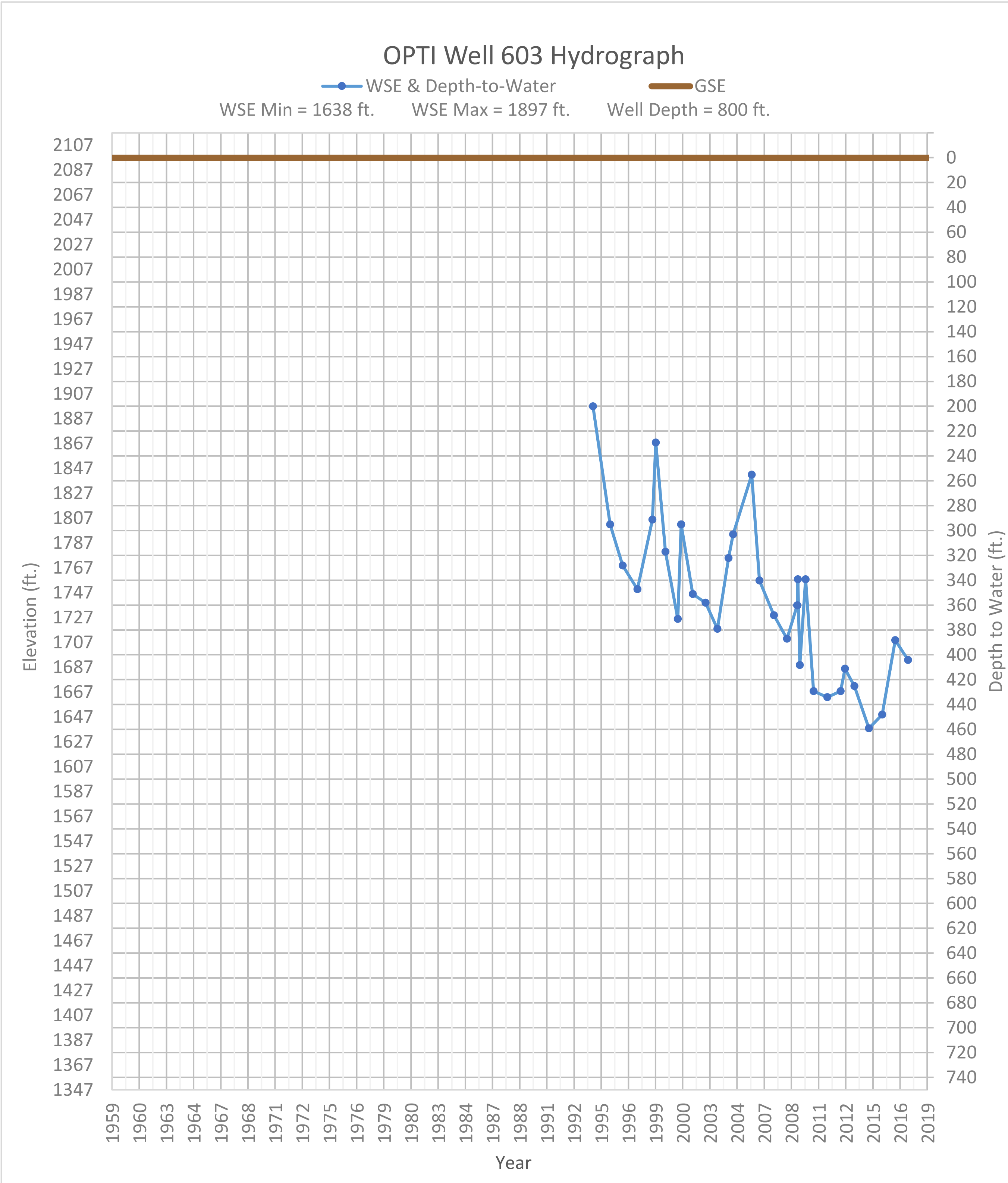
OPTI Well 603 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1638 ft.
WSE Max = 1897 ft.
Well Depth = 800 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2107
2087
2067
2047
2027
2007
1987
1967
1947
1927
1907
1887
1867
1847
1827
1807
1787
1767
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OPTI Well 604 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1607 ft.
WSE Max = 1844 ft.
Well Depth = 924 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2135
2115
2095
2075
2055
2035
2015
1995
1975
1955
1935
1915
1895
1875
1855
1835
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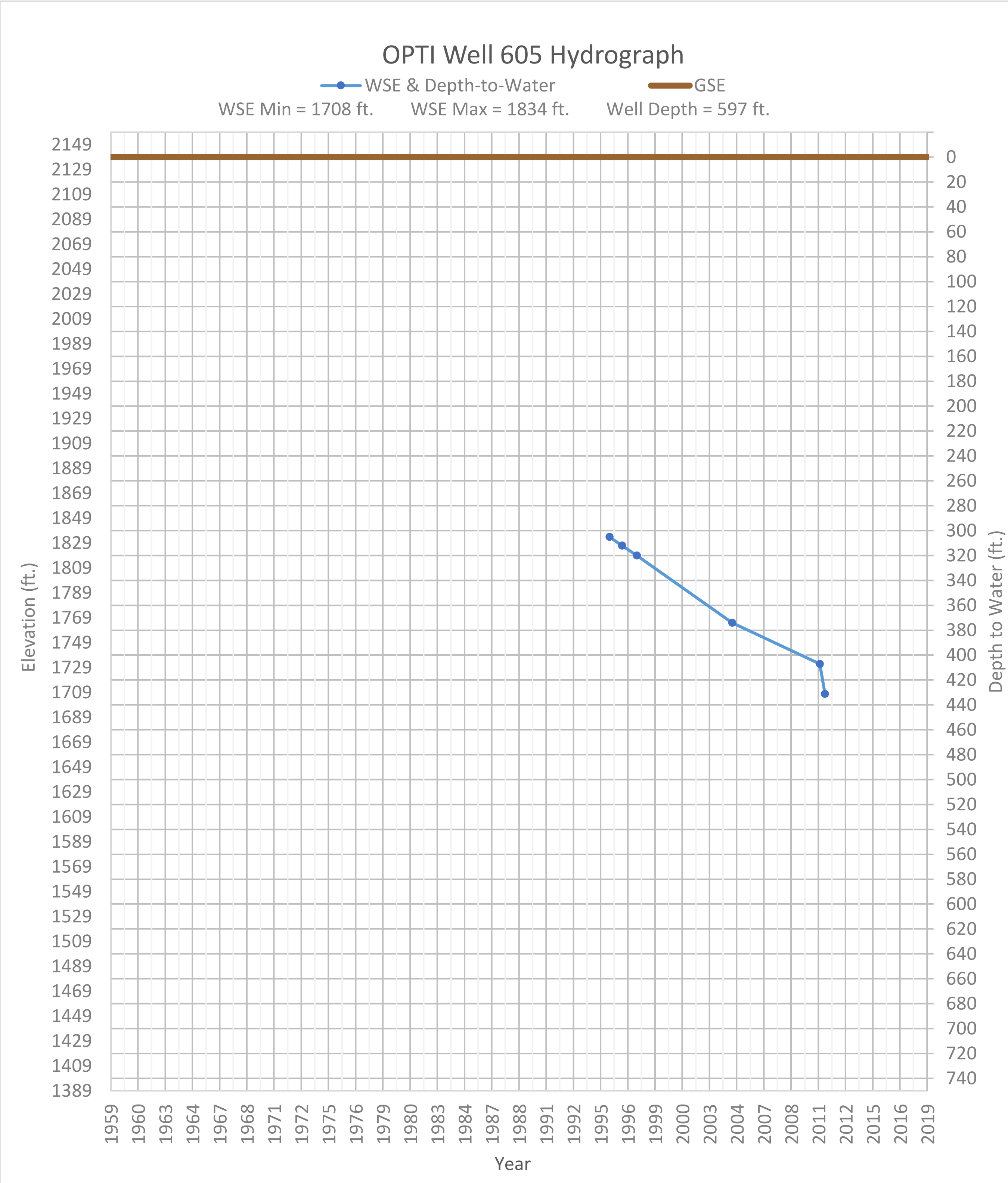
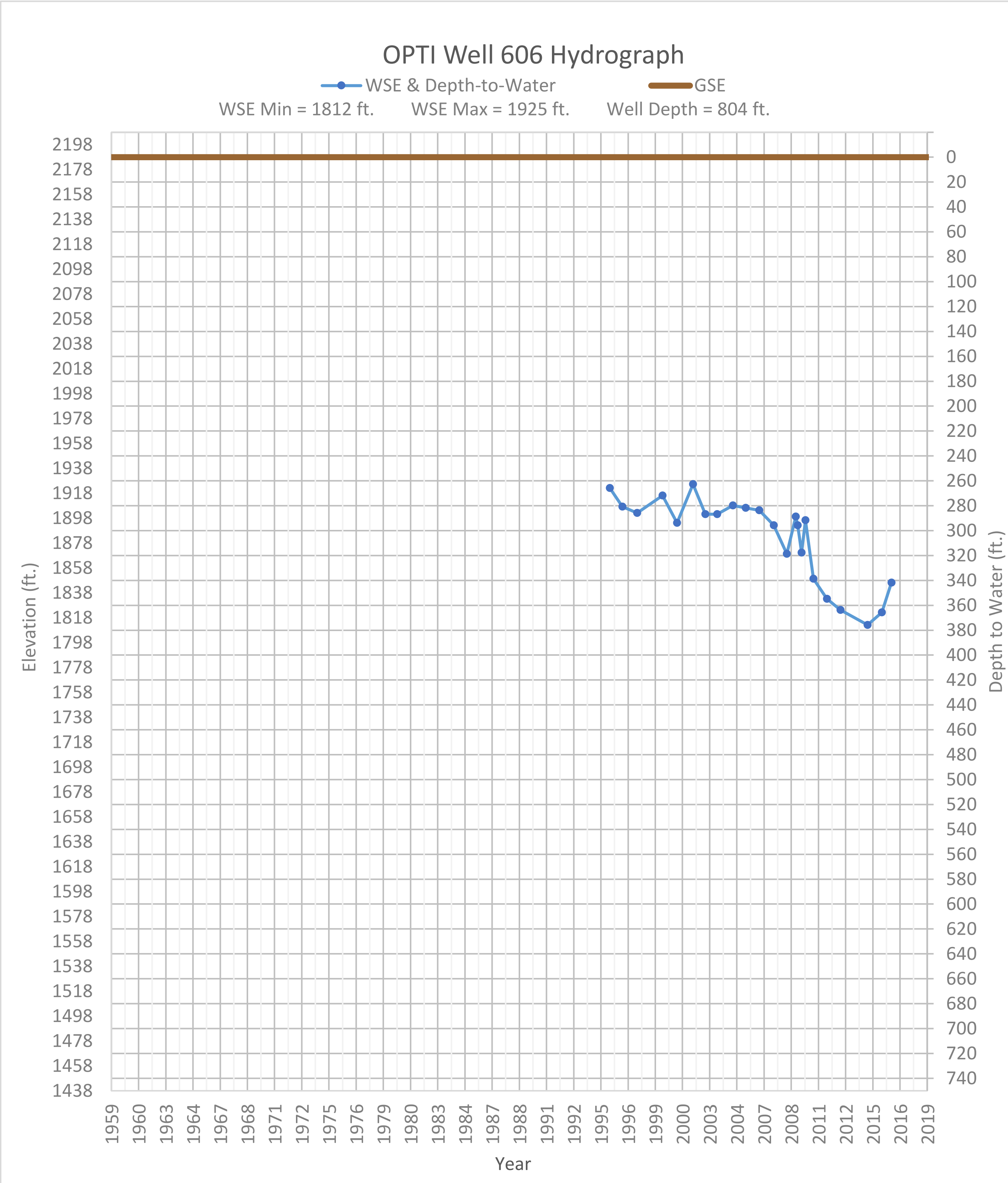
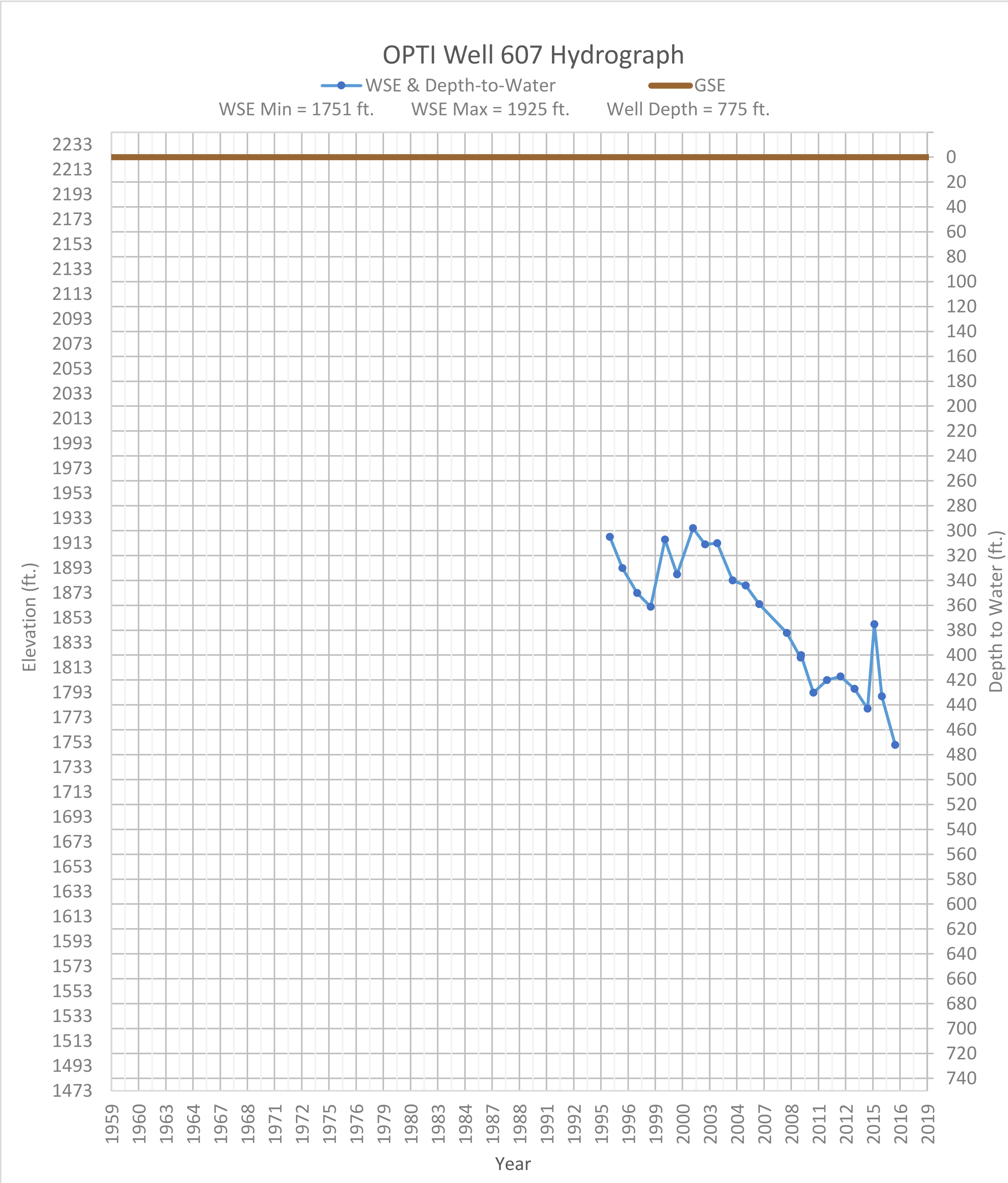


OPTI Well 605 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1708 ft.
WSE Max = 1834 ft.
Well Depth = 597 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 606 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1812 ft.
WSE Max = 1925 ft.
Well Depth = 804 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 607 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1751 ft.
WSE Max = 1925 ft.
Well Depth = 775 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 608 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1789 ft.
WSE Max = 1954 ft.
Well Depth = 745 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2234
2214
2194
2174
2154
2134
2114
2094
2074
2054
2034
2014
1994
1974
1954
1934
1914
1894
1874
1854
1834
1814
1794
1774
1754
1734
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1694
1674
1654
1634
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1474
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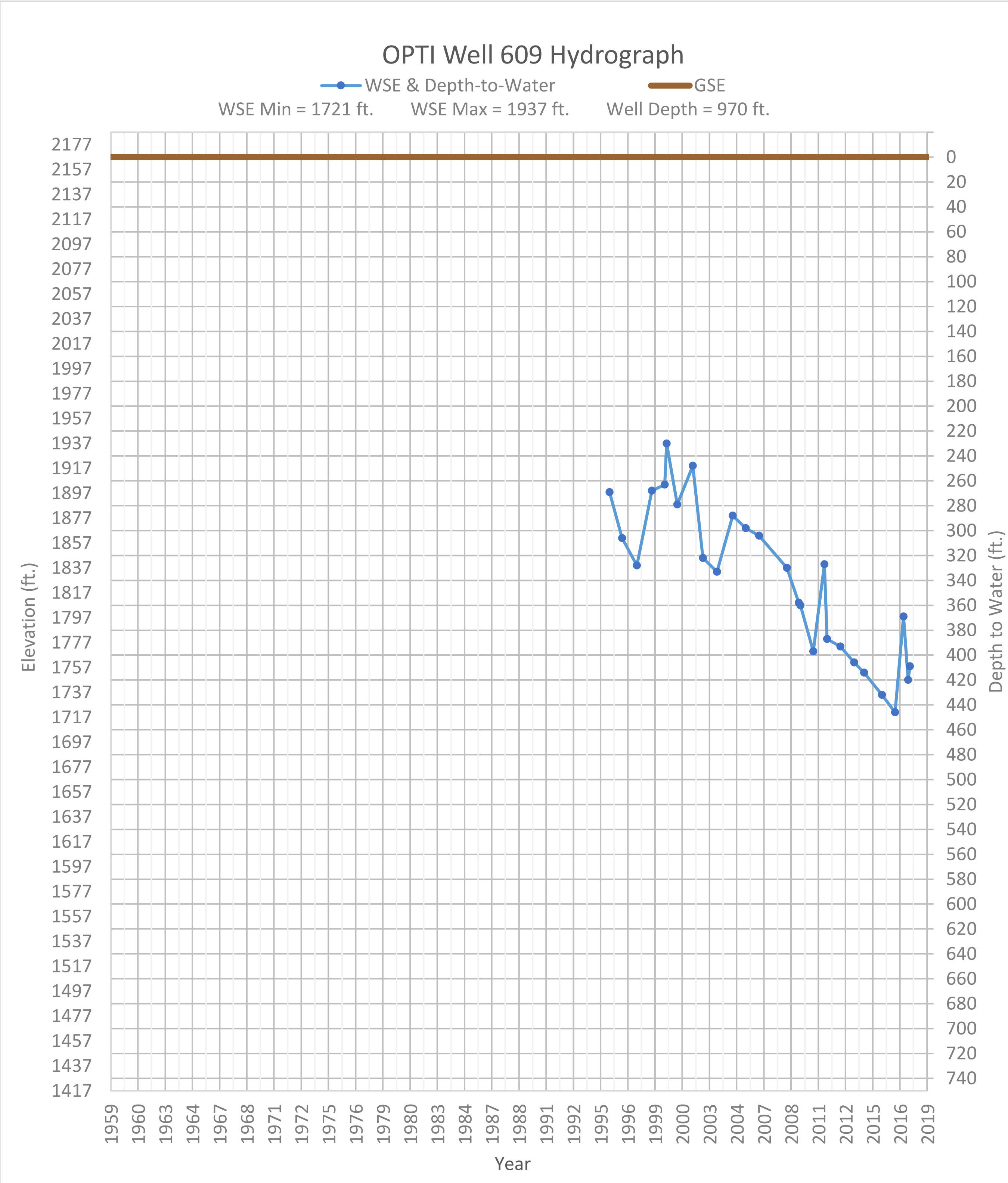
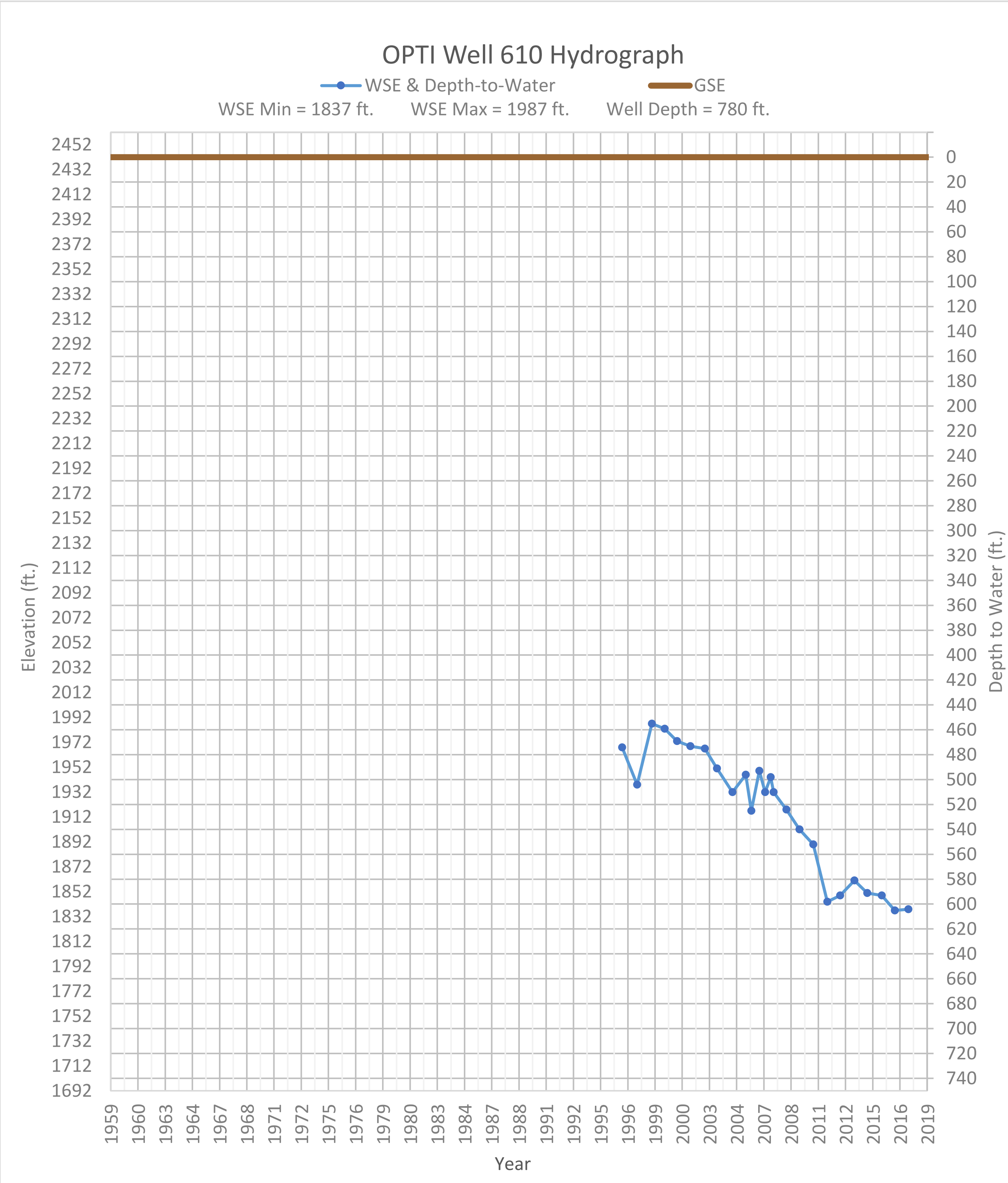
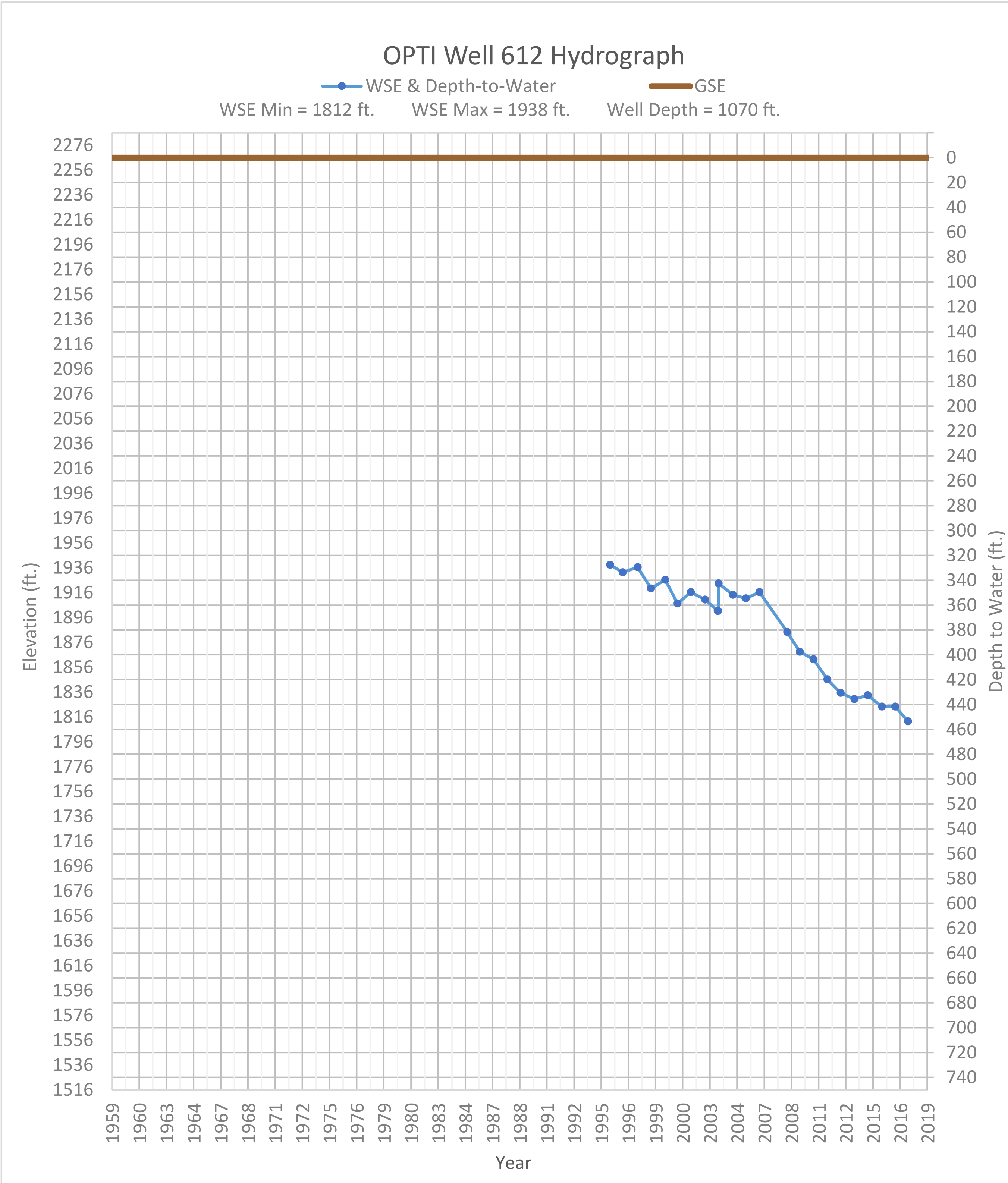


OPTI Well 609 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1721 ft.
WSE Max = 1937 ft.
Well Depth = 970 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

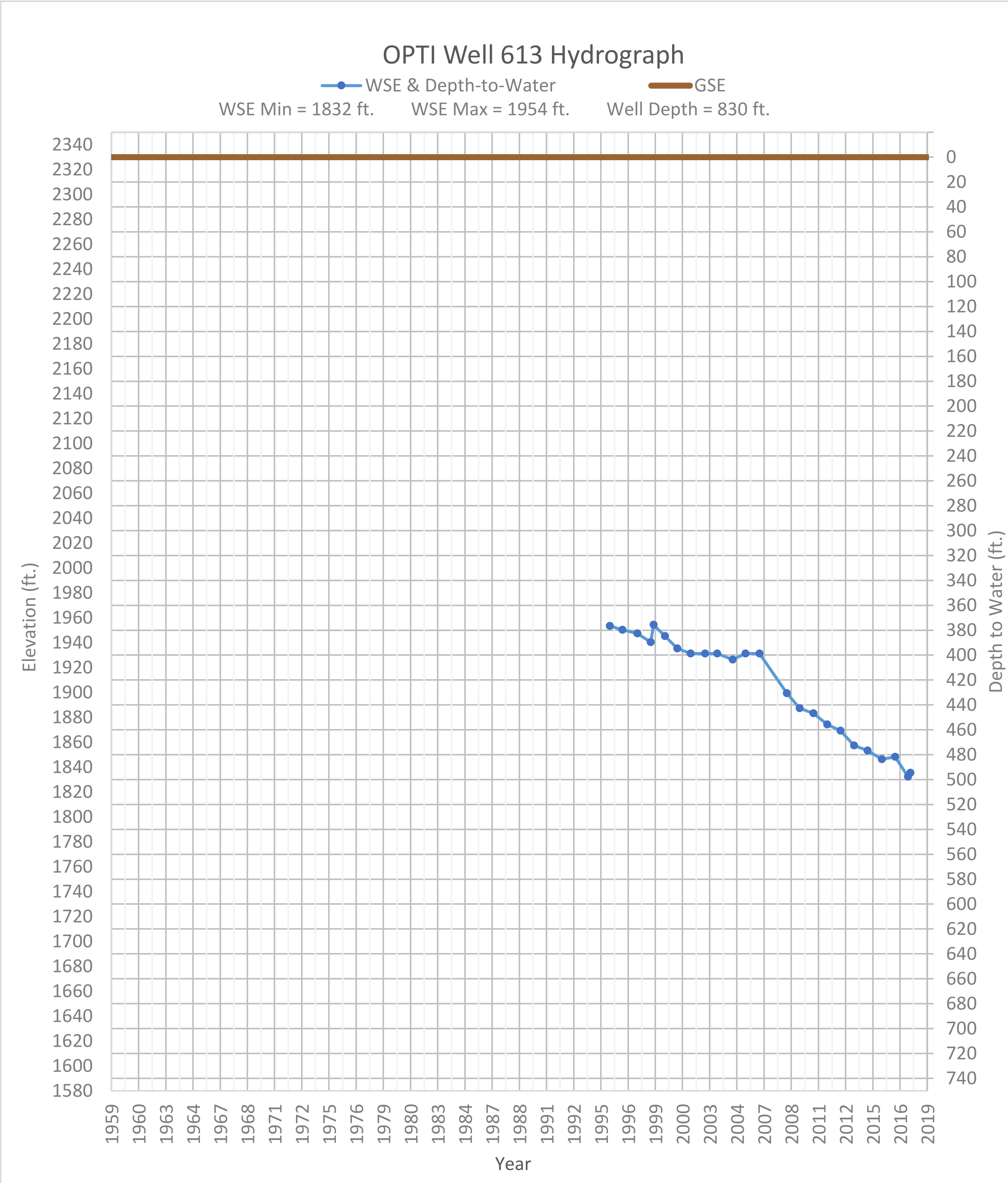


OPTI Well 610 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1837 ft.
WSE Max = 1987 ft.
Well Depth = 780 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 611 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1871 ft.
WSE Max = 1956 ft.
Well Depth = 550 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 612 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1812 ft.
WSE Max = 1938 ft.
Well Depth = 1070 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 613 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1832 ft.
WSE Max = 1954 ft.
Well Depth = 830 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2340
2320
2300
2280
2260
2240
2220
2200
2180
2160
2140
2120
2100
2080
2060
2040
2020
2000
1980
1960
1940
1920
1900
1880
1860
1840
1820
1800
1780
1760
1740
1720
1700
1680
1660
1640
1620
1600
1580
0
20
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120
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160
180
200
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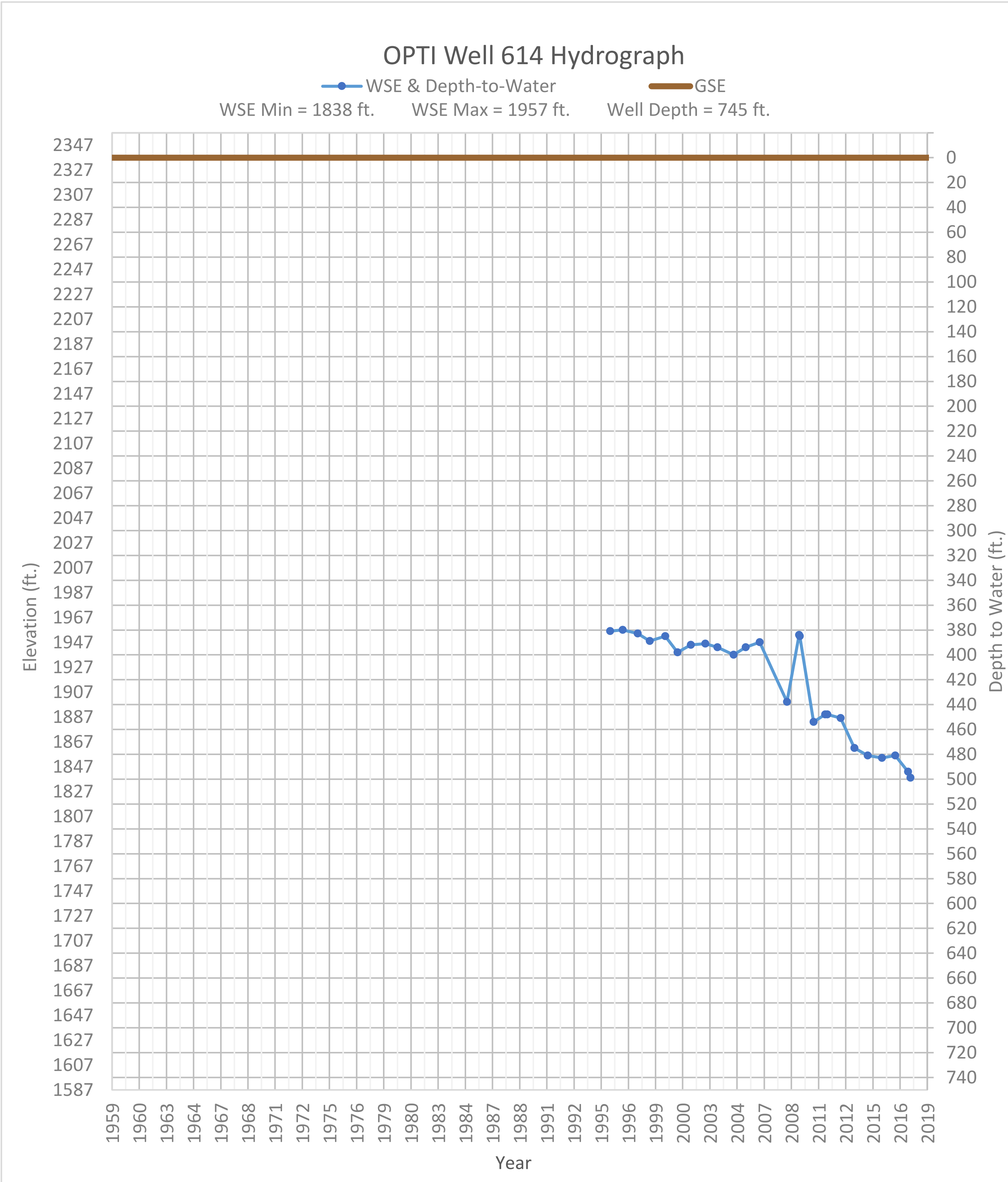
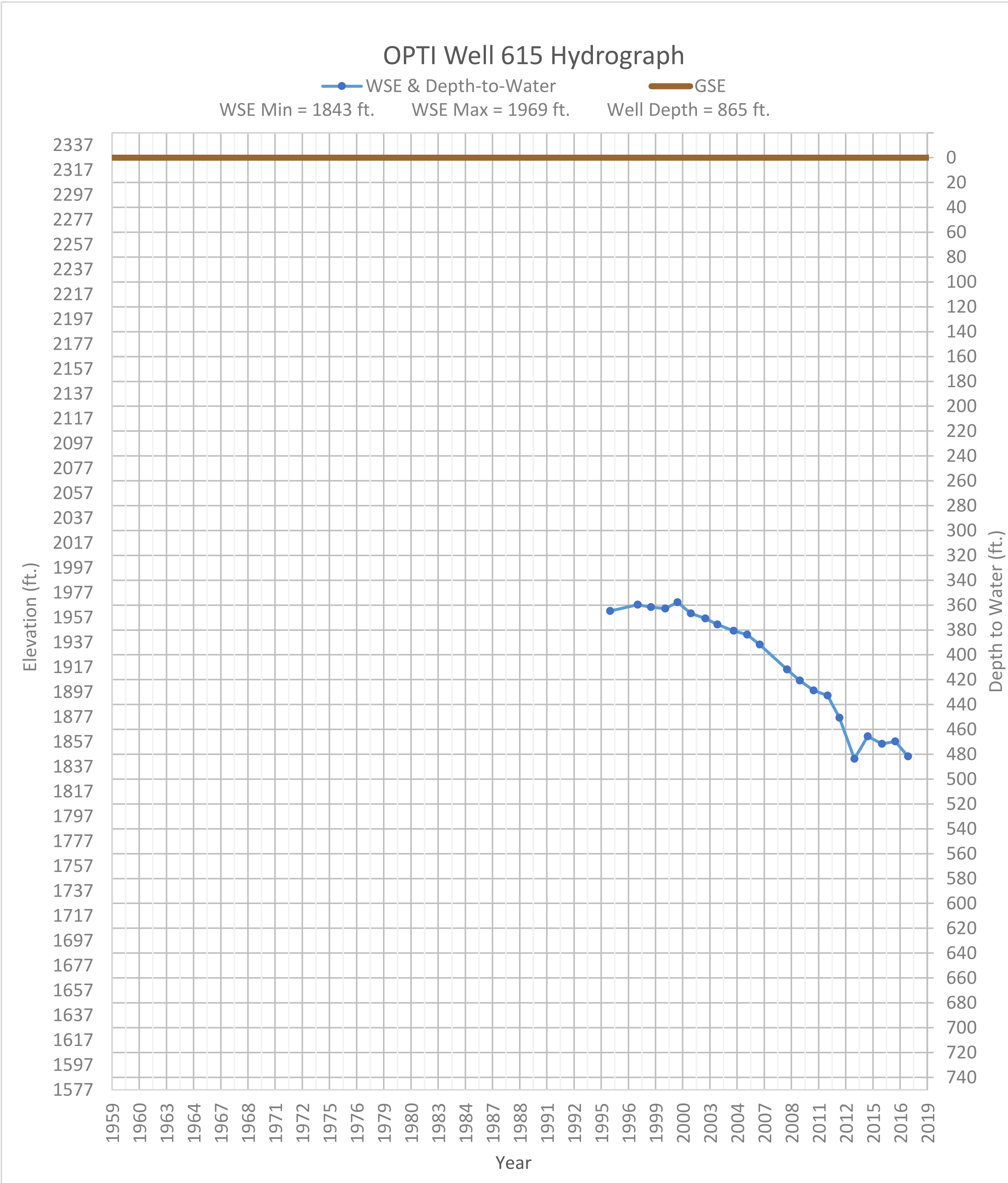
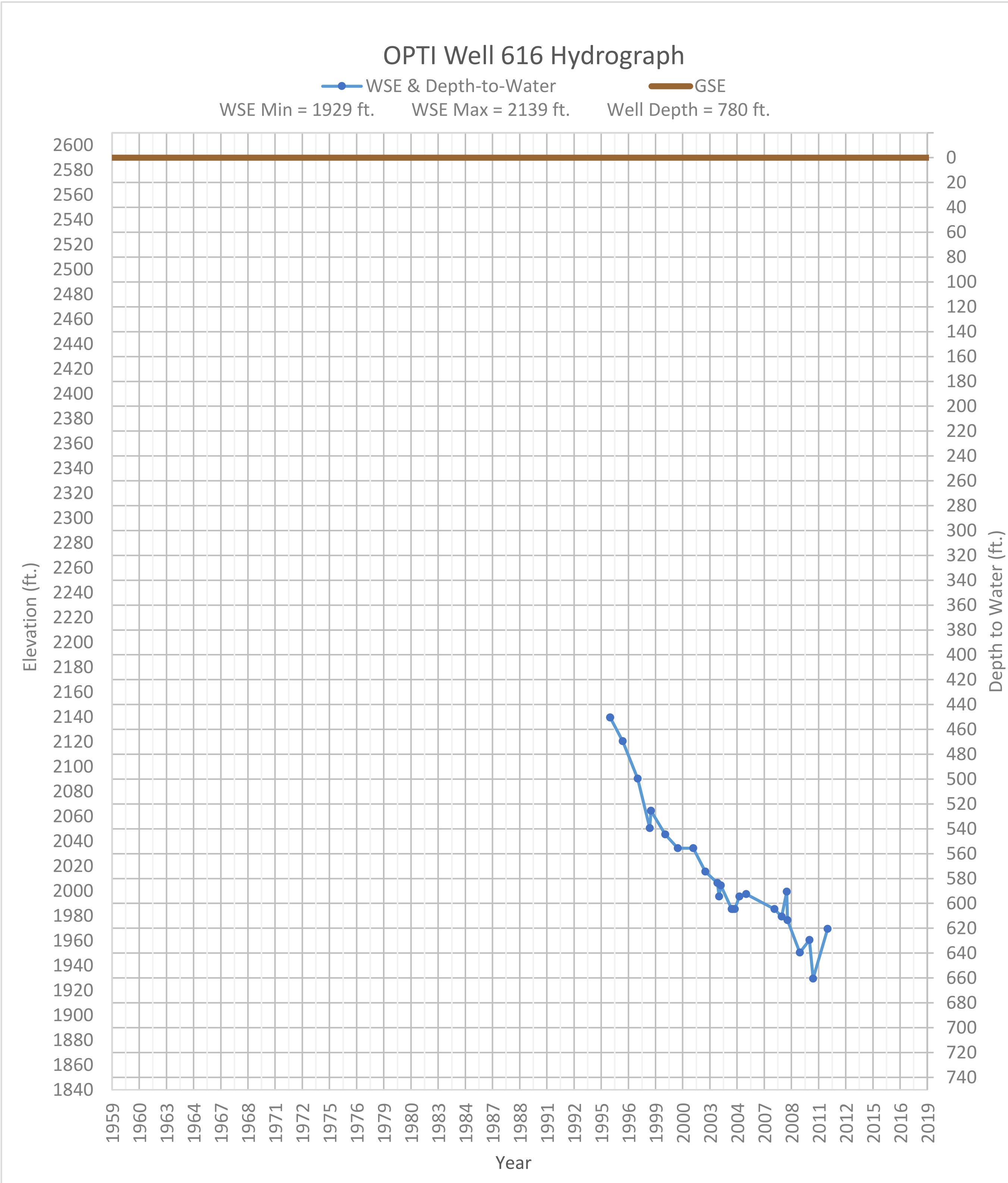


OPTI Well 614 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1838 ft.
WSE Max = 1957 ft.
Well Depth = 745 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 615 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1843 ft.
WSE Max = 1969 ft.
Well Depth = 865 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 616 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1929 ft.
WSE Max = 2139 ft.
Well Depth = 780 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2600
2580
2560
2540
2520
2500
2480
2460
2440
2420
2400
2380
2360
2340
2320
2300
2280
2260
2240
2220
2200
2180
2160
2140
2120
2100
2080
2060
2040
2020
2000
1980
1960
1940
1920
1900
1880
1860
1840
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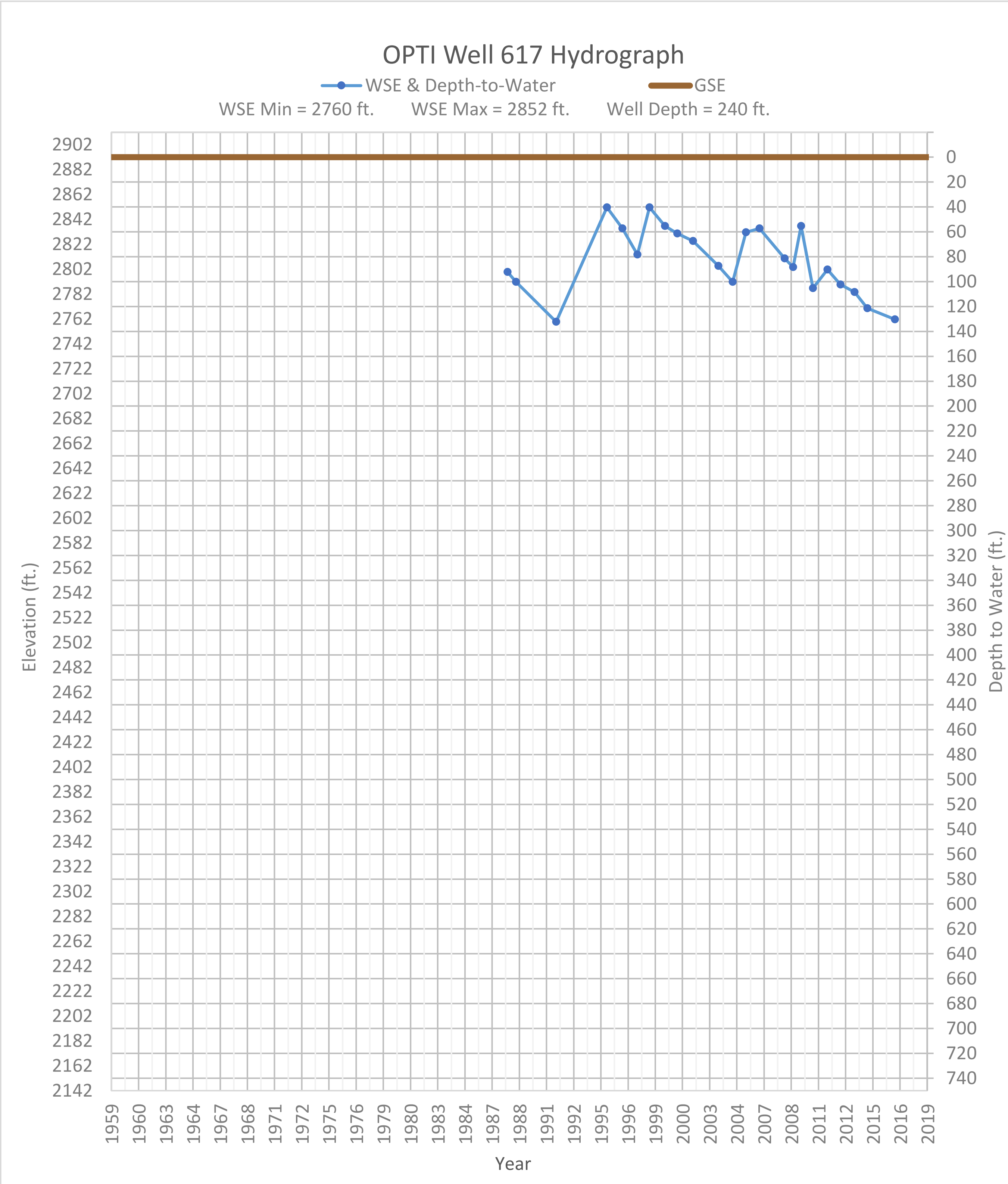

OPTI Well 617 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2760 ft.
WSE Max = 2852 ft.
Well Depth = 240 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 618 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1613 ft.
WSE Max = 1894 ft.
Well Depth = 927 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2173
2153
2133
2113
2093
2073
2053
2033
2013
1993
1973
1953
1933
1913
1893
1873
1853
1833
1813
1793
1773
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2012
2015
2016
2019

OPTI Well 619 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1826 ft.
WSE Max = 1977 ft.
Well Depth = 1040 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2317
2297
2277
2257
2237
2217
2197
2177
2157
2137
2117
2097
2077
2057
2037
2017
1997
1977
1957
1937
1917
1897
1877
1857
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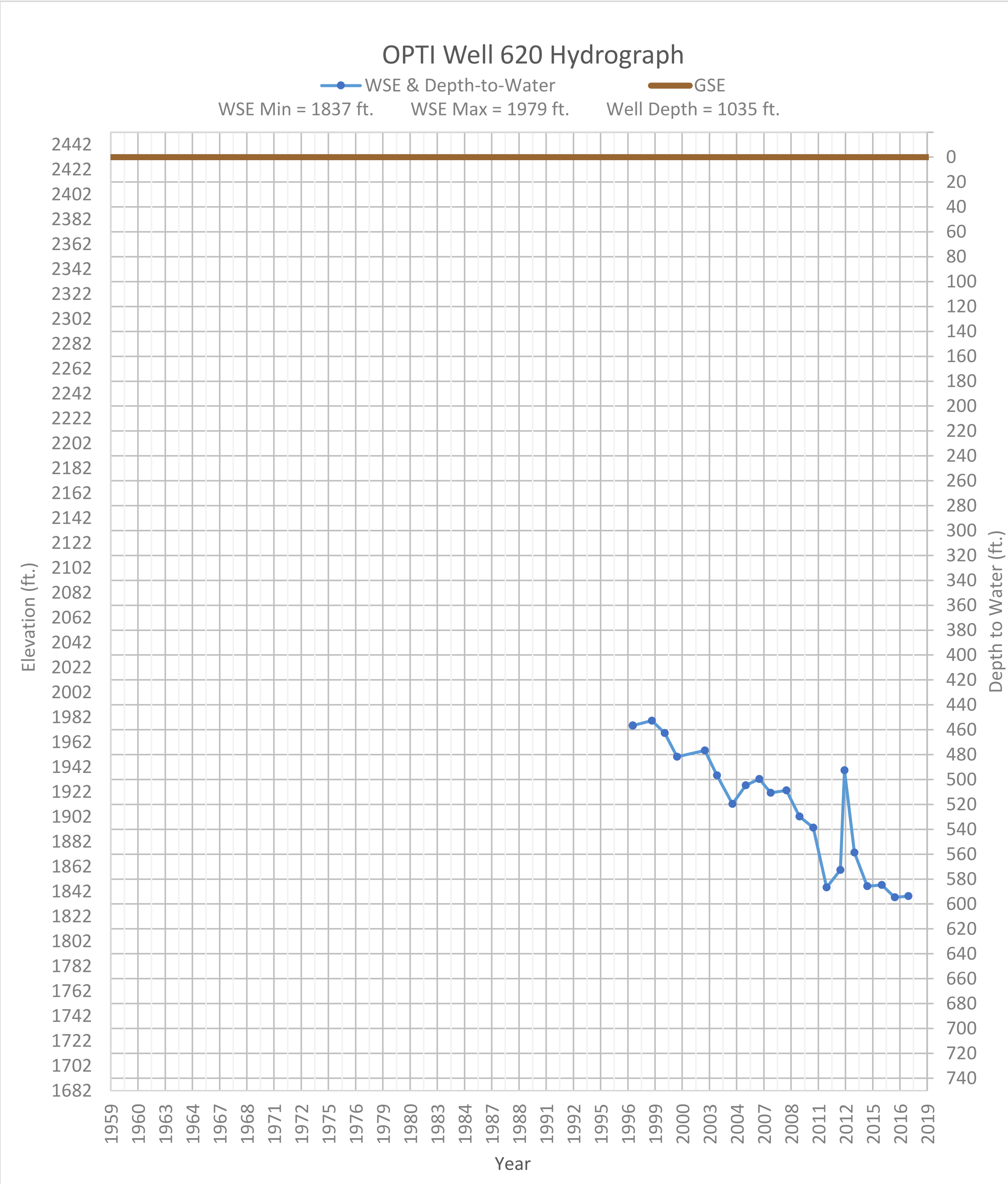
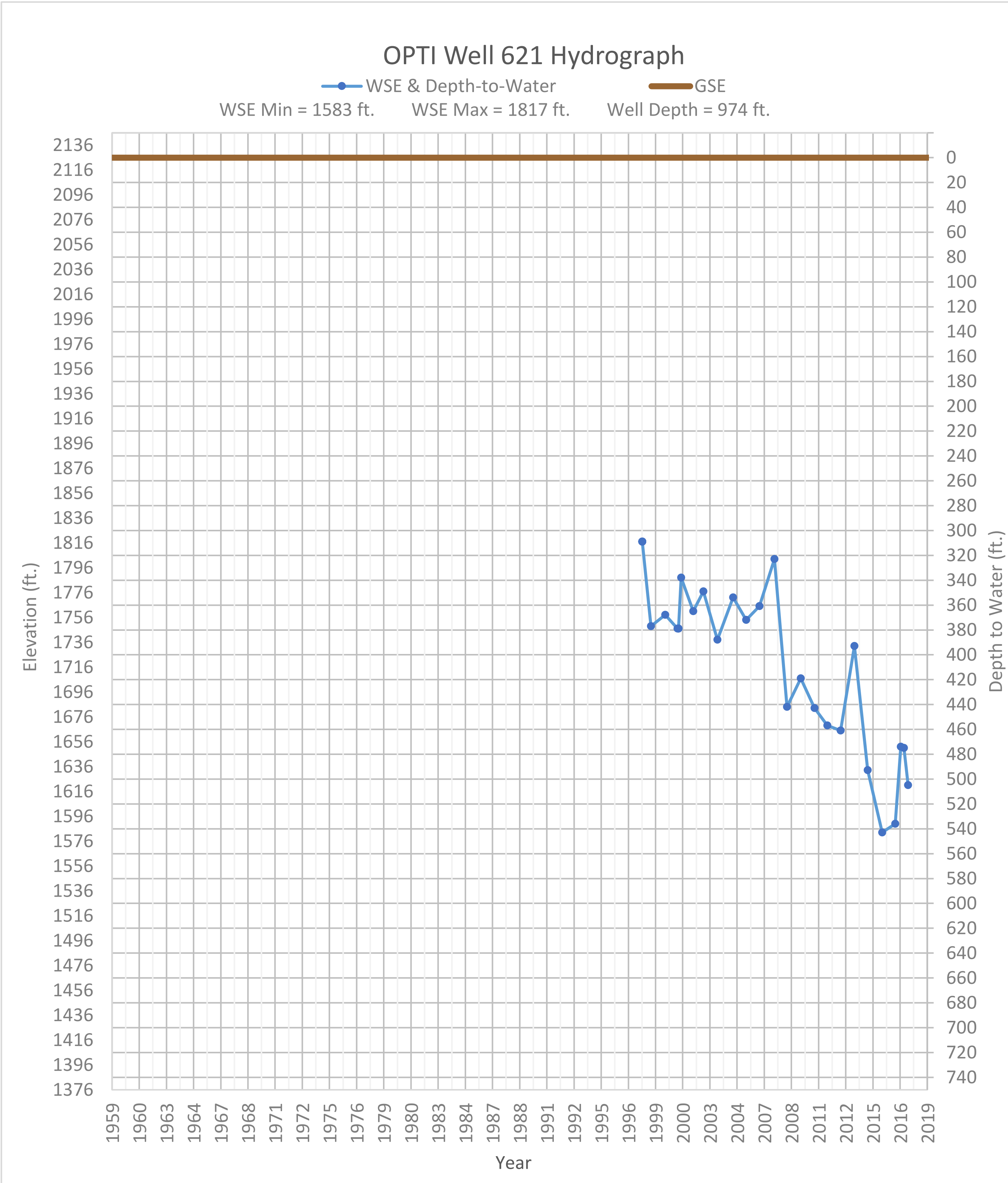

OPTI Well 620 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1837 ft.
WSE Max = 1979 ft.
Well Depth = 1035 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 621 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1583 ft.
WSE Max = 1817 ft.
Well Depth = 974 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2136
2116
2096
2076
2056
2036
2016
1996
1976
1956
1936
1916
1896
1876
1856
1836
1816
1796
1776
1756
1736
1716
1696
1676
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OPTI Well 622 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1794 ft.
WSE Max = 1952 ft.
Well Depth = 1200 ft.
Elevation (ft.)
2229
2209
2189
2169
2149
2129
2109
2089
2069
2049
2029
2009
1989
1969
1949
1929
1909
1889
1869
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1749
1729
1709
1689
1669
1649
1629
1609
1589
1569
1549
1529
1509
1489
1469
Depth to Water (ft.)
0
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40
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OPTI Well 623 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1797 ft.
WSE Max = 1954 ft.
Well Depth = 1040 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2298
2278
2258
2238
2218
2198
2178
2158
2138
2118
2098
2078
2058
2038
2018
1998
1978
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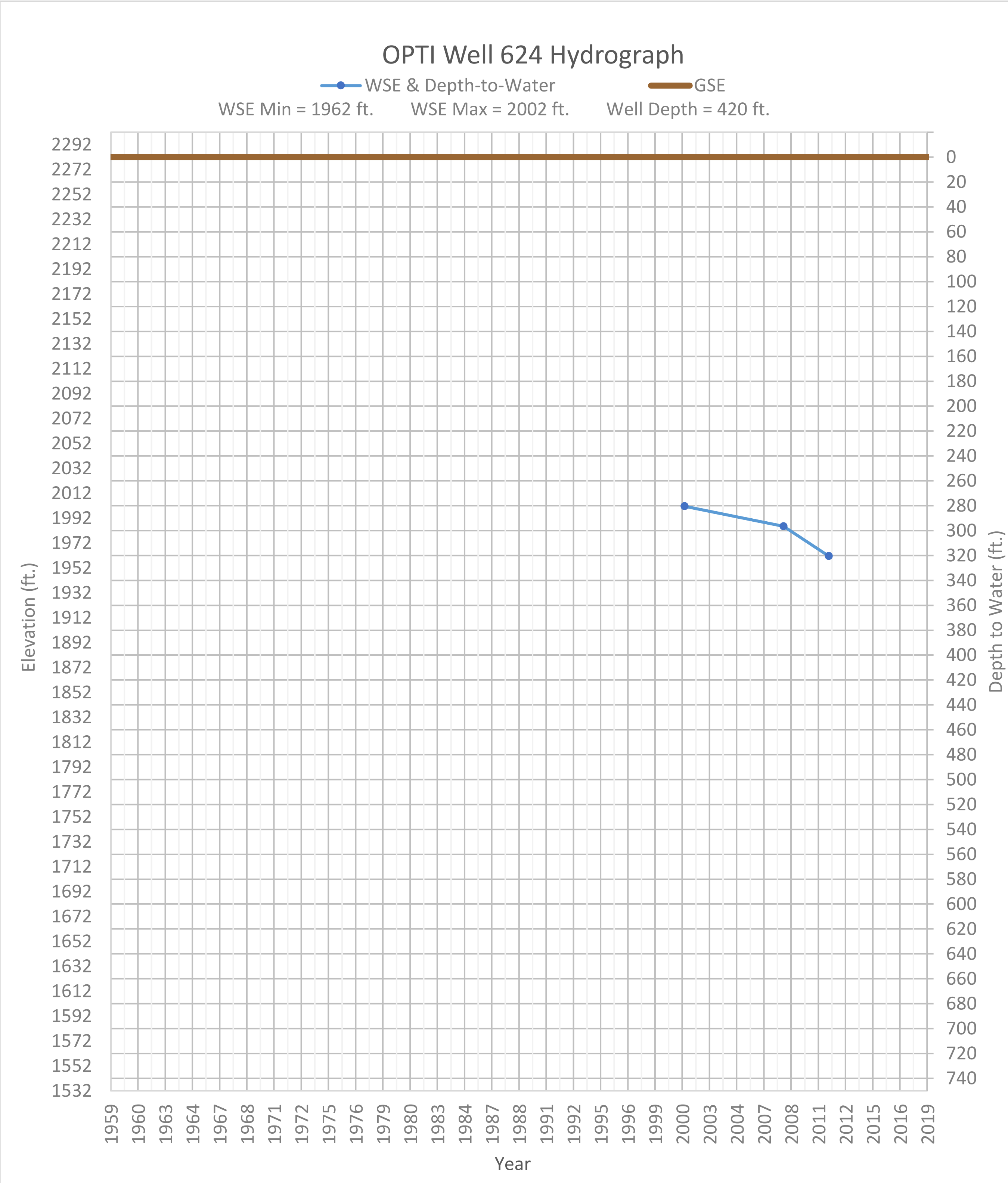
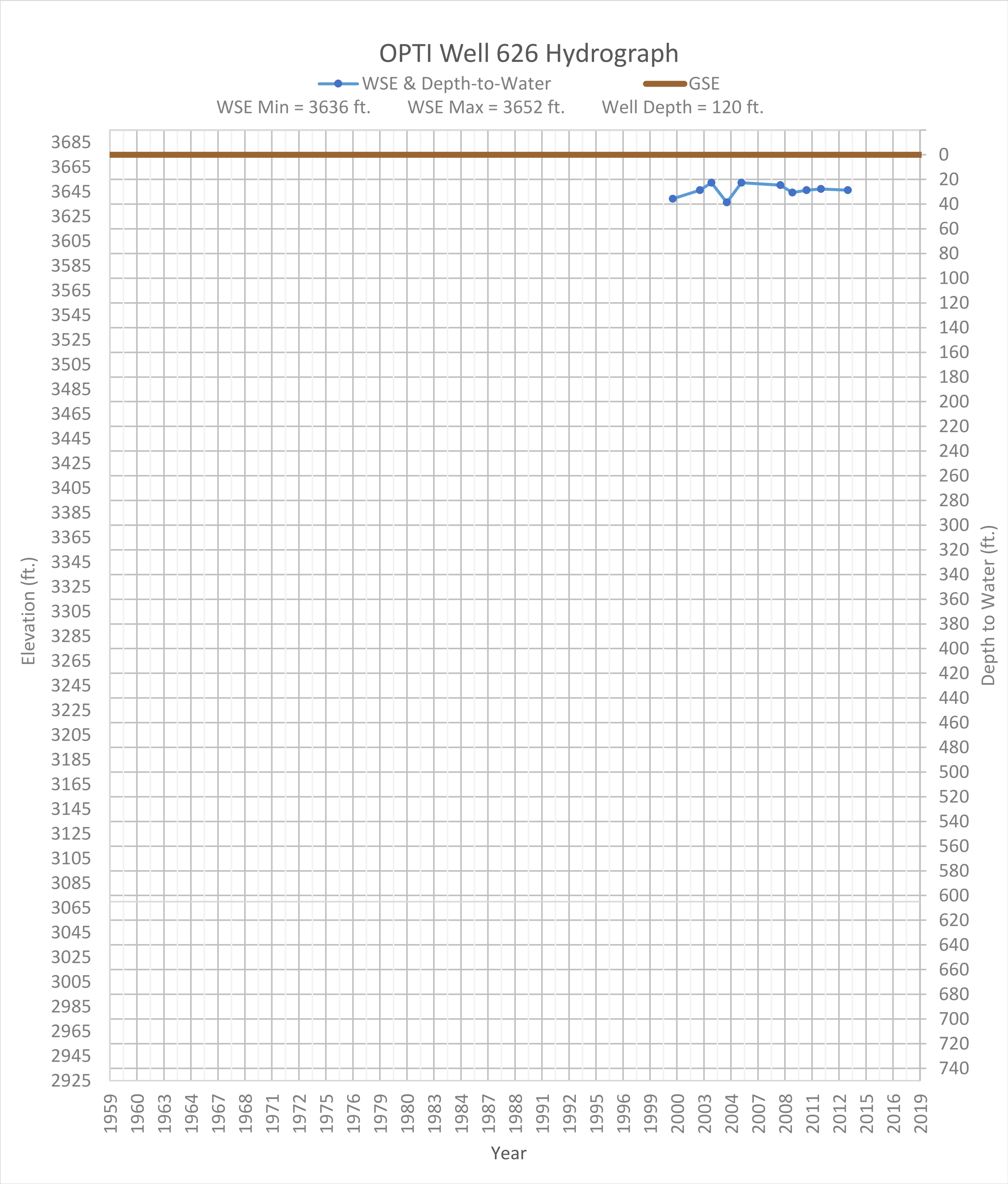


OPTI Well 624 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1962 ft.
WSE Max = 2002 ft.
Well Depth = 420 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 625 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3590 ft.
WSE Max = 3611 ft.
Well Depth = 250 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 626 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 3636 ft.
WSE Max = 3652 ft.
Well Depth = 120 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 627 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1730 ft.
WSE Max = 2076 ft.
Well Depth = 960 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2289
2269
2249
2229
2209
2189
2169
2149
2129
2109
2089
2069
2049
2029
2009
1989
1969
1949
1929
1909
1889
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1849
1829
1809
1789
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1709
1689
1669
1649
1629
1609
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1569
1549
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2016
2019

OPTI Well 628 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1792 ft.
WSE Max = 2078 ft.
Well Depth = 941 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2398
2378
2358
2338
2318
2298
2278
2258
2238
2218
2198
2178
2158
2138
2118
2098
2078
2058
2038
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1978
1958
1938
1918
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2011
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2015
2016
2019

OPTI Well 629 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1826 ft.
WSE Max = 1970 ft.
Well Depth = 1000 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2389
2369
2349
2329
2309
2289
2269
2249
2229
2209
2189
2169
2149
2129
2109
2089
2069
2049
2029
2009
1989
1969
1949
1929
1909
1889
1869
1849
1829
1809
1789
1769
1749
1729
1709
1689
1669
1649
1629
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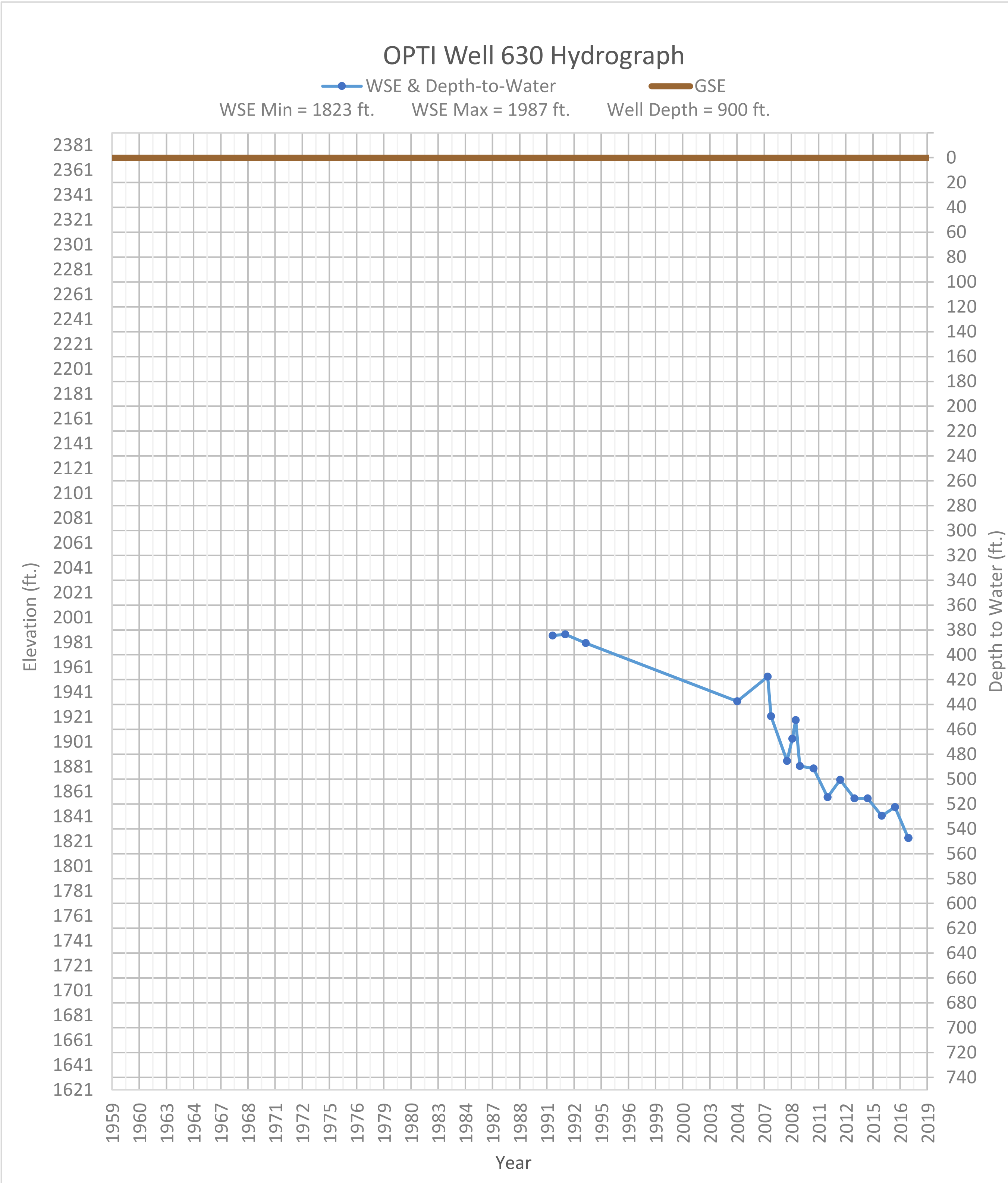

OPTI Well 630 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1823 ft.
WSE Max = 1987 ft.
Well Depth = 900 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2381
2361
2341
2321
2301
2281
2261
2241
2221
2201
2181
2161
2141
2121
2101
2081
2061
2041
2021
2001
1981
1961
1941
1921
1901
1881
1861
1841
1821
1801
1781
1761
1741
1721
1701
1681
1661
1641
1621
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2011
2012
2015
2016
2019


OPTI Well 631 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1830 ft.
WSE Max = 2033 ft.
Well Depth = 960 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2377
2357
2337
2317
2297
2277
2257
2237
2217
2197
2177
2157
2137
2117
2097
2077
2057
2037
2017
1997
1977
1957
1937
1917
1897
1877
1857
1837
1817
1797
1777
1757
1737
1717
1697
1677
1657
1637
1617
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2016
2019

OPTI Well 632 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1837 ft.
WSE Max = 2252 ft.
Well Depth = 960 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 633 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1813 ft.
WSE Max = 1958 ft.
Well Depth = 1000 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2374
2354
2334
2314
2294
2274
2254
2234
2214
2194
2174
2154
2134
2114
2094
2074
2054
2034
2014
1994
1974
1954
1934
1914
1894
1874
1854
1834
1814
1794
1774
1754
1734
1714
1694
1674
1654
1634
1614
0
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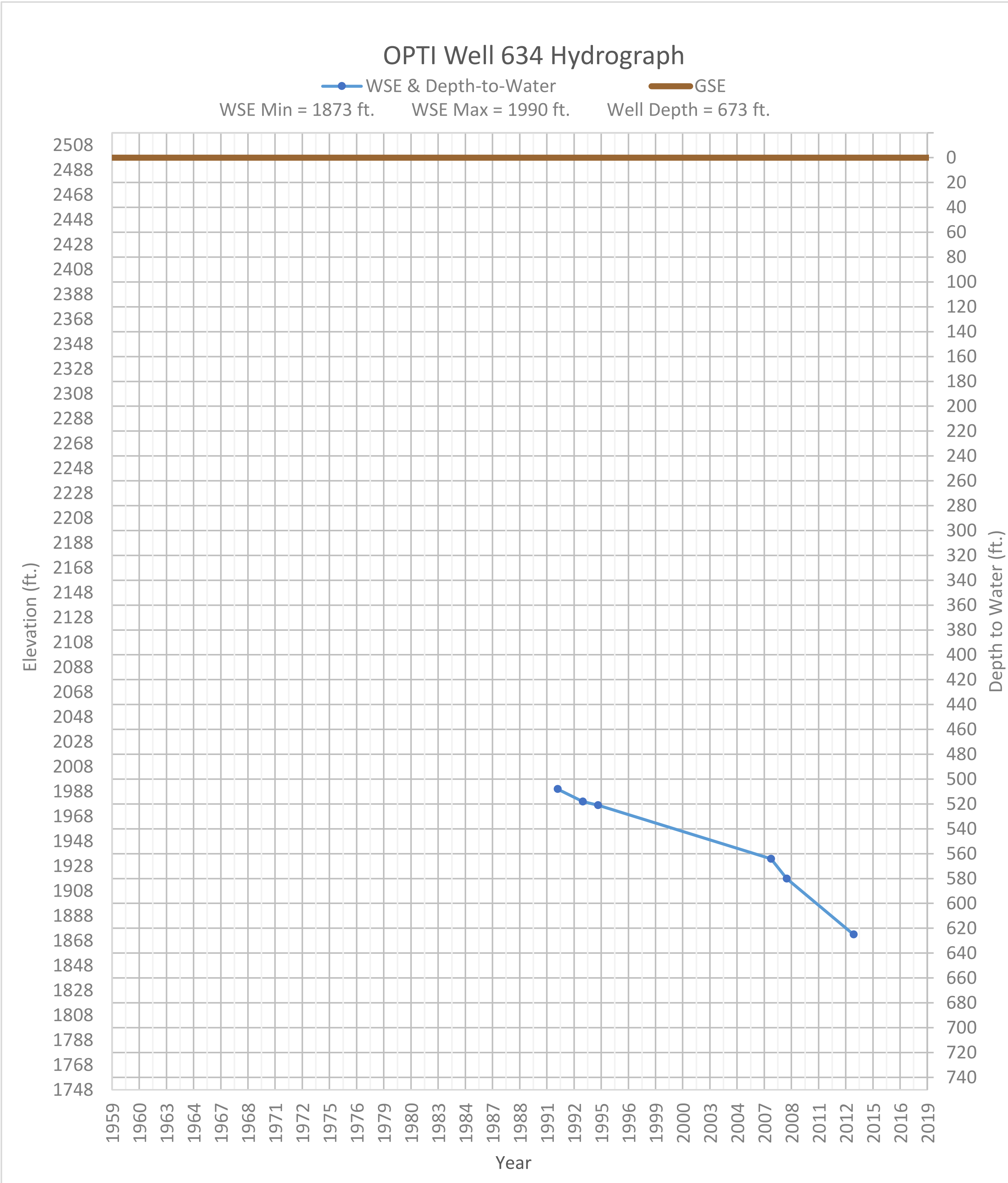
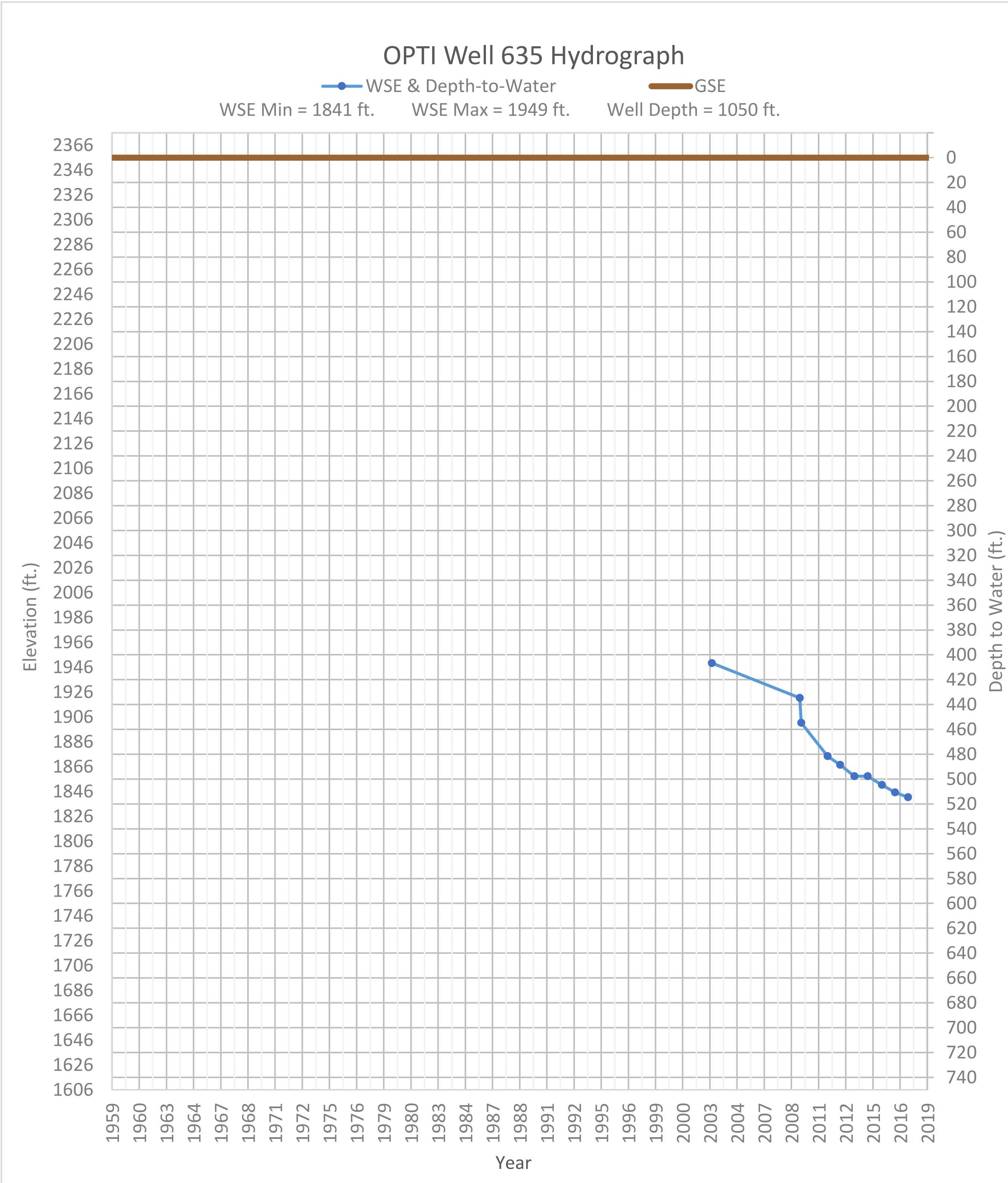


OPTI Well 634 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1873 ft.
WSE Max = 1990 ft.
Well Depth = 673 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 635 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1841 ft.
WSE Max = 1949 ft.
Well Depth = 1050 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2366
2346
2326
2306
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
1786
1766
1746
1726
1706
1686
1666
1646
1626
1606
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20
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80
100
120
140
160
180
200
220
240
260
280
300
320
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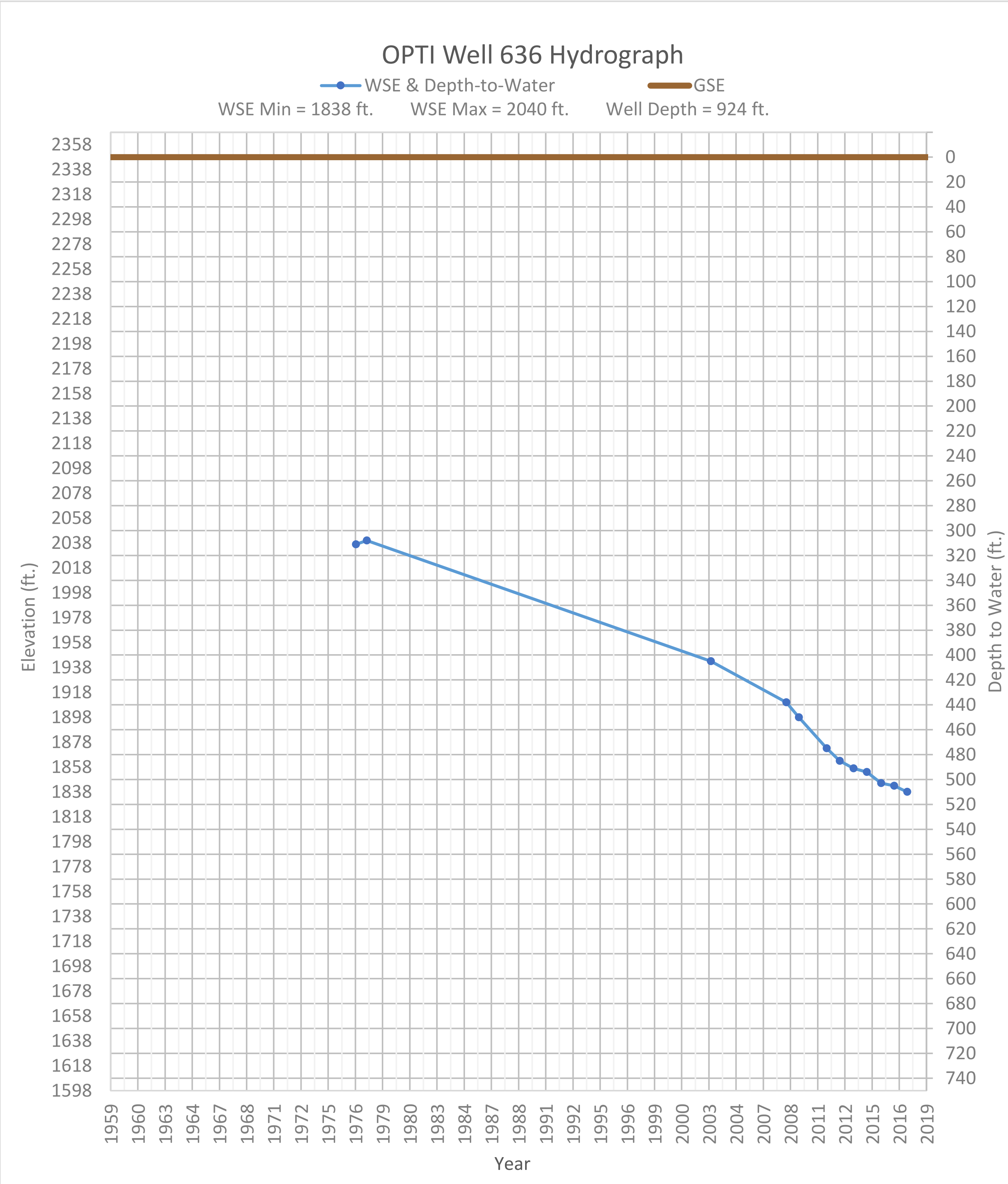
OPTI Well 636 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1838 ft.
WSE Max = 2040 ft.
Well Depth = 924 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2358
2338
2318
2298
2278
2258
2238
2218
2198
2178
2158
2138
2118
2098
2078
2058
2038
2018
1998
1978
1958
1938
1918
1898
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1678
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1638
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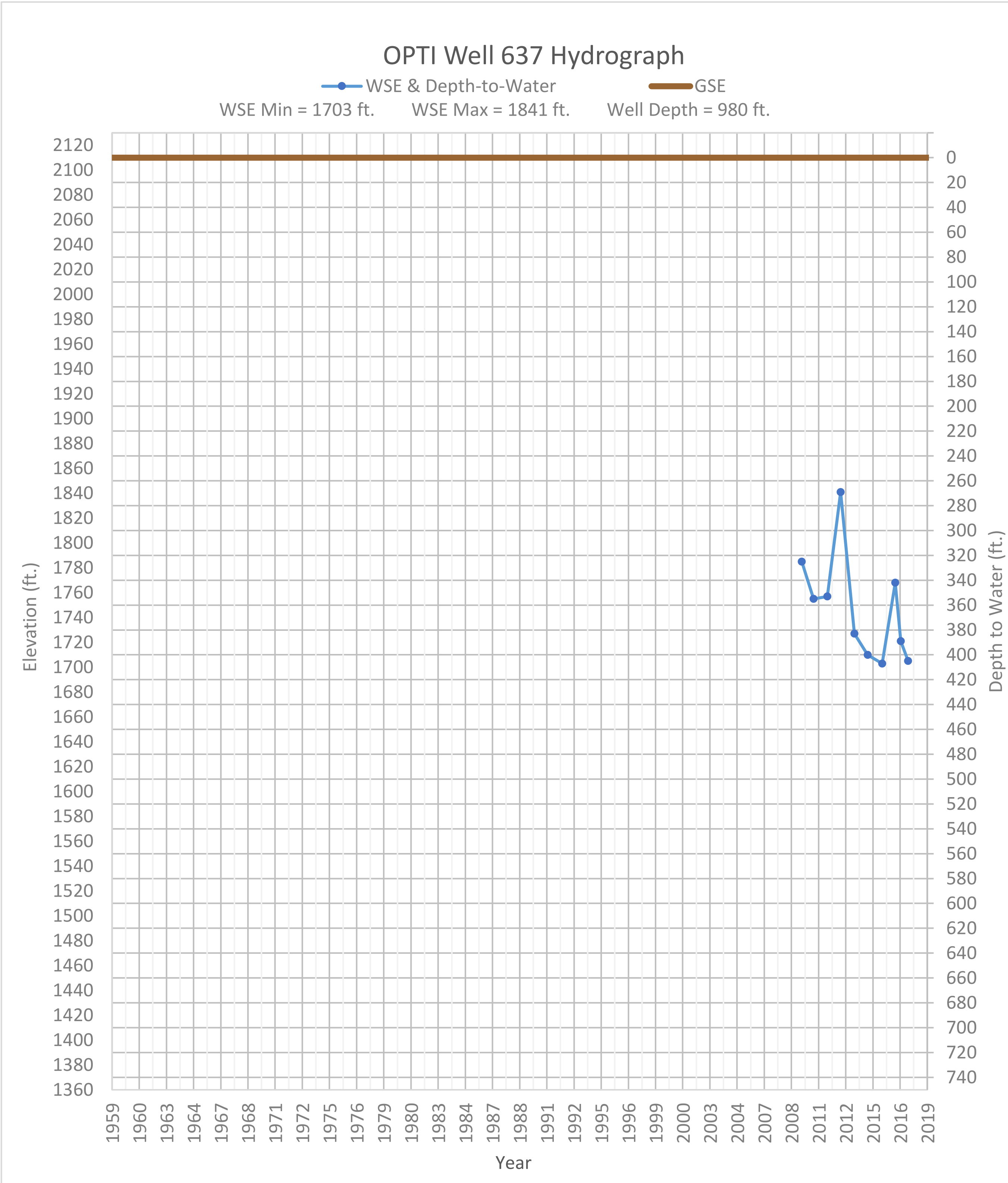
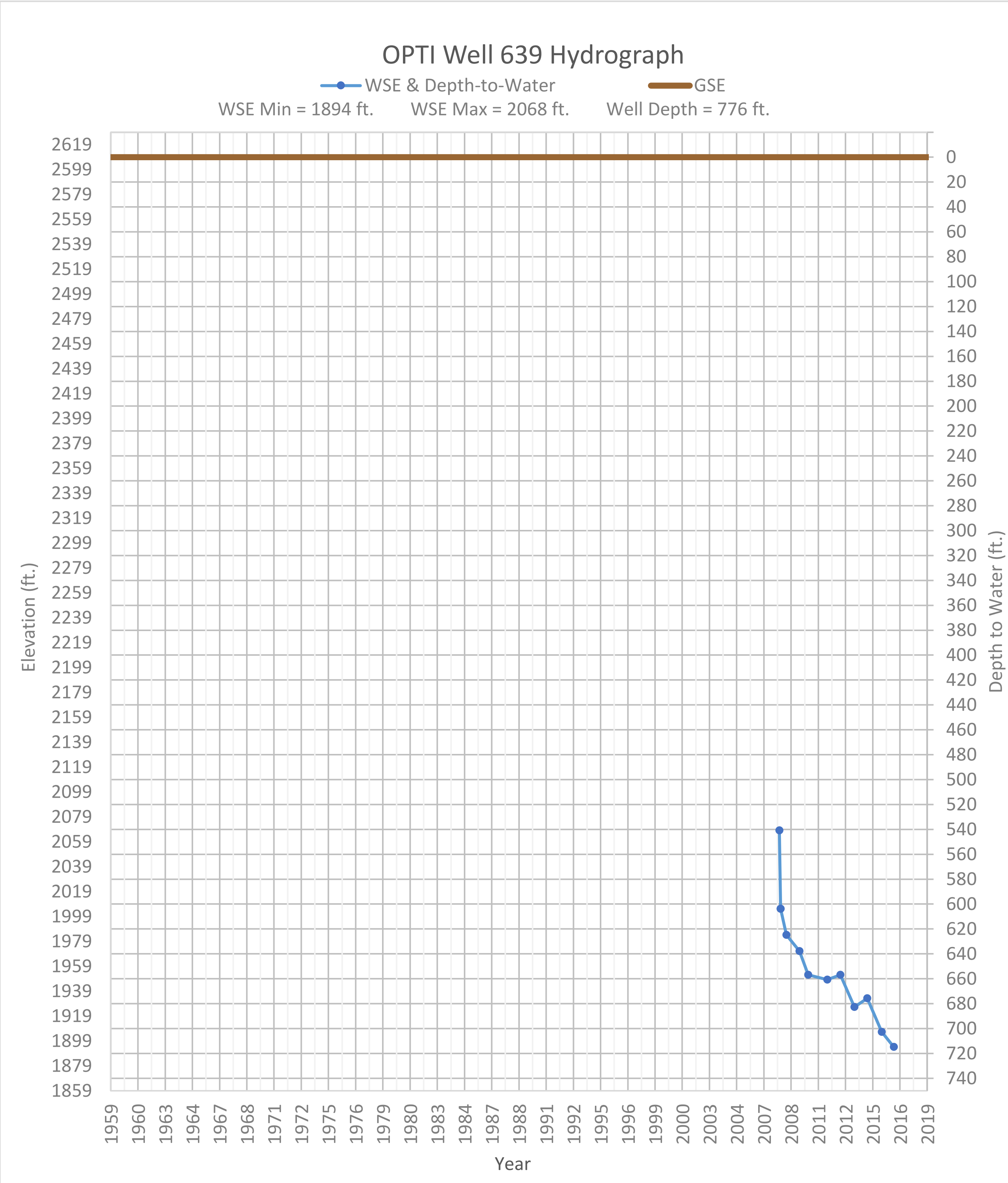
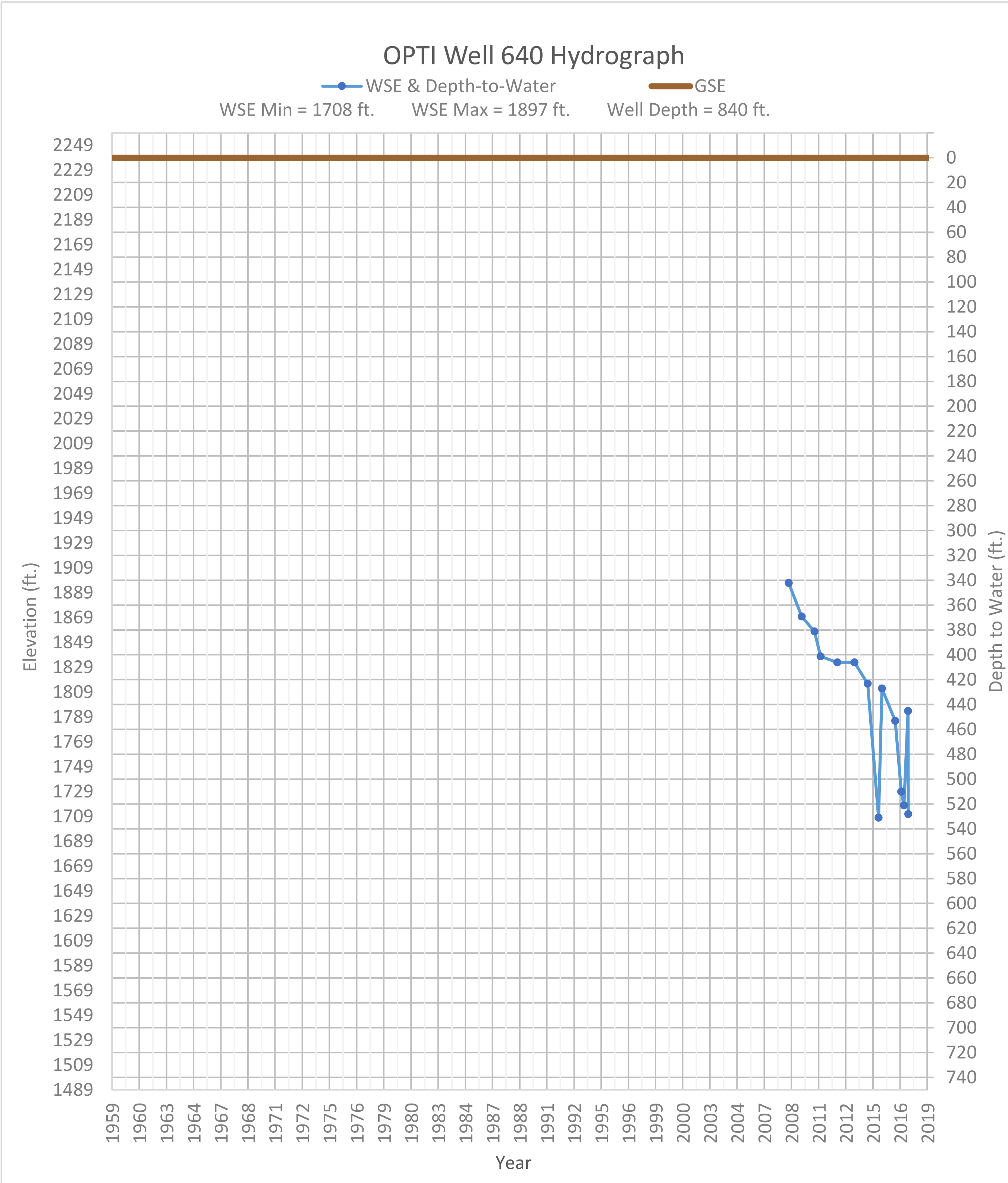


OPTI Well 637 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1703 ft.
WSE Max = 1841 ft.
Well Depth = 980 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 638 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1833 ft.
WSE Max = 1929 ft.
Well Depth = 1006 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

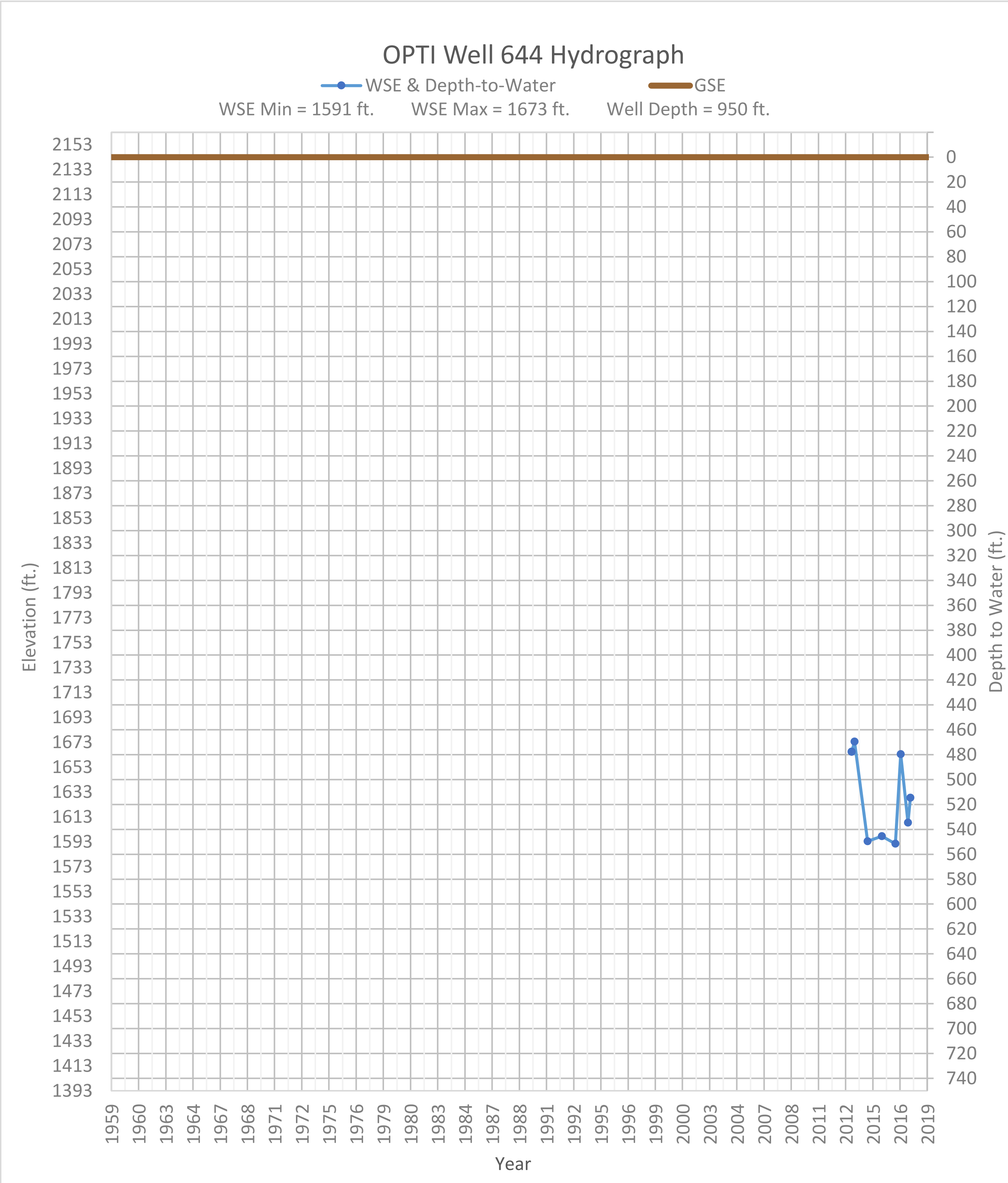


OPTI Well 639 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1894 ft.
WSE Max = 2068 ft.
Well Depth = 776 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

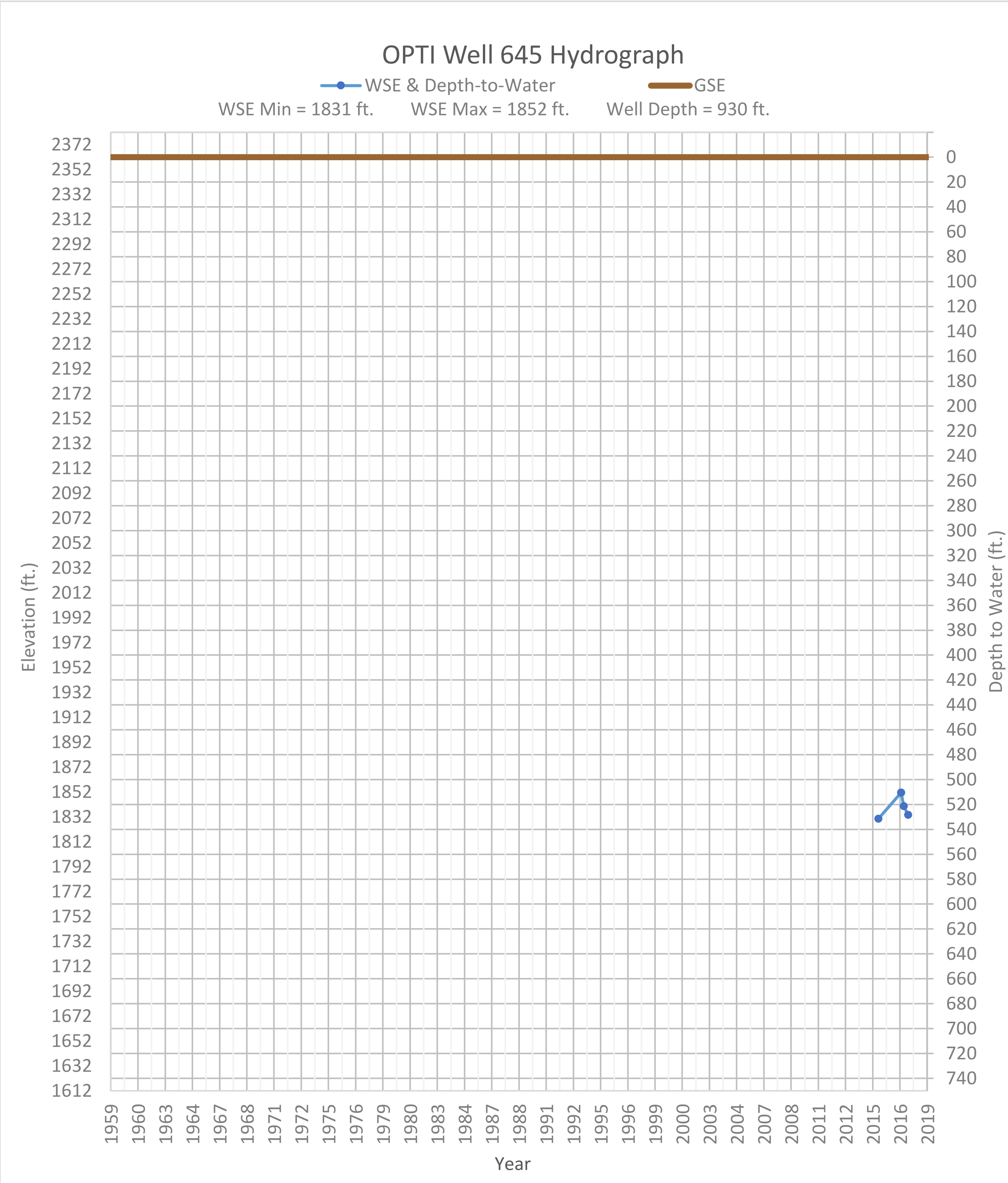

OPTI Well 640 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1708 ft.
WSE Max = 1897 ft.
Well Depth = 840 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 641 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1762 ft.
WSE Max = 1864 ft.
Well Depth = 800 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 642 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1745 ft.
WSE Max = 1907 ft.
Well Depth = 1000 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 644 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1591 ft.
WSE Max = 1673 ft.
Well Depth = 950 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 645 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1831 ft.
WSE Max = 1852 ft.
Well Depth = 930 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2372
2352
2332
2312
2292
2272
2252
2232
2212
2192
2172
2152
2132
2112
2092
2072
2052
2032
2012
1992
1972
1952
1932
1912
1892
1872
1852
1832
1812
1792
1772
1752
1732
1712
1692
1672
1652
1632
1612
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180
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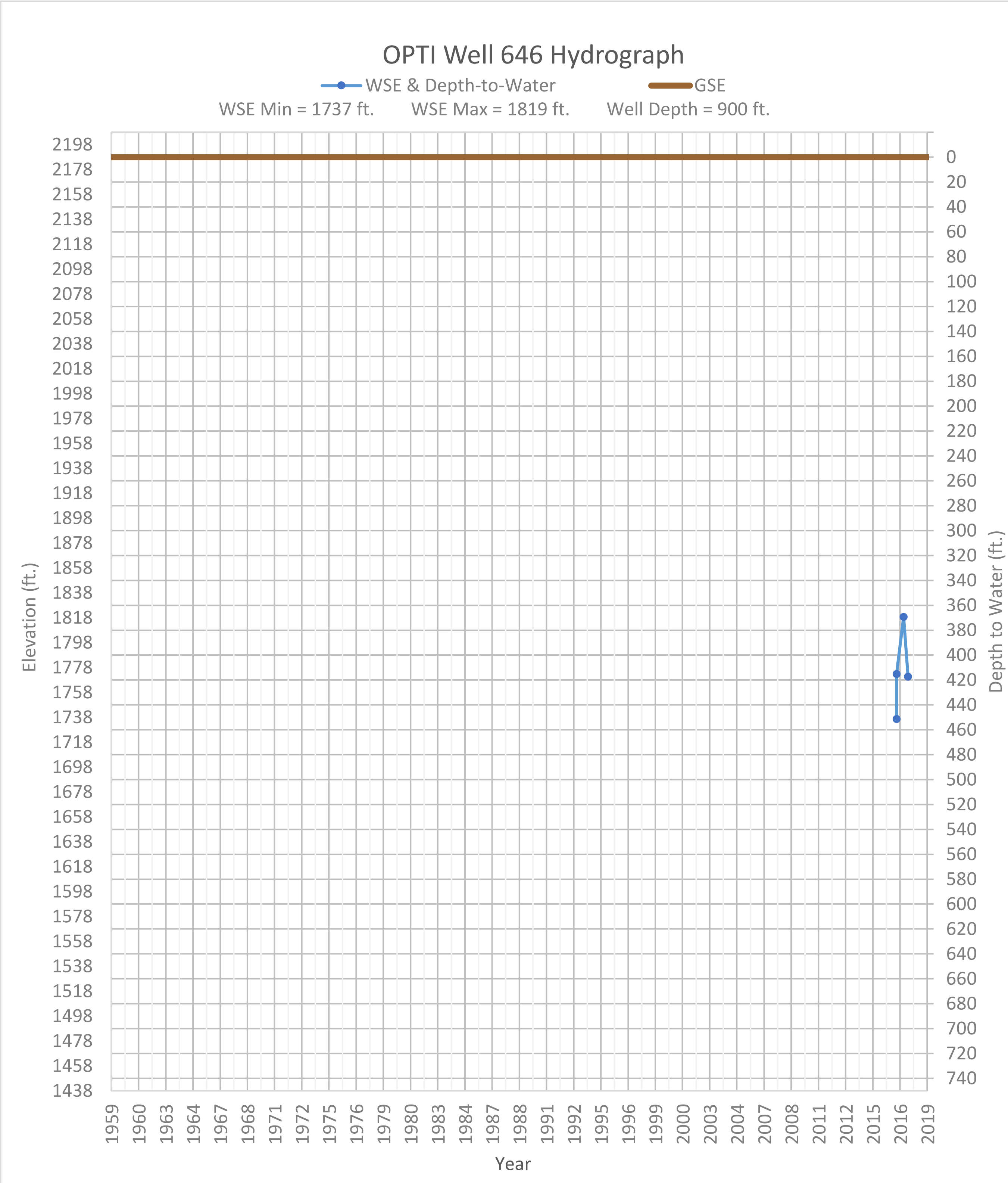
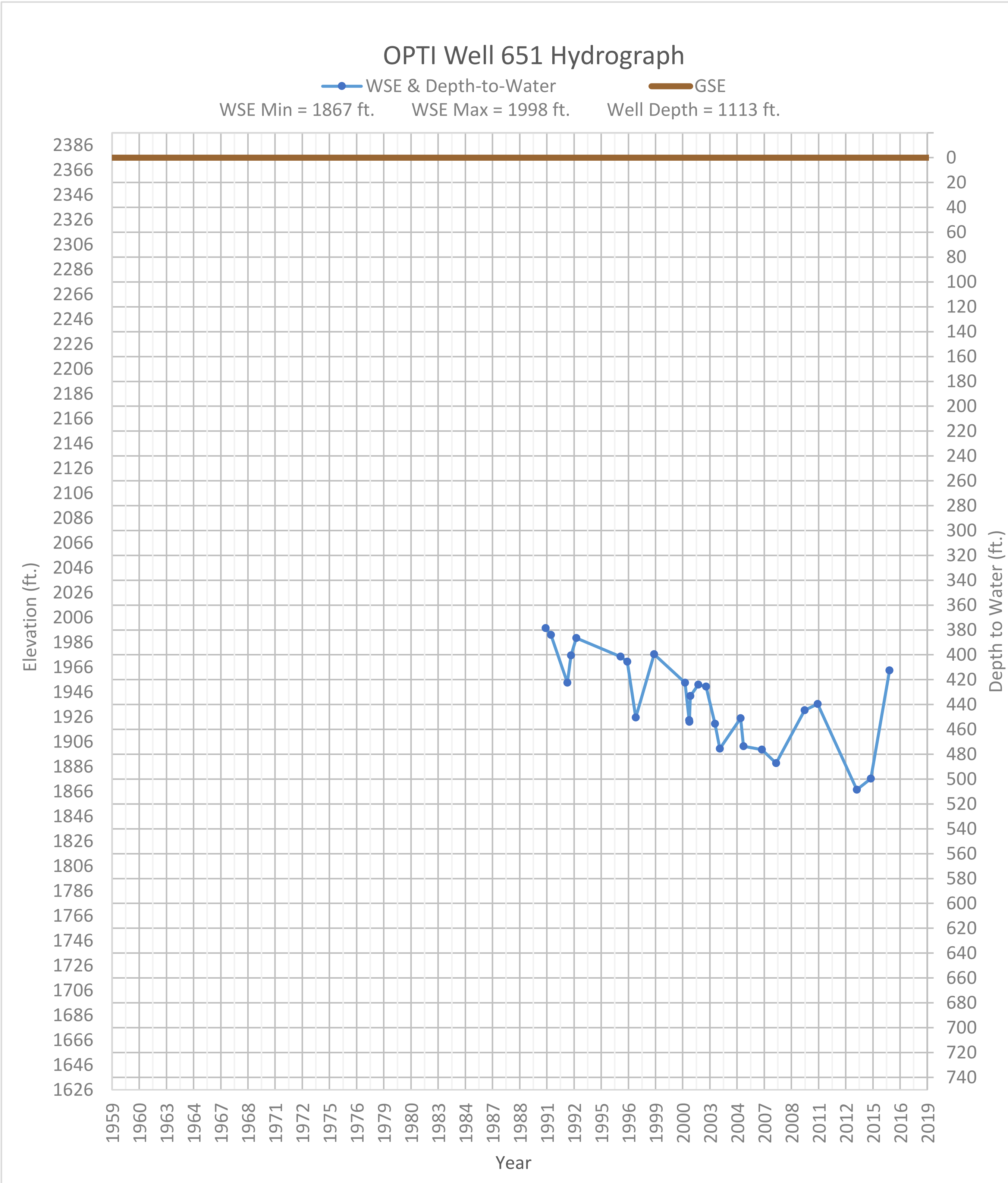
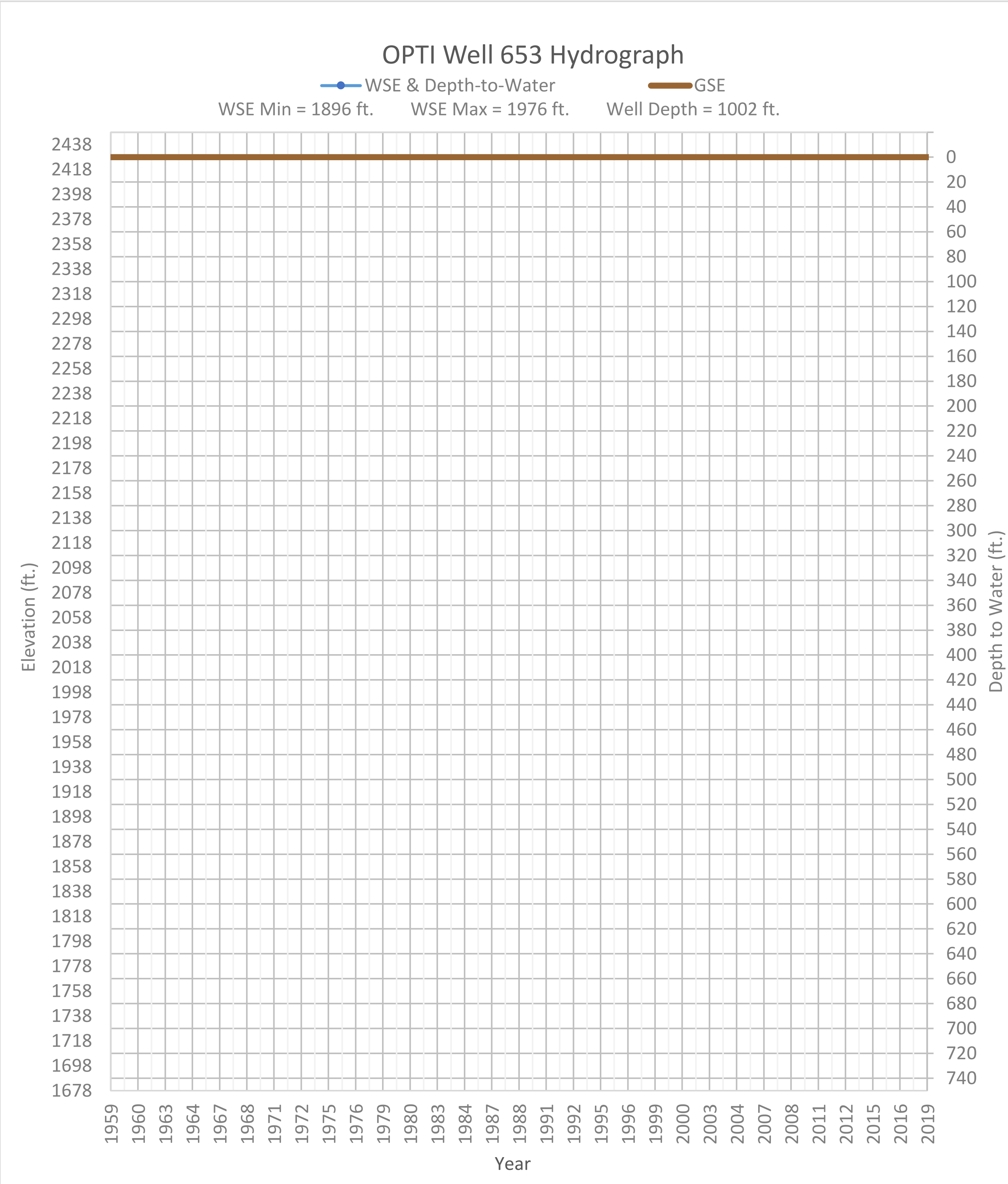
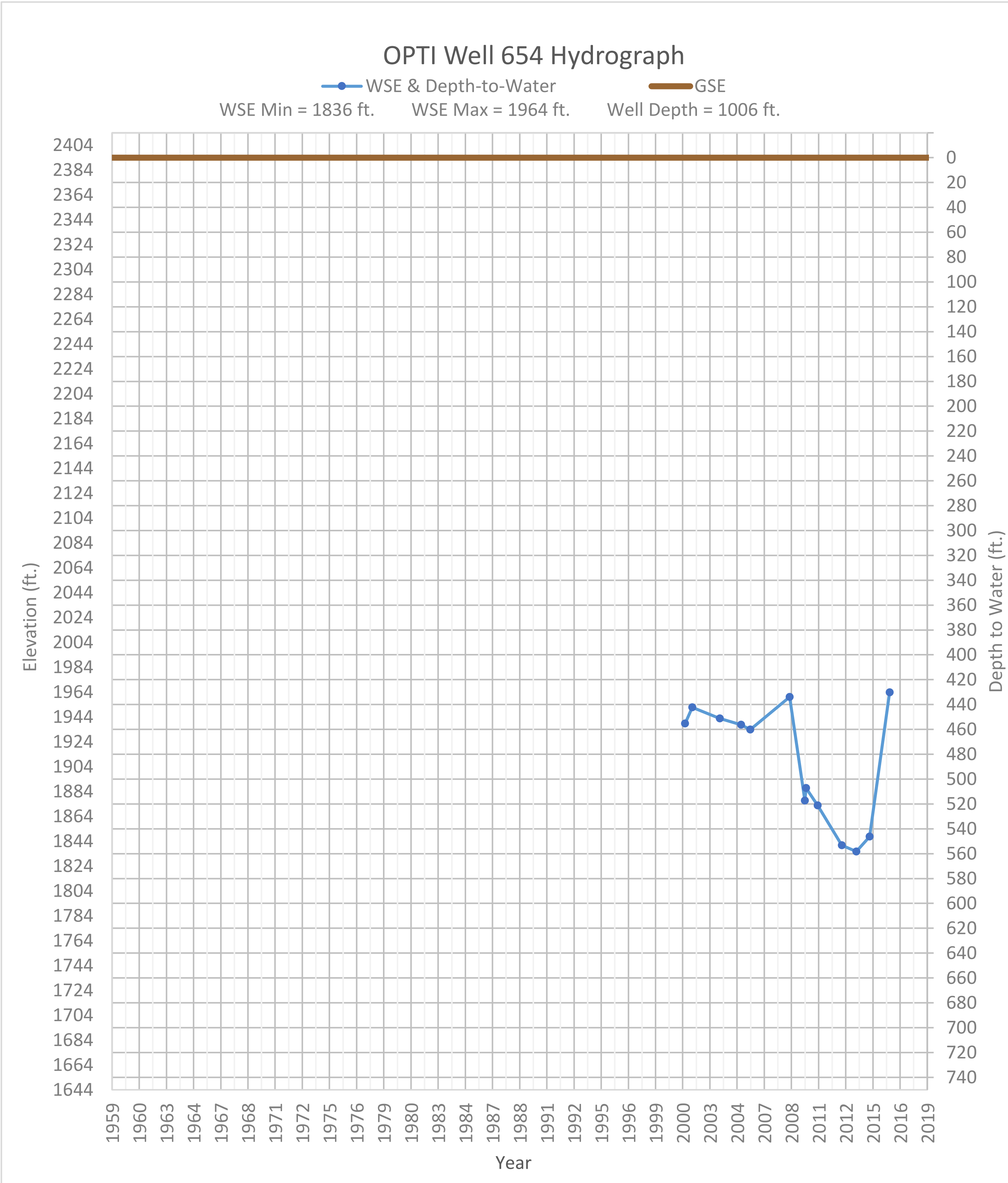


OPTI Well 646 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1737 ft.
WSE Max = 1819 ft.
Well Depth = 900 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 651 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1867 ft.
WSE Max = 1998 ft.
Well Depth = 1113 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 653 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1896 ft.
WSE Max = 1976 ft.
Well Depth = 1002 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 654 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1836 ft.
WSE Max = 1964 ft.
Well Depth = 1006 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2404
2384
2364
2344
2324
2304
2284
2264
2244
2224
2204
2184
2164
2144
2124
2104
2084
2064
2044
2024
2004
1984
1964
1944
1924
1904
1884
1864
1844
1824
1804
1784
1764
1744
1724
1704
1684
1664
1644
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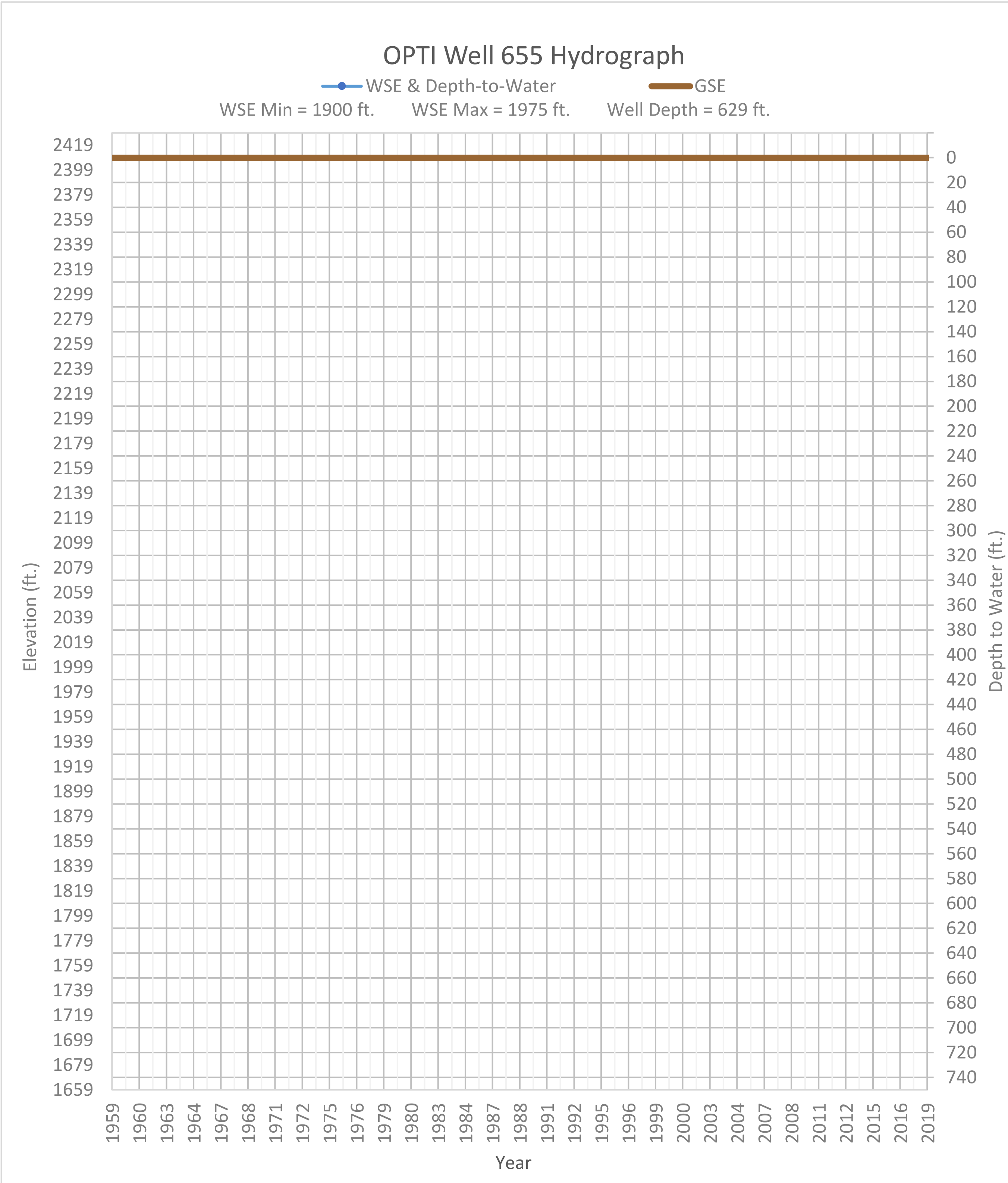
OPTI Well 655 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1900 ft.
WSE Max = 1975 ft.
Well Depth = 629 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2419
2399
2379
2359
2339
2319
2299
2279
2259
2239
2219
2199
2179
2159
2139
2119
2099
2079
2059
2039
2019
1999
1979
1959
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2004
2007
2008
2011
2012
2015
2016
2019

OPTI Well 656 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1916 ft.
WSE Max = 1979 ft.
Well Depth = 930 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 657 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1804 ft.
WSE Max = 2000 ft.
Well Depth = 932 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2355
2335
2315
2295
2275
2255
2235
2215
2195
2175
2155
2135
2115
2095
2075
2055
2035
2015
1995
1975
1955
1935
1915
1895
1875
1855
1835
1815
1795
1775
1755
1735
1715
1695
1675
1655
1635
1615
1595
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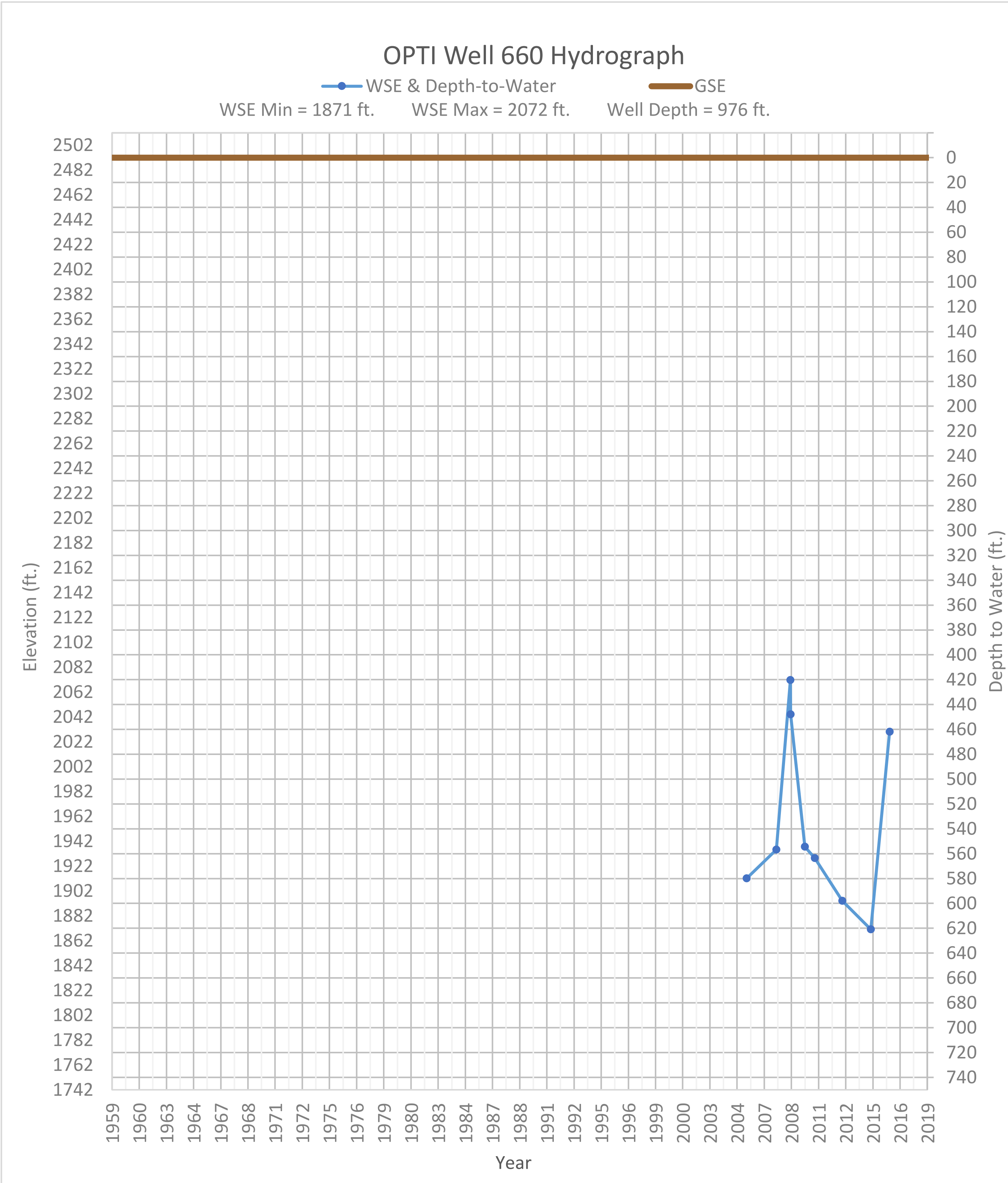
2011
2012
2015
2016
2019


OPTI Well 659 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1861 ft.
WSE Max = 1962 ft.
Well Depth = 869 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 660 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1871 ft.
WSE Max = 2072 ft.
Well Depth = 976 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2502
2482
2462
2442
2422
2402
2382
2362
2342
2322
2302
2282
2262
2242
2222
2202
2182
2162
2142
2122
2102
2082
2062
2042
2022
2002
1982
1962
1942
1922
1902
1882
1862
1842
1822
1802
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1742
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160
180
200
220
240
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360
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480
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540
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580
600
620
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660
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OPTI Well 661 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1875 ft.
WSE Max = 2002 ft.
Well Depth = 1000 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2454
2434
2414
2394
2374
2354
2334
2314
2294
2274
2254
2234
2214
2194
2174
2154
2134
2114
2094
2074
2054
2034
2014
1994
1974
1954
1934
1914
1894
1874
1854
1834
1814
1794
1774
1754
1734
1714
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OPTI Well 662 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1828 ft.
WSE Max = 1941 ft.
Well Depth = 740 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2390
2370
2350
2330
2310
2290
2270
2250
2230
2210
2190
2170
2150
2130
2110
2090
2070
2050
2030
2010
1990
1970
1950
1930
1910
1890
1870
1850
1830
1810
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1730
1710
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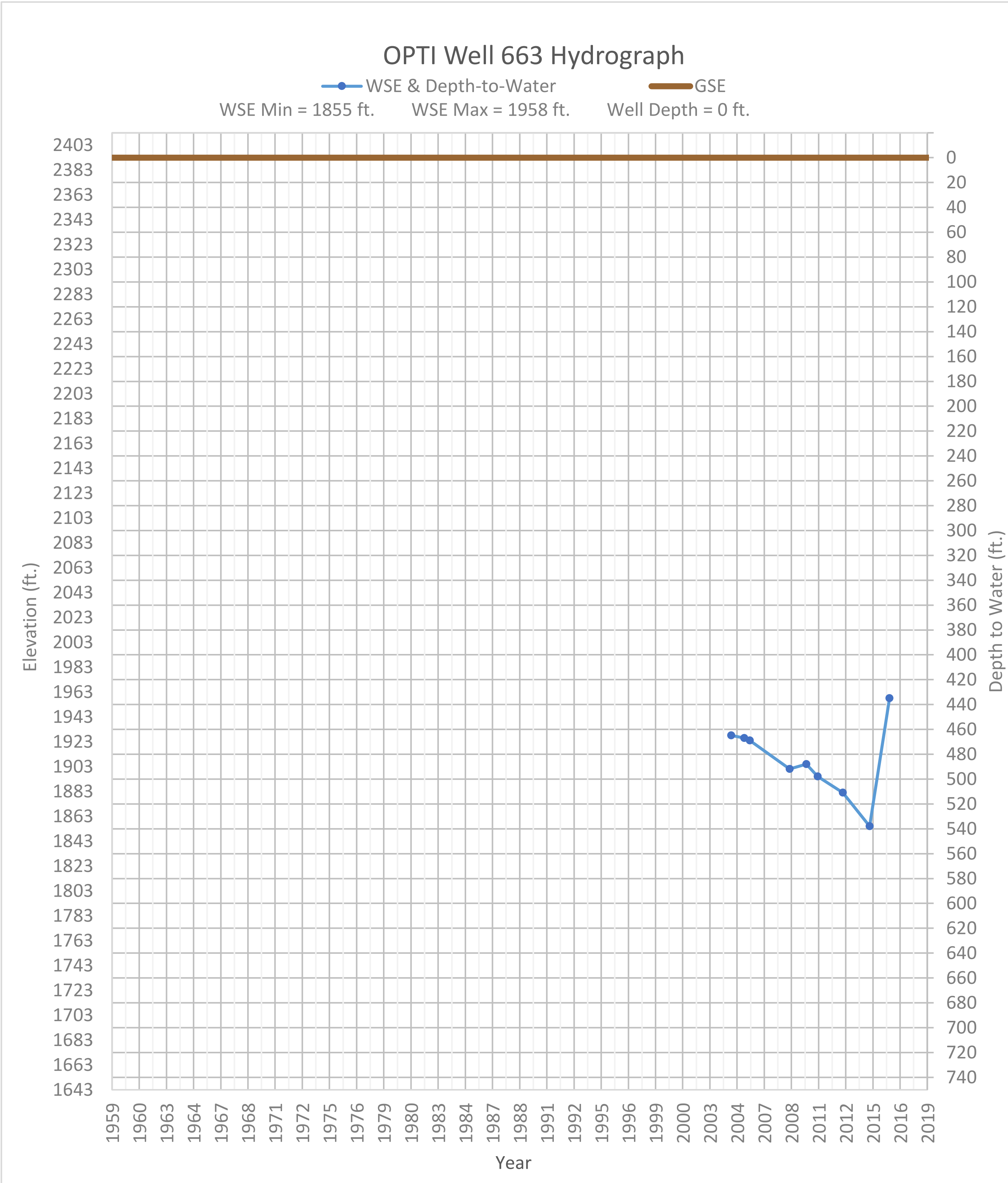
OPTI Well 663 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1855 ft.
WSE Max = 1958 ft.
Well Depth = 0 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2403
2383
2363
2343
2323
2303
2283
2263
2243
2223
2203
2183
2163
2143
2123
2103
2083
2063
2043
2023
2003
1983
1963
1943
1923
1903
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1643
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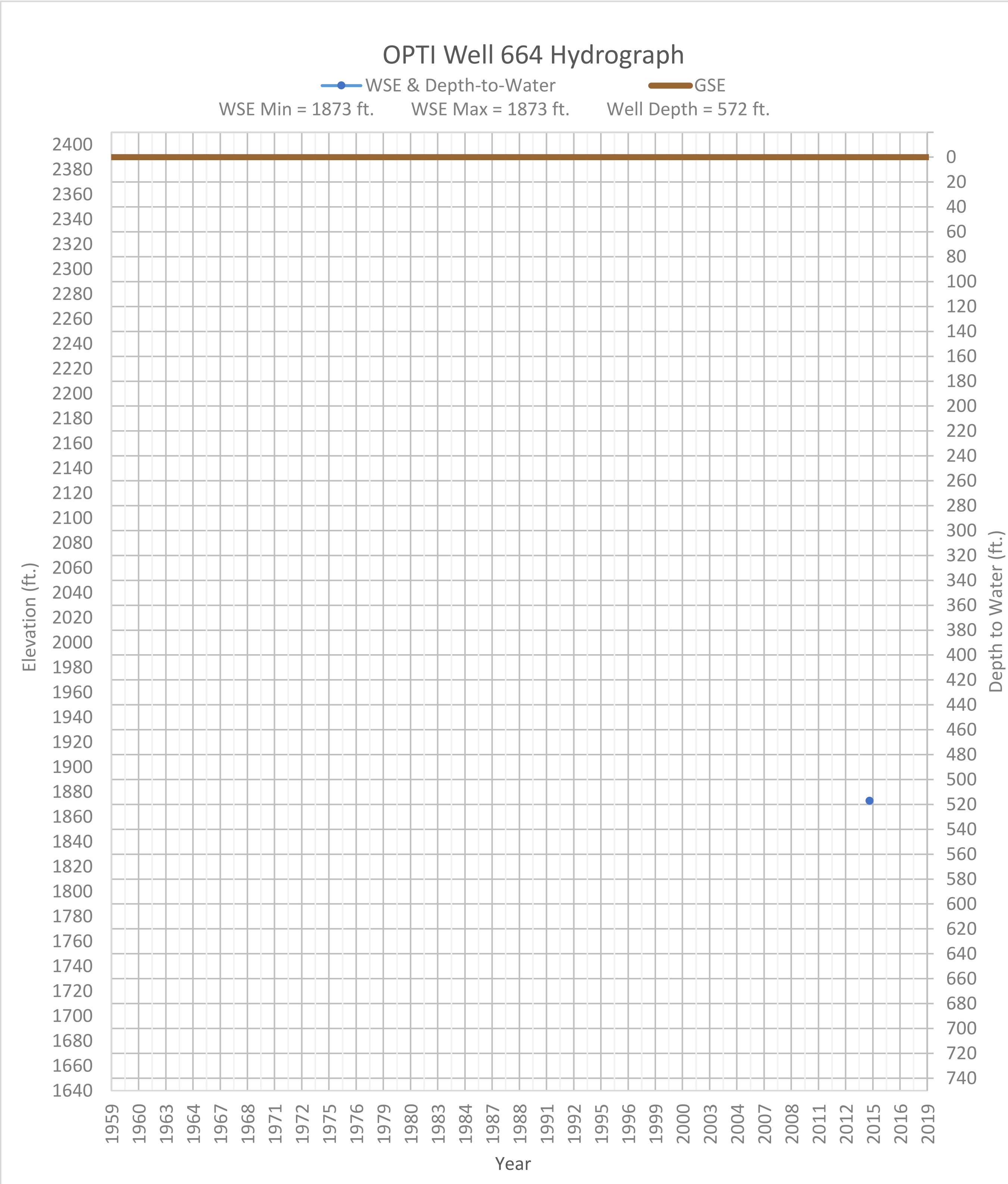
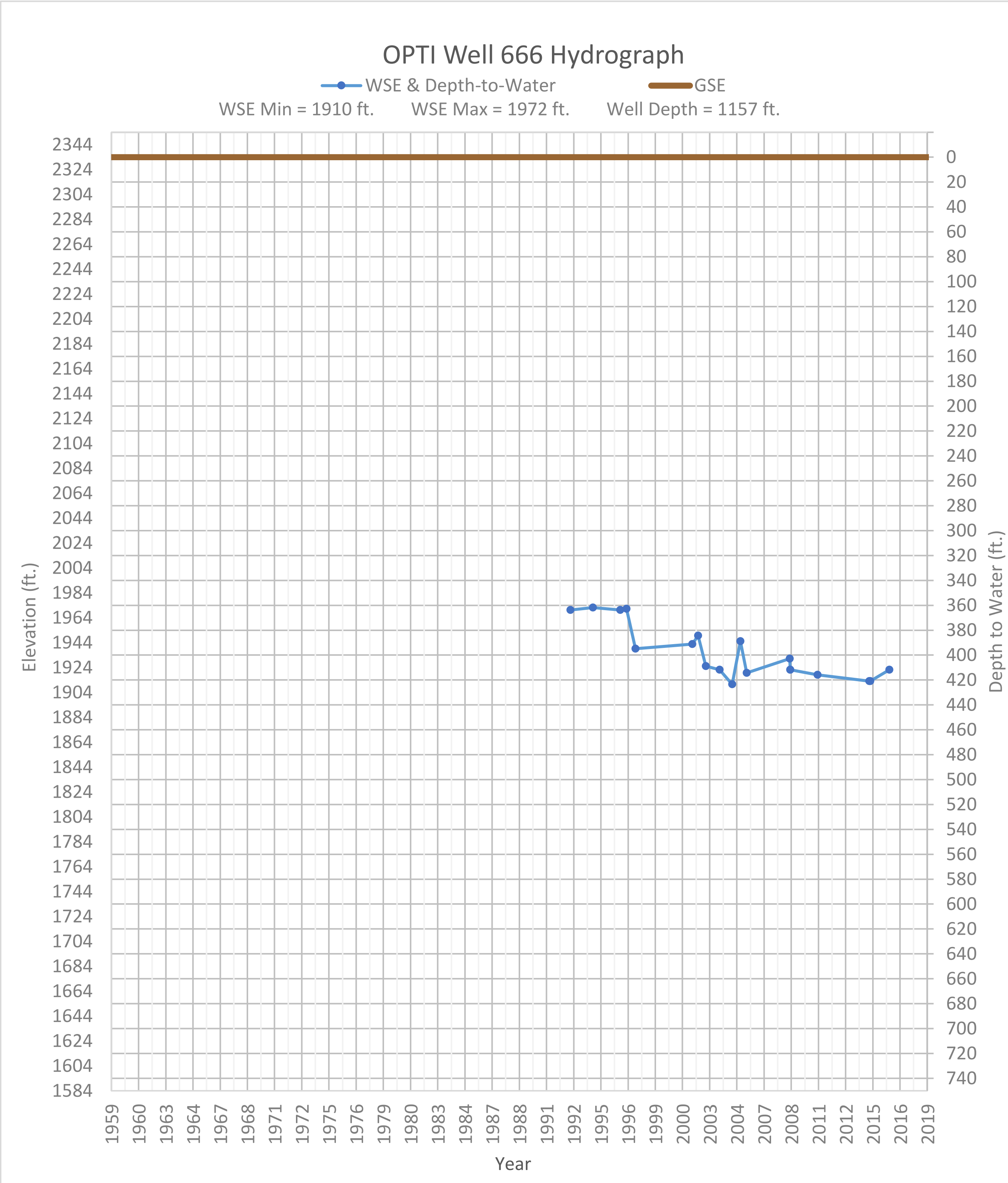


OPTI Well 664 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1873 ft.
WSE Max = 1873 ft.
Well Depth = 572 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 665 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1821 ft.
WSE Max = 1975 ft.
Well Depth = 1200 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 666 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1910 ft.
WSE Max = 1972 ft.
Well Depth = 1157 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2344
2324
2304
2284
2264
2244
2224
2204
2184
2164
2144
2124
2104
2084
2064
2044
2024
2004
1984
1964
1944
1924
1904
1884
1864
1844
1824
1804
1784
1764
1744
1724
1704
1684
1664
1644
1624
1604
1584
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OPTI Well 667 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1829 ft.
WSE Max = 2219 ft.
Well Depth = 1083 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 668 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1764 ft.
WSE Max = 1925 ft.
Well Depth = 1002 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2323
2303
2283
2263
2243
2223
2203
2183
2163
2143
2123
2103
2083
2063
2043
2023
2003
1983
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1943
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1783
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1683
1663
1643
1623
1603
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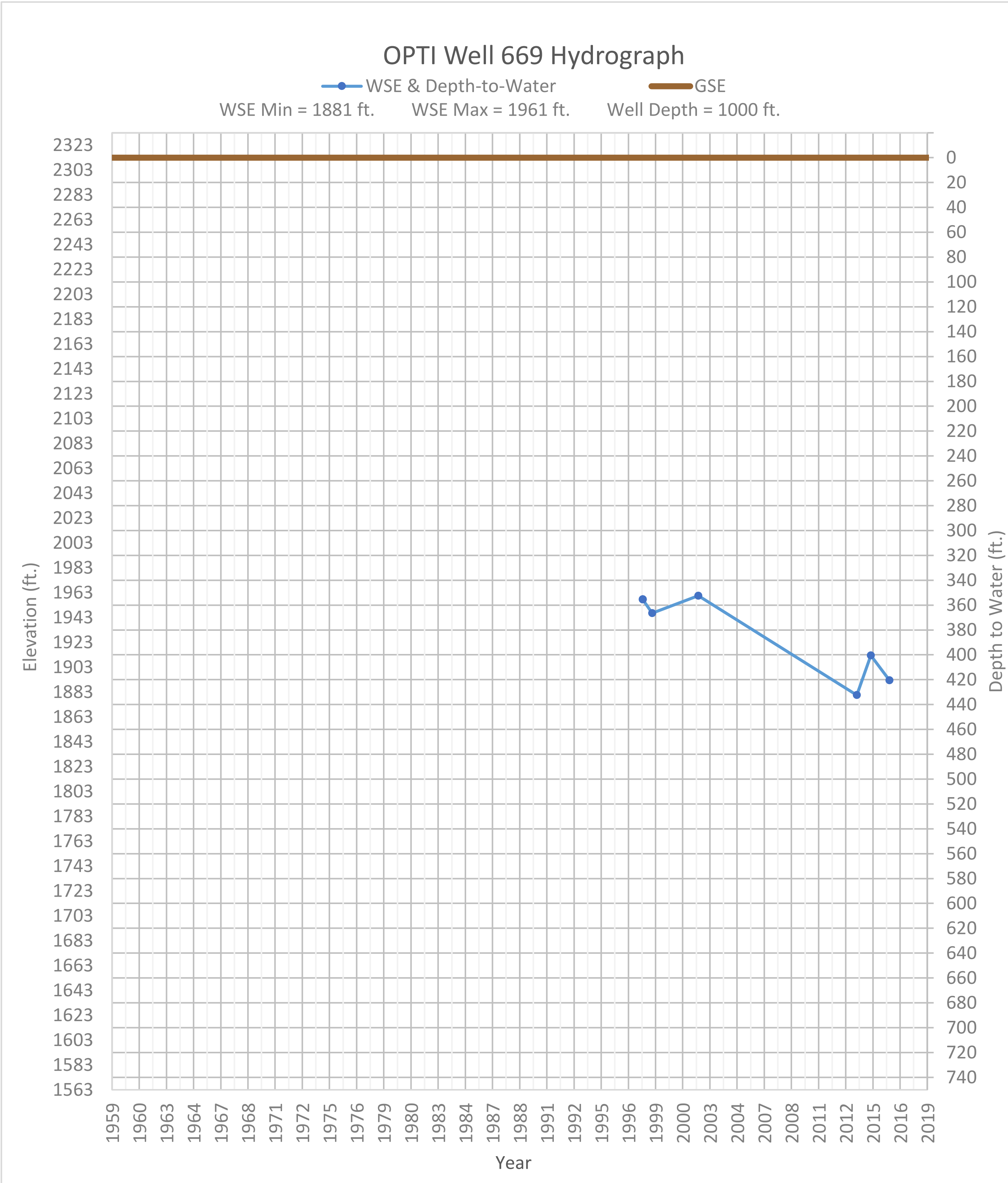

OPTI Well 669 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1881 ft.
WSE Max = 1961 ft.
Well Depth = 1000 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2323
2303
2283
2263
2243
2223
2203
2183
2163
2143
2123
2103
2083
2063
2043
2023
2003
1983
1963
1943
1923
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1883
1863
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1823
1803
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1683
1663
1643
1623
1603
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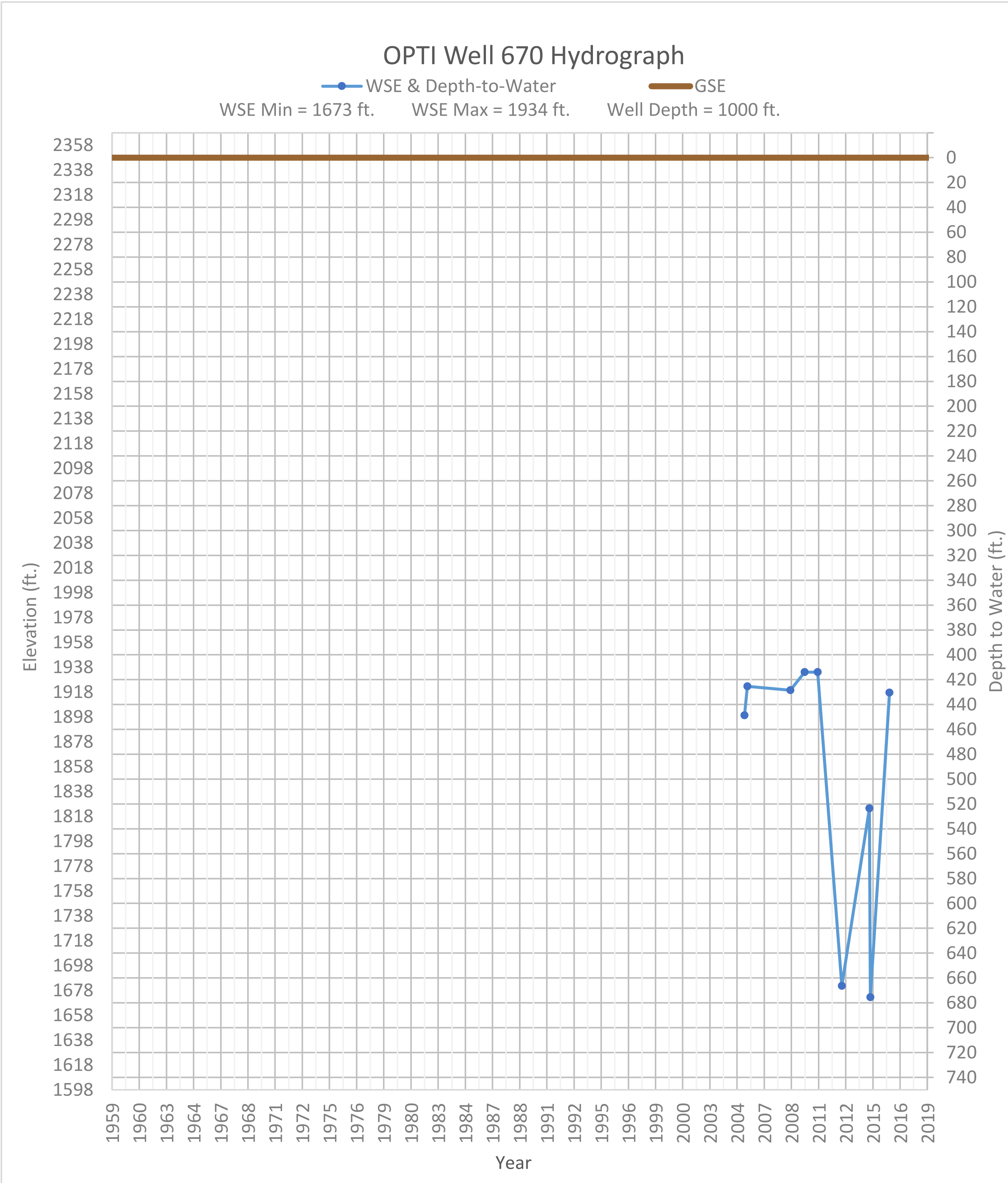

OPTI Well 670 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1673 ft.
WSE Max = 1934 ft.
Well Depth = 1000 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2358
2338
2318
2298
2278
2258
2238
2218
2198
2178
2158
2138
2118
2098
2078
2058
2038
2018
1998
1978
1958
1938
1918
1898
1878
1858
1838
1818
1798
1778
1758
1738
1718
1698
1678
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2011
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2015
2016
2019

OPTI Well 671 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1852 ft.
WSE Max = 1992 ft.
Well Depth = 1002 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2289
2269
2249
2229
2209
2189
2169
2149
2129
2109
2089
2069
2049
2029
2009
1989
1969
1949
1929
1909
1889
1869
1849
1829
1809
1789
1769
1749
1729
1709
1689
1669
1649
1629
1609
1589
1569
1549
1529
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2016
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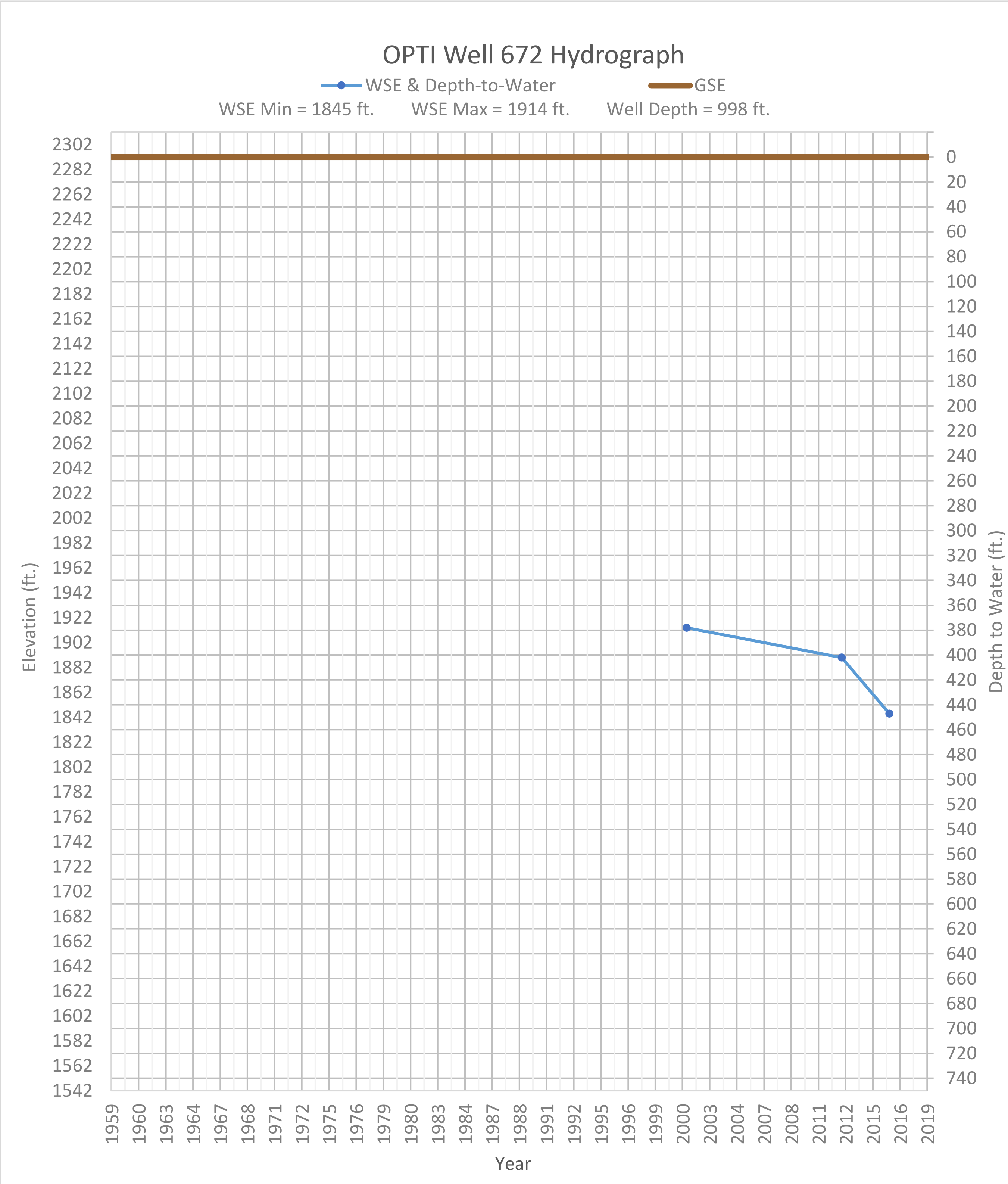

OPTI Well 672 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1845 ft.
WSE Max = 1914 ft.
Well Depth = 998 ft.
Elevation (ft.)
2302
2282
2262
2242
2222
2202
2182
2162
2142
2122
2102
2082
2062
2042
2022
2002
1982
1962
1942
1922
1902
1882
1862
1842
1822
1802
1782
1762
1742
1722
1702
1682
1662
1642
1622
1602
1582
1562
1542
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
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2008
2011
2012
2015
2016
2019
Year

OPTI Well 673 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1852 ft.
WSE Max = 1939 ft.
Well Depth = 1180 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2296
2276
2256
2236
2216
2196
2176
2156
2136
2116
2096
2076
2056
2036
2016
1996
1976
1956
1936
1916
1896
1876
1856
1836
1816
1796
1776
1756
1736
1716
1696
1676
1656
1636
1616
1596
1576
1556
1536
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2019


OPTI Well 674 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1809 ft.
WSE Max = 1960 ft.
Well Depth = 1100 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 675 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1859 ft.
WSE Max = 1951 ft.
Well Depth = 1203 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 676 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1740 ft.
WSE Max = 1960 ft.
Well Depth = 735 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 677 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1890 ft.
WSE Max = 1949 ft.
Well Depth = 941 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 678 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1881 ft.
WSE Max = 2167 ft.
Well Depth = 881 ft.
Elevation (ft.)
2379
2359
2339
2319
2299
2279
2259
2239
2219
2199
2179
2159
2139
2119
2099
2079
2059
2039
2019
1999
1979
1959
1939
1919
1899
1879
1859
1839
1819
1799
1779
1759
1739
1719
1699
1679
1659
1639
1619
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
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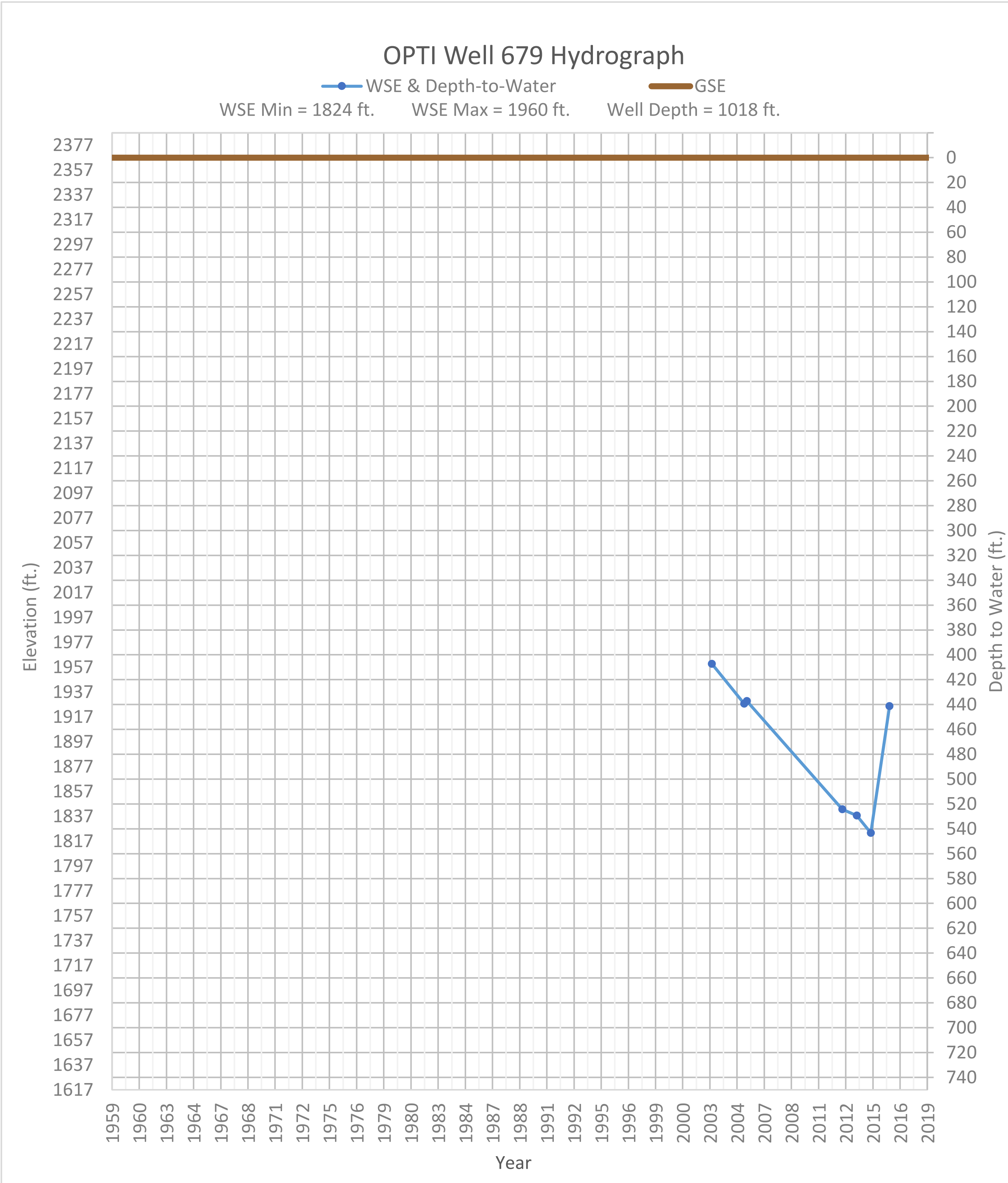
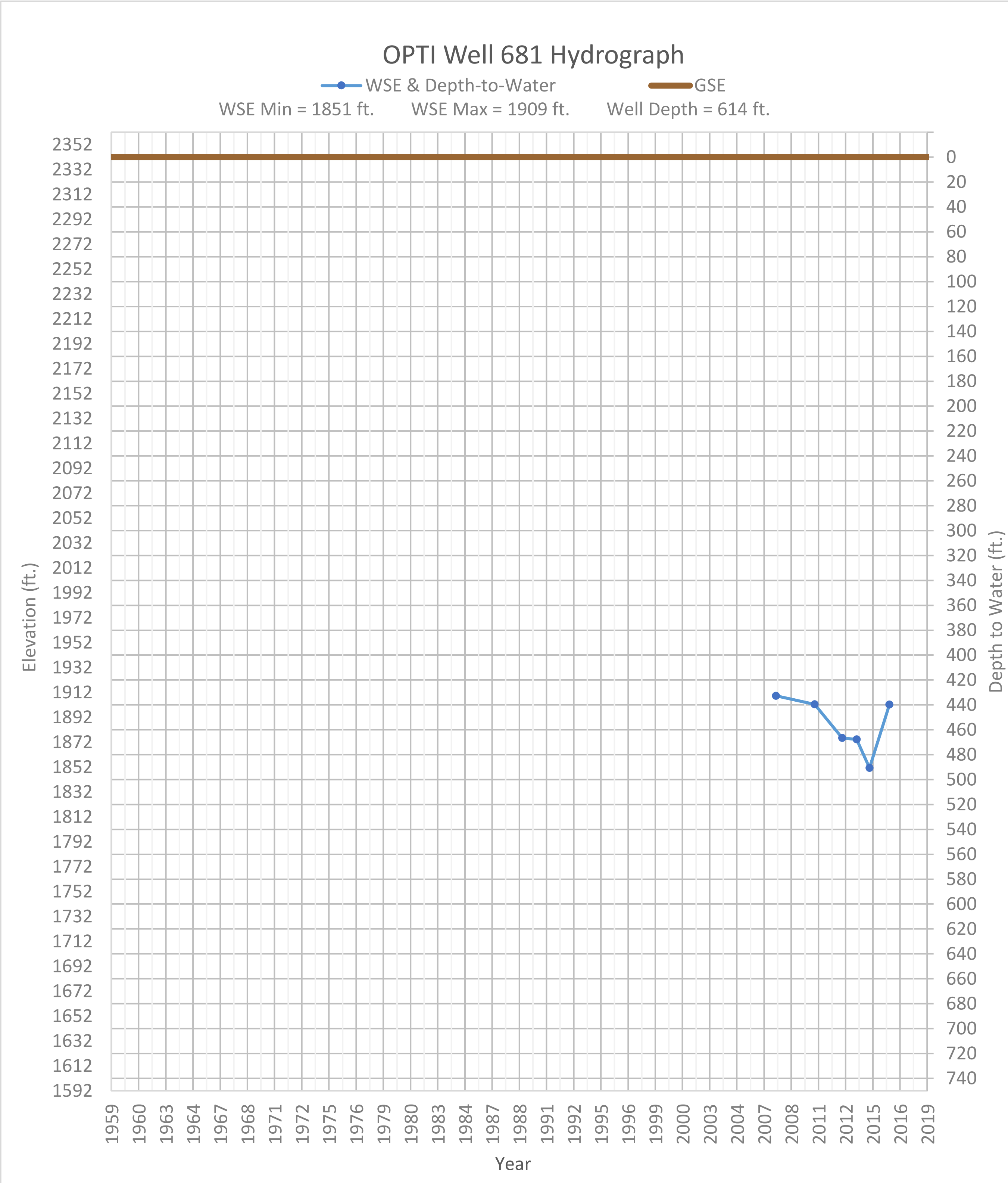
Year

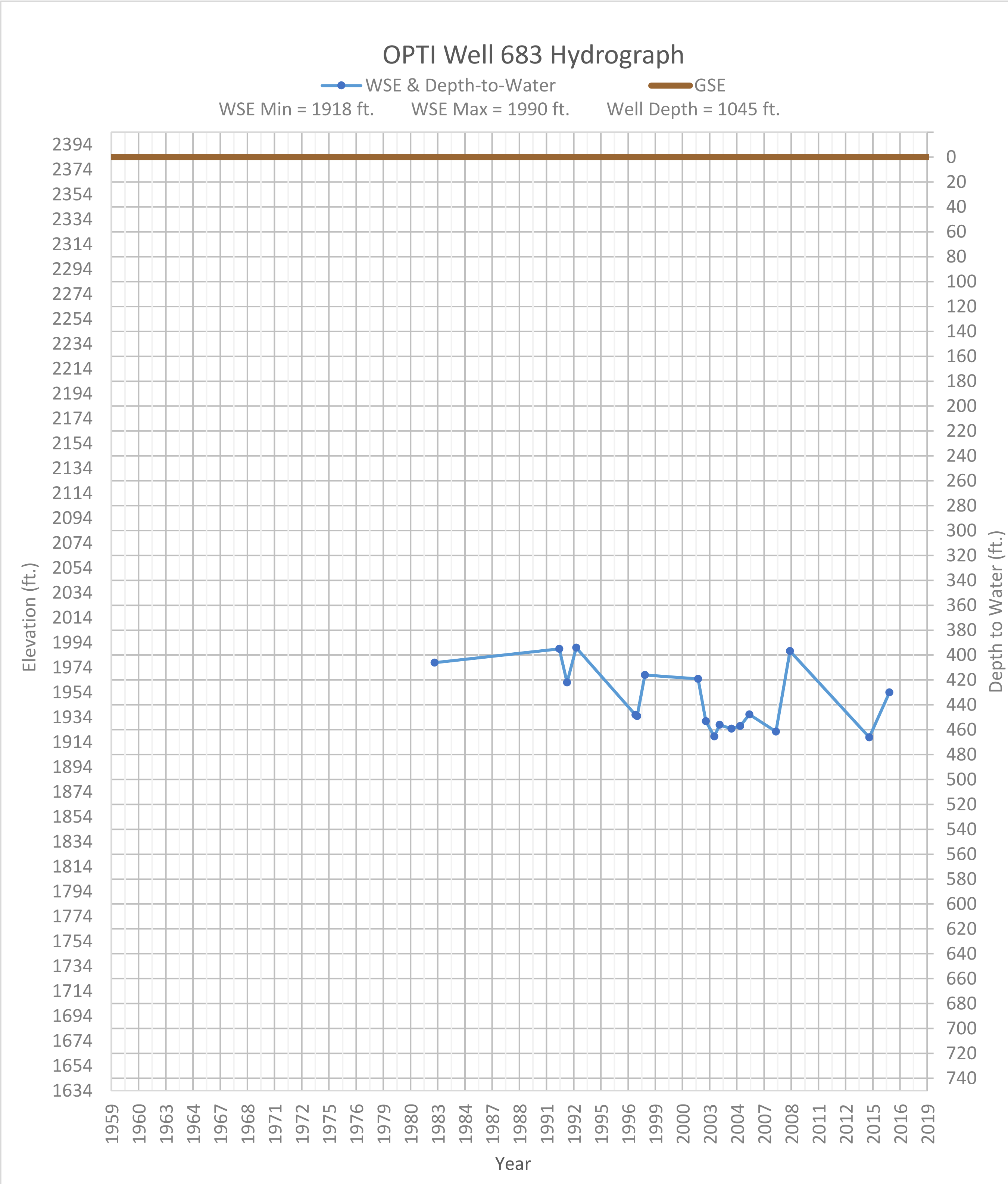


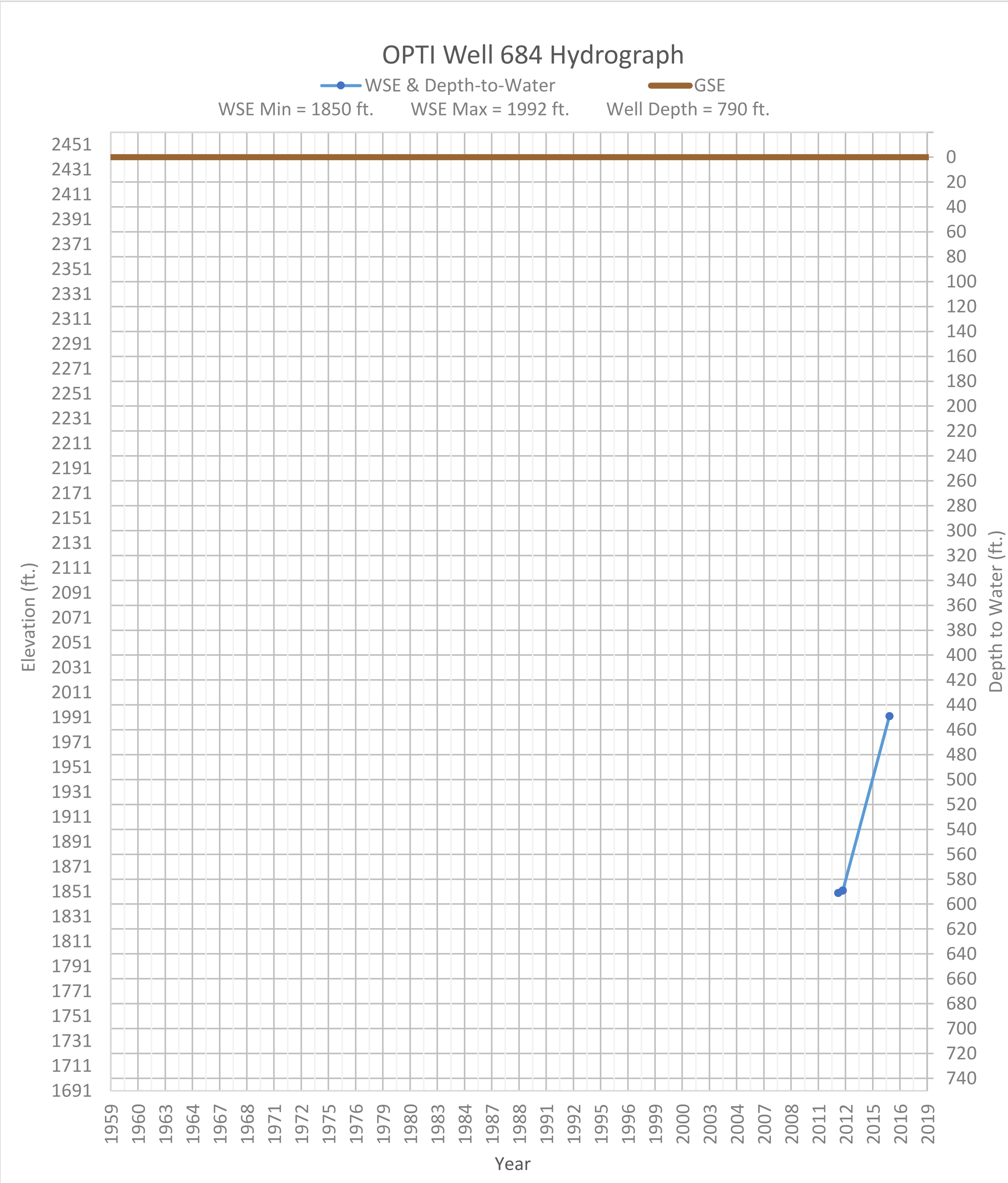
OPTI Well 679 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1824 ft.
WSE Max = 1960 ft.
Well Depth = 1018 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



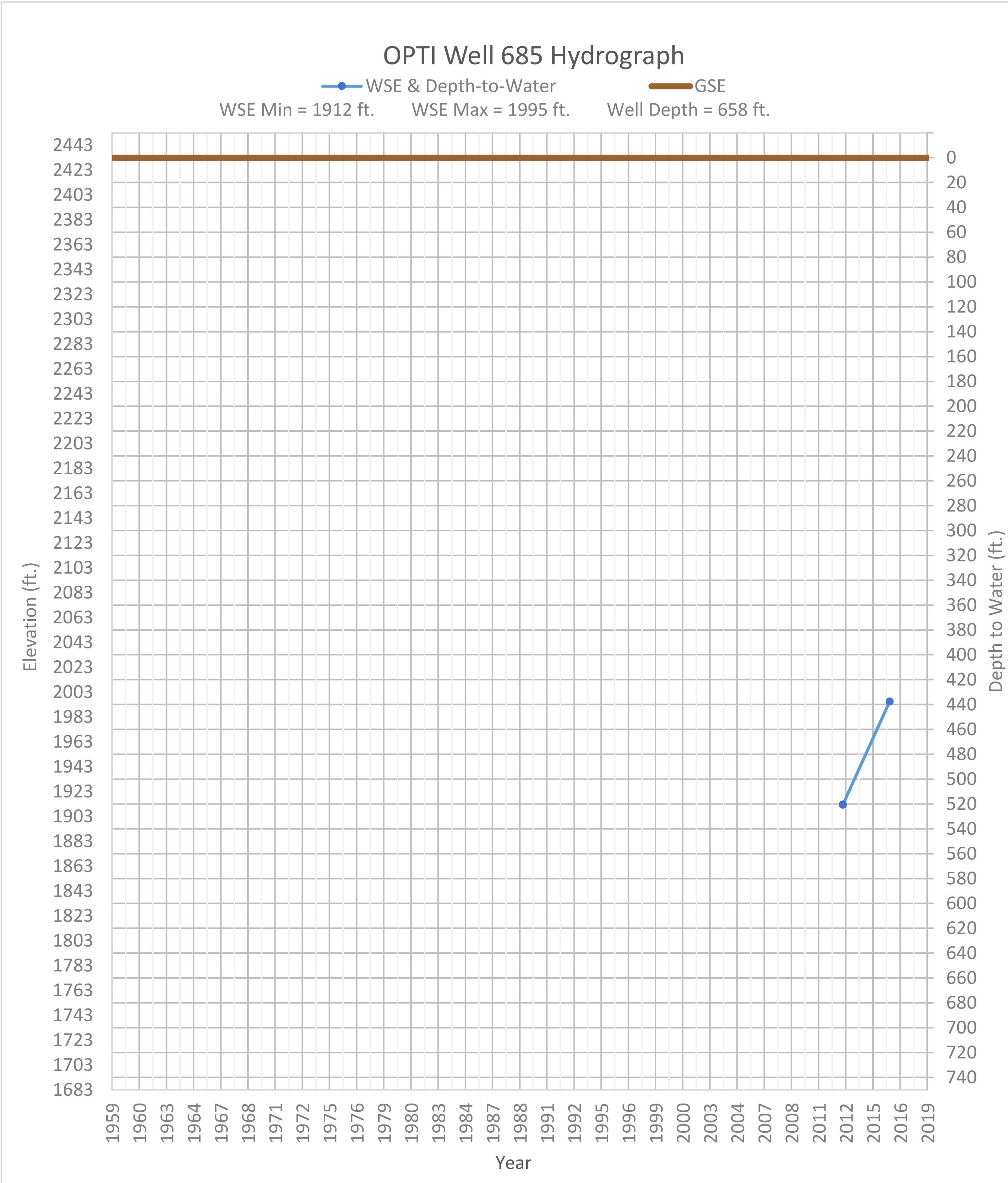
OPTI Well 681 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1851 ft.
WSE Max = 1909 ft.
Well Depth = 614 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 682 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1934 ft.
WSE Max = 1993 ft.
Well Depth = 1300 ft.
Elevation (ft.)
Depth to Water (ft.)
Year

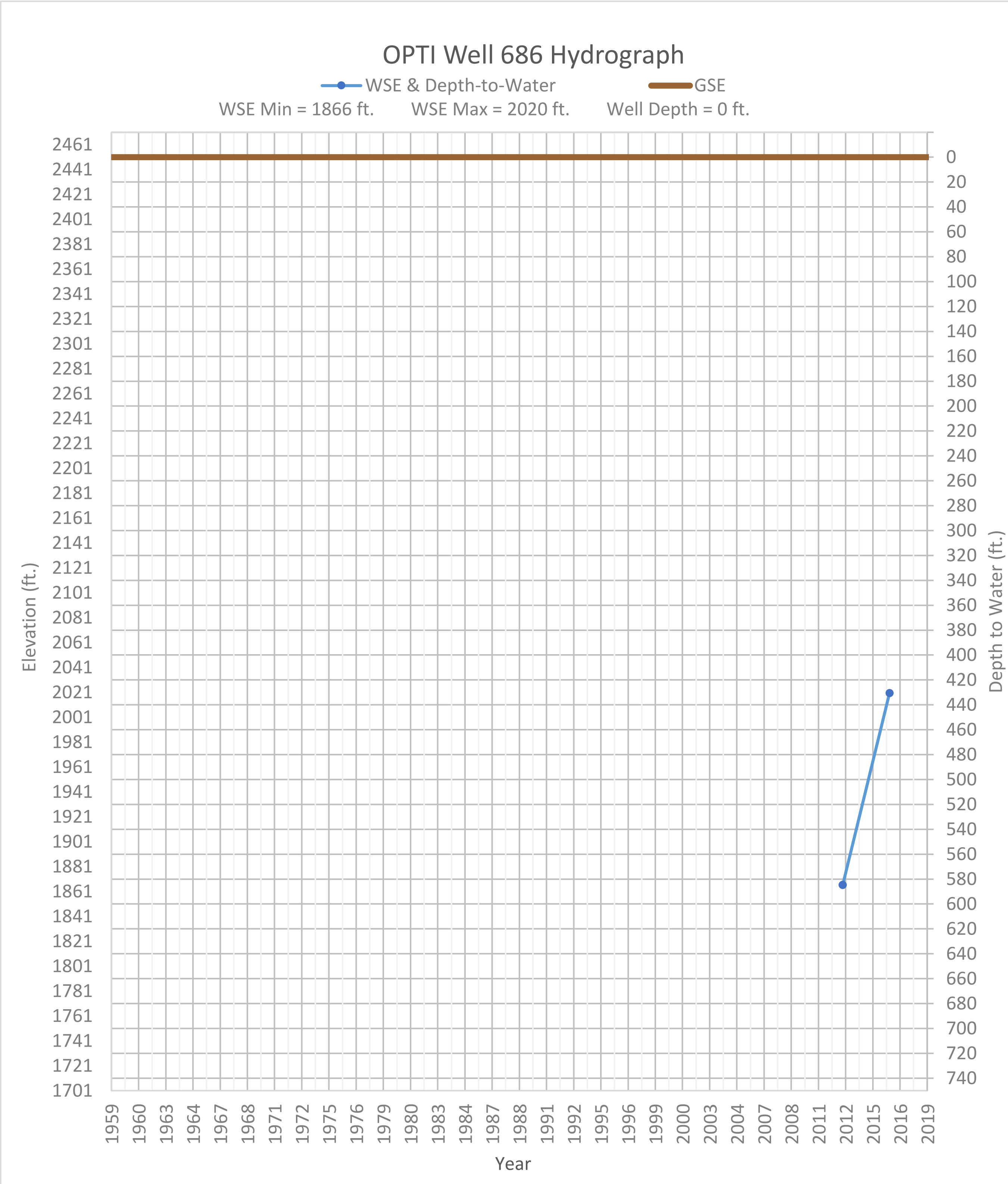

OPTI Well 683 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1918 ft.
WSE Max = 1990 ft.
Well Depth = 1045 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 684 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1850 ft.
WSE Max = 1992 ft.
Well Depth = 790 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 685 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1912 ft.
WSE Max = 1995 ft.
Well Depth = 658 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 686 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1866 ft.
WSE Max = 2020 ft.
Well Depth = 0 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 687 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1781 ft.
WSE Max = 2101 ft.
Well Depth = 1195 ft.
Elevation (ft.)
Depth to Water (ft.)
Year
2308
2288
2268
2248
2228
2208
2188
2168
2148
2128
2108
2088
2068
2048
2028
2008
1988
1968
1948
1928
1908
1888
1868
1848
1828
1808
1788
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1608
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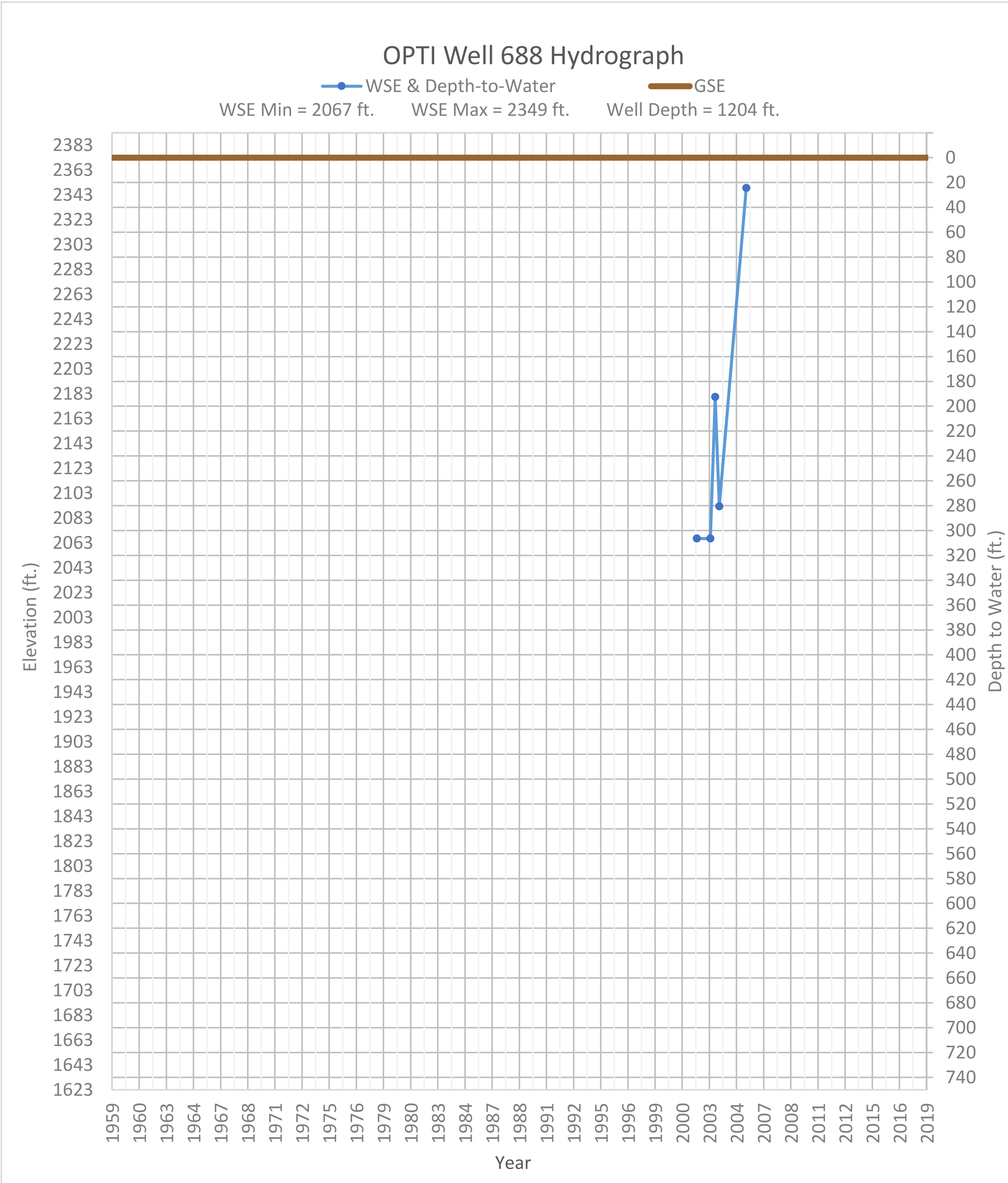
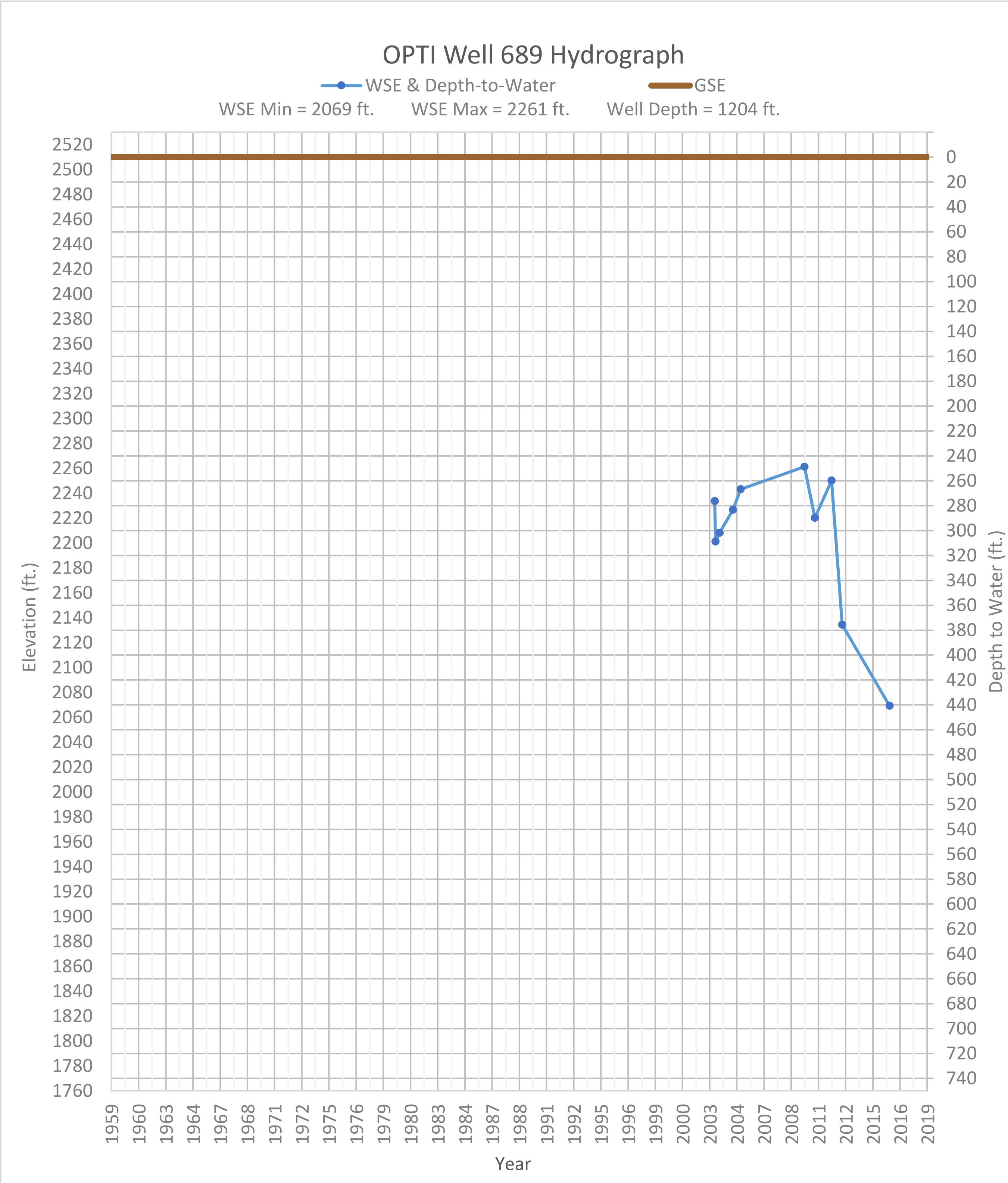
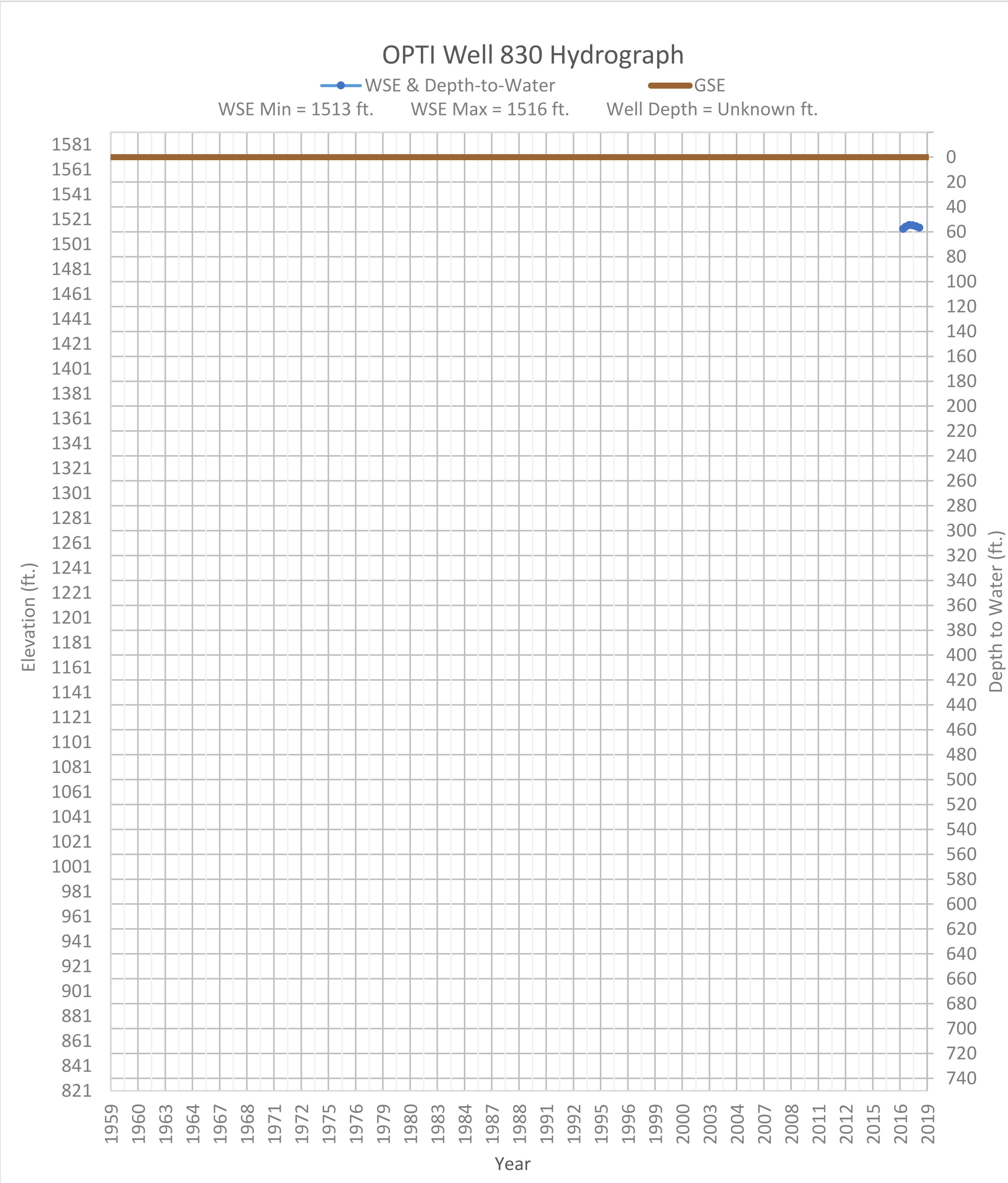
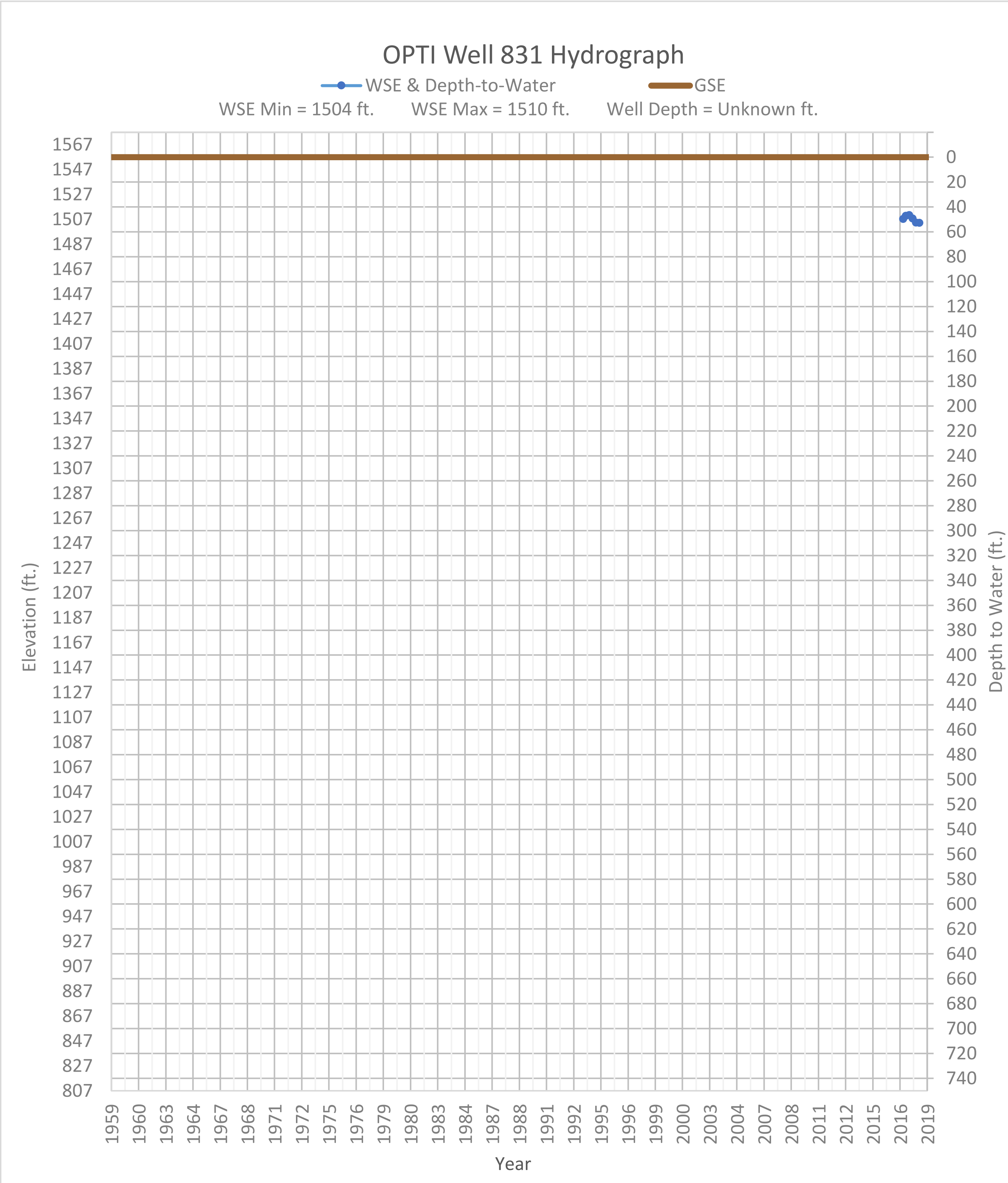


OPTI Well 688 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2067 ft.
WSE Max = 2349 ft.
Well Depth = 1204 ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 689 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 2069 ft.
WSE Max = 2261 ft.
Well Depth = 1204 ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 830 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1513 ft.
WSE Max = 1516 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 831 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1504 ft.
WSE Max = 1510 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1567
1547
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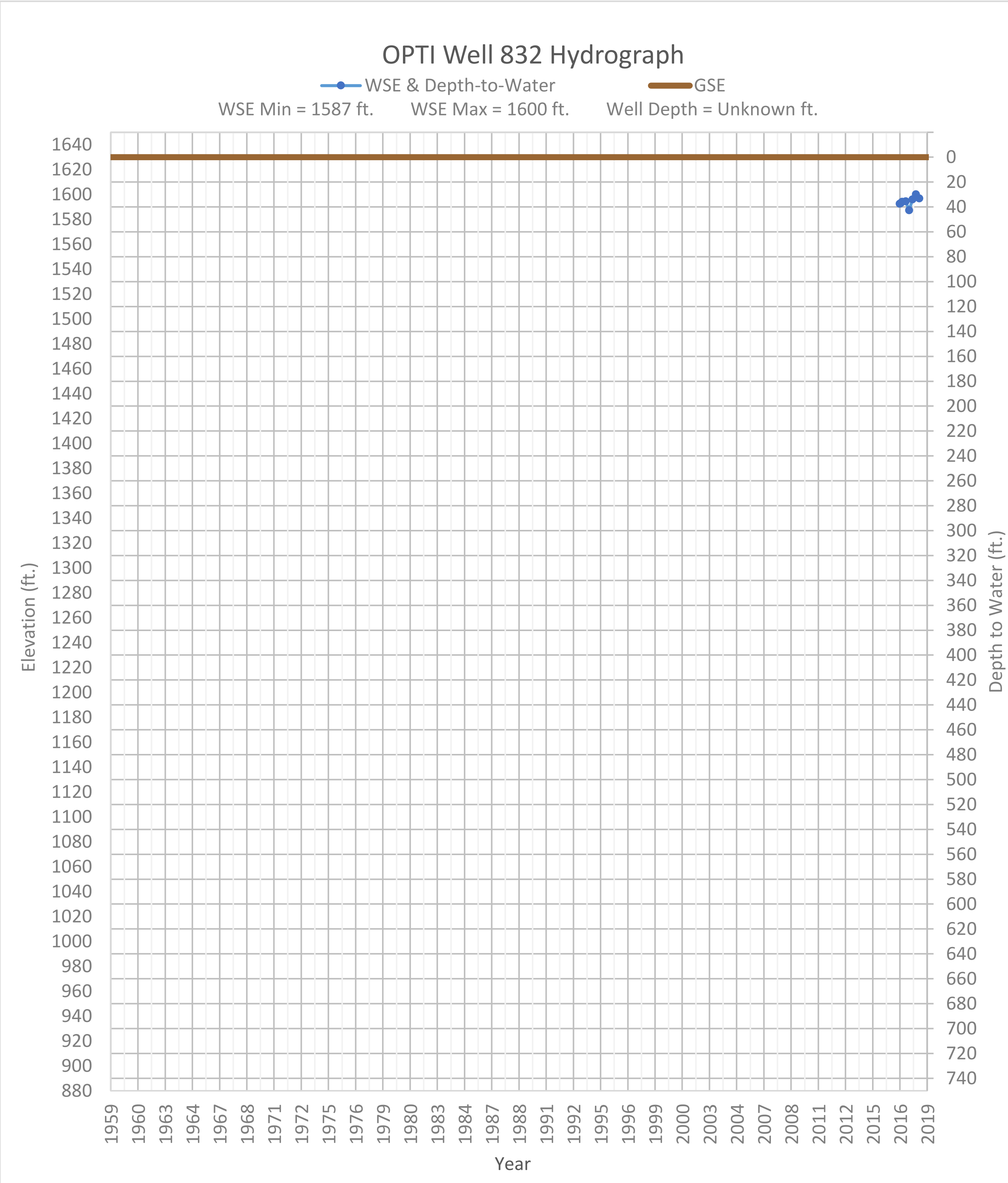
OPTI Well 832 Hydrograph
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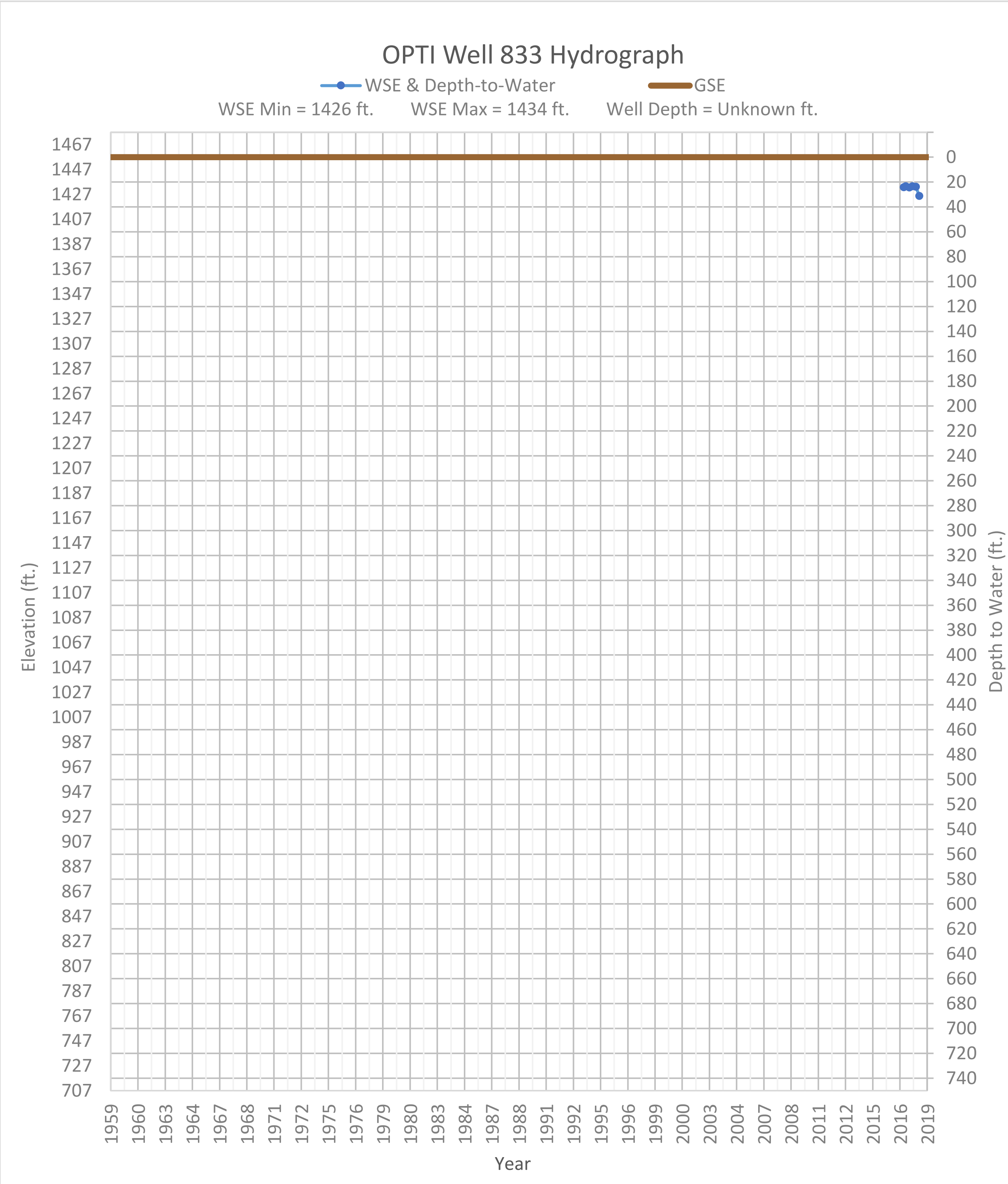
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year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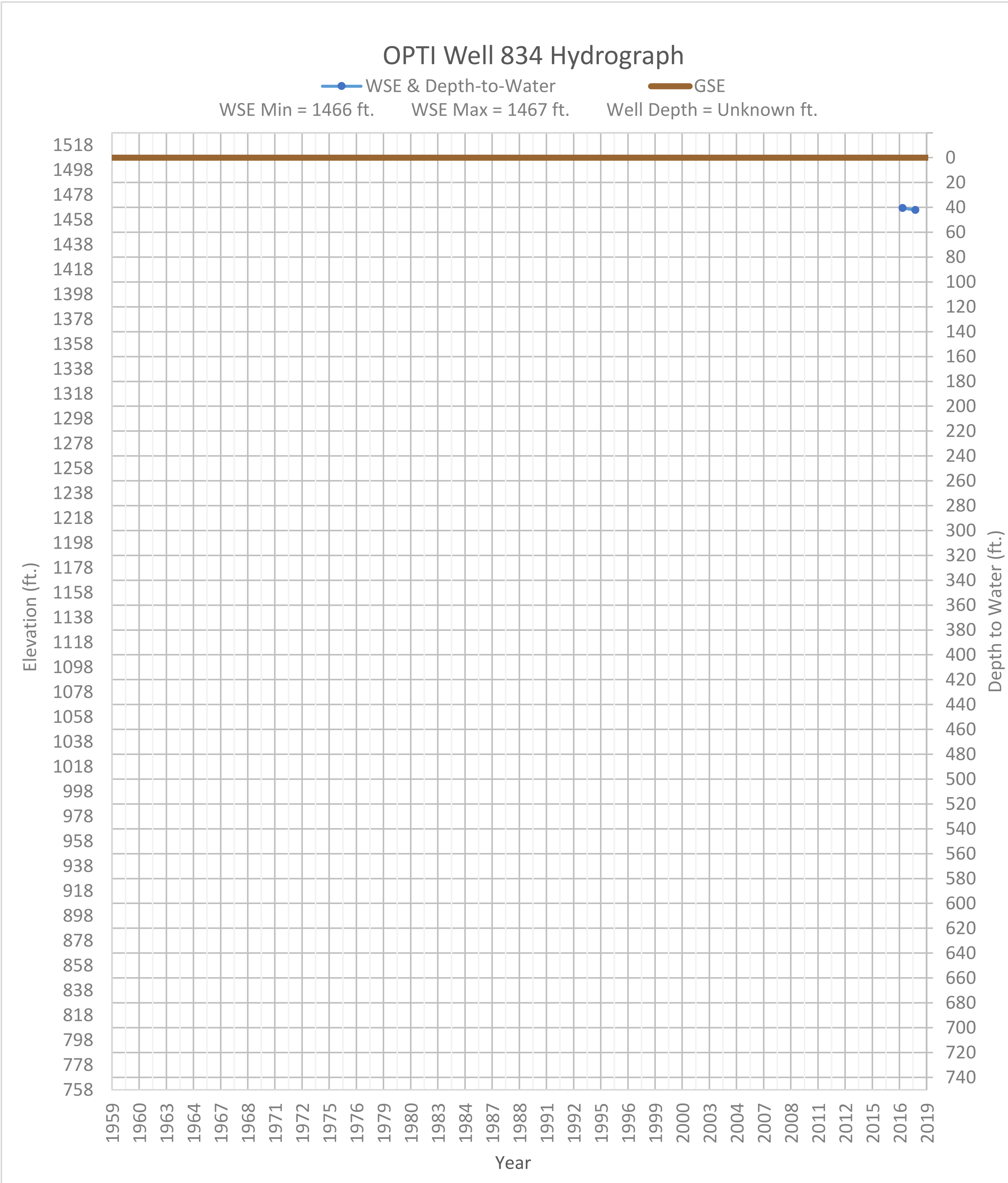
Depth to Water (ft.)
Year


OPTI Well 834 Hydrograph
WSE & Depth-to-Water
GSE
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Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1518
1498
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1278
1258
1238
1218
1198
1178
1158
1138
1118
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818
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OPTI Well 835 Hydrograph
WSE & Depth-to-Water
GSE
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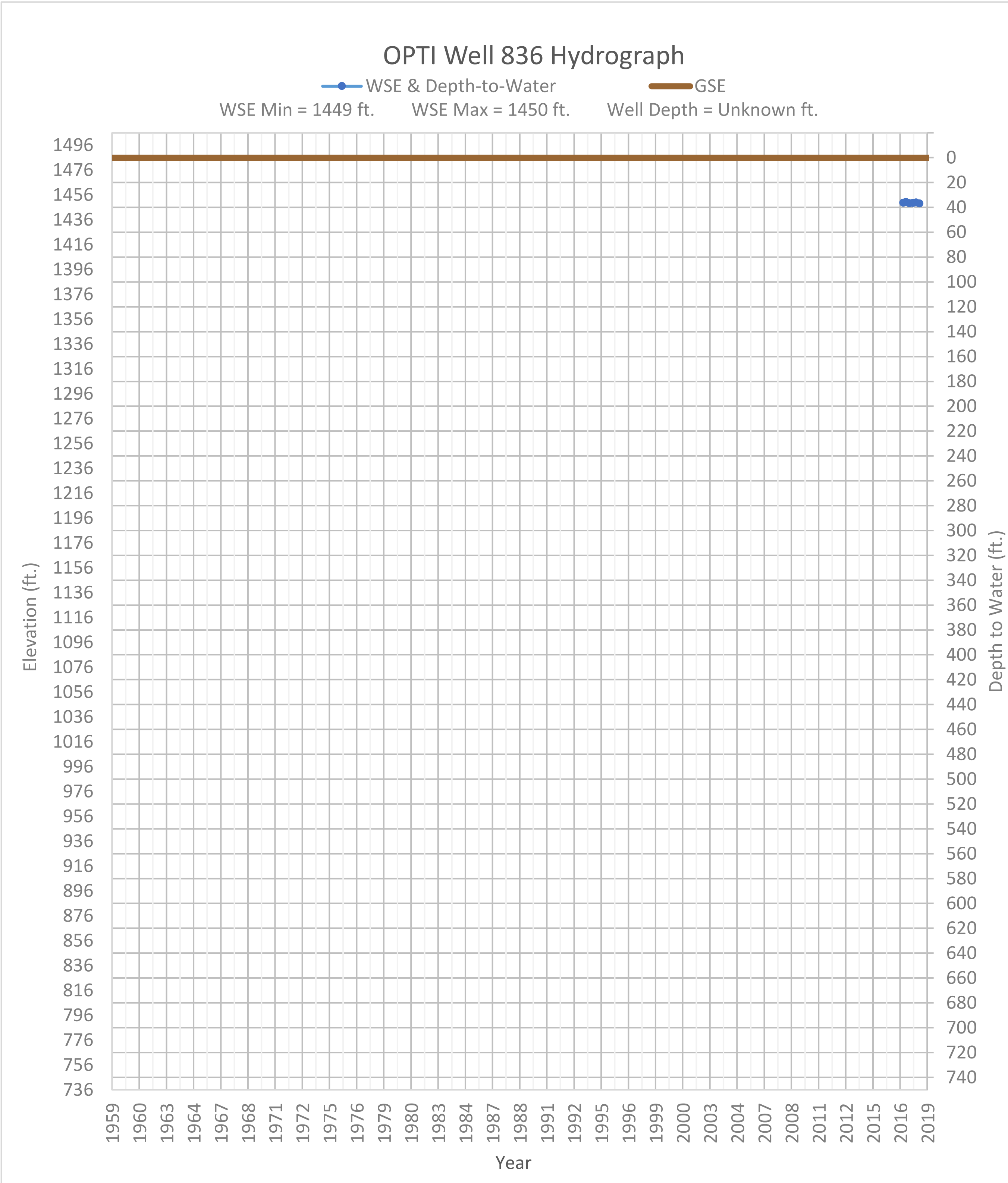
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 836 Hydrograph
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WSE Max = 1450 ft.
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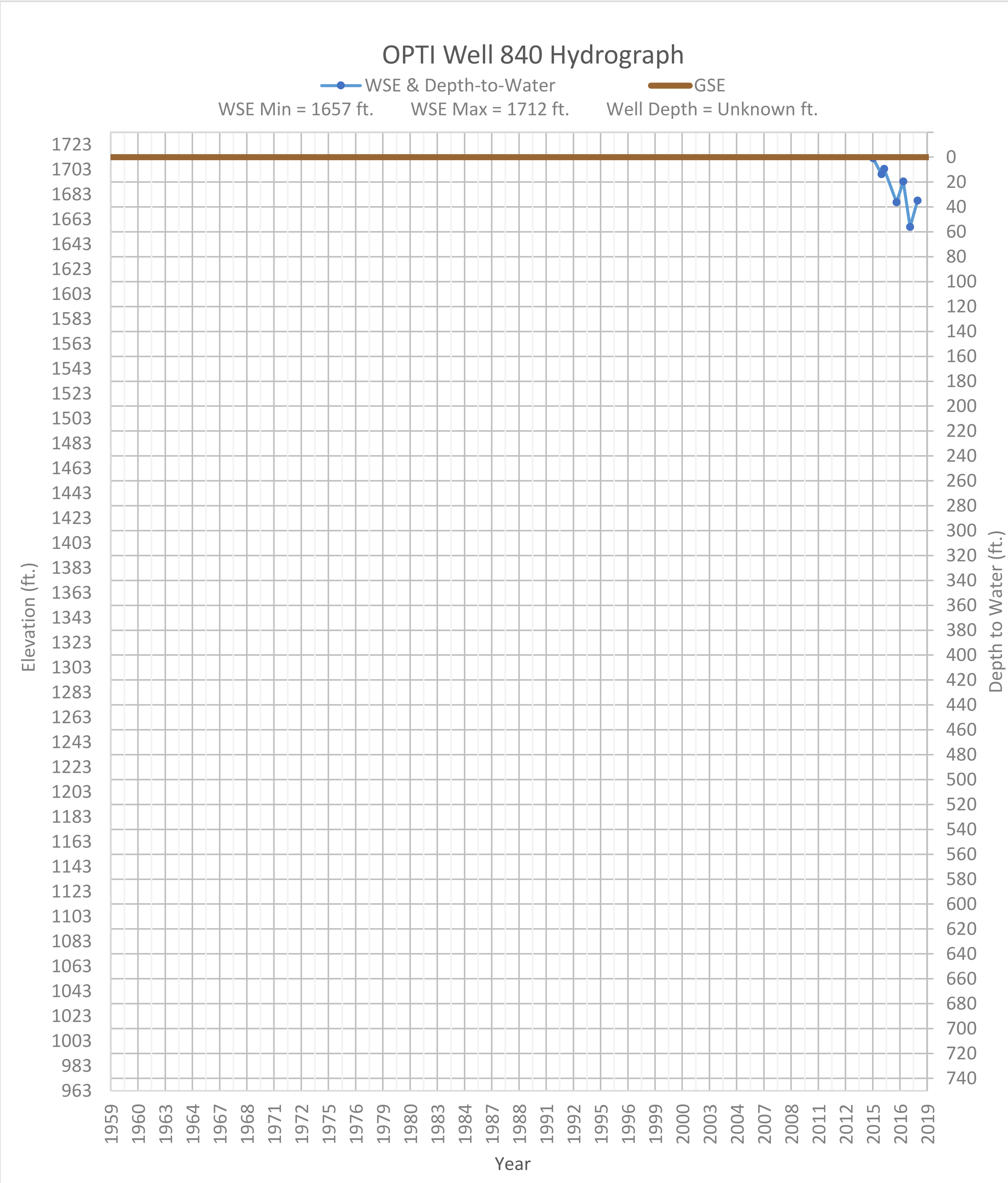
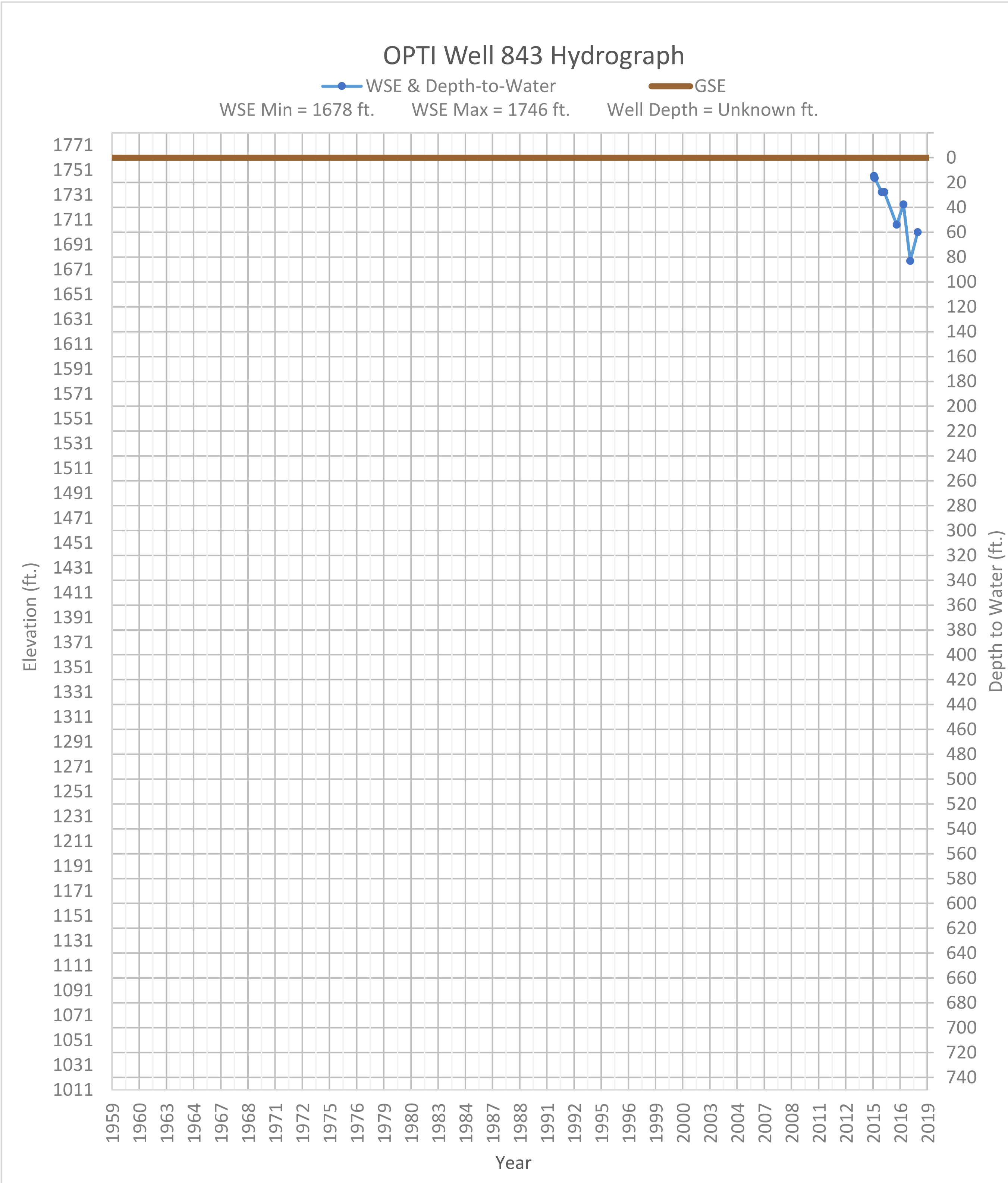
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 840 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1657 ft.
WSE Max = 1712 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 841 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1701 ft.
WSE Max = 1740 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year

OPTI Well 842 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1698 ft.
WSE Max = 1751 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 843 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1678 ft.
WSE Max = 1746 ft.
Well Depth = Unknown ft.
Elevation (ft.)
1771
1751
1731
1711
1691
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1531
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1491
1471
1451
1431
1411
1391
1371
1351
1331
1311
1291
1271
1251
1231
1211
1191
1171
1151
1131
1111
1091
1071
1051
1031
1011
Depth to Water (ft.)
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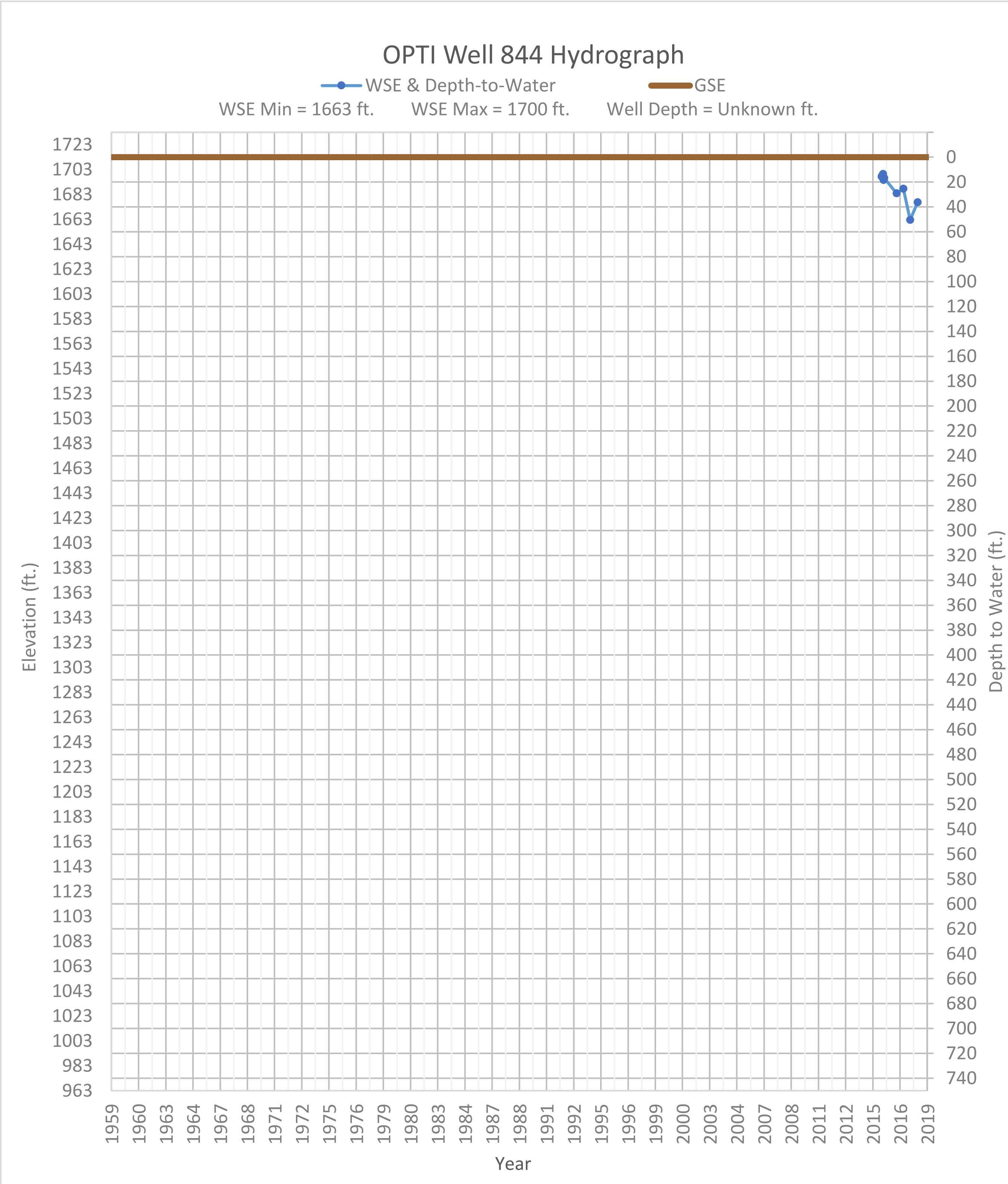

OPTI Well 844 Hydrograph
WSE & Depth-to-Water
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WSE Min = 1663 ft.
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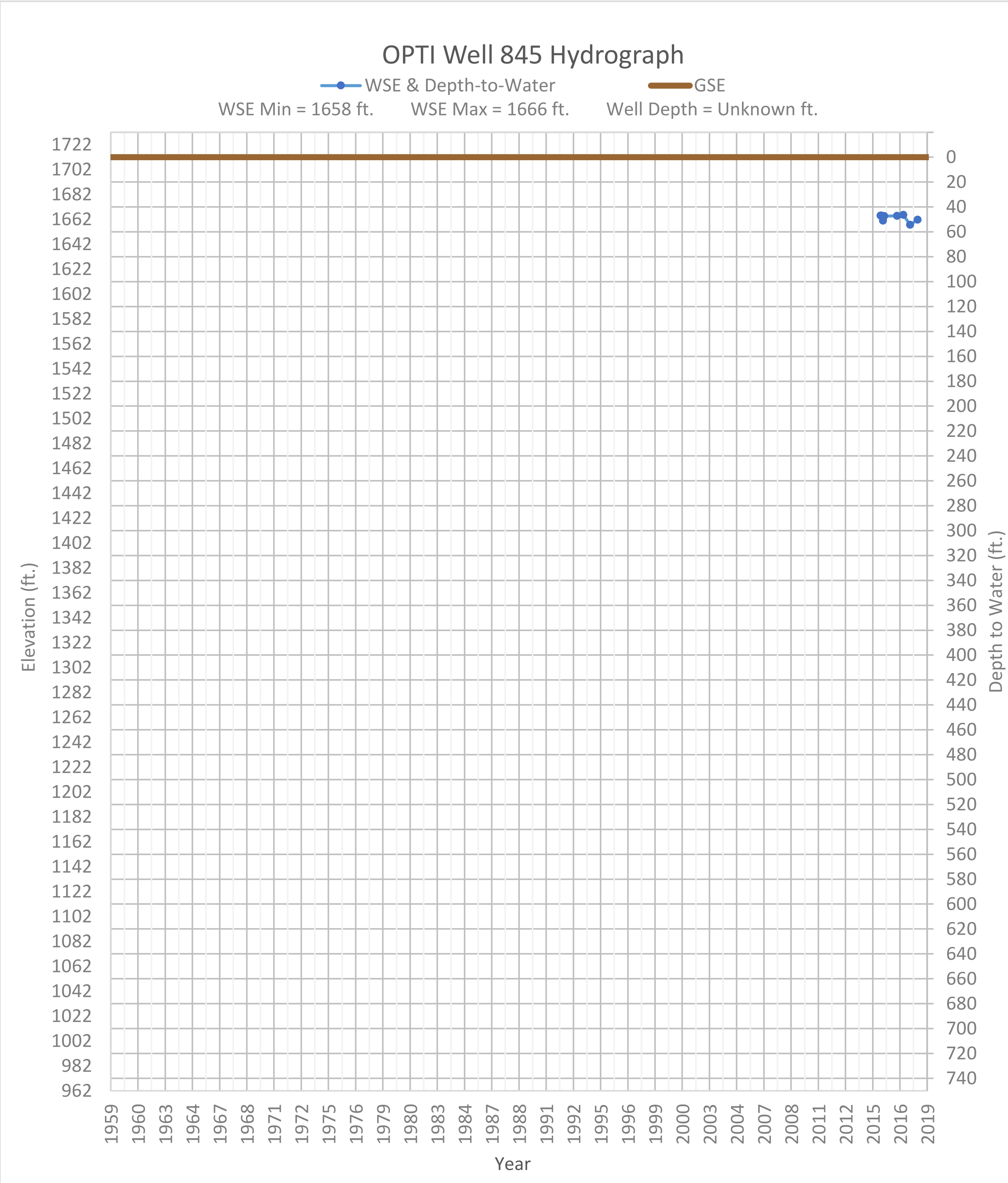
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 845 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1658 ft.
WSE Max = 1666 ft.
Well Depth = Unknown ft.
Elevation (ft.)
1722
1702
1682
1662
1642
1622
1602
1582
1562
1542
1522
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1442
1422
1402
1382
1362
1342
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1282
1262
1242
1222
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Depth to Water (ft.)
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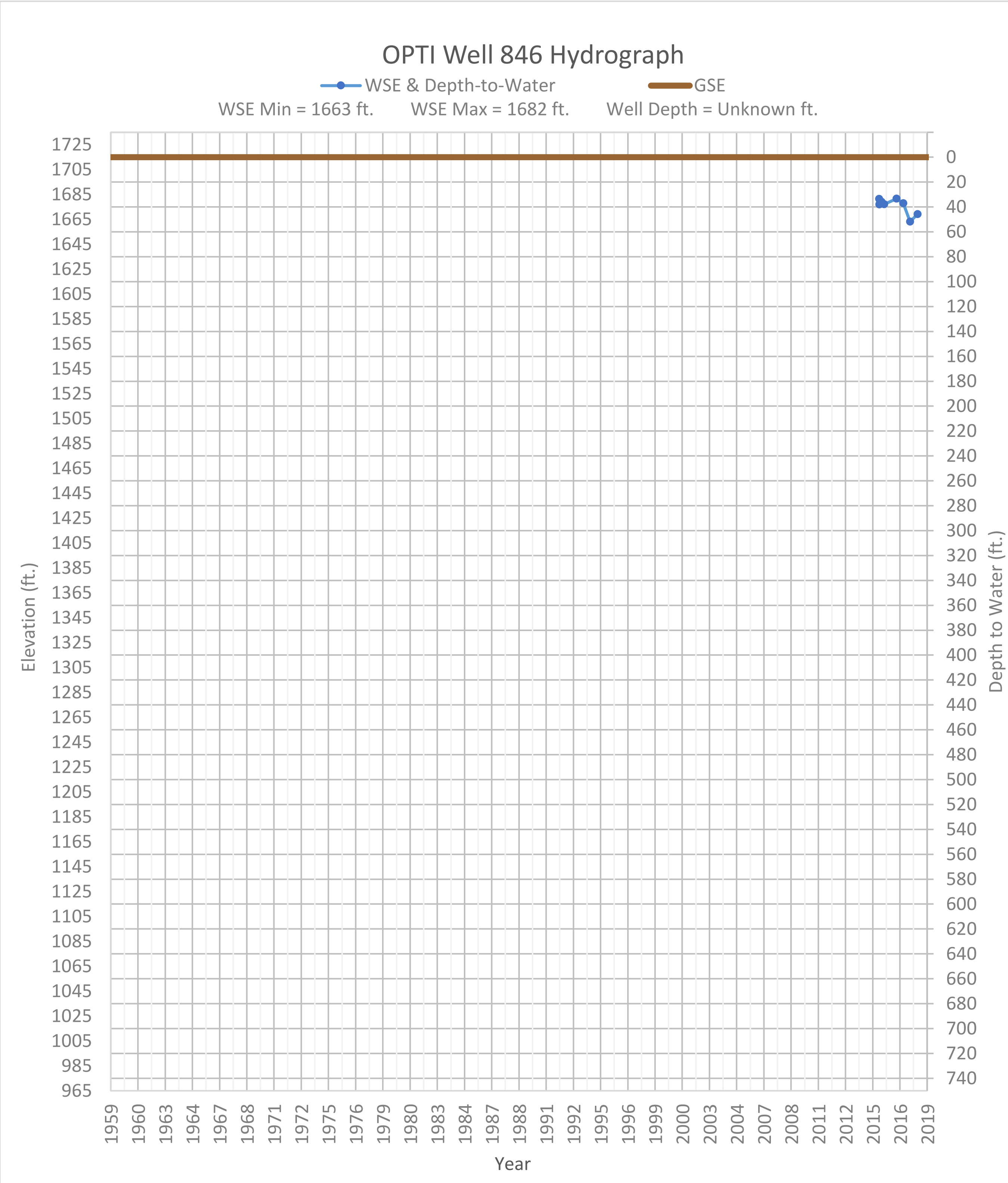
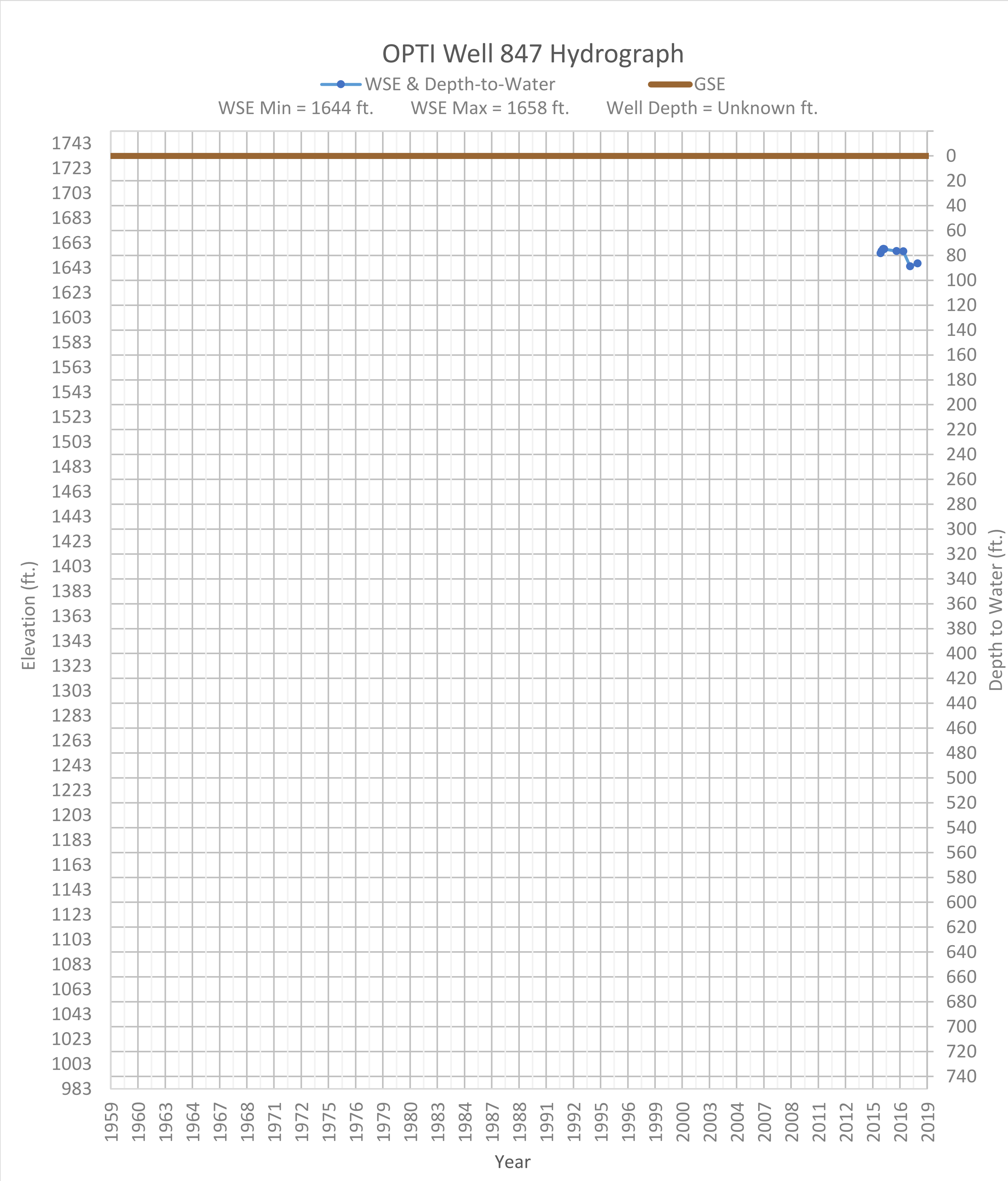
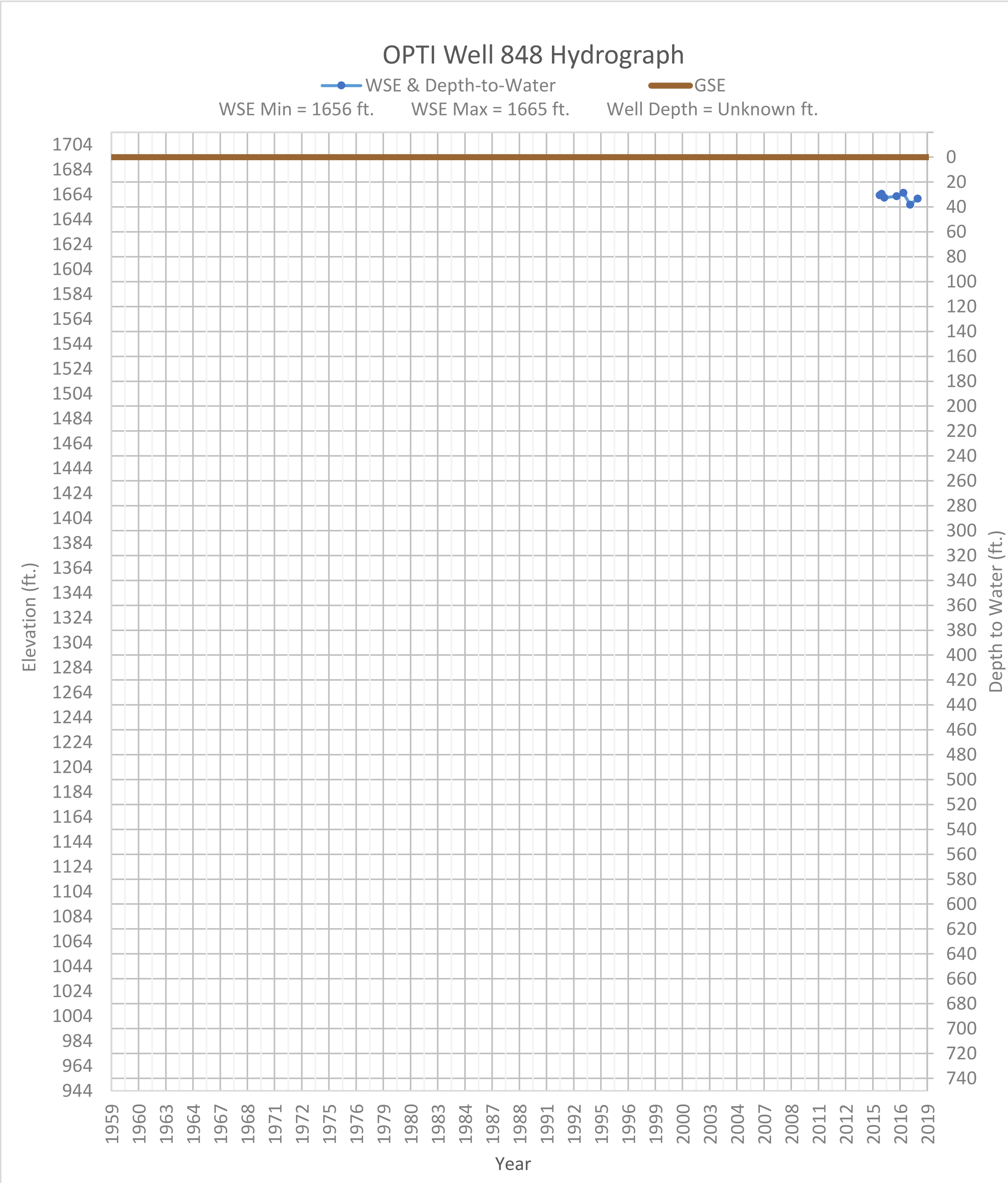


OPTI Well 846 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1663 ft.
WSE Max = 1682 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year



OPTI Well 847 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1644 ft.
WSE Max = 1658 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 848 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1656 ft.
WSE Max = 1665 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1704
1684
1664
1644
1624
1604
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1464
1444
1424
1404
1384
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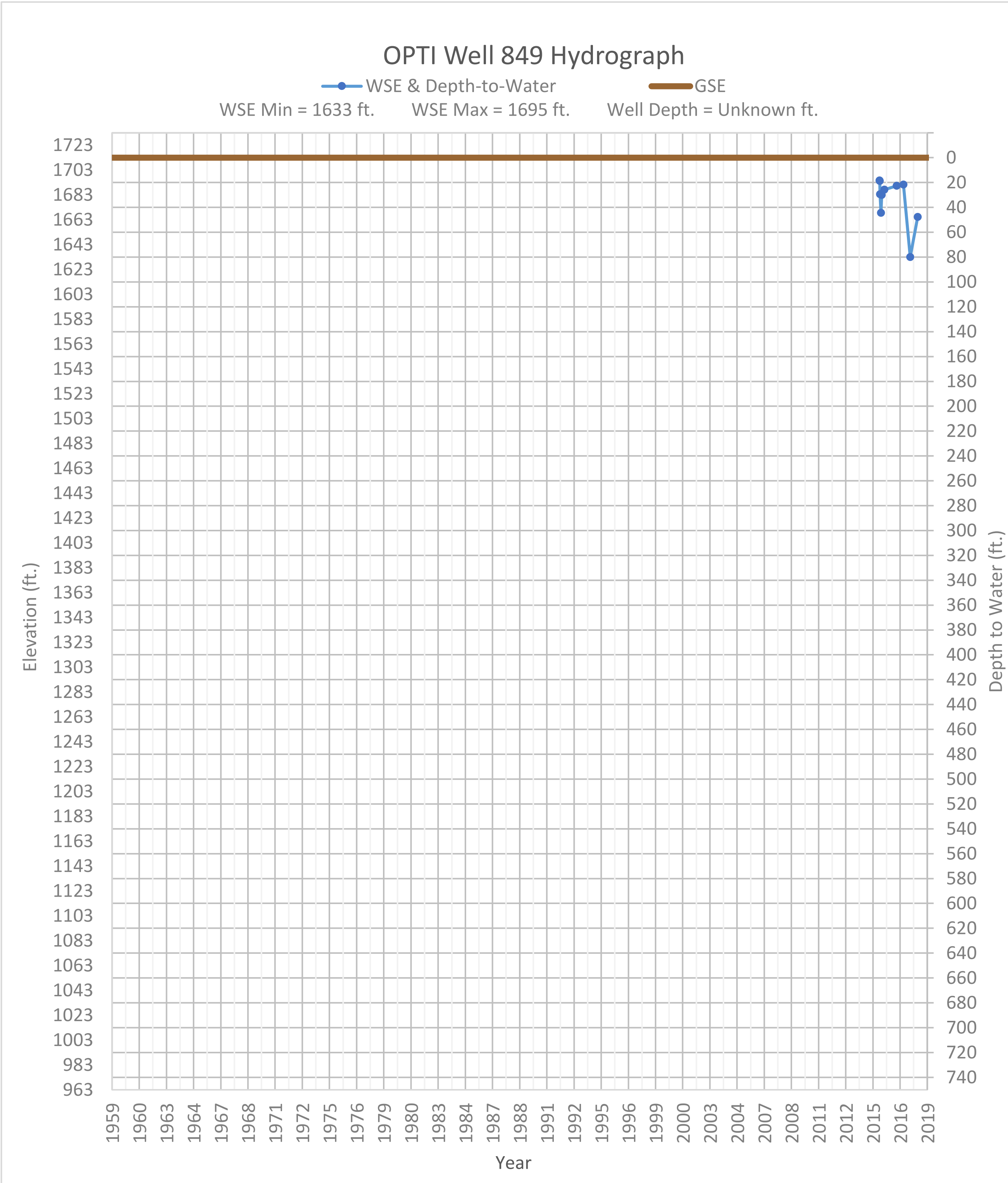

OPTI Well 849 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1633 ft.
WSE Max = 1695 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1723
1703
1683
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1643
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OPTI Well 850 Hydrograph
WSE & Depth-to-Water
GSE
WSE Min = 1654 ft.
WSE Max = 1701 ft.
Well Depth = Unknown ft.
Elevation (ft.)
Depth to Water (ft.)
Year
1769
1749
1729
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Chapter 2
Appendix B

White Paper: Subsidence and Subsidence Monitoring Techniques

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Subsidence White Paper

Author: C. Micah Eggleton - *Environmental Planner* at Woodard & Curran, September 19, 2017.
meggleton@woodardcurran.com

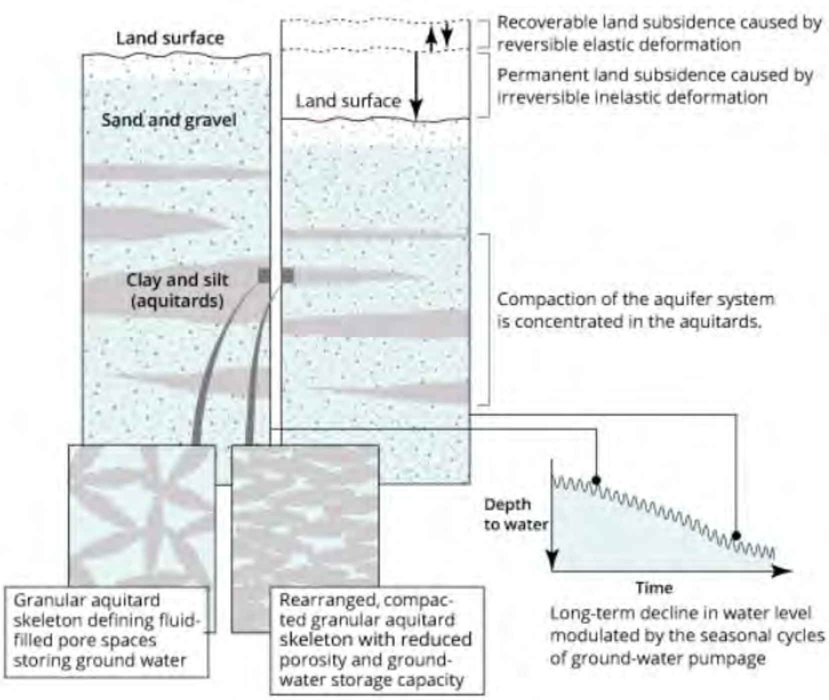
What is Subsidence?

Land subsidence is the sinking or downward settling of the earth's surface, not restricted in rate, magnitude, or area involved. Subsidence is often a result of over-extraction of subsurface water. In these cases, subsidence generally occurs over a large to very large area (10's to 100's of km^2) and may happen over several years.

How Subsidence Occurs

Groundwater saturates the sediments in the subsurface where groundwater is present. Sediments in water bearing units are commonly made up of sands, gravels, silts, and clays. Aquitards are composed of clay materials, and may have multiple thin layers or larger extensive, and/or thicker layers. Groundwater in these materials fills the pore spaces and supports the material's structure. As groundwater levels decline, the sands, gravels, silts, and clays in water bearing units are dewatered, and the water's support of the structure of the materials is removed. Clays in particular rearrange when dewatered and clay grains orient in a similar direction, which reduces the amount of pore space and thus, the clay compacts. As the clays compact, ground surface elevation begins to drop.

Figure 1: Subsidence and Compaction Process



Source: USGS, Ladn Subsidence: Cause and Effect. 9/17/2017. https://ca.water.usgs.gov/land_subsidence/california-subsidence-cause-effect.html#pumping

This is problematic all over the world but is of particular concern in California agricultural communities such as the Cuyama Basin. Cuyama Basin subsidence may have effects on agriculture in a few ways.

1. Water delivery systems that may deliver irrigation water can be affected by land subsidence. Surface canals or gravity lines may not have enough elevation gradient to transport water or may even have reverse flows due to changes in ground surface elevation.
2. Infrastructure such as buildings and roads may be de-leveled and need repair

Not all groundwater pumping results in permanent subsidence. Groundwater reservoirs have an *elastic* and *inelastic* range of stress. Within the elastic range of stress, water levels in a groundwater storage unit can fluctuate without damaging the storage unit's ability to recharge to its original capacity. If water levels in a storage system dip into the inelastic range, the clays compact and cause inelastic land subsidence.

Clays and silts, such as those present in the Younger Alluvium, Older Alluvium, and Upper Morales Formations, generally have lower elastic capabilities, meaning they are not able to recover to their original volume once water has been removed. Once clays and silts are heavily compacted, they often cannot return to their previous saturation capacity even if groundwater levels are increased; this permanently reduces the storage capacity of the aquifer. This loss of aquifer is limited to the water that was stored in the compressed clays, and storage capacity lost is limited to the water that was stored in clays that were compressed, which is reflected in the amount of subsidence measured. Water stored in clay materials is generally not available for use by wells.

Figure 2: Subsidence Visualized

Source: USGS, https://ca.water.usgs.gov/land_subsidence/

Methods of Measuring Land Subsidence

Measurements of elevations, aquifer-system compaction, and water levels are used to improve our understanding of the processes responsible for land-surface elevation changes. Elevation or elevation-change measurements are fundamental to monitoring land subsidence and have been measured by using interferometric synthetic aperture radar (InSAR), continuous GPS (CGPS) measurements, extensometers, and spirit-leveling surveying.

Interferometric Synthetic Aperture Radar (InSAR)

InSAR is a method and product of remote sensing imagery that measure changes in land-surface altitude by sending radar signals (historically C-band but new equipment often uses L- or X-band) to the land surface and measuring the return time of that signal. Changes in land surface elevation are calculated by taking the difference between two SAR images of the same area taken at different times. The difference between the two shows the ground-surface displacement (range change) between the two time periods.

The spatial resolution of InSAR is dependent on the location and resolution of the remote imagery, and whether it is taken from a plane or by orbiting satellite. At its finest resolution, InSAR has a sampling pixel of approximately 25' by 25' from satellites. The resolution of vertical displacement is dependent upon meteorological, observational, and other conditions, but is typically within a few centimeters to millimeters.

Raw InSAR data requires specialized computer programs to process and view. Some agencies and organizations, such as the California Water Science Center, provide InSAR imagery online. Direct data downloads are possible, but require registration approved with UNAVCO as an affiliate with an institution engaged in SAR research to download data. Data is available for anyone to browse online, and there are several agencies/institutes that publish data for specific regions.

Currently, InSAR imagery is obtained via specialized radar equipment on an aircraft and managed by NASA's Jet Propulsion Laboratory (JPL). In December 2021, the satellite NISAR is scheduled to launch; NISAR will provide coverage every 12 days and all NASA data will be free.

Continuous Global Positing System (CGPS)

CGPS stations continuously measure the three-dimensional position of a sensor. There are more than 1,000 sensors in Western North America, with hundreds in California. Most sensors are managed by the Plate Boundary Observatory/UNAVCO and by Scripps Orbit and Permanent Arrary Center (SOPAC), but other groups such as Caltrans also operate sensors. These monitoring stations help measure tectonic movements as well as subsidence, which means data is taken in the X, Y, and Z axis.

Measurements are typically taken every 15 seconds and are processed to produce a daily position. The CGPS system has data/information published online, however, some use is limited and registration is required for certain data access.

Currently, subsidence measurements in and immediately around the Cuyama Basin are taken through CGPS instrumentation.

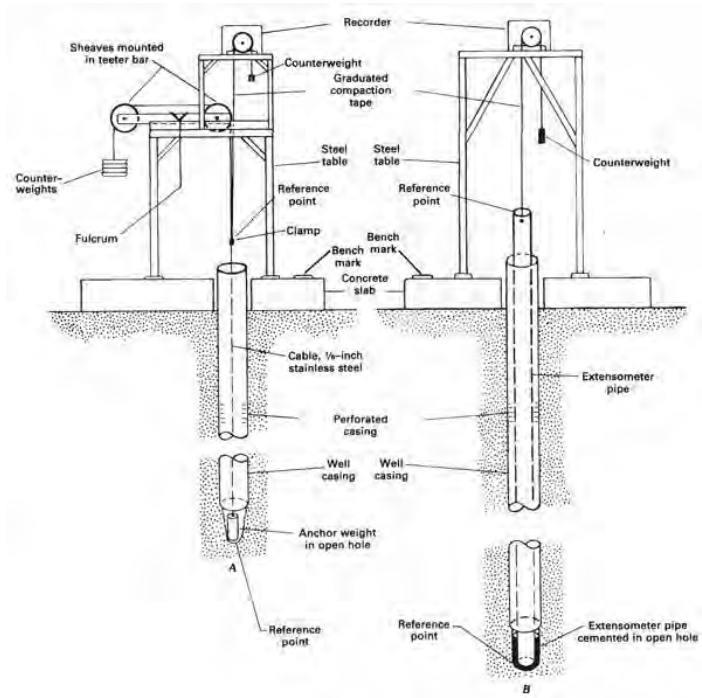
Spirit Leveling

This is the oldest method of measuring subsidence and was used long before electronic aids such as GPS. The primary tool is a Spirit Level in combination with a telescope and graduated vertical rods. Measurements are based on one reference point. This technique is best used for smaller survey areas (5 miles or less) and areas where high spatial density is desired. This is a good option for localized surveying and where cost is a priority.

Extensometers

Extensometers are *one dimensional* indicators of change in a specified depth. In regards to land subsidence, they often measure the change in an aquifer system within a specific depth range – that is to say, if the extensometer extends 20 meters into the ground, it can only measure the change in compaction (or expansion) within those 20m. It is also important to understand that extensometers measure compaction/expansion, *not* elevation.

Between the 1950s and 1970s, more than two dozen extensometers were installed in California's Central Valley by the USGS, with additional units installed since then.



Most extensometers are constructed as cable or pipe borehole extensometers (see the figure to the right above). They function by having a cable or pipe extend to the bottom of a drilled hole to the measuring depth at a specific reference point. At the top of this cable or pipe is a reference point, and attached to the reference point is another cable that extends to the top of a platform near the ground surface, around a wheel, and to a counter weight which maintains tension on all cables. As the ground elevation and bottom reference point change in relation to one another, the wheel turns as the counter weight either drops or rises. This change in the position of the counter weight is equal to the amount of compaction between the two reference points.

Although simple in theory, extensometers can be costly to install due to the drilling that is required and robust equipment needed. In addition, multiple extensometers are often needed to measure compaction across a range of depths and to determine which portion of the subsurface is compacting.

Piezometers

Piezometers measure the hydraulic pressure in a groundwater system. Piezometers are paired with extensometers or CGPS data to analyze stress-strain characteristics of a groundwater system. These systems allow for the calculation of the *skeletal storage coefficient*, which is the standard measure of an aquifer's storage directly related to the compressibility of the soil/storage system. This is what largely controls how "recoverable" an aquifer system is when it is recharged with water.

If water levels continue to decline into the inelastic range of stress, it can become possible to compute the *inelastic storage coefficient* that governs the permanent compaction of the aquifer system. If water levels fluctuate into both of these ranges seasonally or annually, it may be possible to calculate both.

Chapter 2
Appendix C

Cuyama Basin Water Resources Model Documentation

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Attachment C-1 Land Use and Consumptive Water Use of Cuyama Groundwater Basin for Water Years 1996 Through 2016

Attachment C-2 Climate Change Scenario Data Development

Attachment C-3 Groundwater Level Hydrographs for Calibration Wells

Attachment C-4 Evapotranspiration and Applied Water Estimates

Appendix C — Cuyama Basin Water Resources Model Documentation

Introduction

Goals of Model Development

The Cuyama Basin Water Resources Model (CBWRM) was developed to evaluate the recent historical, current, and projected surface water and groundwater conditions in the Cuyama Groundwater Basin (Basin), and simulate various scenarios as part of the Basin's *Groundwater Sustainability Plan* (GSP). The fine temporal and spatial scale of the CBRWM allows the Cuyama Basin Groundwater Sustainability Agency (CBGSA) and its stakeholders to evaluate the effect of changing groundwater conditions in different parts of the Basin.

The CBWRM was developed in consultation with members of the Technical Forum, which includes technical staff and consultants representing a range of public and private entities in the Basin. Technical Forum members are listed in Chapter 1, Section 1.3. The Technical Forum held 14 monthly conference calls over the course of CBWRM development, and model data and outputs were provided to Technical Forum members to facilitate review and feedback on model development. This allowed Technical Forum members to review and comment on all major aspects of CBWRM development.

Basin Overview

The Basin encompasses an area of approximately 378 square miles, and includes the communities of New Cuyama and Cuyama, which are located along State Route (SR) 166 and Ventucopa, which is located along SR 33. Figure C-1 shows the Cuyama Basin and its key geographic features. The Basin encompasses an approximately 55-mile stretch of the Cuyama River, which runs through the Basin for much of its extent before leaving the Basin to the northwest and flowing toward the Pacific Ocean. The Basin also encompasses reaches of Wells Creek in its north-central area, Santa Barbara Creek in the south-central area, and the Quatal Canyon drainage and Cuyama Creek in the southern area of the Basin. Primary land use and development in the Basin is agricultural use, which mostly occurs in the central portion east of New Cuyama, and along the Cuyama River near SR 33 through Ventucopa. Additionally, there has recently been new agricultural development in the western part of the Basin.

CBRWM Platform

The CBWRM was developed based on the Integrated Water Flow Model (IWFM) software platform. The IWFM is an open-source, finite element simulation code that supports triangular and quadrilateral elements (Dogrul et al., 2017b). IWFM was specifically designated in the Sustainable Groundwater Management Act (SGMA) regulations as a model supported by the California Department of Water Resources (DWR) for evaluation of the integrated surface water and groundwater resources a basin, including detailed water budget development that meets SGMA requirements. IWFM has been used throughout California for planning and management of water resources, including GSP development. IWFM is also used for DWR's California Central Valley Groundwater-Surface Water Simulation Model

(C2VSim), which is the fine-grid version that is being refined and enhanced by DWR to support SGMA activities throughout the Central Valley at the regional scale (DWR, 2018).

The IWFM Demand Calculator (IDC) is the stand-alone root zone component of IWFM that simulates land surface and root zone flow processes (Dogrul et al., 2017b). It calculates agricultural and urban water demands using inputs including climatic conditions, soil hydrologic conditions, and land use types and cropping patterns. The IDC can be used as a stand-alone model, or it can be combined with IWFM. When combined, the full IWFM model simulates the integrated system of land surface processes and groundwater system and the stream system, as well as interaction among these systems.

CBWRM Development

Model Input Data

The CBWRM historical model simulates Basin hydrologic conditions on a daily time step from water year 1995 through water year 2017 (i.e., October 1, 1994 through September 30, 2017). Table C-1 lists CBWRM files and corresponding major data sources.

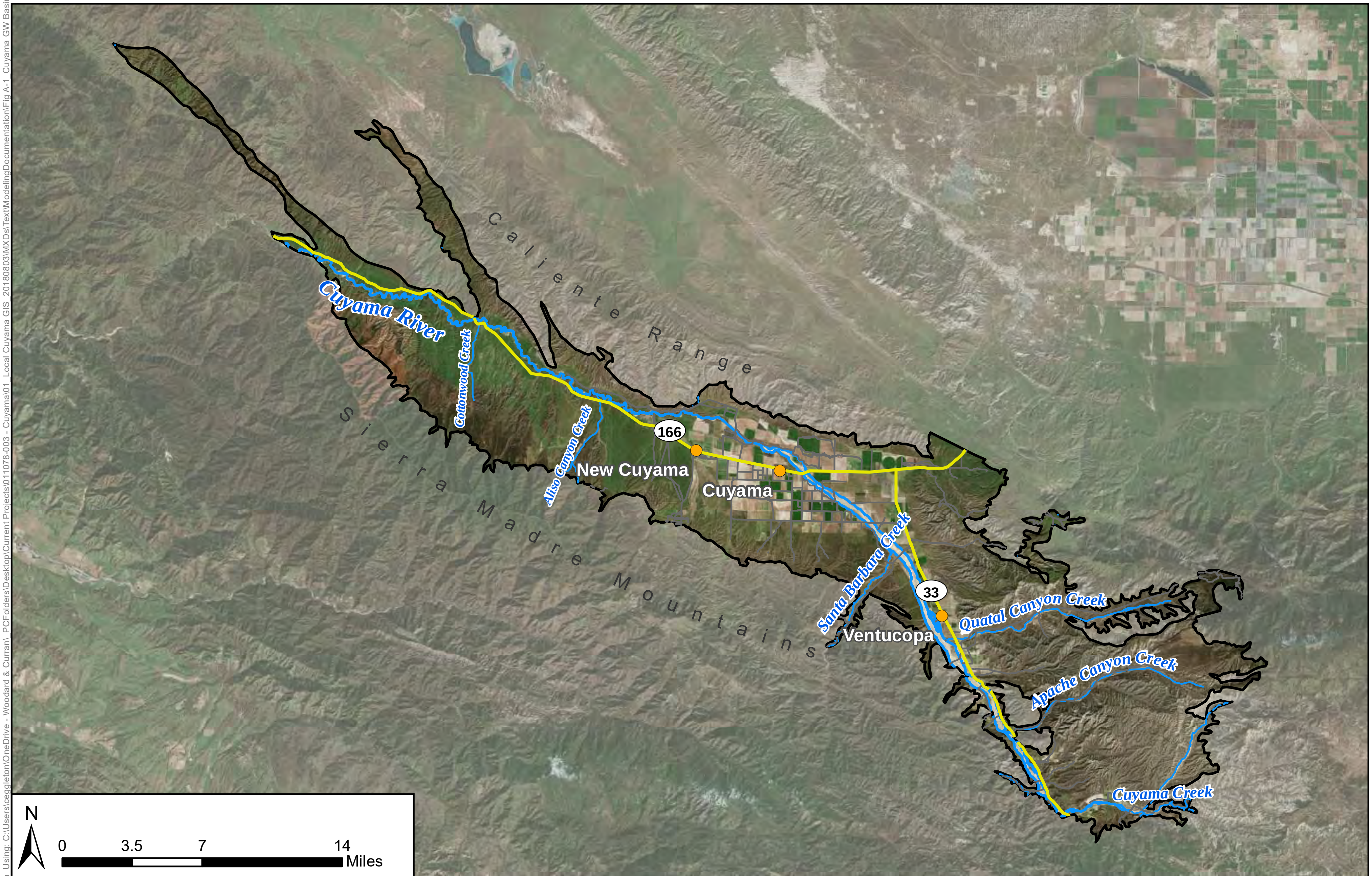

Figure C-1 - Cuyama Valley Groundwater Basin

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Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Legend

- Towns
- Cuyama Basin
- Highways
- Local Roads
- Cuyama River
- Streams/Creeks

Table C-1: CBWRM Major Model Data

Major Data Category	Minor Data Category	Data Source
Hydrogeological Data	Geologic Stratification	Diblee Maps and Cuyama Valley Hydrologic Model (CUVHM)
Stream Data	Stream Configuration	National Hydrography Dataset (NHD)
	Streamflow Records	United States Geological Survey (USGS) and California Data Exchange Center (CDEC) Stream Gages
Hydrological Data	Precipitation	Parameter-Elevation Relationships on Independent Slopes Model (PRISM)
Agricultural Water Demand	Land Use and Cropping Patterns	• DWR • Private Landowners • CBGSA-developed data
	Evapotranspiration	California Irrigation Management Information System (CIMIS)
	Soil Properties	Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO)
Urban Water Demand	Population	United States Census Bureau
	Per Capita Water Use	Cuyama Community Services District (CCSD) Local Information
Water Supply	Groundwater Pumping	CCSD
Other	Initial GW Level Conditions	• DWR Water Data Library • Private landowners
	Small Watersheds	NHD
	GW Level Records for Calibration Wells	• DWR Water Data Library • Private landowners

Analysts developed the 50-year hydrologic period of water years 1968 through 2017 for use in CBWRM to meet SGMA requirements for long-term water budget representation for current and projected Basin conditions.

CBWRM Grid

Analysts developed the finite element grid using the Groundwater Modeling System (GMS) software' the grid development module. The model grid network is composed of a combination of quadrilateral and triangular elements, which allows a detailed representation of various hydrologic, geologic, and jurisdictional features required for development of information about land and water use, water supply, groundwater conditions, and water budget. The CBWRM grid and the specific features used in grid development are shown in Figure C-2. These features include the following:

- The Basin boundary as defined in DWR's Bulletin 118 (DWR, 2004)
- Hydrologic and hydrogeologic features (i.e., Cuyama River and minor streams, faults, and outcroppings)
- The Cuyama Community Services District (CCSD) boundary
- Cuyama Water District boundary

The CBWRM grid contains 6,582 elements with an average element area of 36.8 acres. Primary objectives during grid development were to maintain a manageable number of elements and nodes for model computational performance, to optimize resolution for data analysis, and to contain relatively finer resolution along rivers, which allows for better simulation of stream-aquifer interaction to optimize the model run time and to streamline model output.

Stream Configuration and Watersheds

The CBWRM surface hydrology is represented by nine model stream reaches, representing the Cuyama River. The USGS has two active gages that record flows in the Cuyama River watershed upstream of Lake Twitchell. These include one gage on the Cuyama River downstream of the Basin (ID 11136800), which is located just upstream of Lake Twitchell. This gage has 58 recorded years of streamflow measurements from 1959 to 2017. The other active gage is south of the city of Ventucopa along Santa Barbara Canyon Creek (ID 11136600), and this partial record is limited to seven years (i.e., from 2010 to 2017). In addition, limited data are available from four deactivated gages, as shown in Chapter 1.

The inflow from upper watershed areas originates from ungaged watersheds. Figure C-3 shows the upper watershed areas included in the model. Flows from ungaged watersheds surrounding the Basin are estimated using a simplified rainfall runoff module incorporated in the small watersheds module of the CBWRM. This module simulates the surface water and groundwater contributions from the small watersheds using daily precipitation rates and runoff and infiltration characteristics assigned to each ungaged watershed. The portion of flow from the small watershed that enters the model domain as surface runoff is directed to drain into simulated streams. The portion of flow from small watersheds that infiltrates to ground contributes to the main groundwater system as boundary flows.

All subsurface inflows from these small watersheds are routed to the top model layer in each watershed (Layer 3 in most watersheds) along specified groundwater nodes, with a user-defined maximum percolation rate at each node. Excess flows that do not infiltrate to groundwater enter the simulated streams at user-specified locations. The hydrologic conditions of these small watersheds used to estimate the subsurface and surface flows are represented using parameters (e.g., precipitation, surface layer soil parameters, runoff coefficient) for each watershed. The soil parameters and runoff coefficients were estimated using data from SSURGO (USDA, 2017a).

Precipitation

Rainfall data for the CBWRM area are derived from the PRISM database (PRISM Climate Group, 2018). The database contains monthly precipitation data starting from 1895 and daily precipitation data from December 1, 1981 on a 4-kilometer grid throughout the model area. To develop data for the daily time step of the CBWRM, monthly precipitation data for the 1968 to 1981 time period was downscaled to daily temporal resolution with a similar water year type analysis using the recorded Cuyama River flows. Each of the model elements was mapped to the nearest PRISM reference node, which are uniformly distributed across the model domain. The resulting average annual precipitation is shown in Figure C-4.

Figure C-5 shows the Basin averaged annual rainfall in the model area and the cumulative departure from mean, which is an indication of long-term rainfall trends in the area. The average annual precipitation during the 50-year hydrologic sequence from October 1967 to September 2017 was 13.1 inches, which ranges from an annual average of 11.4 inches in the valley floor to 14.8 inches in the upper watershed areas.

Attachment C-2 describes the climate change scenarios analyzed for projected future conditions, and the modifications made to the precipitation data to reflect the effects of climate change.

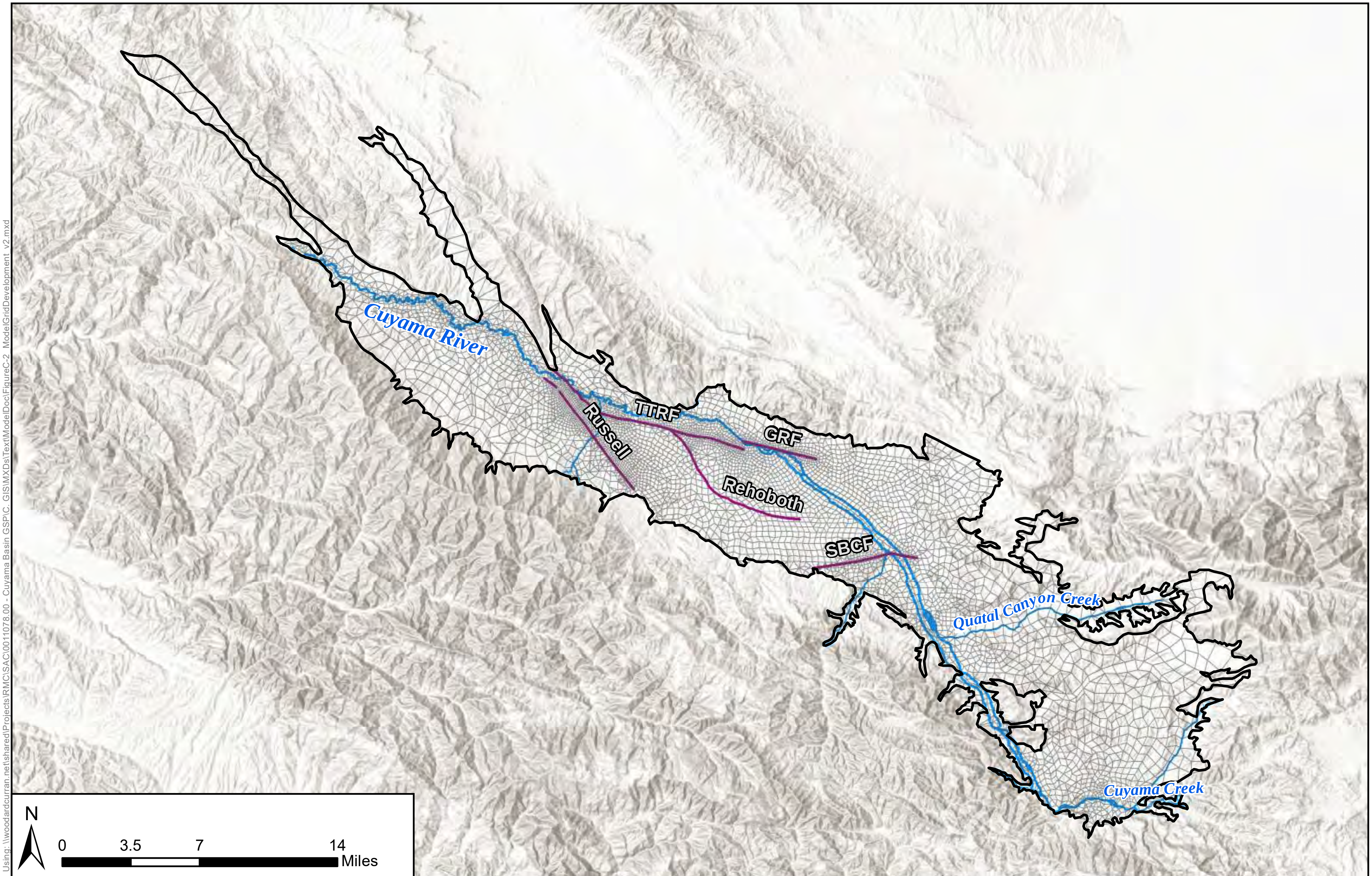

Figure C-2 - Cuyama Valley Groundwater Basin IWFM Grid Development Features

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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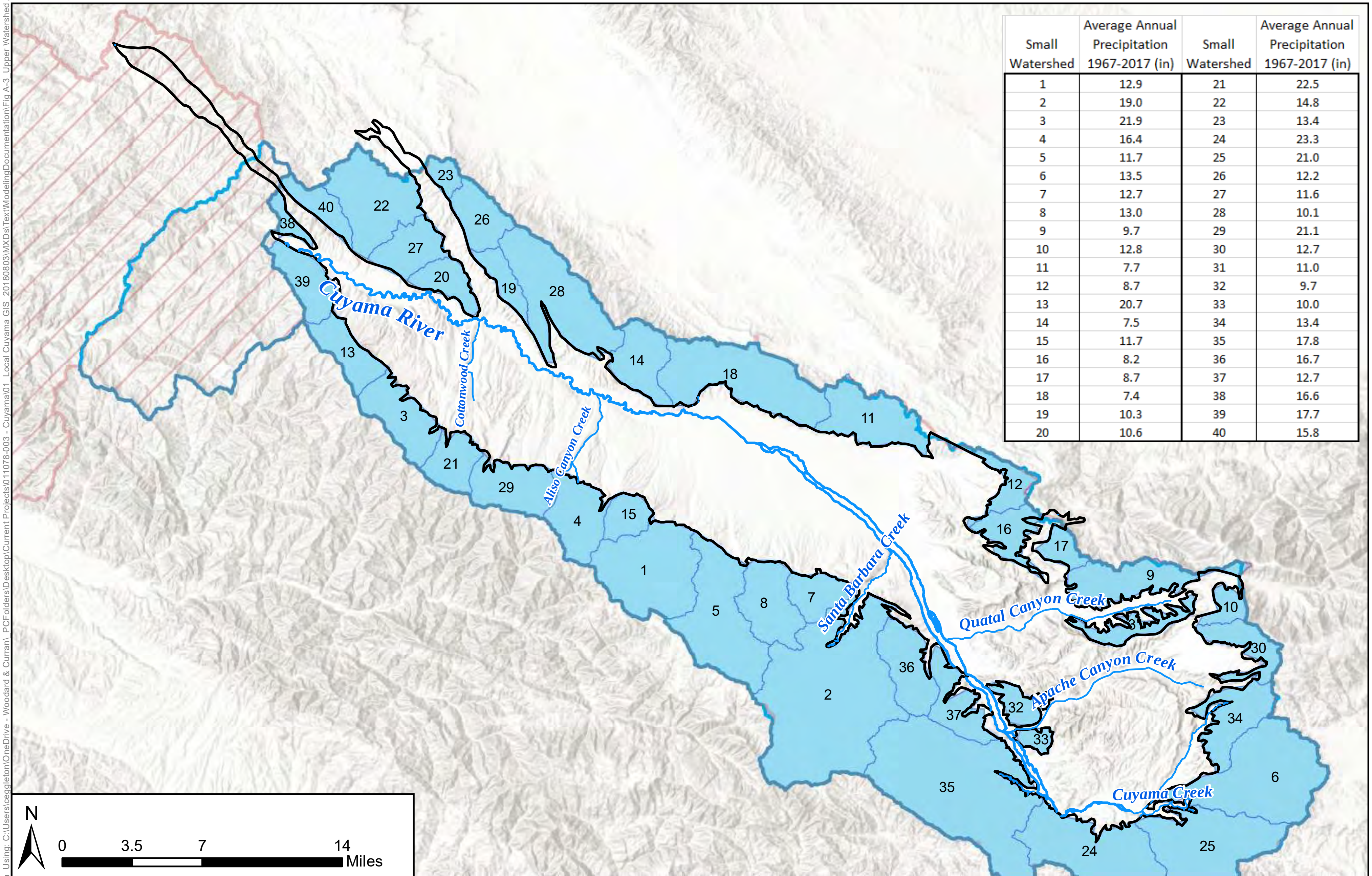
Legend

- Cuyama Basin
- Model Grid
- Faults in CBWRM
- Cuyama River
- Streams/Creeks



Small Watershed	Average Annual Precipitation 1967-2017 (in)	Small Watershed	Average Annual Precipitation 1967-2017 (in)
1	12.9	21	22.5
2	19.0	22	14.8
3	21.9	23	13.4
4	16.4	24	23.3
5	11.7	25	21.0
6	13.5	26	12.2
7	12.7	27	11.6
8	13.0	28	10.1
9	9.7	29	21.1
10	12.8	30	12.7
11	7.7	31	11.0
12	8.7	32	9.7
13	20.7	33	10.0
14	7.5	34	13.4
15	11.7	35	17.8
16	8.2	36	16.7
17	8.7	37	12.7
18	7.4	38	16.6
19	10.3	39	17.7
20	10.6	40	15.8

Figure C-3 - Cuyama Valley Groundwater Basin Upper Watershed Areas in the IWFM Model

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Legend

- Cuyama Basin
- Cuyama River
- Streams/Creeks
- Contributes to Cuyama GW Basin
- Does Not Contribute to Cuyama GW Basin
- Watershed
- Small Watersheds (HUC 12)

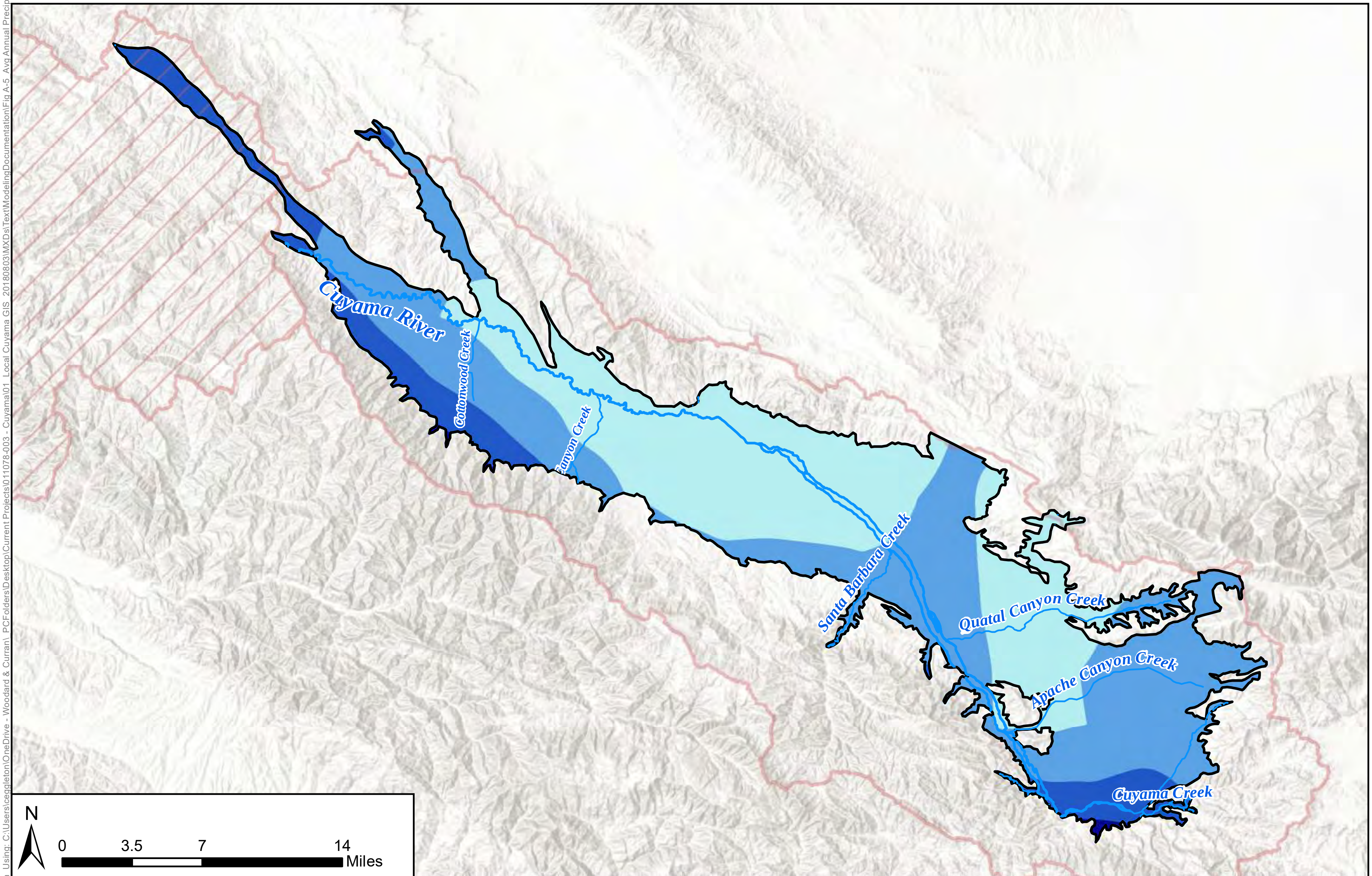

Figure C-4 - Cuyama Valley Groundwater Basin Average Annual Precipitation

Cuyama Basin Groundwater Sustainability Agency

Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

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Legend

- Cuyama Basin
- Cuyama River
- Streams/Creeks
- Contributes to Cuyama GW Basin
- Does Not Contribute to Cuyama GW Basin

Average Annual Precipitation (.in)

- 5.1 - 10
- 11 - 15
- 16 - 20
- 21 - 25

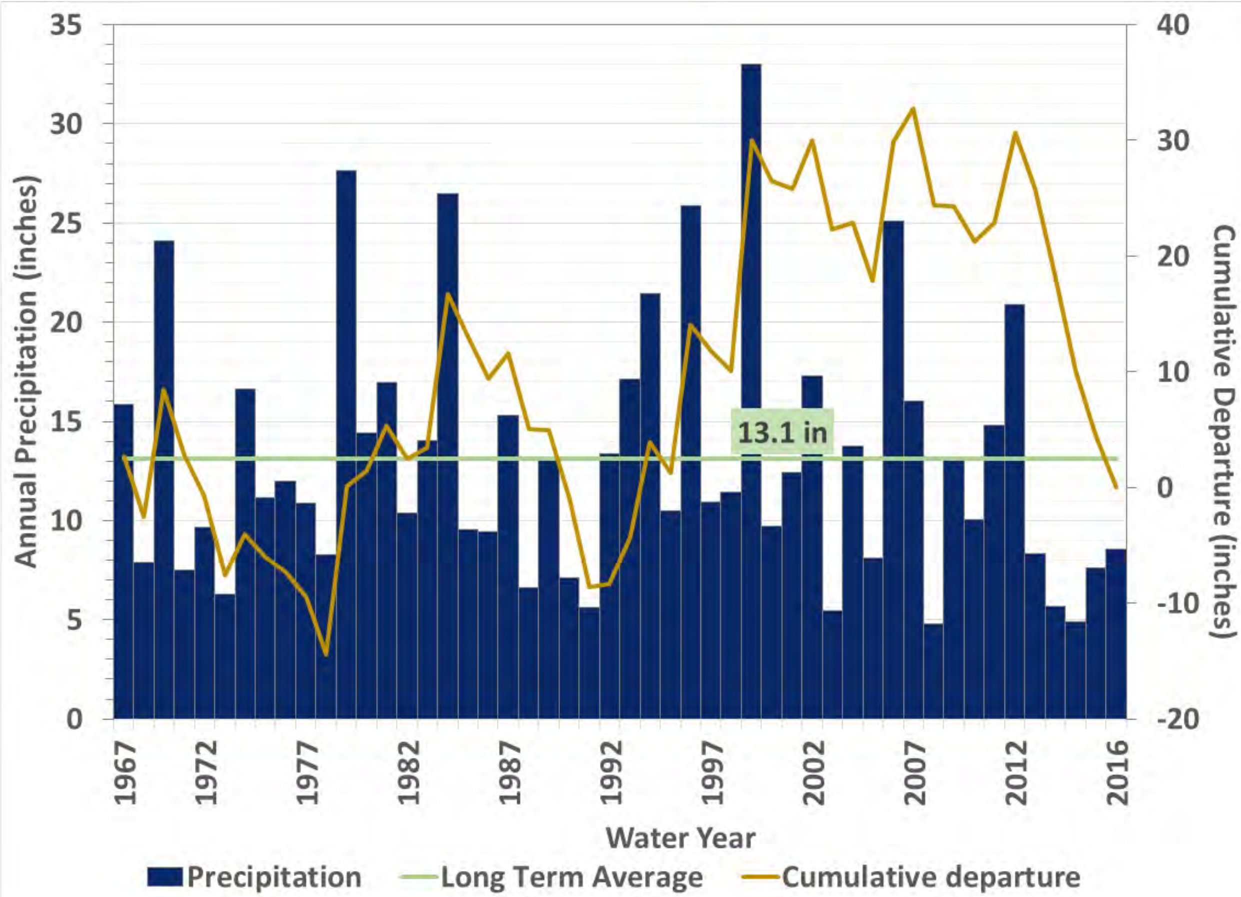

Figure C-5: 50-Year Historical Precipitation and Cumulative Departure from Mean Precipitation

Root Zone Soil Parameters

Soil properties specified in the CBWRM are field capacity, wilting point, total porosity, saturated hydraulic conductivity, and pore size distribution index. These soil properties are specified for each model element, and were used to calculate runoff and infiltration from both rainfall and applied water at each model time step.

DWR's IWFM Soil Data Builder (DWR, 2017) was used in conjunction with the SSURGO (USDA, 2017a) soil data to determine the five soil parameters for each model element. The IWFM Soil Data Builder extracts the SSURGO data relevant to the model area and associates it with each model grid element. For the elements where SSURGO data was incomplete, analysts used the USDA's Digital General Soil Map of the United States (STATSGO2) data (USDA, 2017b) to complement SSURGO parameters.

CBRWM elements are associated with the four hydrologic soil groups according to their runoff potential and infiltration characteristics. NRCS defines these hydrological soil groups as follows (NRCS, 2009):

- **Group A** – Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam, loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.
- **Group B** – Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 and 20 percent clay and 50 to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.
- **Group C** – Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.
- **Group D** – Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential.

Land Use and Cropping Patterns

Land use and cropping patterns are key data sets that support estimation of monthly agricultural water requirements over the period of model simulation. Consistent with the DWR's C2VSim, the CBWRM includes 23 irrigated crop categories and four general land use categories. The general land use categories include urban landscape (e.g., residential areas, school fields, roads, etc.), water surface (e.g., streams, lakes, and reservoirs), riparian vegetation (e.g., native vegetation in the vicinity of surface water), and native vegetation. The 23 irrigated crop categories are combined into six summary-level crop group with similar water use and/or irrigation practices, which also provides a simpler representation of crop group types for planning and policy purposes. Table C-2 lists the land use categories.

Table C-2: Land Use Categories

Land Use Type	Model Category	Grouped Categories
Irrigated Crops	• Apple • Berry • Citrus • Olive • Pistachio • Misc. Deciduous • Misc. Subtropical Fruits	Fruit and Nut Trees
	Vineyards	Vineyards
	• Alfalfa • Mixed Pasture	Alfalfa and Irrigated Pasture
	• Misc. Grain • Misc. Grass • Wheat	Grain
	• Dry Beans • Corn • Misc. Field Crops • Safflowers	Field Crops
	• Carrot • Cole • Mixed Greens • Lettuce • Melons • Onion • Potatoes • Misc. Truck Crops	Truck Crops
	Idle and Fallow Lands	Idle
Other Land Use	• Urban Landscape • Water Surface • Riparian Vegetation • Native Vegetation	

Spatial land use data were used to specify land use types and crop acreages for each model element for each year of simulation. The following data sources were used:

- 1996 data from historical DWR county land use surveys[1]
- 2014 and 2016 data that were developed for DWR using remote sensing data by LandIQ[2]
- 2000, 2003, 2006, 2009, 2012 data that were developed for the CBGSA using remote sensing data; development of these datasets is documented in Attachment C-1.
- Data provided by private landowners for portions of the Basin between 1992 and 2017

Figure C-6 shows the spatial distribution of the major land use categories in the Basin for 2016.[3] Estimated land use in 2016 includes approximately 36,500 acres of irrigated land use. Figure C-7 shows the historical trend of land use categories in the Basin and the projected assumed annual land use pattern for the 50-year hydrologic period used for the projected condition model scenario. The projected annual land use categories are developed based on the 2017 crop categories and acreage values as the basis, with adjustments made for known acreage changes in 2018. Permanent crop acreages were assumed to remain unchanged from 2017-18 values, while annual crop acreages reflect annual variability that was developed based on an autoregressive moving average model that uses the historical land use data sets. The autoregressive moving average was developed such that long-term average acreage for each annual crop type remained unchanged from 2017 values.

[1] https://www.water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Land-Use-Surveys
[2] https://gis.water.ca.gov/app/CADWRLandUseViewer/
[3] Figures for other years can be found in Chapter 1

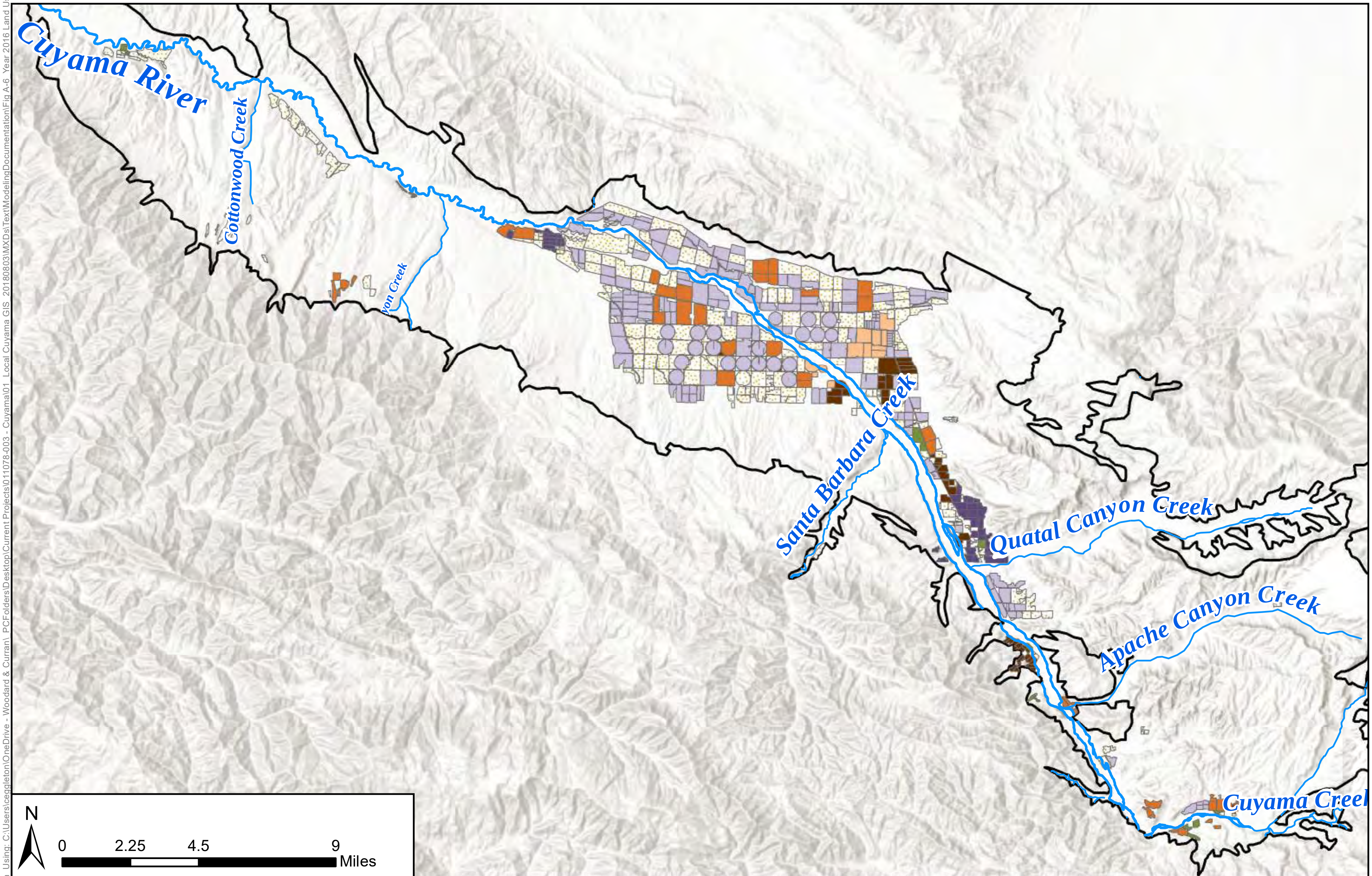

Figure C-6 - Cuyama Valley Groundwater Basin Year 2016 Land Use

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Legend

Cuyama Basin

Cuyama River

Streams/Creeks

Land Use from 2016 Crop Mapping

Alfalfa and Irrigated Pasture

Fruit and Nut Trees

Field Crops

Truck Crops

Vineyard

Grain

Idle

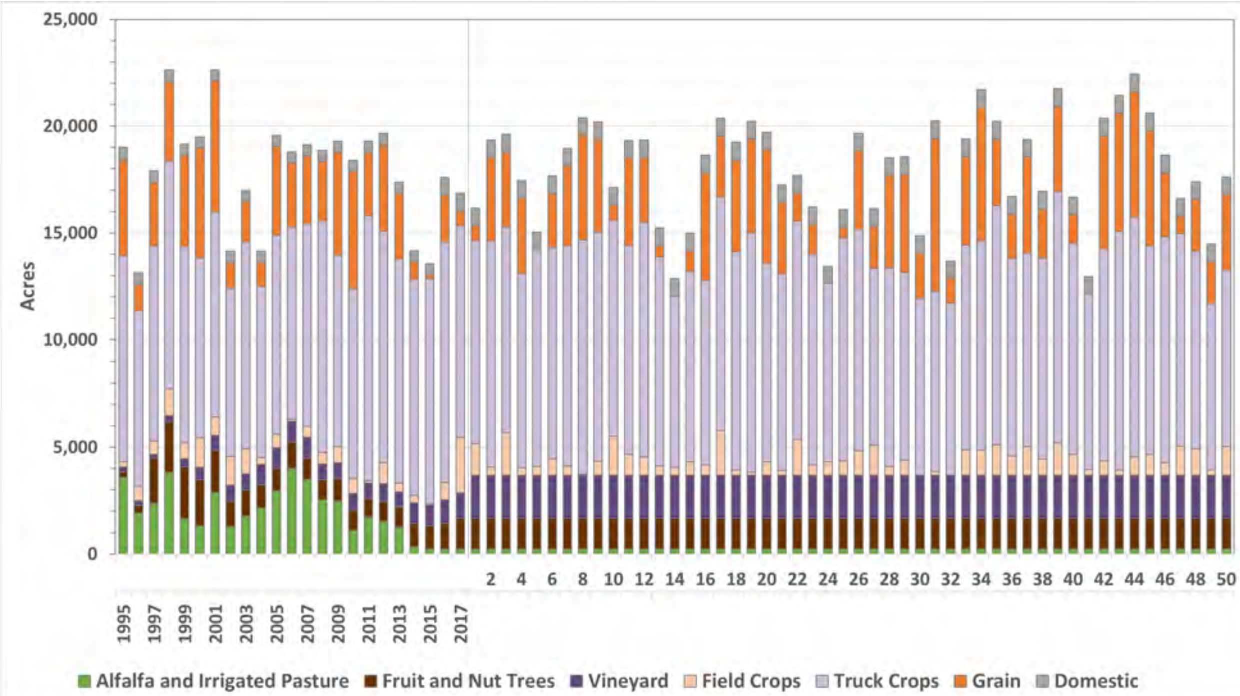


Figure C-7: Historical and Projected Land Use in the Basin

Evapotranspiration

The crop evapotranspiration (ET) requirement is an important factor in agricultural demand estimation. Every land use category must have evapotranspiration assigned for the simulation period. Due to changes in cropping patterns and irrigation practices over time during the historical calibration period, the ET data are specified as a time series during the entire calibration period. ET values are based on the reference evapotranspiration data from Cuyama CIMIS Station. The reference evapotranspiration was converted to crop evapotranspiration using crop coefficients, supplemented by information developed using the Mapping EvapoTranspiration at High Resolution with Internalized Calibration (METRIC) methodology (as described in Attachment C-3). Crop coefficients for each land use category were developed using a daily root zone water balance model (as described in Attachment C-4). This model is driven by the Landsat Normalized Difference Vegetation Index (NDVI) data set, which was originally developed for the Kaweah Delta Water Conservation District in Tulare and Kings counties. The model simulates the rootzone processes on a daily time step, and using remote sensing data, it can capture changes in the timing and intensity of cropping over time.

In the CBWRM, ET represents the net vertical water flux from the land surface and root zone through the upper model layer. Figure C-8 shows the range in annual evapotranspiration rates for each crop category. For climate change scenarios analyzed for projected future conditions, evapotranspiration rates were modified to reflect the effects of anticipated temperature change (Attachment C-2).

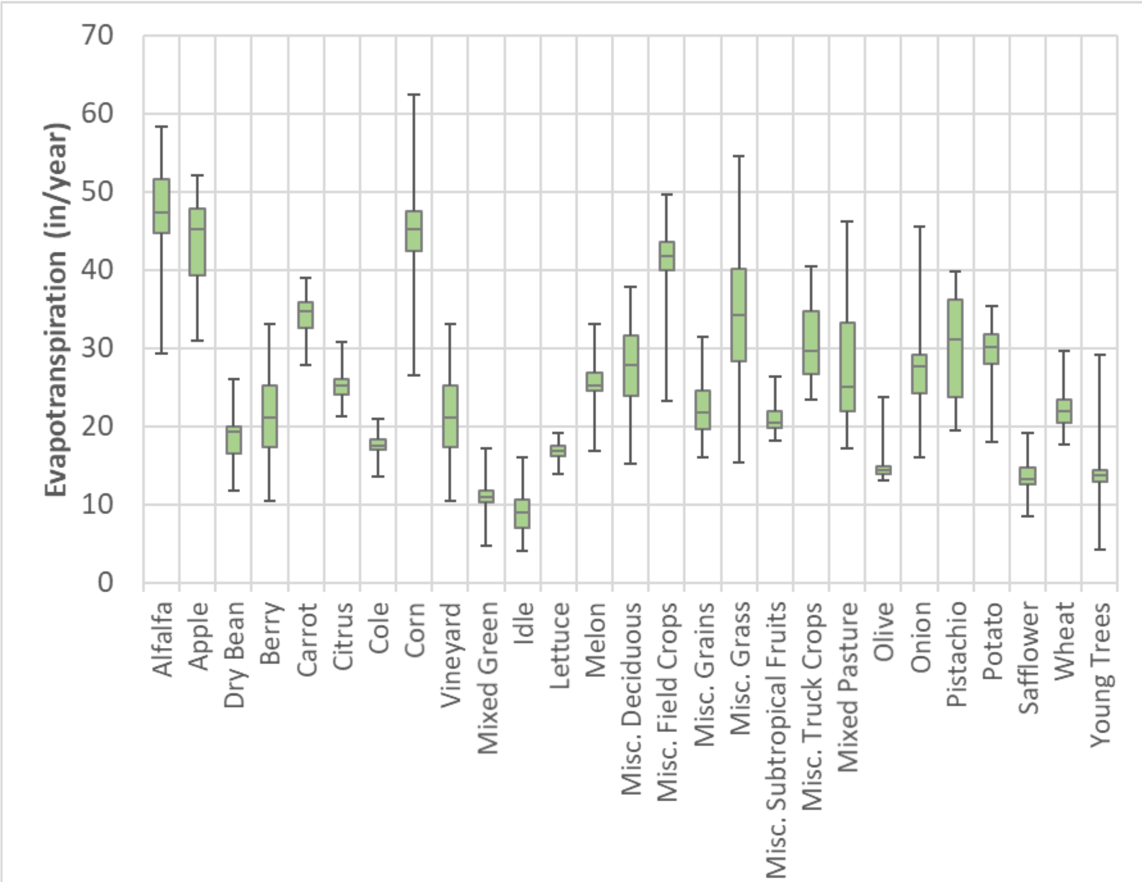


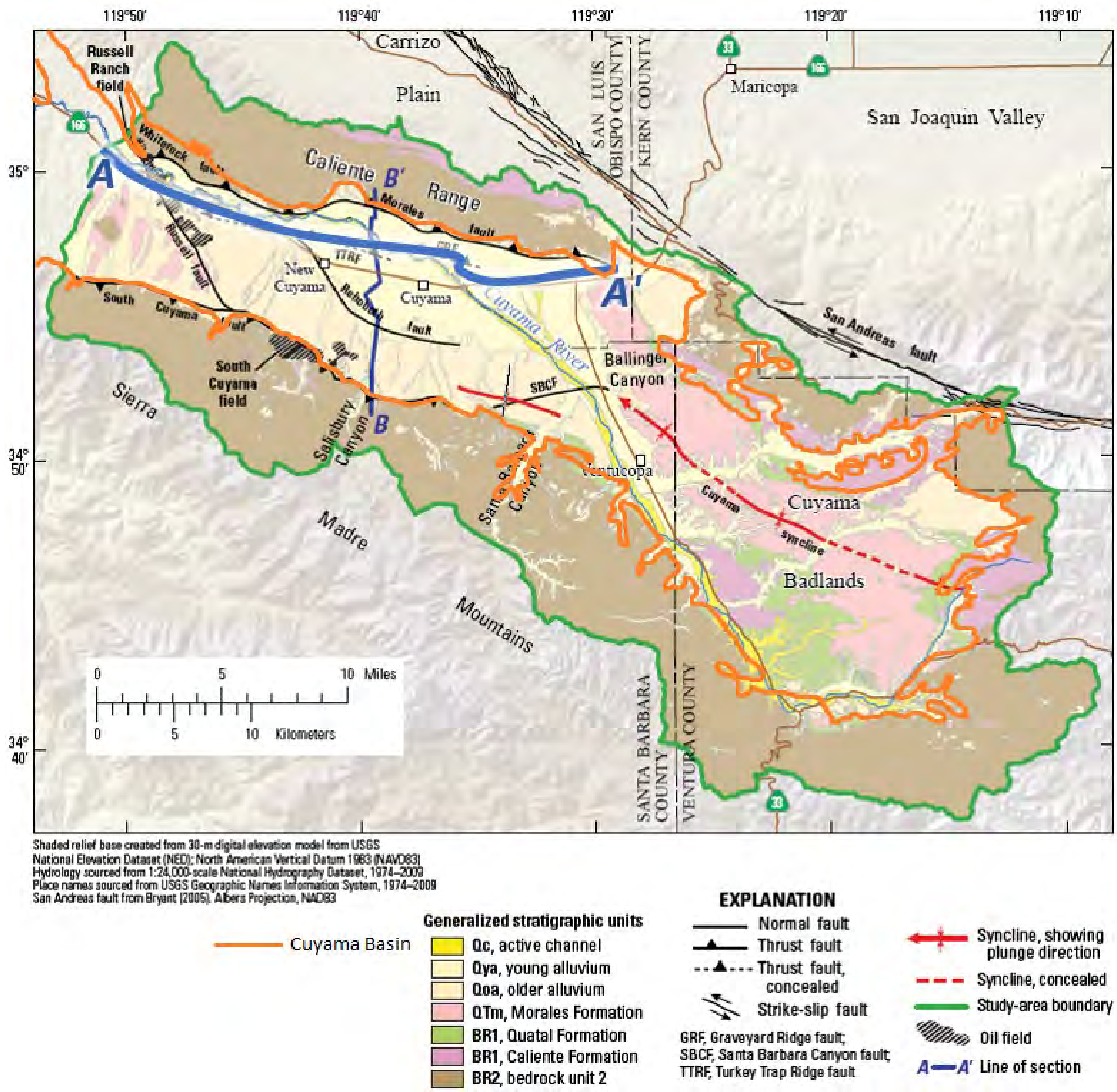
Figure C-8: Annual Evapotranspiration for Each Land Use Type

CBWRM Layering

The CBWRM subsurface zone is characterized by the following three model layers, representing geologic stratification from ground surface to bedrock (listed from top to bottom below) as follows:

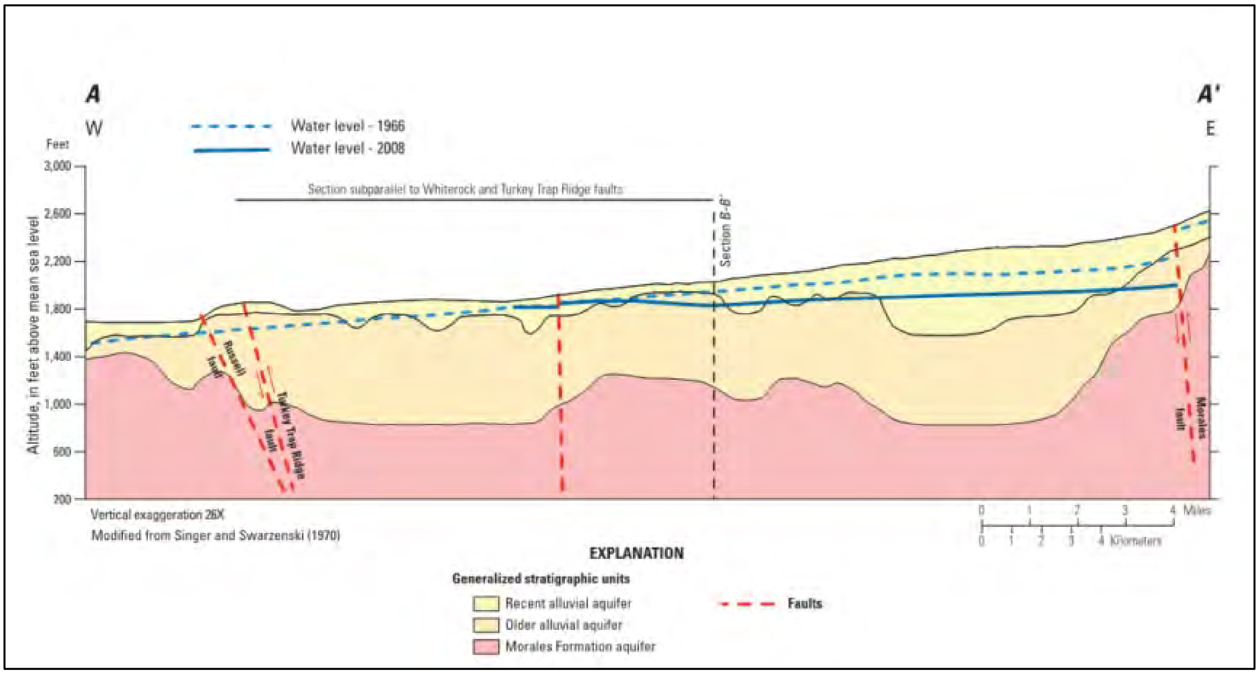
- Layer 1: Recent Alluvial aquifer
- Layer 2: Older Alluvial aquifer
- Layer 3: Morales Formation aquifer

These layers are primarily based on geologic stratification as defined by the USGS (USGS, 2015). They were refined using additional data sets as described in Chapter 2, Section 2.1 of the GSP. Figure C-9 shows the locations of cross sections across the central portion of the Basin as prepared by the USGS in 2013 (USGS, 2013). Figure C-10 shows a west-east cross section that runs near the towns of New Cuyama and Cuyama labeled A-A’, and Figure C-11 shows a south-north cross section labeled B-B’. Figures C-12 through C-14 show the extents and thicknesses of layers 1, 2 and 3 in the CBWRM model.



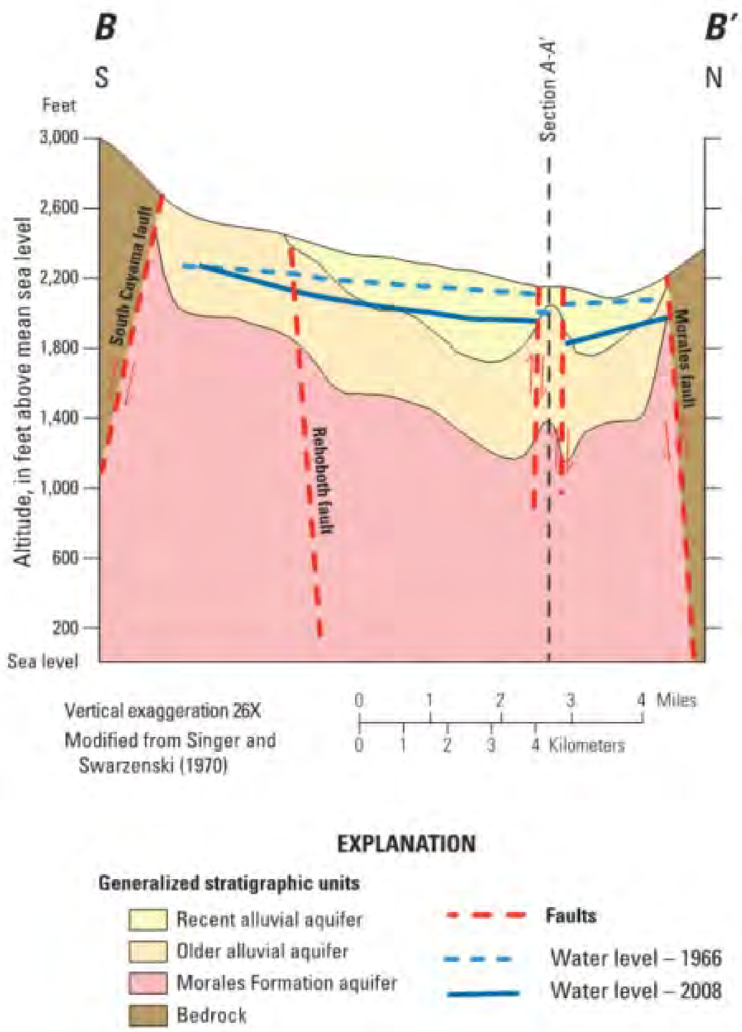
Source: USGS, 2015.

Figure C-9: Location of USGS 2015 Cross Sections



Source: USGS, 2015

Figure C-10: USGS Cross Section A-A'



Source: USGS, 2015

Figure C-11: USGS Cross Section B-B'

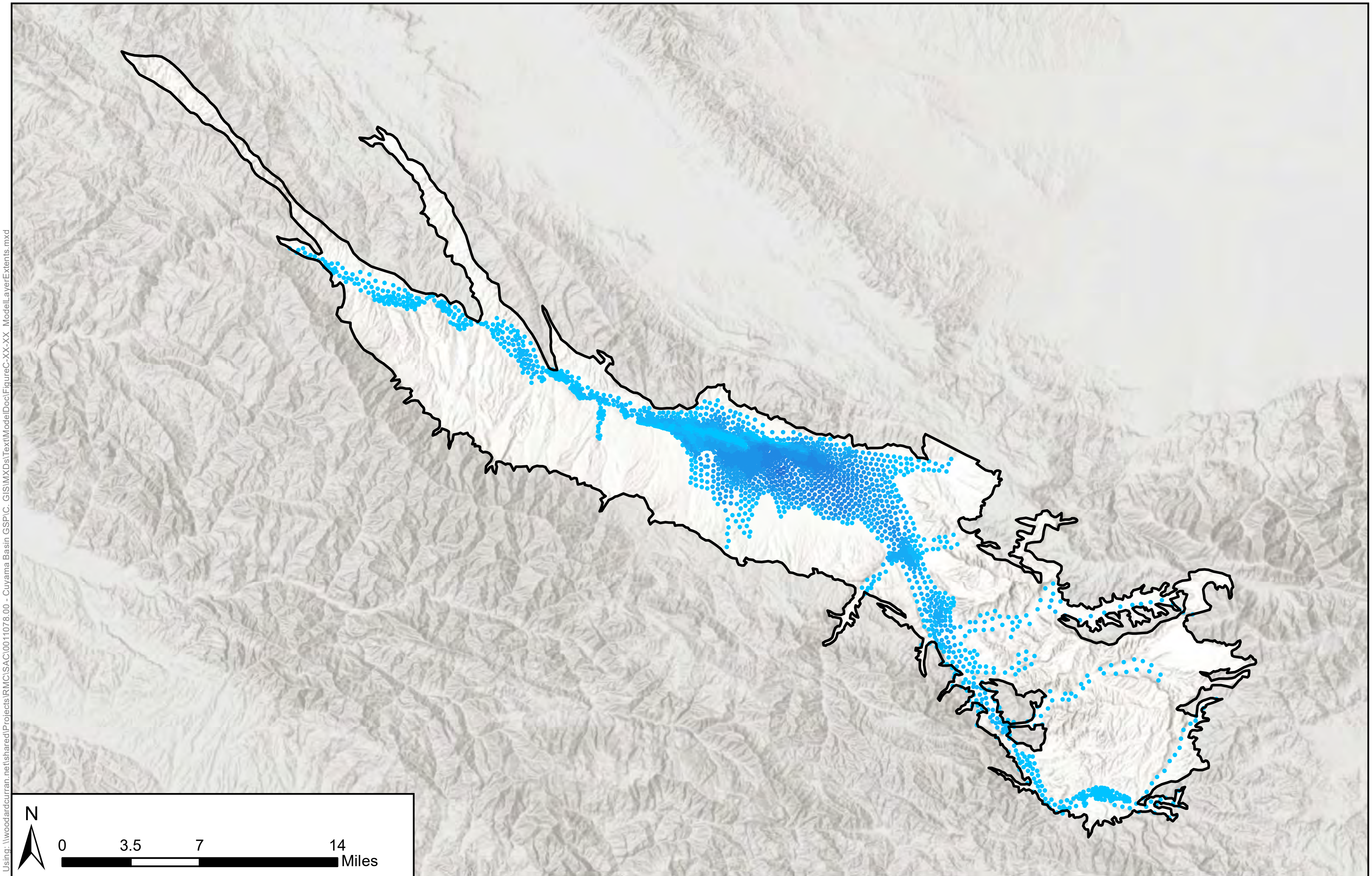


Figure C-12 - CBWRM Layer 1 Extent and Thickness

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Legend

Layer 1 Thickness (ft)

- 10 - 100
- 101 - 200
- 201 - 300
- 301 - 400
- 401 - 500
- 501 - 600
- 601 - 700
- 701 - 800
- 801 - 900
- 901 - 1000
- 1001 - 1100
- 1101 - 1200

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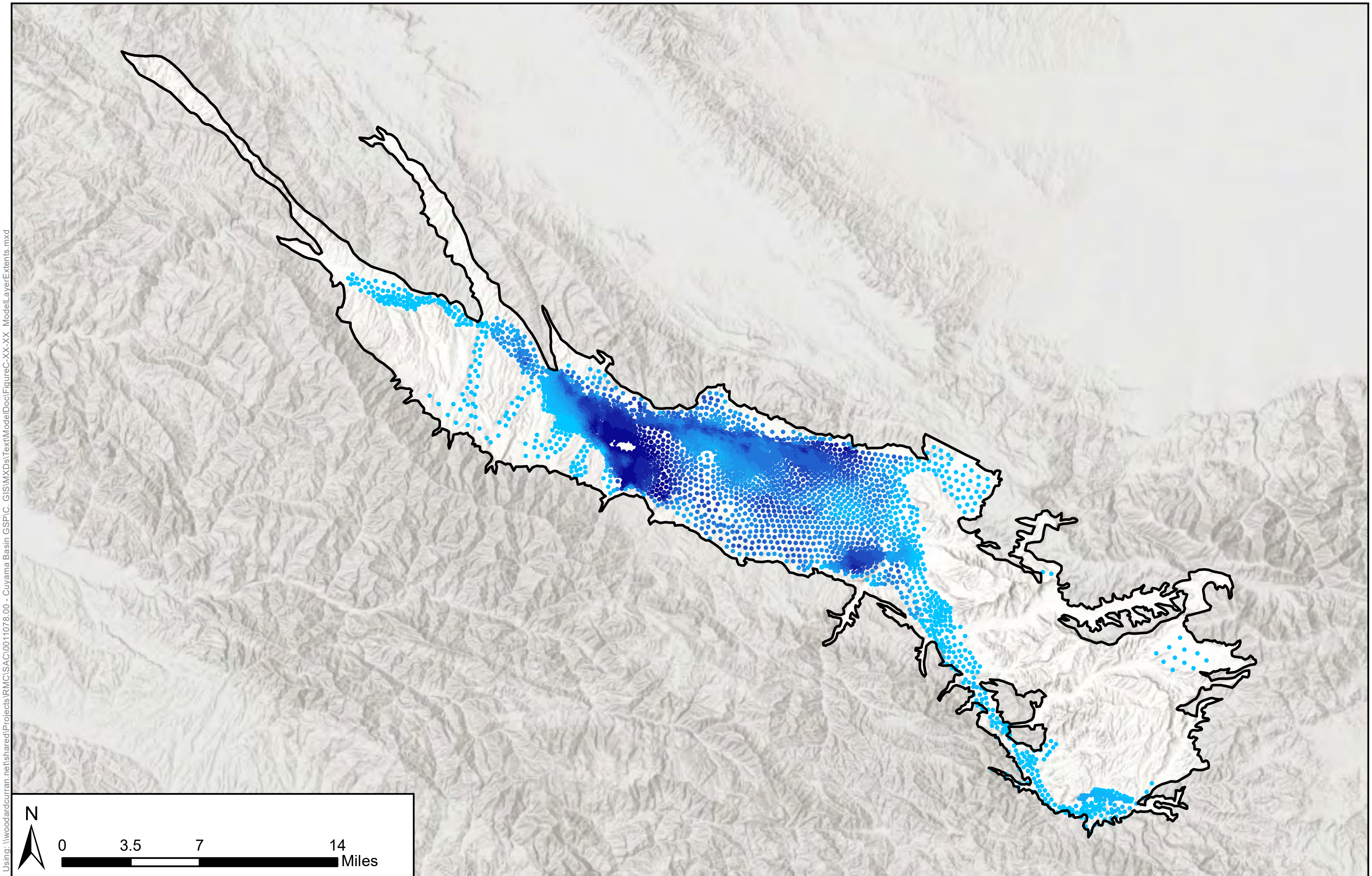

Figure C-13 - CBWRM Layer 2 Extent and Thickness

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Legend

Layer 2 Thickness (ft)

- 10 - 100
- 101 - 200
- 201 - 300
- 301 - 400
- 401 - 500
- 501 - 600
- 601 - 700
- 701 - 800
- 801 - 900
- 901 - 1000
- 1001 - 1100
- 1101 - 1200

Figure Exported: 6/20/2019 By: mceyhan Using: \\woodardcurran.net\shared\Projects\RMC\SAC\0011078.00 - Cuyama Basin GSP\C. GIS\MXDs\Text\ModelDoc\FigureC-XX-XX_ModelLayerExtents.mxd

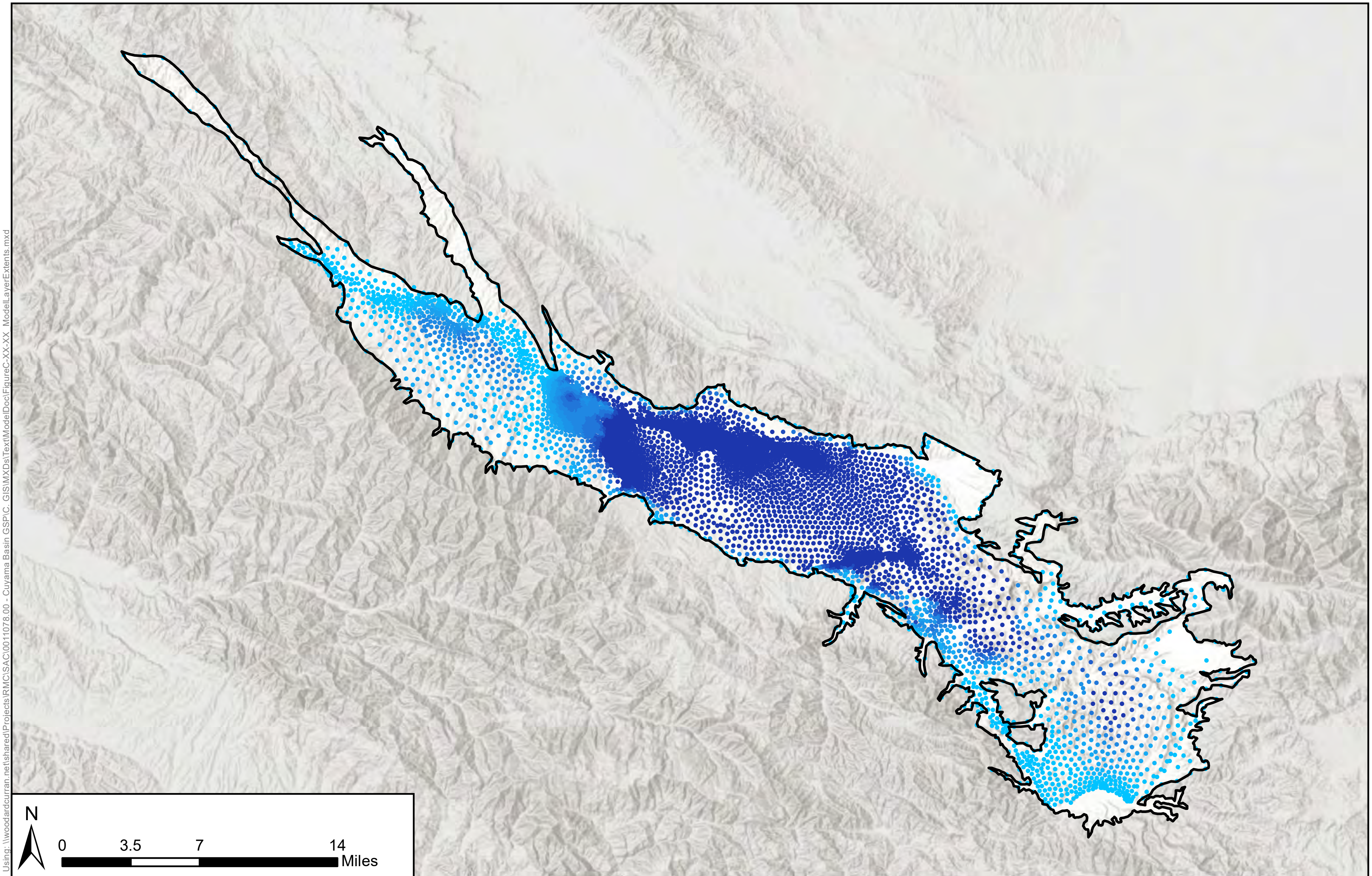

Figure C-14 - CBWRM Layer 3 Extent and Thickness

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Cuyama Valley Groundwater Basin Groundwater Sustainability Plan

December 2019

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Legend

Layer 3 Thickness (ft)

- 10 - 100
- 101 - 200
- 201 - 300
- 301 - 400
- 401 - 500
- 501 - 600
- 601 - 700
- 701 - 800
- 801 - 900
- 901 - 1000
- 1001 - 1100
- 1101 - 1200

Boundary Conditions

As discussed in the previous section, both surface and subsurface inflows within the ungaged watershed areas tributary to the main Basin are simulated using small watersheds module of the CBWRM. No flow boundary conditions were assumed for the rest of the domain boundary.

Initial Conditions

Groundwater heads for each model node and each layer at the beginning of the historical simulation (i.e., October 1, 1994) were developed using groundwater level data described in Chapter 2, Section 2.2. Due to the lack of information on well depth and/or perforation for many of the wells used, groundwater heads for each model layer are assumed to be the same. During the calibration process, some refinements were made by layer, as needed. This assumption, however, results in the use of first few years of simulation for start-up period to stabilize the simulated groundwater levels. Therefore, the model calibration period effectively ends up to be the 20-year period of water years 1996 through 2015.

Water Supply and Demand Data

The following sections describe the data and methodology for the CBWRM water demand and supply calculations. Agricultural water demands were calculated in the IDC portion of IWFM. Agricultural and domestic supplies are specified in the CBWRM's groundwater pumping data.

Agricultural Water Demand

Agricultural water demand is the amount of irrigation water that is required to satisfy the crops' evapotranspiration requirement after rainfall. The IDC is designed to estimate the agricultural water demand for each model element through consumptive use methodology. The IDC calculations rely on model input data for historical crop acreage, irrigation practices, soil moisture requirements, effective rainfall (the portion of rainfall available for crop consumptive use), crop evapotranspiration, and localized soil parameters. This data was compiled, analyzed, synthesized, and processed for input into CBWRM.

Domestic Water Use

IDC calculates urban water demand based on population and per capita water use, and the breakdown of indoor versus outdoor water use by month. For the Basin, the per capita water use was estimated using historical pumping estimates provided by the CCSD (CCSD 2010 to 2017) and population records published for the CCSD service area. Domestic water use during the historical period ranges between 100 and 200 acre-feet per year (AFY).

CBRWM Calibration

The goals of CBRWM calibration were as follows:

- Achieve a reasonable water budget for each component of the hydrologic cycle modeled (i.e., land and water use, soil moisture, stream flow, and groundwater) that is acceptable by the stakeholders to support the development of the GSP
- Maximize the agreement between simulated and observed groundwater levels at select well locations, and simulated and observed streamflow hydrographs at select gaging stations

These objectives are achieved through verification of model input data and adjustment of model parameters.

CBRWM calibration begins after data analysis and input data file development are completed. The calibration effort can be broken down into subsets that align with packages within the IWFM platform. As an integrated surface water and groundwater model, the results of each part of the simulation are dependent on one another. The model calibration can be considered a systematic process that includes the following activities:

- Calibrate water demand estimates for agricultural and urban sectors
- Calibrate surface water features, including the small watershed runoff, boundary flows, and streamflows
- Calibrate overall water budgets for the model area, and model subregions
- Calibrate simulated groundwater levels to observed groundwater levels
- Compare calibration performance with the calibration targets
- Conduct additional refinements to model as necessary

The CBWRM was calibrated to historical groundwater elevation data, with the calibration informed by local data provided by private landowners and other stakeholders.

Due to uncertainty in the initial conditions, a one-year warm-up period was included to allow groundwater levels to stabilize. Thus, the model calibration period for the CBWRM is October 1995 through September 2015, or water years 1996 through 2015 (i.e., 20 years).

Calibration of IDC and Root-Zone Parameters

The goal of IDC calibration is to estimate a reasonable urban and agricultural demand and develop the components of a balanced root zone budget. IDC calibration serves as the foundation of IWFM calibration as demand estimates directly affect the estimates of groundwater pumping. This part of the calibration effort focused primarily on refining individual budget items, while maintaining reasonable root zone parameters.

The calibrated IDC was used to estimate monthly agricultural water demand at each model element during the model hydrologic period. To adjust agricultural demand, elemental root zone parameters were adjusted in accordance with the hydrologic soil group. Figure C-15 shows estimates of annual agricultural water demand in the Basin from water year 1998 to water year 2017. The average annual agricultural water demand during these years is estimated to be approximately 59,000 AFY. The year-to-year variability in estimated agricultural demand reflects the variabilities in land use, precipitation, and temperature experienced historically in the Basin.

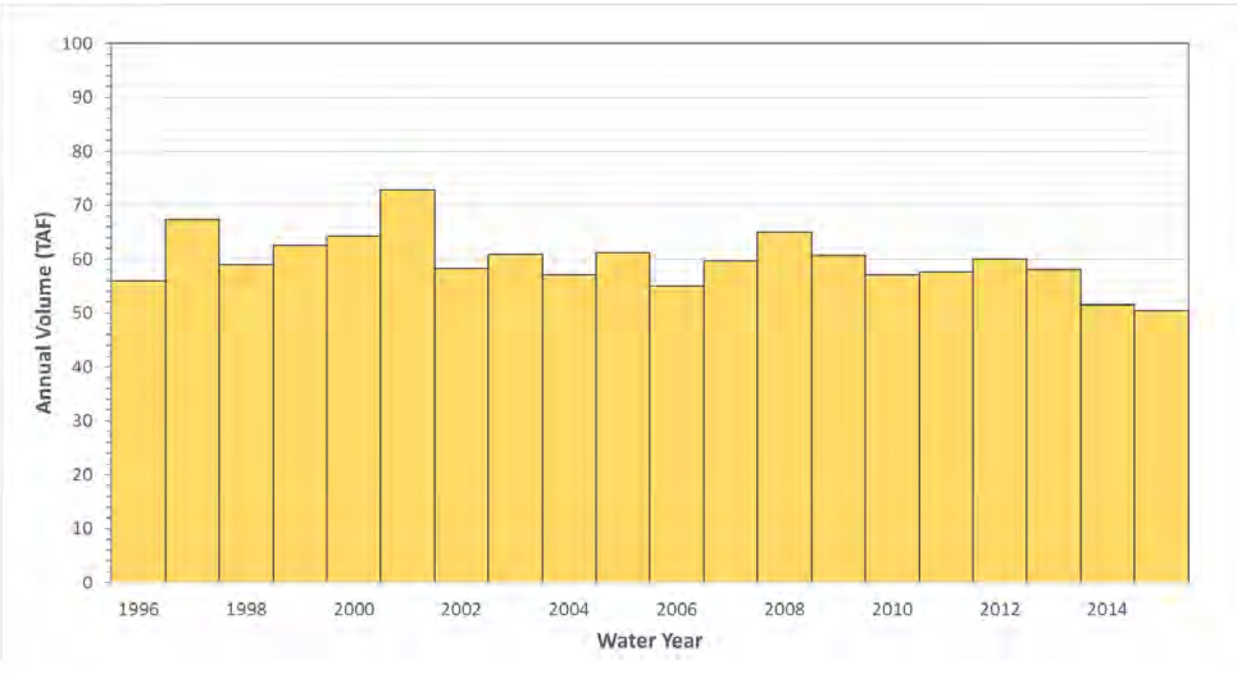

Figure C-15: Annual Agricultural Water Demand

Calibration of Surface Water Features

As discussed above, small watersheds were used to simulate inflows into the model from ungaged watersheds. The small watershed were split between surface water runoff that enters the stream system, percolation that occurs during transport to the streams, and baseflow entering the groundwater system at the model boundary.

In addition to the surface water flows coming from small watersheds, surface water runoff generated over the groundwater basin is collected in the stream network to simulate streamflows and stream-aquifer interaction. Stream-aquifer interaction is calculated based on stream stage, groundwater levels, and channel properties such as streambed hydraulic conductance.

As discussed above, limited streamflow data are available to perform calibration on surface water flows in the model. One USGS gage is available on the Cuyama River downstream of the Basin (ID 11136800), which is located just upstream of Lake Twitchell. The flows from this gage were adjusted to estimate flows at the downstream boundary of the Basin. These adjusted flows as well as available streamflow data from deactivated and active gages on small watersheds were then compared to the flows resulting from the model calibration process.

Calibration of Water Budgets

The aim of the calibration process is to ensure an accurate representation of the hydrologic characteristics of the Basin, confirmed through the analysis of the resulting water budgets. A water budget balances all supplies, demands, and any subsequent change in storage occurring within that specific portion of the hydrologic cycle. IWFM automatically outputs budgets at the subregion scale for processes involving groundwater, the surface layer, streams, the root zone, and small watersheds. IWFM can output select budget information down to a single element or any specific grouping of elements. This feature was used during the calibration process to prepare water budget information by certain geographic areas for planning and comparison purposes.

During this step of the calibration process, CBRWM results are reviewed and summarized into monthly and annual (by water year) budgets. Two key hydrologic components that were reviewed most frequently during the calibration process were the groundwater budget and the land and water use budget. During extensive analysis of water budgets, key model datasets and parameters were adjusted (including parameters related to soil and root zone, small watershed and boundary flows, stream system, and aquifer system), to better match the conceptual understanding of the Basin. CBWRM water budget results are summarized in the following sections.

Land Surface Water Budget

The following components are included in the land surface water budget:

- Inflows:
  - Precipitation
  - Applied Water
- Outflows:
  - Evapotranspiration (Agricultural and Native Vegetation)
  - Domestic Water Use
  - Deep Percolation
  - Runoff

Figure C-16 shows the annual time series of historical land surface inflows and outflows during the calibration period. The Basin experienced about 282,000 AF of inflows each year, of which 223,000 AF is from precipitation and the remainder is from applied water. About 223,000 AFY was consumed as evapotranspiration and domestic use, with the remainder either recharging the groundwater aquifer as deep percolation, stream seepage or leaving the Basin as river flow.

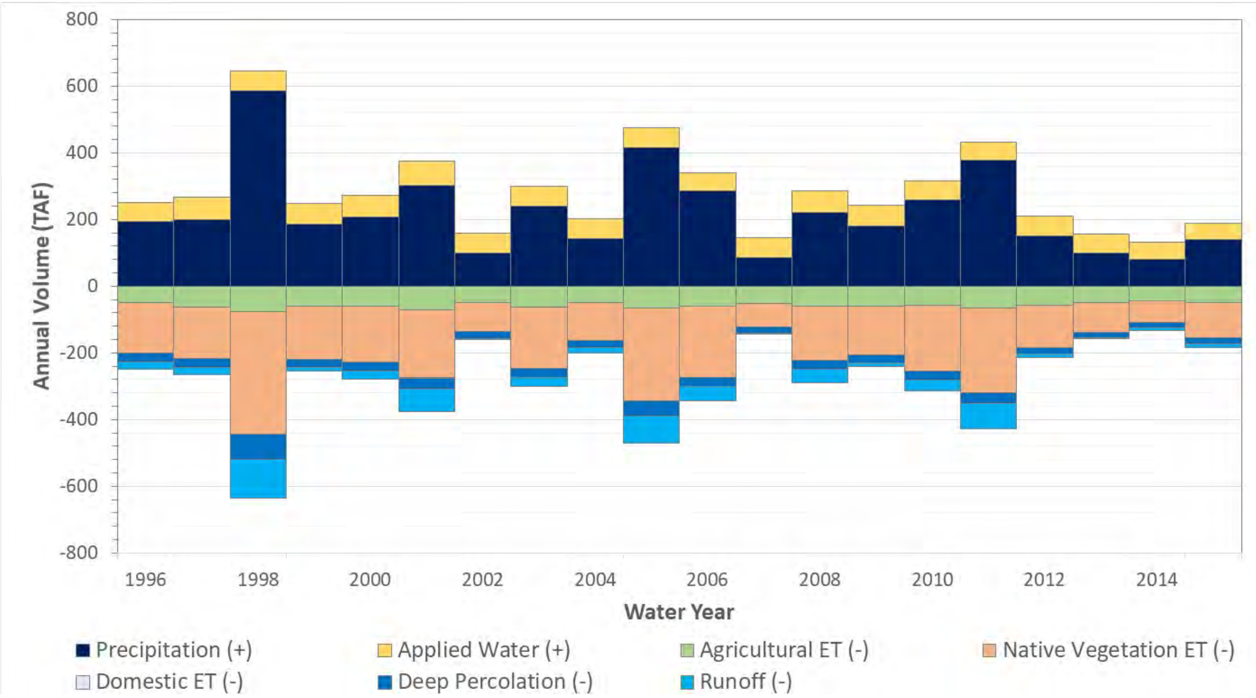

Figure C-16: Land Surface Water Budget Annual Time Series in the Calibration Period

Groundwater Budget

The following components are included in the groundwater water budget:

- Inflows:
  - — Deep percolation
  - — Gain from stream
  - — Subsurface inflow
- Outflows:
  - — Groundwater pumping

Figure C-17 shows the annual time series of groundwater inflows and outflows during the calibration period. The Basin average annual historical groundwater budget has greater outflows than inflows, leading to an average annual deficit in groundwater storage of 24,000 AF. The groundwater storage decreases consistently over time, despite year-to-year variability in groundwater inflows.

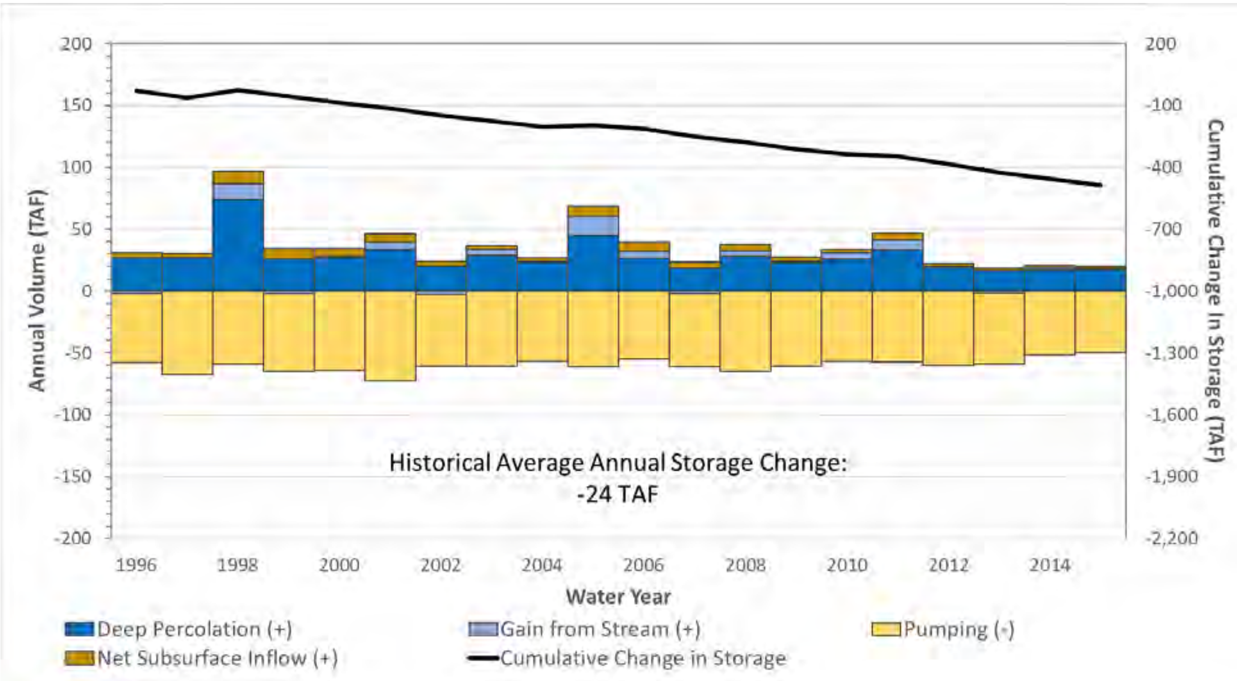

Figure C-17: Groundwater Budget Annual Time Series in the Calibration Period

Groundwater Level Calibration

The goal of groundwater level calibration is to achieve reasonable agreement between the simulated and observed values (in this case, groundwater levels at the calibration wells). Within the CBWRM, 65 wells were used to evaluate the model calibration at both a regional and local scale. These wells are included in the CBGSA's Opti data management system. The calibration wells were selected based on their period of record and availability of observation data, spatial distribution across the model, and trends of nearby wells. These calibration wells are shown in Figure C-18.

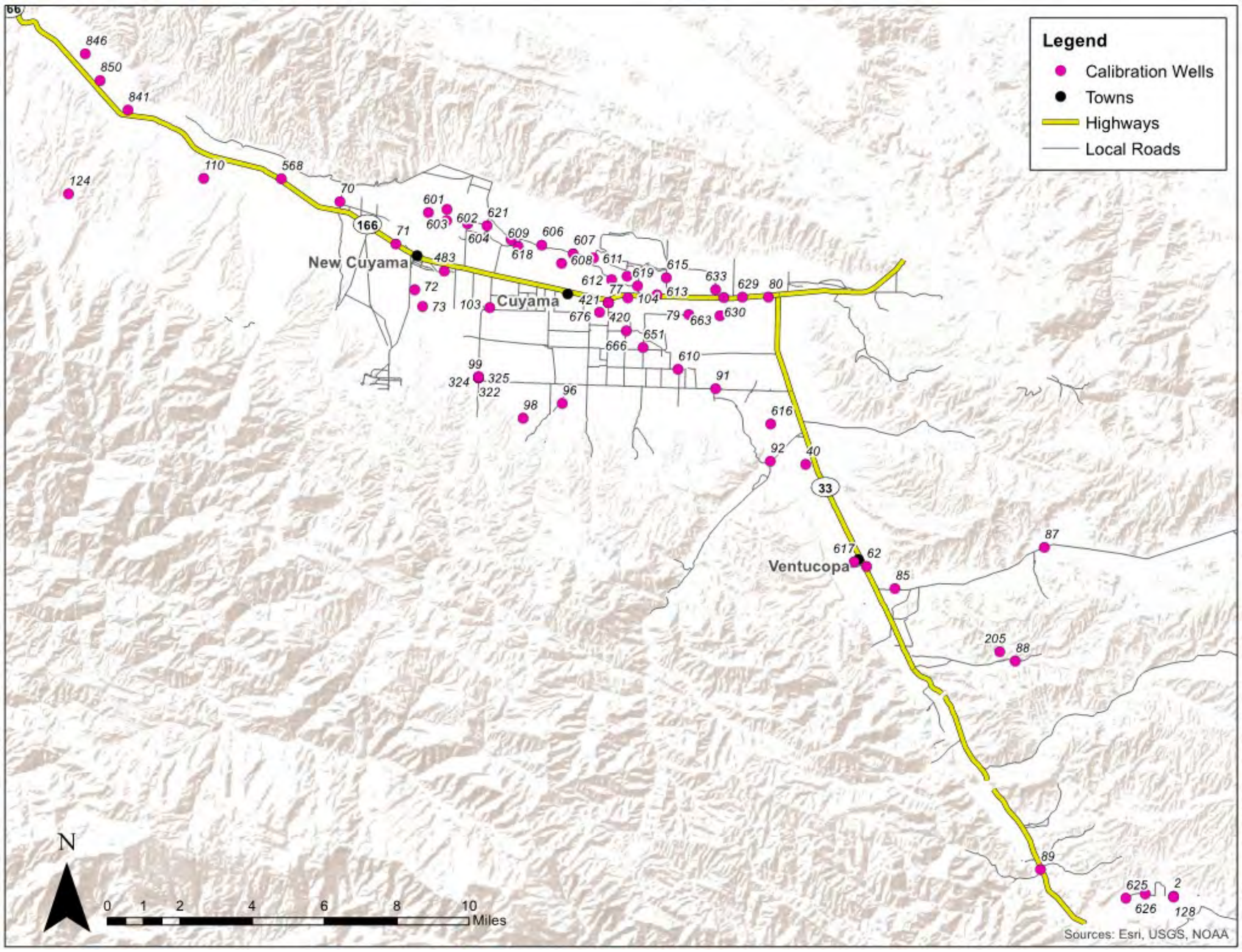

Figure C-18: Location of Calibration Wells

Simulated groundwater levels were calibrated to observed levels through systematic adjustments to aquifer parameters including hydraulic conductivity, specific storage, and specific yield. The goal of groundwater level calibration is to achieve the maximum agreement between simulated and observed groundwater elevations at calibration wells while maintaining aquifer parameters within reasonable range. The groundwater level calibration is performed in two stages as follows:

- The initial calibration effort is focused on the regional scale to verify hydrogeological assumptions made during model data development and confirm the accuracy of general groundwater flow directions. During this stage, simulated groundwater elevation trends, flow directions, and groundwater gradients are compared to those that can be synthesized form the reported data.
- The second stage of calibration of groundwater levels is to compare the simulated and observed groundwater levels at each calibration well. This comparison provides information on the overall model performance during the simulation period. The simulated groundwater elevations at the calibration wells were compared with corresponding observed values for concurrence in long-term trends as well as seasonal fluctuations.

The results of the groundwater level calibration indicate that CBWRM reasonably simulates long-term hydrologic responses under various hydrologic conditions, and the short-term monthly or seasonal fluctuations. Attachment 3 shows a selection of calibration wells with their resulting groundwater level hydrographs.

Figures C-19 and C-20 show a statistical comparison of the final simulated and observed groundwater levels across the entire Basin. As shown in these figures, the model results show a strong correlation with the observed data.

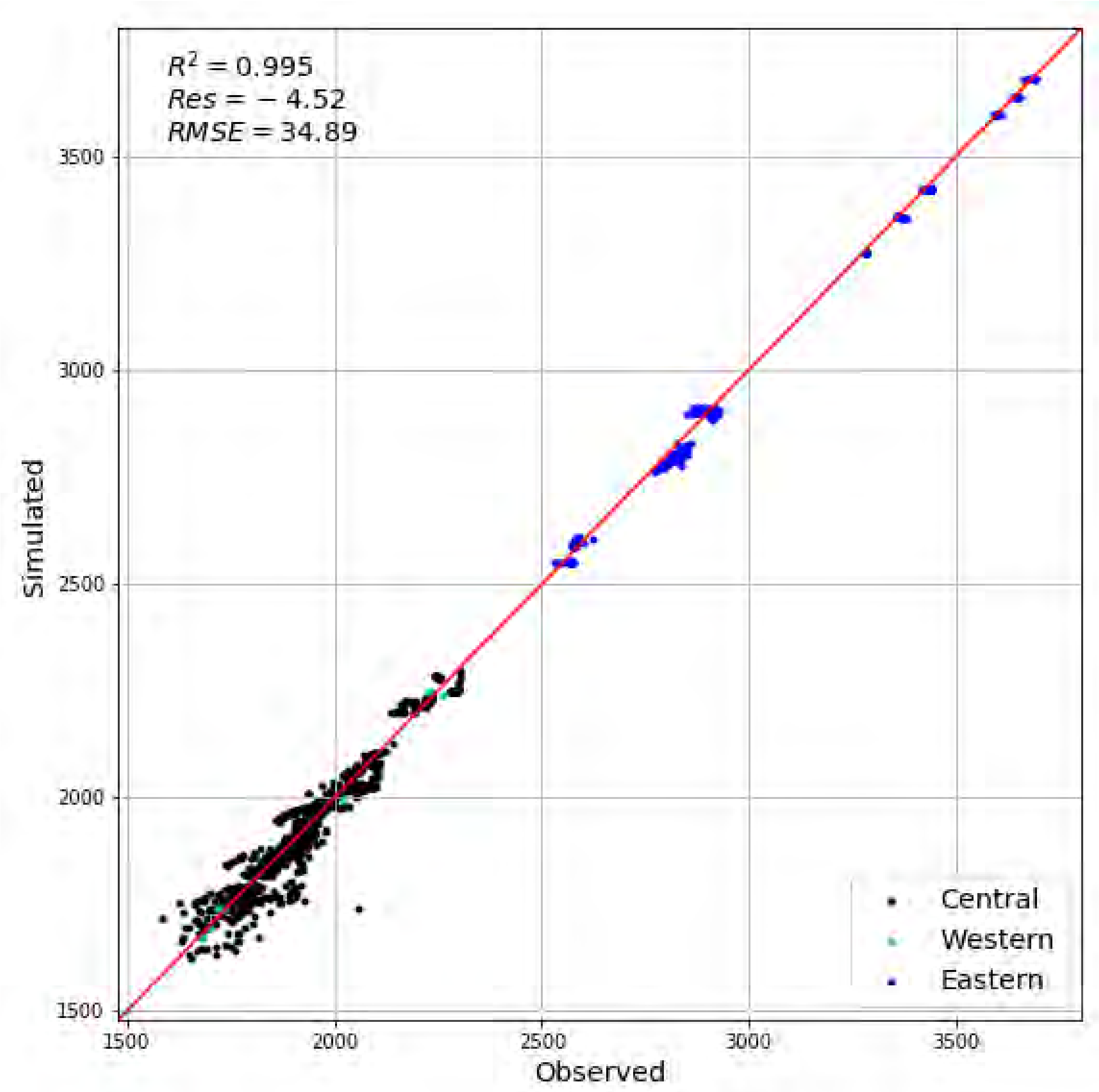

Figure C-19: Comparison of Simulated and Observed Groundwater Levels

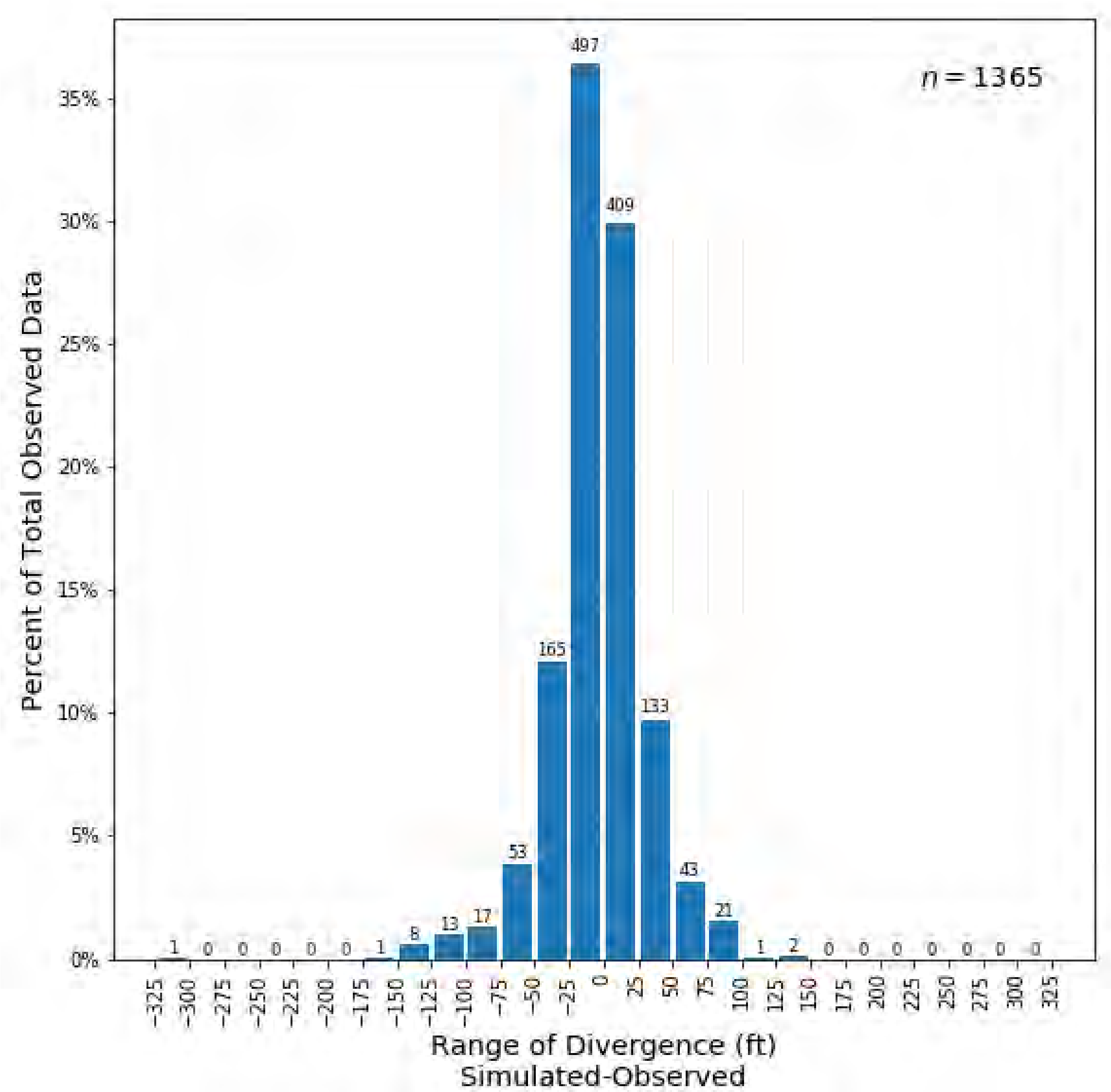

Figure C-20: Histogram of Divergence of Simulated Groundwater Levels from Observed Data

Uncertainty and Sensitivity Assessment

To incorporate the uncertainty that originates from various model inputs such as hydraulic parameters, land use, irrigation practices and agricultural demand, an ensemble of perturbed simulation results were analyzed to quantify the overall effect on the groundwater storage change over the historical simulation period.

Table C-3 shows the range of aquifer hydraulic parameters used in CBWRM as compared to reported values from historical USGS studies. The ranges of horizontal hydraulic conductivity used in CBWRM for layers 1 and 2 is similar to the USGS values. In layer 3, it was necessary to set CBWRM values lower than the reported USGS values in order to provide a good match with historical groundwater levels. The specific yield and specific storage values used in CBWRM are consistent with typical values used for similar geologic formations.

Table C-3: Range of Aquifer Parameters in CBWRM as Compared to Reported Values

Study	Horizontal Hydraulic Conductivity (feet/day)			Specific Yield	Specific Storage
	Layer 1	Layer 2	Layer 3		
CBWRM	$3.0x10^{-1}$ to $2.4x10^{1}$	$1.0x10^{-2}$ to $1.0x10^{1}$	$1.1x10^{-4}$ to $3.5x10^{-2}$	0.08 to 0.25	10-6 to 10-4
USGS Pumping Tests[a]	$1.9x10^{-1}$ to $5.3x10^{1}$	$5.3x10^{-2}$ to $2.6x10^{1}$	$6.6x10^{-2}$ to $2.7x10^{-1}$	N/A	N/A
USGS Slug Tests[a]	N/A	$1.5x10^{0}$ to $2.8x10^{1}$	$1.6x10^{0}$ to $9.9x10^{0}$	N/A	N/A

[a]USGS, 2013b

Table C-4 shows the sensitivity of Basin-wide storage change to various model parameters. Groundwater pumping was tested by simulating plus or minus 20 percent of the baseline value, while the other parameters were tested by multiplying the baseline values by 0.1 and 10 (for specific storage) or by 0.2 and 5 (for the other parameters). Basin-wide storage was found to be most sensitive to groundwater pumping, followed by soil percolation potential and streambed seepage potential.

Table C-4: Sensitivity of Basin-wide Storage Change to Different Parameters

Parameter	Change Factor	Maximum Range (AF)	Deviation of Maximum Range (percent)	Minimum Range (AF)	Deviation of Minimum Range (percent)	Range of Deviation (percent)
Groundwater Pumping	±20	34,945	+45	13,114	-46	91
Aquifer Hydraulic Conductivity	x0.2/x5.0	26,050	+8	23,103	-4	12
Specific Yield for Shallow Aquifer System	x0.2/x5.0	26,124	+8	23,384	-3	11
Specific Storage for Semi-confined Aquifer Systems	x0.1/x10.0	24,153	0	23,985	0	<1
Streambed Seepage Potential	x0.2/x5.0	29,368	+22	20,054	-17	39
Soil Percolation Potential	x0.2/x5.0	26,688	+11	17,118	-29	40
Tributary Watershed Flows	x0.2/x5.0	25,107	+4	24,103	0	4

Accounting for these uncertainties in combination with comparisons of observed and simulated groundwater elevations, the upper and lower bounds for the cumulative groundwater storage change are presented in Figure C-21 below. The upper and lower bounds for the average groundwater storage change that result in a similar correlation of observed and simulated groundwater elevations are estimated to range from 22,000 to 27,000 AFY.

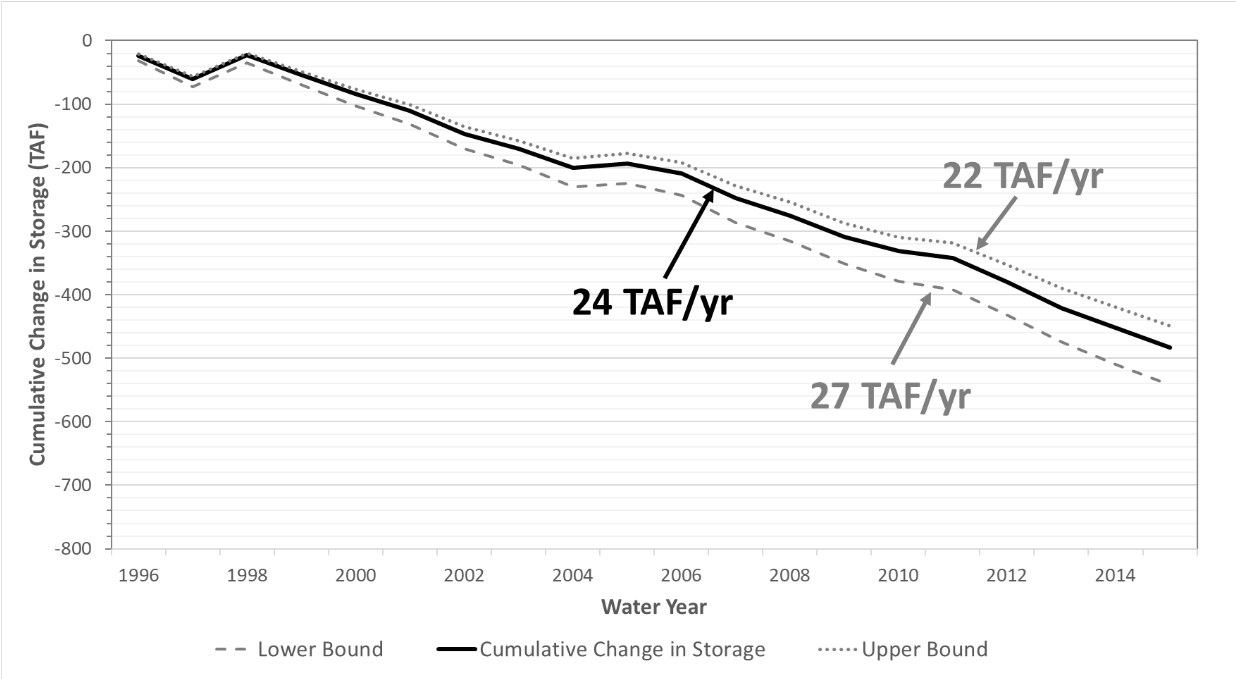

Figure C-21: Lower and Upper Bounds for the Groundwater Storage Change

Conclusions and Recommendations

The CBWRM is the latest analytical model based on DWR’s state-of-the science modeling platform, IWFM. The CBWRM has relied on data sets from various sources, and was developed to support GSP development with the primary purpose of assessing hydrologic and groundwater conditions in the Basin during the recent historical period from water 1998 to water year 2017. CBWRM also assesses hydrologic and groundwater conditions under the Basin’s current level of development and under projected conditions.

Based on analysis, the following conclusions are made:

1- CBRWM is reasonably calibrated, and reflects a reasonable representation of the Basin’s hydrologic and hydrogeologic conditions
2- CBRWM calibration meets the intended need to support GSP development
3- GSP stakeholders and the Technical Forum have reviewed model development and calibration results, and have agreed that the CBWRM, as it stands, is an appropriate tool to be used for assessment of and planning for sustainable groundwater conditions in the Basin.

The following recommended actions would support future model updates:

- **Continue engagement with local stakeholders**. Continue working with local agencies and groundwater users in the Basin to further understand the local operations of the groundwater system and improve representation of groundwater users in the model by collecting additional data. Specific data to be considered are irrigation practices outside the main District areas, groundwater level data, information on the well profiles and characteristics.
- **Perform additional hydrogeological conceptualization.** Specific areas can benefit from additional hydrogeologic investigations. These include eastern part of the basin in the vicinity of the Ventucopa area, as well as the western part of the model, downgradient from the Russel Fault. In addition, data about effectiveness of the fault system in the area are very sparse. Additional targeted groundwater exploration and/or groundwater level monitoring should focus on the areas near the fault systems.
- **Improve streamflow record collection.** Currently, there are no long-term streamflow gaging stations within the CBWRM. As part of GSP implementation, at least two streamflow gaging stations should be installed and monitored regularly, so that Basin inflows and outflows are properly monitored.
- **Improve representation of small watersheds.** Surface water flow from and evapotranspiration losses in the ungaged watersheds represent a relatively large portion of the Basin water budgets. Additional investigations on the native vegetation ET, and runoff conditions in the ungaged watersheds can improve model representation of this feature.
- **Develop groundwater pumping estimates.** As groundwater pumping is the primary outflow from the groundwater system, an accurate representation of outflow significantly improve CBWRM performance. A pilot project is recommended to monitor and measure groundwater use and well discharge for select parcels based on cropping patterns and geographic location relative to the river and relative to other hydrologic features, such as faults.

  Incorporate future data into model calibration. Data will be collected using the CBGSA's groundwater monitoring network, and should be used to re-assess and improve the HCM, CBWRM parameter values and CBWRM calibration, especially in areas of the Basin where little or no data exist currently. In addition, model predictions should be compared to actual future climate and water availability conditions to provide insights into model performance.

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Attachment C-1

Land Use and Consumptive Water Use of Cuyama Groundwater Basin for Water Years 1996 Through 2016

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TECHNICAL MEMORANDUM – DRAFT

LAND USE AND CONSUMPTIVE WATER USE OF CUYAMA GROUNDWATER BASIN FOR WATER YEARS 1996 THROUGH 2016

To:	Woodard & Curran
From:	Land IQ
Date:	June 19, 2018

INTRODUCTION

Accurate and current information on constantly changing consumptive water use for crops is critical not only to water rights administration, but also to sustainable groundwater management, agricultural irrigation management, and to environmental and water quality protection. Land IQ has been contracted by Woodard & Curran to analyze consumptive water use in the Cuyama Groundwater Basin for these purposes and overall Groundwater Sustainability Plan (GSP) development data resources.

This memorandum provides methods and results of crop type identification for selected water years (1996, 2000, 2003, 2006, 2009, 2012, 2014 & 2016) during the 20 year time period. Multiple sources of data are used in the identification of each field. These sources include aerial imagery, satellite photography, DWR land use surveys and ground survey information.

This documentation also provides estimates of crop evapotranspiration (ET) for the 1996 and 2016 water years (10/1/1995 – 9/30/1996, 10/1/2015 – 9/30/2016). The surface energy balance model, METRIC (Mapping Evapotranspiration with high Resolution and Internalized Calibration), is applied to estimate monthly and annual evapotranspiration. The input data include CIMIS weather station data and USGS Landsat 5 & 8 satellite images.

DETERMINING LAND USE

Land use is one of the most influential inputs to a consumptive use or groundwater model. This analysis was used to develop estimates of land uses associated with agricultural production in the Cuyama Groundwater Basin. Crop type information optimizes estimations of evapotranspiration, applied water, deep percolation return flows and other water balance input data requirements.

LAND USE DATA SOURCES

Available resources for crop mapping in recent years are more refined and accurate and in past years. Table 1 shows the types of aerial/satellite imagery as well as data availability for each year. Taking this into account, the accuracy and specifity of crop identification is greatest in the most recent mapping years (2014 & 2016). In more recent years, data allows individual crop types to be identified, instead of a more general category (e.g. Miscellaneous Truck Crops).

TABLE 1. SUMMARY OF DATA SOURCES AVAILABLE FOR EACH ANALYSIS YEAR

Year	Land Use Survey Data	Google Earth	NAIP Imagery	Landsat
2016	✔	✔	✔	✔
2014	✔	✔	✔	✔
2012	-	✔	✔	✔
2009	-	✔	✔	✔
2006	-	✔	✔	✔
2003	-	-	✔	✔
2000	-	-	-	✔
1996	✔	-	-	✔

LAND USE SURVEY DATA

The California Department of Water Resources (DWR) publishes land use data for regions on a rotating schedule for all or portions of each California County (DWR, 2018). The Cuyama Valley was last surveyed by DWR in 1996, including >90% of the fields in the Valley. Since then, Land IQ has completed statewide crop mapping for DWR in 2014 and 2016, encompassing the entire Cuyama Valley. In these three years, this data was used as a base layer and updated as needed.

GOOGLE EARTH

Google Earth provides high resolution satellite imagery with some temporal variation. Currently, most Google Earth data is provided by DigitalGlobe's WorldView-3 satellite, providing sub-meter resolution (Digital Globe, 2010). The street view function is also very helpful when identifying past years' crops. The street view in this area is very limited, however, and only available in 2008.

NAIP AERIAL IMAGERY

The National Agriculture Imagery Program (NAIP) captures aerial imagery during the growing season for public use (USDA, 2017). The imagery for the Cuyama Valley was available starting in 2003. NAIP imagery has a fairly high resolution of one meter. This imagery is used to update the field boundary layer for each year because the high resolution allows for the identification of fields that have split or have a different footprint. The drawback to NAIP imagery is that it is only a snapshot in time, with no temporal variation. Figure 1 shows 2009 NAIP imagery of the Cuyama Valley at two different scales to show detail.

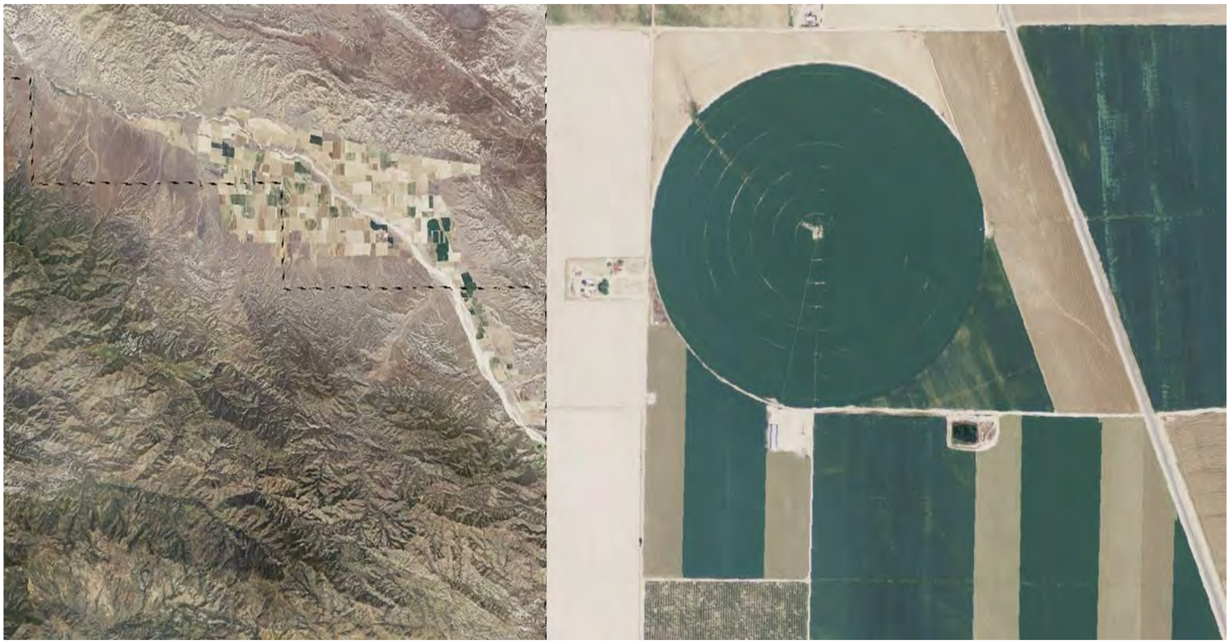

FIGURE 1. NATURAL COLOR COMPOSITE OF NAIP IMAGE, FOR 05/05/2012; 1:300,000 SCALE ON LEFT; 1:9,000 SCALE ON RIGHT.

LANDSAT SATELLITE IMAGERY

Landsat satellite imagery is a joint project between the USGS and NASA that collects imagery for public use. Landsat provides lower resolution imagery (30 x 30 meter pixels) but at a much higher frequency than NAIP (USGS, 2007). Depending on year and cloud cover, imagery for an area could be as frequent as every 8 days. This frequency allows for the observation of the crop in all stages of development. All imagery dates during the growing season are used to identify the color and texture changes, to support the crop type identification.

The Cuyama Valley is within Landsat reference system path 42 and row 36. Landsat 5, 7, and 8 were used for appropriate years. All available growing season images were utilized, except those that had cloud contamination. Figure 2 is an example of the agriculture area in Landsat 5 on June 26, 2009.

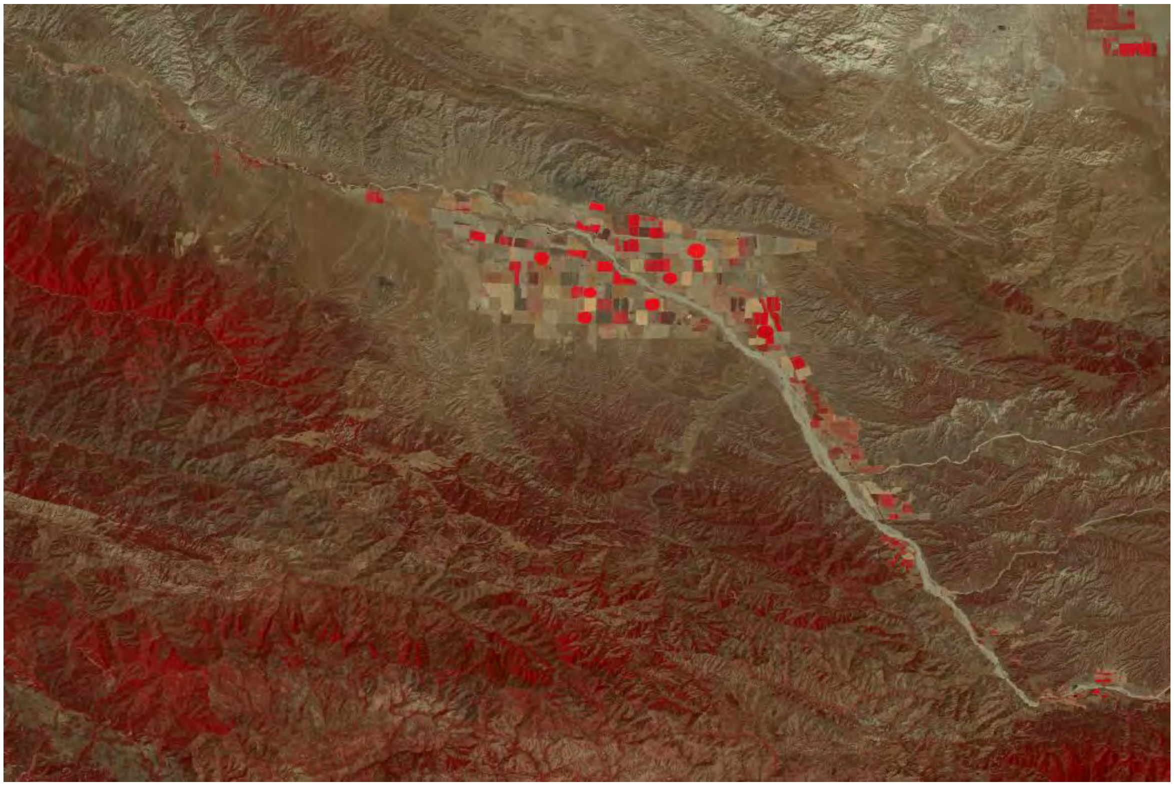

FIGURE 2. FALSE COLOR COMPOSITE OF LANDSAT 5 IMAGE, PATH 42 ROW 36, FOR 06/26/2009. AGRICULTURE IS IN THE MIDDLE OF THE IMAGE.

LAND USE RESULTS

Classification and field boundary updates were completed for each year, using the data sources available. Table 2 summarizes the results of the classification and boundaries. The top 5 crop classes during the 20 year period (excluding idle) were miscellaneous truck, miscellaneous grain and hay, carrots, alfalfa and alfalfa mixtures, and apples.

TABLE 2. SUMMARY OF CROP MAPPING RESULTS

DWR Crop	1996	2000	2003	2006	2009	2012	2014	2016
Alfalfa & alfalfa mixtures	3,574	2,586	1,950	2,201	935	1,356	168	235
Apples	2,475	2,478	1,417	773	518	282	307	331
Beans (dry)	-	259	-	-	-	-	1,064	-
Bush berries	-	-	-	-	-	-	-	21
Carrots	4,698	843	307	566	5,582	6,654	2,302	5,572
Citrus	-	2	2	2	4	4	2	2
Cole crops	-	-	107	137	292	236	182	383
Corn, sorghum and sudan	-	185	209	-	74	-	32	173
Grapes	357	794	768	768	765	853	1,303	1,241
Greenhouses	-	-	-	-	-	-	-	5
Idle	-	8,286	9,971	12,247	9,139	8,449	15,352	13,572
Lettuce/leafy greens	-	-	-	271	212	171	-	612
Melons, squash, and cucumbers	12	-	-	-	-	-	562	50
Miscellaneous deciduous	12	10	10	16	41	35	10	6
Miscellaneous field crops	114	-	-	-	-	-	-	-
Miscellaneous grain and hay	7,462	5,756	5,580	4,712	8,767	6,367	851	3,198
Miscellaneous grasses	-	192	485	192	111	14	22	-
Miscellaneous subtropical fruit and nut	-	-	-	-	-	-	-	7
Miscellaneous truck	3,723	6,842	8,083	9,380	3,451	4,078	6,100	3,322
Mixed pasture	737	104	91	398	273	392	97	142
Native	-	-	-	-	-	166	-	-
Olives	-	4	4	4	4	4	4	517
Onions and garlic	313	10	315	527	983	1,231	615	2,190
Peaches/nectarines	413	348	284	213	75	-	-	-
Pistachios	676	604	604	757	757	722	802	722

DETERMINING CONSUMPTIVE USE

Traditional methods of calculating evapotranspiration can be done quite accurately using weighing lysimeters and eddy correlation monitoring techniques. These methods are limited, however, because they provide point values of ET for a specific location and fail to provide the ET on a regional scale. This limitation has motivated the development of using remotely sensed (RS) data from satellites to evaluate ET over vast areas. Satellite data are ideally suited for deriving spatially continuous ET surfaces that can be pared down to the field scale because of their temporal and spatial characteristics. However, the most accurate use of RS models require calibration to surface measurements.

SURFACE ENERGY BALANCE CONSUMPTIVE USE ANALYSIS – METRIC MODEL

METRIC estimates surface evapotranspiration (ET) based on the evaluation of the energy balance at the earth's surface. METRIC model processes instantaneous remotely-sensed images and weather data, and estimates the partitioning of energy into net incoming radiation (R_n), heat flux into the ground (G), sensible heat flux to the air (H), and latent heat flux (LE). The latent heat flux is computed as a residual in the energy balance, representing the energy consumed by ET. The main advantage of using the energy balance is that the actual ET is computed, rather than a potential ET. A disadvantage of the energy balance approach is in the complexity of calculations and the need for human oversight during calibration. Figure 3 shows a general workflow of the METRIC process.

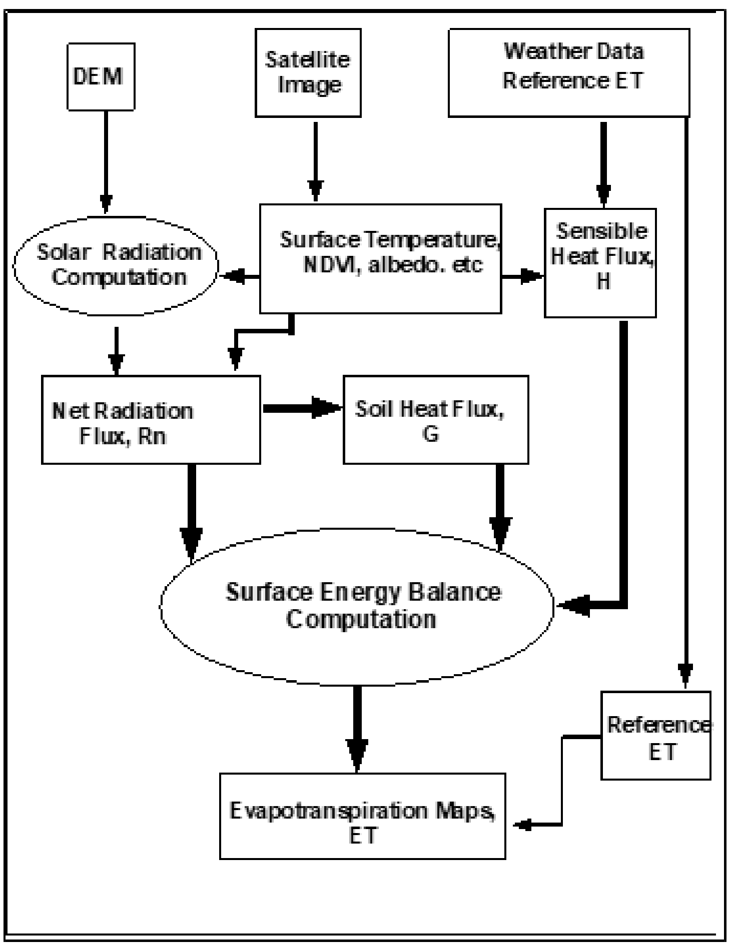

FIGURE 3. GENERAL WORKFLOW OF THE METRIC PROCESS

For the Cuyama Groundwater Basin METRIC application, the Cuyama station (CIMIS station #88) was selected to produce the reference ET (ETo) during calibration. During the internal calibration of sensible heat flux in METRIC, multiple pairs of hot and cold pixels are selected for the model, the one with relative stable result is selected for final calibration. A detailed description of METRIC can be found in Allen et al. (2007a, b; 2008).

METRIC Input Data – Satellite Images

The Cuyama Groundwater Basin is within Landsat reference system path 42 and row 36. For the 1996 water year, Landsat 5 images were used, and for the 2016 water year, Landsat 8 images were used. All available images were utilized, except those that had cloud contamination.

Tables 3 and 4 provide a list of the images used for each water year. A total of 14 Landsat 5 images were modeled by METRIC for the 1996 water year, and a total of 17 Landsat 8 images were modeled for the 2016 water year. For each image, the METRIC model was used to estimate actual daily ET. Linear interpolation was then used to calculate monthly and annual ET.

TABLE 3. DATES OF THE LANDSAT 5 SATELLITE IMAGES USED FOR METRIC PROCESSING IN 1996 WATER YEAR

#	Date of Landsat	Image Type
1	9/24/1995	Landsat 5
2	10/10/1995	Landsat 5
3	11/11/1995	Landsat 5
4	11/27/1995	Landsat 5
5	1/14/1996	Landsat 5
6	5/21/1996	Landsat 5
7	6/6/1996	Landsat 5
8	6/22/1996	Landsat 5
9	7/8/1996	Landsat 5
10	7/24/1996	Landsat 5
11	8/9/1996	Landsat 5
12	8/25/1996	Landsat 5
13	9/10/1996	Landsat 5
14	9/26/1996	Landsat 5

TABLE 4. DATES OF THE LANDSAT 8 SATELLITE IMAGES USED FOR METRIC PROCESSING IN 2016 WATER YEAR

#	Date of Landsat	Image Type
1	10/1/2015	Landsat 8
2	11/18/2015	Landsat 8
3	1/21/2016	Landsat 8
4	2/6/2016	Landsat 8
5	3/9/2016	Landsat 8
6	3/25/2016	Landsat 8
7	4/26/2016	Landsat 8
8	5/12/2016	Landsat 8
9	5/28/2016	Landsat 8
10	6/13/2016	Landsat 8
11	6/29/2016	Landsat 8
12	7/15/2016	Landsat 8
13	7/31/2016	Landsat 8
14	8/16/2016	Landsat 8
15	9/1/2016	Landsat 8
16	9/17/2016	Landsat 8
17	10/3/2016	Landsat 8

METRIC INPUT DATA – WEATHER DATA

METRIC utilizes reference ET as calculated by the ASCE standardized Penman-Monteith equation (ASCE-EWRI 2005) for calibration of the energy balance process. For our study, grass reference ET (ETo) is used in the modeling process. Hourly weather data time steps are needed to represent ETo at the time of the Landsat overpass for calibration of the METRIC energy balance estimation process. ETo was calculated using the RefET software from the University of Idaho (Allen, 2013). California Irrigation Management Information System (CIMIS) weather station #88 at Cuyama was used to provide hourly weather data for ETo calculation. Figure 4 is an example of weather data for May 21st, 1996. Figure 5 shows the annual reference ETo for 1996 and 2016 water years calculated from the CIMIS Cuyama weather station using RefET software.

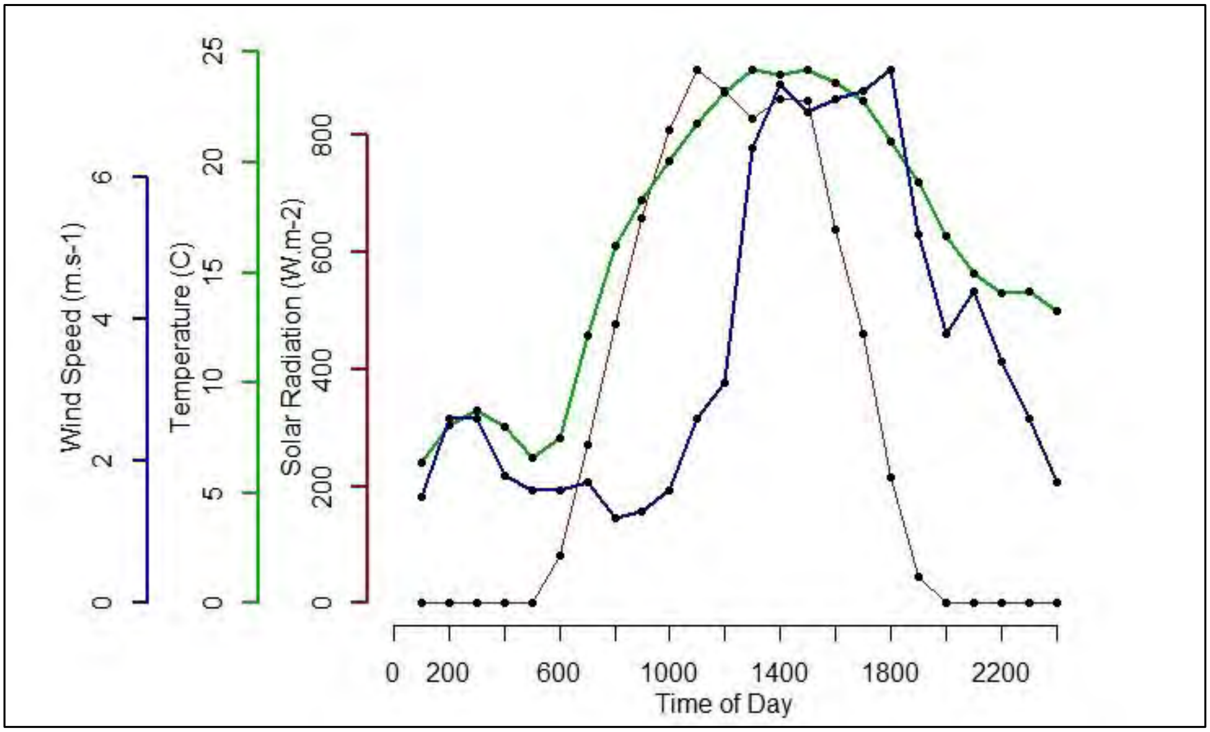

FIGURE 4. CIMIS CUYAMA #88 STATION WEATHER DATA ON MAY 21ST, 1996.

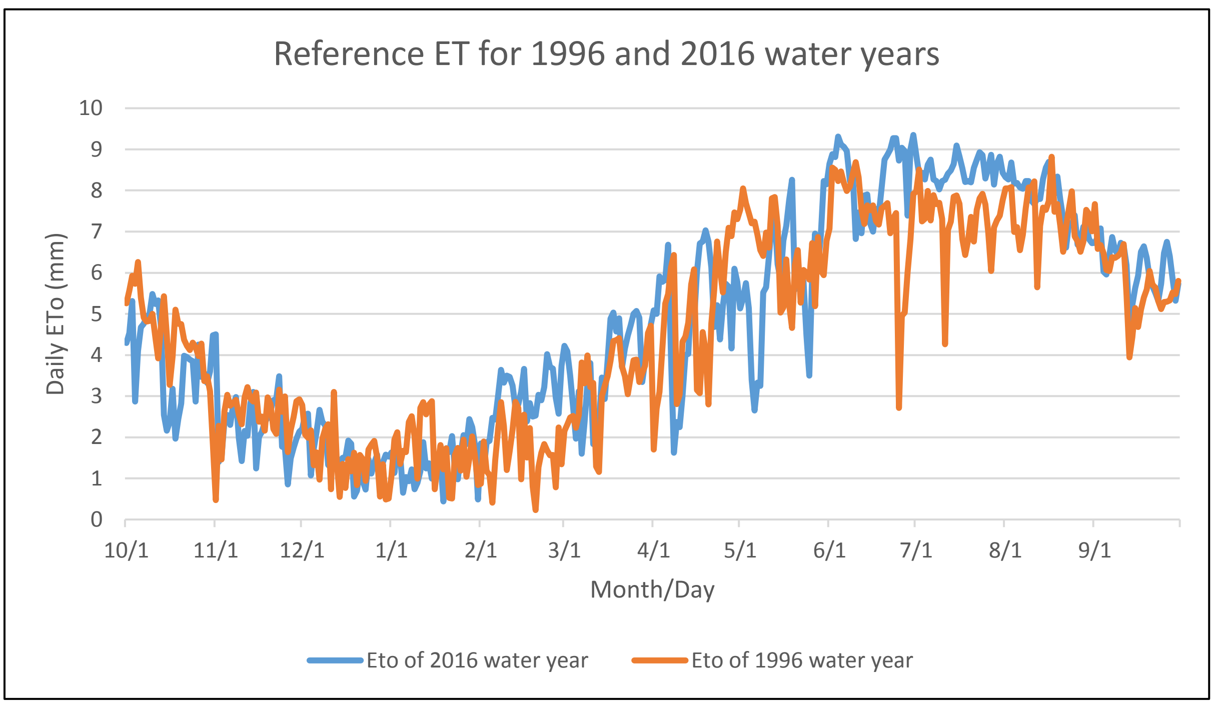

FIGURE 5. REFERENCE EVAPOTRANSPIRATION FOR 1996 AND 2016 WATER YEARS.

CONSUMPTIVE USE RESULTS

The annual ET data for the 1996 and 2016 water years are summarized by major crop types within each year. Tables 5 and 6 show the results of average crop actual ET. Major crops, such as alfalfa, apples, and carrots, have relative higher annual ET in 2016 than 1996, and these could be attributed to a number of factors:

- ➔ 2016 total annual ETo is higher than 1996 total annual ETo. As shown in Figure 5, during the month of June and July, ETo is consistently higher in 2016.
- ➔ The underlying crop layers used for generating the statistics are created differently. 2016 crop layer is created by Land IQ while 1996 crop layer is created by DWR.
- ➔ The field boundary of 2016 is more accurate, compared with 1996 field boundary. And this could cause differences in ET stats.
- ➔ Crop variety and irrigation methods are different in those 2 years, making crops evaporate more water in 2016.

Figure 6 shows the overview of 2016 water year ET over the whole Cuyama Basin. The focus and calibration area for METRIC ET evaluations was the agricultural growing region (valley floor) itself. The surrounding mountains with different elevations and aspects may have differing results.

TABLE 5. SUMMARY OF CROP EVAPOTRANSPIRATION OF 1996 WATER YEAR

Crop Types	1996 Water Year ET (mm)	1996 Crop Acres
Alfalfa and Alfalfa Mixtures	1163	3579
Apples	905	2478
Carrots	800	4705
Grapes	846	357
Miscellaneous Grain and Hay	590	7474
Miscellaneous Truck Crops	618	3729
Mixed Pasture	807	738
Onions and Garlic	591	313
Peaches/nectarines	819	414
Pistachios	683	677

TABLE 6. SUMMARY OF CROP EVAPOTRANSPIRATION OF 2016 WATER YEAR

Crop Types	2016 Water Year ET (mm)	2016 Crop Acres
Alfalfa and Alfalfa Mixtures	1365	235
Apples	1204	331
Carrots	1077	5576
Grapes	822	1242
Miscellaneous Grain and Hay	824	3201
Miscellaneous Truck Crops	818	3324
Mixed Pasture	633	142
Onions and Garlic	986	2192
Pistachios	1266	722
Lettuce/Leafy Greens	789	613
Olives	737	517
Safflower	714	810

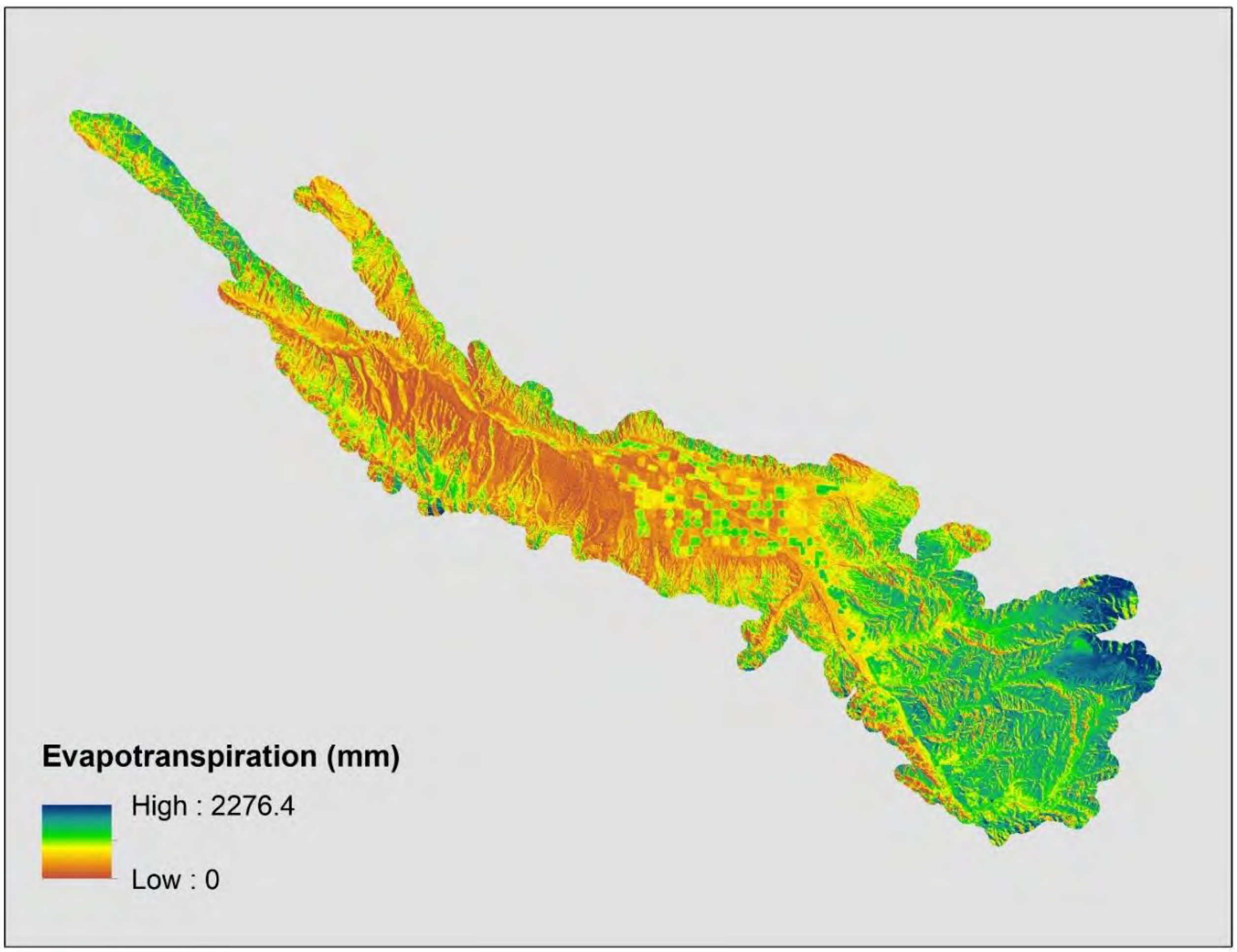

FIGURE 6. 2016 WATER YEAR EVAPOTRANSPIRATION OF THE CUYMA BASIN.

DATA DELIVERABLES

Data delivered as part of the consumptive water analysis efforts are summarized in Table 7.

TABLE 7. SUMMARY OF CROP MAPPING DATA DELIVERABLES

#	File Name	Description
1	CuyamaValley_2016_LandUse_Classification.shp	Crop classification for 2016 water year (attribute: Crop2016)
2	CuyamaValley_2014_LandUse_Classification.shp	Crop classification for 2014 water year (attribute: Crop2014)
3	CuyamaValley_2012_LandUse_Classification.shp	Crop classification for 2012 water year (attribute: Crop2012)
4	CuyamaValley_2009_LandUse.shp	Crop classification for 2009 water year (attribute: Crop2009)
5	CuyamaValley_2006_LandUse.shp	Crop classification for 2006 water year (attribute: Crop2006)
6	CuyamaValley_2003_LandUse.shp	Crop classification for 2003 water year (attribute: Crop2003)
7	CuyamaValley_2000_LandUse.shp	Crop classification for 2000 water year (attribute: Crop2000)
8	CuyamaValley_1996_LandUse.shp	Crop classification for 1996 water year (attribute: Crop1996)
9	1995-10_ETa.tif	Raster image of total evapotranspiration (unit: mm) for October 1995
10	1995-11_ETa.tif	Raster image of total evapotranspiration (unit: mm) for November 1995
11	1995-12_ETa.tif	Raster image of total evapotranspiration (unit: mm) for December 1995
12	1996-01_ETa.tif	Raster image of total evapotranspiration (unit: mm) for January 1996
13	1996-02_ETa.tif	Raster image of total evapotranspiration (unit: mm) for February 1996
14	1996-03_ETa.tif	Raster image of total evapotranspiration (unit: mm) for March 1996
15	1996-04_ETa.tif	Raster image of total evapotranspiration (unit: mm) for April 1996
16	1996-05_ETa.tif	Raster image of total evapotranspiration (unit: mm) for May 1996
17	1996-06_ETa.tif	Raster image of total evapotranspiration (unit: mm) for June 1996
18	1996-07_ETa.tif	Raster image of total evapotranspiration (unit: mm) for July 1996
19	1996-08_ETa.tif	Raster image of total evapotranspiration (unit: mm) for August 1996
20	1996-09_ETa.tif	Raster image of total evapotranspiration (unit: mm) for September 1996
21	1996_total_ETa_mm.tif	Raster image of total evapotranspiration (unit: mm) for 1996 water year

22	2015-10_ETa.tif	Raster image of total evapotranspiration (unit: mm) for October 2015
23	2015-11_ETa.tif	Raster image of total evapotranspiration (unit: mm) for November 2015
24	2015-12_ETa.tif	Raster image of total evapotranspiration (unit: mm) for December 2015
25	2016-01_ETa.tif	Raster image of total evapotranspiration (unit: mm) for January 2016
26	2016-02_ETa.tif	Raster image of total evapotranspiration (unit: mm) for February 2016
27	2016-03_ETa.tif	Raster image of total evapotranspiration (unit: mm) for March 2016
28	2016-04_ETa.tif	Raster image of total evapotranspiration (unit: mm) for April 2016
29	2016-05_ETa.tif	Raster image of total evapotranspiration (unit: mm) for May 2016
30	2016-06_ETa.tif	Raster image of total evapotranspiration (unit: mm) for June 2016
31	2016-07_ETa.tif	Raster image of total evapotranspiration (unit: mm) for July 2016
32	2016-08_ETa.tif	Raster image of total evapotranspiration (unit: mm) for August 2016
33	2016-09_ETa.tif	Raster image of total evapotranspiration (unit: mm) for September 2016
34	2016_total_ETa_mm.tif	Raster image of total evapotranspiration (unit: mm) for 2016 water year
35	Reference_ETo	Reference ET for 1996 and 2016 water years
36	Cuyama Consumptive Use Report	Memorandum summarizing consumptive use efforts (this document)

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Attachment C-2

Climate Change Scenario Development

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1. CLIMATE CHANGE SCENARIO DEVELOPMENT

1.1 Regulatory Background

As prescribed in Section 354.18(d)(3) and Section 354.18(e) of the SGMA regulations, climate change conditions were incorporated into the projected water budgets for the Cuyama Valley Groundwater Basin *Groundwater Sustainability Plan*.

Section 354.18(d)(3) of the SGMA regulations state:

> *"(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:*
>
> *(1) Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.*
>
> *(2) Current water budget information for temperature, water year type, evapotranspiration, and land use.*
>
> *(3) Projected water budget information for population, population growth,* ***climate change****, and sea level rise."*

Section 354.18(e) of the SGMA regulations state:

> *"(e) Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population,* ***climate change****, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions."*

Climate change analysis is an area with continued evolution in terms of methods, tools, forecasted datasets, and the predictions of actual greenhouse gas concentrations in the atmosphere. There is a large number of available combinations of these elements that result in many potential ways to evaluate climate change impacts. For the purposes of this GSP, the method proposed by the California Department of Water Resources (DWR) as a valid method of evaluation in its guidance document was considered adequate (DWR, 2018). Similarly, the "best available information" was deemed the information provided by DWR, customized for the method proposed.

The following resources from DWR were used to carry out the climate change analysis:

- SGMA Data Viewer
- Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development
- Sustainability Plan Development and Appendices (Guidance Document)
- Water Budget BMP
- Desktop IWFM Tools

SGMA Data Viewer provides the location for which the climate change forecasts datasets[1] were downloaded for the Cuyama subbasin (DWR, 2019). The guidance document details the approach, development, applications, and limitations of the datasets available from the SGMA Data Viewer (DWR, 2018). The Water Budget BMP describes in more granular detail how projected water budgets should be computed (DWR, 2016). The Desktop IWFM Tools are available to calculate the projected precipitation and evapotranspiration inputs under climate change conditions (DWR, 2018).

Generally, the methods suggested by DWR in the above resources were used, with a few exceptions to ensure the resolution and scale matched that of the historical and current water budgets. Figure C-2-1 shows the overall process consistent with the Climate Change Resource Guide (DWR, 2018) that describes workflow beginning with baseline historical conditions to perturbed 2070 conditions for the projected model run.

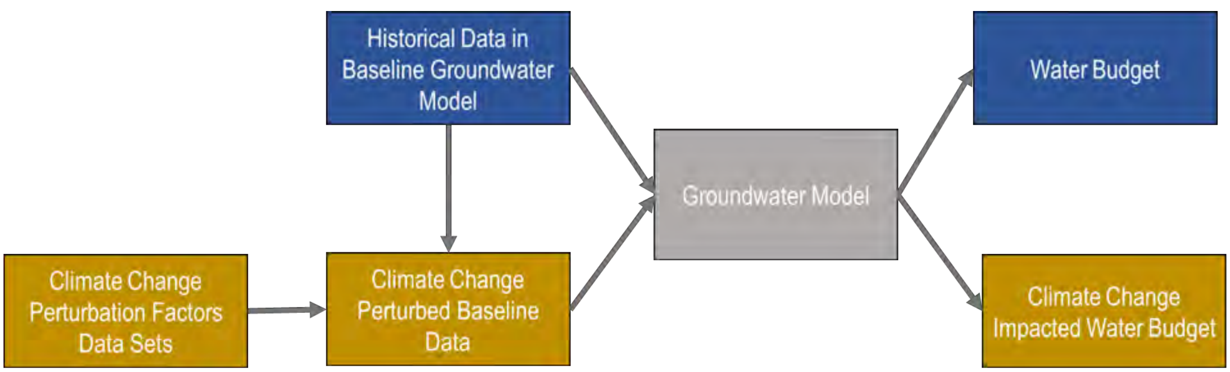

Figure C-2-1: Model Process

[1] In the industry, climate change impacted variable forecasts are sometimes referred to as "data" and their collections are called "datasets." Calling forecasted variable values "data" can be misleading, so this document tries to be explicit about data (i.e., historical data) versus forecasts or model outputs.

Table C-2-1 below summarizes the forecasted variable datasets provided by DWR that were used to carry out the climate change analysis (DWR, 2019).

Table C-2-1. DWR Forecasted Datasets	
Input Variable	DWR-provided dataset
Precipitation	Change factors: VIC model-generated GIS grid with associated change factor time series for each cell
Reference ET	Change factors: VIC model-generated GIS grid with associated change factor time series for each cell

1.2 Climate Change Analysis Methodology

For climate change impacts on groundwater, accepted methods include the assessment of the impacts on the individual water resource system elements that are impacted and directly link to groundwater. These elements include precipitation, streamflow, evapotranspiration and, for coastal aquifers, sea level rise as a boundary condition. For Cuyama, sea level is not relevant. Additionally, in the Cuyama model does not have any stream inflows. For this reason, streamflow under climate change was not perturbed in this analysis.

The methods for perturbing the precipitation and evapotranspiration input files is described in the following sections. Two future scenarios were evaluated in this analysis, according to DWR guidance (DWR, 2018):

- Water Budget under 2030 central tendency conditions to assess near-future impacts of climate change.
- Water Budget under 2070 central tendency conditions to assess impacts of climate change over the long-term planning and implementation period.

1.2.1 Perturbed Precipitation under Climate Change

Projected precipitation change (perturbation) factors are provided by DWR, calculated using a climate period analysis based on historical precipitation from January 1915 to December 2011 (DWR, 2018). Change factors provided by DWR were calculated as a ratio of the value of a variable under a "future scenario" divided by a baseline. DWR used a macroscale hydrologic model that solves the full water and balance in a watershed, called the Variable Infiltration Capacity (VIC) Model. The baseline data corresponds to the 1995 historical template detrended scenario by the VIC model through global circulation model (GCM) downscaling. The "future scenario" corresponds to VIC outputs of the simulation of future conditions using GCM forecasted hydroclimatic variables as inputs. These change factors are thus a simple perturbation factor that corresponds to the ratio of a future with climate change divided by the past without it. Change factors are available on a monthly time step and spatially defined by the VIC model grid. Supplemental tables with the time series of perturbation factors are available by DWR for each grid cell.

Because the Cuyama model has a daily time step, the historical baseline time series (water year 1960 to water year 2017) was aggregated monthly. DWR change factors, or perturbation factors, were then multiplied by historical baseline precipitation to generate projected precipitation under 2030 and 2070 central tendency future scenarios using the Desktop IWFM GIS tool (DWR, 2018). The tool calculates an area weighted precipitation change factor for each model grid geometry. This model grid geometry was generated based on polygons generated around the PRISM nodes that are within the model region.

However, the DWR tool only includes change factors through 2011. The remaining five years of the time series were synthesized according to historically comparable water years. The perturbation factor from the corresponding month of the comparable year was applied to the baseline of the missing years (i.e., 2012 to 2017) to generate projected values. Months with no precipitation in the baseline were assumed a monthly precipitation of 1 millimeter under climate change to account for increased precipitation that cannot be calculated from a baseline of 0 millimeter for these synthesized years. Table C-2-2 below shows the comparable water years assigned for each missing year.

Table C-2-2. Water Years Assigned for Missing Years

Water Year with Missing Change Factors	Comparable Water Year on Record	
	April to September	October to March
2012	1987	2009
2013	1990	1990
2014	1990	1989
2015	2001	1990
2016	1990	1989
2017	1990	1990

Applying Change Factors to Precipitation and ET

DWR datasets include scenarios for 2030 and 2070 timeframes and for conditions similar to historical in terms of precipitation forecasted (central tendency) and conditions wetter and drier. All scenarios available present higher future temperatures. The team selected the 2070 central tendency forecasted conditions for the analysis.

After applying the change factor to the model simulation period (baseline) analysts obtained the precipitation and evapotranspiration under climate change. The resulting perturbed precipitation values and the baseline precipitation values can be found in Figure C-2-2 below. The exceedance plot for these two times series can be found in Figure C-2-3.

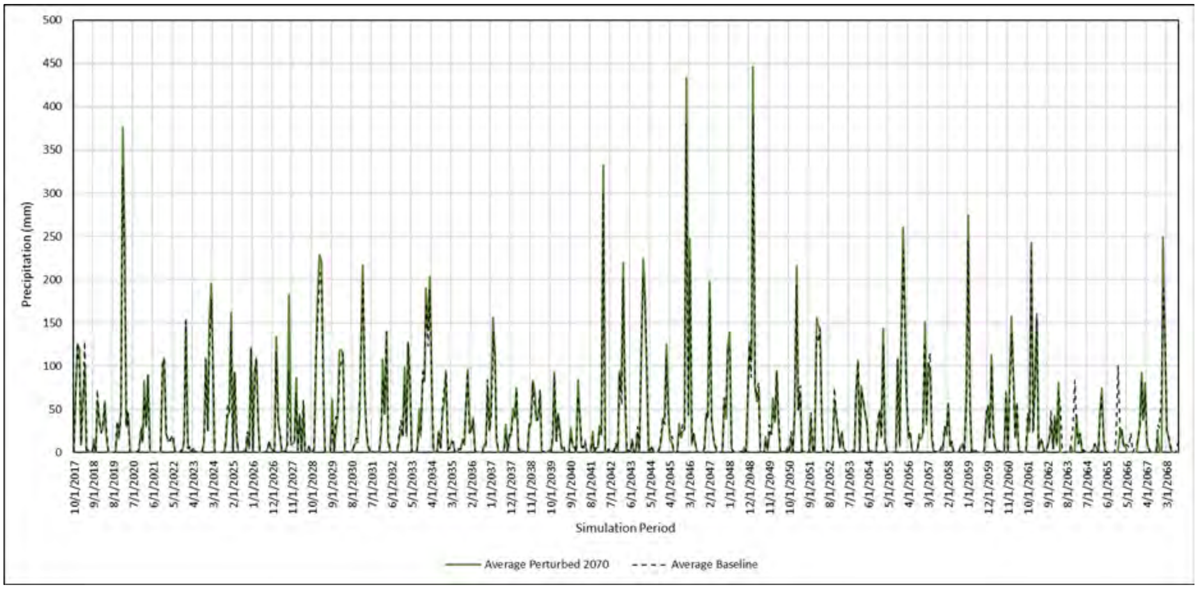

Figure C-2-2. Precipitation Perturbation Factors as Compared to Baseline Values

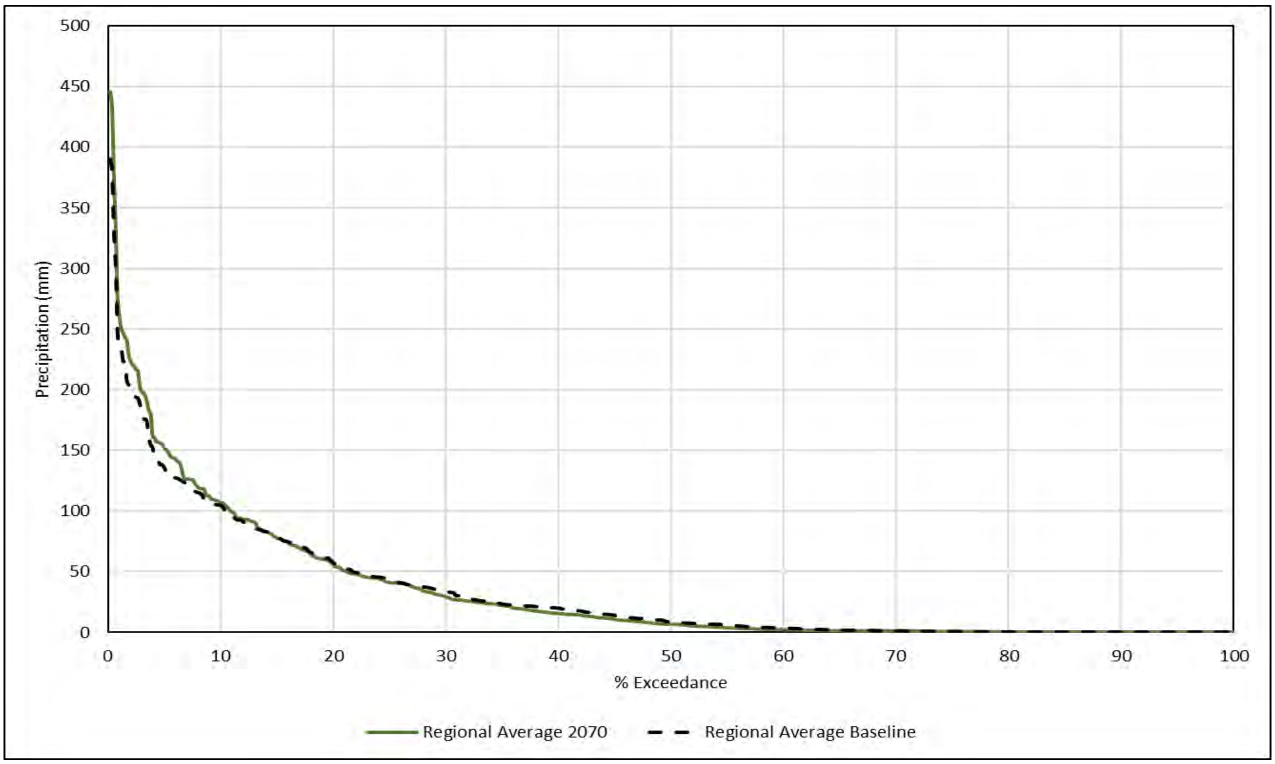

Figure C-2-3. Exceedance of Precipitation Perturbation Factors as Compared to Baseline Values

Figure C-2-4 shows the difference between the regional average under 2070 climate change conditions and the regional average under historical baseline conditions plotted against different amounts of projected monthly precipitation.

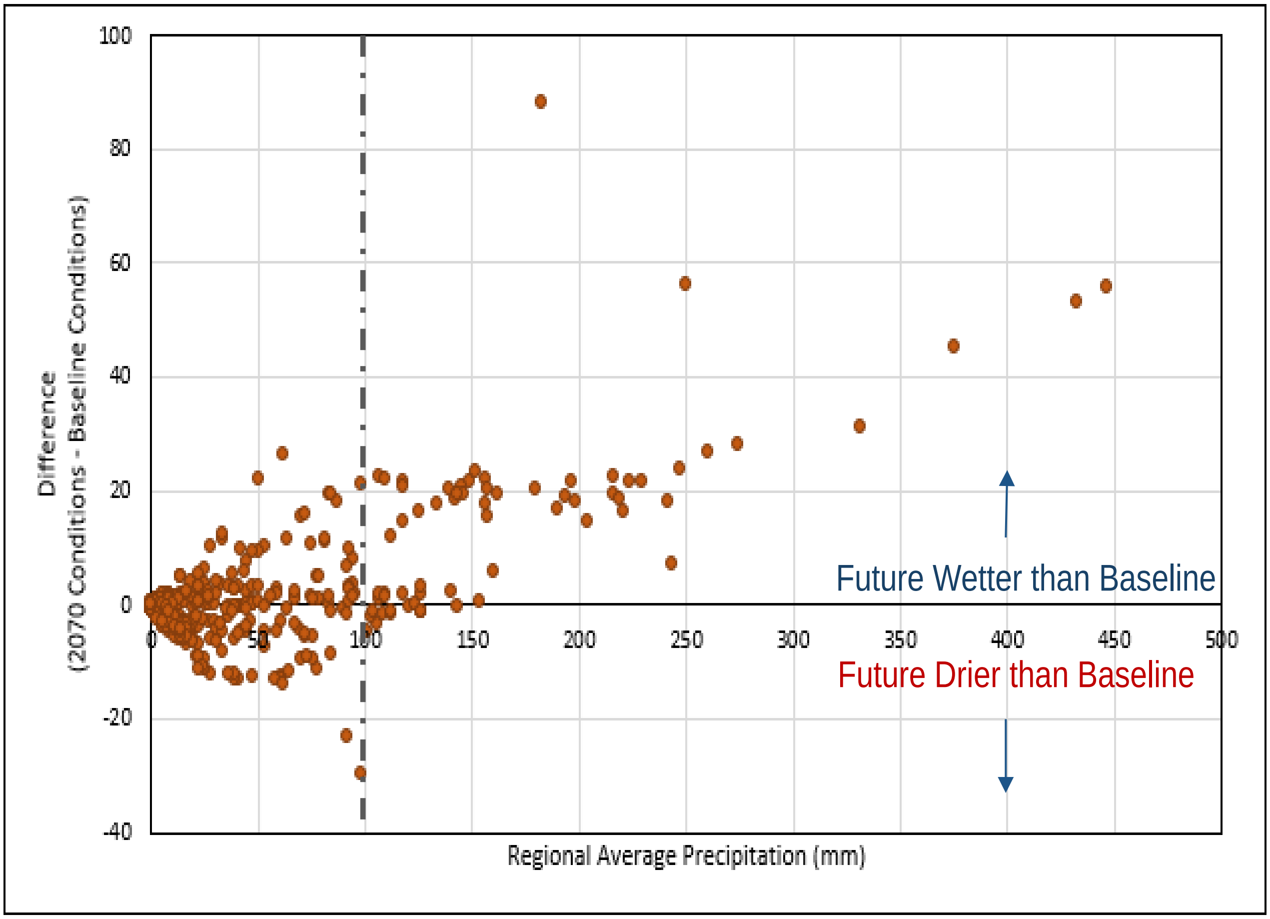

Figure C-2-4. Difference in Monthly Precipitation Estimates as Compared to Baseline Values

This plot demonstrates that in 2070 with climate change added, in low precipitation months, there is approximately equal probability that the month will be wetter or drier than historical conditions. However, under climate change, the 2070 conditions will be always wetter on average in months with precipitation above approximately 100mm. Therefore, under climate change conditions, the occurrence of low precipitation months will likely not change, but the higher precipitation months will be wetter overall than the baseline.

It is important to note that, while the central tendency scenario shows limited changes in future precipitation compared to historical record, the drier and wetter scenarios do show more variability. Figure C-2-5 shows the exceedance curve for the wet scenario and it shows a larger difference to baseline compared to the central tendency. The use of other scenarios can be explored in future GSP updates.

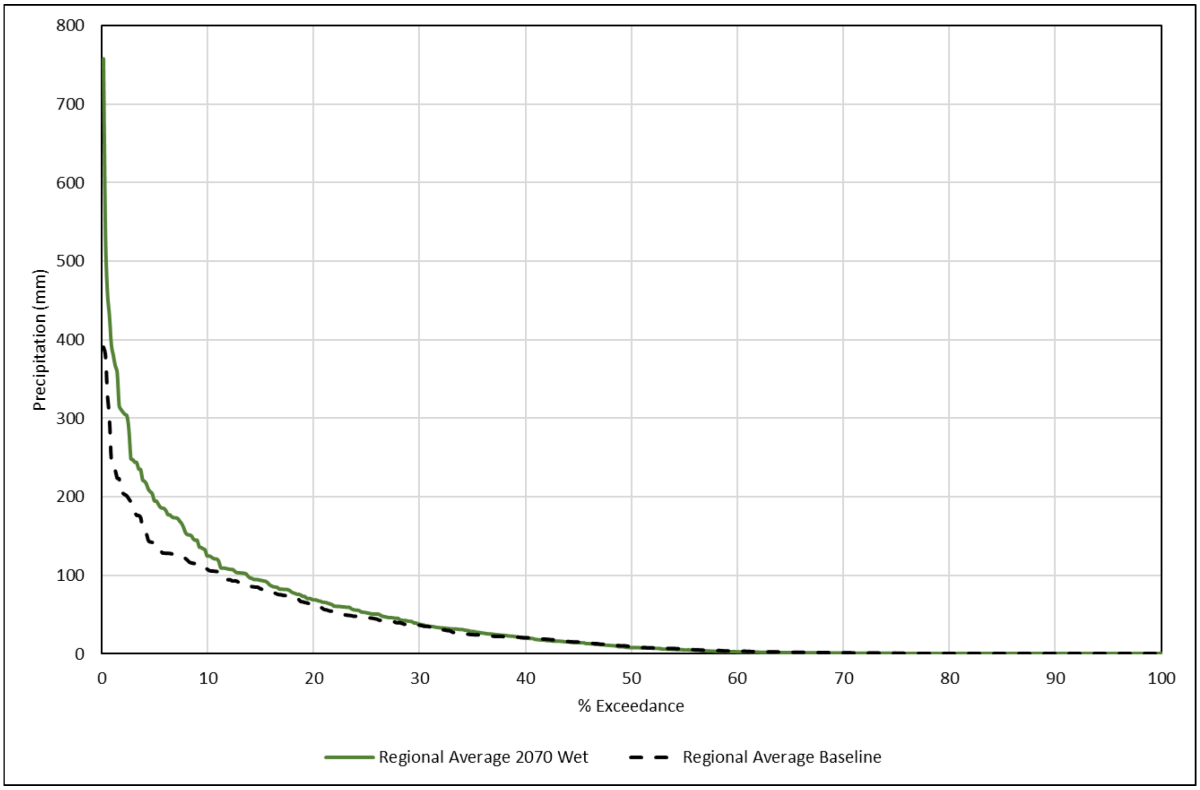

Figure C-2- 5. Exceedance of Wet Scemario Precipitation Estimates as Compared to Baseline Values

Perturbed Evapotranspiration under Climate Change

Reference evapotranspiration (ET) is differentiated only by crop in the Cuyama model. However, because there is no spatial component to ET, the same crop in a different part of the basin is modeled with the same ET. Change factors for ET are available in the same spatially distributed manner as precipitation, as described above. However, to match the level of discretization with the Cuyama model, an average ET change factor was calculated across all VIC grid cells within the Cuyama Subbasin boundary. Therefore, the tool to process ET provided by DWR was not needed or used. Change factors provided by DWR for water year 1964 through December 1, 2011 were averaged. This average ET change factor was then applied to the baseline ET time series for each crop type. Because the same ET change factor was applied over the entire baseline time series, no synthesis was required in this analysis.

- For 2030, average change factor is: **1.03**
- For 2070, average change factor is: **1.07**

To better show the impact of climate change, a sample of years (1994 and 1995) for one crop (melons) is included in Figure C-2-6. Figure C-2-7 shows the exceedance curve for these estimates.

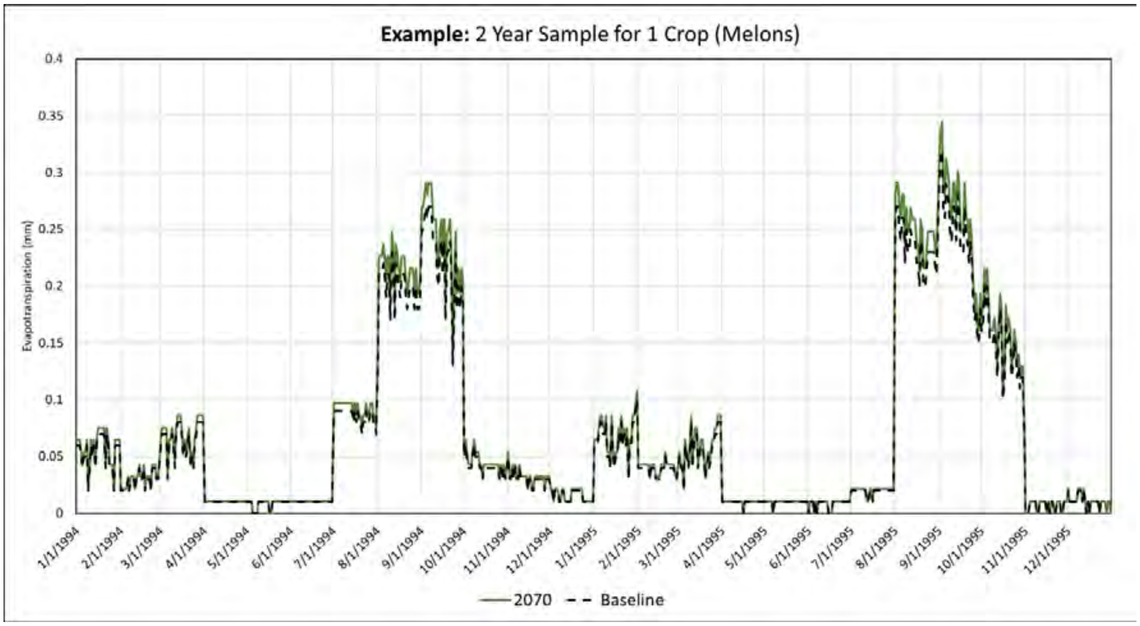

Figure C-2-6. Changes in Melon Evapotranspiration in 1994 and 1995 as Compared to Baseline Values

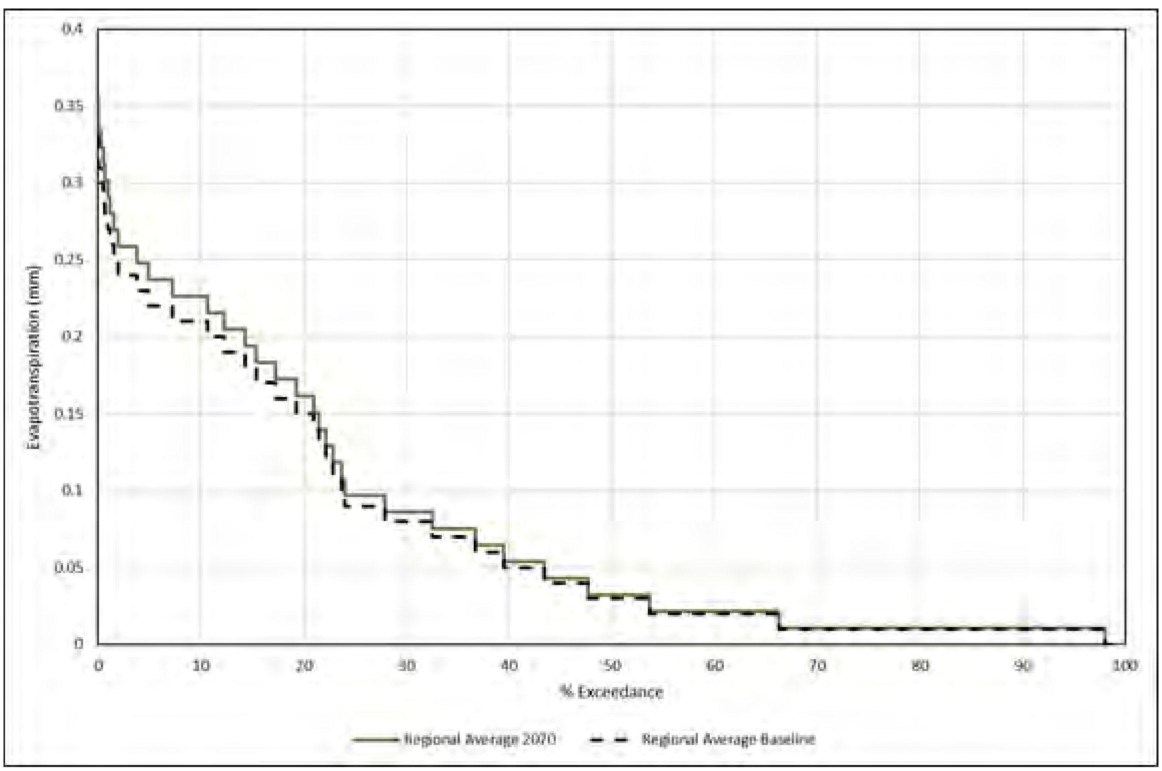

Figure C-2-7. Exceedance of Melon Evapotranspiration in 1994 and 1995 as Compared to Baseline Values

Considerations for this Analysis

By using DWR's climate change datasets, this GSP has chosen to use a climate period analysis. A "period of analysis" method is what DWR proposes since it provides an intuitive way to compare the past and future conditions, preserving historical temporal trends. Under a period of analysis (sometimes referred to as the "delta method") precipitation and Crop ET patterns from the past are mirrored into the future and shifted either higher or lower in magnitude (DWR, 2018). When using a period of analysis method, any difference between the baseline historical conditions and the projected conditions can be attributed only to climate change.

Using a climate period analysis in contrast to a transient analysis, however, brings also some disadvantages. While a significant advantage of this method is that the climate change signal can be isolated from signals of other impacts, temporal changes in the water resources system are ignored in favor of adopting the temporal trends of the past. In a continuously changing and variable climate in California, this approach incurs significant disadvantages. Inter-annual variability in the climate period analysis follows the exact patterns of the historical period it references. Shifting seasonality of precipitation, peak snowmelt, and temperature, are important climate impacts expected through the GSP planning horizon that are not captured in the projected water budget (Langridge, Sepaniak, Fencl, & Mendez, 2018) (PPIC, 2019). Longer drought period than have been recorded historically are also expected according to many climate experts (PPIC, 2019). These changes are also not captured.

Opportunities for Future Refinement

The regulations dictate that GSPs reflect the best available science to make climate change projections. For future GSP updates, climate change analysis incorporation should build off of this baseline work to continually improve projections into the future. Some refinements or modifications may include:

- Use other scenarios (dry and wet) in addition to the central tendency scenario
- Use a transient method as opposed to a period of record method
- Incorporate paleohydrology observations and make inferences about the impacts of longer droughts captured in the paleorecord

1.3 References

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Attachment C-3

Groundwater Level Hydrographs for Calibration Wells

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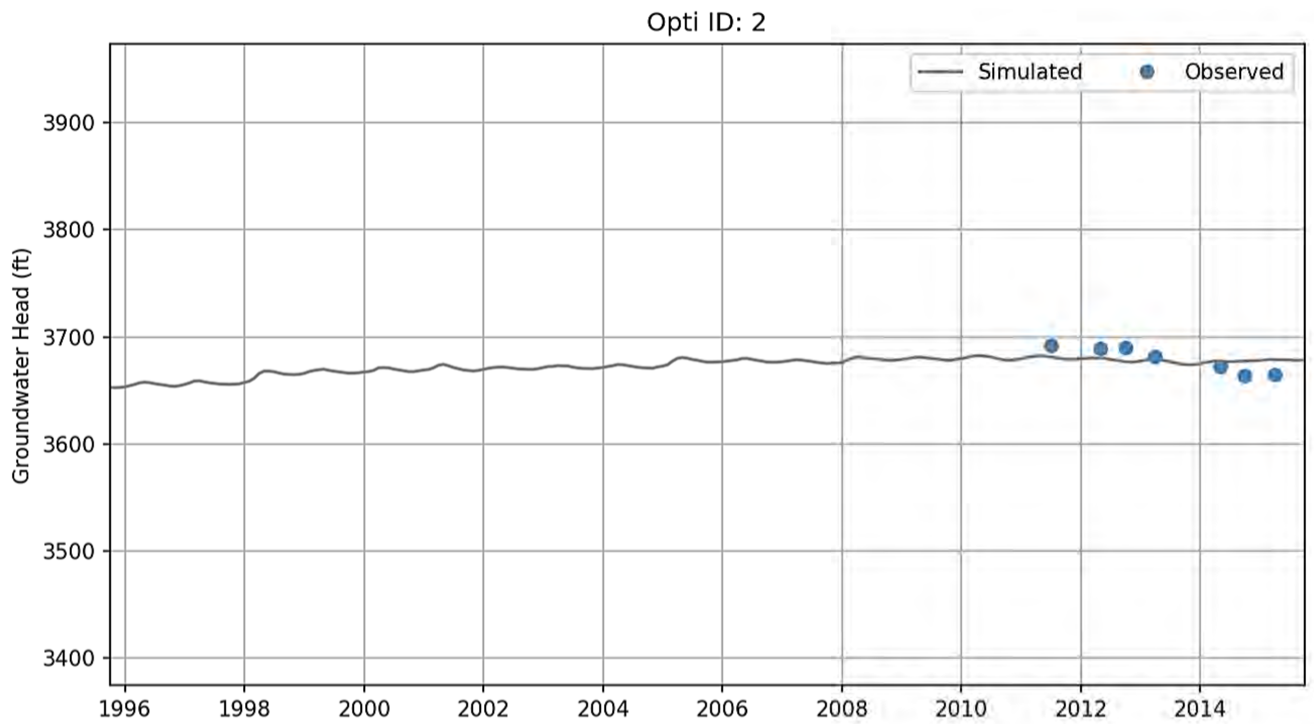
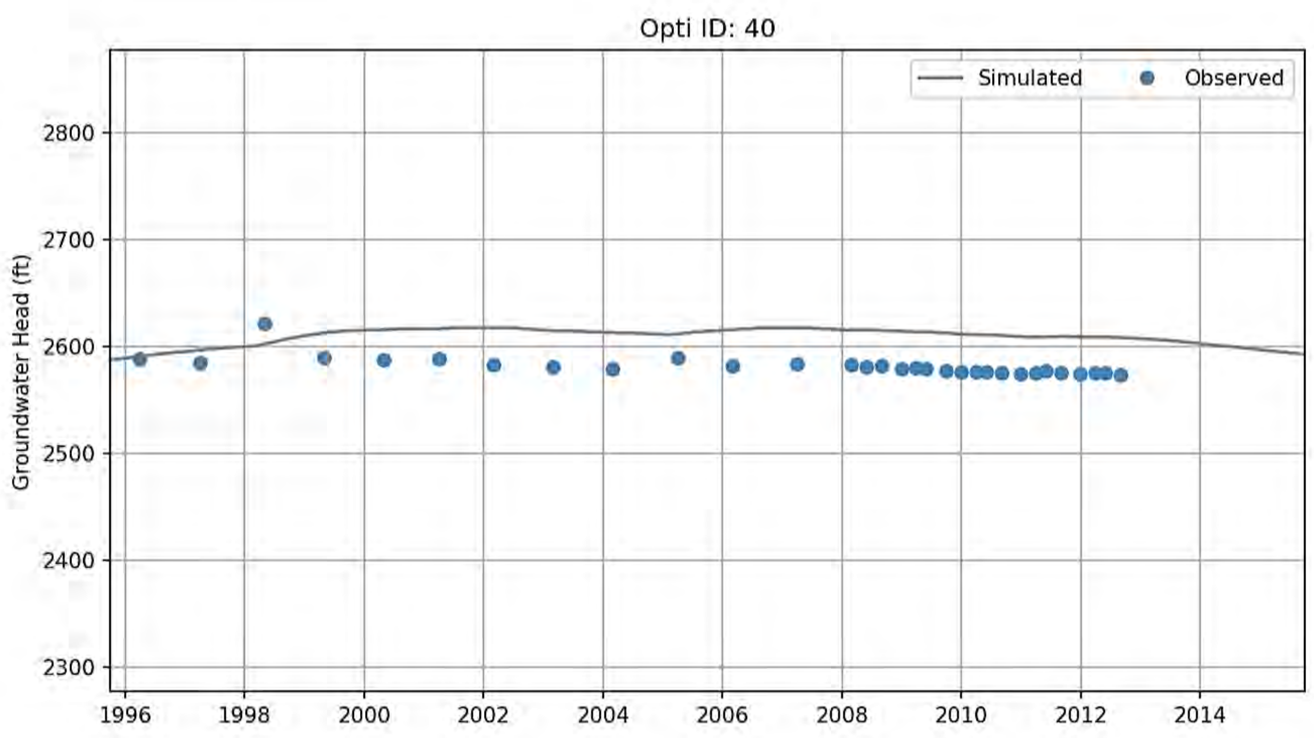
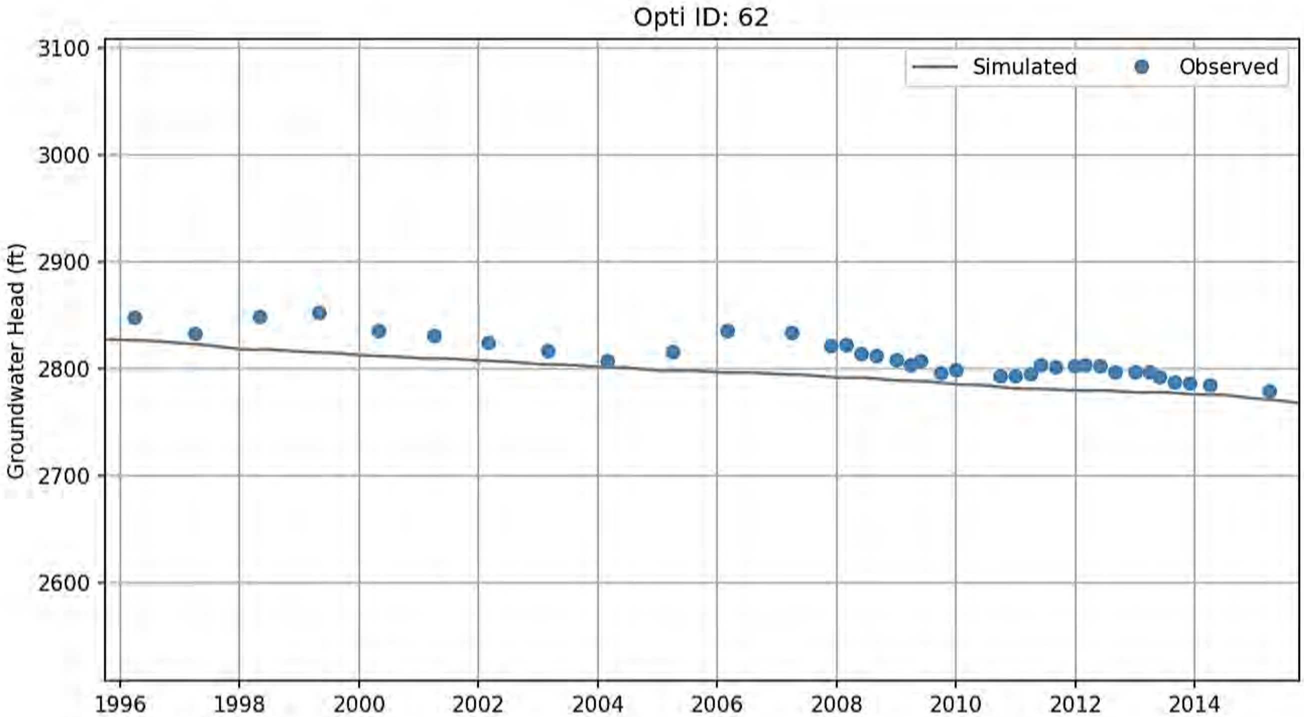
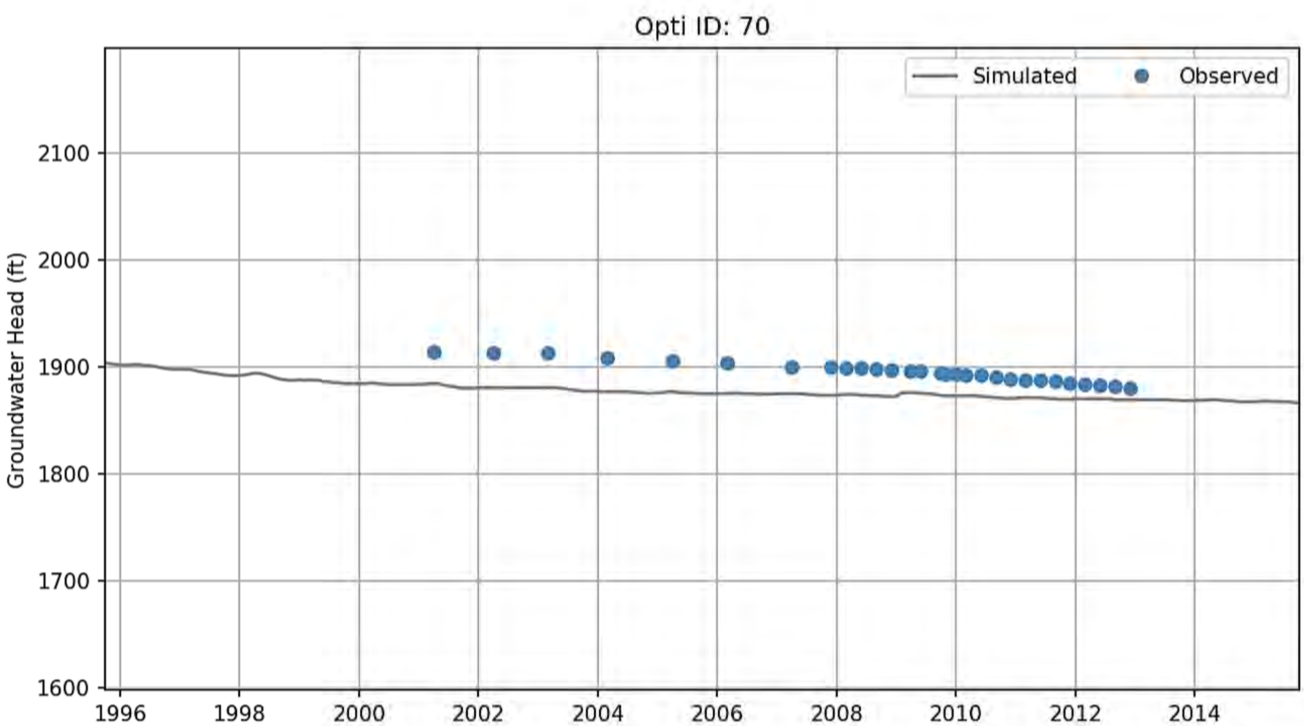

Opti ID: 2
Simulated
Observed
Groundwater Head (ft)
3900
3800
3700
3600
3500
3400
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

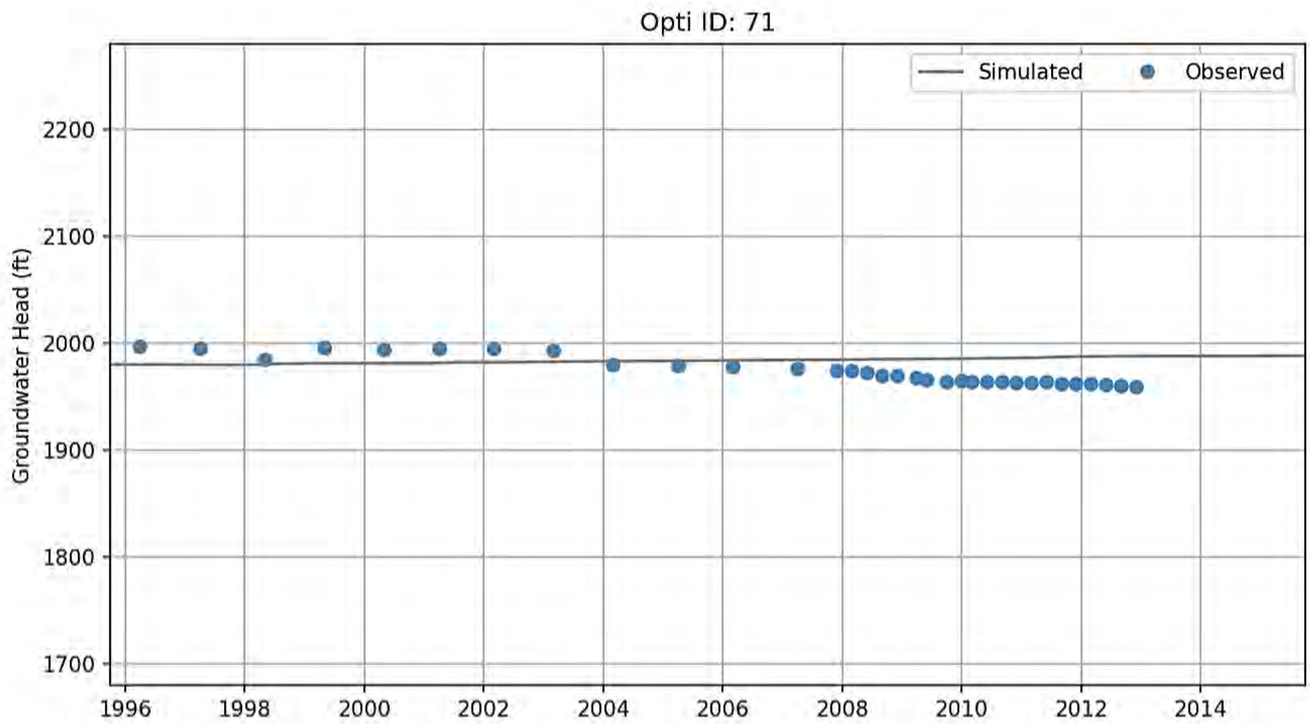

Opti ID: 40
Simulated
Observed
Groundwater Head (ft)
2800
2700
2600
2500
2400
2300
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



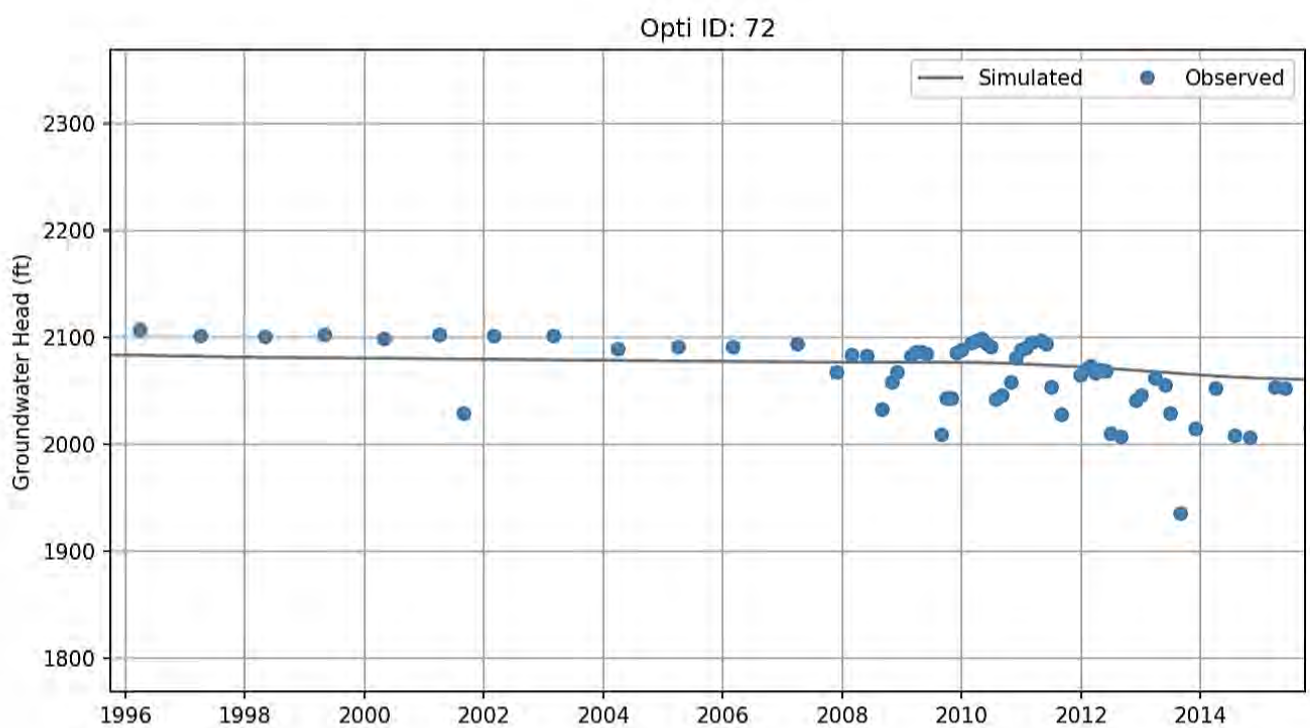
Opti ID: 62
Simulated
Observed
Groundwater Head (ft)
3100
3000
2900
2800
2700
2600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



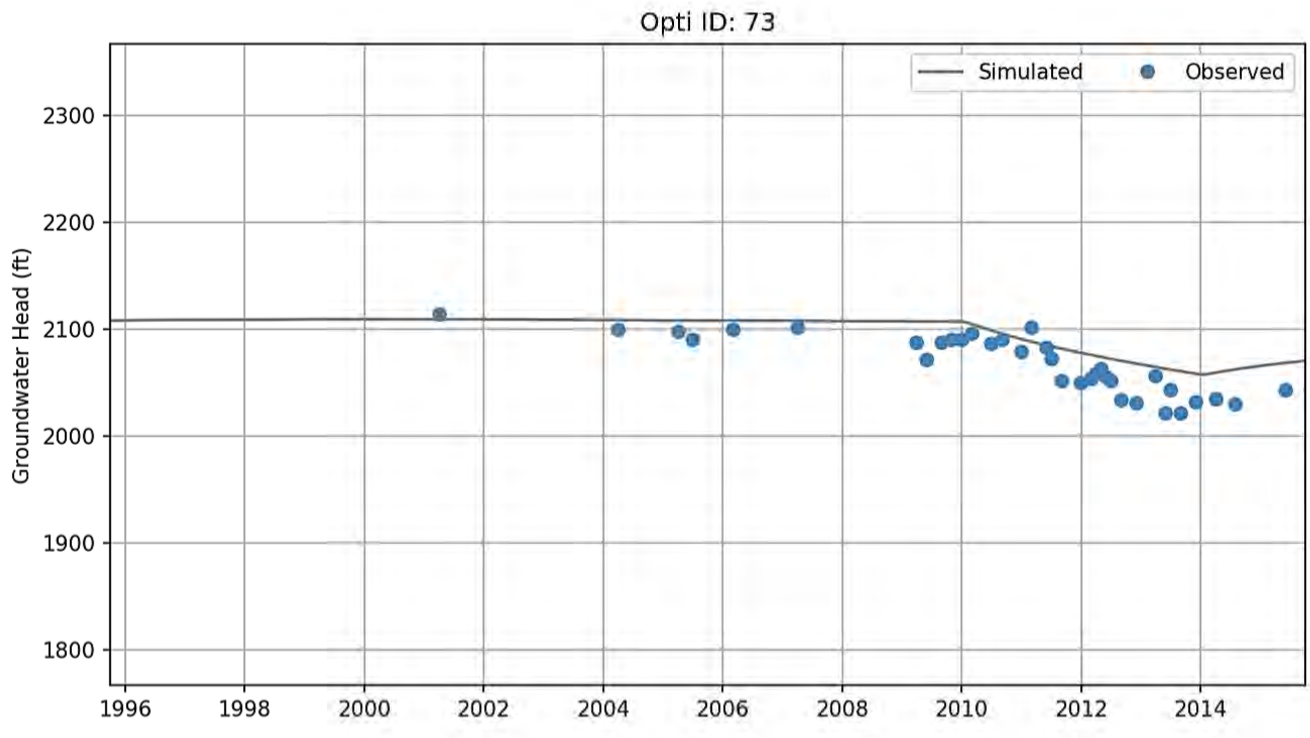
Opti ID: 70
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

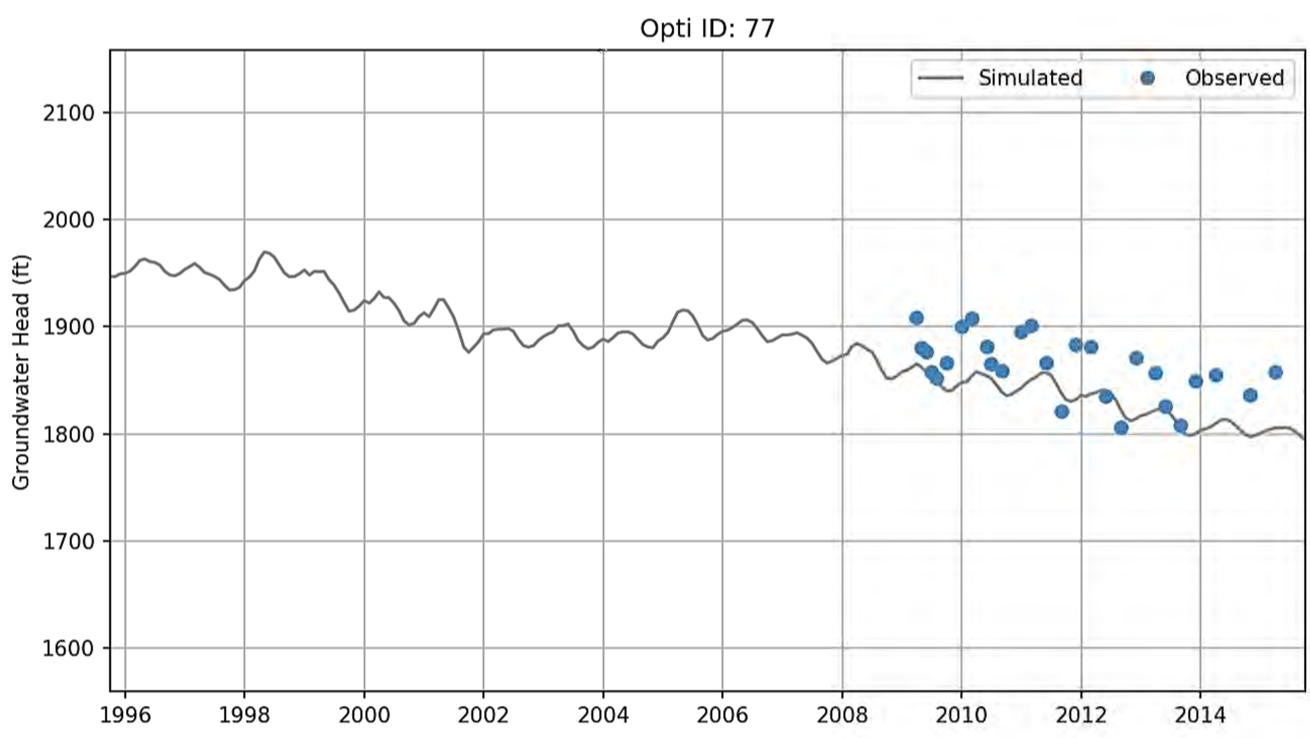


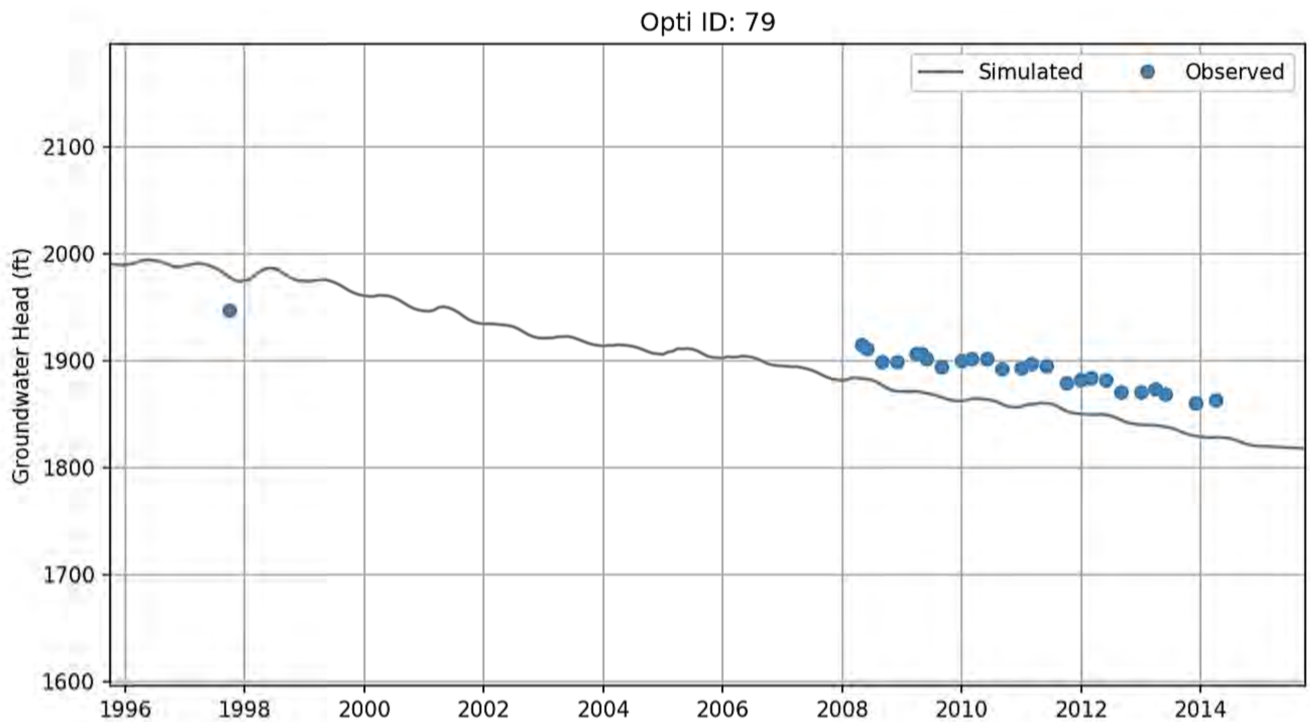
Opti ID: 71
Simulated
Observed
Groundwater Head (ft)
2200
2100
2000
1900
1800
1700
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



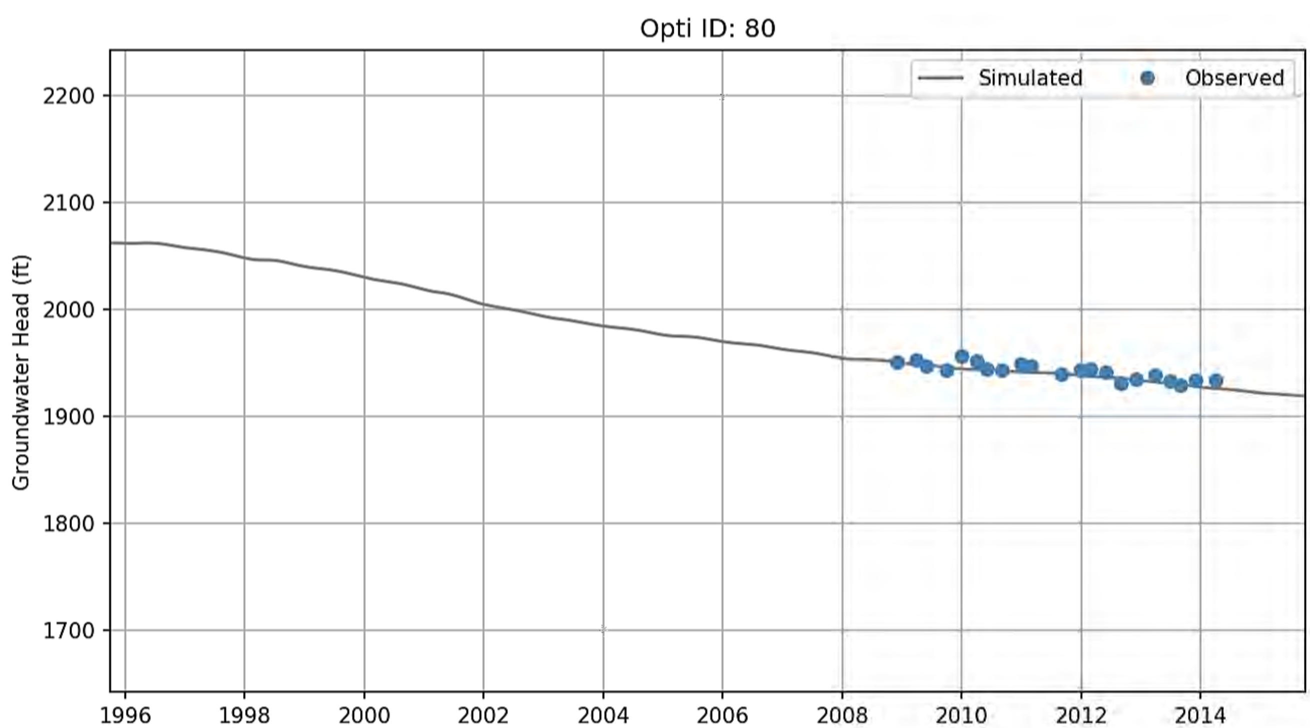
Opti ID: 72
Simulated
Observed
Groundwater Head (ft)
2300
2200
2100
2000
1900
1800
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 73
Simulated
Observed
Groundwater Head (ft)
2300
2200
2100
2000
1900
1800
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

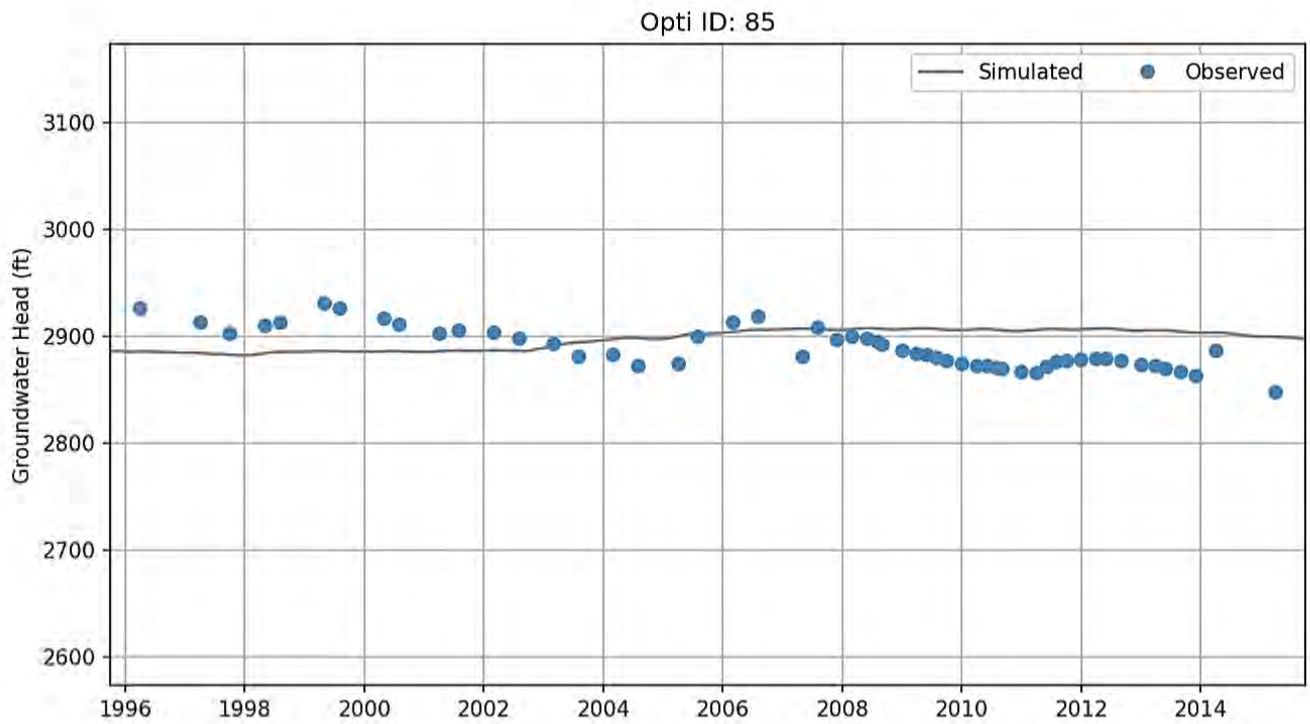

Opti ID: 77
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



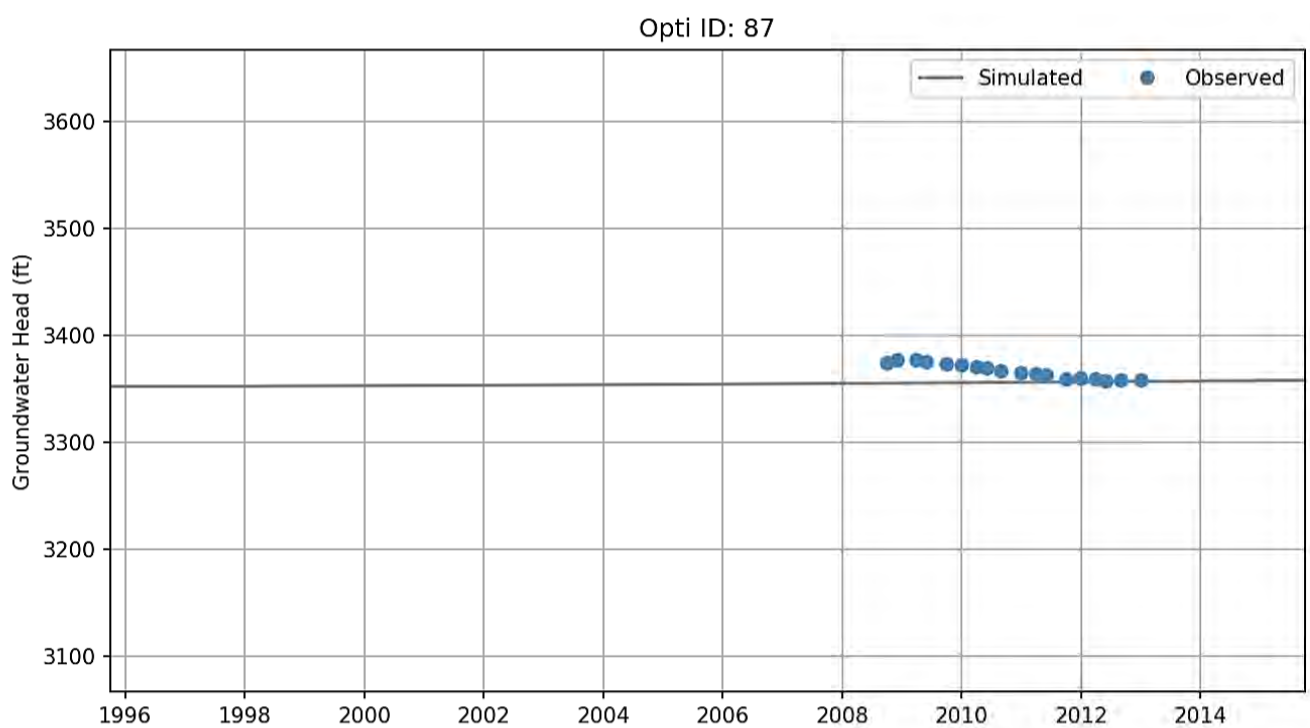
Opti ID: 79
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



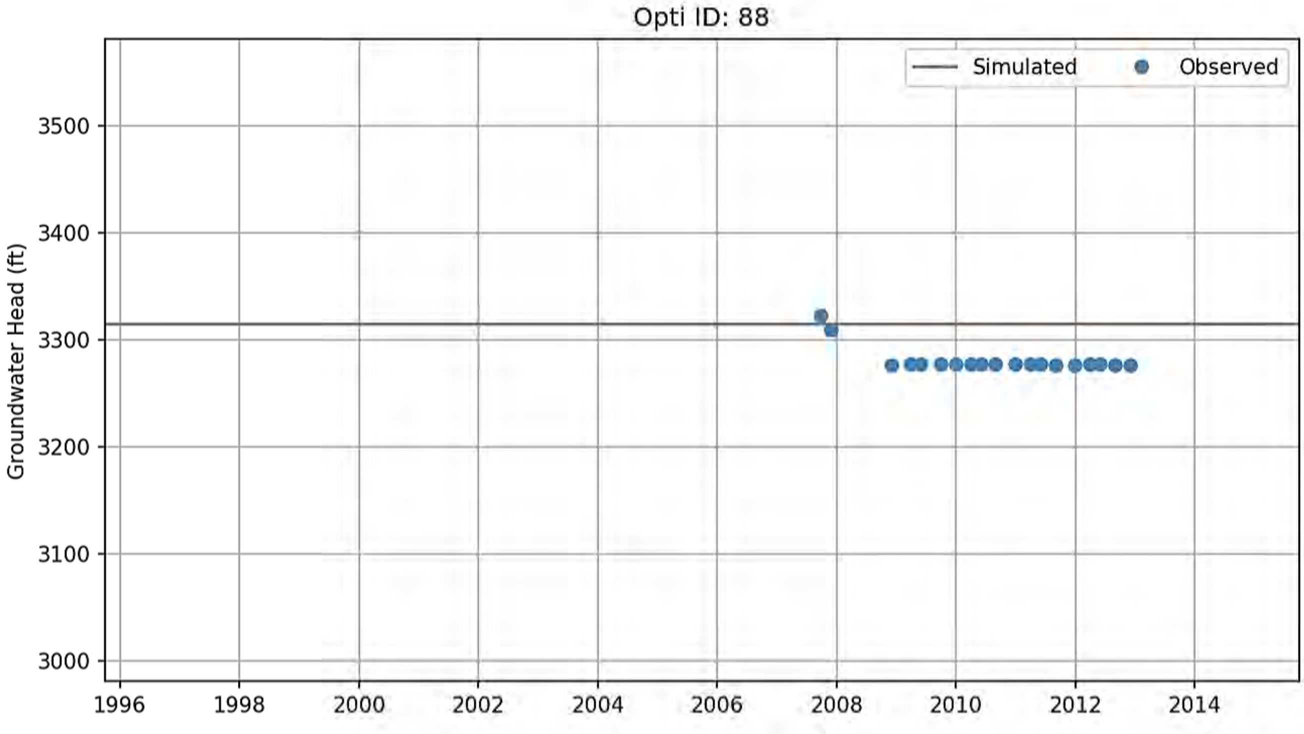
Opti ID: 80
Simulated
Observed
Groundwater Head (ft)
2200
2100
2000
1900
1800
1700
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

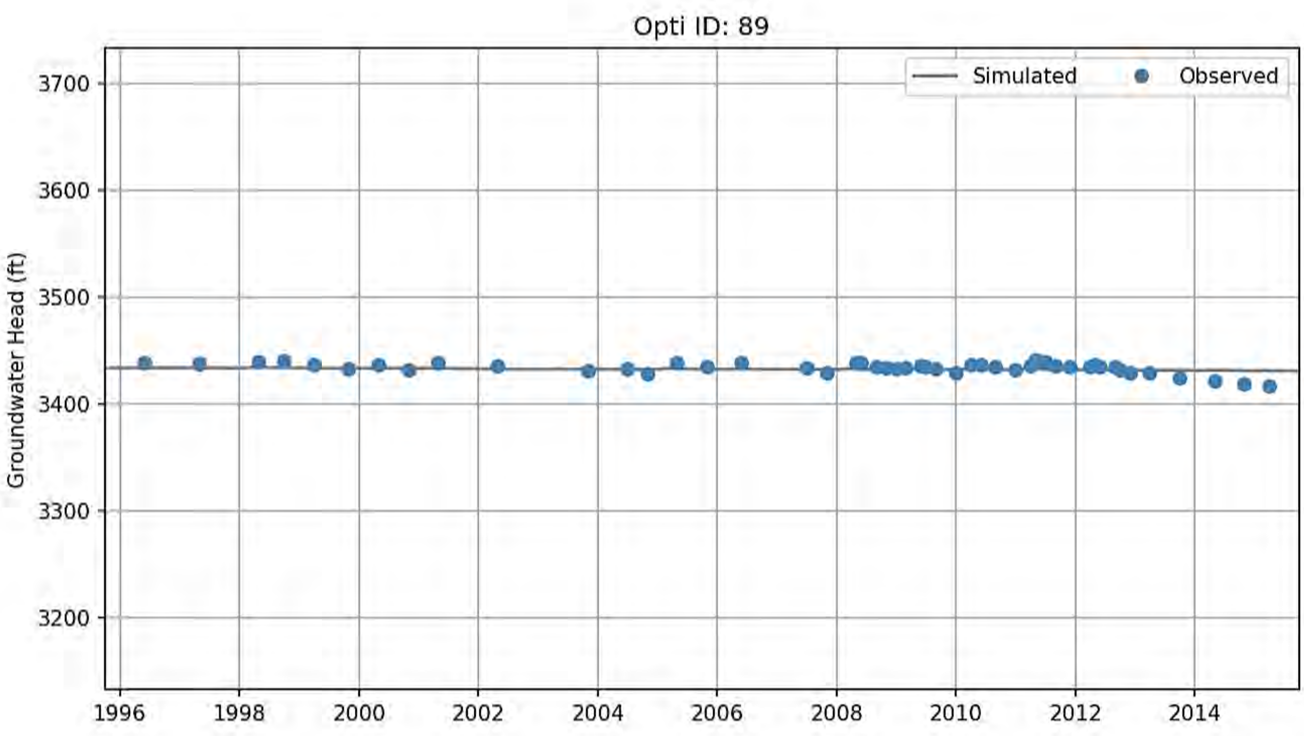


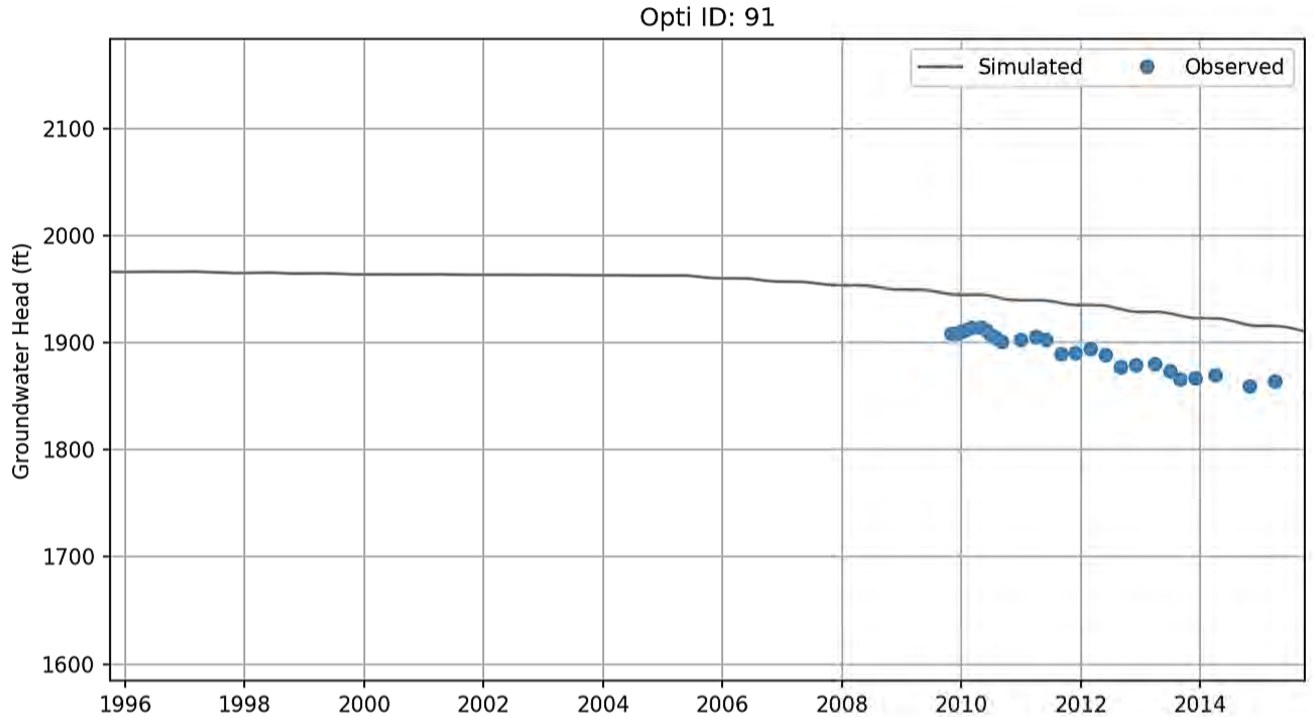
Opti ID: 85
Simulated
Observed
Groundwater Head (ft)
3100
3000
2900
2800
2700
2600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

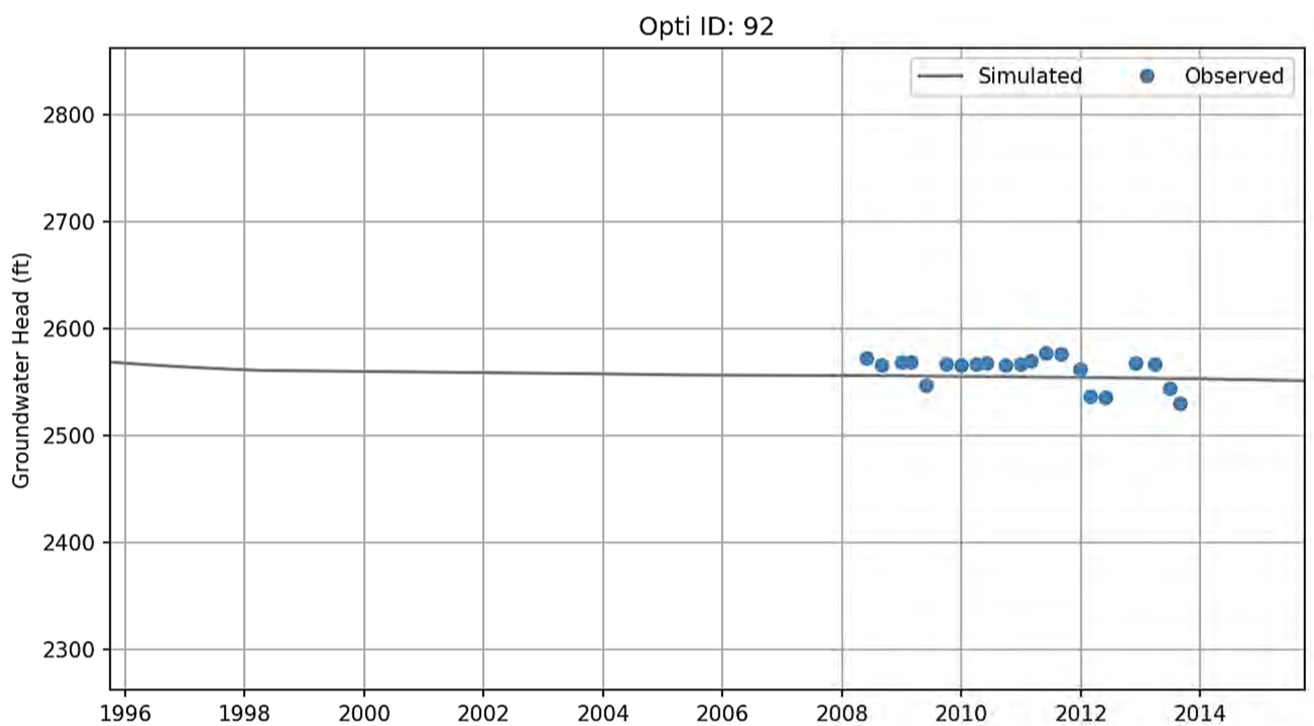


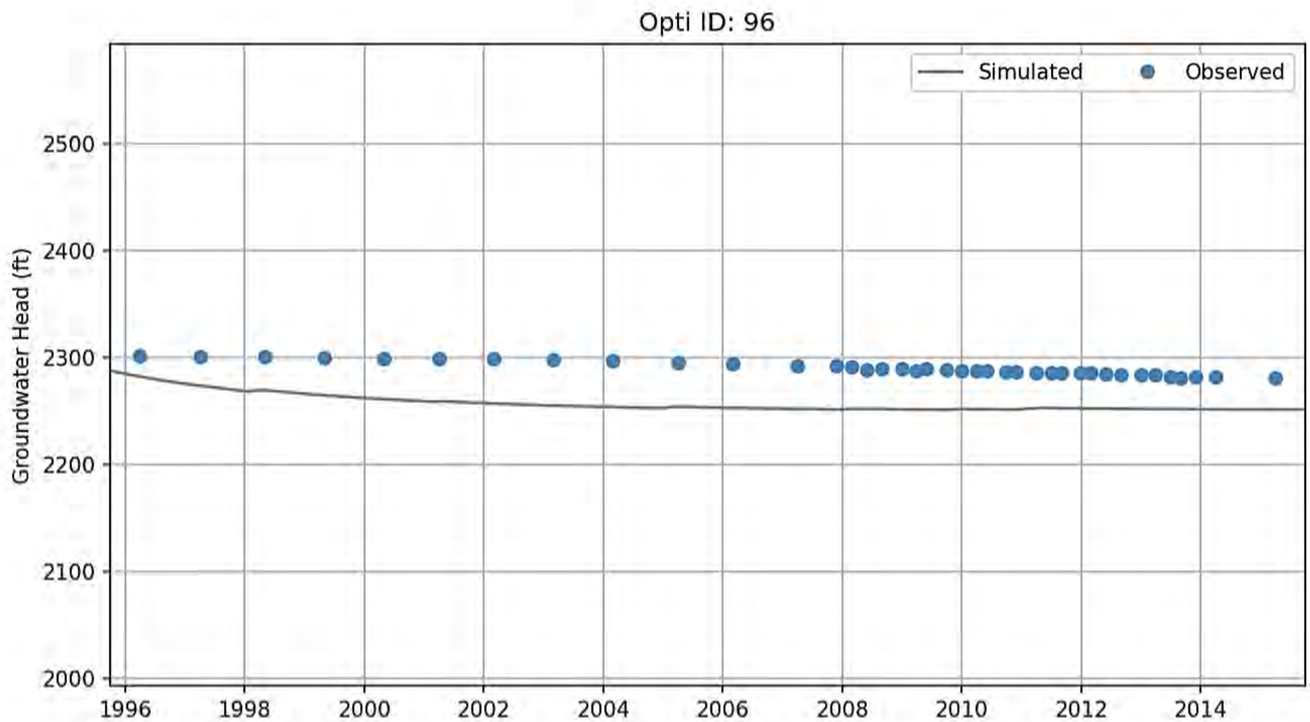
Opti ID: 87
Simulated
Observed
Groundwater Head (ft)
3600
3500
3400
3300
3200
3100
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 88
Simulated
Observed
Groundwater Head (ft)
3500
3400
3300
3200
3100
3000
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

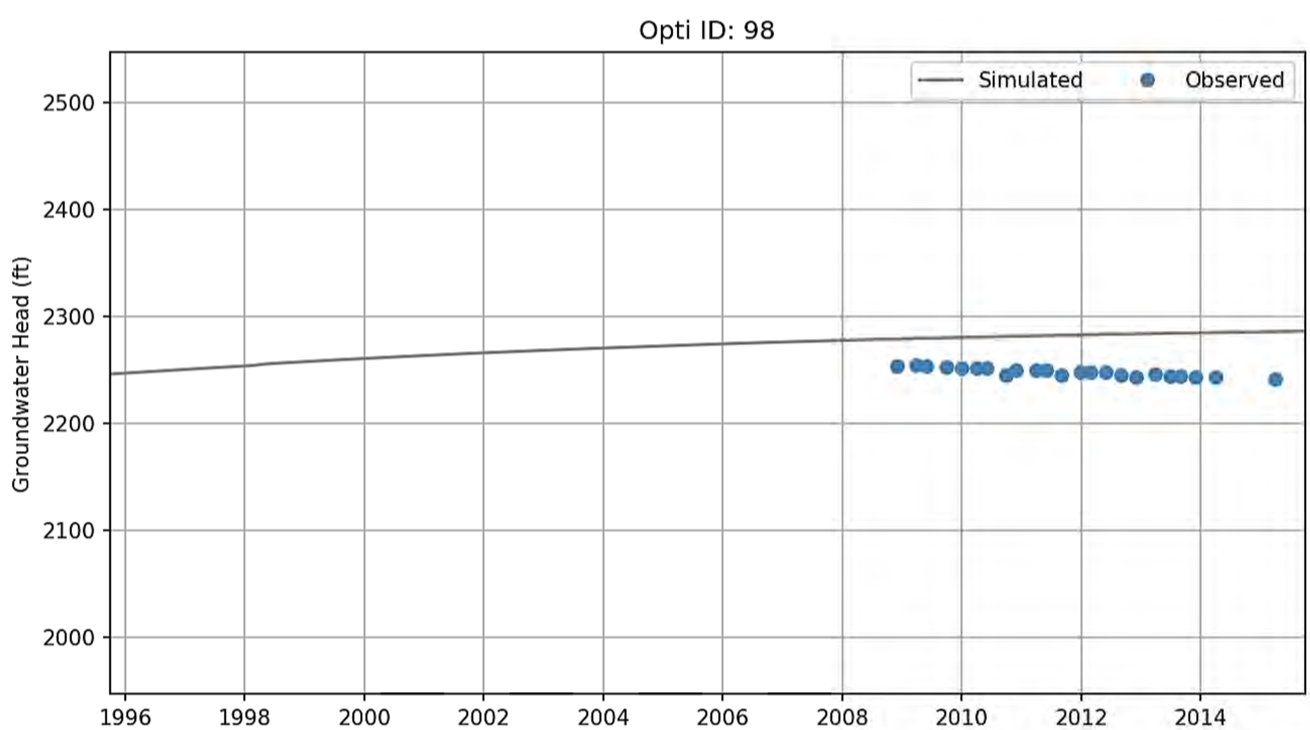

Opti ID: 89
Simulated
Observed
Groundwater Head (ft)
3700
3600
3500
3400
3300
3200
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 91
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

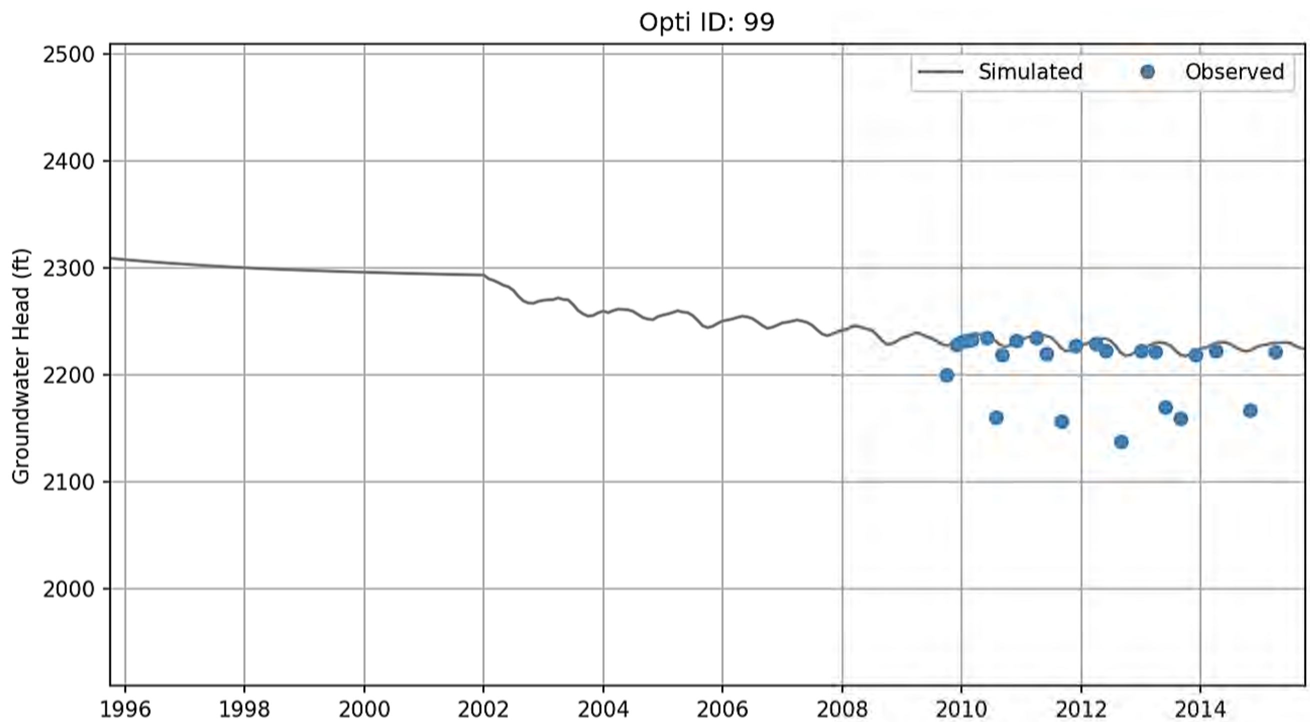

Opti ID: 92
Simulated
Observed
Groundwater Head (ft)
2800
2700
2600
2500
2400
2300
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



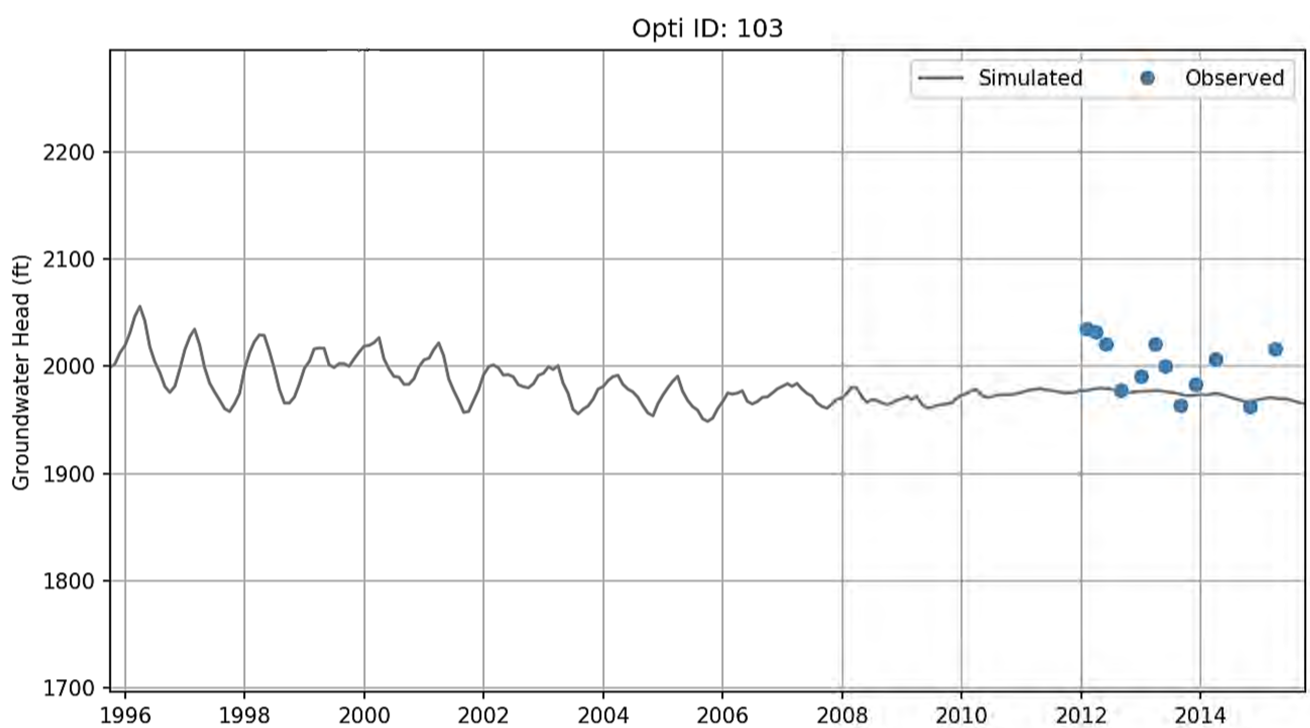
Opti ID: 96
Simulated
Observed
Groundwater Head (ft)
2500
2400
2300
2200
2100
2000
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



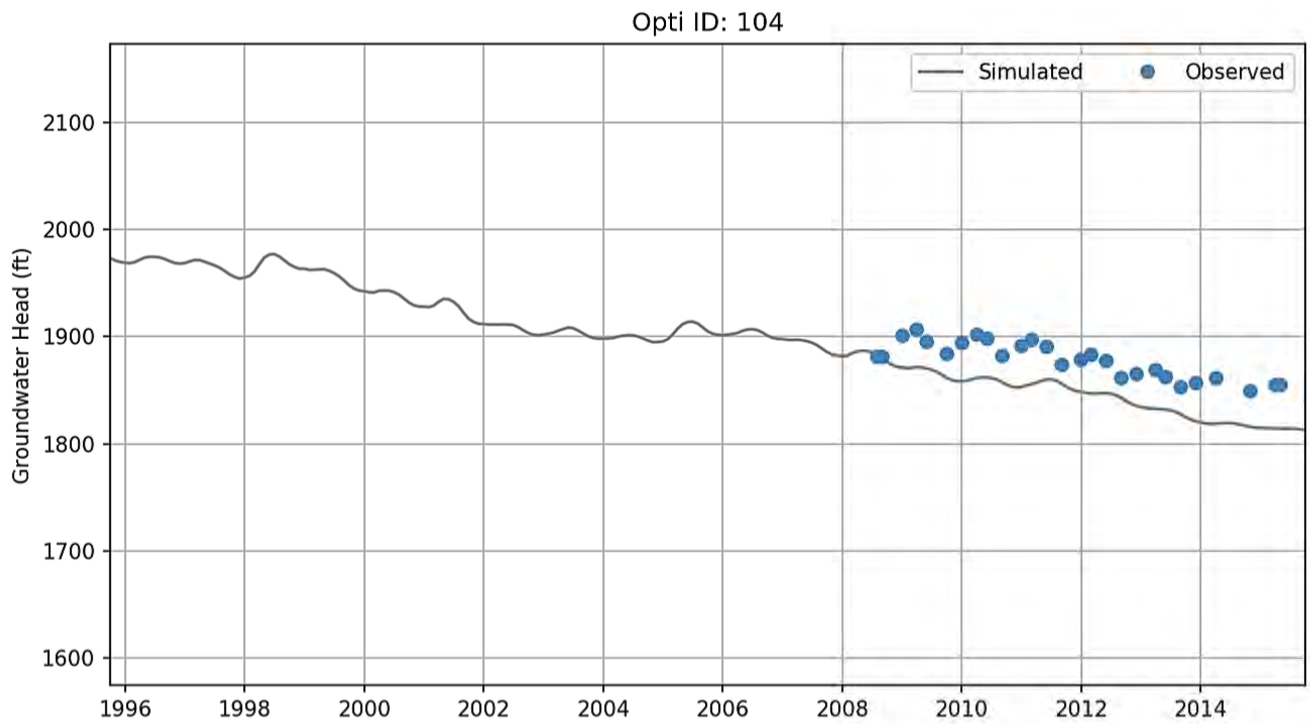
Opti ID: 98
Simulated
Observed
Groundwater Head (ft)
2500
2400
2300
2200
2100
2000
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

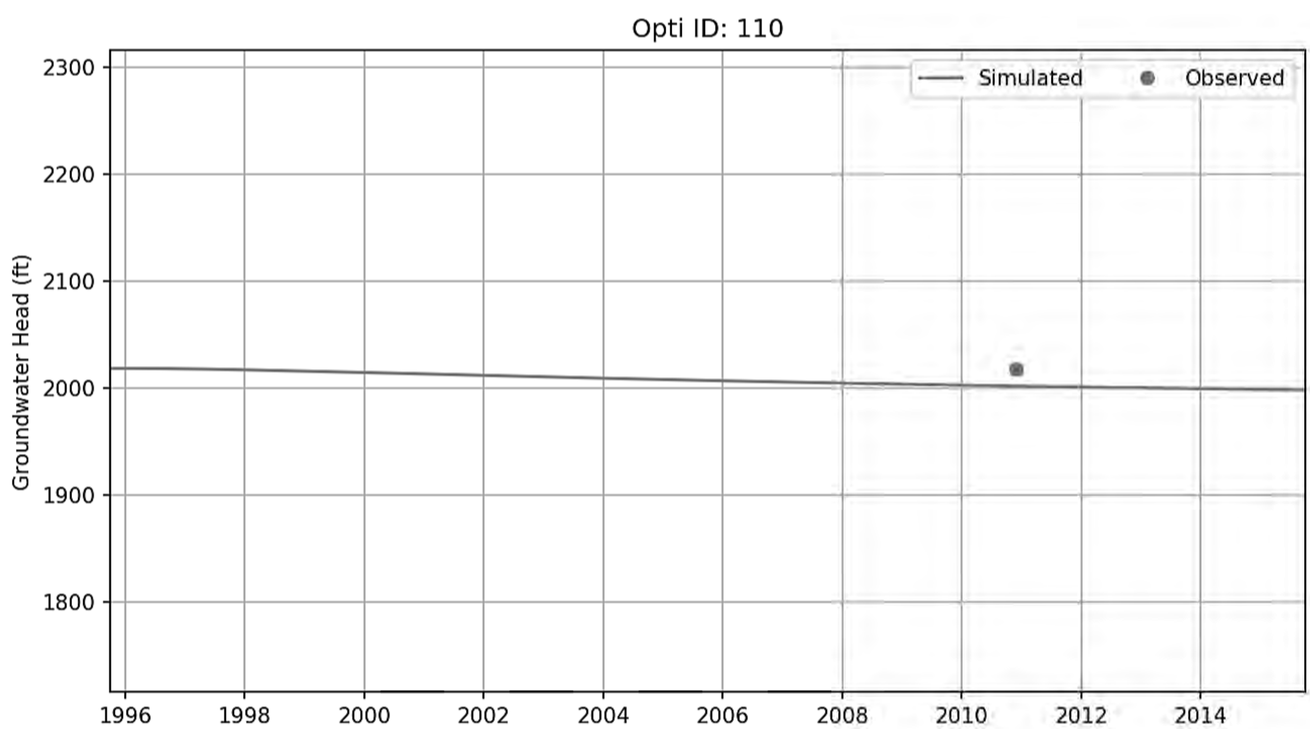


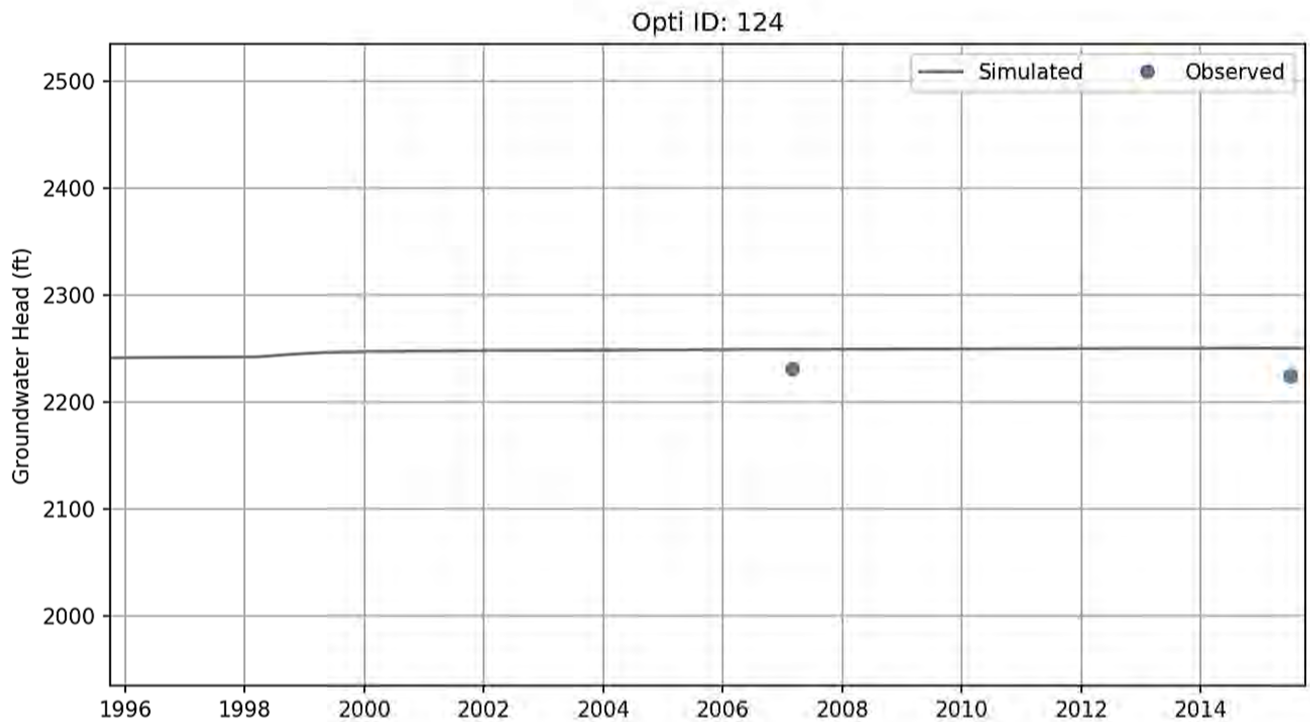
Opti ID: 99
Simulated
Observed
Groundwater Head (ft)
2500
2400
2300
2200
2100
2000
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



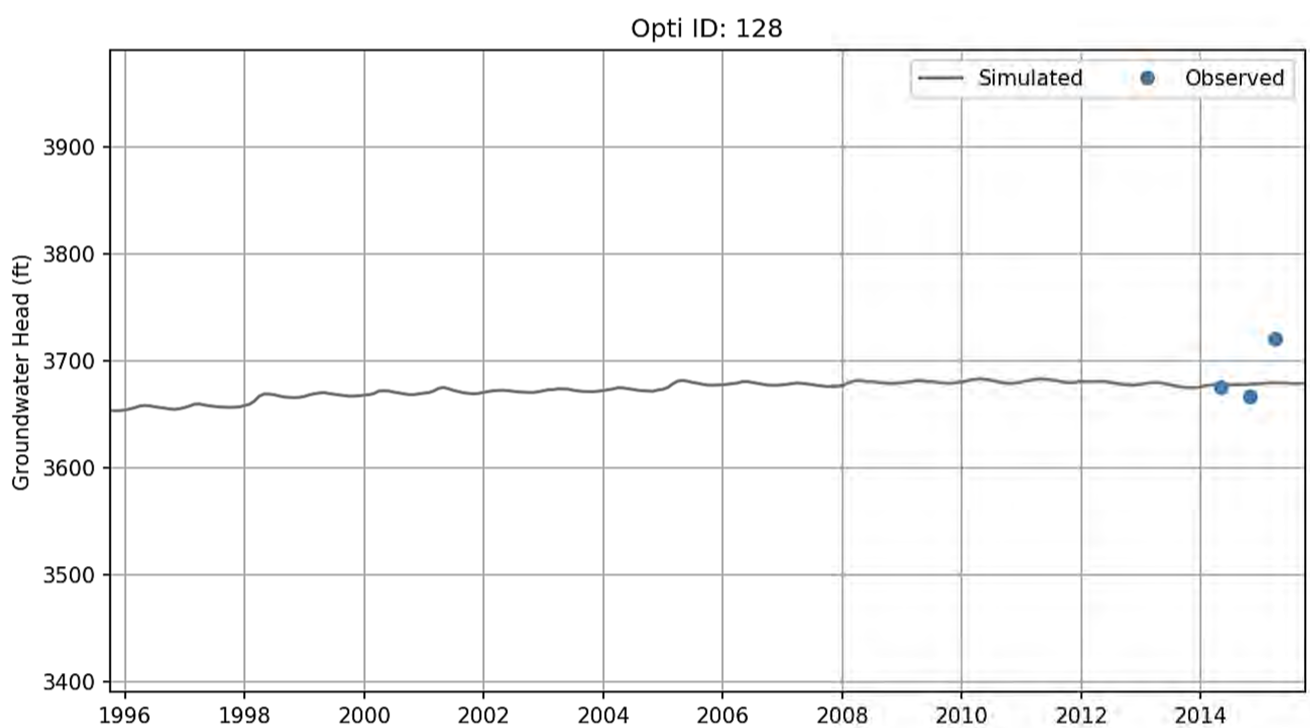
Opti ID: 103
Simulated
Observed
Groundwater Head (ft)
2200
2100
2000
1900
1800
1700
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 104
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

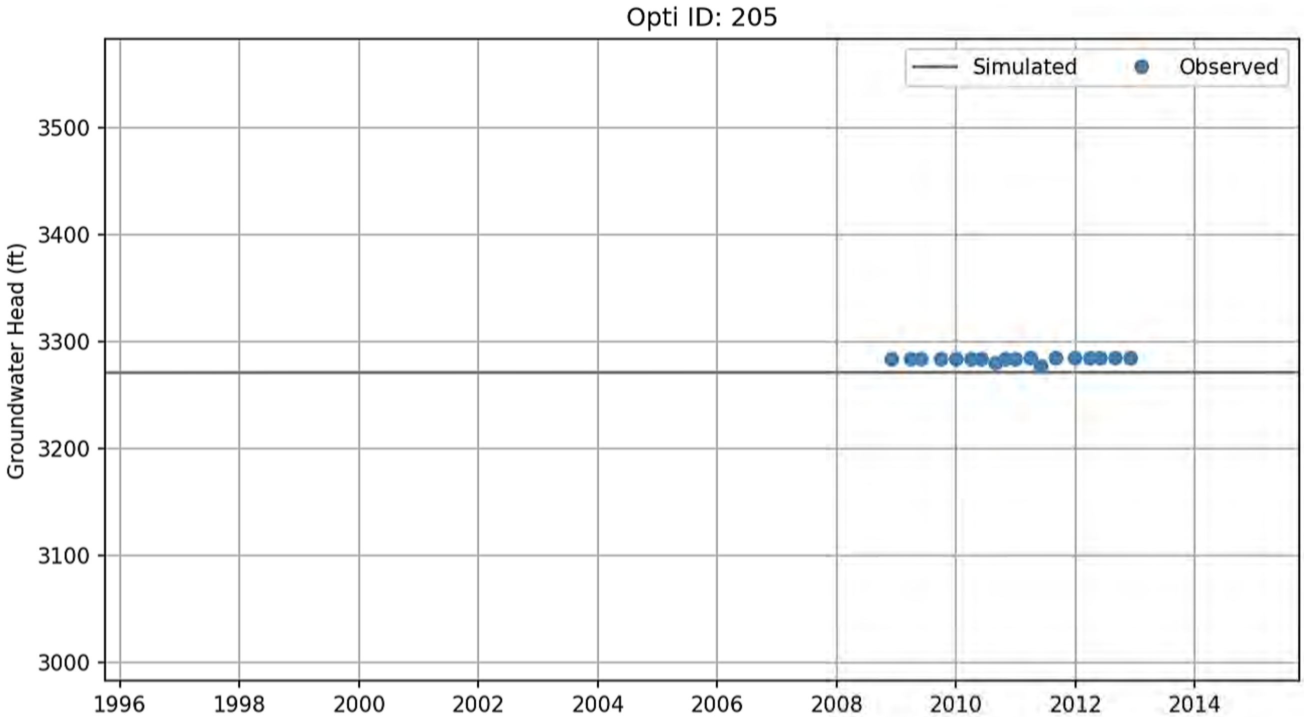

Opti ID: 110
Simulated
Observed
Groundwater Head (ft)
2300
2200
2100
2000
1900
1800
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

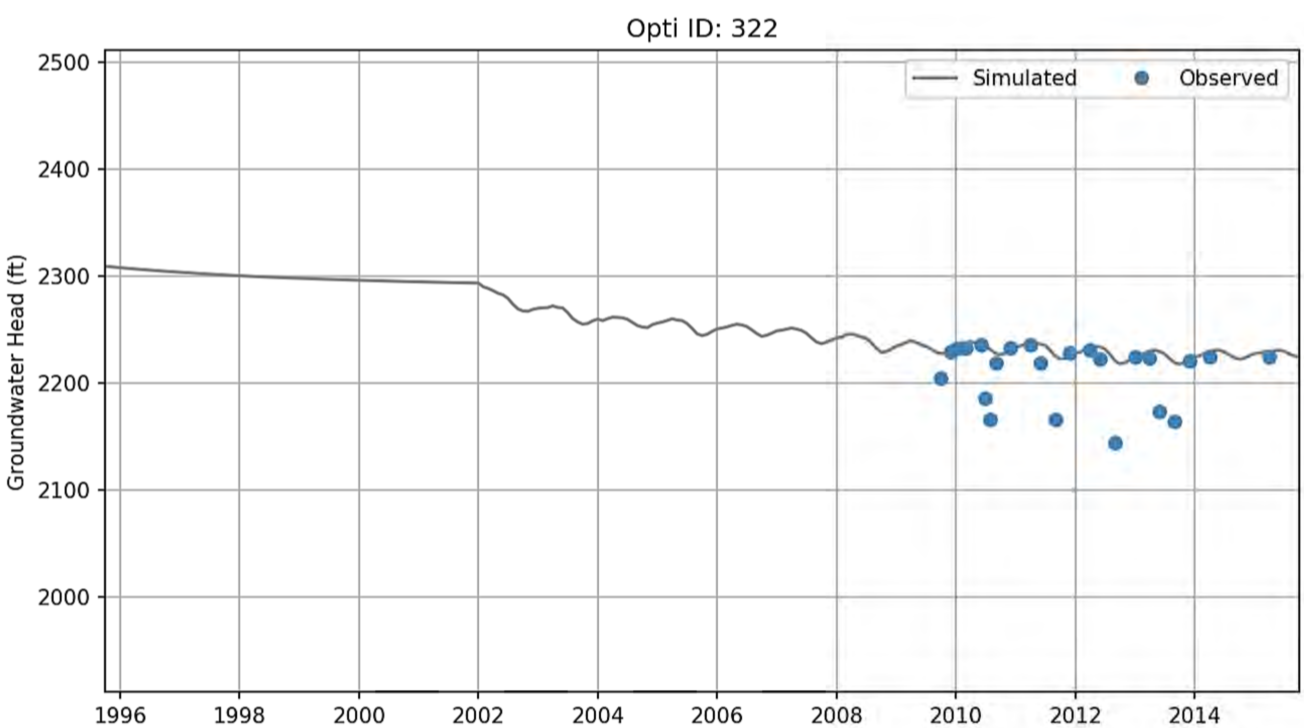


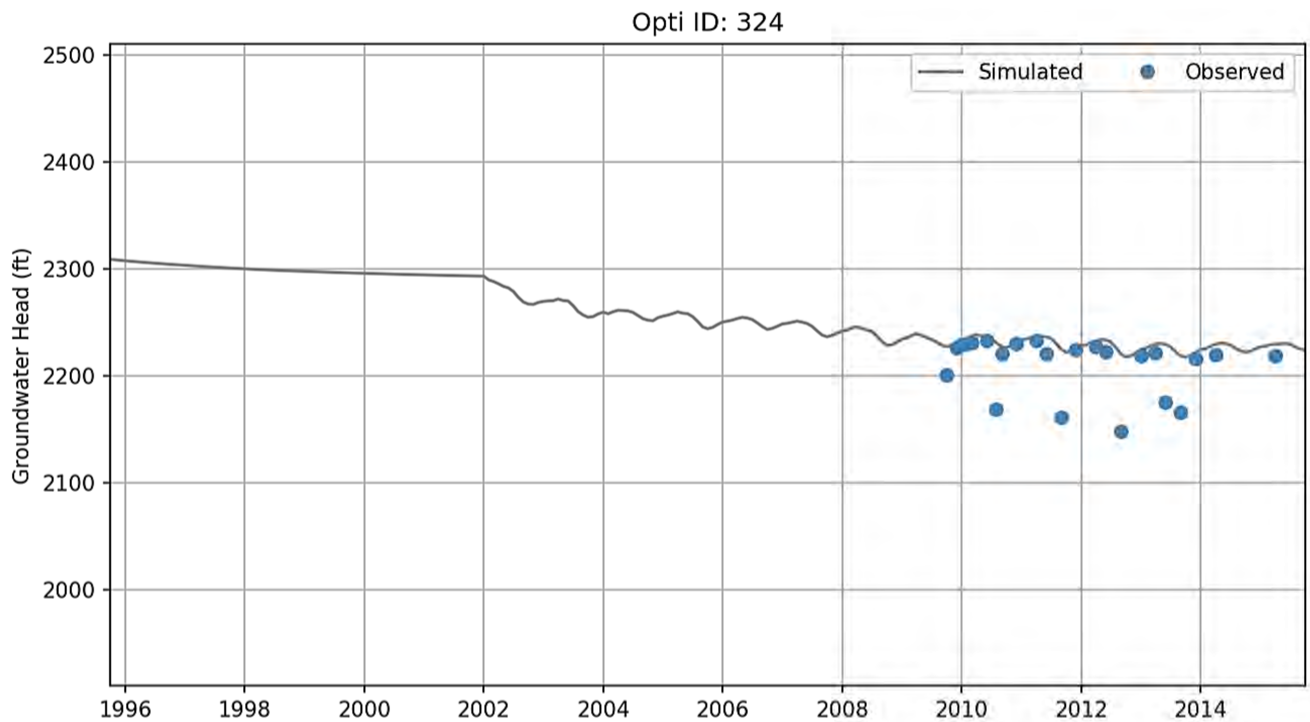
Opti ID: 124
Simulated
Observed
Groundwater Head (ft)
2500
2400
2300
2200
2100
2000
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



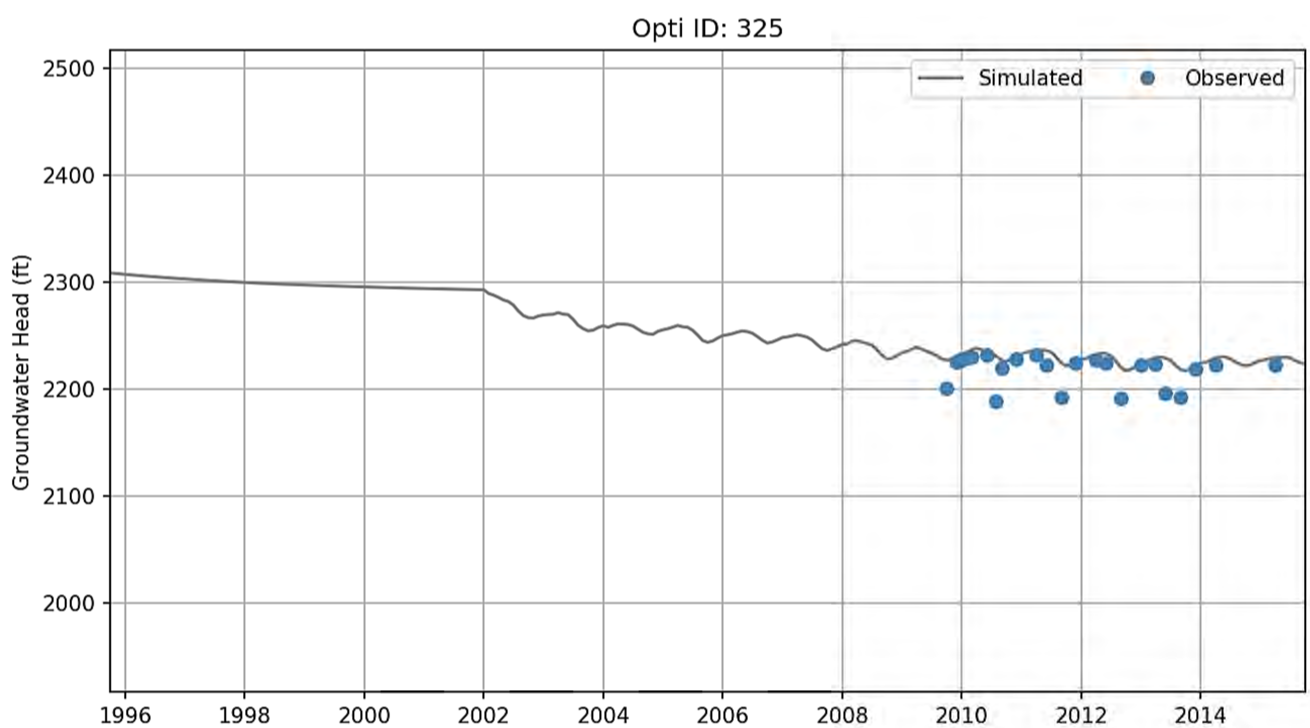
Opti ID: 128
Simulated
Observed
Groundwater Head (ft)
3900
3800
3700
3600
3500
3400
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 205
Simulated
Observed
Groundwater Head (ft)
3500
3400
3300
3200
3100
3000
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

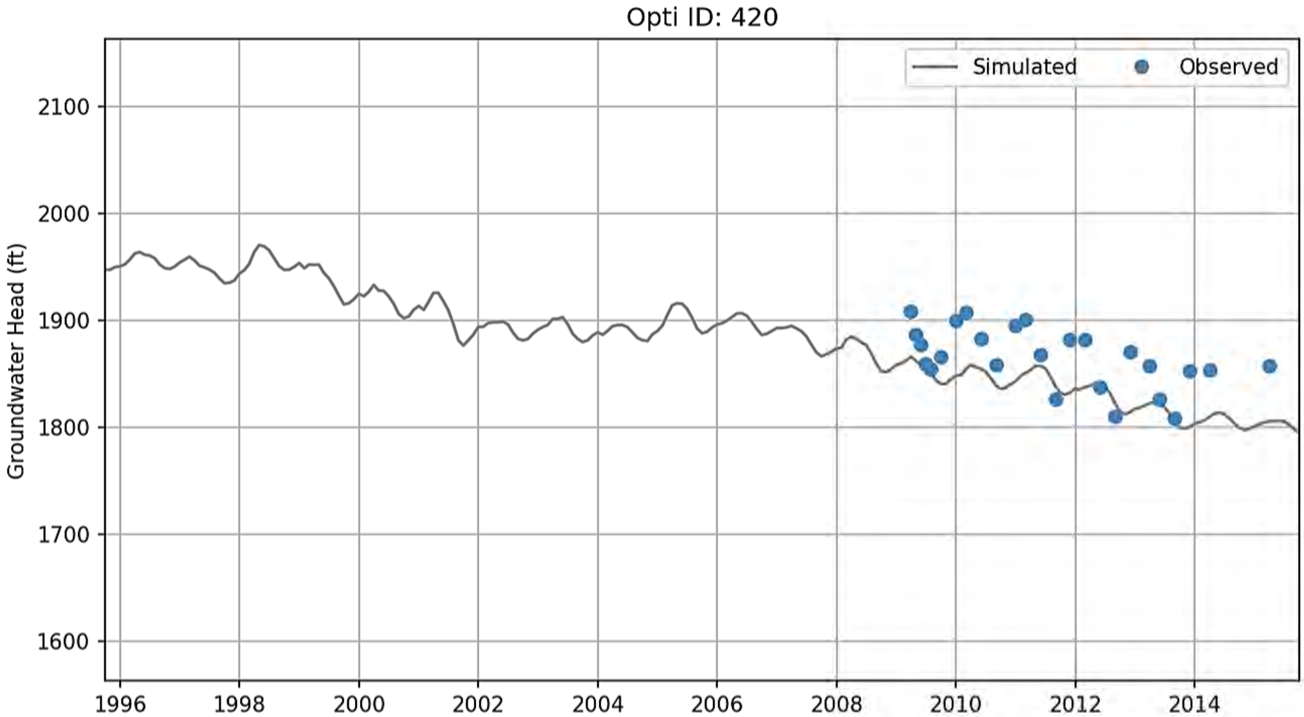

Opti ID: 322
Simulated
Observed
Groundwater Head (ft)
2500
2400
2300
2200
2100
2000
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

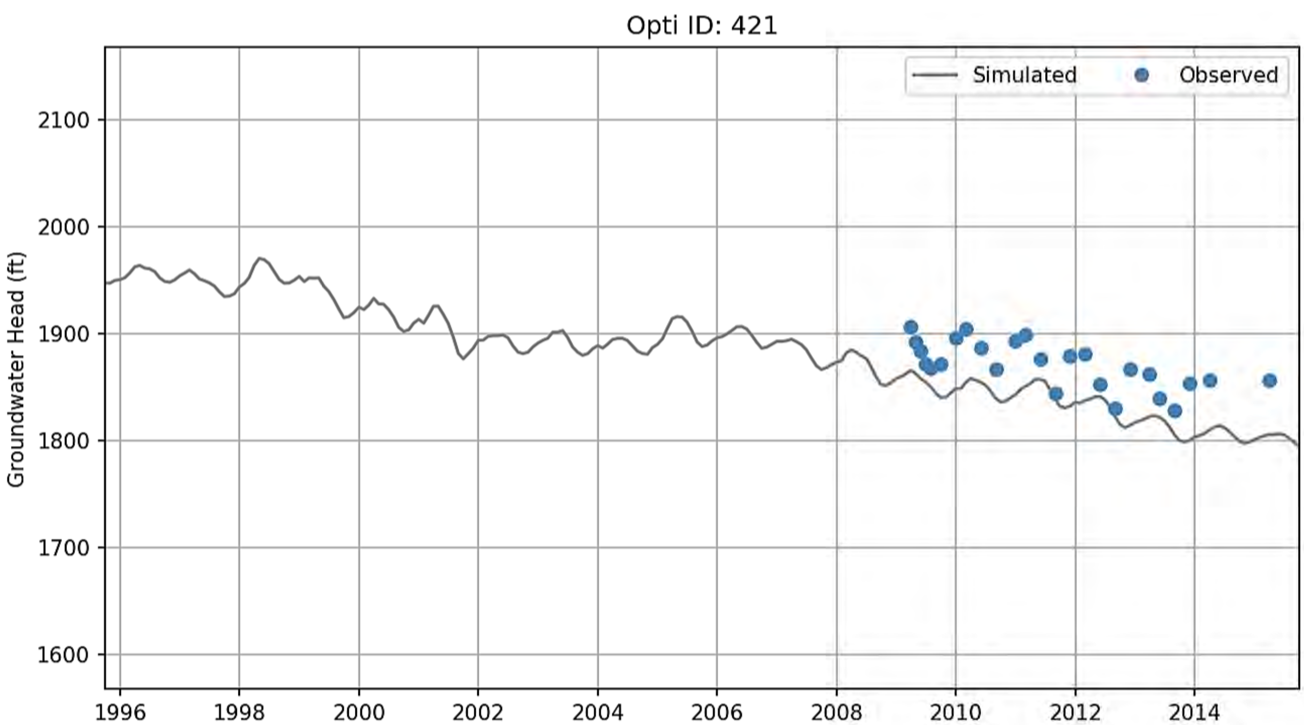


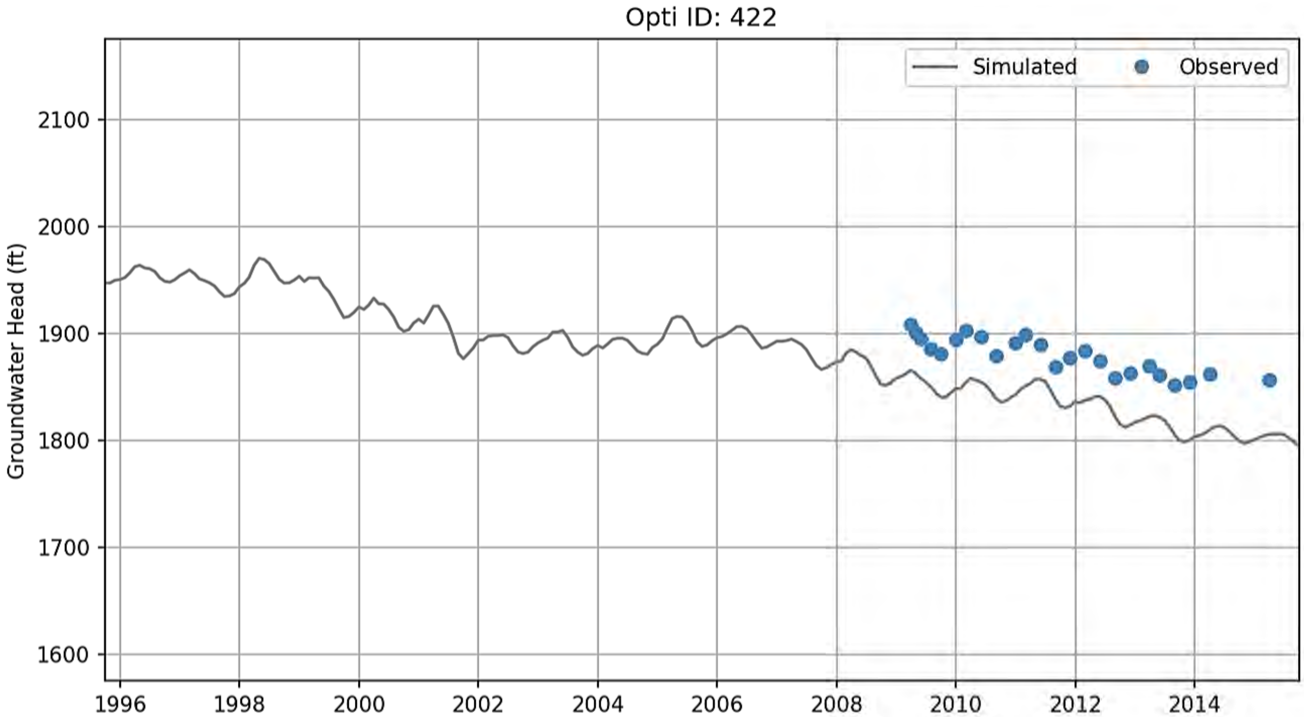
Opti ID: 324
Simulated
Observed
Groundwater Head (ft)
2500
2400
2300
2200
2100
2000
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

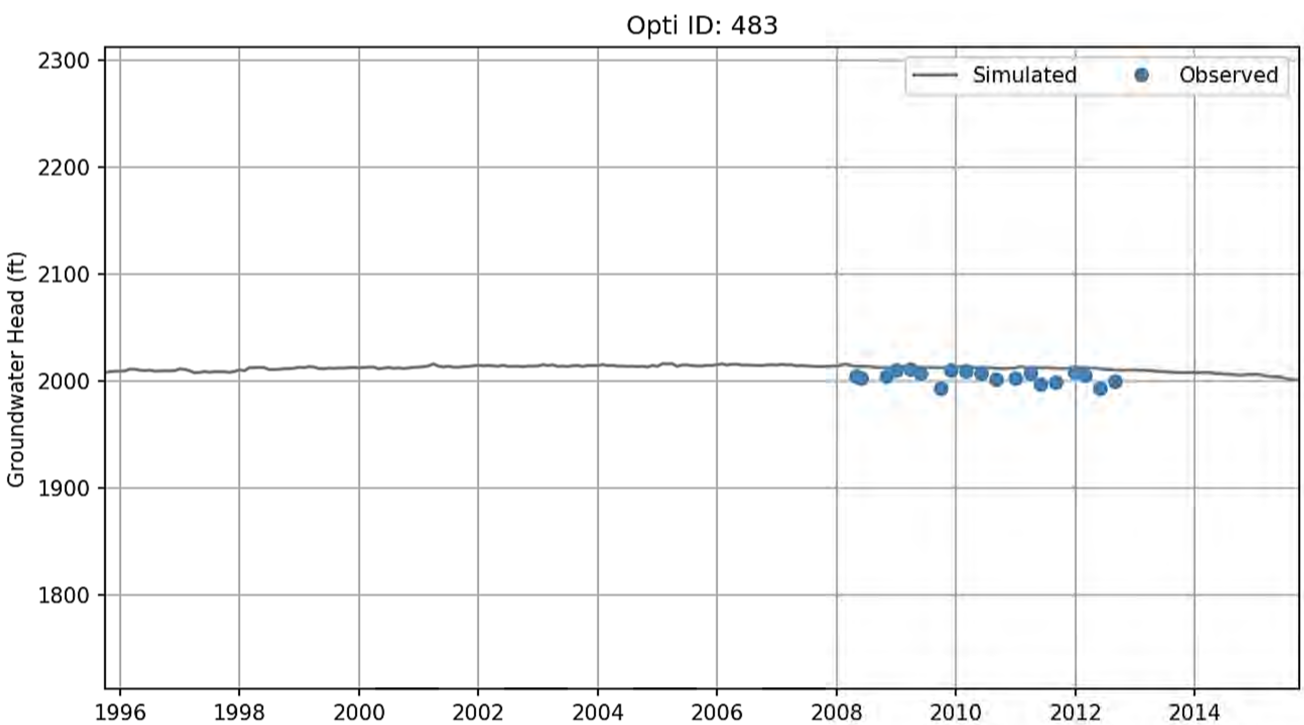


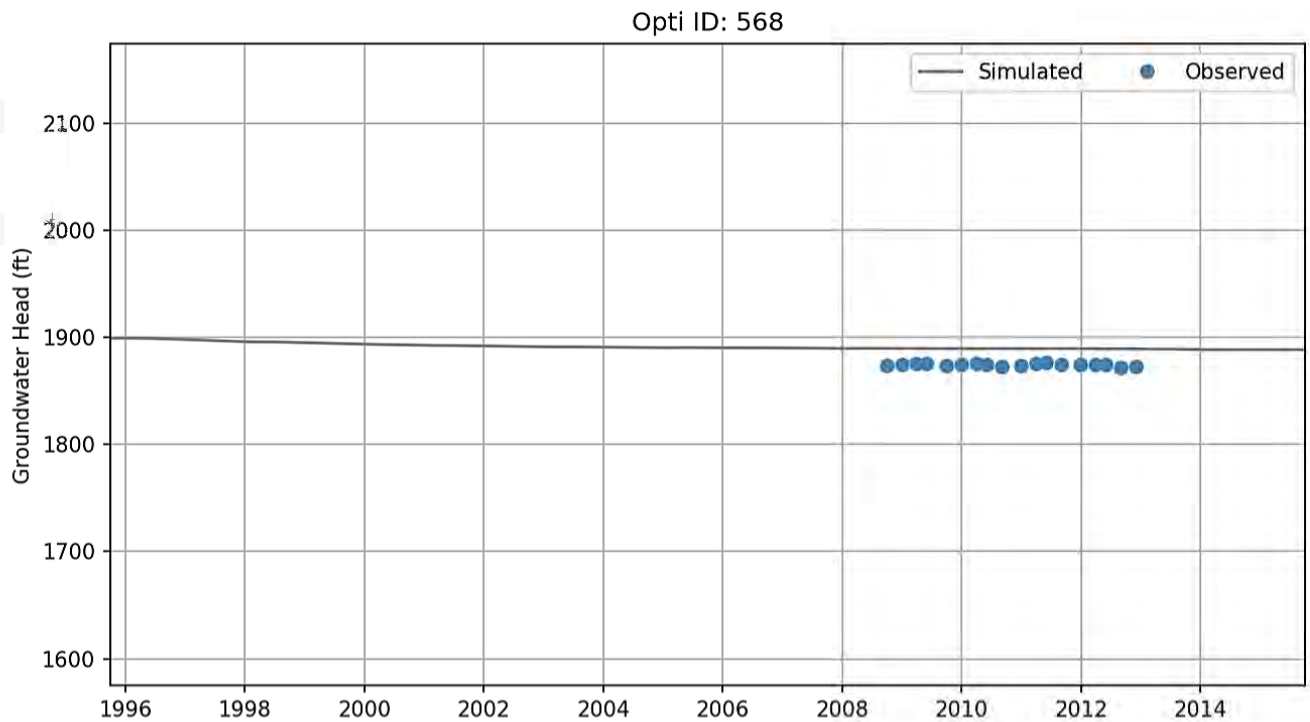
Opti ID: 325
Simulated
Observed
Groundwater Head (ft)
2500
2400
2300
2200
2100
2000
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 420
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

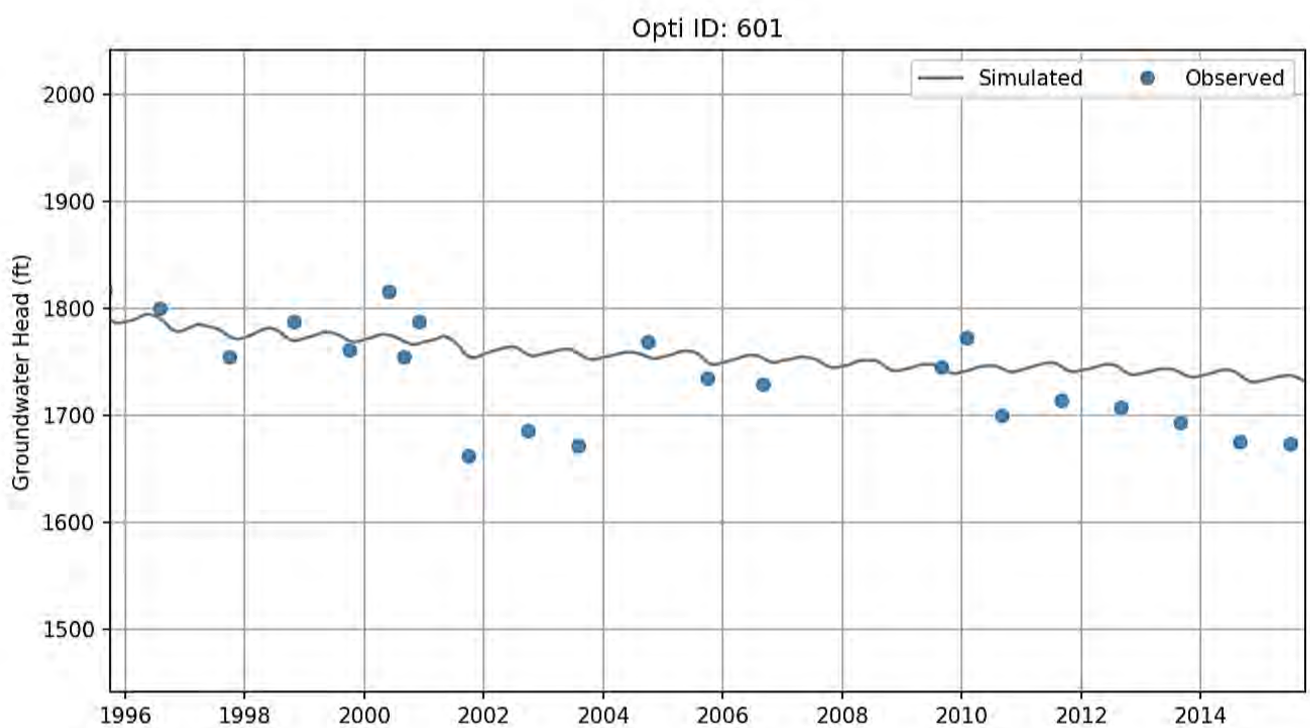

Opti ID: 421
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 422
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

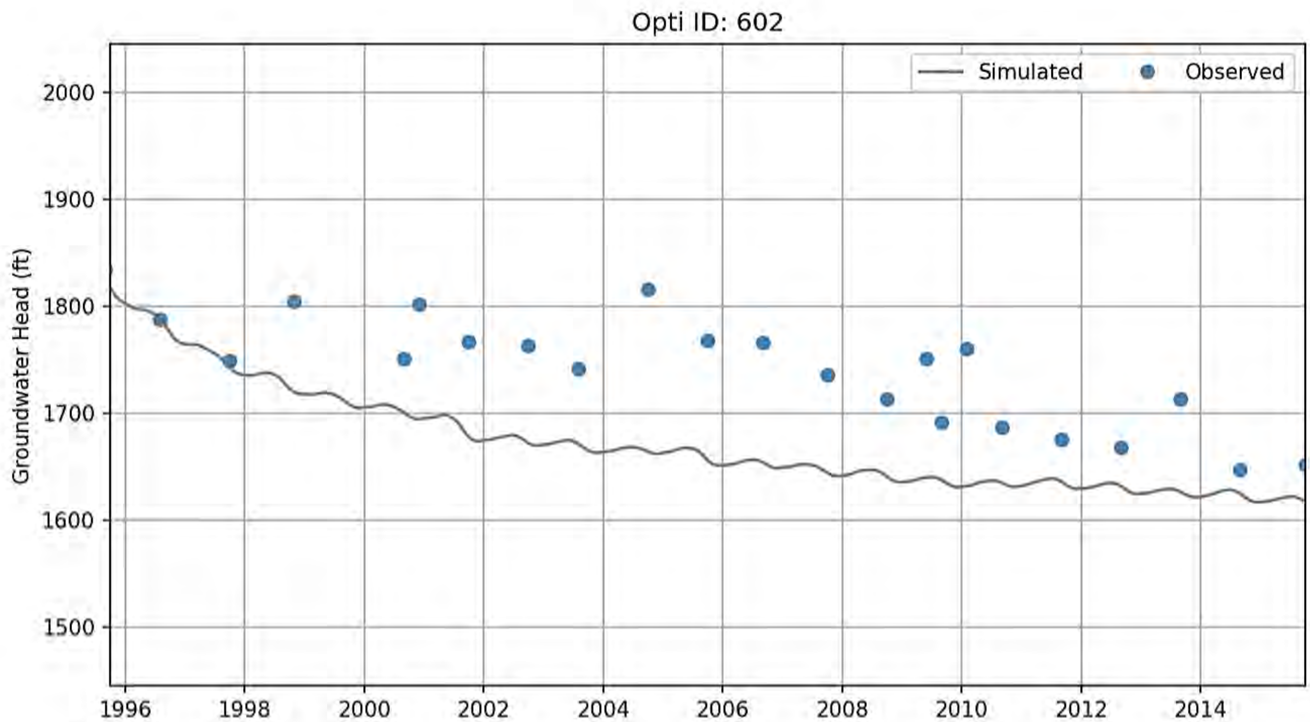

Opti ID: 483
Simulated
Observed
Groundwater Head (ft)
2300
2200
2100
2000
1900
1800
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

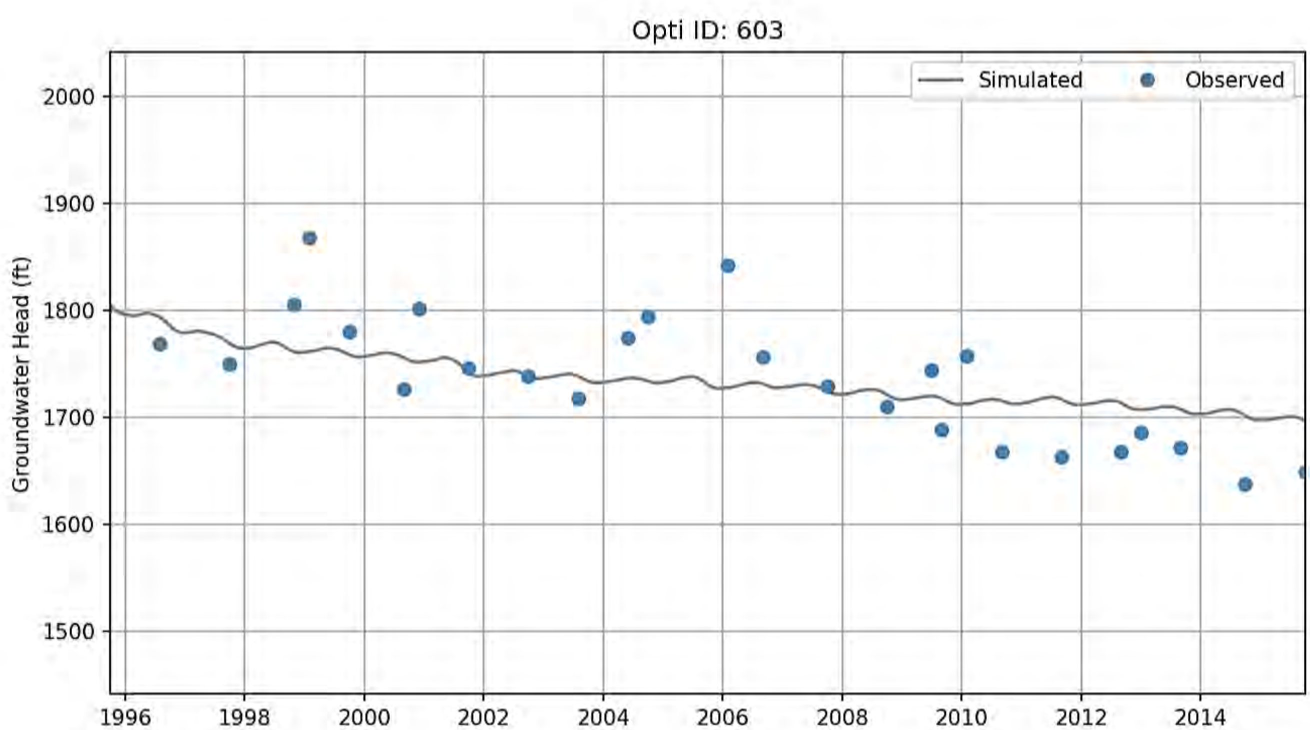


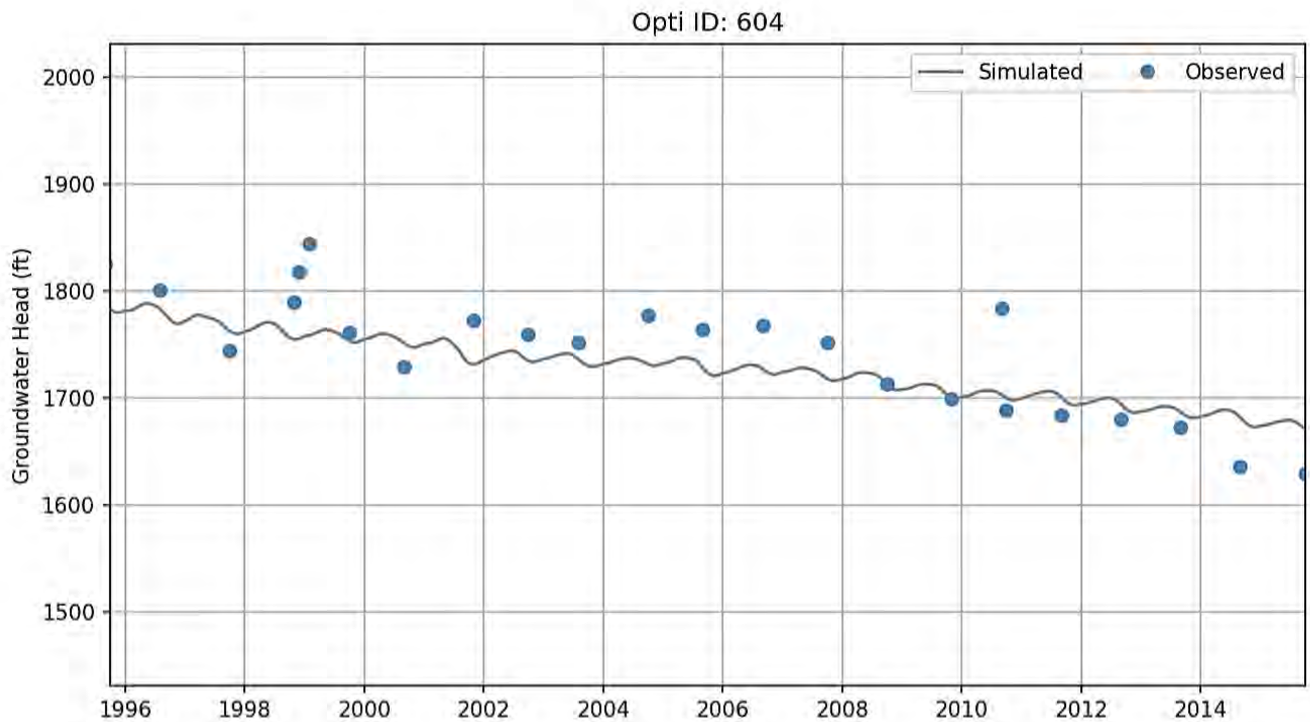
Opti ID: 568
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



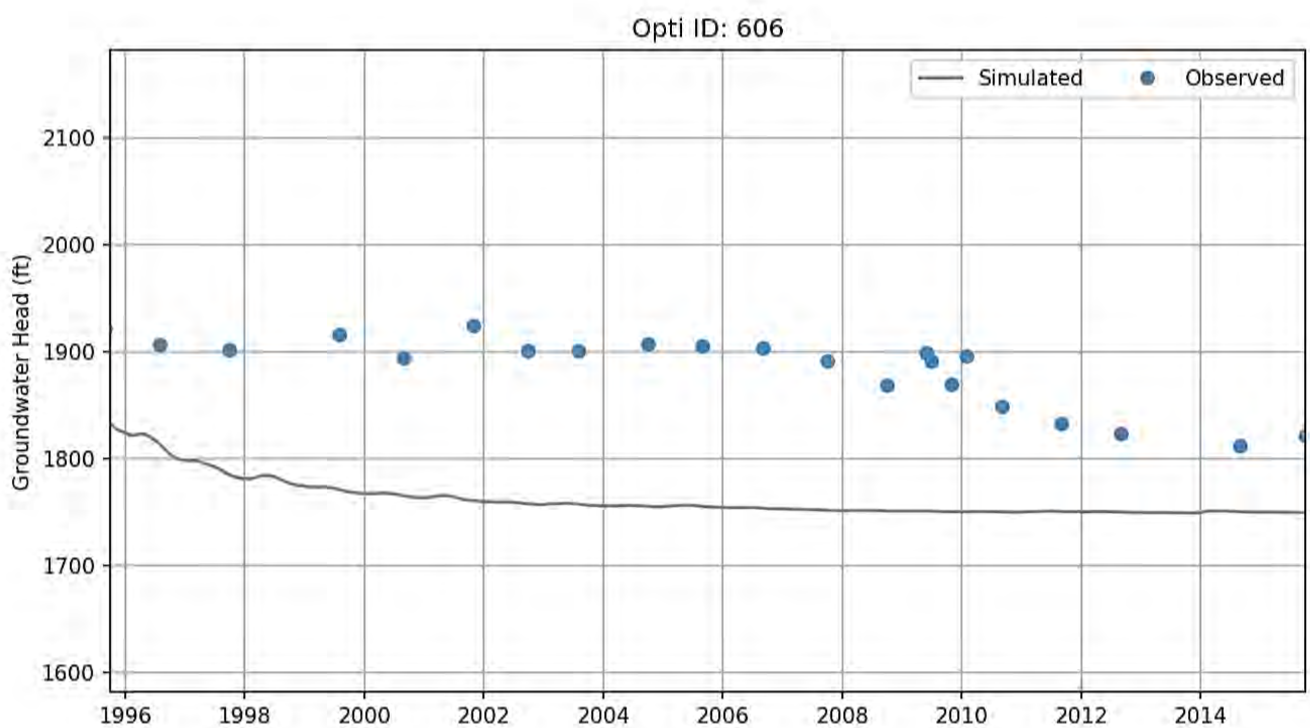
Opti ID: 601
Simulated
Observed
Groundwater Head (ft)
2000
1900
1800
1700
1600
1500
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 602
Simulated
Observed
Groundwater Head (ft)
2000
1900
1800
1700
1600
1500
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

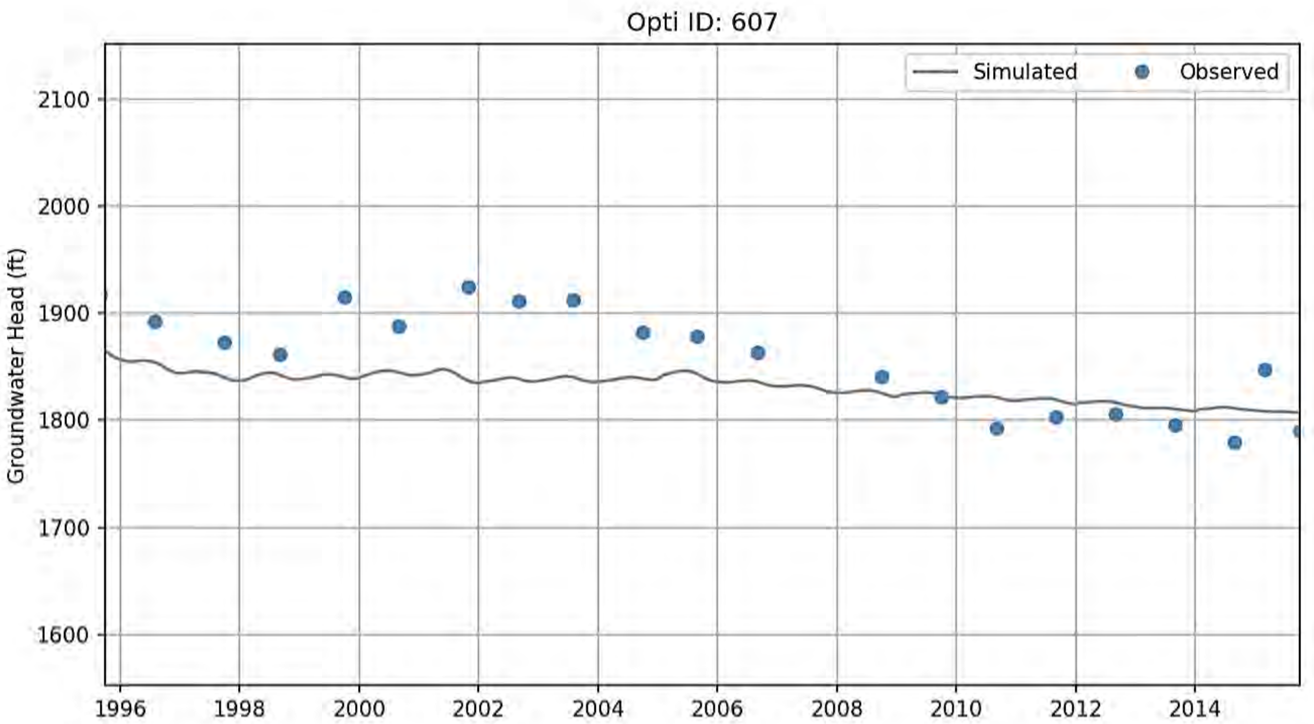

Opti ID: 603
Simulated
Observed
Groundwater Head (ft)
2000
1900
1800
1700
1600
1500
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

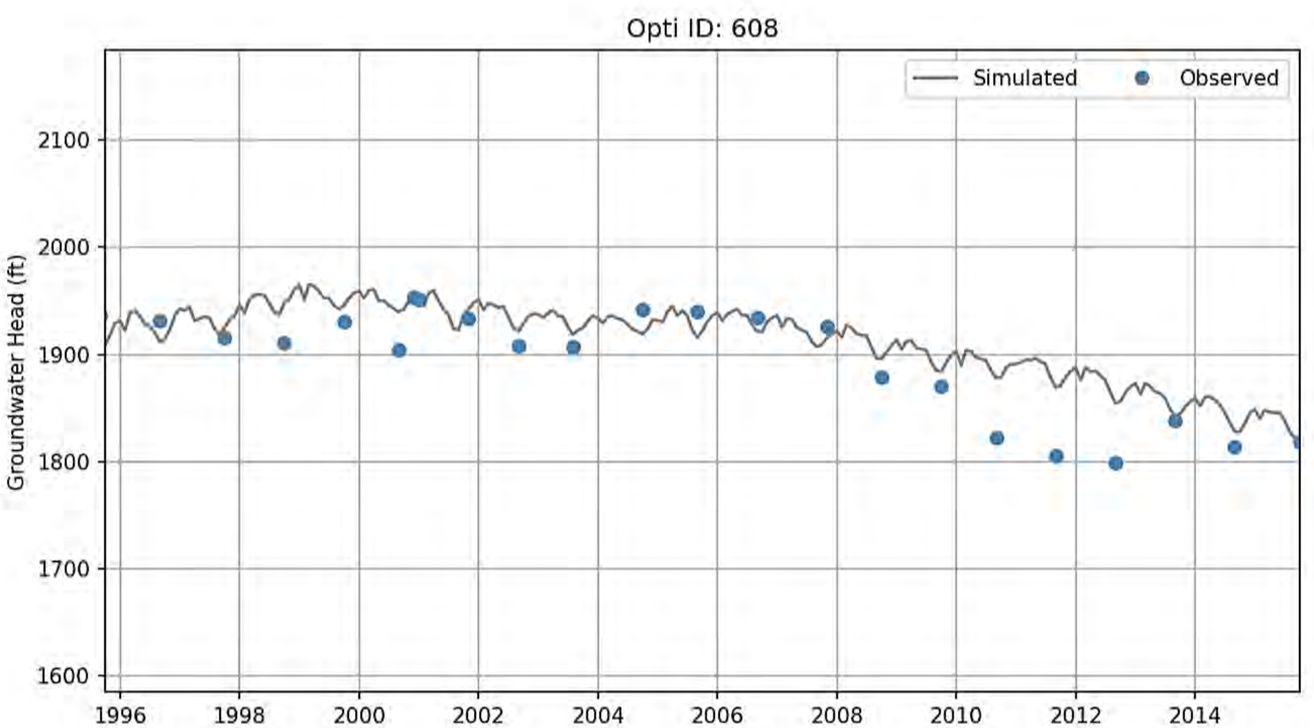


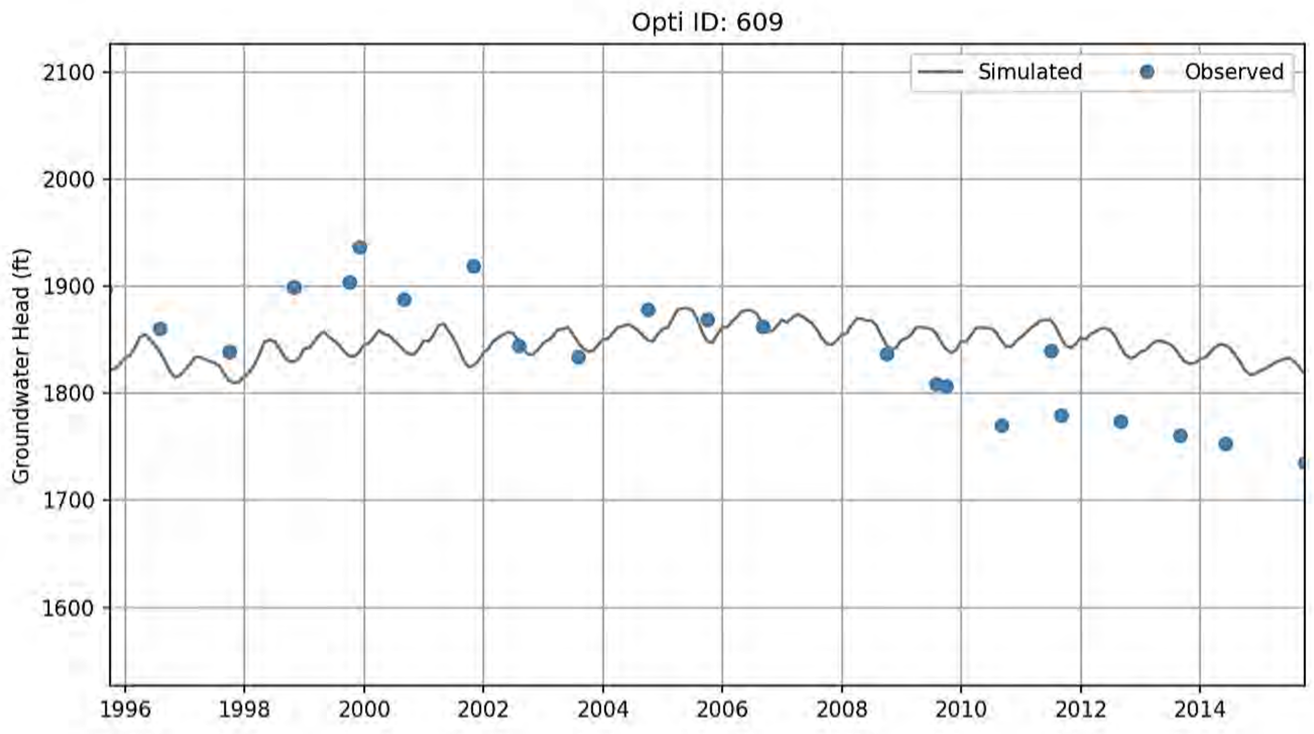
Opti ID: 604
Simulated
Observed
Groundwater Head (ft)
2000
1900
1800
1700
1600
1500
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

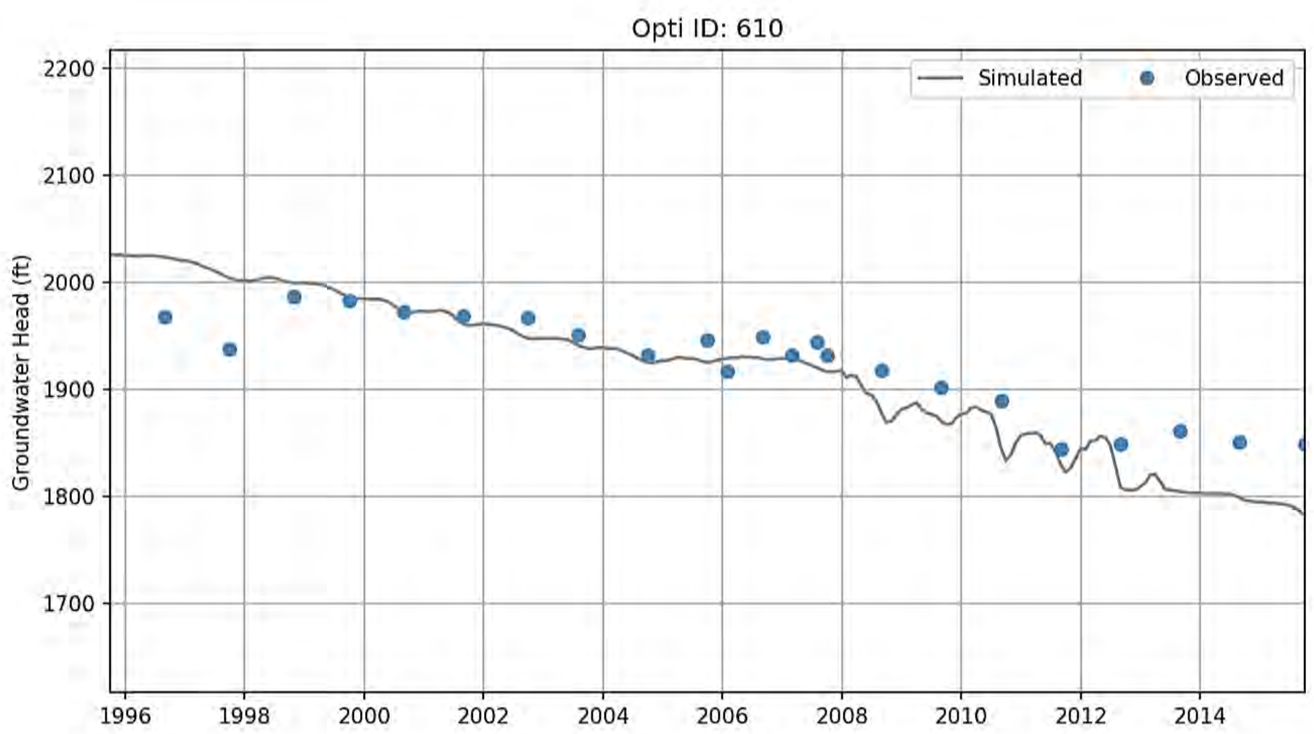


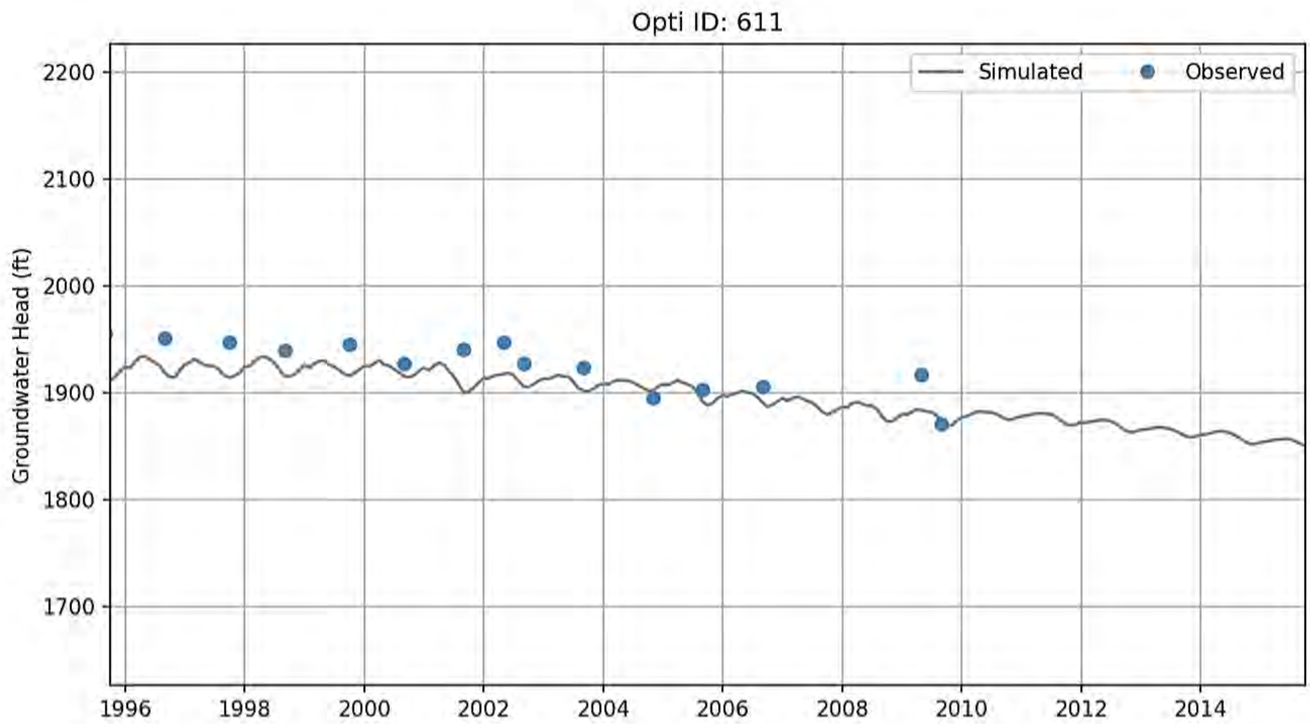
Opti ID: 606
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 607
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

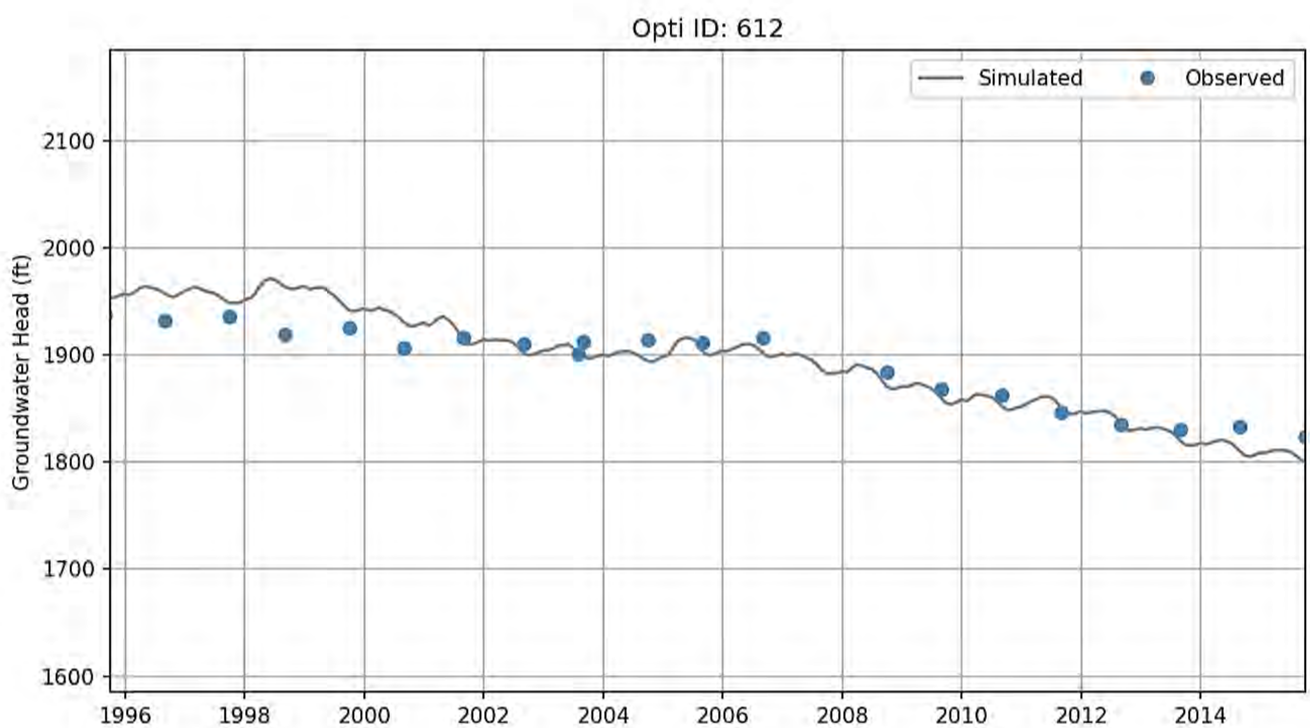

Opti ID: 608
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 609
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

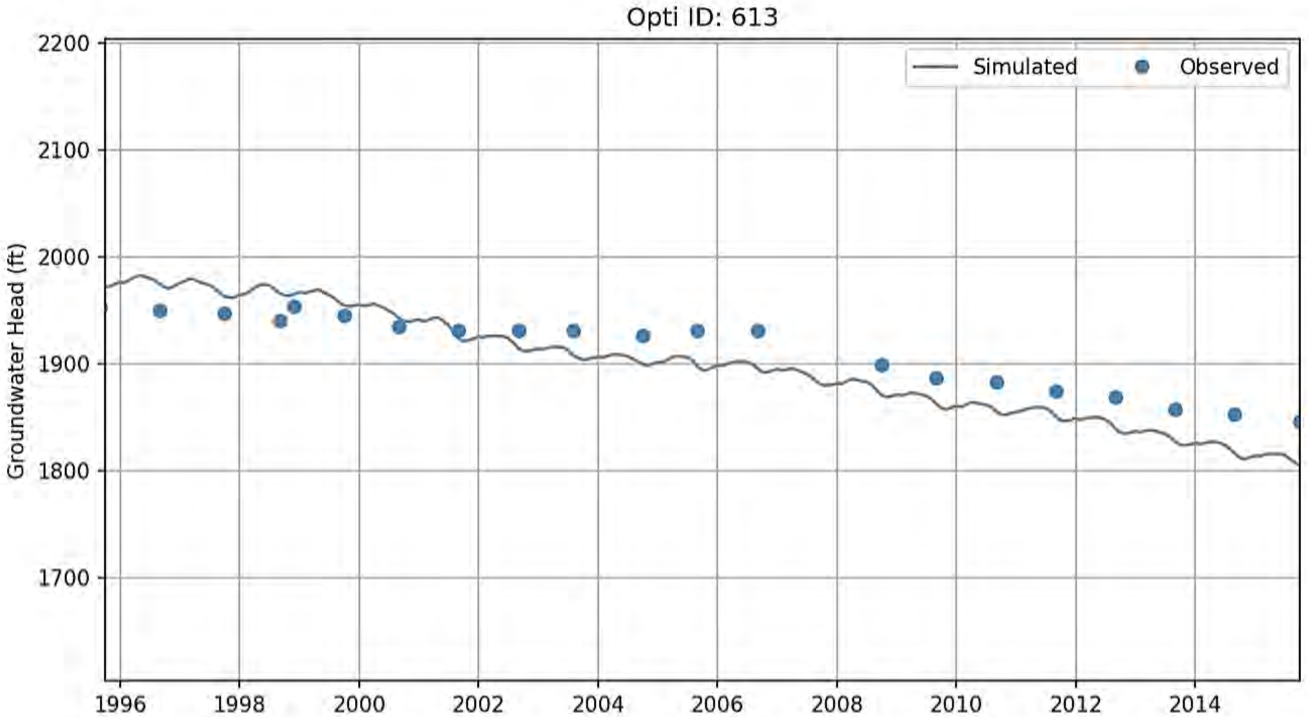

Opti ID: 610
Simulated
Observed
Groundwater Head (ft)
2200
2100
2000
1900
1800
1700
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

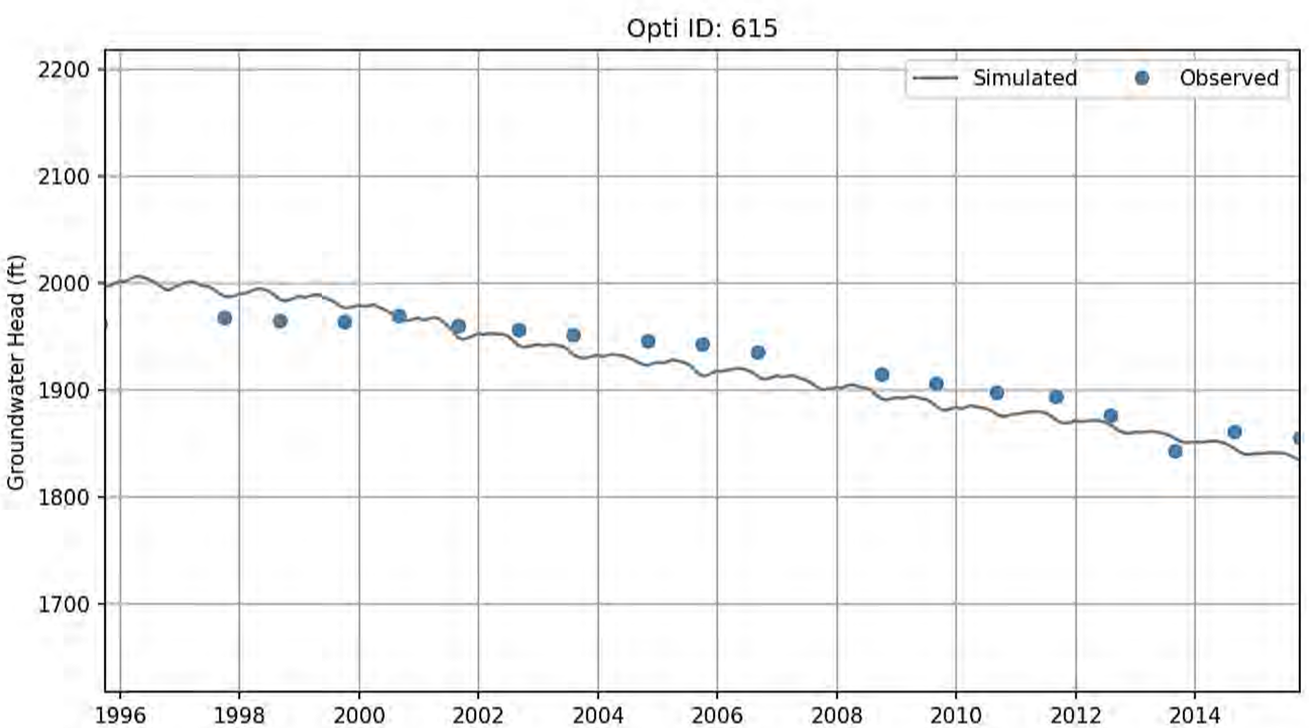


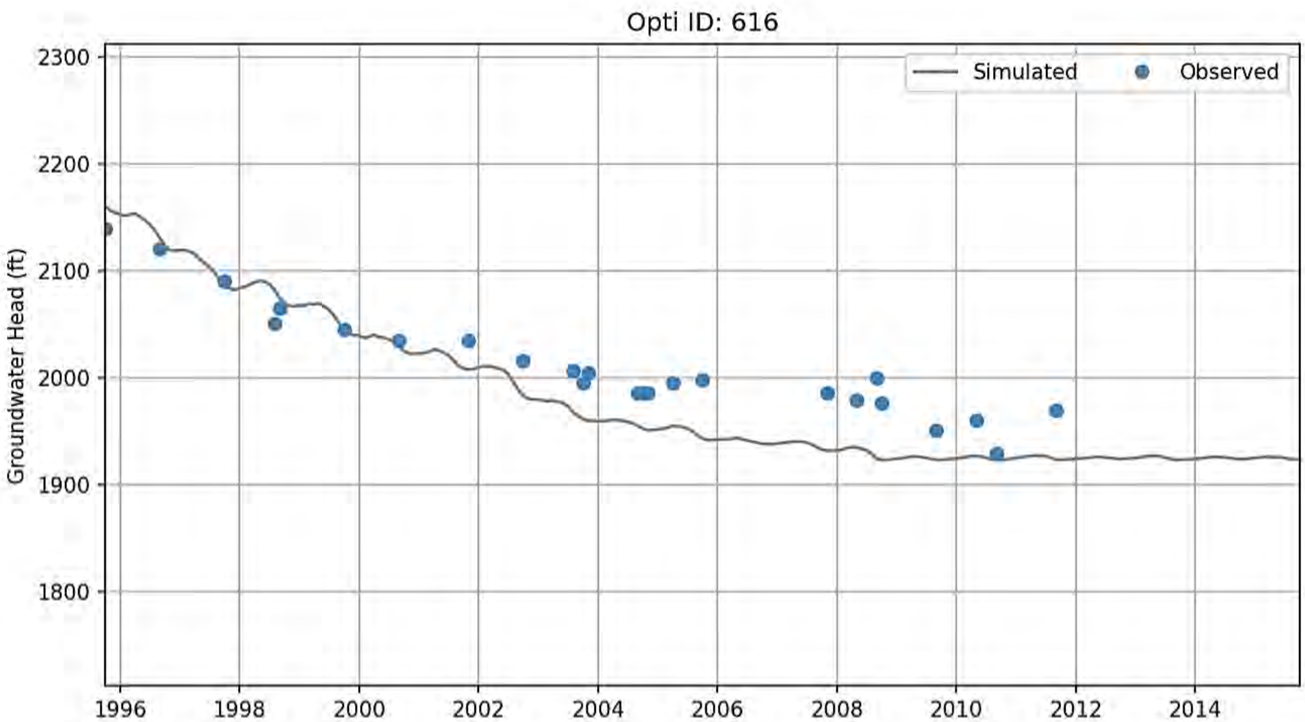
Opti ID: 611
Simulated
Observed
Groundwater Head (ft)
2200
2100
2000
1900
1800
1700
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



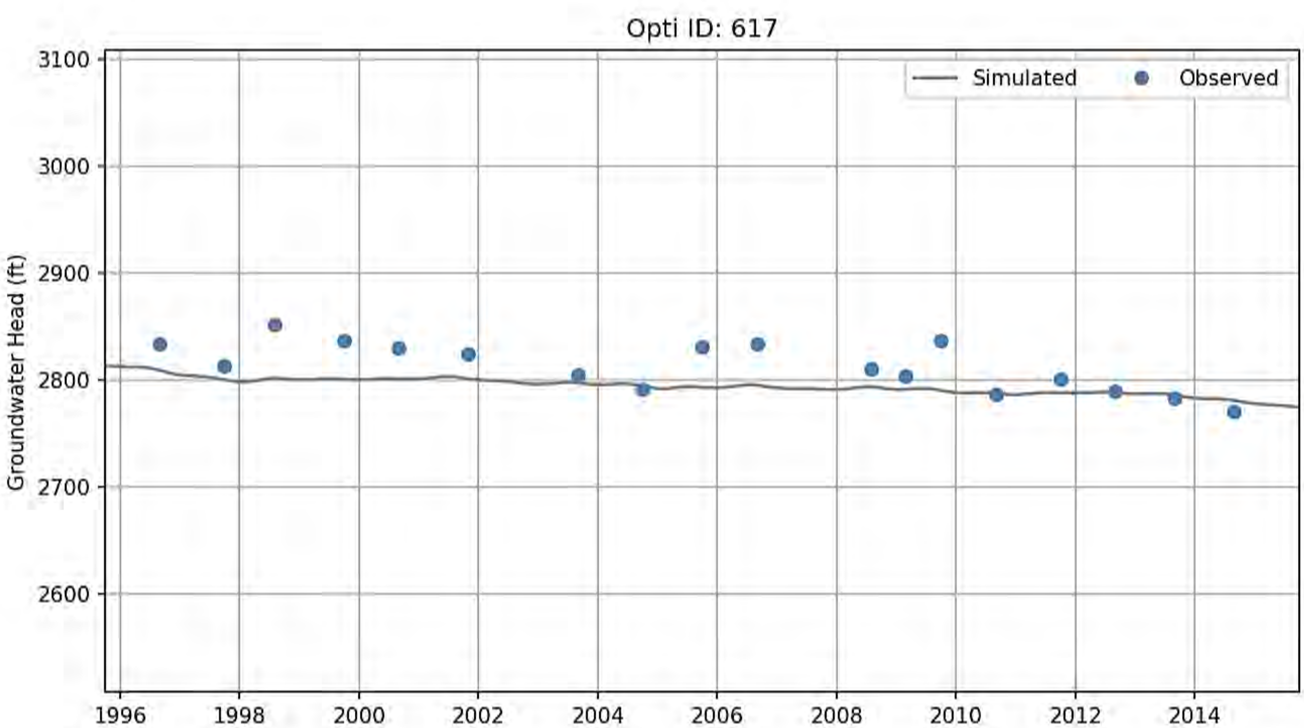
Opti ID: 612
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 613
Simulated
Observed
Groundwater Head (ft)
2200
2100
2000
1900
1800
1700
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

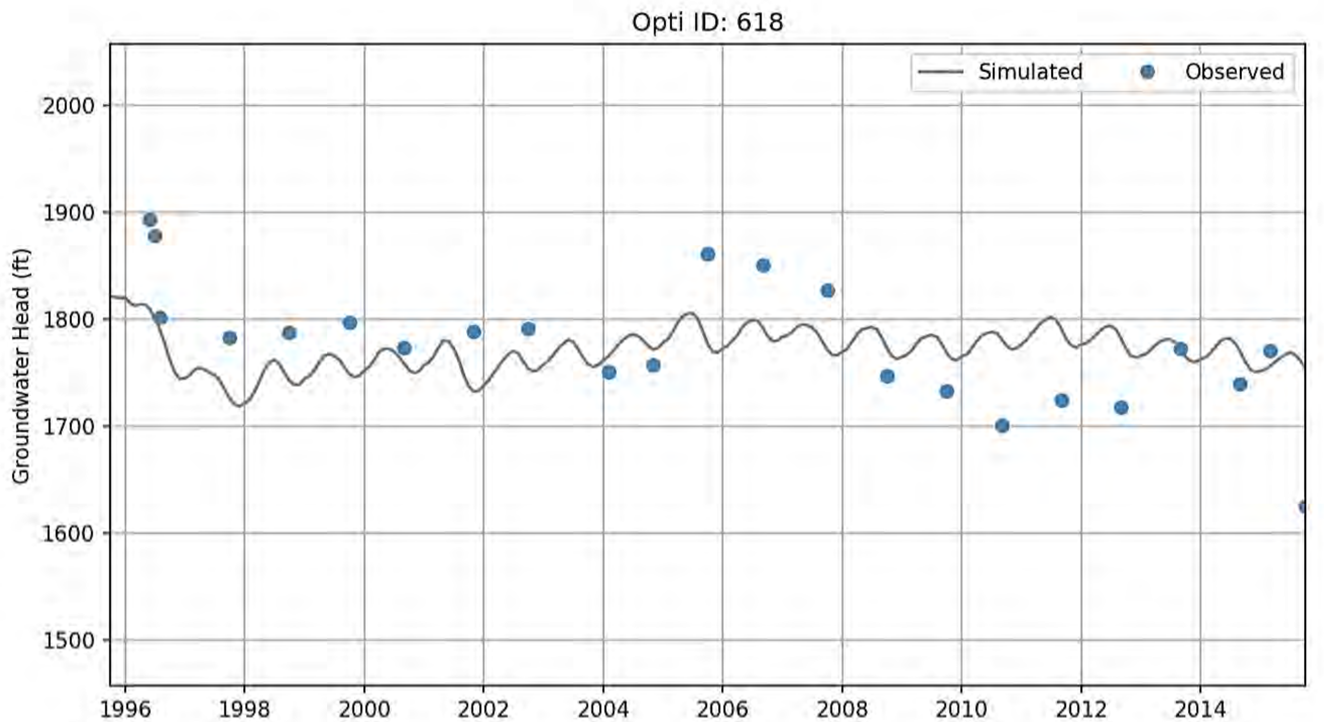

Opti ID: 615
Simulated
Observed
Groundwater Head (ft)
2200
2100
2000
1900
1800
1700
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

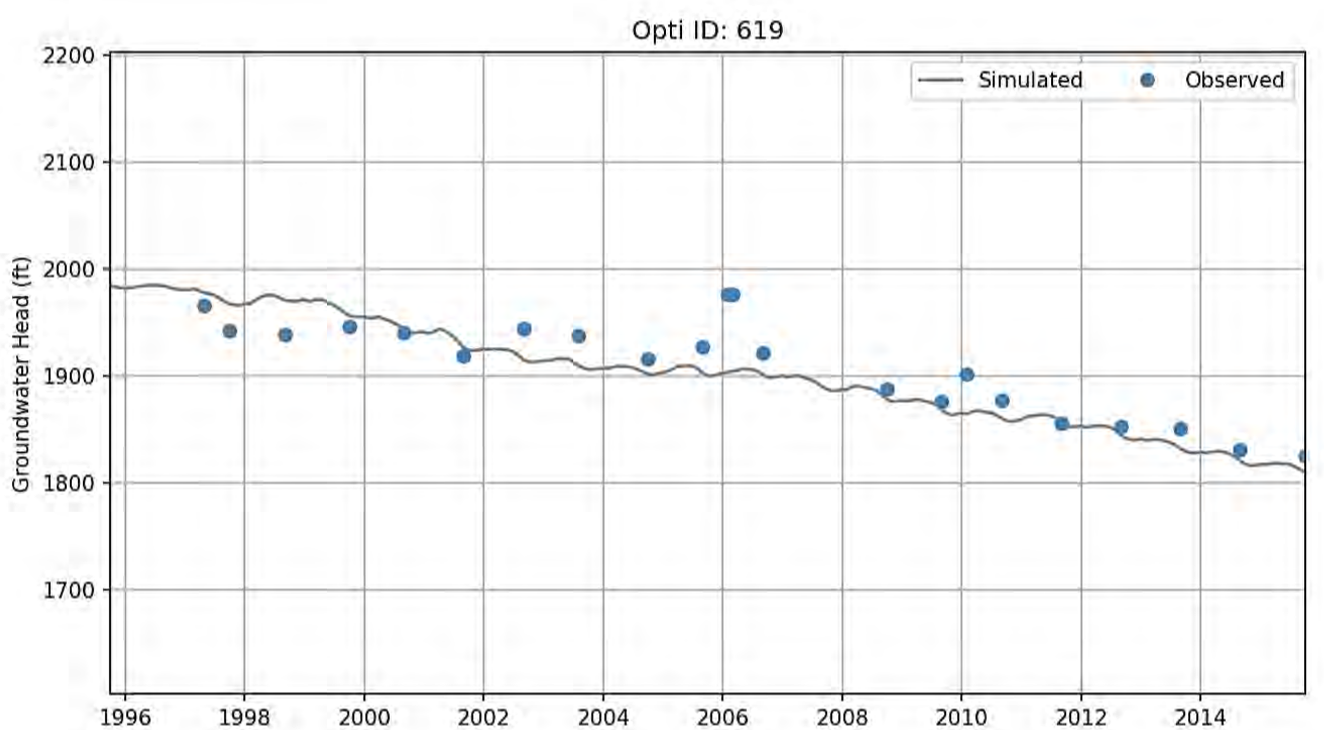


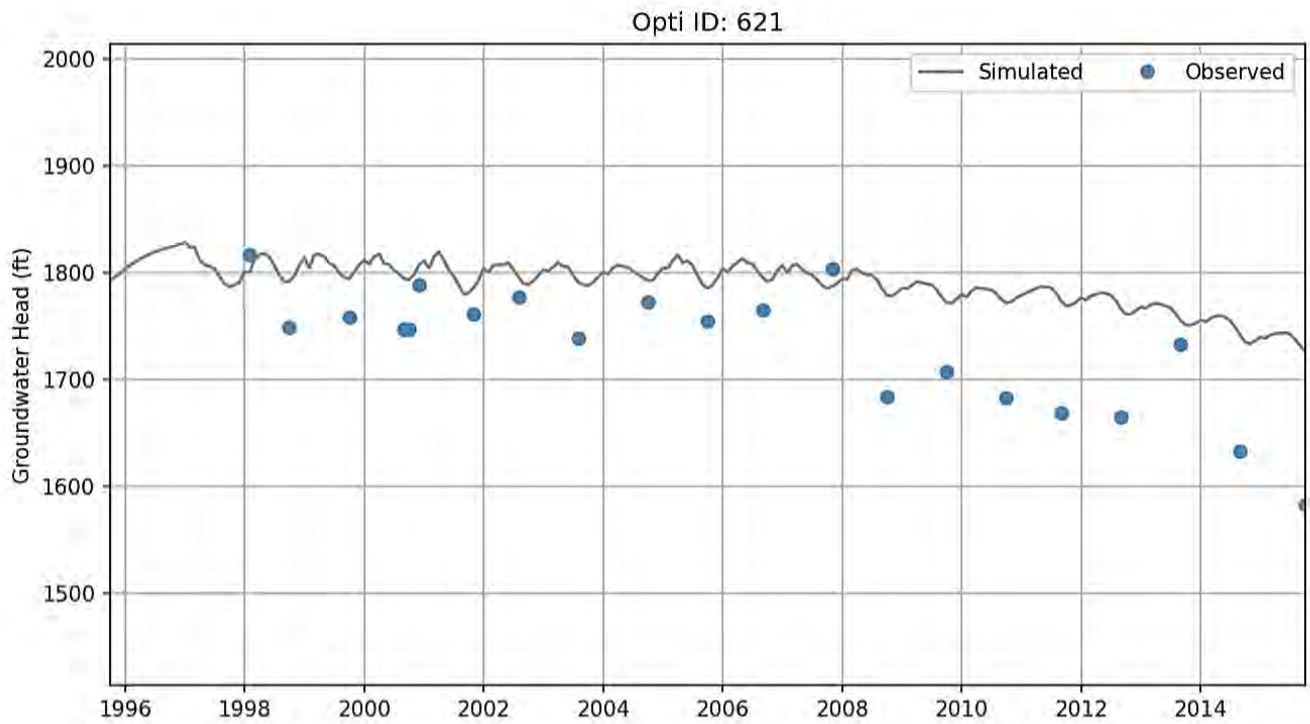
Opti ID: 616
Simulated
Observed
Groundwater Head (ft)
2300
2200
2100
2000
1900
1800
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

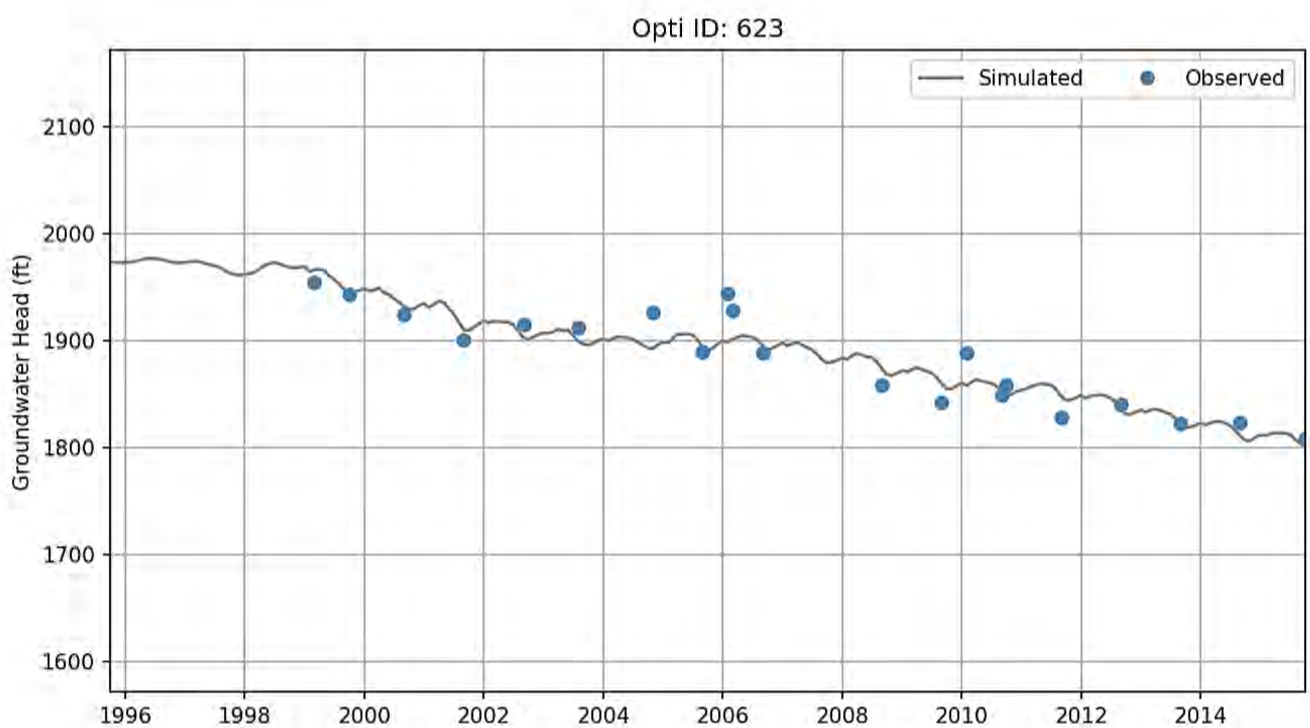


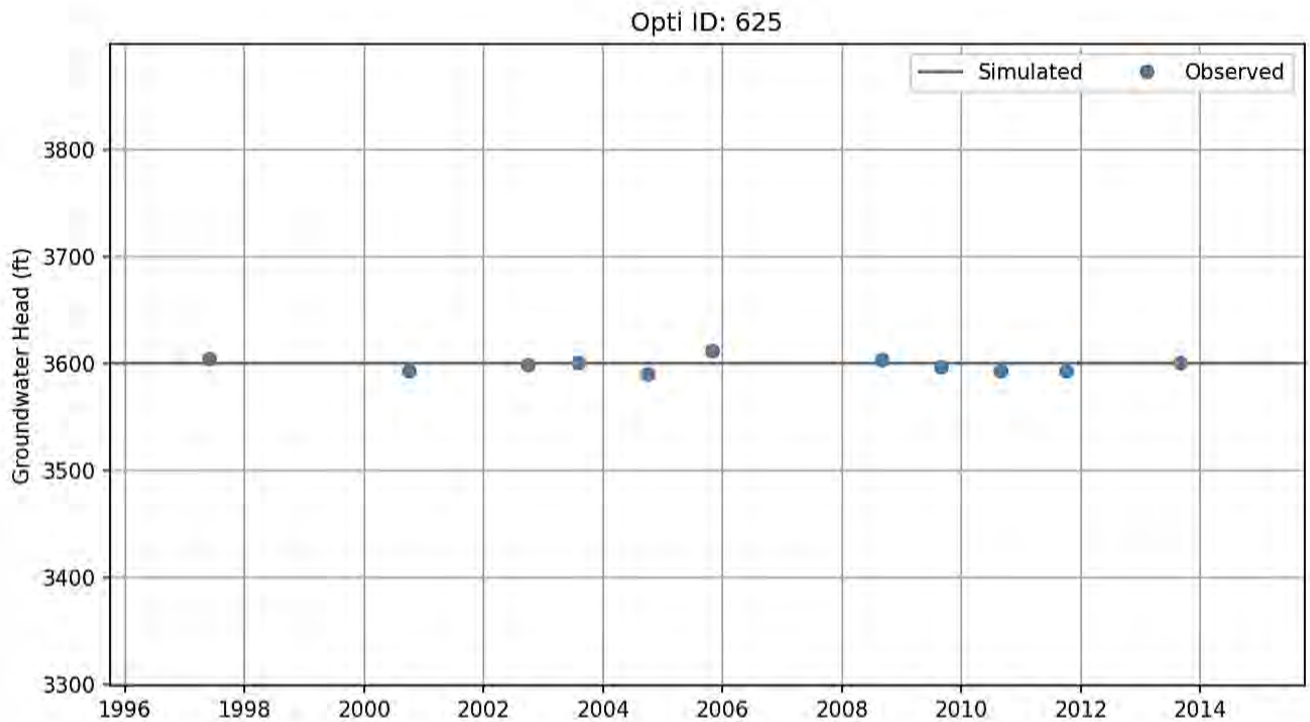
Opti ID: 617
Simulated
Observed
Groundwater Head (ft)
3100
3000
2900
2800
2700
2600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 618
Simulated
Observed
Groundwater Head (ft)
2000
1900
1800
1700
1600
1500
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 619
Simulated
Observed
Groundwater Head (ft)
2200
2100
2000
1900
1800
1700
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 621
Simulated
Observed
Groundwater Head (ft)
2000
1900
1800
1700
1600
1500
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Opti ID: 623
Simulated
Observed
Groundwater Head (ft)
2100
2000
1900
1800
1700
1600
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014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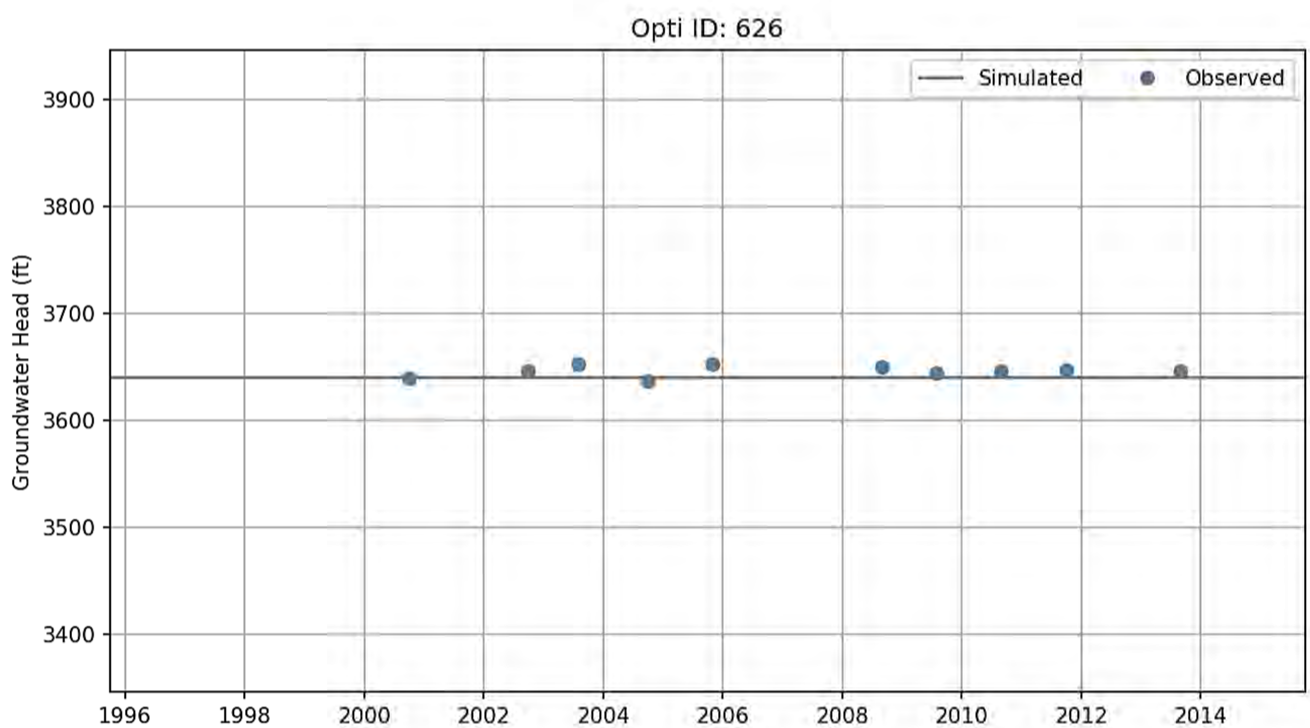
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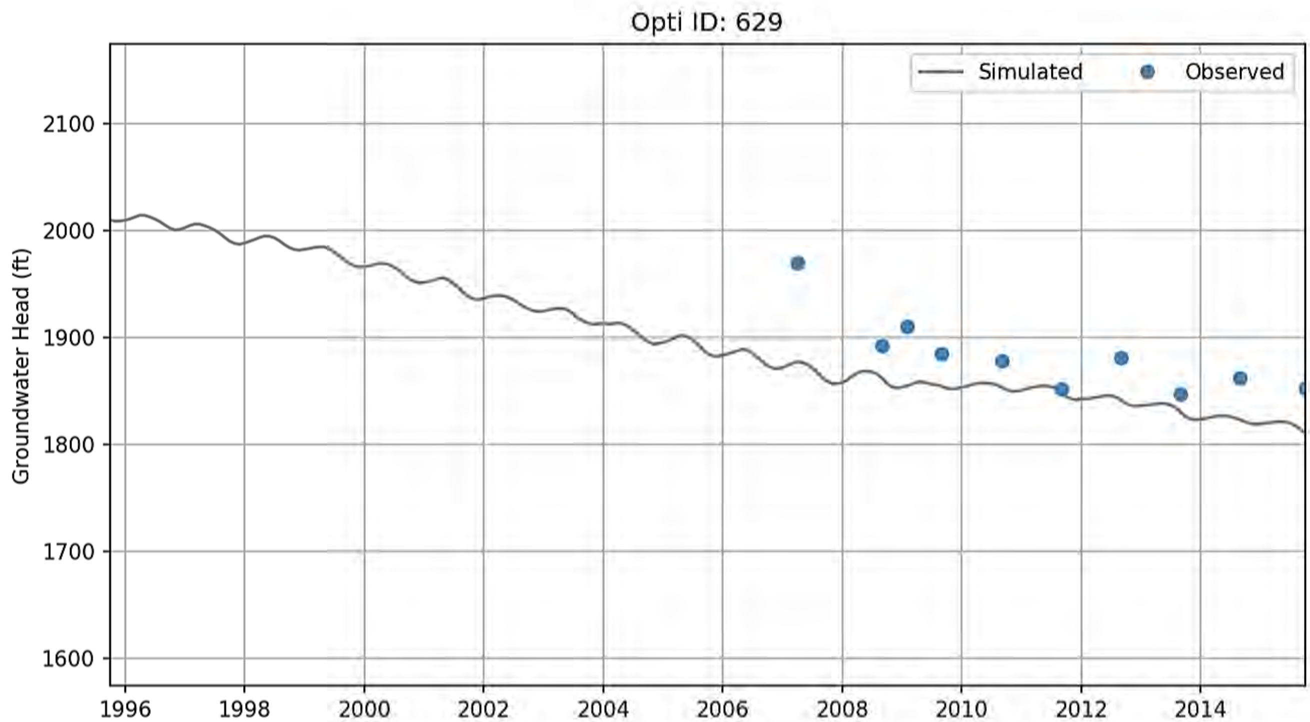

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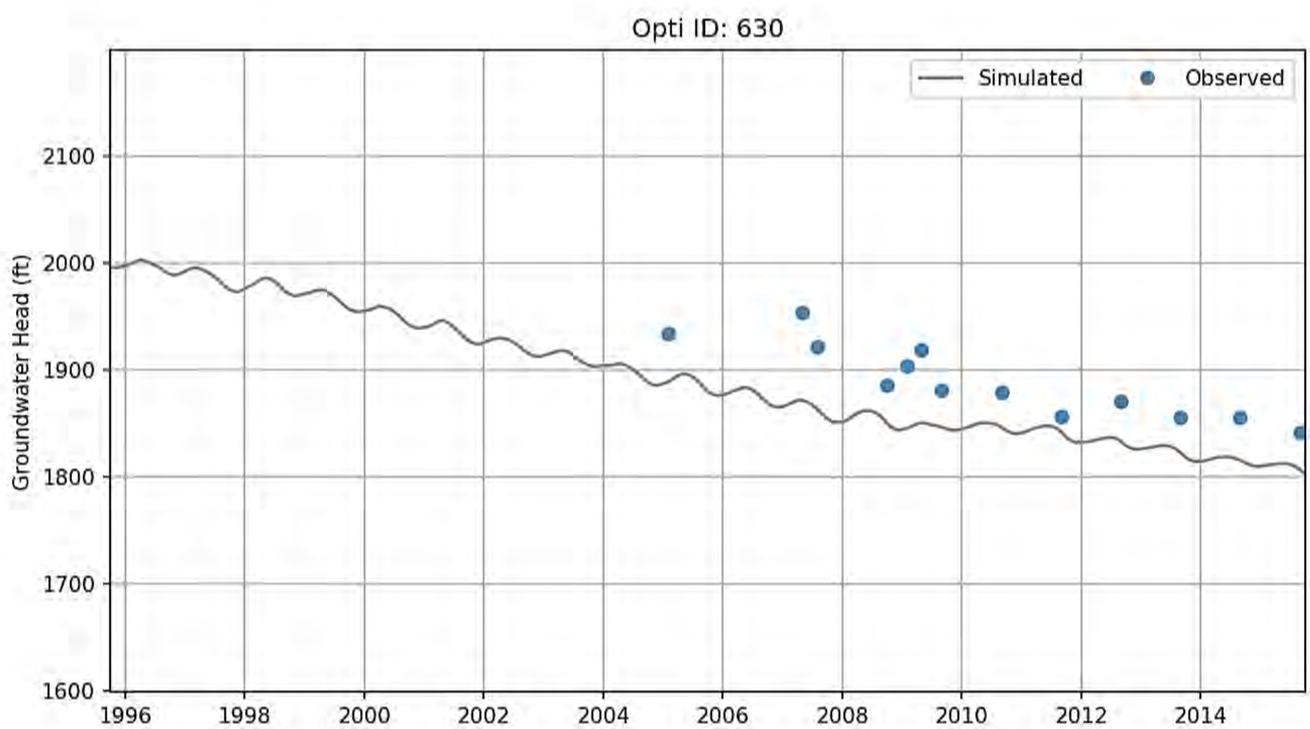

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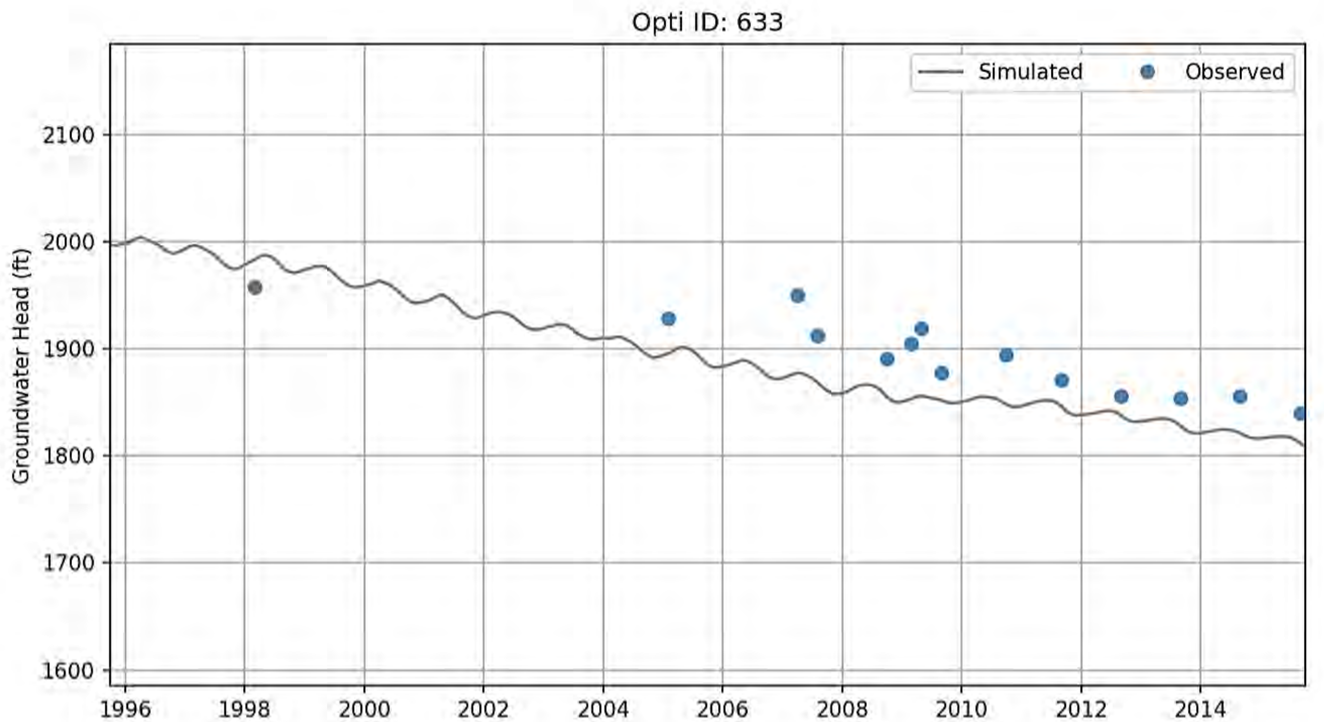
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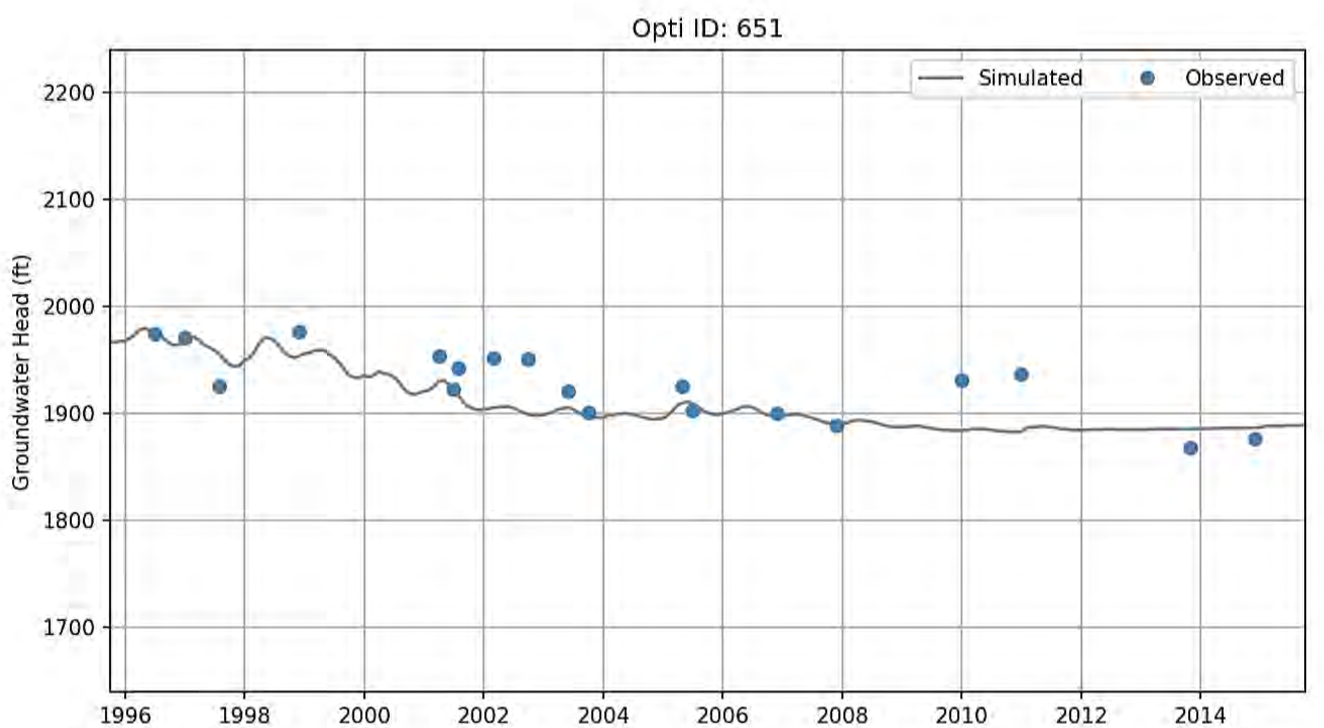
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2006
2008
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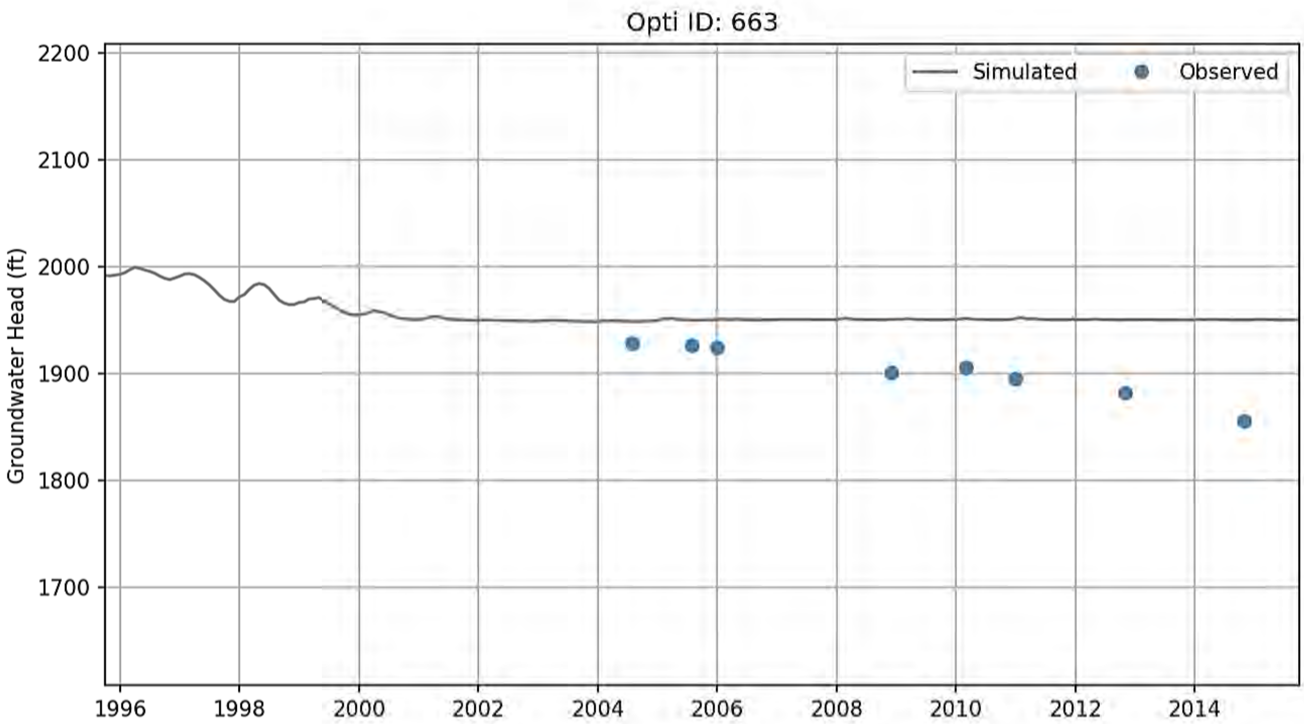
2012
2014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2012
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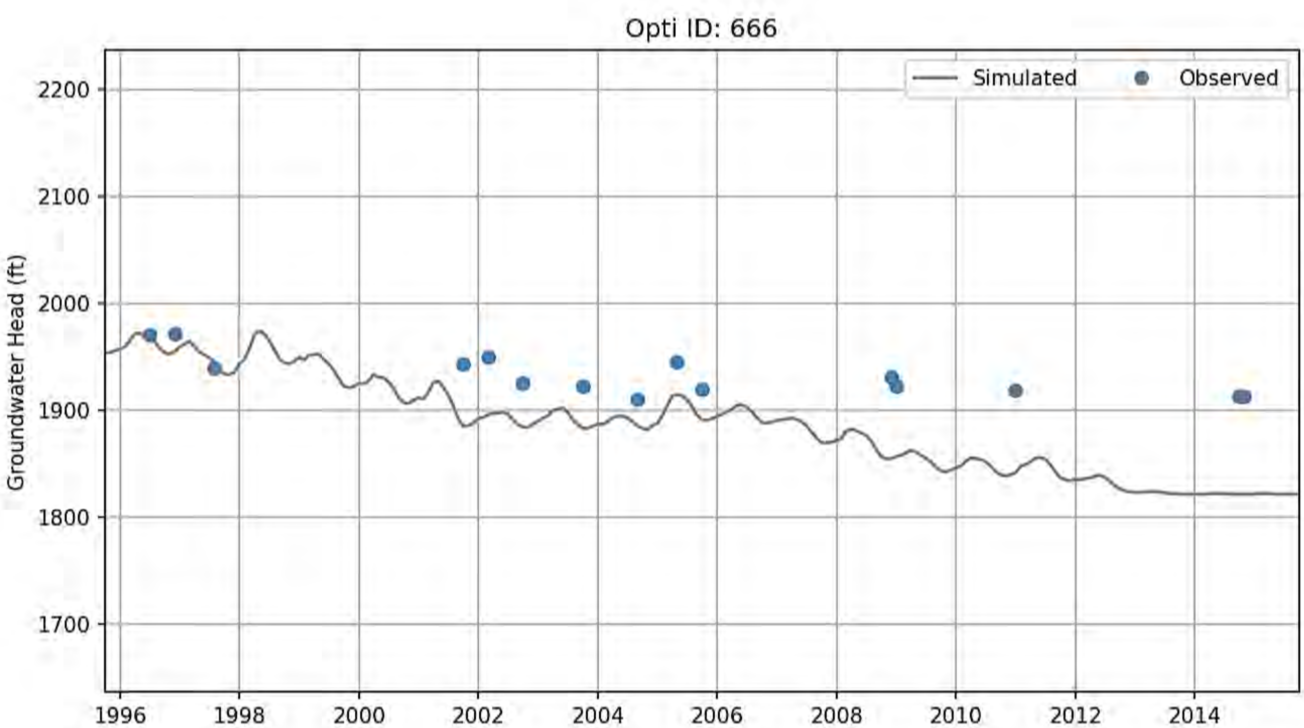
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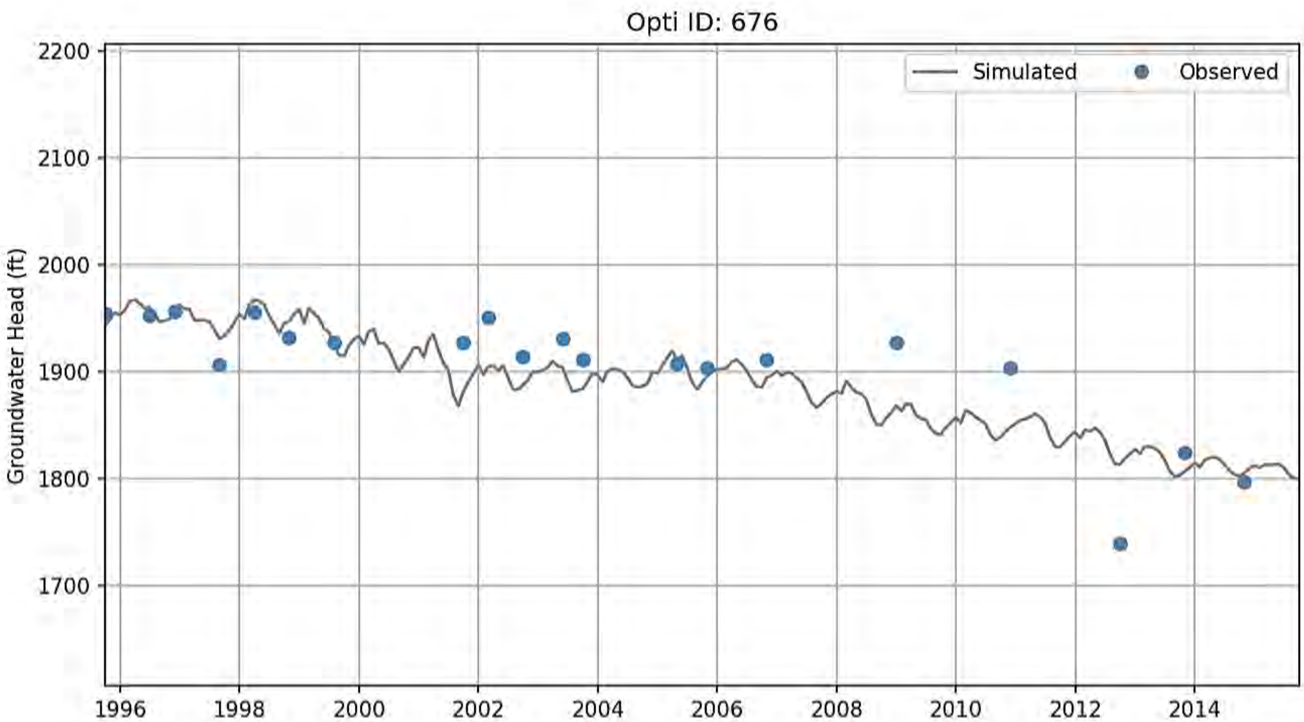
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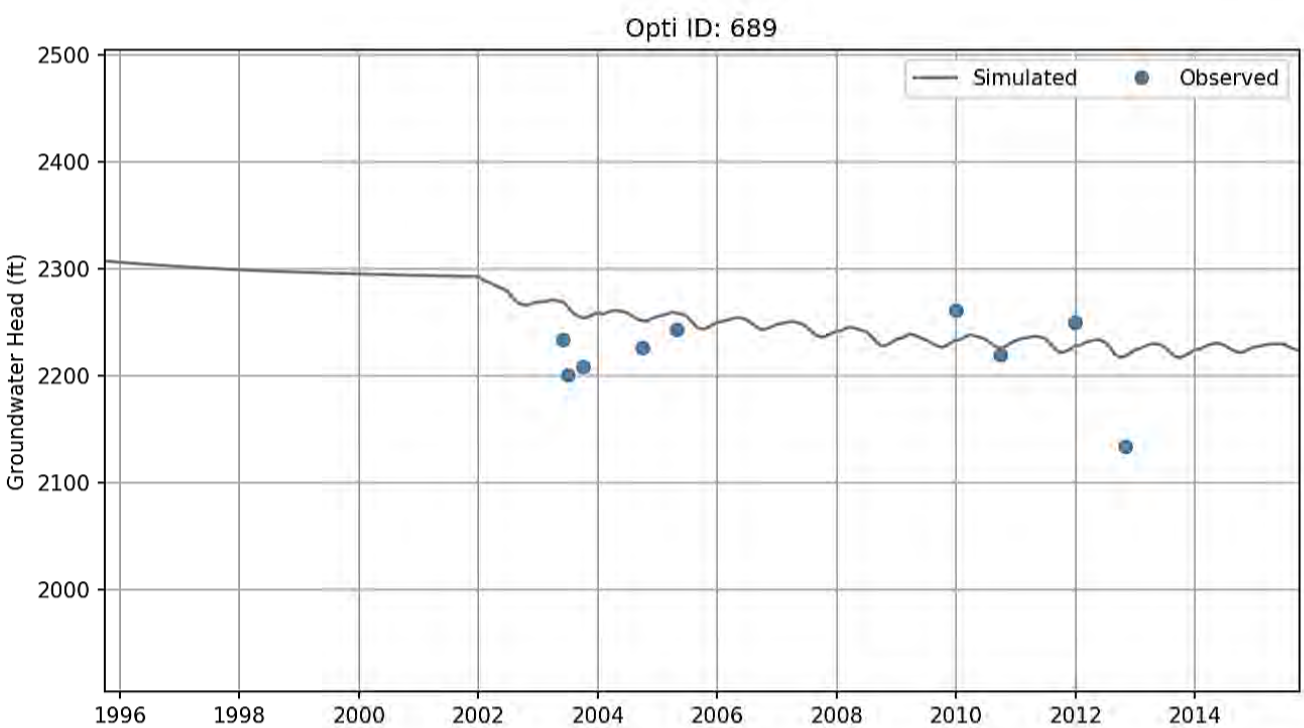
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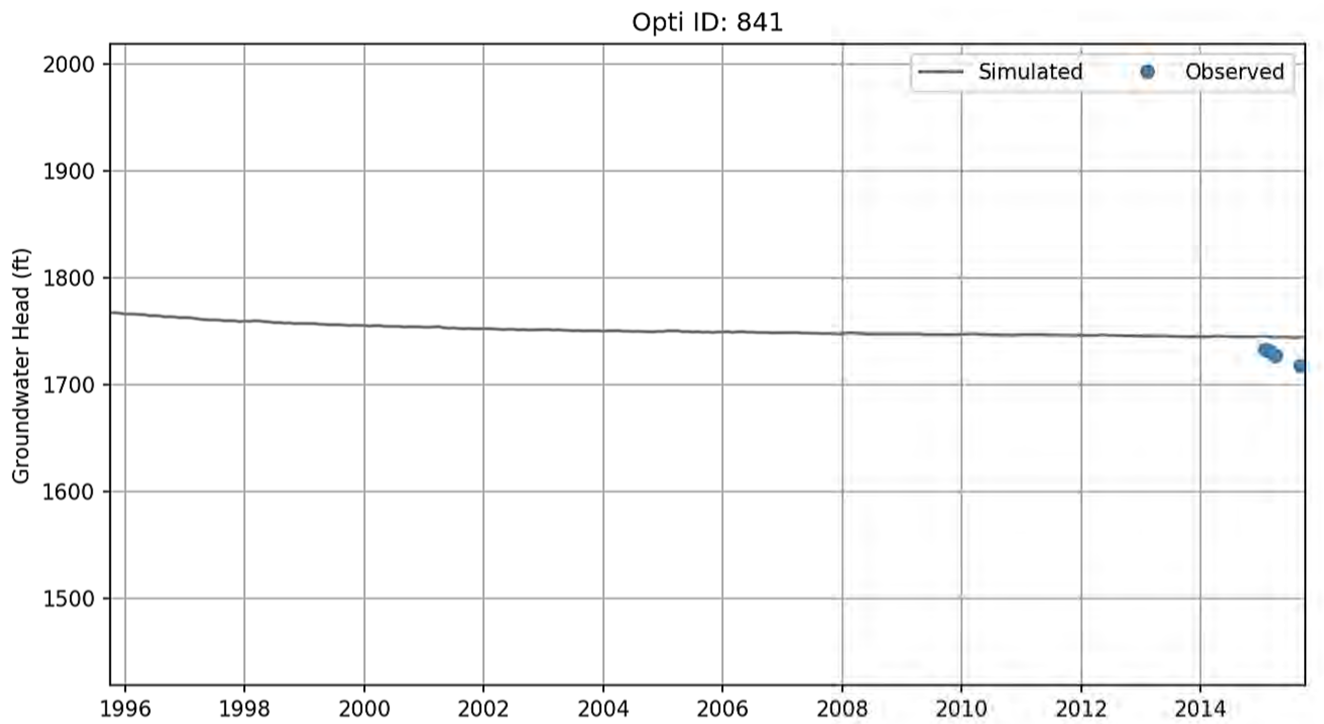

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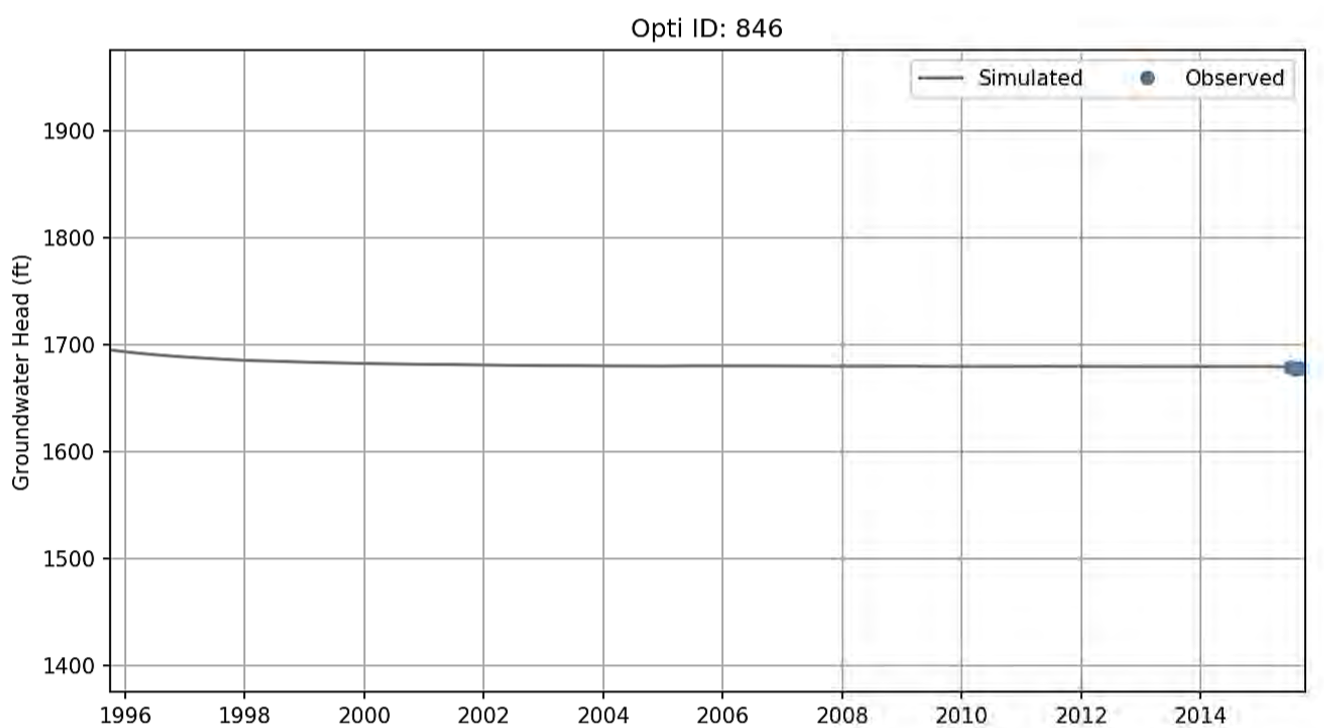

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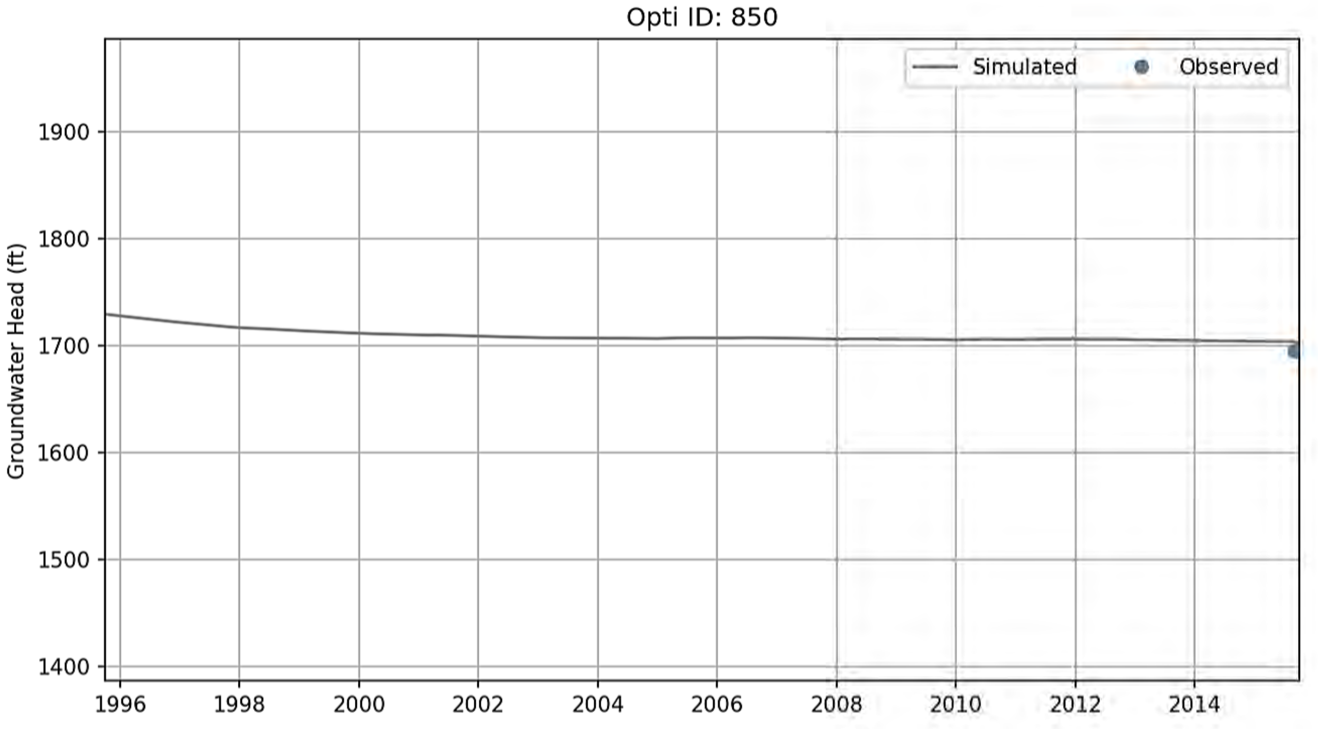

Opti ID: 850
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Observed
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1900
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1700
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1500
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1996
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2012
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Attachment C-4

Evapotranspiration and Applied Water Estimates

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Technical Memorandum

To: Woodard & Curran

From: Davids Engineering

Date: January 7, 2018

Subject: **Cuyama Basin Development of Evapotranspiration and Applied Water Estimates Using Remote Sensing**

1 Summary

The purpose of this effort is to develop time series estimates of agricultural water use for the Cuyama Basin from October 1994 through December 2017. The approach builds upon estimates of actual evapotranspiration (ETa) developed using remotely sensed information from the Landsat satellite.

The consumptive use of water (i.e., evapotranspiration) is the primary destination of infiltrated precipitation and applied irrigation water within the Cuyama Basin. Quantification of consumptive use was achieved by performing daily calculations of evapotranspiration (ET) for individual fields from October 1996 through December 2017. ET was separated into its evaporation (E) and transpiration (T) components. Transpiration was quantified using a remote sensing approach where Landsat satellite images acquired from USGS were used to calculate the Normalized Difference Vegetation Index (NDVI), which was subsequently translated to a basal crop coefficient and combined with reference ET to calculate transpiration over time.

A spatial coverage of field boundaries was developed for the Cuyama Basin, and individual field polygons were assigned cropping and irrigation method information over time based on available data. Field boundaries were delineated by combining polygon coverages in GIS format from Bolthouse Farms, Grimmway Farms, LandIQ, and the California Department of Water Resources (DWR). The area encompassed by the field boundary GIS coverage includes only the Cuyama Basin.

Crop ET was calculated based on a combination of remote sensing data and simulation of irrigation events in a daily root zone water balance model. Due to the remote sensing approach crop ET estimates are relatively insensitive to crop type and irrigation method so detailed, accurate assignment of crop types and irrigation methods to each field is not critical to developing relatively reliable estimates of crop ET. The amount of green vegetation present over time was estimated for each field polygon based on NDVI, which is calculated using a combination of red and near infrared reflectances as measured using multispectral satellite sensors onboard Landsat satellites. Following the preparation of NDVI imagery spanning the analysis period all images were quality controlled to remove pixels affected by clouds.

Mean daily NDVI values for each field were converted to basal crop coefficients. Daily precipitation was estimated based on assembly and review of data from the PRISM Climate Group at Oregon State

University[1]. Daily reference evapotranspiration (ET_o) was estimated based on information from California Irrigation Management Information System (CIMIS) weather stations. Root zone parameters that influence the amount of available soil moisture storage were estimated based on crops and soils present in the Cuyama Basin.

A summary for the 1994 to 2017 analysis period of the annual ET of applied water (ET_{AW}), ET_c (synonymous with ET_a), applied water (AW), deep percolation of applied water (DP_{AW}) and deep percolation of precipitation (DP_{pr}) estimates based on the root zone water balance model is given in the Results section.

Application of remote sensing combined with daily root zone water balance modeling (RS-RZ model) provides an improved methodology for estimation of surface interactions with the groundwater system including net groundwater depletion through estimation of ET of applied water and other fluxes.

2 Introduction

The purpose of this effort is to develop time series estimates of agricultural, urban, and native vegetation water use for the Cuyama Basin from 1996 through 2017. Demand has been quantified at the field scale using a remote-sensing based daily root zone water balance model. Results from this model were used to parameterize an IWFM Demand Calculator (IDC) application that will be incorporated into an IWFM application for the Basin to support GSP development.

3 Methodology

3.1 Daily Root Zone Simulation Model

A conceptual diagram of the various surface layer fluxes of water into and out of the crop root zone is provided in Figure 3.1. The consumptive use of water (i.e., evapotranspiration or ET) is the primary destination of infiltrated precipitation and applied irrigation water within the Cuyama Basin. Quantification of consumptive use was achieved by performing daily calculations of ET for individual fields from October 1994 through December 2017. Evapotranspiration was separated into its evaporation (E) and transpiration (T) components. Additionally, each component was separated into the amount of E or T derived from precipitation or applied water.

[1] PRISM website: http://prism.oregonstate.edu/

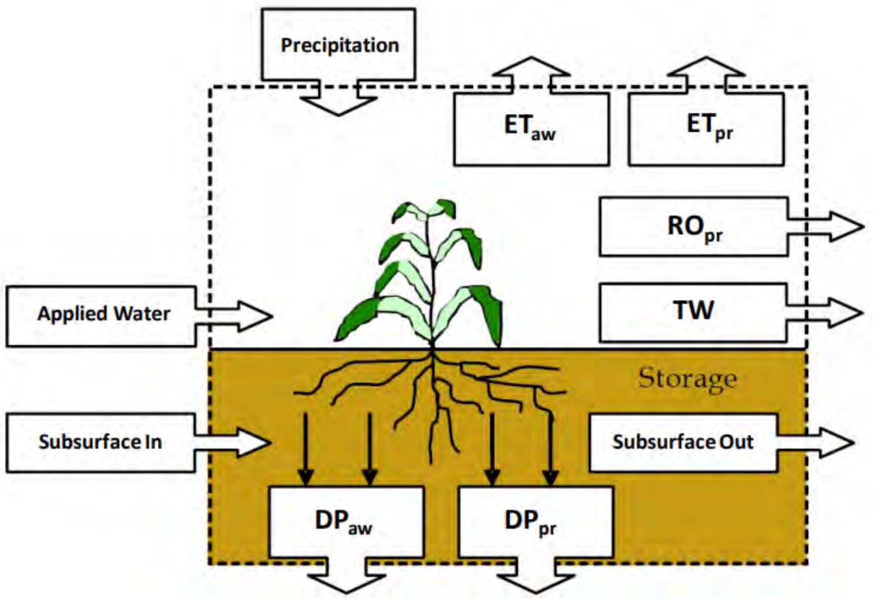

Figure 3.1. Conceptualization of Fluxes of Water Into and Out of the Crop Root Zone

Transpiration was quantified using a remote sensing approach whereby Landsat satellite images acquired from USGS were used to calculate the Normalized Difference Vegetation Index (NDVI), a measure of the amount of green vegetation present. NDVI values were calculated and interpolated for each field over time. NDVI values were then converted to transpiration coefficients that were used to calculate transpiration over time by multiplying daily NDVI by daily reference evapotranspiration (ET_o). Evaporation was quantified by performing a surface layer water balance for the soil based on the dual crop coefficient approach described in FAO Irrigation and Drainage Paper 56 (Allen et al. 1998). On a daily basis, evaporation was calculated based on the most recent wetting event (precipitation or irrigation) and the evaporative demand for the day (ET_o). This methodology is described in greater detail in the Davids Engineering report for the Kaweah Delta Water Conservation District (Davids Engineering 2013).

3.2 Development of Field Boundaries

A spatial coverage of field boundaries was developed for the Cuyama Basin, and individual field polygons were assigned cropping and irrigation method information. For each field polygon, daily water balance calculations were performed for the 1994 to 2017 analysis period, and irrigation events were simulated to estimate the amount of water applied to meet crop irrigation demands. This section describes the development of the field polygon coverage and assignment of cropping and irrigation method attributes.

3.2.1 Development of Field Boundaries

Field boundaries were delineated by combining polygon coverages in GIS format from Bolthouse Farms, Grimmway Farms, LandIQ, and the California Department of Water Resources (DWR). The area encompassed by the field boundary GIS coverage includes only the Cuyama Basin.

3.3 Assignment of Cropping and Irrigation Method

As described previously, crop evapotranspiration (ET) was calculated based on a combination of remote sensing data and simulation of irrigation events in a daily root zone water balance model. A result of the remote sensing approach is that crop transpiration was estimated with little influence from the assigned crop type for each field. Additionally, crop transpiration is the dominant component of ET, meaning that ET estimates are likewise largely independent of the assigned crop type.

Crop evapotranspiration is driven to some extent by the characteristics of the irrigation method and its management, including the area wetted during each irrigation event and the frequency of irrigation. Surface irrigation methods typically wet more of the soil surface than micro-irrigation methods; however, surface irrigated fields are typically irrigated less frequently than their micro-irrigated counterparts. As a result, evaporation rates can be similar among surface and micro-irrigated fields and estimates of evaporation are likewise somewhat independent of the assigned irrigation method. Parameters related to irrigation method were assigned based the predominant irrigation method for each crop, as described by recent historical DWR land and water use surveys.

A key result of the relative insensitivity of the crop ET estimates to crop type or irrigation method (due to the remote sensing approach), is that detailed, accurate assignment of crop types and irrigation methods to each field is not critical to developing reliable estimates of crop ET at the field scale and, more importantly, at coarser scales due to the cancellation of errors in individual field estimates as they are aggregated.

Crop types were assigned to each field based on a combination of data from Bolthouse Farms, Grimmway Farms, LandIQ, and DWR. For fields farmed by Bolthouse or Grimmway, the local data were used. For other fields, available data from LandIQ and DWR were used.

3.4 NDVI Analysis

The amount of green vegetation present over time was estimated for each field polygon based on the Normalized Difference Vegetation Index (NDVI), which is calculated using a combination of red and near infrared reflectances, as measured using multispectral satellite sensors onboard Landsat satellites. NDVI can vary from -1 to 1 and typically varies from approximately 0.15 to 0.2 for bare soil to 0.8 for green vegetation with full cover. Negative NDVI values typically represent water surfaces.

3.4.1 Image Selection

Landsat images are preferred due to their relatively high spatial resolution (30-meter pixels, approx. 0.2 acres in size). A total of 671 raw satellite images were selected and converted to NDVI spanning the period from July 1994 to April 2018. Of the images selected, 207 were from the Landsat 5 satellite, 364 were from the Landsat 7 satellite (first available in 2001), and 100 were from the Landsat 8 satellite (first available in 2013). These images were used to process and download surface reflectance (SR) NDVI from the USGS Earth Resources Observation and Science (EROS) Center Science Processing Architecture (ESPA)[2].

There was sufficient cloud-free Landsat imagery available that no cloud gap filling was necessary. The number of days between image dates ranged from 8 to 96, with an average of 13 days. Generally, there was at least one image selected for each month.

3.4.2 Extraction of NDVI Values by Field and Development of Time Series NDVI Results

Following the preparation of NDVI imagery spanning the analysis period, all images were masked using the Quality Assessment Band (BQA) provided by ESPA to remove pixels affected by clouds and cloud shadows. Then, mean NDVI was extracted from the imagery for each field for each image date. These NDVI values were interpolated across the full analysis period from October 1, 1994 to December 31, 2017 to provide a daily time series of mean NDVI values for each field.

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[2] USGS ESPA website: https://espa.cr.usgs.gov/

Landsat satellite 5 and 7 bandwidths were adjusted to be consistent with bandwidths from Landsat 8 using the following empirical relationship:

$$(\text{Equivalent L8 mean NDVI}) = 0.984*(\text{L5/7 mean NDVI}) - 0.0421 \qquad [3.1]$$

3.4.3 Development of Relationships to Estimate Basal Crop Coefficient from NDVI

Basal crop coefficients (K_{cb}) describe the ratio of crop transpiration to reference evapotranspiration (ET_o) as estimated from a ground-based agronomic weather station. By combining K_{cb}, estimated from NDVI, with an evaporation coefficient (K_e), it is possible to calculate a combined crop coefficient ($K_c = K_{cb} + K_e$) over time[3]. By multiplying K_c by ET_o, crop evapotranspiration (ET_c) can be calculated. For this analysis, ET_o, K_{cb}, K_e, and ET_c (synonymous to actual ET, ET_a) were estimated for each field on a daily time step from October 1, 1994 to December 31, 2017.

Mean daily NDVI values for each field were converted to basal crop coefficients using the relationship based on cropping information from the 2007 Tulare County crop survey conducted by DWR, combined with an analysis of actual evapotranspiration (ET_a) by crop conducted using the Surface Energy Balance Algorithm for Land (SEBAL®) for 2007 (Bastiaanssen et al., 2005; SNA, 2009). Specifically, a relationship between actual basal crop coefficients estimated using SEBAL and field-scale mean NDVI values developed by Davids Engineering (2013) was applied using NDVI data from Landsat to calculate daily basal crop coefficients for each field over time[4].

3.5 Precipitation

Daily precipitation was estimated based on assembly and review of data from the PRISM Climate Group at Oregon State University. Specifically, each field was assigned estimated precipitation from the 4km PRISM grid cell within which its centroid fell.

Annual precipitation totals, averaged over the study area for water years 1995 to 2017, are shown in Figure 3.1. Water year precipitation over the study period varied from 2.7 inches in 2014 to 25.0 inches in 1998, with an annual average of 9.3 inches.

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[3] The estimation of Ke is based on a daily 2-stage evaporation model presented in FAO Irrigation and Drainage Paper No. 56 (Allen et al. 1998).

[4] This relationship is developed based on comparison of the combined crop coefficient to NDVI for individual fields but represents only the transpiration component of ET. Thus, the relationship developed predicts the basal crop coefficient, Kcb.

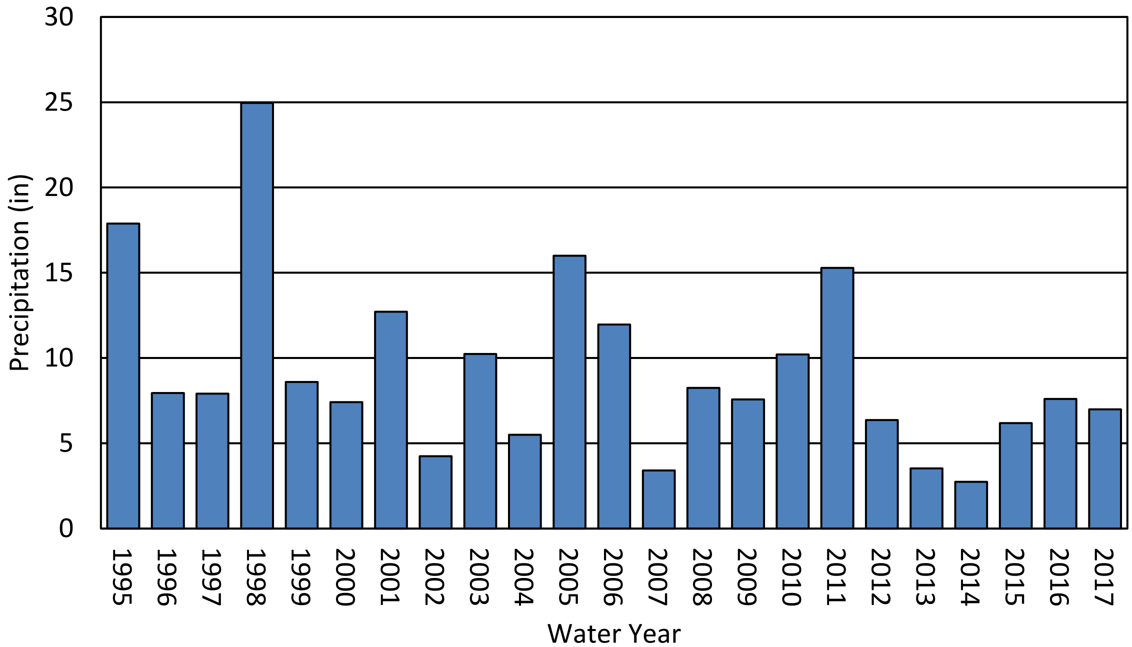

Figure 3.2. Annual Precipitation Totals

3.6 Estimation of Daily Reference Evapotranspiration

Daily reference evapotranspiration (ET_o) was estimated based on information from the California Irrigation Management Information System (CIMIS) weather station at Cuyama. ET_o provides a means of estimating actual crop evapotranspiration over time for each field. Based on review of nearby weather stations with data available during the period of analysis, the Cuyama station (88) was selected based on it being located within the Cuyama Basin, having relatively good fetch, and having available data during the analysis period.

Individual parameters from the available data including incoming solar radiation, air temperature, relative humidity, and wind speed were quality-controlled according to the procedures of Allen et al. (2005). The quality-controlled data were then used to calculate daily ET_o for the available period of record.

3.7 Estimation of Root Zone Water Balance Parameters

Root zone parameters that influence the amount of available soil moisture storage were estimated based on crops and soils present in the Cuyama Basin. Crop parameters of interest include root depth, NRCS curve number[5], and management allowable depletion (MAD). Root depth was estimated by crop group based on published values and a representative mix of individual crops within each crop group for the Cuyama Basin. Curve numbers were estimated based on values published in the NRCS National Engineering Handbook, which provides estimates based on crop type and condition. MAD values by crop were estimated based on values published in FAO Irrigation and Drainage Paper No. 56 (Allen et al., 1998).

[5] The curve number runoff estimation method developed the Natural Resources Conservation Service (NRCS) was used to estimate runoff from precipitation in the model. For additional information, see NRCS NEH Chapter 2 (NRCS, 1993).

Soil hydraulic parameters of interest include field capacity (% by vol.), wilting point (% by vol.), saturated hydraulic conductivity (ft/day), total porosity (% by vol.), and the pore size distribution index (λ, dimensionless). These parameters were estimated by first determining the depth-weighted average soil texture (sand, silt, clay, etc.) based on available NRCS soil surveys. Then, the hydraulic parameters were estimated using hydraulic pedotransfer functions developed by Saxton and Rawls (2006). Next, hydraulic parameters were adjusted within reasonable physical ranges for each soil texture so that the modeled time required for water to drain by gravity from saturation to field capacity agreed with typically accepted agronomic values. Unsaturated hydraulic conductivity (e.g. deep percolation) within the root zone was modeled based on the equation developed by Campbell (1974) for unsaturated flow.

4 Results

4.1 Crop Evapotranspiration

Estimated annual crop evapotranspiration volumes for fields with their centroid within the Cuyama Basin are shown in Figure 4.1. Estimated volumes of ET derived from applied water (ETaw) and precipitation (ETpr) are shown in thousands of acre-feet (taf). Annual ETaw ranged from 38 taf to 53 taf, with an average of 44 taf. Annual ETpr ranged from 4 taf to 33 taf, with an average of 15 taf. Total crop ET ranged from 43 taf to 76 taf, with an average of 58 taf.

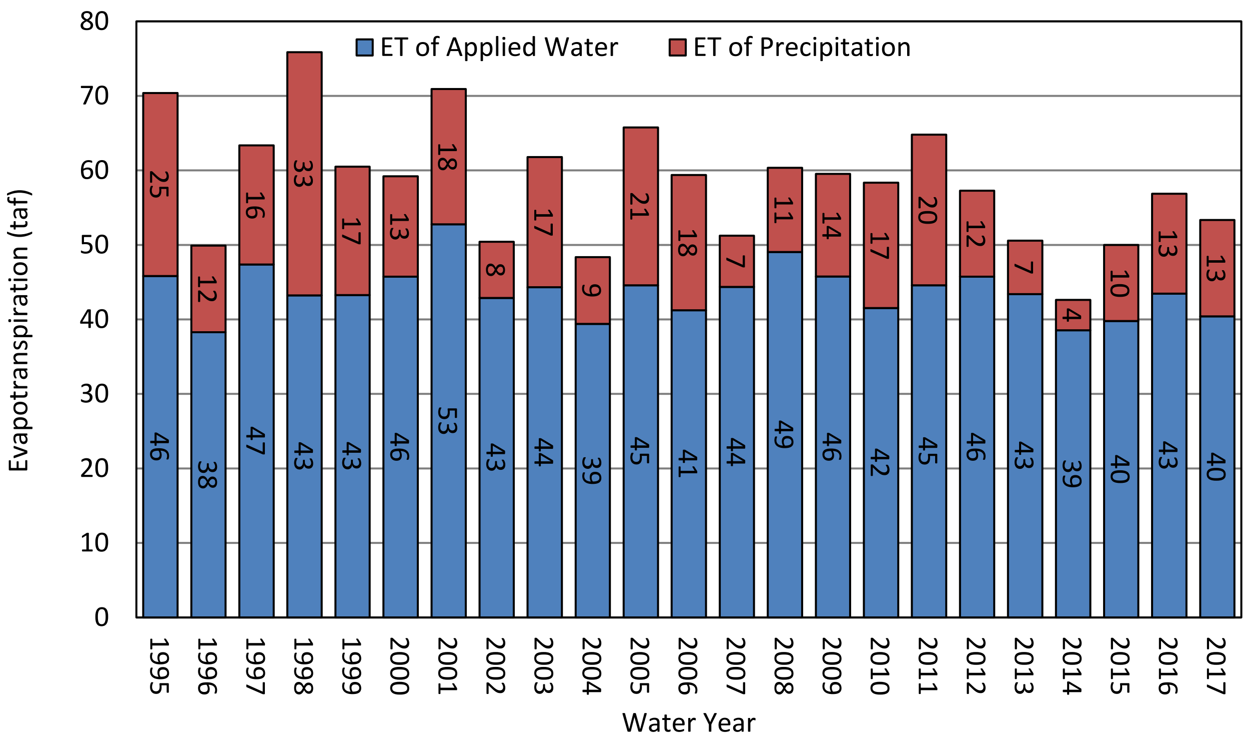

Figure 4.1. Cuyama Basin Crop ET by Water Year

4.2 Irrigation Demands

Annual estimated irrigation demands for fields with their centroid within the Cuyama Basin are shown in Figure 4.2 in thousands of acre feet. Annual demands ranged from 52 taf to 73 taf, with an average of 60 taf.

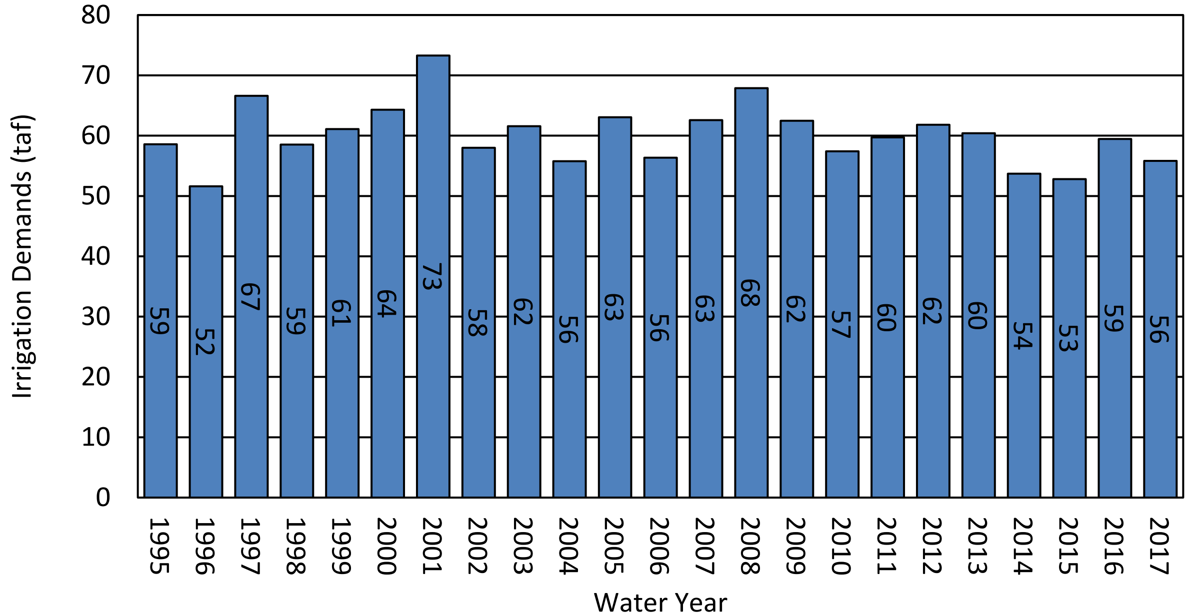

Figure 4.2. Cuyama Basin Irrigation Demands by Water Year

4.3 Deep Percolation

Estimated annual deep percolation volumes for fields with their centroid within the Cuyama Basin are shown in Figure 4.3. Estimated volumes of deep percolation derived from applied water (DPaw) and precipitation (DPpr) are shown in thousands of acre-feet. Annual DPaw ranged from 15 taf to 19 taf, with an average of 17 taf. Annual DPpr ranged from 4 taf to 28 taf, with an average of 10 taf. Total deep percolation ranged from 20 taf to 47 taf, with an average of 27 taf.

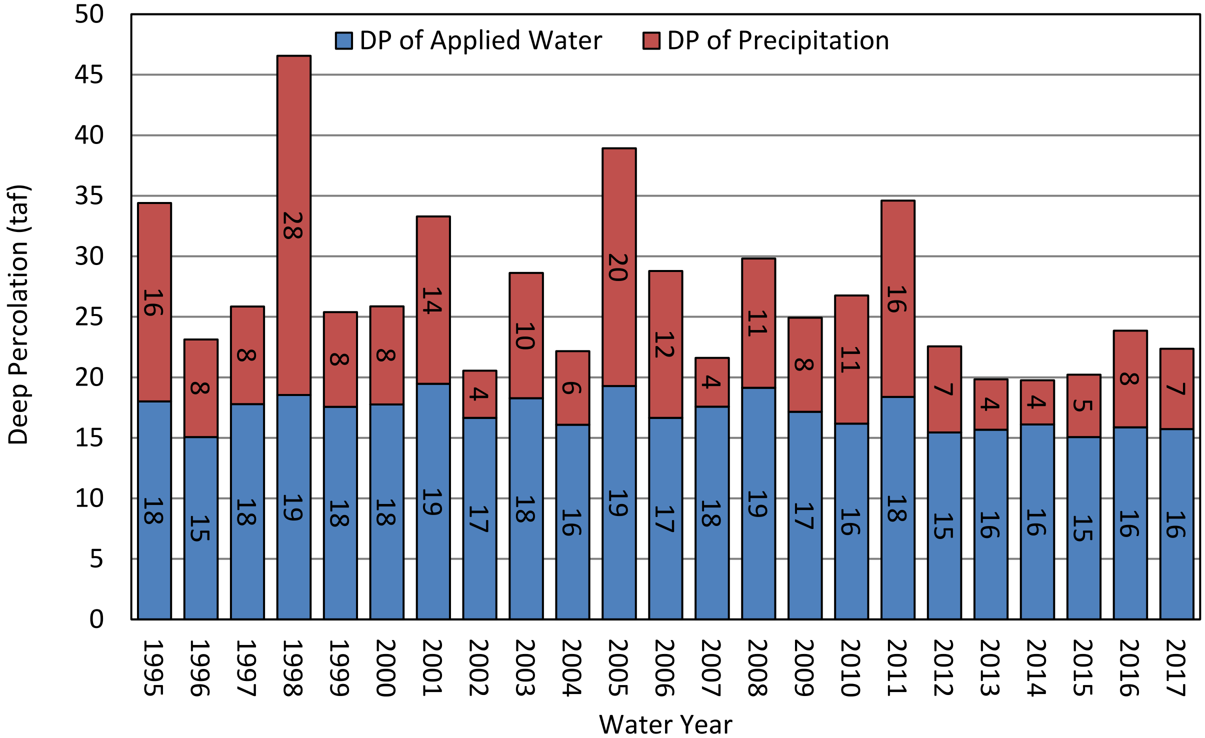

Figure 4.3. Cuyama Basin Deep Percolation by Water Year

4.4 Annual Evapotranspiration by Crop for 2014

Estimated annual evapotranspiration by crop is shown in Figure 4.4, along with the estimated acreage for each crop. Figure 4.4 shows the estimated total ET by crop in inches in 2014. Annual ET ranges from 5 inches for young perennials to 59 inches for alfalfa. The primary crops are carrots, representing 5,500 acres. Grapes, miscellaneous truck crops, pistachios, potatoes and onions and garlic are also significant, representing 948, 838, 761, 668 and 646 acres, respectively.

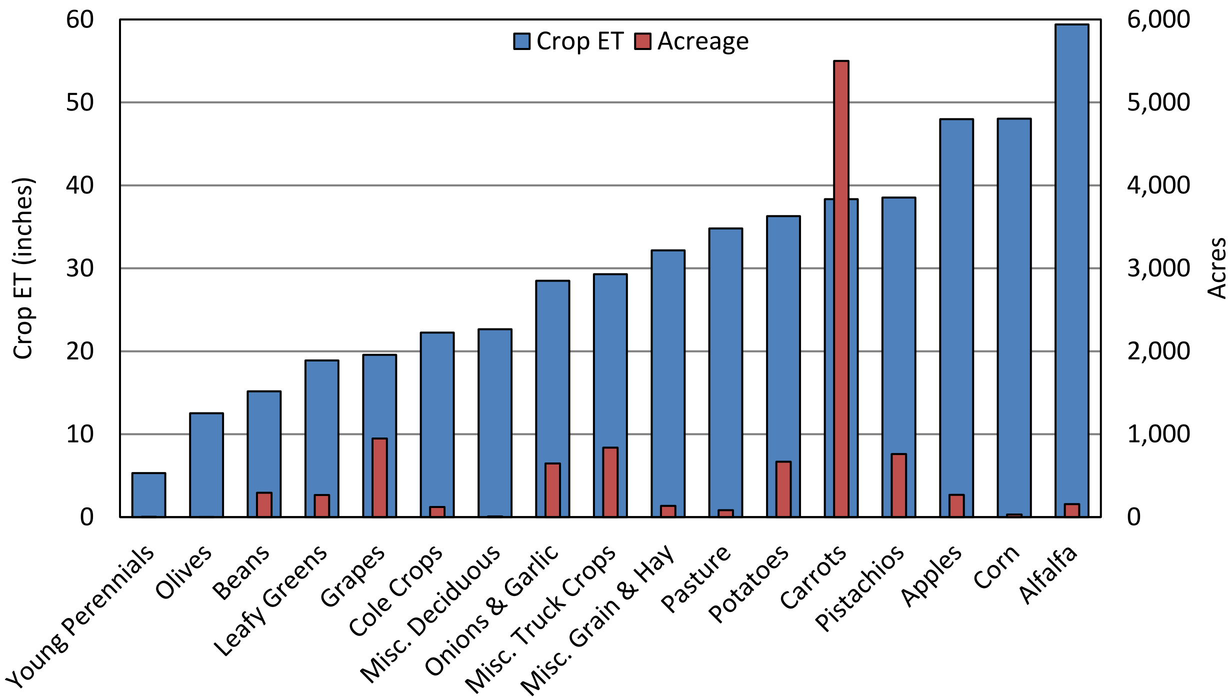

Figure 4.4. Cuyama Basin 2014 ET by Crop and Crop Acreage

Additional monthly plots of the "fraction of reference ET" (ET_{oF}), ET_a and AW by crop for 2014 can be found in the appendix.

5 References

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Allen, R.G., Walter, I.A., Elliott, R.L., Howell, T.A., Itenfisu, D., Jensen, M.E., and R.L. Snyder. 2005. The ASCE Standardized Reference Evapotranspiration Equation. Technical Committee on Standardization of Reference Evapotranspiration. American Society of Civil Engineers. Reston, VA.

Campbell, G.S. 1974 A simple method for determining unsaturated conductivity from moisture retention data. Soil Science. 117:6. Pp 311-314.

Davids Engineering. 2013. Time Series Evapotranspiration and Applied Water Estimates from Remote Sensing. Kaweah Delta Water Conservation District. http://www.kdwcd.com/wp-content/uploads/2018/07/KDWCD-NDVI-ET-Analysis-FINAL-REPORT-March-2013.pdf

NRCS. 1993. Chapter 2 - Watershed Project Evaluation Procedures. National Engineering Handbook Part 630, Hydrology.

Saxton, K.E. and W.J. Rawls. 2006. Soil Water Characteristic Estimates by Texture and Organic Matter for Hydrologic Solutions. Soil Sci. Soc. Am. J. 70:1569–1578.

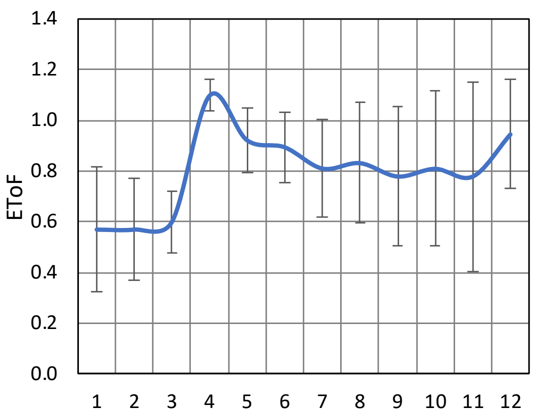
6 Appendix

This appendix includes the following figures:

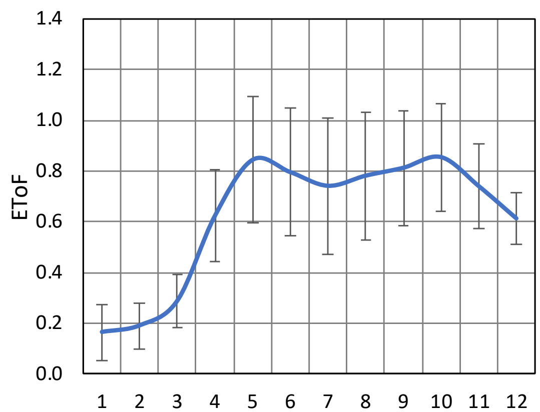
- Average monthly crop water use coefficients or “fraction of reference ET” (EToF) by crop, along with error bars depicting the standard deviation among fields.
- Average monthly crop ET by crop, along with error bars depicting the standard deviation among fields.
- Average monthly applied water by crop, along with error bars depicting the standard deviation among fields.

EToF 2014

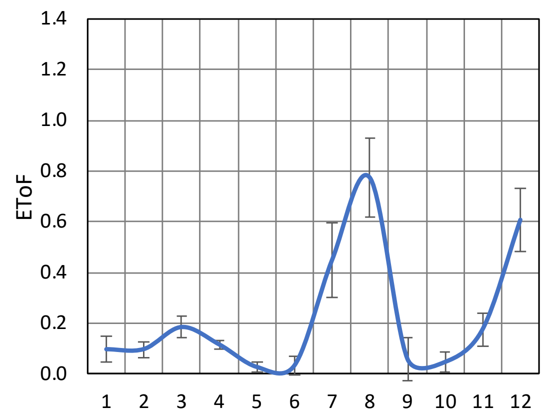
Alfalfa



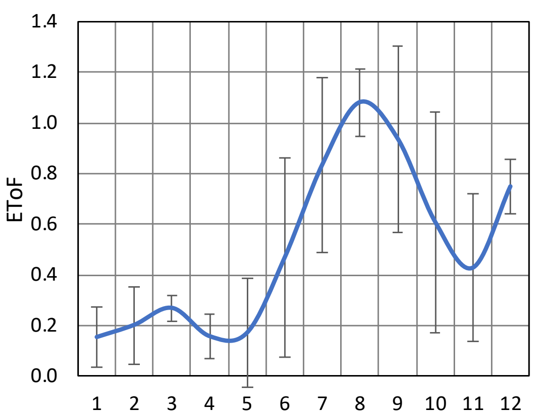
Apples



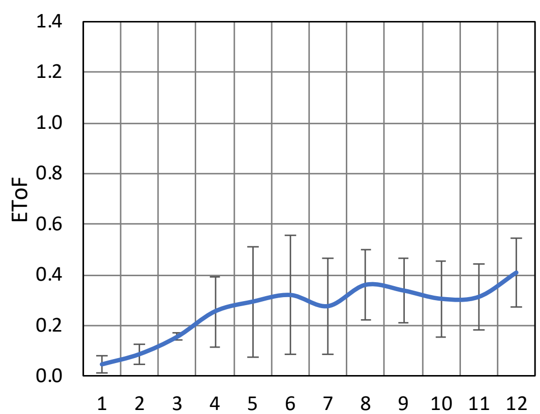
Beans



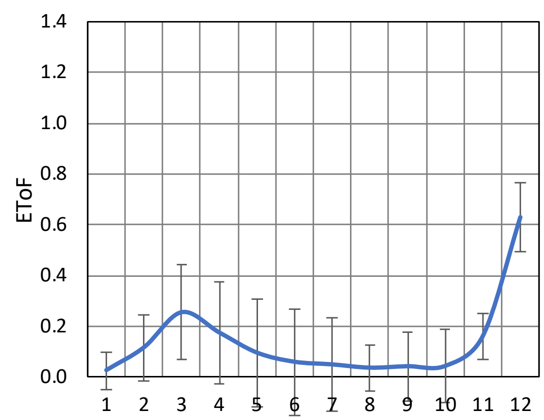
Carrots

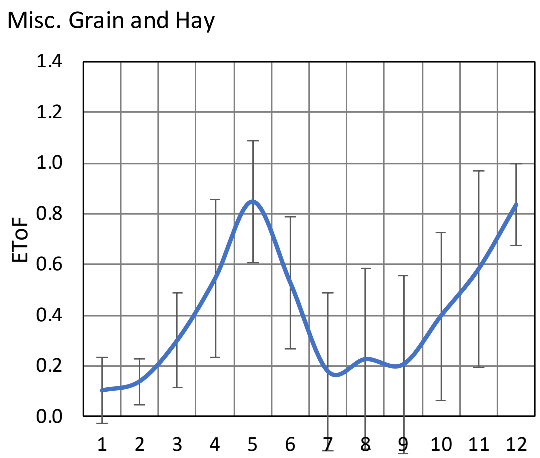


Grapes



Idle




Misc. Grain and Hay
ETOF
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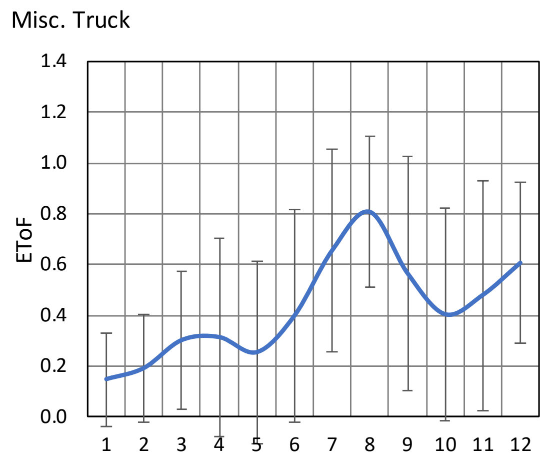
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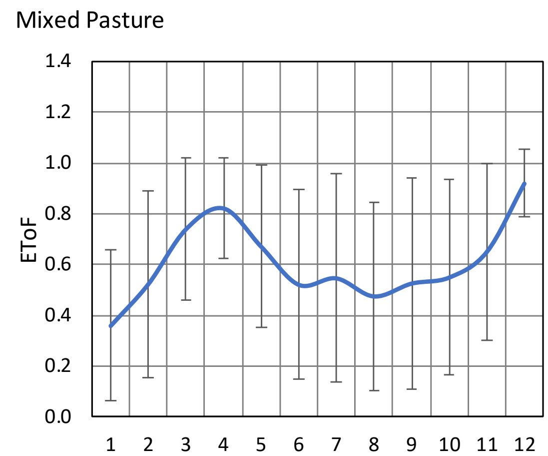
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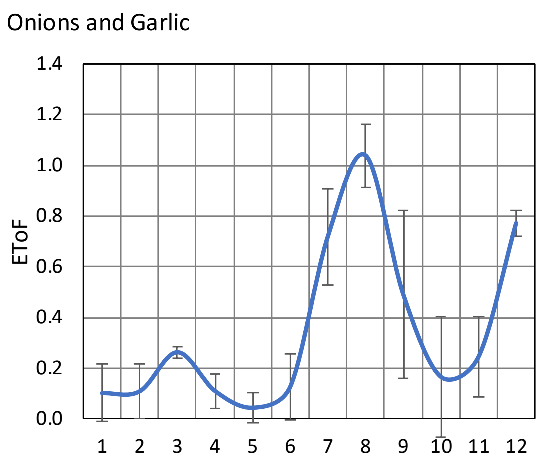
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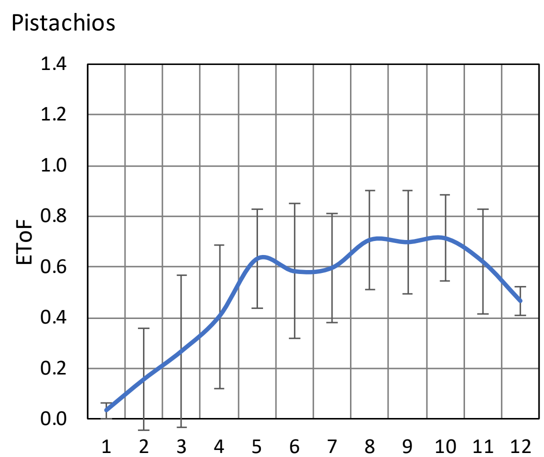
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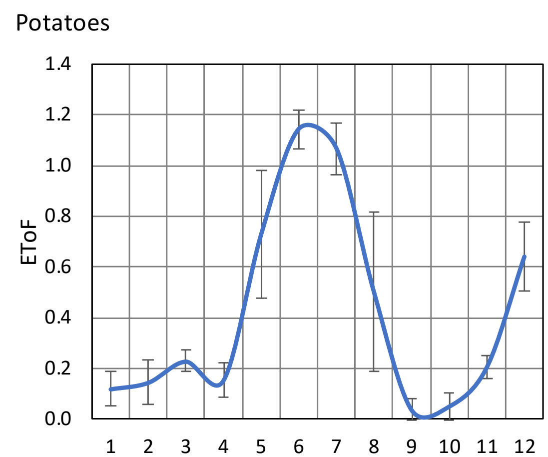
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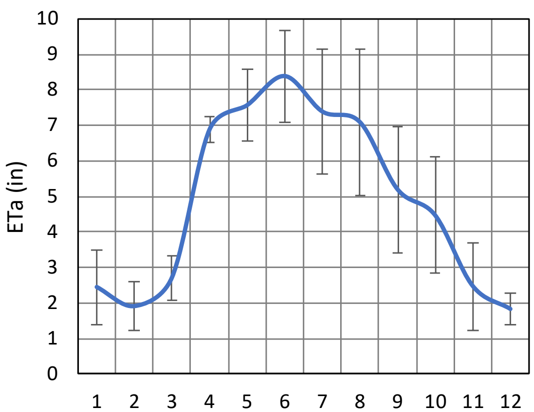

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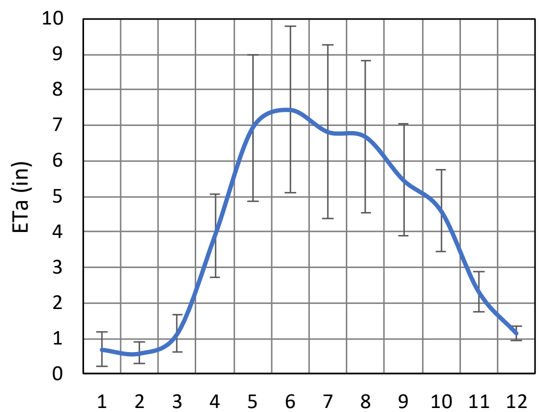

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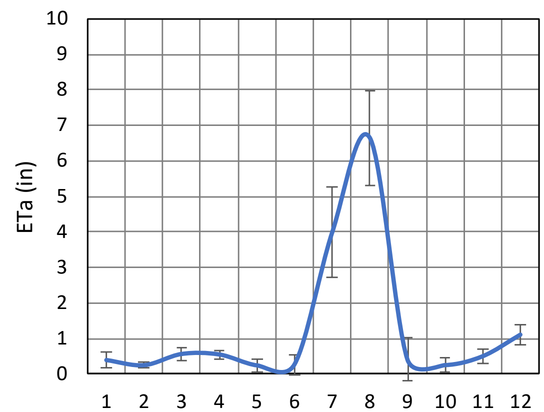

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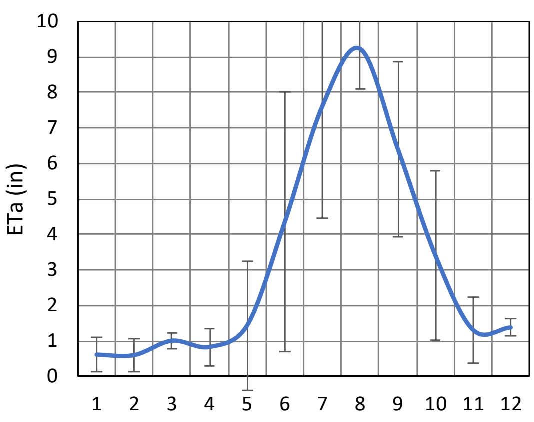

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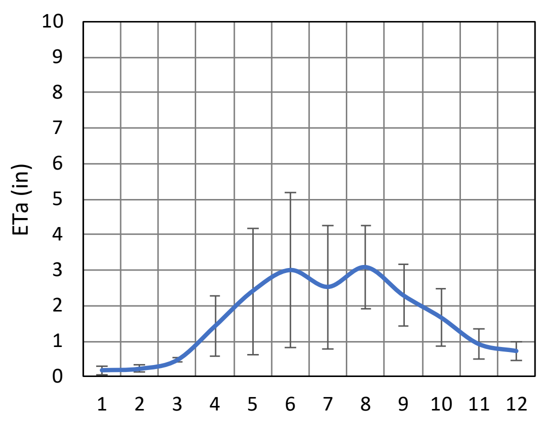

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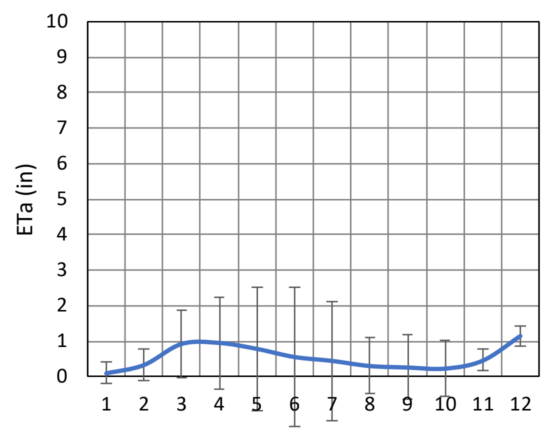

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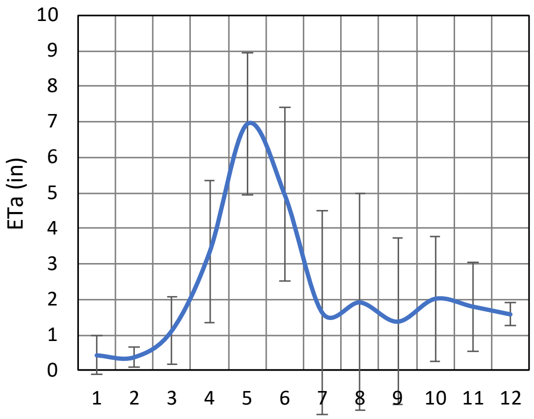

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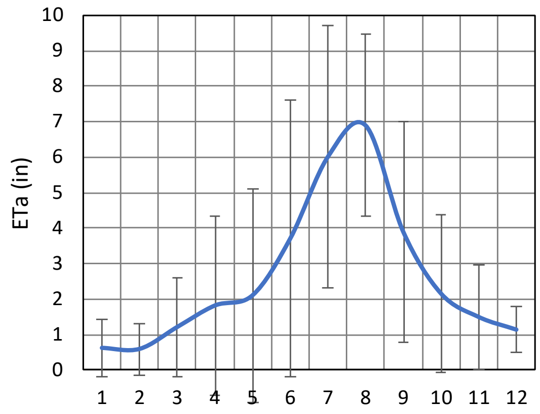

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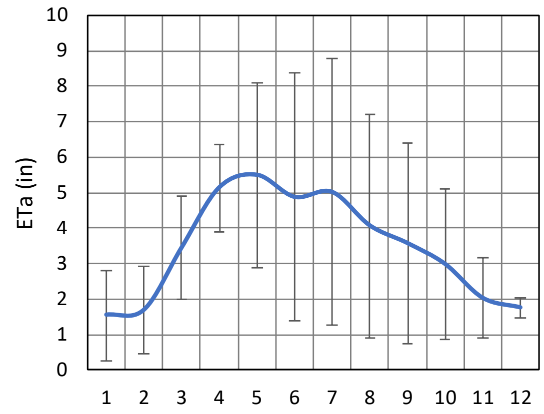

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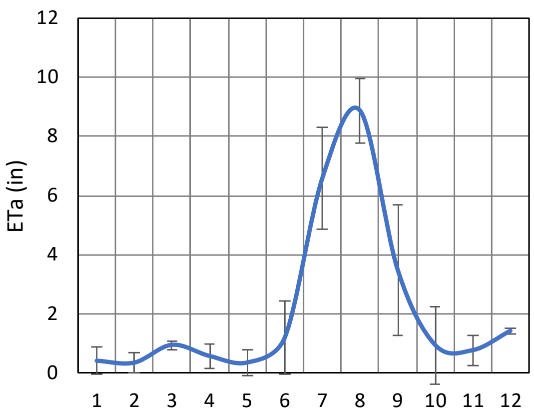

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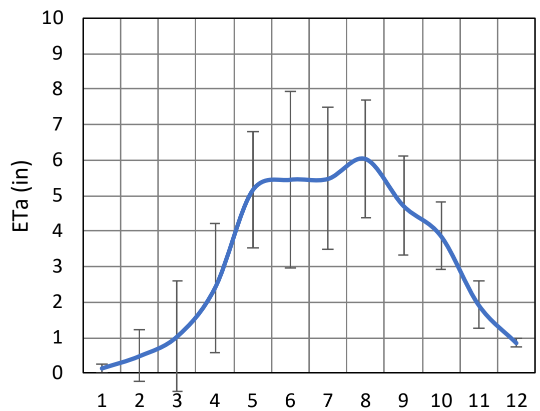

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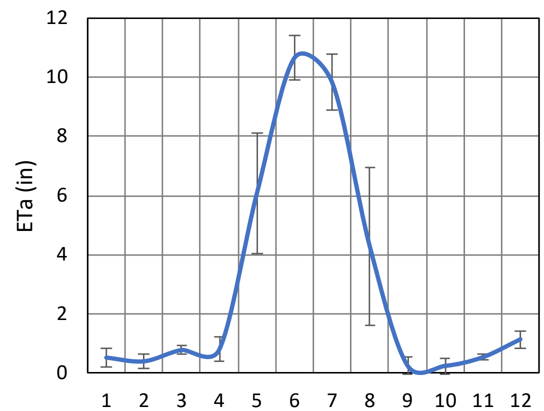

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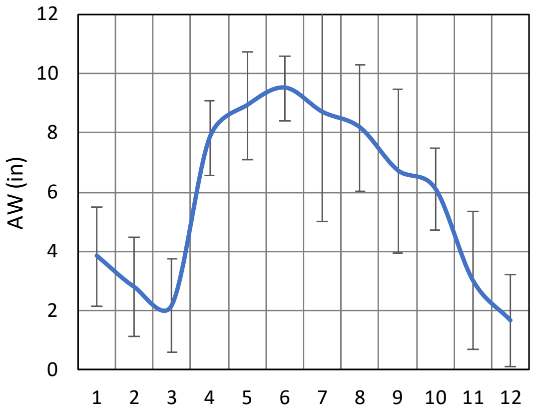
Alfalfa



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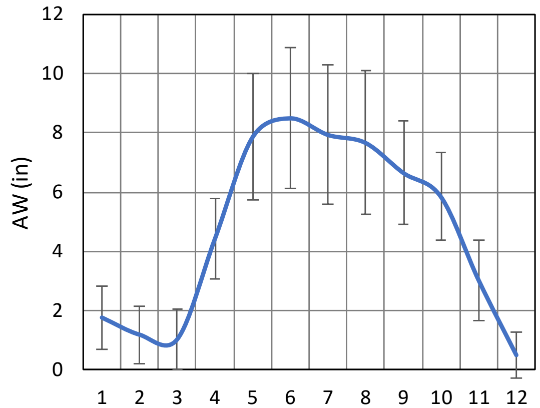

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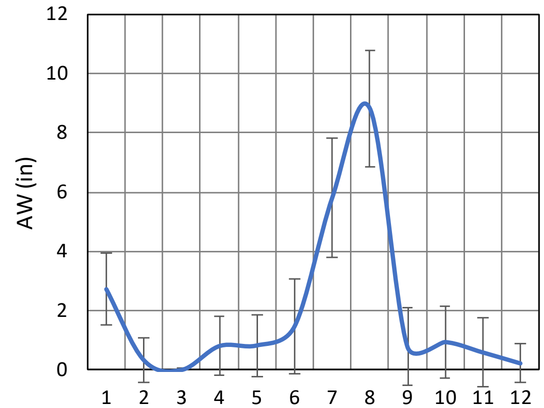

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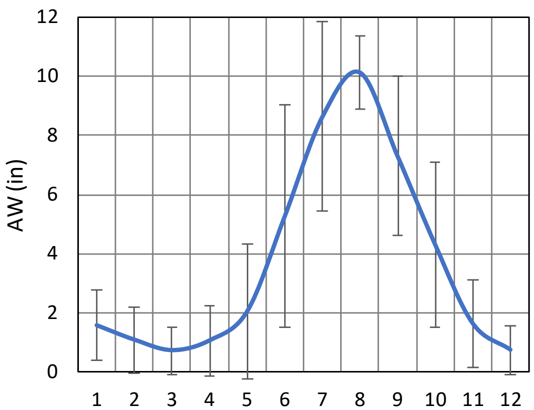

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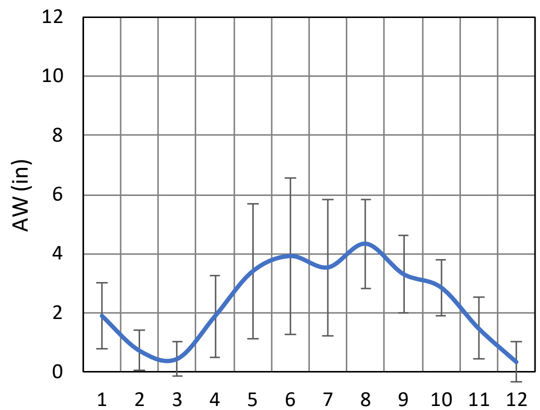

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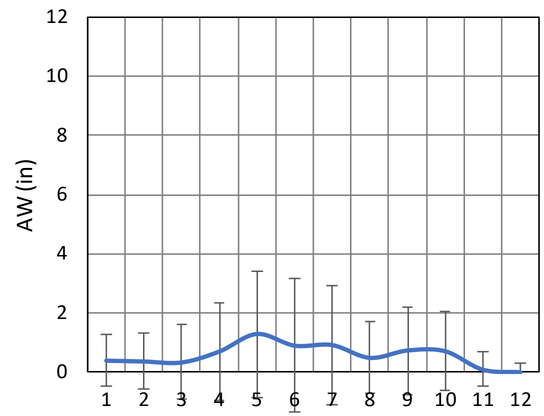

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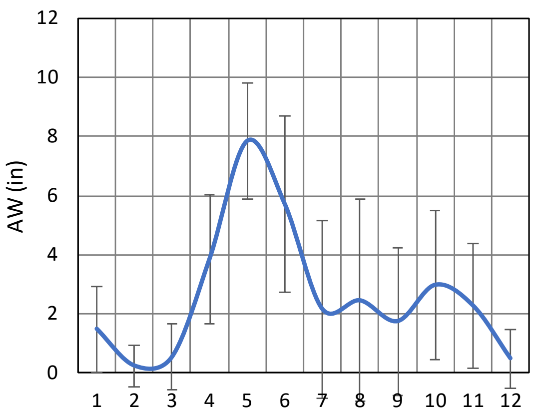

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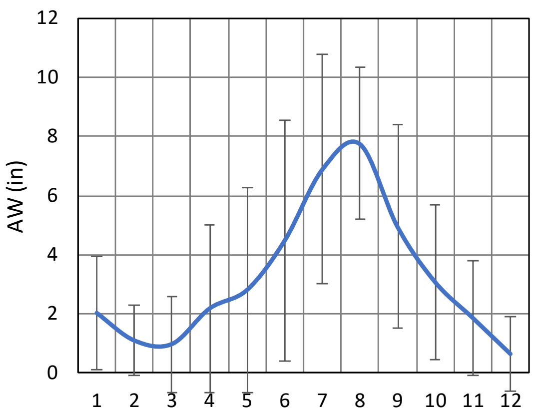

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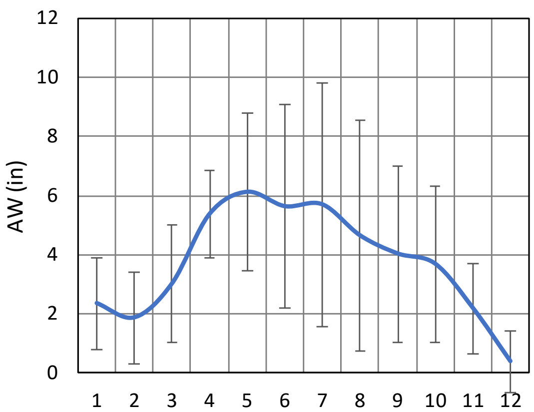

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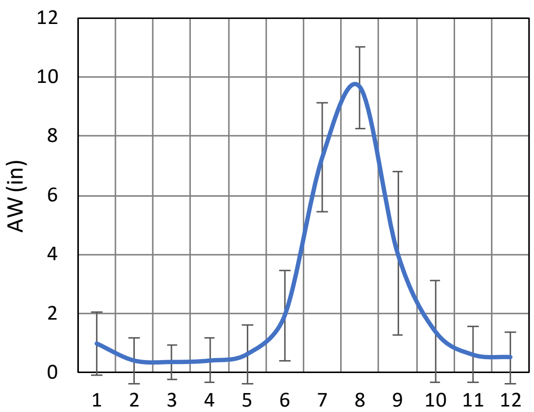

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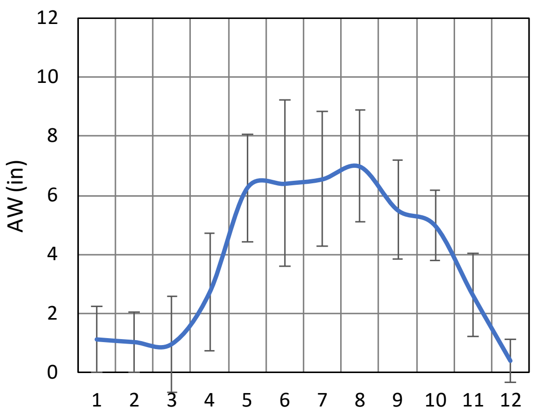

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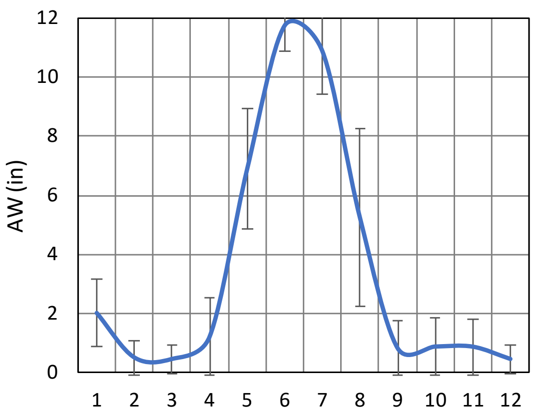

Chapter 2
Appendix D

Technical Memorandum:
Verification of NCCAG-Identified Locations

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TECHNICAL MEMORANDUM

TO: Cuyama Groundwater Sustainability Agency

CC: Brian Van Lienden, Woodard & Curran PM

PREPARED BY: William L. Medlin, PWS, ENV SP

REVIEWED BY: John Ayres and Micah Eggleton

DATE: February 15, 2019

RE: Cuyama GSP Groundwater Dependent Ecosystems Study

As part of the California Sustainable Groundwater Management Act (SGMA), Groundwater Sustainability Agencies (GSAs) are required to develop a Groundwater Sustainability Plan (GSP) to help ensure that groundwater is available for long-term, reliable water supply uses. SGMA was put into place and is enforced by the California Department of Water Resources (DWR). Once implemented, each GSP must address certain key elements such as a baseline groundwater assessment, monitoring, establishing best management practices (BMPs), and setting new regulations with the goal of defining a pathway to achieve sustainable groundwater management within 20 years (DWR 2018).

Within the GSP, a baseline assessment of groundwater conditions must be completed, and part of that assessment includes identification of groundwater dependent ecosystems (GDEs) and an assessment of potential impacts on GDEs. SGMA defines GDEs as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface." The identification and determination of GDEs within a groundwater basin is the responsibility of the GSA that governs the basin. This study specifically focuses on GDEs identified within the Cuyama Valley groundwater basin.

1. CUYAMA VALLEY GROUNDWATER BASIN ECOLOGICAL SETTING

The Cuyama Valley groundwater basin encompasses multiple California ecoregions (Griffith et al. 2016). In terms of land area, the dominant ecoregion is the Central California Foothills and Coastal Mountains (6), sub-ecoregion Cuyama Valley (6am). This ecoregion is characterized by its Mediterranean climate with hot, dry summers and cool, moist winters. Typical vegetative communities consist of chaparral and oak woodlands; grasslands are present at some lower elevations and pine forests are observed at high elevations. Most of the region is comprised of open, low mountains and foothills with some irregular plains and narrow valleys in certain locations. More specifically, the Cuyama Valley is a narrow valley with significant agricultural production. The mainstem Cuyama River flows through the center of the valley from southeast to northwest.

A minor part of the Cuyama Valley ground water basin is in the Southern California Mountains (8) ecoregion, in the Northern Transverse Range (8g) sub-ecoregion. This ecoregion, like other California ecoregions, is characterized by a Mediterranean climate of hot, dry summers and cool, moist winters. Chaparral and oak woodland vegetative communities are still ever-present, however the elevations in this ecoregion are higher generally leading to cooler summers and greater rainfall which result in denser vegetation and large areas of coniferous forests. There is a slope effect that causes some significant ecological differences in the Transverse Range. South-facing slopes receive more annual precipitation (30-40 inches) than the northern-facing slopes (15-20 inches), yet evaporation rates contribute to the development of chaparral communities. While on the northern-facing side of parts of the ecoregion, lower temperatures and evaporation coupled with slow snow melt allow for a coniferous forest that transitions to desert montane habitat. Some areas of severe erosion are common where vegetation has been removed via fire, overgrazing, or other land clearing practices. Many areas in this ecoregion are National Forest public land (Griffith et al. 2016). The Cuyama River headwaters (Quatal Canyon Creek, Apache Canyon Creek, and Cuyama Creek) flow through this ecoregion. Figure 1 (Attachment A) illustrates the general location of the Cuyama Valley groundwater basin in the context of the Ecoregions of California.

2. GDE ASSESSMENT AND FIELD VALIDATION

Using Geographic Information Systems (GIS), Woodard & Curran completed a preliminary desktop analysis of the California DWR *Natural Communities Commonly Associated with Groundwater* (NCCAG) geospatial data set. Woodard & Curran attempted to identify NCCAG polygons that appeared to be "probable GDEs" based on the following observations:

- Presence of a mapped USGS spring or seep
- Inundation visible on aerial imagery
- Saturation visible on aerial imagery
- Dense riparian and/or wetland vegetation visible on aerial imagery

Areas that did not exhibit the above characteristics (or similar) were considered "probable non-GDEs" for purposes of this study. Reference Figure 2 (Attachment A) for geospatial representation of our basin-wide GDE desktop assessment.

In addition to the preliminary desktop analysis of the NCCAG data set, Woodard & Curran also completed a preliminary GDE field validation study throughout portions of the Cuyama Valley groundwater basin. The field study was conducted only on publicly accessible lands (including the Los Padres National Forest) where the NCCAG data set indicated potential presence of GDEs. Field observations were made at NCCAG-mapped seeps, springs, and at other riparian habitats to document plant communities, aquatic or semi-aquatic wildlife, indicators of surface and subsurface hydrology, presence of hydric soils, and other relevant ecological and hydrological data. Photographs were taken in the four cardinal directions (north, east, south, west) at each field validation assessment location, and additional photographs were taken of plant species and other relevant ecological data. Global Positioning System (GPS) points were also collected using a sub-meter Trimble Geo 7x GPS unit at the field validation assessment locations. Preliminary determinations were made at these field assessment locations as to whether an area would be classified as a GDE. Figure 3 (Attachment A) shows the locations of GDE field validation assessment data collection points.

3. RESULTS

Out of 486 NCCAG-mapped polygons (128 GDE_wetland and 358 GDE_vegetation), the preliminary desktop analysis yielded 123 "probable GDEs" and 275 "probable non-GDEs" based on the above-described methodology. Individual polygons were not assessed due to time constraints, but rather groupings of similarly-situated riparian areas or clusters of polygons were assessed via GIS for probability of GDE classification.

The preliminary GDE field validation study assessed six (6) locations in the field on publicly accessible lands. All field assessment sites were in the Los Padres National Forest public lands. One (1) location was along the upper mainstem of the Cuyama River, and the other five (5) locations were in the Apache Canyon Creek watershed. Table 1 below describes each of the field assessment sites in more detail.

Table 1: GDE Field Validation Data Collection Sites

GPS Data Point Name	Latitude / Longitude	NCCAG-Mapped Polygon?	NCCAG Vegetation / Wetland Type	Dominant Plant Species Observed	Other Notes
probable Non-GDE 1	34.760116 N, 119.419661 W	Yes	Vegetation - Riversidean Alluvial Scrub	*Hesperoyucca whipplei, Arctostaphylos glauca, Lepidospartum squamatum, Ericameria nauseosa, Eriogonum fasiculatum, Bromus carinatus*	Soils at data point are sandy, dry and friable; would not stay in soil auger. This location does not appear to be a GDE.
probable Non-GDE 2	34.761994 N 119.375711 W	Yes	Vegetation - Scalebroom	*Lepidospartum squamatum, Ericameria nauseosa, Eriogonum fasiculatum*	Soils at data point are dry and friable; Some pines and junipers are growing in the riparian zone adjacent to river bed; no evidence of hydrology that persists beyond flashy storm events. This location does not appear to be a GDE.
GDE 1	34.778902 N 119.341961 W	No	N/A	*Juncus xiphoides, Juncus patens, Typha domingensis, Scirpus microcarpus, Salix exigua, Salix laevigata, Castilleja sp., Isoetes howellii*	A small stream is flowing at this location and hydrophytic vegetation is present throughout the channel; brown algae observed in flowing stream; crystallized salt or other calcic material observed on stream channel sediments; soils are saturated to the surface in this area. This location appears to be a GDE.
GDE 2	34.801748 N 119.293979 W	Yes	Wetland - Palustrine, Scrub-Shrub, Seasonally Saturated	*Clematis ligusticifolia, Juncus effusus, Salix laevigata, Urtica dioica*	Data point is located at US Forest Service Nettle Springs Campground; USGS mapped spring indicated at data point; groundwater is seeping out of the hillside at this data point; soils sampled on hillslope are hydric and saturated at the surface; water flows in a small channel for approximately 300-500 feet downstream of the spring before drying up. This location appears to be a GDE.
GDE 3	34.772312 N 119.346965 W	No	N/A	*Salix lasiolepis, Baccharis salicifolia, Baccharis pilularis Distichlis spicata, Artemisia californica,*	Data point is located within a small floodplain depression willow thicket. Hydrophytes are present and soils are saturated at

				Juncus patens, *Anemopsis californica,* *Leymus triticoides*	the surface by what appears to be groundwater. Soils are hydric. This location appears to be a GDE.
GDE 4	34.773548 N 119.346732 W	Yes	Vegetation - Riparian Mixed Shrub	*Salix laevigata,* *Juncus patens,* *Leymus triticoides,* *Anemopsis californica,* *Melilotus sp.,* *Isoetes howellii*	A small stream is flowing at this location and hydrophytic vegetation is present throughout the channel; crystallized salt or other calcic material observed on stream channel sediments; soils are saturated to the surface in this area. This location appears to be a GDE.

4. CONCLUSIONS

The Cuyama Valley groundwater basin is a significantly stressed aquifer due to several factors including climate, industrial-scale agriculture, oil and gas exploration and production, ranching, and other land uses. The combination of these factors has drawn the groundwater down to greater than 600 feet below the ground surface in some locations, and this affects GDEs by limiting the amount of groundwater available to ecological communities living at the surface. Especially affected is the Cuyama River mainstem which was observed to be dry throughout much of its reach that was visible during our preliminary GDE field validation study.

However, there do appear to be some GDEs present within the Cuyama Valley groundwater basin as indicated in Table 1. All these areas (GDE 1 – 4) were located within the headwaters of the Cuyama River along Apache Canyon Creek and its floodplain. Areas mapped by the NCCAG data set as seeps and/or springs and the immediately downstream riparian corridors were among the GDEs that were assessed in the field. These locations had hydrophytic vegetation and other near-surface hydrologic indicators that would suggest that the ecological community is dependent on groundwater being present for significant durations during the growing season each year.

Due to access limitations because of private property restrictions, further study should be done along the mainstem of the Cuyama River (and other select tributaries) to determine if GDEs are present within the channel or riparian area.

5. REFERENCES

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Griffith, G.E., Omernik, J.M., Smith, D.W., Cook, T.D., Tallyn, E., Moseley, K., and Johnson, C.B., 2016, Ecoregions of California (poster): U.S. Geological Survey Open-File Report 2016–1021, with map, scale 1:1,100,000, http://dx.doi.org/10.3133/ofr20161021.

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ATTACHMENT A: FIGURES

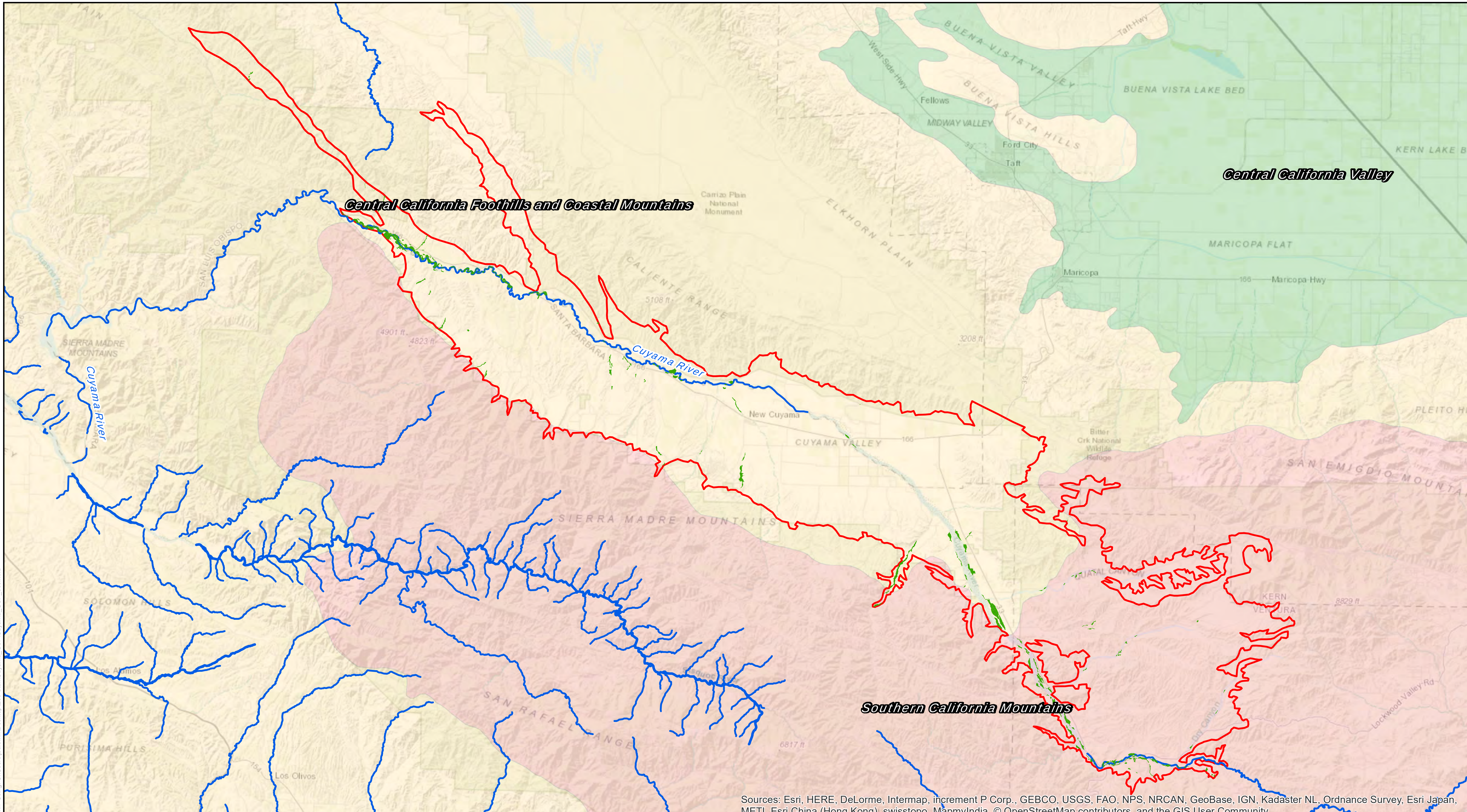

Figure 1:
California Ecoregions
Cuyama Valley Groundwater Basin

Kern, San Luis Obispo, Santa Monica, and Ventura Counties, CA

Legend

- NCCAG Groundwater Dependent Ecosystem
- USGS NHD Streams
- Cuyama Valley Groundwater Basin
- Central California Foothills and Coastal Mountains
- Central California Valley
- Southern California Mountains

0 1.25 2.5 5 Miles

N

WOODARD & CURRAN

Project #: 0011078.01
Map Created: February 2019

Third Party GIS Disclaimer: This map is for reference and graphical purposes only and should not be relied upon by third parties for any legal decisions.
Any reliance upon the map or data contained herein shall be at the users' sole risk. **Data Sources: USEPA Level III Ecoregions of California(2016), USGS NHD**

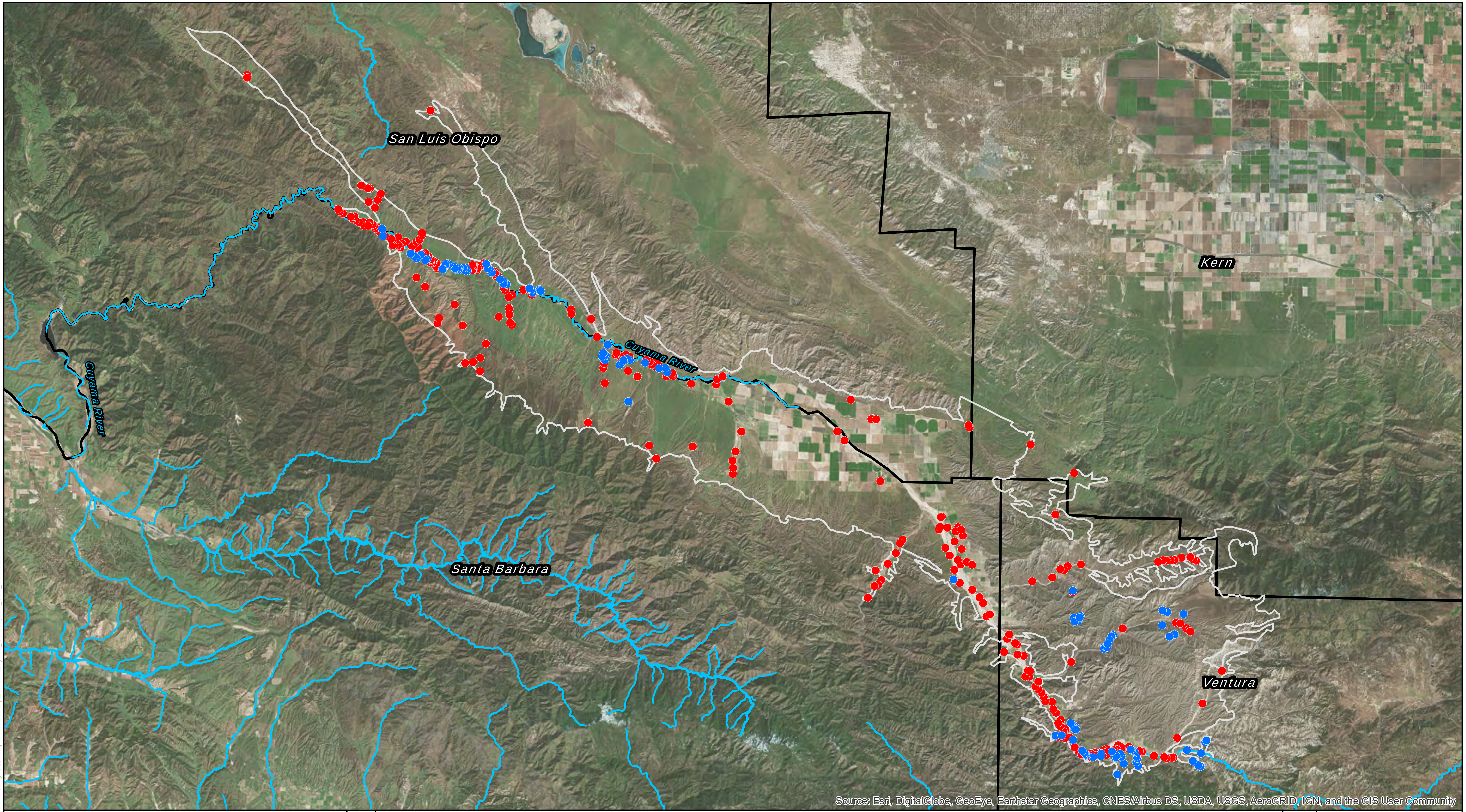

Figure 2: Basin-Wide Groundwater Dependent Ecosystem (GDE) Desktop Assessment

Cuyama Valley Groundwater Basin

Kern, San Luis Obispo, Santa Monica, and Ventura Counties, CA

Legend

- Probable GDE
- Probable Non-GDE
- Streams
- Cuyama Valley Groundwater Basin
- County Boundary

0 1.25 2.5 5 Miles

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WOODARD & CURRAN

Project #: 0011078.01
Map Created: February 2019

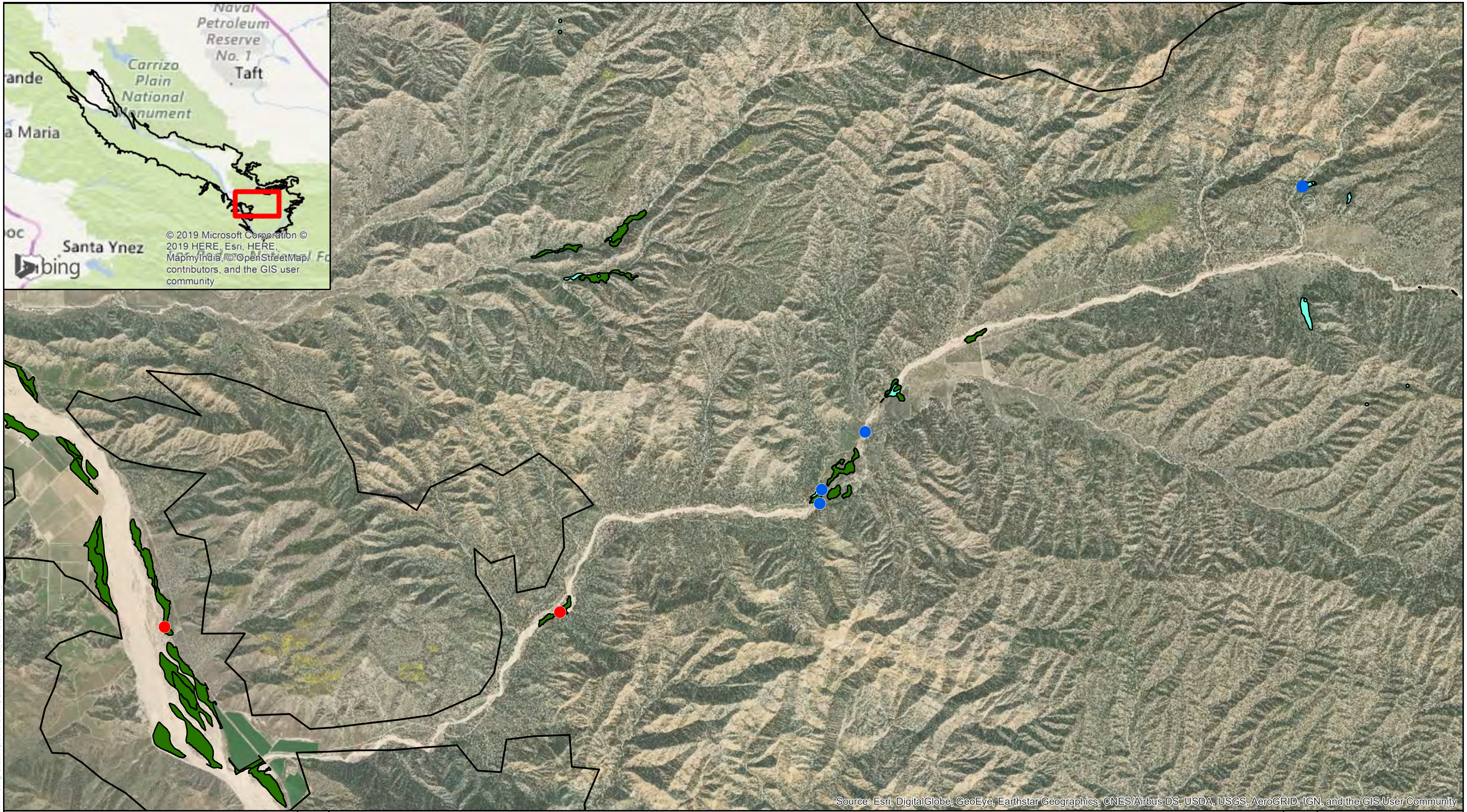

Figure 3: Groundwater Dependent Ecosystem (GDE) Field Validation Sites

Cuyama Valley Groundwater Basin

Kern, San Luis Obispo, Santa Monica, and Ventura Counties, CA

Legend

- Confirmed GDE Data Point
- Probable Non-GDE Data Point
- NCCAG GDE Wetland
- NCCAG GDE Vegetation
- Cuyama Valley Groundwater Basin

1 inch = 3,000 feet

0 1,500 3,000 6,000 Feet

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WOODARD & CURRAN

Project #: 0011078.01
Map Created: February 2019

Third Party GIS Disclaimer: This map is for reference and graphical purposes only and should not be relied upon by third parties for any legal decisions. Any reliance upon the map or data contained herein shall be at the users' sole risk. **Data Sources: CADWR - Natural Communities Commonly Associated with Groundwater(2018)**

ATTACHMENT B: PHOTOGRAPHS

Photo Number: 1 | **View Direction: North** | **Date: October 23, 2018**

Description: Representative photograph taken of potential incorrectly mapped groundwater dependent ecosystem (CA DWR NCAG dataset 2018). Photo taken a GPS point "probable non-GDE 1".

Photo Number: 2 | **View Direction: South** | **Date: October 23, 2018**

Description: Representative photograph taken of potential incorrectly mapped groundwater dependent ecosystem (CA DWR NCAG dataset 2018). Photo taken a GPS point "probable non-GDE 1".

Photo Number: 3 | View Direction: North | Date: October 23, 2018

Description: Representative photograph taken of potential incorrectly mapped groundwater dependent ecosystem (CA DWR NCAG dataset 2018). Photo taken a GPS point “probable non-GDE 2”.

Photo Number: 4 | View Direction: South | Date: October 23, 2018

Description: Representative photograph taken of potential incorrectly mapped groundwater dependent ecosystem (CA DWR NCAG dataset 2018). Photo taken a GPS point “probable non-GDE 2”.

Photo Number: 5 | **View Direction: North** | **Date: October 23, 2018**

Description: **Representative photograph taken of unmapped groundwater dependent ecosystem (CA DWR NCAG dataset 2018). Photo taken a GPS point "GDE 1".**

Photo Number: 6 | **View Direction: South** | **Date: July 26, 2018**

Description: **Representative photograph taken of unmapped groundwater dependent ecosystem (CA DWR NCAG dataset 2018). Photo taken a GPS point "GDE 1".**

Photo Number: 7 | **View Direction: North** | **Date: October 23, 2018**

Description: Representative photograph taken of field-verified mapped groundwater dependent ecosystem (CA DWR NCAG dataset 2018). Photo taken a GPS point "GDE 2".

Photo Number: 8 | **View Direction: South** | **Date: July 26, 2018**

Description: Representative photograph taken of field-verified mapped groundwater dependent ecosystem (CA DWR NCAG dataset 2018). Photo taken a GPS point "GDE 2".

Photo Number: 9 | **View Direction: North** | **Date: October 23, 2018**

Description: Representative photograph taken of unmapped groundwater dependent ecosystem (CA DWR NCAG dataset 2018). Photo taken a GPS point "GDE 3".

Photo Number: 10 | **View Direction: South** | **Date: October 23, 2018**

Description: Representative photograph taken of unmapped groundwater dependent ecosystem (CA DWR NCAG dataset 2018). Photo taken a GPS point "GDE 3".

Photo Number: 11 | **View Direction: East** | **Date: October 23, 2018**

Description: Representative photograph taken of field-verified mapped groundwater dependent ecosystem (CA DWR NCAG dataset 2018). Photo taken a GPS point "GDE 4".

Photo Number: 12 | **View Direction: South** | **Date: October 23, 2018**

Description: Representative photograph taken of field-verified mapped groundwater dependent ecosystem (CA DWR NCAG dataset 2018). Photo taken a GPS point "GDE 4".

Chapter 4 Appendices

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Chapter 4
Appendix A

Monitoring Protocols
for Groundwater Level Monitoring Network

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California Statewide Groundwater Elevation Monitoring (CASGEM) Program

Procedures for Monitoring Entity Reporting

December 2010

Department of Water Resources (DWR) will use the internet as the primary communication tool to notify interested parties and groundwater Monitoring Entities of the status of the CASGEM program on an ongoing basis. Information will be posted at the following website: http://www.water.ca.gov/groundwater/casgem

In addition to the above-referenced website, DWR will distribute information via email. In order to be placed on the CASGEM contact list, please register your contact information at the following website: http://www.water.ca.gov/groundwater/casgem/register/

For questions about the Reporting Procedures, or other technical issues, please contact:

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INTRODUCTION TO CASGEM PROGRAM

In November 2009 Part 2.11 (Groundwater Monitoring) was added to Division 6 of the Water Code by Senate Bill 6 (7th Extraordinary Session) (SB 6), a copy of which is included in the Appendix. (All statutory references in this document are to the Water Code.) The new law directs that groundwater elevations in all basins and subbasins in California be regularly and systematically monitored, preferably by local entities, with the goal of demonstrating seasonal and long-term trends in groundwater elevations. The Department of Water Resources (DWR) is directed to make the resulting information readily and widely available.

DWR developed the California Statewide Groundwater Elevation Monitoring (CASGEM) program in accordance with SB 6 to establish a permanent, locally-managed system to monitor groundwater elevation in California's alluvial groundwater basins and subbasins identified in DWR Bulletin 118. The CASGEM program will rely and build on the many, established local long-term groundwater monitoring and management programs. DWR's role is to coordinate information collected locally through the CASGEM program and to maintain the collected groundwater elevation data in a readily and widely available public database. DWR will also continue measuring its current network of groundwater monitoring wells as funding allows.

The goals of the CASGEM program are to:

- Establish procedures for notification and data reporting by prospective Monitoring Entities (this document)
- Verify local Monitoring Entities in accordance with the Water Code
- Develop an interface for local entities to enter data into a database compatible with DWR's Water Data Library
- Maintain the database and make it easily accessible to the public and local entities for use in water supply planning and management

If no local entities volunteer to monitor groundwater elevations in a basin or part of a basin, DWR may be required to develop a monitoring program for that part. If DWR takes over monitoring of a basin, certain entities in the basin may not be eligible for water grants or loans administered by the state.

During August and September 2010, DWR held 10 workshops throughout the state in cooperation with Association of California Water Agencies (ACWA) to introduce the CASGEM program and explain the purpose and process of the program to local agencies and stakeholders. A copy of the DWR presentation is available on the CASGEM website (http://www.water.ca.gov/groundwater/casgem). A summary of

Frequently Asked Questions (FAQs), primarily from the workshops, is provided in on the CASGEM website.

DWR's main role is to administer the CASGEM program through providing public outreach; creating and maintaining the CASGEM website and online data submittal system; and, supporting local entities through the process of becoming a Monitoring Entity and preparing Monitoring Plans. DWR will use the CASGEM website to provide up-to-date information on the program. The website will also be the access point for the online notification and data submittal systems.

Staff from the DWR regional offices will be available to assist potential Monitoring Entities with the online notification submittal process. After receiving notification from prospective Monitoring Entities, DWR will review them for completeness, verify the authority of the applying entity under Section 10927, and check for overlapping monitoring areas. DWR will advise each party on the status of their notification within three months of submittal and will work with entities to address any deficiencies in their submittals.

DWR encourages local agencies and groups to collaborate to determine who will serve as the Monitoring Entity for the area. However, if more than one party seeks to become the Monitoring Entity for the same area and overlapping monitoring area issues cannot be resolved locally, DWR will make a final determination of the Monitoring Entity for the area. DWR's determinations will consider the order in which entities are identified in Section 10927 and other factors as described in the Water Code.

DWR will post the selection of each Monitoring Entity and its monitoring area on the CASGEM website and will notify each Monitoring Entity in writing. A map-based interface will be available for users to identify the Monitoring Entity for each basin in the state.

DWR will prepare the first status report on the CASGEM program for the Governor and Legislature by January 1, 2012. In this initial report, DWR will report on the extent of groundwater elevation monitoring within each basin. This report will include a statewide prioritization of basins based on water supply, water demand, and other factors identified in Section 10933. DWR will explore options for basins without identified monitoring, with a focus on identifying options for local monitoring. Future status reports on the CASGEM program will be prepared by DWR in years ending in 5 or 0.

PURPOSE OF MONITORING ENTITY REPORTING PROCEDURES

The purpose of these procedures is to introduce the CASGEM program and its components as the framework for implementing SB 6, with particular emphasis on the initial step of establishing Monitoring Entities for each Bulletin 118 basin in the state.

A summary of the requirements of local entities to comply with the CASGEM program is presented in Table 1.

Table 1. Quick Guide for Local Entities

- Determine whether you qualify as a potential Monitoring Entity (see "Requirements to become Monitoring Entity" on pages 9-13)
- Identify the basins within your area (see Bulletin 118)
- Collaborate with other local entities to identify and choose the prospective Monitoring Entity (or Entities) for your area
- Submit Monitoring Entity notification to DWR through CASGEM website (http://www.water.ca.gov/groundwater/casgem) on or before January 1, 2011
- DWR will review the notification and advise the prospective Monitoring Entity of the status of the notification within 3 months of submittal
- Work with staff of the DWR regional office to address any deficiencies in the submittal
- If more than one party seeks to become the Monitoring Entity for the same area, work with staff of the DWR regional office to resolve
- Check the CASGEM website for a listing of the selected Monitoring Entities
- Develop and submit a Monitoring Plan to DWR through the CASGEM website
- Staff from the DWR regional office are available to assist with the Monitoring Plan and to recommend changes
- Submit monitoring data to DWR through the CASGEM website on or before January 1, 2012

CASGEM SCHEDULE

CASGEM Schedule		DWR Activities		Local Entity Activities
2010	July-September	ACWA/DWR Workshops		Collaborate to identify prospective Monitoring Entities
	October-December	•Draft Procedures and Guidelines •Solicit Comments •Finalize Procedures and Guidelines		
		Notification System ready online		Prospective Monitoring Entities submit notifications to DWR
2011	January 1, 2011	Review and designation of Monitoring Entities	Review Monitoring Plans and provide recommendations	Monitoring Entity notifications due to DWR on or before 1/1/2011
	January-March			Monitoring Entities develop and submit Monitoring Plans to DWR
	April-June			
	July-September			Groundwater elevation monitoring begins and continues
	October-December	Preparation of first CASGEM status report		
2012	January 1, 2012	DWR submits first CASGEM status report to Governor and Legislature		First CASGEM data submittals due to DWR on or before 1/1/2012

A timetable for implementing the CASGEM schedule is shown above.

MONITORING ENTITIES

The CASGEM program establishes the framework for collaboration between local monitoring parties and DWR to collect groundwater elevation data throughout the state's 515 basins as defined in Bulletin 118. A Monitoring Entity is a local agency or group that voluntarily takes responsibility for conducting or coordinating groundwater elevation monitoring and reporting for all or part of a groundwater basin.

To determine if you are within a Bulletin 118 basin, please refer to maps and descriptions in Bulletin 118, available online at: http://www.water.ca.gov/groundwater/bulletin118/gwbasin_maps_descriptions.cfm. Geographic Information System (GIS) shapefiles of the basins are also available at this website. DWR can assist in identifying other potential local monitoring parties in each basin.

ROLES AND RESPONSIBILITIES OF MONITORING ENTITIES

Through the CASGEM program, local entities with appropriate authority may notify DWR of their intent to be a Monitoring Entity. Monitoring Entities will have specific responsibilities, including:

- Coordinate with DWR to establish a Monitoring Plan
- Conduct or coordinate the regular and systematic monitoring of groundwater elevations as specified in the Monitoring Plan
- Submit monitoring data to DWR in a timely manner

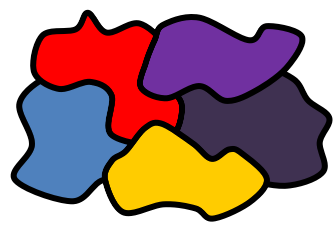
A Monitoring Entity can perform monitoring for any number of basins or portions thereof, but no area can have more than one Monitoring Entity. While the Monitoring Entity is responsible for compiling the data and submitting it to DWR for a particular area, the actual measurements can be taken by any number of agencies that would work under the direction of the Monitoring Entity. (Cooperating agencies would submit data to the Monitoring Entity, not to DWR.) Thus, assuming there are no overlapping areas or gaps in basin coverage for a given area, there are three possible basic scenarios, illustrated in Figure 1:

- A single Monitoring Entity that collects and reports groundwater elevation data for the entire basin (Scenario A);
- Multiple Monitoring Entities that collect and report groundwater elevation data for their portion of the basin (Scenario B); or

- An umbrella Monitoring Entity that coordinates and reports groundwater elevation data collected by multiple agencies within the basin (Scenario C).

Scenario A. One Monitoring Entity collects and reports data for entire basin

Scenario B. One basin, several Monitoring Entities collecting and submitting data



Scenario C. One basin, one Monitoring Entity coordinating and submitting data collected by several agencies

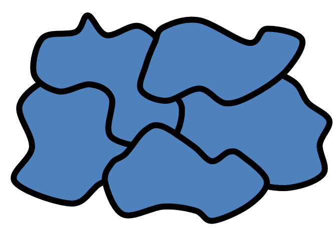


Figure 1. Illustration of possible Monitoring Entity scenarios for a monitored basin.

DWR currently monitors water elevations in about 4,000 wells statewide and cooperates with local and federal agencies to monitor roughly an additional 6,000 wells. DWR plans to continue monitoring groundwater elevations, contingent upon available funding. In some basins DWR currently does most, if not all, of the water-elevation monitoring. In these basins, a local entity still needs to notify DWR of their intent to become the Monitoring Entity. The Monitoring Entity must determine which DWR wells will be included in their CASGEM monitoring network. As long as DWR continues its monitoring program, the department will transmit its groundwater elevation data to the CASGEM system. However, if DWR is unable to continue monitoring for any reason, the Monitoring Entity will be required to re-evaluate its monitoring network to determine which wells to retain in its monitoring network.

REQUIREMENTS TO BECOME MONITORING ENTITY

Section 10927 of the Water Code defines the types of entities that may assume responsibility for monitoring and reporting groundwater elevations as part of the CASGEM program.

A summary list of eligible entities, in order of priority, and notification requirements for each entity is provided below:

1. A **watermaster or water management engineer** appointed by a court or pursuant to statute to administer a final judgment determining rights to groundwater [Section 10927(a)].
   Notification Requirements:
   - Name of Agency
   - Agency Contact Name
   - Address
   - Telephone Number
   - Email Address
   - Any other relevant contact information
   - Authority (as listed in Section 10927)
   - Name and number of basin to be monitored (from Bulletin 118)
   - Map and shapefile showing area to be monitored (Shapefiles do not need to be submitted by the initial January 1, 2011 notification date; Regional Offices can provide assistance to potential Monitoring Entities with shapefiles.)
   - Statement that the entity will comply with the requirements of Water Code Part 2.11
   - Additional information deemed necessary by DWR to identify monitoring area or qualifications of the Monitoring Entity

2. A **groundwater management agency** with statutory authority to manage groundwater pursuant to its principal act that is monitoring groundwater elevations in all or a part of a groundwater basin on or before January 1, 2010 [Section 10927(b)(1)].
   Notification Requirements:
   - Name of Agency
   - Agency Contact Name
   - Address
   - Telephone Number
   - Email Address
   - Any other relevant contact information
   - Authority (as listed in Section 10927)

- Name and number of basin to be monitored (from Bulletin 118)
- Map and shapefile showing area to be monitored (Shapefiles do not need to be submitted by the initial January 1, 2011 notification date; Regional Offices can provide assistance to potential Monitoring Entities with shapefiles.)
- Statement that the entity will comply with the requirements of Water Code Part 2.11
- Additional information deemed necessary by DWR to identify monitoring area or qualifications of the Monitoring Entity

3. A **water replenishment district** established pursuant to Water Code Division 18 (commencing with Section 60000). This part does not expand or otherwise affect the authority of a water replenishment district relating to monitoring elevations [Section 10927(b)(2)].

   Notification Requirements:

   - Name of Agency
   - Agency Contact Name
   - Address
   - Telephone Number
   - Email Address
   - Any other relevant contact information
   - Authority (as listed in Section 10927)
   - Name and number of basin to be monitored (from Bulletin 118)
   - Map and shapefile showing area to be monitored (Shapefiles do not need to be submitted by the initial January 1, 2011 notification date; Regional Offices can provide assistance to potential Monitoring Entities with shapefiles.)
   - Statement that the entity will comply with the requirements of Water Code Part 2.11
   - Additional information deemed necessary by DWR to identify monitoring area or qualifications of the Monitoring Entity

4. A **local agency that is managing all or part of a groundwater basin pursuant to Water Code Part 2.75** (commencing with Section 10750) and that was monitoring groundwater elevations in all or part of a groundwater basin on or before January 1, 2010, or a local agency or county that is managing all or part of a groundwater basin pursuant to any other legally enforceable groundwater management plan with provisions that are substantively similar to those described in that part and that was monitoring groundwater elevations in all or a part of a groundwater basin on or before January 1, 2010 [Section 10927(c)].

Notification Requirements:

- Name of Agency
- Agency Contact Name
- Address
- Telephone Number
- Email Address
- Any other relevant contact information
- Authority (as listed in Section 10927)
- Name and number of basin to be monitored (from Bulletin 118)
- Map and shapefile showing area to be monitored (Shapefiles do not need to be submitted by the initial January 1, 2011 notification date; Regional Offices can provide assistance to potential Monitoring Entities with shapefiles.)
- Statement that the entity will comply with the requirements of Water Code Part 2.11
- Copy of current groundwater management plan
- Statement describing the ability or qualifications of the entity to conduct the groundwater monitoring functions required
- Additional information deemed necessary by DWR to identify monitoring area or qualifications of the Monitoring Entity

5. A **local agency that is managing all or part of a groundwater basin pursuant to an integrated regional water management plan** prepared pursuant to Water Code Part 2.2 (commencing with Section 10530) that includes a groundwater management component that complies with the requirements of Section 10753.7 [Section 10927(d)].

Notification Requirements:

- Name of Agency
- Agency Contact Name
- Address
- Telephone Number
- Email Address
- Any other relevant contact information
- Authority (as listed in Section 10927)
- Name and number of basin to be monitored (from Bulletin 118)
- Map and shapefile showing area to be monitored (Shapefiles do not need to be submitted by the initial January 1, 2011 notification date; Regional Offices can provide assistance to potential Monitoring Entities with shapefiles.)
- Statement that the entity will comply with the requirements of Water Code Part 2.11
- Copy of current groundwater component of integrated regional water management plan
- Statement describing the ability or qualifications of the entity to conduct the groundwater monitoring functions required

- Additional information deemed necessary by DWR to identify monitoring area or qualifications of the Monitoring Entity

6. A **county** that is not managing all or a part of a groundwater basin pursuant to a legally enforceable groundwater management plan with provisions that are substantively similar to those described in Water Code Part 2.75 (commencing with Section 10750) [Section 10927(e)].

   Notification Requirements:

   - Name of County
   - County Contact Name
   - Address
   - Telephone Number
   - Email Address
   - Any other relevant contact information
   - Authority (as listed in Section 10927)
   - Name and number of basin to be monitored (from Bulletin 118)
   - Map and shapefile showing area to be monitored (Shapefiles do not need to be submitted by the initial January 1, 2011 notification date; Regional Offices can provide assistance to potential Monitoring Entities with shapefiles.)
   - Statement that the entity will comply with the requirements of Water Code Part 2.11
   - Statement describing the ability or qualifications of the entity to conduct the groundwater monitoring functions required
   - Additional information deemed necessary by DWR to identify monitoring area or qualifications of the Monitoring Entity

7. A **voluntary cooperative groundwater monitoring association** formed pursuant to Section 10935 [Section 10927(f)]. As described in the Water Code Section 10935, the voluntary associations may be established by contract, a joint powers agreement, a memorandum of agreement, or other form of agreement deemed acceptable by DWR, so long as it contains: the names of the participants; the boundaries of the area covered by the agreement; the name or names of the parties responsible for meeting the requirements; the method of recovering the costs associated with meeting the requirements; and other provisions that may be required by DWR. Entities seeking to form a voluntary association should notify DWR, which will work cooperatively with the interested parties to facilitate the formation of the association.

Notification Requirements:

- Name of Association
- Association Contact Name
- Address
- Telephone Number
- Email Address
- Any other relevant contact information
- Authority (as listed in Section 10927)
- Name and number of basin to be monitored (from Bulletin 118)
- Map and shapefile showing area to be monitored (Shapefiles do not need to be submitted by the initial January 1, 2011 notification date; Regional Offices can provide assistance to potential Monitoring Entities with shapefiles.)
- Statement that the entity will comply with the requirements of Water Code Part 2.11
- Statement describing the ability or qualifications of the entity to conduct the groundwater monitoring functions required
- Statement of intent to meet the association formation requirements described in Section 10935
- Additional information deemed necessary by DWR to identify monitoring area or qualifications of the Monitoring Entity

Local agencies are encouraged to coordinate among themselves to determine the proposed Monitoring Entity or Entities that best suits their area. The resulting interested entity (or entities) should notify DWR of its intent to become a groundwater Monitoring Entity for one or more basins, or portions thereof by the January 1, 2011 deadline. Certain basic information is required for notification, including contact information and additional details depending on the authority of the entity desiring to monitor groundwater (Section 10928), as listed above. This notification information will be submitted to DWR using an online system that will be available by mid-December 2010.

MONITORING PLANS

Monitoring Entities will each develop a Monitoring Plan that includes the following sections: Monitoring Sites and Timing, Field Methods, and Data Reporting. Monitoring Plans should be completed and submitted to DWR by summer 2011. Staff from the DWR regional offices will be available to assist Monitoring Entities with the development of Monitoring Plans, if needed. In determining what information should be reported to DWR, the department will defer to existing monitoring programs if those programs result in information that demonstrates seasonal (annual high and low groundwater elevations) and long-term trends in groundwater elevations. Staff from the DWR regional offices will assist Monitoring Entities to address any gaps in basin coverage (see below) and other monitoring issues and may make recommendations for the location of additional wells. However, the department has no authority to require a Monitoring Entity to install additional wells unless funds are provided for that purpose. Once a Monitoring Plan is established with DWR, Monitoring Entities should notify DWR of any changes to the plan.

Key Components of Monitoring Plans

Submit to DWR by summer 2011

- Monitoring Sites and Timing
  - Well Network Design
  - Selected wells (current)
  - Planned (future) wells
  - Frequency to capture seasonal highs and lows
  - Map and shapefile of monitoring area and well locations

Field Methods for groundwater monitoring

- Methods for measuring
  - Reference Point
  - Static water level
  - Depth to water
  - Standardized form for data collection

Data Reporting

- Online data submittal, minimum July & January each year

Data Gaps

A data gap refers to a basin or portion of a basin that is not included in any of the Monitoring Plans submitted to DWR. This is essentially an area that lacks the density of monitoring wells that would allow seasonal and long-term trends in groundwater elevations to be determined for the basin, subbasin, or a portion thereof. Among the 515 basins defined by Bulletin 118, data gaps may exist for a variety of reasons, including a lack of suitable monitoring wells, lack of groundwater use, access issues, and jurisdictional issues, among others.

If no local entity is able and/or willing to fill a data gap, the department may be required to perform groundwater monitoring functions. If DWR performs this monitoring, local agencies and the county that have the authority under Section 10927 to monitor the area of the data gap would be potentially ineligible for a water grant or loan awarded or administered by the state. The Monitoring Entity or entities with the authority to monitor the area of the data gap should provide detailed information regarding the nature of and reason for the data gap so that DWR may include such information in the prioritization of groundwater basins and subbasins as appropriate.

Agencies and counties that are eligible to be designated Monitoring Entities but choose not participate in the CASGEM program will not lose their state water grant and loan eligibility if their entire service area qualifies as a disadvantaged community (Water Code Section 10933.7(b)). It will be the responsibility of the local agency or county applying for a state water grant or loan to demonstrate their disadvantaged community status at the time they are applying for the grant or loan.

MONITORING SITES AND TIMING

The Monitoring Plan will identify the wells to be monitored and the frequency with which they will be monitored. The Monitoring Plan should explain how proposed monitoring will be sufficient to demonstrate the seasonal and long-term groundwater elevation trends in the monitored area. The density of monitoring locations will depend on the complexity of the basin.

Because of security concerns, the California Department of Public Health (DPH) routinely limits the disclosure of detailed public water supply well location information. Pursuant to Water Code Section 10931, the DWR is required to collaborate with DPH to ensure that the information reported to the CASGEM program will not result in the inappropriate disclosure of information of concern to DPH. At this time, DWR has reached no agreement with DPH regarding the appropriate treatment of public water supply well data. As a result, CASGEM does not currently plan to use such well information in its database.

The Monitoring Plan should contain a table identifying the wells to be monitored and the timing of that monitoring. Because the law specifies that information should demonstrate seasonal and long-term trends in groundwater elevations, at a minimum monitoring should be conducted at each location for the yearly high and low for the basin. The yearly high and low groundwater elevations typically occur in spring and fall, but this may vary from basin to basin. It is very important that the timing of all the measurements in the basin is coordinated. Rationale for selection of the timing (seasonal highs and lows) should be included in the Monitoring Plan.

The information on the monitoring sites and timing to be submitted in the online system should include:

- Well identification number
- State well number
- Location (decimal latitude and longitude, North American Datum (NAD) 83)
- Reference point elevation (feet, North American Vertical Datum (NAVD) 88)
- Land surface datum (feet, NAVD88)
- Map and shapefile with monitoring locations, Bulletin 118 groundwater basin boundary, and boundary of monitoring area
- Frequency and timing of measurements

Field Methods

The consistent and documented collection of groundwater elevation data is important for ensuring that the data can be used across the state, regardless of the Monitoring Entity. The field methods should meet a common set of basic requirements; however, the methods do not have to be exactly the same. Many entities already have in place monitoring efforts that are successful in meeting local needs and that can meet the needs for this program, either as-is or with the incorporation of individual components. The CASGEM program wishes to maintain, to the greatest extent possible, the procedures of high-quality local groundwater elevation monitoring programs, so long as they meet the overall program goals and policies. Of particular concern are the following basic requirements:

- Method(s) to establish the Reference Point, including step-by-step instructions
- Method(s) to ensure static groundwater elevation
- Method(s) to measure depth to water, including step-by-step instructions
- Method(s) and form(s) for recording measurements

It is the responsibility of each Monitoring Entity to develop and implement monitoring protocols that are appropriate to local groundwater basin conditions, protect the water quality of its monitoring wells, and maintain the quality of the data that it submits to the CASGEM Program. DWR has developed field guidelines (Department of Water Resources Groundwater Elevation Monitoring Guidelines) based on a review of existing field methods from DWR and other organizations, which is available on the CASGEM website. Monitoring Entities are welcome to refer to these guidelines when developing field methods for their own Monitoring Plans. However, the DWR guidelines are for internal use in the event that the Department is required to perform groundwater monitoring functions pursuant to Section 10933.5 and are not binding on any other agency. The core of the CASGEM program will rely and build on the many, established local long-term groundwater monitoring and management programs. The department will defer to existing monitoring programs that result in information that demonstrates seasonal and long-term trends in groundwater elevations.

Data Reporting

DWR will develop an online data submittal system for Monitoring Entities to submit their groundwater elevation data. Several methods of submitting data will be available, such as direct online data entry, or upload of data files for batch entry. Initial groundwater elevation data should be submitted to DWR by January 1, 2012. Thereafter, data should be submitted as soon as possible after collection, but no later than January 1st and July 1st of each year, at the minimum. Historical data can also be submitted via the DWR data system to aid in data interpretation. All submitted data will be available to the public, except for confidential data.

Each groundwater elevation data measurement submitted to the online system should include:

- Well identification number
- Measurement date
- Reference point and land surface elevation
- Depth to water
- Method of measuring water depth
- Measurement quality codes

The Monitoring Entity information, well information, and groundwater elevation information is to be provided by the Monitoring Entity. Items labeled as required must be submitted to DWR to report groundwater elevations. Items labeled as recommended should be submitted to DWR if they are available, as they assist in fully evaluating the quality of measurements. DWR will provide standard form(s) for Monitoring Entities to submit groundwater elevation data online. However, if Monitoring Entities cannot use the standard form(s) or provide the data elements listed below, DWR will work cooperatively with Monitoring Entities to develop alternate methods of submitting data.

Entity Information

All entities assuming groundwater monitoring functions as delineated in Section 10927 (a)-(f) are required to submit the following information:

- Monitoring Entity's name, address, telephone number, contact person name and email address, and any other relevant contact information (Section 10928 (a) (1), 10928 (b) (1))
- Name, address, telephone number, email address and any other relevant contact information for entities collecting data that is submitted by a designated submitting entity (Monitoring Entity)
- Groundwater basins being monitored
    - Identify entire basins monitored
    - Identify partial basins monitored

Well Information

The following information about each well is required for the CASGEM online system:

- Unique well identification number. Agencies may use an existing State Well Number, an existing local well designation, or develop their own identification name, using the following protocol:
    - Agency name, abbreviation, or acronym followed by a sequential number (e.g., SGA 01)
    - Groundwater basin – followed by a sequential number (e.g., Llagas 03)
    - Geographic name – followed by a sequential number (e.g., Yolo 12)
    - Well names should be 15 characters long or less
    - Avoid using owner/business names or specific locational information for privacy and security
- Decimal latitude/longitude coordinates of well, using horizontal datum NAD83, and the method of determining coordinates (Actual coordinates are preferred; however, Monitoring Entities may submit approximate locations, as needed, to protect the privacy of well owners. For example, to protect the privacy of a well owner, a Monitoring Entity may submit well coordinate locations that are only within 1000-feet of the actual well location.)
- Groundwater basin or sub-basin
- Reference point elevation of the well (feet) using NAVD88 vertical datum
- Elevation of land surface datum at the well (feet) using NAVD88 vertical datum
- Use of well (e.g., dedicated monitoring, irrigation, domestic, etc)
- Well completion type (e.g. single well, nested, or multi-completion wells)
- Depth of screened interval(s) and total well depth of well, if available (feet)
- Well Completion Report number (DWR Form 188), if available

The following information about each well is recommended for the CASGEM online system:

- State Well Number – assigned by DWR in most cases
- Method by which land surface elevation was determined (for example, topographic map, GPS, etc.)
- Written description of location of well, including distance from nearby landmarks and location of reference point in relation to well appurtenances (DWR Form 429)
- Well information comments

Groundwater Elevation Information

The following information for each groundwater elevation measurement is required for the CASGEM online system:

- Well identification number (see Well Information, above)
- Measurement date
- Reference point elevation of the well (feet) using NAVD88 vertical datum
- Elevation of land surface datum at the well (feet) using NAVD88 vertical datum
- Depth to water below reference point (feet) (unless no measurement was taken)
- Method of measuring water depth
- Measurement Quality Codes

    - If no measurement is taken, a specified “no measurement” code, must be recorded. Standard codes will be provided by the online system. If a measurement is taken, a “no measurement” code is not recorded.)
    - If the quality of a measurement is uncertain, a “questionable measurement” code can be recorded. Standard codes will be provided by the online system. If no measurement is taken, a “questionable measurement” code is not recorded.)
- Measuring agency identification

The following information for each groundwater elevation measurement is recommended for the CASGEM online system:

- Measurement time (PST/PDT with military time/24 hour format)
- Comments about measurement, if applicable

Groundwater elevation data shall be submitted electronically to DWR’s online system. DWR will develop electronic data transmittal (EDT) alternatives and data standards to permit bulk data transfer and assist Monitoring Entities in EDT reporting to DWR. As stated above, if Monitoring Entities cannot use the standard form(s) or provide the necessary groundwater elevation data elements, DWR will work cooperatively with Monitoring Entities to develop alternate methods of submitting data.

The CASGEM online data submittal system will be compatible with the Water Data Library (WDL) (http://www.water.ca.gov/waterdatalibrary/), DWR’s existing groundwater elevation database. The CASGEM system will include data reporting options similar to those in WDL, such as hydrographs, seasonal contour data, and data downloads. The combined accessibility of the WDL and the CASGEM system will be a significant resource for local agencies in making sound groundwater management decisions.

REFERENCES

California Departement of Water Resources. (2003). *California's Groundwater, Bulletin 118-03.*

California Department of Water Resources. (2009). *California Water Plan Update 2009, Bulletin 160-09.*

APPENDIX – SENATE BILL 6 (7TH EXTRAORDINARY SESSION) - GROUNDWATER MONITORING

Senate Bill No. 6

CHAPTER 1

An act to add Part 2.11 (commencing with Section 10920) to Division 6 of, and to repeal and add Section 12924 of, the Water Code, relating to groundwater.

[Approved by Governor November 6, 2009. Filed with Secretary of State November 6, 2009.]

Legislative Counsel's Digest

SB 6, Steinberg. Groundwater.

(1) Existing law authorizes a local agency whose service area includes a groundwater basin that is not subject to groundwater management to adopt and implement a groundwater management plan pursuant to certain provisions of law. Existing law requires a groundwater management plan to include certain components to qualify as a plan for the purposes of those provisions, including a provision that establishes funding requirements for the construction of certain groundwater projects.

This bill would establish a groundwater monitoring program pursuant to which specified entities, in accordance with prescribed procedures, may propose to be designated by the Department of Water Resources as groundwater monitoring entities, as defined, for the purposes of monitoring and reporting with regard to groundwater elevations in all or part of a basin or subbasin, as defined. The bill would require the department to work cooperatively with each monitoring entity to determine the manner in which groundwater elevation information should be reported to the department. The bill would authorize the department to make recommendations for improving an existing monitoring program, and to require additional monitoring wells under certain circumstances. Under certain circumstances, the department would be required to perform groundwater monitoring functions. In that event, prescribed entities with authority to assume groundwater monitoring functions with regard to a basin or subbasin for which the department has assumed those functions would not be eligible for a water grant or loan awarded or administered by the state.

(2) Existing law requires the department to conduct an investigation of the state's groundwater basins and to report its findings to the Governor and the Legislature not later than January 1, 1980.

This bill would repeal that provision. The department would be required to conduct an investigation of the state's groundwater basins and to report its findings to the Governor and the Legislature not later than January 1, 2012, and thereafter in years ending in 5 or 0.

(3) The bill would take effect only if SB 1 and SB 7 of the 2009–10 7th Extraordinary Session of the Legislature are enacted and become effective.

The people of the State of California do enact as follows:

SECTION 1. Part 2.11 (commencing with Section 10920) is added to Division 6 of the Water Code, to read:

PART 2.11. GROUNDWATER MONITORING

Chapter 1. General Provisions

10920. (a) It is the intent of the Legislature that on or before January 1, 2012, groundwater elevations in all groundwater basins and subbasins be regularly and systematically monitored locally and that the resulting groundwater information be made readily and widely available.

(b) It is further the intent of the Legislature that the department continue to maintain its current network of monitoring wells, including groundwater elevation and groundwater quality monitoring wells, and that the department continue to coordinate monitoring with local entities.

10921. This part does not require the monitoring of groundwater elevations in an area that is not within a basin or subbasin.

10922. This part does not expand or otherwise affect the powers or duties of the department relating to groundwater beyond those expressly granted by this part.

Chapter 2. Definitions

10925. Unless the context otherwise requires, the definitions set forth in this section govern the construction of this part.

(a) “Basin” or “subbasin” means a groundwater basin or subbasin identified and defined in the department’s Bulletin No. 118.

(b) “Bulletin No. 118” means the department’s report entitled “California’s Groundwater: Bulletin 118” updated in 2003, or as it may be subsequently updated or revised in accordance with Section 12924.

(c) “Monitoring entity” means a party conducting or coordinating the monitoring of groundwater elevations pursuant to this part.

(d) “Monitoring functions” and “groundwater monitoring functions” means the monitoring of groundwater elevations, the reporting of those elevations to the department, and other related actions required by this part.

(e) “Monitoring groundwater elevations” means monitoring groundwater elevations, coordinating the monitoring of groundwater elevations, or both.

(f) “Voluntary cooperative groundwater monitoring association” means an association formed for the purposes of monitoring groundwater elevations pursuant to Section 10935.

Chapter 3. Groundwater Monitoring Program

10927. Any of the following entities may assume responsibility for monitoring and reporting groundwater elevations in all or a part of a basin or subbasin in accordance with this part:

(a) A watermaster or water management engineer appointed by a court or pursuant to statute to administer a final judgment determining rights to groundwater.

(b) (1) A groundwater management agency with statutory authority to manage groundwater pursuant to its principal act that is monitoring groundwater elevations in all or a part of a groundwater basin or subbasin on or before January 1, 2010.

(2) A water replenishment district established pursuant to Division 18 (commencing with Section 60000). This part does not expand or otherwise affect the authority of a water replenishment district relating to monitoring groundwater elevations.

(c) A local agency that is managing all or part of a groundwater basin or subbasin pursuant to Part 2.75 (commencing with Section 10750) and that was monitoring groundwater elevations in all or a part of a groundwater basin or subbasin on or before January 1, 2010, or a local agency or county that is managing all or part of a groundwater basin or subbasin pursuant to any other legally enforceable groundwater management plan with provisions that are substantively similar to those described in that part and that was monitoring groundwater elevations in all or a part of a groundwater basin or subbasin on or before January 1, 2010.

(d) A local agency that is managing all or part of a groundwater basin or subbasin pursuant to an integrated regional water management plan prepared pursuant to Part 2.2 (commencing with Section 10530) that includes a groundwater management component that complies with the requirements of Section 10753.7.

(e) A county that is not managing all or a part of a groundwater basin or subbasin pursuant to a legally enforceable groundwater management plan with provisions that are substantively similar to those described in Part 2.75 (commencing with Section 10750).

(f) A voluntary cooperative groundwater monitoring association formed pursuant to Section 10935.

10928. (a) Any entity described in subdivision (a) or (b) of Section 10927 that seeks to assume groundwater monitoring functions in accordance with this part shall notify the department, in writing, on or before January 1, 2011. The notification shall include all of the following information:

(1) The entity's name, address, telephone number, and any other relevant contact information.

(2) The specific authority described in Section 10927 pursuant to which the entity qualifies to assume the groundwater monitoring functions.

(3) A map showing the area for which the entity is requesting to perform the groundwater monitoring functions.

(4) A statement that the entity will comply with all of the requirements of this part.

(b) Any entity described in subdivision (c), (d), (e), or (f) of Section 10927 that seeks to assume groundwater monitoring functions in accordance with this part shall notify the department, in writing, by January 1, 2011. The information provided in the notification shall include all of the following:

(1) The entity's name, address, telephone number, and any other relevant contact information.

(2) The specific authority described in Section 10927 pursuant to which the entity qualifies to assume the groundwater monitoring functions.

(3) For entities that seek to qualify pursuant to subdivision (c) or (d) of Section 10927, the notification shall also include a copy of the current groundwater management plan or the groundwater component of the integrated regional water management plan, as appropriate.

(4) For entities that seek to qualify pursuant to subdivision (f) of Section 10927, the notification shall include a statement of intention to meet the requirements of Section 10935.

(5) A map showing the area for which the entity is proposing to perform the groundwater monitoring functions.

(6) A statement that the entity will comply with all of the requirements of this part.

(7) A statement describing the ability and qualifications of the entity to conduct the groundwater monitoring functions required by this part.
(c) The department may request additional information that it deems necessary for the purposes of determining the area that is proposed to be monitored or the qualifications of the entity to perform the groundwater monitoring functions.

10929. (a) (1) The department shall review all notifications received pursuant to Section 10928.

(2) Upon the receipt of a notification pursuant to subdivision (a) of Section 10928, the department shall verify that the notifying entity has the appropriate authority under subdivision (a) or (b) of Section 10927.

(3) Upon the receipt of a notification pursuant to subdivision (b) of Section 10928, the department shall do both of the following:

(A) Verify that each notification is complete.

(B) Assess the qualifications of the notifying party.

(b) If the department has questions about the completeness or accuracy of a notification, or the qualifications of a party, the department shall contact the party to resolve any deficiencies. If the department is unable to resolve the deficiencies, the department shall notify the party in writing that the notification will not be considered further until the deficiencies are corrected.

(c) If the department determines that more than one party seeks to become the monitoring entity for the same portion of a basin or subbasin, the department shall consult with the interested parties to determine which party will perform the monitoring functions. In determining which party will perform the monitoring functions under this part, the department shall follow the order in which entities are identified in Section 10927.

(d) The department shall advise each party on the status of its notification within three months of receiving the notification.

10930. Upon completion of each review pursuant to Section 10929, the department shall do both of the following if it determines that a party will perform monitoring functions under this part:

(a) Notify the party in writing that it is a monitoring entity and the specific portion of the basin or subbasin for which it shall assume groundwater monitoring functions.

(b) Post on the department's Internet Web site information that identifies the monitoring entity and the portion of the basin or subbasin for which the monitoring entity will be responsible.

10931. (a) The department shall work cooperatively with each monitoring entity to determine the manner in which groundwater elevation information should be reported to the department pursuant to this part. In determining what information should be reported to the department, the department shall defer to existing monitoring programs if those programs result in information that demonstrates seasonal and long-term trends in groundwater elevations. The department shall collaborate with the State Department of Public Health to ensure that the information reported to the department will not result in the inappropriate disclosure of the physical address or geographical location of drinking water sources, storage facilities, pumping operational data, or treatment facilities.

(b) (1) For the purposes of this part, the department may recommend improvements to an existing monitoring program, including recommendations for additional monitoring wells.

(2) The department may not require additional monitoring wells unless funds are provided for that purpose.

10932. Monitoring entities shall commence monitoring and reporting groundwater elevations pursuant to this part on or before January 1, 2012.

10933. (a) On or before January 1, 2012, the department shall commence to identify the extent of monitoring of groundwater elevations that is being undertaken within each basin and subbasin.

(b) The department shall prioritize groundwater basins and subbasins for the purpose of implementing this section. In prioritizing the basins and subbasins, the department shall, to the extent data are available, consider all of the following:

(1) The population overlying the basin or subbasin.

(2) The rate of current and projected growth of the population overlying the basin or subbasin.

(3) The number of public supply wells that draw from the basin or subbasin.

(4) The total number of wells that draw from the basin or subbasin.

(5) The irrigated acreage overlying the basin or subbasin.

(6) The degree to which persons overlying the basin or subbasin rely on groundwater as their primary source of water.

(7) Any documented impacts on the groundwater within the basin or subbasin, including overdraft, subsidence, saline intrusion, and other water quality degradation.

(8) Any other information determined to be relevant by the department.

(c) If the department determines that all or part of a basin or subbasin is not being monitored pursuant to this part, the department shall do all of the following:

(1) Attempt to contact all well owners within the area not being monitored.

(2) Determine if there is an interest in establishing any of the following:

(A) A groundwater management plan pursuant to Part 2.75 (commencing with Section 10750).

(B) An integrated regional water management plan pursuant to Part 2.2 (commencing with Section 10530) that includes a groundwater management component that complies with the requirements of Section 10753.7.

(C) A voluntary groundwater monitoring association pursuant to Section 10935.

(d) If the department determines that there is sufficient interest in establishing a plan or association described in paragraph (2) of subdivision (c), or if the county agrees to perform the groundwater monitoring functions in accordance with this part, the department shall work cooperatively with the interested parties to comply with the requirements of this part within two years.

(e) If the department determines, with regard to a basin or subbasin, that there is insufficient interest in establishing a plan or association described in paragraph (2) of subdivision (c), and if the county decides not to perform the groundwater monitoring and reporting functions of this part, the department shall do all of the following:

(1) Identify any existing monitoring wells that overlie the basin or subbasin that are owned or operated by the department or any other state or federal agency.

(2) Determine whether the monitoring wells identified pursuant to paragraph (1) provide sufficient information to demonstrate seasonal and long-term trends in groundwater elevations.

(3) If the department determines that the monitoring wells identified pursuant to paragraph (1) provide sufficient information to demonstrate seasonal and long-term trends in groundwater elevations, the department shall not perform groundwater monitoring functions pursuant to Section 10934.

(4) If the department determines that the monitoring wells identified pursuant to paragraph (1) provide insufficient information to demonstrate seasonal and long-term trends in groundwater elevations, and the State Mining and Geology Board concurs with

that determination, the department shall perform groundwater monitoring functions pursuant to Section 10934.[1]

10933.5. (a) Consistent with Section 10933, the department shall perform the groundwater monitoring functions for those portions of a basin or subbasin for which no monitoring entity has agreed to perform the groundwater monitoring functions.

(b) Upon determining that it is required to perform groundwater monitoring functions, the department shall notify both of the following entities that it is forming the groundwater monitoring district:

(1) Each well owner within the affected area.

(2) Each county that contains all or a part of the affected area.

(c) The department shall not assess a fee or charge to recover the costs for carrying out its power and duties under this part.

(d) The department may establish regulations to implement this section.

10933.7. (a) If the department is required to perform groundwater monitoring functions pursuant to Section 10933.5, the county and the entities described in subdivisions (a) to (d), inclusive, of Section 10927 shall not be eligible for a water grant or loan awarded or administered by the state.

(b) Notwithstanding subdivision (a), the department shall determine that an entity described in subdivision (a) is eligible for a water grant or loan under the circumstances described in subdivision (a) if the entity has submitted to the department for approval documentation demonstrating that its entire service area qualifies as a disadvantaged community.

10934. (a) For purposes of this part, neither any entity described in Section 10927, nor the department, shall have the authority to do either of the following:

(1) To enter private property without the consent of the property owner.

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[1] The reference in Section 10933(e)(4) to Section 10934 has been amended by Stats. 2010, Ch. 328, sec. 237 (S.B. 1330). The new reference will be to Section 10933.5.

(2) To require a private property owner to submit groundwater monitoring information to the entity.

(b) This section does not apply to a county or an entity described in subdivisions (a) to (d), inclusive, of Section 10927 that assumed responsibility for monitoring and reporting groundwater elevations prior to the effective date of this part.

10935. (a) A voluntary cooperative groundwater monitoring association may be formed for the purposes of monitoring groundwater elevations in accordance with this part. The association may be established by contract, a joint powers agreement, a memorandum of agreement, or other form of agreement deemed acceptable by the department.

(b) Upon notification to the department by one or more entities that seek to form a voluntary cooperative groundwater monitoring association, the department shall work cooperatively with the interested parties to facilitate the formation of the association.

(c) The contract or agreement shall include all of the following:

(1) The names of the participants.

(2) The boundaries of the area covered by the agreement.

(3) The name or names of the parties responsible for meeting the requirements of this part.

(4) The method of recovering the costs associated with meeting the requirements of this part.

(5) Other provisions that may be required by the department.

10936. Costs incurred by the department pursuant to this chapter may be funded from unallocated bond revenues pursuant to paragraph (12) of subdivision (a) of Section 75027 of the Public Resources Code, to the extent those funds are available for those purposes.

SEC. 2. Section 12924 of the Water Code is repealed.

SEC. 3. Section 12924 is added to the Water Code, to read:

12924. (a) The department, in conjunction with other public agencies, shall conduct an investigation of the state's groundwater basins. The department shall identify the state's groundwater basins on the basis of geological and hydrological conditions and consideration of political boundary lines whenever practical. The department shall also investigate existing general patterns of groundwater pumping and groundwater recharge within those basins to the extent necessary to identify basins that are subject to critical conditions of overdraft.

(b) The department shall report its findings to the Governor and the Legislature not later than January 1, 2012, and thereafter in years ending in 5 or 0.

SEC. 4. This act shall take effect only if Senate Bill 1 and Senate Bill 7 of the 2009–10 Seventh Extraordinary Session of the Legislature are enacted and become effective.

Chapter 4
Appendix B

USGS Groundwater Data Collection Protocols and Procedures for the National Water-Quality Assessment Program: Collection and Documentation of Water-Quality Samples and Related Data

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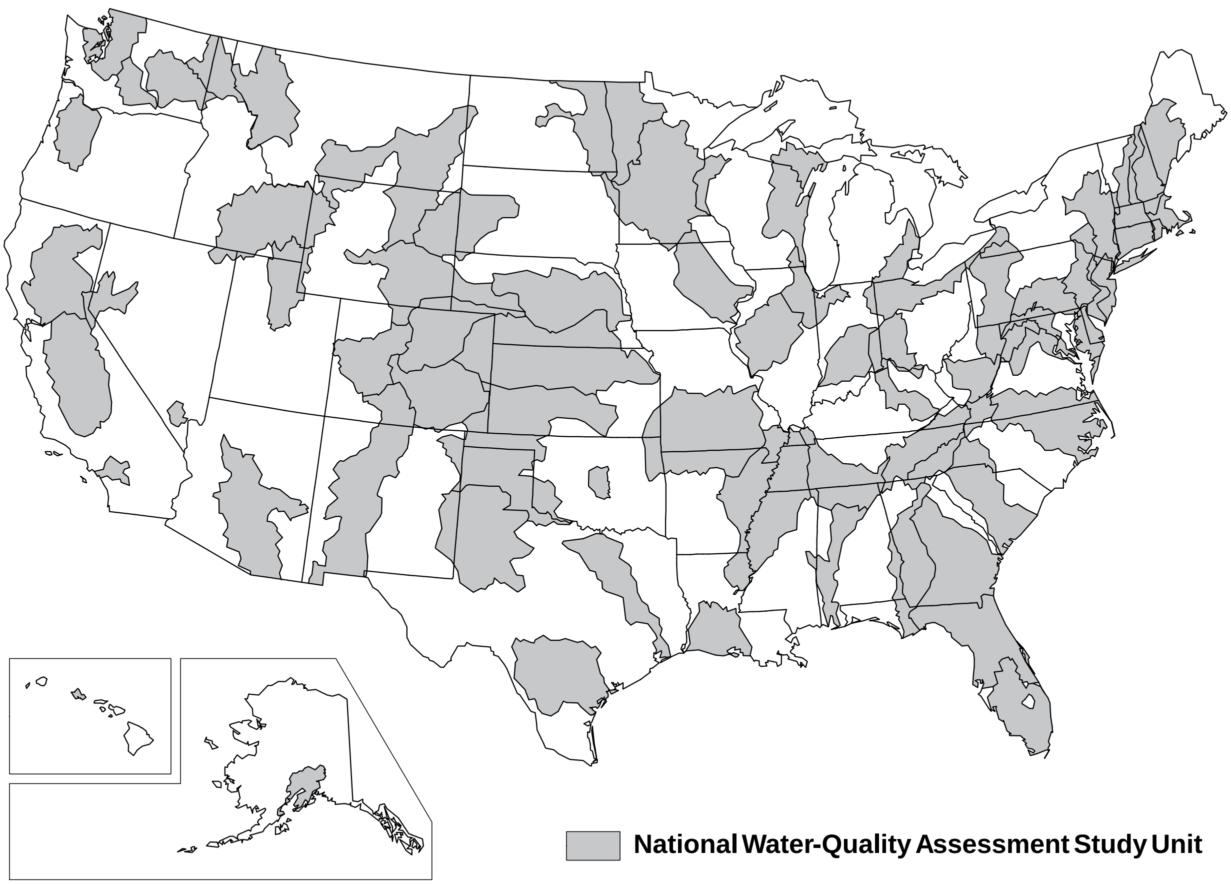
GROUND-WATER DATA-COLLECTION PROTOCOLS AND PROCEDURES FOR THE NATIONAL WATER-QUALITY ASSESSMENT PROGRAM: COLLECTION AND DOCUMENTATION OF WATER-QUALITY SAMPLES AND RELATED DATA

U.S. GEOLOGICAL SURVEY

Open-File Report 95-399



NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

GROUND-WATER DATA-COLLECTION PROTOCOLS AND PROCEDURES FOR THE NATIONAL WATER-QUALITY ASSESSMENT PROGRAM: COLLECTION AND DOCUMENTATION OF WATER-QUALITY SAMPLES AND RELATED DATA

By Michael T. Koterba, Franceska D. Wilde, and Wayne W. Lapham

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U.S. Geological Survey

Open-File Report 95-399

Reston, Virginia
1995

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

Seal

U.S. GEOLOGICAL SURVEY

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FOREWORD

The mission of the U.S. Geological Survey (USGS) is to assess the quantity and quality of the earth resources of the Nation and to provide information that will assist resource managers and policymakers at Federal, State, and local levels in making sound decisions. Assessment of water-quality conditions and trends is an important part of this overall mission.

One of the greatest challenges faced by water-resources scientists is acquiring reliable information that will guide the use and protection of the Nation's water resources. That challenge is being addressed by Federal, State, interstate, and local water-resource agencies and by many academic institutions. These organizations are collecting water-quality data for a host of purposes that include: compliance with permits and water-supply standards; development of remediation plans for specific contamination problems; operational decisions on industrial, wastewater, or water-supply facilities; and research on factors that affect water quality. An additional need for water-quality information is to provide a basis on which regional- and national-level policy decisions can be based. Wise decisions must be based on sound information. As a society we need to know whether certain types of water-quality problems are isolated or ubiquitous, whether there are significant differences in conditions among regions, whether the conditions are changing over time, and why these conditions change from place to place and over time. The information can be used to help determine the efficacy of existing water-quality policies and to help analysts determine the need for and likely consequences of new policies.

To address these needs, the U.S. Congress appropriated funds in 1986 for the USGS to begin a pilot program in seven project areas to develop and refine the National Water-Quality Assessment (NAWQA) Program. In 1991, the USGS began full implementation of the program. The NAWQA Program builds upon an existing base of water-quality studies of the USGS, as well as those of other Federal, State, and local agencies. The objectives of the NAWQA Program are to:

- Describe current water-quality conditions for a large part of the NationÕs freshwater streams, rivers, and aquifers.
- Describe how water quality is changing over time.
- Improve understanding of the primary natural and human factors that affect water-quality conditions.

This information will help support the development and evaluation of management, regulatory, and monitoring decisions by other Federal, State, and local agencies to protect, use, and enhance water resources.

The goals of the NAWQA Program are being achieved through ongoing and proposed investigations of 60 of the Nation's most important river basins and aquifer systems, which are referred to as study units. These study units are distributed throughout the Nation and cover a diversity of hydrogeologic settings. More than two-thirds of the Nation's freshwater use occurs within the 60 study units and more than two-thirds of the people served by public water-supply systems live within their boundaries.

National synthesis of data analysis, based on aggregation of comparable information obtained from the study units, is a major component of the program. This effort focuses on selected water-quality topics using nationally consistent information. Comparative studies will explain differences and similarities in observed water-quality conditions among study areas and will identify changes and trends and their causes. The first topics addressed by the national synthesis are pesticides, nutrients, volatile organic compounds, and aquatic biology. Discussions on these and other water-quality topics will be published in periodic summaries of the quality of the Nation's ground and surface water as the information becomes available.

This report is an element of the comprehensive body of information developed as part of the NAWQA Program. The program depends heavily on the advice, cooperation, and information from many Federal, State, interstate, Tribal, and local agencies and the public. The assistance and suggestions of all are greatly appreciated.

(signed)

Robert M. Hirsch
Chief Hydrologist

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CONVERSION FACTORS AND ABBREVIATIONS

Multiply	By	To obtain
	Length	
inch (in)	25.4	millimeter
	2.54	centimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	2.590	square kilometer
	Volume	
gallon (gal)	3.785	liter
	3785	milliliter
	Flow	
gallon per minute (gal/min)	0.06308	liter per second

Physical and Chemical Water-Quality Units

Temperature: Water and air temperature are given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by use of the following equation:

$$°F = 1.8(°C) + 32$$

Specific electrical conductance of water is expressed in microsiemens per centimeter at 25 degrees Celsius (µS/cm). This unit is equivalent to micromhos per centimeter at 25 degrees Celsius.

method detection limit (MDL): The minimum concentration of a substance that can be identified, measured, and reported with 99-percent confidence that the analyte concentration is greater than zero; determined from analysis of a sample in a given matrix containing analtye.

minimum reporting level (MRL): The smallest measured concentration of a constituent that may be reliably reported using a given analytical method. In many cases, the MRL is used when documentation for the method detection limit is not available.

micrometer (µm), or "micron": The millionth part of the meter--the pore diameter of filter membranes is given in micrometer units.

milligrams per liter (mg/L) or micrograms per liter (µg/L): Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) or water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million.

millivolt (mV): A unit of electromotive force equal to one thousandth of a volt.

nephelometric turbidity unit (NTU): A measure of turbidity in a water sample, roughly equivalent to Formazin turbidity unit (FTU) and Jackson turbidity unit (JTU).

normality, *N* (equivalents/L): The number of equivalents of acid, base, or redox-active species per liter of solution. Examples: a solution that is 0.01 formal in HCl is 0.01 *N* in H^+. A solution that is 0.01 formal in H_2SO_4 is 0.02 *N* in H^+.

GROUND-WATER DATA-COLLECTION PROTOCOLS AND PROCEDURES FOR THE NATIONAL WATER-QUALITY ASSESSMENT PROGRAM: COLLECTION AND DOCUMENTATION OF WATER-QUALITY SAMPLES AND RELATED DATA

By Michael T. Koterba, Franceska D. Wilde, and Wayne W. Lapham

ABSTRACT

Protocols for ground-water sampling are described in a report written in 1989 as part of the pilot program for the National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey (USGS). These protocols have been reviewed and revised to address the needs of the full-scale implementation of the NAWQA Program that began in 1991. This report, which is a collaborative effort between the NAWQA Program and the USGS Office of Water Quality, is the result of that review and revision.

This report describes protocols and recommended procedures for the collection of water-quality samples and related data from wells for the NAWQA Program. Protocols and recommended procedures discussed include (1) equipment setup and other preparations for data collection; (2) well purging and field measurements; (3) collecting and processing ground-water-quality samples; (4) equipment decontamination; (5) quality-control sampling; and (6) sample handling and shipping.

INTRODUCTION

The full-scale implementation of the National Water-Quality Assessment (NAWQA) Program in 1991 required updating the ground-water protocols prepared for the NAWQA pilot program (Hardy and others, 1989) and more detailed information for collecting ground-water-quality data in the NAWQA Program. That effort has resulted in this report and a companion report by Lapham and others (in press). Broader based reports that establish and document ground-water data-collection protocols and procedures for all U.S. Geological Survey (USGS) programs include Radtke and Wilde (in press) and two planned companion reports.[1]

This report describes protocols and recommended procedures for collecting ground-water-quality samples and related data (hereafter referred to as ground-water-quality data) specifically for the Occurrence and Distribution Assessment component of the full-scale NAWQA Program. In addition to updating and expanding the report by Hardy and others (1989), this report complements other reports prepared for the NAWQA Program, including those that describe NAWQA well installation, selection, and documentation (Lapham and others, in press), design of the NAWQA Program (Gilliom and others, 1995; Alley and Cohen, 1991), the conceptual

[1]For further information about the status of these planned reports contact the Office of Water Quality, U.S. Geological Survey, 412 National Center, Reston, VA 22092.

framework of the NAWQA Program (Leahy and Wilber, 1991; Hirsch and others, 1988; Cohen and others, 1988), an implementation plan for the NAWQA Program (Leahy and others, 1990), and a description of a quality-assurance (administrative) plan for the NAWQA pilot program (Mattraw and others, 1989).

For the purposes of this report, a protocol identifies a course of action that is mandatory under most circumstances as a consequence of USGS and NAWQA policies. For example, the routine collection of quality-control samples throughout the period during which ground-water-quality data are being collected is a protocol, and the requirement that equipment be decontaminated between uses according to prescribed methods to avoid cross-contamination of water-quality samples and the wells being sampled is a protocol. A recommended procedure is one that generally is preferred over other procedures that are available or commonly used. A procedure generally is recommended for the purpose of conforming to rules for good field practices and is expected to result in reproducible data of a desired and defined quality. Recommended procedures are not protocols because they are either too restrictive or possibly inappropriate in some situations. For example, one recommended procedure is to measure the water level in the well before ground-water-quality data are collected; this is not possible for some water-supply wells. Another recommended procedure is that equipment decontamination, which is required, be conducted in the field immediately after use; this, however, is not possible for some field-site conditions.

Although modifications are likely as new technologies evolve, the protocols and recommended procedures for data collection and documentation described in this report are considered capable of producing representative data of known quality that are suitable for assessment, while also being feasible to employ, given limitations of time and funds. Their use promotes consistency and comparability of ground-water data among Study Units in the NAWQA Program.

Background

The USGS began full-scale implementation of the NAWQA Program in 1991. The goals of the NAWQA Program are to (1) provide a nationally consistent description of current water-quality conditions for a large part of the Nation's water resources; (2) define long-term trends in water quality; and (3) identify, describe, and explain major factors that could affect observed water-quality conditions and trends (Hirsch and others, 1988).

The design concepts of the NAWQA Program are based in part on a pilot program that began in 1986. The NAWQA pilot program consisted of seven Study Units conducting water-quality assessment in separate study areas. These study areas were distributed geographically throughout the continental United States and represented diverse hydrologic environments and water-quality conditions. Four of the pilot assessments focused on surface water and three focused on ground water. The ground-water pilot study areas were the Carson River Basin in Nevada and California (Welch and Plume, 1987); the Central Oklahoma Aquifer in Oklahoma (Christenson and Parkhurst, 1987); and the Delmarva Peninsula in Delaware, Maryland, and Virginia (Bachman and others, 1987).

The NAWQA Program design that has evolved from the pilot program consists of two major components: (1) Study-Unit Investigations of both surface and ground water, and (2) National Assessment activities, which combine results of individual Study Units for selected topics. This design provides information on water quality for policymakers and managers at local, State, regional, and national scales.

Components and attributes of the current ground-water-sampling design for a Study Unit are described in Lapham and others (in press) and Gilliom and others (1995). In brief, for the full-scale NAWQA Program, investigations of 60 Study Units, ranging in area from 1,200 to more than 60,000 square miles, are ongoing or planned. The 60 Study Units include parts of most of the major river basins and aquifer systems in the Nation, and incorporate about 60 to 70 percent of the Nation's water use and population served by public water supply. Investigations in each Study Unit are being conducted on a rotational rather than a continuous basis. One-third of the Study Units are being studied intensively at any given time. For each Study Unit, a 3- to 4-year intensive period of data collection and analysis will be alternated with a 6- to 7-year period of low-intensity assessment activities. The first intensive period of study for 20 of the 60 Study Units, which is referred to as the Occurrence and Distribution Assessment, began in 1993.

Data from each Occurrence and Distribution Assessment will be aggregated and compared for selected topics from all Study Units, as well as from other programs, to obtain regional and national perspectives on water quality. Consistent methods of data collection by the Study Units are needed for comparability of data. The protocols and recommended procedures described in this report are intended to ensure that consistency.

Purpose and Scope

This report describes protocols and recommended procedures to be used by the NAWQA Program for the collection of ground-water-quality data from wells. Protocols and recommended procedures discussed relate to the plans and preparations for ground-water sampling, and the collecting, processing, and handling of ground-water samples, including well purging, field measurements taken during purging, equipment decontamination, quality-control sampling, and sample documentation, handling, and shipping. Quality-assurance protocols and procedures are incorporated for each data-collection activity.

Quality Assurance and Quality Control

In this report, quality assurance refers to activities that control or guide data-collection methods, such as protocols, recommended procedures, and work plans and schedules. Quality control refers to the data or measurements generated to quantify measurement bias and variability associated with the data-collection process. The quality assurance (QA) activities and quality control (QC) data associated with NAWQA protocols and recommended procedures described in this report are best carried out as an integral part of the plans, preparations, implementation, and documentation used to obtain ground-water-quality data (Shampine and others, 1992). To emphasize the importance of an integrated approach, and the need for all NAWQA ground-water staff to participate, the protocols and recommended procedures that relate to QA and QC appear throughout this report in relation to a variety of responsibilities and activities, rather than being segregated in a separate section.

An integrated approach to QA and QC helps to clarify what needs to be done, when, and by whom through QA activities that are logically and efficiently coordinated with other activities and through the collection of data to assess that the ground-water data collected are of a quality suitable for Study-Unit and National Assessments. In order of discussion, the data-quality requirements for NAWQA ground-water sampling and the role of QC sampling are described in "Data-Quality Requirements." Equipment and supplies specific to QC sampling are described, along with those generally required to obtain water-quality data, in "Selection and Purchase of Equipment and Supplies." The QA requirements for field instruments and water-quality vehicles are incorporated under the respective topics (see "Field Instruments" and "Water-Quality Vehicles"). The design for selecting QC sample types and scheduling their collection are described immediately following the discussion of the design of water-quality sampling schedules.

Protocols and recommended procedures to be followed in collecting QC samples are incorporated as part of a number of activities that occur in chronological order and that define the overall data-collection process at a well. For example, the collection of replicate ground-water samples is described after well purging, and as part of the discussion on the collection of water-quality samples (see "Sample Collection and Processing"), whereas the collection of field blanks is described after equipment decontamination (see "Preparation of Blank Samples"). Preparing special types of samples, including QC samples such as field spikes, is described after the section on field blanks because that is when field-spiked samples for pesticides and volatile organic compounds will be prepared (see "Preparation of Other Routine Quality-Control Samples and Field Extracts of Pesticide Samples"). Finally, documentation activities relating directly to QA and QC are described throughout this report.

Although this report includes many QA-QC protocols and recommended procedures, it does not replace the need for individual Study Units to assess, review, and possibly expand on those described. Study Units are encouraged to publish their QA-QC plans and results independent of any work performed at the national level of the NAWQA Program, and as appropriate for their particular needs.

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COLLECTION AND DOCUMENTATION OF WATER-QUALITY SAMPLES AND RELATED DATA

Ground-water-quality data for the Occurrence and Distribution Assessment of the NAWQA Program are to be collected and documented in accordance with the specific protocols and recommended procedures described in this report and in Lapham and others (in press). Protocols and recommended procedures are provided that cover plans and preparations, collection methods, and the documentation of activities before, during, and after water-quality data are collected. The principles underlying these protocols and recommended procedures have been shown to produce data suitable for the Occurrence and Distribution Assessments of NAWQA in selected pilot areas (Christenson and Rea, 1993; Hamilton and others, 1993; Koterba and others, 1993; and Rea, in press).

The NAWQA ground-water protocols and recommended procedures are applicable for data commonly collected for all three ground-water components (Study-Unit Surveys, Land-Use Studies, and Flowpath Studies) of the NAWQA Program (table 1). Although they are consistent with general guidelines for USGS ground-water data collection (F.D. Wilde, U.S. Geological Survey, written commun., 1995--see footnote 1), these protocols and recommended procedures reflect NAWQA Program objectives, and could differ in some aspects from those of other USGS programs. In particular, because of the perennial nature of the NAWQA Program, methods used by individual Study Units are constrained by the need for national consistency in the quality of data collected and by the degree and type of documentation required.

Data-Quality Requirements

The importance of national consistency in data collection cannot be overstated. Inconsistent methods can lead to variable and biased data measurements.[2] Modifications to collection and analytical methods potentially result in data whose measurements vary or are biased in relation to previously collected data. If not quantified and documented, such modifications complicate trend analysis (Smith and Alexander, 1989).

The protocols and recommended procedures for NAWQA are designed to reduce inconsistencies and enhance the quality of data used in spatial and trend analysis. The purpose of data-quality requirements is to ensure that data-collection methods are consistent, and that the data obtained meet study needs. The NAWQA Program has three requirements related to sample collection: (1) document the methods used to collect ground-water-quality data and all quality-assurance and quality-control measures, (2) ensure that the quality of data collected is known, and (3) demonstrate that the quality of data obtained is suitable for assessment objectives. In meeting these requirements, it is necessary that data-collection and analytical methods be designed, planned, and executed as consistently as possible. This will help reduce bias and variability among the data collected within a single Study Unit and among Study Units.

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[2]The term “bias” is defined in this report as a systematic error that is manifested as a consistent positive or negative deviation from the known or true value. “Variability” is defined as measurement reproducibility or the degree of similarity among independent measurements of the same quantity, often measured as a variance or relative standard deviation and without reference to the known probable or true value.

Table 1. Summary of current (1995) required, recommended, and optional water-quality constituents to be measured in the three ground-water components of the Occurrence and Distribution Assessment, National Water-Quality Assessment Program (from Lapham and others, in press)

[Required water-quality constituents to be measured for the Occurrence and Distribution Assessment are determined partly by the water-quality topics of national interest selected for National Assessment. Topics selected for National Assessment (1994) are nutrients, pesticides, and volatile organic compounds. The topics selected can change over time. Quality-control samples also are required - types of quality-control samples depend on study component. Req, Required; Rec, Recommended; Opt, Optional; NWQL, National Water Quality Laboratory; SC, Schedule; LC, Laboratory Code]

Water-quality constituent or constituent class	Study-Unit Survey	Land-Use Studies	Flowpath Studies[1]	Method[2]
Field measurements				
- Temperature	Req	Req	Req	Field
- Specific electrical conductance	Req	Req	Req	Field
- pH	Req	Req	Req	Field
- Dissolved oxygen	Req	Req	Req	Field
- Acid neutralizing capacity (ANC) (unfiltered sample)[3]	Rec	Rec	Rec	Field incremental
- Alkalinity (filtered sample)[3]	Req	Req	Req	Field incremental
- Turbidity[4]	Rec	Rec	Rec	Field
Major inorganics	Req	Req	Req	NWQL SC2750
Nutrients	Req	Req	Req	NWQL SC2752
Filtered organic carbon	Req	Req	Opt	NWQL SC2085
Pesticides	Req	Req	Opt	NWQL SC2001/2010 NWQL SC2050/2051
Volatile organic compounds (VOCs)	Req	Req or Opt[5]	Req or Opt[6]	NWQL SC 2090
Radon	Req	Req or Rec[7]	Req or Rec[6]	NWQL LC 1369
Trace elements[4]	Opt	Opt	Opt	NWQL SC 2703
Radium	Opt	Opt	Opt	NWQL-Opt
Uranium	Opt	Opt	Opt	NWQL-Opt
Tritium, tritium-helium, chlorofluorocarbons (CFCs)[8]	Rec	Rec	Rec	NWQL LC1565 (tritium)
Environmental isotopes[9]	Rec	Rec	Rec	NWQL-Opt

Table 1. Summary of current (1995) required, recommended, and optional water-quality constituents to be measured in the three ground-water components of the Occurrence and Distribution Assessment, National Water-Quality Assessment Program (from Lapham and others, in press)--Continued

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[1]Selection of constituents for measurement in Flowpath Studies is determined by Flowpath-Study objectives. During at least the first round of sampling, however, the broad range of constituents measured in Study-Unit Surveys and Land-Use Studies will be measured.

[2]Schedules and laboratory codes listed are required for Study Units that began their intensive phase in 1991 or 1994, and apply until changed by National Program directive. Schedules for radium and uranium can be selected by the Study Unit, but require NAWQA Quality-Assurance Specialist approval. A detailed discussion is found in the "Sample Collection and Processing" section of this report.

[3]ANC (formerly referred to as unfiltered alkalinity) is measured on an unfiltered sample. Alkalinity is measured on a filtered sample. A Study Unit could have collected ANC, alkalinity, or both to date.

[4]Turbidity measurements are required whenever trace-element samples are collected to evaluate potential colloidal contributions to measured concentrations of iron, manganese, and other elements.

[5]VOCs are required at all urban Land-Use Study wells, but are optional in agricultural Land-Use Studies. If VOCs are chosen as part of an agricultural Land-Use Study, then they should be measured in at least 20 of the Land-Use Study wells.

[6]VOCs are required at all urban flowpath wells for at least the first round of sampling. If VOCs are measured in an agricultural Land-Use Study, then they should be measured at all Flowpath-Study wells within that Land-Use Study for at least the first round of sampling.

[7]Radon is required at any Land-Use or Flowpath Study well if that well also is part of a Study-Unit Survey; otherwise radon collection is recommended for Land-Use or Flowpath-Study wells located in likely source areas.

[8]Collection of tritium, tritium-helium, chlorofluorocarbons (CFCs), and (or) other samples for dating ground water is recommended, depending on the hydrogeologic setting. For tritium methods, see NWQL catalog; for CFCs, see Office of Water Quality Technical Memorandum No. 95.02 (unpublished document located in the USGS Office of Water Quality, MS 412, Reston, VA 22092).

[9]For a general discussion of the use of environmental isotopes in ground-water studies, see Alley (1993).

This report comprises a substantial part of the documentation requirement. Because of diverse site conditions, well types, equipment requirements, and staff experience, situations could arise where NAWQA protocols and recommended procedures described in this report need to be modified. Modifications at the program level will be made in a systematic manner and initially documented through internal, regional, or national memorandums. For modifications internal to Study Units, the chief of the Study Unit is responsible for ensuring that the proposed modification is discussed with the NAWQA Program Quality-Assurance (QA) Specialist before implementation, and that any modifications used are clearly documented in Study-Unit publications. It also is necessary for the NAWQA Program or individual Study Units to provide evidence of the effect, or lack thereof, of modifications on data quality.

To ensure data quality and suitability (the second and third data-quality requirements) each Study Unit will routinely follow protocols and recommended procedures that are described in detail in the following sections. The QA-QC measures include (1) the collection of selected QC samples in the field to test equipment and methods before data collection begins, and (2) the routine collection of selected QC samples (such as blanks, replicates, and spiked replicate samples) during ground-water-quality sampling. Additional QC samples and QA measures will be taken if modifications in methods of sample and data collection occur that require quantification.

Individual NAWQA Study Units or National Synthesis teams may find it necessary to expand QC data collection to identify specific sources of measurement bias or variability. In addition, it has been necessary in some cases to enhance collection of QC data in order to interpret the corresponding ground-water-quality data (Koterba and others, 1991; Ferree and others, 1992; and Koterba and others, 1994). Study-Unit and National-Synthesis-Team budgets, plans, and preparations need to remain flexible to allow for the possibility that additional QC data could be needed.

Plans and Preparations

Plans and preparations for ground-water sampling are completed well in advance of data-collection activities, yet must remain flexible enough to be modified if circumstances dictate. Preparations include becoming familiar with the protocols and recommended procedures described in this document. Sampling equipment and supplies need to be obtained in time for sampling and for the staff to be trained in their use. The ground-water staff also needs to become familiar with and develop the documentation and management of samples and data, including that for QC samples. Finally, the ground-water staff should make detailed plans and preparations for the first field season, which for most Study Units commonly will begin early in the first year of the Occurrence and Distribution Assessment.

As the Study-Unit Investigation progresses, subsequent plans and preparations for each field season are required annually, and are developed as part of the general workplan. Study Units commonly will complete preparations for sampling several weeks in advance of each field season. Documenting site conditions, water-quality data collection, and reviewing collected data are processes that begin before each field season, continue during data collection, and often extend months beyond each field season.

Five key elements to consider in the initial and (in some cases) annual plans and preparations include (1) site visits to assess conditions that could affect sample and data collection; (2) selecting and obtaining sampling equipment and supplies early, to ensure that those eventually used best meet field conditions and fall within NAWQA Program requirements or recommendations; (3) training, to prepare field teams; (4) conducting a field evaluation, to determine that the equipment and procedures will provide high-quality data and that planned documentation and management activities are adequate; and (5) developing detailed schedules that clearly describe staff responsibilities before, during, and after each field season. Each of these planning and preparation elements is described below in detail.

Site Visits

Wells selected or installed for each ground-water component are visited at least once before sampling. During this or any other visit, site data are reviewed to determine if information is needed to (1) complete documentation requirements (Lapham and others, in press), and (2) plan water-quality sampling activities (table 2). In addition, plans currently (1995) are being developed for screening wells for high concentrations (10 µg/L or greater) of volatile-organic-compound (VOC) contamination (John Zogorski, VOC National Synthesis Team, U.S. Geological Survey, written commun., 1995). This could add to the information that needs to be collected during these site visits for selected wells sampled after 1995.

Selection and Purchase of Equipment and Supplies

Because of the need to obtain nationally consistent data over many years on a wide variety of chemical constituents (table 1), most equipment and supplies not provided by the Study Unit generally should be obtained from one of three USGS suppliers: the Hydrologic Instrumentation Facility, Quality Water Service Unit, and National Water Quality Laboratory (table 3). Each of these suppliers offers the advantage of stocking equipment that otherwise would have to be obtained from multiple sources. These suppliers also conduct QC checks and provide QC data for selected supplies and equipment distributed to USGS personnel. For these reasons, these suppliers are designated as the required or sole-source supplier for such items (table 3, USGS supplier with “S” designation). The USGS suppliers also are recommended as sources for other equipment (table 3, USGS supplier with “R” designation) in order to reduce the time, effort, paperwork, and cost to the Study Unit to locate and obtain equipment. Should the need arise, each supplier also can provide equipment not previously available.

Table 2. Information to obtain when planning water-quality data-collection activities

1. **Type of Well Hookup for Sampling:** Determine if a hookup to a garden-hose-threaded flow valve (common for water-supply wells) or to a portable, submersible pump (common for monitoring wells) is needed for sample collection.

2. **Depth Measurements**: Measure the depth of the well and depth to the water level in the well to check well-construction integrity and to determine pump lift, height of water column, volume of standing water held in the well, and purge volume.[1]

3. **Site Conditions and Restrictions:** Note road or access conditions to the well, areas of low clearance, limits on arrival and departure times, or presence of roaming animals (for example, livestock or pets) that could create problems for a field team.

4. **Contact Person**: Obtain land- or well-owner name and telephone numbers (business and home) and contact owner before or upon arrival, and perhaps upon departure.

5. **Local Maps and Photographs**: Locate well on maps, site sketches, or photographs, and indicate the measuring point for well-depth measurements, as well as areas for equipment setup and waste discharge.

6. **Travel Maps and Travel Times**: Identify route and travel times from District office or previous site, and possible tunnel or bridge restrictions on the transport of gasoline, bottled gas, or methanol (or other organic cleaning agent).

[1]Measurements are made in accordance with National Water-Quality Assessment Program and U.S. Geological Survey protocols (Lapham and others, in press). Purge volume is defined as three times the volume of standing water in the well casing or, in absence of a casing, the borehole.

Table 3. Equipment, supplies, and suppliers for ground-water-quality sampling for the National Water-Quality Assessment Program

[OM, open market; HIF, U.S. Geological Survey Hydrologic Instrument Facility, Stennis Space Center, Miss.; R, recommended supplier; QWSU, Quality Water Service Unit, Ocala, Fla,; SU, Study Unit; µm, micrometer; mm, millimeter; S, sole (required) source of supplies indicated; NWQL, National Water Quality Laboratory, Arvada, Colo.; mL, milliliter; L, liter; ASTM, American Society for Testing and Materials; SC, NWQL analytical schedule; FA, filtered and acidified sample; FU, filtered (unacidified) sample; RU, raw (unfiltered) sample; FCC, filtered, chilled (no preservative added) sample; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; DIW, deionized water; BTD&QS, Branch of Technical Development and Quality Systems, Arvada, Colo.]

Equipment and supplies	**Suppliers**
1. Well-head setup or connection	
• Monitoring well: submersible pump and reel system	OM[1]
• Water-supply well: hook-up segment with garden-hose thread	HIF[2], R
2. Sample-flow transfer system from pump reel to collection point	
• Antibacksiphon device, Teflon, connected in line	HIF, R[3]
• Extension lines for sample flow, Teflon, with connectors	HIF, R
• Manifold, with connectors and Teflon valves, for routing sample flow	HIF, R
• Sample-collection equipment that has connectors to manifold:	
Radon collector with septa, and connectors to manifold	HIF, R
Glass syringe with leur-locked stainless-steel needles	QWSU, R
Teflon, line with connector to manifold, either open ended for turbidity sample collection, or with connector to flowthrough turbidimeter	HIF, R
• Sample-collection and processing chamber frame, PVC or inert material with sample-flow-transfer port	HIF, R
• Preservation-chamber frame, PVC or inert material	HIF, R
• Transparent disposable covers and plastic clips to hold covers inside frames for sample and preservation chamber frames	SU, HIF, R[4]
• Flowthrough chamber with field-instrument ports, manifold connections, and waste line	OM[5]
3. Sample-filtration equipment	
<u>Organic carbon, filtered fractions</u>	
• Stainless-steel cylinder unit with nitrogen-gas deso-quick connect, gas scrubber, and gas line with connector to secondary regulator	HIF, R
• Nitrogen gas tank, with primary and secondary regulators	OM
• Filter membranes, 0.45-µm, 47-mm diameter, silver	QWSU, S
• Safety belts, to secure gas tank	OM
• Container, to collect spent silver nitrate membranes	SU
<u>Pesticides</u>	
• Aluminum or stainless-steel unit	OM, NWQL[6]
• Filter membranes, 0.7-µm, 142-mm diameter, baked, GF/F grade glass microfiber	QWSU, S
• Connector from filter unit to sample-chamber outflow tube	SU[6]

Table 3. Equipment, supplies, and suppliers for ground-water-quality sampling for the National Water-Quality Assessment Program--Continued

Equipment and supplies	Suppliers
Inorganic (major ions, nutrients, and trace elements)	
• Filter units, capsule with self-contained 0.45-µm[7], pleated, Supor capsule	QWSU, S
• Convoluted (spiral configuration) Teflon sample-flow lines from filter unit to sample-chamber outflow tube[8]	OM
4. Sample Bottles (sample containers, caps, and protective foam sleeves)	
Organic samples	
• Volatile organic sample (SC2090), 40-mL amber vial, baked (Teflon-lined cap)--three vials per sample (Also includes trip blanks.)	NWQL, S
• Pesticides (SC2001 or 2010) sample: 1-L amber bottle, baked (Teflon-lined cap)	QWSU, S
• Pesticides (SC2050 or 2051) sample: 1-L amber bottle, baked (Teflon-lined cap)	QWSU, S
• Organic carbon (SC2085) samples (filtered): 125-mL, amber bottle, baked (Teflon-lined cap)	QWSU, S
• Sleeves, foam, for 40-mL, 1-L, and 125-mL containers	QWSU, S
Inorganic samples	
• Radon (LC1369) sample: scintillation vial (one per transport tube)	NWQL, S
• Major cations (SC2750): filtered, acid-rinsed, 250-mL clear polyethylene bottle (with clear cap), FA--two per sample (one archived by SU)	QWSU, S
• Trace elements (SC2703, SC172, LC112 for arsenic and LC87 for selenium for field blanks): acid-rinsed, 250-mL clear polyethylene bottle (with clear cap), FA--one per sample	QWSU, S
• Major anions (SC2750): 500-mL, clear polyethylene bottle labeled FU, clear 28-mm neck (with black cap)--one per sample	QWSU, S[9]
• Nutrients (SC2752): 125-mL amber polyethylene bottle (with black cap), FCC--one per sample	QWSU, S
• Unfiltered sample (SC2750) RU for laboratory measurements: 250-mL clear polyethylene bottle (with black cap)--one per sample	QWSU, S
(Order black caps for 28-mm bottle neck separately)	QWSU, S
5. Sample and Shipping Forms and Shipping Supplies	
• Field form (standard National Water Quality Field Form or District analog)[10]	SU
• Analytical Services Request (ASR) forms for NWQL	NWQL, S
• Sample Reply Form (Study Unit to NWQL) and return envelope, self-addressed, stamped (see appendix, fig. A20, for example)	SU
• Overnight shipping labels	Contract Carrier
• Surface-mail shipping labels (supplied and prepared at District Office)	SU

Table 3. Equipment, supplies, and suppliers for ground-water-quality sampling for the National Water-Quality Assessment Program--Continued

Equipment and supplies	Suppliers
• Coolers, with latch lid and drain port, maximum loaded weight of 50-60 lbs. (for overnight sample delivery)	OM
• Heavy cardboard boxes, maximum loaded weight, 20 lbs. (surface delivery)	OM
• Plastic bags, heavy, 4-mil (for holding ice and overnight samples in cooler)	OM
• Plastic bags, resealable (for holding ASR and other forms mailed with samples)	OM
• Filament tape (to secure lid and drain cap of cooler, and surface-delivery boxes)	OM
6. Field-titration equipment[11]	
• Digital or other titrator meeting USGS specifications	QWSU, R
• Acid cartridges (for digital titrator)--0.16 and 1.6 Normal sulfuric acid	QWSU, S
• Extra acid-delivery tubes for digital titrator, clear plastic	QWSU, R
• Glass beakers (250 mL)	OM
• Volumetric pipets, glass, Class A (for preparing filtered samples)	OM
• Magnetic stirrer and small Teflon-coated stir bars	OM
7. Field instruments[11]	
• pH (electrometric) meter	OM
• pH electrodes and refill solutions (specify type of electrode)	QWSU, R
• Specific electrical conductance meter	OM
• Dissolved-oxygen (amperometric) meter and associated equipment (sensor cable, membrane and solution kit)	OM or QWSU
• Pocket barometer (used for pressure correction to dissolved-oxygen meter)	HIF, R
• Calibration wand and cup (for dissolved oxygen)	HIF, R[12]
• Turbidity (nephelometric) meter (turbidity measurement generally is recommended, but required for trace-element sampling)	OM
• Temperature measurement: thermistor thermometer (recommended), possibly part of other field meters. Also need a liquid-in-glass thermometer, ASTM certified, 0.1°C-graduated range of -5 to 45°C (for calibrating thermistor thermometer)	QWSU, R OM, R
8. Miscellaneous equipment and supplies	
• Parafilm	HIF, R
• Forceps (tweezers), Teflon-tipped stainless steel (to handle filter membranes for organic and inorganic samples); or steel forceps (for flat glass-fiber and silver membranes) and plastic forceps (for cellulose nitrate or other inorganic-sample membranes)	OM
• Plastic beakers and small cups, used to hold solutions for calibrating or checking field-instrument sensors	OM, R

Table 3. Equipment, supplies, and suppliers for ground-water-quality sampling for the National Water-Quality Assessment Program---Continued

Equipment and supplies	Suppliers
9. Decontamination equipment and supplies	
• District deionized water (DIW) (conductivity ≤1 μS/cm), quality controlled	SU
• Inorganic-free blank water (IBW) (quality controlled for major ions and trace elements)	QWSU, S[13]
• Pesticide-free blank water (PBW) or volatile and pesticide-free blank water (VPBW) (for pesticides or volatile organics)	NWQL, S[13]
• Methanol, pesticide-grade high purity (organic-sampling equipment)	OM
• Laboratory detergent, phosphate free, concentrated: diluted to a 0.1 percent decontamination solution, by volume, with DIW	QWSU, R
• Wash bottles, polyethylene, 250 mL or 500 mL (for DIW and IBW)	QWSU, R
• Wash bottles, Teflon, 500 mL (for PBW and VPBW)	QWSU, R
• Wash bottle, for methanol or other organic solvent, 250 mL	OM
• Laboratory gloves, powderless (latex or vinyl) (for decontamination and sample collection)	QWSU, R
• Plastic trays (3)	HIF, R
• Pump standpipes (glass graduated cylinders or pipette jars are preferred)	HIF, R[14]
• Forced-hot-air dryer, portable, vehicle-powered (for evaporating methanol residues)	OM
• Teflon bags, small (for small organic-sampling equipment and pump intake)	HIF, R
• Heavy aluminum foil (for wrapping organic-carbon and pesticide-filter-unit inlets and outlets	OM
• Plastic bags, resealable (for small inorganic sampling equipment)	OM
• Plastic bags, large, for enclosing cleaned pump reel, extension lines, and other large equipment	HIF, R
• Paper tissues, lint free, soft, disposable, large and small sizes (for example, Kimwipes)	OM
10. Safety equipment	OM[15]
• Fire extinguishers (A-B-C type) with mounts	
• Safety goggles or glasses	
• Eye-wash bottle	
• Emergency spill kits for any chemicals being used	
• Approved containers for transporting pure and used methanol	
• Safety cones, large	
• Material Safety Data Sheets	
11. Chemical reagents (kits include equipment for dispensing reagent)	
Preservatives	
• VOC samples (SC2090) -- 1:1 hydrochloric acid (kit)	NWQL, S
• Acrolein and acrylonitrile samples (SC1401) -- 1:1 hydrochloric acid	NWQL, S[16]
• VOC samples in chlorinated water matrix--ascorbic acid (with scoop)	NWQL, S[17]
• Inorganic (FA) samples for major cations (SC2750) and trace elements (SC2703)--nitric acid, 1-mL glass ampoule, one per sample	QWSU, S[18]

Table 3. Equipment, supplies, and suppliers for ground-water-quality sampling for the National Water-Quality Assessment Program--Continued

Equipment and supplies	Suppliers
Standards	
• pH standard buffers (pH 4, 7, and 10)	QWSU, S
• Specific electrical conductance standards (50 to 50,000 µS/cm; for low-conductivity waters of ≤20 µS/cm, use pH 4.31 buffer)	QWSU, S[19]
• Turbidity standards--Formazin	OM
• Dissolved-oxygen "zero" standard dilutions, freshly prepared with reagent grade sodium sulfite and cobalt chloride	OM[20]
Spike and other solutions	
• VOCs (SC2090, SC2091, SC2092): standard NAWQA spike solution and spike-solution kit	NWQL, S
• Pesticides (SC2050 or 2051 and SC2001 or 2010): standard NAWQA spike solution and spike-solution kits	NWQL, S
• Mixtures, required for trace elements (SC2703)	BTD&QS, S
• IBW, PBW, VPBW (see no. 9, "Decontamination equipment and supplies")	NWQL and QWSU, S
12. Optional Equipment[21]	
• Equipment for isotope, radiochemical, and other special samples--for example, deuterium-oxygen, tritium, uranium, radium, mercury, chlorofluorocarbons	OM
• Field solid-phase-extraction equipment for pesticide samples	NWQL, S

[1] That meets NAWQA Program requirements; see text.

[2] To remove oils and other manufacturing or shipping residues, and before assembling HIF or other equipment that includes Teflon tubing (without metal fittings), soak tubing for 30 minutes in a 5 percent hydrochloric acid solution rinsed with tap water until rinsate has pH similar to tap water, then final rinse three times with DIW. For a 5-percent acid solution, add 5 milliliters of 12 normal (concentrated) acid (specific gravity 1.19 and trace-element free) to each 100 milliliters of DIW (specific conductance not to exceed 1.0 microsiemens at 25 degrees Celsius).

[3] Required for each portable pump system (monitoring wells) or hook-up setup (water-supply wells). Purchase separately from pump system; a single unit can be interchanged between portable-pump and hook-up systems.

[4] Recommended design that allows cover to be attached inside frame with small, plastic clips.

[5] Flowthrough chamber from HIF meets design criteria for use with individual field instruments--pH, dissolved oxygen, specific electrical conductance, and temperature--required for ground-water-quality sample collection.

[6] For aluminum filter unit purchased through NWQL that is set up for solid-phase extraction, SU supplies a short Teflon tube (1/2-inch outer diameter, 3/8-inch inner diameter) that slips over standard nipple connection on filter unit and is connected by a 5/8-inch outer diameter by 1/2-inch inner diameter Teflon sleeve to the tube extending from the sample chamber frame to the filter unit.

[7] For ground water that contains colloidal material, filter membranes with a pore size less than 0.45 µm are required if the filtrate data must represent ion concentrations in solution. The filter pore size in general should not exceed 0.2 µm.

[8] Commonly sold in 5-foot lengths and can be cut into small lengths. Convoluted is preferred over corrugated type because latter is prone to trapping sediment, and must be replaced frequently (Johnson and Swanson, 1994).

[9] RU sample is not needed with trace-element schedule SC2703 if field conductivity is recorded on trace-element ASR form, along with a notation (in comment line to laboratory) that there is "no RU sample."

Table 3. Equipment, supplies, and suppliers for ground-water-quality sampling for the National Water-Quality Assessment Program--Continued

[10]To be filed with ASR Forms (SU copy) every time samples are collected at well (see appendix, fig. A8, for example).

[11]Refer to table 5 and Radtke and Wilde (in press) for descriptions of equipment and equipment specifications.

[12]Use air-calibration-chamber-in-water method (Radtke and Wilde, in press, Sec. 6.2).

[13]IBW, PBW and VPBW are laboratory-produced waters quality-controlled for specified analyses. The primary use of these waters is for blank samples, but they also can be used in small quantities for ultraclean decontamination procedures. PBW and VPBW contain about 0.1 mg/L of organic carbon (NWQL Technical Memorandum 92.01--unpublished document available from NWQL, 5293 Ward Road, Arvada, CO 80002), but analyses could differ among lots.

[14]Glass is the preferred standpipe material for decontaminating pump equipment because it does not readily absorb contaminants (Reynolds and others, 1990), especially if used repeatedly after equipment exposure to volatile organic compounds.

[15]Contact District Safety Officer for suppliers and specifications.

[16]Acrolein requires careful acidification to pH between 4 and 5 (acrylonitrile can withstand acidification to pH less than 2).

[17]Only required if sample water for VOC analyses is chlorinated; ascorbic acid will be supplied with the VOC preservative kit (NWQL) upon request. Otherwise, obtain ascorbic acid from the OM. DO NOT SUBSTITUTE SODIUM THIOSULFATE for ascorbic acid.

[18]Ultrapure nitric acid also available in 1-mL glass or Teflon ampoules.

[19]Purchase standards that bracket water-quality sample values.

[20]Prepare dissolved-oxygen standard solution fresh on day of use instead of repeatedly purchasing and discarding commercially available solutions.

[21]For assistance with (1) isotope, radiochemical, and other specialized equipment, contact the NAWQA Quality Assurance Specialist; (2) solid-phase extraction equipment, contact the NWQL, Methods Research and Development Program; and (3) chlorofluorocarbons (CFCs), contact Niel Plummer or Ed Busenberg, USGS National Research Program, MS 432, Reston, VA 22092.

Equipment not commonly provided by the Study Unit or USGS suppliers usually can be obtained on the open market (table 3, OM under supplier) and includes portable pumps for collecting samples at monitoring wells, and field instruments, vehicles, and storage facilities associated with ground-water-quality data collection. Each of these items is discussed separately below.

Pump systems

Several low-discharge, submersible pumps are available for collecting water-quality samples from wells. These pumps contain sample-wetted parts that consist mainly of Teflon and corrosion-resistant 316-stainless steel. On the basis of pump characteristics and results from decontamination tests (F.D. Wilde, U.S. Geological Survey, written commun., 1995--see footnote 1) these pumps are suitable for collecting a wide array of samples, including those required for NAWQA (table 1).

Use of low-discharge, submersible, portable pumps (such as the Fultz Model No. SP-300, Keck Model No. SP-84, Grundfos Model No. Redi-Flo2, and Bennett Model No. 180 or 1800) is required for NAWQA when sample collection from monitoring wells involves microgram-per-liter concentrations of VOCs, pesticides, or possibly trace elements. These pumps also are suitable for the collection of major ion, nutrient, and selected radionuclide samples.

From among suitable pump types, the choice for each Study Unit comes down to weighing the differences in pump performance characteristics (for example, pump diameter, lift capability, flow rate, portability, repairability, and power requirements) against characteristics of wells in the network (for example, well internal diameter, accessibility, purge volumes and times, and lift requirements) to determine the pump(s) that best meet Study-Unit needs. This decision process is illustrated for three pumps and shallow wells (table 4). (A similar process can be used to evaluate other pumps and deeper wells than those illustrated in table 4.) To select which of these pumps best meets sampling needs, the Study Unit can compare selected pump characteristics--primarily lift potential and pumping rate--with anticipated well or site characteristics--primarily depth to water level (lift), purge volume, and purge time (which, for practical reasons, is best kept to less than about 2 hours). If more than one pump type is adequate, other factors, such as repairability, power requirements, or cost can be used to refine the selection process. If most wells can be sampled with one pump type, and only a few wells require a second pump type (for example, deep wells), the Study Unit should consider collaborating with other Study Units or projects within the District to obtain the second pump to collect samples. (Well development is not at issue in this discussion. Pumps to be used for the collection of water-quality samples are not designed, and should not be used, to develop wells.)

Table 4. Example of a method to determine pump-system suitability as a function of selected well and pump characteristics

[in, inches; ft, feet; gal, gallons; ---, not applicable]

Well characteristics					Pump characteristics and suitability	
Well	Diameter (in)	Water-column height (ft)	Required purge volume[1] (gal)	Required lift or total dynamic head[2] (ft)	Maximum pumped volume at given lift in 2 hours for indicated pump system[3,4]	Pump-system suitability[5,6]
1	2	20	10	25	120 (Fultz SP-300)	Suitable
1	2	20	10	25	144 (Keck SP-84)	Suitable
1	2	20	10	25	840 (Grunfos Redi-Flo2)	Suitable
2	4	60	118	75	96 (Fultz SP-300)	Unsuitable
2	4	60	118	75	132 (Keck SP-84)	Suitable
2	4	60	118	75	768 (Grunfos Redi-Flo2)	Suitable
3	2	40	20	160	---[7] (Fultz SP-300)	Unsuitable[7]
3	2	40	20	160	---[7] (Keck SP-84)	Unsuitable[7]
3	2	40	20	160	538 (Grunfos Redi-Flo2)	Suitable

[1]**Required purge volumes** (in gallons) as a function of well diameter and water-column height.

Well diameter (in inches)	Water-column height (in feet) 20	40	60	80	100	120	140	160	180	200	240	260
	Required purge volume (in gallons)											
2	10	20	29	39	49	59	69	78	88	98	108	118
4	39	78	118	157	196	235	274	313	353	392	431	470
6	88	176	264	353	441	529	617	705	793	881	969	1,058

Where **purge volume** equals three times the borehole or casing volume. The borehole or casing volume, V (in gallons), is calculated as $V = 0.0408 \times H \times D^2$, where H is the **water-column height** (in feet), and D is the well **diameter** (in inches).

[2]In these examples, the **required lift** is equivalent to total dynamic head and is estimated as the depth to water in the well. This assumes that the purge takes place with the pump intake at the top of the water column, and that the water level in the well does not decline appreciably with pumping. Note that for submersible pumps (for example, helical rotor gear, progressing cavity, bladder, and piston pumps) Lift = pump depth + frictional tubing loss; for centrifugal-pump designs, this is more accurately described as total dynamic head (TDH), where TDH = depth to water + frictional tubing loss.

Table 4. Example of a method to determine pump-system suitability as a function of selected well and pump characteristics--Continued

[3]**Maximum pumped volume** is calculated using the pumping rate for a given pump system from manufacturer's specifications at the required lift (or TDH) multiplied by an assumed purging time of 2 hours.

Example pumping rates in gallons per minute (gpm) as a function of lift (TDH) for selected pump systems from manufacturer's specifications. With antibacksiphon device, extension lines, and directional-control flow valves that follow pump-reel system, effective pumping rate is assumed to be 80 percent of that given by the manufacturer. Actual rates, particularly as lifts approach the limit of each system, could be less than those specified.

	Lift (in feet)											
Pump system	0	25	50	75	100	125	150	175	200	225	250	275
	Pumping rate (gpm)											
Fultz Model No. SP-300	1.1	1.0	0.9	0.8	0.7	0.5	0.4	---	---	---	---	---
Keck Model No. SP-84	1.3	1.2	1.2	1.1	1.0	0.9	0.8	---	---	---	---	---
Grunfos Model No. Redi-Flo2	7.2	7.0	6.7	6.4	6.0	5.7	5.0	4.4	3.8	3.0	2.1	---

Example **maximum pumped volume** (gal) as a function of lift for the three pump systems given above, assuming pumping time is 2 hours.

	Lift (in feet)											
Pump system	0	25	50	75	100	125	150	175	200	225	250	275
	Maximum pumped volume in 2 hours (in gallons)											
Fultz Model No. SP-300	132	120	108	96	84	60	48	---	---	---	---	---
Keck Model No. SP-84	156	144	144	132	120	108	96	---	---	---	---	---
Grunfos Model No. Redi-Flo2	864	840	804	768	720	684	600	538	456	360	252	---

[4]For practical reasons, and except when quality-control samples are taken, field teams aim to complete all activities at each well within 4 to 6 hours. Thus, purge times generally need to be kept under 2 1/2 hours, with the pumping rate during the last half hour equal to the sampling rate (no more than about one tenth of a gallon per minute).

[5]Pump-system suitability is determined as follows:

Suitable if the **maximum pumped volume** at a given lift (or TDH) in 2 hours for the indicated pump type is equal to or greater than the **required purge volume**.

Unsuitable if the **maximum pumped volume** at a given lift in 2 hours for the indicated pump system is less than the **required purge volume** or if the **required lift** (or TDH) exceeds the maximum for the pump.

[6]When two or more pump types meet requirements outlined above, other factors considered in pump selection include ability of pump system to be decontaminated adequately, portability, susceptibility of pump to seizure, ease of repair and use in the field, and cost. It is assumed comparison is among pumps that are constructed and can be operated in a manner suitable for NAWQA sampling.

[7]**Required lift** exceeds maximum lift of the pump; therefore, pump is unsuitable under conditions given in this example.

Regardless of the pump type chosen, the pump system (pump intake, tubing, and reel) must meet certain requirements. The pump can be purchased without an antibacksiphon because a suitable antibacksiphon is to be added by the Study Unit (table 3). The pump line should be solid, high-density Teflon tubing. Teflon-lined polypropylene or other tubing is not recommended because the exterior tubing often is not as inert as Teflon. In addition, the outer tubing can separate from the Teflon lining, causing the thin-walled Teflon tubing to pinch or collapse. Suitable pump tubing can be ordered in 50-ft segments connected with 316-stainless steel (SS-316) quick connections, which makes it possible to use the shortest length of tubing needed for each well. In addition, it is recommended that the reel that holds the tubing be designed to turn (while raising or lowering the pump intake and tubing), while the pump is in operation, and while the pump-reel outlet is connected to an extension line that runs to the remainder of the sample-collection setup.

Other types of equipment (bailers, bladder pumps, peristaltic pumps) can be considered for some site conditions, or special data-collection needs. The use of such equipment generally is not recommended. Most alternative sample-collection devices are either limited in their lift potential, constructed of materials that are unsuitable or difficult to decontaminate, or deliver the sample in a manner (for example, under suction) that they cannot be used for most sites, or do not provide data of suitable quality for all NAWQA constituents (F.D. Wilde, U.S. Geological Survey, written commun., 1995--see footnote 1).

Study Unit staff that need to collect ground-water-quality samples using equipment other than that specified (table 3) must discuss their plans with the NAWQA QA Specialist. At a minimum, it is expected that sufficient QC data are available, or will be collected, to verify that the ground-water data obtained with the alternative equipment is similar in quality to data being obtained by the NAWQA Program in general.

Field instruments

Each Study Unit is to obtain suitable field instruments to collect data for pH, specific electrical conductance (SC), dissolved oxygen (DO), and temperature (T). If samples for trace elements (such as iron, manganese, aluminum, or uranium) are collected, sample turbidity (TU) also is measured. These data (pH, SC, DO, T, and possibly TU) are part of the required water-quality record for each ground-water sampling site (table 1), and also serve as QC measures that are used to assess the chemical variability of water before and at the time samples for other chemical constituents are collected. In collecting these data, however, the field instruments used must meet certain requirements (table 5).

Table 5. Requirements for meters and sensors used for field measurements taken at ground-water-quality sites of the National Water-Quality Assessment Program (modified from Radtke and Wilde, in press)

[°C, degrees Celsius; mV, millivolt; Δmv/ΔpH, change in millivolts divided by change in pH at measurement temperature (in °C); ≥, greater than or equal to; µS/cm, microsiemens per centimeter at 25°C; ≤, less than or equal to; >, greater than; mg/L, milligrams per liter; NTU, nephelometric turbidity units; NWIS-I, National Water Information System-I]

Field measurement	Performance requirements
Temperature (°C) (recommend thermistor-type thermometer)	Reading to 0.1°C for temperatures from -5 to 45°C; bias within 0.2°C. (Requirement applies to any thermistors used in association with other field measurements, including those contained in other field-measurement systems. Sampling thermal systems can require readings and calibration to 52°C.)
pH (standard units; require electrometric method) and field titrations	Reading to 0.1 standard unit (or 0.05 unit for instruments that display more than two digits to the right of the decimal). Temperature compensating; mV readout; rapid electrode response--maximum 15- to 20-second elapsed time for reading to "lock-on" the low pH calibration buffer after meter is calibrated with high pH 7 buffer; pH electrode must pass slope-test [(Δmv/ΔpH) ≥ 0.94 x (Theoretical Nernst slope)], corrected for temperature.[1]
Specific electrical conductance (µS/cm at 25°C)	Reading within 5 percent of full scale at ≤100 µS/cm or within 3 percent of full scale at >100 µS/cm; temperature compensation range from -2 to 45°C or greater, if needed. Instrument must compensate for temperature to provide readings at 25°C, or temperature readings are required to apply correction factor and report measurement at 25°C.
Dissolved oxygen[2] (require amperometric method)	Reading to 0.3 mg/L or less for concentrations ≥1 mg/L. Temperature compensation and temperature measurement required. Field barometer needed to determine barometric pressure correction factor.
Turbidity (recommend nephelometric method)	Select instrument designed to provide precise and unbiased measurements at 0 to 40 NTU. Reading within 5 percent full scale for 1 to 500 NTU, and within 0.02 NTU for turbidity less than 1 NTU. Turbidity entered into the NWIS-I data base must be made using nephelometric measurements.

[1]Slope test and temperature correction are described in Radtke and Wilde (in press).

[2]Use spectrophotometric or iodometric method for accurate measurements of dissolved-oxygen concentrations less than 1 mg/L (Radtke and Wilde, in press).

Water levels are to be determined whenever possible before other water-quality data are collected from wells (Lapham and others, in press). The static water level within a few hundred feet below land surface is measured using a chalked steel tape, and the measurement is repeated until two consecutive measurements differ by no more than 0.02 ft, or until the reason for less precise measurements is determined and documented. In addition, the depth from land surface to the bottom of the well is measured during each site visit whenever possible to verify the integrity of the well construction.

Each field instrument must be calibrated, operated, maintained, and stored, and the necessary calibration and test results documented according to USGS protocols. The protocols for ground-water-quality field measurements are described in Radtke and Wilde (in press).

Water-quality vehicles

Different vehicle designs will be used among Study Units because of differences in terrain, accessibility of sites, travel distances, trip duration, and other factors. In selecting and modifying a vehicle for water-quality data collection, however, it is recommended that safety and quality control be given high priorities. Study Unit staff also are encouraged to research designs already in use and to dedicate vehicle(s) solely to the collection of water-quality data.

Safety is a vital concern. The most important thing a water-quality vehicle will carry is the field team. To protect the team, all equipment is secured and properly stored behind passenger barriers when in transit, and without affecting the driver's visibility. In addition, vehicle supplies should include safety cones; safety glasses; fire extinguishers; first-aid, eye-wash, and chemical-spill kits; and Material Safety Data Sheets--all placed where they are readily accessible. If sample collection or processing occurs inside the vehicle, ventilation must be adequate and there must be sufficient room to operate. Flex hose is used to vent combustion exhaust away from a vehicle that is stationary with the engine running, and is stored and transported outside of the sampling vehicle. Flammable solvents (such as methanol) and pressurized gases (such as nitrogen) are transported according to local and State regulations. Regular service and maintenance and before-departure safety inspections of the vehicle are scheduled by the field team. If questions arise in regard to safety or inspection procedures, methods, or equipment, contact the District safety officer.

Quality assurance of the sampling vehicle is critical to a successful investigation. This vehicle should enable the field team to collect high-quality samples and data. Despite diverse external conditions, the vehicle should provide a clean environment for sampling and equipment, and a suitable environment for protecting equipment from damage during transport. The vehicle design also should provide temporary protection of field instruments, chemical reagents, buffers, preservatives, standards, and most water-quality samples from extreme heat and cold. It also must provide for the temporary (and contaminant-free) storage of some samples (VOCs, pesticides, nutrients), and some reagents (for example, spike solutions for pesticides and VOCs and VOC acid preservative) at near-freezing temperatures. If the vehicle interior is used for the collection or processing of water-quality samples, then adequate lighting, plumbing, and counter space are needed. Sample collection and preservation chambers are used whether working inside or outside the vehicle. These reduce contamination of and from the vehicle interior.

Obtain and design vehicles that can be dedicated solely to water-quality sampling. A vehicle used for water-quality data collection is not used for the storage (even temporary) of a generator using gasoline or other types of fume-producing fuels, or of heavily soiled equipment, clothing, or tools. Nor should a vehicle previously used for such storage be converted to a water-quality vehicle. One might even question the adoption of a used water-quality vehicle if samples were collected and, in particular, preserved within the vehicle without regard to possible vehicle contamination. In each case above, there is a risk that the vehicle will be, or has been, permanently contaminated.

Storage facilities

Field vehicles are not suitable for storage of most supplies and some equipment used for water-quality data collection. When not in operation, the vehicles cannot provide adequate protection from extreme heat or cold, which can destroy or degrade chemical standards, buffers, and other reagents, as well as damage some field instruments. Especially during extremes in temperature, remove sensitive supplies and equipment from an idle vehicle to a safe indoor location on a daily basis. Clean and secure facilities, which are separate from those used for other types of NAWQA equipment (such as generators, fuel, drilling supplies and materials, and permanently soiled gear), are needed for longer periods of storage.

Timing of purchases

Durable equipment and supplies (such as vehicles, pump systems, plastic bottles) are ordered well in advance of the first field season, and thereafter on an as-needed basis. Begin vehicle purchase and modification(s) 12 to 14 months before the vehicle is needed for water-quality data collection. Nonperishable, and limited quantities of perishable supplies (see below) are purchased and on hand at least 3 to 6 months before water-quality data collection begins. Pump systems and other sample-collection equipment also can take up to several months to obtain, assemble, and modify to complement vehicle design.

Some supplies, such as most chemical solutions, have a limited shelf life. As part of their planning, Study Units should (1) follow manufacturer's recommendations on storage, and (2) query their suppliers about shelf life for any preservatives, buffers, standards, and reference samples, as well as for blank, spike, surrogate, and instrument-sensor solutions, or any other chemical reagents. This will prevent overstocking and reduce waste. Upon receiving these supplies, the date of receipt and the expiration date should be marked clearly on time-sensitive supplies. Study Units also are required to record supply lot numbers. Without these records, the QA and QC information that exists for these supplies, and provided by lot number, cannot be utilized by the Study-Unit or NAWQA National Program. This is one of the quality-assurance measures that could be needed to correctly interpret water-quality QC data.

Study-Unit staff are likely to select the most appropriate vehicle design, pump system, and related equipment after information from site visits is obtained, and after sampling teams have had some training (see "Training" below). Following training, the field teams need their equipment and supplies for practice, and to verify that they are suitable for water-quality data collection (see "Field Evaluation" below). Therefore, most nonperishable equipment and supplies need to be on hand at least 3 to 6 months in advance of the first field season of data collection.

Training

Modifications in USGS protocols and recommended procedures (F.D. Wilde, U.S. Geological Survey, written commun., 1995--see footnote 1), and the need for consistency dictate that training in the collection and management of water-quality data is required for most Study-Unit staff. This training is to be obtained through USGS Level I courses and field experience, ideally before water-quality data collection begins (table 6).

Field Evaluation

Each Study Unit is required to test and evaluate the sample-collection equipment and procedures that commonly will be used (table 6, no. 4). This is separate from, and occurs after, the field training with Study-Unit equipment. To avoid unnecessary delay in planned data collection while awaiting laboratory results, this test should be conducted at least 2 months before sample and data collection begin. Ideally, the evaluation can occur toward the end or after the field exercise devoted to equipment shakedown and cross-training (table 6, no. 3).

To conduct the test, the Study Unit selects a well with measurable concentrations of as many of the following contaminants as possible: VOCs, pesticides, nutrients, and (if targeted for investigation by the Study Unit) trace elements. The field team collects samples for all constituents (in the order and manner in which samples commonly are going to be collected--see "Sample Collection and Processing"). After sample collection, equipment is decontaminated. Field blanks for all constituents are collected with the decontaminated equipment. Two field-spiked, blank samples are prepared for the VOC schedule and for each pesticide schedule. One blank sample for the VOC schedule is spiked by one field-team member, and its replicate is spiked by the other field-team member. One field-team member also spikes the blank sample for one pesticide schedule; the other field-team member spikes the other blank sample for the second pesticide schedule. (Definition of QC samples is provided in "Design of Quality-Control Sampling and Schedules.") All ground-water-quality samples and QC samples are sent to the NWQL for analysis.

Data from the ground-water-quality and QC samples are evaluated by the Study Unit, and the evaluation and data are forwarded as soon as possible to the National Program (NAWQA QA Specialist). These data are to confirm that (1) the ground water contained measurable levels of some contaminants, (2) decontamination procedures removed contaminants from equipment, and (3) the procedures used to prepare spiked blanks led to acceptable recoveries of selected VOCs and pesticides.

The evaluation assures the field team, Study Unit, and National Program that the protocols and procedures are satisfactory. Potential problems identified by the Study Unit(s) are corrected before sample and data collection begins.

Table 6. Recommended sequence of training-related activities to prepare for National Water-Quality Assessment (NAWQA) Program ground-water-quality data collection

[USGS, U.S. Geological Survey; QC, quality control; NWQL, National Water Quality Laboratory]

1. Determine data-collection and management training needs.

- Review protocols and recommended procedures (this report).
- Review National Field Manual (Radtke and Wilde, in press).
- Incorporate possible modifications to above (commonly described in NAWQA or USGS internal memorandums).

2. Train field team(s) and data-management personnel accordingly and formally.

- Through USGS Level I and higher level training courses.[1] Field Water-Quality Methods for Ground Water and Surface Water (G0282) currently is required for at least one member of each team placed in field for data collection. It is recommended that at least one member of the Study-Unit staff attend the course Quality-Control and Sample Design and Interpretation (GO342). (A field team is assumed to consist of two people.)
- Take data-collection and QC training courses early, ideally in the fiscal year before intensive data collection begins.

3. Enhance and reinforce formal training.[2]

- New field team(s) can accompany or temporarily employ experienced (mentor) teams from another Study Unit that is completing data collection in the fiscal year before the new team will begin data collection. Select mentors on the basis of similarities in types of wells, terrain, equipment, and other factors that the two Study Units have in common.
- New field team(s) should practice data collection with equipment that will be used, and alternate activities to ensure each team member is cross-trained in all aspects of data collection.

4. Evaluate data-collection protocols, recommended procedures, and equipment.[3]

- Conduct data collection at a contaminated well at least 2 months before any water-quality data collection begins. Include field blanks and field-spiked source-solution blanks. Submit ground-water-quality and all QC samples to NWQL for analysis.
- Evaluate and share results with the National Program. (See text for further discussion).

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[1]The Level I course provides individual training in ground-water-quality and surface-water-quality data-collection protocols and procedures that include those for the National Water-Quality Assessment Program. Other courses can be taken that cover data management and analysis, such as that recommended for QC.

[2]Because modifications to protocols and recommended procedures are likely to occur, training without taking the formal course currently is not considered an acceptable substitute for all members of a field team.

[3]See discussion in section entitled "Field Evaluation."

Design of Ground-Water-Quality Sampling Schedules

As part of planning for field sampling, schedules are prepared annually or more frequently, if needed, for the collection of ground-water-quality and QC data for each ground-water component (Study-Unit Survey, Land-Use Study or Flowpath Study) targeted for investigation each year. These schedules list the daily activities for the field team, data managers, and support staff.

For ground-water-quality samples, the schedule describes the timing and order in which wells for each ground-water component are targeted for data collection (table 7). General scheduling considerations include component factors, travel times, personnel requirements, and site conditions (table 8). Each schedule is designed over a period of several months, and before any ground-water-quality samples are collected.

Study Units will pay particular attention to factors that enhance the consistency and quality of samples and data obtained and provide the Study Unit and National Program with the necessary data to determine the quality and suitability of data collected for NAWQA assessments (table 9). The design and scheduling of QC data collection, which are critical and integral parts of water-quality data and data collection (Shampine and others, 1992), are discussed in detail in the next section. For most of the other factors (tables 8 and 9), it is assumed that the information needed is obtained through staff planning meetings and site visits conducted before data collection begins.

As a general rule, except for Flowpath Studies, most Study Units will find that a single, two-person field team often needs a day to conduct data-collection activities at one well. With experience, and under the optimum field conditions, some teams will be able to collect data from more than one well per day. In the case of Flowpath Studies, the close proximity and shallow depths of wells also could permit sampling at more than one well per day. In addition, wells targeted for QC data collection could require an additional team member to complete activities in a single day.

Table 7. Example of a sampling schedule for a 28-well Land-Use Study

[Assumes (a) one (two-person) field team generally collects samples on a weekly run (Monday-Thursday); (b) incorporation of general scheduling considers component factors, travel times, personnel, and site conditions (table 8), as well as requirements to enhance data quality (table 9); and (c) routine quality-control sampling occurs at selected wells distributed throughout the collection period (third person possibly joins team). SRS, standard reference samples for trace elements; VOC, volatile organic compound]

Period of activity		Activity to be conducted by team
Week 1	Day 1 (M)	Depart for Well 1: collect ground-water (GW) samples.
	2 (T)	Well 2: Collect GW and quality-control (QC) samples.
	3 (W)	Well 3: Collect GW samples.
	4 (Th)	Well 4: Collect GW samples, return to office, unload vehicle.
	5 (F)	Evaluation and preparation: Study Unit reviews progress, plans, sampling schedule, and completes final preparations for following week's activities.
Week 2	Days 8-12	Wells 5-8: Similar schedule as week 1, but without QC data collection.
Week 3	Day 15 (M)	Well 2: Review QC data and continue sampling if no problems appear; decision to sample two wells per day when possible is made.
	16 (T)	Team and staff complete preparations, team departs office.
	17 (W)	Well 9: Collect GW and QC samples (including one SRS).
	18 (Th)	Wells 10 and 11: Collect GW samples.
	19 (F)	Team returns to office and, aided by staff, unloads and cleans vehicle.
Week 4	Days 22-26	Wells 12-15: Similar to schedule for week 2.
Week 5	Day 29 (M)	Well 9: Review QC data and continue sampling if no problems appear. Team, aided by staff, completes preparations, and departs office.
	30 (T)	Wells 16 and 17: Collect GW samples.
	31 (W)	Well 18: Collect GW samples.
	32 (Th)	Well 19: Collect GW and QC samples (with VOC trip blank, as planned); team returns to office late in day.
	33 (F)	Team and staff unload, clean, and restock vehicle.
Week 6	Days 36-40	Wells 20-23: Similar to schedule for week 2.
Week 7	Day 43 (M)	Well 24: Team departs office, collects GW samples.
	44 (T)	Well 25: Collect GW samples.
	45 (W)	Wells 26 and 27: Collect GW samples.
	46 (Th)	Well 28: Collect GW and QC samples, team returns to office and with staff unloads and cleans vehicle.
	47 (F)	Vehicle goes in for regular service and maintenance.
Week 8	Day 50 (M)	Team and staff receive QC data (wells 19 and 28). If QC data are satisfactory, sample collection continues unabated. Team and staff prepare for next component to be sampled. Remaining two SRS samples needed for the year will be included in data collection for the next component.

Table 8. Basic considerations in designing annual ground-water-quality sampling schedules for Study-Unit components (Land-Use Studies, Study-Unit or Subunit Surveys, and Flowpath Studies) of the National Water-Quality Assessment Program

1. **Component factors**
   - Number of each type of component.
   - Number of wells per component.

2. **Travel times**
   - Between office and wells.
   - Between wells.
   - Between well and overnight shipping sites.

3. **Personnel**
   - Number of field teams.
   - Number of individuals per team (generally consider two members; possibly third person at wells that include QC sample collection).
   - Experience of personnel in team.
   - Office staff support.

4. **Site and seasonal conditions**
   - Equipment setup time (water-supply or monitoring well).
   - Purge time.
   - Data-collection requirements (ground-water quality only or ground-water quality and quality control).
   - Duration of field season.

Table 9. Requirements for the design of National Water-Quality Assessment Program ground-water-quality sampling schedules to enhance data quality

[QA, quality assurance; QC, quality control; VOC, volatile organic compound; NWQL, National Water Quality Laboratory; μg/L, micrograms per liter]

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1. **Schedule to avoid seasonal or other problems in data used for spatial analysis**
   - Except for Flowpath Studies, collect all samples for all components in shallow-depth wells between late spring and early fall if those samples include seasonally-applied chemicals.[1]
   - Except as noted below, complete sampling for a given component in the shortest time possible, and before the same field team begins data-collection at another component.

2. **Integrate quality-assurance and quality-control (QA and QC) data collection** into each component schedule
   - Conduct QA procedures and collect QC data at selected sites in each component throughout the period of water-quality data collection.

3. **Set reasonable performance levels;** initially, collect samples at one well per day for Land-Use Studies (or Study-Unit Survey) so that:
   - With time and experience, the long-term average could approach two wells per day.
   - Wells selected for QC data collection typically will require a full day and possibly an additional person.
   - Sampling at more than two wells per day could be possible, particularly for Flowpath Studies (shallow-depth wells in close proximity).

4. **Avoid over-specialization**; schedule frequent rotation of duties among the field-team members
   - Prepare for unexpected absences to prevent a halt in sampling, or the collection of potentially poor-quality data.

5. **Schedule data collection at wells known or suspected of having high (greater than 10 μg/L) VOC or pesticide concentrations** near the end of the data-collection period to avoid cross-contamination of other wells or samples
   - Take additional field blanks to check that equipment is decontaminated before the same equipment is used at another well.
   - Notify NWQL (on Analytical Service Request form--comment to laboratory line) if it is known or suspected that VOC or pesticide concentrations are expected to exceed 10 μg/L.

6. **Plan for resampling**, regardless of whether or not it can be anticipated
   - Despite the best planning, teams sometimes find they are inadequately equipped for data collection..
   - Data-quality reviews could indicate resampling is necessary.
   - Resampling is recommended near the end of the fiscal year (first week in September).

7. **Provide time for data review, schedule revision, and equipment maintenance**, if the component consists of 20 or more wells, which generally will require 2 or more months to sample
   - With intermittent periods (day or two in length) of no data collection.
   - To review progress, make scheduled revisions, and discuss QC data.
   - To restock, maintain, repair, or replace equipment and supplies.

8. **Schedule data collection to avoid exceeding sample-holding time**, which begins when the sample is collected, and ends with sample analysis
   - Holding times for water samples of radon, nutrients, pesticides, and VOCs are the shortest--3, 5, 7, and 14 days, respectively.
   - From late spring to early fall (the peak analysis period) at least half the holding time can expire **after** samples are logged in at the NWQL.
   - Because radon has a short half-life (3.6 days), samples for this element should not be collected on a Friday, unless they can reach the NWQL by noon on that Friday.

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[1]Pesticide concentrations measured in ground water nationwide appear higher and more uniform throughout this period than the concentrations measured from late fall to early spring (J.E. Barbash and E.A. Resek, in prep., Pesticides in Ground Water; Distribution, Trends, and Governing Factors: Ann Arbor Press, Chelsea, Mich.).

Design of Quality-Control Sampling and Schedules

Each Study Unit is required to collect similar types of QC samples (table 10). Those that are collected regularly throughout each field season are referred to as “routine QC samples.” Additional QC samples, referred to as “topical QC samples,” occasionally could be collected by some or all Study Units to isolate and resolve problems or evaluate modifications to NAWQA field methods.

The data obtained from routine or topical QC sampling are used to estimate the potential bias (either from contamination or in recovery) and measurement variability for selected analytes. Routine QC samples provide the data required by the NAWQA Program to make general inferences about bias and variability for all water-quality data collected. Bias and variability measurements from routine QC samples reflect combined field and laboratory errors that occur during data collection. Measurements obtained from topical QC sampling will reflect errors associated with a specific field or laboratory procedure employed by NAWQA and targeted for study.

Study Units can use QC data in several ways. Those that can derive bias and variability estimates from routine QC sampling in a timely manner can use the results not only to assess the quality of data being collected, but also, in some cases, to identify wells that need to be resampled (Koterba and others, 1991). In the case of topical QC data, sources of sample contamination or bias that occur as a result of sample collection and processing, initially identified through routine QC sampling, can be isolated and eliminated (Rea, in press; Koterba and others, 1991).

Bias and variability estimates also can be used during data analysis and interpretation of ground-water-quality data. For each ground-water component, the magnitude of these error estimates provide an indication of the quality of ground-water data collected (Koterba and others, 1991 and 1993). In addition, as water-quality data from different Land-Use Studies or Subunit Surveys are compared, contrasted, or combined, the corresponding routine estimates of bias and variability from QC data also can be compared, contrasted, and combined to make inferences about the quality and suitability of the aggregated water-quality data that are being used for Study-Unit or National Assessments.

In some cases, data analysis and interpretation can depend on the timely analysis of routine and topical QC data obtained in the field combined with timely discussion of these data with the National Program and the NWQL. Examples of the above, which led to modifications in Study-Unit field methods and in the QC sampling design, and ultimately improved data quality, analysis, and interpretation include studies by Ferree and others (1992) and Koterba and others (1994). Their experience indicates how critical it is for Study-Unit plans to remain flexible. These plans must allow for the possible modification of the initial designs for routine QC sampling (as described below), or the methods used to collect these and ground-water-quality samples (described later in this report). Such modification could prove critical to correctly identifying the occurrence and distribution of contaminants in ground water and their relation to Study-Unit landscape and subsurface features.

Table 10. Quality-control samples for ground-water components of the National Water-Quality Assessment (NAWQA) Program

[Definitions are consistent with those of the U.S. Geological Survey Branch of Technical Development and Quality Systems (BTD&QS) and the Office of Water Quality. NWQL, National Water Quality Laboratory; VOCs, volatile organic compounds]

Sample type	Description	Purpose
1. Blanks[1]	Types include field, source-solution, and trip.	Assess bias from contamination of blank water.
•Field	Blank water passed through equipment in the field, and collected in a manner similar to that used to collect water-quality data, but after equipment is used and decontaminated.	Verify that decontamination procedures are adequate, and that field and laboratory protocols and recommended procedures do not contaminate samples.
•Source solution[2]	Blank water placed directly in the sample container, but in a clean environment.	Verify that blank water is contaminant-free just before it is used for a field blank.
•Trip	Blank water placed in sample container by NWQL, shipped to study with empty containers, and returned unopened by Study Unit from field for analysis.	Verify that shipping, handling, and intermittent storage of containers does not result in contamination or cross-contamination of samples.
2. Replicates[3]	Two or more ground-water-quality samples collected sequentially for the same analytes.	Assess combined effects of field and laboratory procedures on measurement variability.
3. Field spikes[4]	Types include samples prepared from blank water or from ground water.	Assess recovery bias of analytes in spike solution.
•Source-solution water[5]	Two source-solution blanks to which identical volumes of spike solution are added, but by different members of field team. For VOCs, preserve with NWQL acid before spiking.	Verify equipment and procedures for field spiking, handling, shipping, and analysis lead to similar results among Study Units.
•Ground water	Two or more replicate ground-water-quality samples to which identical volumes of spike solution are added in a manner that does not substantially alter sample matrix. For VOCs, preserve with NWQL acid before spiking.	Assess recovery bias and variability in relation to different ground-water matrices.

Table 10. Quality-control samples for ground-water components of the National Water-Quality Assessment (NAWQA) Program--Continued

Sample type	Description	Purpose
4. Standard reference (mixtures)	Prepared by BTD&QS as mixtures, sent to Study Units collecting trace-element samples, shipped unopened from field to NWQL for analysis.	Assess recovery bias and variability of selected trace elements.

[1]Blank water is certified by supplier as free of analytes of interest at concentrations that exceed NAWQA detection or reporting level. A trip blank is only required for VOCs.

[2]Because blank solutions are not regularly analyzed for dissolved organic carbon (DOC), source-solution blanks are required along with field blanks for this analyte. A source-solution blank for DOC is required each time a field blank for DOC is taken.

[3]Chemical composition of water entering the well and being collected is assumed constant during time needed to collect sequential samples (including replicates).

[4]Spike solutions for NAWQA contain either selected VOC or pesticide analytes; solutions are obtained and used in accordance with instructions from the NWQL. At least one unspiked (background) ground-water sample from the same well used to obtain the samples for field spikes is analyzed in conjunction with field-spiked samples (see text).

[5]Preserved and spiked source-solution blanks for pesticides and VOCs are prepared only as part of the initial evaluation of equipment and procedures before data collection begins.

Routine quality-control samples: type, number, site selection, and timing

The current NAWQA QC sampling design for ground water is based on the integrated approach described by Shampine and others (1992). Under this design, it is recommended that each Study Unit follow similar procedures (tables 11 and 12) to identify (1) the types of routine QC samples collected, (2) the wells at which these samples will be obtained, and (3) the timing of QC sample collection for each of the ground-water components scheduled for data collection in each field season. These procedures ensure that the data obtained for each routine QC sample type (1) represent major differences in the major ion chemistry (sample matrix) of ground water targeted for study, (2) are suitable for estimating measurement bias and variability for the analytes of interest, and (3) reflect possible temporal variations in field and laboratory methods during the time period that ground-water-quality data are collected (table 13).

It would be ideal in terms of planning, efficiency in the field, and costs **if similar routine QC designs** could be used for **all** ground-water components. Because Land-Use Studies, Study-Unit (or Subunit) Surveys, and Flowpath Studies differ in their design and scope, the types and numbers of routine QC samples, the wells selected for collecting these samples, and the timing of visits to the wells selected will differ somewhat among these components.

It would be ideal in terms of planning, efficiency, and costs if **all** routine QC samples could be collected at the **same** well sites for each ground-water component. Representative and suitable QC data, however, often can only be obtained by scheduling the collection of different types of routine QC samples at different wells within a given component (see below), or, in the case of the VOC trip blank and (possibly) trace-element standard reference samples, at wells selected from among several components sampled in the same field season (table 13, footnote 1).

Land-Use Studies. A typical Land-Use Study is focused primarily on one major land-use classification, and for ground water, involves the collection of samples for a variety of analytes (table 1) from each of a relatively small number of wells (about 30, including reference wells) completed at shallow depths and often in a single aquifer. Therefore, a typical design for routine QC data collection requires the collection of many different QC sample types to cover the variety of analytes being investigated (table 12). It also requires a minimal number of samples for each QC-sample type because differences in the quality of ground water among wells are assumed to reflect chiefly the intensity of a single land use on the shallow part a single aquifer.

Some wells in the Land-Use Study will need to be chosen (if possible, and according to methods described later in this section) specifically to collect the required number of routine, replicate ground-water samples and routine field blanks (table 13). These wells are chosen, in part, because they are likely to provide samples with measurable (greater-than-method-reporting-level) concentrations. (Estimating the variability of measurements for a given analyte using replicate samples requires that these samples contain measurable, greater-than- or equal-to-method reporting-level concentrations for that analyte.) They also are selected, if possible, to provide a range in measurable concentrations that reflect the effects of that land use on shallow ground-water quality.

Table 11. Procedures to identify the type and schedule the annual collection of routine quality-control data for ground-water components of the National Water-Quality Assessment Program

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1. Identify analyte groups for which water-quality data will be collected that field season

- On the basis of national requirements (table 1).
- To which are added local Study-Unit interests, such as trace elements.

2. Identify routine quality-control (QC) data to be collected

- On the basis of the Study-Unit component (for example, see table 12).
- Determine QC sample types by analyte group to be collected.
- Determine number (or frequency) of each type to be collected.

3. Identify wells and develop schedules for routine QC data collection for each component[1]

- Select wells to provide suitable and representative QC data (see text and table 13).
- Schedule visits to these wells to provide QC data collection for each analyte group throughout the months that water-quality data for that analyte group and component are being collected (see text and table 13).

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[1]If volatile-organic-compound (VOC) and trace-element samples are collected during a given field season, then at least one VOC trip blank, in addition to field blanks and spiked replicate samples, and at least three trace-element standard-reference samples are sent from the field to the National Water Quality Laboratory for analysis.

Table 12. Required type and minimum number (or frequency) of routine quality-control samples for a Land-Use Study of the National Water-Quality Assessment Program

[Field blanks and field-spiked, source-solution blanks taken during the evaluation of methods are not included below. Assume study consists of 25 to 30 wells. Trace-element field blanks use National Water Quality Laboratory (NWQL) Schedule SC172 with selenium (LC0087) and arsenic (LC0112). All other routine quality-control samples use the same NWQL schedule or laboratory code used for the corresponding water-quality samples. DOC, dissolved (filtered) organic carbon; ALK, alkalinity (field-titration, filtered ground-water sample); and ANC, acid-neutralizing capacity (field titration, unfiltered ground-water sample; VOCs, volatile organic compounds]

Analyte group[a]	Routine quality-control sample type	Required number (frequency)
1. Commonly present in measurable concentrations: major ions, nutrients, and DOC. (ALK and ANC--replicates only)	**Field blanks**	Minimally at 2, but preferably at 3, well sites.
	Source-solution blanks	(Every time a DOC field blank is taken, only for DOC.)
	Replicate (2) ground-water samples per well	Minimally from 2, but preferably from 3 wells at different sites.
2. Commonly present in measurable concentrations in some, but usually not all, areas:		
• Pesticides or VOCs	**Field blanks**	Minimally at 2, but preferably at 3, well sites.
	Trip blank	(One per field season, only for VOCs.)
	Field-spiked, replicate (2) samples per well	Minimally at 2 well sites.
• Trace elements (such as NWQL SC2703)[b]	**Field blanks**	Minimally at 3 to 5 well sites.[c]
	Standard-reference-sample mixtures	(Three per field season.)
	Replicate (2) ground-samples per well	Minimally from 3 to 5 wells at different sites.
• Radionuclides (such as radon)	**Replicate (2) ground-samples per well**	Minimally from 3 wells at different sites.

[a]For tritium, deuterium-oxygen isotopes, or chlorofluorocarbons, contact a National Water-Quality Assessment Program Quality-Assurance Specialist.

[b]Through 1995, some Study Units collected and temporarily archived water-quality and quality-control samples.

[c]If trace-element concentrations of interest are low (less than 10 µg/L), collect the maximum number of field blanks, and the minimum number of replicate sample sets specified. For high concentrations, collect the minimum number of field blanks, and maximum number of replicate sample sets.

Table 13. Well- and site-selection criteria for routine quality-control samples collected for ground-water components of the National Water-Quality Assessment Program

[Field blanks and field-spiked, source-solution blanks taken during the evaluation of data-collection methods are not considered below. DOC, dissolved (filtered) organic carbon; VOC, volatile organic compounds; NWQL, National Water Quality Laboratory]

Routine QC sample type	Well (site) selection criteria for Study-Unit (or Subunit) Survey, or Land-Use or Flowpath Study ground-water components
Field blanks (all analytes, except radon)	Select wells where it is known or suspected that ground water (1) at each well contains measurable (greater-than-method-reporting-level) concentrations of most to all analytes and (2) collectively, for the wells chosen, reflects some of the diversity in ground-water-quality conditions (range in concentrations for these analytes) for which the ground-water component is designed.[a]
Source-solution blanks (DOC)	Use the same well sites selected for DOC field blanks (above) for each component.
Trip blank (VOC)	Sent from one randomly selected well site from among all well sites for all components at which VOC samples are collected during the same field season.
Replicate ground-water samples (inorganic analytes, radio-nuclides (radon), and DOC)	Use the same wells selected for field blanks (above) for each component.[a]
Field-spiked, replicate, ground-water samples (VOC and pesticides)	Select wells where it is known or suspected that ground water at each well (1) contains measurable concentrations of inorganic analytes and DOC (similar to those found at routine QC sites selected for field blanks and replicate ground-water samples), but (2) do not contain measurable concentrations of those VOCs or pesticides found in NAWQA-NWQL spike solutions and of interest to the Study Unit for each component.[a]
Standard-reference samples (trace elements)	Sent from 3 well sites selected from among all well sites for all components at which trace-element samples are collected during the same field season.[a]

[a]Schedule data collection for selected wells so that water-quality and routine QC samples are obtained from at least one of these wells early, at least another of these wells mid-way through, and at least at still another of these wells near the end of the entire time period during which water-quality data that relate to the type of QC sample type specified are being collected for the component or, in the case of trace-element standard reference samples, for the field season.

Field blanks are collected at the same wells used to obtain replicate ground-water samples; namely, at wells likely to have measurable concentrations of analytes in ground water. This makes it possible to verify that (1) the sampling equipment was exposed to measurable concentrations of contaminants, and (2) equipment decontamination procedures were effective. (The latter cannot be verified if the wells selected for field blanks contain no measurable contaminants.)

Additional Land-Use Study wells that differ from those selected for replicate ground-water samples and field blanks need to be selected for VOC and pesticide field-spiked samples. Criteria for selection of wells for spiked samples (table 13) ensure that the QC data are representative--reflect the type(s) of ground water in the Land-Use Study area where VOC or pesticide contaminants are found but that unspiked samples do not contain the VOCs or pesticides of interest. This means that recovery estimates from spiked samples (in which the analytes of interest have been added in the spike solution) are likely to reflect recoveries from ground-water samples that contain these same analytes in similar concentrations.

The criteria also ensure that the field-spiked QC data are suitable--reflect recoveries that are unbiased. Samples that contain measurable concentrations of pesticides or VOCs--in excess of a few tenths of a microgram per liter--and that are spiked with similar VOCs or pesticides in accordance with current NWQL protocols generally will provide recovery estimates that have a positive bias. The bias results because the recovery generally is calculated on the basis of the measured concentration divided by the theoretical concentration of the spiked sample, where the latter is estimated from the amount of analyte added in the spike solution. Recovery estimates cannot be determined precisely by correcting for the background (unspiked) sample concentration, unless at least triplicate unspiked, and triplicate spiked, samples are collected.

The scheduling (timing) of routine QC data collection for the Land-Use Study is determined after the wells for routine QC data collection have been selected. This involves scheduling site visits at these wells such that routine QC data are obtained early, about mid-way through, and near the end of the 1- to 3-month period it commonly takes to complete data collection for a Land-Use Study. This implies that the ground-water sampling schedule for a Land-Use Study, or any other ground-water component, cannot be finalized until the routine QC sampling design is developed (table 7).

Study-Unit (or Subunit) Surveys. A typical Study-Unit Survey is designed to obtain occurrence and distribution data on a variety of analytes (table 1). In this respect, a Study-Unit Survey is somewhat similar to a Land-Use Study. A Study-Unit Survey differs from a Land-Use Study in some respects, which affects the routine QC design.

A Study-Unit Survey can involve data collection from as many as 100 to 120 wells associated with multiple, rather than one, land use. These wells also often will be distributed among several Subunit Surveys, each consisting of about 30 wells. The 30 wells in each Subunit Survey often will be completed in shallow and deep parts of one or more aquifers. Thus, wells in a subunit generally will reflect a greater diversity in land-use and water-quality conditions than that associated with a single Land-Use Study. Overall, data collection from these Subunit Surveys collectively will take more time to complete than it will take to complete a single Land-Use Study.

Because Study-Unit or Subunit Surveys and Land-Use Studies often will involve the collection of similar types of ground-water-quality data, the types of routine QC samples required for a survey for each analyte are similar to those required for a Land-Use Study (table 12). The minimum number of each type of QC sample required for each Subunit Survey is at least the same number as that required for a Land-Use Study. Because of the potential for a greater diversity in landscape and subsurface conditions in Subunit Surveys compared to Land-Use Studies, however, it is recommended that at least one or two additional sites be selected for replicate ground-water samples for the inorganic analytes (major ions, nutrients, alkalinity, acid neutralizing capacity, dissolved organic carbon, and possibly trace elements) and the field blanks in each Subunit Survey.

If the Study-Unit Survey is designed as a single entity (not conducted using Subunit Surveys), then the minimum number of QC samples required for each sample type for the survey is increased in direct proportion to the number required for a Land-Use Study (table 12) on the basis of the total number of wells being sampled for the survey divided by the total number of wells being sampled for a Land-Use Study (which for the purposes of this calculation is taken as 25). Thus, a survey that involves 50 wells requires twice the minimum number of each type of QC sample than generally is required for a Land-Use Study.

Survey wells are selected for routine QC samples and scheduled for data collection using the same approach outlined above for a Land-Use Study. Different wells are selected for the different types of QC samples to provide QC data that are representative of differences in water quality, suitable for providing estimates of measurement bias, variability, and recovery, and cover the time period during which the Survey ground-water-quality data are collected (table 13).

Flowpath Studies. A typical Flowpath Study will assess spatial differences and possibly temporal variability in each of a selected number of analytes among wells located in different parts of a local ground-water flow system. The number of wells used for water-quality data collection commonly will be less than 20, with most wells completed in a single aquifer that underlies a single land use.

The routine QC design for a Flowpath Study involves the selection of routine QC sample types (as described in table 12) that relate to only those analytes that are targeted for investigation by the Study Unit. These routine QC sample types are to be collected at selected sites the first time the flowpath wells are sampled and, thereafter, at sites and times that reflect Flowpath Study objectives--such as evaluating spatial or temporal differences in analyte concentrations. As a general rule, the sites selected and frequency of routine QC sample collection are to be sufficient to establish that possible spatial differences or temporal trends in analyte concentrations at, or among, flowpath wells are not primarily a function of measurement bias or variability that result from field and laboratory methods.

Nested Studies. Ideally, the ground-water design for a Study Unit calls for Flowpath Studies to be located in selected Land-Use Study areas, and that each Land-Use Study be located in a (Subunit) Survey area. Theoretically, this implies that routine QC data collected for one component could serve as routine QC data for another component. Ideally, this also is efficient in terms of planning, field work, and costs. Use of this approach, however, requires the routine QC design requirements be met for each individual component.

To ensure that routine QC data from one component are valid routine QC data for another component, one component must be geographically nested within the other. That is, at least one well must be part of both components--the well that will be used to obtain the QC data common to both components. Data collection for both components must overlap in time, and occur at the well targeted to provide the required ground-water and routine QC data needed for both components during that period of data-collection overlap.

Example of routine quality-control design: a case study

Regardless of the ground-water component, the design, and in particular, selection of sites for routine QC data collection commonly will be determined using limited information. In particular, to obtain representative QC data, the wells selected are to reflect the diversity of water-quality conditions likely to be found among the wells used to collect ground-water data in each component. In a number of cases, however, the quality of ground water in terms of analyte concentrations at each well will not be known until after NAWQA data are collected.

When water-quality data are lacking, other types of data are used to make inferences about the likely quality of water at each well. Useful ancillary data include (1) water-quality data from nearby wells (retrospective data), (2) data on surface features (such as land use, crop types, and associated chemical use) from site visits and published data, and (3) data on subsurface features (such as lithology and well depth) which are obtained during well selection (or installation) and from published data on aquifer characteristics.

An inferential approach to identify and evaluate routine QC-sample data-collection sites and data was employed in the Delmarva Peninsula pilot NAWQA study. In this study, Hamilton and others (1992) used retrospective water-quality data (primarily major cations and anions) to describe spatial and depth-related differences in ground water throughout the Study Unit, and to identify agriculturally-affected ground water as well as unaffected (or natural) types of ground water in the study area (fig. 1-A, encircled regions). To design QC sampling for this Study-Unit Survey, Koterba and others (1991) used the above information along with data on surface features (general land use, and different agricultural activities such as crop type and related liming, and fertilizer and pesticide use) and subsurface features (well depth and aquifer lithology) at each well to select those for replicate routine QC samples (except those for field spikes) and some field blanks. The combined ancillary data described above indicated that different types of ground water were likely to be encountered (fig. 1-A), and that most analytes (major ions, nutrients, organic carbon, trace elements, and perhaps pesticides) were likely to be found at detectable (above detection level, but less than reporting level) or higher concentrations at the selected wells.

Additional wells for QC data collection were selected that reflected a diversity in ground-water types, but where it was initially inferred that pesticides found in NAWQA spike solutions and of interest to the Delmarva Peninsula Study-Unit staff (primarily triazines and acetanilides) were not likely to be found in samples from this second set of wells. These wells were used to obtain samples for pesticide field spikes.

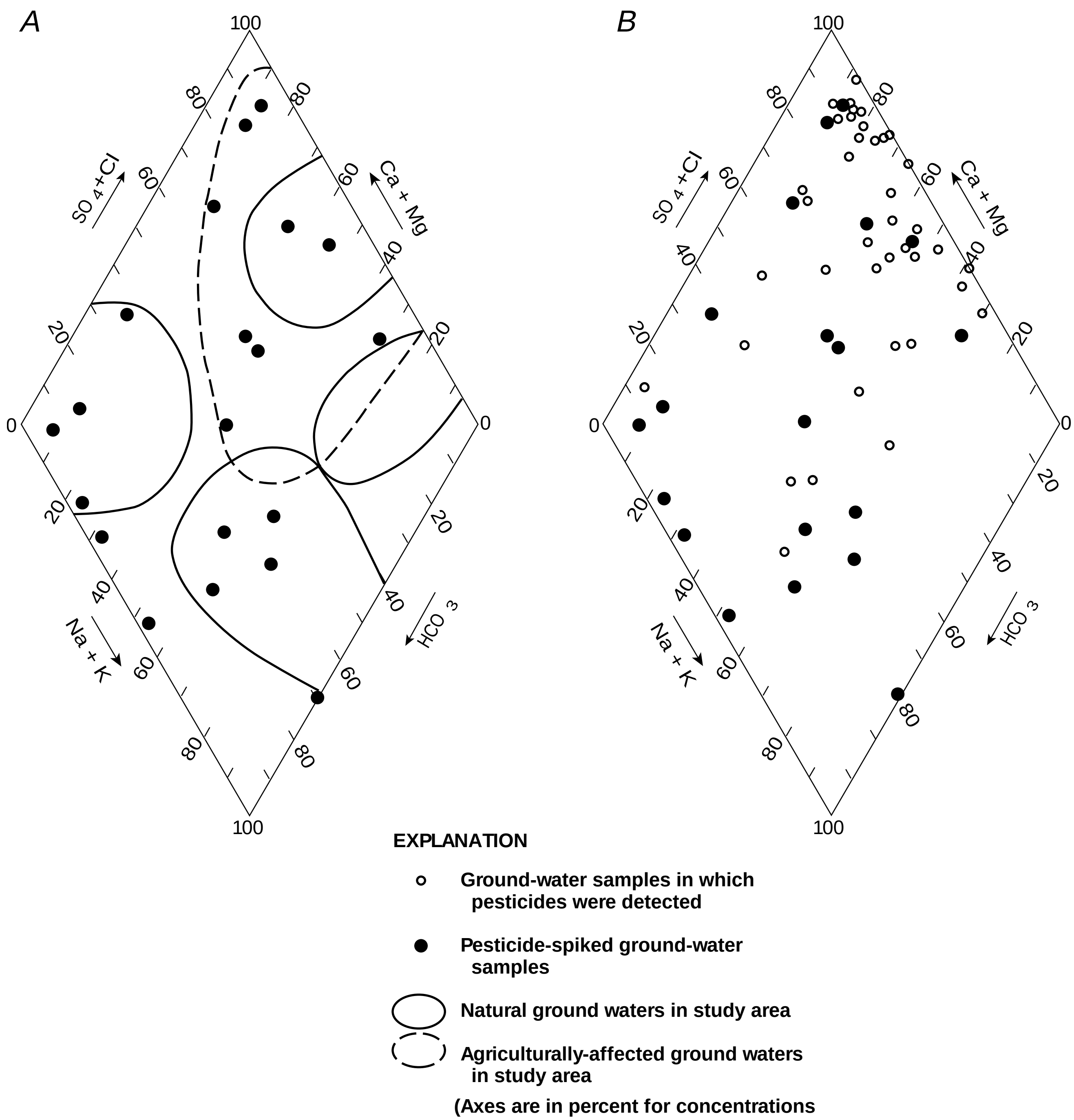

Figure 1. Distribution of wells selected for pesticide spikes in relation to the major-ion composition of (A) natural and agriculturally-affected ground waters, and (B) ground-water samples in which pesticides were detected in the Delmarva Peninsula (Koterba and others, 1993).

As water-quality samples and data were obtained by the Delmarva Study Unit, the major-ion data were plotted, including data from those wells selected for routine QC sampling. In general, plots illustrated that the different types of ground water described by Hamilton and others (1992) were being collected, and in particular, that the sites chosen for QC data collection also reflected most of the different types of ground water found in the Study-Unit Survey area (fig. A1, plotted points). Thus, the QC data were considered representative of the types of ground-water quality found in the study area.

Another key element addressed by the staff of the Delmarva Peninsula Study was to assess the suitability of replicate ground-water sample or field-spiked ground-water sample QC data to provide estimates of the method (field and laboratory) variability in concentration measurements or method bias in recovery, respectively, for selected analytes. This was done in part by using field-blank and unspiked (background) concentration data. In the Delmarva Peninsula Study, field blanks (12) were collected at different sites and times, and in each case, after equipment was contaminated (as later verified by the ground-water samples collected), and then field decontamination procedures were conducted. Blank data provided no evidence that samples (ground-water or other QC, including replicate or field-spiked samples) were subject to contamination in the field (by ambient conditions or equipment cross-contamination) or thereafter (during handling, shipping, and laboratory analysis). Further evidence that the QC data from field-spiked samples was suitable also came from the corresponding unspiked ground-water samples. Of 21 wells selected for field-spiked samples, only one yielded an unspiked sample that had a measurable concentration for any of the pesticides of interest. Thus, on the basis of field-blank and background-sample concentration data, it was demonstrated that there was: (1) no evidence samples of any type were contaminated during or after their collection, (2) that field decontamination procedures were adequate, and (3) that replicate and field-spiked data were not compromised by ambient or cross-contamination, and were suitable for estimating, in an unbiased manner, the method variability in concentration measurements and the method bias in recovery for selected analytes.

Additional data plots (for example, fig. 1-B) were constructed to illustrate that the wells chosen for pesticide field spikes generally reflected the types of ground water in which these same pesticides appeared as a result of what was considered normal pesticide use in the Study-Unit Survey area. Thus, it was argued that field-spiked sample data were representative of the types of ground water in which pesticides sometimes were found.

In terms of estimating pesticide recovery and measurement variability, only one of the 21 wells chosen by the Delmarva Peninsula Study-Unit staff for field spikes yielded a background sample with measurable concentrations of some of the pesticides found in NAWQA spike solutions and of interest to the Study Unit. This implied that, except for the data from that one well, the field-spiked sample data were suitable for obtaining unbiased recovery and variability estimates for those pesticides of primary interest to the Study Unit. Thus, for most of the pesticide analytes in question, recovery and measurement variability estimates were obtained using spiked samples from all 21 wells (Koterba and others, 1993). In the case of the one analyte found in the background sample from one well, the data from only 20 wells was used to estimate recovery and measurement variability.

The preceding discussion offers one approach that made it possible to select wells and design ground-water and routine QC sampling schedules each year to provide representative and suitable QC data for a 100-well Study-Unit Survey, which took 2 years to complete sample collection. Although the example above is for a Study-Unit Survey, the approach also is applicable to Land-Use and Flowpath Studies.

The above approach also illustrates how a Study Unit can graphically demonstrate that the wells selected for routine QC data collection represent different types of ground-water quality found in a component study area. If this visual analysis of QC data is made in a timely manner (before ground-water sampling for a component is complete), it is possible to incorporate wells not yet sampled, or initially selected, into the routine QC design to improve the representative nature of the QC data.

Topical quality-control samples

Field and laboratory equipment and methods for the collection of ground-water-quality data, including those for QC, could be modified as a result of routine QC data analysis, shifts in National Program priorities, or results from other studies. Modifications will be designed and implemented in a systematic manner, preceded by a NAWQA memorandum that explains the nature of the modification, the reason for the modification, and the manner in which the modification will be documented and evaluated. As part of this modification process, which is considered topical in nature, Study-Unit participation could be requested by the National Program. On some occasions, this could require additional QC samples be collected by some or all Study Units.

Individual Study Units could find additional QC samples are necessary to address a topic of local concern. For example, additional field and trip blanks could be required to verify that VOC contaminants are in the ground water, and are not being introduced during and after sample collection (Rea, in press). In other cases, additional blanks and spiked samples could be required to correctly assess method-related problems (Koterba and others, 1994).

Sample Coding and Data Management

The current electronic systems for sample and data management (LIMS-NWQL, NWIS-I-QWDATA, and NWIS-I-QADATA) do not provide a simple means of relating or differentiating among ground-water-quality and QC samples obtained from a single well. Although there are several ways to overcome this problem, the need to aggregate ground-water-quality and QC data on a regular basis at the Study Unit and National Program level requires consistent coding and management of samples and data among Study Units. For this reason, protocols for coding and electronically storing routine QC samples and data were developed (tables 14 and 15). In the case of topical QC data, coding is provided as part of each national topical QC-data request.

Table 14. Sample container coding requirements for ground-water-quality and routine quality-control samples of the National Water-Quality Assessment (NAWQA) Program

[NWQL, National Water Quality Laboratory, Denver, Colo.; SC, laboratory schedule; LC, laboratory code (in lieu of schedule); FA, filtered and acidified (nitric acid); RU, raw (unfiltered) and untreated; FU, filtered and untreated]

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1. Routine ground-water sample-bottle labels:

- NAWQA and Study-Unit four-letter code: for example, "NAWQA-POTO" (for Potomac NAWQA Study Unit)
- Local well identifier code
- Bottle type--NWQL sample designation schedule or laboratory code: for example, FA-SC2750
- Date of sample collection (MM-DD-YY, month-day-year), for example, 06-31-94
- Time of sample collection (HH:**00**, hours-minutes, military time)[a] for example, 12:00

2. Routine quality-control sample-bottle labels:

- NAWQA and Study-Unit four-letter code, same as above
- Local well identifier code, same as above
- Bottle type--NWQL schedule or laboratory code, where schedule or laboratory code used is given below
- Date of sample collection (MM-DD-YY, month-day-year), same as above
- Time of sample collection (HH:MM, hours-minutes, military time) where minutes are assigned values other than 00, according to the following format:

Time	Routine QC-sample type time-of-collection codes.[b]
HH:**01**	**Replicate--organic-carbon, nutrient, pesticide, volatile-organic, radon or major ion samples,** use SC2085, SC2752, SC2001 and SC2050, SC2090, SC2091, or SC2092, LC1369, and SC2750 (FA, RU, and FU), respectively. (For replicate cartridges, use SC2010 and SC2050, in lieu SC2001 and SC2051, respectively. Replicates for pesticide and volatile-organic compounds are optional.)
HH:**02**	**Field spike-1st--for pesticide or volatile-organic samples,** use same schedules cited under replicates above.
HH:**03**	**Field spike-2nd--for pesticide or volatile-organic samples,** use same schedules cited under replicates above.
HH:**04**	**Field spike-3rd (optional)--for pesticides or volatile-organic samples,** use schedules cited under replicates above.
HH:**05**	**Field blank--pesticide, volatile-organic, organic-carbon samples--(which require NWQL pesticide and VOC-free blank water, or if no field blank for VOCs taken, require NWQL pesticide-free blank water),** use same schedules cited for replicates above. **Field blank--nutrient samples (which require QWSU inorganic-free blank water),** for SC2752**.**
HH:**06**	**Field blank--major-ion (which require QWSU inorganic-free blank water)** for SC2750.
HH:**07**	**Solution blank--organic carbon only, (required because NWQL blank water is not analyzed for organic carbon),** use SC2085.

Table 14. Sample container coding requirements for ground-water-quality and routine quality-control samples of the National Water-Quality Assessment (NAWQA) Program--Continued

Time	Routine QC-sample type time-of-collection codes.[b]
HH:**08**[b]	**Trip blank--volatile organic samples only (which requires NWQL trip blanks found in box that sample vials are obtained in),** use SC2090.
HH:**09**[b]	**Primary trace-element ground-water-quality sample**, such as for SC2703.
HH:**10**[b]	**Replicate trace-element ground-water-quality sample,** such as for SC2703.
HH:**11**[b]	**Field blank--trace-element samples only (which require QWSU inorganic-free water),** and in lieu of SC2703 use SC172 and add LC0112 (arsenic) and LC0087 (selenium).
HH:12[b]	**Standard Reference Sample--for trace-element samples only,** such as for SC2703.

[a]This is a generic time value--the nearest hour to the true time--that is the basis for linking samples taken from a well during a particular visit. Some situations, or samples, require the true time of collection also be recorded--for example, to identify the time at which radon is taken. True time can be recorded, along with the reason it is being recorded, on the field form, as in the case of radon, in the message to the laboratory section on the NWQL-ASR form.

[b]Except for trace elements (for example, SC2703), additional sample bottles under other schedules can be added under the above time codes if and only if (1) they do not contain analytes in common with the samples and schedules already listed, and (2) if they are composed of blank water, it is the same type of blank water being used for the samples already listed above. If these conditions cannot be met, use other time codes (and NWQL analytical service request forms) for the additional samples. Note that for trace elements, unique time codes are required.

Table 15. Storage and coding requirements for ground-water-quality and quality-control samples and data of the National Water-Quality Assessment Program

[NWIS-I, National Water Inventory System; QWDATA, Quality of Water Data Base; QADATA, Quality-Assurance Data Base; NWQL, National Water Quality Laboratory; BTD&QS, Branch of Technical Development and Quality Systems; QWSU, Quality Water Service Unit; mL, milliliters]

1. Data Storage (check District policy):

- Routine ground-water-quality data in NWIS-I (QWDATA) database.
- Routine quality-control data in NWIS-I (QADATA) database.
- Topical quality-control data in NWIS-I (QADATA) database.

2. Sample and Data Coding on Analytical Service Request (ASR) Forms:

- Use same local well identifier as on sample container, add corresponding station identification code (15-digit latitude-longitude-sequence number) and use same date for all ground-water and quality-control samples collected at a well during a site visit.
- Use different time-of-sample collection codes for quality-control samples.[1]
- Use additional codes below for quality-control samples (in accordance with BTD&QS):[2]

For BLANKS: Coding required

Blank type	Sample medium	Sample type	Blank solution type (99100)	Blank solution source (99101)	Blank sample type (99102)
Trip	Q	2	10, 40, or 50	10, 60, or 80	30
Equipment	Q	2	10, 40, or 50	10, 60, or 80	80
Field	Q	2	10, 40, or 50	10 or 80 only	100
Solution	Q	2	10, 40, or 50	10 or 80 only	1

where Q denotes an artificial sample; 2 implies a blank sample; blank solution type 10, 40, or 50 implies inorganic-free, pesticide-free, or volatile-organic-free blank water, respectively; blank solution source 10, 60, or 80, implies blank water from the NWQL, District, or QWSU (Ocala), respectively; blank sample type 30, 80, 100, and 1 correspond to the blank types specified in the first column, respectively. Only NWQL or QWSU water should be used for field blanks. Record lot number of blank solution on ASR form.[3]

For REPLICATES: Coding required

	Sample medium	Sample type	Replicate type (99105)
Regular sample	6	7	20
Second sample	S	7	20

where 6 implies a ground-water sample; S implies a replicate ground-water sample; 7 implies replicate samples; and 20 implies samples were collected sequentially.

Table 15. Storage and coding requirements for ground-water-quality and quality-control samples and data of the National Water-Quality Assessment Program--Continued

2. Sample and Data Coding on Analytical Service Request (ASR) Forms--continued

- Use additional codes below for quality-control samples (in accordance with BTD&QS)[2]--continued

For SPIKED SAMPLES (pesticides and volatile organic compounds):

	Coding required					
	Sample medium	Sample type	Replicate type (99105)	Type of spike (99106)	Source of spike (99107)	Volume of spike (mL) (99108)
For each spiked sample	S	1	20	10 or 20	10	0.1

where S denotes a replicate ground-water sample; 1 implies a spiked sample; 20 implies a sequentially-collected sample; 10 or 20 implies spike was done in field, or at NWQL, respectively, 10 implies source of spike solution was the NWQL (required); 0.1 implies a 100-microliter volume of spike solution was used. Record lot number of spike vial on ASR form.[3]

For REFERENCE SAMPLES (of trace elements, obtained from BTD&QS):

	Coding required		
	Sample medium	Sample type	Reference type (99103)
For each reference sample	Q	3	35

where Q denotes an artificial sample; 3 implies a reference sample; and 35 implies a reference sample that is a blend of standards. Record reference sample bottle code as received from BTD&QS on ASR form.[3]

[1]Use different time codes to distinguish QC samples and prevent data overwrites (see table 14).

[2]Storage of ground-water-quality and quality-assurance data in NWIS, Branch of Quality Assurance Memorandums 90.03 and 92.01 (unpublished memorandums located in the USGS BTD&QS, P.O. Box 25046, Mail Stop 414, Denver Federal Center, Lakewood, CO 80225).

[3]Write message to lab on comment line on ASR form.

To easily group ground-water-quality and QC data from selected sites, the containers for these samples are coded in a systematic manner that employs some common codes (table 14--NAWQA Study-Unit code, local well-identifier code, schedule or laboratory code, and date of collection). For example, ground-water-quality and routine QC samples from the same well and time of site visit are given the same local well-identifier code (on sample containers), and the same local well and 15-digit (latitude-longitude-sequence number) identification codes in NWIS-I, and the same date of collection (on containers and in NWIS-I). These common codes facilitate linking selected types of samples (field blanks with the ground-water sample collected before the blank was taken, one replicate sample with another, or a spiked sample with an unspiked sample). If common codes are not used, recoding, or the creation of additional codes by the Study Unit, will be needed to link data requested by the National Program. In either case, the Study Unit will be adding unnecessarily to its workload.

To manage sample data efficiently, and reduce confusion, it is best if routine QC sample data are stored and managed through NWIS-I QADATA, and ground-water-quality sample data are stored and managed through NWIS-I QWDATA (table 15). Efficient data management, reduced data loss, and improved ease of interpretation also are best achieved if different routine QC-sample types, taken in relation to the same well and time of site visit, are uniquely coded in at least some respects, and ancillary information that relates to each routine QC-sample type is documented on the ASR form (tables 14 and 15). Thus, different time, medium, and QC-sample codes are used for different types of routine QC samples. Ancillary information, such as the lot number of the blank water or the spike solution, also is coded and essential to interpreting QC data correctly. Illustrations of how data and codes are to be stored are provided for each type of QC sample routinely collected (see appendix).

Consistent coding benefits each Study Unit in several ways. First, except for a few codes, such as time of sample collection, most sample containers and forms generally can be filled out before the field team departs for sampling. Most of this same information also can be logged into NWIS-I in advance. This report (tables 14 and 15 along with the appendix) provides a comprehensive summary of appropriate codes that are needed to complete these presampling coding and management activities.

The prescribed codes will reduce the loss of data through overwrites. Data overwrites can occur in several ways. For example, one of the most common overwrite problems occurs when two different sample containers and their corresponding ASR forms have the same identification, date, and time codes, and one inadvertently requests analyses that involve at least one common analyte (parameter code) for both samples. Another common problem arises when one makes corrections to NWIS-I (QADATA or QWDATA), but does not have these processed through NWQL-LIMS. In either case, corrections are overwritten and data can be lost electronically when the NWQL submits or resubmits analytical results to NWIS-I through LIMS original record or provides updates to this record. To avoid problems, the Study Unit must code samples correctly. In addition, if corrections are made in the District, the Study Unit also must request the corrections be processed through the NWQL-LIMS system.

The prescribed codes will ensure that the sample container for a particular analysis is used for that analysis. For example, if sample containers are sent for major ions (SC2750--FA) and trace elements (SC2703--FA), they must be sent under separate ASR forms with different times to ensure that the trace-element analysis is done using the SC2703 sample and not the SC2750 sample. Because of potential differences in filter loading that affect filtrate concentrations between these two samples, it is critical that trace-element data come from an analysis of the SC2703 sample.

Finally, use of the prescribed codes (tables 14 and 15) is necessary for requests from the National Program for ground-water and QC data. If alternative coding is used, the data will need to be recoded by the Study Unit before the data are forwarded to the National Program.

Final Presampling Plans and Preparations

During the last month or two before the first field season for data collection begins, the Study Unit will complete presampling plans and preparations. This will involve a number of activities (table 16) that, in addition to scheduling water-quality and QC sampling, will include the following:

1. Creating a field file that contains copies of all the information needed for the current sampling run;

2. Preparing sample containers and filter units;

3. Checking that all the equipment and supplies needed for sample collection at each well listed in the file have been obtained and safely stored in the vehicle; and

4. Checking that the vehicle is in good and safe working condition, and that safety equipment is present and functioning properly.

In addition to the well schedule (table 7), the field file contains information critical to completing activities at each well (table 16), which could differ among wells. As sampling continues, the file is updated regularly in terms of those wells scheduled for data collection throughout the remainder of the field season.

Table 16. Activities related to final plans and preparations before sampling begins

1. **Create a field file,** in part, from previously collected information, that contains:
   - A well schedule (chronological list of wells to be sampled during the scheduled run).
   - A checklist of the sample and data-collection activities to be carried out at each well--
     (a) a list of analytes to be sampled--by bottle type (for example, FA), in order of collection and processing, including quality-control samples,
     (b) a list of information required, and the necessary forms, to complete any documentation not completed during previous site visits, and
     (c) a form for noting changes in, or providing additional information on, land use.
   - Copies of site, well, measurement point, and sampling setup location maps and photographs for each well.
   - Notes on any special site conditions that could affect sample and data collection at a well, including roaming animals and locked gates, or a well, that on the basis of screening tests, might require special QC sampling and decontamination procedures.
   - The contact person's (well or land-owner's) name and telephone number for each well.
   - Field cover, well-purge, Analytical Service Request, and field-instrument calibration forms--completed to extent possible for each well. Also include some extra, blank copies of each form. (Calibration notebooks can be used instead of individual forms.)
   - Overnight-mail shipping forms and labels, completed to extent possible, and the shipper's telephone number.
   - Study-Unit (SU) sample-transfer and temperature-check form for NWQL (Sample login) with SU-addressed, stamped envelope for each well. (Also have the telephone number for NWQL (Sample login)).
   - Calibration notebook(s) for field meters.
   - Copies of the NAWQA protocols for sample and data collection, and the U.S. Geological Survey National Field Manual for Collection of Water-Quality Data (Radtke and Wilde, in press).

2. **Prepare sample containers and filter units** that are:
   - Cleaned if necessary,
   - Labeled to the extent possible, and
   - Bagged, for each well,
   - With each container tightly capped. (Recommend plastic container be half filled with DIW.)

3. **Provide routine checks** that cover the equipment and supplies stored in field vehicles (see table 3 for detailed list), for:
   - Calibration and use of field meters for temperature, pH, acid-neutralization capacity, alkalinity, specific electrical conductance, dissolved oxygen, and possibly turbidity.
   - Collection, processing, preservation, and, possibly field extraction of ground-water and quality-control samples.
   - Field-equipment decontamination.
   - Sample shipment or temporary storage.
   - Disposal or temporary storage of waste materials.

4. **Provide predeparture checks** each time the field team leaves the District office or a well that:
   - Cover vehicle safety and condition.
   - Ensure all field equipment is properly and safely stored.

As part of the final presampling preparations, some sample containers require rinsing (table 16). For example, it is required that all sample containers and caps for filtered and acidified samples (FA designation), which includes those for major ions and trace elements, be rinsed at least three times with either QWSU IBW or DIW -- ASTM Type 1 water (conductivity less than 1.0 µS/cm at 25°C). It is recommended, however, that FU, RU, and FCC containers also be rinsed as described above before use. After the final rinse, it also is recommended, as a QC measure on the container seal, that each container be half-filled with the same water used for rinsing and capped before storing the container for transport to the field. If the container is less than half full when pulled from storage in the field, the container is discarded, and another similarly rinsed container is used in its place. This implies that several additional containers for each sample type are prepared as above and in advance of at least the first field-team trip. After rinsing, sample containers can be labeled with the appropriate codes, except for date and time of collection, before they are transported to the field. This will reduce the time necessary to complete setup activities in the field before samples are collected.

Although at least three different filter units commonly will be used (table 3), only the one for filtered inorganic samples, the 0.45-µm fibrous filter (capsule), can be prepared before the field team departs for the field. It is required that 1.0 L of QWSU water or DIW (ASTM-Type-1) be passed through this filter before it is used. Preconditioning is to occur within 5 days before use. A peristaltic pump head with Tygon tubing, or a Teflon diaphragm pump head with convoluted Teflon tubing can be used to force the preconditioning water through the capsule filter. The pump also is used to force as much water as possible from the capsule after it is preconditioned. To avoid mildew, the preconditioned capsules are placed in nested, resealable plastic bags and stored in a cool environment (refrigerator or cooler with ice) before use.

Different filter units might need to be prepared to address topics of interest germane to a specific Study Unit component. A Flowpath Study that involves geochemical modeling and other techniques to interpret dissolved inorganic chemical data from ground water requires additional samples be obtained with these samples filtered through a membrane with a pore size of 0.2 or 0.1 µm or less. Currently, only flat (plate) filter membranes are available with a pore size of 0.1 µm or less. Preparation of these membranes and the equipment needed is described in an internal document (F.D. Wilde, U.S. Geological Survey, written commun., 1995--see footnote 1). To determine the appropriate filter type and pore size, it is recommended that a comparison sample analysis be made between data obtained from NAWQA samples passed through 0.45–µm capsule filters and Study-Unit samples passed through 0.1–µm membranes to determine if there is an appreciable difference in trace-element concentrations.

Final plans before sample collection include the office support effort required to maintain the field effort. The field effort typically involves repeating activities (such as those in table 16) on a regular basis during a single field season. To plan for the office support needed, consider that each time the field team returns: (1) the sampling vehicle(s) generally is (are) unloaded, cleaned, and restocked; (2) forms and other information are transferred from field to office files; (3) the field file is restocked with information on the next set of wells to be sampled; (4) samples brought from the field are archived or shipped from the office; and (5) field and sample-related data and forms are transferred to data managers, with copies being archived into NAWQA site files.

If the planning document or workplan assigns all of the above activities solely to the field team, their field schedule must allow ample time to complete these activities. The workplan also should reflect that team members could have a backlog of work pending as a result of their absence. A field team that keeps good records in the field--of supplies that are running low, or of equipment that is in need of repair or replacement--can expedite preparations for the next field effort. While in the field, mobile phones also provide an efficient means of communicating needs in advance or when emergencies arise.

During final preparations, Study-Unit data managers integrate their plans to review the data-collection process. Workplans, developed during the last month or two before sampling begins, include verification of field forms returned by field teams, the login of sample and data information from these forms, and the updating of any new information (such as changes in land use). Workplans also include regular retrievals and quality-control checks on NWQL data returns. Of particular importance is the timely retrieval and evaluation of routine QC data, which can be used to assure field teams that data collection can continue unabated. Finally, data management workplans are to include the development of NAWQA water-quality files for wells at which ground-water samples are collected. These files generally are distinct from other files, such as the GWSI file, in that they chiefly contain records and information pertaining to ground-water-quality sampling. Thus, each of these files contains copies of sample-collection field forms, NWQL and other laboratory request forms, and water-quality-data summaries (in particular, NWIS-I site and time-specific lists (WATLISTS) of water-quality data).

Field Protocols and Recommended Procedures

A field team could spend 2 to 5 hours traveling to and from each well that is scheduled for the collection of ground-water-quality samples. At each well, the team will perform some, or all, of the following activities:

(1) Equipment setup.

(2) A well purge, to remove standing water, and field measurements.

(3) Sample collection and processing.

(4) Decontamination of field equipment, including possible breakdown and storage of sampling equipment.

(5) Preparation of blank samples.

(6) Preparation of other routine quality-control samples and field extracts for pesticide samples.

(7) Handling and shipping of samples, including completion and verification of field, laboratory, and other forms.

Each activity is described below in its approximate chronological order of occurrence.

Equipment Setup

Upon arrival, the field team contacts the land or well owner (if necessary), and locates the well and areas for conducting on-site activities (table 17). The field team carries out the remaining setup and other on-site activities after selecting one field-team member, hereafter referred to as **Team Member A**, who is responsible for the collection of all water-quality samples throughout the day. From this point on, **Team Member A** generally performs only those on-site activities that are least likely to lead to the contamination of samples during or after collection. The other field person, **Team Member B**, also performs activities required in order to collect samples and data, but in some cases the activities performed potentially heighten the risk of sample contamination if that person also were to collect water-quality samples.

Field team roles, which are maintained throughout the day regardless of the number of wells visited, are alternated between team members on a regular, preferably day-to-day, basis. This ensures that each team member can perform all on-site activities associated with ground-water-quality data collection.

It is recommended that team members wear clothing appropriate to their assigned activities. **Team Member A** wears clothing that is tightly knit and not likely to shed lint. Powderless latex (when using methanol) or powderless vinyl gloves are required. **Team Member B** initially wears work gloves and coveralls over attire, similar to that of Team Member A. Work gloves and overalls are removed after the completion of setup activities that involve handling equipment that could be heavily soiled or contaminated (table 17). **Team Member B** also is required to wear powderless latex or vinyl gloves during sample handling and preservation. Safety goggles or glasses are worn whenever either team member is handling chemical reagents that are potentially toxic or hazardous.

Well Purging, Grab Samples, and Field Measurements

Before water-quality samples are collected, the well is purged of standing water. Grab samples taken near the end of the purge are used to determine (1) the amount of NWQL hydrochloric acid needed to acidify the VOC samples, and (2) the normality of QWSU sulfuric acid to use for field titrations. Field data are obtained during the latter stage of the purge, immediately before sample collection. The purge, as well as grab-sample analyses and field measurements, are carried out in an efficient, and to the extent possible, consistent manner throughout the NAWQA Program (table 18).

The well purge ensures that the field-measurement and sample data that are subsequently collected reflect the chemistry of water in the aquifer, and not that of the water that has been standing in the well. The purge also conditions sampling equipment and reduces turbidity (sediment and colloids) caused by either the lowering and start-up of a portable pump, or the start-up of a water-supply pump.

Table 17. Initial field-team setup activities related to on-site protocols and procedures at wells used for ground-water-quality and routine quality-control data collection for the National Water-Quality Assessment Program

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1. Field team arrives, consults field file (table 16), and carries out initial setup activities as follows:

   - Contacts land or well owner (if necessary)
   - Verifies following points and areas of interest (modify site-file maps and update photographs and forms as necessary):

     Land use and land cover in vicinity of well[1]
     Well location and water-level measurement point
     Parking areas for vehicle(s)
     Areas for field-equipment setup and well-water discharge

2. To provide quality assurance, the field team divides remaining setup duties, which are carried out as follows:

   - **Team Member A**

     Calibrates and sets up field instruments for titrations, turbidity, and flowthrough chamber[2]
     Assembles sample-wetted equipment for purge and collection[3]
     Completes labeling of sample containers and forms (primarily by adding date and time of collection)[4]

   - **Team Member B**

     Sets up safety cones (as needed)
     Measures water levels (if possible, static depth to water and depth of well)[3]
     Checks for oil residues in well (on measurement tape)
     Calculates purge volume (from well diameter and depth measurements, otherwise assumes it equals three casing (or wellbore) volumes)[5]
     Attaches waste lines to purge setup (see fig. 2, routes to prevent flooding in work area and near power supplies)
     Sets up pump system (as needed, fig.2, for monitoring well, in well drained area)
     Sets up power supply (for portable pump, avoids wastewater areas; using vehicle power, checks fuel is sufficient, attaches exhaust hose(s) to vehicle(s), and voids exhaust downwind of work areas; using portable generator, checks and, if necessary, fills fuel tank)

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[1]See appendix, figure A1, and update as necessary.

[2]According to “Field Instruments” section and appendix, figures A2 to A6.

[3]See text and figure 2.

[4]According to “Sample Coding and Data Management” section and appendix, figures A8 to A20.

[5]See appendix, figure A7.

Table 18. Field-team activities for purging a well for ground-water-quality and quality-control data collection

[NWQL, National Water Quality Laboratory; HCl, hydrochloric acid; VOC, volatile organic compound; QWSU, Quality Water Service Unit; mL, milliliter; H_2SO_4, hydrosulfuric acid; ANC, acid-neutralizing capacity; ALK, alkalinity]

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1. Field team identifies approach to be used to purge well on basis of:
   - Standard purge protocol (see table 19)
   - Recent pumpage from well
   - Possible use of packers
   - Well capacity
   - Possible use of other customized purge criteria
   - Well type (monitoring or water-supply well)[1]

2. Field team divides site duties on the basis of assigned roles for the day, and carries them out as follows:

Team Member A

- Records flow rate and volume of flow from the well and through the equipment setup.[2]
- Collects grab samples near end of purge to determine and record:[3]
  (1) the number of drops of NWQL HCl required to reduce the pH of VOC 40-mL sample to 1.7 to 2.0 (to a maximum of 5 drops for VOC sample preservation), and
  (2) the normality (1.6 or 0.16) of QWSU H_2SO_4 titrant, and volume in milliliters (50 or 100) of the ground-water sample (for field titrations of ANC and ALK).
- Records field measurements, including final median values required under protocol.[2]

Team Member B

- Conducts purge (and routes flow as needed to obtain field measurement data (see fig.2)).
- Adjusts and measures initial and final flow rates through purging setup and pump rates in well (as required and needed)[1].
- Monitors (if necessary) pump work rate (amperage) and power supplies (fuel levels).

Both Team Members

- Assess stability of chemical and physical measures to determine when samples are collected.[4]
- Document decision on whether or not to sample, and why.

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[1]See text, including section on "Purging Different Types of Wells."
[2]See appendix, figure A7.
[3]See "Grab Samples for Titrations and Volatile-Sample Preservation" and appendix, figures A8 and A9.
[4]See "Final Assessment of Chemical Stability."

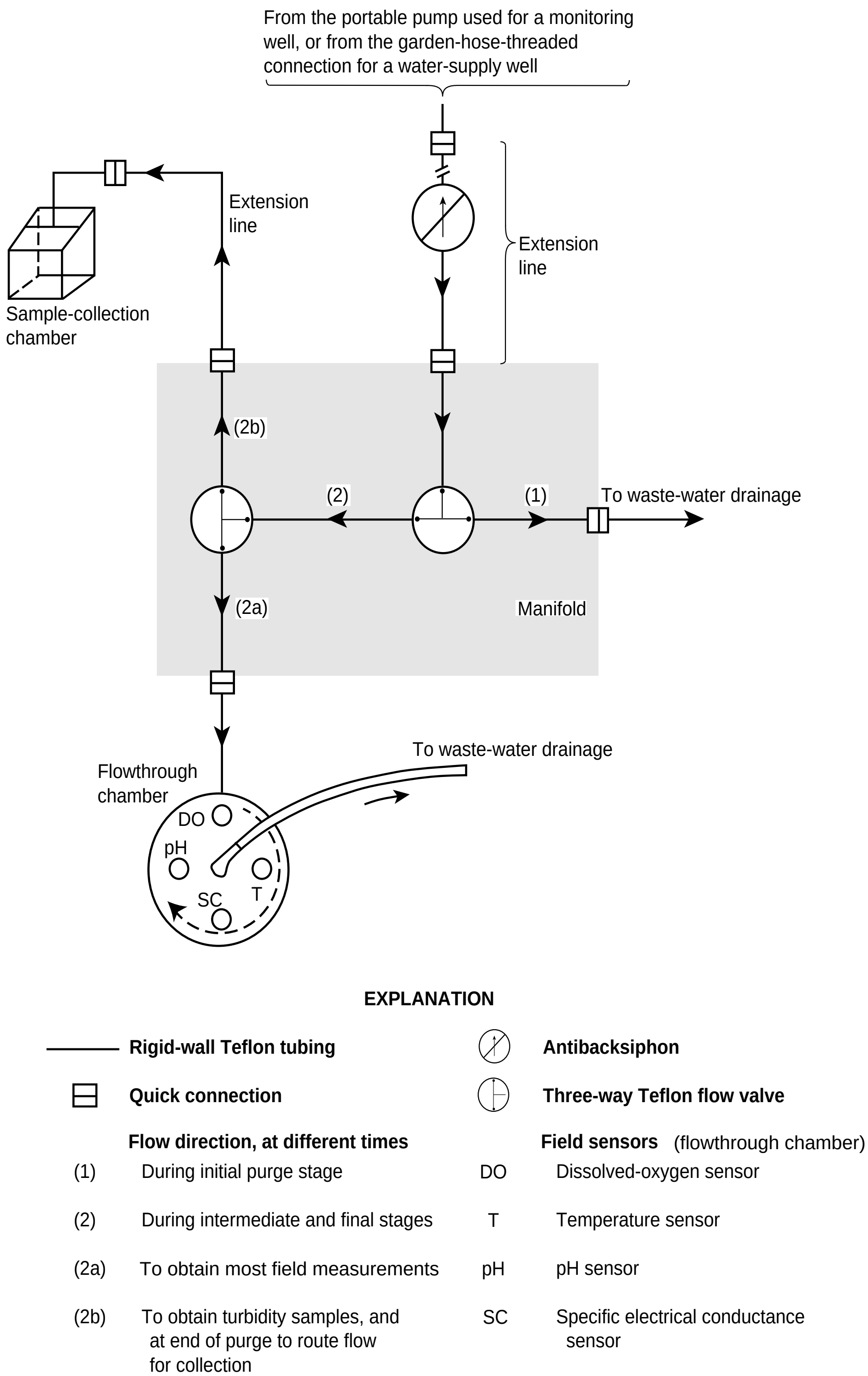

Figure 2. Schematic of equipment setup for well purge and sample collection.

Despite differences in scientific opinion as to when and how much purging are necessary, and the criteria used to assess when purging is complete, NAWQA field teams will use the standard USGS procedures and criteria for purging and collecting field measurements (table 19). In applying the purge protocols, the equipment and procedures used can differ in some respects on the basis of recent pumping, well capacity, study component, and well type (see below). With some exceptions, the same equipment (fig. 2), criteria (table 19), and similar procedures are used to purge and collect ground-water-quality samples. Deviations from the standard purge protocols that are not described below are discussed in advance, if possible, with the NAWQA QA Specialist.

Acceptable deviations from standard purge protocols

Four possible exceptions to the standard purge procedures are recognized and accepted. The first relates to recent pumping. If it can be documented that a volume of water equivalent to the purge volume already has been pumped from a water-supply or monitoring well within the 24-hour period before the field team arrives, sample collection can begin after equipment has been flushed or "conditioned" with ground water and field measurements have been shown to be stable. This effectively reduces the purge time to that needed to achieve stable field measurements (table 19, minimally about 15 to 25 minutes).

The second exception to the standard purge protocols relates to well capacity. When the permeability of the aquifer is low, and a slow recovery limits well capacity, it often is possible to quickly evacuate the standing water from the well. For a monitoring well, the field team lowers the pump intake slowly, and evacuates the well at a pump rate that does not suspend sediments. Field measurements and samples are obtained after the water level has recovered to at least 90 percent of the level measured before evacuation, and provided recovery occurs within 24 hours of evacuation.

The third exception to the standard purge protocols also relates to well capacity. When packers have been placed in a well to restrict the zone of water withdrawal, the purge volume is equivalent to three times the volume between the packers. Given that this purge volume could be quite small, the field team again could find that only a 15- to 25-minute purge at the low flow rate is needed to remove the necessary water and obtain stable field measurements. As a quality-control measure, pressure transducers, installed above and below the packers, are recommended to determine that leakage is not occurring across packers or from above or below the zone isolated for sampling.

The fourth exception to the standard purge protocols is related to the ground-water component sampled. When purge criteria can be customized for the well and in relation to specific sampling objectives, these purge criteria can be used in place of the standard criteria. This exception is most appropriate for investigations that focus on a specific, but limited group of analytes, such as in a NAWQA Flowpath Study (table 1). In fact, it is recommended that Study Units develop and use purging procedures and criteria that best correlate with the concentrations of analytes being investigated. For example, a customized purge criteria for sampling VOCs is described by Gibs and Imbrigiotta (1990).

Table 19. Standard protocols and recommended procedures for conducting and assessing well purging for the National Water-Quality Assessment Program (modified from F.D. Wilde, U.S. Geological Survey, written commun., 1995--see footnote 1)

[Assumes that well capacity is not a limiting factor; see text for further discussion of exceptions. °C, degrees Celsius; %, percent; ≤, less than or equal to; >, greater than; <, less than; µS/cm, microsiemens per centimeter at 25°C; mg/L, milligrams per liter; NTU, nephelometric turbidity units]

1. Purge a minimum volume of water equal to three times the casing (or wellbore) volume.[1]
2. Reduce rate of flow from well, if possible, but at least through setup, to no more than about 0.1 gallon (~500 milliliters) per minute for 15 to 25 minutes near end of purge (sample-collection rate).[2]
3. Monitor pH, temperature, specific electrical conductance, and dissolved oxygen throughout the purging process, but particularly during last 15 to 25 minutes. (If trace-element samples are being collected, include turbidity measurements as part of monitoring.)
4. The well is considered purged after at least three casing volumes have been removed and values of monitored parameters between 5 successive measurements separated by about 3- to 5-minute time intervals are within the allowable difference specified below:

Parameter	Allowable difference or value
pH	± 0.1 units (± 0.05 units if instrument displays 2 or more digits to the right of the decimal)
Temperature	± 0.2°C (thermistor)
Specific electrical conductance (SC)	± 5%, for SC ≤ 100 µS/cm ± 3%, for SC > 100 µS/cm
Dissolved oxygen (DO)	± 0.3 mg/L
Turbidity (TU)	± 10%, for TU < 100 NTU: ambient TU is <5NTU for most ground-water systems (visible TU > 5 NTU)

- If measurements appear stable, the median value of the last five measurements for each parameter (except for pH) is recorded on the appropriate forms (see appendix, figs. A7 and A8), and the field team proceeds with sample collection. For pH, only the last measurement is recorded.
- If criteria for stability is not achieved, purging is continued until either the field measurements stabilize, or the equivalent of five or more wellbore or casing volumes have been removed, depending on the judgment of the field team. The field team records the final field measurements in the manner noted above, and notes any parameters which remain unstable.
- If measurements remain unstable, the field team must decide whether or not to continue with sample collection.
- A lack of stability, indicated by a consistent trend in values upward or downward for pH, SC, DO, and TU, indicates possible problems in well design, or purging setup or technique. It is recommended that samples not be collected from a well if the setup or technique cannot be altered to obtain stable measurements.

[1]Standing volume is calculated from depth to water and depth of well measurements (see appendix, fig. A7).

[2]If a high initial rate is used, reduce rate of flow from well and through purge-collection setup to this rate.

Each of the above exceptions actually fulfills the intent of the standard protocols. In each case, the procedures and criteria used ensure the removal of stagnant water, and the chemical and physical stability in flow before samples are collected. In addition, and regardless of what purge criteria are used, the standard field measurements (DO, SC, T, pH, and, if trace-element samples are collected, TU) also are determined and documented. They are part of the NAWQA data collected at each well (table 1). Thus, except for pH, the median value of the last five stable values for each standard measurement, and any customized purge criterion, are recorded as part of the data of record. For pH, only the last measurement is recorded.

Purging with different flow rates

With the exception of some Study-Unit Survey Flowpath-Study components (table 1), wells used by NAWQA generally are completed at relatively shallow depths in water-table aquifers. As a general rule, the purge procedures described above are completed within about 2 to 2 1/2 hours, which includes the 15- to 25-minute period at the low flow rate required for sample collection (about 0.1 gal/min or 500 mL).

A low flow rate is required at the end of the purge (and during sample collection) for consistency and technical reasons. In combination with a portable, submersible pump, a low flow rate:

(1) is obtainable and maintainable for most, if not all, wells;
(2) reflects a discharge that can be sustained at low pump amperage and without surging;
(3) reduces the likelihood that sources of ground water entering the well will change (Reilly and others, 1989);
(4) is likely to lead to uniform, or at least less turbulent, flow;
(5) reduces the potential for degassing of some constituents, such as VOCs and radon;
(6) reduces the likelihood of entraining colloids and other artifacts dislodged and suspended by turbulence; and
(7) provides a rate of flow that is manageable during sample collection.

To achieve some of the above in sampling water-supply wells when the rate of flow through the well is high and uncontrollable, part of the flow is diverted (through the equipment setup) at the required low rate.

Although use of a higher rate of flow throughout the purge and sample-collection period than that required near the end of the purge reduces purge and sample-collection times, it also reduces the likelihood that the benefits described above will be achieved. As a compromise that aids in reducing field times, while maintaining some consistency and quality control, higher flow rates (during the initial part of the purge) than the required low flow rate (near the end of the purge) can be used provided these conditions are met: (1) that the high flow is sustainable, (2) that the high flow is not highly turbulent, (3) that field measurements, including turbidity, which could change precipitously at first under the high flow, stabilize relatively quickly, and remain about the same (no abrupt changes), and (4) that turbidity, in particular, does not remain elevated, but approaches a generally acceptable value (table 19).

Purging different types of wells

Perhaps the most substantial differences among wells that the field team could encounter in applying the standard purging protocol (table 19), or one of the acceptable deviations to that protocol, occurs in relation to well type (monitoring or water-supply well). Because water-supply wells for NAWQA are chosen on the basis of suitable construction for ground-water-quality data collection (Lapham and others, in press), they are equipped with pumps that can be used to obtain water samples. The location of the well pump intake and the pump rate, however, generally cannot be controlled by the field team. This implies that the field team only has limited control of some aspects of the purge and sample-collection process at these wells. This is not the case for most monitoring wells. Because data collection at most monitoring wells selected by NAWQA will require the use of a portable pump whose intake location and flow rate can be modified, the field team has considerable control over the purge and sample collection process for this type of well. Despite the differences in level of control between water-supply and monitoring wells, and to promote consistency in purging and data collection from these two types of wells, it is required that field teams follow the standard procedures (table 19), when possible, or follow acceptable alternative procedures for purging each type of well. Further guidance on purging either type of well is provided below.

Water-Supply Wells. Water-supply wells used by NAWQA are selected, in part, because they have pumps deemed suitable for producing samples of suitable quality. The field team, however, generally cannot alter the rate at which these pumps operate, nor the location of the pump intake. Generally, the field team only can control the flow rate through their own equipment when purging or collecting samples.

To determine the manner in which the purge of a water-supply well is conducted, the field team first estimates the volume of water that will be removed from the well using the ground-water supply-pump rate and the final 15 to 25 minutes of purging (when stability measurements must be made). If the estimated volume is about equal to or exceeds the required purge volume, then evacuation of the required purge volume will take only about 15 to 25 minutes. In this case, the field team sets up the equipment and then conducts the purge. This situation commonly arises for small water-supply wells, such as those used for single dwellings. Setting the equipment up first, and then purging this type of well will prevent overpurging, which could adversely affect the quality of data obtained by NAWQA for some VOCs (Gibs and Imbrigotta, 1990).

For a water-supply well that requires a purge time considerably longer than 15 to 25 minutes (for example, more than 2 hours), the field team has the option to request that the well pump be turned on before they arrive. This approach commonly is needed for high-capacity wells used for irrigation or drinking-water supplies. The field team arrives, however, in time to set up equipment, complete the final 15- to 25-minute phase of purging using the low flow rate through their equipment, and obtain stable field measurements before the required purge volume is evacuated. If this option is used, the field team also requests that static water-level data be collected by the pump operator before pumping begins.

As a final consideration in purging a water-supply well, the field team keeps the water-supply pump operating throughout the purge and sample collection. This ensures the removal of standing water from the well, and clears standing water from any plumbing lines leading to the sampling equipment.

To ensure the water-supply well continues to operate, the field team can open more flow valves than just the one connected to their equipment. This also will reduce the likelihood of back-flow of water stored in plumbing lines that could be connected to the line that transports water to the sample-collection setup. Backflow often occurs if the plumbing system is not equipped with antibacksiphons. Antibacksiphons generally are absent in secondary distribution lines on low-capacity supply wells, such as those used by rural homeowners for local supplies.

Since water-supply pumps operate continuously during the purge and sample collection, there is a chance that the supply pump could burn out. Although most commercial pumps are designed to operate for hours without problems, old, worn pumps are a potential problem. If a pump burns out, the field team generally should expect to replace it upon the owner's request. To limit the chance of pump burnout, the field team needs to work quickly and efficiently to keep the total pumping time required to purge and sample as short as possible. If this is achieved by using a high flow rate, through setup equipment, this flow rate is reduced to about 0.1 gal (500 mL) per minute during the final stage of the purge and during sample collection.

Monitoring Wells. Because the field team supplies the pump, they control the rate at which water is pumped from the well and through their equipment, as well as the location of the pump intake in the well. During the purge of a monitoring well, it is important to recognize that pump intake rate, emplacement, and location can influence the quality of the water obtained. Thus, it is important that these pumps be used in a consistent manner for the purge and sample collection at different monitoring wells.

As in the case of a water-supply well, the first step in applying the purge protocol to a monitoring well is to determine if the required purge volume can be evacuated in the 15 to 25 minutes needed for field measurements at the required low-flow rate for sample collection. For this 15- to 25-minute period, and a rate of about 0.1 gal (500 mL) per minute, about 1.5-2.5 gal (7-11 L) will be evacuated from the well. If the required purge volume is less than or equal to this volume, the field team sets up all equipment and then purges the well at this low rate. If the required purge volume exceeds about 1.5-2.5 gal, the field team can purge the well at an initially high, but acceptable, flow rate (as described earlier) to reduce the purge time, and then reduce the flow rate to the sample-collection rate for the final 15 to 25 minutes of the purge, and take and document final field measurements.

Pump intake emplacement is a consideration in the purge of a monitoring well. To reduce the suspension of sediments in the well, the pump intake always is lowered slowly into the well. Initially, the intake is placed just below the surface of the water standing in the well.

With the setup equipment properly configured to route flow directly to waste (fig. 2), the pump is turned on at an initially low rate to avoid sediment suspension in the well. If the required purge volume is small, and the entire purge can be conducted within 2 hours at the low rate required for final field measurements and sample collection, the pump rate is slowly adjusted to a rate of about 0.1 gal (500 mL) per minute. This rate is verified by measuring the outflow from the waste line, and recorded (appendix, fig. A7).

If the required purge volume is high, and an initially high pump rate is desired, the pump rate is slowly increased until either the maximum acceptable flow (as described earlier) or pumping capacity is reached (because of pump limitations or well capacity). In general, unless the well capacity is extremely low and purging cannot be completed within 2 to 2 1/2 hours, rapid evacuation of the standing water in the well is avoided. As noted earlier, the initial flow rate is measured at the waste-line outflow and recorded (appendix, fig. A7).

After the initial flow rate has been measured, the flow is rerouted through the instrumented flowthrough chamber (fig. 2) and the purge continues. Field measurements are made and recorded from this point on (appendix, fig. A7).

As the purge continues, and to enhance the evacuation of all standing water, the pump intake in unpacked wells is lowered slowly until it resides a distance above the open (perforated, or screened) interval that is equal to 7 to 10 times the diameter of the well casing (borehole). Assuming the monitoring well was designed correctly with a short open interval of 2 to 10 ft (Lapham and others, in press), this final location of the intake aids in promoting the flow of water from the entire screened interval to the pump intake.

Any substantial changes in pump intake location (lift) could affect the flow rate. Thus, all changes in pump intake location are completed before the final 15- to 25-minute stage of the purge. At this time, any high pump intake rate is reduced to about 0.1 gal (500 mL) per minute, and the last five sets of successive field measurements are taken, while the last of the required purge volume is evacuated from the monitoring well.

Grab samples for titrations and volatile-sample preservation

During the final 15 to 25 minutes of the purge, or whenever measurements appear stable in relation to the purge criteria (table 19), two grab samples are taken**.** The first is a 100-mL sample which, if the pH exceeds 4.5, is quickly titrated to roughly determine the acid neutralizing capacity (ANC) of the sample (Radtke and Wilde, in press). From the ANC value, the field team determines the optimum sample volumes and titrant normality (1.6 *N* or 0.16 *N* sulfuric acid) to be used for subsequent, quantitative field titrations (table 20). If the sample pH is 4.5 or less, no field titrations for ANC or alkalinity are required.

If VOC samples are scheduled for collection at the well, a second 40-mL grab sample is obtained in a clean glass beaker to determine the amount of NWQL hydrochloric acid needed to preserve VOC samples (from March 31, 1993 to January 31, 1994, samples were preserved with NWQL-concentrated hydrochloric acid). The acid is added drop by drop to this beaker, the sample is stirred or mixed, and the pH is measured after each acid addition until it is between 1.7 and 2.0. The number of drops of NWQL acid used must be recorded on field forms (appendix, figs. A8, A10-A, A11-A, A12-A, and A13-A). To avoid damage to NWQL instruments, however, no more than 5 drops of NWQL hydrochloric acid are to be added to a VOC sample (Bruce Darnel, VOC National Synthesis Team, U.S. Geological Survey, written commun., 1995).

Table 20. Field-titration procedures for ground-water samples of the National Water-Quality Assessment Program

[mg/L, milligrams per liter; mL, milliliters]

- Except when replicate titrations are scheduled at selected wells, one filtered, and (optionally) one unfiltered, sample will be titrated at each site.[1]
- The unfiltered sample is titrated for acid-neutralizing capacity (ANC, mg/L[2]). The filtered sample is titrated for alkalinity (ALK, as mg/L $CaCO_3$; carbonate, as mg/L CO_3^{-2}, bicarbonate, as mg/L HCO_3^{-}; and hydroxide, as mg/L OH^{-}).
- Conducted in the field on fresh samples by the incremental addition of titrant, generally with digital equipment, and the recommended volume of sample and normality of titrant, as follows:

Parameter(s)	Expected Value	Sample Volume	Titrant Normality
ANC or ALK	0.0-50 mg/L as $CaCO_3$	100 mL	0.16
ANC or ALK	50-200 mg/L as $CaCO_3$	50 mL	0.16
ANC or ALK	200-1,000 mg/L as $CaCO_3$	100 mL	1.6
ANC or ALK	Exceeds 1,000 mg/L as $CaCO_3$	50 mL	1.6

- Estimates of ANC, ALK, and contributing species are determined by the Inflection-Point Method (Radtke and Wilde, in press). Inflection points to determine ANC or ALK and contributing species are near pH values of about 8.2 and 4.5 for most waters buffered by the carbonate system.
- If difficulties arise in determining titration endpoints--which could be encountered for saline, low-conductivity, low-alkalinity, anoxic, or organic-rich ground waters--the Gran-Function Plot Method is recommended (Radtke and Wilde, in press).
- Field titration data are recorded (appendix, fig. A9) and later stored electronically under the appropriate parameter codes in NWIS-I QWDATA (for primary ground-water samples) or NWIS-I QADATA (for replicate ground-water samples).

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[1]Before 1996, titration of an unfiltered sample was required and titration of a filtered sample was optional.

[2]Reporting values above assigns carbonate chemical species as the primary sources of neutralizing capacity. At this writing, appropriate parameter codes are not available to enter data above in NWIS-I in milliequivalent units.

Final assessment of chemical stability

The field team decides whether or not to collect ground-water-quality samples on the basis of the relative stability of field measurements taken near the end of the purge, as the last of the required purge volume is evacuated from the well (table 19). It is recommended that samples not be collected if unstable field measurements persist. Unstable measurements generally indicate one or more of the following is true: (1) that the source of water entering the well is changing with time, (2) that a decreasing proportion of water leaving the well is water that initially was standing in the well, or (3) that water is entering the well in a disproportionate manner as time elapses from a new source or from several sources. Thus, the resulting water-quality data obtained from sampling a well with unstable field measurements may or may not relate to the land use, aquifer, or other conditions being investigated.

Sample Collection and Processing

Sample collection begins when purge criteria have been met. The type and number of individual ground-water-quality and QC samples obtained, however, depend on the ground-water component (Study Unit Survey, Land-Use Study, or Flowpath Study) for which samples are being collected (table 1). Study-Unit (or Subunit) Surveys and Land-Use Studies commonly include the collection of samples for organic, inorganic, and possibly trace-element, radiochemical, and isotopic analyses. Flowpath Studies generally are limited in scope and require fewer samples than either Surveys or Land-Use Studies. For each component, routine, and possibly topical, quality-control samples also are scheduled for collection at selected wells.

Regardless of the particular component under investigation, protocols and procedures are followed in a consistent, timely, efficient, and quality-controlled manner. The protocols and procedures that follow describe the sample-collection methods to be used for NAWQA ground-water-quality studies (table 21), and include the collection and processing (filtration, preservation, handling, and shipment) of water-quality and QC samples for a given analysis. In addition, the protocols also specify an order or sequence in which groups of samples for different analytes are collected under these protocols, which generally is to be similar at each well in a given component, and among components with similar data-collection requirements.

Overall, the NAWQA sample-collection protocols and recommended procedures (table 21) follow USGS protocols and procedures (F.D. Wilde, U.S. Geological Survey, written commun., 1995--see footnote 1). Thus, samples for organic analytes (unfiltered, then filtered) are collected first, followed by samples for inorganic analytes (filtered, then unfiltered), which in turn are followed by the collection of samples for other (ancillary) analytes--isotopes, radiochemicals, and chlorofluorocarbons (table 21). Routine replicate ground-water-quality samples, including those for field spikes, are collected in conjunction with the primary ground-water-quality samples (table 21). (Routine QC samples that use blank water are collected in the field after ground-water-quality samples and after the decontamination of sample-collection equipment.)

Table 21. Collection order, processing, preservation, and field storage required for ground-water-quality and replicate samples for the National Water-Quality Assessment Program

[Except as noted, equipment used is described earlier (table 3). Except as noted, samples are (possibly filtered and) obtained in a collection chamber, and (if necessary) chemically preserved in another chamber. Except for filtered inorganic samples (see below), all routine replicate samples, including those for field spikes, are obtained sequentially for each National Water Quality Laboratory (NWQL) schedule or laboratory code. Replicate samples for filtered inorganics (FA, FCC, FU, and alkalinity) are collected after the first set of these samples are obtained, and with a second Quality Water Service Unit (QWSU) capsule.

GCV	glass chilled volatile	GCC	glass chilled chromatograph	SC	(NWQL) schedule	LC	(NWQL) lab code
HCl	(NWQL) hydrochloric acid	**CG**	change gloves	mL	milliliter	mm	millimeters
µm	micrometers	L	liters	$N_2(g)$	nitrogen gas	lb/in^2	pounds/square inch
PBW	(NWQL) pesticide blank water	FA	filtered acidified	FCC	filtered chilled	HNO_3	(NWQL) nitric acid
DIW	deionized water	FU	filtered untreated	RU	raw untreated	U	Uranium
Ra	Radium	ASR	analytical service request	°C	degrees Celsius	≤	less than or equal to]

Sample type (SC, LC) and order of collection	Team Member A: Filtration	Team Member A: Collect, by filling	Team Member A: Quality-assurance checks or measures	Team Member B: Chemical preservation	Team Member B: Temporary storage
1. Organic filtered and unfiltered					
• Volatile organics (SC2090, SC2091, or SC2092 with SC1306)	None	3, GCV, 40-mL amber, glass vials, sequentially; using Teflon tube to fill each vial from its base until overflow occurs	Avoid sample aeration when filling. Replace vial if gas bubble appears after capping. (Team Member B, re-check, immediately after preserving)	Add 1 to 5 drops HCl to each vial, and record amount [on field and ASR forms]	Sleeve and chill[1]
• Organic carbon (SC2085)	**CG**, use tweezers, and place a QWSU, 0.45 µm, 47-mm-diameter silver filter in cylinder. Fill with sample, cap, and (outside of chamber) pressure-filter [$N_2(g)$, ≤15 lb/in^2][2]	1, GCC, 125-mL, amber bottle to neck base after first discarding the initial 25 mL of filtrate to waste (do not rinse bottle)	Do not include plastic filter separator, or flip filter over during removal from package. Do not overpressurize filter cylinder	None	Sleeve and chill[1]
• Pesticides (SC2001 or SC2010, SC2050 or SC2051)[3]	**CG**, use tweezers, and place a NWQL, 0.7 µm, 142-mm-diameter, baked, glass-fiber filter in plate unit, prewet the filter, close unit, and void air[4]	1, GCC, 1.0-L, amber glass bottle for each SC after first discarding the initial 125 mL of filtrate to waste (do not rinse bottle)	Prewet membrane with 10 - 20 mL of NWQL PBW. Do not fill bottle beyond neck to reduce breakage if sample volume expands on chilling	None	Sleeve and chill[1]

Table 21. Collection order, processing, preservation, and field storage required for ground-water-quality and replicate samples for the National Water-Quality Assessment Program--Continued

	Team Member A			Team Member B	
Sample type (SC, LC) and order of collection	Filtration	Collect, by filling	Quality-assurance checks or measures	Chemical preservation	Temporary storage
2. Inorganic, filtered					
• Trace elements (SC2703-FA)	**CG**, and attach QWSU 0.45-µm, preconditioned Supor capsule filter with flexible Teflon tubing, and void air[3] from capsule.	1, FA, 250-ml, clear, prerinsed, poly bottle to neck base after a 25-mL filtrate rinse (include cap)	Invert capsule (arrow up), and tap to evacuate air while filling. Verify DIW is still in sample bottle from office prerinse before use; otherwise replace bottle	Add 1-mL ampoule of HNO_3	In dry cooler, avoid extreme heat or cold
• Major ions (SC2750-FA and archive)	If possible, use same capsule as above, otherwise replace with another preconditioned capsule in manner above.	2, FA, 250-mL, clear, prerinsed, poly bottles to necks after 3, 25-mL filtrate rinses on each (include cap)	Verify DIW is still in each bottle from office prerinse before use; otherwise replace bottle	Add 1-ml ampoule HNO_3 to each bottle, **CG**	In dry cooler, avoid extreme heat or cold
• Nutrients (SC2752-FCC)	**CG**, and, if possible, use the same capsule as above, otherwise replace in manner above.	1, FCC, 125-mL amber, prerinsed, poly bottle to neck base after 3, 25-mL filtrate rinses (include cap)	Verify DIW is still in bottle from office prerinse before use; otherwise replace bottle	None	Sleeve and chill[1]
• Major ions (SC2750-FU)	If possible, use same capsule as above, otherwise replace in manner above.	1, FU, 250-mL, clear, prerinsed, poly bottle to neck base after 3, 25-mL filtrate rinses (include cap)	Verify DIW is still in bottle from office prerinse before use; otherwise replace bottle	None	In dry cooler, avoid extreme heat or cold
• Alkalinity (ALK)	If possible, use same capsule as above, otherwise replace in manner above.	1, FA, 250-mL, clear, prerinsed, poly bottle to top after 3, 25-mL filtrate rinses (include cap), and cap bottle	Verify DIW is still in bottle from office prerinse before use; otherwise replace bottle	On basis of grab sample, pipette the required volume of filtrate into 250-mL beaker, titrate, and record data[5]	None

Table 21. Collection order, processing, preservation, and field storage required for ground-water-quality and replicate samples for the National Water-Quality Assessment Program--Continued

Sample type (SC, LC) and order of collection	Team Member A: Filtration	Team Member A: Collect, by filling	Team Member A: Quality-assurance checks or measures	Team Member B: Chemical preservation	Team Member B: Temporary storage
2. Inorganic unfiltered					
• Major ions (SC2750-RU)	None	1, RU, 500-ml, clear, prerinsed poly bottle to neck base after 3 25-mL rinses with raw sample (include cap)	Verify DIW is still in bottle from office prerinse before use; otherwise replace bottle	None	In dry cooler, avoid extreme heat or cold.
• Acid-neutralization capacity (ANC), recommended	None	1, FA, 250-mL, clear, prerinsed poly bottle to top after 3, 25-mL rinses with raw sample (include cap)	Verify DIW is still in bottle from office prerinse before use; otherwise replace bottle	On basis of grab sample, pipette the required volume into a clean, 250-mL beaker, titrate, and record data[5]	None
3. Other Samples					
• Trace elements (1.0-L samples, for example, U, and Ra)	**CG**, and attach preconditioned capsule in manner similar to that used for SC2703 above[3]	1, FA, 1-L, clear, prerinsed, poly bottle to neck base for each element after a 25-mL rinse of bottle and cap	Verify DIW is still in bottle from office prerinse before use, otherwise replace bottle	**CG**, and add 2 HNO_3 ampoules to each bottle	In dry cooler, avoid extreme heat or cold.
• Tritium isotopes	None	1, 1.0-L, clear, prerinsed poly bottle, filled to top after 3, 25-mL rinses (include cap with conical insert)	Verify DIW is still in bottle from office prerinse before use, otherwise replace bottle. Leave no headspace in bottle	None	In dry cooler, avoid extreme cold or heat.
• Deuterium-Oxygen isotopes	None	1, 125-ml, glass, amber bottle to top after 3, 25-ml rinses (include cap with conical insert)	Leave no headspace in bottle	None	In dry cooler, avoid extreme heat or cold.

Table 21. Collection order, processing, preservation, and field storage required for ground-water-quality and replicate samples for the National Water-Quality Assessment Program--Continued

Sample type (SC, LC) and order of collection	Team Member A: Filtration	Team Member A: Collect, by filling	Team Member A: Quality-assurance checks or measures	Team Member B: Chemical preservation	Team Member B: Temporary storage
3. Other, continued					
• Radon (LC1369)	Disconnect extension line to sample chamber, attach radon-collection unit to manifold, partly close valve on unit. Check all sample-wetted lines up to unit for gas bubbles, and dislodge any by tapping lines with hard object. (Record on ASR form if bubbles reform before samples are obtained)	1, radon scintillation vial, after rinsing syringe barrel twice with sample before injecting 10.0 mL of sample into vial at base of mineral oil. Cap and shake 10 seconds. Note and record actual time on ASR form (comments-to-NWQL line)	Compare oil level in vial before use to that in vial from another tube. Return vial unused to NWQL if oil level is low. Create sufficient back-pressure in device to create easy withdrawal of sample without degassing. Void all air from syringe after second rinse before inserting syringe needle into septum of device. Initially withdraw 15 mL of sample, invert syringe [needle up], void sample to leave 10.0 mL in syringe barrel, reinsert needle (down) into vial to collect	None	Repack vial in shipping tube, wrap ASR form (with collection time) around tube, fix with rubber band, and place tube in resealable plastic bag.
• Chlorofluorocarbons (CFCs)	Modify setup to attach CFC--collection unit (Busenberg and Plummer, 1992) to manifold or pump tubing outlet	Three to five CFC vials filled according to procedures used by Busenberg and Plummer (1992)	Critical to avoid air entrainment or sample degassing during collection (See radon above)	None; can be stored indefinitely if not biologically active	In partitioned box to reduce breakage

[1]Glass containers are placed in foam sleeves, and chilled samples generally stored in ice. Desired temperature of chilled samples is 0 to 4 °C

[2]Cylinder and nitrogen-gas filtration system are available from Hydrologic Instruments Facility (table 3, in this report).

[3]Possible flow adjustment could be required to increase flow from filtration unit to about 0.1 gallon (500 mL) per minute.

[4]Samples under schedules SC2010 and SC2051 require Study Unit to extract water samples and send extracts to NWQL (see section on Pesticide Solid-Phase Extraction).

[5]Volume of filtrate and normality of titrant determined from grab sample taken near end of purge (table 20, in this report). National Field Manual (Radtke and Wilde, in press) discusses incremental and Gran titration methods and calculations. For NWIS-I, recommend using parameter codes as indicated in appendix (fig. A8).

Field-team functions

The setup (fig. 2) used to purge the well is modified slightly for sample collection. The short turbidity-collection line is replaced by an extension line that runs to the sample-collection chamber. The flow, which has been passing through an instrumented flowthrough chamber, is rerouted (for example, using the second three-way flow valve as shown in fig. 2) through this extension line that is connected to the sample-collection chamber. The rate of flow through the sample-collection setup is about 0.1 gal (500 mL) per minute.

In general, samples are obtained and, with one or two exceptions, processed (for example, filtered) by **Team Member A** (table 21). Except for radon and chlorofluorocarbons, which require special collection equipment, and dissolved organic carbon, which requires a pressurized filtration, samples are obtained (sample containers are opened, if necessary, final rinsed, filled, and closed) only within the collection chamber. As each sample container is removed from the chamber, it is set aside on a clean surface, and not handed directly to **Team Member B**. This reduces the likelihood of contamination of **Team Member A**, the chamber, and subsequent samples, as collection continues.

In general, **Team Member B**, who has removed coveralls and work gloves, preserves (if necessary) and temporarily stores samples (table 21). **Team Member B** also performs field titrations.

Chemical preservation of NAWQA samples currently (1995) requires a single preservation chamber (for NWQL hydrochloric and nitric acids). This chamber is separate from that used to collect samples (table 3). During preservation, samples are opened, preserved, and closed in this chamber by **Team Member B**.

Throughout the collection process, the field-team members frequently replace their gloves at logical intervals to further reduce sample contamination (table 21, CG). If either one leaves the collection or preservation areas to perform other tasks, gloves must be replaced before activities in these areas are resumed.

Near the end of the sample-collection process, field titrations (particularly when replicate filtered (ALK) or unfiltered (ANC) samples are taken) generally will require most of **Team Member B's** time**.** Therefore, **Team Member A** often will complete the collection of all samples after that for ANC with little or no assistance (table 21).

Special considerations for selected sample types

With adequate training and preparation, collection procedures for most sample types require no more than a conscientious effort to rinse and fill a bottle in a clean setting to obtain high-quality data. Situations arise, however, which necessitate processing samples simultaneously with their collection, or which require modifications to the general field-equipment setup and protocols described (table 21).

Filtered Samples. To obtain high-quality samples, care must be taken in the use of filter units and to avoid overpressurizing these units. The NWQL aluminum plate filter (for pesticide samples) is prepared in the collection chamber (table 21) and has a simple nipple fitting, which is connected to the sample outflow orifice inside the sample chamber by a short piece of Teflon tube. Air is evacuated from the plate unit using the trip valve on top of the unit as it is filled by raw sample flow. After evacuating the air, the trip valve is closed. Initially, some filtrate is discarded before any samples are collected (table 21).

The sample for dissolved (filtered) organic carbon (DOC) is collected directly in the DOC filter cylinder in the collecting chamber. The DOC cylinder subsequently is capped, removed from the chamber, and the sample filtered under N_2 gas at a low (15 lbs/in^2 or less) internal pressure. (Pressures in excess of 15 lbs/in^2 can be hazardous and can rupture the filter membrane and invalidate the sample.)

Routine NAWQA 0.45-µm-filtered inorganic samples are obtained using the QWSU capsule filter (for inorganic samples). The capsule is preconditioned before use (see “Final Presampling Plans and Preparations”). The capsule nipples are attached to flexible Teflon lines, which allow the capsule to be inverted (arrow on capsule denotes direction of flow) during its final rinse and use. Inverting the capsule so that the flow is vertically upward while the capsule initially fills with water, combined with tapping the side of the capsule several times while it fills, forces most air out of the capsule. Purging most of the air from the capsule filter helps prevent oxidation and possible precipitation of redox-sensitive analytes (for example, iron, manganese, aluminum, and uranium) that would (negatively) bias filtrate concentrations. Procedures for filtering inorganic samples that require filters with 0.2-µm or smaller pores are described in an internal document (F.D. Wilde, U.S. Geological Survey, written commun., 1995--see footnote 1).

In some instances, filter clogging by fine sediment, or even finer colloids, could markedly reduce the rate of sample flow through the filter units described. Field teams are not to increase flow by forcing water through a filter unit under increasing pressure. Instead, either clean the clogged unit (see “Decontamination of Field Equipment” below) and reinstall the cleaned filter, or simply replace the clogged unit with a second filter unit of similar type. It is most efficient to have a second unit available. A second capsule filter unit also is required for the collection of replicate, filtered inorganic ground-water samples.

Radon and Chlorofluorocarbon (CFC) Samples. Collection of these samples occurs outside the sample-collection chamber and requires modifying the sample collection setup--replace the extension line from the flow manifold to the sample-collection chamber with the appropriate collection device (fig. 2). In either case, sample extension and pump-reel lines are inspected to determine if gas bubbles are forming inside the line, or if any air is being drawn into the sample flow at any connection. If these lines are adequately insulated to prevent warming of the sample flow and connections are air tight, bubbles generally are not present. The presence of bubbles indicates possible degassing of radon and CFCs from sample flow or entrainment of CFCs from air that enters loose connections. Initially, bubbles often can be dislodged and evacuated with sample flow by striking the extension or pump-reel line sharply with a hard, blunt object. Connections can be tightened to prevent air entrainment. This, combined with backpressure created by partially closing the valve on the radon-collection unit or backpressure created in the operation of the CFC collection unit, often will reduce degassing during sample collection.

For radon samples, the collection unit valve is partially closed, the glass syringe needle is inserted through the septum port of the unit, and the unit valve is further closed until there is sufficient backpressure to create an almost effortless withdrawal of water into the syringe. The syringe is partially filled, withdrawn from the septum, inverted (needle up), and the water ejected to waste. This syringe rinse is repeated at least one time. After the final rinse, and with the syringe plunger completely depressed (no air or water in syringe barrel) the needle is reinserted through the septum, and about 15 mL of sample are withdrawn slowly into the syringe barrel to avoid suction and degassing. The needle is withdrawn from the septum, the syringe inverted (needle up), and the sample slowly ejected to waste until only 10.0 mL remains in syringe barrel. The syringe needle is tipped downwards, and the needle tip inserted into the mineral oil, and to the bottom of the radon sample vial. The 10.0 mL sample is injected slowly, the syringe removed, the vial firmly capped, and the actual time (in military format) of sample collection is recorded (see appendix, fig. A10). If no replicate sample is taken, the vial is shaken for 15 seconds, repacked in tube, the tube capped, and the NWQL-ASR form (lab copy) for radon (LC1369) is wrapped around the tube, secured with a rubber band, and the tube temporally stored (table 21). If a replicate sample also is collected, the height of the oil levels in the two vials is compared before either sample is collected and should be similar. If levels are noticeably different, return the vial with the low oil level to NWQL with a note explaining the problem.

Because it can take a considerable amount of time to set up and collect samples for chlorofluorocarbons (CFCs), they generally are the last samples collected at a well. As in the case of radon, their collection requires that the sample-collection setup be modified. The CFC unit used to collect samples (Busenberg and Plummer, 1992) replaces the extension line and sample-collection chamber, or the CFC unit can be connected directly to the portable pump outlet (fig. 2). Before connecting the CFC unit, it is recommended that flow be routed through the flowthrough chamber, and field measurements be taken to characterize conditions at the onset of CFC sampling. The procedures for collecting CFC samples are described in Busenberg and Plummer (1992).

Decontamination of Field Equipment

Decontamination is the cleaning process used to remove contaminants from equipment. Sample-wetted equipment used by NAWQA is decontaminated after sample collection at each well, preferably before the equipment dries. Decontamination is conducted in clean and protected environments (in field area, vehicle, or chamber) as is appropriate to the equipment being cleaned. If this is not possible, the equipment is at least flushed and rinsed, preferably with a low-phosphate detergent, followed by a clean water (DIW) rinse, before it is temporarily stored for thorough cleaning at a later date and before it is reused to collect samples.

On the basis of NAWQA pilot studies, studies conducted by the Office of Water Quality, and data reported from other sources, the decontamination protocols and procedures for NAWQA (tables 22 and 23) generally are capable of removing a broad suite of contaminants from equipment affected by (a) milligram-per-liter contaminant levels for metals and metal complexes, and (b) microgram per liter contaminant levels for pesticides and volatile organic compounds. The decontamination protocols and recommended procedures for NAWQA assume equipment was (or will be) used to collect filtered and unfiltered samples for most analytes (table 1). The actual efficiency of these protocols and recommended procedures to remove contaminants to below NAWQA method-detection or reporting levels can differ depending on the type of equipment used, the solubility and concentration of the contaminant, and the length of time equipment is exposed to the contaminant.

Table 22. Decontamination of small equipment used for sample collection

[Volumes of solutions used (detergent, deionized water-DIW, methanol, and final rinse water) depend on Study-Unit equipment setup. DIW used for rinses must have a conductivity that does not exceed 1.0 microsiemens per centimeter at 25 degrees Celsius. A 0.1- to 0.2-percent detergent solution is prepared by adding about 5 to 10 drops of detergent concentrate to each gallon of DIW. **CG** indicates field-team members are to change to clean, powderless, latex or vinyl gloves before proceeding. Latex gloves are used when handling methanol. DOC, dissolved (filtered) organic carbon; VOCs, volatile organic compounds]

	SMALL FIELD-EQUIPMENT CATEGORIES[1]		
DECONTAMINATION STEPS BY CATEGORY	Equipment with nonmetallic parts (for inorganics only). Includes convoluted Teflon tubing used on capsule filter, turbidity sample vials, and field-titration Teflon stir bars, glass beakers, volumetric pipettes, graduated cylinders, and polyethylene bottle for ALK (ANC) sample collection.	Equipment with metal parts and for inorganics, but not exposed to methanol. Includes the DOC filter unit, the short Teflon line with metal quick-connect used to obtain turbidity samples, and the radon-collection equipment--syringe with metal leur-lock fitting, syringe needles, and the sample-collection unit.	Equipment with nonmetallic parts, and rinsed with methanol for organics. Includes pesticide filter unit, the short Teflon tubes for VOC sample-collection and for attaching pesticide filter unit to a sample-chamber outflow port, tweezers, and the short Teflon-metal hook-up line (without plastic garden-hose-threaded fitting to well).
1. PREPARATION	For each equipment category, disassemble parts, and place them in a small, clean, colorless, polypropylene basin dedicated to that category.		
2. DETERGENT WASH	Cover and fill parts in each basin with detergent, and let stand at least 10 minutes; then scrub each part gently with a soft-bristled brush that contains no metal parts and is dedicated to that basin.		
3. DIW RINSE	Rinse each part thoroughly with DIW at least three times to remove detergent solution and any particulate matter. Complete rinsing of equipment, and also rinse basin and brush, in one category, and **CG** before proceeding to equipment in the next category. Place rinsed equipment on a non-contaminating surface dedicated to the equipment in that category, and loosely cover equipment to prevent recontamination. Plastic sheets can be used for equipment in the first category; aluminum foil can be used for equipment in the other categories. **Complete decontamination step (5) below for first two categories before proceeding with the methanol rinse (4) of equipment in the last category)**.		
4. METHANOL RINSE	**(Third equipment category only) CG (latex),** wear safety glasses; in a well-ventilated area free of open flames or sparks, rinse each piece of equipment at least three times with small amounts of methanol from a Teflon squeeze bottle. Place each rinsed part on a clean, noncontaminating surface (such as aluminum foil) and loosely cover rinsed parts (with foil sheet) to avoid recontamination. Rinse each part over the basin previously used for detergent and DIW rinse. Transfer used methanol from this basin to a waste container after all parts are rinsed, and before drying parts.		
5. DRY, INSPECT, and STORE	**CG** and use a portable dryer, or air dry, each part, in clean area. After each part is dried, inspect it. Replace chipped or cracked glassware, or scratched turbidity vials. Replace tubing if mold, mildew, or imbedded sediment are present. Replace filter seals if cracked or severely crimped. Store equipment in the first category in two nested, resealable plastic bags, and that from other categories in Teflon bags or wrap in aluminum foil and then place in a resealable plastic bag.		

[1]Field sensors are each thoroughly rinsed with DIW, blotted dry, inspected along with field meters, and (if necessary) reconditioned and stored according to manufacturers' recommendations.

Table 23. Decontamination of setup equipment used for sample collection

[Volumes of solutions used (detergent, deionized water (DIW), methanol, and final-rinse water) depend on the Study-Unit equipment setup used. DIW used for final rinse must have a specific conductance that does not exceed 1.0 microsiemens per centimeter at 25 degrees Celsius. For methanol-rinsed equipment, it also should be volatile-organic-compound-free and pesticide-free. A 0.1- to 0.2-percent detergent solution is prepared by adding about 5 to 10 drops of detergent concentrate to each gallon of DIW. **CG** indicates the field-team members are to change to clean, powderless latex or vinyl gloves before proceeding. Use latex gloves when handling methanol.]

DECONTAMINATION STEP	Exterior of portable pump intake and pump tubing drawn from pump reel	Interior of pump intake and sample-wetted tubing[1]; including that from reel, flow manifold, flowthrough chamber, and all extension lines
1. PREPARATION	**CG**, raise intake from well, coil tubing onto plastic sheet set to drain, or into plastic basin, and disconnect tubing at pump-reel that runs to remainder of setup.	Place pump intake[2] in clean standpipe.[3] Route flow from pump intake through setup to sample chamber. Temporarily attach one end of a Teflon return-flow line to the outflow tube in the sample chamber, and run the other end of this line back to the standpipe.
2. DETERGENT WASH	Pour detergent solution over pump intake and tubing. Scrub both gently with a soft-bristled brush that has no metal parts.	Fill standpipe with detergent solution to level above pump intake. Begin pumping, and note the time when return-flow line has filled. Direct flow from this line back into standpipe, and cycle detergent at 500 milliliters per minute for at least 5 cycles, or 10 minutes. At end of cycling, add more detergent to the standpipe, route flow to partially fill field-instrument flowthrough chamber and waste lines. Stop pump.
3. DIW RINSE	**CG**, raise intake and tubing above sheet or basin, and rinse at least 3 times with DIW to remove detergent and any particulates. Proceed to inspection and storage (Steps No. 6 and 7).	**CG**, rinse standpipe and intake, individually, at least 3 times to remove detergent. Reroute flow back to sample chamber, add DIW to standpipe, and pump, without cycling, until grab samples from the open end of return-flow line (now directed to waste) indicate DIW rinse is detergent free (no sudsing). Halt pump. Shake flowthrough chamber to suspend any sediment, then drain detergent from this chamber and waste lines. Add more DIW to standpipe, start pump, route flow to the flowthrough chamber, and rinse chamber several times to remove detergent. Repeat for waste lines. (Flowthrough chamber and waste lines are inspected and stored at this time, see below. If methanol is not required, go to Step No. 5, FINAL RINSE, second paragraph).
4. METHANOL RINSE[4]	None. (Detergent scrub considered effective for cleaning exterior of pump intake and pump tubing.)	Reroute flow to sample chamber, and put free end of return-flow line near the methanol waste container. **CG,** rinse intake and standpipe, individually 3 times, place intake in standpipe, and, if possible, force air into first several feet of pump tubing (to mark end of DIW and beginning of methanol rinse.) Fill the stand pipe with methanol to level above pump intake. Add and pump at least 2 liters of methanol into setup. If the setup storage is less than 2 liters, collect methanol as it leaves from end of return-flow line in waste container. Halt pump. Put methanol left in standpipe into waste container. Pump air if possible into tubing (to mark end of methanol). Proceed to final rinse.

Table 23. Decontamination of setup equipment used for sample collection--Continued

DECONTAMINATION STEP	Exterior of portable pump intake and pump tubing drawn from pump reel	Interior of pump intake, and sample-wetted tubing, including that from reel, flow manifold, flowthrough chamber, and all extension lines
5. FINAL RINSE) (DIW)	None	**CG**, and DIW rinse standpipe and intake individually at least 3 times. Add and pump DIW through setup to sample-collection chamber and out return-flow line. On basis of air marking, line storage, and pump rate, collect methanol from return-flow line as it is forced out by final rinse. Pump at least an additional 0.1 gallons of DIW through setup for every 10 feet of methanol-wetted tubing, including return-flow line, to waste after used methanol is collected. Disconnect sample chamber from manifold, discard used chamber bag, DIW-rinse chamber frame, and dry. Repeat above for the preservation chamber. DIW rinse and dry exterior of extension lines and flow manifold. Inspect and store each piece of equipment as it is dried according to procedures below.
6. INSPECTION	Simultaneously dry, inspect, and recoil tubing on pump reel. Dry with large, disposable, lint-free towels. Check for stains, cuts, or abrasions, and repair or replace as necessary. Check and repair pump intake and antibacksiphon for loose or missing screws.	Inspect to ensure flowthrough chamber and waste lines are free of sediment. Extensions lines also are inspected for stains, cuts, or serious abrasions. and sediment. The flow manifold also is checked for stains or sediment, and to ensure valves and quick-connect fittings are in good working order. Repair or replace as necessary to eliminate any problems.
7. STORAGE	Except for pump intake and sufficient pump tubing to place intake in standpipe, cover the pump reel and recoiled tubing with a clean, plastic sheet or bag or other noncontaminating material. Clean pump intake as described on right.	Store flowthrough chamber, waste lines, looped and recoupled extension lines, and flow manifold in clean plastic bags. Place pump intake inside Teflon or other noncontaminating bag, and then under material used to cover pump-reel assembly. Fit sample and preservation chambers with clean bags. Unless field blanks are taken, store equipment in vehicle for transport.

[1] Before their initial use, all sample lines are acid washed to remove oils and other manufacturing residues. (See table 3.)

[2] Pump intake and reel tubing are that used on-site to collect samples. For a hook-up connection that attached setup to a garden-threaded-hose valve on a water-supply pump, a small, portable pump, such as a Teflon diaphragm pump head mounted on a 12-volt electric drive pump, or a valveless metering pump with a ceramic piston (for example, Fluid Metering Instrument Model QB1-CSC or CSV) with 12-volt power can be used. Either pump is fitted with Teflon convoluted or rigid-wall tubing (acid-washed when first obtained). The outflow tube from the pump is fitted with the appropriate quick-connect to attach it to the extension line that ran from the hook-up connection to the flow manifold (fig. 2).

[3] Standpipe is of sufficient height to supply necessary head for pump intake to operate. For some pumps, such as the Grundfos Redi-Flo2, this head requirement is critical. Standpipe also must not absorb methanol (table 3).

[4] Performed when it is known or suspected that equipment was exposed to pesticides or volatile organic compounds.

In general, decontamination by NAWQA field teams includes a low-phosphate, dilute-detergent wash and scrub of equipment, followed by multiple rinses with DIW (tables 22 and 23). A methanol wash also is used on selected equipment that is likely to have been contaminated by volatile organic compounds or pesticides.

Except for CFCs, the equipment required for decontamination, including that for safe handling of methanol, has been described (table 3). Decontamination of CFC sample-collection equipment is to be done by the supplier of that equipment (Eurybiades Busenberg, U.S. Geological Survey, written commun., 1995).

During field decontamination of NAWQA equipment, it is essential that the cleaning solutions used be completely removed as part of the decontamination process before equipment is reused. The residual presence in sample-collection equipment of detergent and methanol can bias some measurements. Reports of organic carbon samples being affected by residues of detergent and methanol have been verified. Removal of methanol and detergent from pump-reel lines or the purge and collection setup (fig.2) requires that adequate volumes of rinse water are passed through these lines. Study Units can calculate the storage volume of these lines (table 24). The sample-collecting setup storage volume is not only useful in estimating the amount of dilute detergent and DIW needed for decontamination, but also is needed to determine the volume of high-purity water needed for field blanks.

Ideally, the final rinse water after the methanol rinse (table 23) should not contain detectable quantities of the analytes of interest. Study Units need to ensure that rinse-water composition does not lead to equipment contamination that can ultimately compromise the interpretation of the water-quality data.

To obtain the suitable quality of DIW final rinse water for methanol-rinsed equipment, ASTM Type 1 DIW is passed through a charcoal filtration system, stored in noncontaminating containers under noncontaminating conditions, and periodically analyzed to ascertain that it is free of the compounds of interest at the method detection limit. Alternatively, NWQL volatile- and pesticide-free blank water (VPBW) can be used for the final DIW rinse.

Decontamination of equipment exposed to high concentrations of contaminants (for example, VOCs in excess of 10 μg/L) could require procedures that are more rigorous than the protocols and recommended procedures described here and involve cleaning agents that differ from those commonly used (such as hexane). Whatever procedures are used, they must be documented by the Study Unit. This enables the National Program to identify potential problems and modify procedures accordingly. Questions regarding equipment decontamination and the use of other decontamination procedures can be directed to the NAWQA QA Specialist.

Table 24. Estimation of decontamination solution volumes for standpipe and sample-wetted tubing

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The storage volume, Vs, of a set of pump-reel and extension lines can be estimated as follows:

Vs = [(Lp x Cp) + (Le x Ce)] + [Csp x Vsp]

where Vs is storage volume, in gallons
Lp is length of pump-line segment being cleaned, in feet
Le is length of extension lines, in feet
Cp (or Ce) = 0.023 gallons per foot for a 3/8-inch internal-diameter (ID) line
or = 0.041 gallons per foot for a 1/2-inch ID line
Csp = 0.264 gallons per liter,
Vsp is volume of solution needed to fill standpipe to minimum level required to operate pump, in liters.[1]

Examples:

Given: (1) Lp; the sample-wetted line segment is 100 feet for a pump-reel system that has a 1/2-inch ID line;
(2) Le; two 10-foot, 3/8-inch ID extension lines, one running from the pump-reel outlet to the sample collection chamber, and another running from the chamber back to the pump-reel (return-flow line to standpipe), and
(3) Lsp; that the minimum volume of solution required in the standpipe to operate the pump is 0.8 liter.

(A) Estimate the volume of detergent solution needed for the detergent wash cycle.
Answer:
Vs= [(100 x 0.041)+ (20 x 0.023)] + [0.264 x 0.8] = 4.87 gallons

(B) Estimate volume of District deionized water needed to displace detergent solution.
Answer: Vs, ideally.[2]

(C) Estimate volume of high-purity water needed to displace 2 liters of methanol just pumped into the system.
Answer: Vs, ideally.[3]

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[1]The minimal volume is that which corresponds to a level of solution in the standpipe which, if maintained, allows the pump to operate without entraining air into flow. Once this level is reached, remove pump and measure this volume.

[2]Estimate assumes no mixing of the two solutions and ignores potential for detergent to adhere to tubing walls. As a general rule, it is recommended that outflow from end of return-flow line be checked for sudsing to determine when detergent has been removed.

[3]Estimate assumes no mixing at the interface of the two solutions and ignores potential for methanol to adhere to tubing walls. As a general rule, it is recommended that an additional 0.1 gallons (~ 0.4 liters) of high-purity water for each 10 feet of pump and extension line used be displaced from sample-wetted lines (pump-reel line-to-sample chamber) to remove methanol residues. Thus in the example above, another 0.2 (= [(100 + 10) x (0.1/20)]) gallons (4 L) of DIW would be pumped from the system. This implies a total of about 6.1 (= 4.9 + 1.2) gallons (24 L) of water would be used to remove methanol from the setup equipment.

Preparation of Blank Samples

To verify that decontamination is adequate, field and possibly other blanks are prepared at selected well sites in each ground-water component (see "Routine Quality-Control Samples: Type, Number, Site Selection, and Timing"; and appendix, figs. A13 (A,B), A14, A18, and A19). These field blanks are collected immediately after the equipment that was used to collect samples at the well has been decontaminated. Methods used to obtain, process, preserve, temporarily store, and analyze field blanks (table 25) generally are similar to those used for corresponding ground-water samples (table 21). With the exception of trace-element field blanks, field blanks are analyzed using the same NWQL schedules used to analyze ground-water-quality samples.

Study Units are required to use specific types of water for field blanks (table 3). Generally, NWQL VPBW is required for VOC field blanks, and either NWQL VPBW or NWQL PBW is required for pesticide field blanks. Field blanks for dissolved organic carbon are obtained using either NWQL water types, but a DOC source-solution blank also must be taken (table 25, footnote 3; and appendix, fig. A14). The QWSU IBW is required for trace-element, major-ion, and nutrient field blanks. These blank solutions are analyzed regularly (by lot number) by the NWQL to certify that they are free of measurable concentrations of NAWQA analytes. Lot numbers are recorded by the field team as part of the required data record for NAWQA field, solution, and trip blanks (see appendix, figs. A13, A14, and A19).

Except for trace elements, all field blanks are analyzed using the analytical NWQL schedule or laboratory code used for the corresponding ground-water-quality samples. For trace-element field blanks, NWQL schedule SC172 and laboratory codes LC0112 (As) and LC0087 (Se) are used in lieu of SC2703 to obtain concentration data at method detection limits (equal to or in excess of 0.1 μg/L).

Preparation of Other Routine Quality-Control Samples and Field Extracts of Pesticide Samples

As part of their data-collection activities, field teams will sometimes need to obtain, prepare, or process selected types of samples at some sites on the basis of required routine QC sampling for each ground-water component (for example, table 12). For example, the field team occasionally will collect replicate ground-water-quality samples at selected wells and field spike these samples with known amounts of selected VOCs or pesticides. If VOC samples are being collected for a Study-Unit (or Subunit) Survey or Land-Use Study, spiked VOC ground-water samples are required at selected sites. The field team also will submit at least one trip blank per field season for VOCs from the field. If pesticide ground-water samples are being collected, pesticide field spikes are required. The field team also has the option of either extracting pesticides (under NWQL schedules SC2010 and SC2051) from spiked or unspiked ground-water samples, or sending these water-quality samples to the NWQL for extraction (under NWQL schedules SC2001 and SC2050). Finally, if trace-element samples (SC2703) are collected, the field team will send three standard reference samples per field season from the field to the NWQL for analysis. Each of these activities requires that special equipment be used, or that specific procedures be followed (described below). It is strongly recommended that field spikes, solid-phase extraction, and the preparation of trip-blank and reference samples be done after all ground-water samples have been collected, equipment has been decontaminated, and (if applicable) field blanks have been collected.

Table 25. Field-blank sample-collection protocols and procedures for ground-water components of the National Water-Quality Assessment Program

[DIW, District deionized water with specific conductance less than 1.0 microsiemens per liter; NWQL-VPBW, National Water Quality Laboratory volatile organic and pesticide-free blank water; NWQL-PBW, pesticide-free blank water; QWSU-IBW, Quality Water Service Unit inorganic-free blank water; DOC, dissolved (filtered) organic carbon; gal, gallons; L, liters; ~, approximately]

1. **Assumptions:** Equipment just used to collect ground-water samples has been decontaminated and, except for the pump intake being in a standpipe, is set up on site in the same manner as it was for the collection of ground-water samples.

2. **Determine Blank-Solution Types and Volumes Required[1]:**

Field blank(s) collected	Required blank-solution type	Minimum volume in gal (L)	Required procedure
VOCs and DOC[2] or pesticides and DOC	NWQL-VPBW NWQL-PBW	1.5 (~ 6)	Waste 0.5 gal, then collect field blanks; can use DIW to force last of VPBW or PBW water through the system.
VOCs, DOC, and pesticides	NWQL-VPBW	2.0 (~ 8)	Waste 0.5 gal, then collect field blanks; can use DIW to force last of VPBW or PBW water through the system.
Major ions, and nutrients, or trace elements	QWSU-IBW	1.0 (~ 4)	Waste 0.5 gal, then collect field blanks; can use DIW to force last of IBW water through the system.
Major ions and nutrients, and trace elements	QWSU-IBW	1.5 (~ 6)	Waste 0.5 gal, then collect field blanks; if necessary, use DIW to force last of IBW water through the system.
Combinations of organics and in-organics above	NWQL-VPBW or NWQL-PBW and QWSU-IBW	1.5 to 2.0 1.0 to 1.5	Waste 0.5 gal of the VPBW or PBW water, then collect organic field blanks; can use the IBW water to force the VPBW or PBW water through the system; waste 0.5 gal of IBW water, then can collect inorganic field blanks using DIW to force IBW water through the system.

Table 25. Field-blank sample-collection protocols and procedures for ground-water components of the National Water-Quality Assessment Program--Continued

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3. General Field-Blank Collection Procedure--The procedure for collection of blanks assumes organic (VOC--SC2090, SC2091, or SC2092, Pesticide--SC2001 or SC2010 and SC2050 or SC2051, and DOC--SC2085) and inorganic (Trace-element--SC2703, Major ion--SC2750, and Nutrient--SC2752) field blanks are collected. This is the most complex type of field-blank collection.[3]

- Divide Field-Team Duties--Recommend that a three-person team be used. The standard two-person field team collects samples in a manner similar to that used to collect ground.-water samples; the third person adds blank water(s) to standpipe, and controls flow through system as needed to facilitate field-blank collection.

- Check Flow Setup--from standpipe to sample collection chamber (fig.2), ensure that adequate volumes of DIW and the required blank water(s) are arranged in order and within easy reach of person stationed at standpipe.

- Set Low Flow Rate--Once pumping is initiated, set flow (on basis of measurement at chamber outflow) to about 0.1 gal. (500 mL) per minute or less to avoid wasting excessive amounts of blank water.

- Route blank solutions in presorted manner--As solutions are changed, pump operator should change to clean gloves, empty residual solution from standpipe, and rinse pump intake and standpipe, individually, at least three times each, with the next solution, and attempt to pump air segment into pump line before adding next solution to standpipe to mark change in solution type.

  If air segment cannot be used to mark end of one solution and beginning of next, then the change in solutions is determined solely on the basis of the storage volume in lines (table 24) divided by the pumping rate (estimated above) to determine the time it takes for the solution to travel from the standpipe to the outflow chamber. Once pump is started, and this time has elapsed, it is assumed the correct solution is flowing from chamber outflow.

  Regardless of whether air segments or timed flow or both are used to assess when the desired solution arrives at the chamber, 0.5 gal (~ 2 L) of the solution are passed to waste before the field blanks that require that water type are collected.

  To limit the amount of blank water used, and left standing in pump-reel or extension lines after all samples that require that blank-water type have been collected, one type of water can be used to force the last of another type from the lines and to the chamber for collection.

- Collect field blanks in prescribed manner --The order, manner, and quality-control measures and checks associated with obtaining, processing, preserving, and temporarily storing field blanks are identical to the order, manner, and quality-control measures and checks that would be used to collect a corresponding set of ground-water-quality samples (see table 21).

Table 25. Field-blank sample-collection protocols and procedures for ground-water components of the National Water-Quality Assessment Program--Continued

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4. Break Down Equipment Setup--After field blanks have been collected, equipment is broken down and stored, accordingly (see tables 22 and 23). Exceptions include filter units using filter membranes that are removed and discarded, and the sample preservation chamber. If filters for organics (pesticides and DOC) were used, the units are opened and filters discarded. Units are final rinsed, reassembled and stored (see table 22, step 5, and table 23, step 7). The sample-preservation chamber also is decontaminated before it is stored.

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[1]If portable pump was used, the same pump and length of pump line used to collect ground-water samples is decontaminated and used to obtain field blanks.

[2]Note that VPBW and PBW are not certified free of organic carbon. A solution blank of that lot of water used for the DOC field blank is sent to the NWQL for DOC analysis (see footnote no. 3 below).

[3]NWQL-PBW cannot be used for VOC field blanks. Either NWQL water type can be used for DOC field blank, but both water types contain about 0.1 mg/L of organic carbon. A solution blank sample of water from the same lot of NWQL water used for DOC field blank, poured directly into DOC 125-mL amber sample bottle) is required for every DOC field blank. The lot number of the water used for the solution blank is recorded on the ASR form (see appendix, fig. A14).

[4]With one exception, samples are analyzed using NAWQA schedules. The exception is trace-element field blanks, for which the low-level NWQL blank schedule (SC172 with laboratory codes added for arsenic and selenium) is recommended (see appendix, fig. A18).

Pesticide and volatile-organic-compound (VOC) spiked samples

Required equipment and procedures to spike ground-water samples in the field are obtained from the NWQL in kits prepared for the NAWQA Program (table 3). Training in field spiking is required, and can be obtained through the basic course required for NAWQA ground-water field teams (table 6). Because of the need for recovery and variability data on field spikes for the National Program, Study Units that wish to modify spike equipment or procedures as described below, or in NWQL kits for the NAWQA Program, by using different spike solutions or volumes for routine QC spiked samples, are to discuss their plans with the National Program (NAWQA QA Specialist).

At each site where pesticide field spikes are scheduled, at least three 1.0-L ground-water sample bottles are required for each NWQL pesticide schedule (SC2001 or SC2010 and SC2050 or SC2051). These samples are collected sequentially during the collection of ground-water-quality samples and chilled (table 21). One bottle for each schedule serves as the ground-water-quality sample for the well. It also serves as a background sample (to determine what pesticides, if any, were present in the other two sample bottles before they were spiked). The other two sample bottles are used for replicate field spikes. Each of these is spiked with 100 µL of NWQL-pesticide-spike solution.

Currently, for VOC field spikes (SC2090, SC2091, or SC2092), at least seven sample vials of ground water are collected sequentially and chilled (table 21). Three vials are needed for the ground-water-quality sample, which also is the background sample for the field-spiked samples. Replicate, field-spiked VOC samples (consisting of two vials each) are prepared by spiking each vial with 100 µL of NWQL-VOC-spike solution.

In general, all samples (pesticide or VOC) are spiked with 100 µL of spike solution, which results in a concentration of about 1 to 3 mg/L, depending on the analyte. If the background sample concentration of the analyte (in the unspiked sample) exceeds about one-tenth the concentration in spiked samples, the recovery data from spiked samples generally is considered positively biased (dependent in part on the amount of analyte present before spiking). Use of a volume of spike solution in excess of 100 µL, or a spike solution with higher concentrations than that commonly prepared by the NWQL, could reduce the bias. Recovery data from the use of such a spike solution, however, will relate only to the high, and not the low, concentrations of the analyte.

Once prepared, field-spiked samples are chilled to 0 to 4°C, and generally treated in a manner identical to that of the corresponding background sample. Important information that relates to the spiked sample (lot number, volume, and source of spike solution) are recorded on field and NWQL ASR forms (appendix, fig. A12).

Pesticide solid-phase extractions

The option is available for Study Units to extract pesticides from ground-water-quality samples (unspiked and spiked) or field blanks in the field, rather than having extractions done at the NWQL. Extracts are collected on solid-phase cartridges and sent to the NWQL for analysis under SC2010 and SC2051. Extraction equipment and procedures, prepared by the NWQL for

NAWQA, can be obtained from HIF or NWQL (table 3). Training in the extraction procedure is required, and is obtained through the basic course required for NAWQA ground-water sampling field teams (table 6).

The decision to submit solid-phase extracts instead of water samples to the NWQL requires careful consideration. Field extractions are practical and should be considered in situations where transporting glass bottles, shipping weights, or shipping times pose a serious problem. Extraction is recommended if pesticide water samples (for SC2001 and SC2050) cannot be shipped and reach the laboratory within 72 hours after collection, or when information is available that indicates the analytes of interest could degrade rapidly during transit. Field extractions also are recommended if the transportation of large, glass, sample bottles, or the sheer weight of water samples, poses a hazard for the samples or the field team (for example, if wells are located in remote areas that are accessible only by foot or light plane).

For Study Units that require a quick turnaround time on analytical results, sending field extractions rather than water samples, particularly at peak production times at the NWQL, could expedite data returns. The Study Unit should contact the NWQL in advance of adopting this strategy, however, as there may be no backlog in analysis. In addition, special handling to expedite analysis can be arranged with the NWQL at an additional cost.

Sending field extractions instead of water samples has another potential benefit. Field extractions allow the field team to extract less than a liter of sample, which is useful if water samples are known or suspected to contain concentrations that exceed the linear operating range of NWQL methods (currently about 100 μg/L). In such cases, a measured (by weight difference) sub-volume of the original 1-L water sample can be extracted. As an alternative, however, the field team can request that the NWQL extract only part of a water sample (use comment line on NWQL ASR form), and thereby achieve the same results.

Field extractions can reduce the costs of NWQL analysis and overnight shipping, particularly if the Study Unit is some distance from the NWQL. Whether or not sending field extractions instead of water samples is cost effective depends on whether or not the reduced costs in analysis and shipping are less than the cost of obtaining, using, and maintaining extraction equipment and related supplies. The cost and time of labor associated with extracting samples also should be factored into the decision. A 1-L sample typically requires one field-team member about 45 minutes to extract, not including the time and labor cost needed for equipment assembly and decontamination. Overall, Johnson and Swanson (1994) found laboratory processing required 32 percent fewer hours than on-site processing of extracts by a field team for each of two prototype sites in the Central Nebraska Study Unit.

The time involved to set up equipment, conduct the extraction, and decontaminate, disassemble, and store this equipment can make it difficult for a two-person field team to perform extractions on-site at every well, given all the other on-site activities that the field team typically is required to perform. Therefore, extractions usually are performed after most other on-site activities are completed. Alternatively, extractions can be performed by a third person, perhaps off-site at a designated facility. This is probably the only practical method to field extract numerous pesticide samples in the field. For example, each routine QC site for pesticides requires a minimum of six field extractions (one 1-L ground-water sample, plus two 1-L spiked ground-water samples for each of the two pesticide schedules).

VOC trip-blank and trace-element standard reference samples

Two types of routine QC samples require no sample collection, but are routinely sent from selected sites in the field--the VOC trip blank and the standard trace-element reference sample (table 10). Neither is ever opened by Study Unit personnel.

The VOC trip blank can be found in the box in which NWQL VOC vials are shipped. When shipped by the NAWQA team from the field, the lot number (if not on the vial) can be found on the box, and is recorded on the NWQL ASR form sent with the vial (appendix, fig. A15).

Each Study Unit that conducts trace-element sampling in a given field season must request three standard trace-element reference samples from the BTD&QS (table 10). These reference samples are sent from different ground-water sites by the field team during that field season. At each site, the field team records on the NWQL ASR form the original sample identification code found on each bottle and relabels the bottle with the site identification code (appendix, fig. A19) before the sample is shipped.

Handling and Shipping of Samples

Handling and shipping protocols divide ground-water-quality and routine QC samples collected at a well into three groups (table 26). One group requires samples be shipped overnight at less than 4°C. Another group can be shipped by surface (first class) mail at an ambient temperature. The third group is stored by the Study Unit, and possibly shipped for analysis at a later date by surface mail.

To ensure that the samples collected will provide the data desired, the field team verifies that all sample containers required from the well are present, and that all the information required on container labels and field, NWQL-ASR, and other forms, is complete. It is important that the containers are properly labeled, and that all forms contain the information needed by the NWQL and the Study-Unit data manager (see appendix).

Samples that require overnight shipping (table 26, Group One) can undergo physical, biological, or radiochemical transformation or degradation within a short period of time. This is reflected in their maximum holding times (elapsed time between sample collection and analysis). The maximum holding time for Group One samples is 3 to 5 days, except for VOCs, which have a 14-day holding time. Holding times for most of these samples are dependent on maintaining low sample temperature (less than 4°C). During the period when most samples are being sent to the NWQL (about April through October), at least half the holding time can expire after these samples reach NWQL login and before they are analyzed. Thus, all of these samples must be shipped without delay. In addition, and except for radon, these samples also must be packed in a sufficient amount of ice to maintain low temperatures until received at NWQL and refrigerated.

Table 26. Sample handling for shipment of ground-water-quality and quality-control samples

[°C, degrees Celsius; lbs, pounds; mil, manufacturer bag thickness; SASE, self addressed and stamped envelope; NWQL, National Water Quality Laboratory; ASR, Analytical Service Request; SC or LC, NWQL schedule or laboratory code; FCC, FA, FU, and RU are bottle-type designations; CFC, chlorofluorocarbon]

Sample	Shipping	Procedures
Group One:		
Volatiles--SC2090, SC2091, and SC2092 Pesticides--SC2001 and SC2050 or SC2010 and SC2051 Nutrients--SC2752-FCC Organic Carbon--SC2085 (Add small (250-mL) polyethylene bottle filled with water and labeled "For Temperature Check, at Login.")	Overnight at 0 to 4°C, and for safe handling, at weight less than 50 lbs.	Place samples in mesh bag and place "Temperature Check" bottle in middle of sample containers. Place a large, 4-mil plastic bag in cooler, add layer of ice, and place mesh bag on ice inside plastic bag. Surround and cover mesh bag with ice, then twist and seal outer plastic bag with waterproof tape.
Radon--LC1369	Overnight (with above or separate from above).	Place resealable plastic bag containing radon tube(s) atop large plastic bag above. Combine ASR forms with Study-Unit Login reply form and SASE in nested, resealable, plastic bags, and tape to inside of cooler lid. Put return address on inside of lid. Close lid, secure it, and cooler drain cap with strong tape. Attach air bill.
Group Two:		
Major ions--SC2750--FA FU, and RU Trace elements--samples SC2703 (blanks--SC172)	Surface, first-class mail, at ambient temperature and, for safe handling, weight less than 50 lbs.	Place trace-element samples in two nested, resealable plastic bags and place sealed bags in a heavy cardboard container; pack in bubble pack, enclose forms (ASR and login-reply forms, and SASE) in nested, resealable plastic bags. Seal container with strong tape and attach mailing label with return address.
Group Three:		
Isotopes of tritium, deuterium, and oxygen; major-ion (archive) sample (SC2750--FA); and possibly CFC samples	Initially archive in a dry, cool, and clean storage area; possibly ship (via regular surface mail).	Archive individual samples in a partitioned, heavy cardboard container. List sample types and date on side of container. Also archive ASR and any other forms.

To verify that low temperatures are maintained, each overnight shipment includes a small (250-mL) polyethylene bottle filled with uncontaminated water (for example, deionized), marked “For Temperature Check at Login.” This bottle is placed in the middle of the other samples being shipped. The NWQL login personnel will check the temperature of the water in this bottle, record it on the Study-Unit’s “Login-Reply Return Form” (appendix, fig. A20), and return this form via the self-addressed and stamped envelope provided by the Study Unit. This form and envelope initially are included with the NWQL ASR forms, which are double bagged in resealable plastic bags, and taped to the inside of the shipping cooler (table 26). Study-Unit data managers are to file the return forms, and keep a record of sample temperatures, particularly those that exceeded 4°C.

As a rule, water-quality samples with 3- to 5-day holding times should not be collected on a Friday, particularly Fridays associated with 3-day weekends, because 3 to 5 days could elapse before samples are analyzed. Radon, with a short half-life of approximately 3.6 days, is definitely not collected if it cannot be shipped within 24 hours of collection and arrive at NWQL login before 12:00 p.m. on any Friday.

Samples sent by regular surface mail (first class) have longer holding times than overnight samples and do not need to be chilled (table 26, Group Two). It is recommended, however, that these samples be shipped within a week or two of collection.

Samples archived by the Study Unit (table 26, Group Three) can include replicates (distinct from those required for routine QC samples) of major ions (SC2750, FA bottle only), trace elements (for example, SC2703), isotope samples (for tritium, deuterium, and oxygen), and chlorofluorocarbon (CFC) samples. Archived major-ion and trace-element samples should be discarded as soon as it is known that analytical reruns are not required. Isotope samples can be held for several years provided bottles remain sealed. Samples for CFCs can be held for at least several years, provided they are not biologically active (Eurybiades Busenberg, U.S. Geological Survey, written commun., 1995).

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APPENDIX. EXAMPLES OF FIELD FORMS FOR THE COLLECTION OF GROUND-WATER DATA AND SAMPLES FOR THE NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

Examples of field and analytical service request forms for the National Water Quality Laboratory are provided in this appendix. Included are forms for the following:

A1. Land-use and land-cover field sheet for the 1991 Study Units, National Water-Quality Assessment Program.[1]
A2. Example of quality-control and calibration form for the dissolved-oxygen sensor and meter.
A3. Example of quality-control and calibration form for the specific electrical conductance sensor and meter.
A4. Example of quality-control form for a thermistor thermometer.
A5. Example of quality-control form for a pH sensor and meter.
A6. Theoretical slope values of Nerst equation for pH electrode (modified from Plummer and Busenberg, 1981).
A7. Example of a purge form for a well.
A8. Example of a ground-water-quality sample-collection field form.
A9. Example of field-titration form.
A10-A. Example of an analytical service request form for primary ground-water-quality samples that require overnight shipping.
A10-B. Example of an analytical service request form for primary ground-water-quality samples that can be shipped surface (first class) mail.
A11-A. Example of an analytical service request form for replicate ground-water-quality samples that require overnight shipping.
A11-B. Example of an analytical service request form for replicate ground-water-quality samples that can be shipped surface (first class) mail.
A12-A. Example of an analytical service request form for replicate field-spiked, ground-water samples for pesticides and volatile organic compounds: first set, TIME: HH:02.
A12-B. Example of analytical service request form for replicate field-spiked, ground-water samples for pesticides and volatile organic compounds: second set, TIME: HH:03. (If optional third set is taken, use a third form similar to the one above but with TIME: HH:04.)
A13-A. Example of analytical service request form for field blanks that require National Water Quality Laboratory blank water and overnight shipping.
A13-B. Example of an analytical service request form for field blanks that require Quality of Water Service Unit inorganic-free blank water (QWSU-IBW) and surface mail shipping.
A14. Example of an analytical service request form for dissolved (filtered) organic carbon (DOC) solution blank composed of either NWQL volatile pesticide-free blank water (VPBW) or pesticide-free blank water (PBW).
A15. Example of an analytical service request form for a volatile-organic-compound (VOC) trip blank.
A16. Example of an analytical service request form for a primary trace-element ground-water sample (SC2703).
A17. Example of an analytical service request form for a replicate trace-element ground-water sample (SC2703).
A18. Example of an analytical service request form for a ground-water trace-element (SC2703) field blank.
A19. Example of an analytical service request form for a standard-reference trace-element (SC2703) sample for ground water.
A20. Example of Study Unit login reply form sent with samples shipped by overnight mail.

[1]Land-use and land-cover field sheet for the 1991 Study Units is being evaluated for use by the 1994 Study Units.

LAND-USE/LAND-COVER FIELD SHEET - GROUND-WATER COMPONENT OF NAWQA STUDIES - Page 1 (04/93)

1. NAWQA Study-Unit name using 4-letter abbreviation: ____________
Field-check date ___/___/___ Person conducting field inspection:______________________________
Well station-id:___________________ Latitude:__________________ Longitude:____________________

2. LAND USE AND LAND COVER CLASSIFICATION - (modified from Anderson and others, 1976, p.8). Check all land uses that occur within each approximate distance range from the sampled well. Identify the predominant land use within each distance range and estimate its percentage of the total area within a 1/4-mile radius of the well.

Land use and land cover	Within 100 ft	100 ft-1/4 mi	Comments
I. URBAN LAND			
--Residential			
--Commercial			
--Industrial			
--Other (Specify)________			
II. AGRICULTURAL LAND			
--Nonirrigated cropland			
--Irrigated cropland			
--Pasture			
--Orchard, grove, vineyard, or nursery			
--Confined feeding			
--Other (Specify)________			
III. RANGELAND			
IV. FOREST LAND			
V. WATER			
VI. WETLAND			
VII. BARREN LAND			
Predominant land use			
Approximate percentage of area covered by predominant land use			

3. AGRICULTURAL PRACTICES within 1/4 mile of the sampled well.

a. Extent of irrigation - Indicate those that apply.
Nonirrigated ____ Supplemental irrigation in dry years only ____, Irrigated ____

b. Method of irrigation - Indicate those that apply.
Spray ___ Flood ___ Furrow ___ Drip ___ Chemigation ___ Other ___ (Specify) ____________

c. Source of irrigation water - Indicate those that apply.
Ground water ____ Surface water ____ Spring ____
Sewage effluent ____ (treatment): Primary ____ Secondary ____ Tertiary ____

d. Pesticide and fertilizer application - Provide information about present and past pesticides and fertilizers used, application rates, and application methods.____
____

e. Crop and animal types - Provide information about present and past crop and animal types, and crop rotation practices.____
____

Entered by____________________ Date ___/___/___ Checked by __________________ Date ___/___/___

Figure A1. Land-use and land-cover field sheet for the 1991 Study Units, National Water-Quality Assessment Program.

LAND-USE/LAND-COVER FIELD SHEET - GROUND-WATER COMPONENT OF NAWQA STUDIES-Page 2 (04/93)

Well station-id: ______________________________ Field-check date: ____/____/____

4. LOCAL FEATURES - Indicate all local features that may affect ground-water quality which occur within each approximate distance range from the sampled well.

Feature	within 100 ft	100 ft - 1/4 mi	Comments
Gas station			
Dry cleaner			
Chemical plant or storage facility			
Airport			
Military base			
Road			
Pipeline or fuel storage facility			
Septic field			
Waste disposal pond			
Landfill			
Golf course			
Stream, river, or creek Perennial __ Ephemeral __			
Irrigation canal Lined __ Unlined __			
Drainage ditch Lined __ Unlined __			
Lake Natural __ Manmade __			
Reservoir Lined __ Unlined __			
Bay or estuary			
Spring Geothermal (> 25 C)__ Nongeothermal__			
Salt flat or playa Dry __ Wet __			
Mine, quarry, or pit Active __Abandoned__			
Oil well			
Major withdrawal well			
Waste injection well			
Recharge injection well			
Other ______________			

Figure A1. Land-use and land-cover field sheet for the 1991 Study Units, National Water-Quality Assessment Program--Continued.

LAND-USE/LAND-COVER FIELD SHEET - GROUND-WATER COMPONENT OF NAWQA STUDIES -Page 3 (04/93)

Well station-id: ______________________________ Field-check date: ____/____/____

5. LAND-USE CHANGES - Have there been major changes in the last 10 years in land use within 1/4 mile of the sampled well? Yes __, Probably __, Probably not __, No __ If yes, describe major changes.

6. ADDITIONAL COMMENTS - Emphasize factors that might influence local ground-water quality.

Remarks

Figure A1. Land-use and land-cover field sheet for the 1991 Study Units, National Water-Quality Assessment Program--Continued

Model ____________________________; Serial Number (W) ____________________

Date	Time	Electrode Condition					Calibration								
		Membrane	Membrane changed last	Gold cathode and silver anode	Electro-lyte	Battery	Red-line	Zero	Meter[1] temper-ature (°C)	Saturated DO at temperature (mg/L)	Atmo-spheric. pressure (mm Hg)	Correction factor	Calibra-tion DO (mg/L)	Adjusted (Y or N)	Initials of testor

°C = degrees Celsius; mg/L = milligram per liter; mm Hg = millimeters of mercury

[1]See temperature quality-control form for thermistor used with this instrument (fig. A4).

Figure A2. Example of quality-control and calibration form for the dissolved-oxygen (DO) sensor and meter.

Model ____________________; Serial number (W) _____________________

	Condition of:			Conductance calibration:						
Date	Electrode	Meter	Therm-istor[1]	Standard # 1 less than 100 µS/cm	Reading µS/cm at 25°C	Within 5% of standard	Standard # 2 greater than 100 µS/cm	Reading µS/cm at 25°C	Within 3% of standard	Initials and action taken

[1]See thermistor form for quality-control tests on thermistor, all readings at 25° Celsius (25°C) in microsiemens per centimeter (µS/cm).

Figure A3. Example of quality-control and calibration form for the specific electrical conductance sensor and meter.

Model ____________________ Serial number (W) __________________

Date	Low temperature (0 to 5°C)			High temperature (15 to 35°C)			Action taken	Initials
	ASTM thermometer[1] reading (°C)	Meter reading (°C)	Within 0.2°C?	ASTM thermometer reading (°C)	Meter reading (°C)	Within 0.2°C?		

[1]American Society for Testing and Materials (ASTM) thermometer, serial number ________________________.
Specify thermistor use by checking one below:
pH ____ Specific electrical conductance ____ Dissolved oxygen ____ Turbidity ____ Temperature _____

Figure A4. Example of quality-control form for a thermistor thermometer measuring degrees Celsius (°C).

			Reading		Reading								
Date	Low pH buffer	High pH buffer	mV low	mV high	pH low	pH high	Buffer temper- ature (°C)	Actual slope[1] ΔmV/ ΔpH	Theoret- ical slope at temper- ature[2]	Slope ratio[3] (%)	Pass (Y or N)	Response time[4] (seconds)	Initials/ action taken[5]

[1]Actual slope = ΔmV/ΔpH, where ΔmV is difference in millivolt readings between low and high pH buffers, and ΔpH is difference in measured pH (that meter locks on) between low and high pH buffers.

[2]Theoretical slope of Nernst equation (see fig. A6) as function of buffer temperature in degrees Celsius (°C).

[3]Slope ratio in percent = (actual slope/theoretical slope) x 100. An acceptable ratio is one greater than or equal to 95.0 percent.

[4]Response time for meter to lock onto low pH buffer after calibration on high pH buffer. An acceptable value is less than or equal to 15 seconds.

[5]Initials of person performing quality control, and action taken by that person. See temperature quality-control form for thermistor used with this instrument (fig. A4).

Figure A5. Example of quality-control form for a pH sensor and meter.

Temperature[1]	Theoretical slope[2]	Temperature	Theoretical slope
0	54.197	21	58.364
1	54.396	22	58.562
2	54.594	23	58.761
3	54.792	24	58.959
4	54.991	25	59.157
5	55.189	26	59.356
6	55.388	27	59.554
7	55.586	28	59.753
8	55.784	29	59.951
9	55.983	30	60.149
10	56.181	31	60.348
11	56.380	32	60.546
12	56.578	33	60.745
13	56.777	34	60.943
14	56.975	35	61.141
15	57.173	36	61.340
16	57.372	37	61.538
17	57.570	38	61.737
18	57.769	39	61.935
19	57.967	40	62.133
20	58.165		

[1]Degrees Celsius, record to nearest tenth of degree.
[2]Interpolate theoretical slope for buffer temperatures between whole degree values.

Figure A6. Theoretical slope values of Nerst equation for pH electrode at temperature specified (modified from Plummer and Busenberg, 1981).

WATER-LEVEL MEASUREMENTS, PURGE VOLUME, AND FIELD MEASUREMENTS BEFORE SAMPLING

USGS I.D.: ______________________________ Date ___________________________ Time ____________________

Local Well I.D.: ___________________________ Field Team I.D.: _________________________

Well diameter (D, inches): ____________ Depth to water[1] (feet): _____________ Depth of well[1] (feet):______________

Height of water column (H, feet): __________________ Casing (borehole) wetted volume (= $0.0408HD^2$, gallons) ____

Purge volume (= 3 x casing volume, gallons): ____________________ Pump type: _________________________________

Time (min.)	Pump depth (feet)	Pump rate (gpm)	Volume pumped (gal)	Water appearance (clear, cloudy, etc.)	Temper-ature (°C)	Dissolved oxygen (mg/L)	pH	Specific conductance (μS/cm at 25°C)	Turbidity (NTU)
Except for pH, median values of final 5 measurements; to be used on ASR forms and field sample-collection forms (fig. A9).[2]									

min. = minutes; gpm = gallons per minute; gal = gallons; °C = degrees Celsius; mg/L = milligrams per liter; μS/cm at 25°C = microsiemens per centimeter at 25°C; NTU = nephelometric turbidity unit

[1]Reference datum was measurement point __________________ Land surface datum (surveyed) ____________________

Equipment used ____ Accuracy _____________________

[2]For pH, after other final measurements are taken, temporarily divert flow and use final pH value obtained on standing water in flowthrough chamber.

Figure A7. Example of purge form for a well.

LOCAL ID ______________________ **RECORD #** ______________________

Station identification number (lat. / long. / seq.)	Type	Date (Y M D)	Time
1 [| | | | | | | | | | | | | |]	[ ]	[| | | | |]	[| | |]
1 2 … 16	17	18 … 23	24 … 27

Local Well Number	Site	Geologic Unit	Hydrologic Unit
[ ]	[ ]	[ ]	[ ]

State	District	County
[ ]	[ ]	[ ]

Sampled by ______________________

Location ____

*	Code	Value	Remarks
Yield when sampling (GPM)	00059		
Minutes pumped before sampling	72004		
Sampling method	82398		

4010 = thief sample
4020 = bailer
4030 = suction pump
4040 = submersible pump
4050 = squeeze pump
4060 = gas reciprocating
4070 = air lift
4080 = peristaltic pump
4090 = jet pump
4100 = flowing well

	Code	Value	Remarks
Sampling condition	72006		

0.10 = site was being pumped
0.11 = site had been pumped recently
4. = flowing
8. = pumping
30. = seeping

	Code	Value	Remarks
Static water level (feet)	72019		
Altitude lsd (feet)	72000		
Depth to top sample interval	72015		
Depth to bottom sample interval	72016		
Finished well depth (feet)	72008		
Hole depth (feet)	72001		

	Code	Value	Remarks
Water temperature	00010		
Air temperature	00020		
Specific conductance	00095		
Dissolved oxygen	00300		
Turbidity	72008		

	Code	Value	Remarks
pH field	00400		
Alkalinity total field*	39086		
Bicarbonate total field	00453		
Carbonate total field	00452		
Acid neutralization capacity*	00419		

*For Gran-method titrations, values of Alk and ANC in mg/L have parameter codes 29802 and 29813, respectively.

Bottles Filled	Volume	Treatment

Comments:

Quality-control samples taken? ☐ Yes ☐ No

Any land-use changes? ☐ Yes ☐ No

Was form updated? ☐ Yes ☐ No

VOCs--acid used: Drops to pH 2 ☐ Drops used ☐

Figure A8. Example of a ground-water-quality sample-collection field form.

Units of acid	pH	Δ pH	Δ units acid	Δ ph/ Δ units

Units of acid	pH	Δ pH	Δ units acid	Δ ph/ Δ units

Station identifier | Date | Time

Normality of acid | Volume of acid to pH ~ 8.3

Type of titration: Incremental, inflection point

Volume of acid to pH ~ 4.5

ANC, mg/L $CaCo_3$[a]

Comments:

Alk, mg/L $CaCo_3$[b]

Bicarbonate, mg/L HCO_3^-

Carbonate, mg/L $CO_3^=$

[a]ANC - acid neutralizing capacity; on unfiltered sample from inflection point at about pH = 4.5.

[b]ALK - alkalinity, carbonate, and bicarbonate, on filtered sample from inflection points at about pH = 8.3 and 4.5.

Figure A9. Example of field-titration form.

U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

SMS CONTROL NO	NWIS RECORD NO	LABORATORY ID	SAMPLE SET

WICh52 — STATION NAME
382454075200301 — STATION ID OR UNIQUE NO

TOWSON, MD	(410) 512-4800	SHEDLOCK	WICh52	GW
FIELD OFFICE	*PHONE NO.	*PROJECT CHIEF	FIELD SAMPLE ID	SITE TYPE

24	024	045	442400000
*STATE	*DISTRICT/USER	CNTY	*PROJECT ACCT NO

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0800
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES

SCHEDULE 1: SC2090
SCHEDULE 2: SC2001
SCHEDULE 3: SC2050
SCHEDULE 4: SC2085
SCHEDULE 5: SC2752

**SAMPLE MEDIUM: 6
GEOLOGIC UNIT: 112BVDM
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 9 or 7[a]
**HYDRO EVENT: 9

CODE: 1369 | 82303 (A/D, A circled)
CODE: ____ | ____ (remaining CODE lines blank)

FIELD VALUES[b]

LAB/P CODE	VALUE	RMK
21/ 00095	245	
/00010	11.1	
/00076	2	
51/ 00400	6.1	
/00300	2.2	
/99105	20	
2 / 00419	11.5	
/00452	1.2	
/00453	9.3	
39086	11.2	

+COMMENTS: (LIMIT TO 138 CHARACTERS: [c] Time of radon sample: 08:40; VOC, HCl added: 4 drops

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA PHONE: (410) 512-48400 DATE: 01 /20 /95[d]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

___FA ___RU ___FU ___FAM ___RAM ___RC ___FC ___FAB ___CU
___RA ___RAH ___S= ___CN- ___RCB 1 DOC ___TOC ___SOC ___COD
___VOA ___CHY ___O&G ___PHENOL 2 GCC 3 GCV, 1 FN, 1 FCC OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY: ________ APPROVAL NO. ________
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER ________
POSSIBLE HAZARDS ________

REVISED 04/92 +COMMENTS TO BE STORED BY THE LABORATORY *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS **MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Use 7 if any replicate ground-water samples are taken for the above schedules or those on figure A10-B.

[b]If 9 used for sample type, add all P-codes, including those under field values, except for 99105, which is left blank. If 7 used for sample type, inlcude P code 99105. Also add P codes to QWDATA record for sample.

[c]This is a priority message, must appear.

[d]Overnight shipping is recommended for all samples. Do not put radon tube in ice.

Figure A10-A. Example of an analytical service request form for primary ground-water-quality samples (including radon) that require overnight shipping.

US. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

SMS CONTROL NO | NWIS RECORD NO | LABORATORY ID | SAMPLE SET

WICh52 — STATION NAME
382459075200301 — STATION ID OR UNIQUE NO

TOWSON, MD — FIELD OFFICE
(410) 512-4800 — *PHONE NO.
SHEDLOCK — *PROJECT CHIEF
WICh52 — FIELD SAMPLE ID
GW — SITE TYPE

24 — *STATE
024 — *DISTRICT/USER
045 — CNTY
442400000 — *PROJECT ACCT NO

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0800
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES

SCHEDULE 1: SC2750
SCHEDULE 2:
SCHEDULE 3:
SCHEDULE 4:
SCHEDULE 5:

**SAMPLE MEDIUM: 6
GEOLOGIC UNIT: 112BVDM
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 9 or 7[a]
**HYDRO EVENT: 9

A/D	A/D	A/D	A/D
CODE: |	CODE: |	CODE: |	CODE: |
CODE: |	CODE: |	CODE: |	CODE: |
CODE: |	CODE: |	CODE: |	CODE: |
CODE: |	CODE: |	CODE: |	CODE: |

FIELD VALUES[b]

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21/ 00095	245		51/ 00400	6.1		2 / 00419	11.5	
/00010	11.1		/ 00300	2.2		/00452	1.2	
/00076	2		/99105	20		/00453	9.3	
						39086	11.2	

+COMMENTS: (LIMIT TO 138 CHARACTERS: [c]

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA PHONE: (410) 512-48400 DATE: 01 /27 /95[d]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

1 FA	1 RU	1 FU	FAM	RAM	RC	FC	FAB	CU
RA	RAH	S=	CN-	RCB	DOC	TOC	SOC	COD
VOA	CHY	O&G	PHENOL	GCC		OTHER		

CUSTOM/SPECIAL SAMPLE APPROVED BY: APPROVAL NO.
PROGRAM/PROJECT: XX NAWQA DRINKING H20 FILL IN OTHER
POSSIBLE HAZARDS

REVISED 04/92 +COMMENTS TO BE STORED BY THE LABORATORY *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Use 7 if any replicate ground-water samples are taken for the above schedules or those on figure A10-A.

[b]If 9 used for sample type, add all P codes, including those under field values, except for 99105, which is left blank. If 7 used for sample type, include P code 99105. Also add P-codes to QWDATA record for sample.

[c]No comments; otherwise, priority comments on figure A10-A could be overwritten.

[d]Recommend samples be sent surface mail within 2 weeks of collection date.

Figure A10-B. Example of an analytical service request form for primary ground-water-quality samples that can be shipped surface (first class) mail.

U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO	NWIS RECORD NO	LABORATORY ID	SAMPLE SET

STATION NAME: WICh52 — STATION ID OR UNIQUE NO: 38245907500301

FIELD OFFICE	*PHONE NO.	*PROJECT CHIEF	FIELD SAMPLE ID	SITE TYPE
TOWSON, MD	(410) 512-4800	SHEDLOCK	WICh52	GW

*STATE	*DISTRICT/USER	CNTY	*PROJECT ACCT NO
24	024	045	442400000

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0801
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES

SCHEDULE 1: SC2085
SCHEDULE 2: SC2752
SCHEDULE 3: SC2090
SCHEDULE 4: SC2001
SCHEDULE 5: SC2050

**SAMPLE MEDIUM: S
GEOLOGIC UNIT: ___
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 7
**HYDRO EVENT: 9

CODE	A/D	CODE	A/D	CODE	A/D	CODE	A/D
1369	82303						

FIELD VALUES[a]

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21/ 00095			51/ 00400			2 / 00419		
/99105	20		/			/		
/			/			/		

+COMMENTS: (LIMIT TO 138 CHARACTERS: [b]Time of radon sample: 08:45; VOC, HCl added: 4 drops

LOGIN COMMENTS: ___

SHIPPED BY: M. KOTERBA PHONE: (410) 512-4840 DATE: 01 /20 /95[c]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

___FA	___RU	___FU	___FAM	___RAM	___RC	___FC	___FAB	___CU
___RA	___RAH	___S=	___CN-	___RCB	___DOC	___TOC	___SOC	___COD
___VOA	___CHY	___O&G	___PHENOL	2 GCC	3 GCV, 1 RN, 1 FCC OTHER			

CUSTOM/SPECIAL SAMPLE APPROVED BY: ___ APPROVAL NO. ___
PROGRAM/PROJECT: XX NAWQA ___ DRINKING H20 FILL IN OTHER ___
POSSIBLE HAZARDS ___

REVISED 04/92 +COMMENTS TO BE STORED BY THE LABORATORY *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Add P codes noted above to form and to QADATA record for this sample.
[b]This is a priority message, must appear.
[c]Overnight shipping with primary samples (fig. A10-A) is recommended.

Figure A11-A. Example of an analytical service request form for replicate ground-water-quality samples (including radon) that require overnight shipping.

U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM **QA**

SMS CONTROL NO: ____ NWIS RECORD NO: ____ LABORATORY ID: ____ SAMPLE SET: ____

STATION NAME: WICh52 STATION ID OR UNIQUE NO: 382459075003 01

FIELD OFFICE: TOWSON, MD *PHONE NO.: (410) 512-4800 *PROJECT CHIEF: SHEDLOCK FIELD SAMPLE ID: WICh52 SITE TYPE: GW

*STATE: 24 *DISTRICT/USER: 024 CNTY: 045 *PROJECT ACCT NO: 442400000

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0801
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES

SCHEDULE 1: SC2750 **SAMPLE MEDIUM: ____ **SAMPLE TYPE: 7
SCHEDULE 2: ____ GEOLOGIC UNIT: ____ **HYDRO EVENT: 9
SCHEDULE 3: ____ **ANALYSIS STATUS: H
SCHEDULE 4: ____ **ANALYSIS SOURCE: 9
SCHEDULE 5: ____ **HYDRO CONDITION: 9

CODE: ____ | A/D ____ (blank code lines, 4 columns × 4 rows)

FIELD VALUES[a]

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21/ 00095	245		51/ 00400	6.1		2 / 00419	11.5	
/00010	11.1		/ 00300	2.2		/00452	1.2	
/00076	2		/99105	20		/00453	9.3	
						39086	11.2	

+COMMENTS: (LIMIT TO 138 CHARACTERS): [b] ____

LOGIN COMMENTS: ____

SHIPPED BY: M. KOTERBA PHONE: (410) 512-48400 DATE: 01 /27 /95[c]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

1 FA 1 RU 1 FU ___FAM ___RAM ___RC ___FC ___FAB ___CU
___RA ___RAH ___S= ___CN- ___RCB ___DOC ___TOC ___SOC ___COD
___VOA ___CHY ___O&G ___PHENOL ___GCC ________ OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY: ____ APPROVAL NO. ____
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER ____
POSSIBLE HAZARDS ____

REVISED 04/92 +COMMENTS TO BE STORED BY THE LABORATORY *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Add P codes noted above to form and to QADATA record for this sample.
[b]No comments; otherwise, priority comments on figure A11-A could be overwritten.
[c]Surface (first-class) shipping with primary samples (fig. A10-B) is recommended.

Figure A11-B. Example of an analytical service request form for replicate ground-water-quality samples that can be shipped surface (first class) mail.

U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM **QA**

SMS CONTROL NO | NWIS RECORD NO | LABORATORY ID | SAMPLE SET

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0802
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2090
SCHEDULE 2: SC2001
SCHEDULE 3: SC2050
SCHEDULE 4: ____
SCHEDULE 5: ____

**SAMPLE MEDIUM: S
GEOLOGIC UNIT: ____
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 1
**HYDRO EVENT: 9

CODE	A/D	CODE	A/D	CODE	A/D	CODE	A/D
99105	20	99107	10				
99106	10	99108	0.1				

FIELD VALUES

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21/ 00095			51/ 00400			2 / 00419		
/			/			/		
/			/			/		

put lot numbers for all spikes on this form

+COMMENTS: (LIMIT TO 138 CHARACTERS): [b]SC2090: spike lot no.; SC2001: spike lot no.; SC2050: spike lot no.

LOGIN COMMENTS: ____

SHIPPED BY: M. KOTERBA PHONE: (410) 512-4840 DATE: 01 / 20 / 95[c]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

___FA ___RU ___FU ___FAM ___RAM ___RC ___FC ___FAB ___CU
___RA ___RAH ___S= ___CN- ___RCB ___DOC ___TOC ___SOC ___COD
___VOA ___CHY ___O&G ___PHENOL 2 GCC 2 GCV OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY: ____ APPROVAL NO. ____
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER ____
POSSIBLE HAZARDS ____

REVISED 04/92 +COMMENTS TO BE STORED BY THE LABORATORY *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Use indicated spiked-sample P codes; include in QADATA record for sample.
[b]Include lot number of each spike vial used with each schedule.
[c]Ship overnight with primary unspiked (background) ground-water samples (fig. A10-A).

Figure A12-A. Example of an analytical service request form for replicate field-spiked, ground-water samples for pesticides and volatile organic compounds; first set, TIME: HH:02.

U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO ____ NWIS RECORD NO ____ LABORATORY ID ____ SAMPLE SET ____

STATION NAME: WICh52 — STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD — *PHONE NO.: (410) 512-4800 — *PROJECT CHIEF: SHEDLOCK — FIELD SAMPLE ID: WICh52 — SITE TYPE: GW

*STATE: 24 — *DISTRICT/USER: 024 — CNTY: 045 — *PROJECT ACCT NO: 442400000

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0803
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2090 — **SAMPLE MEDIUM: S — **SAMPLE TYPE: 1
SCHEDULE 2: SC2001 — GEOLOGIC UNIT: ____
SCHEDULE 3: SC2050 — **ANALYSIS STATUS: H — **HYDRO EVENT: 9
SCHEDULE 4: ____ — **ANALYSIS SOURCE: 9
SCHEDULE 5: ____ — **HYDRO CONDITION: 9

CODE	A/D	CODE	A/D	CODE	A/D	CODE	A/D
99105	20	99107	10				
99106	10	99108	0.1				

(A circled in the first two A/D headings)

FIELD VALUES[b]

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21 / 00095			51 / 00400			2 / 00419		
/			/			/		
/			/			/		

put lot numbers for all spikes on this form

+COMMENTS: (LIMIT TO 138 CHARACTERS): [b]SC2090: spike lot no.; SC2001: spike lot no.; SC2050: spike lot no.

LOGIN COMMENTS: ____

SHIPPED BY: M. KOTERBA — PHONE: (410) 512-4840 — DATE: 01 / 20 / 95[c]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

___FA ___RU ___FU ___FAM ___RAM ___RC ___FC ___FAB ___CU
___RA ___RAH ___S= ___CN- ___RCB ___DOC ___TOC ___SOC ___COD
___VOA ___CHY ___O&G ___PHENOL 2 GCC 2 GCV OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY: ____ APPROVAL NO. ____
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER ____
POSSIBLE HAZARDS ____

REVISED 04/92 — +COMMENTS TO BE STORED BY THE LABORATORY — *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS — **MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Use indicated spiked-sample P codes; include in QADATA record for sample.
[b]Include lot number of each spike vial used with each schedule.
[c]Ship overnight with primary unspiked (background) ground-water samples (fig. A10-A).

Figure A12-B. Example of an analytical service request form for replicate field-spiked, ground-water samples for pesticides and volatile organic compounds; second set, TIME: HH:03. (If optional third set is taken, use a third form similar to the one above but with TIME: HH:04.)

U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO: ____ NWIS RECORD NO: ____ LABORATORY ID: ____ SAMPLE SET: ____

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075003O1

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0805
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2090
SCHEDULE 2: SC2001
SCHEDULE 3: SC2050
SCHEDULE 4: SC2085
SCHEDULE 5: ____

**SAMPLE MEDIUM: Q
GEOLOGIC UNIT: ____
**ANALYSIS STATUS: 4
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 2
**HYDRO EVENT: 9

CODE	A/D	CODE	A/D	CODE	A/D	CODE	A/D
99100	50						
99101	10						
99102	100						

FIELD VALUES [b]

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21 / 00095			51 / 00400			2 / 00419		
/			/			/		
/			/			/		

+COMMENTS: (LIMIT TO 138 CHARACTERS: NWQL VPBW: Lot no.

LOGIN COMMENTS: ____

SHIPPED BY: M. KOTERBA
PHONE: (410) 512-4840
DATE: 01 / 20 / 95[c]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

___FA ___RU ___FU ___FAM ___RAM ___RC ___FC ___FAB ___CU
___RA ___RAH ___S= ___CN- ___RCB 1 DOC ___TOC ___SOC ___COD
___VOA ___CHY ___O&G ___PHENOL 2 GCC 3 GCV OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY: ____ APPROVAL NO. ____
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER ____
POSSIBLE HAZARDS ____

REVISED 04/92 +COMMENTS TO BE STORED BY THE LABORATORY *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Add all P-codes to form and to QADATA record for sample.

[b]Priority comment, blank water lot number. If SC2090 not taken, NWQL pesticide-free blank water can be used, and if it is used, change the P code 99100 to "40" and the comment to "NWQL PBW: lot no."

[c]Ship blank samples with corresponding ground-water-quality samples.

Figure A13-A. Example of an analytical service request form for field blanks that require National Water Quality Laboratory blank water and overnight shipping.

U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM **QA**

SMS CONTROL NO | NWIS RECORD NO | LABORATORY ID | SAMPLE SET

WICh52 — STATION NAME
382459075200301 — STATION ID OR UNIQUE NO

TOWSON, MD — FIELD OFFICE
(410) 512-4800 — *PHONE NO.
SHEDLOCK — *PROJECT CHIEF
WICh52 — FIELD SAMPLE ID
GW — SITE TYPE

24 — *STATE
024 — *DISTRICT/USER
045 — CNTY
442400000 — *PROJECT ACCT NO

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0806
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2750
SCHEDULE 2:
SCHEDULE 3:
SCHEDULE 4:
SCHEDULE 5:

**SAMPLE MEDIUM: Q
GEOLOGIC UNIT:
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 2
**HYDRO EVENT: 9

CODE:	A/D	CODE:	A/D	CODE:	A/D	CODE:	A/D
	50						
	10						
	100						

FIELD VALUES

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21/ 00095			51/ 00400			2 / 00419		
/99100	10		/ 99102	100		/		
/99101	80		/			/		

+COMMENTS: (LIMIT TO 138 CHARACTERS)[b]: QWSU IBW: Lot no.

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA PHONE: (410) 512-4840 DATE: 01 /27 /95[c]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

1 FA, 1 RU, 1 FU, ___ FAM, ___ RAM, ___ RC, ___ FC, ___ FAB, ___ CU
___ RA, ___ RAH, ___ S=, ___ CN-, ___ RCB, ___ DOC, ___ TOC, ___ SOC, ___ COD
___ VOA, ___ CHY, ___ O&G, ___ PHENOL, ___ GCC, ___ OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY: ________ APPROVAL NO. ________
PROGRAM/PROJECT: XX NAWQA ___ DRINKING H20 FILL IN OTHER ________
POSSIBLE HAZARDS ________

REVISED 04/92 +COMMENTS TO BE STORED BY THE LABORATORY *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS **MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Add all P codes to form and to QADATA record for this sample.
[b]Priority comment, must appear.
[c]Recommend field-blank samples be shipped surface mail with corresponding ground-water samples (see figs. A10-A,B).

Figure A13-B. Example of an analytical service request form for field blanks that require Quality of Water Service Unit inorganic-free blank water (QWSU-IBW) <u>and</u> surface mail shipping.

U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO	NWIS RECORD NO	LABORATORY ID	SAMPLE SET

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0807
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2085
SCHEDULE 2: ___
SCHEDULE 3: ___
SCHEDULE 4: ___
SCHEDULE 5: ___

ORY CODES: *SAMPLE MEDIUM: Q
GEOLOGIC UNIT: ___
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 2
**HYDRO EVENT: 9

CODE	A/D	CODE	A/D	CODE	A/D	CODE	A/D

FIELD VALUES [b]

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21/ 00095			51/ 00400			2 / 00419		
/99100	50		/ 99102	1		/		
/99101	10		/			/		

+COMMENTS: (LIMIT TO 138 CHARACTERS) [c]: NWQL VPBW: Lot no.

LOGIN COMMENTS: ___

SHIPPED BY: M. KOTERBA PHONE: (410) 512-4840 DATE: 01 / 20 / 95 [d]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

___FA	___RU	___FU	___FAM	___RAM	___RC	___FC	___FAB	___CU
___RA	___RAH	___S=	___CN-	___RCB	1 DOC	___TOC	___SOC	___COD
___VOA	___CHY	___O&G	___PHENOL	___GCC			___OTHER	

CUSTOM/SPECIAL SAMPLE APPROVED BY: ___ APPROVAL NO. ___
PROGRAM/PROJECT: XX NAWQA ___ DRINKING H20 FILL IN OTHER ___
POSSIBLE HAZARDS ___

REVISED 04/92 +COMMENTS TO BE STORED BY THE LABORATORY
*MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Add all P codes noted to form and to QADATA record for this sample.

[b]If DOC field blank (fig. A13-A) taken with NWQL PBW, instead of NWQL VPBW, change the P code 99100 to "40" and the comment to "NWQL PBW: lot no."

[c]Priority comment, must appear in relation to blank water used (NWQL PBW or NWQL VPBW).

[d]This DOC solution blank is shipped overnight with the corresponding DOC field blank (fig. A13-A).

Figure A14. Example of an analytical service request form for dissolved (filtered) organic carbon (DOC) solution blank composed of either NWQL volatile pesticide-free blank water (VPBW) or pesticide-free blank water (PBW).

U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO | NWIS RECORD NO | LABORATORY ID | SAMPLE SET

WICh52
STATION NAME

382459075200301
STATION ID OR UNIQUE NO

TOWSON, MD — FIELD OFFICE
(410) 512-4800 — *PHONE NO.
SHEDLOCK — *PROJECT CHIEF
WICh52 — FIELD SAMPLE ID
GW — SITE TYPE

24 — *STATE
024 — *DISTRICT/USER
045 — CNTY
442400000 — *PROJECT ACCT NO

BEGIN DATE: 1995 01 20 0808
END DATE:
YEAR MONTH DAY TIME

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2090
SCHEDULE 2:
SCHEDULE 3:
SCHEDULE 4:
SCHEDULE 5:

**SAMPLE MEDIUM: Q
GEOLOGIC UNIT:
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 2
**HYDRO EVENT: 9

A/D
CODE: | CODE: | CODE: | CODE:
CODE: | CODE: | CODE: | CODE:
CODE: | CODE: | CODE: | CODE:
CODE: | CODE: | CODE: | CODE:

FIELD VALUES[b]

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21/ 00095			51/ 00400			2 / 00419		
/99100	50		/ 99102	30		/		
/99101	10		/			/		

+COMMENTS: (LIMIT TO 138 CHARACTERS: VOC trip-blank vial: Lot no.

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA PHONE: (410) 512-4840 DATE: 01 / 20 / 95[c]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

___FA ___RU ___FU ___FAM ___RAM ___RC ___FC ___FAB ___CU
___RA ___RAH ___S= ___CN- ___RCB ___DOC ___TOC ___SOC ___COD
___VOA ___CHY ___O&G ___PHENOL ___GCC 2 GCV OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY:______ APPROVAL NO.______
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER______
POSSIBLE HAZARDS______

REVISED 04/92 +COMMENTS TO BE STORED BY THE LABORATORY *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS **MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Add all P codes noted to form and to QADATA record for this sample.
[b]NWQL VPBW is assumed for trip blanks; priority comment, lot no. of VOC trip blank vials.
[c]Ship overnight with corresponding volatile ground-water samples collected in vials from same lot (fig. A10-A).

Figure A15. Example of an analytical service request form for a volatile-organic-compound (VOC) trip blank.

U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM **QA**

SMS CONTROL NO	NWIS RECORD NO	LABORATORY ID	SAMPLE SET

STATION NAME: WICh52 — STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD — *PHONE NO.: (410) 512-4800 — *PROJECT CHIEF: SHEDLOCK — FIELD SAMPLE ID: WICh52 — SITE TYPE: GW

*STATE: 24 — *DISTRICT/USER: 024 — CNTY: 045 — *PROJECT ACCT NO: 442400000

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0809
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2703
SCHEDULE 2:
SCHEDULE 3:
SCHEDULE 4:
SCHEDULE 5:

**SAMPLE MEDIUM: 6
GEOLOGIC UNIT: 112BVDM
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 9 or 7[b]
**HYDRO EVENT: 9

CODE	A/D [c]	CODE	A/D	CODE	A/D	CODE	A/D
LC0112							
LC0087							

FIELD VALUES [d]

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21/ 00095	245		51/ 00400	6.1		2 / 00419	11.5	
/00010	11.1		/ 00300	2.2		/00452	1.2	
/00076	2		/99105	20		/00453	9.3	
						39086	11.2	

+COMMENTS: (LIMIT TO 138 CHARACTERS: (INDICATE HERE IF SC EXCEEDS 2,000)

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA — PHONE: (410) 512-4840 — DATE: 01 / 27 / 95[e]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

1 FA [f] ___RU ___FU ___FAM ___RAM ___RC ___FC ___FAB ___CU
___RA ___RAH ___S= ___CN- ___RCB ___DOC ___TOC ___SOC ___COD
___VOA ___CHY ___O&G ___PHENOL ___GCC ___OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY:________ APPROVAL NO.________
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER________
POSSIBLE HAZARDS________

REVISED 04/92 — +COMMENTS TO BE STORED BY THE LABORATORY — *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS — **MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Add all P codes noted to form and to QADATA record for this sample.

[b]If a replicate trace-element sample is collected (fig. A17), code sample type as 7; otherwise, code as 9.

[c]Add labcodes for arsenic (LC0112) and selenium (LC0087).

[d]Include field measurements (median values), particularly for specific electrical conductance (SC) at 25 degrees Celsius (P code 00095), and note on comment line if SC exceeds 2,000.

[e]Recommend sample be shipped surface mail with other primary inorganic samples (see fig. A10-B).

[f]Only the FA sample bottle is required if Study Unit acidifies sample, provides field SC value, and indicates in comment field if SC exceeds 2,000 microsiemens per centimeter at 25 degrees Celsius.

Figure A16. Example of an analytical service request form for a primary trace-element ground-water sample (SC2703).

US. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM **QA**

SMS CONTROL NO	NWIS RECORD NO	LABORATORY ID	SAMPLE SET

STATION NAME: WICh52 STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD *PHONE NO.: (410) 512-4800 *PROJECT CHIEF: SHEDLOCK FIELD SAMPLE ID: WICh52 SITE TYPE: GW

*STATE: 24 *DISTRICT/USER: 024 CNTY: 045 *PROJECT ACCT NO: 442400000

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0810
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2703 **SAMPLE MEDIUM: S **SAMPLE TYPE: 7
SCHEDULE 2: GEOLOGIC UNIT:
SCHEDULE 3: **ANALYSIS STATUS: H **HYDRO EVENT: 9
SCHEDULE 4: **ANALYSIS SOURCE: 9
SCHEDULE 5: **HYDRO CONDITION: 9

CODE	A/D [b]	CODE	A/D	CODE	A/D	CODE	A/D
LC0112							
LC0087							

FIELD VALUES

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21/ 00095	245	[c]	51/ 00400			2 / 00419		
/99105	20		/			/		
/			/			/		

+COMMENTS: (LIMIT TO 138 CHARACTERS:

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA PHONE: (410) 512-4840 DATE: 01 /27 /95[d]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

1 FA [e] ___RU ___FU ___FAM ___RAM ___RC ___FC ___FAB ___CU
___RA ___RAH ___S= ___CN- ___RCB ___DOC ___TOC ___SOC ___COD
___VOA ___CHY ___O&G ___PHENOL ___GCC ___OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY: ___ APPROVAL NO. ___
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER___
POSSIBLE HAZARDS ___

REVISED 04/92 +COMMENTS TO BE STORED BY THE LABORATORY *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Add all P codes noted to form and to QADATA record for this sample.

[b]Add labcodes for arsenic (LC0112) and selenium (LC0087).

[c]Include field measurements (median values), particularly for specific electrical conductance (SC) at 25 degrees Celsius (P code 00095), and note on comment line if SC exceeds 2,000.

[d]Recommend sample be shipped surface mail with other primary inorganic samples (see fig. A10-B).

[e]Only the FA sample bottle is required if Study Unit acidifies sample, provides field SC value, and indicates in comment field if SC exceeds 2,000 microsiemens per centimeter at 25 degrees Celsius.

Figure A17. Example of an analytical service request form for a replicate trace-element ground-water sample (SC2703).

U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO	NWIS RECORD NO	LABORATORY ID	SAMPLE SET

STATION NAME: WICh52
STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD
*PHONE NO.: (410) 512-4800
*PROJECT CHIEF: SHEDLOCK
FIELD SAMPLE ID: WICh52
SITE TYPE: GW

*STATE: 24
*DISTRICT/USER: 024
CNTY: 045
*PROJECT ACCT NO: 442400000

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0811
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC172[b]
SCHEDULE 2:
SCHEDULE 3:
SCHEDULE 4:
SCHEDULE 5:

**SAMPLE MEDIUM: Q
GEOLOGIC UNIT:
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 2
**HYDRO EVENT: 9

CODE	(A)/D [c]	CODE	A/D	CODE	A/D	CODE	A/D
LC0112							
LC0087							

FIELD VALUES[d]

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21/ 00095			51/ 00400			2 / 00419		
/99100	10		/ 99102	100		/		
/99101	80		/			/		

+COMMENTS: (LIMIT TO 138 CHARACTERS) QWSU IBW: Lot no.; SC is less than 2,000

LOGIN COMMENTS:

SHIPPED BY: M. KOTERBA PHONE: (410) 512-4840 DATE: 01 /27 /95[e]

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

1 FA [f] ___RU ___FU ___FAM ___RAM ___RC ___FC ___FAB ___CU
___RA ___RAH ___S= ___CN- ___RCB ___DOC ___TOC ___SOC ___COD
___VOA ___CHY ___O&G ___PHENOL ___GCC ___OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY:___ APPROVAL NO.___
PROGRAM/PROJECT: XX NAWQA ___DRINKING H20 FILL IN OTHER___
POSSIBLE HAZARDS___

REVISED 04/92 +COMMENTS TO BE STORED BY THE LABORATORY *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS **MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Add all P codes noted to form and to QADATA record for this sample.
[b]SC172 required for field blanks instead of SC2703--provides detection-level or higher concentration data.
[c]Add labcodes for arsenic (LC0112) and selenium (LC0087).
[d]Include priority comments; note that SC value is not given under the P code (this is blank water).
[e]Recommend sample be shipped surface mail with other primary inorganic samples (fig. A10-B).
[f]Only the FA sample bottle is required if the Study Unit acidifies sample and provides SC comment.

Figure A18. Example of an analytical service request form for a ground-water trace-element (SC2703) field blank.

U.S. GEOLOGICAL SURVEY - NATIONAL WATER QUALITY LABORATORY
ANALYTICAL SERVICES REQUEST FORM

QA

SMS CONTROL NO	NWIS RECORD NO	LABORATORY ID	SAMPLE SET

STATION NAME: WICh52 STATION ID OR UNIQUE NO: 382459075200301

FIELD OFFICE: TOWSON, MD *PHONE NO.: (410) 512-4800 *PROJECT CHIEF: SHEDLOCK FIELD SAMPLE ID: WICh52 SITE TYPE: GW

*STATE: 24 *DISTRICT/USER: 024 CNTY: 045 *PROJECT ACCT NO: 442400000

	YEAR	MONTH	DAY	TIME
BEGIN DATE:	1995	01	20	0812
END DATE:				

SCHEDULES, FIELD AND LABORATORY CODES [a]

SCHEDULE 1: SC2703
SCHEDULE 2: ______
SCHEDULE 3: ______
SCHEDULE 4: ______
SCHEDULE 5: ______

**SAMPLE MEDIUM: Q
GEOLOGIC UNIT: ______
**ANALYSIS STATUS: H
**ANALYSIS SOURCE: 9
**HYDRO CONDITION: 9

**SAMPLE TYPE: 3
**HYDRO EVENT: 9

CODE	A/D [b]	CODE	A/D	CODE	A/D	CODE	A/D
LC0112							
LC0087							

FIELD VALUES [c]

LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK	LAB/P CODE	VALUE	RMK
21/ 00095			51/ 00400			2 / 00419		
/99103	35		/			/		
/			/			/		

+COMMENTS: (LIMIT TO 138 CHARACTERS: Bottle Code: ; SC less than 2,000

LOGIN COMMENTS: ______

SHIPPED BY: M. KOTERBA PHONE: (410) 512-4840 DATE: 01 | 27 |

BOTTLE TYPES (PLEASE FILL IN NO. OF TYPES SENT)

1 FA[e] __RU __FU __FAM __RAM __RC __FC __FAB __CU
__RA __RAH __S= __CN- __RCB __DOC __TOC __SOC __COD
__VOA __CHY __O&G __PHENOL __GCC ______OTHER

CUSTOM/SPECIAL SAMPLE APPROVED BY: ______ APPROVAL NO. ______
PROGRAM/PROJECT: XX NAWQA __DRINKING H20 FILL IN OTHER ______
POSSIBLE HAZARDS ______

REVISED 04/92 +COMMENTS TO BE STORED BY THE LABORATORY *MANDATORY FOR ACCEPTANCE FOR LABORATORY ANALYSIS
**MANDATORY FOR STORAGE IN WATSTORE/NWIS

[a]Add all P codes noted to form and to QADATA record for this sample.

[b]Add labcodes for arsenic (LC0112) and selenium (LC0087).

[c]Include priority comments; note that SC value is not given under the P code (this is blank water). Specify bottle code originally found on bottle as received from BTD&QS.

[d]Recommend sample be shipped surface mail with other primary inorganic samples (fig. A10-B).

[e]Only the FA sample bottle is required if the Study Unit acidifies sample and provides the SC comment.

Figure A19. Example of an analytical service request form for a standard-reference trace-element (SC2703) sample for ground water.

LOGIN REPLY SHEET

Date Mailed: ____________________ Person sending shipment: ________________________

Place from which shipment was mailed: ______________________________________

Shipped via: ____

Type of Sample (circle one): ORG NUT PEST VOC RADON INORG

Station Numbers of Samples in This Shipment

_______________________________________ _____________________________________

_______________________________________ _____________________________________

_______________________________________ _____________________________________

_______________________________________ _____________________________________

_______________________________________ _____________________________________

LOGIN STAFF:

Please enter the following information on this form and mail the form back to us with the attached self-addressed, franked envelope. Note that there is an 8-ounce bottle of tap water in this shipment marked “TEMPERATURE” for use in measuring water temperature.

Person logging in shipment: ____

Date Shipment Arrived:

Water Temperature:

Comments (if applicable):

If you have any questions about this shipment, please contact:

Name: _____________________________________

Telephone: ( ) __________ - _______________

E-mail or Internet: _________________________________

Thank You For Your Participation in This Quality Assurance Program.

Figure A20. Example of Study Unit login reply form sent with samples shipped by overnight mail.

Errata for Open-File Report 95-399

Corrections are by Michael Koterba; January 24, 1996

Page 16, Table 3, Footnote 21, Item (1)--**change from**:

"For assistance with (1) isotope, radiochemical, and other specialized equipment, contact the NAWQA Quality Assurance Specialist;"

to:

"For assistance with (1) deuterium-oxygen isotopes, and quality-assured sample bottles and caps for these isotopes, contact Tyler Coplen, Isotope Fractionation, USGS National Research Program, MS 431, Reston, Va. (via isotopes@usgs.gov); for assistance with tritium isotopes, and quality-assured sample bottles and caps for these isotopes, contact Robert Michel, Isotope Tracers, MS 434, USGS National Research Program, Menlo Park, Calif. (via tritium@mailrcamnl.wr.usgs.gov);"

Page 66, Table 21, 3. Other Samples--Columns for Tritium isotopes and Deuterium-Oxygen isotopes **change from**:

Team Member A

Sample type (SC, LC) and order of collection	Collect, by filling	Quality-assurance checks or measures
• Tritium isotopes	1, 1.0-L, clear, prerinsed poly bottle, filled to top after 3, 25-mL rinses (include cap with conical insert)	Verify DIW is still in bottle from office prerinse before use, otherwise replace bottle. Leave no headspace in bottle
• Deuterium-Oxygen isotopes	1, 125-ml, glass, amber bottle to top after 3, 25-ml rinses (include cap with conical insert)	Leave no headspace in bottle

to:

Team Member A

Sample type (SC, LC) and order of collection	Collect, by filling	Quality-assurance checks or measures
• Tritium isotopes	1, 1.0-L, dry, high-density-poly (preferred) or glass bottle, without prerinsing, until it overflows, and seal with a cap with conical insert	To reduce breakage of glass bottles caused by samples freezing during shipment, pour out sample until the water level is at the bottle shoulder seam.
• Deuterium-Oxygen isotopes	1, 60-mL, dry, clear, glass (preferred) or poly bottle, without prerinsing, until it overflows, and seal with a cap with conical insert	To reduce breakage of glass bottles caused by samples freezing during shipment, pour out sample until the water level is at the bottle shoulder seam. Samples collected in poly bottles are sent immediately for analysis, and are unsuitable for archiving.

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Chapter 5 Appendix

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Chapter 5
Appendix A

Hydrographs Showing Minimum Thresholds, Measurable Objectives and Interim Milestones

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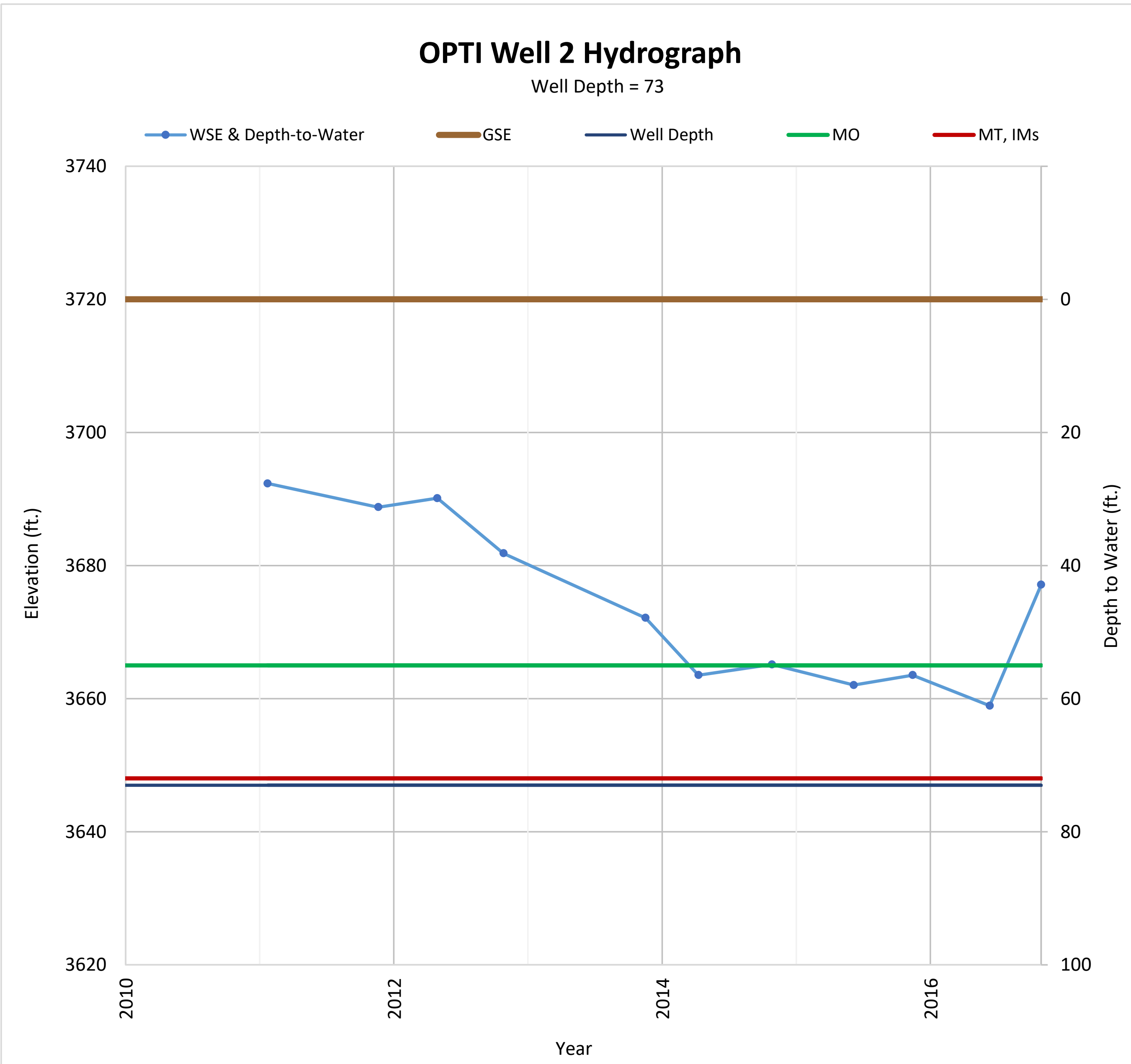
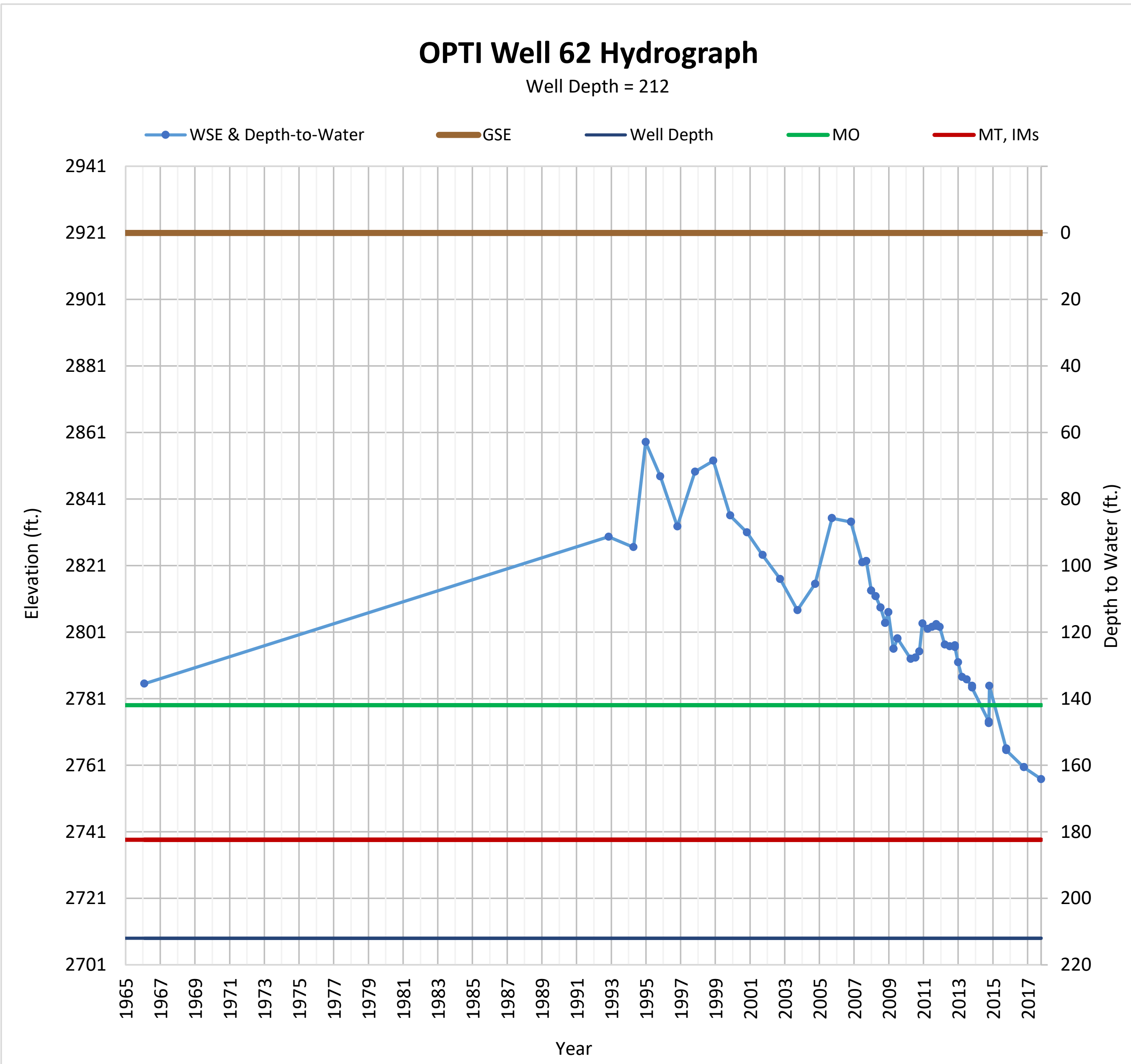
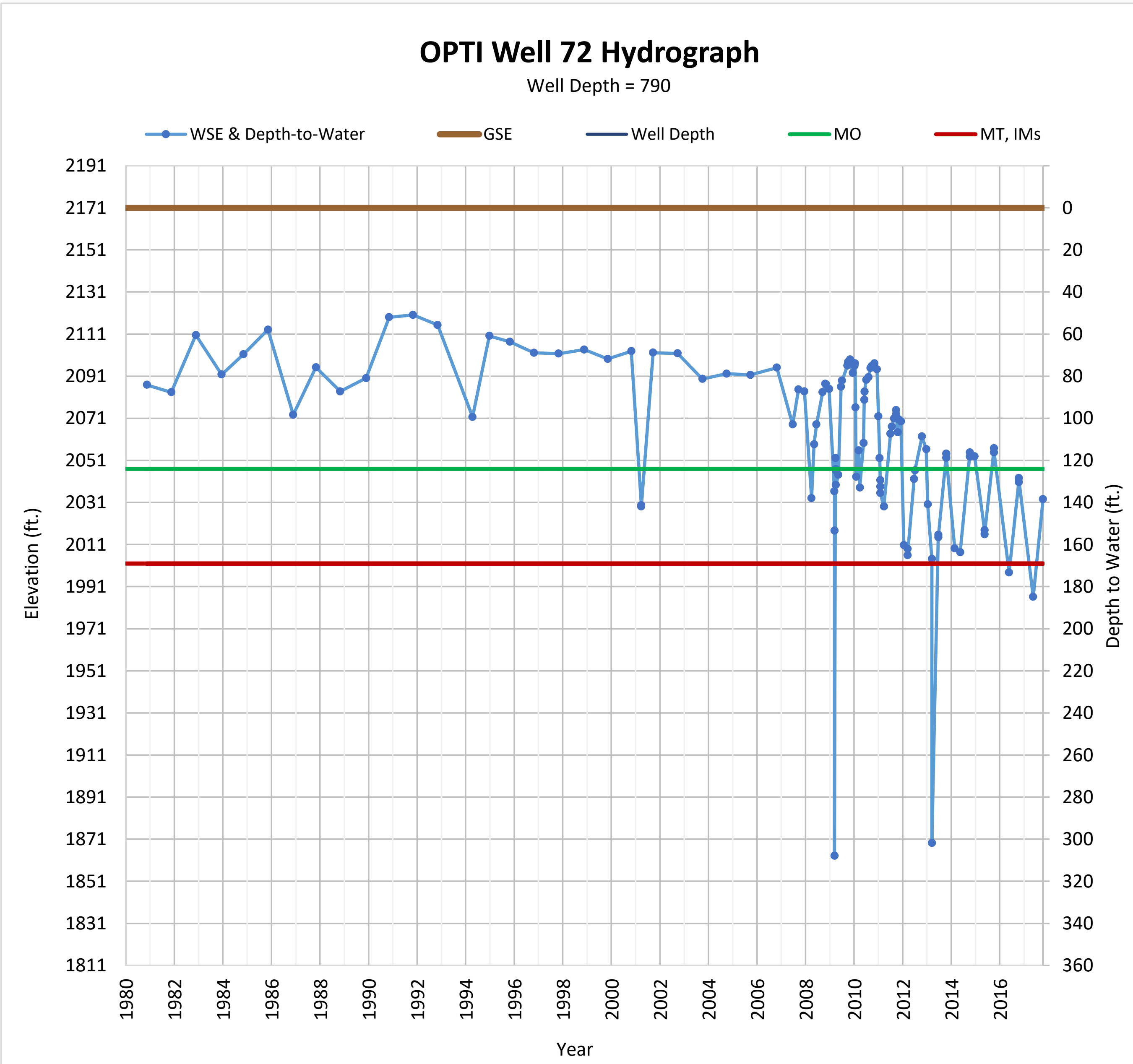
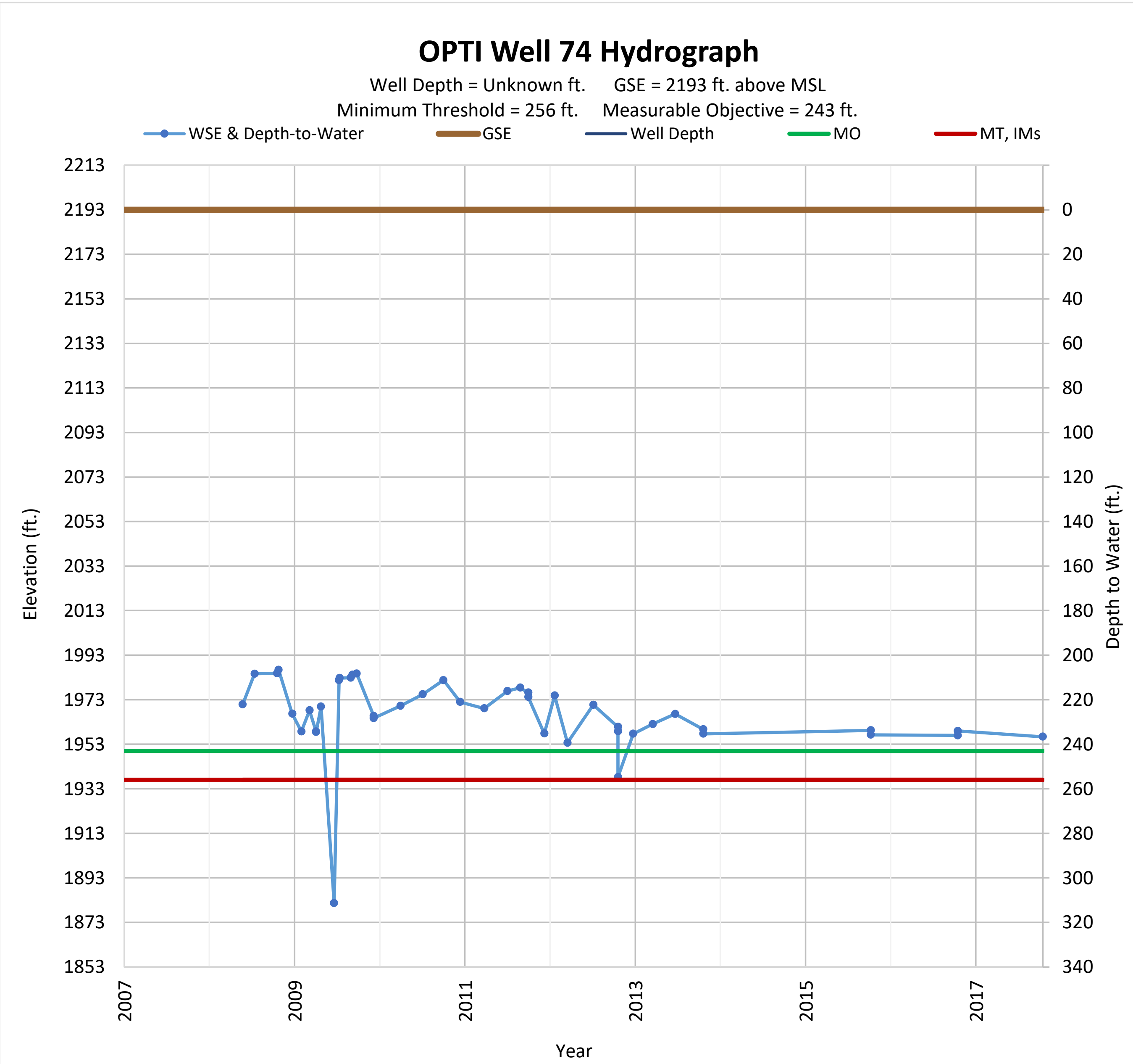
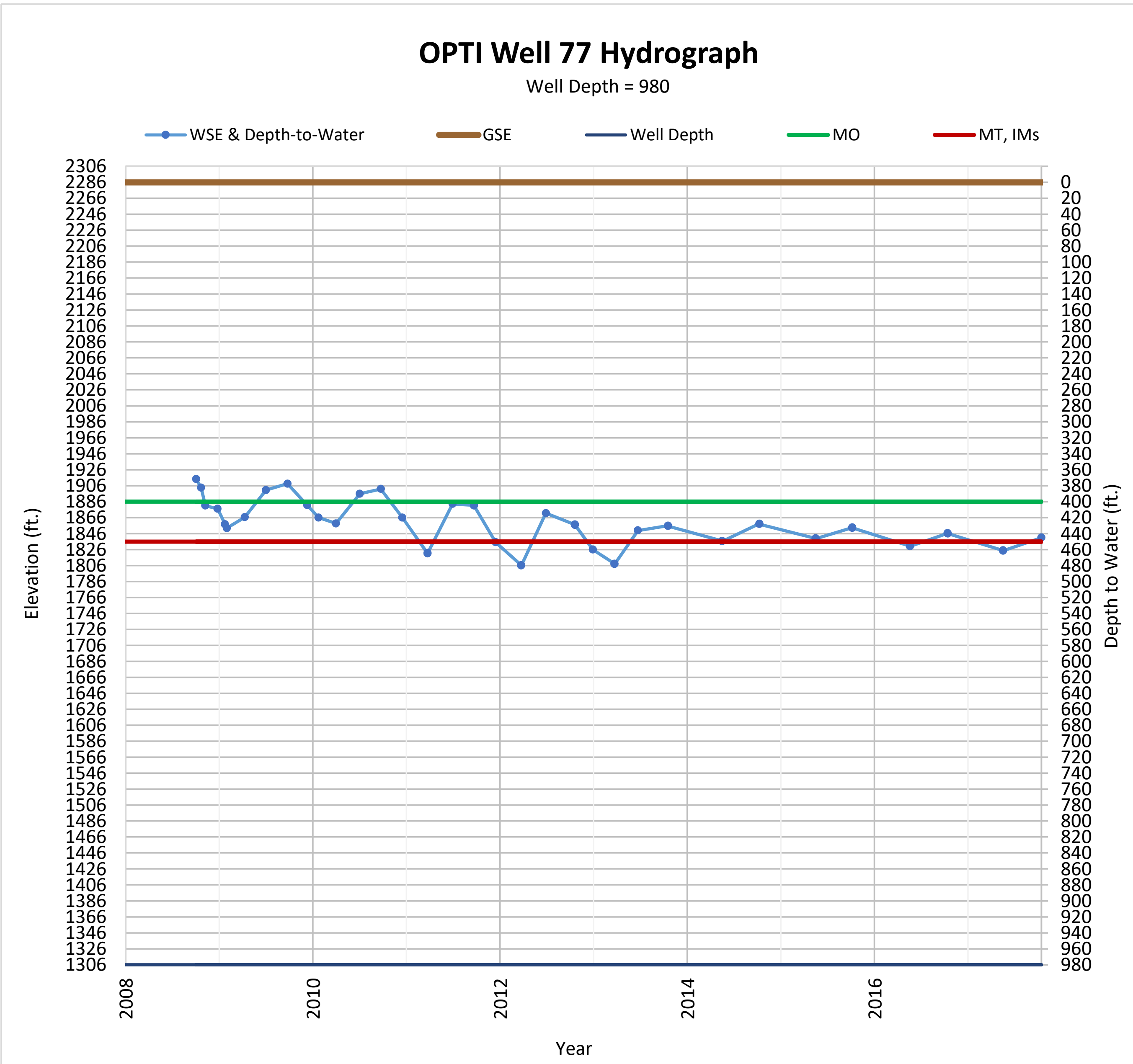

OPTI Well 2 Hydrograph
Well Depth = 73
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
3740
3720
3700
3680
3660
3640
3620
0
20
40
60
80
100
Elevation (ft.)
Depth to Water (ft.)
2010
2012
2014
2016
Year

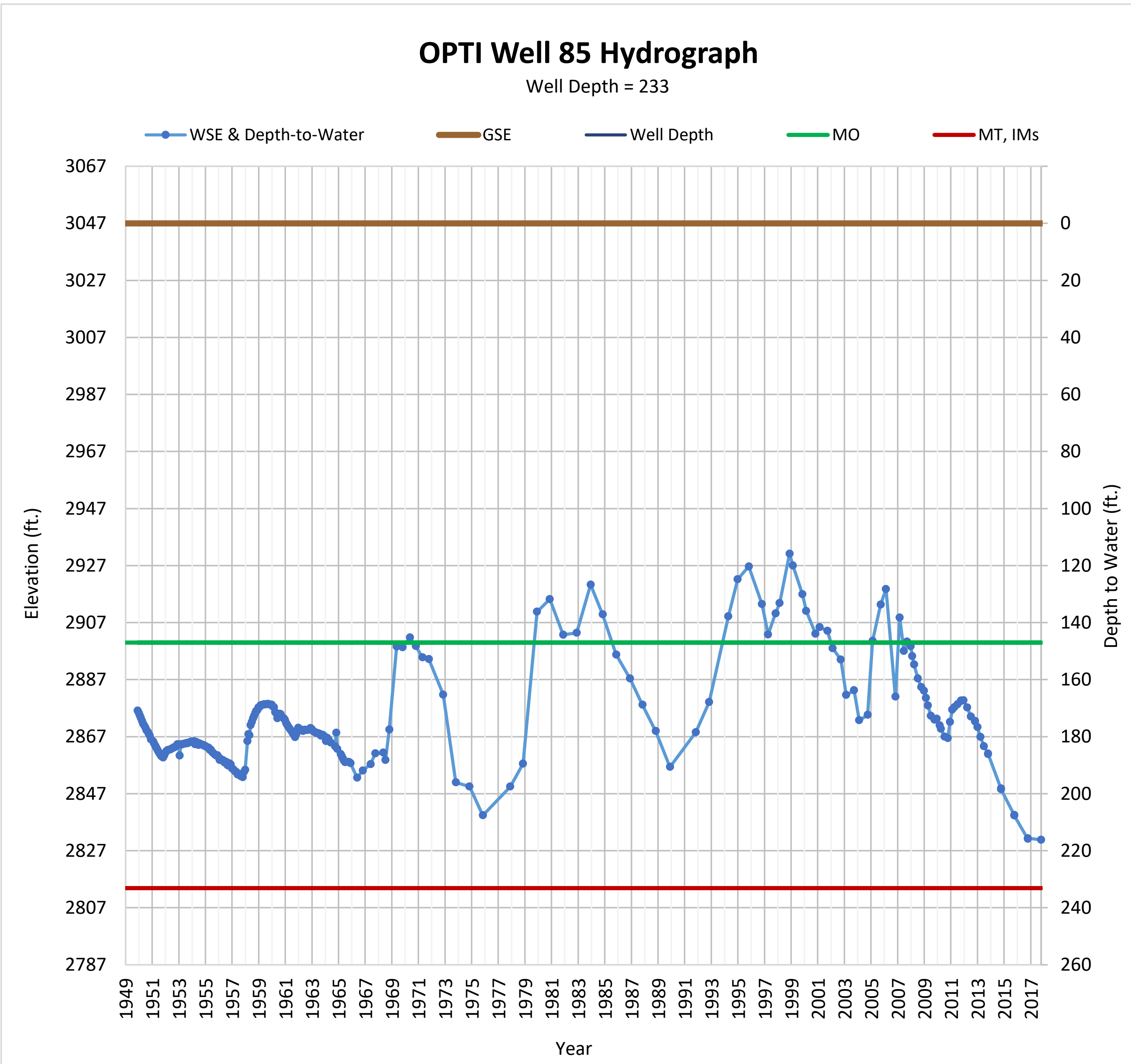


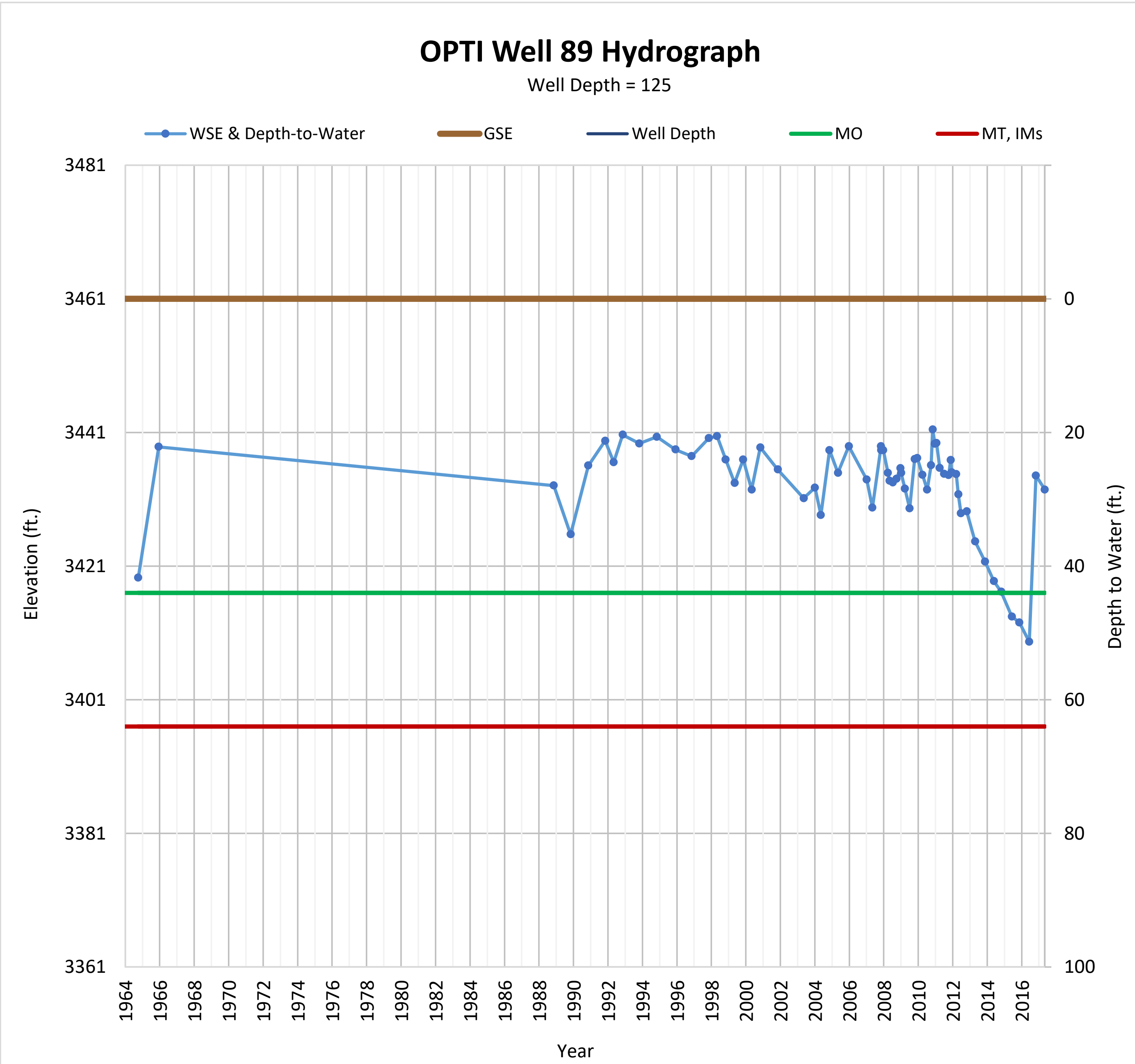
OPTI Well 62 Hydrograph
Well Depth = 212
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2941
2921
2901
2881
2861
2841
2821
2801
2781
2761
2741
2721
2701
0
20
40
60
80
100
120
140
160
180
200
220
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017

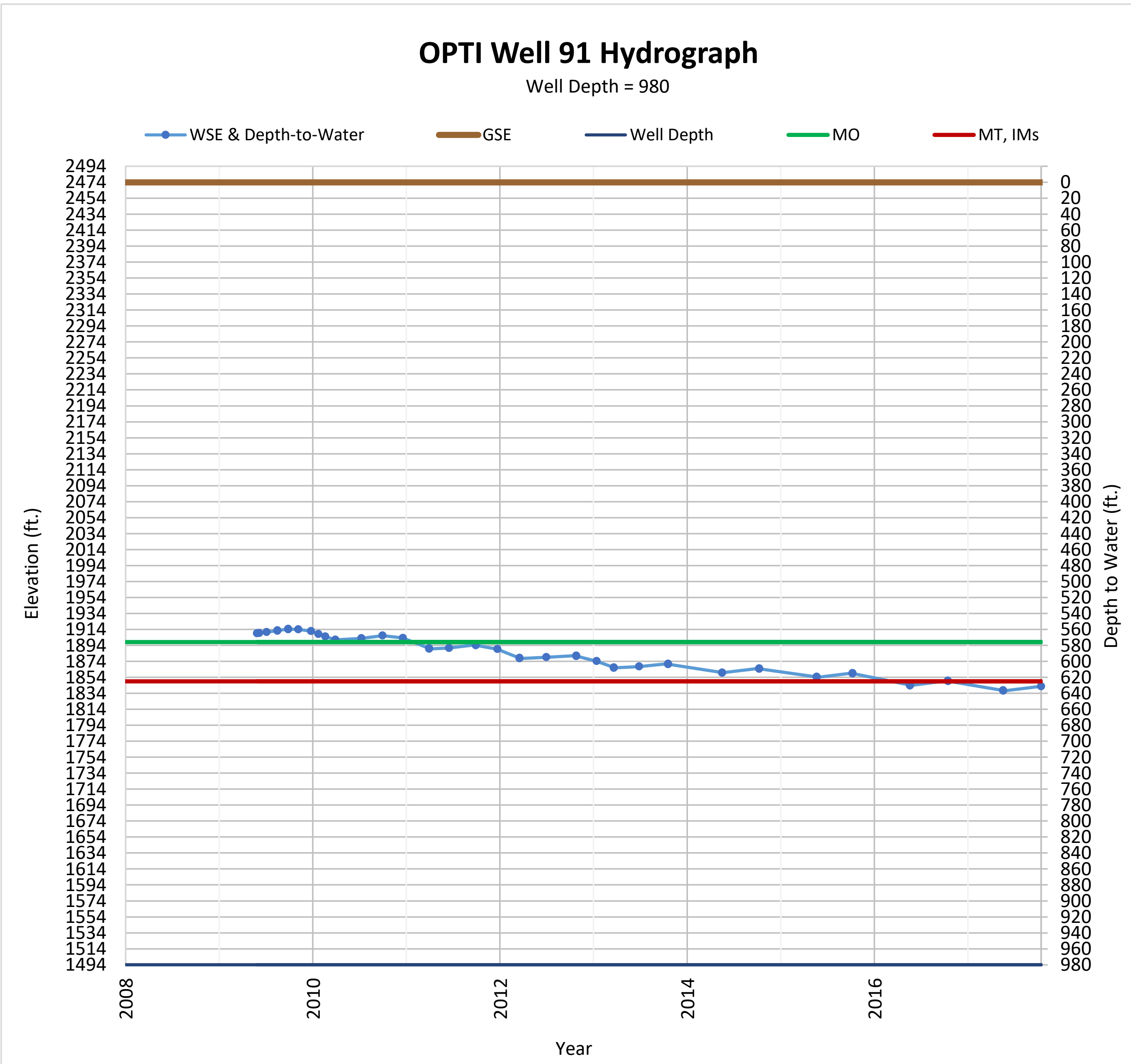

OPTI Well 72 Hydrograph
Well Depth = 790
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2191
2171
2151
2131
2111
2091
2071
2051
2031
2011
1991
1971
1951
1931
1911
1891
1871
1851
1831
1811
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


OPTI Well 74 Hydrograph
Well Depth = Unknown ft.
GSE = 2193 ft. above MSL
Minimum Threshold = 256 ft.
Measurable Objective = 243 ft.
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
2213
2193
2173
2153
2133
2113
2093
2073
2053
2033
2013
1993
1973
1953
1933
1913
1893
1873
1853
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
2007
2009
2011
2013
2015
2017
Year

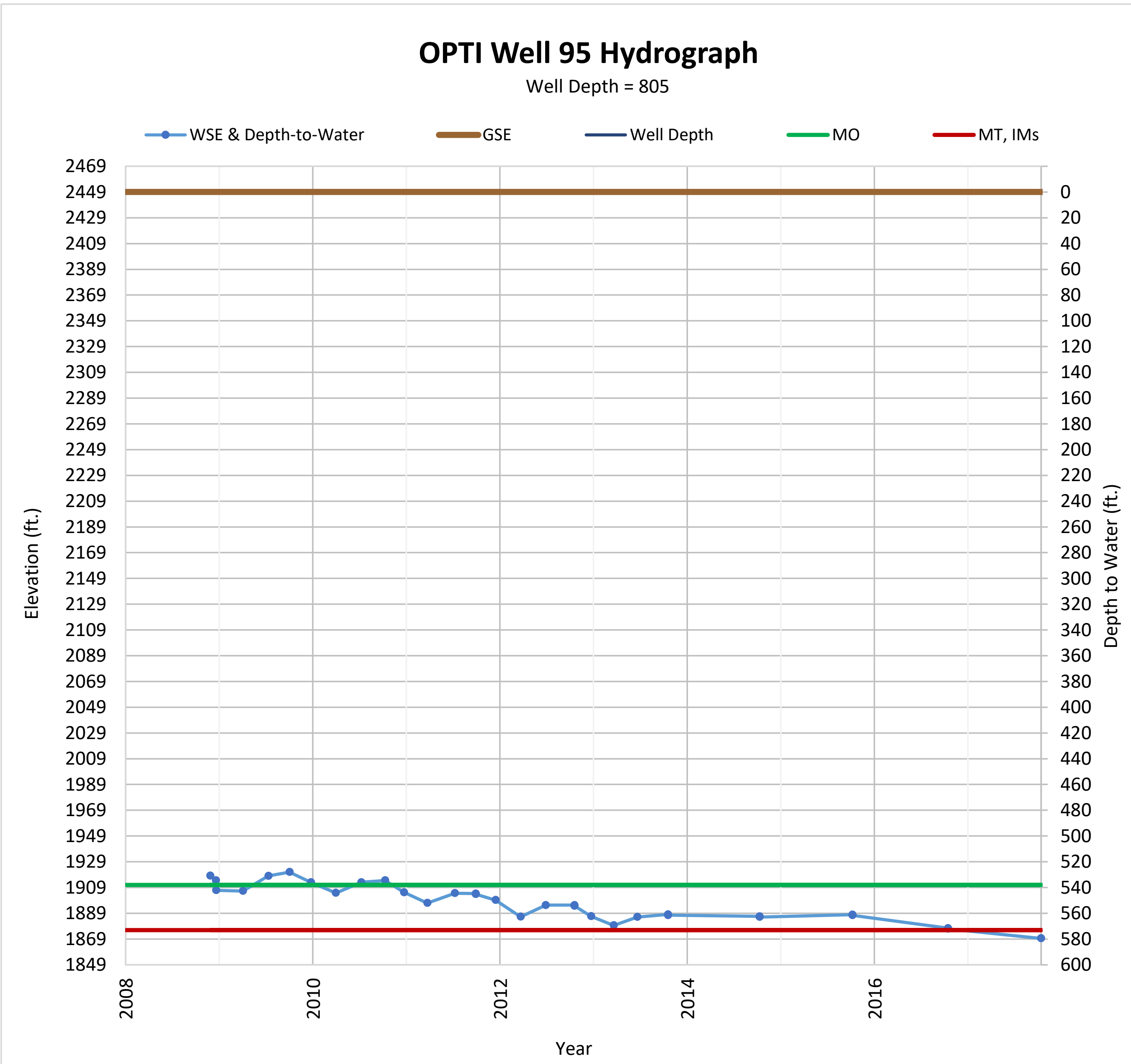

OPTI Well 77 Hydrograph
Well Depth = 980
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2008
2010
2012
2014
2016

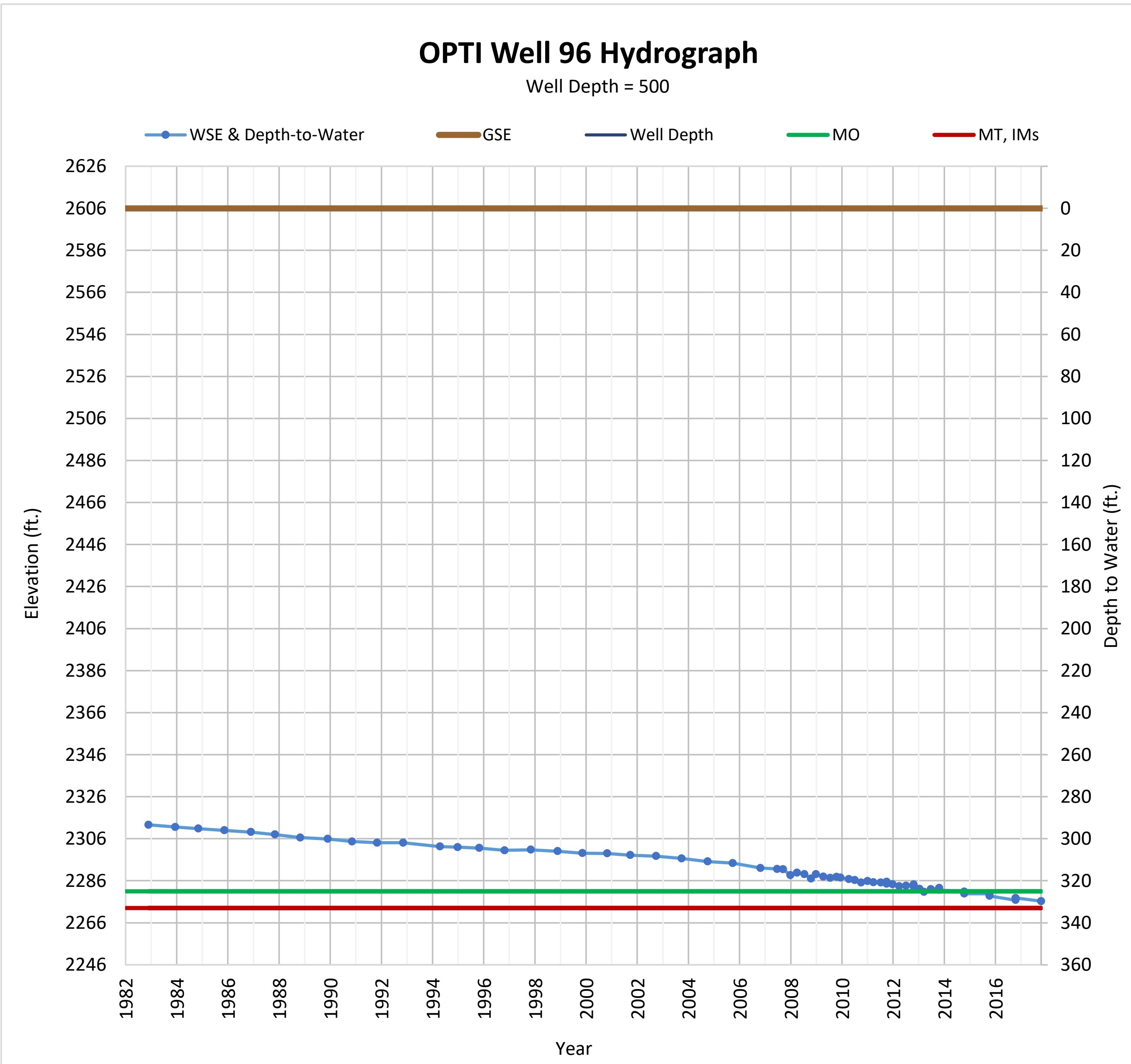

OPTI Well 85 Hydrograph
Well Depth = 233
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
3067
3047
3027
3007
2987
2967
2947
2927
2907
2887
2867
2847
2827
2807
2787
0
20
40
60
80
100
120
140
160
180
200
220
240
260
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017

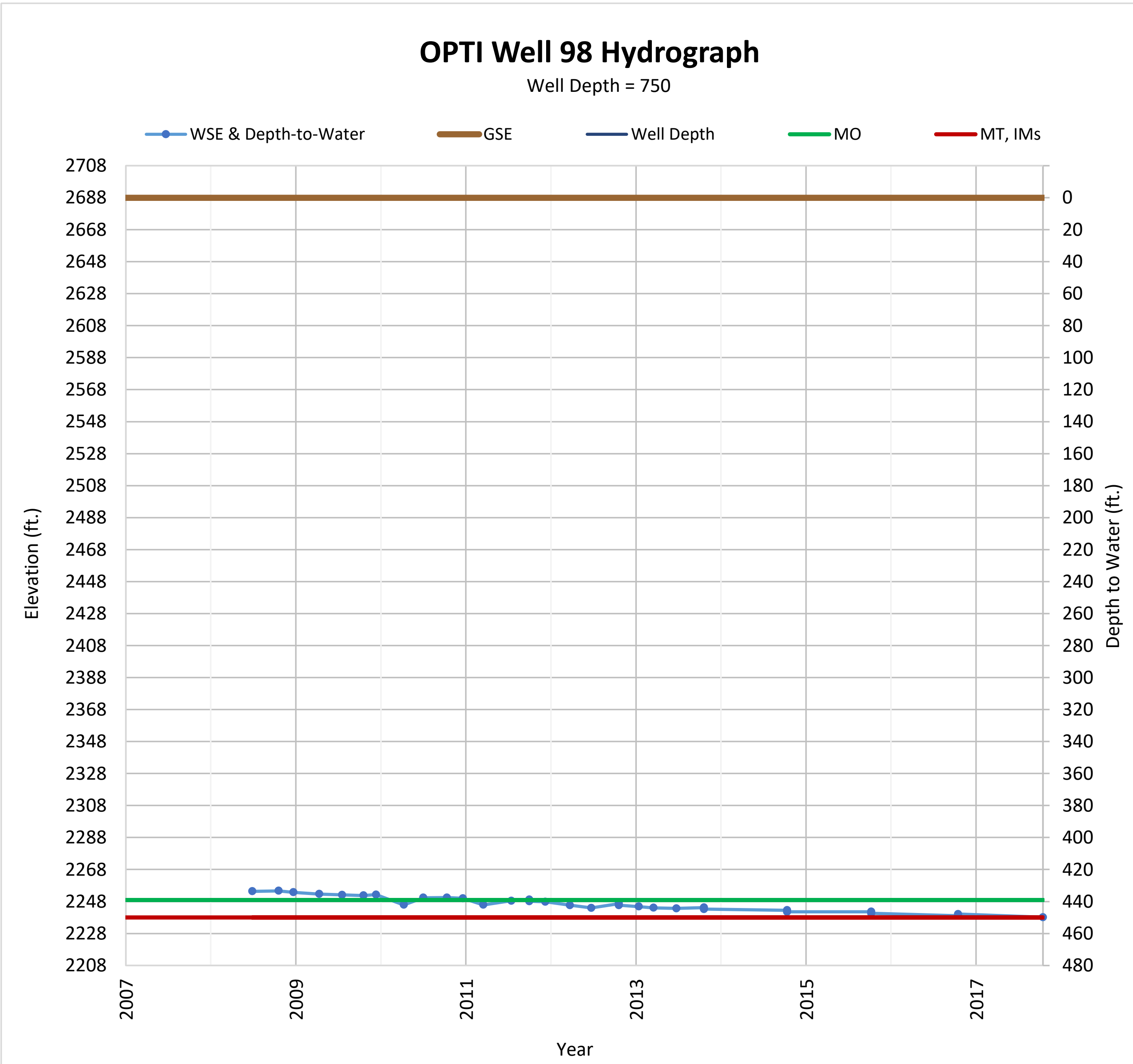

OPTI Well 89 Hydrograph
Well Depth = 125
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
3481
3461
3441
3421
3401
3381
3361
0
20
40
60
80
100
Elevation (ft.)
Depth to Water (ft.)
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year



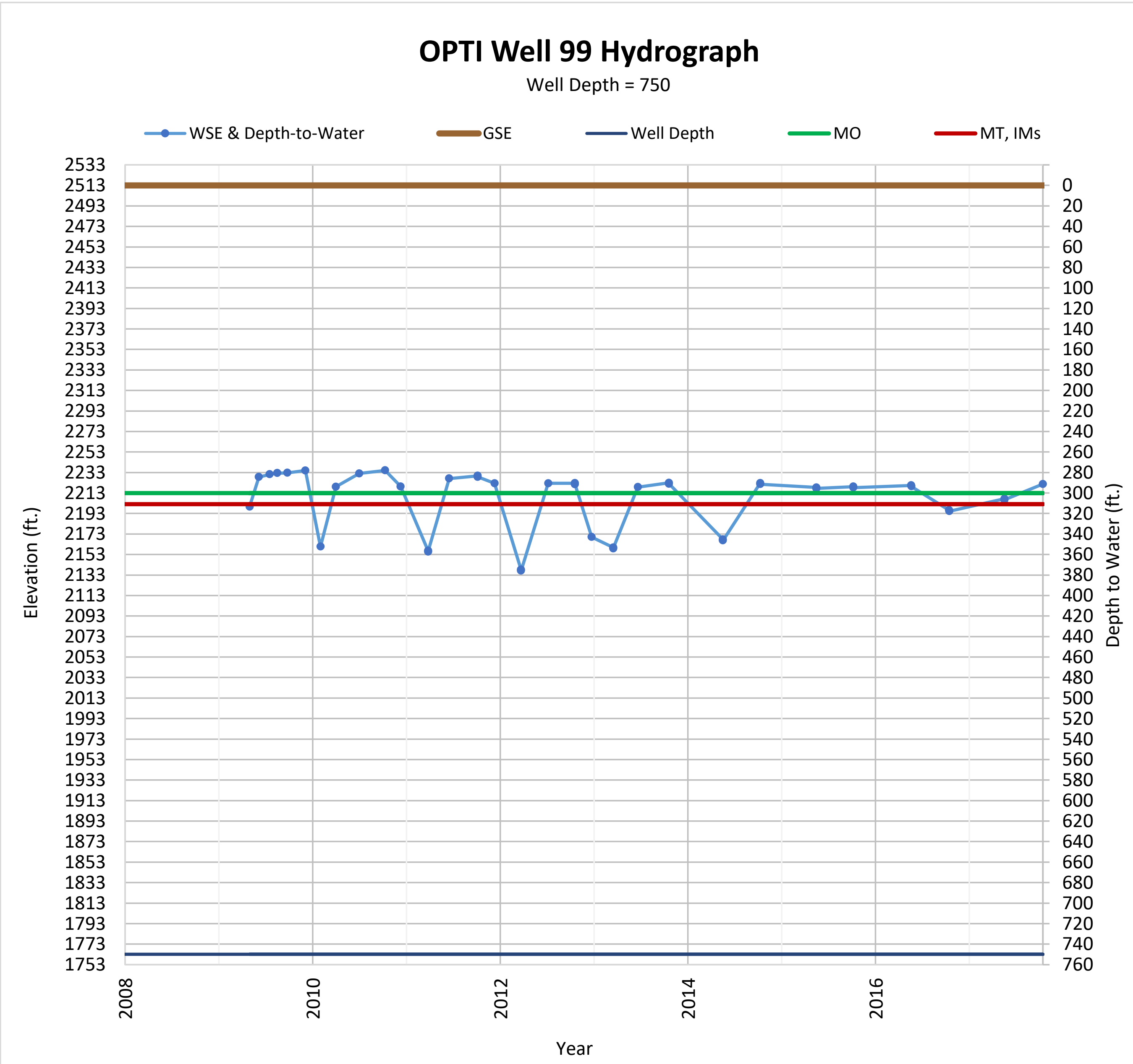
OPTI Well 91 Hydrograph
Well Depth = 980
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2008
2010
2012
2014
2016

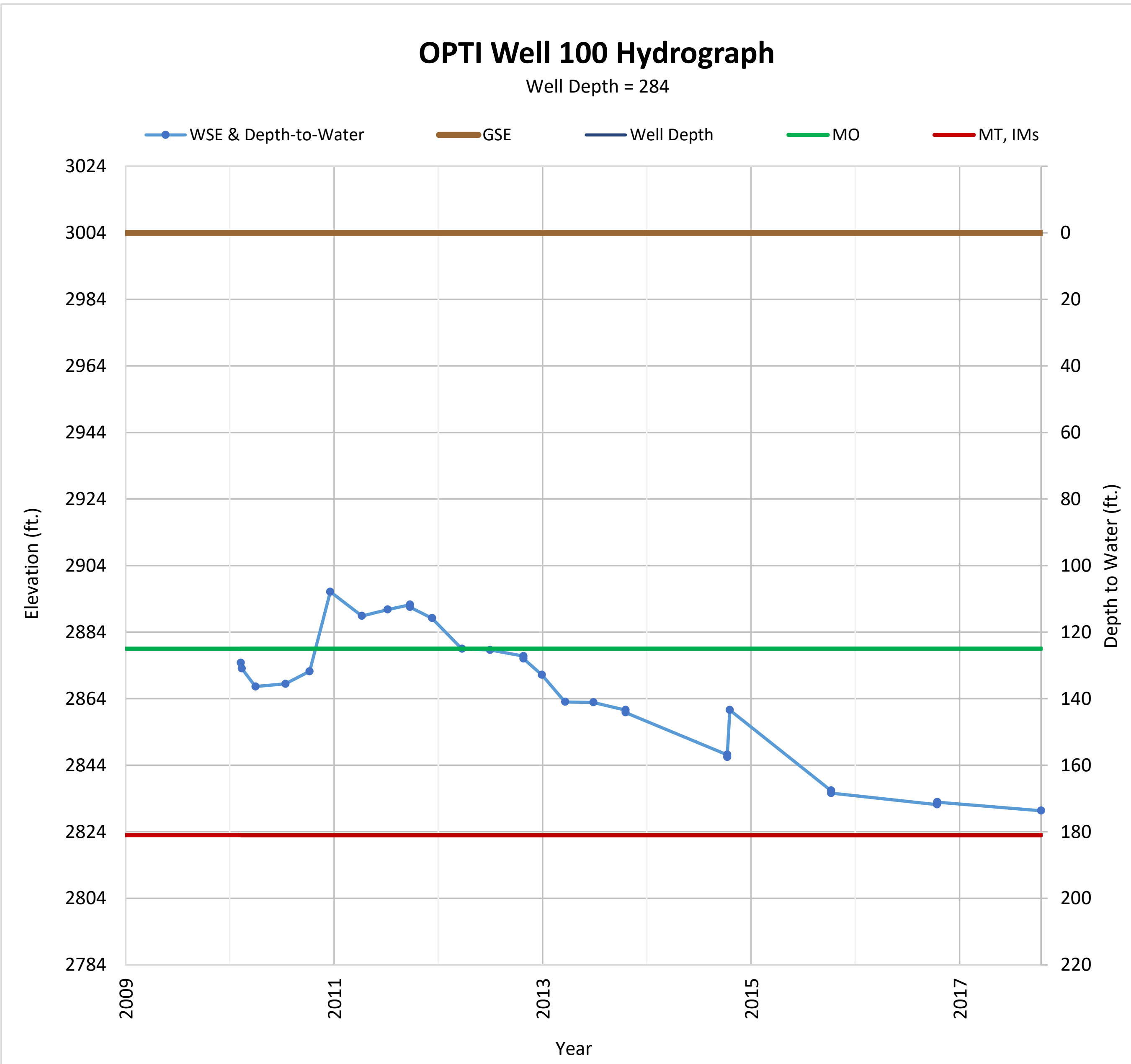

OPTI Well 95 Hydrograph
Well Depth = 805
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2469
2449
2429
2409
2389
2369
2349
2329
2309
2289
2269
2249
2229
2209
2189
2169
2149
2129
2109
2089
2069
2049
2029
2009
1989
1969
1949
1929
1909
1889
1869
1849
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
2008
2010
2012
2014
2016

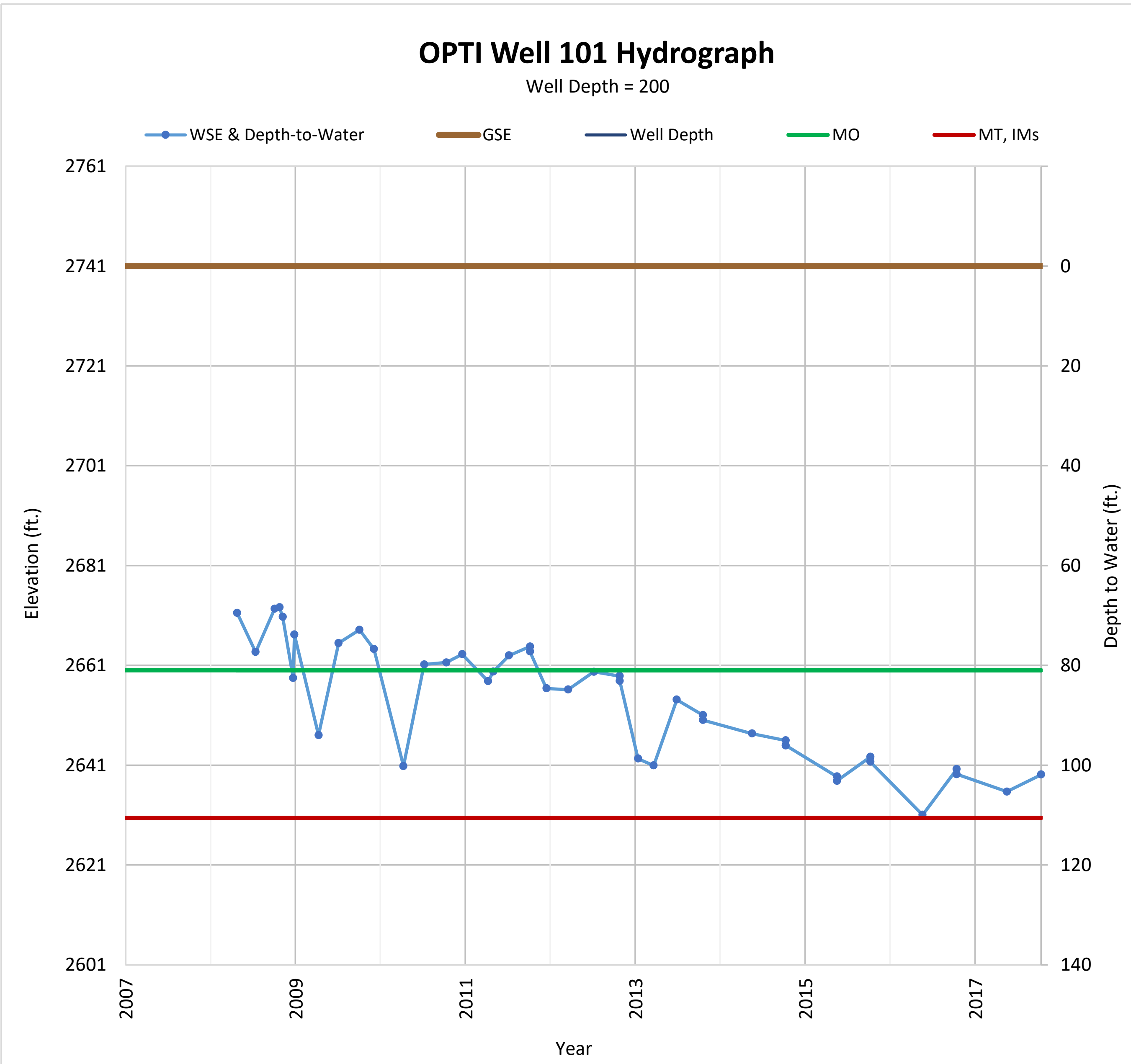

OPTI Well 96 Hydrograph
Well Depth = 500
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2626
2606
2586
2566
2546
2526
2506
2486
2466
2446
2426
2406
2386
2366
2346
2326
2306
2286
2266
2246
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

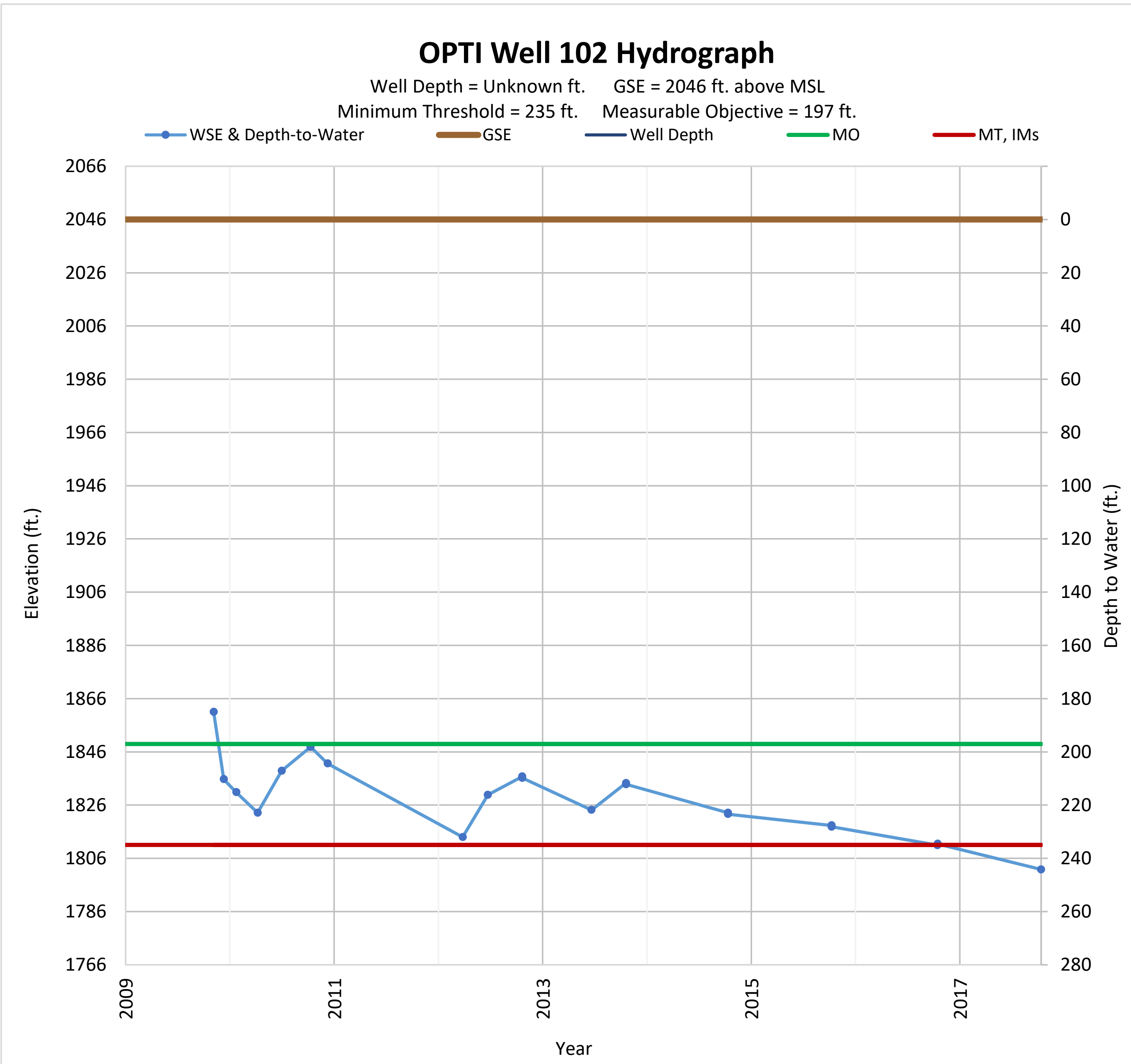


OPTI Well 98 Hydrograph
Well Depth = 750
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2708
2688
2668
2648
2628
2608
2588
2568
2548
2528
2508
2488
2468
2448
2428
2408
2388
2368
2348
2328
2308
2288
2268
2248
2228
2208
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
2007
2009
2011
2013
2015
2017

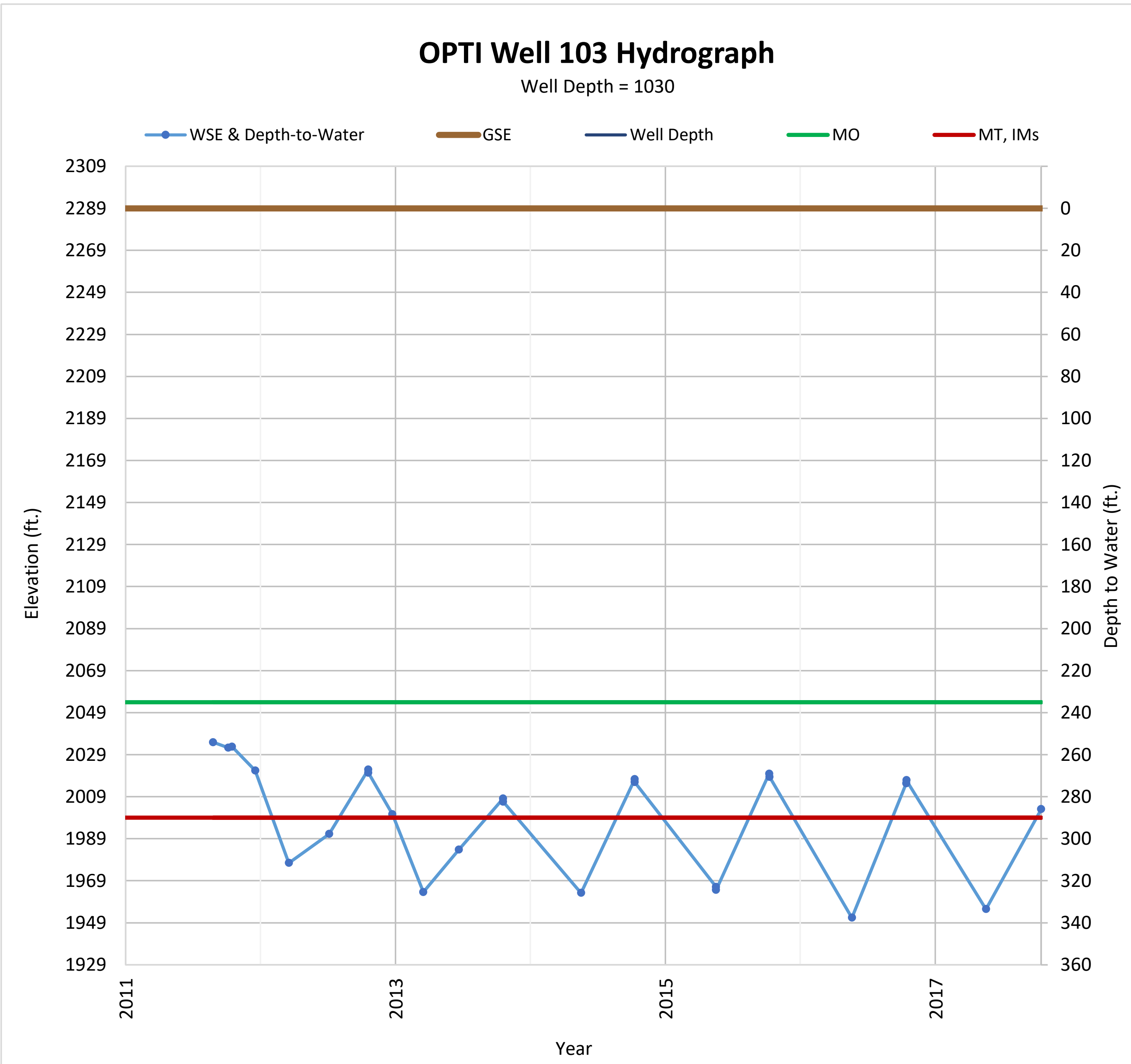

OPTI Well 99 Hydrograph
Well Depth = 750
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2008
2010
2012
2014
2016

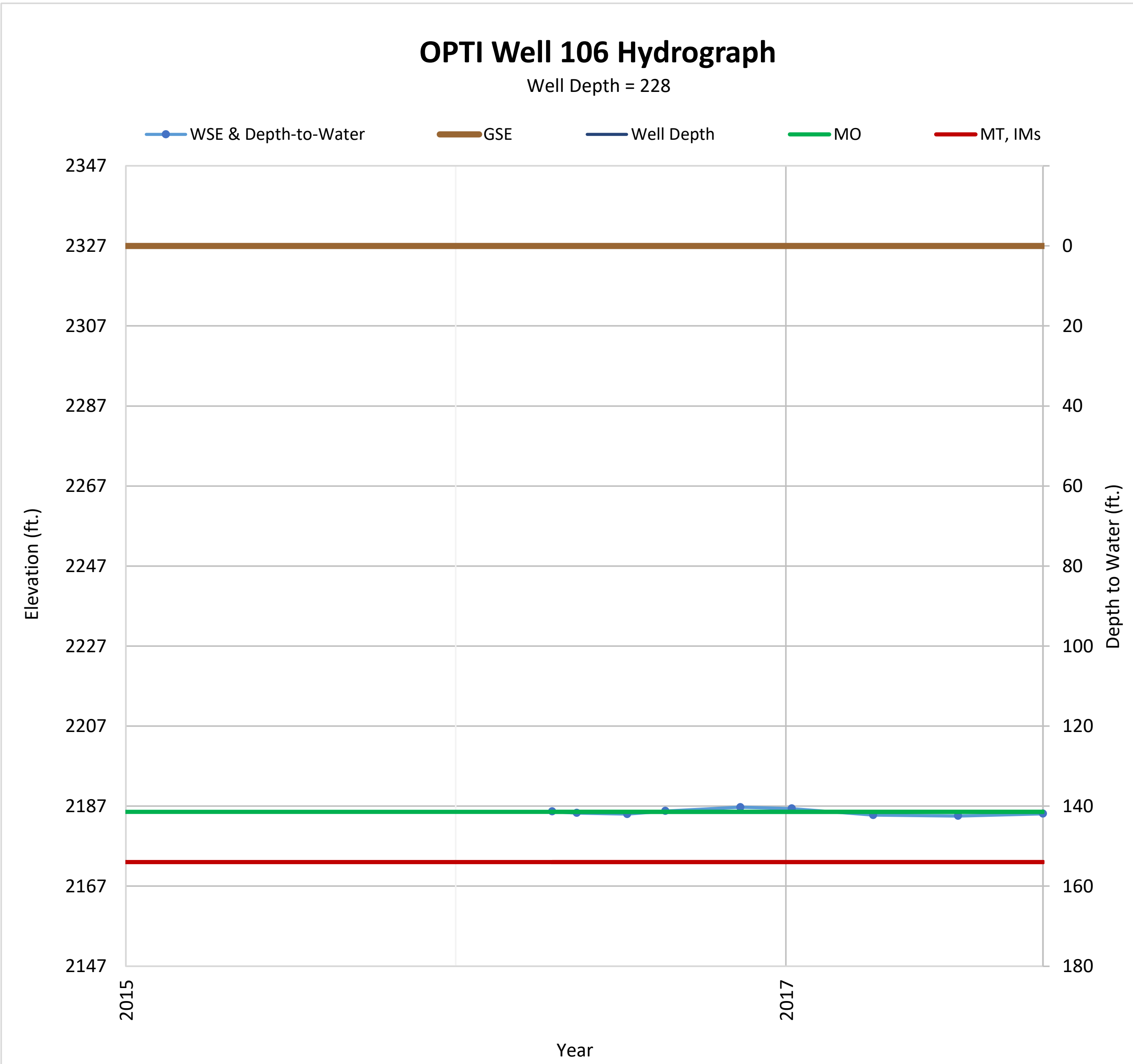

OPTI Well 100 Hydrograph
Well Depth = 284
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
3024
3004
2984
2964
2944
2924
2904
2884
2864
2844
2824
2804
2784
0
20
40
60
80
100
120
140
160
180
200
220
2009
2011
2013
2015
2017
Year

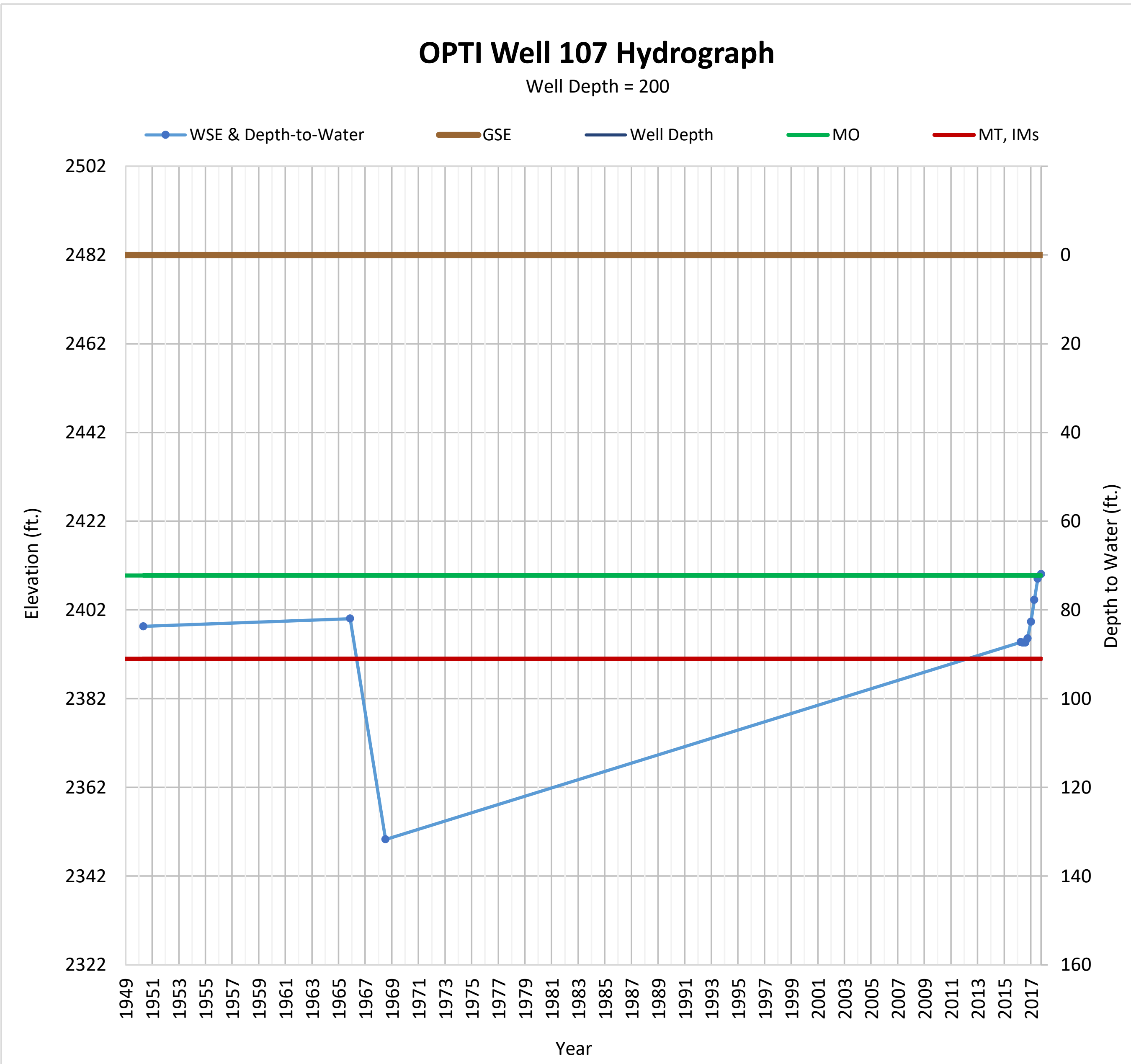

OPTI Well 101 Hydrograph
Well Depth = 200
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
2761
2741
2721
2701
2681
2661
2641
2621
2601
0
20
40
60
80
100
120
140
2007
2009
2011
2013
2015
2017
Year



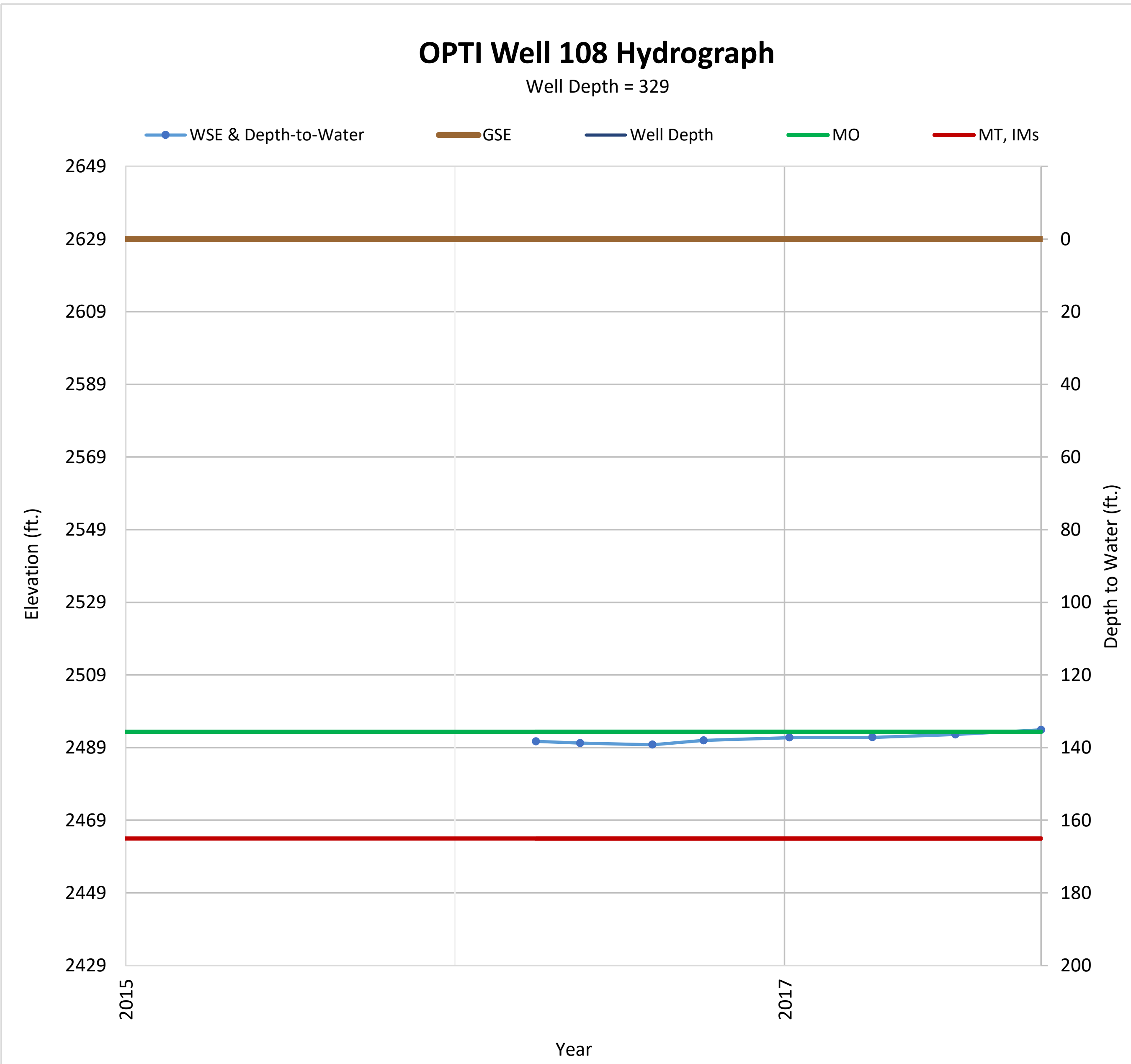
OPTI Well 102 Hydrograph
Well Depth = Unknown ft.   GSE = 2046 ft. above MSL
Minimum Threshold = 235 ft.   Measurable Objective = 197 ft.
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
1786
1766
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
2009
2011
2013
2015
2017

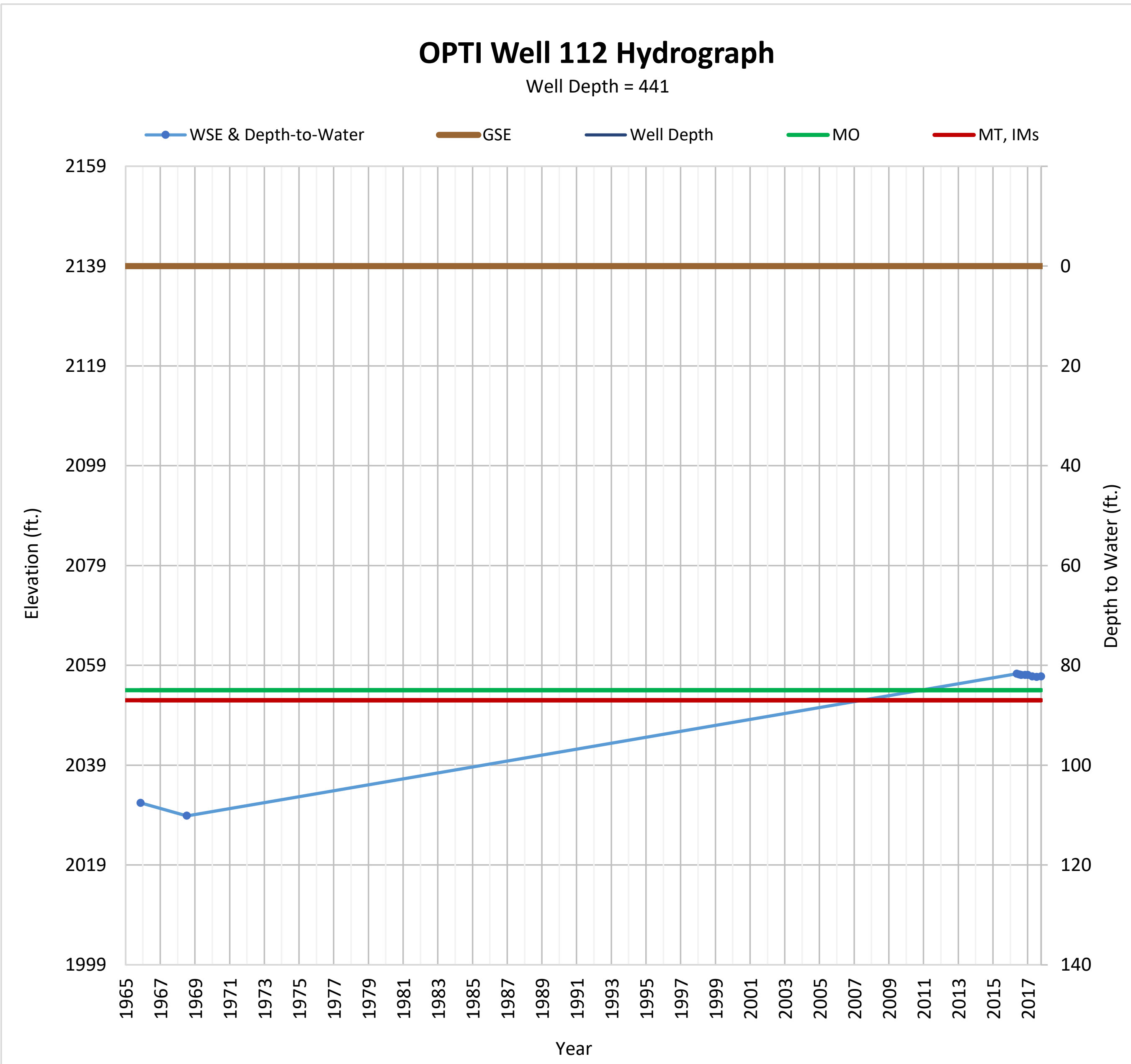

OPTI Well 103 Hydrograph
Well Depth = 1030
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2309
2289
2269
2249
2229
2209
2189
2169
2149
2129
2109
2089
2069
2049
2029
2009
1989
1969
1949
1929
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
2011
2013
2015
2017
Year


OPTI Well 106 Hydrograph
Well Depth = 228
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2347
2327
2307
2287
2267
2247
2227
2207
2187
2167
2147
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
2015
2017
Year



OPTI Well 107 Hydrograph
Well Depth = 200
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2502
2482
2462
2442
2422
2402
2382
2362
2342
2322
0
20
40
60
80
100
120
140
160
1949 1951 1953 1955 1957 1959 1961 1963 1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015 2017


OPTI Well 108 Hydrograph
Well Depth = 329
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
2649
2629
2609
2589
2569
2549
2529
2509
2489
2469
2449
2429
0
20
40
60
80
100
120
140
160
180
200
2015
2017
Year



OPTI Well 112 Hydrograph
Well Depth = 441
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2159
2139
2119
2099
2079
2059
2039
2019
1999
0
20
40
60
80
100
120
140
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
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1997
1999
2001
2003
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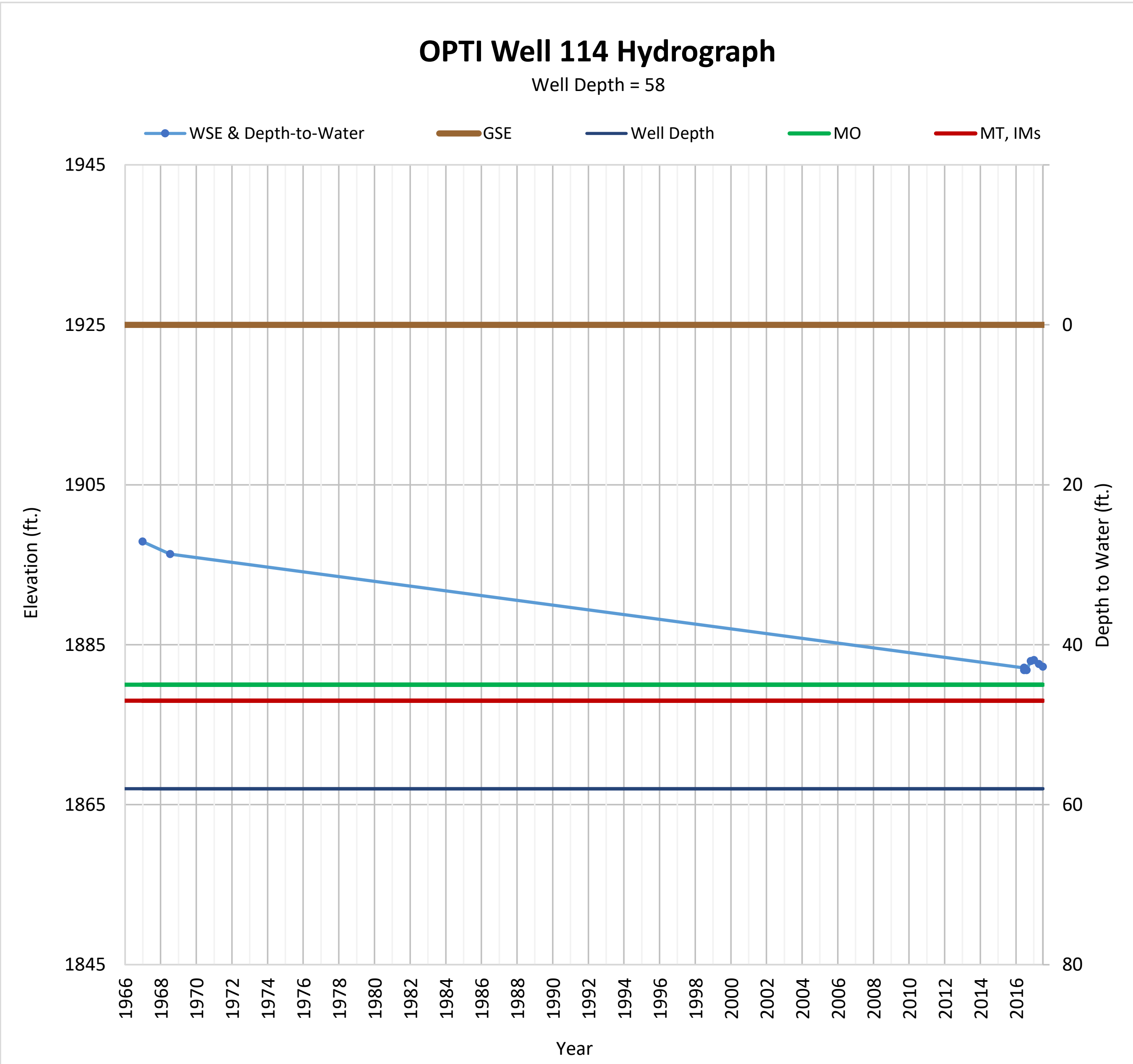
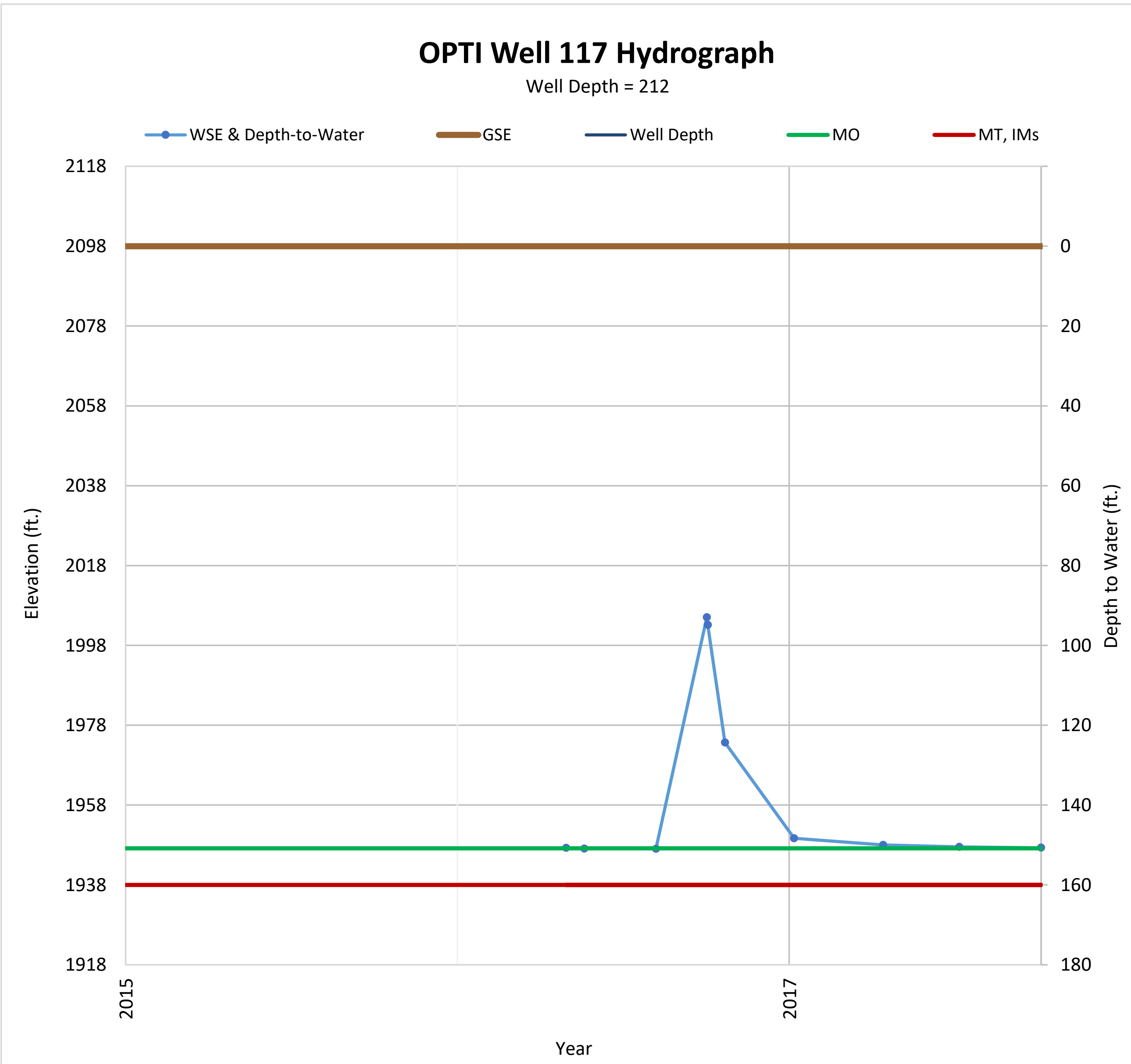
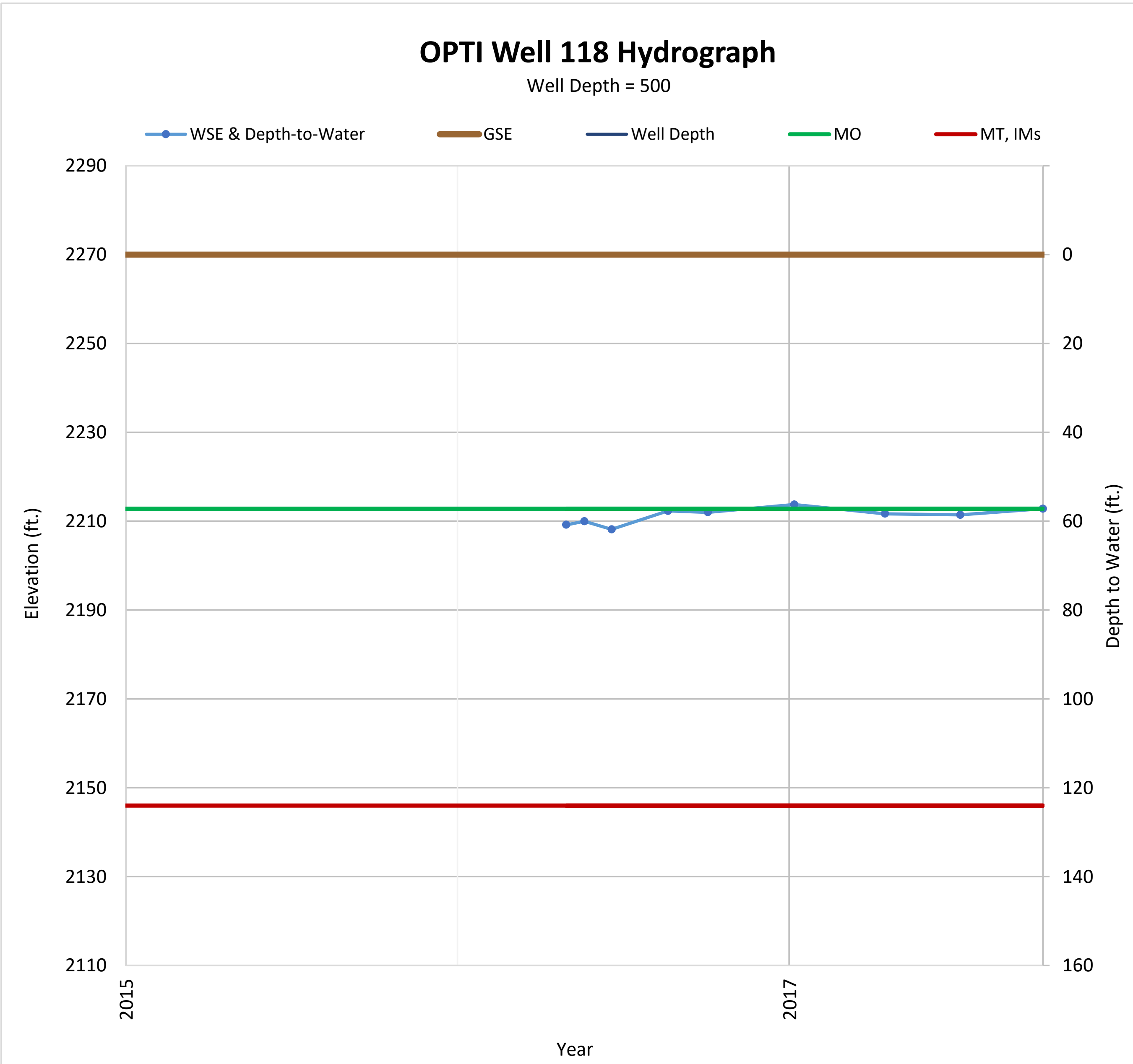
2007
2009
2011
2013
2015
2017



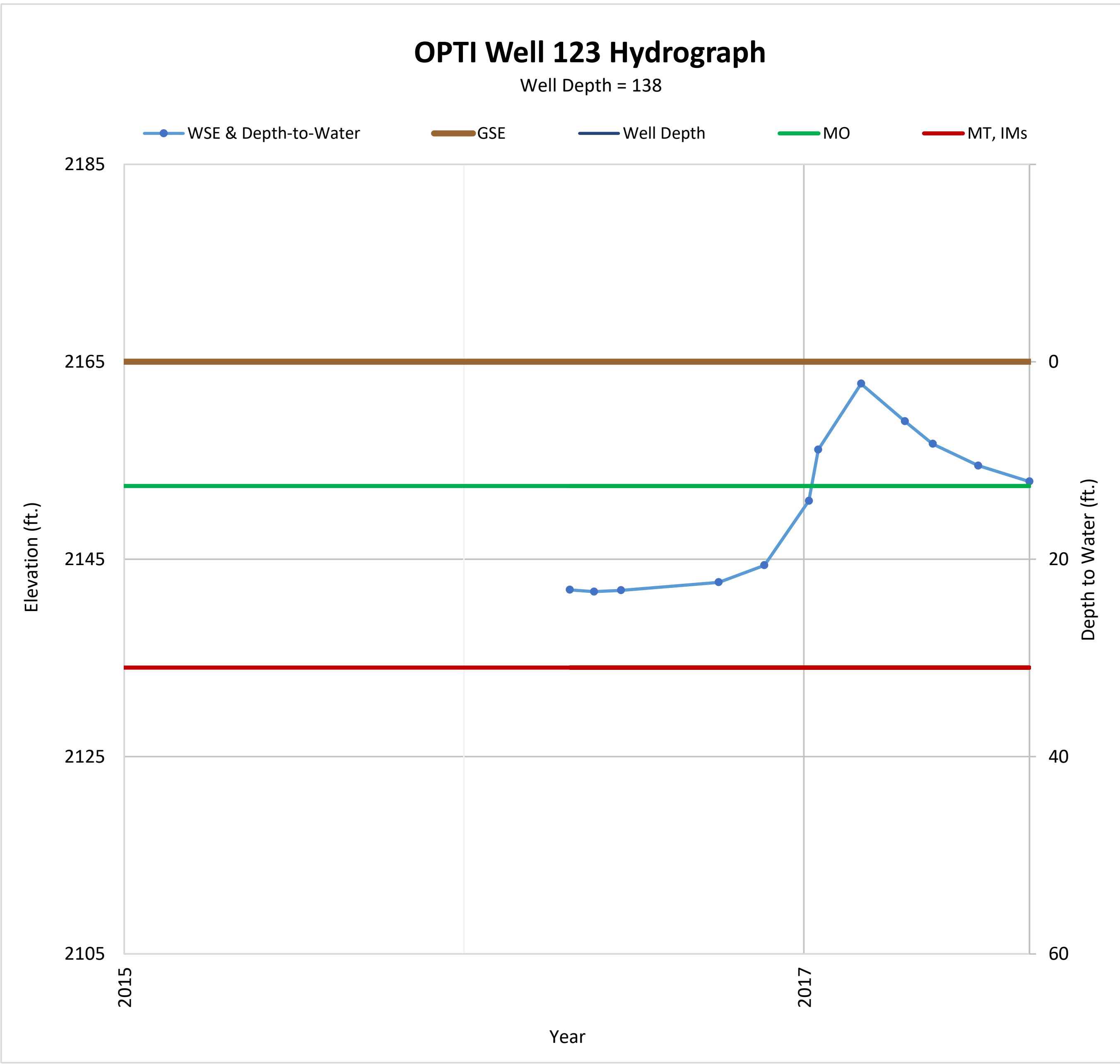
OPTI Well 114 Hydrograph
Well Depth = 58
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1945
1925
1905
1885
1865
1845
0
20
40
60
80
Elevation (ft.)
Depth to Water (ft.)
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year



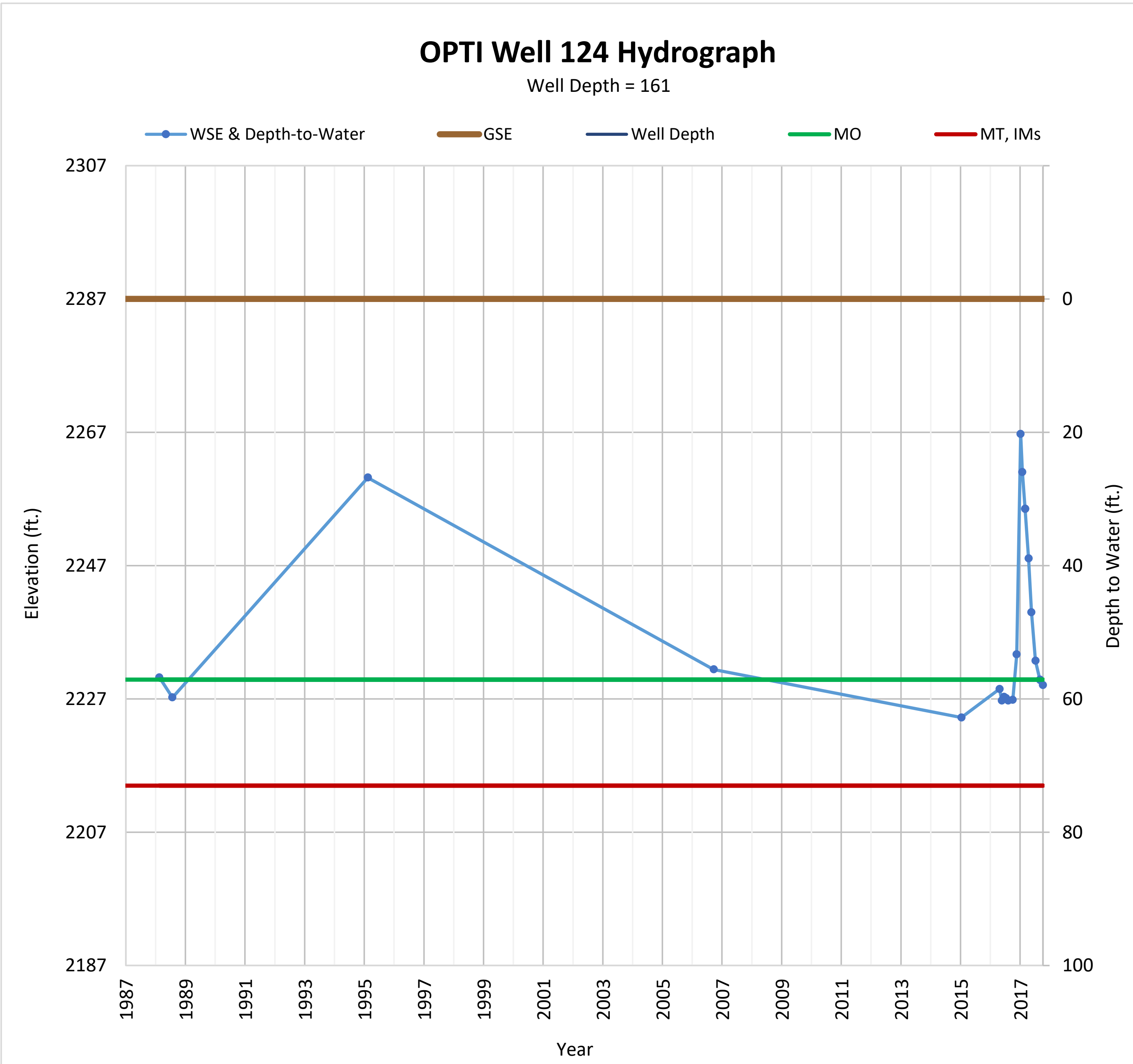
OPTI Well 117 Hydrograph
Well Depth = 212
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
2118
2098
2078
2058
2038
2018
1998
1978
1958
1938
1918
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
2015
2017
Year



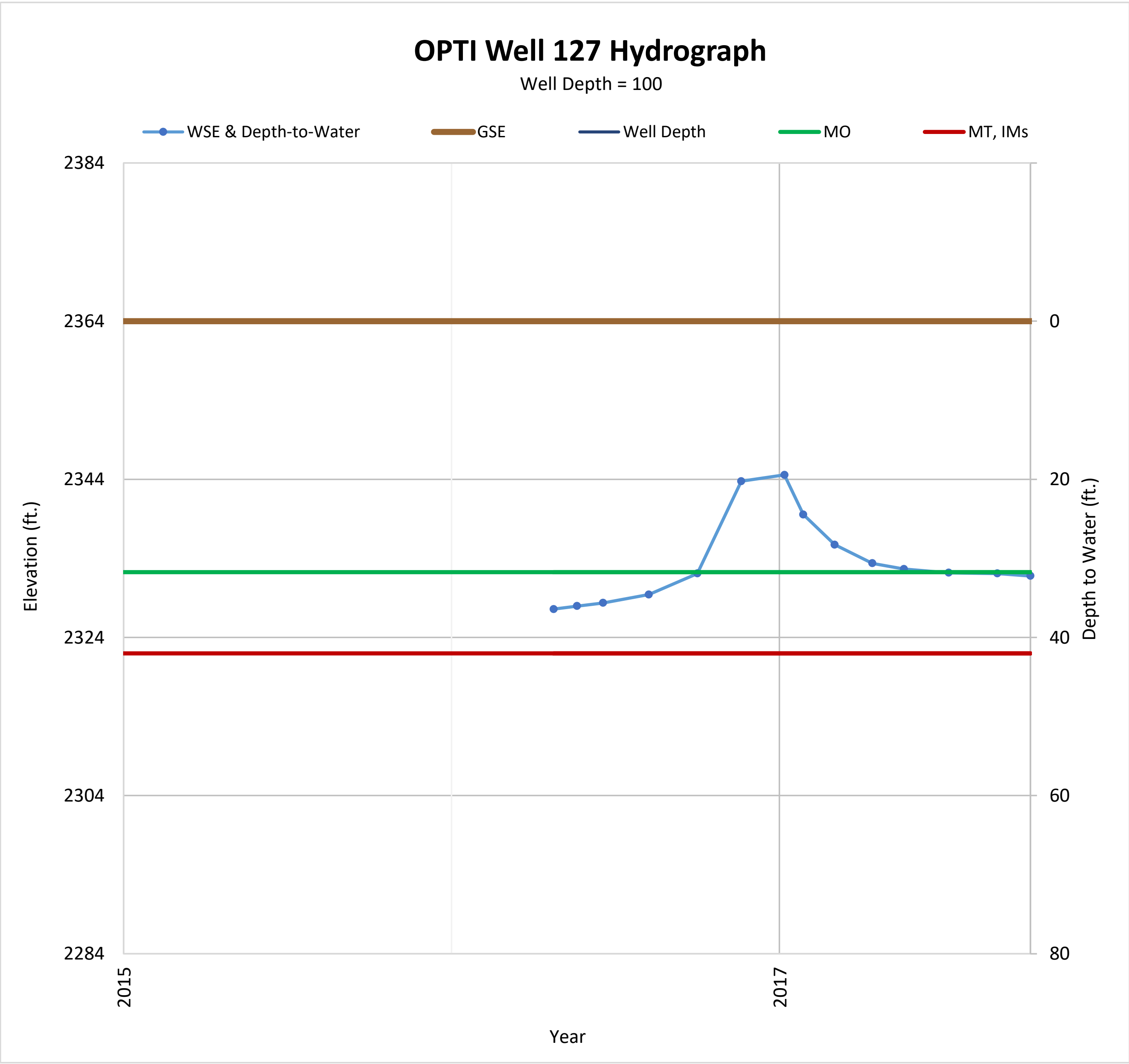
OPTI Well 118 Hydrograph
Well Depth = 500
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
2290
2270
2250
2230
2210
2190
2170
2150
2130
2110
0
20
40
60
80
100
120
140
160
2015
2017
Year

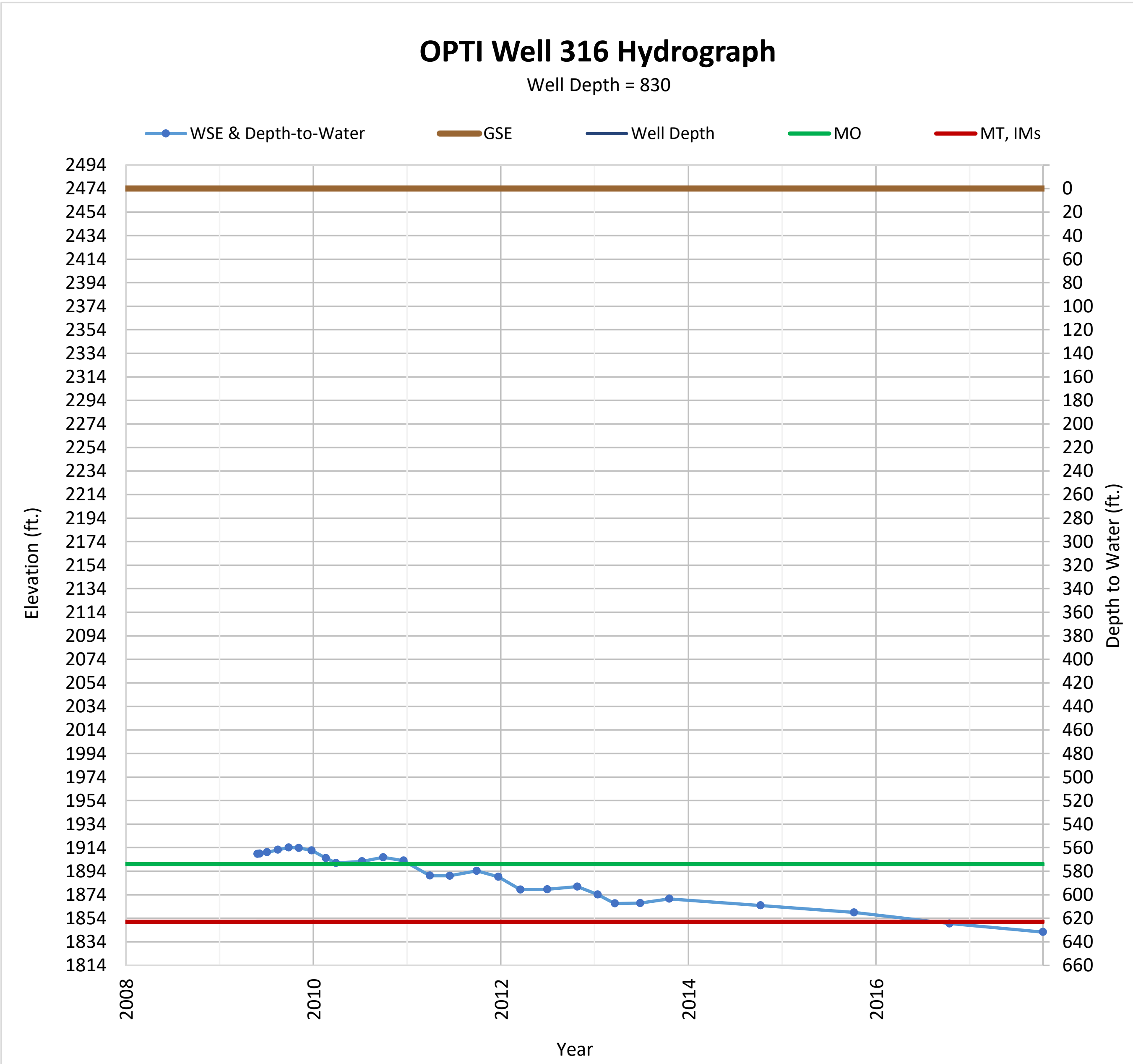


OPTI Well 123 Hydrograph
Well Depth = 138
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
2185
2165
2145
2125
2105
0
20
40
60
Elevation (ft.)
Depth to Water (ft.)
2015
2017
Year

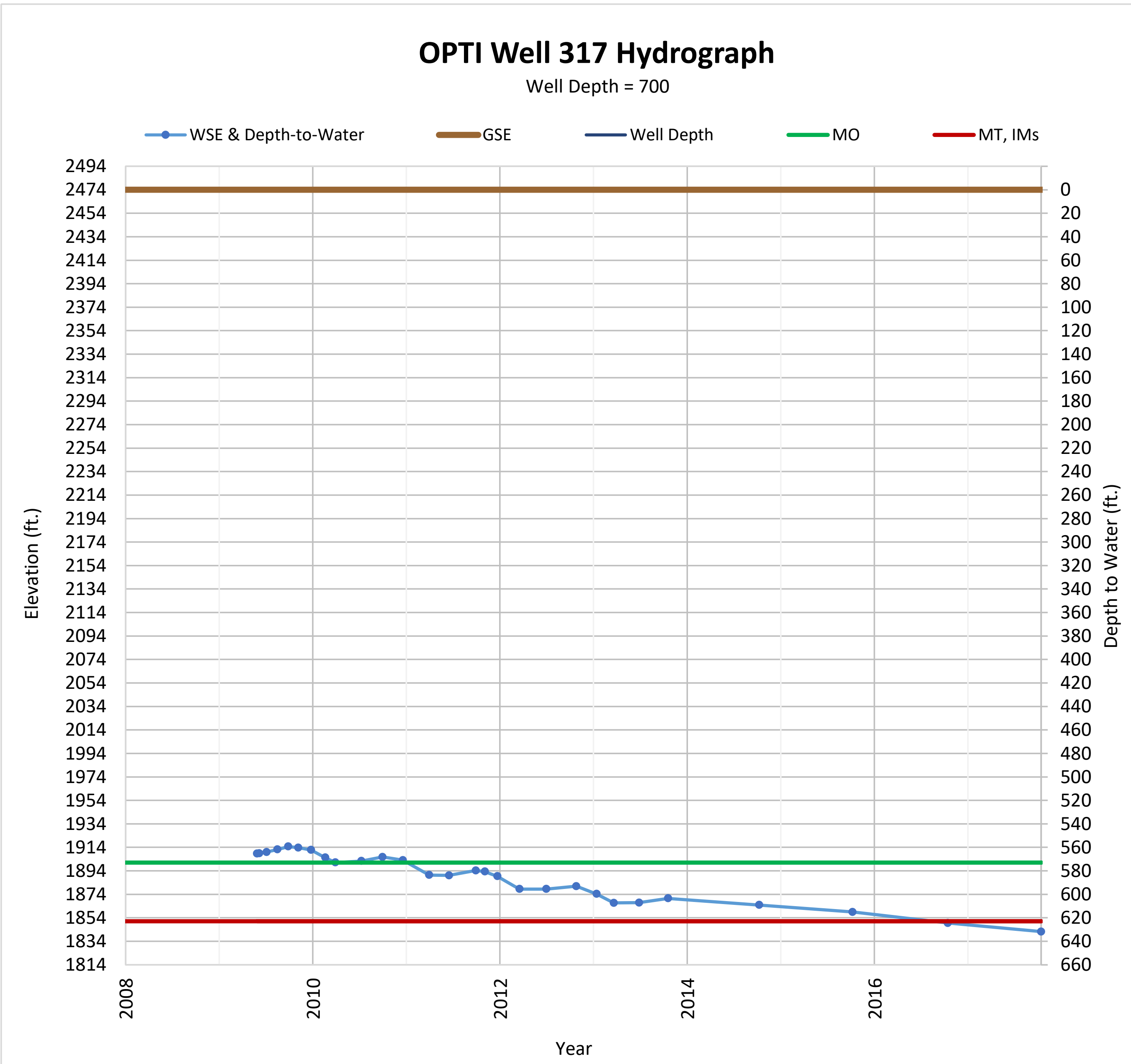


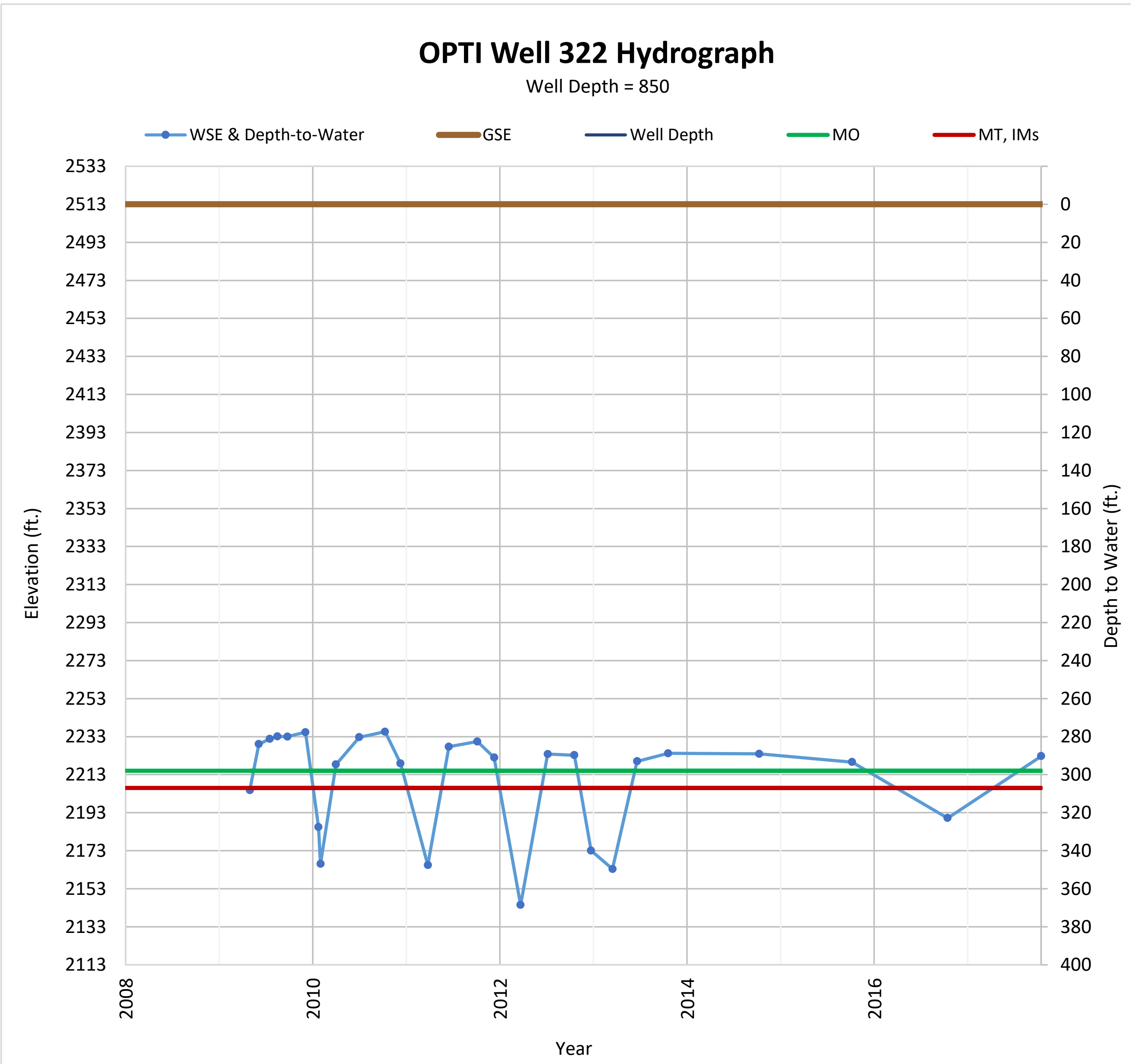
OPTI Well 124 Hydrograph
Well Depth = 161
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2307
2287
2267
2247
2227
2207
2187
0
20
40
60
80
100
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017


OPTI Well 127 Hydrograph
Well Depth = 100
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
2384
2364
2344
2324
2304
2284
0
20
40
60
80
Elevation (ft.)
Depth to Water (ft.)
2015
2017
Year

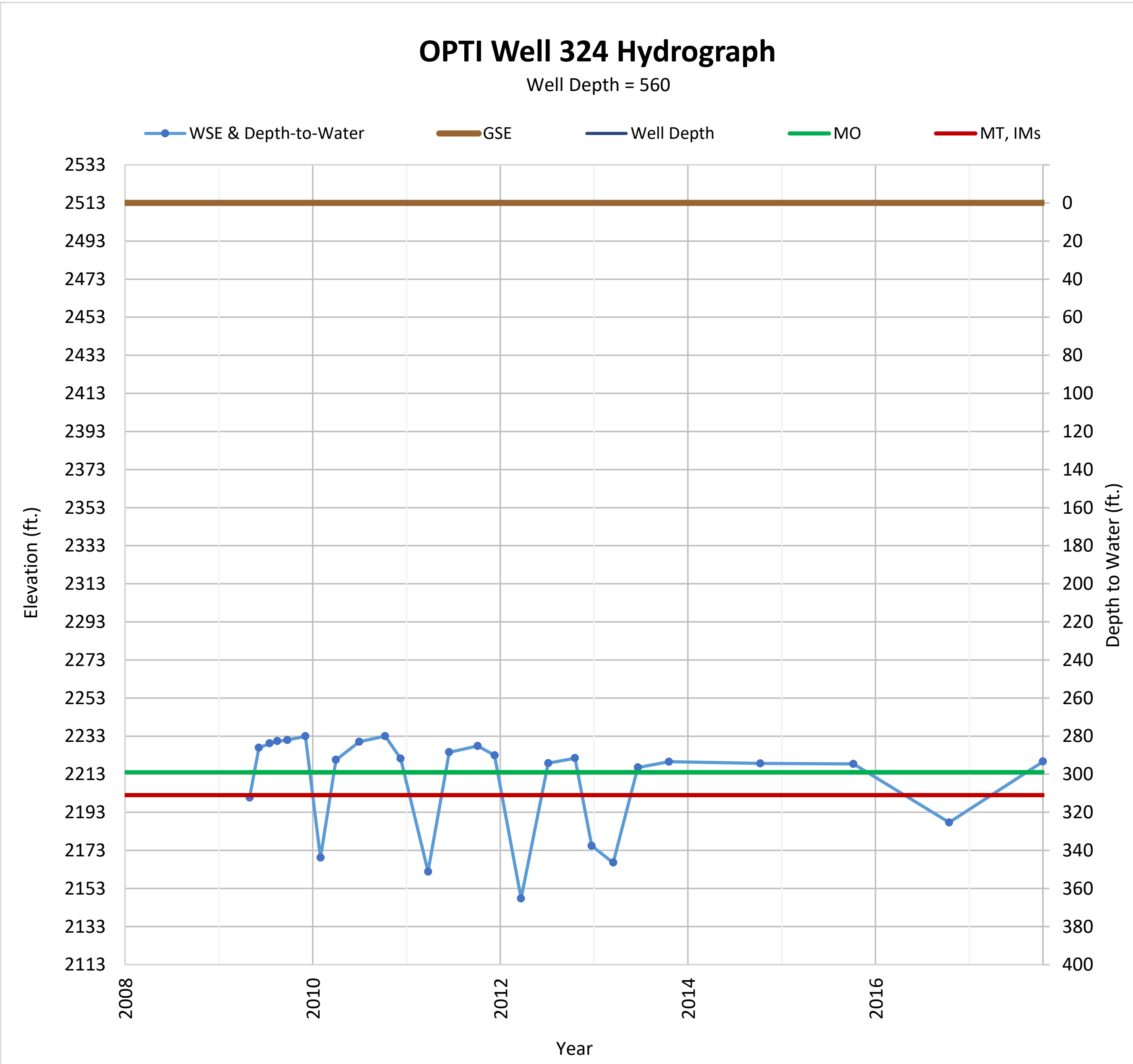


OPTI Well 316 Hydrograph
Well Depth = 830
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
2494
2474
2454
2434
2414
2394
2374
2354
2334
2314
2294
2274
2254
2234
2214
2194
2174
2154
2134
2114
2094
2074
2054
2034
2014
1994
1974
1954
1934
1914
1894
1874
1854
1834
1814
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
2008
2010
2012
2014
2016
Year

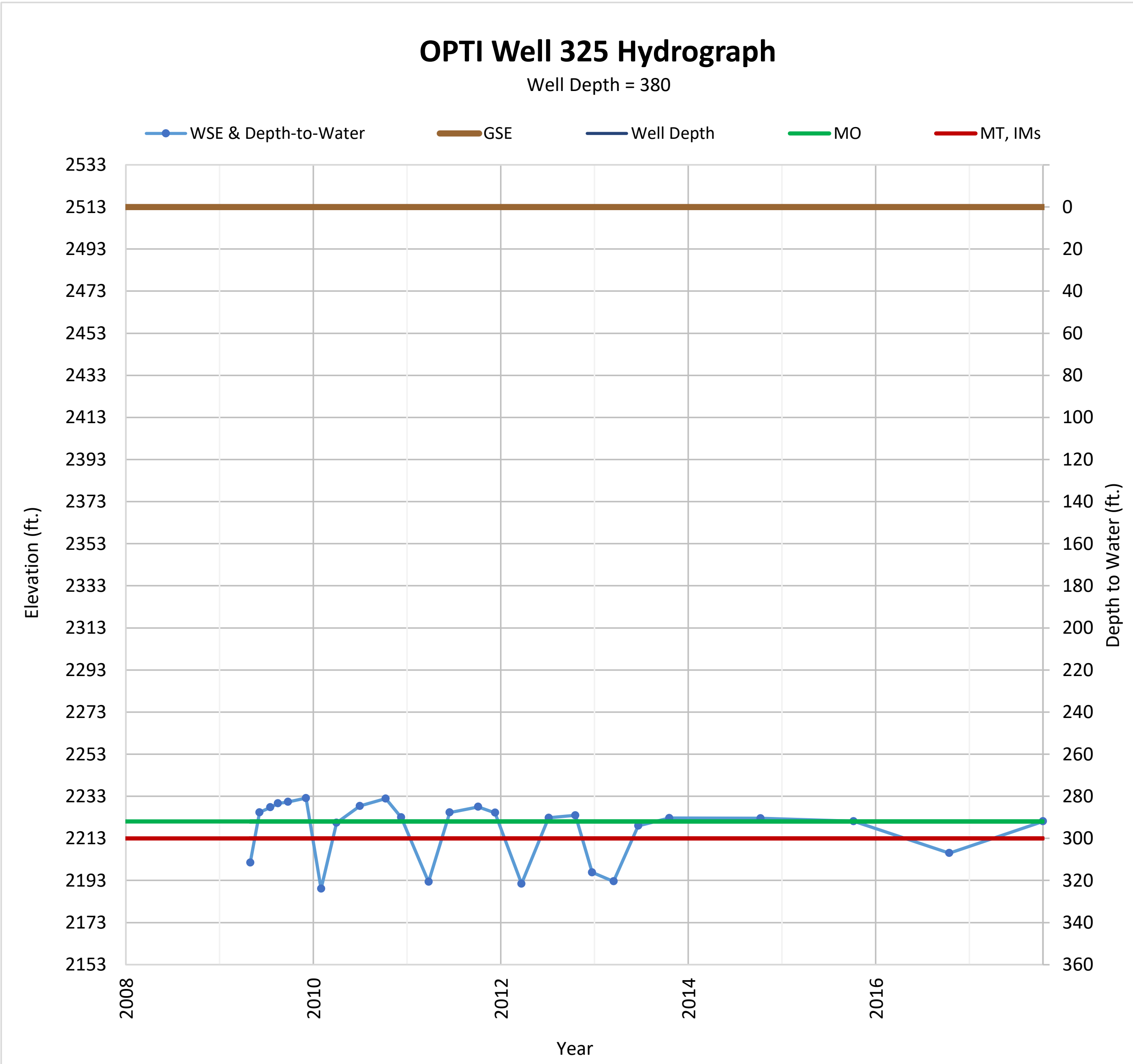

OPTI Well 317 Hydrograph
Well Depth = 700
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2494
2474
2454
2434
2414
2394
2374
2354
2334
2314
2294
2274
2254
2234
2214
2194
2174
2154
2134
2114
2094
2074
2054
2034
2014
1994
1974
1954
1934
1914
1894
1874
1854
1834
1814
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
2008
2010
2012
2014
2016



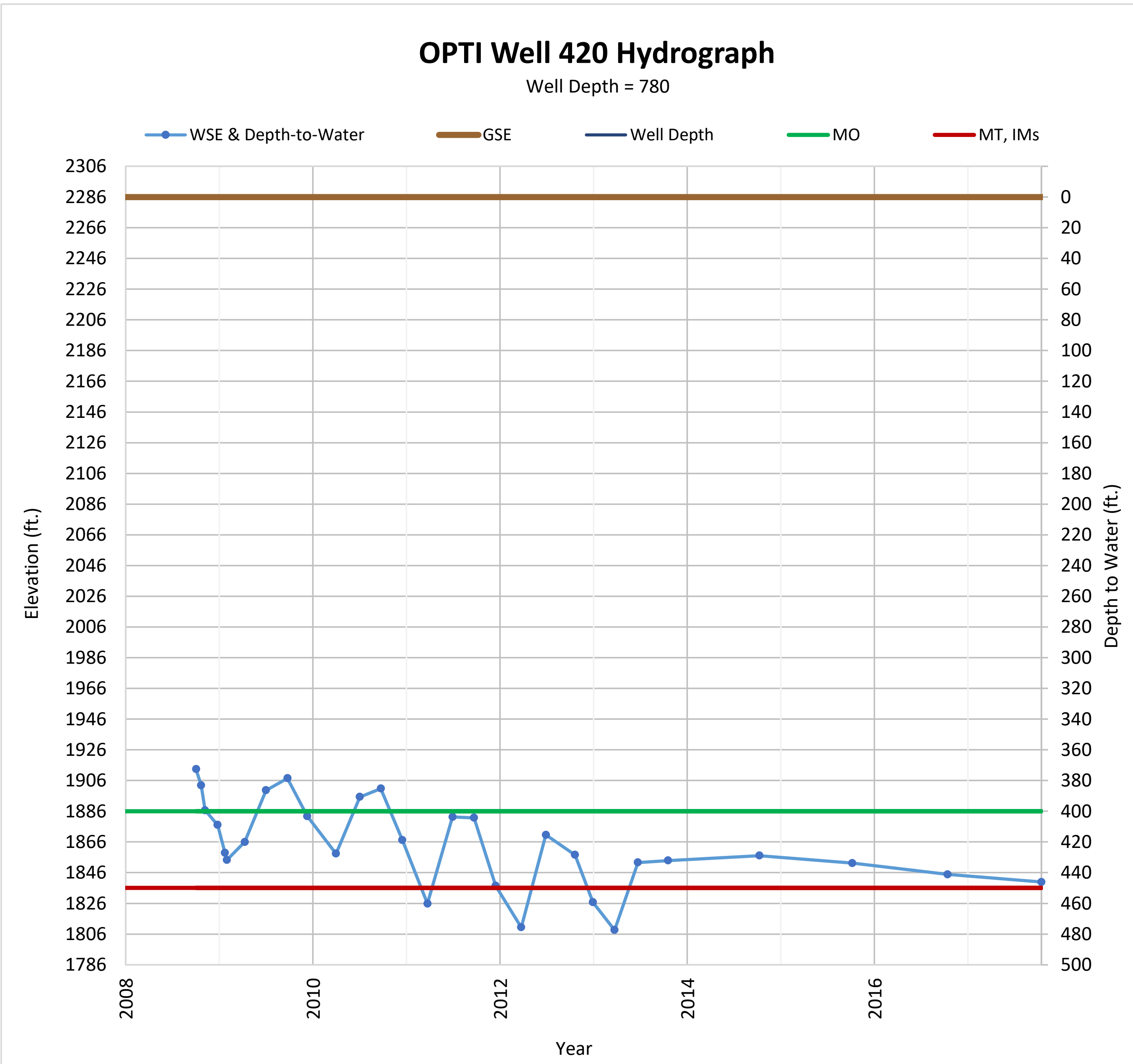
OPTI Well 322 Hydrograph
Well Depth = 850
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
2533
2513
2493
2473
2453
2433
2413
2393
2373
2353
2333
2313
2293
2273
2253
2233
2213
2193
2173
2153
2133
2113
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
2008
2010
2012
2014
2016
Year



OPTI Well 324 Hydrograph
Well Depth = 560
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
2533
2513
2493
2473
2453
2433
2413
2393
2373
2353
2333
2313
2293
2273
2253
2233
2213
2193
2173
2153
2133
2113
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
Elevation (ft.)
Depth to Water (ft.)
2008
2010
2012
2014
2016
Year



OPTI Well 325 Hydrograph
Well Depth = 380
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
2533
2513
2493
2473
2453
2433
2413
2393
2373
2353
2333
2313
2293
2273
2253
2233
2213
2193
2173
2153
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
2008
2010
2012
2014
2016
Year


OPTI Well 420 Hydrograph
Well Depth = 780
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2306
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
1786
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
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420
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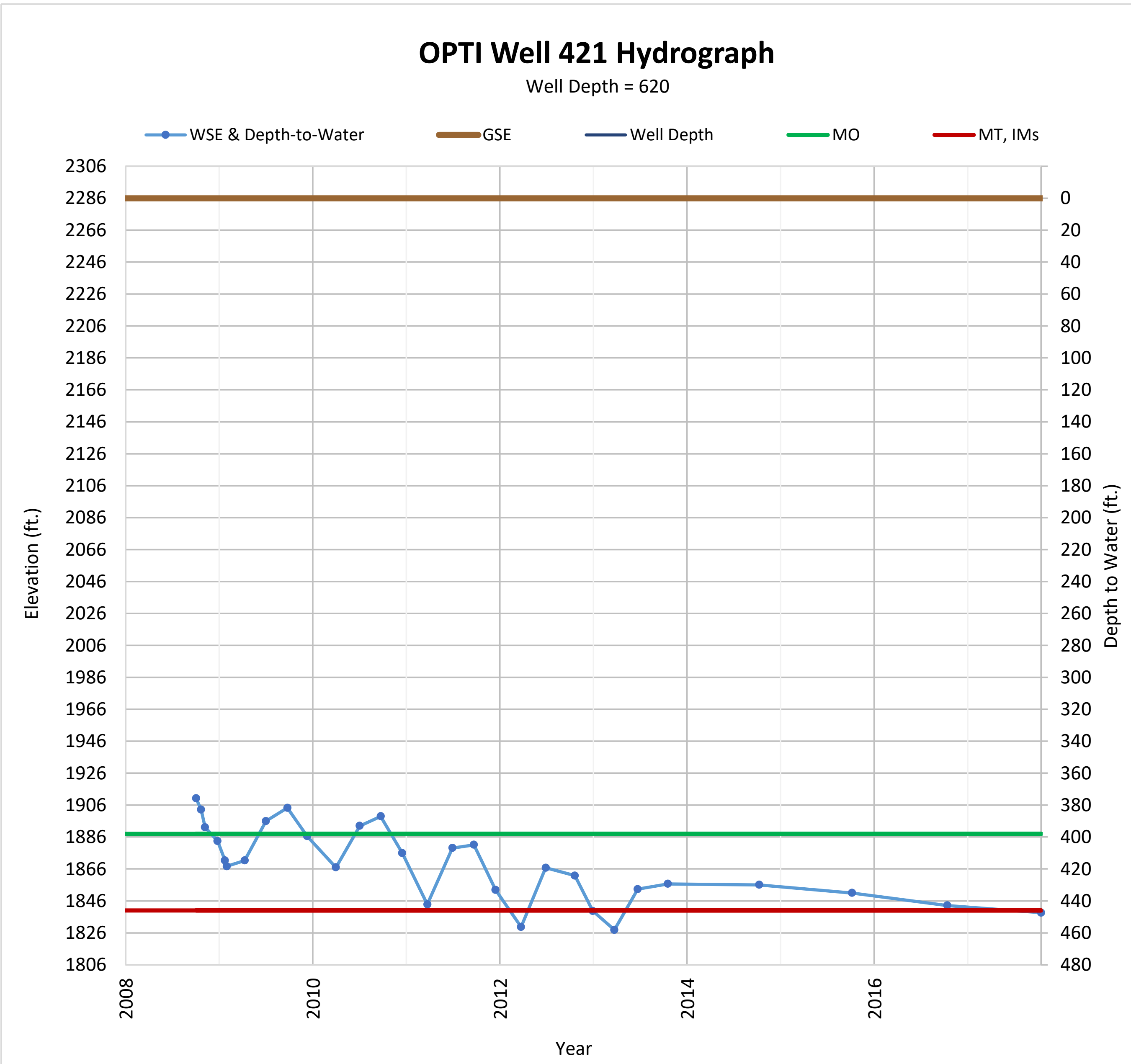
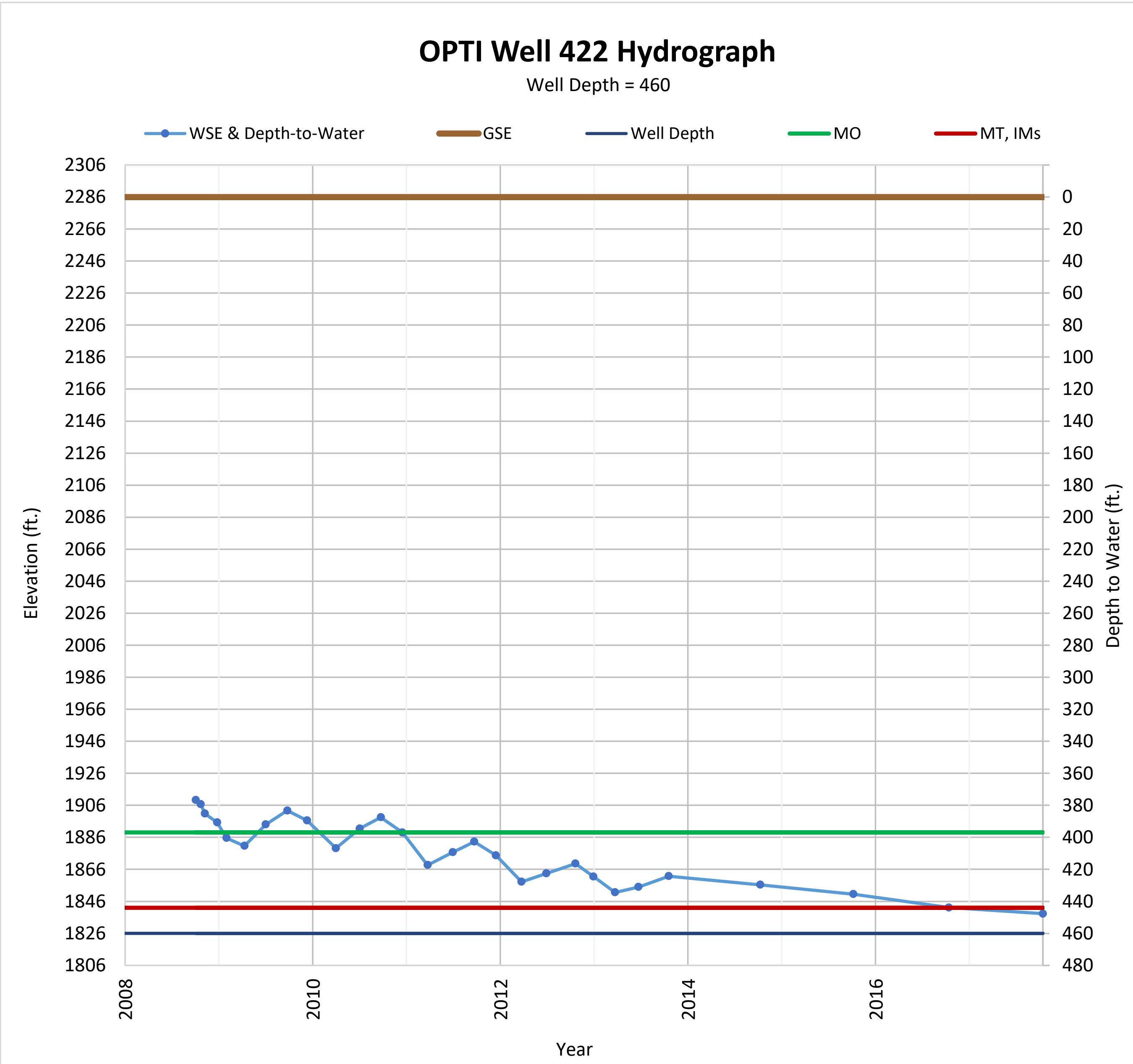
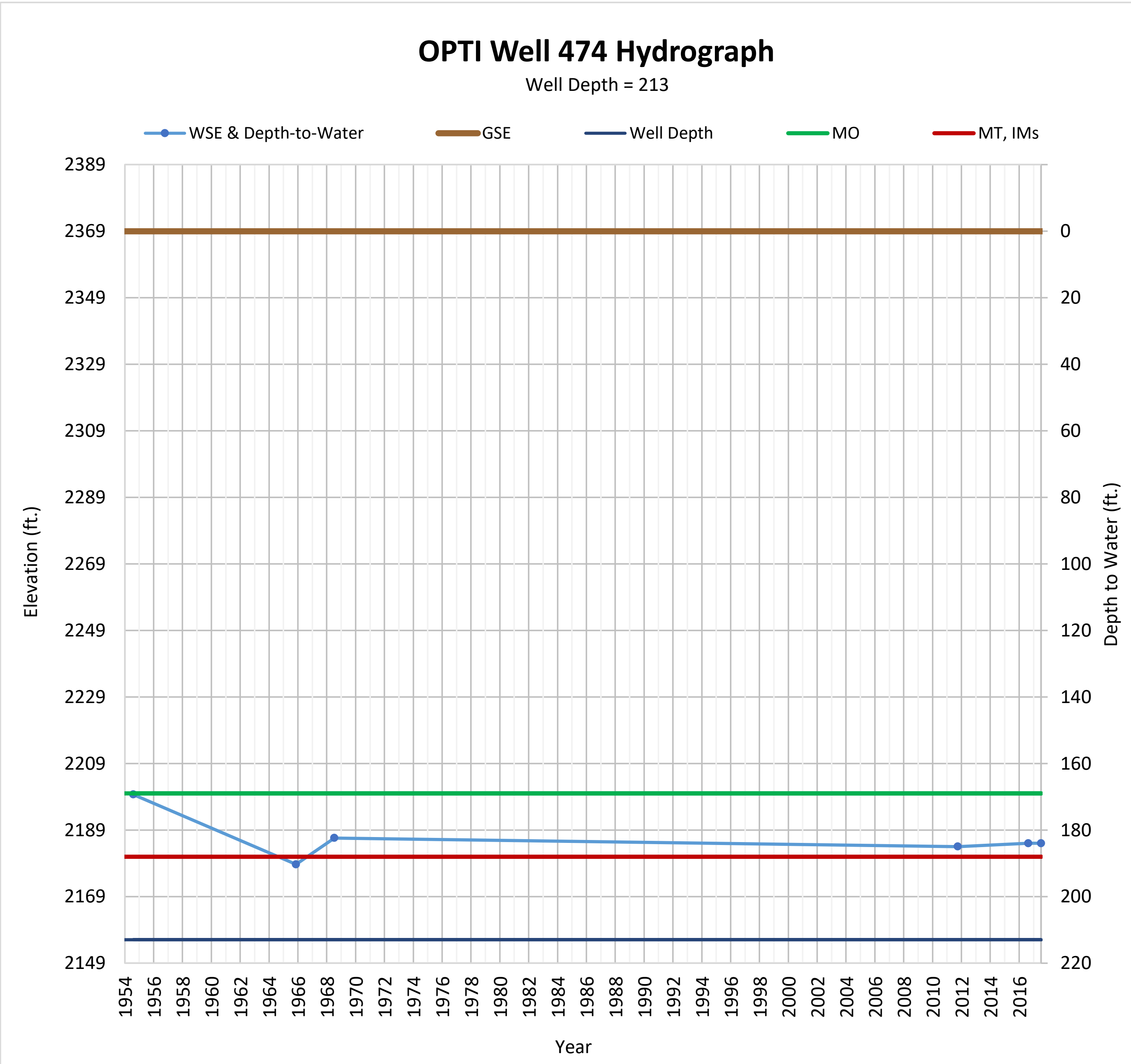
460
480
500
2008
2010
2012
2014
2016

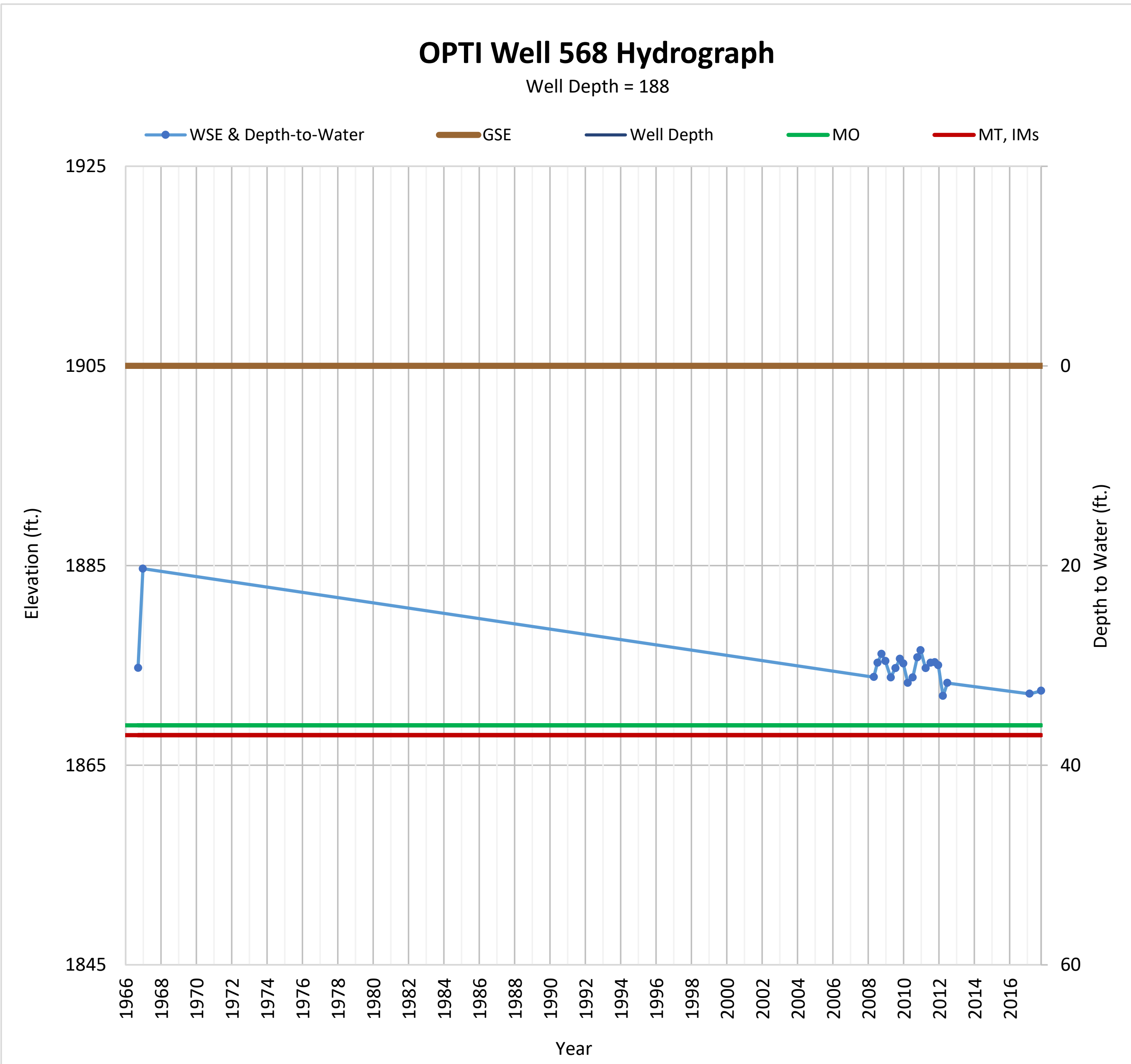


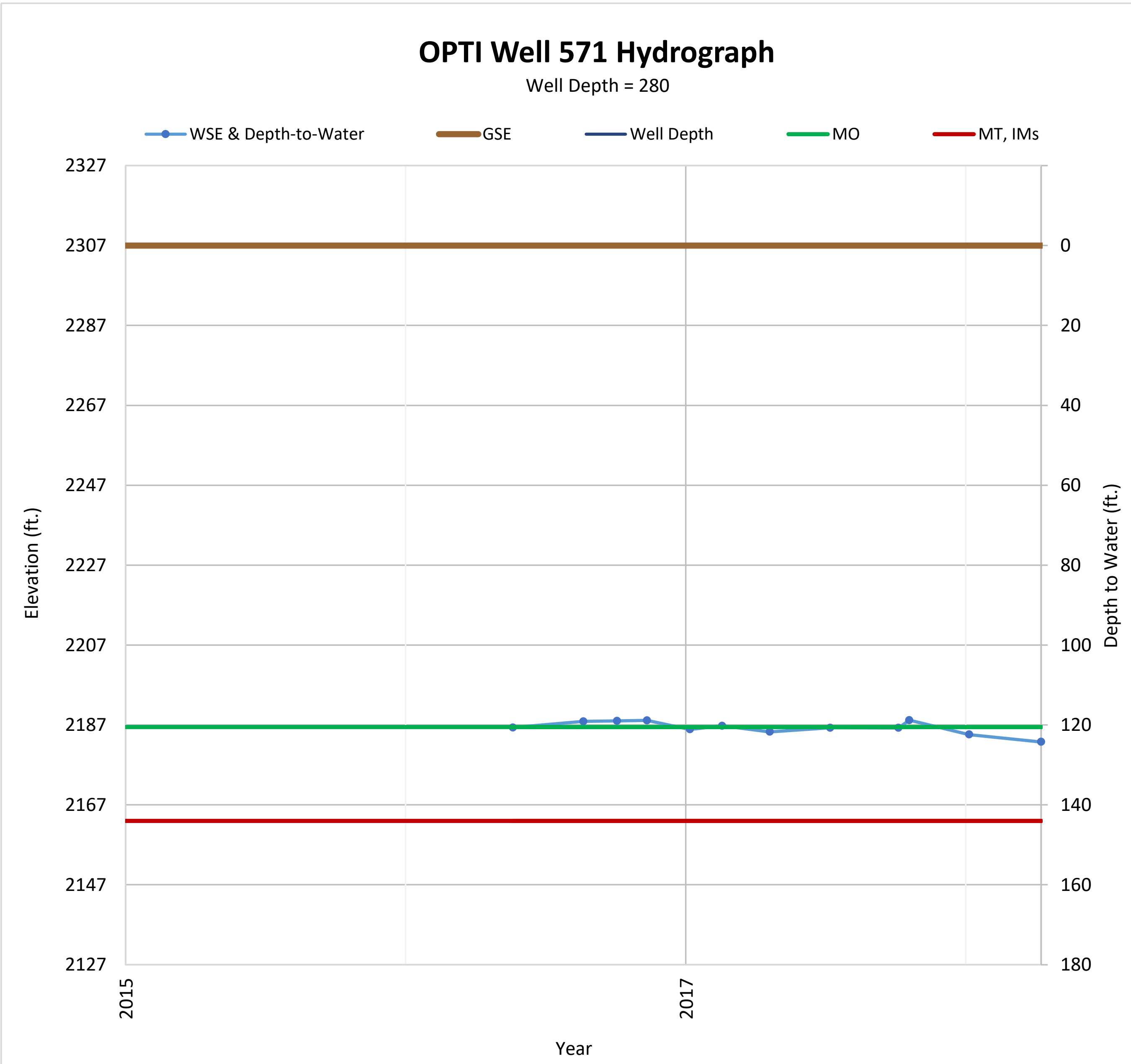
OPTI Well 421 Hydrograph
Well Depth = 620
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2306
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
2008
2010
2012
2014
2016

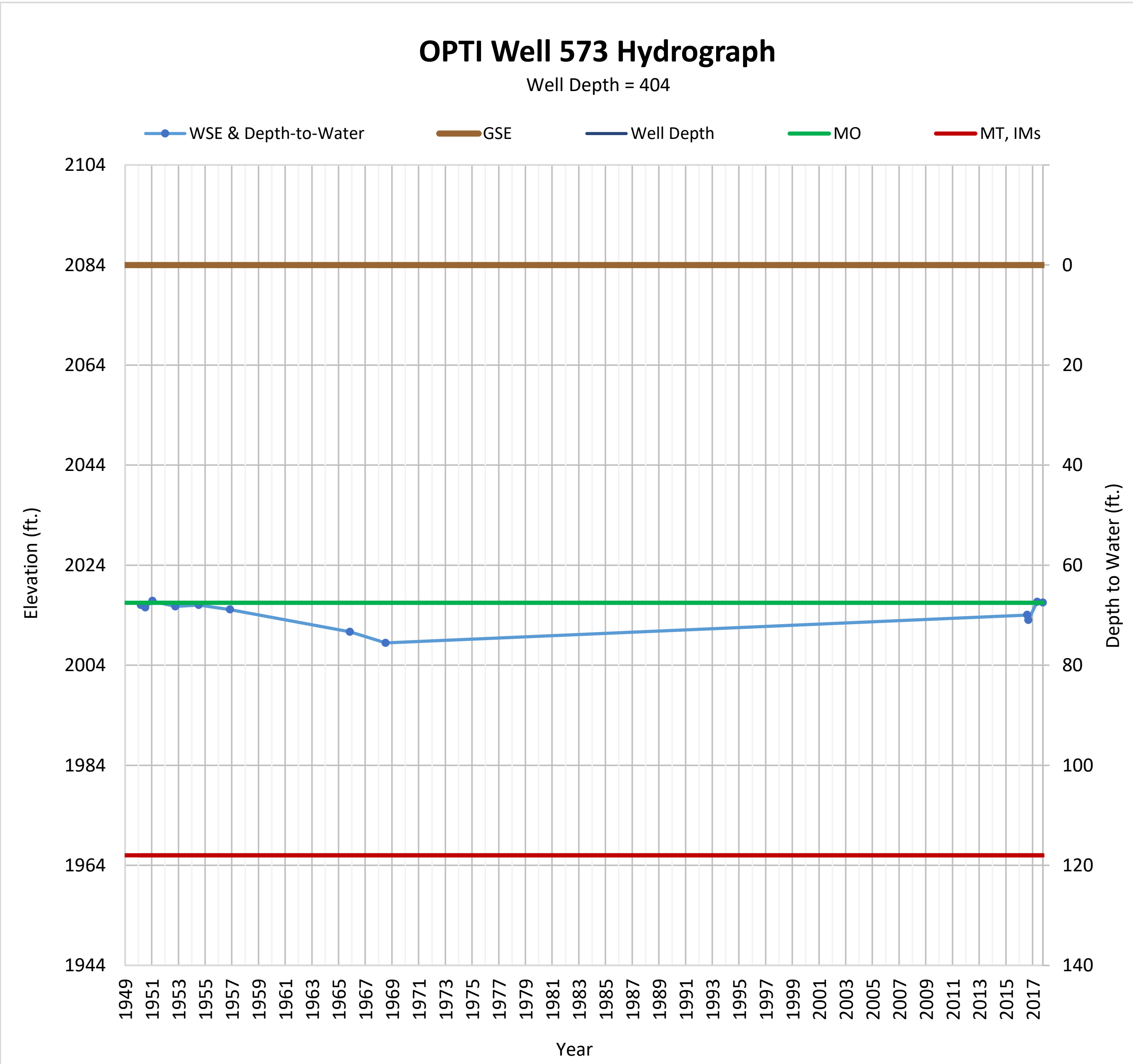

OPTI Well 422 Hydrograph
Well Depth = 460
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2306
2286
2266
2246
2226
2206
2186
2166
2146
2126
2106
2086
2066
2046
2026
2006
1986
1966
1946
1926
1906
1886
1866
1846
1826
1806
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
2008
2010
2012
2014
2016



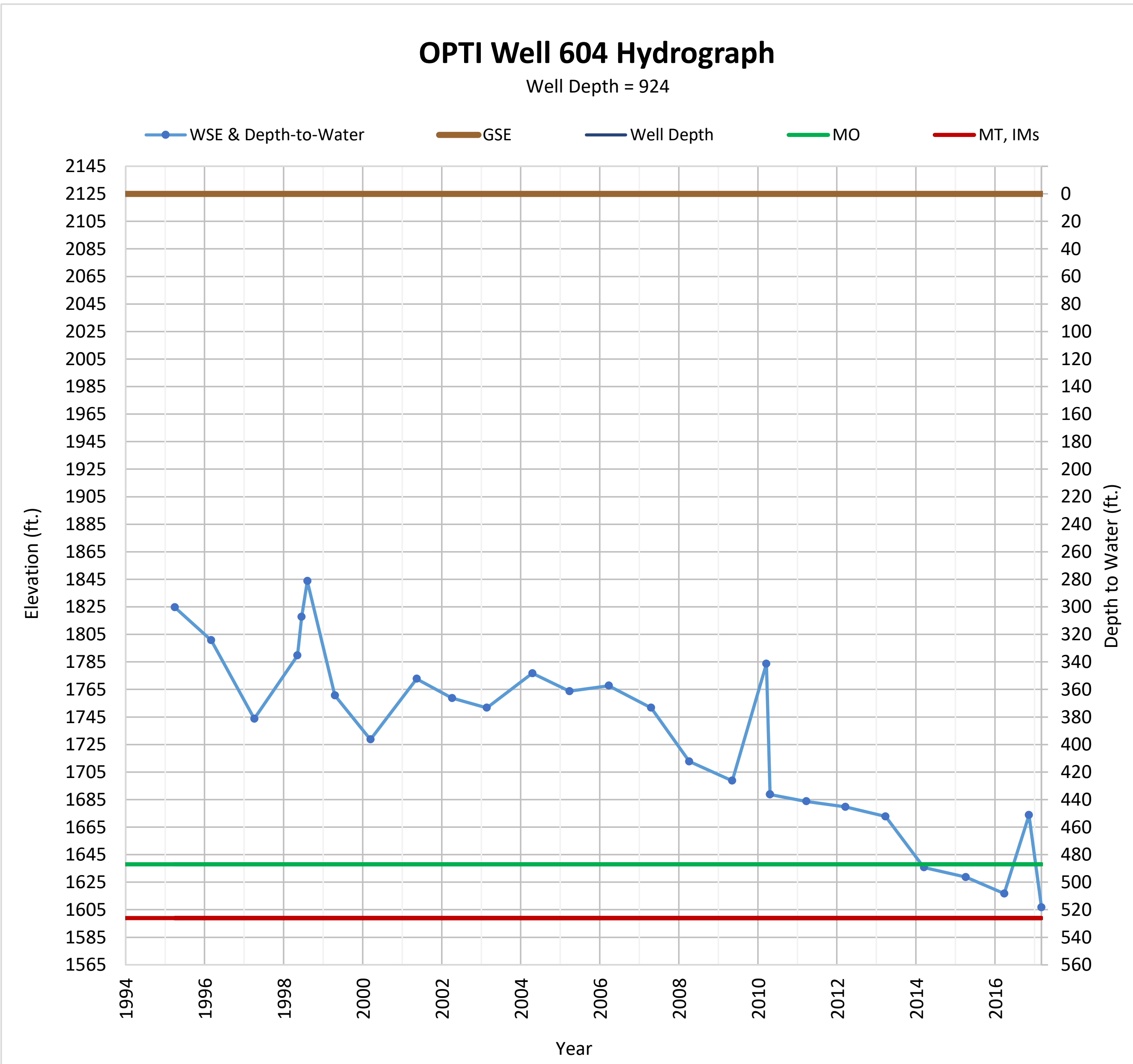
OPTI Well 474 Hydrograph
Well Depth = 213
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2389
2369
2349
2329
2309
2289
2269
2249
2229
2209
2189
2169
2149
0
20
40
60
80
100
120
140
160
180
200
220
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

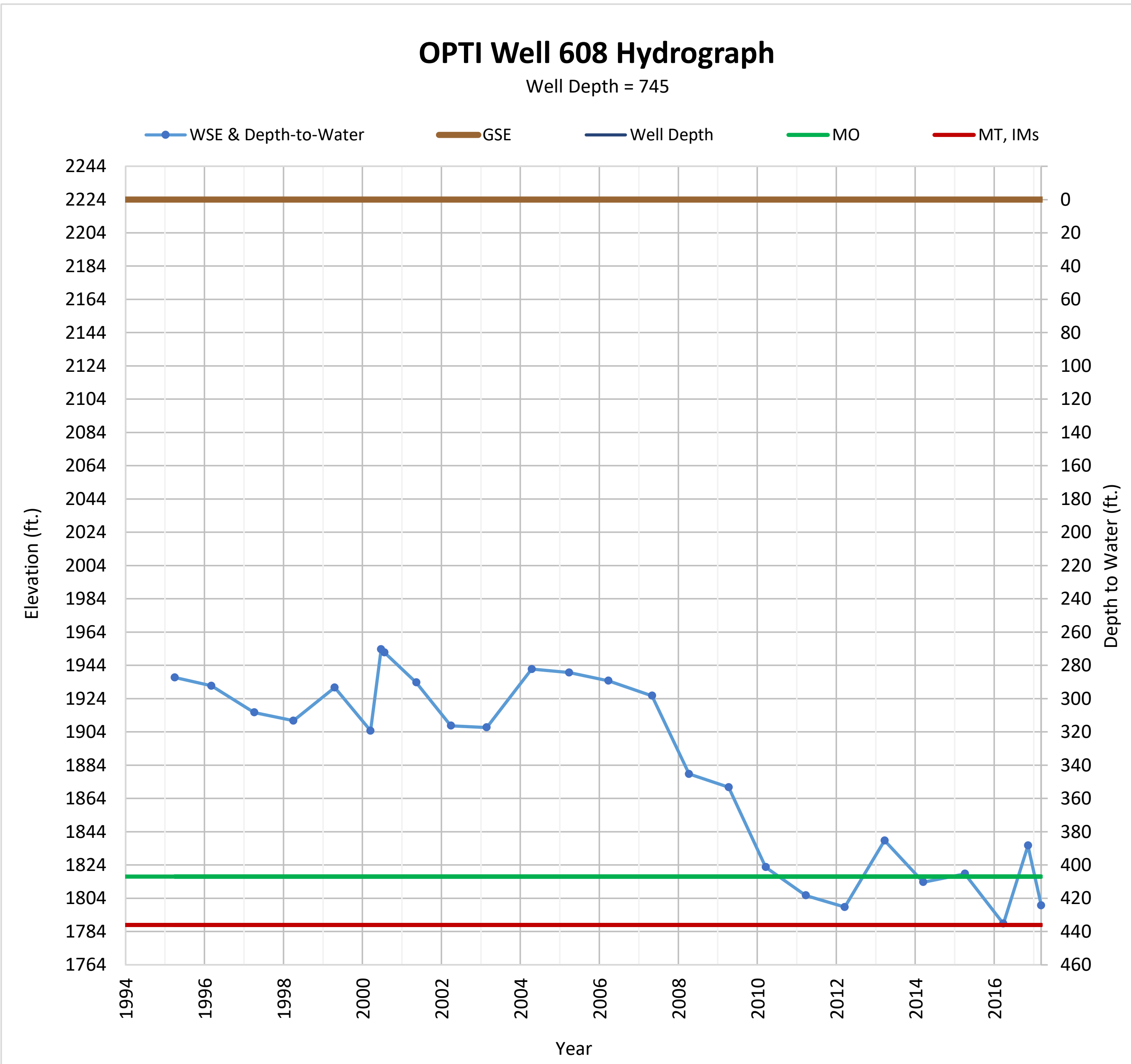

OPTI Well 568 Hydrograph
Well Depth = 188
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1925
1905
1885
1865
1845
0
20
40
60
Elevation (ft.)
Depth to Water (ft.)
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Year


OPTI Well 571 Hydrograph
Well Depth = 280
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
2327
2307
2287
2267
2247
2227
2207
2187
2167
2147
2127
0
20
40
60
80
100
120
140
160
180
Elevation (ft.)
Depth to Water (ft.)
2015
2017
Year

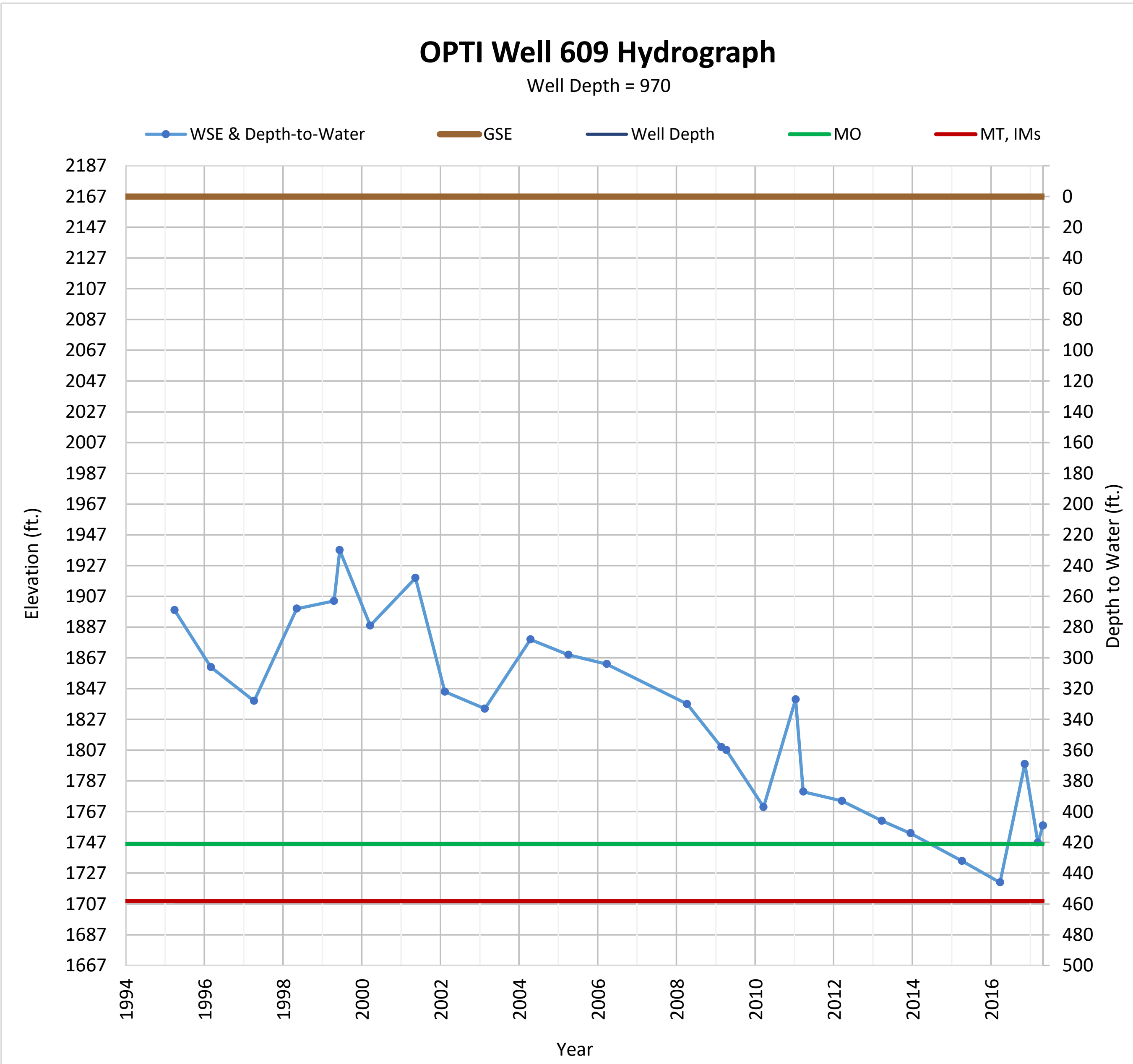


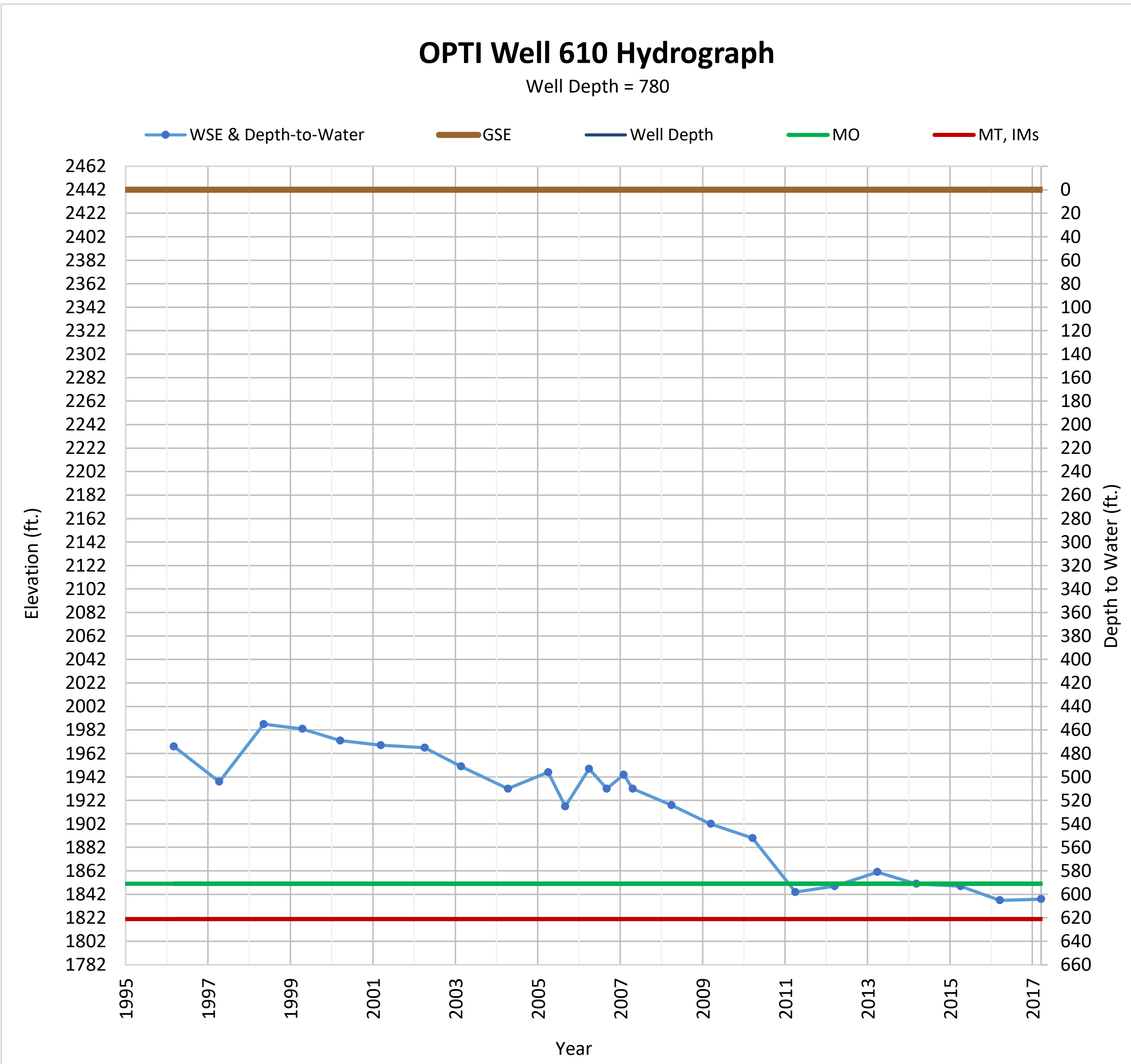
OPTI Well 573 Hydrograph
Well Depth = 404
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2104
2084
2064
2044
2024
2004
1984
1964
1944
0
20
40
60
80
100
120
140
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017


OPTI Well 604 Hydrograph
Well Depth = 924
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2145
2125
2105
2085
2065
2045
2025
2005
1985
1965
1945
1925
1905
1885
1865
1845
1825
1805
1785
1765
1745
1725
1705
1685
1665
1645
1625
1605
1585
1565
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

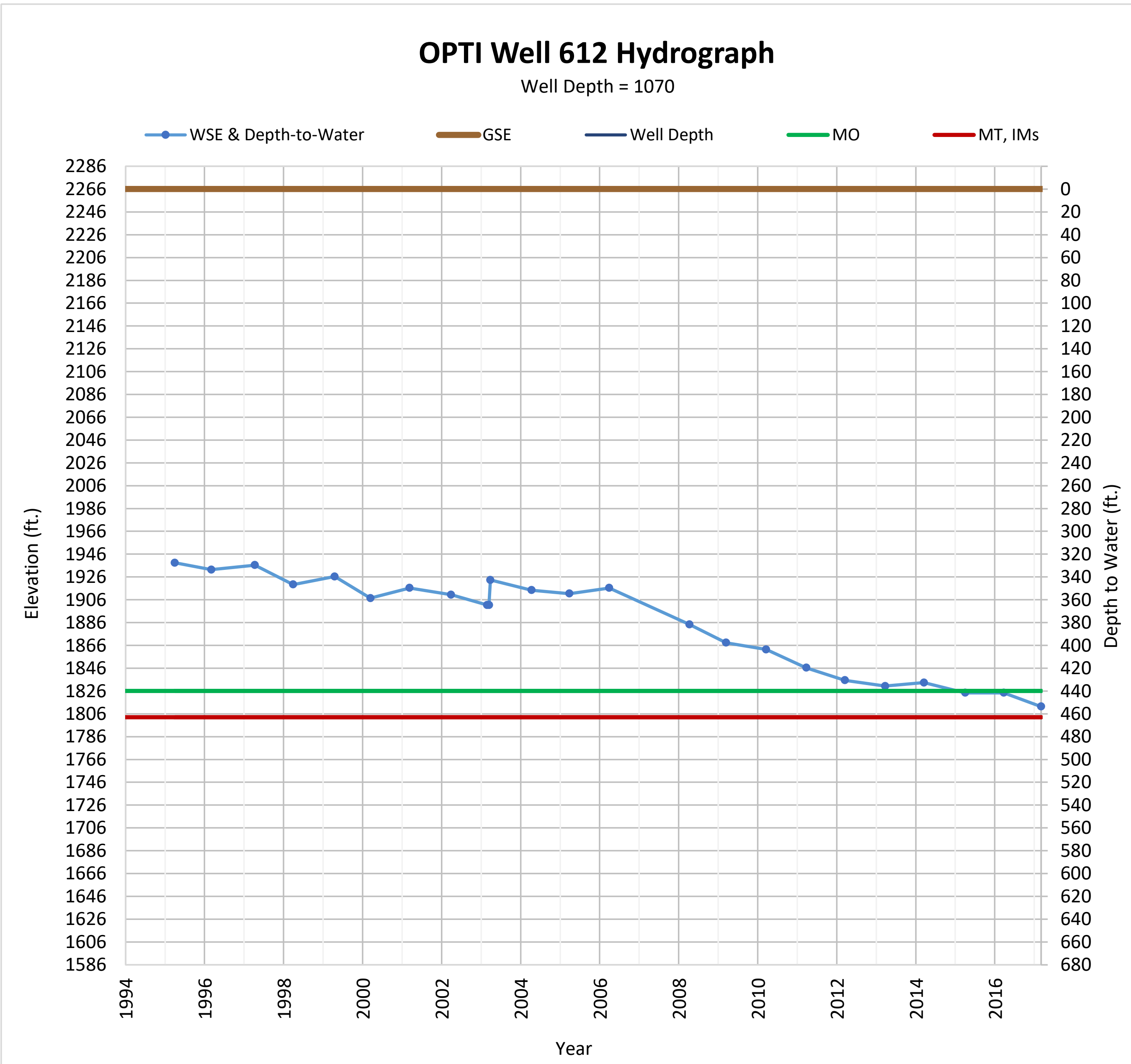


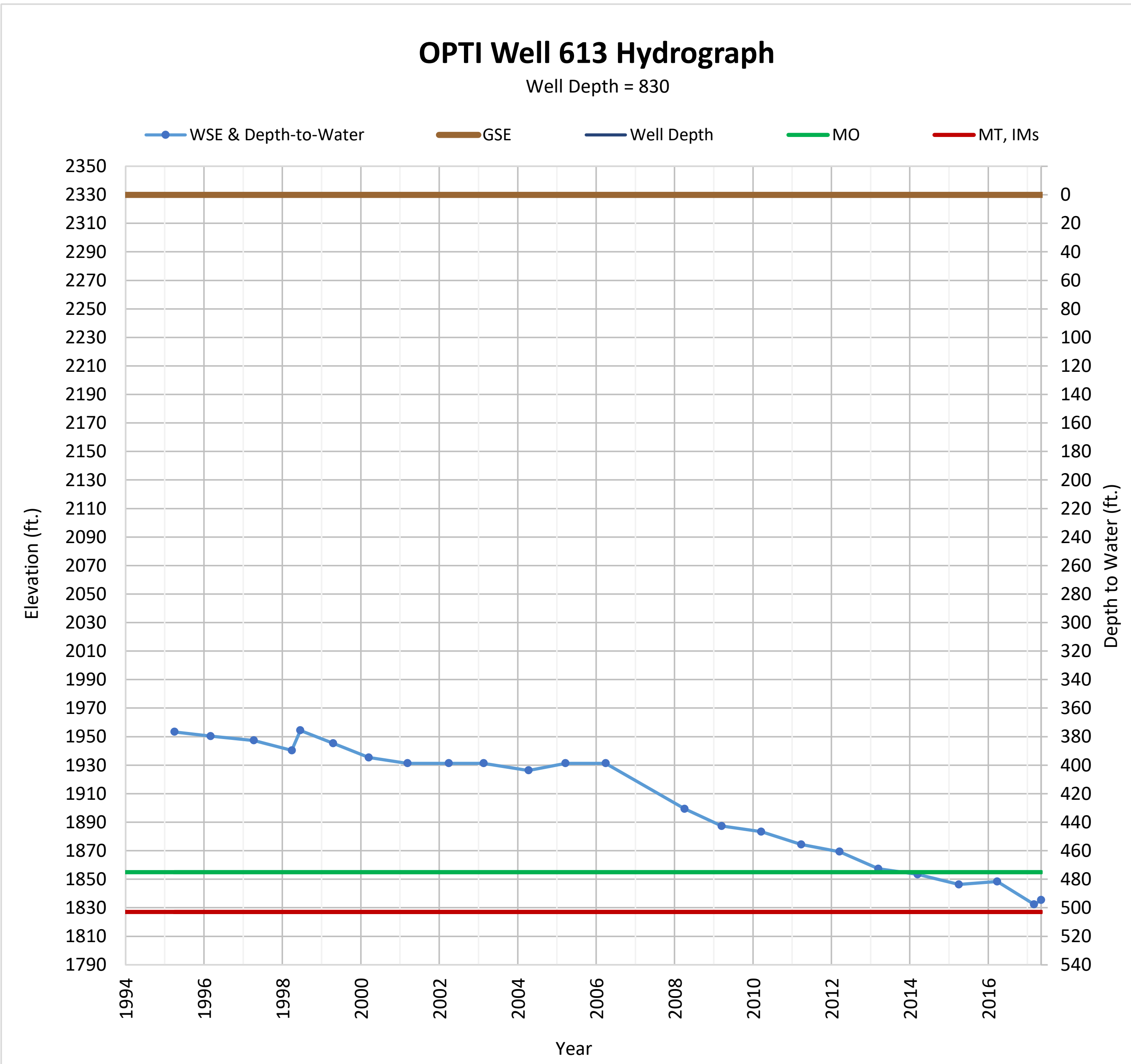
OPTI Well 608 Hydrograph
Well Depth = 745
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2244
2224
2204
2184
2164
2144
2124
2104
2084
2064
2044
2024
2004
1984
1964
1944
1924
1904
1884
1864
1844
1824
1804
1784
1764
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

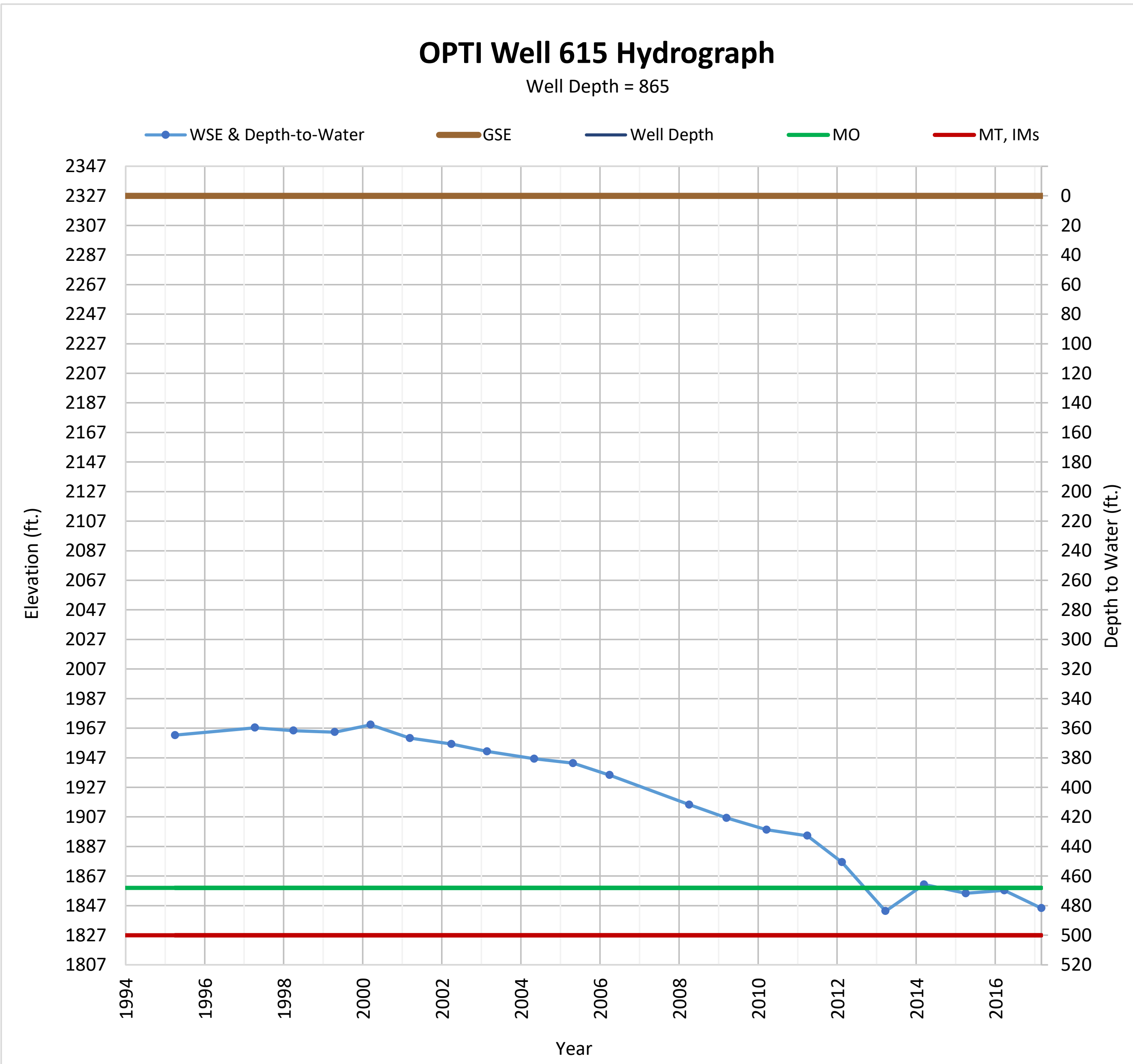

OPTI Well 609 Hydrograph
Well Depth = 970
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2187
2167
2147
2127
2107
2087
2067
2047
2027
2007
1987
1967
1947
1927
1907
1887
1867
1847
1827
1807
1787
1767
1747
1727
1707
1687
1667
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



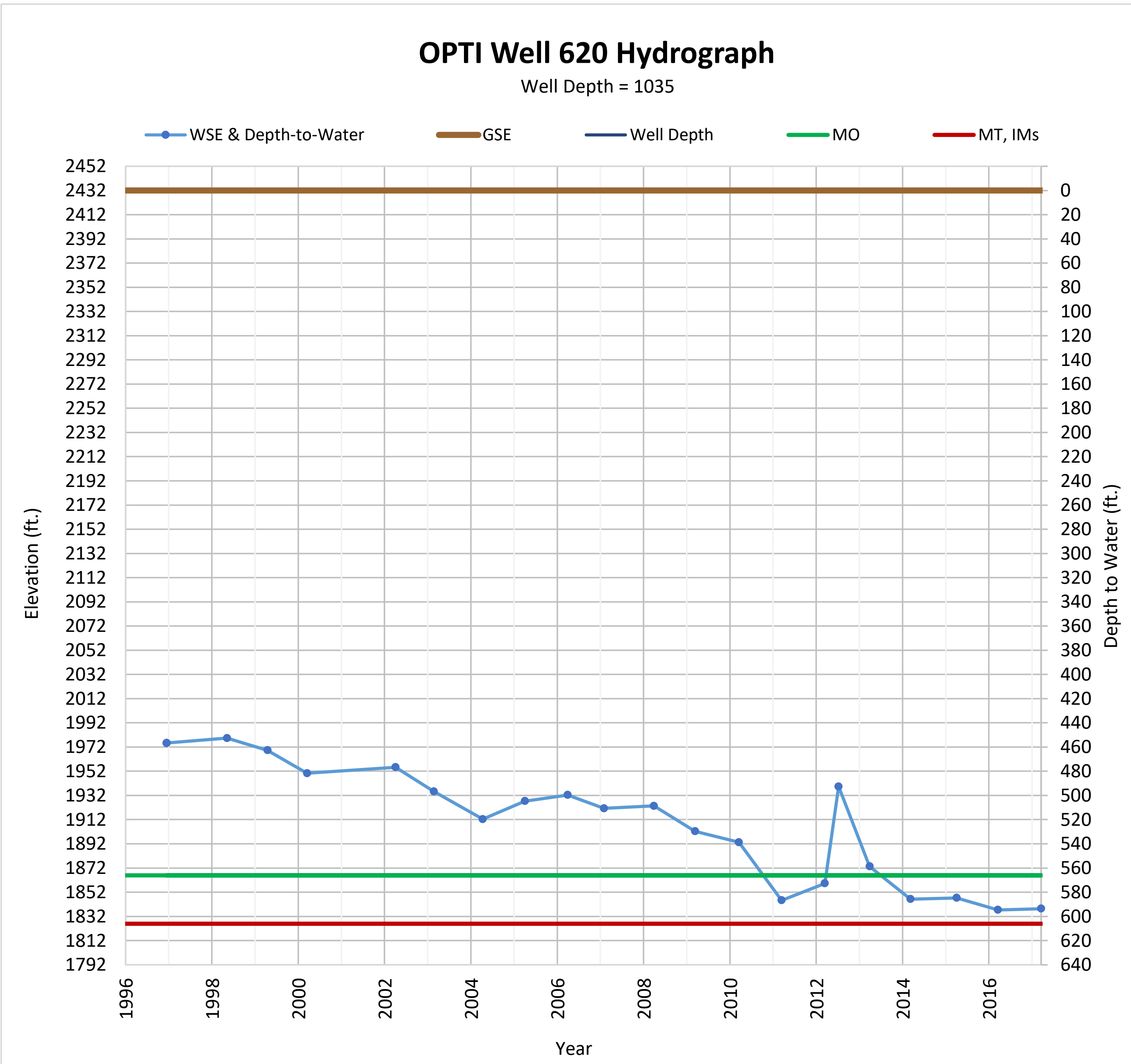
OPTI Well 610 Hydrograph
Well Depth = 780
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2462
2442
2422
2402
2382
2362
2342
2322
2302
2282
2262
2242
2222
2202
2182
2162
2142
2122
2102
2082
2062
2042
2022
2002
1982
1962
1942
1922
1902
1882
1862
1842
1822
1802
1782
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017

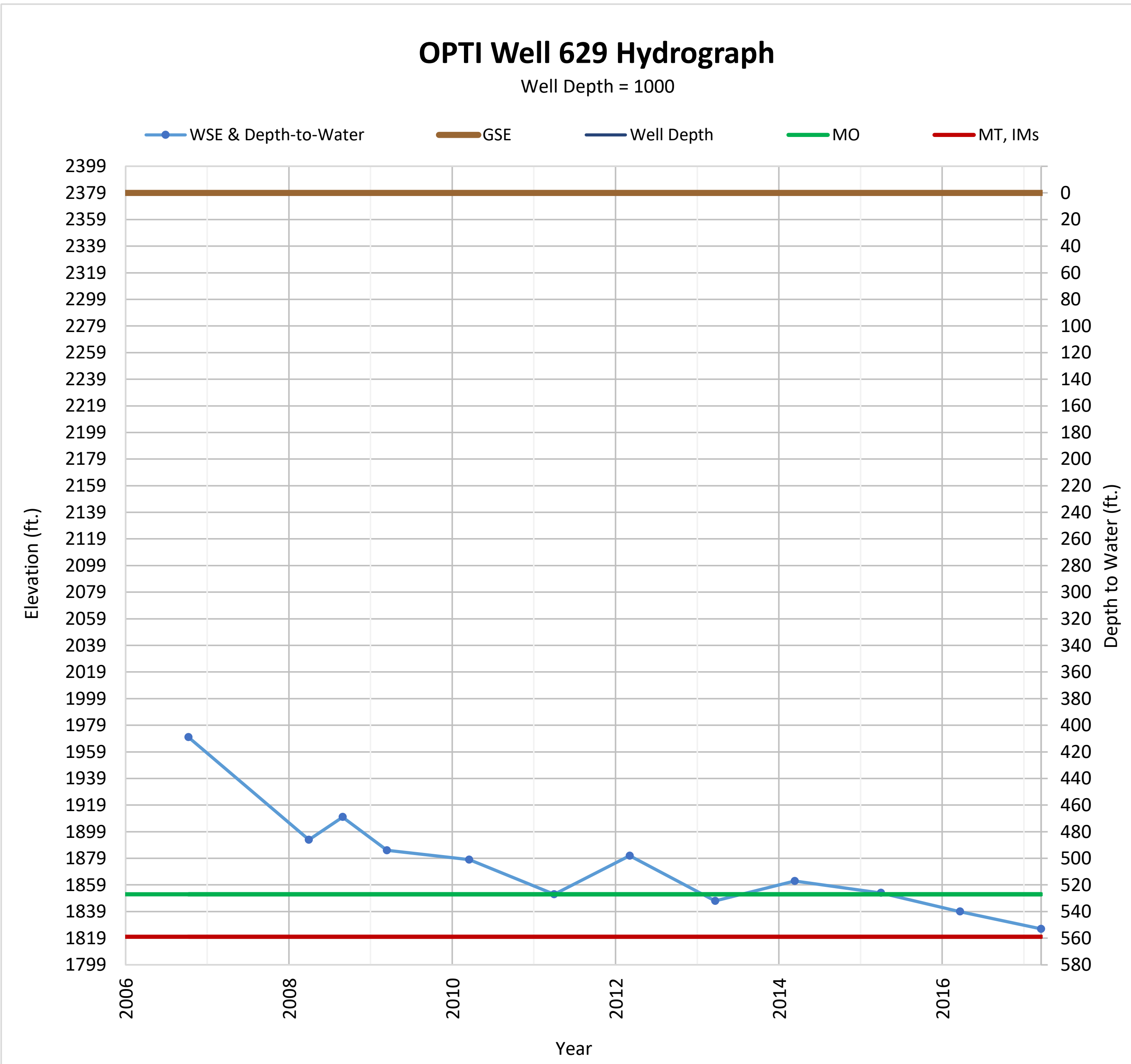

OPTI Well 612 Hydrograph
Well Depth = 1070
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year


OPTI Well 613 Hydrograph
Well Depth = 830
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2350
2330
2310
2290
2270
2250
2230
2210
2190
2170
2150
2130
2110
2090
2070
2050
2030
2010
1990
1970
1950
1930
1910
1890
1870
1850
1830
1810
1790
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016



OPTI Well 615 Hydrograph
Well Depth = 865
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2347
2327
2307
2287
2267
2247
2227
2207
2187
2167
2147
2127
2107
2087
2067
2047
2027
2007
1987
1967
1947
1927
1907
1887
1867
1847
1827
1807
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


OPTI Well 620 Hydrograph
Well Depth = 1035
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2452
2432
2412
2392
2372
2352
2332
2312
2292
2272
2252
2232
2212
2192
2172
2152
2132
2112
2092
2072
2052
2032
2012
1992
1972
1952
1932
1912
1892
1872
1852
1832
1812
1792
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


OPTI Well 629 Hydrograph
Well Depth = 1000
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2399
2379
2359
2339
2319
2299
2279
2259
2239
2219
2199
2179
2159
2139
2119
2099
2079
2059
2039
2019
1999
1979
1959
1939
1919
1899
1879
1859
1839
1819
1799
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
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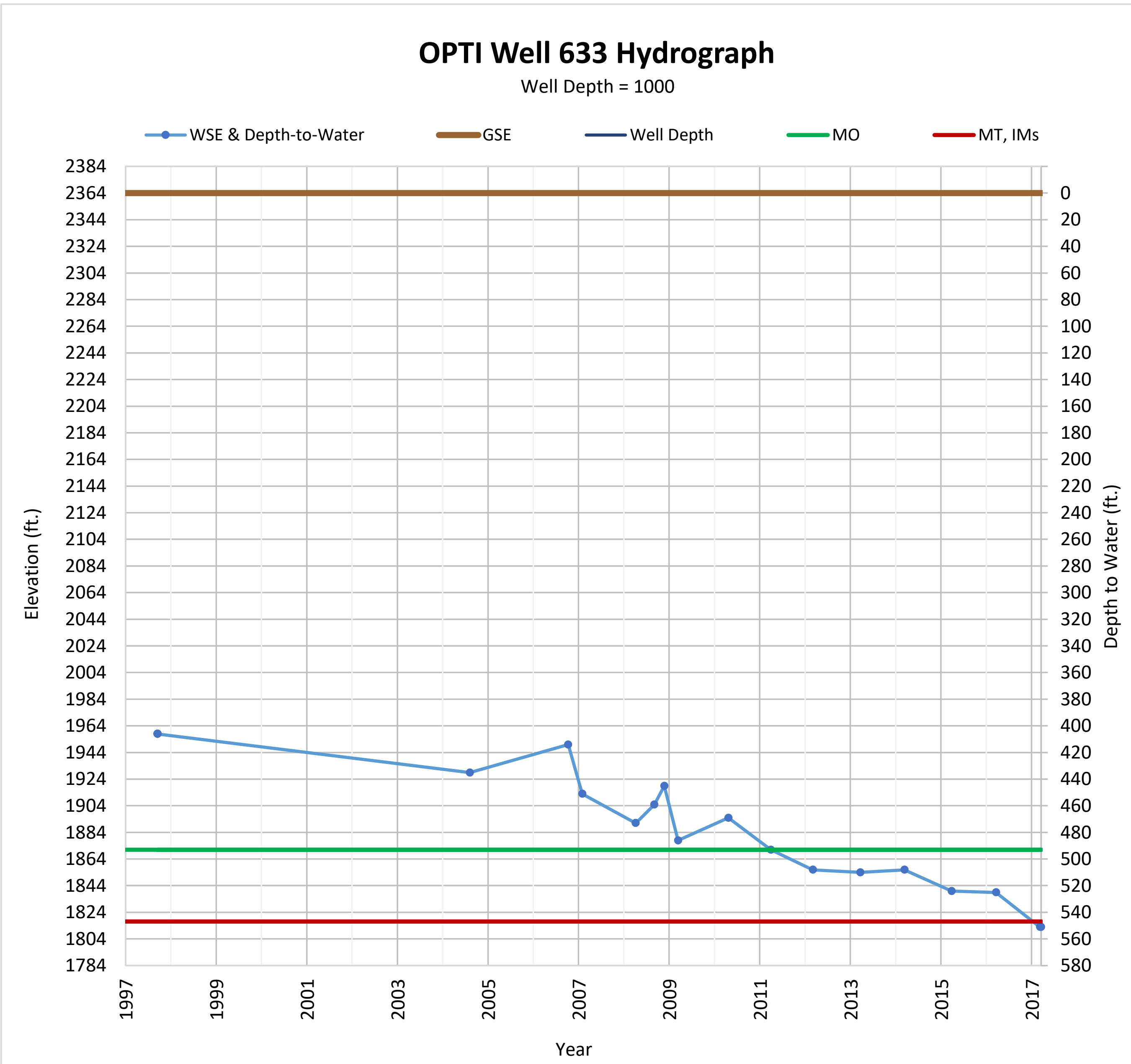
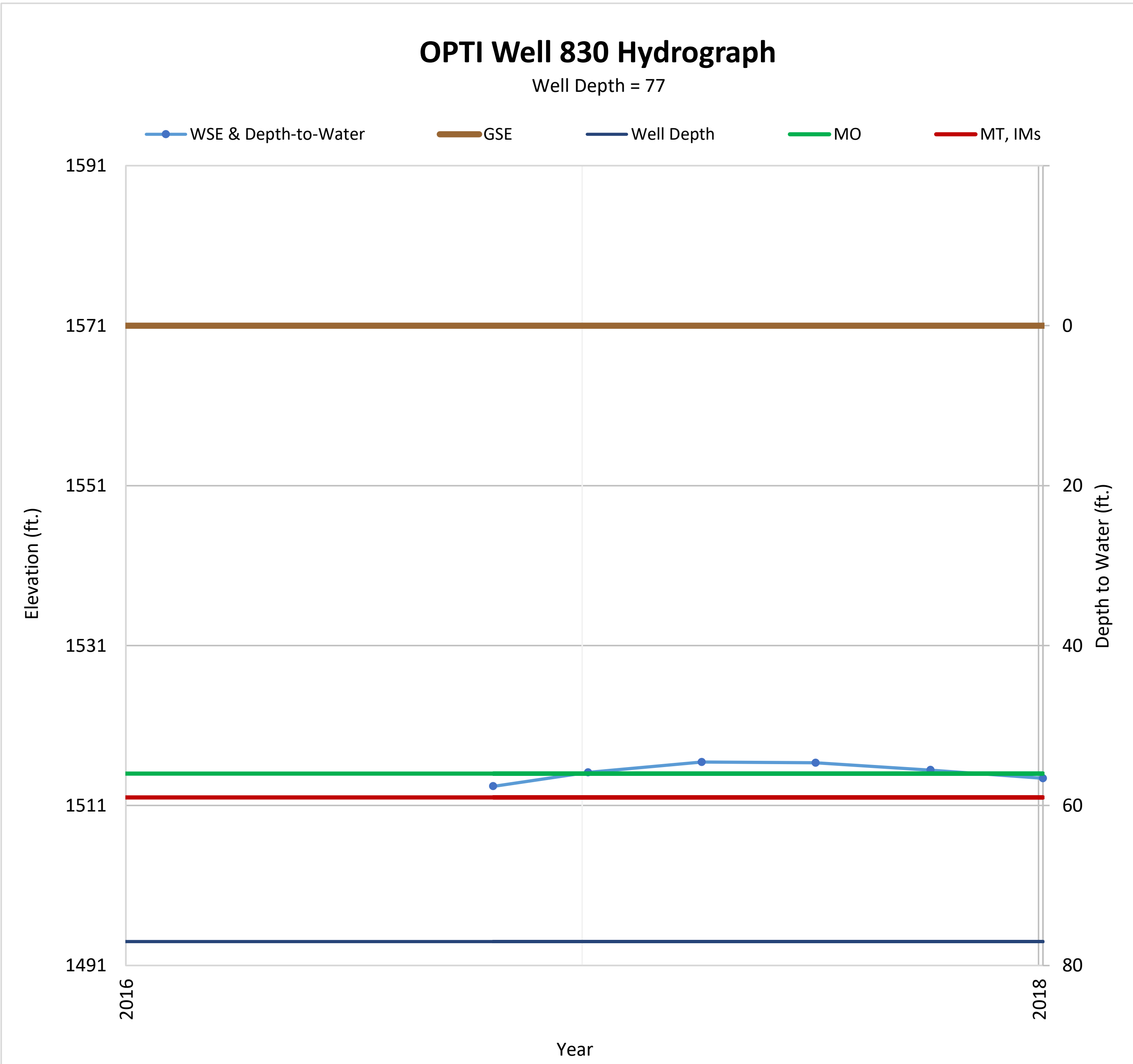
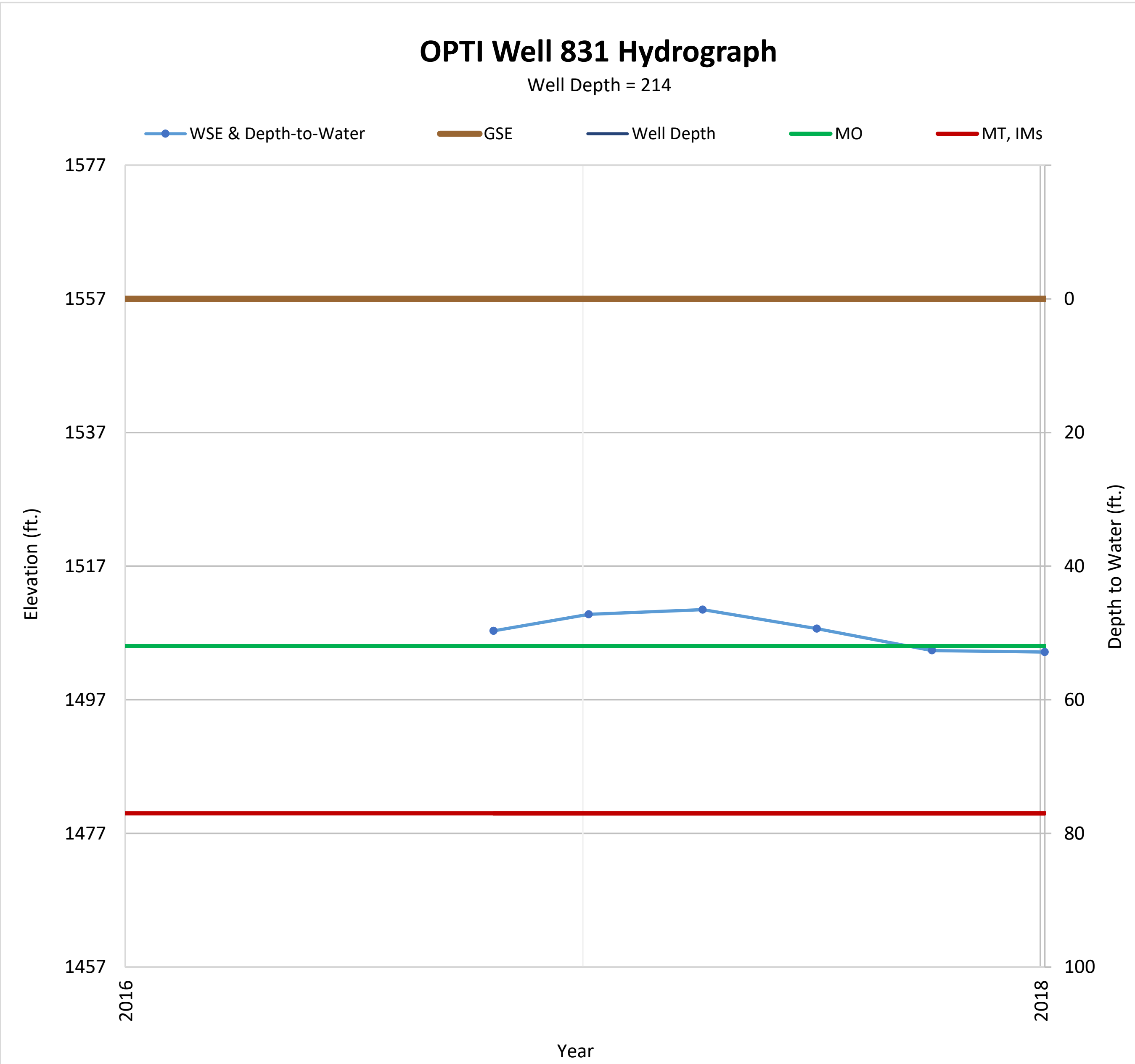
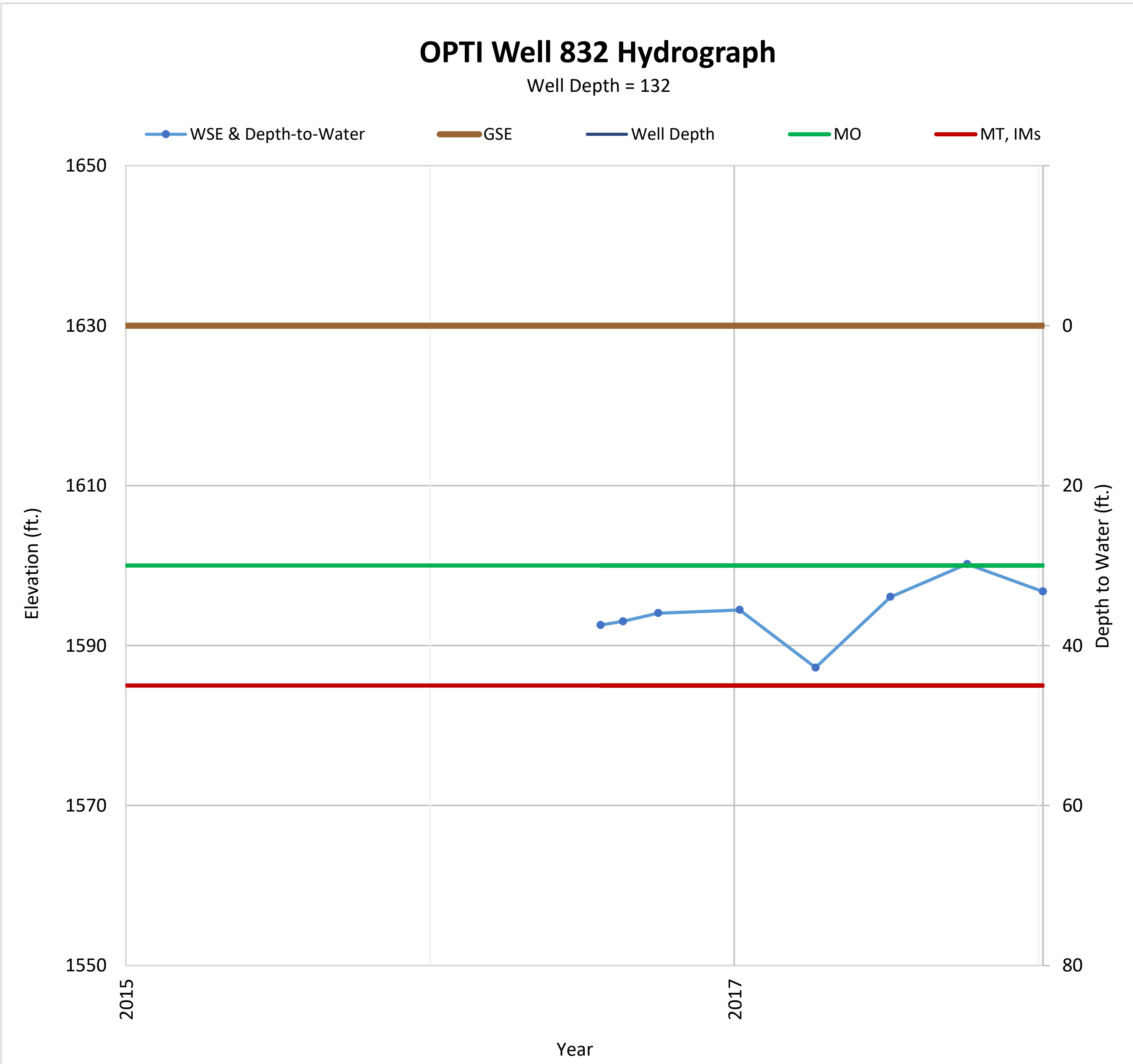
520
540
560
580
2006
2008
2010
2012
2014
2016



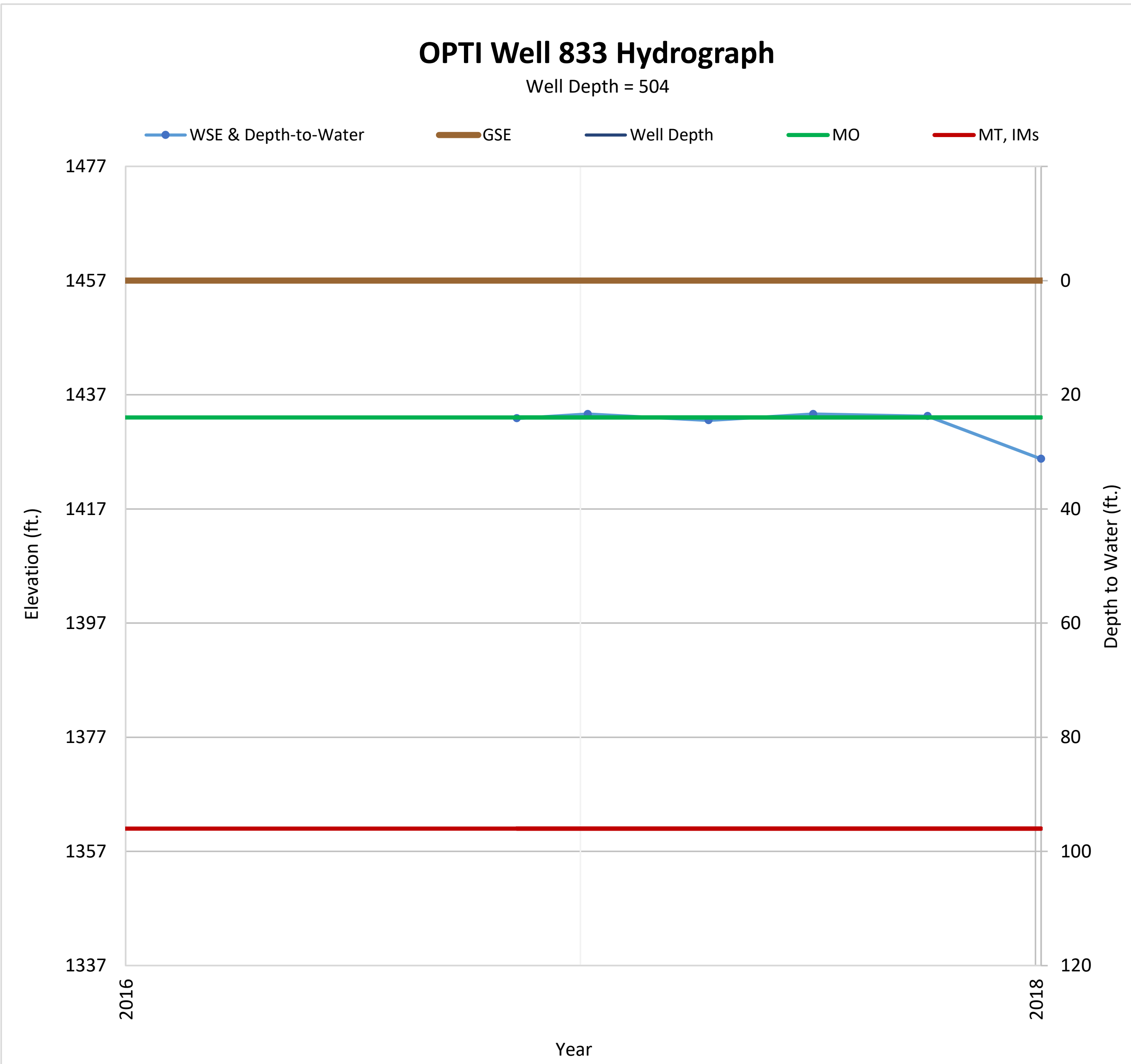
OPTI Well 633 Hydrograph
Well Depth = 1000
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
Year
2384
2364
2344
2324
2304
2284
2264
2244
2224
2204
2184
2164
2144
2124
2104
2084
2064
2044
2024
2004
1984
1964
1944
1924
1904
1884
1864
1844
1824
1804
1784
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017

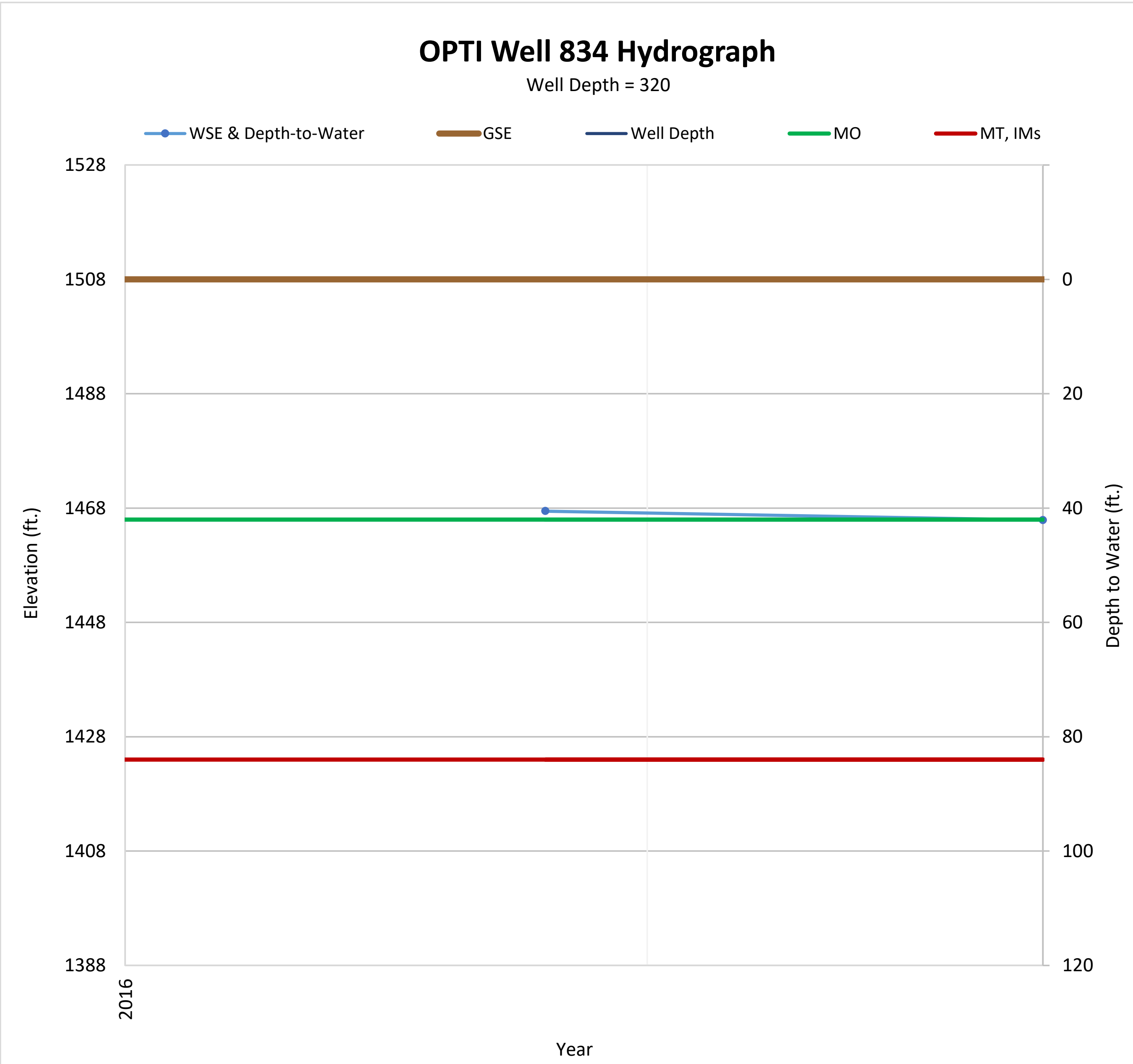

OPTI Well 830 Hydrograph
Well Depth = 77
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
1591
1571
1551
1531
1511
1491
Depth to Water (ft.)
0
20
40
60
80
2016
2018
Year

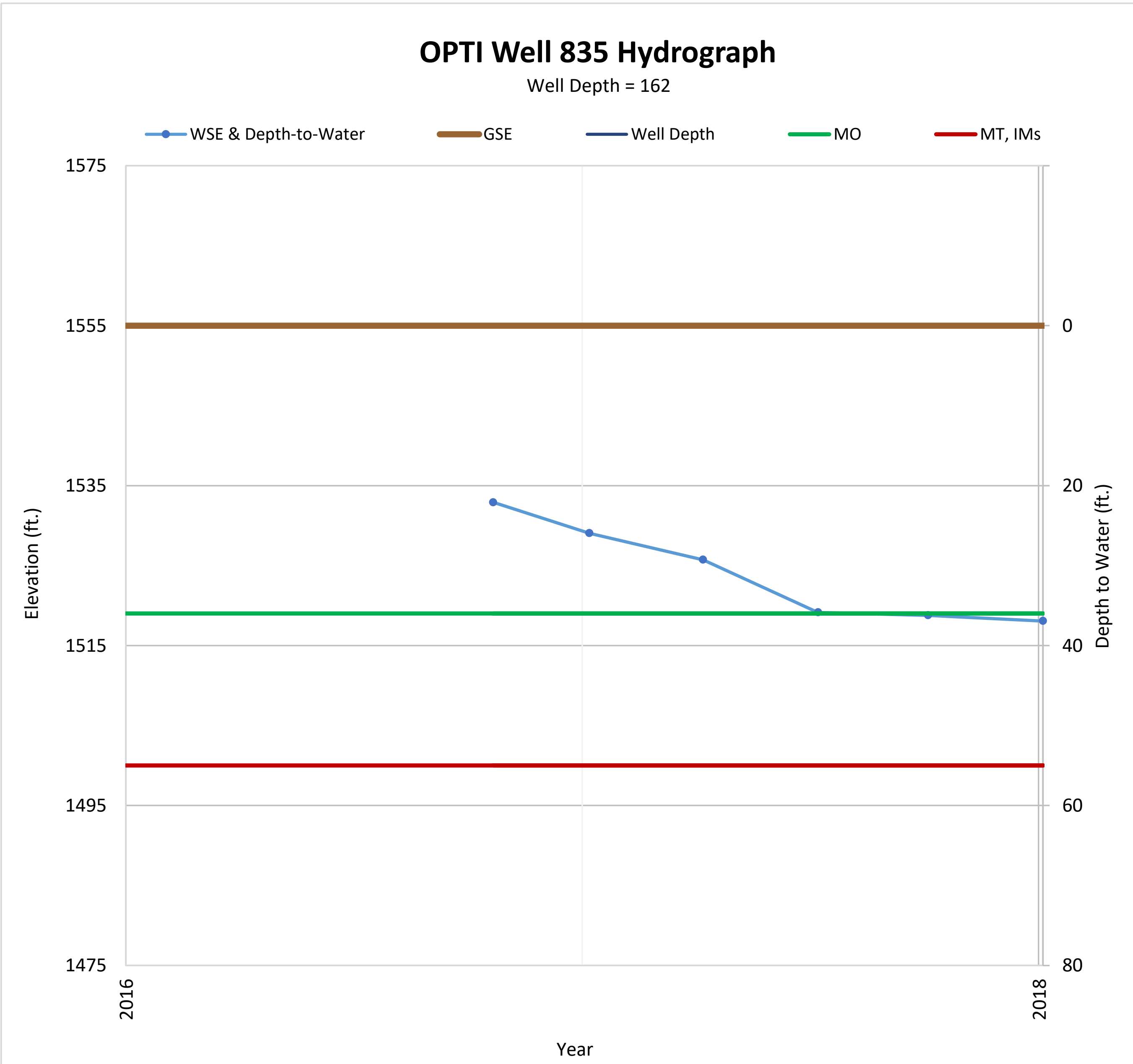

OPTI Well 831 Hydrograph
Well Depth = 214
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1577
1557
1537
1517
1497
1477
1457
0
20
40
60
80
100
Elevation (ft.)
Depth to Water (ft.)
2016
2018
Year



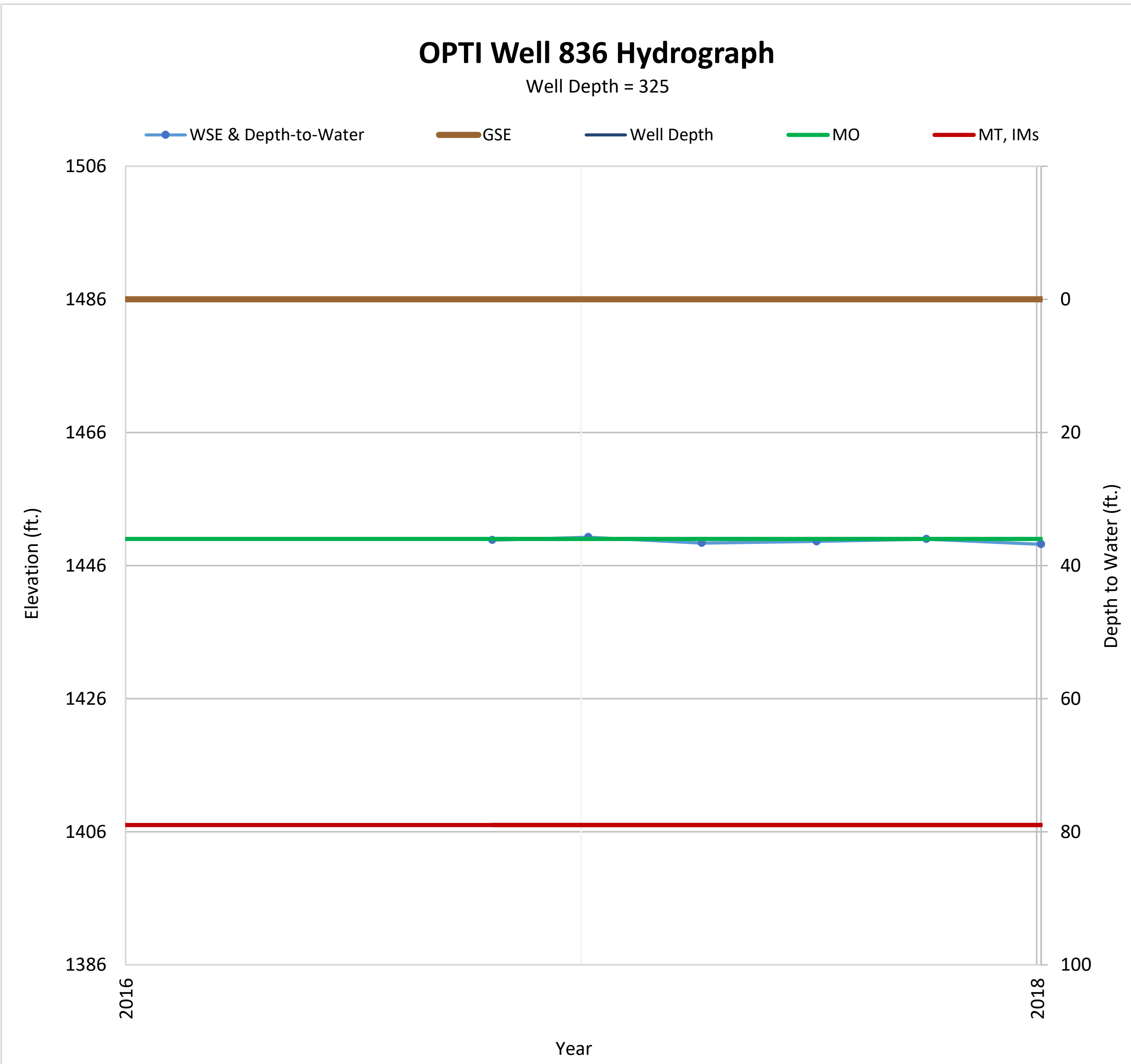
OPTI Well 832 Hydrograph
Well Depth = 132
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1650
1630
1610
1590
1570
1550
0
20
40
60
80
Elevation (ft.)
Depth to Water (ft.)
2015
2017
Year


OPTI Well 833 Hydrograph
Well Depth = 504
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1477
1457
1437
1417
1397
1377
1357
1337
0
20
40
60
80
100
120
Elevation (ft.)
Depth to Water (ft.)
2016
2018
Year

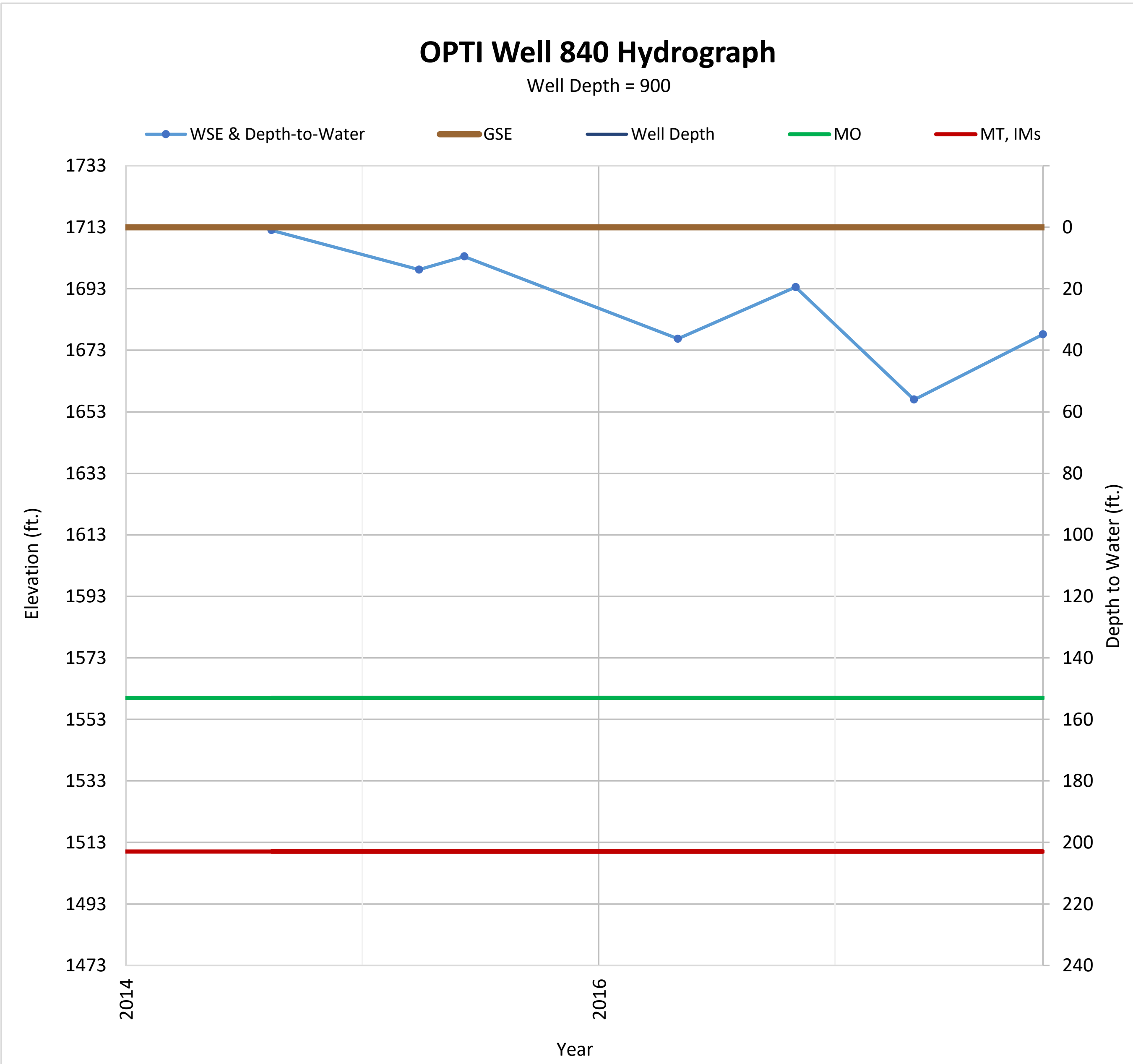

OPTI Well 834 Hydrograph
Well Depth = 320
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1528
1508
1488
1468
1448
1428
1408
1388
0
20
40
60
80
100
120
Elevation (ft.)
Depth to Water (ft.)
2016
Year

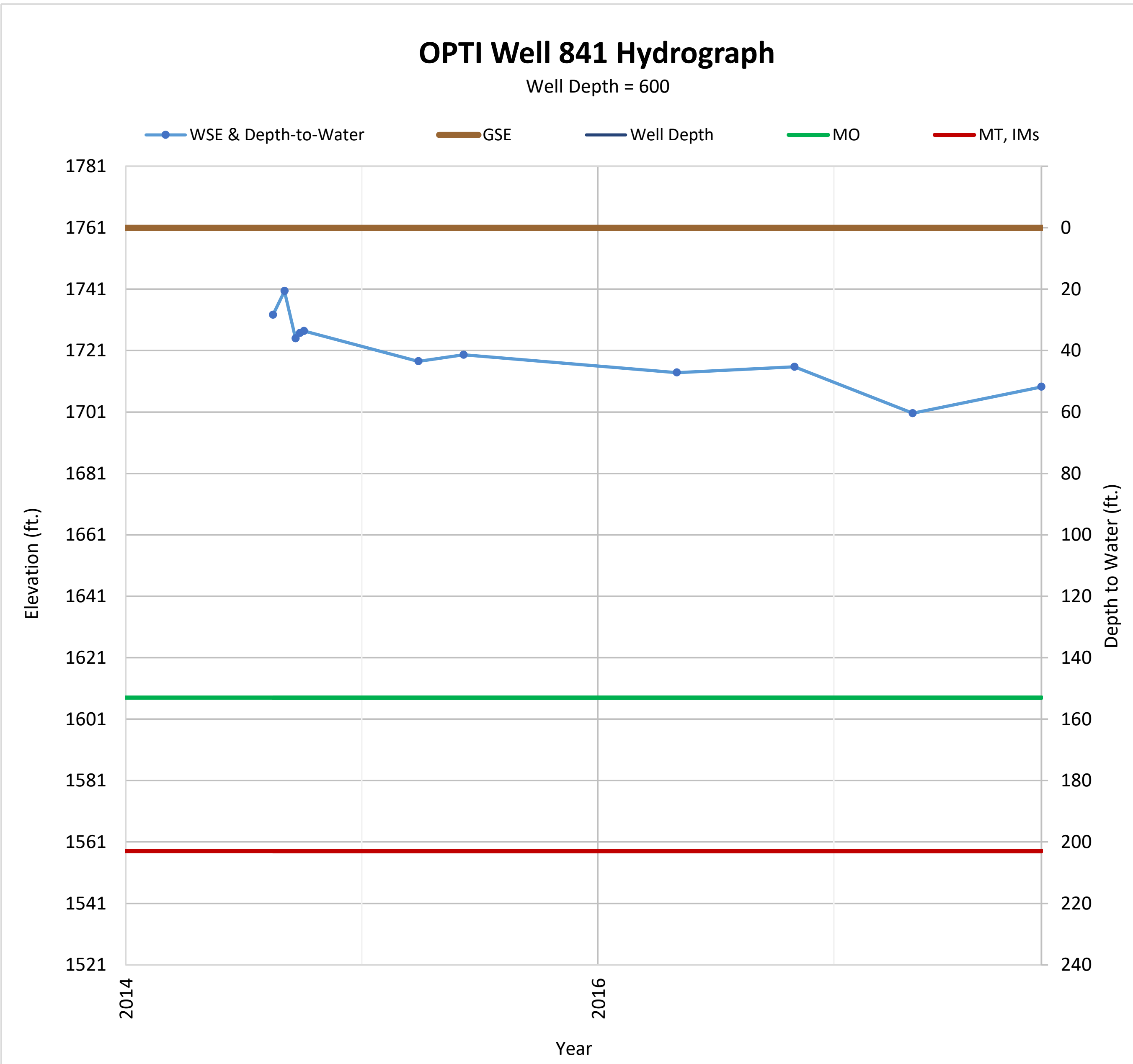


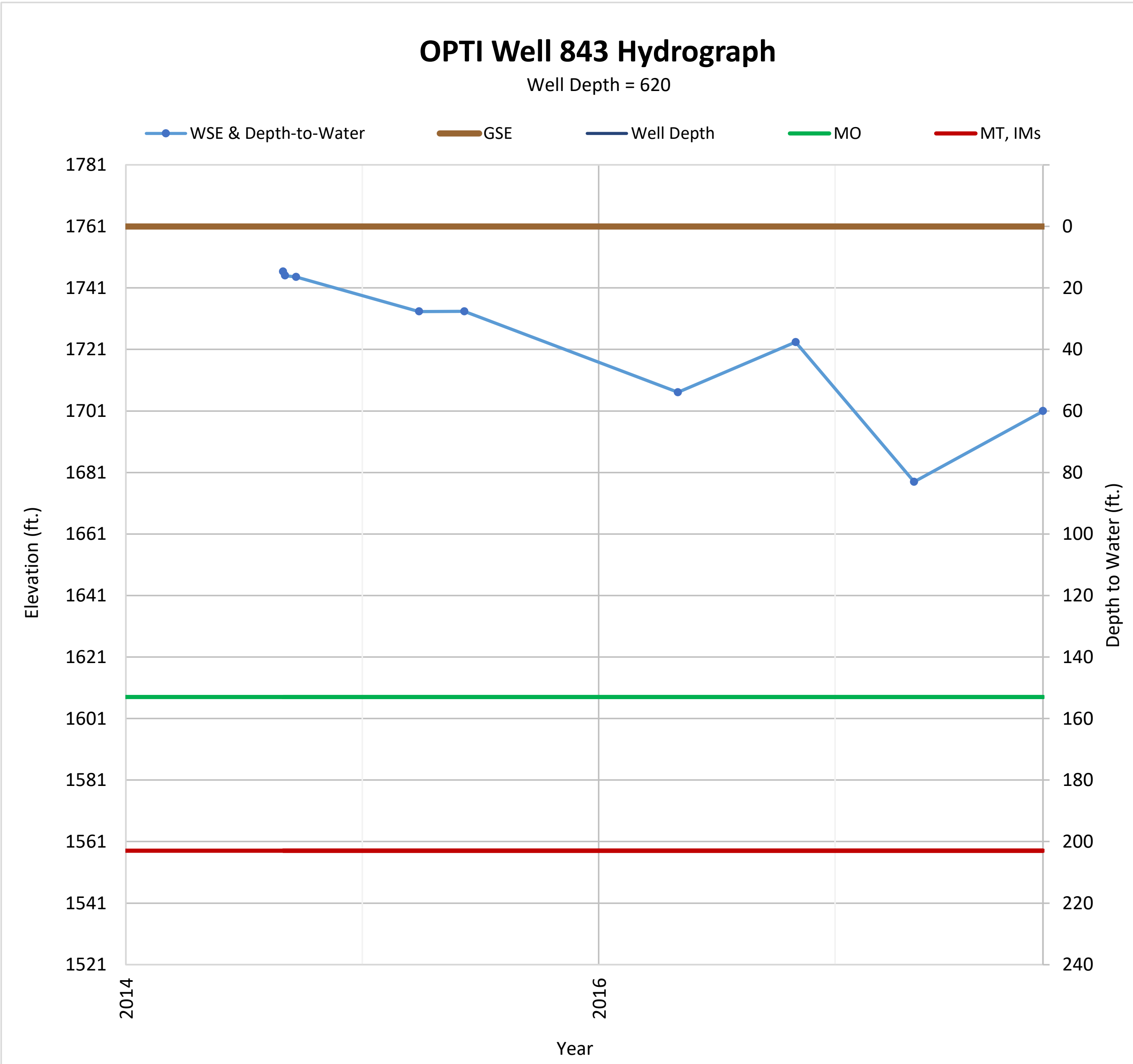
OPTI Well 835 Hydrograph
Well Depth = 162
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1575
1555
1535
1515
1495
1475
Elevation (ft.)
0
20
40
60
80
Depth to Water (ft.)
2016
2018
Year



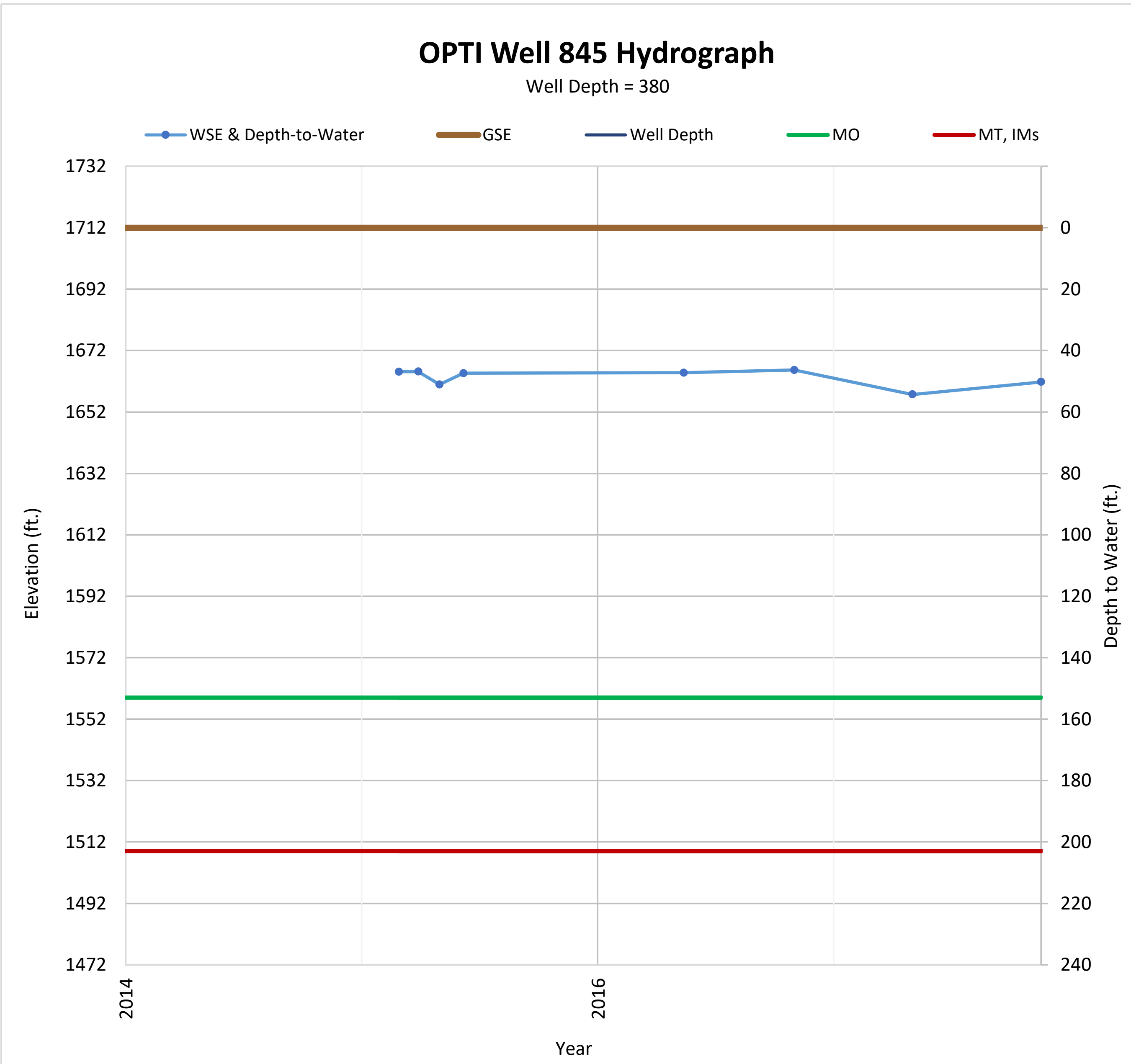
OPTI Well 836 Hydrograph
Well Depth = 325
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1506
1486
1466
1446
1426
1406
1386
0
20
40
60
80
100
Elevation (ft.)
Depth to Water (ft.)
2016
2018
Year

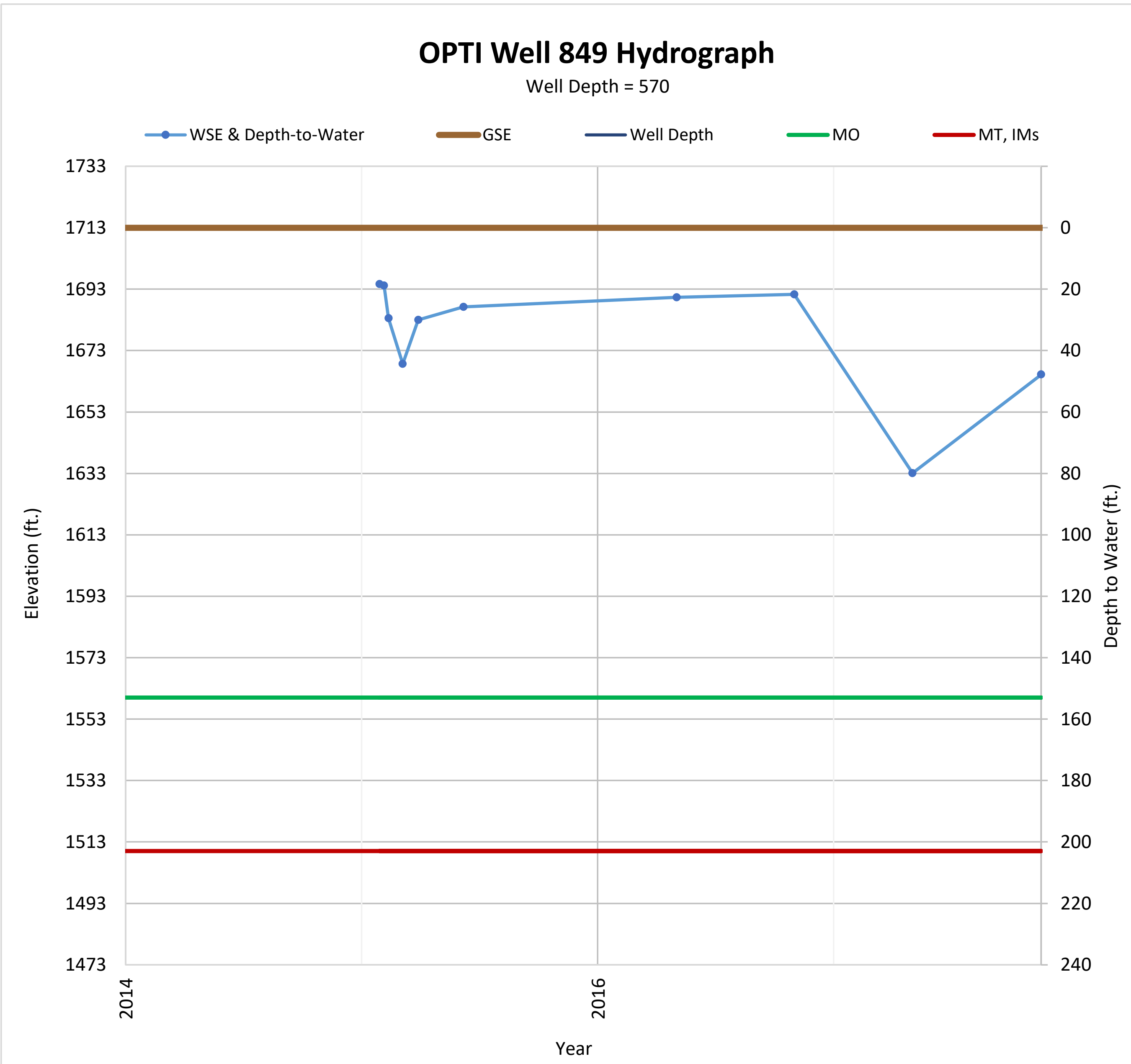

OPTI Well 840 Hydrograph
Well Depth = 900
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1733
1713
1693
1673
1653
1633
1613
1593
1573
1553
1533
1513
1493
1473
Elevation (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
Depth to Water (ft.)
2014
2016
Year


OPTI Well 841 Hydrograph
Well Depth = 600
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
1781
1761
1741
1721
1701
1681
1661
1641
1621
1601
1581
1561
1541
1521
0
20
40
60
80
100
120
140
160
180
200
220
240
2014
2016
Year



OPTI Well 843 Hydrograph
Well Depth = 620
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
Depth to Water (ft.)
1781
1761
1741
1721
1701
1681
1661
1641
1621
1601
1581
1561
1541
1521
0
20
40
60
80
100
120
140
160
180
200
220
240
2014
2016
Year


OPTI Well 845 Hydrograph
Well Depth = 380
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
Elevation (ft.)
1732
1712
1692
1672
1652
1632
1612
1592
1572
1552
1532
1512
1492
1472
Depth to Water (ft.)
0
20
40
60
80
100
120
140
160
180
200
220
240
2014
2016
Year


OPTI Well 849 Hydrograph
Well Depth = 570
WSE & Depth-to-Water
GSE
Well Depth
MO
MT, IMs
1733
1713
1693
1673
1653
1633
1613
1593
1573
1553
1533
1513
1493
1473
0
20
40
60
80
100
120
140
160
180
200
220
240
Elevation (ft.)
Depth to Water (ft.)
2014
2016
Year

Chapter 6 Appendix

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Chapter 6
Appendix A

Cuyama Basin Data Management System
Opti Data Public User Guide

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Cuyama Basin Data Management System

optiDATA

Public User Guide

CUYAMA BASIN GROUNDWATER SUSTAINABILITY AGENCY

WOODARD & CURRAN

Opti Public User Guide

Opti is a one-stop-shop for transparent data management and analysis that enables integrated performance tracking to support sustainable water management. This Public User Guide has been developed to assist you with navigation and usage of the Cuyama Basin Data Management System (DMS). Please see the Appendix for specific data types and quality codes configured in this implementation.

The DMS may be accessed at: http://opti.woodardcurran.com/cuyama

Please click on Guest Login to access the DMS as a guest user. If you would like to gain additional access to the DMS for data updates and management, please contact: Taylor Blakslee (tblakslee@hgcpm.com).

Public usage of the DMS is explained in the following modules:

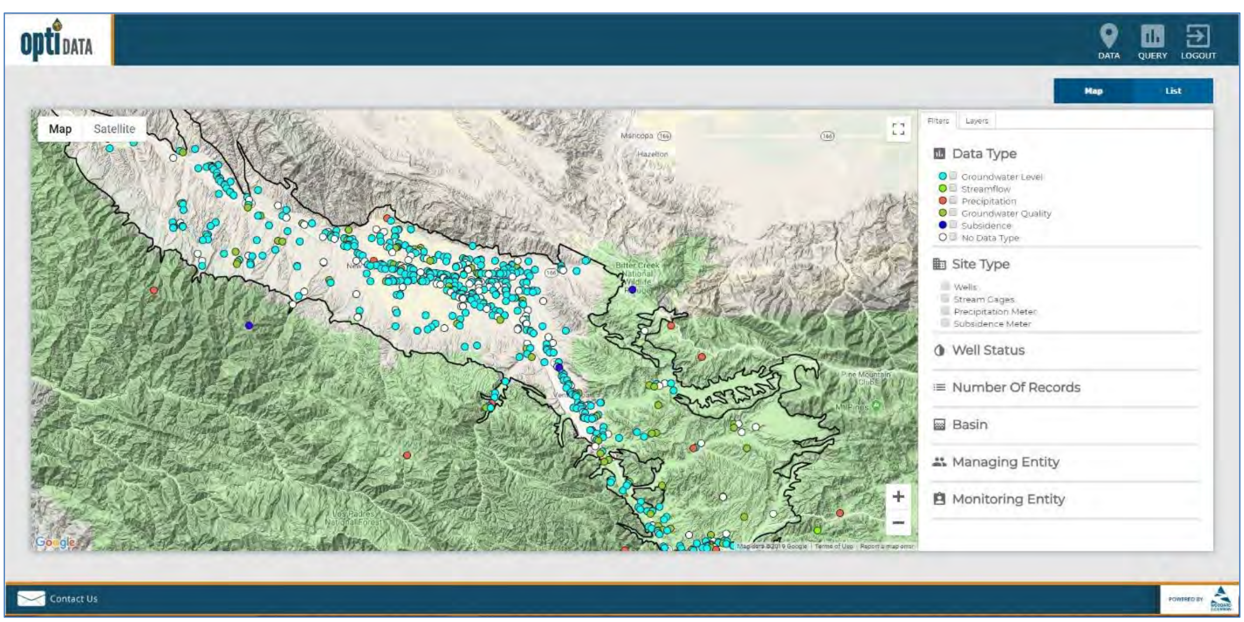
- Data
- Query

Module: Data (Top)

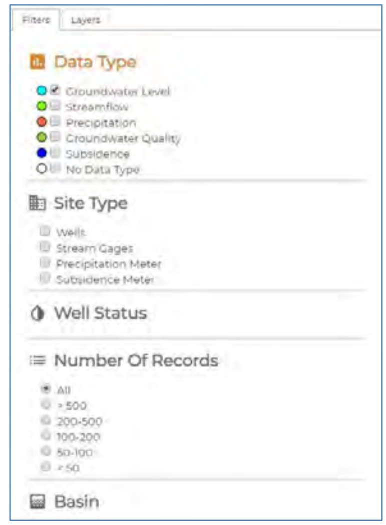
The Data module contains two available submodules that allow you to view water resources data and their associated site information: Map and List. Upon entering the DMS, a welcome message will be displayed. Click Close to continue to the Map.

Submodule: Map

The Map submodule displays the sites (wells, stream gages, facilities, etc.) as point locations on the map.



Feature: Change the Google Map display



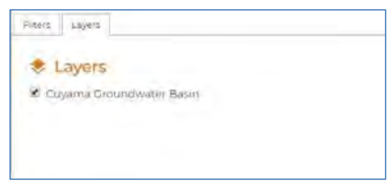
- To move the location or extent of the map display, use the "+" and "-" icons in the lower right-hand corner of the map. You may use the pan tool to move the focal location of the display.
- To change the base layer of the map display, select an option from the upper l eft-hand side of the map display (Map or Satellite).

Feature: Filter the results displayed on the map

- On the Filters tab on the right-hand panel, select the checkboxes for the options for which you would like to filter the results.
- Select sites based on:
    - data type associated with the site,
    - site type,
    - number of data records,
    - entity, or
    - a combination of any filter.

Please note that sites may have more than one data type associated with them, e.g., groundwater level and groundwater quality.

Feature: Change the layers displayed on the map



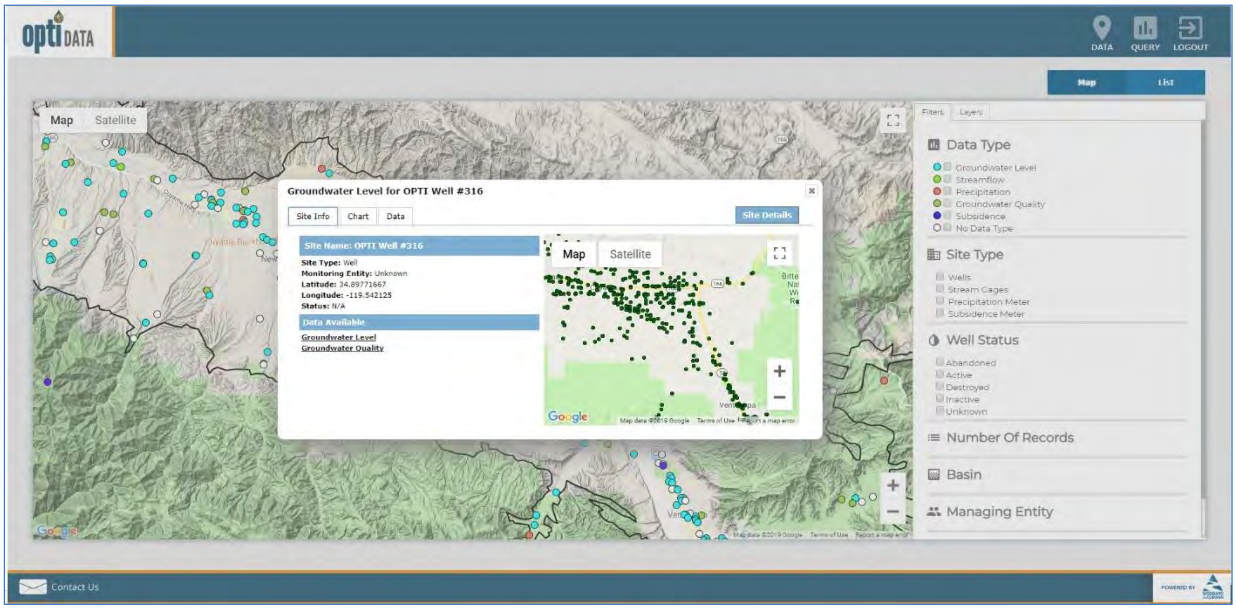
- Click on the Layers tab on the right-hand panel.
- Select the layers that you wish to have displayed. Upon selection, the map will be updated to show the selected layers.
- You may click on features on the layer to view information on that feature.

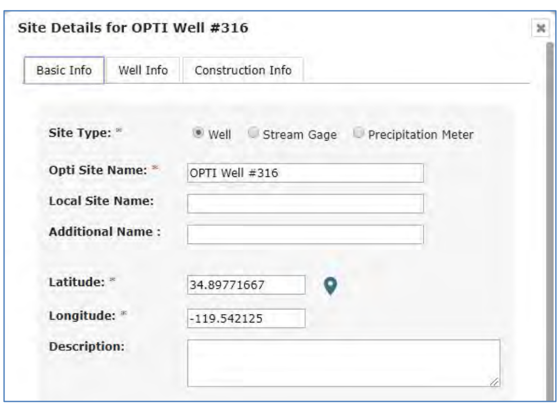
Feature: View site information on the map

- Click on a site on the map. The site information will be displayed with tabs for Site Info, Chart, and Data.
- To view site detailed information, click on the Details link. The Site Details page will open.
- To view a chart of the data, click on the Chart tab. You may change the parameter by selecting a parameter from the drop-down list in the upper right-hand corner. You may update the chart timeline by selecting the Start Date and End Date and clicking Update. You may export the data to Excel by clicking Export.
- To view a table of the data, click on the Data tab. You may change the parameter by selecting a parameter from the drop-down list in the upper right-hand corner. You may narrow the tabular

list by selecting the Start Date and End Date and clicking Update. You may export the data by clicking Export.

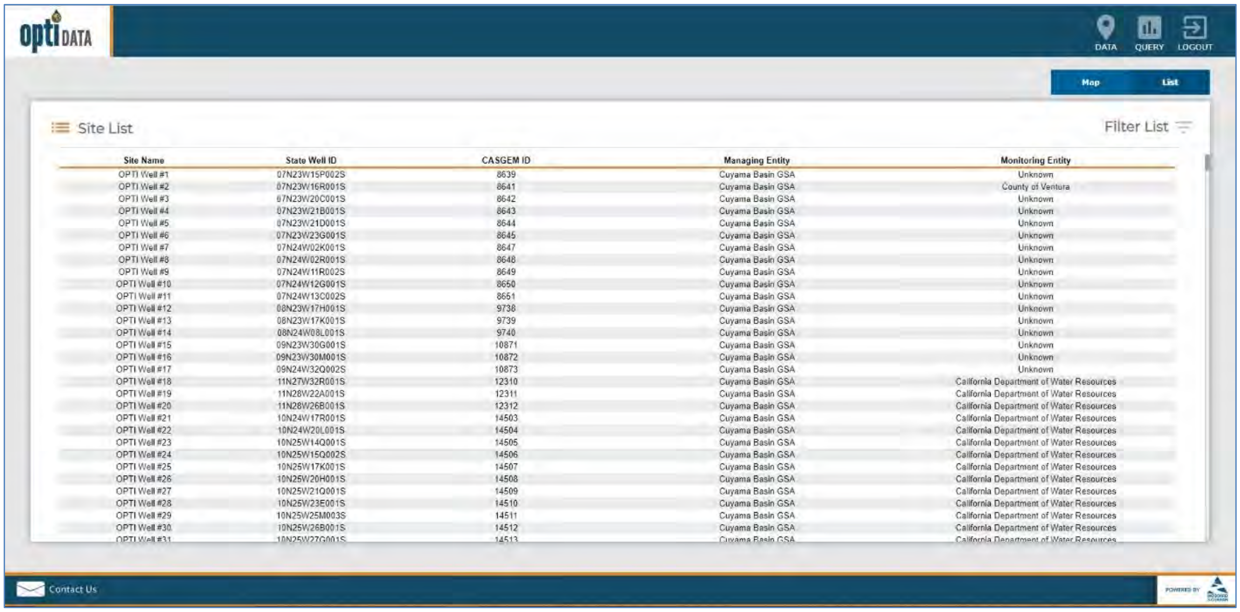
- To select a different data type for the site, click on the data type available under “Data Available” on the Site Info tab.





Submodule: List

The List submodule contains a list of sites in a sortable, tabular format.



Feature: Filter and/or sort sites

- Select data type, site type, number of records, or entity from the drop-down menu at the top of the table to filter sites.
- Click on the table headers to alphabetically or numerically sort the selected column.

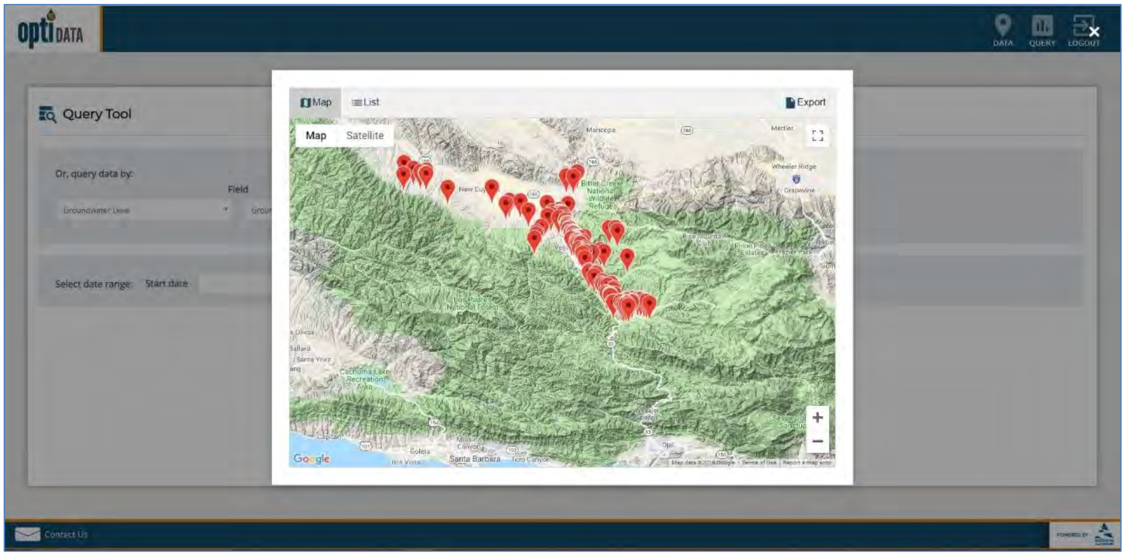
Feature: View site information from list

- Click on the selected site name in the list. The site information will be displayed with tabs for Site Info, Chart, and Data. The Site Details page is available through this dialogue box. The following information may be available:

Basic Info	Well Info	Construction Info
Site Type Opti Site Name Local Site Name Additional Name Latitude/Longitude Description County Managing Entity Monitoring Entity Type of Monitoring Type of Measurement Monitoring Frequency	State Well ID MSC (Master State Well Code) USGS Code CASGEM ID Ground Surface Elevation (ft) Reference Point Elevation (ft) Reference Point Location Reference Point Description Well Use Well Status Well Type Aquifers Monitored Groundwater Basin Name/Code Groundwater Elevation Begin/End Date Groundwater Elevation Measurement Count Water Level Measurement Method Groundwater Quality Begin/End Date Groundwater Quality Measurement Count Comments	Total Well Depth Borehole Depth Casing Perforations Top/Bottom Elevation Casing Diameter Casing Modifications Well Capacity Well Completion Report Number Comments

Module: Query (Top)

The Query module allows users to search for sites and data using different parameters and values.



Feature: Create new query

- Click on the Query icon in the menu.
- To create a new query:
  - Select the following options from the drop-down menu under "Or, query data by:":
    - Entity
    - Site Name
    - Groundwater Level
    - Streamflow
    - Precipitation
    - Groundwater Quality
    - Surface Water Quality
  - If the selected option has associated parameters, select a parameter in the second drop-down menu.
  - Select an Operator. Please note that for text searches, you may use the "Like" option with wildcards (%).
  - To add additional rows to the query, click on the blue "+" button and complete.
  - To remove rows from the query, click on the red "-" button.
- To select data within a particular date range, complete the Start date and End date fields.
- Click Run. A window will open with a map view of the results.
  - Click on the site in the map to view the data for the site.
  - Click on the List tab to view the data in a list format. You may click on a site to view the data.
  - Click on Export to export the data to Excel.
- To clear the query, click the Clear button at the bottom of the page.

Appendix – Cuyama Basin Specific Implementation Information

Data Types

The following data types are currently configured in the DMS. Please note that this list may change as more data becomes available.

Data Type	Parameter	Units	Currently Has Data in DMS
Groundwater Elevation	Depth to Groundwater	feet	Yes
	Groundwater Elevation	feet	Yes
Groundwater Quality	Total Dissolved Solids (TDS)	MG/L	Yes
	Nitrate (NO3)	MG/L	Yes
	Arsenic	UG/L	Yes
	Benzene	UG/L	
	Chloride	MG/L	
	Hexavalaent Chromium (CR6)	UG/L	
	Dibromochloropropane (DBCP)	UG/L	
	Methyl Tertiary Butyl Ether (MTBE)	UG/L	
	Perchlorate	UG/L	
	Tetrachloroethylene (PCE)	UG/L	
	Specific Electrical Conductivity (SC)	UMHOS/CM	
	1,1,1-Trichloroethane (111-TCA)	UG/L	
	Trichloroethylene (TCE)	UG/L	
	1,2,3-Trichloropropane (123-TCP)	UG/L	
	CL	PPM	
	EC	Mmhos	
	TDS	PPM	
Streamflow	Streamflow	CFS	Yes
Precipitation	Precipitation	inches	Yes
	Reference Evapotranspiration (ETo)		
	Average Air Temperature		
Subsidence	Subsidence	Vertical (mm)	Yes

Quality Flags for Measurement Data

The following quality flags are currently configured in the DMS. Please note that this list may change as more data becomes available.

ID	Quality Flag	Associated Data Type
1	Caved or deepened	Groundwater Level
2	Pumping	Groundwater Level
3	Nearby pump operating	Groundwater Level
4	Casing leaking or wet	Groundwater Level
5	Pumped recently	Groundwater Level
6	Air or pressure gauge measurement	Groundwater Level
7	Other	Groundwater Level
8	Recharge or surface water effects near well	Groundwater Level
9	Oil or foreign substance in casing	Groundwater Level
10	Acoustical sounder	Groundwater Level
11	Recently flowing	Groundwater Level
12	Flowing	Groundwater Level
13	Nearby flowing	Groundwater Level
14	Nearby recently flowing	Groundwater Level
15	Measurement Discontinued	Groundwater Level
16	Pumping	Groundwater Level
17	Pump house locked	Groundwater Level
18	Tape hung up	Groundwater Level
19	Can't get tape in casing	Groundwater Level
20	Unable to locate well	Groundwater Level
21	Well has been destroyed	Groundwater Level
22	Special/Other	Groundwater Level
23	Casing leaking or wet	Groundwater Level
24	Temporarily inaccessible	Groundwater Level
25	Dry well	Groundwater Level
26	Flowing artesian well	Groundwater Level